Participant Welcome Packet

Unifying Innovations in Forecasting Capabilities Workshop

A Unified Forecast System (UFS) Collaboration Powered by the Earth Prediction Innovation Center (EPIC) in partnership with Jackson State University (JSU)

Dates:
Monday, July 22, 2024 - Friday, July 26, 2024

Time:
Monday: 1:00 PM – 7:30 PM CDT
Tuesday 9:00 AM – 5:45 PM CDT
Wednesday: 9:00 AM – 6:00 PM CDT
Thursday 9:00 AM - 6:30 PM CDT
Friday: 9:00 AM – 12:30 PM CDT

Location:
Jackson State University in Jackson, MS and Online

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Goals

1. Share the current status of and future plans for the community-based Unified Forecast System.
2. Share successes and challenges related to contributing to the Unified Forecast System.
3. Identify ways academia, industry, and operations can work together to enhance the Unified Forecast System, accelerate their own contributions, and measure their success.

Objective

To build on the existing collaboration between the public, private, and academic sectors within the Weather Enterprise. By highlighting the importance of community building and the shared goal of advancing the UFS, the workshop serves as a key event for fostering enhanced communication and collaboration. It offers a unique venue where participants can explore how these sectors are able to unite effectively, thereby boosting forecasting capabilities, spurring innovation, and achieving success more efficiently.

Abstract

This year, we will focus on integrating sectors of the Weather Enterprise and fostering a community aligned with EPIC's mission, emphasizing government research and the crucial role of community building. UIFCW24 is about engaging and uniting our efforts to advance forecasting capabilities for a more informed future. The theme for this year's workshop is Collaborative Progress in Earth System Modeling.

In-Person, Virtual, and Hybrid Logistics

In-person

Address: Jackson State University Student Center, 1400 John R. Lynch St #3230, Jackson, MS 39217

Parking: Parking is free and available at One University Place parking lot.

Lunch: Lunch will be provided to ALL in-person attendees by Flavours by Sodexo at JSU during the scheduled 1-hour lunch break each full day of the workshop (Tuesday – Thursday). However, federal employees are **REQUIRED** to pay for lunch if you intend to participate in the lunches. Lunch will be served through the honor system.

Virtual
Most presentations will be livestreamed. The livestream will be available on EPIC's website at epic.noaa.gov.

Your online engagement platform will be through Slack. Click here for more information.

Hybrid
See the above info; come and go as you please.

About EPIC

The Earth Prediction Innovation Center, or "EPIC", will accelerate community-developed scientific and technological enhancements to operational applications used for numerical weather prediction (NWP). NOAA is working closely with entities in the Weather, Water, and Climate Enterprise (public, private, and academia, for example) to inform EPIC's planning, development, and strategy.

About UFS

The Unified Forecast System (UFS) is a community-based, coupled, comprehensive Earth modeling system. UFS numerical applications span local to global domains and predictive time scales from sub-hourly analyses to seasonal predictions. It is designed to support the Weather, Water, and Climate Enterprise and to be the basis for NOAA's operational Earth system modeling applications.

The UFS community includes researchers, developers, and users from NOAA, educational institutions, federal agencies, and the private sector. The UFS supports research and development in the community and accelerates the transition of research successes to operations.

About UFS-R2O

The UFS-R2O Project is a major collaborative effort focused on transitioning UFS applications and new research innovations into the NWS National Centers for Environmental Prediction (NCEP) operational modeling suite. The project is supported and managed by both the NWS Office of Science and Technology Integration (OSTI) Modeling Program, and the OAR Weather Program Office (WPO) Joint Technology Transfer Initiative (JTTI), enabling partnerships and opportunities for joint development of next generation, UFS-based operational systems across organizations including the NCEP Environmental Modeling Center (EMC), Climate Prediction Center (CPC), OAR labs, the Developmental Testbed Center (DTC), and multiple academic partners.

The UFS-R2O Project began in July 2020, and the first three years of the project (Phase I; July 2020 - June 2023) resulted in many accomplishments, leading to significant advancements in developing the FV3-based systems including the Hurricane Analysis and Forecast System (HAFS) version 1, the regional Rapid Refresh Forecast System (RRFS) version 1, the Global Forecast System (GFS) version 17 and Global Ensemble Forecast System (GEFS) version 13. The Phase II of the project (July 2023 - June 2026) will continue to develop and improve global, regional, and hurricane prediction systems and their components for data assimilation, physics, atmospheric composition, infrastructure, and verification and post-processing.

About Jackson State University (JSU)

Jackson State University has a rich history of empowering diverse students to become leaders through educational excellence. Today, they continue that tradition through their collaborative and technologically advanced academic programs, while their urban location allows them to put learning into practice by serving their communities.

Their student-centered approach makes JSU feel like a home away from home, and they offer a holistic college experience with numerous clubs, organizations, athletic events, and other extracurricular activities for all Tigers to enjoy.

Connect With Us

Slack will be your go-to online hub to chat with speakers and connect with other attendees. We will also be sharing updates and information through the UIFCW24 Slack workspace and via X when you use **#UIFCW24.** Join the UIFCW24 Slack workspace to connect with us!

You can also follow @NOAAEPIC on X or @NOAAEPIC on Instagram for the latest news from EPIC.

Slack

*Please note that if you have a Slack account, adding a new workspace will prompt you to "Create Account." Although it sounds counterintuitive, click "create an account," select the email address associated with your Slack account, and then refresh your desktop application so that the new "UIFCW 2024" workspace shows up in the left sidebar.

Please email support.epic@noaa.gov with any questions or concerns.

WiFi Information: A wireless connection is available through the WiFi name, **NOAA_GUEST** and the password is **NoAa@J$Uz4**

Daily Agenda

*SUBJECT TO CHANGES, please refer to EPIC's website at epic.noaa.gov for important updates

Monday, July 22nd

All times Central Daylight Time

12:00 pm **Registration**
In-Person Attendees: Registration will begin on the 3rd Floor in the JSU Student Center
Virtual Attendees: If you have any general questions about UIFCW, you can ask them in the Slack channel.

1:00 pm **Welcome and Kickoff**
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

Gillian Petro, EPIC/STC (biography)

1:15 pm **Opening Remarks by Dr. Denise Jones Gregory, Provost and Vice-President of Academic Affairs, Jackson State University (JSU)**
Dr. Denise Jones Gregory, Provost and Vice-President of Academic Affairs, JSU (biography)

1:30 pm **Collaborative Progress in Community Modeling and the Importance and Need for Diversity & Inclusion**
Chairs: Dr. Maoyi Huang, NOAA/OAR/WPO/EPIC (biography) and Dr. DaNa Carlis, Director, NOAA/OAR/ESRL/NSSL & AMS (biography)

Moderated by Dr. Maoyi Huang

Panelists:
Dr. Almesha Campbell, JSU (biography)
Dr. Sen Chiao, Howard University (biography)
William L. Parker Jr., NOAA/NWS (biography)
Dr. Wilbur L. Walters Jr. (biography)

Dr. Neil Jacobs, UCAR (biography)

2:30 pm **UFS Governance**
Dr. Stephan Smith, OSTI (biography)
Dr. Neil Jacobs, UCAR (biography)

3:15 pm **Break**

3:45 pm **NOAA Modeling Team Accomplishments and Future Direction**
Dr. Curtis Alexander, NOAA/OAR/GSL (biography)
Kathryn Shontz (biography)

4:30 pm **State of EPIC and the UFS**
Kevin Garrett, NOAA, UFS-R2O (biography),
Dr. Vijay Tallapragada - Senior Scientist, NOAA/NWS/EMC (biography)
Dr. Maoyi Huang, NOAA/OAR/WPO/EPIC (biography)
Dr. Neil Jacobs, UCAR (biography)

5:30 pm **Adjourn**

5:45 pm **Networking Mixer at JSU Student Center 2nd Floor**
Dr. Almesha Campbell, JSU (biography)

Tuesday, July 23rd

All times Central Daylight Time

8:00 am **Registration**
In-Person Attendees: Registration will begin on the 3rd Floor in the JSU Student Center
Virtual Attendees: If you have any general questions about UIFCW, you can ask them in the Slack channel.

9:00 am **Welcome and Kickoff**
In-person attendees: A&B Ballroom

Virtual attendees: Livestream Link

Dr. Tracy Fanara, NOAA/NOS/IOOS (biography)

9:05 am **Opening Remarks by Dr. Michael Morgan, Assistant Secretary of Commerce for Environmental Observation and Prediction**
Dr. Michael Morgan, NOAA (biography)

9:15 am **Future of Modeling & Data Assimilation Consortium**
Dr. John Ten Hoeve, WPO/NOAA (biography)
Dr. Ivanka Stajner - Acting Director, NOAA/NWS/EMC (biography)
Dr. Maoyi Huang, NOAA/OAR/WPO/EPIC (biography)
Dr. Stephan Smith, OSTI (biography)
Dr. Xuguang Wang, OU (biography)
Dr. Damian Wilson, UKMO (biography)

10:25 am **EPIC's UFS Community Support and Data Management**
Gillian Petro, EPIC/STC (biography)
Jong Kim, EPIC/STC (biography)

10:55 am **Break**

11:15 am **Student Session**

11:15 am - Shreyas Dhavale -The Origin, Structure, and Tracks of the Monsoon Onset Vortex - Integrating Theory and Predictability Studies using the UFS for early season impacts on the Monsoon (biography) (abstract)

11:25 am - Nowrin Mow - Change in Lake Michigan's circulation dynamics with varying bathymetry (biography) (abstract)

11:35 am - Jorge Bravo - Assessing WRF High-Resolution Simulation of Precipitation during Superstorm Ida across the New York Metropolitan Region (biography) (abstract)

11:45 am - Anna Glodzik - Surface Energy Balance Across the 18-site New York State Mesonet Flux Network (biography) (abstract)

11:55 am - Daoyang Bao - Quantifying Compound and Nonlinear Effects of Hurricane-induced Flooding Using a Novel Coupled Hydrological-Ocean Model (biography) (abstract)

12:15 pm **Lunch Break**

1:15 pm **Effective Use of Artificial Intelligence/Machine Learning (AI/ML) in Numerical Weather Prediction (NWP)**
Dale Durran, University of Washington / NVIDIA (biography)
Dr. Sergey Frolov, NOAA/OAR/ESRL/PSL (biography)
Dr. Daryl Kleist, NOAA/NWS/NCEP/EMC (biography)

2:30 pm **Keynote: Breakthroughs in Model Performance**
Sarah Lu, University at Albany - SUNY & JCSDA (biography)

3:00 pm **Break**

3:30 pm **A Social Science Approach to Unified Community Modeling**
Alison Gregory, UFS (biography)
Kimberly Klockow McClain, NWS/NCEP (biography)

4:00 pm **Status Update on MPAS from Across Organizations & Moderated Discussion**
Chairs: Kate Fossell, Mesoscale and Microscale Meteorology Lab at NSF NCAR (biography) and Dr. Curtis Alexander, NOAA/OAR/GSL (biography)

Dr. Ligia Bernardet, NOAA/ESRL/GSL/DTC (biography)
Bill Skamarock, NSF NCAR/MMM (biography)
Dr. Louis Wicker, NOAA/NSSL (biography)

5:30 pm **Adjourn**

Wednesday, July 24th

All times Central Daylight Time

8:00 am **Registration**
In-Person Attendees: Registration will begin on the 3rd Floor in the JSU Student Center
Virtual Attendees: If you have any general questions about UIFCW, you can ask them in the Slack channel.

9:00 am **Welcome and Kickoff**
Samantha Lang, EPIC/William M. Lapenta Intern (biography)

9:05 am **Parallel Sessions with Q&A**
SESSION ON THE MEDIUM-RANGE WEATHER (MRW) APPLICATION AND SUBSEASONAL-TO-SEASONAL (S2S) APPLICATION
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

9:05 am - *Catherine Thomas - Overview of the Next Global Forecast System GFSv17 (biography) (abstract)*

9:19 am - Jessica Meixner - Updates on Wave Coupling for the next Global Forecast System GFSv17 (biography) (abstract)

9:33 am - Bing Fu - Status of the next version GEFS (v13) (biography) (abstract)

9:47 am - Sulagna Ray - Improvements in week 3&4 ocean forecasts in recent GEFS prototypes targeting GEFSv13 (biography) (abstract)

10:01 am - Linjiong Zhou - Toward Global 6.5-km Weather Prediction and Storm-Resolving Simulation (biography) (abstract)

10:15 am - Shan Sun - An NSST Alternative in UFS: SkinSST (biography) (abstract)

10:29 am - Weiwei Li - Hierarchical Testing to Inform SFS Development: An Investigation from DYNAMO Field Campaign (biography) (abstract)

10:43 am - Benjamin Cash - Diabatic Heating and Vertical Motion in Coupled UFS, or An Unexpected Path to R2O (biography) (abstract)

Parallel Sessions Regarding

SESSION ON CROSS-CUTTING - SYSTEM ARCHITECTURE

In-person attendees: Theatre Room

Virtual attendees: Livestream Link

9:05 am - *Z. George Xue - The Gulf of Mexico Coastal Hazards Forecast System (biography) (abstract)*

9:15 am - Benjamin Cash - Community Modeling on Community Platform (biography) (abstract)

9:25 am - Kristopher Booker - EPIC Systems Architecture Enabling Rapid Innovation (biography) (abstract)

9:35 am - Jacob Carley - The Operational Implementation Process - Bringing UFS Innovations to Society (biography) (abstract)

9:45 am - Alex Burrows - Porting of the Global-Workflow to Gaea-C5 (biography) (abstract)

9:55 am - Christina Holt - The Unified Workflow Tools and a Proposed UFS Applications Framework (biography) (abstract)

10:05 am - Brian Weir - Driving the User Experience with UW Tools (biography) (abstract)

10:15 am - Eric J. Lingerfelt - The Research Repository for Data and Diagnostics (R2D2): A Distributed Data Management System for JEDI Data Assimilation Workflows (biography) (abstract)

10:25 am - Wei Huang - Running Global-workflow on AWS (biography) (abstract)

10: 35 am - Chris Harrop - Building Federated MPAS Workflows For Research And Development With Chiltepin and UWTools (biography) (abstract)

Parallel Sessions Regarding

SESSION ON UFS APPLICATIONS - AIR QUALITY
In-person attendees: Senate Chamber
Virtual attendees: Livestream Link

9:05 am - Kai Wang - Updates to the UFS-AQM online prediction system for the National Air Quality Forecasting Capability (biography) (abstract)

9:19 am - Wei Li - Updates and evaluation of NOAA's online-coupled air quality model within the Unified Forecast System (biography) (abstract)

9:33 am - Christopher Rozoff - A dynamical ensemble approach to characterizing uncertainties in the prediction of air quality downstream of the massive western US wildfires of 2020 (biography) (abstract)

9:47 am - Emily Faber - Investigation Of the Impact of Alluvial Flows in the UFS Dust Scheme (biography) (abstract)

10:01 am - Wei-Ting Hung - Development and evaluation of a machine learning based wildfire spread prediction model for regional air quality forecasting (biography) (abstract)

10:15 am - Jeff McQueen - Evaluation of NOAA's global UFS coupled aerosol predictions (biography) (abstract)

10:29 am - Jian He - Incorporating GFDL-AM4.1 chemistry into NOAA's Unified Forecasting System for global air quality application (biography) (abstract)

10:43 am - Lin Gan - A Technical Overview of the Transition of the UFS-based AQMv7 into Operations - AQMv7 Implementation Experience (biography) (abstract)

11:00 am **Break**

11:15 am **Virtual Poster Slam (Virtual Participants Only)**
Virtual attendees: Livestream Link
The virtual poster slam provides a unique opportunity for the virtual audience to participate and engage in the virtual poster slam to hear authors present their posters. If you are attending virtually, you will make your way to the

#virtual-posters slack channel and find all of the posters there, as well as the live stream link above.

VIRTUAL POSTER PRESENTERS

11:18 am - Nate Crossette - Background Error Covariances in the JEDI System (biography) (abstract)

11:21 am - Linlin Cui - An Evaluation Case Study on the Pre-trained Machine Learning Model FourCastNet-v2 (biography) (abstract)

11:24 am - Fabio Diniz - Impact of Observing Systems on Earth System Prediction (biography) (abstract)

11:27 am - Hamideh Ebrahimi - Advancements in Assimilation of Ocean Color Radiance Data (biography) (abstract)

11:30 am - Keenan Eure - Simultaneous Assimilation of Dual-Polarization Radar and All-Sky Satellite Observations to Improve Convection Forecasts (biography) (abstract)

11:33 am - Ashley Griffin - Building Infrastructure to Support the Next-generation Joint Effort for Data Assimilation Integration (JEDI) System for NOAA, NASA, U.S. Air Force, U.S. Navy, and UK Met Office (biography) (abstract)

11:36 am - Clémentine Hardy Gas - Enabling Different Ensemble Data Assimilation Scenarios In JEDI Using The SkyLab Workflow (biography) (abstract)

11:39 am - Bo Huang - The NOAA global Aerosol ReAnalysis (NARA) (biography) (abstract)

11:42 am - Chan-hoo Jeon - Code Refactoring Practices and Benefits for the UFS Land Data Assimilation Workflow System (biography) (abstract)

11:45 am -Benjamin T Johnson - New Opportunities for Satellite-based Sensor Simulation (biography) (abstract)

11:48 am - Erin Jones - Flow-Dependent Vertical Localization in Hybrid 4DEnVar for Improvement of UFS Medium-Range Weather Application Global and Tropical Cyclone Track Numerical Prediction (biography) (abstract)

11:51 am - Mariah Pope - Post-Processing High-Resolution Deterministic NWP Model with Machine Learning to Produce Cost-Effective, Operational Probabilistic Forecasts (biography) (abstract)

11:54 pm - Mark Potts - Prototype in-core Gain Form Ensemble Transform Kalman Filter (GETKF) Data Assimilation (DA) using JEDI and a coupled UFS model (biography) (abstract)

11:57 pm - Benjamin Ruston - Updates to environmental observation usage in JEDI Skylab (biography) (abstract)

12:00 pm - Christian Sampson - A Hybrid Tangent Linear Model in The Joint Effort for Data Integration (JEDI) system (biography) (abstract)

12:03 pm - Hui Shao - Advancements in Data Impact Studies using JEDI and UFS: Insights from the Radio Occultation Modeling Experiment (ROMEX) (biography) (abstract)

12:06 pm - Alen Shrestha - Artificial Intelligence based workflow for generating up-to-date land use information of the United States for flood risk Snydermodeling. (biography) (abstract)

12:09 pm - Edward Snyder - Expanding the testing framework for the Short-Range Weather Application (biography) (abstract)

12:12 pm - Gregory Thompson - All-Sky Geostationary Satellite Radiance Data Assimilation in JEDI (biography) (abstract)

12:15 pm - Zhifeng Yang - Impact of assimilating radar and lidar observations on improving the bore forecast during PECAN campaign (biography) (abstract)

12:18 pm - Yue Yang - Impacts of Model Physical Parameters at the Air-Sea Interface on the Background of HAFS-MOM6 EnVar Data Assimilation System for Hurricane Fiona (2022) (biography) (abstract)

12:21 pm - Gamal Zayed - Advancements in Local Oscillator Design for Enhanced Terrestrial and Space Weather Forecasting (biography) (abstract)

12:24 pm - Gamal Zayed - Collaborative Data Assimilation for Accurate RF Localization: A Community Modeling Approach (biography) (abstract)

12:27 pm - Mengliang Zhang - Enhancing Rainfall Predictions with Graph Neural Networks on the GEFS Dataset (biography) (abstract)

11:30 am **Poster Session (In person Participants)**

If you are present in person, you will walk along the catwalk and engage with our in-person presenters as you would at any other poster session.

Abstracts for both the in-person and virtual posters can be found next to the names of the authors below.

Blackman

IN-PERSON POSTER PRESENTERS

Keven Blackman - RRFS-SRW Convergence - Developing a clear path for the community to operations (biography) (abstract)

Anthony David Jr. - A Climate Justice Approach To Major Flooding Events (biography) (abstract)

Prabal Das - Enhancing Precipitation Type Classification Using Random Forests (biography) (abstract)

Benjamin Green - Sensitivity of Atmospheric Vertical Resolution to Biases in SFS Prototypes (biography) (abstract)

Wei Huang - A Neural Network to Assimilate CRTM Brightness Temperature (biography) (abstract)

Zakiya Johnson - Developing an Effective Set of Questions to Extract Partner Needs from NWS IDSS (biography) (abstract)

Aaron Jones - Empowering Forecasting Innovation Through EPIC Community Engagement and User Support (biography) (abstract)

Sina Khani - On the forecast of ocean surface fields within the coupled seasonal ensemble Unified Forecast System (UFS) prototype (biography) (abstract)

Jong Kim - Hierarchical Decomposition of the UFS Test Cases and DevOps Test Framework Infrastructures (biography) (abstract)

Joseph Knisely - Advancing Methodologies for Uninterrupted, Basin-Wide Data Assimilation in the Hurricane Analysis and Forecast System (HAFS) (biography) (abstract)

Nadim Mahmud - Characteristics and Seasonality of the Minimum Oxygen Zone of the Bay of Bengal and Arabian Sea (biography) (abstract)

Murali Nageswara Rao Malasala - Forecasting Integrated Water Vapor Transport and Precipitation on U.S. West Coast with Atmospheric River Analysis and Forecast System (biography) (abstract)

Gina Azarell Martinez Velez - Remote Community Modelling Forecasted Inundations (biography) (abstract)

Margarita Mora - Evaluating the HAFS Forecasts Environmental Flow of Hurricane Idalia (2023) (biography) (abstract)

Yanda Ou - A Novel Hypoxia Forecast System using Combined Numerical and ML/AI Models (biography) (abstract)

Natalie Perlin - Streamlining UFS Application Builds: Spack-Stack vs. HPC-Stack Package Managers (biography) (abstract)

Corey K. Potvin - Training GraphCast-based WoFS forecast emulators (biography) (abstract)

Zachary Shrader - Stochastic Physics Unit Test Overview of Use Cases and Review of Code Drivers (biography) (abstract)

Ivanka Stajner - Transitioning to Unified Forecast System Applications for Operations - Update from NOAA's Environmental Modeling Center (biography) (abstract)

Yu-Cian Tsai - Unified Forecast System Model Performance in Madden-Julian Oscillation Simulation and Eastern Pacific Teleconnection for Subseasonal to Seasonal Predictions (biography) (abstract)

Tao Sun - All-Sky satellite radiance data assimilation using Gain-form of Local Ensemble Transform Kalman Filter within MPAS-JEDI: implementation, tuning, and evaluation (biography) (abstract)

Beiming Tang - Downscaling UFS to high resolution using Machine learning data fusion (biography) (abstract)

Hendrik L. Tolman - The state of the UFS in 2024 (biography) (abstract)

Jun Wang - Machine Learning-based weather prediction model development at EMC (biography) (abstract)

Yixuan Wang - Using HAFS to Drive a Dynamically Coupled Hydrological-Ocean Model for Hurricane-Induced Compound Flooding Forecast (biography) (abstract)

Xuejin Zhang - Microphysics Parameterization Development Progress in Hurricane Analysis Forecast System (HAFS) (biography) (abstract)

Zhan Zhang - Hurricane Analysis and Forecast System (HAFSv2) Upgrades and Operational Implementation (biography) (abstract)

12:00 pm **Lunch Break**

1:00 pm **Parallel Sessions with Q&A**

SESSION ON HURRICANE ANALYSIS AND FORECAST SYSTEM (HAFS)
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

1:00 pm - Sundararaman Gopalakrishnan - Research and Developments of the Hurricane Analysis and Forecast System (biography) (abstract)

1:15 pm - Ping Zhu - Numerical Simulations of Tropical Cyclones using a Scale-Aware Three-Dimensional TKE Turbulent Mixing Scheme (biography) (abstract)

1:30 pm - Bin Liu - 2024 HAFS-A Configuration Based Real-Time Parallel Experiment with Upgrades in Model Initialization, Physics, Dynamics and Coupling (biography) (abstract)

1:45 pm - Kun Gao - Towards Turbulence-Permitting Simulations of the Entire Tropical Cyclone Vortex with FV3 (biography) (abstract)

2:00 pm - Jiayi Peng - HAFS Based Ensemble in Cloud (biography) (abstract)

2:15 pm - Yue Yang - Recent Development of GOES-16 ABI All-Sky Radiances Data Assimilation for HAFS: System Description and Impact on Hurricane Laura (2020) (biography) (abstract)

2:30 pm -Tsung-Han Li - Using novel observations at the air-sea interface to evaluate the coupled ocean-atmosphere background ensemble forecasts from a self-cycled HAFS data assimilation system for Hurricane Finoa (2022) (biography) (abstract)

2:45 pm - JungHoon Shin - Development of the Cloud and Vertical Velocity Initialization Process in the HAFS-Vortex Initialization (biography) (abstract)

3:00 pm - Sarah Ditchek - The Sensitivity of the Impact of G-IV Reconnaissance Data to HAFSv1 Version (biography) (abstract)

3:15 pm - George Alvey - Evaluation of Hurricane Analysis and Forecast System (HAFS) Error Statistics Stratified by Internal Structure and Environmental Metrics (biography) (abstract)

Parallel Sessions Regarding
SESSION ON UFS APPLICATIONS - COASTAL, MARINE AND SPACE WEATHER
In-person attendees: Theater Room
Virtual attendees: Livestream Link

1:00 pm - Saeed Moghimi - Status and plans for developing UFS Coastal model and coupled applications (biography) (abstract)

1:12 pm - Ufuk Turunçoğlu - Development and Code Infrastructure of the Coastal Modeling Framework Based on Unified Forecast System (UFS-Coastal Application) (biography) (abstract)

1:24 pm - Yunfang Sun - UFS-Coastal Applications for tropical storms using coupled SCHISM and WAVEWATCH III (biography) (abstract)

1:36 pm - Jana Haddad - User support, external testing, and project planning of the UFS Coastal coupling infrastructure in partnership with UFS Coastal Applications Team (biography) (abstract)

1:48 pm - Xiaochen Zhao - Investigating the Hurricane-induced Salt Variation across the Land-Estuary-Ocean Continuum Using A Dynamically Coupled Hydrological-Ocean Modeling (biography) (abstract)

2:00 pm - Joannes Westerink - Improving Tidal Forcing Functions in STOFS-2D-Global, NOAA's Fast Integrated Multi-Scale Multi-Process Operational Water Level Model (biography) (abstract)

2:12 pm - Joseph Zhang - Development of a new operational forecast system for the southeastern US (SECOFS) (biography) (abstract)

2:24 pm - Aijun Zhang - NOAA's Coastal Ocean Operational Forecast Systems, Products, and Future Plan (biography) (abstract)

2:36 pm - Q&A: Coastal, Marine

2:40 pm - Oladayo O. Afolabi - Evaluating the SAMI2 Model's Performance in the Brazilian Sector During the December 2015 Geomagnetic Storm (biography) (abstract)

2:51 pm - Hager M. Salah - Investigation and Prediction of Ionospheric Irregularities over Egypt (biography) (abstract)

3:02 pm - Hassan Nooreldeen - Enhancing Ionospheric Forecasting In Egypt: Utilizing GNSS Data and Deep Neural Networks (biography) (abstract)

3:12 pm - Q&A: Space Weather

Parallel Sessions Regarding
SESSION ON CROSS-CUTTING - PHYSICS, VERIFICATION, FOLLOWED BY CROSS-CUTTING - DYNAMICS AND NESTING
In-person attendees: Senate Chamber
Virtual attendees: Livestream Link
1:00 pm - Dustin Swales - The Common Community Physics Package and Single Column Model Version 7 (biography) (abstract)

1:14 pm - Weiwei Li - Advanced Testing and Evaluation by DTC for UFS Physics Development (biography) (abstract)

1:28 pm - Tara Jensen - Most Recent Strides in Enhancing the METplus Verification and Diagnostic Capability to Support UFS Development Activities (biography) (abstract)

1:42 pm - Tim Marchok - Use and distribution of the GFDL Vortex Tracker as part of the Unified Forecast System (biography) (abstract)

1:56 pm - Corey Potvin - Storm-Based Verification and Intercomparison of Warm-Season Forecasts from the HRRR, RRFS, C-SHiELD, and NSSL MPAS models (biography) (abstract)

2:10 pm - Cheng Dang - A generic model interface for the Community Radiative Transfer Model (CRTM) (biography) (abstract)

2:24 pm - Isaac Moradi - Advancements in the Assimilation of Spaceborne Microwave and Radar Observations (biography) (abstract)

2:38 pm - Q&A: Physics, Verification, and Validation

2:40 pm - Lucas Harris - Global Storm-Resolving Climate Simulations in GFDL X-SHIELD (biography) (abstract)

2:52 pm - Peter Caldwell - Global Storm-Resolving Simulations with the Simple Cloud-Resolving E3SM Atmosphere Model (biography) (abstract)

3:04 pm - William Ramstrom - Multiple Moving Nest Implementation for the Hurricane Analysis and Forecast System (HAFS) (biography) (abstract)

3:16 pm - Meiyun Lin - The GFDL Variable-Resolution Global Chemistry-Climate Model for Research at the Nexus of US Climate and Air Quality Extremes (biography) (abstract)

3:30 pm **Break**

3:45 pm **Physics Parameterizations Across Scales for UFS Applications**
In-person attendees: A&B Ballroom

Virtual attendees: Livestream Link

Jian-Wen Bao, NOAA/PSL (biography) (abstract)

4:15 pm	**Seasonal Forecasting in the UFS: Opportunities and Challenges** *Philip Pegion, NOAA/Physical Sciences Laboratory (biography)*
4:45 pm	**Current and Future Strategies for Verification and Post-Processing of Numerical Weather Prediction Models at NOAA Environmental Modeling Center** *Jason Levit, NOAA/EMC (biography)*
5:15 pm	**Future Plan for Weather and Climate Modeling (GFS, GEFS, S2S, SFS)** *Cristiana Stan, George Mason University (biography) (abstract)* *Dr. Yan Xue, NWS/OSTI/Modeling Program (biography)*
5:45 pm	**Adjourn**

Thursday, July 25th

All times Central Daylight Time

8:00 am **Registration**
In-Person Attendees: Registration will begin on the 3rd Floor in the JSU Student Center
Virtual Attendees: If you have any general questions about UIFCW, you can ask them in the Slack channel.

9:00 am **Welcome and Kickoff**
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

Dr. Jamese Sims, Thee Anomaly, LLC (biography)

9:05 am **Round Table Discussion on Community Modeling Including Focus Groups**
*****This will not be live-streamed or recorded** Please Note - The virtual link for the roundtable will be emailed out to those who registered.***

Moderated by
Alison Gregory, UFS (biography)
Dr. John Ten Hoeve, WPO/NOAA (biography)
Ji Sun Lee, Director of Social, Behavioral, and Economic Sciences (SBES) Program, NOAA/NWS
Dr. Valerie Were, NOAA/NWS & CIRA (biography)

10:30 am **Invited Student Presentations**
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

10:30 am - ReneDiego Martinez - Developing a Jupyter Notebook-based tutorial of the GDAS Proxy Application for Enhanced Data Assimilation in Earth System Prediction (biography) (abstract)

10:40 am - Samantha Lang - Highlights and Recommendations for Student Engagement from the Unified Forecast System Student Ambassador (biography) (abstract)

10:50 am - Q&A

11:00 am **Break**

11:15 am **Operationalizing "Cool" for the UFS**
Dr. Tracy Fanara, NOAA/NOS/IOOS (biography) (abstract)
Alison Gregory, UFS (biography) (abstract)

12:00 pm **Lunch**

1:00 pm **Parallel Sessions with Q&A**
SESSION ON SHORT-RANGE WEATHER (SRW) APPLICATION AND RAPID REFRESH FORECAST SYSTEM (RRFS)
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

1:00 pm - Matthew E. Pyle - Current Status of the Rapid Refresh Forecast System (biography) (abstract)

1:15 pm - Israel Jirak - Evaluation of the Rapid Refresh Forecast System during the 2024 NOAA HWT Spring Forecasting Experiment (biography) (abstract)

1:30 pm - Adam Clark - Evaluations of deterministic and ensemble regional MPAS configurations for severe weather forecasting during the 2024 NOAA/Hazardous Weather Testbed Spring Forecasting Experiment (biography) (abstract)

1:45 pm - Curtis Alexander - Rapid Refresh Forecast System Development for Version 2 (biography) (abstract)

2:00 pm - Terra Ladwig - Recent Collaborative Development of the Three Dimensional Real-Time Mesoscale Analysis (3DRTMA) using the Short Range Weather Application (biography) (abstract)

2:15 pm - Aaron Johnson - Ensemble correlations between all-sky ABI water vapor channel radiance and MPAS ensemble state variables: Flow dependence and implications for RRFS data assimilation (biography) (abstract)

2:30 pm - Break

2:40 pm - Irena Ivanova - Towards Explicit Effects of Forest Canopy Shading and Turbulence on Boundary Layer Ozone in UFS-SRW Air Quality Model (biography) (abstract)

2:55 pm - James Beisman - Incorporation of RRFS - Smoke and Dust (SD) capabilities into the UFS Short-Range Weather (SRW) Application (abstract)

3:10 pm - Q&A

SESSION ON UFS APPLICATION - OCEANS AND ECOLOGY

In-person attendees: Theatre Room

Virtual attendees: Livestream Link

1:00 pm - Le Zhang - Quantifying Carbon System Resilience of a River-dominated Shelf to Hurricanes: A Case Study of Ida (biography) (abstract)

1:10 pm - Yonggang Liu - Short-Term Forecast of Karenia brevis Trajectory on the West Florida Shelf (biography) (abstract)

1:20 pm - Fei Ye - Forecasting coastal flooding, including inland extremes and heavy precipitation with STOFS-3D (biography) (abstract)

1:30 pm - Paola Dosal - Improving Spatial Resolution in NOAA's Historical Flood Data with the Coastal Ocean Reanalysis (biography) (abstract)

1:40 pm - Maitane Olabarrieta - Forecasting Hurricane Impacts in the US East Coast and Gulf of Mexico (biography) (abstract)

1:50 pm - Kehui Xu - Coupled Ocean Modeling Testbed (COMT) Platform for Physics and Contaminant Exchange through the River - Estuary - Ocean Continuum (biography) (abstract)

2:00 pm - Dante M. L. Horemans - Optimizing the forecasting skill of correlative estuarine species distribution models using mechanistic model output (biography) (abstract)

2:10 pm - Jilian Xiong -Impact of estuarine exchange flow on mul6-tracer budgets in the Salish Sea (biography) (abstract)

2:20 pm - Aaron Bever - Coupled Hydrodynamic-Biogeochemical Forecasting using the Chesapeake Bay Environmental Forecasting System (biography) (abstract)

2:30 pm - Maitane Olabarrieta - Forecasting the Impacts of Lake Operations on the Estuarine Hydrodynamics and Pollutant Transport (biography) (abstract)

2:40 pm - Jia Wang - Great Lakes Earth System Model using FVCOM+CICE Models: Hindcast (1979-2021) and Future Climate Projections (1979 - 2100) (biography) (abstract)

2:50 pm - Zhengchen (John) Zang - A numerical study of eastern oyster (Crassostrea Virginia) larvae growth and dispersal in Barataria Bay, Louisiana (biography) (abstract)

3:00 pm - Lu Wang - Simulating ocean acidification in the Northeast U.S. region using a fully coupled three-dimensional biogeochemistry and ecosystem model (biography) (abstract)

3:10 pm - Ogooluwa Adeagbo - Detangling the Elevated Sea-surface pCO2 in a River-Dominated Continental Shelf Using a High-Resolution Regional Ocean Model (biography) (abstract)

SESSION ON UFS APPLICATION - LAND/SURFACE MODELS FOLLOWED BY CROSS-CUTTING - DATA ASSIMILATION

In-person attendees: Senate Chamber
Virtual attendees: Livestream Link

1:00 pm - Michael Barlage - UFS Land: Facilitating Land Model and Data Assimilation Development With a Community Focus (biography) (abstract)

1:10 pm - Andrew Newman - UFS forecast model evaluation and improvement for S2S hydrometeorological prediction in the Western United States (biography) (abstract)

1:30 pm - Siwei He - Evaluating snow and soil simulations in the unified forecast system (UFS) short-range weather system (biography) (abstract)

1:50 pm - Cenlin He - Enhancing snowpack physics in the Noah-MP land surface model (biography) (abstract)

2:10 pm - Myung-Seo Koo - Current Status and Plan of KIM/Noah-MP Coupled Model (biography) (abstract)

2:30 pm - Zhaoxia Pu - Coupled Land-Atmosphere Data Assimilation Within the Joint Effort for Data Assimilation (biography) (abstract)

2:45 pm - Zhiquan (Jake) Liu - A prototype of convection-permitting data assimilation system with regional MPAS-JEDI: hybrid-4DEnVar and assimilation of hourly ABI radiances (biography) (abstract)

3:00 pm - Cory Martin - JEDI-Based Atmospheric Composition Data Assimilation Progress at NWS (biography) (abstract)

3:15 pm - Jeffrey Whitaker - Assimilating real observations with ML modelsemulators (biography) (abstract)

3:30 pm **Break**

3:45 pm **Emerging Technologies: AI/ML**

In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link
3:45 pm - David Harrison - An Evaluation of AI-Generated Global NWP Emulators in the NOAA HWT Spring Forecasting Experiment (biography) (abstract)

4:00 pm - Montgomery Flora - WoFS-Cast: A machine learning model for high-resolution storm-scale weather forecasting (biography) (abstract)

4:15 pm - Jorge Guerra - Toward Basic Characterization of Machine Learning Methods Applied to Computational Geophysical Flows (biography) (abstract)

4:30 pm - Sadegh Tabas - Training GraphCast with NOAA's GDAS Reanalysis Data for Global Weather Forecasting (biography) (abstract)

4:45 pm **Research to Operations (R2O) and Operations to Research (O2R): How Innovations Move Through the Funnel**
Dr. Thomas Auligné, JCSDA (biography)
Dr. Christiane Jablonowski, University of Michigan (biography)
Chandra Kondragunta, JTTI (biography)
Dr. Louisa Bogar Nance, DTC (biography)
Dr. Andrea J. Ray, NOAA/OAR/ESRL/PSL, Hydrometeorological Testbed, & TBPGCC Chair (biography)

Moderated by: Kathryn Newman, DTC (biography)

6:15 pm **Adjourn**

Friday, July 26th

All times Central Daylight Time

8:00 am **Registration**
In-Person Attendees: Registration will begin on the 3rd Floor in the JSU Student Center
Virtual Attendees: If you have any general questions about UIFCW, you can ask them in the Slack channel.

9:00 am **Welcome and Kickoff**
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

Alison Gregory, UFS (biography)

9:05 am **NOAA Data Assimilation Strategy**
Dr. Daryl Kleist, NOAA/NWS/NCEP/EMC (biography)

9:15 am **Updates and Challenges for Data Assimilation**
9:15 am -Tom Auligne - The Joint Effort for Data assimilation Integration (JEDI): Status and Updates (biography) (abstract)

9:30 am - Xu Lu - Hurricane Inner-core Data Assimilation Upgrades for HAFSv2 and 2024 Real-Time Parallel Experiments (biography) (abstract)

9:45 am - Ming Hu - Rapid Refresh Forecast System Data Assimilation System: version 1 overview and version 2 development status (biography) (abstract)

10:00 am - Yongming Wang - Recent Development of JEDI-based Data Assimilation for GFS and RRFS at OU MAP Lab (biography) (abstract)

10:15 am - Stelios Flampouris - Impact assessment of the Tomorrow.io Microwave Sounder (TMS) constellation (biography) (abstract)

10:30 am - Jonathan Poterjoy - Nonparametric Data Assimilation Directions for the UFS: From Thunderstorms to Ice (biography) (abstract)

10:45 am **Coffee Break / Land DA System Demo**
In-person attendees: Theatre
Virtual attendees: Livestream Link

Moderated by Gillian Petro, EPIC/STC (biography)

11:15 am **Panel Discussion on Partnerships: How to Expand Our Community**
In-person attendees: A&B Ballroom
Virtual attendees: Livestream Link

Moderated by Tamara Battle, NOAA (biography)

Panelists
Dr. Neil Jacobs, UCAR (biography)
Dr. Jamese Sims, Thee Anomaly, LLC (biography)
Alycia Triplett, Howard University, NCAS-M II (biography)
Dr. Hendrik Tolman, NOAA/NWS/OSTI (biography)

12:00 pm **Debrief: Findings, Recommendations, and Closing Statements**

Dr. Neil Jacobs, UCAR (biography)
Kevin Garrett, NOAA, UFS-R2O (biography),
Tamara Battle, NOAA (biography)
Christopher Domanti, EPIC/Raytheon (biography)
Dr. Jamese Sims, Thee Anomaly, LLC (biography)

12:30 pm **Adjourn**

Additional Training Opportunities

Workshops/Training & Room Location

All times Central Daylight Time

Date	Time	Event	Location
Monday, July 22nd	8:00am - 12:00pm	Training 1 | Application Training SRW and new users → AWS (Virtual Only) Register here	Room 3210
Monday, July 22nd	8:00am - 12:00pm	Training 2 | Graduate Training → Visualization and Data to Include Level 2 Git Training Register here	Senate Chamber
Monday, July 22nd	8:00am - 12:00pm	Training 3 | Weather Prediction with Google's GraphCast AI Model Register here	Theater Room

Virtual Attendance

Your virtual hub for the workshop will be on EPIC's website, utilizing the UIFCW24 Slack workspace. Virtual posters will be available to view in the UIFCW Slack workspace, #virtual-posters. You may also choose to "huddle" with the virtual poster presenter through Slack.

Slack

*Please note that if you have a Slack account, adding a new workspace will prompt you to "Create Account." Although it sounds counterintuitive, click "create an account," select the email address associated with your Slack account, and then refresh your desktop application so that the new "UIFCW 2024" workspace appears in the left sidebar.

Speaker Biographies - Keynotes and Opening Remarks

In alphabetical order by last name

Dr. Almesha L. Campbell

Almesha L. Campbell, Ph.D., is the Assistant Vice President for Research and Economic Development at Jackson State University (JSU). In this capacity, she supports the Vice President with overall responsibility for the Division of Research and Economic Development. For over 12 years, she has served as the Director for Technology Transfer and Commercialization at JSU. She continues to manage the intellectual property process, from triage of invention disclosures to commercialization.

Almesha designs and manages a number of national and local programs around innovation and entrepreneurship in an effort to broaden the participation of underrepresented minorities in these areas. She has garnered approximately $12M in federal grants and contracts since 2016. She is the principal investigator or co-principal investigator for several federally funded programs including the National Science Foundation (NSF) Mid-South I-Corps Hub and the National Institutes of Health REACH Hub, the NSF Enabling SBE Science via the Network for Transformative Research program, the NSF Engines Development Award: Advancing Food Security and Climate Resilience (MS), and the recently awarded NSF Accelerating Research Translation program led by the University of Southern Mississippi.

Dr. Denise Jones Gregory

Dr. Denise Jones Gregory serves as the Provost and Vice President for Academic Affairs at Jackson State University. With over 20 years of higher education experience, Dr. Gregory formerly served as Associate Provost of Student Success and Diversity at Samford University. In this capacity, she oversaw three high-priority student areas on campus: the Office of Diversity, the Office of Accessibility and Accommodations, and the Academic Success Center. She was also responsible for managing and approving multiple budgets, ensuring quality customer care and engagement.

Dr. Gregory also served on the Executive Leadership Team, President's Council, and University Council, playing a pivotal role in developing the university's strategic plan. Furthermore, Gregory has served as NCAA Faculty Athletic Representative and participated in more than 20 faculty and staff search committees annually.

A native of Columbus, Mississippi, Dr. Gregory received her Bachelor of Science in chemistry from Jackson State University and her doctorate from the Georgia Institute of Technology. She is a member of Delta Sigma Theta Sorority, Inc. and on the regional leadership team as primary advisor to the Samford University chapter. She is also a life member of the Jackson State University National Alumni Association (JSUNAA) and treasurer of the Birmingham Chapter.

Dr. Michael Morgan

Michael C. Morgan, Ph.D., is the Assistant Secretary of Commerce for Environmental Observation and Prediction. In this role, Dr. Morgan is responsible for providing agency-wide direction regarding weather, water, climate, and ocean observations, including in situ instruments and satellites, and the process of converting observations to predictions for environmental threats. Dr. Morgan has more than 25 years of demonstrated scientific leadership. Prior to joining NOAA, he most recently served as a professor and associate department chair in the Department of Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison, where his research was focused on the analysis, diagnosis, prediction, and predictability of mid-latitude and tropical weather systems.

Dr. Morgan is a fellow of the American Meteorological Society (AMS). He earned his S.B. in Mathematics and Ph.D. in Meteorology from the Massachusetts Institute of Technology.

Speaker Biographies

In alphabetical order by last name

Ogooluwa Adeagbo

I'm Ogooluwa Adeagbo, a doctoral student at LSU studying how our changing climate impacts ocean chemistry. My research uses coupled ocean models to understand how rising carbon dioxide levels lead to ocean acidification, which can harm marine organisms like shellfish. I'm passionate about sustainable ocean management and believe collaboration is key to finding solutions. I'm excited to participate in the UIFCW workshop and discuss the impact of climate change on marine ecosystems.

Dr. Oladayo Olayiwola Afolabi

Oladayo Olayiwola Afolabi is a Nigerian scientist with a strong background in physics and geophysics. He earned his Bachelor of Technology (B.TECH) in Pure and Applied Physics in December 2010 and his Master of Technology (M.TECH) in Radio Propagation, Ionospheric, and Space Physics in October 2017, both from Ladoke Akintola University of Technology, Nigeria.

In April 2024, Oladayo completed his PhD in Space Geophysics from the National Institute for Space Research in Brazil. He currently works as a scientific officer at the National Space Research and Development Agency (NASRDA) in Nigeria, contributing to the country's advancements in space research and technology.

Oladayo is a dedicated member of several professional organizations, including the American Geophysical Union, the African Geophysical Society, and the Nigerian Geophysical Society.

Dr. Curtis Alexander

Curtis Alexander is the Deputy Director of GSL. Dr. Curtis Alexander (NOAA/OAR/GSL) received his undergraduate and graduate degrees from The Pennsylvania State University (1999) and the University of Oklahoma (2002, 2010), respectively. His graduate work focused on studying severe convective storms, including tornadoes, using high-resolution mobile Doppler weather radar observations. He joined the Global Systems Division (now Laboratory — GSL) of NOAA/ESRL in 2009, first as a University of Colorado CIRES employee before becoming a NOAA federal employee in 2016. He focused his research in NOAA on developing high-resolution model systems to support convection-allowing model forecasts, including data assimilation of storm-to-mesoscale information. He became a division chief for the now Assimilation and Verification Innovation Division of GSL in 2017. He has helped transition multiple versions of the Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR) from research to operations at NWS/NCEP between 2014 and 2020. He is also a co-lead on the Unified Forecast System Short-Range Weather/Convection Allowing Model Application Team.

Dr. Trey (George) Alvey

Dr. George (Trey) Alvey is currently an Assistant Scientist at the University of Miami (CIMAS) and the Hurricane Research Division at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML). His research is currently focused on tropical cyclone intensification, particularly during the early stages of tropical cyclone development. This includes subtopics such as vortex scale dynamics and vortex alignment utilizing observational tools such as ground radar and modeling systems like the Hurricane Analysis and Forecast System (HAFS).

Dr. Thomas Auligné

Dr. Thomas Auligné is the Director of the Joint Center for Satellite Data Assimilation (JCSDA), a research center based on a multi-agency partnership between NOAA, NASA, the U.S. Navy, and the Air Force. He is responsible for the mission to accelerate and improve the quantitative use of satellite data in weather, ocean, climate, and environmental analysis and prediction systems. Before joining the JCSDA in 2015, Dr. Auligné held research scientist positions at the National Center for Atmospheric Research (NCAR), the European Centre for Medium-Range Weather Forecasts (ECMWF), and Me´ te´ o-France. Dr. Auligné earned his M.S. in Meteorology and Ph.D. in Atmospheric Physics from Paul Sabatier University in Toulouse, France. His main topics of interest are data assimilation, remote sensing, artificial intelligence, Earth system prediction, and improving transition from research to operations.

Hager Mohammed Salah Awad

My name is Hager Awad. I'm a Physics assistant lecturer at Canadian International College in Egypt. Also, I'm a Ph.D. student at the Space Weather Monitoring Center. My early career research tackles the field of ionospheric research, which involved investigating and predicting ionospheric variations and irregularities. I gained expertise in data analysis using measurements from ground-based instruments and different satellites, ionospheric models, and machine learning. I am currently working on my PhD research that utilizes machine learning algorithms to predict ionospheric irregularities under various conditions in the northern anomaly crest. I aim to develop new forecasting techniques and tools for predicting ionospheric variations to improve space weather forecasting capabilities and improve the effects of space weather prediction on infrastructure. I am excited to learn about the latest innovations in space weather forecasting and to collaborate with other researchers in the field.

Daoyang Bao

I'm a graduate student at the LSU Department of Oceanography and Coastal Sciences. With ten years of experience in ocean modeling, my current research focuses on Ocean-Hydrological Model Coupling, Hurricane-induced Compound Flooding, and Operational Modeling.

Jian-Wen Bao

Jian-Wen Bao has been leading a team effort in the Physical Sciences Laboratory of NOAA's Earth System Research Laboratories to evaluate and improve the performance of physics parameterizations in NOAA's operational numerical weather prediction models.

Dr. Michael Barlage

Land model physics and data assimilation developer at NOAA/GSL focusing on land-atmosphere coupling, the impact of the land surface on atmospheric processes, and the application of surface observations to evaluate and initialize land models within earth prediction systems.

Tamara Battle

Tamara L. Battle is the Science and Policy Analyst / Special Assistant directly supporting the Deputy Assistant Administrator for Science (DAAS) of NOAA's Oceanic and Atmospheric Research (OAR). Tamara serves as the primary contact for the coordination of activities involving OAR labs, for DAAS analysis and communications, and for other responsibilities as determined by the DAAS.

Prior to working in OAR HQ, Tamara served more than six years in NOAA's Weather Program Office (WPO), most recently as the Policy and Partnerships Manager, leading coordination and oversight for the Weather Research and Forecasting Innovation Act of 2017 (the "Weather Act") and other weather policy topics. Before joining WPO, she spent five years at the National Science Foundation as a Science Assistant with the Division of Graduate Education and as a Science Analyst within the Division for Chemical, Bioengineering, Environmental, and Transport Systems.

Tamara has a B.S. in Environmental Science from Medgar Evers College, CUNY, a M.A. in Geology from The City College of New York, CUNY, and a M.S. in Atmospheric Sciences from Howard University.

Dr. Ligia Bernardet

My work straddles the interface between research and operations in numerical weather prediction. As the Chief of the GSL Earth Prediction Advancement Division, I contribute to planning and supporting the execution of model development in the areas of physical parameterizations, interactions between domains of the earth system (atmosphere, land, ocean, and sea ice), air composition, and atmospheric chemistry. Our products are used by the National Weather Service to create numerical guidance for forecasters and by the general community to conduct research. I am passionate about creating mechanisms that facilitate synergistic interactions between the research and operational communities. For that reason, I work on projects for the Developmental Testbed Center that aim at engaging the academic community in using NOAA models and evaluating innovations supplied by the community. Connecting with the research community is a key ingredient for accelerating the transition of innovations to operations and creating better forecasts.

Dr. Aaron Bever

Dr. Aaron Bever has more than 15 years of experience combining field observations and state-of-the-art three-dimensional (3D) hydrodynamic, water quality, sediment transport, and wave models to better understand hydrodynamics, water quality, and sediment transport in coastal and estuarine systems. Dr. Bever's recent work has focused on salinity, water temperature, turbidity modeling, sediment transport in San Francisco Bay, and methods to better estimate and forecast hypoxia in the Chesapeake Bay. His work in multiple estuarine systems combining long-term field-collected data sets with numerical model results has demonstrated that numerical models can give valuable insight for supporting management decisions and improving observational sampling strategies and strategic instrument deployments.

Keven Blackman

Keven graduated from the University of Illinois, Springfield, with a Masters of Science in Computer Science. For over 21 years, Keven has worked in computer science and meteorology. He has led weather programs ranging from Air Force Support applications, numerical weather modeling, and cloud architect of meteorology applications to migrating the Air Forces data to the cloud. Currently, he is the Chief Engineer of the Earth Prediction Innovation Center (EPIC). He is honored to be charged with driving community contributions to the United Forecast Model (UFS) weather model. He is also currently a Ph.D. candidate in Information Technology with a focus on artificial intelligence. He will retire next year after 20 years in Air Force Weather, both Active Duty and National Guard.

Kris Booker

Kris leads the NOAA EPIC Platform Team. He worked for NOAA previously (NEXRAD Operational Support Facility) as an undergraduate student. He holds a Bachelor of Science in Meteorology from the University of Oklahoma with a minor in Management of Information Systems. Prior to joining Tomorrow.io as a DevOps Engineer, he was a Senior Systems Engineer at Perforce Software and has worked for various private weather companies (Vaisala, Universal Weather & Aviation) during his 20-year career. Kris is an avid aviation enthusiast and aspiring private pilot.

Alex (David) Burrows

My graduate and postdoctoral work focused on large-scale atmospheric dynamics, including global-teleconnection patterns, upper- and lower-level jetstream variability, forced- and natural-climate variability, and more. I transitioned out of academia to the NCEP Central Operations team during the WCOSSI to II port as a scientific programmer/analyst who provided the supporting link between the model development community and the forecast-production environment. Currently, I am on the EPIC Atmospheric River team working with PSL, GSL, EMC, EPIC, and more to develop a UFS Medium/Short Range Weather-type atmospheric river application for the western North America coast that is accessible across multiple NOAA RDHPCS and Cloud Service Providers.

Peter Caldwell

Peter Caldwell is a Lawrence Livermore National Lab (LLNL) staff member who leads the Simple Cloud-Resolving E3SM Atmosphere Modeling effort. His research is broadly focused on clouds and their role in climate change, with a special interest in stratocumulus, cloud feedback, high-resolution global climate model development and evaluation, regional climate modeling, numerics of climate models, and statistical analysis of climate model ensembles.

Peter came to LLNL in 2007 as a postdoc working on regional climate modeling. Before that, he worked on his PhD at the University of Washington (UW) under the tutelage of Christopher S. Bretherton. While at UW, Peter used observations and simple models to understand the physical processes underlying stratocumulus response to a changing climate. Peter's original background is in math, and much of his current research spans the boundaries of climate science, numerical analysis, statistics/data science, and computer science.

Jacob Carley

Dr. Jacob Carley is the Chief of EMC's Engineering and Implementation Branch. The Branch supports EMC's mission by developing workflows, leading innovation with newer technologies, working with internal/external collaborators to develop applications and components, enabling a smooth transition of applications from research to operations, enabling scientists to work on different HPC platforms, and exploring ways to improve the efficiency of these systems.

Dr. DaNa Carlis

DaNa L. Carlis, Ph.D., is an award-winning meteorologist and serves as the Director at NOAA’s National Severe Storms Laboratory (NSSL). At NSSL, he is responsible for leading the laboratory's scientific and information technology efforts. As NSSL Director, he leads the premiere severe weather research laboratory with more than 180 scientists, engineers, and administrators. Prior to NSSL, DaNa served as the Deputy Director of NOAA’s Global Systems Laboratory (GSL) in Boulder, CO, and before GSL at the Weather Program Office (WPO) in Washington, DC, where he was the founding program manager of the Earth Prediction Innovation Center (EPIC) and Next Generation Global Prediction System (NGGPS) programs. DaNa enjoys that he’s able to work between science, policy, and society to ensure better products and services for the American people.

Dr. Benjamin Cash

Dr. Benjamin Cash is a Research Professor in the Department of Atmospheric, Oceanic, and Earth Sciences and is also a researcher with the Center for Ocean-Land-Atmosphere Studies (COLA) at George Mason University. He received his B.A. in Earth and Planetary Science from Harvard University in 1994 and his Ph.D. in Meteorology from the Pennsylvania State University in 2000. Dr. Cash joined COLA in 2002 and George Mason University in 2014. His research has focused on three main areas: 1) the impact of climate variability and change on human health, particularly through the spread of infectious disease, 2) understanding and separating the predictable and unpredictable components of the climate system, with an emphasis on drought, and 3) the application of high-performance computing resources to improving climate models. His current research focuses on the dynamics and predictability of the ongoing extreme droughts across the globe.

Dr. Sen Chiao

Sen Chiao is the Director of the NOAA Cooperative Science Center in Atmospheric Sciences and Meteorology (NCAS-M) and a Professor of Interdisciplinary Studies at Howard University. NCAS-M is a research-through education enterprise led by Howard University and includes seven partner institutions. Dr. Chiao provides the executive leadership for NCAS-M through strategic communications, the design of the overall scientific focus and plans, and oversight, management, and planning for the implementation of all aspects of the NCAS-M programmatic activities.

Dr. Adam Clark

Dr. Adam J. Clark is a federal research meteorologist at the National Oceanic and Atmospheric Administration's (NOAA) National Severe Storms Laboratory (NSSL) and an affiliate associate professor in the School of Meteorology at the University of Oklahoma. Clark's research involves developing model diagnostics, verification, and visualization strategies for high-resolution ensemble forecasts and exploring model physics sensitivities and predictability at convective scales. He is also one of the lead planners and facilitators for the annual NOAA Hazardous Weather Testbed Spring Forecasting Experiments. The experiments convene research and forecasting experts from around the world to improve predictions of severe weather hazards.

Dr. Nathan Crossette

As a Computational Scientist at the JCSDA (Joint Center for Satellite Data Assimilation), I work on implementing generic background error covariance (B-Matrix) models in the SABER (System Agnostic Background Error Representation) package of the JEDI data assimilation system. I earned my PhD in physics from the University of Colorado Boulder, studying errors in complex systems.

Dr. Linlin Cui

Linlin Cui is currently a scientist with Lynker working at NOAA/NWS/NCEP/EMC. Her work is focused on developing data-driven weather forecast models and machine learning models for correcting bias in GFS products.

Cheng Dang

Cheng Dang joined the JCSDA in Boulder, CO, in January 2020 as a project scientist with the Community Radiative Transfer Model (CRTM) core team. Her primary responsibility and focus include improving the representation of aerosol species and their solar optical properties in CRTM for a better constraint on AOD and irradiance data assimilation and exploring other scientific questions revolving around aerosol radiative effects.

Dr. Prabal Das

Dr. Prabal Das is a Post-Doctoral Research Associate at the University of Texas at Arlington, specializing in Hydro-climatology. With a Ph.D. from IIT (ISM) Dhanbad and an M.Tech from NIT

Karnataka in India, his research focuses on applying machine learning to predict hydrological and climatological phenomena. Currently, he is involved in a NOAA project related to forecasting precipitation types across the U.S. Dr. Das's expertise includes Python, R, GIS tools, and deep learning for climate data analysis. He has published extensively and serves as a reviewer for leading journals. For more about his work, visit his Google Scholar or ResearchGate profiles.

Shreyas Dhavale

I am Shreyas Dhavale, a recipient of the NOAA Weather Program Office Innovation for Next Generation Scientists (WINGS) Fellowship and a PhD Candidate at the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University.

My PhD research is on the 'Monsoon Onset Vortex (MOV),' which is a synoptic weather system that forms in the Arabian Sea in some years during the onset of the Indian Summer Monsoon. I study the origin, structure, and predictability of the MOV in the Reanalysis data, Satellite observations, and numerical models such as WRF and UFS.

I am a recipient of the 2024 John S. Irwin Award for Scientific Excellence from the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University.

I am passionate about studying and predicting weather in the tropics. I am a co-blogger of the blog 'Vagaries of the Weather', which focuses on weather events for the Indian Subcontinent region.

Before joining North Carolina State University for my PhD, I completed my Masters in Atmospheric Sciences from Savitribai Phule Pune University in collaboration with the Indian Institute of Tropical Meteorology. I have a Bachelor's in Electronics and Telecommunication Engineering from the University of Mumbai, India.

Fábio Diniz

Fábio Diniz joined the JCSDA in August 2020 as a Project Scientist working with the observations team. His role is to contribute to the development of Forecast Sensitivity-based Observation Impact (FSOI) capabilities in the Joint Effort for Data Assimilation Integration (JEDI) system.

Dr. Sarah Ditchek

Sarah Ditchek is an Associate Scientist at the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) and is affiliated with NOAA's Atlantic Oceanographic and Meteorological Laboratory's Hurricane Research Division. Her research quantifies the impact of tropical cyclone (TC) reconnaissance data on TC forecasts. She also uses her TC-verification package, named "GROOT", to provide graphics for the Post-TC Verification page on the AOML Hurricane Model Viewer website. She received her B.S. in Geology and Geophysics with a concentration in Atmosphere, Ocean, and Climate from Yale University in 2014 and her Ph.D. in Atmospheric Science from the University at Albany in 2019.

Christopher Domanti

Chris graduated from Cornell University with a Master of Engineering in Systems Engineering and has spent 12 years in the Raytheon organization supporting a variety of programs in the weather and climate domains, including the Joint Polar Satellite System Common Ground System (JPSS CGS), the Earth Observing Systems Data and Information System Evolution (EOSDIS) and Development (EED), and the Advanced Weather Interactive Processing System (AWIPS). Starting as a Systems Engineer and gaining experience in each step of the systems development lifecycle, Chris transitioned to Program Management, where he is now the Program Manager of the Earth Prediction Innovation Center (EPIC) contract.

Paola Marie Santini Dosal

Paola Santini Dosal is a passionate marine biologist from Puerto Rico, currently studying Marine Biology with a minor in Political Science. Her journey in the field of marine sciences is marked by significant achievements and a deep commitment to both research and community service.

After moving to Florida at 16 for better educational opportunities, Paola faced and overcame numerous challenges, including discouragement due to her accent. Despite this, she graduated from Valencia College in Spring 2024 with an Associate of Arts, earning the highest Honors distinction and multiple awards such as Puma of the Year and Honors College Scholar Distinction. Her hard work and dedication also led her to become one of fifteen NOAA EPP/MSI Scholars for 2024, selected from a pool of 4,000+ applicants. This prestigious scholarship has given her the chance to intern at NOAA Headquarters and further her research in marine sciences.

At the University of Central Florida (UCF), Paola is actively involved in the MEC Lab, where she studies shifts in fish species along the East Coast. She has also worked on assessing the health of Amazonian dolphins using drone technology and investigating the impact of sea level rise in Miami and Ocean Park Beach, Puerto Rico. Her collaboration with NOAA's Coastal Ocean Reanalysis (CORA) project aims to educate the public about coastal changes and their effects.

Paola's dedication extends beyond her academic and research pursuits. She is committed to giving back to the Central Florida community, evidenced by her volunteer work with the Adult Literacy League, where she teaches English to adult learners. Her journey reflects resilience, determination, and a profound passion for marine conservation.

Through her work, Paola aims to advance scientific knowledge and inspire future generations about the importance of preserving marine ecosystems. While still an undergraduate, her story is one of perseverance and admiration.

Dale Durran

Dale Durran is a professor and past Chair of the Department of Atmospheric Sciences at the University of Washington. His research focuses include atmospheric predictability, mountain meteorology, and numerical weather prediction. Most recently, he has been focused on using deep learning to change our current paradigm for numerical weather prediction, sub-seasonal, and seasonal forecasting. He is a fellow of the American Meteorological Society (AMS) and a recipient of the AMS's Jule Charney Award. He has written over 120 scientific publications, the graduate-level textbook "Numerical Methods for Fluid Dynamics with Applications to Geophysics" and "perspective" articles about climate change for the Washington Post. His sculpture was included in the first ArtScience Virtual Exhibit exhibit of American Geophysical Union's 2022 Fall Meeting.

Hamideh Ebrahimi

Hamideh is a project scientist with the Joint Center for Satellite Data Assimilation (JCSDA) at UCAR, working at NASA's Global Modeling and Assimilation Office (GMAO). She is working on the assimilation of surface-sensitive radiances and on the implementation of coupled Atmosphere/ocean/sea-ice data assimilation capability within the Joint Effort for Data-assimilation Integration (JEDI) project.

Keenan Eure

Keenan started working at the Global Systems Laboratory of NOAA in Boulder, CO, through the Cooperative Institute for Research in the Atmosphere (CIRA) in 2024. He joined the Assimilation, Verification, and Innovation Division (AVID), working on all-sky satellite data assimilation of observations from both the Joint Polar Satellite System (JPSS) and the Geostationary Operational Environmental Satellite (GOES) for the Rapid Refresh Forecast System (RRFS).

Keenan received his Ph.D. in 2024 and M.S. in 2021 from the Pennsylvania State University. His research focuses on the simultaneous data assimilation involving Doppler weather radar and satellite observations to improve numerical weather prediction model convection forecasts. Keenan was a NASA Future Investigators in Earth and Space Science Technology (FINESST) fellow and formerly a Penn State Dean's Distinguished Graduate Fellow. With his work, he worked to improve the accuracy of the location and timing of convection initiation and to provide models with better information on severe weather threats.

Currently, he is also on the AMS Board on Representation, Accessibility, Inclusion, and Diversity (BRAID) Committee, as well as the AMS Weather Analysis and Forecasting (WAF) Committee. Keenan previously attended the University of Maryland, graduating with high honors in 2018 with a degree in atmospheric and oceanic science. He serves on their alumni committee.

Emily Faber

Emily Faber is a Ph.D. candidate in Atmospheric Physics at the University of Maryland, Baltimore County (UMBC), mentored by Dr. Adriana Rocha Lima. She holds a B.Sc. in Physics from Clemson University and an M.Sc. in Atmospheric Physics from UMBC. Her research focuses on mineral dust emission drivers using global models and measurements.

Emily's research addresses the crucial role of mineral dust in the climate system. Using the Unified Forecast System (UFS), Emily explores the representation of alluvial flows—areas of dry lakes and riverbeds that, despite being sub-grid to the model, significantly impact dust emissions due to their efficiency in seasonal and decadal cycles. By comparing modeled aerosol optical depth (AOD) with satellite data, she works on generating and applying a global, non-static alluvial flow map to the FENGSHA dust emission scheme within the UFS. Her work focuses on accurately representing these sub-grid scale features which are crucial for determining the quantity and sources of dust emissions and enhancing model accuracy on seasonal to climatic scales.

Dr. Tracy Fanara

Tracy Fanara is an environmental engineer and research scientist with a BS, ME, and PhD from the University of Florida. Tracy spent almost a decade as a project engineer, designing and modeling water, wastewater, hydrologic, and hydrodynamic systems worldwide before and during her research at UF. Tracy's research focused on integrated hydrodynamic modeling, ecotoxicology, chemical transport, and water treatment (for Earth and space). Before coming to NOAA, Tracy managed the Environmental Health Research Program at Mote Marine Laboratory, which focused on harmful algae bloom (HAB) research and mitigation. Tracy gained international attention through her communication efforts during the 2018/2019 Florida Water Crises due to her expertise in hydrology and coastal ecology. To mitigate human health and economic impacts of environmental hazards, Tracy developed citizen science programs, three smartphone applications, and redeveloped a website (visitbeaches.org) for publicly available environmental data with over 2 million users. Tracy is now the Coastal Modeling Portfolio Manager for the National Ocean Service (NOAA/NOS), where she manages coastal and ocean modeling efforts to inform decision-making and mitigate threats to human lives and livelihoods on our coasts. Tracy spends time outside of work on the ocean, diving in caves, running STEM and environmental camps for middle school girls (Mission: Tampa Bay), unearthing dinosaurs, and communicating science on TV and to students through her mission, Inspector Planet. Tracy was recently Xylem YSI's Mission: Water Hero and was featured in Marvel's Unstoppable Wasp, which led to her co-produced comic series, Seekers of Science.

Stylianos Flampouris

Stelios Flampouris, Ph.D. (University of Hamburg), is the Vice President of Science and Technology for Tomorrow.io. He leads edge-cutting multidisciplinary research (Numerical Weather Forecasting Modeling and Data Assimilation, Machine Learning Modeling, and Satellite retrievals), operational teams, and activities focused on weather prediction. His scientific interests are focused on operational forecasting.

In parallel, Stelios is in charge of innovation at the Earth Prediction and Innovation Center (EPIC) NOAA, where he designed the architecture of the infrastructure required for the UFS Weather Model and Applications to support the UFS Community within the EPIC contract.

Stelios's dual role is the first demonstration of the first public-private development of the UFS Weather Model.

Over the past two decades, Stelios has served at NOAA - NWS (USA) in multiple roles, Naval Research Lab - Stennis (USA), and Heron Center (Germany), leading innovation, teams, and programs on the subjects of Coupled Modeling and Data Assimilation, Signal Processing, and cutting-edge technologies in the fields of Remote Sensing and Machine Learning in support of the forecast of the Earth system.

Dr. Montgomery Flora

I'm a research scientist at CIWRO and have been associated with OU for nearly a decade. I earned my PhD at the University of Oklahoma, developing the "WoFS-ML-Severe" products available on the cloud-based WoFS web viewer (https://cbwofs.nssl.noaa.gov/) and novel verification methods for high-resolution CAM ensemble output. My AI expertise also includes explainability methods, which includes writing a recent AMS AIES tutorial paper (https://journals.ametsoc.org/view/journals/aies/3/1/AIES-D-23-0018.1.xml) and developing scikit-explain (https://github.com/monte-flora/scikit-explain)

Kate Fossell

Kate Fossell is the Assistant Director of the Mesoscale and Microscale Meteorology Laboratory (MMM) at NSF NCAR, where she helps to advance strategic lab priorities, including collaborations on MPAS with NOAA and other partners. She also works on the Partnerships team in the NSF NCAR Director's Office and is currently serving as the Interim Strategic Partnerships Lead. Her scientific background revolves around short-range and convective scale weather, including numerical weather prediction, ensemble prediction systems, data assimilation, storm surge modeling, as well as containerized and cloud-based forecasting systems.

Dr. Sergey Frolov

Dr. Frolov is a data assimilation and coupled model forecasting expert with a strong track record of formulating and implementing advanced computing algorithms that drive Earth Science modeling and observation workflows. Past contributions include scientific support for negotiating the US-Canada water sharing treaty, design of the US strategy for harmful algal bloom observations, implementation of the coupled data assimilation, and ensemble forecast component of the Navy's S2S forecast model. Dr. Frolov's present foci are helping NOAA to develop and execute a coordinated strategy for the inclusion of the deep learning forecast model emulators into NOAA's research-to-operations pipeline, the transition of NOAA to the JEDI software stack, and the development of the coupled reanalysis using NOAA's Unified Forecast System.

Dr. Bing Fu

Dr. Bing Fu is a physical scientist at NOAA/NWS/NCEP/EMC. He is interested in numerical weather models, ensemble forecasting, and S2S prediction. Since joining the EMC in 2015, he has been working on tuning the stochastic physics in GEFS. He is one of the major developers of the current operational GEFSv12 and is now co-leading the development of GEFSv13.

Lin Gan

Mr. Lin Gan is an IT Specialist who worked at NCEP for 15 years. He is the system architecture designer for NCEP Model Analyses and Guidance We system https://mag.ncep.noaa.gov/ for NCEP/NCO and IT specialist for NCEP/EMC. He has been working on ecFlow workflow and running implementation parallel for operational implementation projects for major models in NCEP/EMC like the Global Forecast System (GFS), Air Quality Model (AQM), and Hurricane Analysis and Forecast System (HAFS).

Kun Gao

Kun Gao is an Associate Research Scholar at Princeton University. His research focuses on improving the prediction of hurricane intensity, track, and heavy rainfall in high-resolution numerical models. He also conducts basic research to understand how storm-scale processes (e.g., convection, large eddies) affect hurricane structure and intensity changes and how large-scale atmospheric variability affects basinwide and regional-scale hurricane activity.

Kevin Garrett

Kevin Garrett is the Modeling Program Director at the NWS Office of Science and Technology Integration (OSTI). Mr. Garrett oversees the management of the NWS Modeling Programs, including the Next-Generation Global Prediction System (NGGPS), the Hurricane Forecast Improvement Program (HFIP), the National Air Quality Forecast Capability (NAQFC), Weeks 3-4, and COASTAL Act. The Modeling Programs create and support opportunities to advance NWS operational numerical weather prediction (NWP) capabilities, with a current emphasis on transitioning the NCEP production suite to the Unified Forecast System (UFS) and improving model guidance across space and time scales to meet the needs of NWS forecasters and other users and stakeholders. Mr. Garrett serves on several committees, teams, and working groups, including the Development Testbed Center (DTC) Management Board and the UFS Steering Committee. Prior to joining the NWS, Mr. Garrett spent several years in the NOAA/NESDIS Center for Satellite Applications and Research, leading the Data Assimilation Science Team to advance the use and impact of satellite observations in global NWP systems.

Anna Glodzik

Anna will be entering her first year as a graduate student on the Atmospheric Science PhD track at University at Albany this fall. She recently received her Bachelor’s in Atmospheric Science from The Ohio State University this past December. Since graduating, she has been working as a research assistant for the SUNY Research Foundation where she has been working directly with the New York State Mesonet (NYSM) Flux Network to evaluate its performance and output, specifically focused on the surface energy budget. Her research is part of a project between the NYSM and NCAR in an effort to make comparisons between data from the mesonet and output from the prototype HR runs. The goal of this project is to create land-atmospheric coupling metrics, which will eventually be added to METplus. She hopes to make her work on this project the foundation of her PhD thesis and expand her research to incorporate more climate modeling as she progresses through her degree and beyond.

Dr. Sundararaman Gopalakrishan

Dr. Sundararaman “Gopal” Gopalakrishnan is a senior meteorologist with the U.S. National Oceanic and Atmospheric Administration (NOAA)’s Atlantic Oceanographic and Meteorological Laboratory

(AOML)'s Hurricane Research Division (HRD) and principal architect of NOAA's Hurricane Weather Research and Forecasting (HWRF) system. His research involves simulating a variety of complex, non-linear, scale interacting systems starting from dry thermals (Large Eddy Simulations) to hurricanes; examining the mesoscale structures and evolution as well as the mechanism(s) whereby they develop; testing theories, hypotheses, and various near-surface model physical representations; and finally interpreting, to the extent possible, the modeled and the observed behavior of these systems. He has over 60 publications in peer-reviewed international journals. In the past, he has served as an Associate Editor for the Monthly Weather Review and Weather and Forecasting. Dr. Gopal is the co-editor of the textbook entitled "Advanced Numerical Modeling and Data Assimilation Techniques for Tropical Cyclone Predictions (publishers: Capital Press, India, and Springer, Germany). Gopal is the head of the modeling group at the Division, where he supervises and mentors advanced scientists and students at post-graduate and postdoc levels. He also leads the Next-Generation Hurricane Prediction Program and Research to Operational transitions in NOAA. He currently serves as the developmental manager for NOAA's Hurricane Forecast Improvement Program (HFIP).

Benjamin Green

Ben Green is a research scientist at CIRES/CU and NOAA/GSL, working on NOAA's subseasonal-to-seasonal modeling efforts.

Clémentine Hardy Gas

Currently working at JCSDA in Data Assimilation, I dedicate significant effort to refining our workflow to work with the operational weather models from NOAA and NASA, particularly focusing on Ensemble Data Assimilation.

Alison Gregory

Alison Gregory is the Community Engagement Specialist for the Unified Forecast System (UFS). In this role, she is responsible for coordinating engagement efforts for the UFS community and EPIC program office. Her work utilizes social science strategies to improve and evaluate the sense of community among UFS stakeholders. Alison has spent the past 10 years working on various projects that bridge the gap between social science and environmental fields, such as watershed management, Arctic research, and energy policy. Alison received a Bachelor's degree in Atmospheric and Oceanic Sciences from the University of Colorado at Boulder and a Master's degree in Sociology from Colorado State University. She also has a bachelor's degree in environmental sociology and political science.

Ashley Griffin

Ashley joined the Joint Center for Satellite Data Assimilation (JCSDA) on the Joint Effort for Data assimilation Integration (JEDI) infrastructure team as a software engineer in February 2023. Her primary focus on the team is setting up and maintaining real-time systems and research and development systems in the cloud and on HPCs. She works on automating data ingest and integrating those pipelines into our DA workflow.

Jorge E. Guerra

I'm an atmospheric scientist and engineer with advanced training in computational physics and geophysical fluid dynamics. My expertise is in the construction of numerical weather prediction models from first principles through to modern implementations on heterogeneous computing systems.

Jana Haddad

Jana is a coastal modeler and physical oceanographer with a project management background. She currently works in the Coastal Marine Modeling Branch at NOAA OCS, assisting with technical management and coordination of Storm Surge Modeling Team projects. She is the project manager for the UFS Coastal project, which is currently in active development in collaboration with NCAR's ESMF/NUOPC team.

Dr. Lucas Harris

Lucas Harris is a Research Physical Scientist and Deputy Division Lead in the Weather and Climate Dynamics Division of NOAA's Geophysical Fluid Dynamics Laboratory. He is the head of the FV3 Team and leads the development of the FV3 Dynamical Core and the SHiELD unified weather-to-subseasonal model; he also contributes to the GFDL suite of climate models and to the UFS. He holds a PhD in Atmospheric Sciences and an MS in Applied Mathematics, both from the University of Washington.

Dr. David Harrison

Dr. David Harrison is a research scientist employed by the University of Oklahoma's Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO) in partnership with the National Weather Service's Storm Prediction Center (SPC). He also serves as a lead facilitator of NOAA's Hazardous Weather Testbed Spring Forecasting Experiment. David's research and experience primarily center around the application of machine learning for severe and high-impact weather forecasting and the operational implementation of those products within SPC.

Christopher Harrop

Chris Harrop is a Senior Associate Scientist at the Cooperative Institute for Research in Environmental Sciences (CIRES) at CU Boulder, working within the Scientific Computing Branch at the NOAA Global Systems Laboratory (GSL). His work focuses on developing scientific workflows and exploring emerging technologies in High Performance Computing (HPC) and their application to Numerical Weather Prediction (NWP). He earned a B.S. in Computer Science from Colorado State University in 1991 and an M.S. in Computer Science from the University of Oregon in 1996. Throughout his career at CIRES, Harrop has observed challenges in scientific computing from the perspective of multiple NOAA laboratories, each having different requirements. His career in scientific computing began in the NOAA Aeronomy Laboratory (now CSL), where he worked on data acquisition software for scientific instruments. He later joined the NOAA Climate Diagnostics Center (now PSL) before moving to his current role at GSL. One of Harrop's most well-known contributions is developing the Rocoto workflow management system, which is used to automate much of NOAA's modeling system experiments.

Cenlin He

Cenlin He is a project scientist at NSF NCAR working on land surface modeling and land-atmosphere interactions. He is leading the community Noah-MP model development, including the application and enhancement of the NOAA UFS/NoahMP modeling system. He is also coordinating the international community effort to develop the WRF-urban model.

Jian He

I develop and apply chemical transport models to understand changes in the atmospheric composition and associated impacts on environment and climate.

Siwei He

Siwei is an assistant professor at Montana State University. Siwei's research integrates observations (both from in-situ monitoring networks and high-resolution remote sensing), physically-based models, statistical methods, and high-performance computing to study land-surface and hydrological processes and their impacts on other processes (e.g., atmospheric circulation, ecosystems, infrastructure, energy, sustainability, and society) at regional and global scales.

Dom Heinzeller

Dom Heinzeller is a computational scientist and the JEDI infrastructure lead at the Joint Center for Satellite Data Assimilation. His career spans from theoretical astrophysics to numerical weather prediction, which he pursued in Japan, New Zealand, Germany, and the United States.

Dr. Christina Holt

Dr. Christina Holt has a background in data assimilation for numerical weather prediction systems, and focuses her efforts on improving the software and software practices associated with those systems. She is the Product Owner of the UFS Unified Workflow Team and works with the UFS Community to find solutions for improving how we configure and run UFS components, and how we chain them together in workflows used both in research activities and for NOAA operations.

Dante M. L. Horemans

Before starting as a Postdoctoral Research Associate at Virginia Institute of Marine Science, I obtained a Bachelor's and Master's degree in theoretical physics and did my Ph.D. research at the Department of Biology (Antwerp, Belgium) in close collaboration with Delft Institute of Applied Mathematics (Delft, Netherlands). I have been combining theoretical work and application, including outreach to stakeholders both in Europe and the U.S.A. This uses numerical process-based models and statistical machine-learning techniques applied to physical and biogeochemical estuarine and coastal systems, and their interactions. I am especially intrigued by biogeophysical interactions and feedback mechanisms, such as the impact of estuarine phytoplankton on suspended sediment through flocculation, which I extensively studied during my Ph.D, or the effect of changes in environmental conditions on harmful algal blooms, which I currently study at Virginia Institute of Marine Science.

Ming Hu

Experts in data assimilation for operational regional NWP systems.

Bo Huang

Bo Huang an atmospheric scientist with extensive scientific and applied knowledge in data assimilation. His current research focuses on developing and extending aerosol data assimilation (DA) capability within Joint Effort for Data assimilation Integration (JEDI) and assisting its transition to operation at NCEP/EMC of NOAA.

Dr. Maoyi Huang

Maoyi Huang, Ph.D., joined the NOAA Weather Program Office (WPO) in August 2021 as the EPIC Program Manager. Prior to WPO, she was the COASTAL Act Program Manager and the lead of land, water, coastal, and cross-cutting infrastructure program areas with the National Weather Service Office of Science and Technology Integration's Modeling Programs Division. Her scientific expertise lies in understanding the complex multiscale interactions of terrestrial hydrological and ecological processes using an Earth system modeling approach through model development, applications, analysis, and model-data integration. She has published over 100 papers in peer-reviewed journals.

Prior to joining NOAA, Maoyi was a senior research scientist at Pacific Northwest National Laboratory from 2010-2020, where she was responsible for proposal development, scientific and software developments, project management, reporting, and review for projects funded by the Department of Energy, the National Aeronautics and Space Administration (NASA), and the United States Geological Survey. She was a research assistant professor in the Department of Civil, Structural, and Environmental Engineering at the State University of New York at Buffalo from 2008-2009 and a Postdoctoral Research Associate in the Department of Global Ecology at Carnegie Institution for Science from 2005-2008. She earned her master's and doctorate in civil and environmental engineering in 2001 and 2005 from the University of California at Berkeley.

Wei Huang

Wei Huang works at I2X Technologies and is a partner with RTX EPIC. Wei is currently working on implementing Global-workflow on NOAA-Cloud, which includes AWS, Azure, and Google. Before joining EPIC, Wei had worked on JEDI and GDASApp at NOAA/PSL. Wei is a software engineer of cloud computing and high performance computing, data analysis, and visualization with a strong meteorological background.

Wei-Ting Hung

I am a postdoc in the chemistry group at NOAA ARL affiliated with George Mason University. I got my PhD from the State University of New York, SUNY Albany. My research focuses on wildfire impacts on air quality in terms of emissions and transport, among others.

Irena Ivanova

Dr. Irena Ivanova recently joined George Mason University (GMU) as a research associate and a NOAA Air Resources Laboratory affiliate through the Cooperative Institute for Satellite Earth Systems Studies (CISESS). She received her PhD from McGill University, Canada, working on the explicit numerical simulations of aerosol-cloud interactions in boundary layer clouds, and a postdoctoral fellowship at Environment and Climate Change Canada (ECCC) Meteorological Research Division (MRD) developing the aerosol radiative effects in the Canadian Numerical Weather Prediction (NWP) model. She subsequently worked as a physical scientist at the Swedish Meteorological and Hydrological Institute (SMHI), developing the aerosol-cloud interactions in the Earth system model EC-Earth, and at the ECCC Air Quality Research Division working on numerical modeling and data assimilation of stratospheric ozone chemistry and dynamics. At GMU, she is currently developing the effects of forest canopy shading and turbulence on boundary layer ozone and meteorology.

Dr. Christiane Jablonowski

Christiane Jablonowski is a Professor in the Department of Climate and Space Sciences and Engineering at the University of Michigan. She received her Ph.D. in Atmospheric Science and Scientific Computing from the University of Michigan in 2004, was a postdoctoral scientist at the National Center for Atmospheric Research (NCAR), a visiting scientist at NOAA's Geophysical Fluid Dynamics Laboratory, and has worked as a consultant at the European Centre for Medium-Range Weather Forecasts (ECMWF) in the U.K..

Dr. Jablonowski's research portfolio includes atmospheric fluid dynamics, weather and climate modeling, including high-resolution modeling, tropical dynamics, model hierarchies and coupling techniques, numerical methods, scientific computing, and machine learning techniques for the climate sciences. She works with the weather and climate models from NOAA, the Department of Energy (DoE), and NCAR. She is a co-lead of the Short-Range-Weather application team for NOAA's Unified Forecast System (UFS), a member of the Steering Committee for NCAR's Community Earth System Model (CESM), and a former co-chair of the CESM Atmosphere Model Working Group. In 2011, she received the DoE Early Career Award and the Presidential Early Career Award for Scientists and Engineers (PECASE).

Dr. Neil Jacobs

Dr. Neil Jacobs is the Chief Science Advisor for the community Unified Forecast System, part of the University Corporation for Atmospheric Research's Cooperative Programs for the Advancement of Earth System Science and hosted at North Carolina State University. He previously served as both Acting Under Secretary of Commerce for Oceans and Atmosphere and Assistant Secretary of Commerce for Environmental Observation and Prediction, where he was responsible for the strategic direction and oversight of over $6 billion in annual spending, including key investments in space innovation, remotely-piloted autonomous systems, and the development of a community modeling framework to advance U.S. weather and climate prediction, while unlocking the partnership potential of non-governmental and private organizations to study the oceans and promote a blue economy. Dr. Jacobs holds BS degrees in mathematics and physics from the University of South Carolina, and an MS and PhD in air-sea interaction and numerical weather prediction from North Carolina State University.

Tara Jensen

Tara Jensen is a Project Manager at NSF NCAR/RAL and the Developmental Testbed Center. She has served as the Project lead for the enhanced Model Evaluation Tools (METplus) for just under 10 years. METplus is the verification and diagnostics software system that is available to the UFS model development community as well US and internationally based operational centers.

Chan-Hoo Jeon

Code manager of the Land-DA workflow and SRW-AQM (Short Range Weather Application for Air Quality Modeling) at NOAA/EPIC (Earth Prediction Innovation Center)

Dr. Israel Jirak

Dr. Israel Jirak is the Science and Operations Officer (SOO) at the NOAA/NWS/Storm Prediction Center (SPC). He joined the SPC in 2010 as a Techniques Development Meteorologist and was promoted to the SOO position in 2012. He earned a B.S. degree in Atmospheric Science from the University of Kansas and an M.S. and Ph.D. degrees in Atmospheric Science from Colorado State University. In his current position at SPC, Dr. Jirak advises on research projects for a Federal staff of ~30 forecasters and development meteorologists, as well as ~10 researchers at the University of Oklahoma Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO). He also serves as the focal point of research-to-operations at the SPC by collaborating with NOAA laboratories and academic institutions through the NOAA Hazardous Weather Testbed (HWT). In the HWT, Dr. Jirak co-organizes and co-leads the annual Spring Forecasting Experiment (SFE), which brings together forecasters, researchers, and developers from across the world to address severe weather forecasting challenges. Over the last decade, the HWT SFE has focused on developing and evaluating optimal configurations of convection-allowing models and ensembles for severe weather forecasting and testing innovative scale- and phenomenon-appropriate subjective and objective verification approaches.

Aaron Johnson
Research Scientist in the Multiscale data Assimilation and Predictability (MAP) lab at University of Oklahoma.

Dr. Benjamin Johnson
Dr. Benjamin Todd Johnson is an atmospheric scientist with extensive experience in the development and operational integration of radiative transfer models and satellite data assimilation systems. He currently holds the position of Project Scientist II at the University Corporation for Atmospheric Research / Joint Center for Satellite Data Assimilation in Boulder, Colorado, where he has been instrumental in advancing the capabilities of the Community Radiative Transfer Model (CRTM).

Dr. Johnson earned his Ph.D. in Atmospheric Science from the University of Wisconsin-Madison, where his research contributed significantly to the understanding and application of radiative transfer in atmospheric models. He also holds a Master’s degree in Atmospheric Science from Purdue University and a Bachelor’s degree in Physics from Oklahoma State University.

In his professional role, Dr. Johnson has managed diverse teams of scientists and engineers, overseeing significant projects that enhance the integration of satellite observations into weather prediction models. His work has led to the improvement of weather forecasting by incorporating advanced computational techniques and fostering collaborations across federal agencies and international partners.

Dr. Johnson is committed to the application of a holistic approach to solving complex meteorological challenges, focusing on the enhancement of predictive accuracy and operational efficiency in weather modeling. His leadership extends into community service, where he actively participates in workshops and seminars, aiming to elevate the scientific understanding and application of atmospheric data assimilation within the meteorological community.

Zakiya Johnson
Zakiya Johnson is a senior Meteorology major from Atlanta, Georgia attending Jackson State University. She has always been fascinated by meteorology, especially its social sciences aspect. Her research aims towards improving weather products and communication of weather across disciplines. Previously, she interned at the NCAS-M Experimental Training Summer Program, the National Weather Center, and participated in Research Experience for Undergraduates to present her research at conferences locally and nationally. Her goal is to inspire children to explore STEM careers and to help others understand weather through forensic meteorology.

Aaron Jones
Aaron is the Product Owner of the EPIC Community Engagement Team, a retired Air Force veteran with over 20 years of experience in weather operations, forecasting, and analysis. During his career, he gained valuable experience through multiple deployments managing high-tempo weather operations, as well as in many diverse areas such as cybersecurity infrastructure development,

network administration, and system implementation. Apart from his military experience, Aaron received his associate's degree in meteorology, a Bachelor of Science in Information Technology and a Master of Science in Cybersecurity.

Erin Jones

Erin Jones is a PhD student in the Multi-scale data Assimilation and Predictability (MAP) Laboratory at the University of Oklahoma. She received a Bachelor of Science in Meteorology from Millersville University of Pennsylvania and a Master of Science in Meteorology from the University of Oklahoma. Erin has also been the recipient of several awards, including an American Meteorological Society Graduate Fellowship. Her research focuses on the development and applications of multiscale and flow-dependent data assimilation to be utilized with global numerical weather prediction, specifically the UFS MRW application.

Sina Khani

I am a Research Scientist at CIRES CU Boulder / NOAA GSL. Previously, I was a Research Associate at UT Austin, working on coupled atmosphere-ocean-wave developments for storm surge forecasts from Aug 2021 to Feb 2024. I received my PhD in Applied Mathematics at the University of Waterloo in Canada in 2015. After my PhD, I held a few postdoctoral positions: I was a Postdoctoral Researcher at the Swiss Federal Institute of Technology at Lausanne (EPFL) working on atmospheric boundary layer turbulence using the Weather Research and Forecasting Model (2015-2016); I was a Postdoctoral Fellow at Princeton University (Princeton-GFDL) working on mesoscale eddy parameterizations in modular ocean model (2016-2019); and I was Postdoctoral Researcher at the University of Washington in Seattle working on subtropical upper-pycnocline energy distributions at North Pacific using observational data (2019-2021).

Dr. Jong Kim

Jong Kim works as the EPIC code management team product owner to support the UFS Weather Model and Application development and release. Jong's decades-long career has been focused on numerical weather forecasting and climate modeling. Before joining EPIC, he worked as a lead support scientist and software engineer at NOAA-NCEP EMC (Environmental Modeling Center) and NASA-GFDL GMAO (Global Modeling and Assimilation Office). His early career includes a computational scientist position at the Mathematics and Computer Science Division of the DOE Argonne National Laboratory. He received his Ph.D. from the University of Utah.

Dr. Daryl Kleist

Dr. Daryl Kleist is head of the Data Assimilation and Quality Control Group at the Environmental Modeling Center (NOAA/NWS/NCEP). His interests include operational data assimilation, numerical weather prediction, atmospheric predictability, targeted observing, and forecast sensitivity. He first joined the staff at EMC as a contractor in 2003, eventually becoming a federal employee in 2011. In 2014, he joined the faculty at the University of Maryland-College Park, Department of Atmospheric and Oceanic Sciences, where he remained until 2017, when he rejoined the federal staff at EMC. In addition to his position at EMC, he currently serves as editor for the monthly weather review and a member of the Scientific Steering Committee of the World Weather Research Programme at the World Meteorological Organization. He earned his B.S. and M.S. degrees at the University of Wisconsin-Madison and his Ph.D. at the University of Maryland-College Park.

Kim Klockow-McClain

Kim Klockow-McClain is a UCAR Senior Social Scientist supporting the National Weather Service/NCEP. In this role, Kim provides support within and across the National Centers to integrate social science knowledge into their products, practices and policies. Kim's research background involves behavioral science applied to weather and climate risk, especially in the communication of forecast uncertainty and response to hazardous weather warnings.

Joseph Knisely

Joseph Knisely is a PhD-track graduate student in the Department of Atmospheric and Oceanic Science at the University of Maryland. His research advisor is Dr. Jonathan Poterjoy. He is the recipient of the WPO Innovation for Next Generation Scientists (WINGS) Dissertation Fellowship. Joey received his Bachelor's in Physics from Penn State University. His primary research interests include data assimilation, observation bias correction, and tropical cyclone forecasting.

Chandra Kondragunta

Program Manager for the Joint Technology Transfer Initiative Program, WPO/OAR/NOAA.

Myung-Seo Koo

I have been developing the Korean Integrated Model (KIM) and oversee the development of a coupled model. To improve extended medium-range forecasts, we have introduced the Noah-MP land surface model and are working to enhance performance by comparing and verifying it with the existing Noah land surface model employed in KIM.

Dr. Terra Ladwig

Terra has a B.S., M.S., and Ph.D in Meteorology from the University of Oklahoma. Her research background is in hourly to sub-hourly EnKF assimilation of radar observations. She has been at GSL since 2014, contributing to rapidly updating assimilation for improved hazardous weather prediction. Terra has led the Data Assimilation Branch and is currently the Deputy Chief for the Assimilation and Verification Innovation Division (AVID).

Samantha Lang

Samantha Lang is a fourth-year undergraduate student majoring in meteorology and minoring in marine science at N.C State University. She is an intern with the NOAA William M. Lapenta student internship program as the 2024 Student Ambassador for the Unified Forecast System, working under the direction of the Earth Prediction Innovation Center team and the Weather Program Office at NOAA Headquarters in Silver Spring, MD. She is working to improve the UFS Student Engagement Plan created by last year's student ambassador to improve outreach between the UFS and academia/students and the meteorology curriculum. She is under the mentorship of Jennifer Vogt, Alison Gregory, Neil Jacobs, and Maoyi Huang. She is very honored to have this opportunity to speak at UIFCW 2024.

Jason Levit

Jason Levit has been the Branch Chief for the Verification, Post-Processing, and Product Generation Branch at the NOAA Environmental Modeling Center since 2017. Prior to joining EMC, Jason held positions in government, academia, and the private sector, all focusing on integrating science and technology together to help forecast hazardous weather.

Tsung-Han Li

Worked at Multi-scale Data Assimilation and Predictability [MAP] Laboratory led by Prof. Xuguang Wang for a couple of years.

Dr. Wei Li

Wei holds a Ph.D. in Atmospheric Science from the University of Houston and has extensive experience developing and running air quality models.

Weiwei Li

Always has a strong passion for helping enhance the predictive capabilities of multiscale processes with longer lead times. I deeply believe that 1) advancing model physics and associated formulations for realistically representing physical processes and 2) improving our knowledge of sources of predictability are two essential ingredients (in addition to optimizing model initialization) for fundamentally increasing forecasting accuracy, reliability and lead times on physical grounds. My research has been following these two directions and covering atmospheric processes across multiple spatiotemporal scales, involving moist convection, atmospheric boundary layers, synoptic-scale phenomena such as tropical cyclones, African easterly waves, and Rossby wave breaking, and up to the Madden-Julian Oscillation (MJO) and large-scale circulation. My background also includes large-scale diagnostics, combined with comprehensive knowledge of model physics through actively working for the Common Community Physics Package (CCPP) and its associated single-column model (SCM) related projects. Currently leading two Developmental Testbed Center (DTC) projects: "Testing and Evaluation of Unified Forecast System (UFS) Physics for Operations: Advanced Physics Testing, Evaluation and Improvement" (NOAA UFS R2O) and "Toward a Unified Physics Package for the UFS Applications: Advanced Physics Testing, Evaluation and Improvement" (NOAA OAR), and participating multiple other model physics related projects under DoE and NCAR.

Meiyun Lin

Meiyun Lin started federal service as a Physical Research Scientist at NOAA Geophysical Fluid Dynamics Laboratory (GFDL) in September 2021. From June 2010 to September 2021, she was a Research Scholar at NOAA GFDL and Princeton University’s Cooperative Institute for Modeling the Earth System. Lin’s research seeks to advance knowledge on the interactions of air quality with weather and climate to inform public policy. Specifically, her current research focuses on land-biosphere feedback to air quality extremes in a changing climate, such as reductions in ozone removal by drought-stressed vegetation, increases in wildfire and dust emissions, and changes in BVOC emissions from vegetation. She leads development of the GFDL variable-resolution global chemistry-climate model (AM4VR) for research at the nexus of U.S. climate and air quality extremes. Her article (Lin M. et al., JAMES 2024) documenting this model was selected for featuring as an Editor's Highlight by AGU. Her past research has examined how climate variability and change modulates intercontinental pollution transport, intrusions of stratospheric ozone deep into the troposphere, and their impacts on surface air quality. Learn more about Lin's research at https://www.gfdl.noaa.gov/meiyun-lin-homepage/.

Eric Lingerfelt
Eric Lingerfelt is a senior software engineer on the JEDI core team at the JCSDA. He is the project lead for the Research Repository for Data and Diagnostics (R2D2) distributed data management system.

Bin Liu
UFS Hurricane Analysis and Forecast System developer and repository admin.

Dr. Yonggang Liu
Dr. Yonggang Liu currently serves as the Director of the Ocean Circulation Lab at the College of Marine Science, University of South Florida. As a physical oceanographer, he aims to better understand the ocean circulation on the West Florida Shelf, including the interactions/exchanges of water properties between the estuaries, the shelf, and the offshore (Loop Current) system of the Gulf of Mexico. He uses both in situ observations and numerical models in coastal ocean research, and he is interested in applying physical oceanography to marine environmental issues, such as storm surge forecasts, wastewater plume modeling, oil spill tracking, and Karenia brevis red tide predictions. He also develops and applies novel data analysis methods in meteorology and oceanography.

Dr. Zhiquan (Jake) Liu
Dr. Zhiquan (Jake) Liu is an expert in data assimilation with more than 20 years of experience in the field. He is a Project Scientist IV at the Mesoscale and Microscale Meteorology (MMM) Laboratory of the NSF National Center for Atmospheric Research (NCAR). He is currently the lead of WRF Data Assimilation and the Deputy head of the Prediction, Assimilation, and Risk Communication (PARC) within MMM. He has developed satellite radiance DA capability in WRFDA and applied satellite DA to improve severe weather and air-quality prediction over the years. In the past several years, Dr. Liu has also been leading a team for the development of MPAS-JEDI, i.e., the new generation MPAS data assimilation system based upon the Joint Effort for Data assimilation Integration (JEDI).

Dr. Sarah Lu
Sarah Lu completed her BS in Atmospheric Physics at National Central University, Taiwan, and her MS and PhD in Atmospheric Sciences at University at Albany, State University of New York (SUNYA).

She is a research associate with Atmospheric Sciences Research Center (ASRC), SUNYA. She is also affiliated with the Joint Center for Satellite Data Assimilation (JCSDA/UCAR). Her research focuses on quantifying the distributions of tropospheric aerosols, its impact on weather forecasts and climate predictions, and improving aerosol forecasts through the assimilation of satellite and in situ observations. Her group also conducts regional air quality modeling research to investigate how pollutant distributions are affected by local weather patterns, characterize pollutant transport and evolution, and quantify the contributions from local versus non-local emission sources.

Xu Lu

I am an earlier career physical scientist working on hurricane data assimilation.

Murali Nageswara Rao Malasala

Dr. Murali Nageswara Rao is an accomplished Meteorology and Oceanography expert with over 18 years of experience, currently serving as UCAR Associate Scientist-II at NOAA's Environmental Modeling Center (EMC). He earned his Ph.D. and master's in physical Oceanography from Andhra University. Dr. Rao specializes in enhancing weather and climate forecasts through advanced downscaling techniques, focusing on model climatology and diagnostic analysis globally. He uses methods like the Frequency Match Method (FMM), Quantile-Mapping (QM), Machine Learning (ML), and Deep learning models to improve forecast accuracy, particularly for atmospheric rivers and associated precipitation over the US West Coast.

Dr. Rao's career includes contributions to major international projects and roles at leading institutions such as the IITs in Delhi and Bhubaneswar, IITM Pune, The University of Texas at Austin, NOAA NCEP CPC International desks, etc. He has published around 50 papers in prestigious journals and is a member of multiple meteorological societies. His work has earned him numerous awards, including the UCAR Special Recognition and the IMS Biennial Monsoon Research Awards. Dr. Rao continues to develop innovative forecasting products to improve risk management in sectors like agriculture, health, and water resources.

Dr. Cory Martin

Dr. Cory Martin is a Physical Scientist in the Data Assimilation and Quality Control Group at the NOAA NWS National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC). His primary responsibilities are to aid in the transition of operational data assimilation systems to the Joint Effort for Data assimilation Integration (JEDI) framework and to help coordinate land surface and atmospheric composition data assimilation activities for EMC. He has a BS in atmospheric sciences from Ohio State University and an MS and PhD in atmospheric and oceanic science from the University of Maryland, College Park.

Dr. Jonathan Martinez

Dr. Jonathan Martinez is a Research Scientist at the Cooperative Institute for Research in the Atmosphere (CIRA) and is stationed at the National Hurricane Center (NHC) in Miami, FL. Jon's research background primarily specializes in the multiscale dynamics contributing to tropical cyclone formation, intensification, and expansion. His research approach blends a variety of observational techniques and high-resolution numerical simulations to comprehensively investigate the tropical cyclone life cycle. Jon is currently working at CIRA/NHC under the Hurricane Forecast Improvement Program (HFIP) with a focus on developing research-based applications and products to aid tropical cyclone forecasts.

Renediego Martinez

ReneDiego "Diego" Martinez is from San Antonio, Texas, a rising junior at Texas A&M University-Corpus Christi, majoring in Atmospheric Science and minoring in Applied Mathematics. Diego is currently completing his Bachelor's degree and will graduate in Spring 2026. He plans to continue his education by obtaining his Master's degree in Atmospheric Science and his PhD in Atmospheric Science, focusing on severe mesoscale meteorology. Diego is a NOAA Educational Partnership Program with Minority Serving Institutions (EPP/MSI) Class of 2024 Scholar. He is extremely passionate about meteorology and the processes involved in tornadogenesis in supercells, and he hopes to be able to further predict and model the development of tornadoes. This past summer, Diego had the opportunity to intern at the Office of Oceanic and Atmospheric Research (OAR) in the Earth Prediction Innovation Center (EPIC) and support the Global Data Assimilation System (GDAS) Proxy Application utilized in the Unified Forecast System (UFS).

Jeff McQueen

Research meteorologist at NWS NCEP and AQ model team leader.

Jessica Meixner

Jessica Meixner is a Physical Scientist in the Coupled Modeling Division at the Environmental Modeling Center (EMC) within NOAA/NWS/NCEP. Jessica is serving as the co-project lead for the transition to operations project for the next Global Forecast System, GFSv17, and is co-lead of the marine cross-cutting team for UFS-R20. She received her bachelor of science in Mathematics from Texas Tech University and an MS and PhD in Computational and Applied Mathematics from The University of Texas at Austin.

Dr. Saeed Moghimi

After completing his PhD in 2005, Dr. Saeed Moghimi spent four years in an assistant professor position in the Department of Civil Engineering of Arak University. In 2009, he was awarded an Alexander von Humboldt fellowship in Physical Oceanography at the Institute for Baltic Sea Research, Germany. His scientific research on model coupling, water column turbulence and mixing, wave modeling, coastal ocean circulation modeling, wave-current interaction, and the use of data assimilation methods for predicting coastal ocean geophysical variables made him one of the few people with this caliber and expertise for tackling coastal modeling related problems.

He serves as the NOAA's National Ocean Service Storm Surge Modeling Team Lead at the Coastal Marine Modeling Branch at CSDL/OCS/NOS/NOAA. He is leading all related efforts concerning the operational storm surge and tide forecast system capabilities, such as 1) research and development, 2)research-to-operation (R2O), 3) operational support, 4) regular upgrades and maintenance, and 5) skill assessment and dissemination.

Margarita Mora

I am a Master's student at Howard University. I was raised in California's Bay Area and obtained my Bachelor's in Meteorology from San Jose State University. My goal in pursuing meteorological research is to aid underprivileged communities through the continued development of forecasting models.

Dr. Isaac Moradi

Dr. Isaac Moradi has over 20 years of experience as a remote-sensing scientist. Currently a Research Scientist at the University of Maryland (UMD), affiliated with the NASA Global Modelling and Assimilation Office and NOAA STAR, he brings a wealth of knowledge in radiative transfer modeling, data assimilation, and analyzing satellite data, with a particular focus on microwave and radar observations.

In addition to mentoring several undergrad and graduate students and junior faculty, he is a member of the AMS Committee on Radio Frequency Allocation, executive member of the AMS Forecast Improvement Group (FIG), UMD Senate, UMD Appointment, Evaluation, and Promotion, and the UMD Research Council.

Nowrin Mow

Nowrin is a M.Sc. student in the Marine, Estuarine, and Environmental Science (MEES) program at the University of Maryland Eastern Shore. In addition to being a student, she also serves as a lecturer for Principles of Biology Labs within the Department of Natural Science there. Prior to her current endeavors, she earned her bachelor's degree in civil engineering and completed a master's in structural engineering at the Bangladesh University of Engineering and Technology. Before transitioning to academia, she honed her technical and management skills during her five-year industry tenure. Her current research interests revolve around environmental engineering, particularly physical oceanography and numerical modeling.

Dr. Louisa Bogar Nance

Dr. Louisa Bogar Nance earned her B.S. in Atmospheric Science from Oregon State University and Masters of Science and Ph.D. in Atmospheric Science from University of Washington. Following postdoctoral fellowships with COMET and the National Research Council, Dr. Nance joined the University of Colorado, Cooperative Institute for Research in Environmental Sciences (CIRES) as a Research Associate with the Environmental Technology Laboratory (ETL). During her time at ETL, she participated in a number of field programs (e.g., Mesoscale Alpine Programme and PacJET) and projects focused on providing new tools to operational forecasters. In 2003, Dr. Nance moved to NSF NCAR as the first official hire for the WRF Developmental Testbed Center (DTC), an effort focused on accelerating the transition of research to operations to advance the skill of operational numerical weather prediction models. After serving as the Acting Director of the DTC for 14 months, Dr. Nance was appointed Director of the DTC on June 6, 2019.

Dr. Andrew Newman

Dr. Andrew 'Andy' Newman has Atmospheric Science B.S. and M.S. degrees from the University of North Dakota and a Ph.D. in Atmospheric Science from Colorado State University. He has been at the US National Center for Atmospheric Research (NCAR) since 2011, where he is a hydrometeorologist focusing on developing actionable Earth science for partners spanning water, climate, human health, and heat across spatiotemporal scales. When he is not at work, he's mostly trying to keep up with his six and three year old daughters and Lucy, the beagle.

Hassan Mahdy Nooreldeen

With a robust background in astrophysics and space weather, Hassan holds a B.Sc. in Space Science. He is pursuing an M.Sc. in the same field, specializing in forecasting space weather hazards for space-based applications and serving as a Space Environment Engineer at the Egyptian Space Agency, focusing on Satellites Mission Design, and developing diagnostic models for space environment characterization and prediction. Hassan's expertise lies in optimizing mission efficiency while addressing the challenges posed by the unpredictable space environment and dynamic space weather conditions.

Dr. Maitane Olabarrieta

Dr. Maitane Olabarrieta is an Associate Professor at the Civil and Coastal Engineering Department and an Associate Director of the Center for Coastal Solutions at the University of Florida. Her research interests cover diverse oceanographic processes related to coastal hazards: flooding, erosion, and transport of contaminants. Her main research goal is to improve the predictive capabilities of coastal hazards using numerical models: transport of pollutants, erosion, and flooding during extreme events and long-term coastal morphodynamic changes. She received her Ph.D. from the University of Cantabria (Spain) in 2006. She was one of the main developers of the OPROMS oceanographic forecast system currently used by the Environmental Institute of Cantabria (IH-Cantabria). In 2009, she moved to Woods Hole (USA), where she started her postdoctoral research at the USGS (Woods Hole Center). In 2013, she joined the University of Florida as an assistant professor, leading the Coastal Hazards Modeling Lab. Undergraduate and graduate students in the Coastal Hazards Modeling Lab combine advanced numerical modeling, in situ measurements, and remote sensing to analyze the feedback between the hydrodynamics, contaminant and transport processes, and coastal morphology at various spatial and temporal scales. Dr. Olabarrieta's work on coastal morphodynamics has been recognized by the Presidential Early Career Award for Scientists and Engineers 2019, the AGU's Outstanding Reviewers Recognition Award 2018, and the NSF Early Career Development Award 2016.

Yanda Ou

My interest is oceanic modeling, including process-based physical-biogeochemical models, ML/AI models, and operational modeling systems. My study area is the Gulf of Mexico and estuaries along the coastal Gulf.

William (Bill) L. Parker Jr.

William "Bill" Parker is a graduate of Jackson State University and is currently the meteorologist-in-charge of the National Weather Service Weather Forecast Office in Jackson, MS, better known as "Action Jackson". This office serves some of the most weather-vulnerable communities in our nation, covering parts of Mississippi, Louisiana, and Arkansas.

Bill strongly believes in serving his local community and is a true diversity champion. Over his nearly thirty years of service within the National Weather Service, he has successfully recruited hundreds of students to work in NOAA facilities through volunteer and internship opportunities. As a result, Bill has received 14 awards directly related to being a diversity champion and promoting STEM education and outreach for NOAA.

Bill understands the direct impacts hazardous weather has on minority and underserved communities. After personally warning and alerting his own family members of the dangers of Hurricane Katrina, he also housed more than sixty evacuees after the devastating storm. He has served in ministry for 26 years, including serving as a foreign missionary in Haiti, and currently serves as the Pastor of Word Alive Church and Communion House. Bill has been married to Mrs. Melanie Quincy Parker for 28 years, and they have three sons and one daughter.

Philip Pegion

Mr. Philip Pegion is a physical scientist at NOAA's Physical Sciences Laboratory and deputy division chief of the Modeling and Data assimilation division. Mr. Pegion received his Masters of Science in Meteorology from Florida State University in 1999, then worked in the NASA Seasonal-to-Interannual Prediction Project/Global Modeling and Assimilation office for over eight years, then one year at the National Weather Service's Climate Prediction Center before moving joining the Physical Sciences Laboratory (formally Division) through the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado in 2009.

His current research focuses on improving numerical weather prediction through advances in atmospheric modeling, data assimilation, and better use of ensembles by better accounting of model uncertainty with a focus on Seasonal prediction. Philip has authored or co-authored over 40 peer-reviewed publications and presented at many national and international meetings, including invited talks to ECMWF, CWB, and NCEP.

Jiayi Peng

A senior meteorologist.

Dr. Natalie Perlin

Dr. Natalie Perlin has a background in engineering meteorology, atmospheric sciences, and numerical Earth System modeling. She received her Ph.D. from Tel-Aviv University. Dr. Perlin brings more than 25 years of experience in numerical modeling and data analysis in atmospheric and ocean sciences. She has worked on many projects that included model improvement and software development for the users' community, design and implementation of coupled modeling systems, development of post-processing algorithms, and visualization methods applied to observational and modeling data in environmental sciences. Dr. Perlin joined the NOAA EPIC project in 2022 as a Sr. Systems Engineer.

Gillian Petro

Gillian Petro is the user support team lead at the Earth Prediction Innovation Center (EPIC). She has worked on documentation and user support for the Short-Range Weather Application, the UFS Weather Model, the Land Data Assimilation System, the Unified Post Processor, and the Hurricane Analysis and Forecast System. Gillian brings a diverse range of experience to the EPIC Program thanks to her previous work for the National Institute of Standards and Technology (NIST), Baltimore City Public Schools, and the American University Law Review.

Gillian received an M.S. in Data Analytics from University of Maryland Global Campus and a J.D. from American University Washington College of Law. In law school, she served as senior staff on the American University Law Review, which published her legal commentary and provided ample opportunity to edit and fact-check legal scholarship.

Mariah Pope

Mariah enjoys working at the intersection of environmental science & engineering, and data science to study climate and weather. She is currently working as a Senior Data Scientist at Tomorrow.io and works with EPIC on the atmospheric rivers team. Prior to this, she earned both a Bachelor of Science in Biological Sciences from Clemson University and a Master of Science in Earth and Environmental Engineering from Columbia University. Since 2015, Mariah has worked as an environmental scientist, a senior research scientist studying climate and weather for private companies, and studied atmospheric rivers as a research assistant at NASA.

Dr. Jonathan Poterjoy

Jonathan is an Associate Professor at the University of Maryland, where he runs a research group that focuses on various aspects of data assimilation for Earth system models.

Mark Potts

Mark graduated from the University of Colorado, Boulder with a Ph.D. from the Program for Atmospheric and Oceanic Sciences. Mark worked for several organizations, including the Department of Defense, NASA, and private industry before coming to NOAA in 2015 as a Senior Computational Scientist for the Environmental Modeling Center. He has 25 years of experience in scientific research and HPC software development. Currently, Mark is leading the effort to couple JEDI to the UFS and chairs the UFS Release Coordination Cross-Cutting Team.

Corey Potvin

Dr. Corey Potvin is a research meteorologist at the NOAA/OAR National Severe Storms Laboratory (NSSL) and an affiliate faculty member of the University of Oklahoma (OU) School of Meteorology. He received M.S. and Ph.D. degrees in meteorology from OU in 2006 and 2010. Since 2012, Potvin has been contributing to NSSL's Warn-on-Forecast (WoF) program, which is endeavoring to operationalize a convection-allowing ensemble – the WoF System (WoFS) – that provides real-time forecast guidance for thunderstorm hazards. He co-chairs the NOAA AI Working Group and is a member of the NSF AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography (AI2ES). Dr. Potvin's expertise includes idealized storm modeling, ensemble data assimilation and prediction, forecast verification, traditional machine learning, and deep learning.

Zhaoxia Pu

Dr. Zhaoxia Pu is a professor of atmospheric sciences at the University of Utah, a fellow of the American Meteorological Society and a fellow of Royal Meteorological Society, and a member of NOAA Science Advisory Board. Her research is devoted to improving the prediction of high-impact weather and extremes. Areas of interests include numerical weather prediction, data assimilation, numerical modeling, and predictability.

Matthew Pyle

Matthew works as a physical scientist within the Engineering and Implementation Branch of the Environmental Modeling Center. He's currently helping to manage the implementation of the Rapid Refresh Forecast System (RRFS). He has historically been involved with getting scientific upgrades for high-resolution regional models into operations, such as the High Resolution Ensemble Forecast (HREF) system and its constituent models.

William Ramstrom

William Ramstrom is a senior software engineer in the Modeling Group at NOAA's Hurricane Research Division and U. Miami/CIMAS, focused on developing moving nests in the Hurricane Analysis and Forecast System (HAFS).

He earned a BS in Computer Science and an MS in Atmospheric Science from both MIT.

His prior work in the private sector included operational aviation weather forecasting, real-time WRF forecasts, radar data assimilation, and hurricane vortex initialization.

Dr. Miodrag Rancic

Dr. Miodrag Rancic received his Ph.D. in Meteorology (1988) from the School of Meteorology, University of Belgrade, Serbia. He held a postdoctoral appointment (1989-1992) at the Center for Analysis and Prediction of Storms (CAPS) at the University of Oklahoma. He has worked ever since at NCEP on various problems related to numerical modeling of atmosphere and data assimilation.

For the last couple of years, he has been developing a new covariance operator at EMC, working with the 3DRTMA team.

Dr. Andrea Ray

Dr. Andrea Ray is a scientist at the NOAA Research Physical Sciences Lab (PSL), a coordinator for the NWS/OAR Hydrometeorological Testbed, and the Chair of the cross-NOAA Testbed and Proving Ground Coordinating Committee (TBPGCC). For most of her career, her work has focussed on understanding user needs across time scales and transitioning research into applications and use in a variety of contexts (R2X), as well as feeding back needs to research and X2R). Dr. Ray often serves as a connector or translator between the weather and climate research/info and the practitioners and researchers who use/could use it. She also works to assess the needs of natural resources and other decision-makers for weather, water, and climate knowledge to better inform them about critical environmental vulnerabilities and to cultivate community stakeholder relationships for NOAA science. Dr. Ray was involved for many years in the NOAA Regional Integrated Climate and Assessment (RISA) for the Interior West, and in 2020, she served as the acting Testbed Portfolio Manager for the NOAA Weather Program Office. She holds a Doctorate in Environment and Society Geography and a Certificate in Environmental Policy from the University of Colorado, a Masters in Oceanography from the University of Delaware, and a Bachelor's in Geophysical Sciences from the University of Chicago.

Sulagna Ray

Sulagna Ray is a physical oceanographer who trained and worked on the evaluation of UFS prototypes, with a particular focus on ocean forecasts at the Environmental Modeling Center. Her expertise involves understanding the dynamics of the upper ocean processes and related ocean-atmosphere interactions relevant to sub-seasonal to decadal-scale predictions. Her research takes advantage of observation-based estimates like reanalysis, in parallel to in-situ observations, to study the dynamics of the upper ocean. In her current position, she contributes towards the development of GFS, GEFS, and SFS applications through in-depth evaluations of ocean analyses and forecasts. She develops diagnostics of ocean-atmosphere interactive processes in parallel. She holds a doctorate in Oceanography from Texas A&M University and a Masters in Applied Mathematics from University of Calcutta.

Christopher Rozoff

A project scientist working in mesoscale meteorology, extreme weather, and prediction.

Dr. Benjamin Ruston

Dr. Benjamin Ruston is a senior research scientist at the University Corporation for Atmospheric Research (UCAR), where he leads an innovative observation team at the Joint Center for Satellite Data Assimilation (JCSDA). At the forefront of environmental observation assimilation, Dr. Ruston and his team are developing cross-cutting strategies while examining new missions and pioneering techniques. Their work focuses on creating adaptable and customizable solutions for complex assimilation systems and effectively using a large and diverse volume of observations.

The JCSDA is renowned for developing the Joint Effort for Data Assimilation Integration (JEDI). At the JCSDA, Dr. Ruston and the OBS team have a mission to build a configurable platform that swiftly adapts to incorporate environmental observations across a wide range of scientific applications. This platform enables researchers to effortlessly explore various scientific avenues, such as quality control adjustments, observation error and correlation analysis, and increasing the volume of assimilated observations.

Central to their efforts is the Unified Forward Operator (UFO) component of JEDI, which Dr. Ruston and his team continue to develop, guide, and support. Their goal is to enhance the demonstration process, improve the effective use of observational data, and achieve the perfect balance between complementary observing systems.

Dr. Christian Sampson

Christian is an applied mathematician with a background in Climate and Earth science. He has studied and modeled physical processes in sea ice and traveled to the Arctic and Antarctic for fieldwork. More recently, he has been involved in data assimilation as it applies to problems in weather and climate. He is excited to continue in this field at JCSDA!

Dr. Greg Seroka

Greg Seroka is an oceanographer and meteorologist with the Office of Coast Survey in the National Oceanic and Atmospheric Administration (NOAA).

Dr. Seroka supports marine navigation and disaster mitigation through several projects. He recently led an effort to operationalize and upgrade a state-of-the-art global model for forecasting storm surge and tides, and serves as Project Manager for an effort to improve its performance in the Pacific region. He is currently leading the operational transition of annual upgrades to the model's global, Atlantic and Pacific three-dimensional components. These forecast tools are essential for safe and efficient marine navigation and protecting coastal communities during storms. Dr. Seroka is also involved with an international effort to standardize oceanographic data for mariners, such as water levels and surface water currents, which are important for developing coherent marine navigation systems across international waters.

Prior to his work at NOAA, Greg earned his Ph.D. in physical oceanography from Rutgers University with a Graduate Certificate in Energy. His research improved hurricane intensity forecasts and assessed offshore wind energy resources in the U.S. Mid-Atlantic. He received his master's in atmospheric science from Texas A&M, where he worked on improving lightning forecasts, and his bachelor's (honors) in meteorology from Penn State, where he served as President of the Campus Weather Service.

Hui Shao

Team lead on Unified Forward Operator Development and Space Weather Application at JCSDA.

Dr. JungHoon Shin

I am a HAFS model developer at EMC/NOAA. I received my Ph.D. at the University of Maryland in the US, and during my Ph.D. course, I studied Hurricane Sandy by using the WRF model with an advanced bogus vortex algorithm. So, I have a strong background in hurricane dynamics and vortex initialization. I have been working at the EMC hurricane model team since 2019. In the EMC hurricane model team, I am leading the improvement of HAFS vortex initialization system. Also, although my main task at the EMC hurricane model team is vortex initialization, I am doing some HAFS physics optimization as a side task.

Zachary Shrader

I am a Systems Engineer and Scrum Master for NOAA EPIC Code Management. I have worked on the EPIC project and for Raytheon for three years.

Alen Shrestha

I am a water resources engineer at Olsson. My interests lie in linking AI and ML to water resources engineering (WRE). WRE is a vast field, and my expertise actively deals with hydrology and hydraulics at the watershed level. Regardless of the size, the goal is to provide efficient flood management solutions.

Dr. Jamese Sims

Dr. Jamese Sims is the Owner and Chief Executive Officer of Thee Anomaly, LLC, a meteorology consulting firm, and the creator and host of Thee Anomaly Podcast. Dr. Sims previously served as the National Oceanic and Atmospheric Administration (NOAA) Senior Science Advisor for Artificial Intelligence and Director of the Modeling Program within the National Weather Service Office of Science and Technology Integration. In 2020, Dr. Sims established and chaired the NOAA Science and Technology Synergy Committee to coordinate strategic planning of NOAA's emerging science and technology and, from 2019-2021, Dr. Sims served as co-chair of the NOAA Diversity and Professional Advancement Working Group, a NOAA-wide employee resource group focused on the recruitment, retention, and advancement of underrepresented groups within the NOAA workforce. Sims received a B.S. in meteorology from Jackson State University and a Ph.D. in atmospheric sciences from Howard University.

Bill Skamarock

Dr. Skamarock is a senior scientist and head of the weather modeling and research section of the Mesoscale and Microscope Meteorology Laboratory at the National Science Foundation's National Center for Atmospheric Research. He was one of the lead scientists for the Advanced Research WRF model and is the lead scientist for the Model for Prediction Across Scales - Atmosphere.

Dr. Stephan Smith

Steve Smith joined the National Weather Service (NWS) in 1993 and has brought diverse and talented people from different organizations together to solve challenging problems. Prior to his current position, he was Director of NWS' Meteorological Development Lab. He has been a catalyst in improving the transition of research to operations by creating policies, processes, and funding initiatives. In addition, he has been a leader in promoting diversity, healthy organizational culture, and service equity toward advancing NWS's mission. As Director of the Office of Science and Technology Integration (OSTI), Steve is responsible for the Meteorological Development Laboratory (MDL), the Operations Proving Ground (OPG), the NWS Modeling Program, and the NWS Social Behavioral and Economic Science Program, which he established in 2022. Steve earned his Ph.D. and M.S. degrees in Meteorology from McGill University in Montreal, Canada. He received his B.S. in Mathematics and Physical Sciences from the University of Maryland.

Edward Snyder

Eddie graduated from the University of Oklahoma in 2015 with a bachelor's degree in meteorology. He has spent nearly a decade in the private meteorology sector and has been employed in various roles. Throughout this time, he was a business-to-business and business-to-customer support specialist, a forensic meteorologist team lead, and a meteorological developer. He helped migrate on-premises workflows to AWS and automated manually intensive jobs using Python and AWS services. Currently, he is a member of the EPIC Software Integration Team, where he helps develop, support, and test the UFS Weather Model and its applications.

Sulagna Ray

Sulagna Ray is a physical oceanographer by training, working towards understanding the physical processes driving upper ocean variability relevant to predictions across time scales. She is a climate scientist involved in model diagnostics, building tools and metrics for evaluating ocean-atmosphere interactive processes in next-generation climate models.

Hui Shao

Team lead on Unified Forward Operator Development and Space Weather Application at JCSDA.

Kathryn Shontz

Kathryn is the Deputy Director of the NOAA/NESDIS Office of Common Services, which is responsible for implementing NESDIS enterprise IT systems, including the development and migration of all NESDIS data and production to the NESDIS Common Cloud Framework. Kathryn also serves as the NOAA Modeling Team Chair for all of NOAA, aligning modeling activities and investments across the organization.

Kathryn previously served in the Office of the Under Secretary for NOAA to develop and demonstrate an enterprise cloud-based Data Lake, focusing on support to near-real-time applications. In her recent role as Cloud Innovation PM at the NESDIS Office of Satellite Architecture and Advanced Planned (OSAAP), Kathryn delivered the prototype NESDIS cloud infrastructure enterprise solution, where she led an integrated development team of organizational experts. She also created the NESDIS-level Requirements to empower a data-driven procurement of satellite data and sensors to meet the mission. Kathryn has held program management, systems engineering, and science positions across NESDIS and NOAA, highlighting her expertise in IT systems, scientific code integration, and data management.

Kathryn holds a Master of Science degree in Atmospheric and Oceanic Science from University of California, Los Angeles, specializing in high resolution modeling of hurricane rapid intensification, and a Bachelor of Science in Meteorology from Florida Institute of Technology.

Dr. Ivanka Stajner

Dr. Ivanka Stajner is the Acting Director of the Environmental Modeling Center (EMC) at NOAA's National Weather Service. EMC is a leader in developing the earth system model in the United States. The center develops, integrates, tests, and implements a suite of models that provide foundational operational guidance used by forecasters to produce life-saving watches and warnings for significant environmental and weather events.

Ivanka has been EMC's Deputy Director since 2018. Previously, Ivanka was the Deputy Manager for the National Weather Service, Office for Science and Technology Integration Modeling Programs such as the Next Generation Global Prediction System (NGGPS) and Hurricane Forecast Improvement Program (HFIP). She was the manager for the National Air Quality Forecast Capability (NAQFC), which provides operational predictions of ozone concentrations, fine particulate matter (PM2.5), wildfire smoke, and windblown dust in the air we breathe. Prior to joining NOAA, Ivanka was a lead scientist at Sciences Applications International Corporation (SAIC). She led the efforts to combine satellite ozone observations with global atmospheric models at the Global Modeling and Assimilation Office (GMAO) of NASA’s Goddard Space Flight Center in Greenbelt, Maryland. Using data assimilation techniques, she studied stratospheric and tropospheric ozone.

Ivanka earned her Ph.D. and M.S. in mathematics from the University of Illinois in Urbana-Champaign and her B.S. in mathematics from the University of Zagreb in Croatia. She was an Associate Editor for the Journal of Geophysical Research-Atmospheres.

Dr. Cristiana Stan

Professor Cristiana Stan holds a Bachelor of Science in Physics and a Master of Science in Atmospheric Physics from University of Bucharest. She received her Ph.D. in Atmospheric Science from Colorado State University for her theoretical work in the field of geophysical fluid dynamics. Her research interests center on weather and climate prediction and predictability with a focus on the large-scale dynamics and predictability of tropical and midlatitude variability. With her group, Cristiana conducts research on topics addressing the role of cloud representation in modeling tropical cyclone activity, monsoon circulations, Madden-Julian Oscillation, and ENSO under current conditions and future climate change scenarios, tropical-extratropical teleconnections on intraseasonal time scale, and subseasonal-to-seasonal variability of the extratropics. She is also involved in the development of ML/AI methods for climate data analysis.

Professor Stan is a member of the Steering Group of the WMO/WWRP SAGE Project and a member of the WMO/WCRP Joint Scientific Committee (JSC). She is the co-lead of the UFS MRW/S2S Application Team.

Dr. Tao Sun

Tao Sun received his B.S. and Ph.D. from Nanjing University of Information Science and Technology, China. He is currently a Project Scientist 1 in the Mesoscale and Microscale Meteorology Laboratory, NSF National Center for Atmospheric Research. His main research interests are multiscale assimilation algorithms, satellite radiance/radar data assimilation, and short-term numerical weather prediction (NWP). He is currently working on the ensemble data assimilation based on the Joint Effort for Data assimilation Integration (JEDI) with the Model for Prediction Across Scales - Atmosphere (MPAS-A) (MPAS-JEDI).

Shan Sun

Shan Sun is the chief of the S2S branch at the Earth Prediction Advancement Division in the Global Systems Laboratory at NOAA. Her focus is on the development of coupled models for sub-seasonal to seasonal applications. She has multi-year hands-on experience working with atmosphere, ocean, sea-ice and aerosols modules in the Unified Forecast System. Her research interests range from short-term numerical weather prediction, sub-seasonal to seasonal predictability, ocean-atmosphere interaction, to oceanic thermohaline circulation and climate change and variability.

Dr. Yunfang Sun

Dr. Yunfang Sun received his Ph.D. in Marine and Atmospheric System Modeling and Analysis from the University of Massachusetts School of Marine Science. His research encompasses global climate change, sea level rise, natural hazards, rainfall dynamics, data mining and machine learning, harmful algal blooms, fishery dynamics, estuary and coastal ocean processes, remote sensing, and HF radar ocean observation, as well as the dynamics of coupled oceanic-atmospheric modeling.

Dustin Swales

Physics developer with experience/interest in NWP model infrastructure, radiative transfer parameterizations, cloud-to-radiation physics coupling, and machine-learning-based approaches.

Sadegh Tabas

I'm a dedicated Machine Learning Scientist with a deep-rooted passion for unraveling the complexities of our planet's climate and weather systems through cutting-edge technology. My journey in data science has led me to specialize in climate modeling, weather forecasting, geospatial machine learning, and the application of explainable and physics-informed machine learning techniques. These methods not only help us make more accurate predictions but also provide valuable insights into the underlying physical processes driving climate and weather phenomena.

Dr. Vijay Tallapragada

Dr. Vijay Tallapragada has been the Senior Scientist (ST) for the Environmental Modeling Center (EMC) of the National Centers for Environmental Prediction (NCEP) in College Park, MD, since August 2022, responsible for providing strategic direction for the implementation of community-based modeling systems within the Unified Forecast System (UFS) framework for operational applications at NCEP. Dr. Tallapragada is co-leading the UFS Research to Operations

(UFS-R2O) Project with participation from larger NWP enterprises in advancing the development of a comprehensive UFS coupled Earth System Model for various forecast applications. Prior to that, he was the Chief of Modeling and Data Assimilation Branch and Global Climate and Weather Modeling Branch at NCEP/EMC during 2015-2022, where he led the development, implementation, and advancement of NCEP operational Modeling Systems spanning weather, sub-seasonal and seasonal timescales for providing accurate and reliable forecast guidance. In his previous role as the Hurricane Team Leader at NCEP from 2006 to 2015, Dr. Tallapragada developed and implemented state-of-the-art hurricane models for operational tropical cyclone predictions across the globe.

Dr. Tallapragada is also the co-PI for the Atmospheric River (AR) Reconnaissance Program and co-chairs the AR Data Assimilation and Modeling Steering Committee. He is also the Development Manager for NOAA's Hurricane Forecast Improvement Project (HFIP). Dr. Tallapragada serves on various national and international advisory committees for operational Numerical Weather Prediction, research programs, and observational field campaigns.

Apart from recognition at various levels, Dr. Tallapragada is the recipient of the NOAA National Weather Service Isaac Cline Award for Scientific Leadership in 2013, the US Dept. of Commerce Gold Medal for HWRF in 2014, NOAA Administrator's Award for Next-Generation Global Prediction System (NGGPS) in 2017, US Dept. of Commerce Gold Medal for Global Forecast System (GFS) in 2020, Robert & Joanne Simpson Award for Tropical Meteorology in 2022, American Meteorological Society (AMS) Banner Miller Award and Weather and Forecasting Distinguished Scientific Achievement Award in 2019, and is elected as Fellow of the AMS in 2022. He holds a Ph.D. in Tropical Meteorology, M.Tech. Degree in Atmospheric Science and M.S. Degree in Meteorology from Andhra University in India and has more than 150 refereed publications in various journals of international reputation. He has supervised five Ph.D. students and three master's students.

Beiming Tang

Dr. Beiming Tang is a postdoc at George Mason University and an affiliate of NOAA Air Resources Laboratory. He finished his PhD at the University of Iowa. Dr. Tang's research focuses on numerical modeling development and machine learning.

Dr. John Ten Hoeve

Dr. Ten Hoeve currently serves as the Deputy Director of the Weather Program Office. In his role, he oversees four divisions that manage a combined $70M portfolio of weather research and development grants and activities for NOAA. In addition to providing extramural research grants, Yi-Cheng Teng. WPO also manages several initiatives to support open science and development from weather modeling to social science, including the Earth Prediction Innovation Center.

Prior to WPO, John served as the Deputy Director of the Office of Organizational Excellence at NOAA's National Weather Service. In that role, John led the development of the National Weather Service's 2019-2022 Strategic Plan, fostered partnerships with the Weather, Water, and Climate Enterprise, and enabled NWS to become a more agile and effective organization by improving organizational processes and culture. John helped design and establish the first organizational health and culture program at the NWS, influencing nearly all offices across the agency. He also served as the NWS line office representative to NOAA's Regional Collaboration Network. Through his 12-year career in the federal government, John has also worked in the NOS IOOS Program Office and the White House Office of Management and Budget. John joined NOAA through the Presidential Management Fellows program.

John has published over a dozen peer-reviewed papers on a variety of topics from weather to renewable energy. He holds a Certificate in Public Sector Leadership from Harvard University, a M.S. and Ph.D. from Stanford University in Environmental Engineering, and a B.S. from Penn State in Meteorology.

Dr. Catherine Thomas

Catherine Thomas is co-project lead for the next major implementation of the Global Forecast System (GFSv17). She is part of the data assimilation team at the Environmental Modeling Center in NCEP with a focus on algorithm development for the GFS. She earned her B.S. in Meteorology from Millersville University and her M.S. and Ph.D. in Atmospheric and Oceanic Science from University of Maryland College Park.

Greg Thompson

My current area of research is all-sky satellite radiance data assimilation, particularly with regard to clouds and precipitation. My latest effort is the visible satellite DA from GOES and VIIRS.

Dr. Hendrik Tolman

Dr. Ir. Hendrik L. Tolman is the Senior Advisor for Advanced Modeling Systems of the Office of Science and Technology Integration (OSTI) of the National Weather Service (NWS). Before joining OSTI, he was at the Environmental Modeling Center (EMC) of the NWS for more than 20 years as a wave modeler (original development of the WAVEWATCH III wave model), Marine Modeling Branch Chief, and the Director. As senior advisor, Dr. Tolman champions the Unified Forecast System (UFS), the use of social and behavioral science in forecasting, and regularly represents the NWS with respect to its use of Artificial Intelligence / Machine Learning. In this field, he has been active since ca. 1995.

Dr. Tolman holds a Doctorate (Dr., PhD equivalent) and Engineering degree (Ir., Masters equivalent) from the Civil Engineering Department of Delft University of Technology in the Netherlands. He is a naturalized US citizen of Dutch origin.

Dr. Yannick Tremolet

Dr Tremolet has been leading the Joint Effort for Data assimilation Integration at the JCSDA since 2017. Before joining the JCSDA, his career has focused on data assimilation (4D-Var), primarily at ECMWF. He also worked at NOAA/EMC and NASA/GMAO.

Alycia Triplett

Alycia is a 2nd Year PhD student studying Atmospheric Sciences at Howard University in Washington, DC, under the advice of Dr. Terri Adams. She is also an NCAS-M Fellow. Alycia received her Bachelor of Science in Meteorology summa cum laude from Jackson State University in April of 2022. During her time at JSU, Alycia discovered her interest in the public's risk perception, decision-making, and risk communication associated with severe weather events in socially vulnerable communities. She has had diverse research experiences, varying from marine biology and air-sea interactions to cognitive interviewing and decision support. Currently, Alycia is completing an internship at NOAA's Global Systems Laboratory in Boulder, CO, investigating what, when, why, and how fire weather partners use various products and information sources throughout their decision-making timelines.

Yu-Cian Tsai

I am Taiwanese and currently a first-year PhD student at Colorado State University. My research focuses on investigating MJO's performance in subseasonal to seasonal forecast models.

Ufuk Turuncoglu

Ufuk Turuncoglu is currently working as a senior software engineer at the National Center of Atmospheric Science (NCAR). He earned his Bachelor of Meteorological Engineering at Istanbul Technical University, Turkey, in 2000, his MSc in Atmosphere and Ocean Sciences in 2003, and his PhD in Computational Science and Engineering from Istanbul Technical University, Berkeley, in 2011. After completing his PhD, Ufuk accepted a position as a research scientist at the International Center of Theoretical Physics (ICTP) in Italy, where he worked for two years doing research in coupled model development. During that time, he developed and applied a new fully coupled regional earth system model (RegESM) to different problems. He also focused on developing an in situ visualization system that works with coupled models.

Jillian Xiong

Hi there! My name is Jilian Xiong and I'm a postdoc working with Dr. Parker MacCready at the School of Oceanography, University of Washington. I got my PhD from Virginia Institute of Marine Science, William and Mary. My research mainly focuses on understanding how estuarine and coastal circulations influence biological or biogeochemical processes, such as harmful algal bloom, hypoxia, and environmental DNA. To answer the question "What does physics do to biogeochemistry?" I used realistic oceanographic numerical models, including LiveOcean (built based on ROMS), SCHISM, and EFDC.

Dr. Yan Xue

Yan Xue manages the Weeks 3-4 Program and Notice of Funding Opportunity (NOFO) grants within the NWS Office of Science and Technology Integration (OSTI) Modeling Program Division. The Weeks 3-4 Program supports the improvement of Weeks 3-4 forecast products at NWS and the development and implementation of the next-generation sub-seasonal Global Ensemble Forecast System (GEFS) under the Unified Forecast System (UFS) Framework. Recently, She led the development of NOAA's first UFS-based Seasonal Forecast System (SFS) with a budget of $6.5 million for Fiscal Year 2023 (FY2023). Her achievements in this role include establishing an SFS Application Team involving participants from NWS, OAR, NCAR, and academia and leading the team in completing NOAA's SFS Development Plan.

Prior to joining OSTI-Modeling, she worked at the Climate Prediction Center (CPC) of NCEP for 18 years, focusing on climate variability and predictability, subseasonal-to-seasonal prediction, coupled model analysis, ocean monitoring, coupled reanalysis, and observing system experiments.

Yan Xue completed her undergraduate studies at the University of Science and Technology of China with a BA in Physics and graduate studies at Columbia University with an MS and PhD in Geophysical Science.

Gina Azarell Martinez Velez

My name is Gina Azarell Martinez Velez, PE. I obtained my Bachelor of Science in Civil Engineering in June 2016 from the University of Puerto Rico at Mayaguez. After graduating, I have worked in both public and private industries as a Civil Engineer, providing a variety of services such as water supply modeling, agriculture field surveys, stormwater management design, water and wastewater design, site design, and hydraulic-hydrologic modeling (H&H). At present, I am working on a Master of Science in Mechanical Engineering as a distance student at Purdue University in West Lafayette.

Dr. Jonathan Vigh

Dr. Vigh leads several hurricane-related projects within RAL and serves as a support scientist on several other projects. He is the leader of the WxRisk project, which is building personalized weather risk tools such as the HurricaneRiskCalculator web app. Dr. Vigh is also the Principal Investigator (PI) of a joint project with Colorado State University and the University of Miami which is implementing forecast support products of tropical cyclone (TC) intensity and structure from aircraft reconnaissance observations. Dr. Vigh is serving in the project manager role for another project, which is implementing TC diagnostics in the METplus software package. Dr. Vigh is also working in a support scientist role to develop an evaluation system for space weather using METplus.

In addition to these projects, Dr. Vigh is the lead developer of the Tropical Cyclone Guidance Project (TCGP), which provides real-time model guidance for TCs, and the Climate Risk Management Engine (CRMe), which supports climate science and risk applications. Dr. Vigh also writes research papers, develops funding proposals, and participates in service activities. He also collaborates internationally to improve TC data sharing.

Jonathan Vigh's research interests include tropical cyclones and risk communication. He has studied the problem of eye formation in hurricanes and other geophysical vortices to learn how the eye/eyewall structure impacts the subsequent intensification of the storm. He has also done extensive work to construct several new aircraft-based data sets to further investigate structure and intensity changes in tropical cyclones, with a particular focus on the radius of maximum winds

(RMW). He is working on using ensembles to better predict TC RI. Finally, he is working to improve hazard and risk communication for TCs.

Jennifer (Jen) Vogt

Jennifer Vogt is a seasoned meteorologist and project coordinator with extensive experience in atmospheric science, project management, and federal program coordination. She holds a Master of Science in Atmospheric Science from the University of Wyoming and a Bachelor of Science in Meteorology from Millersville University of Pennsylvania.

Jennifer currently serves as a Physical Scientist with the NOAA/OAR/WPO Earth Prediction Innovation Center (EPIC), leading community and stakeholder engagement where she designs innovative approaches to expand the UFS community.

With a career spanning over a decade, Jennifer has previously worked as a Meteorologist for the National Weather Service (NWS) in Albany, NY, and Jackson, KY. Her roles have included web development, emergency management, satellite program leadership, and public outreach. She has been recognized for her contributions to impact-based decision support services and has received commendations for her leadership and coordination skills.

In addition to her professional roles, Jennifer has been a mentor to interns, developed training materials, and led significant projects such as the 2023 and 2024 Unifying Innovations in Forecasting Capabilities Workshop. Jennifer wants to extend a heartfelt thank you to everyone who contributed to UIFCW over the past three years and has supported her throughout her career thus far.

Jia Wang

Jia Wang is a research ice climatologist at NOAA Great Lakes Environmental Research Laboratory (GLERL), Ann Arbor, Michigan. He received a Ph.D. in physical oceanography at the Institute of Oceanology, Chinese Academy of Sciences in 1987 and in meteorology at McGill University in 1993. He joined GLERL in July 2007 while he was a research professor at University of Alaska Fairbanks International Arctic Research Center (IARC) from 1998 to 2007. His research interests include coupled ice-ocean modeling from coastal to basin scales, Great Lakes, polar and subpolar climate change and lake/sea ice variability, oceanography, and numerical modeling of coupled ice-lake/ocean-wave systems. He developed regional earth system models and fully coupled ocean/lake-ice-wave models, which were used for real-time nowcast/forecast systems. He holds several professional memberships: American Geophysical Union and International Association for Great Lakes Research. He received several awards and certificates, including the NOAA GLERL Director's Award for Scientific Productivity of 2007, Outstanding Productivity and Excellence in Science of the Year 2000, JAMSTEC, Japan, 2000. He is actively involved in public services as an associate editor for Ocean Dynamics. He served on the international steering committee in the Ice Committee of IAHR from 2012-2016 and International Workshop on Modeling the Ocean (IWMO) since 2014. He also serves as a reviewer and panelist for the US and international journals and funding agencies. He co-chaired two international workshops, the 2016 International Workshop on

Ice and the 2022 IWMO, both in Ann Arbor, Michigan, USA, and chaired numerous sessions at national and international conferences. He has published 151 refereed journal articles with an H-index of 44, 7 refereed book chapters, 18 proceedings papers, and 31 internal reports.

Jun Wang

Jun Wang is a Physical Scientist working at the National Centers for Environment Prediction (NCEP) Environmental Modeling Center at College Park, MD. She has been developing, maintaining, and troubleshooting weather and climate operational models running at NCEP, providing numerical prediction guidance to public society worldwide. Her interests include numerical model prediction, coupled modeling, model infrastructure, and AI/ML for weather and climate.

Dr. Kai Wang

Dr. Kai Wang is currently a contractual physical scientist working at NOAA/NWS/NCEP/EMC. He has been providing key support in developing NOAA's latest air quality forecasting system, AQMv7, based on the UFS modeling system. Before joining EMC, Kai has been working as a research scientist at Northeastern University and NC State University. He got his Ph.D. from NC State and M.S./B.S. from Peking University of China. His research interests cover a wide range of atmospheric sciences and air quality forecasting topics. He has published more than 40 peer-reviewed journal articles.

Lu Wang

Lu Wang is a modeler with expertise in both hydrodynamic and biogeochemical models, focusing on ocean acidification in the Northeast U.S. region. Lu is now working as a postdoc in Dr. Changsheng Chen's lab.

Dr. Xuguang Wang

Dr. Xuguang Wang obtained her B.S. in Atmospheric Science from Beijing University, China, and her Ph.D. in Meteorology from the Pennsylvania State University. Dr. Wang is currently a Robert Lowry Chair Professor and Presidential Research Professor of the School of Meteorology at University of Oklahoma (OU). She leads a Multiscale data Assimilation and Predictability (MAP) lab at OU. Her research ranges from developing novel methodologies for data assimilation and ensemble prediction to applying these methods for global, hurricane, and convective-scale numerical weather prediction systems that assimilate a variety of in-situ and remote-sensing observations. She has published more than 130 papers in peer-reviewed journals. The data assimilation research and development by the OU MAP team have been adopted by multiple US NOAA NWS operational modeling suites. Dr. Wang is also excited about cultivating the next-generation workforce in data assimilation. So far, she has directly advised 17 MS students, 21 PhD students, and 22 postdocs during her tenure at OU. Dr. Wang also takes community scientific leadership roles such as serving as a co-lead of the observation and data assimilation task team to perform US Congress-mandated Priorities for Weather Research (PWR) study, a member of UCAR Developmental Testbed Center (DTC) science advisory board and WMO WWRP Predictability, Dynamics and Ensemble Forecasting working group. The multi-University Consortium for Advanced Data Assimilation Research and Education (CADRE) that she leads is recommended for funding by NOAA.

Yixuan Wang

I am a third-year Ph.D. student majoring in oceanography from Louisiana State University. I am going to integrate WRF-Hydro into the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System, coupling the hydrological and ocean models (ROMS) along the land-ocean boundary.

Dr. Yongming Wang

My primary research interests lie within the area of data assimilation and atmospheric modeling, with a focus on advancing the skill of convective-scale numerical weather prediction systems by developing and improving data assimilation methods.

Dr. Zhuo Wang

Dr. Zhuo Wang is a professor in the Department of Atmospheric Sciences at University of Illinois at Urbana-Champaign. She has served as editor of the Journal of Atmospheric Sciences, chair of the American Meteorological Society (AMS) Committee on Tropical Meteorology and Tropical Cyclones, co-chair of the US CLIVAR PPAI panel, and co-chair of the WMO Working Group on Tropical Meteorology Research (TMR). Her research mainly focuses on tropical meteorology, climate dynamics, and sub-seasonal to decadal prediction and predictability of extreme weather and climate.

Dr. Shih-Wei Wei

Dr. Shih-Wei Wei is a postdoctoral fellow at JCSDA. Shih-Wei's Ph.D. work focused on assimilating aerosol-affected infrared observations. As a postdoctoral fellow in the COMPO team at JCSDA, Shih-Wei works on Level 1 aerosol data assimilation.

Brian Weir

With a career spanning over a decade, Brian specializes in modernizing science-driven applications to operate on cloud platforms, customizing technical workflows, and implementing new technology. Prior to his role at Raytheon, Brian held key positions in geophysics, where he led seismic imaging projects globally, contributed to technological advancements, mentored teams, and authored numerous publications. His diverse skill set includes proficiency in Fortran, Python, and various tools and databases. Brian holds a Master of Sciences in Applied Physics from Miami University.

Dr. Valerie Were

Valerie Were, Ph.D., is a Social and Behavioral Science Program Analyst with the Cooperative Institute for Research in the Atmosphere (CIRA). In that role, she helps the Social, Behavioral, and Economic Sciences Program at the National Weather Service (NWS) turn weather, water, and climate information into social action by integrating social with physical sciences. Before joining CIRA in August 2021, Valerie was the Social Science Lead at the NOAA Cooperative Science Center for Earth System Sciences and Remote Sensing Technologies, where she was responsible for incorporating human dimensions into the Center's education, training, and research. Prior to that, she was a contractor in the NOAA Chief Economist's Office, which coordinates social sciences across the agency. Valerie holds a B.S. in Watershed Science from Utah State University and survived the winters to earn an M.S. in Water Resources Science and a Ph.D. in Natural Resources Science and Management from the University of Minnesota-Twin Cities. When she's not working, she's likely enjoying an outdoor activity, watching sports, reading, or replacing the house plants she can't seem to keep alive.

Joannes Westerink

Joannes Westerink is the Joseph and Nona Ahearn Professor of Computational Science and Engineering in the Department of Civil and Environmental Engineering and Earth Sciences at the University of Notre Dame. Westerink develops high-resolution heterogeneous unstructured mesh, multi-physics, multi-scale hydrodynamic codes and models for the hydrodynamics of the coastal ocean and has successfully transitioned these to practitioners for a wide range of applications, including the analysis and design of major flood control projects and coastal ocean water level forecasting systems. Westerink has pioneered the successful use of global to channel scale highly heterogeneous unstructured mesh coastal ocean models with mesh resolution varying by up to four orders of magnitude. This encompasses the optimization of algorithms, development of high-performance codes in vector and parallel computing environments, the linkages of circulation models to weather and short wind wave models; model verification, validation, and uncertainty quantification; and the application of codes to oceans, continental shelf regions, estuaries, rivers, and coastal flood plains. Westerink is the co-developer of the widely used ADCIRC finite element-based shallow water equation code. ADCIRC has evolved into a community-based coastal hydrodynamics code with wide-ranging applications within academia, government, and the private sector worldwide. The U.S. Army Corps of Engineers, the Federal Emergency Management Agency, and the National Oceanic and Atmospheric Administration all use ADCIRC in support of coastal water level and flooding analyses and forecasts.

Dr. Jeffrey Whitaker

Dr. Whitaker is the Chief of the Modeling and Data Assimilation Division of the NOAA Physical Sciences Laboratory. His research focuses on the use of ensembles for data assimilation and prediction.

Dr. Louis J. Wicker

I have a broad set of research interests that generally focus on numerical analysis, simulation, and forecasts of severe convection and tornadoes. My original research interests in supercells and tornadoes can be traced back to nearly my high school days in the late 1970s. While obtaining my undergraduate and Master's degrees at University of Oklahoma in the 1980s, I became an avid storm chaser and eventually was fortunate enough to be able to work on some of the first in situ deployments of instruments near severe storms with my mentors: Howie Bluestein (OU) and later Don Burgess and Bob Davies-Jones (NSSL). I got the modeling bug while working with Dr. Tzvi Gal-Chen on satellite temperature assimilation for my Master's degree. I left Oklahoma in the summer of 1986 to begin a Ph.D. at the University of Illinois. I was fortunate to have Dr. Robert Wilhelmson as my dissertation advisor, and together, we investigated tornadogenesis within supercells using some of the first sub-200m resolution numerical simulations. The work was facilitated and supported by one of the five original and newly formed NSF computing centers, the

National Center for Supercomputing Applications. I became very interested in the developing paradigm of "computational science" that is now ubiquitous across most scientific disciplines. During most of the 1990s, I was a professor of Atmospheric Sciences at Texas A&M University. In 1999, I was very fortunate to be able to return to my meteorological roots here in Norman as a scientist at the National Severe Storms Lab. My work today continues to focus on severe storms and tornadoes. The tremendous effort and resulting progress by hundreds of scientists during the past 30 years has led to a substantial increase in our scientific understanding of severe weather, and this progress has led to improved forecasts and more accurate warnings for the U.S. public.

Dr. Damian Wilson

Dr Damian Wilson obtained his PhD at the University of Reading, studying cloud processes with radar. He has worked as a scientist at the UK Met Office for over 25 years, initially developing representations of cloud physics processes for numerical modeling and then exploring weather and climate data applications to government stakeholders. His responsibilities now include being Head of the Science Profession at the Met Office, where he is responsible for championing and facilitating the professional development of around 700 staff against the context of a rapid change towards using data science and machine-learning approaches.

Dr. Kehui Xu

Dr. Kehui (Kevin) Xu is the Director of the Coastal Studies Institute and Professor of the Department of Oceanography and Coastal Sciences at the College of Coast & Environment at Louisiana State University, Baton Rouge. Dr. Xu is a geological oceanographer whose research is focused on coastal restoration, sediment diversion, sediment management, coastal morphodynamics, sediment transport, sedimentary geology, and coastal processes. Dr. Xu has published a total of >110 peer-reviewed journal articles. Since joining LSU, Dr. Xu has been holding the James P. Morgan Distinguished Professorship. In recent years, Dr. Xu received the LSU Alumni Association Faculty Excellence Award, the LSU Alumni Association Rising Faculty Research Award, the LSU Tiger Athletic Foundation Undergraduate Teaching Award, and the Phi Kappa Phi Non-Tenured Professor Award. Dr. Xu has been serving as Associate Editor of Estuarine, Coastal and Shelf Science, a highly-respected, international, multidisciplinary journal.

Dr. Z. George Xue

Dr. Xue heads the LSU Coupled Ocean Modeling group, one of the largest regional modeling groups in the Gulf of Mexico and the top supercomputer user in the State of Louisiana. Dr. Xu’s group uses a state-of-the-art numerical technique to represent the interaction between land and ocean processes along the Gulf Coast. Every year, Dr. Xue’s group consumes more than 10 million Service Units (an hour per core) to simulate and assess a wide range of coastal hazards, including hurricanes, compound flooding, land loss, eutrophication, hypoxia, ocean acidification, and others. Since joining LSU in 2014, Dr. Xue has raised more than $44 million in extramural funds for LSU as a PI or co-PI from various federal and state agencies, including the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration

(NOAA), National Academy of Sciences (NAS), Bureau of Ocean Energy Management(BOEM), Louisiana Board of Regions, and others.

Dr. Xue received the 2022 LSU Rainmaker Award in the mid-career category of Science, Technology, Engineering, or Mathematics. Only one LSU faculty member campus-wide receives this distinguished honor each year.

Yue Yang

Dr. Yue Yang is a research scientist at the University of Oklahoma. Her research interests include developing and understanding the radar data assimilation (DA) for convective storms and the satellite DA for hurricanes and improving the DA capability for hurricanes in the coupled atmosphere-ocean model toward the fully coupled DA system.

Zhifeng Yang

His research interests are air quality and mesoscale convective systems by employing the methodology of modeling and data assimilation. The air quality focuses on the particle and ozone forecasts and their impacts on the climate and pollution. Mesoscale convective systems mainly focus on cold pool bore propagation and convection initiation. He is a postdoc at Howard University after receiving his bachelor's in Atmospheric Sciences from Lanzhou University in China, a master's in Meteorology from University of Nebraska-Lincoln, and a PhD in Atmospheric Physics from University of Maryland Baltimore County. The models employed in his research are WRF, WRF-Chem, and MPAS, and data assimilation systems are DART (Chem/DART) and PSU-WRF-EnKF. He has assimilated chemical species and is working on assimilating radar and lidar observations to improve convection initiation forecast.

Fei Ye

Fei Ye is an Associate Research Scientist at the Virginia Institute of Marine Science, where he focuses on developing advanced modeling approaches and applying them in studying coastal and oceanic processes.

He is a core developer of the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) and the primary developer of the 3D component of NOAA's Surge and Tide Operational Forecast System (STOFS-3D-Atlantic). Fei Ye's research plays a critical role in advancing the capabilities of SCHISM, particularly enhancing the effectiveness of cross-scale 3D baroclinic applications on ocean-to-creek domains. This capability is exemplified in STOFS-3D-Atlantic, which focuses on understanding and predicting coastal flooding, including the impacts of inland extremes and heavy precipitation.

At the conference, Fei Ye will present the latest advancements in STOFS-3D-Atlantic, highlighting its capabilities in forecasting coastal and inland flooding. He will also discuss its ability to efficiently ingest bathymetry from the latest surveys, thereby enhancing preparedness and response strategies.

Zhengchen (John) Zang

I am a biological/geological oceanographer focusing on planktonic food web modeling, fisheries, and sediment transport.

Gamal Zayed

Gamal Zayed is a member of the Dream Team that received the NASA Space Apps 2022 "Global Finalist" award for their web application predicting the vertical total electron content of the ionosphere. Their work was presented at the HamSCI Workshop 2023: "Forging Amateur-Professional Bonds" at the University of Scranton, Pennsylvania. Their presentation is available here.

In 2024, Gamal contributed to the HamSCI Workshop held at Case Western Reserve University in Cleveland, Ohio. His research focused on utilizing the dual edges of the in-field Weak Signal Propagation Reporter Live (WSPRlive) dataset and the ideal mathematical Friis Propagation model with numerical solutions for navigational location estimation. The publication can be found here.

Gamal is an Assistant Lecturer at the American University in Cairo's School of Sciences and Engineering (SSE). He also holds assistant lecturer positions in Computational Sciences and Artificial Intelligence at Zewail City and the Department of Computer Engineering at Cairo University.

His current research involves integrating Machine Learning and Artificial Intelligence into Communications Systems and Space Weather. His Master of Science research focused on Visible Light Communications (VLC) utilizing bio-inspired algorithms, such as Particle Swarm Optimization (PSO), and enhancing location estimation within VLC. His graduation project involved Wireless Communications Network Optimization, developing a 4G-extended consistency check tool for 2G and 3G networks.

As an R&D at Orange Innovation Labs (Orange Labs Egypt), Gamal developed mathematical models to quantify the Quality of User Experience (QoE) across six telecommunication services: Voice over IP (VoIP), Video Streaming, Internet Protocol Television (IPTV), Gaming, Metaverse, and Internet of Things (IoT). He later joined STMicroelectronics for a project implementing one-bit compressed sensing using Convex Optimization.

Building on his research interest in Space Weather and Communications Engineering, Gamal aspires to learn Amateur Radio techniques to deliver empirical research and leverage Machine Learning and Artificial Intelligence for predictive analytics.

Aijun Zhang

I am a hydrodynamic ocean modeler and NOS/CO-OPS modeling team lead. I primarily focus on the transition and implementation of National Ocean Service (NOS) coastal ocean operational forecast systems and operational applications and products. My biggest achievement in the past years is the development of a Coastal Ocean Modeling Framework (COMF). COMF is a set of standards and tools for developing and operating NOS's hydrodynamic model–based coastal ocean operational forecast systems (OFS) by providing a standard and comprehensive software infrastructure to handle multiple hydrodynamic models for any geographic domain. It facilitates ease of operations and interoperability, minimizes redundant efforts, and ensures high time-and-cost efficiency for OFS development, transition, and Operation & Maintenance; provides standard tools for real-time data handling & maintenance; provides standard tools for graphics and web products and standard skill assessment and evaluation tools. I oversee the transition and implementation of all NOS coastal ocean operational forecast systems and have led the CO-OPS modeling team in transitioning 15 forecast systems to operations on the NOAA High Performance Computing System (HPCS).

I have served in NOS' Modeling Prediction Team which makes NOS modeling strategy and implementation plan, the National Modeling Team of NOAA's Climate, Ecosystem, Fisheries Initiative (CEFI), the operational ocean forecasting working group of the NOAA Modeling Team, Unified Forecast System (UFS), etc.

Joseph Zhang

Joseph Zhang is the lead developer of the next-generation, open-source, 3D coupled geophysical fluid dynamics-biogeochemistry model on unstructured grids (SCHISM; schism.wiki). The model uses several novel methods (hybrid unstructured grids and flexible vertical coordinates; implicit time stepping) to enable effective cross-scale, creek-to-ocean capability without the need for bathymetry smoothing or grid nesting.

Le Zhang

A graduate student at the Dept. of Oceanography at Louisiana State University working on numerical modeling of ocean biogeochemistry.

Mengliang Zhang

Mengliang Zhang is a CSE PhD student at UT Arlington. He is working with researchers to solve precipitation prediction problems.

Dr. Xuejin Zhang

Dr. Xuejin Zhang is a Meteorologist employed in NOAA's Atlantic Oceanographic and Meteorological Laboratory's Hurricane Research Division. He studies tropical cyclone forecasts and simulation, land-air-sea interaction, regional climate, and parallel computing during his more than two-decade career. His expertise is in numerical algorithms, atmospheric dynamics, model initialization, and microphysics parameterization and observation. He leads the NOAA's Unified Forecast System (UFS) R2O Hurricane Application Team. He obtained his Ph.D. at NC State University.

Dr. Zhan Zhang

Dr. Zhan Zhang obtained his Ph.D degree in tropical meteorology from Florida State University. He has worked at various research and operational organizations, including the Chinese National Meteorological Center (CNMC), the European Centre for Medium-Range Weather Forecast (ECMWF), and the National Centers for Environmental Prediction (NCEP). He is now a physical scientist affiliated.

Xiaochen Zhao

Xiaochen Zhao is a postdoc researcher from the coupled ocean modeling group at Louisiana State University (LSU). Her current research focuses on developing a coupled hydrological-ocean model to understand the resilience and recovery of coastal ecosystems to extreme weather events, such as hurricanes. She also works on the deployment and application of the operational forecast system. Xiaochen is also interested in exploring and using a combined observation and modeling approach to investigate coastal areas' hydrological and ecological processes.

Linjiong Zhou

I am a researcher at Princeton University, working at the Geophysical Fluid Dynamics Laboratory (GFDL). I am leading the SHiELD (System for High-resolution prediction on Earth-to-Local Domains) global prediction system development as part of the NOAA Research Global-Nest Initiative. In particular, my research focuses on building a novel integrated dynamics-physics coupling framework and developing advanced but efficient cloud microphysics parameterization to improve global weather prediction from large-scale to mesoscale. I am actively involved in the SHiELD developments that contributed to the DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains (DYAMOND) project and Different Models-Same Initial Conditions (DIMOSIC) project.

Dr. Ping Zhu

I am a professor at the Department of Earth and Environment at Florida International University. My research focuses on boundary layer meteorology, hurricane dynamics and modeling, convection, and turbulence and cloud parameterizations.

Abstracts

Organized by session

Invited Presentations

EPIC/UFS Community Support and Data Management

Gillian Petro, Jong Kim, Sylvia Chin, Zachary Shrader, Kristopher Booker, Anna Kimball, and Josh Kublnick

The NOAA Earth Prediction Innovation Center (EPIC) helps advance the Unified Forecast System (UFS) by providing tools and knowledge to the community. The EPIC program supports a broad range of work within the UFS community through a spectrum of tasks, including code and data management, user support, and DevOps platform infrastructure. In this talk, we discuss code and data management efforts, such as CI/CD options, handling of feature integration through GitHub Issues, and provision of publicly available data for supported repositories. Additionally, we highlight user support efforts, particularly those related to documentation and GitHub Discussion forums. Examples will be drawn from work with EPIC-supported repositories such as the UFS Weather Model, the Short-Range Weather Application, the Land DA System, the Unified Post Processor, UW Tools, Stochastic Physics, and the Hurricane Analysis and Forecast Application. We provide an assessment of current UFS community support activities, highlight challenges that impact this work, and discuss future options for addressing community gaps and needs.

The Origin, Structure, and Tracks of the Monsoon Onset Vortex - Integrating Theory and Predictability Studies using the UFS for early season impacts on the Monsoon

Shreyas Dhavale

In certain years, during the onset of the Indian Summer Monsoon, a synoptic scale vortex, known as the Monsoon onset vortex (MOV), forms in the Arabian Sea within the seasonal northward propagating region of precipitating convection. Many MOVs intensify into tropical cyclones and significantly impact the onset and advance of the Monsoon. This work focuses on the case studies of past MOVs and the associated features of the Indian Summer Monsoon in the UFS S2S prototypes 5, 6, and 8. The UFS performance varies for the 3 MOV cases of 2011, 2014, and 2015, with the formation and track of the 2015 MOV being predicted better than the other cases. Through the analysis of the Somali jet index, we highlight the potential interactions between precipitation and monsoon dynamics, which still pose challenges for accurate sub-seasonal weather prediction in the monsoon regions.

Change in Lake Michigan's circulation dynamics with varying bathymetry

Nowrin Mow, Bishnupriya Sahoo, Meng Xia, and Ayumi Fujisaki-Manome

Lake Michigan significantly impacts regional weather and climate. However, climate change has led to reduced ice cover, unpredictable weather patterns, and fluctuations in water levels. Previous studies projected a significant increase in lake surface current speed during specific months under different climate change scenarios. In addition, there is also a need to compare the changes in circulation dynamics in the lake due to varying bathymetry over time. In this study, we devised a Finite-Volume Community Ocean Model (FVCOM) framework to resolve the complex topography of Lake Michigan and simulate lake current, water level, and lake surface temperature (LST) using two bathymetries produced by NCEI in 1996 and GEBCO in 2023 with wind forcing from CFSv2 and other forcing parameters from NARR for the years 2023. The GEBCO's bathymetry datum was converted from above mean sea level to a depth below geoid by adjusting lake surface elevation (176 m). The study found a bathymetric variation of about 50 m in north-east to mid-east Lake Michigan. The effects of lake bathymetry change on circulation were significant at these locations, thereby contributing to the hydrodynamics of the entire lake. Model simulations found that yearly average surface current speed and LST were increased by 47.8% and 16.7%, respectively, in 2023 when the lake bathymetry was replaced with the GEBCO 2023 data. The lake's average water level significantly increased by 115% (1.065m). Further, the existing model is coupled with wave and ice modules to comprehend Lake Michigan's wave-current-ice climate beneath varying coastal geomorphology.

Assessing WRF High-Resolution Simulation of Precipitation during Superstorm Ida across the New York Metropolitan Region

Jorge Bravo, Marouane Temimi, and Mohamed Abdelkader

The main goal of this research is the assessment of the performance of operational regional weather forecasting using the Weather and Forecast Research (WRF) model, version 4.4.2. Employing a three-tiered nested domain approach with resolutions of 9km, 3km, and 1km, we effectively downscaled the Global Forecast System (GFS) forecast during superstorm Ida over the New York Metropolitan Area. WRF was initialized using GFS forecasts between 2021-08-30 and 2021-09-01 in six-hour intervals, resulting in twelve distinct GFS outputs over a span of 120 forecast hours.

After transitioning from a tropical system, Ida evolved into an extratropical system, influenced significantly by interactions with an Atlantic frontal system. These dynamics sustained Ida's convective potential, resulting in substantial precipitation events over the Northeastern US. Utilizing the WRF model, our goal is to reproduce the atmospheric conditions fostering this convective behavior from historical forecast data. To ensure a robust comparative analysis, historical station records were sourced from three distinct repositories: the National Centers for Environmental Information (NCEI) of NOAA (24 stations), Mesonet NY (18 stations), and Mesonet NJ (35 stations).

Seven statistical metrics were employed to critically assess the models' outputs against on-the-ground measurements. These metrics encompassed parameters such as the difference between precipitation peaks, coefficient of determination, Percent Bias, and the Kling-Gupta Efficiency. To enhance the spatial validation of the WRF simulations, cumulative rainfall maps were juxtaposed against Multi-Radar/MultiSensor System (MRMS) data. Specifically, WRF showcased enhanced KGE values and reduced PB values across varying forecast lead times. A key observation

was the temporal disparity in precipitation peaks between WRF and GFS. As the event's peak approached, WRF exhibited markedly superior performance relative to GFS predictions.

Overall, the research underscored WRF's potential to substantially augment early warning systems and drive regional flood models, making it a candidate for an integration in the operational Stevens Flood Advisory System that uses meteorology from global models. This work sets a precedent for blending Mesonet observations from two distinct networks for a comprehensive assessment of weather forecasts throughout the NYC metropolitan area, promising enhanced stakeholder engagement and enriched weather and climate communication. Future work will focus on assessment of the model’s sensitivity to microphysics and PBL schemes and their impact on precipitation forecast

Surface Energy Balance Across the 18-site New York State Mesonet Flux Network

Anna Glodzik, Scott Miller, Sarah Lu, and Jason Covert

The New York State Mesonet (NYSM) Flux Network consists of 18 sites across New York that have been measuring surface energy balance components since 2018: incoming and outgoing shortwave and longwave radiation, eddy covariance momentum flux and latent and sensible heat fluxes, and ground heat flux. To date, the network has generated over 100 site-years of continuous 30-minute fluxes. A NOAA Joint Technology Transfer Initiative (JTTI) collaborative project between UAlbany and NCAR aims to advance land-atmosphere coupling evaluation metrics using NYSM observations in enhanced Model Evaluation Tools (METplus) and evaluate high-resolution forecast model output (an experimental version of the Unified Forecast System). To ensure the accuracy and consistency of the flux site data, quality assurance flags and/or scores were assigned to each flux measurement and used to filter data prior to further analyses. The quality-controlled radiation components, turbulent fluxes, and ground heat flux from each flux site were evaluated to identify diurnal, seasonal, and interannual variability. Data from surrounding flux networks (e.g., Ameriflux, NEON Network) were utilized to validate some features observed in the NYSM data. By establishing the network’s ability to produce reliable estimates of the energy balance components, the NYSM observational flux data can be a robust tool for evaluating land surface models such as Noah MP and coupled model systems such as the UFS.

Quantifying Compound and Nonlinear Effects of Hurricane-induced Flooding Using a Novel Coupled Hydrological-Ocean Model

Daoyang Bao, Z. George Xue, and John C Warner

Hurricane-induced compound flooding events occur when inland flooding and storm surges coexist at the land-ocean continuum. Traditional models, which are typically one-way linked, do not account for the interactions between these two flooding mechanisms. To address this limitation, we recently introduced a dynamical coupling method, enabling a two-way seamless connection between hydrological and ocean models. Implementing this method in a coupled hydrological-ocean model with WRFHydro and ROMS on the COAWST platform improved accuracy in simulating hurricane-induced compound flooding compared to traditional methods. We further developed the coupled modeling system by introducing a local inertial equation. We also added an algorithm to the overland routing of WRF-Hydro to simulate diagonal flow between computational cells. These modifications significantly improved the model's skill, evidenced by its enhanced capability of capturing backwater effects and increased model accuracy and stability. Using Hurricane Florence (2018) as a case study, we conducted four sensitivity experiments and derived a framework from detangling, defining, and quantifying compound and nonlinear effects during the compound event. Model diagnosis showed that the compound effects were most significant in the lower Northeast Cape Fear River, where the flood levels resulting from the combination of both land and ocean processes surpassed those caused by each individual process alone. The nonlinear effects were generated from the interaction between the two processes, which reduced water levels in the channels while increasing them on the floodplain. The technologies and analytical methods developed in this study are transferable, allowing adaptation to various coupling frameworks and application to the analysis of other hurricane-induced compound flooding events.

A Social Science Approach to Unified Community Modeling

Alison Gregory and Kim Klockow McClain

This talk will highlight how social science principles have been used to evolve operational concepts for new weather technologies, outline the current state of the UFS community, and share upcoming efforts to use social science strategies to support the UFS. The UFS Community and the broader numerical weather prediction and modeling community would greatly benefit from the inclusion of social science best practices. Understanding the current community goals and perspectives is foundational to building a productive community of practice that can be sustained over time.

A Unified Representation of Convective Mixing on Subgrid Scales in the UFS

Jian-Wen Bao, Sara Michelson, Haiqin Li, and Sungsu Park

The parameterization of vertical mixing associated with subgrid convection in weather and climate models, particularly in the gray zone of model resolution where convective clouds are only partially resolved, is still a challenging problem. The parameterization must exhibit a generalized transitional behavior as the model's horizontal resolution varies. A practical approach to address this is to scale the eddy transport intensity from a conventional convection parameterization scheme by a quadratic function of the fractional area covered by convective updrafts in the grid box (Arakawa and Wu, 2013). However, this approach is theoretically limited despite its popularity due to the idealized scenario of deep convection in quasi-equilibrium used in its development. Furthermore, there is a theoretical ambiguity when applying this approach, particularly for a fractional area covered by convective updrafts in the grid cell that is not close to zero. An alternative approach for a general representation of subgrids is to represent subgrid convection as nonlocal asymmetric eddies due to subgrid convection relative to the grid-mean vertical flow (Park, 2014). This approach treats subgrid convection as an unresolved air motion relative to the grid-mean vertical motion. The transitional behavior of the subgrid convection representation across the gray zone is realized by the size of the plumes representing unresolved convective motion, which is a function of the model's horizontal resolution. This approach can simulate all unresolved convective transport of atmospheric properties within a single steady framework using multiple convective plumes. It also involves the parameterization of unresolved cold pool and convection organization within the atmospheric boundary layer to rectify the lack of convection memory across the time step in conventional convection parameterizations. This presentation will introduce a unified approach for representing subgrid convection in the UFS and show preliminary results of experimenting with this approach using 1-D and 3-D UFS simulations.

Advancements in the UFS Applications based on GFS, GEFS, and SFS

Cristiana Stan and Avichal Mehra

The next generation of medium range weather and climate prediction applications developed by NWS/NCEP for operations include three systems: the deterministic GFSv17, the subseasonal ensemble GEFSv13, and the seasonal ensemble SFSv1. These three systems share the FV3 dynamical core, CCPP atmospheric physics package, Noah MP land model, MOM6 ocean model, and CICE6 sea ice model. The WAVEWATCH III wave model is included in the medium-range application driven by GFSv17 as well as in the subseasonal ensemble GEFS v13. The subseasonal application supported by GEFSv13 and seasonal application supported by SFSv1 will include the GOCART aerosol model. The main model components are coupled through the Community Mediator for Earth Prediction Systems (CMEPS), which was jointly developed by NOAA and NCAR. Other differences among the three systems include the horizontal resolution and initialization methods. The considered resolutions are comparable to the state-of-the-art systems used by other operational centers. GFSv17 is being developed as a high-resolution system (~9km), GEFSv13 is configured at 25 km, and SFSv1 at 50 km. The real-time initialization strategy for all applications consists of a weakly coupled data assimilation system for all model components. GEFS and SFS applications are using a replay strategy for reforecasts.

This presentation will cover the current details of these systems along with their future developments.

Developing a Jupyter Notebook-based tutorial of the GDAS Proxy Application for Enhanced Data Assimilation in Earth System Prediction.

ReneDiego Martinez, Krishna Kumar, Cameron Book, Keven Blackman, and Maoyi Huang

The Earth Prediction Innovation Center (EPIC) is developing a Data Assimilation (DA) Proxy App, a generic community version based on the structure of the Global Data Assimilation System (GDAS) Application (GDAS App) and global-workflow from the National Centers for Environmental Prediction (NCEP) global model utilizing the Joint Center for Satellite Data Assimilation's (JCSDA) Joint Effort for Data assimilation Integration (JEDI) framework for data assimilation.

Partnering with the EPIC team, this presentation will highlight accomplishments from my summer internship project as a 2024 NOAA EPP/MSI Undergraduate Scholar. This project involves a comprehensive review and understanding of the GDAS App and global-workflow software, testing and verifying the GDAS Proxy App on NOAA's on-prem Research & Development High Performance

Computing system (RDHPCS) with a focus on cycling runs using low-resolution atmospheric model configurations. Finally, the Jupyter Notebook platform will be used to document the steps of setting up and executing the GDAS Proxy App and to provide iterative tutorials to the UFS scientific and academic community.

Highlights and Recommendations for Student Engagement from the Unified Forecast System Student Ambassador

Samantha Lang, Jennifer Vogt, Alison Gregory, Neil Jacobs, and Maoyi Huang

The ongoing development of the community-based Unified Forecast System (UFS) brings together the Weather, Water, and Climate Enterprise to innovate and improve NOAA's operational numerical Earth system prediction applications. The Weather, Water, and Climate Enterprise is composed of academia, industry, the private sector, and the federal government. The UFS Student Ambassador role builds on work completed by previous William M. Lapenta interns, focusing on outreach and communication activities with academia.

This presentation will highlight outreach activities accomplished by the UFS Student Ambassador throughout her William M. Lapenta internship. She will also highlight recommendations to the community on how to better engage with and involve students working with the UFS. Additionally, the UFS Student Ambassador will provide updates to the UFS Student Engagement Plan to encourage the next generation of students to join the UFS community.

Operationalizing "Cool" for the UFS

Alison Gregory and Tracy Fanara

Background/Objectives: The ultimate goal of our nation's weather forecasting is to save lives and property. Increasing users of the UFS will further support this mission. One of the main hurdles currently facing UFS adoption is how to make the UFS appeal to broader audiences in more creative ways, aka how do we make the UFS "cool"? This presentation demonstrates three areas where we can begin to envision the UFS being utilized in unique and different settings.

Methods: For the UFS to be "cool," it needs to be relevant, functional, and innovative. This means we need to increase awareness of the UFS, make it easy to use, and align user incentives. In this presentation, we will explore strategic avenues to increase awareness of the UFS. To make the UFS easier to use, we must also improve our products by putting more effort into visual elements such as animated post-processing maps, interactive features, and even augmented reality. Finally, we can align incentives by improving our workforce through academic user support and innovative student engagement.

Results: Weather affects everyone, everywhere. So why is the UFS not more prolific? We argue that increasing awareness, improving ease of use, and aligning incentives will broaden usage and improve public perceptions of the UFS.

Conclusions: Improving the way our community views and utilizes the UFS will be key to increasing users and building public awareness of the UFS. This increased engagement will improve forecasting capabilities as more users mean more stakeholders committed to contributing to our nation's forecast models.

Research to Operations (R2O) and Operations to Research (O2R)

NOAA's Testbeds (TBs) and Proving Grounds (PGs) are crucial mechanisms for transitioning research into operations (R2O) within NOAA and other partner agencies and, ultimately, into societal benefits. TBPGs support the R2O process through working relationships for developmental testing in a quasi-operational framework among researchers and operational scientists/experts, including partners in academia, the private sector, and government agencies, aimed at solving operational problems or enhancing operations in the context of user needs. Via testing and the evaluation of new and innovative forecasting and communication techniques, they facilitate the orderly transition of research innovations into operational implementation. They also put innovations in front of NOAA forecasters and users, including emergency managers and broadcast meteorologists, to introduce new products and get feedback on their utility to support operations. Finally, TBPGs provide feedback from operations and testing into research and research priorities. This session will describe the various ways NOAA TBPGs are engaging with UFS, including UFS-related model evaluation (e.g., RRFS), data assimilation, physics testing, and evaluation of forecast innovations by users, as well as the various ways that TBPGs engage the community. The session will also provide more in-depth examples of engagement with UFS for two NOAA Testbeds: Joint Center for Satellite Data Assimilation (JCSDA) and the Developmental Testbed Center (DTC). JCSDA supports the data assimilation community through regular JEDI-SKYLAB roll-up public software releases and leads the development of an end-to-end joint data assimilation testbed that includes comprehensive features such as data ingest, workflow integration, experiment management, and diagnostic tools. The DTC supports the broad Earth System Model (ESM) community in testing and evaluation activities of new models, technologies, and techniques through the development, support, and application of two key software tools that are central to a hierarchical system development (HSD) approach for the atmospheric component of Earth System Model – the Common Community Physics Package (CCPP) and its companion Single-Column Model (SCM) and the advanced Model Evaluation Tools (METplus) verification package. Using the development and testing process supporting the implementation of the Rapid Refresh Forecast System (RRFS), a regional configuration of the Unified Forecast System, as an example, it will also be demonstrated how HSD informed recent RRFS design decisions and provided R2O/O2R engagement opportunities for the university community. The session will wrap up by describing the ways in which NOAA's Weather Program Office (WPO) supports the transition of community weather research from the American Weather Enterprise to the NWS operations through its Joint Technology Transfer Initiative (JTTI), as well as other WPO funding opportunities.

Medium-Range Weather and Subseasonal to Seasonal Applications

Overview of the Next Global Forecast System GFSv17

Catherine Thomas, Jessica Meixner, Jongil Han, Hui-Ya Chuang, Bing Fu, Rahul Mahajan, Jun Wang, Michael Barlage, Neil Barton, Andrew Benjamin, Alicia Bentley, L. Gwen Chen, Yali Mao, Wen Meng, Raffaele Montuoro, Lydia Stefanova, Guillaume Vernieres, and Jiande Wang

The Environmental Modeling Center (EMC) is working towards the next operational implementation of the Global Forecast System, GFSv17. This implementation leverages the Unified Forecast System (UFS) Application for Medium Range Weather (MRW) and Sub-seasonal to Seasonal (S2S) and the UFS community at large. A major goal for GFSv17 is to employ a UFS-based fully coupled atmosphere-land-ocean-ice-wave model. The coupled model will be part of a weakly coupled data assimilation system, with new non-atmospheric data assimilation components based on the Joint Effort for Data assimilation Integration (JEDI) software. There will also be greater alignment with the Global Ensemble Forecast System (GEFS) in both model and infrastructure development and more consistent GEFS initialization through a new early cycle ensemble analysis from the GFS.

This presentation will provide an overview of the GFSv17 system along with the current status and future plans while highlighting the connections to the UFS community. Prototype experiment results from the development of the coupled model, as well as data assimilation integration, will also be shared.

Updates on Wave Coupling for the next Global Forecast System GFSv17

Jessica Meixner , Matthew Masarik , Saeideh Banihashemi, Ali Salimi-Tarazouj, Ricardo Campos , Ghazal Mohammadpour, and Avichal Mehra

The medium range weather deterministic forecast model for NCEP is the Global Forecast System. The operational version (GFSv16) is one-way coupled from the atmospheric model, the finite volume cubed sphere dynamical core FV3, to the wave model, WAVEWATCH III. The next version, GFSv17, will include two new components, the MOM6 ocean model and the CICE6 ice model. This implementation leverages the UFS Application for Medium Range Weather (MRW) and Sub-seasonal to Seasonal (S2S) and the UFS community at large. A major goal for GFSv17 is to employ a UFS-based fully coupled atmosphere-land-ocean-ice-wave model. Specifically for the wave model, updates include having input from the atmosphere, ocean, and ice components and feedback to the atmosphere and ocean components. Another major planned upgrade for the wave model is utilizing unstructured grids, allowing for improved scalability and additional resolution as desired. This presentation will provide a status update on the wave component in GFSv17 and how it impacts the fully coupled forecasts.

The Global Ensemble Forecast System (GEFS) for subseasonal ensemble forecasts out to 45 days

Bing Fu, Neil Barton, Philip Pegion, Fanglin Yang and Avichal Mehra

Following the development of the UFS coupled model prototypes which were targeting the next version of GFS (v17), the latest ensemble prototypes for the next version of GEFS (v13) include the latest updates from the coupled model, especially the atmospheric model physics. As it has been decided to include two-way aerosol coupling for all the ensemble members in GEFSv13, significant effort has been made to finalize the model configuration as well as to design various experiments to investigate the impact of aerosol coupling. A blending emission scheme has been developed to provide the missing emission information for real time forecasts with aerosol coupling. Prior to the implementation of the GEFSv13, a 30-year reforecast is planned for model calibration and future bias correction. The NOAA Physical Sciences Laboratory (PSL) has completed the generation of 30-year GEFSv13 reanalysis data for reforecast using the “replay” approach from existing ERA5 atmospheric reanalysis and ORAS5 ocean reanalysis. This GEFSv13 reanalysis dataset has been tested in our latest ensemble prototypes. This presentation will show the model results from the latest ensemble prototypes. The status of GEFSv13 and associated future plans will also be presented.

Improvements in week 3&4 ocean forecasts in recent GEFS prototypes targeting GEFSv13

Sulagna Ray, Lydia Stefanova, Bing Fu, Phil Pegion, Neil Barton, Jiande Wang, and Avichal Mehra

The next generation NWS/NCEP operational Global Ensemble Forecasting System (GEFS) is being developed as a fully coupled UFS application that includes atmosphere, ocean, land, wave, sea ice, and aerosol components. Towards building seamless prediction systems, ensemble prototypes targeting GEFSv13 leverage the Global Forecast System (GFS) prototypes’ development of advanced atmospheric physics and new features to individual components. The configuration of the ensemble prototypes involves an atmospheric component with FV3-dynamical core and advanced physics package resolved on C384, L127; an ocean component - MOM6 at 0.25°, 75 hybrid levels; a sea-ice component - CICE6 - same as the ocean; a wave component - WAVEWATCH III on 0.25°; and a two-way coupling of aerosol with blended emissions. Experiments are conducted by generating ensembles (10 perturbed and one unperturbed member) with perturbations in both the atmosphere and ocean initial conditions and the inclusion of advanced stochastic schemes - representing uncertainties from both initial condition and model. In between the latest successive GEFS prototypes, the initial conditions of individual components are updated, a two-way coupling of aerosol is included, and minor model changes are added. Here, we will present the results from these latest ensemble prototypes, with a particular focus on the week 3&4 forecasts of the ocean. Improved ocean initial conditions likely affect the forecast biases due to the long ocean memory and are an important step towards an overall improvement in subseasonal-to-seasonal forecast.

Toward Global 6.5-km Weather Prediction and Storm-Resolving Simulation

Linjiong Zhou, Lucas Harris, Jan-Huey Chen, Kun Gao, Kai-Yuan Cheng, Mingjing Tong, Alex Kaltenbaugh, Matthew Morin, and Lily Johnston

A common strategy to improve weather model forecasts is to increase the model's resolution, which requires more computing power and the inclusion of updated dynamic and physical processes to handle smaller-scale features. The Geophysical Fluid Dynamics Laboratory has developed the 13-km System for High-resolution prediction on Earth-to-Local Domains (SHiELD) for global weather prediction and the 3.25-km eXperimental-SHiELD (X-SHiELD) for global storm-resolving simulation. However, the 13-km model is not sufficient for some high-impact weather systems, but the computational expense of the 3.25-km model has not been affordable for regular use. In this study, we introduce a 6.5-km version of SHiELD, designed to bridge the gap between medium-range global weather prediction and global storm-resolving simulation while remaining feasible for real-time forecasts. This model operates in the "gray zone" (at grid spacings of 10 km or below), where thunderstorms are partially resolved, necessitating adjustments to physical parameterizations originally designed for coarser resolutions. Comparative analyses with the 13-km SHiELD over a three-year hindcast period show significant improvements in global, regional, tropical cyclone, and continental convection predictions. These findings demonstrate that the 6.5-km SHiELD can be used to advance weather prediction by effectively addressing both synoptic weather systems and specific storm-scale phenomena in a single global model.

An NSST Alternative in UFS: SkinSST

Shan Sun, Rainer Bleck, and Dongxiao Zhang

We have made seasonal forecasts using NOAA's coupled Unified Forecast System (UFS), which features the FV3 atmospheric model with the Global Forecast System (GFS) physics package, as well as the MOM6 ocean model and the CICE6 sea ice model. The baseline experiments are based on the UFS coupled model Prototype HR3, with the NSST (near-surface sea surface temperature) algorithm set as default. Notably, the modeled sea surface temperature (SST) exhibits an overall positive bias.

We conducted a second set of experiments identical to the control experiment in all respects, except that we replaced the NSST algorithm, originally developed for uncoupled atmospheric applications, with a skin temperature scheme that makes full use of information from the ocean model's mixed layer algorithm. The results indicate a reduction in bias for both tropical SST and the atmospheric energy budget compared to the control experiments. The feedback between temperature and energy flux highlights the importance of proper skin temperature representation in the coupled system.

Hierarchical Testing to Inform SFS Development: An Investigation from DYNAMO Field Campaign

Weiwei Li and Shan Sun

This study used the hierarchical system development method to facilitate the development of Seasonal Forecast System (SFS) based on the Unified Forecast System (UFS). The Dynamics of the Madden-Julian Oscillation (MJO) (DYNAMO) field campaign over the Indian Ocean was focused. A series of hierarchical simulations, adopting the latest UFS prototype physics, were conducted using both the fully-coupled SFS and the Common Community Physics Package (CCPP) single-column model (SCM). Assessed against observations, comparisons of simulations from the SFS and observation-forced SCM suggest room for improvement in the SFS model. In particular, it showed that smaller-than-observation amplitude sea-surface temperature (SST) diurnal cycles and unrealistic cloud cover conditions coincided in both models. However, SCM experiments help elucidate no clear causal relationship between them. In addition, unlike in SCM, the SFS simulations have difficulty simulating the MJO transition from shallow to deep convection during the active convective phase of this MJO event, which is related to the biased environmental flow simulated by the SFS. The work also examined the moist physics behavior across various scales, from medium-range to seasonal, for cloud macro, microphysical, and radiation properties. Results suggest that sophisticated approaches to enhance physics scale-adaptiveness are desired.

Diabatic Heating and Vertical Motion in Coupled UFS, or An Unexpected Path to R2O

David Straus, Erik Swenson, Chul-Su Shin, James Kinter, and Benjamin Cash

Here, we present an analysis of diabatic heating in the prototype-p8 configuration of the coupled UFS application. We find that diabatic heating in the lower stratosphere in the UFS is the opposite of similar estimates made for ERA5. Further analysis of the stratosphere uncovered errors in the vertical circulation, leading directly to code modifications addressing the issues discovered.

Cross-Cutting - System Architecture

The Gulf of Mexico Coastal Hazards Forecast System

Z. George Xue, Xiaochen Zhao, Yanda Ou, Zhengchen Zang, Ziyan Lei, and Muhamad Farid Geonova

The Gulf of Mexico Coastal Hazards Forecast System (GMx-CHFS) is built on the Coupled Ocean–Atmosphere–Wave–Sediment Transport (COAWST) modeling system, which integrates the Weather Research and Forecasting model (WRF) and its hydrological extension (WRF-Hydro), the Regional Ocean Modeling System (ROMS), and the Simulating Waves Nearshore model (SWAN). GMxCHFS comprises three forecast systems: 1) a Mississippi River model utilizing WRF-Hydro to forecast surface water head and streamflow using atmospheric data from the National Water Model (NWM) and river discharge data from USGS; 2) a Gulf of Mexico ocean model producing forecasts for ocean circulation, waves, and biogeochemical cycles using atmospheric forcings from the North American Mesoscale Forecast System (NAM) and boundary conditions from HYCOM and WAVEWATCH III; and 3) high-resolution dynamically coupled hydrological-ocean models for hurricane-induced compound flooding. The GMx-CHFS provides 72-hour forecasts updated every 6 hours, utilizing LSU's HighPerformance Computing System. The Mississippi River operational model offers detailed hourly streamflow forecasts with a 250-m resolution, utilizing topography data from the National Hydrography Dataset. The ocean forecast system delivers 1 km horizontal resolution daily forecasts for the entire Gulf of Mexico, incorporating real-time river discharge either from USGS gauges or the Mississippi River model. The ocean model outputs, including surface elevation, current velocity, water temperature, salinity, significant wave height, and nutrient concentrations, are archived on GCOOS and IOOS servers. In addition to standard ocean physics, the ocean model offers real-time forecasts of hypoxia and carbon cycling, enhancing the system's capability to monitor and predict critical environmental parameters. GMx-CHFS also features several high-resolution (100m) sub-domains for compound flooding forecasts, where WRFHydro and ROMS are dynamically coupled to realize a seamless transition across the land-estuary-ocean continuum. These high-resolution compound flood sub-domains are driven by the open boundary condition from the "parent" Gulf of Mexico ocean model. Upon the landfall of a hurricane, a selected sub-domain will be activated if the landfall is projected within its domain. This setup enhances model performance and stability, providing comprehensive and reliable environmental forecasts by integrating atmospheric, hydrological, and oceanographic processes across basin, regional, and local scales.

Community Modeling on Community Platforms

Benjamin Cash

This presentation will discuss the challenges and successes in running UFS applications from the perspective of a member of the university community. Topics will include accessing the code, obtaining computing resources, obtaining model files, configuring and running the model, etc.

EPIC Systems Architecture Enabling Rapid Innovation

Kristopher Booker and Anna Kimball

The NOAA EPIC program has enabled an accelerated pace of numerical weather prediction innovation through their collaboration with our various government, academic, and enterprise partners, as well as the overall modeling community at large. Open-source access to the UFS modeling code has made it simple for scientists and engineers to become contributors. Swift integration and feedback through various CI/CD code pipeline tools and processes have broken down the bottlenecks that once constrained innovation. Additionally, the creation of public community dashboards has further progressed the level of transparency within the modeling community to foster a climate of collaboration and rapid innovation. This collaborative spirit has increased community engagement and broken down the silos that once existed between scientific research groups. The creation of a robust regression testing framework has allowed expedient testing of new scientific innovations while ensuring integrity. Further quality control measures have been enforced through the use of static code analysis tools to ensure contributions conform to operational compliance standards. Coupled with effective code management, these measures should lead to faster adoption of improved modeling techniques and overall forecasting skills.

The Operational Implementation Process - Bringing UFS Innovations to Society

Jacob R. Carley, Steven Earleb, Rahul Mahajana, Matthew E. Pylea, Katherine Friedmana, and Lin Gan

The process of implementing an operational Earth system prediction system into operations at the National Weather Service is complex and may seem opaque to those not routinely involved in such a process. To implement any system in operations, whether it be the GFS or RTMA, a strict series of rules must be followed in order to deliver a package that is (1) fast and straightforward to debug for real-time failures, (2) consistent in design across the modeling suite, and (3) ensures 99+% reliability. When requirements are not met, crucial innovations from the scientific community will either (1) not be implemented in operations, thus denying the benefit of improved science to society or (2) be severely delayed (a year or more) as development teams address outstanding issues to reach compliance. In this talk, we shall provide a broad overview of the process, requirements, experiences, and risks. We will close with a note on the need for process change in the UFS era.

Porting of the Global-Workflow to Gaea-C5

D. Alex Burrows and Anil Kumar

Working closely with NOAA's Environmental Modeling Center, the Earth Prediction Innovation Center's (EPIC) Atmospheric Rivers' team is leading the porting of the global-workflow (GW) to Gaea's new C5 platform. This includes staging of the GW's fixed and initial condition files for testing. These files are currently located in a world-shared directory that allows access for all users. Spack-stack is the software package currently used to build and run GW, which was previously ported to Geaa-C5 by EPIC's software integration team. Porting the GW also requires the individual porting of the GW submodules including (1) UFS-utilities, GFS-utilities, Unified Post Processor, and the UFS-weather-model for forecast-only runs, i.e., no data assimilation (DA), (2) Gridpoint Statistical Interpolation (GSI), GSI-utilities, and GSI-Monitor for atmospheric DA, and (3) Global Data Assimilation System Application for coupled DA. Currently, all submodules successfully build on Gaea-C5 and test runs have been conducted, including atmosphere-only forecast runs at C48, C96, and C384 and coupled (atmosphere-ocean-ice-wave) runs at C48.

The Unified Workflow Tools and a Proposed UFS Applications Framework

Christina Holt, Paul Madden, Emily Carpenter, Naureen Bharwani, Fredrick Gabelmann, and Brian Weir

The UFS Unified Workflow Project has made significant progress toward building a set of tools and drivers to facilitate the unification of configuration and run-time portions of UFS applications. The uwtools Python package is regularly updated and readily available via the Anaconda.org ufs-community repository.

With these tools in hand, the framework for unification across applications is coming together as our team works diligently to get them integrated into the Short Range Weather Application and collaborates with other teams to incorporate uwtools into the UFS Land DA, Subseasonal to Seasonal, and the UFS Coastal applications, as well as supporting early development of the RRFS v2 with MPAS and JEDI. In this talk, we'll give an update on the current state of the Python package and our recommendation on how it can be used to form the framework for unification across UFS applications supporting research-to-operations.

Driving the User Experience with UW Tools

Brian Weir, Frederick Gabelmann, Christina Holt, Paul Madden, Emily Carpenter, and Naureen Bharwani

A key element of the UFS Unified Workflow Project is the introduction of a comprehensive suite of drivers designed to provide a well-defined interface to configure components and to streamline the preparation of their run-time requirements. These drivers offer a modular and highly customizable framework, facilitating the execution of tasks within a NWP system.

In this presentation, we will explore the advantages of employing graph-oriented design principles to prepare run directories and execute programs for NWP systems using UW Tools.. We will delve into the intricacies of the user interface, highlighting how it enhances user interaction and usability. Additionally, we will provide a walkthrough of the procedures for operating various components using these drivers, demonstrating their flexibility and ease of use.

The Research Repository for Data and Diagnostics (R2D2): A Distributed Data Management System for JEDI Data Assimilation Workflows

Eric J. Lingerfelt, Tariq J. Hamzey , Evan Parker, Maryam Abdi-Oskouei, Jérôme Barré, Fábio Diniz, Clémentine Gas, Ashley Griffin, Dominikus Heinzeller, Stephen Herbener, Benjamin Ruston, Christian Sampson, Travis Sluka, Kristin Smith, and Yannick Trémolet

To harness the full potential of ever-increasing volumes of data from new and evolving Earth observation systems, a new online database software system has been developed and deployed by the JCSDA. As a core component of JEDI, the Research Repository for Data and Diagnostics (R2D2) performs data registration, management, and configuration services for high performance computing data assimilation computational workflows. R2D2 satisfies these requirements by offering a centralized, model agnostic platform for handling diverse datasets and provides a generic data solution for DA scientists. R2D2 is a multi-tier system comprising a series of distributed, interconnected data hubs whose holdings are indexed according to an SQL database schema and accessible by a dynamic, intuitive Python API. We present an overview of R2D2's utilization in the flagship Skylab application and future enhancements to the system.

Running Global-workflow on AWS

Wei Huang

With the successful implementation of global-workflow on AWS, EPIC will work closely with NOAA EMC stakeholders to teach interested researchers to use global-workflow on AWS, starting with tutorials on how to create clusters on NOAA parallelworks, how to clone global-workflow on AWS, and then how to compile and run global-workflow on AWS. EPIC will also start to invest in how to run global-workflow more efficiently and how to run higher resolution UFS models and Data Assimilation on AWS and other cloud platforms like Azure and Google Cloud.

Building Federated MPAS Workflows For Research And Development With Chiltepin and UWTools

Naureen Bharwani, Christopher W Harrop, and Isidora Jankov

Many numerical weather prediction (NWP) workflow developments are aimed at scientists who contribute to the prediction modeling systems by transitioning their Research to Operations (R2O), supplying incremental improvements to these models. In contrast, research to build workflows that explore long range future NWP compute capabilities, high performance computing (HPC), and emerging technologies, require a novel approach to workflow design.These workflows are essential for exploring emerging computational technologies and paradigms, and applying exascale compute resources to tackle grand challenge problems. This presentation will describe our progress in building federated Model for Prediction Across Scales (MPAS) workflows using our new federated workflow system, Chiltepin, which leverages Globus Compute and Parsl to meet these emerging technological demands.

The necessity for diverse computational and data resources, often geographically and institutionally distributed, is a hallmark of research for grand challenge applications. By federating NWP workflows through Chiltepin, we aim to integrate and manage these disparate resources, enabling robust and seamless execution of advanced applications such as high-resolution global ensemble forecasting as well as training and incorporation of machine learning models into the NWP ecosystem.

A key component of our approach is the integration of the Unified Workflow Tools (UWTools) drivers for the MPAS model into Chiltepin. This integration facilitates seamless coordination and execution of complex MPAS workflows across multiple platforms by leveraging the robust drivers already developed for traditional R2O workflows. We will present our progress and challenges encountered in leveraging UWTools in Chiltepin to build a federated MPAS application.

Advancing UFS Applications - Air Quality

Updates to the UFS-AQM online prediction system for the National Air Quality Forecasting Capability

Kai Wang, Jianping Huang, Ivanka Stajner, Fanglin Yang, Raffaele Montuoro, Cory Martin, Jeff McQueen, Ho-Chun Huang, Brian Curtis, Hyundeok Choi, Haixia Liu, Shobha Kondragunta, Chuanyu Xu, Fangjun Li, Barry Baker, Daniel Tong, Youhua Tang, Patrick Campbell, James Wilczak, Dave Allured, and Irina Djalalova

NOAA has developed a unified forecast system (UFS)--based online air quality prediction system (AQPS). This system was successfully implemented on May 14, 2024, as an operational forecast model, air quality model version 7.0 (AQMv7.0), to provide numerical guidance for air quality forecasting nationwide. During the AQMv7.0 implementation, NESDIS' Regional hourly Advanced Baseline Imager (ABI) and Visible Infrared Imaging Radiometer Suite (VIIRS) Emissions (RAVE) v1 fire data were utilized to improve fire emission calculations and their impacts on air quality predictions.

However, the primary satellite that RAVE products rely on has been upgraded from NOAA-20 to NOAA-21. The UFS-AQPS system has been updated to accommodate this change, along with a bug fix in the AQM source code to handle primary organic emissions associated with fires and point sources. The year-long retrospective simulations from May 2023 to April 2024 are completed using the updated system. In this presentation, the new simulations are compared with the AQMv7.0 predictions and evaluated against AirNow observations across different seasons and regions, with a focus on intense fire events, such as the Quebec fires in June 2023.

Moreover, the presentation will highlight ongoing efforts to further improve national air quality forecasting capabilities, which include refining model horizontal resolution from 13 km to 9 km and improving chemical initial conditions (e.g., nitrogen dioxide (NO2), fine particulate matter (PM2.5), and aerosol optical depth (AOD)) through data assimilation technology, along with upgrades to the UFS-atmospheric model, air quality model, and national emission inventories.

Updates and evaluation of NOAA's online-coupled air quality model within the Unified Forecast System

Wei Li, Beiming Tang, Patrick C. Campbell, Youhua Tang, Barry Baker, Zachary Moon, Daniel Tong, Jianping Huang, Ivanka Stajner, Raffaele Montuoro, and Robert C. Gilliam

The air quality forecasting system is an essential tool widely used by environmental managers to mitigate adverse health effects of air pollutants. This work presents the latest development of the next-generation regional air quality model (AQM) forecast system within the Unified Forecast System (UFS) framework in the National Oceanic and Atmospheric Administration (NOAA). The UFS air quality model incorporates the U.S. Environmental Protection Agency (EPA)'s Community Multiscale Air Quality (CMAQ) model as its main chemistry component. In this system, CMAQ is integrated as a column model to solve gas and aerosol chemistry while UFS processes the transport of chemical species. The current AQM version 7 (AQMv7) is coupled with an earlier version of CMAQ (version 5.2.1). Here, we describe the development of the updated AQMv7 by coupling to a 'state-of-the-science' CMAQ version 5.4. The updates include improvements in gas and aerosol chemistry, dry deposition processes, and structural changes to the Input/Output (IO) interface, enhancing both computational efficiency and the representation of air-surface exchange processes. A simulation was conducted for the period of August 2023 to assess the effects of these updates on the forecast performance of ozone (O3) and fine particulate matter (PM2.5), two major air pollutants over the continental United States (CONUS). The results show that the updated model demonstrates a significantly enhanced capability in simulating O3 over the CONUS by reducing the positive bias during both day and night, leading to a reduction of the mean bias by 50% and 72% for hourly and the maximum daily 8-hour average O3, respectively. Spatially, the updated model lowers the positive bias of hourly O3 in all of the ten EPA regions, particularly within the Great Plains. Similarly, the updates

induce uniformly lower two fine particulate matter (PM2.5) concentrations across the CONUS domain, reducing the positive bias in the northeast and central Great Plain and exacerbating the negative bias in the west and south. The updated model does not improve model performance for PM2.5 in the vicinity of fire emission sources as compared to AQMv7, thus indicating a focal point of model uncertainty and needed improvement. Despite these challenges, the study highlights the importance of the ongoing refinements for reliable air quality predictions from the UFS-AQM model, which is the future replacement of NOAA's current operational air quality forecast system.

A dynamical ensemble approach to characterizing uncertainties in the prediction of air quality downstream of the massive western US wildfires of 2020

Christopher Rozoff, Rajesh Kumar, Padhrig McCarthy, Jared Lee, Wenfu Tang, and Stefano Alessandrini

To help guide advisories and various societal decision processes aimed at reducing humanity's detrimental exposure and risks tied to poor air quality, NOAA predicts ozone (O3), fine particulate matter (PM2.5), and other harmful pollutants each day. Unfortunately, air quality forecasts still suffer from errors emanating from the driving datasets, inaccurate emissions, and an incomplete understanding of air quality processes. With increasingly intense western North American wildfires producing expansive and harmful smoke plumes that impact many millions of people downstream, it is important to improve prediction.

This work aims to design a dynamical ensemble based on the NOAA's Online Community Multiscale Air Quality (Online CMAQ) embedded within the UFS. The ensemble is based on perturbations of (a) meteorological and chemical initial and lateral boundary conditions, (b) anthropogenic, biogenic, and biomass burning emissions, (c) secondary organic aerosol response to temperature changes and solubility of semi-volatile organic compounds (SVOCs), and (d) removal processes including the hygroscopicity of aerosols and dry deposition velocities of O3, precursors, and SVOCs. Such a perturbation strategy leads to >50 ensemble members. In this presentation, the ensemble is evaluated against AirNOW observations of O3 and PM2.5 in the summer of 2020 when extensive smoke plumes were generated by historic western US wildfires. The ultimate goal of the project is to develop down-selection techniques with calibration to reduce the ensemble size to ~10 members such that the majority of skill and ensemble quality is retained. This will provide a cost-effective air quality ensemble for NOAA's operational air quality forecasting.

Investigation of The Impact of Alluvial Flows in the UFS Dust Scheme

Emily Faber, Adriana Rocha Lima, and Barry Baker

Mineral dust is an important part of the climate system we live in. Dust hotspots emit tons of dust annually with the help of local meteorology and soil characteristics. As one of the most abundant aerosols, it is important to characterize and define the climate and human impacts of dust. To do this, we must first understand how much dust there is in the atmosphere, model its emission, and transport it correctly. Using the Unified Forecast System (UFS), we examine how alluvial flows are represented. Alluvial flows are areas of dry lakes and riverbeds that are subgrid to the model but may have an outsized impact on the amount of dust emitted as they emit efficiently on seasonal and decadal cycles. Here we compare and explore modeled values of aerosol optical depth (AOD) to satellite data. Further, we look at how a global, non-static alluvial flow map can be generated and applied to the FENGSHA dust emission scheme within the UFS and how to quantify its impact on model accuracy on seasonal to climatic scales. We show that a more accurate representation of these ephemeral, sub-grid scale features ultimately impacts the two most important characteristics of dust emission – how much there is and where it comes from.

Development and evaluation of a machine learning based wildfire spread prediction model for regional air quality forecasting

Wei-Ting Hung, Barry Baker, Patrick Campbell, Youhua Tang, Lacey Holland, Ravan Ahmadov, and Johana Romero-Alvarez

Wildfire spread, the spatiotemporal variations of wildfires, is a complex and highly variable process attributed to wildfire behavior. Currently, operational air quality forecast models often use persistent fires based on the latest available observation, which may not represent realistic fire behaviors in the future and do not consider the fire spread over time. Hence, this study proposes a novel machine learning (ML) wildfire spread model for regional-scale air quality forecast model applications. The proposed ML model predicts both fire propagation and intensity by predicting the spatial distribution and magnitude of fire radiative power (FRP) for the next 24 hours. The model is trained using hourly datasets during 2020 over CONUS with 3- km spatial resolution, and the FRP predictions are used in the Rapid Refresh Forecast System with Smoke and Dust (RRFS-SD) model as fire inputs for application assessment. A four-day period in September 2020 during the historical California wildfire season is selected for evaluation. Preliminary results show that the ML model well captures the spread of wildfires with R-squared (R^2) near 0.7 and good spatial similarity (~95%). The RRFS-SD surface smoke concentration predictions based on real-time fire products and FRP predictions show good agreements, indicating that FRP predictions can represent future fire activities properly. However, the ML model generally underestimates fire intensity, leading to lower total column aerosol optical depth (AOD) predictions in RRFS-SD. Missing information on new ignitions and restricted spread area in the ML model could also result in possible uncertainties in air quality forecasting.

Evaluation of NOAA's global UFS coupled aerosol predictions

Jeff McQueen, Fanglin Yang, Raffaele Montuoro, Li Pan, Partha S. Bhattacharjee, Barry Baker, Li Zhang, Siyuan Wang, Cory Martin, Ivanka Stajner, Gregory J. Frost, Georg A. Grell, and Shobha Kondragunta

NOAA is developing a next-generation global aerosol prediction capability within the Unified Forecast System (UFS) FV3 cubed-sphere grid framework to better represent and forecast impacts of wildfires on AQ and impacts of aerosols globally on weather from hourly to subseasonal scales. These systems include online-coupled prognostic model components for atmosphere, ocean, sea ice, waves, and aerosols and rely upon state-of-the-science interoperable atmospheric physics schemes accessible via the Common Community Physics Package (CCPP) framework. In 2025, it is expected that the coupled UFS system will replace the current NWS operational Global Ensemble Forecast System (GEFS)v12, Currently, v12 includes one ensemble member with aerosols using the Goddard

Chemistry Aerosol Radiation and Transport (GOCART) module. In contrast, the updated UFS utilizes a tightly coupled NOAA-NASA unified GOCART module. The chemistry and aerosol modules used for GEFSv13 include simple sulfur chemistry, hydrophobic and hydrophilic black and organic carbon, and a 5-bin sea salt module. Additionally included is an updated version of the FENGSHA 5-bin dust module, wildfires modeling using Fire Radiative Power (FRP), and smoke emissions from the NESDIS Global Biomass Burning Emissions Product (GBBEPx). Smoke plume rise modeling is not used in v13 to constrain unrealistically long-range smoke transport. Other potential inclusions include aerosol-radiative feedback, and assimilation of VIIRS aerosol optical depth (AOD) is being developed and evaluated for inclusion into GEFSv13. Finally, plans call for the inclusion of aerosols in all 31 members, thereby providing probabilistic as well as deterministic aerosol predictions.

This presentation will overview the aerosols capabilities and results from prototype testing for the experimental UFS-based GEFS v13. Total and speciated aerosols will be evaluated against NASA's MERRA-2 reanalysis for GEFS retrospectives during summer 2023. Special attention will be paid to analyzing both weather and aerosol performance for high-impact aerosol events. Simulations will be run \with and without aerosol radiative feedback to further quantify the impact of aerosols on large-scale weather.

Incorporating GFDL-AM4.1 chemistry into NOAA's Unified Forecasting System for global air quality application

Jian He, Li Zhang, Rebecca Schwantes, Barry Baker, Ravan Ahmadov, Larry Horowitz, Vaishali Naik, Zachary Moon, Jordan Schnell, Georg Grell, Quazi Rasool, Colin Harkins, Siyuan Wang, Patrick Campbell, Youhua Tang, Beiming Tang, Margaret Marvin, David Fillmore, Matthew Dawson, and Brian McDonald

The current configurations of NOAA's Unified Forecasting System (UFS) for atmospheric composition application include NASA's 2nd-generation GOCART aerosol model with minimal gas-phase chemistry for global subseasonal to seasonal forecasts and CMAQ chemistry for US air quality forecast. To expand the capability and enable the flexibility of the UFS for air quality application at both global and regional scales, we have been developing the Configurable ATmospheric Chemistry (CATChem) component, which would include all chemical and aerosol processes needed to perform atmospheric chemistry and composition simulations. We will also include options to use gas-phase chemical mechanisms and aerosol schemes of varying complexity. The flexibility of CATChem will make the UFS applicable for both research and operational forecasting needs within the unified chemistry component. As the first step towards this goal, CATChem is connected to the UFS (UFS-Chem) through the Common Community Physics Package framework, with NOAA GSL's GOCART aerosol model as the default aerosol module option. In this work, we incorporate key chemical and aerosol processes from NOAA GFDL's full chemistry model AM4.1 into CATChem within the UFS framework. Specific processes include gas-phase chemistry for both troposphere and stratosphere, lightning emissions of nitrogen oxides, dry and wet deposition for both gasses and aerosols, aerosol thermodynamics, and formation of secondary organic aerosols. Model results will be compared to the GFDL-AM4.1 model and evaluated with the aircraft measurements from the Atmospheric Tomography Mission. UFS-Chem with AM4.1 chemistry would be the first configuration of the UFS for global air quality applications.

A Technical Overview of the Transition of the UFS-based AQMv7 into Operations - AQMv7 Implementation Experience

Lin Gan, Jianping Huang, Steven Earle, and Jacob Carley

The Air Quality Model (AQM) v7 package is the first regional air quality prediction system built on the Unified Forecast System (UFS) implemented into National Weather Service (NWS) operations. The system provides numerical guidance of surface ozone (O3) and particulate matter with a diameter equal to or less than 2.5 micrometers (PM2.5), serving vulnerable populations and reducing exposure to poor air quality. The Environmental Modeling Center (EMC) Engineering and Implementation Branch (EIB) was involved in the Environmental Equivalence (EE2) review and the development of the ecFlow workflow of the AQMv7 package. Many implementation-related tasks were put in place to ensure the package follows the production standards, delivers reliable results, incorporates appropriate exception handling, and maintains restart capability.

In this talk, we will provide a broad overview of the community solution, implementation standards, process of transition to operations, and the lessons learned from the implementation. We will conclude by emphasizing the importance of bridging the gap between the research community and operational implementation requirements.

Virtual Posters - Please see the UIFCW24 Slack #virtual-poster-slam to view the posters (Abstracts below)

Background Error Covariances in the JEDI System

Nate Crossette, Benjamin Menetrier, Marek Wlasak, Stefano Migliorini, Daniel Holdaway, Mayeul Destouches, Ricardo Todling, Steven Vahl, Christian Sampson, Francois Hebert, and Anna Shlyaeva

Joint Effort for Data Assimilation Integration (JEDI) is developed at the JCSDA in collaboration with NOAA, NASA, the US Navy, the US Air Force, the UK Met Office, and NCAR. The goal of the project is to develop a cutting-edge data assimilation system that can be used with different prediction systems, including atmosphere, land, ocean, sea-ice, atmospheric composition, and coupled Earth system prediction systems. An important input to the data assimilation process is the background state (also called the a priori or reference state) of the system being forecasted. The true background state cannot be fully known, so it must be estimated. Errors in the estimation of the background state are accounted for with the background error covariance matrix B. SABER (System Agnostic Background Error Representation) is the JEDI system component that provides different background error covariance representations that can be used with a wide range of the Earth System models. This presentation will show the current status of and plans for the background error covariance capabilities in JEDI.

An Evaluation Case Study on the Pre-trained Machine Learning Model FourCastNet-v2

Linlin Cui, Jun Wang, Sadegh Tabas, and Jacob Carley

Machine learning techniques are increasingly recognized as viable tools for operational weather prediction due to their efficiency and competitive performance relative to conventional numerical weather prediction models. This study assesses the effectiveness of FourCastNet-v2, a machine learning model utilizing the vision transformer (ViT) architecture and Spherical Harmonics Neural Operators, designed for modeling non-linear chaotic and dynamical systems on spherical surfaces. The Spectral Fourier Neural Operators (SFNOs) employed in FourCastNet-v2 not only retain the advantage of Fourier Neural Operators (FNOs) in simulating long-range dependencies in spatio-temporal data but also address their limitation in learning operators in spherical coordinates.

The National Centers for Environmental Prediction (NCEP) has initiated the use of pre-trained machine learning weather prediction models, including GraphCast and FourCastNet-v2, with Global Data Assimilation System (GDAS) data as input. The daily forecast results are accessible to the public on AWS. This study presents the model performance evaluation of FourCastNet-v2 through the computation of Anomaly Correction Coefficient (ACC) scores and mean-squared error across several key atmospheric variables. Additionally, the effectiveness of FourCastNet-v2 in predicting a specific winter storm event is detailed.

Impact of Observing Systems on Earth System Prediction

Diniz, Fabio, Vandenberghe, François, and Ruston, Benjamin

The Joint Center for Satellite Data Assimilation (JCSDA) and its partners recently introduced the Joint Effort for Data assimilation Integration (JEDI) SkyLab application, a tool to estimate observation impact on analyses and short-range forecasts. JEDI provides a demonstration application of an integrated Earth System DA capability (atmosphere, ocean, sea ice, land surface, aerosols, and trace gasses). A variety of emerging observing systems are continuously being interfaced with JEDI across the multiple components of the Earth System. The use of well-established observing systems is continuously being improved in Skylab. The goal of the JEDI SkyLab application is to be a vehicle to decrease the timeline for operational implementation by creating configurations for these observing systems.

The JCSDA OBS team is the primary developer of the Unified Forward Operator (UFO) component of the JEDI system. In this component, version 3 of the Community Radiative Transfer Model (CRTM) is employed for use with a large range of environmental monitoring sensors.

We will cover a general overview of the JEDI SkyLab application and show evaluation techniques that have been developed to monitor the impact of observations. An ability to compare the response of system changes in the observation statistics will also be demonstrated. Lastly, we will demonstrate the use of CRTM for an emerging sensor, the TROPICS microwave sounder, in an Observation Simulation Experiment (OSE). Also shown will impact on the Skylab application and response seen in the other observing systems, such as radiosondes and programs of record sounders such as ATMS.

Advancements in Assimilation of Ocean Color Radiance Data

Hamideh Ebrahimi, C Rousseau, D Holdaway, T Sluka, and G Vernieres

The Sea-ice, Ocean, and Coupled Assimilation (SOCA) project is one of the main projects of the Joint Center for Satellite. Data Assimilation (JCSDA). The domain of the SOCA project involves integrating data assimilation techniques across the marine elements of the Earth system, encompassing the ocean, sea-ice, waves, and ocean biogeochemistry, while also addressing the interconnections among these components.

A significant emphasis lies in constructing foundational elements for a coupled ocean/sea-ice/atmosphere data assimilation capability. By employing the coupled Joint Effort for Data Assimilation Integration (JEDI) infrastructure, the direct assimilation of surface-sensitive microwave/infrared/visible radiances for observations like ocean color becomes achievable. The first step to assimilate the ocean color radiance is a coupled H(x) to simulate these observations. Here, the progress in the integration of NASA's Ocean Atmosphere Spectral Irradiance Model (OASIM) ocean color forward operator in the Unified Forward Operator (UFO) will be discussed, and H(x) for ocean color observations will be demonstrated with existing MODIS observations.

Simultaneous Assimilation of Dual-Polarization Radar and All-Sky Satellite Observations to Improve Convection Forecasts

Keenan Eure, David Stensrud, Yunji Zhang, Matthew Kumjian, and Darrel Kingfield

Accurate forecasts of severe weather are both a priority and a challenge for the National Oceanic and Atmospheric Administration (NOAA). Issuing timely and accurate warnings of these threats is a NOAA responsibility that is conducted in service. Yet, modeling internal structures of convection is difficult, as the details of these structures affect the storm mode, intensity, and longevity. Recent studies suggest that novel observations from the WSR-88Ds and GOES-16 have the potential to improve the convection forecasts in convection-allowing model (CAM) ensemble forecasting systems. Several distinct polarimetric signatures have been identified from the early stages of deep convection, such as the differential reflectivity (ZDR) column. These are vertical protrusions of positive ZDR values above the environmental melting level and can aid significantly in characterizing storm updrafts. Information on the updraft location and intensity has the potential to improve CAM representation of convection evolution. In addition, GOES-16 infrared (IR) all-sky brightness temperatures (BTs) provide complementary information and coverage on cloud structures that Doppler radars cannot directly measure. To explore the benefits of both types of observations, an ensemble data assimilation approach is applied to a severe weather event on 1 May 2018. The Weather Research and Forecasting (WRF-ARW) model is used, and observations are assimilated using an Ensemble Kalman Filter (EnKF). Conventional, WSR-88D ZDR and GOES-16 all-sky BTs are assimilated separately and jointly over a 4-h period and results are compared to explore the influence of these observations on different aspects of the severe convective event.

Building Infrastructure to Support the Next-generation Joint Effort for Data Assimilation Integration (JEDI) System for NOAA, NASA, U.S. Air Force, U.S. Navy, and UK Met Office

Ashley Griffin, D. Heinzeller, S. Herbener, E. J. Lingerfelt, E. Parker, Y. Tremolet, and T. Auligne

The Joint Effort for Data Assimilation Integration (JEDI) provides a data assimilation framework for Earth system prediction. JEDI is a collaborative project run by the Joint Center for Satellite Data Assimilation (JCSDA) supported by NOAA, NASA, U.S. Air Force, U.S. Navy, and UK Met Office. The interagency partnership is key to transition data assimilation research to operational modeling systems and academic communities. This transition is possible through robust computational infrastructure, comprehensive testing, open-source software, and agile development.
JEDI requires a large number of software packages to build and run experiments using several forecast models such as the Unified Forecast System (UFS), the Goddard Earth Observing System (GEOS), the Modular Ocean Model (MOM6), the Model for Prediction Across Scales (MPAS), the Navy Environmental Prediction sysTem Utilizing the NUMA corE (NEPTUNE), and the Met Office LFRic. In order to support multiple configurations of the JEDI software on High Performance Computing systems, commercial clouds, workstations, and laptops, a package management software stack (spack-stack) developed by JCSDA, the NOAA Environmental Modeling Center (EMC) and the U.S. Earth Prediction Innovation Center (EPIC) is used.

Built on top of spack-stack, JCSDA's Skylab Earth System Data Assimilation is an end-to-end system that features the following JEDI components: the Experiments and Workflow Orchestration Kit (EWOK), a data store for observation and model data called the Research Repository for Data and Diagnostics (R2D2), and an Interface for Observation Data Assimilation (IODA) to handle observational data. Skylab utilizes JEDI to model the atmosphere, ocean, sea-ice, soil moisture, snow, aerosols, and trace gasses. With a system this advanced, continuous integration and automated testing is key to rapid and effective code development at the research and production levels.

This presentation covers the JEDI infrastructure team's development efforts for the next-generation data assimilation system by leveraging cloud computing environments for research, development, and near real-time applications of JEDI. Developing a Continuous Integration/Continuous Delivery (CI/CD) pipeline using tools such as GitHub, Docker containers, various Amazon Web Services (AWS), and CodeCov enables the rapid testing and implementation of emerging technologies. The future of data assimilation lies in the ability to support new software environments and integrate new datasets in a ready-to-use format for research and operations in a matter of days.

Enabling Different Ensemble Data Assimilation Scenarios In JEDI Using The SkyLab Workflow.

Clémentine Hardy Gas, Yannick Trémolet, Tsz-Yan Leung, Kate Huxtable,
Andrew Lorenc, Maryam Abdi-Oskouei, Fabio Diniz, Dom Heinzeller, Eric Lingerfelt,

Benjamin Ruston, and Christian Sampson
"The Ensemble Data Assimilation (EDA) approach involves using multiple model simulations, each initialized with slightly different conditions, to account for uncertainty in the model and the observations. This method has been shown to be effective in improving the accuracy and uncertainty estimates of forecasts and has been widely used in weather forecasting applications.

The Joint Center for Satellite Data Assimilation (JCSDA) has developed a comprehensive workflow (SkyLab) to facilitate the execution of diverse EDA scenarios. These scenarios can involve different instruments, algorithm choices such as background error covariance or cost function, and even different weather models. The SkyLab workflow serves as the orchestrator, driving the underlying JEDI code (Joint Effort for Data assimilation Integration) to execute the different EDA experiments. In this study, we present an overview of our workflow's architecture and a comparative analysis of three distinct methods employed to conduct EDA experiments. The first method involves a distinct DA run for each member. The second approach leverages block-based methods: since many similar optimization problems are solved, it is possible to use information from all the members to construct a better approximation of the eigen-structure of the matrix at the heart of the optimization problem and accelerate the convergence. The block Lanczos algorithm is such an example. Finally, we introduce a novel application developed at the UK MetOffice of an EDA solving for the full unperturbed control run and only the perturbations of the ensemble members. During our presentation, we will illustrate how the SkyLab workflow developed at JCSDA helps us set up and compare these different experiments. We will highlight the advantages and trade-offs associated with each ensemble method, with results from experiments using real observational data and the NOAA United Forecast System (UFS) model. Furthermore, we will discuss practical considerations and implications for future operational implementation.

The NOAA global Aerosol ReAnalysis (NARA)

Bo Huang and Mariusz Pagowski
A NOAA global Aerosol ReAnalysis (NARA) product is being produced at NOAA/OAR/GSL for the years 2018-2022 as an extension of our initial aerosol reanalysis product for the year 2016 only (Wei et al., 2024). In our extended NARA product, the forecast model adopts the NOAA United Forecast System-Aerosols (UFS-Aerosols) coupled with NASA's second-generation Goddard Chemistry Aerosol Radiation and Transport (GOCART) model. The data assimilation system is based on the three-dimensional ensemble-variational (3DEnVar) framework built in the Joint Efforts for Data Assimilation (JEDI). The Aerosol Optical Depth (AOD) retrievals at 550 nm derived from the Visible/Infrared Imager Radiometer Suite (VIIRS) instrument on the Suomi National Polar-orbiting Partnership (SNPP) satellite are assimilated to provide the reanalysis of aerosol mass mixing ratios in UFS-Aerosols. Compared to the model-free run without AOD assimilation, the aerosol reanalysis shows significantly improved agreement with both assimilated VIIRS AOD retrievals and independent Aerosol Robotic Network (AERONET) AOD. Such improvement of the aerosol reanalysis was extended to the subsequent forecasts beyond five days. System development, description, and evaluation of NARA will be presented at the workshop.

Code Refactoring Practices and Benefits for the UFS Land Data Assimilation Workflow System

Chan-hoo Jeon

When implementation procedures are distributed across multiple organizations and institutes, coding standard guidance plays a critical role to enforce operational quality and enhance troubleshooting efficiency. To improve the internal structure and maintainability of the UFS land DA workflow repository (https://github.com/ufs-community/land-DA_workflow), several refactoring approaches have been applied to ensure an enhanced code management and integration process. In the Land DA System, the componentized Noah-MP land surface model (LSM) of the UFS Weather Model (WM) and the Joint Effort for Data assimilation Integration (JEDI) system are used to assimilate Global Historical Climatology Network (GHCN) snow depth observation data via the Local Ensemble Transform Kalman Filter-Optimal Interpolation (LETKF-OI) algorithm. Based on the National Center for Environmental Prediction's (NCEP) Central Operations (NCO) Implementation Standards, an open-source Python package of the Unified Workflow Tools (https://github.com/ufs-community/uwtools) has been adopted to help automate the land DA common tasks needed for the standard numerical weather prediction (NWP) workflow steps.
We also provide an overview of the continuous integration/continuous delivery and deployment (CI/CD) DevOps options of the Jenkins pipeline and SonarQube static code analysis system deployed at the land DA workflow repository.

New Opportunities for Satellite-based Sensor Simulation

Benjamin T Johnson, Quanhua (Mark) Liu, Cheng Dang, Isaac Moradi, Yingtao Ma, and Nicholas R Nalli

The JCSDA Community Radiative Transfer Model (CRTM) has long stood as a fundamental tool for the assimilation and simulation of radiance data within meteorological and environmental systems. The latest iteration, CRTM v3, represents a significant leap forward in both functionality and adaptability. This presentation provides an overview of the novel features and enhancements incorporated into CRTM v3, with a special focus on its utilization in Joint Effort for Data assimilation Integration (JEDI) and Unified Forward Operator (UFO).
This critical advancement in CRTM v3 enables accurate modeling of polarized light across diverse atmospheric and surface conditions (e.g., clouds, aerosols, snow cover, sea ice, ocean, and land surfaces), creating new and exciting opportunities in remote sensing applications and atmospheric research. By implementing full Stokes polarization, CRTM v3 addresses complex interactions between light and matter, offering more realistic simulations of radiative transfer processes.

A technical highlight of the CRTM v3 release is its ability to read both binary format files and netCDF4 coefficient files as part of a transition away from binary formats. This mixed capability ensures seamless integration until all legacy coefficients are converted to netCDF4. Furthermore, the addition of space-based radar simulation capabilities has broadened the scope of CRTM's application.

One of the most exciting developments of CRTM v3 is its application in small satellite missions such as TROPICS (Time-Resolved Observations of Precipitation Structure and Storm Intensity with a Constellation of Smallsats). The new functionalities have proven particularly potent in enhancing data assimilation, modeling, and predictive accuracy within smallsat platforms. Practical examples will be provided to elucidate how these updates have contributed to optimizing smallsat missions.

This talk will also explore real-world case studies showcasing CRTM v3's integration with the JEDI/UFO framework. By detailing the underlying methodologies and presenting examples, we aim to illuminate how CRTM v3's advancements align with modern requirements and stand as a testament to publicly accessible community-driven scientific innovation. The open-source collaborative model of CRTM ensures that there is equitable access for all developers / users to contribute to and utilize the model in their own applications without restrictions.

We will also briefly highlight the future of artificial intelligence methods to further accelerate the computational speed of CRTM -- essential for operational requirements -- while increasing the scientific accuracy of the model.

Flow-Dependent Vertical Localization in Hybrid 4DEnVar for Improvement of UFS Medium-Range Weather Application Global and Tropical Cyclone Track Numerical Prediction

Erin Jones and Xuguang Wang

In ensemble-based data assimilation for numerical weather prediction, limitations in ensemble size due to computational cost restrictions introduce spurious background forecast error correlations. Ideal covariance localization dampens spurious correlations while retaining correlations with dynamic-based significance. Therefore, localization based on atmospheric spatial length scales can help to discern correlations with a dynamic connection. Currently, commonly used data assimilation systems utilize a fixed localization value. Several methods have been proposed to improve horizontal covariance localization to reflect the structure or the multiscale nature of the underlying flow. However, there are limited studies on improving vertical covariance localization.

This study will describe a vertical flow-dependent localization (vFDL) scheme to be used within hybrid 4DEnVar for UFS MRW global forecasts. This approach uses the percentage of ensemble variance explained by the leading mode at each grid point as the predictor of the vertical localization scales. It was found that this method can identify areas of increased or reduced vertical localization that are consistent with the underlying dynamic structure of the flow. Global forecasts using vFDL show significant improvement over forecasts using fixed localization at 4–5-day lead times, most notably at tropospheric levels exhibiting larger correlation length scales. Additionally, results indicate that vFDL can potentially improve tropical cyclone track prediction for up to 5 days in lead time compared to an experiment using constant localization. Diagnostics suggest that vFDL allows for more accurate correlations to be used for data assimilation within and surrounding the tropical cyclone, leading to improvements in the large-scale environmental flow.

Post-Processing High-Resolution Deterministic NWP Model with Machine Learning to Produce Cost-Effective, Operational Probabilistic Forecasts Integrating JEDI and METplus for Evaluation of Atmospheric Composition Forecasts

Mariah Pope, Ashley Payne, Luke Conibear, Allison Reed Harris, Maxfield Green, Kushal Keshavamurthy, Stylianos Flampouris, and Arun Chawla

Probabilistic forecasts provide a range of possible weather outcomes rather than a single deterministic prediction, which is invaluable to stakeholders making decisions. Ensemble forecasts from traditional numerical weather prediction (NWP) models are often at reduced resolution to balance their computational costs. We present a fully operational machine learning (ML) model that rapidly post-processes deterministic High-Resolution Rapid Refresh (HRRR) forecasts to generate bias-corrected, probabilistic forecasts for several variables over the contiguous United States. Our model combines the strengths of NWP modeling with machine learning to produce hourly, cost-effective ensemble forecasts at a 3 km resolution without running multiple simulations. We use a multi-task neural network with a Continuous Ranked Probability Score (CRPS) loss function applied to the HRRR. We use station observations, high-resolution land-use and topographic features, and ECMWF reanalysis version 5 (ERA5) as targets. Our CRPS function allows the multi-task neural network to learn a predictive distribution and output a full ensemble with a flexible number of members. Using the CRPS as a metric to validate probabilistic forecasts, we find an average 30% improvement over the HRRR model. In this presentation, we will demonstrate the operational efficiency and the added value due to ML-based processing through applications and comparative studies.

Prototype in-core Gain Form Ensemble Transform Kalman Filter (GETKF) Data Assimilation (DA) using JEDI and a coupled UFS model

Mark Potts

As part of the Water in the West project, which is targeted towards improving NOAA's capability to accurately forecast atmospheric river events along the west coast of North America, NOAA-EPIC and NOAA-PSL are collaborating to build a coupled JEDI-UFS ensemble forecast system with data assimilation cycling. This new system will be accomplished via "in-core" memory transfers from UFS ensemble members to JEDI and greatly reduce one of the biggest bottlenecks (I/O) to computing a cycled forecast using Ensemble Kalman Filter techniques. This discussion will present a prototype system for computing the GETKF analysis using this approach and further detail the next steps that will be required to bring these new capabilities into operations.

Updates to environmental observation usage in JEDI Skylab

Benjamin Ruston, Hui Shao, Greg Thompson, Francois Vandenberghe, Fabio Diniz, Lindsey Hayden and Samantha Maticka

The Joint Effort for Data Assimilation Integration (JEDI) is a coordinated and collaborative development between interagency partners and the Joint Center for Satellite Data Assimilation (JCSDA). The JEDI system is designed to be an open-source developed software with high configurability allowing the selection of observation operators, a wide selection of unique filters for quality control, and methods and approaches in specifying observation error. A component of JEDI is the Unified Observation Operator (UFO). The UFO observation object can be passed to different observation operators, filters, and observation functions easily, allowing a high level of customization. For example, for GNSS-RO, the JEDI UFO component includes the NOAA NBAM operator, one from the UK Met Office, and options based on the ROPP from the EUMETSAT ROM-SAF. After selecting an operator, multiple methods of lower tropospheric quality control for the GNSS-RO data have been added, and these allow selective application and monitoring of each per yaml configuration. Other areas of work include exploring and fostering work to include and refine new operators, such as those for ground and space-based radar, airborne radio occultation, advancement in all-sky radiance assimilation, and exploring visible and UV reflectances. A primary goal of the JCSDA and its partners is to enhance the capability to quickly integrate both existing and new observations and methods, demonstrating this in a functional system and one that partner organizations can readily test in parallel and adopt.

A Hybrid Tangent Linear Model in The Joint Effort for Data Integration (JEDI) system.

Christian Sampson, Tom Hill, Tom Fearon, Maryam Abdi-Oskouei, Jerome Barre, Yannick Tremolet, and Anna Shlyaeva

4d-Var has been shown to provide some of the most reliable weather forecasts to date but it has its pitfalls. In particular, 4d-Var depends heavily on a tangent linear model (TLM) and an adjoint to the tangent linear model. While conceptually simple, coding these two elements is extremely time-intensive and difficult. A small change in the larger weather model can induce months of work on its TLM and delay the benefits of improvements on the model side. In this talk, I will introduce the hybrid tangent linear model (HTLM), developed in [Payne 2021], which is aimed at avoiding these pitfalls and presenting a generic implementation of it in the JEDI system. The HTLM is similar to other ensemble linear models, such as the Localized Ensemble Tangent Linear Model (LETLM) [Frolov 2018], which uses nonlinear ensembles to directly estimate the tangent linear model but requires large ensembles and large samples within them for accuracy. In contrast, the HTLM leverages any available incomplete TLM (perhaps dynamics only) by first forwarding an ensemble of perturbations with it and then employing a LETLM with sampling only on a column to find coefficients for a corrective update of the TLM forwarded perturbation. This is done for each time step in the 4dvar window. These coefficients can then be used in a 4d-Var assimilation updating the incomplete TLM and adjoints at each time step. The HTLM formulation reduces the number of ensemble members and size of samples within them that are needed for accuracy when compared to a full LETLM. It also provides update coefficients that can be re-used later in other 4d-Var assimilations. The generic implementation of the HTLM in JEDI provides the opportunity for any model with a JEDI interface to do 4d-Var assimilation with it. I will also present some current results with the JEDI-HTLM, plans for further development, and challenges of the method.

Advancements in Data Impact Studies using JEDI and UFS: Insights from the Radio Occultation Modeling Experiment (ROMEX)

Hui Shao, Hailing Zhang, Lindsey Hayden, and Ben Ruston

The Joint Effort for Data Assimilation Integration (JEDI) system, developed at JCSDA and soon to be employed by partners including NOAA, NASA, NRL, and the Met Office, represents a significant leap forward in data assimilation capabilities. Combining established operational features with innovative research developments, JEDI serves as a versatile platform for the comprehensive evaluation of data assimilation methods and forecasting techniques, with the overarching goal of refining configurations to enhance operational Numerical Weather Prediction (NWP).

In this presentation, we provide an overview of our ongoing research and development efforts utilizing the JEDI and Unified Forecast System (UFS) frameworks, focusing specifically on the Radio Occultation Modeling Experiment (ROMEX) studies. As part of an international collaborative endeavor, ROMEX aims to assess the impacts of radio occultation observations, leveraging data volumes that far exceed previous operational capacities. Throughout our study, we have achieved significant milestones, including the establishment of a local JEDI-R2D2 database structure for efficient data management, as well as the setup and configuration of cycling JEDI-UFS systems. We delve into the intricacies of data inclusion and selection processes, configuration parameters for background and observation errors, and the utilization of forward operators within the JEDI system. Finally, we present preliminary assimilation results from the ROMEX data impact study.

Artificial Intelligence based workflow for generating up-to-date land use information of the United States for flood risk modeling.

Alen Shrestha, Kapil Dhital, Balbhadra Thakur, and Lee Beshoner

This research project presents a novel approach to augmenting flood risk modeling through the integration of artificial intelligence (AI) techniques for generating the most up-to-date land cover land use (LULC) information. The need for this approach also stems from the limitations of existing systems, which are not robust enough to identify the ever-changing and diverse land cover features. The proposed workflow leverages Sentinel-2 imagery, geographic information system (GIS) data, and advanced deep learning algorithms to automatically extract and update LULC categories which play a significant role in flood risk assessment. The methodology involves training data acquisition, preprocessing, feature extraction, model training, validation, and integration with hydraulic modeling. By harnessing AI capabilities such as image classification and object detection, the workflow enables the prompt generation of accurate and up-to-date LULC information crucial for improving the precision of flood risk assessments. The current research discusses the implementation of the proposed workflow and evaluates its performance through case studies in various climatic regions of the United States. Moreover, this work offers enhanced flood risk management strategies by providing decision-makers with accurate flood risk information by associating the latest land cover changes. This information serves as a fundamental geographical metric for flood risk assessment. A broader impact of this research will be achieved by advancing the integration of AI-based output into hydrodynamic modeling for flood risk forecasting with improved disaster resilience and response planning.

Expanding the testing framework for the Short-Range Weather Application

Edward Snyder

Thorough testing is the foundation of any successful software application. Thankfully, the Short-Range Weather Application (SRW App) currently has a number of testing frameworks in place including unit testing for Python and data retrieval through GitHub Actions, testing various configurations of the SRW App via the Workflow End-to-End tests, and checks forecast skill score through the Jenkins pipeline. However testing between components and tasks within the SRW App workflow is lacking. To bridge this gap, developers at EPIC implemented the integration task as part of the SRW App workflow. This new task uses the unit test Python library and is set up so that SRW App developers could add their own classes and functions for testing components to this task. Currently, the integration task only checks for the existence of the weather model output files, with future development of checking for the post-processed (UPP) output files soon to come. EPIC hopes that this python friendly task will be the catalyst for other SRW App developers to contribute integration tests to reduce this testing gap further.

All-Sky Geostationary Satellite Radiance Data Assimilation in JEDI

Gregory Thompson, Benjamin Johnson, Benjamin Ruston, Fabio Diniz, and Cheng Dang

The Joint Center for Satellite Data Assimilation (JCSDA) processes satellite radiance data using JEDI (Joint Effort for Data assimilation Integration) software. The Unified Forward Operators (UFO) in JEDI uses the Community Radiative Transfer Model (CRTM) to simulate numerical model brightness temperature or visible reflectance to compare to observations. UFO is also responsible for quality control, assignment of observational errors, and bias correction. The USA GOES-East/West satellite data are resampled to a common spacing of 64 or 8 km spacing for sensitivity tests. The typical Cloud Impact Parameter function by Okamoto et al. (2014) to assign observational error in clouds was scaled to lower the errors where the model background was nearest the observed values. In this presentation, we aim to show how JEDI performs while assimilating GOES water vapor, infrared, and visible reflectances at varying resolutions while using NOAA's Unified Forecast System (UFS) within the GFS model (FV-3).

Impact of assimilating radar and lidar observations on improving the bore forecast during PECAN campaign

Zhifeng Yang, David N. Whiteman, Xingchao Chen, Yunji Zhang, Belay Demoz , Jose D. Fuentes, Charles Ichoku, and Joseph L. Wilkins

The assimilation of radar reflectivity and radial velocity from the WSR-88D radar and lidar water vapor profile observations could improve the forecast of the location and timing of bore associated with nocturnal convection. This study describes the assimilation of such data observed during the 2015 Plains Elevated Convection at Night (PECAN) field campaign. The model and data assimilation system employed is the Pennsylvania State University Weather Research and Forecasting model Ensemble Kalman Filter (PSU-WRF-EnKF) cycling data assimilation system. The lidars include the Atmospheric Lidar for Validation, Interagency Collaboration and Education (ALVICE), University of Wyoming King Air compact Raman lidar, ARM Raman lidar, and NCAR micropulse Differential

Absorption Lidar (DIAL). To better evaluate the strengths and limitations of radar and lidar observations, they are assimilated separately and jointly. The bore propagation was observed by both radar and ALVICE lidar in Kansas on 14 July 2015, and a nocturnal convection was initiated near the bore/density current. Without assimilating any observations, the WRF model didn't simulate the location of the bore well, even though it captured the bore structure quite well. The assimilation of WSR-88D radar observations corrected the location of nocturnal convection, and the assimilation of lidar Observations improved the location and timing forecasts of the associated bore through the comparison with independent observations. Deterministic forecasts initialized from the EnKF analysis can predict the timing, height, and shape of the bore, even though different lead times vary. The improved predictions also accurately reveal the whole processes of mesoscale convective systems and bore generation.

Impacts of Model Physical Parameters at the Air-Sea Interface on the Background of HAFS-MOM6 EnVar Data Assimilation System for Hurricane Fiona (2022)

Yue Yang, Xuguang Wang, Xu Lu, Hyun-Sook Kim, Jun A. Zhang, HeeSook Kang, and Yongzuo Li

To achieve a fully coupled ocean-atmosphere data assimilation (DA) system for the Hurricane Analysis and Forecast System (HAFS) with the Modular Ocean Model version 6 (MOM6) ocean coupling capability, establishing a physically consistent ensemble background across the air-sea boundary is necessary. As a first step, this study evaluates the control and ensemble background and tests the sensitivity of the background to physical parameters associated with the air-sea interaction. Experiments are conducted for Hurricane Fiona (2022) with the self-cycled EnVar DA system. The impacts of model physical parameters at the air-sea interface on the control and ensemble background during DA are assessed using novel observations for the ocean and atmosphere, such as sail drones, Airborne Expendable Bathy-Thermograph (AXBT) probes, underwater gliders, dropsondes, and Stepped Frequency Microwave Radiometer (SFMR) winds. The baseline experiment (HAFS-MOM6) is equipped with the default settings of physical parameters. Results for the 6-h control background show that HAFS-MOM6 captures temporal evolutions of variables at the air-sea interface and air and water temperature profile patterns. However, negative biases exist in temperature and wind speed, which can be attributed to the ensemble background's under-dispersive sampling and model bias. Instead of the local vertical mixing scheme for the upper ocean in HAFS-MOM6, HAFS-MOM6KPP is designed with the non-local K-profile parameterization (KPP). As a result, HAFS-MOM6KPP yields improved performance by correcting model biases across the air-sea boundary. Therefore, perturbing physical parameters at the air-sea interface shows the potential to improve the quality and increase the diversity of ensemble background.

Advancements in Local Oscillator Design for Enhanced Terrestrial and Space Weather Forecasting

Gamal Zayed, Yehea I. Ismail

Accurate weather prediction and space weather monitoring are vital for safeguarding society and infrastructure from severe atmospheric events. Doppler radar systems play a crucial role in both

terrestrial weather forecasting and space weather monitoring, providing valuable insights into precipitation, wind patterns, and ionospheric disturbances.

This study focuses on advancements in local oscillator design tailored for Doppler radar applications, with implications for both terrestrial weather forecasting and space weather monitoring. Leveraging UMC65 process technology with a supply voltage of 1.4 V, the design targets an oscillation frequency of 13 GHz to capture detailed atmospheric dynamics and ionospheric disturbances.

Critical to the design is the stringent control of phase noise, ensuring minimal signal distortion and high sensitivity in detecting Doppler shifts and ionospheric irregularities. Additionally, power efficiency and signal integrity are prioritized to enable sustainable operation in remote or mobile radar installations, which are crucial for both terrestrial and space weather monitoring applications.

Furthermore, the design incorporates multi-finger transistor configurations, optimizing current-carrying capacity and stability while adapting to varying environmental conditions. These advancements contribute to pushing the boundaries of local oscillator performance and enhancing the capabilities of Doppler radar technology in understanding atmospheric dynamics and monitoring space weather phenomena.

In summary, this research bridges the gap between terrestrial weather forecasting and space weather monitoring, facilitating more accurate predictions and enhancing our understanding of atmospheric and ionospheric processes.

Collaborative Data Assimilation for Accurate RF Localization: A Community Modeling Approach

Gamal Zayed, Nathaniel A. Frissell

Data assimilation plays a pivotal role in enhancing real-time processes such as location estimation for various navigational applications. The Ham Radio Science Citizen Investigation (HamSCI) has significantly contributed to this domain by providing a comprehensive dataset through the Weak Signal Propagation Reporting Network (WSPRnet), which covers vast terrestrial spaces via continental transmission-reception reporting.

WSPRnet, a volunteer-based initiative by radio amateurs, offers a rich dataset generated from narrow-bandwidth (6 Hz) signal transmissions. Each transmission, characterized by a known call sign and low power, experiences signal attenuation before being received, resulting in a single dataset grid entry in the global WSPRnet database. This dataset supports a range of assimilation, modeling, and forecasting activities. By harnessing the collective data contributed by the amateur radio community, our study demonstrates how community-driven efforts can drive advancements in real-time navigational systems. This collaborative approach not only improves data accuracy and reliability but also fosters a shared understanding and development of technologies crucial for unified international frequency coordination, a core objective of the UIFCW.

Despite the extensive coverage of WSPRnet, the need for uninterrupted communication nodes is critical for reliable localization and navigation systems. This requirement is met by the IntlWSPR project, initiated in 2021, which established a network of 40 beacons transmitting 23 dBm signals continuously – the initial beacon's hardware and antenna were installed at a Satellite Ground station near Milano, Italy. By integrating IntlWSPR with WSPRnet, a robust, continuous-time dataset is created, facilitating the generation of a real-time localization performance database for system evaluation.

This study leverages the Friis free-space path loss propagation model to calculate the received power ideally based on the gains of two communication nodes distributed on a sphere centered at the transmitter. Through numerical solutions, we introduce a novel mathematical approach for solving location estimation equations using the Friis model and the IntlWSPR project. Our results demonstrate that localization errors are generally below 10 meters, except in cases where beacon outages occur, such as TF3D in Rangárþing ytra, Iceland; M0JUJ in Hampshire, United Kingdom; R0CBZ in Solnechny District, Khabarovsk Krai; and PR7DEE in Paraíba, Brazil. Additionally, we explore marginal case studies to illustrate the impact of globally distributed beacons on location estimation accuracy.

In summary, this research bridges the gap between the cooperative, open-source IntlWSPR (as part of the WSPRnet) dataset and mathematical free-space propagation models, achieving acceptable tolerances for navigation-related location estimation. Future work will focus on integrating Deep Learning techniques, specifically Artificial Neural Networks (ANNs), to predict user locations within uncensored spatial grids, further enhancing the precision of real-time localization systems.

In Person Posters

RRFS-SRW Convergence - Developing a clear path for the community to operations

Keven Blackman, Cameron Book, Jacob Carley, Steven Earle, Christina Holt, Jong Kim, Natalie Perlin, and Mark Potts

There was a collaborative effort between EPIC, EMC, GSL, and NCO to better understand how community and operational model development can co-exist and not diverge, creating a clear path for research to flow to operations. A Tiger-Team was created to better understand the issues that caused the divergence, focusing on operational standards, speed of development, peer-review mechanism, requirements, and balancing flexibility vs operational standards. This presentation will outline the recommendations needed to be completed across all associated development teams to converge the RRFS and SRW baselines and better understand the keys to convergence and mitigating future divergence as other community applications come online.

A Climate Justice Approach to Major Flooding Events

Anthony David Jr., Gina Eosco, Jonathon Mote, and Joseph Conran

Environmental justice confronts the historical marginalization of minority communities from decision-making, perpetuating unequal government service distribution. Climate justice emphasizes fair resource allocation amid long-term climate change effects. Extreme weather exacerbates disparities, especially in vulnerable Gulf and coastal regions facing heightened hurricane risks. To address climate justice concerns effectively, integrating social and weather/climate data is vital. This research methodically identifies priority areas for flood vulnerability interventions in post-Katrina New Orleans, Louisiana. By integrating the Social Vulnerability Index with flood depth data and employing multivariate clustering, spatial clusters of extreme flood depth in socially vulnerable areas are analyzed. The results provide insights into the intersection of high social vulnerability and flood depth, informing equitable responses for recovery, mitigation, and resilience. This approach demonstrates methodological rigor and robustness in addressing research questions. Moreover, it strongly integrates data assimilation and JEDI and FAIR data principles, underscoring the significance of merging social and weather/climate data to mitigate both physical and social vulnerabilities associated with flooding.

Enhancing Precipitation Type Classification Using Random Forests

Prabal Das and Yu Zhang

Accurate prediction of precipitation types—rain, snow, ice pellets, and freezing rain—during the cool seasons is vital for public and transportation safety. Traditional methods, such as logistic regression, are often incapable of pinpointing precipitation types. This study explores two machine learning techniques, namely the Random Forest (RF), and multiclass Artificial Neural Network. to enhance the accuracy of precipitation type classification. We performed hindcast experiments utilizing reforecast data from the Global Ensemble Forecast System (GEFS) as predictors and mPING observations as ground truth. The experiments show that RF achieved about 60% accuracy (CRPS = 0.22) for lead times up to 96 hours. However, it faced challenges with misclassifying categories like freezing rain and ice pellets due to highly imbalanced classes. To enhance the predictive accuracy for less common classes, current initiatives include integrating the Synthetic Minority Oversampling Technique (SMOTE) to alleviate class imbalance issues. As far as the multiclass ANN is concerned, the model was able to predict the minority classes, but the overall accuracy was lower than that of the RF models.

Sensitivity of Atmospheric Vertical Resolution to Biases in SFS Prototypes

Benjamin W. Green, Sina Khani, and Shan Sun

Currently, NOAA is in the process of transferring operational dynamical subseasonal-to-seasonal predictions from the decade-plus-old CFSv2 to two different Unified Forecast System (UFS)-based coupled models: GEFSv13 for medium-range and subseasonal (0-48 days), and the Seasonal Forecast System (SFS) for time scales out to 1 year. The development of a standalone SFS allows for several aspects of its configuration (e.g., resolution, physics suite) to depart from GEFS to be most suitable for seasonal prediction needs. One of the many outstanding questions about the SFS

configuration is the setup of the vertical layers in the atmosphere (in both number and placement, referred together hereafter as "resolution"). To investigate the question of vertical resolution in the atmosphere, two sets of experiments are run: one using the GEFS-based 127 layers ("L127") and the other with 64 layers ("L064"). For both L064 and L127, hindcasts integrated forward at least 9 months were initialized from 1991-2022 (start dates of May 21-25 form a 5-member time-lagged ensemble); to examine the sensitivity of results to initialization season (e.g., the spring predictability barrier for ENSO), L127 experiments were also initialized November 1-5 1991-2022. Of particular interest are the upper atmosphere (for the Quasi-Biennial Oscillation) and sea-surface temperature (for ENSO forcing). Preliminary results from these simulations indicate that L127 is not obviously superior to L064 in terms of atmospheric model biases. This finding may allow for a reduction in computational cost in SFS, or motivate a more targeted vertical resolution to better capture processes more relevant at seasonal timescales.

A Neural Network to Assimilate CRTM Brightness Temperature

Wei Huang

A neural network is designed to assimilate brightness temperature from a temperature field, and its backward computation is used to adjust the temperature field. Therefore, this method has the potential to be used as a data assimilation tool for CRTM brightness temperature.

Developing an Effective Set of Questions to Extract Partner Needs from NWS IDSS

Zakiya Johnson, Daphne LaDue, Ivy Jeffries, Alex Marmo, and Dereka Carroll

The National Weather Service (NWS) provides Decision Support Services (DSS) to "core partners," including emergency managers. Other sectors, such as Schools, Fire Departments, Law Enforcement, and Public Works or Transportation Departments, also need decision-support information to help them plan, coordinate resources, and take action. This study explores how local officials make their decisions while also constructing a method in which NWS Weather Forecast Offices (WFOs) can obtain this type of information for themselves.

Our student-led team created and tested a set of questions to understand partner needs with DSS-specific questions via interviews and focus groups to learn about their decision-making thought processes. These questions were tested in a slower-timescale winter weather and faster-timescale warm season convective severe weather to understand NWS partner's needs from forecast information.

Responses were analyzed to understand how different sectors use DSS, their information needs and how their responsibilities drive those needs. Making connections across sectors help us make recommendations for forecast improvements to meet the needs of diverse partners. Our team is also analyzing the success of alternate wordings, composition, and how the context of each question affects how participants responded. We will also discuss planned improvements to our question set, which will be tested in additional WFOs before being shared with the NWS.

Empowering Forecasting Innovation Through EPIC Community Engagement and User Support

Aaron Jones, Gillian Petro, Charlene Barone, Laura Generosa, Maryia Davis, Jef Dodson, Jessica Wheeler, Amber Jenkins, Joshua Kublnick, and Keven Blackman

The Earth Prediction Innovation Center (EPIC) is dedicated to accelerating contributions to the Unified Forecast System (UFS) by engaging the community and providing community members with the necessary tools and knowledge to contribute innovations to our Nation's forecasting and modeling systems. The EPIC Community Engagement (ECE) team supports EPIC's innovation through several initiatives, including community training events and the annual Unifying Innovations in Forecasting Capabilities Workshop (UIFCW). It also publishes and publicizes dynamic content on social media, the EPIC Community Portal (ECP), GitHub, and other platforms to meet the community's evolving needs and remove barriers to innovation. The User Support (US) team complements ECE's efforts by updating UFS application documentation, compiling technical FAQs, and monitoring support requests. The US team provides ECE with immediate feedback on community engagement efforts, which allows ECE to adjust content and outreach strategies based on community needs and requests. This collaboration results in a responsive support environment that rapidly evolves to meet the community's needs, ensuring that users and developers have the support they require to innovate within our national forecasting systems.

On the forecast of ocean surface fields within the coupled seasonal ensemble Unified Forecast System (UFS) prototype

Sina Khani, Benjamin W. Green, and Shan Sun

The output of the Unified Forecast System (UFS)-based coupled model that entails hindcasts with time-integration of 12 months over the years 1991-2022 is assessed for the forecast skill. The UFS model is run at 1° horizontal resolution for the atmosphere and ocean and vertically has 64 atmosphere and 75 ocean layers. The model prototype also covers five time-lagged ensemble members initialized on May 21-25, respectively. The horizontal structure of correlation, root-mean-square error (RMSE), and bias of sea surface temperature (SST) field are studied in comparison with the observational OISST dataset. It is shown that SST correlation (RMSE) decreases (increases) with lead months, while the spatial patterns of correlation (and RMSE) are similar at various lead times.

Also, preliminary results of ocean variables, including potential temperature, zonal currents, and salinity at the upper ocean (0-200 m depth), will be discussed in the context of seasonal forecasts. We compare UFS ocean outputs with those from ORAS5-ECMWF (Ocean Reanalysis System 5 prepared by the European Center for Medium-Range Weather Forecasts) regridded into 1° horizontal resolution (the original ORAS5 dataset is at 0.25° resolution). We will investigate how the vertical structure of ocean fields in our model prototype is similar/different from those of high-resolution ORAS5 reanalysis. This study is important for the model accuracy in our UFS-based model prototype for seasonal time scales.

Hierarchical Decomposition of the UFS Test Cases and DevOps Test Framework Infrastructures

Jong Kim, Stylianos Flampouris, Cameron Book, and Kristopher Booker

A robust testing framework is the required tool for accelerating the development of the UFS weather components, models, and applications, minimizing the cost of testing and permitting comparisons among different approaches in a systematic and consistent manner. Built on customized code bases for internal applications, current UFS Weather Model baseline test cases provide foundational testing infrastructure for acceptance to operations, including several multi-resolution global and regional configurations. To further enhance the existing UFS test system, an evidence-based decision-making hierarchical test framework is proposed and demonstrated for a streamlined code integration process with UFS cases, ideal test cases, and regression test cases. With a review of ongoing test system refactoring approach, a prototype development process and maturation of the UFS code bases is illustrated in several ways (funnel, pyramid, or a combination of pyramids (physical process vs. computational complexity), infinity loops, and significantly more complex diagrams) to utilize the EPIC-supported continuous integration and deployment (CI/CD) pipeline infrastructure.

Advancing Methodologies for Uninterrupted, Basin-Wide Data Assimilation in the Hurricane Analysis and Forecast System (HAFS)

Joseph Knisely, Dr. Jonathan Poterjoy, and Dr. Kenta Kurosawa

The Hurricane Analysis and Forecast System (HAFS) features flexible model configurations for both operational and research purposes. In particular, HAFS can operate with a large, static analysis domain that permits the uninterrupted assimilation of measurements basin-wide. This feature opens new research directions for TC prediction. The current presentation discusses findings from a series of numerical experiments performed over the peak of the 2022 TC season. These experiments seek to optimize the use of satellite radiance measurements by performing DA over an extensive domain, which permits the continuous collection and self-cycling of innovation statistics needed to perform variational bias correction. This design choice is motivated by Knisely and Poterjoy (2023), who show that such schemes can be effective for HAFS domain configurations that extend over entire hurricane basins. Furthermore, DA requires careful estimation of background uncertainty, but current operational regional NWP systems often use relatively small ensemble sizes which can lead to sampling deficiencies. All HAFS experiments performed for this research use a combined 40-member HAFS ensemble and 80 additional ensemble perturbations from the GDAS system, which consequently reduces sampling errors. Finally, we implement a Bayesian DA technique called the local particle filter (LPF) for direct comparisons with an EnKF. Since the LPF does not rely on covariances alone when describing background uncertainty, this method presents advantages for DA applications that are strongly impacted by nonlinear model dynamics and measurement operators. Lastly, we examine strategies for combining ensemble analyses and forecasts generated from basin-wide DA experiments with forecast domain configurations that closely resemble operational HAFS model configurations.

Characteristics and Seasonality of the Minimum Oxygen Zone of the Bay of Bengal and Arabian Sea

Nadim Mahmud, Bradford S. Barrett, Imtiaj Ahmed Easty, and Kh. Dola Wahid

The occurrence of intense oxygen minimum zone (OMZ) is known in the Bay of Bengal (BoB), but it has been recently reported to have become more acute and is at its tipping point. This project will show that the intensification of OMZ to acute condition is a random and short-term rather than perennial phenomenon based on re-evaluation of old and recent information in the BoB. Short-term modifications in dissolved oxygen (DO) in the OMZ are caused by balance among physical forcings: salinity stratification, occurrence of cyclonic (CE), and anticyclonic eddies (ACE). The analysis will reveal that 'acute OMZ' is only a transient phenomenon in the Bay since the dynamic periodic physical forcings, particularly ACEs, do not allow it to become a dead zone. The oxygen minimum zone (OMZ), sometimes referred to as the shadow zone, is the zone in which oxygen saturation in seawater in the ocean is at its lowest. This zone occurs at depths of about 200 to 1,500 m (660–4,920 ft), depending on local circumstances. Unlike its neighboring Arabian Sea, the Bay of Bengal (OMZ) is somewhat different in nature. It still shows a trace of oxygen at 70m depth and below, ranging from 032-. 064 mg/l, albeit way below the Oxygen level (5 mg/l) needed to support aquatic life and other uses.

Forecasting Integrated Water Vapor Transport and Precipitation on U.S. West Coast with Atmospheric River Analysis and Forecast System

Murali Nageswara Rao Malasala, Xingern Wu, Keqin Wu, and Vijay Tallapragada

Atmospheric rivers (ARs) are vital weather phenomena, transporting moisture from the tropics to higher latitudes, often exceeding the Amazon River's flow rates. Along the U.S. West Coast, ARs bring intense rainfall, impacting the regional water cycle significantly. However, AR landfalls can lead to extreme precipitation events, causing floods, travel disruptions, and property damage. Increasing AR frequency and size due to global warming underlines the urgent need for better monitoring and forecasting of associated precipitation patterns. Characterized by concentrated Integrated Water Vapor Transport (IVT), ARs form narrow bands in the troposphere where moisture accumulates. To address AR challenges, a high-resolution regional Atmospheric River Analysis and Forecast System (AR-AFS) was developed. Leveraging the FV3 dynamical core and GFSv16 initial conditions, AR-AFS provides 5-day forecasts with approximately 3 km spatial resolution over the Northeast Pacific and Western North America. In this study, AR-AFS integrates Thompson microphysics for both convective and non-convective processes. Evaluation against Stage IV observations and Reanalysis products employs standard metrics like Root Mean Squared Error, Mean Bias, Correlation Coefficient, and Index of Agreement to assess predictive skill for IVT and associated precipitation over the U.S. West Coast. Statistical categorical skill scores like POD, FAR, Frequency Bias, SR, TS, and ETS are computed. Approximately 32 forecast cycles during the AR seasons of 2022 and 2023 are used for evaluation. By enhancing our understanding and prediction of AR-associated precipitation, AR-AFS aims to mitigate risks and improve disaster preparedness for the U.S. West Coast and beyond.

Remote Community Modelling Forecasted Inundations

Gina Azarell Martinez Velez

The motivation for this study originates from the lack of stream data, such as flow or stage during flood events in many remote communities, which are misinformed regarding the associated risks of flooding during an extreme storm event such as hurricanes, tropical storms, convective systems, and other storm events. Because they are typically located in rural areas where there is little to no interest investment in installing gauges to extend forecasting services, this study was conducted to develop a simple approach to reach this community by creating a hydraulic two-dimensional model and using any nearby gage within the basin of study to be used as a reference point relative to the location of the community. The methodology for calibration consists of creating or obtaining an existing fully HEC-RAS 2D model, using the meteorological tools use the rain-on-grid approach, selecting storms that had occurred within the basin of study, adding an infiltration layer to account for the losses and using the observation flow and stage gage data from the storm event to ensure the losses and other calibration parameters reflect the natural behavior of the river basin. Once the calibration is sensible, simulate a probable forecasted inundation for a remote community by assuming forecasted precipitation will impact that location.

Evaluating the HAFS Forecasts Environmental Flow of Hurricane Idalia (2023)

Margarita Mora, Qian Tan, Xuejin Zhang, and Sen Chiao

This study aims to evaluate the Hurricane Analysis and Forecast System (HAFS) forecasts for the environmental flow of Hurricane Idalia (2023). Accurate forecasting of tropical cyclone tracks is critical for mobilizing localized disaster preparedness operations. Uncertainty in TC track forecasts would increase when forecasting for longer lead times. In this study, HAFS-A 00Z and 06Z forecasts for Hurricane Idalia were used for a comparative case analysis alongside ERA5 Reanalysis. The analysis of this study spans three days, beginning at day 0 to day +3 for Hurricane Idalia. To further study the environmental flow on track forecasts in the HAFS, differences from the ERA5 in the 500 hPa steering flow and geopotential heights were evaluated to identify how the large-scale condition in the HAFS resulted in track deviations. Forecasts from 00Z and 06Z each show notable track uncertainty, particularly in lag days +2 to +3. Differences in 500 hPa geopotential heights suggest that improper modeling of a trough south of Hurricane Idalia misdirects winds, creating predominantly zonal flow within the HAFS hurricane track. Further study of other cases is necessary to understand other possible large-scale patterns within the HAFS model and enhance the product in service of regions at risk of experiencing hurricane landfall.

A Novel Hypoxia Forecast System Using Combined Numerical and ML/AI Models

Yanda Ou*, Z. George Xue, Supratik Mukhopadhyay, Magesh Rajasekaran, and Dylan Wichman

Coastal hypoxia poses significant economic threats, such as diminishing commercial fisheries and inflating seafood prices, with an average annual cost of $2.4 billion. Existing forecast models, primarily targeting seasonal fluctuations, often rely on either computationally intensive process-based models or statistical methods with limited accuracy and resolution. Balancing accuracy and efficiency in hypoxia prediction is challenging due to complex physical and biogeochemical processes, especially for daily variations that significantly impact marine organisms. We present a novel methodology for daily hypoxia forecasts in the northern Gulf of Mexico using a combination of 3D coupled physical-biogeochemical models, machine learning (ML), and artificial intelligence (AI) models. The numerical model provides 14-year well-validated hindcasts for training the 1D (hypoxia area) ML and 2D (spatial distribution) AI models. The ML model, an ensemble of generalized linear model (GLM) and generalized additive model (GAM), efficiently and accurately forecasts hypoxic areas, demonstrating its superior performance against the hindcast test set and the shelf-wide cruise measurements. The AI model, an ensemble of U-net and DeepLabv3+ models, accurately forecasts hypoxia spatial extents, showcasing its high binary classification accuracy, precision, and recall against hindcast test set and cruise measurements. Both models are robust when applied to independent hydrodynamic forecasts (HYCOM and FVCOM). This study innovatively employs hindcast data from 3D numerical models to achieve efficient daily hypoxia forecasts, highlighting the potential of ML and AI models in water quality prediction.

Streamlining UFS Application Builds: Spack-Stack vs. HPC-Stack Package Managers

Natalie Perlin, Ratko Vasic, Cameron Book, and Edward Snyder

The use of Unified Forecast System (UFS) applications relies on various software packages essential for model components, workflow tasks, and data exchange. To manage the complex interdependencies among these software packages, NOAA, the Joint Center for Satellite Data Assimilation (JCSDA), and other UFS-supporting partners jointly developed the spack-stack software manager. Spack-stack is based on the widely-used Spack package manager and is tailored for High-Performance Computing (HPC) environments. However, adapting to specific user systems requires significant effort and consumes substantial disk space.

In contrast, an older package manager for UFS applications, the hpc-stack, was developed by the Environmental Modeling Center (EMC), and was used successfully on different systems. It is more lightweight but necessitates explicit management of package interdependencies during installation for specific hpc-stack versions.

This presentation provides a comparative analysis of the build and installation statistics for spack-stack and hpc-stack across multiple systems. Additionally, we compare the performance of identical UFS applications (UFS-SRW-App) running using each software stack.

Training GraphCast-based WoFS forecast emulators

Corey K. Potvin and Montgomery L. Flora

The advent of AI models that compete with traditional global NWP is a promising development that should be extended to convection-allowing models (CAMs). Toward that end, co-author Flora has adapted Google DeepMind's open-source GraphCast, originally developed for global prediction at ~25-km scales, to NSSL's regional, 3-km Warn-on-Forecast System (WoFS) framework. We are training these new “WoFS-Cast” models to emulate WoFS member forecasts in a fraction of the time. Augmenting the WoFS with WoFS-Cast members could lead to more timely, accurate, and calibrated ensemble forecasts. We are particularly concerned with the ability of WoFS-Cast to produce realistic forecasts of thunderstorm evolution at 0–3-h lead times. Preliminary WoFS-Cast predictions are encouraging, and there is considerable room for scaling up both the model and training dataset. Before devoting all of our (limited) computational resources to training large models on the full training dataset, however, we are using simplified experiments to rapidly explore the impacts of various model design choices. For example, we are evaluating the benefits of neighborhood- and sharpness-based loss functions to forecasts of intermittent fields (e.g., reflectivity, vertical velocity). We are also assessing how WoFS-Cast accuracy varies with the forecast output interval of the training dataset; archived WoFS forecasts have output available every 5 min, whereas a more typical output interval for archived CAM forecasts is 60 min. Our goal for these sensitivity experiments is to inform development not only of the WoFS-Cast, but of all CAM-scale AI weather prediction models across NOAA.

Stochastic Physics Unit Test Overview of Use Cases and Review of Code Drivers

Zachary Shrader, Fernando Andrade, Michael Lueken, Chan-Hoo Jeon, and Jong Kim

"The Earth Prediction Innovation Center (EPIC), launched by NOAA/WPO to accelerate the community's development and integration of innovations to the Unified Forecast System (UFS) Weather Model System. A significant aspect of the center’s work is the continuous improvement and development of the UFS-WM along with the Stochastic Physics pattern generator for the UFS, developed at NOAA/ESRL/PSL, in regard to code reproducibility and operational readiness of the code in support of the community development.

This poster presentation summarizes a breakdown of the Stochastic Physics Unit Tests and how the testing is used to validate the software and confirms each unit is performing as designed. Additional diagramming of the main code drivers that instantiate the overall Unit Testing framework will also be provided, with a detailed analysis of what tests look to verify within the code. Also important is the output generated by the Stochastic Physics Unit Tests and understanding its practical uses to developers. Finally, this poster aims to introduce EPIC’s automated integration of the Stochastic Physics Unit Tests, how it was implemented, and how it can assist developers in the code verification process.

The stochastic physics unit tests overview discussed within this poster presentation are meant to educate and provide a demonstration to users of the innerworkings, best practices and intended uses of the tests, so community members have documented examples and explanations to assist them in understanding how the tests work and when to utilize them."

Transitioning to Unified Forecast System Applications for Operations - Update from NOAA's Environmental Modeling Center

Ivanka Stajner, Vijay Tallapragada, Jason Levit, Jacob Carley, Avichal Mehra, Daryl Kleist, and Fanglin Yang

NOAA's Environmental Modeling Center (EMC) is a lead developer of NCEP's Operational Prediction Suite (OPS) at the National Weather Service (NWS), which is used for the protection of life and property and the enhancement of the economy. EMC transitions to operations and maintains more than 20 numerical OPS systems that NWS, NOAA, other federal agencies, and various stakeholders use. These systems are developed through close collaboration with academic, federal, and industry partners. EMC enhances, transitions-to-operations, and maintains OPS systems for weather, ocean, climate, land surface, hydrology, hurricanes, and air quality for the U.S. and global domains.

NCEP's OPS is transitioning to the Unified Forecast System (UFS) framework. The UFS is being designed as a community-based, comprehensive atmosphere-ocean-sea-ice-wave-aerosol-land coupled Earth modeling system with coupled data assimilation and ensemble capabilities for applications spanning from local to global and predictive time scales ranging from sub-hourly analyses to seasonal predictions. Disparate legacy OPS applications that are maintained by EMC are being transitioned to the UFS framework. Fewer resulting applications will consolidate NCEP's OPS using common scientific components and technical infrastructure. This streamlined OPS is expected to accelerate the transition of research into operations and simplify maintenance.

We highlight EMC's major recent development and operational implementation projects, including for example new UFS-based hurricane and air quality applications, advances in satellite data assimilation and a new verification system. We present EMC plans, within the overall NOAA strategy, and links with other modeling efforts within NOAA, and in the broader U.S. community.

Unified Forecast System Model Performance in Madden-Julian Oscillation Simulation and Eastern Pacific Teleconnection for Subseasonal to Seasonal Predictions

Yu-Cian Tsai and Eric D. Maloney

This study evaluates the subseasonal to seasonal (S2S) prediction in the Unified Forecast System (UFS) model for the Madden-Julian Oscillation (MJO) and its remote impacts on the eastern Pacific (EP) during the boreal summer season (May-October) from 2011 to 2018. Utilizing four experimental versions, Prototypes 5, 6, 7, and 8, the study finds that although the UFS model generally captures the MJO's propagation characteristics near the initialization time, it encounters difficulty in accurately predicting the propagation speed and decay rate of the MJO beyond 15 days. Specifically, the model simulates slower-moving MJOs that maintain too strong at amplitude. Teleconnected effects on the EP are delayed and too strong during the S2S forecast period, potentially leading to less accurate predictions of tropical cyclone (TC) genesis. The analysis of moist static energy (MSE) budget reveals that all the UFS Prototypes underestimate the damping effect of vertical MSE advection and the amplifying effect of longwave radiative heating, indicating weaknesses in tropical convective parameterization and cloud radiative feedback. Notably, the model's weaker damping effect on MJO maintenance is attributed to a more bottom-heavy convective structure. These deficiencies result in less efficient energy export, weaker damping of MJO convection, and delayed MJO remote impact on the EP. Consequently, improving the UFS model's accuracy in capturing MJO propagation and maintenance processes is crucial for better predicting MJO's teleconnections to TC genesis and enhancing forecast capabilities for extreme events in the EP during the S2S forecast period.

All-Sky satellite radiance data assimilation using Gain-form of Local Ensemble Transform Kalman Filter within MPAS-JEDI: implementation, tuning, and evaluation

Tao Sun, Jonathan J. Guerrette, Zhiquan Liu, Junmei Ban, Byoung-Joo Jung, and Chris Snyder

The Gain-form of the Local Ensemble Transform Kalman Filter (LGETKF) has been implemented in the Joint Effort for Data assimilation Integration (JEDI) with the Model for Prediction Across Scales - Atmosphere (MPAS-A) (i.e., MPAS-JEDI). LGETKF applies vertical localization in model space and is particularly convenient for assimilating satellite radiance data, which does not have an explicit vertical height assigned for each channel. The additional efforts are made to optimize ensemble analysis procedures and improve the computational efficiency in the cycling workflow of MPAS-JEDI's LGETKF analysis. The quality control, bias correction, all-sky observation error model, and cloudy observation operator within the JEDI framework are employed to enable MPAS-JEDI's LGETKF to assimilate satellite radiance observations in all-weather situations, in addition to conventional observations and clear-sky radiances. To optimize assimilation configurations in LGETKF, a series of sensitivity experiments are conducted to evaluate the impact of adding all-sky window-channel AMSU-A radiances above the conventional observations and clear-sky radiances from AMSU-A's temperature sounding channels and MHS's water vapor channels. It is found that a combination of relaxation to prior perturbation (RTPP) and relaxation to prior spread (RTPS) aids LGETKF in maintaining the ensemble spread across cycles. A smaller horizontal localization scale proves preferable for all-sky AMSU-A radiance assimilation. The performance of all-sky radiance assimilation in LGETKF is evaluated through two one-month global cycling experiments with 80 ensemble members at 60 km grid spacing, with and without assimilation of all-sky AMSU-A radiances. Verification against Global Forecast System (GFS) analyses illustrates the benefits of all-sky assimilation in reducing short-term and 7-day forecast errors of almost all variables, despite some slight degradations on temperature. Further observation space verification demonstrates that the all-sky assimilation of LGETKF can improve the forecasts with a better fit to satellite winds and all-sky radiances. In addition, short-term ensemble forecasts initialized from LGETKF analyses are used as ensemble background error covariance (BEC) in deterministic cycling hybrid-3DEnVar. The results underscore the advantages of using the ensemble BEC from all-sky LGETKF over that from clear-sky LGETKF. Overall, MPAS-JEDI's LGETKF shows robust and stable performance in all-sky radiance assimilation and holds great potential for both research and operation applications.

Downscaling UFS to high resolution using Machine learning data fusion

Beiming Tang, Barry Baker, Patrick Campbell, Youhua Tang, Daniel Tong, Lacey Holland, Zachary Moon, Wei Li, Siqi Ma, and Yunyao Li

Air quality is essential for human health. Higher-resolution routine concentration maps are useful for exposure studies. This study demonstrates the initial results for downscaling UFS to high resolution (1km) through machine learning and data fusion. The downscaled model is evaluated by observations from ground stations (AirNow, EPA AQS) systems using NOAA-developed visualization tool Melodies-Monet from June to August 2024 and also evaluated using observations collected from the AEROMMA field campaign. This study shows UFS applications have significant potential for air quality exposure studies.

The state of the UFS in 2024

Hendrik L. Tolman

The Unified Forecast System (UFS) is rapidly becoming a fully open-source research and operations capability. NOAA uses the UFS to simplify its Production Suite of operational models, and to accelerate the rate of improvement of the Production Suite. The broader research community uses the UFS to accelerate research and simplify the Transition to Operations process. The poster will lay out the present state of development of the UFS in terms of which community models are presently making up the base code stack of the UFS (now, for the first time, identifying MPAS as a possible part of this stack) and how this code stack maps to UFS application releases, UFS applications in production and UFS applications in research.

Machine Learning-based weather prediction model development at EMC

Jun Wang, Sadegh Tabas, Linlin Cui, Wei Li, Jun Du, Bing Fu, and Jacob Carley

Machine learning-based weather prediction (MLWP) models have been under rapid development in the past couple of years. These models leverage autoregressive neural network architectures and are trained using reanalysis data generated by operational centers, demonstrating proficient forecasting abilities. These MLWP models, once trained, take significantly less computational resources to produce forecasts compared to traditional numerical weather prediction (NWP) models, all while maintaining or surpassing conventional NWP performance.

This presentation will provide an overview of the development of MLWP models for the global deterministic and ensemble forecast system at the NCEP Environment Modeling Center (EMC). Several state-of-the-art MLWP models, including GraphCast and FourCastNet, have been installed. Experimental real-time global forecasts with products comparable to operational GFSv16 have been made publicly available on the cloud. Additional fine-tuning with these models has been conducted to improve the forecast results. Also, a U-NET-based ML model has been developed to correct the biases of operational GFS products, including 2m temperature and Convective Available Potential Energy (CAPE), with promising results. Future work to improve the forecast performance for possible MLWP operational implementation will also be presented.

Using HAFS to Drive a Dynamically Coupled Hydrological-Ocean Model for Hurricane-Induced Compound Flooding Forecast

Yixuan Wang, Z. George Xue, Daoyang Bao, Bin Liu, and Zhengchen Zang

Hurricane-induced compound flooding events, a significant challenge, occur when inland hydrological processes and oceanic processes, such as storm surges, coincide at the land-ocean interface. The devastating Hurricane Ida, a Category 4 hurricane, caused severe flooding in Louisiana and Mississippi, particularly in New Orleans, due to a combination of storm surge and heavy rainfall. Traditional models often operated in standalone mode or within a linking framework, where a 'main model' simulated compound flooding using boundary conditions from other models. We recently developed a new coupling solution and realized the seamless transition of model coverage in the land-ocean continuum. We integrated WRF-Hydro into the

Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System, coupling the hydrological and ocean models (ROMS) along the land-ocean boundary. We adapted the coupled model to the Louisiana coast to assess the contributions of different processes—atmosphere, river, and surge—to the compound flooding event during Hurricane Ida in 2021, providing valuable insights for future flood management strategies. Two series of sensitivity tests were carried out driven by the atmospheric forcings of the Hurricane Analysis and Forecast System (HAFS) and Climate Forecast System Version 2 (CFSv2), respectively. The performance of the two atmospheric forcing in compound flood forecasts is diagnosed and discussed.

Enhancing Rainfall Predictions with Graph Neural Networks on the GEFS Dataset

Mengliang Zhang, Xinyue Hu, Yingying Zhu, and Yu Zhang

Skillful ensemble quantitative forecasts play increasingly crucial roles in diverse societal applications. Existing post-processing techniques offer limited ability to improve the skills of raw ensemble in depicting heavy-to-extreme precipitation. With funding from the WPO innovation program, a team at UT Arlington is exploring an alternative, hybrid ML-parametric post-processing strategy that uses a Graphical Neural Network (GNN) to depict spatially dependent errors. The GNN model used here is a multi-layer perceptron that refines node representations through aggregation of neighbor information, enabling the extraction of complex spatial-temporal features from GEFS data.

We perform hindcast experiments to determine the forecast skills of post processed probabilistic precipitation forecasts. The outcomes are mixed: GNN model outperforms a baseline method based on a single-layer ANN for low-moderate rainfall amounts, but its performance is comparable with the latter at higher amounts. Further experiments are underway to determine the potential of alternative training methods to improve the efficacy of GNN in depicting heavy-to-extreme precipitation events.

Microphysics Parameterization Development Progress in Hurricane Analysis Forecast System (HAFS)

Xuejin Zhang, Xin Yang, Hua Leighton, Linjiong Zhou, Kun Gao, Ruiyu Sun, and Lucas Harris

Tropical cyclone track forecasts have made significant progress in the past several decades. One of the main factors is better forecast guidance provided by Numerical Weather Prediction (NWP) models. However, our progress in forecasting tropical cyclone intensity, including rapid intensification, has advanced slowly or plateaued due to our limited understanding of cloud, precipitation, and latent heating processes within tropical cyclones in NWP models. In order to improve the representation of those microphysical processes, GFDL, EMC, and AOML are working together to improve and implement GFDL's latest microphysics parameterization scheme, called GFDL Microphysics v3 or GFDL MP v3, in UFS weather model and hurricane application, i. e. HAFS. In this study, we will report on the progress of implementing the latest GFDL MP v3 in HAFS. We will also compare the simulated tropical cyclones by HAFS with GFDL MP v1 to those by GFDL's T-SHiELD with GFDL MP v3. The critical microphysics properties will also be validated by in-situ observations to identify the potential improvement in the microphysics parameterization schemes in HAFS and T-SHiELD.

Hurricane Analysis and Forecast System (HAFSv2) Upgrades and Operational Implementation

Zhan Zhang, Xuejin Zhang, Bin Liu, Avichal Mehra, Vijay Tallapragada, Sundararaman Gopalakrishnan, and Frank D. Marks, Jr., Aaron Poyer, William Komaromi, and Jason Anderson

After multiple years of accelerated developments and collaborative efforts among research and operational communities, NOAA's first operational version of the Unified Forecast System (UFS) based hurricane prediction system, version-1 of Hurricane Forecast and Analysis System (HAFSv1), was implemented on June 27, 2023.

Two upgraded configurations of HAFS (HAFSv2) have been finalized, aiming for operational implantation in the 2024 North Atlantic hurricane season. Both configurations attempt to address the issues identified in HAFSv1 during the 2023 hurricane season and have been extensively tested. In this presentation, two final configurations of HAFSv2 upgrades, which include the increase of model resolution, relocation of hydrometeor and vertical velocity variables vortex initialization process, the MOM6 ocean mode coupling capability, and further improvement of model physics schemes, will be presented, and discussed. Three-year retrospective results (2021-2023) based on HAFSv2 will be evaluated, analyzed, and compared with the results from HAFSv1.

Hurricane Analysis and Forecast System (HAFS)

Research and Developments of the Hurricane Analysis and Forecast System

Sundararaman Gopalakrishnan, Ghassan Alaka, William Ramstorm, Lew Gramer, Xuejin Zhang, and Zhan Zhang

The Hurricane Analysis and Forecasting System (HAFS) is NOAA's next-generation, ocean-atmosphere-coupled multi-scale numerical model and data assimilation system. An integral part of the Hurricane Forecast Improvement Program (HFIP) strategic plan to address the Weather Act, two regional versions of HAFS with uniform resolution of 6 km and embedded storm following nest at about 2 km horizontal resolution to cover the core of the Tropical Cyclone and its immediate surrounding were implemented in operations in 2023. We will provide a progress report on the

Research & Developments and the proposed HFIP real-time experiments during the 2024 hurricane season with HAFS.

Numerical Simulations of Tropical Cyclones using a Scale-Aware Three-Dimensional TKE Turbulent Mixing Scheme

Ping Zhu, Kwun Fung, Xuejin Zhang, Jun Zhang, Jian-Wen Bao, and Zhan Zhang

How to realistically represent the three-dimensional (3D) sub-grid scale (SGS) transport induced by the unresolved turbulence in numerical models is a longstanding problem in numerical weather prediction. In the state-of-the-art operational forecasting models, the coherent horizontal and vertical turbulent mixings induced by turbulent eddies are treated separately, with the former being handled within a model's dynamic solver and the latter being treated by a standalone module outside the dynamic solver, often known as the planetary boundary layer (PBL) scheme. This separated parameterization strategy is based on two considerations. First, in fair-weather conditions, the vertical turbulent mixing is much stronger than the horizontal mixing. Thus, it is appropriate to parameterize horizontal and vertical mixing separately. Second, most model physics, such as microphysics and radiation, are parameterized in a one-dimensional (1D) vertical column framework. Thus, it is natural to parameterize the vertical turbulent mixing in a 1D framework as well so that different parameterizations can be bundled together known as the model physics package. However, in the inner core of a tropical cyclone (TC), turbulent eddies tend to generate inter-connected horizontal and vertical turbulent mixing with comparable magnitudes because of the large lateral contrasts across the eyewall and rainbands. This poses a challenge for the separated horizontal and vertical turbulent mixing schemes to realistically represent the 3D turbulent transport in the TC inner core. The problem becomes even more serious as model resolution increases to the gray zone where turbulent eddies possess both isotropic and anisotropic characteristics. To relax the problem, we have been developing a scale-aware (SC) 3D moist turbulent kinetic energy (TKE) turbulence scheme for treating the 3D turbulent mixing in the gray zone. The new SA-3D TKE scheme considers full 3D TKE shear production tensor and 3D TKE turbulent transport and pressure correlation. In addition, it parameterizes the horizontal and vertical turbulent mixing in a consistent way based on the prognostically predicted TKE. The new SA-3D TKE scheme has been implemented in the Hurricane Analysis and Forecast System (HAFS) and validated by comparing HAFS's simulations of historical storms with the NHC Best-Track data and in-situ aircraft and airborne Doppler radar data. Currently, we are working with the Environmental Modeling Center (EMC) NOAA to transition the new SA-3D TKE scheme from research to operations.

2024 HAFS-A Configuration Based Real-Time Parallel Experiment with Upgrades in Model Initialization, Physics, Dynamics and Coupling

Bin Liu, JungHoon Shin, Biju Thomas, Hyun-Sook Kim, Zhan Zhang, Weiguo Wang, Lin Zhu, Chuan-Kai Wang, Yonghui Weng, Jing Cheng, Xu Lu, Bin Li, Maria Aristizabal, Yongzuo Li, Nathalie Rivera-Torres, Avichal Mehra, and Vijay Tallapragada

As a manifest of the great collaboration among the UFS hurricane application team, the HAFS initial operational capability (HAFSv1) was implemented in June 2023, and the HAFSv2 operational upgrade is upcoming and targeting July 2024. For the 2024 HFIP real-time demo project, a HAFSv2A configuration based HAFSv2.0.1A real-time parallel experiment is proposed and developed with additional upgrades and improvements in vortex initialization, inner-core data assimilation, model physics, and dynamics, as well as atmosphere-wave-ocean coupling. The vortex initialization is further upgraded through improving the central pressure enhancement procedure. For the inner-core DA, in addition to assimilating new observations, the storm-following 3D-IAU (Incremental Analysis Update) approach is developed and incorporated. Besides, atmospheric and ocean model physics, dynamics, and coupling will be further optimized for hurricane forecasting using the new parallel global RTOFS input data for ocean initial and open boundary conditions. Retrospective tests will be conducted with the HAFSv2.0.1A configuration for selected North Atlantic storms to demonstrate its track and intensity forecast skills. It will also be used in one of the 2024 HFIP real-time parallel demo experiments, which will be diagnosed, assessed, and compared with other real-time experiments as well as the current operational hurricane models.

Towards Turbulence-Permitting Simulations of the Entire Tropical Cyclone Vortex with FV3

Kun Gao, Joseph Mouallem, and Lucas Harris

The FV3-based models have demonstrated tremendous success in terms of capturing the global Tropical Cyclone (TC) climatology and interannual variability at O(100km) resolution and predicting TC track and intensity at O (1km) resolution at the weather timescale. At GFDL, we are pushing the frontier of FV3's application in TC and extreme weather simulation and forecasting. The flexible multi-level nesting capacity in FV3 allows its application for O(100m) and even finer simulations that cover the entire TC vortex. In this talk, we represent the use of O(100m) resolution nested configuration to simulate the evolution of the entire TC vortex for four days in an idealized setting. The simulation represented the intensification process of the TC vortex well and successfully captured the km-scale finger-like clouds in the TC inner region, resembling the features observed in intense hurricanes in the real-world. The characteristics of the turbulent eddies that caused the formation of these finger-like clouds will be presented.

HAFS Based Ensemble in Cloud

Jiayi Peng, Zhan Zhang, Rajendra Panda, Weiguo Wang, Bin Liu, Avichal Mehra, Vijay Tallapragada, Xuejin Zhang, Sundararaman Gopalakrishnan, Aaron Poyer, William Komaromi, and Jason Anderson

The lack of a skillful and reliable high-resolution ensemble is a great challenge for the forecasters in NHC and JTWC to issue TC intensity, structure change, and hazard probability forecasts. To fulfill the gap, the Hurricane Analysis and Forecast System (HAFS) based ensemble prediction system (EPS) was ported to the Amazon Web Service cloud, which was running in real-time in 2023 to provide hurricane probabilistic forecast guidance for NHC forecasters. The stochastic physics in the HAFS ensemble includes Stochastically Perturbed Physics Tendencies (SPPT), Stochastically Kinetic

Energy Backscatter (SKEB), and Stochastically Perturbed PBL Humidity (SHUM). The initial and lateral boundary conditions were generated from the NCEP operational GEFS 21-member forecast data. The performance of the HAFS ensemble for 2023 Atlantic hurricane forecasts was compared with the global GEFS and ECMWF ensemble forecasts. This demonstrates the advantages of the higher resolution regional ensemble forecasts for hurricane track, intensity, Rapid Intensification (RI) probability, and hazards probability guidance. The 2024 HAFS ensemble will include the Vortex Initialization, Data Assimilations, and more Stochastic Parameter Perturbations, which is expected to provide a better probability forecast guidance for the 2024 Atlantic storms.

Recent Development of GOES-16 ABI All-Sky Radiances Data Assimilation for HAFS: System Description and Impact on Hurricane Laura (2020)

Yue Yang, Xuguang Wang, and Xu Lu

The all-sky radiance observations from the Advanced Baseline Imager (ABI) aboard the GOES-16 satellite provide the high-resolution spatial and temporal sampling of hurricane cloud structures and surrounding environments over the open ocean. Many efforts have been made to effectively assimilate ABI all-sky radiances, with the aim of improving forecasting capabilities. However, problems remain in the ABI all-sky radiances data assimilation (DA) for hurricane predictions. For example, the nonlinear observation operator in the EnVar DA framework causes cost function gradient imbalance and slow minimization. In addition, large storm location errors of background during DA, especially for hydrometeor fields, can degrade analyses due to the violation of the Gaussian error assumption. To alleviate these issues, the ABI-enhanced Hurricane Analysis and Forecast System (HAFS) self-cycled dual-resolution EnVar DA system is established and developed to include the direct assimilation of ABI all-sky radiances, vortex relocation (VR), and hydrometeor-enabled VR (HVR). The impacts of directly assimilating ABI all-sky radiances and HVR are investigated for Hurricane Laura (2020). Results show that including brightness temperature as a state variable speeds up the minimization, leading to broader and larger increments. HVR works reasonably well in all state variables including hydrometeors. VR and HVR show positive impacts on the improvement of intensity predictions. Therefore, VR is needed when assimilating inner-core observations from ABI. HVR is viewed as necessary to assimilate cloud sampling observations since HVR produces better hurricane structure analyses and subsequent intensity forecasts than VR.

Using novel observations at the air-sea interface to evaluate the coupled ocean-atmosphere background ensemble forecasts from a self-cycled HAFS data assimilation system for Hurricane Finoa (2022)

Tsung-Han Li, Xuguang Wang, Xu Lu, Jun Zhang, Hyun-Sook Kim, HeeSook Kang, and Yongzuo Li

A field campaign was conducted during Hurricane Fiona (2022), where unique observations sampling the properties at the air-sea interface were collected. These observations included saildrone, paired dropsonde, and AXBT. Saildrone measured air-sea interface variables, including atmospheric parameters and oceanic parameters. Paired dropsonde and AXBT allowed measures of boundary layer structure and ocean thermal structure data to depths of approximately 400 meters. These observations altogether could also derive 3D thermal fluxes at the air-sea interface. A self-cycled data assimilation experiments were designed and implemented for the Hurricane Analysis and Forecast System (HAFS) coupled with the HYbrid Coordinate Ocean Model (HYCOM) for Fiona (2022). These novel observations at the air-sea interface were leveraged to evaluate the background ensemble of this DA system. It was found that the deterministic forecast matched the dropsonde/AXBT observations well in both the boundary layer and ocean structure. Air-sea interface verifications from saildrones indicated good agreement between the forecast and observations, with some identified biases. Thermal flux verifications also demonstrated consistency regarding the storm shape and size. The ensemble forecast verification results showed that the ensemble spread was largest when the saildrone was close to the TC center. In the boundary layer, some ensemble members were closer to the observations than the deterministic experiment. This study sheds light on the performance of the coupled ocean-atmosphere background ensemble and provide insights on how to improve the current state-of-the-art DA system for the eventual fully coupled ocean-atmosphere DA for hurricane prediction.

Development of the Cloud and Vertical Velocity Initialization Process in the HAFS-Vortex Initialization

JungHoon Shin, Zhan Zhang, Bin Liu, Yonghui Weng, Chuan-Kai Wang, Qingfu Liu, Avichal Mehra, and Vijay Tallapgrada

Background/Objectives: The previous Vortex Initialization (VI) method used in the operational Hurricane Analysis and Forecast System (HAFSv1) had an issue due to an inconsistency between the cloud and hurricane vortex in the model's initial condition (IC). To fix this model IC issue, the cloud and vertical velocity relocation–cycling capability has been developed on top of the existing VI.

Methods: In the new VI, the cloud and vertical velocity fields of the Global Forecasting System analysis are relocated to the correct position for the cold start cycle, and for the warm start cycle, these variables are cycled from the previous HAFS forecast field. Several sensitivity experiments were conducted using the 2023 HAFSv1.1A real-time experiment configuration to examine the impact of this new VI.

Results: The sensitivity experiment results show that the experiment using cloud and vertical velocity relocation–cycling capability produces a somewhat better intensity forecast than the experiment without this relocation–cycling. Also, if the vertical velocity is not relocated or not cycled (i.e., relocating/cycling cloud field only) in the VI, the intensity forecast is degraded. The convective structure of the model IC from the new VI is validated against the observation, and the results reveal that the new VI is able to reproduce the overall observed convection pattern, creating a much more realistic initial cloud structure.

Conclusions: The HAFS experiment with a new VI demonstrates that relocating–cycling cloud and vertical velocity in the model IC improves not only the intensity forecast but also the model's initial cloud structure.

The Sensitivity of the Impact of G-IV Reconnaissance Data to HAFSv1 Version

Sarah Ditchek, Jason Sippel, Ryan Torn, Lisa Bucci, and Wallace Hogsett

The tropical cyclone (TC) flight-track strategy conducted by NOAA's Gulfstream IV-SP (G-IV) has changed in recent years. The current strategy includes three components: 1) a circumnavigation at around 330 km from the TC center; 2) a second circumnavigation at around 165 km, when possible, that was implemented operationally in 2018; and 3) environmental sampling guided by ensemble sensitivity metrics, implemented operationally in 2019. Given the latter two additions, the overall G-IV impact on TC forecasts needs to be quantified, and ways to optimize the strategy further should be assessed. These results and optimizations can then be delivered as guidance for use during G-IV flight-track planning.

This project initially used HAFSv1-A to quantify the overall G-IV impact on TC forecasts. To do so, it compared two experiments: one that assimilated and another that denied G-IV reconnaissance data. Experiments covered the 15 TCs that had tasked G-IV missions during the 2020–2023 hurricane seasons, resulting in 469 individual forecasts that included 56 G-IV missions. Results indicated that while G-IV reconnaissance data was beneficial for tropical storm forecasts, it was detrimental for hurricane forecasts. Since more recent ad-hoc experiments suggested that the impact of all reconnaissance data in HAFSv1 was dependent on the version used, the G-IV experiments were rerun with HAFSv1-B. In doing so, the detrimental G-IV impact on hurricane forecasts disappeared. Thus, this presentation will share preliminary results on the differences in the overall G-IV impact between HAFSv1 versions.

Evaluation of Hurricane Analysis and Forecast System (HAFS) Error Statistics Stratified by Internal Structure and Environmental Metrics

George Alvey, Ghassan Alaka, Lewis Gramer, and Andrew Hazelton

Although tropical cyclone (TC) track and intensity forecasts have continued to improve in recent years, the relative lack of analysis relating both environmental conditions and internal storm characteristics to forecast errors has precluded a better understanding of these relationships, particularly for cases that undergo rapid intensification (RI). Recent studies have shown the importance of vortex alignment for RI; however, exactly how and why certain storms align remains poorly understood. This study builds upon other recent studies that showed forecast error statistic stratifications with environmental metrics such as vertical wind shear by also including internal storm dynamics. In this way, the study uniquely addresses poorly understood aspects of internal storm dynamics like vortex tilt by examining not only their impact on forecast errors but also how they relate to environmental conditions and their cooperative interactions with precipitation processes.

A three-year retrospective sample of forecasts in the North Atlantic basin from two HAFS configurations (-A and -B) demonstrates that TCs within moderate-to-high shear environments as well as larger tilt magnitudes, have the largest forecast track errors on average. Smaller tilt magnitudes have larger absolute intensity errors in short-range forecasts, whereas larger tilt magnitudes tend to have larger negative intensity biases at medium range. TCs with a tilted vortex are shown to have both downshear left and downtilt left oriented positional track biases. Furthermore, those cases with greater downshear biases tend to have more convection and larger positive intensity biases, highlighting the importance of the interplay between inner core characteristics and forecast errors.

Advancing UFS Applications - Coastal, Marine, and Space Weather

Status and plans for developing UFS Coastal model and coupled applications

Saeed Moghimi, Maoyi Huang, Jana Haddad, Panagiotis Velissariou, Yunfang Sun, Bahram Khazaei, Soroosh Mani, Fariborz Daneshvar, Armaghan Abed-Elmdoust, Alexander Kurapov, Ed Myers, Corey Allen, Ufuk Turuncoglu, Ann Tsay, Greg Seroka, Ayumi Fujisaki-Manome, Shachak Peeri, Tracy Fanara, Derrick Snowden, Patrick Burke, Ali Salimi, Saeideh Banihashemi, Avichal Mehra, Ali Abdolali, Carsten Lemmen, Joseph Zhang, Damrongsak Wirasaet, Joannes Westerink, Hernan G. Arango, Scott Durski, and Jihun Jung

NOAA's National Ocean Service (NOS) is partnering with the Oceanic and Atmospheric Research (OAR), National Weather Service (NWS), and coastal ocean modeling community to develop its next-generation coastal ocean coupling infrastructure for integration into the NOAA Unified Forecast System portfolio.

In this presentation, we will share our roadmap and the current status of the development of UFS-Coastal (ufs-coastal-model) coupling infrastructure and its downstream applications (ufs-coastal-app). The current development team consists of developers from the ESMF/NUOPC team at NCAR and the NOS Storm Surge Modeling Team at the Office of Coast Survey. Substantial support is also provided by coastal ocean model developers (ROMS, ADCIRC, SCHISM and FVCOM) as well as support from the WaveWatchIII team at NOAA Environmental Modeling Center and the US Army Corps of Engineers.

Development and Code Infrastructure of the Coastal Modeling Framework Based on Unified Forecast System (UFS-Coastal Application)

Ufuk Turuncoglu, Panagiotis Velissariou, Saeed Moghimi, Yunfang Sun, Damrongsak Wirasaet, Joannes Westerink, Y. Joseph Zhang, Carsten Lemmen, Jianhua Qi, Siqi Li, Changsheng Chen, Hernan G. Arango and Edward Myers

As a part of the ongoing effort of NOAA to simplify its Modeling Production Suite and migrate to Unified Forecast System (UFS), a new application that aims to support forecast requirements of coastal applications is being developed at the Coastal Marine Modeling Branch (CMMB, NOAA/NOS/OCS). The new application shares much of the UFS Weather Model infrastructure and its components by adding specialized coastal ocean model components such as ADCIRC, FVCOM, ROMS, SCHISM, and the Parametric Hurricane Modeling System (PaHM). The new application is flexible enough to combine different components of the modeling system through the use of ESMF/NUOPC (Earth System Modeling Framework/National Unified Operational Prediction Capability) layer to meet specific application requirements. For instance, the UFS Weather Model provided CDEPS (Community Data Models for Earth Prediction Systems) data component capability can be combined along with the active ocean model component to isolate two-way interactions and complex feedback in the air-sea interface and to enable a better understanding of storm surge and their effects. Moreover, the ESMF/NUOPC-based CMEPS (Community Mediator for Earth Prediction Systems) mediator component can also be used to define complex interactions among different model components like mapping and merging of exchange fields. It also enables testing and use of state-of-art coupling technologies, such as the exchange grid approach, to calculate atmosphere-ocean fluxes and coupling through the nested domains without any major development. Sharing the same infrastructure with the UFS Weather Model is also critical to reduce redundancy and improve efficiency across different applications and facilitates the use of new features developed in one application with the others like the UFS-Coastal application.

UFS-Coastal Applications for tropical storms using coupled SCHISM and WAVEWATCH III

Yunfang Sun, Jana Haddad, Panagiotis Velissariou, Ali Abdolali, Ufuk Turuncoglu, Ann Tsay, Joseph Zhang, Saeideh Banihashemi, Ali Salimi-Tarazouj, Armaghan Abed-Elmdoust, and Saeed Moghimi

The simulation and analysis of coastal ocean responses to tropical storms is a key use case for the Unified Forecast System-Coastal (UFS-Coastal) application framework. This study uses UFS Coastal to couple and run the two-dimensional (depth-averaged) Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) and WAVEWATCH III (WW3). These model components were forced with atmospheric data (ATM) through the Community Data Models for Earth Prediction Systems (CDEPS). Here, we present results from surge simulations for a few tropical storms, such as Hurricane Ian 2022, a Category 5 Atlantic Ocean hurricane.

Our approach included the following coupling configurations: ATM+SCHISM, ATM+WW3 (w/o obc) and ATM+SCHISM+WW3 (w/o obc), etc. The simulations were used to assess the influence of wave-current interactions and deep-ocean wave forcing on storm surge predictions. Comparative analyses were conducted using observed data from NOAA buoy stations. Standard statistical measures validated the coupled system's performance and highlighted its spatial and temporal capabilities and limitations. The findings underscore the critical role of wave dynamics in storm surge modeling and demonstrate the UFS-Coastal's predictive potential for total water levels, wave heights, and flood inundation mapping.

User support, external testing, and project planning of the UFS Coastal coupling infrastructure in partnership with UFS Coastal Applications Team

Jana Haddad, Greg Seroka, Saeed Moghimi, John Kelley, Ayumi Fujisaki-Manome, Olivia Doty, Ufuk Turuncoglu, Ann Tsay, Maoyi Huang, Panagiotis Velissariou, Yunfang Sun, Bahram Khazaei, Armaghan Abed-Elmdoust, Alexander Kurapov, Ed Myers, Corey Allen, Shachak Pe'eri, Tracy Fanara, Derrick Snowden, and Patrick Burke

The UFS Coastal project, led by the NCAR Earth System Modeling Framework (ESMF) team and the National Ocean Service (NOS) Office of Coast Survey (OCS) Storm Surge Modeling Team, aims to establish a prototype application-level framework (UFS Coastal App) for coastal forecasting requirements. UFS Coastal App will contain the workflow and necessary pre- and post-processing tools on top of the underlying coupling infrastructure. This talk will focus on tools and principles we are using to plan and manage the UFS Coastal project as open source and open science software in the context of the NOS-wide transition to Agile.

Guiding the development and planning are the engagement with envisioned stakeholders and continuous feedback from external evaluators. The stakeholders include the research/academic community of coastal modelers as well as modelers across NOAA as UFS applications are merged into operational workflows. The project also benefits from continuous feedback and engagement with the UFS Coastal Applications Team (UFS-CAT) sub-application marine navigation team, which is tasked with developing consensus criteria for selecting operational UFS models that support the marine navigation community, and testing and evaluating coastal model cores (e.g., ROMS and SCHISM) within the UFS Coastal coupled model infrastructure. The UFS-CAT effort also incorporates and builds the next generation of coastal modelers and exposes the community and university partners to the present and future NOAA operational coupled ocean modeling suite via UFS Coastal. Collaboration, support, and feedback loops with community modelers and testers are centralized on GitHub. The development team participates in quarterly planning meetings to set the roadmap, determine the next milestones, and build a backlog of tasks for achieving each milestone, making use of GitHub's Project features to track progress and document project activities.

Investigating the Hurricane-induced Salt Variation across the Land-Estuary-Ocean Continuum Using A Dynamically Coupled Hydrological-Ocean Modeling

Xiaochen Zhao, Z. George Xue, Daoyang Bao, and John Warner

Coastal salinity is crucial for the structure and productivity of coastal ecosystems and for providing socio-economic benefits to adjacent communities. Evaluating the spatiotemporal variations of salinity is challenging due to the complex interactions of terrestrial and oceanic hydrological processes, including river discharge, winds, tides, sea level rise, and storms. To evaluate coastal salinity variations driven by these hydrological processes, a dynamically coupled hydrological-ocean model was configured to represent salt transport and exchange across the Land-Estuary-Ocean Cerrone(LEO) continuum. This newly developed model integrates a process-based hydrological model (WRF-Hydro) with an overland salinity module, regional ocean model (ROMS), and modified coupler (MCT) on the Coupled-Ocean-Atmosphere-Wave-Sediment-Transport (COAWST) platform.

This model was applied to investigate how runoff and winds control the estuarine salinity dynamics and freshwater plume development in the Cape Fear River Estuary, North Carolina, during the passage of Hurricane Florence (2018). Initially, estuarine salinity was regulated by wind-forced water level gradients and later dominated by the substantial runoff from the estuary head. In the coastal ocean, the large runoff volume predominantly formed freshwater plume with its westward movement resulting from interactions among runoff, winds, and estuary geomorphology. The coupled model also simulated the salinity in the upper estuary's low-lying freshwater wetlands, indicating potential saltwater intrusion threats. This study demonstrates that the coupled modeling can serve as a holistic tool by incorporating hydrological and oceanic processes to evaluate saltwater intrusion, trace coastal pollutants, and detangle pathways of water and material exchanges along the LEO continuum, contributing to coastal management and restoration projects.

Improving Tidal Forcing Functions in STOFS-2D+-Global, NOAA's Fast Integrated Multi-Scale Multi-Process Operational Water Level Model

Joannes J. Westerink, Damrongsak Wirasaet, Albert Cerrone, Aman Tejaswi, Dylan Wood, Zach Cobell, Edward Myers, Saeed Moghimi, Greg Seroka, and Yuji Funakoshi

NOAA's Global Surge and Tide Operational Forecast System (STOFS-2D-Global) has been running operationally with variable resolution between 80m and 24km. The model incorporates optimized high resolution along all U.S. coastlines, extends onto the coastal floodplain, and is driven by tides and GFS-FV3 winds, sea ice, and atmospheric pressure. The development version is also driven by thermohaline circulation (with temperature and salinity fields downscaled from Global RTOFS) and hydrology. STOFS-2D+-Global is the most accurate global non-data assimilative tide model and is fast, running at 2.4 wall clock minutes per day of simulation on 2400 TACC Frontera cores.

In order to further improve total water levels, we are expanding the tidal forcing functions from 8 to 24 constituents using traditional Fourier decomposed equilibrium tide approximations. Specifically, we expand the number of forcing constituents from the primary eight astronomical constituents to 24 primary, long term, and secondary astronomical constituents to be consistent with NOAA's standard set of 37 constituents. This can make a substantial difference in the accuracy of the computed daily and extreme tides. There appear to be some discrepancies between popular nodal factor and equilibrium argument codes such as UTide, TMD, PyTide, and Tidefac. This becomes crucial for long-term simulations. In addition, we have also integrated direct gravitational forcing into ADCIRC, based on celestial angles of the sun and moon relative to the Earth's surface. This eliminates the need for Fourier synthesis as well as for nodal factors and equilibrium arguments.

Development of a new operational forecast system for southeastern US (SECOFS)

Joseph Zhang, Lucila Houttuijn Bloemendaal, Saeed Moghimi, Aijun Zhang, Nicolas Alvarado, Kyle Ward, Hyungju Yoo, Tracy Fanara, and Ed Myers

Natural hazards such as coupled inland-coastal compound flooding have increasingly become serious threats to coastal communities. With BIL funding support, we are developing a new 3D southeastern coast operational forecast system (SECOFS)(from Chesapeake Bay to Florida

Panhandle) and a disjoint domain for Puerto Rico. The final SECOFS system is envisioned to be a UFS application in which CDEPS (data cap) will provide forcing to a coupled SCHISM-WW3 application. The dynamical two- or one-way coupling with inland hydrology component, i.e., National Water Model (NWM) or NextGen, is yet to be determined. We are actively engaging end users and stakeholders throughout the project and have so far incorporated numerous suggestions from navigation managers on the SECOFS mesh. The US east coast portion of SECOFS has been preliminarily validated, and we will present the latest results for this region, including total water level, currents, and tracers (temperature and salinity). Through SECOFS, we are also exploring the feasibility of the new agile DevOps in the R2O2R cycle for rapid prototyping of new OFS.

NOAA's Coastal Ocean Operational Forecast Systems, Products, and Future Plan

Aijun Zhang and Carolyn Lindley

The National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS) has developed and implemented 15 coastal ocean operational forecast systems (OFS) in the past 20 years based on community ocean models. Those OFS provide valuable nowcast and forecast guidance to the maritime community to inform their decisions on navigation safety, the protection of human health, coastal resilience, emergency response, and living resource management. NOS has been collaborating with partners to test, evaluate, and implement additional OFS to fill gaps in geographical coverage of U.S. coastal waters, including major ports and estuaries, and Great Lakes. NOS has also recently invested resources in expanding and enhancing NOS' OFS capabilities, such as data assimilation under the Joint Effort for Data Assimilation Integration (JEDI), ice forecasting, migration and development of infrastructure framework of the National Unified Operational Prediction Capability (NUOPC) for dynamic coupling of multiple models, and improved shared infrastructure for coastal ocean model verification and evaluation.
This presentation will give an overview of NOS' OFS current status, operational products, data dissemination, development of new capabilities, challenges in improving OFS performance, and a near-term plan for future operational implementations. It will also identify potential opportunities for collaboration with partners in academia and the maritime community.

Evaluating the SAMI2 Model's Performance in the Brazilian Sector During the December 2015 Geomagnetic Storm

Oladayo O. Afolabi, Claudia M. N. Candido, F. Becker Guedes, and C. Amory-Mazaudier

This study evaluates the performance of the SAMI2 model in the Brazilian longitudinal sector during the geomagnetic storm on December 20, 2015. The SAMI2 model is a two-dimensional, first-principle, physics-based ionospheric model that simulates the evolution of the low- and mid-latitude ionosphere. We ran the SAMI2 model from December 18 to 30, 2015, and compared its Vertical Total Electron Content (VTEC) outputs with Global Positioning System (GPS) VTEC data in the Brazilian sector during the geomagnetic disturbances. We estimated the ionospheric electric current disturbance (Diono) using the H-component of the Earth's magnetic field and applied semblance cross-correlation wavelet analysis to isolate the magnetic signature of the disturbance dynamo (Ddyn), noting its development on December 21, 2015. Our findings indicated a significant

Root Mean Square Error (RMSE) of 8.4 TECU on December 21, 2015, during the recovery phase, attributed to equatorward disturbance winds that altered the quiet-time electrodynamics of the Brazilian equatorial ionosphere. This inhibited the eastward flow of the equatorial electrojet and caused VTEC depletion in the Equatorial Ionization Anomaly (EIA) region. The SAMI2 model overestimated this VTEC depletion, leading to the large RMSE recorded on December 21, 2015. The study revealed that the electric field inputs in the SAMI2 model failed to account for the effects of equatorward disturbance winds, resulting in an overestimation of VTEC depletion. We recommend incorporating the disturbance wind component into the SAMI2 model to enhance its performance in the equatorial and low-latitude ionosphere during geomagnetic storms.

Investigation and Prediction of Ionospheric Irregularities over Egypt

Hager M. Salah, Hassan Nooreldeen, Daniel Okoh, M. Youssef, and Ayman Mahrous
In this study, we investigate the occurrence of ionospheric irregularities during the post-sunset time over Egypt at Helwan SCINDA station on the geographic coordinates of 29.86°N and 31.32°E. It is an excellent platform for irregularities studies because it is located near the northern crest of the equatorial anomaly. Despite numerous studies on the growth and development of different ionospheric variations, the prediction of ionospheric irregularities occurrences remains unsolved. Thus, we report the results of an Artificial Neural Network model for these irregularity predictions. IRI-hmF2 and IRI-foF2 parameters were used to improve inputs and support our prediction NN model. The correlation coefficient between predictions and observations is 0.89. Meanwhile, the RMSE value is 0.11.

Enhancing Ionospheric Forecasting in Egypt: Utilizing GNSS Data and Deep Neural Networks

Hassan Nooreldeen, Ayman Ahmed, Ayman Mahrous, and Mohamed Yossuf
This study aims to develop a novel prediction model that surpasses current methodologies in terms of performance. It will utilize Global Navigation Satellite System (GNSS) data to investigate the complexities of ionospheric irregularities over Egypt.

To accomplish our objective, we leverage the capabilities of a recently established network of dense GNSS reference stations spread across the country. This network enables us to gather a comprehensive GNSS Vertical Total Electron Content (VTEC) dataset. The heart of our research is creating and meticulously assessing a deep neural network (DNN) model. Our DNN model incorporates solar and geomagnetic indices, along with the VTEC, as input variables.
To evaluate the efficiency of our DNN model, we performed a comprehensive assessment by comparing it with the well-established IRI2020 model. Our forecasts for quiet-time VTEC over several days closely match actual observations. However, during storm conditions, the accuracy of our predictions decreases rapidly after a few hours.

This study highlights our extensive GNSS network's crucial role in improving forecasting accuracy, particularly for quiet-time VTEC. Despite reduced accuracy during storms, our DNN model

significantly advances current methodologies, benefiting both scientific research and space technology applications.

Cross-Cutting - Physics, Verification, and Validation Followed by Dynamics and Nesting

The Common Community Physics Package and Single Column Model Version 7

Dustin Swales, Ligia Bernardet, Grant Firl, Mike Kavulich, Jimy Dudhia, Sam Trahan, Man Zhang, Weiwei Li, Tracy Hertneky, Lulin Xue, Soren Rasmussen, and Mike Ek

Version 7 of the Common Community Physics Package (CCPP) and accompanying CCPP Single Column Model (CCPP SCM) is scheduled to be released by the Developmental Testbed Center (DTC) in mid-2024. The CCPP is a major component of the Unified Forecast System (UFS) and is embedded within selected NOAA's operational systems, such as the Hurricane and Analysis Forecast System (HAFS), and is slated for inclusion in all upcoming UFS operational systems. While the CCPP is included as part of NOAA's current/future operational plans, the CCPP is intended to be used as a research tool by the larger community. Development of the physical parameterizations contained within the CCPP reflects contributions from NOAA's laboratories and centers and from the broader community (e.g., NCAR/NRL/Universities). The CCPP SCM facilitates this development by being efficient for CCPP physics developers, allowing for the full development process to be incremental and hierarchical within the larger UFS ecosystem.

In this presentation, we will provide an overview of the CCPP's current state, introduce new features included in Version 7, and discuss future development plans. Some of the new capabilities in Version 7 are the ability to create SCM cases from UFS output, support for running single-precision physics simulations, and expanded testing and visualization tools.

Advanced Testing and Evaluation by DTC for UFS Physics Development

Weiwei Li, Man Zhang, Tracy Hertneky, Evelyn Grell, Jimy Dudhia, Joe Olson, Anders Jensen, Ruiyu Sun, Linjiong Zhou, Lisa Bengtsson, and Fanglin Yang

In the past year, the Developmental Testbed Center (DTC) has collaborated closely with the UFS physics working groups to advance the UFS physics development. This presentation will showcase our contributions through the semi-idealized case studies using the CCPP single-column model (SCM) and process-level testing and evaluation (T&E). We will delve into the T&E of the updated MYNN-EDMF scheme, the aerosol-aware Thompson–Eidhammer microphysics scheme, and our ongoing assessment of multiple microphysics schemes in the UFS. This presentation will highlight key findings on the challenges of properly representing decoupling between the cloud layer and boundary layer in a marine stratocumulus case, mixed-phase clouds in several Arctic cases, and cloud-radiation-moist physics interactions across multiple cases. The presentation will also discuss the physics behaviors across scales, from convective-allowing to medium-range to seasonal forecasts. Lastly, we will share our work for the physics development of the UFS Seasonal Forecast

System (SFS), specifically our investigation of the relationship between problematic diurnal cycles of sea-surface temperature and misrepresented clouds, and our efforts to better understand model issues related to clouds and microphysical properties at coarser resolutions (e.g., 100 km).

Most Recent Strides in Enhancing the METplus Verification and Diagnostic Capability to Support UFS Development Activities

Tara Jensen, John Opatz, Tina Kalb, Dan Adriaansen, Mrinal Biswas, Andrew Newman, Mike Ek, Jonathan Vigh, Kathryn Newman, Michelle Harrold, and Tracy Hertneky

Verification and diagnostic activities are critical to developing fully coupled Earth System Modeling (ESM) frameworks and Numerical Weather Prediction (NWP) systems. Besides assessing how the model dynamics and physics perform, understanding how the complexity of the component models perform is very important. Significant work on adding support for evaluating the components of ESM and NWP models has occurred within the enhanced Model Evaluation Tools (METplus) verification and diagnostic software system during the past 5+ years. The enhancements have been completed in support of developing a unified evaluation capability for the Unified Forecast System (UFS) and ensuing applications.

Having reproducible results via a consistent framework is important for model developers, operational centers, and UFS stakeholders alike. The METplus system provides a suite of tools developed with a view towards providing that consistent platform not only for the UFS but also for both US and international modeling systems. The tools are designed to be highly flexible to allow for quick adaptation to meet evaluation and diagnostic needs across many temporal and spatial scales. A suite of Python wrappers facilitates a quick set-up and implementation of the system and enhances the pre-existing plotting capabilities.

This presentation will focus on some of the most recent developments within the evaluation areas of land modeling, space weather, marine and cryosphere, tropical cyclone diagnostics, and unstructured grids. Through the examples provided, the presentation will highlight examples of the flexible configurability of METplus and highlight the aspects that are being used operationally by NCEP Centers.

Use and distribution of the GFDL Vortex Tracker as part of the Unified Forecast System

Timothy Marchok and Caitlyn McAllister

The GFDL Vortex Tracker has been used in the post-processing jobs of numerous operational models at NCEP since 1998, and it is also used by other research organizations within the atmospheric sciences community. This tracker provides objective guidance on critical metrics associated with both tropical and extratropical cyclones that are forecast by numerical models. This past year, an effort was begun to establish the GFDL Vortex Tracker as a proper community-supported vortex tracker for the Unified Forecast System (UFS). This talk will provide an overview of the capabilities of the GFDL Vortex Tracker and will also detail accomplishments to date in establishing a comprehensive GitHub repository for this tracker that adheres to UFS community development standards.

The tracker analyzes model output to diagnose critical metrics of storm position, MSLP, maximum wind, and various wind radii metrics, including the radii of 34-, 50- and 64-knot winds and the radius of maximum winds. Also included are metrics for cyclone phase space diagnostics and storm-centric values of SST, deep-layer wind shear, and lower-tropospheric vorticity. The tracker can run in a mode that tracks already-existing, numbered tropical cyclones, or it can run in a genesis mode that detects and tracks new storms that form during the evolution of a model forecast.

A GitHub repository has been established for the GFDL Vortex Tracker. This repository has already been used in support of the operational HAFS models at NCEP. The development of this repository continues with the addition of unit testing and continuous integration.

Storm-Based Verification and Intercomparison of Warm-Season Forecasts from the HRRR, RRFS, C-SHiELD, and NSSL MPAS models

Corey Potvin, Larissa Reames, Adam Clark, David Dowell, Michael Duda, Thomas Jones, Kent Knopfmeier, Ted Mansell, Bill Skamarock, Yunheng Wang, Lou Wicker, and Nusrat Yussouf

Most current convection-allowing models (CAMs) use one of three dynamical cores: the Advanced Research version of the Weather Research and Forecasting model (ARW), the Finite-Volume Cubed-Sphere model (FV3), or the Model for Prediction Across Scales (MPAS). While the UFS was envisioned to use a single dynamical core, modeling groups have been unable to match ARW or MPAS CAM performance with the FV3, so the MPAS is being considered as an additional UFS core. After extensive efforts to transition the ARW-based prototype Warn-on-Forecast System (WoFS) to FV3, NSSL began running three daily MPAS CAMs to assess MPAS as a next-generation WoFS core. The three MPAS models differ only in microphysics and driving model: the High-Resolution Rapid Refresh (HRRR), or EMC's deterministic, CONUS-domain Rapid Refresh Forecast System (RRFS) prototype. Moreover, the NSSL MPAS physics is similar to the HRRR and RRFS physics. Thus, forecasts from the five models can be compared to estimate the effects of different dynamical cores, driving models, and microphysics and to assess the relative performance of candidate modeling systems. These models, along with GFDL's FV3-based CONUS System for High-resolution prediction of Earth-to-Local Domains, were evaluated and compared in the 2023 Hazardous Weather Testbed Spring Forecasting Experiment (SFE). We complement the subjective SFE findings using a storm object framework to verify and compare the models' 00 UTC forecasts of near- and pre-storm environments. We analyze 1–36-h forecast times over May–June 2023. Our results confirm the SFE findings and support consideration of the MPAS for UFS CAM systems.

A generic model interface for the Community Radiative Transfer Model (CRTM)

Cheng Dang and Benjamin Johnson

The Community Radiative Transfer Model (CRTM) is a fast, multi-layer column radiative transfer model used in numerical weather prediction, calibration, and validations across multiple federal agencies and universities. The accuracy of the CRTM largely relies on the model's physical assumptions on surface emissivities, aerosol and cloud optical properties, transmittance, and spectral coefficients, which are pre-computed and stored in multiple coefficient look-up tables (LUTs) to ensure operational efficiency.

While CRTM excels in traditional sensor-oriented cases and scenarios that align with currently available physical assumptions, it becomes less convenient for simulations involving applications beyond. To facilitate this process and make CRTM simulations more accessible for broader applications, this presentation introduces the newly developed generic model interface in CRTM. We will demonstrate how to set up CRTM simulations by adopting the generic interface and user-defined atmospheric profile properties, and we will introduce supporting packages required for necessary pre-treatment. This new feature will be released as an optional interface in CRTM version 3.2 or later with no impact to the traditional CRTM model interface.

Advancements in the Assimilation of Spaceborne Microwave and Radar Observations

Isaac Moradi, Ron Gelaro, Benjamin Johnson, Satya Kaluri, Nancy Okeudo, Arlindo da Silva, and Yanqiu Zhou

Radiative transfer models are extensively used for the assimilation of satellite observations into NWP models and retrieving geophysical products from satellite measurements. The Community Radiative Transfer Model (CRTM) is a community model developed by NOAA JCSDA and widely used for different purposes requiring RT calculations. CRTM requires bulk optical properties of hydrometeors in the form of lookup tables in order to perform all-sky RT calculations. However, the current cloud scattering lookup tables in CRTM assume spherical shapes for all frozen hydrometeors, whereas actual clouds contain frozen particles with diverse shapes.
The first part of this presentation addresses the implementation and validation of a comprehensive Discrete Dipole Approximation (DDA) cloud scattering database into CRTM, specifically targeting microwave frequencies. The DDA technique proves effective in simulating the optical properties of non-spherical hydrometeors in the microwave region. The original DDA database assumes total random orientation when calculating single scattering properties. Single scattering properties and water content-dependent particle size distributions are used to generate the required mass scattering parameters for CRTM. The evaluation of results involved a collocated dataset comprising short-term forecasts from the Integrated Forecast System of the European Center for Medium-Range Weather Forecasts and satellite microwave data. The findings demonstrate that the DDA lookup tables significantly reduce discrepancies between simulated and observed values when compared to the Mie tables.

Passive instruments lack the ability to provide vertically resolved measurements of clouds and precipitation, which can be obtained by active radar instruments. However, incorporating these active measurements into data assimilation systems presents challenges due to the absence of fast-forward radiative transfer models and difficulties in error modeling. The second part of the presentation discusses the evolution, systematic evaluation, and comprehensive sensitivity analysis of an innovative, forward radar model seamlessly incorporated within the CRTM framework. The forward model relies on the hydrometeor scattering properties generated using the discrete dipole approximation technique. The model is able to compute reflectivity and attenuated reflectivity across diverse radar instruments and zenith angles as long as the instrument-specific coefficients for CRTM are available. Rigorous evaluation utilizing CloudSat measurements reveals substantial agreement between simulations and observations, contingent upon consistency between hydrometeor input profiles and measured reflectivity profiles. Current efforts include the integration of the forward radar simulator into the Joint Effort for Data assimilation Integration (JEDI) framework. This integration not only includes generating new observation formats for spaceborne radars but also adapting the Unified Forward Operator to effectively process radar measurements. This ongoing initiative provides new capabilities for the assimilation of spaceborne radar measurement, which can lead to improving the representation of precipitation and clouds in the NWP models.

Global Storm-Resolving Climate Simulations in GFDL X-SHiELD

Lucas Harris, Kai Cheng, Linjiong Zhou, and Spencer Clark

We present years-long simulations in multiple climates using the eXperimental System for High-resolution prediction on Earth-to-Local Domains, X-SHiELD. This is a configuration of SHiELD, which couples the FV3 dynamical core to a modified form of the GFS physics. X-SHiELD runs at a global 3.25-km grid spacing, explicitly representing deep convection worldwide without a parameterization. We demonstrate a number of applications specific to global kilometer-scale modeling, including global characteristics of intense and rotating convection. We also examine how extreme precipitation, mountain snowpack, and tropical waves change under warming and how km-scale models like X-SHiELD can be used for machine learning applications. Finally, we describe the possibilities, challenges, and limitations of current km-scale modeling and prospects for further X-SHiELD development.

Global Storm-Resolving Simulations with the Simple Cloud-Resolving E3SM Atmosphere Model

Peter Caldwell, Christopher Terai, and Lawrence Livermore

The Simple Cloud-Resolving E3SM Atmosphere Model (SCREAM) is E3SM's new km-scale global atmosphere model. It was built from scratch in C++ using the Kokkos performance portability library to enable efficient simulation on all of DOE's exascale computers. Using all of the world's fastest supercomputer (Frontier), it can complete 1.26 simulated years in a single wall day. This extreme resolution leads to an improved representation of clouds and storms, though some biases remain. SCREAM has a high equilibrium climate sensitivity (ECS) at 3 km horizontal resolution and a much weaker ECS at 12 km grid spacing.

Multiple Moving Nest Implementation for the Hurricane Analysis and Forecast System (HAFS)

William Ramstrom, Ghassan J. Alaka, Jr., Xuejin Zhang, and Sundararaman G. Gopalakrishnan

The Hurricane Analysis and Forecast System (HAFS) is the tropical cyclone (TC) application of NOAA's Unified Forecast System (UFS). Single storm-following high-resolution nest functionality was implemented and run operationally as HAFS v1.0 for the 2023 hurricane season. We have upgraded the code to allow multiple moving nests, each independently tracking a separate tropical cyclone. Using a regional configuration allows for more accurate forecasts of the interactions between multiple storms within a single basin. In a global configuration, we can forecast long-range interactions between storms in different basins, with nests positioned on multiple faces of the cubed sphere. Combinations of static and moving nests have also been enabled in the model to permit high-resolution nesting over a static geographical area as well as a storm-following nest.

We will discuss the algorithm used to implement multiple moving nests, the details of the parallel processing on processors assigned to each nest, and the performance efficiency of the current implementation for different numbers of moving nests. Planned experiments with a near real-time parallel basin-scale configuration with 2-3 moving nests will be described.

The GFDL Variable-Resolution Global Chemistry-Climate Model for Research at the Nexus of US Climate and Air Quality Extremes

Meiyun Lin, Larry W. Horowitz, Ming Zhao, Lucas Harris, Paul Ginoux, John Dunne, Sergey Malyshev, Elena Shevliakova, Hamza Ahsan, Steve Garner, Fabien Paulot, Arman Pouyaei, Steven J. Smith, Yuanyu Xie, Niki Zadeh, and Linjiong Zhou

We present a variable-resolution global chemistry-climate model (AM4VR) developed at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) for research at the nexus of US climate and air quality extremes. AM4VR has a horizontal resolution of 13 km over the US, allowing it to resolve urban-to-rural chemical regimes, mesoscale convective systems, and land-surface heterogeneity. With the resolution gradually reducing to 100 km over the Indian Ocean, we achieve multi-decadal simulations driven by observed sea surface temperatures at 50% of the computational cost for a 25-km uniform-resolution model. In contrast with GFDL's AM4.1, which contributed to the sixth Coupled Model Intercomparison Project at 100-km resolution, AM4VR features much improved US climate mean patterns and variability. In particular, AM4VR shows improved representation of precipitation seasonal-to-diurnal cycles and extremes, notably reducing the central US dry-and-warm bias; western US snowpack and summer drought, with implications for wildfires; and the North American monsoon, affecting dust storms. AM4VR exhibits excellent representation of winter precipitation, summer drought, and air pollution meteorology in California with complex terrain, enabling skillful prediction of both extreme summer ozone pollution and winter haze events in the Central Valley. AM4VR also provides vast improvements in the process-level representations of biogenic volatile organic compound emissions, interactive dust emissions from land, and the removal of air pollutants by terrestrial ecosystems. We highlight the value of increased model resolution in representing climate–air quality interactions through land-biosphere feedback. AM4VR offers a novel opportunity to study global dimensions of US air quality, especially the role of Earth system feedback in a changing climate. The paper is published in J. of Advances in Modeling Earth Systems (https://doi.org/10.1029/2023MS003984).

Short-Range Weather (SRW) Application and Rapid Refresh Forecast System (RRFS)

Current Status of the Rapid Refresh Forecast System

Matthew E. Pyle, Curtis R. Alexander, Jacob R. Carley, Stephen Weygandt, and Shun Liu

The Rapid Refresh Forecast System (RRFS) is a regional 3 km ensemble and deterministic forecasting system based on the Unified Forecast System (UFS) and currently targeting an implementation into NWS operations in 2025. This talk will summarize the final system configuration in place for RRFSv1, and review the final iterative development process performed earlier this year in conjunction with detailed evaluations of real-time and retrospective forecasts. Deterministic and ensemble results from this year's Hazardous Weather Testbed experiment will be shared, and the remaining challenges for RRFS to overcome ahead of a possible operational implementation will be described.

Evaluation of the Rapid Refresh Forecast System during the 2024 NOAA HWT Spring Forecasting Experiment

Israel Jirak, Adam J. Clark, David Harrison, and Jake Vancil

The 2024 NOAA Hazardous Weather Testbed Spring Forecasting Experiment (SFE2024) was conducted from 29 April – 31 May with participation from forecasters, researchers, and model developers from around the world. The focus of SFE2024 was to evaluate the FV3-based Rapid Refresh Forecast System (RRFS) and corresponding RRFS Ensemble Forecast System (REFS) as potential future operational replacements in the National Weather Service for the deterministic High Resolution Rapid Refresh (HRRR) model and the High Resolution Ensemble Forecast (HREF) system, respectively. Several deterministic and ensemble evaluations were conducted to compare the performance of the RRFS and REFS to the operational baselines and other CAM forecasts. For the deterministic evaluations, the 0000 and 1200 UTC runs of the RRFS were compared to the operational HRRR for Day 1 (i.e., valid f12-f36 and f00-f24, respectively); the 2100 and 0000 UTC runs of the RRFS were compared to the operational HRRR for the first twelve hours (i.e., valid f00-f12); and the 0000 UTC runs of the RRFS were compared to other deterministic CAMs in a blind evaluation for Day 1 (i.e., 0000 UTC runs valid f12-f36) and Day 2 (i.e., 1200 UTC runs valid f24-f48). For the ensemble evaluations, the 0000 UTC runs of the REFS were compared to the HREF for Day 1 (i.e., valid f12-f36), and various member configurations of the 1200 UTC REFS were compared to the HREF for Day 1 (i.e., valid f00-f24) and Day 2 (i.e., valid f24-f48). The subjective evaluation results of these RRFS and REFS forecasts from the SFE2024 will be discussed, offering evidence regarding the optimal ensemble configuration and overall operational readiness of the RRFS and REFS for severe weather forecasting.

Evaluations of deterministic and ensemble regional MPAS configurations for severe weather forecasting during the 2024 NOAA/Hazardous Weather Testbed Spring Forecasting Experiment

Adam Clark, Kent Knopfmeier, Yunheng Wang, Nusrat Yussouf, Larissa Reames, Israel Jirak, Louis Wicker, Pamela Heinselman, David Dowell, Craig Schwartz, Michael Duda, William Skamarock, and Patrick Burke

For the second consecutive year, regional configurations of the Model for Prediction Across Scales (MPAS) are tested for severe weather forecasting applications during the 2024 NOAA Hazardous Weather Testbed Spring Forecasting Experiment (SFE 2024), which runs from 29 April – 31 May 2024. These include three CONUS-domain, 3-km grid-spacing configurations developed at the National Severe Storms Laboratory (NSSL): (1) MPAS HT, (2) MPAS HN, and (3) MPAS RT. In these names, the last two letters denote the initialization dataset and microphysics scheme, respectively. "HT" is HRRR/Thompson, "HN" is HRRR/NSSL, and "RT" is RRFS/Thompson. All three of these configurations use the MYNN boundary layer parameterization, RUC land surface model, and RRTMG short and long wave radiation. The configurations are initialized at 0000 and 1200 UTC, with HRRR initializations running 48 h and RRFS ones 60 h. Several updates to the model physics have been made since the initial testing was conducted during SFE 2023. Additionally, a version of the RRFS Ensemble Forecast System (REFS) in which the Finite Volume Cubed Sphere (FV3) members are replaced by MPAS members will be tested. The MPAS members in this experimental REFS configuration include the MPAS RT members run at NSSL, as well as five members run at the Global Systems Laboratory (GSL) that are initialized from perturbed REFS analyses. Daily model evaluations will assess performance characteristics alongside the HRRR, HREF, RRFS, REFS, and other experimental systems. Ultimately, these tests are helping advance the use of MPAS within NSSL's Warn-on-Forecast System (WoFS), and exploring potential use within the framework of NOAA's Unified Forecast System (UFS) initiative. This talk will present preliminary results from these evaluations and highlight notable cases of interest.

Rapid Refresh Forecast System Development for Version 2

Curtis R. Alexander, Matthew E. Pyle, Stephen Weygandt, and Jacob R. Carley

The Unified Forecast System (UFS) Rapid Refresh Forecast System (RRFS) application will be NOAA's flagship hourly updating, convection-allowing deterministic and ensemble prediction system and, with its implementation, will facilitate the retirement of several operational convection-allowing modeling (CAM) systems in the present production suite. This new 3-km system will extend over a large North American domain. Through support from the UFS-R2O project along with other collaborations across the UFS CAM application team, and particularly between GSL and EMC, the first version of the RRFS has been finalized with a planned field evaluation during 2024 and potential operational implementation in 2025.

With the first version frozen, attention has been turned to development of the second version of the RRFS. Two foundational changes are being tested, including the transition to the Joint Effort for Data Assimilation Integration (JEDI) software framework and the MPAS (Model Prediction Across Scales) dynamic core. In addition to these changes, additional capabilities will include enhancements to the data assimilation design, including the use of additional observations, enhanced multiscale assimilation techniques, and coupling of earth system components. Complementing data assimilation advancements will be model physics improvements for more scale-aware adaptivity, including sub-grid cloud interactions. Forecast ensemble design changes are also being evaluated using the MPAS dynamic core and various sources of spread. This presentation will highlight many of these testing and development efforts for RRFSv2, including opportunities for collaboration across the UFS community.

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Recent Collaborative Development of the Three Dimensional Real-Time Mesoscale Analysis (3DRTMA) using the Short Range Weather Application

Terra Ladwig, Manuel Pondeca, Guoqing Ge, Ed Colon, Craig Hartsough, Matthew Morris, Ming Hu, Annette Gibbs, Sijie Pan, Raj Panda, Junjun Hu, Jim Abeles, Gang Zhao, Jim Purser, Miodrag Rancic, Curtis Alexander, Jacob Carley, Steve Weygandt, and Israel Jirak

The development of the Three-Dimensional Real-Time Mesoscale Analysis (3DRTMA) system continues at NOAA’s NCEP and GSL, with the implementation tentatively targeted for 2025. The 3DRTMA, which represents a specific application of the UFS Short-Range Weather Application (SRW App), will subsume the operational RTMA surface analysis to provide a holistic 3D analysis that meets situational awareness needs and unifies NOAA’s nowcasting analysis capabilities. The first version of the 3DRTMA is intended to be an hourly updating analysis system that uses NOAA’s Grid Point Interpolation (GSI) system configured in the 3DEnVar mode. The 3km Rapid Refresh Forecast System (RRFS) will provide the model background state, and the analysis includes many observations with a goal of representing the state of the atmosphere to the fullest extent possible, as well as earth system components (i.e., significant wave height).

Prototype versions of the 3DRTMA are under development and evaluation. The 3DRTMA has been evaluated during the NOAA Hazardous Weather Testbed Spring Forecasting Experiment (SFE) in the past several years, and an advertising of the primary 3DRTMA parallel to the NWS community with a solicitation for regular feedback from forecasters is forthcoming.

This presentation will share results from the 3DRTMA development and evaluation, use of SRW App, quantitative fit of the near surface thermodynamic fields, and qualitative feedback from developers and users.

Ensemble correlations between all-sky ABI water vapor channel radiance and MPAS ensemble state variables: Flow dependence and implications for RRFS data assimilation

Aaron Johnson, Xuguang Wang, and Andrew Shearer

Recent studies demonstrated that ensemble-based data assimilation of all-sky infrared radiance from the ABI instrument on GOES-16 and GOES-17 can improve convective scale forecasts. However, the maximum benefit of radiance observations is likely not being realized due to limitations of the ensemble-based background error covariance (BEC). In particular, under-dispersion of the background ensemble can result in situations where most ensemble members forecast a cloudy scene, but the observation indicates clear air and situations where most ensemble members forecast clear air but the observation indicates cloud. In such situations, the analysis increment can be too small and/or be physically unrealistic due to improperly using cloudy cross-variable covariances for a clear air observation and vice versa. Hybrid ensemble-variational (EnVAR) data assimilation has been shown to mitigate similar issues during the assimilation of radar reflectivity observations. However, assimilation of the ABI all-sky radiances with hybrid EnVAR requires implementation of a static component of the BEC that is consistent with the relationships between ABI radiance and meteorological processes beneath the cloudtops. The present study aims to quantify such relationships, their variability across different cases, and quantifiable aspects of their flow dependence, such as convective morphology and precipitation intensity. A dataset of 31-member MPAS ensemble forecasts initialized from GEFS analyses on ten diverse convectively active cases was generated and is used in this study. In addition to presenting the vertical correlation structures associated with different meteorological processes, implications for hybrid EnVAR data assimilation of ABI all-sky radiances will also be investigated and discussed.

Towards Explicit Effects of Forest Canopy Shading and Turbulence on Boundary Layer Ozone in UFS-SRW Air Quality Model

Irena Ivanova, Patrick C. Campbell, Paul Makar, Wei-Ting Hung, Barry Baker, Youhua Tang, Zachary Moon, Rick Saylor, Fanglin Yang, Jianping Huang, Ivanka Stajner, and Raffaele Montuoro

The chemistry of the Earth’s atmosphere close to the surface is known to be strongly influenced by vegetation. However, the widely used "big-leaf" approximation in numerical weather prediction and air quality models neglects two critical aspects of the forest environment in the description of the large-scale influence of forests on air pollution: the reduction of photolysis reaction rates and the modification of vertical transport due to the presence of foliage. The absence of these processes in three-dimensional models, including the newly operational Unified Forecast System-Short Range Weather-Air Quality Model (UFS-SRW-AQM) at NOAA, maybe a significant cause for the positive bias in surface ozone forecasts over North America in and around contiguous forested regions within the continent. Here, we first show the reductions in the tropospheric ozone in UFS-SRW-AQM through the combined effects of forest canopy shading and turbulence when applying an integrated forest canopy correction on the photolysis rates and on the vertical turbulent transport of tracers, heat, and momentum, calculated using state-of-the-art canopy datasets from remote sensing. The integrated

approach improves the near-surface ozone predictions compared to monitoring data during August 2023 (by 4.17 % for NMB and 0.64 % for NME over the US against AirNow), but the overall canopy effect is smaller compared to limited sub-canopy observations in the forest research community and compared to previous modeling efforts using an explicit canopy layer approach. Thus, we next present our progress on representing the explicit effects of foliage shading and foliage-modified vertical diffusion in the UFS-SRW-AQM on three canopy layers that closely follow methods by our collaborators at Environment Climate Change Canada, with the main difference being that in UFS-SRW-AQM the effects on the vertical diffusion of tracers are both direct (due to the modified tracers' eddy diffusivities) and indirect via the changes in meteorology (due to the modified heat and momentum diffusivities).

Incorporation of RRFS - Smoke and Dust (SD) capabilities into the UFS Short-Range Weather (SRW) Application

James Beisman, Johana Romero-Alvarez, and Keven Blackman

NOAA's Global Systems Laboratory has developed a next-generation high-resolution smoke and dust forecasting model, RRFS-SD. The NOAA EPIC program has been tasked with incorporating RRFS-SD smoke and dust simulation capabilities into the UFS SRW application. The Common Community Physics Package is utilized in both RRFS-SD and UFS SRW to provide a physics framework for the transport of smoke and dust. Many pre-processing features needed to be ported from RRFS-SD or developed. These features include: 1) ingestion of high-resolution VIIRS I-band and high-frequency GOES-16/17 fire radiative power data, 2) interpolation of fire radiative power data onto arbitrary model grids, 3) estimates of biomass burning emissions, fire heat fluxes, and hourly wildfire potential 4) extraction/generation of initial conditions and lateral boundary conditions for fields relevant to smoke and dust. The UFS SRW Application can simulate smoke and dust transport on all Tier-1 NOAA systems.

UFS Application - Oceans and Ecology

Quantifying Carbon System Resilience of a River-dominated Shelf to Hurricanes: A Case Study of Ida

Le Zhang, Z. George Xue, Kanchan Maiti, Xinping Hu, John White, and David Lagomasino

Marine carbon systems on river-dominated shelves exhibit large variability across a broad range of spatial and temporal scales. Controlled by complex physical-biogeochemical interactions, its ability to retain resilience under disturbance warrants careful investigation, especially stressed by the changing climate. The northern Gulf of Mexico (NGoM) is a typical river-dominated marine carbon system with strong seasonal cycles in organic carbon generation and sequestration, and at the same time, subject to frequent hurricane disturbance. The Mississippi-Atchafalaya River system substantially shapes the coastal carbon system by delivering freshwater, particulate, and dissolved carbon compounds and associated biogenic processes such as photosynthesis, respiration, calcification, etc. However, how these processes determine the resilience of the marine carbon system in response to eventual impacts, such as hurricanes, remains unknown. Based on a well-validated coupled physical-biogeochemical model, we present a numerical investigation of the NGoM carbon system's responses to Hurricane Ida (2021). Our results revealed that the fluvial discharge increased the resistance of the NGoM shelf carbonate system but prolonged its recovery time due to disturbance to the stratification. In addition to the control experiment, two sensitivity tests with no river (NoR) and 150% river discharge (150R) were carried out to investigate how changes in riverine influence can affect the carbon system's resilience. Future climate, characterized by stronger stratification, greater river discharge, and more frequent intense hurricanes, likely exacerbate the effects of hurricane disturbance and further reduce the resilience of the coastal carbon system in a river-dominated shelf. The 150R experiment showed that enhanced stratification due to the warm climate and elevated river discharge required a longer time to recover, and the biogeochemical processes could not return to pre-event levels within one month of the passage of a major hurricane.

Short-Term Forecast of Karenia brevis Red Tide Trajectory on the West Florida Shelf

Yonggang Liu, Robert H. Weisberg, Lianyuan Zheng, Katherine A. Hubbard, Eric G. Muhlbach, Matthew J. Garrett, Chuanmin Hu, Jennifer P. Cannizzaro, Yuyuan Xie, Jing Chen, Sebin John, and Laura Y. Liu

Blooms of the toxic dinoflagellate Karenia brevis, also known as harmful algal blooms (HABs) or red tides, occur almost annually on the west coast of Florida, killing fish and other marine life, threatening public health and adversely impacting local economies. Mitigating such effects requires improved red tide forecast capabilities on the West Florida Shelf. A short-term Lagrangian trajectory forecast tool is developed to help federal, state, and local end users monitor and manage red tides on the west coast of Florida. The automated forecast products are based on the established West Florida Coastal Ocean Model (WFCOM) and Tampa Bay Coastal Ocean Model (TBCOM) nowcast/forecast systems. Observed K. brevis cell count data are uploaded daily into the models to generate 3.5-day forecasts of the bloom trajectories both on the shelf and in the estuaries. The tracking tool displays modeled bloom trajectories at the surface and near-bottom with five categories of cell concentrations (each approximately representing an order of magnitude difference in concentration). More general and user-friendly maps are also produced to provide red tide advisories along the coast, including those integrated with satellite imagery.

Forecasting coastal flooding, including inland extremes and heavy precipitation with STOFS-3D

Fei Ye, Yinglong Zhang, Linlin Cui, Haocheng Yu, Zizang Yang, Saeed Moghimi, Greg Seroka, and Edward Myers

Co-occurring inland and coastal flood drivers pose significant threats to coastal communities. Accurate forecasts of these floods require proper treatment of the coastal transition zone where storm surge, tides, river runoff, and precipitation converge. The model mesh must accurately represent the river network connecting upstream rivers with the coast, enabling improved coupling

between coastal and hydrologic models. For a 3D operational forecast at the continental scale, the mesh size must be optimized, and the ensuing upgrades must be efficient and streamlined. This presentation demonstrates how NOAA's 3D Surge and Tide Operational Forecast System (STOFS-3D) addresses these challenges. STOFS-3D utilizes a novel semi-automated meshing tool to extract key bathymetric features from digital elevation models (DEMs). Anisotropic elements are employed to represent narrow rivers and small-scale bathymetric features such as levees, barrier islands, and the intracoastal waterway cost-effectively. The accurate representation of river morphology enables direct bathymetric interpolation without smoothing. The streamlined meshing process is crucial for continuously integrating updated DEMs into the operational forecast model. The hydrodynamic core of STOFS-3D, the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM), seamlessly handles processes from creeks to the ocean with a robust and efficient semi-implicit finite-element solver. Additionally, the operational forecast includes automatic skill assessment and product dissemination, including water levels, water currents, water temperature, and salinity.

Forecast and hindcast studies using STOFS-3D show satisfactory results for coastal and inland flooding. Sensitivity tests highlight the importance of DEM quality and accurate mesh representation for ensuring hydraulic connectivity. Recent examples demonstrate the forecast's ability to quickly ingest new DEMs to enhance the simulated river connectivity.

Improving Spatial Resolution in NOAA's Historical Flood Data with the Coastal Ocean Reanalysis

Paola Santini Dosal and Analise Keeney

NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) is the authoritative source for accurate, reliable, and timely coastal oceanographic and meteorological information. CO-OPS maintains and operates NOAA's National Water Level Observation Network (NWLON), which provides real-time and historic water level observations at over 200 locations across U.S. coastlines. While useful, NWLON-based information applies only to the immediate vicinity of each station, creating extensive gaps in both densely populated and remote coastlines where station distances can exceed 200 miles. To bridge these gaps and better serve coastal communities, NOAA's Coastal Ocean ReAnalysis (CORA) couples long-term water level observations with hydrodynamic modeling to create historical information between tide stations. CORA uses the ADCIRC model coupled with the SWAN model to simulate surface gravity wave spectra and account for time-averaged wave contributions. A skill assessment by the University of Hawaii's Sea Level Center found that CORA performed quite well when compared to NWLON observations. The ADCIRC mesh is interpolated onto a continuous geospatial grid with 500 m resolution for ongoing development. This summer, my internship with NOAA will focus on enhancing the wealth of CO-OPS' products and services. I will use data derived from CORA to construct use cases and applications for the dataset, in addition to GIS-based visualizations for educational outreach materials. This work will supplement the collection of impact graphics in the Coastal Inundation Dashboard captured through webcam observations and citizen scientists.

Forecasting Hurricane Impacts in the US East Coast and Gulf of Mexico

Maitane Olabarrieta, John C. Warner, Christopher R. Sherwood, Mark Carson, Emma Manzella, Joe Zambon, Ruoying He, George Xue, Yanda Ou, Muhamad Geonova, Arthriya Subgranon, Steven Klepac, Jim Thomson, Isabel Houghton, Martha Schonau, Luca Centurioni, Elias Hunter, Jon Moskaitis, and James Doyle

Background and Objectives: Coastal communities face significant hazards from storm surges and large waves during hurricanes, leading to severe flooding, shoreline erosion, and infrastructure damage. Accurately predicting these impacts is crucial for effective planning and the implementation of protective measures such as seawalls and flood barriers. The primary objective of the Hurricane Coastal Impacts project, funded by the National Oceanographic Partnership Program (NOPP), is to enhance the accuracy of hurricane impact forecasting systems.
Methods: This study utilizes in situ water level and wave measurements alongside forecasting systems based on the COAWST (Coupled Ocean-Atmosphere-Wave-Sediment Transport) modeling system to predict and verify water levels, waves, and associated impacts during recent hurricanes.
Results: We compared observed and predicted directional wave spectra, water levels, and impacts during two recent hurricanes: Hurricane Ian (2022) and Hurricane Idalia (2023). Results indicate that the numerical predictions are generally accurate in forecasting storm surges, provided that the hurricane path and intensity are correctly reproduced by meteorological forecasts. However, the verification of wave spectra revealed an overestimation near the hurricane's eye.
Conclusion: The application of the COAWST-based forecasting system to recent hurricanes, verified with in situ observations from drifting wave buoys, demonstrates significant advancements in predicting water levels and waves. These outcomes represent a major step forward in forecasting coastal erosion and impacts on residential buildings, enhancing the resilience of coastal communities.

Coupled Ocean Modeling Testbed (COMT) Platform for Physics and Contaminant Exchange through the River - Estuary - Ocean Continuum

Kehui Xu, Jorge Brenner, Steven F. DiMarco, Felimon Gayanilo, Courtney K. Harris, Z. George Xue, Daoyang Bao, Rongqing Du, and Zhiyun Du

One key topic area to advance coastal modeling capabilities for Integrated Ocean Observing Systems is to improve ocean prediction through coupling techniques applicable to ocean circulation, air, ecosystem, wave, and other components. A critical gap is our ability to predict exchanges across the river/ocean boundary that become of first-order importance during large storms when oceanic surges and extreme precipitation cause large fluctuations and even reversals in the flow direction. To address this, the overarching goal of our COMT project is to further develop the coupling between a state-of-the-art process-based community land surface/hydrological model and a 3D community ocean circulation model to better predict temperature, salinity, water level, buoyancy, sediment, and contaminant transport through the River - Estuary - Ocean Continuum with the consideration of both barotropic and baroclinic processes. Major tasks in this project include the coupling between ocean and hydrological models the coupling of contaminant and sediment transport modules. The coupled

model is applied to the testbed of Galveston Bay during Hurricane Harvey with a focus on how temperature, salinity, and sediment concentration impact buoyancy and contaminant transport. Multiple domains are used in this study, including one high-resolution domain focusing on the sediment and mercury dispersal in Buffalo Bayou and another one focusing on the dynamics in Galveston Bay. The relative contributions of rivers, waves, tides, and hurricanes are also compared.

Optimizing the forecasting skill of correlative estuarine species distribution models using mechanistic model output

Dante M. L. Horemans, Marjorie A. M. Friedrichs, Pierre St-Laurent, Raleigh R. Hood, and Christopher W. Brown

Predicting the change in the distribution pattern of estuarine and coastal organisms is critical for mitigating risks associated with climate change and environmental variability. Correlative species distribution models (SDMs), which relate species' abundances to environmental data using machine learning methods, are particularly useful for generating such predictions as they do not require a priori insight into the complex species' dynamics. Although correlative SDMs are typically developed using in situ environmental observations, their predictions are commonly created by forcing SDMs with environmental information generated by mechanistic models. This hybrid data-model approach can expand the temporal and spatial domain of the projections. However, it may decrease the SDM prediction skill because of biases associated with the mechanistic model output. We test the hypothesis that training SDMs using environmental mechanistic model output may enhance model prediction skills by compensating for biases in the mechanistic model. We train SDMs for seven estuarine harmful algal bloom taxa (HABs) observed in the Chesapeake Bay (U.S.A.) using both multi-decadal in situ environmental observations and mechanistic environmental output provided by a 3D hydrodynamic - biogeochemical model. Training the SDMs using mechanistic model output rather than in situ data improves the model prediction skill by more than 10 %. This demonstrates that although errors in SDM predictions can be caused by using imperfect environmental fields derived from mechanistic models, these uncertainties may be diminished by training SDMs using these same environmental fields. Our insights will be used to add multiple HABs to our Chesapeake Bay Environmental Forecasting System (www.vims.edu/cbefs).

Impact of estuarine exchange flow on multi-tracer budgets in the Salish Sea

Jilian Xiong, Parker MacCready, and Aurora Leeson

Estuarine exchange flow, which is often many times greater in magnitude than the volume transport of river discharge, regulates all aspects of estuarine biogeochemical processes. Residence time is important to biogeochemistry, but this can be influenced by much more than the exchange flow, depending on the tracer in question. In the study, we analyzed realistic simulations from a coupled physical-biological model to quantify the volume-integrated budgets of heat, total nitrogen (TN), and dissolved oxygen (DO) in the Salish Sea and its inner basins due to net exchange flow (influx - outflux) and other processes influencing each tracer. The Salish Sea is a large, floral estuary in the US and Canadian Pacific Northwest. The model, LiveOcean (MacCready et al., 2021, JGR Oceans), was validated with extensive hydrographic and moored observations. The seasonal variations in net budgets are primarily regulated by air-sea heat flux (for heat), exchange flow (for TN), and combined air-sea flux, photosynthesis, respiration, and exchange flow (for DO). The exchange flow exports heat and DO all year round except for occasions when intrusions of the surface warm and oxygen-rich water from the coast bring in heat and DO. The amount of heat/DO export by the exchange flow approximates heat/DO import from the atmosphere/photosynthesis/respiration. Exchange flow dominates TN imports in the summertime and TN exports in the wintertime. The results allow an understanding of which processes are important for forecasting and management of hypoxia and other properties.

Coupled Hydrodynamic-Biogeochemical Forecasting using the Chesapeake Bay Environmental Forecasting System

Aaron J. Bever, Marjorie A.M. Friedrichs, and Pierre St-Laurent

Real-time nowcasts (current conditions) and 2-day forecasts of environmental conditions in the Chesapeake Bay have been continuously available online via the Chesapeake Bay Environmental Forecasting System (CBEFS) since February 2017. The automated forecasts are conducted using a 3D coupled hydrodynamic-biogeochemical model that runs daily. The forecast model code is routinely updated to ensure the forecast model stays current with the continuously developed hindcast research version. Forecasts include salinity, water temperature, pH, aragonite saturation state, harmful algal blooms, Vibrio vulnificus, sea nettles, dissolved oxygen, hypoxic volume, waves, and water clarity. Per stakeholder request, real-time model-data comparisons for salinity, temperature, water level, and waves are automatically conducted daily. Riverine freshwater inflows, temperature, and salinity inputs to the forecast system are specified relatively accurately using observed data and relationships developed by comparing USGS gauge data to the Chesapeake Bay Program Phase-6 Watershed model (CBPWM). Artificial Neural Networks (ANNs) were developed based on output from the CBPWM for the additional inputs necessary for biogeochemical modeling (e.g., nutrients, inorganic suspended solids). A quasi-data-assimilation method is used to improve non-tidal water surface elevation by forcing it at the mouth of the Bay. Graphics and information tailored to stakeholder requests are updated daily on the VIMS CBEFS webpage (www.vims.edu/cbefs), and detailed 3D information is available on the MARACOOS Chesapeake Bay OceansMap webpage (https://oceansmap.maracoos.org/chesapeake-bay/). Overall, this coupled hydrodynamic-biogeochemical forecast system includes state-of-the-art science and provides a wealth of hydrodynamic and ecological information to a wide range of stakeholders throughout the year.

Forecasting the Impacts of Lake Operations on the Estuarine Hydrodynamics and Pollutant Transport

Maitane Olabarrieta, Scott Lee Young, Jiahua Zhou, Hithaishi Hewageegana, Jose Maria Gonzalez Ondina, Jorge Armando Laurel, David Kaplan, and Nicholas Chin

Background and Objectives: Water quality in an estuary is directly influenced by physical forcings (e.g., freshwater discharge and wind forcings) which modify water quality by altering the fluxes and concentrations of different chemical constituents and changing residence times.

Methods: Motivated by the current urgency for improved water quality-related coastal hazard predictions, we have developed and verified a system based in the COAWST model that forecasts the main physical parameters that affect the estuarine circulation and pollutant pathways (water levels, water temperature, salinity, and the 3D velocity field).
Results: The current version of the system is being applied and tested in the Caloosahatchee River Estuary (CRE) and the St Lucie Estuary (SLE). These estuaries are located on the west and east coasts of the Florida peninsula, respectively. They are connected to Lake Okeechobee through a series of dams and canals. Freshwater discharges from Lake Okeechobee into the CRE are frequent and highly regulated. However, direct discharges from the lake into SLE are less frequent and occur when lake water elevations are extreme. Hydrodynamics and pollutant transport pathways differ for each estuary. We describe the development of the forecasting system, and we analyze the influence of freshwater discharges from Lake Okeechobee on salinity, water temperature patterns, and the overall circulation in the estuaries. The forecasting system has been used to determine the impacts of freshwater releases from Lake Okeechobee and to track algal blooms within the CRE.
Conclusion: In conclusion, the COAWST-based forecasting system represents a significant advancement in estuarine water quality management, offering precise predictions and analyses that support effective decision-making and environmental stewardship.

Great Lakes Earth System Model using FVCOM+CICE Models: Hindcast (1979-2021) and Future Climate Projections (1979 - 2100)

Jia Wang, David Cannon, Ayumi Fujisaki-Manome, Abby Hutson, Jame Kessler, and Andrea VanderWoulde

As with many of the world's largest lakes, the Laurentian Great Lakes have undergone significant changes over the last century, with substantial warming driving increases in summer surface temperatures and decreases in seasonal ice cover. While significant effort has been made to characterize changing surface conditions, changes in subsurface conditions, including stratification, heat content, and vertical mixing, remain largely unexplored despite their importance in regulating biogeochemical cycles in the lakes. In this study, we investigate historical and projected changes in thermal structure and ice cover in the Laurentian Great Lakes between 1979 and 2100 using a coupled hydrodynamic-ice model (FVCOM+CICE). The model is forced using a combination of reanalysis products (NARR) and global climate models (CMIP6: GFDL-ESM4, MIROC6, ECEarth3), and future projections are explored under three shared socioeconomic pathways (SSP1-2.6, SSP2-4.5, SSP5-8.5). Analysis revealed significant increases in surface (0.4 – 0.6 ℃/decade) and subsurface (0.1 – 0.4 ℃/decade) temperatures over the historical period (1979 – 2021), as well as notable increases in the strength and duration of summer stratification (1 – 5 days/decade). This warming led to declines in both annual average ice cover (1 – 8 %/decade) and ice volume (0 – 3 km3/decade), along with a general weakening of stable inverse winter stratification. Future climate projections (2014 – 2100) highlight continued warming trends, with a 50 – 80% reduction in annual maximum ice cover under all scenarios by the end of the century. Simulations suggest that extreme warming (SSP5-8.5) will lead to 3 – 8 ℃ increases in summer surface temperature by 2100, resulting in mixing regime shifts in Lakes Michigan, Huron, and Ontario (dimictic to warm monomictic). These shifts would have significant consequences for Great Lakes ecosystems, affecting fisheries, water quality, and nutrient cycling across the region.

A numerical study of eastern oyster (Crassostrea Virginia) larvae growth and dispersal in Barataria Bay, Louisiana

Zhengchen (John) Zang, Z. George Xue, Shaye E. Sable, Megan K. La Peyre, Timothy A. Stephens, David C. Lindquist, Kenneth A. Rose, and Yanda Ou

The Eastern Oyster is an important bivalve species in coastal Louisiana due to its role as an ecosystem engineer and its high commercial value. Oyster biomass accrues based on larval growth, settlement, and recruitment to the population, and the influence of environmental stressors on larval growth, mortality, and dispersal critically controls the success of larval settlement and resulting oyster biomass. We used the Regional Ocean Modeling System (ROMS) for Barataria Bay to provide the physical fields as inputs to the oyster larval transport, growth, and mortality model of Dekshenieks et al. (2000). Coupled model simulations were designed to examine the spatiotemporal pattern of oyster larvae dispersal and to explore the primary environmental drivers affecting oyster larvae pelagic growth, survival, and settlement. Low salinity during the spring spawning season is identified as the primary factor resulting in slowed larval growth and failure for larvae settlement. The idealized 0-D oyster larvae growth simulations indicate that increased salinity variability can further exacerbate the negative impact of water freshening on larvae growth. Given the profound impacts of climate change and anthropogenic disturbances on physical environments and water quality in Barataria Bay, a better understanding of the response of oyster larvae physiology to concurrent and spatial-temporally dynamic multi-stressors is critical in forecasting the effectiveness of future restoration actions and for developing adaptive management strategies.

Simulating ocean acidification in the Northeast U.S. region using a fully coupled three-dimensional biogeochemistry and ecosystem model

Lu Wang, Changsheng Chen, Joseph Salisbury, Robert C Beardsley, and Jackie Motyka

The Northeast Biogeochemistry and Ecosystem Model (NeBEM) was developed by integrating the Northeast Coastal Ocean Forecast System (NECOFS) with the European Regional Seas Ecosystem Model (ERSEM). Process-oriented studies suggested that the changes in Ωa were predominantly manipulated by DIC variability in the Middle Atlantic Bight (MAB) and Georges Bank (GB), and DIC plus TA in the Gulf of Maine (GOM) and Scotian Shelf (SS). Over the outer shelf, the total DIC amount was predominantly replenished by the onshore slope-water inflow. The model suggested that warm core rings (WCRs) and eddies (WCEs) played an essential role in enhancing the slope-water transport to the shelf, which accounted for a ~35% increase in the DIC flux. The distribution of the simulated nTA:nDIC ratio varied from region to region. The biogeochemical variability of TA and DIC was primarily controlled by the nitrification/denitrification process in the GOM and MAB, the air-sea

CO_2 exchange in the open sea, and the multiple biogeochemical processes in SS and GB. Increased atmospheric CO_2 loading against global warming will enlarge the yearly minimum Ωa area and increase the probability of having the minimum Ω_a to occur earlier. Warming will increase the probability of having the yearly lowest Ω_a to occur in the bottom layer in the GOM and MAB. Due to the cancellation of global warming and increased atmospheric CO_2 loading effects, the TA and DIC variability will still be controlled by the nitrification/denitrification process in the GOM and MAB and multiple biogeochemical processes in SS and GB.

Detangling the Elevated Sea-surface pCO2 in a River-Dominated Continental Shelf Using a High-Resolution Regional Ocean Model

Ogooluwa Adeagbo, Z. George Xue, Le Zhang and Yanda Ou

Over the past two decades, global warming has led to increasing sea surface temperatures in the Northern Gulf of Mexico, which, together with the elevating Mississippi River discharges, can potentially affect the regional air-sea CO_2 flux trend. Grasping the mechanisms driving these air-sea CO_2 flux changes is imperative for understanding their ramifications on regional carbon cycling. We recently accomplished a 20-year coupled ocean-carbon model hindcast for the Gulf of Mexico using the Regional Ocean Modeling System (ROMS). The model's robustness is verified via remote sensing, underway measurements, and CO_2 buoy records. The model hindcast revealed a trend of increasing pCO_2 and decreasing pH. We present results from four series of sensitivity tests aiming to untangle the mechanism behind the elevated pCO_2 level of the river-dominated shelf water: a benchmark "control run," a "baseline" run assuming no warming effects, a "no-river" run to examine the contribution from the Mississippi River discharges, and a "no-bio" run to isolate impacts from biogeochemical processes in the ocean. Our findings revealed that sea-surface pCO_2 had been steadily rising significantly over the past 20 years, with a rate of 1.19 µatm/yr ("control run,"). The increasing trend will be slightly increased (1.76 µatm/yr) if no river inputs are included. When biogeochemical processes are excluded, shelf pCO_2 increasing trend will be further exacerbated to 2.08 µatm/yr. These preliminary results suggest that elevated biological processes can counteract the potential increase in sea surface pCO_2 induced by riverine chemical inputs in river-dominated shelves.

UFS Application - Land/Surface Models

UFS Land: Facilitating Land Model and Data Assimilation Development With a Community Focus

Michael Barlage

A collaborative effort is currently underway to develop NOAA's next-generation Unified Forecast System (UFS) framework. Within the UFS, there are multiple major earth system components, including the atmosphere, oceans, and land. UFS applications span local to global domains and predictive time scales from sub-hourly to seasonal. These wide-ranging applications pose challenges and provide opportunities for the development and evaluation of UFS land components.

This presentation will discuss ongoing efforts in addressing and coordinating within UFS: land model physics advances both within the CCPP physics repository and through a separate land component and a JEDI-based land data assimilation capability.

To facilitate UFS community engagement and accelerate R2O transition, a hierarchical testing approach is being developed that involves a spectrum of LSM-only simulations, a single-column coupled land-atmosphere modeling system, and coupled simulations both without and with a prognostic ocean. This approach is used to isolate and quantify the impacts of individual components before systematically increasing complexity and inherently introducing non-linear, difficult-to-track interactions. This provides a direct pathway for candidate models to diagnose problem areas in the model process chain, which enables the identification of specific parameterizations that are the source of poor model performance.

The presentation will focus more deeply on two ongoing efforts in UFS Land development with a community focus: the creation of a component land model capability in UFS and the creation of a JEDI-based land data assimilation capability. A successful UFS land effort will expedite community involvement in land model development and contribute to looking beyond the land surface model as a boundary condition by providing land surface process-level information to expanding user communities.

UFS forecast model evaluation and improvement for S2S hydrometeorological prediction in the Western United States

Andrew Newman, Yifan Cheng, Andrew Bennett, Arezoo RafieeiNasab, Thomas Enzminger, Kathryn Newman, Ethan Gutmann, and Andrew Wood

The land states and fluxes greatly influence land-atmosphere coupling in many regions. As Noah-MP will become the land surface model in next-generation UFS applications, it is essential to ensure that the model can simulate high-fidelity land states and fluxes in the coupled modeling system. In this study, we specifically focus on optimizing the parameters in Noah-MP to better simulate hydrometeorology as well as terrestrial hydrology in the coupled system, with an emphasis on precipitation, snow, soil moisture, and streamflow. Typically, uncoupled land model optimization is performed using data atmospheres, which ignores the coupled land-atmosphere feedback and, therefore, compromises the usability of optimized land parameters in coupled systems. To address this challenge, we propose to use the single-column model (SCM) in selecting sensitive parameters and model optimization because the SCM allows rapid iteration of test configurations with at least 1-D land-atmosphere interactions. In addition, we aim to reveal the differences in sensitive parameter selection by conducting sensitivity experiments using both standalone Noah-MPand in the SCM. We present an initial testbed where we have configured the UFS land model to 95 Ameriflux sites to perform model experiments. We diagnose initial results by quantifying the biases in energy and hydrologic fluxes using the default parameter sets using an information theoretic approach, which provides novel insight into process-level biases which can be improved via optimization.

Evaluating snow and soil simulations in the unified forecast system (UFS) short-range weather system

Siwei He and collaborators

It has been demonstrated that land-surface conditions play a critical role in numerical weather prediction (NWP) models. Deficiencies in land-surface representation can lead to meteorological biases in weather forecast models. The Rapid Refresh Forecast System (RRFS) is NOAA's next-generation short-range regional weather prediction model. In parallel, a forecast system focused on predicting atmospheric rivers (ARs) affecting the Western U.S. is being developed, which is named UFS-AR. Noah-MP is the land surface model being tested both in RRFS version 2 and UFS-AR. Therefore, evaluating its capability to simulate land-surface properties, such as snow and soil, is essential. This study aims to illustrate the advantages and identify deficiencies in the Noah-MP land surface model. We will utilize multiple data sources, including both in-situ observations and remote sensing products, to evaluate Noah-MP's performance in simulating snow and soil processes at the spatial and temporal dimensions. The results will offer valuable guidance for further development and improvement of the Noah-MP land-surface model.

Enhancing snowpack physics in the Noah-MP land surface model

Cenlin He, Ronnie Abolafia-Rosenzweig, Tzu-Shun Lin, Michael Barlage, Fei Chen, and David Gochis

Noah-MP is a key land component of NOAA UFS. Based on previous studies, there are still nontrivial biases in capturing mountain snowpack characteristics in both offline and online Noah-MP simulations. Therefore, in this presentation, we will summarize a series of key process-level snowpack physics enhancements we have recently developed in Noah-MP in order to improve the simulation of critical mountain snowpack features and near-surface meteorology in UFS. Our model improvements cover processes of snowpack compaction, snow albedo, snow cover, and canopy turbulence. In the future, we plan to improve other key snow processes such as canopy-snow interception, and to test these snowpack improvements in a coupled UFS/Noah-MP system to assess the snow feedback to the atmosphere and near-surface meteorology.

Current Status and Plan of KIM/Noah-MP Coupled Model

Myung-Seo Koo, Hyeon-Ju Gim, Mee-Hyun Cho, Jaeyoung Song, Yonghwan Kwon, Sanghee Jeon, and Kyung-Hee Seol

The Korean Integrated Model (KIM) was developed for global weather forecasting in the first Phase (2011–2019) of the Korea Institute of Atmospheric Prediction Systems (KIAPS), and it has become the operational model of the Korea Meteorological Administration (KMA) since April 2020. To improve the predictability beyond two weeks, it is necessary to better represent the physical process and interaction between the atmosphere and surface. Therefore, the KIAPS Phase 2 project (2020–2026) aims to newly couple the ocean/sea-ice/wave/river-routing models to the operational KIM. In addition, the current Noah land surface model (LSM) will be replaced with Noah-Multiparameterization (Noah-MP) LSM to enhance the bio-physical and hydrological complexity. Various versions of Noah-MP have been coupled to KIM (KIM/Noah-MP), which was evaluated in comparison with KIM/Noah on medium-range weather forecasts and long-term simulations. The recent version of KIM/Noah-MP is based on the modernized/refactored Noah-MP version 5, and it was highly optimized within the KIM framework. In the workshop, the current status and future plan will be presented in detail.

Cross-Cutting - Data Assimilation

Coupled Land-Atmosphere Data Assimilation Within the Joint Effort for Data Assimilation Integration with the Unified Forecast System and the Impact on Near-surface Weather Forecasting

Zhaoxia Pu and Kian Huang

Soil moisture plays an essential role in land-atmosphere interactions and significantly influences near-surface weather conditions. Accurate representation of soil moisture and its interaction with the atmosphere in numerical weather prediction (NWP) models is essential for numerical forecasts of near-surface atmospheric conditions. This study develops a coupled land-atmosphere data assimilation framework using the Joint Effort for Data Assimilation Integration (JEDI) and NOAA's new-generation Unified Forecast System (UFS) at a regional scale to assimilate soil moisture and atmospheric variables. Results demonstrate the benefits of coupled soil moisture and near-surface data assimilation for short-range weather forecasts, including quantitative precipitation forecasts. Because of advances in understanding the role of vertical localization in strongly coupled land-atmosphere data assimilation, the implementation and tests presented in this paper create a solid foundation for coupled land-atmosphere data assimilation using JEDI and UFS.

A prototype of convection-permitting data assimilation system with regional MPAS-JEDI: hybrid-4DEnVar and assimilation of hourly ABI radiances

Zhiquan (Jake) Liu, Tao Sun, Junmei Ban, Ivette Baños, Byoung-Joo Jung, and Robert Nystrom

MPAS-JEDI is a new-generation global-/regional-unified community data assimilation (DA) system for the Model for Prediction Across Scales – Atmosphere, based upon the Joint Effort for Data assimilation Integration (JEDI) framework. MPAS-JEDI's analysis is done directly on the MPAS unstructured grid and can be applied seamlessly to MPAS uniform and variable-resolution meshes, making it convenient to use and configure for various applications with deterministic and/or ensemble DA algorithms. A prototype DA system at a grid spacing of 3.7 km has been implemented with regional MPAS-JEDI, which features 6-hourly cycling dual-resolution hybrid-4DEnVar with the assimilation of hourly ABI radiance data. The hourly ensemble input of hybrid-4DEnVar comes from MPAS downscaled ensemble forecasts (at a grid spacing of 15 km) from the 30-member GEFS analyses. The system's performance on cloud and precipitation forecasts over the Eastern US is evaluated using ABI radiance data and Stage-IV rainfall observations for a 2-week period in July 2023 with active convective storms. The impact of using hybrid-4DEnVar on performance metrics will be demonstrated by comparing it to its 3D counterpart, and the benefits and challenges of assimilating clear-sky and all-sky ABI radiances will be presented. Directions for further improvements to the system will also be discussed. Lessons learned from this prototype system will be useful for the development of NOAA's Rapid Refresh Forecast System Version 2 (RRFS-v2), which adopts MPAS-A and MPAS-JEDI.

JEDI-Based Atmospheric Composition Data Assimilation Progress at NWS

Cory R Martin, Hyundeok Choi, Jianping Huang, Daryl Kleist, Jeff McQueen, Ivanka Stajner, Andrew Tangborn, Yaping Wang, Hongli Wang, and Jérôme Barré

Current estimates of annual mortality from poor air quality are over 100,000 per year in the United States, far exceeding all other weather hazards combined, which are lower than 600 per year. At NOAA's National Weather Service, progress is being made to improve global and regional air quality and aerosol forecasting through collaborative efforts on both model improvements and enhanced data assimilation (DA) capabilities. The Global Ensemble Forecast System (GEFS) includes a version of the Goddard Chemistry Aerosol Radiation and Transport (GOCART) scheme coupled with the Finite-Volume Cubed Sphere (FV3) dynamical core. GEFS currently provides 5-day forecasts of aerosols from a single control member, and the upcoming upgrade plans to have longer aerosol forecasts from all members. The Air Quality Model (AQM) is an upgraded regional air quality prediction system using the Limited Area Model (LAM) version of FV3 coupled with the Community Multiscale Air Quality (CMAQ) model to provide inline atmospheric chemistry.
Here, we present an overview of our current data assimilation activities for both global and regional atmospheric composition applications using the Joint Effort for Data assimilation Integration (JEDI) software suite. Results from experiments supporting the transition to operations of global aerosol DA will be presented with a focus on Variational Bias Correction, usage of observations (quality control, thinning vs superobbing), and background error covariance estimation. Additionally, results of both trace gas (nitrogen dioxide retrievals) and aerosol (satellite aerosol optical depth and surface particulate matter) assimilation in the regional AQM will be shown. Finally, longer-term plans will be outlined, including simultaneous state and emissions updating through strongly coupled DA with JEDI.

Assimilating real observations with ML emulators

Jeffrey S. Whitaker and Laura Slivinski

There has been a recent surge in development of accurate global atmospheric model emulators, including full ML model emulators (FourCastNet, PanguWeather, GraphCast, GenCast) and hybrid models (NeuralGCM). Evaluation of these models has generally been focused on forecasts, mostly with 1-10 day lead times. However, forecasts rely on accurate initial conditions that, in the context of operational weather prediction, generally come from a cycled data assimilation system. While there have been a few DA studies that utilize emulators, these studies have focused on synthetic observation experiments. Here, we present what is, to our knowledge, the first study of a DA cycling system using pure hybrid ML models to assimilate real observations. A reduced observation network consisting of only surface pressure observations is assimilated into several popular emulators, including NeuralGCM and PanguWeather, using an ensemble Kalman filter. This experiment design provides an informative test case since the performance of the DA system relies on accurately capturing ensemble covariances to update unobserved state variables, where the observed variables are not part of the loss function used in the optimization process. NeuralGCM is a natural model to test in this context since it includes a publicly available stochastic model that may be more appropriate for an ensemble DA system. Results will be presented from experiments that cycle with emulators, including neuralGCM, and compared to those from experiments that cycle with a coarse-resolution version of a fully physical model, NOAA's operational Global Forecast System. Preliminary conclusions and lessons learned will be discussed.

The Joint Effort for Data assimilation Integration (JEDI): Status and Updates

Yannick Trémolet

The long-term objective of the Joint Effort for Data assimilation Integration (JEDI) is to provide a unified data assimilation framework for research and operational use for all components of the Earth system and for different applications. The objectives are to reduce or avoid redundant work between government agencies and within the community and increase the efficiency of research and the transition from development teams to operations. It is planned for operational implementation by the JCSDA partner agencies in the coming years.

In this project, the concept of models is clearly separated from the observation handling with clear interfaces. The data assimilation algorithms are themselves separated from the model space and observation space components. With this separation of concerns, it is easier for specialists in each area to contribute without unexpected consequences in other parts of the system and to work in parallel on each component. As the system is maturing, applications are being put in place to start validation in realistic configurations. In this talk, an overview of the system and the current status of the implementation and testing of the various data assimilation components and for models such as the UFS and MPAS will be presented.

Hurricane Inner-core Data Assimilation Upgrades for HAFSv2 and 2024 Real-Time Parallel Experiments

Xu Lu, Jing Cheng, Yonghui Weng, Bin Liu, Zhan Zhang, Avichal Mehra, and Vijay Tallapragada

Recently, several major DA-related upgrades have been implemented into Hurricane Analysis and Forecast System version 2 (HAFSv2) to improve hurricane analysis and prediction. For example, Scale-Dependent Localization (SDL) applies different localization length scales simultaneously based on the scales of weather systems, managing the multi-scale interactions in the complex evolution of hurricanes. Enhanced Atmospheric Motion Vectors (AMVs), key supplementary observations over the open ocean, are also assimilated for hurricane DA. These upgrades have shown neutral to positive impacts on overall track and intensity forecasts. Additional DA-related developments on top of HAFSv2 include the storm-following three-dimensional Incremental Analysis Update (3DIAU) after DA and the hydrometeor update during DA. The 3DIAU is a post-DA approach that addresses model adjustment issues such as spin-down or spin-up, while the hydrometeor update is crucial for future DA of all-sky satellite radiances or radar reflectivity observations. These capabilities are considered for testing in the upcoming 2024 HAFSv2.0.1 real-time parallel experiments. Further capabilities are being considered as we transition the HAFS DA system from GSI to JEDI. More detailed results and discussions on the improvements in DA from these new capabilities will be presented.

Rapid Refresh Forecast System Data Assimilation System: version 1 overview and version 2 development status

Ming Hu, Shun Liu, David Dowell, Chunhua Zhou, Ting Lei, Haidao, Lin, Xiaoyan Zhang, Donald Lippi, Sho Yokota, Ruifang Li, Jacob R. Carley, Terra Ladwig, Curtis Alexander, Stephen Weygandt, Jaymes Kenyon, Eric James, Hongli Wang, and Sijie Pan

The Rapid Refresh Forecast System (RRFS) is NOAA's next-generation regional convection-allowing high-frequency cycling ensemble data assimilation and forecast system for the National Weather Service. The RRFS is being developed collaboratively by EMC and GSL, as well as the greater Unified Forecast System (UFS) community. The RRFS features a North American domain with a 3 km horizontal grid spacing. Its data assimilation system (RDAS) includes coupled hourly deterministic and ensemble data assimilation cycles. This talk will overview major features of the RRFS version 1 data assimilation system, including GSI-based hybrid 3D ensemble-variational analysis and EnKF ensemble analysis, moderately coupled atmosphere and soil data assimilation, non-variational cloud analysis, spin-up cycles and large-scale blending, analysis schemes of surface, radar-reflectivity, lightning, and satellite radiance observations.

While the RRFS version 1 is under final evaluation and testing toward its operational implementation, the development of the 2nd version of the RRFS has started. The RRFS version 2 will use the Joint Effort for Data Assimilation Integration (JEDI) as its analysis component. Ongoing assessment and integration of JEDI within the RDAS framework for RRFSv2 will be introduced.

Recent Development of JEDI-based Data Assimilation for GFS and RRFS at OU MAP Lab

Yongming Wang and Xuguang Wang

OU MAP lab, in close collaboration with NOAA EMC and OAR labs, has made extensive efforts to advance NOAA's global and regional operational data assimilation (DA) systems within the GSI-based framework in the past decade. OU MAP lab continues contributing to the advancement of these operational DA systems by performing DA research and development based on the Joint-Effort for DA Integration (JEDI) framework. In this meeting, we will present our recent progress of the DA developments for the JEDI-based EnVar and EnKF by the OU MAP team in collaboration with NOAA and JCSDA.

For the global DA and forecast system, the following efforts are being made. 1) We develop a cycled EnVar and EnKF DA workflow incorporating JEDI and FV3 components in collaboration with EMC and JCSDA. 2) The simultaneous multiscale DA method using model space scale dependent localization (SDL) within the GSI-based EnVar context is migrated to the JEDI-based EnVar. The efforts being made for the regional Rapid Refresh Forecast System (RRFS) include 1) a cycled EnVar and EnKF DA workflow incorporating JEDI and FV3LAM/MPAS-A components, 2) extending the JEDI/IODA interface to read in the MRMS radar reflectivity observations, 3) developing the multiscale DA capability for the assimilation of radar and in-situ observations, 4) examining the flow-dependent localization method for radar DA, and 5) conducting initial tests to explore the impact of these aforementioned developments and to compare the performance among different models (FV3LAM vs. MPAS-A) and DA frameworks (JEDI vs. GSI).

Impact assessment of the Tomorrow.io Microwave Sounder (TMS) constellation on the forecast

Jonathan J. Guerrette, Ryan E. Honeyager, S. Joseph Munchak, Stylianos Flampouris

The Tomorrow.io Microwave Sounder (TMS) satellite constellation is set to begin launching this year. This constellation will include up to 18 satellites, positioned in a combination of sun-synchronous and 45-degree inclined orbital planes, providing sub-hourly global revisit rates. The onboard instrument is an enhanced version of the TROPICS (Time-Resolved Observations of Precipitation Structure and Storm Intensity with a Constellation of Smallsats) design, featuring an onboard calibration target and improved digital signal processing.

Pre-launch preparations involved simulating TMS observations using the Community Radiative Transfer Model (CRTM) and an internal radiance simulation package (RadSim). These simulations supported retrieval studies and Observation System Simulation Experiments, running 6-hour data assimilation and forecast cycles over two months at a 13 km resolution on a cubed-sphere grid. These experiments based on the Unified Forecast System have yielded several significant outputs that allow the impact assessment of the TMS constellation in various configurations. To reach this level, the instrument configurations for the Joint Effort for Data assimilation Integration (JEDI) system have been developed, and the quality control and observation error models for TMS in clear-sky and all-sky conditions have been established. These pre-launch studies prove that the assimilation of TMS radiances improves precipitation characterization and water vapor-dependent fields. In this presentation, we discuss the forecast impacts when TMS data is assimilated in clear-sky and all-sky configurations and provide estimates on the benefits of increasing the number of TMS satellites.

Nonparametric Data Assimilation Directions for the UFS: From Thunderstorms to Ice

Jonathan Poterjoy

Most data assimilation techniques used for environmental models have a Bayesian interpretation. If we choose a prior distribution for prior model variables (typically a Gaussian) and a likelihood function based on assumed observation uncertainty (also typically a Gaussian), we can arrive at numerical methods that either solve for parts of the posterior distribution or draw samples from it.

This presentation highlights new developments and model implementations that adopt "nonparametric" choices for priors and likelihoods—meaning no specific distribution shape is assumed. Moving beyond parametric assumptions has many practical advantages for the diverse modeling applications within the UFS. Nonparametric choices for the prior can lead to greater physical fidelity in ensemble members updated during data assimilation and used to initialize dynamical models. Nonparametric choices for the likelihood can lead to more optimal use of novel datasets (e.g., assimilating images instead of point measurements) and the removal of ad hoc quality control algorithms. In addition to describing new research directions on this topic, we will survey progress made for several UFS applications, with a focus on convective-scale modeling, hurricanes, and coupled sea ice-ocean modeling.

Emerging Technologies: AI/ML

An Evaluation of AI-Generated Global NWP Emulators in the NOAA HWT Spring Forecasting Experiment

David Harrison, Tim Supinie, Israel Jirak, and Adam Clark

Recent advances in machine-learning technology have enabled private sector entities to explore and develop AI-generated global weather models that emulate traditional global numerical weather prediction (NWP). These AI NWP emulators have been shown to perform statistically equal to or better than the ECMWF's Integrated Forecast System on a variety of fields while requiring significantly less computational time and resources. While these objective results are promising, it is unclear how the AI NWP emulators might compare to traditional global NWP when operationally applied for severe weather forecasting. To that end, three AI-generated global NWP models were subjectively evaluated as part of NOAA's 2024 Hazardous Weather Testbed Spring Forecasting Experiment (SFE). Publicly released versions of NVIDIA's FourCastNetv2, Huawei Cloud's Pangu-Weather, and Google's GraphCast were run at the Cooperative Institute for Research in the Atmosphere (CIRA), and global forecasts were produced at 0.25° grid spacing out to 10 days. Around 150 virtual and in-person participants of the 2024 SFE subjectively evaluated the AI NWP emulators by assessing the prognostic 500- and 850-mb geopotential height and wind, 2-m temperature, and 6-h QPF (available for GraphCast only). These forecasts were compared to the operational GFS forecast at 7-day lead times and evaluated against GFS analysis and the Multi-Radar/Multi-Sensor QPE analysis. Forecast soundings were also derived for each AI model, and participants provided feedback on the vertical structure and physical consistency of the model forecasts. This presentation will detail the design of the AI NWP emulator evaluation and provide preliminary results from the experiment.

WoFS-Cast: A machine learning model for high-resolution storm-scale weather forecasting

Montgomery Flora and Corey Potvin

Developing machine learning models to compete with 3D physically-based numerical weather prediction (NWP) is a burgeoning area of research. Almost all current applications, however, are trained on global ERA5 data, which is too coarse for storm-scale modeling. Recently, we refactored Google's GraphCast framework for limited-area modeling at storm scales. This framework (known as WoFS-Cast) is trained on multiple years of Warn-on-Forecast System (WoFS) data, an 18-member convection-allowing ensemble with forecast output available every 5 minutes. For this initial effort, we aim to emulate the existing WRF-based forecast system rather than train on storm-scale analyses. Model evaluations include both grid-based and object-based verification. The environmental fields are reasonably well predicted for lead times up to 2 hr, whereas intermittent fields get blurred as expected. Major scientific and technical challenges exist (e.g., blurriness, GPU resources). In this presentation, we will discuss our plans for further developing this AI-NWP emulation, including generative AI approaches (e.g., diffusion).

Toward Basic Characterization of Machine Learning Methods Applied to Computational Geophysical Flows

Jorge E. Guerra and Daniel Abdi

As we encounter a moment of rapid adoption of Machine Learning (ML) as an alternative toolkit for the forecasting of environmental systems, questions remain about the interpretability and physicality of end-to-end ML forecasting engines. In order to continue an effort to bring greater interpretability and adoption of ML techniques, we present examples of direct relationships between simple (shallow) ML regression models and known results from applied numerical analysis. Our approach is focused on generating pure training data in the sense that it comes from common one-to-one mathematical mappings such as elementary functions/function compositions and their analytical derivatives over a discretized 1-D domain. We hypothesize that an ML regression model presented with such data must converge to an object that approximates discrete differentiation operators known from the literature. We present a few examples of such objects re-discovered in this context, starting with a simple 5-point convolutional layer model reproducing the common 4th order centered finite difference formula. Furthermore, we investigate the influence of grid resolution on the regression/learning process and establish proper convergence criteria for such simplified models. Lastly, we outline this approach as a complementary means of discovering potentially novel numerical differentiation methods with specific properties.

Training GraphCast with NOAA's GDAS Reanalysis Data for Global Weather Forecasting

Sadegh Tabas, Jun Wang, Linlin Cui, Matt Long, and Jacob Carley

Accurate medium-range global weather forecasts serve as a critical cornerstone in informing decision-making processes across various societal and economic sectors. In recent years, the landscape of weather prediction has undergone a profound transformation with the emergence of machine learning (ML)-based models, showcasing unprecedented efficacy compared to traditional numerical weather prediction (NWP). These cutting-edge models leverage diverse ML architectures, such as Graph Neural Networks (GNNs), Convolutional Neural Networks (CNNs), Fourier Neural Operators (FNOs), and Transformers. Among these advancements, GraphCast, a pioneering

ML-based approach developed by Google DeepMind, has received particular attention in the community. Leveraging direct training from reanalysis data, GraphCast expedites global weather predictions across numerous variables within mere minutes. Impressively, GraphCast forecasts show improved accuracy in predicting severe weather events, including phenomena like tropical cyclones, atmospheric rivers, and extreme heat. However, the efficiency of the current version of the GraphCast relies on high-quality historical weather data for training, typically sourced from ECMWF's ERA5 reanalysis. Concurrently, the National Centers for Environmental Prediction (NCEP) has initiated collaborative endeavors with the research community to develop Machine Learning Weather Prediction (MLWP). Within this context, our study represents a pioneering effort to advance the state-of-the-art by devising a methodology for parallel training of GraphCast using Global Data Assimilation System (GDAS) data obtained from NCEP's operational Global Forecast System (GFSv16) model. Noteworthy for its spatial resolution of 0.25 degrees latitude-longitude and temporal resolution of 6 hours, GDAS provides real-time initial conditions to make real-time MLWP global forecasts possible. Our investigation involves a meticulously devised framework encompassing model training, validation, and testing procedures, as well as a comparative analysis of GraphCast performance when trained and initialized with GDAS data versus ERA5 and HRES data. Alongside this comparative analysis, we investigate the advantages and limitations of GraphCast leveraging GDAS data while proposing potential approaches for enhancing future iterations of this study.

Planning Committee

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