Participant Welcome Packet

Unifying Innovations in Forecasting Capabilities Workshop

Presented by the Earth Prediction Innovation Center (EPIC), Unified Forecast System (UFS), and UFS Research to Operations (R2O) Project

Dates:
Monday, July 18th - Friday, July 22nd, 2022

Time:
Monday: 1:00 PM - 5:30 PM ET
Tuesday through Thursday: 9:00 AM - 6:00 PM ET
Friday: 9:00 AM - 12:00 PM ET

Location:
Holiday Inn, College Park, MD and Online

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Goals

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

Objective

To understand how academia, industry and operations work together to enhance the Unified Forecast System (UFS) and can leverage this knowledge to accelerate contributions and measure their success.

Abstract

The Earth Prediction Innovation Center (EPIC), the Unified Forecast System (UFS), and the UFS Research to Operations community are coming together to deliver a five-day Unifying Innovations in Forecasting Capabilities Workshop. Throughout the week, attendees will have the opportunity to explore avenues for their own research development, learn about updates to the UFS, share successes within the scope of contributing the most reliable and accurate forecast modeling system in the world, and voice their thoughts on where our exciting future will go from here. It is the goal of the workshop to engage the greater weather enterprise and academia in the on-going effort to accelerate contributions to the Unified Forecast System. This first-of-its-kind event is your chance to dive into innovations in forecasting.

In-Person, Virtual, and Hybrid Logistics

In-person

Address: *Holiday Inn of College Park, 10000 Baltimore Ave, College Park, MD 20740*

Parking: Parking is available in the hotel parking lot. Please do not park in the IKEA parking lot unless it is outside of store hours (10AM-9PM).

Hotel information

COVID protocols

Virtual

Most presentations will be live-streamed. Breakout sessions will utilize Google Meet and will be available to you via our slack channel.

Livestream will be available concurrently through Vimeo and Facebook. The links will also be posted on EPIC's website at epic.noaa.gov.

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

Hybrid

See 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 into the operational applications for numerical weather prediction (NWP). NOAA is working closely with entities in the weather enterprise (public, private, and academia for example) to inform the planning, development, and strategy for EPIC.

About UFS

The Unified Forecast System (UFS) is a community-based, coupled, comprehensive Earth modeling system. The 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 Enterprise and to be the source system for NOAA's operational numerical weather prediction 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 Unified Forecast System - Research to Operations (UFS-R2O) Project is a subset of the UFS supported by NOAA that focuses on the transfer of innovations into operations (lower part of the R2O "funnel").

The UFS-R2O is a broad collaborative project between National Weather Service (NWS) and non-NWS researchers that is created for efficiently incorporating cutting-edge research and innovation into the NWS operational forecasting systems. While R2O pathways have always existed in the operational model development at the NWS Environmental Modeling Center (EMC), the UFS-R2O project is a pioneering effort to formally bring a large number of researchers, model developers and academics under an overarching project to collectively work toward the next generation global prediction system.

Connect with us

Connect with us

We will be collecting questions, comments and other information via Twitter when you use **#UIFCW2022.**

You can also follow EPIC on Twitter, #NOAAEPIC or on Facebook, @NOAAEPIC

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

WiFi Information:

A wireless connection is available through the IHG Guest connection option.

1. Please choose IHGConnect from your wireless connection options. Password is: *WASCB*
2. Once your computer is connected, open your internet browser. You will be prompted to accept the hotel terms and conditions.
3. Once accepted you will have internet access to other web pages.
4. **Please note**: you will need to re-accept these terms and conditions every 24 hours or anytime you disconnect from IHGConnect then reconnect.

If you encounter difficulty accessing the Internet, please see the front desk.

Daily Agenda's

*SUBJECT TO CHANGES, please refer to slack for important updates

Monday, July 18th

All times Eastern

12:00 pm	**Registration** **In-Person Attendees:** Registration will begin in the hotel lobby **Virtual Attendees:** If you have any questions about joining virtually, we will have a google meet open for questions HERE.
1:00 pm	**Welcome and Kickoff** *Dr. Jamese Sims*
1:10 pm	**Setting the Vision** 1:10 pm - *Mary Erickson, NOAA (biography)* 1:20 pm - *Dr. Cisco Werner, NOAA (biography)* 1:30 pm - *Dr. Dorothy Koch (biography) and Dr. Steve Smith (biography), NOAA* 1:50 pm - *Dr. Maoyi Huang (biography), Dr. Jamese Sims (biography), and Dr. Neil Jacobs (biography)*
2:30 pm	**Break**
3:00 pm	**Panel Discussion: Understanding Roles and Responsibilities** *Moderated by Dr. Jamese Sims* *Panelists:* *Dr. Neil Jacobs, UFS Chief Science Advisor (biography)* *Dr. Jamese Sims, NOAA (biography)* *Dr. Maoyi Huang, NOAA (biography)* *Dr. Hendrik Tolman, NOAA (biography)*
4:00 pm	**Vision Success Stories** *4:00 pm - Dr. Gokhan Danabasoglu, NOAA (biography)* *4:30 pm - Kathryn Newman, NCAR/DTC (biography)* *5:00 pm - Dr. Thomas "Tom" Auligne, JCSDA (biography)*
5:30 pm	**Adjourn**
6:00 pm	**Networking Dinner at Buffalo Wild Wings**

Tuesday, July 19th

All times Eastern

8:00 am **Registration**
In-Person Attendees: Registration will begin in the hotel lobby

Virtual Attendees: If you have any questions about joining virtually, we will have a google meet open for questions HERE

9:00 am **Welcome and Kickoff**
Dr. Maoyi Huang

9:10 am **Science Spotlight on Coupled Modeling**
9:10 am - Dr. Avichal Mehra, NOAA (biography)
9:35 am - Dr. Ehab A Meselhe, Tulane University (biography)

10:00 am **Break**

10:30 am **Enabling/Advancing UFS Research to Operations: Role of Working Groups, Development Teams and Infrastructure**
10:30 am - Dr. Shachak Pe'eri, NOAA (biography)
10:50 am - Dr. Vijay Tallapragada, NOAA (biography)
Dr. James "Jim" Kinter, George Mason University (biography)
Dr. Jeffrey Whitaker, NOAA (biography)
11:10 am - Dr. Arun Chawla, NOAA (biography)

11:30 am **Question & Answer Session with CI/CD Pipeline Speakers**
Moderated by Dr. Maoyi Huang

Panelists:
Dr. Shachak Pe'eri, NOAA (biography)
Dr. Vijay Tallapragada, NOAA (biography)
Dr. James "Jim" Kinter, George Mason University (biography)
Dr. Jeffrey Whitaker, NOAA (biography)
Dr. Arun Chawla, NOAA (biography)

12:00 pm **Lunch Break with a Virtual Networking Session**

In-person guests are encouraged to explore the local area and find lunch during this time. There will be the option to purchase a lunch through the Holiday Inn for $20 daily.

Presentation by Audrey Maran (Communications Specialist, NOAA Office of Education, biography), "Student and Early Career Opportunities at NOAA," covering how to find opportunities for students and recent graduates at NOAA and *perspectives on NOAA's fellowship and professional pathways. Open to all attendees and those with an interest in learning more about NOAA careers and next steps.*

Join the virtual networking session at this ***link***.

1:00 pm **Readiness Levels presentation with Q&A**
Dr. Annette Hollingshead, NOAA

2:00 pm **Research to Operations (R2O) presentation with Q&A**
Dr. Arun Chawla, NOAA (biography)

2:30 pm **Libraries Presentation with Q&A**
Dr. Arun Chawla, NOAA (biography)

3:00 pm **Break**

3:30 pm **Bridging the Gap - Case Study Break-Out Groups**
The workshop will break-out into breakout sessions. Each group will have a moderator present their research and highlight where it became stalled along the R2O2R process. Working groups will have the opportunity to ask questions and clarify their understanding. Together, the working groups will come up with solutions to how the scientist in their group could overcome their barrier to success.

VIRTUAL BREAK-OUT ROOMS

Virtual Case-Study #1 - *METplus case study moderated by Tara Jensen*
Additional information available HERE
Google meet link

Virtual Case-Study #2 - *Geostationary Lightning Mapper (GLM) case study moderated by Brian Gockel*
Additional information available HERE
Google meet link

Virtual Case-Study #3 - *Infrared Radiometer Data case study moderated by Kenny James*
Additional information available HERE
Google meet link

Virtual Case-Study #4 - *Creating Group Forks case study moderated by Rahul Mahajan*
Additional information available HERE
Google meet link

IN-PERSON BREAK-OUT ROOMS

In-Person Case-Study #1 - *Noah-MP: An R2O Journey case study moderated by Michael Barlage and Michael Ek*

Additional information available HERE

Join in Breakout Room A

In-Person Case-Study #2 - *Stream Radar case study moderated by Aaron Pratt*

Additional information available HERE

Join in Breakout Room B

4:30 pm **Breakout Room Debrief**

A representative from each breakout session will share their case study and the solutions discussed during their discussion. Google meet link

6:00 pm **Adjourn**

Wednesday, July 20th

All times Eastern

8:00 am **Registration**
In-Person Attendees: Registration will begin in the hotel lobby

Virtual Attendees: If you have any questions about joining virtually, we will have a google meet open for questions HERE

9:00 am **Welcome and Kickoff**
Dr. Vijay Tallapragada

9:10 am **Science Spotlight on Physics**
9:10 am - Dr. Lisa Bengsston, Swedish Meteorological and Hydrological Institute (biography)

9:35 am **One Stack to Build Them All: The NOAA-EMC/JCSDA Spack-stack**
Dr. Dominikus "Dom" Heinzeller, JCSDA (biography) (abstract)

10:00 am **Break**

10:30 am **Parallel Sessions with Application Teams**

SESSION ON SHORT-RANGE WEATHER
In-person attendees: Room A
Virtual attendees: Vimeo Live Stream Link

10:30 am - Jacob Carley - Status and Opportunities with the Rapid Refresh Forecast System (biography) (abstract)

10:45 am - Adam Clark - Unified Forecasting System results from recent NOAA/Hazardous Weather Testbed Spring Forecasting Experiments (biography) (abstract)

11:00 am - Miodrag Rancic - An overview of future research projects within UFS-RTMA (biography) (abstract)

11:15 am - Samuel Degelia - Development and research of assimilating GOES-16 ABI all-sky radiance observations in FV3-LAM using hybrid EnVar (biography) (abstract)

11:30 am - Nicholas Gasperoni - An FV3-LAM multiscale EnVar System for the 2021 and 2022 Hazardous Weather Testbed Spring Forecast Experiments: Systematic impact of valid time shifting to increase ensemble size (abstract)

11:45 am - David Wright - Evaluating the Impacts of Hourly Updating Lake Surface Conditions on the Lake-Effect Snow Forecasting Capabilities of the Unified Forecast System's Short-Range Weather Application (biography) (abstract)

SESSION ON MEDIUM-RANGE WEATHER

In-person attendees: Room B

Virtual attendees: Vimeo Live Stream Link

10:30 am - Sergey Frolov - Cycling prototypes: vehicle for collaboration and development of the MRW/S2S application NOAA OAR/PSL (biography) (abstract)

10:45 am - Jian-Wen Bao - A Unified Stochastic Physics Framework for Simulating Uncertainty in Subgrid Processes (biography) (abstract)

11:00 am - Weiwei Li - Physics Assessments by DTC in Support of the Upcoming GFS and GEFS 2024 Implementations (biography) (abstract)

11:15 am - Bing Fu - The Development of UFS-based Coupled Global Ensemble Forecast System for weather and subseasonal forecast (biography) (abstract)

11:30 am - Zachary Lawrence - A Diagnostic Toolbox for Evaluating Stratosphere-Troposphere Coupling Processes in NOAA's UFS (biography) (abstract)

11:45 am - Shan Sun - Simulating Aerosol Direct Effect on Subseasonal Prediction Using a Coupled UFS with GEFS-Aerosols Model (biography) (abstract)

SESSION ON HURRICANE ANALYSIS AND FORECAST SYSTEM

In-person attendees: Room C

Virtual attendees: Vimeo Live Stream Link

10:30 am - Zhan Zhang - Toward Initial Operational Capability: Progresses, Challenges, and Issues in Developing and Improving Hurricane Analysis and Forecast System (HAFS) (biography) (abstract)

10:45 am - Xuejin Zhang - Developing Initial Operational Capabilities of Hurricane Analysis and Forecast System: Current and Future Priorities (biography) (abstract)

11:00 am - William Ramstrom - Moving Nest Implementation in the Hurricane Analysis and Forecast System (HAFS) (biography) (abstract)

11:15 am - Weiguo Wang - An Overview of HAFS physics parameterizations (biography) (abstract)

11:30 am - Bin Liu - The Regional Ocean-Coupled HAFS with a Storm-Following Moving Nest and Inner-Core Vortex Initialization and Data Assimilation (biography) (abstract)

11:45 am - Kyungmin Park - Coupled Model Development for Advanced Forecasting and Analysis of Extreme Water Levels (biography) (abstract)

12:00 pm **Lunch Break with a Virtual Networking Session**

In-person guests are encouraged to explore the local area and find lunch during this time. There will be the option to purchase a lunch through the Holiday Inn for $20 daily.

Presentation by Keeli Otto (Employee Services Division, Oceanic and Atmospheric Research, biography) and Angela Dunn (Human Resources Business Advisor, Office of Human Capital Services), "Pathways Program Overview," covering the Pathways Program. Open to all attendees and those with an interest in learning more about NOAA careers and next steps.

*Join the virtual networking session at this **link**.*

1:00 pm **Keynote Presentation**

Community, Connection, and Collaboration: How Putting People First Advances Technological Innovation

Dr. Gina Eosco (biography) and Michael Michaud (biography)

Currently, community modeling emphasizes technological needs for designing the future of model innovation. Equally important is recognizing that people advance technology. Using social science knowledge, data, and methods, the future of modeling depends upon building a sense of community among its members and tying model advancements to societal value. Placing people first will allow members to thrive and innovate to advance the nation's forecast modeling system.

2:00 pm **Early Career Workforce and Student Panel**

Moderated by Ayesha Wilkenson (biography), Dr. Logan Dawson (biography), and Ashley Stagnari (biography)

Panelists:
Dr. Jonathan Poterjoy, University of Maryland (biography)
Brianne Nelson, NCAR (biography)
Dr. David Wright, University of Michigan (biography)
Dr. Iman Gohari, Intel

3:30 **Break**

4:00 **Poster Session**

This poster session will be hybrid so there will be two ways in which we conduct it. If you are in-person, you will walk through the ballroom and engage with our in-person presenters as you would at any other poster session. If you are virtual, you will make your way to #posters channel and find all of the posters (as well as their google meet links) there. If you have any questions, feel free to reach out to the virtual moderator on slack at @mandy.parson.

Abstracts for the in-person posters can be found next to the names of the authors below. Abstracts for the virtual presenters can be found in the #posters slack channel.

IN-PERSON POSTER PRESENTERS

Luiz Bacelar - How can we drastically decrease spin-up compute time for Land Surface Models while keeping the current physical parametrizations? (biography) (abstract)

Malaquías Peña - Developing a consistent wind-wave-current data assimilation scheme for the 3D-RTMA (biography) (abstract)

Hedanqiu Bai - The impact of tropical SST biases on the S2S precipitation forecast skill over the Contiguous United States in the UFS coupled model (biography) (abstract)

Kevin Lupo - Displacement Error Characteristics of 500-hPa Troughs and Cutoff Lows in Operational GFS Forecasts (biography) (abstract)

Laura Slivinski - Overlapping Windows in a Global Hourly Data Assimilation System (biography) (abstract)

Gill-Ran Jeong - Updating Anthropogenic Emissions for NOAA's Global Ensemble Forecast Systems for Aerosols (GEFS-Aerosols): Application of Bias Scaling Methods (biography) (abstract)

Carlos Carrillo - How predictable is short-term drought in the northeastern United States? (biography) (abstract)

Daoyang Bao - A Numerical Investigation of Compound Flooding during Hurricane Harvey (2017) using a Dynamically Coupled Hydrological-Ocean Model (biography) (abstract)

Yanda Ou - Hydrodynamic and Biochemical Impacts on the Development of Hypoxia in the Louisiana– Texas Shelf: Statistical Modeling and Hypoxia Prediction (biography) (abstract)

Song-You Hong - Representation of Partial Cloudiness Effect in a Bulk Cloud Microphysics Scheme (biography) (abstract)

Hyun-Sook Kim - Regional HYbrid-Coordinate Ocean Model (HYCOM) coupling Hurricane Analysis and Forecast System (HAFS) (biography) (abstract)

Xiaochen Zhao - A High-resolution Operational Forecast System for Mississippi River Basin: Calibration for Lower Mississippi River Watershed (abstract)

Jonathan Poterjoy - Exploring new data assimilation methodology within the NOAA Hurricane Analysis and Forecast System ([biography]) ([abstract])

Dustin Swales - Using UFS forcing with a single column model: Can we reduce the steps in the development hierarchy? ([biography]) ([abstract])

Bill Lamberson - Better Utilization of UFS Ensemble Forecast Information Within the National Weather Service Through Ensemble Clustering and Sensitivity Tools ([biography]) ([abstract])

Patrick Tripp - IOOS Coastal Modeling Cloud Sandbox ([abstract])

Minsuk Ji - Operational Requirement Test System for the UFS Weather Model Development ([abstract])

Hailan Wang - Evaluating NOAA GEFSv12 Subseasonal Reforecasts for Predicting U.S. Drought ([biography]) ([abstract])

VIRTUAL POSTER PRESENTERS

Gang Liu - NOAA Coral Reef Watch's Subseasonal-to-Seasonal Outlook Product - Analyzing a Critical Prediction Tool for Coral Reef Management, Conservation Planning, and Communication ([biography])

Tao Zhang - A New GFSv15 based Climate Model Dataset and Its Application to Problems in Climate Variability, and Predictability ([biography])

Daniel Steinhoff - West-WRF NRT Forecast Simulations ([biography])

Manuel Pondeca - 3DRTMA development at NOAA's NCEP and GSL: Status and challenges ([biography])

Li Bi - Hurricane Analysis and Forecast System (HAFS) Regional Data Assimilation Experiments during 2021 Hurricane Season ([biography])

Siyuan Wang - Evaluating UFS-Aerosols using Global-Scale, Multi-Seasonal Suborbital Airborne Observations ([biography])

Youhua Tang - Compare and Evaluate JEDI AIRNow and AOD Assimilations for RRFS-CMAQ: a Case Study for Summer 2019

Xu Lu - Assimilating GOES-16 all-sky ABI radiances with the HAFS dual-resolution EnVar DA ([biography])

Dustin Grogan - Investigating the Impact of Aerosols on Medium-Range Weather Forecasts in the Unified Forecast System ([biography])

Molly Smith - Recent development in the METexpress verification visualization system ([biography])

Ruiyu Sun - Thompson Microphysics Scheme in the NOAA Unified Forecast System

Linlin Pan - Impacts of different physics suites on Hurricane forecasting with the UFS Short-Range Weather Application (biography)

Rebecca Schwantes - Towards Enhanced Research Capabilities for Improving Air Quality and Atmospheric Composition Prediction within the Unified Forecasting System (biography)

Joannes Westerink - Developments of Global ESTOFS: Optimizing Global Tides and Driving Thermohaline Circulation by Downscaling Density from Global RTOFS

Ricardo Campos - Visualization and validation methods applied to wave modeling

Yingtao Ma - Updates to the Community Radiative Transfer Model (CRTM) supporting advanced data assimilation within the UFS (biography)

Jong Kim - Support for the Hurricane Analysis and Forecast System (HAFS) with High Resolution Regional Modular Ocean Model v6 (MOM6) Initialization (biography)

Greg Seroka - NOS' Surge and Tide Operational Forecast System (STOFS) (biography)

William Lewis - Toward More Cogent Scorecards (biography)

6:00 **Adjourn**

Thursday, July 21st

All times Eastern

8:00 am **Registration**

In-Person Attendees: Registration will begin in the hotel lobby

Virtual Attendees: If you have any questions about joining virtually, we will have a google meet open for questions HERE

9:00 am **Welcome and Kickoff**

Dr. Tracy Fanara

9:10 am **Science Spotlight on Data Assimilation**

9:10 am - Dr. Xuguang Wang, University of Oklahoma (biography)

9:35 am - Dr. Stelios Flampouris, Tomorrow.io (biography)

10:00 am **Break**

Virtual Poster Session Questions? Join the Google Meet for answers

10:30 am **Parallel Sessions with Emerging Applications and Cross-Cutting Concepts**

CROSS-CUTTING SESSION #1

In-person attendees: Room A

Virtual attendees: Vimeo Live Stream Link

10:30 am - Fanglin Yang - On the Development and Evaluation of Atmospheric Model Physics for the Unified Forecast System Applications Across Scales (biography) (abstract)

10:45 am - Michael Barlage - Enhancing Community UFS Land Model Development Through Advancing Land Component and Land Data Assimilation Capabilities (biography) (abstract)

11:00 am - Ali Abdolali - Advancements in WAVEWATCH III modeling Framework (biography) (abstract)

11:15 am - Ricardo Todling - Bringing GSI Background Error Covariance Capability to JEDI (biography) (abstract)

11:30 am - Bo Huang - JEDI-Based Ensemble-Variational Data Assimilation System for Global Aerosol Forecasting at NCEP: System Development and Near-Real-Time Experiments (biography) (abstract)

11:45 am - Chengsi Liu - Implementation, testing, and evaluation of radar data assimilation capabilities within the JEDI hybrid EnVar/EnKF system for the Rapid Refresh Forecast System (biography) (abstract)

CROSS-CUTTING SESSION #2

In-person attendees: Room B
Virtual attendees: Vimeo Live Stream Link

10:30 am - Marlon Johnson - Raytheon's Approach to Fulfilling the Contract Project and Management Plan (biography) (abstract)

10:45 am - Oliver Elbert - Pace: a Python-Based Implementation of FV3GFS / SHiELD for GPU and CPU Supercomputers (biography) (abstract)

11:00 am - Brian Curtis - Unified Forecast System Weather Model: Building a code-base with multiple components and multiple applications (biography) (abstract)

11:15 am - Ufuk Turuncoglu - Towards an Exchange Grid Implementation within the UFS (biography) (abstract)

11:30 am - Maria Gehne - Diagnostics of Tropical Variability for Numerical Weather Forecasts (biography) (abstract)

11:45 am - James Nelson - The Weather Prediction Center Development and Training Branch: R2O Activities within the Hydrometeorological Testbed (HMT) (abstract)

SESSION ON EMERGING APPLICATIONS

In-person attendees: Room C
Virtual attendees: Vimeo Live Stream Link

10:30 am - Rob Redmon - NOAA Center for Artificial Intelligence: Progress Toward an AI-Ready Agency (biography) (abstract)

10:45 am - Saeed Moghimi - CoastalApp: A Coupling Infrastructure Developed in Partnership with Coastal Ocean Modeling Community (biography) (abstract)

11:00 am - Peter Sheng - Applications of A Rapid Forecasting and Mapping System (RFMS) for Storm Surge, Wave, and Inundation (abstract)

11:15 am - John Warner - Development and Applications of an Ocean, Infragravity Wave, Morphological, and Structural Response Coupled Nearshore Prediction System (biography) (abstract)

11:30 am - Z. George Xue - A novel dynamically coupled ocean-river modeling suite for hurricane-induced compound flooding (biography) (abstract)

11:45 am - Panagiotis Velissariou - On-Demand Hurricane Storm Surge Modeling Using the UFS Coastal Modeling Framework CoastalApp: A Case Study for Hurricane Florence (2018) (biography) (abstract)

12:00 pm **Lunch**

In-person guests are encouraged to explore the local area and find *lunch during this time. There will be the option to purchase a lunch through the Holiday Inn for $20 daily.*

1:00 pm **5 Year Strategy - Transition to UFS Applications**
Dr. Vijay Tallapragada, NOAA (biography)

1:30 pm **Release Coordination**
Dr. Maoyi Huang, NOAA (biography)
Dr. Neil Jacobs, UFS (biography)
Dr. Ligia Bernardet, NOAA (biography)
Dr. Arun Chawla, NOAA (biography)
Dr. Natalie Perlin, RedLine (biography)
Dr. Mark Potts, EPIC (biography)

3:00 pm **Break**

3:30 pm **Academia and the UFS**
Dr. Christiane Jablonowski, University of Michigan (biography)
Dr. Eric Anderson, Colorado School of Mines (biography)
Dr. Ayumi Fujisake, University of Michigan (biography)
Dr. Louis "Lou" Wicker, NOAA (biography)

4:45 pm **Community Modeling Board**
Dr. James "Jim" Kinter, George Mason University (biography)
Dr. Fred Carr, University of Oklahoma (biography)
Dr. Hendrik Tolman, NOAA (biography)
Dr. Neil Jacobs, UFS (biography)

6:15 pm **Adjourn**

Friday, July 22nd

All times Eastern

8:00 am **Registration**
In-Person Attendees: Registration will begin in the hotel lobby

Virtual Attendees: If you have any questions about joining virtually, we will have a google meet open for questions HERE

9:00 am **Welcome and Kickoff**
Dr. Neil Jacobs

9:10 am **Science Spotlight on Model Diagnostics**
9:10 am - Tara Jensen, NCAR/DTC (biography)

9:35 am **Break**

10:30 am **Game Plan for Sustained Engagement**
Linda Taylor, NOAA (biography)
Leah Dubots, NOAA (biography)
Dr. Yan Xue, NOAA (biography)

11:00 am **Debrief: Findings, recommendations, & closing statements**
Dr. Neil Jacobs, UFS (biography)
Dr. Jamese Sims, NOAA (biography)
Dr. Maoyi Huang, NOAA (biography)
Dr. Hendrik Tolman, NOAA (biography)

12:00 pm **Adjourn**

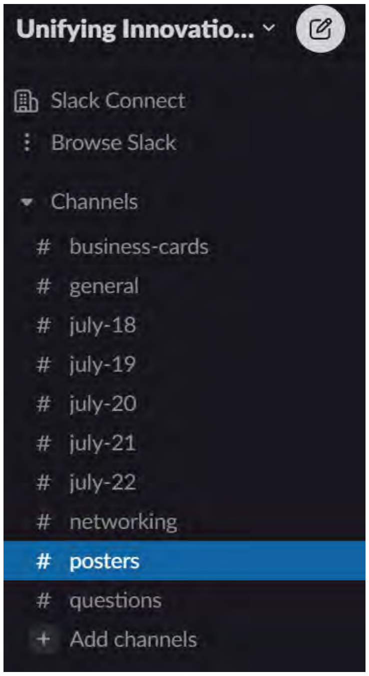
COVID Protocols

Steps we're taking to keep you safe:

- **Monitoring.** The Centers for Disease Control and Prevention (CDC) updates their community levels indicator weekly on Thursday's at 8:00 pm ET. Here's our plan to keep all attendees safe:
    - **MEDIUM.** The community level in Prince George's County, MD is MEDIUM community transmission, therefore the the planning committee is taking the following steps:
        - **NOAA's current guidance is that masks are encouraged when closely interacting with others. However, due to the venue's requirements, masks WILL be required at the workshop.**
        - All attendees are encouraged to bring proof of vaccination or a negative COVID test within three days of attending the workshop.
            - All of the health information that you provide to us will follow health data management best practices.
        - *We are limiting in-person attendance to 100 attendees* to allow for social distancing. Please do not show up if you haven't registered prior to July 13th.
    - To learn more about community levels and COVID prevention at each level, please visit https://www.cdc.gov/coronavirus/2019-ncov/science/community-levels.html#anchor_47145
- **Personal protective equipment.** Masks, cleaning wipes, and hand sanitizer will be provided to all attendees.
- **COVID-19 exposure and quarantine.** The workshop organizers highly encourage any individuals who are concerned about COVID-19 exposure to consider the virtual engagement opportunities provided. The workshop team is working to accommodate all attendees and their comfort levels through a fully hybrid venue. Please follow the guidelines provided by the CDC regarding quarantine and exposure (here)
- **Venue:**
    - All attendees are required to wear masks indoors.
    - Rooms at the venue site are cleaned daily.
    - All frequently touched surfaces at the venue site are cleaned.
    - 6-7 individuals will be seated per table. Table proximity will be adjusted according to the number of individuals per room.

Virtual Attendance

Your virtual hub for the workshop will be on Slack. Regardless of whether or not you have used slack before, we ask that you follow this link so that you can sign up for the workspace*.

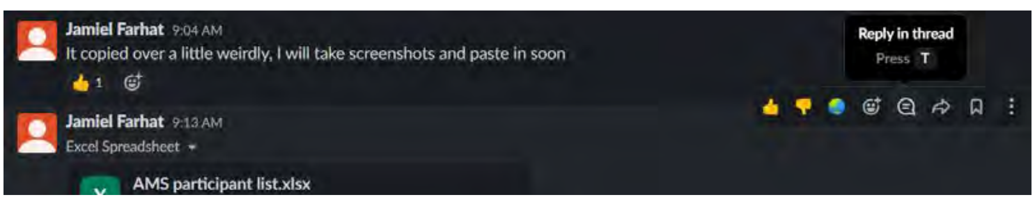


Once you have signed up, you'll notice different channels along the left side. Here are a few to-do's to get things started:

- ☐ Introduce yourself under #business-cards. Let us know your name, your position, and the best way to contact you.

- ☐ If you are looking for future employees or interns, feel free to make a post in #networking with an outline of what you are looking for. Alternatively, if you are looking for employment opportunities, introduce yourself and your qualifications in the channel as well.

When responding to others, click "reply in thread" so that conversations stay organized.



Each day, you can log in and join the #channel that corresponds with the current day. There you will find the agenda for the day, speakers and their bios, as well as links to each presentation as they happen. We will also be posting break-out rooms with specific topics during breaks and lunches so that you will have the opportunity to talk with other participants throughout the week.

*Please note that if you have a slack account, adding a new workspace will prompt you to "Create Account". It's a little confusing but go ahead and "create an account" and then refresh your desktop application so that the new workspace shows up in the left sidebar.

Case Studies

Case Study - Stream Radar Hydrologic Observing Capabilities

Project Goal: Siting and installation of 14 Stream Radars and the transfer of their real-time data for inclusion in an operational model.

Moderator: Aaron Pratt

Problem: Originally involved a Water Information System as the preferred data transfer conduit because the operational model already ingests data from it. However, the organization had no formal commitment to this project and the team could not have control of this data flow mechanism.

Current Status: Cloud-based server with Amazon Web Services (AWS) are being configured to collect, store and distribute the Stream Radars data. Earlier consideration of commercialization options may have prevented this project from stalling.

Case Study - Assimilating Infrared Radiometer Data into Convective-Scale Models

Project Goal: Assimilate thermodynamic profiles retrieved from Atmospheric Emitted Radiance Interferometers (AERIs) with the NSSL Experimental Warn-on-Forecast System for ensembles (NEWS-e) into a WRF ensemble

Moderator: Kenny James

Problem: Data assimilation methodology was developed in the Data Assimilation Research Testbed (DART) scheme prior to the UFS community developing the JEDI framework.

Current Status: Since the target environment changed, this project pivoted to a knowledge transfer rather than systems transfer.

Case Study - Optimizing Geostationary Lightning Mapper (GLM) Use

Project Goal: Implement new Geostationary Lightning Mapper (GLM) products that provide forecasters with full access to the GLM data from both GOES-16/-17.

Moderator: Brian Gockel

Problem: The project successfully developed GLM products accessible to forecasters but continues to iterate through NOAA Testbeds and the Operational Proving Ground. It is still not accepted for full operationalization due to technical issues implementing the product.

Current Status: Developers continue to struggle with integrating the product into operations.

Case Study - Noah-MP: An R2O Journey

Project Goal: Create a replacement for the Noah land surface model using more sophisticated model physics with multiple options for process-level parameterizations. The end product was the Noah-MP LSM.

Moderator: Michael Barlage, Michael Ek

Problem: The Noah-MP land model was developed in 2011 and has not transitioned to operations. There is no direct link to the community version of Noah-MP so code divergence has occurred.

Current Status: Noah-MP is currently in prototype testing for both UFS MRW and SRW Applications. An effort is being made to submodule the authoritative repository so that UFS applications can benefit from community development.

Case Study - METplus

Project Goal: Accept community contributions into METplus for use by the UFS community

Moderator: Tara Jensen

Problem: We are trying to transition community developed diagnostics into operations on WCOSS2

Status: The METplus team has several diagnostics that have been transitioned into the software. Decisions had to be made as to how to refactor the code to fit into the framework. Some Python libraries were directly integrated only to be discovered later that operations will not accept them for implementation on new operational computers.

Case Study - Creating Group Forks for the UFS

Project Goal: Create guidelines for group/institutional repositories

Moderator: Rahul Mahajan

Problem: Sometimes groups and/or organizations may want to use forks to collaborate. This can become an intractable problem if all these group forks become independent development repositories.

Status: A group is trying to put together guidelines for group/institutional repositories. This case study is to review these guidelines and provide feedback.

Speaker Biographies

In alphabetical order by last name

Ali Abdolali

Ali Abdolali is a senior scientist working at EMC/NCEP at the National Oceanic and Atmospheric Administration (NOAA). He is the wave infrastructure lead at NCEP/NOAA. His team is in charge of design, implementation and maintenance of forecast and hindcast wave modeling systems for global to regional and sub-seasonal or seasonal scales within UFS.

Eric J. Anderson

Dr. Eric Anderson is an Associate Professor in Civil & Environmental Engineering and the Hydrologic Science and Engineering Program at the Colorado School of Mines. His research focuses on the interactions between lakes and coastal systems and the atmosphere, including development of real-time hydrodynamic-ice forecast systems, extreme storms such as meteotsunamis, and ecological impacts. Formerly, he was a physical scientist at the National Oceanic and Atmospheric Administration (NOAA) Great Lakes Environmental Research Laboratory (GLERL).

Tom Auligne

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 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 has held research scientist positions at National Center for Atmospheric Research (NCAR), the European Centre for Medium-Range Weather Forecasting (ECMWF), and Météo-France. Dr. Auligné earned a M.S. in Meteorology and a 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.

Luiz Bacelar

I am a third year Ph.D. student in Civil and Environmental Engineering at Duke University. My research focus is in reduced order modeling for physically based land surface models using machine learning techniques.

Hedanqiu Bai

I am a postdoctoral researcher at George Mason University working with Dr. Cristiana Stan on subseasonal to seasonal (S2S) prediction. My research interests focus on tropical meteorology using a combination of observations and models. I got my PhD from Texas A&M University.

Daoyang Bao

Ph.D student working on hurricane-induced compound flooding.

Jian-Wen Bao

Dr. 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 numerical weather prediction models. Recently, he has been working on the evaluation of microphysics schemes in NWP models and developing process-level stochastic physics in NOAA's Unified Forecast System (UFS).

Michael Barlage

Physical Scientist at NOAA's Environmental Modeling Center leading the Land Team for both physics and data assimilation and co-Lead of the UFS Land Working Group.

Lisa Bengtsson

Dr. Lisa Bengtsson is a research scientist at CIRES and the NOAA ESRL Physical Science Laboratory (PSL). She joined CIRES/NOAA in 2017, after working as a research scientist at the Swedish Meteorological and Hydrological Institute (SMHI) since 2006. Her research efforts aim to enhance the theoretical understanding of how to account for model uncertainty emerging from sub-grid scale physical processes, in particular cumulus convection, and has a strong interest in seeing this improved understanding transferred to operational weather prediction systems. Dr. Bengtsson earned her MSc and PhD degrees at Stockholm University in Sweden, and her BSc degree in atmospheric sciences from the University of Wisconsin-Milwaukee, in the USA.

Ligia Bernardet

My work straddles the interface between research and operations in numerical weather prediction. As the deputy 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 of the Developmental Testbed Center that aim at engaging the academic community in using NOAA models and at 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.

Li Bi

I am the support scientist in the EMC HWRF group, interests also include remote sensing, satellite DA and applications.

Jacob Carley

Jacob is a Physical Scientist in the Modeling and Data Assimilation Branch at the Environmental Modeling Center. He works in the Data Assimilation and Quality Control Group and has a background in convective-scale data assimilation. Jacob has worked on upgrades and implementations for the NAM and RTMA systems. He now leads the Rapid Refresh Forecast System development project at EMC and works closely with colleagues across NOAA, academia, and the wider community.

Frederick "Fred" H. Carr

Dr. Fred Carr is currently the McCasland Foundation Presidential Professor Emeritus and Director Emeritus in the School of Meteorology at the University of Oklahoma. After receiving his PhD from Florida State University under Dr. T. N. Krishnamurti, and having a post-doc position at SUNY-Albany with Dr. Lance Bosart, he began his 43-year career at OU in 1979. His research interests include numerical weather prediction, data assimilation, synoptic, mesoscale and tropical meteorology, and use of new observing systems. Dr. Carr has provided service to a wide variety of professional activities, including the National Research Council's "Network of Networks" report, the Oklahoma Mesonet Steering Committee, the UCAR Board of Trustees, Associate Director of the NSF Center for the Analysis and Prediction of Storms, and as a founder of COMET at UCAR. He was Director of the OU School of Meteorology for 14 years, during the period when the National Weather Center was built. He has served as Co-Chair of three committees (UCACN, UMAC and CMrC) that provided guidance to NCEP, NWS and NOAA on improving U.S. Numerical Weather Prediction, and is now co-Chair of NOAA's Community Modeling Board. He was President of the American Meteorological Society in 2016 and served on the AMS Executive Committee from 2015-2019. He is a Fellow of the AMS and currently chairs its Committee on Ethics.

Carlos M. Carrillo

Climate scientist exploring climate variability and change with a focus on drought.

Arun Chawla

Arun Chawla is the Branch Chief for the Engineering & Implementation branch at EMC, responsible for developing software infrastructure for numerical modeling systems that are transitioned to operations from EMC. Arun has a background in ocean modeling and has been involved in transitioning modeling systems to operations since 2006 when he joined EMC.

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 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. He also worked for the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) at the University of Oklahoma from 2011 to 2015, served as a National Research Council post-doc for NSSL from 2009 to 2011.

Brian Curtis

Brian received his B.S. in Meteorology from SUNY Oswego and M.S. / Ph.D. in Computational Sciences and Informatics from George Mason University. He spent time at the US Naval Research Laboratory working as a computational scientist in the geospace sciences and switched to NOAA/EMC with IMSG as a scientific programmer/analyst.

Gokhan Danabasoglu

Dr. Danabasoglu is a Senior Scientist and the Chief Scientist for the Community Earth System Model (CESM) at the National Center for Atmospheric Research, Boulder, CO. He is an expert in ocean and Earth system modeling. His research focuses primarily on understanding the role of the oceans in the Earth's climate system and computational modeling of the ocean, including developing parameterizations to represent unresolved physics in ocean general circulation models. His specific areas of research include investigations of mechanisms, prediction, and impacts of inter-annual to decadal time scale climate variability, particularly associated with the Atlantic meridional overturning circulation.

Logan Dawson

Dr. Logan Dawson is a Physical Scientist in the Verification, Post-Processing, and Product Generation Branch at the Environmental Modeling Center (EMC). Logan leads the branch's Regional Verification Team and is a member of EMC's Model Evaluation Group (MEG). He has extensive experience in convective-scale numerical weather prediction and forecast verification and validation.

Samuel K. Degelia

Samuel Degelia is currently a Postdoctoral Research Fellow at the University of Oklahoma in the Multi-scale data Assimilation and Predictability (MAP) laboratory. His work focuses on improving data assimilation strategies for convective-scale applications.

Leah Dubots

Leah Dubots is a Management and Program Analyst supporting the EPIC program within NOAA's Weather Program Office (WPO). Leah started with WPO as a NOAA Pathways Intern before she transitioned to a full-time position. Leah earned a Master of Public Policy from the University of Maryland, Baltimore County (UMBC) and a Bachelor of Science in Environmental Science & Studies with a concentration in Policy & Management from Towson University.

Oliver Elbert

Oliver Elbert is a software engineer at NOAA's Geophysical Fluid Dynamics Laboratory and the Allen Institute for Artificial Intelligence working on model development for heterogeneous supercomputer architectures. He received his PhD in Physics from UC Irvine.

Gina Eosco

Dr. Gina Eosco is the Social Science and FACETs (Forecasting A Continuum of Environmental Threats) Program Manager for NOAA's Weather Program Office. As a social scientist, Dr. Eosco focuses on the human dimensions of weather science, forecasts, and services ensuring that people, including forecasters, partners, and publics, are part of the research and application process.

Prior to joining NOAA, Dr. Gina Eosco worked as a social scientist and risk communication expert for 2 years with Cherokee Nation Strategic Programs (CNSP) supporting NOAA's Weather Program

Office. Before CNSP, she worked for Eastern Research Group conducting stakeholder engagement activities, employing social science research, as well as translating science into policy documents. At ERG, she worked with scientific agencies such as the National Hurricane Center and National Weather Service on evaluating visual designs, new warnings, and most notably, the hazard simplification project, an evaluation of the NWS watch, warning, and advisory program. She has extensive facilitation experience conducting over 60 focus groups and workshops with emergency managers, broadcast meteorologists, NWS forecasters, and the public.

She is an active member of the Society for Risk Analysis, National Weather Association, as well as the American Meteorological Society. She is the 2019 recipient of the AMS Award for Early Career Professional Achievement, as well as the 2020 recipient of OAR's Daniel L. Albritton Outstanding Science Communicator Award. Dr. Eosco earned her M.S. and Ph.D. in weather risk communication from Cornell University, and a B.S. in Environmental Science and Policy from the University of Maryland.

Mary Erickson

Mary C. Erickson is the deputy director of the National Weather Service, a role she has filled since January 2017. Her primary responsibilities include leading the agency's major change initiatives, ensuring accurate and timely service delivery to key stakeholders, supporting management-labor relations, and building important relationships with America's Weather Industry. She also champions water and inundation programs and directs efforts to improve employee engagement throughout the organization that supports a culture where belonging, inclusion and diversity can thrive.

Ms. Erickson has served in various roles across NOAA for more than 30 years. In her most recent position as the director of the National Centers for Coastal Ocean Science -- an office in NOAA's National Ocean Service -- she ensured the timely and effective transition of ecosystem science solutions from research and development to operations and applications. Prior to that, she served as chief of NOAA's Coast Survey Development Laboratory, where she and her team developed ocean technology to support safe and efficient navigation and sustainable, healthy coasts.

Tracy Fanara

Dr. Tracy Fanara is an environmental engineer, research scientist, and communicator with a BS, ME, and PhD from the University of Florida's College of Environmental Engineering. Tracy has expertise ranging from ocean science, stormwater hydrology and design, community science and tech development, water treatment and harmful algae. Tracy is the Coastal Modeling Portfolio Manager for the National Ocean Service (NOS) where she works with scientists, managers, and modelers, to develop a community modeling and operational framework to protect coastal communities, lives and livelihoods in a changing world. Tracy co-produces a STEM comic book called "Seekers of Science" and runs Mission Tampa Bay, a STEM Camp focused on underserved middle school girls. Tracy is a contributor to national media outlets including National Geographic, Science Channel, Weather Channel, and FOX; she was also featured in Marvel's Unstoppable Wasp Comic book, and was named Xylem YSI's Mission Water, Water Hero.

Stylianos Flampouris

Stylianos "Stelios" Flampouris, Ph.D., is the Vice President of Science and Technology at Tomorrow.io. He is responsible for the company's seamless multiscale analysis and forecast systems and oversees the operational NWP activities, data-driven modeling, and bespoke solutions. In addition, he serves the NOAA/WPO EPIC project as Product Owner of Infrastructure.

Before joining Tomorrow.io, Stelios served the National Weather Service in multiple roles. As a member of the Science and Technology Integration Office of the NWS, served on the management board of the UFS-R2O project, advising NOAA senior executive leadership on coupled data assimilation, numerical weather modeling, and Cross-Cutting Infrastructure and new technologies. As team lead and developer at NOAA/NWS/NCEP, he led the marine data assimilation team, managed a broad portfolio of applications, and spearheaded the successful introduction of the JEDI to the NWS. As an individual developer, he has contributed to several operational products, including RTMA and WW3.

Sergey Frolov

Dr. Frolov is a data assimilation and coupled model forecasting expert with National Oceanic and Atmospheric Administration. Dr. Frolov has 15+ years of experience discovering, implementing, and transitioning advance computing algorithms in support of Earth Science modeling and observation workflows. Dr. Frolov's work contributed to the negotiation of the US-Canada water sharing treaty, design of the National strategy for harmful algal observations along the US West Coast, to the implementation of the data assimilation and the ensemble forecast component of the Navy's seasonal-to-subseasonal forecast model. Dr. Frolov's current work at the Physical Sciences Laboratory is focused on data assimilation for coupled reanalysis and weather forecast applications. Dr. Frolov holds his Ph.D. degree in Environmental Information Technology from the Oregon Health and Science University (Portland, OR, USA), M.Sc. degree from the Central European University (Budapest, Hungary); and B.Sc. degree from the International Sakharov Environmental University (Minsk, Belarus).

Bing Fu

I am a physical scientist working on GEFS (Global Ensemble Forecast System)

Ayumi Fujisaki-Manome

Fujisaki-Manome's research program aims to improve predictability of hazardous weather, ice, and lake/ocean events in cold regions in order to support preparedness and resilience in coastal communities. The main question her research aims to address is: what are the impacts of interactions between ice and oceans / ice and lakes on larger scale phenomena, such as weather, storm surges, and sea/lake ice melting? Fujisaki-Manome primarily uses numerical geophysical modeling to address her research question. Her work has focused on applications to the Great Lakes, Arctic Ocean, the Alaskan coastal region, and the Sea of Okhotsk.

Maria Gehne

Dr. Maria Gehne is an Associate Scientist at the Cooperative Institute for Environmental Research at the University of Colorado, Boulder. Before joining CIRES she worked as a postdoctoral fellow in the Climate Analysis Section at the National Center for Atmospheric Research. Her research focuses on large scale tropical convection and its predictability and representation in numerical weather forecasts. She received her Ph.D. in 2012 from New York University in atmosphere ocean science and mathematics.

Dustin Grogan

I'm a research scientist in the Atmospheric Sciences Research Center at the University of Albany. My research interests include aerosol interactions with the dynamics of the atmosphere, the genesis and development of tropical cyclones, air quality, and the predictability and variability of weather and climate over North Africa.

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, work that he pursued in Japan, New Zealand, Germany and the United States.

Songyou Hong

I have been working on the development of physical parameterization algorithms such as YSU PBL and WSM/WDM microphysics schemes.

Bo Huang

Research Scientist at CU/CIRES and NOAA/OAR/GSL.

Maoyi Huang

Dr. Maoyi Huang joined the NOAA Weather Program Office (WPO) in August 2021 as the Earth Prediction Innovation Center 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 review journals.

Prior to joining NOAA, she 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 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 PhD and MS in Civil and Environmental Engineering in 2005 and 2001 from the University of California at Berkeley.

Christiane Jablonowski

Christiane Jablonowski is a Professor in the Department of Climate and Space Sciences and Engineering at the University of Michigan. She has worked at ECMWF and NCAR, and was a visiting scientist at NOAA GFDL in 2006. Dr. Jablonowski's research lies at the interface between weather and climate modeling, scientific computing, and data science. Her current work focuses on the dynamical cores (the fluid dynamics component) and coupling techniques for weather and climate models including the UFS. She is a member of the UFS R2O project team, a co-lead of the UFS-CAM application team, a member of the Steering Committee for NCAR's CESM model, and a co-chair of the CESM Atmosphere Model Working Group.

Neil Jacobs

Neil Jacobs is currently the chief science advisor for the Unified Forecast System (UFS) within UCAR's Cooperative Programs for the Advancement of Earth System Science (CPAESS). Neil was the previous Assistant Secretary of Commerce for Environmental Observation and Prediction and Under Secretary of Commerce for Oceans and Atmosphere from 2018 to early 2021. Prior to NOAA, he was the Chief Scientist at Panasonic Avionics Corporation, where he directed the research and development of both the aviation weather observing platform and weather forecast model programs. Neil holds BS degrees in mathematics and physics from the University of South Carolina and MS and PhD in atmospheric science from North Carolina State University.

Tara Jensen

Tara Jensen is an atmospheric scientist at NCAR serving as the project manager for the METplus verification and diagnostics framework, which is supported to the community via the Developmental Testbed Center (DTC). She has a Master's Degree in Atmospheric Science from Colorado State University and has worked on the METplus team for more than 13 years. She also now serves in the role of DTC Deputy Director for the NCAR node and is one of the co-chairs of the United Forecast System (UFS) Verification and Validation Cross-cutting Team, the chair of the AMS Probability and Statistics Committee, and serves on several other UFS-related committees.

Gill-Ran Jeong

Gill-Ran Jeong is a postdoctoral research fellow at George Mason University and NOAA Air Resources Laboratory. Gill-Ran got a Ph.D. at Georgia Institute of Technology in 2007 and her research interests are finding the impacts of aerosols on weather/climate systems through their light absorption and hygroscopic capacities, which are determined by the physiochemical characteristics of aerosols and their atmospheric loading. She is currently working on developing an emissions processing system for NOAA aerosol and atmospheric composition (AAC) models in the Unified Forecast System (UFS) framework, performing simulations with UFS AAC models and evaluating results toward the improvement of emissions inputs.

Marlon Johnson

Mr. Johnson is an accomplished IT executive, with over 15 years of IT consulting and systems integration expertise across the Public and Private sector. Mr. Johnson demonstrated strategic leadership in growing company profits by writing business cases and successful proposals, as well as creating corporate technology roadmaps that align IT portfolios with market needs. Mr. Johnson demonstrated tactical leadership by managing large scale consulting and engineering efforts of agile developments, continuous deploys, and cloud migrations. Mr. Johnson was recognized for his career accomplishments in receiving the 2011 BEYA STEM Modern Day Technology Leader (MDTL) Award.

Hyun-Sook Kim

Physical oceanographer who has been involved in the development of coupled Hurricane-Ocean modeling systems, and in the transitions of HWRF and HMON to operational. My interests include a 3-way coupling Hurricane-Ocean-Wave model system and also data assimilation.

Jong Kim

Coupled Earth system modeling and data assimilation system development.

James (Jim) Kinter

Jim is a Professor in the Climate Dynamics program of the department of Atmospheric, Oceanic and Earth Sciences at George Mason University. He is also Director of the Center for Ocean-Land-Atmosphere Studies (COLA). Jim earned a PhD in geophysical fluid dynamics in 1984 at Princeton University. He held positions at NASA Goddard, University of Maryland , and the Institute of Global Environment and Society, prior to joining GMU in 2001.

Dorothy Koch

Dr. Dorothy Koch has been the Director of the NOAA Weather Program Office (WPO) since April 2021. WPO includes a broad portfolio of modeling, testbed, social science, observations, disaster supplemental and policy relevant to weather. WPO supports research to improve operational forecasts in the National Weather Service (NWS) and fosters innovative research approaches, with most of WPO resources provided to the external community. WPO supports the UFS, notably through the EPIC program and the UFS R2O Project, as well as through other programs such as S2S and the Joint Technology Transfer Initiative (JTTI). In addition to directing WPO, Dr. Koch is the Weather portfolio steward and the Chair of NOAA's Modeling Board. Prior to joining WPO, Dr. Koch was the Director of the NWS Modeling Division within the Office of Science and Technology Integration (2019-2021), and prior to that managed the Department of Energy's Earth System Modeling portfolio (2010-2019), and before that worked as a Research Scientist developing the aerosol component of the GISS climate model at Columbia University and NASA Goddard Institute for Space Studies.

Bill Lamberson

Meteorologist with a focus on data analysis and ensemble forecasting. I currently research and develop tools that simplify and data mine ensemble forecasts so that forecasters can better understand their output and incorporate them into their forecast processes.

Zachary D. Lawrence

Dr. Zachary Lawrence is a research scientist with the Cooperative Institute for Research in Environmental Sciences (CIRES) and the National Oceanic and Atmospheric Administration (NOAA) Physical Sciences Laboratory (PSL). His research interests and areas of expertise primarily focus on stratosphere-troposphere coupling, subseasonal-to-seasonal prediction, atmospheric dynamics, and chemistry-climate interactions.

William E. Lewis

Will is a South Carolina native who has been living in Wisconsin for 20 years and enjoys fishing when he's not debugging code.

Tsung-Han Li

I (He) got my PhD degree from the University of Hawaii at Manoa at 2019, and then started to work on data assimilation with Prof. Xuguang Wang at the University of Oklahoma.

Weiwei Li

A project scientist at NCAR and DTC, working on NWP and UFS with physics-focused testing and evaluation techniques.

Bin Liu

NCEP operational hurricane forecast system developer.

Chengsi Liu

I am a senior research scientist at the Center for Analysis and Prediction of Storms(CAPS) of the University of Oklahoma (OU). My research focuses on data assimilation on a convective scale.

Gang Liu

Dr. Gang Liu is a physical scientist and oceanographer with the NOAA Coral Reef Watch (CRW) program at NOAA/NESDIS/STAR. Dr. Liu has been developing and operating NOAA CRW's world-renowned global decision support system for coral reef management. He conducts research for product development; investigates historical changes in thermal conditions impacting coral reef ecosystems; and develops, implements, and maintains CRW's satellite-based and modeled products. Using CRW's satellite monitoring products and modeled subseasonal-to-seasonal predictions, Dr. Liu also monitors near real-time changes in the coral reef environment around the world, including developing coral bleaching heat stress; issues warnings; and communicates with collaborators and users in the field.

Mong-Ming Lu

Dr. Mong-Ming Lu is a project professor at the Department of Atmospheric Sciences of National Taiwan University (NTU). Before joining the NTU in 2018, she served as Chief Researcher at the Central Weather Bureau of Taiwan for more than two decades. Her current research focus is on bridging weather and climate prediction evaluation and attribution over the South China Sea surrounding regions in particular for Taiwan and the Philippines.

Xu Lu

Early Career Research Scientist on hurricanes, data assimilation, and NWP.

Kevin Lupo

I started as a postdoc at NCAR in September 2021 after completing my PhD in Atmospheric Science at SUNY Albany. Prior to this, I completed the B.S. and M.S. Meteorology programs at Plymouth State University. My research interests are in numerical weather prediction, ensemble prediction systems, and mesoscale and synoptic meteorology.

Yingtao Ma

Yingtao Ma is a research scientist with the Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins. He currently works with the Community Radiative Transfer Model (CRTM) team at NOAA/NESDIS Center for Satellite Applications and Research (STAR), College Park, MD. He received his Ph.D degree from the University of Maryland at College Park (UMCP) in 2004, and worked in the Department of Atmospheric & Oceanic Science until 2014, engaged in research on surface radiation budget retrieval and satellite remote sensing. Before joined CIRA he worked as a staff scientist for Atmospheric and Environmental Research, Inc. (AER), working on the redesign and enhancement of AER's Line-By-Line Radiative Transfer Model (LBLRTM). His research interests are atmospheric radiative transfer, remote sensing of the earth's atmosphere and surface, surface radiation budget and atmospheric measurements and instrumentation.

Audrey Maran

Audrey is a communications specialist in the NOAA Office of Education with professional experience as an educator, researcher, and communicator. She leads the higher education communication efforts, which include the Hollings and EPP/MSI programs. Audrey first joined NOAA through the John A. Knauss Fellowship Program in 2019. She has a Master's and Ph.D. in Biological Sciences from Bowling Green State University and B.S. in Science Education from Bowling Green State University.

Avichal Mehra

Dr. Avichal Mehra has about 25 years of experience leading and performing scientific development and research in the areas of operational forecasting, dynamics of coupled atmosphere-land-ocean-wave models, numerical analysis, model diagnostics, and analyzing and interpreting geophysical data and model results. As Chief of the Dynamics and Coupled Modeling Group, Dr. Mehra has taken on the responsibility of providing key science and technical leadership/supervision to help build global and regional UFS-based coupled applications and frameworks for future operational systems at National Weather Service/National Centers for Environmental Prediction (NWS/NCEP). Dr. Mehra has been been involved with the development and transition of operational Hurricane Models and operational Ocean Forecast systems at NWS/NCEP for more than a decade and serves as a Co-lead of the UFS Global Application Team, Co-chair of ICAMS implementation team for Global Coupled Modeling and represents NWS/NCEP in WMO/IOC's Expert Team on Operational Ocean Forecast Systems (ETOOFS).

Ehab Meselhe

Ehab Meselhe, Ph.D., P.E., is Professor in the Department of River-Coastal Science and Engineering at Tulane University. Dr. Meselhe research focuses on development and applications of numerical models to rivers, watersheds and coastal areas. Dr. Meselhe is a registered Professional Engineer in the states of Iowa and Louisiana.

Michael Michaud

Michael Michaud is a Ph.D. candidate in the Disaster Science and Management Program at the University of Delaware. In 2011 he graduated from Lyndon State College (now Northern Vermont University - Lyndon) with a degree in Atmospheric Science. He also earned his Master of Education in Educational Leadership and Policy from the University of Utah in 2016. With backgrounds in both the physical and social sciences, he is passionate about integrating knowledge from the social, behavioral, and economic sciences into the Weather Enterprise. He also sees the importance of building community to promote collaboration, both within the sciences and elsewhere. Michael is also an active member on the American Meteorological Society Board for Societal Impacts.

Saeed Moghimi

After completion of his PhD in 2005, Dr. Saeed Moghimi spent four years on 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.

Brianne Nelson

Brianne is an Associate Scientist at NCAR/RAL & DTC. She primarily works on testing and evaluation using METplus.

Kathryn Newman

Kathryn Newman is an Associate Scientist at the National Center for Atmospheric Research/Research Applications Laboratory and in the Developmental Testbed Center (DTC). Kathryn has over a decade of experience with software support and testing and evaluation (T&E) activities in the DTC, with an emphasis on research-to-operations-to-research (R2O2R). She has led/co-led the hurricane tasks in the DTC since 2015, where she oversaw several R2O transitions into the operational Hurricane Weather Research and Forecast (HWRF) system. In recent years, she has co-led physics T&E activities using the Hierarchical System Development (HSD) approach to support UFS physics development.

Keeli Otto

Keeli Otto is a Management and Program Analyst with the OAR Employee Services Division. She is the OAR Pathways Program Manager and Student Programs Coordinator. She has been with OAR since May 2018.

Yanda Ou

I am interested in oceanic modeling including coupled 3D models and machine learning based models. In the previous four years, I studied northern Gulf of Mexico hypoxia using a coupled hydrodynamic-biogeochemical model and machine learning methods with a goal to understand the responses of hypoxia to the changing aquatic environments and to develop a hypoxic area prediction model.

Kyungmin Park

Kyungmin Park is a Ph.D. candidate in the Ocean Science and Engineering program at the Georgia Institute of Technology. Using multidisciplinary knowledge and skills, he has developed and deployed a high-resolution model on the U.S. east coast. Collaborating with governments, Kyungmin has helped coastal communities to make data-driven decisions for risk assessments, coastal protection and evacuation plans.

Linlin Pan

NOAA/GSL

Shachak Pe'eri

Dr. Shachak Pe'eri is the chief of NOAA's Coast Survey Development Lab. With more than three years of experience as Coast Survey's Marine Chart Division Cartographic Support Branch chief and more than eleven years of experience as an associate research professor at the University of New Hampshire, Shachak has a deep knowledge of the current and emerging technologies critical for our mission. He has a Ph.D. in geophysics with extensive post-doctoral experience in coastal and ocean mapping including airborne lidar bathymetry, satellite and aerial remote sensing, and autonomous vessels. Shachak is also committed to the development of employees through the internationally accredited professional cartographic certification program (CAT-B) that he established (and for which he received a NOAA Administrator's Award last year).

Malaquias Peña

Received his MS from the University of Oklahoma and PhD from the University of Maryland both in meteorology. He held a position at EMC/NCEP/NWS as task leader on ensemble modeling and then as engineer in the NGGPS program to support the creation and evaluation of an early version of the

Seasonal UFS. He is currently conducting research on fine resolution numerical modeling and data analysis for solar and offshore wind energy.

Natalie Perlin

M.Sc. 1993 in Engineering Meteorology (Russian State Hydrometeorological University);
Ph.D. 2001 in Mesoscale Meteorological Modeling (Tel-Aviv University); 2000-2013: Postdoctoral and Research Associate (College of Earth, Ocean and Atmospheric Sciences, Oregon State University); 2014-2021: Scientist (Rosenstiel School of Marine and Atmospheric Science, University of Miami); 2022-present Sr. Software Engineer for the NOAA-EPIC project Over 25 years of experience with environmental numerical modeling: atmospheric, ocean, wave, oil transport, coupled models, from hurricane-scale to climate models; model coupling and model development. Research areas: mesoscale atmospheric modeling, mesoscale air-sea interaction, coastal environments and marine boundary layers, ensemble climate modeling, atmospheric teleconnections, deep-sea oil transport modeling Work experience with workstations, Cray, local clusters, HPC computing in on-premise and cloud environments.

Manuel Pondeca

Received PhD in Meteorology from Florida State University in 1996. Joined EMC in 2001 as a contractor. Lead developer of the NOAA operational RTMA/URMA system. Currently one of the managers for 3DRTMA development.

Jonathan Poterjoy

Jon Poterjoy is an Assistant Professor at the University of Maryland. His research expertise includes data assimilation, numerical weather prediction, and probabilistic forecasting and verification.

Mark Potts

Mark joined Redline Performance Solutions in 2015 as a Senior Computational Scientist and has since worked, largely at NOAA/EMC, as a software developer on various HPC-related projects. He has more than 20 years of software development experience, including more than 15 years of work in research and application development using HPC systems.

William Ramstrom

William Ramstrom is a member of the Modeling Team at NOAA's Hurricane Research Division in Miami, FL, focused on moving nest functionality for the HAFS system. He earned an MS in Atmospheric Science and a BS in Computer Science, both from MIT. His professional background includes time in the private sector working on projects from real time WRF modeling, aviation forecasting, radar hail diagnostics, to radar data assimilation and hurricane initialization.

Miodrag Rancic

Working on development of numerical methods for modeling of the atmosphere and data assimilation for the last 30 plus years at NOAA/NCEP/EMC, NASA, and academia in various roles.

Rob Redmon

Dr. Robert Redmon is a senior scientist with NOAA’s National Centers for Environmental Information (NCEI) where he serves as the lead for both the Space Weather Follow On (SWFO) Science Center and the NOAA Center for Artificial Intelligence (NCAI, noaa.gov/ai). He is a graduate of the 2021 NOAA Leadership Competencies Development Program (LCDP) class XI “Transformers”.

Rebecca Schwantes

Rebecca Schwantes is a research chemist at the NOAA (National Oceanic and Atmospheric Administration) Chemical Sciences Laboratory in Boulder, CO. Her research focuses on the development of reduced chemical mechanisms for use in regional and global atmospheric chemistry models to improve the simulation of air pollutants such as ozone and secondary organic aerosol.

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; serves as Project Manager for an effort to improve its performance in the Pacific region; and is currently leading operational transition of annual upgrades to the model's global, and Atlantic and Pacific three-dimensional components. These forecast tools are essential for safe and efficient marine navigation and for 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 PhD in physical oceanography from Rutgers University with a Graduate Certificate in Energy, where 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.

Jamese Sims

Dr. Jamese Sims is the Director of the National Weather Service (NWS) Office of Science and Technology Integration (OSTI) Modeling Program. The OSTI Modeling Program Team is responsible for supporting a variety of NWS numerical weather prediction/modeling and research initiatives to improve weather forecasts. Dr. Sims oversees a $20M budget, funding programs that accelerate and advance the development of new models, and foster collaboration among NOAA research scientists, federal labs, operational forecasters and the academic community. Examples of the modeling programs include efforts to improve guidance for hurricane track, intensity, and storm surge forecasts; develop an end-to-end air quality forecast capability; advance research to extend forecast skill beyond 8-10 days; and implement a weather-scale, fully-coupled numerical weather prediction system.

Laura Slivinski

Laura is a data assimilation research scientist who is currently developing a rapidly-updating global data assimilation system. She is also interested in strongly coupled data assimilation, and recently co-led the development of the 20th Century Reanalysis version 3.

Molly Smith

Molly Smith does model verification and web programming at NOAA's Global Systems Laboratory. She has also done research in tropical cyclones.

Stephan “Steve” Smith

Dr. Stephan Smith is Director of the Office of Science and Technology Integration (OSTI). Steve joined the NWS in 1993, and, as a branch chief in MDL, has brought diverse and talented people together from different organizations to solve challenging problems. He led the development and implementation of more than 30 decision support tools and guidance products to enhance NWS operations, for which he has been recognized with the NOAA Administrator’s Award and the DOC Bronze Medal. At the NOAA level, Steve has been a catalyst in improving the transition of research to operations through the creation of policy, processes, and funding initiatives. In 2013, he established the NOAA Virtual Laboratory, a foundational piece of the NWS R2O2R strategy. In 2019, Steve was selected as the Director of the NWS Meteorological Development Laboratory (MDL).

Steve earned both 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. Before joining NWS, Steve was a Research Associate at the Cooperative Institute for Research in the Atmosphere (CIRA) in Fort Collins.

Ashley Stagnari

Rising Junior at Cornell University majoring in Environment and Sustainability with a concentration in Environmental Policy and Governance. My academic interests include climate science and climate change mitigation. This summer, I am working at NOAA as a William M. Lapenta intern for the Earth Prediction Innovation Center (EPIC) on a social science research project centering on the intersection between weather modeling and community engagement.

Daniel Steinhoff

Daniel is a research meteorologist who focuses on numerical weather prediction and atmospheric dynamics. His dissertation research explained the dynamics and climate forcing of foehn winds over the McMurdo Dry Valleys of Antarctica. He continued as a Postgraduate Scientist (2011-2013) and Project Scientist (2013-2019) at the National Center for Atmospheric Research (NCAR), where his primary research involved weather and climate impacts on vector-borne diseases. He developed a water container energy balance model that can be used to estimate thermal suitability for the dengue vector mosquito Aedes aegypti, and was involved in several mosquito sampling and household survey campaigns in Mexico. While at NCAR he also participated in research focused on the representation of ENSO effects on rainfall in climate models over Colombia, rainfall processes over the United Arab Emirates, mesoscale meteorological simulations over equatorial Africa for predictive disease modeling, and several atmospheric transport and dispersion studies. Daniel’s current research at CW3E involves numerical weather prediction of atmospheric rivers and precipitation over the Western U.S. This includes model parameter sensitivity studies, near real-time forecasting, and re-forecast applications. He also works with other CW3E researchers on atmospheric process studies to improve the understanding and predictability of atmospheric rivers across spatial scales.

Shan Sun

My research is on the development of coupled ocean-atmosphere-ice models for sub-seasonal to climate prediction, aerosol effect on weather and climate, numerical weather prediction, air-sea interaction, ocean general circulation modeling as well as climate change and climate variability.

Dustin Swales

CCPP-physics developer.

Vijay Tallapragada

Dr. Vijay Tallapragada is the Chief of Modeling and Data Assimilation Branch at NOAA Environmental Modeling Center (EMC), leading the development and advancement of operational Numerical Weather Prediction (NWP) systems. He is the co-lead of the Unified Forecast System Research to Operations (UFS-R2O) project, and is spearheading the transition of NCEP Production Suite into UFS based applications. He is also the Development Manager for Hurricane Forecast Improvement Project (HFIP) and enabled transition of advanced research into operations for global tropical cyclone predictions.

Linda Taylor

I work for DOC at NOAA's NWS and am the federal UFS C&O WG Co-Chair.

Ricardo Todling

Ricardo Todling has worked at NASA for over 30 years. He started under a Fellowship from the National Academy of Sciences, went into a post-doc position; then a little over 10 years of Contractor work; to then, a Civil Servant position. His area of expertise is data assimilation. He contributed to providing support for assimilation and weather prediction systems from the launch of NASA Terra Satellite back in the late 90s to numerous other NASA Missions since then. Over the years, Dr. Todling has collaborated with various institutions. With NOAA, he actively participated in the development of the Gridpoint Statistical Interpolation analysis system, which is used today at several other centers for data assimilation and weather forecasting. More recently he has been involved in the NASA GMAO work to upgrade its data assimilation applications to use components of the multi-agency JEDI system being developed under the Joint Center for Satellite Data Assimilation coordination. Dr. Todling is also the author of a number of scientific publications from basic research on data assimilation techniques to reports on large reanalysis efforts.

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 that 20 years, as wave modeler, Marine Modeling Branch Chief and Director. Dr. Tolman holds a Doctorate (Dr., PhD equivalent) and Engineering degree (Ir., certified Msc. equivalent) from the Civil Engineering Department of Delft University of Technology in the Netherlands. He is a naturalized US citizen of Dutch origin.

Ufuk U Turuncoglu

Ufuk Utku Turuncoglu is a software engineer at NCAR. His main areas of interest are computational simulation of atmosphere and ocean model components, development of fully coupled earth system models, visualization with in situ techniques, process automation with scientific workflow systems and climate science. He had also experience in teaching computational science and engineering and earth system sciences at university as associate professor and publications around those topics.

Panagiotis Velissariou

Dr. Panagiotis Velissariou is a coastal engineer and modeler with scientific interests in coastal processes, sediment transport, wave-current interactions, storm surge modeling, coastal/regional forecasting and the development of coupled modeling systems. A Greek native, Dr. Velissariou received his B.Sc. in Agricultural Engineering from the Aristotle University of Thessaloniki, Greece, his M.Sc. in Water Resources Engineering from the Ohio State University, Columbus, Ohio and his Ph.D. in Coastal and Ocean Engineering from the Ohio State University, Columbus, Ohio. He was a member of the group that developed and maintained the award winning Great Lakes Forecasting System (GLFS). In 2011, Dr. Velissariou moved to Tallahassee, Florida where he accepted a research scientist position at the Center of Oceanic and Atmospheric Administration (COAPS) at Florida State University (FSU), and worked on model coupling using HYCOM, ROMS, SWAN, WAVEWATCH III, WRF, and the Community Earth System (CESM) models. While at FSU, he developed the Gulf of Mexico Earth Forecasting System (GoM-EFS) a three dimensional prediction system for the Gulf of Mexico that links coastal/ocean processes with the atmosphere using multi-model components and algorithms. In 2018, Dr. Velissariou joined the National Water Center (NOAA/NWS/OWP), Tuscaloosa, Alabama as a senior coastal scientist where he worked in the development of a coupled modeling system between the National Water Model (NWM), and the DFlow FM and ADCIRC hydrodynamic models to create a comprehensive and efficient numerical framework for total water and flood inundation forecasting at the Eastern US. Coast that simulates interactions of inland hydrologic processes, freshwater stream-flows, tides, surges and winds under normal and extreme event conditions. He is currently a senior coastal scientist and modeler at the Coastal Marine Modeling Branch (CMMB) of the Office of Coast Survey (OCS) at the National Oceanographic and Atmospheric Administration National Ocean Service (NOAA/NOS) where he is leading the development efforts of the HSOFS forecast system and the development of the CoastalApp framework a fully coupled, NUOPC/ESMF enabled modeling system for coastal studies. He is also the developer of the Parametric Hurricane Modeling System (PaHM) that generates on-demand atmospheric wind fields from hurricane track data. Dr. Velissariou can be contacted by email: panagiotis.velissariou@noaa.gov or by phone at (205) 227-9141.

Yan Xue

Dr. Yan Xue is a Program Manager at NOAA National Weather Service (NWS) Office of Science and Technology Integration Modeling Program Division (OSTI-M). OSTI-M supports the development of NWS next-generation forecast systems, including high-resolution regional severe weather and hurricane models, global medium-range weather to subseasonal-to-seasonal prediction, air quality forecasts and coastal systems. As the Program Manager for the Weeks 3-4 program, Dr. Xue manages projects on research & development for advancement of the Medium-Range Weather / Subseasonal-to-Seasonal (MRW/S2S) Application, improvement of Weeks 3-4/S2S products at Climate Prediction Center (CPC) and University projects from OSTI Notice of Funding Opportunity (NOFO) calls. To promote the community engagement in the Unified Forecast System Research to Operation Project (UFS R2O), Dr. Xue organized the UFS R2O Town Halls at the AGU, AMS and Ocean Science Meetings, and co-organized the Weeks 3-4/S2S Webinar with the OAR/WPO/S2S Program since 2020. In addition, she serves on the NOAA's National Oceanographic Partnership Program (NOPP) Committee that facilitates partnerships between federal agencies, academia, and industry to advance ocean science and technology, and as the Executive Secretary for the Executive Committee of Developmental Testbed Center (DTC).

Siyuan Wang

Siyuan Wang is a research scientist working on various topics including wildfire impacts on air quality and climate system, chemistry-climate interactions, etc.

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 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 100 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 16 MS students, 17 PhD students and 21 postdocs during her tenure at OU. Dr. Wang also takes community scientific leadership role 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.

Weiguo Wang

PhD in Meteorology. Operational research on improving and developing physics schemes under Hurricane conditions.

John Warner

I work as a physical oceanographer at the USGS for over 20 years, specializing in coastal ocean and nearshore processes of sediment transport, wave-current interaction, and development of coupled modeling systems.

Hailan Wang

Dr. Hailan Wang is a meteorologist specializing in drought monitoring and prediction at the NOAA Climate Prediction Center (CPC). She leads and performs research and development to improve CPC drought monitoring and prediction products. She also conducts climate research to study causes, mechanisms, predictability, and prediction of drought.

Cisco Werner

Dr. Francisco (Cisco) Werner is the acting Assistant Administrator for Oceanic and Atmospheric Research and performs the duties of NOAA Chief Scientist.

Cisco previously served in NOAA Fisheries as Director of Scientific Programs and Chief Science Advisor where he led NOAA Fisheries' efforts to provide the science needed to support sustainable fisheries and ecosystems. This included overseeing the activities of NOAA's six regional Fisheries Science Centers, including 24 labs and field stations. He has also led numerous U.S. international scientific activities, including investigating the ocean's role in climate change, fisheries management, and science collaborations with other countries.

Prior to joining NOAA Fisheries, he was Professor and Director of the Institute of Marine and Coastal Studies at Rutgers University, and also held several positions at the University of North Carolina, Chapel Hill. Cisco's research has focused on the oceanic environment through development of numerical models of ocean circulation and marine ecosystems. He has studied the effects of climate and physical forcing on the structure, function and abundance of commercially and ecologically important species, and contributed to the development and implementation of ocean forecasting systems. Originally from Maracaibo, Venezuela, Cisco earned his BSc in Mathematics, and his MSc and PhD in Oceanography, all from the University of Washington.

Louis J. Wicker

I have a broad set of research interests which generally are focused 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 doing my work with Dr. Tzvi Gal-Chen on satellite temperature assimilation for my Master's degree. I left Oklahoma in 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.

Jeffrey Whitaker

Co-lead of the UFS-R2O project and researcher specializing in ensemble prediction and data assimilation for weather prediction.

Ayesha Wilkinson

Meteorologist at the NWS in Boulder, CO

Denise Worthen

I'm a code manager for UFS Weather Model with primary responsibility for the coupled applications. I am also code manager for the CMEPS mediator and CICE6 sea ice model.

David Wright

Dr. David Wright is a postdoctoral research fellow at the University of Michigan and a visiting scientist at NOAA's Great Lakes Environmental Research Laboratory (GLERL) studying the use of coupled modeling systems to improve atmospheric and hydrodynamic forecasts for the Great Lakes region.

Z. George Xue

Dr. Xue has a joint appointment at Dept. of Oceanography and Coastal Sciences and the Center for Computation and Technology at LSU. Dr. Xue is a broadly trained oceanographer with extensive experience in sediment, nutrient, and carbon dynamics of the Mississippi River-Gulf of Mexico system and the Mekong River- South China Sea system.

Fanglin Yang

Dr. Yang obtained his Ph.D. degree in atmospheric sciences at the University of Illinois at Urbana-Champaign. Currently he serves as the Chief of the Model Physics Group at NOAA Environmental Modeling Center (EMC) to oversee all model physics related activities. He worked on the development, diagnosis and evaluation of the Global Forecasts Systems (GFS) at EMC from

2004 to 2020. Before joining EMC, he worked at NOAA Climate Prediction Center and then at NASA Goddard Space Flight Center for a few years. Dr. Yang has published more than 40 peer-reviewed journal articles on climate diagnosis and modeling and numerical weather prediction. He served as reviewers for multiple scientific journals and US grant agencies.

Li Zhang

My work focuses on the development of complex coupled modeling systems to simulate atmospheric composition, air quality, weather and their interactions.

Tao Zhang

I am currently a scientist working in NOAA CPC to address climate issues by using FV3 GFS.

Xuejin Zhang

UFS R2O Hurricane Application Team co-lead

Zhan Zhang

PhD from Florida State University, have been working at EMC as main developer of HWRF and HAFS systems, currently EMC hurricane modeling team lead and co-lead of UFS-R2O project.

Abstracts

Organized by session

Invited Presentation

One stack to build them all: the NOAA-EMC/JCSDA spack-stack

Dom Heinzeller, Kyle Gerheiser

Complex applications like the Unified Forecast System (UFS) and the Joint Effort for Data assimilation Integration (JEDI) rely on a large number of third-party software packages to build and run. These packages can include I/O libraries, workflow engines, Python modules for data manipulation and plotting, the NOAA NCEP libraries, the Earth System Modeling Framework (ESMF), aerosol chemistry packages, and several ECMWF libraries for complex arithmetics and grid manipulations.

Numerous efforts were made in the past to create a software stack that is easy to install, maintain, develop, and support, and that provides a consistent set of packages. Even though the current UFS and JEDI systems have a large overlap in their software dependencies, developments have diverged into separate software stacks (hpc-stack and jedi-stack). To avoid duplication of efforts and provide users and developers with a single system that supports both the UFS and the JEDI applications, NOAA-EMC and JCSDA in late 2021 joined efforts to develop spack-stack, a software stack that builds on the open-source spack package manager for supercomputers, Linux and macOS. spack-stack supports all NOAA RDHPC and WCOSS2 systems, all HPCs of the JCSDA partner agencies, Amazon Web Services, and NOAA ParallelWorks cloud computing platforms, generic Linux and macOS systems, and software containers.

We expect to roll out spack-stack in the first half of 2022 and to replace hpc-stack and jedi-stack by the end of the year. Excellent documentation and readily available support to the community will be required for a successful deployment of the system. To this end, we invite EPIC to join the development efforts to provide the users with a single, consistent set of instructions for how to build and run the UFS and JEDI applications.

Short Range Weather

Status and Opportunities with the Rapid Refresh Forecast System

Jacob R. Carley and Curtis R. Alexander

The Rapid Refresh Forecast System (RRFS) is NOAA's next convection-allowing, rapidly updated forecast system and is underpinned by the UFS. The implementation of the RRFS in 2024 will allow for the retirement of the large suite of legacy regional modeling systems currently in operations, ultimately leading to a simpler and more unified suite of operational models. The path toward this simpler, unified state presents a healthy challenge for the RRFS development community. In particular, the legacy systems (e.g. HRRR, NAM nest, HREF) have collectively benefitted from decades of development, setting a high performance standard for the first implementation of the RRFS. Growing engagement across the UFS has established a foundation for sustained community contributions that have, and will continue to, accelerate progress with the RRFS toward a successful first implementation (and many thereafter). In this talk we will discuss the current status of the RRFS, outstanding challenges, and emerging areas for community research contributions.

Unified Forecasting System results from recent NOAA/Hazardous Weather Testbed Spring Forecasting Experiments

Adam J. Clark, Israel L. Jirak, Burkely T. Gallo, Kent H. Knopfmeier, Brett Roberts, and Yunheng Wang

A major component of the 2021 and 2022 NOAA Hazardous Weather Testbed (HWT) Spring Forecasting Experiments (SFEs) has included assessment of various deterministic and ensemble FV3-LAM configurations within the Unified Forecasting System (UFS). This talk will highlight some of the most relevant and interesting comparisons, and gauge the progress of current UFS-based systems in meeting or exceeding the skill of current operational systems like the High- Resolution Rapid Refresh (HRRR) and the High-Resolution Ensemble Forecast (HREF) system for severe weather forecasting applications.

An overview of future research projects within UFS-RTMA framework

Miodrag Rancic, R. James Purser, Manuel De Pondeca, Edward Colon, Gang Zhao, Annette Gibbs, Ting Lei, Jacob Carley

The framework of the 3D Real Time Mesoscale Analysis (RTMA) project within the UFS represents an attractive test ground for research and development of novel methods and technologies which potentially may lead to overall significant improvements of real-time data assimilation. This presentation will summarize some of the ideas and projects that belong to this category. An important role in future developments will belong to the application of ML/AI technology. We plan to apply ML/AI to downscale the RRFS short-term forecast, which should lead to improved background fields for the 15-min updating 3D RTMA analysis. Along the way, we plan to introduce a short-term, 15 min, model forecast through an ML/AI proxy, which later may prove valuable for nowcasting. Another important development is the Multigrid Beta Filter (MGBF), a new, highly scalable method for the implementation of background error covariances based on the application of a beta filter with a parallel multigrid. A series of future upgrades of this technique will be described, such as, the development of an inhomogeneous, anisotropic version of the filter and the introduction of a multivariate option, which will add some degree of cross-covariances between the hitherto independent dynamical control variables of the assimilation scheme. We plan to apply ML/AI for the calibration of the MGBF, and to combine these two techniques for the estimation of the analysis uncertainty. With the anticipated transition of the analysis system from the GSI to the JEDI, the development of a MGBF version capable of handling unstructured grids has already begun. Other future projects include the development of a 4D-covariance capability extending the 3D RTMA, exploiting the RTMA's existing Hilbert curve projection and sorting software to test a scheme proposed to improve the preconditioning in the critical step of minimizing the cost function, and the application of the developed multigrid structure to speed up the minimization.

Development and research of assimilating GOES-16 ABI all-sky radiance observations in FV3-LAM using hybrid EnVar

Samuel K. Degelia and Xuguang Wang

The Rapid Refresh Forecast System (RRFS) aims to unify convective-scale data assimilation (DA) and modeling techniques around the Finite Volume Cubed-Sphere Dynamic Core (FV3). High resolution observations from the Advanced Baseline Imager (ABI) onboard GOES-16 can provide cloud information not detectable by the ground based radars. However, many questions remain about how to best assimilate these novel observations in the FV3 system. This presentation investigates methods for assimilating GOES-16 ABI all-sky radiances within the FV3 Limited Area Model (FV3-LAM). We will overview new developments that have been made for assimilating these observations in a hybrid EnVar system including additive noise inflation, observation-based relaxation to prior spread (RTPS), online bias correction using radar anchoring, and adaptive observation errors. Additionally, we will present analysis and forecast impacts when assimilating ABI all-sky radiances in FV3-LAM for 1) a supercell initiated along a dryline in Texas and 2) a severe nocturnal MCS. These impacts include a better analysis of synoptic-scale cloud features, faster spin-up of a supercell, and better suppression of spurious convection through the removal of spurious anvil clouds.

An FV3-LAM multiscale EnVar System for 2021 and 2022 Hazardous Weather Testbed Spring Forecast Experiments: Systematic impact of valid time shifting to increase ensemble size

Nicholas Gasperoni, Xuguang Wang, Yongming Wang, Tsung Han Li

The valid time shifting (VTS) method is a cost-effective way to increase the background ensemble size for ensemble-based data assimilation (DA) systems. This is accomplished by including ensemble information at valid times before and after the central analysis time from ensemble forecasts initialized from the base ensemble analysis at previous DA cycle time. This method effectively increases the first guess ensemble size by a factor of 3 at a fraction of the added cost to the DA system (≤ 50%). In this study, the VTS was implemented within the multiscale GSI-based hybrid ensemble variational (EnVar) system for the realtime 2021 and 2022 Hazardous Weather Testbed (HWT) Spring Forecasting Experiments (SFEs). This hybrid system is run by the Multi-scale data Assimilation and Predictability (MAP) laboratory and was previously implemented for realtime 2017-2019 HWT SFEs. Additionally, this convective-scale EnVar system was run fully coupled with the next-generation Finite Volume Cubed Sphere Limited Area Model (FV3-LAM) over the CONUS domain. The system includes both conventional in situ observations (mesoscale environment) and radar reflectivity (storm-scale) hourly DA components. For the 2021 SFE, the VTS configuration was tested for the storm-scale radar DA component only, and the results are compared with the baseline hybrid EnVar system run without VTS (NoVTS) over realtime forecasts from May 3 – June 4. Each system was run with RRFS-like hourly cycling of both radar and conventional observations, including 36 base ensemble members initialized at 18Z each day from GEFS. Quantitative neighborhood-based verification of 1-h precipitation and updraft helicity fields are presented from the 2021 SFE. Results show consistent positive impact of skill of the VTS approach in each of the above fields within the first 18 hours of the forecast, with larger differences at smaller scales of verification and for severe cases featuring upscale growth of convection During the 2022 SFE, the VTS is tested for both conventional and radar DA components, with the goal of identifying relative impacts of VTS for different scale components of the DA on forecasts of the mesoscale environment and convective systems. Subjective results show that radar-only VTS outperforms conventional-only and both-component VTS at early forecast hours, in part due to reduced spurious convection. However, both-VTS outperforms radar- only VTS at mid-range (6-12) hours, better matching the evolution of MCS structure. Preliminary objective verification and diagnostics will be presented from the 2022 SFE.

Evaluating the Impacts of Hourly Updating Lake Surface Conditions on the Lake-Effect Snow Forecasting Capabilities of the Unified Forecast System's Short-Range Weather Application

David Wright, Christiane Jablonowski, Ayumi Fujisaki-Manome, Lydia Gilbert, Bryan Mroczka, Philip Chu, Greg Mann, Eric Anderson, Brent Lofgren

The formation of lake-effect snowfall downwind of the Laurentian Great Lakes has been shown to be highly sensitive to lake surface conditions. Attempting to accurately capture the spatial and temporal variations in these conditions is paramount to successfully predicting the timing and intensity of the snowfall. During the winter months, cloud cover over the lakes often limits or delays the realization of these variations which restricts the use of remotely sensed products. This motivates the need for the model-based lake surface information in weather prediction models. This presentation will evaluate the forecast skill of the Unified Forecast System's Short-Range Weather Application (UFS-SRW) in simulating lake-effect snowfall over the Great Lakes region when providing the lake surface characteristics generated from the Finite Volume Community Ocean Model (FVCOM) hydrodynamic model. Updates to the UFS-SRW modeling framework have been made to allow for the lower boundary conditions (lake surface temperature, lake ice fraction, and lake ice temperature) of the atmospheric model to be updated hourly over the forecast horizon. Hourly updating and temporally static lake surface conditions provided by FVCOM will be compared to remotely sensed lake surface conditions to show the difference in forecast skill across the three methods. In addition, simulations using 1 km horizontal grid spacing over the Great Lakes will be presented to highlight current limitations in the explicit representation of lake-effect snowfall bands at 3km horizontal resolution in the UFS-SRW.

Medium Range Weather

Cycling prototypes: vehicle for collaboration and development of the MRW/S2S application

Sergey Frolov, Jeff Whitaker, Clara Draper, Daryl Kleist, Avichal Mehra, Fanglin Yang, Rahul Mahajan

The collaborative nature of the UFS development presents a unique challenge for streamlining individual contributions towards an operational transition. Consider the problem of the medium range weather prediction (MRW)—the cornerstone of the NOAA weather prediction capabilities. An integrated application for MRW will require coordination of development and timelines from the coupled modeling, physics development, data assimilation, and infrastructure groups. Each group might comprise contributors from the NOAA weather service and research labs, academia, and inter-agencies entities such as JCSDA. Conducting repeatable, controlled scientific experimentation across such a diverse community has been a challenge.

To coordinate the development and provide a structured path from research to operations, we propose a concept of coupled cycling prototypes. Each prototype will be comprised of freely available source codes, compiled executables, and software stack; fixed configurations for the model and data assimilation system; fixed initial conditions, observations and model forcings; and a reference set of outputs from a cycling prototype (including analysis, reforecasts, and observational scores). As NOAA develops a candidate for operational transition, a sequence of progressively more realistic (and computationally more expensive) cycling prototypes will be released to the development community. Unlike more formal reanalysis and reforecasts datasets that cover multiple decades and are updated infrequently, cycling prototypes are shorter in duration and are designed to allow the diverse community to repeat and improve upon a known scientifically valid and operationally relevant configuration. In this presentation, we will provide specific suggestions for the sequence of cycling prototypes that are considered in support of the GFSv17 and GEFSv13 transition targets. Preliminary results will be presented. We will also discuss opportunities for collaboration between UFS R2O, UFS community, and EPIC programs.

A Unified Stochastic Physics Framework for Simulating Uncertainty in Subgrid Processes

Jian-Wen Bao, Sara Michelson, Philip Pegion, Jeffrey Whitaker, Lisa Bengtsson, Cecile Penland

Numerical weather prediction (NWP) systems nowadays need to be capable of providing not only high-quality deterministic forecasts, but also information about forecast uncertainty. The ensemble forecast technique is commonly used to provide an estimation of forecast uncertainty. Since a great deal of the forecast uncertainty comes from dynamical and physical processes not resolved or explicitly represented numerically, there is a need to correctly quantify and simulate the uncertainty associated with these processes as required by the ensemble forecast technique. To address this need, we have developed a new stochastic physics scheme for simulating the uncertainty in parameterizations in the NOAA Unified Forecast System (UFS). This scheme is derived from the connection in mathematical physics between the Mori-Zwanzig formalism and multidimensional Langevin processes. It follows the correspondence principle, a philosophical guideline for new theory development, such that it can be shown that the previously implemented stochastic uncertainty quantification schemes in the UFS are particular cases of this scheme. We will show how we have used this scheme to simulate uncertainty at the process level of unresolved dynamics and physics in the UFS. We will also present a preliminary performance comparison of previously-implemented stochastic physics schemes with the newly-developed process-level scheme in the UFS medium-range ensemble prediction.

Physics Assessments by DTC in Support of the Upcoming GFS and GEFS 2024 Implementations

Weiwei Li, Man Zhang, Tracy Hertneky, and Ligia Bernardet

The next operational implementations of the Global Forecast System (GFS v17) and Global Ensemble Forecast System (GEFS v13) are scheduled for 2024, but work is already underway to code and test a number of upgrades to these modeling systems. While innovations are planned in all aspects of the end-to-end system, as a member of the Unified Forecast System (UFS) Research-to-Operations (R2O) physics subproject over the past two years, the Developmental Testbed Center (DTC) has been particularly involved in supporting the development and improvement of the physics suite. To shed light on error sources associated with the model physics, the DTC conducted both performance-level verifications and process-level evaluations, employing the Common Community Physics Package (CCPP) along with its Single-Column Model (CCPP SCM), the extended Model Evaluation Tools (METplus) package, and numerous in-house diagnostics. In particular, the DTC supported physics developers in adding their innovations to the CCPP, conducted experiments in one- and three-dimensional configurations, and analyzed results from its own runs as well as from runs conducted by developers and the NOAA Environmental Modeling Center (EMC) to determine the suitability for the upcoming implementations. For example, we contributed to a number of evaluations of alternate gravity wave drag (GWD) parameterization configurations, including the assessment of the small-scale orographic GWD implemented in the CCPP to ascertain that the new configuration did not adversely affect the canonical distribution of energy among various scales of motion. We evaluated innovations in the surface layer, planetary boundary layer (PBL) and convective representations, as well as in stochastic physics, which were important physics updates for operations. Also, evaluations of multiple versions of the Rapid Radiative Transfer Model for General Circulation Models (RRTMG-Parallel; RRTMGp) radiation scheme using the SCM experiments revealed that this new radiative scheme, or its coupling with other physical processes, produces excessively warm temperatures over Antarctica (Fig. 1). These evaluations, which on more than one occasion revealed bugs that were subsequently fixed by developers, contributed to the decision to adopt or reject specific innovations for the latest GFS/GEFS prototype, dubbed P8c. The integration of DTC testing and evaluation activities with development activities under the auspices of the UFS and UFS-R2O physics working groups represents a new and successful paradigm in cooperation. DTC assessed innovations at a rapid pace and in close collaboration with developers, providing actionable information to assist EMC and project leads in determining physics configurations for the upcoming GFS and GEFS implementation. This presentation will give an overview of highlights of these testing and evaluation activities.

The Development of UFS-based Coupled Global Ensemble Forecast System for weather and subseasonal forecast

Bing Fu, Yuejian Zhu, Philip Pegion, Hong Guan, Bo Yang, Eric Sinsky, Xianwu Xue, Jiayi Peng, Fanglin Yang and Avichal Mehra

The current operational Global Ensemble Forecast System version 12 (GEFSv12) was implemented in NCEP operations in September 2020. This is the first Unified Forecast System (UFS)-based GEFS which has demonstrated significant improvements in probabilistic forecast guidance at weather, medium range and sub-seasonal scales based on the evaluation of 31-year reforecasts and 3-year retrospective forecasts. Next, NOAA/NCEP is planning to implement a fully coupled UFS global forecast system (GFS) and GEFS around 2024. There is a critical need to test and evaluate the fully coupled GEFS experiments in preparation for the next model upgrade. Recently we have been working on the fully coupled GEFS versions following the development of UFS coupled model prototype version 5 (P5), version 7 (P7) and version 8 (P8). Besides major updates from the model components like land model, ocean model and ice model, there are also significant atmospheric model physics updates including PBL scheme, microphysics and gravity wave drag following the development of these model prototypes. In the meantime, three coupled ensemble prototypes, namely Ensemble Prototype 1 (EP1), Ensemble Prototype 2 (EP2) and Ensemble Prototype 3 (EP3), have been developed in alignment with those coupled deterministic model prototypes. These ensemble prototypes focus on quantifying forecast uncertainties through tuning and merging existing SKEB, SPPT scheme for atmosphere, introducing initial ocean perturbations and ocean stochastic schemes. This presentation aims to evaluate and compare the results from these coupled ensemble prototypes experiments as well as stochastic physics application, configuration and tuning progress in these coupled ensemble prototypes for weather and subseasonal forecast.

A Diagnostic Toolbox for Evaluating Stratosphere-Troposphere Coupling Processes in NOAA's UFS

Zachary D. Lawrence, Amy H. Butler, Laura Ciasto, Dillon Elsbury, Judith Perlwitz, Eric Ray

Stratosphere-troposphere coupling can be an important source of subseasonal to seasonal forecast skill. Processes and events involving the stratosphere such as sudden stratospheric warmings can modulate tropospheric processes in predictable ways and sometimes provide forecast windows of opportunity. However, models often struggle to represent such stratosphere-troposphere coupling processes; changes in the circulation related to model biases and parameterizations can feedback and alter the two-way coupling between the two layers. Here we present a diagnostic toolbox that has been used to evaluate subseasonal stratosphere-troposphere coupling processes in GEFSv12 hindcasts and recent UFS prototypes. We have used our toolbox to provide a comprehensive evaluation of stratosphere-troposphere coupling in GEFSv12, including in the context of other subseasonal prediction systems. Furthermore, by applying our toolbox to multiple UFS prototypes, we have been able to track the evolution of UFS-model stratospheric biases involving the quasi-biennial oscillation (QBO) and stratospheric polar vortex. Using a combination of GEFSv12 hindcasts and reanalysis has also allowed us to put constraints on the tropospheric response to extreme stratospheric polar vortex events in the UFS prototypes, highlighting the need for UFS-based ensemble forecasts.

Simulating Aerosol Direct Effect on Subseasonal Prediction Using a Coupled UFS with GEFS-Aerosols Model

Shan Sun, Georg Grell, Li Zhang and Judy Henderson

We investigate the aerosol direct effect on subseasonal predictions using NOAA's Unified Forecast System (UFS) – specifically, the coupled atmosphere (FV3), ocean (MOM6), wave (WW3) and sea ice (CICE6) model, combined with the current operational GEFS-Aerosols that is based on the GOCART aerosol modules from WRF-Chem. Experiments with 32-day integrations were carried out with initialization in May and September from 2003 to 2019. We found that in the multi-year simulations, the estimated aerosol optical depth from the online coupled aerosol component is in good agreement with the MODIS satellite observations. Two more parallel sets of experiments are carried out as well, using either modeled climatological aerosol concentrations or zero aerosol concentration in lieu of the aerosol model. The modeled radiative forcing of the aerosol direct effect is shown to be negative compared to the no-aerosol experiments. The UFS with the modeled climatological aerosol concentrations is able to capture most of the radiative forcing seen in the experiments with prognostic aerosols. This suggests a possible alternative of replacing the costly chemistry module with the modeled aerosol concentration climatology in the subseasonal applications.

Toward Initial Operational Capability: Progresses, Challenges, and Issues in Developing and Improving Hurricane Analysis and Forecast System (HAFS)

Zhan Zhang, Xuejin Zhang, Bin Liu, Avichal Mehra, Vijay Tallapragada, Sundararaman Gopalakrishnan, and Frank D. Marks, Jr.

The Hurricane Analysis and Forecast System (HAFS) is a Unified Forecast System (UFS) application for tropical cyclone (TC) prediction that is aimed to become operational in FY23. HAFS is a cloud-permitting, high-resolution regional atmosphere-ocean-wave coupled forecast modeling system with storm-following moving nests, vortex initialization, and an inner-core data assimilation system. The community-based HAFS is designed to promote research to operation to research (R2O2R) transitions and to provide forecasters with reliable, robust, and skillful guidance on TC track, intensity, including rapid intensification (RI), storm size, genesis, storm surge, rainfall, and tornadoes associated with TCs for all global oceanic basins. The Initial Operational Capability (IOC) of HAFS, planned for the 2023 hurricane season, will replace NOAA's current operational TC forecast systems, the Hurricane Weather Research and Forecasting (HWRF) model and Hurricanes in a Multi-scale Ocean-coupled Non-hydrostatic (HMON) model. HAFS is under active development at NOAA. To demonstrate the performance of HAFS and to prepare its IOC for FY23, multiple HAFS configurations have been tested in real time since 2019, supported by the Hurricane Forecast Improvement Program (HFIP). This presentation will update the current status of HAFS developments, discuss challenges and issues identified during the developments, and plans for HAFS IOC.

Developing Initial Operational Capabilities of Hurricane Analysis and Forecast System: Current and Future Priorities

Xuejin Zhang, Zhan Zhang, Avichal Mehra, Vijay Tallapragada, Frank D. Marks, Jr., and Sundararaman G Gopalakrisnan

Hurricane Analysis and Forecast System (HAFS) is planned to become the next-generation multi-scale numerical model for Tropical Cyclone (TC) application under the NOAA's Unified Forecast System (UFS) in the 2023 hurricane season. It has five salient components: (1) storm- following telescopic moving nests, (2) high-resolution physics configured for TC application, (3) multi-scale Data Assimilation (DA) with vortex initialization, (4) three-way atmosphere-ocean- wave coupling framework, and (5) intensive hurricane observational platforms to support the multi-scale DA system as well as the chosen physics packages and system verifications. We will present HAFS development priorities in the next 2-3 years after implementing IOC in the 2023 hurricane season. These development priorities are: flexible refinement for moving nest, multi-scale data assimilation, physics parameterizations for tropical cyclone, research and forecast products, the seamless research-to-operation transition mechanism, and the streamline public release process. The moving nest development prioritizes implementation of multiple moving nests, feedback and storm-storm interactions, and flexible refinement capability for moving nest. As an analysis and forecast system, HAFS will develop the multi-scale data assimilation system tailoring for tropical cyclone application. The multi-scale data assimilation component will be capable of assimilating available conventional, WSR-88D radar network, and satellite radiance and derived products for its large-scale environment and TC vortex, the special observations of TC vortex from Hurricane Field Program and coastal radar network at NOAA. Physics parameterizations will focus on microphysics parameterization and its interactions with other physics, Planetary Boundary Layer physics, air-sea-land processes, and ocean-wave- atmosphere coupling.

We will also develop new research and forecast products for research and operations from academia, private and public communities to align the community UFS effort. To accelerate the transition among development, operation, and community applications, we have developed a transition and public release model through collaborative projects among academia, research labs, NOAA's operational centers under the guidance of HFIP since 2009. We will follow this successful development process for HAFS development.

Moving Nest Implementation in the Hurricane Analysis and Forecast System (HAFS)

William Ramstrom, Xuejin Zhang, Kyle Ahern, and Sundararaman G. Gopalakrishnan

We have implemented moving nest functionality for the Hurricane Analysis and Forecast System (HAFS), an application of the Unified Forecast System (UFS), based on the Finite-Volume Cubed-Sphere (FV3) dynamical core. The moving nest code covers atmospheric prognostic variables, surface properties, and physics variables, permitting a high-resolution nest to follow a tropical cyclone or other moving system. The moving nest can resolve small-scale features, then interact with the parent grid through the two-way feedback mechanism. It has been implemented for both global and regional configurations. It can dynamically shift the model prognostic variables as well as all relevant physics variables, surface prognostic and diagnostic variables, and static terrestrial attributes. An internal storm tracker based on the storm tracking algorithm from HWRF automatically keeps the nest aligned with the storm center. We will discuss the latest developments and show forecast runs for high-impact hurricanes.

An Overview of HAFS physics parameterizations

Weiguo Wang, Bin Liu, Zhan Zhang, Avichal Mehra, and Vijay Tallapragada

The Hurricane Analysis and Forecast System (HAFS) is being actively developed under the NOAA Unified Forecast System operational hurricane model. Sub-grid scale processes are parameterized by several physics schemes for physical processes of the surface layer, boundary layer, cumulus convection. microphysics, radiative transfer, and etc on the scales smaller than the HAFS grid size. The current physics package follows that in the NCEP's global forecast system, with the modifications in the surface layer and boundary layer to improve intensity forecasts. We will describe the physics schemes that could be used in the first operational configuration, with focus on the tropical-cyclone-related modifications and their impacts on HAFS simulations. Challenges and future developments to improve physics schemes in tropical cyclone environments will be discussed.

The Regional Ocean-Coupled HAFS with a Storm-Following Moving Nest and Inner-Core Vortex Initialization and Data Assimilation

Bin Liu, Zhan Zhang, JungHoon Shin, Biju Thomas, Yonghui Weng, Li Bi, Weiguo Wang, Lin Zhu, Maria Aristizabal, John Steffen, Chuan-Kai Wang, Xu Li, Qingfu Liu, Avichal Mehra, and Vijay Tallapragada

As the Unified Forecast System's (UFS) hurricane application, Hurricane Analysis and Forecast System (HAFS) is a community-based data assimilation and air-sea-coupled modeling system capable of providing reliable, robust, and skillful model forecasts for tropical cyclones (TCs). HAFS development is one of the key strategies of the HFIP plan to address its science and research to operation challenges, and currently the initial HAFSv1 operational implementation is planned for the 2023 hurricane season to replace the operational regional hurricane forecast systems (HWRF and HMON). With the newly developed UFS-based static and moving nesting capabilities, a regional storm-centric ocean-coupled HAFS moving-nesting configuration was established with a 6-km regional parent and a 2-km storm-following moving nest. In addition, the sophisticated vortex initialization and inner-core data assimilation techniques were utilized to further improve its TC forecast skills. Retrospective tests were conducted with this regional storm-centric HAFS moving-nesting configuration for selected 2020 and 2021 North Atlantic storms to demonstrate its track and intensity forecast skills. This configuration is planned to be used in one of the 2022 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.

Coupled Model Development for Advanced Forecasting and Analysis of Extreme Water Levels

Kyungmin Park, Emanuele Di Lorenzoa, Fei yeb, Y. Joseph Zhangb, Harry Wangb, Ivan Federicoc, Nadia Pinardid

Coastal cities and communities are on the frontline as climate change swells oceans and redraws maps. Yet, despite the emerging threats of sea-level rise and flooding, water level information along most coasts is inadequate and relies on course resolution models and observations. The lack of information means it is impossible to capture the spatiotemporal variations in water levels associated with extreme events. Consequently, little is known of the underlying drivers of flooding in the rivers and creeks around residential areas. These limitations pose challenges for understanding, predicting, and mitigating the regional and city-scale impacts of natural catastrophes and climate-related coastal floods. They also imply that coastal communities cannot make proper data-driven decisions for coastal protection and management plans. This project is developing new high-resolution coupled model applications to overcome the limitation of existing technologies, and use the developed model to diagnose and understand the role of extreme water level drivers along the East Coast of the United States. Currently, the developed model plays a key role in the 3-day forecast system in Chatham County (GA), which has been used by the Chatham Emergency Management Agency and the City of Savannah to plan emergency protocols and advance a city-wide resilience planning process. The high-resolution models will support and be combined with the recently launched hyper-local water level sensing network that the Southeast Coastal Ocean Observing Regional Association (SECOORA) is developing to serve real-time data to coastal communities along the entire Southeast coast of the United States. Using the models developed here, a series of sensitivity simulations will provide the data to assess the relative roles and contributions of different hurricane forces on spatial and temporal patterns of extreme water levels. This study shows that oceanic adjustments to hurricane forcing (e.g., change in Gulf Stream, upwelling/dowelling and Ekman transport) have a higher influence on extreme water levels on the U.S. southeast coast than local atmospheric wind and pressure. It reveals that the oceanic adjustments cause rebounding water levels even after hurricanes dissipate, which can reach up to a high tide level on the Georgia coast. These new insights into the multiple drivers of abnormal sea levels before/during/after hurricane events provide critical data needs and best practices to scientists, engineers and policymakers.

In-Person Posters

How can we drastically decrease spin-up compute time for Land Surface Models while keeping the current physical parametrizations?

Luiz Bacelar, Nathaniel Chaney

Computational efficiency is a target for any operational forecast system. One of the deficiencies of these systems is the computational time required to assemble initial conditions over land; this is especially important as the community continues to move towards finer spatial resolutions. Most continental forecast systems still discretize LSMs in a regularly spaced grid, which makes higher spatial resolution frameworks limited in number of ensemble runs due to its computational cost. HydroBlocks incorporates a tilling scheme in Noah-MP LSM by unregularly shaped Hydrological Response Units (HRUs), decreasing the space of calculation at the same time which preserves a high-resolution land heterogeneity representation. The hierarchical scheme of unsupervised machine learning algorithms enables the clustering of regions by hydrological behavior, avoiding an unnecessary overload of computational resources. This work demonstrates how the LSM component of HydroBlocks converges to the same gridded structure of Noah-MP in WRF-Hydro hydrological model. When varying the number of clusters on Hydroblocks, 2 years of continuous hourly simulations can be done in a fraction of 0.00082325 of WRF-Hydro cores-hour. In a specific configuration of HRUs, we tested an ensemble workflow when perturbating different physical parameters on Noah-MP. The results were compared with remote sensed Land Surface Temperature for different time-scales. Our experiments were performed in White Sulphur Springs neighborhood, located in a steep watershed in West Virginia, highly susceptible to flash flood events. Hydroblocks tilling scheme could potentially decrease the operational wall- time of Noah-MP LSM spin-up periods, while keeping the same options of physical parametrizations. The proposed architecture could make it possible to enable ensemble runs, as the operational forecasting capabilities move towards a generation of hyper resolution LSM.

Developing a consistent wind-wave-current data assimilation scheme for the 3D-RTMA

Malaquías Peña, Stylianos Flampouris, Manuel Pondeca, Enrique Curchitser, Leonel, Romero, Cesar Rocha, Isidora Jankov, Jacob Carley, Guillaume Vernieres, Daryl Kleist

The two-dimensional Real-Time Mesoscale Analysis (RTMA) suite implemented in 2006, with numerous upgrades through 2021, has been a cornerstone for guidance, monitoring, nowcasting, and forecast verification in its role as the NWS analysis of record. With the inclusion of Significant Wave Height (SWH) in the 2018 implementation, the RTMA expanded its capabilities to support NWS forecast offices in charge of providing coastal, marine and ocean analyses with estimates of the state of waters at the margins of the continental U.S. Leveraging the ongoing NOAA developments of the RRFS, the 3D-RTMA, and JEDI within the EMC's Data Assimilation Team, the UFS-R2O, and the JEDI project, a new project has been selected to advance the science and technology of data assimilation of surface wind, sea wave, and surface ocean current for 3D-RTMA. Analysis of marine variables requires an effective exploitation of observational information and the integration of models that capture key processes and air-sea interactions occurring over a wide range of spatial and time scales. The proposed project aims to improve the blending of global and local-scale weather and oceanographic variability by expanding the JEDI protocols for marine observations and advanced data assimilation, and by applying sound scientific principles of mesoscale modeling. Its main outcome is a 3DRTM version with consistent wind-wave-currents variables, with evaluation and recommendations for operational implementation. The numerical outcomes of these proposed system will facilitate mesoscale data to a community of practice for observing data impact, data integration, and coastal model evaluation. Four key analysis enhancements are identified and will be addressed: physical consistency in the three-way interaction wind-waves-currents, reduced bias of the background fields, higher fidelity of fields, and improved analysis uncertainty. To achieve the proposed enhancements the following objectives are pursued: (1) to increase the robustness of the data quality control system for marine and ocean variables–especially the High-Frequency radar and satellite altimetry data, (2) to implement the IODA libraries for preparation of forward operators for each of the new observations to be included, (3) to implement an appropriate configuration of the regional MOM6 ocean model to provide surface current's first guess fields, (4) to implement a bias-correction scheme for positional and amplitude error reduction in the background fields, and (5) to develop and evaluate configurations of the background error covariance across the three fields. In collaboration with the JEDI project, the team is intended to design, develop, and test a hybrid data assimilation scheme of wind-wave assimilation constrained to current conditions.

The impact of tropical SST biases on the S2S precipitation forecast skill over the Contiguous United States in the UFS coupled model

Hedanqiu Bai and Cristiana Stan

This work investigates the impact of tropical sea surface temperature (SST) biases on the subseasonal to seasonal (S2S) precipitation forecast skill over the Contiguous United States (CONUS) in the Unified Forecast System (UFS) coupled model Prototypes 5 and 6. Boreal summer (June - September) and winter (December - March) for 2011-2018 were analyzed. Impact of the tropical West Pacific and tropical North Atlantic warm SST biases is evaluated using multivariate linear regression. A warm SST bias is found over the tropical West Pacific. This bias influences the CONUS precipitation remotely through the wave-activity flux in both seasons. During boreal winter, a warm SST bias is found over the tropical Atlantic. This bias partly affects the pressure center of the North Atlantic Subtropical High (NASH), which in the forecast is weaker than in reanalysis. The weaker NASH favors an enhanced moisture transport from the Gulf of Mexico, leading to increased precipitation over the southeast US. During boreal summer, the NASH pressure center is also weaker and in addition, its position is displaced to the northeast, thus further regulating the CONUS summer precipitation. The SST biases over the two tropical regions and their impact become stronger as the forecast lead increases from week 1 to 4. The variance of the CONUS precipitation errors explained by the SST biases is up to 10%. These results suggest that by correcting the tropical SST biases in the coupled model, the precipitation forecast skill may improve moderately regardless of biases in other fields.

Displacement Error Characteristics of 500-hPa Troughs and Cutoff Lows in Operational GFS Forecasts

Kevin M. Lupo, Craig Schwartz, Glen Romine

Cutoff lows are often associated with high-impact weather; therefore, it is critical that operational numerical weather prediction systems accurately represent the evolution of these features. However, medium-range forecasts of upper-level features using current and previous versions of the UFS MRWA are often subjectively characterized by excessive synoptic progressiveness, i.e., a tendency to advance troughs and cutoff lows too quickly downstream. To better understand synoptic progressiveness errors, this research quantifies seven years of 500-hPa trough and cutoff low position errors over the Northern Hemisphere, with the goal of objectively identifying regions where synoptic progressiveness errors are common. Specifically, 500-hPa features are identified and tracked in 6–240-hour 0.25° GFS forecasts during April 2015–March 2022 as local maxima in the slope of the 500-hPa geopotential height field and compared to corresponding 500-hPa GFS analyses. Features identified in short- and medium-range forecasts both prior to and following the transition of the GFS to the FV3 dynamical core are generally associated with easterly zonal position errors over the conterminous United States (CONUS) and northern Eurasia (e.g., Fig. 1). Additionally, the forecast distribution of mid-latitude 500-hPa cutoff lows appears to be shifted poleward over these regions with respect to verifying analyses, such that the mean latitude of cutoff lows generally increases with forecast hour. The persistent easterly position errors are consistent with anecdotal cases of synoptic progressiveness over the CONUS and suggest that systematic progressiveness errors possess regional variability over the Northern Hemisphere. Further research is planned to identify conditions under which cases of synoptic progressiveness occur and to examine potential deficiencies in model physics, which may influence these errors.

Overlapping Windows in a Global Hourly Data Assimilation System

Laura C. Slivinski, Donald E. Lippi, Jeffrey S. Whitaker, Guoqing Ge, Jacob R. Carley, Curtis Alexander, Gilbert P. Compo

The US operational global data assimilation system provides updated analysis and forecast fields every six hours, which is not frequent enough to handle the rapid error growth associated with fast-moving hurricanes or other storms. This motivates development of an hourly-updating global data assimilation system, but observational data latency can be a barrier. Two methods are presented to overcome this challenge: “catch-up cycles”, in which a 1-hourly system is reinitialized from a 6-hourly system that has assimilated high-latency observations; and “overlapping assimilation windows”, in which the system is updated hourly with new observations valid in the past three hours. The performance of these methods is assessed in a near-operational setup using the Global Forecast System by comparing short-term forecasts to in-situ observations. In this metric, the overlapping windows method generally outperforms the 6-hourly control. The catch- up cycle method performs similarly to the 6-hourly control; reinitializing from the 6-hourly control does not appear to provide a significant benefit. Results suggest that the overlapping windows method performs well in part because of the hourly-update cadence, but also because hourly cycling systems can make better use of available observations.

Updating Anthropogenic Emissions for NOAA’s Global Ensemble Forecast Systems for Aerosols (GEFS-Aerosols): Application of Bias Scaling Methods

Gill-Ran Jeong, Barry Baker, Patrick C. Campbell, Rick Saylor, Li Pan, Partha Bhattacharjee, Daniel Tong, and Youhua Tang

Anthropogenic emissions are essential inputs to air quality and climate models. Because of the required time and effort in the development of anthropogenic emissions inventories, their representation in models is typically not up-to-date with the most recent human activities. In this work, we first update the anthropogenic emissions inventory in NOAA’s operational Global Ensemble Forecast-Aerosols (GEFS-Aerosols) to demonstrate the strong impact on the model’s prediction of Aerosol Optical Depth (AOD), and then we propose a methodology to quickly update the pivotal global anthropogenic sulfur dioxide (SO2) emissions using an AOD bias scaling method. The global anthropogenic emissions are updated from the Community Emissions Data System (CEDS) version 1, representative of the 2014 emissions year, to CEDS version 2, representative of the 2019 emissions year. The AOD bias-scaling method is based on the latest model predictions compared to NASA’s Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA2), and the model bias is subsequently applied to the CEDS 2019 SO2 emissions for adjustment. The monthly mean GEFS-Aerosols AOD predictions are evaluated against a suite of satellite observations (e.g., MISR, VIIRS, and MODIS), ground-based AERONET observations, and the International Cooperative for Aerosol Prediction (ICAP) ensemble results. Results show that updating from the CEDS 2014 to CEDS 2019 emissions leads to significant improvement in the operational GEFS-Aerosols model performance while the application of the bias scaled SO2 emissions can further improve the global seasonal correlation (*r*) and Index Of Agreement (IOA) of predicted AOD against AERONET, particularly for the December-February (DJF) season by 15.8% to 22.2% and -1.1% to 3.7%, respectively. There is a significant improvement in correlation, mean biases, and IOA for modeled AOD against AERONET when applying the bias scaled SO2 emissions in Asia with relatively high correlations ($r > 0.7$), but less so in Europe with moderate correlations ($0.4 < r < 0.5$). Despite relatively high AOD correlations in India, the bias scaling approach slightly degrades model performance, especially during June-August (JJA) by 0.93 to 0.92, which coincides with the Indian wet Monsoon season (i.e., during increased wet scavenging/deposition). Additional studies on emission sources of organic and black carbon aerosols, as well as improved aerosol sink processes, are needed to further improve the GEFS-Aerosols model performance across different global regions.

How predictable is short-term drought in the northeastern United States?

Carlos M. Carrillo, Colin P. Evans, Brian N. Belcher, and Toby R. Ault

We investigated the predictability (forecast skill) of short-term droughts using the Palmer Drought Severity Index (PDSI). We incorporated a sophisticated data training (of decadal range) to evaluate the improvement of forecast skill of short-term droughts (3-month). We investigated whether the data training of the synthetic North American Multi-Model Ensemble (NMME) climate has some influence on enhancing short-term drought predictability. The central elements are the merged information among PDSI and NMME with two post-processing techniques. (1) The bias correction – spatial disaggregation (BC-SD) method improves spatial resolution by using a refined soil information introduced in the available water capacity of the PDSI calculation to assess water deficit that better estimates drought variability. (2) The ensemble model output statistic (EMOS) approach includes systematically trained decadal information of the multi model-ensemble simulations. Skill of drought forecasting improves when using EMOS, but BC-SD does not increase the forecast skill when compared with an analysis using BC (low spatial resolution). This study suggests that predictability forecast of drought (PDSI) can be extended without any change in the core dynamics of the model but instead by using the sophisticated EMOS post-processing technique. We pointed out that using NMME without any postprocessing is of limited use in the suite of model variations of the NMME, at least for the US Northeast. From our analysis, 1-month is the most extended range we should expect, which is below the range of the seasonal scale presented with EMOS (2-month). Thus, we propose a new design of drought forecasts that explicitly includes the multi-model ensemble signal.

A Numerical Investigation of Compound Flooding during Hurricane Harvey (2017) using a Dynamically Coupled Hydrological-Ocean Model

Daoyang Bao, Z. George Xue, Dongxiao Yin

Now at the Department of Physical Sciences, Virginia Institute of Marine Sciences Hurricane-induced compound flooding is a combined result of multiple processes, including overland runoff, precipitation, and storm surge. Hurricane Harvey made landfall in Texas in August 2017 as a Category 4 Hurricane and brought historic amounts of rainfall to southern Texas. The combined effect of rainfall and wind produced a typical compound event in the Houston-Galveston Bay region. In this study, Harvey-induced compound flooding was investigated by a novel coupled hydrological-ocean modeling suite, where a state-of-the-art hydrological model (WRF-Hydro) is connected with a regional ocean model (ROMS) on the platform of the Coupled Ocean-Atmosphere-Wave and Sediment Transport Modeling System(COAWST). The hydrological and oceanic processes were simulated by WRF- Hydro and ROMS, respectively. The compound effect was achieved through the seamless coupling along the boundary shared by the two models. Preliminary model results showed that the coupled model performed well in reproducing the compound effect between runoff and storm surge. With a series of sensitivity experiments, the contribution from different processes was untangled and quantified.

Hydrodynamic and Biochemical Impacts on the Development of Hypoxia in the Louisiana– Texas Shelf: Statistical Modeling and Hypoxia Prediction

Yanda Ou , Bin Li, Z. George Xue

A novel ensemble regression model was developed for hypoxic area (HA) forecast in the Louisiana–Texas (LaTex) Shelf. The ensemble model combines a zero-inflated Poisson generalized linear model (GLM) and a quasi-Poisson generalized additive model (GAM) and considers predictors with hydrodynamic and biochemical features. Both models were trained and calibrated using the daily hindcast (2007–2020) by a three-dimensional coupled hydrodynamic– biogeochemical model embedded in the Reginal Ocean Modeling System (ROMS). A promising HA forecast is provided by the ensemble model with a low RMSE (3,256 km2), a high R2 (0.7721), and low mean absolute percentage biases for overall (29 %) and peak HA prediction (25 %) when compared to the hindcasts. Compared to the Shelf-wide cruise observations, this ensemble model provides an efficient yet more accurate daily HA forecast for the LaTex Shelf than the prevailing NOAA-supported forecast models for the recent years (2012–2020) with a high R2 (0.9200), a low RMSE (2,005 km2), a low SI (15 %), and low mean absolute percentage biases for overall (18 %), fair-weather summers (15 %), and windy summers (18 %) predictions. To test its robustness, the model was further applied to a global forecast model and produces HA prediction from 2012 to 2020 with the adjusted predictors from the HYbrid Coordinate Ocean Model (HYCOM).

Representation of Partial Cloudiness Effect in a Bulk Cloud Microphysics Scheme

Song-You Hong, and So-Young Kim

An alternative concept to represent the partial cloudiness effect on the microphysical processes of a bulk microphysics scheme is proposed. Based on the statistical relationship between cloud condensate and cloudiness, all hydrometeors in the microphysical processes are treated after converting them to in-cloud values by dividing the amount by estimated cloudiness and multiplying it after the computation of all microphysics terms. The underlying assumption is that all the microphysical processes occur in a cloudy part of the grid box. In a 2D idealized storm case, the Weather Research and Forecasting (WRF) single-moment 5-class (WSM5) microphysics scheme with the proposed approach increases the amount of snow and rain through enhanced autoconversion/accretion and increases precipitation reaching the surface.

Regional HYbrid-Coordinate Ocean Model (HYCOM) coupling Hurricane Analysis and Forecast System (HAFS)

Hyun-Sook Kim, Dan Rosen, Bin Liu, Zhan Zhang, and Avichal Mehra

HAFS is planned to become operational in FY23, to replace NOAA's current operational TC forecast systems - the Hurricane Weather and Research and Forecasting (HWRF) and Hurricanes in a Multi-scale Ocean-coupled Non-hydrostatic (HMON). HAFS has initially developed with HYCOM coupling, and has been tested in near real-time each season since year 2019. The latest development includes merging it to the Unified Forecast System (UFS) framework, and adding WAVEWATCHIII to allow the feedback of sea surface roughness to the atmospheric component, FV3. The ocean component is the same HYCOM as in HWRF and HMON, which has proven the modeling skill since 2014 and 2017 respectively. This presentation will introduce differences of coupling framework between HAFS and sun-setting operational systems, domain configurations, potential coupling capability, and comparisons of forecast skills.

A High-resolution Operational Forecast System for Mississippi River Basin: Calibration for Lower Mississippi River Watershed

Xiaochen Zhao, Z. George Xue, Wei Yu3, Dongxiao Yin, Daoyang Bao, Yixuan Wang

The Mississippi River Basin is the largest drainage basin that encompasses > 50% of rivers in the contiguous United States (CONUS). Its associated hydrological processes are vital to modulate regional hydroclimate variability, especially given the increasing hydroclimate extremes (e.g., drought and flood) under a warming climate. Moreover, the vast river discharge contributes a large amount of nutrient-enriched fresh water to the northern Gulf of Mexico, heavily influencing the stability of the coastline and the health of the marine ecosystems. Advances in the assessment of the hydrological processes within the Mississippi River Basin are urgently needed to improve our understanding of those impacts at different spatiotemporal scales. Recent advances in the open-source community hydrological model (WRF-Hydro) incorporate relevant hydrological processes driven by a land surface model (NoahMP), and thus provide accurate forecasts for hydroclimate trend and streamflow. Nevertheless, current modeling efforts mainly focus on continental-level simulations (e.g., National Water Model or NWM). The purpose of this study is to construct a flexible operational Mississippi River model at a high spatial resolution (100 m). The operational model can provide real-time streamflow forecasts for either small-scale nested domains or the whole watershed. The real-time system design can be deployed to different regions and driven by different weather models. This operational forecast system will be part of an integrated regional earth system modeling platform that covers both the Mississippi River Basin and the Gulf of Mexico. We expect this forecasting tool to provide an ensemble forecast of hydrological and coastal extreme events to protect infrastructure and communities, including frequent flooding triggered by cyclones. Such a system can also be used to project medium- and long-term hydroclimate trends and ocean conditions and help to plan regional river and coastal water management initiatives and programs.

Exploring new data assimilation methodology within the NOAA Hurricane Analysis and Forecast System

Jonatha Poterjoy

A multi-institutional effort is currently underway to develop state-of-the-art ensemble-based data assimilation capabilities for the next generation NOAA Hurricane Analysis and Forecast System (HAFS). This project will ultimately provide the framework for generating regional FV3 forecasts conditioned on all operationally available measurements, including those from aircraft reconnaissance flights into tropical cyclones. One sub-goal of this research is to explore fundamental questions related to the design of data assimilation methods that can overcome challenges associated with satellite radiance data assimilation. The primary challenges include: 1) observation bias correction in a limited-area model framework, 2) correcting bias in ensemble-estimated background uncertainty for limited-area models, which follows from the small number of members affordable for high-resolution applications, and 3) non-Gaussian error distributions for multi-scale flow. This presentation will touch on new developments that target all three of these topics. The obstacles presented by the third problem are quite general and present a major challenge for all weather prediction systems that seek faithful probabilistic predictions of mesoscale processes. Therefore, the research methodology adopted for this project includes newly developed Bayesian state estimation techniques in the form of localized particle filters and hybrid methods that combine particle filters with Gaussian-based ensemble Kalman filters and variational data assimilation methods. This presentation will review findings from multi-week experiments performed during an active portion of the 2020 Atlantic Hurricane seasons and discuss long-term implications for adopting non-Gaussian data assimilation for global weather prediction and model physics evaluation.

Using UFS forcing with a single column model: Can we reduce the steps in the development hierarchy?

Dustin Swales, Grant Firl, Mike Ek

Developing and implementing a new physics parameterization for use in an operational setting requires extensive testing and evaluation. This is to ensure that new developments aren't yielding unexpected results and that all computational considerations are being met. From a scientific perspective, this process should be incremental and hierarchical: starting with initial testing of a simple idealized case, then progressing to fully-coupled high-resolution global forecasts on high-performance computing systems. Unfortunately, at the end of this hierarchy, computational time and resource limitations can be problematic and slow development. Using the Common Community Physics Package (CCPP) Single Column Model (SCM) developed by the Developmental Testbed Center (DTC), and driving it with dynamic tendencies from a high-resolution Unified Forecast System (UFS) forecast run, developers would have the ability to get a sense of how their new physics scheme(s) would behave in a fully coupled model, but without the computational burden. Here we test the feasibility of this approach by using forcing from a high-resolution UFS forecast to "replay" the SCM. Our interest is to explore how well the SCM recovers the "UFS state", at first for a forecast at a single column, then eventually using an ensemble of replay columns.

Better Utilization of UFS Ensemble Forecast Information Within the National Weather Service Through Ensemble Clustering and Sensitivity Tools

Bill Lamberson, Brian Colle, and James Nelson

An important component of the UFS system is post-processing, which facilitates usage of the model data by forecasters. Operational forecasters are increasingly incorporating ensemble forecast information into their forecast processes, since it provides information on forecast uncertainty and the range of possible forecast scenarios. This is increasingly becoming a requirement for providing effective Impact-based Decision Support Services (IDSS), a core mission of the NWS. However, forecasters need tools that will help them quickly visualize ensemble forecast data and assess forecast uncertainty and the range of possible forecast solutions. One way to accomplish this is through a post-processing technique known as ensemble clustering. The Weather Prediction Center (WPC) and Stony Brook University (SBU) developed an ensemble clustering tool. The ensemble clustering tool is a post-processing technique that groups ensemble members with broadly similar forecasts together. Another tool is ensemble sensitivity analysis (ESA), a post-processing technique that identifies upstream sensitive regions for a given forecast. This presentation will first overview the multi-model ensemble clustering tool developed by WPC and SBU as part of a NOAA JTTI project to assist forecasters in the preparation of medium-range forecasts. The ensemble clustering tool is an application of fuzzy clustering where ensemble members from the Global Ensemble Forecast System (GEFS) from the UFS, the Canadian Global Ensemble Prediction System (GEPS), and the European Center for Medium Range Weather Forecasts Ensemble Prediction System (ENS) are clustered based on their 500-hPa geopotential height forecasts. A new online software package to do the clustering will be highlighted, which will be available to select NWS field offices for testing in 2022. Feedback from NWS forecasters has shown that the tool also helps them better communicate the forecast and its uncertainty to core partners. A new NOAA JTTI project that will make ESA more available to the forecasters using this same ensemble dataset will also be highlighted.

IOOS Coastal Modeling Cloud Sandbox

Patrick Tripp, Tiffany Vance, Chris L Paternostro, Kris Holderied, Kelly Knee, Parker MacCready

NOAA's Integrated Ocean Observing System (IOOS) and its partners across the National Ocean Service, have developed a Coastal Modeling Cloud Sandbox that provides a framework to foster collaboration across government, industry, and the academic research community. The Sandbox, using Amazon Web Services (AWS), provides a production quality multi-node high performance computing environment to facilitate experimentation, operational fail-over, hindcasting, and more. The goals of the Sandbox include aiding research to operations, improving efficiency, speed, and accessibility, and are aligned with the goals of the coastal coupling community, EPIC, and the Unified Forecast System (UFS) development. Deployment is user and administrator friendly by applying an Infrastructure as Code (IaC) solution to the complex task of creating all the required commercial cloud resources such as storage, networking, and security. The required software libraries and applications needed for running and developing models are also included as part of the Sandbox deployment. Many models have run successfully in the Sandbox including the UFS Short-Range and Medium-Range Weather Applications, operational versions of the National Ocean Service (NOS) forecast models, the University of Washington's LiveOcean model, ADCIRC, the ESMF coupled WRF/ROMS model, and others. It is hoped that this community-based tool will be used to accelerate the integration of regional coastal models into the UFS.

Operational Requirement Test System for the UFS Weather Model Development

Minsuk Ji, Denise Worthen, Jun Wang, Brian Curtis, Dusan Jovic, Bin Li, Arun Chawla

The UFS weather model (UFS WM) is the source system for NOAA's operational numerical weather prediction applications. Changes committed to its code repository need to meet a set of requirements to ensure good code quality. A test system has been developed based on the UFS WM regression test framework to support robust and reproducible source code. The system will take a new feature test case and check the reproducibility with repeated runs, using a different number of threads, decompositions and MPI tasks. The system will also perform the restart run based on the test case and check the reproducibility. It will run the test case in debug mode to catch any compile and run time errors as well. These requirement tests pave away for the development work to smoothly transition to operation. It can also be used as a diagnostic tool to resolve issues associated with code updates. To ensure that these operational requirements are met, a feature test is required for any new feature development and needs to pass this operational requirement test, which is also called the code quality requirement tests. The system comprises a number of shell scripts and is integrated into the repository code management process which involves reviewing, testing and merging code changes from a pull request. This system is part of the UFS hierarchical testing framework that supports research to operation transition in the UFS development community.

Evaluating NOAA GEFSv12 Subseasonal Reforecasts for Predicting U.S. Drought

Hailan Wang, Li Xu, Andrew Badger, Michael Barlage, Helin Wei

Drought is among the most expensive recurring natural disasters to affect the United States (U.S.). Skillful and reliable drought prediction is essential for preparing for and mitigating drought related impacts and costs. This study evaluates and investigates the NOAA GEFSv12 subseasonal reforecasts for predicting U.S. drought out to five weeks, with a focus on the key indicator for agricultural drought – soil moisture. Observational references used for the evaluation consist of in-situ observations and land analysis estimates produced by driving a Noah land surface model (LSM) offline with NLDAS-2 hourly atmospheric forcings, preceded with a sufficient land surface spin-up. The evaluation identifies the dependence of the forecast skill on aspects including regions, seasons, drought events and drought phases. The investigation proceeds by connecting soil moisture forecast skill to its contributing factors, which include the forecast skill of atmospheric forcings (e.g., precipitation, temperature), initial soil moisture anomalies, the accuracy of soil moisture initialization in the GEFSv12 forecast system, and the performance of the GEFSv12 Noah land surface model (LSM). The results show that as the forecast skill of precipitation and temperature decreases with lead time, the skill for soil moisture shows noticeable decrease for week three and beyond, particularly over the southeastern U.S. and coastal Pacific northwest in the topsoil layers, where the effects of the atmospheric forcings are more prominent. Initial soil moisture anomalies contribute substantially to the soil moisture forecast skill, owing to their intrinsic memory on subseasonal timescale. An evaluation of the GEFSv12 initial soil moisture anomalies, however, shows low accuracy in much of the western interior U.S., which adversely impacts soil moisture forecasts for these regions. The low accuracy is found to in part result from the biases of atmospheric forcings (e.g., precipitation) in the GEFSv12 reanalysis, in part from the insufficient land surface spin-ups in the GEFSv12 reanalysis streams. The implications of these results for the development of GEFSv13 forecast system, particularly its land initialization, will be discussed.

Virtual Posters - Please see the Slack Poster Channel for all Abstracts

Cross-Cutting #1

On the Development and Evaluation of Atmospheric Model Physics for the Unified Forecast System Applications Across Scales

Fanglin Yang, NOAA/NWS/NCEP Environmental Modeling Center

NOAA is collaborating with the US weather and climate science community to develop the next generation fully coupled earth system modeling capability for both research and operational forecast applications across different temporal and spatial scales. This presentation describes major changes and updates of atmospheric model physics which are planned for both the global and regional models, including the Global Forecast System (GFS) version 17, Global Ensemble Forecast System (GEFS) version 13 and the Rapid Refresh Forecast System (RRFS) version 1. Strategies are developed to first test individual physics parameterizations in atmospheric-only forecast experiments in the aforesaid applications and then to further evaluate and improve the parameterizations in the integrated earth system modeling applications to reduce model systematic biases and maximize model prediction skills. Significant efforts are made to unify physics parameterizations for all applications to speed up the transition of future physics innovations to operation and to reduce the cost of operational systems maintenance. A few samples will be presented to highlight the successes and challenges of unifying physics parameterizations across scales.

Acknowledgment: This project is a collaborative community effort. Contributions are acknowledged made by Jongil Han, Michael Balarge, Shrinivas Moorthi, Helin Wei, Anning Cheng, Ruiyu Sun, Jili Dong, Eric Aligo, Qingfu Liu, Weizhong Zheng, Rongqian Yang, Yihuya Wu, Wei Li, Lisa Bengtsson, Jian-wen Bao, Michael Toy, Valery Yudin, Shan Sun, Benjamin

Green, Tanya Smirnova, Robert Pincus, Dustin Swales, Joe Olson, Songyou Hong, Evan Kalina, Ligia Bernardet, Weiwei Li

Enhancing Community UFS Land Model Development Through Advancing Land Component and Land Data Assimilation Capabilities

Michael Barlage, NOAA/EMC; Rocky Dunlap, NCAR; Clara Draper, NOAA/PSL; Ufuk Turuncoglu, NCAR; Justin Perket, EMC/GFDL; Azadeh Gholoubi, IMSG@EMC; Zhichang Guo, SRT@EMC; Jiarui Dong, IMSG@EMC

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 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 on-going efforts in addressing and coordinating within UFS: a land evaluation framework, a JEDI-based land data assimilation capability and land model physics advances both within the CCPP physics repository and through a separate land component.

To facilitate UFS community engagement and accelerate R20 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 identification of specific parameterizations that are the source of poor model performance. The evaluation framework is being extended beyond traditional meteorologic validation to land process metrics that focus on the interactions between land and the atmosphere.

The presentation will focus more deeply on two ongoing efforts in UFS Land development with a community focus: creation of a component land model capability in UFS and creation of a JEDI-based land data assimilation capability.

A successful UFS land effort will expedite community involvement in land model development, contribute to looking beyond the land surface model as a boundary condition by providing land surface process-level information to expanding user communities.

Advancements in WAVEWATCH III modeling Framework

Ali Abdolali, Matthew Masarik, Ricardo M. Campos, Denise Worthen, Kyle Gerheiser, Avichal Mehra, Aron Roland, Tyler Hesser, Mary Bryant and Jane M. Smith

The third-generation wave model WAVEWATCH III (WW3) is an open-source community model under active growth in terms of accuracy, efficiency, and applications. In parallel, advancements in the coupling infrastructures between the atmosphere, ocean, and earth systems together with the availability of multiple sources of observations provide an opportunity to expand the model applications from large scale to regional and coastal applications, taking into account various physical processes at various temporal and spatial scales from short-range weather to sub-seasonal to seasonal wave dynamical variability. A few major recent improvements in the model include: the domain decomposition parallelization with the optional implicit scheme; updated depth breaking formulations; and wave-vegetation interaction sink term in wetlands for nearshore applications. With these WW3 has become a powerful tool to efficiently resolve complex shorelines and high-gradient wave zones, incorporating dominant physics in the complicated coastal zones such as wave breaking, wave-current interaction, bottom friction, and scattering, wave-vegetation interaction, and Nonlinearity. For large-scale utilization, the model is actively used in the ufs-weather-model for global and regional applications coupled with atmospheric, sea ice, and ocean circulation models. A significant effort has been made to improve coupling efficiency by introducing a new CESM compatible cap with the mediator and state-of-the-art computer simulations of the Earth's past, present, and future climate states.

In terms of enhancements in the infrastructure, the build system in the WW3 model has been upgraded to Cmake, to improve performance and ease of use. CMake is a widely-used, cross-platform, open-source build system generator that has become a standard in the software community. Compared to the traditional Bash/Make build, CMake offers portability, standardization, and out-of-source builds.In addition, an optimization tool has been developed to tune physical parameters in the model setup in order to minimize the biases between the model outputs and observation data (buoy station and satellite altimeter) in the vicinity of severe events, for long-distance generated swell waves and low seas conditions. A toolkit (ww3_tools) has been developed in parallel to facilitate the wave model data visualization and statistical analysis. It includes but is not limited to the field, time series, and directional spectral data visualization and analysis. Statistical analysis packages are extended to meet specific requirements of the wave models. An overview of these recent advancements in the WAVEWATCH III model will be presented at the conference.

Bringing GSI Background Error Covariance Capability to JEDI

Ricardo Todling, Daniel Holdaway, Benjamin M´en´etrier, Russ Treadon and Catherine Thomas

The first phase of transitioning the NASA GMAO GEOS data assimilation capabilities to JEDI involves the replacement of the GEOS Gridpoint Statistical Interpolation (GSI) with the JEDI analysis. This includes taking JEDI's Unified Observation Operator (UFO), its underlying dependencies, and the JEDI solver enabling a Hybrid 4DEnVar strategy similar to that used in the current GEOS atmospheric data assimilation system. Considerable work is being done to set up a UFO so that it provides observation-minus- background residuals that are as close as possible to those calculated by GSI. In an effort to reduce differences in the solver, the present work focuses on extracting the components implementing the recursive-filter-based formulation of the background error covariance of GSI and porting it to JEDI. Very preliminary work done along these lines already allows for academic exercises such as single-observation type tests when, for example, the wind response to a temperature observation is expected to show nearly geostrophic looking characteristics. When completed, this work is expected to also serve the interests of NOAA's JEDI-based Unified Forecasting System. This presentation will show preliminary results associated with porting the background error covariance of GSI into JEDO. Furthermore, some consideration will be given as to the possibility of porting GSI's Tangent Linear Normal Mode Constraint to add balance constraint capability to JEDI.

JEDI-Based Ensemble-Variational Data Assimilation System for Global Aerosol Forecasting at NCEP: System Development and Near-Real-Time Experiments

Bo Huang, Mariusz Pagowski (CIRES, CU Boulder and NOAA/OAR/GSL), Samuel Trahan (CIRES, CU Boulder and NOAA/OAR/GSL), Shobha Kondragunta (NOAA/NESDIS/STAR), Cory Martin (NOAA/NWS/NCEP/EMC), Andrew Tangborn (IMSG at NCEP/EMC), Daryl Kleist (NOAA/NWS/NCEP/EMC)

A global aerosol data assimilation (DA) system based on the Joint Effort for Data assimilation Integration (JEDI, the next-generation DA system in the US) was recently developed at NOAA with the goal of generating global aerosol reanalysis and improving aerosol forecasts in the Global Ensemble Forecast System - Aerosols (GEFS-Aerosols) model. Specifically, this system leverages the three-dimensional ensemble-variational (3D-EnVar) application with the local ensemble transform Kalman filter (LETKF) for ensemble update in JEDI for aerosol assimilation. The background error covariances in 3DEnVar are currently derived from an ensemble of short-range forecasts. Two AOD forward operators using scattering lookup tables from NASA and the Community Radiative Transfer Model (CRTM), respectively, were developed based on NASA's first-generation Goddard Chemistry Aerosol Radiation and Transport (GOCART) model that is adopted for aerosol parameterization in GEFS-Aerosols. It is currently capable of assimilating the aerosol optical depth (AOD) retrievals at 550 nm (i.e., the most commonly observed satellite aerosol quantity) from the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument and the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. The GEFS-Aerosols model is used to produce control and ensemble aerosol forecasts. To alleviate ensemble spread deficiency in this system, the stochastically-perturbed emission (SPE) approach was developed and implemented to scale and perturb emissions in the Common Community Physics Package (CCPP) version of the GEFS-Aerosols model. The JEDI-based global aerosol DA system was integrated within NCEP/EMC's operational global workflow and is being extensively evaluated using the CCPP version of GEFS-Aerosols. Starting from July 2021, this system was configured for aerosol DA and forecasts in the Near-Real-Time (NRT) experiments at NOAA/OAR/GSL. Cycled NRT DA experiments in October 2021 – April 2022 show that assimilation of VIIRS AOD retrievals at 550 nm efficiently improves simulated AOD against AOD retrievals from MODIS and the Aerosol Robotic NETwork (AERONET) and analyzed AOD from NASA and ECMWF. In addition, the resulting aerosol analyses are in good agreement with those from NASA and ECMWF. Cycled NRT experiment results and more comprehensive evaluations will be presented.

Implementation, testing, and evaluation of radar data assimilation capabilities within the JEDI hybrid EnVar/EnKF system for the Rapid Refresh Forecast System

Chengsi Liu, Ming Xue, Jun Park, Tao Sun, Chong-chi Tong

Radar is the most important instrument that measures the interior of precipitation systems. Assimilation of radar observations has demonstrated clear value in the current operational regional forecasting systems, the Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR), even though their operational versions have yet to take advantage of the most advanced data assimilation (DA) methods. The next-generation forecasting systems based on the FV3 dynamic core within the Unified Forecasting System (UFS) currently plan to use a hybrid ensemble-variational (EnVar) DA technique coupled with a self-consistent ensemble Kalman filter (EnKF). For regional forecasting, the Rapid Refresh Forecast System (RRFS) based on the limited area FV3 (FV3-LAM) and Joint-Effort for DA Integration (JEDI) DA framework will be the next-generation DA and forecast system aiming at convection-allowing weather forecasting, replacing several current regional operational systems. In the past few years, OU/CAPS and NOAA/GSL developed direct radar DA capabilities within GSI framework and demonstrated via extensive parallel testing superior performance to HRRRv4. Aiming at the future RRFS system, the CAPS and GSL team are collaborating with EMC to implement direct radar DA capabilities within the JEDI-based EnKF and hybrid EnVar DA system and test and evaluate it for the target RRFS model configurations based on FV3- LAM. Recently, the following accomplishments have been achieved: (1) develop a new reflectivity operator based on Thompson double-moment microphysics (2) migrate radar data assimilation capabilities from GSI into

JEDI-FV3, including fully porting radar reflectivity operators and their adjoint codes from GSI into JEDI and adding the control variables of hydrometeor mixing ratios and total number concentrations to the JEDI-FV3-LAM interface and applying control variable transform for the hydrometeors; (3) Preliminarily test radar DA using JEDI LETKF/LGETKF/En3DVar coupled with FV3-LAM and compare with the results from GSI; (4) Implement IAU initialization technique within FV3-LAM and evaluate its impact on high-frequency radar DA cycle. The detailed evaluation will be presented at the conference.

Cross-Cutting #2

Raytheon's Approach to Fulfilling the Contract Project and Management Plan

Marlon Johnson

Abstract Not Available

Pace: a Python-Based Implementation of FV3GFS / SHiELD for GPU and CPU Supercomputers

Oliver Elbert

Abstract Not Available

Unified Forecast System Weather Model: Building a code-base with multiple components and multiple applications

Brian Curtis

Abstract Not Available

Towards an Exchange Grid Implementation within the UFS

Ufuk Turuncoglu, Mariana Vertenstein, Denise Worthen, Dominikus Heinzeller, Bob Oehmke, Rocky Dunlap

Atmosphere and ocean interaction, which is a complex feedback mechanism, plays an important role in the physical and dynamical evolution of the planetary boundary and mixing layers by transferring heat and momentum fluxes between them. Due to the importance of detailed and realistic representation of physical processes in the atmosphere-ocean interface, researchers have developed various approaches to compute atmosphere-ocean fluxes in a more accurate way. The exchange grid, which is a grid structure used to represent the intersecting regions of grid cells at the planetary boundary layer, is one of the most important examples of the existing approaches (Balaji et al., 2006). It resolves issues along the coastline due to mismatched land/sea masks and provides explicit access to overlapping areas for computing and conservatively remapping fluxes between components. This allows modeling systems to compute fluxes at the coupling interface at the highest possible spatial resolution. The general approach is used in NASA's GEOS and in GFDL's climate model. In addition, ICONGETM, consisting of the atmosphere model ICON and the ocean model GETM, is also built on the National Unified Operational Prediction Capability (NUOPC) coupling software with flexible data exchange and conservative interpolation via Earth system Modeling Framework (ESMF) exchange grids (Bauer et al., 2021). Despite the existing implementation of exchange grids in various coupled modeling systems, the development of such systems is still very complex and requires expertise in various model components. However, the standardized exchange grid interface in ESMF and its integration with Community Mediator for Earth Prediction Systems (CMEPS) enabled integration of the exchange grid approach in community modeling systems. CMEPS is a NUOPC-compliant mediator component used for coupling Earth system model components and currently being used in NCAR's Community Earth System Model (CESM) and NOAA's subseasonal-to-seasonal coupled system. As a part of this study, the Unified Forecast System (UFS) is extended to take advantage of an exchange grid to compute atmosphere-ocean fluxes. The flexible implementation under CMEPS mediator also allows the user to change the atmosphere-ocean flux computation grid through a configuration option. Since the exchange grid is created under mediator component (CMEPS) using the grids/meshes provided by the atmosphere and ocean models in this implementation, a new Common Community Physics Package (CCPP; Heinzeller et al., 2019) host model has been defined under CMEPS to perform atmosphere-ocean flux computation using the same physics parameterizations as used in the UFS atmosphere model. This allows us to validate the computed fluxes by comparing them with those calculated under the UFS atmosphere CCPP host model. A set of 35-days long simulations performed with different configurations of the UFS (involves both low and high-resolution ocean components) are being used to validate the implementation and perform initial analysis that compares the fluxes computed on different model grids such as atmosphere, ocean and exchange grids. The initial results indicate that computing surface fluxes on the exchange grid enables capturing small scale features in flux computations and guarantee that fluxes are computed at the highest possible resolution regardless of the relative grid resolutions of the atmosphere and ocean components. In addition, the results of 35-days simulations indicated that the exchange grid approach behaves similarly with the existing implementation used under UFS atmosphere and improve the calculated fluxes in some cases when compared with ECMWF's ERA5 reanalysis. Since, the UFS numerical applications span local to global domains and predictive time scales from sub-hourly analyses to seasonal predictions, the ability to use an exchange grid within the UFS to compute inter-component fluxes will provide a way for researchers to evaluate the exchange grid approach in a more comprehensive way under mid-range weather applications (MRW) and Subseasonal to Seasonal Forecasts (S2S) applications. In addition, the approach can be extended to support more tightly coupled configurations, such as cross-component implicit coupling and coupling that takes into account sub-grid scale heterogeneity at the surface in the future.

Diagnostics of Tropical Variability for Numerical Weather Forecasts

Maria Gehne, Brandon Wolding, Juliana Dias, and George N. Kiladis

Tropical precipitation and circulation are often coupled and span a vast spectrum of scales from a few to several thousands of kilometers and from hours to weeks. Current operational numerical weather prediction (NWP) models struggle with representing the full range of scales of tropical phenomena. Synoptic to planetary scales are of particular importance because improved skill in the representation of tropical larger scale features such as convectively coupled equatorial waves (CCEWs) have the potential of reducing forecast error propagation from the tropics to the midlatitudes.

Here we introduce and apply diagnostics from a recently developed tropical variabil- ity diagnostics toolbox, where we focus on two sets of model forecasts. First, two recent versions of NOAA's Unified Forecast System (UFS): operational GFSv15 forecasts and experimental GFSv16 forecasts from April through October 2020. And second, several versions of the subseasonal-seasonal (S2S) component of the UFS: coupled prototypes 5 and 7. The diagnostics include space-time coherence spectra to identify preferred scales of coupling be- tween circulation and precipitation, pattern correlations of Hovm ̈oller diagrams to assess model skill in zonal propagation of precipitating features, CCEW skill assessment, plus a diagnostic aimed at evaluating moisture - convection coupling in the tropics.

Results show that the GFSv16 forecasts are slightly more realistic than GFSv15 in their coherence between precipitation and model dynamics at synoptic to planetary scales, with modest improvements in moisture - convection coupling. However, this slightly improved performance does not necessarily translate to a significant improvement in traditional precipitation skill scores. The comparison between the two GFS versions highlights the utility of these physically based diagnostics in the pursuit of better understanding of NWP model performance in the tropics, while also demonstrating the challenges in translating model advancements into improved skill.

The Weather Prediction Center Development and Training Branch: R2O Activities within the Hydrometeorological Testbed (HMT)

James Nelson

The Weather Prediction Center (WPC) vision of being America's go to Center for high-impact precipitation and hazardous weather events is supported by the Development and Training Branch (DTB) of WPC. WPC forecast operations range from short term (<6hrs) to long term (up to 7 days). WPC is focused on high-impact precipitation (heavy rainfall, heavy snowfall, and ice) in the short term. At longer time ranges, WPC forecasters prepare forecasts of sensible weather elements (temperature, dewpoint, wind, sky, precipitation, and chance of precipitation) with particular focus on potential weather hazards. In order to support and advance WPC's forecast operations; a cornerstone of DTB is the R2O process. DTB engages in collaborative efforts with many scientists throughout the meteorological community focused on heavy rainfall, heavy snowfall, and medium range forecasts. One method for engaging the weather enterprise (UFS, Academic, NOAA Labs, Private, etc.) is through the Hydrometeorological Testbed (HMT) at WPC. The DTB also leverages the NCEP Visiting Scientist Program and other avenues to stay abreast of the latest science and technology. Particular focus is given to the use of ensembles in the forecast process as well as production of probabilistic products. This presentation will highlight the HMT experimental forecast and verification activities supporting R2O that enhance the National Weather Service's Weather Ready Nation initiative.

Emerging Applications

NOAA Center for Artificial Intelligence: Progress Toward an AI-Ready Agency

Rob Redmon

The 2020 National AI Initiative Act authorized a coordinated program across the Federal government to accelerate AI research and application for the Nation's economic prosperity. The National Oceanic and Atmospheric Administration (NOAA) established a Center for Artificial Intelligence (NCAI, noaa.gov/ai) to coordinate the adoption of trustworthy and responsible AI research, development, acquisition, application, information exchange, and plans to develop a public portal with open source NOAA AI applications. To foster NOAA's AI proficiency, workforce development, and leadership, NCAI will host training events and workshops, facilitate application transition from research to operations/commercialization, aid in the governance of AI, and facilitate new partnerships across industry, academia, and government. As with other science-based agencies, NOAA recognizes the benefits of AI in core mission areas of environmental observation, data ingest and stewardship, climate, weather and ocean forecast and prediction, and marine ecosystem and fisheries management. To realize transformative advancements in the quality, scope, and timeliness of NOAA's environmental science, products, and services, NOAA has established a strategy designed to accelerate and integrate AI into key mission areas: enhanced forecast performance and skills, increased efficiency and cost effectiveness in data-related NOAA mission areas, and innovative ways to capitalize NOAA data assets. Our emerging NCAI will help equitably empower NOAA's workforce, partners, and the public to tackle societal challenges. This presentation illustrates NCAI's formulation phase experiences, including the emergence of our Community of Practice; our upcoming annual AI interactive workshop focusing on fire weather, ocean conservation, and interoperable Digital Twins; training needs assessments; and development of an AI-ready standard for open environmental data.

CoastalApp: A Coupling Infrastructure Developed in Partnership with Coastal Ocean Modeling Community

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NOAA National Ocean Service's (NOS) Storm Surge Modeling Team at the Office of Coast Survey (OCS) develops and operates coastal ocean modeling infrastructure to advance NOAA missions in disaster mitigation and safe navigation. NOS Storm Surge Modeling Team in close partnership with its agency, academic and industry partners develops a fully coupled multi-model coastal application (CoastalApp: https://github.com/noaa-ocs-modeling/CoastalApp) to advance our understanding and operational modeling capabilities of the compound (riverine + coastal) flooding processes in the nearshore region, following Unified Forecast System (UFS) best practices. The goal is to provide a flexible and portable modeling framework for coastal applications that supports, but not limited to, storm surge, surface wave, sea ice, ocean-atmosphere-ice-land interactions, sediment transport and water quality studies. The coupling framework can be utilized for deep water to shallow water transformation and coastal applications on various spatial and temporal scales, from short-range to subseasonal-to-seasonal climate variability.

Applications of A Rapid Forecasting and Mapping System (RFMS) for Storm Surge, Wave, and Inundation

Peter Sheng and Vladimir Paramygin

A prototype of an efficient and accurate rapid forecasting and mapping system (RFMS) of storm surge has been developed recently. Given a storm advisory from the National Hurricane Center, the RFMS can generate a coastal inundation map on a high-resolution grid in one minute (reference system Intel Core i7-3770K). The foundation of the RFMS is a storm surge database consisting of high-resolution simulations of 490 optimal storms generated by a robust storm surge modeling system, CH3D (Curvilinear-grid Hydrodynamics in 3D) – SSMS. The RFMS uses an efficient Quick Kriging interpolation scheme to interpolate the surge response from the storm surge database, which considers tens of thousands of combinations of five landfall parameters of storms: central pressure deficit, radius to maximum wind, forward speed, heading direction, and landfall location. The RFMS is applied to Southwest Florida using data from Hurricane Charley in 2004, Hurricane Irma in 2017, and to Florida Panhandle using data from Hurricane Michael in 2018 and validated with observed high water mark data. The RFMS results agree well with observation and direct simulation of the high-resolution CH3D-SSMS. The efficient and accurate RFMS is being used for (1) real-time forecasting during a hurricane, (2) predicting "what- if" scenarios for mitigation planning and preparedness training, and (3) producing a probabilistic flood map. Example applications of the

RFMS for each of the three cases will be presented. The RFMS can provide more accurate surge prediction with uncertainties if NHC can provide more accurate storm forecasts in the future. By incorporating storms for future climate and sea level rise, the RFMS can be used to generate future flood maps for coastal resilience and adaptation planning. The RFMS can be adapted for coastal regions throughout the U.S. and should be of interest to NOAA, FEMA, and other agencies who are concerned with coastal inundation due to tropical cyclones in a changing climate.

Development and Applications of an Ocean, Infragravity Wave, Morphological, and Structural Response Coupled Nearshore Prediction System

John C. Warner, Maitane Olabarrieta, Christopher R. Sherwood, Jin-Si Over, Joe Zambon, Ruoying He, George Xue, Arthriya Subgranon, Steven Klepac

Prediction of extreme storms and their local effects on geomorphology, habitat, and infrastructure are crucial for effective management decisions and to provide early warning for evacuations and to minimize loss of life and property. The National Oceanographic Partnership Program (NOPP) Hurricanes Coastal Impacts (NHCI) project is providing a unique opportunity that combines significant cross-discipline efforts. Atmospheric ensembles will drive local forecasts of water levels, currents, temperature, salinity, geomorphic change, and structure response. These highly resolved coastal models are based on updated digital elevation maps, detailed land cover characteristics, and assessed through comparisons to in-situ storm observations. We have developed the Coupled Ocean Atmosphere Waves Sediment Transport (COAWST) numerical modeling system that can simulate both local and basin-scale ocean, wave, and atmosphere physical processes. We have recently added a nearshore infragravity wave model (InWave), implemented a 5th order sediment bed elevation updating scheme, included an implicit vertical advection algorithm, integrated a vegetation module, and linked to a statistical structure response algorithm. The InWave model drives the 3D ocean circulation model (ROMS) for nearshore physics to propagate wave group patterns from the open boundary that interact within the domain to enhance the variance of wave action density, thus providing a mechanism to generate infragravity wave motion. The model is applied to archived test cases of the Delta Flume and the Delilah experiments. Results are compared to observations of averaged and infragravity waves and currents and demonstrates strong skill for propagation of wave parameters and generation of infragravity waves. The entire modeling system is then applied to investigate Hurricane Michael (2018) that impacted the northwest coast of Florida. It is shown how the offshore wave heights and coastal water levels are modulated by atmosphere – ocean physics. Impacts of a barrier island breach near Cape San Blas, FL are simulated and demonstrate the necessity of including small scale (order several meters) land features such as vegetation cover that modify breaching behavior. Impacts to coastal structures near Mexico Beach, FL are characterized based on predicted damage assessments. Accurate predictions of impacts to these realistic systems requires high resolution nearshore and coastal information of landcover, structure types, bathymetry, topography, and oceanographic observations for comparison to model predictions. This study demonstrates the importance of coupling waves, currents, and coastal land use to predict nearshore morphological change and coastal structure impacts.

A novel dynamically coupled ocean-river modeling suite for hurricane-induced compound flooding

Z. George Xue, Daoyang Bao, Dongxiao Yin, John C Warner

We introduced WRF-Hydro to the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System. The river model (WRF-Hydro) is coupled with the ocean model (ROMS) along the land-ocean boundary, where water level information is exchanged dynamically. A physics-based, fully distributed soil erosion and sediment transport model, WRF- Hydro-Sed, is used to investigate the sediment dynamics in the watershed. The Model Coupling Toolkit was applied at the hydrological and ocean model boundary to assure the seamless exchange of water level, momentum, and sediment. We applied the system to simulate the water and sediment dynamics during the compound flooding incurred by Hurricane Florence in 2018 and Hurricane Harvey in 2017. A series of diagnostic experiments were carried out to assess the contribution of atmospheric, ocean, and river in sediment yield and dispersal from the watershed to the coastal ocean and the compound effects of these processes.

On-Demand Hurricane Storm Surge Modeling Using the UFS Coastal Modeling Framework CoastalApp: A Case Study for Hurricane Florence (2018)

Panagiotis Velissariou, Saeed Moghimi, Edward Myers, Andre van der Westhuysen, Ali Abdolali

Over the years, various parametric wind models have been developed to estimate the surface winds within a tropical cyclone given the track of the storm. Such models can be very useful on forcing ocean and wave models in storm surge simulations, as they are lightweight and they do not require much time or computational resources to produce the wind fields on the fly for the duration of the storm. To this end, the Parametric Hurricane Modeling System (PaHM: https://github.com/noaa-ocs-modeling/PaHM) is developed to be used as a general atmospheric modeling system in support for coastal applications. PaHM is a modeling system that contains a multiplicity of parametric models that can be used to generate the wind fields at run time. PaHM can be used either as a standalone atmospheric model or can be coupled with ocean and wave models via NOAA's Environmental Modeling System (NEMS) that implements the National Unified Operational Prediction Capability (NUOPC). CoastalApp is a UFS compatible modeling framework that contains multiple model and data components coupled 1-way and/or 2-way using the NUOPC/ESMF Coupling Infrastructure. CoastalApp provides a flexible and portable modeling framework for coastal applications that include, but not limited to, storm surge modeling and inundation studies, wave modeling and wave-coast interactions, sediment transport and morphological changes, water quality studies, etc. For the present study we will use the modeling components PaHM, ADCIRC and WAVEWATCH III (WW3) to produce the simulations for Hurricane Florence in the North Atlantic region. ADCIRC and WW3 are used in both 1-way and 2-way coupled configurations with PaHM forcing both models. The prediction capabilities of ADCIRC in coastal areas have been improved by incorporating "baroclinic" adjustments from data supplied by global three-dimensional ocean models. PaHM was used to drive storm surge simulations for Hurricane Florence (2018) on the Eastern Coast of the United States, coupled with ADCIRC and WAVEWATCH III within the CoastalApp (https://github.com/noaa-ocs-modeling/ CoastalApp) framework. The individual parametric models were successfully evaluated using standard statistical measures. The CoastalApp based storm surge simulations using PaHM show promising results on predicting total water levels and flood inundation.

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