EPIC Workshop

Running the Short-Range Weather App on the Cloud
Objective: I can use the Short-Range Weather Application to run, modify, and compare forecast outputs.

Jamiel Farhat - Technical Training Specialist - ?’s about EPIC

Dr. Neil Jacobs - Chief Science Advisor for the UFS - ?’s about UFS

Dr. Mark Potts - Lead Cloud Computing Engineer - ?’s about Accessing the Cloud

Dr. Jeff Beck and Dr. Gerard Ketefian - SRW App Developers - ?’s about the SRW App
How to use Slack
#ams-short-course-2022

If you have a question, pose it in this channel. Click “reply in thread” if answering a question.

If you have technical issues, the break out room is open for one-on-ones.
What is the Unified Forecast System (UFS)?

**Community Based**
- Code is public on Github which engages developers, educational institutions, federal agencies, and the private sector to improve model

**Broad Spatial and Temporal Domain**
- Spans spatial scales from local to global and temporal scales from sub-hourly to seasonal forecasts

**Subset of UFS weather model that satisfies a specific use case (Medium Range Weather, Short Range Weather, Hurricane, etc)**

**Goal to combine suite of forecasting models (GFS, NAM, HRRR, etc) into one**

**Applications**

**Future Operational NWP Model**
Overview of the Unified Forecast System Short-Range Weather (SRW) Application

Jeff Beck

Participating Organizations: EPIC, DTC, NOAA labs (GFDL, EMC, GSL, NSSL, GLERL), NCAR, CIRA, CIRES, CIWRO, others

Code Review Committee: EMC (Chan-Hoo Jeon, Ben Blake, Ratko Vasic), EPIC (Mark Potts, Jong Kim), GLERL/UM (David Wright), GSL (Jeff Beck, Gerard Ketefian, Linlin Pan, Christina Holt, Christopher Harrop, Daniel Abdi), NCAR (Mike Kavulich, Will Mayfield), NSSL (Yunheng Wang)
UFS Background

NOAA’s numerical weather prediction (NWP) efforts have organized around a vision of a unified community-based modeling system, i.e. Unified Forecast System (UFS)

- Configurable for multiple applications across domains from global to regional to convection allowing (and ultimately cloud-resolving) forecasts
- Designed to be the source system for operational applications
- Applications are UFS configurations that support particular forecast requirements
- Each application can combine a numerical model, data assimilation, pre- and post-processing, a workflow, and other elements

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SRW App:
Covers short-range weather & convection-allowing atmospheric phenomena from less than an hour to several days
UFS Short-Range Weather (SRW) Application

- Weather Model
  - Finite-Volume Cubed-Sphere Dynamical Core (FV3)
    - Limited Area Model (LAM) capability
  - Common Community Physics Package (CCPP)

- End-to-end Application
  - User-friendly build system that invokes CMake
  - Experiment generation with support for the Rocoto workflow manager or stand-alone scripts
  - Pre-processing, model execution, post-processing (official release), verification
  - Python scripts for basic graphics

- Comprehensive documentation

- User support forum: https://forums.ufscommunity.org/
SRW Application Features
Background: global configuration

- FV3 = Finite Volume Cubed
- "Cubed" refers to the global cubed-sphere grid, where the sphere surface is projected onto the 6 faces (tiles) of a cube
- Uses a gnomonic projection, i.e. great circles serve as model coordinates
- Offers good grid uniformity: ratio of largest to smallest cell size is only $\sqrt{2}$ (if not using grid stretching/refinement)
- Allows for higher resolution (at a fixed horizontal location) via grid stretching (Schmidt transformation) and grid nesting (refinement), but must still run the forecast on a global domain
SRW Application Features
Regional (or LAM = Limited Area Model) Capability

- Motivated by convection-allowing modeling applications needs
- Uses a single logically rectangular grid with lateral boundary conditions provided by an external model (e.g. FV3GFS, HRRR, RAP, NAM)
- Several predefined grids available in the SRW App. The following are supported in Version 2 of the App:
  - RRFS_CONUS_25km
  - RRFS_CONUS_13km
  - RRFS_CONUS_3km
- User may specify custom domains/grids
SRW Application Features
Regional (or LAM = Limited Area Model) Capability

- Two regional grid generation methods are available: "GFDLgrid" and "ESGgrid"

- "GFDLgrid":
  - Defines the regional grid with respect to a parent global cubed-sphere grid
  - Parent global grid covers the globe with 6 tiles
  - A 7th tile is created as a subregion of tile 6 and serves as regional grid; tiles 1 through 6 discarded before forecast is run

- "ESGgrid":
  - ESG = Extended Schmidt Gnomonic
  - More uniform regional grids than those generated via "GFDLgrid" method
  - Mathematical extension of Schmidt transformation to generate very uniform regional grids

- Most predefined grids in SRW App use the "ESGgrid" method
SRW Application Features

System Steps

- **Build and compile**
  - Umbrella CMake-based build system for all the code components to run the end-to-end SRW App workflow

- **Create an experiment**
  - Many customization options available
  - Script then builds configuration/namelists

- **End-to-end execution with task management using Rocoto or stand-alone scripts**
  - Pre-processing
  - Model execution
  - Post-processing using the Unified Post Processor

- **Python scripts for basic graphics from UPP grib2 files**
SRW Application Features

Workflow Tasks

1. make_grid: Generates grid files
2. make_orog: Generates filtered orography files
3. make_sfc_climo: Generates surface climatology files (used if fields are not available in external model output)
4. get_extrn_ics: Retrieves output files from the external model needed for generating ICs, surface fields, and the 0-th hour LBC
5. get_extrn_lbcs: Retrieves output files from the external model, needed for generating LBCs
6. make_ics: Creates ICs on the native FV3-LAM grid (including surface fields and the 0-th hour LBC)
7. make_lbcs: Creates LBCs for each boundary condition interval on the FV3-LAM grid
8. run_fcst: Runs a forecast (cycle) with the FV3-LAM
9. run_post: Processes write-component forecast output files through UPP generate grib2 files Run once per expt (optional) Run once for each cycle
### SRW Application Features

**Physics suites**

- Four supported physics suites for SRW App v2 (available through CCPP)
- More available in develop branch

<table>
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<tr>
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## SRW Application Features - Code Repositories

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</table>

All components are in public repositories on GitHub. Posting of issues and submission of pull requests encouraged.

Wiki pages on GitHub include helpful/getting started information.
Platform Support

Level 1: Preconfigured platforms
- Prerequisites and libraries installed
- Workflow & model build/run out of the box
- Comprehensive testing before release
- NCAR Cheyenne (Intel & GNU)
- NOAA Hera, Jet, AWS and Google Cloud via Parallel Works
- MSU Orion (Intel)

Level 2: Configurable platforms
- Prerequisites and libraries expected to install
- Workflow and model expected to build/run
- Comprehensive testing before release
- Odin (Intel)
- TACC Stampede (Intel)

Level 3: Limited-test platforms
- Prerequisites and libraries expected to install
- Workflow and model should build and run
- Limited testing
- macOS
- Ubuntu
- RedHat

Level 4: Build-only platforms
- Prerequisites and libraries expected to install
- Workflow and model should build
- Very limited tests of running the model
- All generic platforms with GNU
User Support

- Documentation
  - All components included:
    - UFS_UTILIS, ufs-weather-model, FV3, CCPP, UPP, verification, visualization, etc.

- Forums
  - [https://forums.ufscommunity.org](https://forums.ufscommunity.org)
  - Participation from Subject Matter Experts (SMEs)
  - Build knowledge within the community
SRW Application
Graduate Student Test (GST)

- Help measure success of the release related to code availability and development processes to the broader community
- Assesses whether a student can do the following (easily) in under six hours:
  - Get, build, run, and change code, test code for correct operation
  - Evaluate code with standard diagnostic packages
  - Locate documentation, user support, and training
- Short-Range Weather Application GST
  - Includes a severe weather example case (15 June 2019) as a default, plus allows the user to change the physics suite and resolution in multiple iterations
  - Visually compare a number of output fields through use of Python scripts
Unified Forecast System - Operational Implementation Timelines

![Diagram showing timelines and applications](image-url)

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- **UFS Application**:
  - UFS Medium Range & Sub-Seasonal
  - UFS Marine & Coastal
  - UFS Seasonal
  - UFS Hurricane
  - UFS Short-Range Regional Hires CAM & Regional Air Quality
  - UFS Air Quality & Dispersion
  - UFS Coastal
  - UFS Lakes
  - UFS Hydrology
  - UFS Space Weather

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**EARTH PREDICTION INNOVATION CENTER (EPIC)**