Developmental Testbed Center | DTC

Transitions

NWP FROM RESEARCH TO OPERATIONS

Issue 24 | Winter 2021

dtcenter.org/news/

INSIDE THIS ISSUE

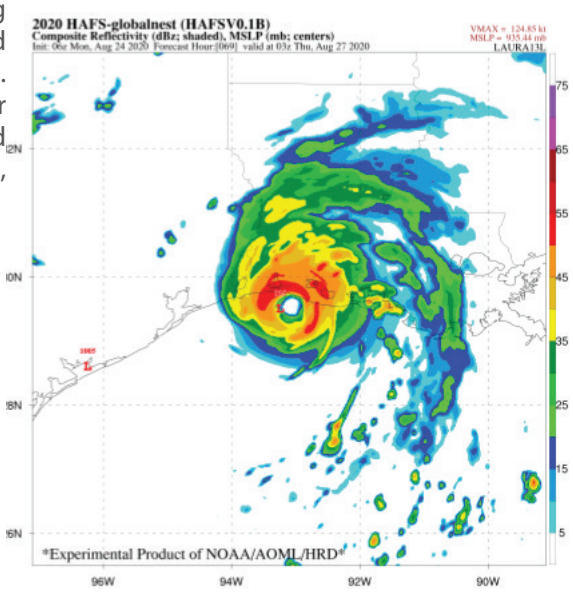
2020 HFIP Annual Meeting Highlights

The three-day HFIP Annual Meeting 2020 was held virtually on November 17-19, 2020. Approximately 130 participants from NOAA line offices, DTC, NCAR, and university partners participated in the meeting. NOAA/NWS/OSTI Modeling Program Division Director Dr. Dorothy Koch kicked off the meeting with welcoming remarks.

Day one focused on HFIP programmatic updates, a discussion of forecasters' needs and current activities supporting operations and a summary of the results from the forecasters' HFIP display survey. Day two consisted of a review of the current state of operational modeling capabilities and results from the 2020 hurricane season real-time experiments, as well as a special panel discussion on the operational modeling challenges faced by both forecasters and the developers that was helmed by panelists from the UK Met Office and ECMWF. The final day opened with updates on the HFIP-funded external research, followed by discussions on the development of the next-generation Hurricane Analysis and Forecast System (HAFS). As is evident from the Agenda, each day was tightly packed with engaging presentations that represented the diverse interests of the field. NOAA/AOML Hurricane Research Division Director Dr. Frank Marks concluded the meeting with a summary and recommendations.

The primary objective of this meeting was to assess the progress made and challenges identified in achieving the HFIP goals, as documented in the 2019 HFIP Strategic plan. This plan was developed under the Weather Research and Forecasting Innovation Act, Section 4.

To meet the plan's objectives, six key strategies were developed: 1) advance the operational HAFS; 2) improve probabilistic guidance; 3) enhance communication of risk and uncertainty; 4) support dedicated high-performance computing allocation; 5) R2O enhancement; and 6) broaden expertise and expand interaction with the external community.



HAFS global nest presented at HFIP Annual Meeting 2020 courtesy of Andrew Hazelton.

(Lead Article continued next page.)

Director's Corner

By Gretchen Mullendore

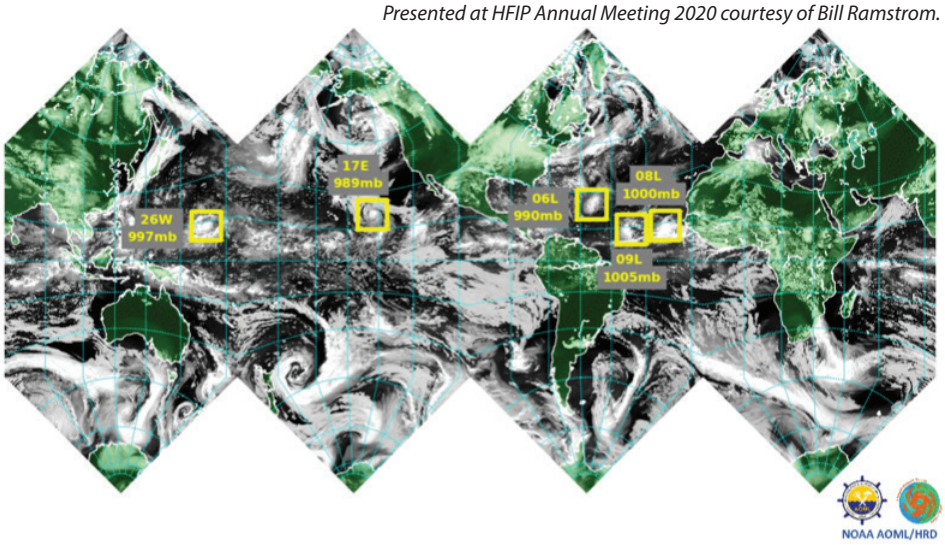
Gretchen Mullendore, NCAR's MMM

The Age of EPIC: What does this mean for DTC?

In 2017, Congress instructed NOAA to establish the Earth Prediction Innovation Center (EPIC) to advance "observational, computing, and modeling capabilities to support substantial improvement in weather forecasting and prediction of high impact weather events." What will the details of EPIC look like? EPIC has not yet been formed, so the community doesn't know, and it's not yet clear that NOAA knows either. Hopefully,

(Director's Corner continued on page 3.)

Presented at HFIP Annual Meeting 2020 courtesy of Bill Ramstrom.

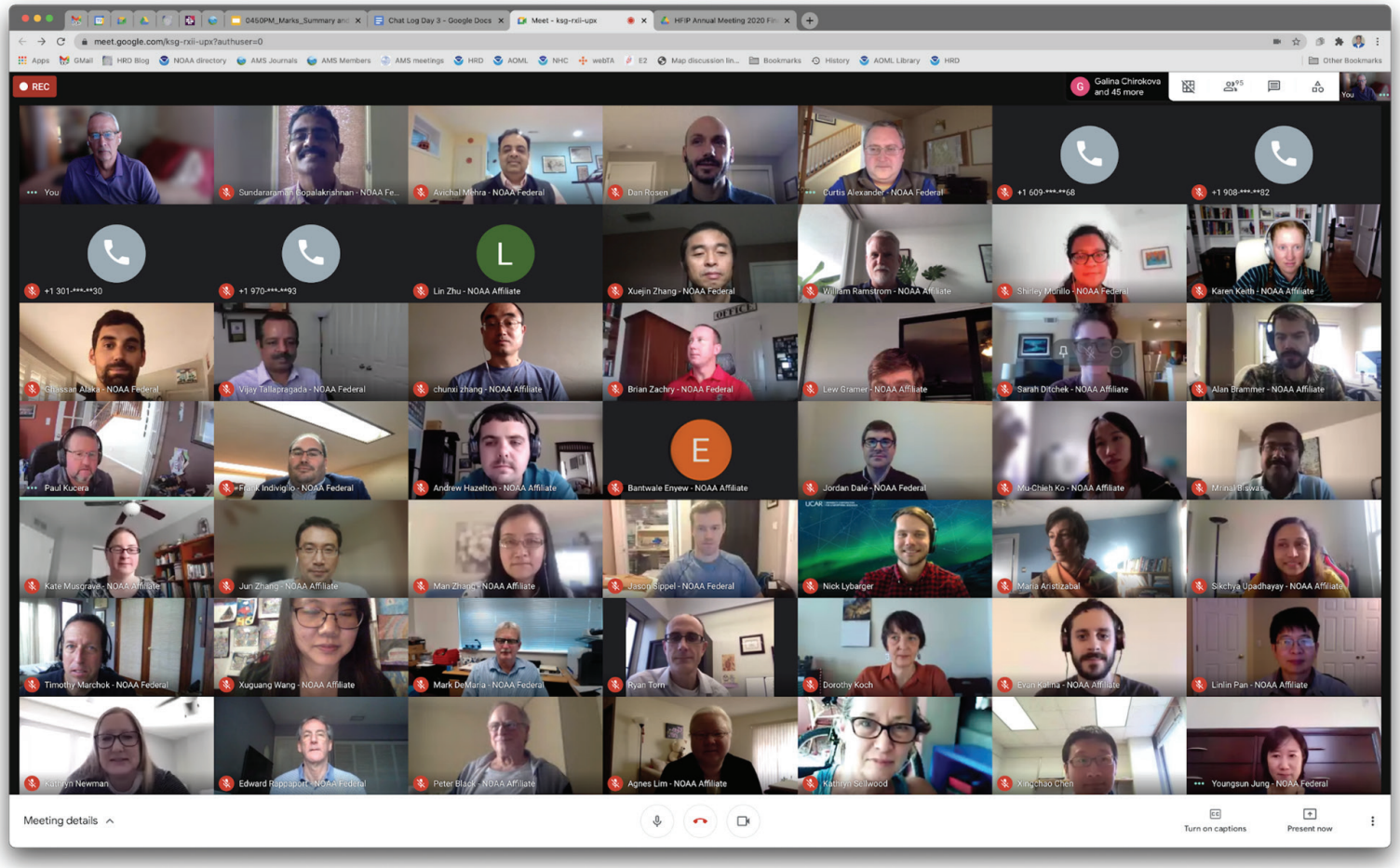


(Lead Story *continued from page one.*)

Throughout the meeting, each key strategy's many successes were enumerated. The 2020 hurricane season marked the second year of successful real-time HAFS testing with four different HAFS model configurations. Improvements in graphical products, tropical roadmap, eight to nine ongoing social and behavioral science projects, and AWIPS/ATCF improvements attributed to the success of the HFIP strategies. As for computation efforts, 60M h/month is dedicated for development, testing, and evaluation of HAFS. The HFIP continues to foster the external university partners by funding three research proposals in 2020.

To address the implementation of HAFS, which is planned for 2022, the meeting convened a discussion of the design and testing of potential 2021 HAFS configurations that could run within the operational HPC resources. The HAFS session attendees recommended maintaining real-time test capability on Research and Development High-Performance Computing (RDHPC) systems (Jet, Hera, & Orion) to test the potential configuration. Other recommendations offered during the meeting included performing an evaluation of 2020 operational problem cases, evaluation of observational impact, evaluation of and improvements to the wind radii metrics, and data display capacity on AWIPS II.

Contributed by Frank Marks, Sikchya Upadhayay, and Youngsun Jung. ■



Director's Corner

(Director's Corner *continued from page one.*)

it can achieve its goal to improve accessibility to the operational code and data so that scientists across the entire weather enterprise community, both research and operations, can collaborate more easily, leading to more timely identification of forecasting challenges and adoption of forecasting improvements.

"Both UFS and EPIC need to coordinate closely with academic, research labs, private companies and across multiple agencies. Fortunately, DTC already does this in their everyday work."

This goal sounds familiar to anyone who has worked with DTC, because this is a significant portion of the core work that DTC has been doing successfully for many years. When browsing the research and tool development performed by (and supported by) DTC, one finds numerous examples of impactful R2O ranging from parameterization development to widely adopted model validation strategies and tools. So, with EPIC poised to take on workflow and tool development traditionally done by DTC, what will DTC's new role be in the Age of EPIC?

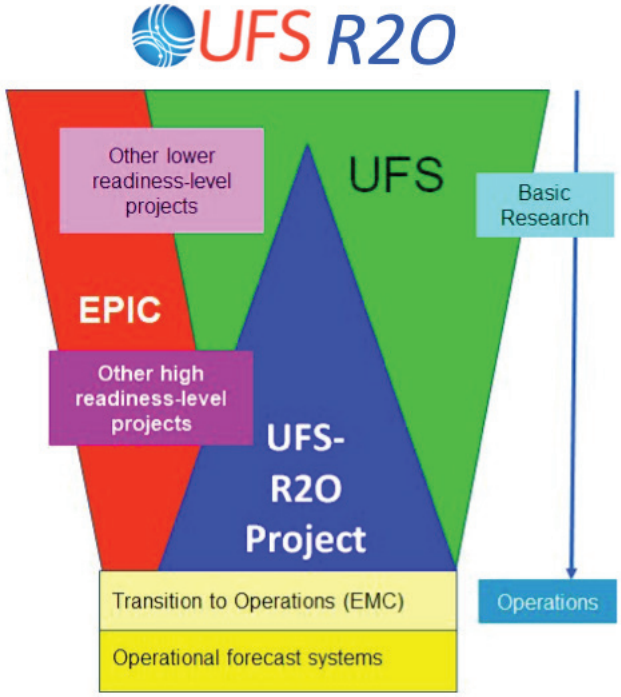
In preparation for inevitable change, DTC has already begun preparing by starting with a critical examination of its own software portfolio, and steps have been taken to ramp down support of some products. Ongoing products will still be supported, but are being shifted toward more community-based support and development strategies. Likewise, research and support of testing and evaluation (T&E) activities have ramped up, which have fostered new partnerships.

DTC is also playing a significant role in supporting the Unified Forecast System (UFS). The UFS is a key component of NOAA's effort to share code with the community and implement model improvements with the envisioned EPIC framework acting as its software and platform support. In addition to supporting UFS workshops, DTC is also helping to develop and manage the Common Community Physics Package (CCPP), which includes a framework and physics schemes for the atmospheric portion of UFS, and METPlus, which is used for validation and verification in the UFS system.

To build a successful entity, both UFS and EPIC need to coordinate closely with academic, research labs, private companies and across multiple agencies. Fortunately, DTC already does this in their everyday work. NOAA should leverage DTC's deep expertise in model development and verification, broadening software accessibility, and building R2O/O2R collaborative teams to ensure EPIC's success.

As a professor at University of North Dakota (UND), I had the pleasure of working with DTC in multiple capacities. From 2015-2016, a graduate student and I collaborated with DTC through the DTC Visitor Program on a project focused on convective-allowing model verification using MODE. It was a great introduction to the many useful tools developed and supported by DTC. I collaborated again through the Big Weather Web project and development of a containerized version of WRF, which is still used in numerics classes at UND. Most recently, I have served for two years as an academic member of the DTC Scientific Advisory Board. Now that I am the Director of MMM, I look forward to continued collaborations in my new role.

Gretchen Mullendore, NCAR's MMM Laboratory Director



The UFS-R2O Project is a subset of the UFS supported by NOAA that focuses on the transfer of innovations into operations, see the lower part of the funnel. EPIC is a new NOAA initiative that will be providing infrastructure and user support.

(Image from NOAA/NWS/OSTI-Modeling.)

DTC VISITOR

Assessing the FV3-LAM Data Assimilation Capability to Represent Convection

Dr. Xuguang Wang is a Robert Lowry Chair Professor and Presidential Research Professor of School of Meteorology of University of Oklahoma. She leads a Multiscale data Assimilation and Predictability (MAP) lab. Her MAP research includes (a) developing new techniques and novel methodologies for data assimilation and ensemble prediction; (b) applying these techniques for global, hurricane, and convective-scale numerical prediction systems that assimilate a variety of in-situ and remote-sensing observations to improve predictive skill; (c) improving the understanding of atmospheric predictability and dynamics through data assimilation and ensemble approaches from global to storm scales; and (d) interdisciplinary research such as leveraging machine learning to improve data assimilation and ensemble prediction.

Over the past 10+ years, Dr. Wang and her MAP team have been actively working on transitioning their data-assimilation research and development on hybrid 3D and 4D EnVar into NOAA NWS operational numerical weather-prediction systems: GFS, HWRF, and HRRR, in collaboration with NOAA research and operational centers. Dr. Wang is also excited about cultivating the next generation in data assimilation. So far she has directly advised 25 students and 19 postdocs on data-assimilation research during her tenure at OU.

Close collaboration with NOAA research and operation centers is essential for effective research-to-operation (R2O) transitioning. While regular research grants typically only enable short visits to collaborate, the DTC Visitor Program allowed Dr. Wang a lengthier visit at NOAA/NCEP/EMC during her sabbatical in Fall 2018. The visit was hosted by Dr. Vijay Tallapragada, chief of the Modeling and Data Assimilation Branch of EMC. The objectives of her visit were to collaborate further with EMC scientists on data-assimilation research and development, and to facilitate the transition of recent data assimilation development of her MAP team into NWS operational global, hurricane and convective-scale prediction systems. During her visit, Dr. Wang also discussed new ways to broaden collaboration between academia and NOAA with the late Dr. Bill Lapenta, then NCEP director, and Dr. Brian Gross, EMC director.

The visit accelerated the development of a multiscale data-assimilation approach in the 4DEnVar data assimilation system for the UFS Medium-Range Weather Application (Huang et al. 2020). This approach allows more effective updating of all resolved scales using all observations at once and therefore improves global forecasts (Fig. 1 below). The visit also expedited transitioning the capability of directly assimilating ground-based radar observation developed by MAP into the operational HRRR (Johnson et al. 2015, Wang and Wang 2017), and the operational HWRF (Lu et al. 2017). Beginning in 2020, these direct ground-based radar data-assimilation capabilities became operational in HRRR and HWRF, as a result of multi-institutional collaboration (OU/MAP, NOAA/NCEP/EMC, NOAA/ESRL/GSL and NOAA/AOML/HRD). These capabilities will be further integrated with the UFS hurricane and convection-allowing modeling (CAM) applications down the road.

Looking into the future, Dr. Wang and her research team at OU plan to continue their basic research to develop novel data-assimilation algorithms that treat non-Gaussianity, new multiscale data-assimilation algorithms (Wang et al. 2020) for weather, and assimilation at the interface between different earth-system components (i.e. coupled data assimilation). They will extend their research and development to enable the effective assimilation of in situ, radar and satellite observations. They will further their work with operational NWP agencies to broaden the impact of basic research through effective R2O. Training the next-generation workforce is critically important for advancing the entire data assimilation field. Dr. Wang strives to continue advancing this effort by advising students and early career scientists.

Contributed by Xuguang Wang. ■

(Continued on next page.)

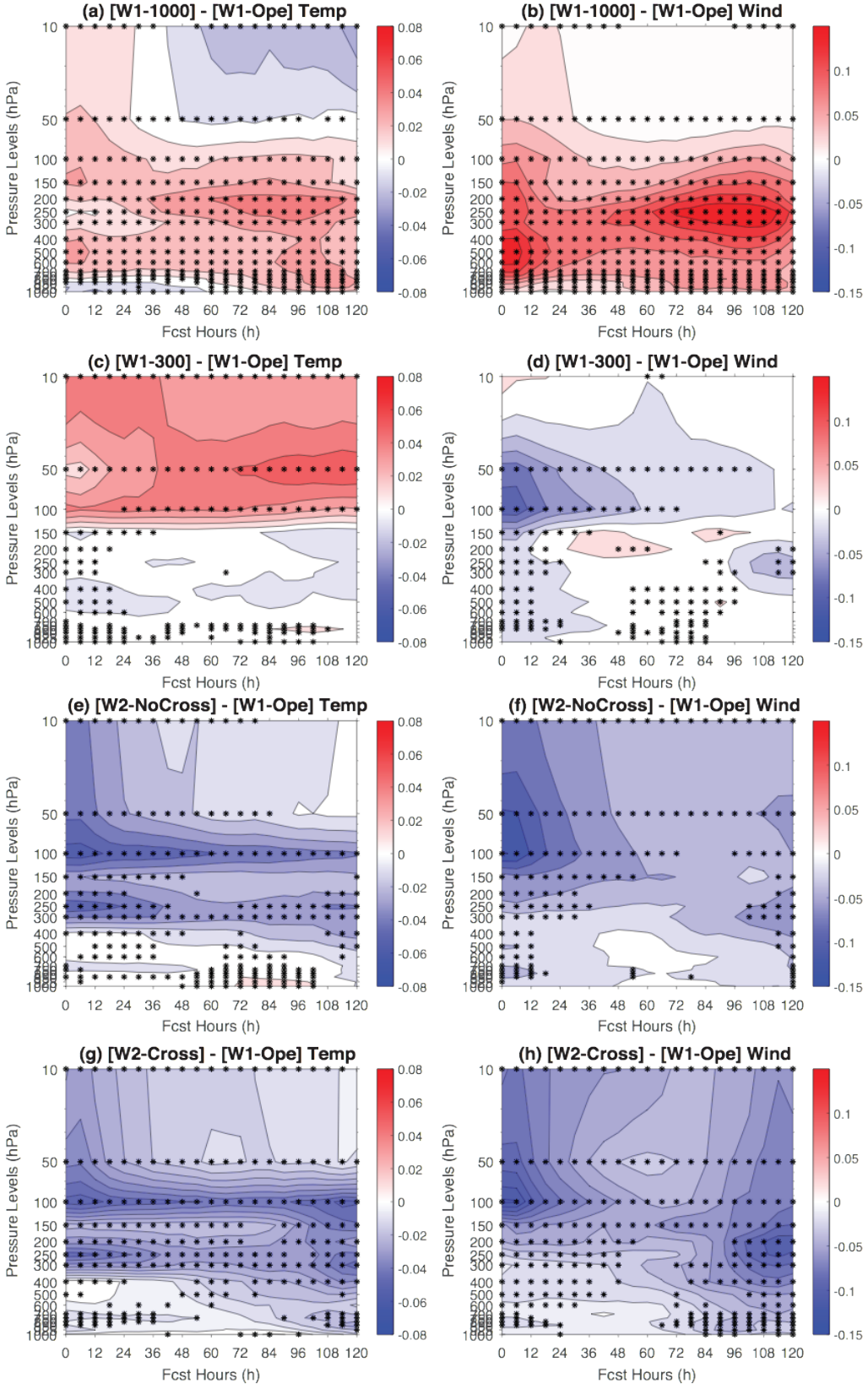


Figure: Using the simultaneous multiscale data assimilation approach in 4DEnVar significantly improved FV3GFS forecast. Adapted from Fig. 8 of Huang, Wang, Kleist and Lei 2020.

WHO'S WHO IN THE DTC

Tatiana Burek NCAR

Many of you may know Tatiana Burek as the developer and gatekeeper of METviewer, the visualization software for the verification package developed and supported by the DTC, but her life took a series of turns to arrive at the DTC. She grew up in Leningrad, Russia where she spent her childhood as a passionate competitor, both as a speed skater and swimmer, all while attending rigorous dance classes. Undaunted by year-round swim team practice sessions in the outdoor pool, whose coach only cancelled classes when temperatures dropped below 20 degrees F, her love of swimming eventually metamorphosed into a passion for scuba diving.

Tatiana and her husband are now avid divers listing trips to venues such as the Great Blue Hole in Belize (her deepest dive was 130 ft), Fiji where she was dazzled by brilliant corals, the cenotes in Mexico where light filters through the cracks in the underwater caves, and numerous night dives when shy sea creatures emerge in the total darkness and are easily spooked by flashlight. She and her husband love the undersea world so much they wanted to bring that experience to the disabled. To pursue this, they participated in carefully structured dive events that introduce this joy to individuals who may never have imagined the possibility of experiencing the marvels of the ocean.

Although Tatiana's mathematical acumen shone brightly during high school, she discovered computer science in college and dove into programming with bold enthusiasm. The odds were in her favor, as it turned out. At the time, computer programming was considered to be a girl's profession and the only two boys in the class were outnumbered by 30 girls. She furthered her education in computer science at Northwest Correspondence Technical University while supporting herself as a programmer.

As is often the case, learning doesn't stop after University. Tatiana moved to the US in 1999, which necessitated not only learning to speak English, but also relearning to program - in English. She went ahead with a full reboot.

Tatiana is now the Software Engineer who both develops and manages METviewer. She found her way to the DTC when METviewer lost its developer and she was offered the opportunity of maintaining it. Barb Brown, John Halley Gotway, and Tressa Fowler so impressed her with the work they were doing that she jumped at the opportunity to join the team! In short, her role is to augment the tool with new features and fix bugs as they arise. Through a non-DTC project, Tatiana also developed a visualization tool for the National Hurricane Center to view hurricane tracks on the interactive map. Creating helpful user interfaces is something she really enjoys. Fortunately, the Research Applications Laboratory is full of opportunities to implement her ideas, while developing helpful tools for scientists.

Hopefully, her future will include more sublime underwater exploration, but in the meantime, she offers this quote, "Do what you can, with what you have, where you are." - Theodore Roosevelt. ■

Upcoming UFS Metrics Workshop

The Developmental Testbed Center (DTC), in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and the Unified Forecast System's Verification and Validation Cross-Cutting Team (UFS-V&V), is hosting a three-day workshop to identify key verification and validation metrics for UFS applications. The workshop will be held remotely 22-24 February, 2021. Approximately 275 participants have registered for this event from across the research and operational community.

The goal of this workshop is to identify and prioritize key metrics to apply during the evaluation of UFS research products and guiding their transition from research-to-operations (R2O). Because all UFS evaluation decisions affect a diverse set of users, workshop organizers are encouraging members from government, academic, and private-sector organizations to participate in the workshop. In preparation for the workshop, a series of three pre-workshop surveys were distributed to interested parties. The results of the surveys have been used to prepare the discussion points of the breakout groups to streamline the metrics prioritization process.

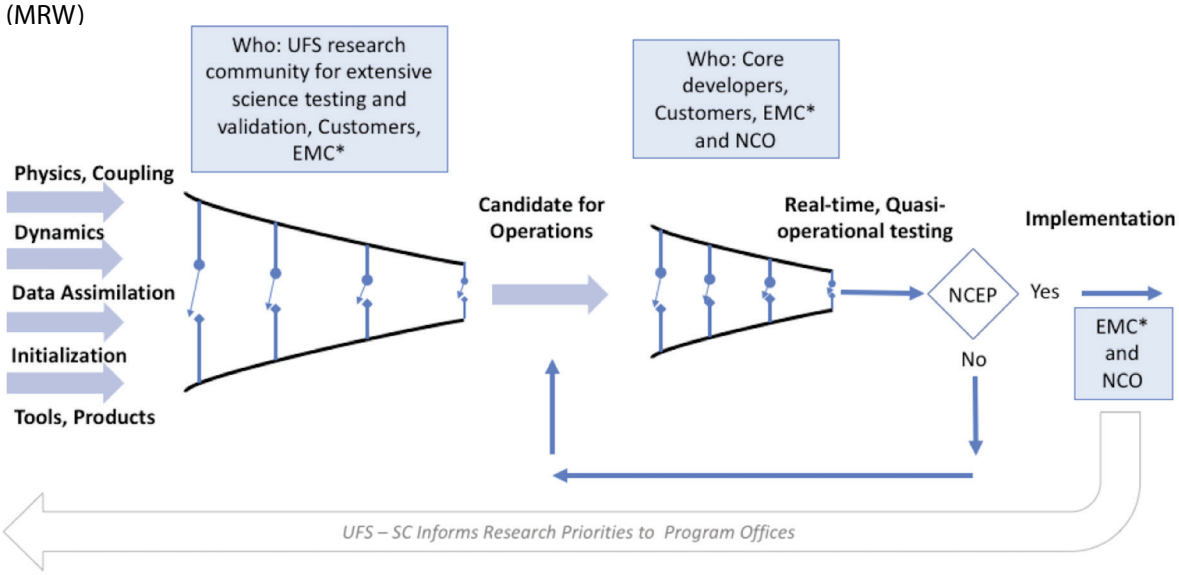
The organizing committee is using the outcome of the 2018 DTC Community Unified Forecast System Test Plan and Metrics Workshop and pre-workshop surveys to form the foundation of the workshop. Ricky Rood, Dorothy Koch, Hendrik Tolman along with the Workshop Co-Chairs will be kicking off the meeting by providing the background and goals for the workshop. The first day features an opening plenary to curate the issues to be addressed in the breakout groups. The end of Day One and Day Two includes breakout groups to allow for final community input into the application forecast challenges along with prioritization across all applications. The workshop will end on Day Three with a final set of breakout groups to discuss how to apply the prioritized metrics to the full R2O development stages and gates. A wrap-up plenary rounds out a robust agenda. The breakout groups will focus on the nine UFS applications along with key forecast challenges:

Model Applications

- Short Range Weather (SRW)
- Medium Range Weather (MRW)
- Sub-Seasonal
- Seasonal
- Atmospheric Quality and Composition
- Coastal
- Hurricane
- Marine and Cryosphere
- Space Weather
- Land/Hydrology

Additional Key Forecast Challenges

- Aviation
- High Impact Weather (beyond hurricanes)
- Weather Extremes
- Data Assimilation



The R2O funnel, in which metrics are used to advance the innovations towards progressively high readiness levels. (Image from Rood, Richard; Tolman, Hendrik, 2018: Organizing Research to Operations Transition Technical Report.)

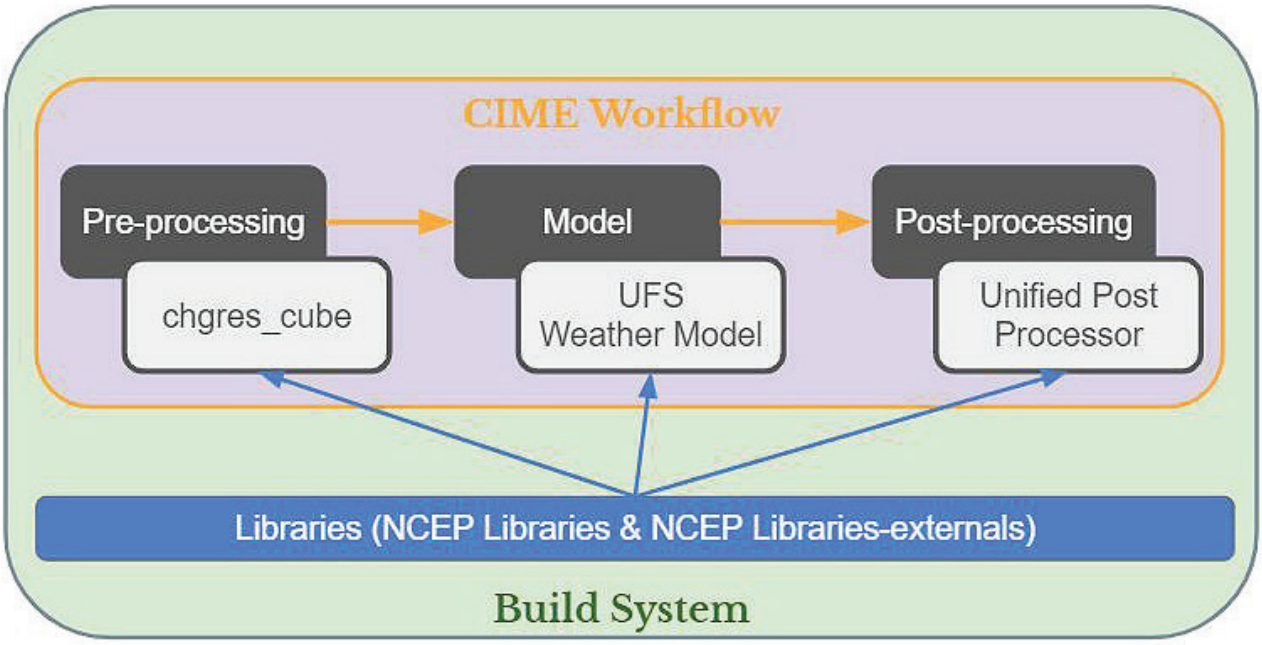
The Workshop Organizing Committee includes Tara Jensen (NCAR and DTC), Jason Levit (NOAA/EMC), Geoff Manikin (NOAA/EMC), Jason Otkin (UWisc CIMSS), Mike Baldwin (Purdue University), Dave Turner (NOAA/GSL), Deepthi Achuthavarier (NOAA/OSTI), Jack Settelmaier (NOAA/SRHQ), Burkely Gallo (NOAA/SPC), Linden Wolf (NOAA/OSTI), Sarah Lu (SUNY-Albany), Cristiana Stan (GMU), Yan Xue (OSTI), Matt Janiga (NRL), and the entire UFS V&V Team.

Contributed by Tara Jensen. ■

Building a Community through Unified Forecast System Medium-Range Weather Application Users' Training

The DTC, in cooperation with subject-matter experts from NOAA's Environmental Modeling Center (EMC) and Geophysical Fluid Dynamics Laboratory (GFDL), as well as NCAR's Climate and Global Dynamics (CGD) Laboratory hosted a live, virtual training session for the Unified Forecast System (UFS) Medium-Range Weather (MRW) Application 4-6 November and 9 November 2020.

The UFS MRW Application targets predictions of global atmospheric behavior out to about two weeks. This training was designed to teach community users how to set up and run the latest officially released UFS MRW Application (version 1.1) for their own experiments. The training comprised a wide range of sessions taught by highly experienced experts and developers in the field. Live lectures were presented by experts on the various UFS components, including the CIME-based workflow, the Finite-Volume Cubed-Sphere (FV3) dynamic core and physics suite options, and pre/



'Build diagram' discussed at the Unified Forecast System Medium-Range Weather Application Users' Training.

post-processing. In addition to lectures, live virtual practice sessions were hosted to broaden experience with building, running, and modifying the system to take full advantage of the supported capabilities for research and forecasting. Throughout the training, participants were able to interact directly with the SMEs to gain a deeper understanding of the system and how to configure it for their purposes. The final day provided an optional "deeper dive" for developers that covered advanced subjects, including code modification, domain configuration, and repository management protocols. The slides from these presentations as well as recordings, are available on the DTC website.

A total of 34 participants registered for the event, representing eight different time zones! Upwards of 54 participants took part in some sessions, with the average being 40-45 attendees including instructors. We had enthusiastic participation in all of the lectures, and the instructors were able to provide prompt and detailed answers to questions raised during the practical sessions using Google Meet and Slack.

Although a virtual meeting was not the preferred method for teaching the material, it nevertheless was a great success, according to the participants. Quotes from the feedback included, "I've really appreciated the practicals and the rapid feedback in the Slack channels." And, "I personally enjoyed this training very much and learned a lot. The materials really helped me consolidate some of my knowledge and skill for different components and functionalities in the UFS apps."

Contributed by Jamie Wolff. ■

DID YOU KNOW

Data on the Cloud

NOAA's Big Data Program (BDP) is providing public access to NOAA's open data on commercial cloud platforms through public-private partnerships with Amazon Web Services, Google Cloud Platform and Microsoft Azure. NOAA generates tens of terabytes of data a day from observations like satellites, radars, and buoys, and from weather models, and other sources. Did you know the available datasets include:

- UFS Coupled Model Prototype 5 (S2SP5), which is the latest experimental version of the UFS coupled atmosphere-ocean-sea ice model. This dataset is a significant intermediate stage in the ongoing development of the UFS seasonal to sub-seasonal application.
- Global Ensemble Forecast System (GEFS) v12 reforecasts for the upcoming GEFS v12 operational implementation. These retrospective forecasts span the period 2000-2019.
- Global Forecast Systems (GFS) Warm Start Initial Conditions for the operational deterministic medium-range numerical weather prediction, which are available four times per day for running forecasts at the 00Z, 06Z, 12Z and 18Z cycles, respectively.
- Other available datasets can be discovered through the registries on all these commercial platforms, including for example, Registry of Open Data on AWS.

Providing this data in the cloud significantly reduces the time needed to access and process the data, opening up new possibilities for in depth study and emerging areas of science. You are encouraged to use the available datasets. A broad collaboration among NOAA and non-NOAA scientists can accelerate innovation into operational modeling for weather and climate prediction.

Contributors: Jena Kent, Jack Settelmaier, Tom Hamill, Stylianos Flampouri, Deepthi Achuthavarier, and Avichal Mehra. ■

NEWS FROM THE DTC

Announcements, Events and Presentations

SOFTWARE RELEASE AND WORKSHOP

SOFTWARE RELEASE: METEXPRESS V3.0.1

2020-12-10 | The DTC is pleased to announce the release of the METexpress application, Version 3.0.1 (dated Oct. 7, 2020). METexpress is a simplified data analysis visualization component of the enhanced Model Evaluation Tools (METplus) verification system. More information can be found here, http://dtcenter.org/news/metexpress-v3-0-1-release

2021 DTC UFS EVALUATION METRICS WORKSHOP

2021-02-22 to 24 | The DTC in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and the Unified Forecast System's Verification and Validation Cross-Cutting Team (UFS-V&V), will be holding a three day workshop to identify key verification and validation metrics for UFS applications. The workshop will be held remotely February 22-24, 2021. More information can be found here, https://dtcenter.org/events/2021/2021-dtc-ufs-evaluation-metrics-workshop

Sponsors

DTC's primary sponsors are the National Oceanic & Atmospheric Administration (NOAA), the Air Force, the National Center for Atmospheric Research (NCAR), and the National Science Foundation.

This newsletter is published by:

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