Issue 1 | Spring 2020

UFS QUARTERLY

UNIFIED FORECAST SYSTEM COMMUNITY NEWS

IN THIS ISSUE

NEWS THIS QUARTER

New Territory

Welcome to the first issue of the UFS Quarterly. We hope you are staying well as we all cope with the personal and professional challenges of COVID-19.

The year has already included major achievements for UFS. There were 50+ talks and events on UFS at the AMS Annual Meeting in Boston. The first UFS community release, the Medium-Range Weather Application 1.0, came out in March to positive feedback. An article in this issue explains how external feedback is being documented using the "Graduate Student Test." The UFS-R20 project, also featured here, has become a vehicle for achieving some of the key UFS capabilities over the next two years.

Scientific and technical teams have pressed ahead with virtual meetings, such as the recent Workflows Workshop, and organizers are busy restructuring the first UFS Users' Workshop so that it, too, can be fully virtual. As we figure out how to work together, some of us with our children and pets at our keyboards, it's encouraging to see how quickly and effectively the UFS project is adapting. Enjoy the newsletter, and be well.

Richard Rood and Hendrik Tolman
UFS Steering Committee Co-Chairs

FEATURED PROJECT

The UFS-R2O Project

The Unified Forecast System (UFS) is a complex effort, with eight distinct forecast applications, covering predictions from less than an hour to more than a year. As a coupled system, it encompasses atmosphere, ocean, ice, land, sea-ice, wave and aerosol model components developed by experts from different organizations. Data assimilation approaches need to be customized for components and applications, and ensemble and post-processing techniques must be designed to produce the most accurate forecasts possible.

In order to span these aspects of research and development, the UFS project has to integrate the contributions of many different projects, funded by diverse sources and covering a wide range of topical areas. Some of these projects are huge - the Hurricane Supplemental of 2019 and 2020 represents over $40M in UFS modeling investments - while others are tiny.

When it was time to plan a core set of NOAA-funded projects for UFS this year, program managers at the National Weather Service (NWS) and Oceanic and Atmospheric Research (OAR) decided to take a new and more holistic approach.

Dorothy Koch of the NWS STI Office explains, “We wanted to be sure that not only were we getting the contributions that we needed to advance our operational mission, but that those contributions were integrated together with research to effectively foster “research to operations” and “operations to research” within a single project team. We have the additional challenge that we must generate improved forecasts in the short term, and also contribute to advancing long-term goals.”

The result is the UFS Research to Operations (UFS-R2O) project. Project leadership includes scientists from NOAA’s NWS and OAR as well as the community, and the team members work at NWS Centers, OAR Laboratories, NCAR and universities. The project must operate within constraints imposed by operational imperatives and public model release timelines, and is structured as a 2-year award with a 3-5 year vision. Work on the 3-5 year vision starts immediately so the research to operations pipeline is continuously fed. Funding for the project is coordinated between the National Weather Service (NWS) and Oceanic and Atmospheric Research (OAR).

Jim Kinter (George Mason University), Vijay Tallapragada (NOAA/NWS/EMC) and Jeff Whitaker (NOAA/OAR/PSL) are the overall UFS-R2O leads. They emphasize that to be successful it must serve both the research and operational communities: “The UFS R2O project has the dual goals of developing modeling innovations from the best available scientific understanding suitable for transition from research to operations, and broadening access to, and usage of, the UFS by the research community.”

The UFS-R2O project will leverage and be coordinated with the broader set of UFS activities through participation on shared teams. These include the UFS Steering Committee, a set of application teams, cross-cutting teams that include system functions such as system architecture and verification and validation, and a set of topical working groups for areas such as data assimilation and atmospheric physics.

UFS-R2O project activities focus on the development of both regional and global UFS applications. At the global scale, the team will continue to develop the Medium-Range Weather (MRW) Application, which focuses on atmospheric behavior out to about two weeks, and the Subseasonal to Seasonal (S2S) Application, which extends predictions from two weeks to about one year. Although the Medium-Range Weather Application currently includes only an atmospheric model and land surface component, a goal is to enable both of these global applications to be based on the same underlying coupled model that includes atmosphere, land, ocean, sea-ice, wave, and aerosol components. Inclusion of an active ocean and other components has been shown to improve medium to extended range predictions (e.g., Zhu and Shukla 2013, Koster et al. 2004). At the regional scale, the focus is on advancing an ensemble-based short range weather application that targets forecasts from less than an hour to a few days. One of the key goals for short-range prediction is to develop a new advanced atmospheric moist physics suite that will be scale-aware for different timescales.

Through these activities, the UFS-R2O project will maintain a focus on advancing a subset of essential capabilities that will be coordinated with a broader set of projects and contributions within the overall UFS community structure. As Dorothy notes, “The bottom line is always, how do we engage the research community to improve our nation’s forecasts?”

R2O2R

Curious about UFS?
Try a Graduate Student Test

For more than a decade, Dr. Jim Kinter had been frustrated by how difficult it was to work with National Weather Service models. It took his students most of a semester to just understand the code, much less make advances that could find their way into operations. The operational workflow - the part of the code that directs the overall sequence of events, including getting initial data, running the model, and post-processing results - was not built for university use. So Jim, a Professor of Climate Dynamics at George Mason University, came up with a software usability test called the Graduate Student Test or GST: a graduate student should be able to get, build, and run code easily, test it for correct operation, and evaluate results with standard diagnostic packages. The student should be able to get user support and training quickly, if they need it. And the student should be able to understand what to do to give their code the best chance of getting into operations.

As the Unified Forecast System (UFS) began to take shape, the GST became a key measure of how successful the UFS project would be in opening its code and development processes to the broader community. Students and postdocs make excellent community representatives because they are motivated to work with UFS, but may be new to its concepts, acronyms, and assumptions.

The first GST was deployed during fall 2019, for a prototype version of the UFS Sub-seasonal to Seasonal (S2S) application. An exciting aspect of this prototype was that it used a portable community workflow called the Common Infrastructure for Modeling Earth (CIME). CIME allowed even a complex, coupled modeling system like the S2S application, with atmosphere, ocean, and ice components, to be run with a few simple commands. To make the GST procedure clear and somewhat quantitative, test takers were asked to perform specific code changes, to complete the test within a specified time, and to fill out a questionnaire about the experience afterwards.

The sample size was modest, but when the first questionnaire results came in, it was clear that the CIME workflow was a winner. Most of the students and postdoctoral fellows who had taken the GST were able to complete it in under the specified time and reported that running the test was … fun! The GST process enabled this feedback to be captured, bugs to be reported, and usability aspects of the system understood prior to a major initiative: the first official community release of UFS. The pressure was on to have this release, the Medium-Range Weather Application 1.0, be user-friendly.

Informed by feedback from the first GST, the release team chose CIME as the workflow. The release was delivered on March 11, 2020 through GitHub, along with a new GST. There is an open registration process and feedback has started to come in. The responses? Enthusiastic and insightful. Where there are issues, detailed feedback from the GST will help to make the next release even more accessible. GSTs are planned for other applications as they are delivered.

Would you like to be part of this process? The GST is open to all, and there is even an allocation available if you need one to try the test. We hope you join us in making the National Weather Service codes among the most usable in the world, as well as the best.

UFS PEOPLE

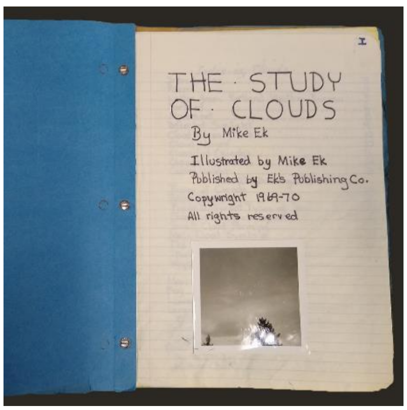
Mike Ek

Mike Ek is currently the Director of the Joint Numerical Testbed at the NCAR Research Applications Laboratory.

A lot of us have that story: the one where, looking back, we can see the beginning of our career path. Mike Ek's story is set on a bus, returning to Portland from an eighth-grade field trip to the Oregon coast. Mike saw a funnel cloud about a half mile away, and made a forecast: "It's gonna hail!" Sure enough, hail pelted the bus a few minutes later, and it dawned on Mike that he could be good at this. He still thinks, "Best forecast ever."

It didn't take long for the young scientist to try his hand at publication. Mike keeps a monograph in his office called The Study of Clouds. Published by "Ek's Publishing Company" and illustrated with photographs, the scholarly detail and the meteorological interest are evident, especially for a 13-year-old author.

That interest followed him through his high school years, where he liked math, physics, weather, and aviation. He completed undergraduate and masters degrees in atmospheric sciences at Oregon State University, then took a forecasting job in Alaska. Flying around the state, he observed and predicted mountain weather and avalanches in cold seasons, and fire weather during warm seasons. During those years, Mike learned about the forecasting part of the "funnel" - the metaphor that the meteorological community often uses to describe the process of entraining many different research efforts (the wide end) into the development of an effective operational forecast system (the narrow end).



Mike ended up back at Oregon State after that, doing research and teaching. He went on to get his Ph.D in a mostly remote arrangement through Wageningen University in The Netherlands, studying what he calls his trinity: land surface, boundary layer, and clouds. Working on development of predecessors of the Noah land surface model and the Yonsei State University Boundary Layer scheme, Mike deepened his knowledge of the more academic, research-oriented parts of the funnel.

Then he hopped back a little closer to operations again, taking a position at the NOAA Environmental Modeling Center (EMC) as a land modeler and later as the Deputy Director. EMC has an important role in the funnel as a place where model codes are evaluated and readied for transition to operations. At this point, Mike's cumulative experience started to give him a unique perspective on how all the parts of the funnel need to coordinate to make great forecasts. Mike was at EMC when the concept for the Unified Forecast System (UFS) took hold: a coupled, configurable system that can be shared by research and operational communities. His most recent move took him to NCAR as the Director of the Joint Numerical Testbed, an organization that serves as a community interface to many of NOAA's operational codes, and interfaces with the Developmental Testbed Center (DTC). Looking at UFS from the community perspective, Mike now has another part of the funnel to explore.

With hands-on experience in forecasting, academic research, transition-to -operations, and community engagement, what does Mike consider the most critical element of the UFS? The idea of Hierarchical Systems Development (HSD) is central to his thinking. HSD describes an iterative way of working that brings many of the elements of the funnel together: shifting quickly and easily from work on a specific parameterization, for example, all the way to testing a fully coupled system. After a lifetime of looking at all the facets of the problem, Mike is now focusing on what he loves best: figuring out how to make all the pieces of a unified forecasting system work together.

For more on HSD, see:

https://ufscommunity.org/index.html#/articles/20190910_Hierarchical_Systems_Develop

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MEETING NOTES

UFS Workflows Workshop and CROW Review

The UFS Workflows Workshop and CROW Review was held on April 28-30, 2020, as a virtual meeting. Organized by UFS collaborators at George Mason University, the Developmental Testbed Center, the National Oceanic and Atmospheric Administration, and the National Center for Atmospheric Research, this meeting allowed participants to learn about the capabilities and design of various workflows that drive different UFS applications. The meeting also included a review of the Configuration manager for Research and Operational Workflows (CROW) software, developed to unify the part of the workflow that specifies the overall sequence of events.

How did it go? Co-organizer Ben Cash of George Mason University says, “The virtual meeting format proved to be far more effective and engaging than I had imagined it would be, especially with over 60 participants (more than double our expectations!). Our goal was to bring the users and developers of workflows for the different UFS applications together for education and dialogue about the capabilities and needs of each of the applications. Judging from the lively discussion and many pages of notes I would say we were highly successful! At the end of the three-day meeting I think everyone walked away with a greater appreciation for the needs and choices driving what was dubbed the 'workflow explosion,' and an interest and willingness to explore efforts to bring it more under control.”

CALENDAR

- UFS Webinar Series, every other Thursday at 1pmMT/3pmET
- July 27-29, 2020: First Annual UFS Users' Workshop

CODE RELEASES

The UFS Medium Range Weather Application v1.0

Model Evaluation Tools: METplus version 3.0, MET version 9.0, and METviewer version 3.0

The Common Community Physics Package (CCPP) and Single Column Model (SCM) v4.0

PRESENTATIONS

List of UFS presentations and events at the 2020 AMS Annual Meeting in Boston, MA

PUBLICATIONS

We hope to increase the emphasis on science advances in future newsletters, and to feature information about ongoing work and UFS-related publications. The list below includes recent (2019 and later) publications that are associated with UFS and UFS components. To include additional publications here, write: ufscommunitycontact@gmail.com

Bengtsson, L., J. Dias, M. Gehne, P. Bechtold, J. Whitaker, J. Bao, L. Magnusson, S. Michelson, P. Pegion, S. Tulich, and G.N. Kiladis, 2019: Convectively Coupled Equatorial Wave Simulations Using the ECMWF IFS and the NOAA GFS Cumulus Convection Schemes in the NOAA GFS Model. *Mon. Wea. Rev.,* **147**, 4005–4025, https://doi.org/10.1175/MWR-D-19-0195.1

Bengtsson, L., J. Bao, P. Pegion, C. Penland, S. Michelson, and J. Whitaker, 2019: A Model Framework for Stochastic Representation of Uncertainties Associated with Physical Processes in NOAA's Next Generation Global Prediction System (NGGPS). *Mon. Wea. Rev.,* **147**, 893–911, https://doi.org/10.1175/MWR-D-18-0238.1

Clark. A., 2019: Comparisons of QPFs Derived from Single- and Multicore Convection-Allowing Ensembles, Wea. Forecasting, 34, 1955-1964, https://doi.org/10.1175/WAF-D-19-0128.1

Gallo, B. T., C. P. Kalb, J. H. Gotway, H. H. Fisher, B. Roberts, I. L. Jirak, A. J. Clark, C. Alexander, and T. L. Jensen, 2019: Initial Development and Testing of a Convection-Allowing Model Scorecard. *Bull. Amer. Meteor. Soc.,* **100**, ES367–

ES384, https://doi.org/10.1175/BAMS-D-18-0218.1

Potvin, Corey K., J. Carley, A. J. Clark, Louis J. Wicker, Patrick S. Skinner, A. E. Reinhart, B. T. Gallo, J. S. Kain, G. S. Romine, E. A. Aligo, K. A. Brewster, D. C. Dowell, L. M. Harris, I. L. Jirak, F. Kong, T. A. Supinie, K. W. Thomas, X. Wang, Y. Wang, and M. Xue, 2019: Systematic Comparison of Convection-Allowing Models during the 2017 NOAA HWT Spring Forecasting Experiment. *Wea. Forecasting*, **34**, 1395-1416, https://doi.org/10.1175/WAF-D-19-0056.1