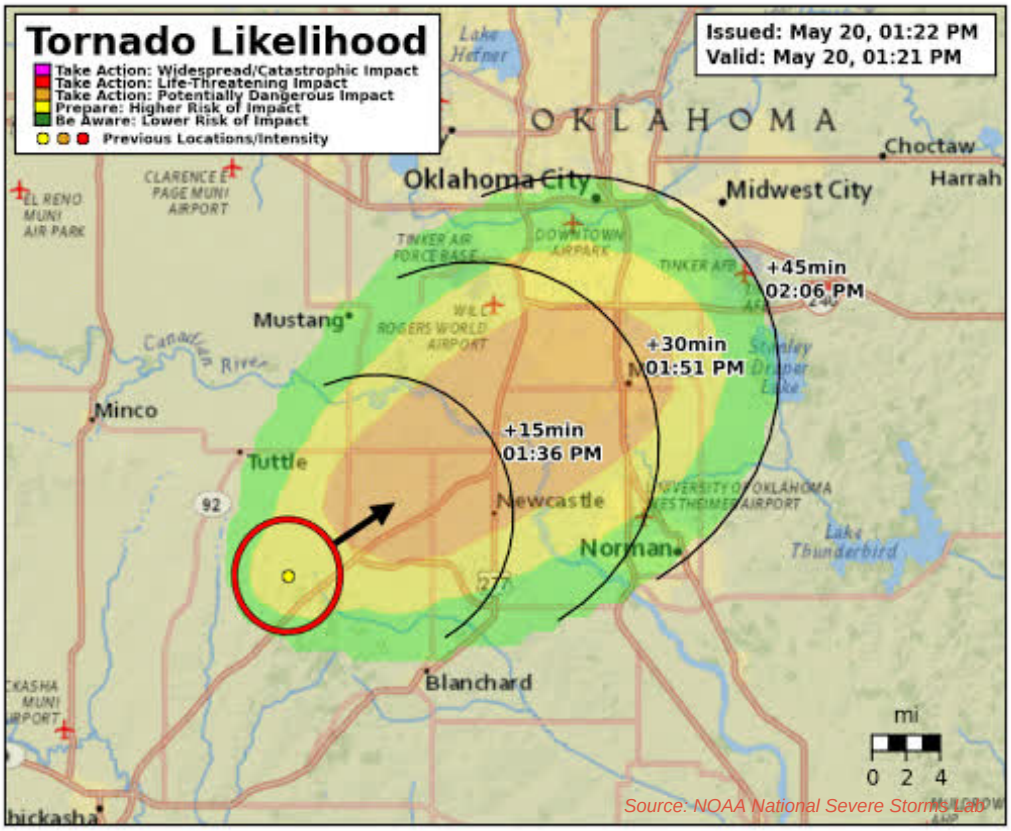
YEAR I, SUMMER 2020

UFS QUARTERLY

BULLETIN OF THE UFS COMMUNITY

WEATHER-READY NATION



FACETs

A PARADIGM SHIFT IMPROVING THREAT AWARENESS

IN THIS ISSUE

The UFS Community Grows Strong Around Sherman's Lagoon

The success of the UFS depends on our ability to collaborate as a community. While the focus of the UFS is to improve operational models, the collaboration starts from within NOAA. Our collective success sits on the shoulders of our ability to collaborate internally at NOAA, and our ability to work closely with the broader community beyond NOAA will benefit from this foundation.

As a recent example, the Office of Oceanic and Atmospheric Research (OAR) and National Weather Service (NWS) have overcome historical barriers. They are now working together to develop the High-Resolution Rapid Refresh model (HRRR) v4.0: OAR manages the development, and NWS is responsible for the subsequent operational implementation. The joint effort on the HRRR is the cornerstone of a unified convection-allowing Rapid Refresh Forecast System (RRFS), which blazes the trail for simplifying the National Weather Service production suite, alongside the implementation of the global ensemble and deterministic forecast systems GEFSv12 and GFSv16.

Within NOAA, Curtis Alexander of OAR and Jacob Carley of NWS led the RRFS effort. NOAA has recognized their important contribution to improving the collaboration between NOAA Line Offices by awarding the Silver Sherman (Order of Sherman's Lagoon) award to both.

To stress the importance of their work outside of NOAA in general, and for the broader UFS Community in particular, the awards were presented at the first annual UFS Users' Workshop, hosted virtually by the Developmental Testbed Center (DTC) in July.

Senior leadership across NOAA select recipients of the Silver Sherman award, and each member of the leadership team can award a single Silver Sherman each year. By using identical language in the awards handed out to Curtis and Jacob, NOAA leadership in effect created a mini-group prize for this effort, a symbolic but essential recognition of a collaborative culture across NOAA line offices that rewards teamwork and broader community engagement.

In this summer edition of our newsletter, other articles emphasize the broader culture change operating within NOAA and across the weather enterprise. We live a unique moment in history that will lead to fair winds and following seas for the UFS Community, with ample benefits to society.

Hendrik Tolman
UFS Steering Committee co-Chair

IN BRIEF

Calendar

Every other Thursday 1pmMT/3pmET
UFS Webinar Series

Nov 4-9 2020
DTC Virtual UFS MRW App Users' Training

Dec 7-11, 2020
AGU Fall Meeting

Jan 10-14, 2021
AMS 101st Annual Meeting

February 22-24 2021
DTC UFS Evaluation Metrics Workshop

UFS Code Releases
Medium Range Weather App v1.1
Short Range Weather App v1.0

Contributors to this Edition

CRTM: Ben Johnson + CRTM Team and students.
UFS PEOPLE: James Kinter, George Mason University.
FACETs: Alison Agather, Gina Eosco (WPO/NOAA), James Correia, Nicole Kurkowski (STI/NOAA) + NSSL.
RTMA: Jacob Carley, Manuel Pondeca (EMC/NOAA), Terra Ladwig (GSL/NOAA) + RTMA Team.
UFS Users' Workshop: Jeff Beck, Ligia Bernardet, Louisa Nance, Weiwei Li (DTC), Yan Xue (STI/NOAA), James Kinter (GMU).

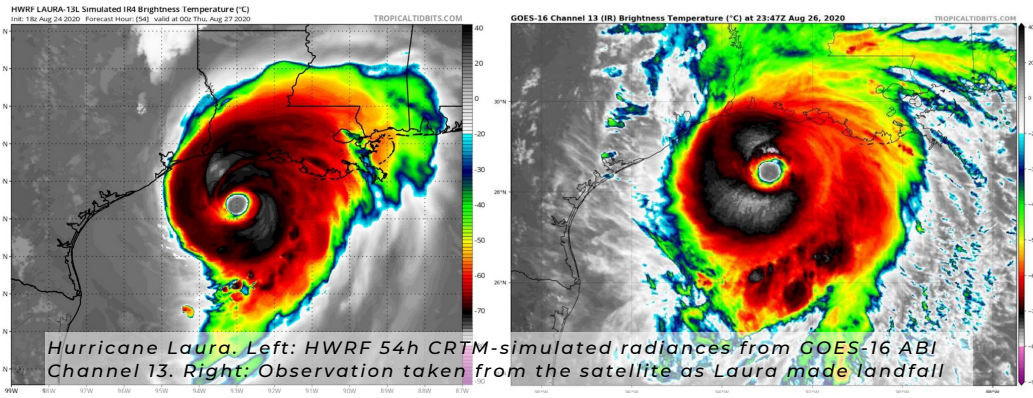
Additional Help: Ricky Rood (Univ Michigan), Dorothy Koch, Hendrik Tolman (STI/NOAA), DaNa Carlis, Leah Dubots, Chantel Bivins (WPO/NOAA), all members of the UFS Communications and Outreach Group.

Thank you, and forgive us if we forgot someone!

CRTM: A COMMUNITY MODELING TRAILBLAZER

A Leader in Transitioning Community Research to Operational Applications

The Community Radiative Transfer Model (CRTM) is a community model with over 40 developers from more than 20 organizations across the weather enterprise contributing to its development over the last 16 years. The CRTM team continues innovating. Recently, it created a graduate student test and generalized its code using open-access modern software development methodologies. As a consequence, it continues to inspire the UFS Community with successful examples of how to transition new ideas to operational systems.



Hurricane Laura. Left: HWRF 54h CRTM-simulated radiances from GOES-16 ABI Channel 13. Right: Observation taken from the satellite as Laura made landfall

"Our model allows us to make the best use of the billions of dollars spent on earth-observing satellites for operational data assimilation, calibration, validation, and post-processing applications", says Ben Johnson, CRTM Project lead at the Joint Center for Satellite Data Assimilation (JCSDA).

The CRTM is a critical operational model that enables satellite data assimilation capabilities in multiple federal agencies, and is also used by many other service organizations, both domestic and international. Its two primary functions are to accurately simulate satellite-based radiances, and to compute the radiance sensitivity to a change in the atmospheric/surface state.

CRTM's first primary function is supported by it's satellite simulator, which is used in bias assessment, quality control, and post-processing. The second, more critical function is fulfilled by algorithms that compute radiance sensitivities, a critical element in interpreting satellite observations to provide the observations-driven increments of an Earth system's model state. Such a role is fundamental to the success of the UFS data assimilation element being developed within JCSDA's Joint Effort for Data Assimilation Integration (JEDI).

CRTM's Graduate Student Test

Starting in May 2017, the CRTM project began defining specific Graduate Student Tests (GSTs) through the CRTM tutorial series. There are three primary GSTs within the CRTM that assess the default functionality of the CRTM. Overall, the three CRTM GSTs only require about 20-30 minutes from initial download to completion. The first test (< 10 min) is simply downloading and compiling the code . The second consists of running a test utility that activates several elements of the code, and verifies that the test is successful (< 1 min). The third and biggest challenge, teaches how to tweak the code: participants modify the test utility to include additional input information, and change the code to provide additional output (~15 min).

The expected benefit of GSTs is to get feedback from users about ease of use, lower barriers to participation, and to more carefully understand the needs and expectations from users. Two-way communication from the students ensures that the CRTM development team is able to maintain the highest level of accessibility and ease of use.

Increasing Community Engagement

The CRTM team developed a Python-based front-end package called PyCRTM, enabling a simple and easy entry of new developers into the CRTM project. This front-end software allows the broadest usage possible. Users can download the package at PyCRTM's GitHub repository.

Getting involved

CRTM welcomes new community members in a variety of ways. The fastest is to contact the CRTM project lead, Dr. Benjamin T. Johnson via his email **bjohns@ucar.edu**. You can also join the CRTM forum at **forums.jcsda.org**, where you can also ask about joining CRTM's GitHub community page.

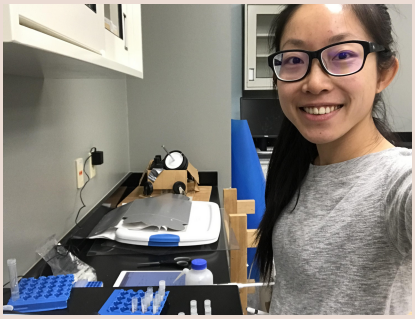
Check CRTM's student stories in the next page!

CRTM COMMUNITY: STUDENT STORIES

Nicholas Kedzuf is in his second year of a MSc in Atmospheric Sciences at the Colorado State University, where he uses radar-based ice number concentration retrievals for studying secondary ice production processes.

"I am particularly interested in the radiative properties of ice particles in the microwave regime. I will use the CRTM to investigate radiative response at cloud scale to changes in ice microphysical characteristics, their relative abundance and size distributions. The hope is to link the cloud's dynamical response to the radiative response. Community modeling is critical for facilitating collaboration between researchers with different research focus. It can contextualize niche research and push the state of the science forward. If open source, it can also lower the barrier to entry and increase/diversify the community, leading to better end-products."

I-Ting KuHow is three years into her PhD at the Colorado State University. She investigates the impact of wildfires on emissions of isoprene and atmospheric oxidative capacity.

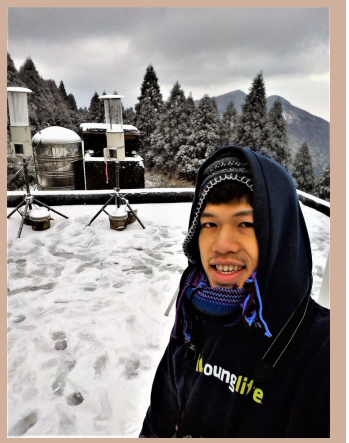


"The CRTM was introduced through a course of advanced radiative transfer, allowing us to do class projects without building a radiative transfer model from scratch. I will use CRTM to understand how current satellite sensors monitor trace gas and retrieve plume height in the areas that are impacted by wildfire smoke. I believe that after using CRTM, my understanding of satellite observations and associated data products will be greatly improved and they will be no longer a black box to me. I think community modeling efforts are awesome! I'm really a chemistry person and do not have much programing experience. The set-up of CRTM and the instruction provide me the easier way into this field, so I could use the information from there to assist my study in the future."

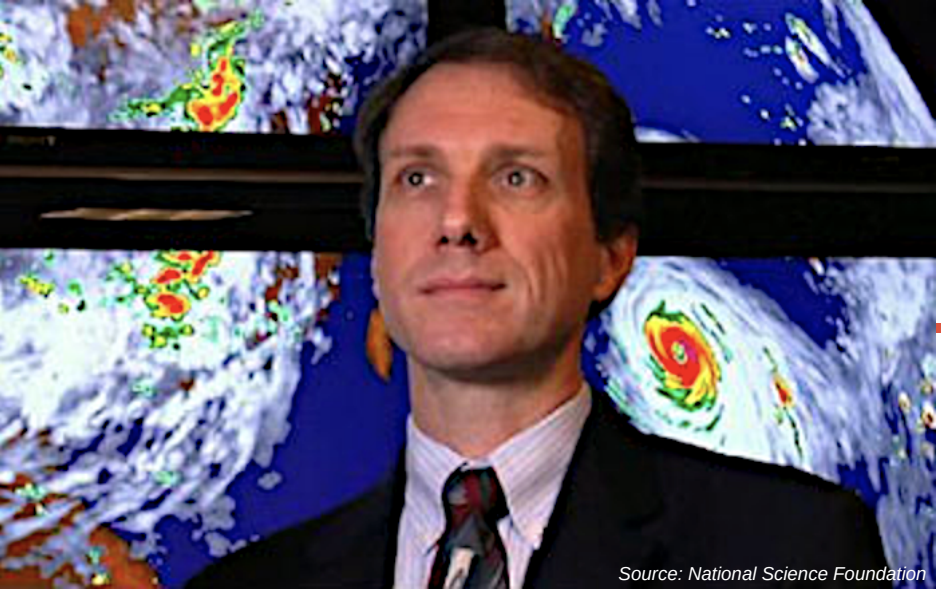
"CRTM is the radiance observation operator in the GSI analysis system, which is the core system in my experiments. As the radiance observation operator, CRTM supplies the radiance simulation of the model state and the Jacobian matrix, which I use to to assimilate hazy-sky observation and examine the response of aerosols. The capability to consider multiple-scattering of aerosols in CRTM is really helpful for me to explore the aerosol impacts on radiance data assimilation. Community modeling efforts such as the CRTM are great because the research energy of the community can contribute and everyone can leverage other people's work in a more efficient way."

Shih-Wei Wei is completing his Major in Atmospheric Sciences at the State University of New York, Albany. He is investigating how to incorporate aerosol information for IR hazy-sky data assimilation.

"I will use the CRTM to understand the radiative effect of clouds in the shortwave spectrum and aerosol-cloud-radiation interactions under the different atmospheric conditions. The simulations from the CRTM could help us understand which parameters are important when developing a retrieval algorithm. Its list of satellite sensors helps me to explore new observational strategies and test them for new scientific questions. It is a great tool for students who haven't had much hands-on experience in radiative transfer. It also provides a good start for us to look into the physical interpretation of remote sensing data. Efforts in trying to keep the model updated, as well as flexible so that it could meet all kinds of needs in terms of research activities are very much appreciated!"



Kevin Yang is a second-year MSc student in Atmospheric Sciences at the Colorado State University studying aerosol and cloud processes using satellite observations.



Source: National Science Foundation

"My hope is that we will see innovation, even just a spark of a good idea at some University, transition to operations in less than two years"

JAMES KINTER

Director of the Center for Ocean-Land-Atmosphere Studies (COLA) at George Mason University (GMU), Professor Kinter is a pioneer in community modeling efforts in the USA.

A Community Modeling Champion Embraces the UFS

James Kinter is a leading proponent of community forecast modeling efforts in the USA. He juggles several leading roles related to the UFS and atmospheric sciences education: he is a co-Principal Investigator in the UFS-R2O Project, a contributor to the UFS Steering Committee, Director of the Center for Ocean-Land-Atmosphere Studies (COLA), and Chair of the Atmospheric, Oceanic and Earth Sciences Department at GMU. Kinter is a champion of community modeling. In our first community Newsletter Q&A, he shares his enthusiasm. He provides a convincing list of arguments demonstrating the immense potential of the UFS Community to help America reclaim its world leadership in weather forecasting.

C&O: *Jim, what inspired you to direct your work to community modeling?*

Kinter: My engagement with community modeling started back in the mid-1980s. My Ph.D. advisor at NOAA's Geophysical Fluid Dynamics Lab, in Princeton, was Kikuro Miyakoda. Kiku was a bit inscrutable as an advisor, kind of on purpose. Still, I learned from him that model development requires a strong focus on prediction. His vision was that it was important to keep a close connection between operational models from the Weather Service and our research. I took that idea into my postdoc with [Jagadish] Shukla's group at the University of Maryland and started using the National Meteorological Center's [former name of NCEP] operational model in our research. We expanded on this idea later when we began collaborating with the European Center (ECMWF). They already had a significant community engagement. Their operational model was used at universities in the UK, France and Italy, and they were bringing new ideas back into their operational models. We approached the ECMWF to ask if we could also collaborate and made a very informal arrangement to use their model. Fast forward to the present. We've been developing these research-to-operations ideas ever since, separately. Now we're trying to bring them together so that innovation can move more quickly back to operational systems.

C&O: *What drove you to help redesign NOAA's operational models through the establishment of a UFS Community?*

Kinter: My involvement with the UFS started because Louis Uccellini [Director of the US National Weather Service] asked, and as you know, he's a force of nature. When Louis was the Director at NCEP, he asked Fred Carr [Professor Emeritus at the University of Oklahoma] and me to lead a review of NCEP. He was feeling the need for external evaluation, and our review provided recommendations that later became the University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for NCEP (UCACN) and the UCACN Model Advisory Committee (UMAC). Louis is a very inspirational leader, so the motivation was initially personal. It became institutional as I got to know a lot of the people inside the Weather Service and how things work. I now know practically everybody, and it's personally satisfying to help them succeed because NOAA is our national agency that makes environmental predictions. Many people have said they could do it better, but the fact is that NOAA does it, and does it very well. Another driving force is scientific motivation. We want to find out how we can help NOAA do it better and

get the US back on top as the leading country in weather and climate prediction. There are many smart people in the US. There's a wide diversity of ideas about improving models, we have all the tools to get things done. It's just a question of bringing all things together in an effective way.

C&O: *Do you think that the idea of building community is essential to make this happen?*

Kinter: Yes. Building trust between the Weather Service and the broader community is essential. For me, it's all about trust, and trust goes in both directions. We need to understand that people inside the Weather Service can't say "it's Saturday, I'm going to go to the beach." There has to be a forecast every day. It has to be on time, it has to be accurate, it has to be useful, and it has to be delivered so that all the stakeholders can take the best advantage of it. None of those things matter much to academics. In academia, it's publish or perish. So it's natural for people inside the Weather Service to distrust people in academia because we don't feel their pain. But it goes the other way too - people in academia have largely given up on the Weather Service because people in operational prediction aren't noticing when researchers come up with something clever. We have to bring these different groups of people together in a common cause to trust each other again. Trust is a saw-tooth curve, it takes a really long time to build, but it takes an instant to destroy. You have to stay committed for the long haul. We have to build UFS as a community organization where we all see that by collaborating, everybody comes out ahead.

C&O: *There have been previous attempts to build research communities that failed. What makes you think we are living an unique moment?*

Kinter: I think what's different is that we never had operational people directly involved before. What's novel about the UFS is this notion of bringing an operational community into close proximity inside the firewall of the circle of trust with a bunch of academics and people who are exclusively oriented towards research. Those are two very different communities with different action-item lists, different priorities, different management structures: everything is different about those two communities. The UFS is bringing them together, and that is novel.

C&O: *What are the paving elements to create that two-way avenue? What do academics have to gain, and what does operations have to gain?*

Kinter: When you do research with an operational code that is run every day by somebody else, you don't have to worry about computer reliability. You also automatically get access to a database that you don't have to generate yourself. These are huge advantages to academics. The advantage for operations is that NCEP would have no way to generate thousands of pages of new developments demonstrated in the scholarly literature. But they can test and implement these advances having this huge community support. The UFS community expands human resources for operations by an order of magnitude because now you've got graduate students, postdocs, faculty, and laboratory scientists around the whole country looking at the same code used in operations. Access to operational codes and data also has a multiplier effect on academics. That two-way street has a strong role in the value proposition for building trust.

"What's novel about the UFS is this notion of bringing an operational community into close proximity with a bunch of academics and people who are exclusively oriented towards research"

C&O: *How do you see the future of weather models and your legacy in 10 or 20 years?*

Kinter: My hope is that we will see innovation, even just a spark of a good idea at some University, transition to operations in less than two years. That's not a total pipe dream. I also see a lot of artificial intelligence and machine learning work that could be applied to automate and accelerate the whole model development cycle. As far as legacy, I try not to put a personal stamp on things. I view myself as just one member of a big community. If the UFS promise of community unification really works, if there are buy-in and trust from all community segments, if we achieve a shorter pathway from research innovation to operations: that would be something I could take partial credit for. But only because I'm part of a large, collaborative group.

FACETs: A Warning Framework Helping Build a Weather-Ready Nation

Warning methodologies have changed little over the past 40 years, but society and its needs have changed significantly. Technology and science have advanced, society and lifestyles have become more diverse, and vulnerability has increased due to environmental and socio-economic factors. Enter FACETs (Forecasting a Continuum of Environmental Threats Program): a framework that aims to modernize the creation, communication, and effective dissemination of risk-based, probabilistic hazard information to empower effective response .

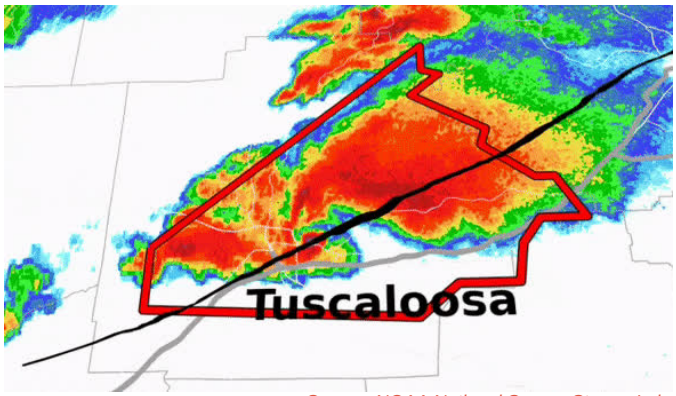
FACETs has the potential to improve the effectiveness of extreme weather threat warning and emergency response, helping save lives and achieve the goal of becoming a weather-ready nation. A recent Washington Post Capital Weather Gang article highlighted current work in the severe weather domain, but the FACETs framework can be applied to all hazards. In fact, FACETs applies to a variety of environmental threats, including winter and tropical weather, marine and aviation forecasting users, seasonal to decadal forecasting, air quality, climate, and more.

The FACETS framework bridges physical and social sciences to create meaningful information for end users. FACETs aims to update current binary, deterministic forecasts by incorporating a continuous flow of probabilistic hazard information into weather risk messaging. Modernized messaging will readily communicate hazardous weather information and better serve the public. Incorporating social and behavioral science throughout research, development, and deployment creates a multidimensional framework centered around user needs.

All scientists can adopt the FACETs framework by integrating seven interrelated components:

- *Probabilistic* hazard information that varies in time and space that depicts threats;
- *Guidance* such as models, observations and post-processed data;
- *Forecasters* who interpret guidance, issue products and warming, and communicate impact-based support;
- *Tools* that enable and help forecasters ingest, analyze, communicate, and disseminate information, products, and services;
- *Useful* output for end-users;
- *Empowered* response by the public; and
- *Verification* of forecasts and processes to improve the forecast system.

These are several reasons UFS investigators, modelers, meteorologists, and scientists should apply the FACETs framework to their project design. Examples of such projects include Warn on Forecast, a project dedicated to increasing warning lead times for severe weather events, including tornadoes, thunderstorms, and flash floods; and in probabilistic models informing forecasts, such as NOAA's Global Ensemble Forecast System (GEFS).



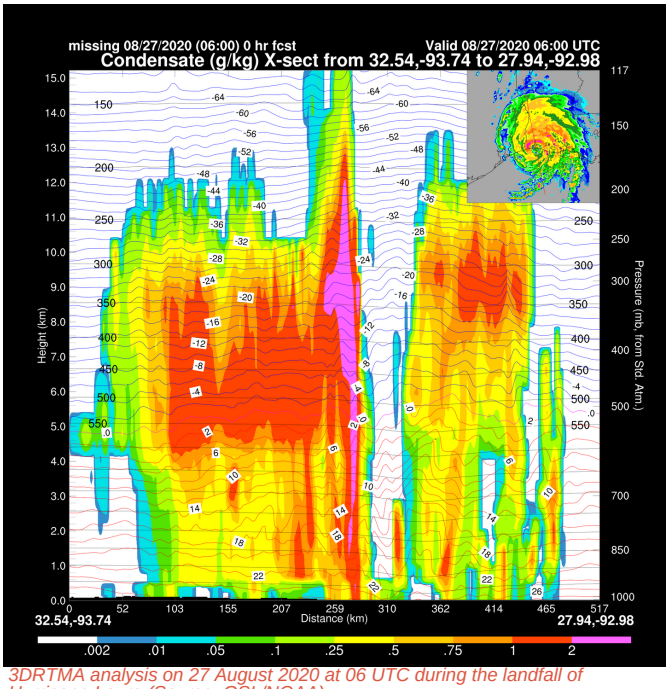
Source: NOAA National Severe Storms Lab

FACETs needs U(FS)!

The FACETs program encourages the UFS Community to get involved. As the weather industry moves towards user-driven modernization, the UFS becomes a great candidate for the FACETs framework because it will grow as a data source generating meteorological model outcomes. The latter can be incorporated into probabilities (e.g., probability of tropical cyclone formation, track, intensity) or artifacts (e.g., rainfall amount, onset, duration, rates) leading to impact assessments (e.g., hazards such as power outages, destruction, flooding etc). FACETs may help the UFS Community to understand model value relative to its purposes, and prioritize those purposes to maximize impacts on forecast processes. Collaboration between UFS and FACETs is mutually beneficial. If you have questions about how your research fits into this framework, or have comments, email **Alison.Agather@NOAA.gov**.

RTMA Prepares for Going 3D with Last Upgrade of it's Two-Dimensional Era

The Real Time Mesoscale Analysis (RTMA), its companion UnRestricted Mesoscale Analysis (URMA), and the Precipitation Analysis are National Weather Service products widely used by the forecasting community. The RTMA suite became operational 14 years ago and has since provided two-dimensional hourly analysis of surface weather elements for situational awareness, verification, and calibration. Development efforts started in 2018 will add a third dimension to the RTMA and replace the 2D version, which saw its last upgrade this summer.



3DRTMA analysis on 27 August 2020 at 06 UTC during the landfall of Hurricane Laura (Source: GSL/NOAA).

The development of a fully three-dimensional RTMA/URMA allows the creation of highly useful nowcasting and situational awareness products, as discussed in a paper presented at the 100th AMS Annual Meeting. Beginning in October 2020, the 3D RTMA development will continue as part of the UFS-R2O project, with the exciting prospect of benefiting from the collaborative research between NOAA and university partners. The 3D RTMA will sunset its two-dimensional version, which was upgraded on July 28th, 2020 at 1200UTC. In this last upgrade of its two-dimensional era, RTMA v2.8 included several advances that will be carried on to its 3D version, expected to be implemented in 2023.

The July 2020 implementation of the Real Time and Unrestricted Mesoscale (RTMA) System v2.8 brings to life a number of advances developed in coordination with stakeholders, which include the National Blend of Models, Weather Forecast Offices and NWS regions, NCEP service centers, and the Federal Aviation Authority (FAA).

Highlights of the RTMA Suite v2.8

- Similarity theory calculations are introduced in the forward operator of near-surface wind assimilation tackling non-standard anemometer heights in mesonet observations,
- The significant wave height analysis is extended to include Great Lakes and Guam,
- The sky cover analysis is (1) retuned to ensure consistency with the ceiling analysis,(2) improved quality control overnight for satellite observations, and (3) data thinning and decorrelation lengths are added to produce a more consistent analysis,
- New temperature downscaling is performed for Guam, Hawaii and Puerto Rico, Wind downscaling is improved for CONUS and Alaska,
- The resolution of the Puerto Rico grid is doubled from 2.5 km to 1.25 km.

Highlights of the Precipitation Analysis

- The Multi-Radar Multi-Sensor QPE replaces the old Stage II precipitation analysis,
- Multi-Radar, Multi-Sensor QPE is now used for precipitation RTMA,
- Added 6h/24h snowfall analysis from the National Operational Hydrologic Remote Sensing Center (NOHRSC) to URMA,
- Improved CONUS offshore precipitation analysis through more sophisticated blending between precipitation analysis datasets,
- Changed Stage IV precipitation analysis product from GRIB1 to GRIB2.

In addition to the innovations and improvements of RTMA v2.8, the upcoming 3D upgrade in 2023 will include full-column representation of standard meteorological fields — temperature, water vapor, and wind, as well as hydrometeors. Analysis updates will be performed at sub-hourly intervals, at least every 15 minutes, with low product latency.

The UFS Users' Workshop Goes Virtual Expanding Community Engagement

With more than 450 participants, the 2020 UFS Users' Workshop went virtual and ensured a broad participation of the UFS Community. Organized and hosted by the Developmental Testbed Center (DTC), the workshop was made viable in spite of restrictions for travel and in-person attendance due to the COVID19 pandemic. DTC's creativity took it beyond expected outcomes, with surprising results.

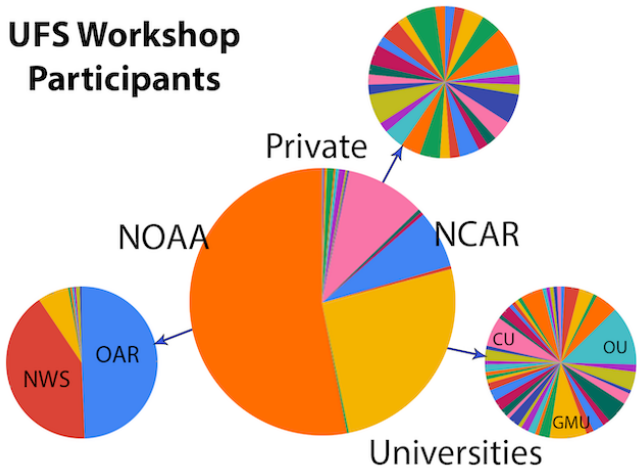
The use of the communication app Slack was one of the innovations that opened new discussion channels. "The use of Slack was highly appreciated by the participants", pondered Weiwei Li, project scientist with the DTC at the National Center for Atmospheric Research (NCAR) and co-organizer of the workshop. Slack provided an opportunity for lively discussions, some of which lasted several weeks after the workshop was over.

With travel barriers removed, the workshop had a large number of participants that may not have been able to join an in-person event. A feedback survey revealed that many participants appreciated not having to travel and the financial benefits this provided. Indeed, easier access led to increasing the diversity of participants. In particular, the large attendance from private companies and universities was unique, showing they are already an important facet of the UFS community.

Broader Research from a Growing Community

The large number of active participants from universities, national laboratories, and private companies, as well as from various parts of NOAA reflects two important aspects of the UFS. "First, the codes themselves, starting with the Medium-Range Application v1.0.0 released in March 2020, are more portable and easier to use. Second, the UFS governance is transparent and inclusive of all individuals and groups that want to contribute and help shape the future of the modeling system", summarized Ligia Bernardet, from DTC and NOAA, co-organizer of the workshop this year.

Presentations made during the workshop (available at this page) revealed that there are many people both inside and outside NOAA who are using the UFS to do research, addressing new applications ranging from convective-allowing short-range forecasting, to global coupled sub-seasonal prediction. The breadth of research areas revealed that a broad cross-section of the community is already engaged in the UFS and is actively contributing. Workshop participants also praised the variety of session topics and included suggestions for even more diversity in the future.



Source: DTC Newsletter

"Doing research with operational tools is moving faster than in my wildest dreams. It is awesome, and a real culture change, both for NOAA opening up to the community, and the community jumping on that opportunity", weighed in Hendrik Tolman, Senior Advisor for Advanced Modeling Systems at the National Weather Service, and co-Chair of the UFS Community Steering Committee.

Beyond "Build It and They Will Come"

The UFS Workshop this year showed clearly that a representative part of the community has embraced using the UFS for their research. James Kinter, co-Principal Investigator in the UFS-R2O Project from the George Mason University (GMU), notes that this shows that the UFS has grown beyond a "build it and they will come" scenario. "A huge attendance at the workshop helped many people see the results of using UFS as a research tool, which will likely stimulate even more community members using the model for other studies", concluded Kinter.

Holding the 2020 workshop virtually had many advantages that the organizers will retain in the future. "Over 80% in a participant survey stated they would prefer a virtual or hybrid workshop to having it all in-person in the future", noted Jeff Beck, DTC researcher at the Cooperative Institute for Research in the Atmosphere (CIRA) and workshop co-organizer. Keeping the door open to remote participation is a winning strategy to ensure future workshops achieve the great success seen this year.

Check out the DTC News workshop article here.

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