Improving Extreme Weather Forecasting Capabilities in support of Power Outage Prediction Activities

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The scope of the project is to develop the next generation extreme weather prediction system by building on our knowledge of extreme weather prediction uncertainty, and its impact in the accuracy and efficiency of the OPM

OBJECTIVES

- ✓ Significantly **improve** the real-time weather prediction of extreme storms (from thunderstorms to tropical storms, blizzards and Nor'easters)
- ✓ Quantify storm weather forecast **uncertainty** with an emphasis on winter weather
- ✓ Assess the **accuracy** of weather prediction in real-time using our in-house online weather forecast verification platform

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A little background…

- Our research group has been working on extreme storm prediction since 2013
- This work is directly related to the Outage Prediction Model (OPM) development and operation by Dr. Anagnostou's research group
- There are 3 weather prediction systems running in-house (2 daily; 1 on an event case) - http://cee-wrf.engr.uconn.edu/
- We have conducted retrospective high-resolution simulations and assessment of storms that impacted the NE US since 2004
- Weather variables of importance for the OPM are: air temperature, wind speed, wind gust, precipitation (rain, snow, ice), and relative humidity.

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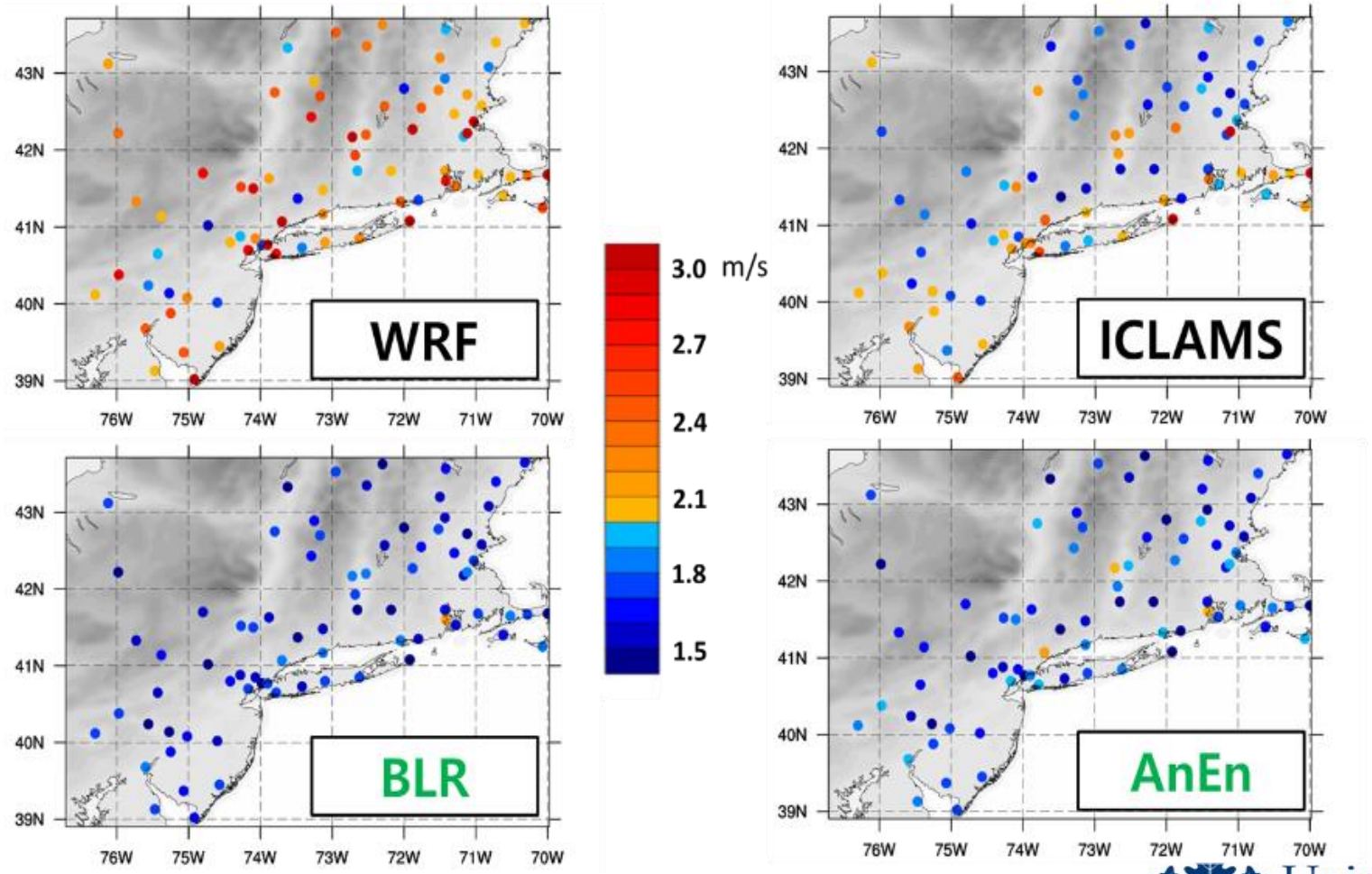
A little background…

Wind speed errors are reduced by 20% on average when implementing Bayesian Linear Regression-BLR and Analog Ensemble-AnEn (55 winter storms have been used in this implementation).



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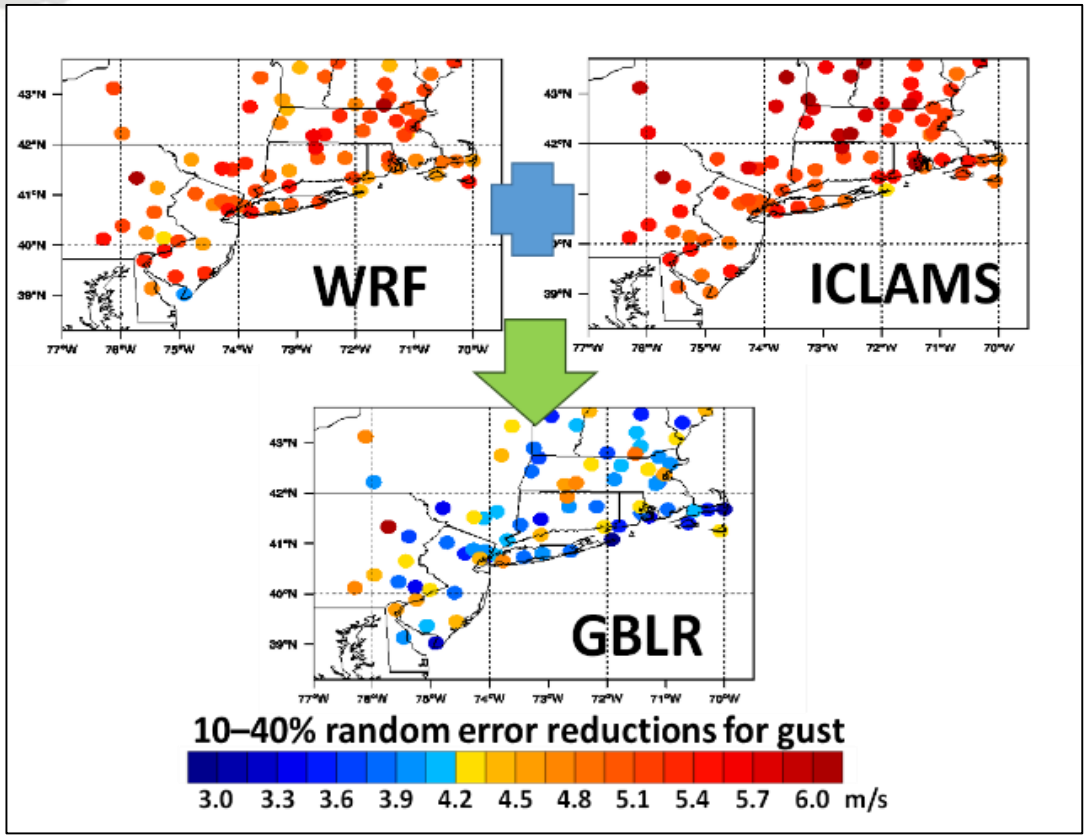
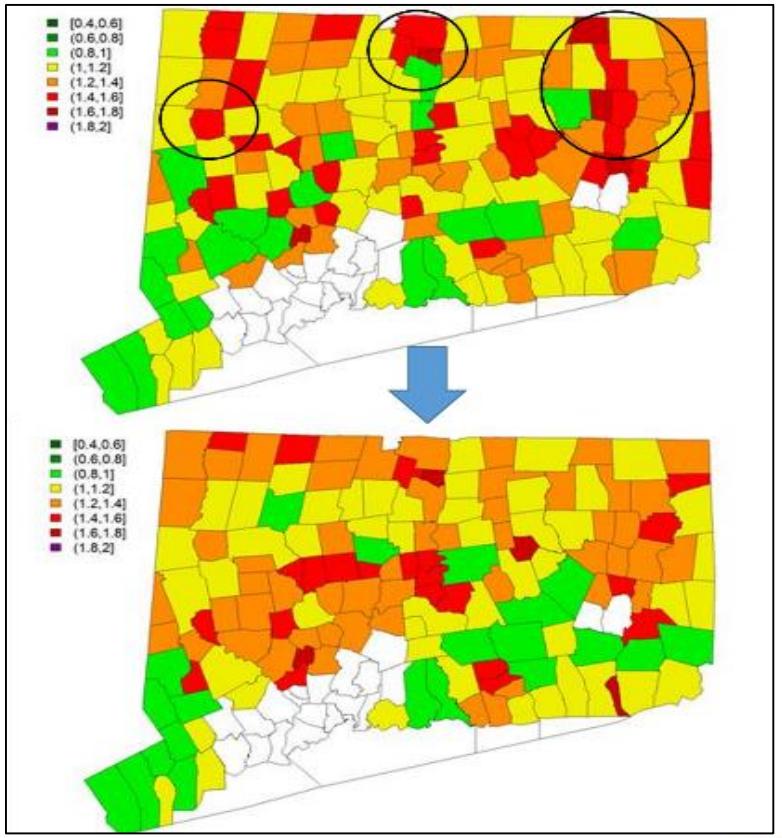
A little background…

Improved Weather Prediction IMPACTS OPM accuracy?

Combined weather product (GBLR) for gust



Power outage prediction error combined product



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PROJECT TASKS

Task 1: Revamping of operational NWP systems

- ✓ Vertical atmospheric layers; cloud microphysics; cumulus parameterization; boundary conditions; initial conditions
- ✓ Test latest WRF version for snow

Task 2: Enhancement of weather forecast products towards quantifying variability and uncertainty

- ✓ Development of a multi-model ensemble weather system: augment our forecast with 2 NWS forecast products
- ✓ Utilization of probabilistic winter weather forecasts from NWS: Probabilities of snowfall and ice accumulation exceeding specific thresholds

Task 3: Continuation of development of the online weather forecast verification platform

- ✓ Inclusion of the WRF model in the verification displays
- ✓ Re-design of the platform to be more user-friendly and clear to the general audience

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Project Timetable and Milestones

Date	Activity Reports	Milestones	Related Tasks
06/2020	Project kick off	Discussion of project plan and deliverables	All
12/2020	Report on new configuration settings for in-house weather forecasting systems	Revamping of in-house weather forecast	Task 1.1
06/2021	Report on using new WRF version and updates on microphysics for **winter events**	Testing and analysis of updated WRF microphysics scheme for winter storms	Task 1.2
12/2021	Report on augmenting in-house weather forecast with NWS products	Quantification of weather forecast uncertainty for variables used by the OPM	Task 2.1
06/2022	Report on utilizing probabilistic winter weather forecasts from NWS	Employ real-time NWS probabilistic winter forecast to verify and assess our in-house weather forecasts	Task 2.2
12/2022	Inclusion of the WRF model in the online verification platform	Revised online weather verification platform outlook	Task 3
06/2023	Final report	Final report	All

TASK 1

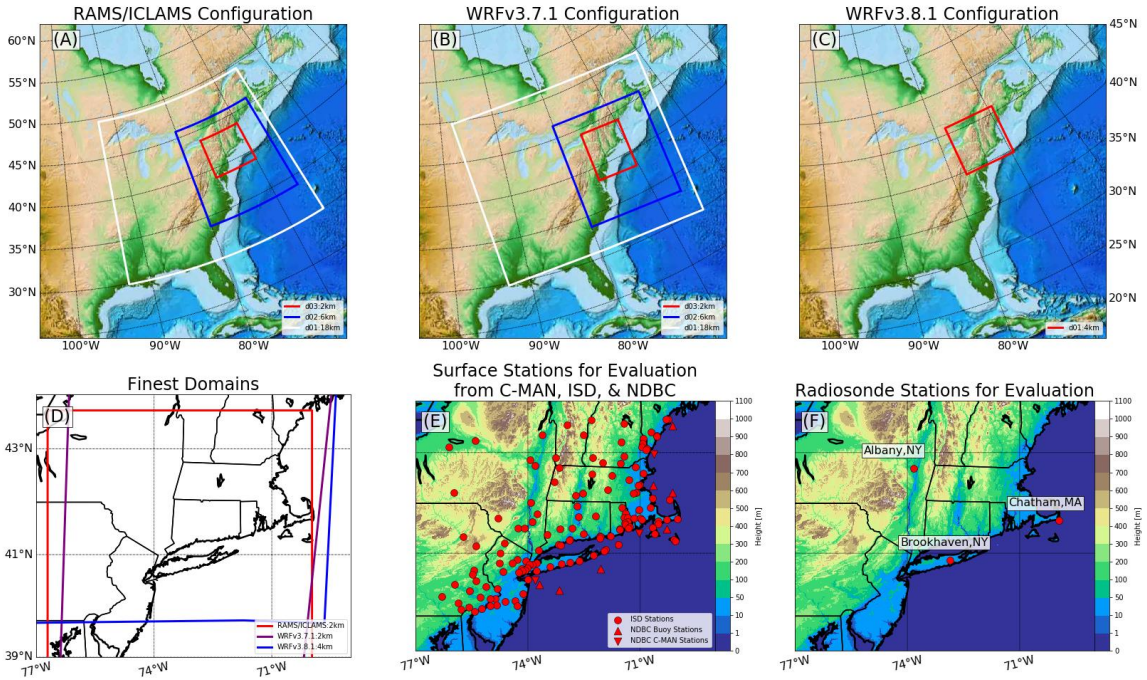
Task 1: Revamping of real-time forecasting system

TASK 1.1: Rerun simulations for each storm type with new configuration settings to evaluate and assess improvements on weather parameters important for OPM.

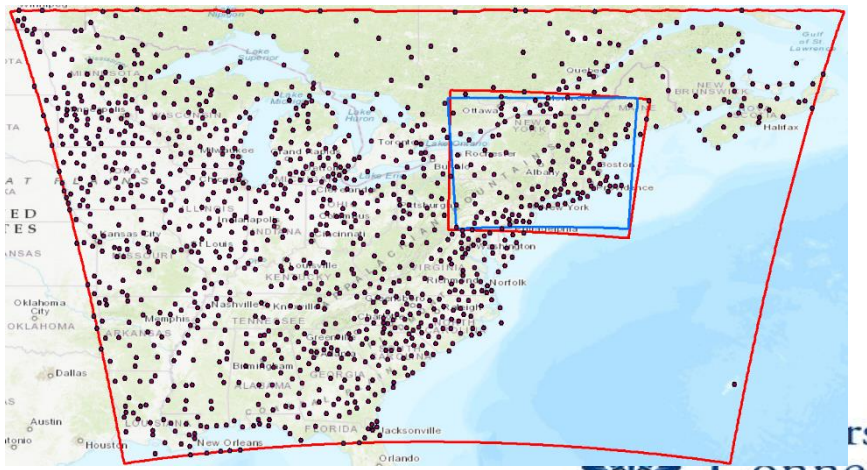
Forecast (real-time)

Analysis (retrospective – after the event)

NEW



WRFv4.2 (most recent version of the model)



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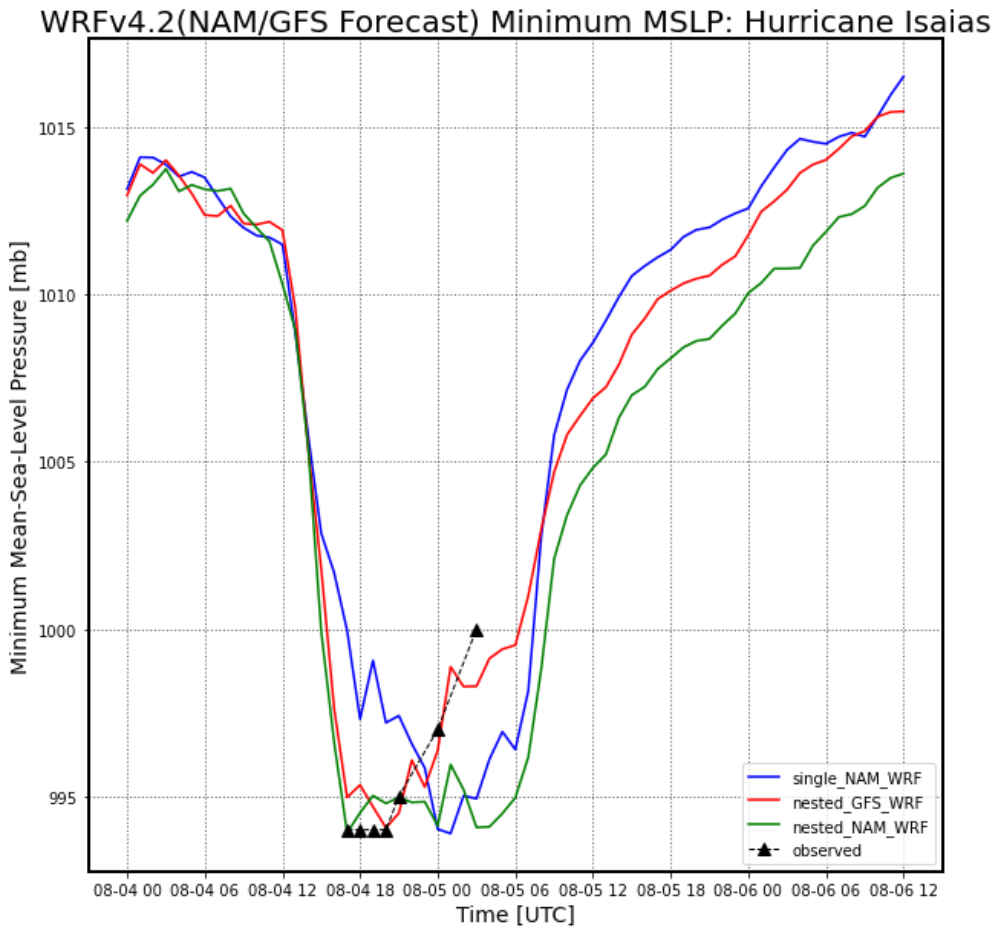
FORECAST OF TROPICAL STORM ISAIAS

Minimum Sea Level Pressure (MSLP) from various simulations



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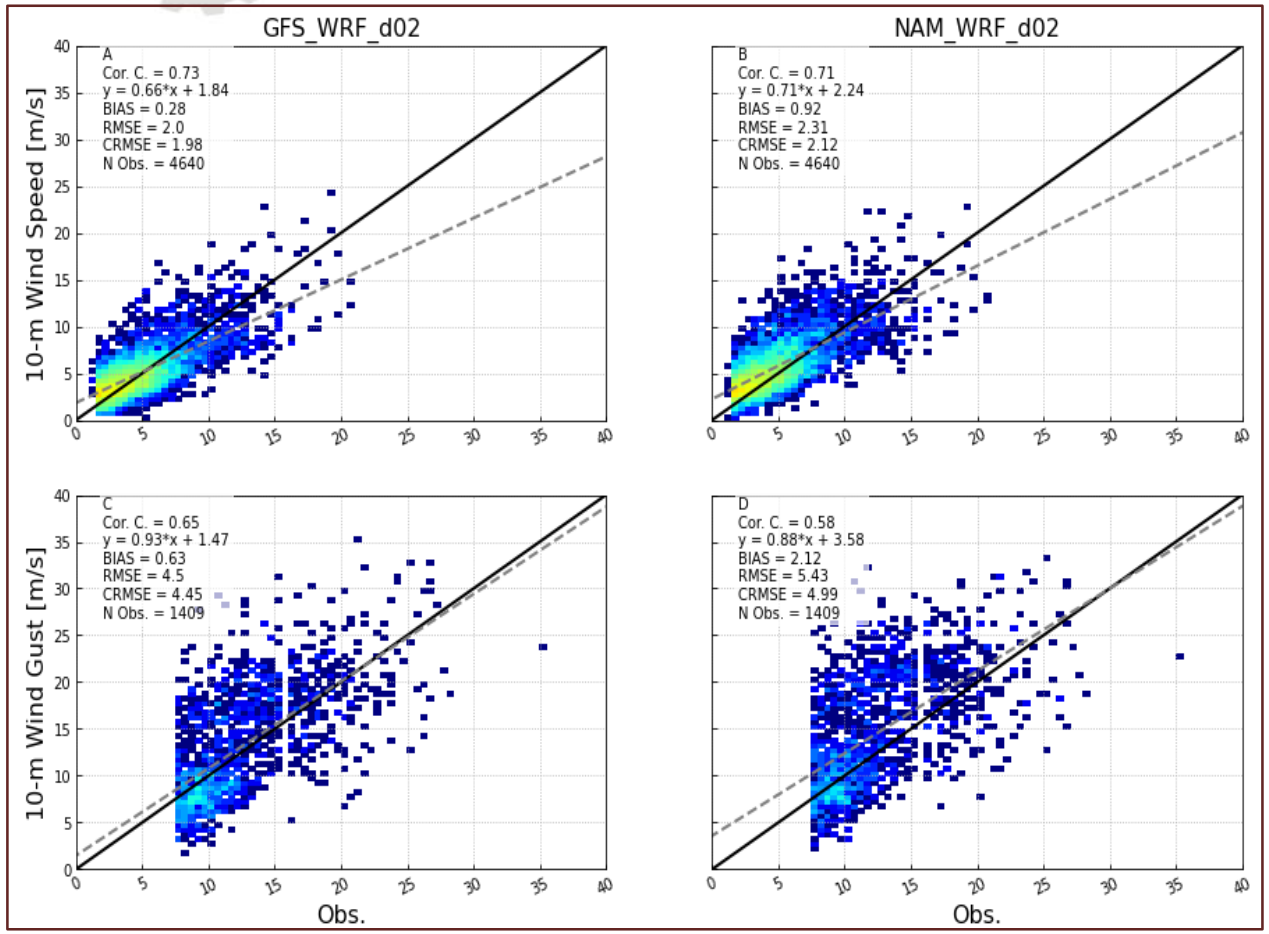
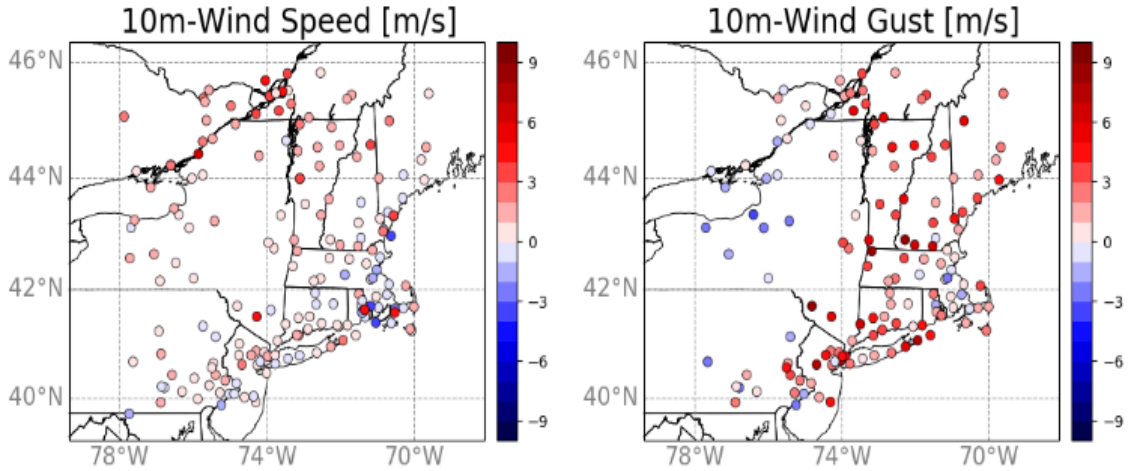
FORECAST OF TROPICAL STORM ISAIAS





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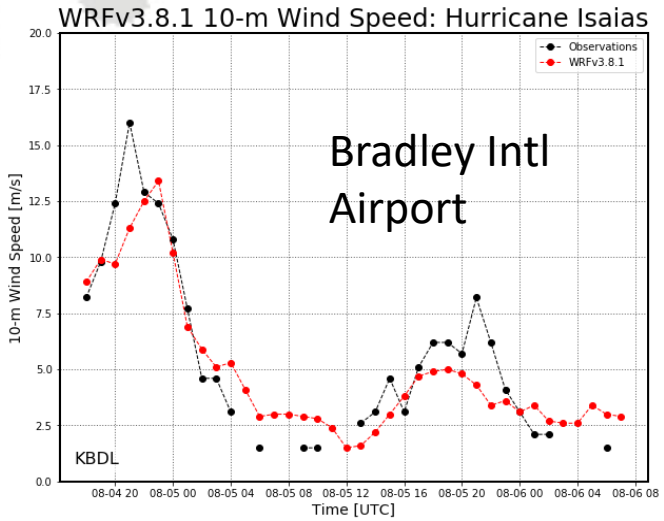
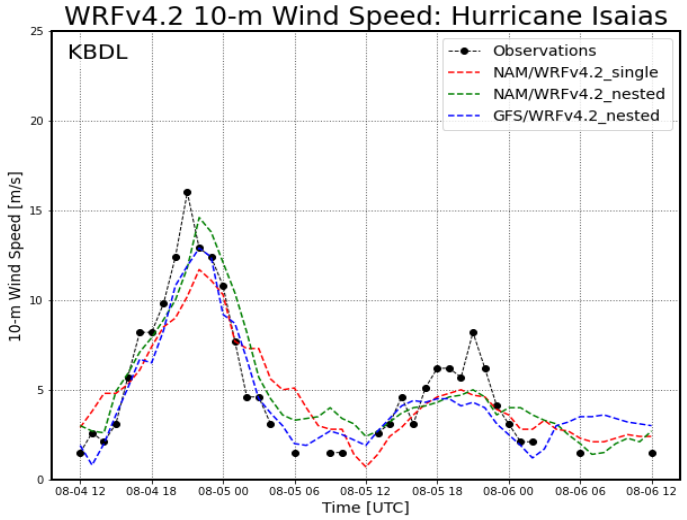
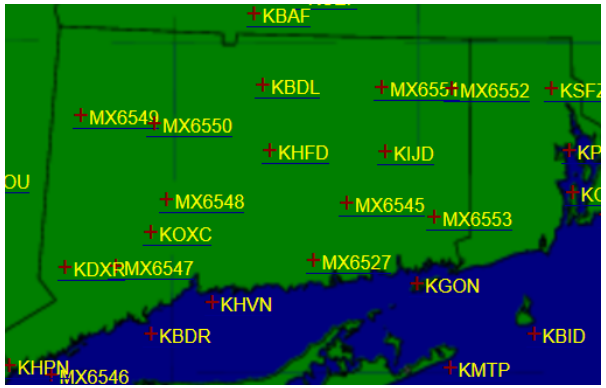
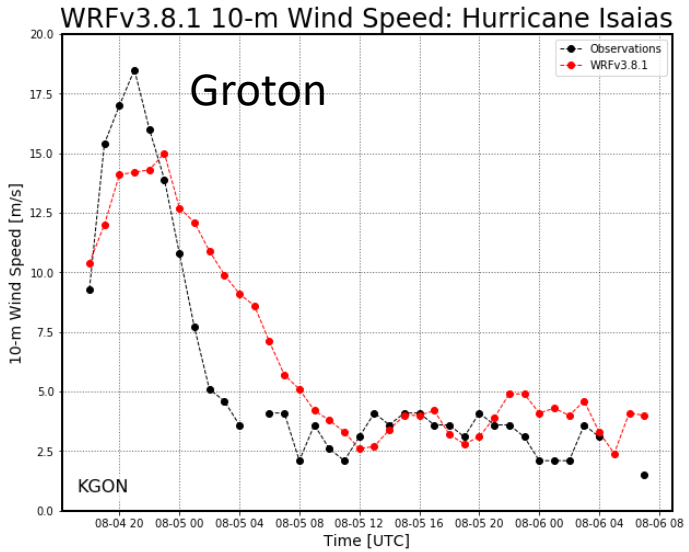
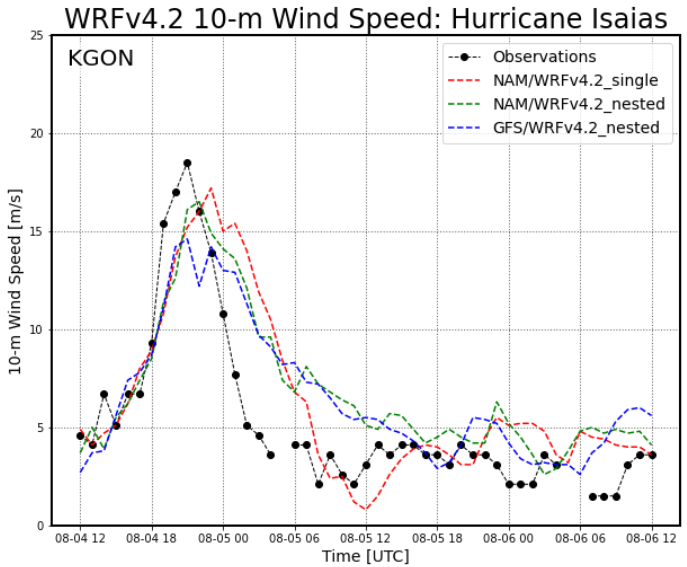
FORECAST OF TROPICAL STORM ISAIAS











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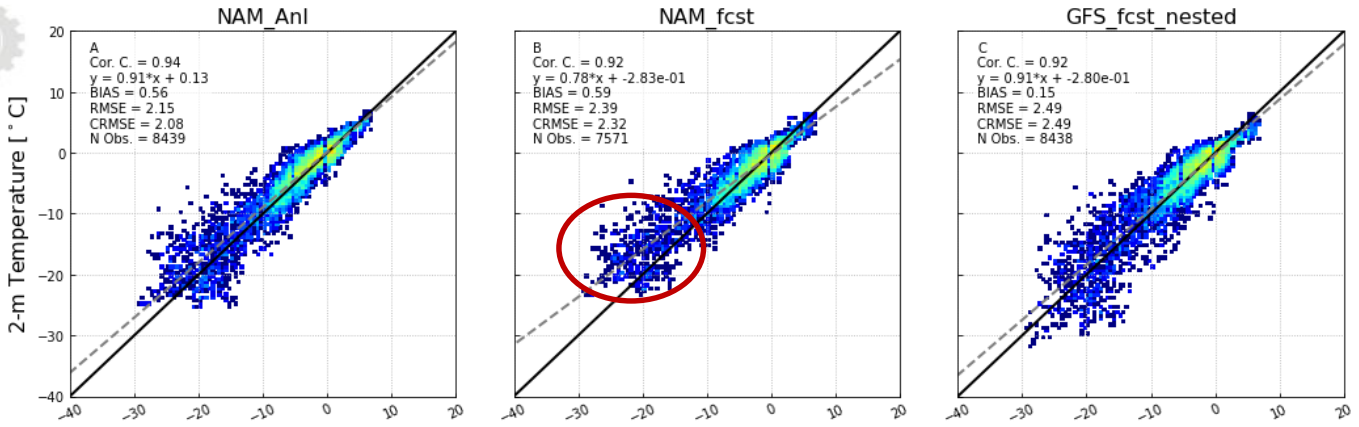
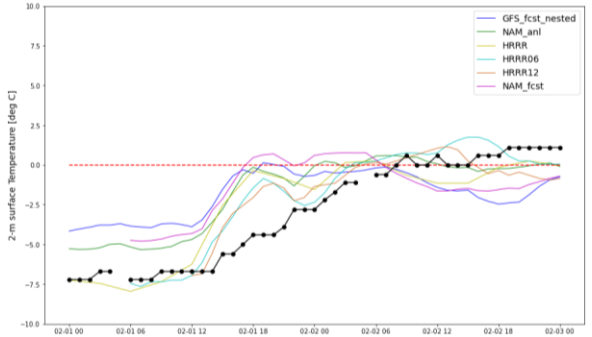
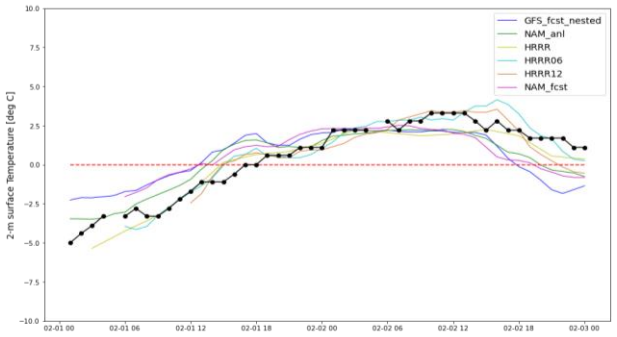
February 1st Snow Storm

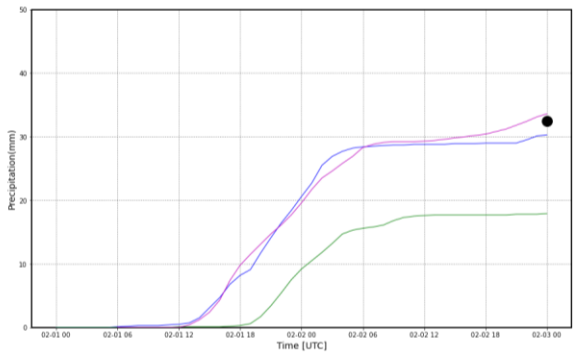
Positive bias for coldest temperatures

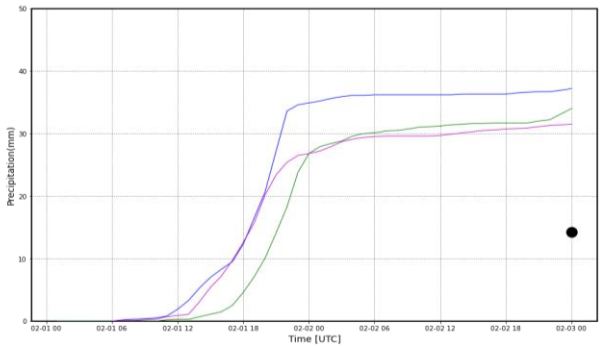


Bradley Intl, CT









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NEXT STEPS

- ✓ Use of the latest WRF version to simulate **winter events** in our database and compare with previous simulations (Task 1.2)
- ✓ Evaluate **winter weather variables** used by the Outage Prediction Models (Task 1.2)
- ✓ Assess weather forecast uncertainty from various initializations (3-4 days ahead up to the day of the event)

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Publications

- Michael S. Walters, Jaemo Yang, and **Marina Astitha***: Evaluation of Winter Weather Prediction During Extreme Snowfall Events for the NE US. Manuscript in preparation for submission to Weather and Forecasting.
- Yang, J., **Astitha, M.***, & Schwartz, C. S., 2019. Assessment of storm wind speed prediction using gridded Bayesian regression applied to historical events with NCAR's real-time ensemble forecast system. Journal of Geophysical Research: Atmospheres, 124, 9241–9261. https://doi.org/10.1029/2018JD029590.
- Samalot, A., **M. Astitha***, J. Yang, and G. Galanis, 2019: Combined Kalman Filter and Universal Kriging to Improve Storm Wind Speed Predictions for the Northeastern United States. Wea. Forecasting, 34, 587–601, https://doi.org/10.1175/WAF-D-18-0068.1.
- Yang, J., **M. Astitha***, L. Delle Monache, and S. Alessandrini, 2018: An Analog Technique to Improve Storm Wind Speed Prediction Using a Dual NWP Model Approach. Mon. Wea. Rev., 146, 4057–4077, https://doi.org/10.1175/MWR-D-17-0198.1.
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- J. Yang, **M. Astitha***, E. Anagnostou, B. Hartman, 2017: Using a Bayesian regression approach on dual-model weather simulations to improve wind speed prediction. Journal of Applied Meteorology and Climatology, Vol 56, 1155-1174, https://doi.org/10.1175/JAMC-D-16-0206.1.
- He, J., D. W. Wanik, B. M. Hartman, E. N. Anagnostou*, **M. Astitha**, M. Frediani, 2016: Nonparametric Tree-based Predictive Modeling of Storm Damage on an Electric Distribution Network. *Risk Analysis*. DOI: 10.1111/risa.12652.
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