The HydroMeteorological Testbed @ WPC
R2O2R Efforts

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Weather Prediction Center Mission

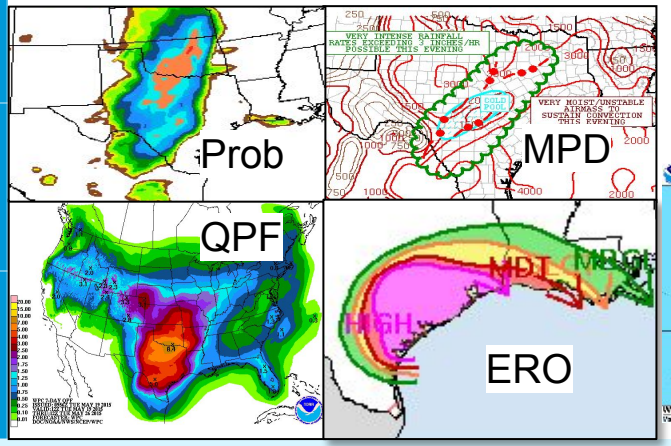
WPC's Mission:

*A leader in the collaborative weather forecast process by delivering responsive, accurate, and reliable **national** forecasts and analyses.*

Vision Statement:

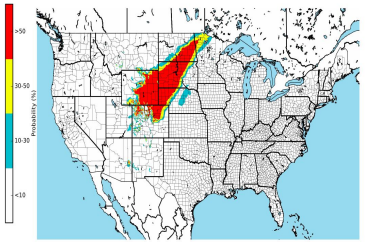
*America's Go-To Center for **high-impact precipitation** events and forecast guidance for a Weather-Ready Nation.*

Related Products:

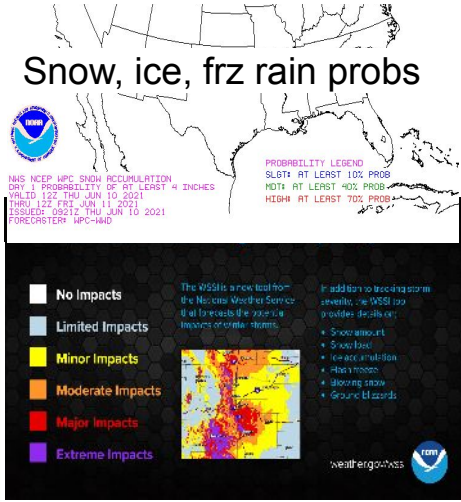


Hazards day3-7

Winter Storm Otlk



Snow, ice, frz rain probs



NOAA Testbeds and Proving Grounds

Arctic Testbed

ATB facilitates testing and evaluation of new research, guidance, forecast techniques, products, and services to improve forecast process and decision support activities in Alaska and the adjacent Arctic. (Charter)

Aviation Weather Testbed

AWT tests new science and technology to produce better aviation weather products and services.

Climate Testbed

CTB accelerates transition of scientific advances from the climate research community to improved NOAA climate forecast products and services. (Charter)

Hazardous Weather Testbed

HWT accelerates transition of new meteorological insights and technologies into advances in forecasting and warning for hazardous weather events. (Charter)

Hydrometeorology Testbed

HMT conducts research on precipitation and weather conditions that can lead to flooding, and fosters transition of scientific advances and new tools into forecasting operations. (Charter)

Joint Center for Satellite Data Assimilation

JCSDA accelerates and improves use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction systems. (Charter)

Coastal & Ocean Modeling Testbed

COMT accelerates transition of advances from the coastal and ocean modeling research community to improved operational ocean products and services. (Charter)

Developmental Testbed Center

DTC improves weather forecasts by facilitating transition of the most promising new NWP techniques from research into operations.(Charter) (TOO)

GOES-R Proving Gound

GRPG tests and evaluates simulated GOES-R products before the GOES-R satellite is launched into space. (Charter)

Joint Hurricane Testbed

JHT is a competitive, peer-reviewed, granting process to choose the best mature research products for testing and transitioning to operations. Includes modeling, data gathering, and decision support components. (Charter)

Operations Proving Ground

OPG serves as a framework to advance NWS decision-support services and science and technology for a weather-ready nation. (Charter)

Space Weather Prediction Testbed

SWPT supports development and transition of new space weather models, products, and services. Infuses new research to improve accuracy, lead-time and value of products, forecasts, alerts, watches, and warnings. (Charter)

Many of the NOAA Testbeds are associated with a NWS National Center (e.g., WPC) and a corresponding OAR Research Lab (e.g., PSL)

HMT Mission

To evaluate & potentially implement new technology, research results, and other scientific advancements from the research & development (R&D) communities to enhance NWS products & services.

Practitioners Cycles: Hoffman et al.

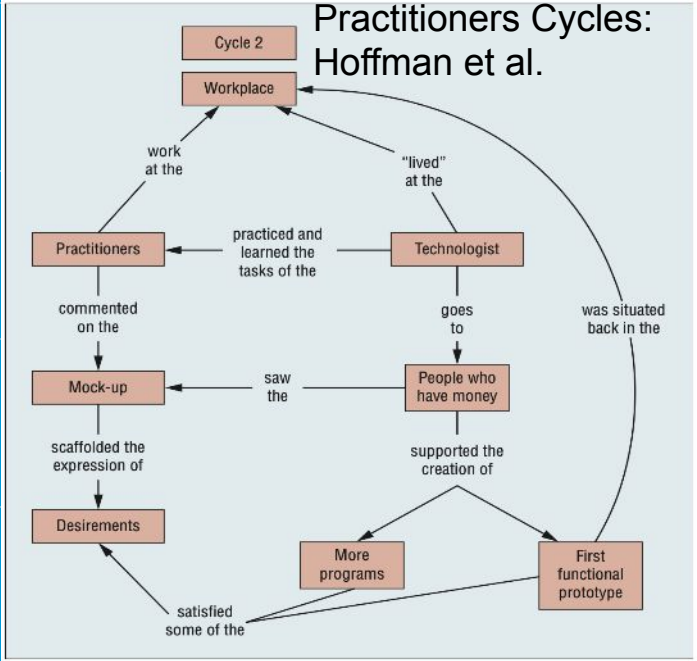
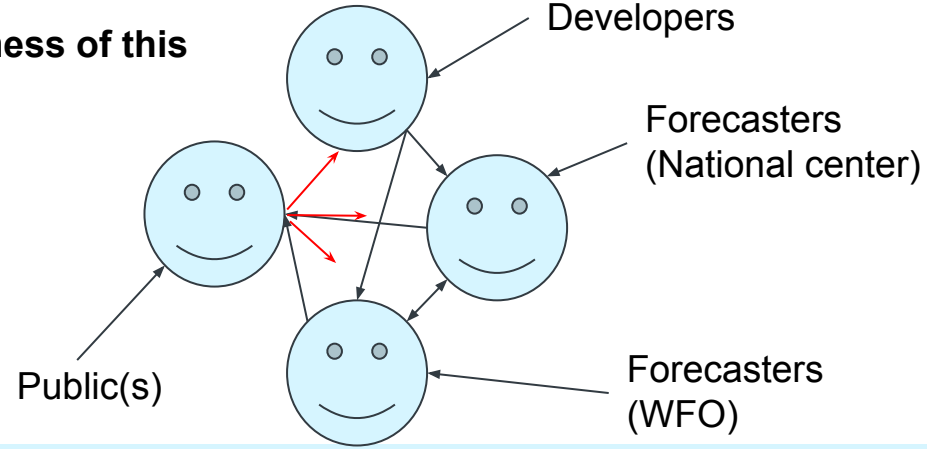


Figure 2. Cycle two of the Practitioner's Cycles.

- Collaborating throughout the sciences
- Building knowledge, tools, experiences, relationships to improve human performance of precipitation forecasts
- Communicating and preparing for extreme precipitation

Uniqueness of this space:



Our People

We would describe ourselves as Bridgers. Not operational meteorologists nor pure researchers, we seek to bridge the R2O gaps by bringing different perspectives, tools, techniques and processes to bear on operational challenges.

HMT Manager: James Nelson[1]
HMT Coordinator: Dr. James Correia Jr[1,2]
WWE Facilitator: Dr. Kirstin Harnos[1,2]
FFaIR Facilitator: Dr. Sarah Trojniak[1,3]
ERFE Facilitator: Bill Lamberson[1,2]

Researchers:
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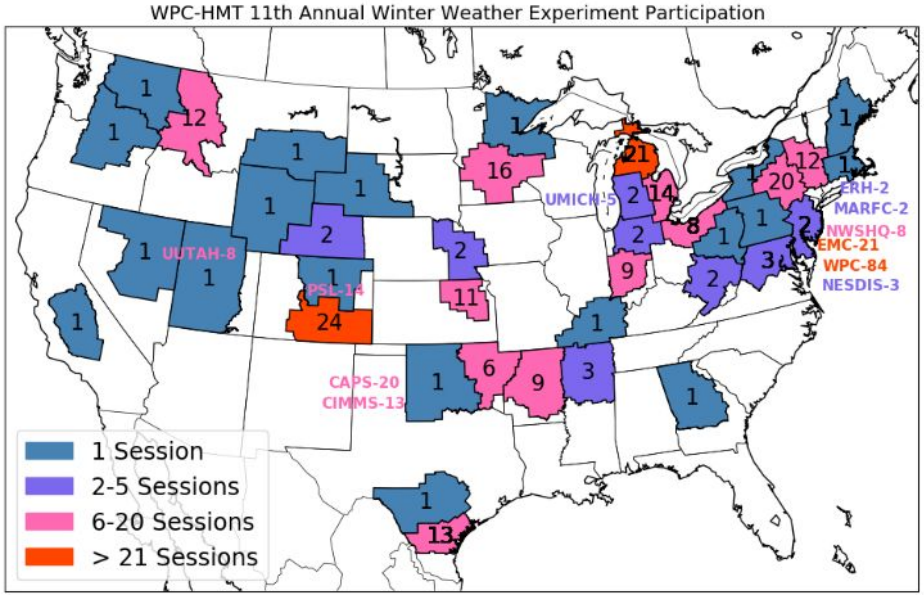
Collaborators
Physical Sciences Lab
Env. Modeling Center
Global Systems Division
National Water Center
National Severe Storms Lab

Grant recipients

Participants
WFO/RFC forecasters
NWS regions
International Forecasters
Academics and students

Stakeholders
FEMA
Emergency Managers
DOTs
School Districts
Industry



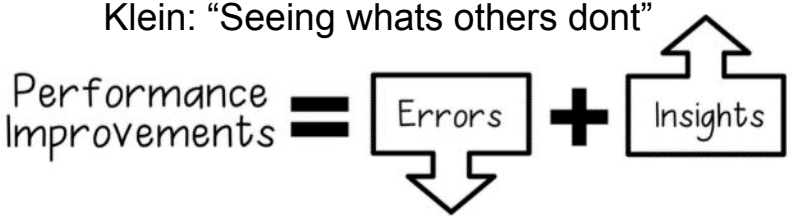
HMT description

We are a group of scientists who bridge the gaps between research & operations, with a goal of improving precipitation forecasting, especially extremes, in a human centered way.

The Hydrometeorological Testbed is a:

- naturalistic decision-making environment,
- a physical & virtual space,
- a collaboration space, and
- an insight-generating laboratory.

Klein: “Seeing whats others dont”



We explore observations and models (NWP, AI/ML and statistical models) in order to evaluate, validate and verify weather-forecasting procedures, tools, and techniques.

HMT Forecast Experiments

1. Extended Range Forecast experiment (Year round)
2. Flash Flood & Intense Rainfall experiment (June & July)
3. Winter Weather Experiment (Feb & March)

- Evaluate and verify model* forecasts (Objective and Subjective)
- Immersive forecast activities
- Collect feedback on forecasts, models, tools, processes
- Discussion!
- Seminars
- Focus Groups with forecasters

We aspire to:

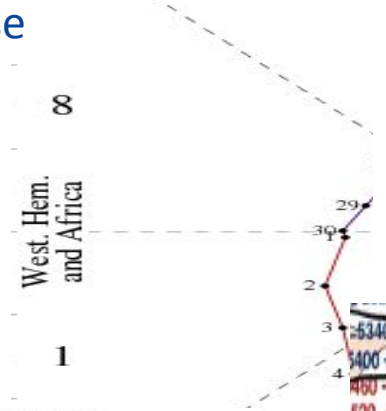
- Bring emerging model improvements & new capabilities to the forecasters and forecasting process
- Create a better environment for forecasters to do their work (forecasting, IDSS)

Extended Range Forecast Experiment (ERFE)

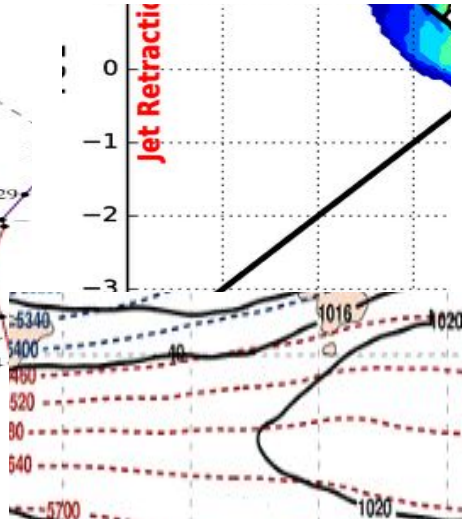
The experiment goal is to investigate any future forecasting methodologies by developing and investigating new tools to tease out high-impact hazardous events in the extended range (3-7) and potentially beyond.

Some methods explored within the ERFE include a Regime Diagnostic Tool, Cluster Analysis Tools, and Ensemble Sensitivity Tools.

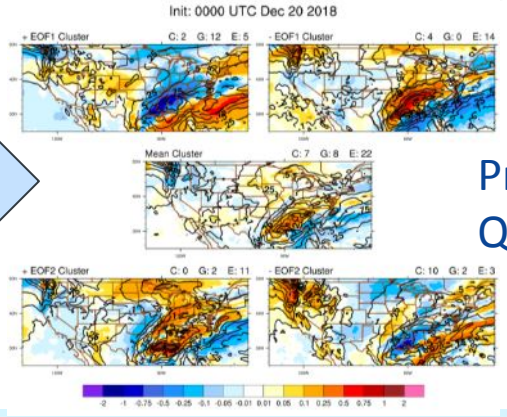
MJO Phase Space



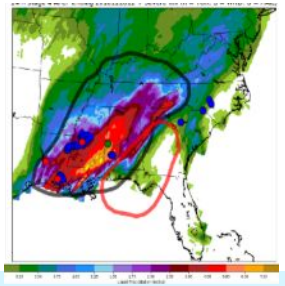
North Pacific Jet Teleconnection Tool



Cluster Analysis - QPF Field

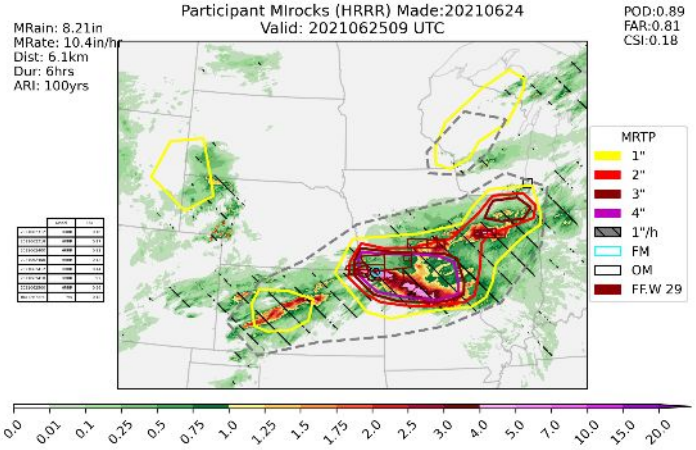


Prototype QPF Hazard

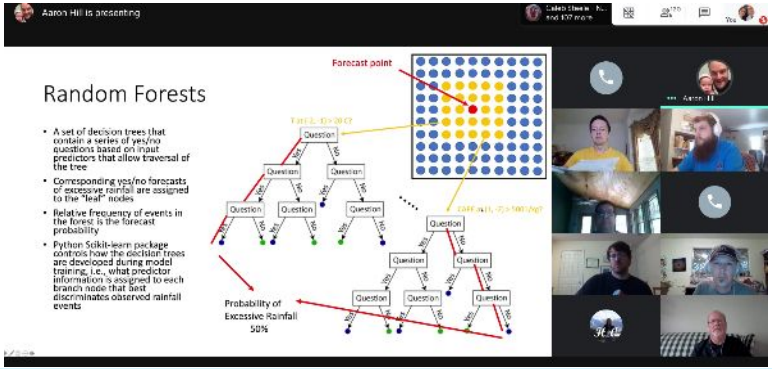


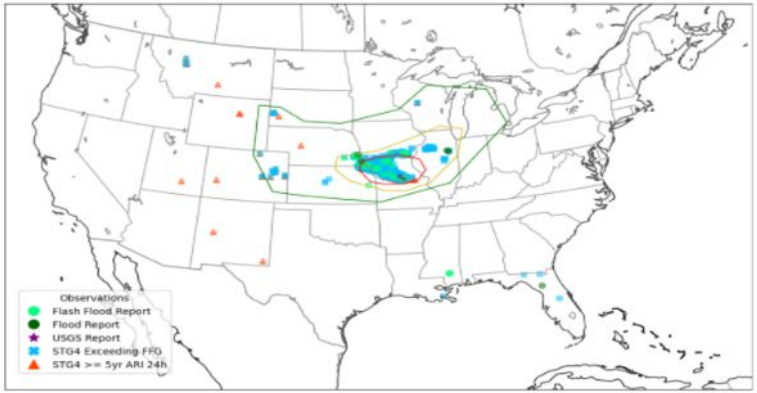
Flash Flood & Intense Rainfall (FFaIR) Experiment

- Evaluate Utility of high resolution convective-allowing deterministic and ensemble models (CAM) QPF in days 1-2; focused on **UFS-based models and ensembles**.
- Evaluate models' and ensembles' timing of precipitation onset, progression, and end during 6 h time periods



Use and evaluation of different configurations of the **Machine Learning** "First Guess" Fields and Forecast Products





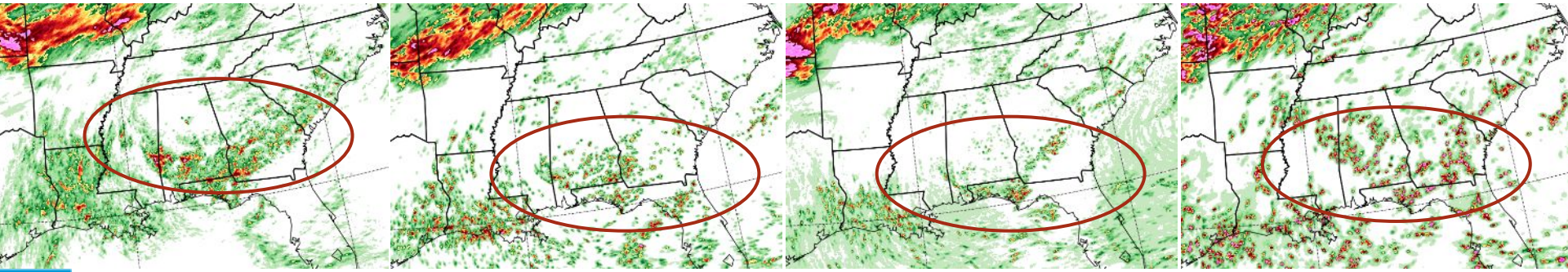
A story about popcorn (from 2021)

MRMS 24h QPE

HRRR 24h QPF

NAMnest 24h QPF

RRFS1 24h QPF

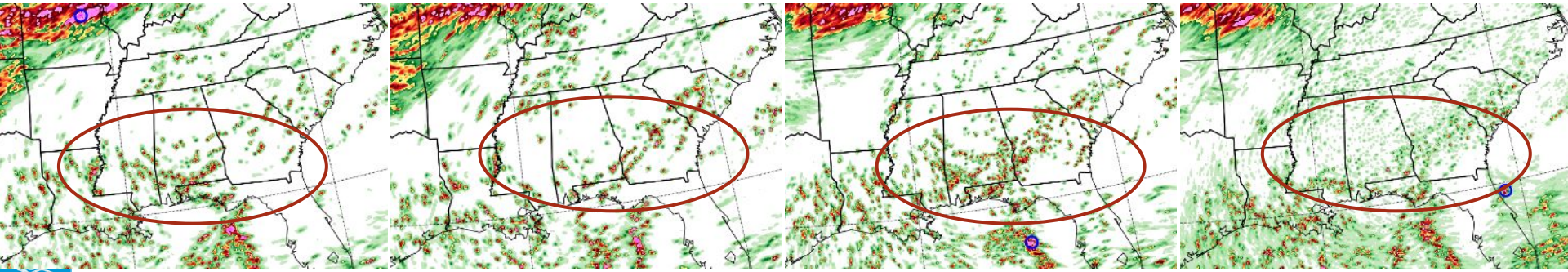


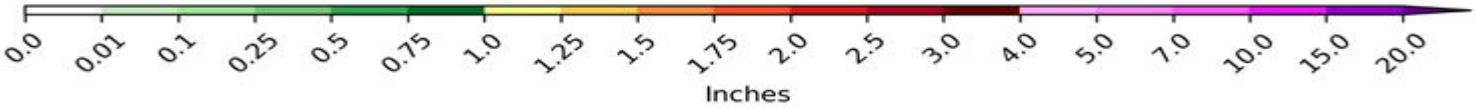
LAMX 24h QPF

LAMDAX 24h QPF

SSEF HRRR-like 24h QPF

SSEF RRFS-like 24h QPF





21z 15 July 2021

MRMS 1h QPE

HRRR 1h QPF

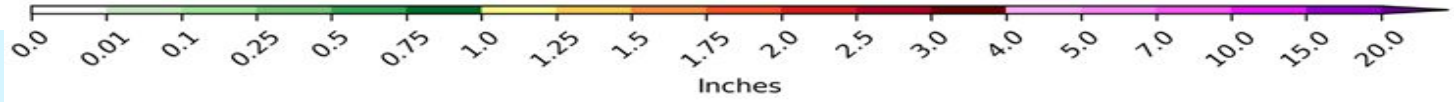
Popcorn observed, but not >5”/hr

LAM 1h QPF

6.01

RRFS1 1h QPF

9.14

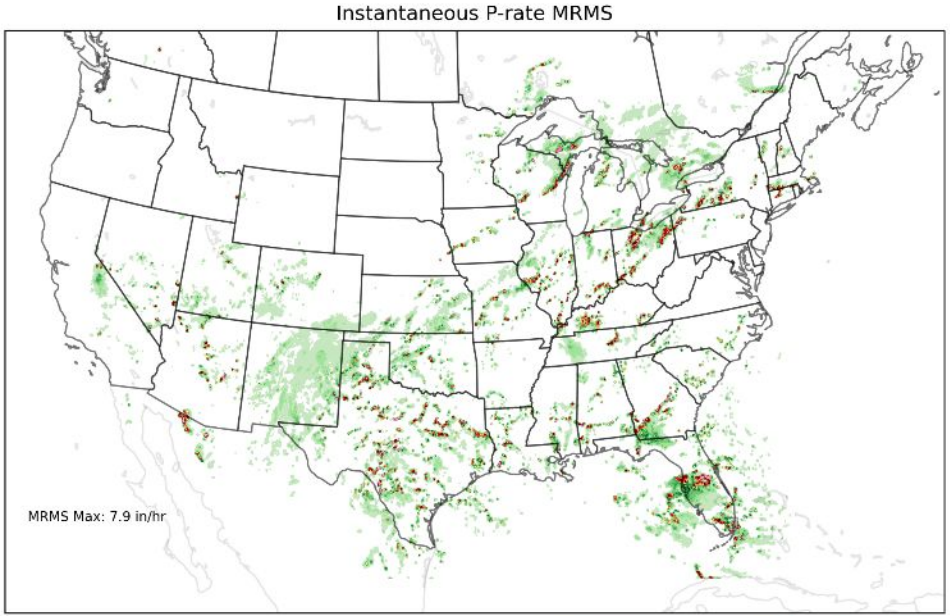


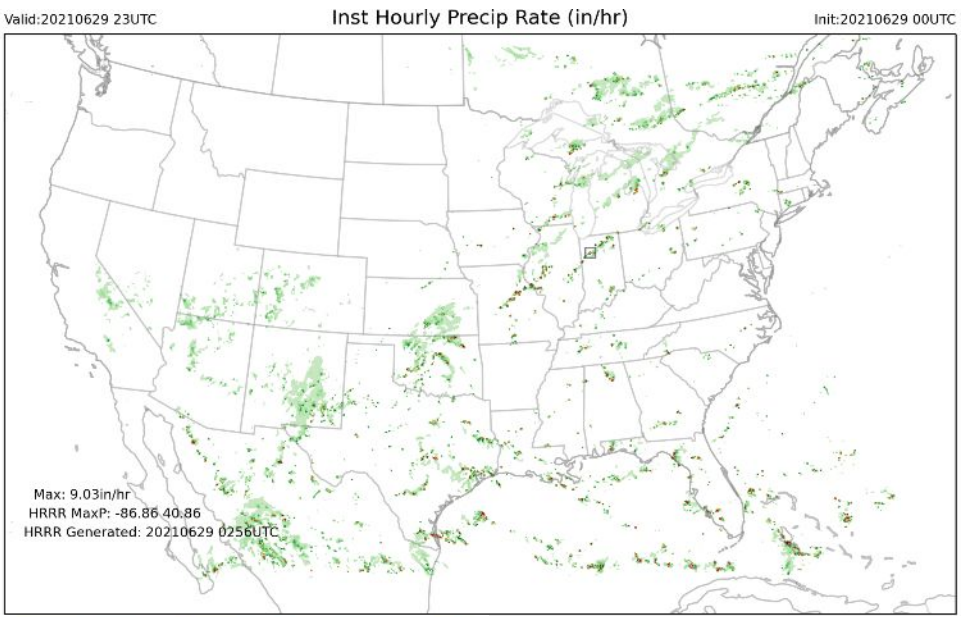
Example Instantaneous Precipitation Rate (p-rate)

MRMS
max - 7.9 in/hr

HRRR and MRMS tend to be < 10”/hour

HRRR
max - 9.03 in/hr





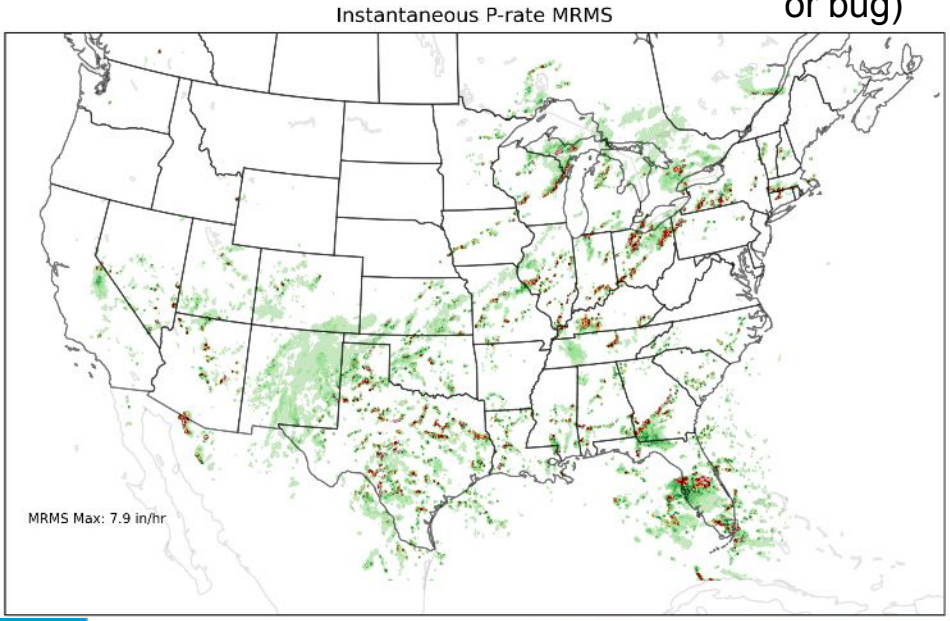
valid 23 UTC 06 June 2021

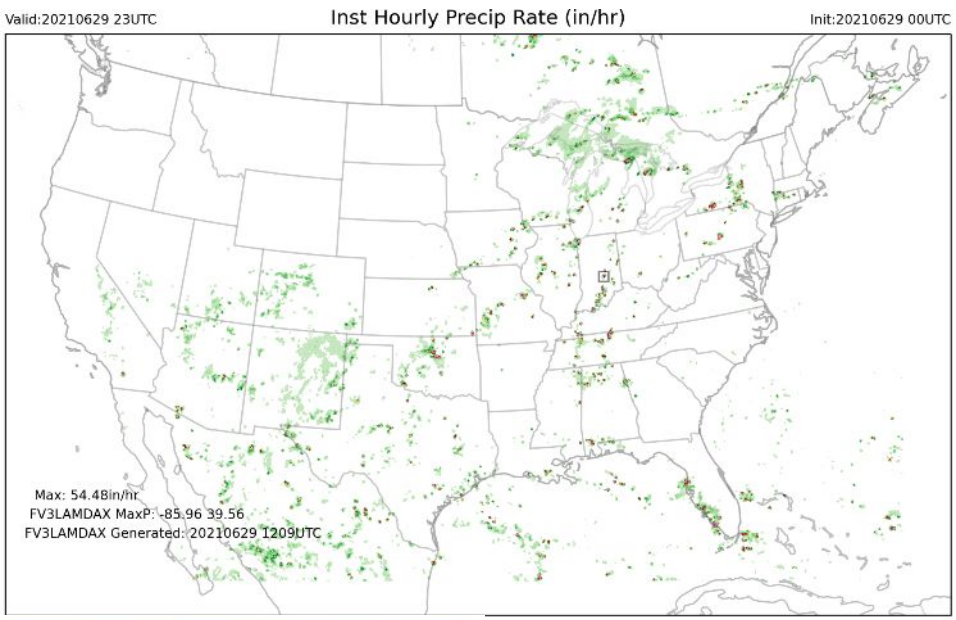
Example Instantaneous Precipitation Rate (p-rate)

MRMS
max - 7.9 in/hr

FV3 tended to be > 40”/hour max (feature or bug)

LAMDAX
max - 54.48 in/hr

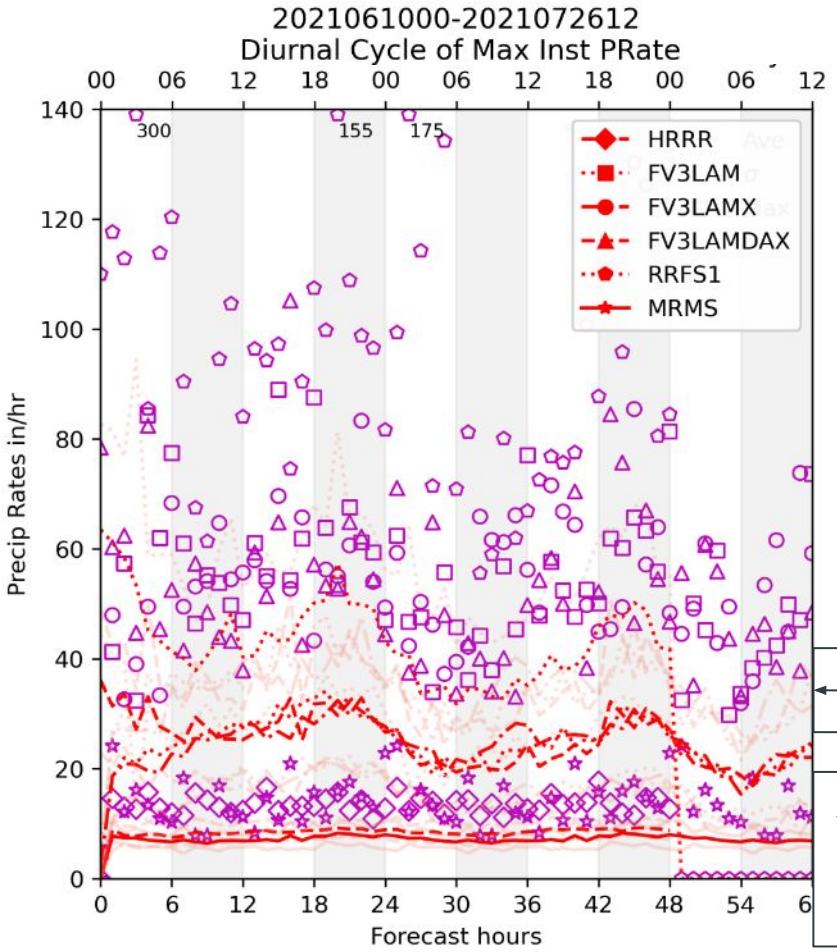




valid 23 UTC 06 June 2021

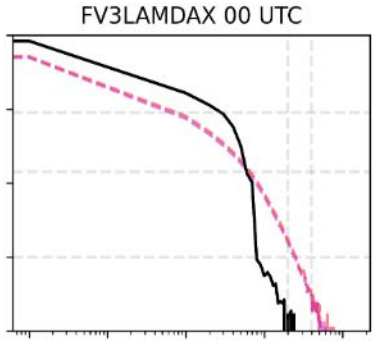
How common is high P-rate? (2021)

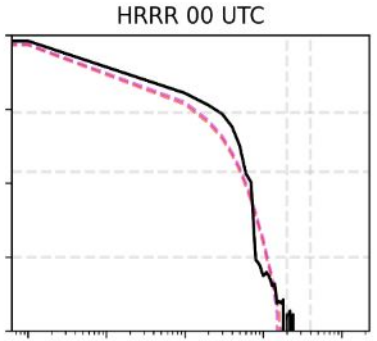
Valid June 1 - July 31, 2021

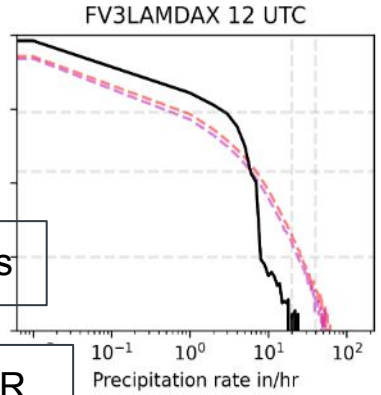


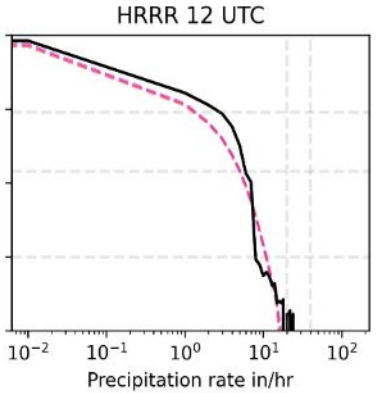
FV3's

HRRR & MRMS









Changes inspired by HMT

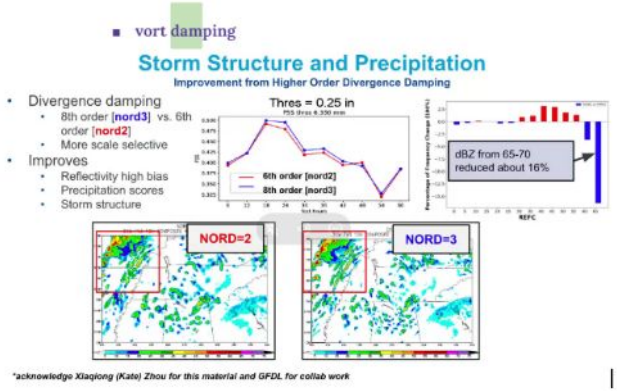
UFS modifications to alleviate the precip rates:

- Microphysics adjustments
- Divergence damping nord2 -> nord3 (ramifications on MCSs?)
- Energy conservation

We requested to add hourly max precip rate to understand this further

Situation has improved (Still seeing sporadic HM rates up to 130”/hr)

Hourly maximum has proven to be a decent diagnostic for detection of subhourly issues.



Winter Weather Experiment (WWE)

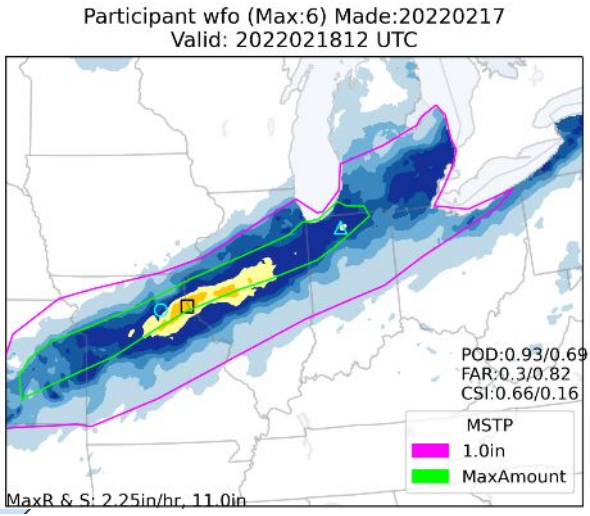
Evaluate convective allowing deterministic and ensemble models (CAM)
Evaluate post-processed products/inputs in Forecast Process

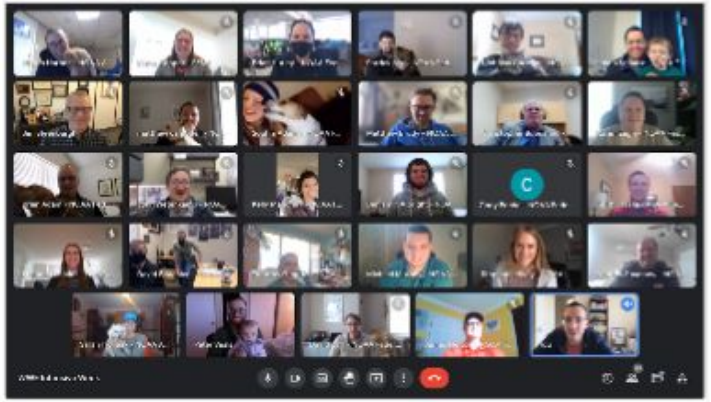
Conveying extreme snowfall information
Use of probabilistic data to inform forecasts and decision making

Enhance collaboration on winter weather forecasting and messaging
Verification to assess performance of experimental data sets (event and season)

Group Discussions with Academia/NWP Community/Product Developers/Social Scientists/Partners/Forecasters:

- P-Type
- Culture
- HMT Future





P-type/SLR

- With p-type, “Variability (& temporality) is the norm”:
  - How do we convey model information to forecasters (snow, ice pellets, fzra, rain and conversion/evolution - sometimes fast, sometimes slow)?

- SLR was also a huge concern, with some forecasters noting that WPC SLR grids can be a useful starting point for further refinement:
  - SLR is variable, on the timescale of minutes
  - Snowfall Rate information is increasingly important (squalls, bands) and how to derive useful “rates” is a current barrier (NDFD or NWP)
    - Hourly max/min?
    - Longevity above threshold? Which threshold?
    - Intensity-duration method?

Sometimes the best innovations are the simplest;
Better model output (new variables/more perspective) can also lead to improved forecasts!

Group Discussion: Culture

Roles of the forecaster:

- More Tasks, Same Time: forecasting, collaboration, key messages & IDSS
- Targets of Opportunity:
  - **Consistency** (day to day) is still a challenge
  - Consistency → **communicate (un)certainty**
  - **Guidance** can't be taken literally, so be:
- "More Probabilistic":
  - Developing scenarios or clusters of solutions - use probabilities:
    - **Snow amounts, rates, timing** are key elements in IDSS briefing packages and communications.
  - Better models translate to better, consistent, reliable, accurate? probabilities
  - How do we get more ensemble members? Faster? Better? Decipherable?
    - Develop run to run consistency (time lag helps but that depends on predictability and phenomenon, time of year)

"I think focusing on those targets of opportunity is definitely the future, … we could all benefit from a robust NBM training to understand the methodology behind its QPF and snowfall to better diagnose a target of opportunity. I think these go hand in hand."

Summary

We are looking forward to expanding the breadth of our knowledge as we seek collaboration with the developer community. The information produced informs the public we serve, from the methods we employ to solve physical science problems, to how we equip and prepare forecasters. Only through many *different perspectives* can we hope to capture a wide-angle view of forecast challenges to improve the predictions of precipitation that empower all of us to save lives and protect property.

We encourage researchers, developers, data visualizers, programmers to reach out so we can work together and appreciate each other's challenges to better apply our various sciences, techniques, and approaches to empower life-saving and protective action against hazards, local and national.

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