Collaborative Development of the 3DRTMA Using SRW-App

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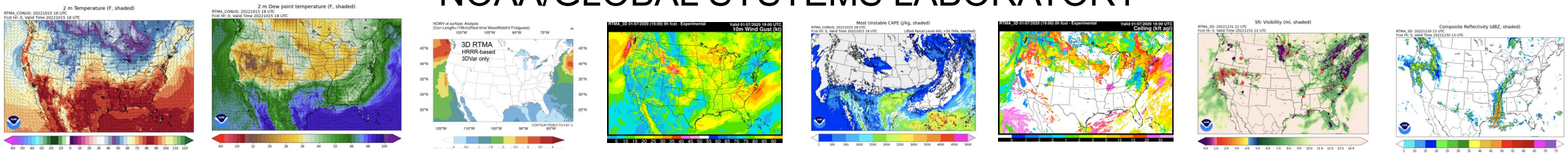
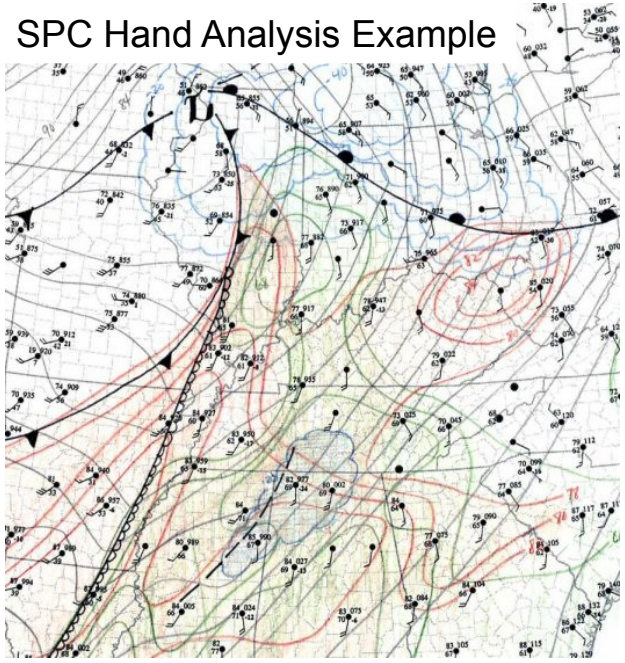
NOAA/GLOBAL SYSTEMS LABORATORY

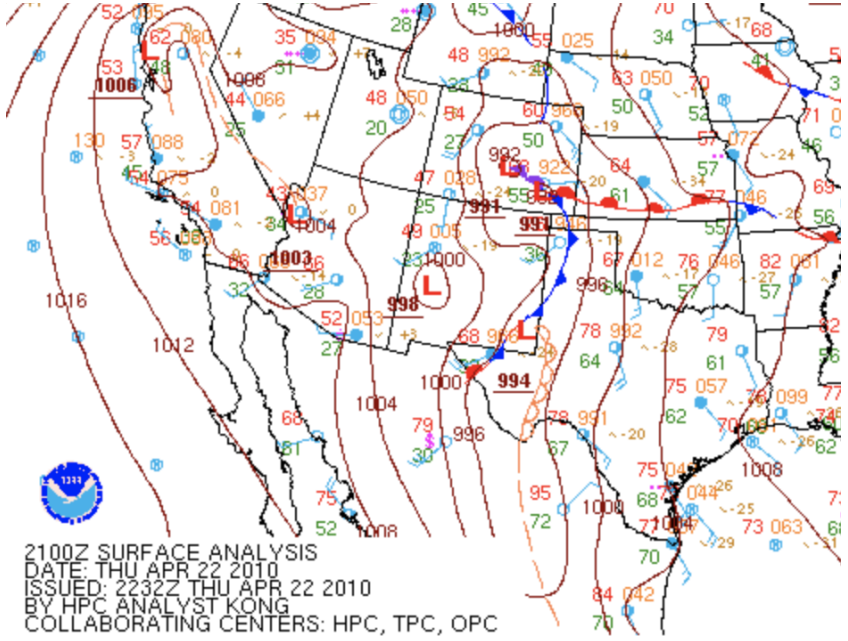


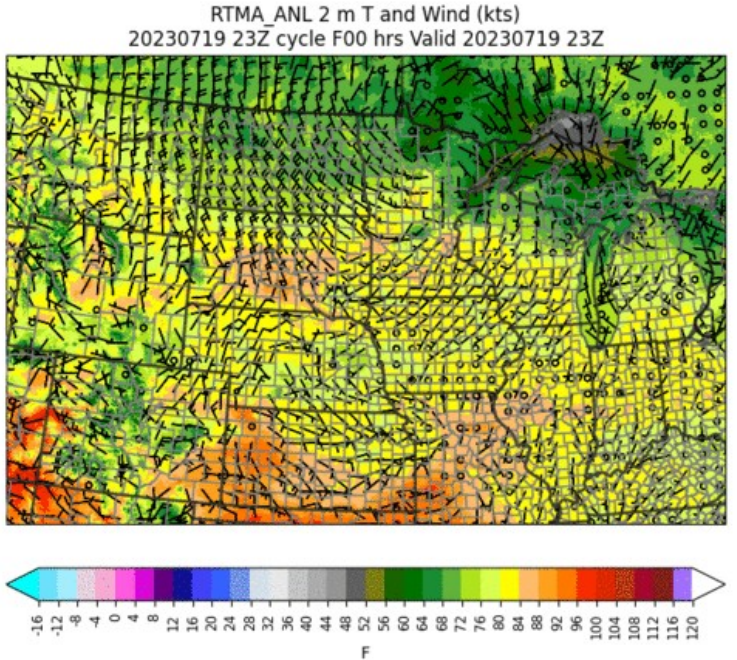
Real-Time Analysis Motivation

- Forecasting, including nowcasting, requires a **timely, accurate, and rapidly updating analysis** of current conditions for situational awareness and to enable forecasters.
- Hazardous wx can evolve on a time scale of minutes and is highly sensitive to subtle thermodynamic changes.
- Analysis systems that are infrequent, coarse resolution, contain only a small set of 2D fields, and/or only leverage surface obs are inadequate.

SPC Hand Analysis Example

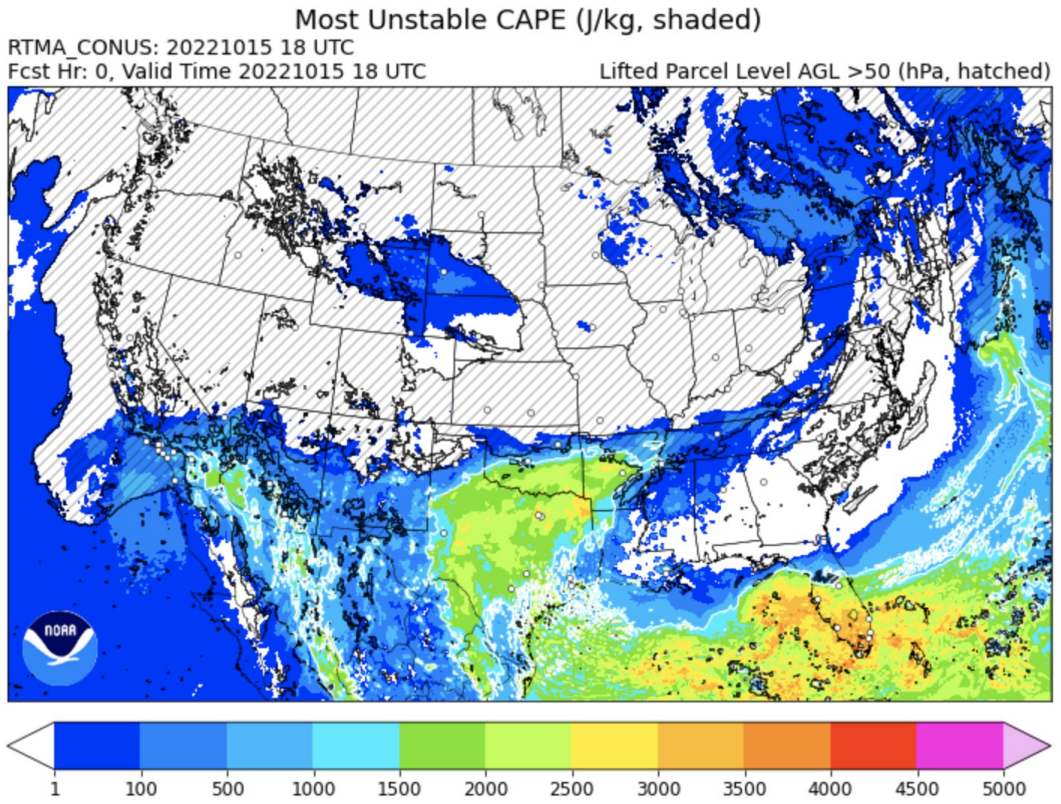






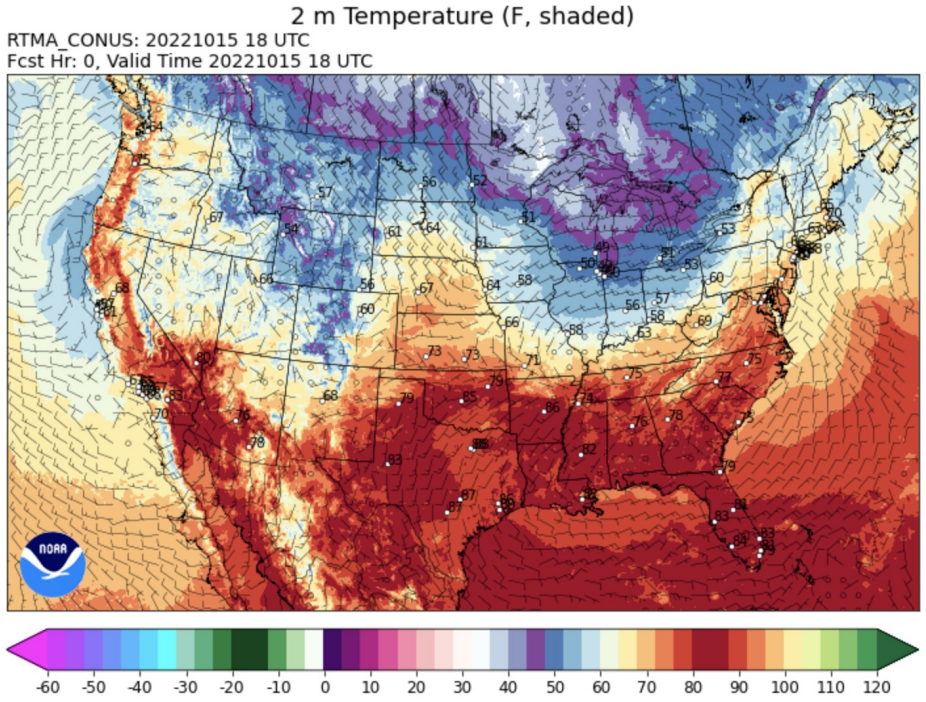
RTMA

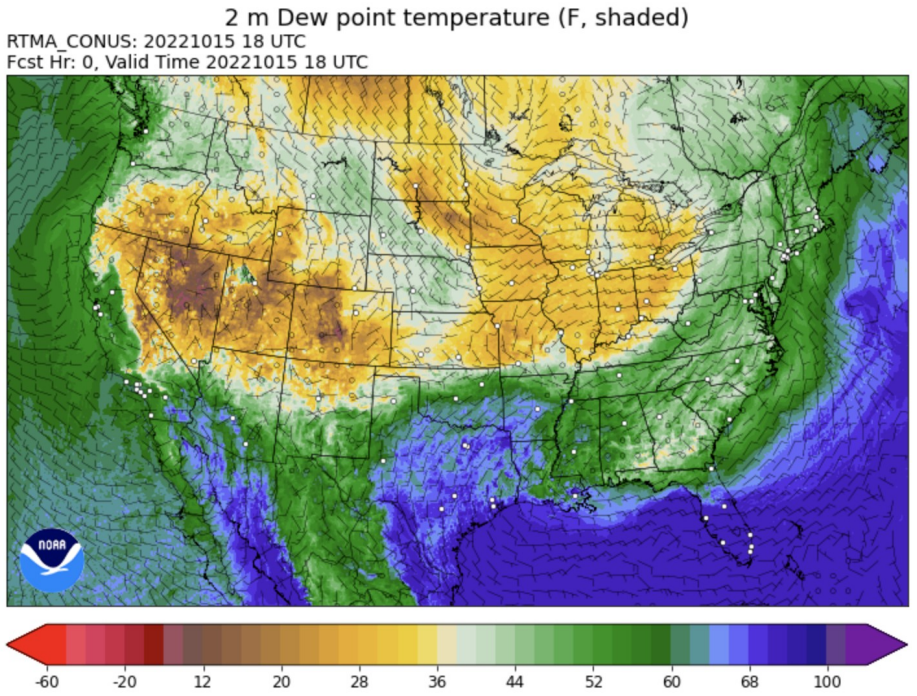
- **Real-Time Mesoscale Analysis (RTMA)**
  - Operational 2DRTMA (hourly) and 2DRTMA-RU (15 mins). Uses 2DVar.
  - Transition to 3D whole atmospheric analysis, and later an ‘on demand’ continuous analysis system. Use 3DEnVar.
  - Supports NWS National Digital Forecast Database (NDFD) operations, NWS national centers (e.g. SPC), and other user groups (e.g. aviation, fire wx, hydrology).
  - Used for situational awareness and nowcasting.



URMA

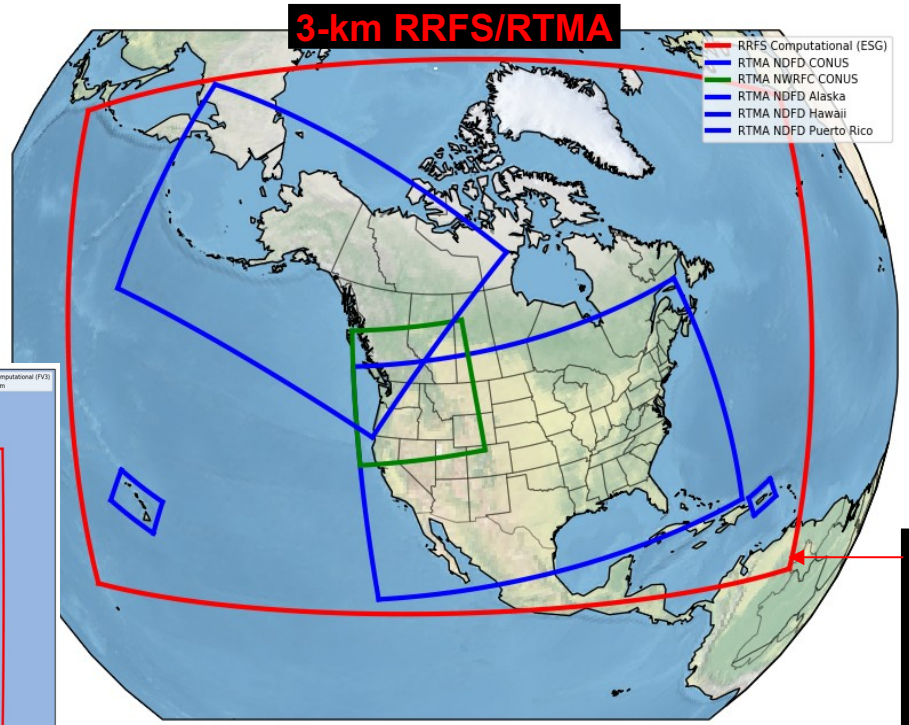
- Companion system: **UnRestricted Mesoscale Analysis (URMA)**
  - Runs in delayed real-time to enable the use of late arriving obs.
  - Serves as NOAA's analysis of record.
  - Used for verification and calibration in National Blend of Models (NBM).



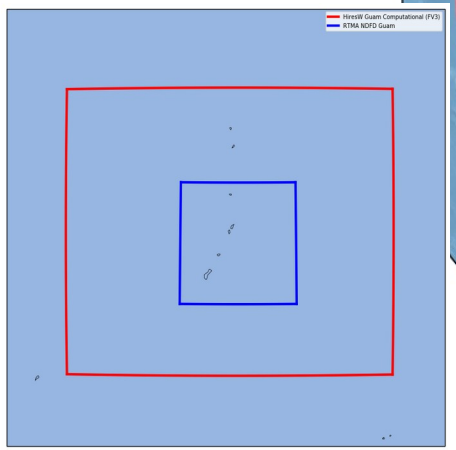


3DRTMA & 3DURMA

- RTMA is a specific configuration of the Unified Forecast System (UFS) Short-Range Weather (SRW) Application.
- RTMA depends on the Rapid Refresh Forecast System (RRFS) to provide background data.



Separate domain for Guam



RRFS 3-km
4881x2961x65

10GB / 3D native file
Rotated Lat-Lon

RTMA needs to provide products on the NDFD grids, which will be significantly more points than RRFS!
(2.5km grid for CONUS, Hawaii, and Guam, 1.25km for Puerto Rico, and 3 km for Alaska NDFD)

*925 million 3-D forecast grid points and 2-3 times 13-km GFS

3DRTMA & 3DURMA

- RTMA is a specific configuration of the Unified Forecast System (UFS) Short-Range Weather (SRW) Application.
  - \+ RTMA specific configuration file; fixed files
  - \+ Leverage innovations in SRW, especially those from RRFS
  - \- No RTMA specific testing in place, so upstream changes can break RTMA and manual intervention is required by GSL/EMC development team
  - \+ RTMA is able to run reliably on the cloud to support prototype demonstration
  - \- Porting to the cloud requires expert staff time and depends on data transfers

Guoqing Ge poster on A Quick Interface for Nesting Gigantic-data within Git Repositories

Raj Panda poster on Cloud based Workflows for RRFS & RTMA

NOAA Model Operational Implementation Timeline

Potential RRFS Schedule Change (Q4FY24 → Q2FY25)
RTMA will follow RRFS

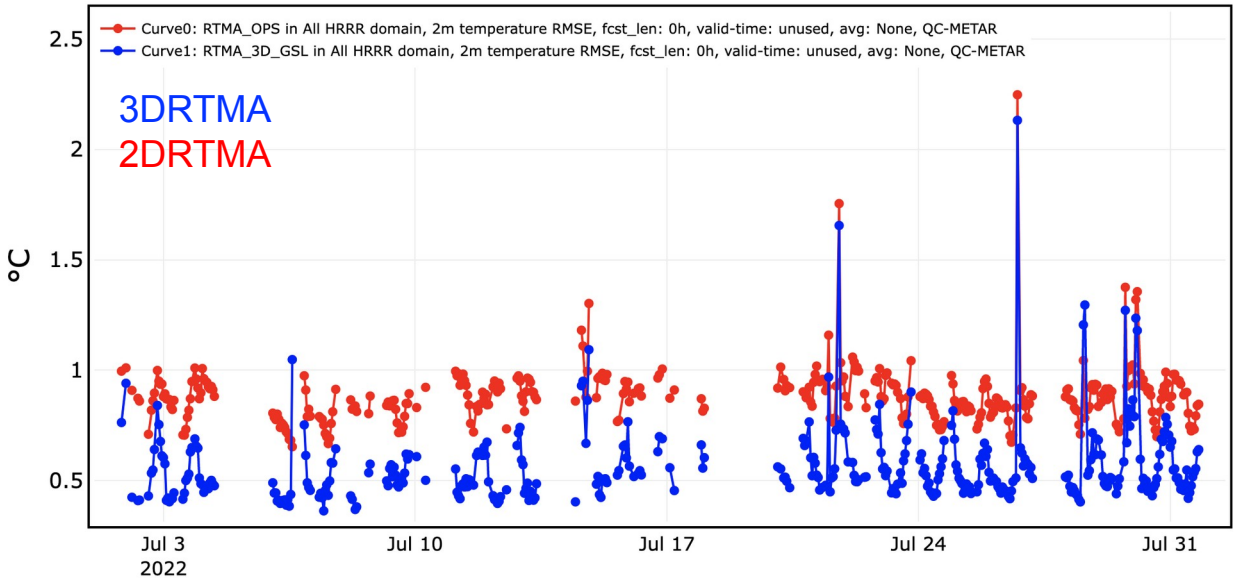
PHASES	FY23			FY24				FY25			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Planning											
R&D											
Intradevelopment T&E											
Science Freeze											
Retro+Real Time Evaluation											
3D RTMA/URMA Implementation											
Retire Legacy 2D suite											

RTMAv1 Operational
Q2FY25 → Q4FY25

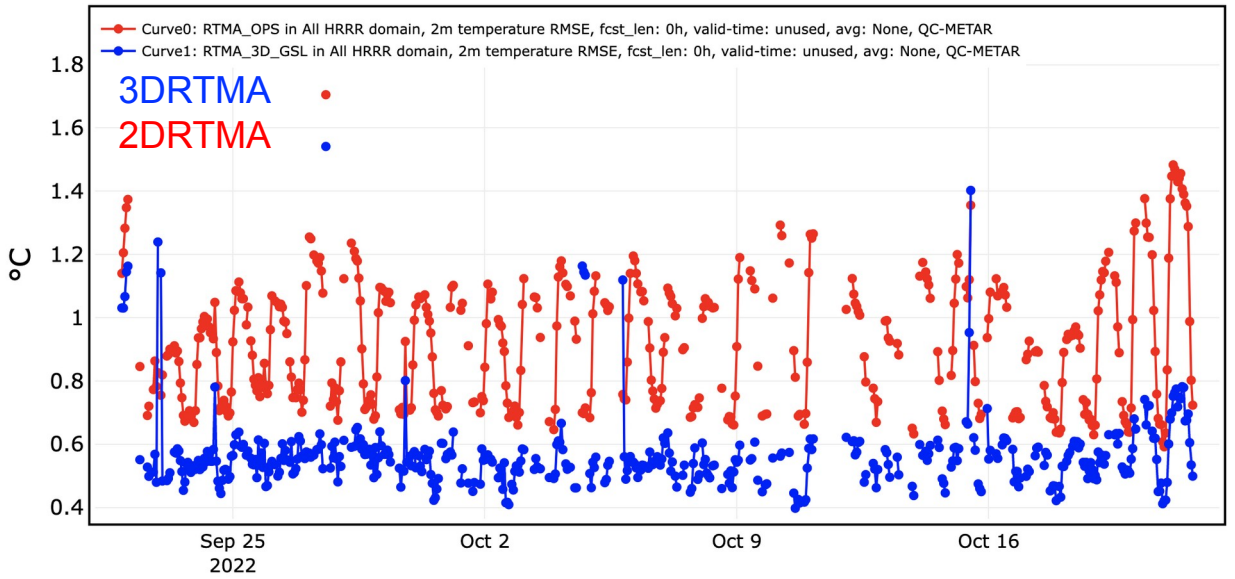
Comparisons to Operational 2D

- Throughout 3DRTMA development we have been comparing to the operational 2DRTMA.
- 3DRTMA is able to fit surface observations more closely.
- Example 2m Temp RMS:

July

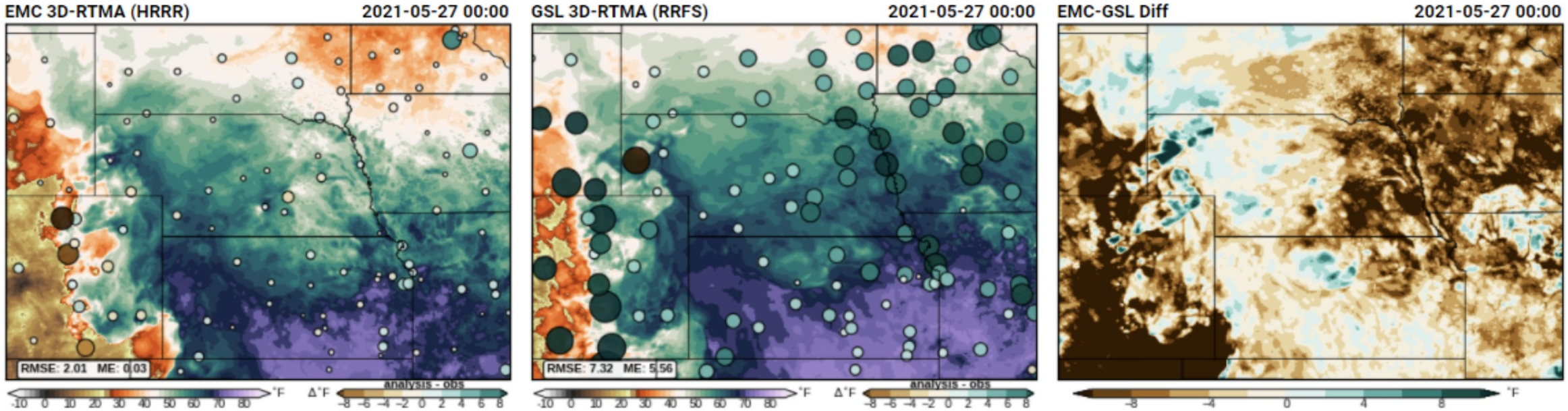


Oct



RTMA Comparisons 2021

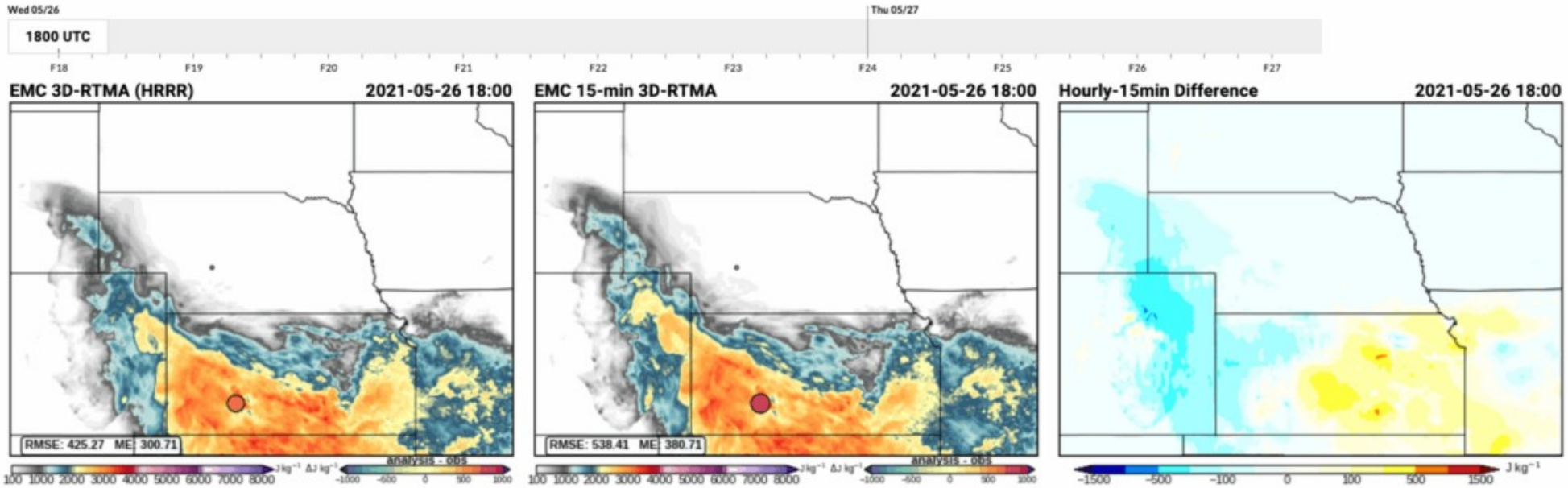
- The FV3-based RTMA first guess was rated **‘much worse’ or ‘slightly worse’** than the HRRR first guess, especially for 2m dew point and reflectivity.



- But the FV3-based RTMA did not have the hydrometeor analysis.
- Upscaled to 40km FV3-based RTMA was rated **‘slightly worse’** than SPC Mesoanalysis.

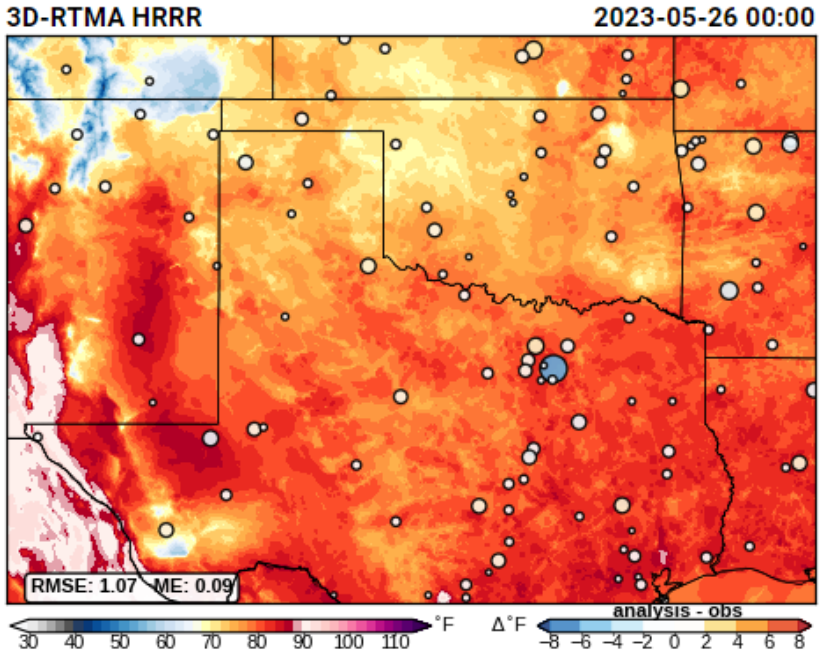
RTMA Subhourly Comparisons 2021

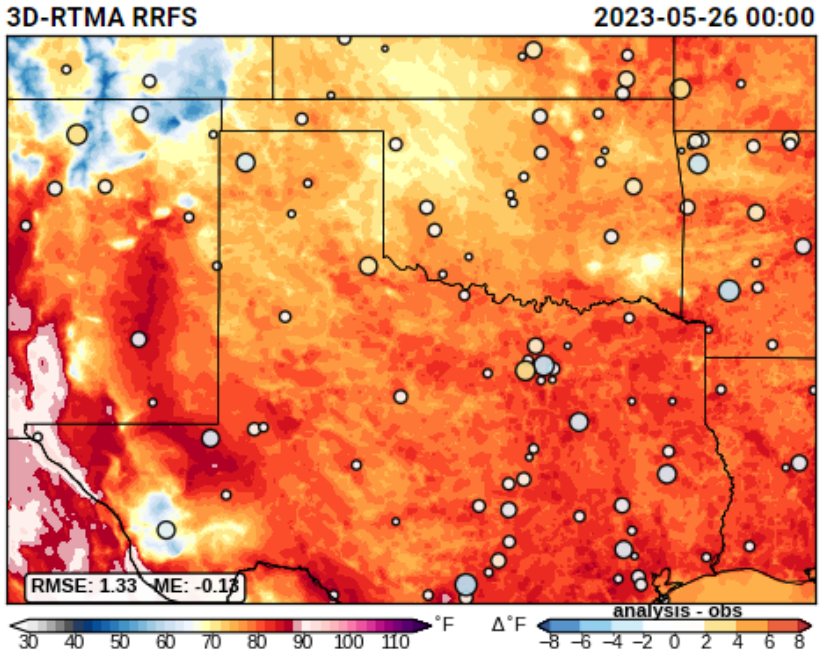
- The 15-min RTMA was rated **“about the same” to “slightly better”** than the hourly RTMA. It did leverage HRRRDAS BEC data instead of the GDAS data in the hourly version.
- Participants noted the analyses at the top of the hour were similar, and the **subhourly data was useful**.
- A discontinuity between the 45min and top of the hour analyses was prevalent, but the majority of participants thought the subhourly analyses provide useful info.

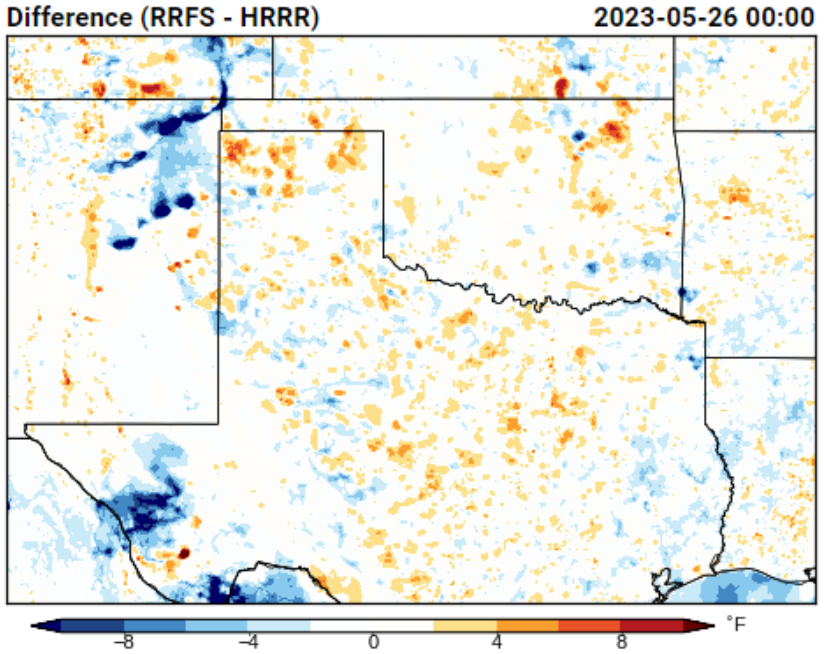


RTMA Comparisons 2022 & 2023

- FV3-based RTMA was rated **“slightly worse” to “about the same”** as the HRRR-based version.
- Analyses are very similar

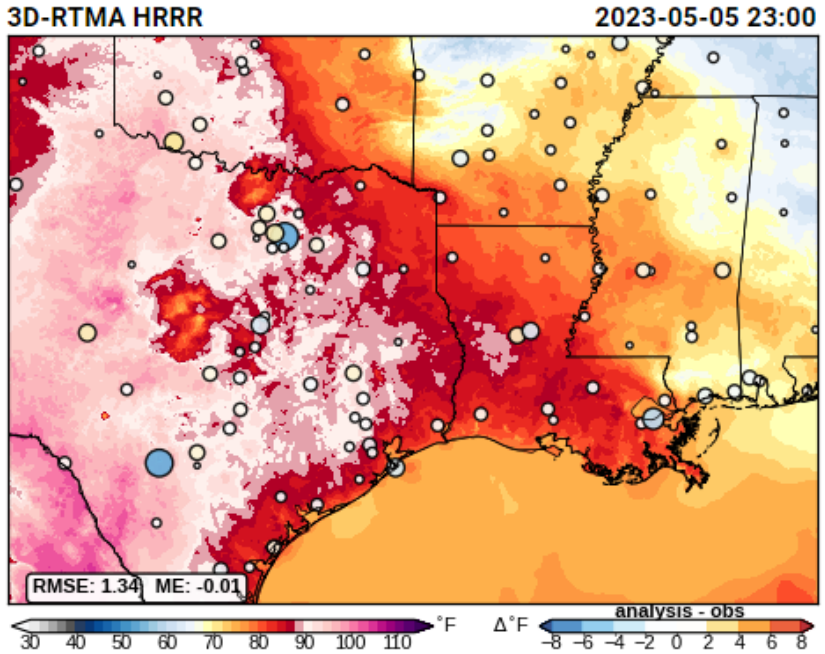


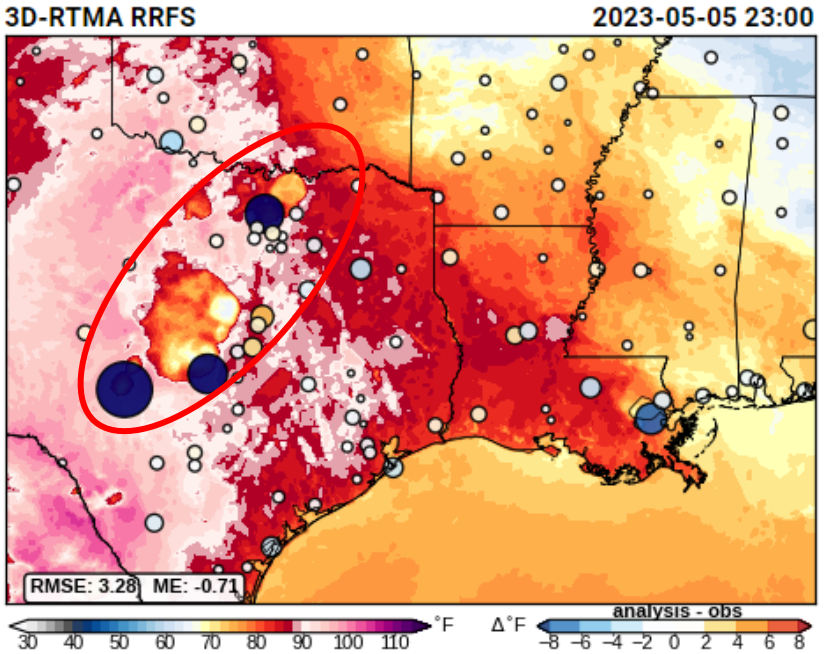


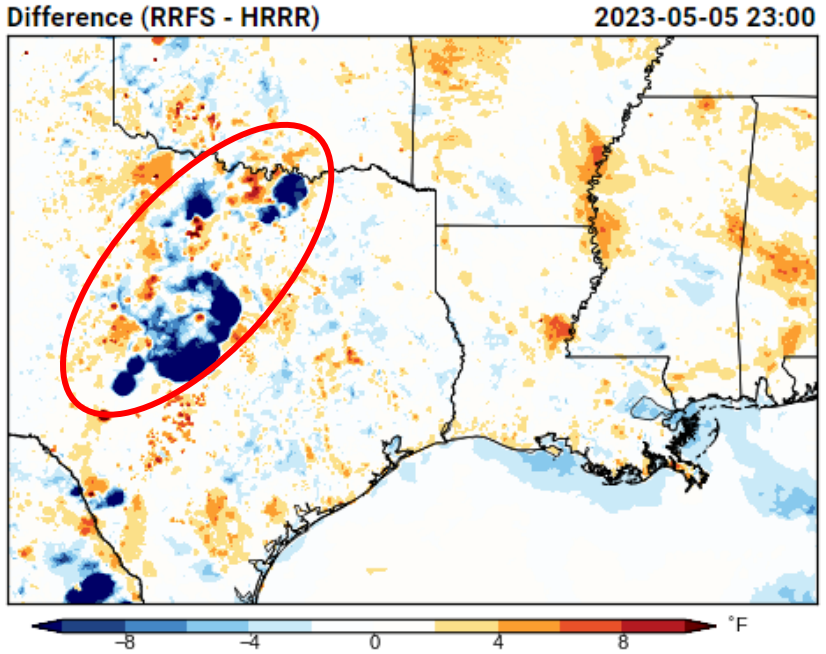


RTMA Comparisons 2022 & 2023

- FV3-based RTMA was rated **“slightly worse” to “about the same”** as the HRRR-based version.
- Thunderstorm outflows too early/cold/expansive

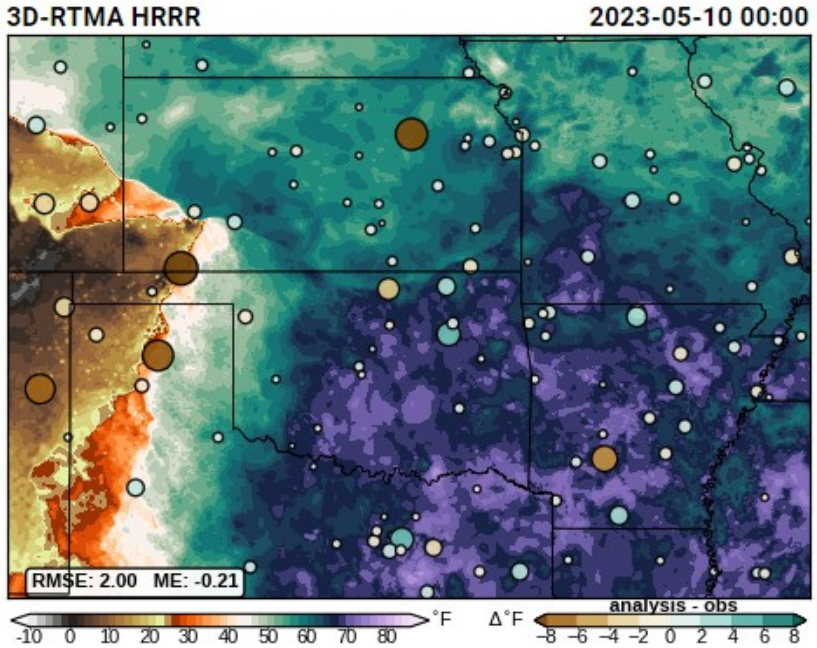


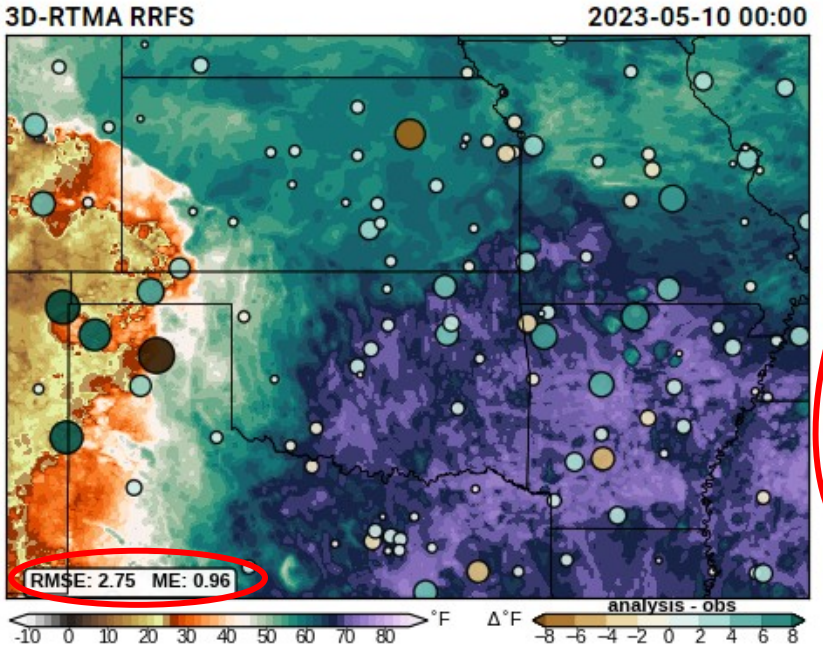


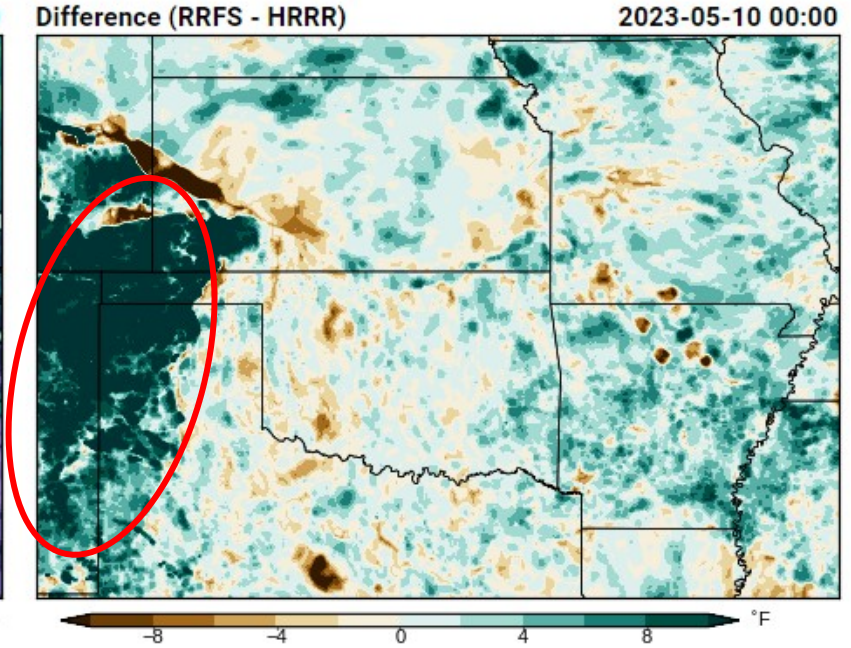


RTMA Comparisons 2022 & 2023

- FV3-based RTMA was rated **“slightly worse” to “about the same”** as the HRRR-based version.
- Moist bias in RRFS version
- RRFS version too moist in dry air/behind dryline







Analysis Visualization

- Evaluating analysis fit to observations including spatial and temporal filtering

RTMA Summary & Future Direction

- Strong dependence of RRFS; both technical and scientific innovations.
- High resolution and low latency requirements are challenging.
- Obs quality control is essential.
- Uncertainty estimation is in development.

See: Jim Purser poster on Geometric Approaches for Adaptive Domain Decomposition With an Application to the Estimation of the Variance of Analysis Error

- Transition to JEDI software for assimilation.

JOB OPENING

CIRES

University of Colorado Boulder

bit.ly/cudasp

CIRES/NOAA GSL has a job opening for a

Data Assimilation Scientific Programmer.

The Scientific Programmer will use and advance the JEDI software for RTMA and RRFS applications. In particular, work toward continuous assimilation approaches, analysis uncertainty estimation, and analysis of complex physical diagnostics will be prioritized. The development will take place in both NOAA High-Performance Computing environments and cloud computing environments. The candidate will have the opportunity to contribute to experimental and future operational RTMA prototypes including real-time experiments and the evaluation of RTMA by developers and interested parties. The candidate will work collaboratively with the GSL and EMC development teams, as well as the larger RRFS and UFS modeling community.