



RTMA/URMA v2.8 Improvements and Plans for the Future

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And many other excellent folks from ESRL/GSD, NWS WFOs and Regions, MDL + the NBM team, and NCEP Centers

¹NCEP/EMC/Modeling and Data Assimilation Branch

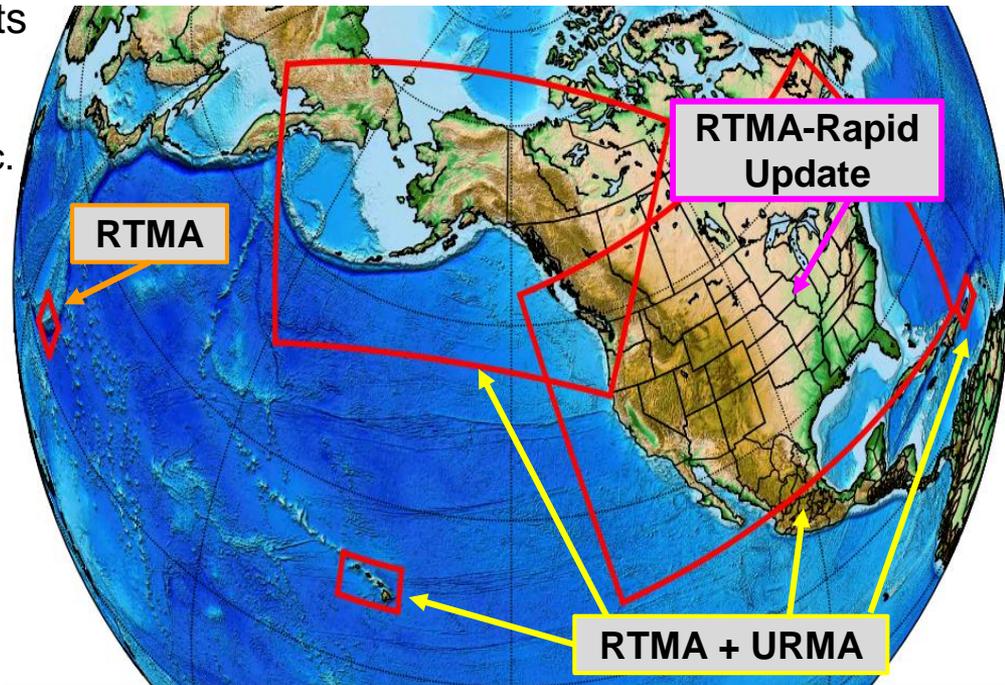
²IM Systems Group

³Systems Research Group

*Now at MDL

RTMA/URMA/RTMA-RU

- 2D, 2.5km* analysis of sensible wx elements
 - 2DVar system
 - 2m T and moisture, 10m wind and gust, ceiling, visibility, sky cover, wave height, etc.
- **Real Time Mesoscale Analysis (RTMA)**
 - Hourly
 - Real time system for nowcasting and situational awareness
- **UnRestricted Mesoscale Analysis (URMA)**
 - Runs 6 hours after RTMA to capture late arriving obs
 - Verification, calibration, analysis of record
 - Calibration in National Blend of Models
- **RTMA-Rapid Update**
 - 15-min updates, low-latency
 - Nowcasting, aviation, + situational awareness



*AK domains are currently at 3 km
*PR now at 1.25 km



v2.8 RTMA/URMA Upgrade: Highlights

- Downscaling/background field improvements [[All stakeholders](#)]
 - 2.5 km → 1.25 km for PR, consistent with NDFD [[NBM](#), [Puerto Rico](#)]
- Improved wind analysis with reduced low bias [[All stakeholders](#)]
- Significant wave height for Guam and Great Lakes [[NBM](#), [Guam](#), [Great Lakes](#)]
- Moisture/dew point analysis enhancements [[NBM](#), [W. Region](#), [WFO Missoula](#)]
- Re-tuned sky cover analysis with enhanced QC [[NBM](#), [CONUS](#), [AWC](#)]
- Consistent ceiling and sky analysis [[All stakeholders](#), esp. [AWC](#)]
- Precipitation enhancements [[CONUS](#) and coastal [CONUS](#), [WPC](#)]
- NOHRSC snow analysis [[CONUS](#), [WPC](#)]
- Expansion of upgrade for better fit to observations for OCONUS (already in CONUS) [[NBM](#), [OCONUS](#)]

Many improvements continue to be motivated via collaboration with highly engaged stakeholder community



Wind Changes: Similarity Theory Adjustment

- Has been assumed that all wind obs are taken at 10 m AGL
 - We know from looking at station photos that this is not true
- For mesonets: wind sensor height will now be a function of provider/network
- Background wind is adjusted via similarity theory to the same height as the observed wind
- Observation is be compared against this adjusted background wind value
- Similar adjustments made to gust analysis

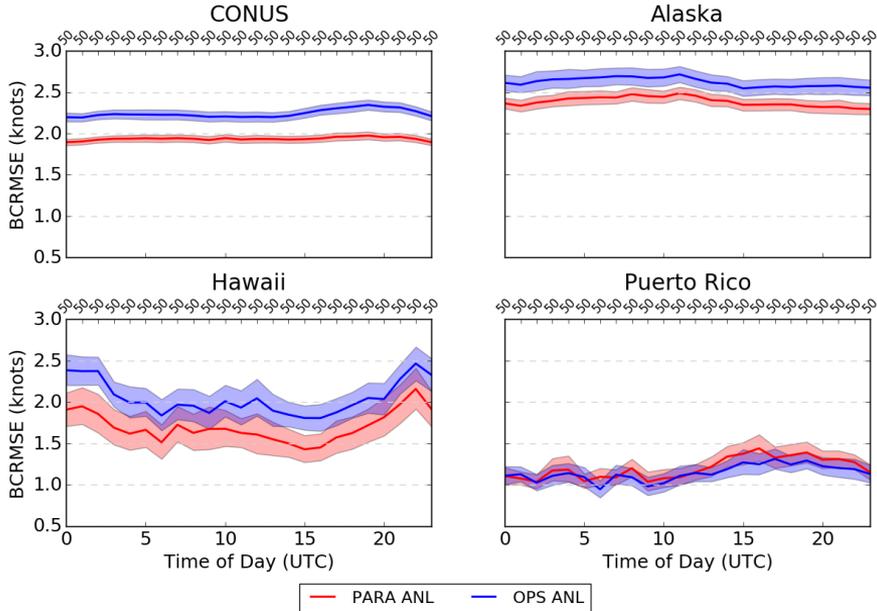




Wind Speed Time Series - Analysis

BCRMSE

Wind Speed BCRMSE - 201911210000 to 202001092300

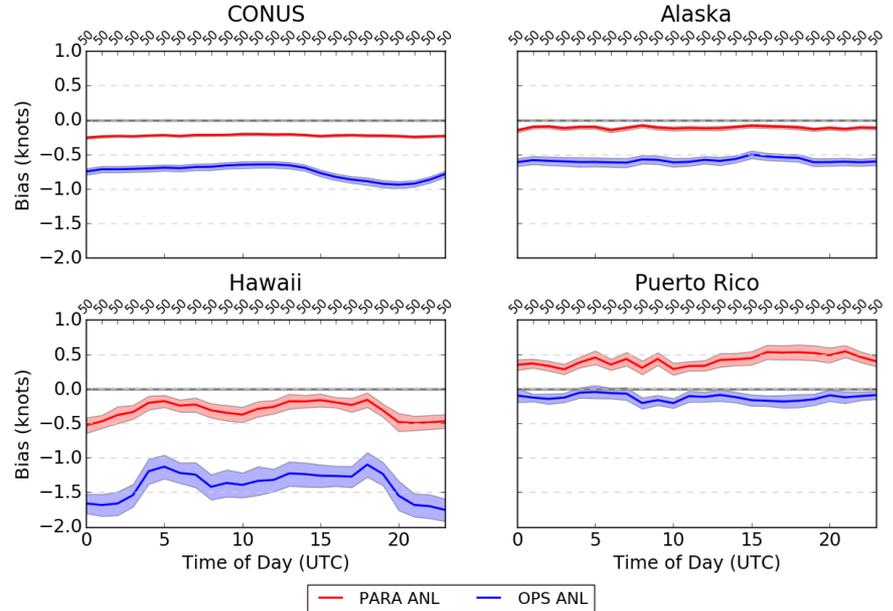


NEW SYSTEM

OLD SYSTEM

Bias

Wind Speed Bias - 201911210000 to 202001092300



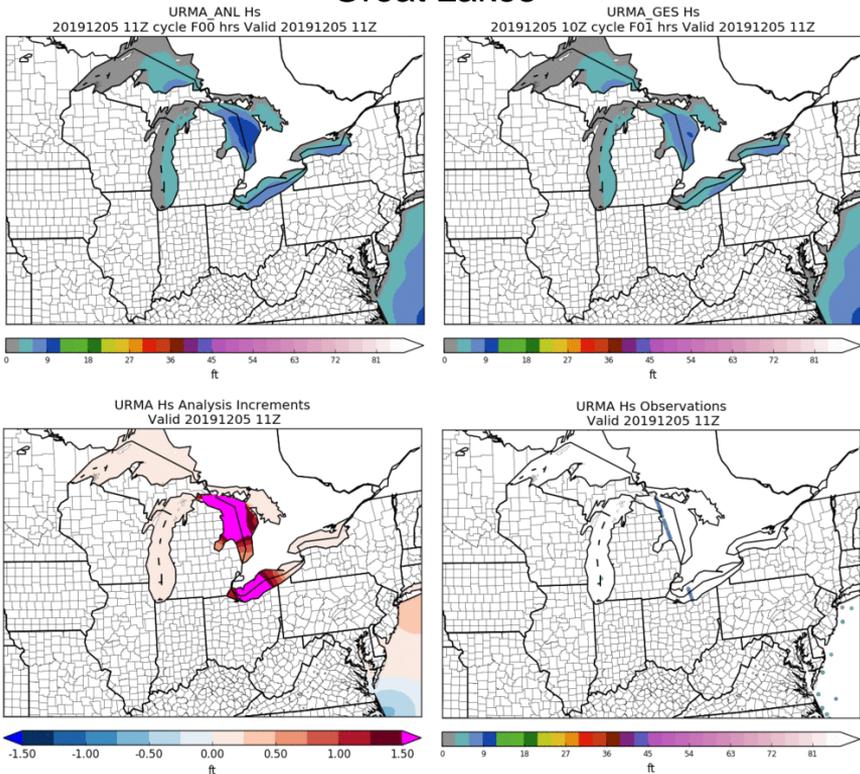
NEW SYSTEM

OLD SYSTEM

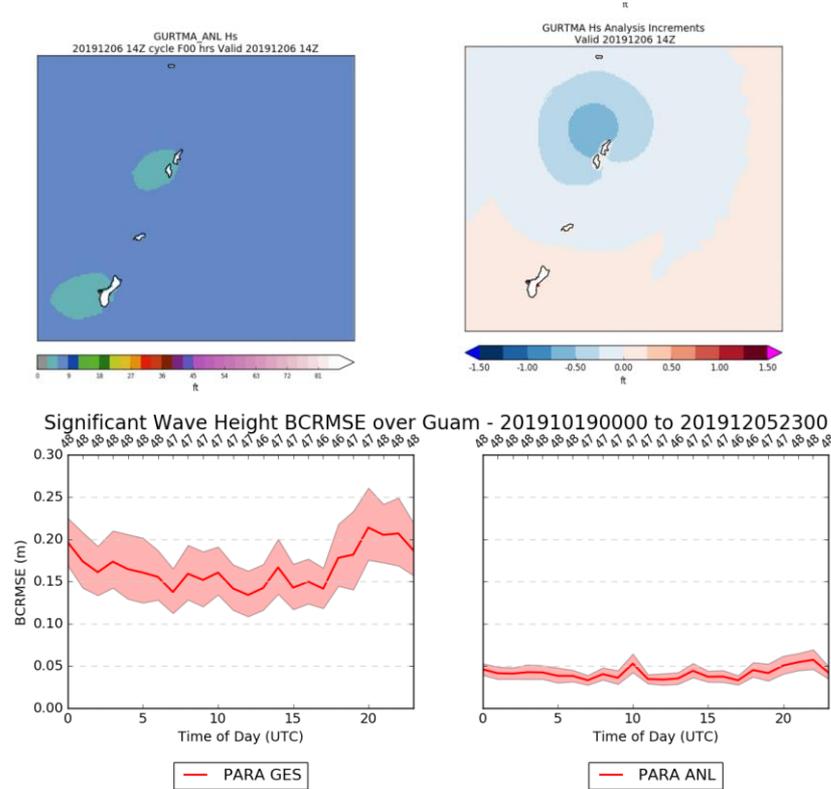
stats are relative to METARs, buoys, and ships

Wave Height v2.8

Great Lakes



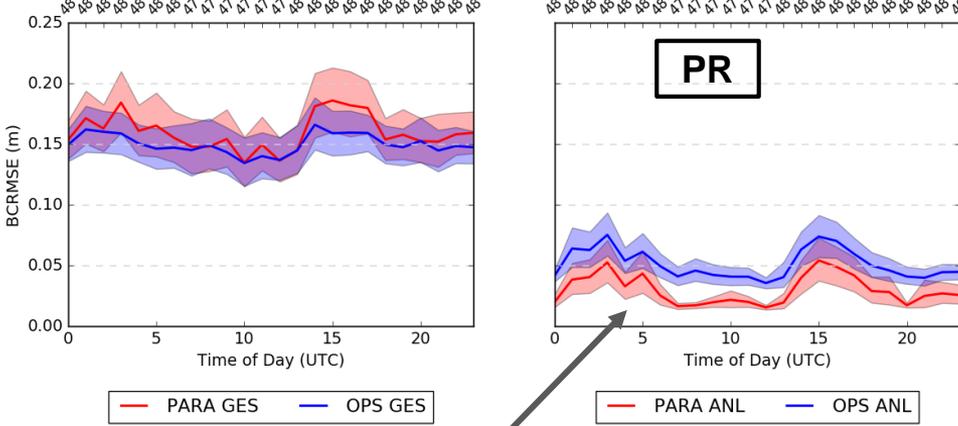
Guam



stats are relative to METARs, buoys, and ships

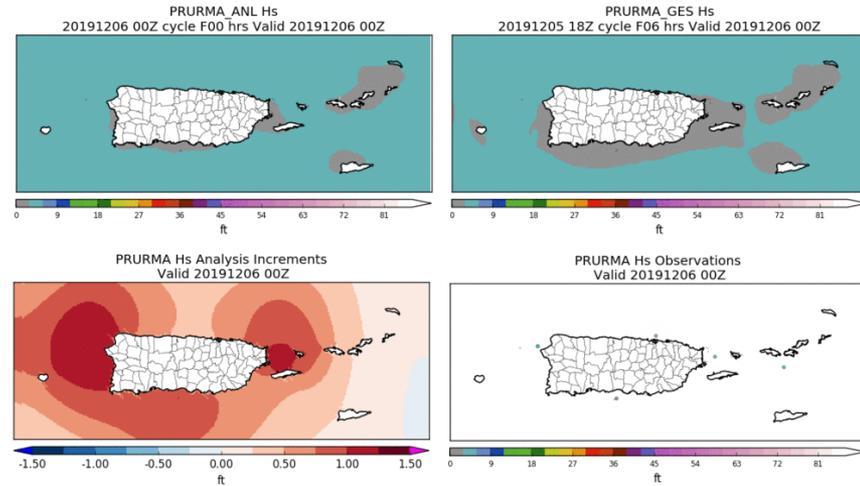
Puerto Rico Wave Height Stats

Significant Wave Height BCRMSE over Puerto Rico - 201910190000 to 201912052300



New grid and higher resolution + new background error = closer fit to obs

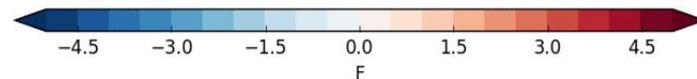
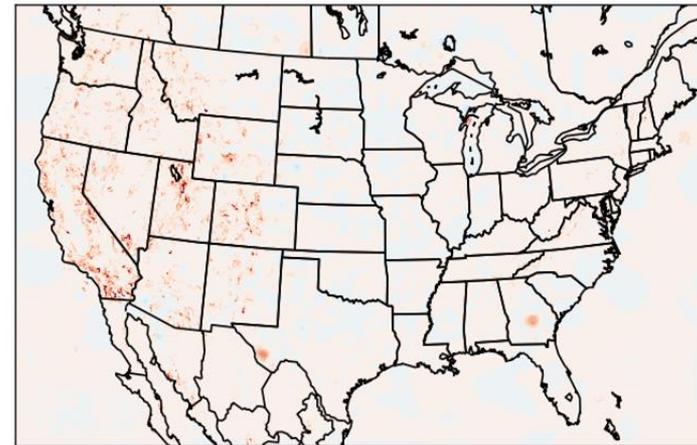
- The spatial resolution of PR was doubled (from 2.5km to 1.25km):
 - The system's parameters were recalibrated
 - PR URMA now has the highest spatial resolution of any wave analysis



Dew Point Analysis Updates

- Moist bias causing issues with FireWx
 - First noticed by WFO Missoula, MT
- Operational Dew Point Product:
 - Q and surface press. analysis is used to derive Td
 - Analysis increments between the computed Td fields is smoothed via a “1-2-1” filter and added to the downscaled Td to generate the final analysis
- The “1-2-1” smoothing filter has been switched off**
- Impacts closely tied to steep terrain
 - Coordinated and approved with Western Region and WFO Missoula

22Z on 29 June 2019



Operational - Retrospective

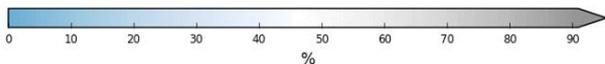
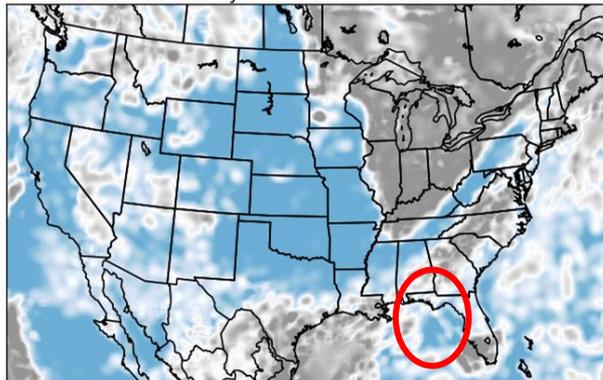


Ceiling and Sky Cover Updates for v2.8

- Ceiling is cleared (i.e., set to maximum ceiling value) when the analyzed sky cover is $< 50\%$
 - Ensuring product consistency
- Reject GOES Imager sky cover observations when:
 - The observation is $< 30\%$; and
 - Solar zenith angle is $> 80^\circ$ (i.e., late evening, overnight, or early morning)
 - Based upon feedback and consultation with GOES product developer and stakeholders
- Reduced thinning of GOES sky cover observations (by half) and tripled the decorrelation length to address feedback of a “splotchy” sky cover analysis
- Add sky cover analysis to RTMA-RU
 - Updates every 15 minutes

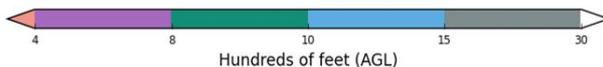
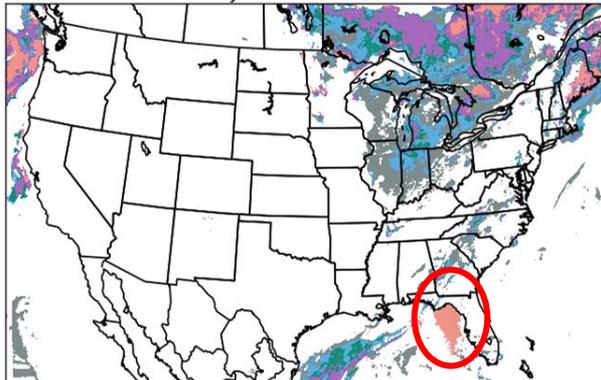
Example: Ceiling clearing

RTMA_ANL Total Cloud Amount
20190315 18Z cycle F00 hrs Valid 20190315 18Z



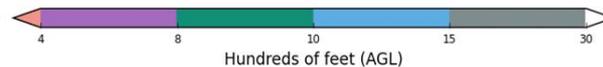
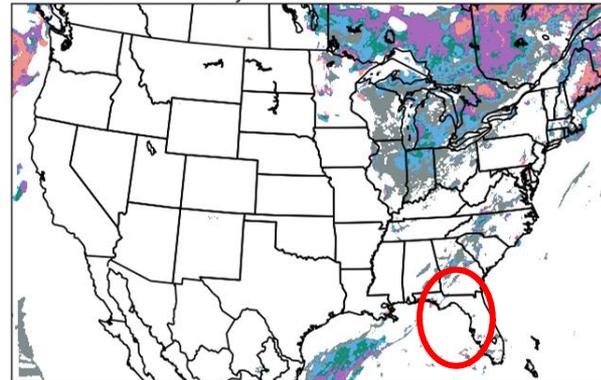
Sky Cover

RTMA_ANL Ceiling
20190315 18Z cycle F00 hrs Valid 20190315 18Z



Original Ceiling

RTMA_ANL Ceiling
20190315 18Z cycle F00 hrs Valid 20190315 18Z

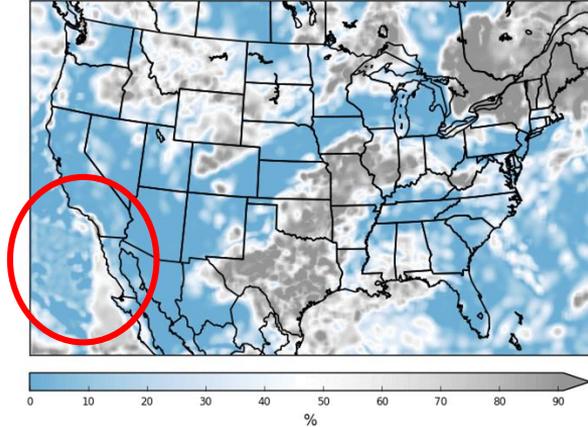


Modified Ceiling

18Z on 15 March 2019

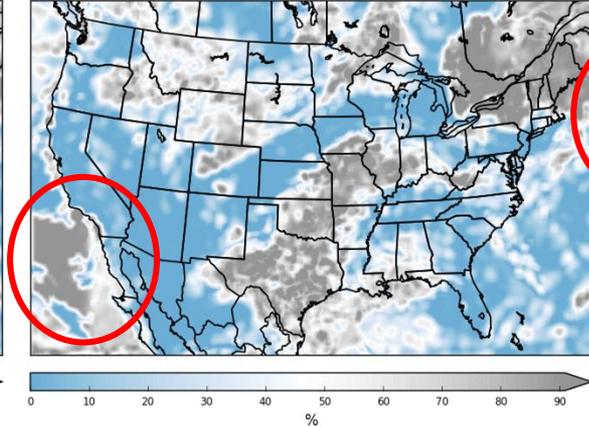
Example: Sky Cover QC

RTMA_ANL Total Cloud Amount
20190424 14Z cycle F00 hrs Valid 20190424 14Z



Original Sky Cover

RTMA_ANL Total Cloud Amount
20190424 14Z cycle F00 hrs Valid 20190424 14Z



Modified Sky Cover (QC)

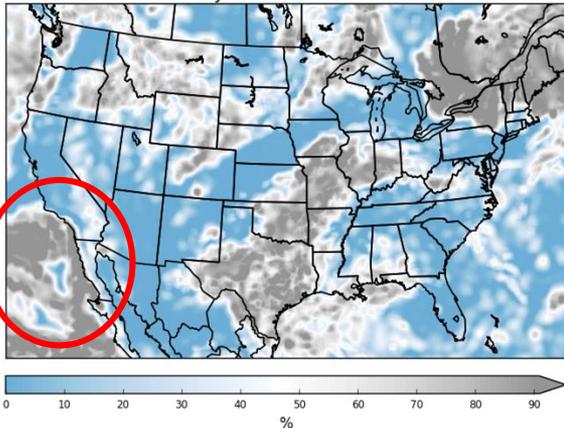


VIS

14Z on 24 April 2019

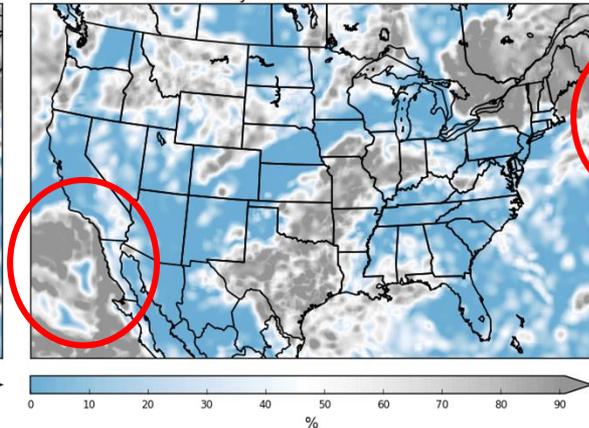
Example: Sky Cover QC

RTMA_ANL Total Cloud Amount
20190424 15Z cycle F00 hrs Valid 20190424 15Z



Original Sky Cover

RTMA_ANL Total Cloud Amount
20190424 15Z cycle F00 hrs Valid 20190424 15Z



Modified Sky Cover (QC)



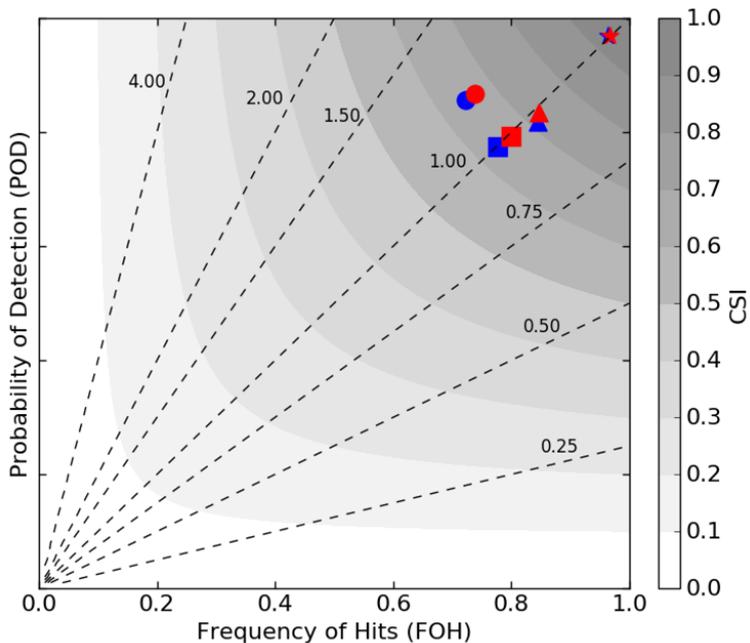
VIS

15Z on 24 April 2019



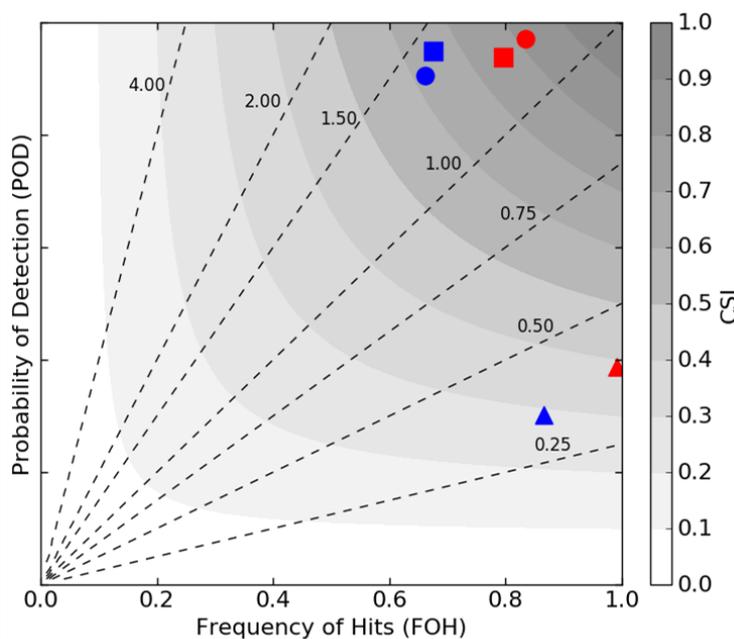
Ceiling and Sky Cover Stats

Ceiling over CONUS - 201912060000 to 201912082300



OPS ANL		PARA ANL	
■ Ceiling ≤ 500 ft (n = 4258)	■ Ceiling ≤ 500 ft (n = 4258)	■ Ceiling ≤ 500 ft (n = 4258)	■ Ceiling ≤ 500 ft (n = 4258)
● Ceiling ≤ 1000 ft (n = 7668)	● Ceiling ≤ 1000 ft (n = 7668)	● Ceiling ≤ 1000 ft (n = 7668)	● Ceiling ≤ 1000 ft (n = 7668)
▲ Ceiling ≤ 3000 ft (n = 21879)	▲ Ceiling ≤ 3000 ft (n = 21879)	▲ Ceiling ≤ 3000 ft (n = 21879)	▲ Ceiling ≤ 3000 ft (n = 21879)
★ Ceiling > 3000 ft (n = 108731)	★ Ceiling > 3000 ft (n = 108731)	★ Ceiling > 3000 ft (n = 108731)	★ Ceiling > 3000 ft (n = 108731)

Sky Cover over CONUS - 201912060000 to 201912082300

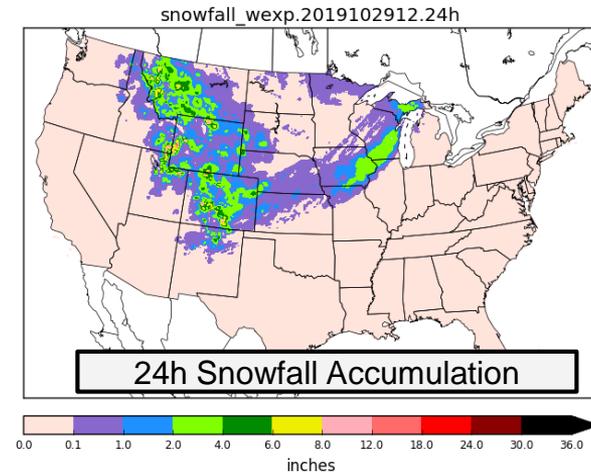
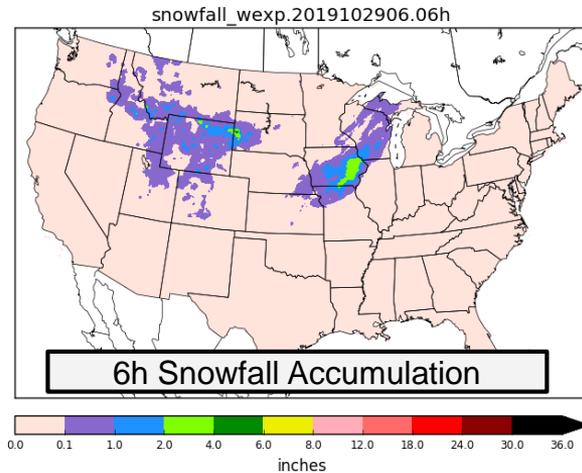


OPS ANL		PARA ANL	
■ Sky Cover ≥ 25 % (n = 68097)	■ Sky Cover ≥ 25 % (n = 68097)	■ Sky Cover ≥ 25 % (n = 68097)	■ Sky Cover ≥ 25 % (n = 68097)
● Sky Cover ≥ 50 % (n = 48877)	● Sky Cover ≥ 50 % (n = 48877)	● Sky Cover ≥ 50 % (n = 48877)	● Sky Cover ≥ 50 % (n = 48877)
▲ Sky Cover ≥ 90 % (n = 45185)	▲ Sky Cover ≥ 90 % (n = 45185)	▲ Sky Cover ≥ 90 % (n = 45185)	▲ Sky Cover ≥ 90 % (n = 45185)

stats are relative to METARs, buoys, and ships

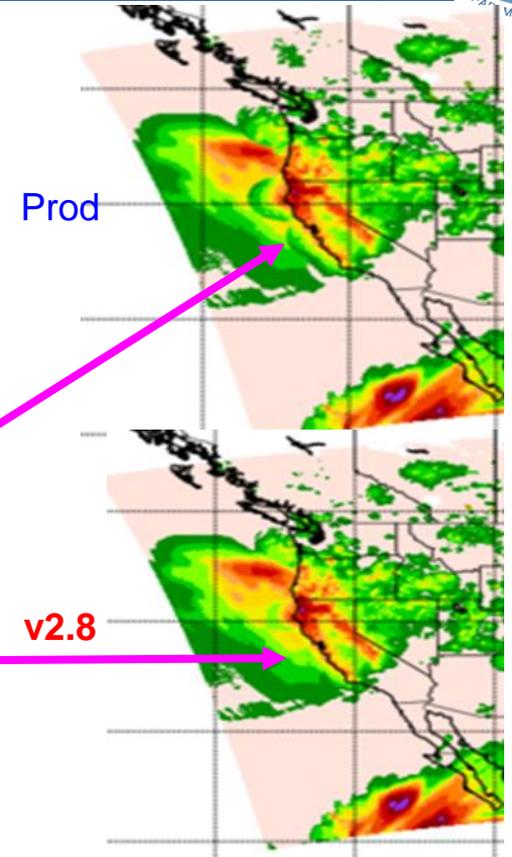
NOHRSC Snowfall Analysis for URMA

- Add NOHRSC 6h/24h snowfall analysis to the precipitation URMA suite
- At the 18Z cycle, process NOHRSC data for current day AND the past 7 days to continually refine snow product
 - Data mapped from NOHRSC's g184 to the expanded ConUS grid (WEXP) for NBM
 - g184 data sent out to AWIPS



Improved Offshore Filling of pcpURMA

- The primary source of ConUS pcpURMA is the NCEP Stage IV
 - mosaicked RFC QPEs → which is limited to RFC domains
- V2.7 introduced offshore filling of ConUS PCPURMA with
 - Gauge-corrected MRMS (where RQI ≥ 0.1)
 - CMORPH
 - Sharp discontinuities can exist between these products
- Solution → apply Whittaker blending function for a smoother pcpURMA offshore filling
 - Approach already used in RTMA/URMA to fill edges around domain





V2.8 RTMA/URMA/RTMA-RU Timeline

Science Briefings

NCO begins 30 day IT test

12/10

04/16/
2020

11/22

12/20

05/25
2020

Science evaluation ended

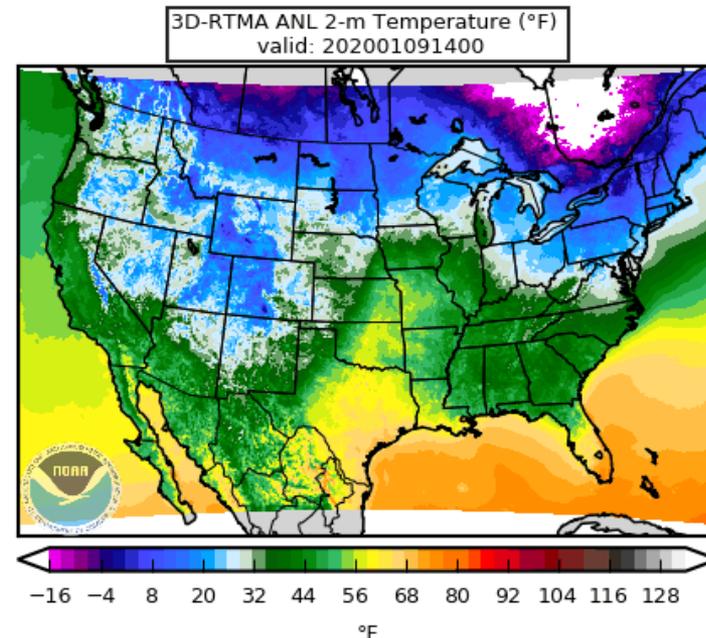
Hand off to NCO

Implementation [latest estimate from NCO]

The last upgrade of the 2D RTMA/URMA system!

2D → 3D-RTMA

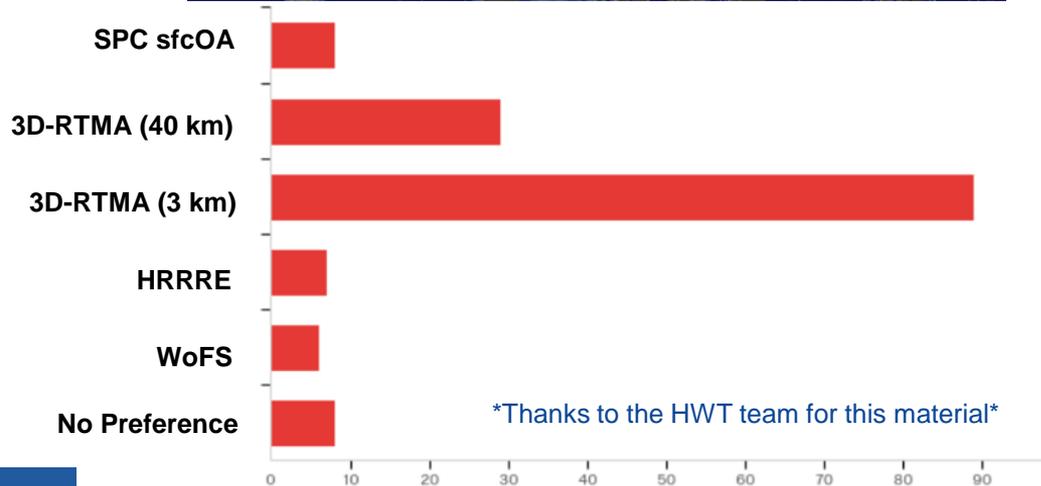
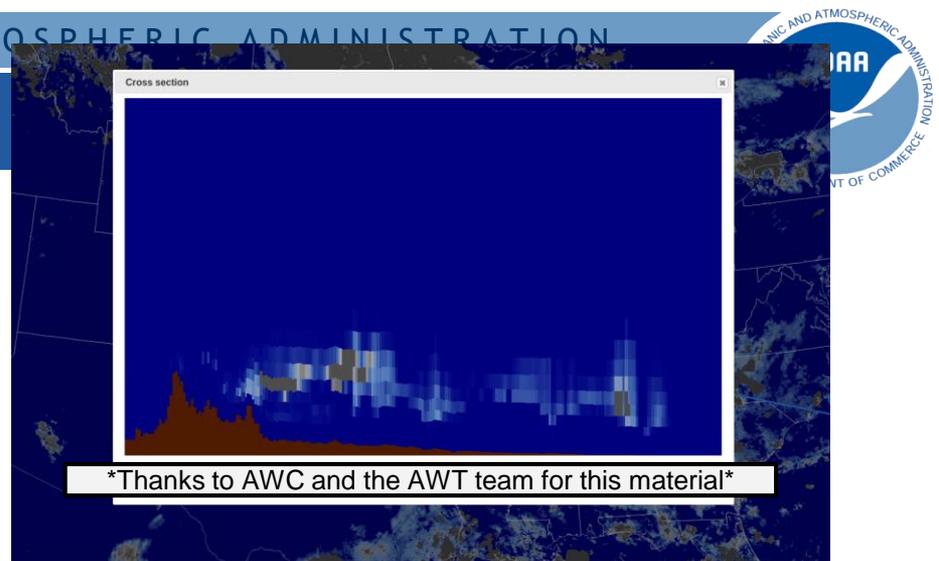
- Joint development effort between EMC + ESRL/GSD
- Real time, rapid updated analysis of 3D atmospheric fields
 - Severe and aviation weather parameters
 - Analysis of hydrometeor and cloud fields
 - Assimilation of radar observations
 - Heavy rainfall, etc.
- 15 min updates
- Low latency
- FY23





3DRTMA in the Testbeds

- Aviation Weather Testbed
 - Better received over the 2D RTMA
 - Ability to interrogate the data in 3D increased confidence in the data owing to apparent vertical consistency
- Hazardous Weather Testbed
 - High resolution 3D RTMA was rated highest quality of all available analyses during the HWT (~90 ratings)

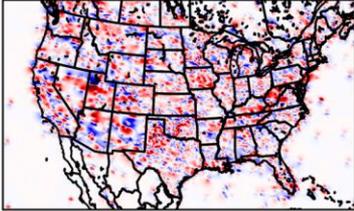


3D-RTMA: Scale Analysis of Wind Increments

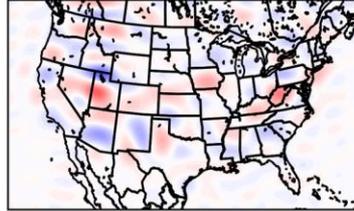
Using HRRR Ensemble Error Covariances

Using Static Background Error Covariance

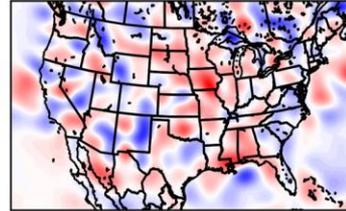
A) Original function of U10 of anl_increment_hrrrdas (201911111200)



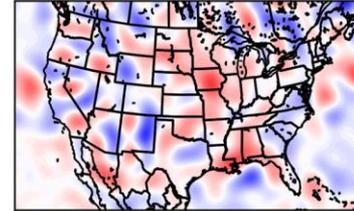
B) Wavelengths ≥ 400 km only



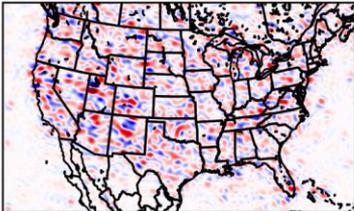
A) Original function of U10 of anl_increment_3dvar_hrrrBE (201911111200)



B) Wavelengths ≥ 400 km only



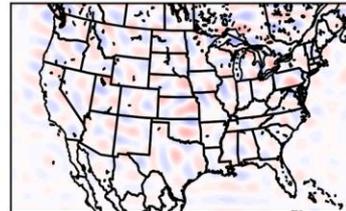
C) Wavelengths ≥ 100 km and < 400 km only



D) Wavelengths ≥ 40 km and < 100 km only



C) Wavelengths ≥ 100 km and < 400 km only



D) Wavelengths ≥ 40 km and < 100 km only



E) Wavelengths ≥ 10 km and < 40 km only



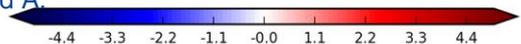
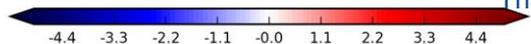
F) Wavelengths < 10 km only



E) Wavelengths ≥ 10 km and < 40 km only



F) Wavelengths < 10 km only



Thanks to G. Zhao for this material and A. Johnson (OU/MAP) for the code



Summary

- V2.8 Upgrade
 - Improved wind analysis through advanced forward operator
 - Expanded support for waves to Great Lakes and Guam
 - Improved sky cover analysis and consistent with ceiling
 - Improvements/updates for precipitation analysis
 - Implementation date: May 2020
 - This is the final 2D RTMA/URMA/RTMA-RU upgrade
- 3D-RTMA is coming in the FY23 timeframe

**The RTMA project benefits tremendously from an active user community.
Thank you!**



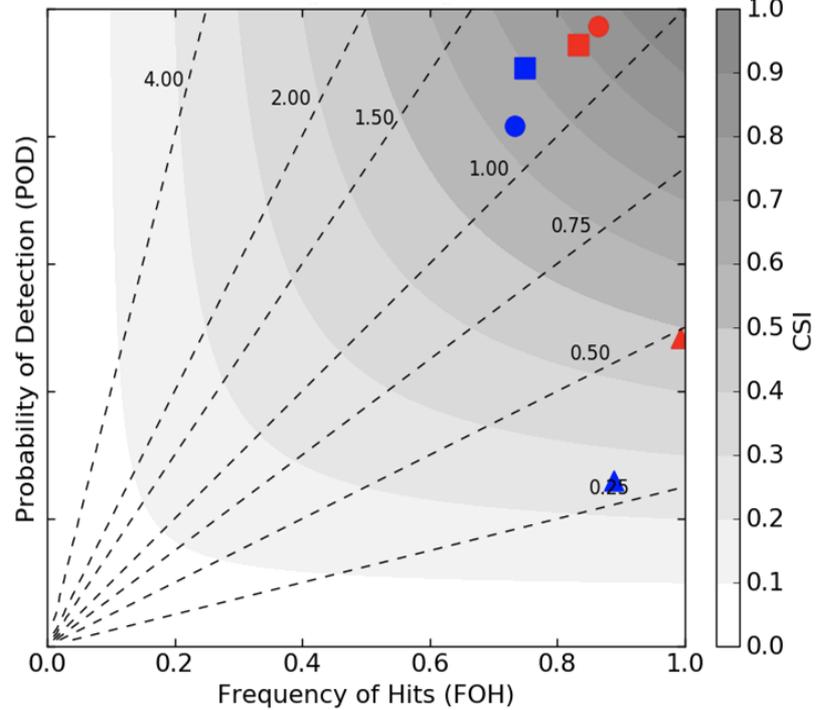
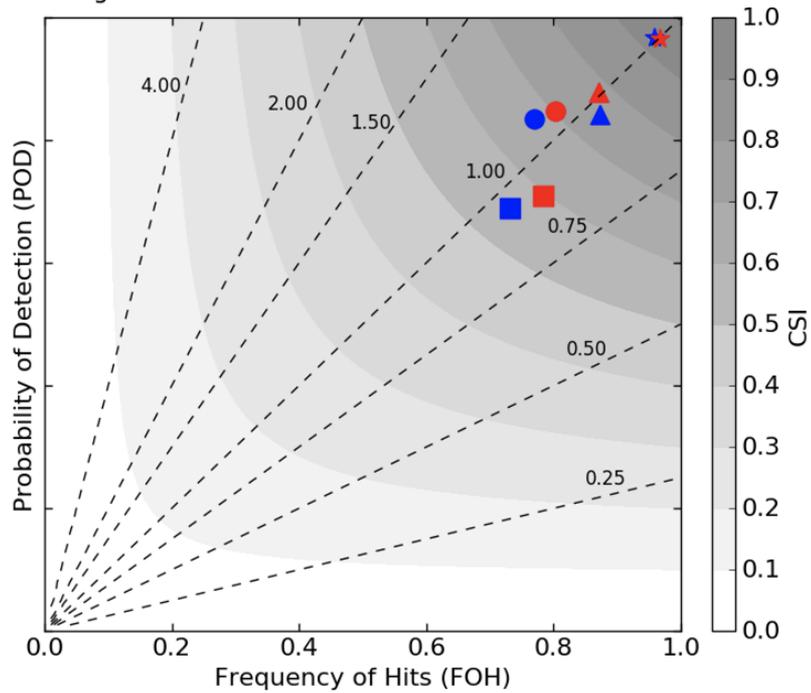
Supplemental Slides



Ceiling and Sky Cover Stats

Ceiling over CONUS - 201910190000 to 201912052300

Sky Cover over CONUS - 201910190000 to 201912052300



OPS ANL		PARA ANL	
■	Ceiling ≤ 500 ft (n = 72183)	■	Ceiling ≤ 500 ft (n = 72183)
●	Ceiling ≤ 1000 ft (n = 166365)	●	Ceiling ≤ 1000 ft (n = 166365)
▲	Ceiling ≤ 3000 ft (n = 430687)	▲	Ceiling ≤ 3000 ft (n = 430687)
★	Ceiling > 3000 ft (n = 1631735)	★	Ceiling > 3000 ft (n = 1631735)

OPS ANL		PARA ANL	
■	Sky Cover ≥ 25 % (n = 1073990)	■	Sky Cover ≥ 25 % (n = 1073990)
●	Sky Cover ≥ 50 % (n = 817750)	●	Sky Cover ≥ 50 % (n = 817750)
▲	Sky Cover ≥ 90 % (n = 759999)	▲	Sky Cover ≥ 90 % (n = 759999)

stats are relative to METARs, buoys, and ships

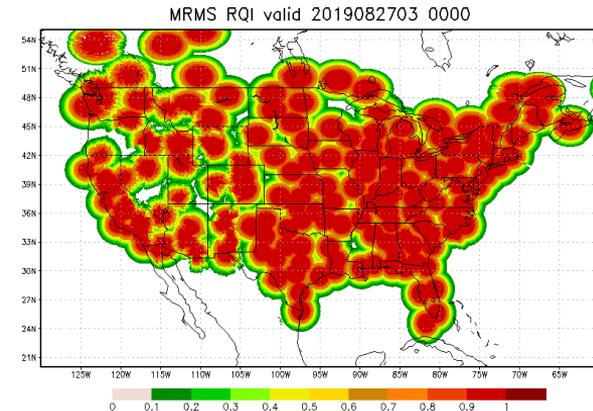
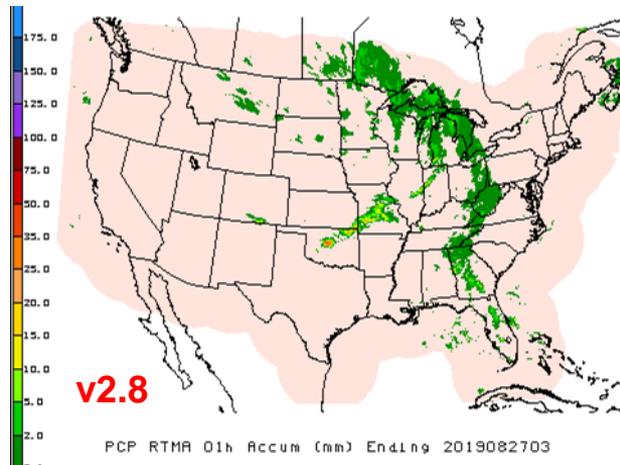
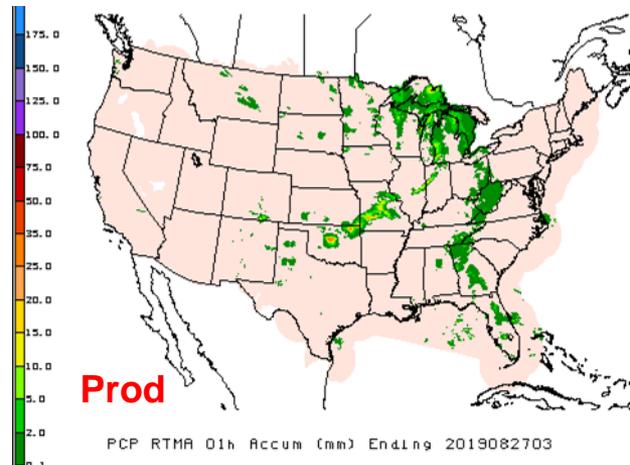


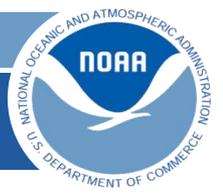
QPE RTMA/URMA Changes for v2.8

- Precip *RTMA*
 - Real time, low-latency QPE → currently from Stage II/IV (+33 min)
 - **v2.8:** Replace with radar-only MRMS; change hourly run schedule from hh:33 to hh:15
 - Improve latency
 - Situational awareness
- Precip *URMA*
 - Backbone is Stage IV and is rerun regularly ~1 week after valid time to refine/enhance as RFCs transmit revised data (what the NBM uses)
 - **v2.8:** Add NOHRSC snowfall analysis
 - **v2.8:** Add a blending for a smoother offshore filling with MRMS and CMORPH QPE
 - **v2.8:** Change hourly run schedule for PCPANL/pcpURMA from hh:33 to hh:55
 - Request by OWP, RFCs for RIDGE II, so more RFC QPEs can be included for current hour
 - More complete coverage, earlier
- PCPANL v4.0 (upstream job of RTMA/URMA):
 - Discontinue Stage II analysis - prod suite simplification
 - Add another 30h rerun of Stage IV 24h mosaic (for water.weather.gov/precip)
 - Supplements the current ~daily rerun schedule and gives chance for updated RFC QPE's to get out to public (e.g. water.weather.gov/precip)

pcpRTMA using MRMS

- Use radar-only MRMS QPE
 - Lower latency
 - Less affected by data outages than gauge-corrected MRMS QPE
- Radar quality index (RQI) added as companion to each hour's pcpRTMA array
 - Provide users with info about quality of the QPE
 - RQI arrays will be available on NOMADS (not AWIPS)

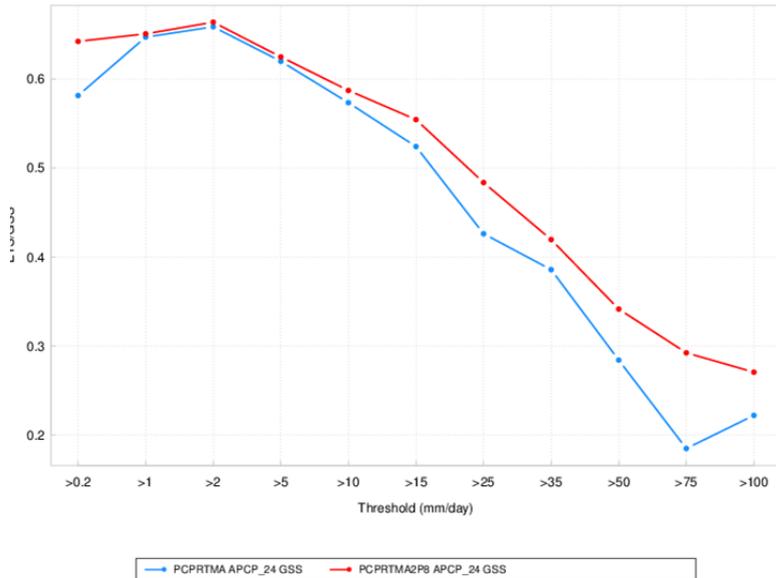




pcpRTMA using MRMS: validation

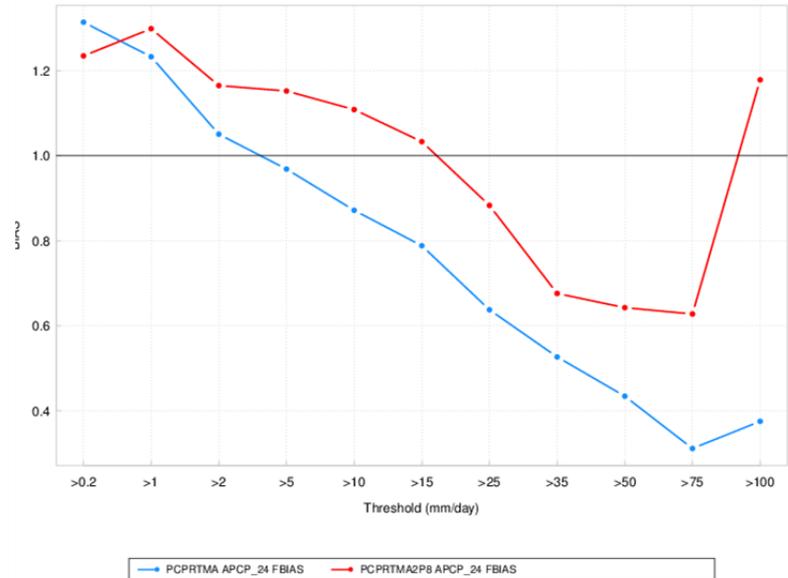
Prod vs. v2.8 pcpRTMA: 24 QPE validation vs. daily gauges (1 Aug - 30 Nov 2019)

ETS/GSS, PCPRTMA vs. PCPRTMA2P8, 2019-08-01 - 2019-11-30



ETS vs. threshold

BIAS, PCPRTMA vs. PCPRTMA2P8, 2019-08-01 - 2019-11-30



Bias vs. threshold