

The Weather Prediction Center's Winter Weather Experiment: Plans for the 15th WWE (2024-2025)

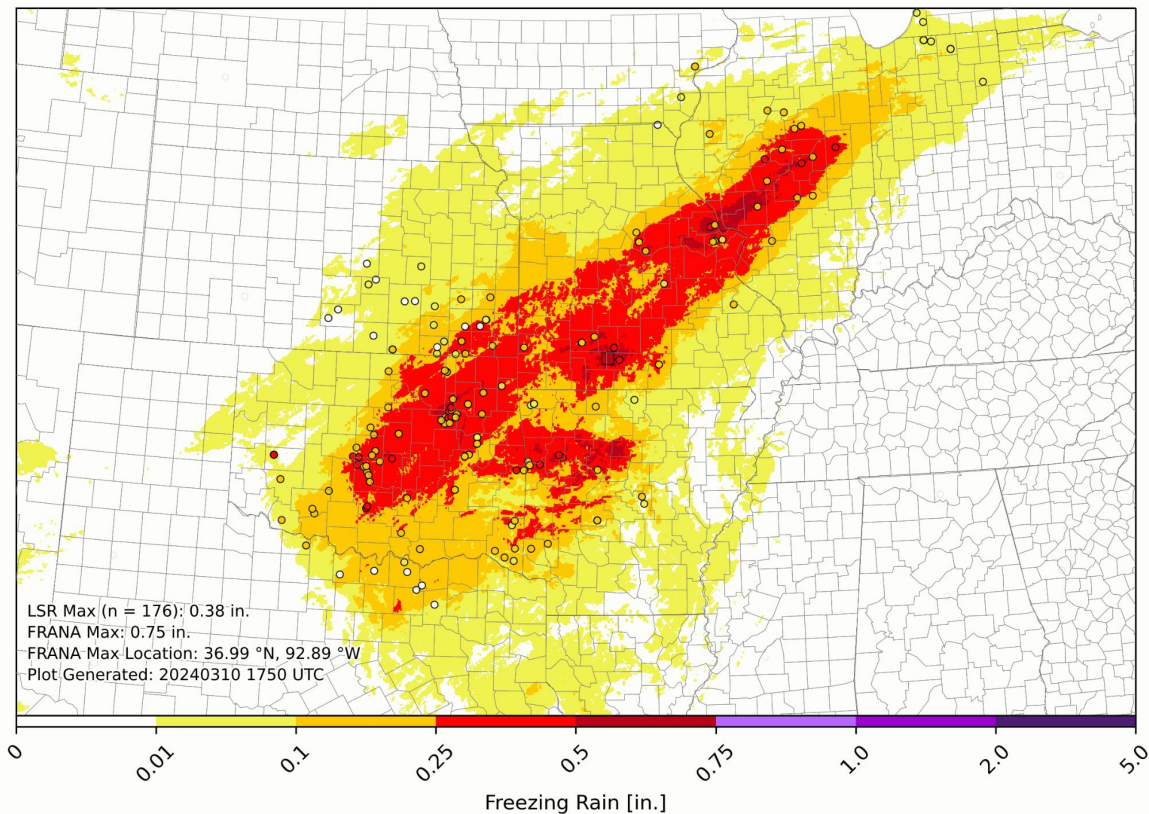
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¹CIRES/CU Boulder ²NOAA/NWS/NCEP/WPC



WWE/PEAR Seminar Series - 21 January 2025





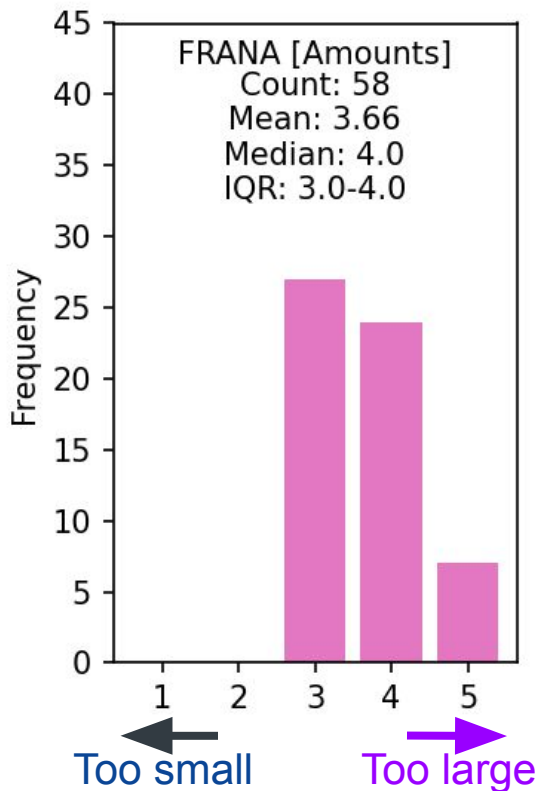
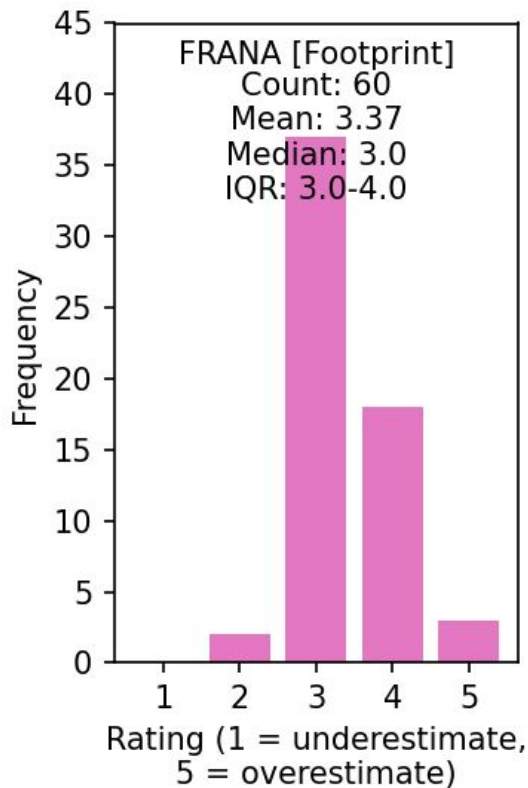
Comparison of FRANA to freezing rain local storm reports (LSRs):

- FZRA footprint generally well-captured
- Maximum FRANA amounts (>0.25") overestimated compared to LSRs, especially to the northeast into MO/IL

23 January 2024 Freezing Rain Case Study



FRANA: Overall Subjective Evaluation Results



WWE intensive week participants answered evaluation survey questions about FRANA: **How well did it perform in terms of its footprint and maximum amounts?**

FRANA footprint (0.01" flat ice) was generally accurate but case results showed it **overestimated max amounts in some cases from 2023-24.**

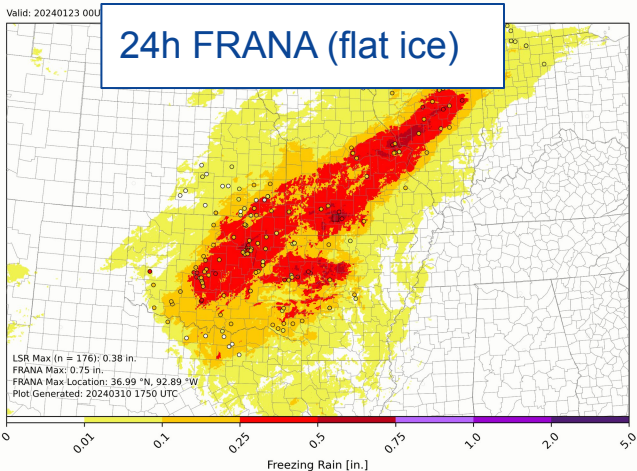
Despite biases which are being addressed in the current winter season, participants generally found FRANA **useful as an observational dataset.**



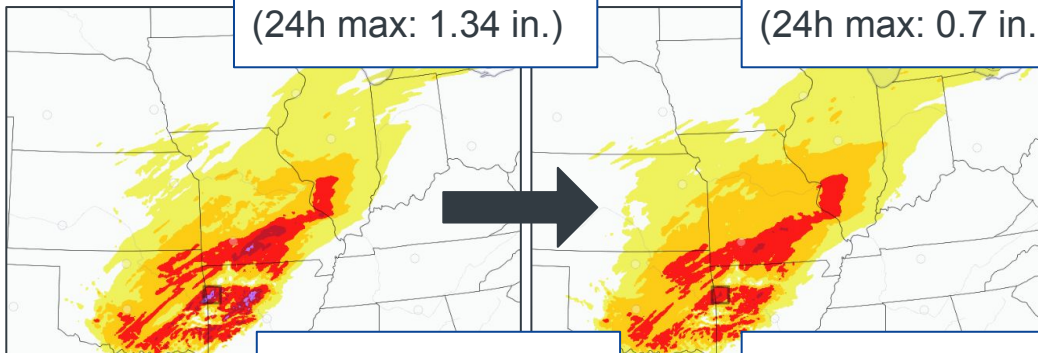
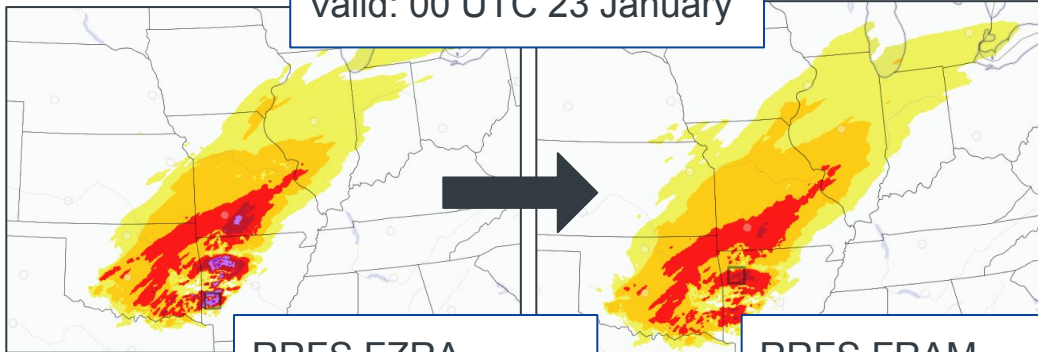
S. Plains / Ozarks Freezing Rain Event: 22-23 Jan 2024

Post-processing using freezing rain accumulation model (FRAM) often **reduces extreme FZRA QPF maxima**, makes model guidance more representative of obs

Forecast init: 00z 22 Jan 2024 (f24)



Valid: 00 UTC 23 January





New REFS Capability: Freezing Rain QPF Probabilities



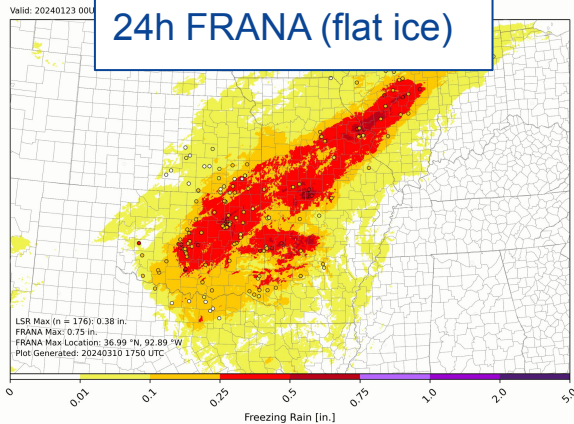
During WWE, we investigated REFS FZRA QPF probs, found them useful esp. for footprint forecast activity



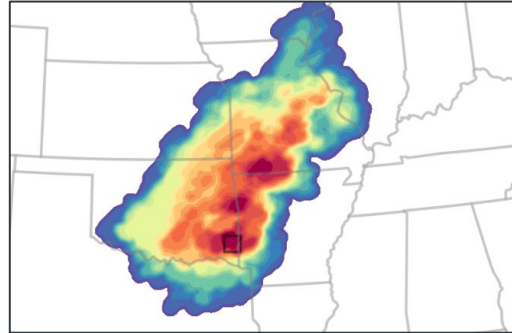
Would be better to have FRAM probs to align with NWS forecast products (flat ice)



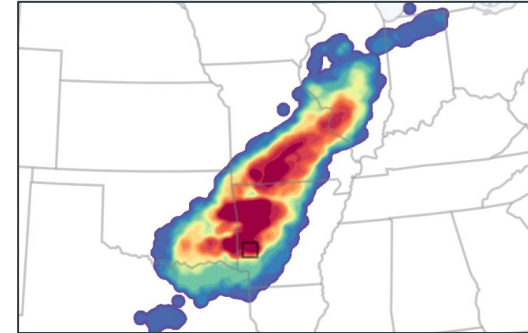
24h FRANA (flat ice)



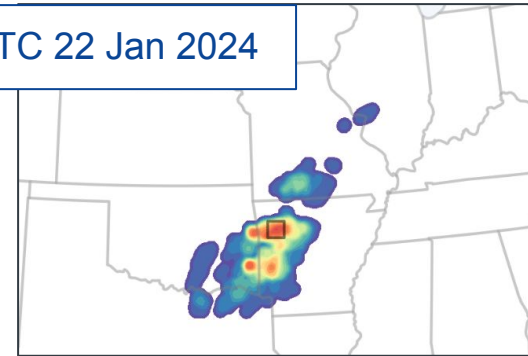
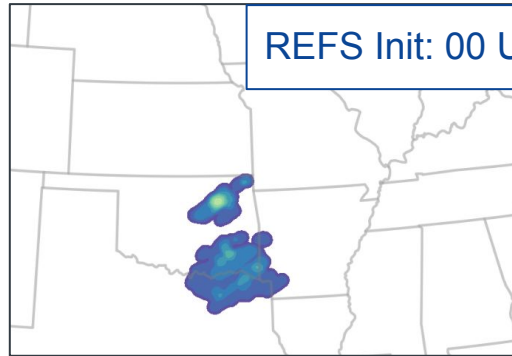
Valid: 12 UTC 22 Jan 2024



Valid: 00 UTC 23 Jan 2024



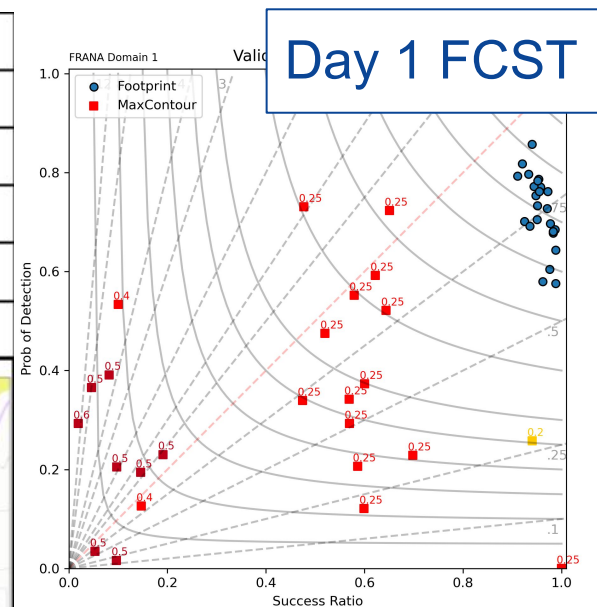
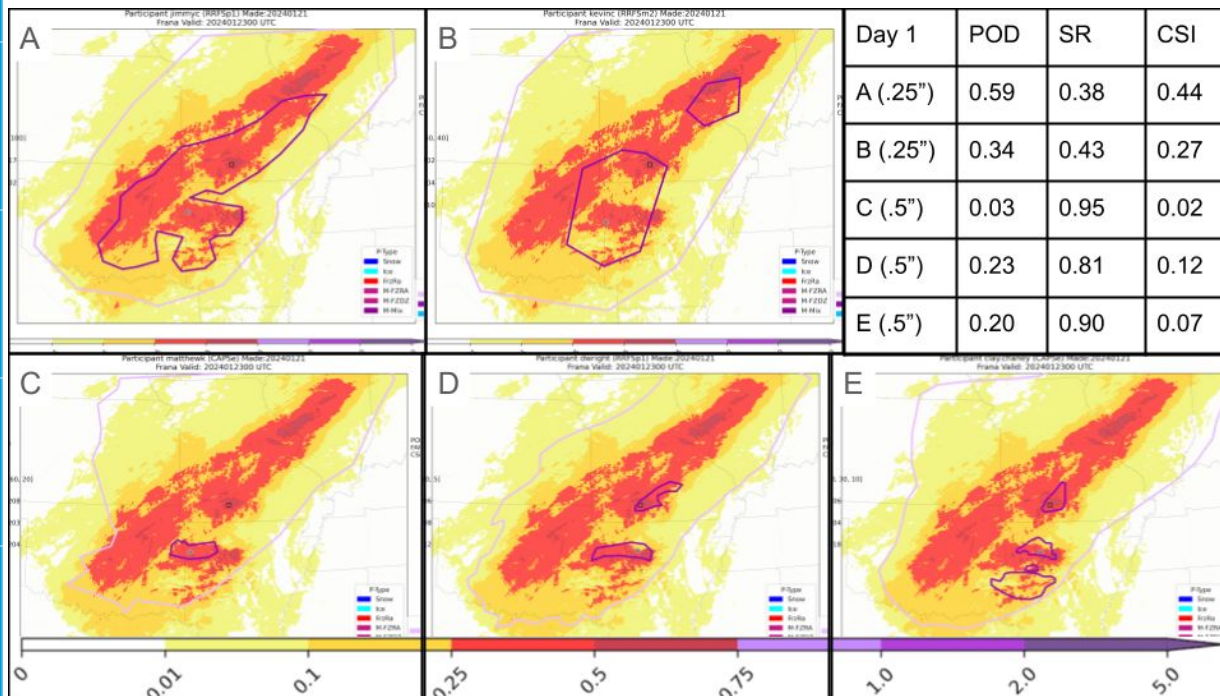
REFS Init: 00 UTC 22 Jan 2024





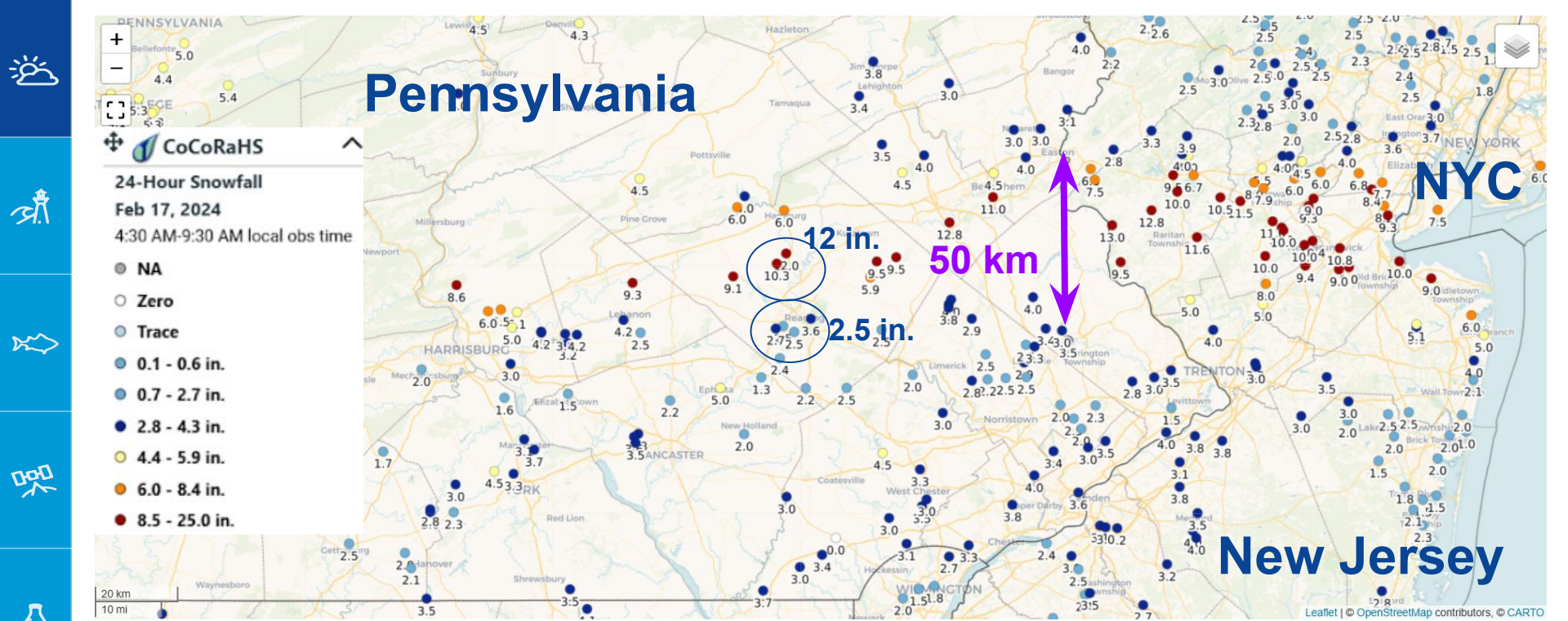
Participant MSTP Forecasting and Verification

Last year, we forecasted both the FZRA footprint (0.01" flat ice) and maximum amount (selected by individual forecaster) for freezing rain cases:



Verification against 24h FRANA





16-17 February 2024

Mesoscale Snowband Case Study

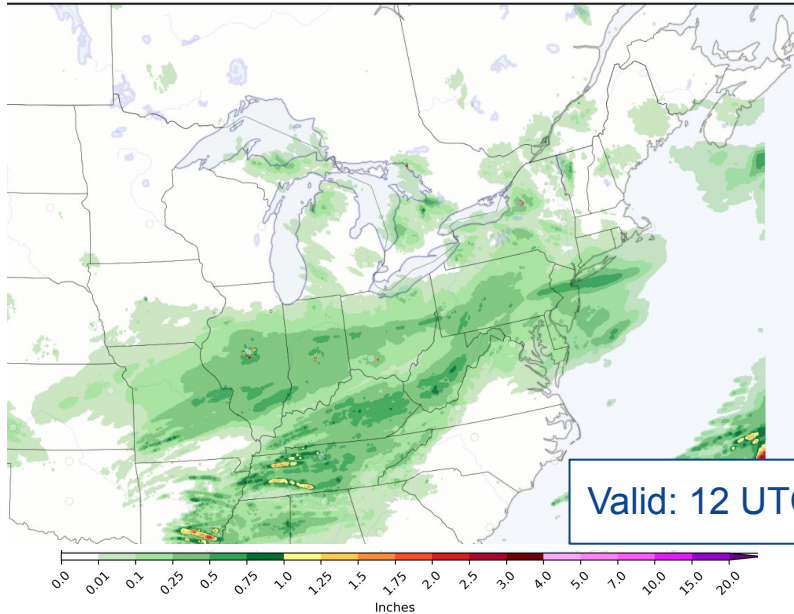


Northeast Mesoscale Snowband Event - 17 Feb 2024

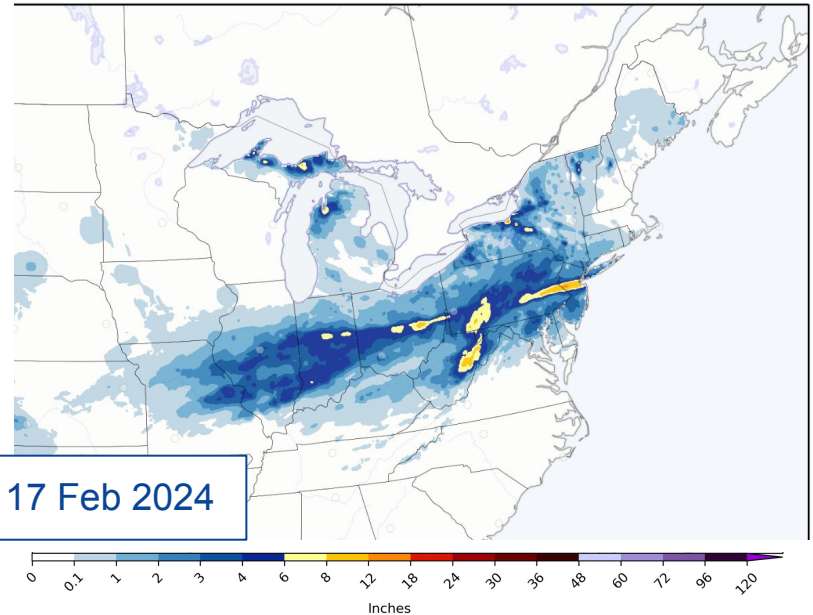
Low-predictability, narrow mesoscale snowbands with very high SLR (20-25:1 observed)



MRMS 24h QPE



NOHRSC 24h Snowfall



Valid: 12 UTC 17 Feb 2024





CAPS Ensemble Mean Products: Day 3 Lead Time

In this case:

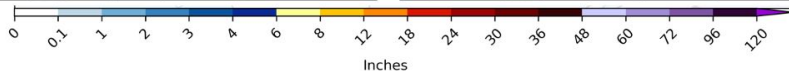
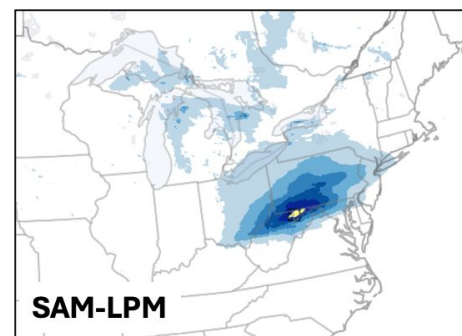
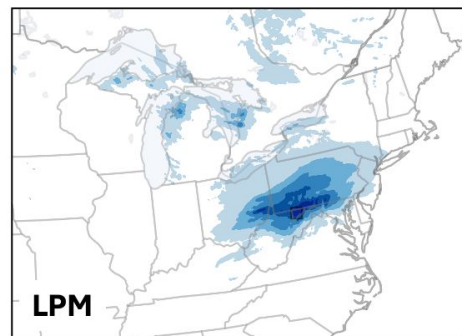
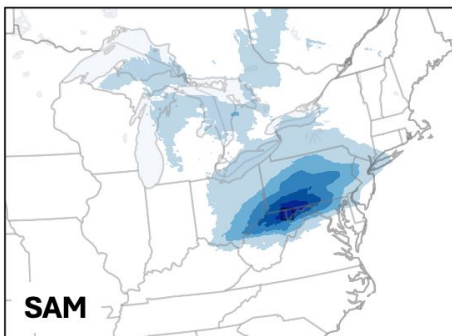
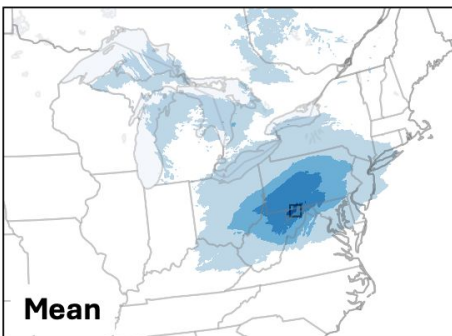
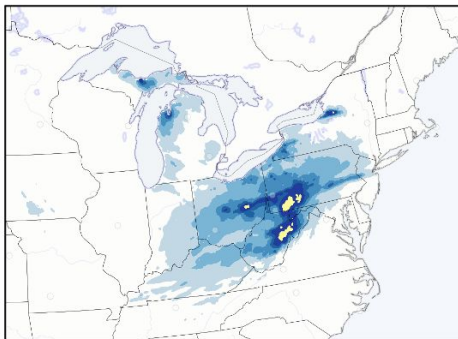
We found local prob. matched mean (LPM) products to be most useful for 6h snow time windows

Alone, new spatially aligned mean (SAM) product did not provide as much value to forecasters

CAPS Ens., Init: 00 UTC 14 Feb 2024

Valid: 06 UTC 17 Feb 2024 (f78)

NOHRSC 6h Snow





New Capability: REFS Prob. Matched Mean (PMM) Snowfall



Forecast init:

12z 15 Feb 2024 (1500 UTC)



MRMS



NOHRSC



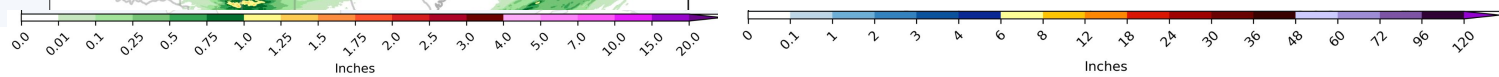
REFS 24h QPF Mean

REFS 24h Snow Mean

No ens. guidance captured the mesoscale extremes of this event even at nowcast lead times, but **probability matching fields helped retain some of the mesoscale structure and banding esp. in earlier forecasts with large spread**

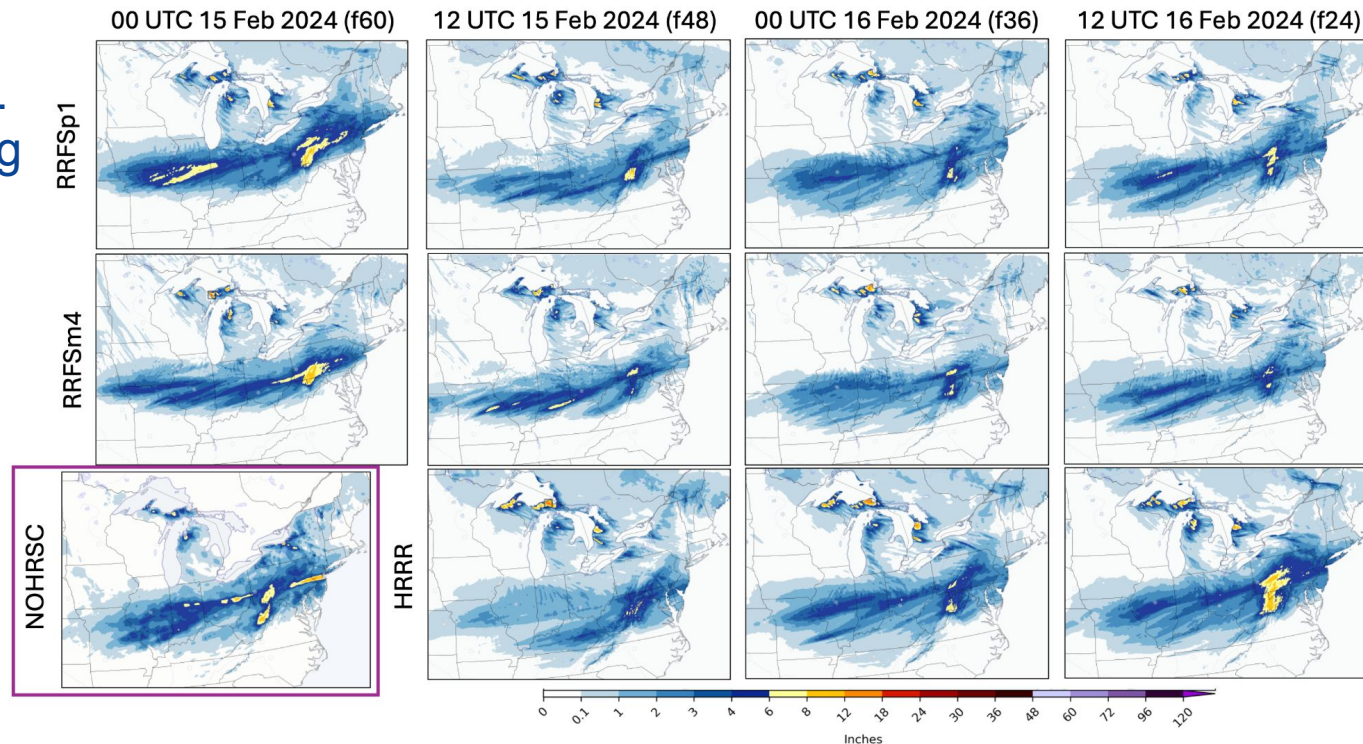
REFS 24h Snow PMM

Valid: 12 UTC 17 Feb 2024



CAM guidance struggled to capture mesoscale snowfall amounts...

- Some hints of enh. mesoscale banding but **errors in magnitude and location**
- At shorter lead times, **HRRR slightly better than RRFS**
- Difficult forecast challenge even at Day 1 lead time



Decreasing lead time →



Univ. of Utah Machine Learning SLR Project



Machine learning SLR based on RRFSp1 model inputs, used to create unique snowfall output



Utah ML SLR has slightly higher values than raw RRFSp1 output, but still struggled to capture outlier event (20:1 SLRs observed)



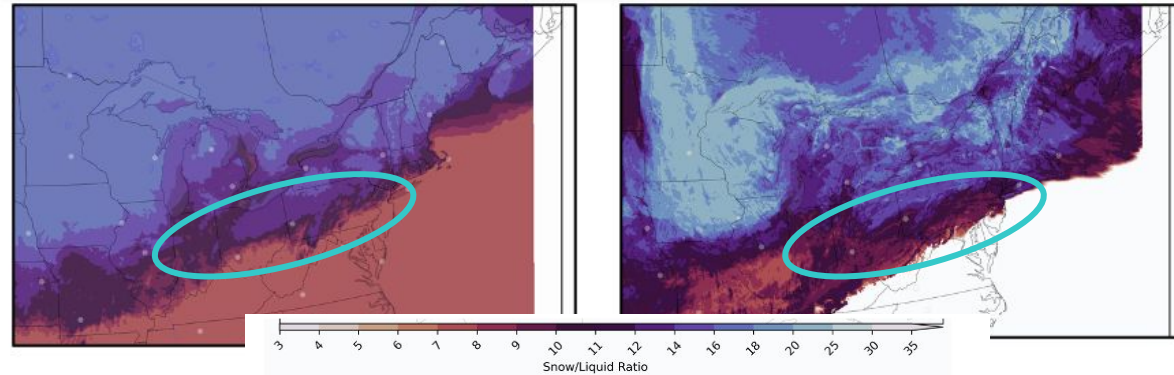
Opportunity for future research and development



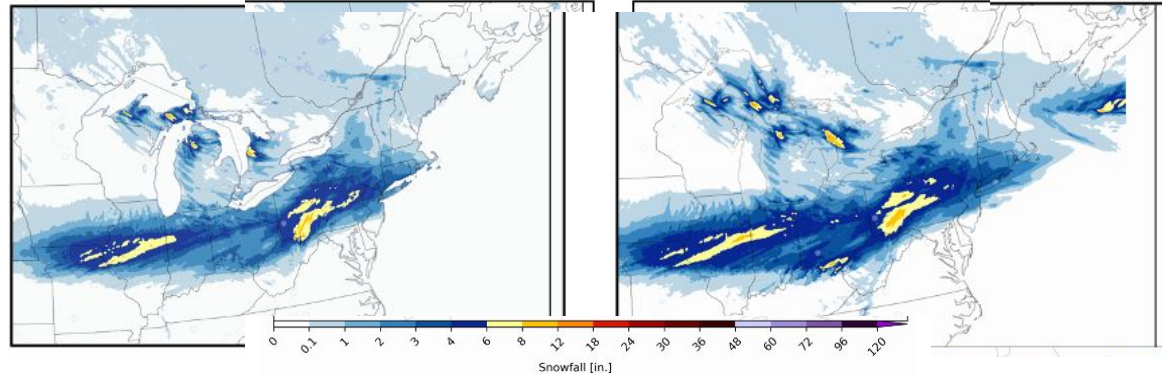
RRFSp1

Utah ML

1h SLR



24h ASNOW

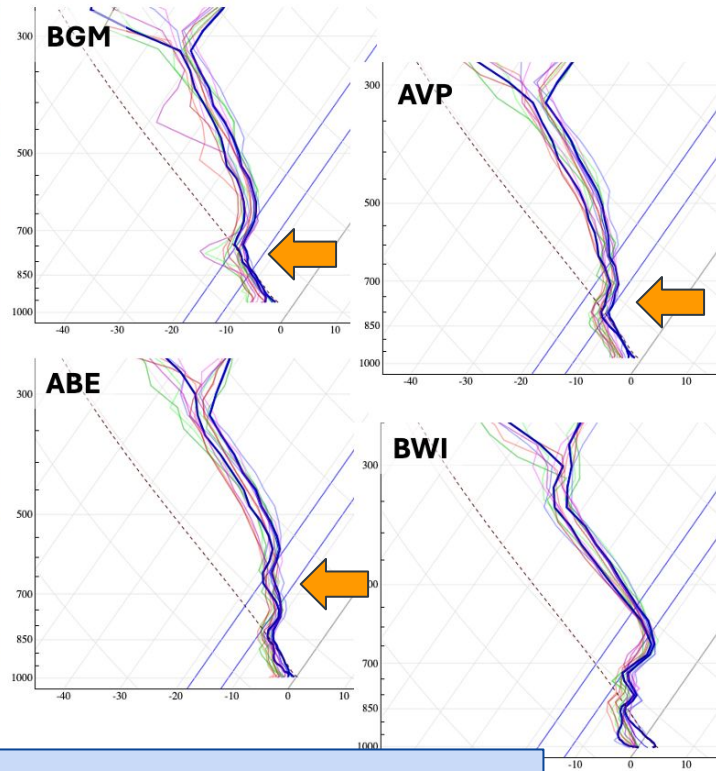
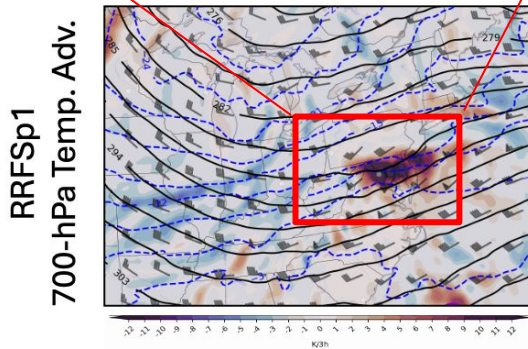
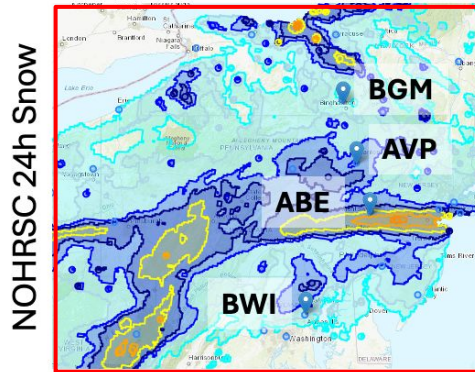




Yet, mesoscale ingredients for heavy snowfall were still present in CAMs (in hindsight)

Despite modest snowfall forecasts, CAM forecasts had **strong signal for mesoscale lift in the general area** (fronto., warm air adv. at 850-700 hPa)

Forecast soundings had **deep near-isothermal, saturated layer** between -12 and -18 °C (dendritic growth zone)

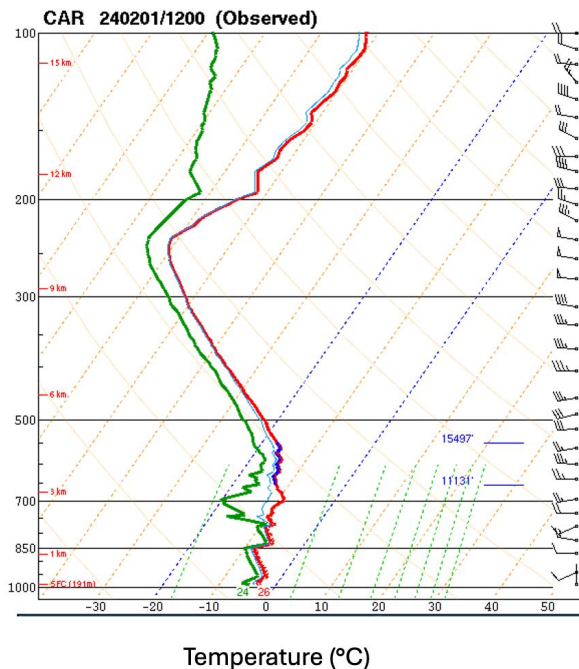


How can heavy snow ingredients be better utilized?

Using HMT sounding viewer tools, we noted a consistent cold bias in some REFS members...

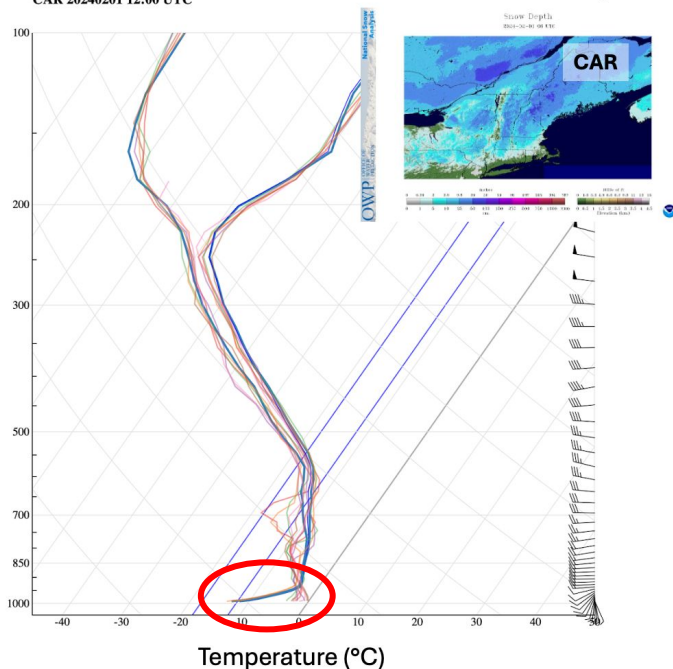
- Noted in REFS m2, m5 (GFS PBL/SL scheme)
- Only in cases over new or existing snowpack
- Found several examples across different regions of the U.S. during the winter

Observed (Caribou, ME)



Forecast

CAR 20240201 12:00 UTC



NOHRSC Snow Depth







15th Winter Weather Experiment: HMT @ WPC

Retrospective events are being selected (Nov - Feb)

Immersive forecast experiment will be conducted over 3 weeks, simulating days 3,2,1 progression for both snow and freezing rain events.

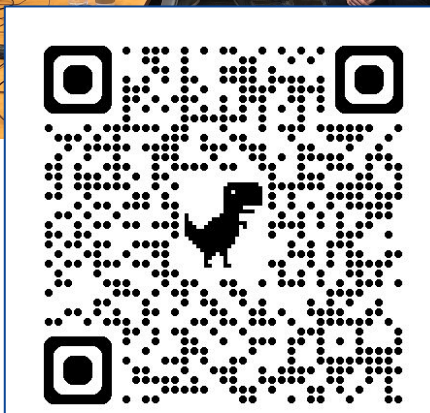


Goals: Generate insight on...

- **Experimental models**
REFS @EMC | FV3 and ML @CAPS-OU | MPAS @GSL, NSSL
- **Funded projects**
SLR @U-Utah | FRANA @CIWRO/NSSL | lake-effect snow @GLERL | ensemble soundings (WPC-HMT collab. w/ SPC)
- **Winter phenomena**
mesoscale snow bands | lake-effect | freezing rain | SLR | snow squalls | terrain challenges



Process: engaging researchers, forecasters, developers in a pseudo-operational environment through forecast exercises, model evaluation & verification, with a seminar series and focus groups (funded projects)



Hybrid and virtual options: registration is still open!



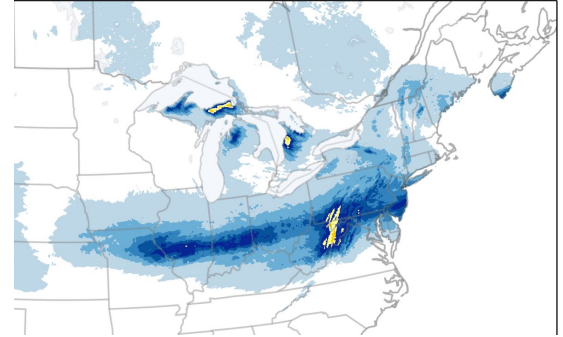


WWE 2024-2025 Plans - Activities and Tools



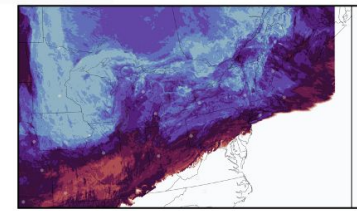
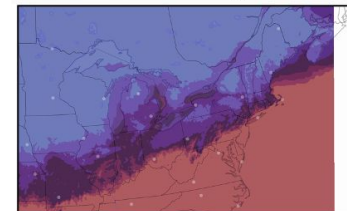
Evaluation/Verification Activities

- **RRFS, CAPS (FV3); CAPS, GSL, NSSL (MPAS)**
 - Help provide feedback to developers by verifying and evaluating FV3 and MPAS forecasts against current operational models
 - Get forecasting experience with the RRFS, which is planned to become the new CAM ensemble for the NWS, replacing the HREF
- **Machine Learning Products**
 - Can ML methods improve ensemble products and probabilities for snowfall and SLR forecasts?



RRFSp1

Utah ML





WWE 2024-2025 Plans - Activities and Tools



Monday	Tuesday	Wednesday	Thursday	Friday
9:30 am - Orientation and Introductions	9:30 am - Verification for Case 1	9:30 am - Fcst. Brief Case 2	9:30 am - Fcst. Brief Case 3	9:30 am - Fcst. Brief Case 3
10:30 am - Fcst. Brief Case 1		10 am - Day 1 MSTP and sounding activity	10 am - Day 3 MSTP and sounding activity	10 am - Day 1 MSTP and sounding activity
11 am - Day 2 MSTP and sounding activity	11:30 am - Case 1 discussion	11:30 am - Verif. for Case 2	11:30 am - Fcst. Brief Case 3	11:30 - Start <u>verif.</u> for Case 3
12 pm - Lunch	12 pm - Lunch	12 pm - Lunch	12 pm - Lunch	12 pm - Lunch
1 pm - Continue Day 2 activity	1 pm - WWE Seminar	1 pm - Verif. for Case 2	1 pm - WWE Seminar	1 pm - Verif. for Case 3
2 pm - Science discussion activity	2 pm - Fcst. Brief Case 2		2 pm - Day 2 MSTP and sounding activity	
3 pm - Fcst. Brief Case 1	2:30 pm - Day 2 MSTP and sounding activity	3:30 pm - Case 2 discussion		3 pm - Case 3 discussion
3:30 pm - Evaluate Day 1 models	4 pm - Science discussion activity		4 pm - Science discussion activity	3:30 pm - End-of-week discussion
5 pm - End	5 pm - End	5 pm - End	5 pm - End	5 pm - End

Intensive week schedule (draft):

- Planning to forecast and evaluate 3 cases per intensive week





Key Datasets



CAPS: 10-member FV3 and MPAS mixed physics ensemble



REFS: 14-member FV3 mixed physics ensemble with time lagging, including the HRRR



GSL: deterministic MPAS forecast

NSSL: deterministic MPAS forecast



CAPS CAM Ensemble 2024-25 Winter Members

Experiment	Microphysics	PBL	Surface	LSM	Cu Parameter	IC/LBC (like system)	Notes
FV3-LAM Members							
M0B0L0	Thompson	MYNN	MYNN	NOAH	None	GFS /GFS	AI-1
M1B0L0	NSSL	MYNN	MYNN	NOAH	None	GFS/GFS (WoF)	AI-2
M1B0L2	NSSL	MYNN	MYNN	RUC	None	GFS/GFS (RRFSm1)	
M0B2L1	Thompson	TKE-EDMF	GFS	NOAHMP	None	GFS/GFS (GFSv16)	AI-3
M0B2L2	Thompson	TKE-EDMF	GFS	RUC		GFS/GFS	AI-4
MPAS Members							
M0B0L2_MP	Thompson	MYNN	MYNN	RUC	None	GEFS_m1	GSL-01
M1B0L2_MP	NSSL	MYNN	MYNN	RUC	None	GEFS_m2	NSSL-01
M0B0L0_MP	Thompson	MYNN	MYNN	NOAH	None	GEFS_m3	NCAR-01
M1B0L0_MP	NSSL	MYNN	MYNN	NOAH	None	GEFS_m4	
M1B0L2Cx_MP	Thompson	MYNN	MYNN	NOAH	SA-New-Tiedtke	GEFS_m5	

Naming

M: Microphysics

B: Boundary Layer

L: Land Sfc Model

P: GFS Initial/Bndy Cdx

C: Cu Parameterization

PI: Initial perturbations



Rapid Refresh Forecast System Ens. (REFS) [as of Nov 2024]

- Ensemble forecasts at 00/06/12/18 UTC

	MP	PBL	sfc	lsm	Cu	IC/LBC
m0 (ctrl)	Thompson	MYNN	MYNN	RUC	saSAS deep	RRFS hybrid/GFS
m1	Thompson*	TKE-EDMF	GFS	RUC*	G-F dp*+sh	RRFS enkf1/GEFSm1
m2	Thompson*	MYNN*	MYNN*	RUC*	saSAS deep	RRFS enkf2/GEFSm2
m3	NSSL#	MYNN*	MYNN*	RUC*	G-F deep*	RRFS enkf3/GEFSm3
m4	NSSL#	TKE-EDMF	GFS	RUC*	G-F dp*+sh	RRFS enkf4/GEFSm4
m5	NSSL#	MYNN*	MYNN*	RUC*	saSAS deep	RRFS enkf5/GEFSm5
m6 (m0-6h)						
m7 (m1-6h)						
m8 (m2-6h)						
m9 (m3-6h)						
m10 (m4-6h)						
m11 (m5-6h)						
m12 (HRRR)	Thompson	MYNN	MYNN	RUC	None	HRRRDAS / RAP
m13 (m12-6h)						

Sources of spread:
 EnKF ICs, GEFS
 LBCs, time-lagging,
 multi-physics,
 stochastic
 parameter
 perturbations(*),
 and fixed parameter
 perturbations (#)

*Thanks to Jili Dong for this work



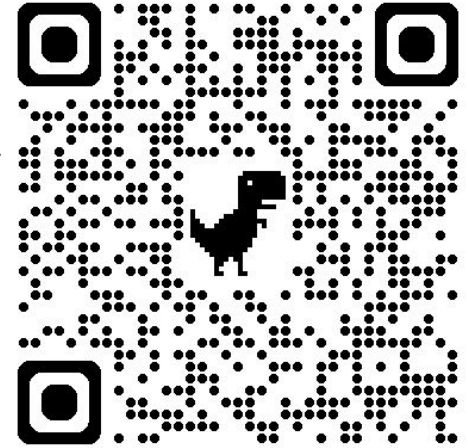


WWE Participation

Contact: massey.bartolini@noaa.gov

Here's how to join us:

- WWE/PEAR seminar series (Nov-March): open to all, Google Meet
 - **Tuesdays/Thursdays, 1 pm Eastern**
- Intensive weeks: open to all, virtual (Google Meet), possible in-person (WPC)
 - **Dates: Feb 10-14, Feb 24-28, Mar 10-14**
- Focus groups (FRANA, road hazards): [NWS forecasters only](#)
 - **January-March, virtual (Google Meet)**
- Longer term:
 - Always open to suggestions for testing of new R2O ideas, or challenging/low-predictability winter weather cases



WWE intensive week registration

Seminars start (Nov)

This seminar

Intensives, Focus groups (Feb/Mar)

Seminars end (March)

