



FRANA

Freezing Rain Accumulation National Analysis

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How do we know how much ice fell for an event?

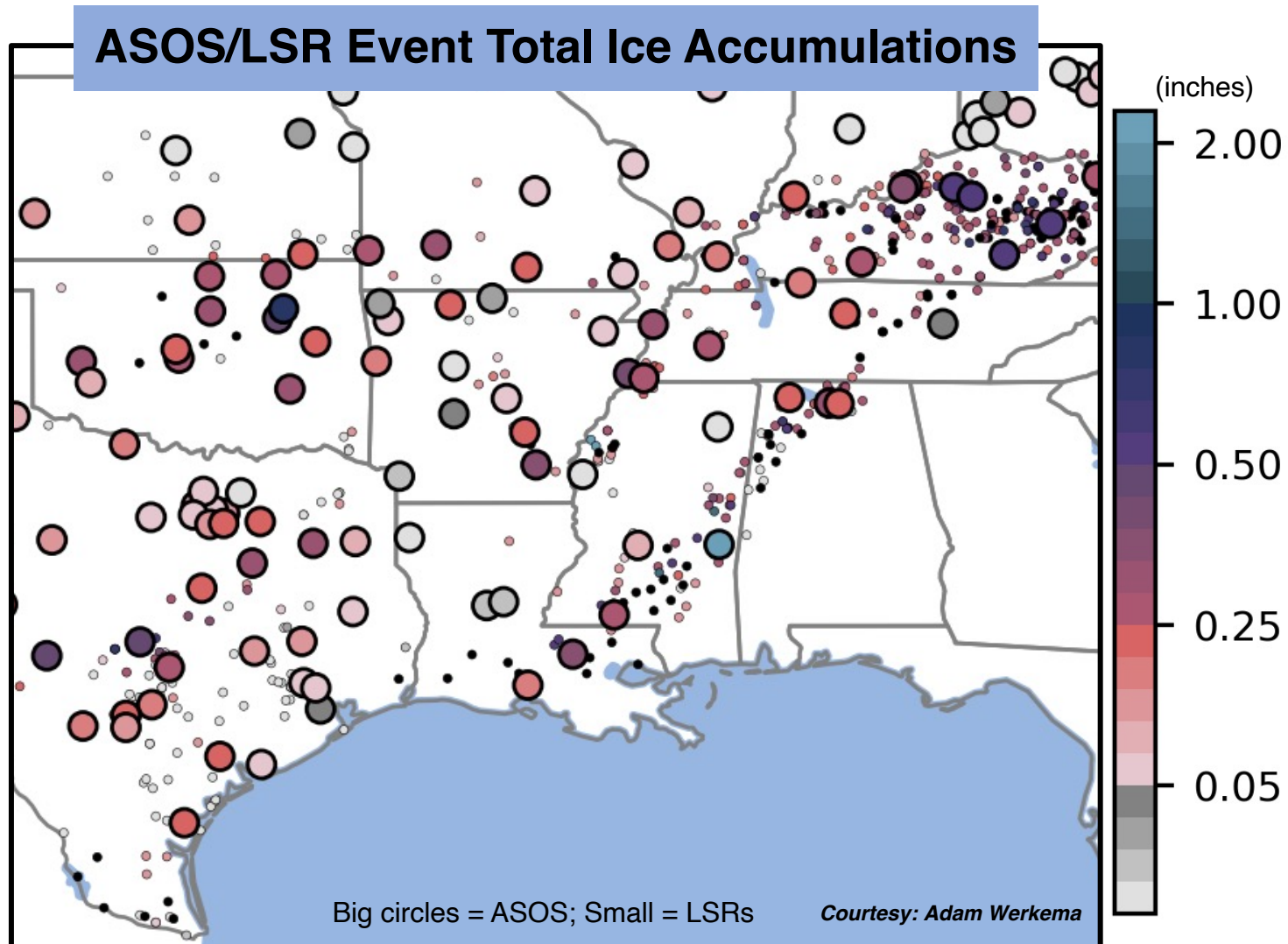


Verification Data

Current Products

- ASOS Goodrich icing sensor

How do we know how much ice fell for an event?



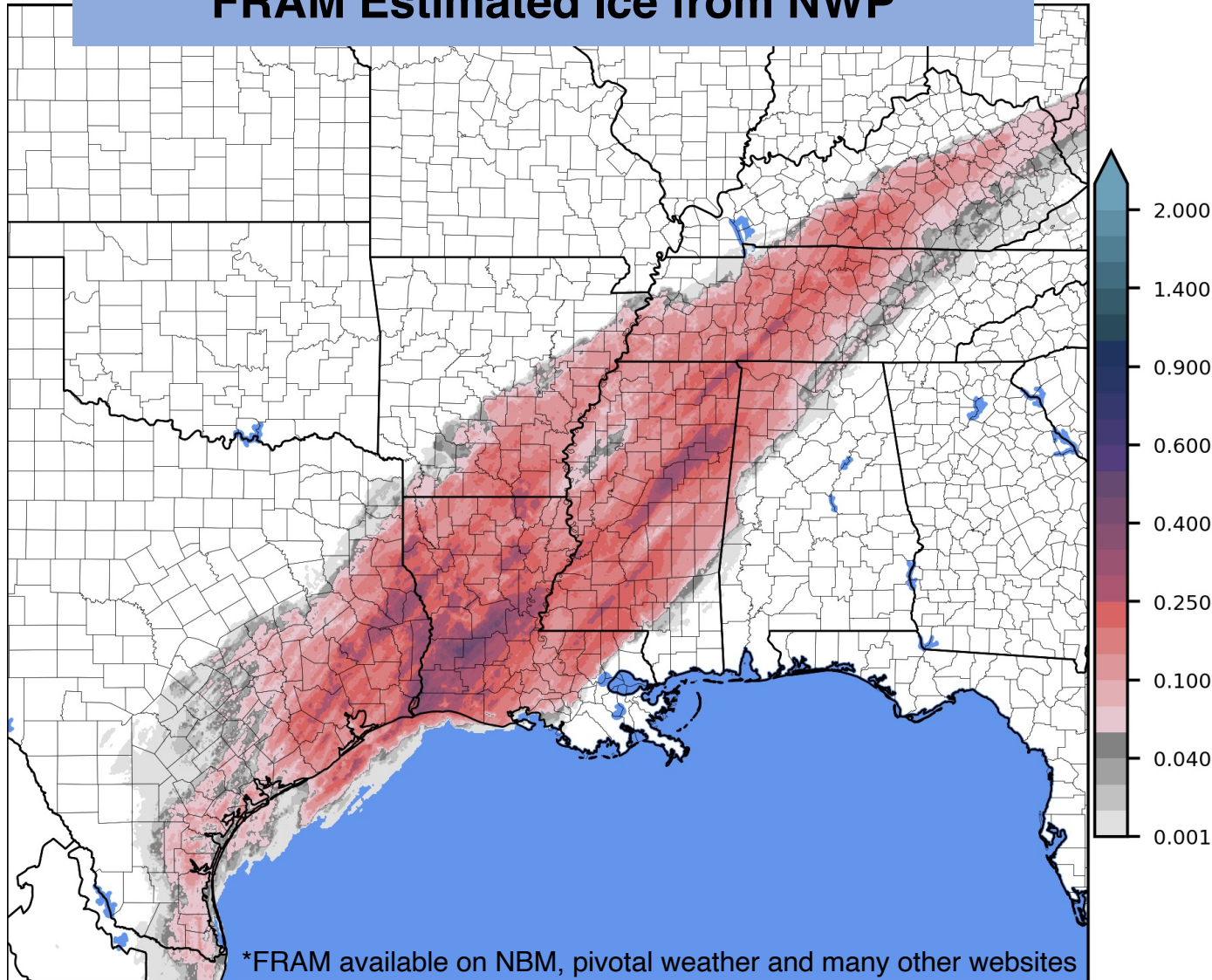
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- ASOS Goodrich icing sensor
- Local Storm Reports (LSRs)/mPing

How do we know how much ice fell for an event?

FRAM Estimated Ice from NWP



Verification Data

Current Products

- ASOS Goodrich icing sensor
- Local Storm Reports (LSRs)/mPing
- Freezing Rain Accumulation Model (FRAM) on NWP

Freezing Rain Accumulation National Analysis

FRAM Estimated Ice from NWP

Multi-Radar Multi-Sensor Suite

FRAM

MRMS

**MRMS Gridded Ice
Analysis (FRANA)**

Verification Data

Current Products

- ASOS Goodrich icing sensor
- Local Storm Reports (LSRs)/mPing
- Freezing Rain Accumulation Model (FRAM) on NWP

Freezing Rain Accumulation National Analysis

HRRR 0-hr Forecast (Temp & Wind Speed)

SBC Precipitation Type

FRANA

Reflectivity

MRMS Multi-

Verification Data

Current Products

- ASOS Goodrich icing sensor
- Local Storm Reports (LSRs)/mPing
- Freezing Rain Accumulation Model (FRAM) on NWP

New Product

- FRANA
 - HRRR Model Analyses (0hr Fcast)
 - MRMS Precipitation (Multi-Sensor QPE)
 - Spectral-Bin Classifier (SBC) Precipitation Type
 - MRMS Base Reflectivity 1-hr Max

MRMS

Technical Specifications

Temporal Resolution

- Some radar products update every 2 minutes
- Other products update hourly

Domain: CONUS

Horizontal Grid Resolution: 1 km

Input Data Fields

Multi-Sensor QPE (MSQPE)

- Hourly Product
- Radar
- Prism Climatology
- HRRR/RAP 1hr fcast Blend
- Evaporation Correction
- Rain Gauge Correction

Base Reflectivity 1-hr Max

- Hourly product
- Max reflectivity in the base scans from the previous hour

Spectral Bin Classifier (SBC)

- Hourly product
- Bin-microphysics model that diagnoses precipitation type at the surface

MRMS – NWP

- HRRR/RAP Analyses
- 10-meter wind speed
- 2-meter wetbulb temperature
- As new NWP becomes operational, MRMS fields will update to the new data streams

FRANA

Temporal Resolution: Hourly

Grid Resolution: 1 km MRMS grid

Output fields

- FRAM Flat Ice Accumulations
- FRAM Radial Ice Accumulations
- Trace ice is declared numerically as (0.001 inches)

Ice Accumulation Math

Freezing Rain Accumulation Model (FRAM)

A linear regression model that ingest precipitation rate, wetbulb temperature, and wind speed. See [Sanders and Barjenbruch 2016](#) for the full equations.

1. Solve for an Ice-liquid ratio (ILR) for each variable

MRMS MSQPE



ILR Precip
Equation

HRRR Wetbulb (T_w)



ILR Wetbulb
Equation

HRRR Wind (WS)



ILR Wind
Equation

2. Calculate final ILR by weighting each variable according to the weather.

Near Freezing Conditions ($T_w > -0.35^\circ\text{C}$)

$$ILR = .7xILRPrecip + .29xILRWetbulb + .01ILRwind$$

Cold ($T_w \leq -0.35^\circ\text{C}$) & Higher Wind ($WS > 12\text{kts}$)

$$ILR = .73xILRPrecip + .01xILRWetbulb + .26ILRwind$$

Cold ($T_w \leq -0.35^\circ\text{C}$) & Lower Wind ($WS \leq 12\text{kts}$)

$$ILR = .79xILRPrecip + .20xILRWetbulb + .01ILRwind$$

3. Final Ice Accumulation

$$\text{Flat Ice} = ILR \times MSQPE$$

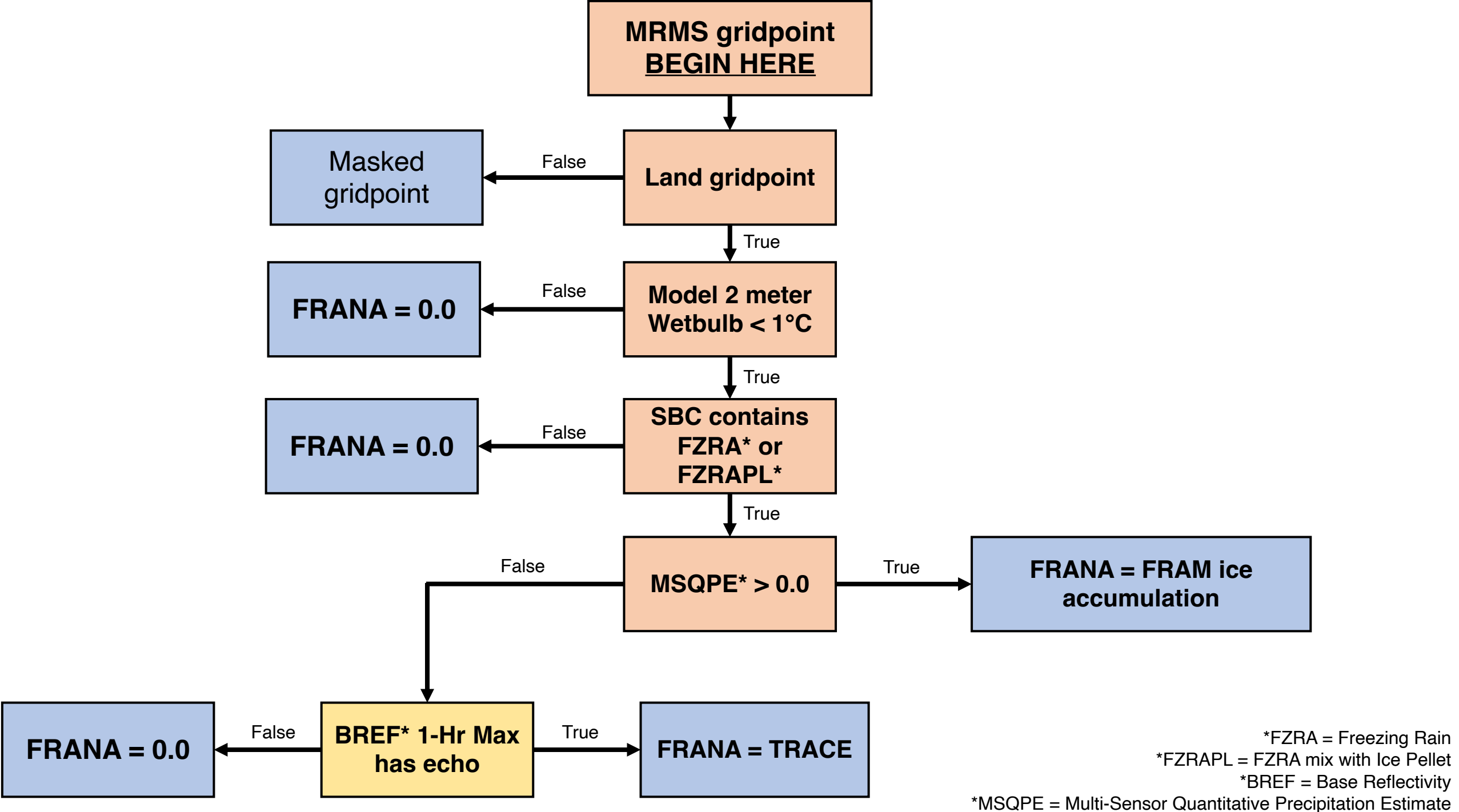
$$\text{Radial Ice} = \text{Flat Ice} \times 0.394$$

Trace Ice

Trace ice is only declared when all of these conditions are true:

1. The model 2-m wetbulb is less than 1°C
2. The SBC precipitation type suggest freezing rain or a mix (e.g. refreezing)
3. MSQPE = 0.0
4. MRMS base reflectivity has had echo within the past hour.

Trace ice is numerically represented as 0.001 inches of ice in the grids for accumulation purposes.

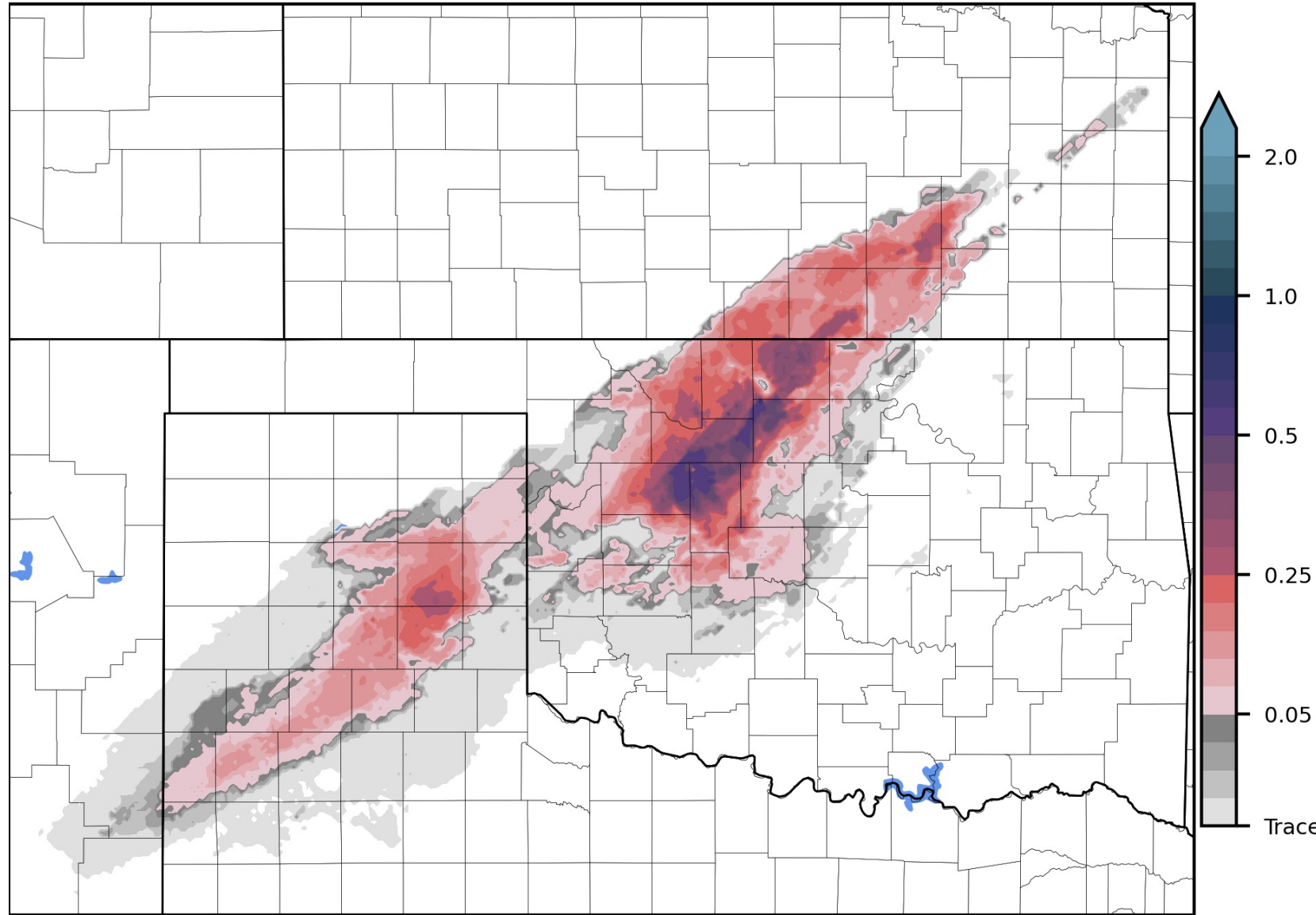


Case Study -- November 25th/26th 2023

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC

Thanks to NWS WFO's for reaching out to us! Your feedback on this event helped us identify problems and make changes to FRANA.

NWS Feedback: Footprint looks reasonable but the magnitude of the ice accumulations looks high.

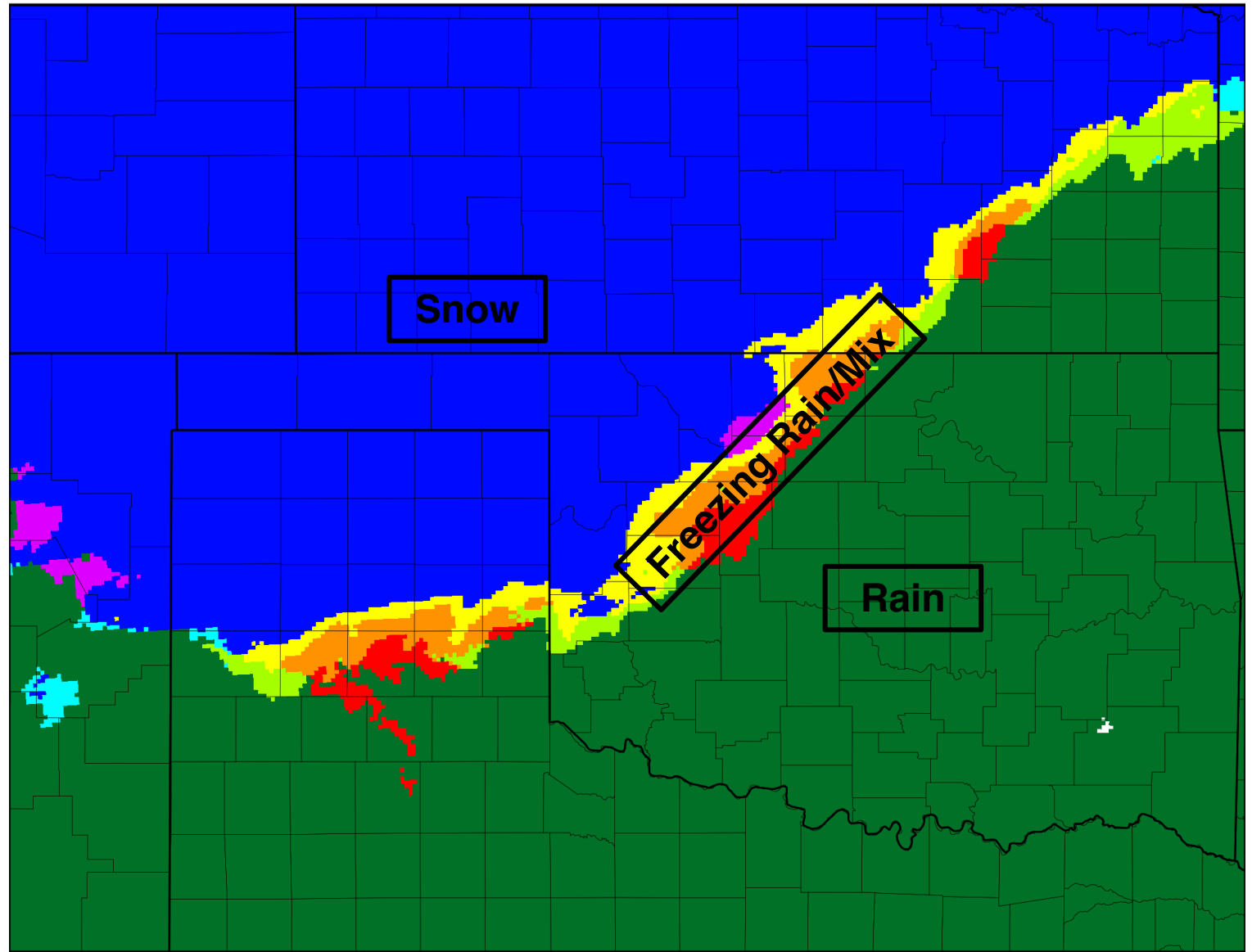


Case Study -- November 25th/26th 2023

SBC Valid: (Sat) Nov 25, 2023 23 UTC

Event Details

- This event had a transition zone from rain to snow in the SBC
- Gauges were freezing up and unable to correct the QPE

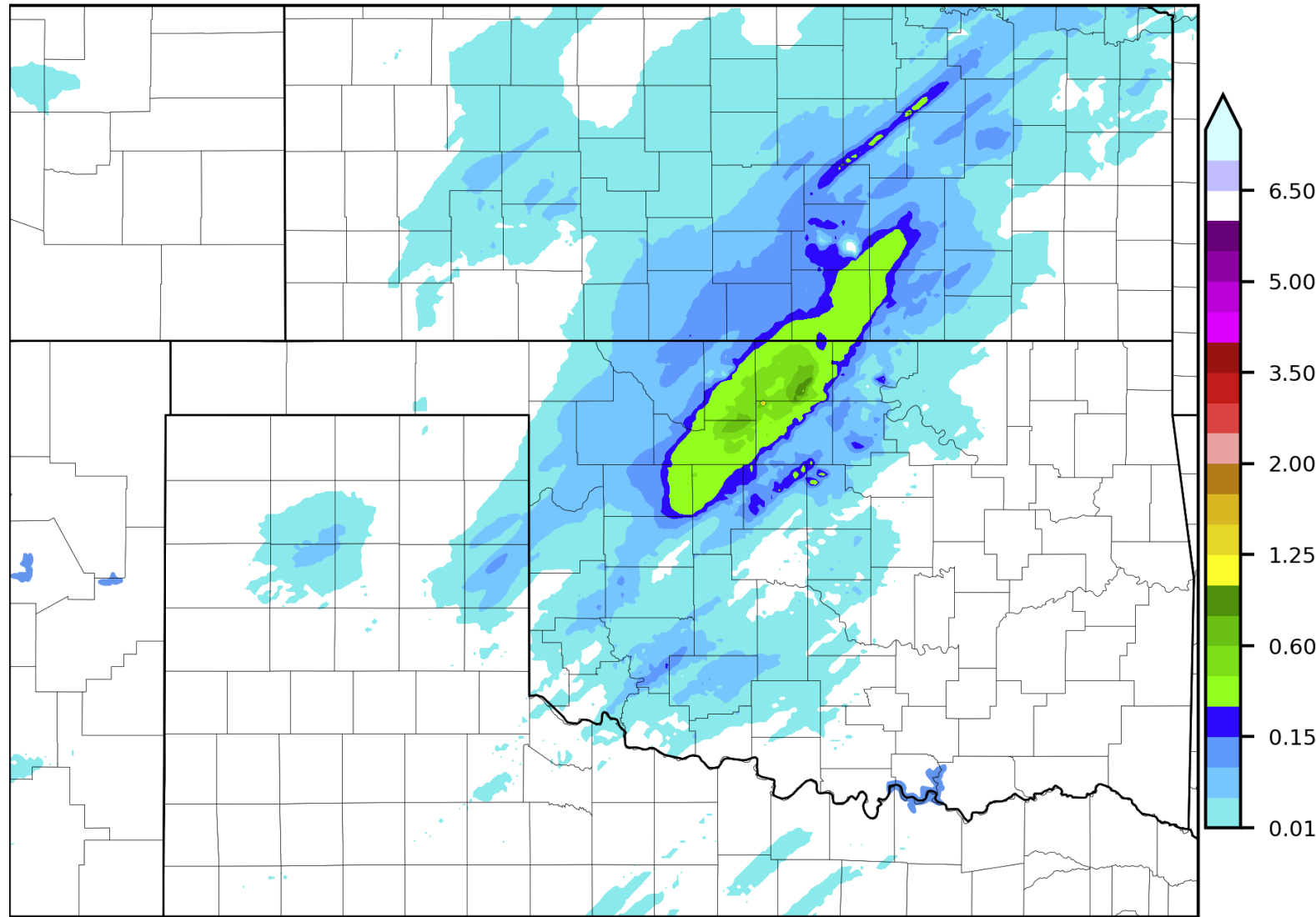


Case Study -- November 25th/26th 2023

Pass 1 Valid: (Sat) Nov 25, 2023 23 UTC

Event Details

- This event had a transition zone from rain to snow in the SBC
- Gauges were freezing up and unable to correct the QPE
- Radar estimates of liquid were too high (likely due to bright-banding and poor Z-R or Z-S relationships in this area)
- The yellow bullseye (1 in/hr) is due to a new wind farm. The MRMS team has to manually add those locations to the grids (in progress).

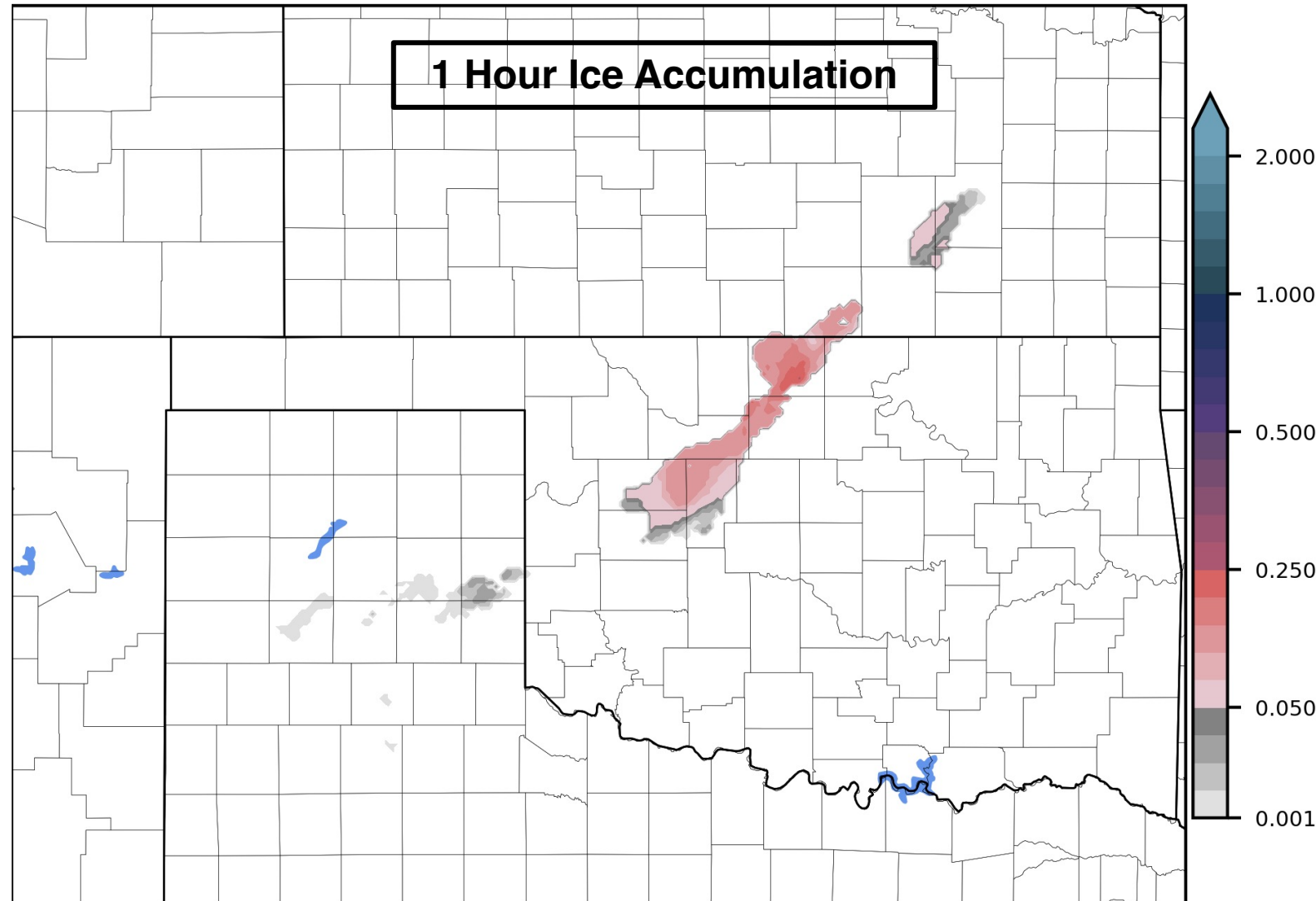


Case Study -- November 25th/26th 2023

FRANA Valid: (Sat) Nov 25, 2023 23 UTC

Event Details

- This event had a transition zone from rain to snow in the SBC
- Gauges were freezing up and unable to correct the QPE
- Radar estimates of liquid were too high (likely due to bright-banding and poor Z-R or Z-S relationships in this area)
- The yellow bullseye (1 in/hr) is due to a new wind farm. The MRMS team has to manually add those locations to the grids (in progress).
- FRAM was producing ILR's of roughly 0.3, but because of the overwhelming QPE, the hourly ice accumulation rates were close to 0.25 inches/hour (e.g. too high)



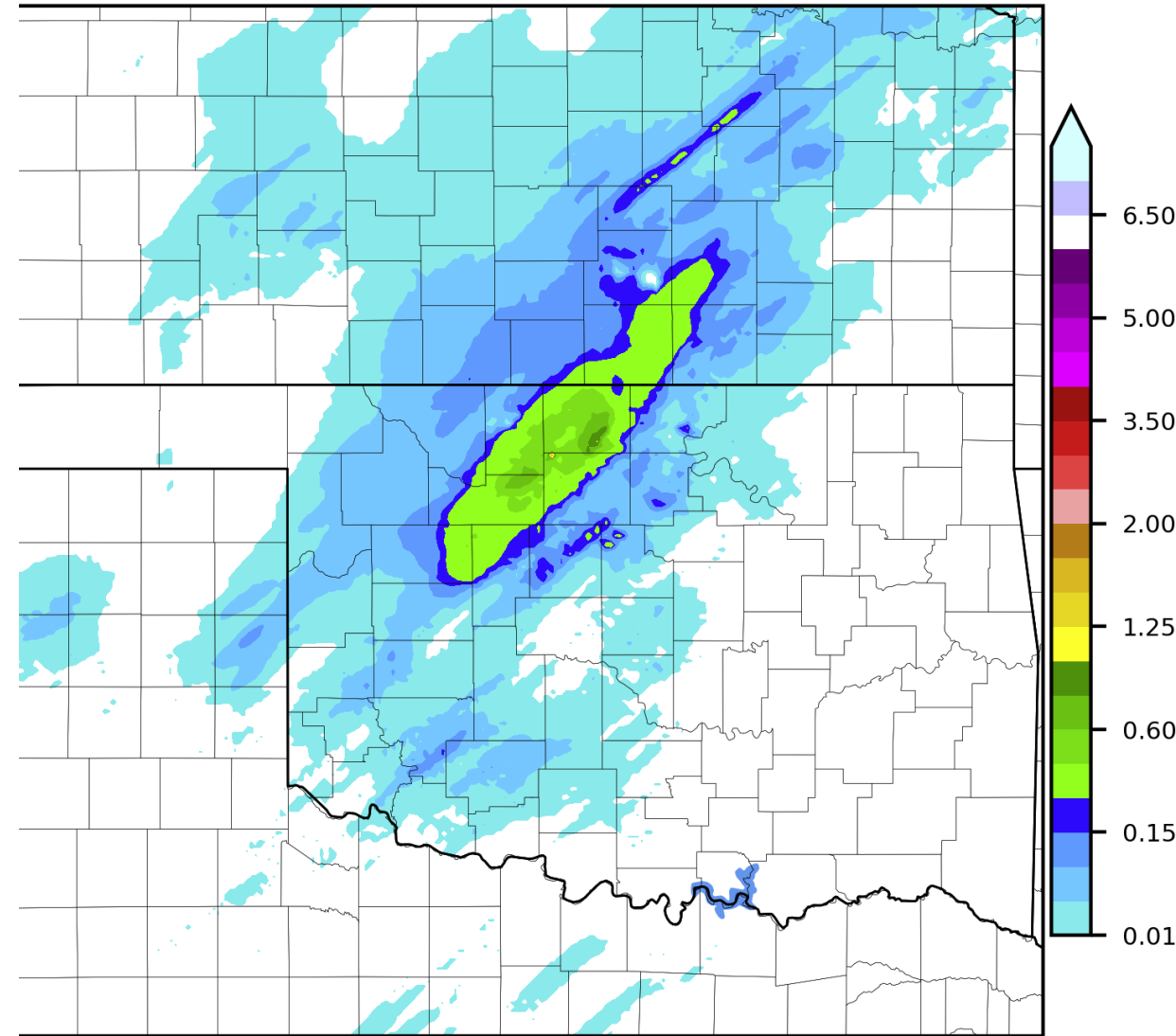
Temporary patch for this winter season

Capping the 1hr precipitation rates

- Liquid precipitation rates will be capped at 0.15 inches/hour. When rates exceed 0.15 in/hr, a fraction is maintained so gradients in the QPE field can still percolate to FRANA.
- The cap of 0.15 in/hr is based off of the 3-year ASOS archive from this study as well as the ASOS archive that Brian Barjenbruch and Kris Sanders used to develop FRAM. This threshold was the 99th percentile for liquid precip rates in the archive.

Before capping	After capping
0.12	0.12
0.15	0.15
0.2	0.18
0.3	0.195
0.35	0.202
0.4	0.21
0.45	0.217
0.5	0.225
0.55	0.232
0.6	0.24
0.65	0.247
0.7	0.255
0.75	0.262
0.8	0.27
0.9	0.285
1.0	0.3

Valid: (Sat) Nov 25, 2023 23 UTC



Temporary patch for this winter season

How will this affect FRANA's performance?

Q: What about convective freezing rain?

A: Convective freezing rain is rare. But if it does happen this winter, FRANA *may* underestimate ice accumulations during convective freezing rain. **NWS Forecasters:** If you see an event this winter that is convective freezing rain, please report it to us so we can look into it.

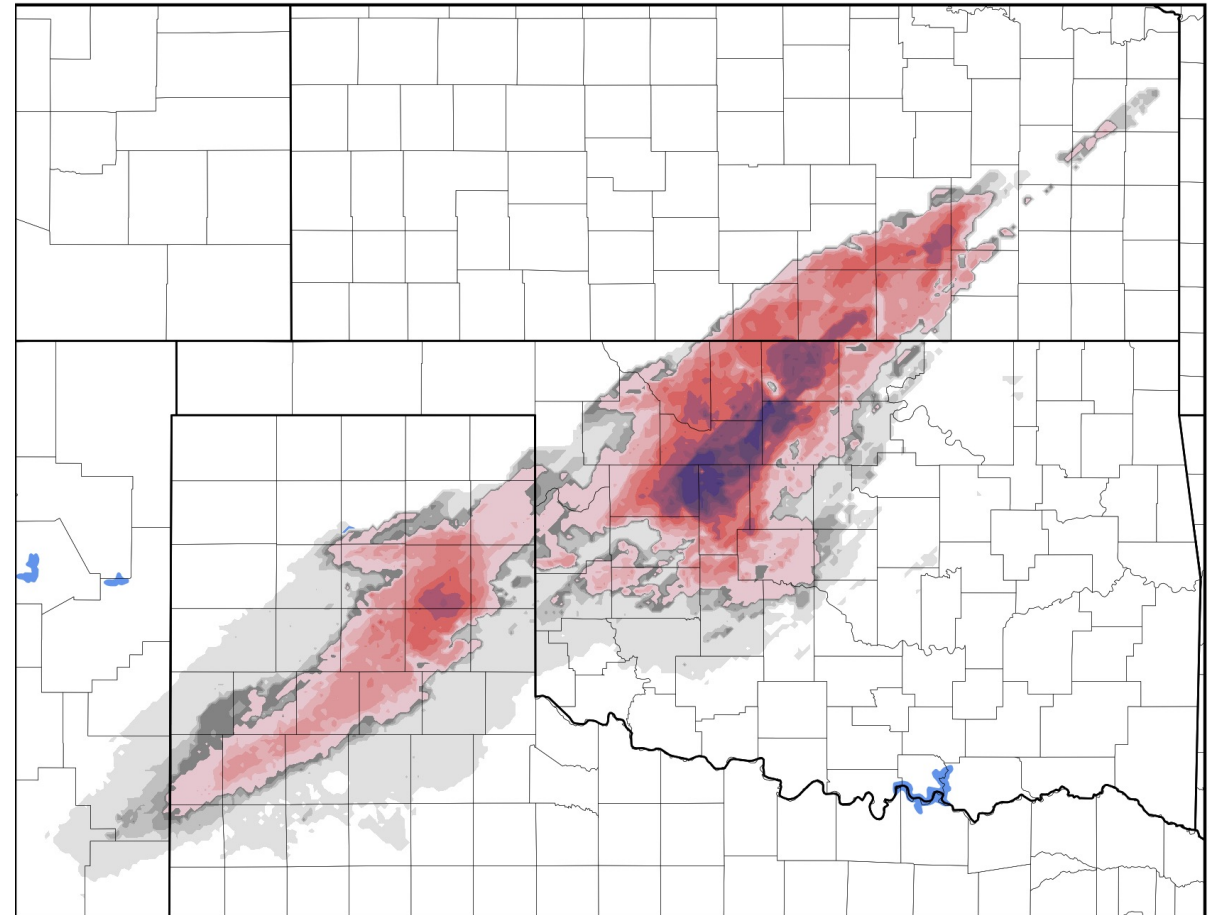
Q: How will this affect FRANA during regular/light freezing rain events?

A: The median liquid precip rate for freezing rain is 0.05 inches/hour. As long as liquid rates stay below 0.15 in/hr, there will be no cap imposed on these events. **NWS Forecasters:** If you see evidence of bright-banding in an event, please report it to us so we can look into it.

Q: How will this affect FRANA's footprint?

A: No changes will occur to the footprint. The cap will just reduce the magnitude of the ice accumulations when the QPE runs hot.

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC

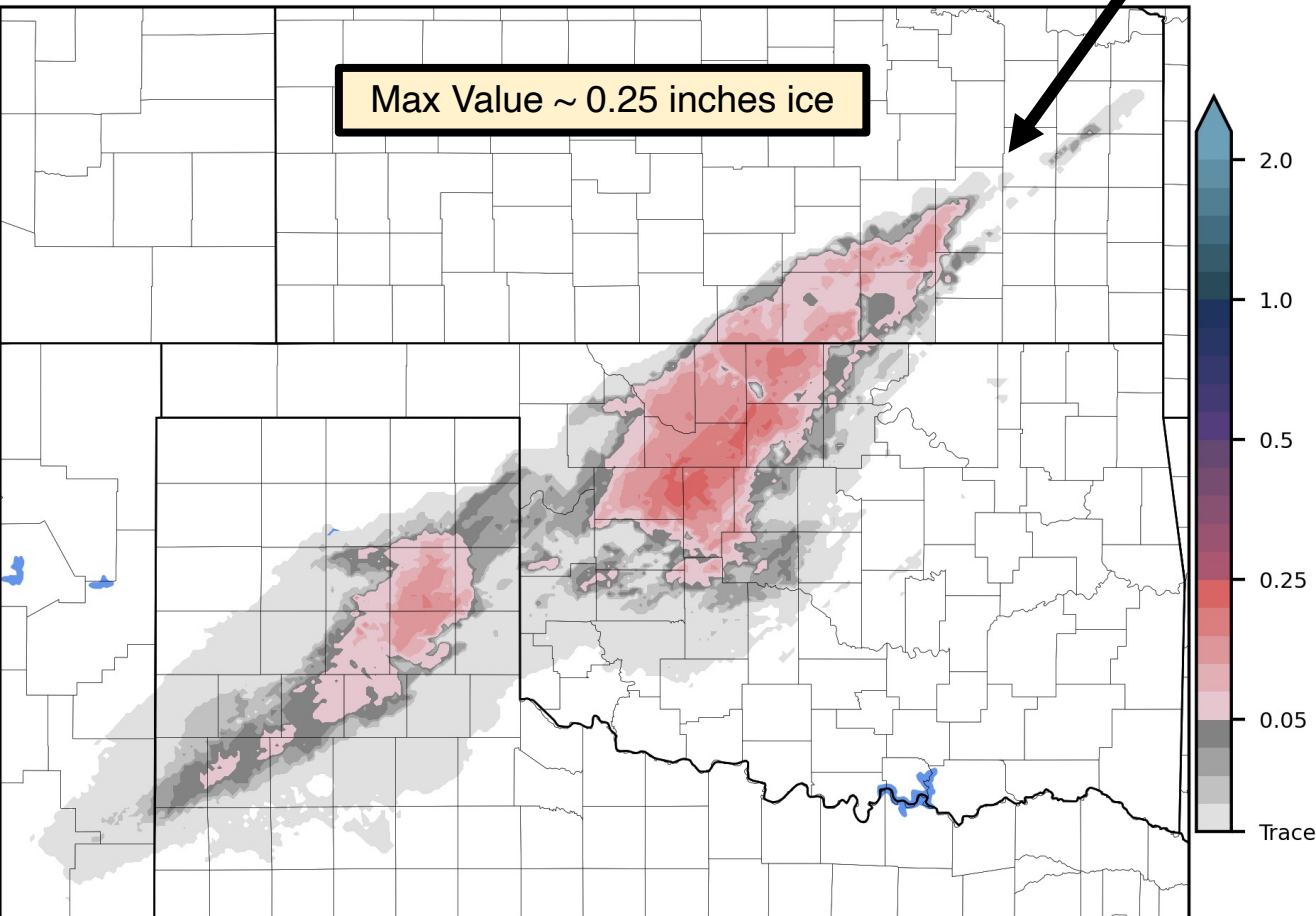


Temporary patch for this winter season

FRANA updated: December 6, 2023 21UTC

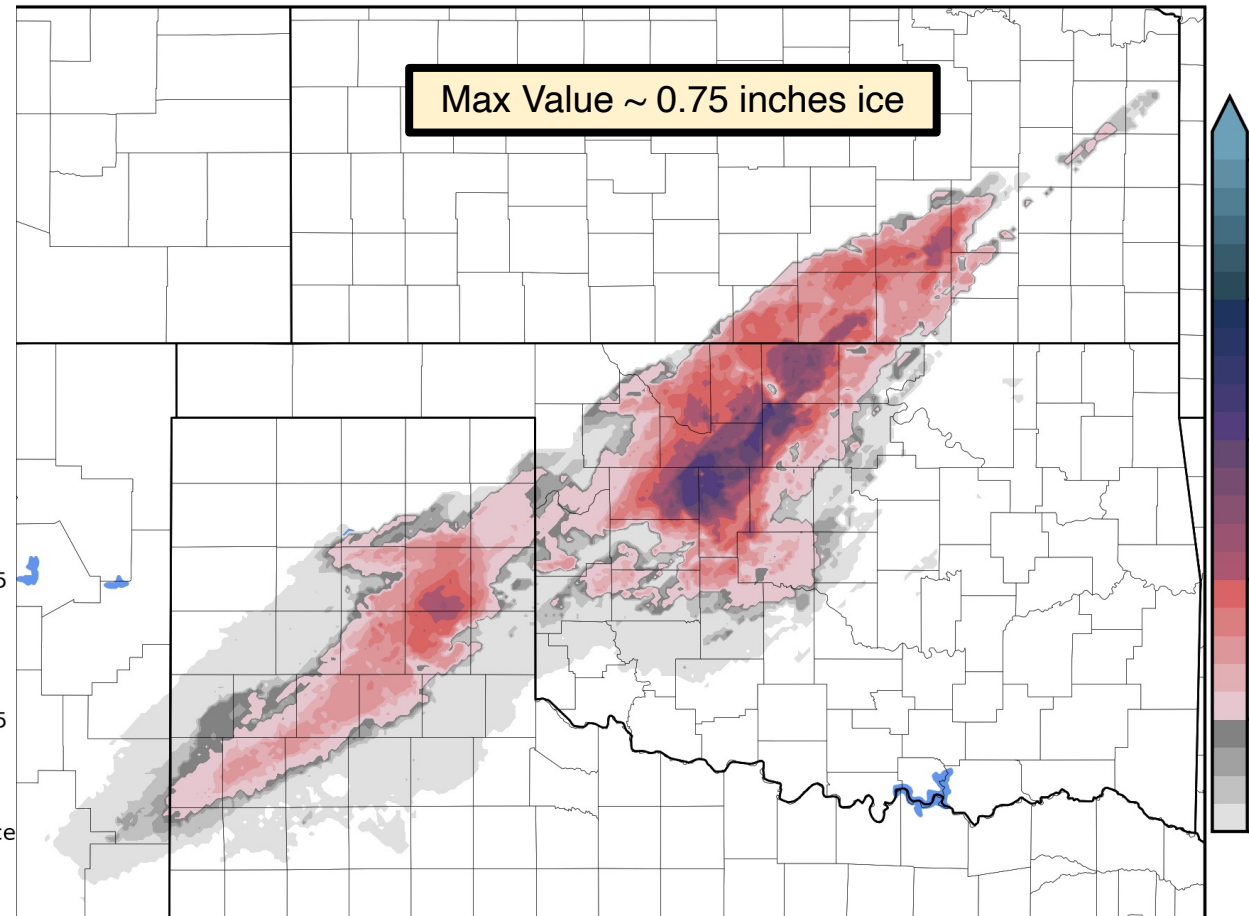
FRANA with the 0.15 in/hr cap

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC



FRANA – no QPE cap

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC



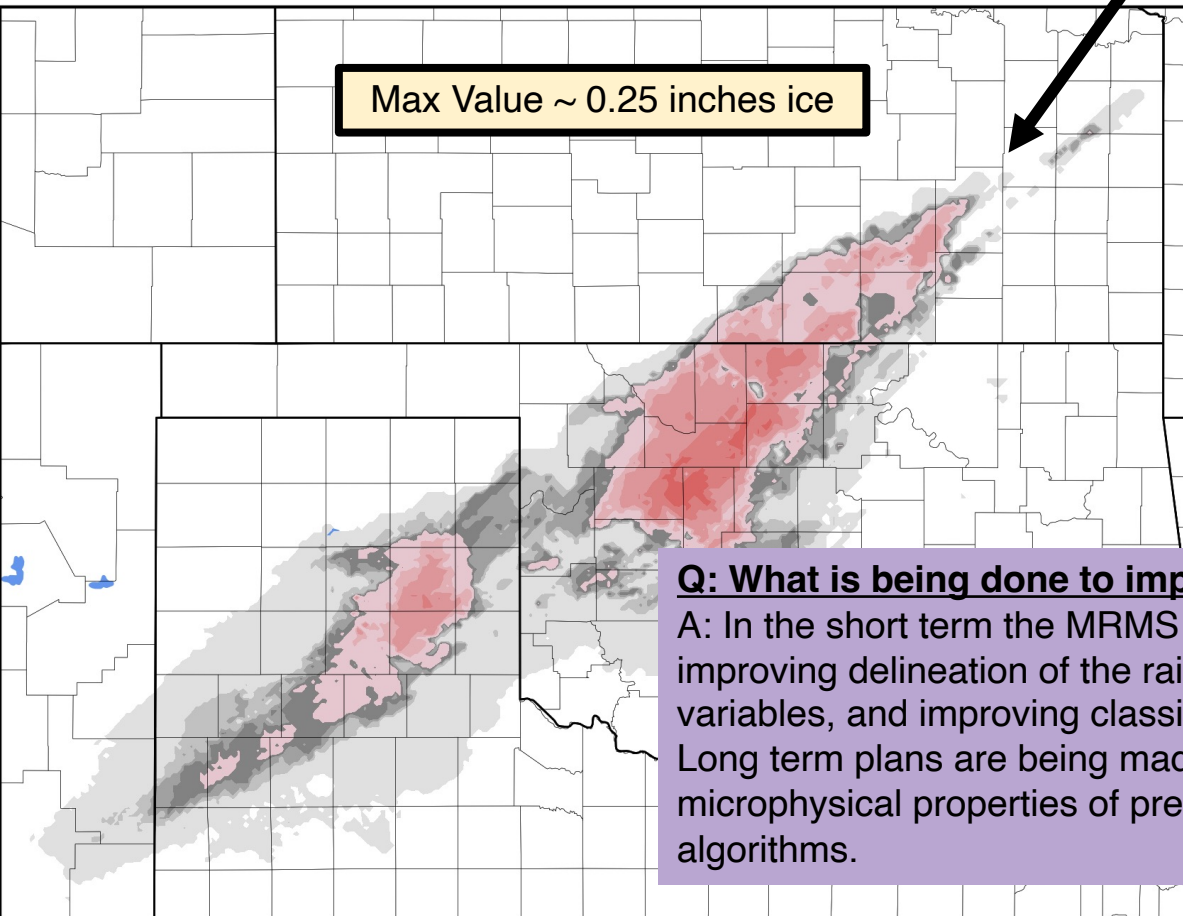
Temporary patch for this winter season

FRANA updated: December 6, 2023 21UTC

FRANA with the 0.15 in/hr cap

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC

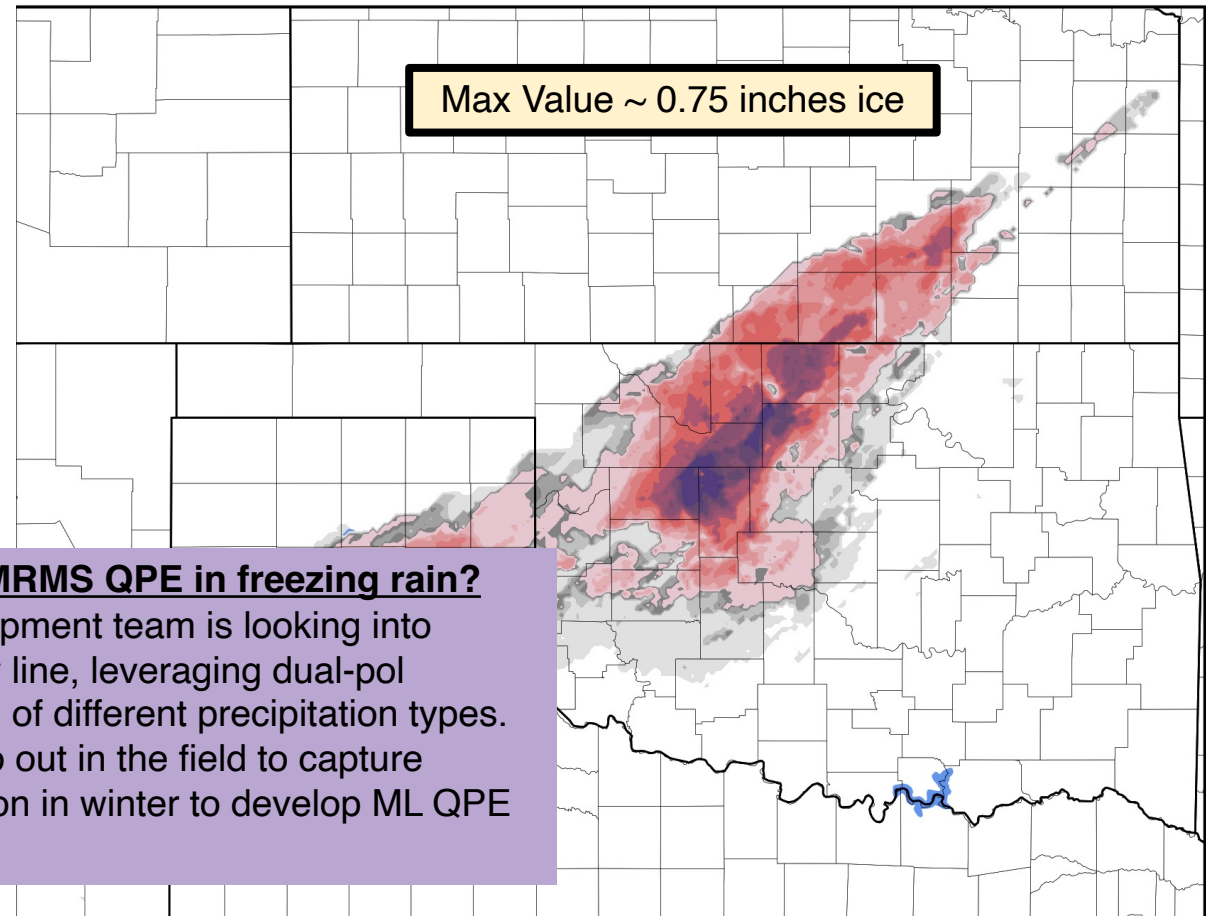
Max Value ~ 0.25 inches ice



FRANA – no QPE cap

Flat 27hr Total Valid: (Sun) Nov 26, 2023 08 UTC

Max Value ~ 0.75 inches ice



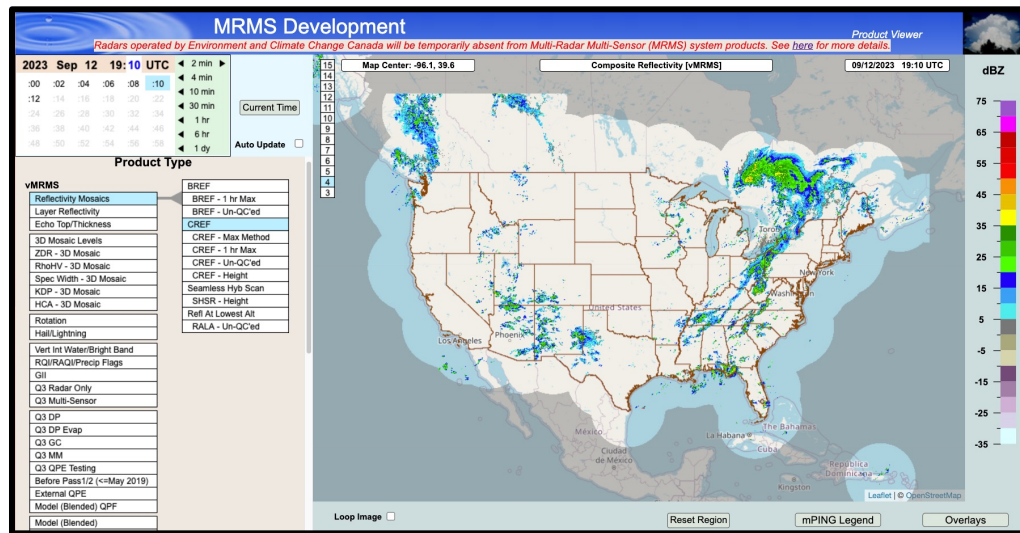
Q: What is being done to improve MRMS QPE in freezing rain?

A: In the short term the MRMS development team is looking into improving delineation of the rain/snow line, leveraging dual-pol variables, and improving classification of different precipitation types. Long term plans are being made to go out in the field to capture microphysical properties of precipitation in winter to develop ML QPE algorithms.

How can I access FRANA this winter?

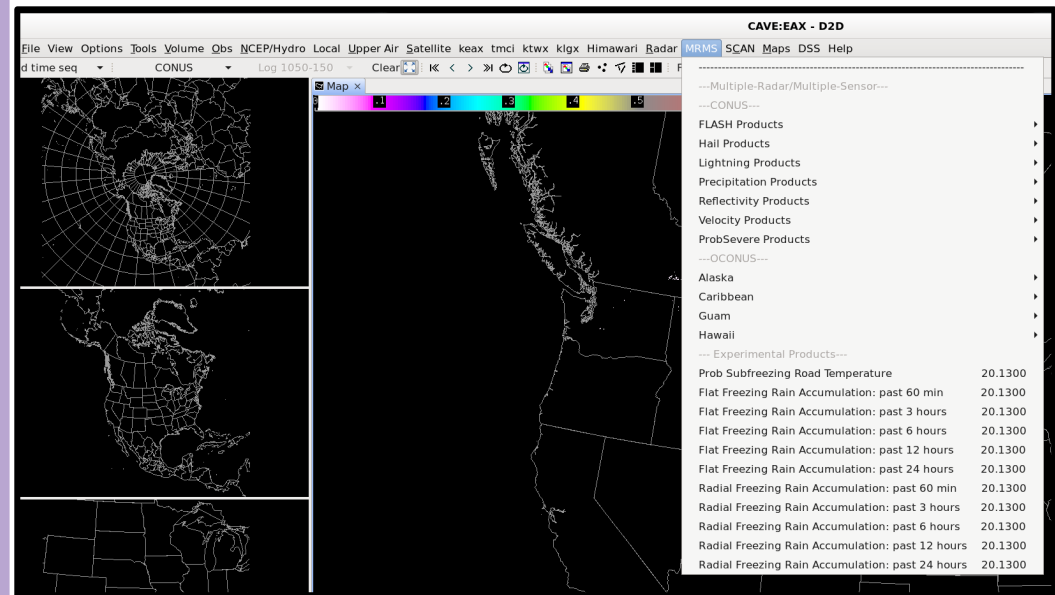
vMRMS Web Viewer (noaa.gov IP address only)

This is an experimental MRMS viewer hosted by NSSL. The product can be found under the tab "FRANA". Link: <https://mrms-dev.nssl.noaa.gov/qvs/vmrms/viewer/>



AWIPS Live Data (LDM)

NWS Forecasters: These grids can be ingested into AWIPS at your office. In AWIPS, this will be at the bottom of the MRMS menu (see picture). If you are missing data, contact your regional headquarters for assistance.



How can I provide feedback?

Google Feedback Form

Find something weird, really cool, or egregiously bad in FRANA? Let us know! You can contact us directly or fill out the google form below.

Google Reporting Form:

<https://forms.gle/TTgZ6oMhpKjUCC8H7>

CIWRO/NSSL FRANA Developer Team

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Product Description Document

<https://docs.google.com/document/d/1pjJaKhQJZPbcndUW8Rc7IVRC2LBrcNI6jeWb-Pz-6Ts/edit?usp=sharing>

WWE Forecaster Focus Groups

NWS Employees Only

If you use FRANA over the winter, we would appreciate your participation in a focus group that is being hosted in the 2023-2024 Winter Weather Experiment (WWE). If you are interested in participating, please reach out to the WWE coordinators for more details.

WWE Facilitator

Massey Bartolini – Massey.Bartolini@noaa.gov