Cobb SLR Methodology and Application in NBM v4.1

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Snowfall, a subject I love to talk about

- Diagnosing the Snow-Liquid-Ratio (SLR)
  - ↳ Cloud/Sub cloud processes
  - ↳ Ground processes
  - ↳ Cobb Methodology
- Applications
  - ↳ NBM algorithms
  - ↳ Cobb Probabilistic Winter Wx Tool
- Verification Approach
  - ↳ Areal approach leveraging CoCoRahs estimates/distributions
  - ↳ Isolating NWP snow amount forecast errors (QPF, T/Tv, SLR, WS)

Motivation

- Provide improved forecasts of snowfall in support of winter alerts and provision of IDSS.
- Provide a conceptual model through which forecasters can understand and anticipate the snow ratio and its probable evolution over a given forecast event.
- Support the development of the National Blend of Models (NBM)
- Improve ensemble / probabilistic snowfall forecasts

Original Inspiration (2004)

- Wintertime Cloud Microphysics of Baumgardt (NOAA/NWS)
- Crosshair approach of Waldstreicher (NOAA/NWS)
- Canadian snow ratio decision tree algorithm by Dubè (Met. Services of Canada)

My old house in Presque Isle, ME

What determines the observed Snow Liquid Ratio (SLR)?

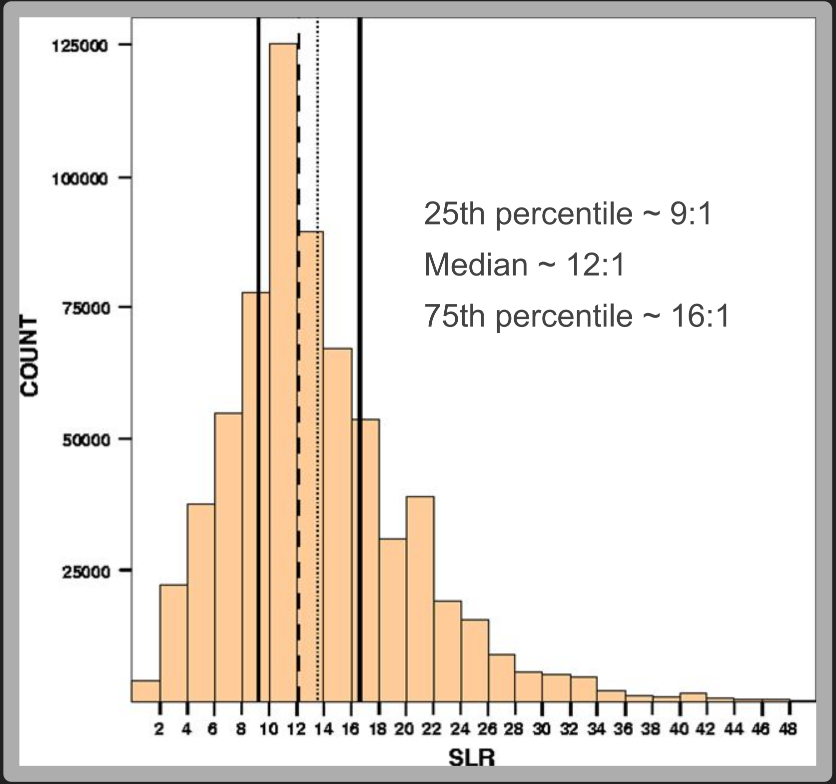
The SLR of freshly fallen snow is directly related to its predominant crystalline structure (shape & size of ice crystals)

This structure depends on:

➔ In-cloud deposition, accretion, and aggregation f(T, RH, Uvv)

➔ Sub-cloud processes such as sublimation, partial melting, aggregation, and refreezing f(T, RH, Uvv)

➔ Surface or ground effects of fragmentation, compaction, sublimation, and melting f(T, Tg, RH, Uvv, Wnd, INSOLATION)



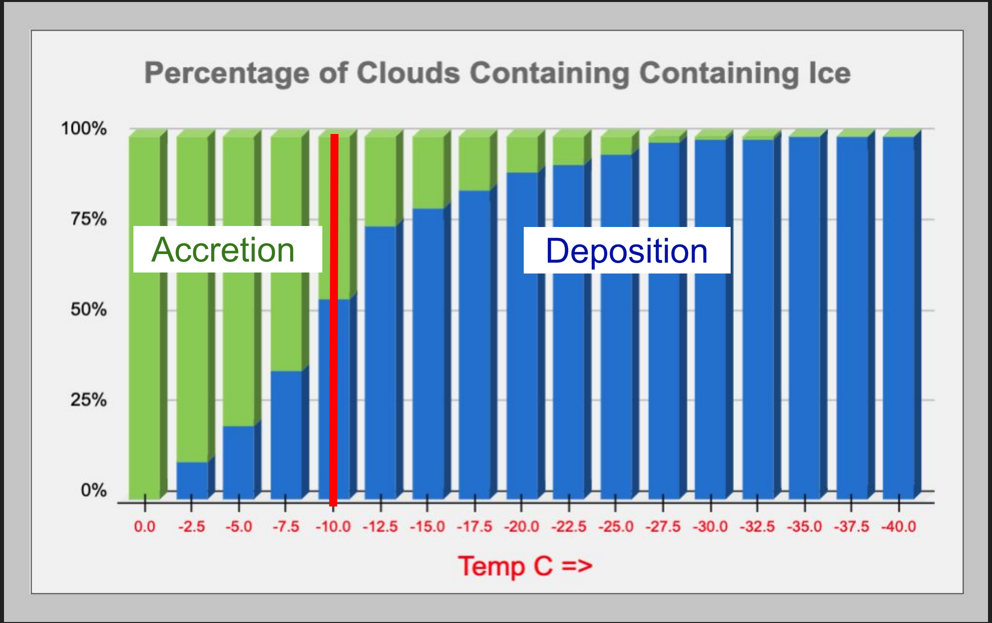
(from Baxter 2005)

Ice Nucleation and Crystal Growth

As a first guess, lack of active ice nuclei at temperatures above -10ºC increasingly favor growth via accretion while deposition is favored at colder temperatures.

Silver Iodine	**-4ºC**
Copper Sulfide	**-7ºC**
Sea Salt	**-8ºC**
Kaolinite	**-9ºC**
Volcanic Ash	**-13ºC**
Vermiculite	**-15ºC**

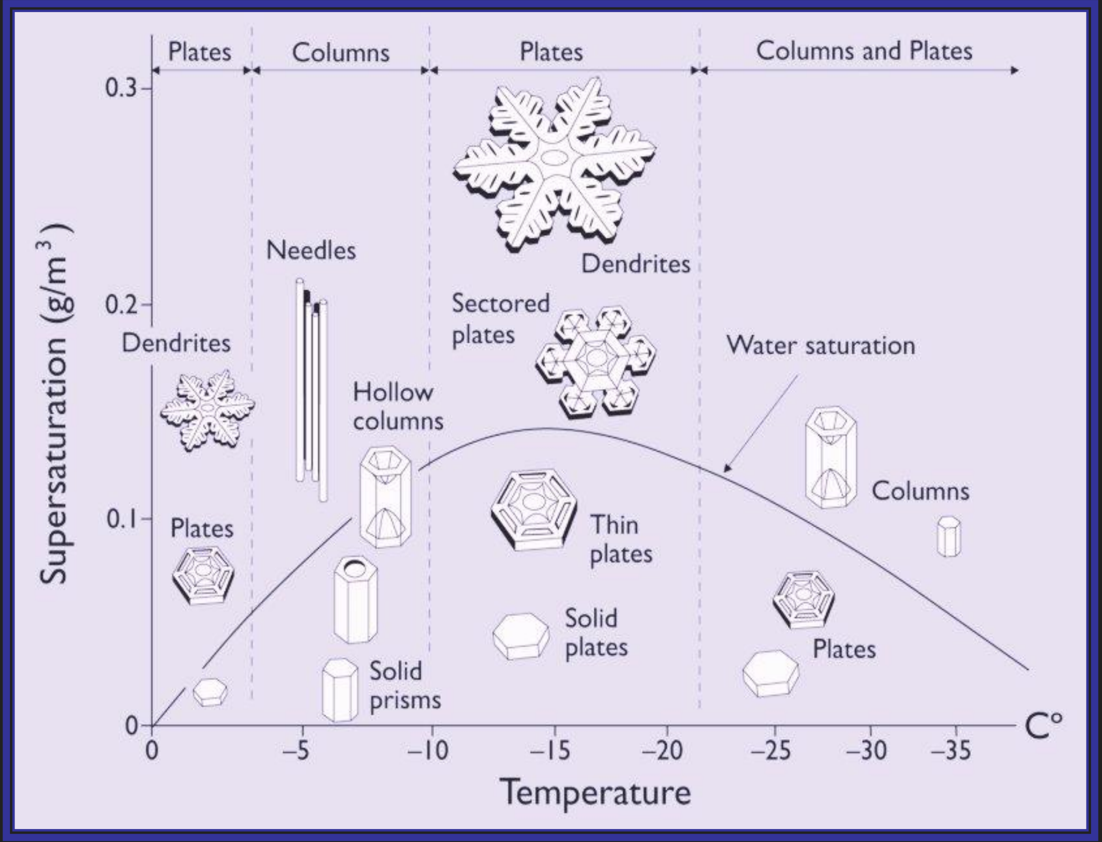
(Adapted from Baumgardt, 1999)



(Adapted from COMET)

Depositional Growth

- Crystal habit is a function of humidity and temperature
- Dendrites (branched plate forms) grow between -12ºC and -18ºC when RH_W > 100% and are associated with higher SLRs
- Max growth rates are observed around -15ºC
- Needles (columnar forms) grow between -4ºC and -6ºC and may be important in ice multiplication processes

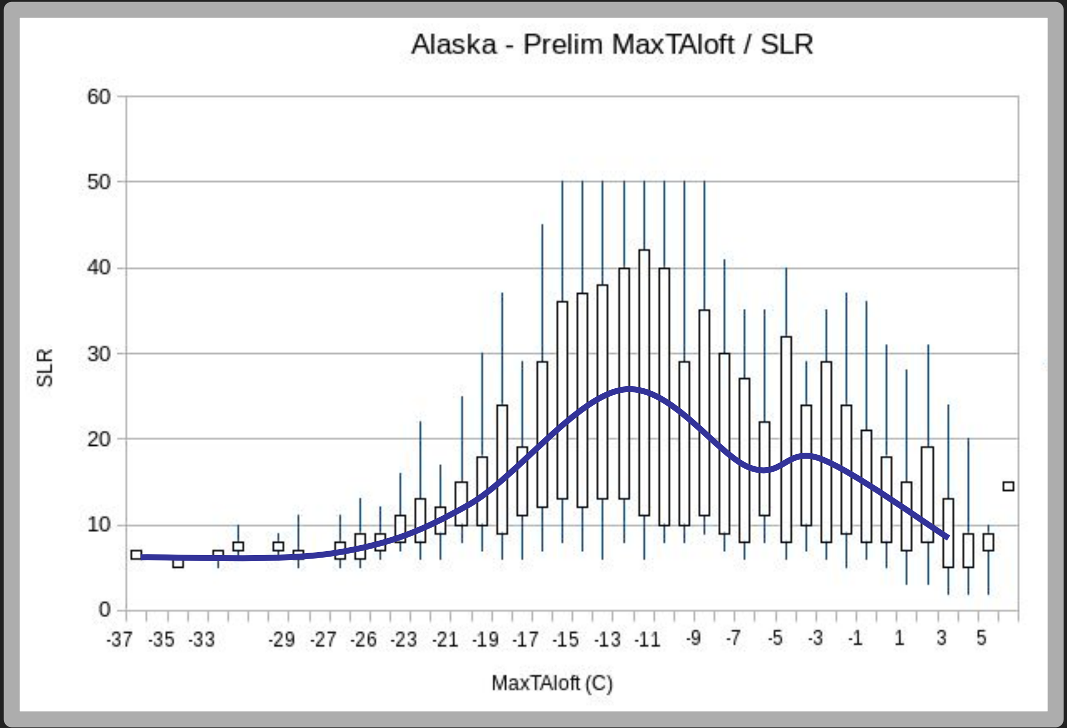


(From Libbrecht, 1999)

Utility of MaxT Aloft as a first Guess - Just Okay?

Based on 1,500 snowfall observations across Alaska with observed wind speeds < 20 mph. Cold ground and low solar elevation minimize effects of surface processes.

- ➔ Relatively low SLRs above 0ºC and below -19ºC
- ➔ Highest SLR associated with the dendritic growth zone (DGZ) with a secondary max with needles growth near -5ºC
- ➔ Largest spread in observed SLRs also associated with dendritic and needle growth

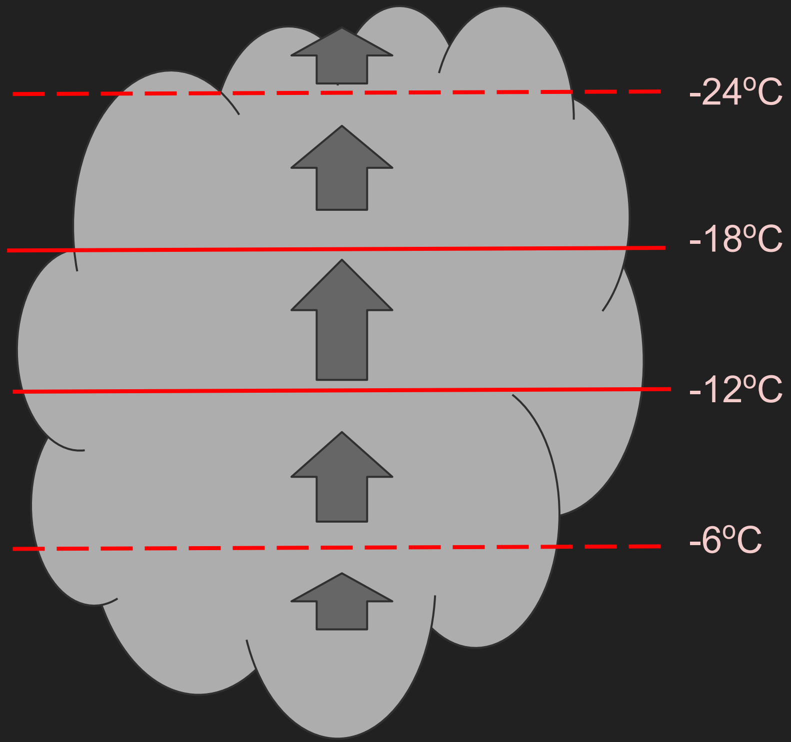


Courtesy Gene Petrescue NWS AK


Observed 30:1 Snow Ratio

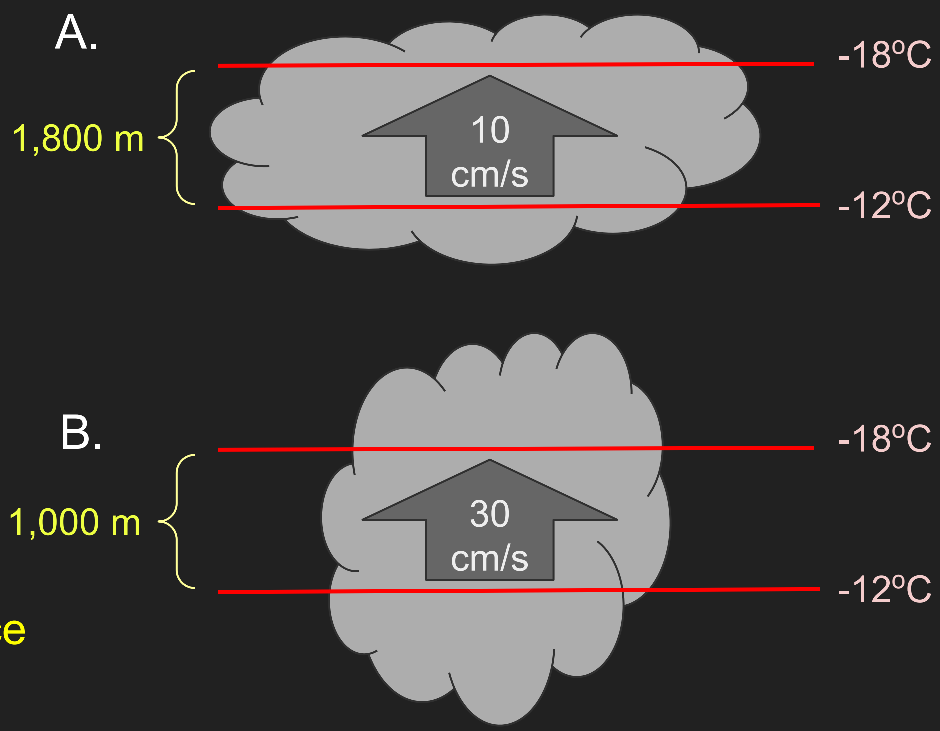
Importance of Vertical Motion (Crosshairs Approach)

- Upward vertical velocity (Uvv) maxima along with RH identify precipitation source regions
- Waldstreicher (2001) showed that warning event snowfalls were often associated with the collocation of Uvv maxima with the DGZ
- The colocation inferres greater precipitation efficiency combined with higher SLRs on average
- Lower SLRs were observed when Uvv maxima was below (warmer) than DGZ and lower snowfall amounts overall were associated with Uvv maxima above (colder) than DGZ



Importance of Vertical Motion (Residence Time)

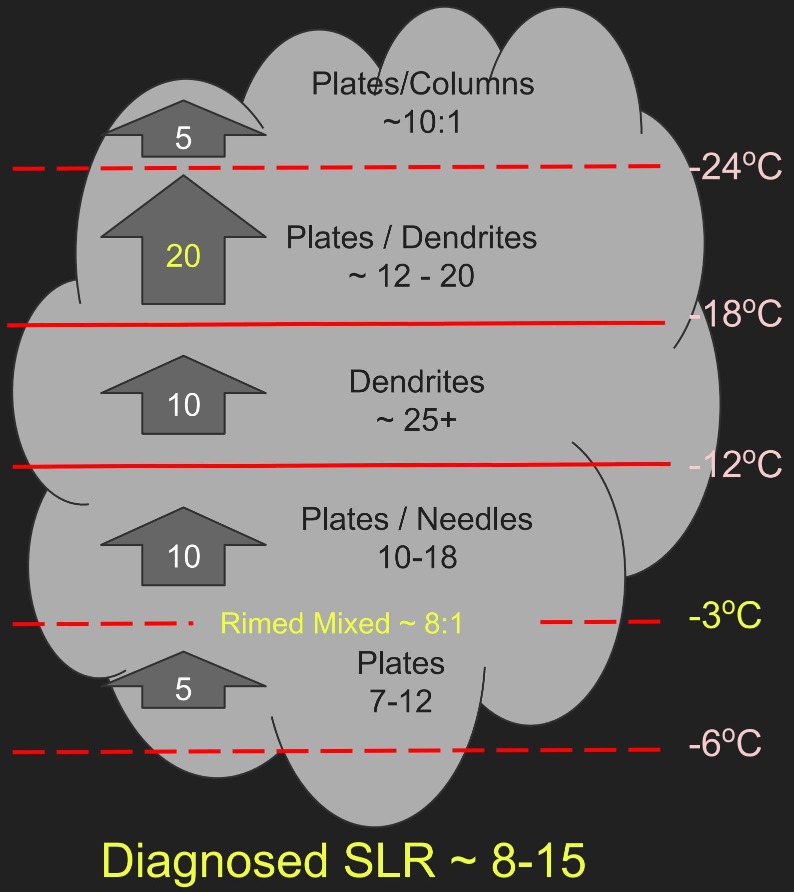
Terminal Fall Velocities	
Cloud Ice	1 - 20 cm/s
Dendrites/Needles	25 - 100 cm/s
Mixed aggregates	75 - 125 cm/s
Rimed, wet, or melting aggregates	100 - 200 cm/s
Graupel	150 - 300 cm/s



Which scenario will yield a larger residence time? (assume a 60 cm/s fall speed)

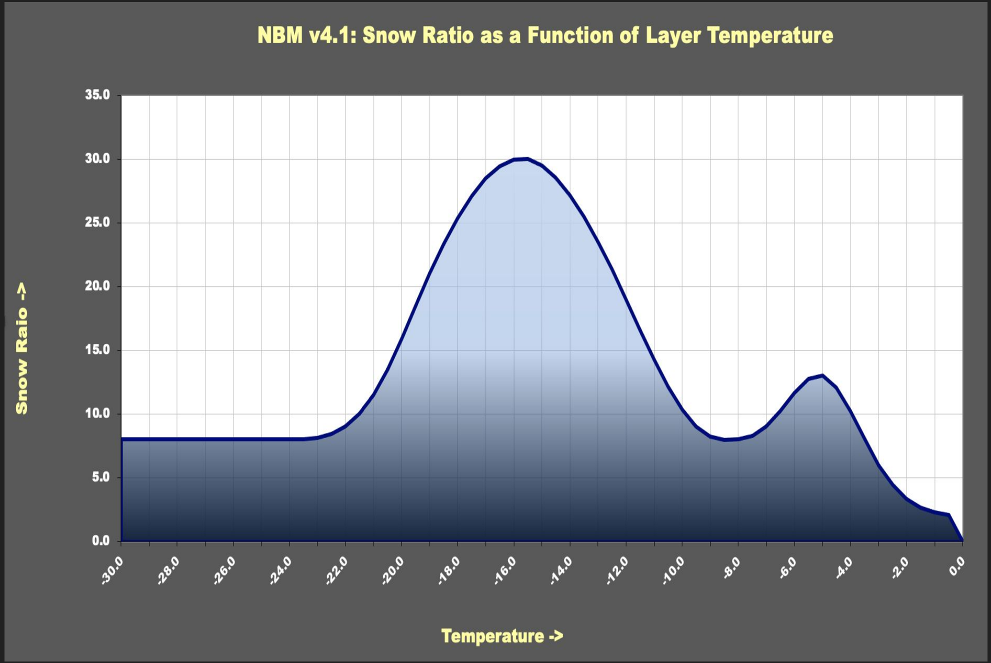
MaxT combined with Crosshair

- Dube (2003) combined the two approaches into a decision tree.
- Approximate SLRs were assigned to discrete temperature range based on expected crystal habit(s)
- First the SLR associated with T of Max Uvv was diagnosed.
- Second the max Uvv was modified by the SLR associated with MaxT
- A colder MaxT along with a Crosshair signature led to higher SLRs
- Overall the Dube approach helps to narrow the range of probable SLRs over using MaxT or snowfall expectations with Crosshair.



Cobb Method

- Generalized the approach of Dube by synthesizing a continuous SLR curve as a function of temperature and successively integrating SLR contribution of each cloud layer.
- Uses a weighting function based on Uvv, RH, and thickness / mass to determine the contribution of each layer
- Results in a “top-down” 2-dimensional continuous SLR diagnosis that can be used to calculate snowfall
- Developed as a Perl script, then AWIPS GFE SmartTool, and presently included in NBM
- Perl script includes P-type diagnosis and surface effects of wind, melting and compaction
- NBM v4.2 code will incorporate melting when Tw > -0.5C.



$$Snow\ Ratio = SR(T) \times \frac{layer\ Weighting\ Factor}{\sum layer\ Weighting\ Factors}$$

NBM v4.1 Cobb Method

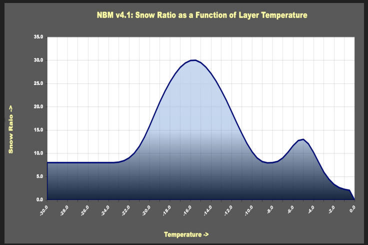
- Integration from 925 - 300 mb with vertical resolution of 25 mb with some interpolation depending on NWP dataset
- Incorporate a simple +/- temperature perturbation for calculating layer SLR
- Set downward VV (vertical velocity) to “1” so that saturated layers can still contribute to SLR
- Also a minimum VV of “1” ensures a continuous gridded SLR field
- Use the square root of the VV for VVw (layer VV weight) to limit excessive single layer contribution (primarily a concern w/ CAMS)

$$SLR = \frac{\sum (SR(T) \times PVVw\ )}{\sum PVVw)}$$

$$PVVw = VVw \times RHw$$

$$RHw = \frac{(RH)^2}{6400}$$

SR(T) =

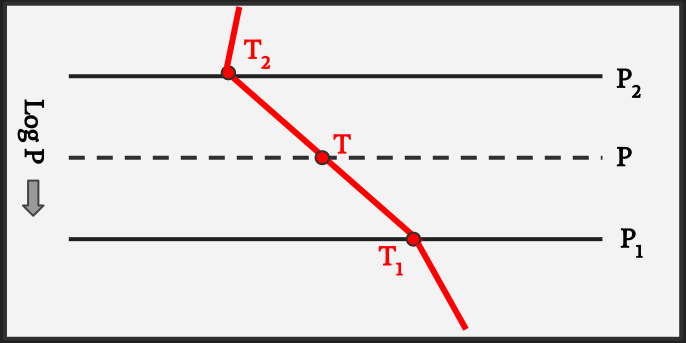


NBM v4.1 Logarithmic Vertical Interpolation for Ensembles

- Applying Cobb to Ensembles (ECMWFe, GEFS, SREF).
  - The vertical resolution of these data sets is limited to mandatory levels for (P, T, and RH). UVV is only available at 700 and 800 mbs for ECMWFe.
  - Logarithmic interpolation is used estimate (P, T, RH, and UVV) at 25 mb intervals between 925 - 300 mb. UVV is assumed to be zero at mandatory levels where it is missing. This interpolation would is the equivalent of picking off data points along a straight line between two temperatures at known levels on a SkewT-LogP diagram

$$y = y_{p1} + \left[\frac{y_{p2} - y_{p1}}{log\frac{P_2}{P_1}}\right]\left[log\frac{P}{P_1}\right]$$

Where y is the variable to interpolate (T, RH, UVV) at level P. P_2 and P_1 are mandatory pressure levels immediately above(below) P where y_2 and y_1 are known.

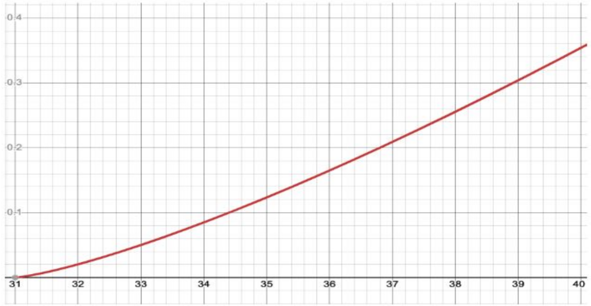


NBM V4.2 SnowMelt Function for “Warm” Snowfall

Experiment 1: Steps to incorporate SLR correction to account for melting snow:

- Calculate each “cloud base” SLR and blend as previous.
- Calculate potential snow melt for falling snow based on the following equation:

$$QPFmelt = \left[\frac{(0.5Tsfc - 15.50)}{10}\right]^{1.3}$$



- Revise the blended SLR as:

$$SLR_{new} = SLR \times \left[\frac{QPF - QPFmelt}{QPF}\right]$$

If QPF_{melt} > QPF set SLR_{new} to zero, i.e. there will be no snow accumulation.

- Adjust logic to allow for a p-type of snow with temps ≤ 40F.

Melting Rates (hourly)	32F	33F	34F	35F	36F	37F	38F	39F	≥40F
	0.02	0.05	0.08	0.12	0.16	0.21	0.26	0.30	0.35

Hourly Snowfall Rates w/ Surface Melt Function NBM v4.1

Cloud SLR = 20:1 | Tw Threshold = 33F | Melt Factor = 0 | Size Factor = 0

Temperature (F)

Hourly Precipitation (Liquid Equivalent)	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	
0.30	6.0	6.0	6.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.30
0.29	5.8	5.8	5.8	5.8	5.8	5.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.29
0.28	5.6	5.6	5.6	5.6	5.6	5.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.28
0.27	5.4	5.4	5.4	5.4	5.4	5.4	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.27
0.26	5.2	5.2	5.2	5.2	5.2	5.2	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.26
0.25	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25
0.24	4.8	4.8	4.8	4.8	4.8	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.24
0.23	4.6	4.6	4.6	4.6	4.6	4.6	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.23
0.22	4.4	4.4	4.4	4.4	4.4	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.22
0.21	4.2	4.2	4.2	4.2	4.2	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.21
0.20	4.0	4.0	4.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.20
0.19	3.8	3.8	3.8	3.8	3.8	3.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.19
0.18	3.6	3.6	3.6	3.6	3.6	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.18
0.17	3.4	3.4	3.4	3.4	3.4	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.17
0.16	3.2	3.2	3.2	3.2	3.2	3.2	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16
0.15	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15
0.14	2.8	2.8	2.8	2.8	2.8	2.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14
0.13	2.6	2.6	2.6	2.6	2.6	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13
0.12	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12
0.11	2.2	2.2	2.2	2.2	2.2	2.2	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11
0.10	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
0.09	1.8	1.8	1.8	1.8	1.8	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09
0.08	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
0.07	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07
0.06	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06
0.05	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
0.04	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04
0.03	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03
0.02	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
0.01	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	
Hourly Melt Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

SLR
1 - 2
3 - 5
6 - 8
9 - 11
12 - 14
15 - 17
18 - 20
21 - 23
25 - 27
27 +

Hourly Snowfall Rates w/ Surface Melt Function Proposed NBM v4.2

Cloud SLR = 20:1 Tw Threshold = 31F Melt Factor = 15 Size Factor = 1.3

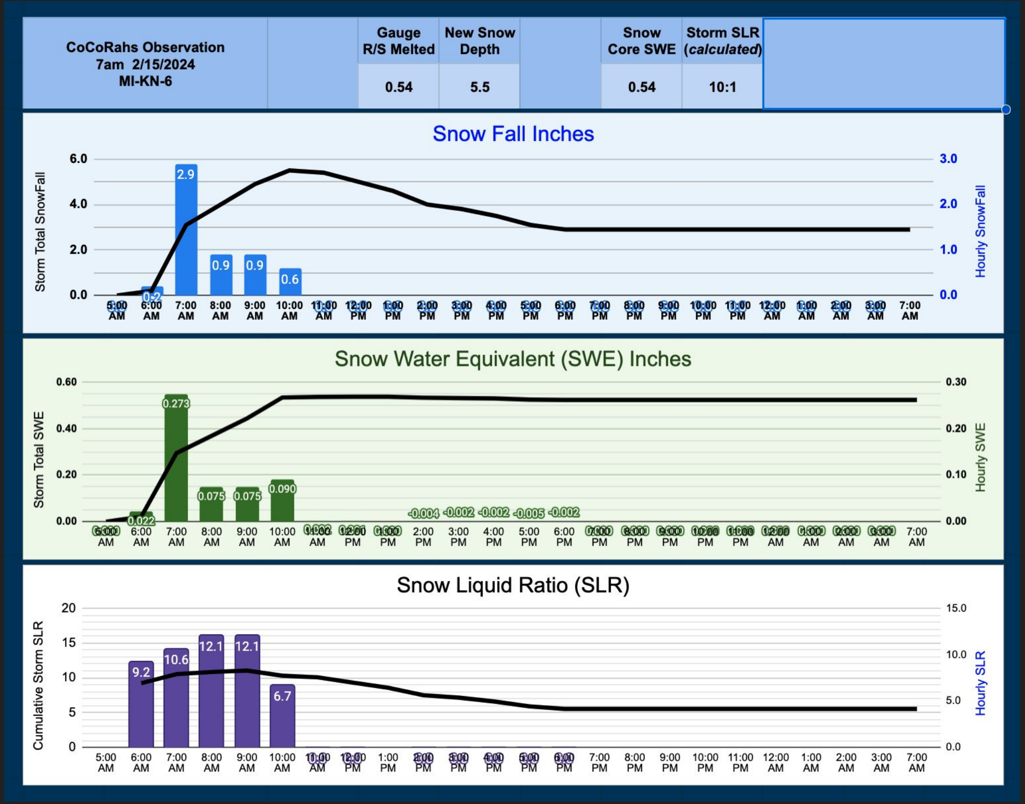
Temperature (F)

Hourly Precipitation (Liquid Equivalent)	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	
0.30	6.0	6.0	6.0	5.9	5.8	5.6	5.4	5.2	5.0	4.8	4.5	4.3	4.1	3.8	3.5	3.3	3.0	2.7	2.4	2.1	1.8	0.30
0.29	5.8	5.8	5.8	5.7	5.6	5.4	5.2	5.0	4.8	4.6	4.3	4.1	3.9	3.6	3.3	3.1	2.8	2.5	2.2	1.9	1.6	0.29
0.28	5.6	5.6	5.6	5.5	5.4	5.2	5.0	4.8	4.6	4.4	4.1	3.9	3.7	3.4	3.1	2.9	2.6	2.3	2.0	1.7	1.4	0.28
0.27	5.4	5.4	5.4	5.3	5.2	5.0	4.8	4.6	4.4	4.2	3.9	3.7	3.5	3.2	2.9	2.7	2.4	2.1	1.8	1.5	1.2	0.27
0.26	5.2	5.2	5.2	5.1	5.0	4.8	4.6	4.4	4.2	4.0	3.7	3.5	3.3	3.0	2.7	2.5	2.2	1.9	1.6	1.3	1.0	0.26
0.25	5.0	5.0	5.0	4.9	4.8	4.6	4.4	4.2	4.0	3.8	3.5	3.3	3.1	2.8	2.5	2.3	2.0	1.7	1.4	1.1	0.8	0.25
0.24	4.8	4.8	4.8	4.7	4.6	4.4	4.2	4.0	3.8	3.6	3.3	3.1	2.9	2.6	2.3	2.1	1.8	1.5	1.2	0.9	0.6	0.24
0.23	4.6	4.6	4.6	4.5	4.4	4.2	4.0	3.8	3.6	3.4	3.1	2.9	2.7	2.4	2.1	1.9	1.6	1.3	1.0	0.7	0.4	0.23
0.22	4.4	4.4	4.4	4.3	4.2	4.0	3.8	3.6	3.4	3.2	2.9	2.7	2.5	2.2	1.9	1.7	1.4	1.1	0.8	0.5	0.2	0.22
0.21	4.2	4.2	4.2	4.1	4.0	3.8	3.6	3.4	3.2	3.0	2.7	2.5	2.3	2.0	1.7	1.5	1.2	0.9	0.6	0.3	0.0	0.21
0.20	4.0	4.0	4.0	3.9	3.8	3.6	3.4	3.2	3.0	2.8	2.5	2.3	2.1	1.8	1.5	1.3	1.0	0.7	0.4	0.1	0.0	0.20
0.19	3.8	3.8	3.8	3.7	3.6	3.4	3.2	3.0	2.8	2.6	2.3	2.1	1.9	1.6	1.3	1.1	0.8	0.5	0.2	0.0	0.0	0.19
0.18	3.6	3.6	3.6	3.5	3.4	3.2	3.0	2.8	2.6	2.4	2.1	1.9	1.7	1.4	1.1	0.9	0.6	0.3	0.0	0.0	0.0	0.18
0.17	3.4	3.4	3.4	3.3	3.2	3.0	2.8	2.6	2.4	2.2	1.9	1.7	1.5	1.2	0.9	0.7	0.4	0.1	0.0	0.0	0.0	0.17
0.16	3.2	3.2	3.2	3.1	3.0	2.8	2.6	2.4	2.2	2.0	1.7	1.5	1.3	1.0	0.7	0.5	0.2	0.0	0.0	0.0	0.0	0.16
0.15	3.0	3.0	3.0	2.9	2.8	2.6	2.4	2.2	2.0	1.8	1.5	1.3	1.1	0.8	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.15
0.14	2.8	2.8	2.8	2.7	2.6	2.4	2.2	2.0	1.8	1.6	1.3	1.1	0.9	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.14
0.13	2.6	2.6	2.6	2.5	2.4	2.2	2.0	1.8	1.6	1.4	1.1	0.9	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.13
0.12	2.4	2.4	2.4	2.3	2.2	2.0	1.8	1.6	1.4	1.2	0.9	0.7	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12
0.11	2.2	2.2	2.2	2.1	2.0	1.8	1.6	1.4	1.2	1.0	0.7	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11
0.10	2.0	2.0	2.0	1.9	1.8	1.6	1.4	1.2	1.0	0.8	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
0.09	1.8	1.8	1.8	1.7	1.6	1.4	1.2	1.0	0.8	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09
0.08	1.6	1.6	1.6	1.5	1.4	1.2	1.0	0.8	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
0.07	1.4	1.4	1.4	1.3	1.2	1.0	0.8	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07
0.06	1.2	1.2	1.2	1.1	1.0	0.8	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06
0.05	1.0	1.0	1.0	0.9	0.8	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
0.04	0.8	0.8	0.8	0.7	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04
0.03	0.6	0.6	0.6	0.5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03
0.02	0.4	0.4	0.4	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
0.01	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	
Hourly Melt Rate	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.15	0.16	0.18	0.19	0.21	

SLR
1 - 2
3 - 5
6 - 8
9 - 11
12 - 14
15 - 17
18 - 20
21 - 23
25 - 27
27 +

Relating Event SLR to incremental observed SLRs

- While hourly SLRs may vary considerably over an event the event or storm SLR will be reflective of the period with the highest precipitation rates.
- As a first guess then, an individual SLR diagnosis at the time of max precipitation rate will be representative of the overall event SLR.

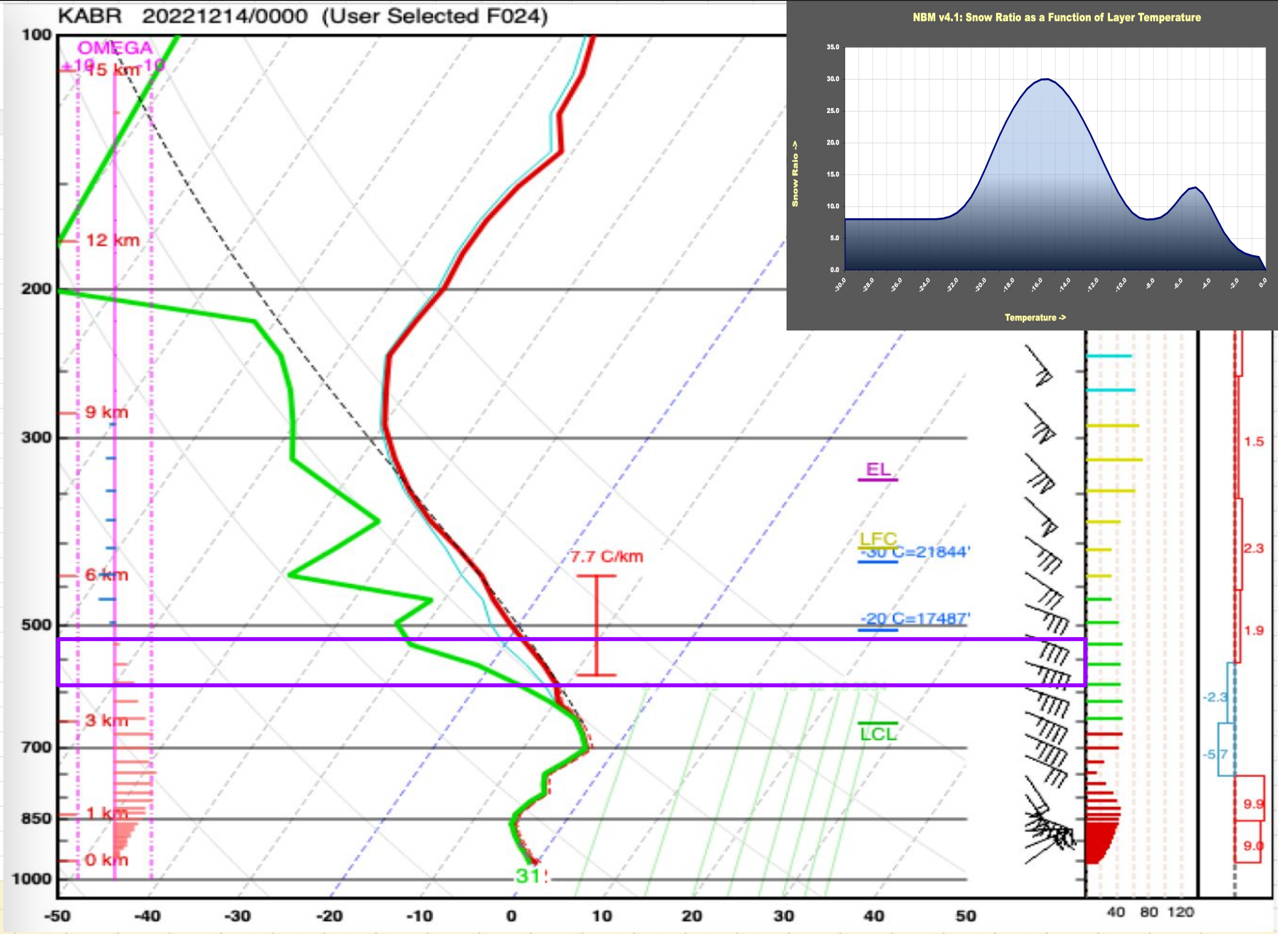


Aberdeen, SD. (KABR)

12-13-2022 00Z (F24) NAM3

NBM v4.1 & v4.2
max SLR 30:1
+/- temps
VV0.5**

P(mb)	T(C)	RH (%)	W (cm/s)	Hght(m)	SLRw	VVw	RHw	PVV	PVVs	SLR
300	-48.6	27	-3	8982	8	1	0.11	0.1	0	8.0
325	-45.2	29	-4.1	8452	8	1	0.13	0.1	0	8.0
350	-41.7	42	-3.9	7954	8	1	0.28	0.3	1	8.0
375	-37.8	54	-3.7	7483	8	1	0.46	0.5	1	8.0
400	-33.4	29	-3.5	7034	8	1	0.13	0.1	1	8.0
425	-29.5	15	-5.5	6605	8	1	0.04	0.0	1	8.0
450	-26.4	31	-6.4	6195	8	1	0.15	0.2	1	8.0
475	-23.7	46	-4.8	5802	8	1	0.33	0.3	2	8.0
500	-20.8	31	-1.1	5425	13	1	0.15	0.2	2	8.4
525	-17.8	31	1.3	5063	26	1	0.15	0.2	2	9.9
550	-15	49	3.5	4713	29	2	0.38	0.7	3	15.0
575	-12.5	64	5.6	4375	21	2	0.64	1.5	4	17.2
600	-10.7	81	7	4049	13	3	1.00	2.6	7	15.7
625	-8.8	95	8.2	3733	9	3	1.00	2.9	10	13.6
650	-6.2	99	10.1	3428	11	3	1.00	3.2	13	12.9
675	-4.5	99	11.5	3132	11	3	1.00	3.4	16	12.5
700	-3.2	98	10.2	2844	7	3	1.00	3.2	19	11.6
725	-4.4	98	9.8	2567	11	3	1.00	3.1	23	11.5
750	-5.7	99	11.4	2300	12	3	1.00	3.4	26	11.5
775	-4.9	99	10.1	2043	12	3	1.00	3.2	29	11.5
800	-4.9	99	9.8	1793	12	3	1.00	3.1	32	11.5
825	-5.6	98	7.6	1551	12	3	1.00	2.8	35	11.5
850	-5.7	99	6.2	1317	12	2	1.00	2.5	37	11.5
875	-4.8	99	4.4	1089	11	2	1.00	2.1	40	11.5
925	-2.2	99	1	650	4	1	1.00	1.0	41	11.4
950	-0.4	96	0	437	2	1	1.00	1.0	42	11.1
955	-0.1	95	0	396	1	1	1.00	1.0	43	10.9
1000	2.3	-99	0	26	0	1	1.53	1.5	44	10.5
					1	1	0.00	0.0	44	10.5



Cobb SLR	10.5
H100 - H70 Thickness (NBM)	10.5
MaxT - Celcius (NBM)	2.3
NBM Blended SLR (33% / 33% / 33%)	**7.8**
H100 - H70 Thickness (Cobb)	10.4
Kuchera (MaxT) Method - Kelvin	3.4

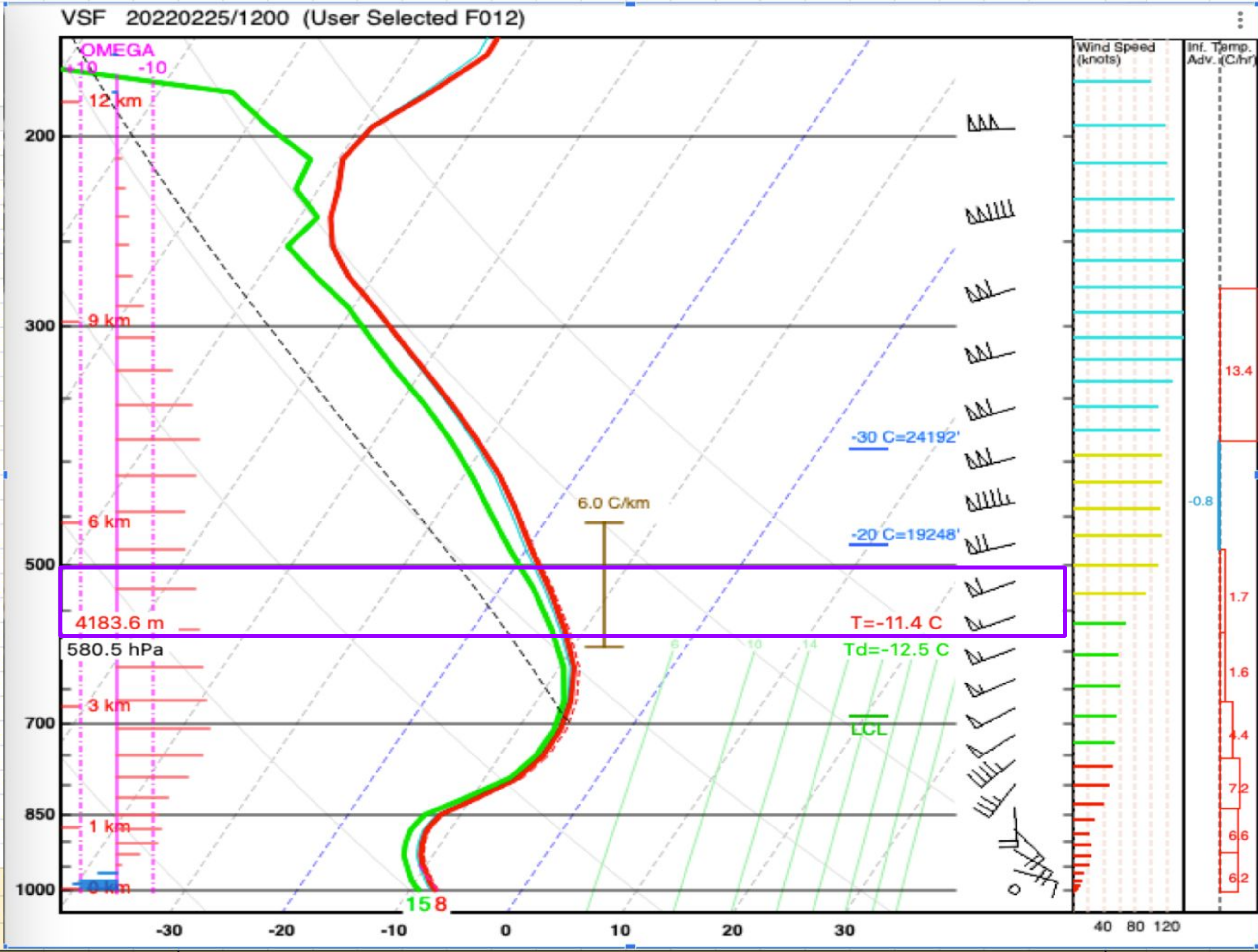
Mean Precip = 0.56 (3) Mean Snowfall = 4.5 (3) Mean SLR = 8:1

Springfield VT

HRRR
2022-02-25 12Z F12

NBM v4.1 & v4.2
max SLR 30:1
+/- temps
VV**0.5

P(mb)	T(C)	RH (%)	W (cm/s)	Hght(m)	SLRw	VVw	RHw	PVV	PVVs	SLR
300	-45.5	75	19.8	9171	8	4	0.88	3.9	4	8.0
325	-40.6	75	29.2	8632	8	5	0.88	4.7	9	8.0
350	-36.1	77	39.5	8122	8	6	0.93	5.8	14	8.0
375	-32.1	79	42.3	7639	8	7	0.98	6.3	21	8.0
400	-28.5	79	40.1	7180	8	6	0.98	6.2	27	8.0
425	-25.4	79	35.7	6743	8	6	0.98	5.8	33	8.0
450	-22.8	81	30.9	6326	9	6	1.00	5.6	38	8.1
475	-20.4	83	29.6	5928	14	5	1.00	5.4	44	8.9
500	-18	86	30.1	5546	25	5	1.00	5.5	49	10.6
525	-15.7	88	31.5	5180	29	6	1.00	5.6	55	12.6
550	-13.7	90	31.1	4827	26	6	1.00	5.6	61	13.8
575	-11.8	91	30.7	4488	18	6	1.00	5.5	66	14.1
600	-10.1	92	30.2	4161	11	5	1.00	5.5	72	13.9
625	-8.7	93	29.8	3846	9	5	1.00	5.5	77	13.5
650	-7.7	94	29.5	3541	9	5	1.00	5.4	82	13.2
675	-7	95	29.1	3247	10	5	1.00	5.4	88	13.0
700	-6.5	95	28.8	2962	10	5	1.00	5.4	93	12.8
725	-6.4	95	27.1	2688	11	5	1.00	5.2	98	12.7
750	-6.4	95	24.8	2423	11	5	1.00	5.0	103	12.6
775	-7	94	21.2	2167	10	5	1.00	4.6	108	12.5
800	-8.3	93	16.9	1920	8	4	1.00	4.1	112	12.3
825	-10.1	91	12.5	1681	11	4	1.00	3.5	116	12.3
850	-12	89	9.9	1452	19	3	1.00	3.1	119	12.5
875	-12.2	89	10.4	1230	20	3	1.00	3.2	122	12.7
900	-11.9	88	9.4	1015	18	3	1.00	3.1	125	12.8
925	-11.3	88	5.2	805	16	2	1.00	2.3	127	12.9
950	-10.3	89	0.1	600	12	1	1.00	1.0	128	12.9
975	-9.1	88	-6.9	399	9	1	1.00	1.0	129	12.8
998	-8.2	91	0	220	8	1	1.00	1.0	130	12.8
1000	-8	-99	0	203						
Cobb SLR										12.8
H100 - H70 Thickness (NBM)										13.3
MaxT - Celcius (NBM)										17.3
NBM Blended SLR (33% / 33% / 33%)										14.5
H100 - H70 Thickness (Cobb)										13.7
Kuchera (MaxT) Method - Kelvin										16.4



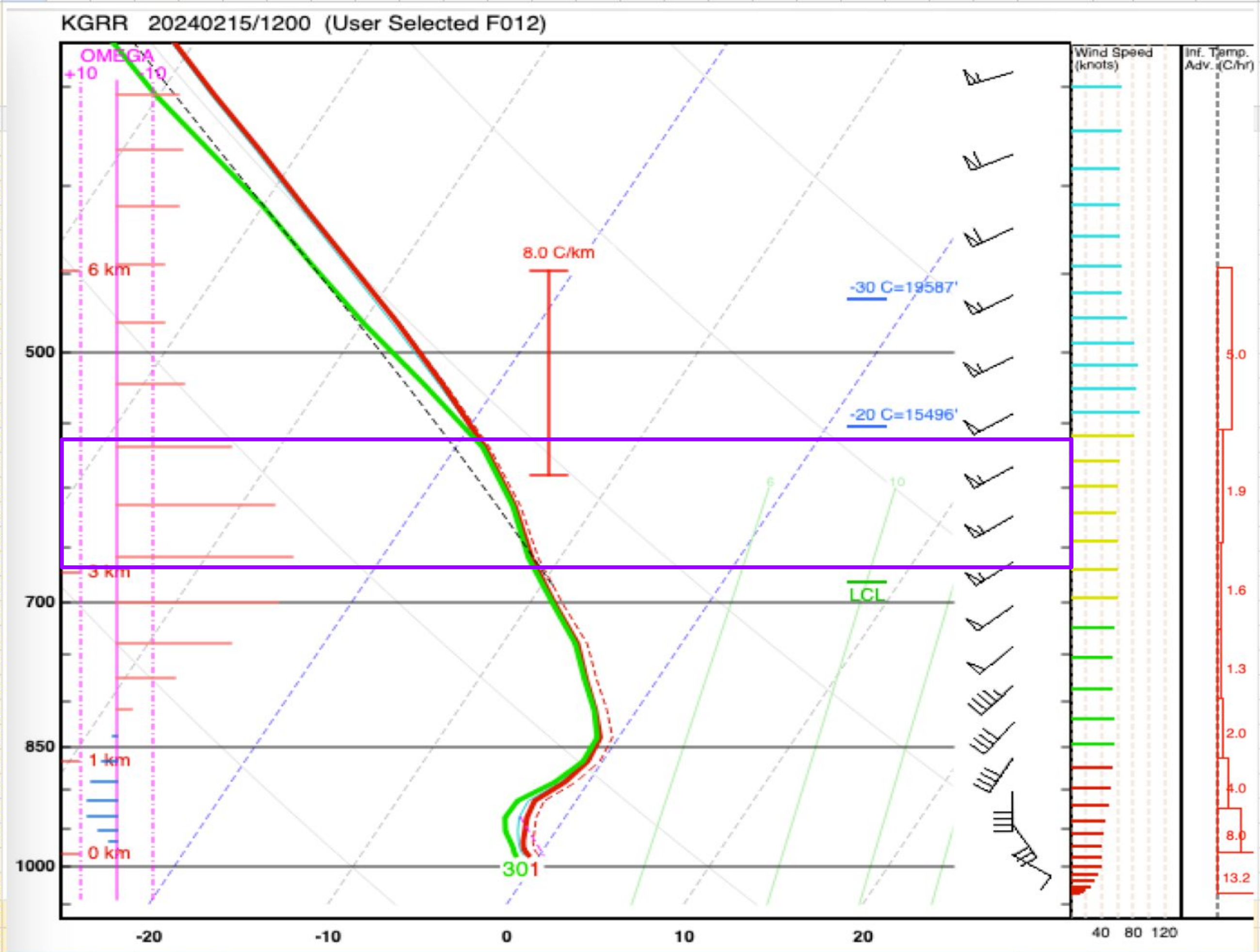
Mean Precip = 0.41 (6) Mean Snowfall = 5.0 (5) Mean SLR = 12:1

Grand Rapids, MI

01-28-2023 12Z (F16) HRRR

NBM v4.1 & v4.2
max SLR 30:1
+/- temps
VV0.5**

P(mb)	T(C)	RH (%)	W (cm/s)	Hght(m)	SLRw	VVw	RHw	PVV	PVVs	SLR
300	-56.7	67	19.5	8918	8	4	0.00	0.0	0	0.0
325	-51.9	64	28.4	8406	8	5	0.00	0.0	0	0.0
350	-47.5	68	31.5	7921	8	6	0.72	4.1	4	8.0
375	-43.2	72	31.9	7461	8	6	0.81	4.6	9	8.0
400	-39.3	76	29.7	7022	8	5	0.90	4.9	14	8.0
425	-35.5	79	25	6604	8	5	0.98	4.9	18	8.0
450	-32	80	20.4	6204	8	5	1.00	4.5	23	8.0
475	-28.7	82	19.6	5819	8	4	1.00	4.4	27	8.0
500	-25.7	87	22.9	5449	8	5	1.00	4.8	32	8.0
525	-22.8	91	27.8	5094	9	5	1.00	5.3	37	8.1
550	-20.2	95	36.3	4751	15	6	1.00	6.0	43	9.1
575	-17.8	98	44.1	4420	26	7	1.00	6.6	50	11.3
600	-15.7	98	50.6	4100	29	7	1.00	7.1	57	13.5
625	-13.8	98	54.9	3791	26	7	1.00	7.4	65	15.0
650	-12.2	98	56.4	3493	20	8	1.00	7.5	72	15.5
675	-10.5	98	54.1	3203	13	7	1.00	7.4	79	15.2
700	-8.7	99	49.8	2922	9	7	1.00	7.1	87	14.6
725	-6.9	99	39.6	2649	10	6	1.00	6.3	93	14.3
750	-5.3	99	28.5	2383	12	5	1.00	5.3	98	14.2
775	-4.1	99	16.4	2125	10	4	1.00	4.0	102	14.0
800	-2.8	99	7	1874	6	3	1.00	2.6	105	13.8
825	-1.6	99	1.2	1629	3	1	1.00	1.1	106	13.7
850	-1	98	-2.1	1391	2	1	1.00	1.0	107	13.6
875	-1	97	-4.6	1160	2	1	1.00	1.0	108	13.5
900	-1.8	94	-6.5	935	4	1	1.00	1.0	109	13.4
925	-2.2	92	-6.9	717	4	1	1.00	1.0	110	13.3
950	-1.8	92	-4.4	505	4	1	1.00	1.0	111	13.2
975	-1.1	95	0.1	298	3	1	1.00	1.0	112	13.1
984	-1	97	0	225	2	1	1.00	1.0	113	13.0
1000	-0.1	-99	0	96						
Cobb SLR										13.0
H100 - H70 Thickness (NBM)										9.8
MaxT - Celcius (NBM)										7.8
NBM Blended SLR (33% / 33% / 33%)										10.2
H100 - H70 Thickness (Cobb)										9.5
Kuchera (MaxT) Method - Kelvin										10.0



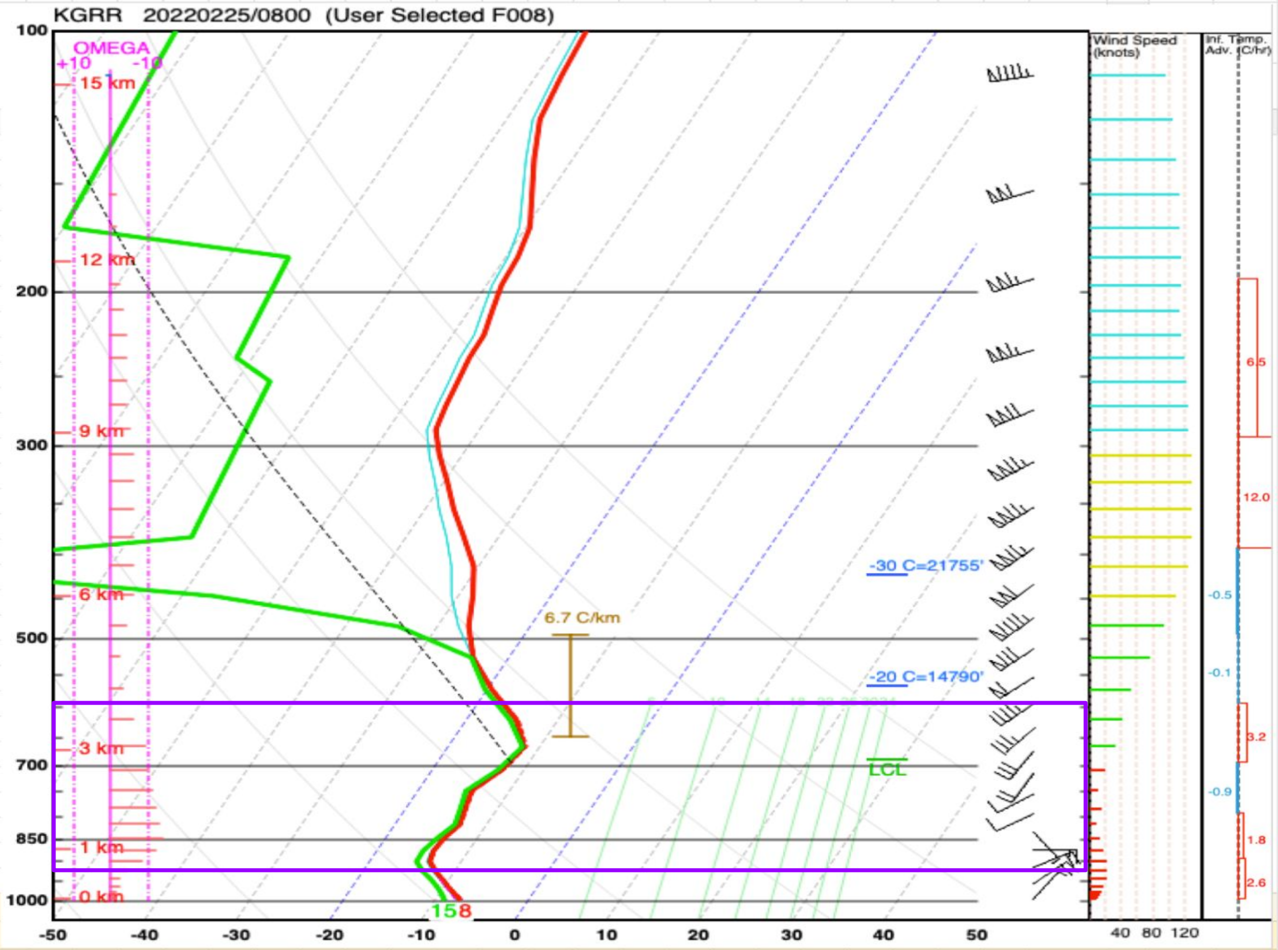
Mean Precip = 0.25 (9) Mean Snowfall = 3.5 (6) Mean SLR = 14:1

Grand Rapids MI

HRRR
2022-02-25 12Z F12

NBM v4.1 & v4.2
max SLR 30:1
+/- temps
VV0.5**

P(mb)	T(C)	RH (%)	W (cm/s)	Hght(m)	SLRw	VVw	RHw	PVV	PVVs	SLR
300	-43.4	6	12.6	8996	8	4	0.01	0.0	0	8.0
325	-40.3	5	12.6	8454	8	4	0.00	0.0	0	8.0
350	-37.5	4	11.8	7946	8	3	0.00	0.0	0	8.0
375	-34.6	3	11.2	7467	8	3	0.00	0.0	0	8.0
400	-31.9	1	10.6	7013	8	3	0.00	0.0	0	8.0
425	-29.8	1	10.1	6584	8	3	0.00	0.0	0	8.0
450	-28.3	10	9.2	6175	8	3	0.02	0.0	0	8.0
475	-27.1	39	6.7	5787	8	3	0.24	0.6	1	8.0
500	-25.6	69	4.6	5416	8	2	0.74	1.6	2	8.0
525	-23.9	98	2.8	5062	8	2	1.00	1.7	4	8.0
550	-21.5	95	3.4	4719	11	2	1.00	1.8	6	8.8
575	-19.1	93	4.2	4391	20	2	1.00	2.0	8	11.8
600	-16.5	94	6	4071	29	2	1.00	2.4	10	15.9
625	-14.3	95	7.8	3764	28	3	1.00	2.8	13	18.3
650	-12.7	97	9.5	3465	22	3	1.00	3.1	16	19.0
675	-12	98	10.5	3177	19	3	1.00	3.2	19	19.0
700	-12.5	97	10.7	2899	21	3	1.00	3.3	23	19.3
725	-13.4	95	11	2632	25	3	1.00	3.3	26	20.0
750	-14.2	95	11.2	2374	27	3	1.00	3.3	29	20.8
775	-13.8	95	11.6	2125	26	3	1.00	3.4	33	21.4
800	-13.3	95	11.9	1883	24	3	1.00	3.4	36	21.7
825	-13.3	95	12.2	1649	24	3	1.00	3.5	40	21.9
850	-13.8	93	12.3	1422	26	4	1.00	3.5	43	22.2
875	-14	91	10.4	1202	27	3	1.00	3.2	46	22.6
900	-13.5	88	6.7	987	25	3	1.00	2.6	49	22.7
925	-12.1	89	3.1	778	19	2	1.00	1.8	51	22.6
950	-10.5	90	1.6	574	13	1	1.00	1.3	52	22.3
975	-8.9	90	0.8	373	9	1	1.00	1.0	53	22.1
994	-7.9	89	0	225	8	1	1.00	1.0	54	21.8
1000	-7.5	-99	0	177						
Cobb SLR										21.8
H100 - H70 Thickness (NBM)										18.8
MaxT - Celcius (NBM)										19.1
NBM Blended SLR (33% / 33% / 33%)										**19.9**
H100 - H70 Thickness (Cobb)										18.1
Kuchera (MaxT) Method - Kelvin										17.9



Mean Precip = 0.11 (13) Mean Snowfall = 2.2 (9) Mean SLR = 20:1

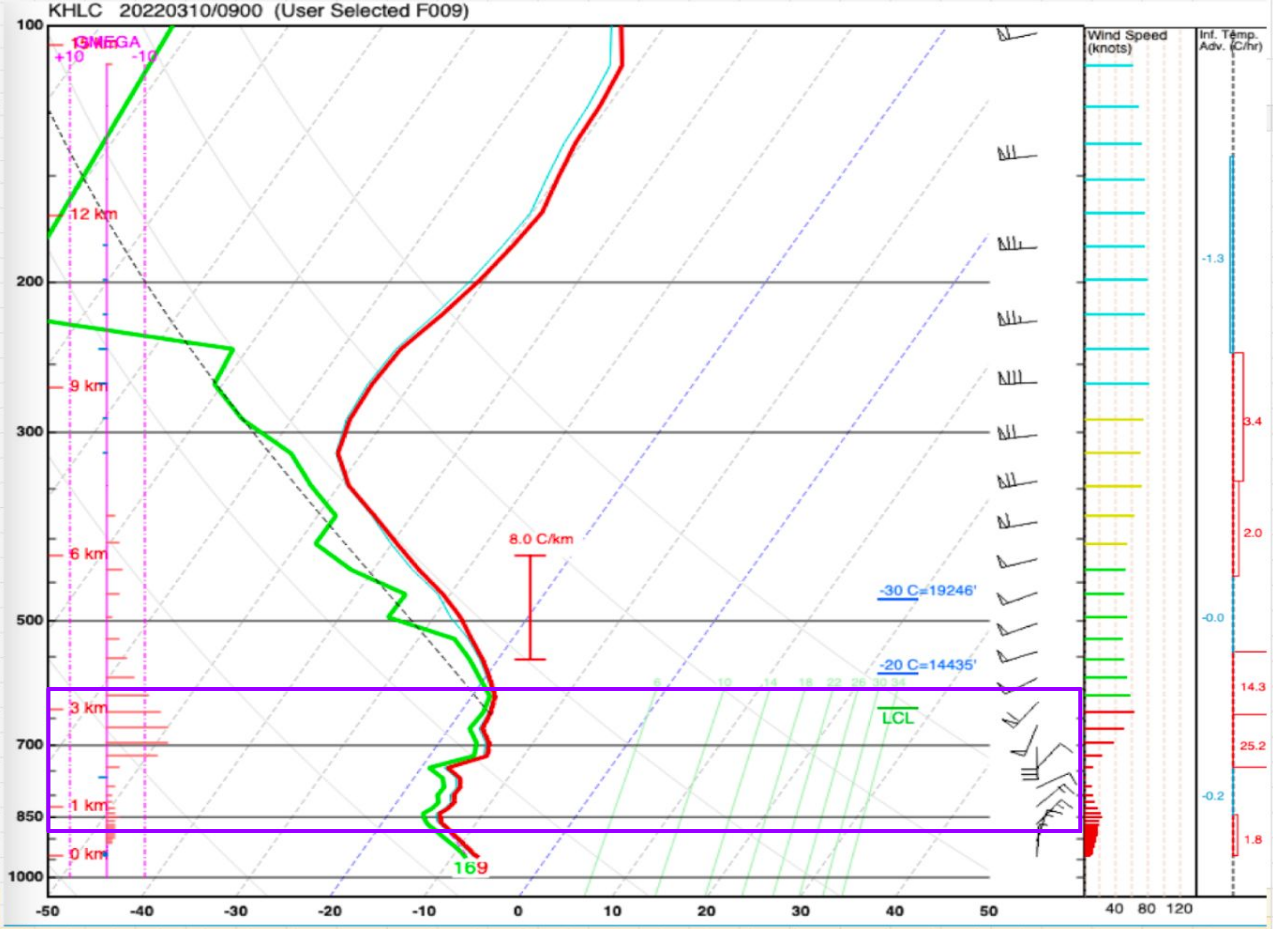
Hill City, KS (KHLC)

03-10-2022 00Z (F09) NAM3KM

NBM v4.1 & v4.2
max SLR 30:1
+/- temps
VV0.5**

P(mb)	T(C)	RH (%)	W (cm/s)	Hght(m)	SLRw	VVw	RHw	PVV	PVVs	SLR
300	-53.4	34	-2.1	8900	8	1	0.00	0.0	0	0.0
325	-51.7	56	-1.5	8383	8	1	0.00	0.0	0	0.0
350	-48.4	62	0.5	7899	8	1	0.60	0.6	1	8.0
375	-44.1	63	3.5	7442	8	2	0.62	1.2	2	8.0
400	-40.3	42	4.8	7005	8	2	0.28	0.6	2	8.0
425	-36.6	44	6	6588	8	2	0.30	0.7	3	8.0
450	-32.9	58	5.4	6189	8	2	0.53	1.2	4	8.0
475	-29.5	60	3.4	5806	8	2	0.56	1.0	5	8.0
500	-26.7	55	2	5438	8	1	0.47	0.7	6	8.0
525	-24.3	84	4.3	5085	8	2	1.00	2.1	8	8.0
550	-22	88	6.4	4744	10	3	1.00	2.5	11	8.4
575	-20.1	90	8.4	4416	16	3	1.00	2.9	14	9.9
600	-18.4	93	11.8	4099	23	3	1.00	3.4	17	12.6
625	-17.3	94	14.9	3794	27	4	1.00	3.9	21	15.3
650	-16.7	91	17.1	3499	29	4	1.00	4.1	25	17.5
675	-16	89	17.8	3216	29	4	1.00	4.2	29	19.2
700	-14.5	89	16.4	2941	28	4	1.00	4.0	33	20.3
725	-15	87	10.5	2675	29	3	1.00	3.2	36	21.1
750	-16.4	84	0.9	2419	29	1	1.00	1.0	37	21.3
775	-14.7	86	0.6	2172	28	1	1.00	1.0	38	21.5
800	-14.5	86	0.9	1931	28	1	1.00	1.0	39	21.6
825	-14.1	87	1.7	1698	27	1	1.00	1.3	41	21.8
850	-14.2	86	2.6	1472	27	2	1.00	1.6	42	22.0
875	-12.5	88	1.7	1251	21	1	1.00	1.3	44	22.0
900	-10.6	89	1	1035	13	1	1.00	1.0	45	21.8
925	-8.7	91	0	824	9	1	1.00	1.0	46	21.5
944	-7.3	89	0	665	9	1	1.00	1.0	47	21.2
1000	-4.3	-99	0	215	11	1	1.53	1.5	48	20.9
					1	1	0.00	0.0	48	20.9

Cobb SLR	20.9
H100 - H70 Thickness (NBM)	20.1
MaxT - Celcius (NBM)	14.0
NBM Blended SLR (33% / 33% / 33%)	**18.3**
H100 - H70 Thickness (Cobb)	18.8
Kuchera (MaxT) Method - Kelvin	14.3



Mean Precip = 0.43 (7) Mean Snowfall = 8.7 (6) Mean SLR = 20:1

Cobb Winter Wx Tool Applied to Time-Lag GEFS

KGRR Forecast from 06/00z Jan 12, 2024

- Utilizes full vertical resolution of BUFR/Bufkit files for GEFS / GFS
- Uses latest GEFS/GFS (32 members) + previous run (T- 6hr) for total of 64 members
- Processing includes Ptype, SLR, SN/IP/ZR accumulations
- Provides a hands-on approach to understanding ensemble probabilities
- Allows isolation of snowfall components (SLR, QPF, Temp, Wind, etc)

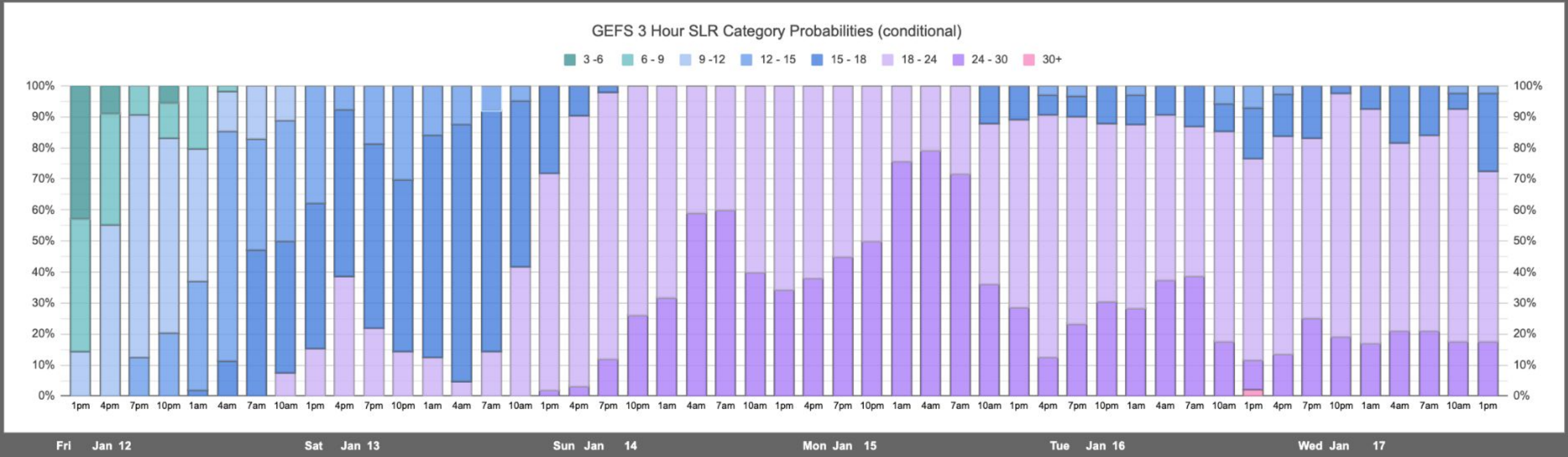
KGRR Jan 12, 2024

- Significant Winter Wx potential with initial synoptic storm followed by several Days of Lake Effect potential
- Dashboard provides overview of potential through the week
-

GEFS SLR for kgrr Issued Fri 20240112/0600z

	Fri	Jan 12							Sat	Jan 13							Sun	Jan	14						Mon	Jan 15							Tue	Jan 16							Wed	Jan	17						Thu	Average
LT	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	Scenario SLR
GFS		7	9		9	14			14		16	15	16	15	15			20	23	21																		24	23	22	19					23	21	20	14	17
GEFS C00		7	11	12	11	13	16	15	17	17	17	15	14	15	16	17	20	19	23	21	23	23	22	21	21	23		25		26	27	26	24	23		23	21	22	23	19	19	18	23	24	25			20	23	20
GEFS P01		9	10	11	8	13	13	16	18	17	17	15	15	16	16	17	18	20	23	21	26	24	24	24	26	25	24	22	27	28			24			21	16			20	17	19	24	25	24	24	22	24		20
GEFS P02		5	8	10	11	12		18	18	17	14	14	18	14	17	21	22	24	24	24	23	21		19	19	18	23	22			19	16	17	20	24	24	23	21	20			26	22	19	23	22	21	20	18	19
GEFS P03	6	10	11	12	12	15	16	16	15	17	18	16	17	15	16	15		19	22	19	25	25	24	21	19	21	22	23	25	26	26	27	23	23				22	24	20							25		23	19
GEFS P04		7	10	9	6	13	15	14	13	19	15	15	15	17	16	17	18			23		24	20												21	22	24	21	22	20	20	20	21	19	20	19	18	20	25	18
GEFS P05		8	10	10	11	14	15	18	18	19	15	14	15	15	16	18	20	19	22	21	23	21	23	23	23	22	23	23	22	24	24	23	22	23	25	24	23			19	17	15	16	15	20	18	16	17	16	19
GEFS P06		5	11	11	12	13	12		15	17	14	13	15	14	17	20	19			24		24	24	22	21	21	22	23	24	25	25	23	21	22	25	22							22	24				18	19	19
GEFS P07			8		11	12	12	11	13		19	17	16	15	14	17	17	20	21	22	23	24		23																										17
GEFS P08		8	11		6	12		10	12	17	15	14	14	14	15	18	19	19	20	22	21	25										27	25	23	23	21	20	22	23	21	20	20	22	21	23					18
GEFS P09		9	11	11	12	14	16	15	18	18	16	15	16	15	14	15	16	17	23	20	19													15	20	15	17			16	16	16	16				22	20	16	16
GEFS P10			7			10	10	13	13			22	22	17	16	17	19	21	22	21	21	25	26	25	25				27					23	22												21	19	21	19
GEFS P11	6	11	12	11	11	13	15	14	18	18	16	15	16	16	16	16		21					24	22	22	21			26	25	27	24	20		20	21	17						19	18	18	17	21	18	16	18
GEFS P12		8	8	9	10	13	14		15			18	19	19	16			22						21	19	22		24	23	23	25	22	20	22	22	24	25	25				21	19	23	24	21		19	22	19
GEFS P13		8	9	8	10	9	11	12	14	16	15	15	15	17	18	18	17	19	23	22	21		26	26	23	21	20	18	20	21	23	22								21	18	22	24				23	21	19	18
GEFS P14		9	11	11	9	13	12	12	13		19	17	18	16	16	14	17	17	17					20	20	21							19	20	25	21				19	20	17	17	19						17
GEFS P15		9	10	10		11	10			16	16	18	18	18	18	19	21	22							26	27	24					25														25				18
GEFS P16		7	10	8	9		12	14	15	18	15	14	15	16	16	18	20	21	23	20	23	22	22	24	24	25		27	26	27	27						26	24	24	22	20	21	24	20	23	22				20
GEFS P17		7	11	11	7	12		10				20	18	15	16	18		21	23	24	22	25	25																								23	21		17
GEFS P18			10	10	10	10	10	10	14	18	20	18	17	17	18	15	17	19	18	19		24	25	22	21	20									22	24	20			19	18	18	19	21						17
GEFS P19		7	12	5	10	14	14	13	16	17	14	14	15	16	16	17	19	21	23	22	23	25	22	21	23	23	22	23	25	26	26		24	24	26	24	23	21							22	25	23			19
GEFS P20			12	8		13	14	16	15	17	18	16	15	15	16	18	17	18	22	21	23	24	25	23	22	22	23	25	25				21	18		15	18	16	16	15	14	17	20	21	22	22	24	25	22	18
GEFS P21			10			11	10	10			17	16	16	16			20	19						22	23				25					19	19	20	21	21	19		17	16	17	19	17	18	18	17	17	18
GEFS P22	9	7	9	11	12	13	15	14	14	14	13	15	14	16	17	22	20	23	21	23	25	23	22	23	24	24	24	24	25	26		20	17	18	19	21	26		27	23	20	19	24	23	25	22	25	24	24	20
GEFS P23			8	8		11	10	13			16	18	20	17	19	19	18	19	22	22	25	23	24	22	22	21	23	23	22	23	20	16	16	15	17	18	19	19	17		16	19	21	21	21	25	24	26	25	19
GEFS P24		8	11	10	7	14	14	15	15	18	19	16	14	15	16	17	17	19	21	22			25	23	22	24	26		25					24			24	24	20		19	18	16	20	22	22	21			18
GEFS P25		9	11			11	10	12	13	17	17	15	16	15	16	17	17	20	20	22	23	22		25	24						27							21	21	23	21	20					28	27	21	19
GEFS P26		4	10	11	7	12			12	18	19	16	15	15	15	17	20	18																										18	19	22	20	24	22	16
GEFS P27		8	11	11	11	13	13	18	14	17	15	14	14	15	16	19	19	20	20	21	25	25	25	24	24	23	23	26	27							23	21	19	20	19	21	22			23	26	26	23	25	19
GEFS P28	4	11	12	9	11	12					16	16	16	16	17	19	19	19	20						23									25							24	23	23	27	22		20	19	20	18
GEFS P29			11	9		12		12	14	19	17	14	15	16	15	18	21	19	20	23	24	24	24	23					26	25	26	26	24	24	25	24	23	24	24				20	19	24					20
GEFS P30		8	11	11	12	14	16	17	17	18	15	13	17	17	16	18	20	19	20	24	21					21	23	20							19	23	23	22	24	18	19			21	23	22	21	21	19	18
GFS-6		8	9	5	12	14			15		16	14	15	15				20	23	22																					27	28		21	19		19	20	16	17
GEFS C00-6		10	11	11	12	14	16	15	17	18	17	15	15	16	16	16	19	19	22	22	22	23	23	22	23	24	25	25	25	24	25		20	21	21	18	22	23		22	22			18	19	17	19	21	19	19
GEFS P01-6		9	10	11	10	11	14	13	17	19	16	14	14	16	16	18	18	20	21	21	20	18	19	24	23	23	23	22			26	23	18		23	20			21	24	19	20	22	22	21	21	22	22	21	18
GEFS P02-6		9	12	10	8	14	14	16	14	14	15	14	15	15	13	15	19	19	21	23	23	23	22	20	19	22	24	25	24	26	25	23		21							23			22	18	21	23	20	15	18
GEFS P03-6		10	10	8	9	13	13					18	16	13	16	15	18	17																						19		24								15
GEFS P04-6		9	11	12	11	13	17	16	15	19		15	15	15	16	16	19	21	24	24	24	25	25	25	23	28		26	24	29										18	21	21	22	21	21					19
GEFS P05-6		10	6	7			10	10	13	16	15	15	18	15	17	18	19	20	23	22								24			26															17	20	22	21	17
GEFS P06-6		9	11	13	14	16	15	13	13	14	14	15	15	17	16	17	18	21	21	23	23	24	21	23	27	25	22	21	25	26	28	26	25					24	19		17	19	24	21					28	20
GEFS P07-6		5	12	9	12	13		13	16		16			16	15	16	18	16															23	23										21	22	20	17			16
GEFS P08-6		8	11	11	11	14	15		13	15	17	14	14	16	17	17	19	18	23	23	22	21												20	17	15	14	16	18	18	20	21	23	20	21	23	19	19	21	17
GEFS P09-6		9	12	13	9	13		17	16	20	17	15	15	14	18	15	17	17	21	21	23	24	24	24	23	23	24	22	22															24	25					19
GEFS P10-6		10	10	10	14	14	17	17	17	18	18	15	15	16	15	17	19	19	21	24	23	24	26	24																			17	18	18	18				18
GEFS P11-6	7	5	11	11	9	14	12	18	17	17	20	16	15	16	17	15		18											24		23	21	19	18	19	18	23	19	19	14	14	14				20				16
GEFS P12-6		7	11	11	11	15	15	14	16	17	15	15	16	17	17	17	18	18	21	23	25	22	24																		21	19	22	23	21	28		22	24	18
GEFS P13-6		9	11	12	14	15	16	17	16	16	14	14	15	17	16	18	21	21	21	24	23	22	23								25		22	23	24	25	25	24	26		30		21	19	17	15	18	21	21	19
GEFS P14-6		9	10			8	10	13	14	17	14	15	15	16	17	16	15	19				23	27	24	24	27	24	24	25									16	17	14	14								17	17
GEFS P15-6		9	10	11	11	14	15	17	16	18	17	14	14	15	18	17	17	19	24	24	24					25	24	22	25		23			13	14	15	20	23	24	19	21	21		21	21	23		21	17	18
GEFS P16-6		11	9	10	11	14	16	16	18	16	18	16	15	15	16	17	17	17														21														18	21	20	22	16
GEFS P17-6		9	9		8	13	14	13	15	17	20	19	16	17	18	14	17	19	20	22																					22	27	24	26						17
GEFS P18-6		6	9	10	13	14	16		17	14	16	15	16	16	17	17	18	19	19	20	24	24	25	23	22	21																			20	18	15	13		17
GEFS P19-6		10	11	12	12	14	16	14	17	15	14	14	14	15	15	21	22	21	25	22					22	23	21	23	22	22	19	17			22	26	24	21	24	28	23	23	25	18	18			20	15	19
GEFS P20-6		10	10		8	12	15	17	14	16	19	16	16	15	15	14	18	18	19	24		24		24	23															21	22			25	20	17	17	20	20	18
GEFS P21-6		10	11	12	12	15	15	16	17	19	16	16	15	16	17	18	19	21	20	21	23	25	26	24	23	24	25	26	24	25	25	23	24	23	23	23	25	25	25	25	23	23	24	26	25	26				21
GEFS P22-6		11	11	11	12	12	14	17	12	17	16	16	16	16	16	19	24	22	23	24	24	24	23	22	24	24	23	24	26	25	25	24	20	20				18	16	16	17							19	17	19
GEFS P23-6	3	10	11	4		12	12	16	12	18	14	15	15	14	14	16	18	18	22	19	22		20	20	21	22	22	24	25	27	26	24	25	22	23	24	23	25	25	25	25	27	27	23	20	22	18			19
GEFS P24-6		6	10	10	13	14	17	13	16	15	14	14	15	16	15	17	19	20	23	21		22	23	20	22	23	25	25	24	24	24	22	19	20	20	21	21	24	25	26	29	20	19	19	22	16			22	19
GEFS P25-6		10	11		8	12		16	19	17	16	15	16	17	17	20	20	21	24	24	25	26	25	27	24	24	24	23	25	24	19	21	21	22	23	24	25	26	26	24	19			20				20	18	20
GEFS P26-6		11	12	12	14	14	13	16	14	16	13	14	16	15	15	18	22	24	23	24	23	22											19	20	21	20	20	24	18	19	21	20	21				16	19		18
GEFS P27-6			9	12	13	14	15	14	18	20	15	13	16	13	18	19	17	18							25																									16
GEFS P28-6	3	8	11	11	15	15	17	14	16	17	19	15	16	18	19	18	18	19	21	24		27		27	24	25	24	25	19	18	19	21	21	20	22	20	19	18	19	18	19	21	21	23	22	23	27	25	27	19
GEFS P29-6		10	11	12	14	16	17	15	18	16	16	18	16	16	14	16	17	19	24	23	22																				23	21	22		17	15	15			17
GEFS P30-6		10	11	10	8	13	14	16	16	18	15	17	14	14	16	15	16	20	23					26	26	23	23	18	19																18	25	26	23	22	18
	Fri	Jan 12							Sat	Jan 13							Sun	Jan	14						Mon	Jan 15							Tue	Jan 16							Wed	Jan	17						Thu	Storm SLR

GEFS Cobb Winter Wx Analysis: kgrr Issued Fri 20240112/0600z



Distribution of 3hr SLRs %

>30:1 is 0%

24 - 30 is 0%

18 - 24 is 56%

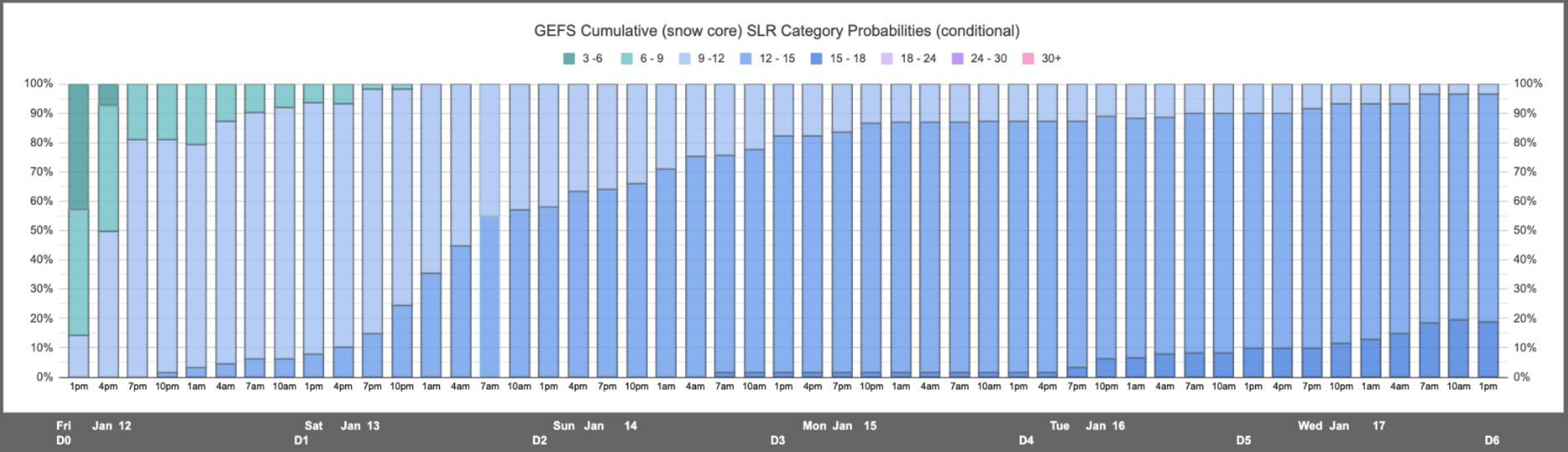
15 - 18 is 39%

12 - 15 is 1%

9 - 12 is 0%

6 - 9 is 0%

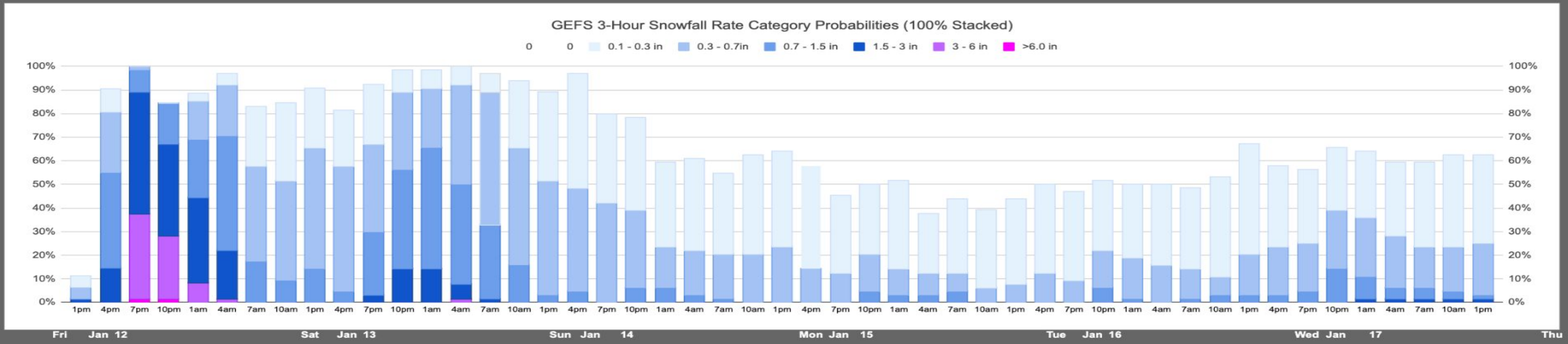
3 - 6 is 0%

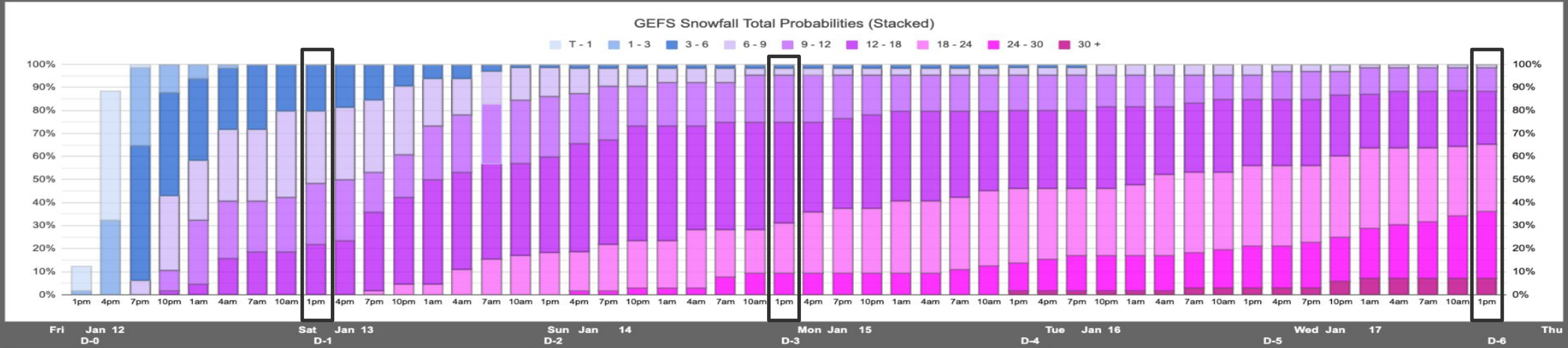


GEFS 3-Hour Snowfall Rates for kgrr Issued Fri 20240112/0600z

	Fri Jan 12								Sat Jan 13								Sun Jan 14								Mon Jan 15								Tue Jan 16								Wed Jan 17								Thu	Storm
LT	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	4pm	7pm	10pm	1am	4am	7am	10am	1pm	Totals
GFS	0.0	0.6	3.2	0.0	0.7	1.1	0.0	0.0	0.3	0.0	0.6	1.1	1.9	1.7	0.8	0.0	0.0	0.4	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.1	15
GEFS C00		0.4	3.0	4.4	1.7	1.2	0.5	0.3	0.3	0.2	0.3	0.8	1.1	0.8	0.5	0.2	0.2	0.4	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2		0.3		0.3	0.3	0.3	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3			0.2	0.2	22
GEFS P01	0.0	0.8	1.9	1.9	0.4	0.8	0.1	0.2	0.4	0.3	0.7	1.2	1.8	1.4	1.1	0.9	0.7	0.4	0.2	0.2	0.3	0.5	0.2	0.2	0.3	0.3	0.2	0.4	0.3	0.3	0.0	0.0	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.2	0.3	0.2	0.5	0.5	0.5	0.2	0.7	0.5	0.0	23
GEFS P02		0.2	0.5	1.5	1.7	0.6		0.5	0.7	0.7	1.8	1.5	2.9	1.8	1.0	0.4	0.4	0.2	0.2	0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2			0.2	0.2	0.2	0.2	0.2	0.7	0.7	0.4	0.2			0.3	0.2	1.3	0.5	0.2	0.2	0.4	0.4	25
GEFS P03	0.5	1.2	3.1	3.4	1.9	2.0	0.6	0.2	0.5	0.3	0.2	0.6	1.5	0.6	0.5	0.3	0.0	0.2	0.2	0.4	0.3	0.5	0.5	0.6	0.6	0.4	0.7	0.7	0.5	0.5	0.3	0.5	0.5	0.2	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	26
GEFS P04		0.4	1.5	1.0	0.6	1.6	0.9	0.1	0.3	0.2	0.5	1.2	1.4	1.0	0.8	0.3	0.2			0.2		0.2	0.2												0.2	0.4	0.5	0.2	0.4	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	18
GEFS P05	0.0	0.6	2.1	3.8	3.0	1.8	0.9	0.4	0.5	0.6	0.9	1.0	1.4	0.8	0.8	0.7	0.6	0.6	0.7	1.5	0.7	0.6	0.7	0.5	0.5	0.4	0.5	0.9	0.9	0.7	0.7	0.5	0.4	0.5	0.3	0.5	0.2	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.5	34
GEFS P06		0.1	2.6	2.6	1.2	0.7	0.1		0.3	0.3	0.3	0.3	0.6	0.4	0.3	0.2	0.2			0.2		0.2	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.5	0.2	0.2	0.2	0.3	0.2							0.2	0.5				0.4	0.2	16
GEFS P07	0.0	0.0	1.6	0.0	3.2	0.6	0.4	0.8	0.1	0.0	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10
GEFS P08		0.6	3.5		0.6	0.4		0.1	0.1	0.2	0.5	1.0	1.3	1.0	0.8	0.5	0.6	0.8	0.6	0.4	0.4	0.3										0.3	0.3	0.5	0.2	0.4	0.2	0.2	0.5	0.4	0.4	0.4	0.2	0.2	0.2					18
GEFS P09	0.0	0.7	3.7	2.5	2.4	1.3	0.3	0.3	0.4	0.4	0.5	1.4	0.8	0.6	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.3	0.6	0.5	0.2	0.0	0.0	0.0	0.2	0.2	0.2	20
GEFS P10			1.1			1.7	1.1	0.9	0.4			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.6	0.4	0.3	0.3	0.5	0.3				0.3					0.2	0.2												0.2	0.2	0.2	11
GEFS P11	0.5	1.5	3.8	1.8	1.5	1.4	0.5	0.1	0.2	0.4	0.3	0.8	1.0	0.8	0.5	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.3	0.3	0.3	0.2	0.2	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.7	0.5	0.4	0.2	0.2	21
GEFS P12		1.0	1.0	2.6	1.2	1.4	0.3		0.2			0.2	0.4	0.6	0.3			0.2						0.2	0.4	0.2		0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3				0.2	0.4	0.9	0.2	0.2		0.2	0.4	15
GEFS P13	0.0	0.5	2.8	2.6	1.3	0.5	0.7	0.7	0.4	0.3	0.8	0.9	0.6	0.5	0.5	0.4	0.3	0.2	0.5	0.2	0.2	0.0	0.3	0.5	0.7	0.4	0.4	0.4	0.6	0.6	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.5	1.7	1.5	24
GEFS P14		1.3	1.8	2.8	0.7	0.5	0.1	0.1	0.3		0.2	0.5	0.7	0.3	0.3	0.1	0.2	0.2	0.2					0.2	0.2	0.2							0.2	0.2	0.3	0.2				0.4	0.6	0.9	0.2	0.2						14
GEFS P15	0.0	0.9	2.4	2.2	0.0	1.0	0.2	0.0	0.0	0.2	0.2	0.2	0.2	0.5	0.5	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	11
GEFS P16		0.5	2.4	1.4	0.1		0.1	0.1	0.5	0.4	0.5	0.8	0.9	0.8	0.8	0.7	0.6	0.4	0.5	0.6	0.5	0.2	0.2	0.2	0.2	0.3		0.3	0.3	0.3	0.3						0.3	0.2	0.2	0.2	0.4	0.4	0.7	0.6	0.2	0.2				18
GEFS P17	0.0	0.4	3.9	2.8	0.4	0.2	0.0	0.1	0.0	0.0	0.0	0.2	0.7	0.8	0.5	0.2	0.0	0.2	0.2	0.2	0.7	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	13
GEFS P18		0.0	1.1	1.8	1.0	0.5	0.1	0.2	0.1	0.2	0.2	0.4	0.2	0.2	0.4	0.8	0.3	0.4	0.4	0.2		0.2	0.3	0.2	0.2	0.2									0.2	0.2	0.2			0.2	0.2	0.2	0.2	0.2						11
GEFS P19	0.0	0.4	3.2	1.2	1.6	3.1	0.7	1.3	0.3	0.5	1.1	1.1	0.8	0.8	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.5	0.5	0.2	0.2	0.3	0.3	0.3	0.0	0.2	0.2	0.3	0.5	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.8	0.2	0.0	0.0	24
GEFS P20		0.1	2.9	2.6		1.2	0.3	0.3	0.5	0.3	0.4	0.6	0.8	0.9	0.5	0.5	0.3	0.4	0.2	0.2	0.2	0.2	0.5	0.5	0.4	0.4	0.5	0.8	0.5				0.2	0.2		0.2	0.4	0.3	0.2	0.2	0.1	0.3	0.8	1.5	0.9	0.7	0.7	0.5	0.4	24
GEFS P21	0.0	0.0	2.4	0.0	0.0	0.8	0.2	0.1	0.0	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.4	0.2	0.2	0.0	0.2	0.2	0.3	0.4	0.2	0.2	0.2	0.2	0.2	9
GEFS P22	1.5	0.7	1.6	2.8	2.5	1.8	1.2	0.8	0.8	1.0	2.2	2.0	1.4	1.1	0.5	0.4	0.6	0.5	0.4	0.5	0.3	0.5	0.4	0.2	0.2	0.2	0.2	0.2	0.3	0.3		0.2	0.2	0.5	0.2	0.2	0.3		0.3	0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.3	0.2	0.2	32
GEFS P23	0.0	0.0	1.0	2.1	0.0	0.3	0.4	0.3	0.0	0.0	0.2	0.4	0.4	0.5	0.8	0.6	0.5	0.6	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.2	0.5	0.2	0.2	0.2	0.2	0.3	0.3	0.7	0.9	0.8	0.6	0.2	0.0	0.2	0.2	0.4	0.6	0.2	0.3	0.2	0.3	0.3	19
GEFS P24		0.6	2.5	0.9	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.5	0.8	0.6	0.5	0.3	0.2	0.2	0.2	0.2			0.3	0.5	0.4	0.2	0.3		0.3					0.2			0.2	0.2	0.2		0.2	0.2	0.3	0.4	0.2	0.2	0.2			14
GEFS P25	0.0	0.6	2.2	0.0	0.0	0.6	0.3	0.5	0.7	0.2	0.3	0.8	1.4	1.4	1.3	1.2	0.5	0.8	0.6	0.4	0.2	0.4	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.3	0.6	17
GEFS P26		0.1	1.8	1.7	0.5	0.5			0.2	0.2	0.4	0.6	0.6	0.5	0.3	0.2	0.2	0.2																										1.1	1.0	0.7	0.4	0.2	0.4	12
GEFS P27	0.0	0.6	3.5	3.7	1.8	2.9	0.8	0.4	0.8	0.5	0.5	0.8	0.8	0.5	0.5	0.2	0.4	0.6	0.6	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.5	0.3	0.3	0.2	0.3	25
GEFS P28	0.2	1.8	5.4	2.6	3.1	1.0					0.5	0.8	1.1	1.0	0.5	0.4	0.4	0.4	0.2						0.2									0.3							0.2	0.5	0.2	0.3	0.2		0.2	0.2	0.4	22
GEFS P29	0.0	0.0	3.6	2.4	0.0	0.2	0.0	0.4	0.3	0.4	0.5	1.1	1.4	1.3	1.1	0.7	0.6	0.6	0.4	0.5	0.2	0.5	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.2	1.0	0.2	0.0	0.0	0.0	0.0	21
GEFS P30		0.6	2.8	3.2	2.0	1.0	0.6	0.3	0.9	0.5	1.2	1.2	0.9	0.7	0.6	0.5	0.4	0.4	0.4	0.5	0.2					0.2	0.2	0.2							0.2	0.5	0.5	0.4	0.5	0.4	0.2			0.2	0.2	0.4	0.6	0.4	0.4	24
GFS-6	0.0	1.1	2.6	0.8	1.0	1.0	0.0	0.0	0.3	0.0	0.6	0.6	1.4	2.0	0.0	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.2	0.4	0.0	0.6	0.2	0.2	15
GEFS C00-6		1.0	3.2	4.6	3.1	1.4	0.5	0.3	0.3	0.4	0.3	1.1	0.8	0.8	0.6	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.3		0.2	0.2	0.2	0.2	0.2	0.2		0.2	0.2			0.2	0.4	0.9	0.6	0.2	0.4	27
GEFS P01-6	0.1	1.1	3.6	4.3	0.5	0.6	0.1	0.5	0.2	0.2	0.6	0.4	0.1	0.3	0.3	0.4	0.5	0.6	0.6	0.6	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.3	0.2	0.2	0.0	0.2	0.2	0.0	0.0	0.2	0.7	1.0	0.4	0.4	0.2	0.2	0.4	0.2	0.4	0.4	23
GEFS P02-6		0.9	4.1	2.8	1.3	0.7	0.7	0.2	0.7	0.3	1.1	1.0	0.5	0.6	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.2	0.3	0.2	0.3	0.3	0.2		0.2							0.2			0.2	0.7	0.2	0.2	0.2	0.2	22
GEFS P03-6	0.0	0.8	1.8	1.5	0.9	1.6	0.3	0.0	0.0	0.0	0.0	0.2	1.0	0.5	0.6	0.3	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10
GEFS P04-6		0.7	3.6	6.2	0.6	2.0	0.7	0.2	0.3	0.2		0.3	2.6	2.0	1.1	0.5	0.4	0.4	0.5	0.5	0.5	0.3	0.5	0.3	0.2	0.3		0.3	0.2	0.3										0.2	0.4	0.4	0.4	0.2	0.2					27
GEFS P05-6	0.0	2.9	1.1	1.1	0.0	0.0	0.4	0.9	0.5	0.3	0.2	0.5	1.4	0.9	0.9	0.4	0.4	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	0.2	0.2	15
GEFS P06-6		0.8	3.4	5.7	3.2	1.3	0.8	0.5	0.8	0.8	1.4	1.2	1.4	1.0	0.8	0.5	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3				0.2	0.2		0.2	0.2	0.2	0.2						0.3	30
GEFS P07-6	0.0	0.2	4.1	4.3	0.8	0.5	0.0	0.1	0.2	0.0	0.2	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.9	0.2	0.2	0.0	0.0	13
GEFS P08-6		0.6	2.5	4.2	2.4	1.3	0.3		0.3	0.3	0.3	0.4	0.8	0.6	0.9	0.3	0.4	0.2	0.2	0.2	0.2	0.2												0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.4	0.5	0.4	0.4	0.2	0.6	1.0	0.8	22
GEFS P09-6	0.0	0.7	7.1	5.3	1.5	0.8	0.0	0.3	0.3	0.4	0.9	1.1	0.9	0.6	0.5	0.3	0.3	0.5	0.6	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	27
GEFS P10-6		1.0	2.0	1.9	2.0	1.1	0.3	0.3	0.5	0.5	0.5	0.5	1.4	1.3	0.6	0.7	0.2	0.2	0.4	0.5	0.5	0.5	0.3	0.2																			0.5	0.7	0.2	0.2				19
GEFS P11-6	0.6	0.3	2.5	1.4	0.7	1.0	0.4	0.2	0.3	0.3	0.4	1.3	0.6	0.3	1.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	15
GEFS P12-6		0.8	3.9	4.4	1.7	1.5	0.3	0.6	0.3	0.3	1.1	1.7	1.1	1.0	0.9	1.4	0.5	0.2	0.2	0.2	0.3	0.2	0.2																		0.2	0.2	0.2	0.5	0.4	0.3		0.4	0.2	25
GEFS P13-6	0.0	0.9	2.6	1.6	1.5	1.2	0.8	0.3	0.6	0.3	1.0	1.8	1.2	4.1	2.2	0.7	0.6	0.4	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.5	0.5	0.8	0.5	0.5	0.3	0.0	0.3	0.0	1.5	1.1	1.2	0.9	0.2	0.2	0.6	33
GEFS P14-6		1.1	4.1		0.1	0.9	0.4	0.3	0.1	0.3	0.8	1.5	1.1	0.6	1.2	1.0	0.5	0.2				0.2	0.3	0.2	0.5	0.3	0.2	0.2	0.3									0.2	0.3	0.1	0.1								0.2	17
GEFS P15-6	0.0	1.1	1.9	2.9	1.8	1.1	0.2	0.3	0.8	0.5	0.9	1.3	1.0	0.3	0.4	0.5	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.4	0.3	0.0	0.2	0.0	0.0	0.1	0.1	0.2	0.2	0.5	0.5	0.2	0.2	0.2	0.0	0.4	0.4	0.2	0.0	0.2	0.2	21
GEFS P16-6		1.9	1.7	1.1	0.6	1.1	0.3	0.3	0.4	0.2	0.2	0.6	0.9	0.8	0.5	0.5	0.3	0.2														0.2														1.6	1.3	0.4	0.2	15
GEFS P17-6	0.0	1.1	2.2	0.0	0.8	0.8	0.3	0.3	0.3	0.2	0.2	0.4	0.3	0.3	0.5	0.3	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.2	0.5	0.0	0.0	0.0	0.0	0.0	10
GEFS P18-6		0.2	0.8	1.0	0.7	0.4	0.3		0.5	0.4	0.2	0.9	1.6	1.0	0.7	0.7	0.7	0.8	0.6	0.8	0.7	0.7	0.5	0.2	0.2	0.2																			0.4	0.4	0.5	0.1		16
GEFS P19-6	0.0	1.2	1.7	3.4	2.6	1.3	0.5	0.4	0.7	0.3	0.8	1.0	0.3	0.3	0.2	0.2	0.4	0.2	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.5	0.4	0.2	0.2	0.2	0.0	0.0	0.2	0.3	0.5	0.2	0.2	0.3	0.5	0.5	0.3	0.2	0.4	0.0	0.0	0.2	0.2	22
GEFS P20-6		1.4	2.4		2.4	2.9	0.9	0.5	0.7	0.2	0.4	0.8	1.1	1.1	0.6	0.1	0.2	0.2	0.2	0.2		0.2		0.2	0.2															0.2	0.2			0.5	1.6	0.7	0.5	0.2	0.2	21
GEFS P21-6	0.0	2.2	4.5	2.6	0.8	1.2	0.2	0.2	0.5	0.4	0.5	2.1	2.1	1.4	1.0	0.5	0.2	0.6	0.4	0.6	0.9	0.5	0.8	0.5	0.2	0.2	0.3	0.3	0.2	0.3	0.8	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.5	0.5	0.2	0.3	0.3	0.3	0.0	0.0	0.0	32
GEFS P22-6		1.5	2.8	4.4	2.5	1.6	0.6	0.5	0.5	0.3	0.2	0.5	0.5	0.3	0.6	0.2	0.2	0.4	0.5	1.0	1.0	0.7	0.7	0.4	0.5	0.2	0.2	0.5	0.3	0.3	0.3	0.2	0.2	0.2				0.2	0.2	0.2	0.2							0.4	0.2	26
GEFS P23-6	0.2	1.5	2.8	0.8	0.1	1.6	0.8	0.3	0.6	0.4	0.8	1.5	1.7	1.0	0.8	0.3	0.4	0.5	0.4	0.4	0.2	0.0	0.2	0.4	0.4	0.4	0.4	1.0	0.8	0.8	0.8	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.8	1.0	0.8	0.5	0.9	0.6	0.4	0.2	0.0	0.0	31
GEFS P24-6		0.2	2.0	2.3	0.8	0.3	0.3	0.5	0.3	0.5	1.3	0.8	0.6	0.8	0.6	0.5	0.6	0.4	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.5	0.5	0.2	0.2	0.2	0.2	0.4	0.4	0.5	0.5	0.3	0.3	0.2	0.6	1.1	0.4	0.3			0.2	22
GEFS P25-6	0.0	1.5	4.8	0.0	0.9	0.8	0.0	0.3	0.4	0.9	0.8	0.6	0.5	1.0	0.7	0.6	0.4	0.4	0.2	0.5	0.8	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.5	0.5	0.2	0.2	0.2	0.4	0.5	0.7	0.5	0.5	0.8	0.5	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.4	25
GEFS P26-6		1.7	3.2	2.6	2.0	1.1	0.3	0.3	0.8	0.6	0.3	0.4	0.5	0.6	0.5	0.2	0.2	0.2	0.5	1.4	0.5	0.2											0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.4	0.4	0.2				0.2	0.2		22
GEFS P27-6	0.0	0.0	2.0	3.4	2.1	0.7	0.2	0.4	0.4	0.4	1.2	1.3	0.6	0.3	0.4	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
GEFS P28-6	0.1	0.8	2.0	2.2	1.7	0.9	0.5	0.1	0.2	0.3	0.4	1.7	2.4	1.3	1.0	0.7	0.5	0.6	0.4	0.2		0.3		0.3	0.5	0.3	0.2	0.3	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.6	0.7	0.7	0.5	0.3	0.5	0.3	27
GEFS P29-6	0.0	0.9	3.3	4.7	3.1	1.8	0.7	0.5	0.5	0.3	0.3	0.5	0.3	0.3	0.3	0.5	0.3	0.4	0.5	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.2	0.3	0.2	0.0	0.0	21
GEFS P30-6		1.4	3.5	3.0	0.6	1.4	0.6	0.2	0.3	0.2	1.1	2.2	1.0	0.6	0.6	0.2	0.2	0.2	0.2					0.3	0.3	0.2	0.2	0.4	0.4																0.5	0.5	2.6	0.9	0.4	24

GEFS Cobb Winter Wx Analysis: kgrr Issued Fri 20240112/0600z





Snow Totals Excedence %

>30 is 7%

>24 is 31%

>18 is 62%

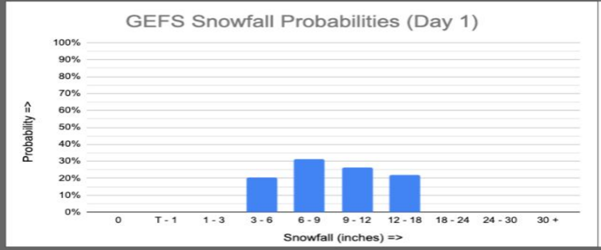
>12 is 87%

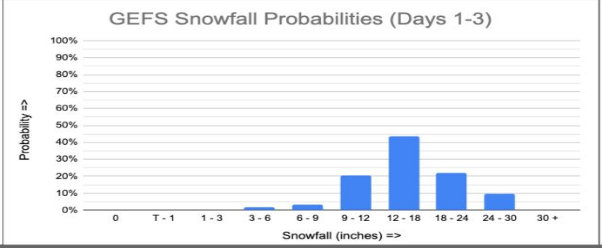
>9 is 98%

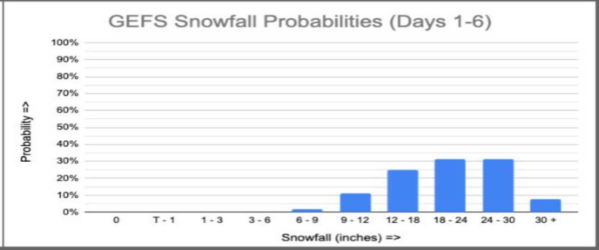
>6 is 100%

>3 is 100%

>1 is 100%

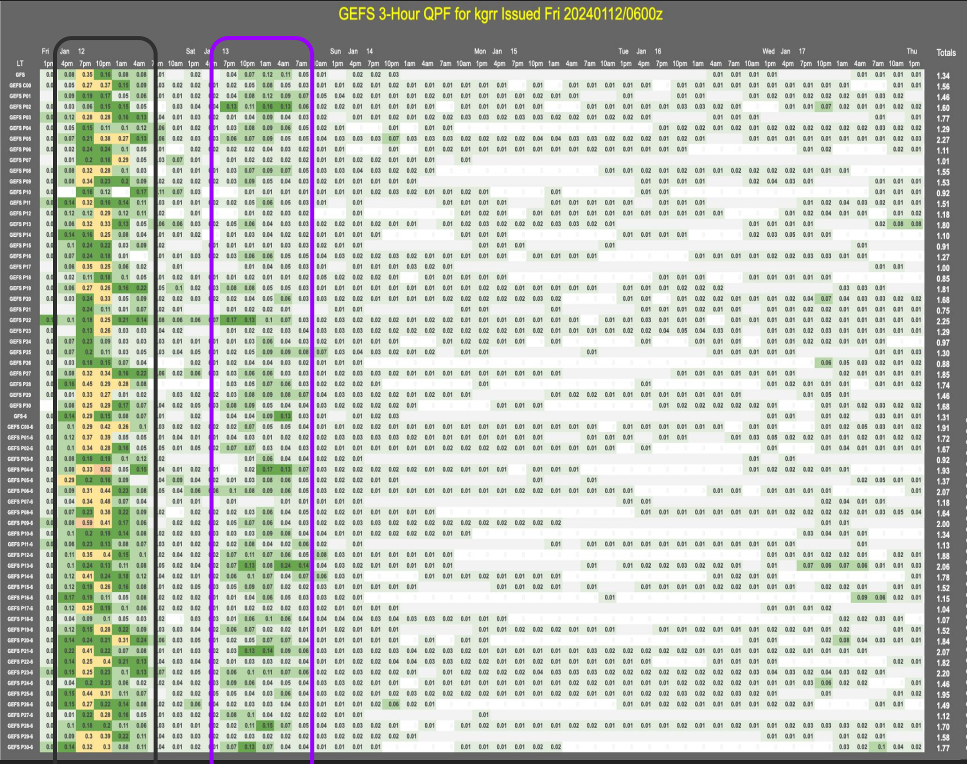


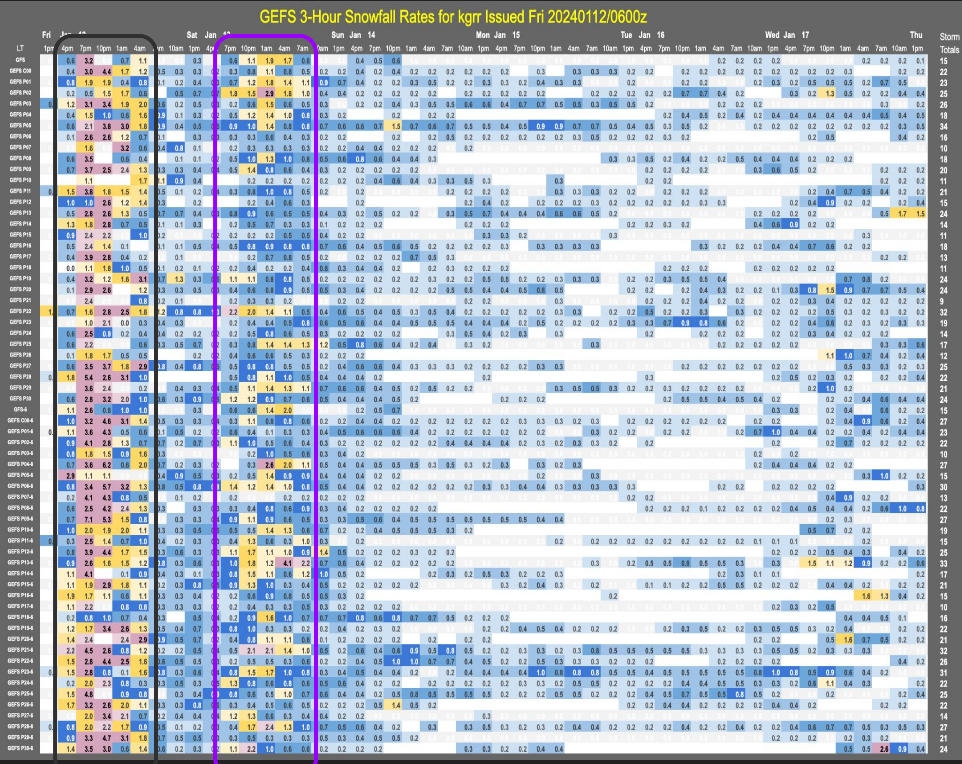


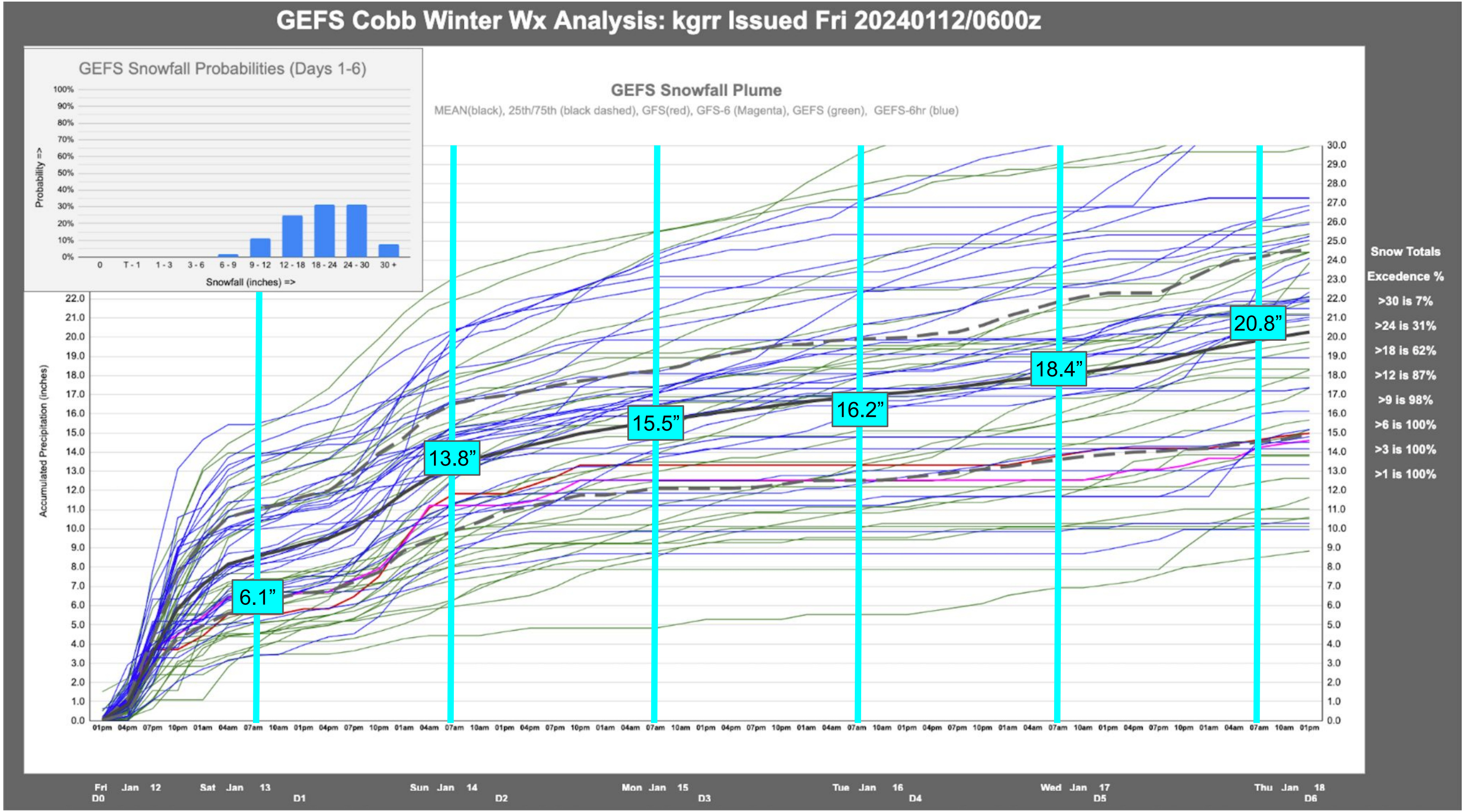


Cobb Winter Wx Tool Applied to Time-Lag GEFS

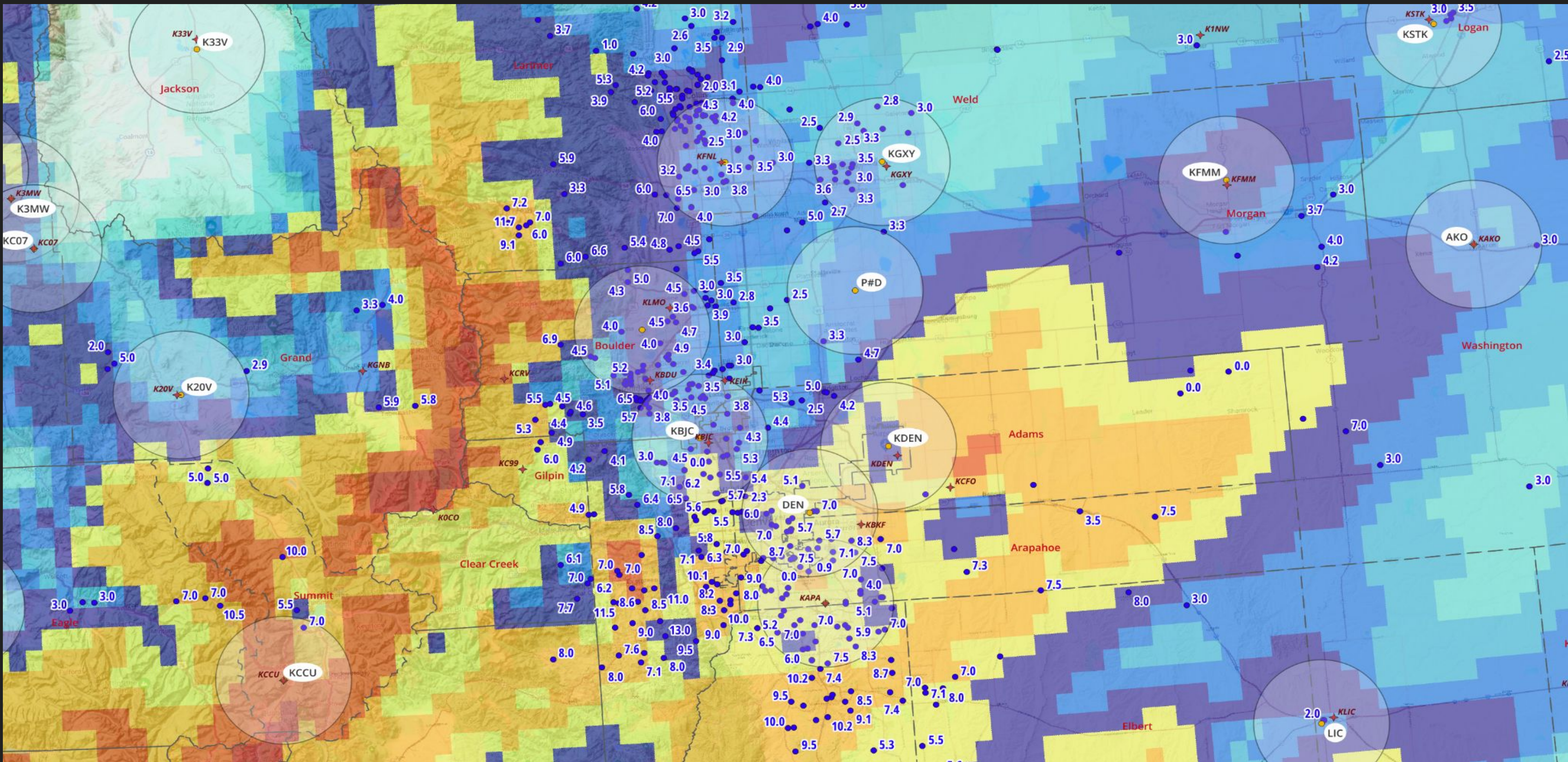
KGRR Forecast from 06/00z Jan 12, 2024






GEFS Cobb Winter Wx Analysis: kgrr Issued Fri 20240112/0600z
GEFS Snowfall Probabilities (Days 1-6)
Probability =>
Snowfall (inches) =>
0
T - 1
1 - 3
3 - 6
6 - 9
9 - 12
12 - 18
18 - 24
24 - 30
30 +
GEFS Snowfall Plume
MEAN(black), 25th/75th (black dashed), GFS(red), GFS-6 (Magenta), GEFS (green), GEFS-6hr (blue)
Accumulated Precipitation (inches)
6.1”
13.8”
15.5”
16.2”
18.4”
20.8”
Snow Totals
Excedence %
>30 is 7%
>24 is 31%
>18 is 62%
>12 is 87%
>9 is 98%
>6 is 100%
>3 is 100%
>1 is 100%
Fri Jan 12
D0
Sat Jan 13
D1
Sun Jan 14
D2
Mon Jan 15
D3
Tue Jan 16
D4
Wed Jan 17
D5
Thu Jan 18
D6

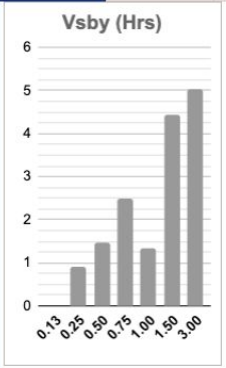
Verification / Validation Efforts

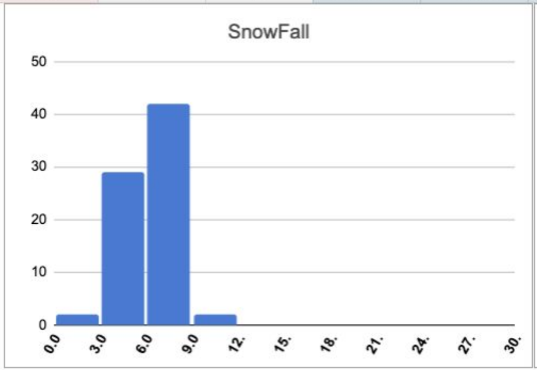


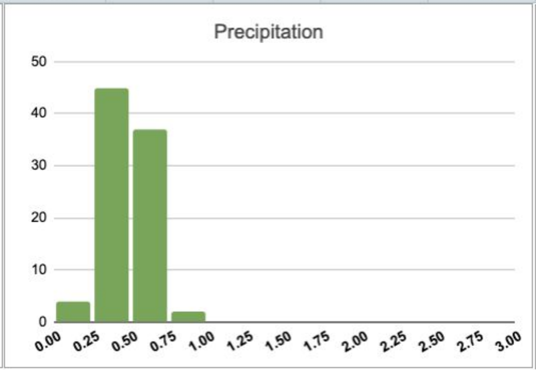
Verification / Validation Efforts

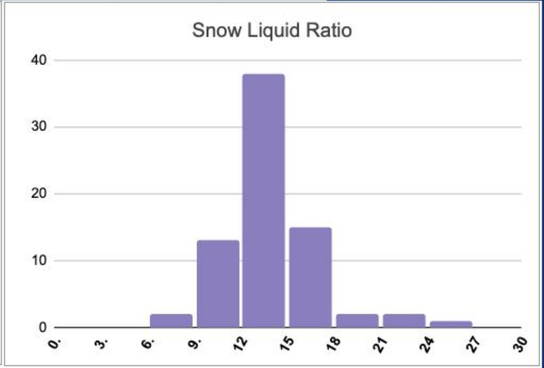
DEN (39.75, -104.87)
2023-10-29

	WetBulb Temp (F)		Wind (mph)		Hours per Visibility Threshold (SM)									
Metar	Max	Avg	Peak G	Avg Gust	Min 6hrs	Tot <0.75	Tot <3.0	0.13	0.25	0.50	0.75	1.00	1.50	3.00
KDEN	25.3	20.9	8	5	7:00 PM	4.84	15.65	0	0.9	1.46	2.48	1.35	4.43	5.03









		SnowFall					Precipitation					Consensus Snow to Liquid Ratio (SLR)				
OBS #	Avg Dist	25%	Median	75%	Mean	StdDev	25%	Median	75%	Mean	StdDev	25%	Median	75%	Mean	StdDev
94	16	5.5	6.5	7.5	6.4	1.8	0.41	0.48	0.54	0.47	0.14	12	13	15	14	3
									SWE Snow Liquid Ratio =>			12	14	15	14	3

Obs Date	Obs Time	ition Num	ation Name				Gauge Catch	Snow	SWE	SLR	Consensus SLR		METAR	BUF ID	Distance (km)	Obs Count

24HR CoCoRahs Consensus vs Simple NBM Comparison for 12Z 15Mar2023

Deterministic snowfall forecast based on corrected simple blend means for Tw, QPF, and Cloud SLR

	Observed				HREF 12Z 14Mar2023																									
	Area Mean Values				Raw Fcst / Cor Fcst		No Snow Melt				Snow Melt > 33F				$\left(\frac{(0.5\cdot x-15.50)}{10}\right)^{1.3}$				$\left(\frac{(0.5\cdot x-15.50)}{15}\right)^{1.3}$				$\left(\frac{(0.5\cdot x-15.75)}{10}\right)^{1.3}$				$\left(\frac{(0.5\cdot x-15.75)}{12}\right)^{1.3}$			
STN	Twsfc	SN	QPE	SLR	QPF	Twsfc	SN	Bias	ARE	SLR	SN	Bias	ARE	SLR	SN	Bias	ARE	SLR	SN	Bias	ARE	SLR	SN	Bias	ARE	SLR	SN	Bias	ARE	SLR
MEAN								3.10	0.67			0.14	0.32			-1.27	0.28			-0.10	0.26			-0.30	0.26			0.13	0.27	
KORH	31.5	7.6	1.01	7:1	1.07	31.7	12.7			14	9.2			10	7.6			8	9.2			9	9.0			9	9.7			10
					1.01	31.5	12.2	4.6	0.61	13	9.4	1.8	0.24	10	7.9	0.3	0.04	8	9.2	1.6	0.21	10	9.1	1.5	0.20	10	9.5	1.9	0.25	10
KALB	32.8	6.6	0.93	7:1	0.73	32.4	9.9			14	8.3			12	5.2			7	6.6			10	6.5			9	7.1			10
					0.93	32.8	12.5	5.9	0.89	15	9.4	2.8	0.42	11	5.6	-1.0	0.15	6	7.8	1.2	0.18	9	7.2	0.6	0.09	8	8.1	1.5	0.23	9
KCON	32.7	11.3	1.10	10:1	0.72	32.3	9.1			14	4.7			8	2.7			4	4.4			7	3.9			6	4.7			8
					1.10	32.7	13.6	2.3	0.20	14	4.9	-6.4	0.57	6	4.4	-6.9	0.61	5	7.2	-4.1	0.36	8	6.1	-5.2	0.46	7	7.3	-4.0	0.35	8
KMHT	33.3	11.4	1.39	8:1	1.09	33.1	13.1			14	7.5			8	5.5			6	7.8			8	7.0			8	7.9			8
					1.39	33.2	16.5	5.1	0.45	15	9.5	-1.9	0.17	8	7.8	-3.6	0.32	7	10.5	-0.9	0.08	9	9.5	-1.9	0.17	8	10.6	-0.8	0.07	9
KBED	33.6	3.2	1.45	3:1	1.61	33.5	14.7			16	6.6			7	5.2			5	7.2			8	6.7			7	7.4			8
					1.45	33.6	13.2	10.0	3.13	16	5.9	2.7	0.84	7	4.2	1.0	0.31	5	5.9	2.7	0.84	7	5.5	2.3	0.72	6	6.1	2.9	0.91	7
KPWM	32.9	4.8	0.72	6:1	0.88	32.9	10.7			14	7.4			9	5.2			6	6.7			8	6.6			8	7.2			9
					0.72	32.9	8.7	3.9	0.81	14	6.0	1.2	0.25	9	3.7	-1.1	0.23	5	5.0	0.2	0.04	8	5.0	0.2	0.04	7	5.4	0.6	0.13	8
KMPV	28.8	11.8	0.72	16:1	0.41	28.7	6.0			15	6.0			15	5.6			14	5.7			14	5.8			14	5.8			14
					0.72	28.8	10.5	-1.3	0.11	15	10.4	-1.4	0.12	15	9.9	-1.9	0.16	14	10.1	-1.7	0.14	14	10.1	-1.7	0.14	14	10.2	-1.6	0.14	15
KRUT	30.3	9.7	0.89	10:1	0.65	29.3	9.1			14	8.9			14	8.0			12	8.2			12	8.4			13	8.5			13
					0.89	30.3	11.8	2.1	0.22	14	10.2	0.5	0.05	12	8.5	-1.2	0.12	9	9.5	-0.2	0.02	11	9.5	-0.2	0.02	11	9.8	0.1	0.01	11
KCEF	33.2	3.3	0.70	5:1	0.54	33.6	6.1			17	2.3			6	1.1			3	1.9			5	1.7			4	2.0			5
					0.70	33.1	8.2	4.9	1.48	15	4.0	0.7	0.21	8	3.0	-0.3	0.09	5	4.2	0.9	0.27	8	3.9	0.6	0.18	7	4.3	1.0	0.30	8
KPSF	29.8	8.2	0.71	9:1	0.86	29.8	12.5			15	11.4			13	9.9			12	10.9			13	11.0			13	11.3			13
					0.71	29.8	10.2	2.0	0.24	15	9.3	1.1	0.13	13	7.7	-0.5	0.06	11	8.6	0.4	0.05	12	8.8	0.6	0.07	13	9.1	0.9	0.11	13
KBTV	32.5	11.2	1.10	12:1	0.58	31.5	8.2			15	6.9			12	5.3			9	5.9			10	6.1			11	6.3			11
					0.84	32.5	11.2	0.0	0.00	16	7.6	-3.6	0.32	10	5.6	-5.6	0.50	7	6.9	-4.3	0.38	9	6.7	-4.5	0.40	9	7.2	-4.0	0.36	10
KBGR	31.9	4.2	0.49	9:1	0.50	31.1	6.2			13	5.9			12	4.6			9	5.2			11	5.5			11	5.6			11
					0.49	31.9	5.8	1.6	0.38	13	4.6	0.4	0.10	10	2.7	-1.5	0.36	6	3.6	-0.6	0.14	8	3.6	-0.6	0.14	8	3.9	-0.3	0.07	9
KUCA/ KRME	31.3	6.5	0.55	12:1	0.44	32.7	5.9			14	4.9			12	3.2			7	4.0			9	4.0			9	4.3			10
					0.55	31.3	7.7	1.2	0.18	14	7.5	1.0	0.15	14	6.8	0.3	0.05	12	7.1	0.6	0.09	13	7.2	0.7	0.11	13	7.3	0.8	0.12	13
KITH	24.5	5.3	0.33	16:1	0.72	24.8	12.0			17	12.0			17	12.0			17	12.0			17	12.0			17	12.0			17
					0.33	24.5	5.5	0.2	0.04	17	5.5	0.2	0.04	17	5.5	0.2	0.04	17	5.5	0.2	0.04	17	5.5	0.2	0.04	17	5.5	0.2	0.04	17
KSYR	30.6	7.5	0.81	10:1	0.38	30.6	5.6			15	5.6			15	4.4			11	4.9			13	5.2			14	5.3			14
					0.81	30.7	12.1	4.6	0.61	15	12.1	4.6	0.61	15	10.7	3.2	0.43	13	11.3	3.8	0.51	14	11.6	4.1	0.55	14	11.7	4.2	0.56	14
KHFD	35.4	1.8	0.56	4:1	0.62	34.9	5.0			18	1.4			3	0.5			1	1.0			2	0.9			2	1.1			2
					0.56	35.4	4.3	2.5	1.39	23	0.3	-1.5	0.83	1	0.1	-1.7	0.94	0	0.4	-1.4	0.78	1	0.3	-1.5	0.83	1	0.5	-1.3	0.72	1

Current / Future Work

- Complete verification of past two seasons
- Investigating incorporation of a Rime Factor
- Diagnose snow size distribution (mass) to improve wet snow vs sleet/rain discrimination
- Improve surface/ground effects of wind, solar insolation, and warm ground temperatures
- Develop ensemble probability graphics to include RRFSe, SREF, and HREF

Thank You

Contact: Daniel.Cobb@noaa.gov