Winter Storms – Analysis, Prediction and Communication

Neil A. Stuart

NOAA/NWS Albany, NY

ATM362

High Impact winter storm events becoming more frequent – Just a few notable storms in the past 30 years
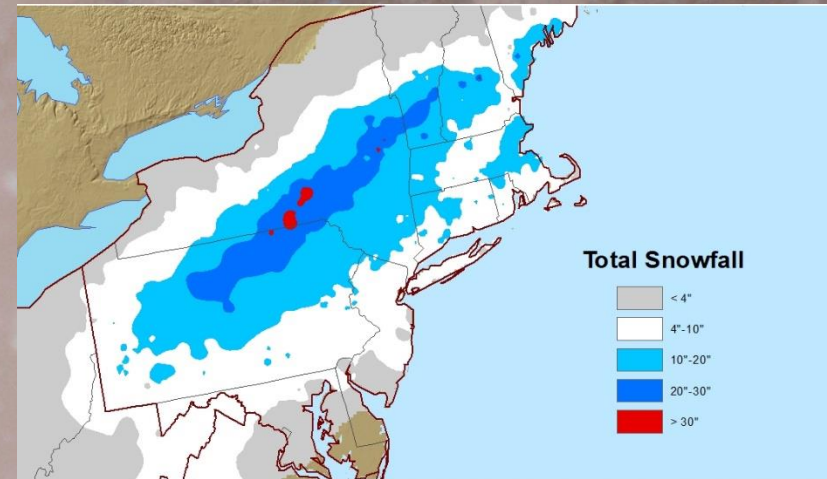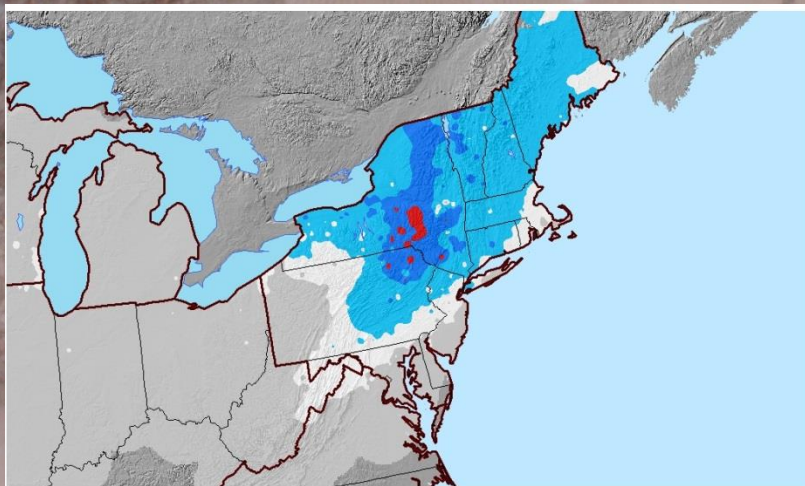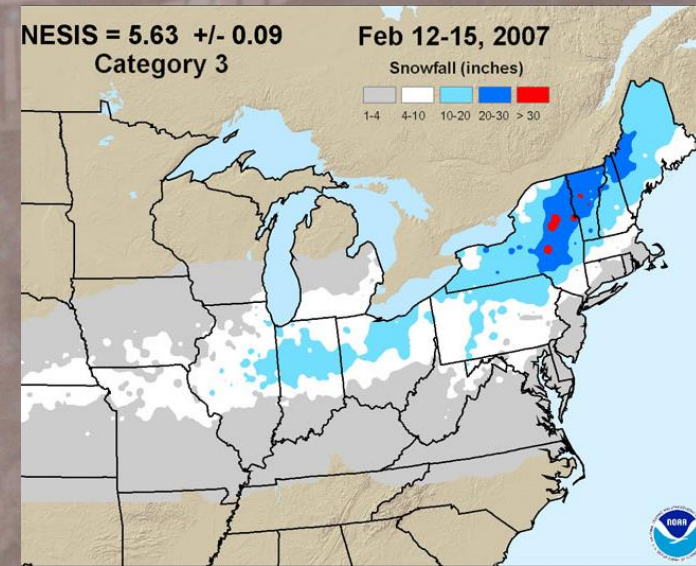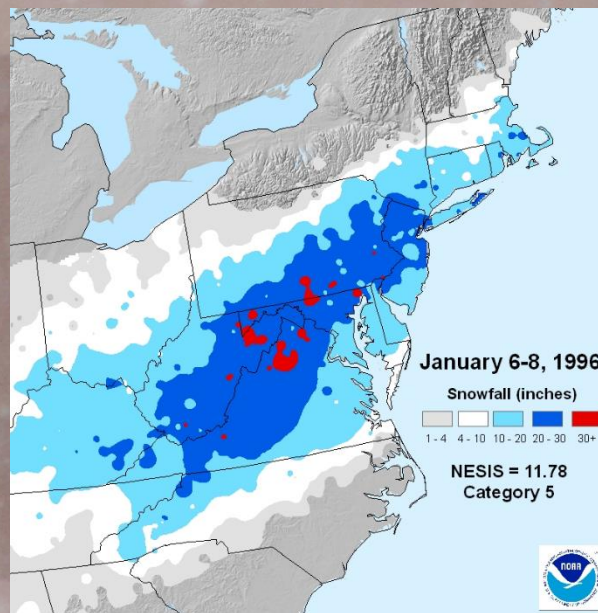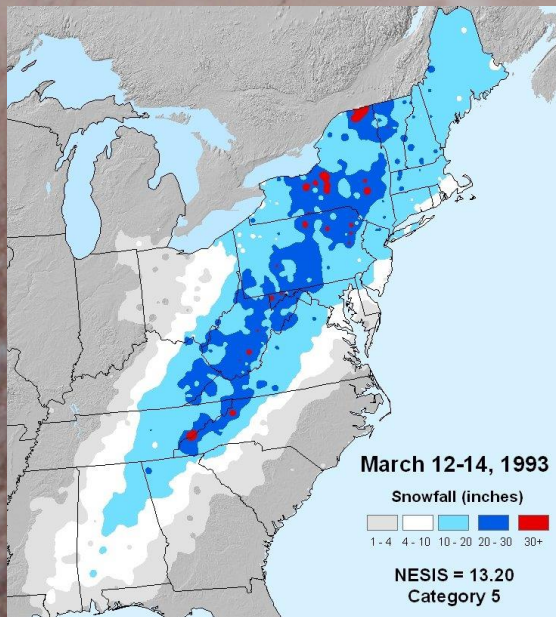
Many types of threats – Mesoscale Banding (UL), Mohawk/Hudson Convergence (UR), Mixed Precipitation (LL) and Upslope (LR)

KALB

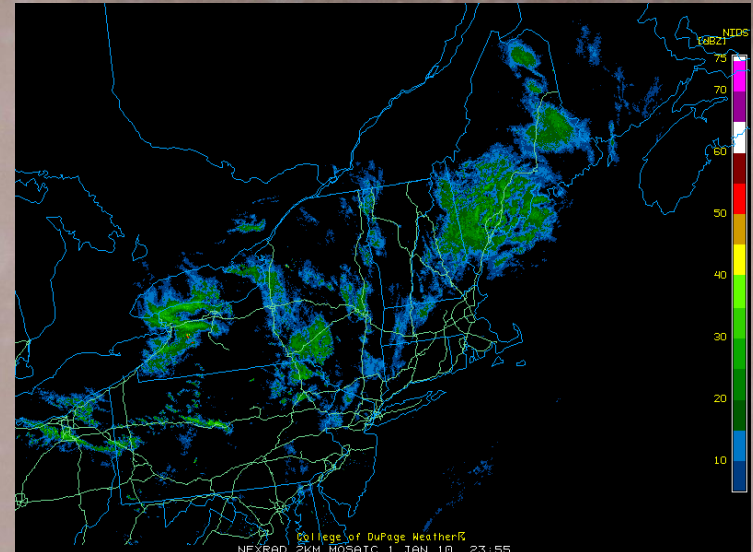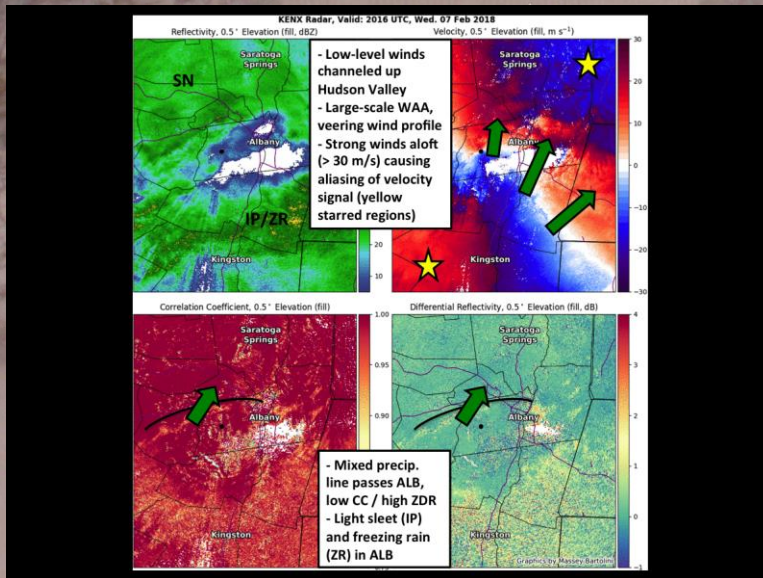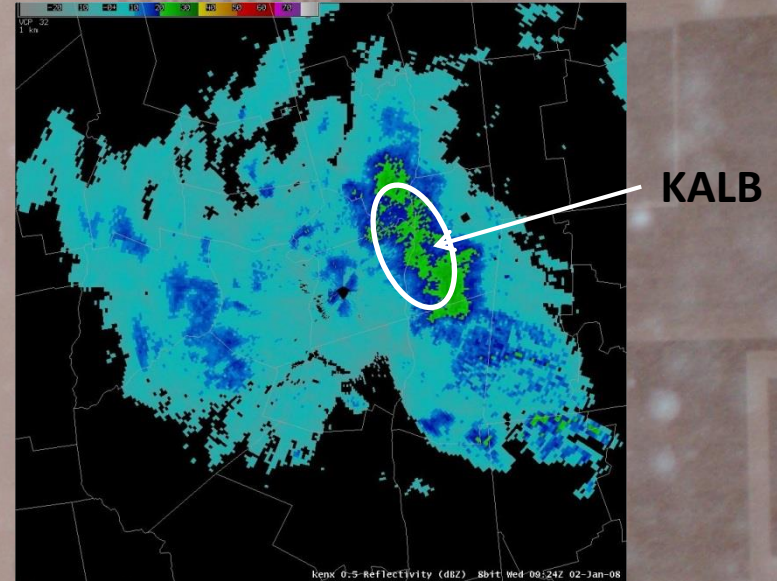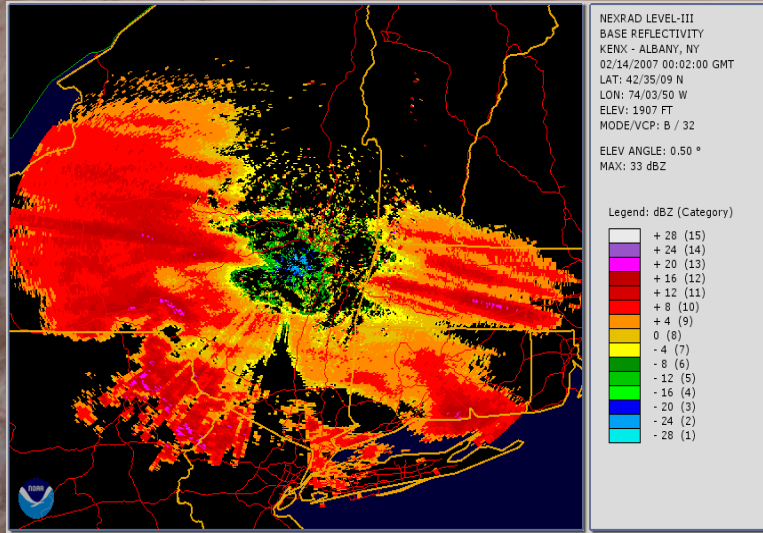# Predicting Winter Weather - It is as simple as:

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  - ✓ **Where is its origin (Gulf, Atlantic, Great Lakes, Pacific)?**
  - ✓ **Are moisture and forcing coincident?**
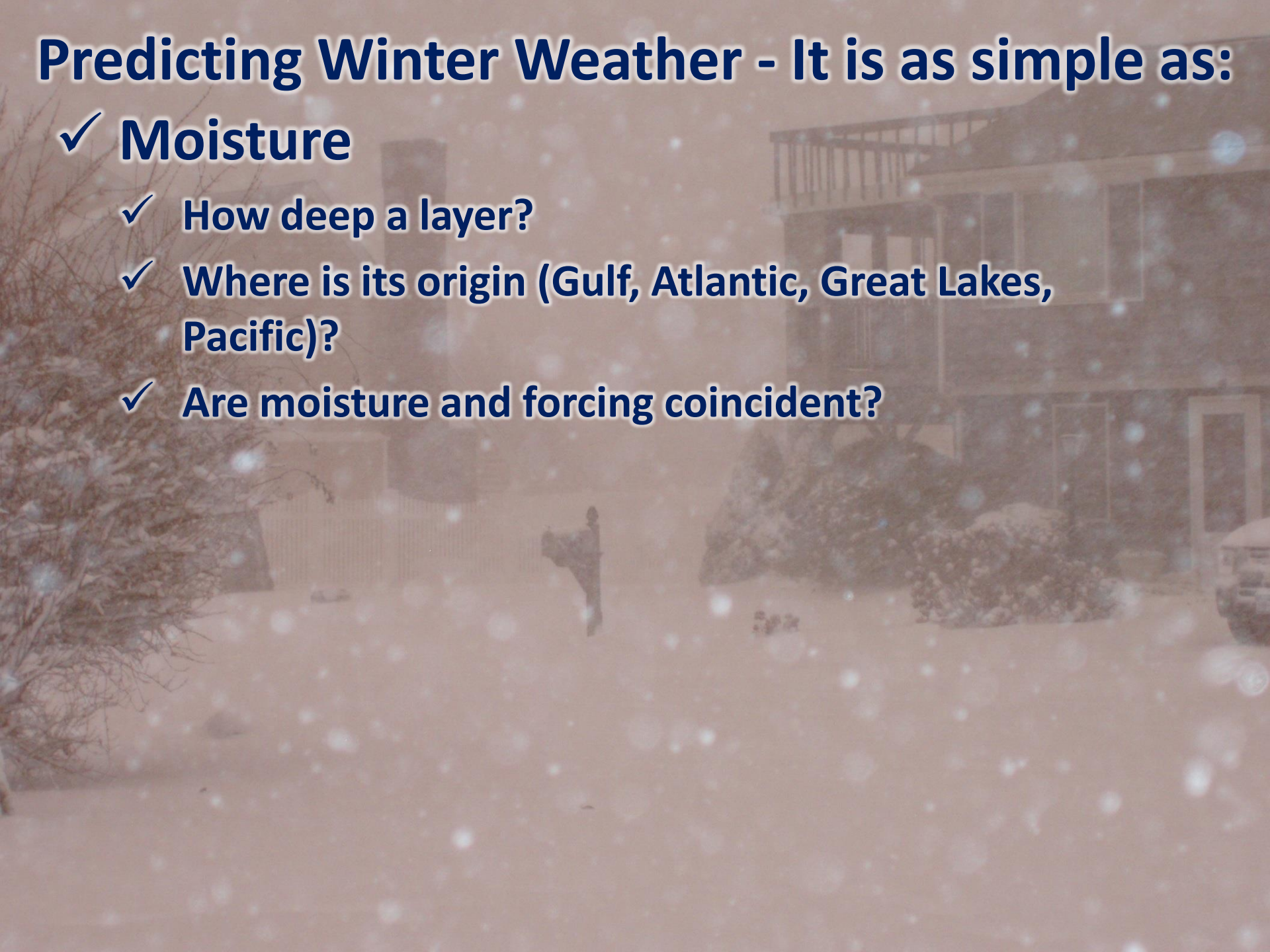
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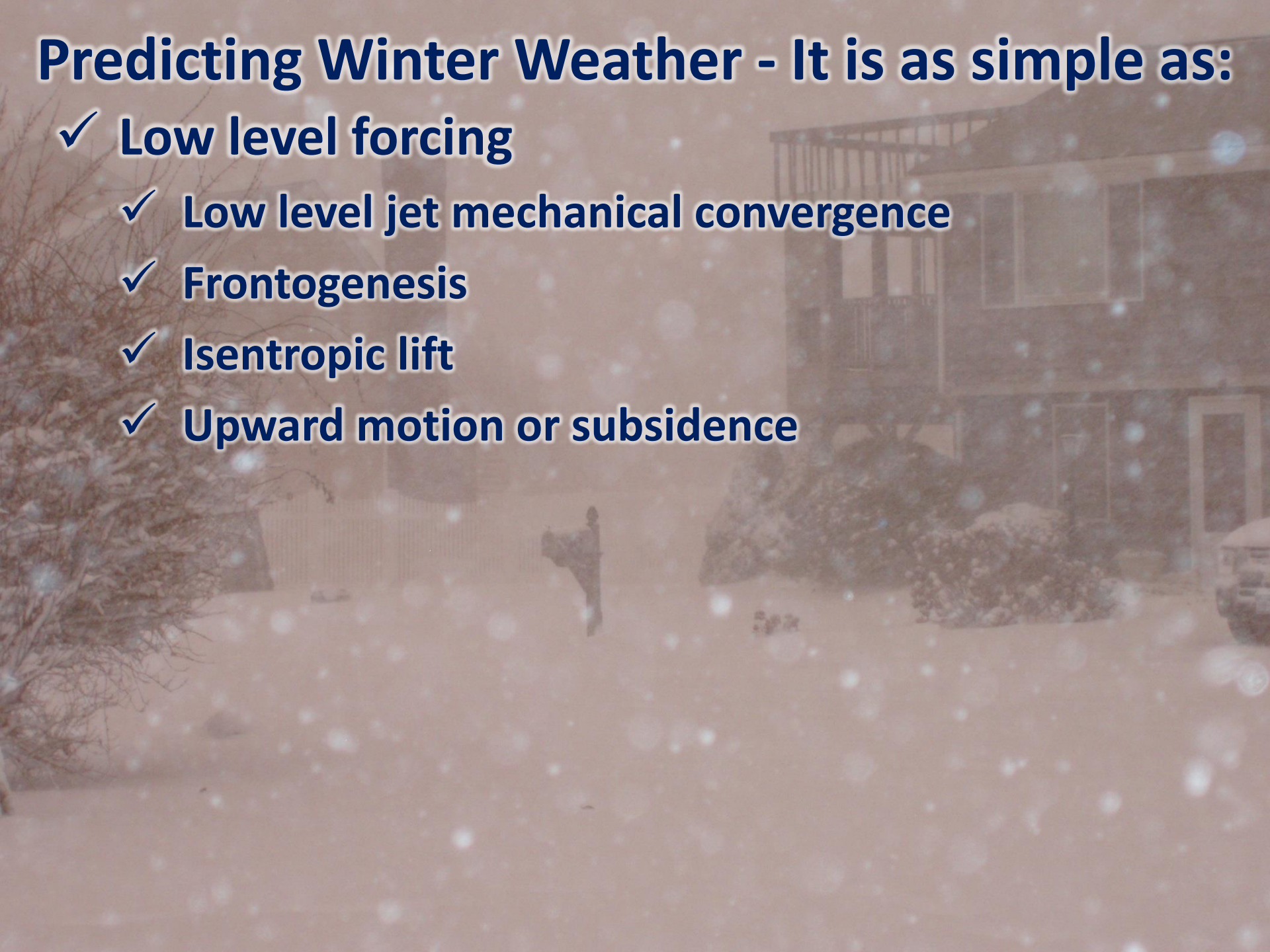
Predicting Winter Weather - It is as simple as:

- ✓ **Upper level dynamics**
  - ✓ **Vorticity/PVA**
  - ✓ **Upper jet dynamics (direct and indirect circulations)**
  - ✓ **Upper convergence or divergence resulting in subsidence or upward motion**

Predicting Winter Weather - It is as simple as:

- ✓ **Local/Mesoscale processes**
  - ✓ **Upslope/downslope proximate to terrain**
  - ✓ **Convergence/divergence due to terrain features**
  - ✓ **Thermal/moisture profiles/gradients between the surface and boundary layer**
 - ✓ **Lake Effect Snow bands**

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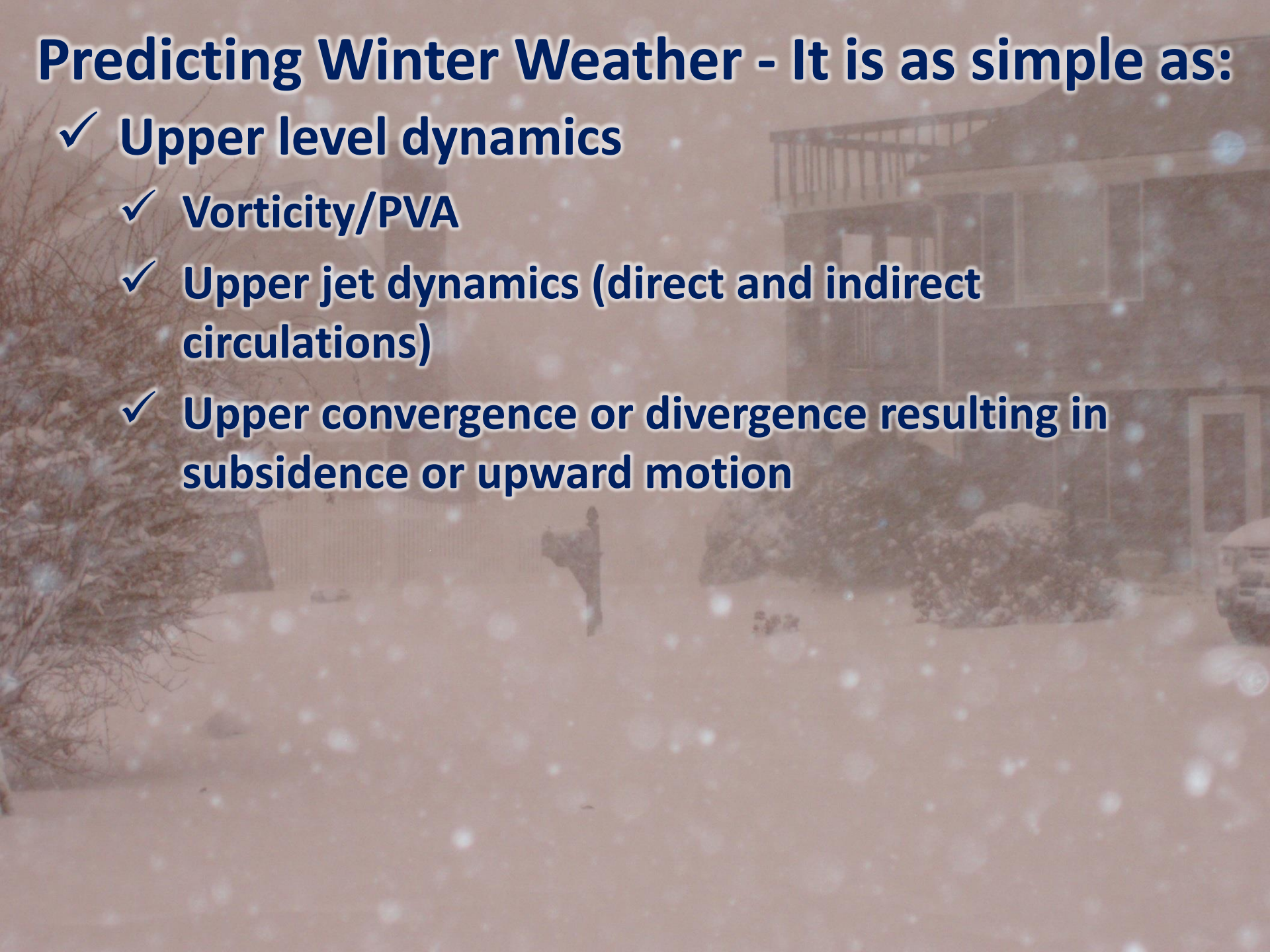
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O.K. maybe not so simple!

Outline

- ✓ **Synoptic Analysis**
  - ✓ **Conceptual Models – Longwave patterns, Pattern recognition**
  - ✓ **Data, Deterministic NWP Models, Ensembles, Anomalies**

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  - ✓ **HRRR, HREF, 3Km NAM**

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  - ✓ **Conceptual Models – Sounding profiles for different precipitation types, Thermal profiles for SLR**
  - ✓ **Radar, satellite, NY Mesonet, Upper air**

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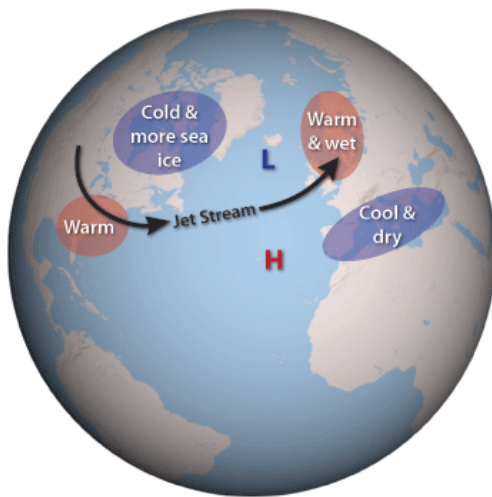
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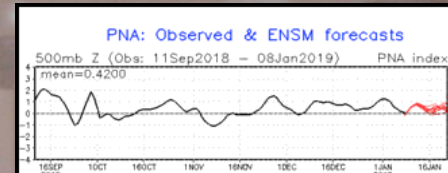 - ✓ **Radar, satellite, NY Mesonet, Upper air**

Large scale pattern recognition – (Just a few examples below among many other large scale patterns/oscillations)
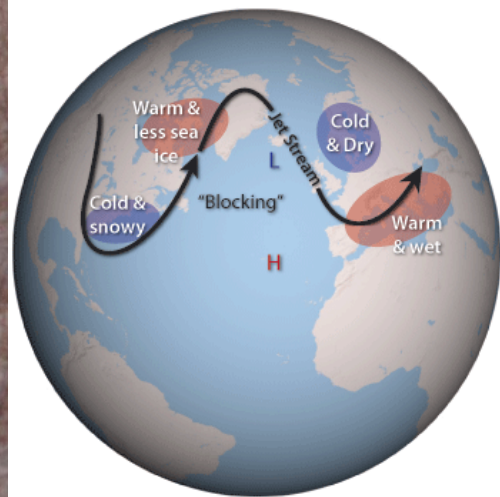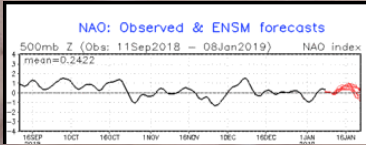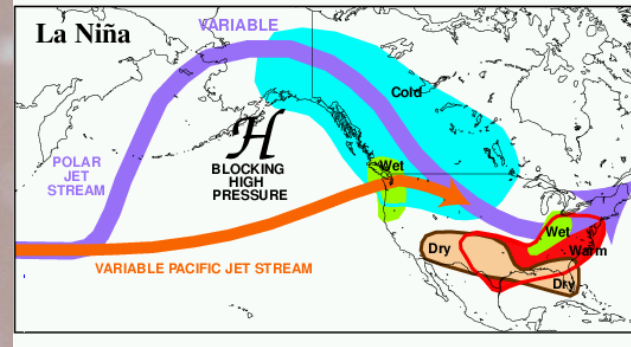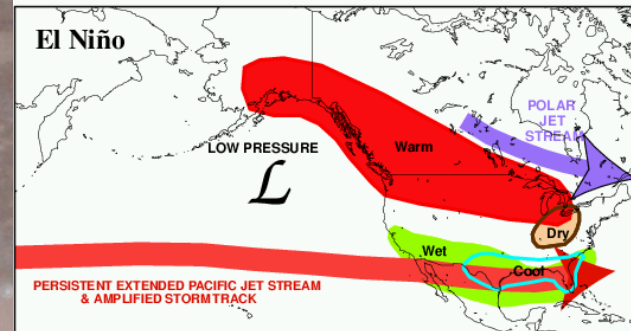
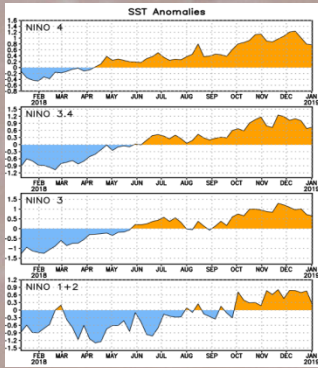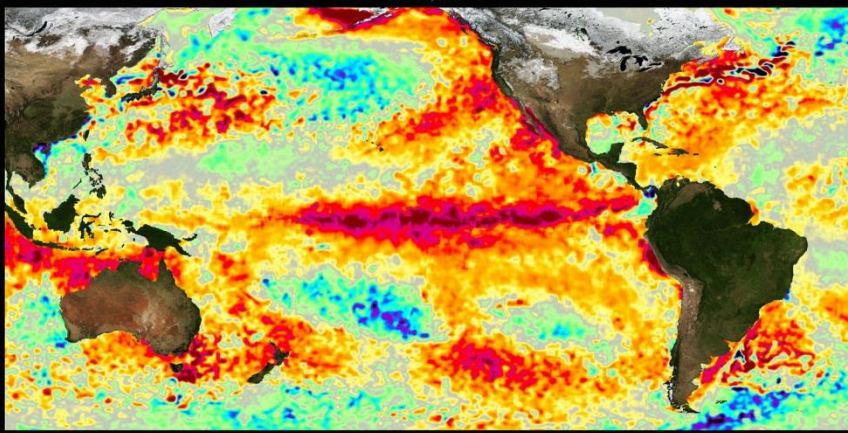# Madden Julian Oscillation and downstream effects – (Again just one large-scale circulation among many others)

(RMM1,RMM2) phase space for 29-Nov-2018 to 7-Jan-2019

Labelled dots for each day.
Blue line is for Jan, green line is for Dec, red line is for Nov.

T composites (JFM)   Significance (%) (JFM)
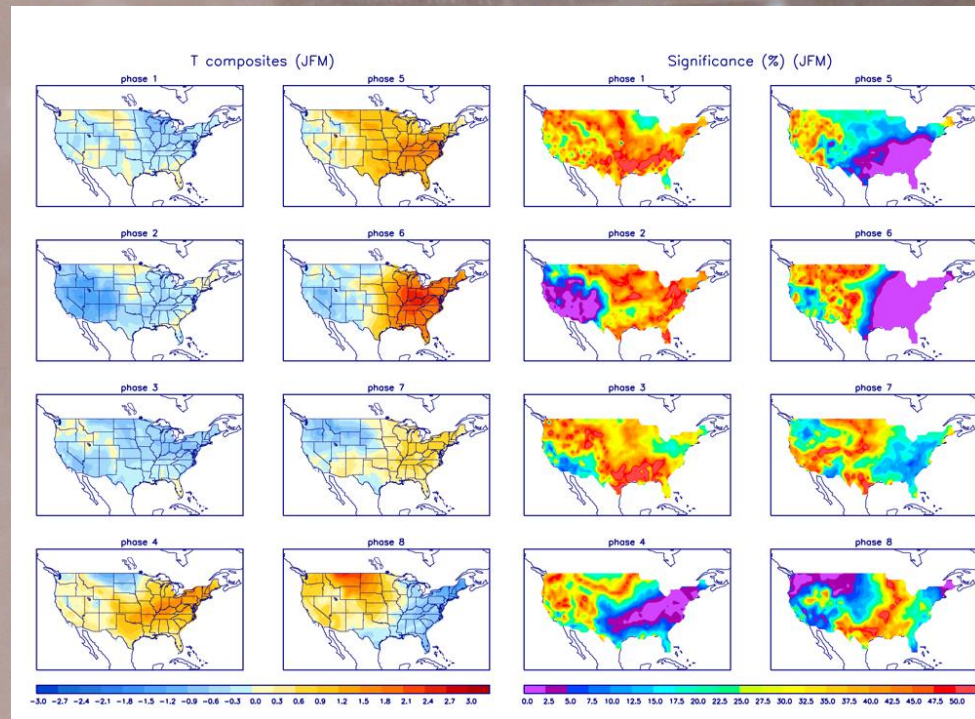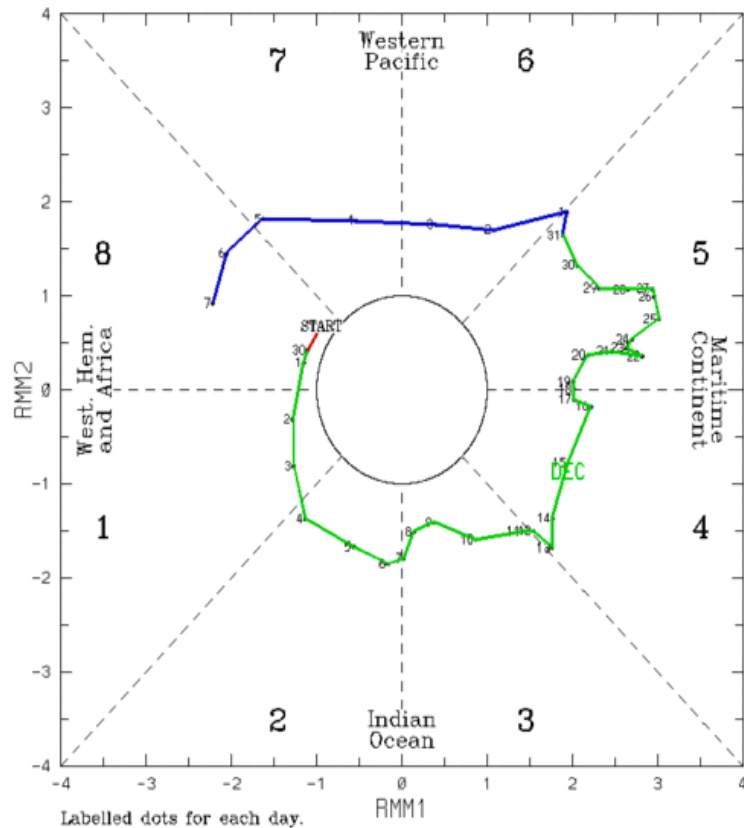
Data analysis – Current State of the Atmosphere

Situational Awareness Table

Model Run: Jan 4, 2019 12Z **Table Region:** Northeast U.S. **Plot Region:** Northeast U.S. **Output:** NAEFS Return Interval [View Table]

Dropdown options:
- NAEFS Standardized Anomaly
- NAEFS Percentile
- NAEFS Return Interval
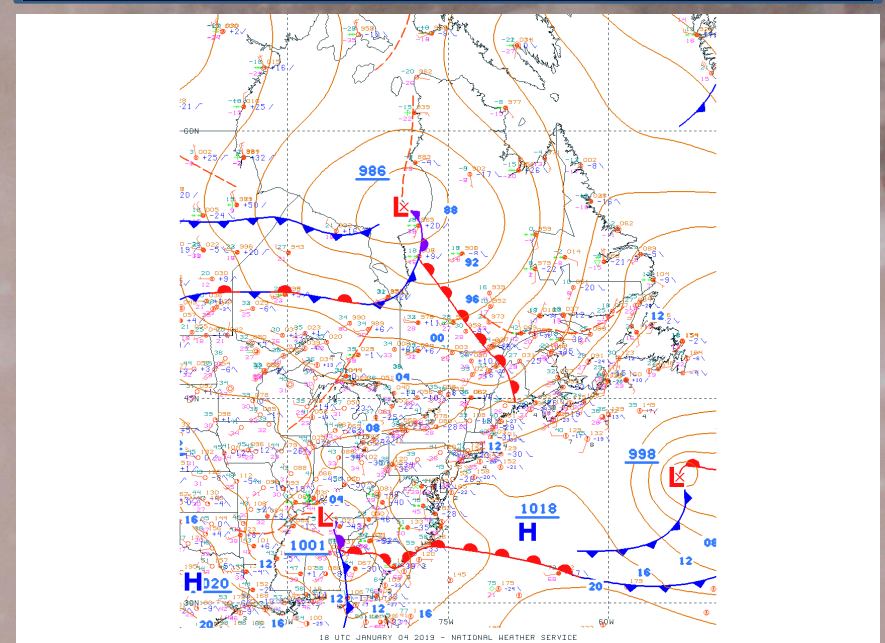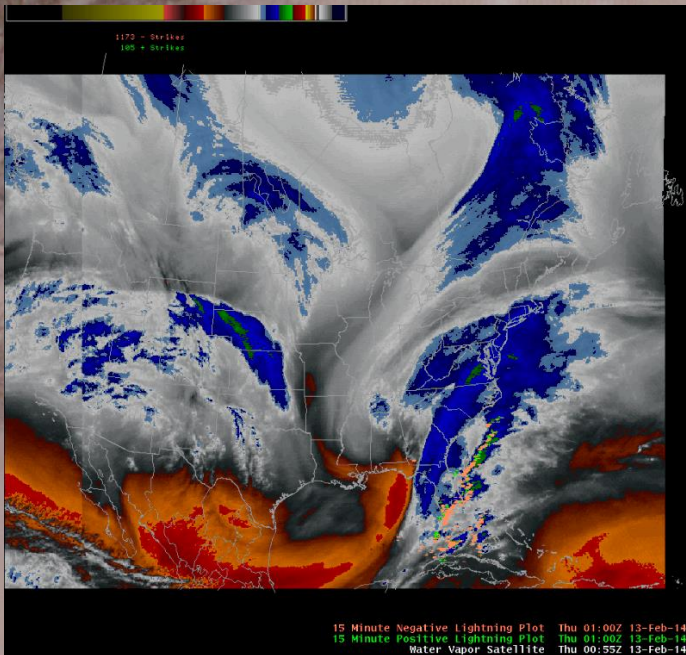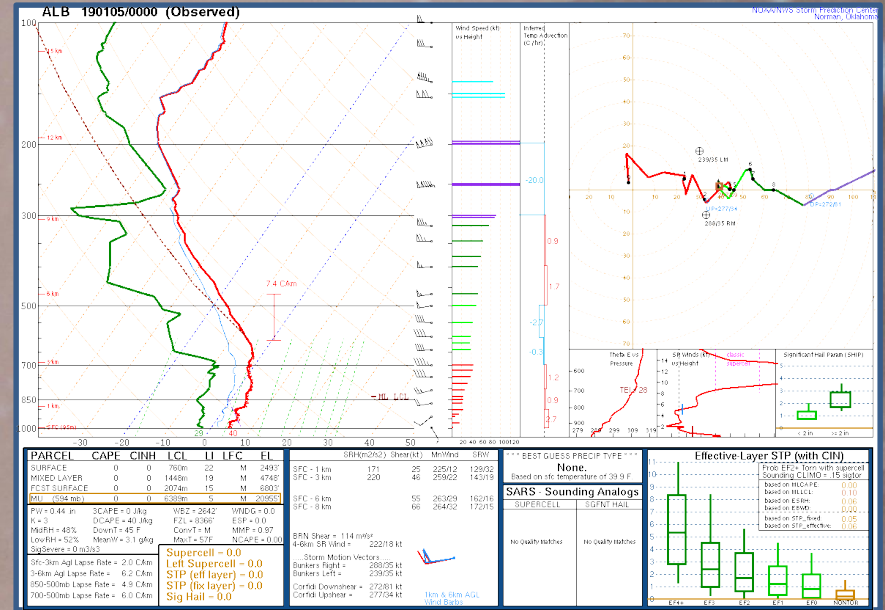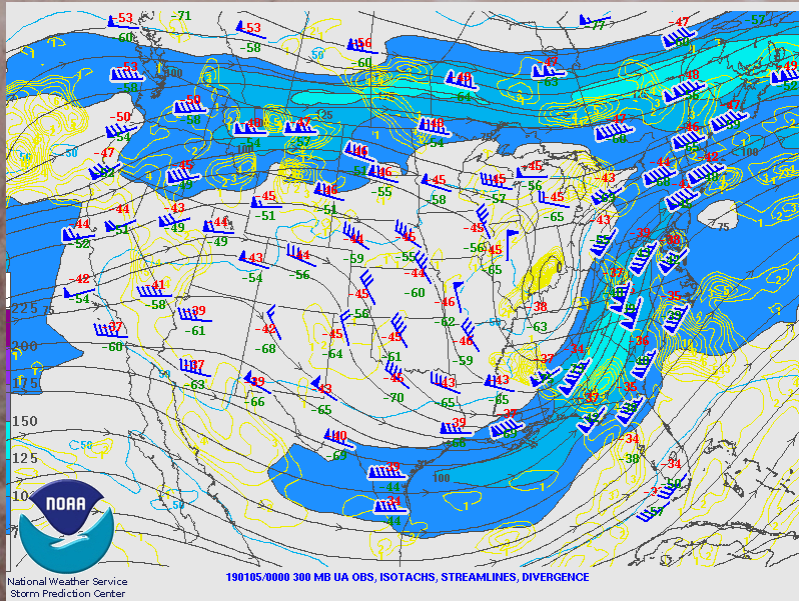- NAEFS Probabilities
- GEFS QPF M-Climate
- GEFS M-Climate Anomaly
- GEFS M-Climate Percentile
- GEFS M-Climate Return Interval

WFO Northeast U.S. Table   Jan 4, 2019 12Z Run

			Z	T	U	V	WSP	SLP	Q	PW	IVT
0	Fri 4th	12Z	1	5	5	30	5	2	10	5	2
6		18Z	1	2	30	10	5	2	30	10	10
12	Sat 5th	00Z	1	5	10	5	5	2	5	5	5
18		06Z	1	5	10	30	2	2	5	2	5
24		12Z	2	5	10	10	5	2	5	5	5
30		18Z	2	5	10	5	5	2	30	1	5
36	Sun 6th	00Z	2	1	5	5	5	2	5	1	2
42		06Z	2	1	10	5	1	2	1	0-1	0-1
48		12Z	1	1	2	30	2	0-1	2	0-1	0-1
54		18Z	5	2	5	30	5	0-1	10	0-1	0-1
60	Mon 7th	00Z	10	5	5	30	5	1	5	1	0-1
66		06Z	30	10	5	30	2	1	30	1	1
72		12Z	30	30	2	30	5	1	30	2	5
78		18Z	30	30	1	30	5	0-1	30	2	5
84	Tue 8th	00Z	10	5	1	10	2	1	2	1	1
90		06Z	5	5	1	5	1	1	1	0-1	0-1
96		12Z	2	1	0-1	1	0-1	0-1	0-1	0-1	0-1
102		18Z	1	1	1	1	0-1	0-1	0-1	0-1	0-1
108	Wed 9th	00Z	0-1	0-1	1	0-1	0-1	0-1	0-1	0-1	0-1
114		06Z	0-1	0-1	2	1	0-1	0-1	0-1	0-1	0-1
120		12Z	0-1	0-1	2	1	0-1	0-1	0-1	0-1	0-1
126		18Z	0-1	0-1	1	2	0-1	0-1	0-1	0-1	0-1
132	Thu 10th	00Z	0-1	0-1	1	2	1	0-1	0-1	0-1	0-1
138		06Z	0-1	0-1	1	2	0-1	0-1	0-1	0-1	0-1
144		12Z	0-1	0-1	1	2	0-1	0-1	0-1	0-1	0-1
150		18Z	0-1	0-1	1	2	0-1	0-1	0-1	0-1	0-1
156	Fri 11th	00Z	0-1	0-1	1	1	0-1	0-1	0-1	0-1	0-1
162		06Z	0-1	0-1	0-1	1	0-1	0-1	0-1	0-1	0-1
168		12Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
174		18Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
180	Sat 12th	00Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
186		06Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
192		12Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
198		18Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
204	Sun 13th	00Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
210		06Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
216		12Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
222		18Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
228	Mon	00Z	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1

If you experience ... ease proceed to the operational NCEP version located ...

How to naviga ...

On the main tab ... to a sub-table with data for each vertical level
Click a value (e.g., ... that time and field at all levels

On a sub-table: ... image for that hour, field and level
Click a level (e.g., '500') to loop images for that field and level at all forecast hours

For a different table: Select the desired Model Run, Table/Plot Region, and Output Type from the drop-down menus above, and click View Table

The NAEFS Ensemble: A 42-member ensemble consisting of 21 GEFS ensemble members and 21 Canadian (GEPS) members. Each set of 21 members includes a control run and 20 initial condition perturbations. Although the GEFS and GEPS are run at native resolutions of 55 and 66 km, respectively, the NAEFS is distributed on a 1x1-degree grid.

NAEFS Standardized Anomaly: How different is the model forecast from the climatological mean? Compares the NAEFS ensemble mean forecast to a 3-week running mean and standard deviation derived from the 1979-2009 Climate Forecast System Reanalysis. Standardized anomaly = (NAEFS_forecast - CFSR_climatology_mean) / (CFSR_climatology_standard_deviation)

NAEFS Percentile (Recommended): Where would the model forecast fall with respect to climatology? Example: MAX at 00Z indicates that values in the current NAEFS forecast are greater than all 00Z values in the CFSR climatology for a 3-week period centered on the valid day. Forecasters are encouraged to focus on "MAX" and "MIN" values, indicating that the ensemble is forecasting an event that would fall outside the 1979-2009 climatology for this time of year

NAEFS Return Interval: How often do these forecast values show up in the climatology? Specifically, how often were the CFSR values (in a 3-week period centered on the valid time) more extreme than values in the NAEFS forecast. Example: a return interval of 5 on Feb 15th means that roughly every 5 years, there is a day in mid-February when values in the current forecast were met or exceeded. Another example: "outside CFSR climate" for temperature means that none of the mid-Febrary reanalyses were this warm between 1979 and 2009.

NAEFS Probabilities: How many of the ensemble members produce "extreme" values? Indicates the fraction of NAEFS members with values either higher or lower than any CFSR reanalysis (in a 3-week period centered on the valid time). 60% probability of a min for MSLP on 00Z 15 Sept means that 60% of the NAEFS members have MSLP values lower than any 00Z, mid-September reanalysis. We use the word "extreme" loosely because these are rarely all-time highs or lows -- they're just outside the 1979-2009 climatology for this time of year

GEFS Model Climate: How does this forecast compare to past forecasts? Same calculations as for the NAEFS outputs, but in this case the GEFS ensemble mean is compared to the GEFS reforecast climatology (1985-2012). The current forecast is placed in the context of reforecasts with the same lead time and similar valid dates (e.g., the current 36-h forecast valid at 00Z on 15 Mar 2013 is compared to all 36-h reforecasts valid between 5 and 25 Mar, 1985-2012.) For example, large M-Climate temperature anomalies mean that it's unusual for the ensemble mean to already be this warm at this lead time. *For M-Climate QPF, a 3-month, rather than 3-week, climatological window is used.*
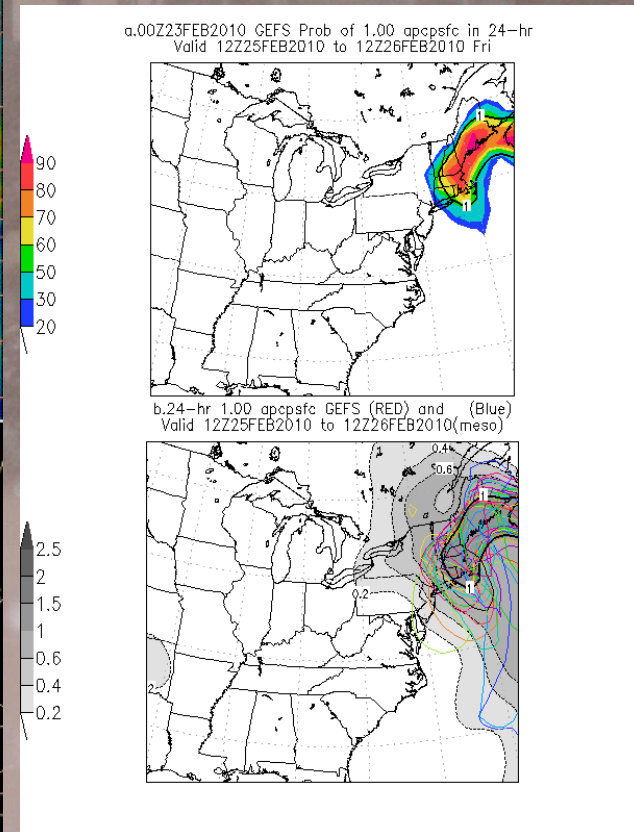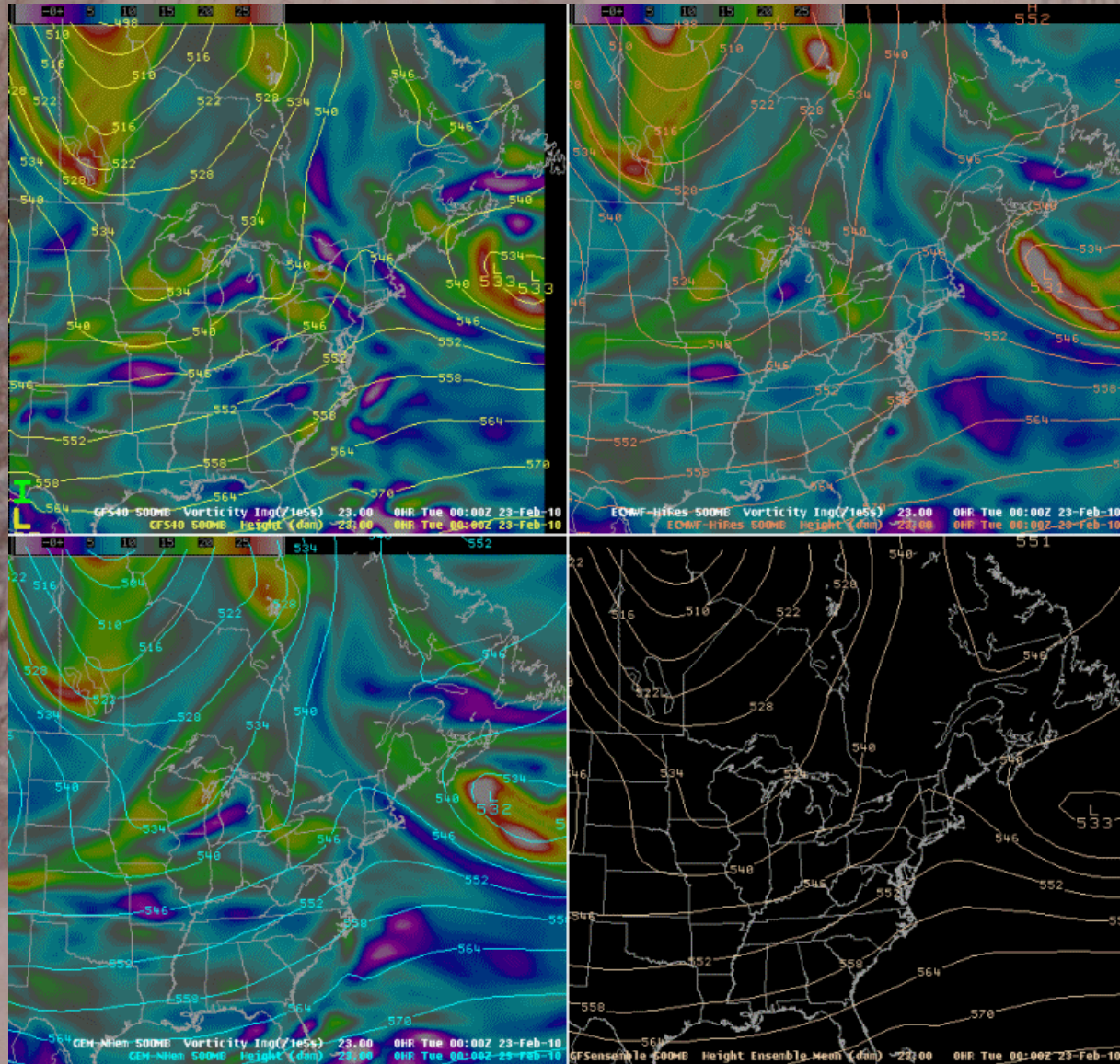
Ensemble based guidance, anomalies and run-to-run changes
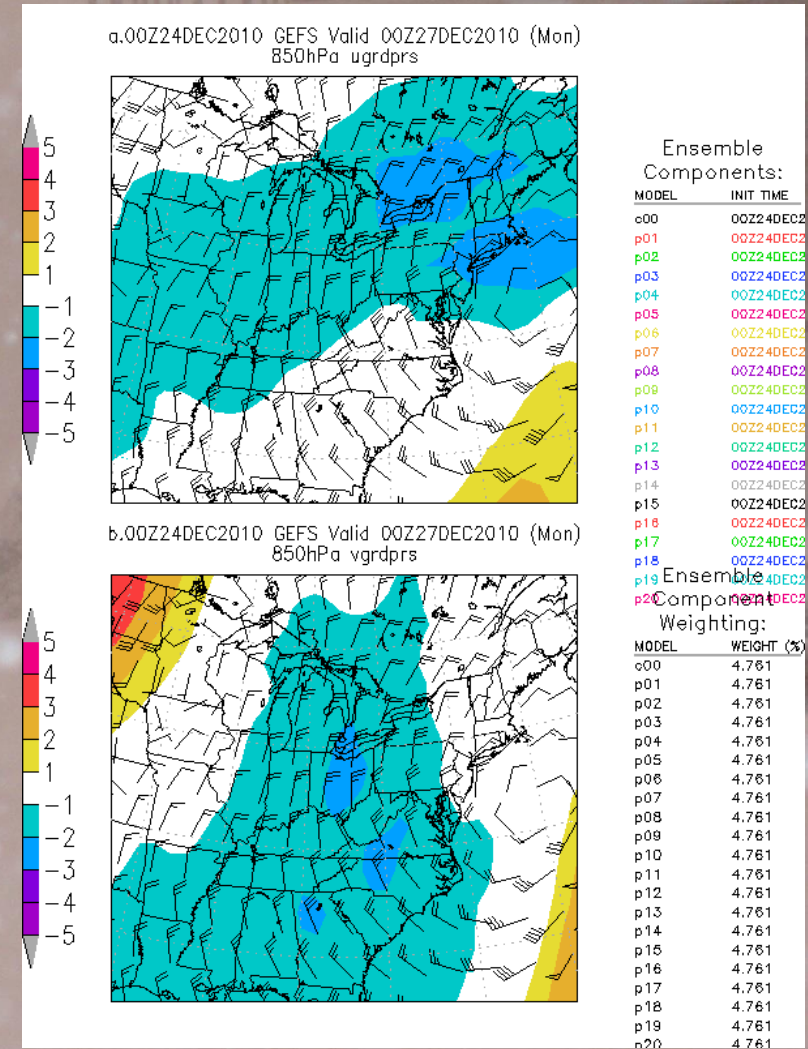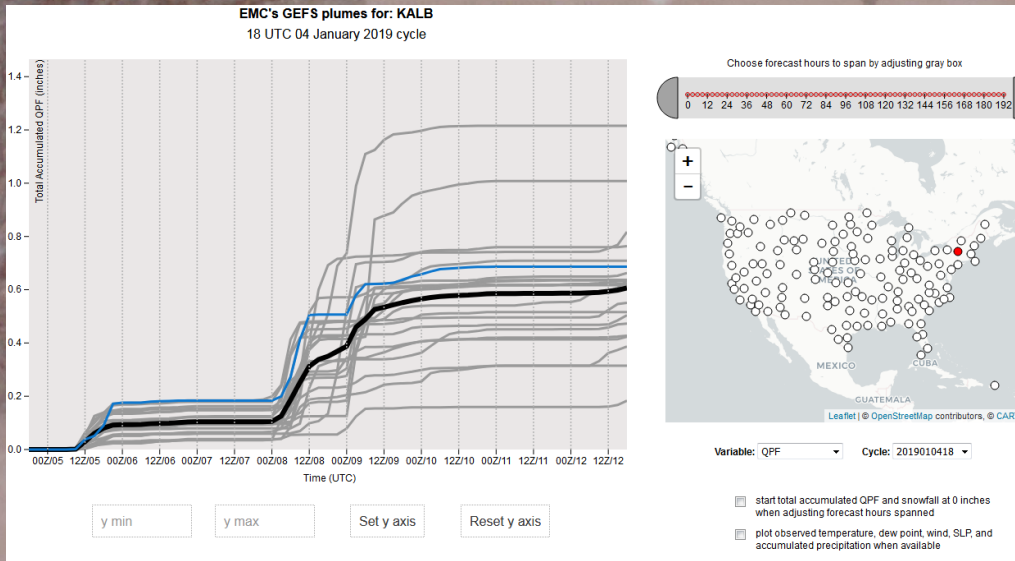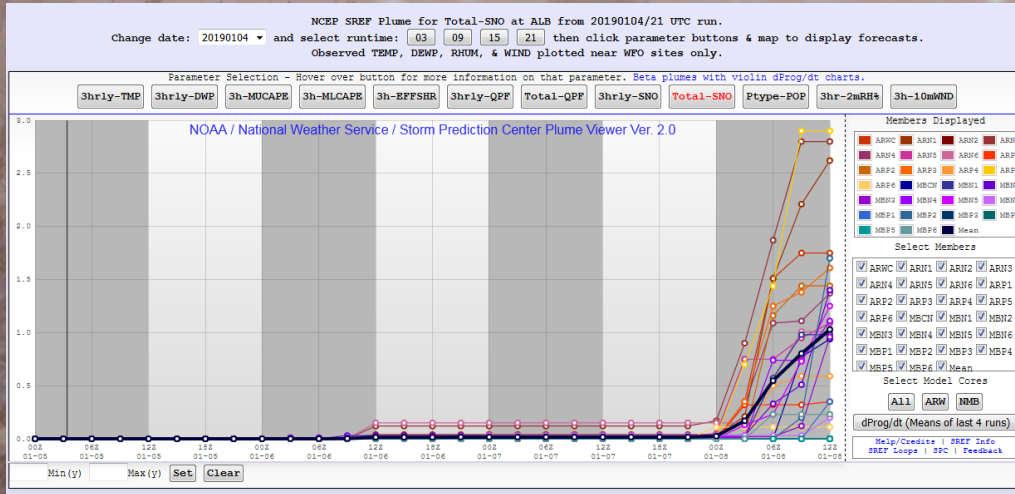
Comparing derived fields from deterministic models such as the GFS, ECMWF, CMC/GEM and GFSEnsemble mean

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Mesoscale snow band conceptual models
(Ualbany CSTAR work from Dave Novak and James Kenyon)
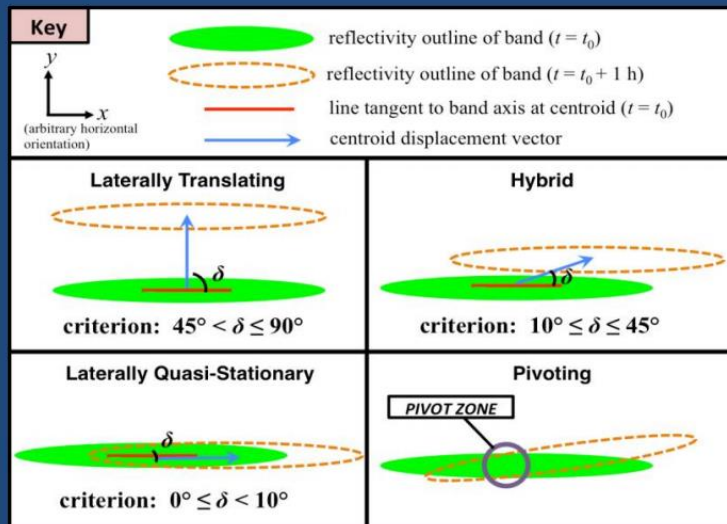
Mesoscale snow band conceptual models – a word about the importance of frontogenesis/EPV

Storm Prediction Center Mesoanalyses:
650-500 hPa layer frontogenesis/EPV –
not the typical 850-700 hPa layer

Must look at multiple levels and layers – layer where dendritic growth zone is important (coming up later)
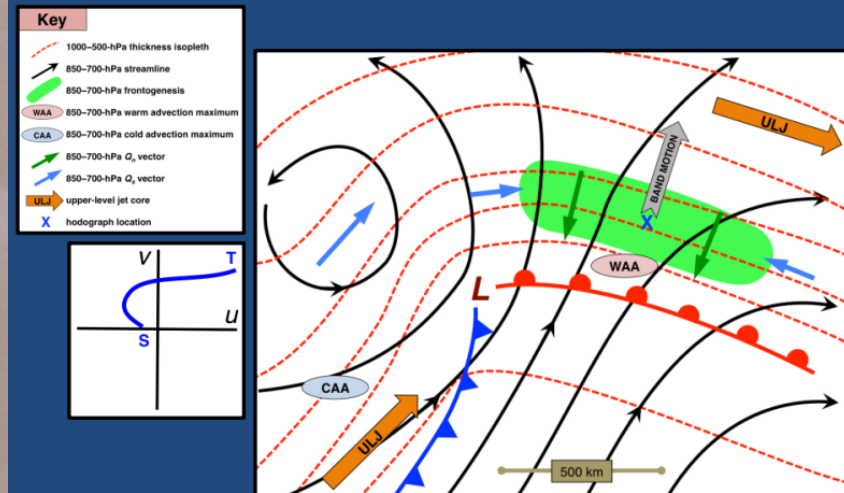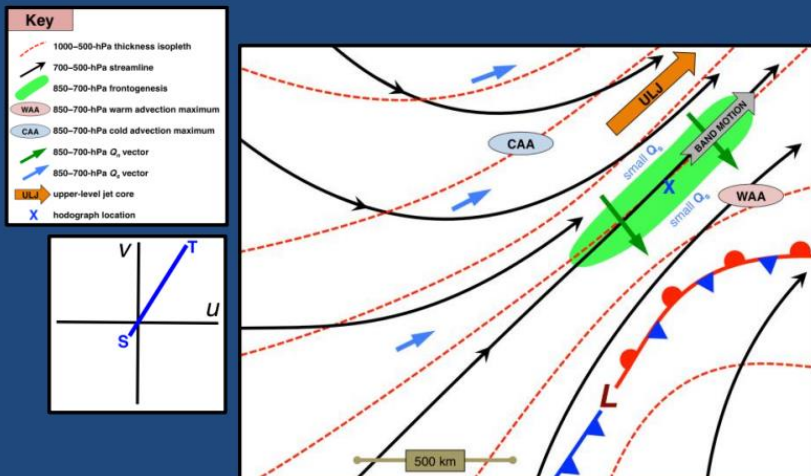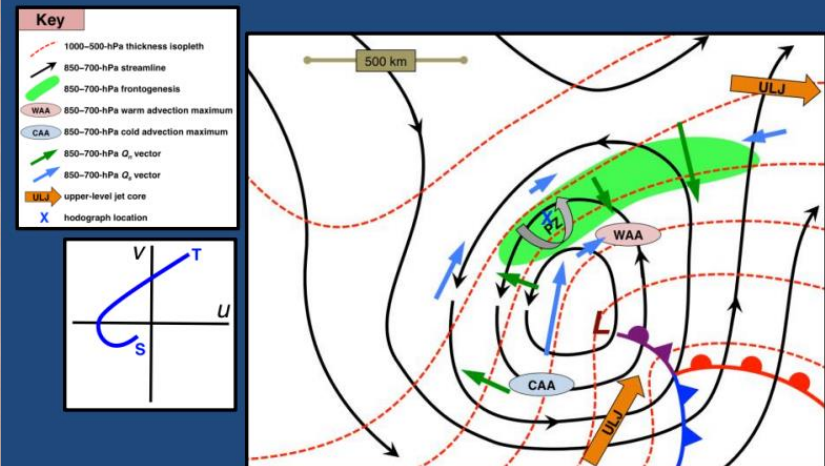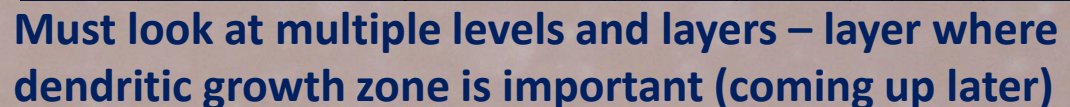
Mesoscale snow band conceptual models – a word about the importance of frontogenesis/Isentropic lift
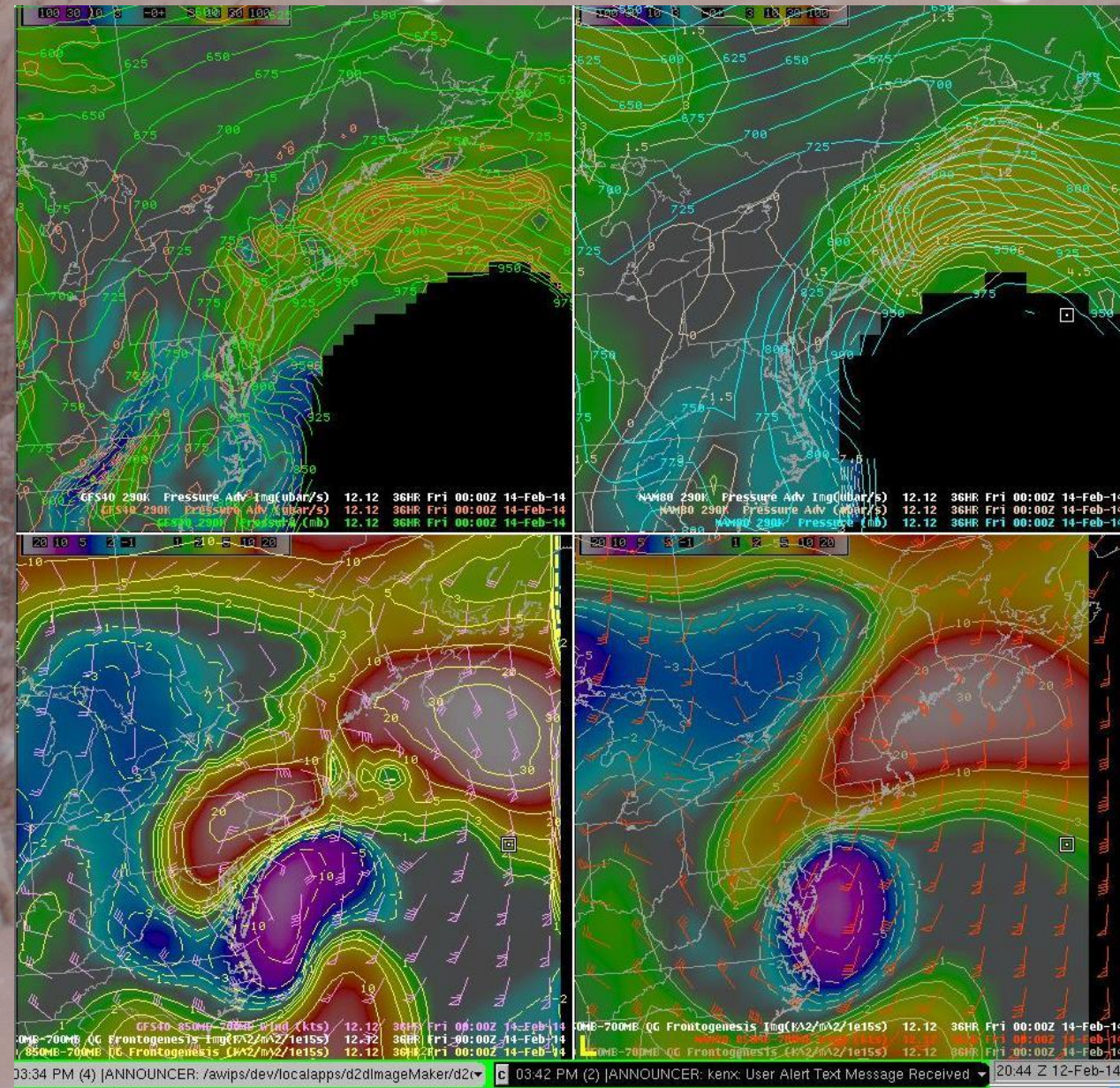
Isentropic lift at 290K

850-700 hPa
QG frontogenesis and winds -
Pettersen Frontogenesis very
useful as well

Upslope snows – Froude Number

```
925-850 mb Layer Average Wind/RH. Avg QPF over the _GreenBerkLitchHills.
Date   Time           Wind RH% 700 850T QPF
Day mm/dd hhZ Frd# DDFF (%) RH% (C) (in)
=== ===== === ==== ==== === === === ====
Wed 01/09 06Z 0.13 2013  95  75   0 0.00
Wed 01/09 09Z 0.19 2110  98  91   0 0.09
Wed 01/09 12Z 0.51 2714  97  88  -3 0.12
Wed 01/09 15Z 0.58 3125  96  90  -4 0.15
Wed 01/09 18Z 0.95 3035  94  77  -5 0.08
Wed 01/09 21Z 1.42 2934  94  68  -7 0.02
Thu 01/10 00Z 1.28 3034  93  72  -8 0.02
Thu 01/10 03Z 0.93 3030  93  76  -8 0.02
Thu 01/10 06Z 0.99 3028  94  77  -9 0.01
Thu 01/10 09Z 0.99 3127  93  85 -10 0.01
Thu 01/10 12Z 0.85 3228  93  85 -11 0.02
Thu 01/10 15Z 1.06 3228  93  84 -12 0.02
Thu 01/10 18Z 0.98 3128  89  85 -12 0.01
Thu 01/10 21Z 0.57 3131  87  73 -11 0.00
Fri 01/11 00Z 0.46 3133  87  69 -11 0.00
Fri 01/11 03Z 0.41 3131  86  56 -12 0.00
Fri 01/11 06Z 0.39 3131  84  43 -12 0.00
Fri 01/11 09Z 0.38 3132  81  35 -13 0.00
Fri 01/11 12Z 0.36 3133  80  16 -13 0.00
Fri 01/11 15Z 0.36 3129  73   1 -14 0.00
Fri 01/11 18Z 0.45 3128  55   4 -15 0.00
Fri 01/11 21Z 0.55 3131  54  27 -16 0.00
Sat 01/12 00Z 0.51 3136  53  35 -16 0.00
Sat 01/12 03Z 0.50 3132  54  22 -16 0.00
Sat 01/12 06Z 0.48 3136  54  47 -14 0.00
Sat 01/12 09Z 0.54 3135  56  46 -15 0.00
Sat 01/12 12Z 0.56 3134  58  43 -14 0.00
Sat 01/12 15Z 0.52 3030  60  47 -14 0.00
Sat 01/12 18Z 0.51 3023  63  43 -14 0.00


Run total areal avg QPF for the _GreenBerkLitchHills is: 0.57 inches.

Froude Number (Frd#):
Frd# < 0.5 Flow is subcritical and blocked.
        Upslope clouds/precip backed farther upwind of and up to mtn crest.
        Gap winds possible.
Frd# 0.5-1 Flow is subcritical/slow moving/blocked.
        Upslope clouds/precip falls immediately upwind of mtn crest.
        Gap winds possible.
Frd# 1-2 Flow is critical.
        With strong winds, Mountain waves/downslope winds possible.
        Precip falls close to mountain ridge crests and on lee side.
Froude > 2 Flow is supercritical/unblocked(rapid flow).
        Air flows freely over terrain.
        Persistent upslope snow not favored. Scattered snow showers and flurries.

Relative Humidity (RH):
        925-850 mb RH > 90% needed for upslope precipitation.
        with 700mb RH > 70% favors upslope snow.
        with 700mb RH > 90% greater amounts of W upslope snow possible.

850mb Temperature (T degC) Westerly Upslope Snow Ratios: (Avg=28:1)
        T > -11         10-15:1
        T -11 to -15    25-35:1
        T < -15         15-20:1
```

Mohawk Hudson Convergence
(Ualbany CSTAR work by Mike Augustyniak)

Mohawk Hudson Convergence

kenx 0.5 Reflectivity (dBZ)   8bit Wed 09:24Z 02-Jan-08
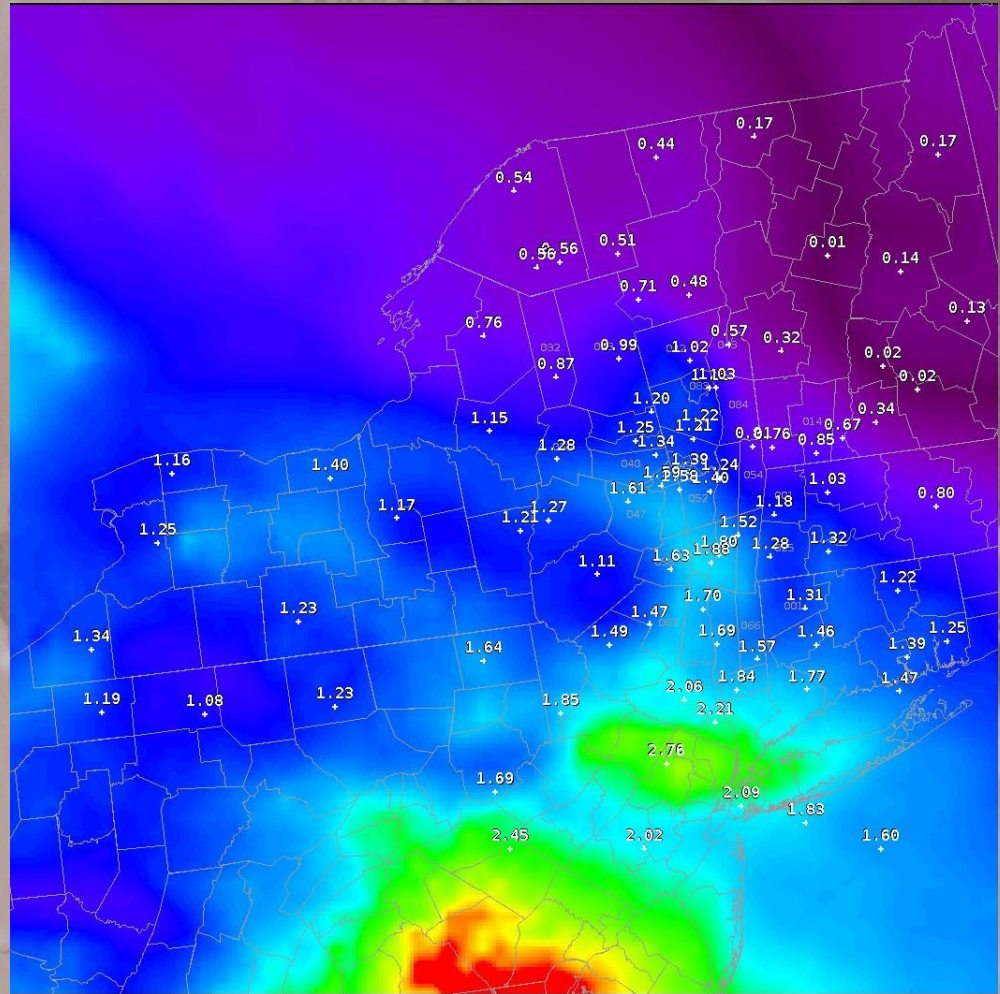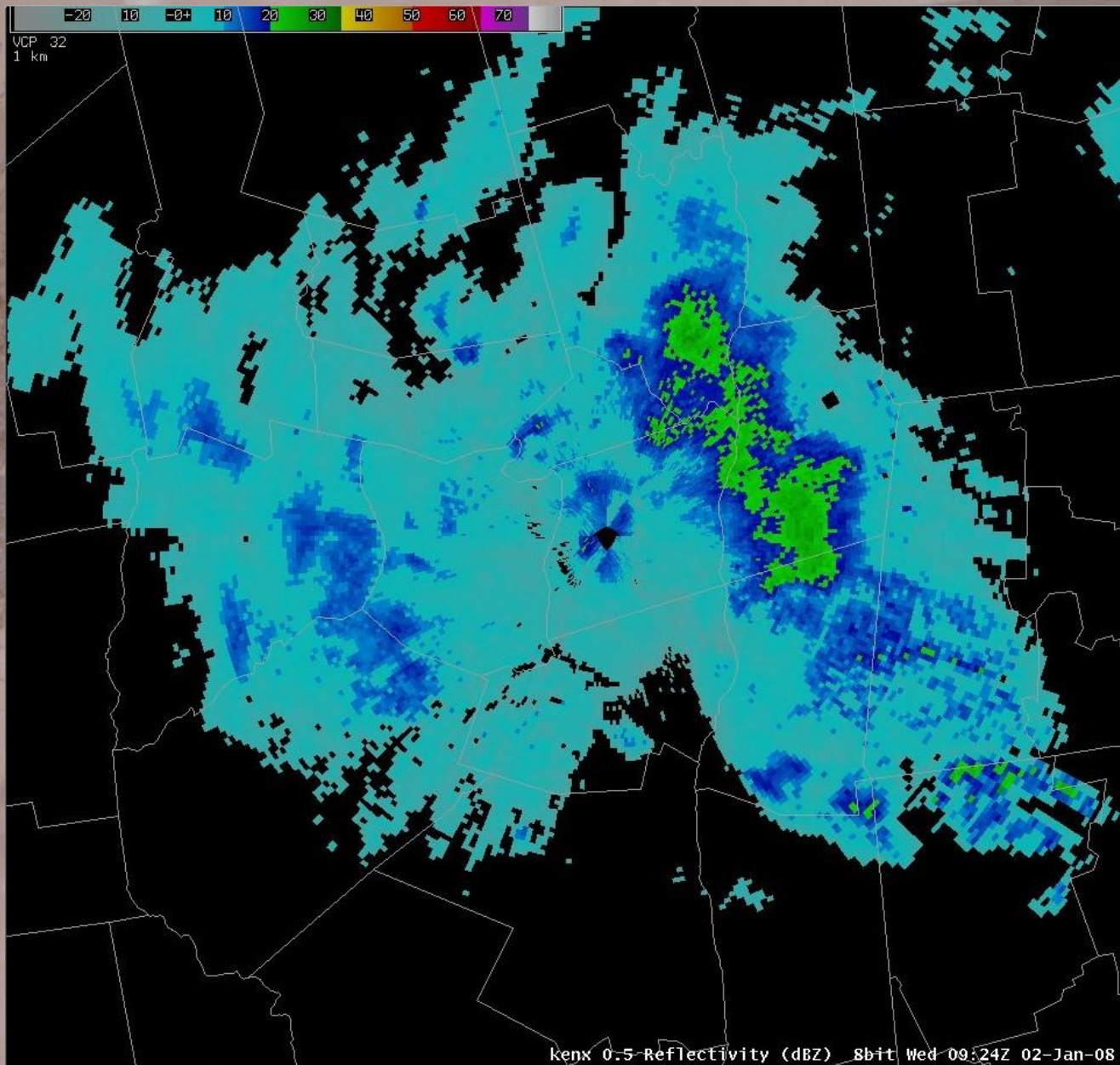
HREF individual member forecasts – HREF replaced SSEO and NCAR Ensemble
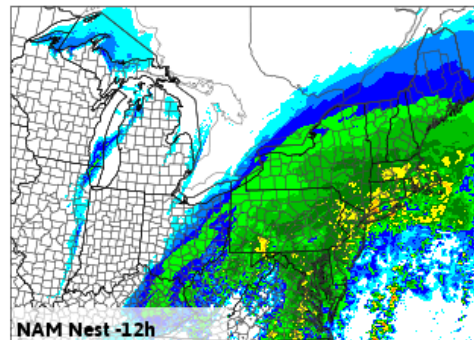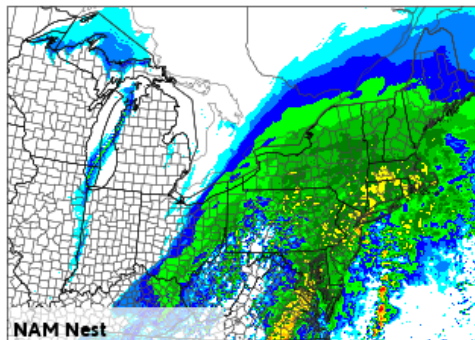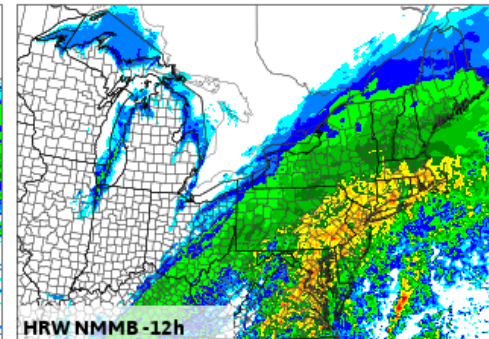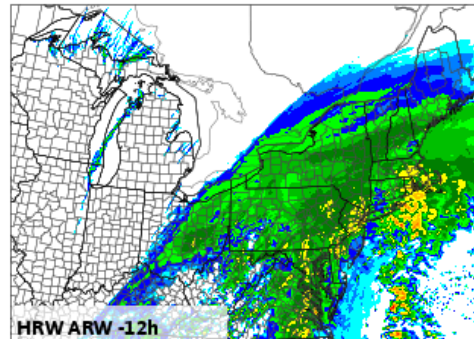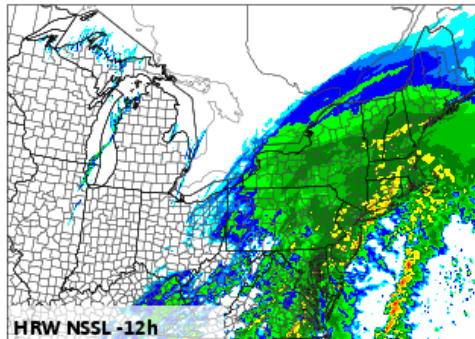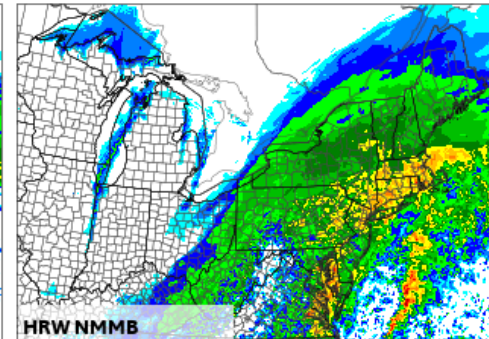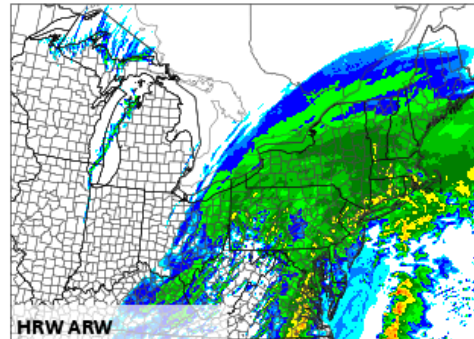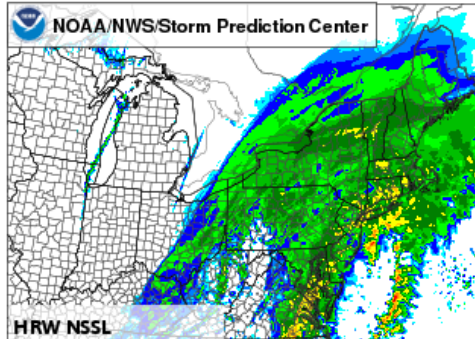
HREF ensemble mean

HRRR/HRRRE and others

NAM 3KM (and others)

Another way to look at the NAM 3KM in AWIPS D2D

19.06   0HR Sat 06:00Z 19-Jan-19
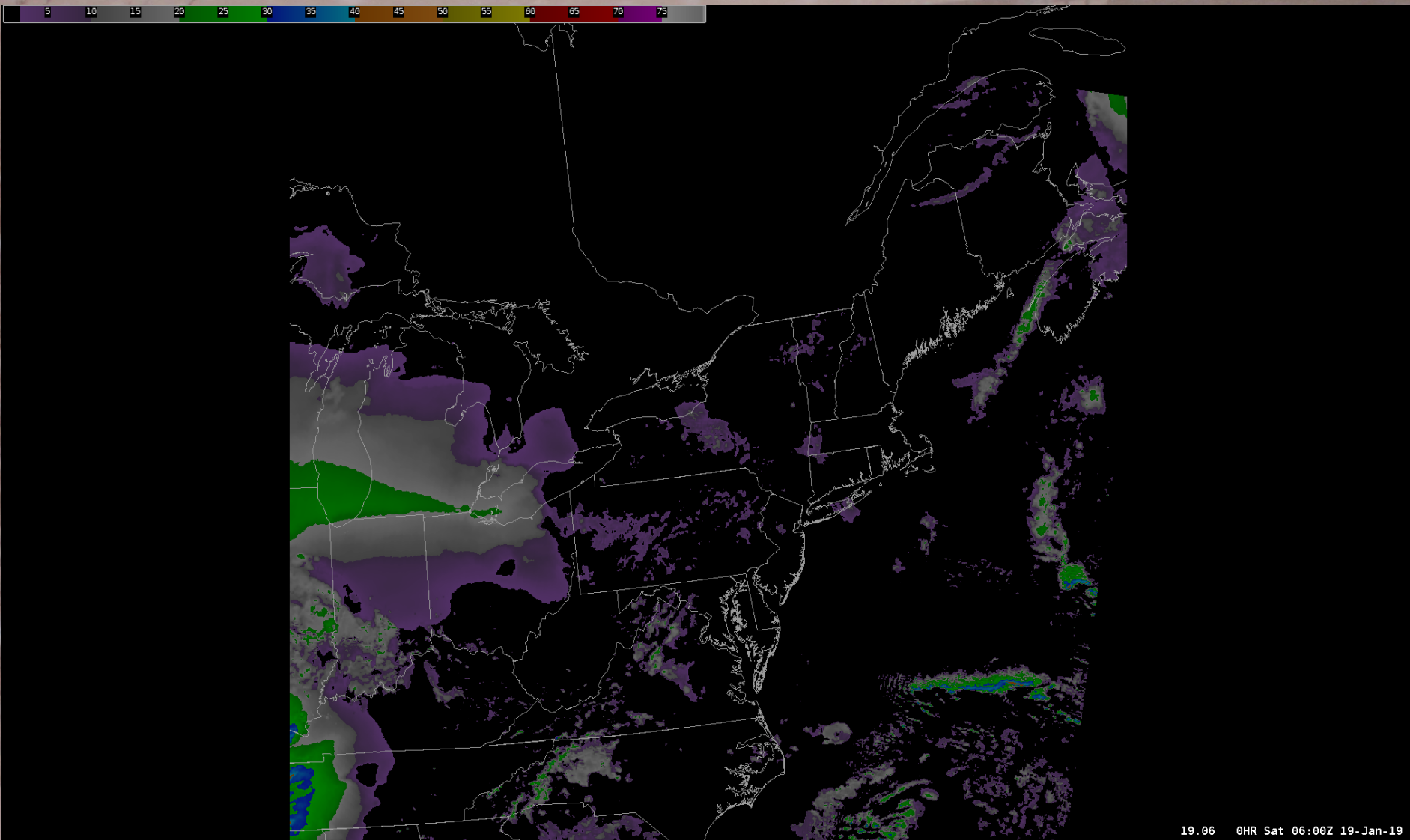
Reflectivity forecasts

NAM 3KM 2 meter temperatures
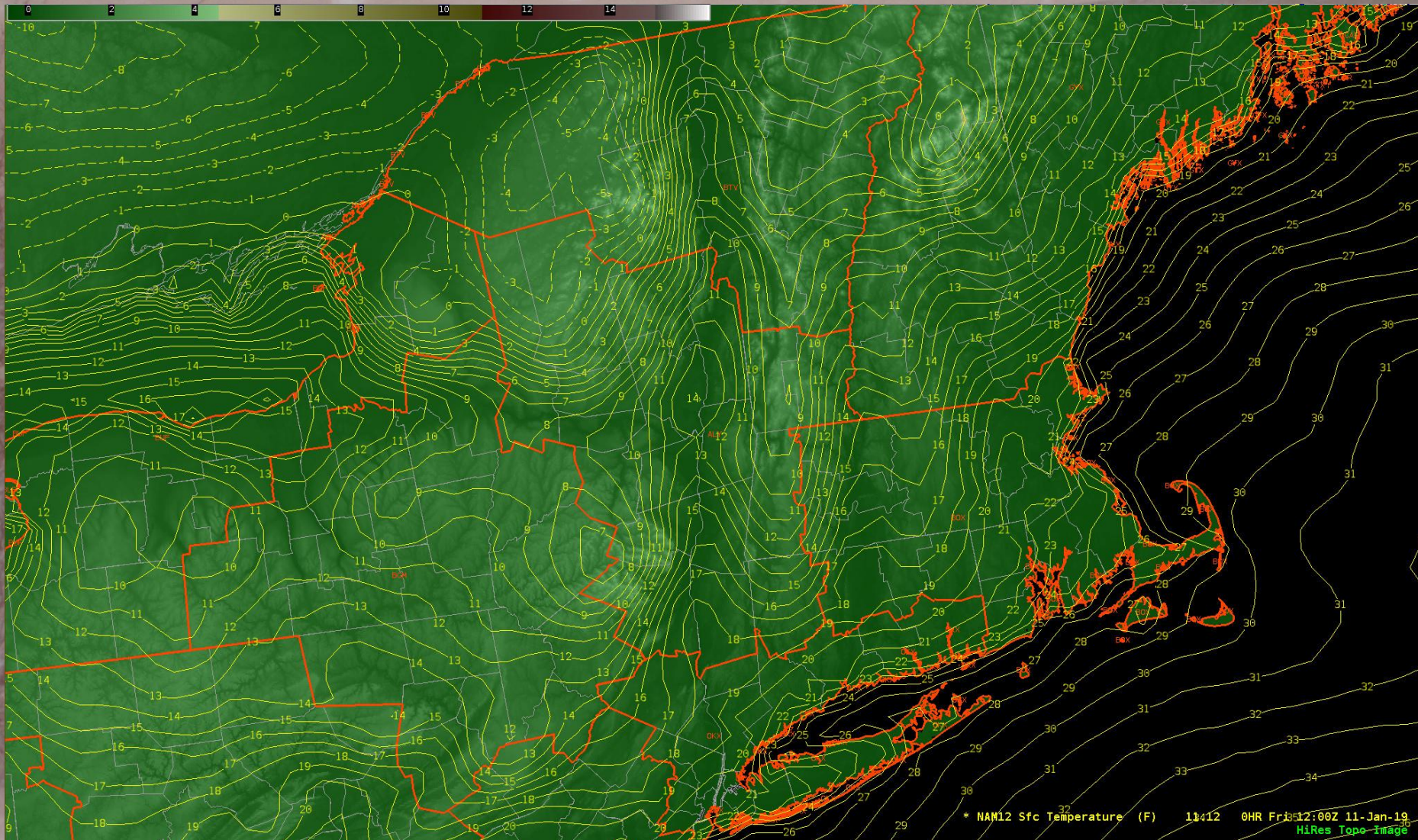
Very terrain dependent

✓ **How do NAM 3KM 2 meter temperatures compare with MOS guidance?**

✓ **Is the rest of the MOS forecast guidance consistent with what you analyzed in plan view?**


```
ï»¿
274
FOUS21 KWNO 050600
MAVNE1
KALB   GFS MOS GUIDANCE    2/05/2014   0600 UTC
DT /FEB   5       /FEB   6             /FEB   7             /
HR   12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 00 06
X/N           30          9          18          4          20
TMP  23 26 28 28 25 22 18 13  9 12 16 16 14 11  9  8  7 14 18 15  8
DPT  17 19 20 19 16 13  8  3  0  1  3  4  3  1 -1 -1 -1  3  4  3 -2
CLD  OV OV OV OV OV OV OV SC SC SC CL FW BK BK OV OV BK BK FW SC CL
WDR  01 03 02 35 33 33 32 33 32 32 30 29 29 28 24 24 25 26 27 26 26
WSP  05 09 05 05 08 09 08 05 05 06 05 05 05 04 05 04 05 09 11 09 09
P06       100    84     7     0     4     2     0     0     5  0  0
P12          100        7        6        3        8
Q06        3     2     0     0     0     0     0     0     0  0  0
Q12           4        0        0        0        0
T06       1/ 2  1/ 9  0/ 0  0/ 8  0/10  0/ 2  0/ 7  0/ 3  0/ 4  0/ 5
T12           1/ 9        0/10        0/12        0/ 5  0/14
POZ   4 10 11  7  4  3  3  3  4  3  3  2  2  2  3  4  5  4  4  2  4
POS  96 90 89 93 96 98 98 97 96 97 97 97 98 97 97 96 95 96 96 95 96
TYP   S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S  S
SNW                       6                    0
CIG   3  3  2  3  4  5  6  8  8  8  8  8  8  8  8  8  8  8  8  8  8
VIS   2  1  1  1  5  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7
OBV  FG FG BL FG BR  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N
```

```
ï»¿055
FOUS44 KWNO 050000
METNE1
KALB   NAM MOS GUIDANCE    2/05/2014   0000 UTC
DT /FEB   5             /FEB   6             /FEB   7       /
HR   06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 18 00
X/N              27          9          23          11    26
TMP  27 26 24 25 25 24 23 21 16 12  9 16 21 22 19 16 15 14 14 24 20
DPT  20 20 19 20 20 18 16 14  9  4  0  3  5  5  5  6  7  7  7  8  6
CLD  OV OV OV OV OV OV OV OV OV OV BK CL SC SC OV OV OV OV OV OV OV
WDR  00 02 01 01 02 34 33 34 32 32 32 31 29 27 27 21 23 19 25 28 27
WSP  00 03 04 05 07 08 13 07 05 04 02 05 07 07 03 04 04 04 05 13 05
P06       94    92    85    29     1     3     1     0     4  6  4
P12              92        33        4        4    13
Q06        2     3     3     0     0     0     0     0     0  0  0
Q12              4        0        0        0  0
T06       5/ 2  4/ 9  1/10  0/ 1  0/ 0  1/ 3  1/ 2  1/ 7  1/ 5  1/15
T12       5/ 9        1/10        1/ 3        1/ 7     2/ 7
SNW                 6                    0
CIG   7  7  4  4  3  4  5  5  5  6  8  8  8  8  7  8  6  6  6  6  7
VIS   7  7  5  2  2  2  4  5  7  7  7  7  7  7  7  7  7  7  7  7  7
OBV   N  N BR FG BR BR BR BR  N  N  N  N  N  N  N  N  N  N  N  N  N
```

Compare all parameters offered in the MOS guidance, successive runs and for all locations within the forecast area (KGFL, KPOU, KPSF, KDDH etc.)

Once synoptic and mesoscale analyses are complete, it is all about local effects

- ✓ **Synoptic Analysis**
  - ✓ Conceptual Models – Longwave patterns, Pattern recognition
  - ✓ Data, Deterministic NWP Models, Ensembles, Anomalies
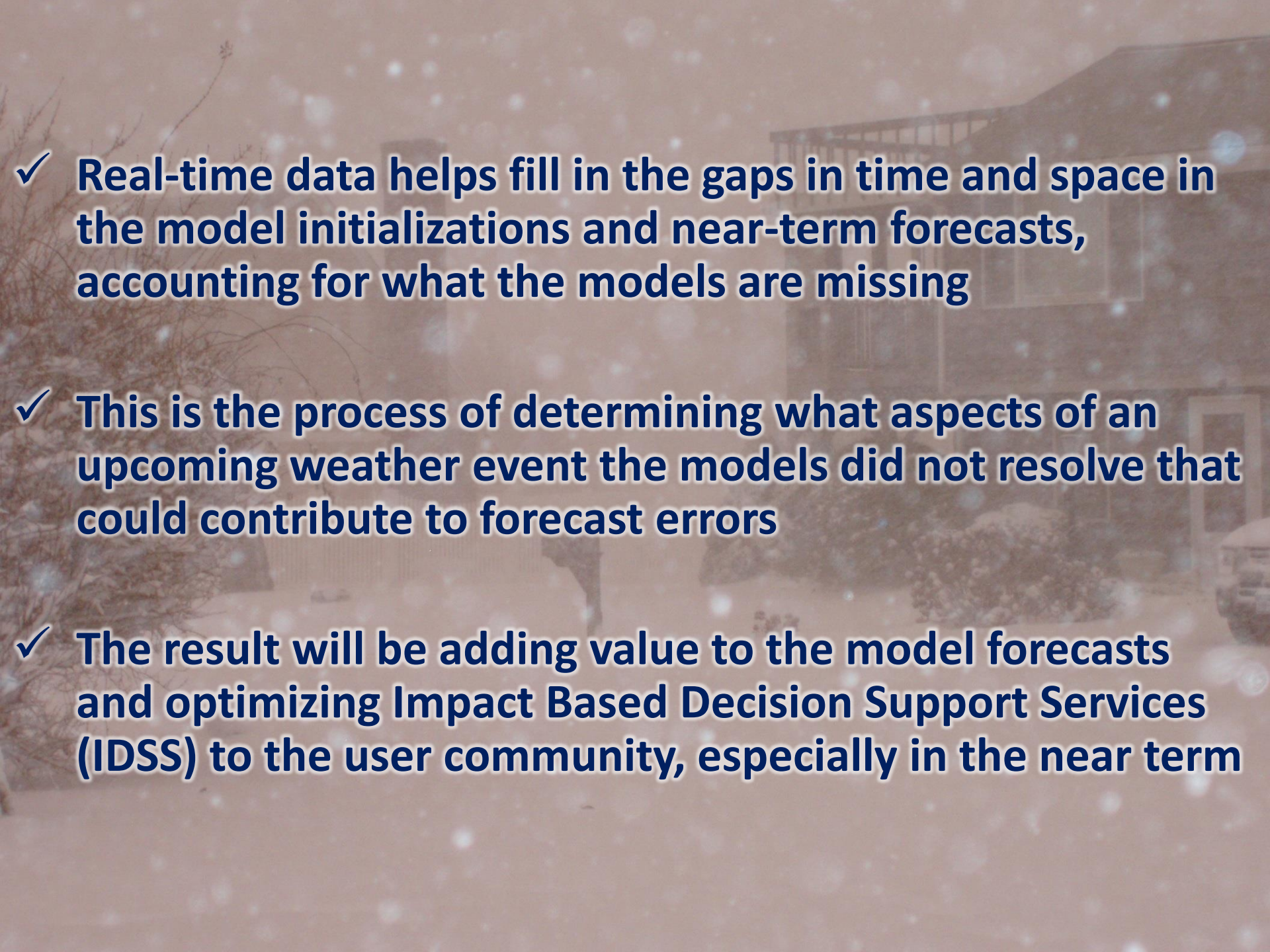
- ✓ **Mesoscale Analysis – Data, CAMs, CAM ensembles**
  - ✓ Conceptual Models – Banding, MHC, Upslope
  - ✓ HRRR, HREF, 3Km NAM

- ✓ **Real-time data trends**
  - ✓ Conceptual Models – Sounding profiles for different precipitation types, Thermal profiles for SLR
  - ✓ Radar, satellite, NY Mesonet, Upper air

- ✓ **Real-time data helps fill in the gaps in time and space in the model initializations and near-term forecasts, accounting for what the models are missing**

- ✓ **This is the process of determining what aspects of an upcoming weather event the models did not resolve that could contribute to forecast errors**

- ✓ **The result will be adding value to the model forecasts and optimizing Impact Based Decision Support Services (IDSS) to the user community, especially in the near term**

✓ **Subtle differences in depths of layers have a big effect on precipitation type – model vertical resolutions vary, resulting in varying skill in predicting thermal/moisture layers**
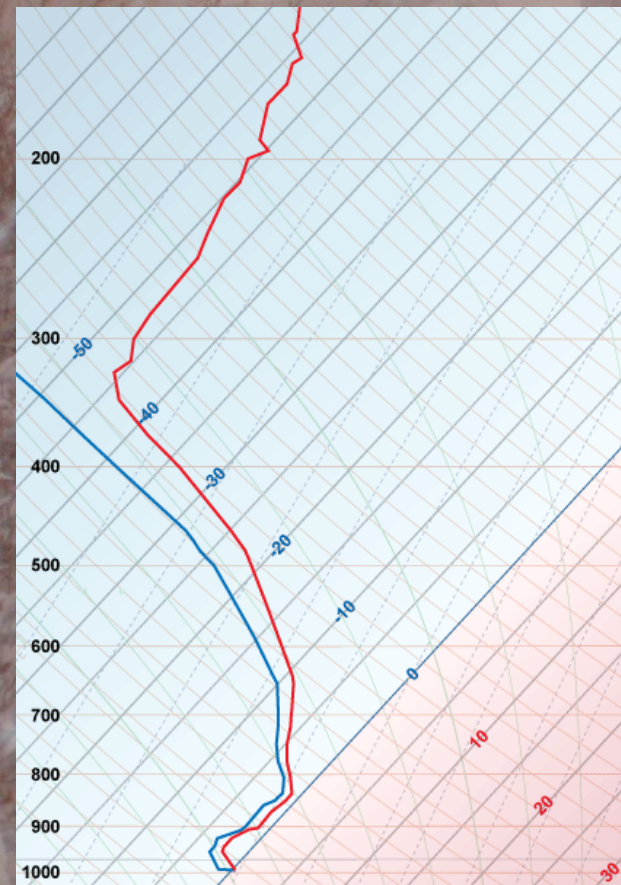
Snow sounding
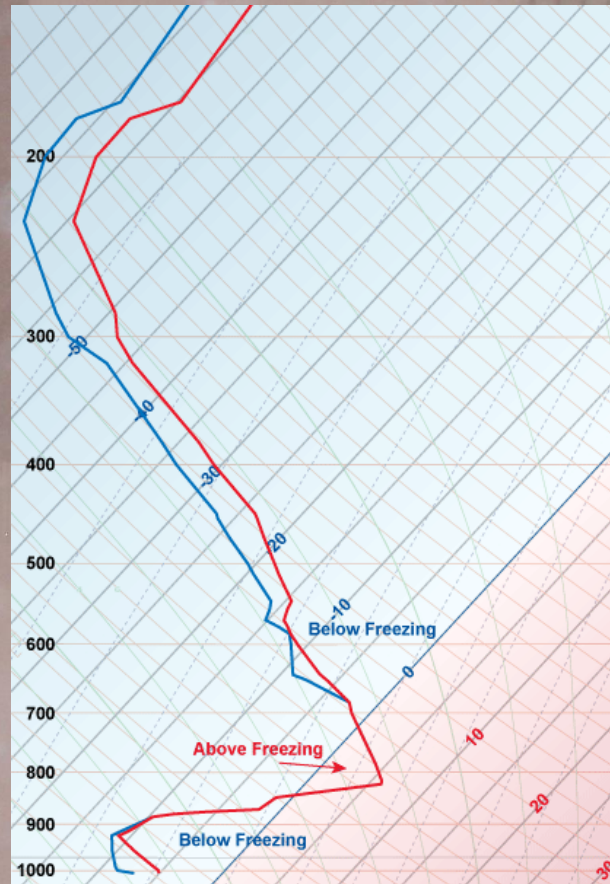
Sleet sounding
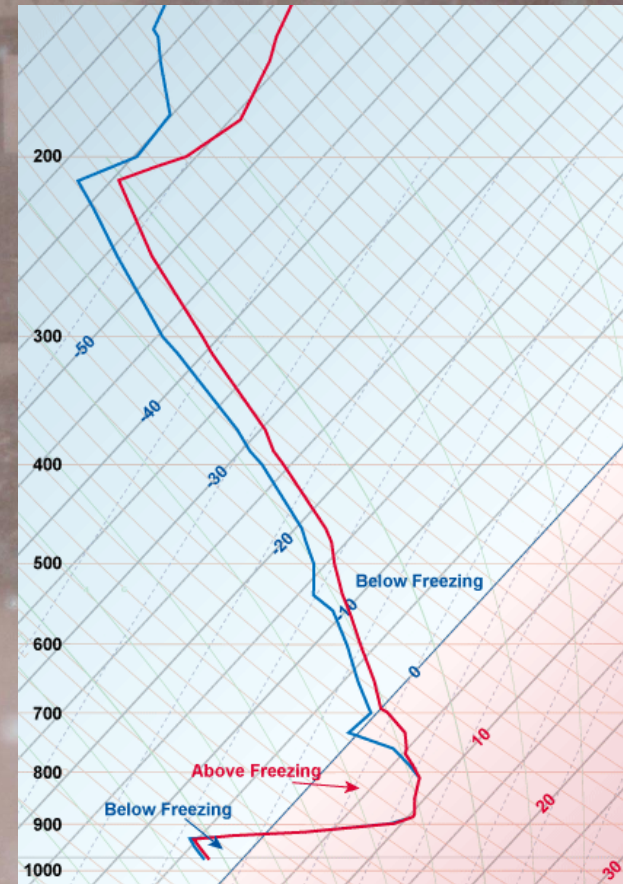
Freezing rain sounding

Note importance of looking at thermal profiles through a deep layer: Can't just rely on temperatures at mandatory levels like 850 hPa, you would miss an important warm layer

Subtle differences in depths of layers have a big effect on precipitation type – model vertical resolutions vary, resulting in varying skill in predicting thermal/moisture layers

Figure 1. From the VISIT session "Precipitation-Type Forecasting: The Top-Down Approach". A warm layer temperature below 1 degree C will produce snow if ice is introduced to the layer.

Freezing drizzle sounding

✓ **Subtle differences in depths of layers have a big effect on precipitation type – model vertical resolutions vary, resulting in varying skill in predicting thermal/moisture layers**

11-12 December 2008 Ice Storm
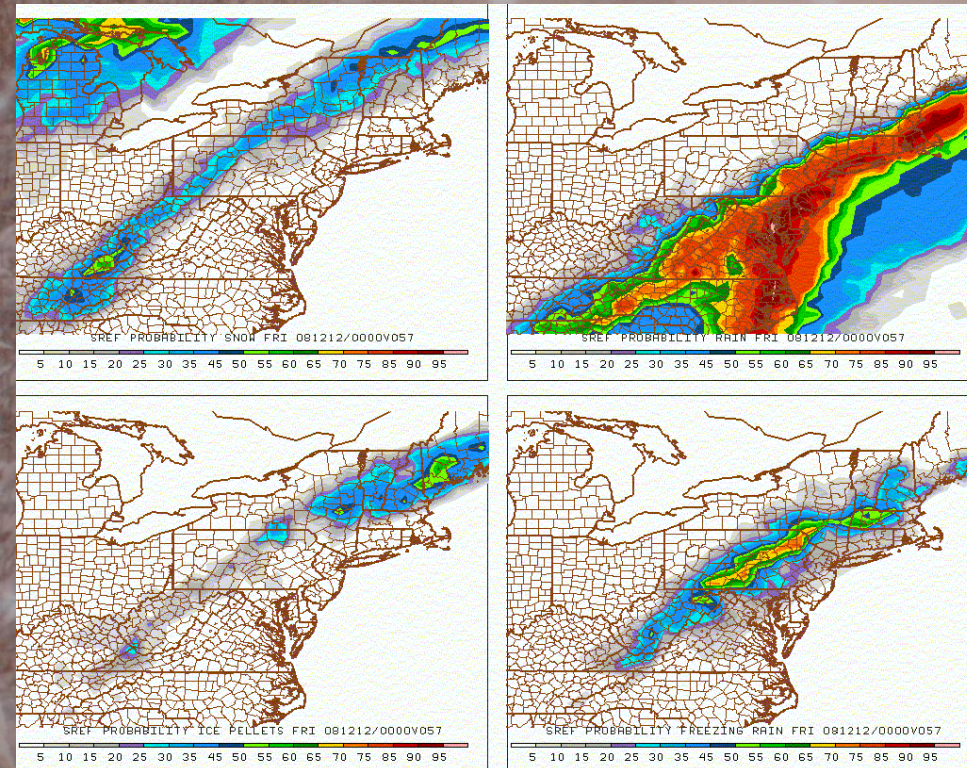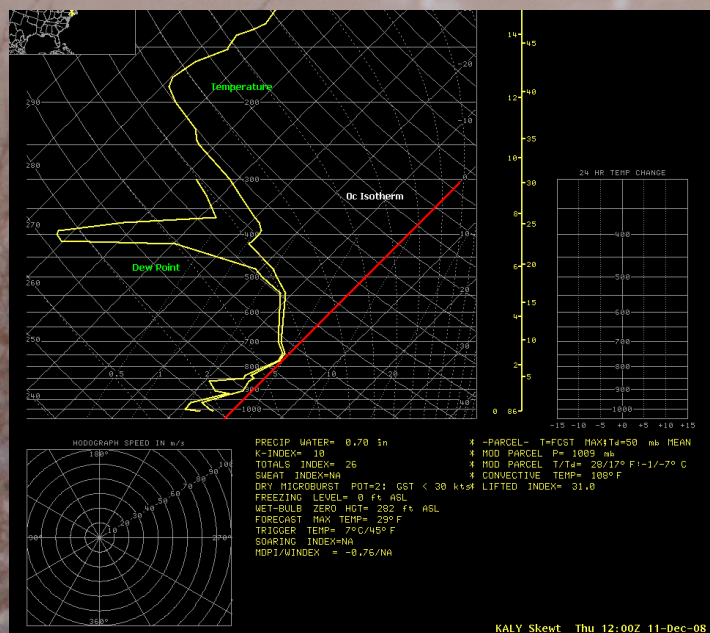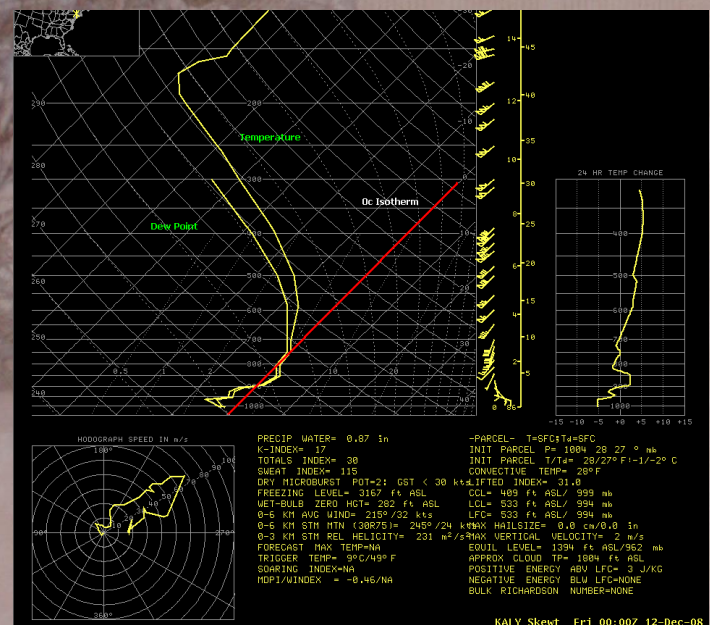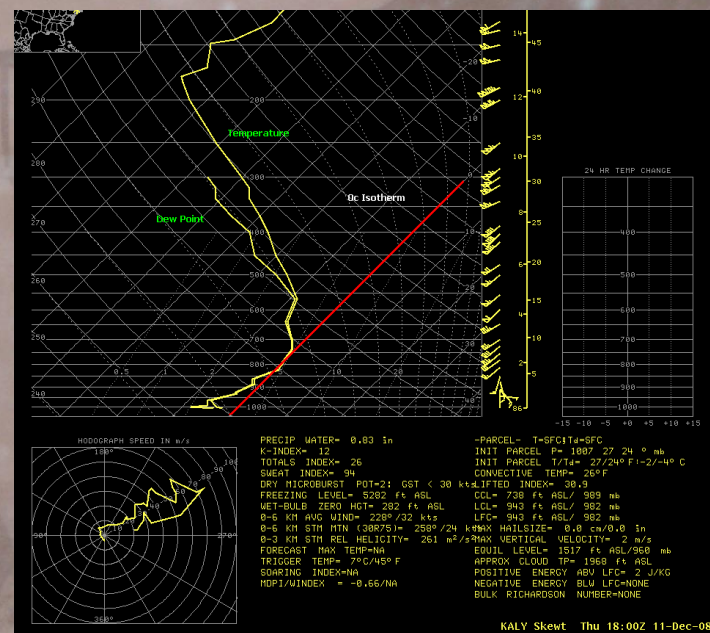
SREF P-Type predictions

Weather Prediction Center Guidance

Note importance of looking at thermal profiles through a deep layer

Can't just rely on temperatures at mandatory levels like 850 hPa, you would miss an important warm layer
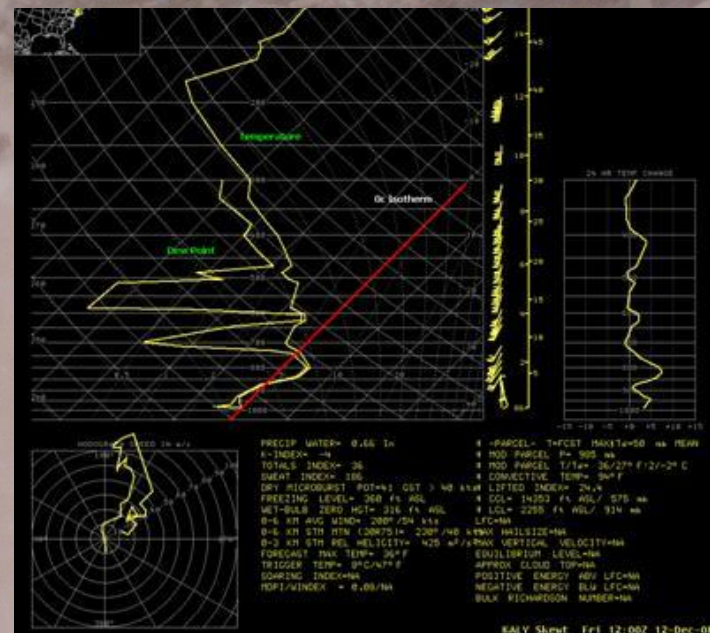
Snow to liquid ratios – above climatology when the core of maximum vertical motion extends through the -12C to -18C saturated layer
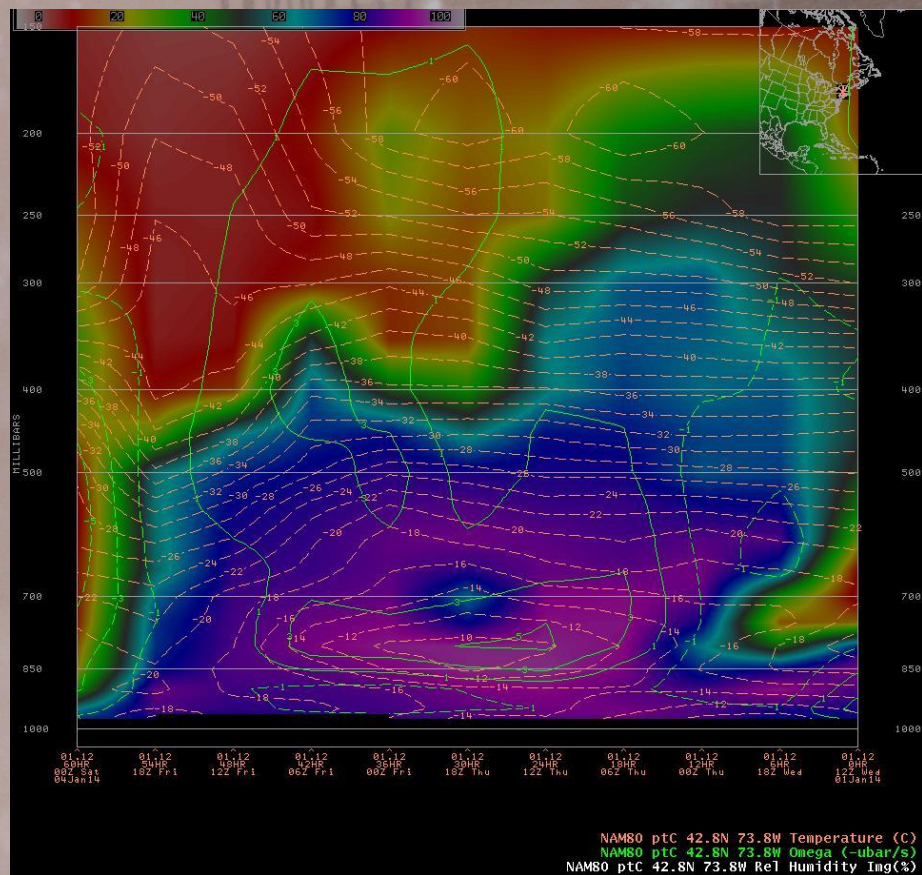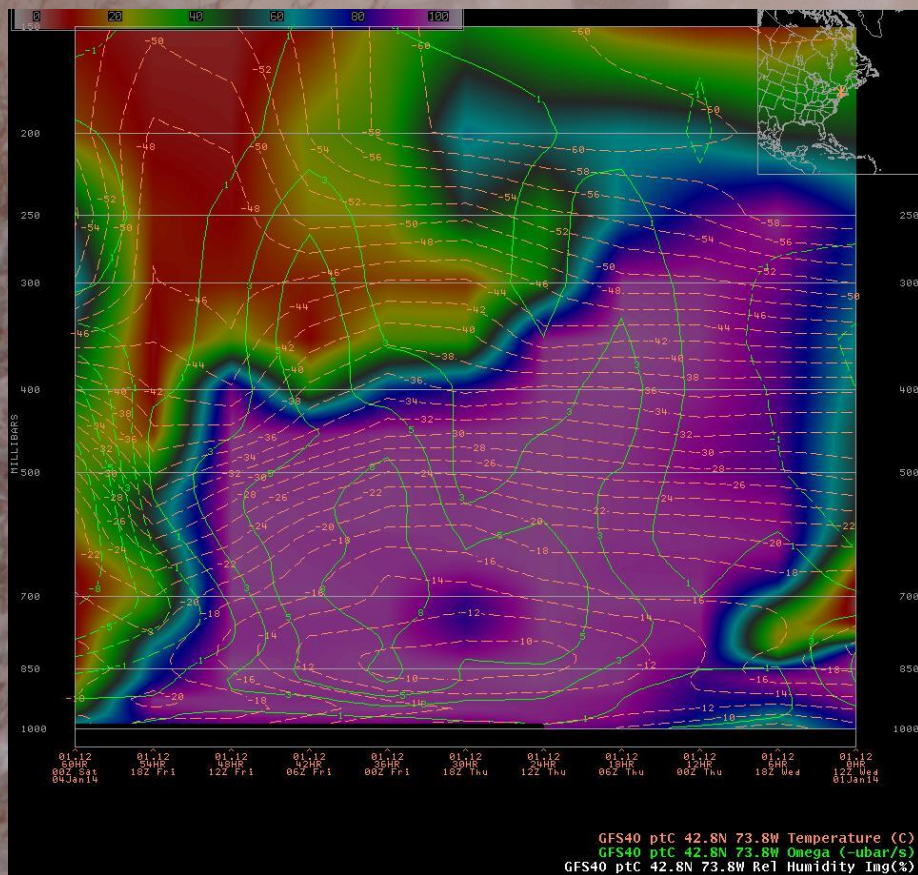
Maximum vertical motion through the dendritic growth zone in GFS but not NAM – which will be right?

Snow to liquid ratios – above climatology when the core of maximum vertical motion extends through the -12C to -18C <u>saturated</u> layer
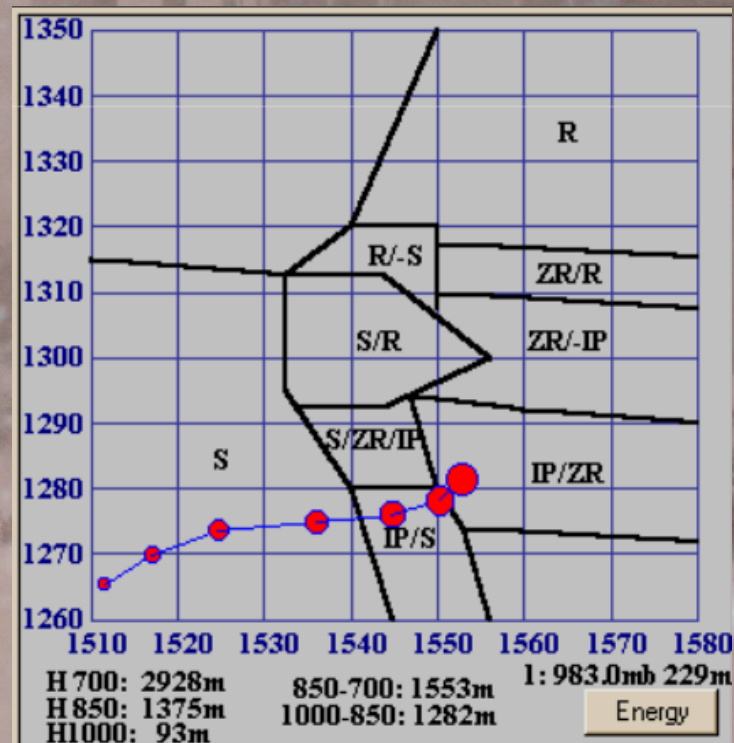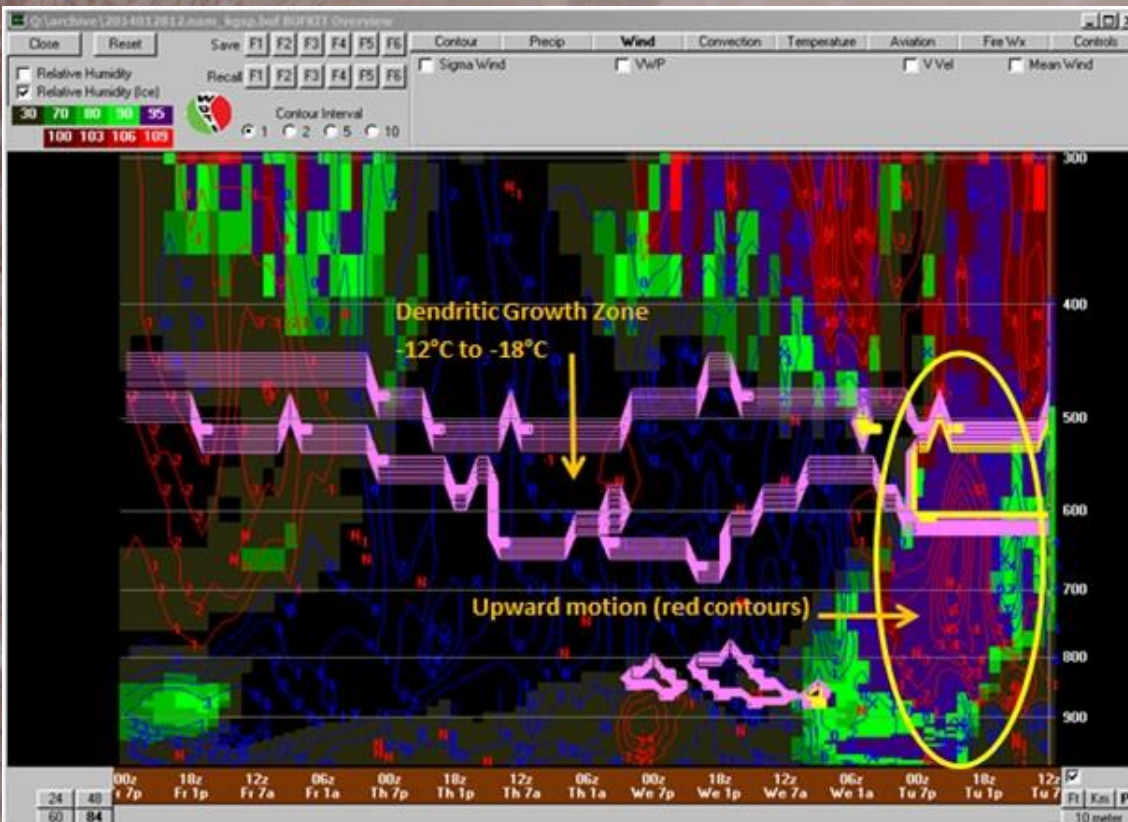
BUFKIT output very effective for analyzing precip. type and vertical resolution of atmospheric parameters – Great for Lake Effect, too

- Probabilistic forecasts from the Weather Prediction Center

- These are for snow but probabilities for freezing rain are also available

- Numerical probabilities for precipitation amounts (WPC, GFSEnsemble, SREF, HREF etc.) can be a more objective method of determining confidence levels for Outlook (30%)/Watch(50%)/Warning(80%)/Advisory(80%)
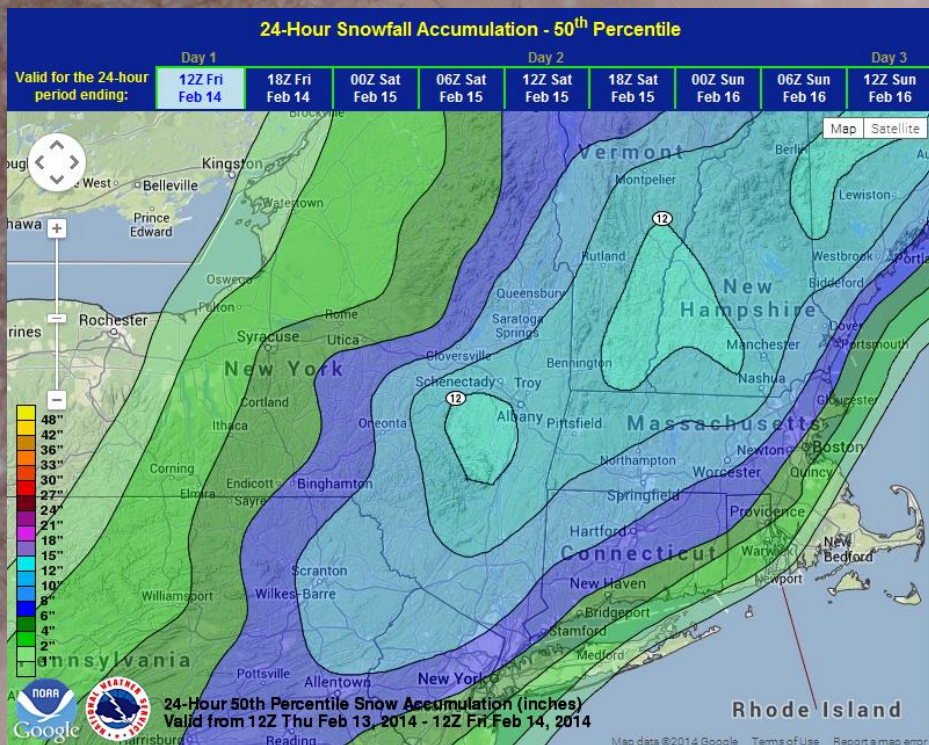
By percentile
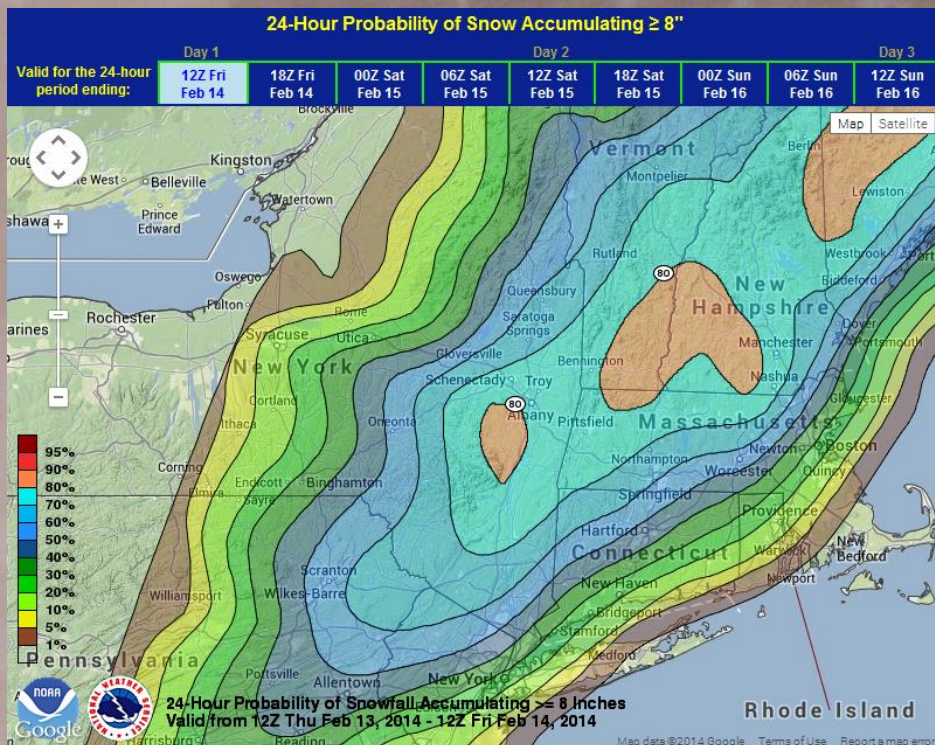
By amount

- ✓ **Probabilistic forecasts from the NWP Model Ensemble Output**

- ✓ **Numerical probabilities for precipitation amounts (WPC, GFSEnsemble, SREF etc.) can be a more objective method of determining confidence levels for Outlook (30%)/Watch(50%)/Warning(80%)/Advisory(80%)**

- ✓ **Disagreements between ensembles often occurs but that is where experience and expertise help determine which guidance is resolving important storm features better**
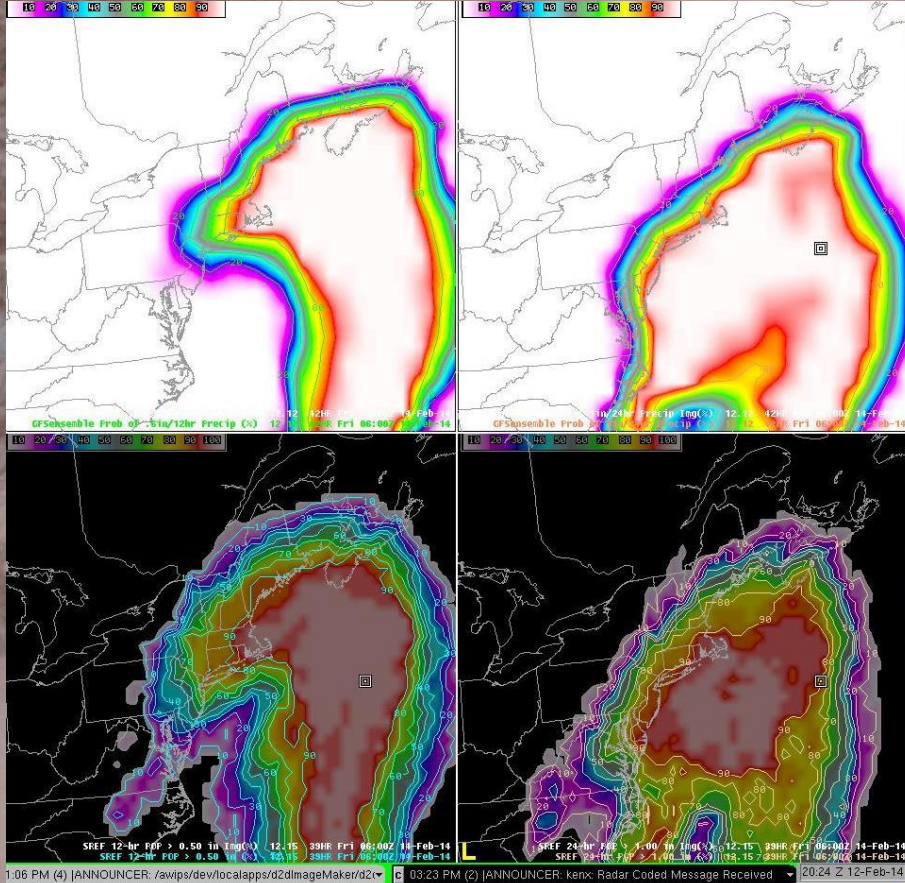
GFSEnsemble probability for 0.60" and 1.00" liquid equivalent

SREF probability for 0.50" and 1.00" liquid equivalent

✓ Radar and lightning trends – near-term precipitation type and intensity

feb14snow.wmv

https://www.youtube.com/watch?v=_iCYTPeXNCQ
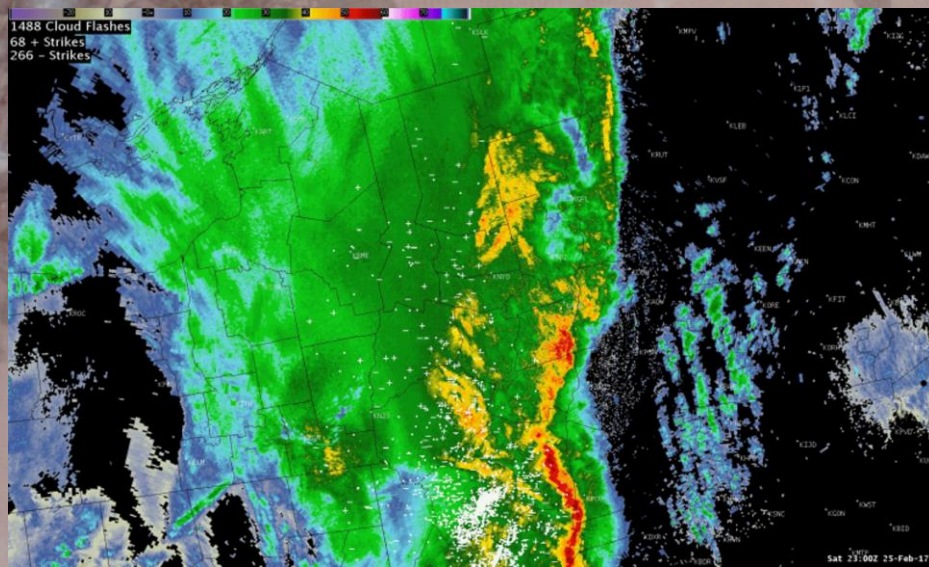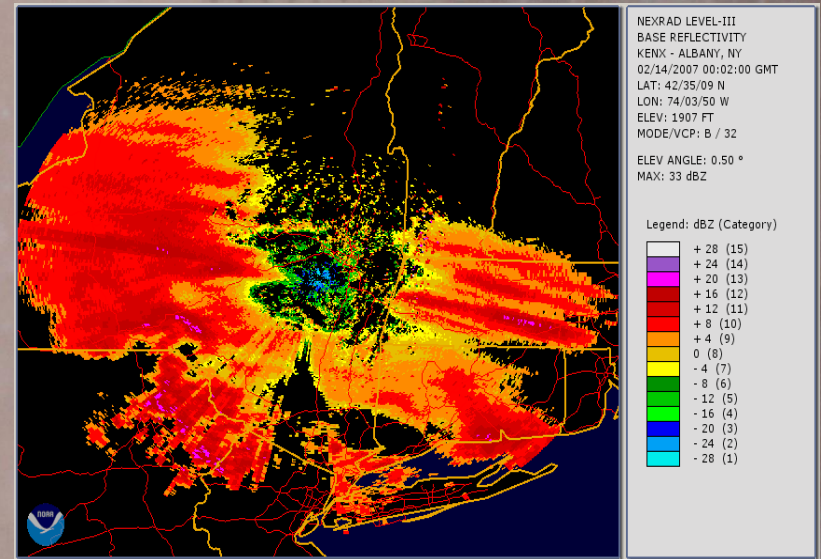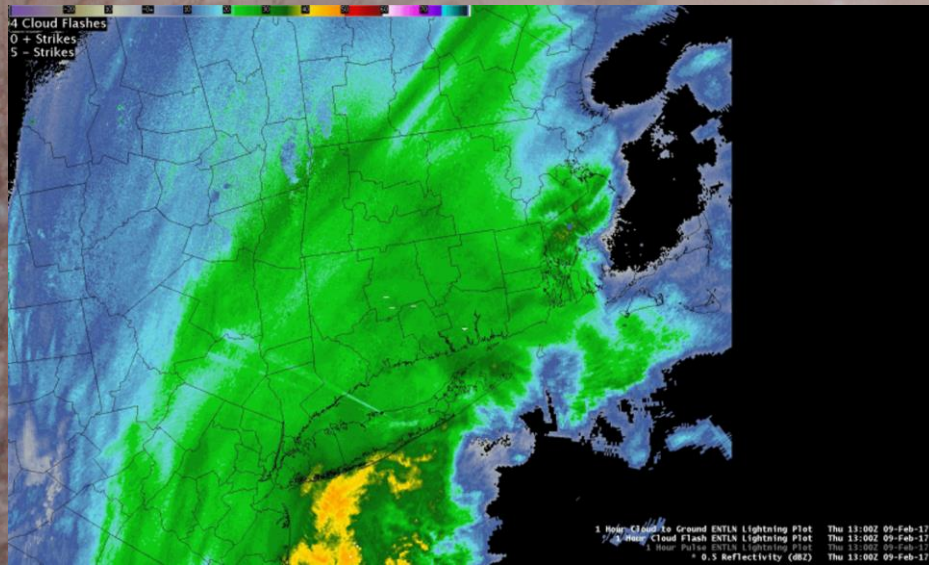
✓ DUAL POL Radar data – near-term precipitation type and intensity
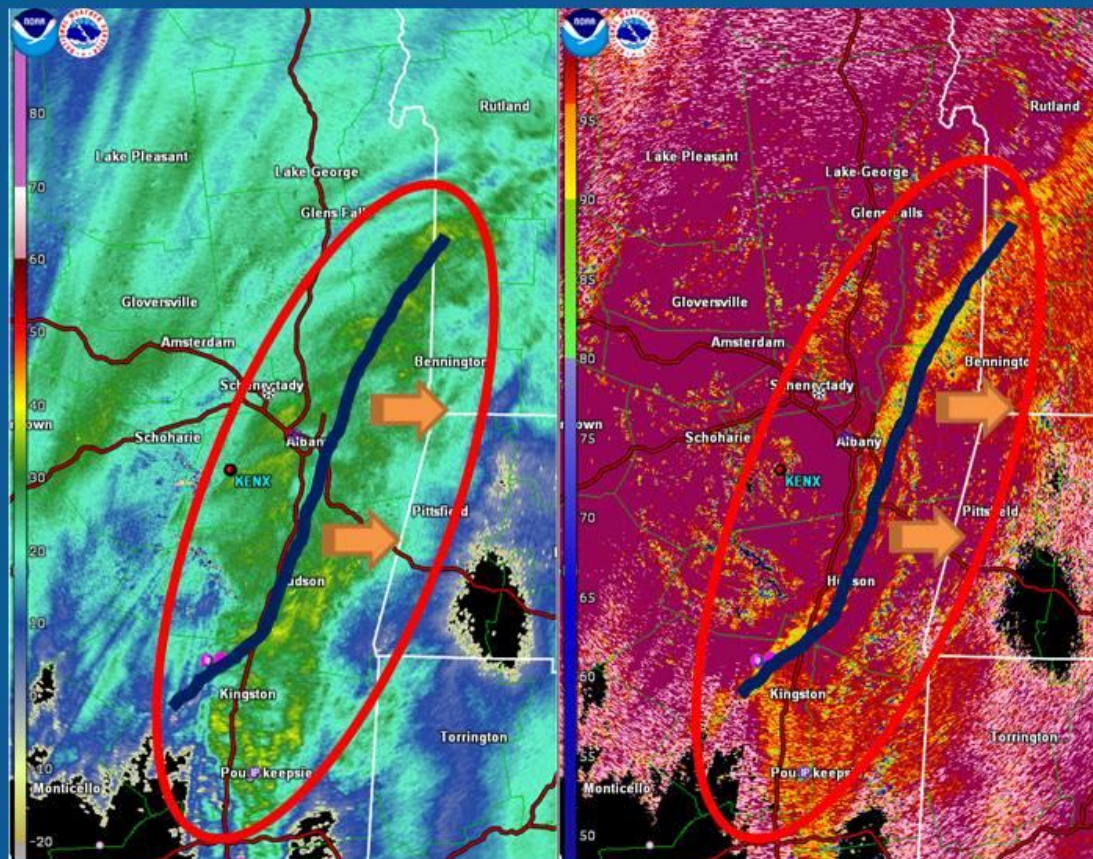
✓ DUAL POL Radar data – near-term precipitation type and intensity
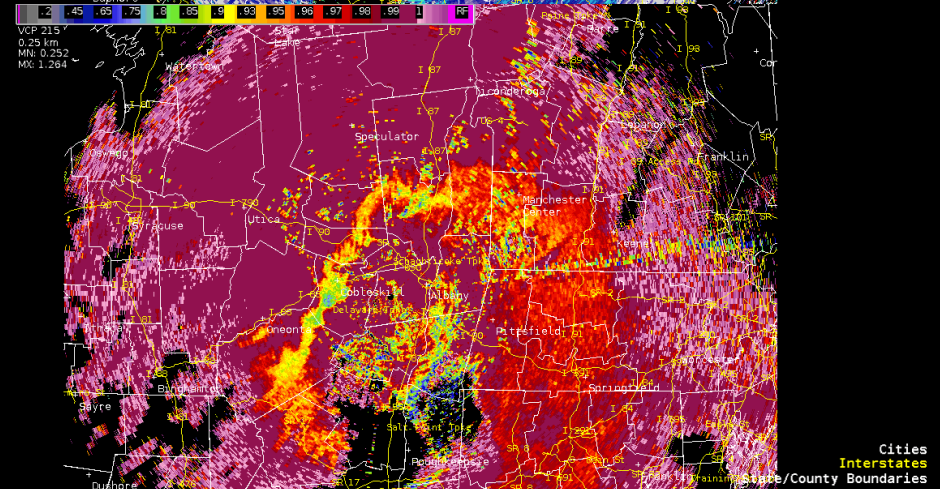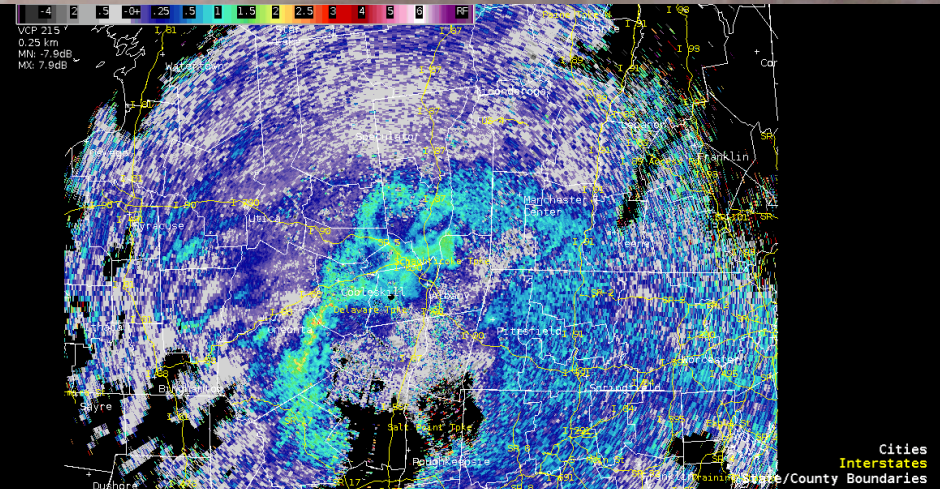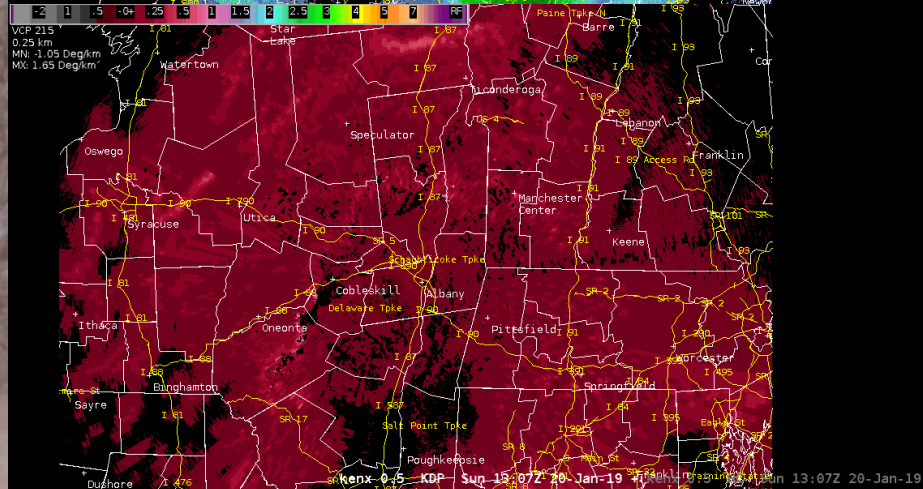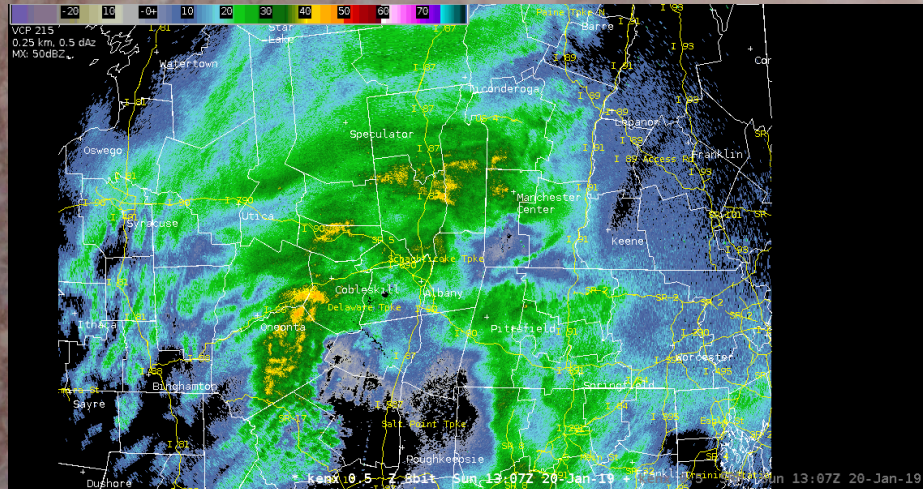
A quick note about Lake Effect – BUFKIT is the ideal tool to evaluate instability class, inversion heights and flow trajectories to predict band type, intensity and inland extent

Single Band Example
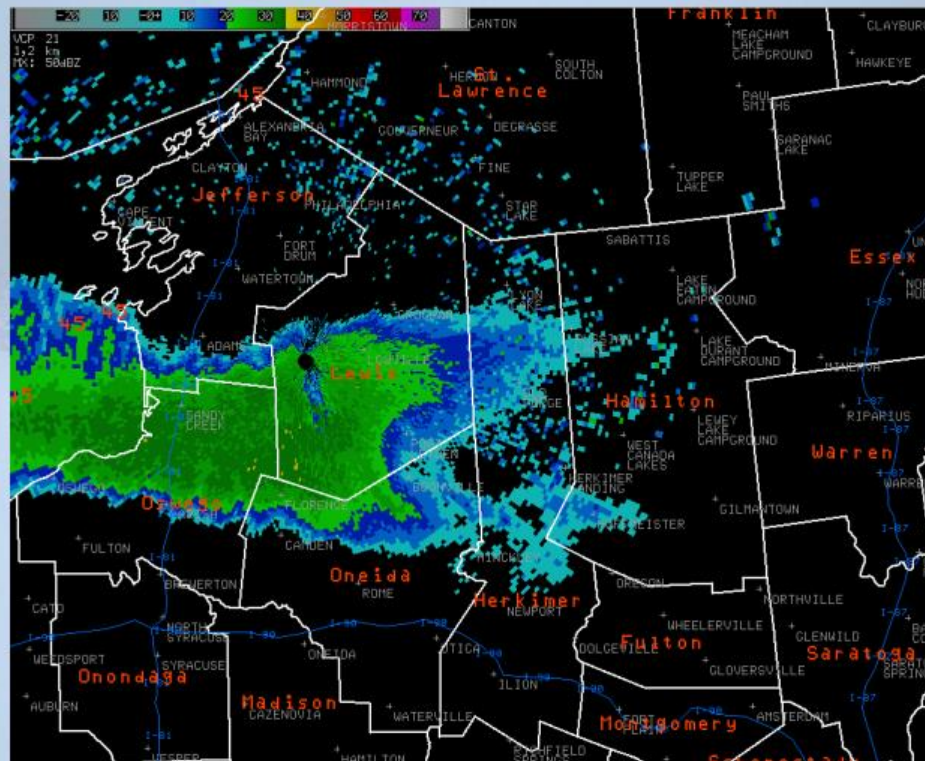
Multi Band Example
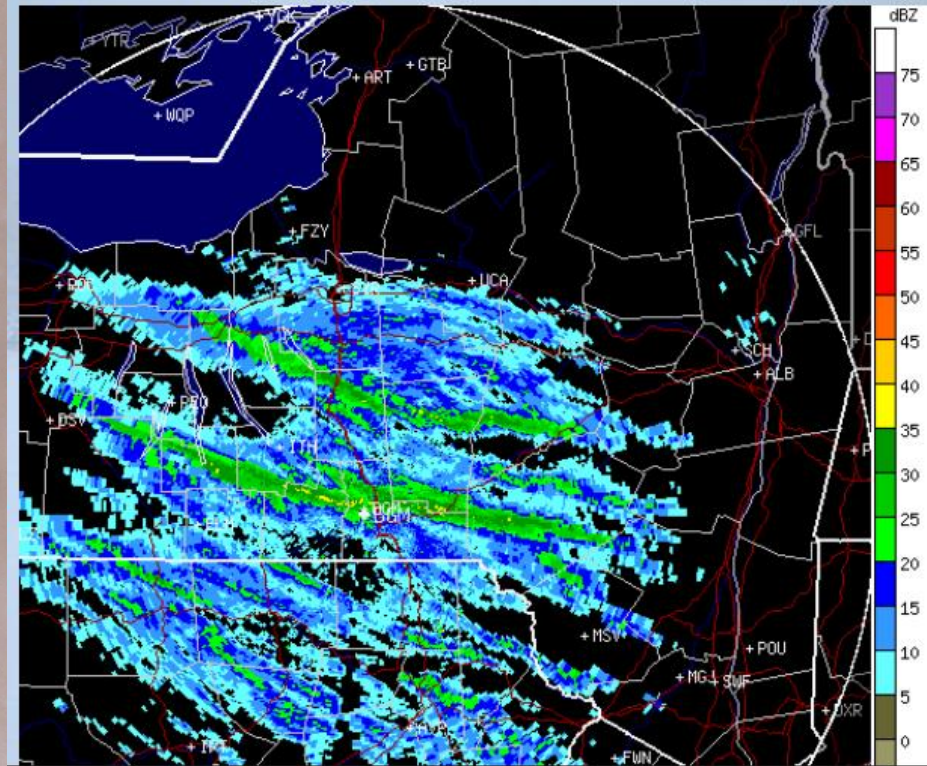
Important to be aware that bands can extend farther inland than the radar depicts due to the height of the radar beam

O.K., now back to our regular scheduled programming →

✓ Mesoscale observations and analyses

✓ Mesoscale observations and analyses (courtesy of Nicholas Bassill)
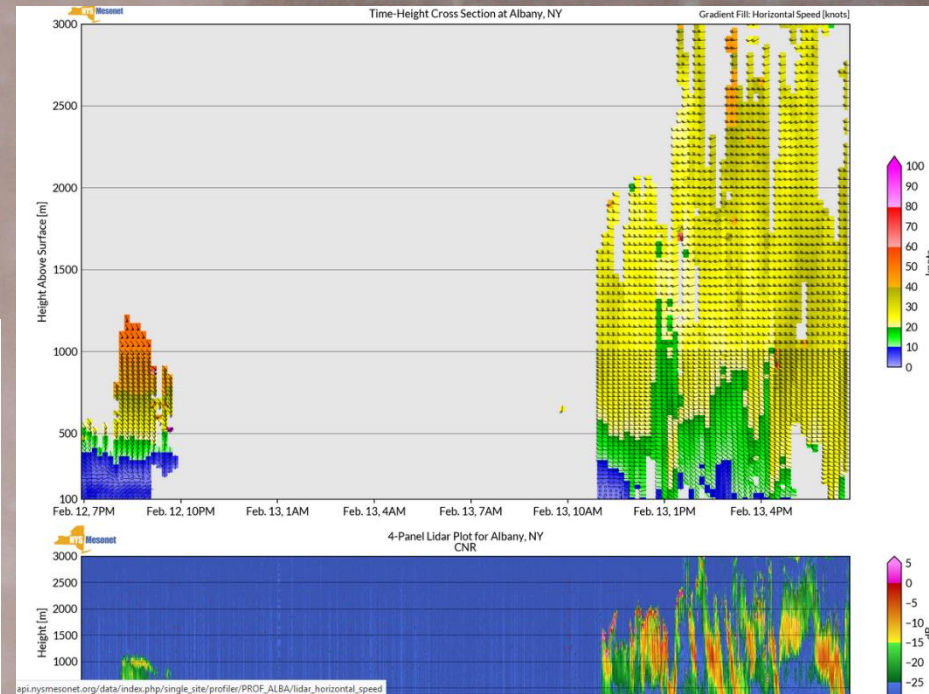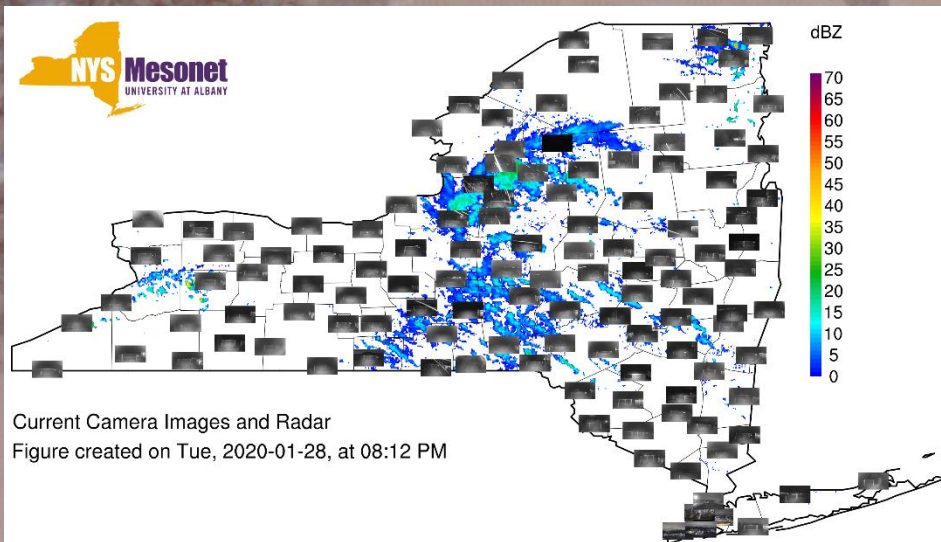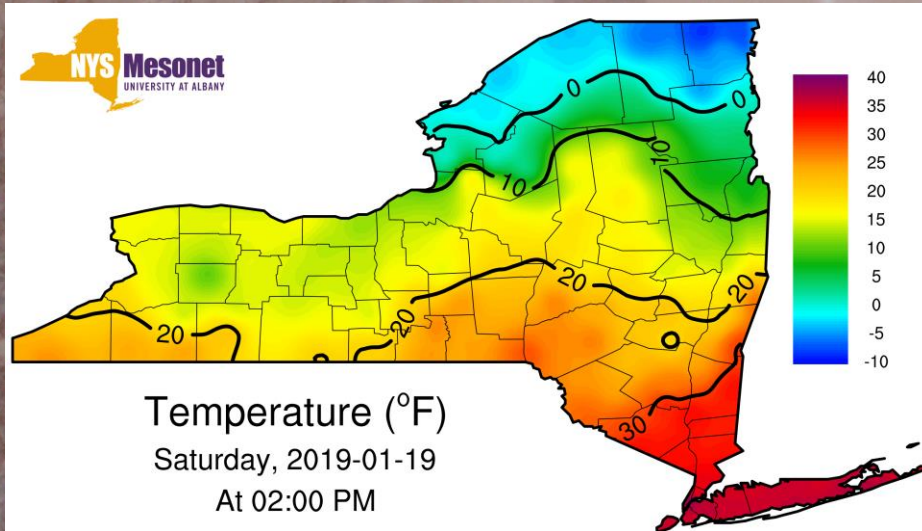
✓ Mesoscale observations and analyses (Storm Prediction Center)
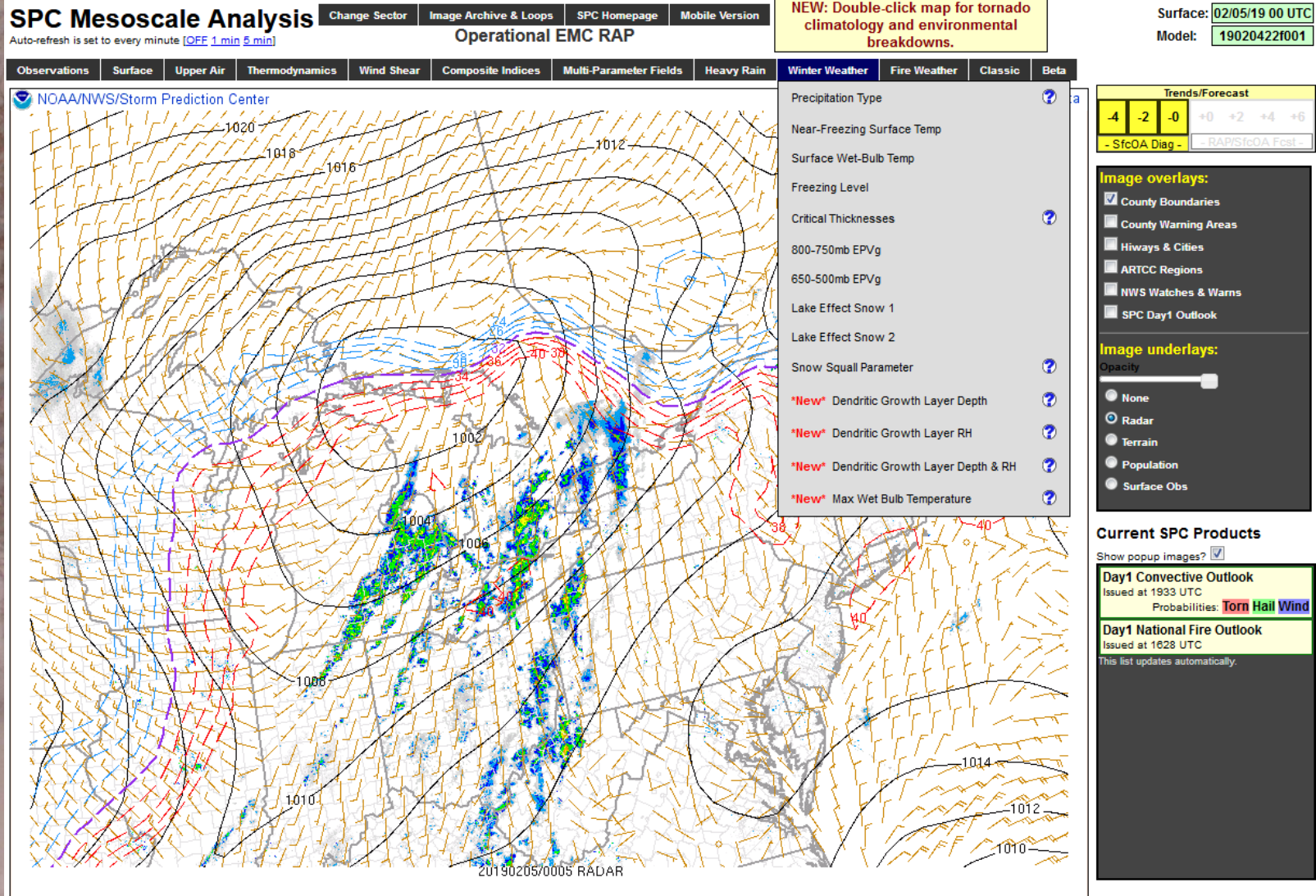
✓ Goes-16 satellite trends – CH2 Red Vis

Albany

Albany
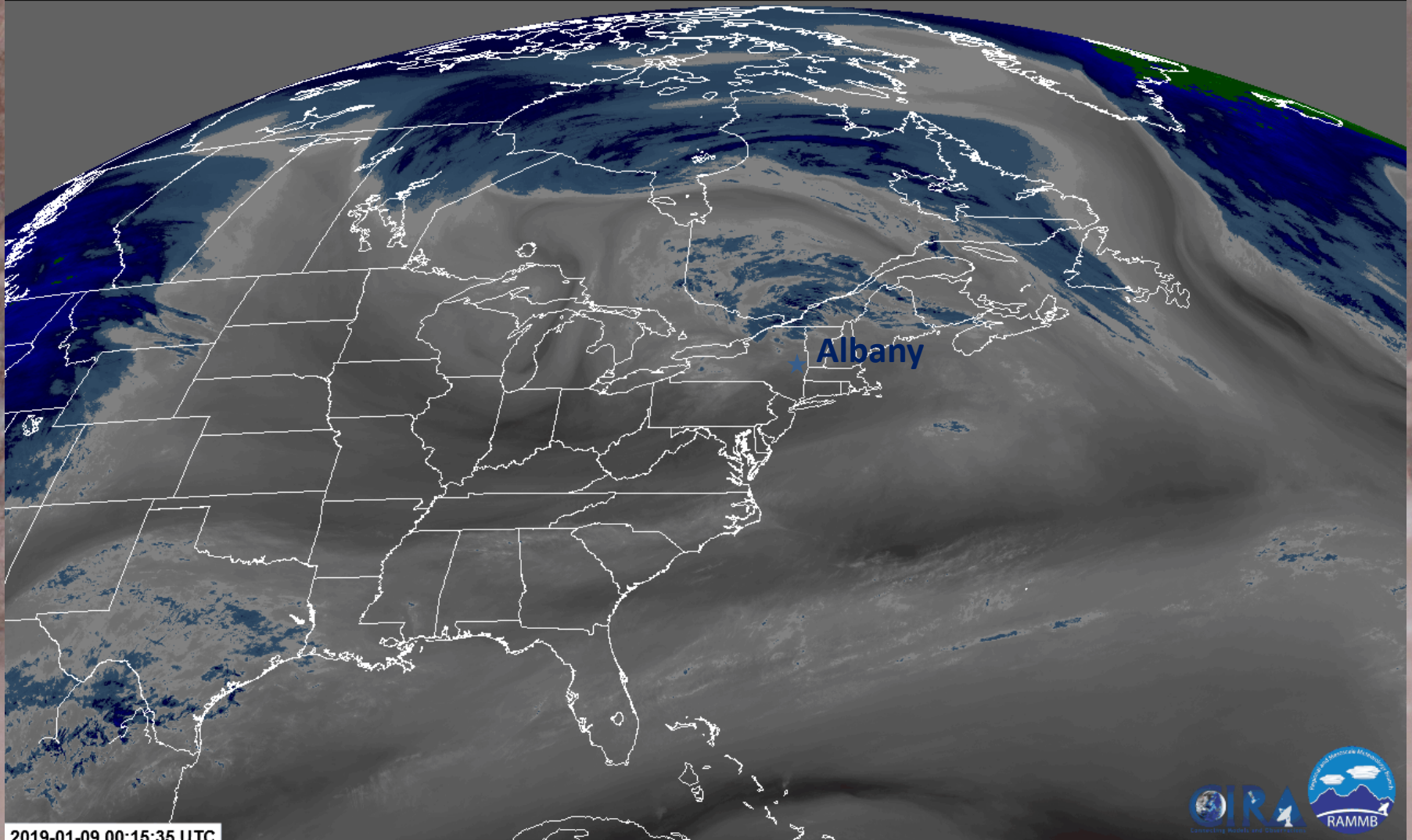
2019-01-09 00:15:35 UTC

A brief word about Snow Squall Warnings – treat like Severe Thunderstorm Warnings, increasing ability to predict since similar to thunderstorms
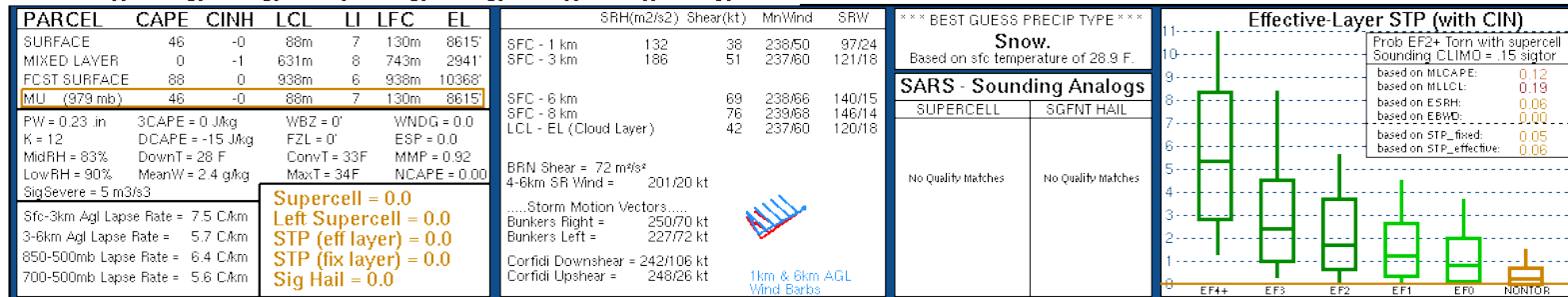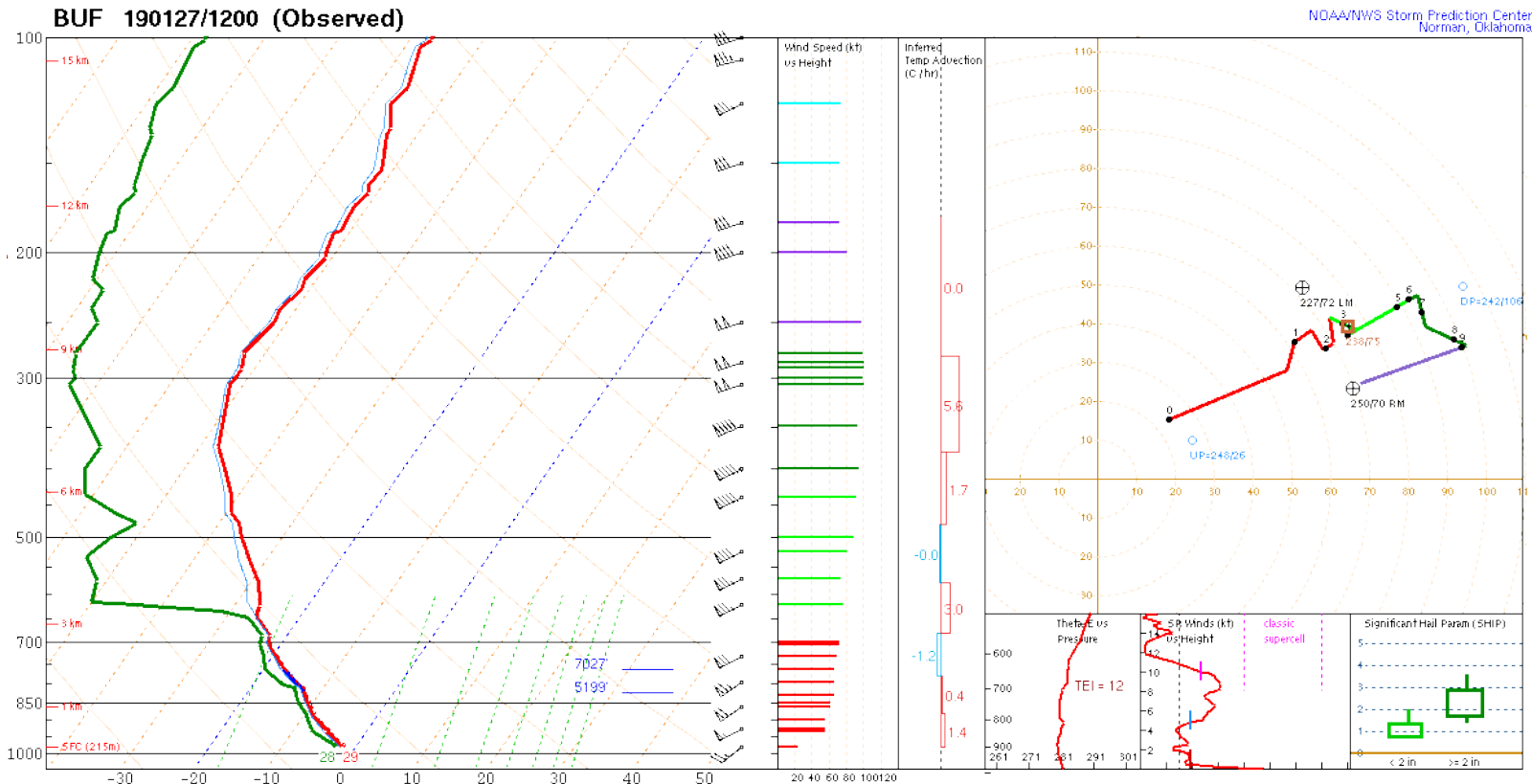
✓ **A brief word about Snow Squall Warnings – treat like Severe Thunderstorm Warnings, increasing ability to predict since similar to thunderstorms**
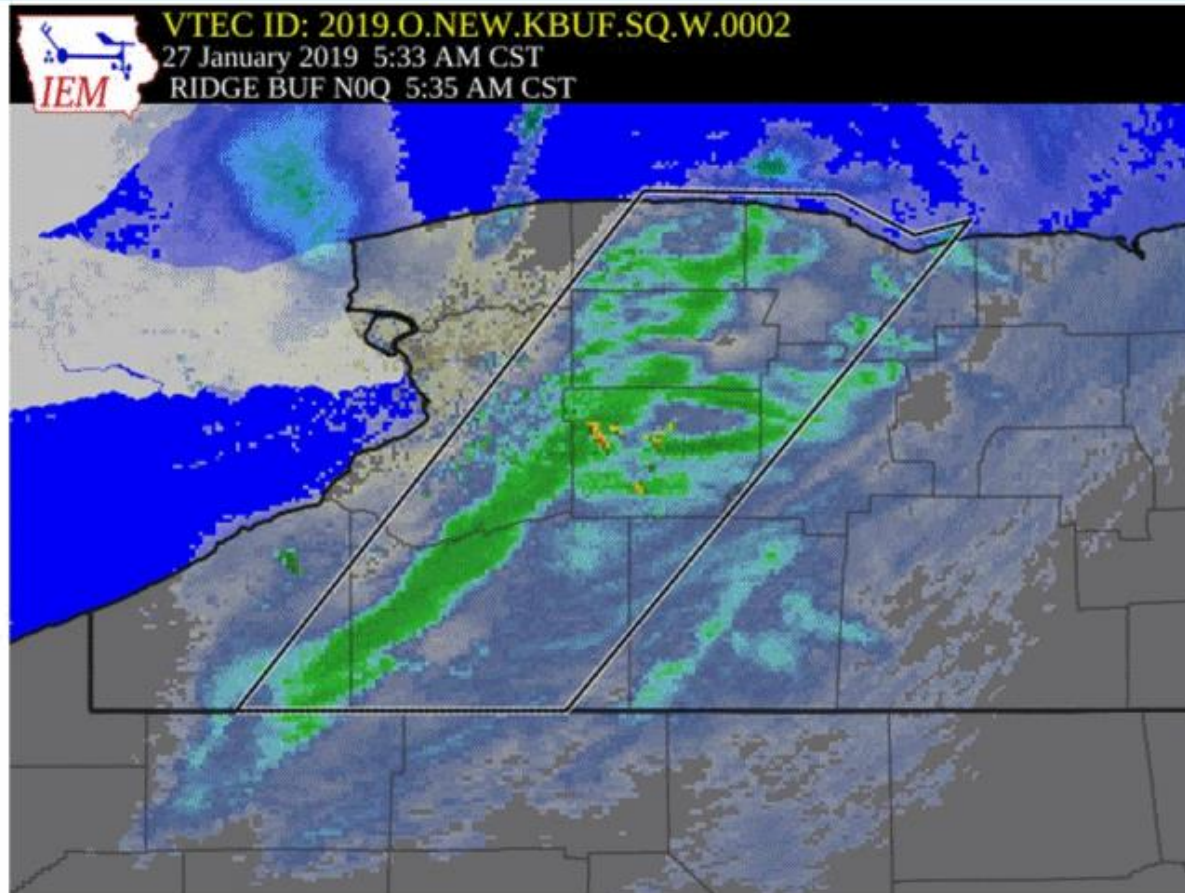
- ✓ O.K., time to issue the forecasts and briefings –
  - ✓ Variety of population methods and smart tools in a Graphical Forecast Editor (GFE)
  - ✓ Oh, and we have to coordinate with neighboring offices
  - ✓ All this data and model analysis, populating grids, editing and coordination takes **LOTS OF TIME**
  - ✓ Delicate balance of what we choose to analyze, how to produce grids that we believe most accurately represents what we think will happen
  - ✓ We have to cut off the meteorology at some point and meet the deadlines to issue everything to partners and the user community
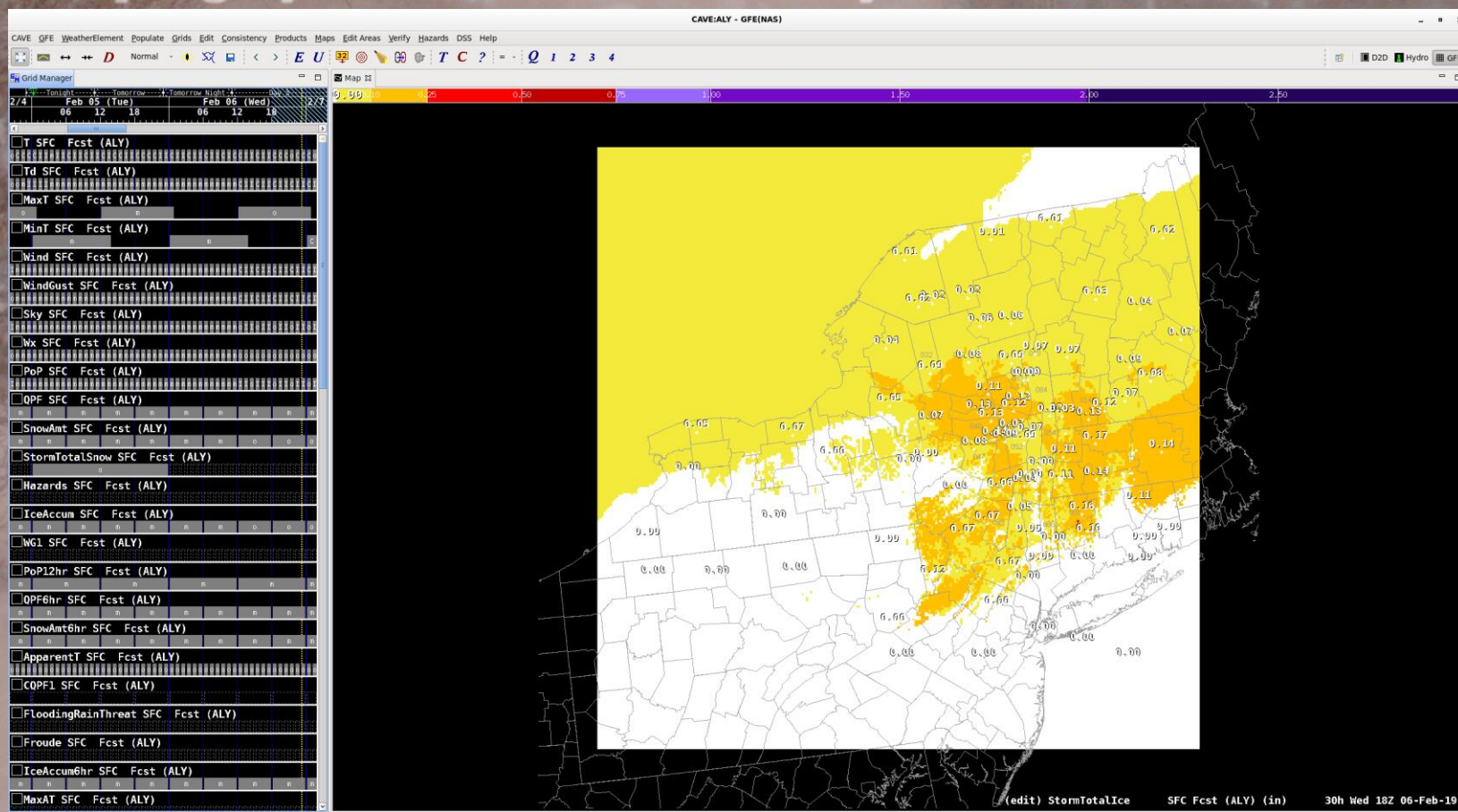
- O.K., time to issue the forecasts and briefings –
  - Variety of population methods and smart tools in GFE
  - Coordinate with neighboring offices
  - Data, model analysis, populating grids, editing and coordination = LOTS OF TIME
  - Balance what we choose to analyze, how to produce grids that most accurately represents what we think will happen
  - Have to cut off the meteorology at some point - meet the deadlines to issue everything to partners and the user community

(02:21:31) **BGM BGM-Short Term Forecaster 2:** ALY/BUF... I think we are going to hold off and wait and see how the winds are doing around midnight. So far we only have a few locations that are gusting at wind advisory and the remaining sites are below. It will be a close call. I think I want to wait and let the 10PM shift handle if they want to extend the advisory or not. -kat

(02:21:48) **ALY ALY-Public Forecaster 1:** BUF/BTV...I did notice the strongest boundary layer winds do shift more into eastern and southern NY through the night so I understand letting your headlines expire. I see KSYR, KRME, KELM and KN23 gisting very high right now post wind shift and not showing any sings of diminishing. It may be more our and BGM's issue to consider. Thanks. Neil

(02:24:30) **ALY ALY-Public Forecaster 1:** BGM..I see KSYR, KRME, KELM and KN23 gusting very high right now post wind shift and not showing any sings of diminishing. We'll look at 10 PM observations and see if there are any trends for diminishing winds. Thanks. Neil

(02:32:42) **BGM BGM-Short Term Forecaster 2:** ALY... we see SYR at 16 G 20. We had a peak wind of 44 but that was at 114Z. I am not seeing where you are seeing that? -kat

(02:34:13) : BGM BGM-Short Term Forecaster 2 has left the room.

(02:37:47) **ALY ALY-Public Forecaster 1:** BGM...yes, saw peak wind at 0114Z but upstream in KELM/KITH at 0142-0152Z big gusts and KRME showing 37 Kt at 0130Z. That seems to be the nature of gusty winds, intervals, localized channelling, lots that models can't resolve well. Again, 10 PM observations will hopefully show good trends of diminishing winds. Thanks. Neil

(02:47:18) : WPC Surface Analysis 1 has entered the room.
(02:51:52) : WPC Lead/Day 1 QPF 1 has left the room.
(02:59:04) : ALY ALY-Public Forecaster 3 has left the room.

(03:02:36) **ALY ALY-Public Forecaster 1:** BGM...good to see winds diminishing a little even though you and KELM are still gusting well. Some mesonet obs also show some good gusts but on the downward trend. Will let wind advisory expire naturally at midnight. Thanks. Neil

(03:03:24) : WPC Lead/Day 1 QPF 1 has entered the room.

(03:04:41) **BGM BGM-Short Term Forecaster 1:** BUF/CTP/ALY/PHI/OKX - HRRR 925mb winds show 40+ kts across a large portion of our FA overnight. Currently gusting to 40 at KELM, and we are getting reports of power flashes near Binghamton. Anyone considering extending the wind advisory? dp/bgm

(03:04:55) : OKX Short Term Forecaster 2 has left the room.
(03:05:12) : OKX Short Term Forecaster 1 has entered the room.
(03:08:45) : BGM BGM-Short Term Forecaster 2 has entered the room.
(03:08:56) : BUF BUF-Long Term Forecaster 1 has entered the room.
(03:11:13) : BGM BGM-Short Term Forecaster 3 has entered the room.

(03:11:18) **BGM BGM-Short Term Forecaster 1:** We will extend the wind advisory until 12z for the entire FA. Mid shift will cut areas overnight as needed.

(03:13:35) **OKX Short Term Forecaster 1:** BGM...we do not have an advisory right now and we have pretty strong inversion across our eastern areas. Maybe some gusts inland overnight, but right now going to hold off on issuing anything

(03:14:09) **ALY ALY-Public Forecaster 1:** BGM...well, my northern areas will likely continue to diminish and it seems even the Mohawk Valley is showing signs of winds gusting just below advisory and usually channelling enhances winds down the Mohawk Valley. Now, the Schoharie Valley and the eastern Catskills may see some gusts but temperatures are cooler there and some inversions are limiting the mixing seen in mesonet observations. The strongest wind may actually stay along and west of the eastern Catskills based on the models as the low level wind core shifts more south than east. Keeping advisory up til midnight and decision to extend or not will depend on trends between now and midnight. Thanks. Neil

(03:15:04) : GYX Long Term Forecaster 1 has entered the room.

(03:20:01) **BGM BGM-Short Term Forecaster 1:** aly-okx-ctp-phi-buf: Looks like we'd be on an island if we extended. So after conferring with the incoming mid shift, we decided to allow the advisory to expire at 5z as planned. Will handle localized issues with an SPS. Thanks for the collaboration. dp/bgm

O.K., time to issue the forecasts and briefings

Created: 01/19/19 at 17:56 UTC
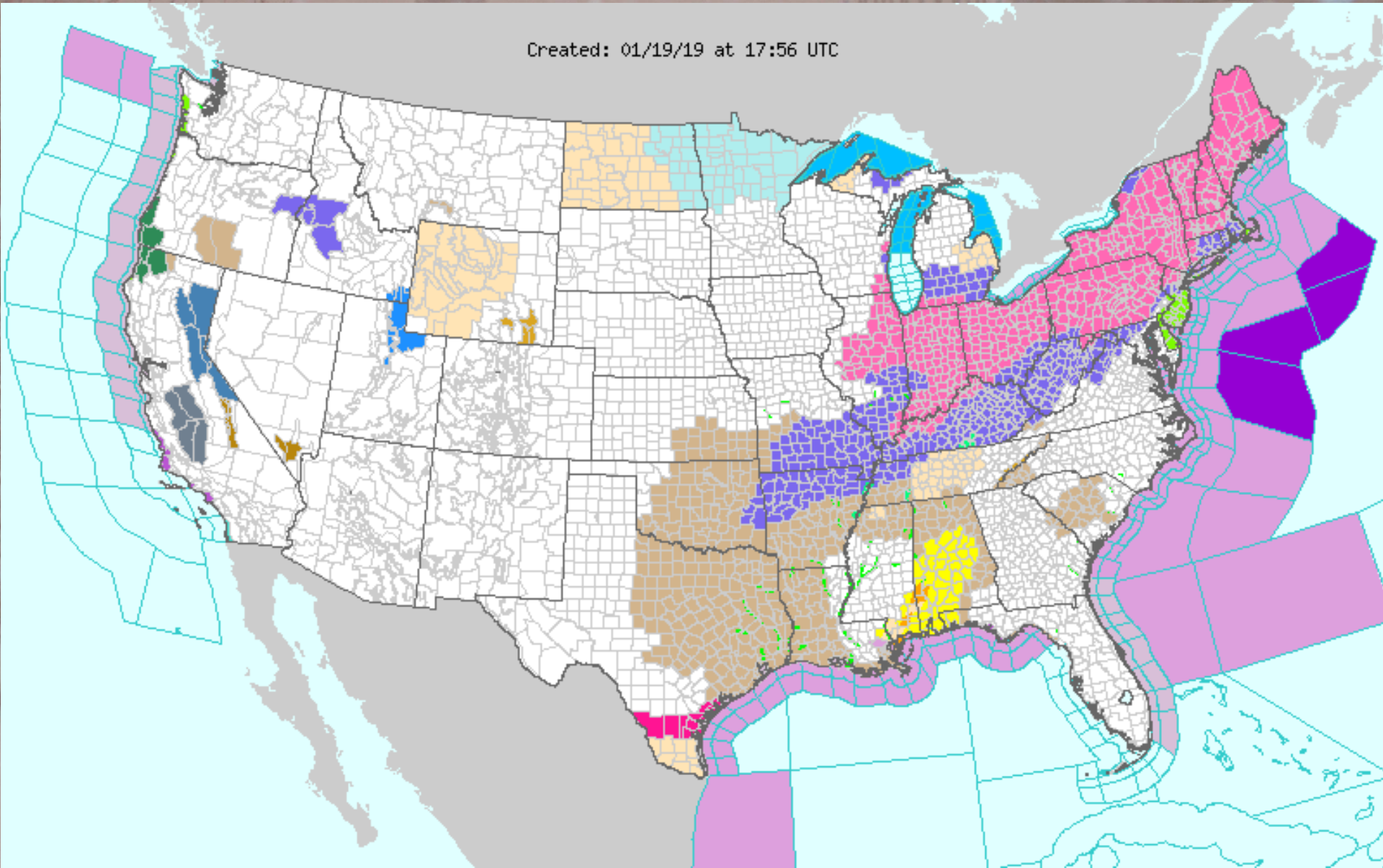
Specialized multi-slide briefings for Emergency Managers and other deep core partners – also uploaded to our NWS Albany NY web site – graphics based on GFE with text explanations
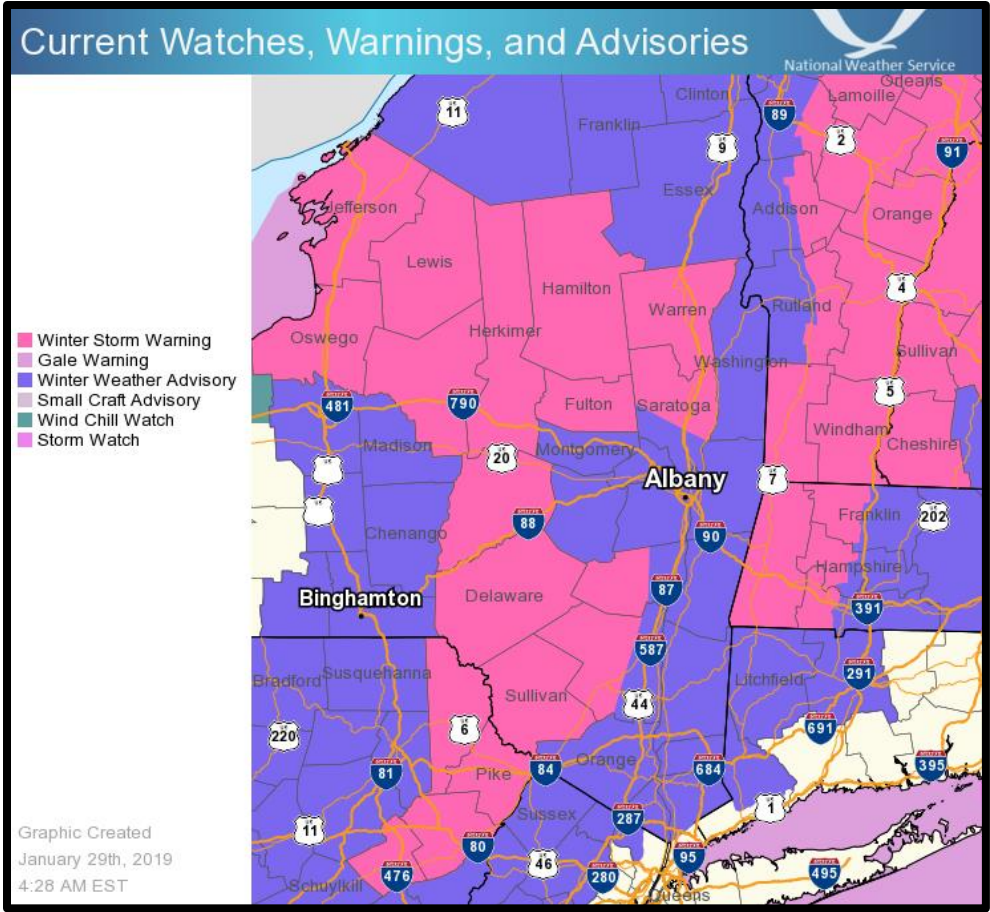
Winter Storm

Decision Support Briefing # 4
As of: 500 AM January 29, 2019

What Has Changed?
- ✓ *Berkshires upgraded to a Winter Storm Warning*
- ✓ *Winter Weather Advisories now in effect for the Greater Capital Region, Taconics, mid Hudson Valley, Schoharie Valley, Helderbergs, eastern Mohawk Valley, Washington Co., and Litchfield County, CT*

Current Watches, Warnings, and Advisories
National Weather Service

- ■ Winter Storm Warning
- ■ Gale Warning
- ■ Winter Weather Advisory
- ■ Small Craft Advisory
- ■ Wind Chill Watch
- ■ Storm Watch

Graphic Created
January 29th, 2019
4:28 AM EST

Event Summary

Winter Storm Expected….

✓ Confidence is **HIGH** that this event will occur and **Moderate to High** on expected impacts

✓ Period of greatest impact for snow: This Morning – daybreak Wednesday

✓ Wind Chill threat: Wednesday night – Thursday morning & Thursday night – Friday morning

Snow will overspread the area from west to east this morning over eastern New York and this afternoon over western New England. Snow will be heavy at times tonight.

Berkshires upgraded to a Winter Storm Warning.
Winter Weather Advisories now in effect for the Greater Capital Region, Taconics, mid Hudson Valley, Schoharie Valley, Helderbergs, eastern Mohawk Valley, Washington Co., and Litchfield County, CT.

Frigid air will move into the region Wednesday night through Friday. Dangerous to life threatening wind chills are expected Wednesday night – Friday morning

O.K., the storm is over, now what?

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  - ✓ **Skill of models/ensembles**
  - ✓ **Skill of humans adding value to model/ensemble forecasts**

- ✓ **Many methods**
  - ✓ **Graphics comparing forecasts to observed**
  - ✓ **Statistics comparing various forecast parameters**
  - ✓ **Receiving feedback from users, positive and negative**

- ✓ **Applying lessons learned to improve for the next storm**

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Verification methods
Gazpacho: GIS-based plots and comparisons
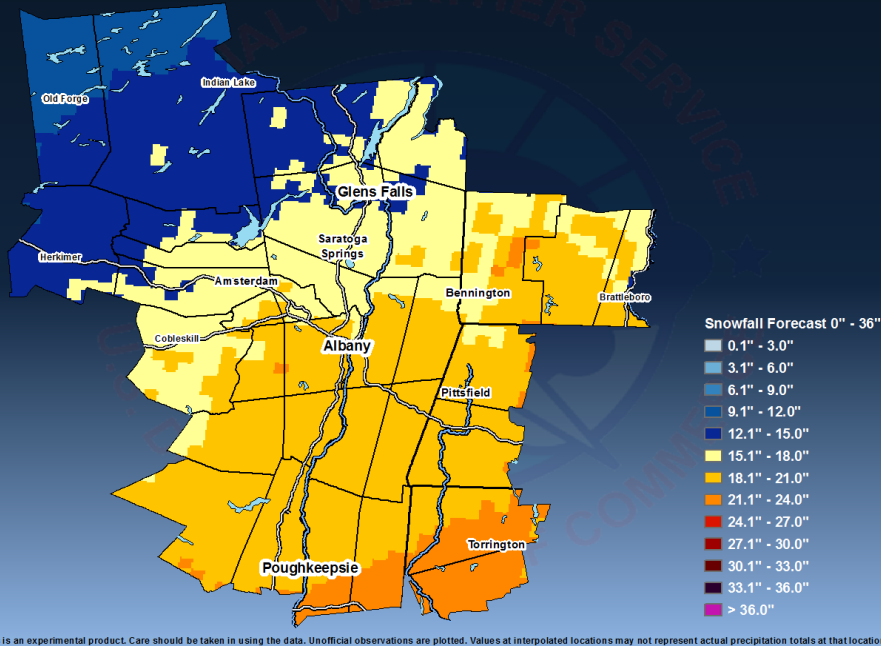
Gridded snow forecast
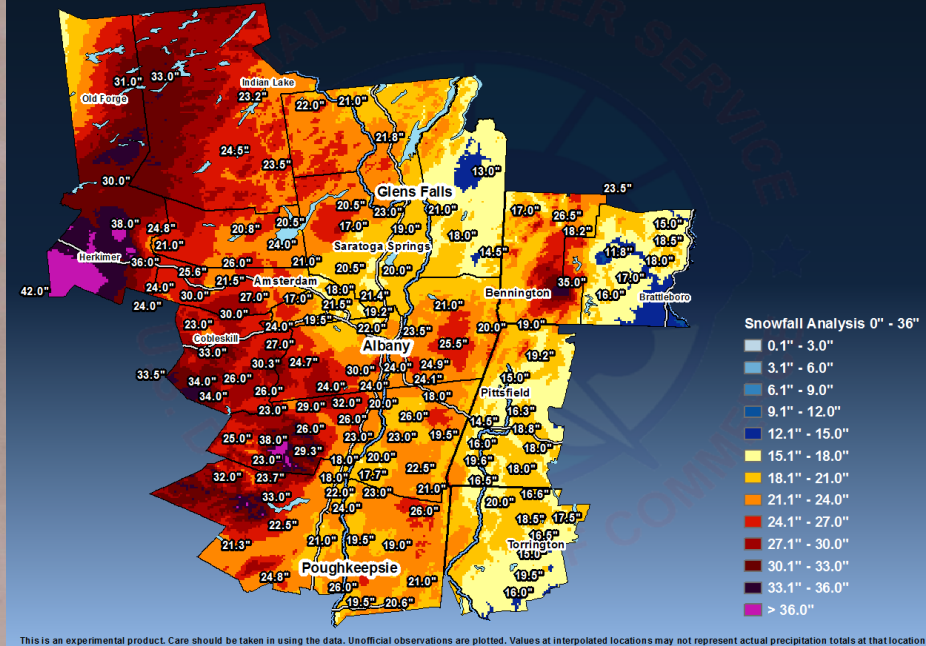
Observed snow

**Gazpacho: Developed by Charles Gant of NWS Greenville-Spartanburg, SC
and Joe Villani and Vasil Koleci of NWS Albany, NY**

Verification methods
Gazpacho: GIS-based plots and comparisons

Snowfall difference – under forecasted in western areas and over forecasted in eastern areas

Verify by zone average

Verification methods
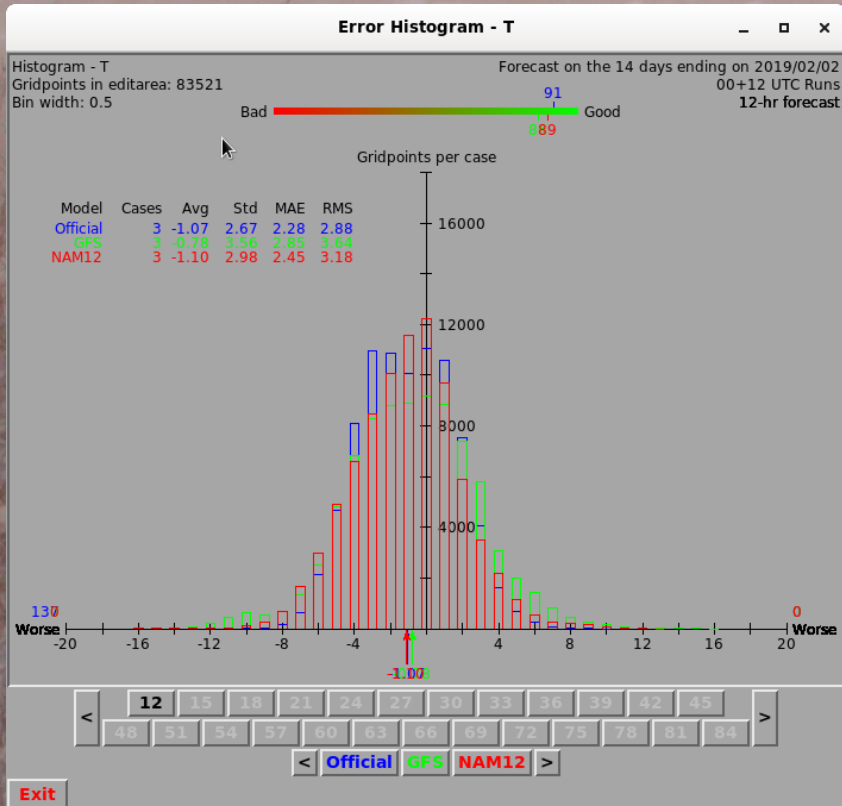
Various methods to verify temperatures and other parameters - Boiverify
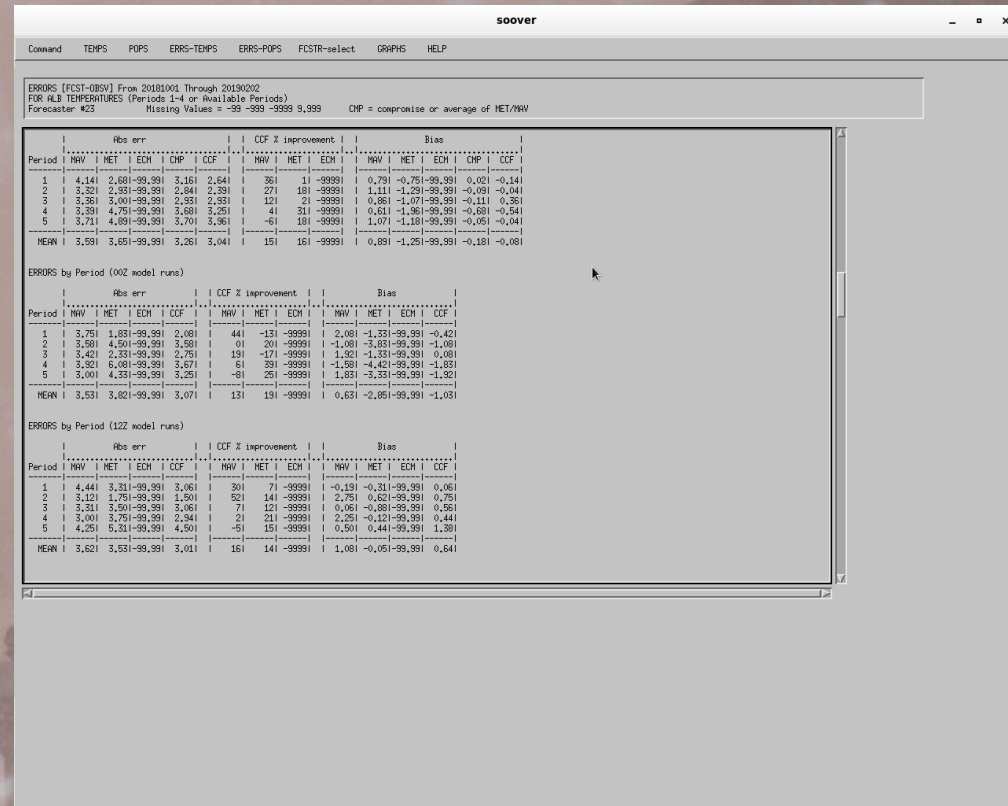
Various methods to verify temperatures and other parameters - LinuxSoover

Verification methods
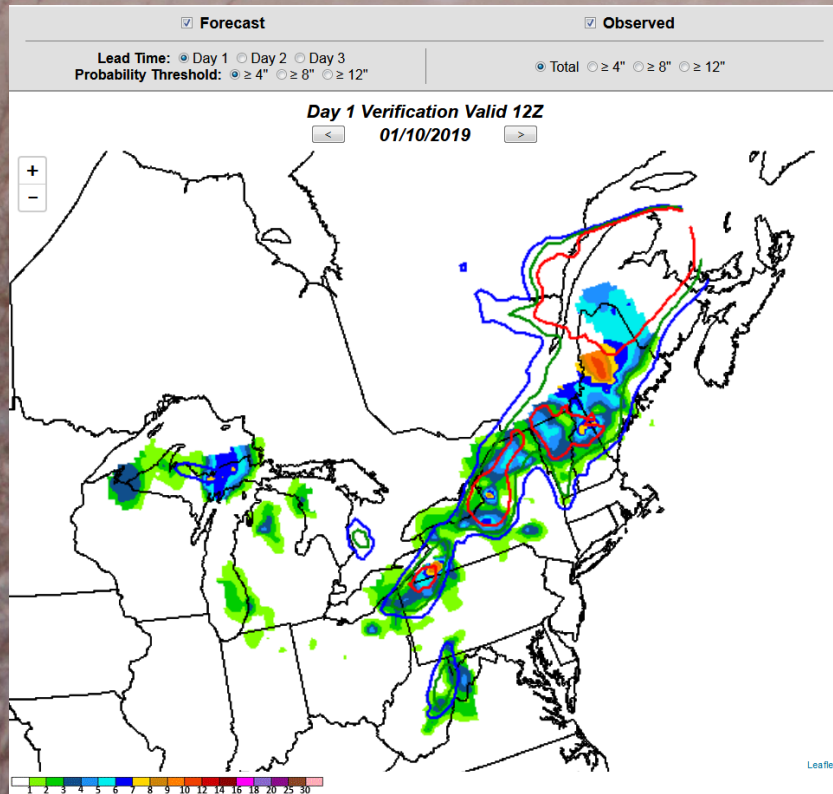
WPC probabilistic verification

Statistics on POD, FAR, CSI and lead time from the NWS Verification web site

Applying lessons learned – User feedback

Responses and feedback from social media users – Facebook and Twitter

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Applying lessons learned – Internal Quality Assurance Reports for significant events

8. Customer Feedback:

"I liked that the winter storm watch went out as early as it did for this event...from what I recall it went out Saturday afternoon – lots of lead time for a big event, even though at that time there was great uncertainty in storm track. But a good call there. And the change to blizzard warning for the event was appropriate which I think really helped in cementing the message that the traveling would be a nightmare throughout the region, which was really what we were trying to convince people to avoid...and I think that worked out well based on news reports showing a minimum of traffic accidents and issues through the duration of the storm.

The experimental snowfall projection graphics on the website were what really stood out to me... excellent. The March 14 storm was the first time I had looked at those products and the concept of offering the three scenarios of "Expect this much" "The most probable amount" and "This is possible" are very effective at telling the story, even for the very probability challenged public. I'm going to try to figure out a way to do something similar on air for next season...although for us they would be quite labor and time intensive to produce which will make it tricky. But it's definitely the way to go in the future."

"Overall good lead time with NWS communications, forecast was accurate and your graphics are very good as well. Thx."

"Thank you very much for your briefings which are incredibly helpful in our storm preparations. The only comment that I have is that there was not enough mention of the possible snow ratios in either the briefings or your daily forecast discussion. The consistency of the snow is very critical for the utility industry, so we would welcome as much information on snow ratios as possible in your future forecasts. Thank you."

"Thank you guys for keeping the area alerted and informed about the storm yesterday, I really appreciate the hard work you guys put in leading up to/during a system like this. I chased the storm out in the Berkshires yesterday afternoon, and I can honestly say that the conditions we experienced were nothing short of life threatening. On top of the extremely heavy snow, we experienced some outrageous winds near the town of Florida MA, with a wind gust of 74 mph. measured by our mobile weather station. Feel free to share my video on your page for educational purposes!"

Many people on social media questioned the airport's total of 17.0", because it was the lowest total in the area. It's easy to see why people are critical of that report. But it does make sense given that it's one of the areas most susceptible to blowing in the Capital District. We double-checked the report with the observer, so I'm not sure what more can be done

8. Customer Feedback:

Thank you for providing these weather briefings. They are very helpful to the Department when we are preparing our storm responses. I have one question/request – earlier in the week, one of the NWS Offices (I believe it was Albany) included a Statewide map of expected snowfall in addition to the regional map that is normally provided. This Statewide map was incredibly useful to us because it allowed us to look at the entire picture. We still used the briefings from all of the other offices for specific details, but the single Statewide map gave us something to quickly reference as we conducted our pre-storm planning. Is there any way we can get a Statewide map in all of your briefings?

Kudos to NWS Albany for good weather sleuthing and for your caution that mixing could occur with the snowstorm (February 7 snow event) as suggested by multiple NAM runs in contrast to the colder GFS/ECMWF global solutions.

Ultimately – No forecast is perfect: life-long learning is the key!
Remember: Weather occurs in the atmosphere, not the models – Any Questions?