Evaluation of a Revised Bourgouin "Layer-Energy" Technique for Top-Down Precipitation-Type Forecasts

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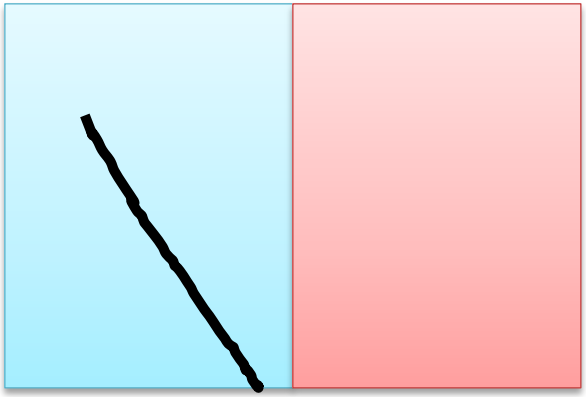
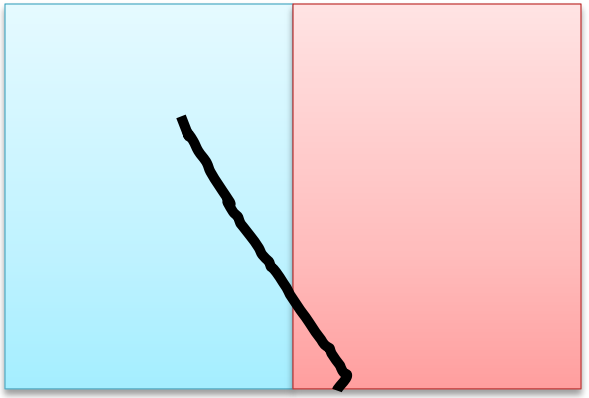
Top-Down: The Idea of Energy Layers

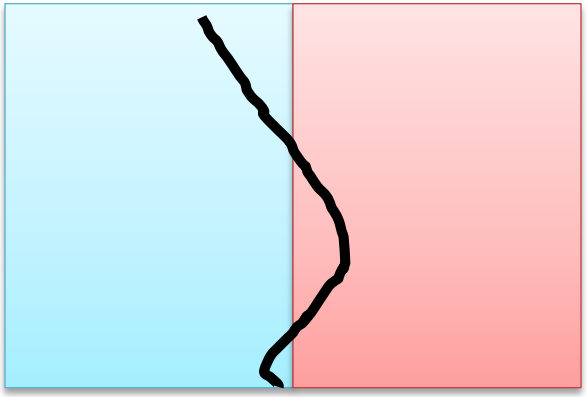
Will there be enough energy in a layer (warm or cold) to produce a phase change?



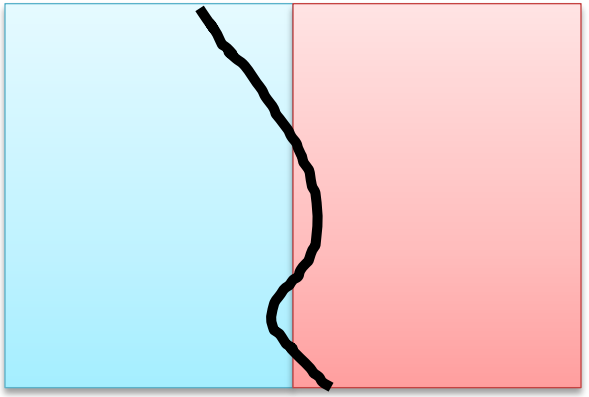
No layers – all freezing



One layer: surface melting

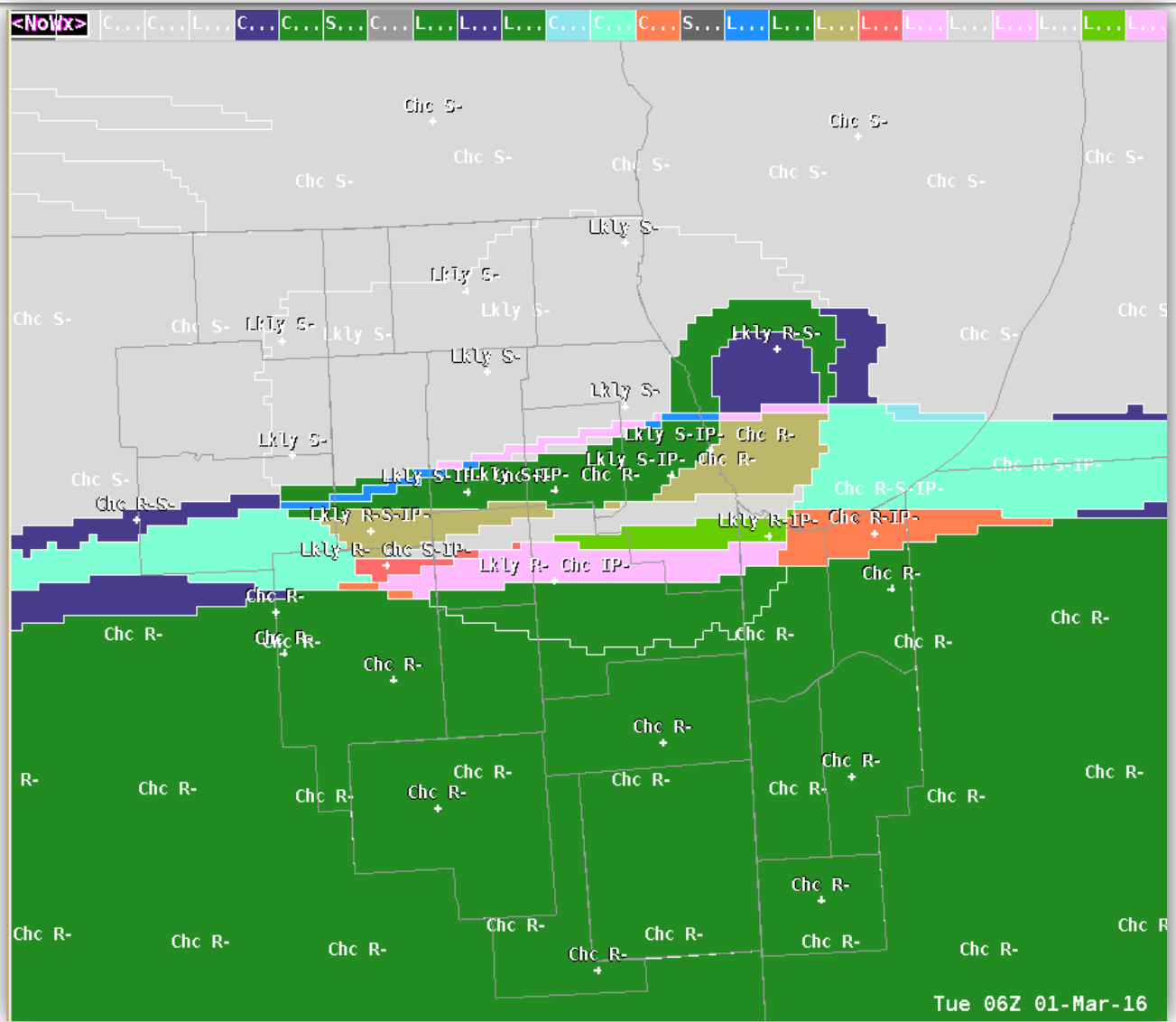


Two layers: elevated melting and surface freezing

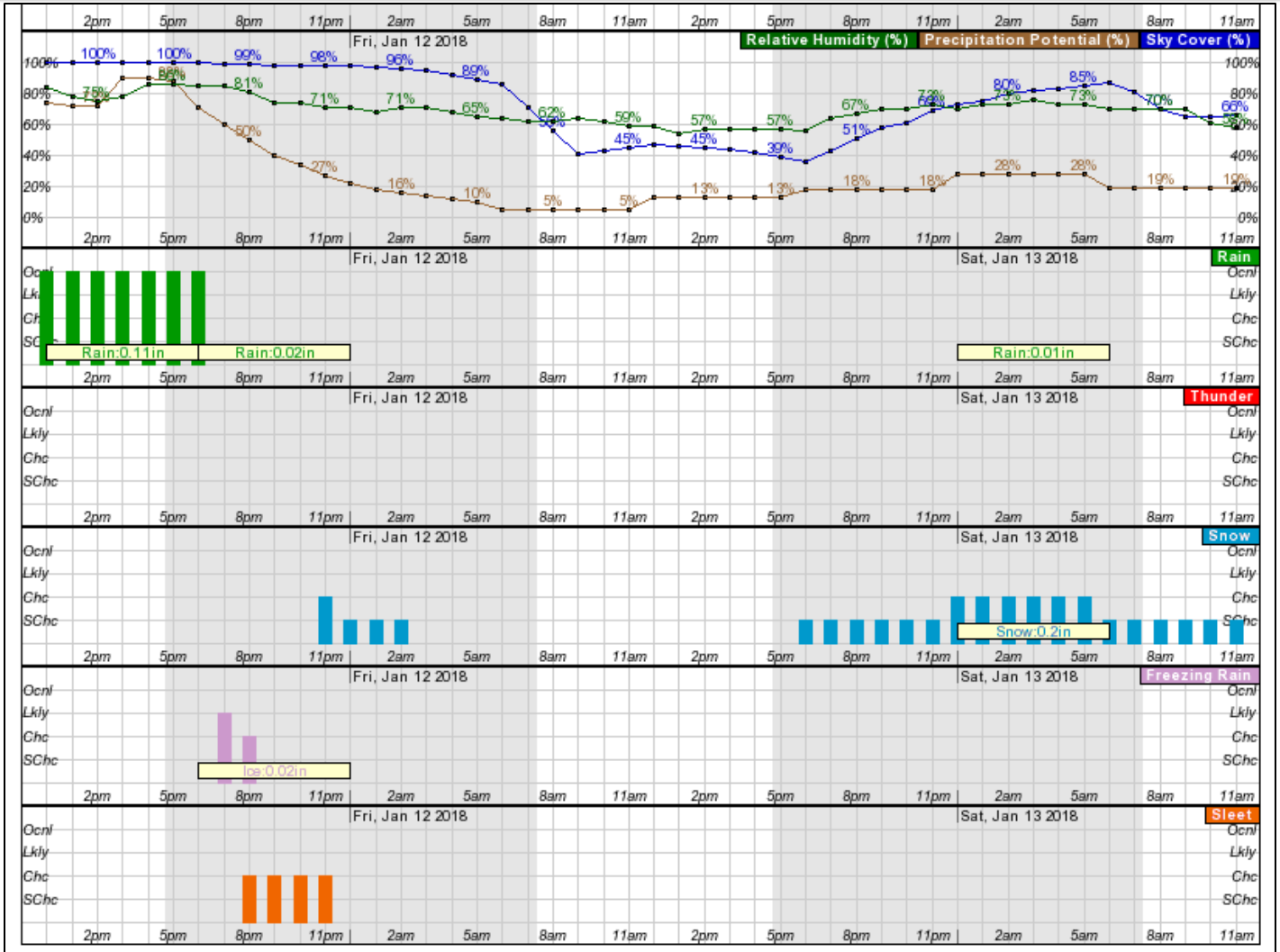


Three layers: elevated melting, elevated freezing, and surface melting

GFE Hourly Weather Grid



NDFD Weather at a Point



Friday, January 12 at 6am
Temperature: 20 °F Dewpoint: 10 °F Wind Chill: 5 °F Surface Wind: N 15G26mph

RAIN

THUNDER

SNOW

FREEZING RAIN

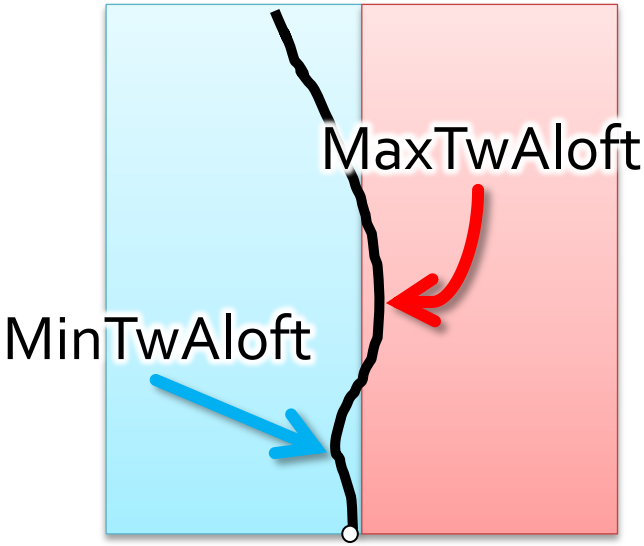
SLEET

Outline

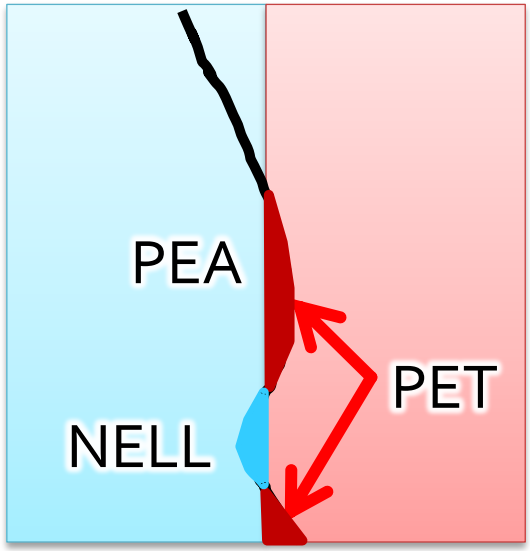
- Review of two Top-Down techniques
- Some concerns with the traditional approach
- Improvements to original Bourgouin technique
- Verification studies (RAOB vs METAR)
- Development activities and future plans

Top-Down Techniques

- **TRADITIONAL**
  Uses temperature or wet-bulb thresholds
  - MaxTAloft
  - MinTAloft



- **LAYER-ENERGY OR BOURGOUIN**
  Uses melting and refreezing energies
  - PositiveEnergyAloft
  - NegativeEnergyLowLevel
  - PositiveEnergyTotal

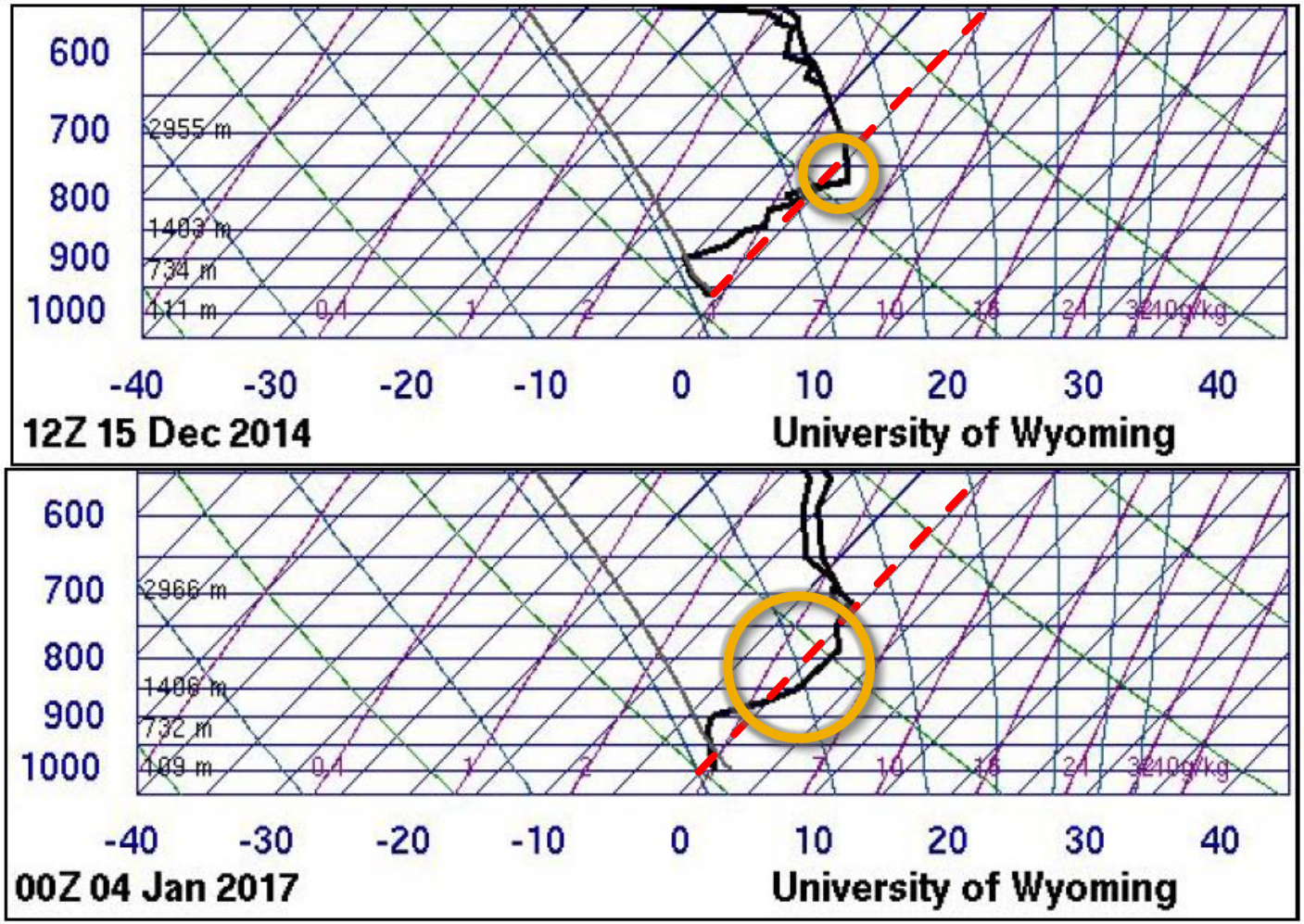


Concerns with Traditional Approach

- Does MaxTwAloft give actual melting potential?
- No freezing rain until MaxTwAloft > 2.5 to 3C
  - Exception: When SfcT > 0 but SfcTw < 0
- Sleet requires refreezing layer > 2500' deep
- Sleet not possible with SfcT > 0 C

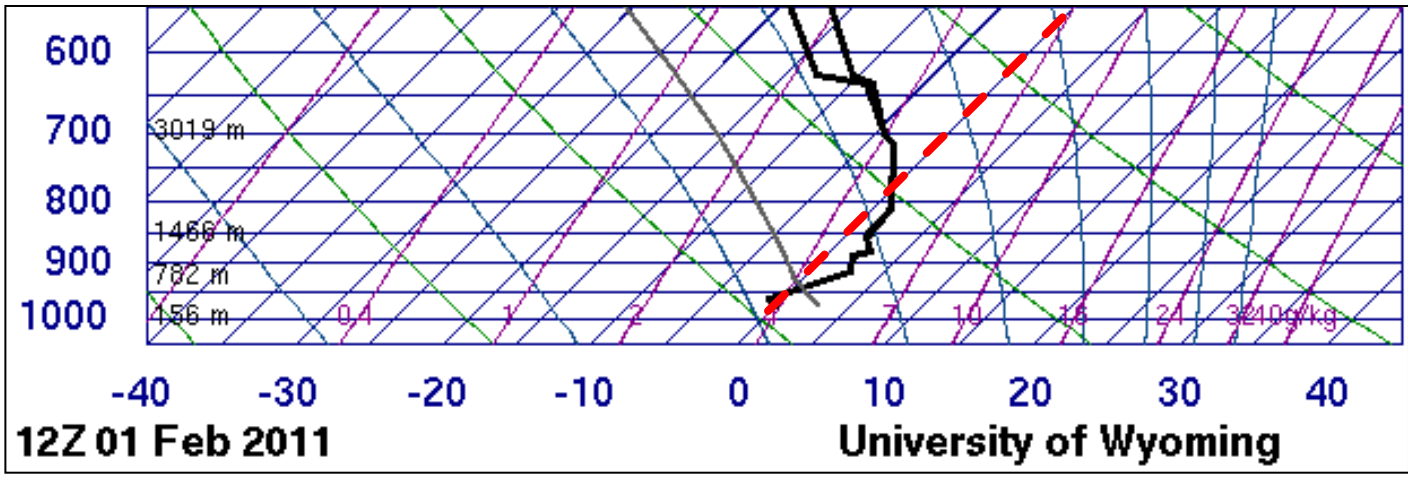
Concerns with Traditional Approach

MaxTwAloft not always a great indicator of melting energy



Concerns with Traditional Approach

Sleet assumed and ProbRefreeze not considered until MaxTwAloft is > 3 C

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KPIT
011121Z 00000KT 2SM -FZRASN SCT003 OVC020 00/M01

011151Z 00000KT 2SM -FZRASN BR OVC016 00/M01

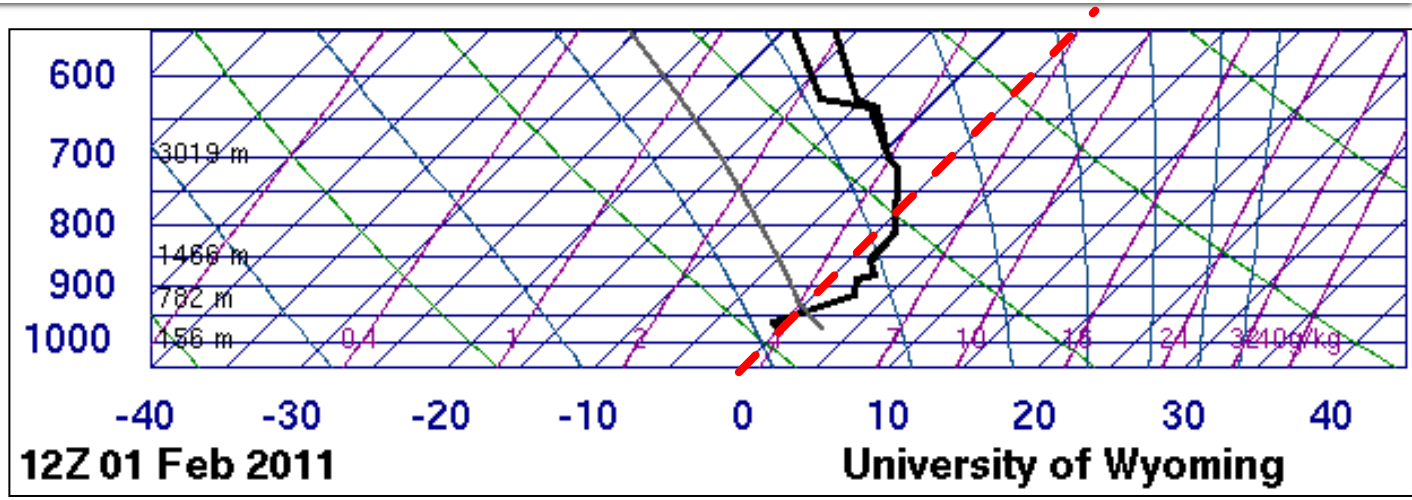
011224Z 00000KT 2SM -FZRA BR FEW002 OVC013 00/M01
```

Except…

Concerns with Traditional Approach

…when:
MaxTAloft > 1
and SfcT > oC
and SfcTw < oC
you get ZR

BUT…
if SfcT
drops below oC
you switch to
sleet…unless
MaxTwAloft > 3



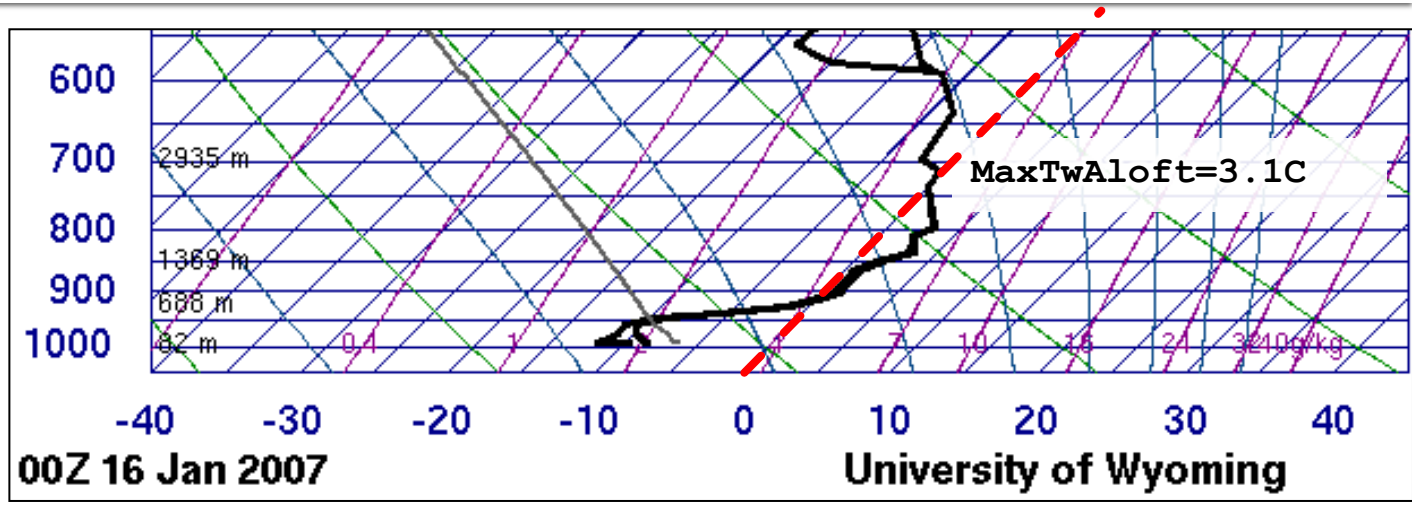

```
KPIT
011121Z 00000KT 2SM -FZRASN SCT003 OVC020 00/M01

011151Z 00000KT 2SM -FZRASN BR OVC016 00/M01

011224Z 00000KT 2SM -FZRA BR FEW002 OVC013 00/M01
```

Concerns with Traditional Approach

Refreezing layer must be over 2500 ft deep or else ProbRefreeze is zero

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60006 T10671083 11056 21067 56020

KPWM 160032Z 36011KT 9SM UP OVC010 M07/M08 A2981 RMK
AO2 UPB26FZRAE26 CIG 008V014 P0000
```
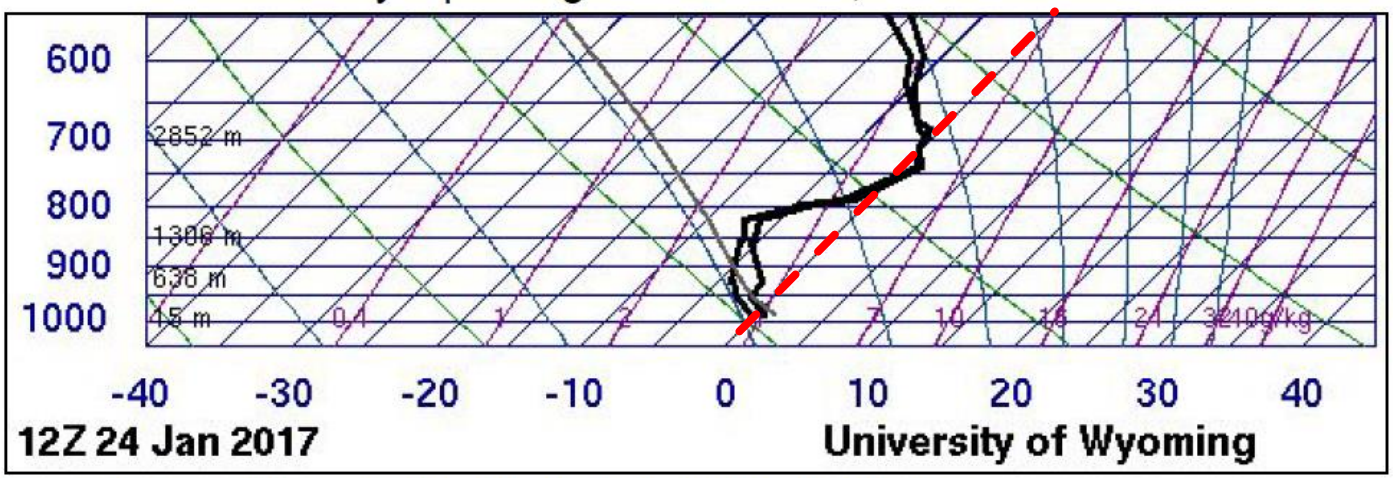

Concerns with Traditional Approach

Sleet not possible with SfcT > 0

This was actually a prolonged sleet event, with 1-2 inches of sleet.



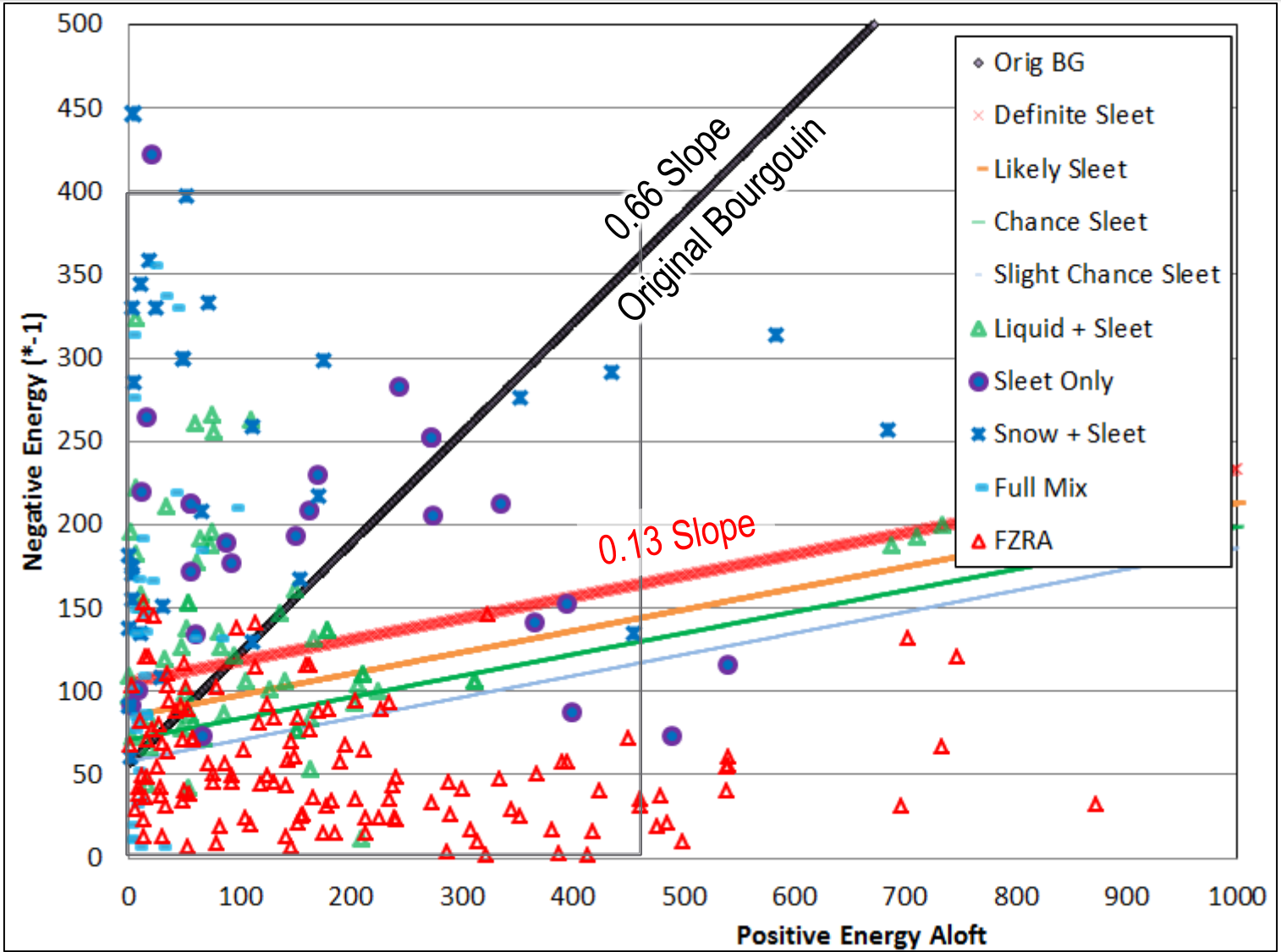
KALB 241151Z 35009KT 6SM -PLDZ BR BKN008 OVC035 01/M01 A2956
KALB 241218Z 35008KT 2 1/2SM -PLRA BR BKN008 OVC030 01/M01 A2957 RMK AO2
SFC VIS 4 DZE18RAB18 P0001 T00061011

Modified Bourgouin Technique

- Uses wet bulb instead of temperature
- Uses a flatter linear relationship between melting/positive energy aloft and low-level refreezing/negative energy
- Gradually increases or decreases chances of a given P-Type

Modified Bourgouin Technique

Local studies indicated a flatter sleet/liquid threshold



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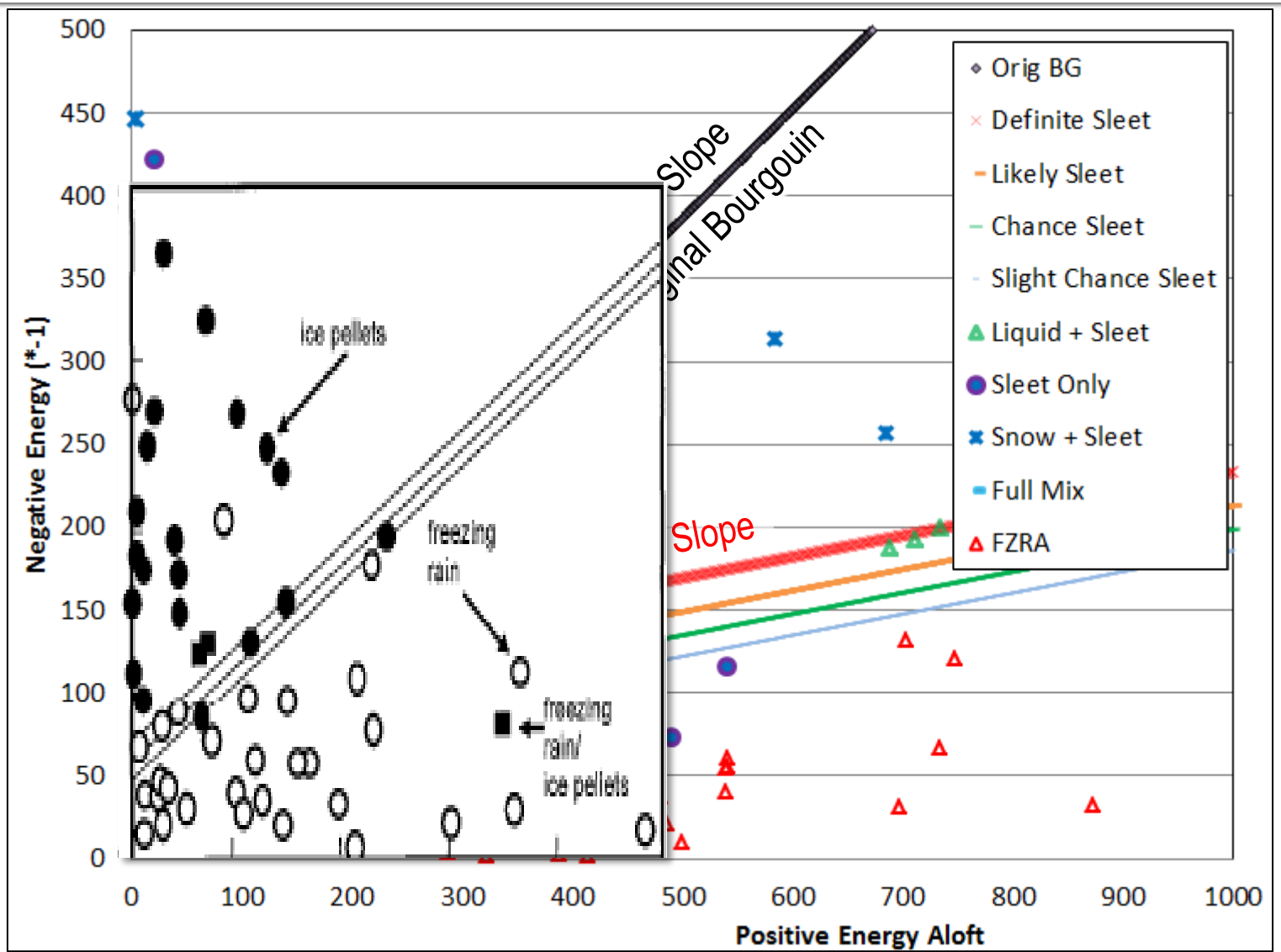

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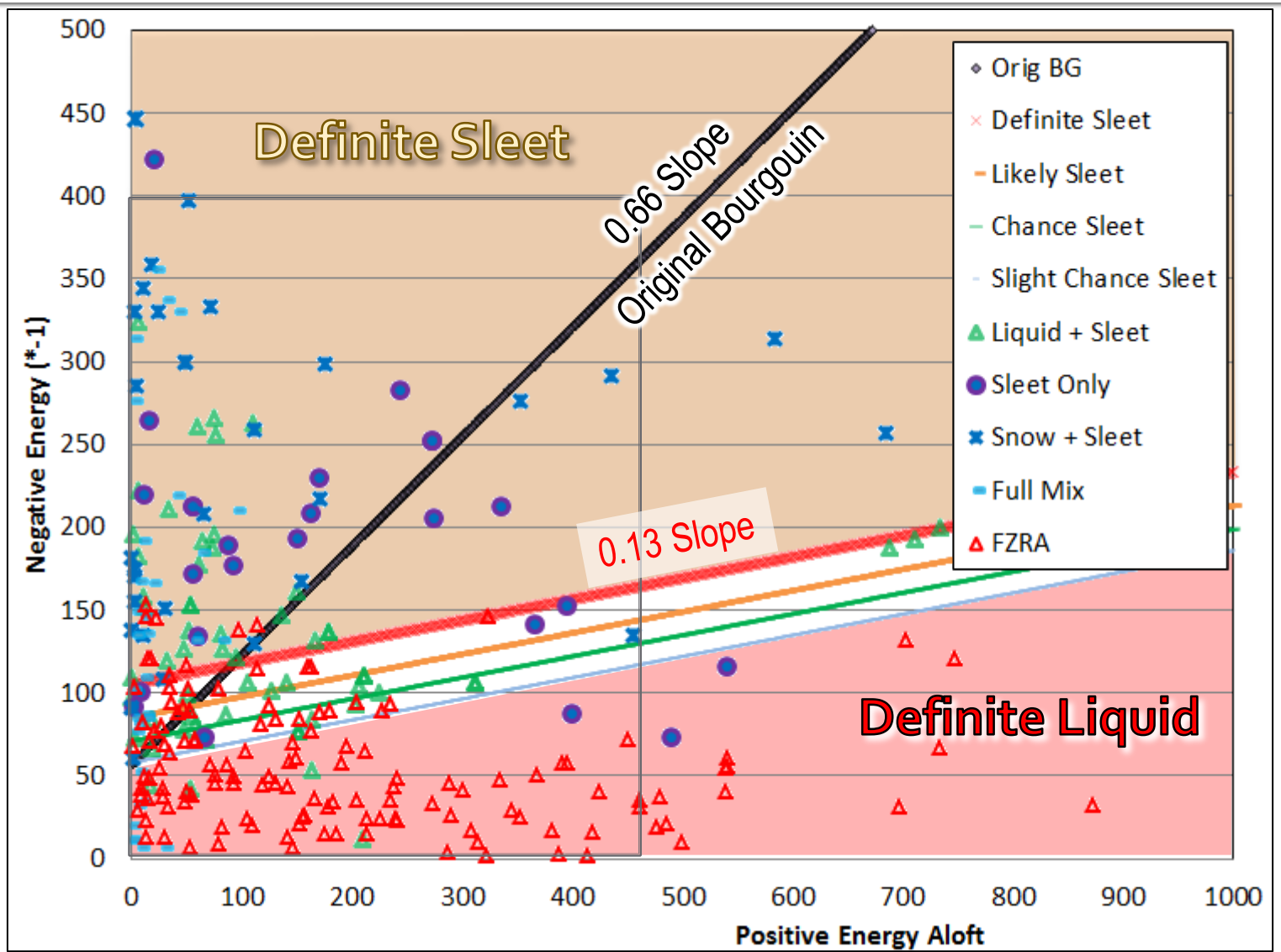
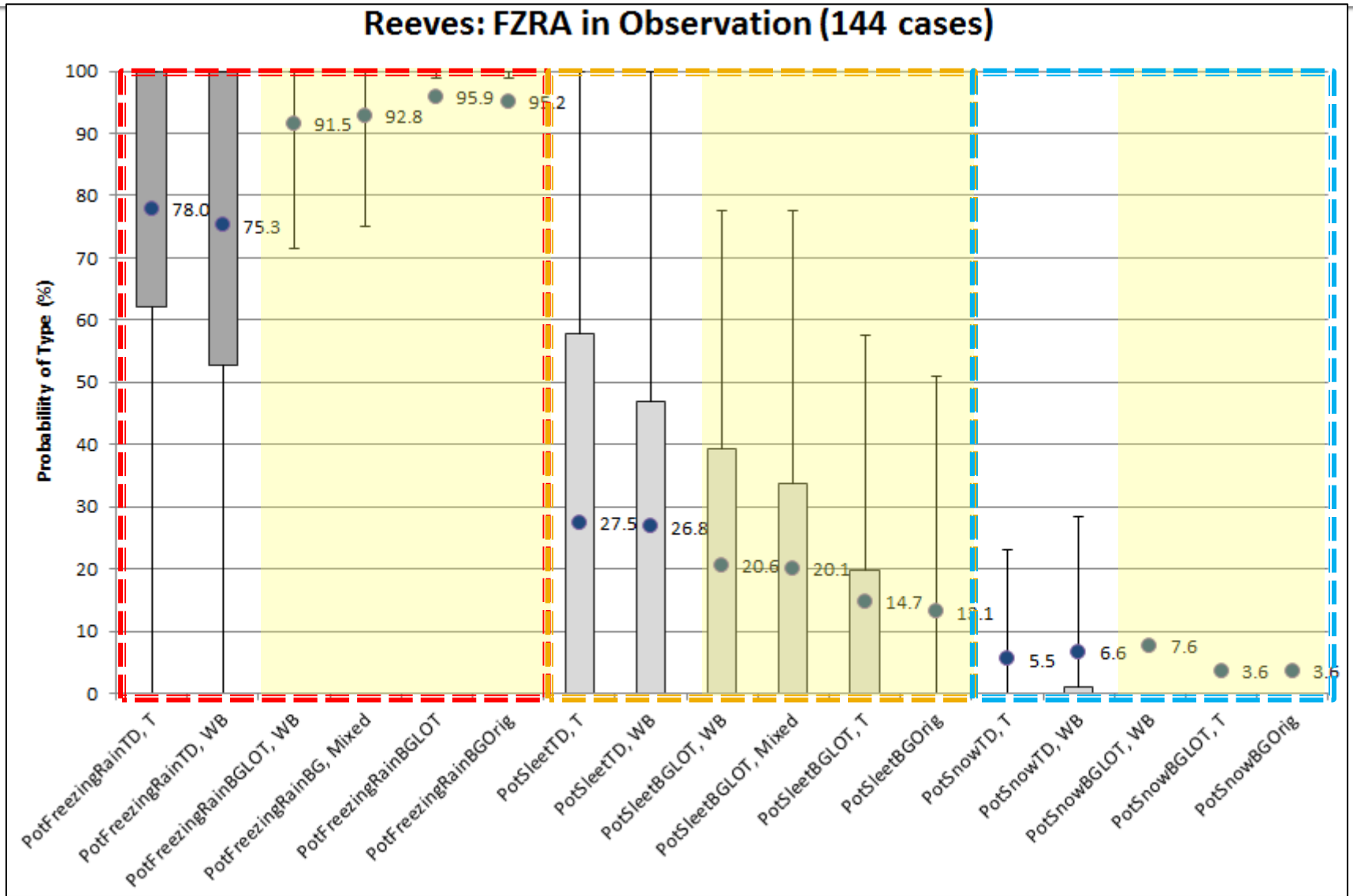
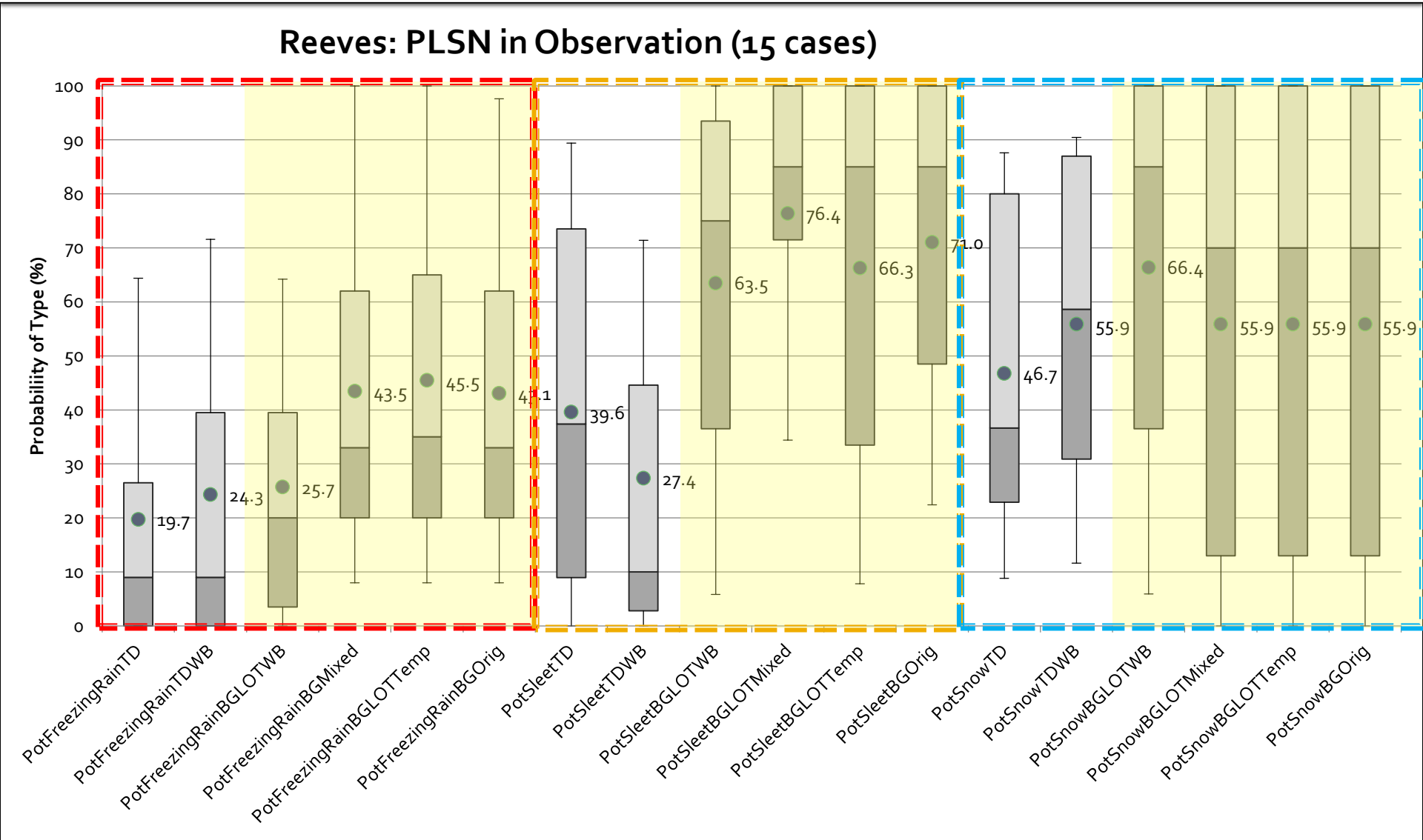


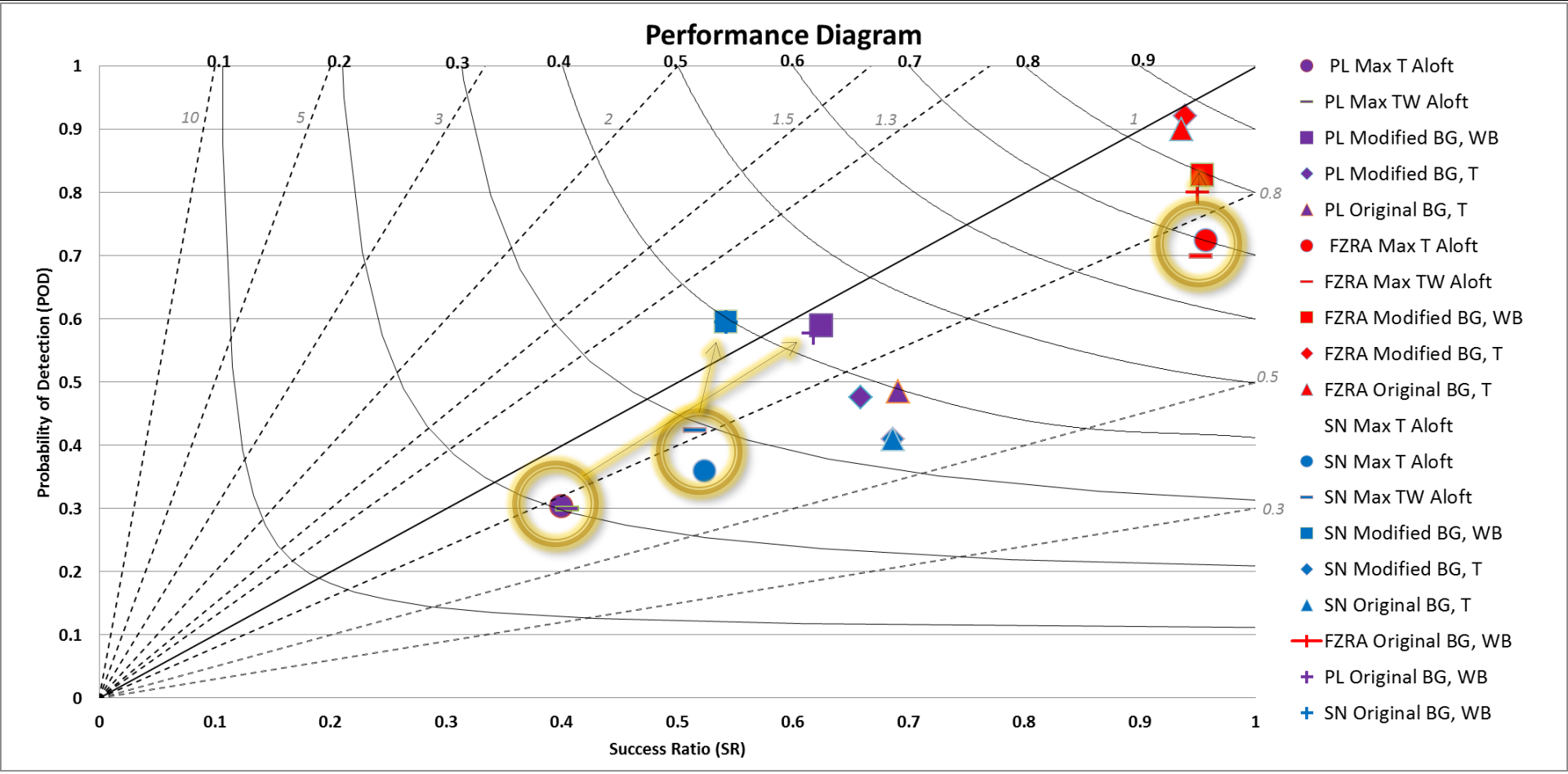
Verification Studies: Freezing Rain (Reeves/Baumgardt/Birk)



Verification Studies: Sleet/Snow (Reeves/Baumgardt/Birk)



An alternative look for all 230 obs

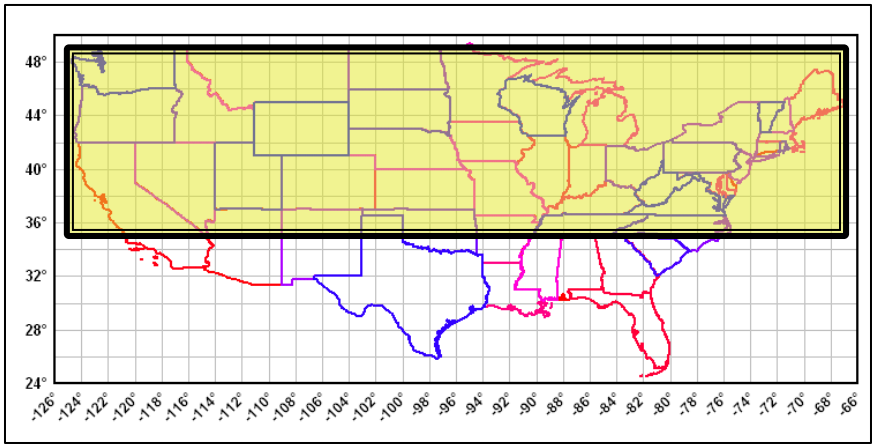


Curved lines show CSI increasing toward the top right

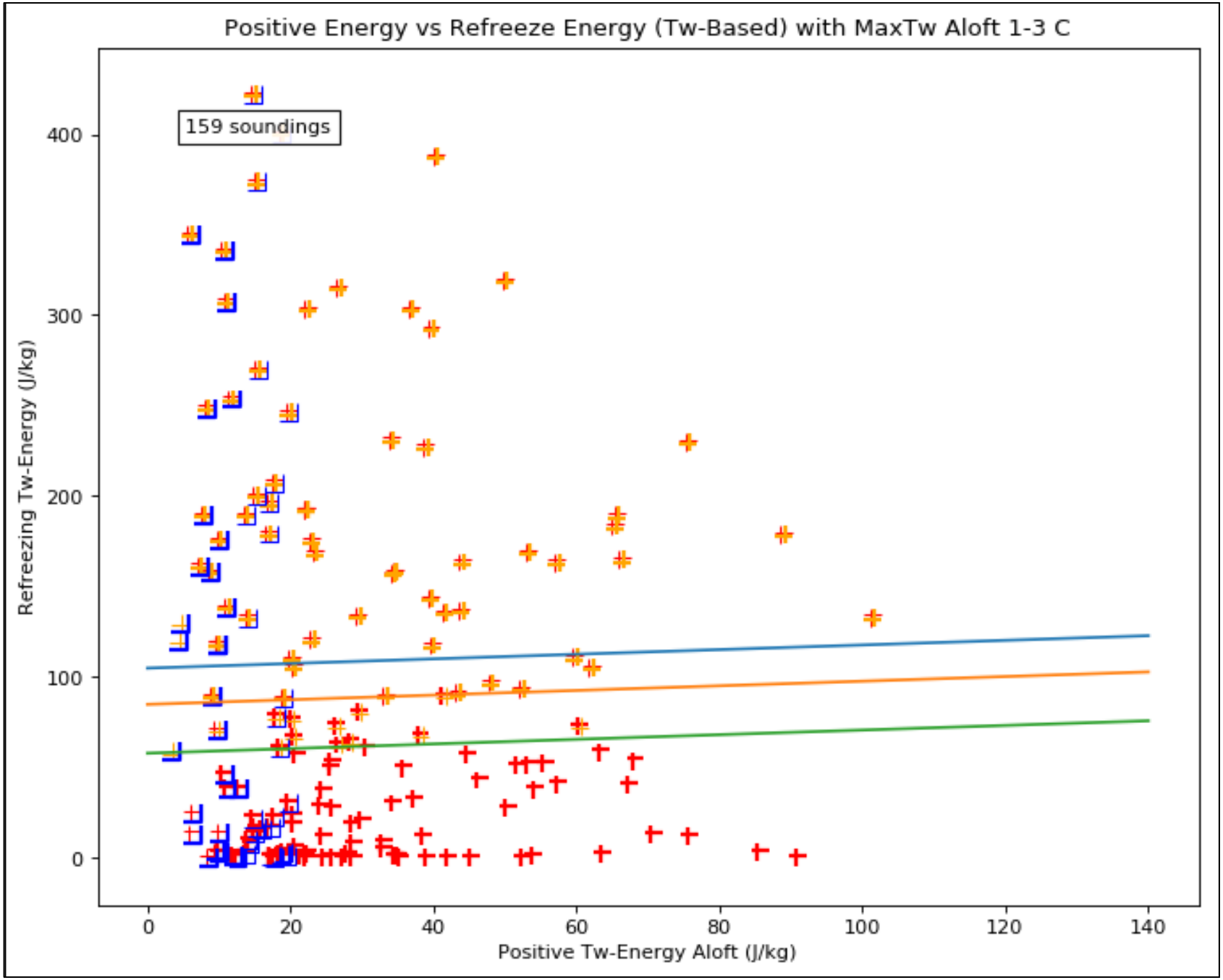
Y axis shows POD increasing toward the top

X axis shows FAR *decreasing* toward the right

Separate RAOB Database Study



- North America
  35°- 49° latitude
- 11 Winters (Dec-Feb)
  - 2006-07 thru 2016-17
  - Also Nov 2015
- Only kept soundings with:
  - Surface Temperature: -12 C < T < 4 C
  - Mean RH > 80% in sounding (for precip to be plausible)
  - Mean RH > 75% in DGZ (for ice nucleation)
  - At least 30 vertical levels
  - Top of sounding is below freezing
- Totals
  - 98,535 RAOB soundings examined
  - 5,115 met all conditions


Positive Energy vs Refreeze Energy (Tw-Based) with MaxTw Aloft 1-3 C
159 soundings
Refreezing Tw-Energy (J/kg)
Positive Tw-Energy Aloft (J/kg)
0
100
200
300
400
0
20
40
60
80
100
120
140

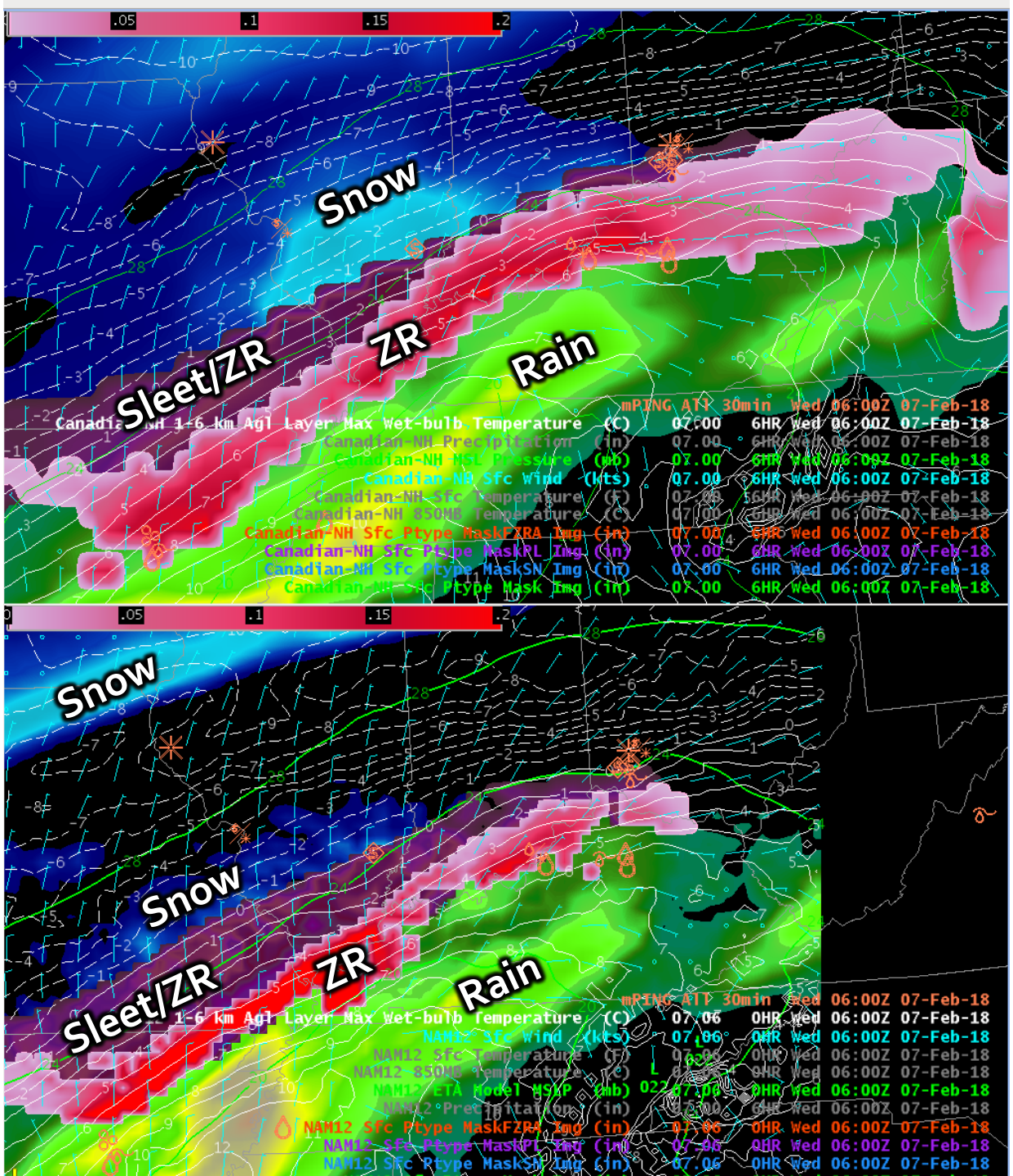
Development Activities & Future Plans

- Energy technique operational at Chicago
- Available in GFE practice mode elsewhere
- Evaluated for multiple events in 2017-18
- QPF shaded by precip-type available for D2D
- Proposal being discussed for National Blend of Models

Brand new!

D2D display of model QPF, shaded according to dominant precipitation type calculated from the layer-energy technique.

Corresponding mPING observations also are shown.



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Kevin.Birk@noaa.gov