Using MODIS/VIIRS Night-Time Microphysics RGB Imagery with Proximity Soundings to Diagnose Low-Topped Precipitation Events

Paul Nutter
NWS Great Falls, MT

Kevin Fuell
NASA/SPoRT

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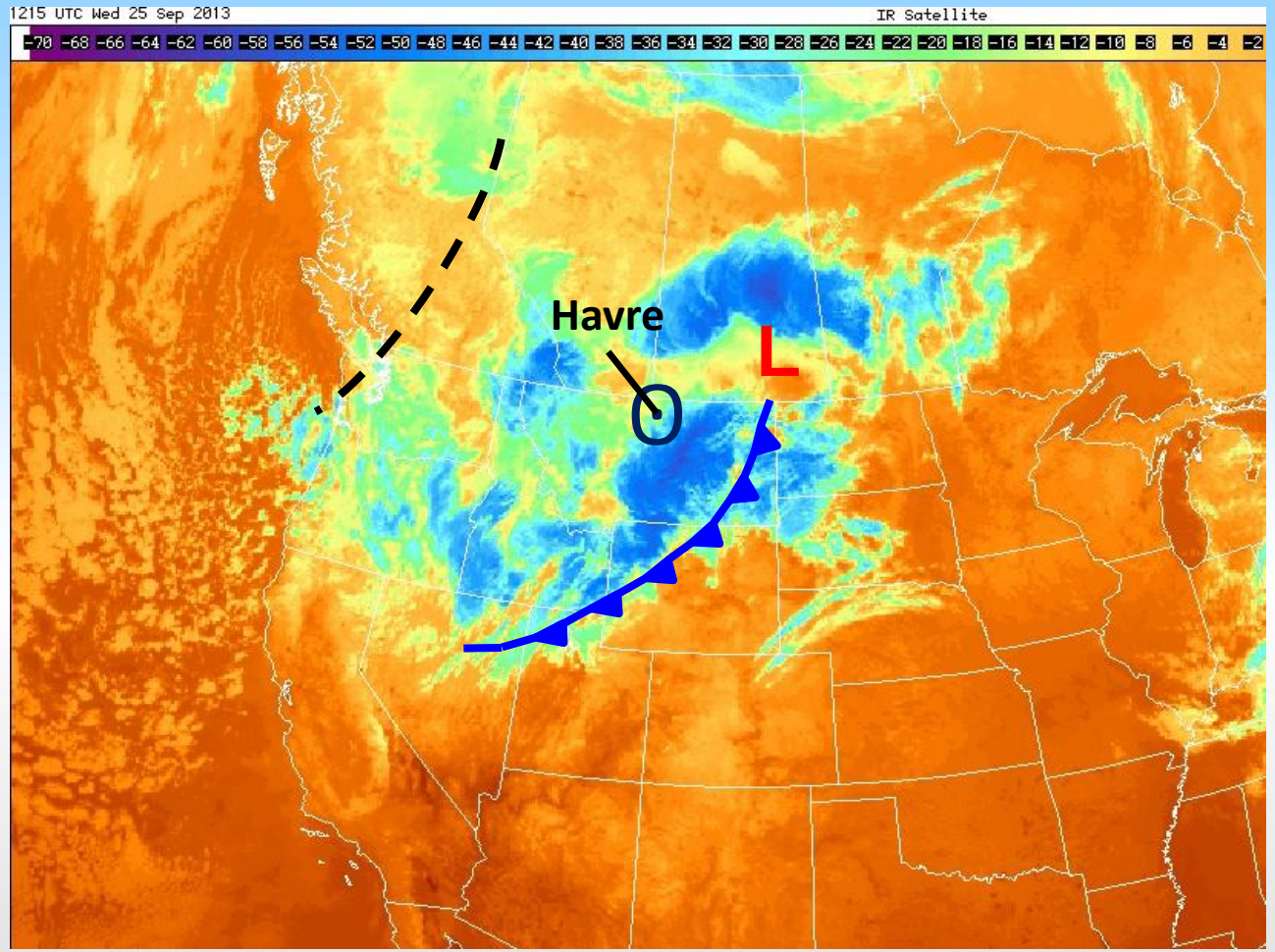
Low-Topped Precipitation

- Heavy rain at Havre, MT
  - 12Z, 25-Sept-2013 (6am MDT)
    - Still dark; sunrise occurred at 7:09 am MDT
  - 50% forecast 12hr POP
  - Just a few pixels on radar 0.5° base reflectivity

- Could Night-time Microphysics RGB imagery enhance situational awareness?

GOES 11 µm IR Satellite

1215 UCT 25 Sep 2013

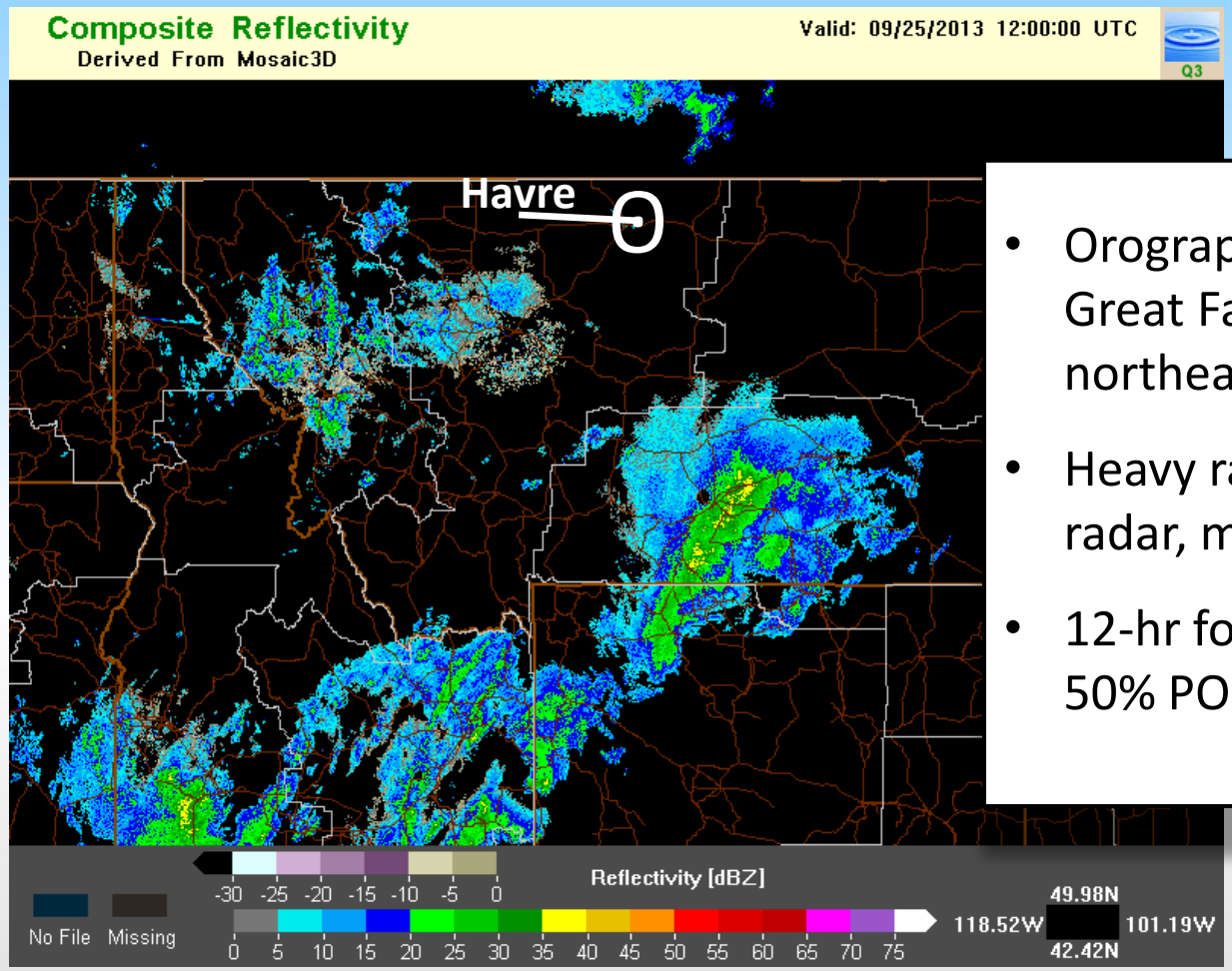


http://www.mmm.ucar.edu/imagearchive/

Havre is on a transition line; dry slot to west, rain showers to east.

Composite Reflectivity

12 UTC 25-Sep-2013

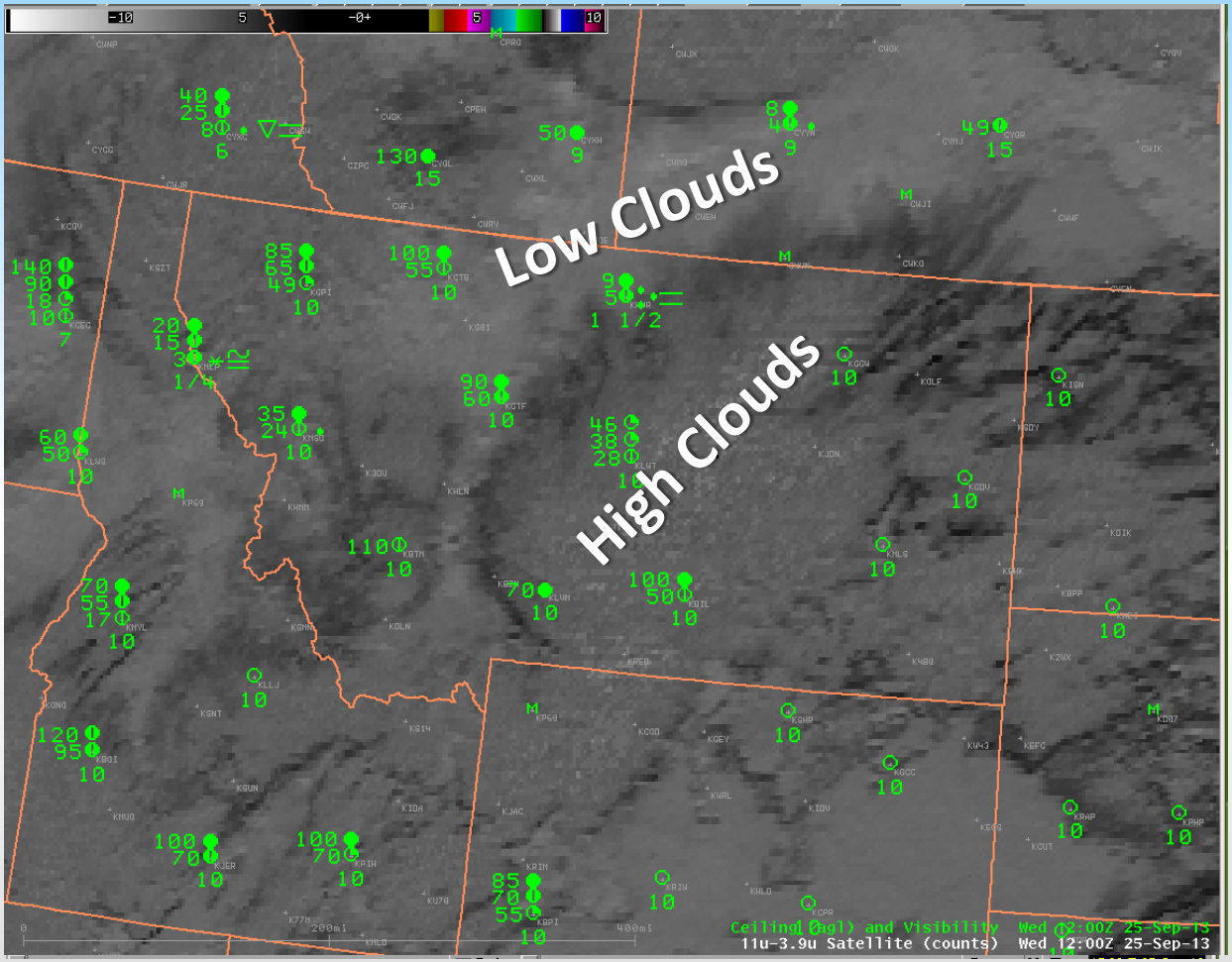


http://nmq.ou.edu/applications/qvs_2d_maps.html

- Orographic showers west of Great Falls on low-level northeasterly flow.
- Heavy rain band near BYZ radar, moving northeast.
- 12-hr forecast included 50% POP at Havre.

GOES 11-3.9 µm Satellite

Ceiling & Visibility Obs



Widespread stratus layer with areas of higher, apparently deeper clouds

KHVR, 1000 UTC:

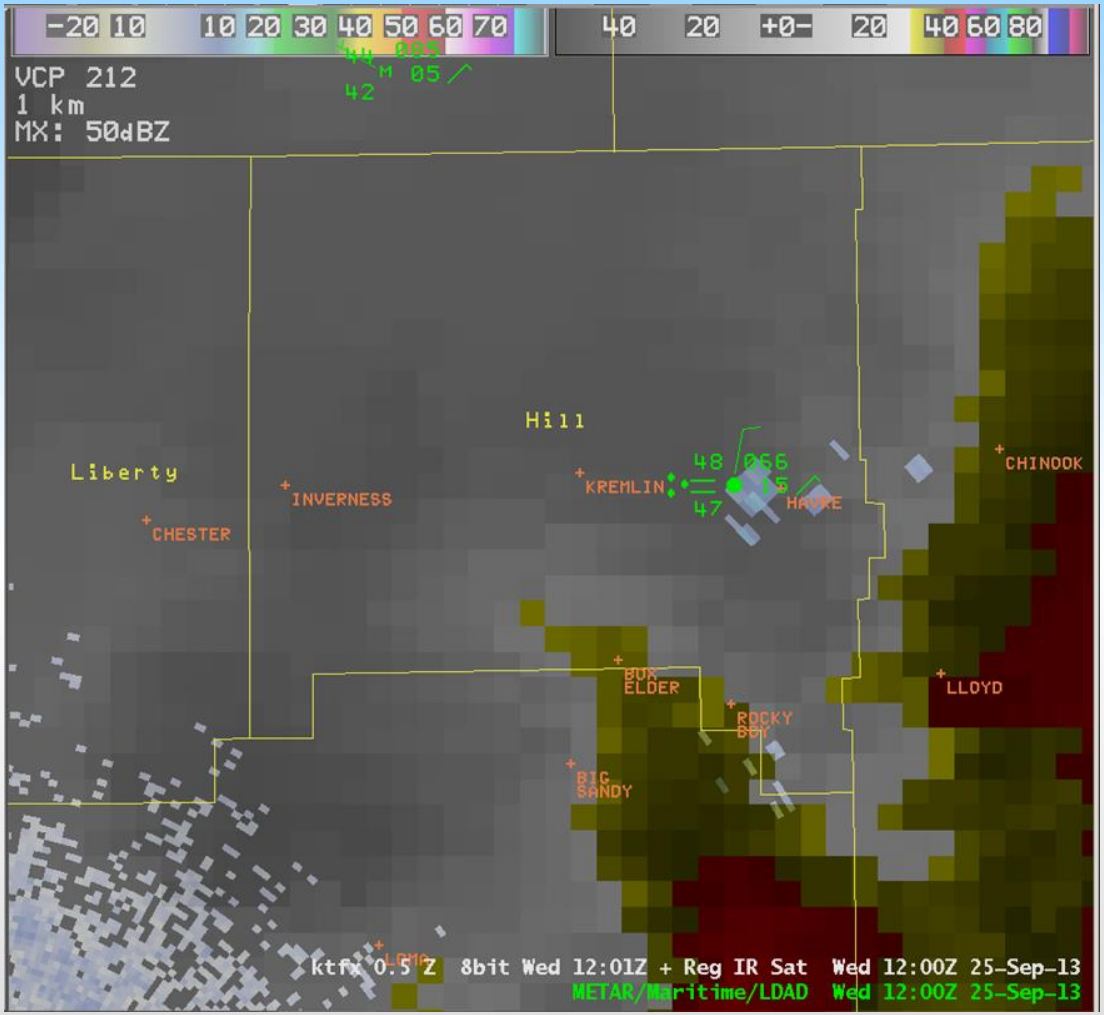
- OVC 900 ft AGL

KHVR, 1200 UTC:

- BKN 500 ft AGL
- OVC 900 ft AGL
- 1.5 mi visibility
- Heavy rain, fog

0.5° Base Ref with GOES 11 µm IR

12 UTC 25-Sep-2013



- Heavy rain report at Havre was a “surprise” given radar and satellite trends at this time.
- 12Z KHVR TAF amended to add at TEMPO group for SHRA.
- What more can we learn about why these low clouds produced heavy rain?

0.5° Base Ref with GOES 11 µm IR

with AWIPS “Pop-up” Skew-T

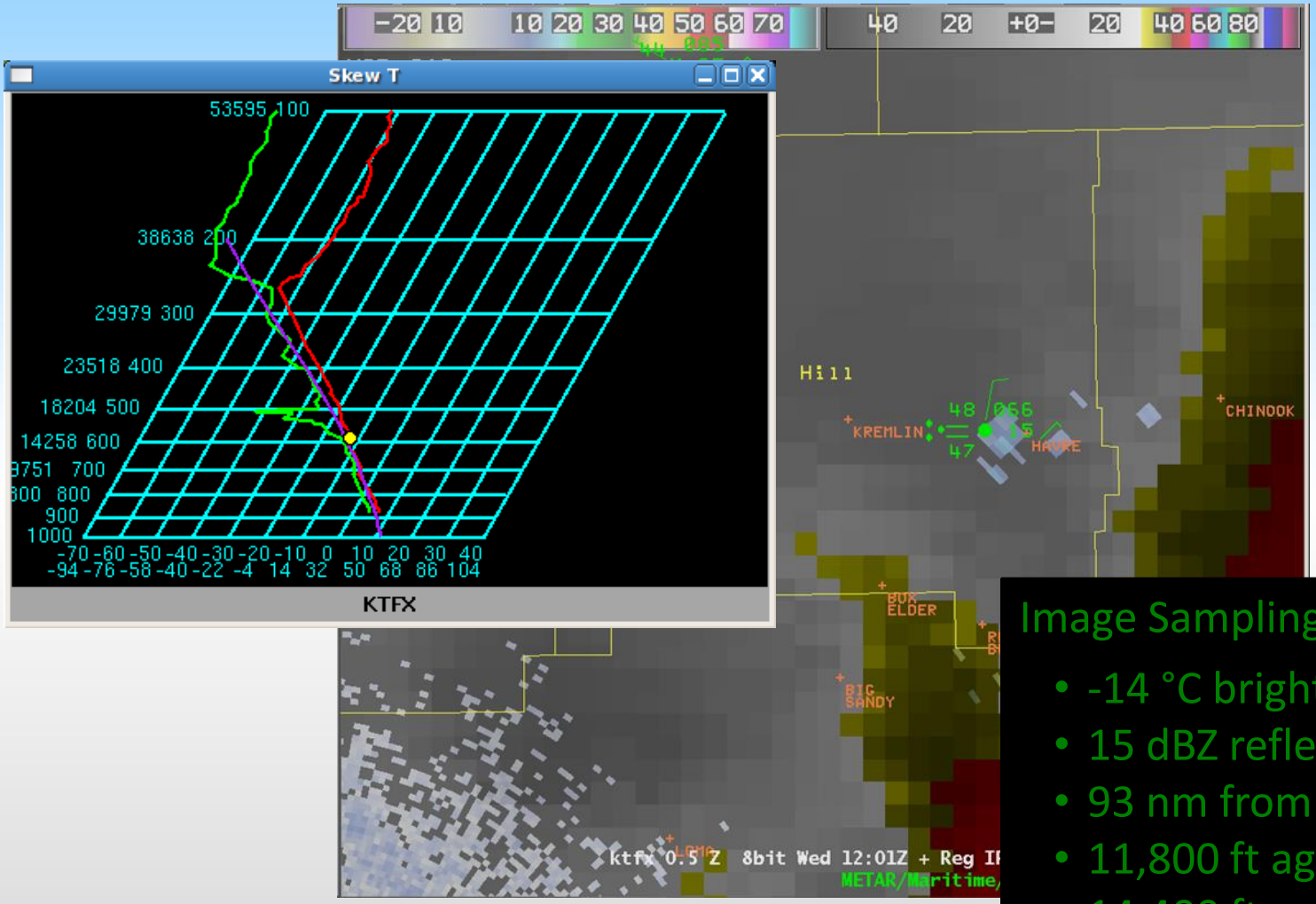
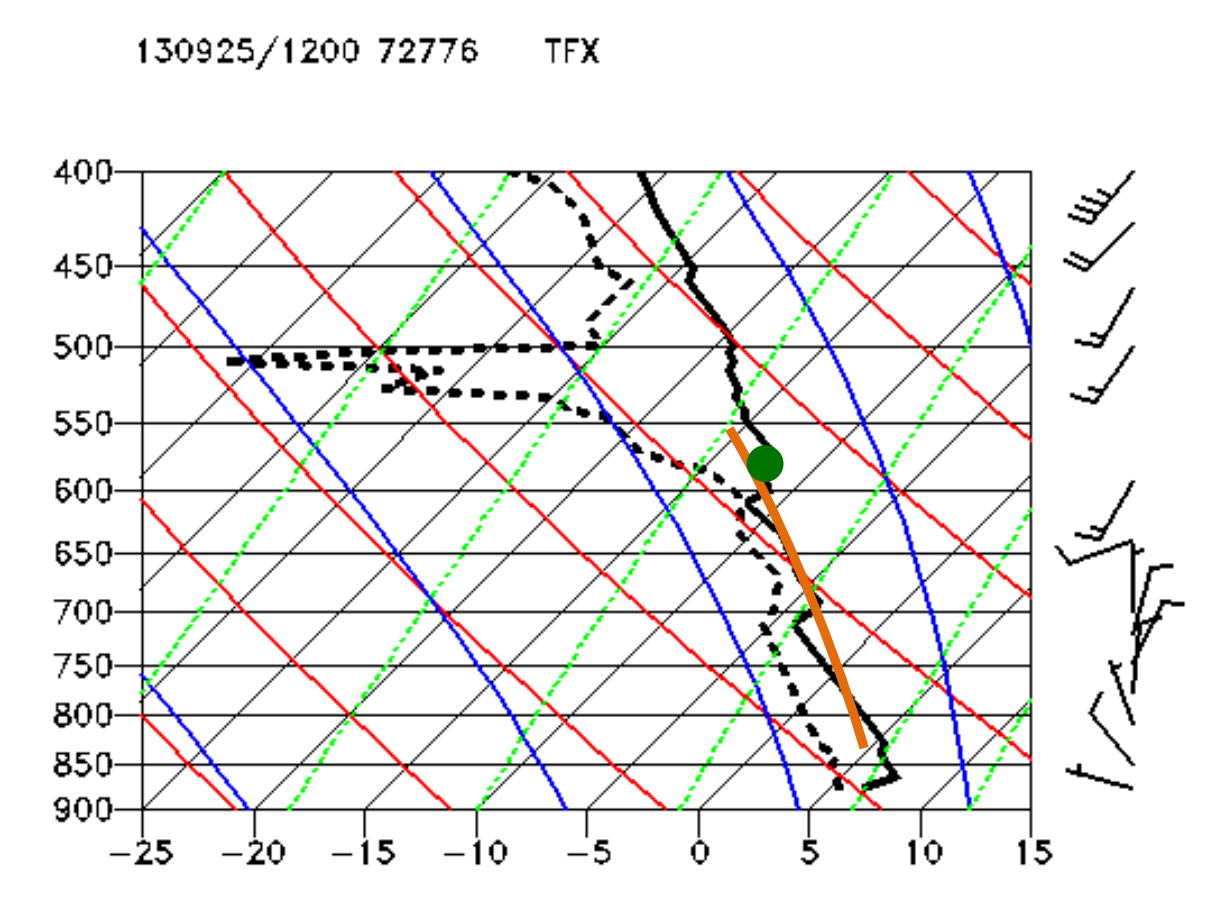


Image Sampling Shows:

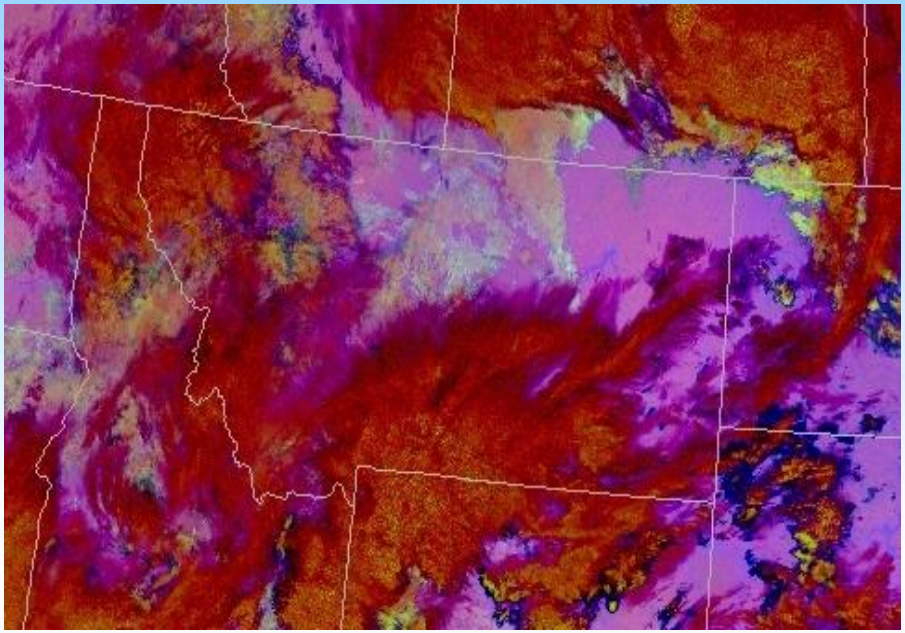
- -14 °C brightness temp
- 15 dBZ reflectivity
- 93 nm from radar
- 11,800 ft agl
- 14,400 ft msl

Great Falls 12Z Sounding

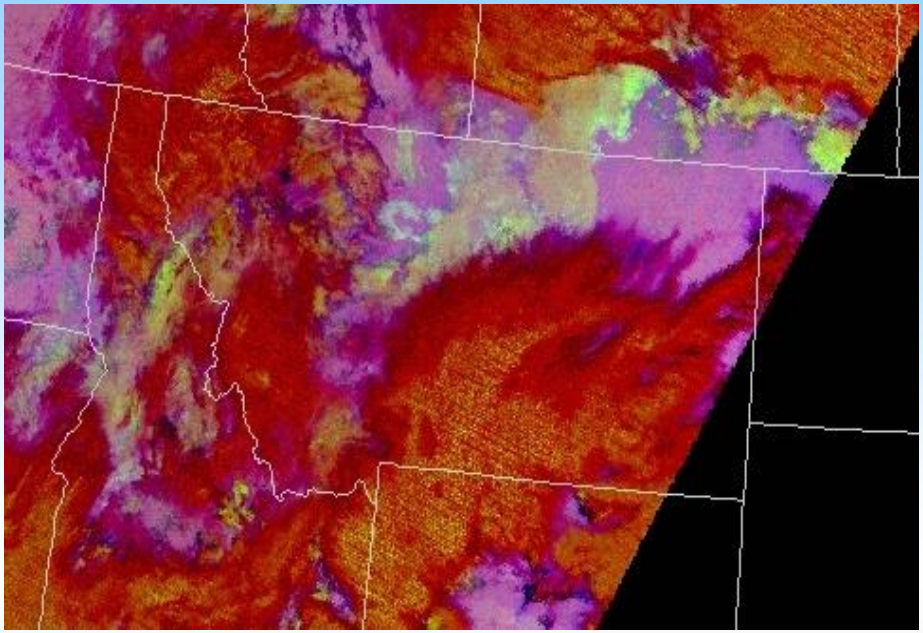


- Most unstable parcel lifts from 867 mb, with 17 J/kg CAPE.
- Convective temp is 52F; parcel likely needs mechanical lift.
- Mid-level dry, stable layer; limits cloud height.
- Saturated layer from around -5 to -12C. Ice or water?

Nighttime Microphysics RGB



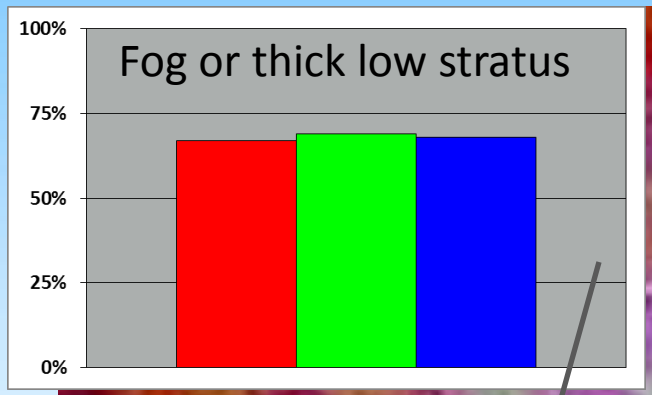
VIIRS, 0924 UTC 25 Sept 2013

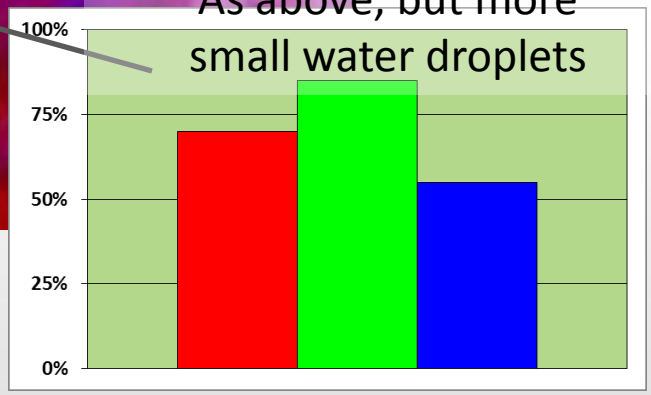


AQUA MODIS, 1010 UTC 25 Sept 2013

- Delineation of high cloud, low cloud, and clear skies now obvious compared to GOES imagery.
- Possible delineation of fog vs. stratus, and orographic showers over northern Rocky Mountains.
- Note enhanced spatial resolution in VIIRS image.

RGB Pixel Saturation





AQUA MODIS, 1010 UTC 25 Sept 2013

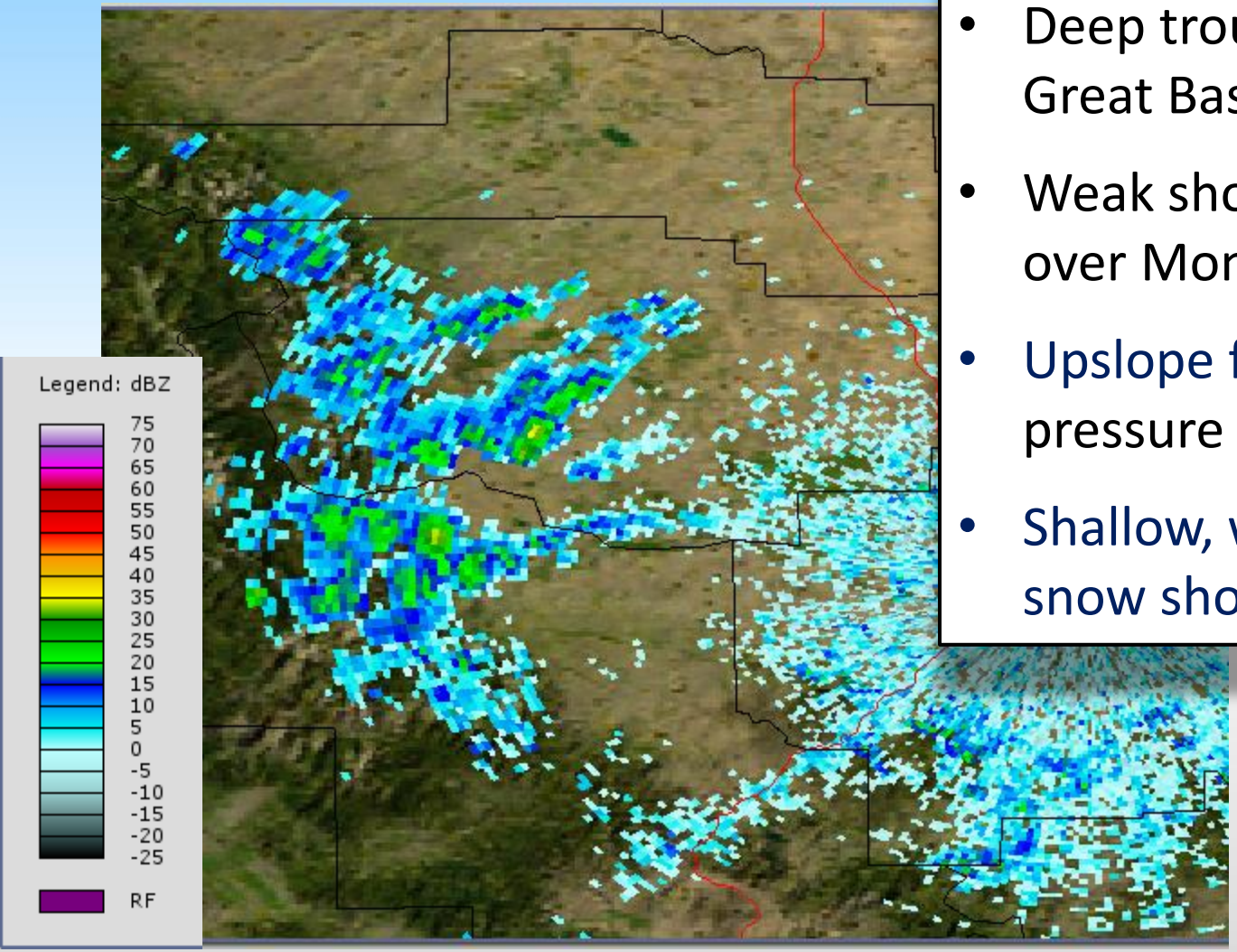
- Red: [12-10.8 μm] Optical depth (cloud thickness)
- Green: [10.8-3.9 μm] Particle phase; presence of water
- Blue: [10.8 μm] Temperature…but inverted. Warmer is more blue.

Havre Event Summary

- Low-topped +RA not seen on Radar
- GOES imagery of limited additional value
- Radar Pop-up Skew-T reveals conditionally unstable layers near saturation, -5 to -12 °C.
- MODIS/VIIRS Nt Microphysics RGB suggests super-cooled water (strong green).
- Development of precipitation is most efficient with mixed ice/water at these temperatures (i.e., Rogers and Yau, *A Short Course in Cloud Physics*)

Mixed Phase Precipitation

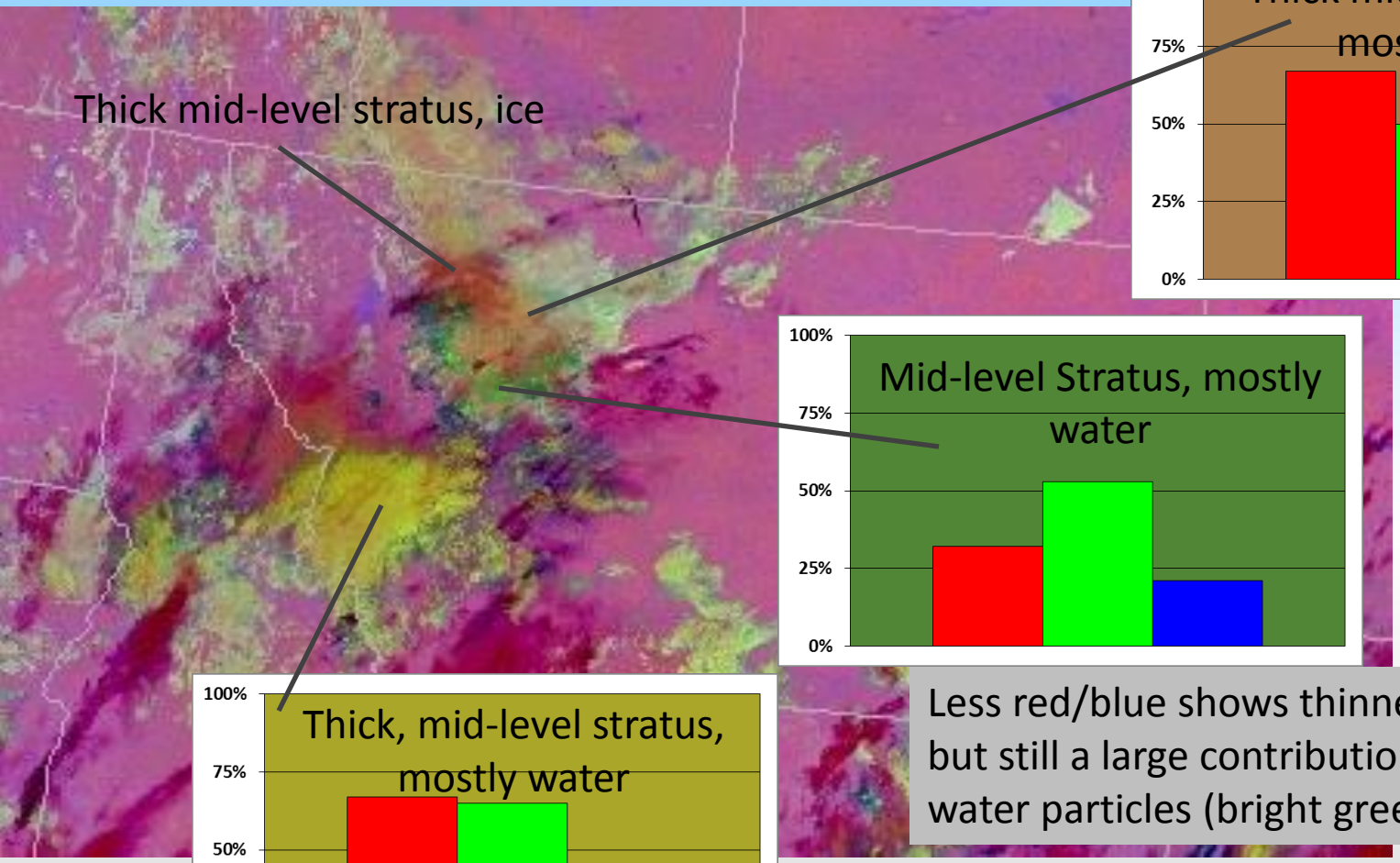
10:09 UTC, Oct 09 2013

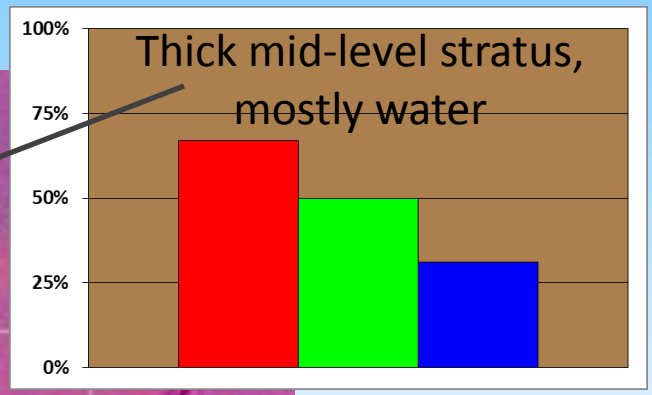


- Deep trough over Great Basin.
- Weak shortwave ridge over Montana.
- Upslope flow; surface high pressure strengthening.
- Shallow, weak rain or snow showers.

VIIRS Nt Microphysics RGB

10:02 UTC, 09 Oct 2013

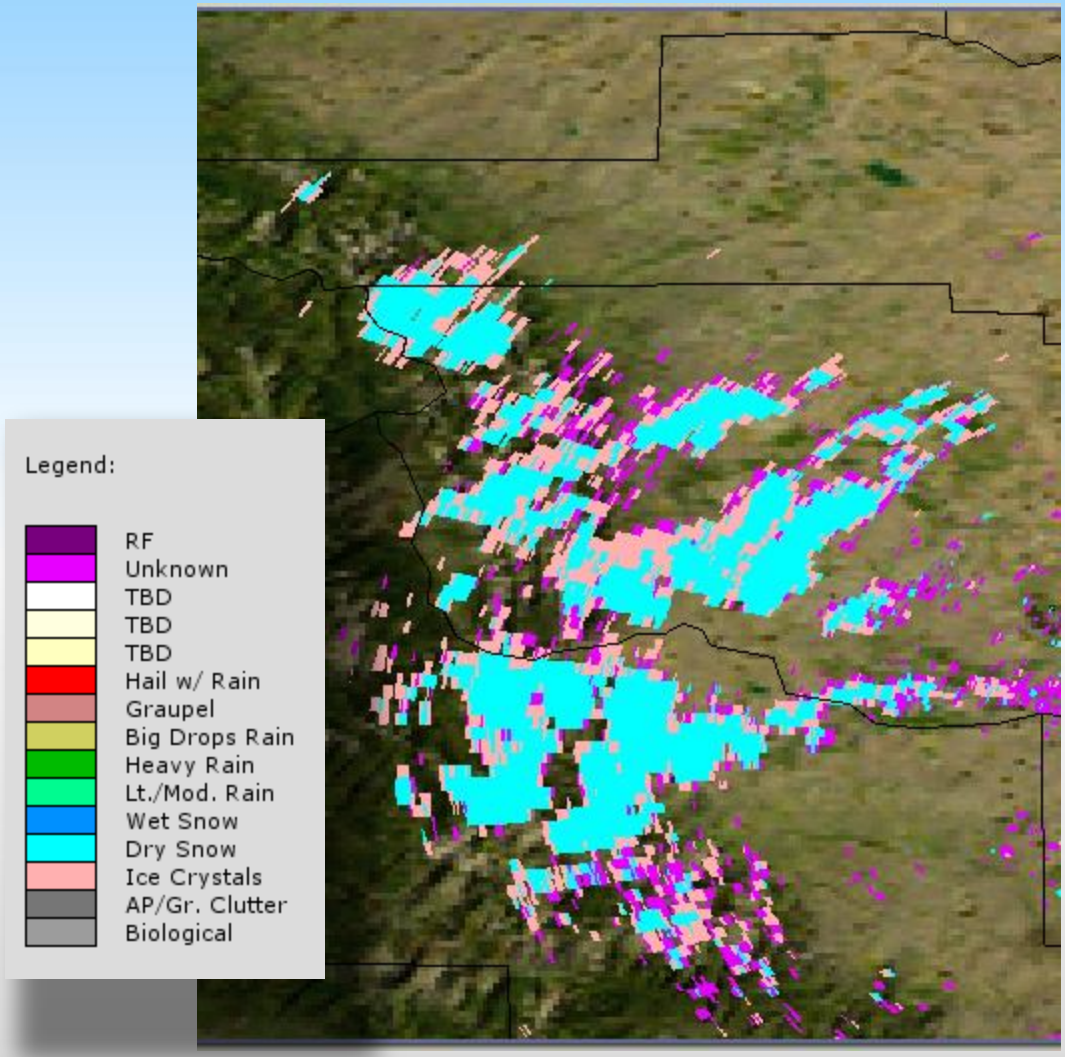




Less red/blue shows thinner, colder clouds, but still a large contribution from small water particles (bright green)

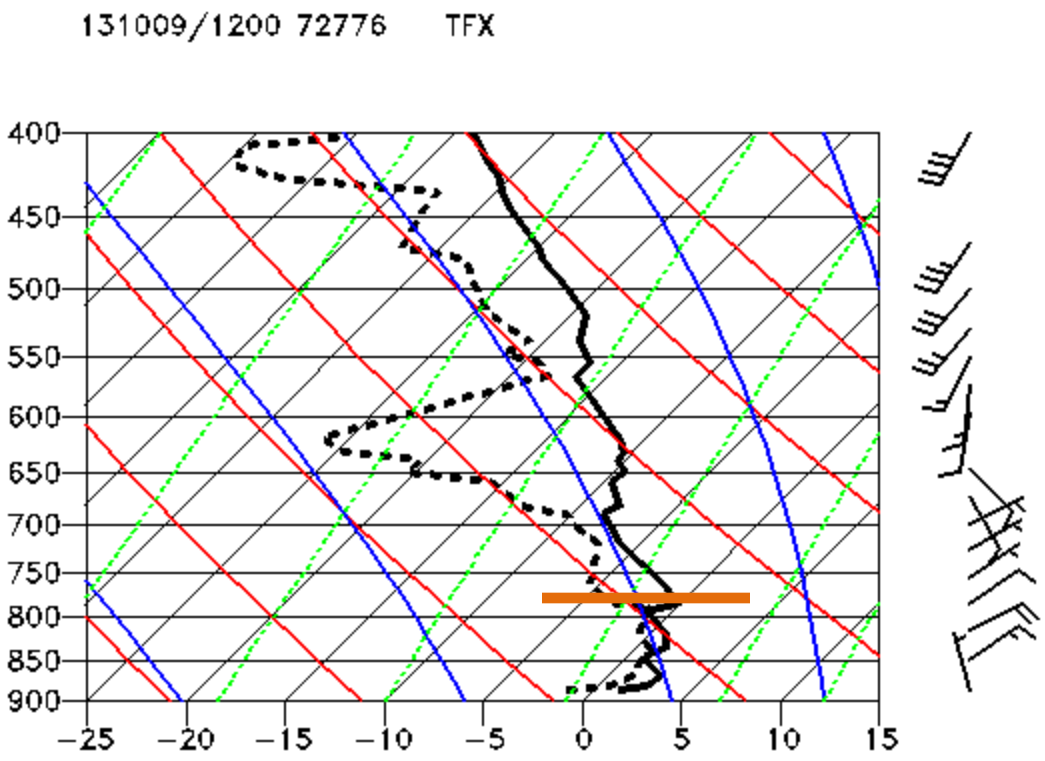
Dual-Pol Hydrometeor Class.

10:09 UTC, Oct 09 2013



- Mix of dry snow and ice crystals.
- Recall that melting layer algorithm relies on RUC analysis.
- Green in Nt Microphysics RGB initially suggests large water particles.
- What does sounding suggest?

12Z TFX Sounding, 09-Oct-2013

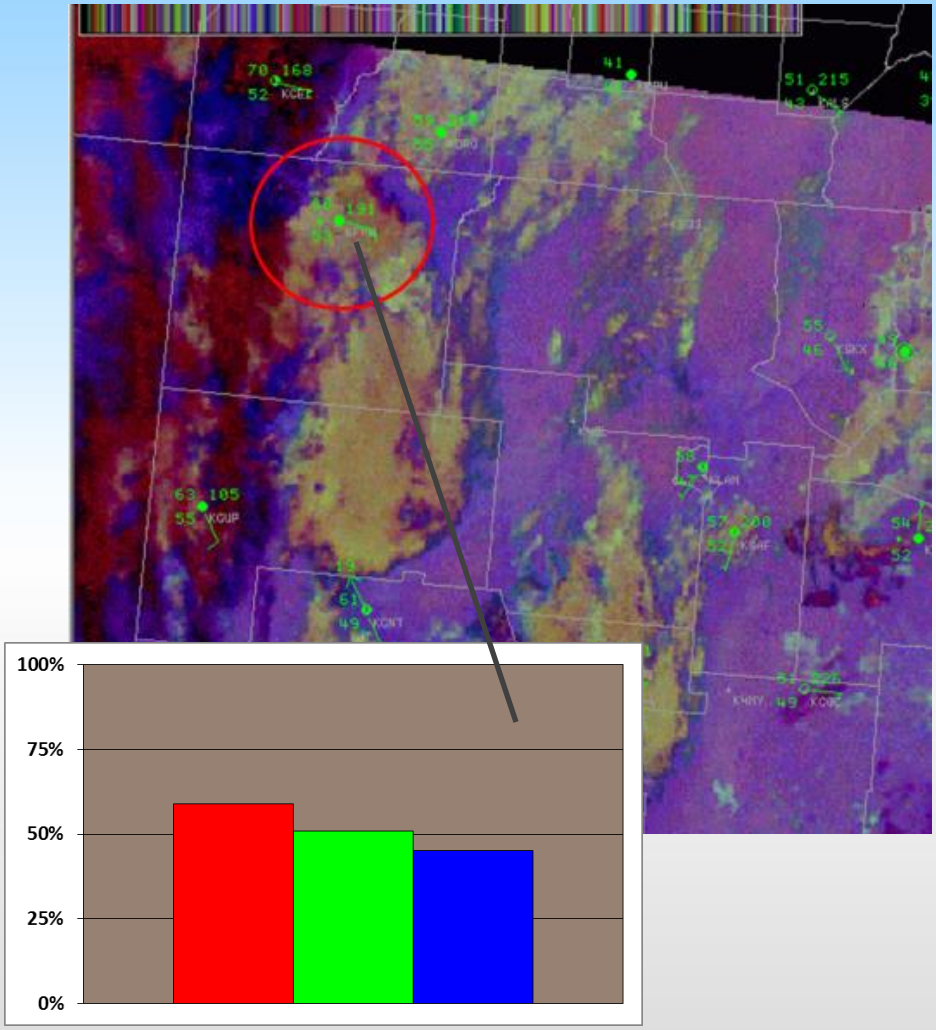


Orange line is approx height of radar beam over showers

- Stable, saturated layer capped by inversion just above FZL.
- Also saturated near 700 mb; possible source of ice crystal precipitation?
- Mid-level clouds possible around 560 mb.
- Radar shows ice/dry snow, but VIIRS Nt micro and sounding together suggest elevation dependent rain or snow.

Low-Topped RA in N. Mexico

VIIRS Nt Micro, 07:53 UTC, 17 July 2013



- Brian Guyer, NWS ABQ. Post to SPoRT Blog.
- ABQ Radar 0.5° scan is at 15 kft AGL near rain report at Farmington, so no coverage at 135 nm from radar.
- 00Z ABQ sounding reveals temp at this level near -10 C, becoming saturated by 12Z.
- Super cooled or mixed species in cloud to generate efficient rainfall?
- ✓ Tan/light green shading suggests cold thicker cloud / small water droplets

Summary

- Tan with green channel color saturation of 50% or more suggest mixed or warm rain microphysical process.
- Nt Micro RGB can enhance situational awareness:
  - Improved spatial detail for cloud coverage in radar gaps, including vertical layers
  - Use proximity soundings (Raob or Model Analyses) to identify temperature of cloud feature seen in RGB
- Limitations:
  - High clouds may obscure lower level water signature
  - Temporal coverage
  - Nighttime use only