Profiling Radar and Snow Microphysical Properties from Extended Ground Observations in the Upper Great Lakes

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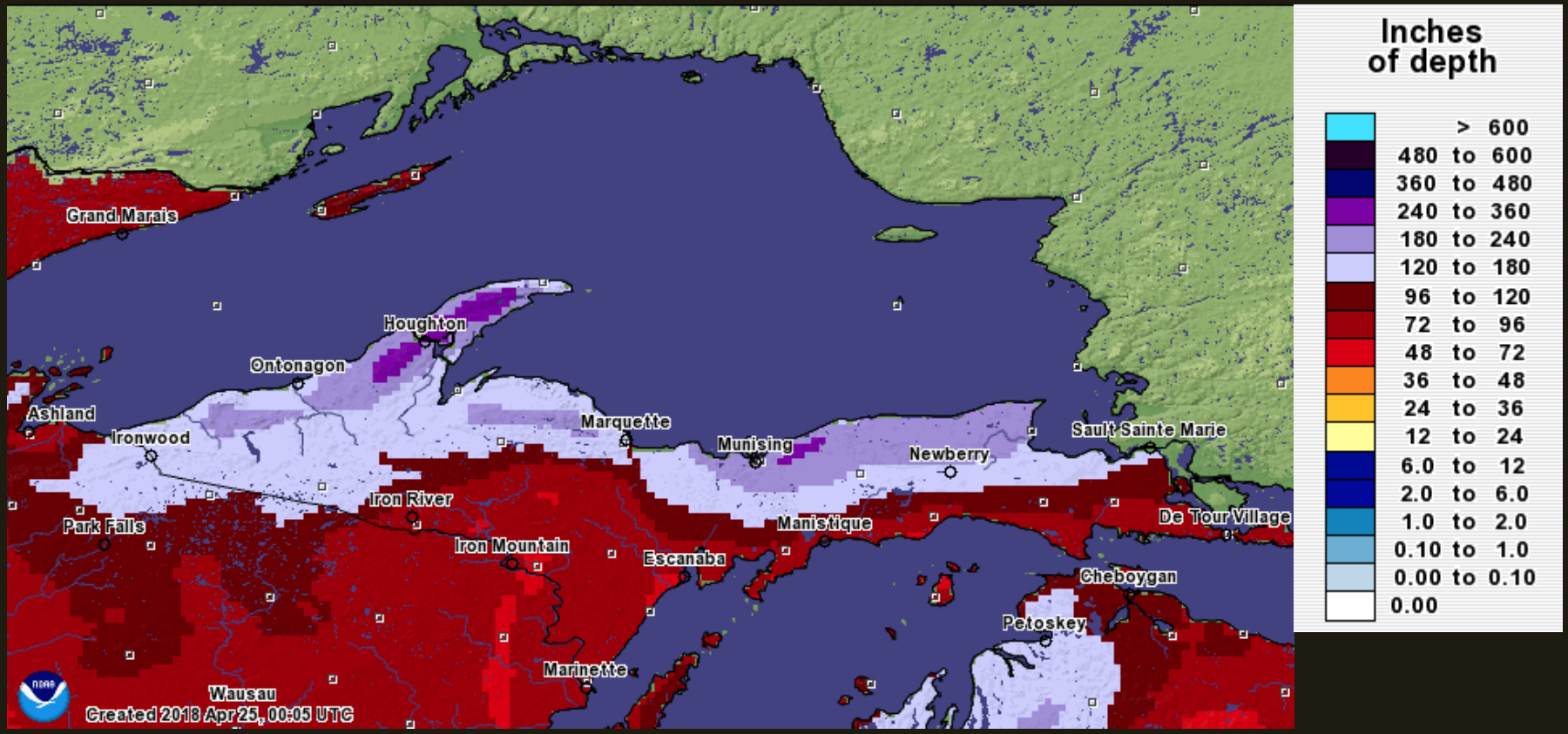
Great Lakes Operational Meteorology Workshop 2018 – Cleveland OH

2017-18…so far

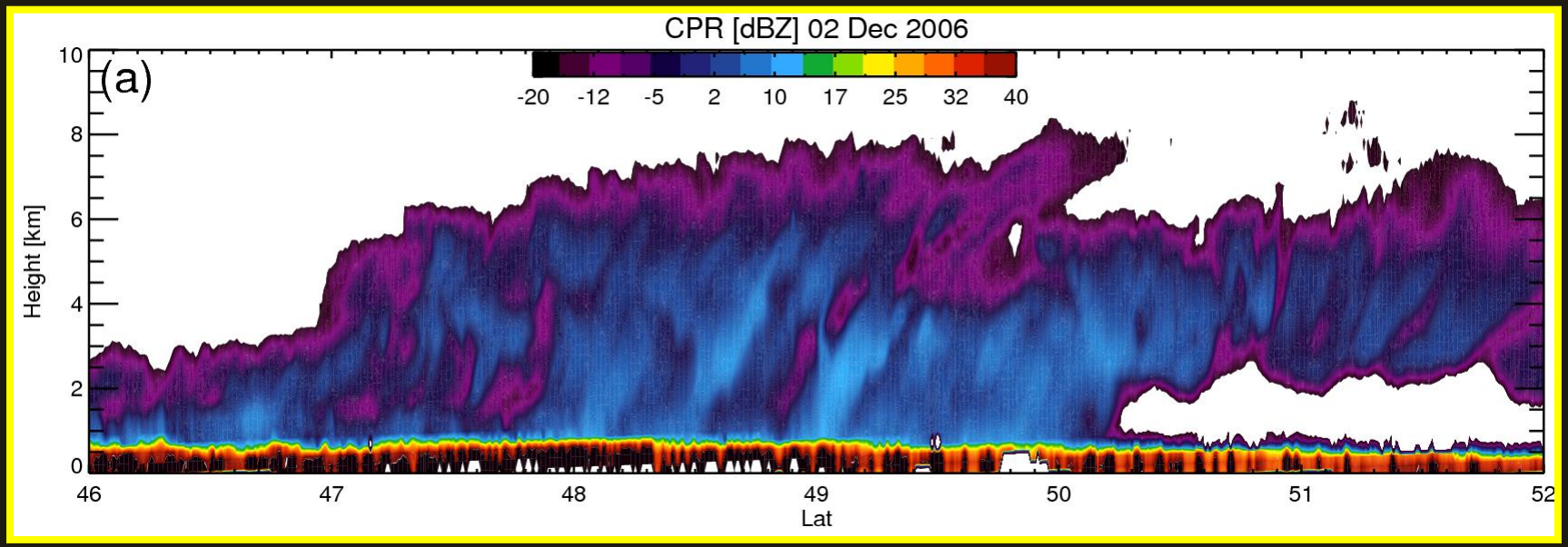


Convective Snow – Global Perspective

CloudSat (Courtesy of JPL)

CloudSat Cloud Profiling Radar

- W-band (94 GHz)
  - less attenuation from clouds
- ~1.5 km footprint
- 240 m vertical bins
- 2006-current



CloudSat Cloud Profiling Radar

- Limitations
  - ~26 dBZ for CloudSat
- CPR not replaced until late 2020s at earliest…

Ground Evaluation Needs

- Is it snowing?
- Snowfall partitioning statistics
- What happens sub 1km?
- GPM: how much snow < 12 dBZ?
- Snow particle size distribution (Z-S)

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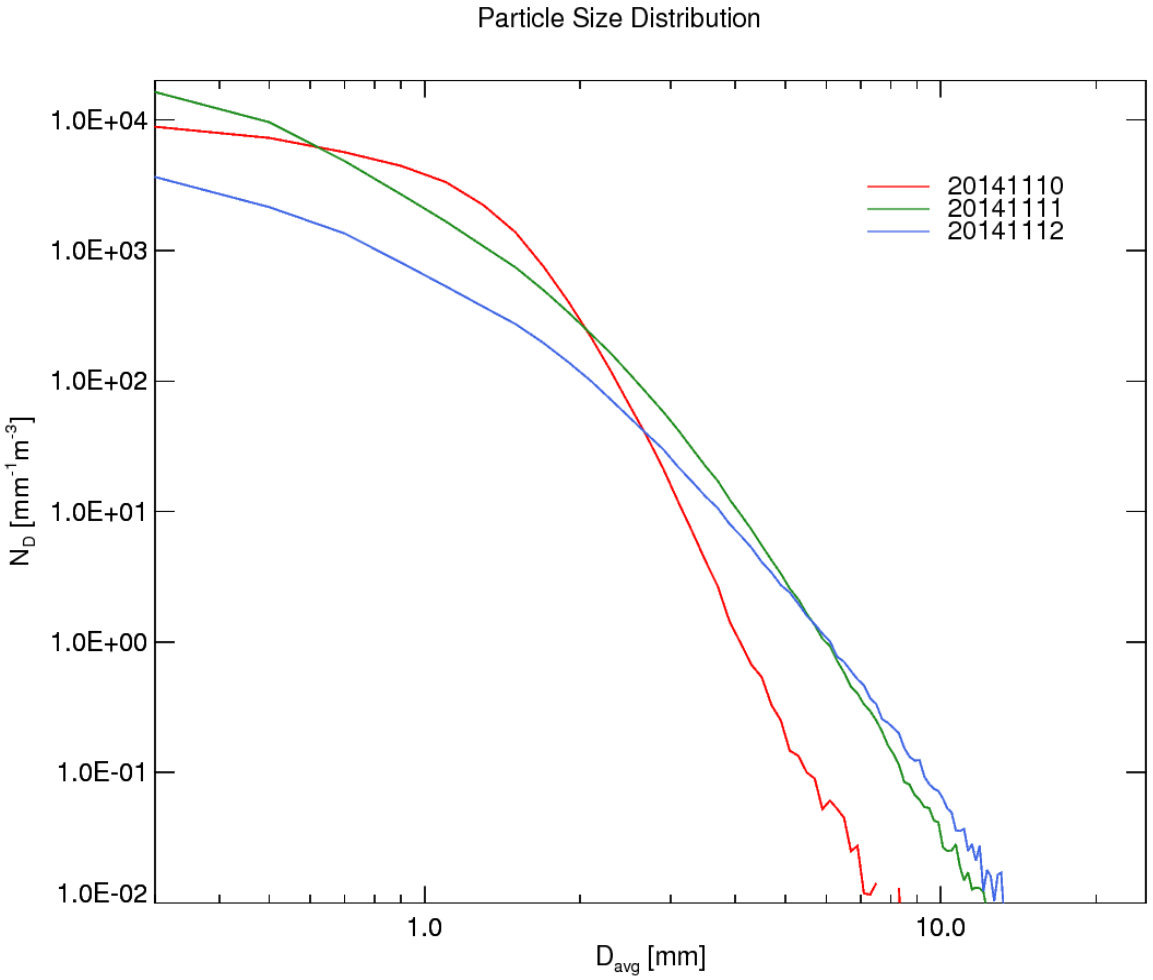
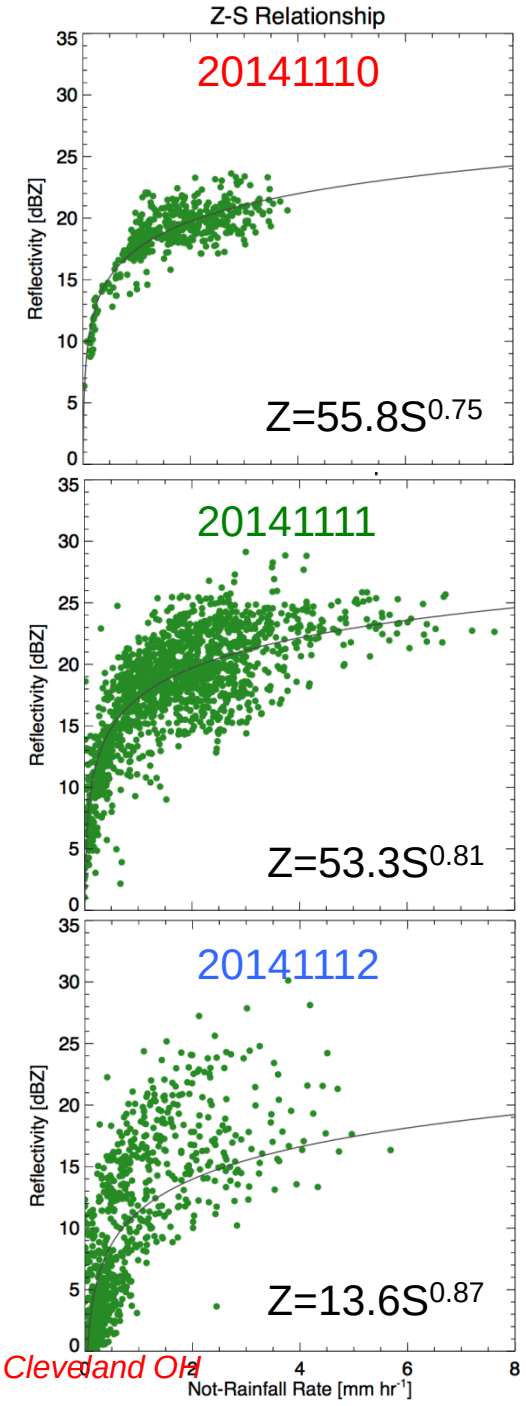
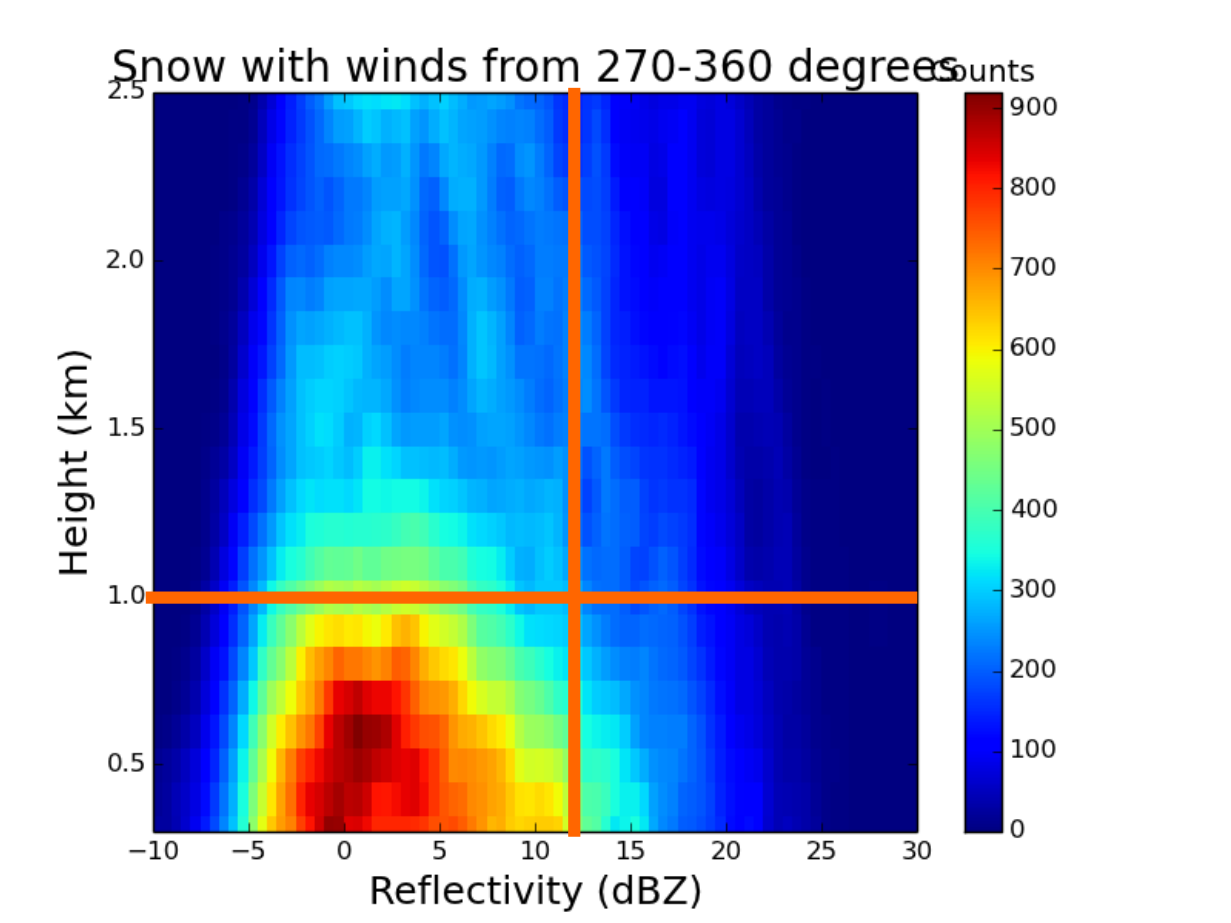
- GPM: how much snow < 12 dBZ?
- Snow particle size distribution (Z-S)
  - Systematic differences (lake-effect vs. system)?
  - Radar + microwave radiometer implications

Z-S: Snowfall Modes





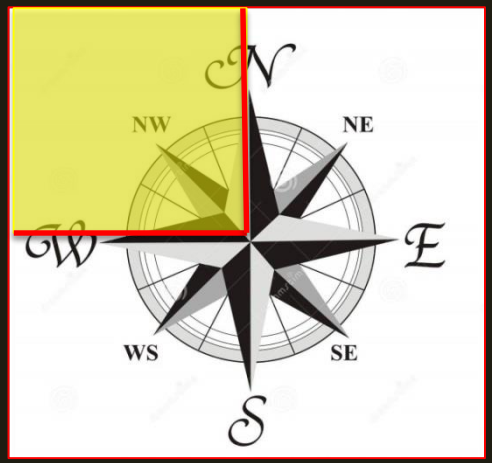
Seasonal MRR Analysis – NW Winds



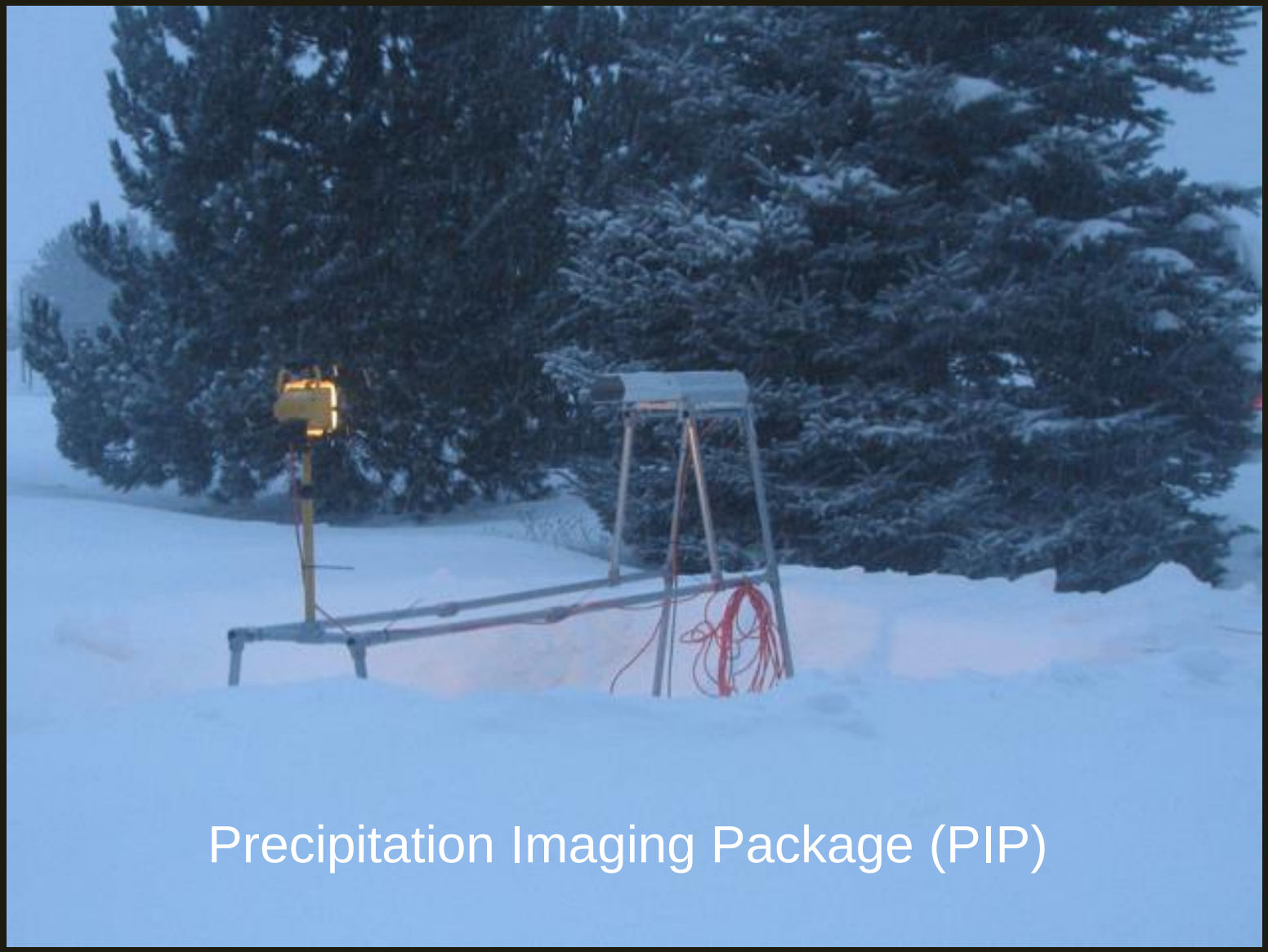
Combine MRR with sfc met data:

Temperature < 2.0 C

WD: 270 to 360°



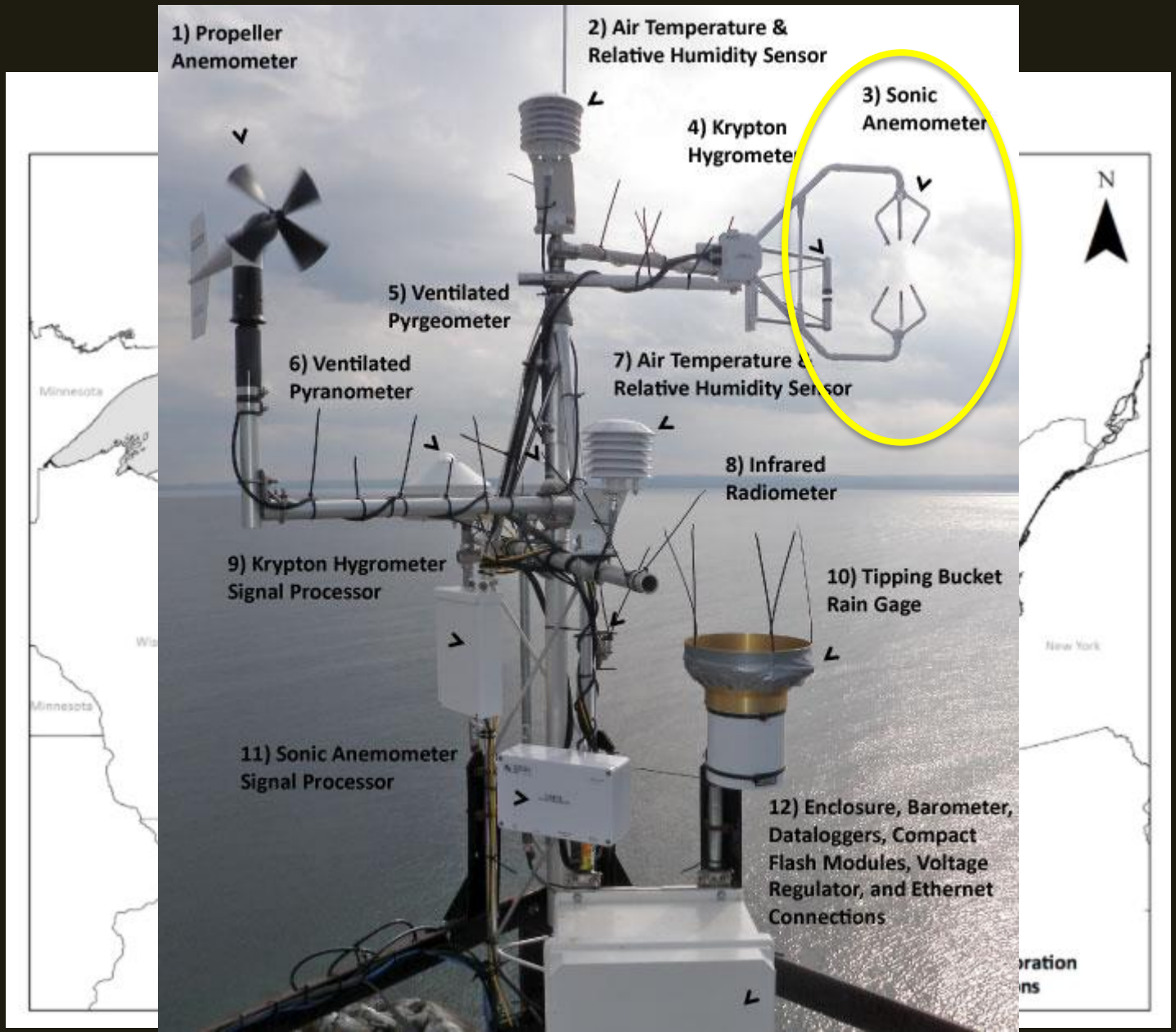
Snowfall Observatory



Precipitation Imaging Package (PIP)

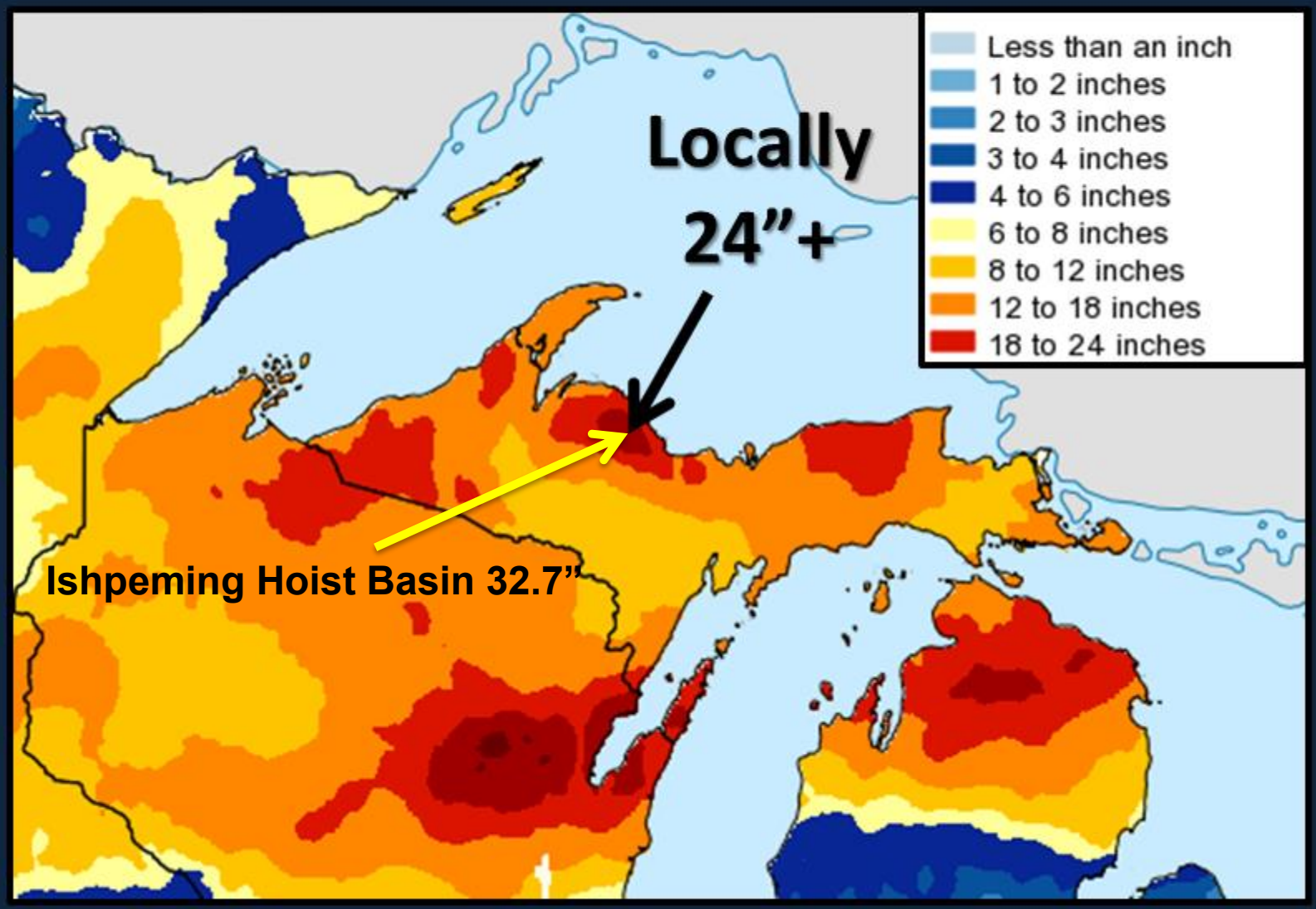
Snowfall Observatory – Micro Rain Radar (MRR)


Precipitation Imaging Package (PIP)
MQT NWS NEXRAD + Surface Obs
Micro Rain Radar (MRR)

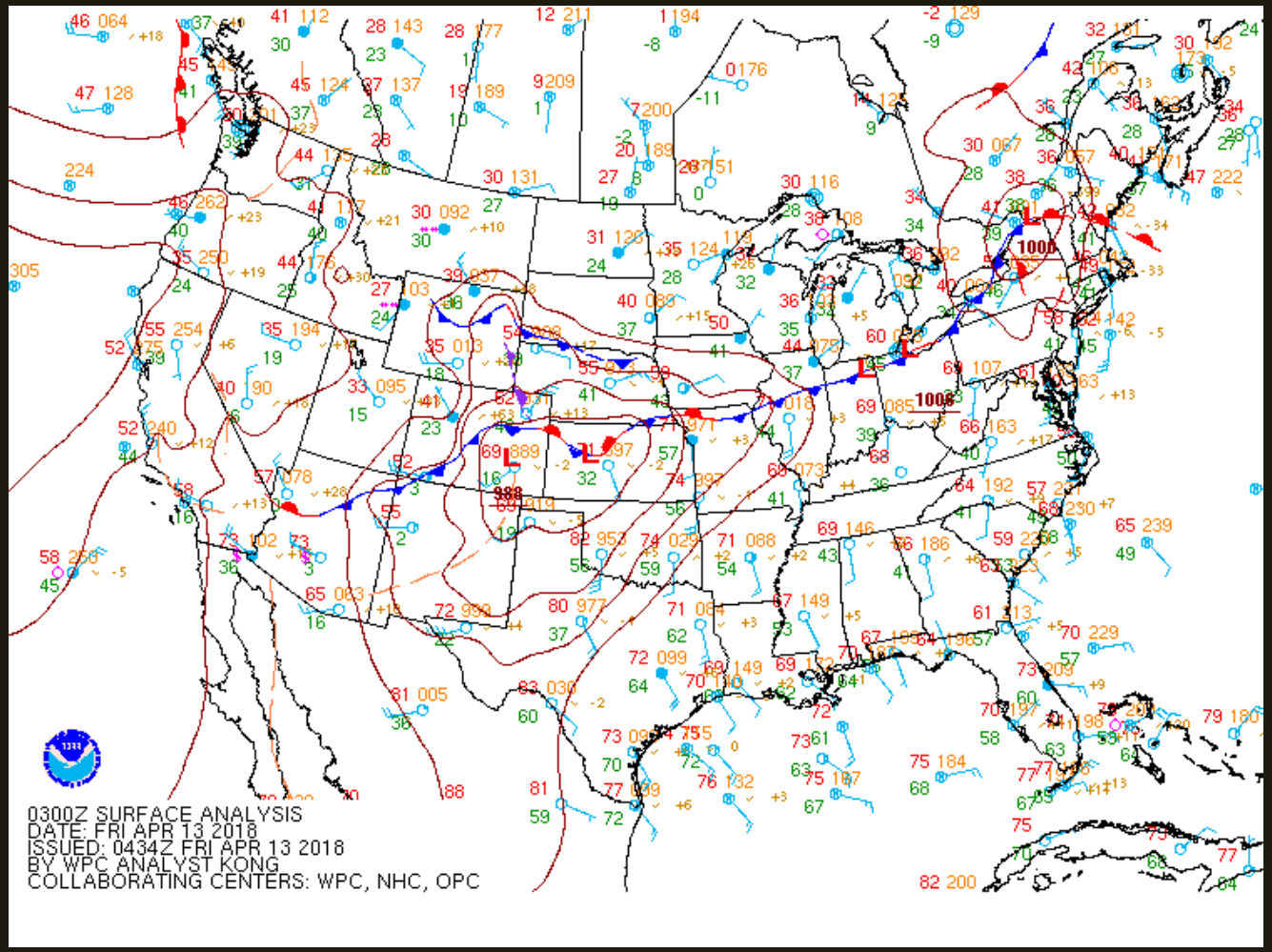

1) Propeller Anemometer
2) Air Temperature & Relative Humidity Sensor
3) Sonic Anemometer
4) Krypton Hygrometer
5) Ventilated Pyrgeometer
6) Ventilated Pyranometer
7) Air Temperature & Relative Humidity Sensor
8) Infrared Radiometer
9) Krypton Hygrometer Signal Processor
10) Tipping Bucket Rain Gage
11) Sonic Anemometer Signal Processor
12) Enclosure, Barometer, Dataloggers, Compact Flash Modules, Voltage Regulator, and Ethernet Connections
N
Minnesota
New York

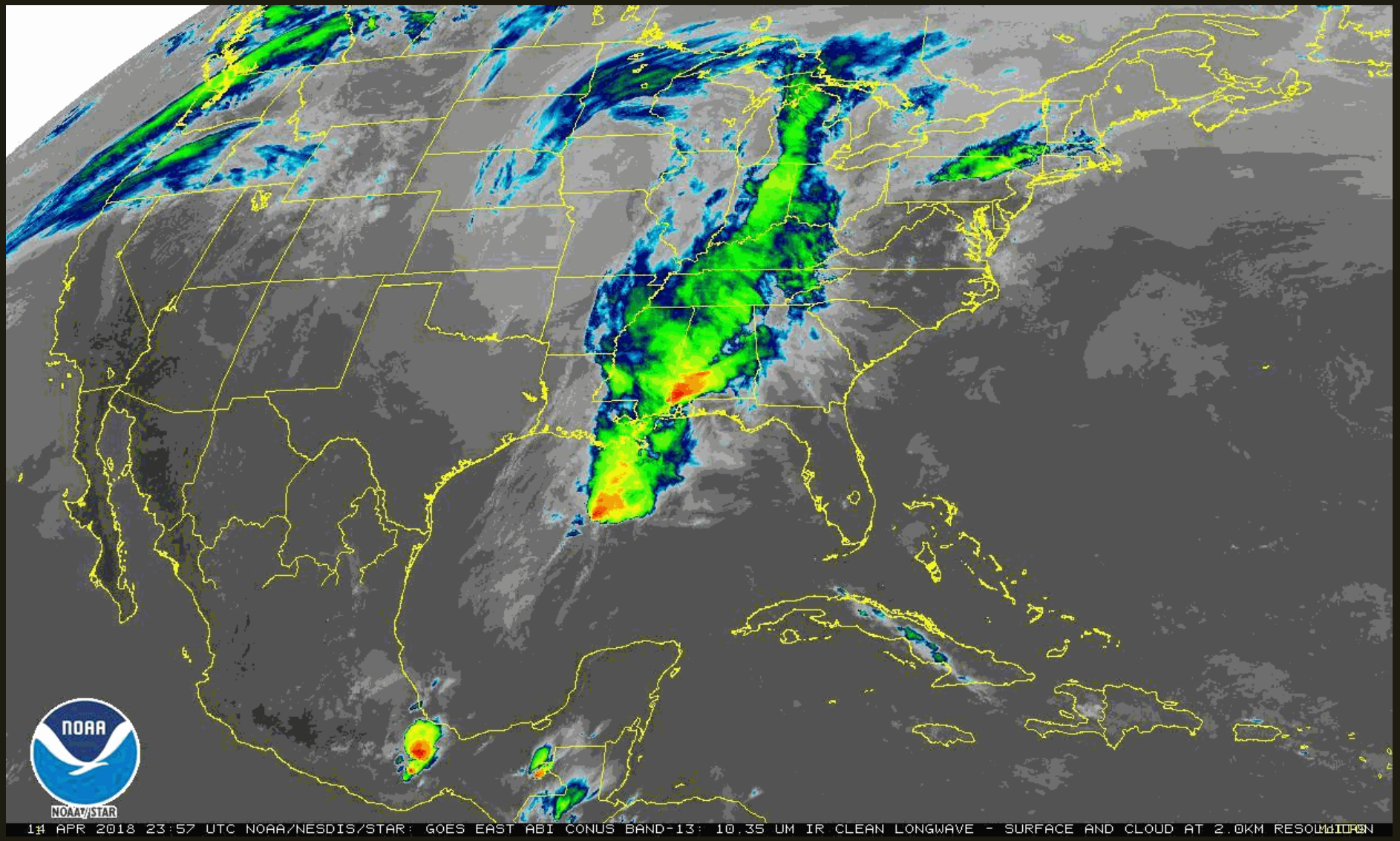
13-16April2018

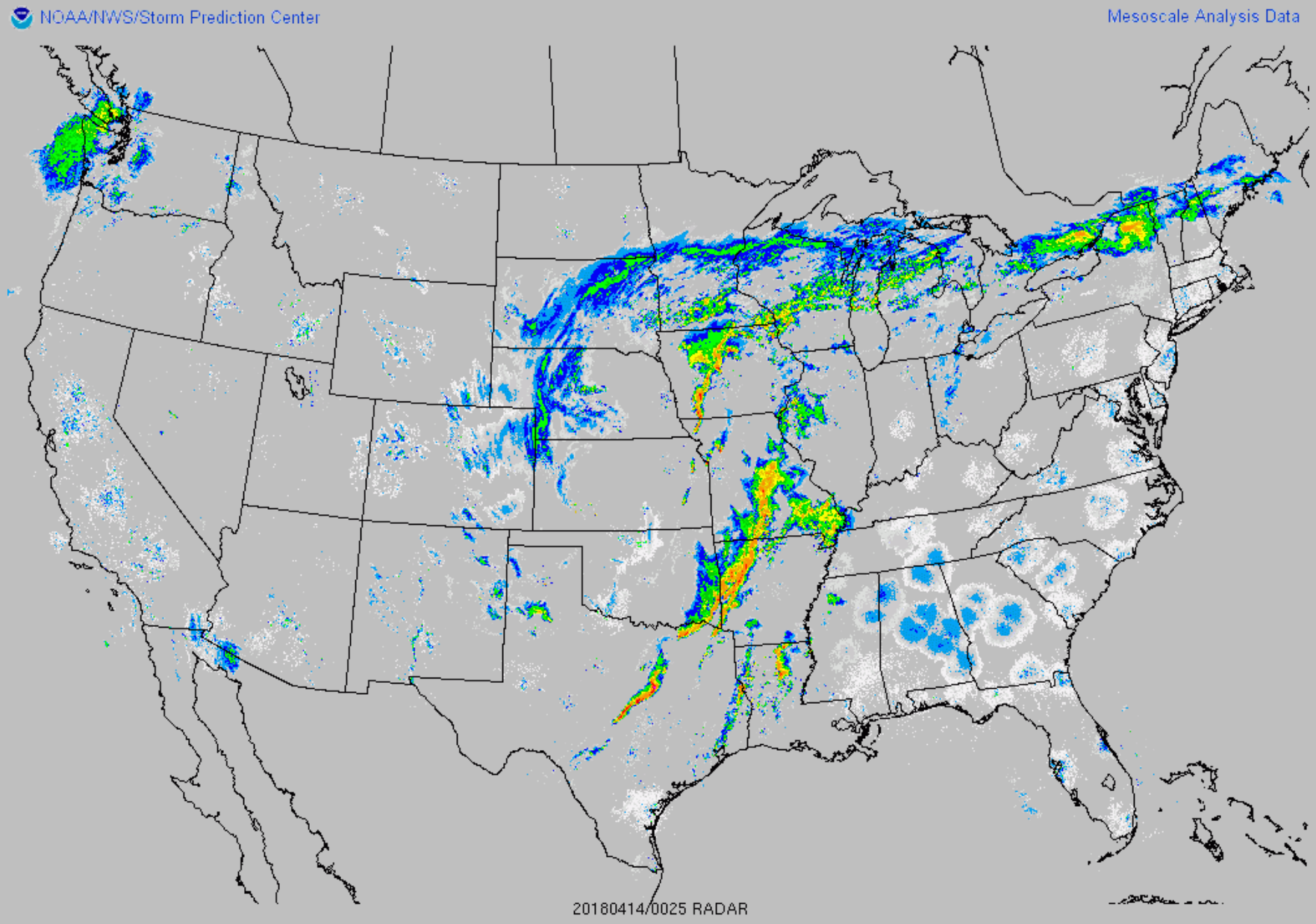
Storm Total Snowfall



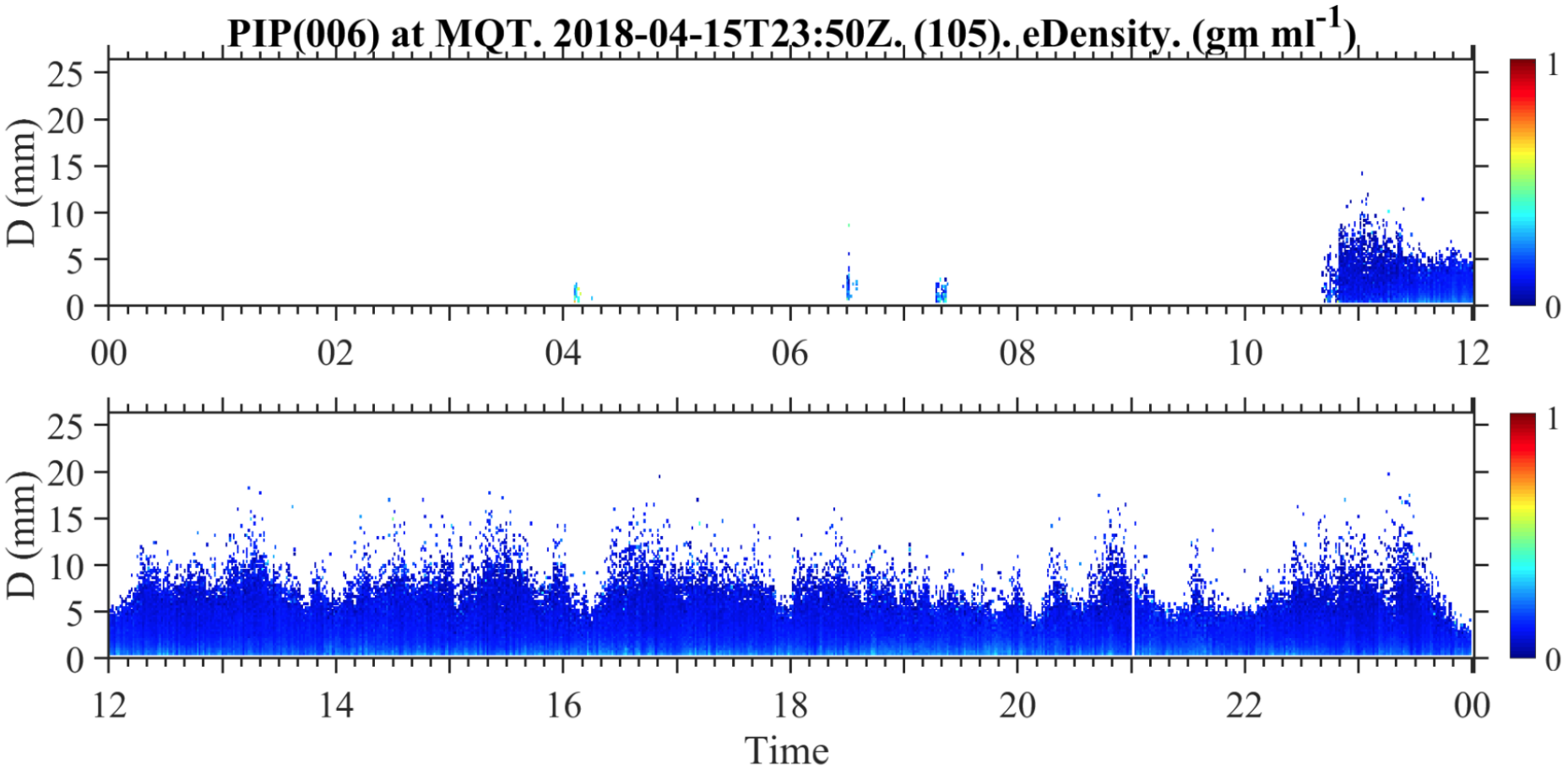
Prolonged Event…

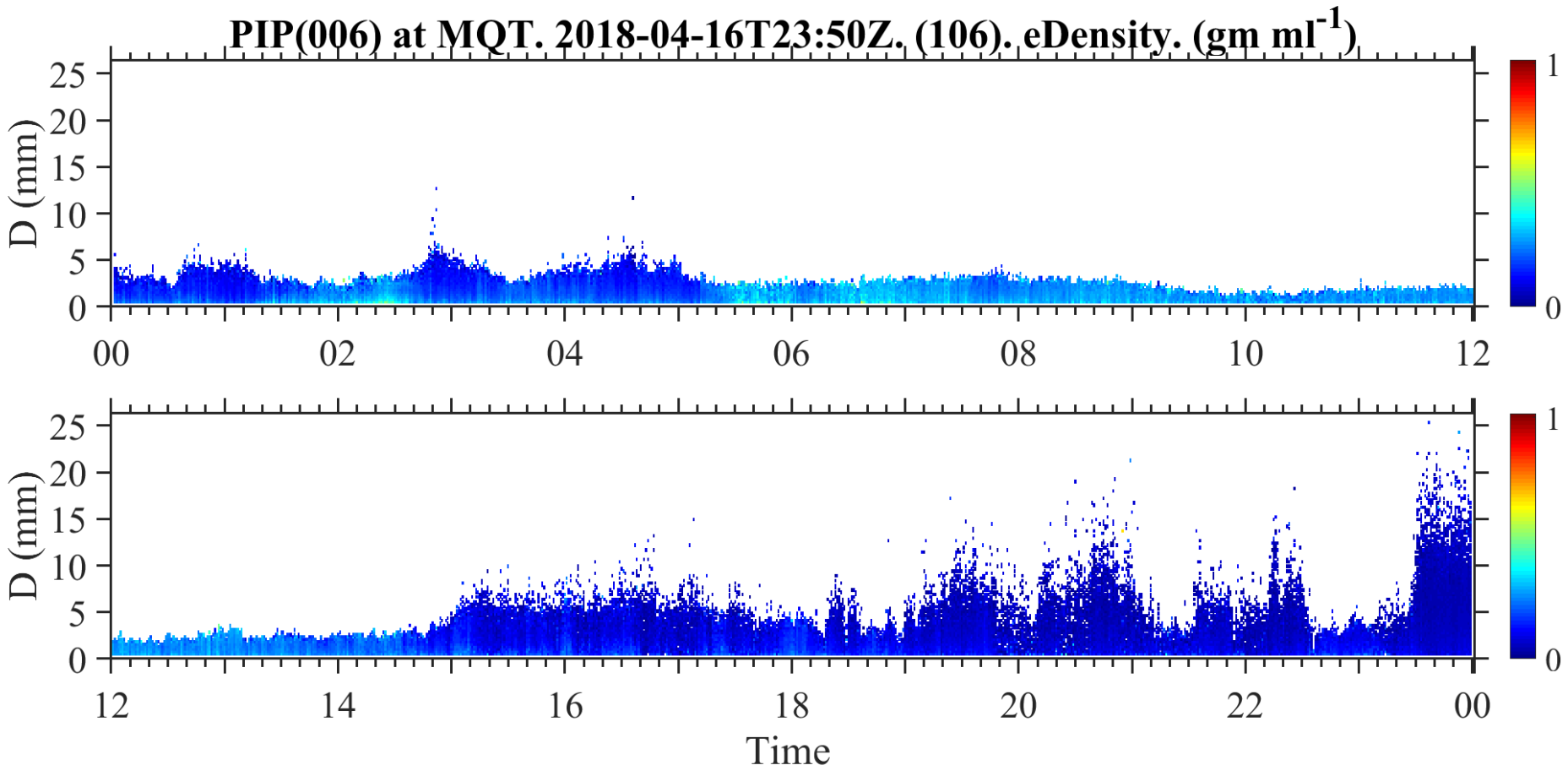



NOAA
NOAA/STAR
14 APR 2018 23:57 UTC NOAA/NESDIS/STAR: GOES EAST ABI CONUS BAND-13: 10.35 UM IR CLEAN LONGWAVE - SURFACE AND CLOUD AT 2.0KM RESOLUTION


NOAA/NWS/Storm Prediction Center
Mesoscale Analysis Data
20180414/0025 RADAR

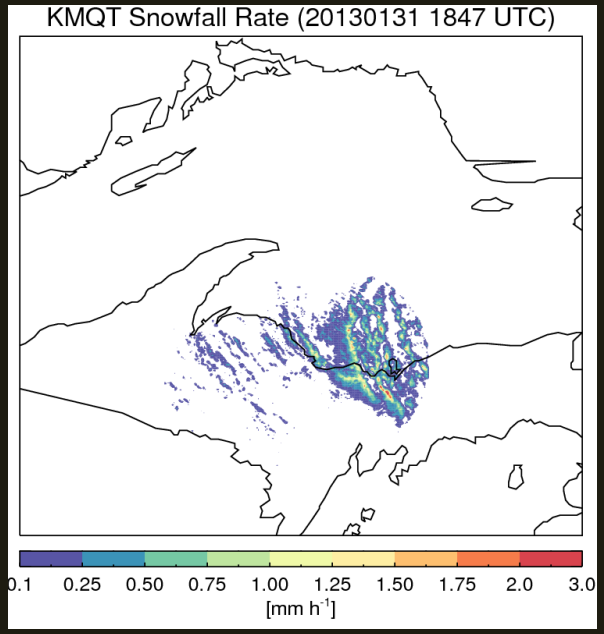
Synoptic Look…Transitioned to Lake

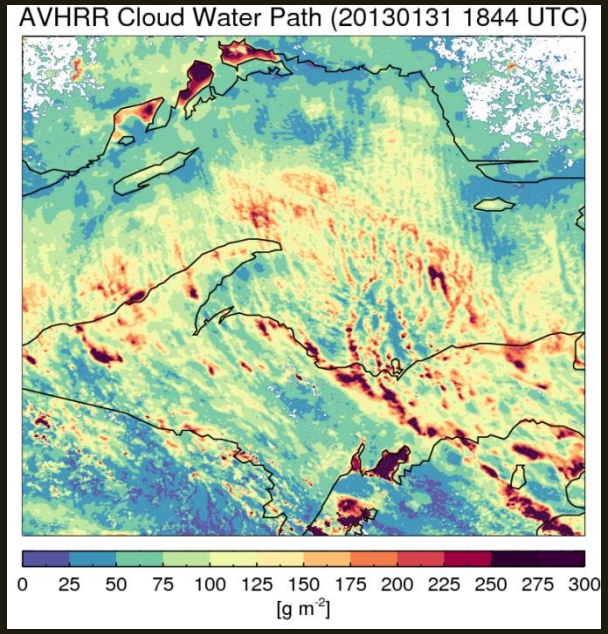


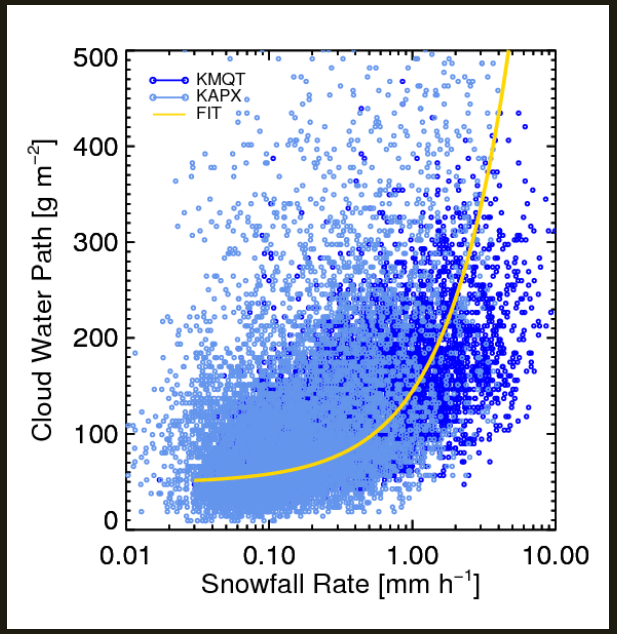

PIP(006) at MQT. 2018-04-16T23:50Z. (106). eDensity. (gm ml-1)
D (mm)
25
20
15
10
5
0
00
02
04
06
08
10
12
1
0
D (mm)
25
20
15
10
5
0
12
14
16
18
20
22
00
Time
1
0

GOES Lake-Effect Snow Product

- "Calibrate" satellite products with NEXRAD
  - 100 km range
  - Develop empirical relationships (*CWP-S*)
- Satellite snowfall estimates augment NEXRAD





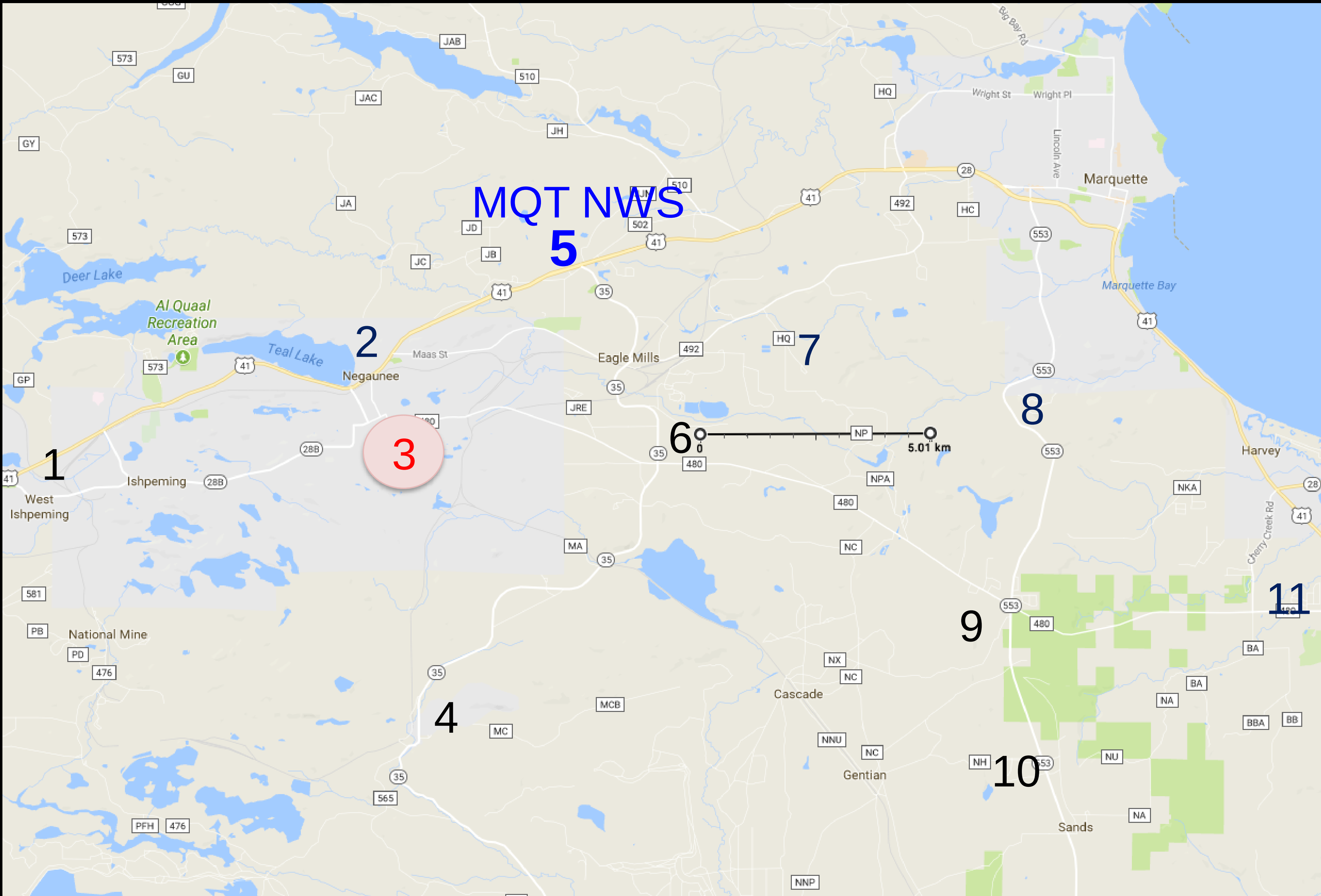


NOAA Projects

- GIMPAP
  - Satellite-based lake-effect snow product
- GOES-East
  - MQT as primary evaluation site
  - PIP → Refine NEXRAD lake-effect Z-S

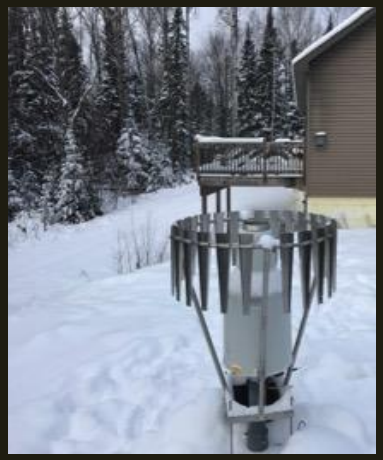
NASA Pluvio Deployment

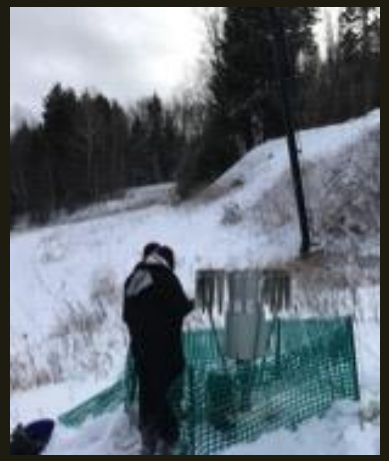
- Snowfall variability typical NASA satellite footprint (~15 km) deployment
- NWS MQT role & community involvement



MQT NWS
5
1
2
3
4
6
7
8
9
10
11
Marquette
Marquette Bay
Harvey
Negaunee
Ishpeming
West Ishpeming
Eagle Mills
Deer Lake
Teal Lake
Al Quaal Recreation Area
National Mine
Cascade
Gentian
Sands
Maas St
Wright St
Wright Pl
Lincoln Ave
Big Bay Rd
Cherry Creek Rd
0
5.01 km

Deployment 2017-18





Parsivel

- Laser Disdrometer
- Captures size/speed of particles
  - In our case…dendrites
- 32 separate size and velocity clases
- Data used to calculate type/amount/intensity/kinentic energy of precip/vsby in precip

Pluvio

- Accuracy within 0.004”
- Solar options
- Used in terrain locations…first time in LES

Future Projects

- NWP linkages
  - SLRs
  - Air-lake interaction
  - Lake-effect snow properly modeled?
  - Short-term forecasting applications

- NASA: no change 2018-19…hinted at longer
  - Perhaps additional MRRs (from SK Olympics)
  - Addt'l Pluvio's (disdrometer)
- MRR + PIP deployment MQT, DLH, & APX

MQT MRR + PIP Publications

Kulie et al (2018): A snowfall microphysical and profiling radar observatory in the Upper Great Lakes. *Mon. Wea. Rev*., In Preparation.

Pettersen et al (2017): Profiling radar properties associated with Great Lakes snowfall modes. *Atmos. Meas. Tech*., In Preparation.