

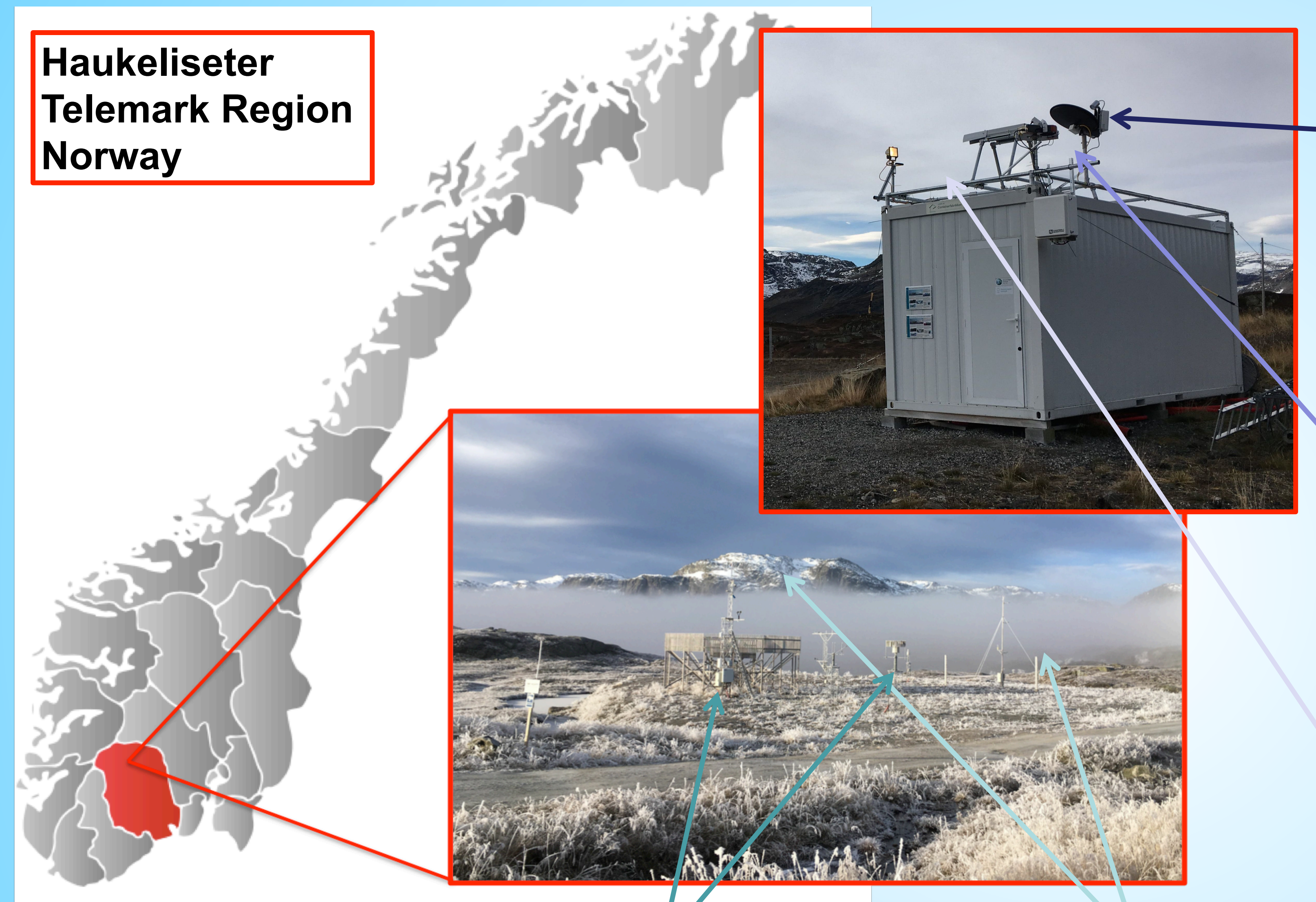
Ground based remote sensing retrievals and observations of snowfall in the Telemark region of Norway

Claire Pettersen¹, Tristan L'Ecuyer², Norm Wood¹, Steven Cooper³, Mareile Wolff⁴,
Walter Petersen⁵, Larry Bliven⁶, Samantha Tushaus¹, Claire Schirle³, and James Earley¹

¹University of Wisconsin-Madison, Space Science and Engineering Center, Madison, Wisconsin, claire.pettersen@ssec.wisc.edu
²University of Wisconsin-Madison, Atmospheric and Oceanic Sciences Department, Madison, Wisconsin
³University of Utah, Department of Atmospheric Sciences, Salt Lake City, Utah
⁴Norwegian Meteorological Institute, Oslo, Norway
⁵Marshall Space Flight Center, Earth Science Office, Huntsville, Alabama
⁶National Aeronautics and Space, Goddard Space Flight Center/Wallops Flight Facility, Wallops Island, Virginia



Haukeliseter
Telemark Region
Norway



MicroRain Radar (MRR)

- 24 GHz Frequency Modulated Continuous Wave Radar
- Height range 3000 m/100 m bin
- Optimized for snow using Maahn et al., (AMT 2012)



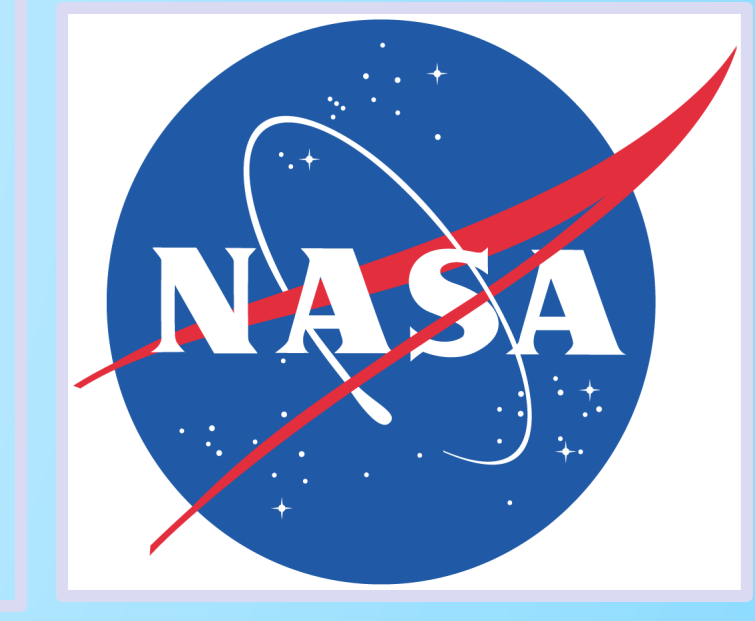
Multi-Angle Snowflake Camera (MASC)

- Records fall speed and diameter
- Resolves snowflakes from 0.01 to 10cm



Particle Imaging Package (PIP)

- Camera and light coupled for imaging falling precipitation
- Captures ~400 images/second



Geonor Precipitation Gauges

- 1 double-fence
- 2 single-fence

10-meter

- wind speed/direction

2-meter

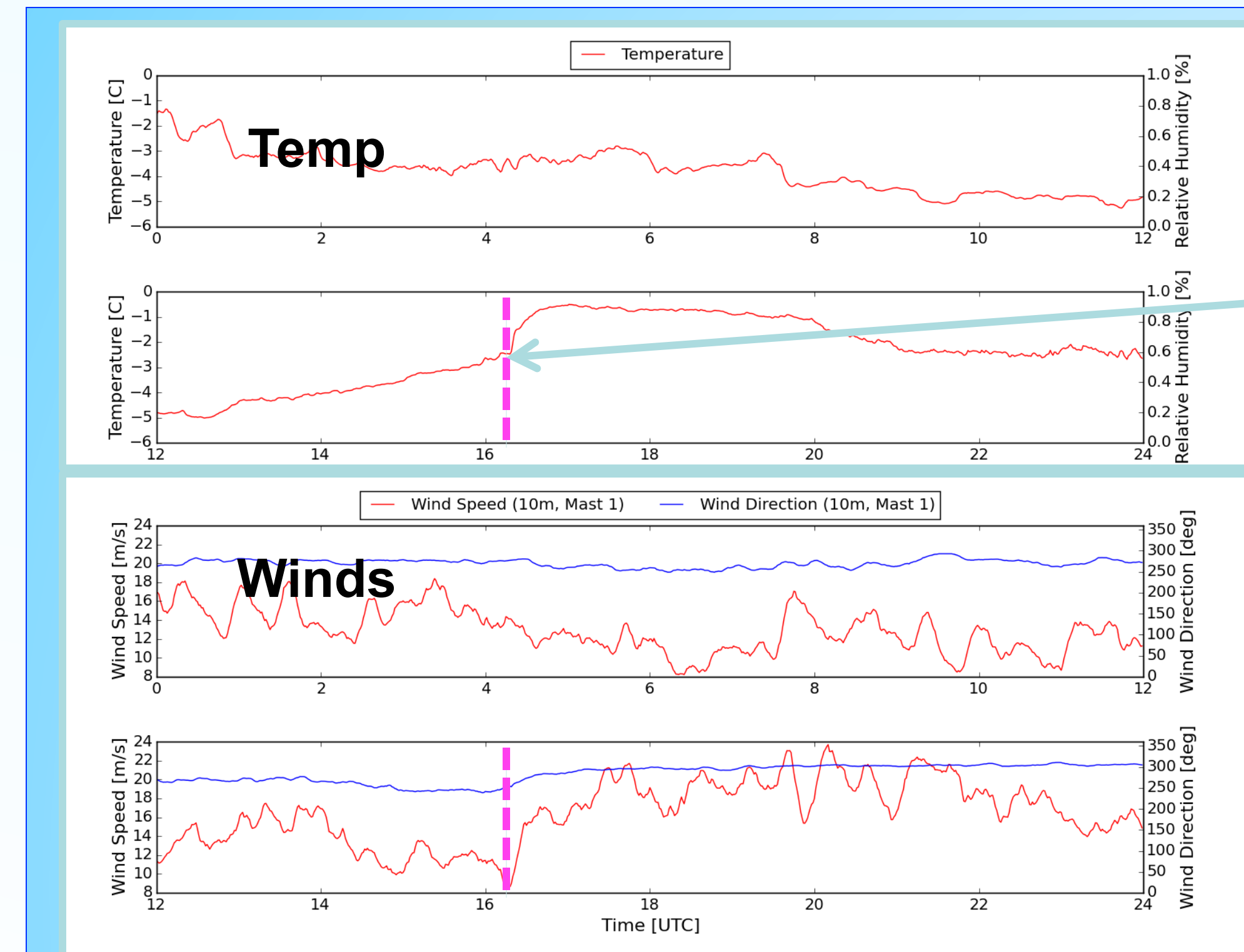
- Temperature/RH



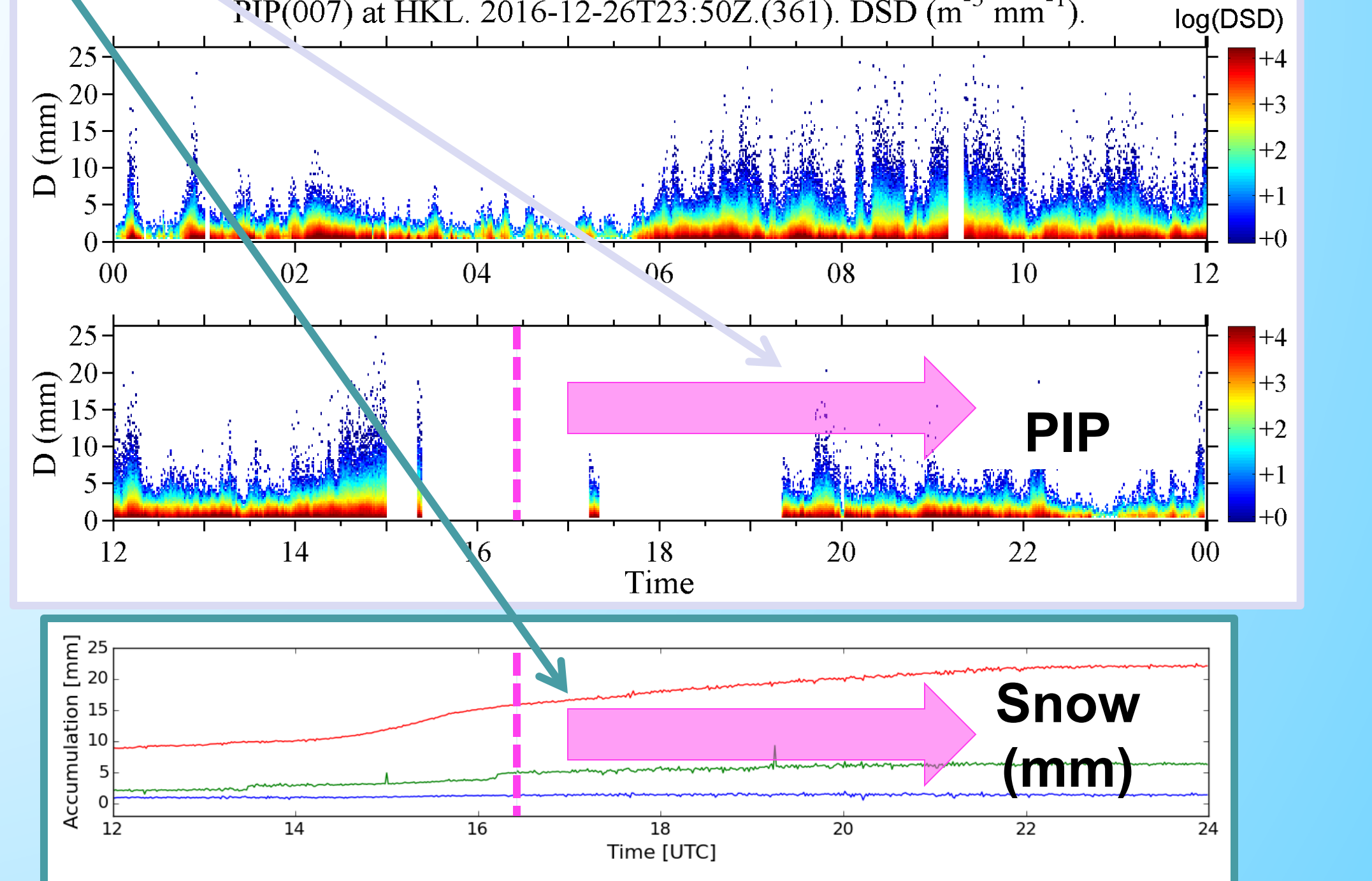
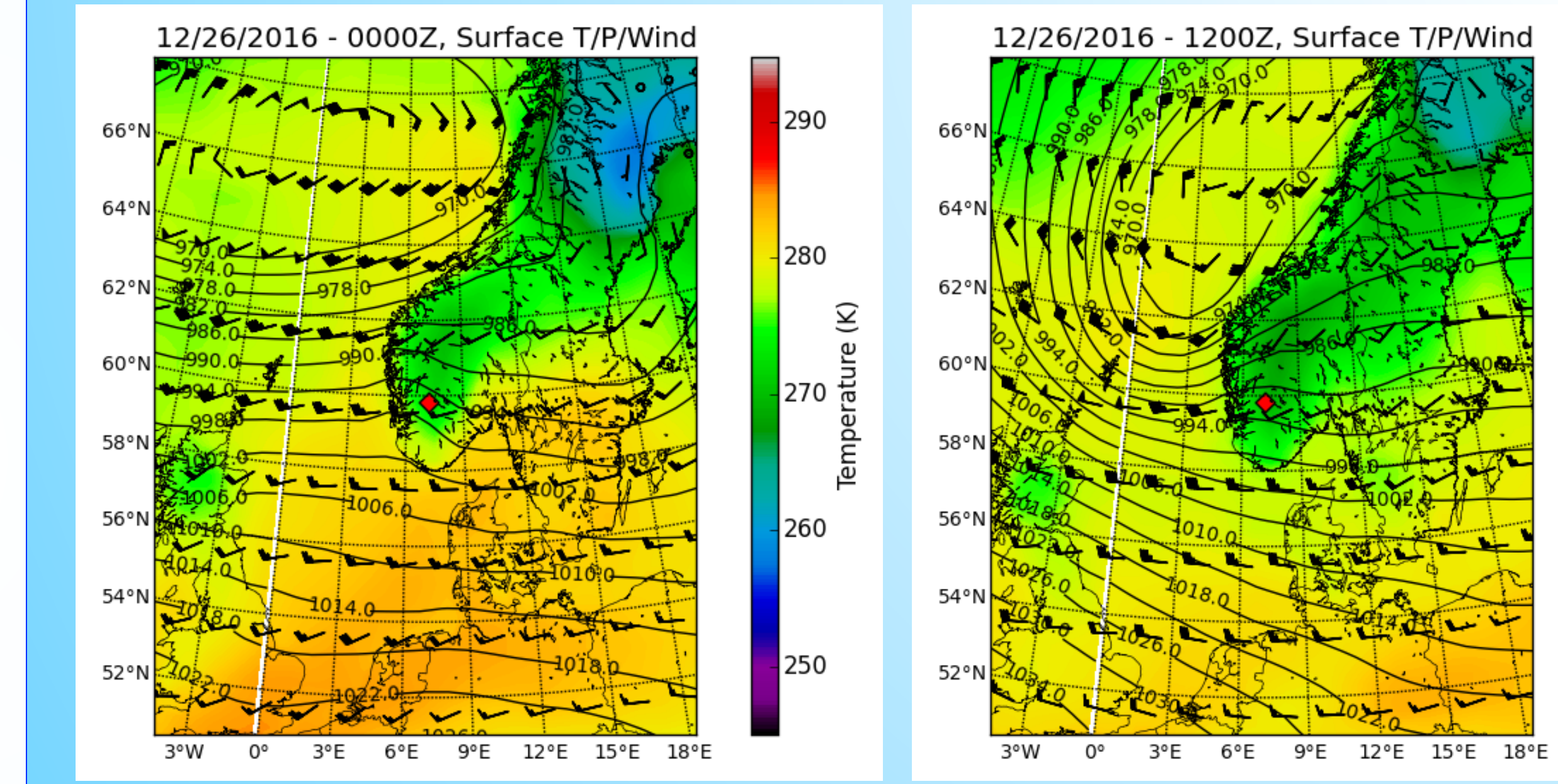
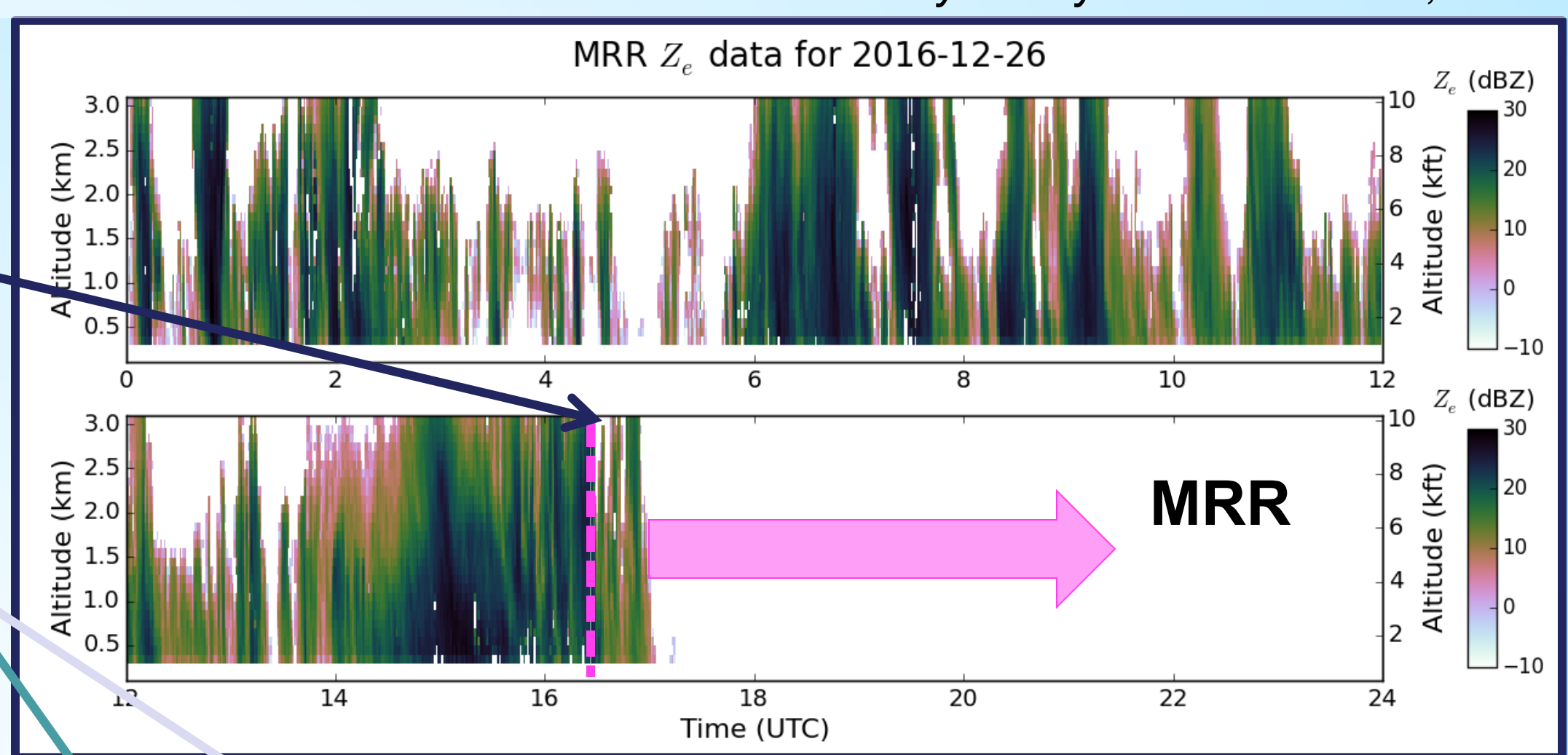
NSF Grant: 1531690
Impact of Snowfall Processes on Potential Vorticity Generation in High-Latitude Snow Events

December 25 – 27, 2016: Extreme Weather System Urd

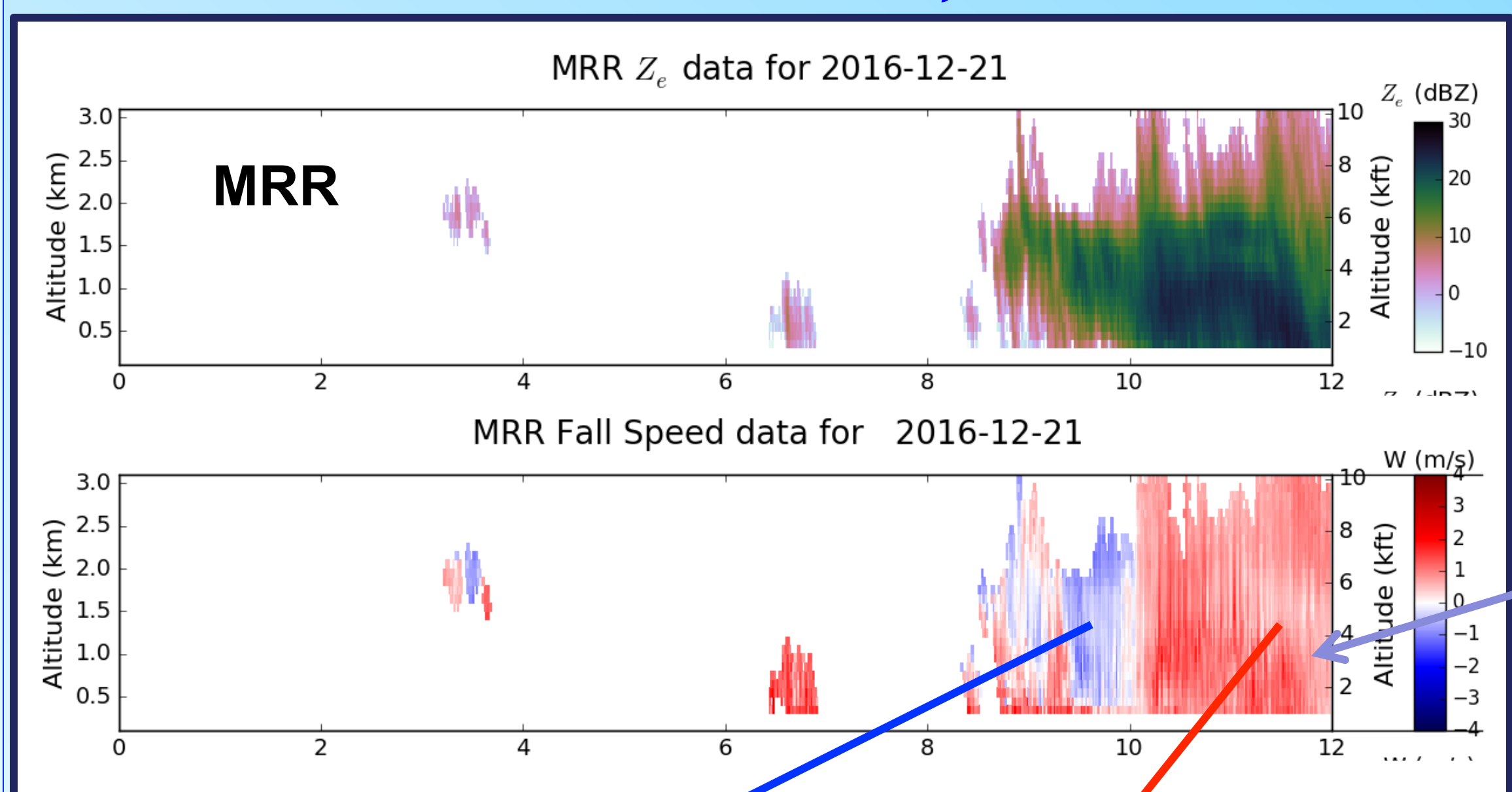
Extreme Weather heading toward southern Norway
Norway Today – December 25, 2016
'Urd' has reached hurricane strength
Norway Today – December 26, 2016



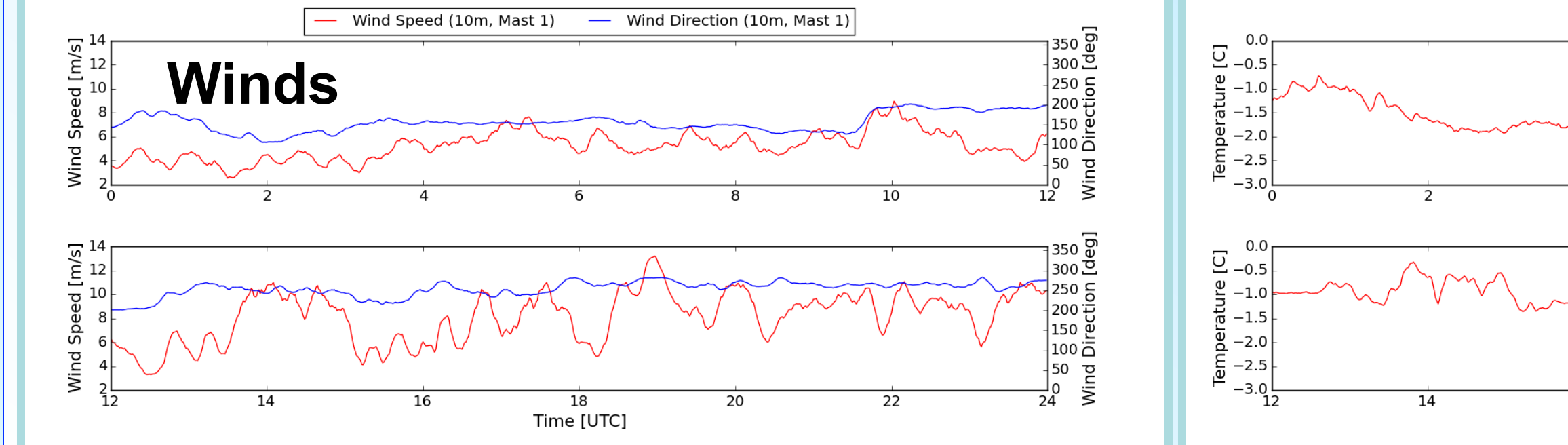
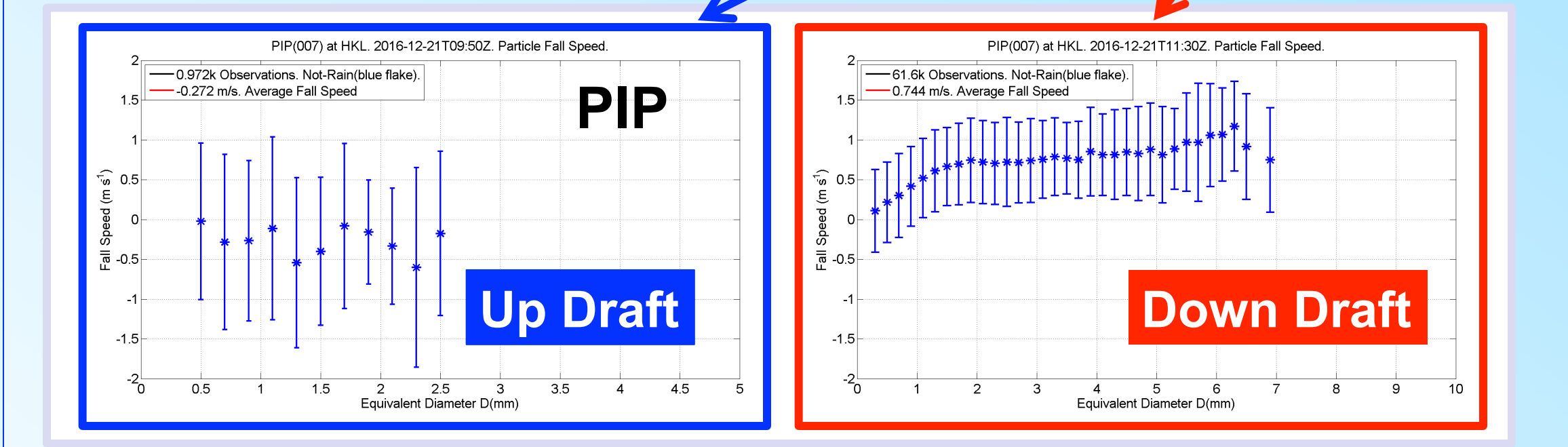
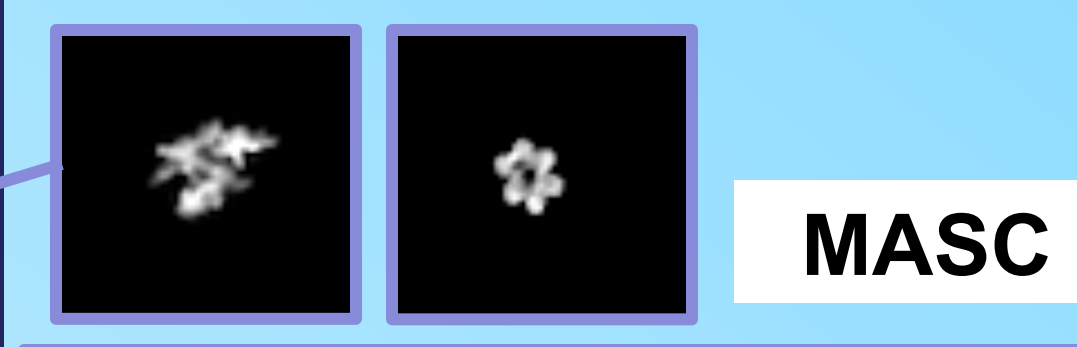
Temperatures climb to ~0F starting at 1600UTC and the MRR heater cannot keep pace with the wet and heavy snowfall
The PIP and Geonor show that it continues to snow throughout the day



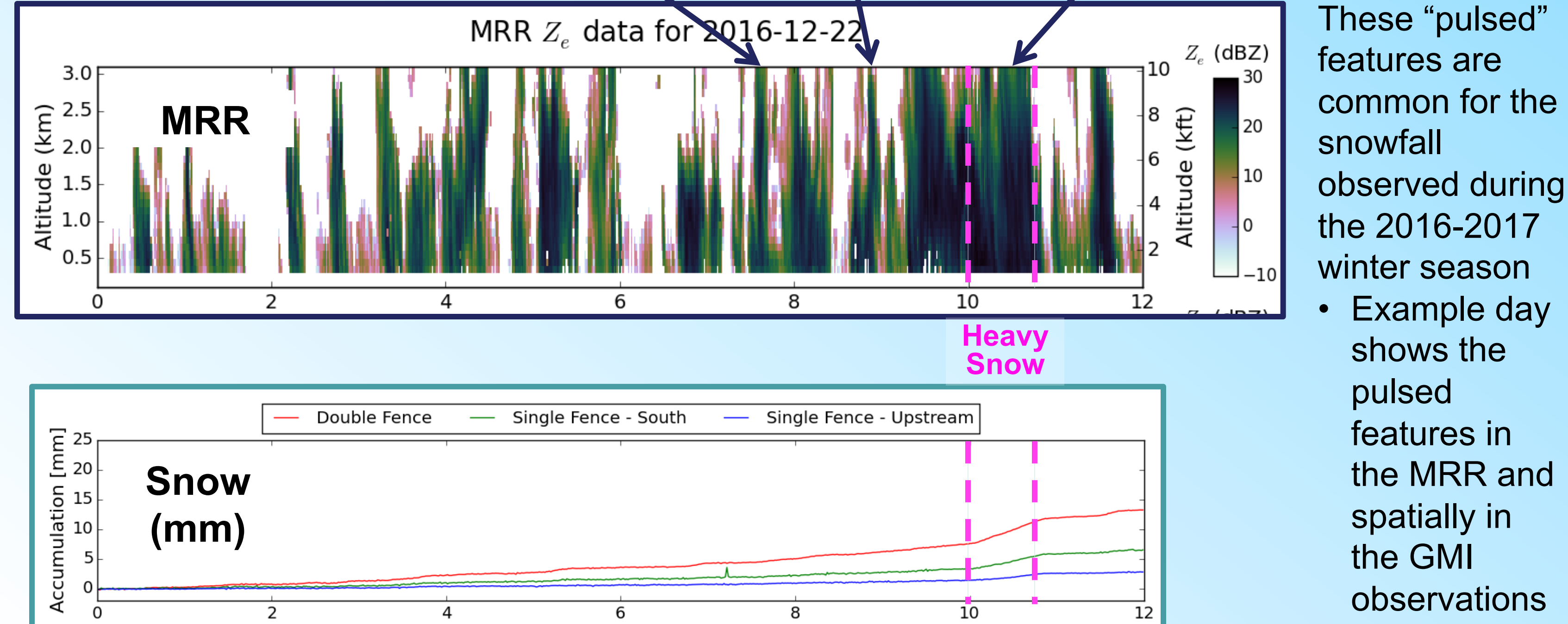
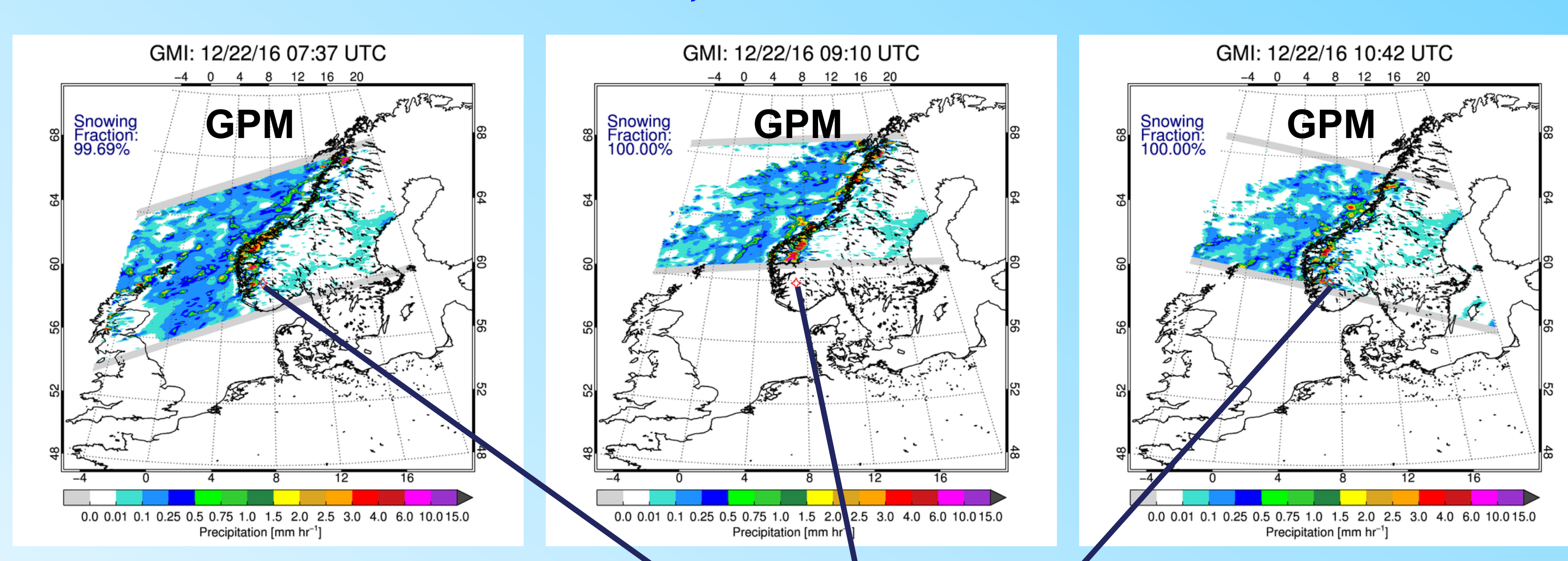
December 21, 2016: Turbulent Snowfall



Turbulent updrafts are present in the PIP, MASC, and MRR observations.
• These deep updrafts are coincident with a shift in the wind direction and a increase in temperature

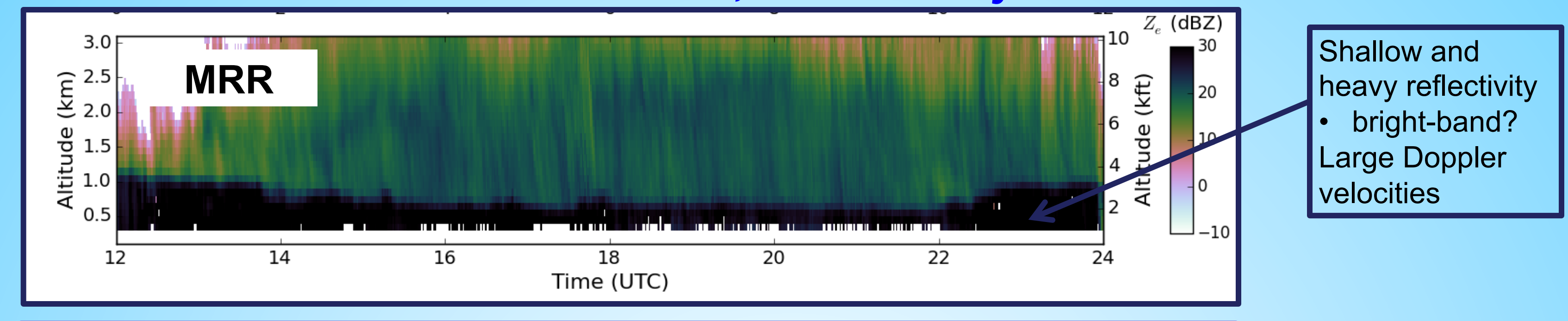


December 22, 2016: Pulsed Snowfall

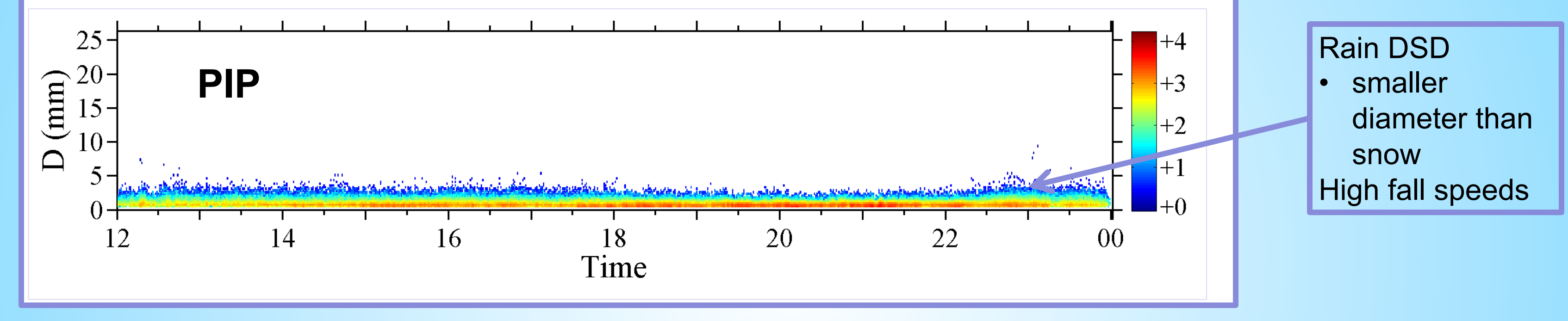


These "pulsed" features are common for the snowfall observed during the 2016-2017 winter season
• Example day shows the pulsed features in the MRR and spatially in the GMI observations

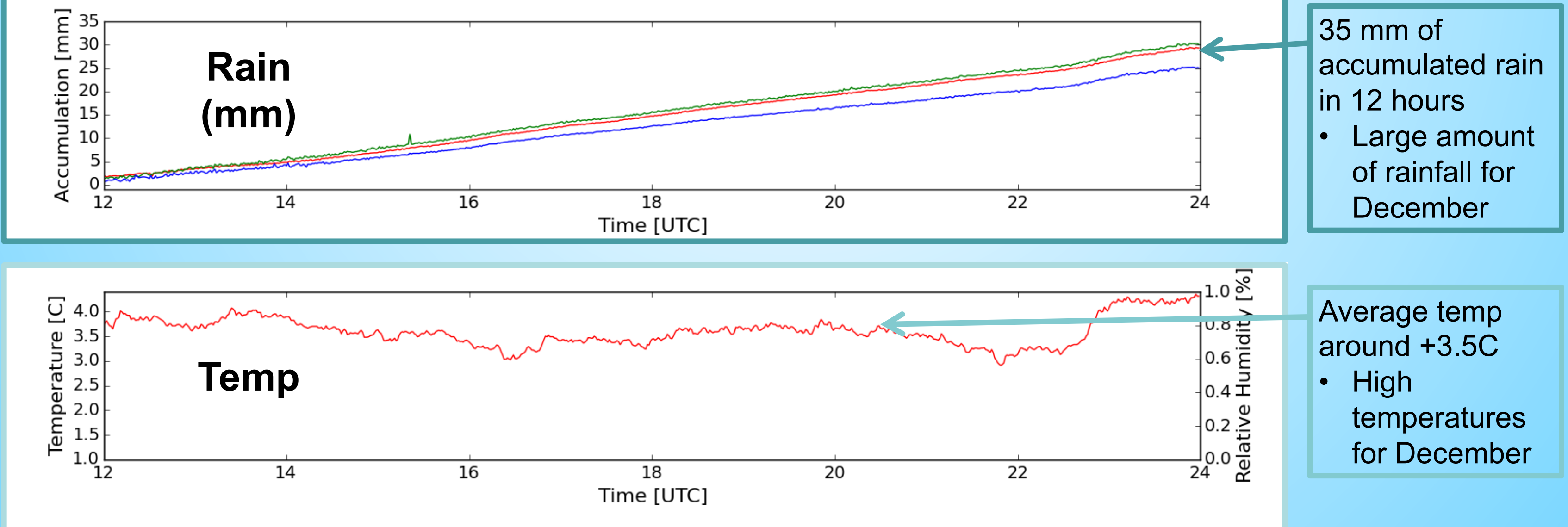
December 30, 2016: Heavy Rain



Shallow and heavy reflectivity
• bright-band?
Large Doppler velocities



Rain DSD
• smaller diameter than snow
High fall speeds



35 mm of accumulated rain in 12 hours
• Large amount of rainfall for December

Average temp around +3.5C
• High temperatures for December