Structure of an Extra Tropical Cyclone in the Arctic

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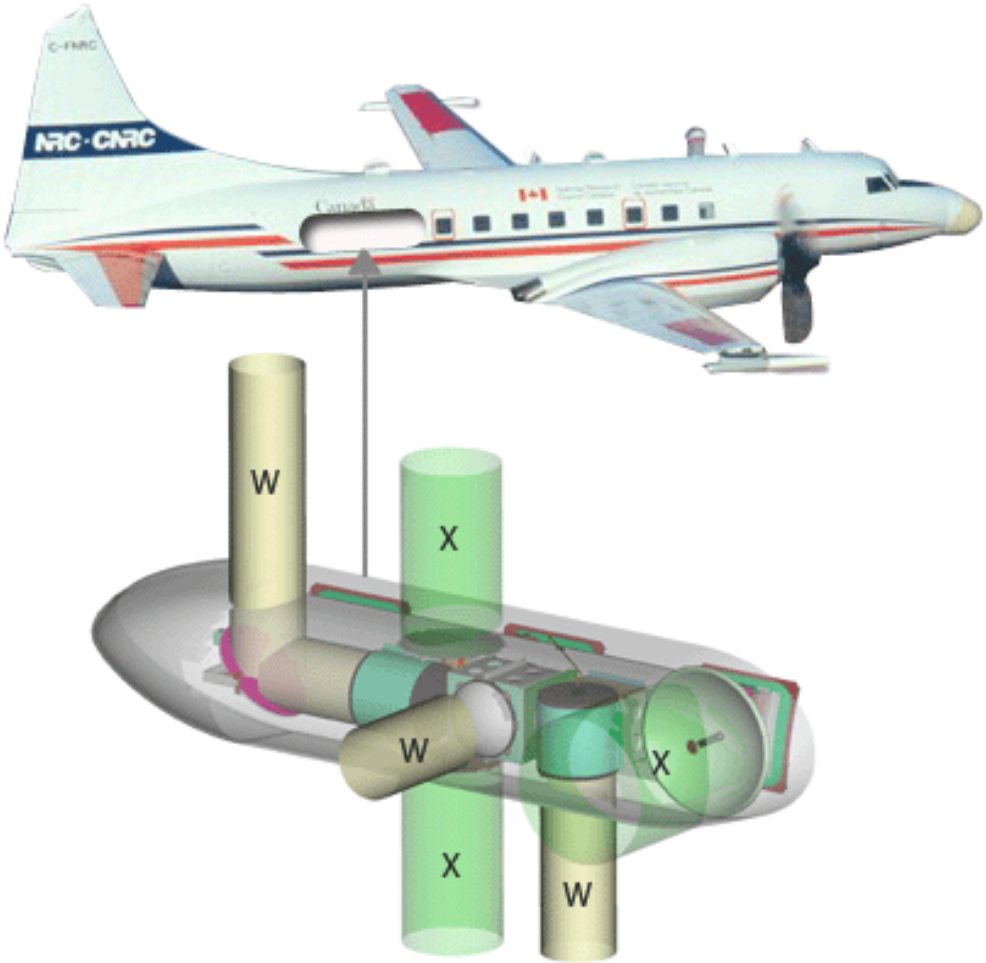
STAR Background

Storm Studies in the Arctic (STAR)

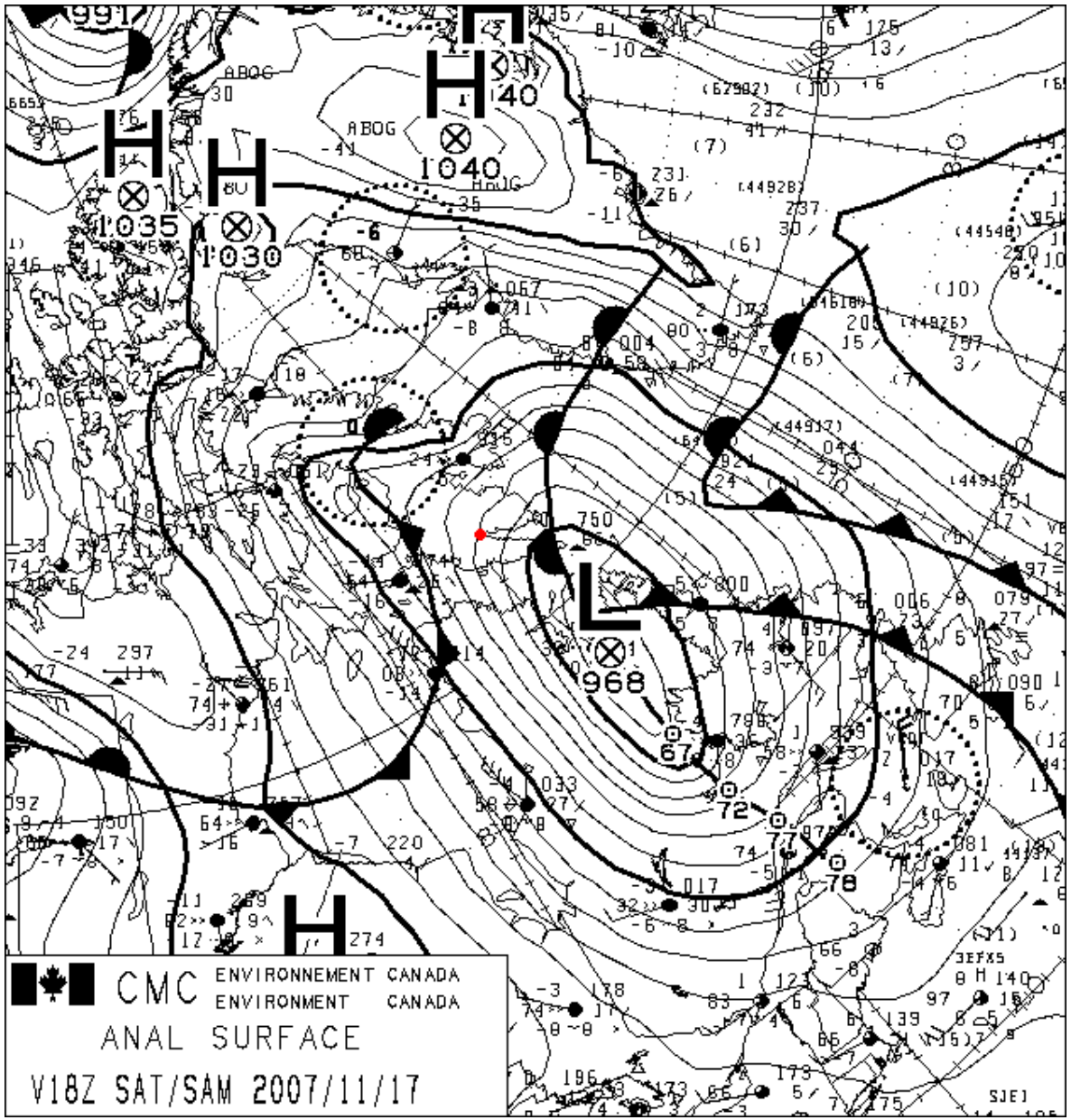
- a 2 month project “to better understand severe Arctic storms and their associated hazardous conditions and to contribute to their better prediction”
- A variety of instruments ere deployed in and around Iqaluit, Nunavut

NRC Convair-580



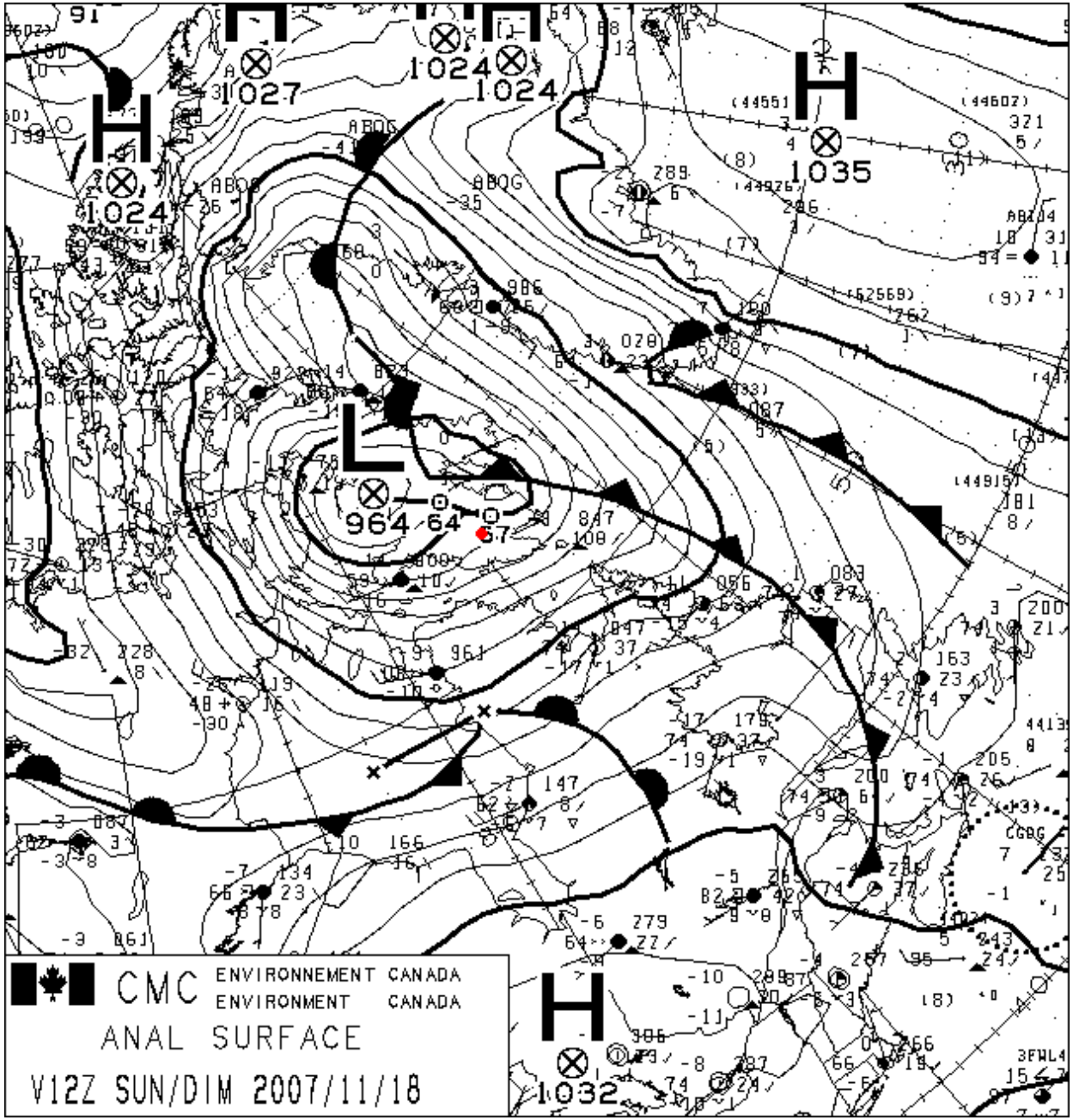
- NAWX
  - Up, down and side W and X band radars
- Dropsondes
- Probes – 2DC, 2DP, 2DG, Nevzorov, FSSP96, LWC, TWC, RID

The event



On the 17th a deep mid-latitude storm was analyzed as a deep low (open wave stage MLC) over northern Quebec.

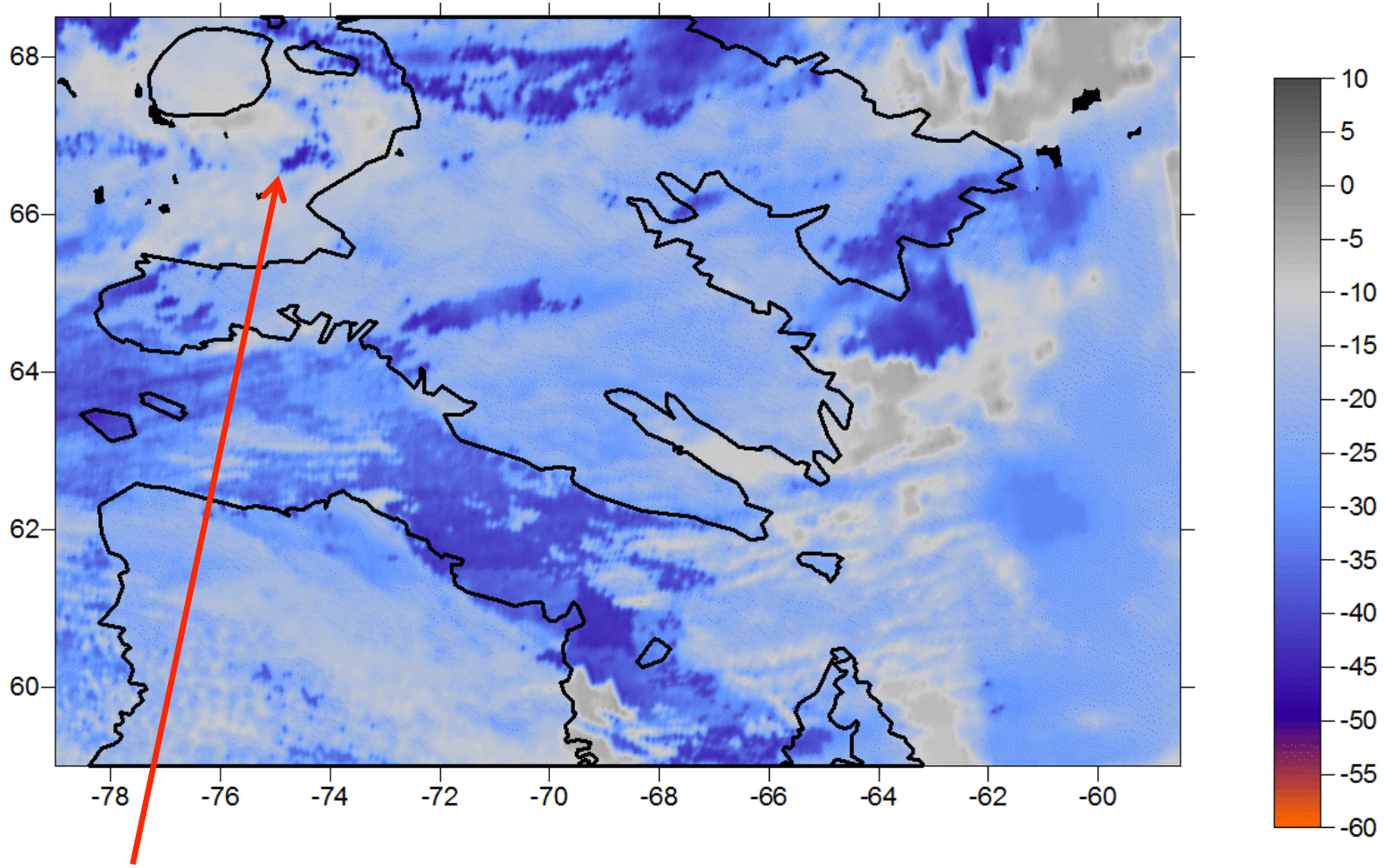
A research flight was conducted through the storm and the crew over nighted in Goose Bay, Newfoundland.



By the 18th the storm had continued to deepen and moved to Foxe Basin.

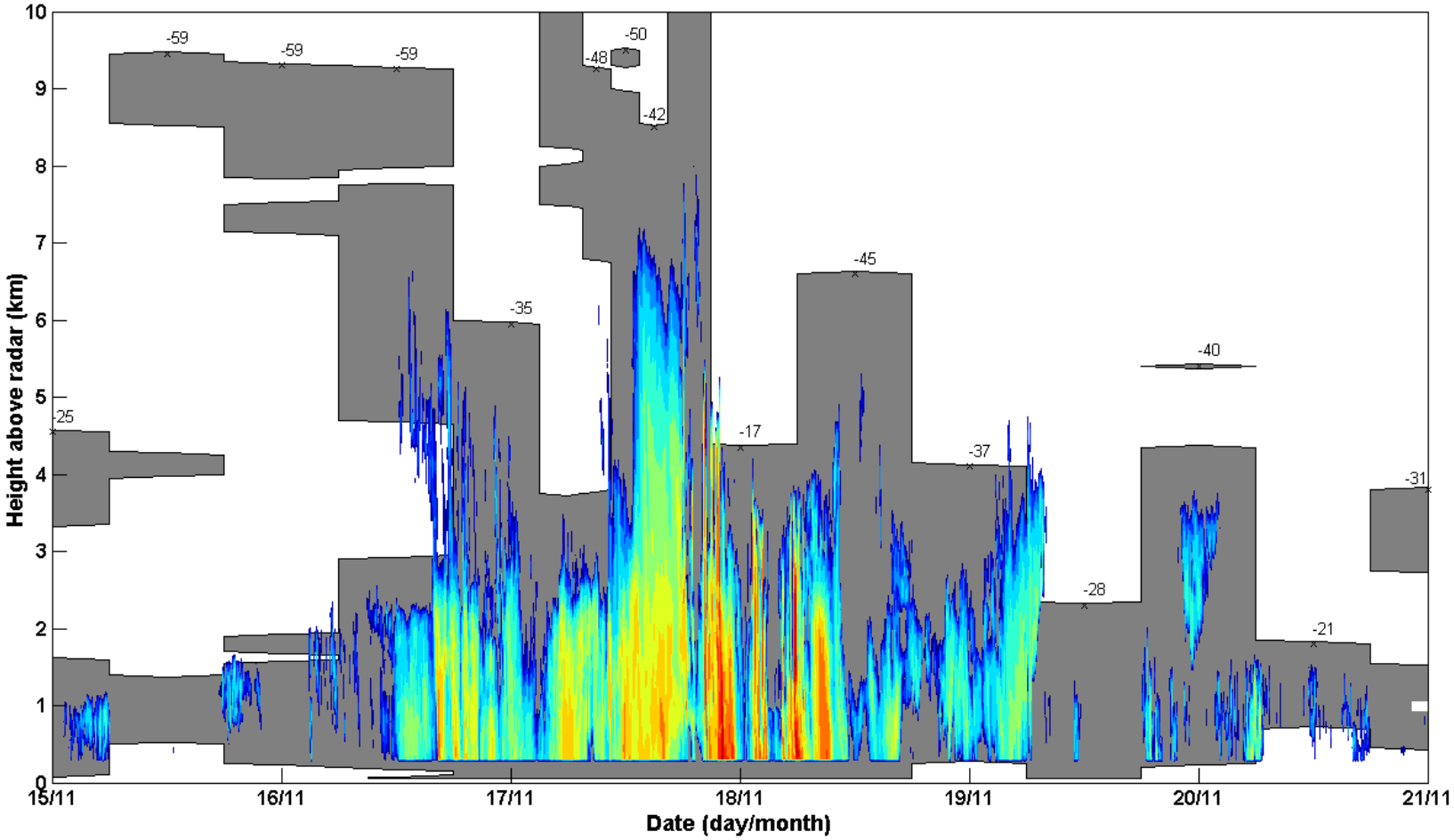
Decision was made to fly through and sample the low.

MODIS Cloud Top Temperatures



The storm can be seen in the MODIS Cloud Top Temperatures at 1725 UTC 18 November 2007

What was happening in Iqaluit……

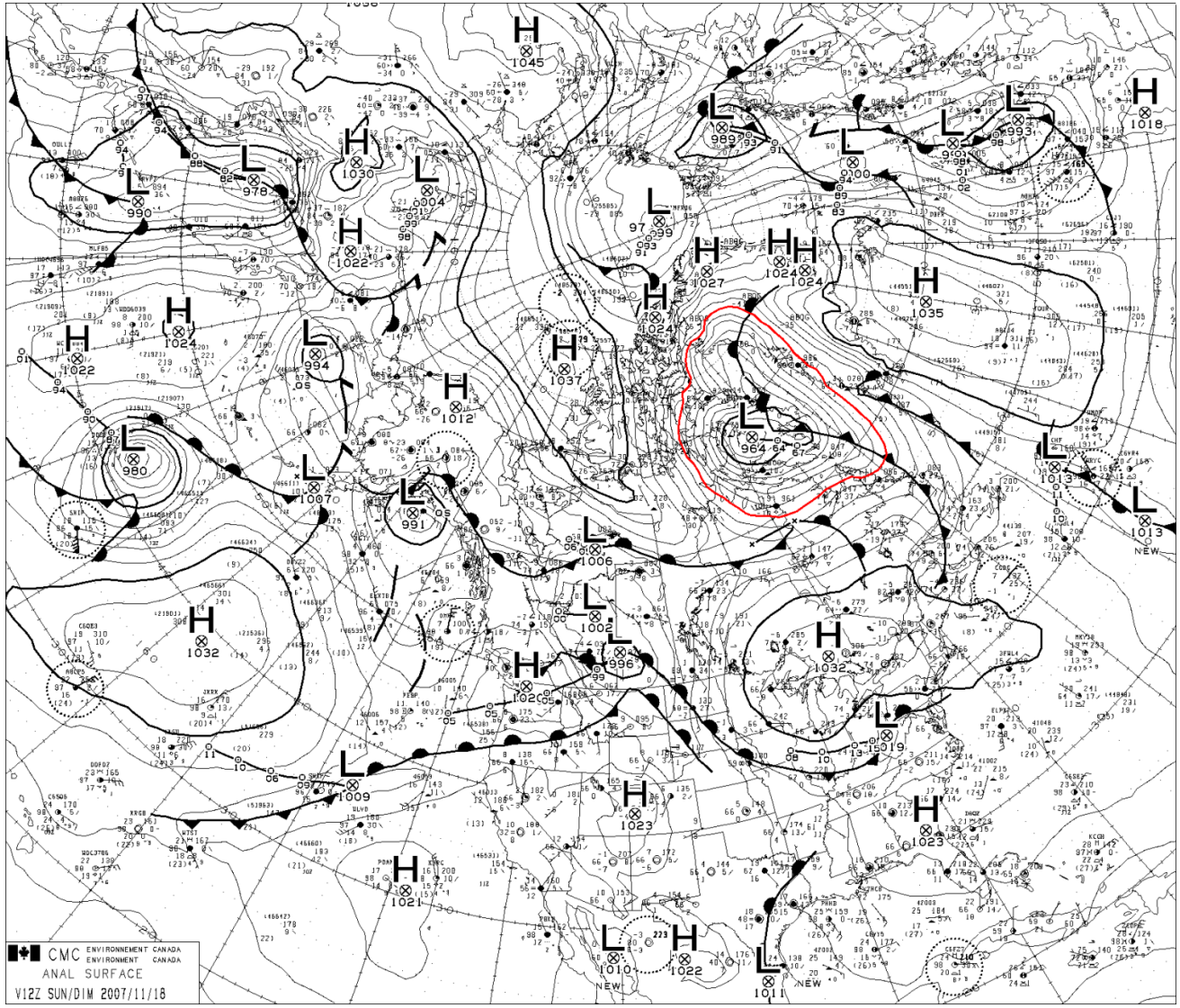


Minimum pressure was 963 mb, wind speed 54 km/h

Objective

- To examine the dissipating stage of a mid-latitude storm
  - The system had a very low pressure
  - Given climate change scenarios, this part of the world could see increased marine/air traffic
  - Also to fly along the CloudSat path

Perspective

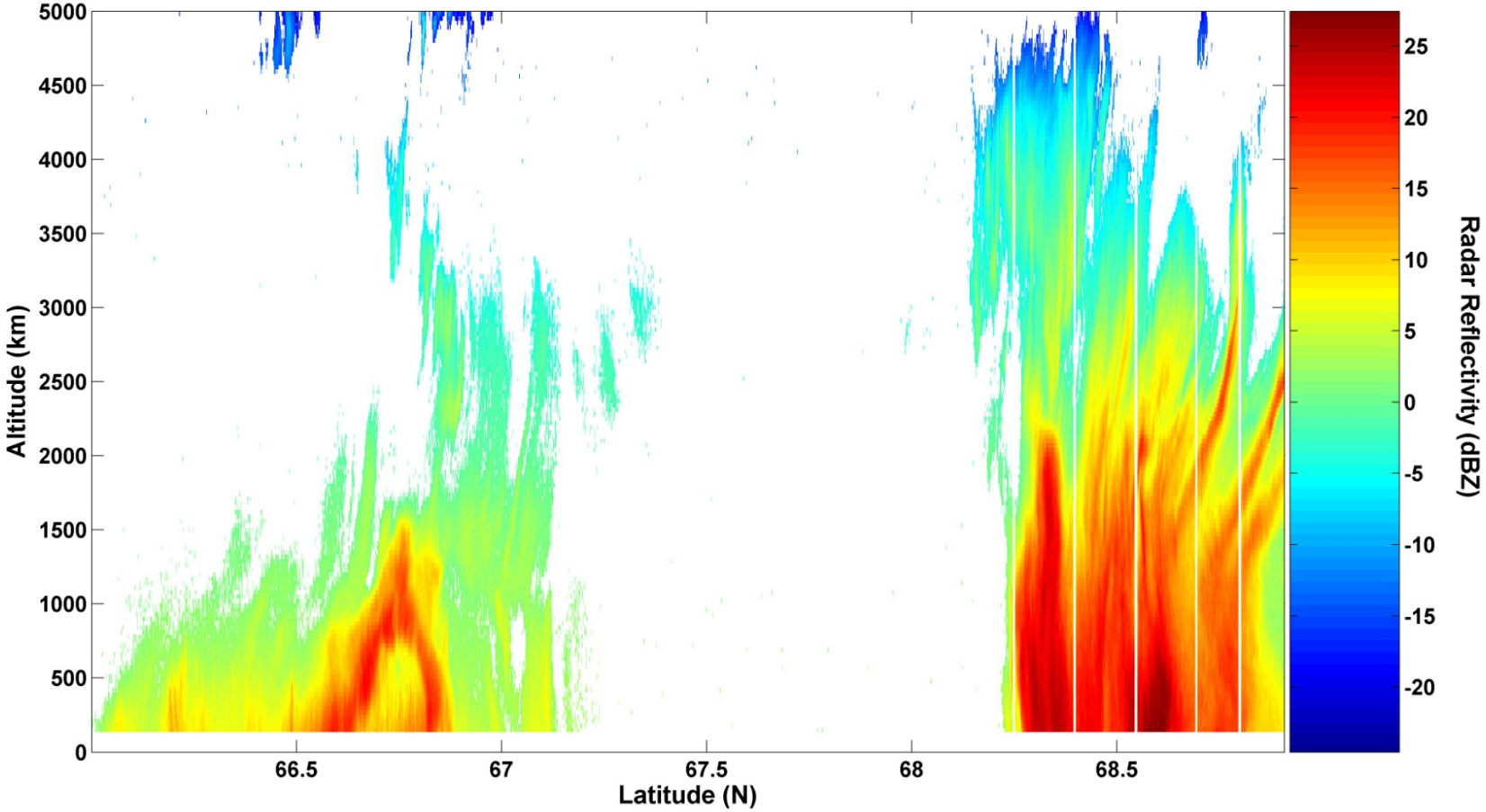


The storm was the lowest analyzed pressure system within the E.C. surface analysis.

Flight Plan

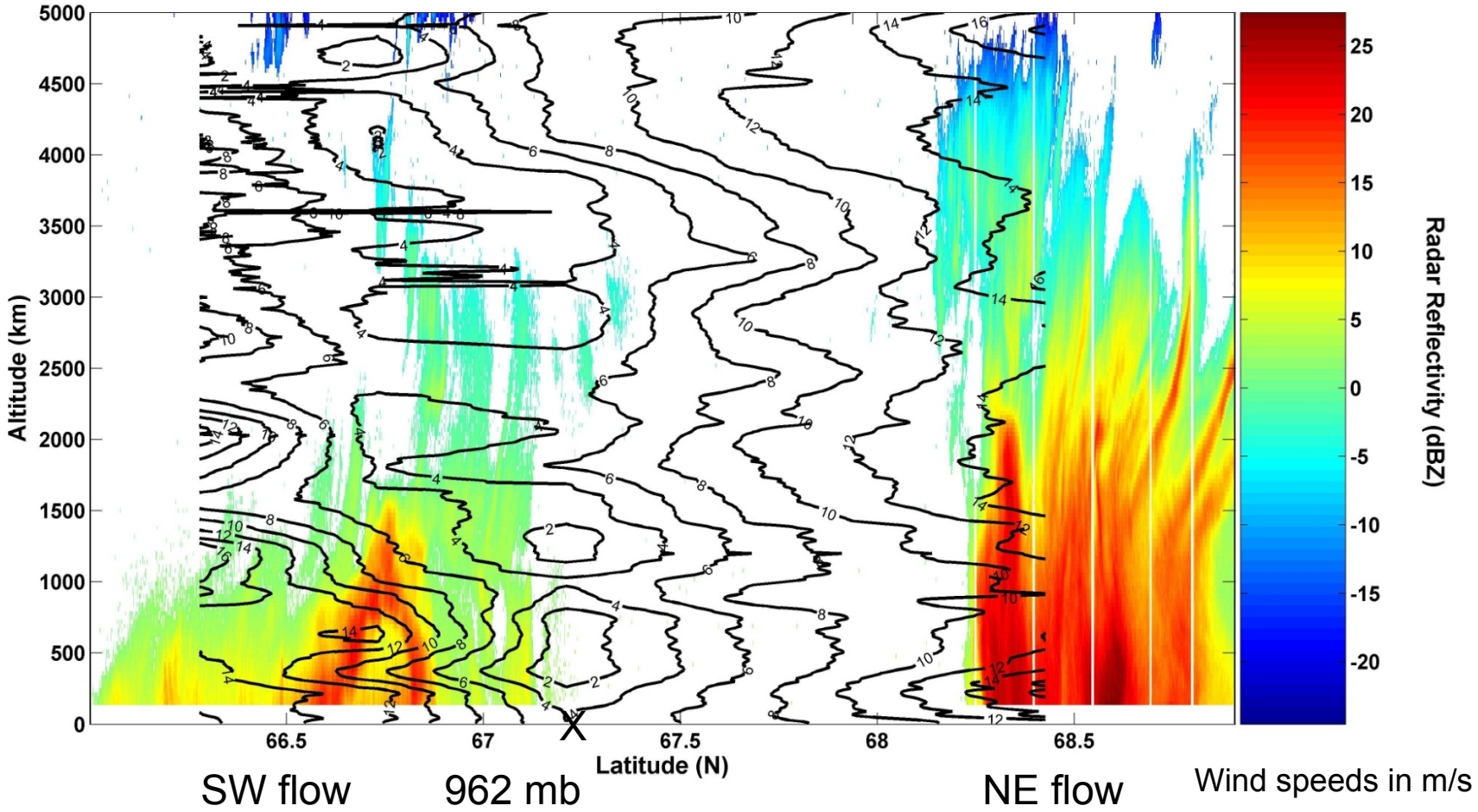
Fly out from Iqaluit, follow the CloudSat over-pass. North-bound path at 5.5 km altitude, south-bound path at 0.5-1 km

X-Band Reflectivity (northbound)



Two regions of reflectivity, a “stronger” northerly region with higher clouds compared to the south. System at least 200 km across

X-Band Reflectivity and Windspeed

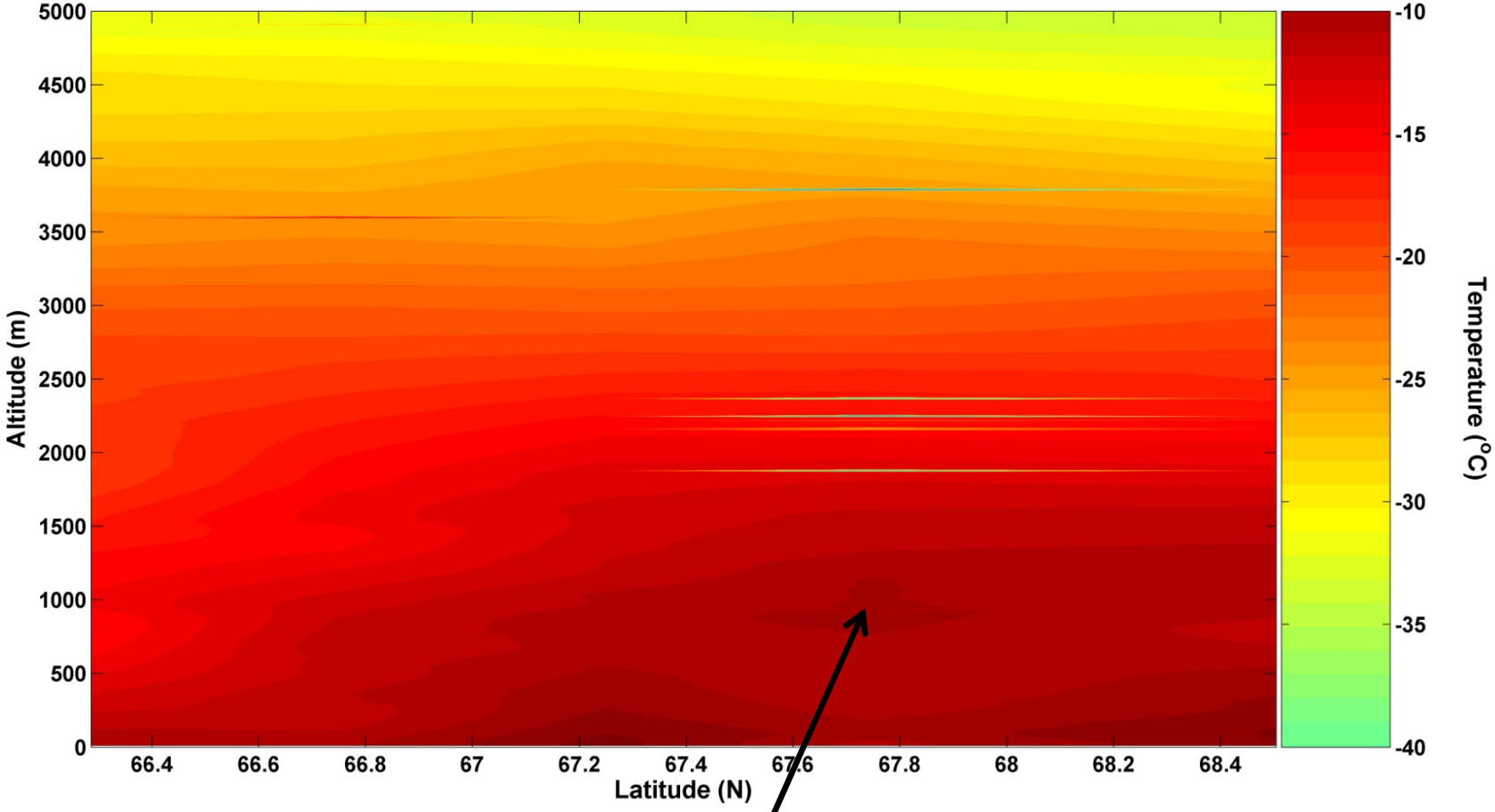


SW flow 962 mb NE flow

Wind speeds in m/s

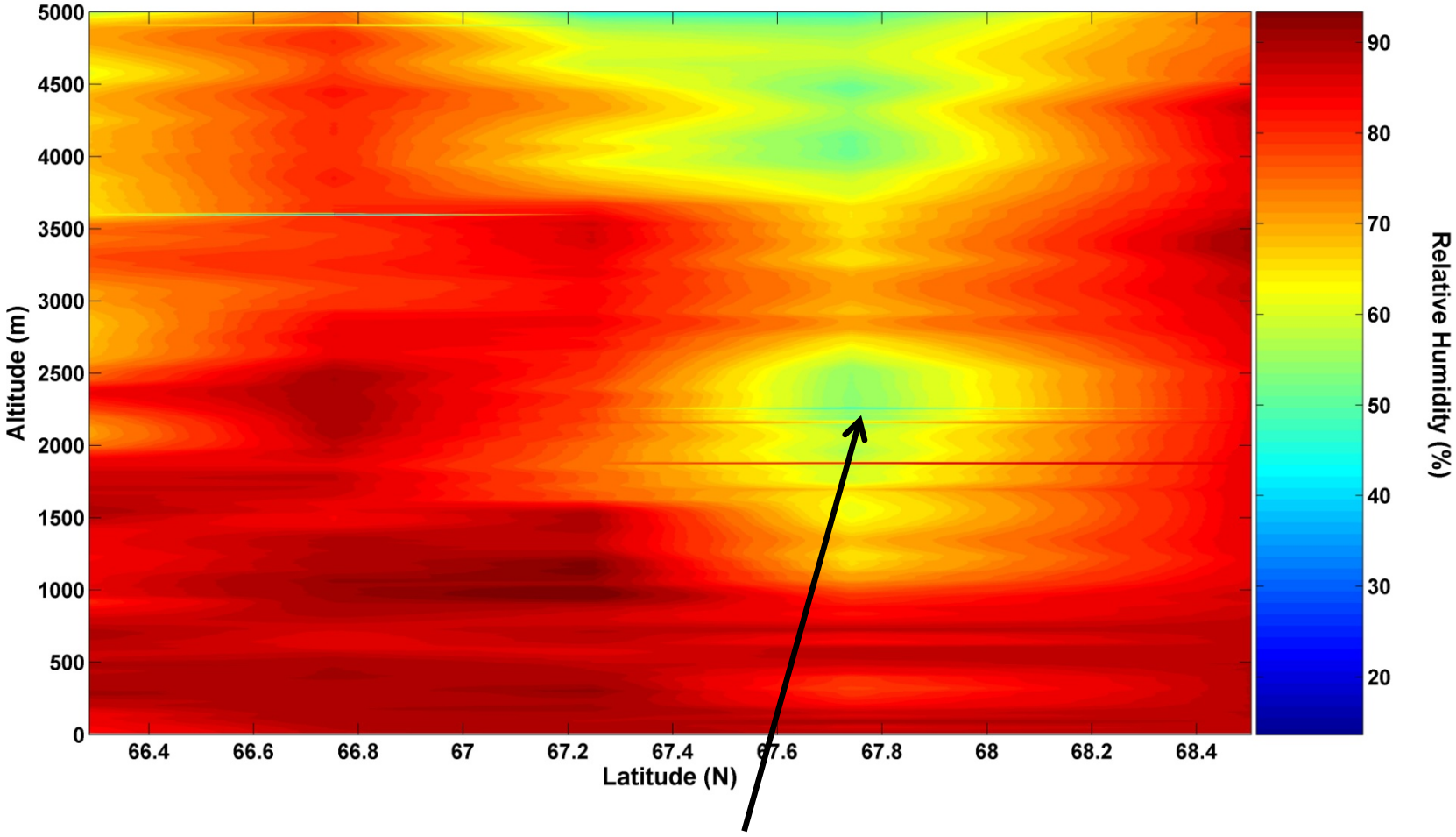
Low wind speed “center” with stronger winds extending out. Lowest pressure at the surface coincident with the lowest wind speed. Direction of the wind indicative of a cyclonic system.

Temperature



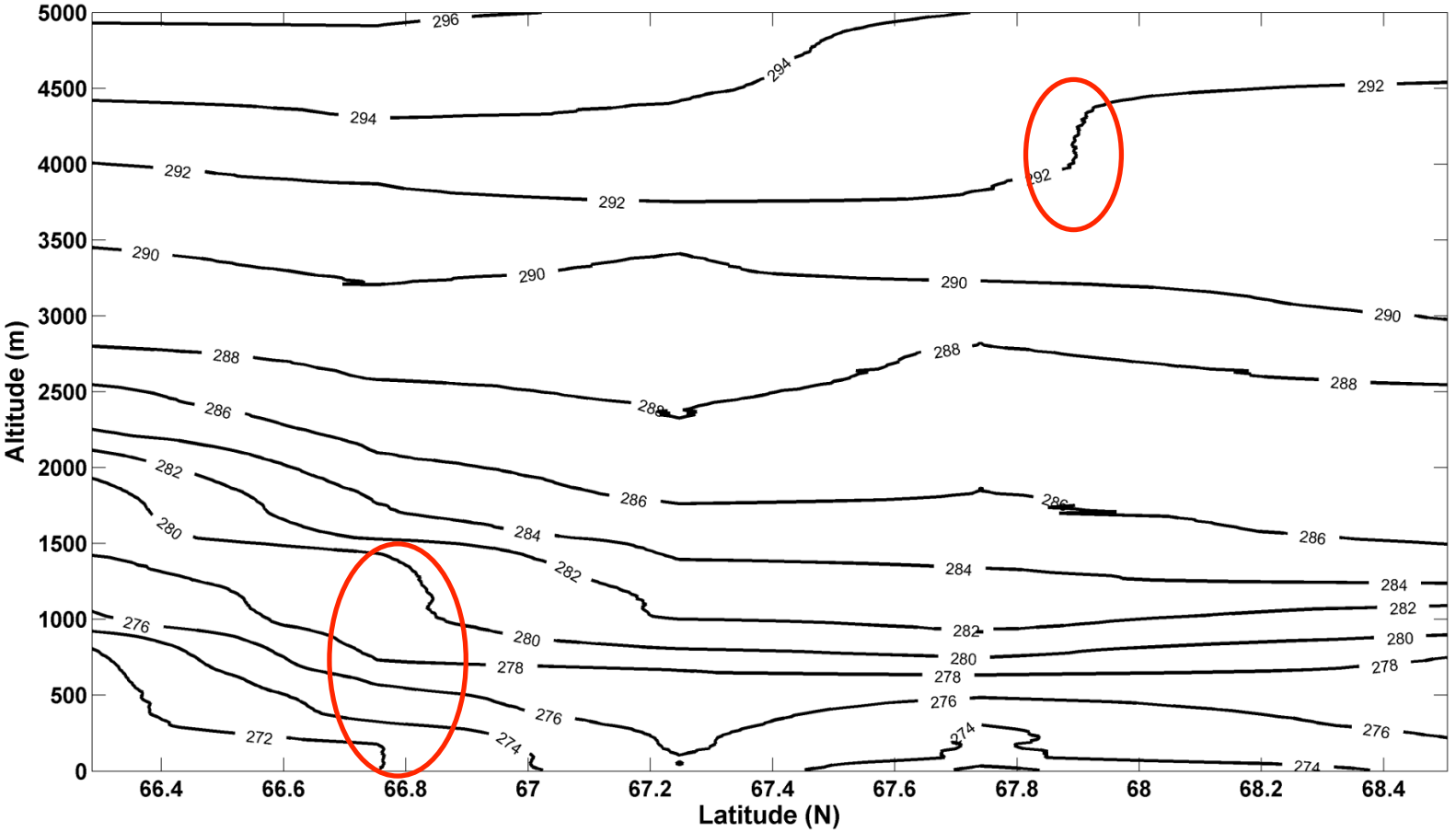
"Warm" temperatures in the central core of the storm, implies an area of stability

Relative Humidity



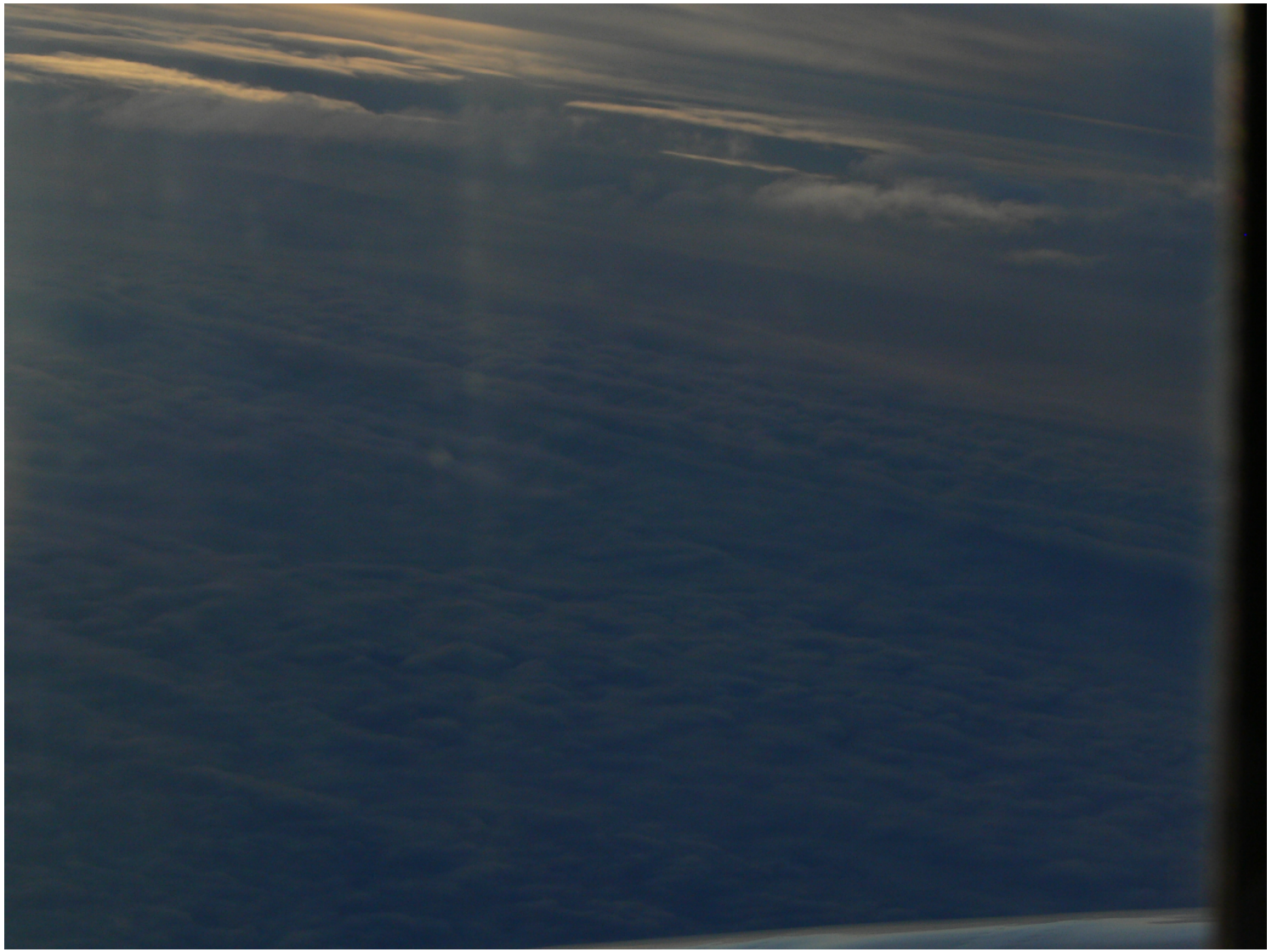
High reflectivities (clouds) in the north and south, but a dry core at upper levels (2 km)

Equivalent Potential Temperature



No real areas where E.P.T. decreases with height (i.e. not unstable), but some areas in the north and south where constant with height (i.e. neutral)

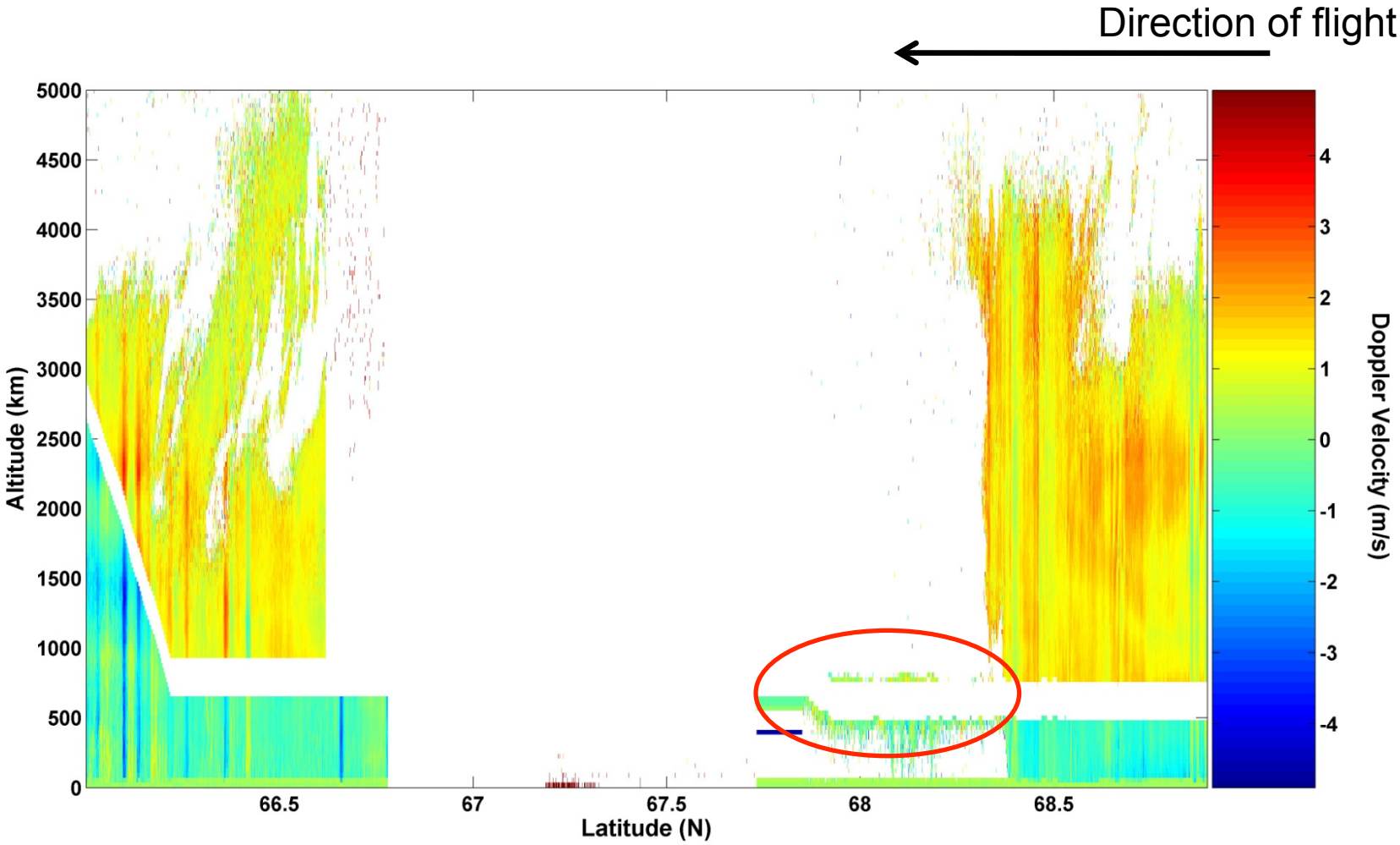
Looking out the window……



On the north-bound flight, the central (dry, warm) section of the storm had a flat(ish) cloud top

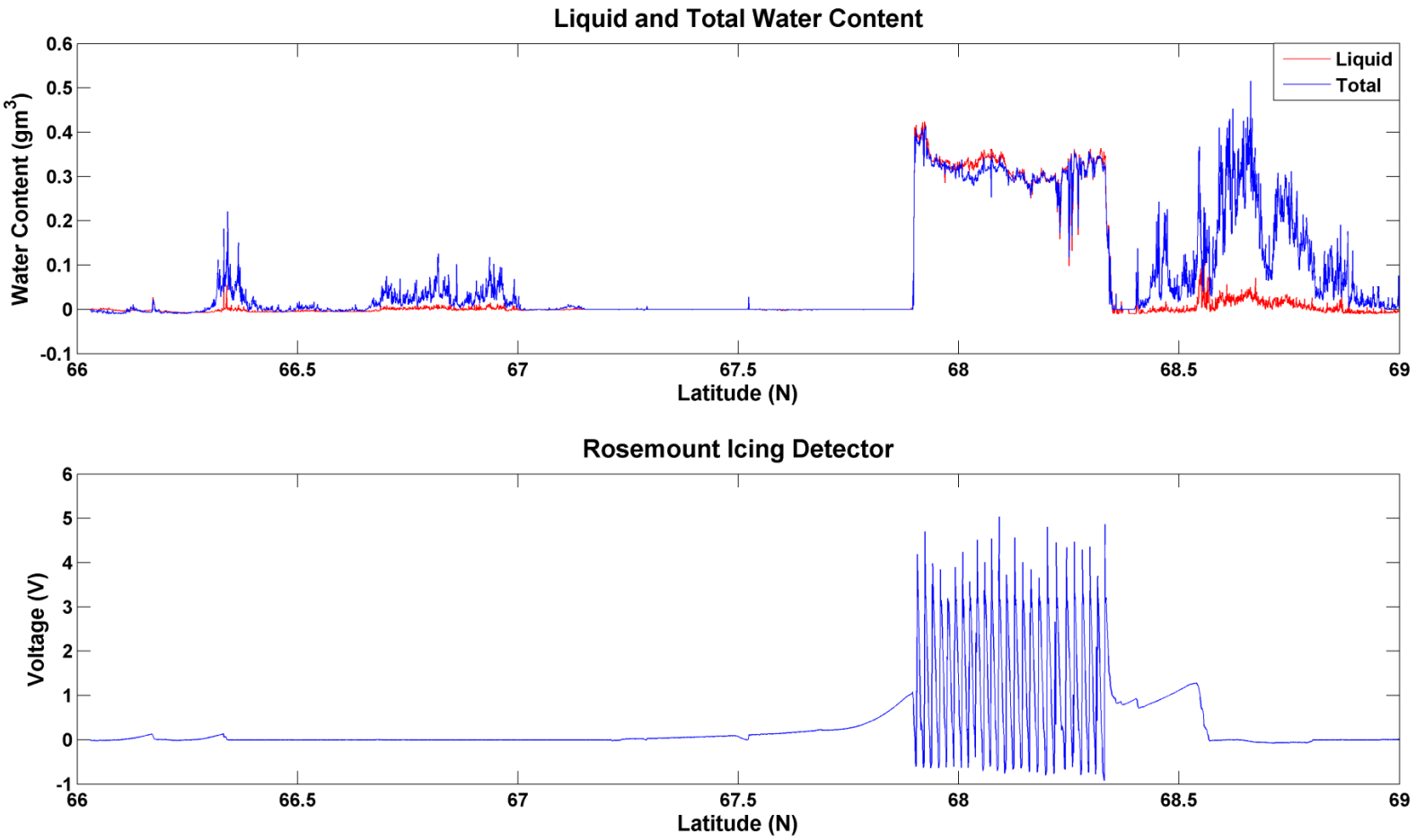
Time of photo was 1817 UTC

W-Band Doppler Velocity (southbound)

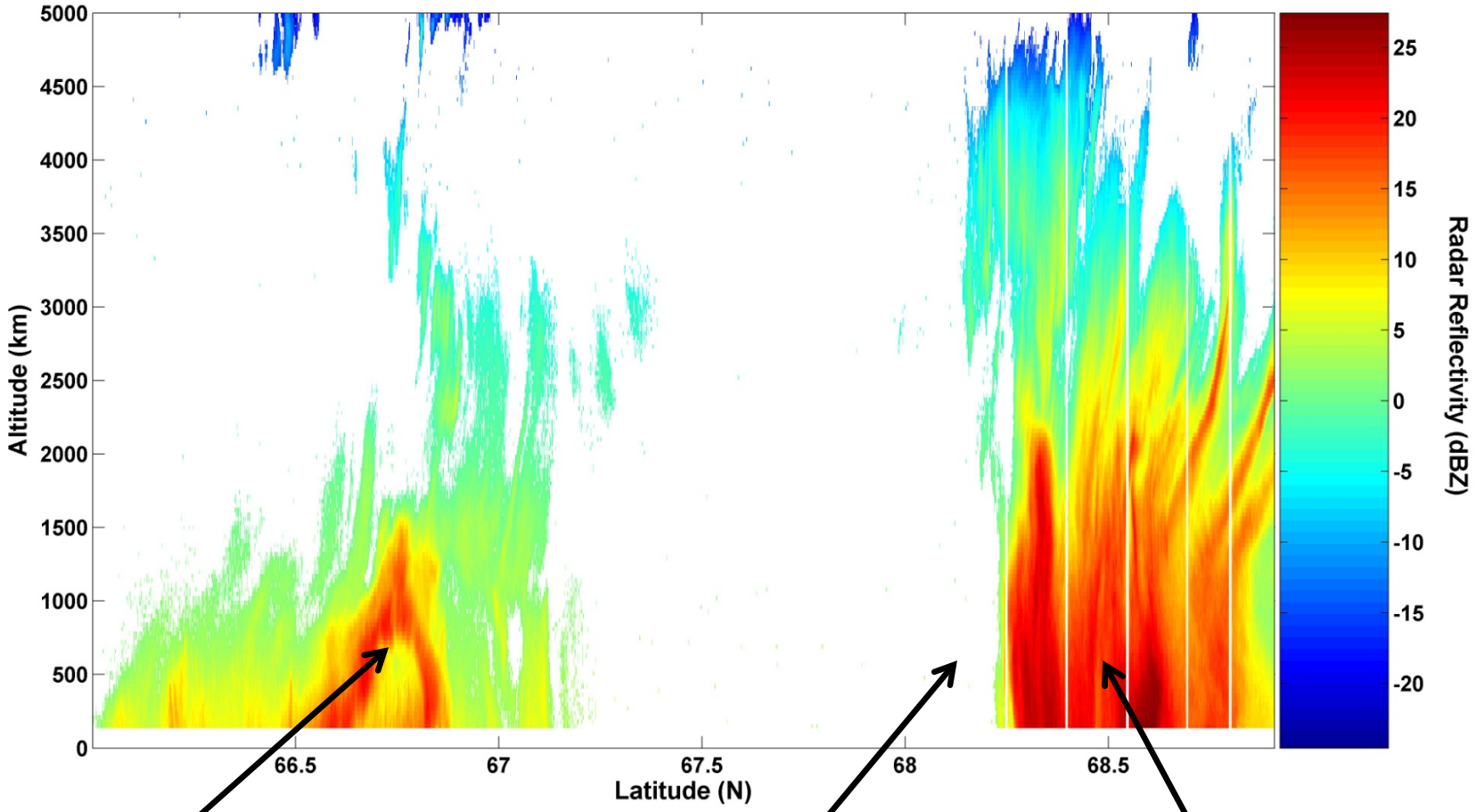


Doppler velocities indicate fall speeds approximately 1 m/s.
Some higher value regions. Also some cloud at 0.5 - 1 km.

PROBES



Mainly liquid water region and ice region to the north, ice region to the south. Higher values correspond to the higher reflectivities in the north.

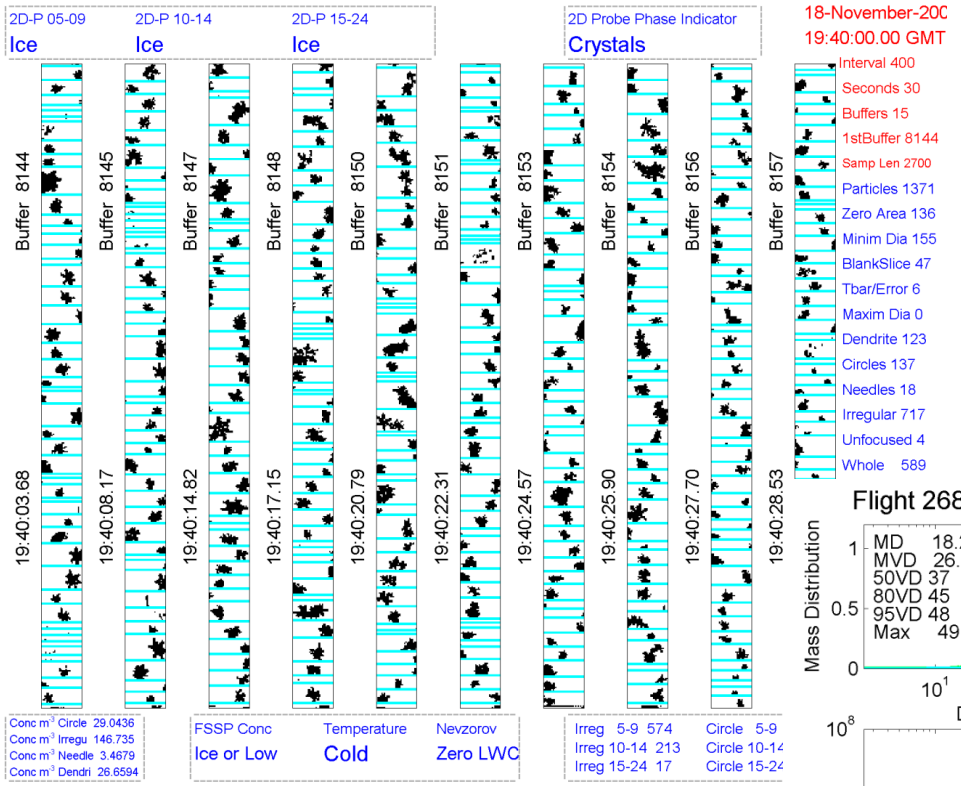


Mainly ice, over 0.2 gm^{-3}

Mainly ice, over 0.5 gm^{-3}

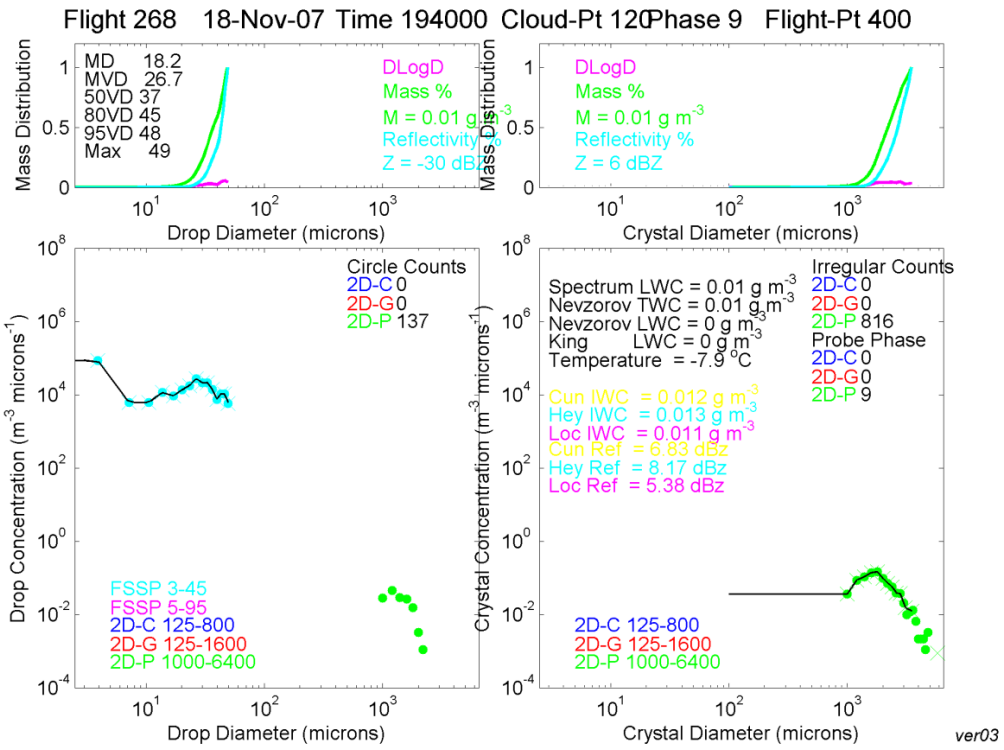
Mainly liquid, 0.3-0.4 gm^{-3}

Probes



Mainly dendrites, irregular or circles in the southern region

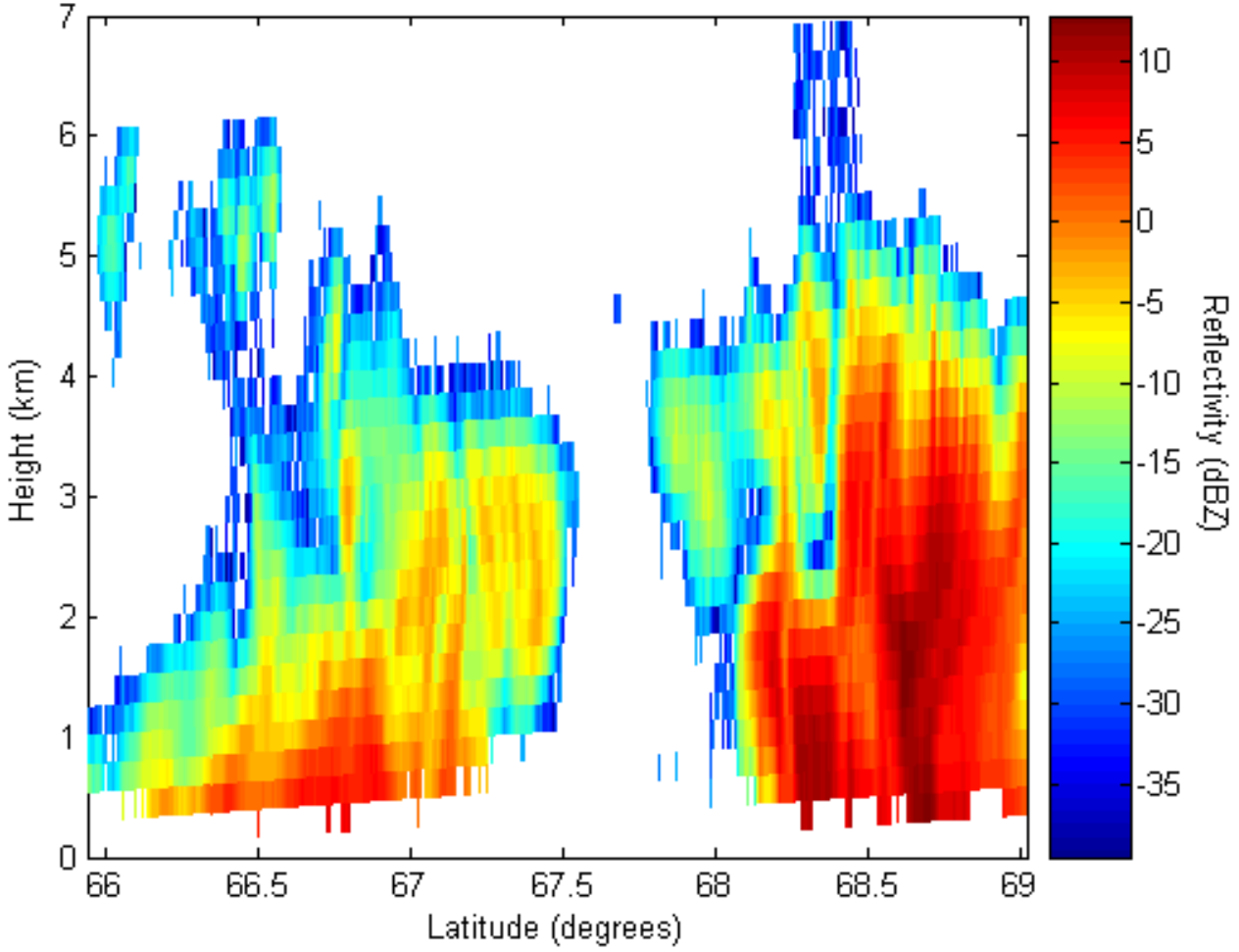
Ice crystals as large as 4-5 mm



When we landed

Icing was evident on the plane when we landed.

CloudSat



While CloudSat operates using a different radar band (W), there were many similarities in the reflectivity pattern.

Also, CloudSat pass was at ~1720 UTC and Convair was at ~1800 UTC

Summary

- The event was an extremely low pressure system (962 Over Foxe Basin, 963 mb at Iqaluit)
- It had a “warm” and “dry” center
- “Relatively benign” wind speeds
- Was not symmetric
- Mainly liquid (north) or ice sections (north and south) of the system
- Higher water contents in the north compared to the south

Summary cont.

- Ice crystal as large as 4-5 mm in the southern region
- CloudSat and the Convair reflectivities exhibited many similarities