

Satellite Observations of Polar Precipitation Using Aqua

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Outline

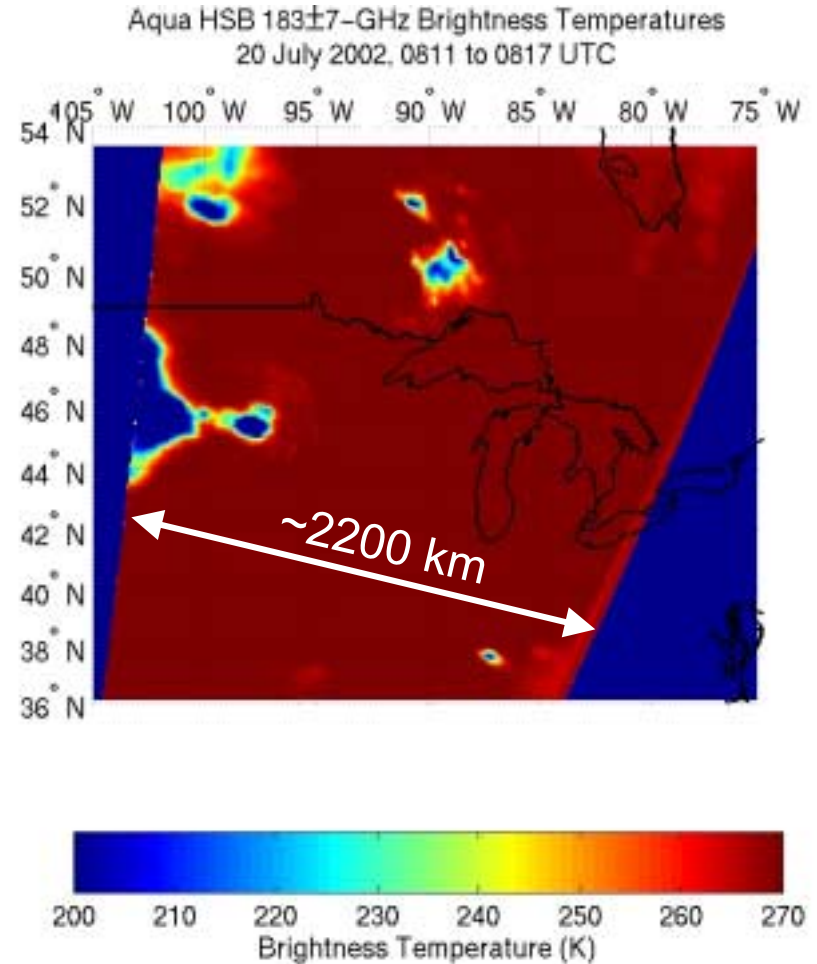
- Description of Aqua AMSU/HSB
- Physical basis of passive microwave precipitation sensing
- Examples of polar precipitation
- Summary

The Aqua Satellite

- Purpose: Collecting information about the earth's water cycle
- Polar orbiting
- 98.8-minute orbital period
- Instruments
 - Atmospheric Infrared Sounder (AIRS)
 - **Advanced Microwave Sounding Unit (AMSU)**
 - **Humidity Sounder for Brazil (HSB)**
 - Advanced Microwave Scanning Radiometer for the Earth Observing Satellite (EOS) (AMSR-E)
 - Clouds and the Earth's Radiant Energy System (CERES)
 - Moderate-Resolution Imaging Spectroradiometer (MODIS)
- Launched May 4, 2002

Aqua AMSU/HSB

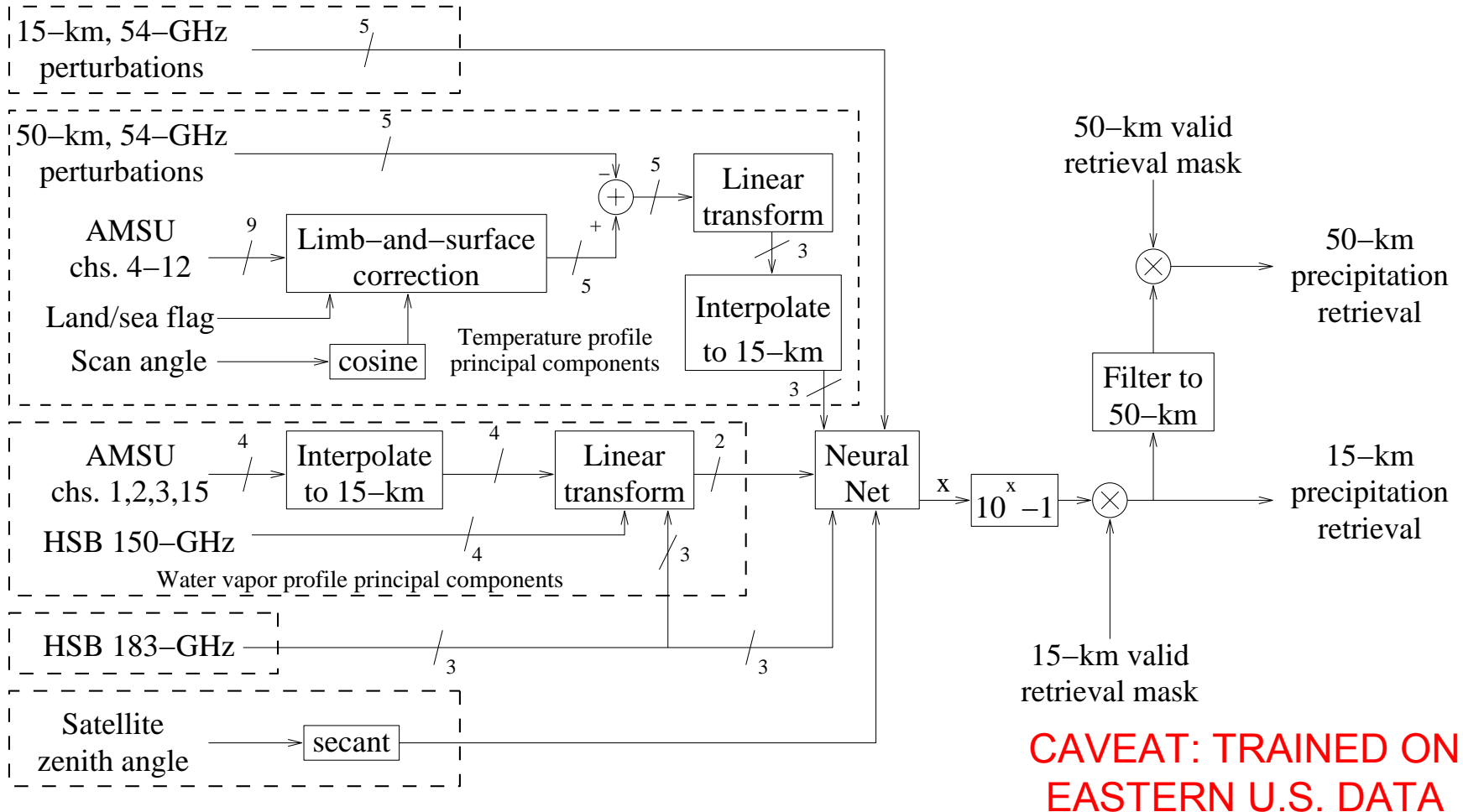
- AMSU
 - Window channels at 23.8, 31.4, and 89 GHz
 - 12 channels in 54-GHz O₂ band
 - ~50-km resolution
- HSB
 - Window channels at 150 GHz
 - 3 channels in 183-GHz H₂O band
 - ~15-km resolution
- Aqua AMSU/HSB channels also aboard AMSU-A/AMSU-B of NOAA-15, 16, and 17



Physical Basis of Passive Microwave Precipitation Sensing

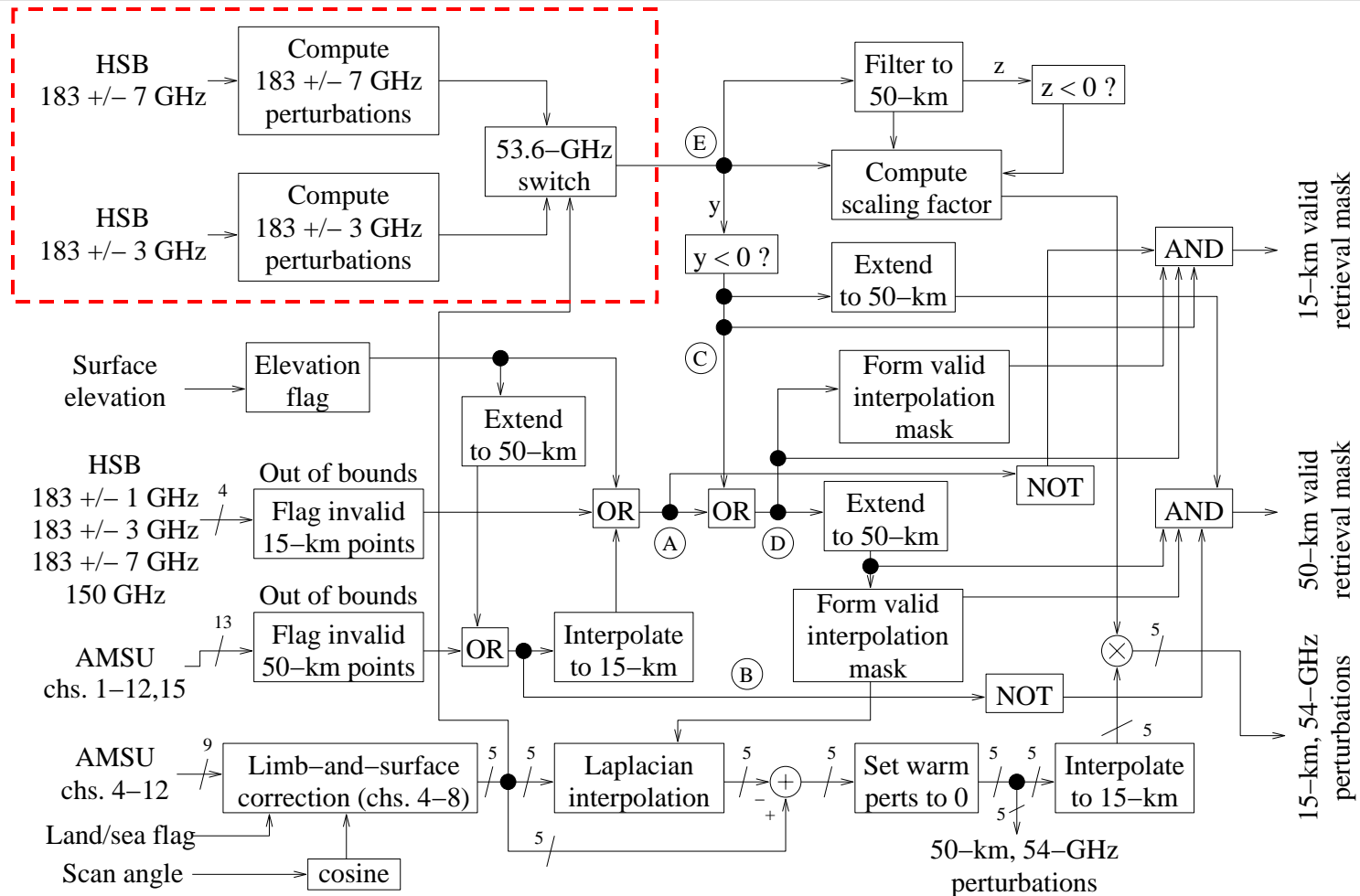
- **Precipitation rate** $\sim \infty$ **humidity** \times **vertical wind velocity**
- Vertical wind velocity
 - Stronger vertical wind \rightarrow $\left\{ \begin{array}{l} \text{Greater hydrometeor size} \\ \text{Greater hydrometeor abundance} \\ \text{Higher cloud-top altitude} \end{array} \right.$
 - Relative albedos (54 vs. 183-GHz) reveal **hydrometeor size**
 - Absolute albedos reveal **hydrometeor abundance**
 - Perturbations (cold spots) in 54-GHz data reveal **cloud-top altitude**
- Absolute humidity
 - 54-GHz band reveal temperature profile
 - 54-GHz and 183-GHz bands reveal water vapor profile

Precipitation-Rate Estimation



Source: F.W. Chen and D.H. Staelin, IEEE Trans. Geosci. & Remote Sensing, Feb. 2003

Precipitation Detection

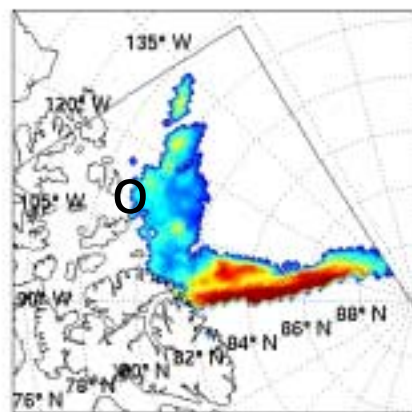


Source: F.W. Chen and D.H. Staelin, IEEE Trans. Geosci. & Remote Sensing, Feb. 2003

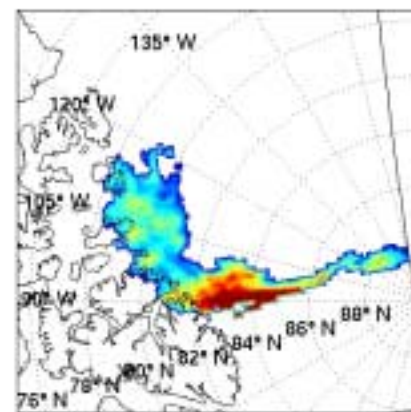
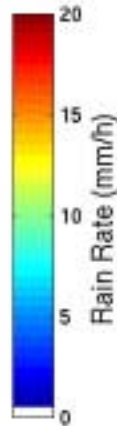
Signs of Polar Precipitation

- Morphological evolution over consecutive overpasses
- Motion over consecutive overpasses
- Cold spots in bands near 54 GHz and 183 GHz
- Very weak correlation with surface-sensitive channels
- Sharp features

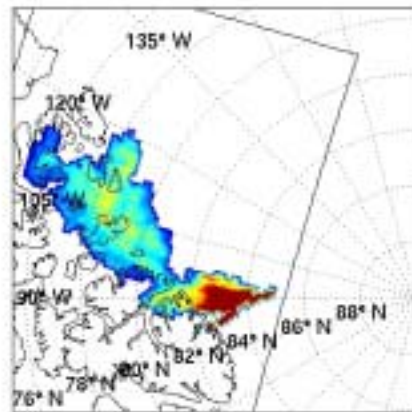
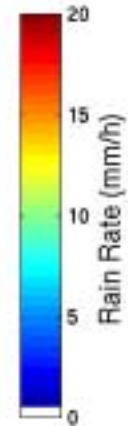
Polar Precipitation, 20 July 2002



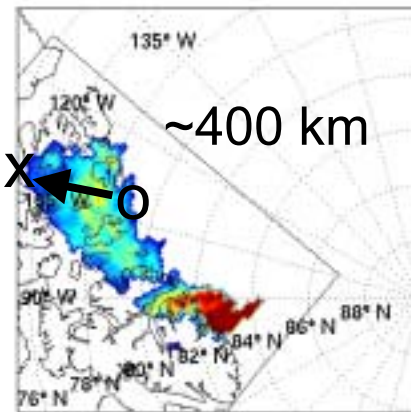
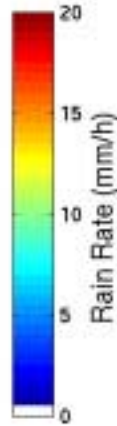
(a) 1122 UTC



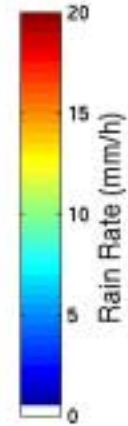
(b) 1300 UTC



(c) 1438 UTC



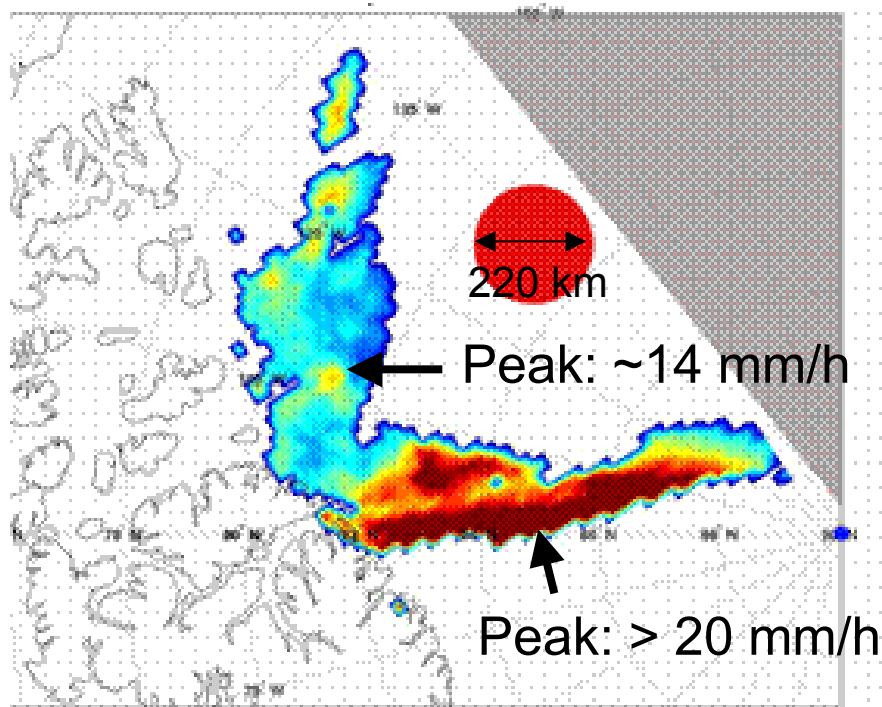
(d) 1615 UTC



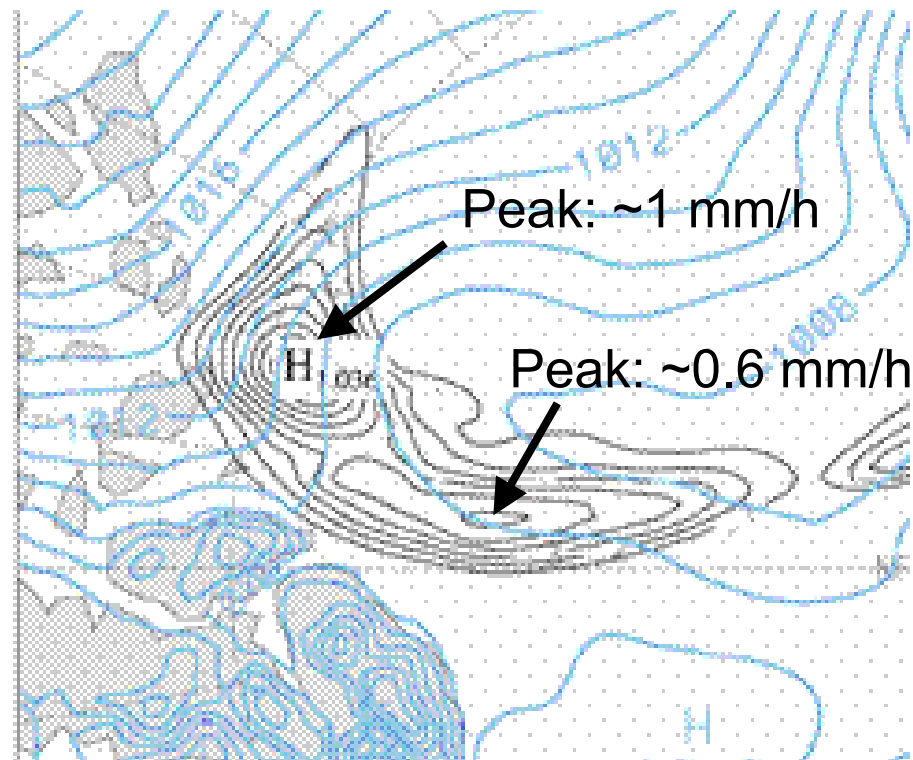
Aqua AMSU/HSB Retrieval vs. MM5 Prediction

20 July 2002

Aqua AMSU/HSB Retrieval

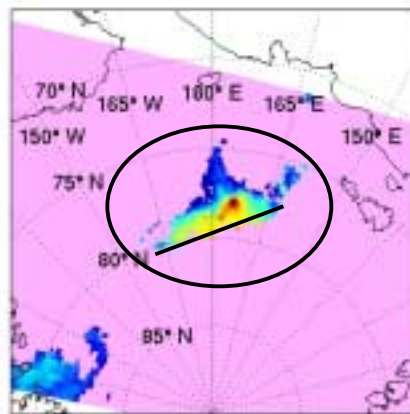


MM5 Prediction

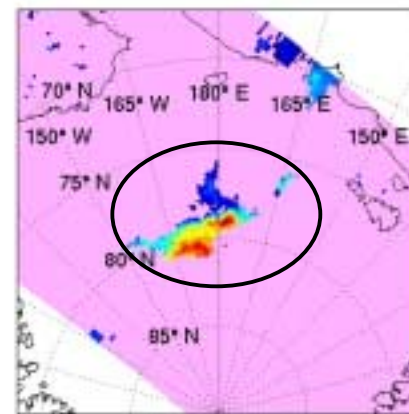


Produced by L. Bai and D.H. Bromwich

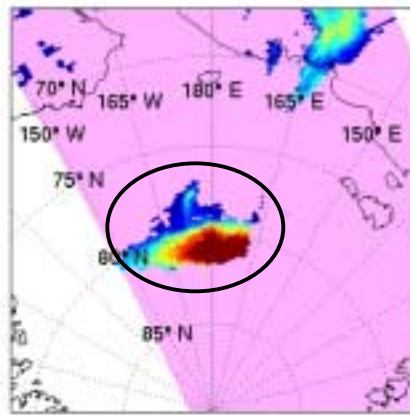
Polar Precipitation, 17 July 2002



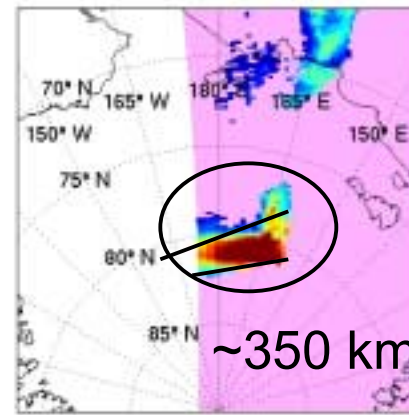
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(b) 2233 UTC

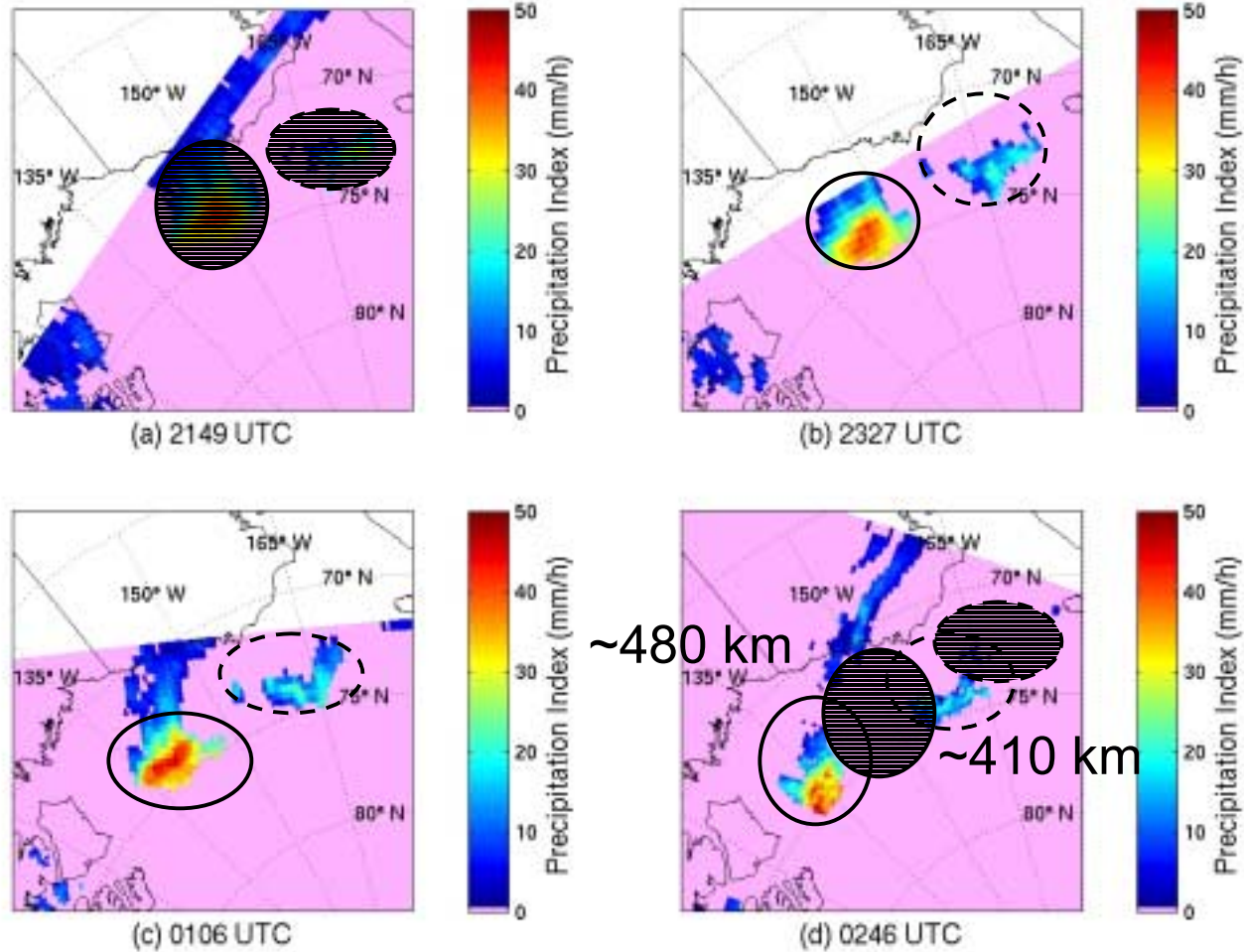


(c) 0015 UTC

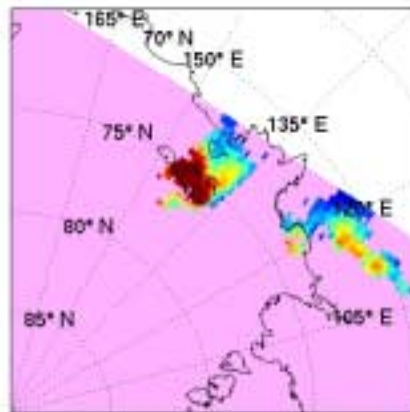


(d) 0157 UTC

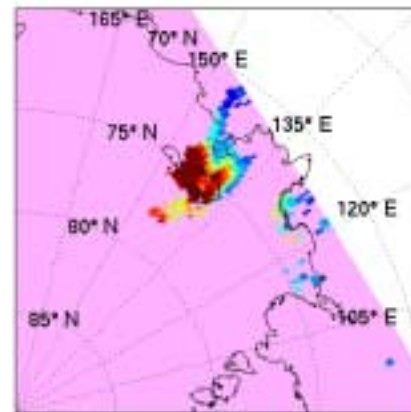
Polar Precipitation, 4 July 2000



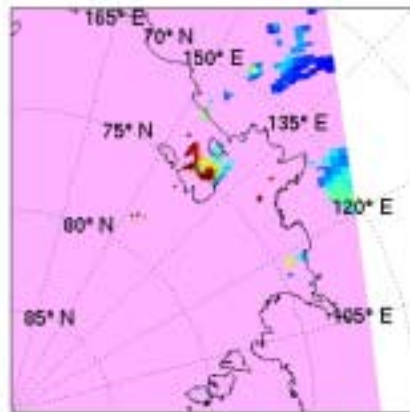
Polar Precipitation, 15 June 2000



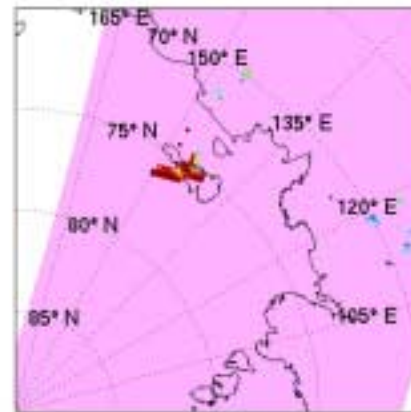
(a) 0339 UTC



(b) 0519 UTC



(c) 0658 UTC



(d) 0839 UTC

Summary

- Aqua AMSU/HSB is capable of sensing precipitation within the Arctic Circle
- Morphological agreement with independent model (MM5)
- Aqua AMSU/HSB precipitation algorithm still needs to be tuned for polar climates