Snowfall Retrieval from Space

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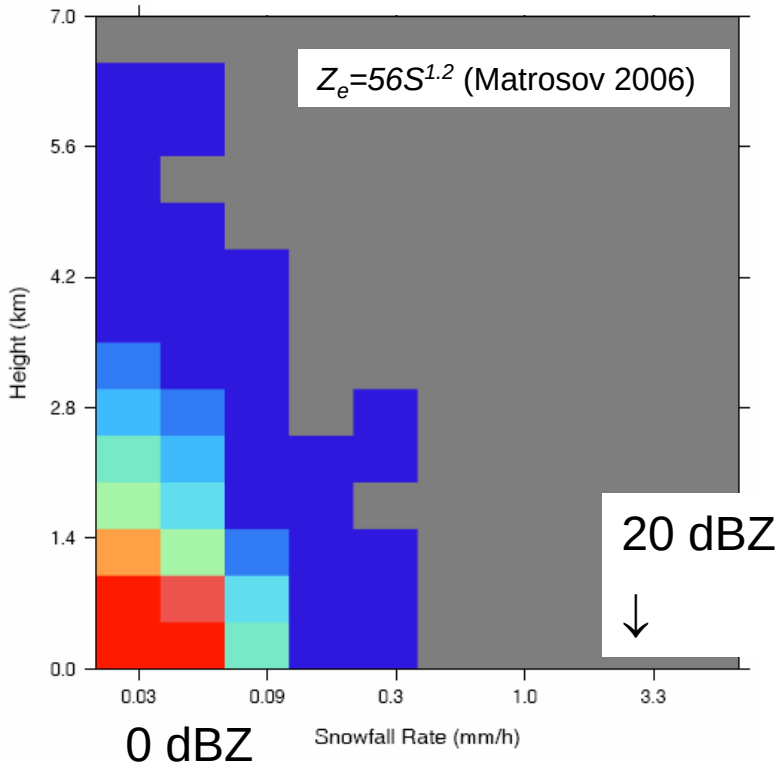
- Mid-latitudes vs. Polar regions
- Radars vs. Radiometers

The difference between mid-latitudes and polar regions

- surface & airborne radar obs

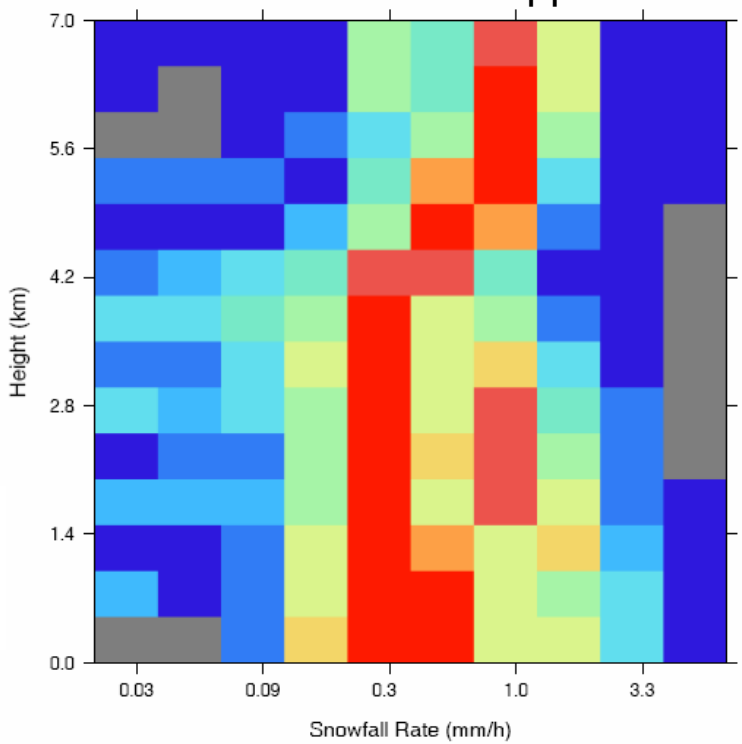
Barrow– Alaska (71°N)
2002 -2005 winters

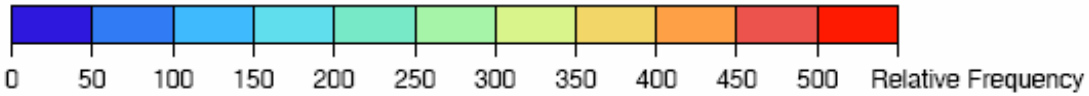
MMCR



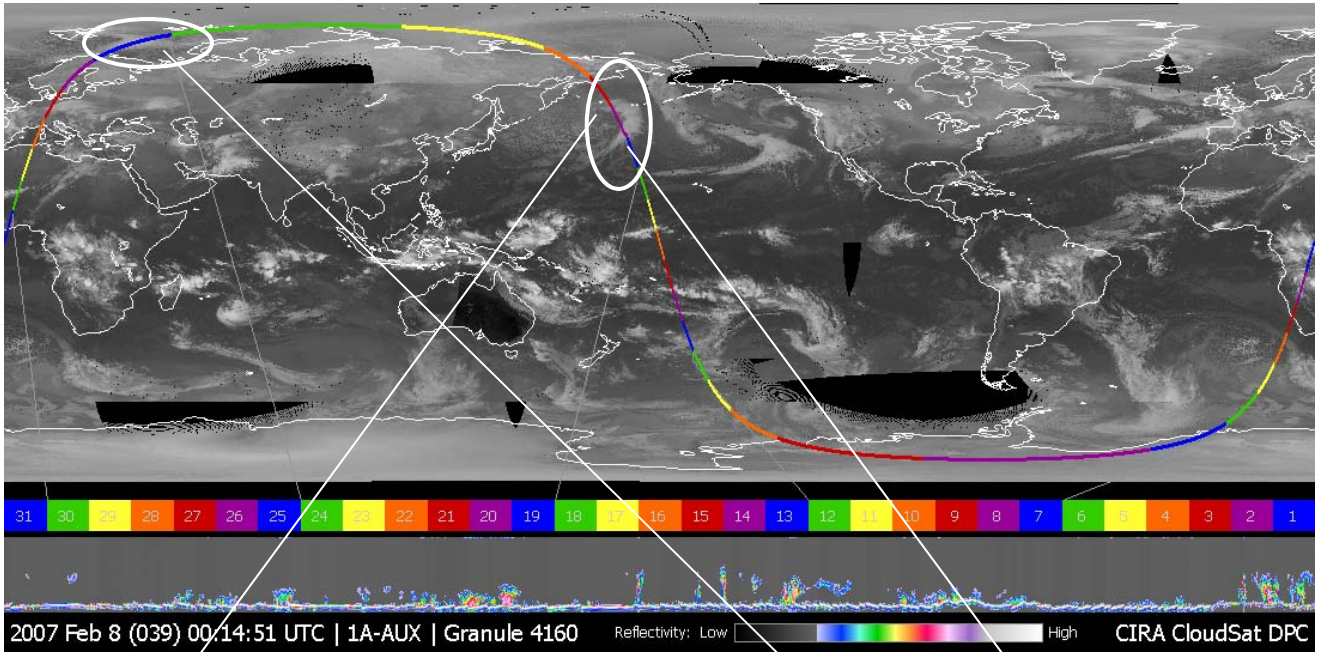
Wakasa Bay – Japan (~35°N)
2001&2003 January

APR-2 & Obama Doppler

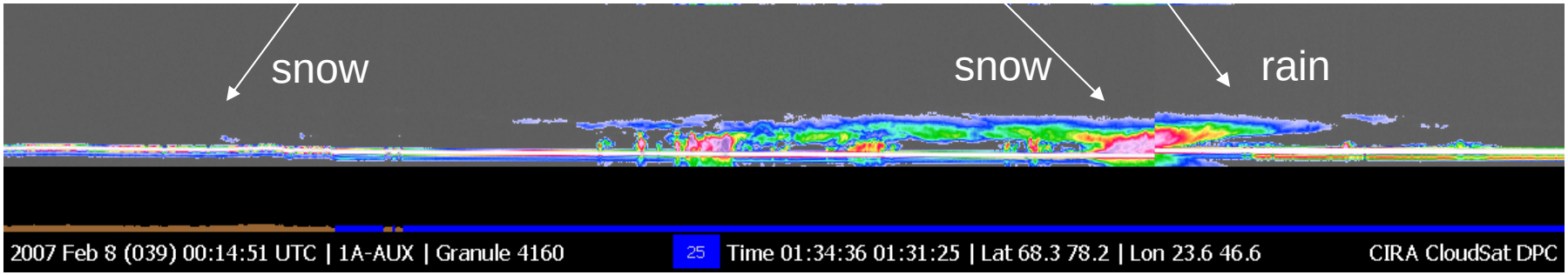




Snowfall examples from CloudSat



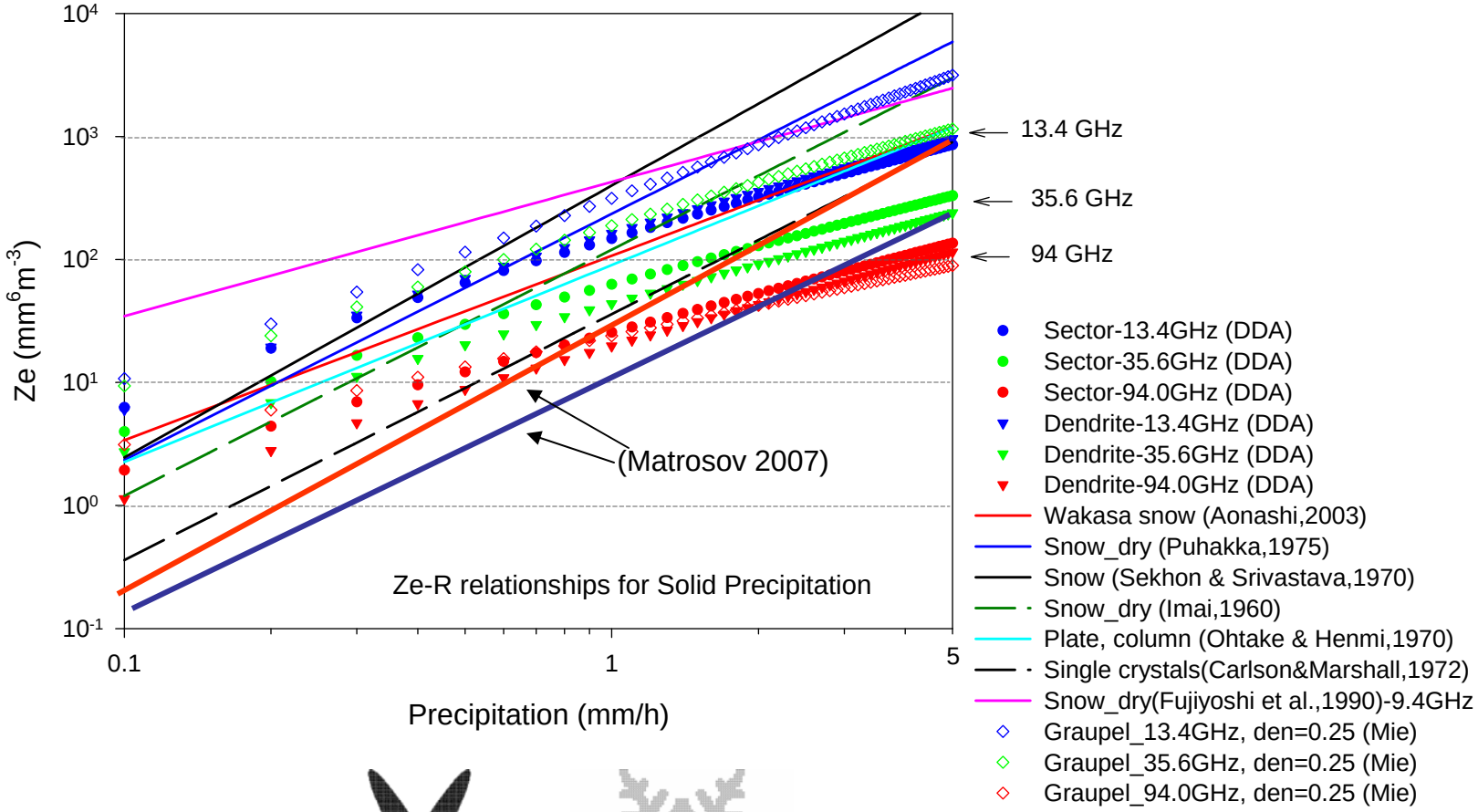
02/08/2007

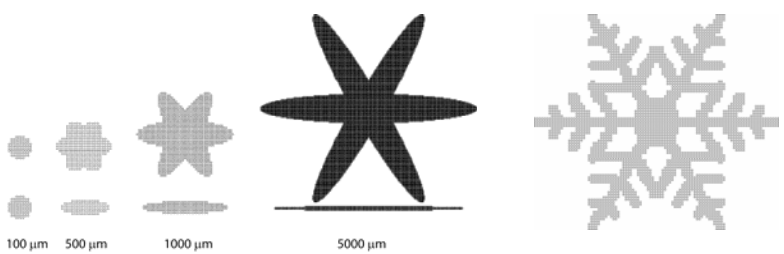


Z-R relations for snowfall

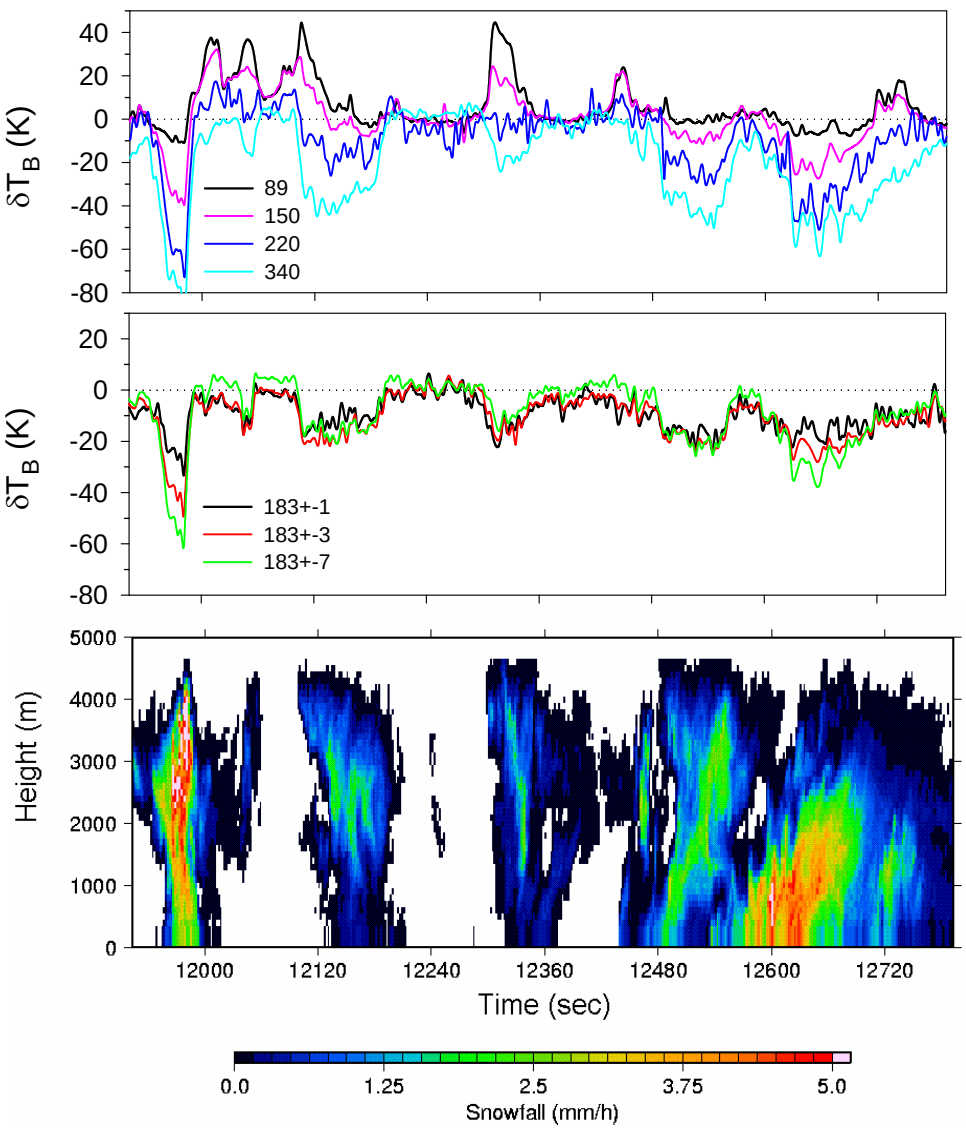
Depends on:

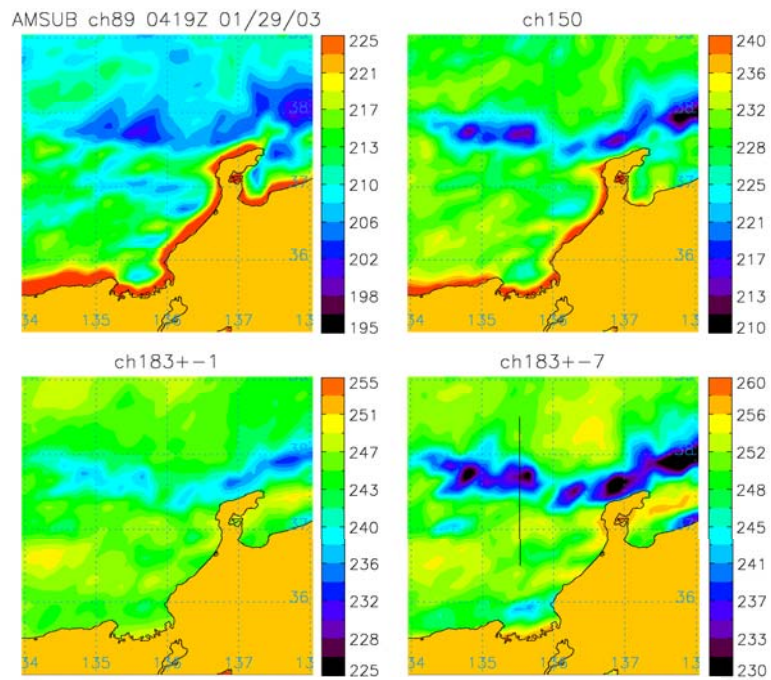
Size Distribution + particle shape

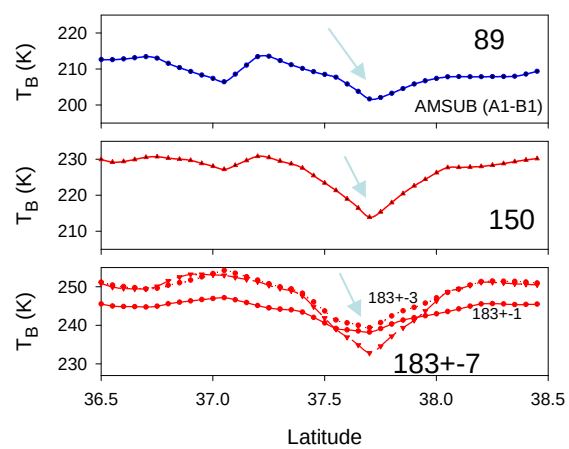




High frequency measurement of snowfall

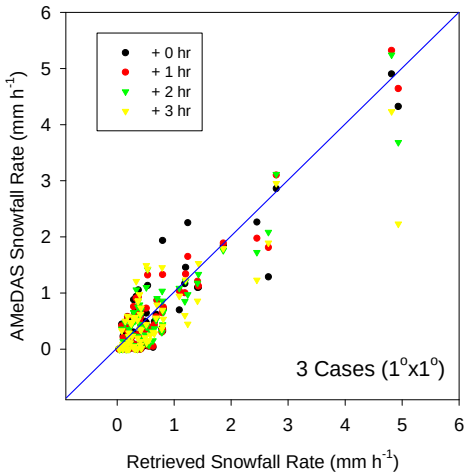






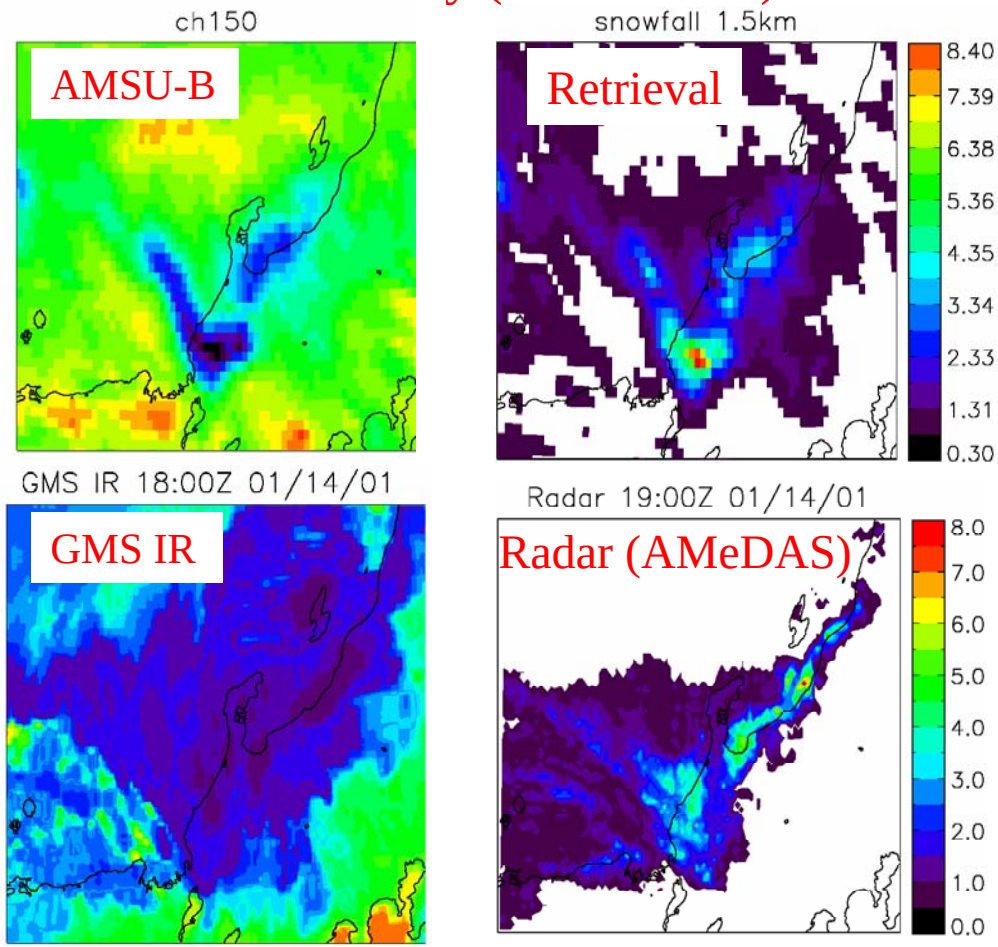
Snowfall Retrieval From High –Frequency Microwave Satellite Observations

- Use surface and airborne radar snowfall observations as the basis to build the a-priori database
- Radiative transfer model utilizes nonspherical snowflakes scattering calculations



Compare AMSU-B Retrieval with AMeDAS radar (3 cases, correlation coefficient: 0.79)

A Case Study (Jan 14 2001)

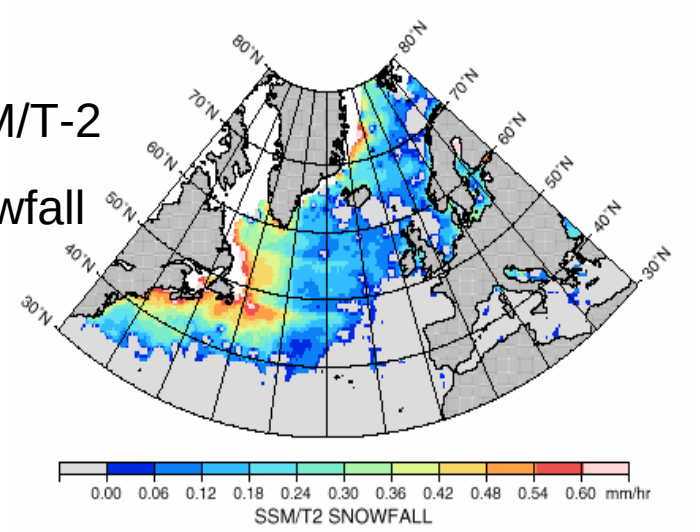


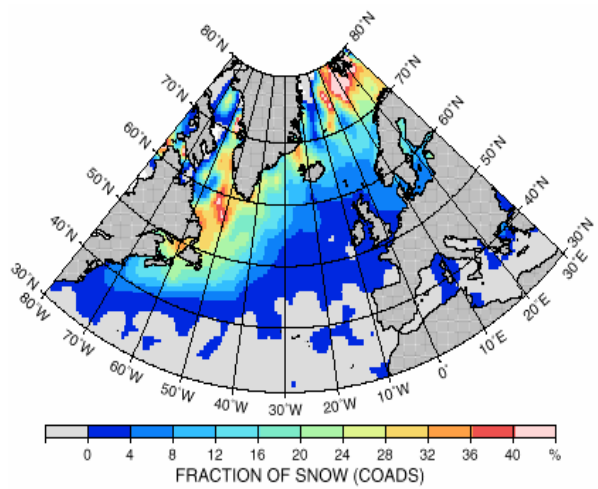
Noh, Liu, et al. (2006)

Below 60°N

Winter Snowfall Distribution

SSM/T-2 snowfall

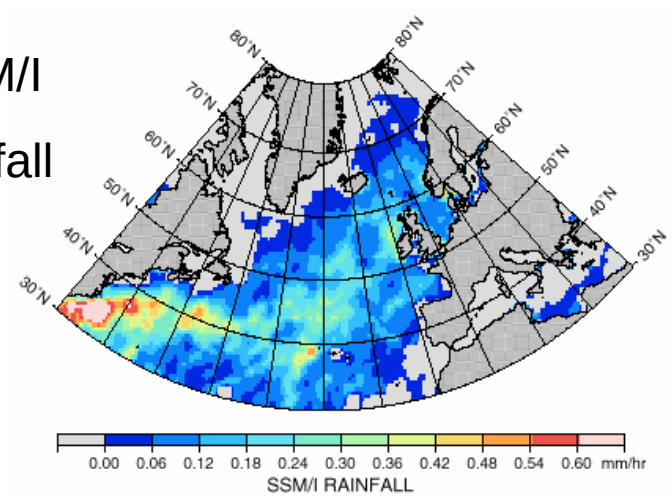


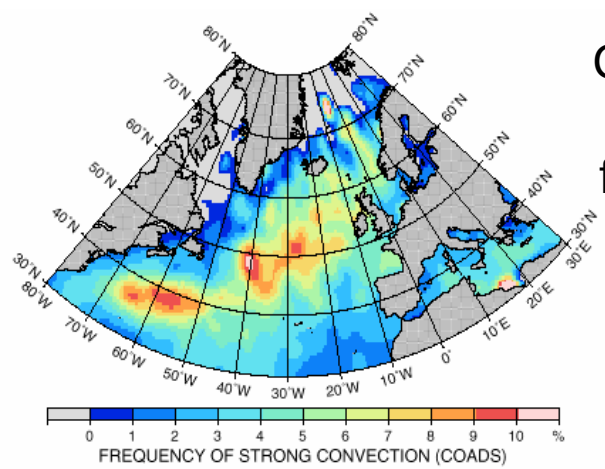


COADS snow fraction

Winter Rainfall Distribution

SSM/I rainfall

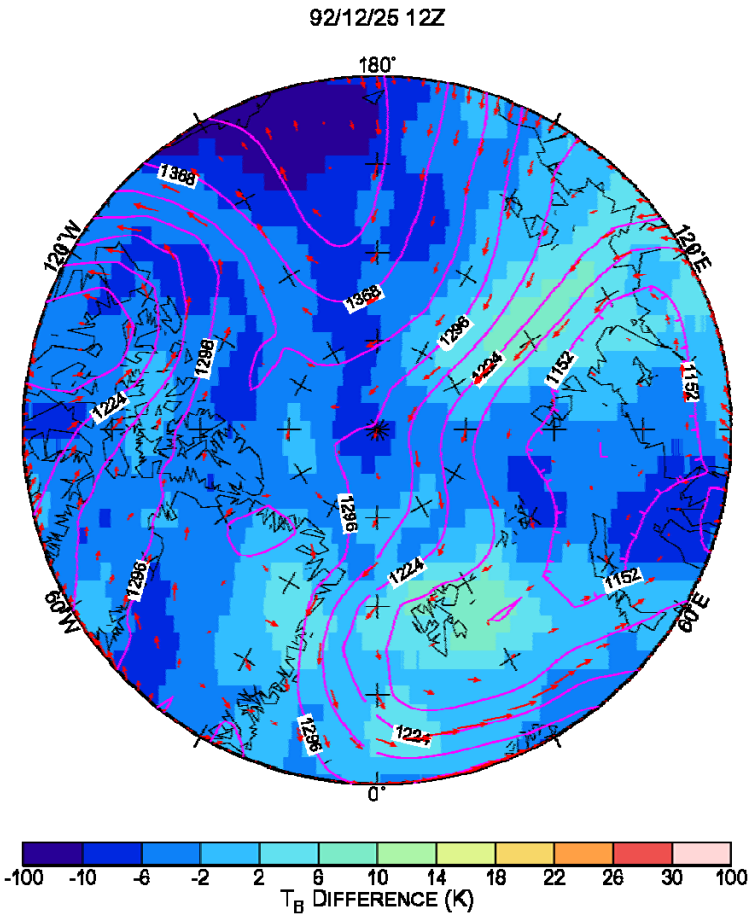


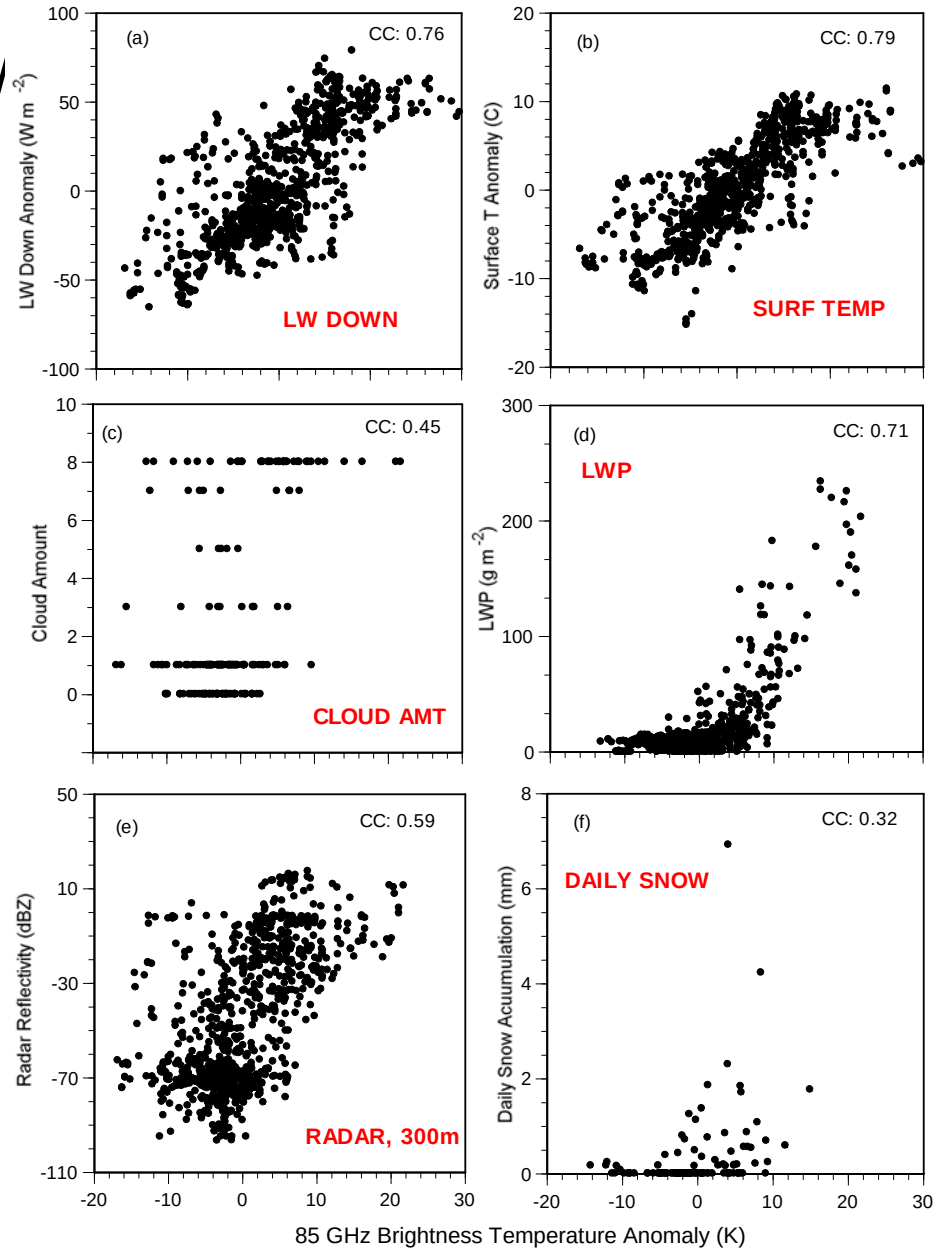


COADS rain fraction

Liu & Curry (1996)

SSM/I 85GHz ΔT_B 92/12/





Liu & Curry (2003)

Detecting Snowfall From Space
- what we knew and what we do not know

- From space radar (CloudSat, future new radars)
  - Pros: physically direct, only need Z to R conversion
  - Cons: CloudSat - spatial coverage, only a 1.4 km wide strip per orbit
  - **Future radar ? (GPM radars can go up to ~67 degree latitudes), how about polar regions ?**
  - **Need minimum detectable dBZ value -10 dBZ or smaller**

- From High-Frequency Microwave Radiometers (AMSU-B, SSMIS, GMI)
  - Pros: More spatial and temporal coverage (4~6 satellites)
  - Cons: 1. weaker signature, 2. physically less direct, 3. surface contamination
  - **Below ~60N degree, particularly over ocean, there have been attempts in retrieving snow from HF-Microwave radiometer obs,**
  - **Above ~60 degree latitudes, ???**

- Polar Regions:
  - **Satellite radars see snow;**
  - Radiometers? Need to explore
    - Studies shows increase of TB associated with cloud/snow at 85, 37 GHz
    - How about even higher frequencies?