Validation of AQUA precipitation products at high latitudes

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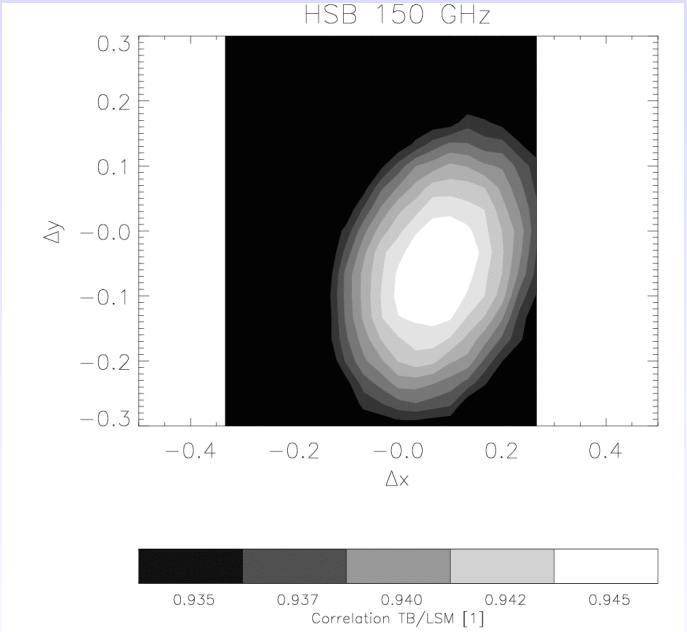
Overview

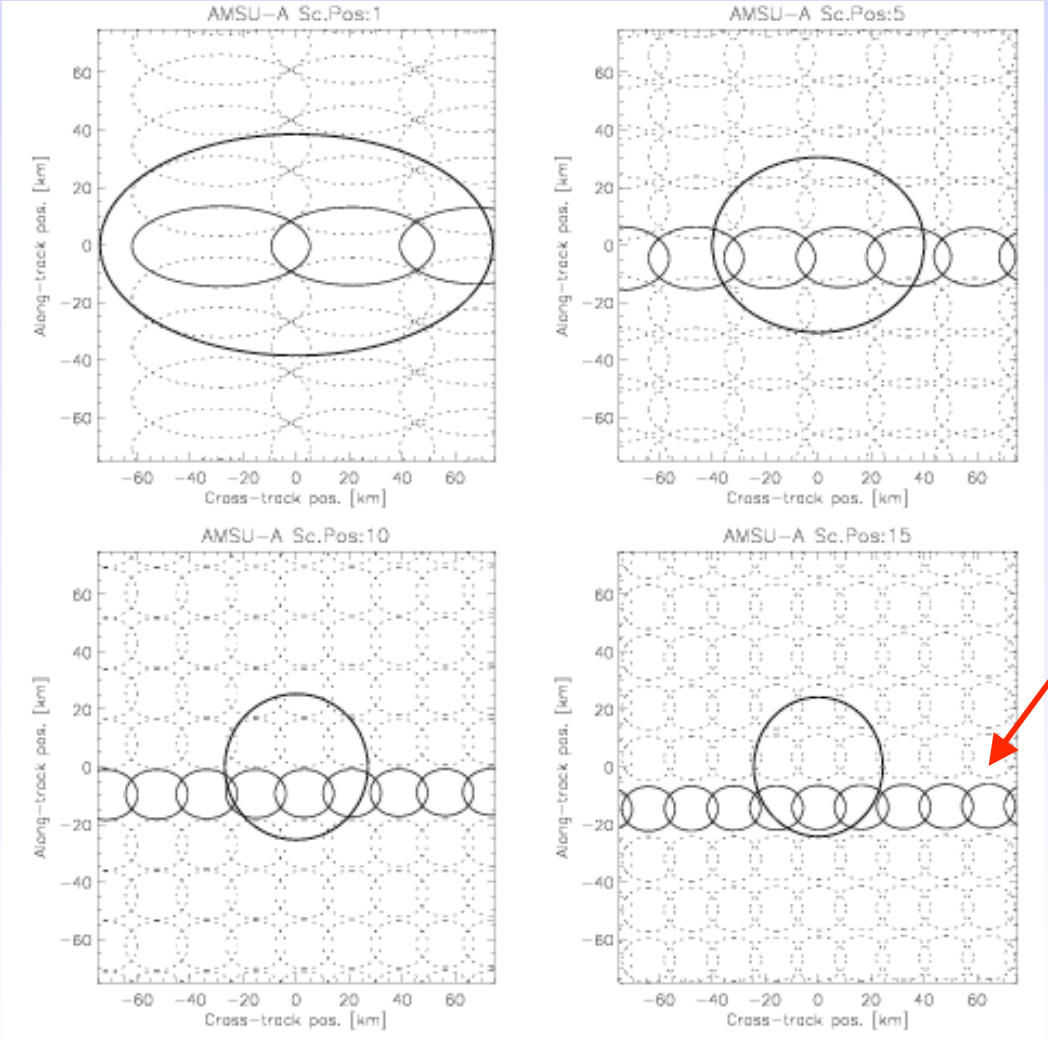
- AMSU/HSB navigation
- Mapping of HSB to AMSU resolution
- Precipitation: Why is it important?
- What validation data do we collect?
- Where are we?
- What is coming next?

AMSU/HSB navigation

- Performed cross-correlation analysis with 150 GHz (free of precipitation and heavy clouds) convolved land/sea mask
- Accuracy of the method is within 0.1-0.2 FOVs
- For the case we looked at the navigation is accurate to within the methods limits



Observation geometry of AMSU/HSB



3dB effective fields of view for AMSU-A and AMSU-B

HSB: Slight undersampling in along-track direction for the innermost scan positions

Optimal mapping of different instruments to of passive mw measurements

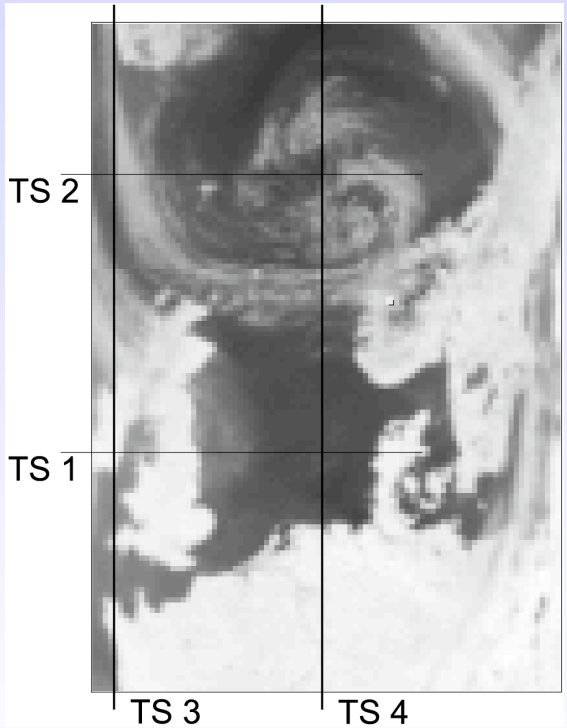
- Find neighboring pixels i=1,..,N and associated weights so that

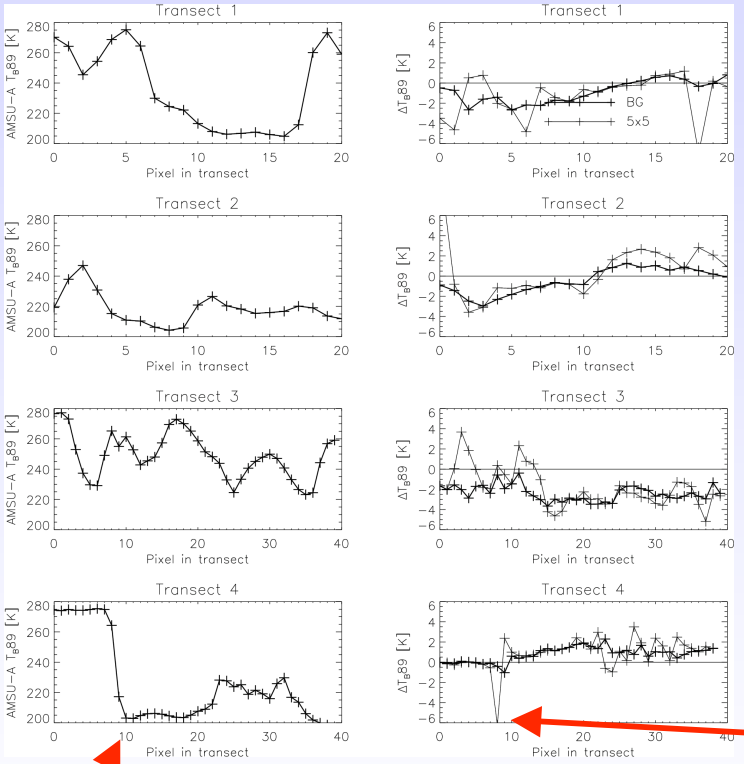
$$T_B = \sum_{i=1}^{N} a_i T_{Bi}$$

- where T_B is the brightness temperature that would be observed by the low resolution mw sensor

- Weights are determined via Backus-Gilbert method. This method allows to optimally resemble the spatial sensitivity of the target sensor

Accuracy of method (AMSU-A 89 GHz versus convolved AMSU-B 89 GHz for four transects)





TB 89 GHz for transects

Difference A-B for BG-method and simple averaging

Rmse-BG: 1.7 K
RMSE-Ave:3.2 K

Note the strong deviations for the simple averaging in regions where there are strong gradients in TB 89

Precipitation

- Spatial and temporal variation of precipitation largely unknown
- We can learn much from TRMM, but high latitude cold season is different from tropical precipitation
- Precipitation events are typically more shallow
- Freezing level is typically low, so ice phase becomes more important
- Rain rate is usually not as high as in the tropics
- NASA/NASDA/ESA will put considerable resources in extending knowledge about mid/high latitude precipitation (GPM)

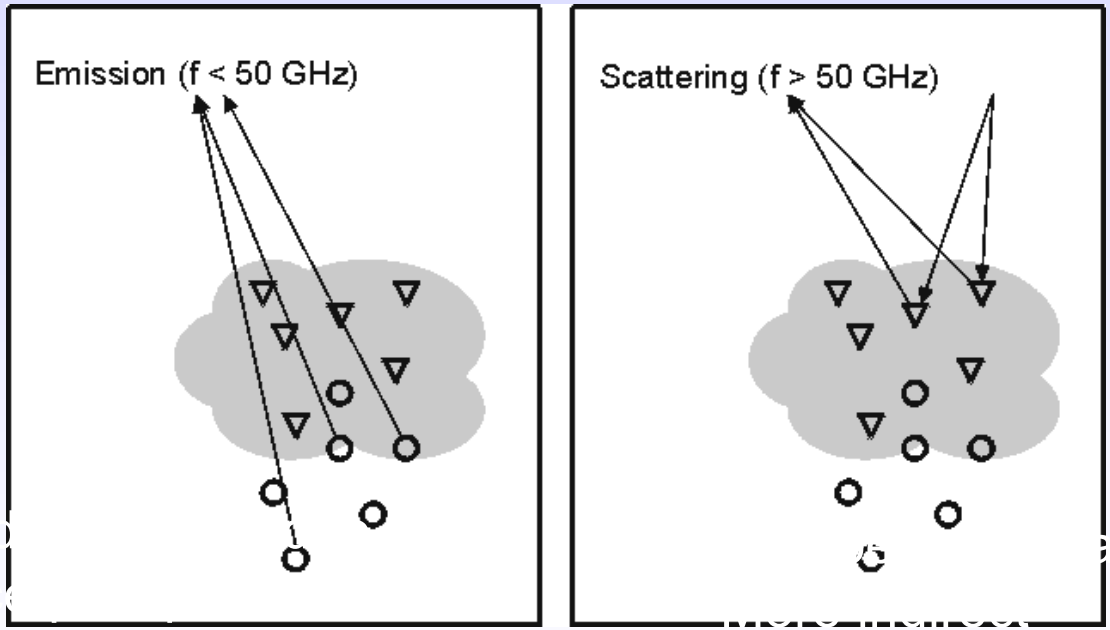
Precipitation: What problems do we face?

1. Physics: Understanding of relations between cloud-microphysics, rain rate at ground, and satellite signal.

2. Technical and scientific validation of algorithms. (But: what would be a valid calibration reference for the satellite retrievals?)

3. Sampling issues associated with the diurnal cycle of precipitation

Passive microwave precipitation signal



- Most o… …ces surface…
- Over cold (water) surfaces only

What do we do?

1. Collection of validation data

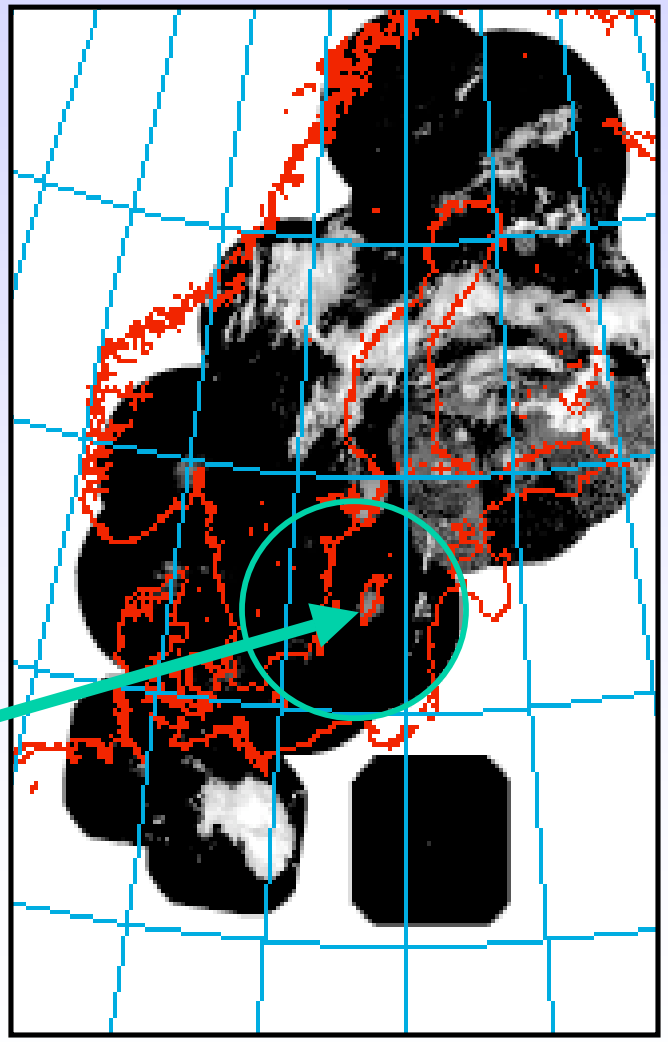
2. Comparsion with AQUA (while AMSR/AMSU/HSB data were not available we started with NOAA data)

3. Simulation studies to understand the relation between cloud microphysics, rainrate and radiometric signal

Dedicated validation observations

Colocated radar/AQUA (UW-Madison/SMHI)

- Data coverage: August 2002-ongoing.
- AQUA AMSR-E/AMSU/HSB
- Latitude range 50 N -70 N
- Network of 25 radars
- Radar reflectivities every 15 minutes
- Gauge-adjusted rain rates every 15 minutes
- volume scans of Gotland radar



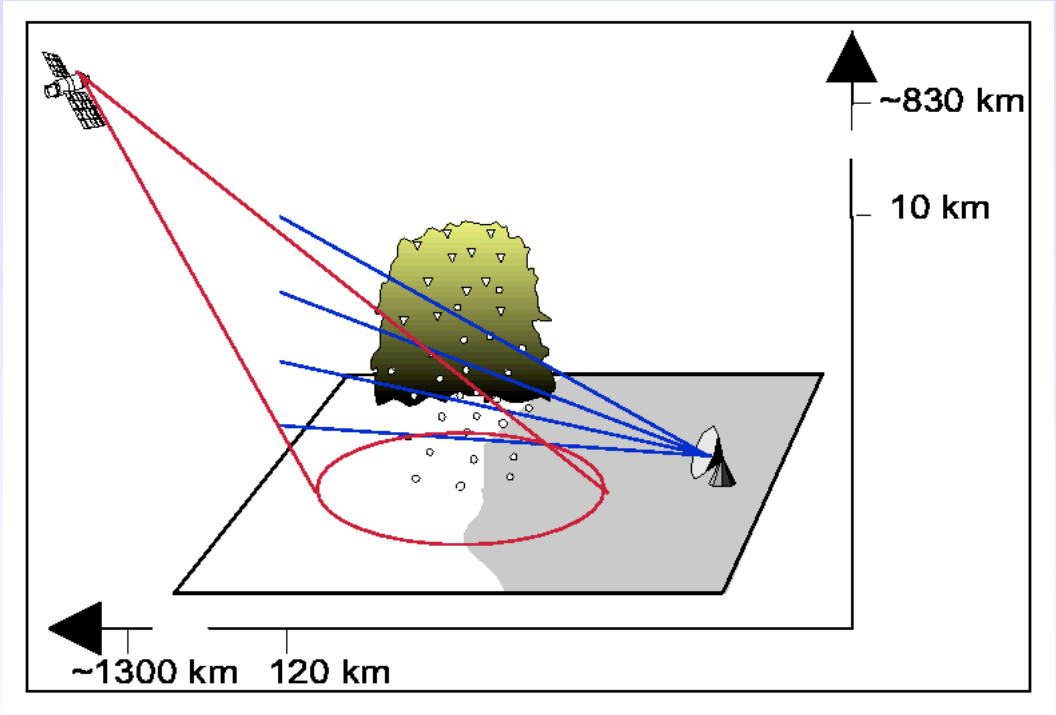
Dedicated validation AQUA observations for rain estimates

- Take coincident radar observations which each AQUA overpass over the Baltic area

- September 2002: 44 overpasses
- October 2002: 60
- November 2002: 57
- December 2002: 60
- January 2002: 58

- Ongoing efforts for at least one year

Observation geometry



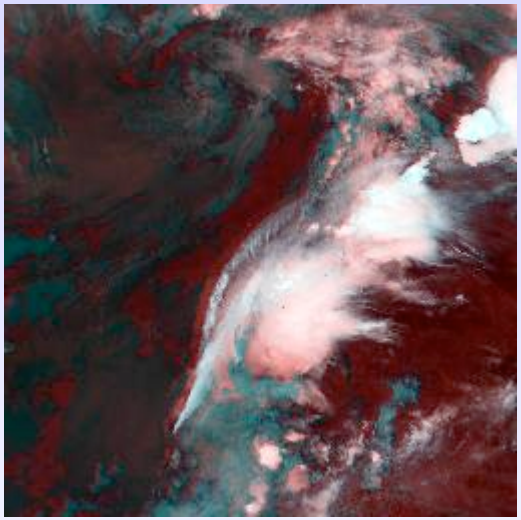
Altitude of radar beam (elevation 0.5°):

@100km distance: 2.2 km

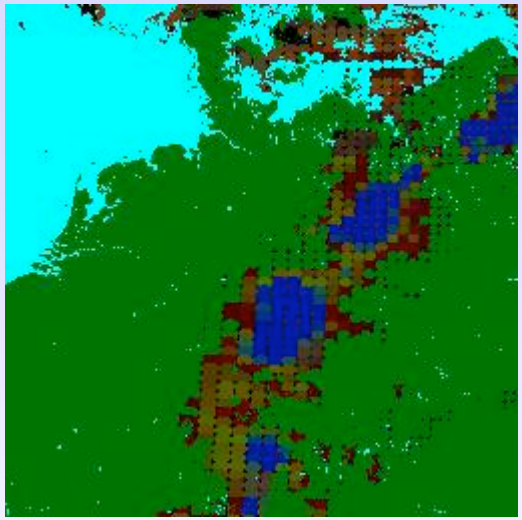
@200km distance: 5.2 km

273 K isothermal typically at 2-3 km

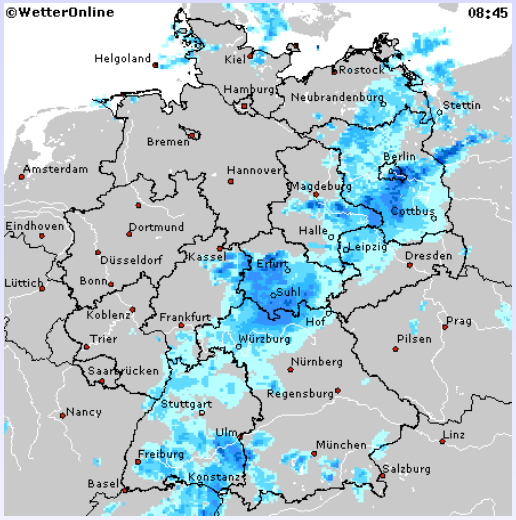
NOAA15 overpass 13 September 2000, 06:43 UTC



RGB AVHRR ch3,4,5



PC product RGB:
red: very light
green:light/moderate
blue:intense



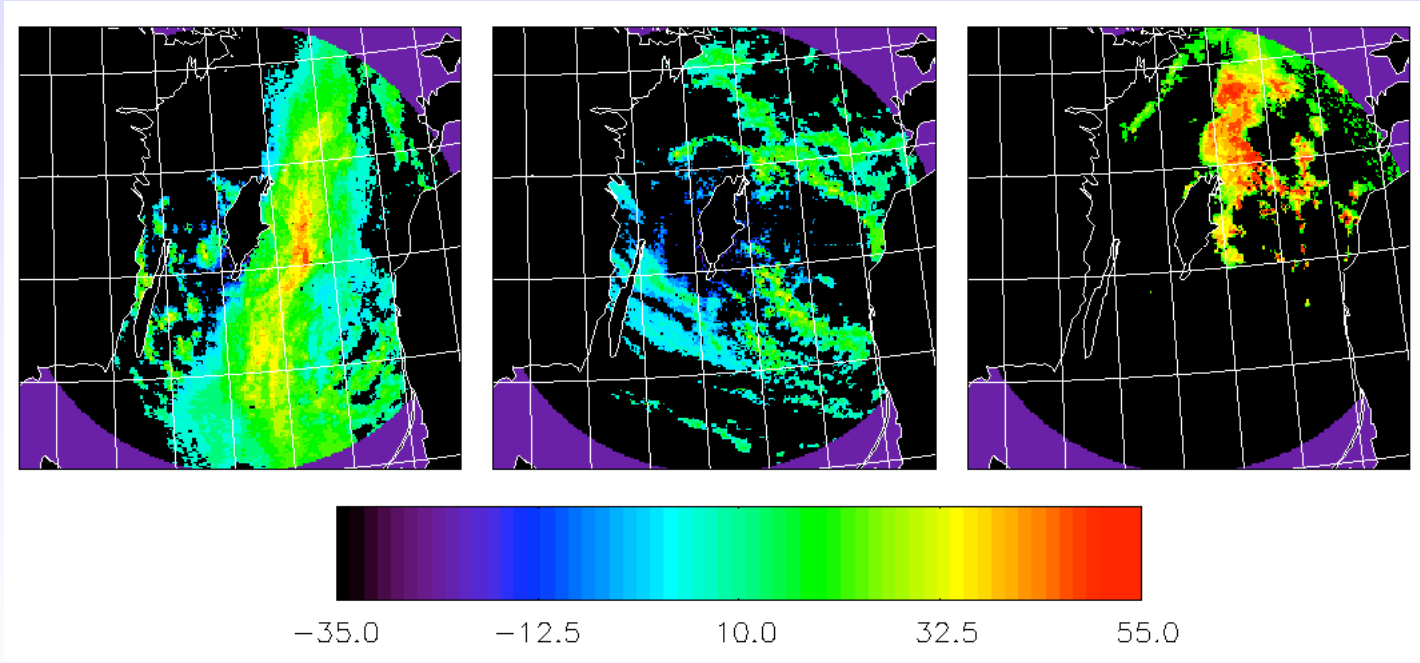
Radar composite

Different precipitation events

Frontal precipitation

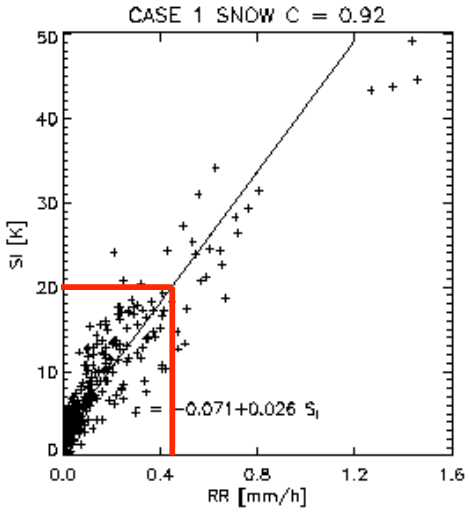
Graupel (Cold air outbreak)

Thunderstorm

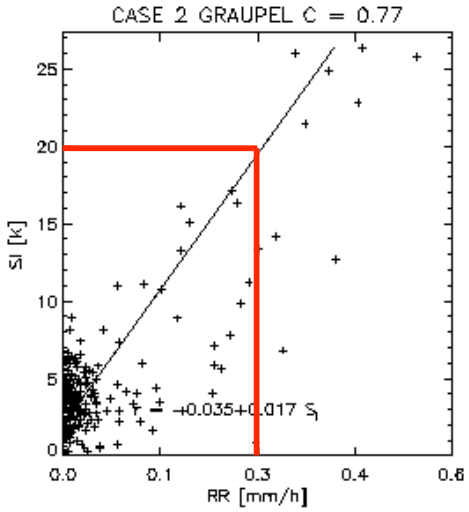


Radar versus passive microwave precipitation estimate

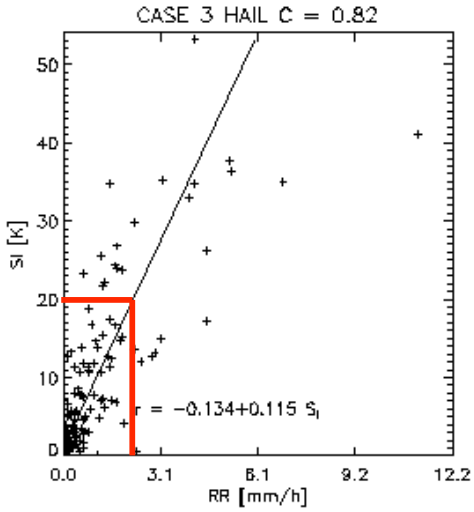
Frontal precipitation



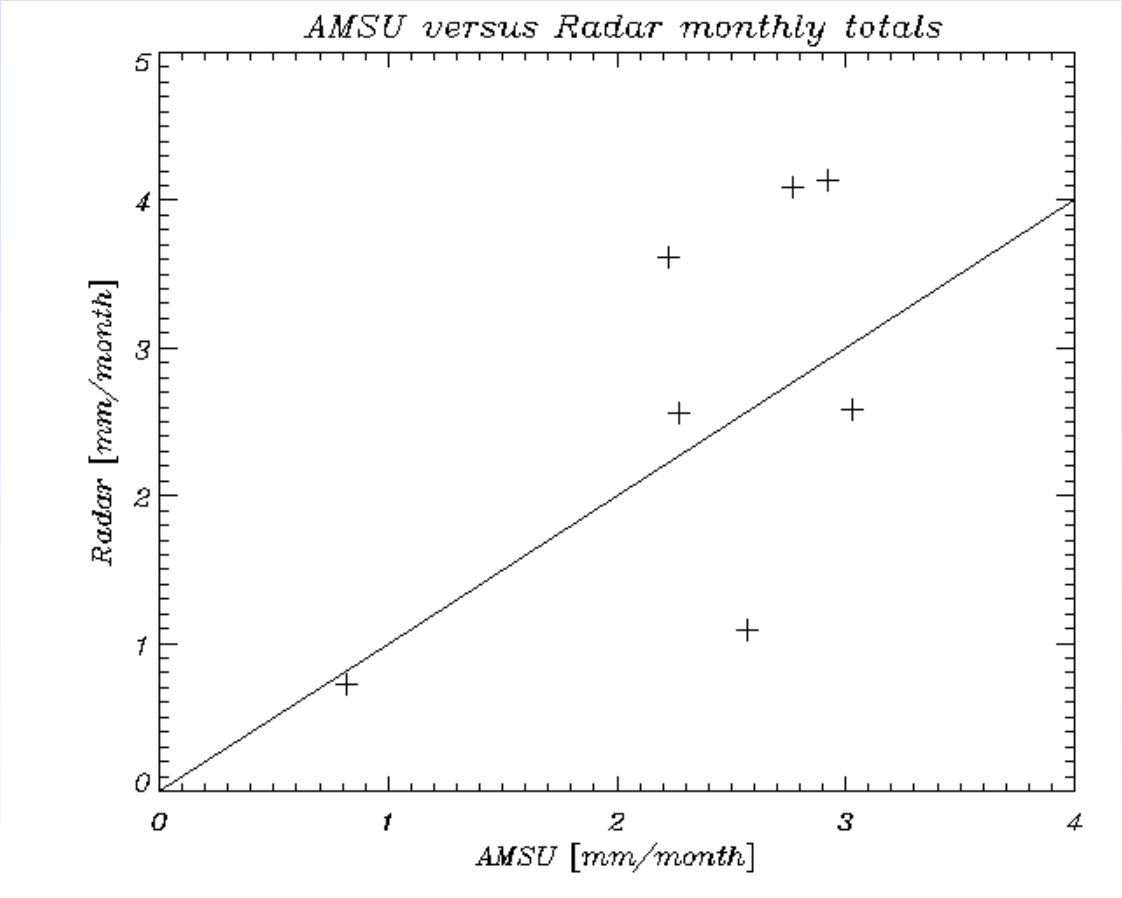
Graupel (Cold air outbreak)



Thunderstorm

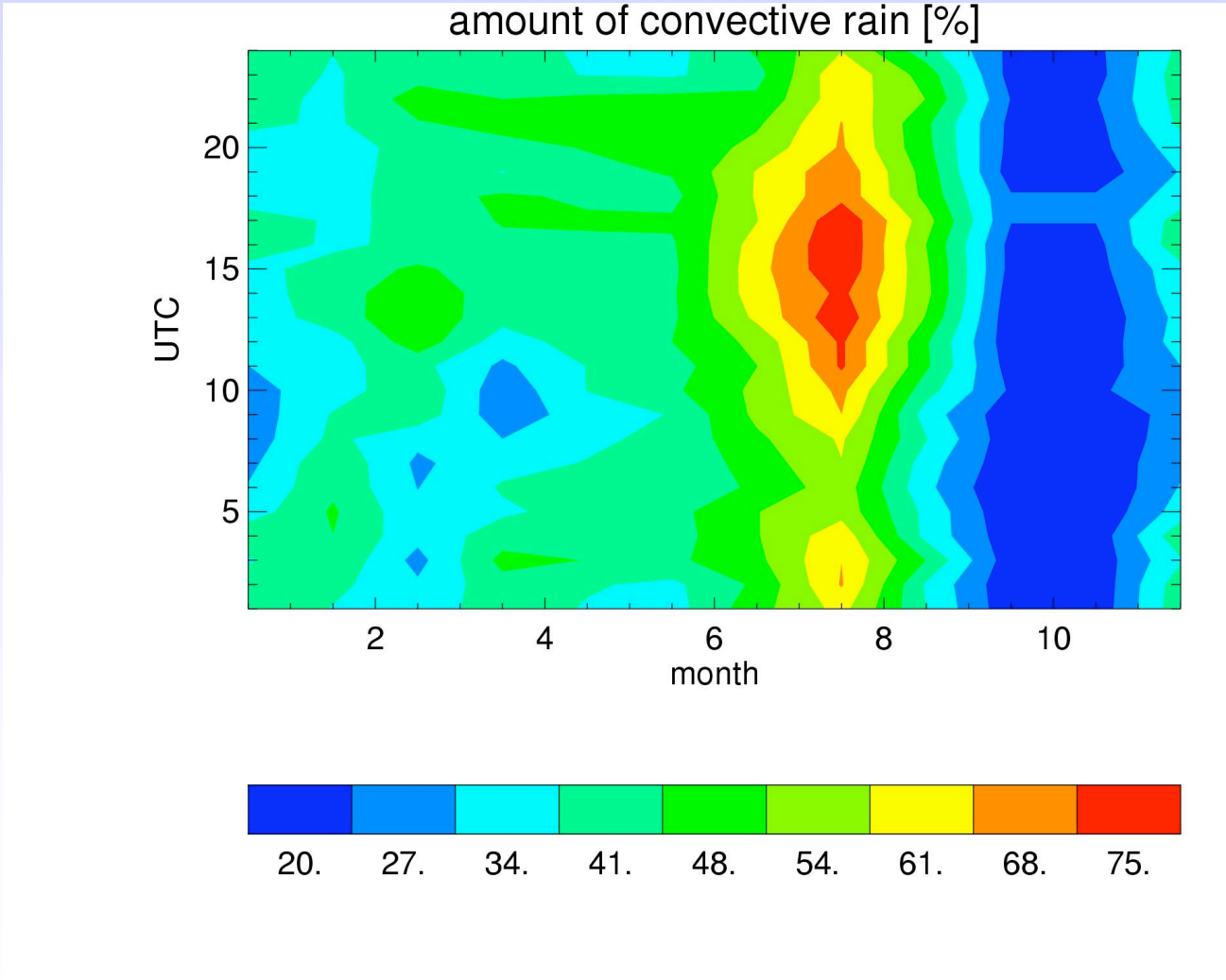


Comparison of rain events
(monthly mean for all pixels with rain rate > 1 mm/h)



C : 0.76

BIAS: 0.19 mm/h
(radar high)
RMSE: 0.93 mm/h

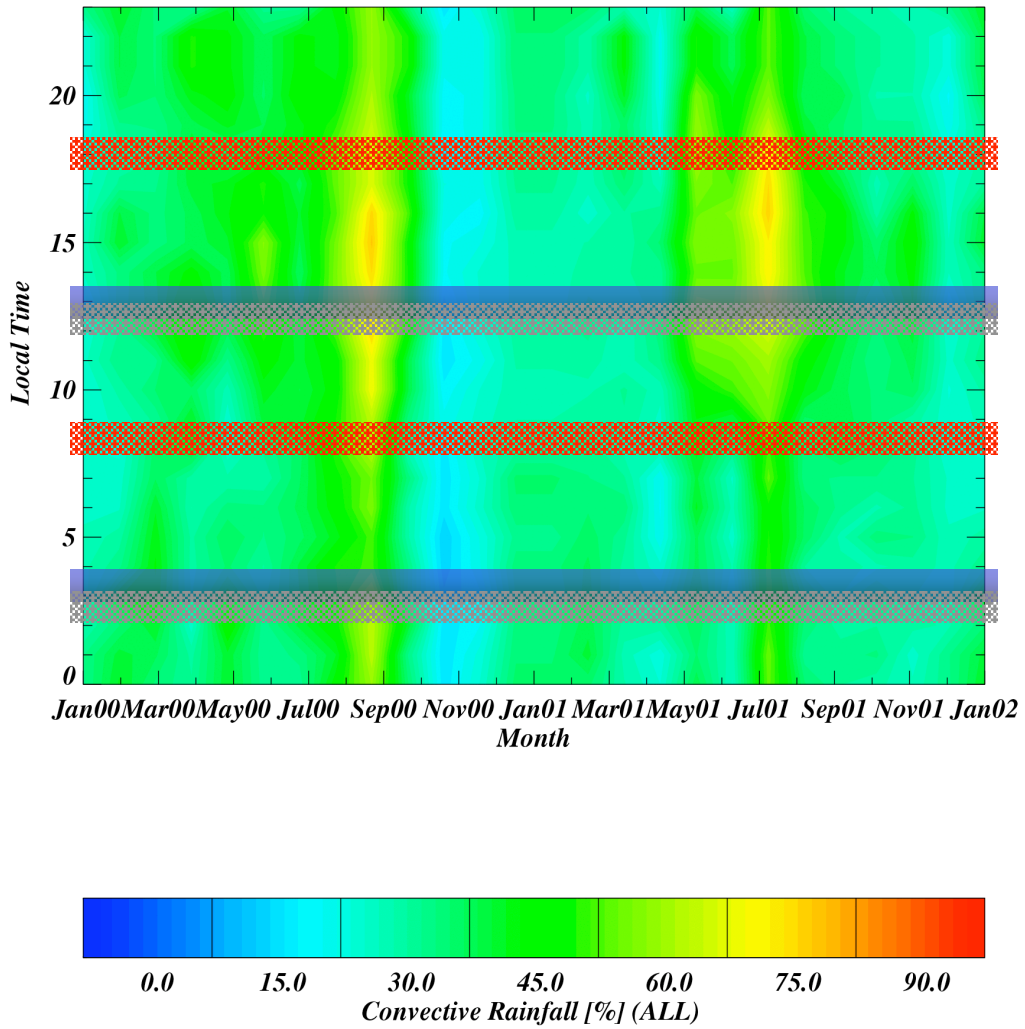

amount of convective rain [%]
UTC
20
15
10
5
2
4
6
8
10
month
20.
27.
34.
41.
48.
54.
61.
68.
75.

Sampling issues at 60^{O}N

N15

N16

AQUA



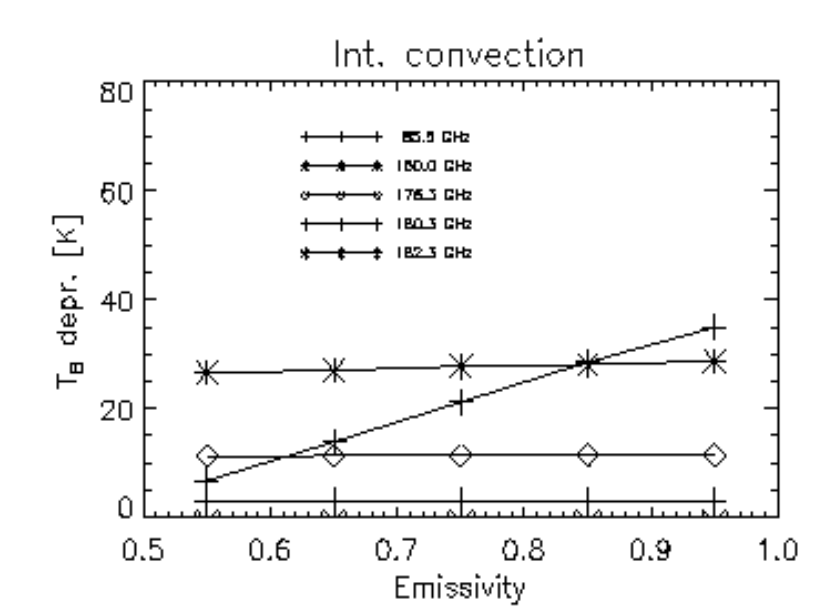
Simulation studies

- Studied the sensitivities of observed TBs at HSB frequencies to cloud ice/rain
- 150 GHz shows best sensitivity, while only little affected by variations in surface emissivity
- 183+-7 less sensitiveto precip but surface completely obstructed
- 183+-1/3 do not see much precipitation at high latitudes
- Study in press Radio Science Bennartz and Bauer (2003)

Outlook

- Ongoing data collection (radar composites and volume scans) efforts for at least one year
- Further simulation studies on the impact of precipitation on 150,183+-X GHz
- Systematic investigation of possible biases etc for different synoptic situations (convective/stratiform precipitation) together with Staelin
- Comparison AMSU/HSB-AMSR-E

Brightness temperature depression due to ice particle scattering as function of surface emissivity for **intensive convection**



- Strongest scattering signal at 150 GHz
- Only 85 GHz shows sensitivity to surface emissivity