Major Problems in Microwave Radiative Transfer Pertaining to Retrieval of Freezing Rainfall and Snowfall Rates

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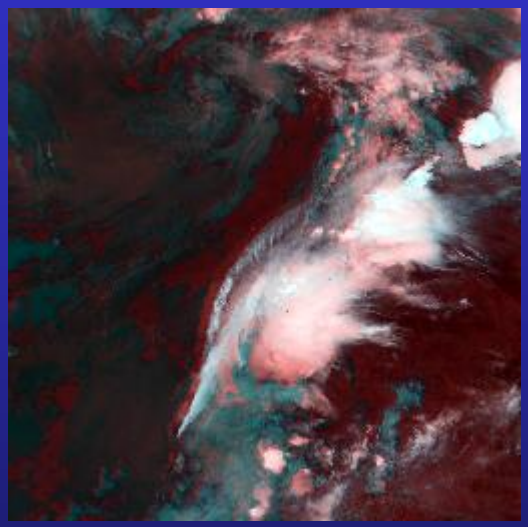
Overview

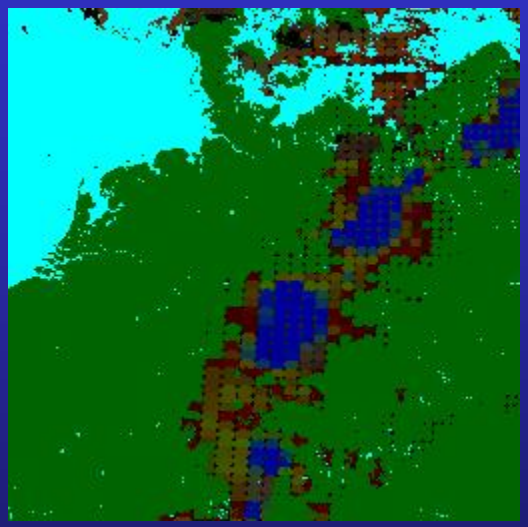
- Where are we?
- Can we detect the phase of precipitation at the surface?
- Precipitation Rate?
- Sampling?
- Conclusions

Where are we?

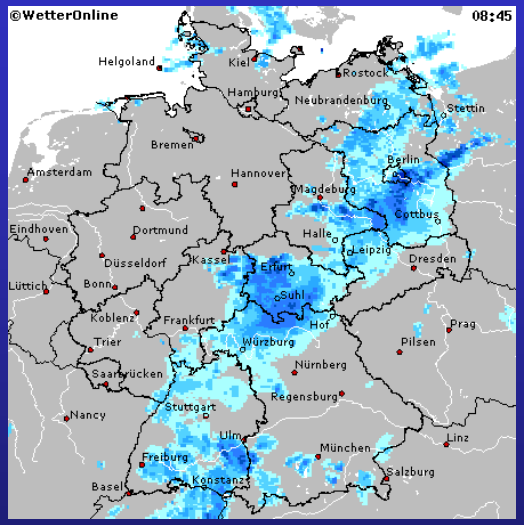
NOAA15 overpass 13 September 2000, 06:43 UTC



RGB AVHRR ch3,4,5

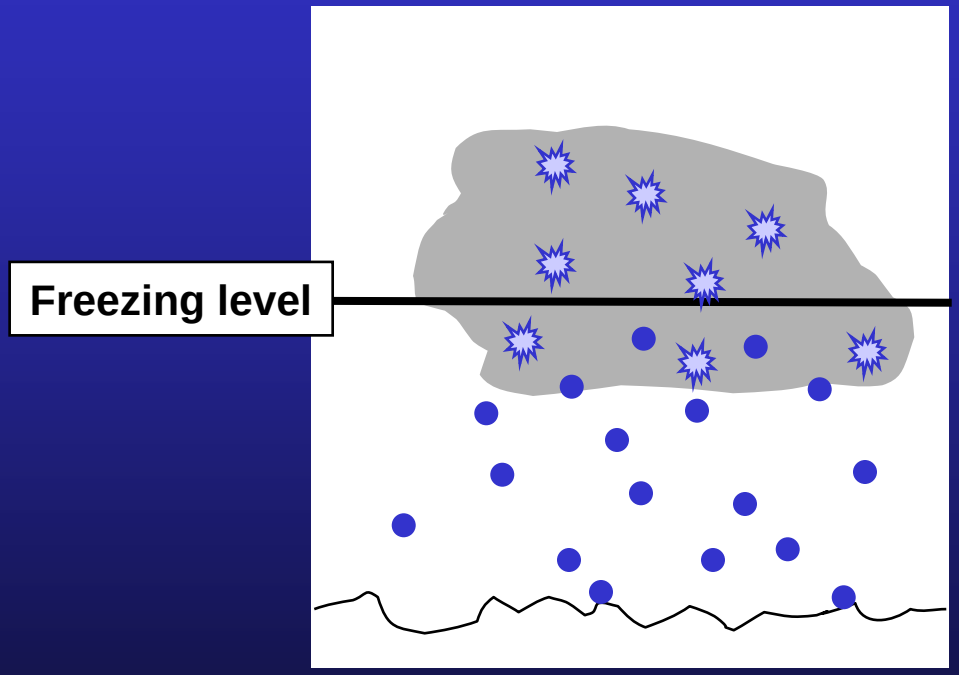


AMSU high freq.
Precip. product
red: very light
green:light/moderate
blue:intense



Radar composite

Can the type of precipitation at the surface be directly detected from passive microwave observations?



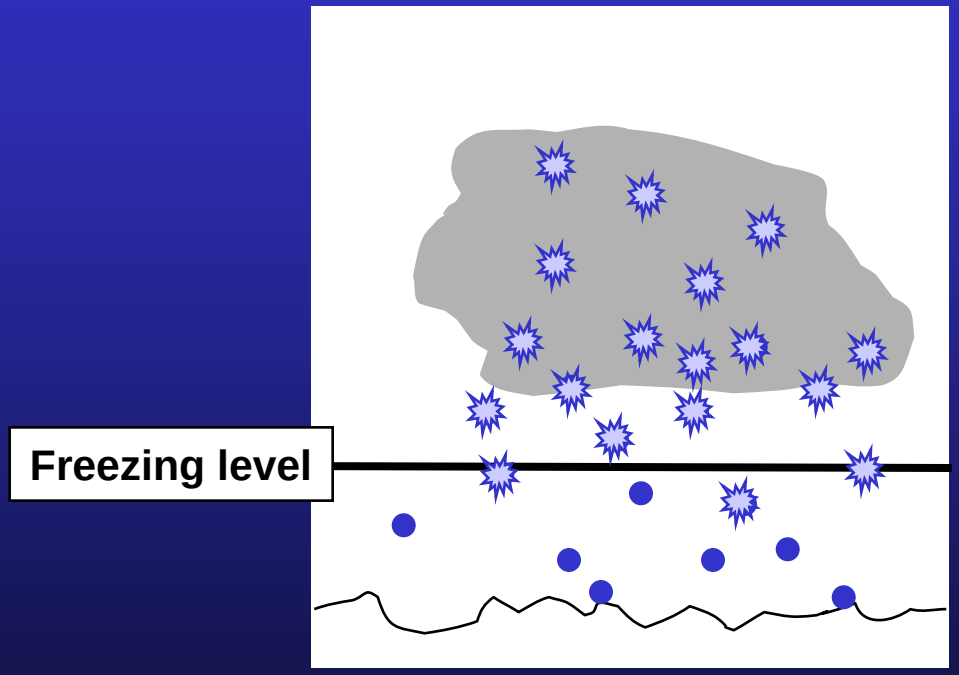
Freezing level high:

Strong emission signal

Scattering signal

Rain

Can the type of precipitation at the surface be directly detected from passive microwave observations?



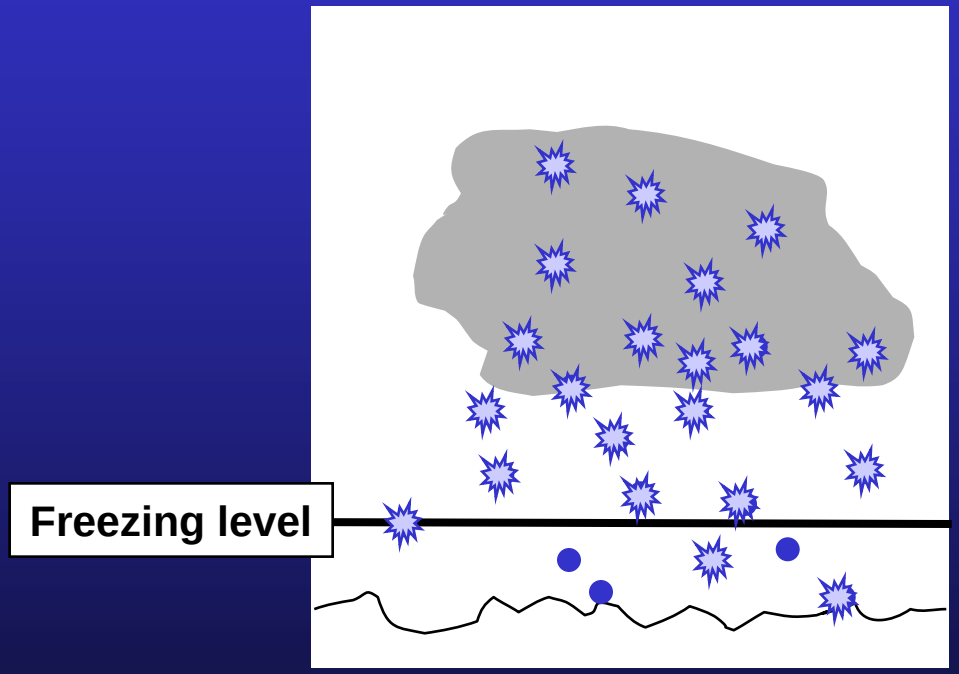
Freezing level lower:

weak emission signal

Scattering signal

Still Rain

Can the type of precipitation at the surface be directly detected from passive microwave observations?



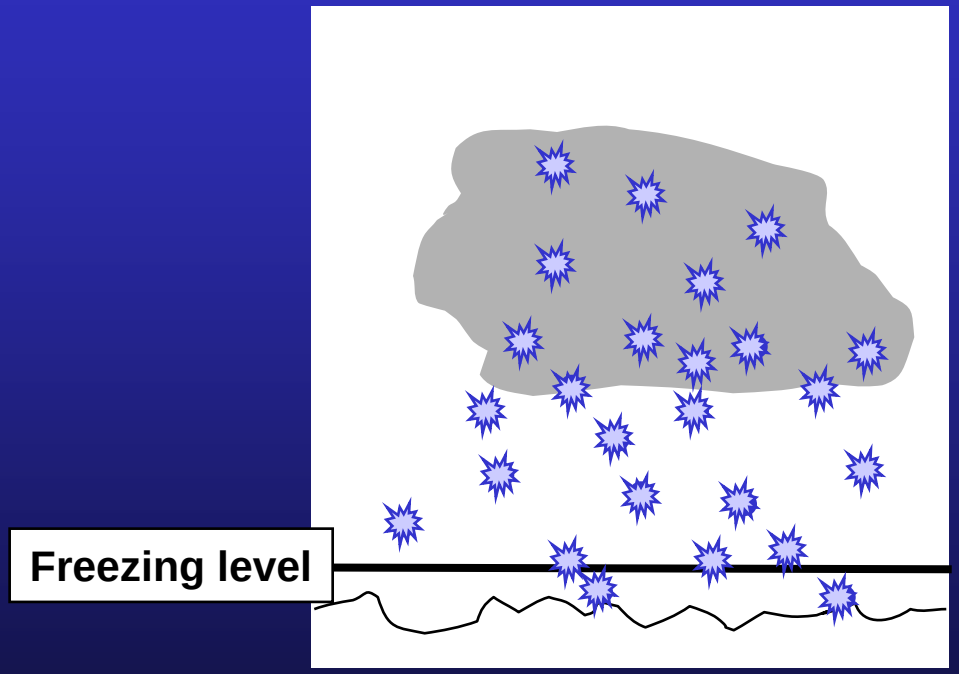
Freezing level lower:

weak or no emission signal

Scattering signal

Mixture

Can the type of precipitation at the surface be directly detected from passive microwave observations?



Freezing level lower:

weak or no emission signal

Scattering signal

Snow

Can the type of precipitation at the surface be directly detected from passive microwave observations?

- **No**. Because passive microwave sensors are only sensitive to column-integrated quantities and not to quantities at any particular level.

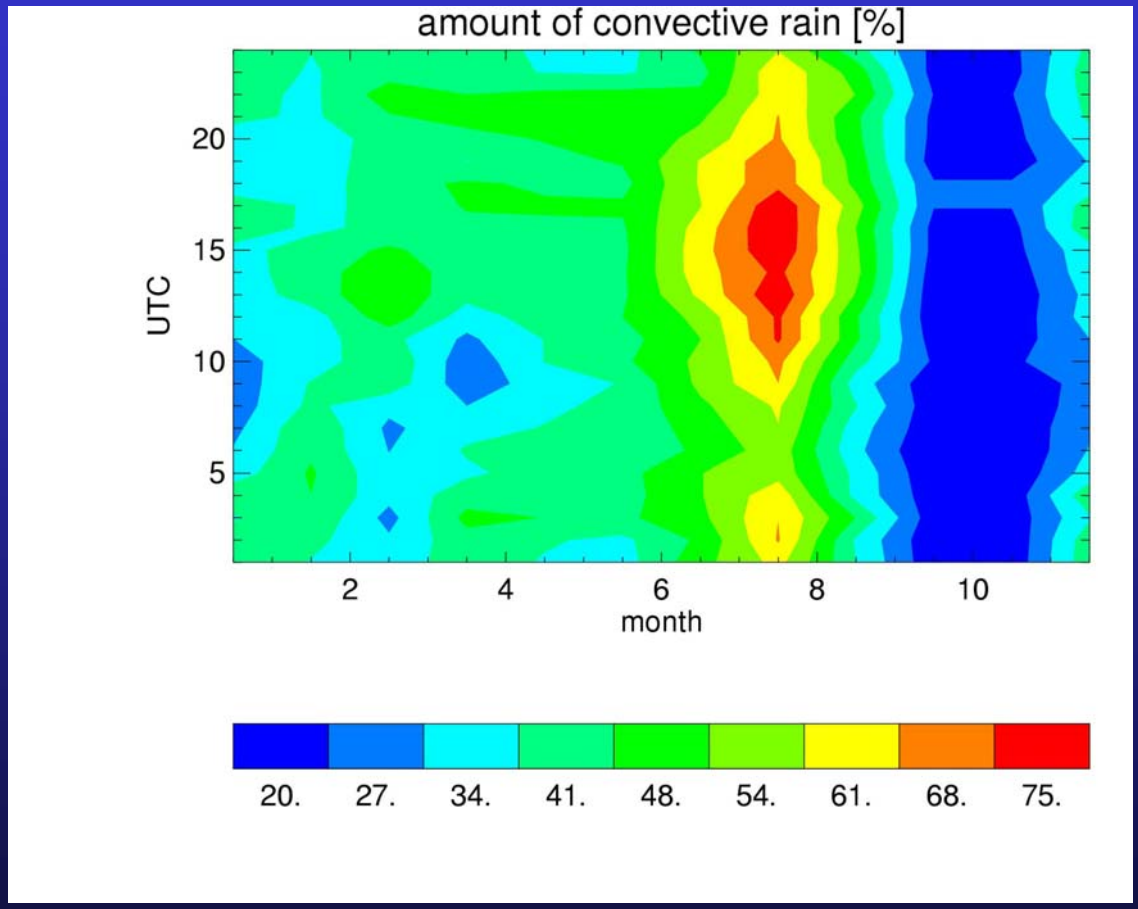
- **Indirectly**: If the freezing level height can be inferred and assumptions about ice particle type, we might be able to estimate the type of precipitation at the surface.

- Note also, that in reality there are many instances where a mixture of rain and snow reaches the ground.

Precipitation rate: Modeling challenges

- Emission signal weak, possibly dominated by cloud liquid water. Coated, melting particles.
- Scattering signal: Non-spherical particles. Scattering properties not well understood.
- Surface emissivity not well described at high latitudes
- Despite recent progress physically self-consistent description (all frequencies, active+ passive) remains challenging.

Sampling: Convective maximum of rain Baltic Sea



Sampling: Convective maximum of rain Baltic Sea

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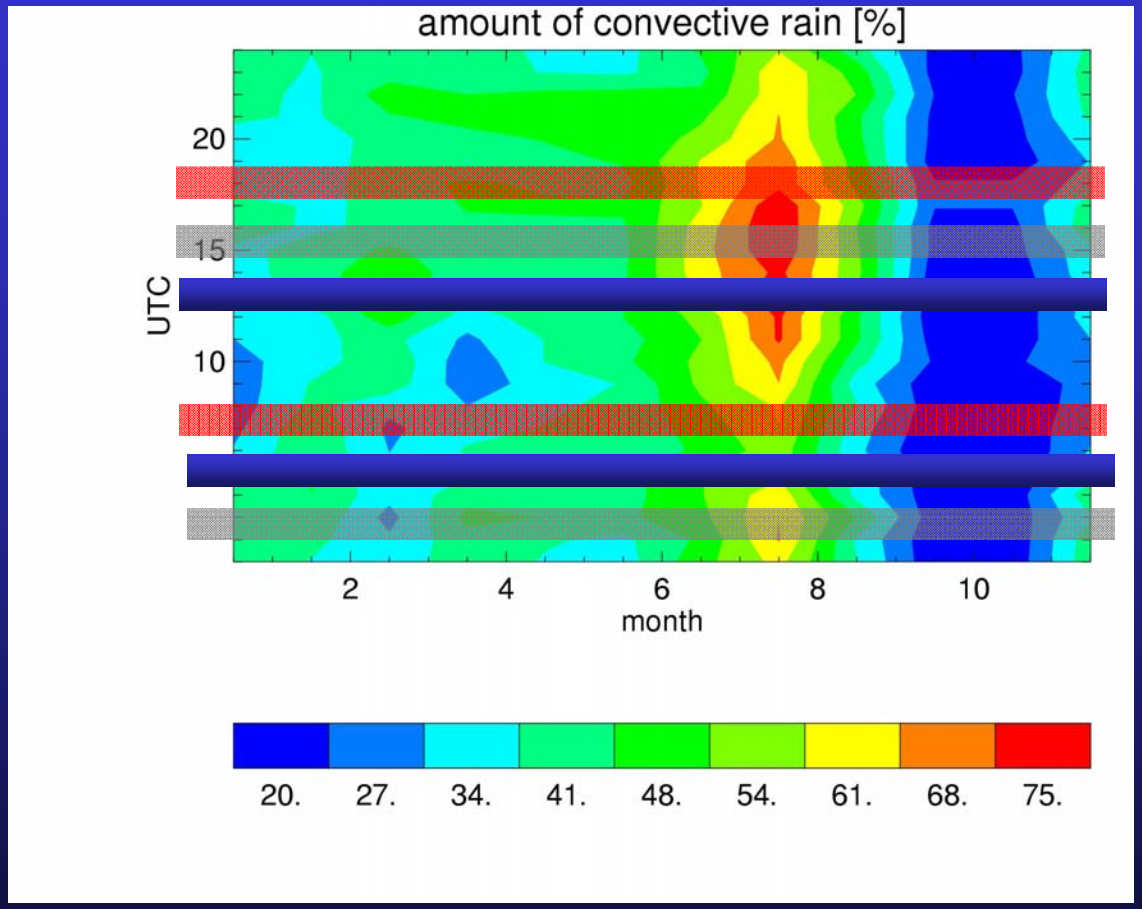

Conclusions

- For quantitative precipitation estimation and/or phase detection at high latitudes active + passive is highly desirable
- Establishment of modeling chain: Two-dimensional spectral cloud models with multiple ice particle and frozen precipitation categories -> non-spherical (inhomogeneous) particle optical property (permittivity, size, shape) modeling - > development of parameterizations for general use in cost-driven applications.
- Development of high-latitude surface emissivity products (10-200 GHz) including error estimates.
- Intensification of data assimilation studies. Bias monitoring. Near-operational testing of modeling chains. High frequencies?