Microwave scattering from wet ice crystal aggregates: A new approach

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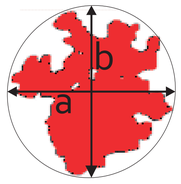
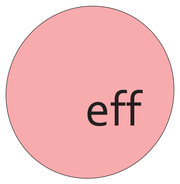
Bulk Model approach

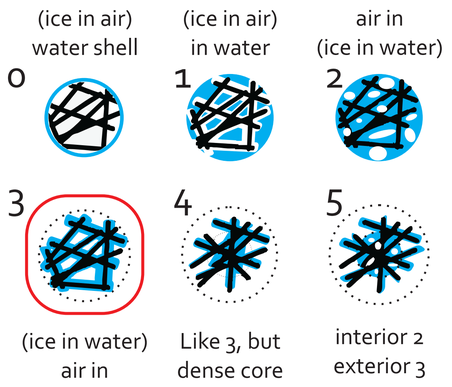
- Estimate ice/water volume/mass
- Estimate enclosing **spheroid** size + aspect ratio



- Compute equivalent dielectric constant (e.g. Maxwell Garnett formula)



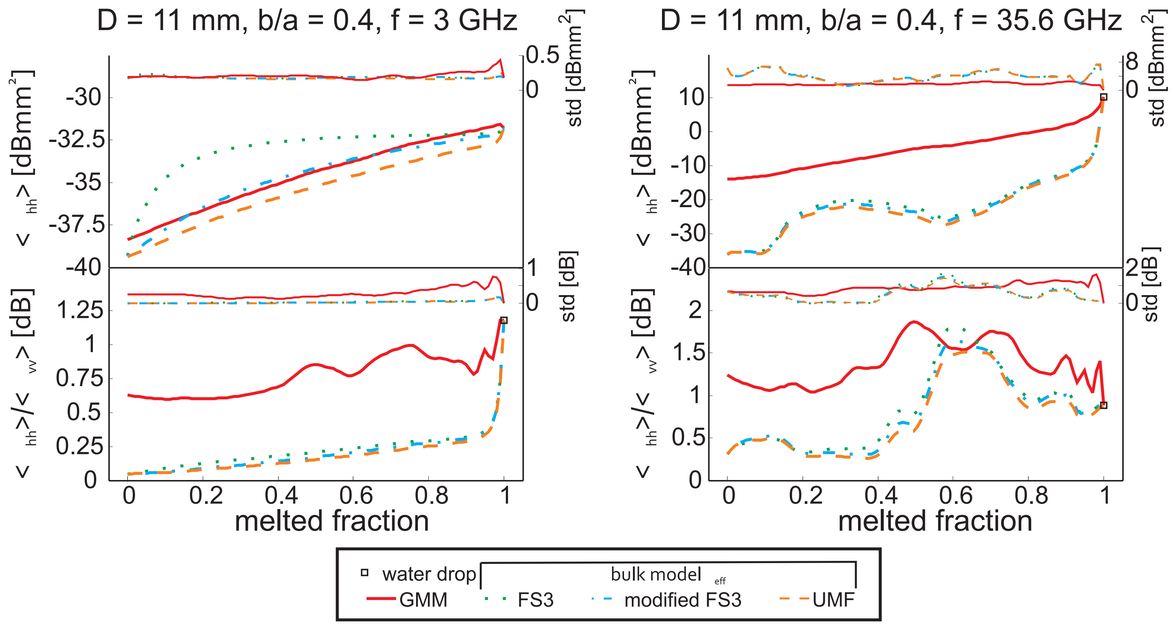
- Compute radar return from Mie- or T-matrix methods

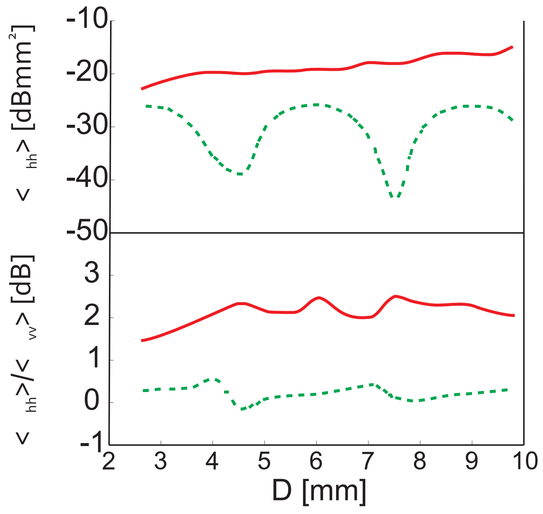


- How to specify $_{eff}$?
- Different models (Fabry and Zawadski)

Generalized Multiparticle Mie

- Method developed by Xu (1995), extending Mie theory to clusters of non-overlapping spheres with arbitrary size, position and dielectric constant
- Very good agreement with experimental data
- High versatility (only limited by computation time/memory requirements).





T-Matrix- GMM comparison

- 3 GHz differences:
  - $_{hh}$ within 1 dB
  - $_{hh}$/ $_{vv}$ within 0.7 dB
- 35.6 GHz large differences:
  - $_{hh}$ 10 to 20 dB!
  - $_{hh}$/ vv up to 1 dB, even before aggregate starts melting

- Dry aggregates: GMM $_{hh}$ >> Bulk $_{hh}$ for D > 3 mm
- Resonance effects in regular shaped bulk models not present in GMM model aggregates
- Much higher $_{hh}$/ $_{vv}$ predicted by GMM for all sizes

Conclusions

- Large uncertainties exist in all radar cross-sections of aggregates at the frequencies of the new ACFR radars
- Particularly problematic in Arctic where aggregates are the dominant precipitation hydrometeor type
- Problem must be addressed if quantitative precipitation estimates will be derived

Botta, G., K. Aydin, J. Verlinde, 2010: Modeling of microwave scattering from cloud ice crystal aggregates and melting aggregates: A new approach. IEEE Geosci Remote Sensing Lett.