The challenge of sub-millimetre-wave scattering

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Scattering by atmospheric ice in the mm-wave and sub-mm-wave spectral regions presents a challenge to the cloud microphysics and light scattering communities. This is because scattering by atmospheric ice, at these frequencies, not only depends on ice crystal shape, orientation and size, but also on how its mass or density evolves with size, and on the shape of the size spectrum. As there is no universal density-size relationship or representation of the size spectrum this makes interpretation of mm-wave and sub-mm-wave observations problematic.

In this talk, the methodologies proposed in [1,2] will be applied to state-of-the-art mm-wave and sub-mm-wave airborne observations of ice cloud that occurred around the United Kingdom [3]. Furthermore, these observations also consisted of state-of-the-art detailed microphysics measurements. From the latter observations, and using the geometric optics approximation to estimate the volume extinction coefficient, ice mass-extinction relationships were previously derived by [4]. The three-component models presented in [2] are applied to predict the geometric-based relationships and these models are then used to simulate the observations in the microwave using a generalized state-of-the-art line-by-line radiative transfer model [5]. The results of these analyzes will be presented and discussed in relation to the scattering challenge.

References

[1] Baran, A. J., *et al*., 2018: The applicability of physical optics in the millimetre and sub-millimetre spectral region. Part II: Application to a three-component model of ice cloud and its evaluation against the bulk single-scattering properties of various other aggregate models. *JQSRT* **206**, 68–80.

[2] Baran, A. J., Hesse E., and Sourdeval O., 2017: The applicability of physical optics in the millimetre and sub-millimetre spectral region. Part I: The ray tracing with diffraction on facets method. *JQSRT* **190**, 83–100.

[3] Fox, S *et al*., 2017: ISMAR: an airborne submillimetre radiometer. *Atmos. Meas. Tech*., doi:10.5194/ amt-10-477-2017.

[4] Fox, S., 2017: ISMAR cloud data summary. *Met Office Internal Note*, 20 pp.

[5] Havemann, S *et al*., The Havemann–Taylor Fast Radiative Transfer Code (HT-FRTC): a multipurpose code based on principal components. In preparation for *JQSRT*.

Preferred mode of presentation: Oral