Temperature dependence of ice particle refractive index and implications in sub-millimeter ice cloud retrievals

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Ice clouds play a substantial role in the Earth's climate system, particularly through their influence on the global energy budget. These influences, coupled with the spatiotemporal variability of ice clouds, impose difficulties in understanding their radiative effects and subsequently our current climate and potential future changes [1]. Fundamental ice cloud parameters for quantifying cloud radiative properties are the ice water path (IWP) and ice particle effective diameter. Current general circulation models vary in their estimation of the cloud IWP by as much as an order of magnitude. Imposing constraints from observations is challenging since ice mass retrievals are generally ill conditioned (i.e., less information content in observations than in the requisite solution). Sub-millimeter (sub-mm) wave radiometry is an emerging technique for characterizing cloud properties due to high sensitivity to ice cloud parameters, in particular the IWP.

Even with this increased sensitivity, it is necessary to make assumptions in ice cloud retrievals, such as ice particle shape (habit) which effects particle single scattering properties. Previous studies have also shown sensitivity of ice particle sub-mm single scattering properties to ice refractive index at certain temperatures [2,3].

In this work we present an information content based approach to understand temperature effects on ice refractive index, and subsequent contributions to ice cloud property retrieval uncertainties over a wide range of sub-mm wavelengths.

References

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