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Information content for cloud ice microphysics in the far-infrared radiance spectrum

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Radiance measurements in the mid-infrared window (8 – 12 μm) have demonstrated sensitivity to ice particle microphysics, due to the spectral variation of the index of refraction of ice within the spectral range. The information content is fairly limited, however, and usually only an effective particle size can be retrieved. By using carefully selected prior constraints, some information about the particle size distribution can be inferred. The far-infrared radiance spectrum (17 – 50 μm) also contains a region of spectrally varying index of refraction. The longer wavelengths imply a significantly smaller scattering size parameter, which in turn gives the ice particles significantly different scattering properties in the far-infrared spectrum relative to the mid-infrared. Generally, the far-infrared shows larger single scatter albedos and weaker forward scattering. Although the far-infrared has a high opacity due to the rotational absorption band of water vapor, we find that for selected microwindows, high altitude ice clouds would be observable in the upwelling radiance spectrum even in atmospheres with high water vapor amounts. Using a modeling study, we investigate the information content for ice microphysical retrievals in variety of conditions. The results show which regions in state space are better constrained by the far-infrared information, and shows the advantage of a combined far-infrared and mid-infrared measurement for ice microphysical retrievals from satellites.