Using radiometric and polarimetric sensitivities of sub-mm/mm and infrared wavelengths to provide information on simultaneous ice water path and effective diameter retrieval

James J. Coy[a,*], Adam Bell[a], Guanglin Tang[a], Ping Yang[a], and Dong L. Wu[b]

[a]*Department of Atmospheric Sciences, Texas A&M University, College Station, TX*
[b]*Climate and Radiation Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD*

[*]*Presenting author (jcoy93@tamu.edu)*

Radiometric and polarimetric calculations of simulated ice clouds composed entirely of aggregate particles are conducted for several wavelengths in the Infrared (IR) and Sub-millimeter/Millimeter (sub-mm/mm) ranges as part of NASA's SWIRP (Compact Submm-Wave and LWIR Polarimeters for Cirrus Ice Properties) project. The scattering/absorption/polarization properties of the aggregates that were calculated at the selected bands before this study are incorporated into a radiative transfer model, ARTS (Atmospheric Radiative Transfer Model) [1] in order to explore ice cloud characteristics in 1D spherical atmospheres.

This study focuses on simulating cirrus clouds using the wavelengths of 441 μm (680 GHz), 1363 μm (220 GHz), 8.6 μm, 11 μm, and 12 μm. The simulated cirrus clouds are made to be composed of a single ice particle habit of 8-column aggregates with a gamma distribution of particle sizes. Simulations are performed for combinations of ice water path (IWP), effective particle diameters (D_{eff}), visible optical thickness, and certain viewing zenith angles with ambient temperatures and pressure levels corresponding to a typical tropical atmosphere. The sensitivity analyses for these cases will focus on the creation of plots that display isolines of IWP and D_{eff} with brightness temperature parameters representing the axes for a combination of two or three wavelengths [2,3]. The brightness temperature parameters being used for this study are polarization difference for microwave wavelengths [4], brightness temperature depression from a cloud-free atmosphere [5], and IR split-window brightness temperature differences [6] that are based on the computed radiances from the ARTS calculations. The results can provide information on the possibility of simultaneously retrieving IWP and D_{eff} using a combination of sub-mm, mm, and IR wavelengths and brightness temperature parameters.

References

[1] Emde, C., S. A. Buehler, C. Davis, P. Eriksson, T. R. Sreerekha, and C. Teichmann, 2004: A polarized discrete ordinate scattering model for simulations of limb and nadir longwave measurements in 1D/3D spherical atmospheres. *J. Geophys. Res.* **109**, D24207.

[2] Wang, C., P. Yang, B. A. Baum, S. Platnick, A. K. Heidinger, Y. Hu, and R. E. Holz, 2011: Retrieval of ice cloud optical thickness and effective particle size using a fast infrared radiative transfer model. *J. Appl. Meteorol. Climatol.* **50**, 2283–2297.

[3] Liu, G., and J. A. Curry, 2000: Determination of ice water path and mass median particle size using multichannel microwave measurements. *J. Appl. Meteorol.* **39**, 1318–1329.

[4] Troitsky, A. V., A. M. Osharin, A. V. Korolev, and J. W. Strapp, 2003: Polarization of thermal microwave atmospheric radiation due to scattering by ice particles in clouds. *J. Atmos. Sci.* **60**, 1608–1620.
[5] Evans, K. F., and G. L. Stephens, 1995: Microwave radiative transfer through clouds composed of realistically shaped ice crystals. Part II: Remote sensing of ice clouds. *J. Atmos. Sci.* **52**, 2041–2057.
[6] Prabhakara, C., R. S. Fraser, G. Dalu, M.-L. C. Wu, R. J. Curran, and T. Styles, 1988: Thin cirrus clouds: seasonal distribution over oceans deduced from Nimbus-4 IRIS. *J. Appl. Meteorol. Climatol*. **27**, 379–399.

Preferred mode of presentation: Poster