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On the evidence for small ice cloud particles as inferred from MidCiX and MODIS observations

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Cirrus clouds play an important role in the regulation of climate. Their precise influence, however, is still poorly understood due in part to uncertainties in the cloud properties themselves. For example, the exact size of the ice particles that compose cirrus clouds is still highly debated. The recent WB57 Mid Latitude Cirrus Cloud Experiment (WB57 MidCiX) found highly ambiguous results for ice particle size dependent upon different instrumentation used. Although satellites may provide an ideal means to monitor ice clouds, the uncertainties in retrieval algorithms such as ice particle shape may lead to large errors in the final estimation of particle size. The goal of this work therefore was to re-examine the retrieval of ice cloud particle size in a more semi-quantitative manner. Instead of trying to determine exact particle size to within a few microns as in a traditional retrieval approach, the goal here was simply to determine if observed radiances were consistent with small or large particles (e.g. 10 microns or 50 microns). Radiative transfer modeling for a variety of different ice crystal types suggests that the traditional infrared split window approach can be used to uniquely identify the presence of small particles (less than 20 microns or so) when the brightness temperature difference between two given window channels reaches some scene-dependent threshhold. The more common operational retrieval approach of a near-infrared channel to estimate particle size suffers from non-uniqueness due to inversion uncertainites and therefore cannot be used as confidently in an absolute sense to identify small or large particles. This split-window threshhold technique therefore was applied to Moderate Resolution Imaging Spectroradiometer (MODIS) data both for global conditions and for WB57 MidCiX test cases. Results suggest that small particles are found frequently for both global and MidCiX cases. It was also found that the MODIS effective radius product, based upon near-infrared considerations, often returned large particles even when high infrared brightness temperature differences would dictate that the ice particles must be small. The role of spectral-varying inversion uncertainties and their influence on retrieval results will be discussed.