Resolving uncertainties in climate predictions by improving the treatment of small ice particles.

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Many model parameterizations of ice clouds used in global climate models (GCMs) are based on observations of ice crystal number concentrations of small (maximum dimension $D < 500$ μm) from 2D Cloud Probes (2DCs) that have been artificially amplified by the presence of shattering artifacts. A large uncertainty in global climate prediction is related both to the ice sedimentation and radiative properties and on liquid to ice conversion rates of mixed phase clouds. In addition to uncertainties in how past data are affected by shattering, recent studies have reached varying conclusions regarding the ability of shatter reducing tips and correction algorithms to remove shattering artifacts. In this presentation, the effect of shattering and the associated uncertainties on the derivation of bulk microphysical properties derived from 2DC data, such as total ice crystal concentration (N), ice crystal number distribution function ($N(D)$), extinction (β), ice water content (IWC), effective radius (r_e) and median mass diameter (D_{mm}) is quantified. These properties, computed from data acquired by 2DCs with standard and shatter reducing tips on the National Research Council of Canada Convair-580 during the Indirect and Semi-Direct Aerosol Campaign (ISDAC), and on the National Science Foundation C-130 during the Instrumentation Development and Education in Airborne Science phase 4 (IDEAS-4) project, are compared as a function of true air speed, pitch, roll, and attack angles, ice crystal habit, median diameter, and temperature. Preliminary results indicate that the 2DC shatter reducing tips eliminate more of the impact of shattered artifacts on $N(D)$, β, and IWC than does the application of the shattering correction algorithms. Our studies suggest that differences greater than a factor of 2 in $N(D < 500\ \mu m)$ may be attributed to shattered artifacts, so considerable improvements of climate model parameterizations of ice are possible with improved measurements of ice.