1. Motivation
- Database of ice cloud microphysical properties has been derived from in-situ observations acquired in variety of locations and from clouds formed by different mechanisms
  - Need probability distribution functions of cloud parameters to understand how properties vary in different regimes
  - Knowledge of shapes and size distributions (SDs) of ice crystals with dimensions \( D_{\text{max}} < 50 \mu m \) needed for database
  - Investigate use of forward scattering probes to derive such SDs

2. Data
- Mid-Latitude Continental Convective Cloud Experiment (MC3E): Studied convective clouds in vicinity of SGP site in 2011 using UND Citation 1University of Illinois, Urbana, IL 2National Center for Atmospheric Research, Boulder, CO
- Storm Peak Laboratory Cloud Property Validation Experiment (STORMVEX) and Colorado Airborne Multi-phase Cloud Study (CAMPS): Studied winter orographic and frontal clouds near Steamboat Springs at ground (STORMVEX) and with Wyoming King Air (CAMPS)

3. Scattering Library
- Single-scattering properties of hexagonal ice crystals with \( D < 50 \mu m \) and varying aspect ratios (ARs, 0.1, 0.25, 0.5, 1.0, 2.0, 4.0) (Fig. 1) calculated using the Amsterdam Discrete Dipole Approximation (ADDA)

4. Cloud Properties
- Fig. 3: MC3E and CAMPS PDFs for IWC dependence on temperature; larger IWCs on average in convective clouds
- Fig. 4: N(D) from MC3E and CAMPS for varying temperatures; effective radii and median diameter larger for wintertime frontal clouds.
- Fig. 5: Total number concentration from MC3E and CAMPS; number concentrations lower for wintertime frontal clouds than for summertime convective clouds. Data in Figs. 3, 4 and 5 currently being used to evaluate model simulations.

5. Particle Sizing by FSSPs
- Fig. 6: Crystal size computed from scattering cross section and Mie theory vs actual crystal size. Blue dots represent mean of all possible values, red dots are minimum and maximum values. Every +50% (orange) and -20% (sky blue) from the 1:1 line (black ) shown
- Fig. 7: Difference between actual crystal size and that determined from Mie theory for crystals with AR of 1.0. Mean and standard deviation of absolute values of blue circles are embedded in each panel.
  - Differences in particle size smallest for \( D_{\text{max}} \sim 10 \mu m \), larger for \( D_{\text{max}}<10 \mu m \) due to interference structures) and for \( D_{\text{max}}>10 \mu m \) due to nonsphericity
  - Differences are up to 112% non-spherical shapes (AR=0.1 and 4.0) have larger differences

6. Summary
1. PDFs of microphysical quantities, complete with uncertainty analysis, now available for several field projects
2. Single-scattering libraries of small crystals being used to study performance of FSSP, and have additional applications as well

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