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The Physics of Clouds: How Aircraft Observations Improve our Knowledge of Clouds for Weather and Climate Studies

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The most fundamental and complex problems in climate and weather center around our poor understanding of cloud properties and our inability to determine effects of cloud processes on weather and climate. Clouds cool Earth by reflecting sunlight and warm it by absorbing infrared radiation: the net impact is a small difference between 2 large terms depending on the size, shape and phases of cloud particles. Clouds also determine how storms evolve, as the latent heat release that drives storms is sensitive to the characterization of cloud particles. Here a comprehensive set of data collected by aircraft probes during projects in the Arctic, Tropics and mid-latitudes is described. Because the base state and variability of cloud properties is used to develop and evaluate cloud parameterization schemes and remote sensing retrievals, the link between cloud properties (ice crystal aspect ratios, crystal shapes, ice crystal size distributions, liquid fractions of mixed-phase clouds) and environmental conditions (location, temperature, total water content, cloud formation mechanism) is presented. Implications for representing cloud microphysics in models and retrieval schemes are discussed.