The microphysical and radiative properties of tropical cirrus observed during TWP-ICE

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Motivation

In-situ data acquired during TWP-ICE by the Scaled Composites Proteus in aged cirrus, fresh anvils, and cirrus of unknown origin are used to investigate the following questions:
1. Are measurements of small crystal concentrations (maximum dimension $D < 50 \mu m$) affected by shattering on inlets/shrouds of probes?
2. Are measurements of size-resolved properties consistent with measurements from bulk probes?
3. How do statistical properties of fresh anvils differ from those of aged cirrus?
4. How do crystal shapes in fresh anvils differ from those in aged cirrus?
5. Can models be developed to describe crystal shapes of fresh anvils/aged cirrus from which single-scattering properties can be computed?

Small Crystal Concentrations

The Cloud and Aerosol Spectrometer (CAS) and Cloud Droplet Probe (CDP) measure concentrations of crystals with $D < 50 \mu m$ using the same working principle (forward scattering) and look-up table. The CAS has a shroud and inlet, whereas the CDP does not (Figure 1 and 2).

Fresh Anvil vs. Aged Cirrus

Crystal Shapes

FIG 11: Representative crystals imaged by CPI during 12 km altitude leg flown through aged cirrus on 29 Jan. 2006. Bullet rosettes and aggregates dominate.

FIG 12: As in FIG. 11, but in fresh anvil 2 Feb. Bullet rosettes absent and plates/aggregates dominate. Statistically significant differences in shapes of large crystals seen in fresh anvils/aged cirrus, small crystals always predominantly quasi-spheres.

Comparing Size-Resolved/Bulk IWC

FIG 4: Sample images from CPI with hollows (out of focus images)

FIG 5: Korolev algorithm realizes hollows, but IWC derived from CIP SDs < IWC measured by Cloud Spectrometer and Impactor (CSI).

FIG 6: IWC derived from Cloud particle Imager (CPI) SDs closer to CSI bulk values.

FIG 15: Idealized plate aggregates with different aggregation index (AI)

Results show CAS affected by shattering—need to determine if shattering exists for other forward scattering probes in other meteorological conditions

Comparison between properties of aged cirrus and fresh anvils shows small crystals more numerous in fresh anvils.

References/Acknowledgments


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