Hemispheric comparison of cirrus cloud evolution using in situ measurements in HIAPER Pole-to-Pole Observations

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Contact information:

• Cirrus cloud and ice supersaturation

Cirrus clouds have large but highly uncertain impacts on Earth’s climate [Chen et al. 2000]. However, due to lack of datasets with both microscale resolution and global coverage, it is unclear if hemispheric differences exist in cirrus cloud microphysical properties and their evolution. Here we compare the time evolution of cirrus clouds’ horizontal segments: ice crystal regions (ICRs) and ice supersaturated regions (ISSRs) at temperature (T) ≤ -40 °C and show different result with previous studies.

• Definitions of ice crystal regions (ICRs) and ice supersaturated regions (ISSRs)

- Phase 1: Clear-sky ISSRs
- Phase 2: Ice crystal nucleation
- Phase 3: Ice crystal early growth
- Phase 4: Ice crystal later growth
- Phase 5: Sedimentation/evaporation

• Hemispheric comparison of RHI evolution

• Conclusions:

1. Similar clear-sky ISS frequencies were observed in the NH and SH, as well as similar mean RHI. Nc and Dc along the five-phase evolution of ISSRs and ICRs.
2. Similar relative timescale of each of five phases between the NH and SH.
3. This result is different from the observations of Ovarlez et al. [2002] which showed that the clear-sky ISS frequency is higher in the SH than NH.

Implications to understanding hemispheric differences in cirrus cloud formation and evolution

1. Hemispheric comparisons are sensitive to the sampling domain and resolution (Kahn et al. 2009), which points out the importance of additional in situ observations across large longitudinal and latitudinal domains.
2. Even though the aerosol optical depth in the SH is ~1 order of magnitude smaller than that in the NH (Clarke and Kapustin, 2010), no strong hemispheric differences were observed HIPPO. Question: whether the hemispheric differences in aerosol forcing would directly influence the formation and evolution of ice crystals, or whether the SH has sufficient amount of efficient ice nuclei.
3. Future study needs to address individual factors: e.g., large scale dynamics, seasonal variability, land versus ocean differences, and aerosol indirect effects.

References: