Global statistics of microphysical properties of cloud-top ice crystals

Ice properties are important for radiation, cloud evolution, precipitation efficiencies, etc. Ice properties are known to vary with, e.g., temperature, humidity (see Fig. on the left and below), and ice nucleation availability. Determining such relationships in the complex atmosphere remains elusive.

2: Optical properties of ice crystals

- Optical thickness
- Ice number
- Ice size distribution

3: Shape and asymmetry parameter retrieval approach

- Aspect ratio and roughness of prisms
- Hexagonal prisms are retrieved by matching multi-angle polarized reflectance at 120°-150° scattering angles with a model.
- The ratio between polarization and aspect ratio and roughness can be seen on the right.

4: Data
- POLARIS-MODIS collocated data at 6.5 km resolution for 2007
- MODIS collection 6 ice effective radius and optical thickness and height
- Conservative ice cloud filter: POLARIS-MODIS phase index
- Extra rainbow detection phase index

6: Global distribution of average optical thickness (of ice clouds with s>5)

7: Yearly-averaged global distribution of cloud-top properties

8: Seasonal variation of profiles (for ice clouds over ocean with s>5)

9: General tendencies

10: Implied % bias on MODIS C6 retrieved s and s from constant asymmetry parameter

MODIS collection 6 retrievals assume an ice model with an asymmetry parameter of 0.754 in the visible.

When the real asymmetry parameter is p., this assumption creates biases of (s-p)/s = 0.005, as seen below. Maps on the right show average biases.

References
- van Diedenhoven et al. J. ANT 2012
- MODIS et al. AOP 2015
- Wielentier et al. J. ANT 2016
- Niskanen et al. J. ANT 2016