Comparison of cloud phases derived by MODIS and CALIOP products

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I. Introduction

The nearly simultaneous observations of clouds from CALIPSO measurements and MODIS-based cloud retrievals have potential to substantially advance our knowledge about the microphysical and optical properties of clouds and their inherent relationships for various cloud systems. The CALIOP 532-nm channel's dual polarization provides unique capabilities for studying hydrometeors in the atmosphere. In this study, we analyzed the relationship between the lidar backscatter and the depolarization ratio for nine types of cloud systems based on the International Satellite Cloud Climatology Project (ISCCP) cloud classification scheme (Rossow and Schiffer, 1999). We also evaluated several hypotheses of MODIS IR phase retrievals, presented by Nasiri and Kahn (2008) in their primarily radiative transfer modeling study, by comparing to the CALIPSO cloud products.

II. Data

❑ The CALIPSO cloud products (level 2 1-km spatial resolution)

- Layer-integrated attenuated backscatter (γ') at 532nm

$$\gamma' = \int_{top}^{base} [\beta'_{//}(z) + \beta'_{\perp}(z)]dz$$

- Layer-integrated depolarization ratio (δ)

$$\delta = \frac{\int_{top}^{base} \beta'_{\perp}(z)dz}{\int_{top}^{base} \beta'_{//}(z)dz}$$

where, $\beta'_{//}$: parallel component of the attenuated backscatter

$\beta'_{\perp}$: perpendicular component of the attenuated backscatter

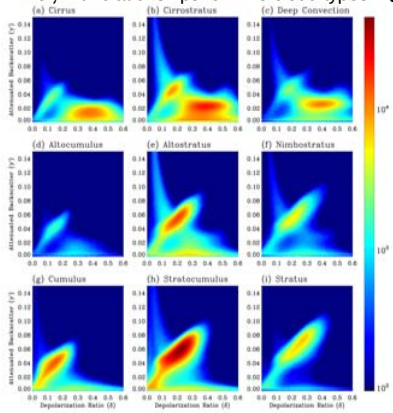
- For $\gamma'-\delta$ relationships, uppermost daytime cloud layers during 12 months from July 2006 to June 2007
- For phase comparison, single layers during 6 months from January to June 2008

❑ The MODIS cloud products (MYD06_L2)

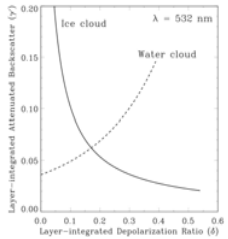
- Cloud top pressure, Optical thickness
- Cloud phase (Bispectral IR algorithm)

III. The $\gamma'-\delta$ relationships

❑ The $\gamma'-\delta$ relationships for nine cloud types



❑ Schematic curves of the $\gamma'-\delta$ relationships



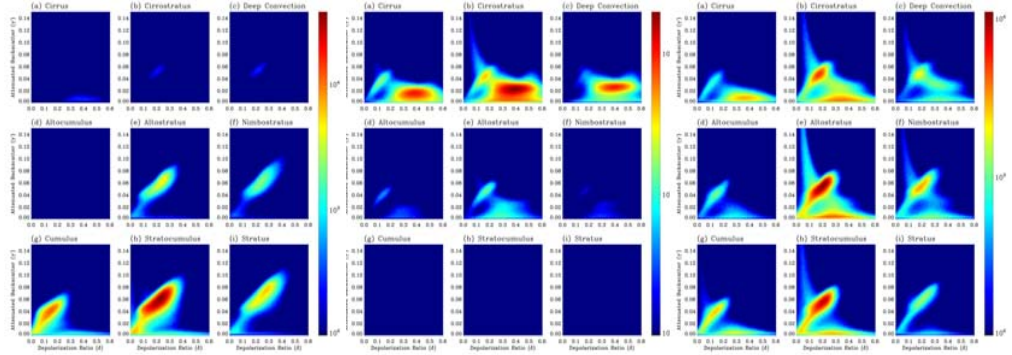
(Hu et al., 2007)

- Randomly-oriented ice particles : high cloud
- Horizontally-oriented ice particles : high & middle cloud, stratocumulus
- Water droplets : mainly middle & low cloud, but also high cloud

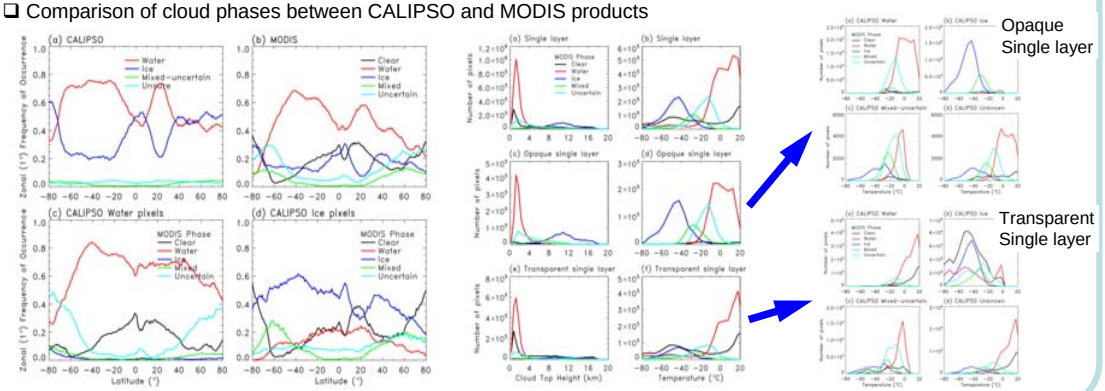
IV. Results

❑ The $\gamma'-\delta$ relationships classified by the MODIS Bispectral IR phase

Water phase | Ice phase | Mixed or uncertain phase



❑ Comparison of cloud phases between CALIPSO and MODIS products



V. Summary

❑ Water clouds flagged by the MODIS algorithm show only water phase features in the $\gamma'-\delta$ relation; however, for the ice clouds flagged by the MODIS algorithm, the co-existence of ice- and water-phase clouds is still observed in the CALIOP $\gamma'-\delta$ relationship. Water feature identified as ice phase by MODIS may be a thick cloud containing thin ice layer over water droplets.

❑ The MODIS IR phase algorithm may tend to 1) classify thin cirrus clouds as water clouds, 2) classify thin cirrus clouds as mixed or unknown, and 3) classify midlevel and/or mid-temperature clouds as mixed or unknown phase.

References:

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