**Background**

- MODIS IR observations (8.5, 11 and 12 μm) provide direct information on cirrus cloud microphysic properties (optical depth, particle size).
- These observations coupled with the standard MYD06 CO₂ slicing cloud height retrievals allow for estimation of cirrus microphysics for all times of day.
- This day/night consistency will allow for diurnal studies of cirrus cloud microphysics – a fundamental property missing from the standard daytime only MYD06 retrievals of cloud properties.
- The work shown below also demonstrates these observations can be used to infer information on the dominant ice crystal habit at cloud-top.
- This knowledge may prove critical in resolving the spectral inconsistency in the cirrus optical depths derived from solar reflectance and IR channels.

**Our Project Status**

- Develop an algorithm to derive cirrus optical and microphysical properties from the MODIS IR observations coupled with existing MYD06 cloud heights [DONE]
- Conduct studies to characterize and understand the IR results in relation to the existing daytime products. [In Progress]
- Implement into future MODIS/NPP Atmospheres data products. [To be Done – not funded yet]

**Methodology**

- Using MYD06 cloud height, cloud emissivities are computed for 8.5, 11 and 12 μm observations from which β values (akin to Angstrom exponents) are derived from the 8.5/11 and 11/12 channel pairs. Only single layer cirrus pixels used.
- For a given habit and a given channel combination, a value of effective radius can be derived from each β value (see figures of β values as a function effective radius for each habit). Ice scattering properties provided by Ping Yang et. al. 2005.
- An optimal analysis is selected based on the method that produces the minimum effective radius difference in the effective radius from each habit. As shown below resulting effective radius difference is << 10 μm which indicates that method has skill. (Optimal differences are small than those when habit is ignored).

**Distribution of Dominant Cloud-Top Ice Crystal Habit**

- Bulk habit distributions show distinct and coherent patterns over these 10 days.
- Global distributions of cloud-top dominant ice habit are largely unexplored.
- Zonal distributions and distributions with MYD06 cloud-top temperature are shown below.
- Relative occurrence of MODIS CS (wrt to all individual habits) is rare.
- Distribution with temperature shows definite patterns that could be exploited in future bulk scattering models.
- For this 10 day period, plates were the most common habit around -20N which is also the region where the IR and MYD06 are in closest agreement.

**Comparison to Current MYD06**

- For greatest impact, we have to understand and reconcile the IR and MYD06 estimates.
- MYD06 optical depths are roughly a factor of two larger than IR optical depths (adjusted to 0.65 μm).
- Note this is similar to comparisons of CALIPSO/CALIOP optical depths to MYD06.
- MYD06 particle radii are much smaller than the IR estimates using the optimal habit.
- This implies that MYD06 models are too absorbing at 2.1 μm and scatter too much in the forward direction at 0.65 μm. (relative to the IR models)
- Zhibo Zhang’s recent work indicates that vertical variations can not account for this.

**Impact of Habit on IR Retrievals**

- No habit can bring the MYD06 and IR optical into agreement.
- Plates generated mean zonal particle sizes close to MYD06.
- The optimal habit results more closely follow aggregates, not plates.
- CS results do not follow MYD06 (though CS habit mixture used in MYD06)

**Conclusions**

- The MODIS IR observations provide useful information on cirrus microphysics that complements that available currently in MYD06.
- This includes some information on ice crystal habit – this work represents one of the first satellite inferences of habit.
- This methodology fits well with the current MYD06 framework and could be added to future versions of MYD06. We are proposing this.
- The IR results are not consistent with the MYD06 results generated from solar reflectances.
- Our analysis indicates that the CS mixture may be too heavily influenced by columns.
- These inferences are likely to change when new more realistic scattering models are available from Ping Yang.

**References**


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