MODIS/CALIPSO Comparisons: Cloud Detection and Altitude

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What is a cloud?

“I know one when I see one.”
ARCL cloud fraction over a 30 minute time period, were ARCL cloud fraction of less than 5% is considered clear. MODIS confidences of greater than 0.95 are considered clear. Agreement between the two approaches is 84% agreement for Terra, 82% for Aqua.

<table>
<thead>
<tr>
<th></th>
<th>ARCL Clear</th>
<th>ARCL Cloud</th>
<th>ARCL Clear</th>
<th>ARCL Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODIS Clear</td>
<td>146 (117)</td>
<td>45 (58)</td>
<td>27.9% (31.5)</td>
<td>8.5% (15.6)</td>
</tr>
<tr>
<td>MODIS Cloudy</td>
<td>38 (12)</td>
<td>298 (185)</td>
<td>7.2% (3.2)</td>
<td>56.5% (49.7)</td>
</tr>
</tbody>
</table>

Comparison of MODIS with 3 years of ARM site observations
MODIS/CALIPSO Collocation

Collocation of MAS with CPL.

Build on this experience, but start simple

MODIS meeting 11/1/2006
What is a cloud?

Preparing for CALIPSO and MODIS: CPL and MAS

The number of occurrences that MAS scene was identified as clear and the cloud physics lidar (McGill, 2002) detected a cloud optical depths (visible wavelengths). This figure suggests that the cloud limit is approximately optical depth 0.3
CALIPSO Backscatter scene

Total Attenuated Backscatter 532 nm

black – CALIPSO,
red – MODIS CO2
Derived cloud top altitude comparison

![Histogram of cloud top altitude differences between MODIS and CALIPSO](image)

- **All Cloudy FOV**
- **CALIPSO >= 6 km**
- **CALIPSO < 4 km**

**Normalized Frequency** vs. **CALIPSO - MODIS (km)**

MODIS meeting 11/1/2006
532 nm Total Attenuated Backscatter, /km /sr
Version: 1.00 Image Date: 09/27/2006

Cloud masking....
Better than I expected...
June 15, 2006 day and night, CALISPO CA>0.95

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<tr>
<th></th>
<th>MODIS CLEAR</th>
<th>MODIS CLOUDY</th>
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</thead>
<tbody>
<tr>
<td>CALIPSO CLEAR</td>
<td>21.6%</td>
<td>5.3%</td>
</tr>
<tr>
<td>CALIPSO CLOUDY</td>
<td>12.8%</td>
<td>60.2%</td>
</tr>
</tbody>
</table>
June 15, 2006 *day only*, CALIPSO CA>0.95

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<thead>
<tr>
<th>CALIPSO</th>
<th>MODIS CLEAR</th>
<th>MODIS CLOUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAR</td>
<td>25.4%</td>
<td>7.4%</td>
</tr>
<tr>
<td>CLOUDY</td>
<td>10.5%</td>
<td>56.7%</td>
</tr>
</tbody>
</table>
Cloud top altitudes from CALIPSO of collocated scenes on June 15, 2006

MODIS & CALIPSO detect cloud

Lots of low level cloud
MODIS clear, CALIPSO cloudy

June 15, 2006 day only, CALIPSO CA > 0.95

June 15, 2006, Daytime MODIS clear, CALIPSO cloudy
MODIS clear, CALIPSO cloudy
June 15, 2006 non-polar regions, night only, CALIPSO CA>0.95
MODIS clear, CALIPSO cloudy

June 15, 2006 daytime, ocean sun-glint free
MODIS clear, CALIPSO cloudy

June 15, 2006 daytime, ocean sun-glint region
MODIS clear, CALIPSO cloudy

June 15, 2006 daytime, land scenes
MODIS clear, CALIPSO cloudy

June 15, 2006 daytime, desert scenes
Where are these low clouds when MODIS clear, CALIPSO Cloud?

June 15, MODIS Clear, CALIPSO cloud top < 2 km
MODIS & CALIPSO see cloud
Cloud Altitude Difference < 1.5 km

June 15, differences < 1.5
MODIS & CALIPSO see cloud

Cloud Altitude Difference > 5 km

June 15, differences > 5
Summary

- In general, global comparison of CALIPSO and MODIS cloud detection consistent with expectations (~80% agreement).
- Consistency between comparisons ground based and surface based active systems.
- Lots of mis-matches with CALIPSO low-level cloud (MODIS clear, CALIPSO Cloudy).
- CO$_2$ cloud height biases of cirrus consistent with expectations.
- Preliminary comparisons, we continue to explore differences....