The MODIS Cloud Data Record

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Overview

Cloud Fraction and Cloud Top Pressure Overview

- Trend?
- Aqua/Terra difference

MODIS Considerations and Biases

- View Angle
- Surface Type
- Other Cloud Fractions from MODIS?
- Averaging games

Some Prelim Comparisons
Global Means

- Day time Cloud Fraction
- Coast lines evident
- Differences where expected: maritime stratocumulus decks, SH land, etc.
Global Means

- Collection 5 Data
- Collection 6 will come soon
  - higher CTP
  - improved sfc
  - 1 km CTP

- 36 spectral bands
- 10:30 am/pm Terra
- 1:30 am/pm Aqua

- CTP:
  - 4 CO₂ bands plus 10μm

- Cloud Top Temperature and Pressure are linearly related...will skip CTT
CF daytime decadal change .35%

• Trend is not significant
  • Would need a 14 year record with this trend
  • If pre-2003 data is removed no trend at all

• Aqua and Terra agree very well Terra until recently was slightly higher than Aqua
Daily Zonal Hovmoller: Terra Daytime Cloud Top Pressure Anomaly

-100 hPa to 100 hPa
Cloud Fraction Day Difference for 7 yrs (Aqua minus Terra)
View Angle Biases

Single Day in the MODIS Orbit

- Geostationary-like view
- 16 day orbit procession
- U-Shape at edges of convection and cloudy regions
- See through holes in clouds or through thin high clouds near nadir
- Most other data sets show similar characteristics
Daytime Cloud Fraction Mean

- Differences not uniform
- Largest differences not where thin high clouds exist

Nadir to 10°

60° to edge of scan
Cloud Fraction vs Viewing Angle

- 7 years of Aqua and Terra
- 16% increase from near nadir to edge of scan
- View angle effect not constant for all cloud types
Nadir vs Edge of Scan

- Changes are not uniform
- Largest changes in CF aren’t the same as largest changes in optical properties

Maddux, B. C., S. A. Ackerman, and S. Platnick, 2010: View Geometry Dependencies in MODIS Cloud Products, J. Tech A, Accepted.
Cloud Fraction Difference Due to Sensor Zenith Angle

Cloud Fraction Difference

Day of year

Cloud Fraction Mean for High (Red) and Low (Blue) Sensor Zenith Angle

Mean Cloud Fraction

Day of year
Active vs. Passive

Surface Type

- MODIS vs Calipso for 2-years of data over Arctic

Figure 5: The mean cloud fraction September to October 2007 (a), difference between 2007 and 2006 September to October mean cloud fraction from MODIS (b), CloudSat/CALIPSO (c), and AMSR-E SIC anomalies (d) for 2007 versus the 2002-2007 time period. White areas for CloudSat/CALIPSO signify an insufficient number of observations, with less than 1800 observations.
### Active vs. Passive

- MODIS vs Calipso for 2-years of data over Arctic
- Large bias at night over ice assuming Calipso is truth
- 21% error in CF translates to a trend error of 2.6%/decade

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**Day**

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<th>Calipso</th>
<th>MODIS-Calipso</th>
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**Night**

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Liu, Y., S. Ackerman, B. Maddux, J. Key, and R. Frey, 2010: Errors in cloud detection over the Arctic using a satellite imager and implications for observing feedback mechanisms, J. Climate, 23(7), 1894-1907.
Who sees a cloud?

- Comparison to other cloud datasets (apples-to-apples)
- Place ‘error bars’ on global mean statistics
- Quantify cloud variability globally

Figure A2: Daily mean cloud amount September 2007 anomaly using (top left) MODIS “Cloud_Fraction_Day_Mean” (CF), and (top right) MODIS “Cloud_Fraction_Combined” (CFC), (bottom left) the difference of the September 2007 anomalies of CF and CFC (CFC minus CF) and (bottom right) the difference between CF and CFC (CFC minus CF).
MOD06 cloud fraction is a quality assured subset of MOD35 to retrieve better cloud optical properties.
Mean Cloud Fraction Difference in Percent (MOD35-MOD06)/MOD35

Differences are due to the QA stuff (clear sky restoral and cloud edges, thin clouds, and surfaces influences).
CTP (red-all cloud) and CTP where OD retrieved (blue) histogram

COD, Re, and WP are blue
CTP and CF are red
More mid level cloud at high latitudes.

But temporal averaging puts high and low clouds together from multiple swaths.
Grid Cell Size and Swath Overlap

Cloud Top Pressure Histogram

21% of mid level clouds in a 1x1 degree grid cell are mid level clouds
Pixel vs Area Weighting

- Not a uniform offset
- Doesn’t change long term mean (.2%)
- Polar regions oscillate opposite mid-latitudes

MODIS Terra Cloud Fraction Area (Red) and Pixel (Blue)
1 degree grid cell averaged does not work for Calipso comparison
High Cloud Fraction  MODIS vs Calipso

10 degree averages are lot better?
High Cloud Fraction MODIS vs Calipso

10 degree colored by Latitude
10 degree ISCCP vs MODIS
High Latitude ISCCP disagrees with MODIS and Calipso
MODIS CODH vs MODIS CF

Colored by MODIS minus Calipso CF
Conclusions

MODIS

Annual Cycle: 2.1%
Decadal Change: .35%
Aqua Terra Difference: <2%

Local Surface Type Biases: 40%
Local View Angle Bias: 60% (globally \(\approx 16\% \text{ or } 4\%\))