A Comparison of GOES Cloud Property Retrievals With Ground and Satellite Based Reference Data From SGP

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Introduction

Daytime and nighttime cloud properties (height, optical depth, effective radius, and liquid/ice water path) have been retrieved from geostationary satellite data starting with GOES-8. The retrievals are based on a legacy algorithm that was developed at NASA Langley Research Center for the CERES (Clouds and the Earth's Radiant Energy System) project, and have been applied to data from GOES, AVHRR, MODIS, MTSAT and MSG. In addition to being available in real-time from NASA, these products are available from the ARM data archive at pixel level resolution over a 10 degree by 14 degree lat/lon area centered over the SGP central facility at Lamont, OK. This poster summarizes the efforts currently underway at NASA Langley to assess the accuracy and reliability of both the daytime and nighttime cloud optical property retrievals from GOES. Comparisons are made with ground-based reference data from SGP (Raman Lidar), as well as retrieval products from other satellite platforms (CLOUDSAT, CALIPSO).

Cloud Top Height: GOES vs. CALIPSO and CLOUDSAT

Data

•GOES-11 pixel-level V2 (6/25/2006-6/7/2007) and V3 (6/8/2007 – 2/14/2009) retrievals, downloaded in ncdf format from ARM.

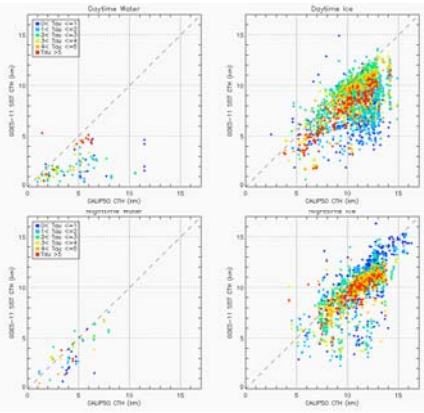
•CALIPSO L2 V2 5 km cloud layer data

•CLOUDSAT L2 5 km GEOPROF-LIDAR data

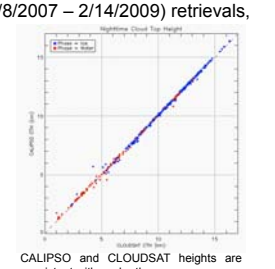
Constraints

•Spatial domain: 32º to 42º N, 91º to 105º W

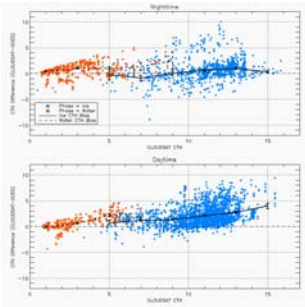
- Time domain: Jun 2006 to Feb 2009
- Optical depth between $0.3 \leq \tau \leq 6$
- Maximum distance between obs = 5 km
- Maximum time difference between obs = 10 min
- # cloud layers: CLOUDSAT = 1 and CALIPSO ≠ 0
- All 3 satellite retrievals return the same phase



GOES CTH compared with CALIPSO CTH for a 10X14 degree domain centered over SGP. Daytime comparisons are shown in the top row, nighttime in the bottom row. Water (ice) clouds are shown in the left (right) column.



CALIPSO and CLOUDSAT heights are consistent with each other.



CLOUDSAT-GOES CTH difference, shown vs. CLOUDSAT CTH. Nighttime is shown in the top plot, daytime in the bottom plot. Nighttime ice cloud retrievals show very little bias, while daytime show a significant bias above ~ 10 km. Mid-level (3-6 km) water clouds exhibit a significant bias for both day and night.

	RMS	Bias	Standard Deviation	N
Day Ice	2.910	-2.178	1.929	2541
Day Water	3.365	-2.445	2.322	123
Night Ice	1.654	-0.369	1.612	4554
Night Water	1.454	-0.863	1.180	62

Table of cloud top height difference statistics (GOES – CALIPSO). Bias<0 indicates that GOES < CALIPSO.

Cloud Optical Properties: GOES vs. Raman Lidar

Data

•10 minute averaged Raman Lidar retrievals from May 1998 to Jan 2004, centered on the GOES observation time

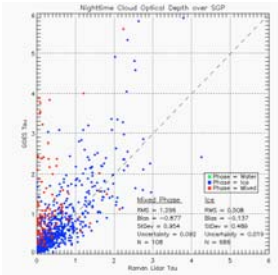
•GOES-8 (05/1998-03/2003) and GOES-10 (04/2003-01/2004) 10 km averaged retrieval data, centered over SGP

Constraints

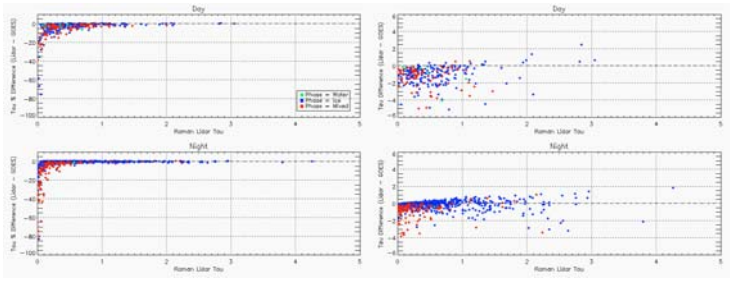
•GOES 10 km averaged cloud fraction ≥ 0.2

•ARSCL # cloud layers = 1, and ARSCL cloud base height ≥ 5 km

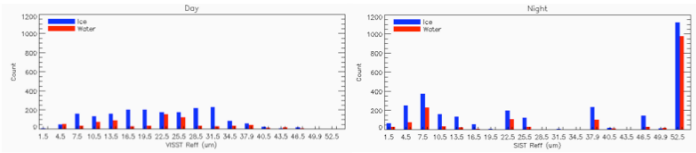
•Optical depth limited to GOES $\tau \leq 6$



Nighttime GOES cloud optical depth compared with Raman Lidar optical depth over SGP.



Percent difference (left column) and absolute difference (right column) between GOES cloud optical depth and Raman Lidar optical depth over SGP. Daytime comparisons are shown in the top row, nighttime in the bottom row. Ice, water, and mixed-phase clouds (as determined by GOES) are shown in blue, green, and red, respectively.



Daytime (left) and nighttime (right) GOES retrieved cloud effective radius, grouped into 3 μm bins. Note the large number of nighttime observations with a radius in the largest bin. This is thought to be an artifact of the retrieval, and is being examined. Possible causes are the background emittance parameterization or satellite calibration (especially for the 3.9 μm channel).

Acknowledgements

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CLOUDSAT data were obtained from the Cooperative Institute for Research in the Atmosphere (CIRA) CLOUDSAT Data Processing Center at Colorado State University

GOES data, Raman Lidar data, and Microwave Radiometer data were obtained from the Atmospheric Radiation Measurement program Climate Research Facility data archive

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Conclusions

Compared to CALIPSO and CLOUDSAT, the GOES-11 daytime cloud top heights are biased low for both water and ice clouds. Larger differences are observed for high clouds (> 10 km) and low optical depth clouds (tau < 2). GOES-11 nighttime cloud top heights show a near zero bias for ice clouds, and a slight negative bias for water clouds. Though the bias is small, a significant amount of scatter is observed. Nighttime GOES-8/10 ice optical depth shows reasonable agreement with the Raman, with the largest errors being associated with clouds for which the Raman tau > 2. Mixed phase/water clouds and daytime retrievals do not show good agreement with the Raman Lidar.