Evaluation of CloudSat Liquid Water Path Observations using CALIPSO, AMSR-E and MODIS Cloud Products

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Introduction

The high sensitivity of CloudSat's Cloud Profiling Radar (CPR) to cloud liquid water content and its sounding capability provide a unique opportunity to study the role of cloud water in the climate system. However, the CPR's high sensitivity to drizzle can produce high biases in cloud liquid water path (LWP) estimates for stratiform marine clouds (Matrosov 2004). Furthermore, surface contamination effectively prevents the CPR from completely sampling shallow clouds or, in some cases, misses them entirely if the clouds lie below about 1 km and are not precipitating.

This study provides a preliminary assessment of CPR-derived LWP observations for nonprecipitating low-level clouds over the oceans using MODIS and AMSR-E observations of LWP.

Data

- Satellite data on Aqua for July 2007 were used
- AMSR-E Level 2A brightness temperature data and Level 2B Ocean Swath products
- Level 2 MODIS data:
  - MYD03 (Geolocation)
  - MYD06 (Cloud products, including LWP, optical depth, and effective radius)
  - MYD35 (Cloud mask)
- Level 2 CloudSat data:
  - 2B-GEOPROF-LIDAR (Combined CloudSat and CALIPSO geometric profiling products)
  - 2B-TAU (optical depth products)
  - 2B-CWC (cloud water content products)
  - 2C-PREC-COLUMN (column precipitation products)

Methods

- Comparisons made at AMSR-E LWP product resolution (10 x 14 km)
- Detailed collocation:
  - MYD06 LWP data were averaged over AMSR-E FOV weighted by antenna pattern
  - CloudSat data were collected within AMSR-FOV (typically 7-10 profiles)
- Criteria used for comparison:
  - Overcast (100% cloud cover within AMSR-E FOV)
  - Nonprecipitating conditions (determined as zero rainfall rate from 2C-PREC-COLUMN products)
  - Cloud tops below 3 km (as determined by 2B-GEOPROF-LIDAR products)

Results

Initial comparisons for selected MODIS granules (Fig. 1) revealed poor agreement between standard (MYD06) MODIS LWP observations collocated with CloudSat LWP observations (variable *RO_liq_water_path* from the 2B-CWC dataset). Further investigation revealed a discrepancy between the 2B-CWC LWP observations and LWP derived from optical depth (*total_optical_depth*) and effective radius (*mean_effective_radius*) obtained from the 2B-TAU datasets (Fig. 2). This discrepancy appears to be caused by an inconsistency between the retrieved LWC profile (*RO_liq_water_content*) and the retrieved optical depth profile (*layer_optical_depth*), where LWC values are not reported at all valid cloud layers as determined from the CloudSat cloud mask (see an example in Figs. 3 and 4).

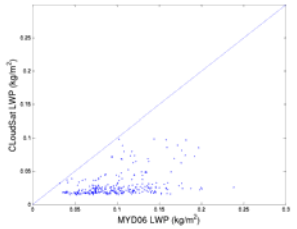


Fig. 1

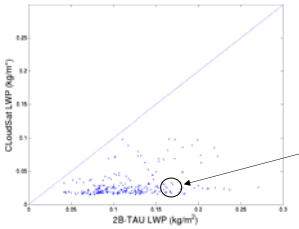


Fig. 2

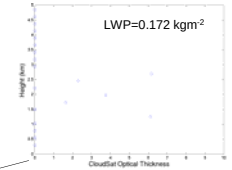


Fig. 3

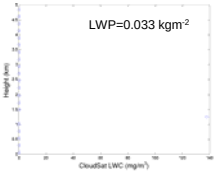
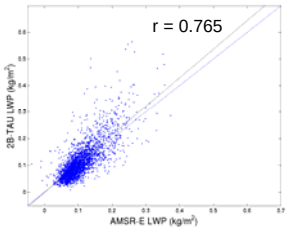
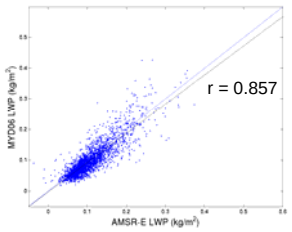


Fig. 4

Comparisons of LWP derived from 2B-TAU optical thickness and effective radius data (right) show relatively good agreement with collocated AMSR-E LWP observations for July 2007. The reliability of the AMSR-E LWP observations were checked against collocated MYD06 LWP observations (far right).





Conclusions

Apparent issues with certain CloudSat 2B-CWC products precluded a comparison of CloudSat LWP observations with MODIS and AMSR-E LWP observations. However, LWP derived from the 2B-TAU products (which are based in part on Level 1b MODIS data) showed relatively good agreement with AMSR-E observations.

References

Matrosov, S. Y., 2004: Evaluation of radar reflectivity-based estimates of water content in stratiform marine clouds. J. Appl. Meteor., 43, 405-419.

Acknowledgments

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