Validation of Cirrus Infrared Scattering Properties Used in the Production of Simulated GOES-R ABI Proxy Data

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Goals

- Evaluate the accuracy of cirrus IR single-scattering/absorption properties in two radiative transfer models (RTMs) used in generating proxy Advanced Baseline Imager (ABI) data from WRF model simulations for GOES-R activities
- Exploit multi-sensor satellite data from the A-Train to evaluate these properties over a wide range of conditions

RTMs

- CIMSS RTM
  - SOI RT solver
  - Gas transmittance: CompactOPTRAN (CRTM v1.1)
  - Cloud properties: Heymsfield et al. (2003) and Baum et al. (2005)
  - IRSSEM (CRTM) – ocean surface emissivity model
- CRTM v2.02
  - MOM/Adding RT solver
  - Gas transmittance: ODAS (i.e., CompactOPTRAN)
  - Cloud properties: Baum et al. (2005)
  - IRSSEM

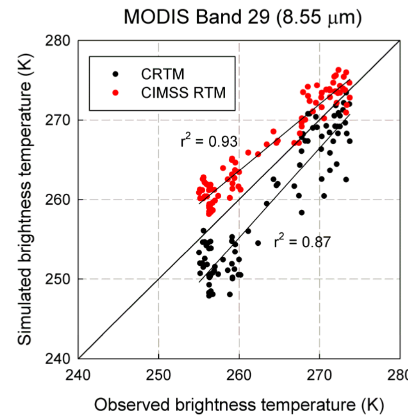
Data

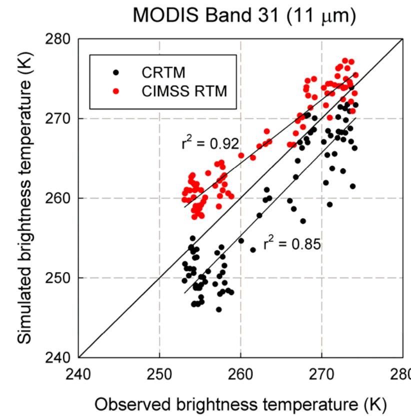
- CloudSat CPR
  - 2B-CWC-RO
  - 2C-PREC-COLUMN
  - 2B-GEOPROF
  - ECMWF-AUX
- Aqua MODIS
  - MYD021KM
  - MYD06 (Cloud products)
- CALIPSO CALIOP
  - LID_L2_05kmCLay-Prov-V2-01

Analysis Methods

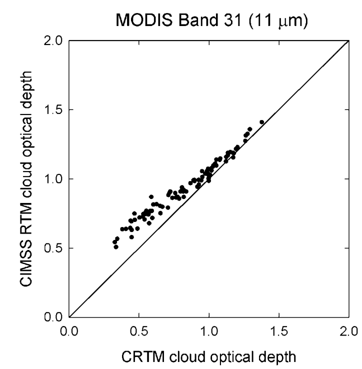
- To maximize the effect of scattering properties in the comparisons, cases (daytime, July 2007) were limited to these situations:
  - Window wavelengths: MODIS band 29 (8.55 µm) and 31 (11.02 µm)
  - High-level (> 7 km) single-layer cirrus with optical depth < 3
  - No low-level clouds (determined from CALIOP data)
  - Ocean only (reduces surface emissivity effects)
  - Non-precipitating clouds (based on CloudSat data)
- Input data for the RTMs:
  - Ice water content (IWC) profiles: CloudSat radar-only data (*Note: CALIOP-observed cloud top heights (CTH) were used to define top of profiles. If differences existed between CALIOP & CPR CTHs, then IWC at CPR threshold of detectability was used to fill in profiles*)
  - Ice particle effective radius (assumed constant with height): MODIS data
  - Temperature/humidity profiles and SST: ECMWF
- Method of Wang et al. (2011) was used to correct for parallax errors when collocating CloudSat and MODIS data.

Results





- CIMSS RTM (above) performs slightly better than the CRTM; however, errors in both RTMs are largely within the errors expected from uncertainties in the IWC and effective radius observations
- Large differences (up to 10 K) between the RTMs are evident despite the fact that similar scattering property databases are used
- Comparison of cloud optical depth at 11 µm between the RTMs (at right) shows they compare well at larger optical depths, where brightness temperature differences are greatest



Conclusions & Further Work

- Preliminary results show that both RTMs compare reasonably well against MODIS observations
- Large differences between the RTMs are not caused by significant differences in cloud optical depth or single-scattering albedo; suggesting the likely culprit is the scattering phase function
- Additional work will investigate further the cause(s) of the RTM differences and include a greater number of cases for analysis

References

Baum, B. A., A. J. Heymsfield, P. Yang, , and S. Thomas, 2005: Bulk scattering models for the remote sensing of ice clouds. 1: Microphysical Data and Models, *J. Appl. Meteor.*, 44, 1885-1895.

Heymsfield, A. J., S. Matrosov, and B. Baum, 2003: Ice water path-optical depth relationships for cirrus and deep stratiform ice cloud layers. *J. Appl. Meteor.*, 42, 1369-1390.

Wang, C., Z. J. Luo, and X. Huang (2011), Parallax correction in collocating CloudSat and Moderate Resolution Imaging Spectroradiometer (MODIS) observations: Method and application to convection study, *J. Geophys. Res.*, 116, D17201, doi:10.1029/2011JD016097.

Acknowledgments

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