Improvements on the Ice Cloud Optical Properties from Visible, Infrared, to Microwave Regions for the Community Radiative Transfer Model

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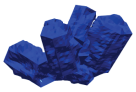
Introduction

- The Community Radiative Transfer Model (CRTM) is developed by the U.S Joint Center for Satellite Data Assimilation (JCSDA).
- CRTM is a powerful tool to perform radiance (and Jacobian) simulations at the top of the atmosphere (TOA) for a versatile of satellite instruments including visible, infrared and microwave sensors.
- Accurate cloud optical property look-up table is the prerequisite of accurate radiance simulation under cloudy sky.
- Temperature dependence of microwave ice property is significant.

Data and Ice Particle Model

MODIS Collection 6 (MC6) ice cloud particle model:

- ***Severely Roughened hexagonal column aggregate***
- ***Optical properties come from the database by Yang et al. (2013)***
- ***Database is extended to the MW***



Particle Size Distribution:

- Modified Gamma size distribution

$$n(r) = n_0 r^{(1-3b)/b} e^{-r/(ab)},$$

where n_0 is a constant,

b is the mean effective variance

Results

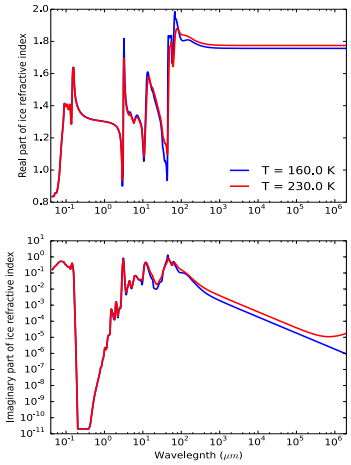


Figure 1. Complex ice refractive index at 160 and 230 K.

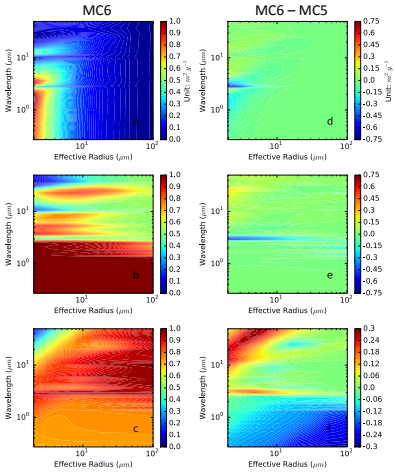


Figure 2. Bulk scattering properties of MC6 ice model in the VIS+IR.

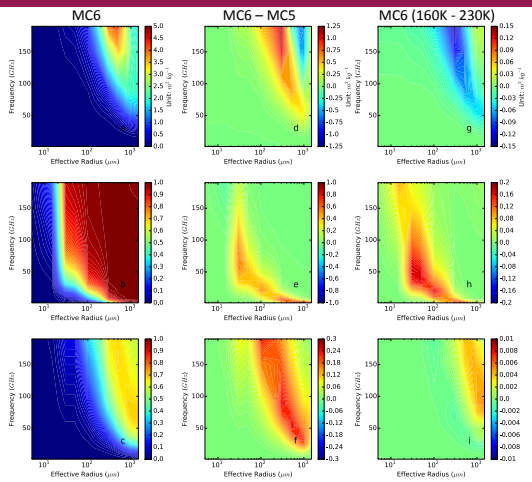


Figure 3. Bulk scattering properties of MC6 ice model in the microwave region and temperature dependence.

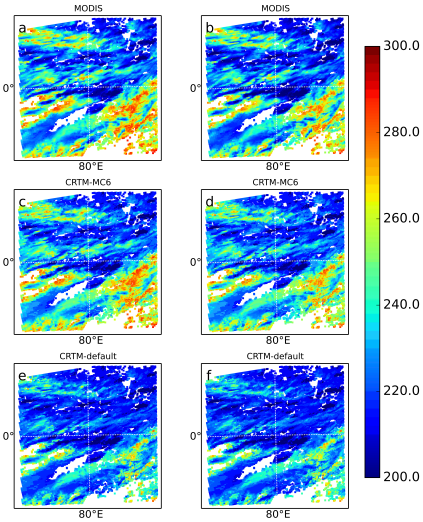


Figure 4. Comparison of observed and simulated brightness temperatures (BTs) at MODIS band 29 and 32.

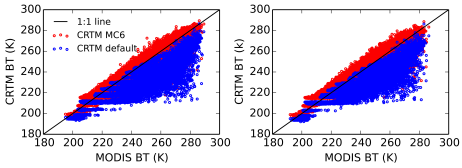


Figure 5. Scatter plot of observed and simulated MC6 BTs at MODIS band 29 and 32.

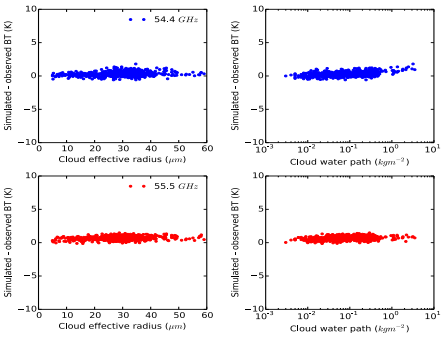


Figure 6. BT differences between MC6 simulations and AMSU-A observations.

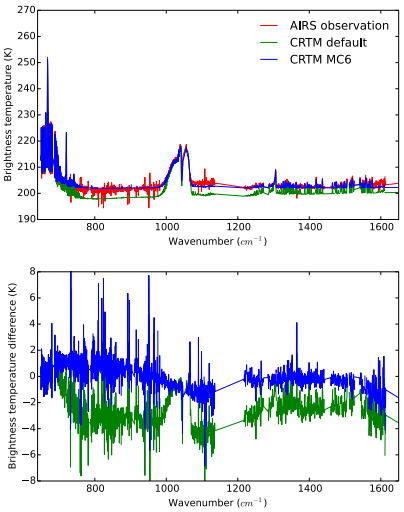


Figure 7. BT differences between CRTM simulations and AIRS observations.

Conclusions

- The ice cloud optical property lookup table for the Community Radiative Transfer Model is updated using the MODIS collection 6 ice particle model.
- Temperature dependence of ice refractive index has been added to the microwave ice optical properties.
- Comparisons between simulated and observed brightness temperatures are carried out for spectral and narrow band instruments like AIRS, MODIS, and AMSU-A.
- CRTM simulations with updated MC6 ice optical properties show much better performance in ice cloud modeling capabilities than the default MC5 ice model.

Acknowledgement and Reference

Reference: **Yi, B.**, P. Yang, Q. Liu, P. van Delst, S. Boukabara, and F. Weng, 2016: Improvements on the ice cloud modeling capabilities of the Community Radiative Transfer Model, submitted to *J. Geophys. Res. Atmos*. This study is supported by NOAA grant NA15NES440003.