Comparison of cloud properties between MODIS and AIRS

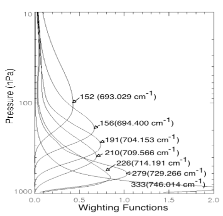
Y. K. Lee,[1] P. Yang,[1] Bryan A. Baum,[2] Hung-Lung Huang,[3] and Bo-Cai Gao[4]

1. Department of Atmospheric Sciences, Texas A&M University, College Station, Texas 77843
2. NASA Langley Research Center, Hampton, Virginia 23681
3. Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, 1225 W. Dayton Street, madison, Wisconsin 53706
4. Naval Research Laboratory, Washington, DC 20375

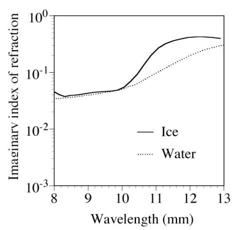
Abstract

This study reports on the comparison of cloud properties between MODIS and AIRS. The MODIS products have cloud properties such as cloud top pressure, effective cloud amount, cloud phase, cloud optical thickness and effective particle size for one layer clouds. For the comparison between MODIS and AIRS, the inference of cloud top properties (cloud top pressure,effective cloud amount, thermodynamic phase, optical thickness, and effective particle size) has been made from radiometric measurements and atmospheric profiles generated from the Atmospheric Infrared Sounder (AIRS) onboard the EOS AQUA platform. The CO_2 slicing method is applied to infer cloud top pressure from AIRS Level 1B (L1B) radiances; additional use is made of Level-2 (L2) Support products. Since there are 2378 wavenumber channels available within the infrared spectral region, more channels are used to find cloud top pressure than with the method as applied to MODIS 15-micron band data. In this study, the CO_2 slicing method uses forward calculations based on the Stand-Alone AIRS Radiative Transfer Algorithm (SARTA); it has 100 vertical pressure layers from 0.005 to 1100 hPa and is considered a fast and accurate radiative transfer model. The cloud thermodynamic phase is inferred from a bispectral method based on the 8.8- and 11-micron channels similar to that used by the MODIS atmospheres team. Based on the cloud top pressure and phase information in addition to a look-up database of ice particle scattering properties, optical thickness and effective particle size are inferred. For each fixel on an AIRS granule, Examples are shown for both ice cloud and water cloud cases.

Cloud top pressure, effective cloud amount and cloud phase determination

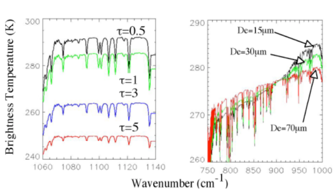


Several weighting function profiles for the AIRS CO2 spectral bands which will be used in this research. is the transmittance from pressure level p to top of the atmosphere.

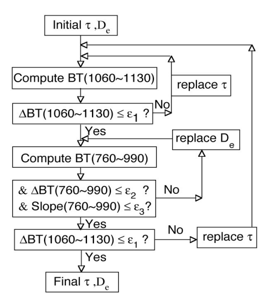


Imaginary index of refraction of ice and water

Cloud optical depth and effective particle size determination



Dependence of Brightness temperature on cloud optical thickness () when De = 30 micron (left) and effective particle size(De) when = 1 (right) using atmospheric environment of a pixel from AIRS granule with one cloud layer at 300 hPa.



Flow chart for the inference of cloud optical thickness and effective particle size

CO2 slicing method
- channels in the CO2 15 micron absorbing band are selected.
- 21 pairs of channels are used.
- SARTA is used to get clear sky radiance.
- output : cloud top pressure and effective cloud amount

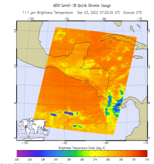
Cloud phase
- the variation of refractive index of ice and water cloud is used

Cloud optical depth
- Brightness temperature is sensitive to the range between 1060 cm-1 and 1130 cm^{-1}.

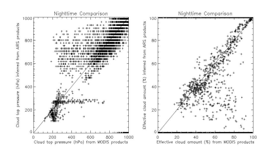
Effective particle size
-Brightness temperature is sensitive to the range 760 ~ 990 cm^{-1}.

Once the information such as cloud top pressure, effective cloud amount and cloud phase is available, cloud optical depth and effective particle size are inferred.

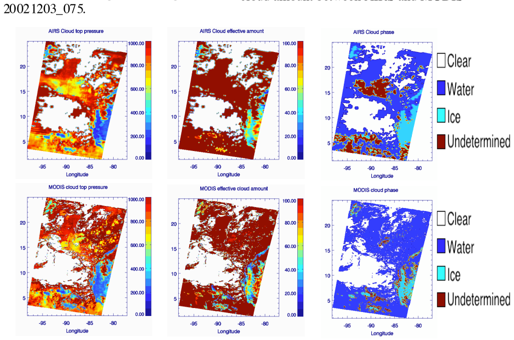
Comparison of Nighttime granule



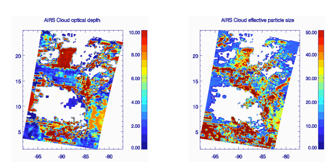
Brightness temperature at 900 cm-1 of an AIRS nighttime granule 20021203_075.



Comparison of Cloud top pressure and effective cloud amount between AIRS and MODIS

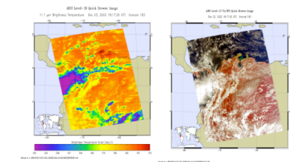


Comparison of cloud top pressure, effective cloud amount and cloud phase between AIRS nighttime granule and corresponding MODIS results.

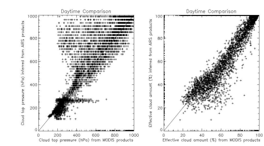


Optical depth and effective particle size retrieved from an AIRS nighttime granule.

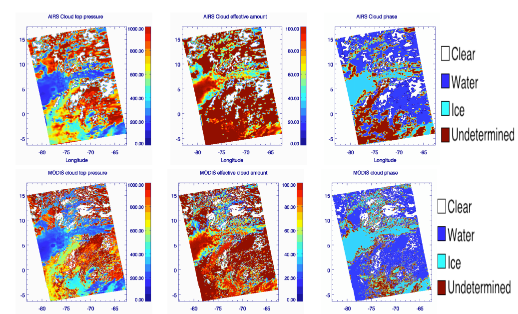
Comparison of Daytime granule



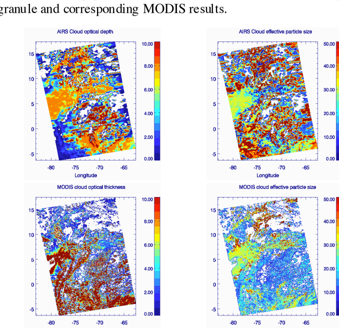
Brightness temperature at 900 cm-1 and visible image of an AIRS daytime granule 20021203_183.



Comparison of Cloud top pressure and effective cloud amount between AIRS and MODIS



Comparison of cloud top pressure, effective cloud amount and cloud phase between AIRS daytime granule and corresponding MODIS results.



Comparison of optical depth and effective particle size between an AIRS daytime granule and corresponding MODIS results.

Preliminary results and discussion :

Cloud properties are inferred using only infrared channels of AIRS and compared with the results from MODIS. The advantage of using AIRS infrared products is that it is applicable to both daytime and nighttime as shown in this study. Cloud optical depth and effective particle size are retrieved using infrared channels with the informaion of cloud top pressure, effective cloud amount and cloud phase.

Although the spacial resolution of AIRS is much lower than that of MODIS, the retrieval results is similar to those of MODIS observation with regard to cloud properties.