Intercomparisons of AIRS Observations with MERRA Reanalysis and Climate Models

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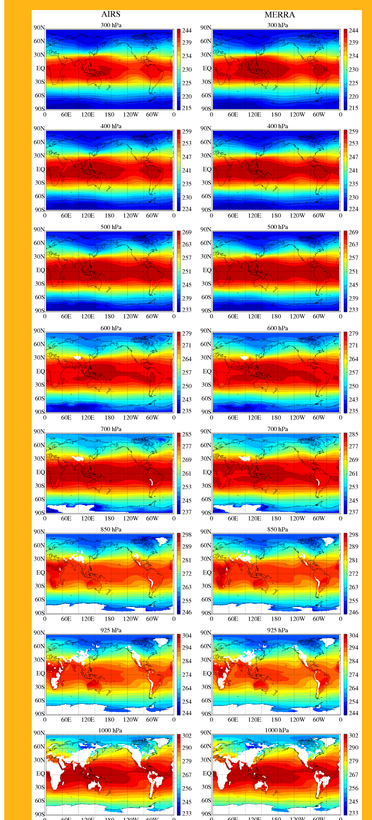
Abstract

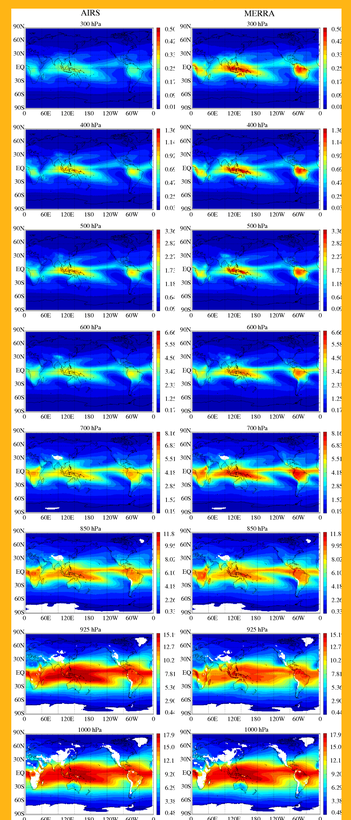
We perform intercomparisons among AIRS (Atmospheric Infrared Sounder) observations, MERRA (Modern-Era Retrospective Analysis for Research and Applications) reanalysis, and CMIP5 models. One of the greatest challenges of using satellite observations from Low Earth Orbit (LEO) to evaluate climate models is to account for differences in the sampling. Climate models are sampled on a regular grid with equal increments in time and space while LEO satellite observations are not. Since AIRS is an infrared instrument its sampling is also affected by clouds. Version 6 of the AIRS processing algorithm will have improved accuracy and increased sampling over the Version 5 algorithm. We compare AIRS and MERRA data with identical sampling to assess how well the satellite observations and reanalysis Water Vapor, Temperature, and Clouds agree when they have the same sampling. Since Version 6 of the AIRS processing algorithms also have improved sampling we use MERRA sampled like AIRS to estimate the improvement in the sampling bias between AIRS Version 5 and Version 6 Results. While the uncertainties in the current generation of climate models are larger than the sampling uncertainties, as the models improve more careful intercomparisons will be necessary. Therefore we compare the differences between AIRS observations and CMIP5 Climate Models to assess the significance of the sampling uncertainties.

Side-by-side comparison of Temperature and Water Vapor

Temperature



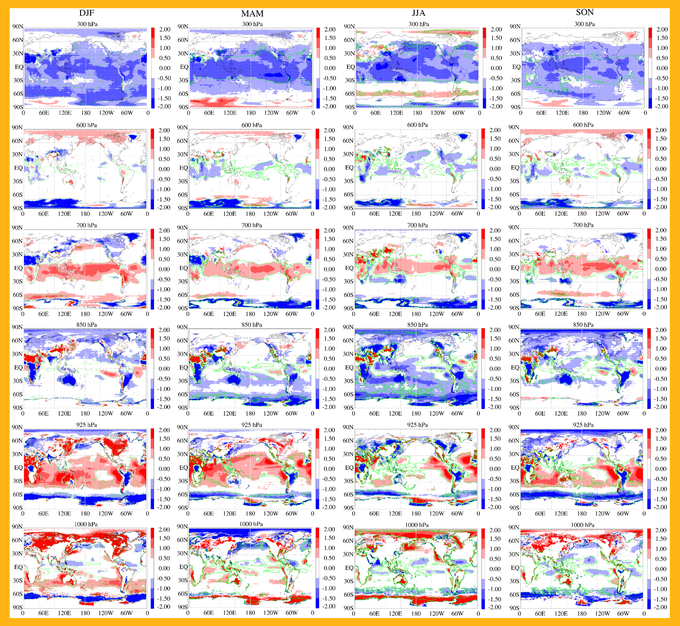
Water Vapor



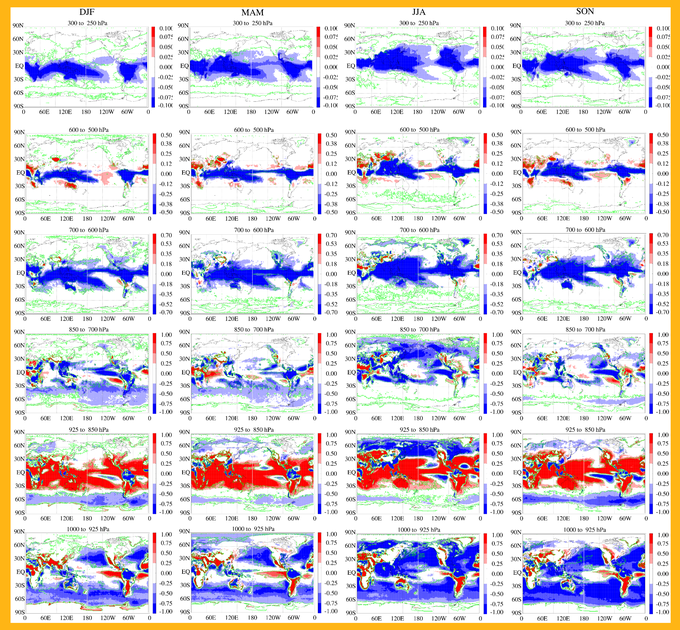
AIRS and MERRA temperature and water vapor show the same spatial structure, though some differences are apparent even in a side by side comparison.

AIRS - MERRA

Temperature [K]



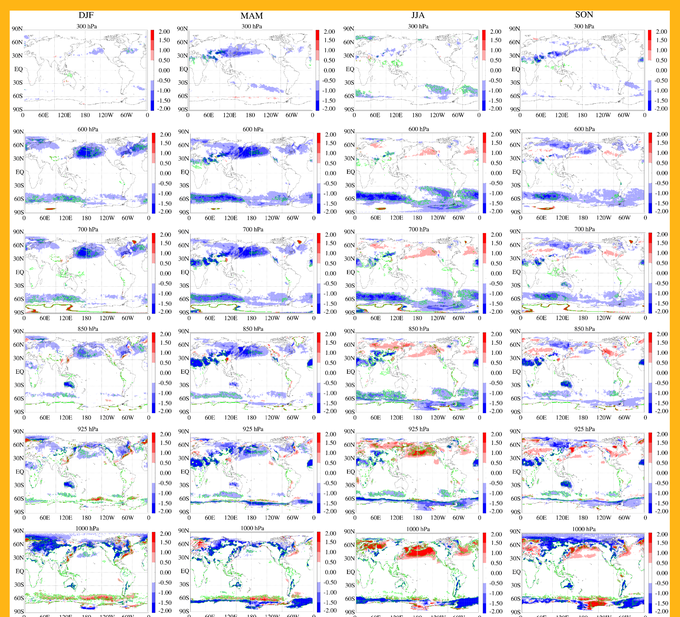
Water Vapor [gm/kg]



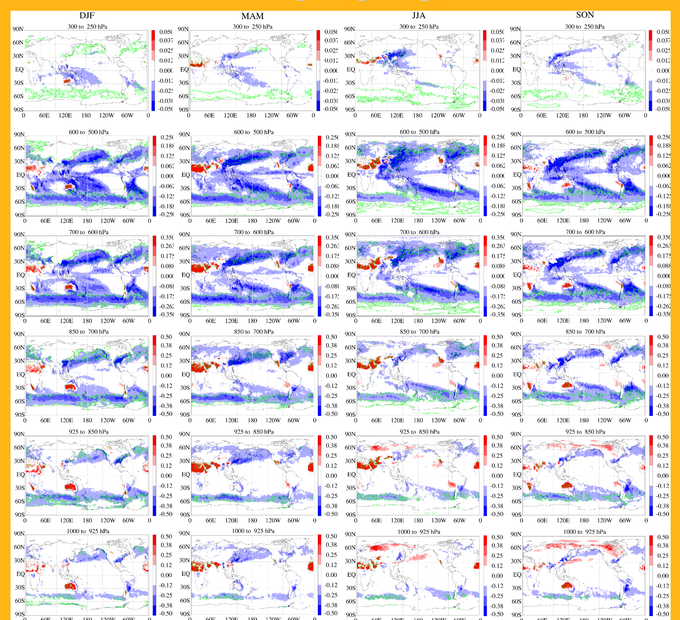
Climatologies from AIRS and MERRA with **similar sampling** show significant differences at the 95% confidence level (shown by the green lines). The figures are only for the ascending part of the orbit.

MERRA – MERRA Climatology with AIRS sampling (with QC – without QC)

Temperature [K]



Water Vapor [gm/kg]



We used MERRA data to estimate the sampling bias of an AIRS climatology.

Conclusions

- The seasonal variability patterns are similar for AIRS and MERRA.
- The AIRS climatology sampling biases they tend to be smaller than other errors and are located in specific geographic regions.
- Sampling issues can be important for comparisons with gridded data sets like climate models.