Investigation of Atmospheric Coupling with Solar Variances

2011 REU Program in Solar and Space Physics

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Summary

Motivation for this project stems from a desire to truly understand how much climate change is caused by human interaction versus natural effects on Earth. In particular, this project performed a comparison of atmospheric model results and measured data from the Microwave Limb Sounder (MLS) on the Aura satellite. The models which were used in the comparison were produced using the Whole Atmosphere Community Climate Model (WACCM) with two different solar spectral irradiance (SSI). The two solar inputs produce significantly different outputs from the WACCM model. The output from these two models were then compared to measured atmospheric data from the Microwave Limb Sounder (MLS) and analyzed to determine which solar input produces a more realistic representation of Earth’s atmosphere. This analysis was performed for hydroxyl radical (OH), ozone, and temperature. It was determined that MLS OH and ozone results showed an overall better correspondence with SORCE model data. Non-solar contributions significantly influence the Earth’s temperature structure so additional analysis is needed to understand the observed effects.

Model Runs

Three Whole Atmosphere Whole Atmosphere Community Climate Model (WACCM) runs were completed with respect to this project which used two very different solar inputs. The first solar input was from the Naval Research Laboratory (NRL) which uses solar irradiance reconstructions based on combined sunspot and facular proxy indicators. As of 2003, the launch of the Solar Radiation and Climate Experiment has made it possible to use actual measured solar spectral irradiance (SSI) from the SIM and SOLTICE instruments. The two difference solar inputs can be see in the figure above which illustrates that the SORCE SSI has a considerably higher solar difference than what is estimated by the NRL SSI. The question we are trying to answer is, which of these solar inputs results in a more accurate WACCM model.

MLS Data Analysis

Aura was launched in July of 2004 and currently still in orbit collecting data. It measures 20 constituents in Earth’s atmosphere, but for the purpose of this project only ozone, OH, and temperature were investigated. All of the capturing and manipulation of the data was done using code written by Samantha Liner using IDL. Once the data was imported, it was separated day and night values using the local solar time. This was done to better see the effects of photochemistry in the atmosphere with respect to ozone and OH. Filters were then applied to separate out unusable data points based off criteria which was found in MLS data documentation. The data was then put into latitude bins which ranged from 80 to minus 80 in 5 degree increments and globally averaged per month and year.

Conclusions

During this 8 week REU project IDL knowledge was developed which allowed for the procurement, separation, filtering, and analysis of MLS OH, ozone and temperature data. Published and non published results were successfully reproduced as well plots not yet seen before and conclusions drawn based off the results.

It was found that:
-Solar forcing in WACCM from SORCE spectra produces a significantly different response than NRL SSI input
-MLS ozone response is comparable to results from SABER instrument (Merkel, 2011)
-A double peak of OH density was present in MLS, SORCE and NRL analysis
-MLS OH and ozone results showed an overall better correspondence with SORCE model data
-With respect to temperature, more analysis is needed to understand the difference in solar and dynamical affects present

Acknowledgements

A special thank you to my advisers, Jerry Harder and Aimee Merkel, for all their help and guidance in this project. Also a thank you to Shuhui Wang for her helpful discussion concerning MLS OH data.

References
