Inter-comparison of CMIP5 Model Representations and Satellite Observations of Cloud-Aerosol Interactions

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Aerosols are a critical component of the Earth's atmosphere and can affect the climate of the Earth at a variety of spatial and temporal scales through their interactions with solar radiation and clouds. Not only can they directly affect the Earth through the transfer of thermal radiation among suspended aerosols, but they can also indirectly impact the planet by affecting cloud processes, and ultimately the hydrological cycle. These indirect effects can alter the structure of a cloud, through reduction of the average size of droplets present in the cloud (first indirect effect) or by reducing the amount of precipitation formed in a cloud (second indirect effect). Because clouds can affect the radiation budget by both warming and cooling the Earth, it is necessary for these direct and indirect effects to be studied further in order to better understand climate change. Recent breakthroughs in global climate modeling efforts have improved our understanding of cloud-aerosol interactions, but many uncertainties and dissimilarities between the models and observed satellite data remain.

In order to identify areas where climate models may poorly represent cloud-aerosol interactions, model data is compared with satellite observations. Here we use cloud and aerosol properties available from the MOderate Resolution Imaging Spectroradiometer (MODIS) satellite (i.e. aerosol optical depth and cloud fraction), and then analyze thee analogous cloud and aerosol properties from CMIP5 models that explicitly include aerosol-cloud interactions. These models include the GFDL am3 and cm3, GISS e2h and e2r, and the NCAR cam5. Similarities and differences between the MODIS and model data are then identified and visualized by calculating the differences between the two data sets to identify regions of the Earth where the models over- or under-predict aerosol or cloud amount.. Through the use of map visualizations, regions and seasons of interest are identified to focus on different aerosols, such as biomass burning smoke, dust, or industrial pollution. Once regions and seasons of interest are identified, the analysis of both the microphysical and radiative effects of aerosols with respect to clouds will be completed by calculating Koren Curves for both the model and satellite data sets. Thus, it will be possible to assess the ability of the CMIP5 models that explicitly include aerosol-cloud interactions to accurately represent satellite observations of aerosols and clouds and their observed relationships.