UNIVERSITY of HAWAI'I MĀNOA

# Department of Atmospheric Sciences
# M.S. Defense Announcement

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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

M.S. Defense Title:

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

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**Date:** **Thursday, November 19, 2015**
**Time:** **2:00 PM**
**Location:** **Hawaii Institute of Geophysics Building, HIG 309**

## Abstract:

Aerosols are a critical component of the Earth's atmosphere and can affect the climate of the Earth through their interactions with solar radiation and clouds. Understanding changes to cloud properties via the direct and indirect effects of aerosols is necessary for evaluating and predicting changes to our climate system. Recent breakthroughs in global climate modeling efforts have improved our understanding of these cloud-aerosol interactions, but many uncertainties and dissimilarities between the models and observations remain. In order to identify regions where climate models poorly represent clouds, aerosols, and parameterized cloud-aerosol interactions, seasonal composites of model data output and satellite observations are compared for the same time period. 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 analogous cloud and aerosol properties from the Coupled Model Inter-comparison Project 5 (CMIP5) models (GFDL, CAM5, MRI-CGCM3, Nor-ESM1-M, and MIROC5) that explicitly include cloud-aerosol interactions. 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. To evaluate observed cloud-aerosol effect due to the presence of absorbing aerosols, regions and seasons of interest are identified to focus specifically on regions with biomass burning activity. The relationship between cloud fraction (CF) and aerosol optical depth (AOD) is evaluated for both the model and satellite data sets. In the case of clouds, the models under-predict more often in the South America (SAM) region compared to the South Africa (SAF) region. The models over-predict CF more often in the SAF region. With regards to seasons, CF is under-predicted by the highest amount during the September October November (SON) season of the SAM region (-0.14 average under-prediction across all models during SON season), and over-predicted by the highest amount during the June July August (JJA) season of the SAF region (average over-prediction of 0.05 across all models during JJA season). In the case of aerosols, the models over-predict most often in the SAF region, and under-predict most often in the SAM region. With regards to seasons, aerosol is over-predicted by the highest amount during the March April May (MAM) season of the SAM region (0.04 average over-prediction across all models during the MAM season). Aerosol is under-predicted by the highest amount during the SON season of the SAM region (-0.19 average under-prediction across all models during the SON season). When evaluating cloud-aerosol interactions where CF is sorted as a function of AOD, we find that the curves for most of the models do not go above 0.3-0.4 for AOD, which implies that those models in particular show an inadequate amount of aerosol. Other models, like GFDL, saturate easily, and appear to only identify the microphysical effect. Neither the model nor the satellite data shows a signal at the low spatial (2.5 x 2.5 degrees) and low time (monthly) resolution. The GFDL model parameterizes the effect, however, in an idealized sense. It is clear that cloud-aerosol interactions, as observed using daily (or higher) temporal resolution data, is not reproducible at the resolution provided by the CMIP5 models.