Effects of Absorbing Aerosol on Cloud Fraction Over Australia

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Understanding the complex interactions between aerosol, clouds and dynamics is an important and necessary step towards understanding the climate system and the development of accurate global and regional climate models. Here, we study the relationships between aerosols, clouds, and large scale dynamics as a function of season for key biomass burning regions including South America, central Africa, equatorial Africa and Asia. We use global, gridded aerosol optical depth (τ_a), fire counts, and cloud fraction (f_c) from Aqua-MODIS, and NCEP NCAR Reanalysis vertical velocities at 500 mb (ω_{500}) as a proxy for dynamic regime.

We find that during biomass burning seasons, f_c in all regions initially increases with increasing τ_a, followed by a systematic decrease with higher τ_a. The observed variation of f_c with τ_a approximately resembles the aerosol microphysics-radiation-feedback (MRF) theory proposed by Koren et al., (2008).

We find that during biomass burning seasons, f_c in both the NCA and SEA regions initially increases with increasing τ_a, followed by a systematic decrease with higher τ_a. The variation of f_c with τ_a approximately resembles the aerosol microphysics-radiation-feedback (MRF) theory proposed by Koren et al., (2008). We find that f_c in the NCA region is more susceptible to aerosol radiative effects, resulting in significant decreases (~30-35%) in f_c at high τ_a. In the SEA, the microphysical affect of aerosol on f_c is more pronounced than the radiative effect, resulting in rapid increase in f_c for small τ_a. By conditionally sorting data by ω_{500} we are able to identify the role of dynamics in controlling the τ_a - f_c relationship and the rate at which f_c changes with τ_a. We find that the MRF theory better represents the regions with - ω_{500} than regions with + ω_{500}. This indicates that additional processes need to be taken into account in order to fully explain the observed relationships.