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Do biomass-burning aerosols significantly modulate the diurnal cycle of clouds and precipitation over Borneo?

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During boreal summer, biomass-burning aerosols over the Borneo Island are a potential source of perturbation for convective precipitation and clouds. Since the diurnal cycle of both biomass burning emission and convection are reproducible from day to day over Borneo, this is a suitable location to investigate interactions between aerosols, precipitation and clouds in a statistically meaningful way. We use the Research and Forecasting (WRF) model that includes a bulk microphysical parameterization of the cloudiness with explicit droplet nucleation and ice activation by aerosols. Five high-resolution simulations of 40 days with explicit convection are performed to study the sensitivity of precipitation and clouds to biomass-burning aerosols: one with observed fire emission; one with no fire emission; one with no direct radiative effect of aerosols; and two with highly absorbing or scattering aerosols. The models results will be analyzed in terms of shallow and convective clouds.

Aerosol loading is maximal over the southeast Borneo, where the cloudiness is dominated by low-level cumulus that develop in the afternoon (maximum cloudiness at 15 LST). Over this region, we will discuss the compensating effects between the warming of the aerosol layer that tends to dissipate clouds in the afternoon, and the increase in CCN levels that tends to increase the low-level cloudiness. As observed, deep convection in WRF is initiated near the northwest coast at 14 LST. Rainfall rates drastically increase between 14 LST and 17 LST over the orography of northern Borneo and then tend to propagate south until 23 LST. During night, the convective area splits into two rainfall maxima over the ocean near the East and West coasts around 4°N. In early morning, only the West maximum remains and then dissipates. Over most convective regions, aerosols tend to decrease the daily maximum of convective precipitation (and high cloud cover). To the first order, this appears to be mostly due to the radiative cooling of the surface by the aerosol layer that decreases the convective instability. However, over some regions of northwest Borneo, aerosols tend to increase high cloudiness and rainfall during the night and in the morning. The origin of this behavior will be discussed.