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Effect of Aerosol on Tropical Large-Scale Precipitation

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Observed negative correlation between aerosol content and surface precipitation amount is very difficult to interpret. This study strives to make several steps to distinguish possible physical processes behind such negative correlation on large scales, including washout of aerosol by rainfall, influences on precipitation by climate and meteorological factors typically associated with aerosol variability, and aerosol effects on rainfall. Efforts are made to (a) compare numerical simulations to observations to identify spatial patterns and temporal behaviors of aerosol washout, (b) isolate effects on rainfall by known climate and weather phenomena, (c) identify higher momentum characteristics of rainfall variation associated with aerosol, such as changes in the rain rate and vertical profiles of associated latent heating, and (d) track the trajectories and sources of aerosol transport and their time-lag relationships with rainfall variability. These steps identify two regions with large-scale negative correlation between aerosol and surface precipitation: the western tropical Atlantic Ocean and the southern Guinea Coast. The negative correlation exists in both daily and monthly mean data. Aerosol washout as a possible interpretation can be reasonably ruled out. Known climate and weather factors (including water vapor) cannot explain the amplitudes of the observed rainfall variations associated with aerosol in a linear sense. The observed changes in precipitation are due mainly to rainfall with light to moderate rain rates and are larger over ocean than over land, consistent to our current understanding of aerosol effects on precipitating cloud. The sources of aerosol in these two regions are both traced to North Africa, especially the Bodele suppression. The negative correlation exists between precipitation and upstream aerosol along their trajectories with a lead of 1 – 3 days. All these results suggest that the observed negative correlation between precipitation and aerosol may be taken as observational evidence of large-scale aerosol effects on precipitation.