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An estimate of the aerosol indirect effect from satellite measurements with concurrent meteorological analysis

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Many studies have used satellite retrievals to investigate the effect of aerosols on cloud properties, but these retrievals are subject to artifacts that can confound interpretation. Additionally, large scale meteorological differences over a study region dominate cloud dynamics, and must be accounted when study aerosol and cloud interactions. We have developed an analysis method which minimizes the effect of retrieval artifacts and large-scale meteorology on the assessment of the aerosol indirect effect. The method divides an oceanic study region into 1X1degree grid boxes, and separates the grid boxes into two populations according to back trajectory analysis: one population contains aerosols of oceanic origin, and the other population contains aerosols of continental origin. We account for variability in the large-scale dynamical and thermodynamical conditions by stratifying these two populations according to vertical velocity (at 700 hPa) and estimated inversion strength, and analyze differences in the aerosol optical depths (AOD), cloud properties, and top of atmosphere (TOA) albedos. We also stratify the differences by cloud liquid water path (LWP) in order to quantify the first aerosol indirect effect.

We apply our method to a study region over the South Atlantic Ocean (0S—30S and 15W—10E) and only consider single-layer low clouds. We find significant reduction in cloud droplet effective radius associated with continental aerosols relative to that associated with oceanic aerosols under all LWP ranges; the overall reduction is about 0.5 µm. We also find significant increase in cloud optical depth and TOA albedo associated with continental aerosols relative to those associated with oceanic aerosols under all LWP ranges; the overall increase in cloud optical depth is about 0.4, and the overall increase in TOA albedo is about 0.008.