Geophysical Research Abstracts
Vol. 21, EGU2019-11707-1, 2019
EGU General Assembly 2019

Intercomparison of biomass burning aerosol properties from in-situ and remote-sensing instruments in ORACLES-2016

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The total effect of aerosols, both directly and on cloud properties, remains the biggest source of uncertainty of climate radiative forcing. Correct characterization of aerosol optical properties, particularly in conditions where absorbing aerosol is present, is a crucial factor in quantifying these effects. The Southeast Atlantic Ocean (SEA), with seasonal biomass burning smoke plumes overlying a persistent stratocumulus cloud deck, offers an excellent natural laboratory to make the observations necessary to understand the complexities of these aerosol-cloud-radiation interactions. The first field deployment of the NASA ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) campaign was conducted in September of 2016 out of Walvis Bay, Namibia. During this deployment, two NASA aircraft (a P-3 and an ER-2) were flown with a suite of aerosol, cloud, radiation, and meteorological instruments for remote-sensing and in-situ observations.

In ORACLES, data collected by multiple instruments are used to derive aerosol properties over this region using eight independent methods. Here we present results from the different instrument retrievals for the 2016 ORACLES flights, with a specific focus on the measures of aerosol absorption. In examining the single scattering albedo (SSA), (absorbing) aerosol optical depth (AOD and AAOD), and absorbing, scattering, and extinction Angstrom exponents (AAE, SAE, EAE), we find reasonable agreement between multiple instruments for given case studies. We find the ORACLES-2016 campaign-average SSA at 500nm to be between 0.85 and 0.88, depending on the instrument considered (4STAR, AirMSPI, or in situ measurements), with the inter-quartile ranges for all instruments between 0.83 and 0.89. This is consistent with previous values reported over the region (between 0.85 and 0.91 for SSA at 500nm). While differences between instruments are observed in the measured SSA average and range, the different SSA measurements agree within uncertainty for specific case studies. This suggests the differences observed in the campaign-average may be dominated by different sampling patterns and the natural physical variability in aerosol conditions over the SEA, rather than fundamental methodological differences. These results suggest that studies which rely on a prescribed set of aerosol properties, such as those considering aerosol radiative effects over the SEA, should consider a realistic spatiotemporal distribution of aerosol optical properties in order to best capture the reality of the aerosol conditions over this region.