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Aerosol-cloud interactions in the South-East Atlantic: knowledge gaps, planned observations to address them, and implications for global climate change modeling

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Southern Africa produces almost a third of the Earth's biomass burning (BB) aerosol particles, yet the fate of these particles and their influence on regional and global climate is poorly understood. Particles lofted into the mid-troposphere are transported westward over the South-East (SE) Atlantic, home to one of the three permanent subtropical Stratocumulus (Sc) cloud decks in the world. The stratocumulus "climate radiators" are critical to the regional and global climate system. They interact with dense layers of BB aerosols that initially overlay the cloud deck, but later subside and are mixed into the clouds. These interactions include adjustments to aerosol-induced solar heating and microphysical effects. As emphasized in the latest IPCC report, the global representation of these aerosol-cloud interaction processes in climate models is one of the largest uncertainty in estimates of future climate. Hence, new observations over the SE Atlantic have significant implications for global climate change scenarios.

We discuss the current knowledge of aerosol and cloud property distributions based on satellite observations and sparse suborbital sampling, and describe planned field campaigns in the region. Specifically, we describe the scientific objectives and implementation of the following four synergistic, international research activities aimed at providing a process-level understanding of aerosol-cloud interactions over the SE Atlantic:

1) ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS), a five-year investigation between 2015 and 2019 with three Intensive Observation Periods (IOP), recently funded by the NASA Earth-Venture Suborbital Program,
2) CLARIFY-2016 (CLoud-Aerosol-Radiation Interactions and Forcing: Year 2016), a comprehensive observational and modeling programme funded by the UK's Natural Environment Research Council (NERC), and supported by the UK Met Office.
3) LASIC (Layered Atlantic Smoke Interactions with Clouds), a funded deployment of the DOE (Department of Energy) ARM Mobile Facility (AMF1) to Ascension Island, nominally for April 1 2016 - March 31 2017, and
4) ONFIRE (ObservatioNs of Fire's Impact on the southeast atlantic REgion), a proposed deployment of the NCAR C-130 aircraft to Sao Tome Island in 2017.