Evolution of Absorbing Aerosol Properties During Long-Range Transport in the Southeast Atlantic Using Remote-Sensing.

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Absorbing aerosols are unique in their ability to influence the climate significantly through their radiative effects; by absorbing sunlight, inducing cloud evaporation, acting as cloud condensation nuclei, and modifying cloud microphysics. Biomass burning (BB) is a major source of absorbing aerosols globally and accounts for about 40% of black carbon in the atmosphere [1]. The Southern African region contributes approximately 35% of the planet's BB aerosol emissions [2]. During the austral winter and spring, smoke is transported westward towards the southeast Atlantic Ocean, where they overlie and interact with a quasi-permanent stratocumulus (Sc) cloud deck [3]. Aerosol-cloud-climate interactions contribute the largest uncertainty to model estimates of anthropogenic forcing, the SEA region thus exhibits a large model-to-model divergence of climate forcing due to aerosols [4]. This makes the region particularly valuable for understanding these interactions. Previous studies focusing on Southern Africa BB have explored the distribution of these particles. However, changes in their optical properties during transport are not well documented.

This study aims to investigate the evolution of BB aerosol optical properties from emission within continental Africa, during transport over land, and then over the Atlantic using remote-sensed observation. Measurements from a collection of remote-sensing instruments taken during the ORACLES campaign are combined with results from two regional models, the WRF-AAM and WRF-CAM5, to explore the changes in the optical properties of smoke plumes as they age. The aerosol age is determined using tracers from the WRF-AAM configured over the region's spatial domain (41 ºS – 14 ºN, 34 ºW – 51 ºE). Changes in extinction, single scattering Albedo (SSA), and Angstrom exponent (AE) with age as well as a comparative analysis between observations and model results were carried out using datasets from airborne 4STAR, ground-based AERONET, and WRF-CAM5 model output.

Analysis showed distinct longitudinal variation in aerosol age and that physical and chemical processes associated with the transport drive changes in the optical properties, with near-source samples being youngest and having relatively low SSA values. Free tropospheric SSA peaks about 5-6 days along the coastline, then gradually decreases over the ocean, reaching its lowest after approximately 12 days.

Keywords: absorbing aerosols, southeast Atlantic, regional climate model, optical properties

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