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Aircraft Measurements of Saharan dust properties and impact of atmospheric transport during Fennec

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Measurements of Saharan dust from recent airborne campaigns have found variations in size distributions and optical properties across Saharan and sub-Saharan Africa. These variations have an impact on radiation and thus weather and climate, and are important to characterise and understand, in particular, to understand how they vary with time after dust uplift, transport, and height in the atmosphere.

New in-situ aircraft measurements from the Fennec 2011 aircraft campaign over a remote part of the Sahara Desert and the Atlantic Ocean will be presented and compared to previous airborne measurements. Size distributions extending to 300 μm will be shown, representing measurements extending further into the coarse mode than previously published for Saharan dust. The dust sampled by the aircraft covered a wide variety of loadings, dust source regions (Mali, Mauritania and Algeria) and dust ages (from fresh uplift to several days old). A significant coarse mode was present in the size distribution measurements with effective diameter up to 23 μm, and the mean size distribution showed greater concentrations of coarse mode than previous aircraft measurements. Single scattering albedo (SSA) values at 550nm calculated from these size distributions revealed high absorption from 0.77 to 0.95, with a mean of 0.85. Directly measured SSA values were higher (0.91 to 0.99) but new instrumentation revealed that these direct measurements, behind Rosemount inlets, overestimate the SSA by 0.02 to 0.20 depending on the concentration of coarse particles present. This is caused by inlet inefficiencies and pipe losses. Previous measurements of SSA from aircraft measurements may also have been overestimates for this reason. This has a significant impact on atmospheric heating rates.
The largest dust particles were encountered closest to the ground, and were most abundant in cases where dust was freshly uplifted. Number concentration, mass loading and extinction coefficient showed inverse relationships to dust age, and showed some sensitivity to the type of uplift for cases of fresh dust. Vertical profiles of dust are found to be significantly different for freshly uplifted dust, aged dust, and dust transported over the ocean. Consequently, changes in the optical properties during dust transport are observed.