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An overview of observations from Fennec supersites: Dust uplift, transport and impacts

John Marsham (1), Martin Todd (2), Richard Washington (3), Douglas Parker (1), Matthew Hobby (1), Cyrille Flamant (4), Azzedine Saci (5), Mohammed Bechir (6), and the The Fennec Team

(1) School of Earth and Environment, University of Leeds, Leeds, UK (jmarsham@env.leeds.ac.uk), (2) University of Sussex, UK, (3) University of Oxford, UK, (4) CNRS and Universite Pierre et MArie Curie, Paris, France, (5) Office National de Meteorologie, Algerie, (6) Office National de Meteorologie, Mauritanie

The summertime Sahara is the world's largest dust source. We present the first detailed in-situ meteorological observations from the central Sahara, made during June 2011 at Fennec supersite 1 (SS1, in the central Sahara) and SS2 (towards the western edge of the Saharan Heat Low, SHL). AODs at SS1 varied from approximately 0.2 to 4, with significant local dust uplift. AODs were much lower at SS2, generally below 1.0, but reaching 2.5.

Most dust was in the second half of June, when the SHL was shifted westwards, leading to stronger low-level jets (LLJs) and cold-pool outflows from moist convection at the SSs. At SS1, this meant that most dust was observed in moist periods, when the site was close to the leading edge of the monsoon. The deep boundary layer in late June allowed dust to be mixed upwards to approximately 5 km.

The impact of dust on peak downward shortwave radiation amounted to 100 to 200 W/m2 per AOD. The more complete data at SS1 show that there the variations in daily mean downward shortwave can be explained by variations in dust (correlation -0.96), or clouds (0.80), since clouds and dust are correlated (0.7). A more complex analysis is therefore required to separate the impacts of clouds and dust on the energy balance in the SHL.

Wind-speed and nephelometer data provide a quantification of the roles of different meteorological mechanisms to dust uplift at SS1. Here, approximately 55% of uplift occurred at night, largely from cold-pool outflows which caused approximately 50% of the total uplift. Both large outflows ("haboobs") and more microburst-like events were observed, with haboobs dominating uplift and AODs. Approximately 15% of uplift occurred between 12 and 18 UTC and approximately 30% as momentum from the nocturnal low-level jet (LLJ) was mixed to the surface between 06 and 12 UTC. The same mechanisms were observed at SS2, but there, before the SHL moved west, the LLJ was often weakened by the Atlantic Inflow and throughout June haboobs were both much rarer and weaker that at SS1. As a result, wind-speeds, uplift frequencies and uplift intensities are all lower at SS2 and increased AODs were typically from dust advected from sources upstream, mostly from enhanced northeasterly LLJ events, rather than from local dust uplift.

Global models are known to represent LLJs poorly, and cold-pool outflows are often almost entirely missing. The data show that this is expected to lead to major biases in all global dust models. The results show that much dust uplift occurs under clouds, in moist air, or at night, where satellite retrievals are either impossible or subject to increased errors. Thus all satellite climatologies are subject to important sampling biases.