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New insights on dust emission mechanisms in the central Sahara: observations from Fennec

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The central Sahara is the dustiest region of the world in boreal summer. The Fennec project instrumented this remote region and the data that has come back has furnished some intriguing insights into the mechanisms of dust emission. Here, observations are presented for the June 2011 intensive observation period (IOP) from the supersite at Bordj-Badji Mokhtar (BBM), in south-west Algeria.

Cold pool outflows produced 11 of the top 15 dustiest events at BBM. Their duration over BBM varied from 3-19h. Several of these outflows travelled long distances to reach the site ($\sim$600km). The average propagation speed of two of the dustiest, 11.6m/s and 16.2m/s, is much higher than the average speed of density currents in the Atlas foothills, estimated at 3-11.1m/s in published work by other authors. Such long-travelled currents also appear to have brought unexpectedly large dust particles to BBM: the three dust events during the IOP with the lowest Angstrom Exponent ($\leq$0) are all convective outflows spawned by mesoscale convective complexes over western Niger.

It is therefore possible that i) the sedimentology over the western Niger region provides much larger particles for emission than over the BBM region ii) the density currents over western Niger have much stronger gust fronts than those spawned near BBM, allowing much larger particles to be uplifted. A third possibility, which may have been the case on the night 16-17 June, is that dust was uplifted over Niger, transported in an elevated intrusion above a stable nocturnal surface layer, and then mixed down to the ground after the surface temperature inversion was eroded. 2m temperatures at BBM were between 1 and 2 standard deviations below the June mean on the morning of 17 June, making it possible that the ‘cold pool’ could in fact have been warmer than the surface and propagated as an elevated intrusion.

Dry convective plume emission and low level jet (LLJ) induced emission and was also observed. Dry convective plume emission started with very large and rapid increases in wind speed after a period of very low wind (an increase of 21m/s in 20 minutes on one occasion), lasted 0.5-2h with a 1hPa pressure well during the strongest plumes, and often exhibited a superadiabatic temperature gradient at low levels. LLJ emission appears to conform to the classic ‘jet breakdown’ theory and observations from other parts of the Sahara. The degeneration of the surface temperature inversion and the propagation of wind speeds towards the surface after sunrise were frequently clear in the lidar wind profiles and radiosonde measurements.