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Identification of Central Saharan Dust Emission Mechanisms in Boreal Summer from Remotely Sensed Plumes

Thomas Caton Harrison, Richard Washington, and Sebastian Engelstaedter
University of Oxford, School of Geography and the Environment, United Kingdom (thomas.catonharrison@keble.ox.ac.uk)

In boreal summer, the central and western Sahara is by far the world's largest source of mineral dust, but the timing of emission events is sporadic. These dust outbreaks fertilise oceans and rainforests, but also generate episodic air pollution events. Sources of this material are only activated when winds exceed local thresholds. Nocturnal low-level jets and cold pool outflows from deep convection are are the primary mechanisms for this, but neither has reliable long-term observational constraints. This is a major source of uncertainty in dust models, whose yearly dust emission load estimates vary considerably.

In-situ observations from the Fennec Campaign show that reanalyses used to estimate low-level jet and cold pool activity are unreliable. One reason for this is the lack of spatiotemporal resolution they afford. As a solution, we infer mechanisms from infrared imagery available at 15-minute resolution from the Spinning Enhanced Visible and Infrared Imager aboard Meteosat Second Generation. Cold pool outflows are observed directly using a threshold applied to cloud-masked brightness temperature fields. An indirect, probabilistic dataset of low-level jet activity is constructed by analysing the characteristics of observed dust plumes. These approaches allow us to create the first observational emission mechanism climatology using data from 2004 to 2017.

While low-level jet activity accounts for the highly active Tidihelt Depression dust source in central Algeria, many other sources align closely with hotspots of cold pool outflow activity. Although these two mechanisms dominate the dust budget at this time of year, their contribution to net dust transport varies significantly across the desert.