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The Role of Deep Convection and Low-Level Jets for Dust Emission in Summertime West Africa - Estimates from Convection-Permitting Dust Simulations

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West Africa is the world's largest source of airborne mineral dust, which has a wide variety of impacts on the Earth System. Mineral dust also affects air quality and visibility with potential effects on human health and transportation.

Convective cold pools and the breakdown of low-level jets (LLJs) are key meteorological drivers of dust emission over summertime West Africa. For a 40-day period during July to September 2006, convection-permitting simulations from the UK Met Office Unified Model are used to drive off-line dust emission computations with three different source descriptions. In order to quantify their relative importance, cold-pool and LLJ-generated dust events are detected by using physically-based algorithms.

Approximately 40% of the modelled dust emission is from LLJs, approximately 40% from cold-pool outflows from deep convection and 20% are potentially related to other meteorological mechanisms during the studied period. These fractions are consistent with new observations from the central Sahara. Models with parameterised convection largely fail to capture the cold-pool based emissions and whether convection is parameterised or explicitly resolved is much more important than which land-surface characterisation used.

Approximately 25% of the cold pool emissions are linked to a newly identified mechanism where aged cold pools form a jet above the nocturnal stable layer. Slightly more than half of dust emissions are simulated from afternoon to night with a minimum before sunrise and in the early afternoon. 60% of the morning-to-noon but only 10% of the afternoon-to-nighttime emissions occur under clear-sky conditions, which will result in large biases in satellite-based studies of dust emission. The results demonstrate the need for further improvements in the representation of moist convection and stable nighttime conditions in global and regional models.