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How well do analyses capture dust-generating winds in the Sahara and Sahel?

Alexander Roberts (1), John Marsham (1), Peter Knippertz (2), and Douglas Parker (1)

(1) Institute of Climate and Atmospheric Science, University of Leeds, Leeds, UK, (2) Institute of Meteorology and Climate Research, Tropospheric Research, Karlsruhe Institute of Technology, Karlsruhe, Germany

Airborne mineral dust is important for weather, climate and earth-system prediction. Uncertainty in winds, as well as the land-surface, are known to be key to model uncertainties for dust uplift. Recent research has shown that during the summer wet season in the Sahel strong winds generated by the cold outflow from organized convective systems are an important dust storm mechanism (so called haboobs), while over the inner Sahara nocturnal low-level jets forming on the pressure gradient around the heat low dominate. Together the Sahel and Sahara are the world's largest dust source. Until now there has been a severe shortage of data for evaluating models for this region. Here, we bring together new observations from the remote Sahara, made during the Fennec project, with Sahelian data from the African Monsoon Multidisciplinary Analysis (AMMA), to provide an unprecedented evaluation of dust-generating winds in the European Centre for Medium-Range Weather Forecasts ERA-Interim (ERA-I) reanalysis. Differences between observations and ERA-I are explored with specific attention to monsoon and non-monsoon influenced regions.

The main results are: (1) High speed winds in instantaneous ERA-I grid-box mean winds are lacking compared to time-averaged wind speed observations; (2) agreement between ERA-I and observations is lower during the monsoon season, even in parts of the Sahara not directly affected by the monsoon; and (3) both the seasonal and diurnal variability is under-represented in ERA-I. ERA-I fails to capture the summertime maximum for monsoon-affected stations and seasonally, correlations between daily-mean ERA-I and observed winds vary from 0.8 to 0.4, with lower correlations for 3-hourly data. These differences demonstrate that the model used in the production of the ERA-I reanalysis is unable to represent some important dust uplift processes, especially during the monsoon season when moist convection plays a key role, and that the product is not sufficiently constrained by observations to counter model process errors.

The value of highlighting these differences lies in the widespread use of ERA-I, both operationally and for research. Especially in its use as a driver for offline dust models. It also shares many features (and therefore problems) with global climate models. Therefore, similar misrepresentations of dust lifting winds are likely in these models – suggesting that the uncertainty of the impact of aeolian dust on a future climate remains large.