

What is the sensitivity of the mineral dust cycle at the regional scale to surface wind speed? First insights from the DRUMS project.

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Modelling of the mineral dust cycle is still a challenging issue both at the global and regional scales: during the last decade, several exercises of model intercomparison highlighted the wide variability of the existing dust models to estimate dust emission fluxes and atmospheric load at both scales. For instance, within the framework of the international AEROCOM Project (<http://aerocom.met.no/>), 15 different global dust models provide a range of possible dust emission fluxes from 400 to 2200 Tg yr⁻¹ for North Africa and from 26 to 526 Tg yr⁻¹ for the Middle East, i.e. still a factor of 5 and 20 respectively (Huneeus et al., 2011).

Whatever the scale, a critical aspect for any dust model is the sensitivity to the meteorological fields used to compute dust emission fluxes (external forcing or simulated by the coupled meteorological or climatic model). Indeed, the intensity of dust emission varies as a power 3 of the surface wind speed, and the number of dust emission events is the number of times the surface wind speed exceeds the wind erosion threshold. As a result, the simulations of dust emissions are extremely sensitive to the way the surface wind speeds are accounted for both in global and regional models. In this context, the aim of the DRUMS (Desert dUst Modeling: performance and Sensitivity evaluation) project was to investigate the sensitivity of a regional dust model (CHIMERE) to this parameter.

This sensitivity study was conducted for 3 years from 2006 to 2008 over the North of Africa (45°N-0°N; 45°W-55°E), where dust emissions are the most intense. Emission fluxes can be simulated there with the most relevant data set of surface properties controlling dust emissions and accounting for the heterogeneity of land surfaces (surface roughness, soil size distribution and texture) of desert regions (Laurent et al., 2008). Meteorological products (forecasts and re-analysis) provided by the most recognized international meteorological centres (US NCEP and ECMWF), and thus the most widely used for the simulations of the mineral dust cycle, were tested. In addition, the benefit provided by the use of the WRF model to downscale the meteorological forcing was evaluated. The estimation of the performance of the CHIMERE model forced by the different meteorological fields was conducted using a unique validation data set compiled during the project by analysing and evaluating (i) the large number of experimental data resulting from the AMMA (African Monsoon Multidisciplinary Analysis) field campaigns, (ii) long-term aerosol monitoring over West Africa (Sahelian Dust Transect) and downwind the Sahara/Sahel region (AERONET), and (iii) recent satellite aerosol products (SeaWiFS AOD). This dataset allowed to validate the main characteristics of the dust cycle (emission, transport, and deposit).