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Evaluation of a regional mineral dust model over Northern Africa, Southern Europe and Middle East with AERONET data

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A variety of regional and global models of the dust aerosol cycle have been developed since early 1990s. Dust models are essential to complement dust-related observations, understand the dust processes and predict the impact of dust on surface level PM concentrations. Dust generation and the parameterization of its deposition processes shows a high variability on spatial and temporal scales. It responds, in a non-linear way, to a variety of environmental factors, such as soil moisture content, the type of surface cover or surface atmospheric turbulence. Thus the modelling of this very complex process is a challenge.

DREAM (Dust Regional Atmospheric Model; Nickovic et al., 2001) provides operational dust forecasts for Northern Africa, Europe and Middle East, as well as for the East-Asia regions. DREAM is operated and further developed in the Barcelona Supercomputing Center. DREAM is fully inserted as one of the governing equations in the NCEP/Eta atmospheric model and simulates all major processes of the atmospheric dust cycle. In order to implement new model versions for operational applications there is a need for extensive checking and validation against real observations.

The present study focuses on the evaluation of forecasting capacity of the new version of DREAM by means of a model-to-observation comparison of the Aerosol Optical Depth (AOD) over Northern Africa, Southern Europe and Middle East for one year. The model provides 72h forecasts initialized at 12UTC of each day with outputs every 1 hour at horizontal resolution of about 1/3º and 24 z-vertical layers in the troposphere. Comparisons against 47 selected AERONET sites are used. Eight size bins between 0.1 and 10 μm are considered, and dust-radiation interactions are included (Pérez et al., 2006). Wet deposition scheme has been also improved.

The simulation has been performed over one year (2004); statistics and time series for the model outputs and AERONET data are used to evaluate the ability of the model to reproduce AOD (at 550nm) associated to mineral dust 24, 48 and 72h ahead. A suit of discrete statistics as Mean Normalized Bias Error (MNBE), Mean Normalized Gross Error (MNGE) and Root Mean Square Error (RMSE) has been used in order to evaluate the model behaviour. Categorical statistics or skill scores, as model accuracy, bias, probability of detection, false alarm rate and critical success index have been implemented to test the capability of the model to simulate AOD exceeding thresholds defined by the quartiles of each AERONET site. A previous aerosol characterization of AERONET data has been performed for our study region in order to discriminate desert dust contributions (Basart et al., 2008).

The first results of the comparison reveal that the modelled dust field agrees in general reasonably well with sun photometer data. Since dust long-range transport is mainly driven by smaller dust particles, the results of this new 8-bins version (with increased number of dust size bins) is considerably better, since the small particle size range (<10μm effective radius) is well described. The best scores are found in North Africa and Middle East. In the Sahel region, an important sub-estimation is observed in wintertime, when the Atlantic outflow transport is important. This is partially due to the more complex processes associated to dust generation in this region (Warren et al., 2007), not well parameterized in dust models yet. Other causes, such as the correct simulation of regional winds or the threshold friction velocity are under research. Moreover, the interaction of mineral dust and biomass burning aerosols from Savannah fires is at its maximum over the region in this season. In southern Europe, the

relative errors are higher than in the rest of our study domain mainly due to the presence of different types of aerosols (such as fine pollution aerosols) which appear well-mixed with desert dust.

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