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Pluriannual simulations of mineral dust emissions from North-eastern Asia and North Africa

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Mineral dust, produced by aeolian erosion over desert areas, has an impact on the Earth radiative budget and is involved in heterogeneous and multiphase atmospheric chemistry. Mineral dust also contributes to the distribution of elements, and in particular of nutrients, over the Earth. Thus, the biogeochemical cycle of mineral dust is of environmental interest to understand climatic changes. The first difficulty to evaluate the mineral dust impacts is to correctly determine their concentration fields. Mineral dust emissions are sporadic and spatially heterogeneous, and must be described as rigorously as possible.

Our study concerns mineral dust emissions from the North-eastern of Asia and the North of Africa by modelling. The major aims of this study are: (1) to quantify mineral dust emissions; (2) to determine the main areas of dust emission in frequency and in intensity; and (3) to investigate the variability of the emissions at the daily, seasonal and inter-annual time scale.

Our approach consists in the simulation of the mineral dust emissions at the continental scale using a physically explicit dust emission scheme. This model is based on integrative parameters characterizing surface features and on meteorological parameters.

Database of the surface features are established for the North-eastern of Asia and the North of Africa at 1/4° x 1/4° spatial resolution. Maps of the aerodynamic roughness lengths have been established based on a composition of protrusion coefficients derived from the POLDER-1 surface products. Soil properties (dry size distribution and texture) are derived from measurements performed on samples from desert areas, or from a soil map derived from a geomorphologic analyse of desert landscapes. Sur-

face re-analyzed meteorological databases of the European Centre for Medium range Weather Forecasts (ECMWF) are used. The influence of soil moisture and snow cover is taken into account and their effects on simulated dust emissions are quantified and discussed. The relevance of the simulated mineral dust emissions have been tested, for example, by comparison with horizontal visibilities measured by meteorological stations closed to source areas, and to aerosol indexes derived from satellite observations (AAI TOMS and IDDI Meteosat). Simulations have been performed in similar conditions, allowing the comparison of mineral dust emission from North-eastern Asia and the North of Africa.

The mineral dust emissions, simulated from 1996 to 2001, range from 100 to 460 Mt.an-1 for the North-eastern of Asia, and from 585 to 760 Mt.an-1 for the North of Africa. Our simulations tend to confirm that the Sahara is the major terrestrial source of mineral dust emission. In North-eastern Asia, the major sources are the Taklimakan desert, northern deserts of China and the Gobi desert. Dust emissions from the Taklimakan and northern deserts of China exhibit a marked seasonal cycle. Moreover, in the Gobi desert, only a few dust emission events are simulated, but the dust amount emitted during each event is generally very large and leads to important monthly and inter-annual variability of the emitted dust. In the North of Africa, the most frequent and intense sources are localised. The seasonal cycles of dust emissions of the western and eastern parts of the Sahara are pronounced but differ from each other.