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Regional Modelling of Saharan Dust: Dust radiative Effects and Feedbacks on Boundary Layer Dynamics

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Mineral dust, mainly emitted by wind erosion in the world's arid and semi-arid regions, represents the largest natural source of particulate matter. It impacts the climate system by changing the atmospheric radiation balance through direct and indirect effects. However, there are still considerable uncertainties determining magnitude and sign of the dust radiative effects (IPCC, 2007). The lack of knowledge is attributed to uncertainties in the optical parameters and the variability of the spatio-temporal distribution of mineral dust.

The German project SAharan Mineral dUst experiMent (SAMUM) is dedicated to clarify the uncertainties in radiative properties of Saharan dust to quantify its radiative forcing. The first phase of SAMUM field experiments took place in Morocco during May and June 2006. The properties of Saharan dust were investigated by ground-based, air-borne and space-borne remote sensing and analysis of field samples.

Within the framework of SAMUM the physically based regional dust model system LM-MUSCAT-DES (Heinold et al., 2007) was developed for simulations of the northern Saharan dust cycle. The model has been successfully tested in several near-source and far-field case studies (Heinold et al., 2007; Helmert et al., 2007; Tegen et al., 2006). Recently, an extensive model evaluation has been performed for the SAMUM period by comparisons with satellite data, lidar profiles from the European Aerosol Research Lidar Network (EARLINET), sunphotometer measurements

at Aerosol Robotic Network (AERONET) stations, and measurements from the SAMUM sites (Heinold et al., submitted).

The regional dust model allows estimation of radiative effects and feedbacks by means of the interaction of the computed dust load with the solar and thermal radiation and with the model dynamics. The results of such feedback mechanisms will be presented. Besides estimates of direct dust radiative forcing, simulations of SAMUM dust episodes have revealed a strong dust impact on the boundary layer dynamics. For the Bodélé depression a mechanism will be presented that describes positive and negative dust radiative effects on surface wind speeds and dust emission in dependence on atmospheric stratification and dust-induced stabilisation.

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