Geophysical Research Abstracts
Vol. 14, EGU2012-10533, 2012
EGU General Assembly 2012


# The Low-Level Jet Phenomenon in North-African Deserts: An Idealized Large Eddy Simulation Study

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Wind-blown dust emitted from desert regions is a major contribution to the global aerosol load. It influences the climate system by changing the atmospheric radiation budget through direct and indirect effects. Dust aerosol also plays an important role in the biogeochemical and hydrological cycle and can affect human health. Quantitative estimates of the spatial-temporal distribution of mineral dust and its manifold effects largely base on model simulations. However, due to the highly nonlinear dependence on peak winds, dust emissions are often underestimated by current dust models.

Various studies have suggested that the breakdown of nocturnal low-level jets (LLJs), which generates peak surface winds usually from morning to midday, is an important meteorological driver of desert dust emissions. LLJs are distinctive maxima in the wind profile of the lowest ∼1.5km of the atmosphere. They primarily form at night as a result of frictional decoupling of air layers above nocturnal inversions. The wind maximum can be explained by an inertial oscillation due to the perturbation of the geostrophic-antitriptic balance. In summer, the large pressure gradient related to the Saharan heat low and strong night-time radiation temperature inversions provide ideal conditions for LLJ formation over the Sahara desert. Global and regional dust models generally match the synoptic-scale dynamics well, but the typical peak in surface wind speeds caused by the LLJ erosion is often not reproduced, as turbulence parameterization and vertical resolution may be insufficient to describe the small-scale processes.

This study is a contribution to the "Desert Storms" project funded by the European Research Council. The project aims at improving the representation of dust-generating meteorological processes in numerical dust models. We present idealized model simulations of LLJs using the Large Eddy Model (LEM) of the UK Met Office. The model is initialized with either idealised diurnal cycles of sensible heat flux or observed surface temperatures, as well as characteristic profiles of potential temperature and wind speed from analysis data. Sensitivity studies are performed to investigate the influence of surface roughness, latitude/Coriolis force and baroclinicity on the formation and decay of LLJs. The model results are used to identify optimal latitude/roughness configurations for maximum LLJ enhancement for a given wind profile. Ideal conditions are found in regions between 10°N and 25°N with roughness lengths $> 0.01$m providing a combination of long oscillation periods and strong ageostrophic wind components. Typical LLJ enhancements range from about 3 to 6m/s, when a geostrophic wind speed of 10m/s is assumed. Maximum values are reached in the Sahel region. The results ultimately serve to develop a LLJ parameterization for usage in global and regional dust models, which allows assessing the importance of the LLJ breakdown for dust emissions.