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The Representation of Nocturnal Low-Level Jets in Meso-Scale Atmospheric Models and its Relevance for Dust Emission

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The entrainment of mineral dust into the atmosphere can be understood as a threshold problem. Besides soil properties, the near-surface horizontal wind speed plays an important role for dust uplift. For North Africa recent studies have shown that the break-down of the nocturnal low-level jet (LLJ) can frequently be related to dust emission, which starts during the morning hours. Many studies on the atmospheric dust cycle involve meso-scale models of the atmosphere, coupled to models of dust emission, transport and deposition. Within this set-up a reliable representation of the atmospheric processes that create high winds near the surface is crucial to simulate the dust emission process as accurate as possible. In particular the location, time, and core wind speed of nocturnal LLJ are essential and determine characteristics for consequent dust emission forced by the daytime erosion of the nocturnal LLJ. Previous studies over North Africa and other arid regions have shown that models tend to dissipate too much momentum from the LLJ during the night and struggle to reproduce the strongest surface gusts during the breakdown phase.

Here we present a study on the representation of nocturnal LLJs leading to dust emission using the Weather Research and Forecasting (WRF) model. For selected cases representing different seasons and locations, nested WRF simulations at different spatial resolutions (e.g. 1.5km, 4km, 7km, 12km) and with different set-ups (i.e. boundary layer schemes) are analysed and validated against observation data acquired operationally and during field campaigns like the African Monsoon Multidisciplinary Analysis (AMMA). Main focus is the spatial and temporal representation of the LLJ and its morning break-down as well as the sensitivity to the chosen model configuration. This study is embedded in the European Research Council funded "Desert Storms" project that among other things aims to improve the representation of LLJs and related processes in a wide range of atmospheric models. To do this, results from this study will be combined with those of large-eddy and global models in the longer run.