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Dust Mobilization due to Density Currents in the Atlas Region: Observations from the SAMUM Field Campaign

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The Saharan Mineral Dust Experiment (SAMUM) first field campaign took place in southern Morocco between 11 May and 10 June 2006. Ground-based in-situ and remote sensing measurements from Ouarzazate airport (30°53'N, 6°54'W) and Tinfou (30°15'N, 5°37'W) provide unique observational data to study the meteorological conditions for dust mobilization in the Atlas region. Usually dust is mobilized by large-scale frontal systems or numerous small-scale dust devils. Here we focus on a little investigated meso-scale mechanism: density currents driven by evaporational cooling of convective precipitation in mountainous regions. The proposed mechanism includes the following steps: (I) Development of deep convection over the (Anti-) Atlas, (II) blowing-off of cloud tops by upper-level winds, (III) generation of a cold pool at midlevels due to evaporation of precipitation in the dry and hot desert air, (IV) a quick spreading of the cold air driven by the pressure gradients related to density differences to the environment, (V) further acceleration along the topographic gradient, (VI) raising of dust by strong winds at the leading edge and mixing through a deep layer by high turbulence. We will present a case study of a density current that was directly observed by the SAMUM team as a shallow 'lobe' of dust filled air approaching the Tinfou site from the northeast on 31 May 2006. Ground based observations show abrupt changes during the passage of the leading dust front such as (I) an increase in relative humidity and water vapour mixing ratio, (II) an increase in wind speed to 10 m/s, (III) wind direction changes from SW to NE, (IV) a decrease in temperature by

3°C, (V) an increase in pressure by 4 hPa, (VI) a decrease in visibility from 50 to 3 km and (VII) an increase in aerosol concentration, mainly for particles of 5 μm diameter. The observed changes are consistent with the proposed mechanism. Visibility and aerosol measurements show a duration of the event of only a few hours. Additional station data from the network of the IMPETUS project in southern Morocco help to analyze the frontal character of this feature and to estimate a relatively slow propagation speed of ˜20 km/h, which is consistent with the observed small temperature differences. Meteosat VIS imagery reveals intense convection over the Moroccan Atlas and Anti-Atlas chains in the afternoon hours of 31 May 2006 and the quickly southwestward spreading, dusty 'cold pool' with a convex leading edge of several hundreds of kilometres length. The presented observations point to an important role of density currents driven by evaporational cooling of convective precipitation over the Anti-Atlas for the generation of strong and turbulent near-surface winds necessary for dust mobilization. Other such events are currently investigated and climatological studies based on IMPETUS data are envisaged. The proposed mechanism is most likely relevant for other mountainous parts of the Sahara like the Ahaggar, Aïr or Tibesti, and might therefore be a key in understanding dust emissions from northern Africa during summer in general.