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Dust Emissions Related to Convective Cold Pools along the Saharan Side of the Atlas Mountains: Observations, Climatology and Modelling Results.

P. Knippertz (1), C. Deutscher (1), J. Trentmann (2), A. Seifert (2), K. Kandler (3), O. Schulz (4), and L. Schütz (1)

(1) Institute for Atmospheric Physics, Johannes Gutenberg University Mainz, Mainz, Germany (knippertz@uni-mainz.de, +49(0)61313923532), (2) German Weather Service, Offenbach, Germany, (3) Institute for Applied Geosciences, Technical University Darmstadt, Darmstadt, Germany, (4) Geographical Institute, University of Bonn, Bonn, Germany

Cooling by evaporation of convective precipitation in the deep and dry sub-cloud layer over desert regions can generate intense downdrafts, and long-lived and extensive atmospheric density currents. The strong gusts at their leading edges can cause so-called haboob dust storms. Despite their importance for the dust cycle, the climatology and the ability of state-of-the-art numerical weather prediction models to realistically simulate the associated convective cold pools has been investigated very little to date.

During the first field campaign of the Saharan Mineral Dust Experiment (SAMUM) in southern Morocco in May/June 2006 several density currents were observed. They were triggered by deep moist convection over the Atlas Mountains during the afternoon and propagated into the foothills in the course of the evening. The passage of the leading edge is associated with a marked increase in dew point, wind speed and pressure, a change in wind direction, and a decrease in temperature and visibility.

Here we present numerical simulations of three of these density currents using the non-hydrostatic COSMO model with 2.8 km horizontal grid spacing, which allows an explicit treatment of deep convection. The model is capable of simulating the timely initiation of convective cells over the Atlas Mountains and the subsequent formation of long-lived, extensive cold pools with a realistic three-dimensional structure. Deviations from available surface and satellite observations are closely related to model deficiencies in simulating precipitating convection over the Algerian Sahara. Sensitivity studies with modified microphysics and boundary layer turbulence schemes reveal a large influence of raindrop size distributions on evaporation and surface rainfall, but a rather moderate influence on the cold pool evolution, while changes to the turbulence length scale affect all three parameters more substantially.

In addition a climatology of density currents in southern Morocco is presented that is based upon 5 years of surface observation from the climate station network of the IMPETUS project (www.impetus.uni-koeln.de). The results show that density currents are predominantly a warm-season phenomenon with an occurrence maximum during the late afternoon and evening. Most systems reach southern Morocco from the Atlas Mountains, but on occasion density currents related to moist convection over the adjacent Mauritanian and Algerian Sahara are observed. The occurrence of density currents is linked with the passage of a weak disturbance across the region that allows a northward transport of moist tropical air along its eastern flank and then contributes to destabilizing the vertical column while over northwestern Africa.