Geophysical Research Abstracts
Vol. 16, EGU2014-6191, 2014
EGU General Assembly 2014

The impact of Atlas Mountain cold-pool events on the position and intensity of the summertime West African heat low

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Recently discovered fluctuations of the summertime West African heat low on different time scales are still not fully understood, but of major importance for an improved prediction of the West African Monsoon system in weather and climate models. It has recently been demonstrated that the cold-pool outflows from convection form a significant component of the West African monsoon and that in a global model the failure to represent these adequately is a major cause of thermodynamic model-bias in the monsoon-ventilated heat-low region.
Here we focus on the extratropical flank of the heat low, which often reaches to the Saharan foothills of the Atlas Mountains in Morocco and Algeria during the summer months. Strong, often orographically triggered convective events over the Atlas Mountains and at their southern flanks are a regularly observed feature during this time. Such events are often associated with evaporatively driven cold-pools, resulting in haboob dust storms in the Saharan Desert. The leading edge of these density currents can reach lengths of several hundreds to a thousand kilometres; its movement is visible on satellite images for up to twelve hours and affects the core region of the heat low. Significant amounts of moisture are transported into the desert this way and can lead to the production of new convective systems there.
We use the Weather Research and Forecast (WRF) model driven by the operational analysis of the European Centre for Medium-Range Weather Forecasting (ECMWF) to investigate the impact of these events on the positions and strength of the heat low in convection-permitting simulations. The aim is to improve the understanding of the involved processes and to quantify the errors that are expected in models that are not able to generate cold pools effectively due to their parametrisations of moist convection. The cases used for this study have been selected based on station measurements and on infrared as well as microwave satellite data. First control runs showed that the model is able to reproduce the cold pools with their position, speed and expansion in a realistic way. The results include (a) an observation-based climatology of the annual cycle and the year-to-year variability of density current occurrences at the southern flank of the Atlas Mountains, (b) sensitivity runs with completely removed convection by suppression of latent heat release and (c) sensitivity runs with convection, but with density currents removed by locally limited evaporative cooling. These results demonstrate the role of Atlas-mountain cold pools in ventilating the heat low.