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The vertical structure of the Saharan boundary layer: Observations and modelling

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The vertical structure of the Saharan atmospheric boundary layer (SABL) is investigated with the use of aircraft data from the Fennec observational campaign, and high-resolution large-eddy model (LEM) simulations. The SABL is one of the deepest on Earth, and crucial in controlling the vertical redistribution and long-range transport of dust in the Sahara. The SABL is typically made up of an actively growing convective region driven by high sensible heating at the surface, with a deep, near-neutrally stratified Saharan residual layer (SRL) above it, which is mostly well mixed in humidity and temperature and reaches a height of $\sim$500hPa. These two layers are usually separated by a weak ($\leq$1K) temperature inversion, making the vertical structure very sensitive to the surface fluxes.

Large-eddy model (LEM) simulations initialized with radiosonde data from Bordj Bardji Mokhtar (BBM), southern Algeria, are used to improve our understanding of the turbulence structure of the stratification of the SABL, and any mixing or exchanges between the different layers. The model can reproduce the typical SABL structure from observations, and a tracer is used to illustrate the growth of the convective boundary layer into the residual layer above. The heat fluxes show a deep entrainment zone between the convective region and the SRL, potentially enhanced by the combination of a weak lid and a neutral layer above. The horizontal variability in the depth of the convective layer was also significant even with homogeneous surface fluxes.

Aircraft observations from a number of flights are used to validate the model results, and to highlight the variability present in a more realistic setting, where conditions are rarely homogeneous in space. Stacked legs were performed to get an estimate of the mean flux profile of the boundary layer, as well as the variations in the vertical structure of the SABL with heterogeneous atmospheric and surface conditions. Regular radiosondes from BBM put these results in the synoptic context for the rest of June 2011.