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An AMMA case-study of banal daytime convection over semi-arid land featuring distinctive modelling issues

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The development of daytime cumulus is a primary feature in the diurnal cycle of convection over land. Such a banal sequence occurred the 10 July 2006 in the afternoon over Niamey, where a few deeper convective cells eventually developed.

From a modelling perspective, the two major assets of this typical convective sequence over a hot semi-arid land are: (i) the evidence that synoptic scales were not a major driver, and (ii) the richness of the observational dataset collected on this day. Indeed, convection developed within the field of view of the MIT radar (see poster by M. Lothon et al., this session), and close to the ARM mobile facility, which combined numerous instruments. The case is also documented at the mesoscale by more than ten automatic weather and surface eddy covariance stations, and a boundary layer aircraft flight. Finally, the largely cloud-free conditions prevailing until the early afternoon hours are ideal for further mapping of the case from satellite products.

Observations emphasize (i) the large magnitude of surface temperature and sensible heat flux, coupled to a weakness of surface evapotranspiration over a still fairly dry land surface, (ii) a strong deepening of the convective boundary layer leading to a sharp daytime decay of low-level moisture and driving a decrease of low-level equivalent potential temperature and CAPE prior to convective initiation. Such features contrast with the current view that daytime convection over land is linked to CAPE increase; they also raise new challenges for models and their turbulent and cumulus parametrizations.

The variety in simulations of the observed sequence by NWP models (ECMWF, ARPEGE and AROME) will be presented. This survey motivated the development of a simpler modelling framework, based on observations. This setup has been used to jointly perform large-eddy simulations (LES) and single-column parametrized runs (including different sets of physical schemes, MesoNH and LMDZ). It is actually possible to accurately reproduce the observed cloud and convective onsets with the LES; its main sensitivities to the applied forcing (initial conditions, larger-scale advection, surface fluxes) will be presented. Finally, results from the LES will be used to briefly discuss the incorrect timing and distinct humidity fields obtained with single-column runs.