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Simulation of the heat wave episode observed in April 2010 over the Sahel with a mesoscale model

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As part of the ACASIS project (Sahelian heat waves and their impacts warning), we simulate with the mesoscale research model Meso-NH a ten-day period of a heat wave case in West Africa which will soon be used as a case of intercomparison of different mesoscale regional and large-scale models. This episode of extreme nocturnal and diurnal temperatures (many records have been beaten like 50°C in Niamey) has been painful for the population (doubling of mortality in many countries) and is part of a warming trend for several decades stronger in spring (2° in 60 years).

A set of different simulations have been realized to study the sensitivity of the results to the numerical configuration and to the representation of physical processes. It includes simulations made with different domain sizes (either covering West Africa or a smaller domain centred on Burkina Faso), different resolutions (horizontal and vertical) and with lateral boundary conditions estimated from either the ECMWF analysis or ERA-Interim, as well as sensitivity tests to soil moisture, shallow and deep convection and aerosol optical thickness (AOT).

We evaluate the ability of the Meso-NH model to simulate the atmospheric low levels, the surface meteorology and energy balance, by comparing simulations results with available observations such as automatic weather and flux stations, SYNOP and radiosonde data, GPS estimates of precipitable water and satellite data of AOT, rain, cloud cover and radiative fluxes.

Parametrized convection generates spurious precipitation that induces an excess of low-level water vapour and a cold temperature bias regardless of the size of the domain and of the horizontal resolution used. The simulation without parametrized convection is in much better agreement with the observations.
The strong increase of the daily minimum temperature observed during the period is well simulated but a cold bias remains accentuated by an underestimated cloud cover at the end of the period.

This study shows that the simulation of the Sahelian heat waves in spring is very sensitive to the parametrizations of physical processes.