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Impact of dust aerosols on the radiative budget, surface heat fluxes, heating rate profiles and convective activity over West Africa during March 2006

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Abstract. The present work analyses the effect of dust aerosols on the surface and top of atmosphere radiative budget, surface temperature, sensible heat fluxes, atmospheric heating rate and convective activity over West Africa. The study is focused on the regional impact of a major dust event over the period of 7–14 March 2006 through numerical simulations performed with the mesoscale, nonhydrostatic atmospheric model MesoNH. Due to its importance on radiative budgets, a specific attention has been paid to the representation of dust single scattering albedo (SSA) in MesoNH by using inversions of the AErosol RObotic NETwork (AERONET). The radiative impacts are estimated using two parallel simulations, one including radiative effects of dust and the other without them. The simulations of dust aerosol impacts on the radiative budget indicate remarkable instantaneous (at midday) decrease of surface shortwave (SW) radiations over land, with regional (9°–17° N, 10° W–20° E) mean of −137 W/m^2 during the 9 to 12 March period. The surface dimming resulting from the presence of dust is shown to cause important reduction of both surface temperature (up to 4°C) and sensible heat fluxes (up to 100 W/m^2), which is consistent with experimental observations. At the top of the atmosphere, the SW cooling (regional mean of −12.0 W/m^2) induced by mineral dust is shown to dominate the total net (shortwave + longwave) effect. The maximum SW heating occurs within the dusty layer with values comprised between 4 and 7° K by day and LW effect results in a cooling of −0.10/−0.20° K by day. Finally, the simulations suggest the decrease of the convective available potential energy (CAPE) over the region in the presence of mineral dust.

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