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Aerosols direct radiative forcing on Djougou (Northern Benin) during the AMMA dry season experiment.

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Abstract.

The purpose of this work is to investigate the direct radiative forcing of aerosols on the supersite of Djougou (Benin, Western Africa) during the AMMA (African Monsoon Multidisciplinary Analyses) dry season experiment. We compute here the direct radiative forcing at the Top Of Atmosphere (TOA), at the Bottom Of Atmosphere (BOA), and into the ATMosphere (ATM). During this period, Sun-photometric measurements indicate a rather turbid atmosphere with a mean Aerosol Optical Depth (AOD), for the overall period, about 0.90 $\pm$ 0.01 at 440 nm. The aerosol absorption coefficient at the surface was comprised between 2 and 90 Mm^{-1}, with a mean value of 19.2 Mm^{-1}(at 520 nm). In the same time, the scattering coefficient ranged between 50 and 400 Mm^{-1}, with an averaged of 160 Mm^{-1}(at 520 nm). This leads to a Single Scattering Albedo (SSA) comprised between 0.75 and 0.95 (at 520 nm) with an average value of 0.90, indicating moderate absorbing aerosols. Differential mobility analyser measurements indicate monomodal (nucleation mode) number size distributions, with a mean geometric diameter of 96.5 nm, associated with a geometric standard deviation of 1.87. The characteristics of the size distribution, associated with the refractive index of aerosols, have been used in the Mie theory for computing aerosol optical properties at different wavelengths. Associated with ground-based observations, the micro pulse lidar indicates the presence of two distinct aerosol layers, with a first one located between the surface and 500 m and a second one, characterized by aged biomass burning particles, located above (1500-3000 m). Based on surface and aircraft observations, sunphotometer retrievals, Lidar profiles and MODIS sensor, an estimation of the daily direct radiative forcing has been estimated for the 17^{th} to 24^{th} January 2006 period, by using a discrete ordinate radiative transfer model. Simulations indicate that aerosols reduce significantly the solar energy reaching the surface (mean ΔF$_{BOA}$ = -61.3 Wm^{-2}) by reflection to space (mean ΔF$_{TOA}$ = -19.0 Wm^{-2}) but predominantly by absorption of the solar radiation into the atmosphere (mean ΔF$_{ATM}$ = +42.3 W.m^{-2}). The mean heating rate at the surface is found to be significant (7.70 ˚K by day). Radiative transfer simulations allow investigating a biomass burning event, occurring during the 17^{th}-18^{th} January and characterized by significant daily ΔF$_{BOA}$ and ΔF$_{ATM}$about -78.7 W.m^{-2}and +63.4 W.m^{-2}. During such events, simulations indicate that instantaneous surface and atmospheric forcings can reach up to -233 W.m^{-2} and +193 W.m^{-2} (for a solar zenith of 31˚).