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Long-term simulations (2000-2007) of Biomass Burning and mineral dust optical properties with the RegCM model over West Africa (AMMA experiment). Comparisons with avalaible AERONET, MODIS and MISR aerosol products

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Africa is the major source of aerosols at global scale. Indeed, throughout the year the northern African atmosphere is mainly dominated by high burden of dust aerosols resulting from the erosion of arid soils by surface winds. Moreover, between December and February, smoke aerosols from biomass burning become an additional major contributor to the total bulk Aerosol Optical Thickness (AOT). These bulk aerosols modulate significantly the regional radiation budget via scattering and absorption of radiation (direct effects), and may affect thermodynamical processes and consequently the water cycle (semi-direct effects).

Whereas recent modelling efforts showed significant impacts of the dust aerosols radiative effects on the West African Monsoon through elevated heat pump feedbacks, biomass burning aerosols effects on the regional climate are still poorly documented. Besides, biomass burning aerosols are able to absorb more significantly solar visible radiation than the dust aerosols due to their sizes and the high content of black carbon. This could lead to important semi-direct effects. Nevertheless, these quantifications remain difficult as main estimated processes keep uncertain (emission, ageing, transport). In that frame, it is now crucial to study aerosol effects on the regional climate by including both dust aerosols and biomass burning aerosols.

In our study, we first discuss results from the RegCM3 regional climate outputs. Simulations of the 2006 dry season were performed with the new biomass inventories developed in the framework of the AMMA campaign [Liousse et al., ACP 2010]. The smoke optical properties were parameterized through off line computations, using Mie calculations and based on the mass distributions for aged aerosols obtained from Dekati impactor measurements at Djougou during the AMMA-SOP0. Hereafter, we analyze how the model can accurately reproduce the main aerosols features compared to measurements from AMMA-SOP0/DABEX field campaigns. This refers to a strong stratification of dust and smoke layers, and a marked seasonal cycle of the aerosol mixture. These features are key parameters for modelling the direct and semi direct effects of aerosols over West Africa.

In a second time, RegCM3 simulations were performed over the period 2000-2006. Thus, the sources and the transport of aerosols are discussed through comparisons of AOT and Single Scattering Albedo with satellite observations from sensors on the AQUA-TRAIN spacecrafts constellation (MODIS/DEEP-BLUE, MISR, POLDER ...) and observations including sunphotometer of Aerosol Robotic Network (AERONET) and Micro Pulse LIDAR at M'bour (Senegal). Comparison of modelled AOT with remote sensing retrievals showed a major disagreement in central Africa, indicating a possible overestimation of biomass burning emissions in the inventories or an inaccurate underestimation of AOT in satellite retrievals. Satellite observations along the gulf of Guinea exhibit a maximum of AOT that is not well simulated by RegCM3. Possible underestimation of dust aerosols loading and transport or underestimation of other sources of carbonaceous aerosols (i.e. fossil fuels and bio-fuels), in particular in the vicinity of Lagos, are discussed. Finally, we present RegCM3 estimates of the radiative forcing due to the mixing of dust and carbonaceous aerosols over the region.