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Assessment of aerosol-cloud interactions during southern African biomass burning activity, employing cloud parameterizations

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In this study, we perform a simulation of the spatial distributions of particle and gas concentrations from a significantly large source of pollution event during a dry season in southern Africa and their interactions with cloud processes. Specific focus is on the extent to which cloud-aerosol interactions are affected by various inputs (i.e. emissions) and parameterizations and feedback mechanisms in a coupled mesoscale chemistry-meteorology model -herein Weather Research and Forecasting model with chemistry (WRF-Chem). The southern African dry season (May-Sep) is characterised by biomass burning (BB) type of pollution. During this period, BB particles are frequently observed over the subcontinent, at the same time a persistent deck of stratocumulus covers the south West African coast, favouring long-range transport over the Atlantic Ocean of aerosols above clouds. While anthropogenic pollutants tend to spread more over the entire domain, biomass pollutants are concentrated around the burning areas, especially the savannah and tropical rainforest of the Congo Basin. BB is linked to agricultural practice at latitudes south of 10° N. During an intense burning event, there is a clear signal of strong interactions of aerosols and cloud microphysics. These species interfere with the radiative budget, and directly affect the amount of solar radiation reflected and scattered back to space and partly absorbed by the atmosphere. Aerosols also affect cloud microphysics by acting as cloud condensation nuclei (CCN), modifying precipitation pattern and the cloud albedo. Key area is to understand the role of pollution on convective cloud processes and its impacts on cloud dynamics.

The hypothesis is that an environment of potentially high pollution enables the probability of interactions between co-located aerosols and cloud layers. To investigate this hypothesis, we outline an approach to integrate three elements: i) focusing on regime(s) where there are strong indications of aerosol-cloud interactions; ii) an emphasis on statistical characterizations of aerosols in the said area(s) and iii) integrate modelling with observation approach. Detailed evaluation of results with observation (e.g. satellite and reanalysis) of cloud and aerosol parameters will provide observational constraints on the simulated interactions in different model setups. This can help to understand some uncertainties in estimating cloud-aerosol interactions and yield valuable information about the process representations in climate models.