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Can we improve the representation of aerosol optical properties in regional chemistry-climate coupled models? A sensitivity analysis to the vertical distribution of aerosols

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The largest uncertainty in estimates of anthropogenic perturbations of the Earth's energy budget is ascribed to atmospheric aerosols. This forcing agent acts through aerosol-radiation (ARI) and aerosol-clouds (ACI) interactions. Both of these interactions depend on the spatio-temporal aerosol distribution as well as on the aerosol size, composition and mixing state which control aerosol optical properties and the ability to act as cloud condensation or ice crystal nuclei. Aerosol vertical distribution is one of the processes which highly influence ARI and ACI depending on the vertical location of particles with respect to other forcing agents as clouds. There exist highly uncertain processes that control aerosol properties and vertical distribution, such as dry deposition, wet scavenging, vertical convective transport or water uptake by particles. The main objective of this work is to estimate the effects of these processes on the vertical distribution of aerosols and their optical properties, which may affect aerosol forcing.

To fulfil the objective, an ensemble of simulations with the regional online-coupled model WRF-Chem V3.9.1.1 has been conducted. Parameters influencing the abovementioned processes were varied according to the existing literature. The simulations cover a high-load aerosol episode during the 2010 summer heat wave over Russia, where important wildfires took place. The variables evaluated are profiles of vertical concentration of different aerosol species as well as the backscatter coefficient (BSCOF) and the aerosol optical depth (AOD) against observational data from the Level 2 of CALIPSO (V3.1) and the Level 2 of MODIS (Collection 6).

Preliminary results indicate that all the studied processes influencing aerosol vertical distribution also affect aerosol optical properties representation (BSCOF and AOD). Dry deposition presents a higher impact for the Aitken mode than for the accumulation mode, potentially because fire particles are emitted into the Greenfield gap. Vertical convective transport and wet scavenging are expected to impact significantly the vertical aerosol mass. The water uptake by particles affects the size of particles by growth and the aerosol optical properties representation.

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