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Influence of horizontal resolution on aerosol hygroscopic growth effects in urban andremote boundary layers in the context of climate impact and adaptation studies

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We share our experiences for impact and adaptation studies, by presenting results of a climate modelling study, which is based on ERA5 data at different horizontal resolutions, i.e., down from approximately 300 km to 25 km. The ERA5 data is used as a meteorological constraint (nudging) to perform a numerical model study on the influence of horizontal resolution on aerosol hygroscopic growth effects on meteorology in urban and remote atmospheric locations. For this sensitivity study we only switch on/off the associated aerosol water mass. Aerosol water is crucial form climate impact and adaptation studies as it links air pollution with weather and climate through direct and indirect radiative feedbacks. We try to separate urban from continental-scale effects using the EMAC atmospheric chemistry climate and Earth system model. EMAC is applied globally in various horizontal resolutions, in a set-up similar to our previous PMAp evaluation study (https://www.eumetsat.int/PMAp), i.e., resolving weather time-scales. We compare our EMAC results of the aerosol optical depth (AOD) against CAMS reference simulations (40 km), various satellite data (MODIS-Aqua/Terra, PMAp) and AERONET surface observations (~ 30km radius around the instrument). While CAMS REA includes AOD data assimilation (Modis/PMAp), EMAC calculates the AOD ab initio from size-resolved aerosol hygroscopic growth without any data assimilation, and with an option to include aerosol-cloud feedbacks. Our results show that the EMAC AOD results are within the range of CAMS and satellite AOD. Aerosol water effect on AOD is noticeable for nudged and free running EMAC versions at both, urban and remote locations. The aerosol water effect is larger for free running EMAC versions, and more pronounced for urban AERONET sites, e.g., Hamburg, Karlsruhe, Thessaloniki, Zaragoza. The moisture feedback with air pollution is resolution dependent (time and space). Generally, this becomes more relevant with increasing resolution due to finer moisture and air pollution gradients, which is an indication for the importance of horizontal resolution for impact and adaptation studies.