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Sensitivity of organic aerosol simulation schemes to climate variables in future climate projections

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Organic aerosol, representing a large fraction of fine aerosols in the atmosphere, can have major impacts on air quality and human health. Simulation of this aerosol is difficult since there are many unknowns in the nature, mechanism and processes involved in the formation of these aerosols. The uncertainty in the simulation of this aerosol becomes more pronounced in climate change context, since the implementation of different schemes for the simulation of organic aerosol in atmospheric models can show varied sensitivities to changes in climate variables.

Multiple schemes have been introduced in the literature for the simulation of organic aerosols in chemistry-transport models, in this work, three of those schemes have been used: a molecular scheme, a standard volatility basis set (VBS) scheme with anthropogenic aging and a modified VBS scheme containing functionalization, fragmentation and formation of non-volatile secondary organic aerosol (SOA) formation for all semi-volatile organic compounds (SVOC). First, simulations with each scheme have been evaluated with organic aerosol concentrations for about 30 European sites from the mainly form the EMEP network.

Because of computational time limitations, 5 years of historic and 5 years of future simulations were performed using the RCP8.5 climatic scenario (representative concentration pathway), the choice of years and the climatic scenario being performed in a way to maximize the differences between future and historic simulations.

The changes between future and historic simulations suggest that for the European area, the scheme including fragmentation and formation of non-volatile SOA shows the highest relative change, while the molecular scheme shows the least (a factor of two lower compared to the aforementioned scheme). Maximum changes are seen over the summer period for biogenic SOA (BSOA) because higher temperatures increase the emissions of major precursors of BSOA formation. The increasing BSOA trend is partially off-set by the temperature induced shift of SVOCs to gas phase. This effect is however scheme dependent, and it is found that it is the least pronounced for the VBS scheme with fragmentation and formation of non-volatile SOA, the latter being independent of gas-aerosol phase equilibrium. For the Mediterranean area, without local BVOC emissions at least over sea, the OA changes are less pronounced and, at least on an annual average, more similar between different schemes.