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Can atmospheric aerosols help improving the representation of European heatwaves?

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Atmospheric aerosol particles are widely known to have an impact on global and regional radiative budget due to their optical, microphysical and chemical properties and are considered to be the most uncertain forcing agent according to the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC AR5). They influence climate by aerosol-radiation and aerosol-cloud interactions (ARI and ACI, respectively). But they also play an important role in the particular occurrence of extreme events. For instance, forcing due to ARI may have an important effect in European and Mediterranean heatwaves. Effects due to ACI are subtler, yet equally important, since they influence the conversion from cloud droplets into rain drops, and thus affect the vertical profile of latent heat release.

In this sense, the Spanish projects REPAIR and ACEX try to assess the impacts of present (1991-2010) and future (2031-2050) aerosols on air pollution, climate change and extreme events. This contribution takes REPAIR and ACEX data and presents the results devoted to the representation of present-climate most important heatwaves over Europe (2003, 2005, 2010 and 2015, affecting respectively Western-Central, Southern, Eastern and Central Europe) and how the inclusions of aerosols in a fully coupled regional chemistry-climate model improves the representation of these events. The model used is WRF-Chem, using EDGAR emissions from HTAP. Simulations cover the Euro-CORDEX compliant domain, including (or not) ARI and ACI interactions. Modelling outputs have been evaluated against the E-OBS v15.0 gridded data (for temperature) and SeaWiFS satellite (for aerosol representation). A number of extreme indices (recommended by the CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices, ETCCDI) have been used, including consecutive summer days (CSU), maximum heat wave duration per year (HWd), monthly maximum value of daily maximum temperature (TXx), number of tropical nights (TR), etc.

The results indicate that all the aforementioned index greatly improve when including atmospheric aerosols in the regional climate model simulations. For instance, the relative bias in CSU for the 2003 European heatwave reduces by 20% when including aerosol interactions (around 10% for the Russian 2010 heatwave). It is not only the indices improving, but the most noticeable improvements are found for the variability of the daily maximum and minimum temperatures during the heatwaves, whose bias reduces by over 50% when including atmospheric aerosols in the simulations. The causes of this improvement are not straightforward and depend on the meteorological situation: reinforcing the ridge responsible for dry and warm air advection over western Europe, modifying the winds and altering the relative humidity, or other modifications in the radiative budget.

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