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Impacts of different aerosol climatologies on the European climate during the last decades

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As summarized in the 5th Assessment Report of the IPCC, the effects of aerosols on the Earth's energy budget are one of the largest uncertainties in a changing climate. Despite a better understanding of aerosol processes since the previous report, it remains unclear to which degree of complexity these processes need to be represented within the climate models to consider their effects in a sufficient manner.
Within the nonhydrostatic regional climate model COSMO-CLM, the aerosol climatology of Tanre from 1984 is widely used to simulate the direct effect of aerosols on radiative processes. Apart from a very low spatial resolution and a missing temporal variability, this climatology is dominated by high values of Aerosol Optical Depth (AOD) over Northern Africa, caused by an overestimation of Saharan dust.
To investigate the impacts of different aerosol distributions on the European climate, the Tanre aerosol climatology is replaced by the more realistic climatologies of Tegen from 1997 and AEROCOM from 2006 with constant annual cycles of AOD. In addition a control simulation without any aerosol feedbacks was performed. The simulations cover a period of 30 years from 1980 to 2010.
In parts of the regions surveyed, we found a near surface cooling, which is strongly linked to AOD, and a broad mid-troposphere warming for all simulations in comparison to the control simulation. A decrease in convective precipitation is mainly caused by stabilization of stratification and by less evapotranspiration resulting from surface cooling. The horizontal differing mid-troposphere warming induces a drop in surface pressure and therefore leads to changes in circulation patterns which are still under investigation. The largest impacts of direct and semi direct aerosol effects was found in summer season.
As next step, pre-calculated transient aerosol data will be used to compile an up-to-date aerosol climatology including temporal changes. One main focus of the study will be to investigate whether a decrease in anthropogenic aerosol load in Europe during the last decades enhances the GHG induced near surface warming.