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Impact of the extreme meteorological conditions during the summer 2003 in Europe on air quality – an observation and model study

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Changes in meteorological conditions, on short as well as on long timescales, have an effect on dynamical and chemical processes in the atmosphere and therefore also on air quality. One method to investigate the effect of a changing climate on the concentration of pollutants is to analyze a synoptic situation in the past which is expected to occur more often in the future in terms of air quality. An advantage of this approach is the availability of measurements. The summer 2003 is often taken as an example for an extreme summer which is expected to occur more often in the future in Europe. It was characterized by heat waves with high temperature, stagnation and little precipitation over large parts of Europe. In order to investigate whether the meteorological conditions in the summer 2003 have a clear effect on the concentration of total PM10 and the secondary inorganic aerosols, the observations of the EMEP network in Europe of the summer 2003 were compared to the average of the summers of a five year period (2003-2007). To analyze whether state-of-the-art chemical transport models are able to reproduce the observed concentrations during this episode simulation runs were performed with the German model REM/Calgrid and the Dutch model LOTOS-EUROS in this study.
The synoptic situation in summer 2003 indeed had an effect on the observed concentration of total PM10 and the secondary inorganic aerosols. The models however did not reproduce the observed high total PM10 concentrations on most of the stations during the summer 2003 to the same extent. One reason for the discrepancy is that not all species (secondary organic aerosols, mineral dust) and sources (forest fire emissions) are included in the models, yet. Another reason is that some processes that are dependent on meteorology may be not sensitive enough in their parameterization. Therefore the dependence of the pollutant concentrations on meteorological parameters was investigated.
The observed and modeled total PM10 and SO4, NH4 and NO3 concentrations were related to daily maximum temperature, daily average wind speed, daily precipitation amount and daily maximum mixing height taken from the ECMWF and a diagnostic meteorology on different stations for the summers of 2003-2007. The observed concentrations of total PM10 and of most of the secondary inorganic aerosols increased at high daily maximum temperature. However, the models are not able to reproduce this relationship for PM10, they underestimate the observed high concentrations.
For a successful coupling of chemical transport models with regional climate models to come to reliable results, the chemical transport models should first be improved in terms of the relation between pollutant concentrations and meteorological parameters.