Modelling surface ozone during the 2003 heat-wave in the UK

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The EMEP4UK modelling system is a high resolution (5×5 km2) application of the EMEP chemistry-transport model, designed for scientific and policy studies in the UK. We demonstrate the use and performance of the EMEP4UK system through the study of ground-level ozone (O3) during the extreme August 2003 heat-wave. Meteorology is generated by the Weather Research and Forecast (WRF) model, nudged every six hours with reanalysis data. We focus on SE England, where hourly average O3 reached up to 140 ppb during the heat-wave. EMEP4UK accurately reproduces elevated O3 and much of its day-to-day variability during the heat-wave. Key O3 precursors, nitrogen dioxide and isoprene, are less well simulated, but show generally accurate diurnal cycles and concentrations to within a factor of ~2–3 of observations. The modelled surface O3 distribution has an intricate spatio-temporal structure, governed by a combination of meteorology, emissions and photochemistry. A series of sensitivity runs with the model are used to explore the factors that influenced O3 levels during the heat-wave. Various factors appear to be important on different days and at different sites. Ozone imported from outside the model domain, especially the south, is very important on several days during the heat-wave, contributing up to 85 ppb. The effect of dry deposition is also important on several days. Modelled isoprene concentrations are generally best simulated if isoprene emissions are changed from the base emissions: typically doubled, but elevated by up to a factor of five on one hot day. We found that accurate modelling of the exact positions of nitrogen oxide and volatile organic compound plumes is crucial for the successful simulation of O3 at a particular time and location. Variations in temperature of ±5 K were found to have impacts on O3 of typically less than ±10 ppb.

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