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SMOKE for Europe – adaptation, modification and evaluation of a comprehensive emission model for Europe

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Abstract. The US EPA regional emission model SMOKE was adopted and modified to create temporally and spatially distributed emission for Europe and surrounding countries based on official reports and public domain data only. The aim is to develop a flexible model capable of creating consistent high resolution emission data for long-term runs of Chemical Transport Models (CTMs). This modified version of SMOKE, called SMOKE for EUROPE (SMOKE-EU) was successfully used to create hourly gridded emissions for the timespan 1970–2010.

In this paper the SMOKE-EU model and the underlying European datasets are introduced. Emission data created by SMOKE-EU for the year 2000 are evaluated by comparison to data of three different state-of-the-art emission models. SMOKE-EU produced a range of values comparable to the other three datasets. Further, concentrations of criteria pollutants calculated by the CTM CMAQ using the four different emission datasets were compared against EMEP measurements with hourly and daily resolution. Using SMOKE-EU gave the most reliable modelling of O_3, NO_2 and SO_4^{2-}. The amount of simulated concentrations within a factor of 2 (F2) of the observations for these species are: O_3 (F2 = 0.79, *N* = 329 197), NO_2 (F2 = 0.55, *N* = 11 465) and SO_4^{2-} (F2 = 0.62, *N* = 17 536). The lowest values were found for NH_4^+ (F2 = 0.34, *N* = 7400) and NO_3^- (F2 = 0.25, *N* = 6184). NH_4^+ concentrations were generally overestimated, leading to a fractional bias (FB) averaged over 22 measurement stations of (FB = 0.83 ± 0.41) while better agreements with observations were found for SO_4^{2-} (FB = 0.06 ± 0.38, 51 stations) and NO_3^- (FB = 0.13 ± 0.75, 18 stations).

CMAQ simulations using the three other emission datasets were similar to those modelled using SMOKE-EU emissions. Highest differences where found for NH_4^+ while O_3 concentrations were almost identical.

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