PM trends in Europe: multi-model and monitoring assessment

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PM trends in Europe during the last decades have been assessed using a multi-model approach in the framework of Eurodelta-TRENDS exercise initiated by the European Monitoring and Evaluation Program Task Force on Measurements and Modeling (EMEP-TFMM). Seven regional models (EMEP/MSC-W, CHIMERE, CMAQ, LOTOS-EUROS, MINNI, Polair3D and WRF-Chem, participated in the EURODELTA-Trends exercise, which builds upon previous iterations of the CITYDELTA and EURODELTA projects (Thunis et al., 2007; Cuvelier et al., 2007; Bessagnet et al., 2014).

Three of the models performed a 21-year hindcast over Europe for the 1990-2010 period, while all the models made calculations for the years 1990, 2000 and 2010. In addition, a series of sensitivity tests have been performed with the purpose of studying the role of meteorological variability, emission changes and boundary conditions.

For the period of 2001-2010, for which enough of PM monitoring data is available, the trends in PM_{10} and $PM_{2.5}$ have been studied based on both modelling results and measurement data. The Mann-Kendall test are applied to calculated and measured annual mean concentrations to detect significant (90% probability) trends, whereas the Sen's slopes are calculated to estimate the absolute and relative declines in PM (Fig. 1)

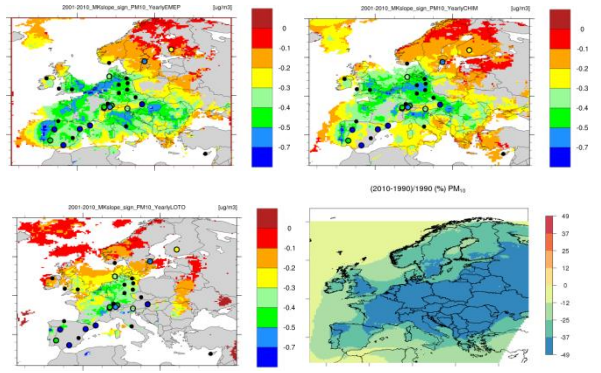

Fig. 1. Sen's slopes for $PM_{2.5}$ (μg/m^3) for 2001-2010 from EMEP, CHIMERE and LOTOS models (grey means insignificant) and from measurements (circles); and the relative change (%) in PM_{10} between 1990 and 2010 (bottom right) according to the EURODELTA 6-model ensemble.

We look at the geographical differences in modelled and observed trends in PM levels (Fig. 2) and PM chemical composition in the period 2001-2010. On average for the sites with observations, the measured trends are -47% for $PM_{2.5}$ and -42% for PM_{10}, while the model calculated trends are somewhat smaller (-29 and -34% respectively), but the differences between the sites are considerable. The effect of meteorological variability is shown to be significant for such short study period, especially for $PM_{2.5}$ (only at 7 out of 18 sites significant trend are observed).

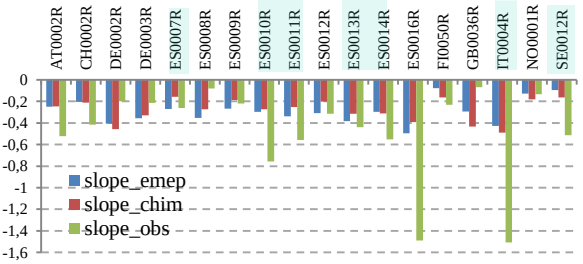

Figure 2. Model calculated and measured Sen's slopes for $PM_{2.5}$ at EMEP sites in the period 2001-2010 (the sites with significant observed trends are marked blue).

Further, 21-year PM trends are assessed based on the results from the three models, and the contribution due to emission reduction is estimated. In addition, PM changes between 1990, 2000 and 2010 from the seven models are presented.

Bessagnet et al. (2014). The EURODELTA III exercise – Model evaluation with observations issued from the 2009 EMEP intensive period and standard measurements in Feb/Mar 2009, CLRTAP, Geneva.
Cuvelier et al. (2007). Atmos. Environ., 41, 189-207.
Thunis et al. (2007). Atmos. Environ., 41, 208-220.