Source attribution of particulate sulfate concentrations at chosen measurement stations in Europe by the use of the CMAQ chemistry transport model

D. Neumann[1], V. Matthias[1], A. Aulinger[1], M. Quante[1], and J. Bieser[1,2]
[1]Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Max-Planck-Str. 1, 21502 Geesthacht, Germany
[2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institute of Atmospheric Physics, Oberpfaffenhofen, 82234 Weßling, Germany
Keywords: sulfate particles, sea salt, Europe, air pollution
Presenting author email: daniel.neumann@hzg.de

In Europe, anthropogenic activities lead to considerable air pollution. The inhalation of fine particulate sulfate, which is one major air pollutant, may induce respiratory and cardiovascular diseases (Brunekreef and Holgate, 2002). Even though sulfur emissions have been reduced in the last decades (EMEP, 2015), atmospheric particulate sulfate concentrations are still too height. Long term measurements of air pollutants, such as performed within the European Monitoring and Evaluation Programme (EMEP), are relevant to observe trends – e.g. induced by legislative acts. However, they lack the possibility of identifying dominant source sectors which is important for defining further actions for improving air quality. At this point, chemistry transport models (CTMs) support the evaluation of measurements by providing information for the source apportionment of air pollutants.

In the presented study, the Community Multiscale Air Quality (CMAQ) model v5.0.1 with cb05tump and Aero6 mechanisms (Binkowski and Roselle, 2003) was employed to identify the contribution of two anthropogenic source sectors and of sea salt emissions to the atmospheric sulfate PM_{10} and $PM_{2.5}$ concentrations. The model domain (24 x 24 km2) covers Northwestern Europe and is nested into a coarser resolved domain covering whole Europe. Meteorological input data was generated by COSMO-CLM. Emissions were calculated according to Bieser et al. (2011) and Kelly et al. (2010). Additionally, an alternative sea salt emission parameterization was tested. Simulations were performed for two month in winter and two month in summer of the year 2013.

The model results were validated by comparing modeled sulfate PM_{10} and $PM_{2.5}$ concentrations with measurements performed at 21 and 4 EMEP stations, respectively, via the Pearsons's correlation coefficient (R) and the mean normalized bias (MNB). The correlation coefficients to the PM_{10} concentrations were between 0.48 and 0.75 during winter and between 0.3 and 0.6 during summer. The MNBs were positive during winter indicating overestimations of sulfate concentrations. During summer, the MNBs were considerably lower and indicated underestimations at Danish and German stations and overestimations at Norwegian and Swedish stations. The correlation coefficients of the $PM_{2.5}$ concentrations (available at four stations only) were quite similar to those of the PM_{10} concentrations. The MNBs showed that fine sulfate particles were slightly underestimated while coarse sulfate particles ($PM_{10} - PM_{2.5}$) are overestimated.

Although the alternative sea salt emissions lead to considerably lower sea salt sulfate PM_{10} and $PM_{2.5}$ concentrations, its impact on the modeled sulfate concentrations is low because anthropogenic sources are the major contributors to particulate sulfate. This leads to the evaluation of the source sectors which will be presented at the EAC2016. The two plots in Fig. 1 may be an outlook for the talk.

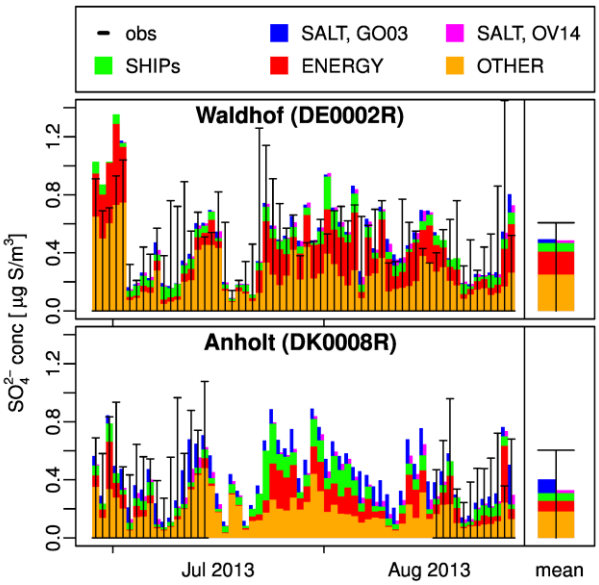

Figure 1. Modeled and measured sulfate PM_{10} at the two EMEP stations Anholt (island) and Waldhof (200 km inland). Modeled concentrations are split into source sectors. Vertical lines are for better optical comparison.

Binkowski, F.S. and Roselle, S.J. (2003) Models-3 Community Multiscale Air Quality (CMAQ) model aerosol component 1. Model description. *J. Geophys. Res. Atmos.* **108**.

Bieser, J., Aulinger, A., Matthias, V., Quante, M. and Builtjes, P. (2011) SMOKE for Europe - adaptation, modification and evaluation of a comprehensive emission model for Europe. *Geosci. Model Dev. Discuss.* **3**, 949–1007.

EMEP (2015) EMEP Status Report 1/2015 "Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components.".

Kelly, J.T., Bhave, P. V, Nolte, C.G., Shankar, U. and Foley, K.M. (2010) Simulating emission and chemical evolution of coarse sea-salt particles in the Community Multiscale Air Quality (CMAQ) model. *Geosci. Model Dev.* **3**, 257–273.