Geophysical Research Abstracts
Vol. 21, EGU2019-6025, 2019
EGU General Assembly 2019

The influence of shipping emissions on air quality in the Baltic Sea region simulated with three chemistry transport models

Matthias Karl (1), Jan Eiof Jonson (2), Andreas Uppstu (3), Armin Aulinger (1), Marje Prank (3,4), Jukka-Pekka Jalkanen (3), Lasse Johansson (3), Markus Quante (1), and Volker Matthias (1)

(1) Helmholtz-Zentrum Geesthacht, Department of Chemistry Transport Modelling, Geesthacht, Germany (matthias.karl@hzg.de), (2) Norwegian Meteorological Institute, Oslo, Norway, (3) Atmospheric Composition Research, Finnish Meteorological Institute, P.O. Box 503, FI-00101 Helsinki, Finland, (4) Cornell University, Ithaka, NY, USA

The Baltic Sea is a busy shipping area, and highly trafficked shipping lanes are closely located near populated coastal zones. Exhaust emissions from ship traffic into the atmosphere are not only enhancing air pollution, they also significantly affect the Baltic Sea environment through acidification and eutrophication of marine waters and surrounding terrestrial ecosystems. Most previous chemistry transport model (CTM) simulations for the Baltic Sea region were performed on a relative coarse grid ($>$10 km grid resolution). Non-linear chemical effects, particularly during ozone formation, and the frequent interaction of large land-based emission sources with ship-related pollution, call for the use of finer grid resolutions. In this study, the atmospheric transport and chemical transformation of emitted pollutants were simulated with three regional CTM systems, CMAQ, EMEP/MSC-W and SILAM. Ship emissions from the Ship Traffic Emission Assessment Model (STEAM), which uses ship position data of the Automatic Identification System (AIS) network, were gridded to the respective model's grid resolution, which was 4 km for CMAQ and SILAM and 11 km for the EMEP/MSC-W model. The main goal of this study was to quantify the effect that shipping emissions have on the regional air quality in the Baltic Sea region when the same shipping emissions dataset but different CTMs in their typical setups are used. The performance of these models and the shipping contribution to the results of the individual models was evaluated with respect to sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and particulate matter ($PM_{2.5}$). Model results from the three CTMs were compared to observations from rural and urban background stations of the AirBase monitoring network in the coastal areas of the Baltic Sea region. The performance of the three CTM systems to predict pollutant concentrations is comparable. However, observed $PM_{2.5}$ in summer was underestimated strongly by CMAQ and to some extent by EMEP/MSC-W. There are significant differences in the calculated ship contributions to the levels of air pollutants among the three models. SILAM predicted a much weaker ozone depletion through NO emissions in the proximity of the main shipping routes than the other two models. In the entire Baltic Sea region, the average contribution of ships to NO_2 levels is 22−28 % and to $PM_{2.5}$ levels is 4.3−6.5 % for the three CTMs. Differences in ship-related $PM_{2.5}$ between the models are mainly attributed to differences in the schemes for inorganic aerosol formation. Results obtained from the use of three CTMs give a more robust estimate of the ship contribution to atmospheric concentrations and deposition than a single model. By using several models the sensitivity of the ship contribution to uncertainties of e.g. boundary conditions, meteorological data and aerosol formation and deposition schemes is taken into account. This is an important step towards a more reliable evaluation of policy options regarding emission regulations for ship traffic and the introduction of a nitrogen emissions control area (NECA) in the Baltic Sea and the North Sea in 2021.