

Impact of a nitrogen emission control area (NECA) for ship traffic on the future air quality in the Baltic Sea region

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Deposition of nitrogen compounds originating from shipping activities contribute to eutrophication of the Baltic Sea and coastal areas in the Baltic Sea region. Emissions of nitrogen oxides (NO_x) from shipping on the Baltic Sea are comparable to the combined land-based emissions of NO_x from Finland and Sweden and have been relatively stable over the last decade. However, expected future growth of maritime transport will result in higher fuel consumption and, if not compensated by increased transport efficiency or other measures, lead to higher total emissions of NO_x from shipping. For the Baltic Sea a nitrogen emission control area (NECA) will become effective in 2021 - permitting only new built ships that are compliant with stringent Tier III emission limits - with the target of reducing NO_x -emissions. In order to study the effect of implementing a Baltic Sea NECA-2021 on air quality and nitrogen deposition two future scenarios were designed; one with implementation of a NECA for the Baltic Sea starting in 2021 and another with no NECA implemented. The same increase of ship traffic was assumed for both future scenarios. Since complete fleet renewal with low NO_x -emitting engines is not expected until 20-30 years after the NECA entry date, year 2040 was chosen as future scenario year. The Community Multiscale Air Quality (CMAQ) model was used to simulate the current and future air quality situation. The nested simulation runs with CMAQ were performed on a horizontal resolution of $4 \text{ km} \times 4 \text{ km}$ for the entire Baltic Sea region. The meteorological year 2012 was chosen for the simulation of the current and future air quality situation since the 2m-temperature and precipitation anomalies of 2012 are closely aligned to the 2004-2014 decadal average over Baltic Proper. High-resolution meteorology obtained from COSMO-CLM was used for the regional simulations. Ship emissions were generated with the Ship Traffic Emission Assessment Model (STEAM) by the Finnish Meteorological Institute (FMI) using the Automatic Identification System (AIS) network data to allocate ship positions. Gridded land-based emissions were taken from the SMOKE-EU model which is based on the official EMEP data. Future land-based emissions were reduced in accordance with current legislation. Model simulations for the current situation show that shipping emissions are the main contributor to ambient NO_2 concentrations over the Baltic Sea. Shipping emissions are responsible for 40-70 % of the particulate nitrate concentrations during the summer months. Relative contribution of shipping emissions to monthly total nitrogen deposition, as a sum of oxidized and reduced nitrogen compounds, was highest in summer, with up to 60 % in the northern part of the Baltic Proper, while it was on average 10 % for other parts of the Baltic Sea. With the NECA in the Baltic Sea in effect from 2021, the reduction of reactive nitrogen concentrations and deposition in the Baltic Sea region compared to a scenario without Tier III regulations is significant.