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TITLE: Impact of a nitrogen emission control area (NECA) on the future air quality and nitrogen deposition to seawater in the Baltic Sea region

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ABSTRACT:

Abstract. Air pollution due to shipping is a serious concern for coastal regions in Europe. Shipping emissions of nitrogen oxides (NOx) in air over the Baltic Sea are of similar magnitude (330 kt yr?1) as the combined land-based NOx emissions from Finland and Sweden in all emission sectors. Deposition of nitrogen compounds originating from shipping activities contribute to eutrophication of the Baltic Sea and coastal areas in the Baltic Sea region. For the North Sea and the Baltic Sea a nitrogen emission control area (NECA) will become effective in 2021; in accordance with the International Maritime Organization (IMO) target of reducing NOx emissions from ships. Future scenarios for 2040 were designed to study the effect of enforced and planned regulation of ship emissions and the fuel efficiency development on air quality and nitrogen deposition. The Community Multiscale Air Quality (CMAQ) model was used to simulate the current and future air quality situation. The meteorological fields, the emissions from ship traffic and the emissions from land-based sources were considered at a grid resolution of 4×4 km2 for the Baltic Sea region in nested CMAQ simulations. Model simulations for the present-day (2012) air quality show that shipping emissions are the major contributor to atmospheric nitrogen dioxide (NO2) concentrations over the Baltic Sea. In the business-as-usual (BAU) scenario, with the introduction of the NECA, NOx emissions from ship traffic in the Baltic Sea are reduced by about 80 % in 2040. An approximate linear relationship was found between ship emissions of NOx and the simulated levels of annual average NO2 over the Baltic Sea in the year 2040, when following different future shipping scenarios. The burden of fine particulate matter (PM2.5) over the Baltic Sea region is predicted to decrease by 35 %?37 % between 2012 and 2040. The reduction in PM2.5 is larger over sea, where it drops by 50 %?60 % along the main shipping routes, and is smaller over the coastal areas. The introduction of NECA is critical for reducing ship emissions of NOx to levels that are low enough to sustainably dampen ozone (O3) production in the Baltic Sea region. A second important effect of the NECA over the Baltic Sea region is the reduction in secondary formation of particulate nitrate. This lowers the ship-related PM2.5 by 72 % in 2040 compared to the present day, while it is reduced by only 48 % without implementation of the NECA. The effect of a lower fuel efficiency development on the absolute ship contribution of air pollutants is limited. Still, the annual mean ship contributions in 2040 to NO2, sulfur dioxide and PM2.5 and daily maximum O3 are significantly higher if a slower fuel efficiency development is assumed. Nitrogen deposition to the seawater of the Baltic Sea decreases on average by 40 %?44 % between 2012 and 2040 in the simulations. The effect of the NECA on nitrogen deposition is most significant in the western part of the Baltic Sea. It will be important to closely monitor compliance of individual ships with the enforced and planned emission regulations.

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