Geophysical Research Abstracts
Vol. 15, EGU2013-3980, 2013
EGU General Assembly 2013


# Manipulating ship fuel sulfur content and modeling the effects on air quality and climate

Antti-Ilari Partanen (1), Anton Laakso (1), Anja Schmidt (2), Harri Kokkola (1), Tuomas Kuokkanen (3), Veli-Matti Kerminen (4), Kari E. J. Lehtinen (1,5), Lauri Laakso (6), and Hannele Korhonen (1)

(1) Kuopio Unit, Finnish Meteorological Institute, Kuopio, Finland (antti-ilari.partanen@fmi.fi), (2) School of Earth and Environment, University of Leeds, Leeds, United Kingdom, (3) Department of Law, University of Eastern Finland, Joensuu Campus, Joensuu, Finland, (4) Department of Physics, University of Helsinki, Helsinki, Finland, (5) Department of Applied Physics, University of Eastern Finland, Kuopio campus, Kuopio, Finland, (6) Climate change, Finnish Meteorological Institute, Helsinki, Finland

Aerosol emissions from international shipping are known to cause detrimental health effects on people mainly via increased lung cancer and cardiopulmonary diseases. On the other hand, the aerosol particles from the ship emissions modify the properties of clouds and are believed to have a significant cooling effect on the global climate. In recent years, aerosol emissions from shipping have been more strictly regulated in order to improve air quality and thus decrease the mortality due to ship emissions. Decreasing the aerosol emissions from shipping is projected to decrease their cooling effect, which would intensify the global warming even further.

In this study, we use a global aerosol-climate model ECHAM5.5-HAM2 to test if continental air quality can be improved while still retaining the cooling effect from shipping. The model explicitly resolves emissions of aerosols and their pre-cursor gases. The model also calculates the interaction between aerosol particles and clouds, and can thus predict the changes in cloud properties due to aerosol emissions. We design and simulate a scenario where ship fuel sulfur content is strictly limited to 0.1% near all coastal regions, but doubled in the open oceans from the current global mean value of 2.7% (*geo-ships*). This scenario is compared to three other simulations: 1) No shipping emissions at all (*no-ships*), 2) present-day shipping emissions (*std-ships*) and 3) a future scenario where sulfur content is limited to 0.1% in the coastal zones and to 0.5% in the open ocean (*future-ships*).

Global mean radiative flux perturbation (RFP) in *std-ships* compared to *no-ships* is calculated to be $-0.4$ W m$^{-2}$, which is in the range of previous estimates for present-day shipping emissions. In the *geo-ships* simulation the corresponding global mean RFP is roughly equal, but RFP is spatially distributed more on the open oceans, as expected. In *future-ships* the decreased aerosol emissions provide weaker cooling effect of only $-0.1$ W m$^{-2}$.

In order to assess the health effects of different emission scenarios we diagnose PM2.5 concentrations from each simulation. Then, we use PM2.5 concentrations and C-R functions to calculate the changes in mortality related to lung cancer and cardiopulmonary diseases. Our preliminary analysis suggests that mortality in *geo-ships* would be lower than in *std-ships*. Strict sulfur content limits also in the open oceans (*future-ships*) would decrease the mortality even more.

Idea of deliberately increasing fuel sulfur content in order to produce a cooling effect can be classified as one form of solar radiation management (SRM). There are several scientific, ethical and political problems associated with SRM technologies and a number of them would be applicable to the idea we present here. For example, there would be a conflict between the existing international treaties and the proposed increase in ship fuel sulfur content. However, our study is increasing the knowledge of air quality and climate trade-offs related to ship emission controls. If the cooling effect of ship traffic is considered too precious to lose, there might be ways to preserve it, while still notably increasing the continental air quality.