

## ***Interactive comment on “Climate and air quality trade-offs in altering ship fuel sulfur content” by A.-I. Partanen et al.***

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This paper uses an aerosol climate model to quantify the radiative forcing and health impacts from several different scenarios for reducing or increasing the sulphur content of shipping fuel.

The paper is well written and has a well thought out experimental design. In particular the sensitivity analysis to quantify the effects of model assumptions is very thoughtful.

The use of RFP (now called ERF in IPCC AR5) is still new and so this paper provides useful new information on the ERF of shipping.

Specific comments:

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Abstract: The IPCC AR5 now uses the term "Effective Radiative Forcing" (ERF) rather than RFP to describe fixed SST experiments. The authors may or may not wish to adopt this too.

Section 2.1

What is the model resolution?

Page 21995, lines 10-12.

Why do the authors have to make assumptions about ACCMIP emissions? This information should be available from Lamarque et al. 2010, (which references Eyring et al. 2010). The authors should understand the origin of this dataset and describe it more fully here.

Page 21996, lines 23-25.

Shipping is a large NO<sub>x</sub> source. The authors should do a rough scaling to estimate the magnitude of the nitrate contribution to health and ERF in order to demonstrate that it has only "minor effects".

Section 3.2

This is the only section where I had some concerns about the methodology. The differences between the health impacts are due to having strips 0, 1 or 2 grid boxes wide. How accurately can the model transport aerosols over 1 grid box? On this scale the amount of pollution reaching the coast might depend on how diffusive or not the advection scheme is, and even on such subtleties as whether the advection is carried out before or after the chemistry and deposition steps. It would be useful for the authors to show detailed maps (eg. of North Sea and Baltic) of the different emissions used so the reader can get a better impression of the size of these coastal strips and their blockiness.

Another way of generating the emission fields would have been to apply the 200 nm

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strip to the original data (at 0.5 x 0.5 deg resolution) and then downgrade it to the model resolution.

Page 22001, line 25 - page 22002, line 5.

I assume the coastal forcing is calculated by averaging the ERF from each grid box in the coastal zone. This needs to be explained better. I first read this as being the forcing due to coastal emissions, which can only be calculated with a separate experiment. This doesn't really show that emission reductions near the coasts have relatively little effect as you wouldn't expect the effect of coast emissions to be confined to the coastal zone, i.e. coastal emissions would also have an ERF over the land and extend further out to sea.

Section 4.1

I am slightly uncomfortable about using words like "desirable" and "optimal" in this section. As discussed in section 4.2 it is not obvious that these words can be defined in a public good sense.

Page 22006, lines 16-18.

Jones et al. found the temperature change was not homogenous, rather the cooling was concentrated in the tropics. This contrasts with the pattern from CO2 where the warming is largest in the Arctic. Therefore geoengineering can't balance the CO2 in each region simultaneously.

Page 22007, lines 14-17.

It would be useful to explicitly mention the timescales over which the ships would be needed to be deployed continuously.

Page 22007, lines 18-22.

Presumably there is horizontal mixing between the open ocean and the continental shelf so the acidification would reach the coast. It would be useful to get an order of

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magnitude estimate of the change in pH compared with that due to doubled CO2.

Page 22008, lines 5-8.

This sentence could be deleted. This study hasn't addressed alternative geoengineering techniques or additional greenhouse gas mitigation measures and so doesn't have the information required to recommend exploring them.

Page 22008, line 12.

Delete "state-of-the-art" as it doesn't add anything.

Page 22009, line 15.

"too precious to lose" is unnecessarily emotive. The two sentences could be simply combined - "The cooling effect of aerosol emissions from shipping could be preserved by...".

Page 22009, lines 19-20.

The sentence "Therefore, it should..." can be deleted.

Figure 6.

x-axis title needed.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 21989, 2013.

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