

Comments to

*The impact of nitrogen and sulphur emissions from shipping on exceedances of critical loads in the Baltic Sea region*

By Sara Jutterström et al.

Abstract

The abstract does not cover the paper very well. Please add (at least) a sentence about the results of the sub-national analysis carried out for Sweden.

Line 39. *In the atmosphere ammonia reacts readily with both HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> forming particulate ammonium sulphate and nitrate ((NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, NH<sub>4</sub>NO<sub>3</sub>).*

Change HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> to H<sub>2</sub>SO<sub>4</sub> and HNO<sub>3</sub> to comply with the sequence used in the rest of the sentence and between the brackets.

Line 49. *but also eutrophication has decreased.*

This requires a reference

Line 59: *with the ultimate aim reducing depositions below the CLs*

Please change to 'with the ultimate aim of reducing depositions below CLs'

Line 79. *limits both for S (SECA) and for NO<sub>x</sub> (NECA).*

Inconsistent. Why not S and N or SO<sub>x</sub> and NO<sub>x</sub>

Line 128. *and include all merchant ships larger than 300 GT*

Please indicate what that means: how much of the total emissions is covered by limiting the data to ships of > 300GT?

Line 147-150. *While for Germany the reason could be underestimation of NH<sub>3</sub> emissions from agriculture, comparison of modelled and measured NH<sub>3</sub> concentrations in Denmark and Poland shows overestimation by the model, indicating that the reason for underestimation of N deposition in these areas is rather availability of sulphuric and nitric acid or limited formation of particulate ammonium nitrate and sulphate.*

This reasoning is hard to follow. Why would one assume an underestimation of NH<sub>3</sub> emissions in Germany being the cause for underestimating N depositions while at the same time the NH<sub>3</sub> concentrations in the adjacent Denmark are overestimated by the model which may, i.m.o. indicate overestimation of emissions of NH<sub>3</sub>. Please rephrase.

Line 169. *Tier III for all ships built (keel laid) 2021 and later, operating in the region*

What does that addition mean, keel laid. Not clear. Is it needed, or is simply built 2021 and later enough?

Line 171. *In order to investigate impact of NECA*

Change to 'In order to investigate the impact of NECA'

Line 234: *Without introducing a NECA (scenario BAU-NoNECA) the contribution to N deposition would in median be more than twice as big as in the BAU case*

Unclear sentence. 'the contribution to N deposition would in median be more than twice as big'. Which median is meant here? The median of the depositions computed over all grid cells? Please clarify.

Line 238: *In the year 2012 deposition of S was still relatively high, reaching to >5 kg ha<sup>-1</sup>yr<sup>-1</sup> at the 1% of most impacted parts of the modelled area*

How is the most impacted part defined? As the area with the highest total deposition or the area with the highest deposition originating from shipping emissions or.... Please explain.

Line 286: *For the countries with the largest exceedances in 2012 there is a great improvement, and the impact of shipping in the year 2040 is rather insignificant*

‘Great improvement ‘ and ‘ insignificant’ So the improvement is from other emission reductions I assume? Please explain.

Line 340. *The highest average deposition of N (on acidification-sensitive ecosystems)*  
*acidification-sensitive ecosystems*: how have these been defined? Do you assume all ecosystems for which CL’s are submitted by Sweden are sensitive, or did you make a selection based on e.g. CLs ? Please explain.

Line 428: *The introduction of NECA will improve the situation in several of the Swedish counties, but more reductions might be necessary to further reduce the impact of shipping, there.*  
This is a vague statement. *More reduction **might be needed***. Make this more conclusive: what **is** needed in light of the AAE and how much can reducing shipping emissions contribute to that.

Line 452. *The reduction in fossil fuel use that will be required to achieve this goal is more far-reaching than what has been adopted in the BAU scenario.*  
Although I understand that this could not be included anymore in the paper, its needs a more extensive discussion. Please add a simple quantitative analysis about what this could mean in terms of emission reductions of S and N from shipping as compared to the scenarios used.

General remark: For exceedance calculations, the CL’s are used from the ICP M&M - CCE database that consists of nationally submitted CLs. Different countries however, submit CLs based on different receptors (surface waters, forest) and may use different CL methods (SMB or empirical) (noted in section 2.3). This leads to differences in CLs (and exceedances) that are not based on ecosystem sensitivity alone. This is for example clearly visible in Figure 5 where there is a change from  $AAE = 0$  to  $AAE > 0$  for CL<sub>Aci</sub> over the Danish-German border which most likely due to differences in CL methods between Germany and Denmark. In figure 6, the AAE of CL<sub>eutN</sub> increases clearly going from Germany over the border to Denmark. Some discussion on this is needed to help the reader understand the figures better.