

Interactive comment on “Projected change in atmospheric nitrogen deposition to the Baltic Sea towards 2020” by C. Geels et al.

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Projected change in atmospheric nitrogen deposition to the Baltic Sea towards 2020
by C. Geels et al.

Answer to anonymous Referee #2:

Reviewer - General comment:

Dear authors, Thank you for this manuscript. In general it is a rather straight forward study, showing the results of a modelling exercise with the well documented DEHM model. Overall, the paper is well written, in clear English. However, there are some remarks to be made: make sure you use the proper tense of English in a consistent way (you have a tendency to mix them in different occasions). Properly introduce

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acronyms/component names/etc once you use them for the first time. Another English thing: sometimes the structure of a sentence looks more Danish than English - for some of the cases I will show them, but perhaps you could check the manuscript for others.

Reply: We thank the reviewer for the comments and the suggested changes to the text. Below we address each of the comments and describe the according changes we have made to the manuscript. We have also tried to restructure some of the sentences so the “Danish” touch is less obvious

Specific comments: p 21534 l 4: although it is rather clear what you mean, there is a mixture of terms used for almost the same thing - new National Emission Ceilings directive (NEC-II), directive on national emission ceilings (NEC).

Reply: We have now changed the manuscript so that we only use the term “National Emission Ceilings directive (NEC-II)”.

Be consistent in the way you define things p 21538 l 5-6: sometimes you explain the ‘smallest’ things, but here everybody is supposed to know what the continuity equation is. Probably that is also the case, but make sure that you explain terms of which you cannot be sure that everybody knows them p 21538 l 6-??: in fact, most of this text is rather ‘boring’ to read. It looks like textbook material and I wonder if this cannot be condensed in some way.

Reply – the other reviewer on this paper has requested more explanations of abbreviations, chemical species etc. The paper therefore now contains more definitions and explanations, but now in a more consistent way.

p 21538 l 23: this is one of those examples of a ‘funny’ sentence - I would rather write ‘Specific dry deposition velocities in DEHM are calculated for the ’ or ‘In DEHM, specific dry deposition velocities are calculated for the ’.

Reply: we follow the suggested changes:

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FROM: "Specific dry deposition velocities are in DEHM calculated for the gases"

TO: "In DEHM, specific dry deposition velocities are calculated for the gases"

p 21540 l 2: 'the applied chemistry module and the dry deposition module have been updated through the years in order to improve the model' (again one of those sentences).

Reply: We have now changed the text: FROM: "Because of the relatively intense focus on nitrogen in the calculations performed within NOVANA, the applied chemistry module and the dry deposition module have through the years been updated in order to improve the model. "

TO: "The applied chemistry and the dry deposition module have through the years been updated in order to improve the calculations of N deposition ".

p 21541: strange to have a representative year being picked out of a period that doesn't include the actual year for which you calculate the deposition.

Reply: We have run the model with input of meteorological data covering the 10 period 1995-2004 and constant anthropogenic emissions. Based on this we found that by using meteorological data for the year 1998 the annual N deposition to the Baltic Sea came closest to the deposition averaged over the full 10 year period. Following the suggestions by reviewer 1 we now call this the "reference deposition year". The period 1995-2004 was originally chosen as it covers the reference period of BASP. Afterwards we found out that the official EMEP emissions from this period had been updated, while the expert emissions applied for model studies had not been updated. We therefore decided to use the most updated emissions data set (2007) where we know that the official and expert emissions agree. As our study is focused on the projected difference in N deposition due to changes in emissions from present day (2007) to 2020 the applied meteorology year is less important (we also do not use projected changes in meteorology). However, in order to analyse the year to year difference in N dep. due

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to meteorology alone and in order not to use a very extreme year we have chosen this method. See also the answer to reviewer # 1 on the same issue.

p 21542 l1-3: in the first three sentences you have three times 'best possible quality and resolution'. perhaps consider dropping a few.

Reply: True, we have changed the text:

FROM: "In order to include the most realistic emission input to the DEHM model, the available emission inventories covering the globe (Representative Concentration Pathways (RCP) database) and Europe (European Monitoring and Evaluation Programme (EMEP) database) have been combined using the best available quality and resolution for the specific areas. The focus has been on obtaining the best possible quality and resolution in emissions in the immediate vicinity of the Baltic Sea. In this context the high quality and high resolution emission data from Denmark (Gyldenkerne et al., 2005; Skjøth et al., 2004) play an important role especially due to the ammonia emissions from the extensive Danish agricultural activities that contribute significantly to local depositions. " TO: "In order to include the most realistic emission input to the DEHM model, the available emission inventories covering the globe (Representative Concentration Pathways (RCP) database) and Europe (European Monitoring and Evaluation Programme (EMEP) database) have been combined using the best available quality and resolution for the specific areas. Specific focus has been on obtaining the best possible emission data set in the immediate vicinity of the Baltic Sea. In this context the detailed emission data set covering Denmark (Gyldenkerne et al., 2005; Skjøth et al., 2004) play an important role especially due to the ammonia emissions from the extensive Danish agricultural activities that contribute significantly to local depositions."

p 21542 l10: another sentence: 'In this study emissions for 2007 were chosen to '

Reply: we have reformulated the sentence: FROM: "Emissions for 2007 were in this study chosen to represent the present day emissions." TO: "In this study the emissions for 2007 will represent 'present day emissions'"

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p 21542 l17-22: you describe that for Denmark you used high resolution data. There is however no indication of the what the consequence of this is when comparing this with other (coarser) emission for other regions. To what extent do you introduce specific difference for Denmark by having this difference in emission resolution?

Reply: We have chosen to combine the available emission data, so that we use the best possible emission input especially in the Baltic region. As we use the higher resolution NH3 emission data for Denmark, the estimated contribution from Denmark to the Baltic Sea will be associated with less uncertainty than the contribution from the other countries. We have not analysed in detail how large the differences is, but we have in an other study shown that the inclusion of a dynamic emission model for NH3 covering Northern Europe gives better agreement with measurements (Skjøth et al. 2011). But emission data with a higher spatial resolution are needed for the other countries around the Baltic before we can get the full advantages of the dynamic emission model for these countries also.

p 21543 l17: 'Nh3 emissions differ more ' – than what?

Reply: we have added some text to make this more clear:

FROM: "The projected changes in the NH3 emissions differ more across the nine countries." TO: "The projected changes in the NH3 emissions differ more than the NOx changes across the nine countries."

p 21543 l22: 'the total N emission is, as a result (of what?), projected '

Reply: We simply mean that as a result of the projected changes in NOx and NH3 the total N is projected to change by app. 30 % ... We try to make this clearer in the text.

FROM: "The total N emission is as a result..." TO: "The total N emission is as a result of the separate changes in NOx and NH3 ..." Reply – we have rephrased these sentences

p 21544 l18: ' 275 km2' - wasn't this higher resolution data?

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Reply: It is true that the emission input has a high resolution, but in this study the model has been run with resolution of 50 km x 50 km (as described in section 2.1). So ' 275 km2' is wrong and we have corrected this in the text.

FROM: "The reason for this overestimation can partly be because the model includes the average emissions within grid cells (in this case an area of ca. 275 km2) and calculates the average deposition to the same grid." TO: "The reason for this overestimation can partly be because the model includes the average emissions within grid cells (in this setup 50 km x 50 km) and calculates the average deposition to the same grid."

p 21544 l24: the DEHM model was validated against two marine sites, and based on that it is assumed that it is representative for the entire Baltic. How valid is such an assumption?

Reply: Unfortunately measurements of nitrogen deposition are very limited, so it is difficult to find a comprehensive dataset for model validation. DEHM has previously been validated against measured concentrations of NH3 and NH4 at the EMEP sites across Europe. We have now included some references to these comparisons. In the current paper we include a comparison to the measured data from Denmark that represents both land and marine conditions in order to document that the model is able to capture the overall processes relevant for nitrogen deposition. Combined with the other validations we refers to now we believe that it is valid to assume that the DEHM model can be used to study the N deposition in the Baltic region. However, we of course hope that more data will be available in the future to support this assumption. The following text has been added to section 2.4 Validation and uncertainties: " In previous studies DEHM has also been validate against measured concentrations of for example the sum of NH3 and NH4+ (denoted SNH) across the EMEP measuring sites in Europe and the model captures the overall measured patterns (Brandt et al., 2011a; Pul et al., 2009)."

p 21545 l18: ' ..., indicating that, in the current study, we might be ..'

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Reply – we have split this sentence into two sentences to make this more clear

p 21552 l 2: 'In this study we focus on the change in deposition towards 2020, solely due to changes in anthropogenic emissions'. And here's another one of those sentences. Please note that I stopped writing them down for the previous pages, so please check it yourself.

Reply – we have rephrased to make this clearer.

Table 4: To what extent was nitrogen deposition included when the BSAP Targets were determined. If not, is it fair to make this comparison. If so, would be nice to know the separation between deposition and direct input through water fluxes. Table 4: does a reduction of -2.94 kt in comparison with the required 6.97 kt reduction mean that the first is -42% of the BSAP reduction? Don't think so.

Reply: The atmospheric nitrogen deposition is not currently included in the BSAP, so we agree with that reviewer that this comparison is interesting. However, it is true that the comparison for Russia is special and could be misunderstood as Russia is the only country where the emission increases towards 2020. We have therefore removed the number for Russia and included the following text in the paper:

FROM: "The overall reduction towards 2020 from the nine countries based on the NEC-II emissions is 21% of the nitrogen reduction required in the provisional BSAP."

TO: "Based on the projected emissions changes the overall reduction in the contribution from eight of the countries is 25 % of the nitrogen reduction required in the provisional BASP. The contribution from Russia is not included here, as this is the only country where the emissions are projected to increase. In this case the increased input of nitrogen would have to be counteracted by further regulation initiatives in Russia. "

Figure 1: typo in caption - appropriate Figure 2 / 3: 'common unit' ? Figure 4: 'divided'?

Reply: ok.

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Supplementary material: Table S1/S2: I have the feeling that the summation is wrong. For total loads this would work, but not for the loads in kg/km² for the different basins/sub-basins. In that case you should use the areas for these basins/sub-basins for calculating the actual deposition to the Baltic Sea.

Reply: Thank you for pointing out a mistake in the table – the over all sum for the Baltic was wrong. We have now removed this information from the table.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 21533, 2011.

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