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Interactive comment on “The impact of shipping emissions on air pollution in the Greater North Sea region – Part 1: Current emissions and concentrations” by A. Aulinger et al.

Anonymous Referee #2

Received and published: 30 April 2015

The paper describes an emission set for shipping in the North Sea and the methods applied when calculating the emissions. These emissions are then applied in the a regional model, calculating the effects of (mainly) North Sea shipping on air pollution in the North Sea region. The scientific methods used are sound, but some aspects of the paper should be improved.

The language should be improved. Some suggested improvements are given in the detailed comments below. Still, the authors should carefully read through the text and improve the language. Some suggestions for improvements are included below. I confess that the motivation to comment on language has decreased towards the end

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of the paper.

A large part of the manuscript describes the methods used to calculate the emissions from North Sea shipping. Several previous estimates of North Sea shipping have been made. A Table comparing the emission estimates from this work to previous studies (in addition to EMEP/CEIP) should be easy to include (Emission estimates from Jalkanen et al, EMEP, Hammingh et al. (2012) etc.). Hammingh et al. also gives a lower estimate of ship emissions in the North Sea than EMEP (and Jalkanen et al. (2012)). They ascribe the difference in their estimates to different assumptions for axillary engines. Please comment.

Ship Emissions are representative for year 2011 (post SECA) whereas the meteorology and air pollution measurements are from 2008. The Recession started in 2008 (but full effect not until 2009?). Much of the effects of the recession had recovered by 2011. This should at least be mentioned/discussed.

In large parts of the North Sea region ozone is NMVOC limited with titration controlling ozone levels much of the year, see for instance Beekmann et al. (2010). This makes the calculation of the effects of ship emissions on ozone levels a challenge. Please comment.

I can not find any information on the horizontal and vertical resolution for the CMAQ chemical tracer model.

Furthermore, the model calculated ozone levels are overestimated, at some sites by as much as 10 ppb. Why? Could it be that your boundary levels (from TM5) are too high? Is there a particular season when the overestimation is larger? Regional models usually perform remarkably well for ozone (see for instance Solazzo et al. (2012) where the CMAQ model is also included).

Detailed comments:

Page 11278, line 20 Based on the information later in the manuscript The total emission

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from shipping is from the North Sea plus some additional sea area west of the North Sea?

Page 11279, line 12 the North Sea is accepted as an (not accounted)

Page 11279, line 15 You should also mention that from January 2010 the EU sulphur directive requires ships to use fuel with 0.1% or less in EU harbours.

Page 11279, line 22 You should add ozone to the list of secondary pollutants.

Page 11282, line 5 - 6 according to this data set

Page 11282, line 8 Delete used and set up: ... required by the chemistry transport model.

Page 11282, line 9 AT open sea

Page 11282, line 10 - 11 Difficult sentence to understand.

Page 11282, line 16 generate instead of elaborate.

Page 11283, line 6 the resulting tracks were rejected

Page 11284, line 3 - 6 Incomprehensible sentence. Please rephrase.

Page 11284, line 9 ... (Table1) were collected from the ship

Page 11284, line 13 Emissions from all vessels

Page 11285, line 6 - 7 It is unfortunate that emissions from mooring was not included in the database.

Page 11285, line 16 I did not quite understand what it means that the axillary engine load was 0.3. Please explain.

Page 11286, line 13 - 17 Here ship emissions are aggregated to a specific model domain. As I understand data funded by Interreg projects should be free to use. Is the dataset available and transferable to other resolutions/projections? If so you should

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state so.

Page 11286, line 22 A ship is sailing, not travelling (even when using an engine). See also next page.

Page 11287, line 2 What is meant by in general?

Page 11287, line 3 calculated for (use assuming instead of for)

Page 11287, line 19 - 22 Please rephrase.

Page 11288 Line 3 - 4 lower, (not less) higher (not more)

Page 11288, line 10 I don't understand the origin of the percentage difference. By high sulphur fuel you mean fuel content of more than 1% sulphur, or a lower percentage?

Page 11288, line 19 - 20 See comment, Page 11278, line 20

Page 11289, line 20 Here you should include something on NO_x versus NMVOC control.

Page 11289, line 21 - 22 PM is also emitted directly, see top page 11285.

Page 11289, line 23 - 25 You should also provide a reference to your land based emissions (what is official European emission inventories). What about emissions from other sea areas as the western part of the Baltic Sea? Please also make it perfectly clear that in the ship sensitivity model run ship emissions are removed only for the North Sea (+ a small additional part of the eastern North Atlantic?)

Page 11291, line 20 - 23 Contrary to NO₂, land based emissions of SO₂ are mainly from relatively few large point sources with variable stack height. How are these large point sources treated in the model?

Page 11292, line 1 SO₄ (sulphuric acid is also emitted directly, see top page 11285.

Page 11292, line 16 - 18 Please rephrase.

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Page 11293, line 14 - 15 Should it be western rather than the eastern part of the Baltic Sea?

Page 11294, line 14 much smaller increases were calculated along

Page 11294, line 23 These pollutants have a relatively short residence time in the atmosphere and are removed by dry and wet deposition.

Page 11295, line 1 Here, not there.

Page 11295, line 8 to those of moderately polluted regions

Page 11295, line 12 - 13 This sentence is hard to read. Please simplify.

Page 11295, line 22 From Figure 2 I get the impression that ship emissions peak in summer.

Page 11296, line 1 Surely you only mean the western border here?

Page 11296, line 13 Pollutant plumes, not clouds

Page 11296, line 8 - 16 Please rephrase this sentence. Furthermore, ammonia emissions have a strong seasonal variation. The dry deposition of gaseous HNO₃ is much faster than for ammonium nitrate. The removal of total nitrate (gaseous HNO₃ + particulate nitrate) should then depend on the availability of ammonium.

Some additional references that I have used

Beekmann, M., and Vautard, R.: A modelling study of photochemical regimes over Europe: robustness and variability, *Atmos. Chem. Phys.*, 10, 10067–10084, doi:10.5194/acp-10-10067-2010, 2010.

Hammingh, P., Holland, M., Geilenkirchen, G., Jonson, J., and Maas, R.: Assessment of the Environmental Impacts and Health Benefits of a Nitrogen Emission Control Area in the North Sea, PBL Netherlands Environmental Assessment Agency, the Hague/Bilthoven, 2012.

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Solazzo, E., R. Bianconi, R. Vautard, K.W. Appel, M.D. Moran, C. Hogrefe, B. Bessagnet, J. Brandt, J.H. Christensen, C. Chemel, I. Coll, H.D. van der Gon, J. Ferreira, R. Forkel, X.V. Francis, G. Grell, P. Grossi, A.B. Hansen, A. Jericevic, L. Kraljevic, A.I. Miranda, U. Nopmongkol, G. Pirovano, M. Prank, A. Riccio, K.N. Sartelet, M. Schaap, J.D. Silver, R.S. Sokhi, J. Vira, J. Werhahn, R. Wolke, G. Yarwood, J. Zhang, S.T. Rao, S. Galmarini: Ensemble modelling of surface level ozone in Europe and North America in the context of AQMEI, *Atmos. Environ.*, 53 (2012), pp. 60–74

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