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Interactive comment on “Impacts of climate change on air pollution levels in the Northern Hemisphere with special focus on Europe and the Arctic” by G. B. Hedegaard et al.

G. B. Hedegaard et al.

Received and published: 25 April 2008

First of all, we would like to thank reviewer number two for a very thorough review of our paper, with many relevant and positive comments. We reply to each in turn in the following:

Reviewer: 1) It would be a nice extension to use not only EMEP stations but also other net works world wide for the evaluation approach performed in the paper, also possibly not only surface measurements but vertical soundings or satellite data might be helpful. It would be nice to have this in possible follow-up papers on this issue.

Answers: We fully agree with the reviewer.

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Reviewer: 2) It is mentioned on page 1762, 2. Model descriptions, that SO₂ emissions from IPCC SRES A2 have been used in ECHAM-OPYC3 to calculate also SO₂ concentrations. As far as I know the emission data from IPCC SRES A2 (which includes also NO_x, CO, and anthropogenic VOC emissions) differs from those used within EGDAR/EMEP. Has the differences in calculated SO₂ concentration between DEHM and ECHAM4-OPYC3 been checked? Can they be attributed to different emission input for SO₂?

Answers: It is corrects that the SO₂ emission data used in DEHM and ECHAM4-OPYC3 are different. However, as the results we are investigating in the paper using DEHM are independent from the SO₂ emissions in ECHAM4-OPYC3, we do not think this is a problem. Both models use the best available emissions for their own purpose. For the same reason we did not check the differences in the calculated SO₂ concentrations. However, also note that it is the SO₄ concentrations that are important for the ECHAM4-OPYC3 results due to the particle nature of SO₄ and gaseous nature of SO₄. The particles of course contribute to the cooling of the atmosphere in the climate run.

Reviewer: To my knowledge, ship emissions, which are expected to increase considerably during the coming decades, are not represented in the IPCC SRES A2 scenario. It might be mentioned on page 1785, line 20-25, that a strong increase of SO₂ emissions by ship traffic is expected for the next decades and, to my knowledge, already has taken place since 1990 worldwide. This will clearly increase SO₂ concentrations as an effect of increasing ship emissions (not meteorology as investigated here). Emissions from ships are also discussed as a major component which might influence the future climate (Lauer, A., V. Eyring, J. Hendricks, P. Jöckel, and U. Lohmann: Global model simulations of the impact of ocean-going ships on aerosols, clouds, and the radiation budget, *Atmos. Chem. Phys.*, 7, 1-19, 2007.)

Answers: It is correct that the ship emissions are not represented in the IPCC SRES A2 scenario. We fully agree with the reviewer that the changes in anthropogenic emis-

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sions, including the ship emissions, are very important for the future concentration levels. We plan to investigate the combined effects in a future paper, where the signals from the both anthropogenic emissions and climate changes (including the biogenic emissions) are evaluated.

Reviewer: 3) With respect to the discussion on the importance of biogenic emissions, in particular isoprene which is handled in DEHM: Temperature, CO₂ concentration and precipitation are mentioned and discussed as factors which have an effect on isoprene emissions. What is the opinion of the authors regarding the impact of land use changes which might lead to different plants with other emissions factors? In particular if you look into the 2090 decade. Are those land use changes included in the IPCC scenarios? Or are there plans to do so in future IPCC calculations?

Answers: We agree with the reviewer that the impacts from land use changes could be huge. We are aware of any databases including land use changes for the next century.

Reviewer: 4) As referee 1 I can only identify 4 model runs (see page 1768, 3. experimental design).

Answers: There are five ten-year simulations, since the 1990-1999 period has been simulated twice with ECHAM4 meteorology – one with variable anthropogenic emissions for the validation case and one with constant 1990 emissions used as the reference for the future scenario simulations.

Reviewer: 5) Page 1773, discussion on overestimation of ozone: Is the overestimation of the monthly averaged ozone concentration mainly due the overestimation of night time values due to the large grid size which might lead to an underestimation of titration of O₃ to NO₂ during night in the emission source regions?

Answers: The overestimation of monthly averaged ozone concentration is actually mainly due the overestimation of night time values. However, the overestimation of night time values is due to dry deposition of ozone, where there is a strong vertical

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ozone profile near the surface during the night in the lowest 10-20 meters. As the lowest model level is approximately 80 m, the model cannot resolve this concentration profile and will give an overestimation when compared to measurements carried out at the 2 m level.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 1757, 2008.

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8, S1976–S1979, 2008

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