

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.

Anonymous Referee #2

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General comments:

Hedegaard et al. (2008) investigates the impacts of climate change on air pollution levels in the Northern Hemisphere with special focus on Europe and the Arctic.

The paper is clearly written, the selected approach is systematic, and the scientific questions addressed are within the scope of ACPD. The title clearly reflects the contents of the paper, the abstract is a very good summary of the objectives and conclusions of the paper.

The investigation of the impact of future climate change on air pollution using numerical

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modelling is a quite new field, where the methods developed for climate modelling are combined with the numerical approach used for air quality modelling. There are not many papers on this issue yet, the paper is a valuable contribution to the scientific questions related to the impact of climate changes on air pollution.

Hedegaard et. al use the chemical transport model DEHM with ECHAM4-OPYC3 as meteorological driver. Meteorological data generated by ECHAM4-OPYC3 with the IPCC SRES A2 scenario have been used to calculate air pollutant concentrations for the Northern Hemisphere for three decades (1990, 2040, and 2090) with a horizontal resolution of 150 km (DEHM). Validation of the modelling system ECHAM4-OPYC3-DEHM has been done for the 1990 decade using "real emissions" (based on EDGAR and EMEP including seasonal and daily variation for the "real emissions") and, in addition, using MM5 as meteorological driver with a "real meteorology" instead of the meteorological data as given by the climate simulation of ECHAM4-OPYC3 ("free run"). Comparison of both data sets with measured data from the EMEP network shows that it is scientifically sound to use data from a "free run" to drive a chemical transport model and to investigate the impacts of climate changes on air pollution until the 2090 decade. The scientific approach is clearly and performed in a very interesting way, it is a pleasure to follow the text of Hedegaard et al.

Specific comments:

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.

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.

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Has the differences in calculated SO₂ concentration between DEHM and ECHAM4-OPYC3 been checked? Can they be attributed to different emission input for SO₂? 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.)

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?

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

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?

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

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