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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of climate and emission changes on nitrogen deposition in Europe: a multi-model study" *by* D. Simpson et al.

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General comments

Deposition of reactive nitrogen to natural ecosystems is currently a high profile environmental issue. Levels of input from atmospheric nitrogen deposition result in the exceedance of critical loads across much of Europe as well as other parts of the world, causing a major global concern. Both scientists and policy makers are interested in future projections of emissions of pollutants (i.e. NOx and NH3) and in assessing how effective technical measures to control emissions will be in reducing the threat to the natural environment. More recently the potential impact of future climate change on air pollution has been the focus of interest. This article is therefore clearly of significance

as it deals with both the impacts of climate change and emissions changes over the European continent in the framework of a multi-model study. The paper is carefully written and well referenced. The supplementary material, figures and tables are relevant to the study. The use of an ensemble of models in the study serves both to provide greater confidence in future predictions of nitrogen deposition as well as to highlight areas (where modelled results diverge) where further research is needed. I am pleased to recommend this paper for publication. A number of points are raised below where some additional clarification could usefully be provided.

Specific comments

(1) Page 6670: The future projection of emissions to the year 2050 inevitably involves considerable uncertainty as the influence of new technology and changes in global commerce and energy consumption are not well known over the next four decades. Can the authors explain what assumptions have been made in the emissions projections (in particular the large emissions reductions for SO2, NOx and VOCs) and give some indication of uncertainty?

(2) Page 6672, line 1: "Both models show rather similar large-scale changes in precipitation to the 2050s though." A comment on the distribution of precipitation changes (i.e. increases in southern Europe, decreases in northern Europe would be useful in the text here).

(3) Tables 2: BIC ('Boundary and Initial Conditions') should be defined

(4) Tables 3: stns: (number of stations) should be defined. Can some general comments be made on the overall correlation statistics? Why are models more successful in their correlation with measurements of NO2 than SO2 (treatment of elevated point sources) and of NH3 than HNO3 (complexity of oxidised nitrogen chemistry)? Are there thought to be any systematic errors in measurements (i.e. are the precipitation chemistry collections made using 'wet-only' collectors or are they made with bulk collectors which may be subject to dry deposition?)

(5) Measurement data has been considered covering an 11 year period, taking average annual mean values to compare with modelled values. Have studies been undertaken on how the models respond to emissions changes and whether the modelled changes in concentration and deposition agree with observed changes? Reference to such studies would be useful here, particularly as the models are subsequently used in a predictive mode.

(6) Page 6682 exceedance of critical loads. The EMEP model has been developed as a European policy model and therefore calculates ecosystem specific deposition. How do the other models deal with dry deposition to different vegetation types? The use of a 'simple' ecosystem-independent critical level suggests that these models do not generate vegetation/ecosystem specific dry deposition values.

(7) Conclusions, page 6686, line 1: The conclusion that for future scenarios ammonia concentrations and dry deposition of reduced nitrogen will increase due to the reduction in the availability of sulphuric acid and nitric acid to react with ammonia is quite important. This illustrates clearly the non-linearity of atmospheric chemical reactions in controlling patterns of deposition. It therefore follows that in the future nitrogen deposition will be more correlated to local emissions (of ammonia) and that long range transport (of particulates) will become relatively less important. This has implications for the effectiveness of national (as opposed to international) policy to reduce emissions and bring down the exceedance of critical loads for nitrogen deposition. I think it is worth mentioning this here.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 6663, 2014.