Atmos. Chem. Phys. Discuss., 14, C8473–C8477, 2014
www.atmos-chem-phys-discuss.net/14/C8473/2014/

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "An evaluation of ozone dry deposition in global scale chemistry climate models" *by* C. Hardacre et al.

Anonymous Referee #1

Received and published: 24 October 2014

This paper compares ozone deposition estimates from a number of global models. The paper is useful in a number of respects, but with too much focus on Europe, and a little too uncritical. I believe the paper can be suitable for publication, but I have some substantial comments that the authors should address.

* A major problem is that the comparison with measurements makes use mainly of very old data from a limited number of sites, almost all of them in Europe, and for short-term periods. The authors seem unaware of the large network of sites which are used to estimate O3 deposition in both Canada and the USA over long-periods (e.g Schwede et al, 2011, Zhang et al. 2002a). Data also exist from South America and Asia Tropical forests - Ganzeveld and Lelieveld showed some back in 1995 and there have been many measurements since then.

* The choice of land-cover categories used in this comparison is also difficult to understand. Why look at data from untypical LCCs such as onion fields, but not at major crop species such as wheat or maize, or of grasslands (outside Europe), which have been the subject of many deposition studies (eg Gerosa et al., 2003, Bassin et al., 2004, Finkelstein, 2001, Stella et al., 2011, Tuovinen et al., 2004, Val Martin et al. 2014). Or data for Tropical forests?

* One problem is the need to make many assumptions when looking at land-cover specific deposition velocities. Related to this, the paper provides few details that would help the reader understand model-to-model differences. There should be a table with some description of the basic features of deposition from each model. Some examples: do the models use constant or e.g. monthly LAI estimates? If so, where from? Are Wesely schemes really used in all models? If not, what is used? Since tropical forests are globally very important, and also turn out here to have very different deposition velocities, the treatment of these also deserves special mention. I do not expect a detailed review, but a paper which compares 15 models for one specific model output (dry deposition) should take the time to catalog such details, and inform the reader about the main characteristics of the models.

* The paper fails to refer to and discuss quite a few previous papers which provide lessons in the difficulties CTMs face with dry-deposition modeling. For Europe the papers of e.g. Tuovinen et al., 2004, 2009 discuss in detail the importance of various factors when dealing with ozone deposition in the EMEP CTM. Similarly, the Canadian AURAMS model team have documented extensive development and testing of dry deposition modules (Zhang et al., 2002b, 2006). Results from such studies should inform any discussion of global CTMs.

* Given these points, I miss a proper discussion of the major weaknesses of current models. P22813, L26-27 makes the claim that 'O3 dry deposition has not previously been reported at this level of detail', but I would argue that the EMEP or AURUMS evaluations are far more detailed in terms of process understanding. The current paper

adds a dimension with a multiple-model comparison, but makes rather broad assumptions with regard to LCC comparisons; it cannot be called illustrative (which is also useful), but not detailed.

* The authors make no mention of the role of chemistry in perturbing real and apparent ozone deposition - for examples issues discussed in Wolfe et al (2011) for forests, or Chang et al. (2004) for oceans. Given that such process may have very important effects on measurements of O3 deposition, some mention is warranted.

* P22798, last paragraph. It would help the reader to get some idea of differences in near-surface O3 over different LCCs, since vertical gradients in O3 can be substantial near the surface.

* Section 5.3 lacks a lot of information and I am really not sure it adds anything. The data used are very old, which is a shame since there have been many nice ozone deposition data sets produced in the last decade (e.g. Stella et al., Biogeosci., 2011). There is no documentation of the sites methodology or data-quality issues. With ozone deposition the latter is very important, since any flux estimate is very sensitive to many factors.

* Units are given in kg/m2/s, which gives values of order 1e-10. Why use such as an awkward unit? For nitrogen deposition a common unit would be kg/ha/year, with 1e-10 kg/m2/s being ca 32 kg/ha/year - much more manageable. In Europe, fluxes tend to be given in mmole/m2/year, more consistent with the POD concept.

* The references used are typically rather old, and should be modernized throughout. As one example, on P22794, L24, the reader is asked to "look for references therein" from a 2005 paper. There have been many important studies the last 10 years, so provide more up-to-date references.

* P22798, L12. Why were fluxes normalized to 30 ppb? A simpler procedure would be to just present deposition velocities.

* P22794, L16-22. This paragraph needs references!

* P22796, L21. Odd not to mention here EMEP, the one (also global) CTM which implements DO3SE. In fact, wasn't DO3SE developed in cooperation with the EMEP team? There are a long list of papers covering this linkage.

* P22799, L13-15. This is a little confusing. I assume you mean normalised fluxes when taking ratios?

* P22806, L6. I agree that deposition to water is important for the sink strength, but deposition to the land ecosystems has important implications for growth and hence carbon sequestration.

* P22807, L16. Agreement between models should not be the aim of any exercise. The aim is to agree with the real world!

References

Chang, W et al., Ozone deposition to the sea surface: chemical enhancement and wind speed dependence Atmos. Environ., 38, 1053-, 2004

Finkelstein, P. Deposition velocities of SO2 and O3 over Agricultural and Forest Ecosystems, Water Air And Soil Pollution, Focus, 1, 49-, 2001

Ganzeveld, L & Lelieveld, J, Dry deposition parameterization in a chemistry general-circulation model and its influence on the distribution of reactive trace gases J. Geophys. Res., 1995, 100, 20999-

Gerosa, G et al., Micrometeorological determination of time-integrated stomatal ozone fluxes over wheat: a case study in Northern Italy Atmos. Environ., 2003, 37, 777-

Rannik, U et al., Ozone deposition into a boreal forest over a decade of observations: evaluating deposition partitioning and driving variables Atmos. Chem. Physics, 12, 12165-, 2012

Schwede, D et al., An intercomparison of the deposition models used in the CASTNET and CAPMoN networks Atmospheric Environment, 45, 1337-, 2011

Stella, P et al., Predicting and partitioning ozone fluxes to maize crops from sowing to harvest: the Surfatm-O-3 model Biogeosciences, 2011, 8, 2869-

Tuovinen, J, et al., Modelling ozone fluxes to forests for risk assessment: status and prospects Annals of Forest Science, 2009, 66, 401-

Tuovinen, J, et al., Testing and improving the EMEP ozone deposition module Atmos. Environ., 38, 2373-, 2004

Val Martin, M, et al., Coupling dry deposition to vegetation phenology in the Community Earth System Model: Implications for the simulation of surface O3 , Geophys. Res. Lett., 41, doi:10.1002/2014GL059651, 2014.

Wolfe, GM et al., Forest-atmosphere exchange of ozone: sensitivity to very reactive biogenic VOC emissions and implications for in-canopy photochemistry Atmos. Chem. Physics, 2011, 11, 7875-7891

Zhang, L, et al., On ozone dry deposition - with emphasis on non-stomatal uptake and wet canopies Atmos. Environ., 36, 4787-4799, 2002a

Zhang, L, et al., Modelling gaseous dry deposition in AURAMS: a unified regional air-quality modelling system Atmos. Environ., 36, 537-, 2002b

Zhang, L, et al., Factors affecting stomatal uptake of ozone by different canopies and a comparison between dose and exposure, Sci. Tot. Env., 370, 117-132, 2006

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 22793, 2014.