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## ***Interactive comment on “Secondary organic aerosol in the global aerosol – chemistry transport model Oslo CTM2” by C. R. Hoyle et al.***

**Anonymous Referee #3**

Received and published: 2 August 2007

This paper describes the inclusion of prognostic SOA into the Oslo CTM2. Gas phase SOA precursors, SOA formation chemistry and the gas and aerosol phase products are simulated in the model. The products are allowed to partition between the gas and aerosol phases. Sensitivity simulations were ran to assess three partitioning assumptions. NO<sub>3</sub> was found to be an important oxidant of SOA precursors and its role is discussed.

The paper is, for the most part, well written and contributes new estimates of global SOA. I recommend the paper to be published in ACP after addressing the following comments.

1. At many points in the paper, SOA is discussed as condensing onto the surface

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of particles (e.g. pp 9059 In 21, pp 9062 In 25, pp 9063 In 1, pp 9065 In 3). This is imprecise and confusing because, in the absorptive partitioning theory used in the paper, SOA is treated as partitioning INTO (rather than ONTO) organic aerosol (or sulfate in a sensitivity simulation). In some places in the paper this is stated more precisely (e.g. pp 9067 In 2).

2. The choice of allowing SOA to partition into the ammonium sulfate mass is interesting and a usefully sensitivity tool, although not necessarily realistic. Please qualify this assumption in the paper with some discussion of its validity. Also, it seems very unlikely that organic aerosol would partition into crystalline ammonium sulfate and since most of these particles have taken up water, why isn't the water mass used for partitioning?

3. In this paper POA is treated as non-volatile. Where-as it is out of the scope of this paper to treat POA as semi-volatile species, recent work (Robinson, et al., 2007) has shown that POA is semi-volatile and that the higher volatile species may oxidize in the atmosphere to lower volatile species. It would usefully to briefly discuss this when POA is described as non-volatile in the paper.

4. pp 9060 In 10. Hydrophobic OC is not subject to wet removal events and has an aging timescale to hydrophilic OC of 21% day-1. This seems as if it may underestimate the removal of organic aerosol. If hydrophobic OC is internally mixed with hydrophilic OC or inorganic species it will activate in a cloud as long as it is large enough to act as a CCN (and in general most of the aerosol mass is in particles large enough to act as CCN). Even if the hydrophobic OC is not initially internally mixed with hydrophilic species it will internally mix with these species at a rate much quicker than 21% day-1 in most cases. See, for example, Riemer, N., H. Vogel, and B. Vogel, Soot aging time scales in polluted regions during day and night, *Atmospheric Chemistry and Physics*, 4, 1885-1893, 2004. Or, similar results are presented in Table 4 of Stier, P., J. Feichter, S. Kloster, E. Vignati, and J. Wilson, Emission-induced nonlinearities in the global aerosol system: Results from the ECHAM5-HAM aerosol-climate model, *Journal of Climate*, 19 (16), 3845-3862, 2006.

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5. pp 9062 In 20. Why does dry deposition not depend on the surface roughness and meteorology?

6. pp 9064 In 18. Chung and Seinfeld used the GISS GCM II'.

7. Table 8. Please make this more descriptive. Instead of listing species as SOA111 etc., please add columns for “Precursor group”, “Product” and “Oxidant” and use descriptive words such as Isoprene and NO<sub>3</sub> for the precursor group and oxidant rather than the numbers. This will save the reader a lot of time.

8. Table 9. The data in this table could be shown much more clearly by also including some 1:1 plots of the measured vs. observed data. Multiple shapes or colors of data points could be used to plot the various OM and SOA concentrations in the table.

9. pp 9086 In 7. Because the wet removal of organic aerosol involves the uncertain aging of hydrophobic to hydrophilic OA, agreement for sulfate wet removal with measurements does not imply agreement for organic aerosol.

10. pp 9069 and Figures 2 and 3. Why do you think the model underpredicted the altitude measurements and overpredicted the temporal measurements?

11. pp 9070 In 9070. A further source of OA error may be in the SOA yields.

Rethinking organic aerosols: Semivolatile emissions and photochemical aging. Science 315, 1259-1263 (A. L. Robinson, N. M. Donahue, M. Shrivastava, A. M. Sage, E. A. Weitkamp, A. Greishop, T. E. Lane, , J. R. Pierce, and S. N. Pandis) 2007.

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 9053, 2007.

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