

## ***Interactive comment on “Insights into secondary organic aerosol formed via aqueous-phase reactions of phenolic compounds based on high resolution mass spectrometry” by Y. Sun et al.***

**Anonymous Referee #1**

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This study by Sun et al. presents results of laboratory experiments showing the ability of phenolic compounds (phenol, guaiacol, syringol) to form high molecular-weight compounds and/or highly oxidized products. The results suggest that these species can act as precursors of secondary organic aerosol (SOA) under atmospheric conditions which is nicely supported by the comparison of mass spectra from the laboratory studies and a fog sample. Since to date the formation processes of SOA and especially the formation of highly oxidized products as identified in the current study are not well understood yet, this study represents an important new piece in our current understanding of SOA formation. The paper is well written and methodology and results are presented clearly. I have a few comments that should be considered before the

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publication of the manuscript.

General comments

- How well does the suggested reaction scheme agrees with prior studies that have analyzed the first-generation (reactive) intermediates of phenol oxidation into the aqueous phase? While the authors cite a few studies, a more thorough discussion of prior studies might be useful (e.g., (Land and Ebert, 1967; Chun et al., 2000; Barzaghi and Herrmann, 2002).

- An estimate of the time scales and efficiency of aqueous phase SOA formation from phenols in the atmosphere might be useful. This could be done by comparing the time scales of phenol losses by gas phase reactions vs SOA formation with the phenol uptake and subsequent SOA formation in the aqueous phase. (Such a comparison might have been done already in the companion paper Sun and Anastasio, in prep, 2010; if so, it should be referred to in the present paper).

Specific comments

p. 2917, l. 1/ 2: I suggest to reword ‘hygroscopicity and radiative impacts’ and state more clearly that it is rather ‘aerosol mass and optical properties (absorption)’ that will be affected.

p. 2917, l. 22: Lim et al., and Altieri et al. did not investigate aqueous phase reactions of isoprene but reactions of their oxidation products (which are already covered by the list above).

p. 2921, l. 18: Specify if ‘molar yields’ or ‘mass yields’ are meant. The latter should be even greater than unity and it is the value that is usually used in SOA model studies.

p. 2922/23: The finding that the mechanism (product distribution) is similar with and without OH radical is interesting. Is there any prior study (with similar/same species) that could suggest a possible mechanism? A reaction scheme (in more detail than in Figure 5) would be highly useful that elucidates OH and/or hv attack at the phenols.

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p. 2023, l. 6 (and Figure 3, Figure S5b): How can the pH dependency of the products and yields be explained? This should be discussed in the context of these two figures.

p. 2924, l. 14: Previous studies of oxalate formation in the aqueous phase have shown that glyoxylate is its direct precursor. Could this be one of the unidentified peaks?

p. 2928, l. 5/6: In previous SOA studies, there has been considerable discussion of the possibility of the reversibility of oligomers formation. Is there any hint in your experiments that the observed high SOA yields only occur at this relatively high water contents or that the products either decay back to their reactants and/or get further oxidized? In other words, should the observed high yields be regarded as maximum yields that decreases upon fog water evaporation?

Table 1: It would be useful to add the OM/OC ratios to the precursor properties.

Technical comments

p. 2924, l. 17: 'Ervens' misspelled

Figure 1: Add (f) in caption

References

Barzagli, P., and Herrmann, H.: A mechanistic study of the oxidation of phenol by OH/NO<sub>2</sub>/NO<sub>3</sub> in aqueous solution, *Phys. Chem. Chem. Phys.*, 4, 3669-3675, 2002.

Chun, H., Yizhong, W., and Hongxiao, T.: Destruction of phenol aqueous solution by photocatalysis or direct photolysis, *Chemosphere*, 41, 1205-1209, 2000.

Land, E. J., and Ebert, M.: Pulse Radiolysis Study of Aqueous Phenol, *Trans. Faraday Soc.*, 63, 1181-1190, 1967.

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