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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of factors controlling global secondary organic aerosol production from cloud processes" *by* C. He et al.

Anonymous Referee #1

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This study discusses the sensitivity of cloud production of secondary organic aerosol (SOA) to several parameters including LWC, T, VOC/NOx, and oxidant concentrations. The analysis is conducted using a climate model to examine these sensitivities on a global scale. The key finding is that in-cloud SOA production is most sensitive to LWC, followed by total carbon chemical loss rate. The topic is of relevance to this journal and is an important one to understand since SOA formation mechanisms are not fully understood, especially in the aqueous phase. The presentation quality of the paper was at an average level.

My issue with this study is that the analysis is superficial and does not significantly advance the community's knowledge of factors influencing SOA production in clouds. The key finding is based on correlation coefficients (does not prove cause-and-effect)

and is arguably a repeat of previous work (e.g. Ervens et al., 2008), including the importance of LWC. In contrast to this older 2008 study (just to name one), the current one under review is conducted at coarser resolution, which will not provide the level of detail needed at the scale of clouds to capture aqueous phase processes in cloud drops. Thus I was left struggling to find the critical mass of new findings needed that would warrant publication. I cannot support publication of this work. More comments can be found below.

Comments:

Introduction: A weakness of this manuscript is that it completely ignores the body of literature describing field measurements related to SOA formation in clouds and more generally in the aqueous phase. Sufficient treatment is given to model and lab papers, but a better balance is needed with field results.

Pg 26932, line 26 and forward: it is not clear to me what is new about this paper as compared to the studies outlined in the previous category. Is there reason to believe a more accurate assessment of factors affecting in-cloud SOA production can be obtained with a global model rather than the parcel model in the Ervens et al. study? It seems that at coarser resolution, it would be much harder to get a solid understanding of factors affecting SOA production in clouds, which occur at a scale more relevant to what a cloud parcel model can provide.

Pg 26932, last line: describe the "framework developed in Liu et al." Do not expect the reader will know what this means when reading this line.

Figure 1. Hard to see the species and text. Make it larger and provide for better visual quality.

Section 3: It would be helpful at the beginning of Section 3 to provide background as to why these factors are chosen and how they are expected to affect in-cloud SOA production. For example, what is the significance of the VOC/NOx ratio. I get the

impression that the authors assume that the readers know exactly how these factors may affect cloud processing, when in fact, this is not the case always.

Section 3: Correlations are not evidence of a cause-and-effect relationship and thus much of the conclusions being reached need to be toned down. For example, line 22-24 of pg 26937 is one such place. Authors must seriously consider what their results can unambiguously prove as the analysis is not too detailed (only correlations) and the relationships at play may be highly non-linear.

Section 3.1/3.2: What factors co-vary with LWC and Total Carbon Loss Rate, which could potentially assist with SOA production? When putting too much weight into correlations, it is critical to provide perspective on what co-varies with the most important parameters.

Section 3: Many of the results agree with those of Ervens et al. (2008), which again begs the question as to why this type of study is being repeated with a model that cannot examine the relevant processes at the scale of single clouds. Example: Line 10-14 on pg 26939.

Section 4 and Tables 2-3: In my opinion, this analysis really does nothing to advance our knowledge of in-cloud SOA production and its sensitivity to parameters such as LWC. It is just an extension of Table 1, which I still struggle to understand as to why it would be better than a modeling study at a more cloud-relevant resolution (and what is being shown that is significantly new as compared to older work).

Section 5: This analysis also does not do much beyond what already was shown in Table 1 in terms of trying to advance understanding of what factors influence SOA formation. Pg 26940, Line 24-25: I don't understand what is meant by "...than the estimation based on detailed cloud chemistry".

Figures 3-7: I find it troubling to invest this many figures and discussion on such a simplified parameterization (Eqn 2), which cannot be expected to capture all of the

aspects influencing SOA production in clouds. Section 6.2 thankfully tries to address some of these issues, but a more important question is what is being learned in this analysis (Figs 3-7) that can significantly advance our knowledge of factors influencing SOA formation.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 26929, 2012.