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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling the partitioning of organic chemical species in cloud phases with CLEPS (1.1)" *by* Clémence Rose et al.

Anonymous Referee #1

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The manuscript provides an overview of a model combination which includes a chemistry scheme for cloud droplets as well as a cloud microphysics scheme. The authors describe the model structure and present an evaluation of the model with a set of sensitivity simulations which are compared against observations at a mountain site.

The topic is timely as recent studies indicate that organic aerosol formation in clouds has been suggested to make a major contribution to the aerosol mass over certain regions (e.g. Ervens et al. 2011). Although the topic does make it appropriate to be published in ACP, since this manuscript mostly focuses on the model details, a more appropriate journal for this paper would have been for example Geoscientific Model Development. However, the manuscript can be accepted if the following comments and concerns are addressed:

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Discussion paper

- My main concern is that the scientific significance of this study has not really been put into context. The section Introduction focuses on explaining the choices for the methods applied in the model framework. It would be more important to explain in Introduction: what are the scientific questions of this study and what is the significance of this topic?

- Page 2, Lines 1-2: "As a first step, CLEPS 1.0 has been integrated in a box model that takes into account neither aerosol particles nor microphysical processes, and thus only allows for the simulation of idealized cloud events" I don't understand what this sentence means? If the box model does not take into account the aerosol particles or microphysical processes, how does it differ from a standalone version of the chemistry model? Has this first step been a part of the work for this manuscript or is there a citation missing?

- Page 2, Line 7: This phrase is very ambigous "the impact of aerosol particles on the cloud chemistry (by nucleation scavenging)" and it should be clarified, what impact is actually meant.

- Page 2: It is said that the calculation of chemistry in a sectional cloud parcel model would be computationally too expensive. With current computing resources this sounds strange. What kind of CPU time does CLEPS require for the runs in this study?

Page 3, Line 34: Henry's law effective → effective Henry's law

Section 2.2.1: The way the activation of droplets is calculated is unclear (even going back to papers Caro et al., (2004) and Lerice et al., (2007). Is it so that the activation of droplets is calculated on each time step, not only at the base of the cloud? The Abdul-Razzak Ghan parameterization calculates the number of activated droplets at the cloud base for an air parcel that is rising adiabatically. This means that the parameterization would not work for the droplet activation in-cloud because the already activated droplets would significantly affect the parcel supersaturation. This effect is not taken into account in the parameterization.

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What was the updraft speed used for the activation parameterization? Are there estimates for updrafts at puy de Dôme?

Page 7, Line 2: What are the "inputs related to the dissolution of the particulate matter in the cloud droplet"?

Page 10: The motivation for the simulation without dissolution is unclear to me. The result from this exercise is that there is less uptake when the particle dissolution is neglected. This seems to me quite obvious since the effective Henry's law constant is (by its definition) always higher than the Henry's law constant.

Page 10, Line 29: What would be considered a significant change in the cloud microphysical properties and which properties are meant here?

The motivation for the comparison between mass transfer and particle dissolution is also unclear. If I am not mistaken, in Figure 9, it is actually the effective Henry's law coefficient that determines the ratio between "particle dissolution" and "mass transfer" (at least for compounds that are not produced by aqueous phase chemistry). This would mean that mass transfer has little to do with this ratio. Would Figure 9 change at all if, for example, the mass transfer coefficient was doubled?

Reference

Ervens, B., A. G. Carlton, B. J. Turpin, K. E. Altieri, S. M. Kreidenweis, and G. Feingold (2008), Secondary organic aerosol yields from cloud-processing of isoprene oxidation products, Geophys. Res. Lett., 35, L02816, doi:10.1029/2007GL031828.

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