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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric organic matter in clouds: exact masses and molecular formula identification using ultrahigh resolution FT-ICR mass spectrometry" *by* Y. Zhao et al.

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The authors thank Referee #2 for his/her helpful comments and suggestions. The manuscript has been strengthened with new references to other ambient observations. All of the comments and suggestions have been considered. Point by point responses to these comments are provided below.

General Comments: This study reports on detailed chemical analyses of two samples of supercooled clouds in Colorado. The authors focus on compounds containing N, S, O, and C. This type of thorough chemical characterization of cloud samples is not

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very common using the techniques applied by the authors. The topic is of interest to this journal as clouds are important for aqueous-phase chemistry and a number of other reasons relevant for climate and biogeochemical cycling of nutrients. Owing to the nature of this study and extensive amount of chemical data, there are many details that are covered, and as a result, the manuscript is somewhat wordy and the reader must be patient to extract the main scientific nuggets, which are certainly embedded and of value to report. I would encourage the authors to see if they have ways to make the manuscript more concise. Upon my reading it appears that key results include the following (i) a higher state of oxidation for organic species as compared to aerosol studies, suggestive of more aqueous oxidation in clouds; (ii) significant influence from biogenic SOA and wood combustion; and (iii) CHNO compounds were frequent, as were CHOS and CHNOS compounds. The data are of high quality and are worthy of publication. The main results are useful to add to the growing literature on the importance of cloud chemistry. The paper is written well. I recommend publication subject to minor revisions suggested below.

Authors Response: We thank the reviewer for his/her positive support of the manuscript. Our approach for the characterization of ambient cloud water is fairly novel. Thus the observations of approximately 3000 molecular formulas in each sample and their limitations are described as thoroughly as possible. The observations were presented with respect to the elemental groups because of the discussion of the possible sources of each subset of compounds. We appreciate the summary of the "key results" from a reader's perspective. They are as we intended and also summarized in the Abstract and Conclusions sections.

Specific Comments: Page 20564, Line 1-5: It may be useful here to also report airborne field measurements showing production of SOA in actual clouds, which is also an excellent indication of the processes in discussion in addition to laboratory experiments. Here are examples that are suggested to fill this gap: Crahan, K. K., et al. (2004), An exploration of aqueous oxalic acid production in the coastal ma-

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rine atmosphere, Atmos. Environ., 38(23), 3757–3764, doi:10.1016/j.atmosenv.2004.04.009. Sorooshian, A., et al. (2010), Constraining the contribution of organic acids and AMS m/z 44 to the organic aerosol budget: On the importance of meteorology, aerosol hygroscopicity, and region, Geophys. Res. Lett., 37, L21807, doi: 10.1029/2010GL044951. Wonaschuetz, A., et al. (2012), Aerosol and gas redistribution by shallow cumulus clouds: An investigation using airborne measurements, J. Geophys. Res., 117, D17202, doi: 10.1029/2012JD018089.

Authors Response: Thank you for the suggested references. We added the following sentence to capture the relevant ambient observations (p20564L4). "In fact, in-cloud production of oxalic acid (Crahan et al., 2004), organic acids (Sorooshian et al., 2010), organosulfates (Pratt et al., 2013) and secondary organic aerosol (SOA; Wonaschuetz et al., 2012) has been observed in ambient measurements." Additional ambient observations from studies of fog water were also added. See also the Authors Response to Referee #1.

Technical Comments: Page 20573, Line 5: "formula" should be "formulas"

Authors Response: Done

Figure 7 caption, Line 1: "Isoabndance" spelled wrong

Authors Response: Corrected.

New References Added:

Crahan, K. K., Hegg, D., Covert, D. S., and Jonsson, H.: An exploration of aqueous oxalic acid production in the coastal marine atmosphere, Atmos. Environ., 38, 3757-3764, 2004.

Sorooshian, A., Murphy, S. M., Hersey, S., Bahreini, R., Jonsson, H., Flagan, R. C., and Seinfeld, J. H.: Constraining the contribution of organic acids and AMS m/z 44 to the organic aerosol budget: On the importance of meteorology, aerosol hygroscopicity, and region, Geophysical Research Letters, 37, L21807, 2010.

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Wonaschuetz, A., Sorooshian, A., Ervens, B., Chuang, P. Y., Feingold, G., Murphy, S. M., de Gouw, J., Warneke, C., and Jonsson, H. H.: Aerosol and gas re-distribution by shallow cumulus clouds: An investigation using airborne measurements, Journal of Geophysical Research: Atmospheres, 117, D17202, 2012.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 20561, 2013.