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Ocean Science Discussions

Interactive comment on "On the chemical dynamics of extracellular polysaccharides in the high Arctic surface microlayer" *by* Q. Gao et al.

Anonymous Referee #1

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This paper describes experiments on the organic composition of seawater and SSML samples collected from Arctic open ice leads, in connection with the organic composition of the aerosol generated by artificially bubbling air through the collected seawater samples. Results show that the SSML was systematically more enriched in organics than the bulk seawater, with polysaccharides accounting for a significant fraction of the organic composition of the collected samples. Significant findings in this study are that the aerosol generated was more enriched in organic matter than the source seawater (eg. factor between 22-70 for polysaccharides) and that large colloidal aggregates were formed by aggregation of low molecular weight gels during the bubbling process.

My major concern about this work is that the bubbling experiments, as described, do not seem to be representative of the bubbling rate expected to occur in ice leads, which

could affect the results and conclusions of this study. While the authors provide only vague information on how their bubbling experiments would match bubble production in ice leads, their description on the experimental operation of this system leads to think that a bubbling rate inducing a significant formation of foam (221, lines 3-9; 236 lines 8-10) was applied. The formation of a foam layer in these experiments implies that bubble production was much higher than the gentle bubble generation expected in open ice leads. If bubbles are responsible for the transport of organic matter from the bulk to the surface, these laboratory experiments would have led to an enhanced transport of organic matter to the SSML with respect to the real process in open ice leads; thus leading to an overestimation of the organic enrichment of the organic aerosol with respect to real bubble/aerosol production and to an enhanced aggregation of organic colloids. Although I consider that these experiments are useful to understand the underlying processes, their quantitative estimations may not be valid for extrapolation to real conditions; hence, unless the authors can prove otherwise, they should clearly state and discuss the caveats implicit in their experimental approach.

Besides this aspect, I consider that this study and its results are interesting and of value for further discussion on the role of biogenic organics on cloud formation and climate regulation in Arctic regions. Hence, I recommend its publication in ACP after the above issues and specific comments indicated below have been addressed.

Specific comments

Abstract. The standard classification of organic fractions used by the authors (i.e. POC and DOM) could be misleading, since these organic fractions are separated as a function of size and not solubility (see discussion in Fuentes et al. (2011)). For example, the DOM fraction, although defined as "Dissolved" Organic Matter comprises a fraction of insoluble colloidal organic matter. Although the authors include a description of the size ranges for the different organic fractions in the methods section, it would be helpful that they specify the size range for these organic pools in the abstract as well. I also recommend the authors to clarify in the abstract that the aerosol was artificially

produced by performing bubbling experiments and not sampled over ice leads.

217, Lines 11-15: This statement seems a bit speculative. Orellana et al. (2011) identified a significant amount of biogenic gel material in aerosol, fog and cloud water samples collected in the Arctic pristine region. This is certainly important for consideration on the effect of this organic matter on particles CCN behavior in Arctic regions; however, it does not demonstrate that the aerosol particles are purely composed of biogenic gels, i.e., that these particles are externally mixed and that these gels can effectively act as CCN. Furthermore, a recent study by Martin et al. (2011) on the CCN behavior of particles sampled over ice leads shows that marine biogenic organics, rather than promoting the formation of CCN, suppress the CCN activity of aerosols, in agreement with previous findings by Leck et al. (2002) and laboratory simulation by Fuentes et al. (2011). I believe the authors should not neglect these findings. I recommend the authors to revise this text and briefly mention findings from the studies cited above.

220, Lines 25-27. The authors should explain which techniques they employed to ensure that their bubble experiments were representative of the very gentle bubble production occurring in ice leads. It is mentioned that bubbles of 300 microns were produced for the experiments; however no information is given regarding the bubble concentration, which must be also relevant for the bubble scavenging process. It would be helpful if the authors provided a comparison between the bubble spectrum from their experiments and measurements by Norris et al. (2011). If the bubble production in their simulation experiments is higher than in real ice leads, then the rate of transport of organic material from the bulk to the water surface and the particle aggregation process may be overestimated with respect to real production. As indicated above, the authors should discuss this issue and reveal any relevant caveats in their experimental work.

221-222, 1-2: “We simulated the accumulation of SML materials by rising bubbles.” This statement seems a bit premature, before the results on the concentration of or-

ganic groups are explicitly discussed.

References

Fuentes, E., Coe, H., Green, D., and McFiggans, G.: On the impacts of phytoplankton-derived organic matter on the properties of the primary marine aerosol – Part 2: Composition, hygroscopicity and cloud condensation activity, Atmos. Chem. Phys., 11, 2585-2602, doi:10.5194/acp-11-2585-2011, 2011

Leck, C., M. Norman, E. K. Bigg, and R. Hillamo (2002), Chemical composition and sources of the high Arctic aerosol relevant for cloud formation, J. Geophys. Res., 107(D12), 4135, doi:10.1029/2001JD001463.

Martin, M., Chang, R. Y.-W., Sierau, B., Sjogren, S., Swietlicki, E., Abbatt, J. P. D., Leck, C., and Lohmann, U.: Cloud condensation nuclei closure study on summer arctic aerosol, Atmos. Chem. Phys., 11, 11335-11350, doi:10.5194/acp-11-11335-2011, 2011.

Norris, S. J., Brooks, I. M., de Leeuw, G., Sirevaag, A., Leck, C., Brooks, B. J., Birch, C. E., and Tjernström, M.: Measurements of bubble size spectra within leads in the Arctic summer pack ice, Ocean Sci., 7, 129-139, 2011.

Interactive comment on Ocean Sci. Discuss., 9, 215, 2012.