Atmos. Chem. Phys. Discuss., 15, C6295–C6297, 2015
www.atmos-chem-phys-discuss.net/15/C6295/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Boundary layer new particle formation over East Antarctic sea ice – possible Hg driven nucleation?" *by* R. S. Humphries et al.

Anonymous Referee #1

Received and published: 27 August 2015

This manuscript reports field observations of various gas phase compounds along with limited aerosol number concentration data made in spring 2012 in East Antarctic pack ice. Across the 32 day campaign, new particle formation was observed only once – on the day with the highest solar irradiation. The chemistry driving the new particle formation event was not clear and could not be determined directly because no method to measure cluster and nanoparticle chemical composition was available on the ship. By essentially eliminating all other likely drivers of new particle formation and due to an anomalously high measured increase in total gaseous mercury during the event, the authors suggest that a mercury driven photochemical nucleation mechanism may be

responsible for the observed new particle formation event.

The manuscript addresses the mechanism of new particle formation in a remote environment not studied previously and therefore addresses a scientific question within the scope of Atmospheric Chemistry and Physics. The manuscript suggests a novel mechanism for new particle formation, which is certainly of interest to the field. The conclusions appear to be supported by the measurements (taking into account the limitations of the equipment available to study the event). Although the authors do not provide conclusive evidence that mercury can drive new particle formation, they do provide some convincing reasoning, and the main purpose of this paper is to propose a new idea that hopefully will be tested in future work. This manuscript is interesting, clearly written and should be accepted for publication in Atmospheric Chemistry and Physics once the minor comments below have been sufficiently addressed.

Comments:

1. In order to make the case that mercury could plausibly be playing a role in the new particle formation event the authors observe, they first need to convincingly discount the impact of all the other likely options: halogens, biogenic compounds, and sulfur-containing compounds. The authors make the most convincing argument with halogens, as IO concentrations were directly measured and found to be more than an order of magnitude lower than levels typical when new particle formation is observed. Similarly, the case against volatile organics appears to be fairly strong. While no direct measurements were made, a proxy was used based on surface water fluorescence, inferring chlorophyll concentrations. During the new particle formation day, inferred chlorophyll concentrations were again more than an order of magnitude lower than typical values measured for secondary organic aerosol formation. The final likely source relates to sulfur, and it is here that the case appears weakest. The authors' discounting of sulfuric acid relies almost entirely on results of a box model. However, the authors do not provide very much detail about the results of the modeling other than to say, rather imprecisely, that they cannot reproduce the observations. But, how close was

the model able to approximate the measurements? Was the best approximation to the measurements still orders of magnitude off from the measurements? Essentially, the authors need to include some more detail (and perhaps give a specific example with values for model outputs) of the model results to more fully make the case that sulfur can be discounted as a likely source for new particles.

2. Generally speaking, more attention needs to be paid to the quality of the figures. For example, Fig. 2, Fig. 3a-b, and Fig. 8a all have two sets of tick marks on the right axis. Additionally, many symbols in the figures are difficult to see, especially in Fig. 8a. The authors may also want to consider making the vertical lines delineating different periods in the new particle formation event (e.g. in Fig. 3) solid lines to more clearly differentiate them from the dotted lines corresponding to the tick marks.

3. Page 19491, line 11: Do the authors mean to refer to period IV here rather than period V?

4. Page 19499, line 17: The authors should provide an appropriate reference for ELVOC.

5. Page 19504, lines 11-12: This sentence is confusing. Should the “and” after “Hgˆ0” be deleted?

6. Page 19508, lines 14-20: Appropriate citations for the APi-TOF, cluster CIMS, and NAIS should be provided in the revised manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 19477, 2015.