

Interactive comment on “Fluxes of gaseous elemental mercury (GEM) in the High Arctic during atmospheric mercury depletion events (AMDEs)” by Jesper Kamp et al.

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Received and published: 19 October 2017

The average GEM re-emission fluxes measured by Kamp and co-authors are a factor of 10 to 1000 higher than fluxes measured by other studies (Table 1). Maximum fluxes of 190 ng m⁻² min⁻¹ were reported. On April 30 GEM re-emission fluxes were larger than 40 ng m⁻² min⁻¹ for a period of at least 4 hours, resulting in a conservative estimated re-emission of 10 ug Hg. At a comparable Arctic coastline site affected by AMDE's total Hg Pools of a maximum of 0.5 ug m⁻² were reported for barrow in Barrow, Ak which is a factor of 20 lower than the re-emitted Hg reported by Kamp et al. (Johnson, K. P., et al. (2008), *J. Geophys. Res.*, 113, D17304, doi:10.1029/2008JD009893) I would like to suggest to the authors to perform a feasibility study and integrate the total amount of Hg that was re-emitted during the strong re-emission event on April 30 and compare it to 1) typical snow Hg pools measured at the study site and 2) the height of the atmospheric column that would need to be depleted of Hg during an AMDE to achieve such high Hg snow pools.

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First, we thank M. Jiskra for his comments. As stated already we measure significant higher fluxes of GEM at Villum Research Station (VRS) located at 81 degree north. Unfortunately, we are missing data for mixing height and the amount of mercury in the snow. We have only a few surface layer concentrations of elemental mercury in the snow, and we are not able to use the data to assess any mass balance for GEM.

The measurement site in Johnson et al. (2008) and in the present study are both located at the cost, but due to the colder climate and nearby glacier, the conditions at VRS is very different from Barrow. Most of the year VRS is surrounded by ice and only in late July to September there is ice-free conditions around the peninsula, where VRS is located. During this period there is a strong flow of fresh water from the nearby ice sheet “Flade Isblink” (Bentzon et al. 2017, *Scientific Reports* | 7: 4941 | DOI:10.1038/s41598-017-05089-3). The upper 2 meters of water around the station is therefore fresh water. During spring, the weather is extreme with very low temperatures, stagnant wind and very low inversion height. First meteorological measurements from an 80 m mast often show inversion at a few 10's of meters. Therefore, GEM is emitted into a very shallow atmospheric layer, which could be the reason for the high fluxes observed. Unfortunately, these measurements were not carried out until 2017. Furthermore, a large part of the snow is drifting snow, so the origin of GEM in drifting snow is difficult to determine.

In the article, we argue that chamber methods as conducted by Johnson et al. (2008) are very different from micrometeorological methods as REA. Enclosure methods as chambers can potentially change temperature, humidity, radiation etc. (Fowler et al., 2001). Chambers cover a very limited area compared to micrometeorological methods. Due to the general

differences in measurement methods we will not perform quantitative comparison between enclosure methods and micrometeorological.

We argue that the event occurring on April 30 is most likely explained by sudden changes in meteorological conditions from a front passing and see this as an extreme case.