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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Circumpolar transport and air-surface exchange of atmospheric mercury at Ny-Ålesund (79° N), Svalbard, spring 2002" *by* J. Sommar et al.

J. Sommar et al.

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The comments presented by Dr. Malcolm are generally sound and most relevant. The authors are most thankful for the interest and time she dedicated to screen the paper. By fixing most of the technical issues pointed out, it is obvious that the paper will improve. They will be corrected correspondingly. Some of the comments on the Figures however appear disproportionate (#13-16).

Specific comments:

1. The acronym PM is somewhat awkward and it is agreeable to change it to Hg-p.

2. The procedures to sample and analyse fractions of airborne mercury will be described in greater detail. Some references will be added when appropriate. These will

involve work by the authors as well by others.

3. The referee put several remarks/questions on surface snow measurements. A more detailed description could be as follows: Snow samples were collected by the removal of the uppermost surface layer of the snow pack with a Teflon funnel on a daily basis and brought indoors where they were allowed to melt into acid cleaned 125 ml volume Teflon bottles. Moreover, no specific precipitation-segregated sampling was performed.

4. On the issue of differences in daily samples of snow at two altitudes. Sampling was on a daily basis schedule only at both sites and not synchronised by each other. The time lag was generally significant. Since the sites are separated by an altitude of 450 m, site specificity as well as dichotomous addition to snow due to difference in meteorology and chemical composition is anticipated. Establishing mercury budgets during MDEs and during the post-MDE regime and address its dynamic cycling are an important although very demanding task. Highly resolved spatial and temporal speciation of mercury in the atmosphere, the snow pack, sea ice and sea water are needed to provide the nominal data required. Such a rigorous sampling protocol has as far as we are aware of not been accomplished and reported in the open literature. This paper presents novel long-term speciated measurements at two significantly altitude separated sites. The MDEs experienced during the 2002 campaign could thus to concluded to be extensive from ground level to above the Zeppelin Station. As Hg0(g) generally exhibit a uniform distribution in the atmosphere, its vertical column density (VCD) below a height of z0 can readily be estimated. The VCD of Total Airborne Mercury lost during MDEs relative to an initial standard background atmosphere ought to be in the interval 0.1-1 μg m-2 [1, 2]. The specific atmospheric profile measurements of mercury at Ny-Ålesund during MDE 2002 imply the lost VCDs to be in the upper range. As the actual VCD profile and its evolution is unknown, the uncertainties are however large. Moreover, the Ny-Aalesund site is not ideal for budget estimates as local transport may well include mixing of air-masses (mixing-in from above with mercury-rich air from the free troposphere) that will make the result more unintelligible. Assuming peak Hg-tot

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concentration in surface snow (˜60 ng/L, density 0.4) derived from a single MDE, the conservation of mass is attained roughly in a depth interval of 5 - 10 cm. Our measurements did not enable us to establish the vertical Hg-tot concentration in the snow-pack. Hence, we will not be able to accurately tell the integrate deposition. The referee suggests a quantitative approach to air-snow exchange. "A significant part of the oxidized mercury deposited onto snow and water surfaces is quickly re-emitted" is concluded after observing a quick decline of Hg-tot in surface snow and a discrepancy in TGM between the ZI and DI stations in the aftermath of a GEMDE. The peak evasion fluxes observed by the gradient method at 20-40 ng m-2 h-1 are fairly elevated and if sustained for an extensive time rapid photo-reduction of the mercury deposited would be concluded. Contrary, as the observed mercury gradient in surface air was generally insignificant, a more moderate average flux ($<$10 ng m-2 h-1) is implied. The dynamical enclosure technique used in parallel indicated evasion of mercury from the snow pack. The steady-state attained in the chamber is however neither comparable in time nor in quantity with the real air-surface exchange process. In order to quantitatively address the emission process, a more sensitive approach is required.

5. The figure 20-40 ng m-2 h-1 only refers to the 3-4 occasions with significant Hg gradient as can be seen in Figure 7.

1. BANIC, C. M., et al. (2003) Journal of Geophysical Research-Atmospheres, 108, art. no.-4264 2. LINDBERG, S. E., et al., Dynamic oxidation of gaseous mercury in the Arctic troposphere at polar sunrise, in Environmental Science & Technology. 2002. 1245-56.

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Interactive Comment