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Interactive Comment

Interactive comment on "How relevant is the deposition of mercury onto snowpacks? – Part 2: A modeling study" *by* D. Durnford et al.

Anonymous Referee #1

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General comments

The manuscript presents description, application results and evaluation of a newly developed snowpack/meltwater model for Hg applicable for large-scale simulations in combination with atmospheric chemical transport models. Air-surface exchange of Hg over snow-covered areas as well as redox processes within snowpack play significant role for Hg cycling in the environment, particularly, in high latitude regions. Although some efforts have been previously done to take into account Hg re-emission from snow the considered study presents the first attempt to develop a detailed physically based model of Hg behavior in snowpack and meltwater.

The subject of the manuscript is relevant to the scope of the journal and the work makes up a new and original contribution. The data collection and interpretation techniques are sound and the drawn conclusions are convincing and justified. The manuscript will be suitable for publication after addressing the specific comments mentioned below.

Specific comments

1. Page 2665, line 12: "Oceanic emissions were increased over Hudson Bay and polewards of 66.5 N . . . in order to reproduce summertime atmospheric GEM concentrations ..." - There is no description of how the emissions from the ocean were modified (e.g. fit monthly mean summertime observations at some sites or increased by the magnitude of Hg in meltwater of appropriate catchment area). It is principal as it affects the later conclusion on the importance of the ocean emission.

2. Page 2667, Figs. 2a, 2b: As it follows from the figure there are snowpacks (seasonal - ?) in quite low-latitude regions (e.g. southern Europe – Italy, Spain; southern states of the US), where snow (if any) can hardly lie on the ground longer than over few days. So mercury in such snow rather originates from wet scavenging than from the air-snow exchange. Some discussion of this aspect could improve understanding of the results.

3. Page 2669, Fig. 2c: Spatial distribution of the meltwater runoff looks very sporadic, whereas one can expect availability of meltwater during spingtime wherever seasonal snowpack takes place. Some clarification of this is needed in the text.

4. Page 2672, line 16: "... strongly suggests that the observed summertime maximum is caused by mercury emitted from the Arctic Ocean itself ..." It is interesting to note that the observed summertime maximum of GEM concentration is less pronounced at another high latitude site – Ny Ålesund – located at Spitsbergen (see, for example, Steffen et al., 2008 or measurement data at ebas.nilu.no). Both sites are located at the Arctic Ocean coast and should present similar behavior of GEM seasonality if we expect uniform increase of Hg emissions over the Arctic in summer. Probably the reason is location of Alert close to the Canadian Archipelago with the long coastline, which is more strongly affected by the meltwater runoff.

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5. Fig. 5: Units of the presented revolatilization flux are not evident (ng m-2). Probably, they should be ng m-2 h-1.

6. Page 2681, lines 3-11, Figs. 7b, 7d: The same for units of the net deposition flux and net accumulation (ug m-2). Are they ug m-2 y-1 ?

7. Page 2681, line 26: "... Simulated concentrations of mercury in snowpacks and runoïňĂ agree well with observations ..." Really, one can hardly talk about a full-scale validation of the snowpack/meltwater model taking into account very limited amount of observations available for comparison. Besides, all of them relate to different time periods and represent very local conditions. So it should be mentioned that additional evaluation of the model is required in detailed case studies and under conditions of particular field measurements.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 2647, 2012.