Near and Below Snow Surface Gradient Measurements of Hg^0 During Barrow Arctic Mercury Study (BAMS) 2004

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Background

Since the discovery of Atmospheric mercury depletion events (AMDE) in Alert in 1995 (*Schroeder et al, 1998*), many studies have been devoted to this phenomenon occurring after polar sunrise which leads to fast deposition of mercury species onto snow surfaces (*Lindberg et al., 2002*). A significant fraction of the deposited mercury can be either re-emitted to the atmosphere via photo reduction processes (*Lalonde et al, 2002*) or accumulated in the snow for further transfer to the ocean or ground during snowmelt. The fraction of re-emitted Hg versus accumulation of Hg is still in debate. Recently it has been realized that the processes of air-snow exchange may also have a large impact on the chemistry of the atmosphere (*Albert et al, 2002*).

Objective

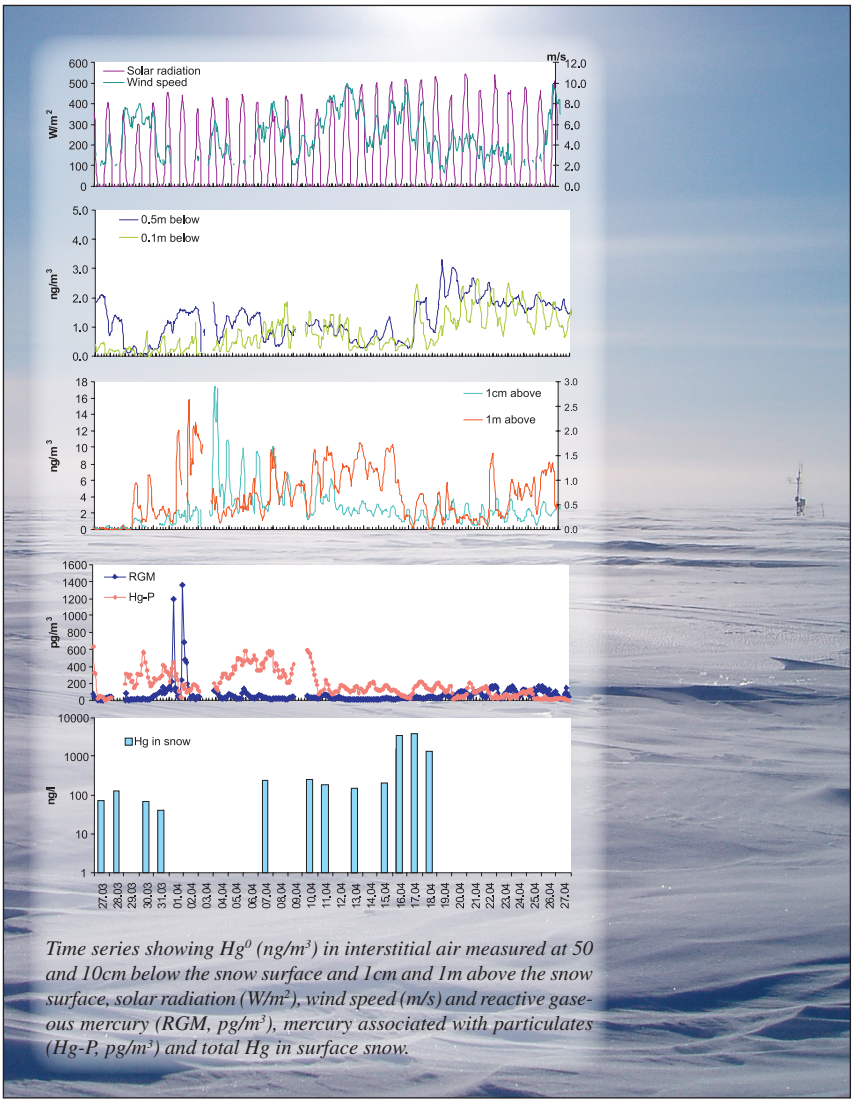
The intent of these measurements was to investigate the possible role of the Arctic snow pack in the depletion of atmospheric mercury and whether it acts as a source or sink.

Method

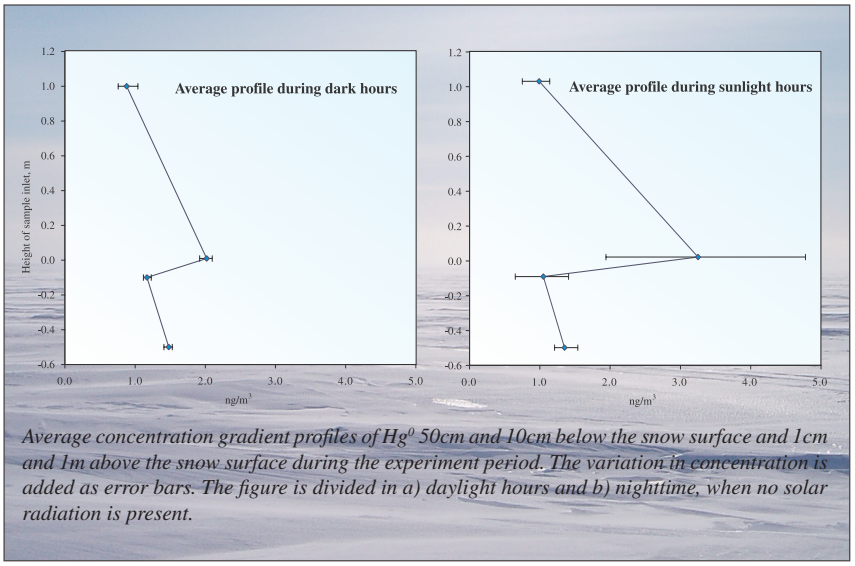
Sample inlets for the gradient measurements of elemental merucry (Hg^0) were positioned 1cm and 1m above the snow surface and 10cm and 50cm below the snow surface. A switching device allowed alternate sampling at all levels and was connected to a 2537A Tekran mercury analyzer. Each level was sampled sequentially for 10 minutes. Sample flow rate was 1.5LPM. Reactive gaseous mercury (RGM) and mercury associated with particulate matter (Hg-P) was collected using the Tekran mercury speciation system.

Summary of results

- Ambient Hg was depleted during 74% of the measurements.
- Hg^0 was fully recovered as RGM and Hg-P during two occasions.
- Delayed re-emission of deposited Hg as Hg^0 could be due to meteorological conditions, bacterial activity or organic matter present in the snow. Some bacteria have the ability to reduce Hg(II) to Hg^0 (*Barkay et al, 2003*).
- Hg^0 at all levels varies to a greater extent during daytime compared to the night.
- Diffusion, meteorological conditions and ventilation within the snow pack can explain variations in concentrations of Hg^0 below the snow surface.
- Concentrations of Hg^0 at 1cm above and 10cm below the surface are strongly correlated to solar radiation.
- Nighttime reduction of Hg(II) to Hg^0 in addition to daytime reduction, probably caused by reactions with hydroperoxy radicals.



Time series showing Hg^0 (ng/m^3) in interstitial air measured at 50 and 10cm below the snow surface and 1cm and 1m above the snow surface, solar radiation (W/m^2), wind speed (m/s) and reactive gaseous mercury (RGM, pg/m^3), mercury associated with particulates (Hg-P, pg/m^3) and total Hg in surface snow.



Average concentration gradient profiles of Hg^0 50cm and 10cm below the snow surface and 1cm and 1m above the snow surface during the experiment period. The variation in concentration is added as error bars. The figure is divided in a) daylight hours and b) nighttime, when no solar radiation is present.

References

- Albert, M.R., et al, Atmos. Environ., v.36, p.2779-2787, 2002.
- Barkay, T., et al, FEMS Microbiology Reviews, v.27, p.355-384, 2003.
- Lalonde, J.D., et al, Environ. Sci. & Tech., v36, p.174-178, 2002.
- Lindberg, S.E., et al, Environ. Sci. & Tech. v.36, p.1245-1256, 2002
- Schroeder, W.H., et al, Nature 394, 331-332, 1998.

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