Measurement of atmospheric mercury species at Zeppelin mountain, spring 2003

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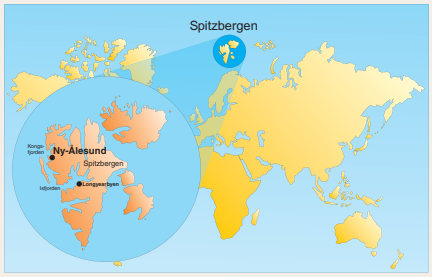


Figur 1: Location of Ny-Ålesund, the norwegian Arctic monitoring site

Abstract:

Speciation of mercury in the atmosphere (GEM, RGM and PM) and snow (Hg-tot) was carried out at Zeppelin mountain (474 m.a.s.l., ~79°N) at Spitzbergen between 10. April to 10. May 2003. One major (GEM < 0,1 ng/m^3) and three minor MDE's were observed during the measurement period. Ozone and GEM correlated well during MDE (R^2 = 0,84). RGM, PM and total Hg in surface snow anti-correlated with GEM. Diurnal variations in GEM (± 0,3 ng/m^3) were observed during non-MDE. Interpretation of the data suggest that MDE's were due to both in situ depletion and long range transport of mercury depleted air masses.

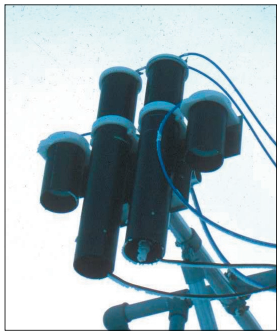
Introduction

Like tropospheric ozone, mercury exhibit episodic depletion in Arctic and Antarctic regions during and after polar sunrise [1, 2, 3]. The mercury depletion events (MDE) correlates well with depletion of ozone. Rapid removal of elemental Hg is due to transformation of elemental Hg to oxidized mercury species. This transformation is interlinked with high concentrations of halogen species such as Cl, Br, ClO and BrO. The halide species are probably derived from heterogeneous reactions at the interface of sea salt aerosols [2]. Speciation studies of mercury in these areas have shown that GEM is oxidized to reactive gaseous mercury (RGM) and particulate bound oxidized mercury (PM) [1, 2, 3, 4]. Both RGM and PM are transient species prone to readily get removed from the atmosphere via deposition. The abundant depletion of mercury infers a significant input of a mobile toxic heavy metal to these sensitive ecosystems. In a joint effort, including research groups from six different countries, MDE's were studied during a one month campaign during spring 2003 at different locations within the Ny-Ålesund International Research and Monitoring Facility. The purpose of this effort was to provide further quantitative information on mercury in different environmental compartments during polar spring and to compare the analytical methods of the different research groups.

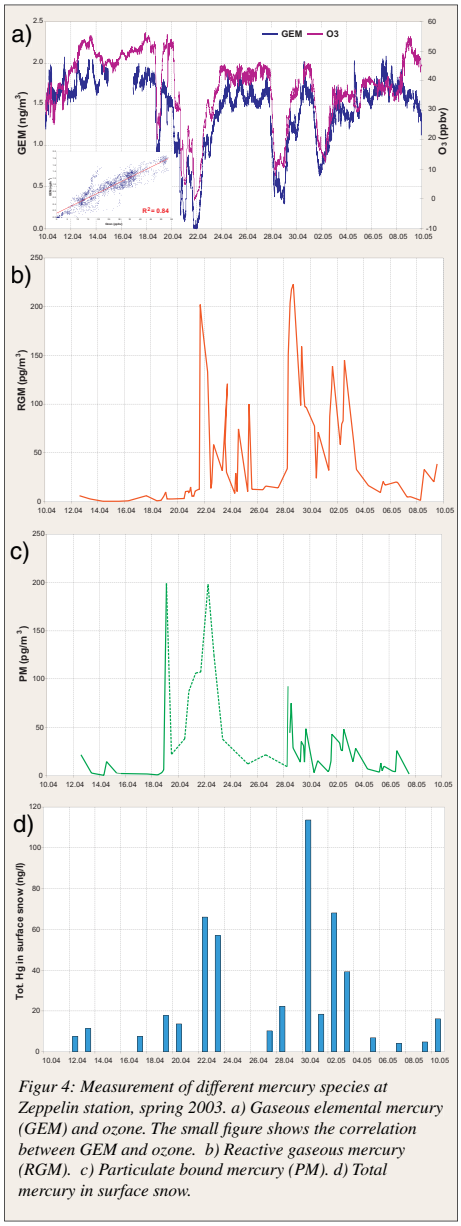
Figur 2: The Norwegian monitoring station at Zeppelin mountain (474 m.a.s.l.)

Experimental

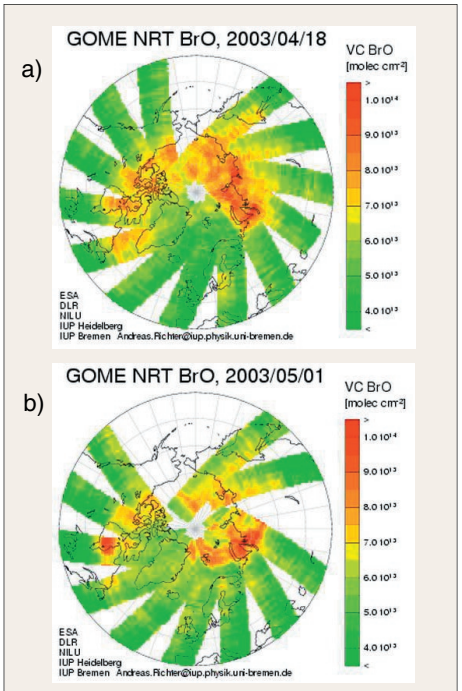
Measurements were performed Zeppelin mountain close to Ny-Ålesund during one month campaign from 10. April to 10. May, 2003. Ny-Ålesund is situated at the southern shore of Kongsfjorden on the West coast of Spitzbergen (fig 1). Samples were taken at the monitoring station operated by NILU at Zeppelin mountain (474 m.a.s.l.) (fig 2). Gaseous elemental mercury (GEM) were collected and analyzed by a Tekran gas-phase mercury analyzer (model 2537). RGM was sampled manually using annular denuders coated with KCl. PM was sampled by collection on quartz filters mounted on so called mini traps. Both RGM and PM could be sampled in the same air-mass or separate (fig 3). RGM and PM was thermally desorbed, converted to elemental Hg and quantified by Tekran 2537. Total mercury in surface snow was collected on a nearly daily basis.



Figur 3: Equipment for collection of RGM and PM



Figur 4: Measurement of different mercury species at Zeppelin station, spring 2003. a) Gaseous elemental mercury (GEM) and ozone. The small figure shows the correlation between GEM and ozone. b) Reactive gaseous mercury (RGM). c) Particulate bound mercury (PM). d) Total mercury in surface snow.



Figur 5: Map of GOME total BrO column. a) Total BrO concentrations 18. april 2003 b) Total BrO concentrations 1. may 2003.

Conclusion

- One major and three minor MDEs occurred during the measurement period.
- The MDE's observed are probably caused by both in situ depletion and long range transport of mercury depleted air masses (fig 5a and fig 5b). The concentration of GEM is reduced much faster during MDE caused by long range transport than by in situ MDE (fig 4a).
- The BrO radical is probably the reactant responsible for the loss of GEM during MDE's.
- RGM, PM and Hg-tot in surface snow anti-correlates well with GEM during MDE's (fig 4b, 4c, 4d).
- RGM and PM have a much shorter residence time in the atmosphere than GEM, making RGM and PM easily deposited on the ground, which also can be observed as elevated concentrations of Hg-tot in surface snow.
- Diurnal variations in the concentrations of GEM was observed during non-MDE, most probably caused by re-emission from the snow surface (fig 4a).

References:

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