Atmospheric speciation of mercury at Ny-Ålesund

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Arctic, gaseous elemental mercury, reactive gaseous mercury, particulate mercury

Introduction

Some Arctic human populations, especially some indigenous communities that consume large quantities of certan species of freshwater fish or marine mammals tissues for their traditional /local food , receive high dietary exposure to Hg (AMAP, 2011). Exposure of current levels in the Arctic can have adverse impacts on human health, particularly for the development fetus and children (AMAP, 2011). Long-range transported atmospheric Hg from sources in Asia, Russia, Europe and Noth-America, is recognized as one of the main antropogenic sources of this toxic pollutant in the Arctic, and especially focus has been on the impact of Atmospheric Mercury Depletion Events (AMDEs) as a means of delivering Hg to the ecosystems for now almost 20 years (Schroeder et al., 1998; AMAP, 2011). In 1995 it was discovered that during spring, unusually low levels of GEM occurred in the Arctic air at Alert (Schroeder et al., 1998). This phenomena was termed AMDEs and was later confermed to occur throughout polar regions (Ebinghaus et al., 2002; Lindberg et al., 2002; Berg et al., 2003; Skov et al., 2004; Steffen et al., 2005; Pfaffhuber et al., 2012). Mercury exist in the atmosphere mainly as gaseous elemental mercury (GEM) which has an atmospheric residence time of 6 months to 1 year. During AMDEs GEM can through a series of photochemically initiated reactions be oxidized to a more shorter lived species which is called reactive gaseous mercury (RGM). RGM can either stay in the air or if there are particles available be attached to these, and reported as particulate mercury (PHg). RGM and PHg can be deposited within hours to weeks.

In the following manuscript five years of atmospheric speciation data for mercury from the Zeppelin station, Ny-Ålesund is presented:

Methods

Ny-Ålesund is a small settlement near sea-level on the western coast of Spitsbergen (Fig. 1). The air sampling is performed at the research station on the nearby Zeppelin Mountain (78°54'N, 11°52E; 474 m a.s.l.). Speciated mercury was measured by automated Tekran mercury instrumentation. RGM was measured with a speciation unit (Model 1130) consisting of a KCl coated denuders while PHg was sampled on a particulate filter (Model 1135) as described in detail by (Steen et al., 2011). The denuder module and the particle module are placed in front of a Tekran 2537A unit. The air is pulled into an analyzer through an impactor designed to remove partcles <2.5 µm at a flow rate of 10 l min^{-1}. The sample flows over a KCL coated quartz denuder to trap the RGM in the 1130 unit and then passes over a particulate filter to trap the PHg in the 1135 unit. GEM passes through both the 1130 and 1135 units and is carried into the 2537 A unit.

Results

The mercury speciation data is presented in Fig. 1. During September to February GEM (left) is constant. March-May atmospheric mercury depletions events (AMDEs) are evident, which make GEM highly variable. Increased concentrations of RGM (middle) occur through the polar day (March-August). RGM is formed through photo-chemically initiated reactions. The highest levels of RGM are during AMDEs, in April. The lowest PHg (right) levels are seen from May to October. November to January PHg levels increase. During winter, Hg transported from Europe dominates the air masses at Zeppelin. The highest concentrations of PHg is from February to April. The high levels seen in March and April are due to oxidation of GEM and associated to particles during AMDEs. At Zeppelin, the high PHg concentrations start in February; one month before AMDEs start at the station. This could be due to transport, either of polluted air from PHg sources or of AMDE-influenced air from lower latitudes where the polar sunrise occurs earlier.

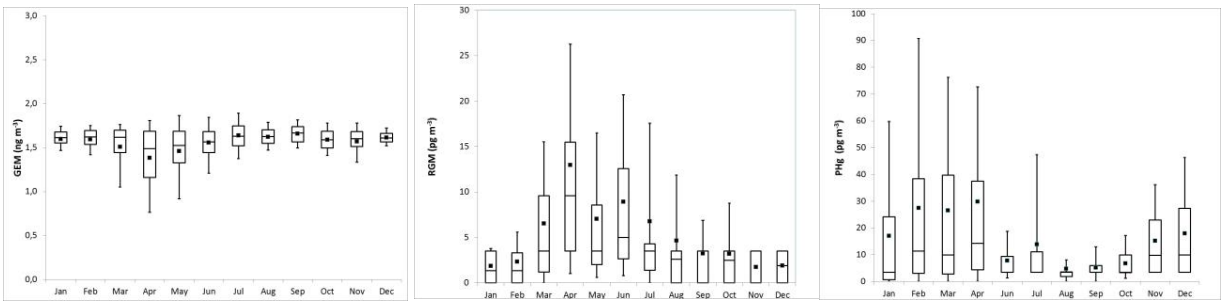

Figure 1. : Box plots presenting the monthly concentration distributions of GEM, RGM and PHg at Zeppelin, Svalbard for 2007 to 2012

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