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Long-term Continuous Monitoring of Mercury in the Russian Arctic: Evaluation of Impact from Icelandic Volcanic Eruptions

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Long-term continuous monitoring of gaseous elemental mercury (GEM, representing major environmental concern due to its ecological hazard) in the surface air at the polar station Amderma, Russia (69.72°N; 61.62°E) using the analyzer Tekran 2537A has been conducted since Jun 2001. Individual measurements were collected every 30 minute interval. It has been shown that during 10 years of observations the so-called atmospheric mercury depletion event (AMDE) was observed every year from the end of Mar till early Jun. The lowest variability in the mercury concentration was observed during Sep-Dec. During the monitoring period the mean annual concentration of GEM decreased from 1.68±0.29 ng/m3 (2001) to 1.31±0.31 ng/m3 (2009). Most likely it has been reflection of the reduction in European anthropogenic emissions of mercury as a result of adopted restrictions.

The AMDE events were registered during winter 2010 as well, although these have not been observed before. During Dec-Feb in daytime for long periods, the GEM concentration was recorded at less than 1 ng/m3. Analyses suggested that changes of mercury concentration may be caused by (i) deposition of marine aerosol particles released from the ice of the coastal zone (e.g. Kara Sea); (ii) dominating southern wind direction from the inland; and (iii) deposition of mercury on particles of the anthropogenic aerosols transported from the middle and low latitudes.

In 2010, behavior of mercury at the Amderma measurement site was very unusual and specific which could be caused by impact of the Eyjafjallajokull volcano eruption in Iceland. Prior to Apr 2010, the mercury concentration at Amderma was, in general, slightly lower compared with previous years. This may be a reflection of the decrease in the European mercury levels in the atmosphere due to the implemeted measures to restrict mercury emissions. The eruption of the Eyjafjallajokull volcano started on 20 Mar 2010, followed by massive release of ash and water vapor due to evaporation of snow and glaciers started on 14 Apr. The mercury concentration at Amderma increased from 13 Apr to end of May 2010 as showed comparison with the mean of multi-year values. It may be worth noting that the volcano eruption coincided with AMDE phenomenon during spring 2010 polar sunrise. To determine potential source of elevated mercury concentration, a set of HYSPLIT atmospheric backward trajectories was calculated and analysed. The trajectory analysis, showing pathways of air masses transport from Iceland, suggested that from the middle of Apr 2010 the Amderma measurement site was in the area affected by transported emissions from the volcano (unlike other monitoring stations of mercury, e.g. Alert in Canada and Ny-Alesund in Norway). In this context, the observed increased levels of mercury in a vicinity of Amderma appear to be unique.

During spring time, both lowered (AMDEs events) and elevated concentration events could occur, where the latter can be associated with atmospheric transport patterns from remote sources of mercury. In particular, the days with measured higher concentrations at Amderma station can be linked with, limited time of the active phase of the Icelandic volcano eruptions and prevailing direction of atmospheric transport. Evaluation of the time-series of gaseous elementary mercury concentration and associated atmospheric transport patterns showed that both the Eyjafjallajokull Grimsvötn volcanoes can be potential sources for increased mercury concentrations at measurement stations in the Arctic regions, and especially followed an active phase of eruption.