Name of research institute or organization:

Institute for Chemical and Bioengineering, Swiss Federal Institute of Technology, ETH Zurich

Title of project:

SwissQuick: Emissions and imissions of atmospheric mercury in Switzerland

Project leader and team:

Dr. Christian Bogdal, project leader
Basil Denzler

Project description:

Mercury is emitted in big amounts into the environment. For Switzerland alone estimates lie in the range of 500 – 1000 kg/yr. The most prominent sources in Europe are combustion processes in power plants, cement and steel works.

Three forms of mercury are distinguished for atmospheric emissions: gaseous elemental mercury (Hg(0)), gaseous oxidized mercury (Hg(II)) and particle bound mercury (Hg(p)), of which Hg(0) makes up for the biggest share of over 90%.

Due to its long residence time, Hg(0) undergoes long-range atmospheric transport [1]. Thus, mercury can occur in regions far away from its initial emission sources.

The long-term monitoring project started in December 2013 at the High-Alpine Research Station Jungfraujoch to improve the understanding of the atmospheric emissions and transport of Hg(0) was continued with interruptions in 2016. Additionally, we were able to start a measurement campaign of Hg(II) and Hg(p). This new data will help to a better understanding of mercury transformation and deposition processes.

A Tekran® 2537X gaseous elemental mercury analyzer is used to measure the concentration of Hg(0) by cold vapor atomic fluorescence spectroscopy (detection limit: 0.1 ng /m^3). The instrument provides a high temporal resolution of 5 min and uses an internal permeation source for automated calibration. A Tekran® Model 1130 Oxidized Mercury Speciation Unit in combination with a Particulate Mercury Module 1135 is used to pre-trap any Hg(II) and Hg(p) over a one hour period. A heating system reduces any species to Hg(0), which is then sequentially analyzed by the 2537X as described previously.

The Hg(0) concentrations measured at Jungfraujoch are comparable to background levels measured worldwide [2]. Hg(II) and Hg(p) levels were found in about the same levels of 10 to 30 pg/m³ throughout the measurement period. Strong peaks in Hg(II) concentration (Figure 1), however, were measured in periods with very low relative humidity (RH) and high ozone (O3) levels. Our first conclusion points into the direction of stratospheric influence, which brings in air masses that cause Hg(II) levels to rise significantly.

Hg(0) monitoring will be continued in 2017. The emerging data set will be used in order to establish new top-down emission estimates of mercury for Europe.

References:

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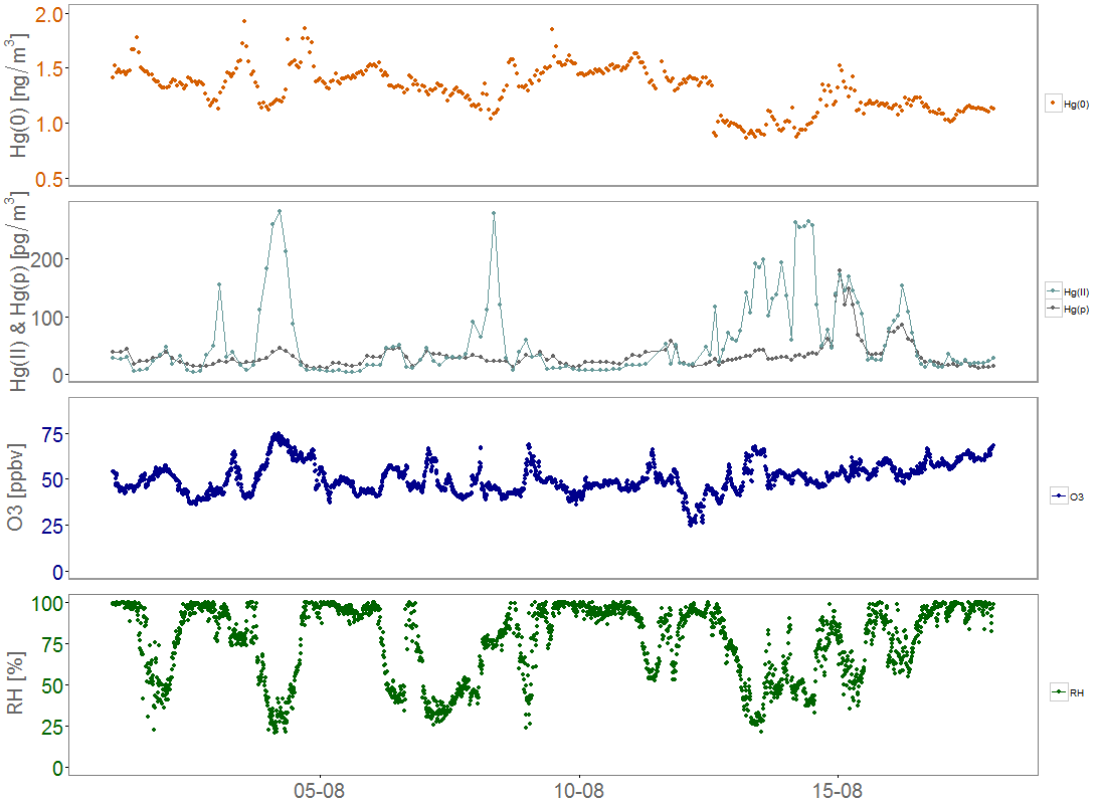

Figure 1. Interesting period with presumable stratospheric influence from top to bottom: Hg(0) concentrations [ng/m³] in 5-minutes resolution and Hg(II) and Hg(p) concentrations [pg/m³] in hourly resolution in comparison to Ozone (O3) concentrations [ppbv] and relative humidity (RH) from 4th of August until 8th August, 2016. Hg(II) spikes in correlation with a drop in RH and high O3 levels.

Key words:

Mercury, gaseous elemental mercury, long-range transport, air monitoring, trajectory modeling, Lagrangian particle dispersion model

Collaborating partners/networks:

Particle dispersion modeling: Dr. Stephan Henne, EMPA, Dübendorf, Switzerland
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Measurement devices: Prof. Dr. Ralf Ebinghaus, Helmholtz-Zentrum Geesthacht

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