Name of research institute or organization:

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

Title of project:

Emissions and imissions of atmospheric mercury in Switzerland

Project leader and team:

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Project description:

Mercury is a heavy metal of particular concern due to its ability to accumulate in ecosystems and its significant negative effects on human health and the environment. Long-term human exposure to small amounts of mercury has been shown to result in serious neurological impairments [1]. The major anthropogenic releases of Hg to the environment result from atmospheric emissions by combustion processes, mainly coal burning and metallurgic processes. Due to its long residence time, gaseous elemental mercury, Hg(0) undergoes long-range atmospheric transport [2]. Thus, mercury can occur in regions far away from its initial emission sources.

With the intention to protect human health and the environment from the anthropogenic emissions and releases of mercury and mercury compounds, the Minamata Convention on Mercury was adopted by the United Nations in October 2013 and is currently open for ratification by the signatory countries. To fulfill the goal of the convention – to reduce the present mercury concentrations in ambient air – the establishment of a worldwide monitoring network is recommended. Switzerland took part in the negotiations on the global mercury agreement and was one of the first nations to sign the convention.

To improve the understanding of the atmospheric transport of Hg(0), a long-term monitoring campaign was started in December 2013 at the High Altitude Research Station Jungfraujoch. The current measurements follow a pilot study that we performed at Jungfraujoch in 2011/12.

A Tekran 2537X gaseous elemental mercury analyzer is used to measure the concentration of Hg(0) by cold vapour 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. The measured Hg(0) concentrations are shown in Figure 1.

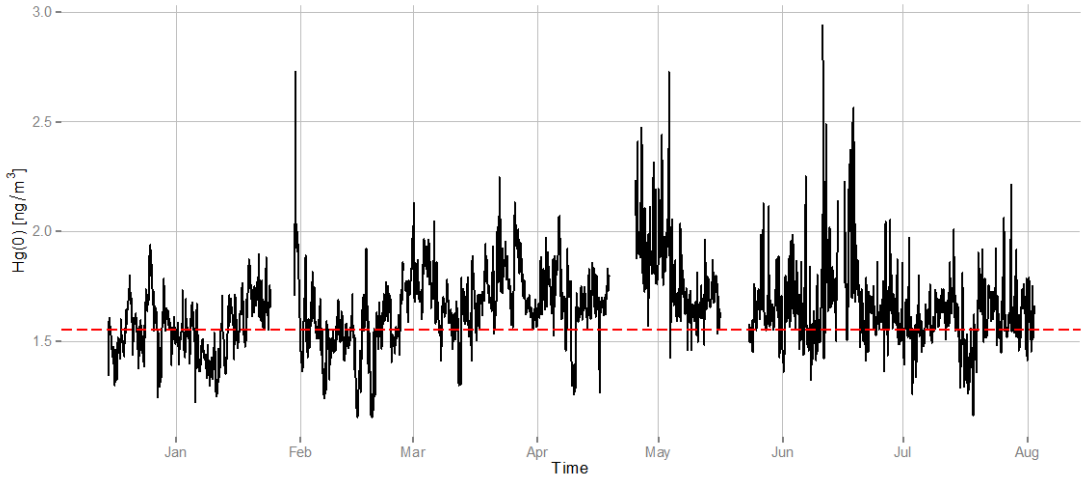

Figure 1. Hourly mean Hg(0) concentrations at Jungfraujoch from December 2013 until August 2014 with a median of 1.55 ng/m^3 (red dotted line).

The Hg(0) concentrations measured at Jungfraujoch are comparable to background levels measured worldwide [2]. The median over the sampling period from December 2013 until August 2014 is 1.55 ng/m^3.

By the use of the Lagrangian particle dispersion model FLEXPART [3] the footprint regions of the air masses at Jungfraujoch were identified every 3 hours. Therefore particles were released at Jungfraujoch and followed backward in time for 10 days on the basis of EMWF wind fields. A potential source contribution function was then used to identify the source regions of the Hg(0) at Jungfraujoch. It compares the footprint of the air masses which resulted in the 10 % highest concentrations measured at Jungfraujoch to the average footprint of the whole measurement period. This procedure produces a relative value for each grid cell, which indicates that air residing in that cell is more often causing high Hg(0) concentrations when arriving at Jungfraujoch. The results are given in Figure 2. It shows that for high Hg(0) concentration events the air masses originated dominantly from regions east of Jungfraujoch. Especially areas in Eastern Europe, including Russia, the Ukraine, and Poland are identified as source regions.

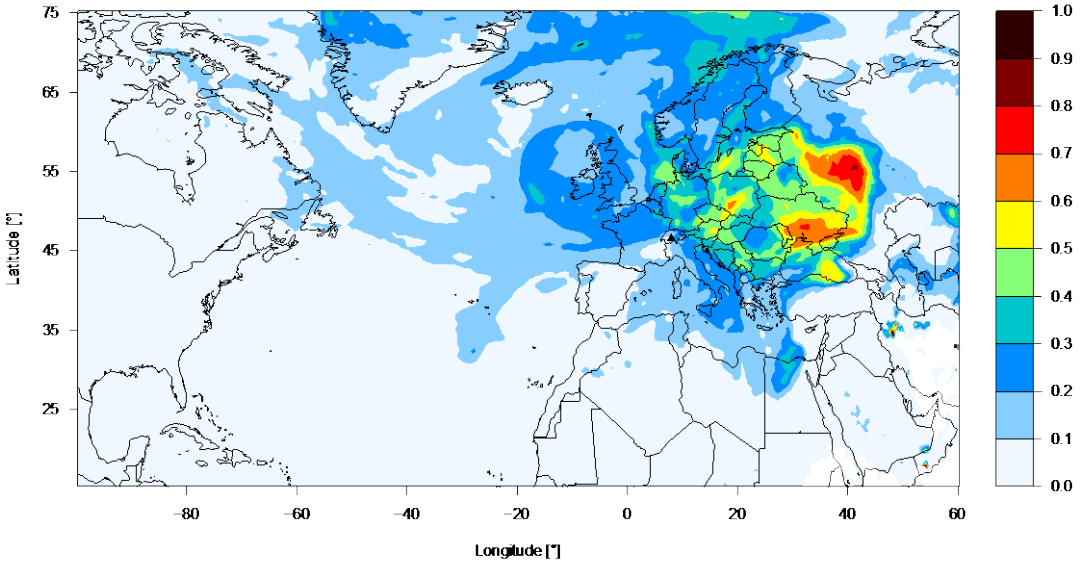

Figure 2. Potential source regions for high Hg(0) concentrations at Jungfraujoch indicated by values above 0.1.

Our next goal is to compare our measurement-based results to the global inventory of anthropogenic mercury emission compiled by AMAP/UNEP. This inventory is based on activity data combined with emission factors of mercury for various industry sectors [4]. According to our study, the AMAP inventory seems to underestimate the emissions from Eastern Europe. Our alternative approach to identify possible source regions could help to improve the current emission inventory.

References:

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