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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Elevated atmospheric mercury concentrations at the Russian polar station Amderma during Icelandic volcanoes' eruptions" *by* Fidel Pankratov et al.

Anonymous Referee #1

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The authors present long-term mercury measurements at a remote site of Amderma on the coast of Kara Sea south of Novaya Zemlya in Russia. They observed events with unusually high concentrations in 2010 and 2011 and attribute them with help of backward trajectories rather convincingly to mercury released by volcanic eruptions in Iceland.

There are several problems with this paper. First, it is written more like a fiction than a scientific paper. Essential information such as description of the site, its climatology, instrument calibration, is missing. Second, beside a rather poor English and poor organisation of the manuscript it contains a number of errors (such as wrong units

for the discussed trends, faulty citations) and omissions (some crucial and more recent references are not mentioned, calculation of the trends is not defined). Third, I think that episodic transport of air masses with high mercury concentrations from volcanic activity in Iceland would be better discussed in event (and their frequency) terms or as an anomaly of seasonal variation, rather than in terms of trends whose discussion makes a substantial part of the paper. In summary, the paper does not meet the standard of a paper in Atmos. Chem. Phys. It could be published after a thorough and far reaching revision of its concept of presentation, figures and text. Some recommended revisions are listed below:

The references are generally not up to date – the most recent estimate of volcanic mercury source by Pirrone et al. (Atmos. Chem. Phys., 10, 5951-5964, 2010) is not mentioned. Pankratov's own paper in Russian Meteorology and Hydrology (Vol. 38, 405-413, 2013) with some experimental details on the Anderma station is not mentioned either. Conference abstracts should not be cited because they are difficult to come by.

Page 1, Abstract:

What does it mean "we estimate the long-range transport" – flux or what?

"New data for volcanic eruptions in Iceland" – source strength or what?

"A change in dynamics" – dynamics of what – transport, meteorology?

"For seasonal variability . . . a negative trend of.. ng/month was fixed" – a trend of seasonal variability or of concentrations? Fixed? Unit of ng/month?

The sentence in line 15 starting with "At the same time" is incomplete.

"The inverse trajectories. . ." backward trajectories are probably meant.

The last sentence reads either as if volcanic emissions were dominating source of atmospheric mercury in the northern hemisphere or as if Amderma station were repre-

sentative for the northern hemisphere or both. Both is wrong.

Page 1, Introduction:

Line 34: “we estimate it at about 800 Mg yr-1” – there is neither a reference nor an estimation presented in this paper.

Line 38: The citation of M. Li Witt, 2010 is a conference paper difficult to obtain. In addition, the initials of Ms Witt are wrong. Please cite M.L.I. Witt et al. (J. Geophys. Res. 113, B06203, doi:10.1029/2007JB005401, 2008; J. Volcanology Geotherm. Res. 178, 636-643, 2008).

Lines 38-40: It is not clear what elevated particle concentrations at Zugspitze have to do with mercury or other trace metals?

Line 41 and the last line of the same paragraph say the same, one of the sentences is redundant.

Page 2, lines 32-33: There are 4 citations of work by Pankratov of which three are conference abstracts difficult to obtain and thus useless to most readers. Please cite only Pankratov Thesis with the doi number which is accessible on internet. Why is the paper by Pankratov et al. (Russian Meteorology and Hydrology, Vol. 38, 405-413, 2013) not cited? It provides some valuable details about the Anderma measurements and an analysis of data until 2011.

Section 2.1: The site has to be described, possible mercury sources in the vicinity enumerated, and precautions to eliminate contaminated data delineated. There are no details about the air sampling (flow rate, position of inlet, tubing, its length and material), maintenance (exchange of gold traps, etc.) and calibration (frequency of calibration of Tekran response to mercury and of air flow rate) of the Tekran instrument. Please add details. A comparison with other sites in the northern hemisphere would be better placed in the discussion.

Page 3, line 15: Backward trajectory arrival altitude of 500 and 3000 m - is this altitude

justified? What is the orography and typical meteorology of the station (possible mercury sources in the surrounding, prevailing wind direction, velocity, height of inversion layer in different seasons)?

Section 3.1: In Fig. 1 the authors show the position of one of the three measurements sites – why not the position of other two? What was the position of site 1, 2 and 3, i.e. distance from the sea? By the way the measurements at the three sites were already compared in the Pankratov et al. 2013 paper. What about local contamination: has it been observed and eliminated from the data?

Section 3.2: This section is nominally about seasonal variation but it deals to a large extent with trends. Figure 3 is not helpful either. The authors should divide the discussion into a section about trends (if neccessary at all) and into a section about seasonal variation after detrending the data.

Page 4, lines 6-7: “The smallest variability of mercury concentrations during AMDEs. . .” – what does it mean? AMDEs mean high variability, the smallest variability would be an absence of AMDEs.

Page 4, line 8: “dynamics of mercury behaviour” – why “dynamics” and not simply “mercury behaviour”?

Page 4, lines 11-14: Because of the trend it would be more appropriate to compare the authors data in 2010 and 2011 with corresponding annual data from Ny Alesund and Alert stations. The data can be found in the literature or obtained from the operators of the stations. The term “significantly” should be accompanied by a significance test.

Page 4, lines 18-27: Trends have to have a unit of concentrations per time. The trends presented here in concentration units cannot thus be trends. Were the trends calculated from all data, from monthly averages or monthly medians? Fig. 2 shows that since about 2011 the frequency of the AMDEs and AMEEs is much higher than in preceding years without changing much the decreasing tendency. The discussed trend is

then likely to be caused by changing frequency and duration of depletion and enhancement events instead of the trend of background. I think that to discuss the 2011 and 2012 anomaly in terms of trend is thus wrong. It is also questionable whether 3 years are sufficient to calculate a trend.

Page 4, lines 28-33: Trend is given in ng/period – the unit is wrong. Which period? Short term changes are not trends!

Section 4: Trend units are wrong.

Section 4.3: In addition to backward trajectories, the long-range transport of volcanic plumes can be documented by remote sensing of SO2 by satellite. Details can be found e.g. in Heue et al. (ACP, 10, 4699-4713, 2010) who used the satellite SO2 sensing to follow the Kasatochi plume from Aleutian Islands in Pacific Ocean to Central Europe.

Page 7, line 7: Mercury measurements at Amderma seem to continue until 2016. By including later data, the anomaly of 2010 and 2011 could be perhaps illustrated better.

Figure 1: This figure could serve as a schematic illustration of the paper content (such as required by Environmental Science and Technology) but is unsuitable for a paper. The insert with the map of Island and its volcanoes can be found in every atlas and can thus be omitted. An insert with a map of the Anderma site (and the three sampling locations mentioned in the text) and the potential mercury sources in the surroundings would be more useful.

Figure 2: The data shown in this figure for 2002- 2004 are very different from those shown in Figure 2 of Pankratov et al. (2013) for the same period. Please explain the difference.

Figure 3: The decreasing trend in Figure 2 for 2010 – 2013 is now an increasing trend in Figure 3? This only shows that the discussion of volcanic influence in terms of trends is questionable at best.

Figure 4: The reader would appreciate the same scale on the x axis – why a) stops at the 22nd week when b) continues until 26th and c) until 25th week? The dotted line in d) is not explained – a running average or what?

Reference Konoplev et al. (2005) -the title and the page numbers are wrong.

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