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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.

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1. Essential information such as description of the site, its climatology, instrument calibration, is missing. Remarks partially accepted. A brief description of the site is sufficient for the purposes of this article. The authors believe that a too detailed description of climatology in the paper is excessive. The article provides the most significant information on the measurement modes. There indicated the accumulation period (30 minutes) and the desorption mode (thermal desorption). More information on calibration can be obtained from the link provided in the article on the Tekran website. 2. such as wrong units for the discussed trends Remarks accepted. Units

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have been changed. 3. 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. Remarks rejected: Episodic transport of air masses with high mercury concentrations from volcanic activity in Iceland are thoroughly described in section 3.2 “Episodes of volcanic eruptions” as an anomaly of seasonal variation. The calculation of the trend for periods of volcanic eruptions made it possible to estimate the degree of increase in the concentration of atmospheric mercury. This approach suggested that the increase in mercury concentrations in spring was associated with volcanic eruptions in Iceland. 4. the most recent estimate of volcanic mercury source by Pirrone et al. (Atmos. Chem. Phys., 10, 5951-5964, 2010) is not mentioned. The remark has been accepted. The reference “Pirrone et al. (Atmos. Chem. Phys., 10, 5951-5964, 2010)” will be added to the list of references. 5. Pankratov‘s own paper in Russian Meteorology and Hydrology (Vol. 38, 405-413, 2013) with some experimental details on the Amderma station is not mentioned either. The remark has been accepted. This reference “Russian Meteorology and Hydrology (Vol. 38, 405-413, 2013)” will be added to the list of references. 6. What does it mean “we estimate the long-range transport” – flux or what? Reply to comment. The term "long-range transport" means the transfer of a pollutant with air masses over long distances. 7. New data for volcanic eruptions in Iceland Reply to comment. For the first time, an increase in the concentration of elemental mercury in the surface layer of the atmosphere at a particular point in the Russian Arctic was associated with volcanic eruptions.. 8. A change in dynamics” – dynamics of what – transport, meteorology Reply to comment. In this case, we talk about the dynamics of atmospheric mercury for the period when the air masses transferred a significant amount of mercury over the measurement site of the monitoring from the south-west direction.

9. For seasonal variability . . . a negative trend of.. ng/month was fixed” – a trend of seasonal variability or of concentrations? Remarks accepted. The mercury concentra-

tion was expressed as ng per month.

10. The sentence in line 15 starting with “At the same time” is incomplete.

11. The inverse trajectories. . .” backward trajectories are probably meant. Remarks accepted.

12. 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 representative for the northern hemisphere or both. Both is wrong. Reply to comment. In this case, the assumption is confirmed that the maximum amount of mercury from volcanic eruptions supply to the environment in a short period of time. This statement is based on data from an ice core study. (Krabbenhoft, D.P. and Schuster, P.F., 2002 ,Glacial Ice Cores Reveal A Record of Natural and Anthropogenic Atmospheric Mercury Deposition for the Last 270 Years: 2002 U.S. Geological Survey Fact Sheet FS-051-02, p. 2.)

13. Introduction: Line 34: “we estimate it at about 800 Mg yr-1” – there is neither a reference nor an estimation presented in this paper. Remarks accepted. Link to article will be added

14. 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). Remarks accepted. Link will be corrected.

15. Lines 38-40: It is not clear what elevated particle concentrations at Zugspitze have to do with mercury or other trace metals? Reply to comment. An example of registration in the atmosphere of elevated concentrations of other particles during the passage of a volcanic cloud above the site of the monitoring.

16. Line 41 and the last line of the same paragraph say the same, one of the sentences is redundant. Remarks accepted. The paragraph will be deleted. 17. 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. Remarks accepted. Link to article will be added.

18. 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 Amderma measurements and an analysis of data until 2011. Remarks accepted. Link to article will be added.

19. 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. Remarks accepted. Technical details will be added.

20. 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)? Reply to comment. To calculate the Backward trajectory using different altitude. Including the altitude of 3000 meters is the height of the main transport in the atmosphere, the free troposphere.

21. 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? Reply to comment. The location of monitoring sites was described in the article Pankratov, F .: The Dynamics of Atmospheric Mercury in the Russian Arctic, Thesis, November 2015, DOI: 10.13140

/ RG.2.1.4255.1767. This information does not represent a value for the fact of registering elevated mercury concentrations at volcanic eruption in Iceland. Local sources of pollution do not significantly affect the resulting values of mercury concentration over the entire observation period.

22. 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 necessary at all) and into a section about seasonal variation after detrending the data. Reply to comment. In this section, seasonal variations are treated as trends for certain time intervals.

23. 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. Remarks accepted. This sentence will be adjusted.

24. Page 4, line 8: "dynamics of mercury behaviour" – why "dynamics" and not simply "mercury behaviour"? Remarks accepted. This sentence will be adjusted.

25. 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. Reply to comment. If possible, I will request data from other stations.

26. 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. Reply to comment. Observation period (2001-2010) of measurements a negative trend (-0.35 ng m-3), and calculated averages for all seasonal.

27. 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. Reply to comment. The construction of a trend for a three-year period is reasonable, since there are no time and quantitative limitation when analyzing any series of values.

28. Page 4, lines 28-33: Trend is given in ng/period – the unit is wrong. Which period? Short term changes are not trends! Reply to comment. -0.66 ng per period, Fig. 4, +0.97 ng per month, -0.88 ng per month. 29. Section 4: Trend units are wrong. Remarks accepted. Trend units will be corrected.

30. 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 Amderma site (and the three sampling locations mentioned in the text) and the potential mercury sources in the surroundings would be more useful. Reply to comment. The possibility of mapping the likely sources of mercury contamination will be considered. 31. 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. Reply to comment. The original data is not changed, a variety of mathematical techniques used to construct graphs. 32. 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. Reply to comment. For the period 2010-2013 (Fig. 2) a downward trend was calculated. The trend to increase (Fig. 3) is calculated for the period 2010-2012. 33. 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. Reply to comment. For the graphs presented in the figure information on the number of weeks is not significant. The link to the article will be corrected.

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