

Interactive comment on “Ten years trends in atmospheric mercury concentrations, meteorological effects and climate variables at Zeppelin, Ny-Ålesund” by T. Berg et al.

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The authors present a detailed analysis of continuous GEM measurements at Zeppelin starting in 2000 and ending in 2009. They do not find any trend in annual median concentrations but they find different trends for different months of the year. They then investigate the influence of meteorological parameters. Their findings are compared with measurements at Alert and Mace Head. Interesting is also the analysis of the GEM dependence on the climatic indicators. The paper is generally well organized and written but at times somewhat vague – see a few comments below. I recommend it publication in the final version.

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The authors wish to acknowledge the reviewer for his/her detailed and exhaustive constructive comments and suggestions that have greatly improved the manuscript.

Specific comments: Page 2274, line 17: “likely” instead of “likely” We have changed likely to probably.

Page 2277, line 12-14: “an extra Teflon filter..” and “due to the presence of two filters..”: Where is the second filter, what type? How frequently were they exchanged?

One of the filters is a part of the Tekran 2537A instrument and is located between the sodalime trap and the goldtraps. The other filter is installed at the start of the heated sample line outside the station, and protects the sample line from snow, rain and dust. Both filters are made of Teflon. The filter outside is changed once a month. The filter inside is in general changed every 3-4 month. Most part of this info (with the exception of the frequency of the changes) is now included in the manuscript(Sampling)

Page 2277, line 16: “Auto calibrations : : . were verified by manual injections regularly”. What does it mean “regularly” – every month, every year?

Regularly have been changed in the text to every 3 or 4 months.

Page 2278, line 9: “: : : from Fetterer et al. (2012).”

The paragraph now reads: “Monthly sea ice area index and maps for the Northern Hemisphere was obtained from National Sea Ice Data Center.....”

Page 2280, line 20: The authors state “that the quality of the measurements was not as good as for the new automatic data” as a reason for not including the previous measurements in the analysis. Does it mean that the old data are not valid any more? Why do the authors believe that new automatic data are better? Because of their accuracy or precision or coverage? I surmise that the coverage was the problem. Please be specific about the quality problem. I would like to point out that “new automatic data” may be consistently inaccurate for a long period between the calibrations of the internal permeation source despite of their high precision and coverage. Manual measurements

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may produce less data but not necessarily of lesser quality.

The manually data are still valid, and the text now reads: "The manually collected data was not included in the present trend analysis because the data coverage was not sufficient for some of the statistical analysis and the measurements were collected using different methods. This was done to assess if these differences reflected a change in the trend analysis."

Page 2278, "Statistics", 1st paragraph: Do I understand it properly that 24 * 31 hourly Mann-Kendall tests and Sen's estimators were calculated for e.g. March? If so is the resulting trend an average or median of these estimates?

Twelve Mann-Kendall tests were performed, one for each month. Within a given month (e.g. January 2000), the up to 31*24 (=744) points are treated as "tied" in time, so no differences between them are counted or used in the Sen's slope calculation. However, each point in Jan 2000 is compared to each point in January of every other year to contribute to the overall sum of signs (for the Mann-Kendall test) and to yield a slope for the pair as part of the Sen's slope estimate. Assuming no missing data, the median of almost 25 million slopes for January ($744 \times 744 \times (9+8+7+6+5+4+3+2+1)$) is the overall slope estimate for January. Error bars on the slope, as well as the significance in the Mann-Kendall trend test, depend on the computed variance of S, which in turn is calculated based on the number of points and number of tied values.

It is also possible to use one value for each month only (e.g. medians, as used in Ebinghaus et al., 2011), in which case there are only 45 pairs ($9+8+7+6+5+4+3+2+1$), however this does not give a good representation of the level of confidence (the error bars will be very large) since the method then assumes only 10 valid data points for each month. Daily values have also been used on this data set (Cole et al., 2012) since the computational time for using hourly values is quite high, however when hourly values are used the results are more precise as expected from the larger number of data points.

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In our opinion, the above extensive details of this method are beyond the scope of this paper and it is best left for the interested reader to consult the referenced textbook. However, the section has been revised to add a bit more information, as follows: "The trend analysis was carried out using the Seasonal Kendall test for trend (a variant of the Mann-Kendall test) and the related Sen's slope estimator (Gilbert, 1987). In the Seasonal Kendall test, each month is treated as a separate data set and twelve Mann-Kendall tests are performed. For the GEM data, each hourly data point was treated as a replicate point for that month and year. The Sen's calculation of slope was then performed to give an estimate of the linear slope for that month (the median of millions of slopes between each hourly pair) and its uncertainty, resulting in trends of different magnitudes and directions in all the months."

Page 2282, line 22: " : : due to less AMDEs" – does it mean less frequent or shallower or both?

Changed as recommended. The text now reads : "less frequent AMDEs"

Page 2283, line 25: " : : show an increase in the number of AMDEs" – according to the text before it should read ".an increase in the number of AMDE hours"

The text is changed to : an increase in the percent of hours of AMDEs.

Page 2287, last paragraph: Relative humidity is not a good parameter because at a given absolute water content it depends strongly on temperature. The lowest GEM concentrations at 80-90% and the highest at 40-50%, both in April, thus just describe the temperature dependence discussed on page 2285. Absolute water content may be a more interesting parameter . We have calculated absolute water content as well as relative humidity and made figures for both. The figure for the absolute water content is almost a copy of the temperature figure since absolute water content also is very dependent of the temperature. We have therefore chosen to still use the relative humidity since it seems to give most information of the two variables.

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Figure 5a, caption: The reader should understand the meaning of the figure without reading the text. What distribution is being shown here? What does % relate to? Perhaps a plot of the number of events would be more informative than that of the relative frequency.

The caption text is now changed to: "Monthly distribution (%) of AMDEs at Zeppelin." The authors feel that a percentage give additional information that is lost if we just shows the number of events, since sampling discontinuities can influence the total number.

Fig. 6, caption: Opposite to Fig. 5a hours are counted here, not events. "Percentage of AMDE hours: : ." is thus more precise wording.

The figure caption is now changed to: "Percent of AMDE hours in March, April, May, June relative to the total measurements for the same period for the period 2000-2009."

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