

**Autor response to Reviewer comments 2, the reviewers comments are in normal black font and the autor response are in blue bold font.**

The manuscript is well written, exemplarily concise and of high scientific quality. One problem is, however, that the data presented already to some degree been published in Obrist et al. (2017) doi: 10.1038/nature22997.

The present manuscript refers to this Nature paper more than 20 times, which hampering a throughout reading obtaining comprehensive informaton from text, tables and figures.

**We thank the reviewer for his positive assessment and the constructive comments.**

**The Hg0 flux dataset is the same as presented in Obrist et al. 2017. The 2017 Obrist study focused on a mass balance of Hg input vs. output in the tundra ecosystem. In this context Hg0 fluxes were presented as cumulative fluxes and Hg stable isotopes were used as source tracers. In the 2500 word letter format of Obrist et al 2017 we had to be very concise and could not discuss individual features in the dataset. In this study we re-visit the flux dataset and discuss for first time diurnal variations in fluxes and how they impact atmospheric concentrations. We also present for the first time Hg0 isotope data of interstitial snow and soil air, which was not presented in Obrist et al.**

**Based on this reviewers comment as well as other reviewers comments we will provide a clearer definition of the objectives of this study in the revised manuscript to highlight the added value of this paper compared to the Obrist et al 2017 paper as follows: “In our previous work we showed that atmospheric Hg(0) deposition to vegetation and soil represents 70% of total atmospheric deposition leading to high Hg levels in Arctic soils (Obrist et al., 2017;Olson et al., 2018). In this study we explore the use of novel mercury stable isotope measurements of Hg(0) in in interstitial snow air and soil pore air to identify the processes driving tundra Hg(0) deposition. We further discuss the effect of terrestrial-atmosphere exchange processes and planetary boundary layer stability on atmospheric concentrations and Hg stable isotope signatures of Hg(0).“**

A basic issue is that a summary tabulaton of flux and ancillary data sta9s9es (number of observa9ons, flux data coverage (%), % of data rejected due undeveloped turbulence or fetch limita9ons etc. etc.) is missing in both papers. Please, provide a table in the main part or in a supplement.

**Mercury flux was calculated for each 30 min, so we have a total of 17568 data points for one full year (i.e., from Oct. 2015 to Sep. 2016). For the sonic data set, we have 10% of missing data (when the Monin-Obukhov length was not measured due to instrument or acquisition failure), 86% of unstable (when z/L was between -2 and -0.1), neutral (z/L between -0.2 and 0.1), and stable (z/L between 0.1 and 2) conditions that were used for the flux calculation, and 4% of very unstable/very stable conditions (z/L less than -2 and more than 2, respectively) that were removed from the data set. Besides, 92% of the Hg gradient data were correctly measured (only 8% of missing Hg concentration measurements). That means that we really calculated a Hg flux for 79% of the time.**

**A summary of this information will be added to the revised manuscript.**

The uncertainty in flux measurements is not mentoned and quantfied. Such a discussion should also include that the flux deriva9on is obtained by asynchronous Hg0 sampling of the two heights.

**Quality control of flux measurements has been discussed in Obrist et al. 2017 as follows: “For quality control, sampling lines were confirmed to be free of contamination during each field visit (approximately every six weeks, using Hg-free air; model 1100, Tekran). In addition, line intercomparisons were conducted at the same intervals to test for line biases between**

the upper and lower inlet lines; for this, both upper and lower inlet lines were set at the same height and measurements were conducted to assess offset. Line intercomparison tests showed no substantial line offsets throughout the study, with the exception of one time when a leak was detected and immediately fixed, and fluxes before that time were corrected”

Gradient based measurement techniques are currently the best available method for measuring net ecosystem exchange fluxes of gaseous elemental mercury. To keep the manuscript concise, we prefer to not discuss general methodological shortcomings in this manuscript, in particular since the main objective of the study was to develop and discuss the Hg stable isotope tracer in terrestrial atmosphere exchange.

The measured Hg<sup>0</sup> deposition velocities should be mentioned and discussed with literature data.

We measured net ecosystem exchange fluxes (Hg<sup>0</sup> deposition – Hg<sup>0</sup> re-emission), since there were no independent measurements of Hg<sup>0</sup> re-emission we cannot calculate net Hg<sup>0</sup> deposition or deposition velocities from our data.

Correlation analysis between measured gases, flux and environmental parameters is not presented.

The focus of this study lies on discussing trends in diurnal variation and time series, where correlation analysis is not very powerful. An extensive discussion of correlations between measured gases, fluxes and environmental parameters would in our view lead to a much longer manuscript. The manuscript is already quite extensive with 8 Figures and we prefer to keep it in the present length.

To improve the readability, consider assigning the oxidation state of Hg in delta and capital delta notations (e.g.  $\delta^{202}\text{Hg}^0$ ,  $\Delta^{199}\text{Hg}^{\text{II}}$ ) when found appropriate. **The nomenclature used in this study is established in the Hg stable isotope community**

Page 2, Line 1: *drawn down*, consider revising **sentence revised**

Page 2, Line 14 – 15: Lindberg *et al.* 1998 is outdated (suggesting foliage as net source of Hg<sup>0</sup>). Consider e.g. Bash and Miller (AE, 2009) or Castro *et al.* (Atmosphere, 2016) **We consider the work of Lindberg *et al.* 1998 as pioneering and would like to give them credit for this and keep the reference. We added the two references suggested by the reviewers to the manuscript.**

Page 3, Line 16: “1.5m apparat”, mistake? **Typo corrected**

Page 4, Line 25: an aerodynamic... consider the aerodynamic... **revised as suggested**

Page 4, Line 29 – 30:  $\Phi$ h the universal temperature profile, provide a reference for the mathematical form used. **The respective reference was added to the manuscript: Monson and Baldocchi, 2014: ISBN 978-1-107-04065-6 (Terrestrial biosphere-atmosphere fluxes. Cambridge University Press)**

Page 5, Line 21: Provide  $\pm$ SD of the mean **We added the standard deviation of the flux measurements**

Page 6, Line 10: ... remained relatively low... try to be more concise (numbers) **We defined low as  $<0.1 \text{ ng m}^{-3}$  and adjusted the manuscript accordingly**

Page 6, Line 16: ODE’s without explanation. Define Ozone depletion events as ODEs. **The definition of ODE’s was added**

Page 6, Line 22: Provide median also, if there is a substantial difference with mean **We added the median of the flux to the revised manuscript**