Interactive comment on "Insights from mercury stable isotopes on terrestrial – atmosphere exchange of Hg(0) in the Arctic tundra" *by* Martin Jiskra et al.

Anonymous Referee #4

Received and published: 17 July 2019

This study combines Hg fluxes and Hg isotopes in atmospheric Hg(0) and Hg(0) from snow air and soil air to investigate the fate of Hg(0) in Arctic tundra terrestrial environment. This study is part of a larger, systematic study, which I think is well planned and well carried out. The data on Hg isotopes in soil air and snow air is very novel, and they indeed provide new insight in Hg cycle in Arctic and support the conclusions from many previous studies about terrestrial-air Hg cycle that were based on experiments and field observations. The paper is also well written and the data is clearly and properly analyzed and interpreted. Overall, I recommend the publication of this paper with minor revisions:

General comment:

The observation of opposite Hg isotope signals between snow air and soil air is indeed interesting. I think it would add some value to this paper if the authors can give a more thorough thoughts on this, especailly regarding the mechanism of Hg isotope signals in snow air. The current interpretation relying on lichen uptake does not seem to be very convincing. The source and process of Hg in lichen and snow air could be very different. Are there any redox processes within snow that could produce the isotope pattern in snow air and what is the possible mechanism?

Specific comment:

1. P6, L1: it is a little confusing for the word "complementary". Does lichen and snow air represent two complementary pools of Hg? Lichen represents a long term accumulation of atmospheric Hg(0) throughout the year, whereas snow air is a more temporary pool of Hg. The source and process of Hg in lichen and snow air could be very different.

2. P6, L26-31: This section is about AMDE season, but why suddenly you switch to the discussion about May, which is after the three AMDE events? What about the isotope signals in snow air during AMDE? Should this be mentioned?

3. P6, L35: Figure 6 seems to be a wrong figure, it is not about even MIF, do you mean figure 4?

4. Figure 4: the x axis should be explained.

5. P8, L1: "do not only reflect", delete "do"

6. P8, L27: Could you show the change of MIF with Hg(0) concentration?

7. P8, L8-9: I agree, but this does not explain your high enrichment factor, which does not distinguish between pure foliar uptake and the net effect of uptake and re-emission. Re-emission would indeed affect the d202Hg and you certainly need to discuss this

scenario, but re-emission likely occurs in all situations and would not cause the difference between yours and other studies. Furthermore, re-emission is accompanied by MIF, but your data shows no change of MIF between day and night.

8. P8, L11-15: I agree with this interpretation and I believe this is a more likely interpretation than the re-emission scenario. The d202Hg in atmospheric Hg(0) is not only affected by foliar uptake. Mixing with other Hg sources should be considered in the first place. The Rayleigh model shown in Figure 6S is based on the assumption that the change of d202Hg was completely caused by processes, which should be clarified.

9. P8, L32: How did you estimate the <5% of total Hg deposition flux? Can you elaborate a little? The concentration of Hg(0) in soil air is almost lowered by half compared to atmospheric Hg(0). This seems to be a significant sink.

10. P8, L34-35: I agree that the difference between soil air and atmosphere is caused by uptake of Hg(0) by soil because the isotope signals are very consistent with the experimental work. However, the opposite Hg isotope signals between soil air and snow air do not directly support that argument that soil Hg(0) sink is minor, because the isotope signals of Hg(0) in snow air is likely controlled by other mechanisms, which I believe is not clearly identified.