Anonymous Referee #3
Received and published: 10 August 2019

The work of Sierra-Hernández et al. describes trace metal analysis of an ice core from the Guliya ice cap in northwestern Tibet that represents deposition from 1971 to 2015. This extends the metals deposition record from that location that previously ended at 1991. The authors demonstrate increased deposition of several trace metals in the 21st century, with some starting to decrease more recently. Trends in deposition are related to industrial activities in the region and to climate. The measurements are made with good analytical rigor, but some of the trends and source attribution could be more convincing. I recommend the changes detailed below be made to the manuscript prior to consideration for publication in ACP.
[Response] Thank you. Following the recommendations by this and the other reviewers we changed the source attribution. Please see our responses below.

General comments
The Authors use two different metrics to assess enrichments of metals, enrichment factor (EF) and excess concentration. The rationale for using two metrics (i.e. the unique information provided by each) is not provided. It would be useful to provide additional information of this type in Section 2.3. Where different trends were observed for each metric (e.g. lines 191-194, Figure 2), the authors should explain the reasoning and implications of these differences.
[Response] The EFs calculated relative to the PSA are particularly small since the composition of the PSA is a much closer representation of the crustal background of the ice samples compared to those obtained using the UCC (upper continental background by Wedephol). Thus, to further demonstrate that these "small" increases are significant, we used a second metric which is the Excess concentration. The excess concentration provides the TE concentration difference between TE deposition after and before the pre-industrial period. For the pre-industrial period we use the 1992 Guliya ice core data comprised between 1650 and 1750. We added a brief explanation in Section 2.3 accordingly.

The difference in trend observed between EF and Excess concentration was due to an error in the Mann-Kendall trend test. Here it is the response to Reviewer #1 to this issue:
For all our statistical tests we used the datasets at full resolution. However, the Mann-Kendall trend tests were performed with the annual dataset. The tests have been re-done using the full resolution EF and Excess concentration datasets. The updated results show that both EFs and Excess concentrations of Bi, Cd, Ni, Pb, Tl, and Zn show significant increasing trends.
The problem with the Excess concentration was that by averaging the values within one year, a large negative value skewed the final results to negative numbers.

Section 3.2 relating the North Atlantic Oscillation (NAO) to enrichments on the Guliya ice cap is very qualitative and speculative. Although it seems reasonable that some relationship exists with the NAO, there is no quantitative analysis provided. The authors mention that correlation was observed in previous studies (lines 303-305). Was there any correlation observed here? It seems a stretch to conclude that the source of enrichments for several trace metals is related to a specific industry in Pakistan (i.e. line 330).
[Response] We have eliminated Section 3.2. Please see the full response regarding this in the responses to Reviewer #2.
We agree with this reviewer (and reviewer #2) that the EF increasing trend might be a combination of regions and sectors, so we have changed throughout the discussion, abstract and conclusions the attribution of TEs to all the regions that influence Guliya (South Asia, western China, and Central Asia).

Specific comments

Line 46: Suggest not using an acronym for five-year plan since the term is used only three times in the manuscript.
[Response] Done.

Lines 55-59: Although the sampling site is given with reference to Xinjiang Province, this area is not labeled on the map in Figure 1(a). This should be added.
[Response] Done.

Lines 125-133: The quality assurance/quality control of the sample analysis is comprehensive and well-described, demonstrating the quality of the presented data.
[Response] Thanks for the comments.

Lines 140-141: Please provide a brief description of the PSA used here along with the reference to the previous study.
[Response] A description has been added accordingly.

Lines 165-167: What about Pb deposition post-2008? The first part of the sentence refers to both Pb and Cd, while the final part of the sentence describes only Cd. Please clarify.
[Response] The final part of the sentence has been changed and it now reads "The 1992 Guliya TE records show that enrichments of Pb and Cd begin ~1975 while the 2015 Guliya record shows they continue to rise into the 21st century until ~2008 when they started to decrease."

Line 252: Statistical information for the significant positive correlations should be provided.
[Response] Done. The significance is $p < 0.001$, and it has been added in the corresponding line.

Line 530: Typo in first word of the caption.
[Response] Done.