Reviewer #1：

(1) Many more cores could be included. The main additions in Antarctica are the Sigl et al. 2015 cores. Even the addition of ITASE cores on the two routes to South Pole from West Antarctica and Taylor Dome would provide valuable spatial information. It would also be interesting to assess multiple cores from the same location, such as South Pole or EDC, to better assess any single core uncertainty. It would be interesting for the authors to comment on whether improving the conversion factor is limited by simply the number of cores, or whether the location and resolution of analysis are also important.

Response: *We thank the reviewer for the insightful suggestion and questions.*

We have tried to include as many cores as available, by periodically check the https://www.ncei.noaa.gov/products/paleoclimatology/ice-core data site. The dataset may appear to be incomplete because we choose not to use the data involving electrical conductivity measurements as they may introduce additional uncertainties. In this revision, we added two more Antarctic ice cores: WDC2020 that is recently available and EDC96 which was not included due to its approximate to Dome C. If there publicly available cores that are still missing in this analysis, please let us know.

We listed the six ITASE cores that have Tambora signals, if there are additional ITASE cores cover this period, we could love to know their names and how to obtain the data.

We take and expand the reviewer's suggestion by examine the routes to South Pole from West Antarctica using the six ITASE cores and from the East Antarctic using five NUS cores. As shown in Table S1, there is no significant and consistent spatial pattern along both routes. We also compare the multiple cores within both South Pole and the coastal DML sites (Table S2) and the results suggest that volcanic signals in the South Pole cores show general agreement, while those in the DML cores may differ by a factor of 4 depending on the volcanic events. Another interesting pattern suggested by both tables is that signal magnitudes for Tambora show better agreement across the cores, likely because they are less influenced by the background noise.

Although additional ice core observations, especially from regions not covered in Figure 1&2 (if available), will certainly help to assess whether increasing the area-coverage of cores would improve the conversion factor, the latter is not limited by increasing the number of cores. Generally speaking, information about the nature of several representative eruptions, or the nature of volcanic cloud transport and aerosol *deposition pattern in the ice caps are more critical. Discussion of this has been added in the revision.*

(2) The analysis of why different sites have different magnitudes of sulfate could be developed more. In Antarctica, the authors find an average for East and West Antarctica and then do a simple area weighting of 80/20. There is much more that could be done to understand the spatial pattern and thus provide a more robust picture. In particular, sites with higher accumulation appear to have higher total sulfate. The authors sort of plot this in Figure 3, but there is almost no discussion of it. The authors should see how much of the variance in the total sulfate can be explained by accumulation. In East Antarctica, the sites are largely concentrated on the high plateau yet the coastal locations have a much larger total sulfate. This could introduce a significant bias.

Response: *The spatial pattern of the volcanic deposition in both Greenland and Antarctic, including the relationship between the accumulation rates and precipitation, has been examined and discussed heavily in our previous study (i.e., Gao, C., Oman, L., Robock, A., and Stenchikov, G. L. Atmospheric volcanic loading derived from bipolar ice cores accounting for the spatial distribution of volcanic deposition, J. Geophys. Res.-Atmos., 112, D09109, doi:10.1029/2006JD007461, 2007). That's why we did not spend much space discussing the spatial deposition pattern in this original submission. However, given the new ice core records added in this work and the reviewer's previous suggestion on examining the two routes to South Pole, we've added more detailed discussion on the spatial pattern of volcanic depositions.*

(3) The authors also need to address the robustness of aerosol loading estimates for Tambora. They indicate a range of 60-80 Tg, but seem to base their estimates off of the 60Tg number. It seems like using the 70 Tg mid-value would be more justifiable. This then translates to the uncertainties.

Response: *We choose the 60 Tg value mainly because it is the value used in the model simulations and the conversion factors could be compared. The uncertainty in Tambora aerosol loading does introduce another layer of uncertainty, but the uncertainty is linear as the conversion factor could be linearly scaled up to the 70 or 80 Tg.*

(4) Defining the different sources of uncertainty in the conversion factor, such as due to individual core representativeness, atmospheric loading uncertainty, and atmospheric/hemispheric transport (i.e. spatial variation), and volcano location. Then addressing each of these in a systematic way.

Response: *We sincerely thank the reviewer's insightful suggestion. The discussion on uncertainty in the conversion factor has been constructed into different sources as suggested in the revision.*

(5) Providing an example of how the new estimates change the volcanic forcing. Are the current estimates of volcanic forcing accurate? Does this new work increase or decrease the range in previously published volcanic forcing (e.g. Toohey and Sigl, 2017).

Response: *The new LTD is used to convert sulfate deposition to sulfate aerosol loading, when comparing with sulfate mass and volcanic forcing from eVolv2k (Toohey and Sigl, 2017), we need to multiply the results with a factor of 0.75. Therefore, taking the 1991 Pinatubo eruption for example, the new estimated SO2 injection is about 18.7Tg, within the range of SO2 release evaluated by Guo et al (2004), and volcanic forcing (-5.58W/m2) is approximately 86% of the previously that (-6.49 W/m2) in eVolv2k.*
(Guo, S., Bluth, G. J. S., Rose, W. I., Watson, I. M., and Prata, A. J.: Re-evaluation of SO2 release of the 15 Jun 1991 Pinatubo eruption using ultraviolet and infrared satellite sensors, Geochem. Geophy. Geosy, 5(4), Q04001, doi.org/10.1029/2003GC000654， 2004.)

On the other hand, we would not consider the current estimates of volcanic forcing are accurate in general, and the new work implicates an increase in the range of previously published volcanic forcing, especially regarding IVI2 with contains no actual estimation of uncertainty range. The following comment has been added at the end of the conclusion:

"The results obtained from this study is a step forward to bring the conversion-induced uncertainty into the reconstruction framework, which hopefully also build a baseline for updating and improving the conversion of volcanic icecap-deposition to atmospheric-loading."