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Comment on cp-2021-100 (Thomas Aubry, Lauren Marshall and Anja Schmidt)

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Community comment on "Magnitude, frequency and climate forcing of global volcanism during the last glacial period as seen in Greenland and Antarctic ice cores (60–9☐ka)" by Jiamei Lin et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-100-CC3, 2021

This manuscript by Jiamei Lin and co-authors represents the first effort to constrain stratospheric volcanic SO2 emissions for the 60-9 ka period using a bipolar array of ice cores, and these emissions are then used to estimate the corresponding volcanic forcing. This will without doubt be a very useful contribution for the community working on volcano-climate interactions.

We would like to draw the attention of the authors to potential improvements for estimating volcanic forcing from emissions.

First, to estimate a global-mean Stratospheric Aerosol Optical Depth (SAOD), the authors use a linear scaling between SAOD and the aerosol loading. However, it is well known that for large eruptions this relationship is not linear (e.g. Crowley and Unterman, 2013). As highlighted by the authors, the scaling used in their work is calibrated against the 1991 Mt. Pinatubo eruption and the reference used does not employ the latest estimates of SO2 mass and SAOD for this eruption. For example, the post-Pinatubo peak global mean SAOD in Crowley and Unterman (2013) (ca. 0.14-0.15) is 16% larger than in the GloSSAC dataset (0.12-0.13, Kovilakam et al. 2020). We suggest that the authors consider either using the EVA model (Toohey et al., 2016) or the EVA_H model (Aubry et al., 2020) to obtain SAOD. EVA is calibrated using more up-to-date data for Pinatubo and is also a reference model for the community as it has been used to derive the volcanic forcing for CMIP6's Paleoclimate Model Intercomparison Project (PMIP4). EVA_H is an extension to EVA that was calibrated using the full 1979-2015 period with state-of-the-art observational datasets. Additionally, in EVA_H the predicted global mean SAOD depends on the eruption latitude, which is not the case in EVA.

Second, to convert global-mean SAOD to global-mean radiative forcing, the authors use the scaling factor of Hansen et al. (2005). This scaling factor was constrained using climate model simulations for the 1991 Mt. Pinatubo eruption without full consideration of rapid adjustments. Several recent studies have suggested that consideration of rapid adjustments leads to a reduction in the scaling factor (e.g., Gregory et al., 2016; Larson & Portmann, 2016; Schmidt et al., 2018; Marshall et al., 2020). Revised scaling factors for a wide range of eruptions are available in Marshall et al. (2020). Collectively, these studies suggest a reduced conversion factor compared to Hansen et al. (2005) and IPCC AR5.

We acknowledge that using more recent methods will result in differences in reconstructed forcings that are likely small relative to uncertainties in ice-core derived estimates of the SO2 mass. We nonetheless think that it remains important to acknowledge and use the latest tools developed by the community to provide volcanic forcing estimates. At the minimum, the authors should discuss differences that may emerge from using different scaling factors.

Thanks again for a very interesting manuscript.

Thomas Aubry, Lauren Marshall and Anja Schmidt.

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