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Direct linking of Greenland and Antarctic ice cores at the Toba eruption (74 ka BP)

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The Toba eruption that occurred some 74 ka ago in Sumatra, Indonesia, is among the largest volcanic events on Earth over the last 2 million years. Tephra from this eruption has been spread over vast areas in Asia where it constitutes a major reference horizon close to the Marine Isotope Stage 3/4 (MIS 3/4) boundary. Up to now, no tephra has been associated with Toba neither in Greenland nor in Antarctic ice cores, but based on Toba tephra identified in marine records from the Arabian Sea it is very likely that Greenland ice core acidity spikes related to Toba occur towards the end of Greenland Interstadial 20 (GI-20). Furthermore, the linking of Greenland and Antarctic ice cores by gas records suggests that the Antarctica counterpart should be situated between Antarctic Isotope Maxima (AIM) 19 and 20. In this work we suggest a direct synchronization of Greenland (NGRIP) and Antarctic (EDML) ice cores based on matching of a pattern of bi-polar volcanic spikes and annual layer counting in both cores around 74 ka BP. The synchronization pattern covers some 2000 years in GI-20 and AIM 19/20 and includes 5 major and several minor acidity peaks that are recognized in both ice cores. The most prominent acidity spikes in this time interval that occur towards the end of GI-20, are those thought to originate from Toba, but the proposed linking is independent of the source of the volcanic spikes. Although the linking of Greenland and Antarctic ice cores around Toba is already quite well constrained by matching of gas records, the relative phasing between ice cores from the two hemispheres still has some uncertainty related to the offset in the age of ice and air bubbles in the ice cores (delta-gas age). The identification of a direct Toba synchronization may help to determine the exact phasing of inter-hemispheric climate during this period and to constrain delta-gas ages. It also provides a way to place paleo-environmental records other than ice cores into a precise climatic context.