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Towards a bipolar layer-counted ice-core chronology for the 41-75 ka time interval

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Precise chronologies have been developed for Greenland and Antarctic ice cores based on counting of annual layers in high-resolution water isotope and impurity profiles. Antarctic ice cores are layer-counted back to 31 ka (WAIS Divide ice core) whereas Greenland ice cores are dated back to 60 ka (NGRIP ice core, GICC05 time scale). Beyond 60 ka, in Marine Isotope Stage 4 (MIS4), annual layers in Greenland are thin (less than 1 cm in NGRIP in the coldest periods) and annual layer counting is more uncertain. In the Antarctic EDML ice core annual layers are somewhat thicker over most of MIS4 although they are still marginal for counting. Greenland and Antarctic ice cores are tightly linked at the Laschamp geomagnetic excursion (41 ka) and at the Toba YTT eruption (74 ka) providing end constrains for the investigated time interval.
In this work, annual layer counting has been performed in parallel in the NGRIP and EDML ice cores for the time interval 41-75 ka using high-resolution records of visual stratigraphy, dust concentrations, and continuous chemistry. For NGRIP the GICC05 time scale is adapted for the period 41-60 ka. The NGRIP and EDML ice cores are then synchronized by identifying series of bipolar volcanic eruptions in acidity records of electrolytic conductivity, sulfur concentrations, and electric measurements of the solid ice (ECM and DEP). The synchronization is constrained by the layer counting that provides interval durations between volcanic markers. In some periods, a pattern of several bipolar volcanic events provides robust synchronization, but there are longer intervals for which there are no synchronization due to the lack of unambiguous bipolar markers. Over periods of robust synchronization the North-South phasing of climate (water isotopes) and dust concentrations can be investigated at decadal precision. During MIS4 the resulting time scale shows a North-South phasing somewhat different from that of the modelled AICC2012 time scale.