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Development and comparison of layer-counted chronologies from the WAIS Divide and EDML ice cores, Antarctica, over the last glacial transition (10-15 ka BP)

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Some ice cores can be very precisely dated far back in time by counting the annual layering in various impurity records, and the most robust chronologies rely on the parallel analysis of annual features expressed in multiple data sets. Layer-counted Antarctic ice-core chronologies are now emerging: Multi-parameter layer counting has been carried out for the Holocene and late glacial section of the EDML ice core, Dronning Maud Land (Vinther et al., in prep.), and a layer-counted timescale for the WAIS Divide core, West Antarctica, reaching back to 30 kyr BP, was recently completed (WDC06A-7; WAIS Divide Members, 2013). Beyond 24 kyr b2k, the main part of this timescale relies solely on electrical measurements on the core.

We here use a novel statistical framework for automated annual layer counting (Winstrup et al., 2012) to extend and improve the two chronologies from EDML and WAIS Divide. Using this method, we have 1) revised the multi-parameter layer counts for the EDML ice core back to 15 kyr BP, and 2) employed high-resolution chemistry measurements from WAIS Divide to obtain a layer-counted multi-parameter timescale for WAIS Divide over the same period (10-15 ka b2k). The EDML and WAIS Divide ice cores have been tightly synchronized using volcanic marker horizons, thus allowing a detailed comparison of annual layer counts between tie points using the various approaches. The corresponding timescales are compared also to the EDML timescale from the flow-model based AICC2012 chronology (Veres, 2012).

For the Holocene section of the period (10-11.7 ka BP), all timescales show very good agreement. The peculiar accumulation anomaly observed in the WAIS Divide layer thicknesses in the beginning of the Holocene is confirmed by the multi-parameter layer counts from both WAIS Divide and EDML. The transition into the Holocene has generally proven a difficult period to date by annual layer counting, since the appearance of an annual layer in the various records can change. This is reflected in discrepancies between the currently available timescales: Using the new volcanic synchronization between EDML and WAIS Divide, we find that the AICC2012 is diverging very significantly from the WDC06A-7 timescale over this period ($\sim$100 yr between 12-13 kyr b2k). Similarly, methane matching shows significant discrepancies between WDC06A-7 and the Greenland Ice Core Chronology 2005 (GICC05), which cannot be reconciled within the specified uncertainty of the respective annual layer counts (WAIS Divide Members, 2013). The two new timescales developed here provide another piece of information to this puzzle.