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Preface

The EPICA (EDC and EDML) ice cores age scales

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Ice cores from Antarctica and Greenland provide unique archives for a detailed record of past climate and atmospheric composition. The European Project for Ice Coring in Antarctica (EPICA) has provided two records in East Antarctica, one at Dome C (EDC, EPICA community members, 2004), and one in the Dronning Maud Land area (EDML, EPICA community members, 2006). EDC provides the longest (in time) ice core available so far, with 800 kyr records of Antarctic temperature (Jouzel et al., 2007), 740 kyr of chemical impurities in Antarctica (Wolff et al., 2006), and 650 kyr records of atmospheric composition (Siegenthaler et al., 2005; Spahni et al., 2005). All these records are currently being extended to 800 kyr.

An accurate chronology is the basis for the interpretation of these climate records and their comparison to other climate records. This is why ice core time scales have always been an area of great interest. There exist numerous methods to date ice cores, that can be grouped in 4 categories: (1) layer counting, (2) use of age markers and correlation with other dated time series, (3) comparison with insolation changes (i.e., orbital tuning), and (4) modeling of snow accumulation, firn densification and ice flow. All these methods have advantages and drawbacks. Layer counting is not feasible when the annual layer thickness is too small to resolve visually. This unfortunately is the case in central Antarctica. The number of accurately dated markers or time series is limited, especially for old periods. Orbital tuning relies on the assumption that the studied record responds linearly to insolation variations. On the other hand, glaciological modeling can be very powerful because it provides a chronology derived from the estimate of the annual layer thickness, and thus leads in general to more realistic event durations. However, these models often contain poorly known parameters, such as the glaciological conditions at the base of the ice sheet, or glacial-interglacial contrast of accumulation rate, which need to be tuned appropriately.

With the completion of the EDC and EDML drillings, the EPICA community wanted to build a common chronology for the interpretation of the paleoclimatic and paleoenvironmental records contained in these ice cores. Constructing an optimal age scale requires bringing together the different dating information described above. For this reason the EPICA community decided to describe in this special issue of *Climate of the Past* the different studies related to dating of the EPICA ice cores, including the actual construction of the EDC3 and EDML1 chronologies.

The ice flow modeling at Dome C is described in Parrenin et al. (this special issue, a), with an interesting discussion on the limit of the current models in Durand et al. (this special issue). Huybrechts et al. (this special issue) modeled the ice flow around and upstream of the EDML station, and inferred the spatial origin of the ice drilled at this site. Loulergue et al. (this special issue) evaluated the gas age at EDC and EDML with the use of a firn densification model, which is tested with independent constraints. Raisbeck et al. (this special issue) measured the beryllium-10 peak at 41 kyr in the EDC ice core. This peak has been used to tie EDC3 and EDML1 onto the layer counted GICC05 chronology of the NorthGRIP core (Vinther et al., 2006; Rasmussen et al., 2006; Andersen et al., 2006; Svensson et al., 2006), and to test the firn densification model used in Loulergue et al. (this special issue). Dreyfus et al. (this special issue) derived an orbital tuning time scale for the bottom part (beyond 350 kyr) of the EDC core with the oxygen 18 of gas bubbles. They show that flow disturbances are present in this basal layer, and that consequently the ice flow model becomes inaccurate. The synchronisation of the EDC and EDML ice cores is done in the ice by the use of common volcanic identification in Severi et al. (this special issue). Another match of

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EDML to the NGRIP ice core via their methane records is presented in Blunier et al. (this special issue). Finally, the actual construction of the time scales is described in Parrenin et al. (this special issue, b) for EDC3 and Ruth et al. (this special issue) for EDML1.

Now that this work has been achieved, the EPICA community is already looking forward to what the next age scale should consist of. Obviously, all independent dating information should be improved in the future, e.g. ice flow modeling, age markers and synchronization links. In particular, the developments related to local insolation proxies (Raynaud et al., 2007; Kawamura et al., 2007) may significantly improve the dating beyond 100 kyr. The statistical method used to put together the different dating information should also be improved, with an automatic construction of the age scale and a rigorous estimation of its uncertainty. Finally, this effort could be extended to other ice cores from Greenland and Antarctica, as well as to marine records, bringing a common and optimized chronology for the paleoclimate community.

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