



Age, thinning and spatial origin of the Beyond EPICA ice from a 2.5D ice flow model

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Abstract. The Beyond EPICA Oldest Ice project is a European project that aims to retrieve a continuous ice core up to 1.5 Ma through deep drilling at Little Dome C (LDC), Antarctica. In order to determine the age of the ice at a given depth before the ice is analysed in detail, 1D numerical models are often employed. However, they do not take into account any effects due to horizontal ice flow. We present a 2.5D inverse model that determines the age–depth profile along a flow line from Dome C (DC) to LDC, which is assumed to be stable in time. This means that flow line features such as flow direction and dome location have not changed over the time period considered. The model is constrained by dated radar internal reflecting horizons. Surface velocity measurements are used to determine the flow line and flow tube width, which also allows the model to consider lateral divergence. This new inverse model therefore improves on the methods used by 1D models previously applied to the DC area. This 2.5D model uses a previously developed numerical scheme with the novelty being the inverse methods used to optimise multiple parameters by comparison to radar constraints. By inferring a mechanical ice thickness, the model predicts either the thickness of a basal layer of stagnant ice or a basal melt rate.

Results show that the deepest ice at Beyond EPICA Little Dome C (BELDC) originates from around 15 km upstream.

The threshold for ice useful for paleoclimatic reconstruction is 20 kyr m^{-1} (20 000 annual layers per metre in the ice column). The oldest ice that meets this age resolution requirement is 1.12 Ma at BELDC according to the model. Over the LDC area, the thickness of a modelled basal layer is 200–250 m at the base of the ice sheet. Looking at modelled ice particle trajectories, interpretations indicate that this layer could be composed of stagnant ice, disturbed ice or even accreted ice (possibly containing debris). We explore the possibilities, though this is an open question that may only be answered by analysis of the Beyond EPICA ice core itself. Finally, we look at other ice cores that have already been drilled and measured, where the model has been applied. We discuss in detail the thinning in the deepest section of these ice cores, which is less than predicted by the model. This could mean that modelled ages are significantly overestimated in the deepest part of the ice column. Given that the age estimate from the 2.5D model is younger than previous estimates, this work shows the importance of considering the representation of the effects of horizontal flow when modelling the age profile.