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Stochastic modelling of basal temperatures in divide regions of the Antarctic ice sheet over the last 1.5 million years

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The quest for oldest ice in Antarctica has recently been launched through an EU H2020 project (Beyond EPICA - Oldest Ice) and aims at identifying suitable areas for a potential future drilling. Retrieving an ice core of such age is essential to understand the relation between orbital changes and atmospheric composition during the mid-Pliocene transition. However, sites for a potential undisturbed record of 1.5 million-year old ice in Antarctica are difficult to find and require slow-moving ice (preferably an ice divide) and basal conditions that are not disturbed by large topographic variations. Furthermore, ice should be sufficiently thick but cold basal conditions should still prevail, since basal melting would destroy the bottom layers. Therefore, ice-flow conditions and thermodynamic characteristics are crucial for identifying potential locations of undisturbed ice. Van Liefferinge and Pattyn (2013) identified suitable areas based on a pan-Antarctic simplified thermodynamic ice sheet model and demonstrated that uncertainty in geothermal conditions remain a major unknown. In order to refine these estimates, and provide uncertainties, we employ a full thermo-mechanically coupled higher-order ice sheet model (Pattyn, 2003; Pattyn et al., 2004). Initial conditions for the calculations are based on an inversion of basal slipperiness, based on observed surface topography (Pollard and DeConto, 2012; Pattyn, in prep.). Uncertainties in geothermal conditions are introduced using the convolution of two Gaussian probability density functions: (a) the reconstruction of the Antarctic ice sheet geometry and testing ice thickness variability over the last 2 million years (Pollard and DeConto, 2009) and (b) the surface temperature reconstruction over the same period (Snyder et al., 2016). The standard deviation, the skewness and the kurtosis of the whole Antarctic ice sheet are analyzed to observe likely probable melt conditions. Finally, we focus on model results in the divide area between Dome Concordia and Dome Fuji, and compare to newly acquired radar data in the region (OIA survey).