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Old ice investigation along the Dome C ridge using a 2.5D thermomecanical ice flow model

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One of the main present-day challenges in ice core sciences, as fixed by the IPICS (International Partnerships in Ice Core Sciences), consists in finding a continuous ice archive as old as 1.5 million year. This would allow to study the MPT, a transition which occurred ∼900,000 yr ago from low amplitude 40,000 yr cycles to high amplitude 100,000 yr cycles. The previous oldest ice core was drilled at Dome C, on the East Antarctic plateau (800,000 years), and some observations seem to indicate that even older ice could be retrieved in the vicinity of the dome.

Fourty kilometers from the dome lies a bedrock relief that makes the ice thinner (∼2700 m), so that the bottom ice could be prevented from encountering basal melting. We show that due to a ridge configuration leading to low horizontal velocities, the ice at this possible drilling site mainly comes from ∼15 km upstream only, so that some assumptions of the model (no basal sliding and uniform geothermal flux) have less impact on the computed results.

The presented model consist in a 2D steady-state ice flow along the ridge to Vostok, that accounts for the widening of the flow tube (2.5D model), anisotropy of the ice, thermal advection and diffusion. The poorly-known parameters of the ice rheology are inversed to minimize the gap between the computed isochrones and observed internal layers. We discuss the possibility that very old ice could lie above the bedrock, depending on the geothermal flux value and the rheological parameters. Our results corroborate those of a recent simple 1D thermo-kinetic ice flow model which inverses the internal layers along a flow line as well and shows that there could be some 1 million year-old ice at ∼40 km south-west of the dome.