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Climate of the Past Discussions

Interactive comment on "Ice thinning, upstream advection, and non-climatic biases for the upper 89% of the EDML ice core from a nested model of the Antarctic ice sheet" *by* P. Huybrechts et al.

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This paper presents the result of a modelling exercise which seeks to explain the age-depth curve at EPICA. This has previously been dated independently (apparently) by Ruth et al, although the methodology is not well described in the paper here.

The age-depth model is computed using the Huybrechts multiple interglacial cycle, forced by some realistic climate parameters, and the Pattyn model around the core site.Some attention has been paid to matching the flows at the boundaries Ages are computed by integrating along trajectories.

This paper is valuable confirmation that the EDML1 time-scale is consistent with glacial

theory and should be published. The glaciological discussion is a bit skimpy, and needs strengthening in order to make this paper satisfying to both climate scientists and glaciologists. My comments appear below.

Apologies that some of my comments refer to fairly recent work by me and colleagues on how topographic disturbances affect particle paths. I think that this work is of relevance; if the discussion group can find earlier references to the same effects, please tell me and the authors.

1 MAJOR POINTS

1. The EDML1 chronology is not well described. They need a paragraph such as the following one I lifted from the EDML1 paper "A chronology called EDML1 has been developed for the EPICA ice core from Dronning Maud Land (EDML). EDML1 is closely interlinked with EDC3, the new chronology for the EPICA ice core from Dome-C (EDC) through a stratigraphic match between EDML 5 and EDC that consists of 322 volcanic match points over the last 128 ka. The EDC3 chronology comprises a glaciological model at EDC, which is constrained and later selectively tuned using primary dating information from EDC as well as from EDML, the latter being transferred using the tight stratigraphic link between the two cores. Finally, EDML1 was built by exporting EDC3 to EDML." - though what exporting means in this context I don't know. The point is that there is apparently already some model input to EDC3.

2. It is not clear what increase in accuracy the Pattyn model is expected to provide. It will of course compute the velocity field better in response to topographic disturbances (see e.g. Hindmarsh et al. 2006), but given that particles are advected in, and experiencing such disturbances all along their travel path, then what increase in accuracy is expected from use of the Pattyn model just locally?

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3. Topography with wavelength roughly the same as the ice thickness and much greater than the ice thickness affects particle trajectories in different ways; this can only be seen by using higher order models (Hindmarsh and others, 2006). Presumably the resolution of the model isn't high enough to capture all this topography, and anyway the details are not being properly computed in the FSM region. Does this matter? Given that topographic errors from BEDMAP underresolution are sometimes positive, sometimes negative, is the net effect computed better, than local variations which might be quite poorly represented?

4. Recent studies (Parrenin and others, 2006) show that topographic influences can effect isochrones downstream for long distances. By inference, the errors from poorly represented topography can result in errors a long way downstream. Did the authors consider any sensitivity experiments with repect to poorly known bedrock topography?

5. The mismatch between EDML1 and the paper is attributed to anomalously high thinning due to bedrock sills. This seems to be arguing that certain elevations are influenced more strongly by bedrock highs than others - a possibility, but how this operates needs to be more explicitly outlined. What are the physical mechanisms for the anomalous thinning - is it computed by the Pattyn model (and therefore presumably due to mechanical effects) or by the Huybrechts model (and therefore presumably due to thermomechanical effects).

6. The matching of boundary conditions between the nested models is not well described (699:23-700:23). The discussion is framed in terms of anomalies (which are not defined, and I only vaguely know what they are) and I didn't really know what they are doing. Slightly worrying was the discussion of mass conservation; if the FSM and LSM models are not conserving mass evenly over the column, then the computation of particle trajectories, which assumes conservation, is going to "concentrate" of "dilute" particle densities. Does this affect the overall result

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or just the accuracy of the result?

2 MINOR POINTS

1. Equation (7) should be referenced.

3 REFERENCES

Hindmarsh, R.C.A., G.J-M.C. Leysinger Vieli, M.J. Raymond and G.H. Gudmundsson, (2006), "Draping or Overriding: The Effect of Horizontal Stress Gradients on Internal Layer Architecture in Ice-Sheets" J. Geophys. Res., 111, F02018, doi:10.1029/2005JF000309.

Parrenin, F., R.C.A. Hindmarsh and F. R'emy (2006), "Analytical solutions for the effect of topography, accumulation rate variations and flow divergence on isochrone layer geometry" J. Glaciol. 52(177), 191-202

Interactive comment on Clim. Past Discuss., 3, 693, 2007.