

Interactive comment on “Is there 1.5 million-year old ice near Dome C, Antarctica?” by
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We would like first to thank the reviewer for his careful work and for his constructive comments!

This is an interesting study on the hot topic of detecting a suitable site for an "Oldest Ice" core in Antarctica. The 1-D model applied by the authors is rather simple, but it is spiced up significantly by assimilating dated isochrones from airborne radar surveys into the model. The findings are certainly not the final word on the matter (nor do the authors claim that they are), but the paper constitutes a decent step forward along the road.

Thank you for your generally positive comment.

I only have a few, rather minor comments the authors should consider:
Line 67: "can be written:" -> "can be written as"

Corrected.

Equation (1): This equation is only correct if horizontal flow is neglected. This should be mentioned already here.

With all respect, we disagree here. This equation is also valid with horizontal flow. It just say that the age is the integral from the surface of the number of layers per meter. It has been used many times in previous studies (Ritz, 1992, Parrenin et al., 2001, 2004, just to name a few). In this case, the accumulation is the one at the place and time of snow deposition and the vertical thinning function contains a term related to layer rotation.

Equation (1): Add a comma after the equation.

Corrected.

Line 74: Add a reference for the equation $\mu = m/a$.

This is a new definition and there is no reference for it (to our knowledge).

Lines 77/78, "Oldest Ice sites have better chance to exist where ice is not overly thick": I think the work by Seddik et al. (Cryosphere 5, 495-508, 2011, doi: 10.5194/tc-5-495-2011) should be mentioned here. These authors applied a full-Stokes 3-D model (Elmer/Ice) to a 200 × 200 km windows around Dome Fuji and found exactly that.

Thank you for the relevant reference that we added:

Consequently, “Oldest Ice” sites have better chance to exist where ice is not overly thick as to lead to basal melting (Seddik et al., 2011), yet thick enough to contain a continuous ancient accumulation.

Equation (6): If I am not misled, the symbol T has not been defined.

Indeed. This is now corrected:

We solve the heat equation (neglecting the heat production by deformation since there is minimal horizontal shear):

$$\frac{d}{dz} \left(k_T \frac{dT}{dz} \right) - c \rho_i D u_z \frac{dT}{dz} = 0, \quad (1)$$

where T is the temperature, $\rho_i = 917 \text{ kg m}^{-3}$ is the ice density (Cuffey and Paterson, 2010), k_T ($\text{W m}^{-1} \text{K}^{-1}$), the thermal conductivity (Cuffey and Paterson, 2010), is given by:

Line 129: "by (Ritz, 1992)" -> "by Ritz (1992)"

Corrected.

Equation (12): The constant in the equation should be 273.16 K rather than 273.116 K.

Actually it should be 273.136 (see below).

The Clausius-Clapeyron constant $7.4 \times 10^{-8} \text{ K Pa}^{-1}$ is the value for pure ice. Using the value $9.8 \times 10^{-8} \text{ K Pa}^{-1}$ for air-saturated glacier ice would have been preferable (Hooke, "Principles of Glacier Mechanics", CUP, 2nd ed., 2005).

We use the formula of Ritz et al. (1992) since it gives the best agreement with the EDC temperature profile (see Passalacqua et al., The Cryosphere Discussion, 2017 for more details):

and T_f , the fusion temperature is given by Ritz (1992):

$$T_f = 273.16 - 7.4 \cdot 10^{-8} P - 2.4 \cdot 10^{-8} P', \quad (2)$$

where $P' = 10^6 \text{ Pa}$ is the partial pressure of air and P , the pressure, is approximated by the hydrostatic pressure:

$$P = \rho_i g \int_z^H D(z') dz', \quad (3)$$

where $g = 9.81 \text{ m s}^{-2}$ is the gravitational acceleration. We used this formula since it gives the best agreement to the measured temperature profile at EDC (Passalacqua et al., 2017).

Line 130: What exactly is the meaning of ρ ? The equation for P is only correct if it denotes the depth-averaged density, $\rho = \bar{D} \rho_i$. Please clarify.

We made this equation clearer:

where P , the pressure, is approximated by the hydrostatic pressure:

$$P = \rho_i g \int_z^H D(z') dz', \quad (4)$$

where $g = 9.81 \text{ m s}^{-2}$ is the gravitational acceleration.

Line 132: "latent heat fusion" -> "latent heat of fusion"

Corrected.

Section 3 (Results and discussions): What I am missing here is a critical discussion of the results against those by Van Liefferinge and Pattyn (2013) [VLP13]. According to Figs. 1 and 3a,b, the authors' LDC area agrees more or less with the candidate "A" by VLP13. However, NP is not close to any of the VLP13 candidates, and the VLP13 candidates "B"- "E" do not look promising in the current study. What are the likely reasons for these discrepancies?

We added the following paragraph in our discussion:

Our LDCP area is generally consistent with Candidate A of Van Liefferinge and Pattyn (Van Liefferinge and Pattyn, 2013) although our area is smaller and constrained to the subglacial highlands under LDC. Van Liefferinge and Pattyn (2013) did not find a candidate at NP. However, the geothermal heat flux maps they relied on have a lower spatial resolution than the details we examine here. Our model does not predict very old ages for Candidates B-C-D-E of Van Liefferinge and Pattyn (2013), although the 1D assumption is problematic in those areas since ice particles experienced very different ice thickness conditions along their path.

Reference Cavitte et al. (in preparation): I think papers in preparation should not appear in the list of references. They can be mentioned in the main text, though (Cavitte et al., paper in preparation).

This reference is now in *The Cryosphere Discussions*.

References Fischer et al. (2013), Fretwell et al. (2012), Parrenin and Paillard (2012), Young et al. (2016): If available, the respective main papers should be cited rather than the discussion papers.

Corrected.

Reference Lliboutry (1979): "Glacialgeol." -> "Glazialgeol." (German journal title)

Corrected.

References Martin and Gudmundsson (2012), Tison et al. (2015): "The Cryosphere" -> "Cryosphere" (ISO-4 abbreviated title)

Corrected.

Reference Purucker (2013): The URL does not appear properly.

Corrected.

Figure 1, title: "radar-lines" -> "Radar lines"

Title has been removed.

Figure 2: What is the meaning of the white areas that appear in some places above the bed? Supposedly an age beyond the range of the colour bar? This should either be mentioned in the caption or indicated by a white triangle (or the like) on the top of the colour bar.

We now mentioned it in the caption:

*Modeled age (in colour scale, **white is for ages older than 1.5 Myr**) along the OIA/JKB2n/X45 radar transect (see red dotted line in Figure 1 for location), together with observed isochrones (in white).*

Figure 2, caption: "red dotted lien" -> "red dotted line"

Corrected.

Figures 3 and 4: The vivid-coloured dots do not make such a good contrast on the pastel-coloured background. Please consider making the dots bigger for better visibility.

For better visibility, we now use a grey scale for the bedrock and we made the dots bigger:

