Review Comments

Title:	Accumulation patterns around Dome C, East Antarctica, over the last glacial cycle
Journal:	The Cryosphere
Date:	01/03/2018

General Comments:

This resubmission represents a significant improvement over the original work. The manuscript has been refocused, moving away from discussion of divide dynamics toward a more straightforward inference of accumulation rates and spatial patterns over the last 73 ka. This set of analyses is more appropriate for the model used, and the language in the manuscript provides the necessary caveats to prevent readers from over-interpreting the authors' results. These improvements are reflected in the detailed response to reviewers provided, which shows significant effort made by the authors to improve the manuscript.

My remaining issues focus on the clarity of writing, the methods description, and the statistical discussion of curvature versus paleoaccumulation. Now that the paper is refocused on the small-scale accumulation trends, the authors need to more convincingly (ie, statistically) show that paleoaccumulation and surface curvature are related if that is to be one of the major claims of the work. There are a few necessary changes before publication, but most comments below highlight opportunities to improve clarity that would simply increase the impact of the work.

Specific Comments:

The methods description is at times unclear, and seems to overcomplicate what is a fairly simple method. Most of my confusion is the result of equations (2), (3), and (4):

1) The basic premise of the paper is that an ice flow model can be used to compute the strain thinning rate: the single unknown required to convert observed, dated layer thicknesses to accumulation rates. According to my read, this makes equations (2) and (4) totally unnecessary. You use the model to infer tau, plug tau into equation (3), and compute a. All the equation manipulation is superfluous – a_o, x_o, and tau are all self-consistent model defined values, just plug in tau, don't substitute a_o and x_o into (3) for tau when a_o and x_o are ultimately a product of tau. It makes the whole computation seem much more complicated to the reader than it is.

2) Using the framework currently provided, it is not clear that equations (2) and (3) can be meaningfully equated. The point the authors make here is that there is residual error between the modeled isochron positions and the observed isochron positions. For a constant time period (defined in $\Delta\chi$) compared across model and observations, the depth to the layers in the model and observations will be different, making the bounds of integration in (2) and (3) different, changing the value for $\int \tau^{-1} dz$, and preventing the equality presented in (4). Alternatively, for a depth range held constant, you would be comparing different mean ages between model and data, introducing another complication to your interpretations.

Additional confusion then came from lines 158-161, where you say you have not yet incorporated any temporal variation into your calculation. But, equation three calculates the spatial pattern of accumulation rate for discrete layer packages in time, giving you four separate time steps of computed accumulation

rates. What new information does R(t) provide, beyond the accumulation rates that you've derived from the data? This needs to be made much clearer for the reader.

My final comment lies with figure 6 and the argument made about spatial correlations in accumulation rate and surface curvature. I still struggle to get the critical information out of figure 6 – the high accumulation rate in the band across the center of the image does appear (somewhat) well correlated, but elsewhere there appears to be significant disagreement between the surface curvature and the accumulation rates, especially in radar lines not contained in the central grid. To argue that these are correlated, the authors need to show (either as a figure that directly relates detrended accumulation rate to surface curvature, or through some statistical metric) the strength of the correlation. It is apparent from your text that the correlation is not as strong statistically as it might be visually (they say in lines 389 and 390 that there is no good functional fit between CPWD and paleoaccumulation), but it is important for the sake of accuracy that this be emphasized to the reader. That paleoaccumulation and surface curvature may appear related in some locations, but also appear unrelated in others, and that is apparent in the authors inability to define a functional relationship between the two parameters. Right now, the conclusions feel a bit overstated.

With those issues addressed, my only remaining technical corrections are focused on the writing, which are not crucial changes before publication. I do think that there are opportunities to improve readability, but those changes are at the discretion of the authors.

Technical Corrections:

Line #	**Comment**
70-72	The specifics of the 1D assumption (and how you know when and where it is violated) need to be discussed before you make this statement. A reader who isn't already familiar with your methods would have little idea what this means.
75-87	This paragraph isn't methods. It should come in the introduction.
100	"… add a number of shallower and deeper isochrones …" seems strange to list both "shallower" and "deeper". You just added isochrones.
101	You should remove the in prep citation. You are not relying on conclusions from another study in this sentence, and citing papers that have not gone through peer review should only be done in extraordinary circumstances.
106-133	I think much of what is said here is not necessary for the paper, and actually makes everything much more confusing. From a reader perspective, it would be much simpler for you to define tau and how it comes from the model (and also its units or how to interpret its values, you quote it as a value of 0.9 later and it took me a while to figure out what that meant), and go from there.

114 This definition leads to significant confusion for me later, because you calculate the spatial pattern for several different time periods (despite saying here that you have a temporally invariant spatial pattern). I think you are better off saying "for each time interval between dated isochrons, we assume a fixed spatial pattern for accumulation rate (a_bar[x]), that can vary in time at frequencies higher than those captured by the radar data (R[t])."

I'm not sure you need this definition at all, it seems like the primary conclusion of the paper is that you computed an accumulation rate field through time a(t,x), using discrete t values chosen based on pickable isochrones. But regardless of how you decide to phrase this, know that it takes a lot of mental energy right now to keep track of exactly what your terms mean, and when things are spatially invariant and when they are temporally invariant.

154 Define how and why you chose the 5km threshold here. This should come after the explanation that shows up at 162-168, where you explain where 1D models work and where they don't.

187+191 In this paragraph you simultaneously say that the ECMWF ERA40 reproduces and doesn't reproduce the accumulation. You need to be more precise in your wording here, it makes for a confusing paragraph.

208 Might help to change the section heading for 2.5 to clearly indicate you are looking at spatial trends.

221-226 This is all methods, not results.

262-270 I find this paragraph and methods description very confusing. You have a proxy for average Holocene accumulation already, it is your $\Delta\chi = 0 - 10{,}000$a. What are you doing here that is better than the radar derived product?

301 Given that tau is a term unique to the model, you need to define earlier what a value of 0.9 would mean. That, after strain thinning, the layer is at 90% of its original thickness. Otherwise, the reader has little idea how to interpret this sentence. You also probably shouldn't use the word "pollute", it feels imprecise.

380 Get rid of one of the drifts. "… and mass drift drift transport."

390 This is the point where you must convince the reader that the surface topography and accumulation are well correlated. You should plot one against the other, to show the reader the strength of the correlation. The map presented in figure 6 can be used to help motivate why some regions might be more well correlated than others, but to prove a baseline correlation you should just plot those two variables together.