We want to thank Johannes Freitag for his kind evaluation of our work, and for his constructive comments. Below we reproduce his comments in red, with our responses in black.

By reading the paper one gets the impression that dating of the deep part of WAIS-D is solved and quite robust even for the estimates of temperature and accumulation rate. Most convincing is in this context Figure 1 where the overlap between the estimates of two different methods for the accumulation rate, d15N and Dage is plotted. However, one parameter in the whole dating procedure is not shown: the thinning on which their approach based on (and the comparing model outputs of the Parrenin Ddepth method as well).

The thinning function we use is based on a simple 1-D ice flow model. We have now added a plot of the thinning function in Fig 1, and added the following detailed description to the text:

"The 1-D ice flow model calculates the vertical ice motion, taking into account the surface snow accumulation, the variation of density with depth, and a prescribed history of ice thickness. Vertical motion is calculated by integrating a depth-profile of strain rate and adding a rate of basal melt. As in the model of Dansgaard and Johnsen (1969), the strain rate maintains a uniform value between the surface and a depth equal to 80% of the ice thickness, and then varies linearly to some value at the base of the ice. This basal value is defined by the "basal stretching parameter" f_b, the ratio of strain rate at the base to strain rate in the upper 80% of the ice column. The basal ice is melting, so part of the ice motion likely occurs as sliding. The along-flow gradient in such sliding is unknown and thus so too is the parameter f_b. We overcome this problem by making both the current ice thickness and the basal melt rate free parameters when optimizing models with respect to measured borehole temperatures. Because the basal melt rate and the f_b parameter affect the vertical velocities in similar fashion, the optimization constrains a combination of melt rate and f_b that is tightly constrained by the measured temperatures. Thus we find that varying f_b through a large range, from 0.1 to 1.5, changes the reconstructed temperature at LGM by less than 0.2^{o}C. (Temperatures prior to the LGM are determined relative to those at LGM by isotopic variations, so this number applies further back in time as well.) Effects of the prescribed ice-thickness history are likewise minor; assuming a 150 m thickness increase from LGM to 15 ka changes the reconstructed temperature at LGM by less than 0.2^{o}C compared to a constant thickness. Note that the 1-D flow model used here is simpler than the one used by Cuffey and Clow (1997) in that it does not attempt to calculate changes in the shape of the strain rate profile; the uknown basal sliding motion at the WD site negates the usefulness of such an exercise.

One output of the 1-D flow model is the strain history of ice layers as a function of depth and time. The cumulative strain is represented by the thinning function $f_\lambda(z)$ \citep{Cuffey2010}, the ratio of annual layer thickness at depth in the ice sheet to its original ice-equivalent thickness at the surface when deposited. The modeled thinning function is shown in Fig. 1e (solid line). In the deep part of the ice sheet $f_\lambda(z)$ becomes increasingly uncertain as the unknown basal melt rate and f_b become the dominant controls. Here we optimize the model by comparing accumulation rates derived from $f_\lambda(z)$ with those implied by a firn densification model and the measured $\delta^{15}N$ of N_2. While this has little effect on the temperature history reconstruction, it provides an important constraint on calculated basal melt rate, an interesting quantity for ice dynamics studies. Our analysis of basal melt rates and further details of the temperature optimization process and 1-D flow modeling will be provided elsewhere (Cuffey et al., in preparation)."

The amount of added details justified a restructuring of the manuscript; we now discuss the ice flow model and temperature reconstruction in their own subsection to improve the overall flow of the manuscript.

In the supplement of the cited publication of WAIS-Divide Project Members (Nature, 2013) I found some data to infer the thinning function at least for half of the time interval in the overlap period (14-23ka BP). Attached to that review you will find a graph displaying the thinning function versus normalized depth (depth divided by total core length). The thinning factor during the glacial period is surprisingly very high in comparison to the earlier Holocene (almost 0.2 difference!, purple curve) or in comparison to the ideal case of constant thinning rate (blue dotted line) or even in comparison to the EDC thinning (red curve) of the same depth. I am not an expert but it seems that it is important to discuss why the thinning (higher thinning factor) of older/deeper ice is much less than younger/shallower ice. I would rather expect the opposite trend that the thinning is higher (lower thinning factor) in deeper ice and especially in glacial ice than in Holocene ice due to the proposed softness of impurity loaded ice.

The thinning function reconstructed by the reviewer is very different from the one we use (revised manuscript Fig. 1e). The reviewer (Johannes Freitag) was kind enough to identify himself, and so we contacted him to find the source of this discrepancy. He discovered an error in his calculations that led to the unusual structure he found in the thinning function. After correcting the error, the thinning function he reconstructs no longer contains the spurious structure.

This issue is therefore based on a misunderstanding, which has now been resolved. The editor (Hubertus Fischer) was cc-ed on our email exchange with the reviewer, and is aware of this resolution.

On the other hand the results of the sensitivity study of the authors about the impurity effect on densification respectively accumulation rate (Figure 4, blue curve) show that in the Glacial period the accumulation rate would be enhanced by a factor of roughly 1.7 to fulfill the

constrains for d15N and temperature. If we assume that there is a impurity effect during the Glacial at WAIS-D (what is negated by the authors so far) the thinning function would be changed to a much more continuously decreasing function (in the attached figure shown as green line) with depth what in my opinion is much more expected and similar to derived thinning functions of other deep ice cores and even to the ideal case. By including the impurity effect in the densification model one would change the glacial accumulation rate by the factor of about 1.7 (if one rely on the temperature reconstruction) and would only slightly change dage by about 200 years (see Figure 4,upper and lower panel). These changes would have not much influence on the chronology at all. I am sure that the authors could give more arguments for the flow model that they use for calculating the thinning function.
As mentioned above, we now provide a more detailed description of how the thinning function was calculated using a 1-D flow model.

I would suggest that they could add a short discussion about the reliability of the flow model for that deep part of the ice sheet.
The thinning function in the deeper part of the ice sheet obviously has a larger uncertainty. We have calibrated the ice flow model by optimizing the fit between the accumulation rates implied by the δ^{15}N/densification model, and those implied by the age constraints.
We have added the following text to the manuscript:

"In the deep part of the ice sheet $f_\lambda(z)$ becomes increasingly uncertain as the unknown basal melt rate and f_b become the dominant controls. Here we optimize the model by comparing accumulation rates derived from $f_\lambda(z)$ with those implied by a firn densification model and the measured δ^{15}N of N_2. While this has little effect on the temperature history reconstruction, it provides an important constraint on calculated basal melt rate, an interesting quantity for ice dynamics studies."

Or do we see here the impurity effect in the WAIS-D deep ice core?
Impurities do probably affect the rheology/viscosity of the ice, but it is uncertain how this would manifest in the thinning function. We performed experiments in which we linked the ice viscosity to the impurity loading, but it did not change the thinning function significantly; certainly not by the amount suggested by the reviewer (factor of 1.7). We did not succeed in finding a flow model/thinning function that was consistent with both the borehole temperature profile and high dust sensitivity in the firn densification model.

Technical comment:
Figure1: Unit of the axis label should be Acc rate (m ice a^{-1}) instead of Acc rate (m a^{-1}).
We have corrected this.