Reviewer: Brenhin Keller

These responses follow the same structure as the original review. We do not include it here because the review was so thorough.

We thank Brenhin Keller for his helpful comments on the manuscript. We would also like to apologise for misrepresenting previous work. We fully appreciate that the authors' work went far beyond simply trying to infer a glacial origin of the Great Unconformity using a single sample analysed with a single thermochronometric system. It is clear that everyone appreciates that multiple samples analysed with multiple thermochronometric systems is the best option. We have clarified this here and have modified the text to highlight this. Furthermore, we appreciate that a glacial origin would not mean synchronous erosion at all locations because glacial erosion is complex. We have modified the text accordingly. We decided to use the GU discussion as a focus for our analysis because it is an exciting problem in Deep Time thermochronometry where uncertainties are likely to have an important impact on the results.

We have modified the title to ensure that is it more general and reflects the fact that damage models are important for a host of different applications. This title better reflects the content of the manuscript but maintains a focus on the GU because this is such an exciting field.

With respect to the issues highlighted with the QTQt modelling, we attempted the model with different burn in durations and found no changes to the solution. It is not clear why the burn in length has such a clear control on the models presented by Kalin McDannell in his comment. All QTQt models were carried out by Kerry Gallagher and the acceptance criteria were carefully monitored. The linear cooling models also look a lot like the maximum posterior solution, even in the updated versions of the plots. These models are probably very sensitive to the size of the prior, the acceptance rates and the proposal distributions. Identifying the "correct" or most suitable thermal, and its uncertainty, is far beyond the scope of our study.

We were able to reproduce the overall inferred thermal history by decreasing the uncertainty in the ages to 25% of the age. This provides us with a relatively precise thermal history and we can see how this changes as model uncertainty is increased. In this way we are expanding the errors but by propagating data uncertainties. Inferred histories from different datasets will be impacted differently by these expanded uncertainties. This exploration should be the focus of a different analysis and we make no recommendations here or suggest that a thermal history is better than any other. We are simply interesting in how uncertainty in the diffusion parameters influences uncertainty in the thermal models. We have developed a method to do this by modelling the diffusion data directly and propagating this uncertainty directly to the QTQt models.

We have introduced a way to quantify uncertainty in radiation damage models and propagate this through to thermal history uncertainty. We have not attempted to estimate uncertainty in radiation damage annealing, which would also influence the inferred thermal histories. For this reason, we would like to reinforce the point raised by the reviewer and other authors, that incorporating additional datasets is important. Incorporating additional thermochronometric data is always a good thing. Incorporating geological constraints is also useful, but it is also interesting to assess what the data can resolve without independent constraints. Ultimately, by modelling the data without constraints, we can investigate what additional data is needed to get back to the correct constraints.