Reviewer: Kalin McDannell

We appreciate the detailed comment provided by Kalin McDannell on our paper. We have reframed some of the introduction and key points in our manuscript to highlight that this is indeed a general problem and certainly not unique to deep time thermochronomety. We would like to take this opportunity to clarify some points, but many of these points should really be discussed in a separate paper that goes into more detail. We have broken this response down into the same sections as the original review.

1. Kinetic model uncertainty

We appreciate that the uncertainties that we have highlighted are not unique to the Great Unconformity debate. We have added text to highlight that this is important for other applications. We have also restructured the introduction to begin with a section on general thermochronometric methods. However, much of the work on deep time thermochronology relies on interpreting data that have been influenced by radiation damage. This is why we focused on this interesting point.

2. Parameter correlations

We think we have done a better job at accounting for these parameter correlations in our revised manuscript. Now we have a modified version of QTQt that explicitly accounts for uncertainties in the damage model. We have also approximated the distribution as 4D guassian that allows us to explicitly define a covariance and correlation matrix. These clearly highlight the model correlations.

3 .The effects of additional constraints on inversions results?

We have removed these inversions because they have caused so much controversy and detract from our very simple message. Instead we show a new QTQt model where we have reduced the uncertainties on the ages. We were unable to replicate the thermal histories inferred from in the comment using the reported data uncertainties. We modified the length of the burn in but this had no effect on the inferred thermal history. This work was carried out by Kerry Gallagher, who is an expert in thermal history modelling.

4. Posterior probabilities

See previous point.

4.1 MCMC burn-in and ZHe uncertainties

K. Gallagher ran the QTQt models with the quoted errors from the original publications. Changing the burn in length made no appreciable difference. Instead, we think the issue may be related to the data uncertainty. We have attempted to address this here and we are now able to recreate a GU-type thermal history.

4.2 Timing of cooling

It is not clear what the reviewer is referring to here. We had used the point in time at which the green colour first appears as this represents when the path is well resolved. This is when the thermal history is resolved, we are saying nothing about when a period of cooling is resolved.

4.3 Continuous spread of ages as a function of eU

Yes, we would argue against binning data in general. The binning of the data potentially removes valuable information that might guide future research. However, binning may be required in certain cases.

5. Bayesian MCMC inversion tests

These models are very interesting and highlight the importance of testing model parameter values. We thank Kalin for highlighting this and we have gone to great lengths to fully explore this in the new QTQt section of our paper.