Many thanks for your comments and suggestions, which have been very helpful for further improving the clarity of our manuscript.

Below please find a detailed response to the comments and suggestions received, and a summary of how the manuscript has been revised. The original comments are copied here in black text, followed by our responses in blue.

The topic of the manuscript, estimating robust estimates of exhumation from thermochronological data, is an important method to study the spatial and temporal relations of tectonic, climate and erosion in various tectonic settings. Numerous papers have been published on this, ranging from simple geometric models, thermal history modelling to 1D to 3D thermal-kinematic models. The contribution of Yuntao Tian et al. is based on the 1D inversion of thermochronological data from age-elevation profiles sharing the same exhumation history. They do largely use the approach of Fox et al. (2014) with, as I understand, only very slight modifications of the data covariance matrix. It is important that this is stated clearly, and that the novelty of their contribution is easy to digest from the reader. It does largely read as a new method, but in most cases simply reprints equations/ideas formerly stated by Fox et al. (2014).

Response: This work followed the method of Fox et al. (2014). We aim to form an automatic and objective workflow that takes into account numerous prior input parameters (such as a priori exhumation rates and its variance, initial geothermal gradient, time interval length etc) to invert rock exhumation from age-elevation relationships (AERs) derived from both surface vertical transects and boreholes. Such a method is required for two reasons: (1) it provides an objective assessment on the models based on the misfits in both age and geothermal gradient. Note that the method of Fox et al. (2014) and its applications did not take the geothermal gradient into account in the model assessment, although the paper did highlight the importance of the parameter in influencing the inverted results. (2) Our new workflow enables researchers to handle a large number of AERs, which are available in many orogens.

Please see my scientific comments and technical corrections for more details:

1. In the abstract, it is unclear what is the outcome of your model application. You state that ‘lessons learned from the experiments’, and afterwards, you propose a modelling strategy. One could get the impression that you have explored the difficulties but have not applied it.

   Response: In fact, we have implemented (rather than “propose”) a new workflow. The statement has been revised as “Putting together these findings, we implemented a new stepwise inverse modeling method for optimizing the model parameters by comparing the observed and predicted thermochronologic data and modern geothermal gradient to mitigate the model dependencies on the initial parameters.”

2. Your approach is largely based on (a reprint of) that from Fox et al. (2014). Please make sure to clearly communicate that you are using his approach with only very slight modifications. It is often not directly recognizable if your equations are new or have been defined elsewhere. In fact, it would be easier to recognize your contribution if you put everything out of the manuscript (in the supplement) that is not new and just focus on your contribution and refer to Fox et al. (2014) for the method.

Response: This work followed the method of Fox et al. (2014). We clarified this in the beginning of the section 2. See above for our own contributions.

3. You applied your suggested modelling strategy to three examples and yielded ‘consistent’ results. This is good, but what is the benefit of running these models if you could just reproduce what others predicted before with ‘simpler’ methods? Please clearly state what is new and why we should use this modelling strategy and also what is different from what Fox et al. (2014) suggested?

   Response: Our results are not always consistent with previous results, for example the inversion of the himalayan Dharladar range transect. As for the KTB example, previous studies did not quantify the rock exhumation history, but cooling histories.

   We use this example to highlight that the new method can handle borehole samples.

4. It would be very nice to extend the applications to a synthetic data with changing exhumation rate and pronounced topography. In Braun et al. (2012) you will find two datasets (Fig. 3 and Fig. 9) that you could use to show the performance of your dataset in comparison to 1D thermal-kinematic modelling. Whatever the outcome is, you could discuss the limitations of some of your model parameterizations, such as the closure depth.

   Response: This suggestion is very useful. We run four synthetic models, please find the details in the section ‘8. Synthetic models’ of the revised manuscript. It is shown that “…the inverted rock exhumation histories for the four synthetic datasets match the whole picture of the synthetic “truth”, but the variations in exhumation are underestimated, and the sharp changes at 5 Ma are smoothed…”

Technical corrections:

Line 24: It is not clear what you mean with ‘lower inversion results’, please be specific.

Responses: revised as “a relatively higher a priori exhumation rate would lead to systematically lower a posteriori exhumation, and vice versa”

Line 40: Say something like ‘Quantifying rock exhumation…’.

Responses: revised

Line 48: Give references to modelling tools such as Pecube (Braun 2003; Braun et al. 2012) and Glide (Fox et al. 2014).

Responses: revised

Line 53-58: Mention that this approach is only applicable for constant cooling rates.

Responses: revised

Line 59: Change to ‘Many analytical …cooling history from thermochronological data.’

Responses: revised

Line 59-67: You may also want to mention the Fourier approach for correction AER from Glotzbach et al. (2015).

Responses: The Glotzbach et al. (2015) is cited and classified into one of the methods for inverting “time-averaged exhumation rates”.

Line 78-80: Change to ‘…Ehlers and Farley, 2003). Estimating reliable exhumation rates requires to account for temporal variations of the thermal field caused by changes in the thermal and kinematic boundary conditions.’

Responses: revised

Line 86-87: I would delete the last sentence.

Responses: revised

Line 90-122: Do mention at the beginning that you are using the approach from Fox et al. (2014) with slight modifications, e.g. covariance.

Responses: Our inversion of exhumation from thermochronologic data followed the linear inversion approach of Fox et al. (2014).

Line 126-128: Replace with ‘The latter can be determined modelling the temperature of the crust using a 1D thermal-kinematic model, which accounts for heat conduction, advection and production…’

Responses: revised

Line 149: Please give a reference for this equation, I guess Mancktelow and Grasemann (1997) and Fox et al. (2014).

Responses: revised

Line 169: Replace fitness with ‘difference between observed and predicted ages weighted by the observed analytical uncertainty’.

Responses: revised

Line 176: Replace ‘data fitness’ with ‘model result’.

Responses: revised

Line 190: Delete ‘change’.

Responses: revised

Line 227: Give a reference for this equation.

Responses: revised

Line 251-255: Simplify and say that '…suing the present-day geothermal gradient (38.9 °C/km) in the misfit calculations does exclude higher and lower prior geothermal gradients of >30 and <20…'

Responses: revised

Line 355: What do you mean with 'latter'?

Responses: the statement is clarified as "…which is 1.5 Myr latter than that of the reference model (7.5 Ma)."

Line 375-376: Your estimate of the most recent exhumation is much lower compared to the raw interpretation, is that due to the overestimation of exhumation due to the topographic perturbation of isotherms?

Responses: Indeed, it is due to overestimation of exhumation due to the topographic perturbation of isotherms. We added the following statements. "AER slope regression of ZHe and AFT ages performed in Deeken et al. (2011) produced apparent erosion rates of ~2.8 km/Myr and ~0.2 km/Myr for the time intervals 6.4–14.5 Ma and 1.7–3.7 Ma, respectively, implying a potential increase in erosion rates at ~3.7-6.4 Ma..." … "… However, the inverted exhumation rates since 3 Ma are significantly lower than the estimation from the AER slope (~2.8 km/Myr), which is likely due to the overestimation of exhumation of the AER slope due to topographic perturbation of isotherms. Such a perturbation is a function of exhumation rates: the higher the exhumation, the larger the perturbation (Glotzbach et al., 2015)…"