Author's reply to reviewer comments 2 (RC2)

Constraining the kinematic, structural and/or topographic history with thermochronological data is not trivial and does require not only knowledge on the method itself, but also on the correct usage of inversion routines to run thermal-kinematic forward models. It is therefore important to report on the correct usage of such tools.

Overall I do like your approach and think that it is a useful technical note that will help users to get faster and saver to a well-balanced interpretation of their thermochronological data.

We thank the reviewer for the positive feedback and suggestions of improvement to our manuscript. We reply to each comment below.

However, I would ask the authors to add two additions:

1. **I would like to see a recommendation from the authors if each user should apply a similar theoretical approach (adapted to their specific case) before using real data. This would be quite easy to apply since they anyway might run a few forward models, which output can be used to drive the initial theoretical inversions. It might be helpful to see which parameters, for instance, are possible to invert/resolve and which are impossible to resolve given the samples, associated data and uncertainties.**

   This suggestion is similar to reviewer #1. We now recommend performing a small initial inversion and a resolution test to identify parameters that the data can actually resolve before running a full and costly inversion (L590-594). In addition, we provide an external python code that enables users to infer posterior probability distributions, correlation and resolution matrices from their inversion. An inverted parameter that does not show good resolution (i.e., Resolution << 0.2) should be removed from the inversion process as it does not bring additional constraints to the model. We refer to our reply to reviewer #1 for more details.

2. **In the same regard, it would be helpful to explore/explain in more detail why some parameters are better resolved compared to others. There might be, for instance, trade-offs between basal temperature and heat production producing similar geotherms or a trade-off between basal temperature and cumulative uplift. Maybe you want to plot the geotherm over time for a few models that do show similar fits but do have different parameterisations.**

   We now explore in further detail the trade-off between parameters. Specifically, we investigate why parameters T_b and H_p are not well resolved. We show that different combinations between these two parameters lead to similar near-surface geothermal gradients, thus hiding a well resolved parameter (i.e., G, see reply to reviewer #1). Following this observation, we now recommend users to either fix thermal parameters to estimated values, or to invert only one of the two. This strategy would simplify the misfit landscape of the problem and would prevent oversampling the parameter space.

Detailed comments:

Line 31: Change to '… crust, assuming or independent estimate geothermal gradients'.

We changed this sentence to "… crust, given assumptions or independent estimates on the geothermal gradient."

Line 34: Maybe change to 2D/3D, since it is also possible and often sufficient to run Pecube in 2D.

As is, Pecube is ran using the 3D formulation only. While a 2D formulation can be used, this would require an adaption to the code that is not currently accessible and does not correspond to the version presented here. Therefore, we prefer to keep the term "3D".

Line 88: I am not an expert in QTQt and the newer version of HeFTy, but please make sure you clearly describe the difference between them. Maybe add one-two more sentences here on the difference.

We changed the sentence to give some more details about the two codes but refer to additional references to guide readers to more detailed reviews. The sentence is now: "This contrasts with other thermochronological modelling tools such as QTQt (Gallagher et al., 2012) and HeFTy (Ketcham, 2005), in which large ensembles of cooling histories are randomly generated and evaluated using appropriate kinetic models but where no thermal model is implemented (see Abbey et al., 2023; Gallagher, 2012; Ketcham, 2024; Murray et al., 2022; Vermeesch and Tian, 2014, for detailed reviews on these two codes)".

Line 221: It is not very clear how you get to Fig. 4b, my guess is that you used Eq. 2. Please state more clearly in the text and figure caption.

In Line 221, we added "In Figure 4b, equation (2) is plotted along with a lower bound of approximatively 0.2N…" to clarify how we get to Fig. 4b.