Review of EGUSPHERE-2025-1853

General comments

The author uses a combination of geological and biological data to model the survival and extinction of life in the future, and conclude that metazoans will become extinct in approximately one billion years. The manuscript is original and the conclusion is novel. This is my first time reading this work, but the manuscript has been substantially improved following the suggestions of other reviewers and is now much clearer. Overall, I think it is a great and intriguing paper. However, I have concerns about the robustness of the results.

In this study, all model parameters were assigned single fixed values, such as abrupt temperature perturbation and extinction rate. Although the author has performed several sensitivity tests by removing individual processes, which is very great, the robustness of the conclusion remains difficult to assess without exploring a boarder range of values for key parameters. As shown in the manuscript, the ultimate demise of metazoans will be driven by episodic warming events. The temperature perturbation ΔTe is based on the mean cooling and warming anomalies associated with past mass extinctions. However, these anomalies vary substantially among the five major extinctions (e.g., the temperature increase during the Permian-Triassic extinction were much greater than that during the Late Devonian extinction, as noted by the author; Kaiho et al., 2022, Biogensciences). In addition, paleo-temperature reconstructions based on different models show considerable discrepancies (e.g., Scotese et al., 2021; Judd et al., 2024, Science). Therefore, it would be very helpful to assess how the predicted timing of metazoan extinction changes under different parameter settings. For instance, if the magnitude of temperature perturbation is comparable to that of the Permian-Triassic extinction, what lifespan of metazoans does the model predict? Similarly, what outcome is obtained if temperature shifts are similar to those of the Late Devonian extinction? Besides, the timing of final extinction is determined by a threshold proportion of surviving diversity, and this threshold will therefore influence the lifespan of metazoans. Although other parameters may also affect the results, sensitivity analyses of these key parameters are essential for evaluating the reliability of the model conclusions.

Minor comments

Line 117. The classic paper by Raup and Sepkoski (1982, Science), which defined the ‘Big Five’ mass extinctions, should be cited as well.

Line 134. The unit of diversity is unclear, and it is difficult for readers to understand why diversity can be low than one.

Line 150. Please clarify why the uncertainty of abrupt event timing was set to 0.03 Gyr.

Line 151. Please specify whether past GAT were derived from this study or from previously published papers?

Line 176-186. Repeated content.

Line 187-200. See general comments.

Line 291. Several parameters throughout the manuscript were referred to as ‘rates’, but their definitions suggest that they represent percentages, rather than rates in conventional palaeobiological sense. The terminology should be clarified or revised for clarity.

Line 295-300. I think it would be helpful to provide an example of the calculations. And it is unclear what ‘this value’ refers to in Line 296. Based on the current description, diversity after recovery (0R) does not appear to be the product of post-extinction diversity (0E) and the recovery rate. For example, if 70% of 100 families survived, and the recovery rate is 1, the recovered diversity would be 70 × 1 = 70 (i.e., 0A). This is inconsistent with the results shown in Figure 5. Please revise these sentences.

Line 297. Why the value 0.029 is used?

Line 301. The term ‘extinction percentage’ is clearer here and improves readability.

Line 402-404. The complete extinction of metazoans on land is defined as fewer than 0.4 families. Please justify the choice of this threshold. Life persisted and diversified after the end-Ordovician extinction and Permian-Triassic extinction despite more severe losses.

Line 556. More references supporting the duration of the cycles are needed.

Line 639-662. Key parameters, including extinction thresholds and temperature perturbations, should be reported together with the corresponding extinction times. This would help readers understand the conditions under which the reported results are obtained.