Biogeosciences Discuss., author comment AC2
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Reply on RC2

Kunio Kaiho

Author comment on "Relationship between extinction magnitude and climate change during major marine and terrestrial animal crises" by Kunio Kaiho, Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-29-AC2, 2022

Author replies for comments of Referee #2

Comment 1 of Referee #2

- The novelty of this study has not been established. The MS says 'relationships between... physical conditions and the magnitude of animal extinctions have not been quantitatively evaluated. My analyses show that the magnitude of major extinctions in marine invertebrates and that of terrestrial tetrapods correlate well with the coincidental anomaly of global and habitat surface temperatures during biotic crises,'. However, it is not accurate that this has not been previously quantitatively evaluated. In particular, Song et al 2021 (Nature Communications) has also published a quantitative analysis of extinction magnitude and temperature change which appears to show, with a larger, statistical analysis, similar conclusions to those stated here (there is also a relevant response paper McPherson et al. 2022 Results in Engineering). E.g. Song et al 2021, which is omitted from the citations of the submitted MS, already concluded, 'The results show that both the rate and magnitude of temperature change are significantly positively correlated with the extinction rate of marine animals.' There is also a branch of the literature considering specifically the correlations and potential periodicity of extinction and bolide impacts. I believe the author of the current MS needs to explain and adequately justify what it is about their findings that is novel with regard to the recent literature for publication to be considered.

Author reply

Thank you for your important comments. For your comment 1, I added results of Song et al 2021 (Nature Communications) in the text. They show a good relationship (R = 0.63) between temperature change and marine extinction rate. The novelty of my study is (i) a significant relationship between temperature change and terrestrial tetrapod extinction magnitude (correlation coefficient R = 0.95 for genus and 0.98 for species), (ii) a significant relationship between extinction magnitude and the global and habitat [marine or terrestrial realm] surface temperature anomalies, (iii) comparison of marine invertebrate and terrestrial tetrapod response for temperature change and explanation of the different extinction magnitudes, (iv) usage of only data having coincidence of mass extinctions and temperature changes in the same outcrop of marine sedimentary rocks resulting in higher relationship (R = 0.93 and 0.94 for genus and 0.91 for species under comparable data for terrestrial tetrapod extinction magnitude) between temperature change and marine extinction magnitude than that of Song et al 2021. I added these in the manuscript.

Comment 2 of Referee #2

- Table 1 shows that the submitted study is based on secondary data compiled from the references indicated there, covering a small sample of 7 geological boundaries. However, it has not been adequately demonstrated that these secondary data are directly comparable. E.g. There are a range of different methods available for calculating extinction magnitudes and it has not been demonstrated that the compiled data use comparable measures e.g. interval lengths, precise choice of numerator and denominator etc. An analogous point also applies to the temperature proxy data.

Author reply

I use the conventional method (total number of extinction genera for a mass extinction interval / total number of genera in a substage just before the extinction) to calculate genera extinction % of terrestrial tetrapods and marine genera extinction % on the end-Guadalupian crisis, because those data fit to this method but not for a new method of Stanley (2016). Marine genera extinction % data of Sepkoski (1996) and Bambach (2006) correspond to the conventional method. Therefore, I used those extinction % data based on the conventional method to compare marine animal extinction % with terrestrial tetrapod extinction % for the seven biotic crises. I added these in the manuscript.

Comment 3 of Referee #2

- There is apparently no statistical analysis provided to test the presented results or conclusions. Furthermore, there is a small sample size of 7 geological boundaries indicated in Table 1, with only 2 events outside the traditional big 5 extinctions. In contrast, for example Song et al 2021 and Fan et al 2020 (Science) have published large statistical analyses, of consistent datasets covering complete series of extinction magnitudes (not hand-selected examples), to test correlations between extinction and environmental proxies.

Author reply

Although Song et al. (2021) analyzed all data of extinctions and sea surface temperature (SST) changes, there are no confirmation of exact coincidence between extinction rate and temperature change for minor extinctions. I use only data showing coincidence of marine extinction horizons and temperature changes in the same outcrop of marine sedimentary rocks to reach the truth on relationships between extinction magnitude and surface temperature change in each biotic crisis. Therefore, I analyze the six mass extinctions and the modern extinction, which coincided with global climate changes. Explanation on statistical analysis is the same as the reply for comment 2. I added these in the manuscript.

Comment 4 of Referee #2

- There is currently inadequate consideration of potential effects of sampling bias on measures such as % extinction. This issue does not appear to be discussed at all despite its considerable importance in this research area. See for example, Alroy (2014 Paleobiology).

Author reply

For consideration of potential effects of sampling bias, I separated data of marine taxa extinction % into three data sets; one is a data group calculated by Sepkoski (1996) with low extinction values (0–5 %) of G–L and H–A, second one is Bambach (2016) with the low extinction values, and the third one is Stanley (2016) based on a new method with the low extinction values because low extinction values do not change largely based on different methods (marked by three types of blue circles in the attached figure). I compared the data based on the conventional methods for both marine and terrestrial extinction % to get the conclusions. Even when I use the other data set based on the new method of marine animals (incomparable data sets for terrestrial data), the figure shows the same conclusions. This confirms the conclusions. I added these in the manuscript.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2022-29/bg-2022-29-AC2-supplement.pdf