Dear Editor and reviewers,

Thank you for considering our manuscript for publication in *Climate of the Past* and for providing helpful comments to improve our manuscript. We have carefully addressed all of the comments and revised our manuscript accordingly. Our replies to comments are listed below, with a few clarifications.

We hope our revisions meet your approval.

With best wishes,

Fen Yang and coauthors

Reviewer #1: Thomas Algeo (reviewer's comments are in italics):

1) The text lacks citations of some key papers on redox conditions at the PTB. The authors have extensively cited my work (many thanks for that!), although they have overlooked several key studies of mine examining PTB redox variation in shallow-marine (Algeo et al., 2007, 2008) and deep-ocean sections (Algeo et al., 2010, 2011) [in fact, they cited Algeo et al., 2010 but failed to identify some of its key findings]. To summarize the importance of these papers: The two studies on the Nhi Tao section demonstrated multiple (at least 8) incursions of euxinic watermasses onto this shallow-marine platform in the earliest Triassic. This demonstrates highly dynamic redox conditions in shallow environments at that time. The two studies on the Japanese sections demonstrated that the deep ocean shifted only to dysoxia, and that the pyrite framboids almost certainly came from much shallower depths (presumably the OMZ at 200-1000 m). Thus, the key change in redox in the open ocean was euxinia in an expanded OMZ globally (200-1000 m water depth) with little to no change in deep-ocean redox conditions (minor shift to dysoxia). This was documented by Algeo et al. (2010, 2011) and supported by modeling (e.g., Winguth and Winguth, 2012):

Reply: Thank you for pointing this out. We have now cited Algeo et al. (2007, 2008, 2010, 2011) and Winguth and Winguth (2012) in the revised manuscript and integrated their main conclusions. Please see lines 44–46 for the discussion on euxinic OMZ expansion, and lines 57–60 for the recurrent euxinic incursions on the shallow-marine carbonate platform.

2) *Re the redox proxies used, framboid size and Fe speciation are shown for both study sections. Beyond this, Mo-U are shown for Ursula Creek and Ce/Ce* for Chibi. The problem here is that Ce/Ce* is not a valid redox proxy when any clayed material is present in a section—even a few percent clays invariably result in a lithogenic REE signature from which no redox information can be drawn. The authors should remove Ce/Ce* from the Chibi section and, for the sake of comparability to Ursula Creek, add Mo-U data.*

Reply: We have removed the Ce/Ce* data from the Chibi section. To ensure comparability with the Ursula Creek section, we have instead added Mo-U data for the Chibi section. The detailed Mo-U data are now provided in the Supplementary Material, with the corresponding description in lines 250–264 of the revised manuscript. Figure 5 has been updated to show the stratigraphic variations of Mo and U, and the newly added Figure 6B presents the covariation of Mo and U across the P-T transition in the Chibi section.

3) *The discussion of marine primary productivity changes around line 340 does not adequately convey what is known about this topic. Primary productivity does not show any consistent pattern globally; there was a lot of regional variation. See Algeo et al. (2013).*

Reply: We agree that primary productivity changes show strong regional variations rather than a globally consistent pattern. We have revised the text to clarify this: However, despite the enhanced detrital delivery, marine primary productivity did not increase globally during the P-T transition; instead, it exhibited strong regional heterogeneity (e.g., Algeo et al., 2013; Grasby et al., 2016, 2020; Müller et al., 2022; Zhang et al., 2023; Sun, 2024). In South China, primary productivity underwent a catastrophic collapse across the EPME, as indicated by sharp declines in total organic carbon concentrations and organic carbon accumulation rates, together with evidence for restricted P recycling and negative cadmium isotopic excursions, while productivity in other Tethyan regions remained relatively stable or showed only modest increases (Algeo et al., 2013; Schobben et al., 2015; Shen et al., 2015; Müller et al., 2022; Zhang et al., 2023). Some sections from the northwestern margin of Pangaea and deep-water Panthalassic settings record substantial increases in organic carbon fluxes and marine productivity during the Early Triassic (Algeo et al., 2013; Schobben et al., 2020). In the study area, indicators from the phosphorus cycle and trace elements document a reduction in primary productivity (Müller et al., 2022; Woods et al., 2023). (Lines 374–385).

4) I have been working to provide a logical and consistent framework for tectonics terminology in Chinese studies. I encourage the authors to read this paper: Algeo, T.J. and Li, H., 2026. Are South China and North China "blocks" or "cratons"?. Palaeogeography, Palaeoclimatology, Palaeoecology, 683, 113464.

Reply: We have updated the terminology, changing "South China Block" to "South China Craton" in accordance with Algeo and Li (2026).

Detailed comments provided in the annotated PDF

Lines 41–45: *This fails to adequately characterize the most likely scenario: euxinia in an expanded OMZ globally (200–1000 m water depth) with little to no change in deep-ocean redox conditions (minor shift to dysoxia). This was documented by Algeo et al. (2010, 2011) and supported by modeling (e.g., Winguth and Winguth, 2012).*

Reply: We have added a description of "the expansion of euxinic oxygen minimum zones (OMZs) at intermediate water depths (~200–1000 m), while deep-ocean redox conditions remained largely unchanged (Algeo et al., 2010, 2011; Winguth and Winguth, 2012)" in Lines 44–46 of the revised manuscript.

Lines 46–50: Multiple geochemical proxies point towards the development of persistent or episodic euxinic conditions in Panthalassa and in epicontinental basins. In deep-water settings of Panthalassa (e.g., the rare records of Japan and New Zealand), small pyrite framboids (mean diameters < 5 μm), significant concentrations of redox-sensitive trace elements such as Mo, and negative pyrite sulfur isotope shifts are all indicative of persistent euxinia and restricted water-column ventilation (Shen et al., 2011; Takahashi et al., 2021). -- *This overlooks some of the most important studies of Japanese PTB sections: Algeo et al. 2010 and 2011*

Reply: Following your suggestion, we have now added the key studies from Japan (Algeo et al., 2010, 2011) to this section. This section has been changed to: In deep-water settings of Panthalassa (e.g., the rare records from Japan and New Zealand), evidence such as small pyrite framboids (mean diameters < 5 μm), significant enrichment of redox-sensitive trace elements (e.g., Mo), and negative pyrite sulfur isotope shifts has been interpreted to indicate either persistent euxinia (Shen et al., 2011; Takahashi et al., 2021) or euxinia largely restricted to oxygen minimum zones, with bottom waters remaining dysoxic to suboxic (Algeo et al., 2010, 2011). (Lines 47–52)

Lines 50–55: "Numerous studies demonstrate that euxinic waters invaded shallow epicontinental basins extensively around the Permian-Triassic (P-T) boundary, including equatorial Tethys (e.g., the South China Block), the Gondwanan margin in mid to high latitudes, and the Pangaea northwestern margin (Wignall and Twitchett, 1996; Neilsen et al., 2010; Grasby and Beauchamp, 2008, Lau et al., 2016; Zhang et al., 2017; Stebbins et al., 2019; Xiang et al., 2020)." -- *True, but this overlooks two key studies demonstrating repeated pulses of euxinic waters into tropical shallow-marine systems, something shown by almost none of these other studies:(Algeo et al., 2007, 2008)*

Reply: We have added "In addition, studies of the Nhi Tao section in Vietnam documented multiple recurrent incursions of euxinic water masses onto a tropical shallow-marine carbonate platform during the earliest Triassic, likely linked to episodic upwelling of sulfidic deep waters (Algeo et al., 2007, 2008)." at the end of this section (Lines 57–59).

Line 68: "……Algeo et al., 2010……" -- *Thanks for citing my 2010 paper here, but the ones you should really be citing are the 2007 and 2008 papers on Nhi Tao Vietnam*

Reply: We have updated the references to cite Algeo et al., 2007 and 2008, as recommended (Line 73).

Line 74: "……. paradigm of globally pervasive anoxia……" -- *this was rejected long ago*

Reply: We have revised this sentence to "These findings suggest that oxygen restriction during the EPME was spatially heterogeneous". (Lines 77–78)

Line 77: "……sea water……" -- *seawater*

Reply: The text has been corrected to "seawater" (Line 80).

Line 290: "The Waiheke section of New Zealand provides one of the few available records from Panthalassa." -- *all the Japanese sections are from central Panthalassa*

Reply: We agree that the Japanese sections are from central Panthalassa. For our study, however, we specifically selected sections that reported iron speciation data, as our focus is on documenting the distribution of ferruginous conditions.

Line 303: "……late Changhsingian……" – upper

Reply: Revised.

Line 326: "……Late Permian……" – Upper

Reply: Revised.

Line 338: "……marine primary productivity appears not to have risen over this period……" – *Primary productivity does not show any consistent pattern globally; there was a lot of regional variation. See Algeo et al. (2013)*

Reply: We have revised the sentence to describe regional variability in marine primary productivity. (Lines 373–383)

Lines 339–340 "This somewhat contradictory scenario could be attributed to strong thermal ocean stratification that inhibited upwelling and vertical mixing (Grasby et al., 2016; Knies et al., 2022)." -- *There was probably no single control; the Earth-system was highly disturbed so there was variation in productivity levels all over the place.*

Reply: We have changed this sentence to "In the study area, indicators from the phosphorus cycle and trace elements document a reduction in primary productivity (Müller et al., 2022; Woods et al., 2023). The contradiction between enhanced continental weathering and reduced marine primary productivity likely reflects multiple environmental stresses during the P-T transition, including reduced vertical mixing and nutrient upwelling due to strong thermal stratification, disrupted nutrient recycling, intensified redox instability, and extreme temperature stress on marine ecosystems and primary producers (e.g., Grasby et al., 2016; Ge and Bond, 2022; Knies et al., 2022)." (Lines 383–389)

Figures 2 and 5: This is a stratigraphic column, not a timeline, so rock-time terms should be used (Lower, Upper) not time terms (Early, Late)

Reply: As suggested, we have updated the "Late Permian" to "Upper Permian" and "Early Triassic" to "Lower Triassic" in Figures 2 and 5.

Figure 3 – spelling error

Reply: We have revised Fanstaque to Fantasque.

Figure 5 -- How about U and Mo data for this study section? Ce/Ce is not a valid redox proxy in shales and argillaceous carbonates. The Ce/Ce* values > 1 are indicative of influence of phosphate on REE distributions*

Reply: Ce/Ce* data have been removed, and Mo and U data have been added. The corresponding text description is provided in Lines 250–264, and the detailed data are included in the Supplementary Material.

The paper would benefit from an interpretative figure as the final figure

Reply: We have added a new Figure 8, indicating marine redox conditions in different regions on paleogeographic maps across the P-T transition.

Reviewer #2: Yongda Wang

The references cited in the main text, particularly in the Introduction section, are relatively outdated. Please update them.

Reply: We have retained the classical references while adding recently published studies from the past 10 years.

It would be better to briefly introduce the proxies used in this study (e.g., Mo_{EF}, U_{EF}) prior to the Results section.

Reply: These redox proxies (pyrite framboid distributions, iron speciation, and Mo-U covariation) were originally presented in Section 5.1 (Redox evolution), following the Results. In the revised manuscript, we have moved this section to precede the Results (now Section 3.4 Framework for redox interpretations) to enhance clarity and readability.

The statement in line 201 lacks objectivity, as this study applies both framboidal pyrite analysis and geochemical proxies.

Reply: We changed this sentence to "Three redox methods, including pyrite framboid mean size, iron speciation, and Mo-U covariation, are applied in our study (e.g., Wilkin and Barnes, 1996; Algeo and Tribovillard, 2009; Poulton and Canfield, 2011)." (Lines 158–160)

The authors aim to illustrate the spatiotemporal evolution of anoxic conditions in epicontinental seas across the Permian–Triassic transition; however, Fig. 7 does not clearly convey this information. If possible, annotating the marine redox conditions in different regions on paleogeographic maps for the end-Permian, PTB crisis, and earliest Triassic would enhance the clarity of the results.

Reply: We have added a new Figure 8 to indicate marine redox conditions in different regions on paleogeographic maps across the Permian-Triassic transition.

Please indicate all cited sections in Fig. 1.

Reply: We have newly cited Wignall and Newton (2003) in Fig. 1c.

Community Comments by Giacomo Medici

Line 32. "An extreme greenhouse climate prevailed during the Early Triassic". Please, add the following references on the Early Triassic climate and stratigraphy.

Reply: We have added the suggested references. (Line 33)

Line 83. Summarize the overall goal of your research on paleoclimate and describe the objectives of your research by using numbers (e.g., i, ii, and iii).

Reply: As suggested, we have revised the last paragraph of the Introduction (Lines 82–88) to summarize the overall goal and objectives of this study numerically:"To better constrain marine redox dynamics in epicontinental seas during the P-T transition under extreme climatic conditions, this study investigates two Upper Permian to Lower Triassic successions from contrasting palaeogeographic settings: Chibi (equatorial Tethys) and Ursula Creek (northwestern margin of Pangaea). Specifically, this study aims to: (i) characterize the spatio-temporal evolution of redox conditions across this transition using integrated iron speciation, framboid morphology, and Mo-U covariation data; and (ii) evaluate regional differences and broader patterns in redox shifts (euxinic vs. ferruginous)."

Lines 85–109. Provide detail on the major Permo-Triassic tectonic phases and mention the major tectonic lines in the study area.

Reply: The major P-T tectonic phases have been added (Lines 90–95), and the major tectonic lines in the two study areas have been added in Lines 97–102 and 115–118, respectively.

Lines 111–136. If the result section is divided in sub-paragraphs, it should be the same for the methodology section. Please, fix the issue and expand the methodology.

Reply: We have adjusted the Methods section by introducing sub-paragraphs that correspond to those in the Results section (i.e., 3.1 Pyrite framboids, 3.2 Iron speciation, and 3.3 Trace elements and enrichment factors calculation).

Lines 357–365. "The Conclusions". This section is too short. Please, expand.

Reply: Some details have been added to the Conclusions section, expanding it from Lines 356–364 to Lines 403–415.

Figures and tables: 1) Figures 1a-c. The logs are of paramount importance. Please, increase the graphic resolution. 2) Figures 1a-c. Make the letters larger. 3) Figure 1c. What about nature of faults? Extensional? 4) Figure 7. Please, increase the graphic resolution also for this figure. 5) Figure 7. Make the letters larger also here.

Reply: We have improved the resolution and increased the font size of Figures 1 and 7. In Figure 1c, the faults have been revised to thrust faults.