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To
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Subject: Referee report on Ph.D. thesis of Jaime Y. Suárez-Ibarra, M.Sc.

Cologne, October 11, 2024

To whom it may concern:

Please receive this report in return to your invitation to act as a reviewer on the Ph.D. thesis submitted by Jaime Yesid Suárez-Ibarra, M.Sc., to the Faculty of Science, Charles University of Prague. You will find my assessment of the thesis in the next paragraphs.

The thesis entitled "*Palaeoceanographic evolution of the western South Atlantic during Marine Isotope Stages 5–1: a foraminiferal perspective*" presents Mr. Suárez-Ibarra's research on the drivers and feedbacks of variability in primary productivity, carbonate dissolution, and carbon burial on the southern continental margin of Brazil over the past c. 110 kyrs, and their significance for the carbon cycle and taphonomy of foraminiferal shells.

The cumulative thesis consists of two publications in peer reviewed scientific journals[1], one manuscript under review with the *Journal of Foraminiferal Research*, a new study planned to be submitted for publication (Chapter 5), a

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[1] I would like to point out that I have acted as reviewer of Article #1 (Suárez-Ibarra et al., 2022).

comprehensive synthesis presenting a discussion of key findings in a global context, and an outlook presenting potential future lines of research.

Mr. Suárez-Ibarra's thesis is well-structured, plainly written, and instructive to read. I particularly appreciate the presentation of figures summarizing major topical processes (e.g., Fig. 1 in the main text, Fig. 4 in Article #2). However, some of the graphs, in particular in figs. 3 and 5 of Chapter 5, appear very dense and compressed and should be expanded to the left and right if considered for submission to a journal. Research questions and objectives are clearly formulated, the results well-presented and thoroughly discussed. I particularly enjoyed the discussion of the results in the larger context of the ocean-climate system, and their implications for our understanding of carbonate dissolution and the taphonomic consequences for the (micro)fossil record. In summary, the thesis clearly demonstrates dedication, diligence and accuracy in Mr. Suárez-Ibarra's approach towards natural sciences and his ability to accomplish meaningful scientific work. His research reflects firm competence to tackle timely, yet challenging research questions through innovative methods, to acquire, integrate and analyze multi-proxy datasets, to apply appropriate statistical methods, and to provide new perspectives in his field of research.

Mr. Suárez-Ibarra evaluates the interplay of primary productivity, water mass geometry, and carbonate dissolution, and their taphonomic consequences for the interpretation of fossilized assemblages. The wealth of generated data is particularly impressive. The multi-proxy data sets come from three cores on the southern continental margin of Brazil, representing a depth transect from c. 1,500 to 2,100 m and covering the past c. 110 kyrs. The new data sets were integrated with available data from other sites along the southeastern Brazilian Margin. Key findings include a latitudinal difference in the forcing mechanisms of primary productivity (orbitally-paced changes of upwelling, riverine input, dust flux, Antarctic ice sheet dynamics); differential mechanisms of carbonate dissolution (organic matter remineralization in the water column vs. water mass corrosivity) with increasing water depth; and evidence for considerable, yet often overlooked dissolution of planktonic foraminiferal shells. The results contribute important paleoceanographic data for the southwestern Atlantic Ocean and add substantially to our understanding of carbon sequestration in the oceans. I thus

consider the presented research an important step forward in our understanding of carbon cycle dynamics in the ocean-climate system. Equally important, the results on carbonate dissolution of foraminiferal shells will provide an important touchstone for future studies on signal preservation in the (micro)fossil record and proxy development.

In conclusion, his thesis clearly demonstrates that Mr. Suárez-Ibarra is deserving a doctoral degree, and I recommend the thesis for the defense.

While I enjoyed reading Mr. Suárez-Ibarra's thesis, there are some areas that I hope he will be able to elaborate on during his thesis defense.

- In Article #2, strengthening of upwelling intensity and continental input (riverine, aeolian) is invoked to explain increased productivity in MIS 2-4. While this assessment is convincing to me, I'd like to expand on the discussion regarding the postulated underlying obliquity forcing. Based on figs. 2 and 3, the proxy records of the abovementioned drivers of primary productivity seem to lag the obliquity minimum as they lag the proxy records for primary and export productivity by several kyrs. I would be interested if the available records may provide explanations for this lag, and if other lead-lag relationships with respect to orbital forcing have been observed in the data sets compiled for the thesis.
- In the submitted manuscript, sea-surface temperatures (SSTs) are reconstructed via planktonic foraminiferal assemblages based on the Modern Analogue Technique. Considering that stable oxygen isotopes ($\delta^{18}O$) have been analysed on shells of *Gdes. Ruber*, and that Mg/Ca ratios may provide an alternative for SST reconstruction: May the observed carbonate dissolution bias either MAT-/assemblage-based or geochemistry-based approaches?
- In chapter 5, the benthic foraminiferal record is addressed through abundances of agglutinated foraminifera. Agglutinated foraminifera are used as indicators of corrosivity at the seafloor, but these may also be explained through oligotrophic conditions and/or increased input of refractory organic matter. I would thus be interested which morphotypes of agglutinated foraminifera are present, and how the high-frequency oscillations between

15-21 kyrs are explained. Furthermore, I wonder if further signs of increased corrosivity in bottom waters are detectable in hyaline and/or miliolid foraminifera from the site (e.g., increased fragmentation, dissolution on shell surface, or abundance of corrosivity indicator *Nuttallides umbonifera*).

In the end, I would like to express my appreciation for Mr. Suárez-Ibarra's profound work. I consider him a very talented scientist with great passion for geosciences, and I wish him all the best for his future research career!

Sincerely,

Patrick Grunert