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Can eustatic charts go beyond first-order? Insights from the Permo-Triassic

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To the first order, eustatic charts are in accord with our understanding of the geodynamic processes that control sea level. By extrapolation, second-order features are also thought to obey to the same rules, and are thus often taken for granted. But this assumption may be jeopardized by a close examination of a characteristic example. The Permo-Triassic period is characteristic for both its purported eustatic signal and its geodynamic and climatic setting are well defined and contrasted. Both the fragmentation of the Pangean supercontinent and the late Paleozoic melting of ice sheets argue for a rise of the eustatic sea level (ESL) whereas eustatic charts show the opposite. Here we review the possible mechanisms that could explain the apparent sea level low, and find that some of them do lower the ESL while others instead only modify the referential, either uplifting continents or tilting the margins where the control points are located. In the first category, we find that (i) dynamic deflections of the Earth surface above subduction zones and their location with respect to continents primarily control absolute sea level while the Pangean supercontinent forms and breaks up, (ii) endorheism that ubiquitously developed at the time of Pangean aggregation also contributed to lowering the ESL by storing water out of the oceanic reservoir. In the second category, we show that (i) the thermal uplift associated to supercontinental insulation and (ii) the dynamic uplift associated with the emplacement of a superplume both give rates of change in the range of long-term changes of ESL. We also show that (iii) the dynamic tilting of continental margins not only produces apparent sea level changes, but also modifies the absolute sea level, which in turn may end up in the paradoxical situation wherein fingerprints of ESL drop are found in the geological record whereas ESL is actually rising. We conclude that the establishment of second to third order absolute sea level changes may stay for a while a chimera.