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Improving global paleogeographic reconstructions since the Devonian using paleobiology

Wenchao Cao, Sabin Zahirovic, Simon Williams, Nicolas Flament, and Dietmar Müller
EarthByte Group, School of Geosciences, The University of Sydney, Sydney, NSW 2006, Australia
(wenchao.cao@sydney.edu.au)

Paleogeographic reconstructions are important to understand past eustatic and regional sea level change, the tectonic evolution of the planet, hydrocarbon genesis, and to constrain and interpret the dynamic topography predicted by time-dependent global mantle convection models. Several global paleogeographic compilations have been published, generally presented as static snapshots with varying temporal resolution and fixed spatial resolution. Published paleogeographic compilations are tied to a particular plate motion model, making it difficult to link them to alternative digital plate tectonic reconstructions. In order to address this issue, we developed a workflow to reverse-engineer reconstructed paleogeographies to their present-day coordinates and link them to any reconstruction model.

Published paleogeographic compilations are also tied to a given dataset. We used fossil data from the Paleobiology Database to identify inconsistencies between fossils paleoenvironments and paleogeographic reconstructions, and to improve reconstructed terrestrial-marine boundaries by resolving these inconsistencies. We used the improved reconstructed paleogeographies to estimate the surface areas of global paleogeographic features (shallow marine environments, landmasses, mountains and ice sheets), to investigate the global continental flooding history since the late Paleozoic, which has inherent links to global eustasy as well as dynamic topography. Finally, we discuss the relationships between our modeled emerged land area and total continental area through time, continental growth models, and strontium isotope ($^{87}Sr/^{86}Sr$) signatures in ocean water. Our study highlights the flexibility of digital paleogeographic models linked to state-of-the-art plate tectonic reconstructions in order to better understand the interplay of continental growth and eustasy, with wider implications for understanding Earth's paleotopography, ocean circulation, and the role of mantle convection in shaping long-wavelength topography.