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The contribution of numerical models to our understanding of the Phanerozoic CO2 history

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Our understanding of the geological regulation of the carbon cycle has been deeply influenced by the contribution of Bob Berner with his well-known model GEOCARB. Here, we will present a fundamentally different carbon cycle model that explicitly accounts for the effect of the paleogeography using physically based climate simulations and using 22 continental configurations spanning the whole Phanerozoic (GEOCLIM, geoclimmodel.wordpress.com). We will show that several key features of the Phanerozoic climate can be simply explained by the modulation of the carbon cycle by continental drift with the notable exception of the Late Paleozoic Ice Age, which is explained by the intense weathering of the Hercynian mountain range. In particular, the continental drift may have strongly impacted the runoff intensity as well as the weathering flux during the transition from the hot Early Cambrian world to the colder Ordovician world. Another fascinating example is the large atmospheric CO_2 decrease simulated during the Triassic owing to the northward drift of Pangea exposing large continental area to humid sub-tropics and boosting continental weathering. Conversely, our model fails to reproduce the climatic trend of the last 100 Ma. This is due to the highly dispersed continental configurations of the last 100 Ma that optimize the consumption of CO_2 through continental weathering. This discrepancy may be reduced if we account for a larger influence of the Earth degassing flux on the atmospheric CO_2 evolution, which could come from the increase contribution of the pelagic component on the oceanic crust on the global carbonate flux and from the many sub-marine LIPs occurring during the Late Cretaceous.