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Orbital-scale deoxygenation trends driven by ventilation in Cretaceous ocean

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Mechanisms driving cyclicity in the marine realm during hothouse climate periods in response to Earth's orbit variations remains debated. Orbital cycles fingerprint in the oceanographic records results from the effect of terrestrial (eg. weathering-derived nutrient supply, freshwater discharge) and oceanic (eg. productivity, oxygenation) processes, whose respective contribution remains to be defined. Here we investigate the effect of extreme orbital configurations on oxygenation state of the ocean using ocean biogeochemistry simulations with the IPSL-CM5A2 Earth System Model under (CT) Cenomanian-Turonian boundary conditions. We also use an additional inert artificial tracer allowing to compute the age of water masses, corresponding to the time spent since the last contact with the surface. Our simulations show that small ocean ventilation changes triggered by orbitally-induced variations in high latitude deep water formation have strong impact on the oceanic oxygen spatial distribution. It is particularly true for the proto-Atlantic basin which is the less oxygenated basin during the CT (Laugie et al., 2021). The eight sets of orbital parameters tested here imply changes in the Atlantic anoxic seafloor area going from 20 to 80%. All three parameters describing the Earth's orbit (eccentricity, precession and obliquity) show a substantial control on these fluctuations. We also note that orbital fluctuations result in important changes in continental runoff but the impact remains highly localized to coastal environments – the open ocean mainly responding to the ocean ventilation. Last but not least, changes in productivity induced by the orbital parameters remain spatially heterogeneous and could be responsible for more local signal within a single basin.

Laugié, M., Donnadieu, Y., Ladant, J. B., Bopp, L., Ethé, C., & Raisson, F. (2021). Exploring the impact of Cenomanian paleogeography and marine gateways on oceanic oxygen. *Paleoceanography and Paleoclimatology*, 36(7):e2020PA004202.