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Evolution of Early Cretaceous paleotemperatures: A balance between global carbon burial rates and large igneous provinces activity

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The lack of a high-resolution, long-term Early Cretaceous paleotemperature record hampers a full-scale comprehension, as well as a more holistic approach, to Early Cretaceous climate changes. Here we present an extended compilation of belemnite-based oxygen, carbon and strontium isotope records covering the late Berriasian – middle Albian from the Vocontian Basin (SE France). Integrated with paleontological and sedimentological evidences, this dataset clearly demonstrates that three intervals of cold climatic conditions have taken place during the Early Cretaceous greenhouse world. More specifically, these have taken place during (1) the late Valanginian-earliest Hauterivian, (2) the late early Aptian and (3) the latest Aptian – earliest Albian. Each of these intervals is associated with high amplitude sea-level fluctuations, pointing at transient installations of polar ice caps. As evidenced by carbon isotope positive excursions, each cold episode is associated with enhanced burial of organic matter on a global scale. Moreover, there is a very good match between the timing and size of large igneous provinces eruptions and the amplitude of Early Cretaceous warming episodes. Altogether, these observations confirm the instrumental role of atmospheric CO_2 variations in the making of Mesozoic climate change. On a long-term perspective, during the Early Cretaceous, the coupling of global paleotemperature and seawater strontium isotopic ratio is best explained by temperature-controlled changes of continental crust weathering rates.