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Constraining the oxygen isotope composition of early Cretaceous seawater

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The oxygen isotopic composition of well-preserved marine fossils fundamentally underpins our understanding of the evolution of the Earth's climate. However, a lack of constraint on the delta18O of seawater provides a major challenge. In this study new analyses of sub-Arctic and Boreal Cretaceous (Berriasian–late Valanginian, ca. 145–134 Ma) fossil molluscs (belemnites) have been undertaken using carbonate clumped isotopes, an approach based on the "clumping" of 13C and 18O in the carbonate mineral lattice into bonds with each other. From our analyses we infer Early Cretaceous marine temperatures ranging from 10 °C to 20 °C. We identify a cooler late Valanginian interval with temperatures consistent with regions a few degrees above freezing. Our combined temperature and delta18O belemnite data imply seawater delta18O values that have a remarkably modern profile in that they are similar to modern high-latitude seawater and much more positive than values typically assumed for Cretaceous seawater. These high oxygen isotope ratios suggest a hydrological cycle similar to the modern rather than a substantial increase towards a more vigorous hydrological cycle. Our results argue for generally warm but dynamic polar climates during Cretaceous greenhouse intervals that were punctuated by periods of ice growth.