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Data-model comparison reveals key environmental changes leading to Cenomanian-Turonian Oceanic Anoxic Event 2

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The middle Cretaceous (Cenomanian Turonian) was a period characterized by major environmental changes, including elevated sea-floor spreading rates, enhanced volcanism, high atmospheric CO2 levels, warming terrestrial and marine temperatures, and the peak eustatic highstand of the Mesozoic. Two well-known perturbations in the global carbon cycle, that are recognized in various depositional settings, mark this interval the Cenomanian-Turonian Oceanic Anoxic Event 2 (OAE2) and the Mid-Cenomanian Event (MCE). Although studies of OAE2 during the past two decades have arrived at consensus that the Caribbean Large Igneous Province (LIP) likely played a key role in triggering OAE2, the details of environmental developments during the Mid-Late Cenomanian leading up to this event, arguably the most significant biogeochemical perturbation of the Late Cretaceous, have only recently been the focus of investigations. This study employs a simple box model, based on previous studies of mid-Cretaceous climate, tectonism, and sea-level change, to test plausible environmental scenarios to explain the behavior of the Middle Cenomanian to Early Turonian carbon cycle. A compilation of published δ13C datasets of carbonates and organic carbon is used to constrain the timing and magnitude of key excursions in δ13C curves as tiepoints for the carbon cycle isotope-mass balance calculation. The model experiments based on our hypotheses successfully reproduce two distinctive features observed in the Mid-Late Cenomanian δ13C curves - 1) decoupling of δ13Ccarb and δ13Corg reflecting increasing carbon isotope fractionation in response to steadily rising pCO2, driven by enhanced volcanic degassing of mantle-derived CO2, which likely proceeded the presumed peak volcanism of the Caribbean LIP; and 2) a long-lived, secondary positive δ13C excursion that documents enhanced organic carbon burial in shallow shelf areas, which expanded during global sea-level rise and highstand. Our results demonstrate a plausible combination of environmental forcings that pre-conditioned the mid-Cretaceous ocean-atmosphere system for a massive

perturbation, the Cenomania-Turnonian OAE2.

Key words: Box model, MCE, OAE2, carbon cycle