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Consequences of regional variations in Mid-Cretaceous hydrologic cycling on tropical Atlantic ocean redox and marine sedimentation

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A surge of high-quality marine and continental paleoclimate records has become available in recent years that stimulated integrated research on climate and ocean dynamics during periods of extreme warmth, e.g. the mid-Cretaceous. These new proxy records have provided a more precise picture how atmospheric and ocean properties have changed in response to climate fluctuations and orbital forcing. There is growing evidence that fluctuations in the hydrological cycle had a major impact on ocean redox conditions, nutrient availability and finally massive marine carbon burial. One of the major challenges in extreme climate research remains the tasks to link and validate geological records from related areas, such as e.g. the evolving Equatorial Atlantic in the Cretaceous, with global climate models, and vice versa.

In this study we explore one element of the hydrological cycle, continental runoff, within the regional context of the tropical Atlantic and its adjacent land masses. To extract similarities and differences between the western and eastern Equatorial Atlantic we compare quantitative runoff data from tropical South America and Northern Africa deduced from GENESIS GCM with high resolution marine organic carbon records from ODP Sites 1261 off Surinam and Site 959 off Ivory Coast. Earlier studies have shown that ocean redox and subsequent organic carbon burial in the eastern Equatorial Atlantic was primarily determined by precessional-driven fluctuations in continental runoff from northern Africa, producing a distinct, robust and long-term cycle pattern in the sedimentary carbon record. Black shale sedimentation, accordingly, was restricted to one specific orbital configuration (creating strongest seasonality) when nutrient and

freshwater runoff exceeded a certain threshold. From these results it may well be expected that similar driving mechanisms, controls and sedimentary cycle patterns are observed in the western Equatorial Atlantic.

Organic carbon records at ODP Site 1261 unexpectedly do not reveal any cyclicity at higher orbital frequencies below the 100-kyr eccentricity band, despite high enough time resolution of the elemental record. Comparison of total annual river discharge into the eastern and western tropical Atlantic do confirm time-offset maxima in discharge between South America and Africa but these almost balance over one full precession cycle and thus can not explain the different sedimentary patterns observed in the eastern and western tropical Atlantic. More significant though were differences in seasonal discharge patterns of both draining areas. South American peak spring runoff remained at very high levels close to or well above the proposed runoff threshold for all four orbital configurations simulated whereas extremes in spring runoff from Africa stretched much wider for the simulated orbital configurations. More specific, the difference between minima and maxima in spring runoff is twice as large off Africa (14%) compared to Africa (7%). These result on regional runoff pattern support the conclusion that the western tropical Atlantic remained more or less permanently in a perturbed mode supporting high organic carbon production and burial (and thus preventing the formation of sedimentary cyclicity) whereas the eastern tropical Atlantic experienced much larger fluctuations in the hydrologic cycle, probably linked to the establishment of a regional atmospheric teleconnection with mid-southern latitudes.