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Orbitally-paced South American Summer Monsoon variability during the mid- to late-Pleistocene

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Hydrological extremes related to the South American Summer Monsoon (SASM) are expected to become more frequent in the near future and might have devastating socioeconomic consequences for the densely populated region of eastern Brazil. Given the complexity in SASM behaviour in space and time, a dense coverage of monsoonal precipitation records, particular those spanning multiple glacial-interglacial cycles, are urgently needed to constrain this high spatial-temporal variability. This information is necessary to reduce the uncertainty associated with projections of SASM precipitation in response to rising anthropogenic greenhouse gas (GHG) emissions. Here we use elemental ratios from X-ray fluorescence scanning of two sediment cores retrieved off the eastern Brazil margin to reconstruct long-term rainfall changes in the hinterland. Our findings from core M125-55-7 (offshore the Doce River, 20°S) reveal that during the past ~320 kyr, precession-paced insolation forcing is the primary pacemaker of variations in SASM precipitation over the Doce basin. We also determined an anomalous interval of weak monsoonal response to insolation forcing during Marine Isotope Stage 6, which we attribute to enhanced wintertime precipitation due to exceptionally strong southeast trade winds created by a steep South Atlantic latitudinal temperature gradient. Moreover, our results suggest that albeit predominantly driven by insolation forcing, the intensity of SASM rainfall responds negatively to GHG forcing, most likely through indirect feedbacks. We propose that GHG forcing directly influences the magnitude of both the inter- and intrahemispheric latitudinal temperature gradients, which in turn modify the strength of atmospheric circulation and precipitation in the tropics. Thus, we suggest that SASM rainfall intensity over tropical eastern Brazil will likely be suppressed by rising CO_2 emissions in the future. Our preliminary analysis of core M125-73-3 (off the Contas River; 12°S) reveals regional differences in monsoonal precipitation between the more northerly Contas basin and the more southerly Doce basin. Most notably, unlike the insolation-paced continental rainfall variability recorded at site M125-55-7, SASM rainfall intensity over the Contas basin appears to be more sensitive to glacial-interglacial scale pacing over the past ~800 kyr. Taken together, our records reveal both the high spatial variability in SASM precipitation over eastern Brazil and the dominant influence of orbital forcing on monsoonal rainfall intensity.