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Isostasy amplifies relative sea-level change on continental-scale deltas

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The nature and contribution of flexural isostatic compensation to subsidence and uplift of passive margin deltas remains poorly understood. We performed a series of simulations to investigate flexural isostatic responses to high frequency fluctuations in water and sediment load associated with climatically-driven sea-level changes. We use a parallel basin and landscape dynamics model, BADLANDS, (an acronym for BAsin anD LANdscape DynamicS) that combines erosion, sedimentation, and diffusion with flexure, where the isostatic compensation of the load is computed by flexural compensation. We model a large drainage basin that discharges to a continental margin to generate a deltaic depocenter, then prescribe synthetic and climatic-driven sea-level curves of different frequencies to assess flexural response. Results show that flexural isostatic adjustments are bidirectional over 100-1000 kyr time-scales and mirror the magnitude, frequency, and direction of sea-level fluctuations, and that isostatic adjustments play an important role in driving along-strike and cross-shelf river-mouth migration and sediment accumulation. Our findings demonstrate that climate-forced sea-level changes set up a feedback mechanism that results in self-sustaining creation of accommodation into which sediment is deposited and plays a major role in delta morphology and stratigraphic architecture.