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The effect of flexural isostasy on continental-scale source-to-sink systems

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Lithospheric flexure is a first-order allogenic control in sediment dispersal systems as flexural rebound causes uplift in upstream regions while isostatic compensation of the sediment load creates accommodation in sinks. However, high-frequency, high-resolution isostatic adjustments to changes in crustal loading and its interaction with sea-level changes are usually not considered as a control in source-to-sink systems. To explore this interaction in passive margins, we use a parallel basin and landscape dynamics model, BADLANDS, (acronym for BAsin anD LANdscape DynamicS) that combines erosion, sedimentation, and diffusion with flexure, and where isostatic compensation of the load is computed by flexural compensation. Our approach creates a series of simulations where sediment is transported by channel flow and linear diffusion processes to generate a delta, and where sea-level curves with contrasting frequencies are prescribed, such in the case of green-house to ice-house periods. These simulations are then compared to a suite flexurally-compensated models. To drive our simulations we use gradient, water discharge, sediment flux and lithospheric elastic thickness values and depositional sediment volumes that are within the range of large-scale source-to-sink systems. Results of the simulations show that transit distances for river mouths to the shelf break are four times larger in the cases with no flexure. In those cases where flexure is not considered, there is no isostatic compensation of the sediment load, limited accommodation, and the delta is forced to prograde farther into the sink. Conversely, in simulations where the isostatic compensation of the sediment load is taken into account, vertical accommodation is created closer to the terminus of the delta, which reduces the transit distances for river mouths to reach the shelf break. These results highlight the importance of considering the effect of isostatic compensation of the sediment load on source-to-sink systems and shelf morphology.