

Time-varying Paleohydrology of the Mississippi River and Present-day Crustal Motion Adjacent to the Gulf of Mexico

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Although the Gulf of Mexico is far removed from the former ice sheet centers, the waxing and waning of Quaternary glaciations have affected the region through large sea level excursions and fundamental changes in routing of sediments into the Gulf of Mexico. The retreat of the Laurentide ice sheet following last glacial maximum (LGM) produced widespread solid Earth deformation during and after ice sheet demise associated with the Bölling/Allerød interstadial (14-12 ka) warming event. The direct response in the Gulf region, however, has long since faded away. Recent glacial isostatic adjustment (GIA) models calibrated by geodetic data show that the long wavelength peripheral bulge which encircles crustal rebound has now migrated over 1000 km north from the Gulf of Mexico and the regional residual vertical motions are quite small (≤ 0.5 mm/a) at present-day [Sella et al., 2007]. However, present-day response to the loading inundation of ~130 meters of equivalent (or eustatic) sea level rise (ESLR) rise at 21-5 kyr BP and Pleistocene sediment transport deposition and loading to the Gulf cannot be dismissed as possible causes of present-day vertical crustal motion. We model both the sediment and ocean load to test predictions of subsidence to that measured using GPS.

Sea level rise in the Gulf of Mexico has occurred at a rate of about 1.8--2.2 mm/yr during the 20th century, or nearly the same as observed globally due to combined steric and water mass changes. Land subsidence enhances the rate of inundation of some coastal lands by many times the rate of global mean sea level rise. Tide gauges in coastal Louisiana, however, record a substantially larger rate of rise and while a number of causal mechanisms may be responsible, their specific contribution is poorly understood. Using a realistic viscoelastic Earth model, detailed geologic parameters for south Louisiana and new GPS data, we demonstrate that Holocene sedimentary loading in the Gulf and Mississippi River delta is capable of contributing to 1--8 mm/yr of subsidence that is largely decoupled from ongoing shallow sediment compaction and anthropogenic causes over areas of $30\text{--}0.75 \times 10^3$ square km.