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Observation and model of post-glacial sediment load and subsidence in the Gulf of Mexico

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Sea level rise in the Gulf of Mexico has occurred at a rate of about 1.8 – 2.2 mm/yr during the 20^{th} century, or nearly the same rate as observed globally due to combined steric and water mass changes. However, critical urban and infrastructural sites , such as the city of New Orleans, rapid subsidence enhances the rate of inundation of coastal lands by many times the rate of global mean sea level rise. A number of local mechanisms may be responsible, including sediment compaction, gravity faulting and fluid withdrawal. Sediment loading is one mechanism that has received little attention. Here we use a combination of viscoelastic modeling and precise Global Positioning System (GPS) measurementsof vertical crustal motion to demonstrate that the enhanced rate of subsidence may be caused, largely, by sediment loading. The excellent agreement of data and model demonstrate that the time-varying Pleistocene and Holocene sediment history is a fundamental aspect of predicting the present-day background lithosphere and mantle vertical response beneath southernmost Louisiana. Upper mantle viscosities inferred from recent studies of Laurentide glacial isostatic adjustment ($\sim$3 x 10^{20}Pa s) are consistent with the viscoelastic 'memory' required for this unique sensitivity to Holocene sediment loading. The load model predicts the observed vertical rates of 1 - 8 mm/yr over areas of 30,000 to 750 km^2, respectively.