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Impact of the Atlantic Multidecadal Oscillation and Mississippi River Discharge Anomalies on Gulf of Mexico Sea-Level Anomalies and Land Loss Rates in the Mississippi Delta

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ABSTRACT

More than 90% of the Mississippi River Delta landscape in south Louisiana is <0.5 m elevation. Land loss was ongoing in the mid 1800s as a natural part of delta evolution but became more widespread by the earliest 20th century due to levees that limited sediment dispersal to the delta plain, and acceleration of global sea-level rise. Mapping of land loss over time also shows land-loss acceleration in the late 1960s to mid 1990s and deceleration after 1995, which has been commonly attributed to local anthropogenic causes, specifically acceleration and deceleration in subsidence from subsurface fluid withdrawals. We identify an alternative chain of causality for anomalaous land loss rates that reflects the Atlantic Multidecadal Oscillation (AMO) and associated anomalies in Mississippi River freshwater discharge and coastal sea level. Our analyses show that what has been called the AMO cool phase produces anomalously strong onshore winds that transport moisture deep into the US midcontinent and Gulf of Mexico watershed, which in turn produces anomalously high Mississippi River discharges to the Gulf of Mexico and strong onshore wind stresses that pile up water to produce higher coastal sea level. By contrast, the AMO warm phase produces a negative anomaly in moisture flux into the US midcontinent that produces anomalously low Mississippi River discharge, as well as alongshore west-to-east directed wind anomalies along the northern Gulf Coast that favor offshore Ekman transport and lower coastal sea-level. Current research argues the AMO signal reflects climate system response to anthropogenic and natural forcing rather than intrinsic variability. Regardless of what causes the AMO signal, we interpret higher land-loss rates of the late 1960s to mid 1990s to reflect anomalously high sea level of the AMO cool phase, whereas lower land-loss rates since 1995 reflect anomalously low sea level of the AMO warm phase.

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