EGU22-11483
https://doi.org/10.5194/egusphere-egu22-11483
EGU General Assembly 2022

Semi-diurnal vs. diurnal tides: implications for coastal wetland adaptability to sea level rise

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Relative sea level rise (RSLR) is widely regarded as a threat to highly valued coastal wetlands such as tidal marsh and mangrove ecosystems. In certain places around the world, coastal wetlands already show signs of submergence due to RSLR, while in other places these wetlands instead show a certain ability to adapt to RSLR through sediment accretion and resulting surface elevation gain. Identifying the factors that drive the global variability in coastal wetland adaptability to RSLR is thus a major scientific and societal challenge. Regional- to global-scale empirical assessments and model projections have revealed that the rate of RSLR itself, the tidal range and sediment supply are major drivers of wetland adaptability. Yet, these assessments ignore the role of the tidal pattern, which varies around the world from semi-diurnal to diurnal. Here, we present a meta-data analysis, including 423 tidal marsh and mangrove sites around the world, to assess the relative influence of tidal patterns, on globally observed rates of wetland elevation change in comparison with local RSLR rates. We demonstrate that the tidal pattern contributes importantly to explain the variability in wetland adaptability to RSLR. Specifically, coastal wetlands occurring under predominantly diurnal tides are more subject to elevation deficits relative to RSLR, as compared to wetlands under predominantly semi-diurnal tides. Using a tidal wetland accretion model, we further illustrate that less frequent, diurnal tides trigger lower sediment accretion rates, hence higher wetland vulnerability to RSLR, across a wide range of scenarios of RSLR rates, tidal ranges, and sediment supply. Our findings highlight the tidal pattern as a previously overlooked yet important driver of coastal wetland adaptability to RSLR and offer new perspectives on the understanding and projection of coastal wetland responses to future RSLR. We also call for new research as tidal patterns may also affect other key wetland ecosystem functions and services.