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Modeling the Impact of Tropical Cyclones on Developed Coastlines Under Future Sea-Level Rise Scenarios

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Global warming and climate change represent a severe hazard for the global population living within low-elevation coastal zones. Coastal communities are already experiencing social and economic impact under current sea-level rise, in the future however, their overall exposure to inundation and erosion will be even greater. These impacts are further magnified under extreme storm conditions, like tropical cyclones. In 2016, Hurricane Matthew skirted the coastline of Palm Beach, Florida. The category 4 storm subjected the area to significant storm surge and powerful wave conditions; leaving a swath of destruction in the storm's wake. In order to provide an insight into coastal change during tropical cyclone events under future sea-level rise scenarios, this study utilizes a coupled 2DH hydrodynamic and morphodynamic XBeach model that is evaluated under two local sea-level projections. Both sea-level rise scenarios are extracted from Kopp et al. (2014) and Kopp et al. (2017), and are applied to a validated hindcast of Hurricane Matthew. The effective doubling of sea-level rise projections under hurricane conditions significantly increases overwash and inundation of the beach. This greater exposure of the entire beach profile to hydrodynamic forces, drives increases in deposition along the backbeach, as well as erosion along the foot of coastal protection structures. Analysis of shoreline hydrodynamics indicate that wave velocities and wave height increase in conjunction with sea-level rise. This experimental structure shows the applicability of XBeach in modeling the impact of future tropical cyclones under changing sea-levels and opens the door for continuing investigations.