**Predictable changes in extreme storm tides and coastal flood risk due to nodal and perigean cycles**

**Alejandra R. Enriquez1, Thomas Wahl1, Hannah E. Baranes2, Stefan A. Talke3, Philip M. Orton4, James F. Booth5, Ivan D. Haigh6**

1Department of Civil, Environmental and Construction Engineering and National Center for Integrated Coastal Research, University of Central Florida, Orlando, FL 32186, USA. (a.enriquez@ucf.edu)

2Gulf of Main Research Institute, Portland, Main, USA

3Department of Civil and Environmental Engineering, California Polytechnic State University, San Luis Obispo, CA 93407, USA

4Oceanography Department, Stevens Institute of Technology, Hoboken, NJ, USA

5Earth and Atmospheric Sciences, City College of New York, and Earth and Environmental Science, The Graduate Center, City University of New York, New York, NY, 10016, USA

6School of Ocean and Earth Science, National Oceanography Centre Southampton, University of Southampton, Waterfront Campus, European Way, Southampton SO14 3ZH, UK

**Abstract**

The 18.61-year nodal and 8.85-year perigean tidal cycles significantly modulate extreme storm tides (EST), influencing the flood hazard at interannual to decadal time scales. Identifying the amplitude and timing of the tidally-induced modulations in EST can help to prepare for and mitigate coastal flood risk. The influence of the nodal/perigean modulations in water levels has been the subject of previous research, however, there are no studies that have propagated these modulations in extreme water levels over land, and thus, the consequences for inundation and value of mitigation are poorly understood. Here, we use a quasi-nonstationary skew surge joint-probability method to assess the tidally-induced variations in potential flood inundation at 344 global tide gauges. The geographic variability in potential flood inundation is assessed in four case studies located in the U.S.

The analyses demonstrate that the nodal/perigean cycles influence EST at 234 tide gauges. Results show spatially coherent regions where the amplitudes of the modulations are particularly relevant in EST. We identify locations that are currently in a positive phase of the modulation and therefore, at a higher risk of flooding, as well as when (year) the next peak of the nodal/perigean modulations is expected to occur. The timing of the peak of the modulation depends on which signal (nodal or perigee) predominates at each site, as well as the relative importance of each cycle over the total amplitude. We demonstrate that tidally-induced changes in EST affect estimates of potential flood risk in a predictable way. The nodal/perigean modulations in EST can lead to changes in 100-year flood plains of up to ~45% in Boston. Further research is needed to include other sources of quasi-predictable interannual and decadal variability in the EST and 100-year flood plains, such as climatic modes.