Drivers of the Spatial and Temporal Variability in Sea Level Extremes

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Extreme sea levels are among the most hazardous threats for the coastal environment. They cause coastal flooding, thus impacting coastal communities, ecosystems and infrastructure, and lead to significant social and economic damage and even fatalities. High waters arise from the interplay of astronomical tides, storm surges and mean sea level variations. Changing climatic and topographic conditions may alter one or more of these contributions to extreme sea levels, leading to increased or decreased coastal vulnerability. Understanding the distribution of extremes, their drivers and the associated risks is therefore an important requirement for coastal management.

Observational evidence of extreme sea levels and their changes relies on high-frequency tide gauge records. Presently, the most extensive data base is the Global Extreme Sea Level Analysis (GESLA) data set, recently compiled and freely released (www.gesla.org). It contains the longest and most geographically representative sea level records at hourly, and higher, temporal sampling. In this contribution, we will make use of the available tide gauge observations to illustrate the geographical coherence of the intensities and frequencies of occurrence of sea level extremes. Changes in extremes at inter-annual to multi-decadal time scales will be shown to be mostly, but not uniquely, driven by mean sea level variations. Long-term changes in the storm surge component of extremes unrelated to mean sea level are documented globally, linked to large-scale climate patterns. Therefore this variability of extremes associated with climate drivers should be considered in the framework of climate change studies. Finally, we test the assumption of stationarity of the probability of extreme occurrence and to which extent it holds when mean sea level changes are considered in combination with storm surges and in the context of a warming climate.

Keywords: extremes, tide gauges