Examining Extreme Sea Level Variations from In-Situ Tide-Gauge Records and Satellite Observations

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The estimation of extreme water level values is a requirement for a wide range of engineering applications. In addition, climate variations of extreme sea levels on the coastal area result from a complex interacting of oceanic, atmospheric and terrestrial processes across a wide range of spatial and temporal scales. There are two major sources of historical sea level observations to characterize extreme sea level events: in-situ data (mainly records from tide gauges) and remote data from satellites. This work presents a study of the extreme sea level climate variability exploring (and comparing) both sources of information worldwide.

Tide-gauge records from the global dataset GESLA2 have been used (Woodworth et al. 2016). After several quality control processes (detection of outliers, jumps in the signals, presence of gaps, etc), monthly maxima from tide-gauge records were selected. On the other hand, novel coastal altimetry datasets become available for the last years (Cipollini et al. 2016). Here, CMEMS satellite sea level data of the Marine Environment Monitoring Service of the EC/ESA Copernicus Programme has been used. The CMEMS dataset has a global coverage and consists of the data gathered by 14 different missions between the years 1993 and 2016. As this study aims at investigating satellite data in close vicinity to the tide gauge stations, the denser spatially unfiltered version of CMEMS sea level variables was used (7km against 65km subsampled by 14km of the filtered version). The sea level variability from CMEMS is corrected for the astronomical tide by using the FES2014 new tide model and the mean sea level variations, sea level anomalies and atmospherically induced variabilities are considered. The spatial correlation between satellite data and each tide-gauge station was analyzed in order to select homogeneous areas of variability. Finally, declustered hourly maxima values from altimeter were used to chose monthly maxima. Once historical monthly maxima from both dataset were selected a non-stationary probabilistic extreme model is used in order to find spatial patterns, seasonal, interannual, decadal and long-term variations (Menéndez and Woordworth, 2010). Analyzing and comparing extreme estimate results (e.g. 50 year return values) from the two sources of observations allow to assess to what extent satellite extreme sea level information can be used along coastlines where no in-situ information of sea level is available.

Keywords: Extreme sea level, tide-gauge, satellite, climate variations, regional patterns