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Examining global extreme sea level variations on the coast from in-situ and remote observations

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The estimation of extreme water level values on the coast is a requirement for a wide range of engineering and coastal management 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.
In this study, variations of extreme sea level return values are investigated from two available sources of information: in-situ tide-gauge records and satellite altimetry data.
Long time series of sea level from tide-gauge records are the most valuable observations since they directly measure water level in a specific coastal location. They have however a number of sources of in-homogeneities that may affect the climate description of extremes when this data source is used. Among others, the presence of gaps, historical time in-homogeneities and jumps in the mean sea level signal are factors that can provide uncertainty in the characterization of the extreme sea level behaviour. Moreover, long records from tide-gauges are sparse and there are many coastal areas worldwide without in-situ available information. On the other hand, with the accumulating altimeter records of several satellite missions from the 1990s, approaching 25 recorded years at the time of writing, it is becoming possible the analysis of extreme sea level events from this data source. Aside the well-known issue of altimeter measurements very close to the coast (mainly due to corruption by land, wet troposphere path delay errors and local tide effects on the coastal area), there are other aspects that have to be considered when sea surface height values estimated from satellite are going to be used in a statistical extreme model, such as the use of a multi-mission product to get long observed periods and the selection of the maxima sample, since altimeter observations do not provide values uniform in time and space.
Here, we have compared the extreme values of 'still water level' and 'non-tidal-residual' of in-situ records from the GESLA2 dataset (Woodworth et al. 2016) against the novel coastal altimetry datasets (Cipollini et al. 2016). Seasonal patterns, inter-annual variability and long-term trends are analyzed. Then, a time-dependent extreme model (Menendez et al. 2009) is applied to characterize extreme sea level return values and their variability on the coastal area around the world.