**Analysis of extreme skew surges combining systematic skew surges and historical water levels**

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**Abstract**

Some recent coastal floods due to exceptional surges point to the importance of considering the risk of marine submersion for the siting and design of coastal facilities. The estimation of extreme water levels is crucial for coastal planning efforts. The distribution of astronomical high tides is deterministic and can be predicted accurately. In recent works, the estimation of extreme water levels is therefore often based on the calibration of a statistical distribution for extreme skew surges. Tide gauge records are frequently relatively short. The uncertainties associated to frequency analyses may significantly be reduced by integrating historical information. Historical events consist in record water levels observed before the beginning of the tide gauge recordings and their corresponding skew surges can be estimated. However, some extreme skew surges can easily remain unnoticed during the historical period, if they coincide with low or moderate tides and do not generate extreme water levels. The exhaustiveness of historical skew surges, which is an essential criterion for an unbiased statistical inference, is therefore not guaranteed.

To deal with this exhaustiveness issue, this study proposes to combine, in a single Bayesian statistical inference procedure the series of measured skew surges for the systematic period, and the extreme sea levels for the historical period. The method is tested through Monte Carlo simulations at four sites (tide gauges) located on the French Atlantic and Channel coasts. Results indicate that the approach provides unbiased quantile estimates, is much more reliable than previously published approaches for the integration of historical skew surges and performs almost as well as an approach based on a perfect knowledge of historical skew surges.