

Supplement

MAROR: a multipoint autoregressive network for forcing-driven, uncertainty-calibrated reconstruction of hourly coastal sea level from 1940 to the present

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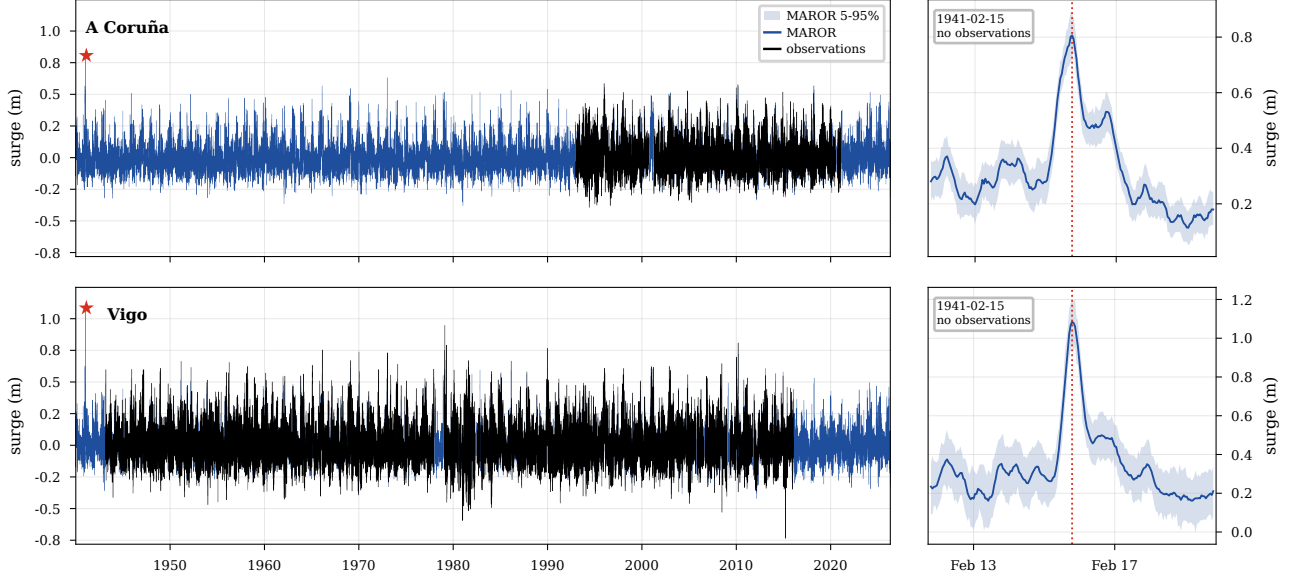


Figure S1: Full MAROR reconstruction at A Coruña and Vigo (Spain–France region), the two tide gauges whose record maximum falls on an event that has no observations. One row per tide gauge, both on a common vertical scale so their amplitudes can be compared directly. Left: the hourly de-tided surge over the whole reconstruction period (1940 to present). Blue is the MAROR reconstruction, run fully self-fed from the atmospheric forcing and the astronomical tide; black is the observed surge, drawn only at the hours where an observation exists, so the absence of data before 1993 at A Coruña and the coverage gaps at Vigo are directly visible. The red star marks the largest reconstructed surge of each record, which occurs on 15 February 1941 at both tide gauges (0.81 m at A Coruña and 1.09 m at Vigo), in a year with no observations and before the satellite altimetry period. Right: a ± 4 day window centred on that event; blue is the MAROR reconstruction with its 5 to 95 % ensemble band, and the observed series (black) is empty because no observation exists. At both tide gauges the reconstructed maximum exceeds the largest surge ever observed there, illustrating that MAROR reconstructs historical extremes that were never available to it as a training target.

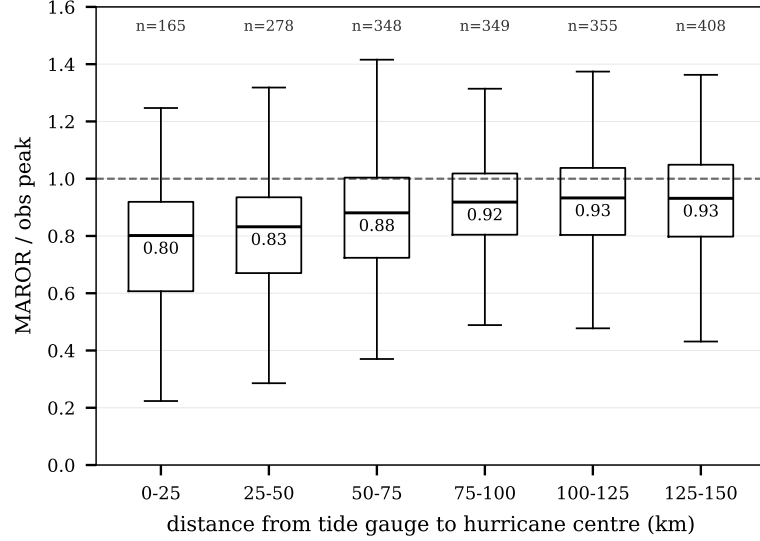


Figure S2: Skill of MAROR at reconstructing tropical-cyclone surge peaks as a function of the distance of the TC center and the tide gauge at the largest surge registered. The statistic is the peak ratio, defined per event as the reconstructed surge peak divided by the observed surge peak, and it is grouped in 25 km bins of the distance from the tide gauge to the cyclone centre at closest approach. An “event” is a pairing of one tropical cyclone with one tide gauge, retained only when the storm was of Saffir–Simpson category 1 or above at its closest approach and that closest approach was within 150 km of the tide gauge. Cyclone tracks, positions and intensities are taken from IBTrACS (USA_SSHS for the category, and the reported centre latitude and longitude for the distance). Events are pooled over all regions that experience tropical cyclones (Gulf of Mexico, US East Coast, Japan North and South, and Western Australia), giving $n = 1903$ events (the number in each bin is printed above the box). For every event the sea-level record is de-tided; the observed peak is the maximum observed storm surge within ± 1.5 days of the closest approach, and the reconstructed peak is the maximum MAROR surge within ± 24 h of the observed peak, the short window allowing a small timing offset between the two. Events whose observed peak is below 0.1 m are discarded to avoid unstable ratios. In each box the central line is the median (its value is annotated just below it), the box spans the interquartile range (25th to 75th percentiles), and the whiskers extend to 1.5 times the interquartile range; outliers are not drawn.