Estimating contribution of high-frequency sea-level oscillations to the extreme sea levels in the Adriatic Sea

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Introduction

Extreme sea levels are known to hit the Adriatic Sea and to occasionally cause floods that produce severe material damage. Whereas the contribution of long-period (T > 2 h) sea-level oscillations to the phenomena has been well researched [1], the contribution of the short-period (T < 2 h) oscillations has been studied only for individual meteotsunami events. We have collected and analyzed 1-min sea-level time series originating from 19 tide gauges, 9 located at the Italian (north and west) and 10 at the Croatian (east) Adriatic coast, precisely with this aim of estimating contribution of the shorter-period oscillations to total extremes.

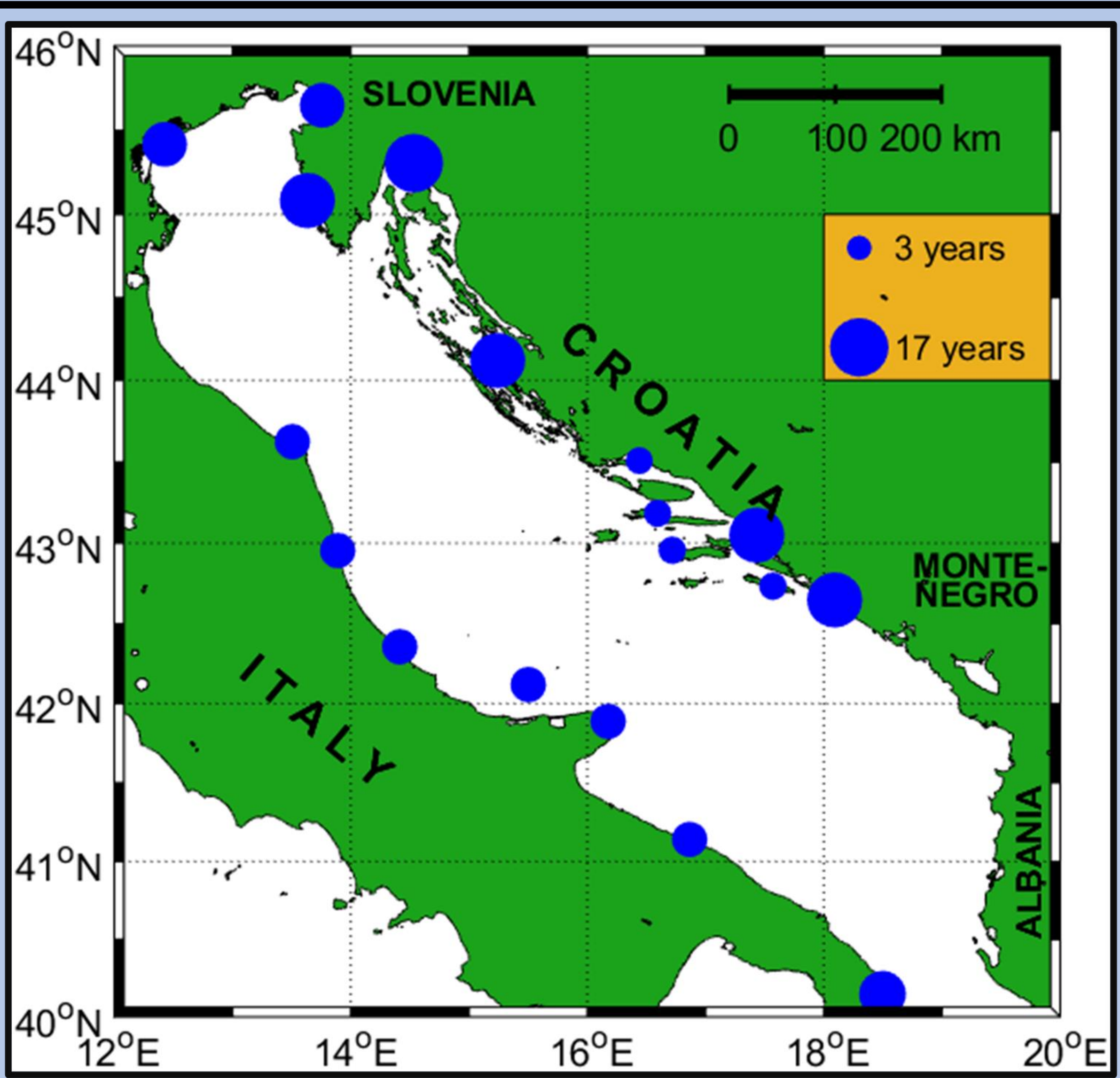

Figure 1. Locations of the Adriatic Sea tide gauges. Size of circles is proportional to length of available sea-level time series.

Method

Prior to analysis, sea-level data were thoroughly checked, and spurious data were removed. This was followed by the removal of tidal signal [2]. Further analyses were done on residual time series. For each station, extreme sea-level episodes were defined as time periods during which residual sea level surpassed its 99.9 percentile value. The residual signal was then split into a high-frequency (T > 2 h) and a low-frequency (T <= 2 h) component. This was followed by statistical estimation of contribution of short-period oscillations to extremes at each station.

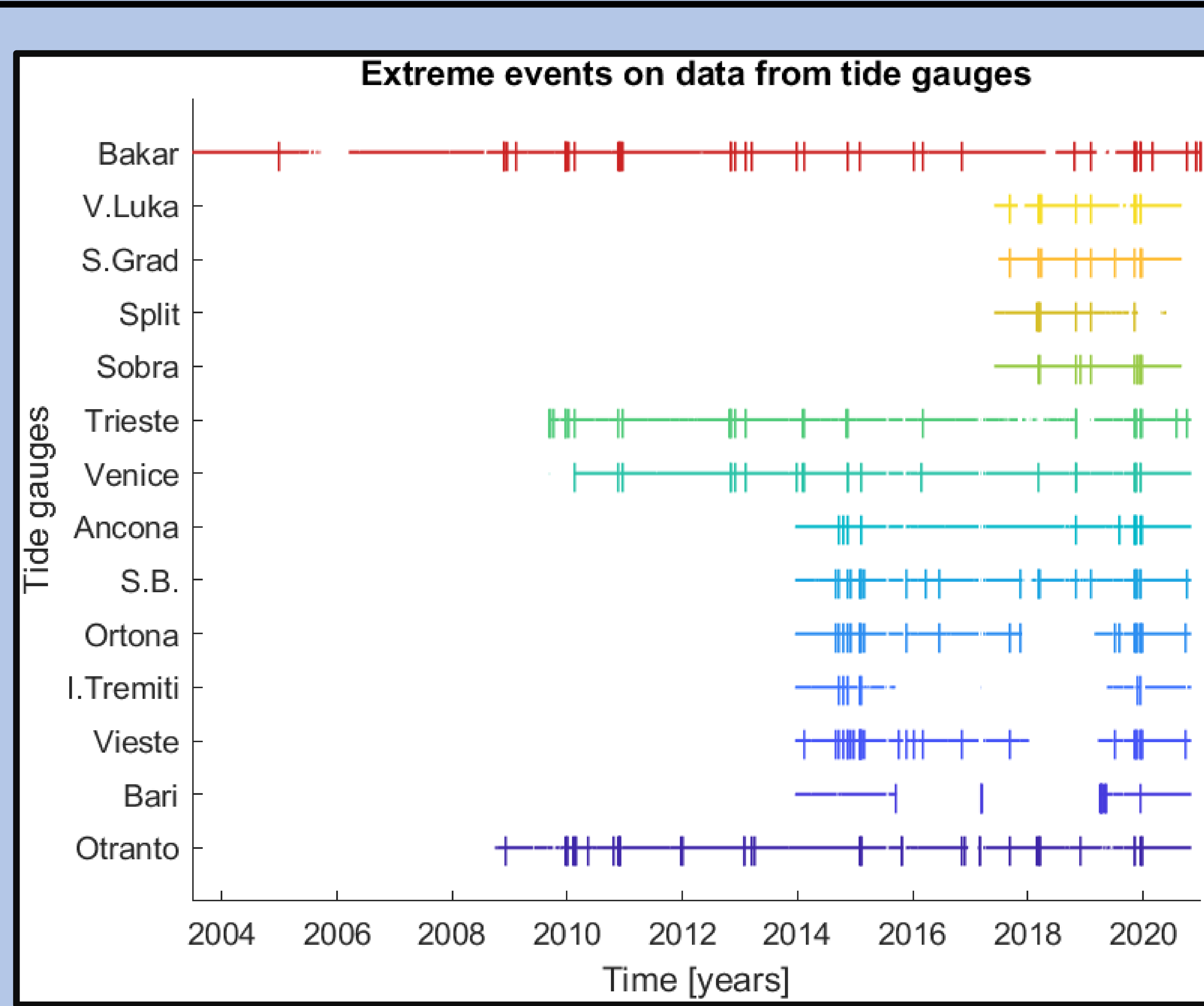

Figure 2. Availability of data and temporal distribution of extreme events (indicated with vertical lines) at each tide gauge.

Results

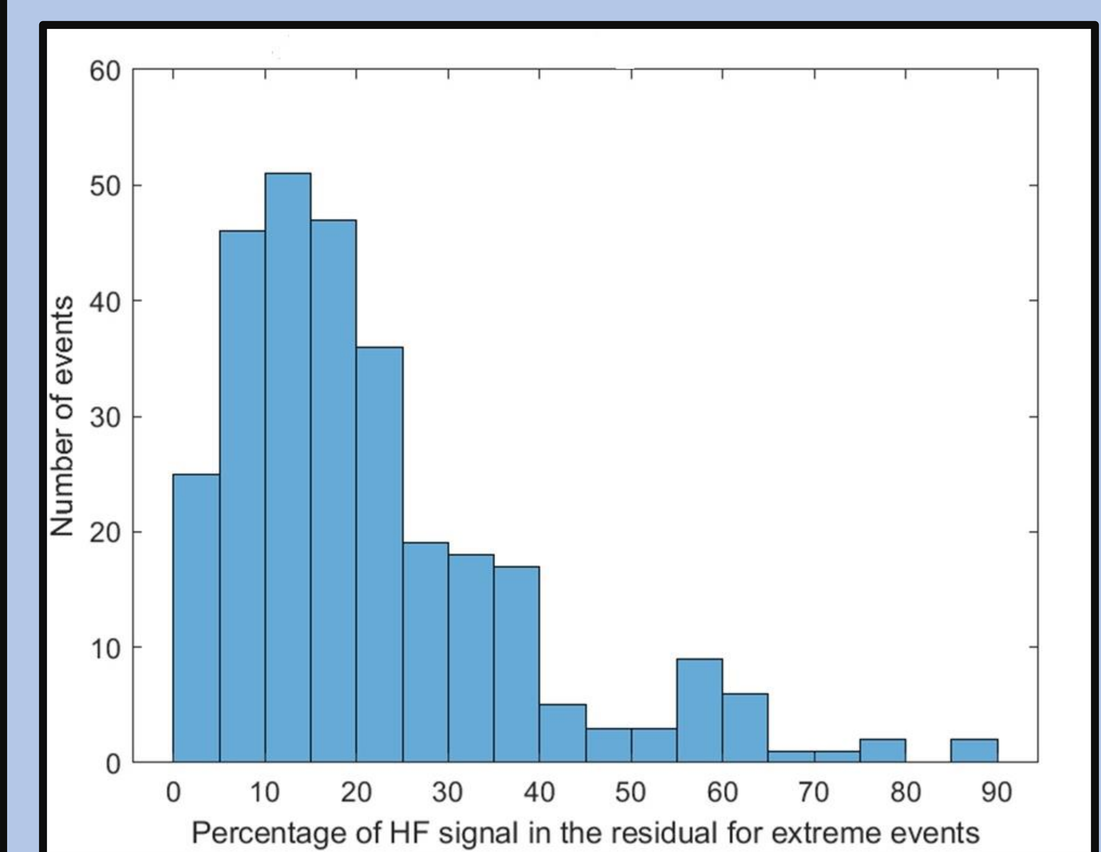

Figure 3. Histogram of all extreme events on all tide gauges. High-frequency oscillations contribute to extreme sea levels:

- with 5-20% in average,
- with more than 50% during 8% of extreme episodes.

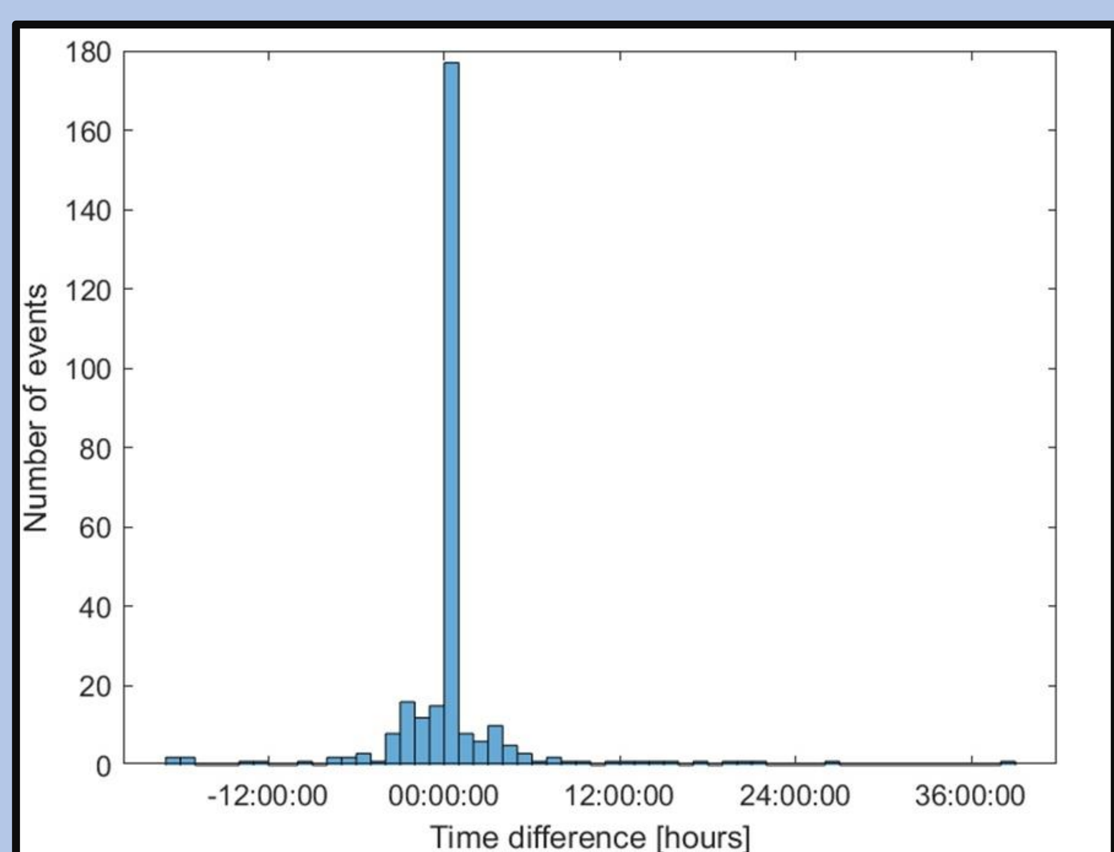

Figure 4. For every tide gauge and all extreme events maximum of high-frequency sea-level oscillations normally happens within +- 30 min of the residual signal maximum.

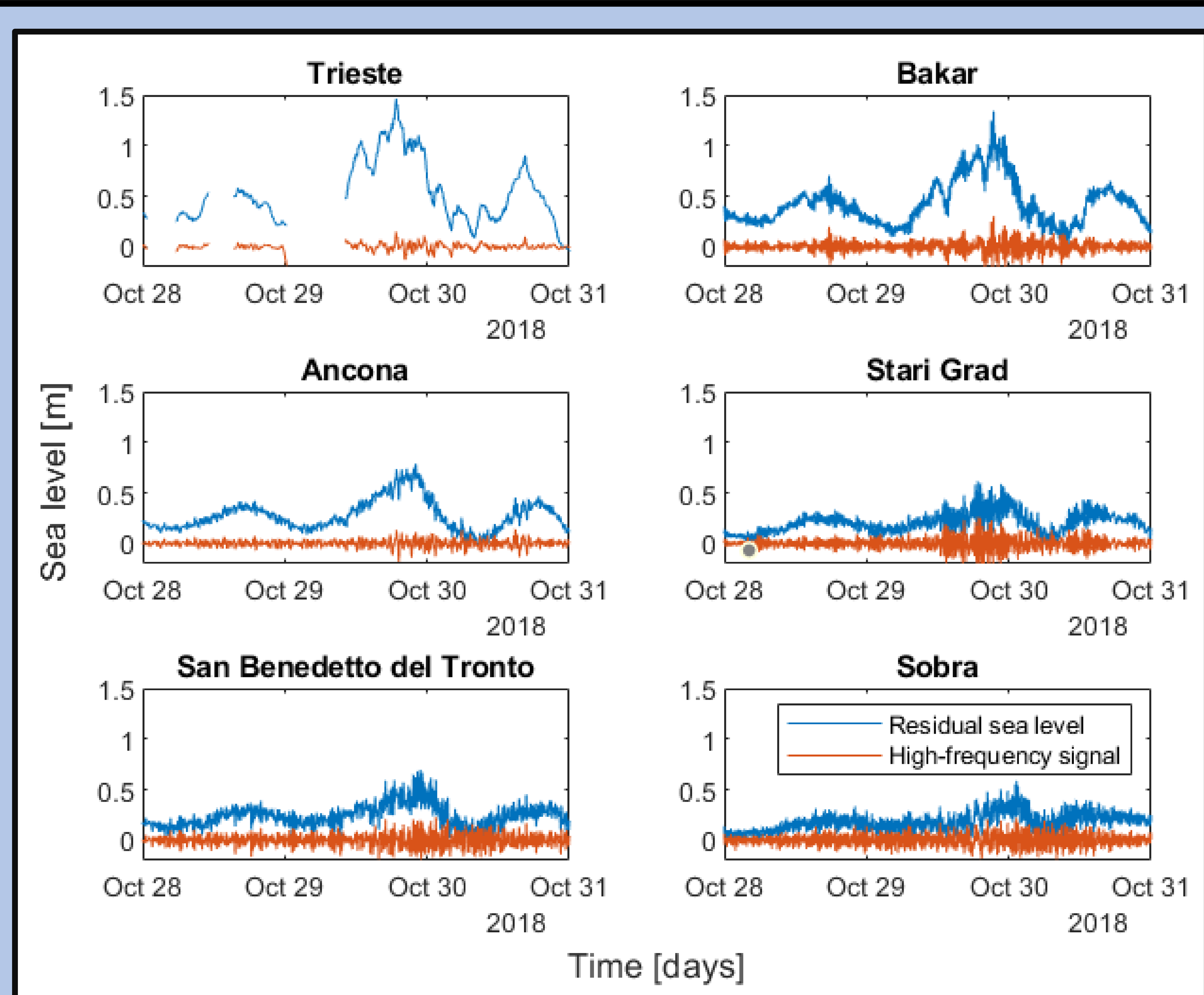

Figure 5. One extreme event on six tide gauges in the Adriatic. There are pronounced spatial differences between amplitudes of high-frequency oscillations during individual events.

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References: [1] Ivica Vilibić, Jadranka Šepić, Mira Pasarić and Mirko Orlić (2017). The Adriatic Sea: A Long-Standing Laboratory for Sea Level Studies. *Pure and Applied Geophysics 174 (2017), 3765–3811 DOI 10.1007/s00024-017-1625-8*

[2] Medvedev, I. P., Vilibić, I.,& Rabinovich, A. B. (2020). Tidal resonance in the Adriatic Sea: Observational evidence. *Journal of Geophysical Research: Oceans, 125,e2020JC016168. https://doi.org/10.1029/2020JC016168*