Extreme wave events attribution using ERA5 datasets for storm surge studies in the northern Adriatic sea

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OPERANDUM
www.operandum-project.eu

STUDY REGION

Northern Adriatic Sea

The Po river valley is one of the Open Air Laboratories of OPERANDUM Project, where different hydro-meteorological hazards occur and NBS are under development to mitigate their impacts.

River flooding (Panaro river), drought (whole valley) and salt intrusion (Po delta) and storm-surge (along the Adriatic coast) have significant impacts on human activities, structures and ecosystems.

In this work we investigate to what extent ERA5 reanalysis of Sea Level Height and Significant Wave Height (SWH) can be used to assess extreme storm-surge events.

We compared hourly ERA5 (0.25°x0.25°) reanalysis with data from Nausicaa wave measuring station (each 30 min, owned by ARPAE), and a database of extreme events in the last 12 years.

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Extreme Events using ERA5

Identified Storm Surge events

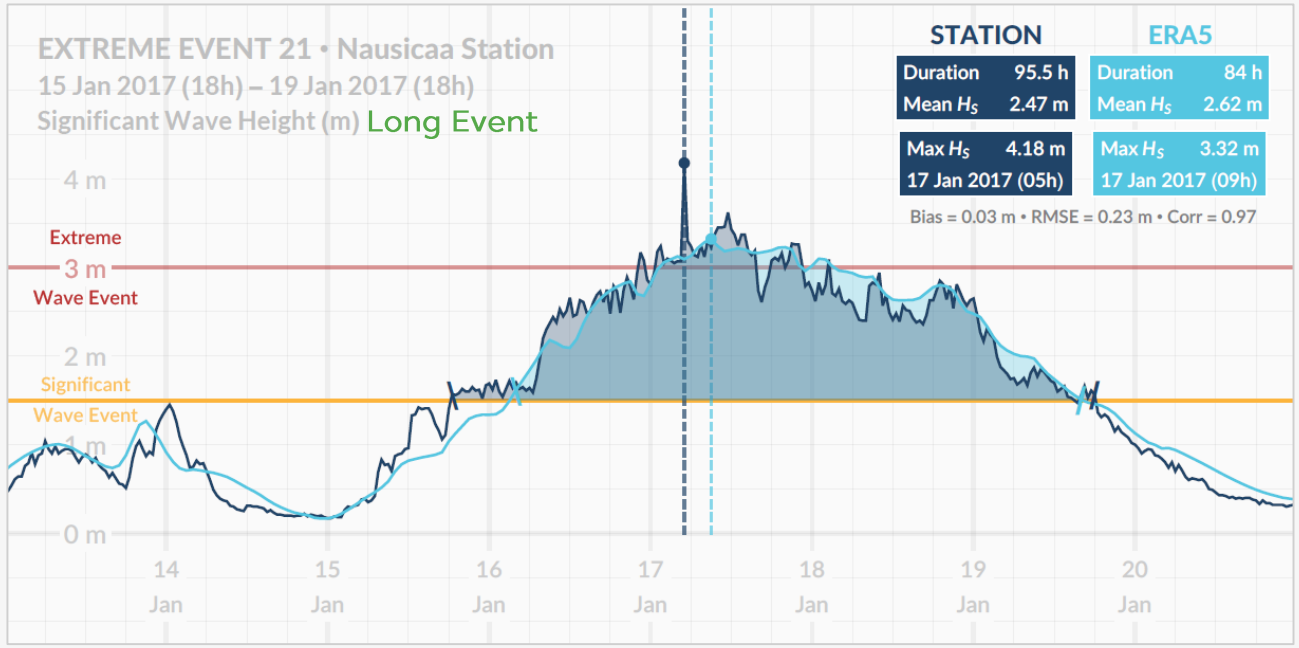
15
Literature
Perini *et al.* (2018)
(1992–2018)

26
Measured data
Nausicaa Station
(2007–2018)

SWH thresholds:

1.5 m
Relevant Events
minimum of 6 hours

3.0 m
Extreme Events
minimum one record



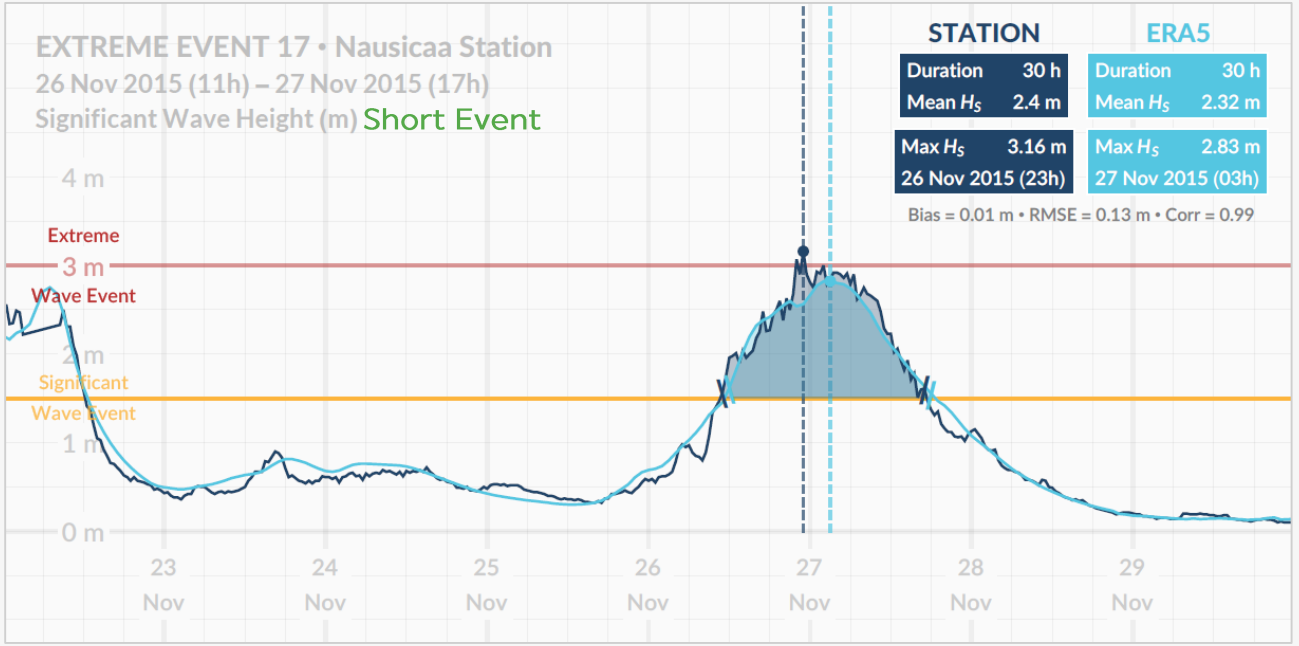


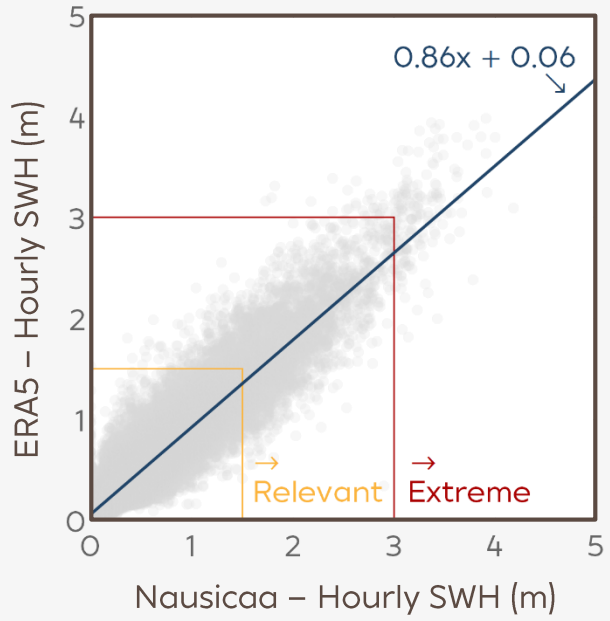
FIGURE ↗

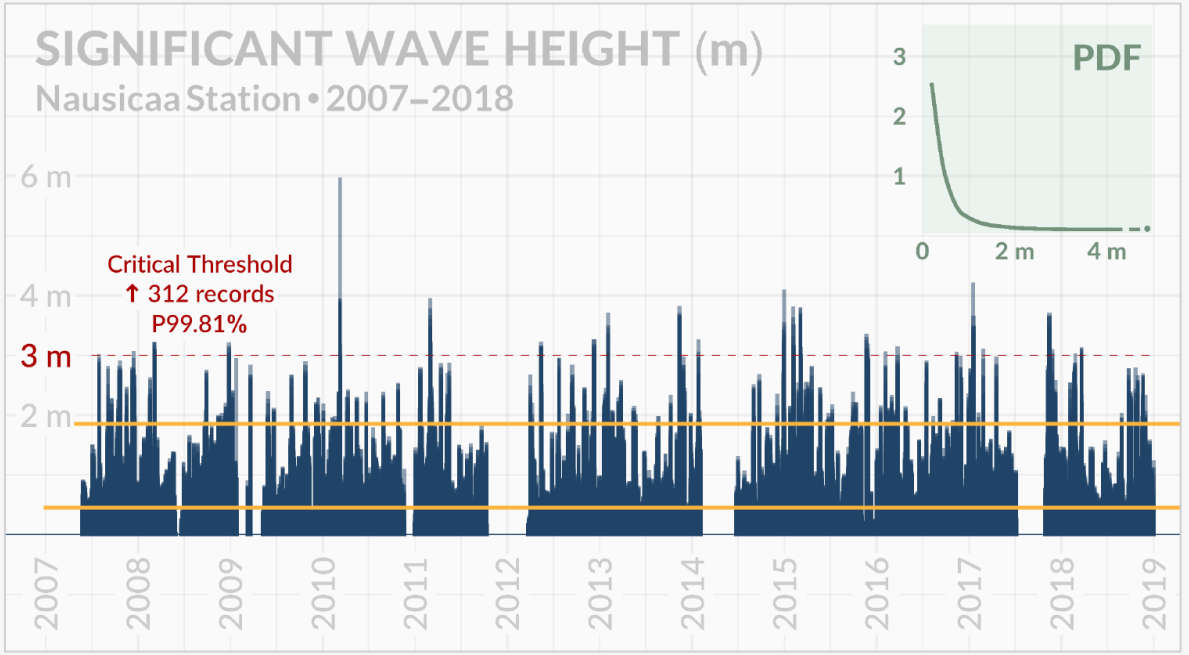
SWH time series comparison using Nausicaa and ERA5 data for two extreme events with long (top) and short (bottom) duration.

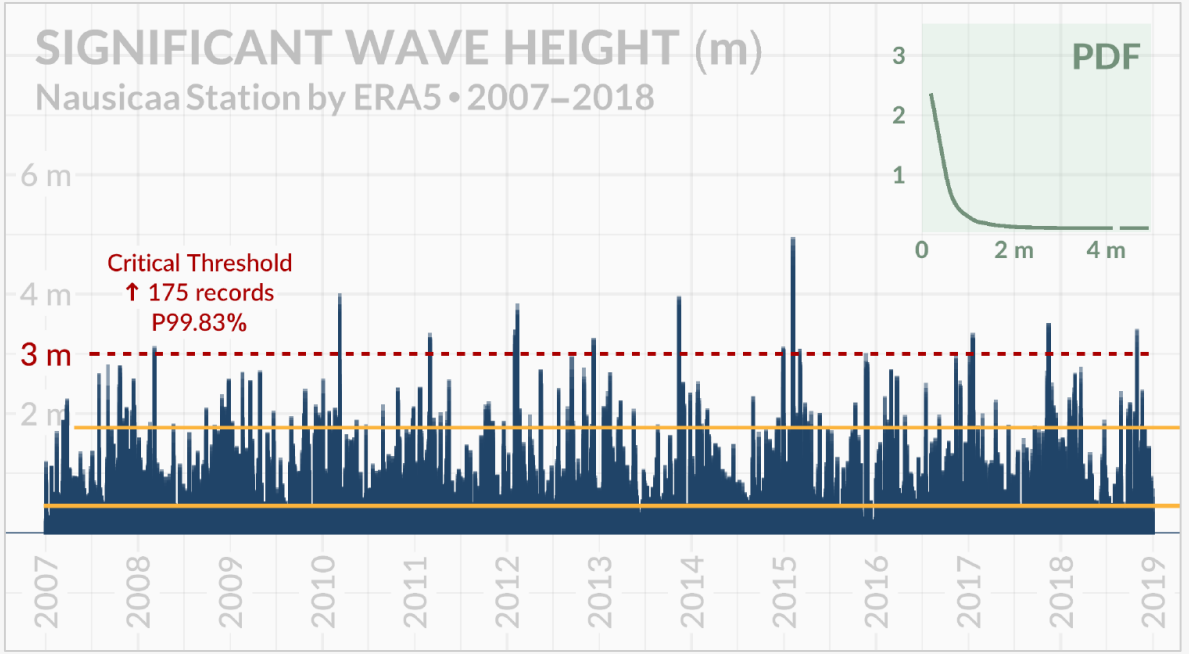
Extreme Events using ERA5

SWH time series analysis (2007-2018)

	Nausicaa	ERA5
SWH Average	0.45 m	0.45 m
SWH St.Dev.	0.44 m	0.41 m
SWH P98%	1.85 m	1.76 m
SWH Records > P98%	3400	2103
SWH Records > 3m	312	175
Relevant Events	169	168
Extreme Events	26	15

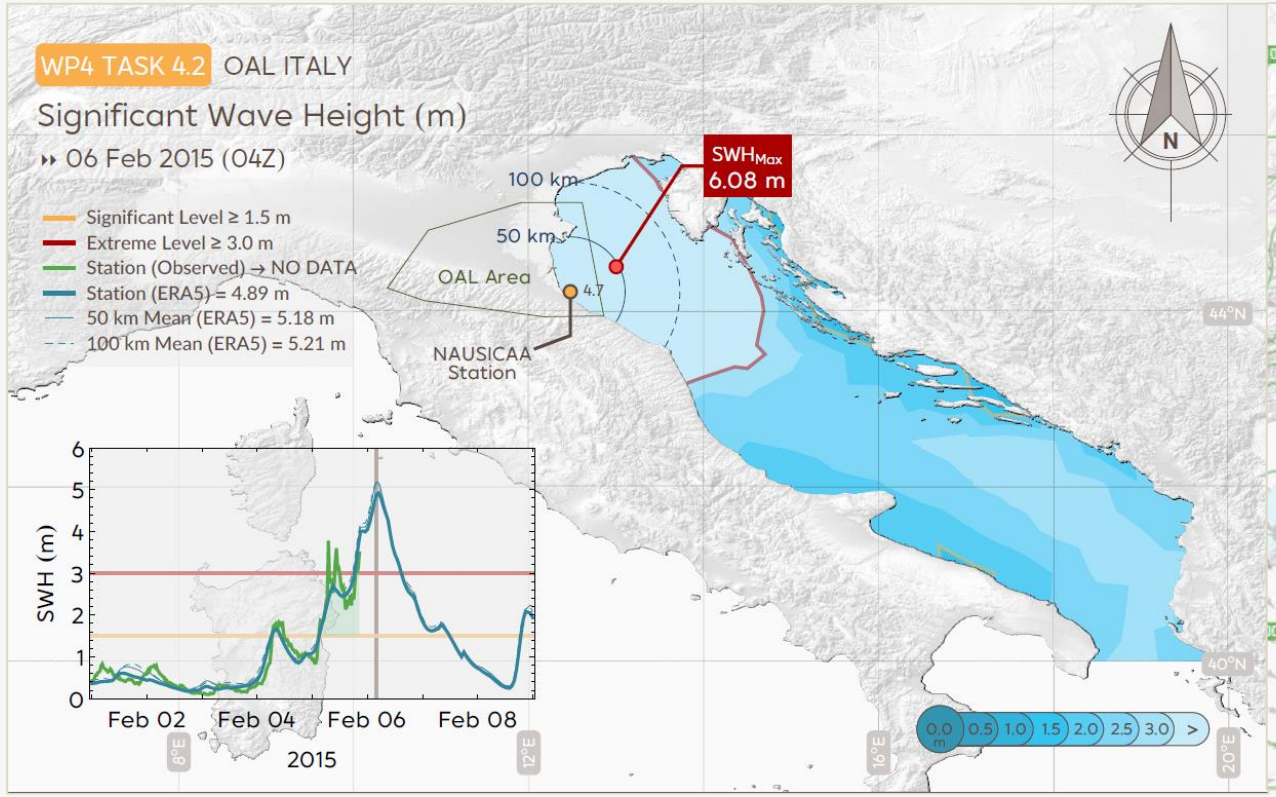


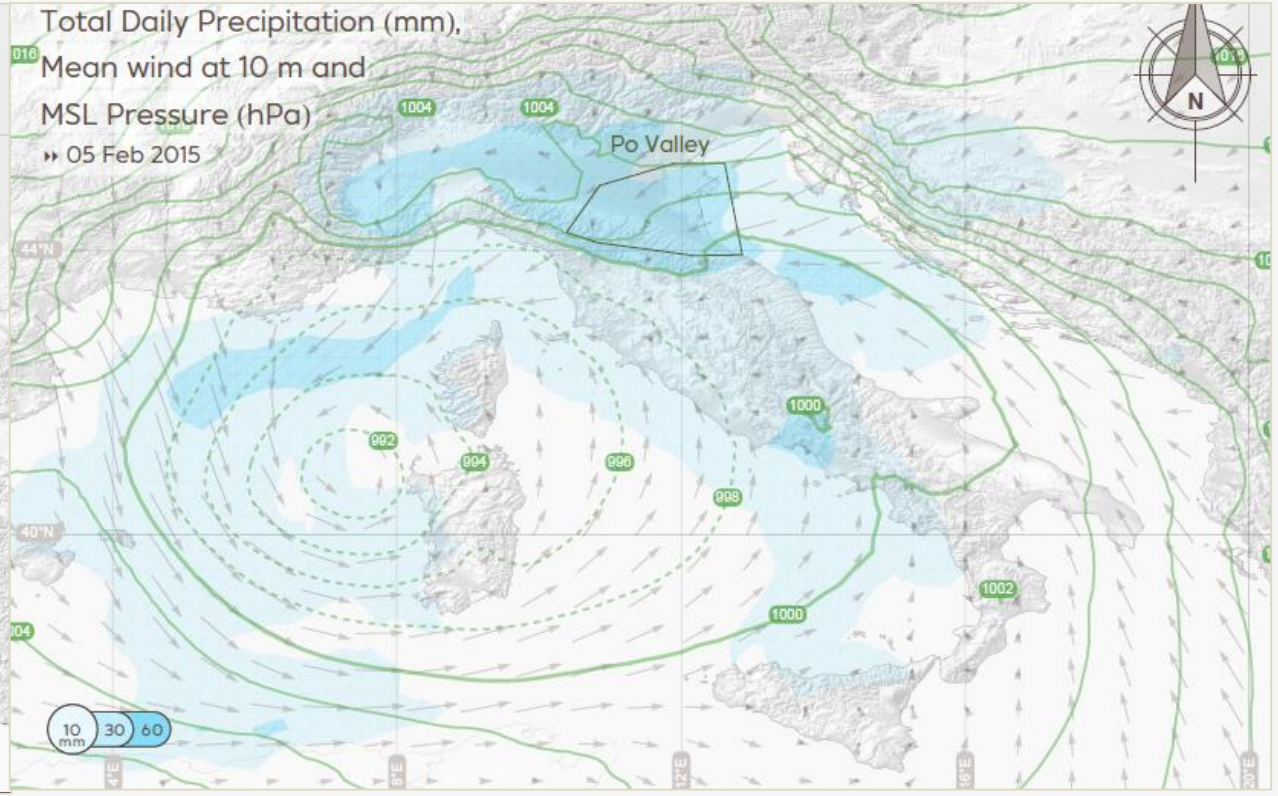




Extreme Events using ERA5

STORM SURGE in Northern Adriatic Sea (5-7 Feb 2015)





EXTREME RECORDS

1.21 m	Sea Level Porto Corsini
4.31 m	Wave Height Nausicaa

WAVE DATA

44°(NE)	Direction
516 m^2h	Energy
74 h	Duration
Severe	Energetic Class

- Surface low-pressure system over Tyrrhenian Sea supported by a deep cut-off low on upper levels.
- Southeast winds over the south Adriatic Sea.
- Strong winds (> 16 m/s) blowing from northeast in the north Adriatic Sea converging on the cold-front area.

FINAL COMMENTS

The capability of ERA5 reanalysis to detect extreme storm-surge events along the North Adriatic coast is assessed with two aims:

- to extend backwards the analysis (1979 onwards);
- to perform the meteorological analysis of extreme events within the same framework.

Results show that:

- In general, ERA5 was able to represent all relevant storm-surge events in the Northern Adriatic Sea, with the exception of a couple events with weak SWH peaks recorded in Nausicaa;
- An extreme event recorded in January 2012 was identified by ERA5 during a period when the Nausicaa buoy was out of operation. Showing the role of reanalysis in filling gaps;
- ERA5 presented problems to represent abrupt oscillations or short-time peaks on SWH. This issue prevented ERA5 to classify 8 of 26 events as extreme events;
- For SWH series extracted from ERA5, values above 3 m reached the 99.83rd percentile for period 2007-2018, and 99.84th when expanded to the last 30 years (since 1989), showing that the 99.8th percentile seems to be a good value for identifying extreme events of storm-surge in the northern Adriatic Sea.