



Sea State CCI
User Consultation Meeting #2
Online meeting



Wind waves and coastal risk in Emilia Romagna Region: monitoring and forecasting

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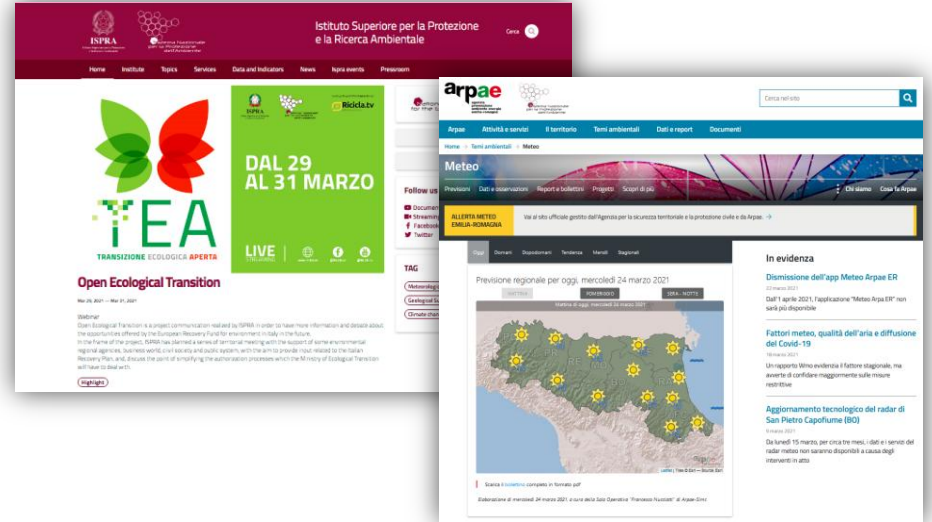


ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale

ISPRA (Italian National Institute for Environmental Protection and Research) is the **National authority** for national issues regarding protection, enhancement and improvement of the environment with a wide expertise in marine and coastal areas:

- **real time monitoring of meteo-marine parameters** through **three** networks, the
 - **national tide gauge network (RMN)**
 - **North Adriatic and Venice Lagoon tide gauges network (RMLV)**
 - **Wave Measurement Network (RON)**
- **operational forecasting system** with a special focus on storm surges in the North Adriatic Sea and the Venice Lagoon
- technical and scientific activities concerning climate change and adaptation
- national environmental databases, environmental data, **statistics, information, reports**

ISPRA coordinates the National System of Environment Protection Agencies (SNPA) ensuring the exchange of information and expertise on environmental monitoring, control and inspections, connecting scientific knowledge communities with environmental administrators and policy makers at national and local level.

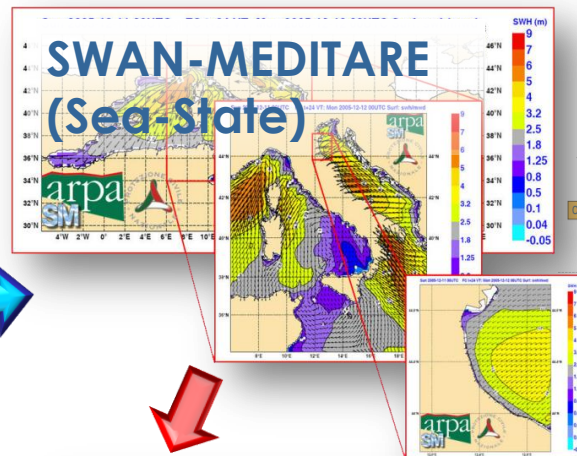
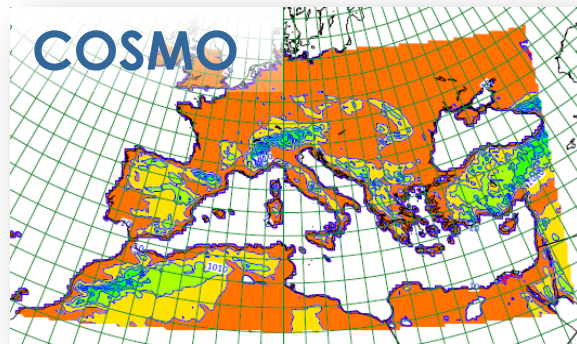


The **Hydro-Meteo-Climate Service of Arpae (Arpae-SIMC)** is the met service in Emilia-Romagna and **Support Centre** for the Civil Protection Agency as well as **Centre of Competence** for the Italian National Civil Protection system.

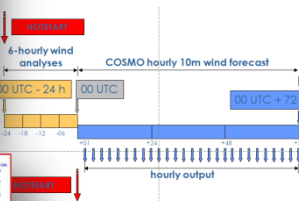
Arpae-SIMC carries out in situ measurements, forecasts and evaluations regarding meteorological and marine climate and waves forecasts and specific applications for bathing water quality studies, coastal risk and oil-spills.

METEO-MARINE-COASTAL OPERATIONAL CHAIN @ ARPAE

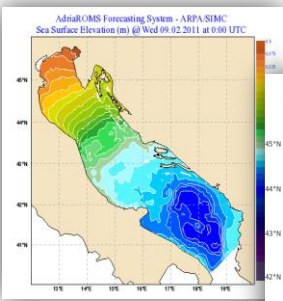
COSMO-5M
 +72h 2.2 km h.r.
COSMO-2I
 +48h, 2.2 km h.r.
COSMO-2I EPS
 +48h 2.2 km 20 membs
COSMO-2I RUC
 +18h every 3h



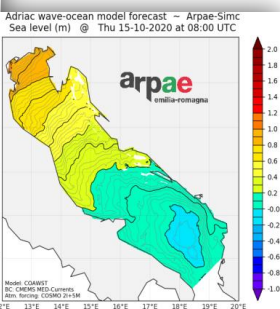
SWAN model
 COSMO-5M
 +72h 25-7-0.5 km h.r.



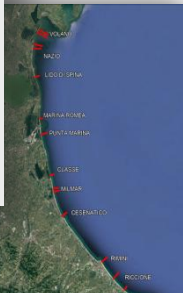
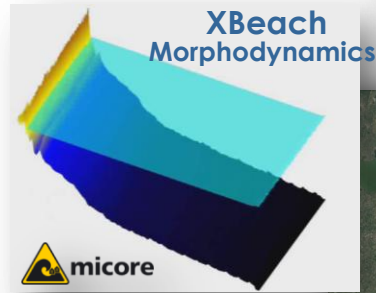
AdriaROMS (ROMS)
 COSMO-5M
 +72h 2km h.r.
 20 σ -layers
 4 harmonics
 BCs from CMEMS-MFS



Adriac waves&circulation



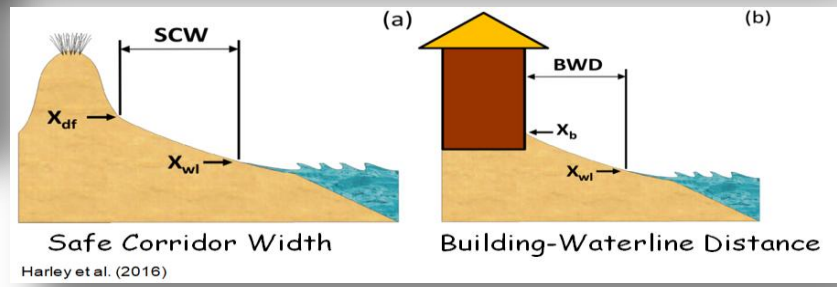
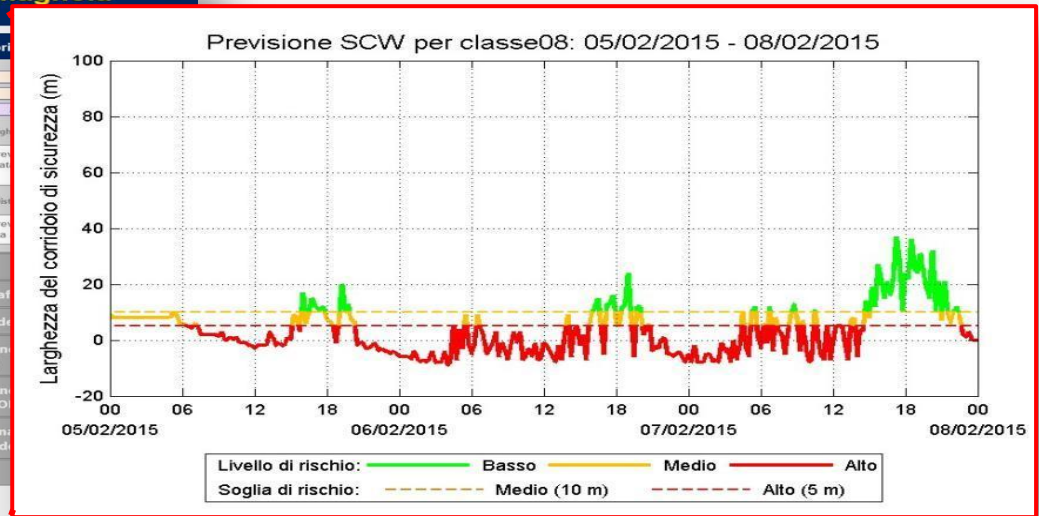
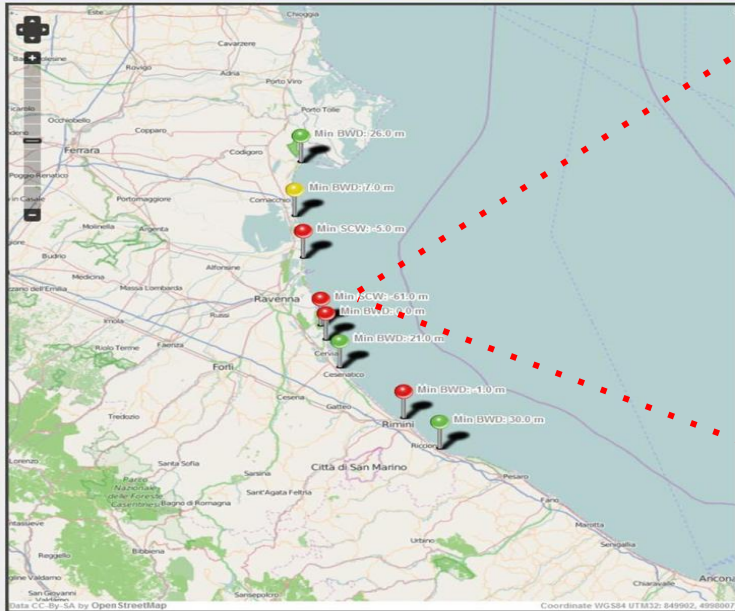
Adriac (COAWST)
 COSMO-2I+5M
 +72h 1km h.r.
 30 σ -layers
 8 harmonics
 BCs from CMEMS-MFS



XBeach model
 16 regional transect
 2 Storm Impact Indicators

Sistema di allerta mareggiate per la costa emiliano-romagnola

Data di esecuzione modello: 05-Feb-2015



Harley et al. (2016)

DECISION SUPPORT SYSTEM FOR COASTAL HAZARDS



Met Service
Arpae-SIMC

Meteo-marine forecasts and
monitoring

Thresholds exceeding :

SWAN-MEDITARE + AdriaROMS/Adriac

Indicators analysis and impacts/risk evaluation:

XBeach

Regional Civil protection BRIEFING

Meteorological Service (Arpae-SIMC)

Geological survey (SGSS)

Civil Protection (ARSTePC)



Regione Emilia-Romagna

Allerta Meteo Emilia-Romagna
Sito ufficiale gestito dall'Agenzia per la sicurezza territoriale e la protezione civile e da ARPAE

Arpae Agenzia per la sicurezza territoriale e la protezione civile

Cosa succede nel tuo comune? [Accedi](#)

Bollettino valanghe 039/2021 valido dalle 00:00 del 25/03/2021

Bollettino di vigilanza 040/2021 valido dalle 00:00 del 25-03-2021: nessuna allerta.

Bollettino valanghe 038/2021 valido dalle 00:00 del 25-03-2021: nessuna allerta.

Oggi PREVISIONE **Domani** PREVISIONE

Previsioni emesse con [Bollettino meteo](#) [Bollettino valanghe](#)

Situazione generale

- Piene dei fiumi
- Frane e piene dei corsi minori
- Temporali
- Vento
- Neve
- Pioggia che gela
- Temperature estreme
- Stato del mare
- Mareggiate
- Valanghe

Informati e preparati

Guide pratiche con consigli su comportamenti, per sapere cosa fare e cosa non fare in caso di.

Materiali

Piene dei fiumi
 Frane e piene dei corsi minori
 Temporali

Regione Emilia-Romagna

ALLERTA arpae emilia-romagna
METEO-IDROGEOLOGICA-IDRAULICA

| DOCUMENTO N. | DATA EMISSIONE | INIZIO VALIDITA' | FINE VALIDITA' |
|--------------|------------------|------------------|------------------|
| 036/2017 | 10/05/2017 11:26 | 11/05/2017 00:00 | 12/05/2017 00:00 |

Criticità idraulica e idrogeologica-temporali

Criticità meteo e marino-costiera

| | CRITICITA' IDRAULICA | CRITICITA' IDROGEOLOGICA | CRITICITA' IDROGEOLOGICA PER TEMPORALI | VENTO | TEMPERATURE ESTREME | NEVE | DIRABICI / PIOGGIA CHE GELA | STATO DEL MARE | CRITICITA' COSTIERA |
|---|----------------------|--------------------------|--|-------|---------------------|------|-----------------------------|----------------|---------------------|
| A | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |
| B | 1 2 | VERDE | VERDE | VERDE | VERDE | | | ARANCIONE | GIALLO |
| C | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |
| D | 1 2 | VERDE | VERDE | VERDE | VERDE | | | ARANCIONE | GIALLO |
| E | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |
| F | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |
| G | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |
| H | 1 2 | VERDE | VERDE | VERDE | VERDE | | | | |

ARPAE SIMC – MARINE-COASTAL MONITORING NETWORK

[HTTPS://WWW.ARPAE.IT/IT/TEMI-AMBIENTALI/MARE/DATI-E-INDICATORI/RETE-DI-MONITORAGGIO-METEO-MARINA](https://www.arpae.it/it/temi-ambientali/mare/dati-e-indicatori/rete-di-monitoraggio-meteo-marina)

arpae agenzia prevenzione ambiente energia emilia-romagna

Arpae Attività e servizi Il territorio Temi ambientali Dati e report Documenti

Home → Temi ambientali → Mare e Costa → Dati e indicatori → Rete di monitoraggio meteo-marina

Mare e Costa

Dati e indicatori Previsioni mare Report e Bollettini Costa Balneazione Normativa Scopri di più

Rete di monitoraggio meteo-marina

La rete di monitoraggio meteo-marina di Arpae è composta dalla boa ondometrica NAUSICAA posta al largo di Cesenatico (FC) che misura altezza sign direzione e periodo dell'onda, otto stazioni ubicate tra la Sacca di Goro e le Valli di Comacchio che registrano in automatico i parametri di temperatura, disciolto, salinità e pH e la stazione mareografica di Porto Garibaldi che rileva il livello del mare.

Dati dalla rete meteo-marina

Le date sono espresse in ora locale (UTC+1, attualmente è in vigore l'ora solare)

Pannello solare
Sistema di acquisizione dati

Alloggiamento sonda multiparametrica

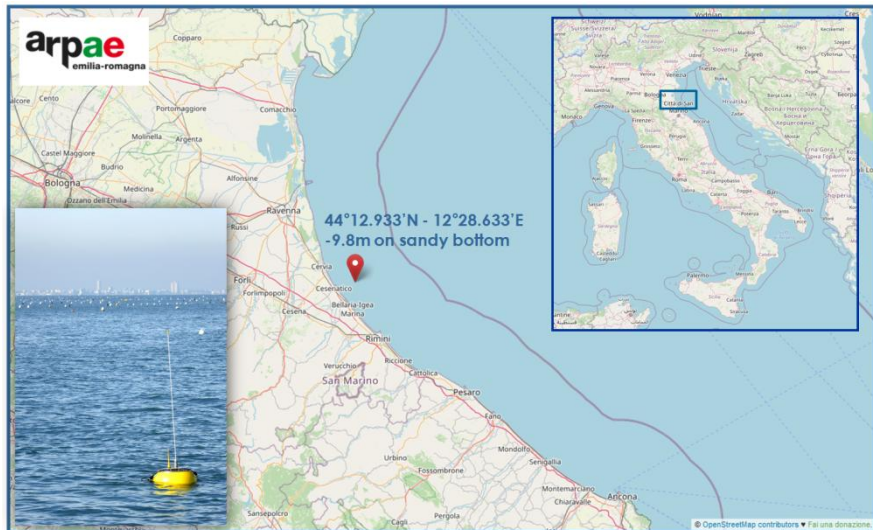
SONDA MULTIPARAMETRICA
Sensore SALINITA'
Sensore TEMPERATURA
Sensore OSSIGENO
Sensore pH

MULTI-PARAMETRIC PROBE STATIONS

TIDE GAUGES

PORTO GARIBALDI STATION
Equipped with 1 multi-parametric probe, 2 tide gauges, 1 permanent GPS station and 1 meteorologic station.

NAUSICAA WAVE BUOY – SINCE MAY 2007



Datawell WAVERIDER MKIII

Transmission: HF and GSM, GPS

Power supply: Hybrid Power System (solar energy combined with primary cells)

Plots available on the Arpae website:

<https://www.arpae.it/it/temi-ambientali/mare/dati-e-indicatori/dati-boa-ondametrica>



Data available on the Arpae web service
<https://simc.arpae.it/dext3r/>

Rapporto IdroMeteoClima Emilia-Romagna

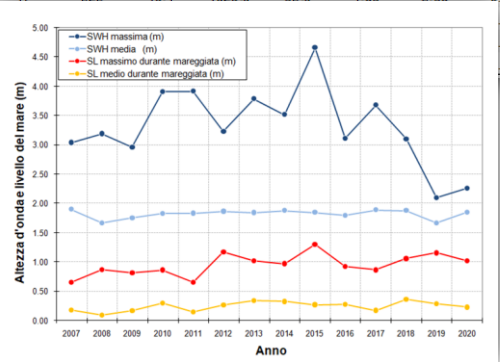
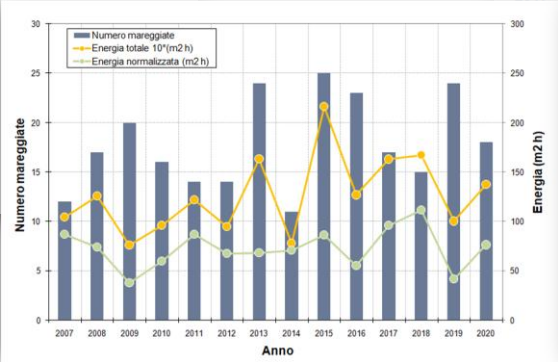
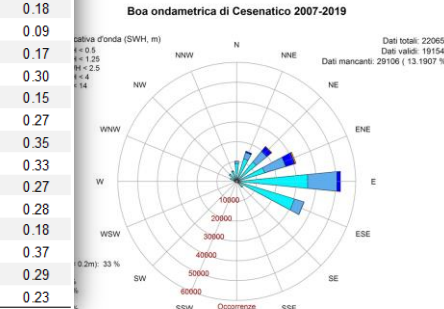
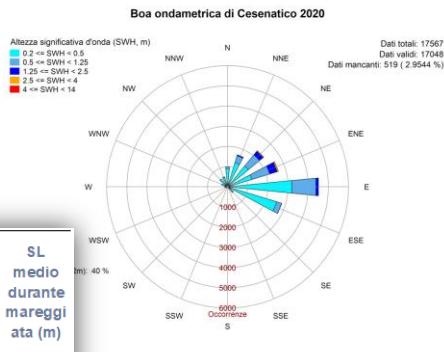
DATI 2019

GRANDINE IO UMIDITÀ NOI EVENTI ESTREMI
 PIOGGIA TU NEVE ALLERTA METEOROLOGICA
 ECOSISTEMA TUTTI MAREGGIATA



| Data e ora (GMT) | Durata (h) | Energia totale (m ² h) | Classe mareggiata | Direzione durante max SWH (*N) | SWH massima (m) | SWH media (m) | SL massimo (m) | SL medio (m) | SL durante SWH max (m) |
|------------------|------------|-----------------------------------|-------------------|--------------------------------|-----------------|---------------|----------------|--------------|------------------------|
| 1/19/2020 21:30 | 24 | 61.2 | 2 | 61 | 1.73 | 1.58 | 0.33 | -0.02 | 0.22 |
| 2/5/2020 15:30 | 18 | 83.3 | 2 | 44 | 2.54 | 2.10 | 0.39 | -0.02 | -0.20 |
| 3/15/2020 5:30 | 5.5 | 12.9 | 1 | 70 | 1.55 | 1.47 | 0.03 | -0.08 | -0.07 |
| 3/22/2020 5:30 | 31.5 | 111.1 | 2 | 59 | 2.45 | 1.83 | 0.30 | -0.03 | -0.21 |
| 3/24/2020 1:30 | 76 | 360.4 | 3 | 44 | 2.84 | 2.15 | 0.40 | 0.04 | -0.04 |
| 3/30/2020 13:00 | 20 | 62.1 | 2 | 48 | 2.24 | 1.72 | 0.39 | 0.09 | 0.26 |
| 3/31/2020 23:00 | 10 | 28.9 | 1 | 61 | 1.88 | 1.65 | 0.24 | 0.08 | 0.18 |
| 4/14/2020 14:00 | 15.5 | 57.7 | | | | | | | |
| 5/6/2020 10:00 | 2 | 7.0 | | | | | | | |
| 5/20/2020 16:00 | 3 | 9.1 | | | | | | | |
| 7/7/2020 3:00 | 8.5 | 53.4 | | | | | | | |
| 9/26/2020 5:30 | 3 | 10.3 | | | | | | | |
| 11/17/2020 0:00 | 11.5 | 32.7 | | | | | | | |
| 11/20/2020 5:30 | 46 | 270.6 | | | | | | | |
| 12/1/2020 22:30 | 15 | 64.3 | | | | | | | |
| 12/5/2020 10:30 | 33 | 85.6 | | | | | | | |
| 12/26/2020 14:30 | 14 | 53.3 | | | | | | | |
| 12/29/2020 8:30 | 4 | 10.0 | | | | | | | |

| Anno | Numero mareggiate | Durata totale (h) | Durata media (h) | Energia totale (m ² h) | Energia normalizzata (m ² h) | SWH media (m) | SWH massima (m) | SL massimo durante mareggiata (m) | SL medio durante mareggiata (m) |
|------|-------------------|-------------------|------------------|-----------------------------------|---|---------------|-----------------|-----------------------------------|---------------------------------|
| 2007 | 12 | 277 | 23.1 | 1042.9 | 86.9 | 1.90 | 3.04 | 0.66 | 0.18 |
| 2008 | 17 | 363.5 | 21.4 | 1255.8 | 73.9 | 1.67 | 3.19 | 0.87 | 0.09 |
| 2009 | 20 | 211.5 | 10.6 | 759.3 | 38.0 | 1.75 | 2.96 | 0.82 | 0.17 |
| 2010 | 16 | 250 | 15.6 | 959.9 | 60.0 | 1.83 | 3.91 | 0.87 | 0.30 |
| 2011 | 14 | 311 | 22.2 | 1219.8 | 87.1 | 1.83 | 3.92 | 0.66 | 0.15 |
| 2012 | 14 | 237 | 16.9 | 947.3 | 67.7 | 1.86 | 3.23 | 1.18 | 0.27 |
| 2013 | 24 | 381.5 | 15.9 | 1632.9 | 68.0 | 1.84 | 3.79 | 1.02 | 0.35 |
| 2014 | 11 | 181.5 | 16.5 | 780.7 | 71.0 | 1.88 | 3.52 | 0.98 | 0.33 |
| 2015 | 25 | 496 | 19.8 | 2162.7 | 86.5 | 1.85 | 4.66 | 1.31 | 0.27 |
| 2016 | 23 | 343 | 14.9 | 1268.0 | 55.1 | 1.80 | 3.11 | 0.93 | 0.28 |
| 2017 | 17 | 325 | 19.1 | 1629.9 | 95.9 | 1.89 | 3.68 | 0.87 | 0.18 |
| 2018 | 06 | 037 | | | | | | | |
| 2019 | 16 | 029 | | | | | | | |
| 2020 | 03 | 023 | | | | | | | |



| CLASSE MAREGGIATA | ENERGIA TOTALE (m ² h) |
|-------------------|-----------------------------------|
| I-debole | E <= 58.4 |
| II-moderata | 58.4 < E <= 127.9 |
| III-significativa | 127.9 < E <= 389.7 |
| IV-severa | 389.7 < E <= 706.9 |
| V-estrema | E > 706.9 |

EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)

Generalized Extreme Values (GEV)

The Generalized Extreme Values model could be fitted for the annual maxima and it is specified by the following parameters: the scale parameters and the shape one similarly to the GPD approach. Depending on the shape parameters it could be obtained a Gumbel, a Frechet or a Weibull. The limit of this approach is that using annual maxima it reduces the amount of extreme measurements to be fitted. However also in this case it has been possible to evaluate return period and the related return level.

EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)

$$P(Y < y) = \text{GEV}(y; \xi, \mu, \sigma) = \exp(-[1 + \xi(y - \mu)/\sigma]_+^{-1/\xi}).$$

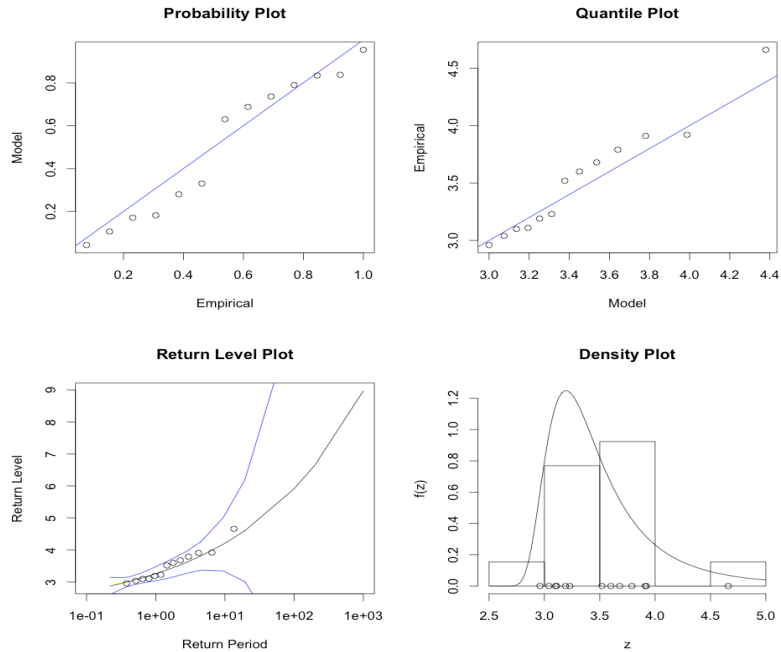
The key parameter is ξ , the shape parameter, and μ , σ are location and scale parameters respectively.

Depending on ξ the GEV could converge to a Gumbel, a Fréchet or a Weibull distribution

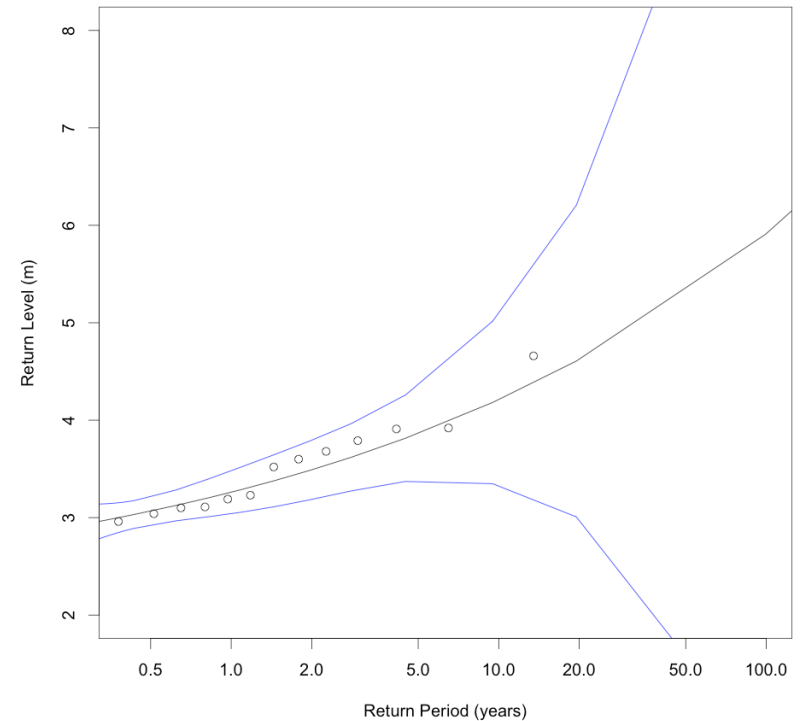
EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)



Return Level Plot (GEV) - Cesenatico 2007-2019



EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)

The Generalized Pareto Distribution model could be fitted for the observed extreme data with considering the following assumptions:

- data are considered as **exceedances from a specific threshold** (1.5 m in ER)
- a sequence of **independent and identically distributed events** (12 hours)

In order to achieve these assumptions the Peak Over threshold approach has been applied. In this method the threshold needs:

- to be neither too high **to get enough observations**
- not too low **not to take into account non-extreme values**

Once declustered maxima, the Generalized Pareto Distribution can be fitted (Pugh, D., 2004) using a maximum likelihood estimation of the distribution parameters such as the scale parameter, the shape parameters (that gives information on qualitative behaviour of the distribution) and the location one. Finally it has been possible to evaluate the return period and the related return level.

EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)

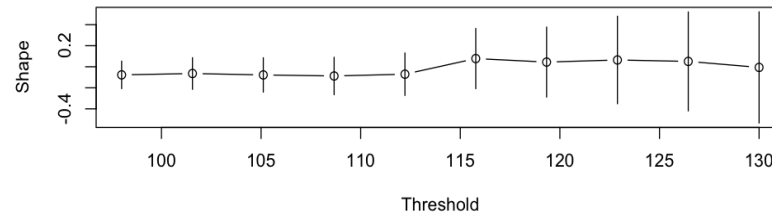
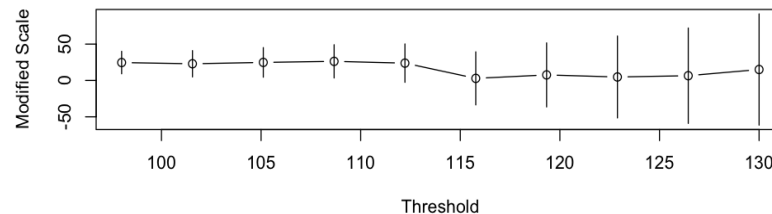
$$\Pr(Y > y + u | Y > u) \approx G(y; u, \xi, \sigma) = [1 + \xi y / \sigma]_+^{-1/\xi}, \quad \text{for } y > 0. \quad (1)$$

Here the distribution function $1 - G$ is the GPD, and the scale parameter σ depends on the threshold u . The shape parameter ξ is the same parameter which appears in the GEV, and therefore controls the weight of the tail. The symbol \approx indicates an approximation. As u increases, the approximation improves, and then, for $y > u$, large u , we get:

$$\Pr(Y \leq y) \approx 1 - \lambda_u [1 + \xi(y - u) / \sigma]_+^{-1/\xi} \quad (2)$$

where:

$$\lambda_u = \Pr(Y > u).$$

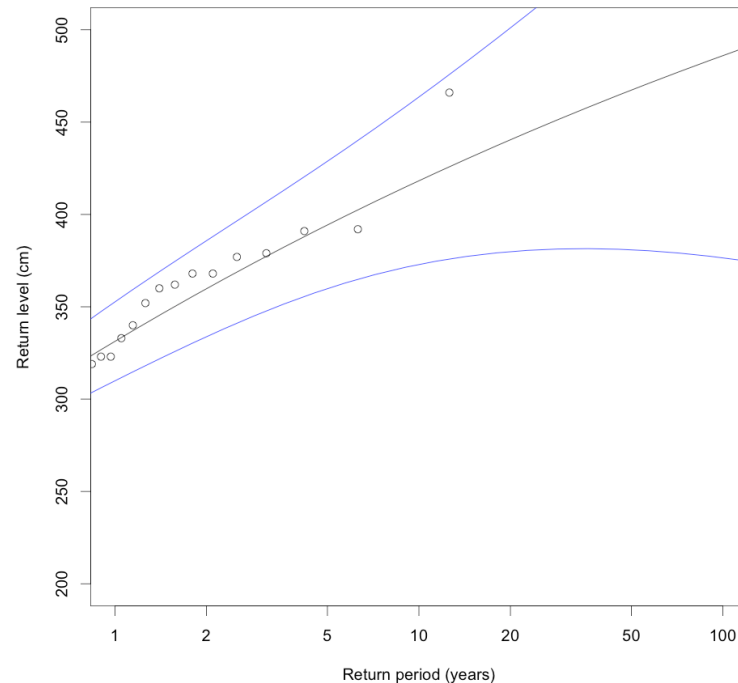
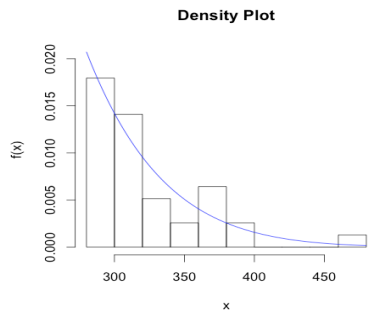
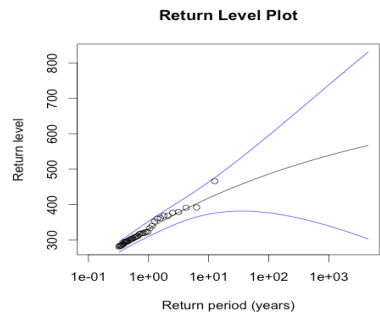
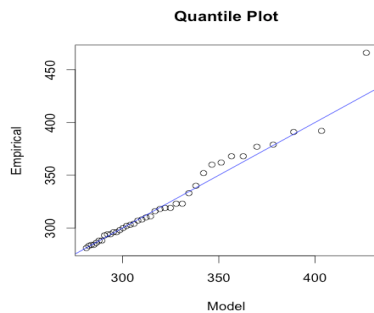
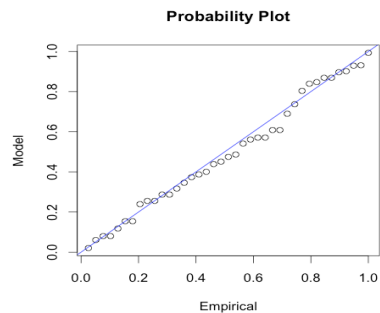


EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)

Return Level Plot - Cesenatico



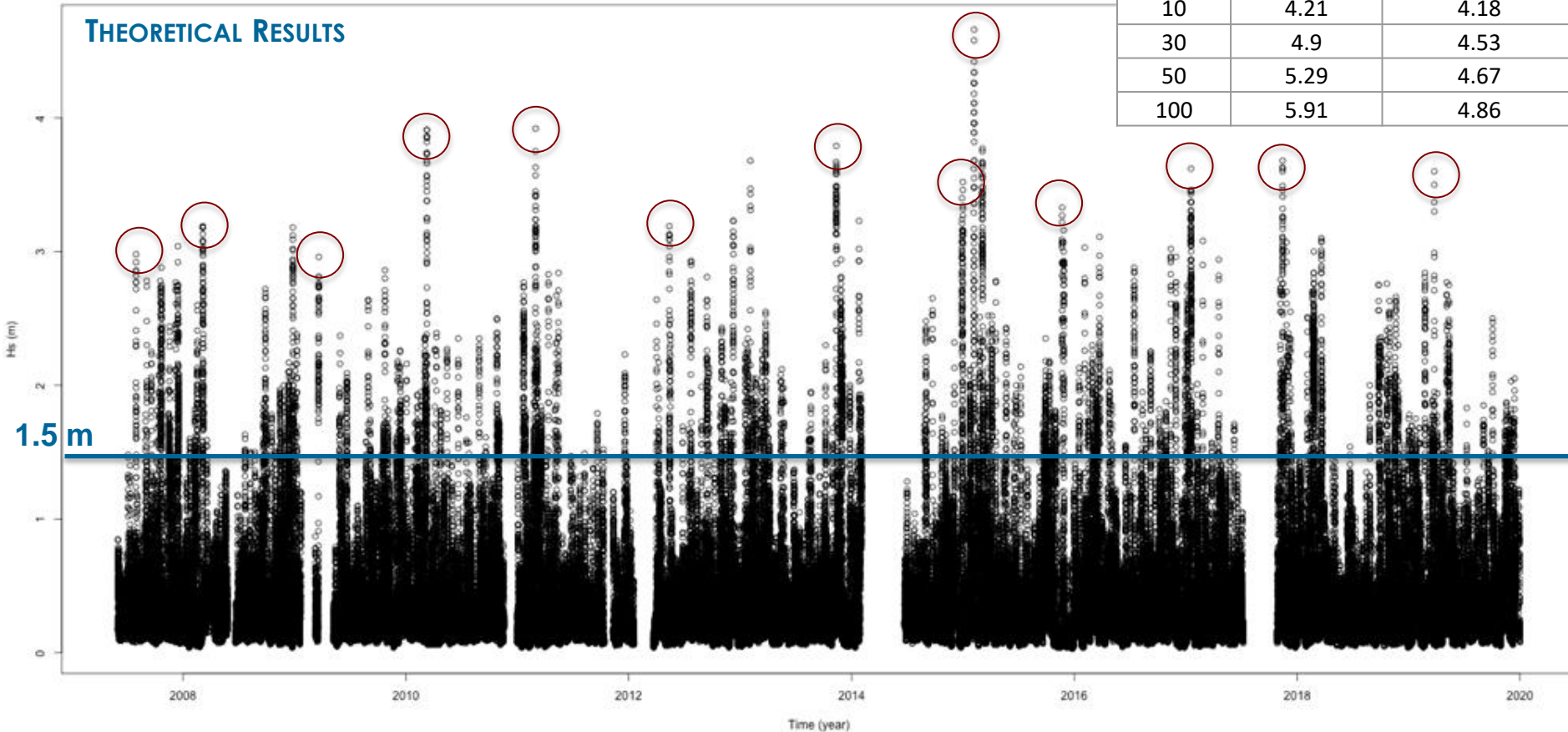
EXTREME EVENTS

WAVES -> 2007-2019

Cesenatico Wave 2007-2019

THEORETICAL RESULTS

| YEAR | GEV Ret. Lev. (m) | POT-GPD Ret. Lev. (m) |
|------|----------------------|--------------------------|
| 1 | 3.26 | 3.31 |
| 5 | 3.86 | 3.94 |
| 10 | 4.21 | 4.18 |
| 30 | 4.9 | 4.53 |
| 50 | 5.29 | 4.67 |
| 100 | 5.91 | 4.86 |





Sea State CCI

User Consultation Meeting #2

Online meeting



sea state
cci

Thank you!