

Validation of Adriac, the new coupled wave-ocean forecasting system for the Adriatic Sea of Arpae-SIMC

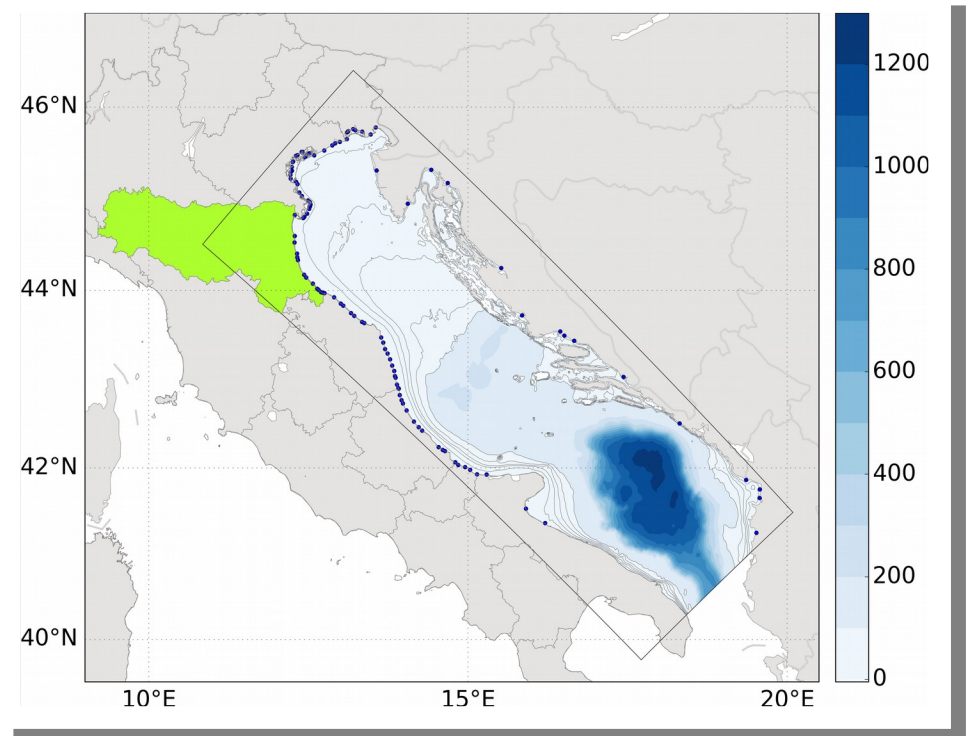
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Arpae-SIMC, Hydro-Meteo-Climate Service of Emilia-Romagna Region, Bologna, Italy

email: lbressan@arpae.it

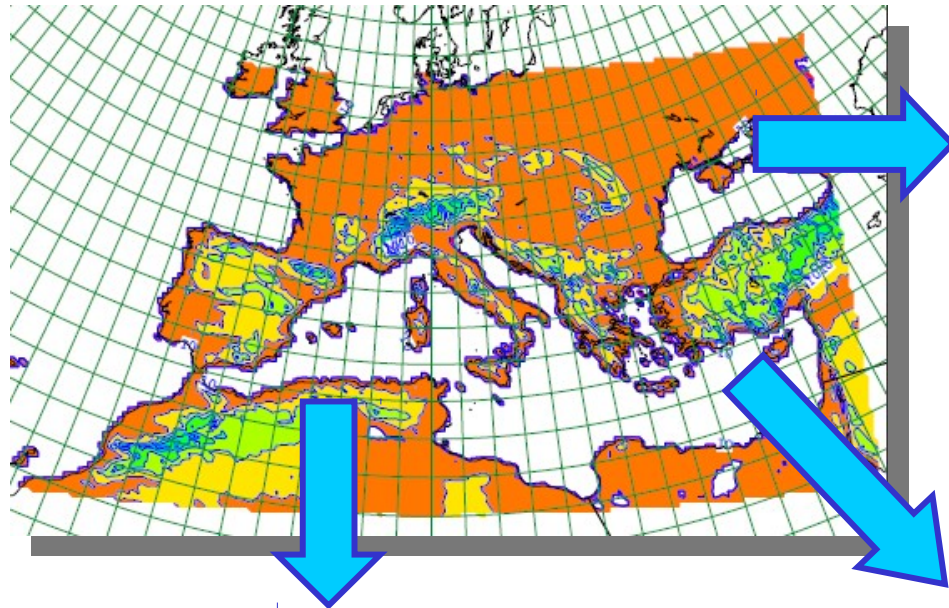
- JONSMOD 2018 ■
- Firenze, Italy ■
- 17 – 19 October 2018 ■

- Introduction
 - Arpae-SIMC and the Civil Protection
- Adriac
 - the new wave-oceanographic model of the Adriatic Sea
- Verification of Adriac
 - Sea level
 - Waves
 - Example of events

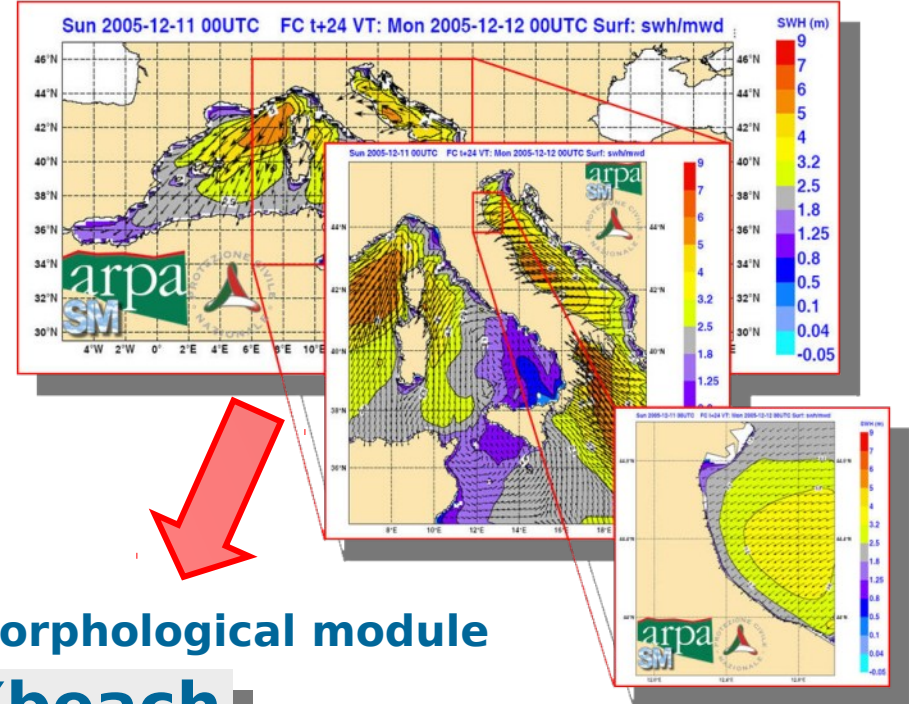


Arpa-SIMC as National Center of Competence for the meteorological and marine modelling of the Italian Civil Protection

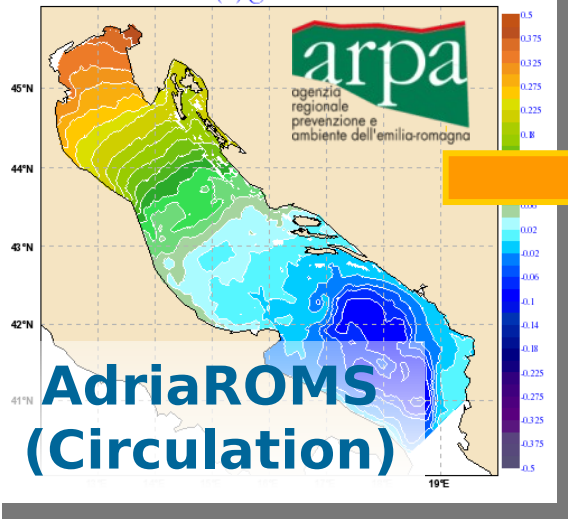
COSMO



SWAN-MEDITARE (Sea-State)

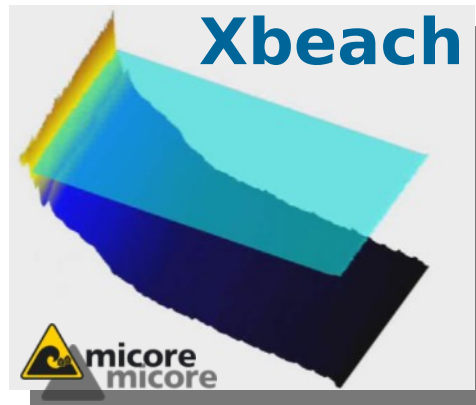


AdriaROMS Forecasting System - ARPA/SIMC
Sea Surface Elevation (m) @ Wed 09.02.2011 at 0:00 UTC



Morphological module

Xbeach



**Chain of
operational models**

Arpae-SIMC as *Centro Funzionale* of the Regional Civil Protection

...provides:

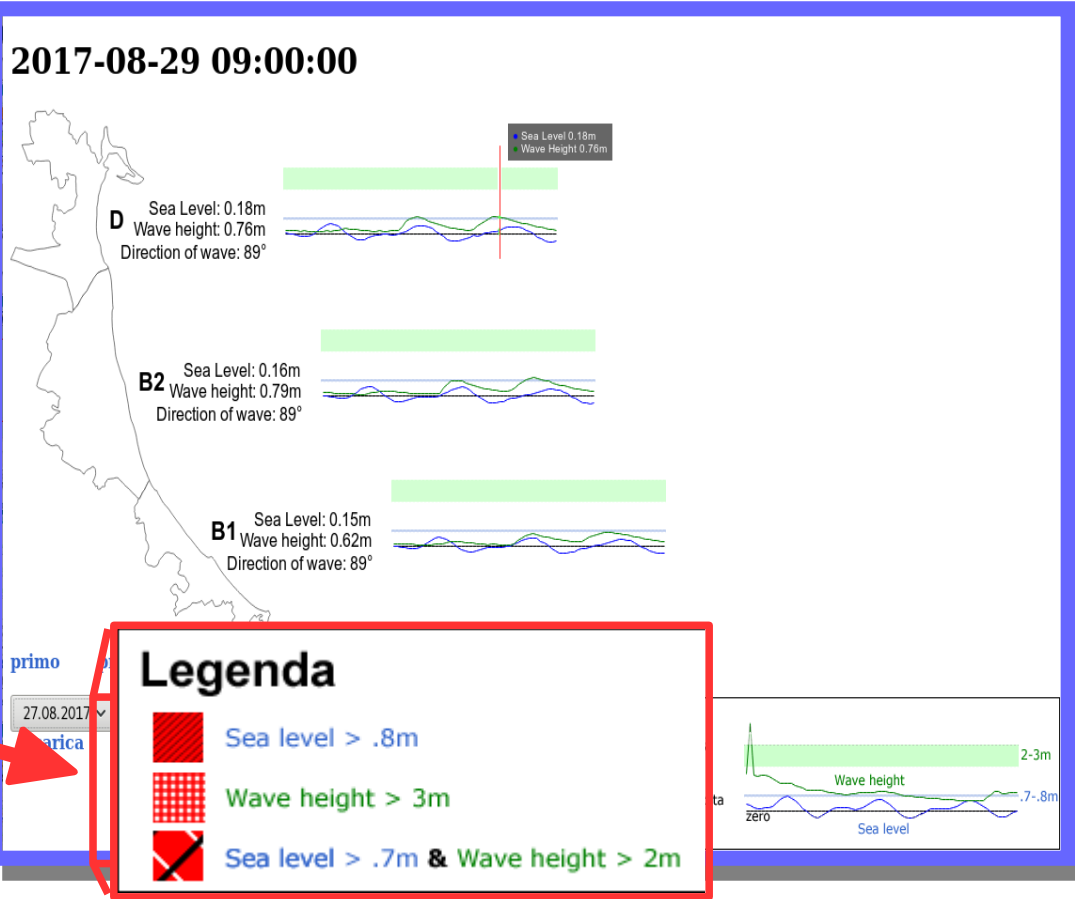
- forecast of meteorological and marine events
- monitoring of events and their short-term forecasts

... and contributes to:

- risk analysis
- alerts and warnings

<https://allertamento.regione.emilia-romagna.it>

COASTAL WARNINGS



COASTAL WARNINGS

Thresholds:

- **sea level** forecast
- **wave height** forecast
- **combined sea level and wave height** forecast

Adriac, the new coupled wave-ocean forecasting system for the Adriatic Sea

COAWST model, coupling

- ROMS (ocean circulation model)
- SWAN (wave model)

Atmospheric forcing COSMO model

every 1h

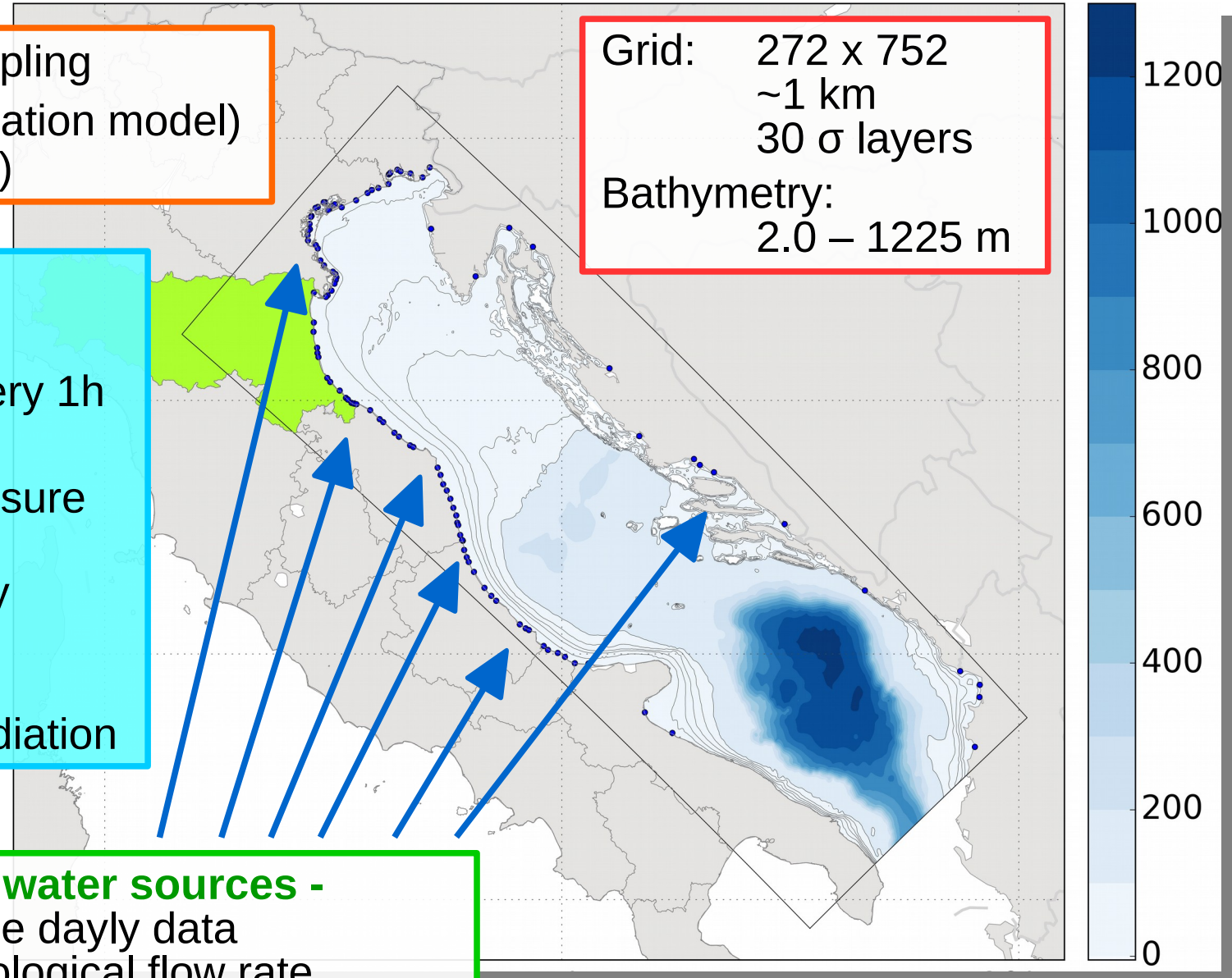
- 10 m u,v wind
- Mean sea level pressure
- 2 m temperature
- 2 m relative humidity
- Cloud cover
- Precipitation rate
- Short-wave solar radiation

River forcing – fresh water sources -

- Po river with real-time daily data
- 48 rivers with climatological flow rate

Grid: 272 x 752
~1 km
30 σ layers

Bathymetry:
2.0 – 1225 m



Adriac, the new coupled wave-ocean forecasting system for the Adriatic Sea

Open boundary at the Otranto channel

- Sea level
- Salinity
- Temperature
- 2D and 3D currents

Warning!

- Mean sea level of parent model different from topography mean sea level

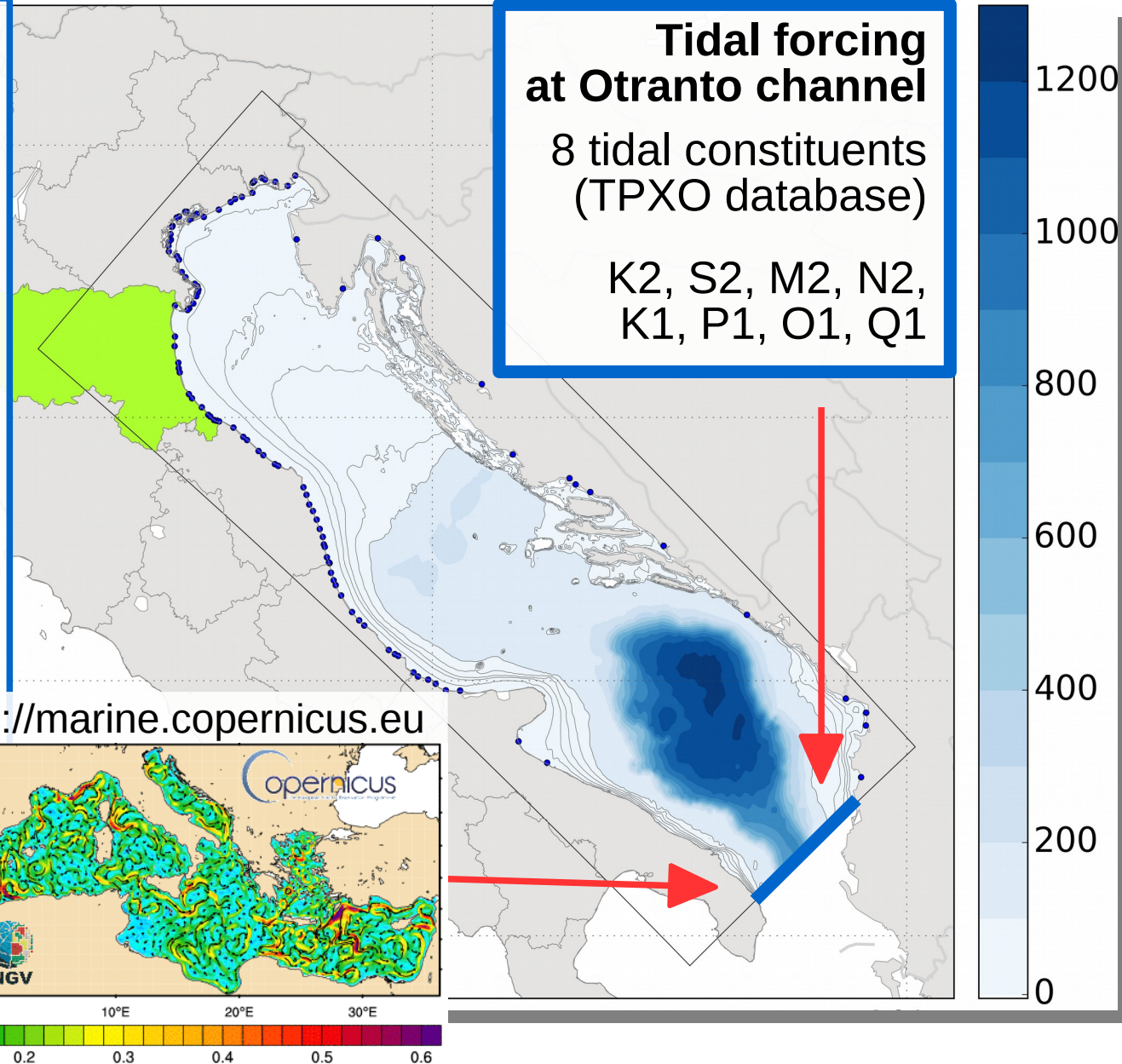
Solution

- Estimation of local offset for sea level

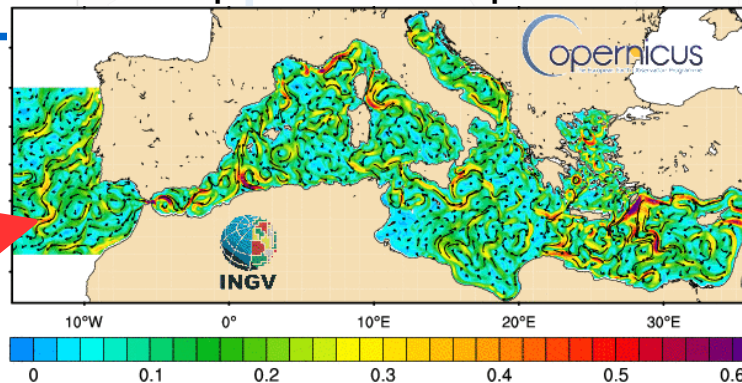
Tidal forcing at Otranto channel

8 tidal constituents
(TPXO database)

K2, S2, M2, N2,
K1, P1, O1, Q1



Copernicus CMEMS
Mediterranean
Forecasting System



Adriac verification: sea level

a2km: AdriaROMS
a2km_b: AdriaROMS with bias removed
adr1km_pop: Adriac (pre-operational)
adr1km_pop_b: Adriac with bias removed

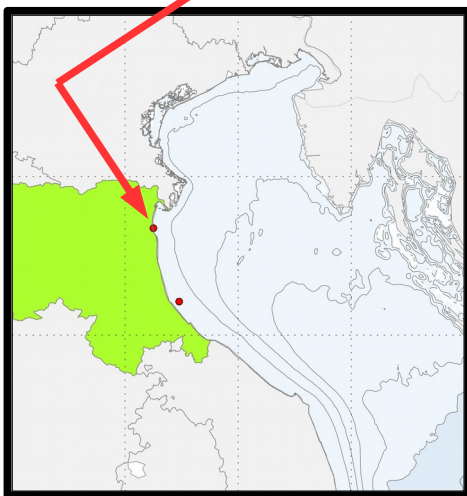
Hindcast verification

Period: 14 months

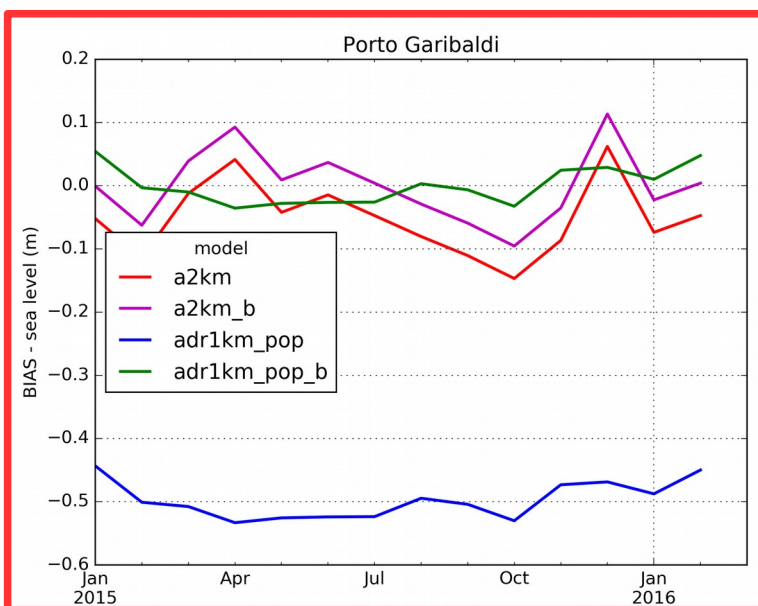
From: 2015-01

To: 2016-02

Porto Garibaldi
tide-gauge

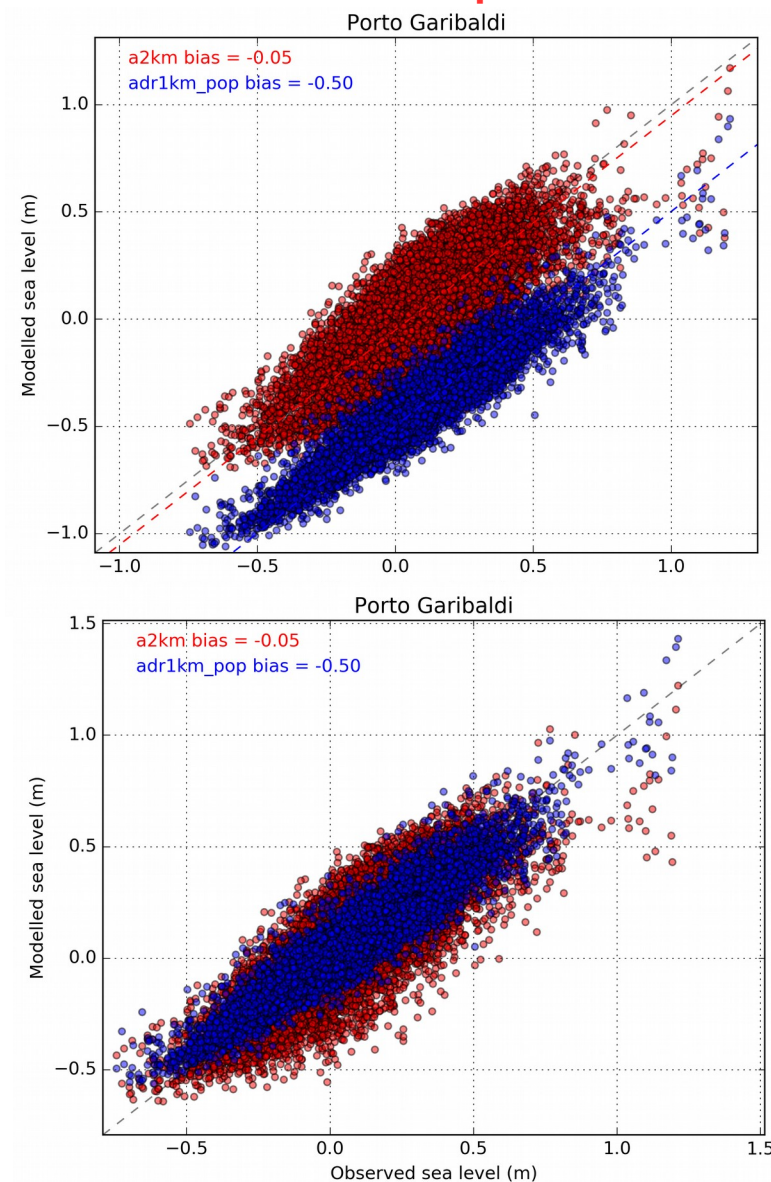


BIAS



Bias removal plays a crucial role.
Similar results also over other
verification sites.

scatterplot



Adriac verification: sea level

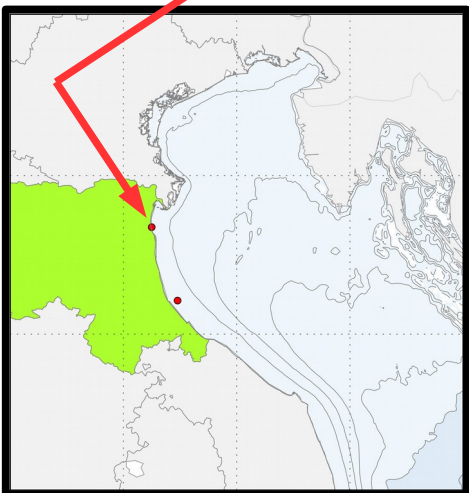
a2km: AdriaROMS
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adr1km_pop: Adriac (pre-operational)
adr1km_pop_b: Adriac with bias removed

	BIAS	RMSE
a2km	-0.05	0.165
a2km_b	-	0.157
adr1km_pop	-0.50	0.504
adr1km_pop_b	-	0.083

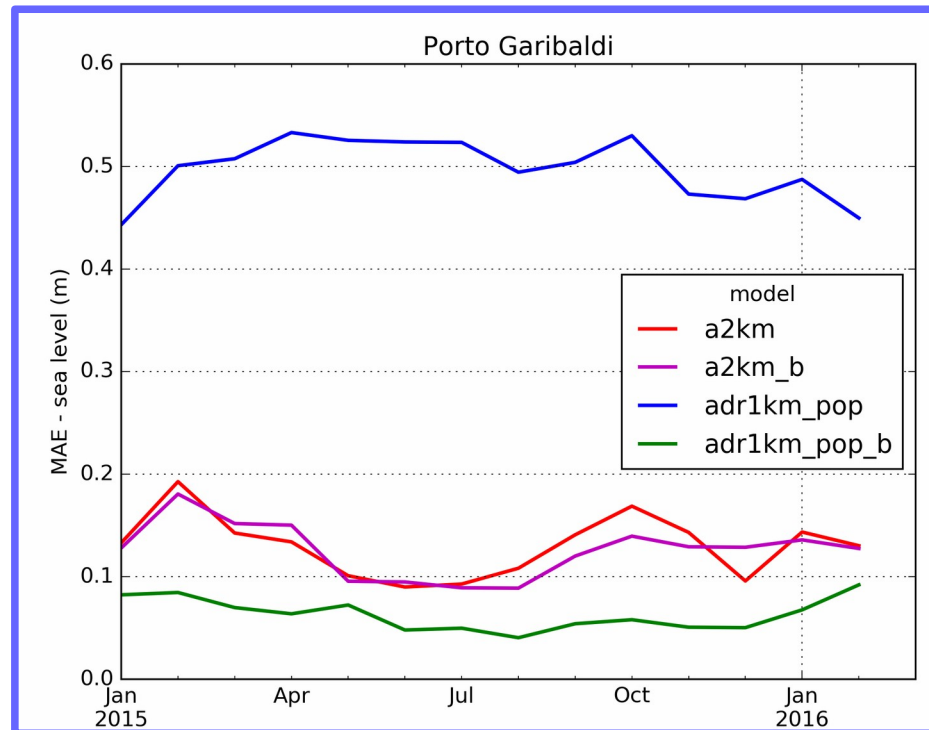
Hindcast verification

Period: 14 months
 From: 2015-01
 To: 2016-02

Porto Garibaldi tide-gauge



RMSE: Root Mean Square Error



Adriac verification: waves

dt = 1h	threshold	n.obs	BS	TS	POD	FA
adr1km_pop	2.0	202	0.500	0.416	0.441	0.119
swanemr	2.0	209	0.536	0.453	0.479	0.107
swanita	2.0	206	0.922	0.506	0.646	0.300

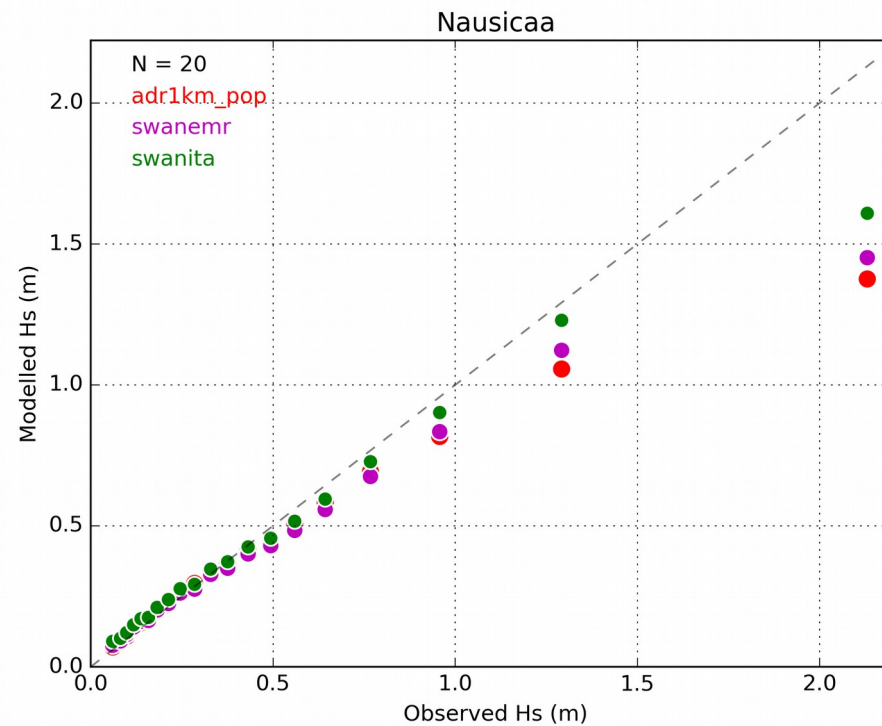
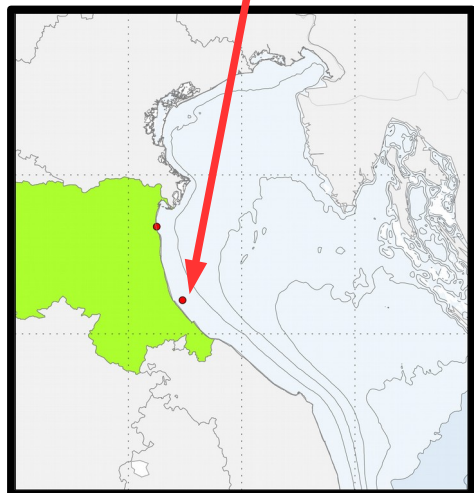
Hindcast verification

Period: 14 months

From: 2015-01

To: 2016-02

Nausicaa
buoy



The new system still needs some improvements. Some tuning is probably required for high waves.

Adriatic verification: waves

dt = 1h	threshold	n.obs	BS	TS	POD	FA
adr1km_pop	2.0	202	0.500	0.416	0.441	0.119
swanemr	2.0	209	0.536	0.453	0.479	0.107
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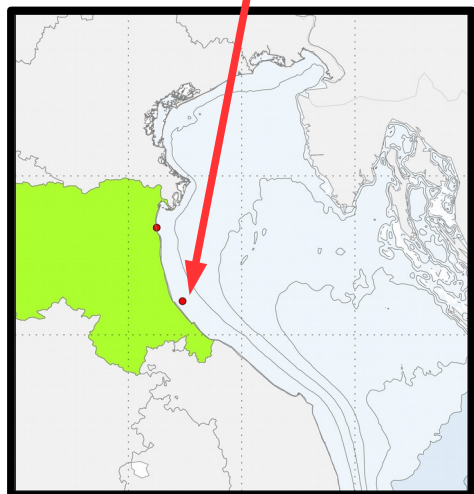
Hindcast verification

Period: 14 months

From: 2015-01

To: 2016-02

Nausicaa
 buoy



$$BS = \frac{\text{hits} + \text{false alarms}}{\text{hits} + \text{misses}}$$

$$TS = \frac{\text{hits}}{\text{hits} + \text{misses} + \text{false alarms}}$$

contingency table

	observed YES	observed NO
modelled YES	hits	false alarms
modelled NO	misses	correct negatives

$$POD = \frac{\text{hits}}{\text{hits} + \text{misses}}$$

$$FA = \frac{\text{false alarms}}{\text{hits} + \text{false alarms}}$$

The new system still needs some improvements. Some tuning is probably required for high waves.

Event of 5 – 7 February 2015

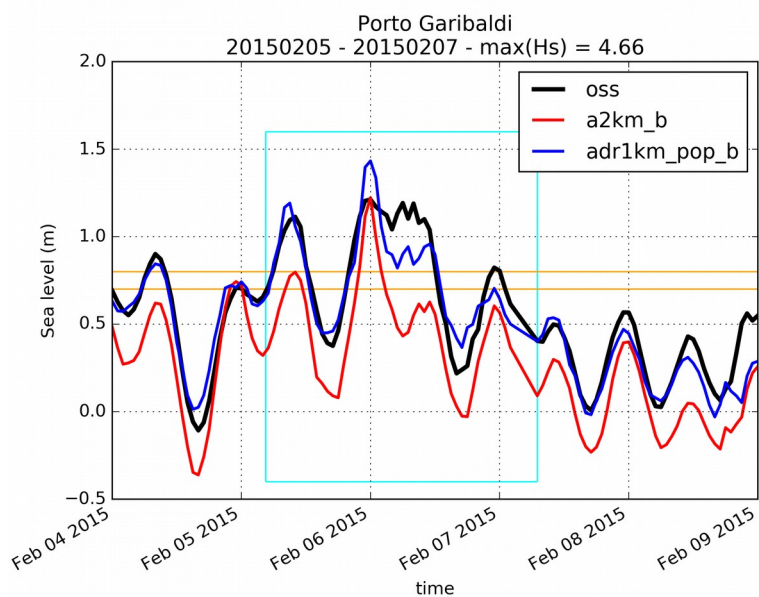
Event of 5 -7 February 2015 on the Emilia-Romagna coast

Coastal warnings

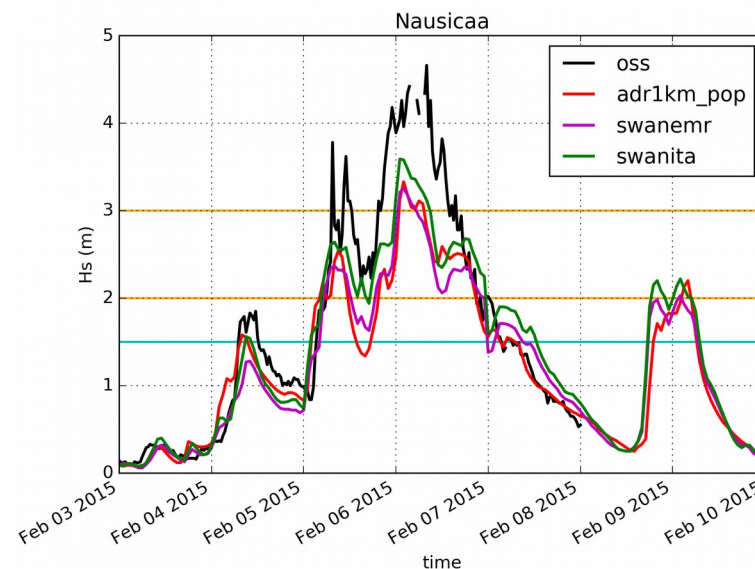
- Sea level > 0.8 m
- Hs > 3.0 m
- Sea level > 0.7 m and Hs > 2.0 m

Better performance of the new system for sea level hindcast

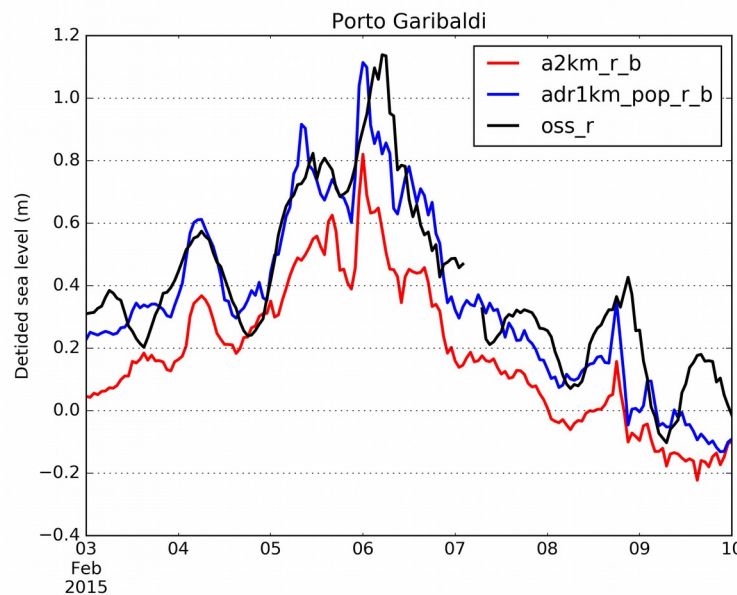
Sea level (m)



Waves



Sea level residuals (m)



Conclusions

- Sea level hindcasts by the new Adriac system show improvements with respect to the operational system.
- Wave hindcast are still to be optimized.

Future work

- Determine the local final offsets for sea level.
- Test the new system in forecast mode.
- Operational implementation (soon!).

Thank you!

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