Mediterranean Wind Wave Model (MWM)

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HyMOLab
Hydrodynamics · MetOcean

Modello Atmosferico

DHI

Modello d’Onda

MWM – Infrastruttura Hardware

MWM
MEDITERRANEAN WIND WAVE MODEL

InfiniBand Interconnection

Parallel processing

Virtual Private Network

UniTS datacenter - *GARR*

Storage

≈ 82 TB FiberChannel - *RAID 6*

24 compute nodes

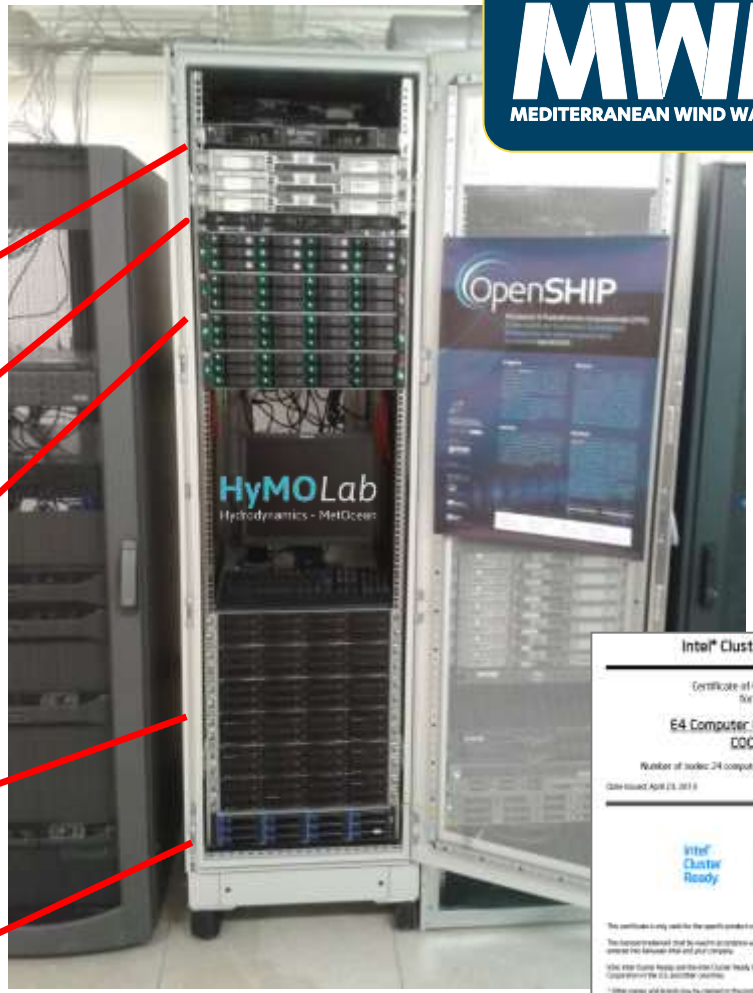
2 x 6 cores/node => 288 cores

700 GB RAM

Master (head) node

2 x 6 cores/node => 12 cores

96 GB RAM




Intel® Cluster Ready

Certificate of Compliance
for

E4 Computer Engineering
COCA

Prodotti MWM

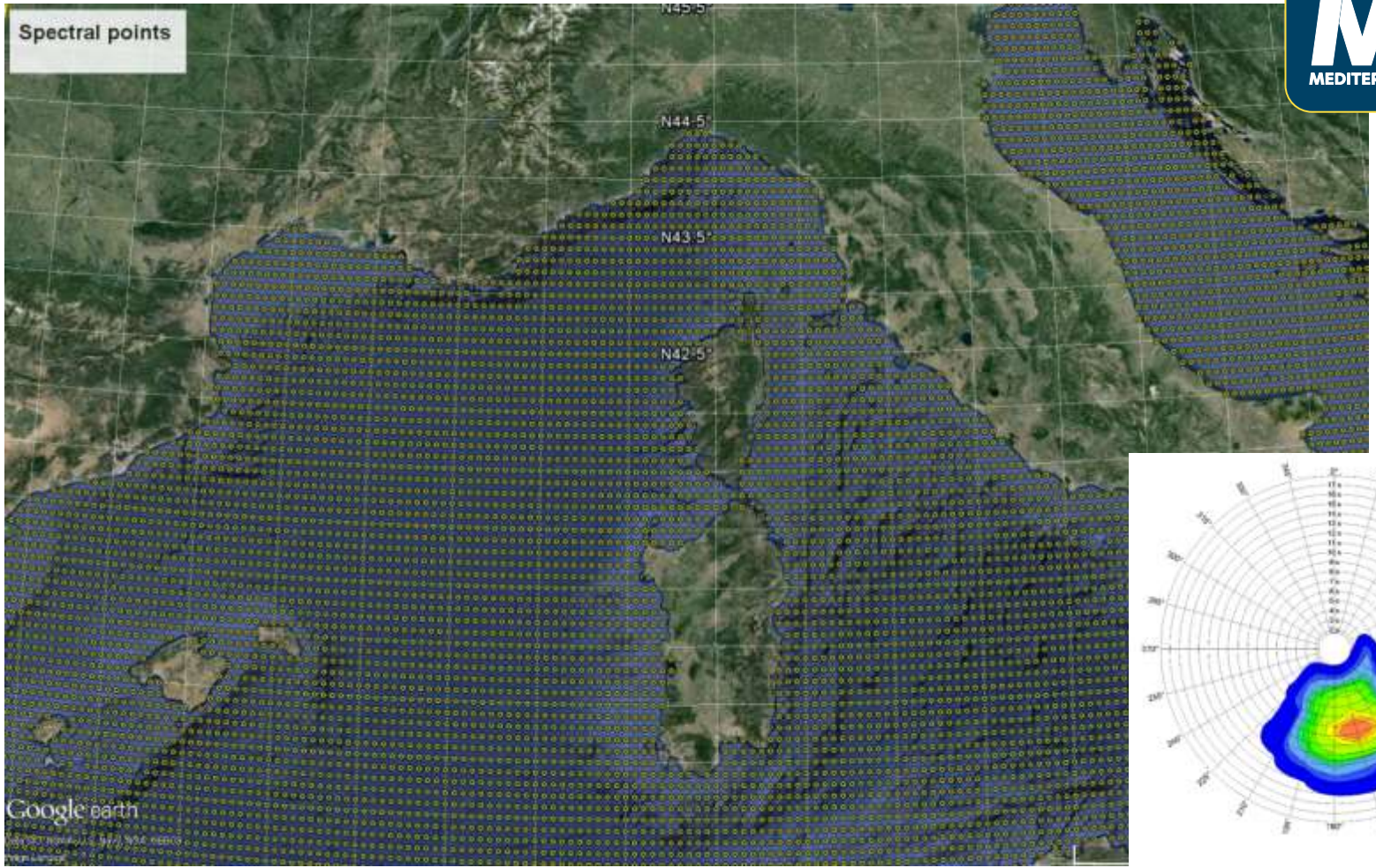
Hindcast Database

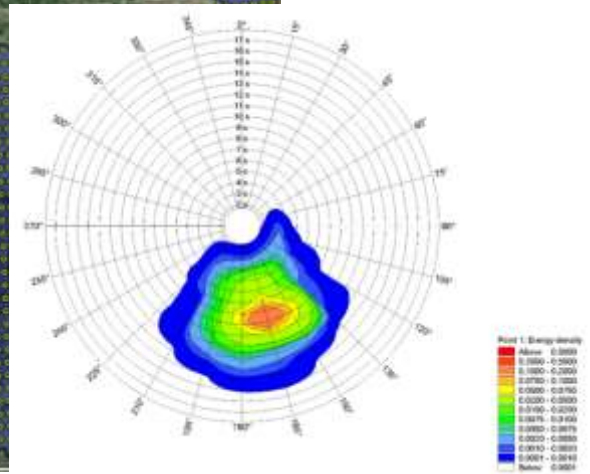
- *35 anni di dati (dal 1979 al 2013)*
- *Risoluzione Spaziale: 0.1 °(~10 km) per il vento e fino a 0.03°(~3km) per le onde*
- *Dati Parametrici disponibili per ogni elemento della mesh (meteo=Lambert; onda=non strutt.)*
  - *Wind speed, WS [m/s]*
  - *Wind gust [m/s]*
  - *Wind direction, WD [deg]*
  - *Significant Wave height, Hs [m]*
  - *Mean wave period, Tm [s]*
  - *Peak wave period, Tp [s]*
  - *Zero crossing period, Tz [s]*
  - *Mean wave direction, MWD [deg]*
  - *Peak wave direction, PWD [deg]*
  - *Directional standard deviation, DSD [deg]*
- *Dati spettrali e vento disponibili da scaffale su una griglia 0.1° x 0.1° (10 km x 10 km)*

Forecast Service

- *Previsioni onde/vento fino a 96h*
- *1 run giornaliero*
- *Servizi di forecast ad alta risoluzione dedicati attivabili su richiesta*

Prodotti MWM – Griglia Dati Spettrali



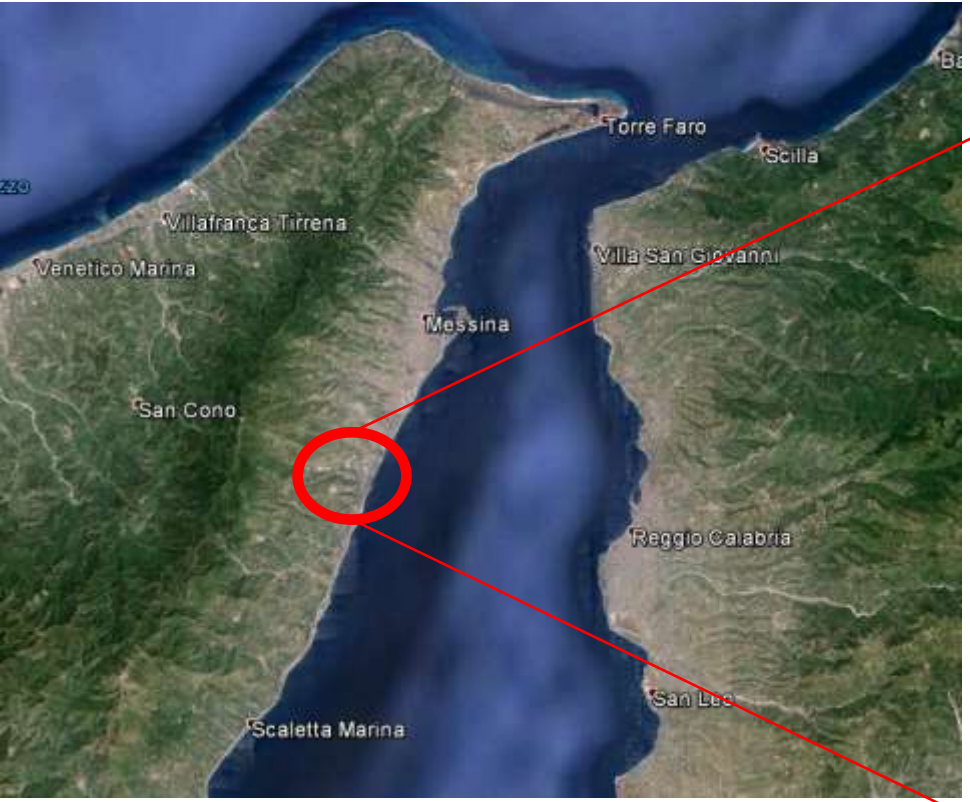


MWM - Applicazioni

MWM
MEDITERRANEAN WIND WAVE MODEL

MWM - Applicazioni

Studio delle soluzioni volte alla mitigazione dell’insabbiamento nel porto di Tremestieri

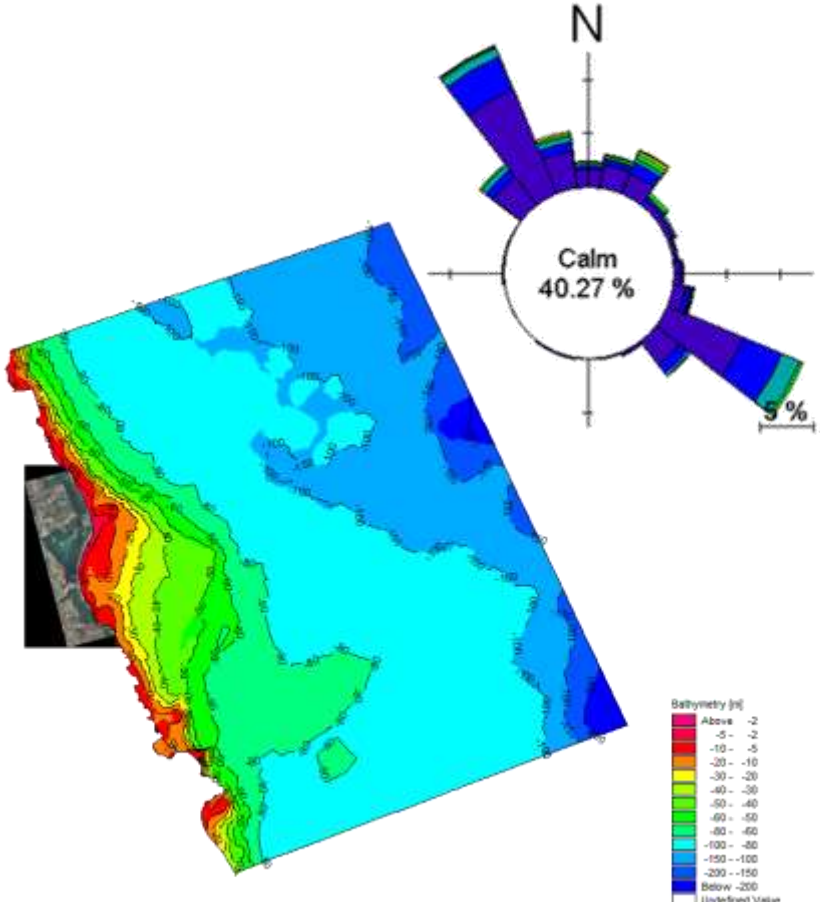


MWM - Applicazioni

MWM
MEDITERRANEAN WIND WAVE MODEL

MWM - Applicazioni

Studio Modellistico delle Dinamiche Costiere del Litorale di Alimini e supporto alla realizzazione di un Sistema di Supporto Decisionale

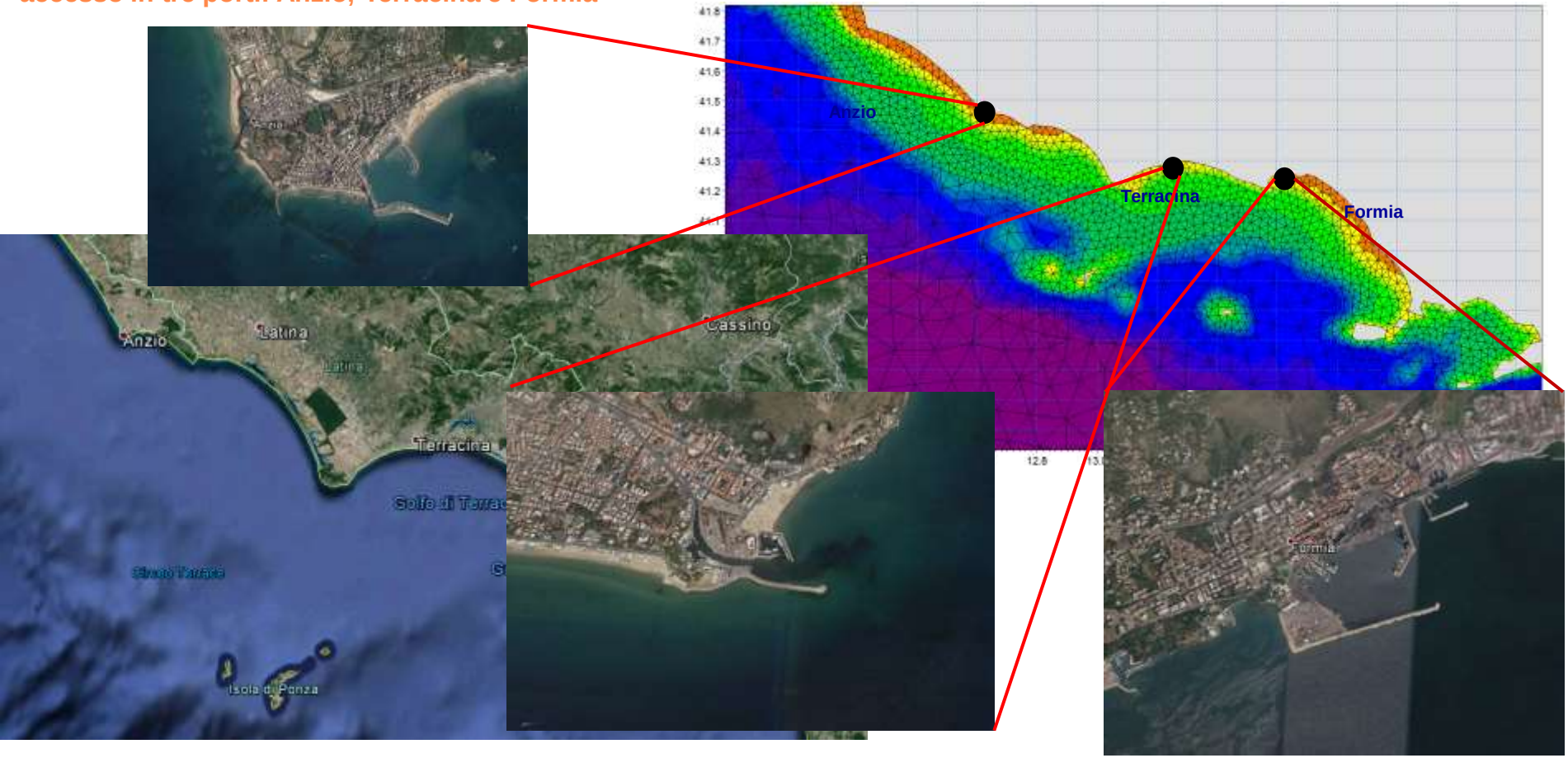


MWM - Applicazioni

MWM
MEDITERRANEAN WIND WAVE MODEL

MWM - Applicazioni

Utilizzo dati da parte di Ente di ricerca laziale, per studio dinamiche costiere e di insabbiamento canali di accesso in tre porti: Anzio, Terracina e Formia



Catena Modellistica

Global Atmospheric Model (Global)		
CFSR by NCEP	Downloaded *Reanalysis*	0.5° (≈ 50 km)

Saha, Suranjana, et. al. (2010)
The NCEP Climate Forecast System Reanalysis.
Bull. Amer. Meteor. Soc., Vol. 91, 1015-1057.

IC and BC

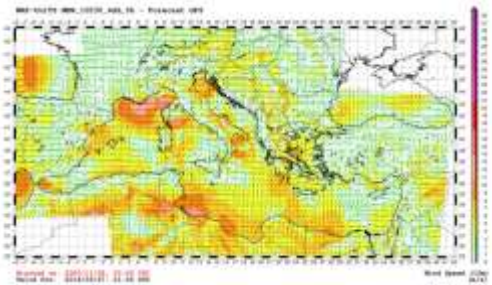
Local Atmospheric Model (Med)		
WRF-ARW	Simulation	0.1° - 0.03°

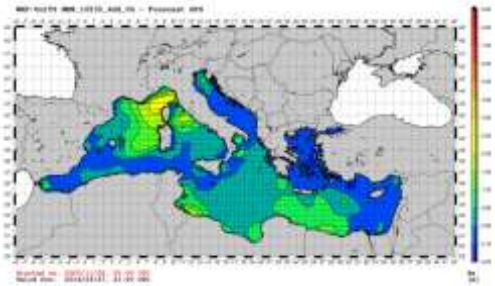
Michalakes J, et. al., (2005)
The WRF Model: Software Architecture and Performance.
In Proceedings of the *11th ECMWF Workshop on the Use of High Performance Computing in Meteorology*. 2005, 56 - 168.

Forcing term

Wave Model (Med)		
MIKE 21	Simulation	0.1° - 0.03°

MWM
MEDITERRANEAN WIND WAVE MODEL



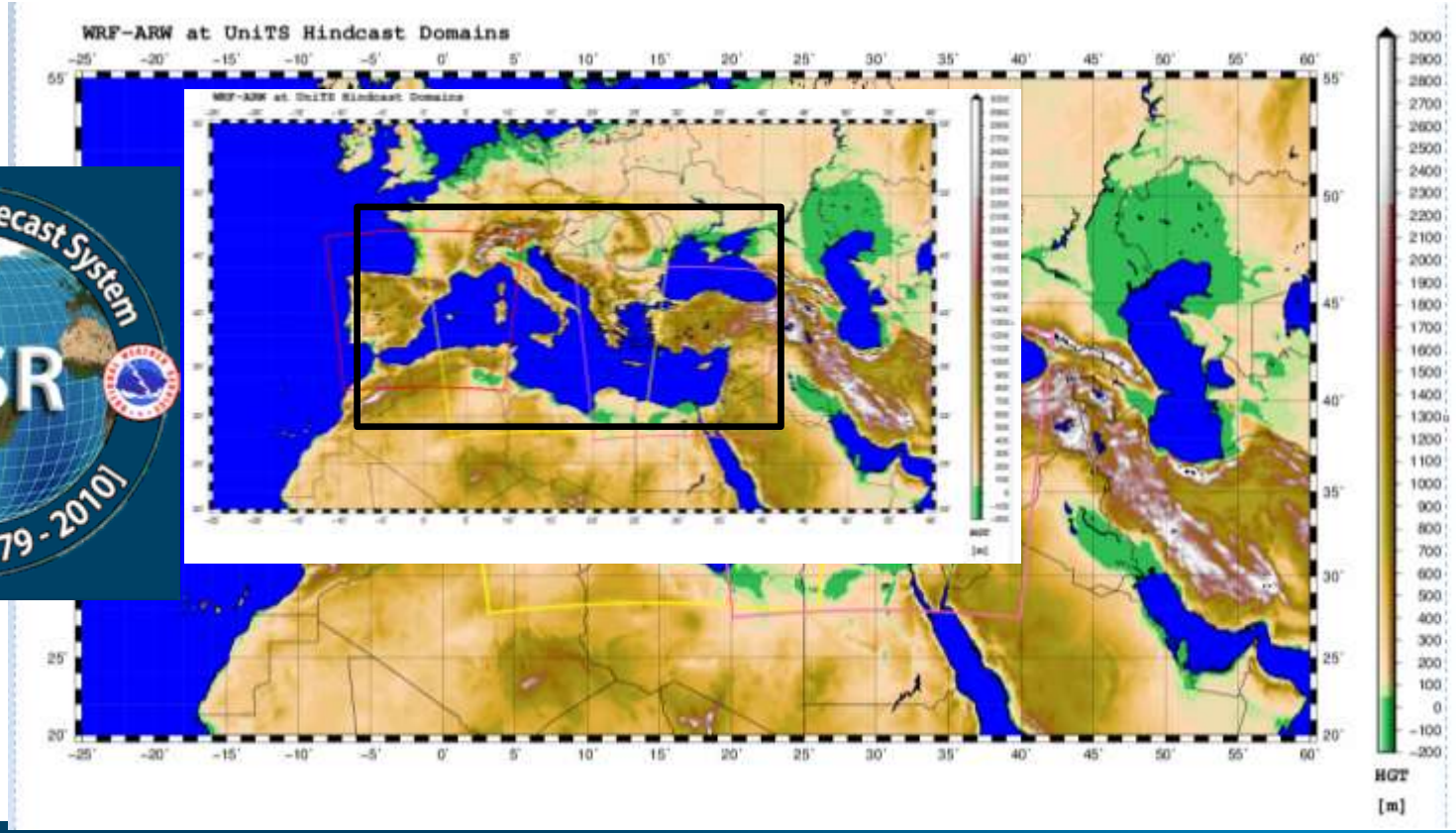


Modello Atmosferico

HyMOLab
Hydrodynamics · MetOcean

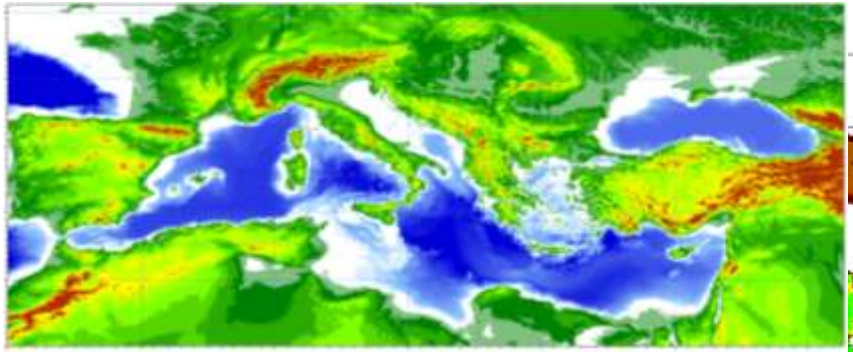
WRF-ARW (NCAR, Boulder) + CFSR (NCAR-NCEP) / GFS

Risoluzione = 0.1° - 0.03°

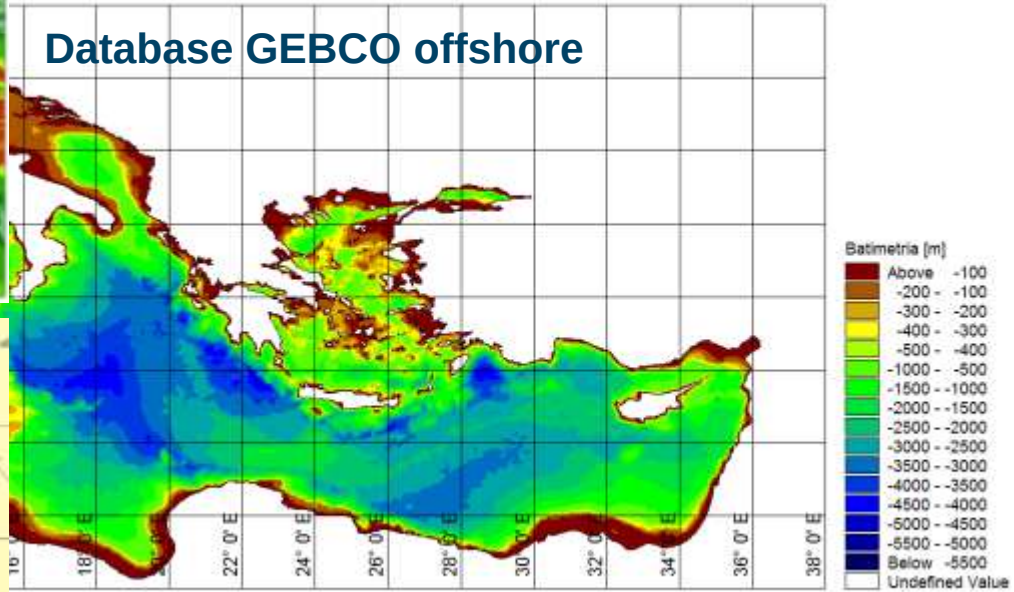


Modello d’Onda

MIKE 21 SW (DHI) - Risoluzione fino 0.03°

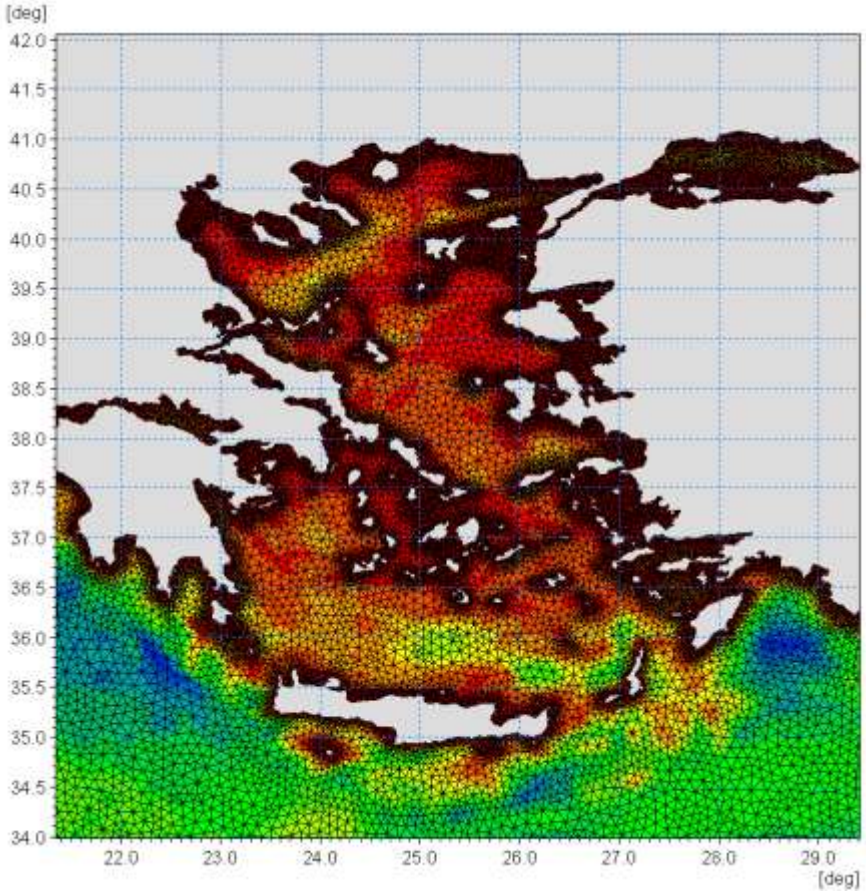


Database GEBCO offshore



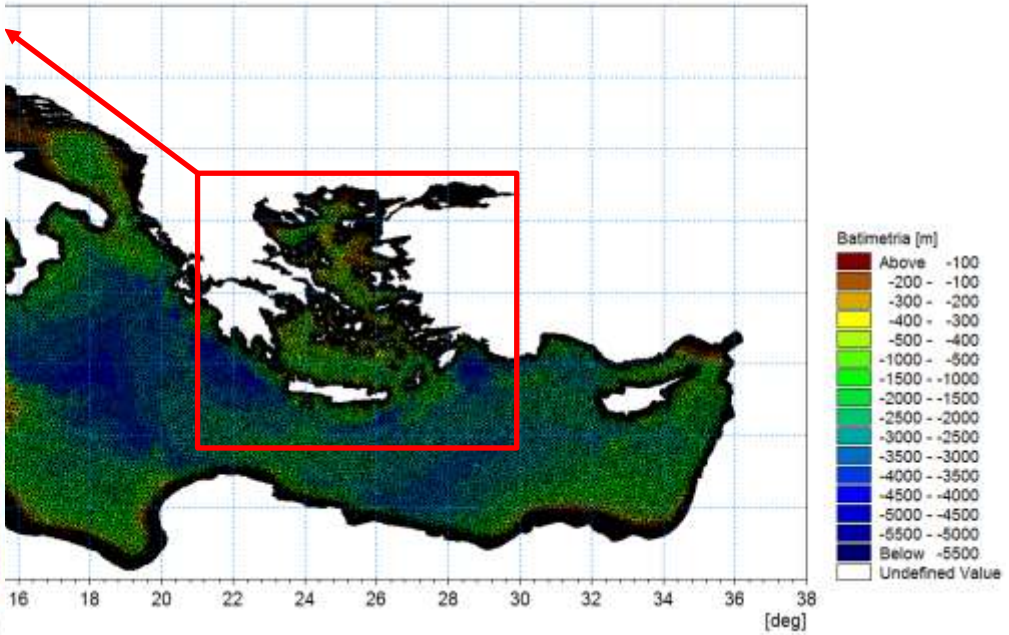
Dati da carta nautica per aree costiere

Modello d'Onda



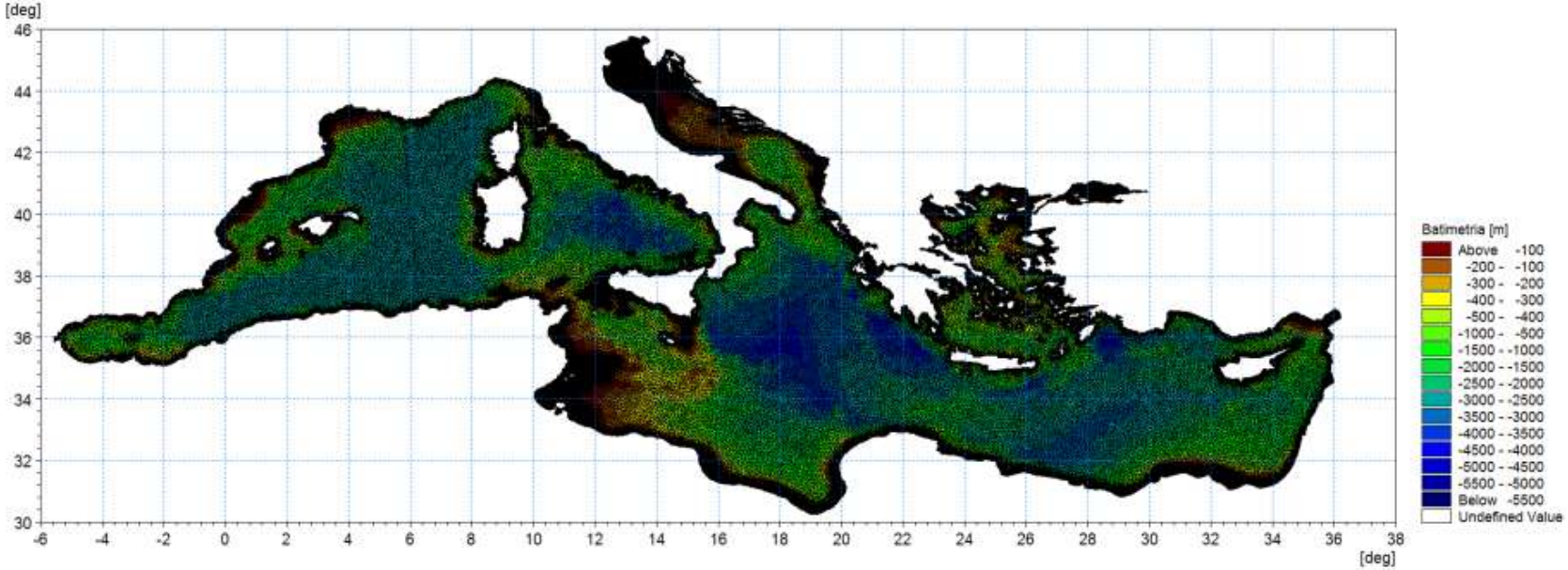
MIKE 21 SW (DHI) – Risoluzione fino a 0.03°

Batimetria: GEBCO + Carta Nautica



Modello d'Onda - Calibrazione

- Calibrazione effettuata confrontando dati delle boe ondametriche nel mediterraneo
- Principali parametri di calibrazione: Dissipazione da White Capping
- Più di 50 configurazioni testate
- Dominio spettrale caratterizzato da 30 frequenze (1.6<T<25 s) e 24 direzioni
- Air-sea interaction: formulazione disaccoppiata

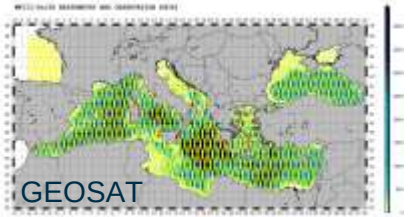


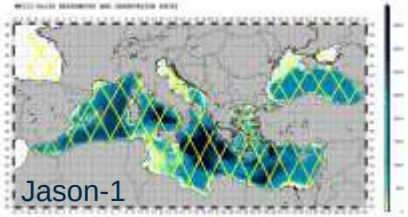
Validazione dei modelli

Satellite Vs Stazione fissa

PROS
- Area estesa (semi-lagrangiano)
- Misure omogenee
- Datasets ragion. validati

CONS
- Campionamento spazio/tempo (≈7 km/s, 10/30 tempo di ritorno)
- Solo Wind Speed & Hs
- Misure indirette (altim & scatter)
- Misure inaccurate verso costa

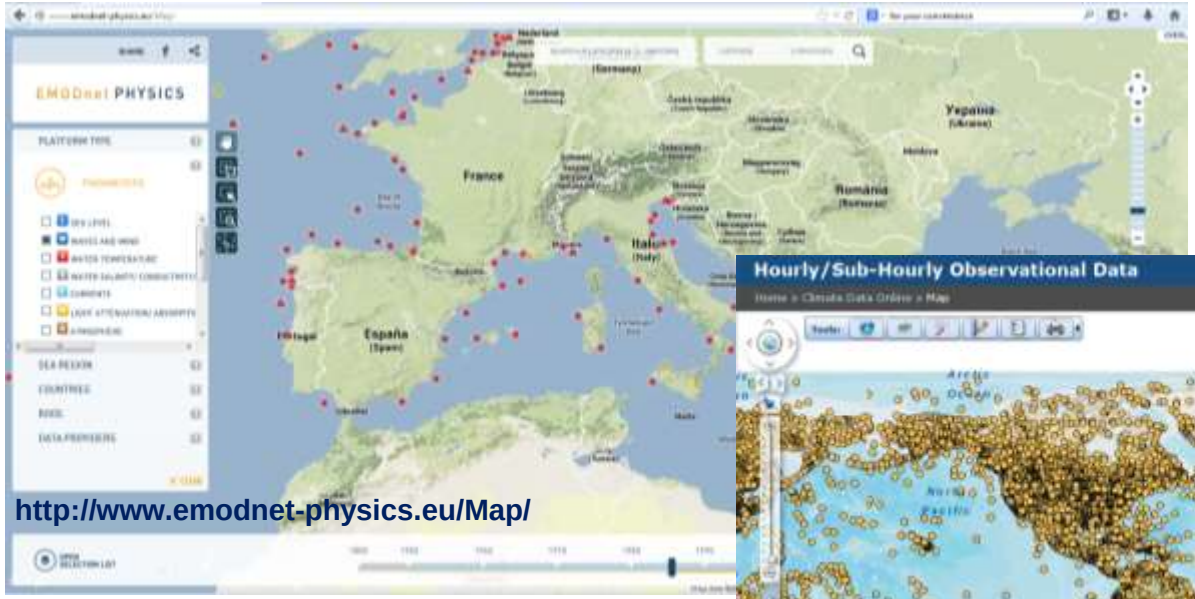




PROS
- Serie (quasi) continue in situ
- Misure dirette
- Direzioni, periodi, spettri,…

CONS
- Strumenti diversi & affidabilità
- Posizione degli anemometri
- Validazione della stazione
- Poche misure offshore

Validazione dei modelli: stazioni fisse



http://www.emodnet-physics.eu/Map/

http://gis.ncdc.noaa.gov/map/viewer

DATI DA 3 RETI ONDAMETRICHE

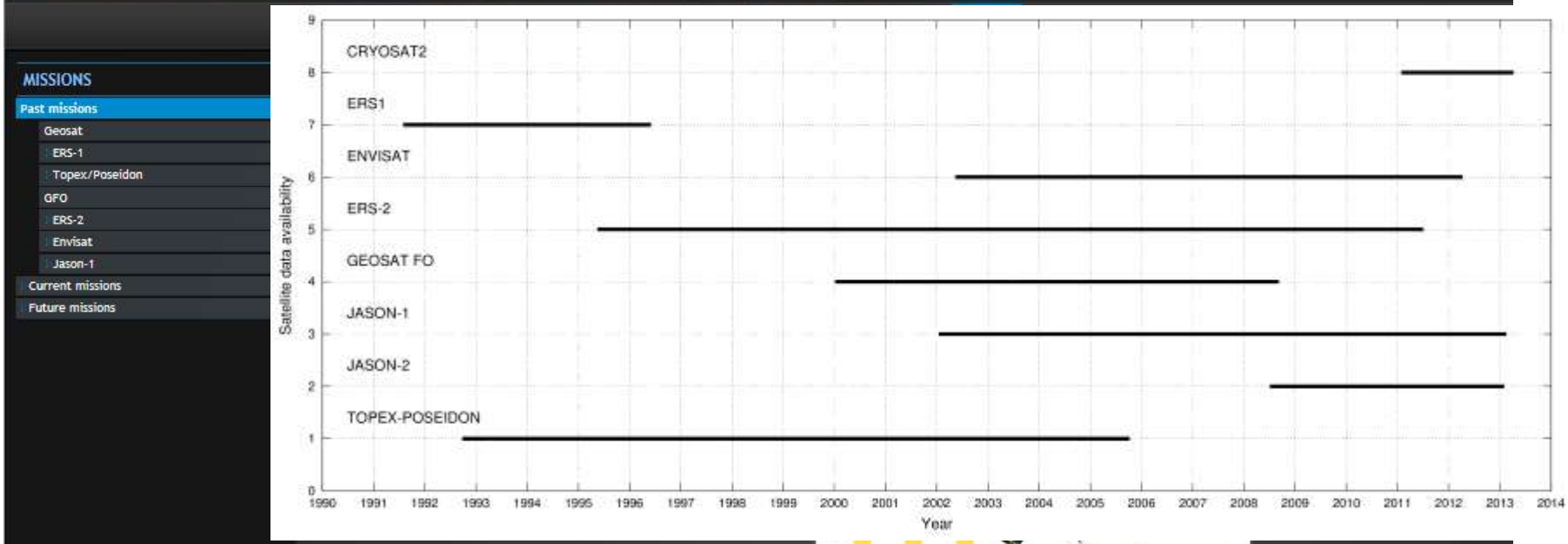
- **REDEXT** (Spanish, PdE)
- **RON** (Italian, ISPRA)
- **POSEIDON** (Greek, HCMR)

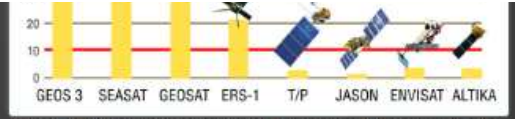
+

- ….
- ….

Validazione dei modelli: satelliti

http://www.aviso.altimetry.fr/en/missions/





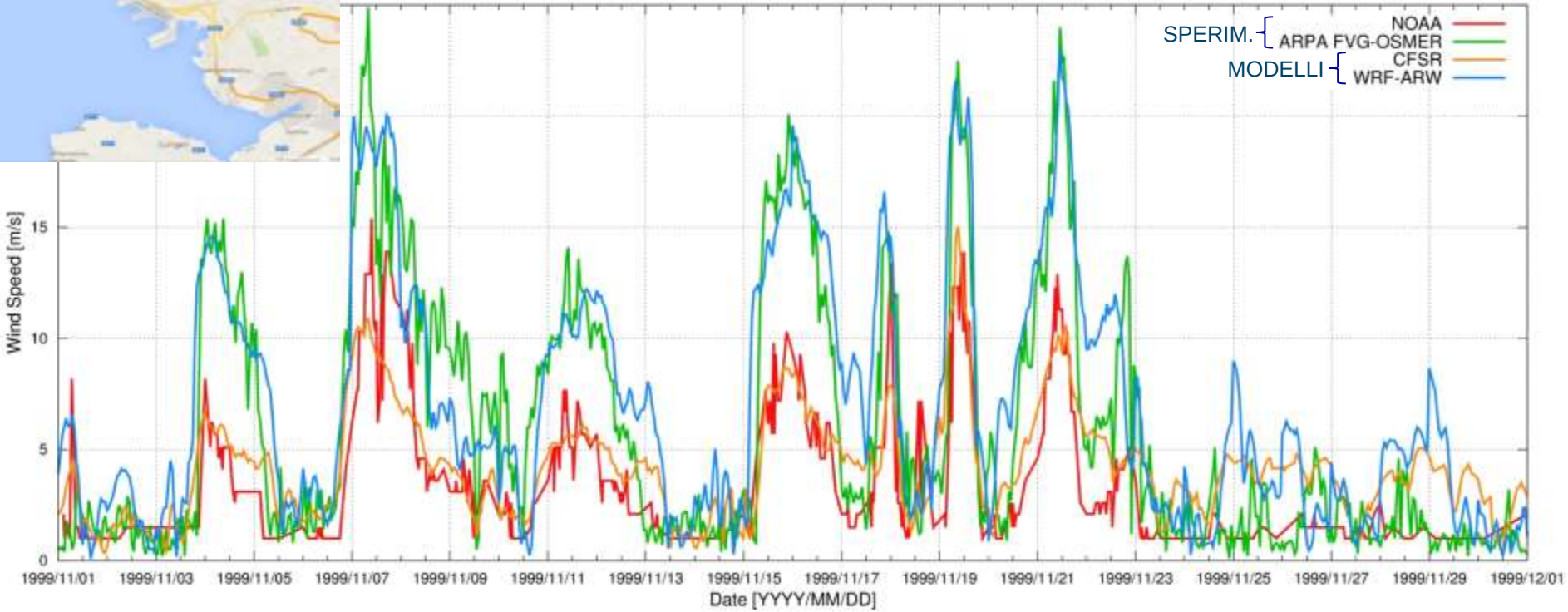
Improvements in measurement accuracy since the first satellite altimetry missions has enabled us to observe ocean variations at close quarters since 1992. (Credits Cnes).

Queffeulou P., Croizé-Fillon D. (2010) Global altimeter SWH data set, version 7. Technical Report, Ifremer.

Queffeulou P. (2009) Altimeter Wave Height Measurements - Validation of Long Time Series. Poster: Ocean Surface Topography Science Team meeting, Seattle, Washington,USA.

Validazione dei modelli: stazioni fisse

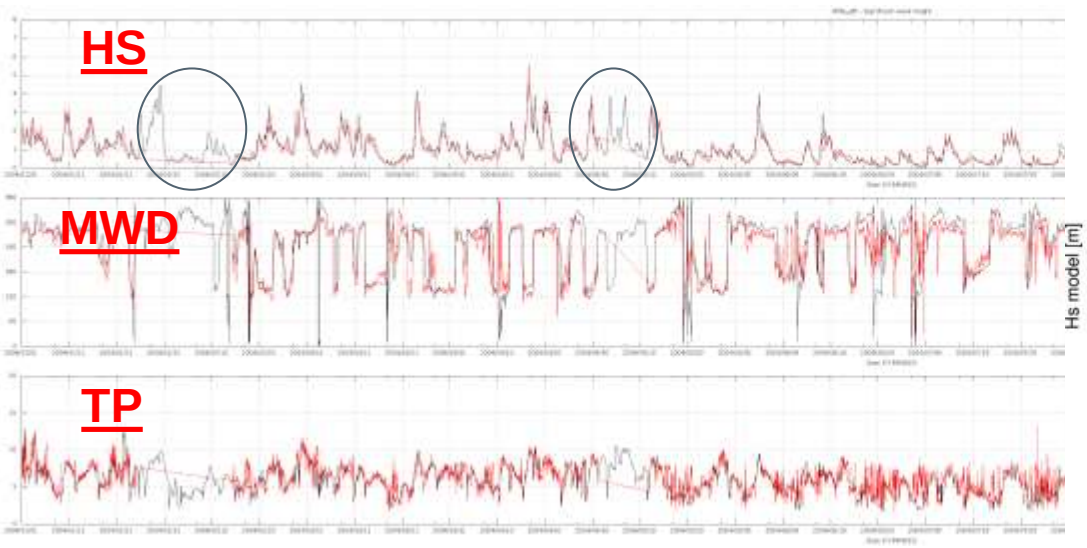
Vento 10m (stesso sito): 2 fonti sperimentali + modello globale + modello LAM

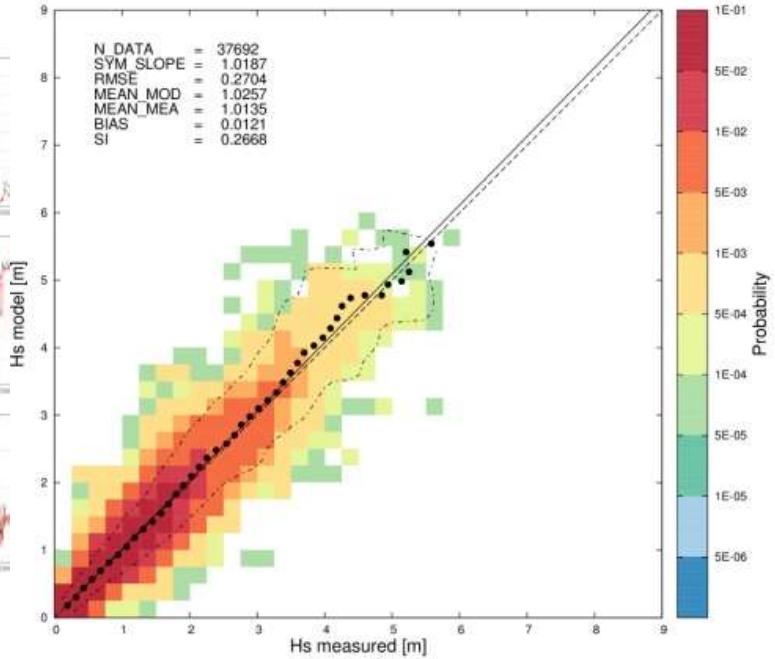


Validazione dei modelli: stazioni fisse

Serie temporali
Confronto **SINCRONO** e **CO-LOCATO**

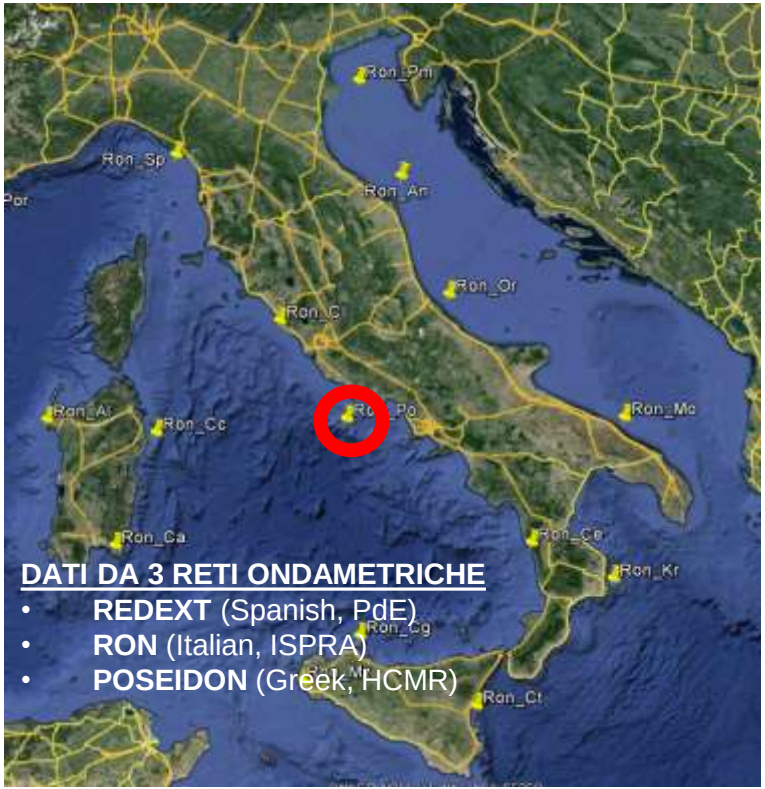
→ Probability Scatter Plots (***PSP***)

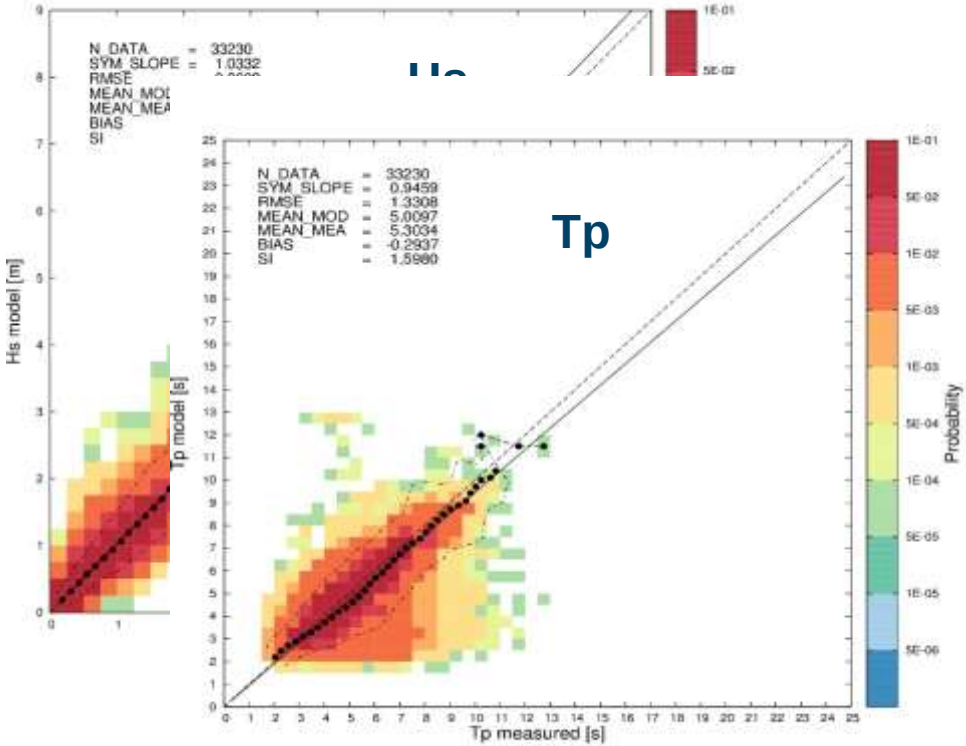




Validazione dei modelli: boe ondametriche

Ponza: LON 12.95° E, LAT 40.87° N





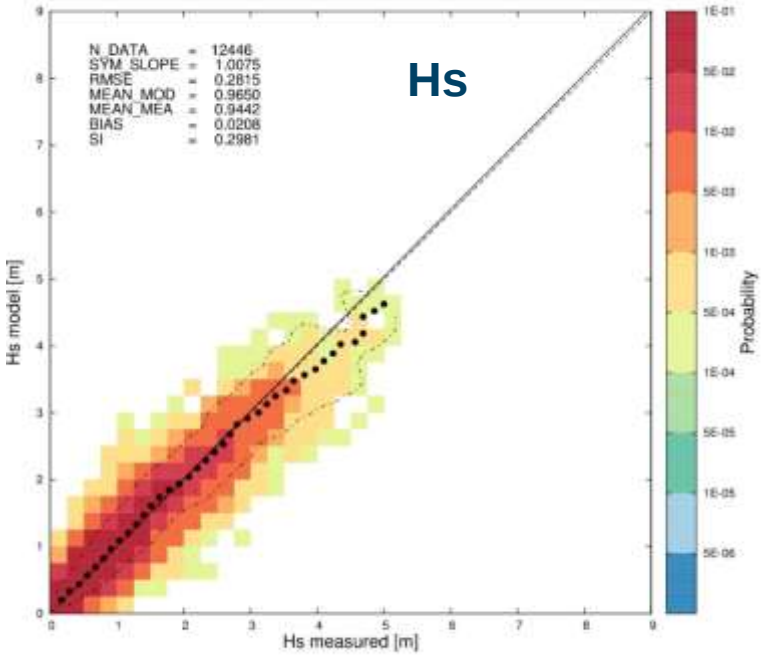
large scatter – issues with Tp measurements

Validazione dei modelli: boe ondametriche

Athos: LON 24.72° E, LAT 39.96° N

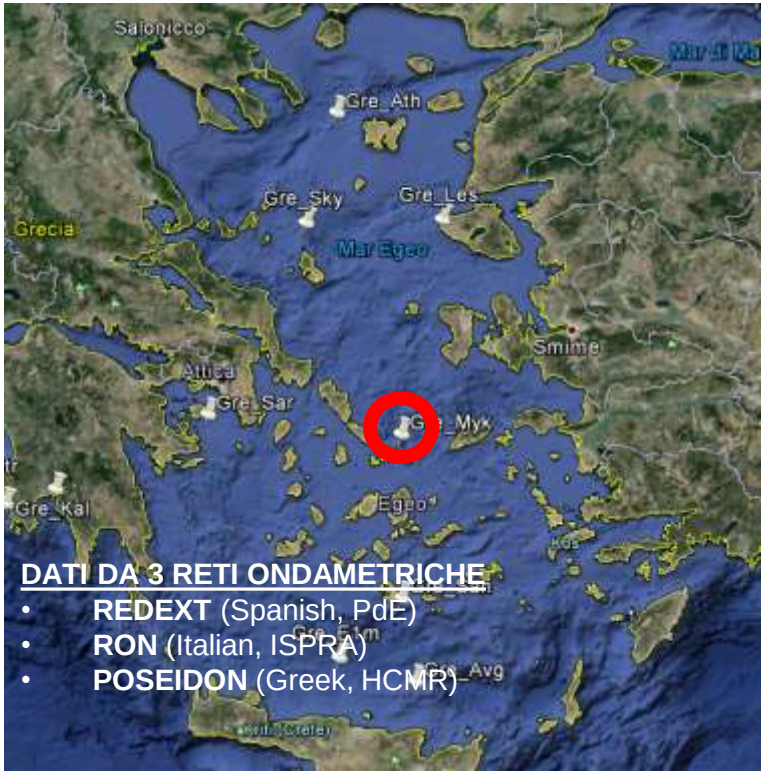
DATI DA 3 RETI ONDAMETRICHE

- **REDEXT** (Spanish, PdE)
- **RON** (Italian, ISPRA)
- **POSEIDON** (Greek, HCMR)



Validazione dei modelli: boe ondametriche

Mykonos: LON 25.46° E, LAT 37.51° N



DATI DA 3 RETI ONDAMETRICHE

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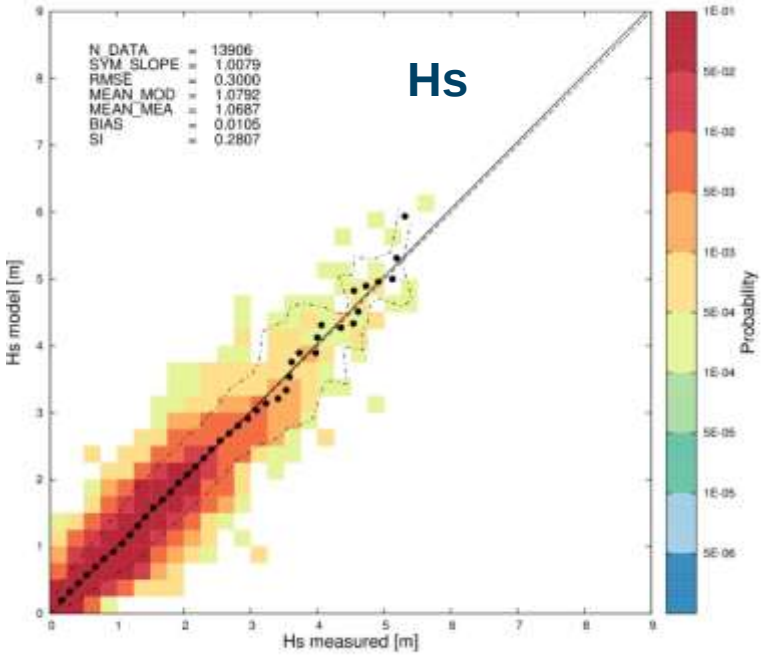
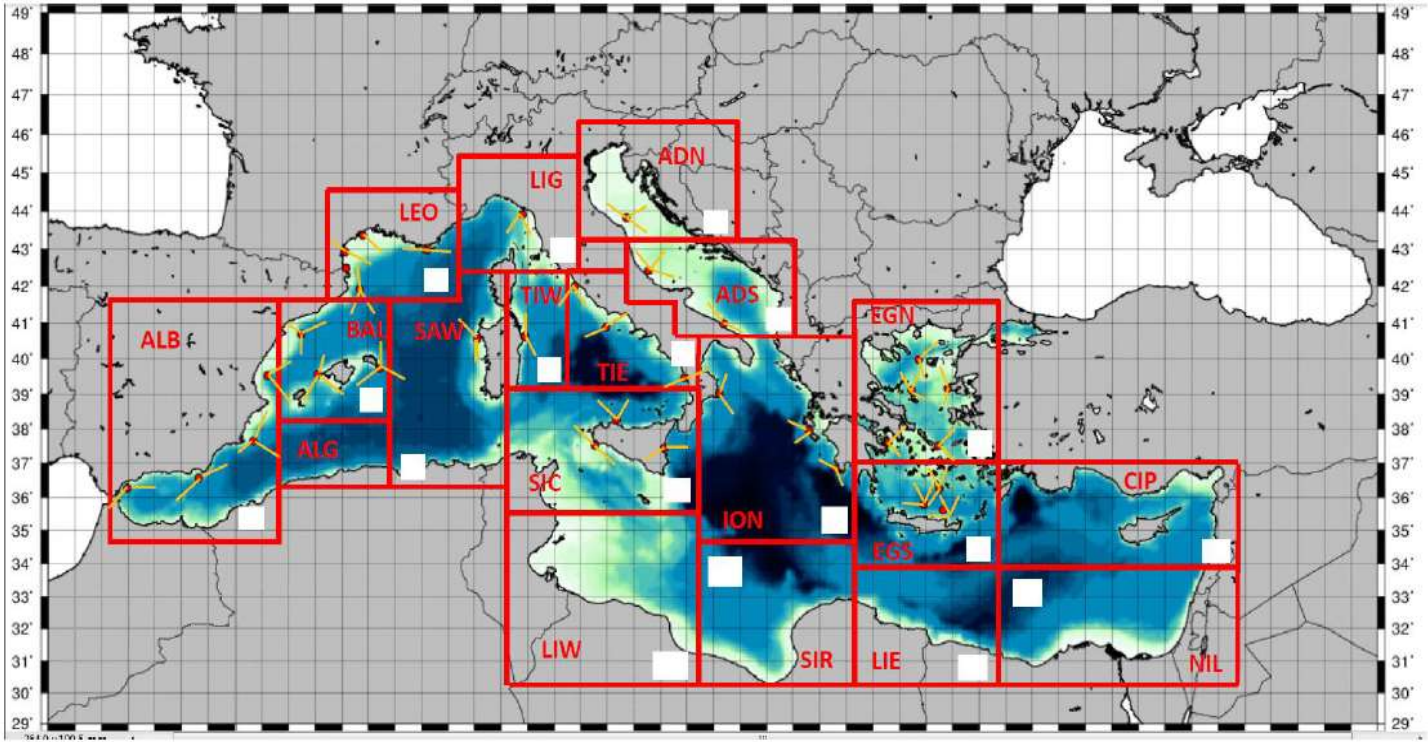


Validazione dei modelli: satellite

7 missioni:

- **Envisat**
- **ERS-2**
- **Geosat FO**
- **Jason-1**
- **Jason-2**
- **Topex-Poseidon**
- **CryoSat**



Intero Mediterraneo + 19 sottodomini

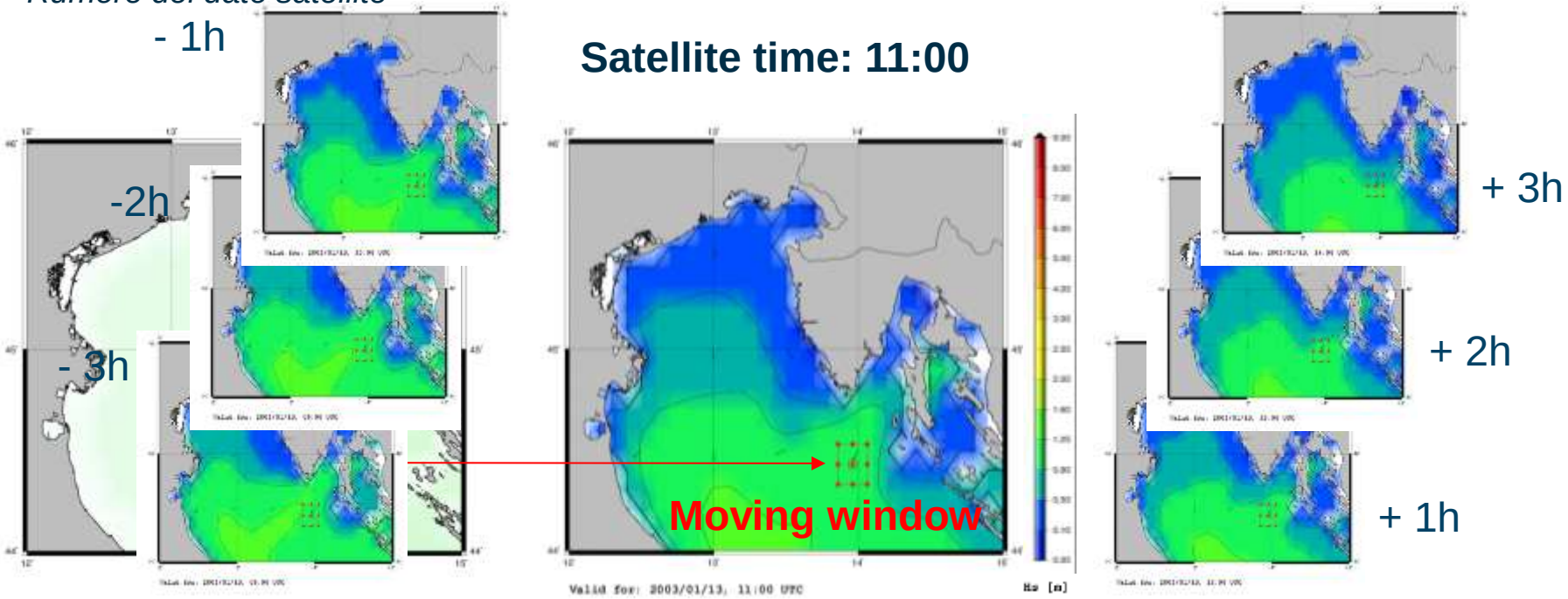
Queffeulou P., Croizé-Fillon D. (2010) Global altimeter SWH data set, version 7. Technical Report, Ifremer.
Queffeulou P. (2009) Altimeter Wave Height Measurements - Validation of Long Time Series. Poster: Ocean Surface Topography Science Team meeting, Seattle, Washington,USA.

Validazione dei modelli: satellite

Confronto **SINCRONO** e **CO-LOCATO**

Sorgenti di errore:

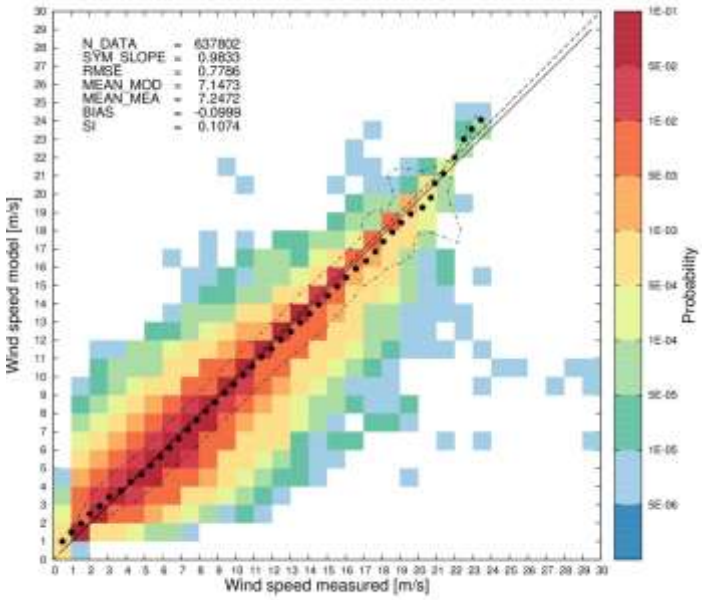
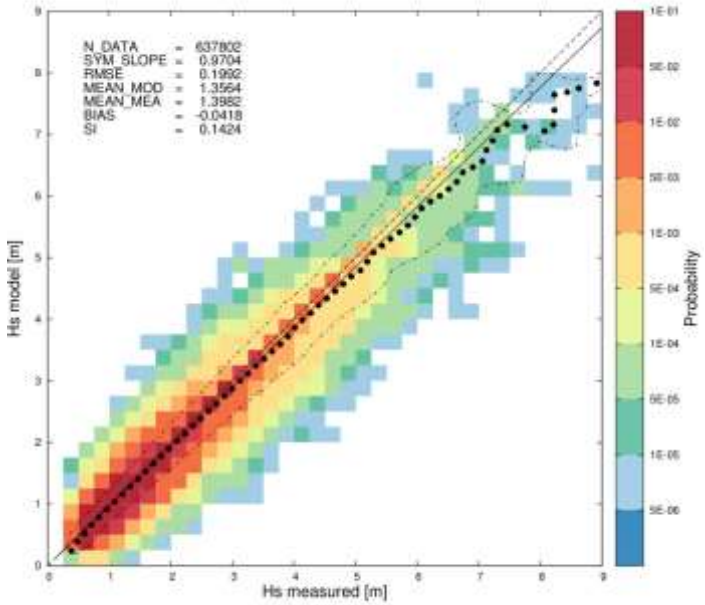
- *Shifts del modello*
- *Gradienti spazio/temporali dei fronti*
- *Ground speed del satellite (≈7 km/s)*
- *Rumore del dato satellite*



Validazione dei modelli: satellite

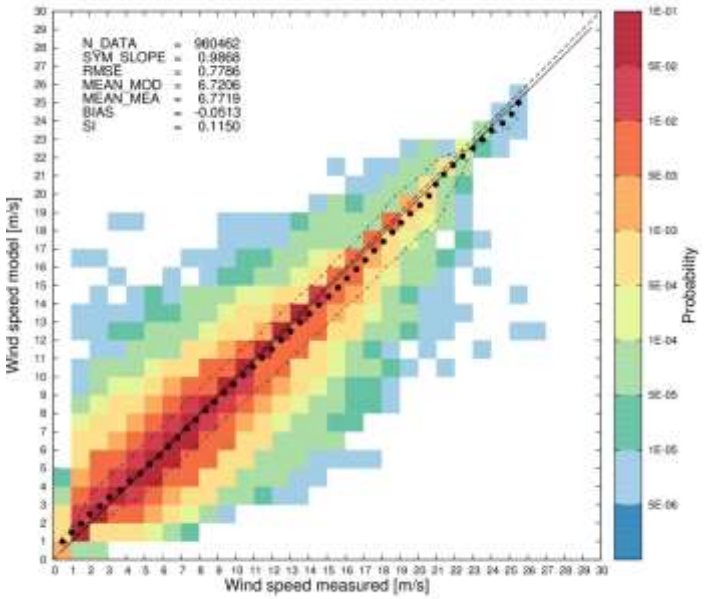
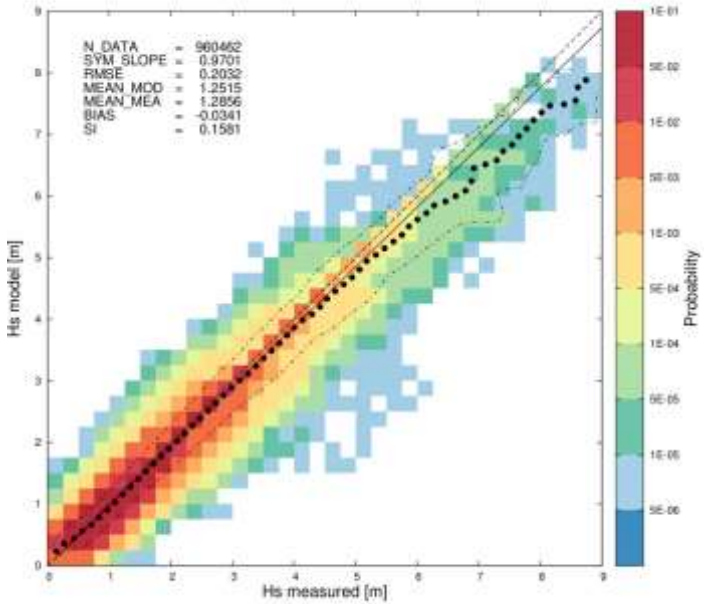
MWM
MEDITERRANEAN WIND WAVE MODEL

ENVISAT

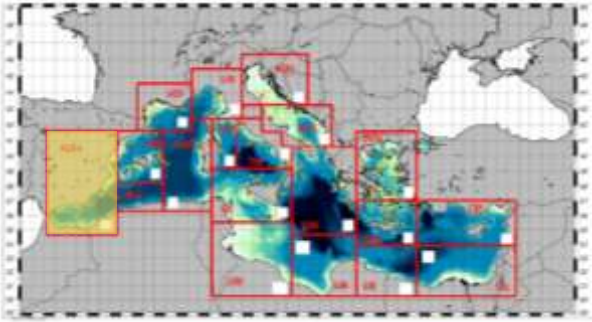
Wind speed (10 m)	**Significant wave height**
	

Validazione dei modelli: satellite

JASON-1

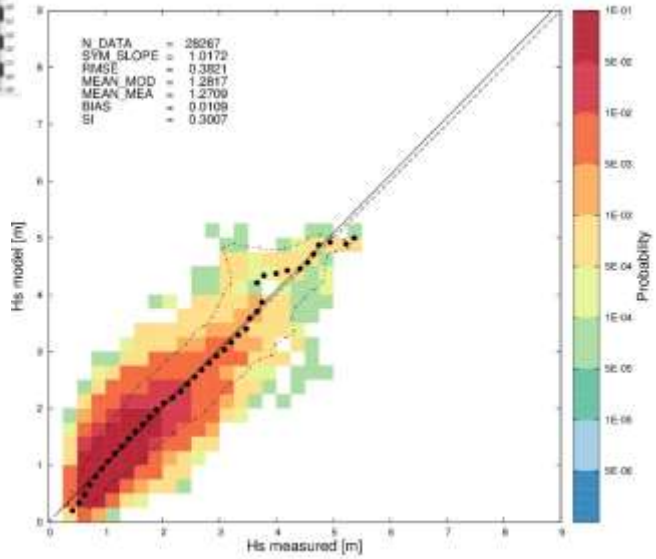
Wind speed (10 m)	**Significant wave height**
	
WS RMSE = 2 m/s → 0.7 m/s	**HS RMSE = 0.3 m → 0.2 m**

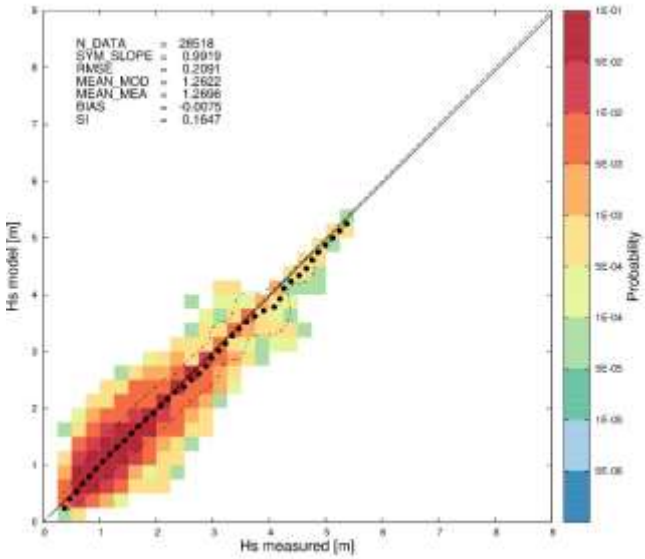
Validazione dei modelli: satellite



Alboran Sea (2002-2011)

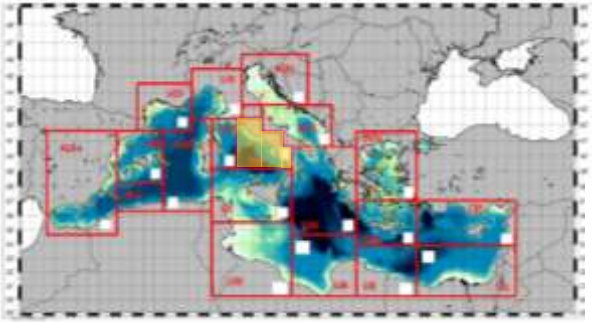
Hs (ENVISAT)





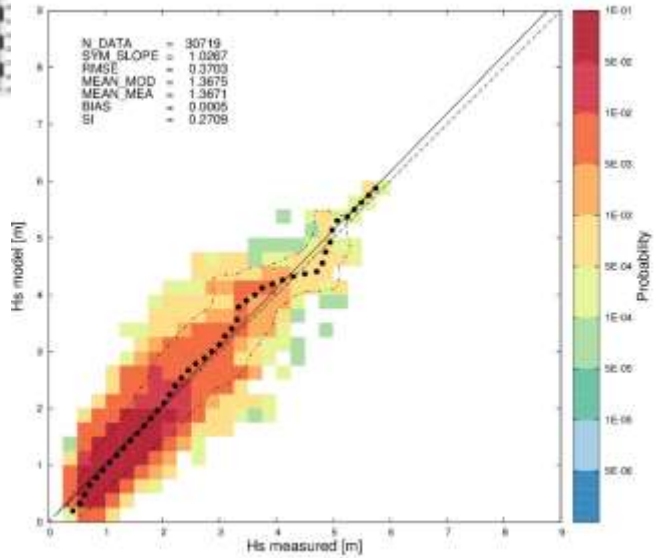
$\Delta\lambda, \Delta\varphi = 0°$ $\Delta t = 0h$ → $\Delta\lambda, \Delta\varphi = 0.1°$ $\Delta t = 3h$

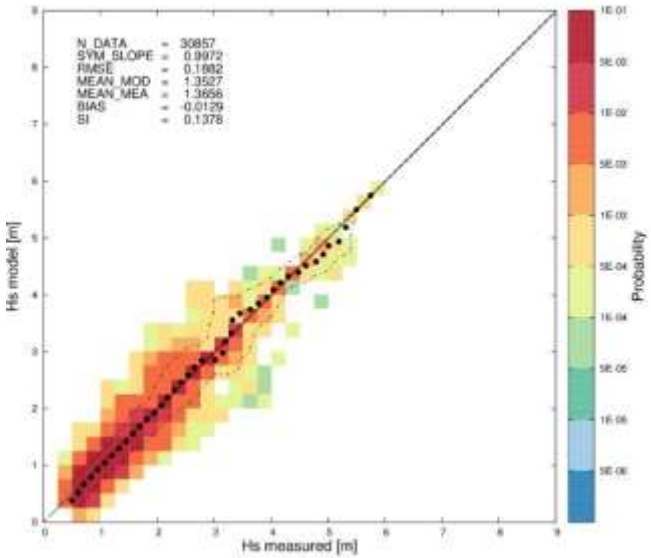
Validazione dei modelli: satellite



Mar Tirreno (2002-2011)

Hs (ENVISAT)





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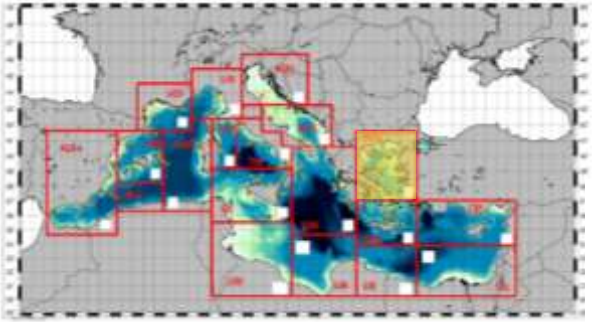
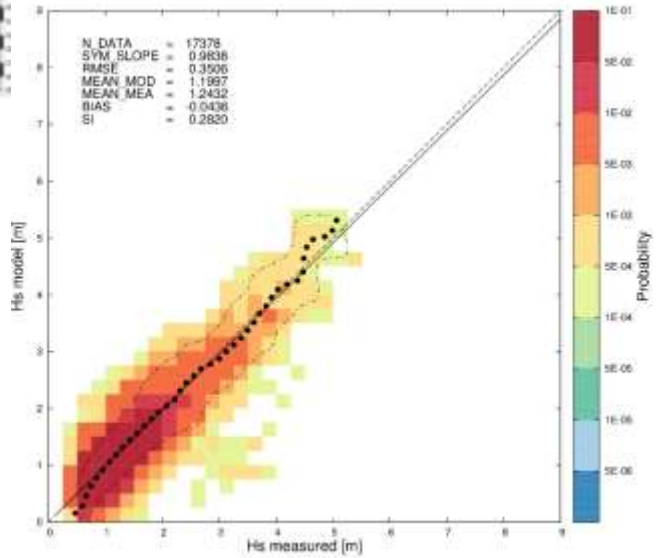
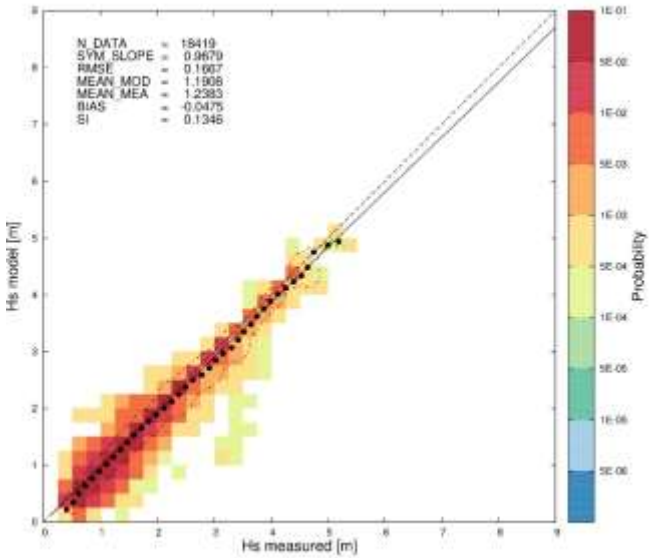
Validazione dei modelli: satellite



Mar Egeo (2002-2011)

Hs (ENVISAT)

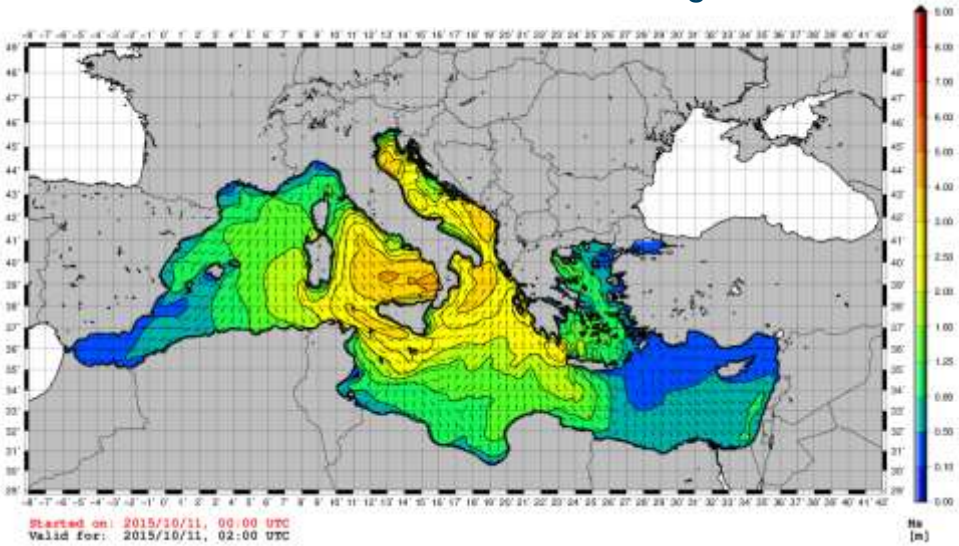




$\Delta\lambda, \Delta\varphi=0°$ $\Delta t=0h$ → $\Delta\lambda, \Delta\varphi=0.1°$ $\Delta t=3h$

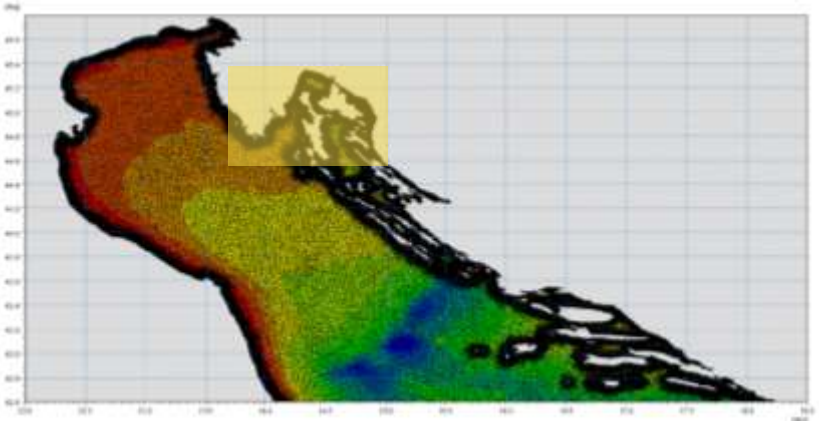
Servizio *Forecast*

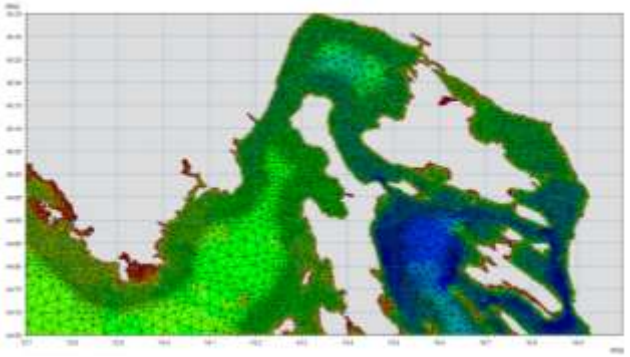
Su scala Mediterranea: + 96 ore, 1 run / giorno



Stessi set-up, risoluzioni e domini utilizzati in modalità *hindcast*

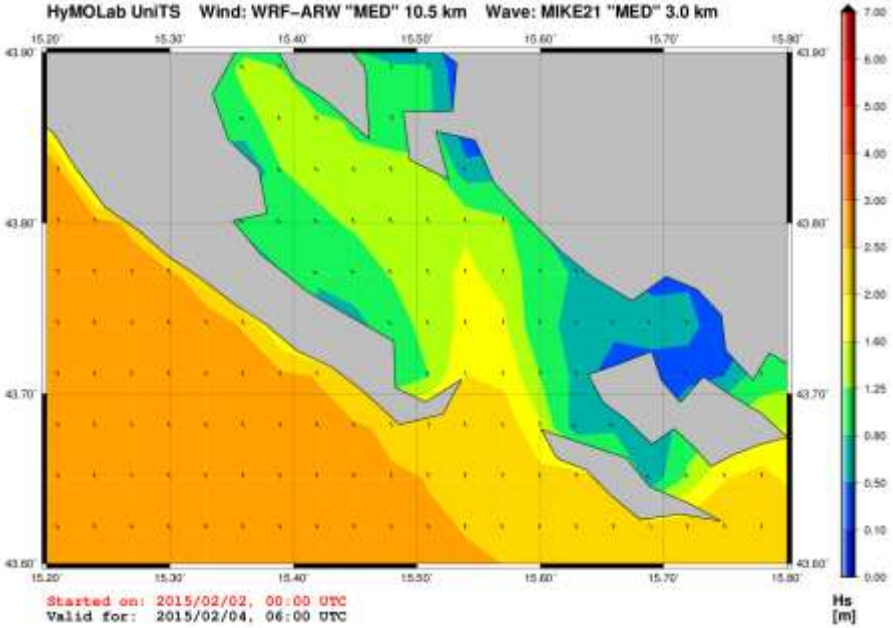
Su scala locale (a progetto)

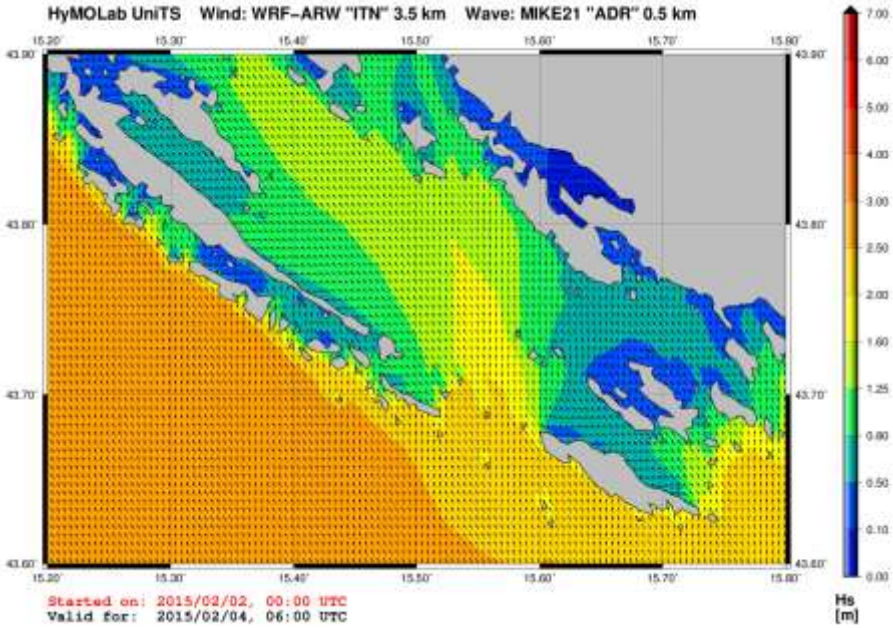




Servizio *Forecast*

Servizio per ARPA/FVG: caso di SCIROCCO (costa croata)

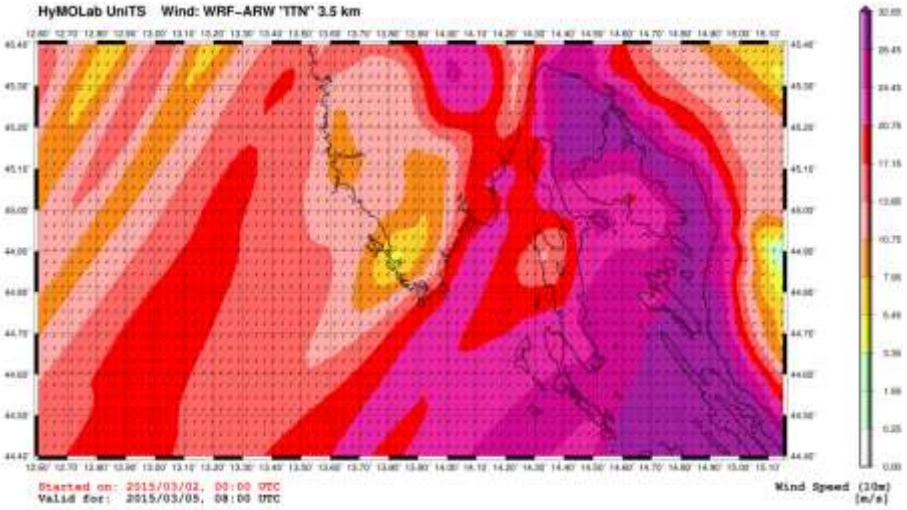


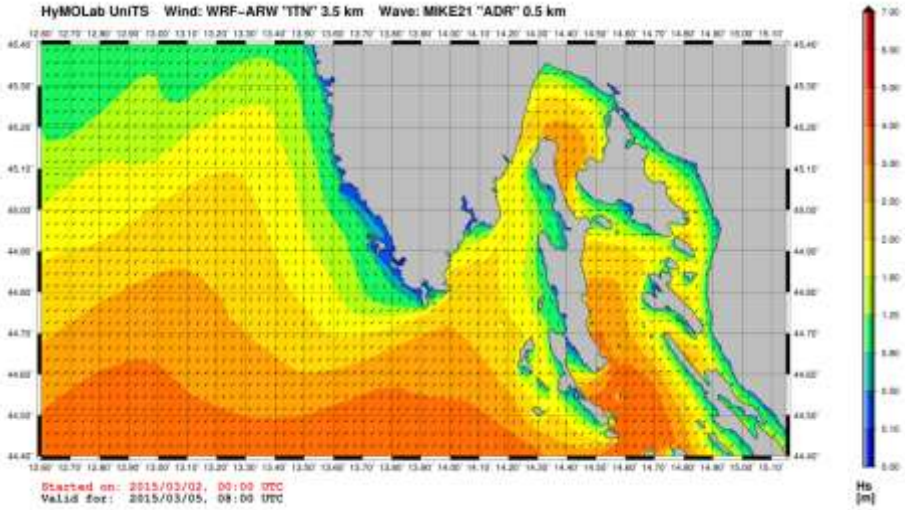


Servizio *Forecast*

MWM
MEDITERRANEAN WIND WAVE MODEL

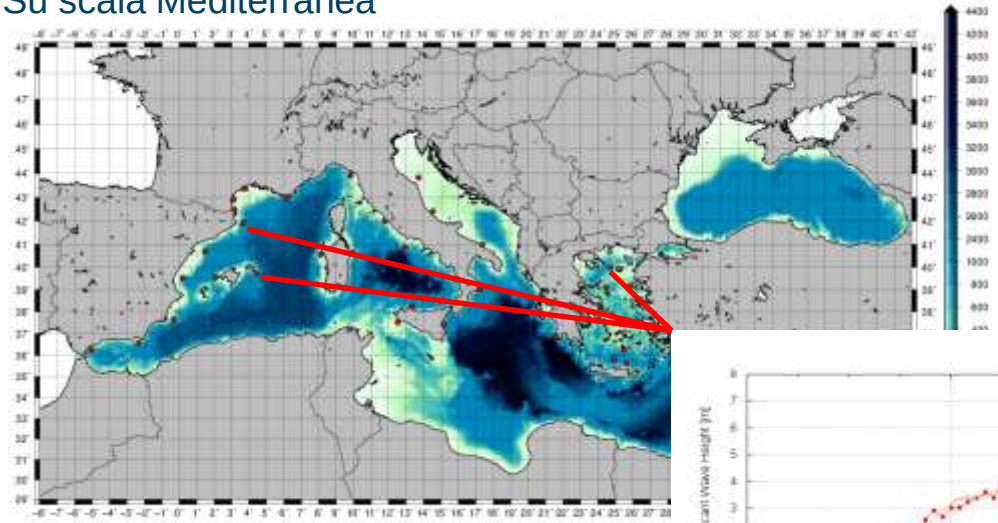
Servizio per ARPA/FVG: caso di BORA (costa croata)



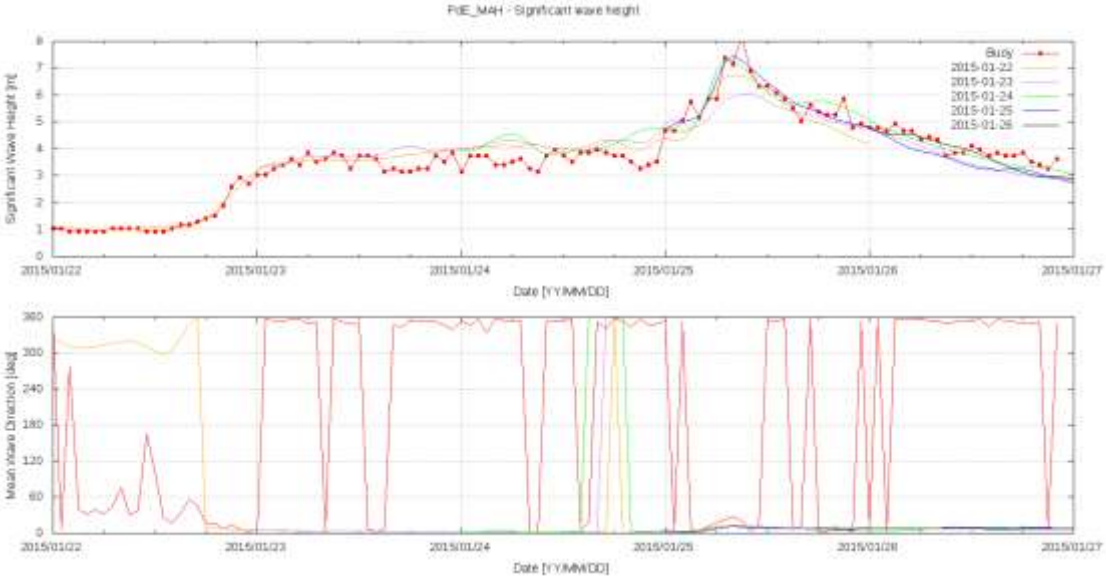


Servizio *Forecast*

Su scala Mediterranea



Fase di sviluppo (1st year)
Validazione preliminare
Confronti quotidiani delle serie con dati boa



http://hymolab.units.it

Thank you

DHI

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