Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

International Renewable Energy Agency

2019 OCEAN ENERGY EUROPE
30 SEPT - 1 OCT, DUBLIN

Ocean Energy resource mapping and assessment

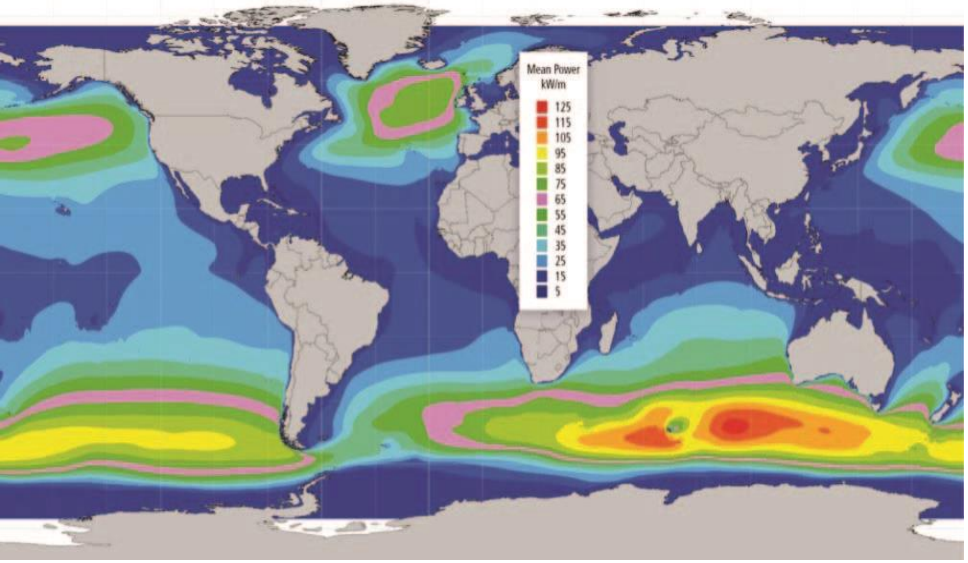
Dublin October 2nd 2019

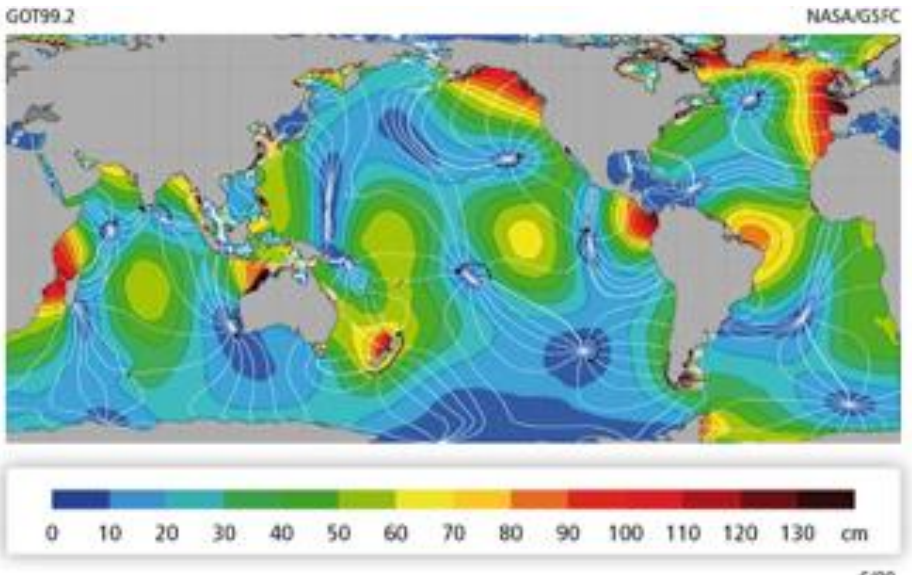
Gianmaria Sannino / Head of the Climate Modelling and Impacts Laboratory @ ENEA

Ocean energy potential

Wave energy is the largest untapped form of renewable energy in the world. It is on track to produce 10% (**500 GW**)of the global energy demand in the upcoming decades. The global installed capacity of wind and solar power at the end of 2014 was 360 GW and 150 GW respectively.

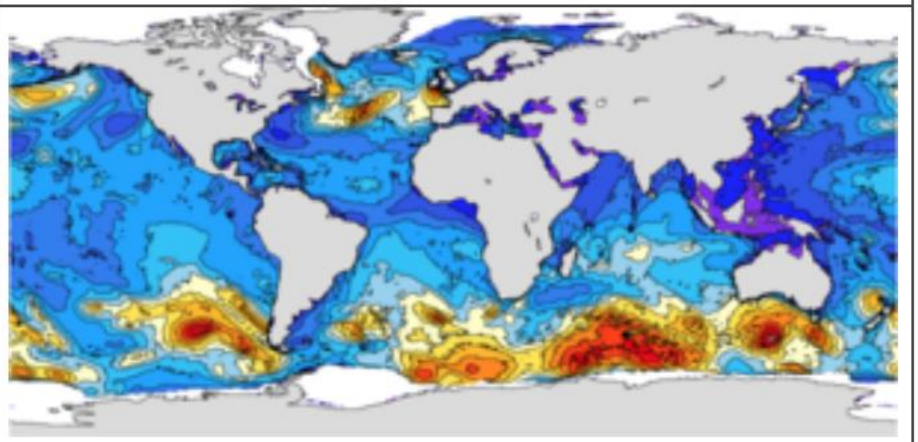
The estimates of global potential of **tidal energy** generation vary, but it is widely agreed that tidal stream energy capacity could exceed **120 GW** globally.





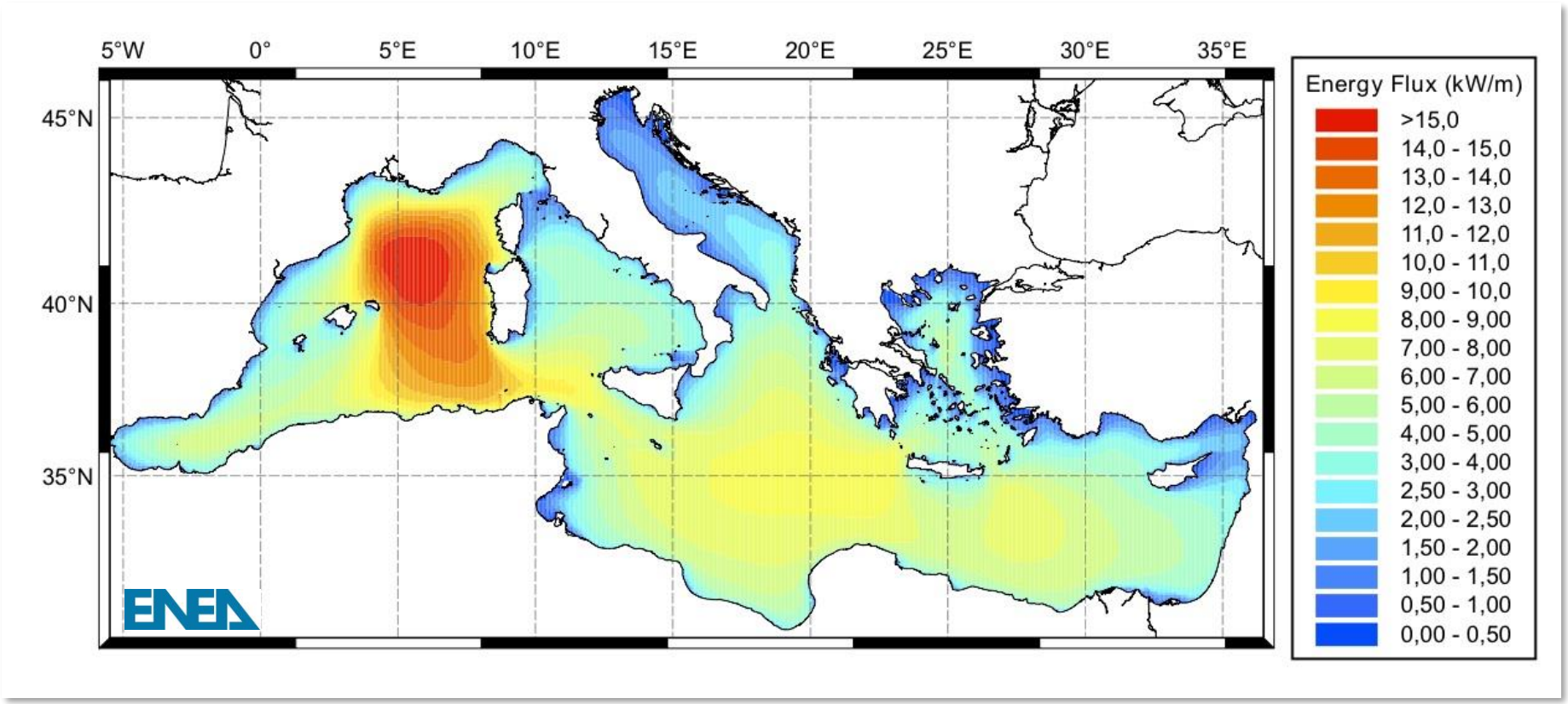
Ocean Energy resource assessment: data availability

Ocean Energy resource assessment: data availability

GLOBAL_ANALYSIS_FORECAST_WAV_001_027		
GLOBAL OCEAN WAVES ANALYSIS AND FORECAST UPDATED DAILY		
MODEL	●	GLO
SWH MWP VMDR VSDXY WW SW1 SW2 ⓘ		
0.083 degree x 0.083 degree (Surface only)		
From 2016-03-01 to Present		
3-hourly-instantaneous		
MORE INFO ADD TO CART WMS Sub-setting		

About 8Km resolution

Wave energy in the Mediterranean Sea



Distribution of average power per unit crest in the Mediterranean between 2001 and 2010.

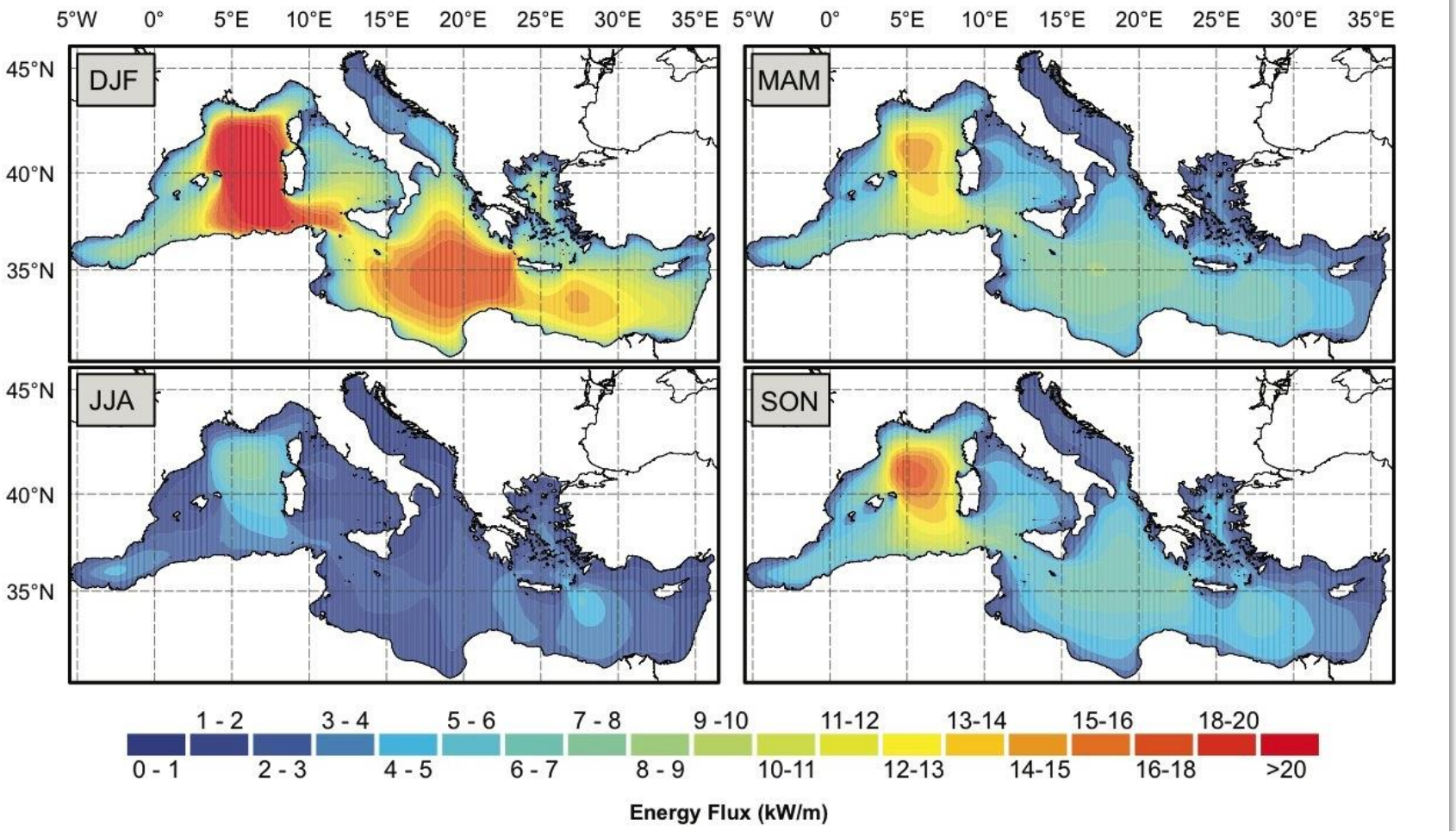
$$J = \frac{\rho g^2}{64\pi} T_e H_s^2$$

ENEA

Liberti, Carillo, Sannino, Ren. Energy. 2013

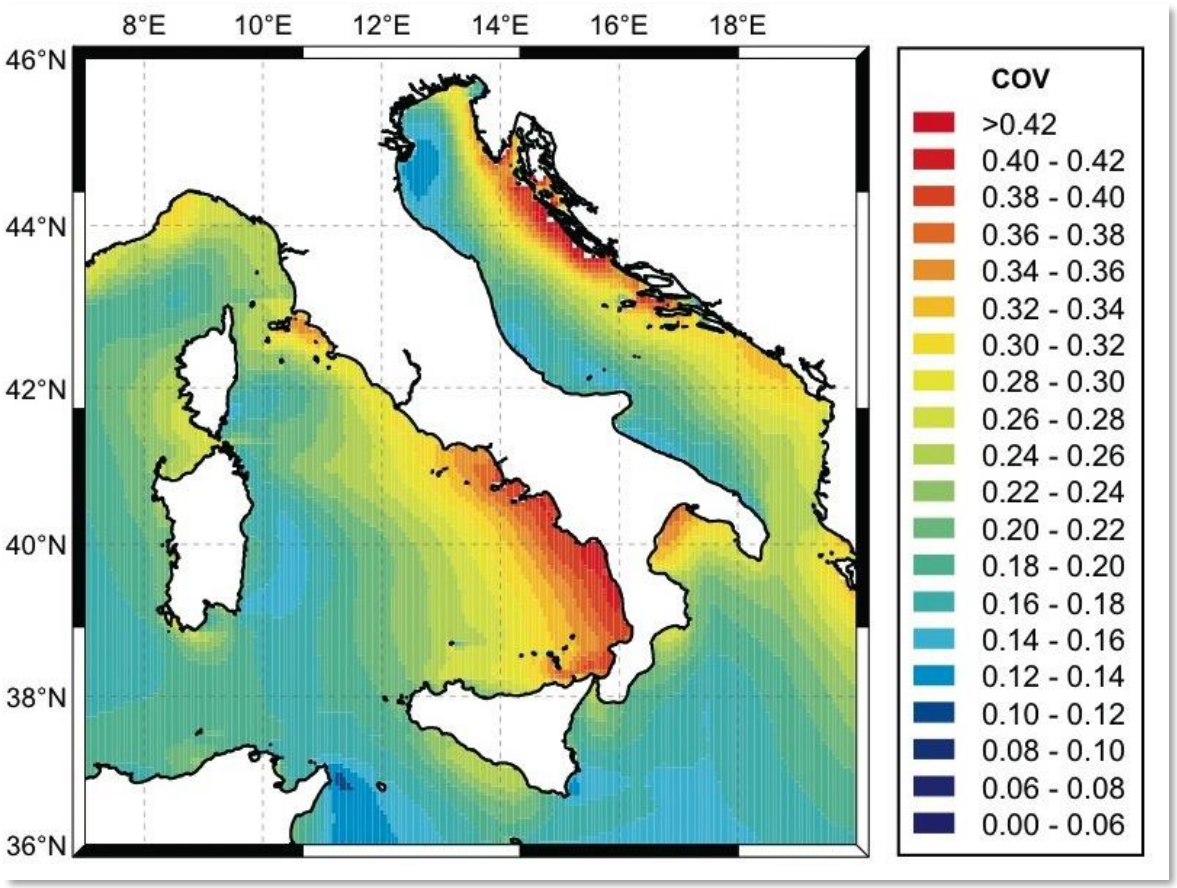
Wave energy assessment for the Mediterranean

Seasonal average energy flux



Wave energy assessment along the Italian coasts

Yearly average variability



Distribution of the Coefficient of Variation (COV) of the yearly average power fluxes for years 2001-2010 around Italy.

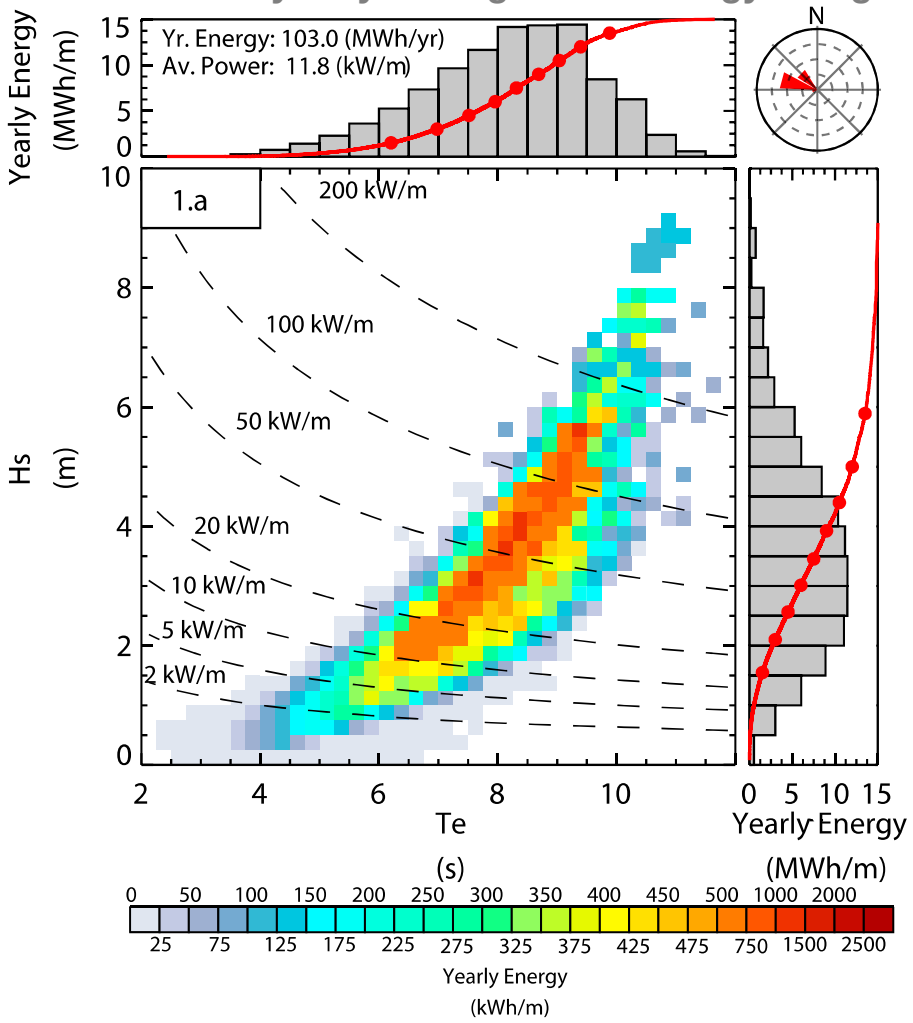
σ Standard deviation (yearly)

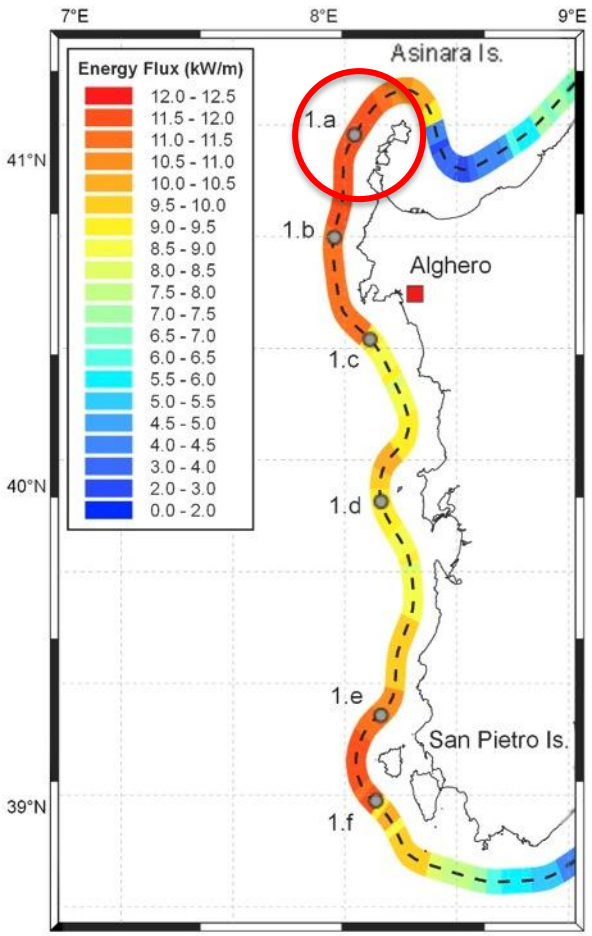
μ Averaged yearly value

$$COV = \frac{\sigma}{\mu}$$

Wave energy assessment along the Italian coasts

Distribution of yearly average wave energy along west Sardinia

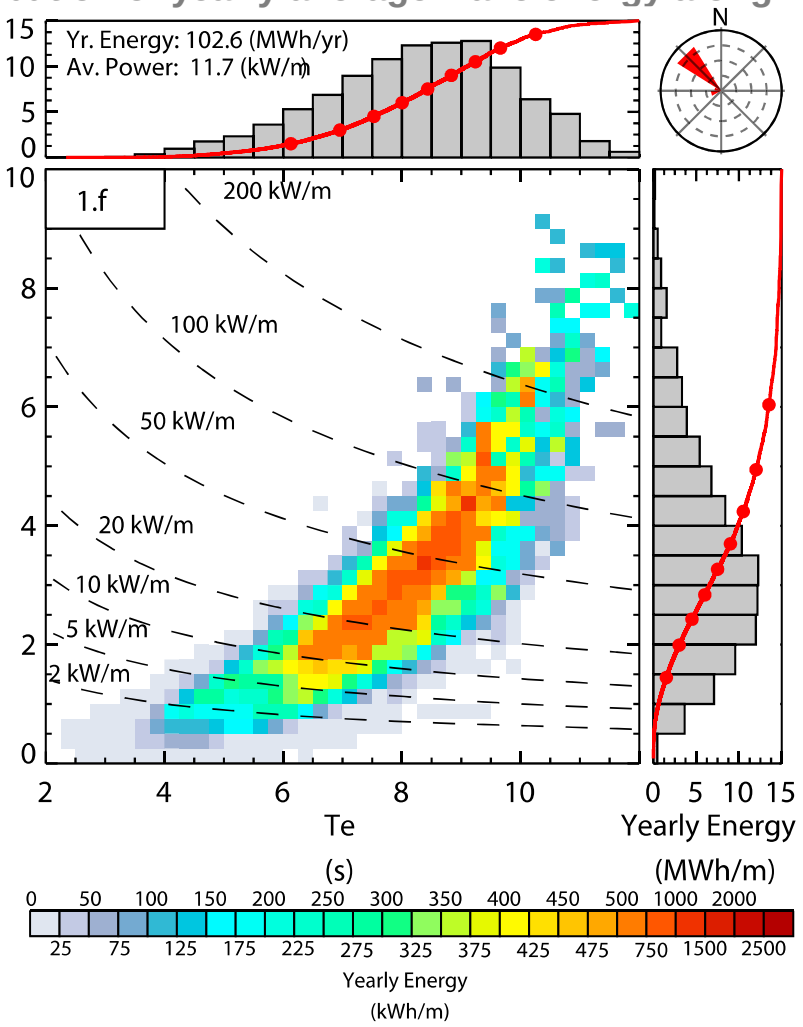


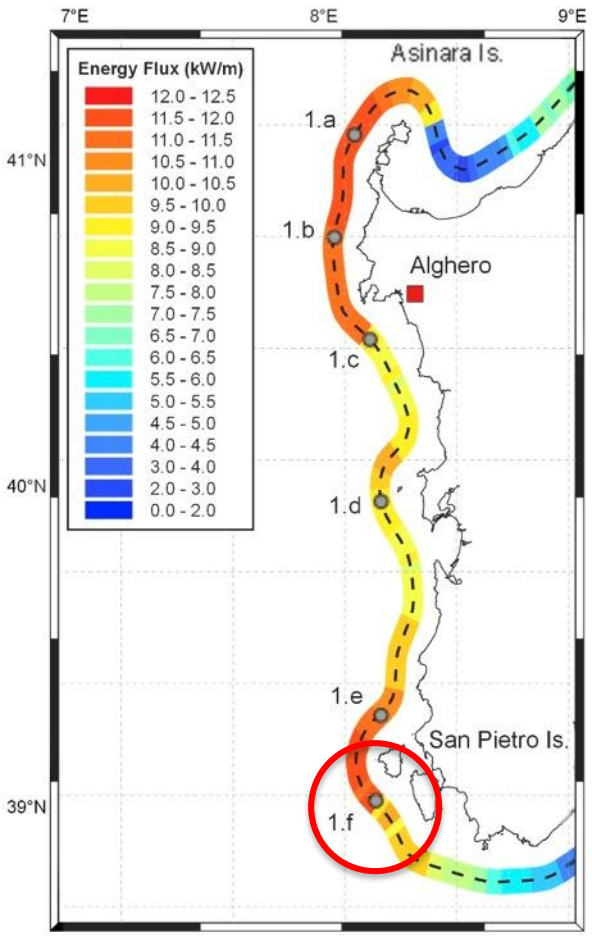


Distribution of wave energy as a function of significant wave period and significant wave height at specific points. Lower left panel shows the average yearly energy associated with sea states identified by *Te* and *Hs* couples. Dotted lines mark reference power levels. Upper panel shows the energy distribution as a function of *Te* only; right panel as a function of *Hs* only. Red lines in the upper and right panels are the cumulative energy as a percentage of the total. Red dots on the cumulative lines mark each 10*th* percentile. Rose plot in the upper right panel shows energy distribution over wave incoming direction. Each circle represents 20% fractions of the total energy.

Wave energy assessment along the Italian coasts

Distribution of yearly average wave energy along west Sardinia





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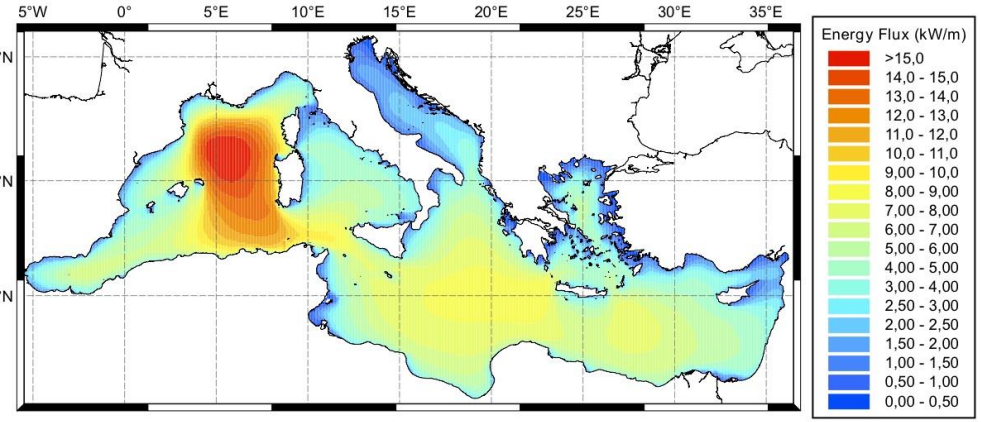
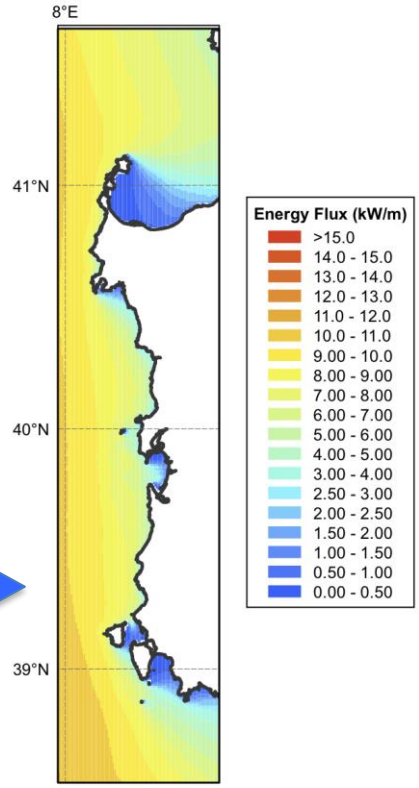
Wave energy assessment along the Italian coasts



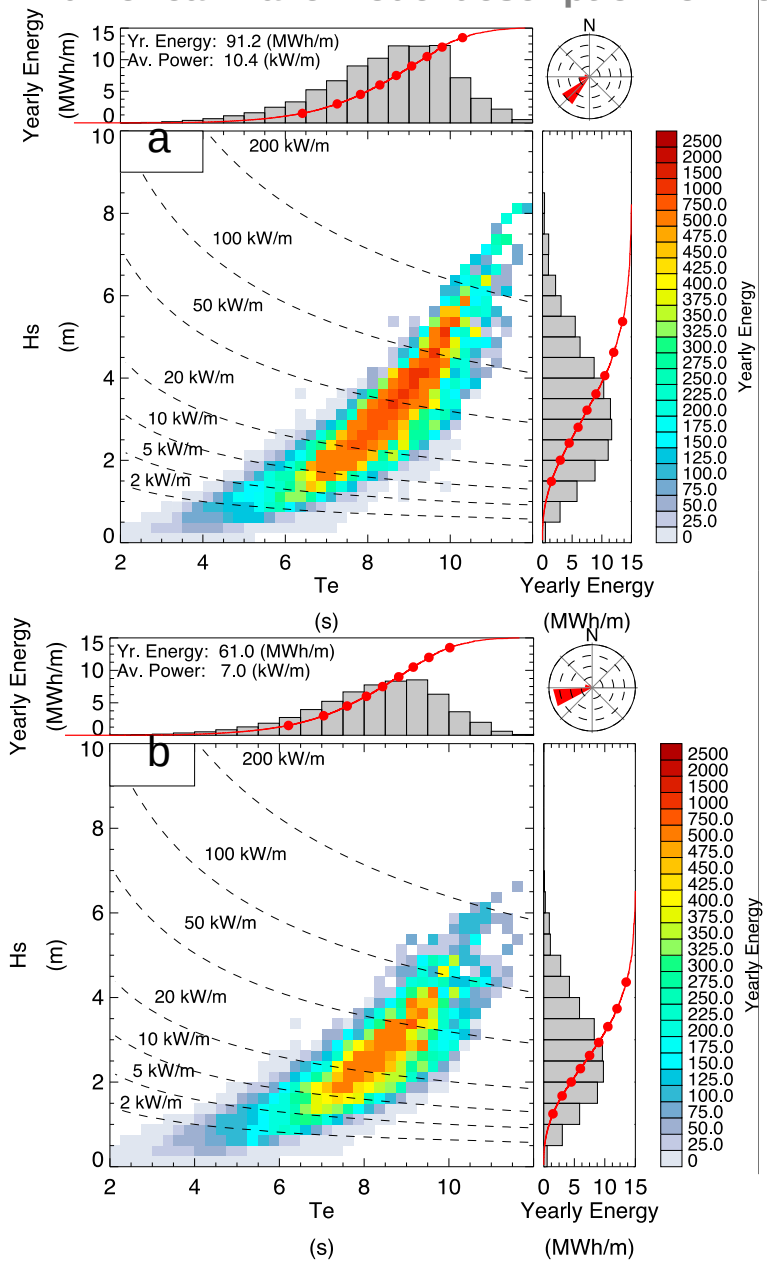
WAM
(1/16°x1/16°)

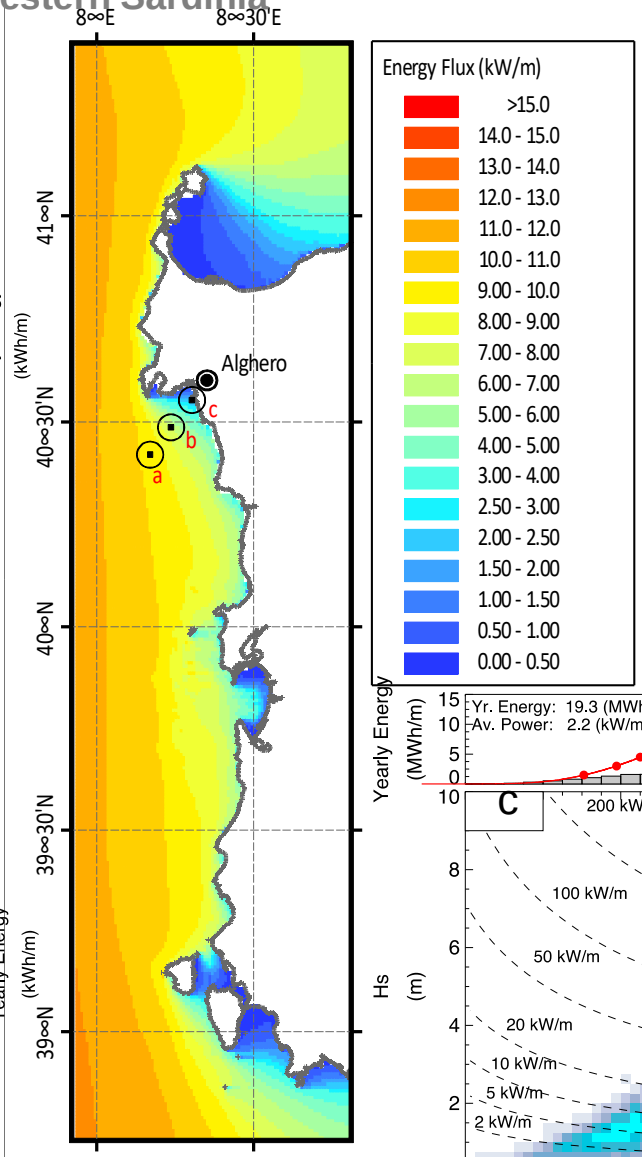


WAM/SWAN
(1/120°x/120°)

Wave energy assessment along the Italian coasts

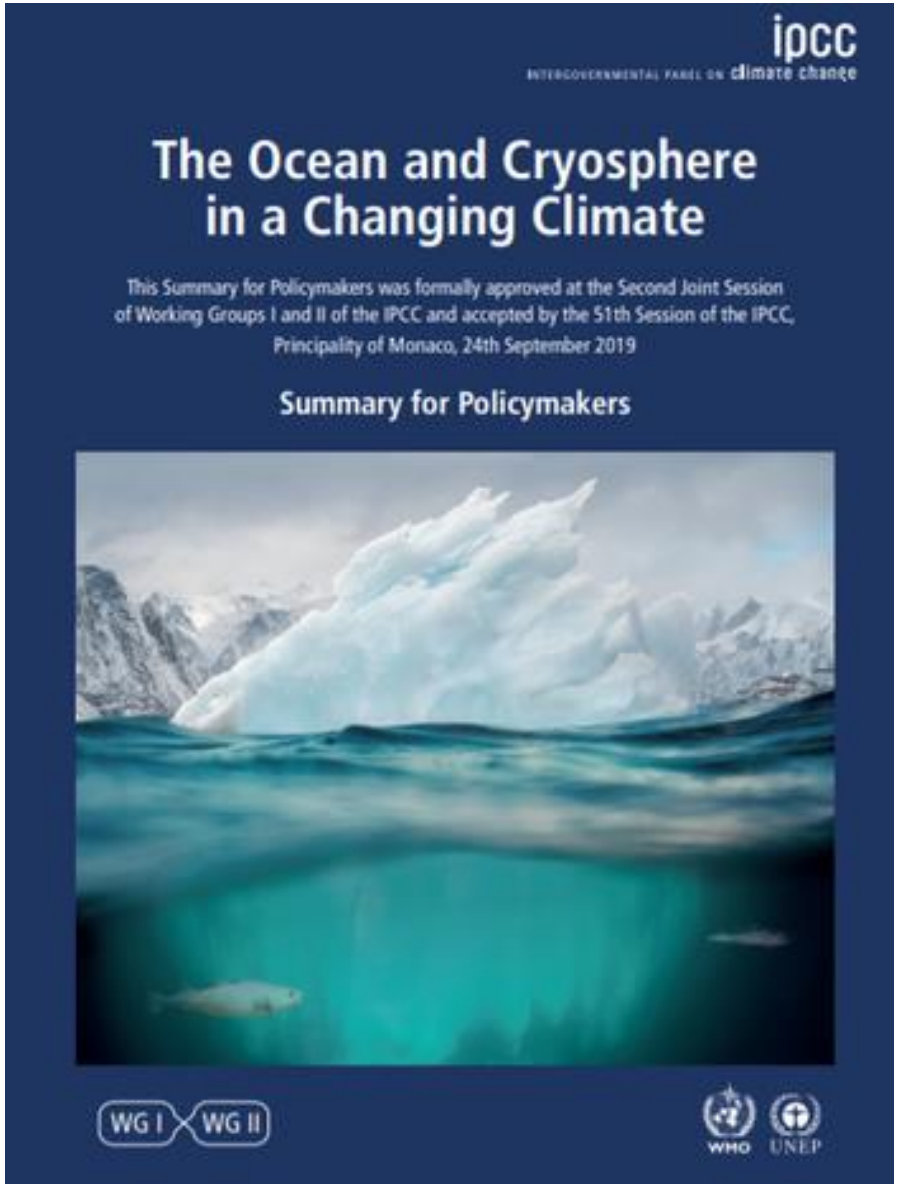
Numerical Wave model description for western Sardinia





a,b,c: three points located at 19600 m, 9300 m and 830 m respectively from the coast. These points are distributed along a straight line pointing offshore from Alghero, at decreasing depths ranging from 13m to 114 m

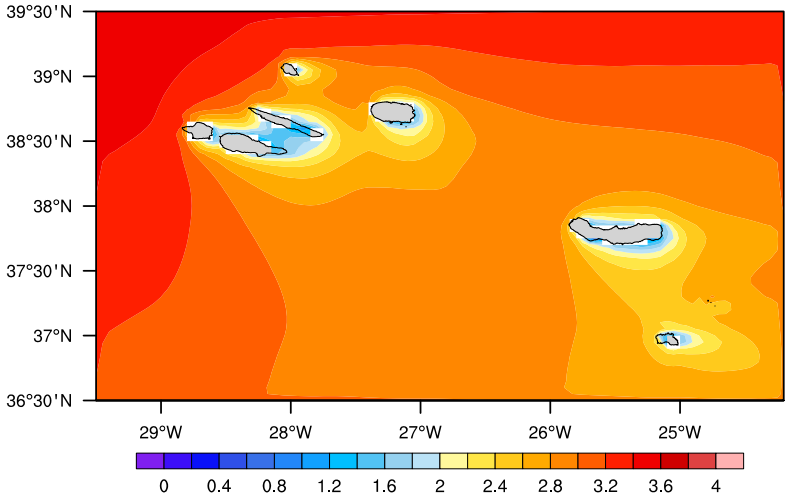
Ocean Energy and Climate Change



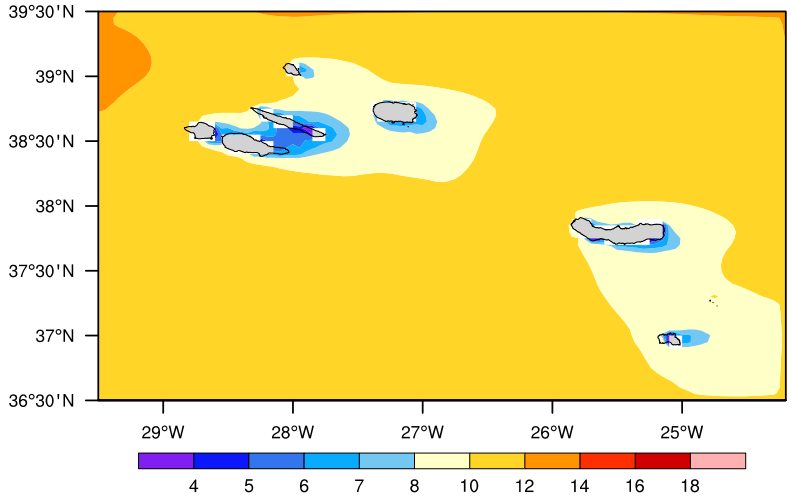
Ocean renewable energy can support climate change mitigation ..., although their potential **may also be affected by climate change**.

Wave Energy and Climate Change @ Azores

1996-2005

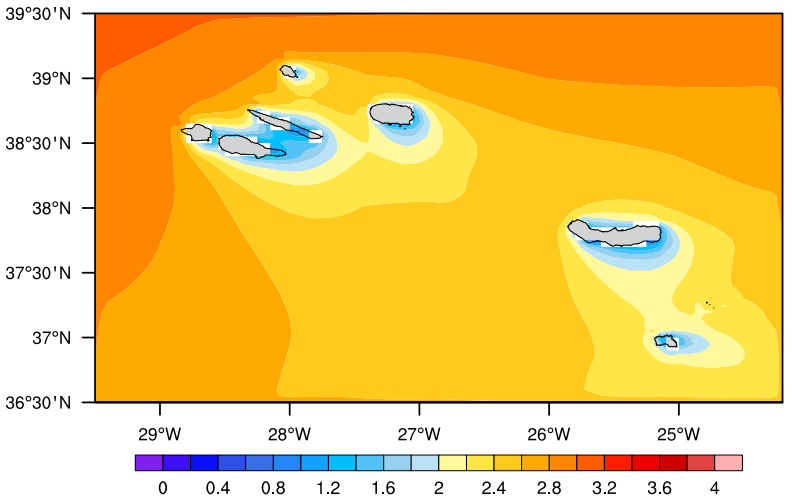


Hs (m) mean DJF

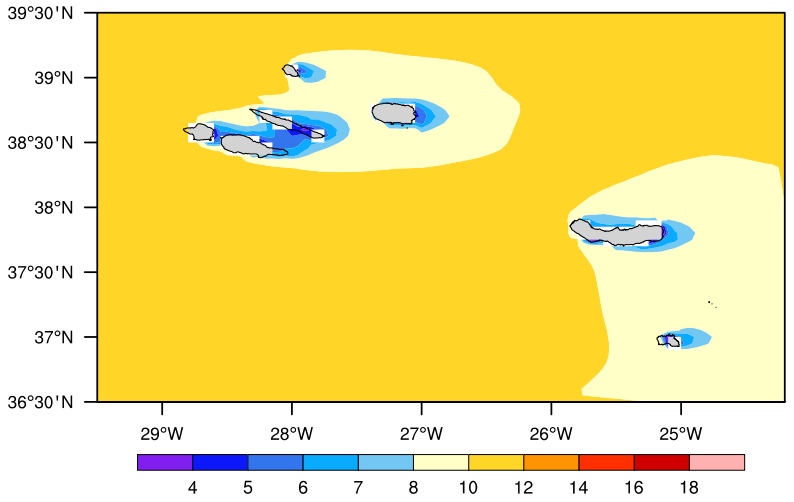


Hs (m): Return level - 10 years

2090-2099 (rcp 8.5)



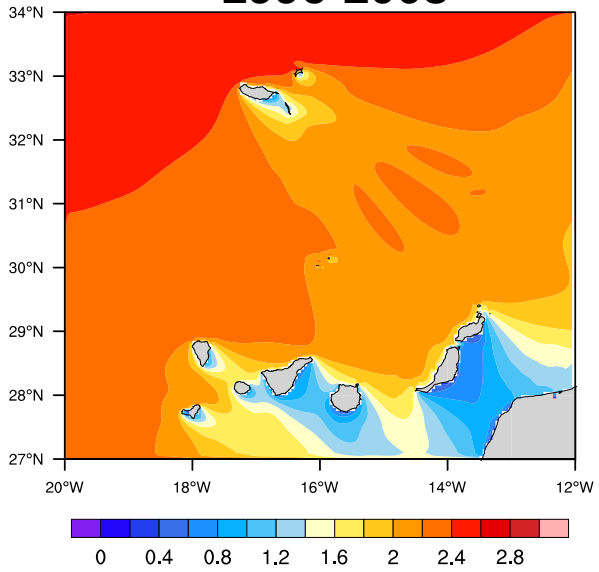
Hs (m) mean DJF



Hs (m): Return level - 10 years

Wave Energy and Climate Change @ Canaries

1996-2005



Hs (m) mean DJF

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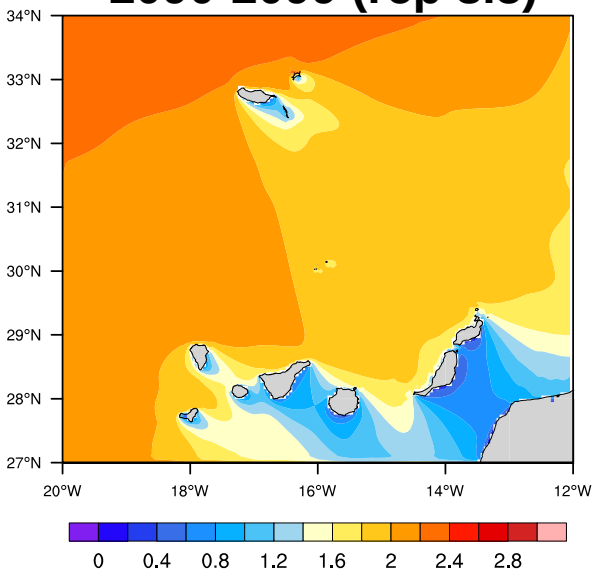

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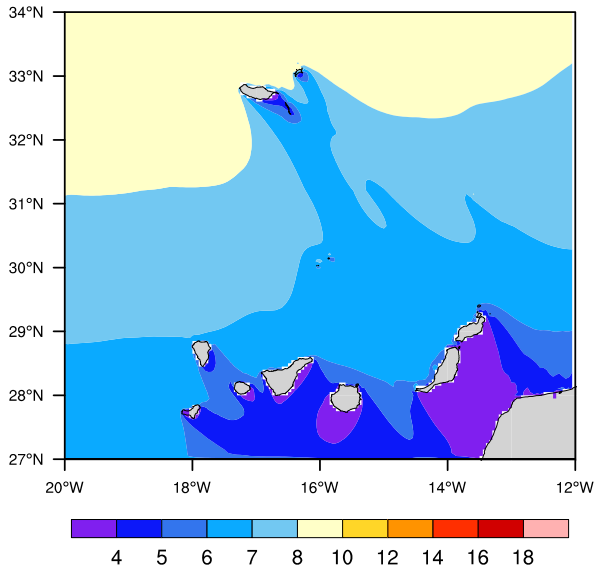
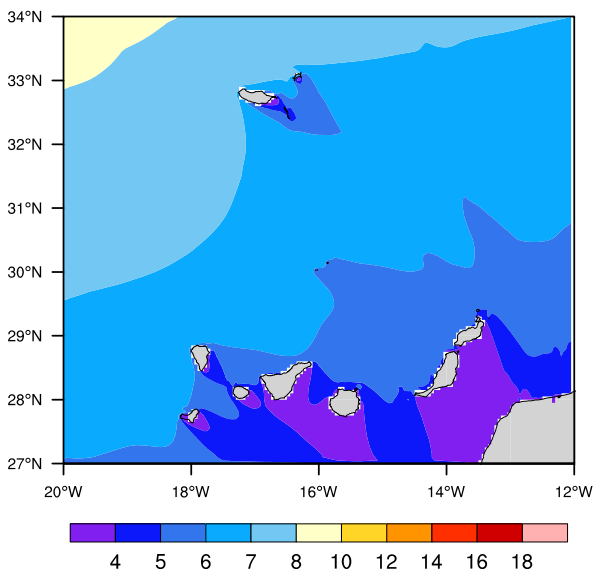
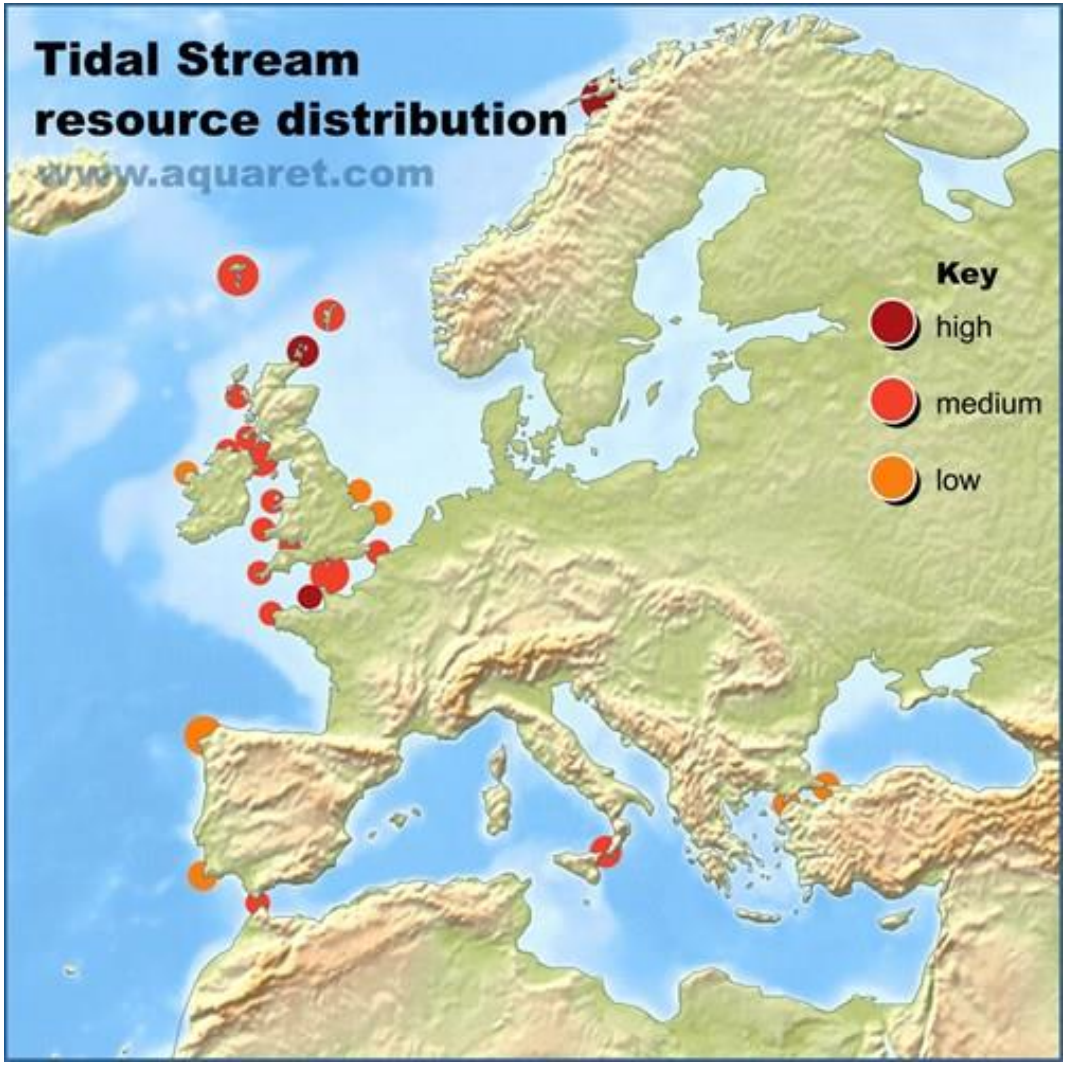


Hs (m): Return level - 10 years



Hs (m): Return level - 10 years

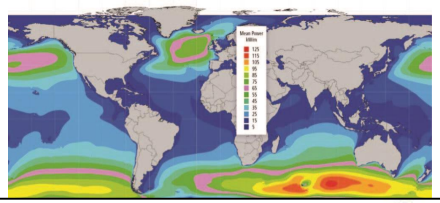
EU tidal energy sources



Source: Aqua-RET (2012)

Tidal energy assessment for the Mediterranean

The RE resource in the ocean comes from six distinct sources, each with different origins and requiring different technologies for conversion



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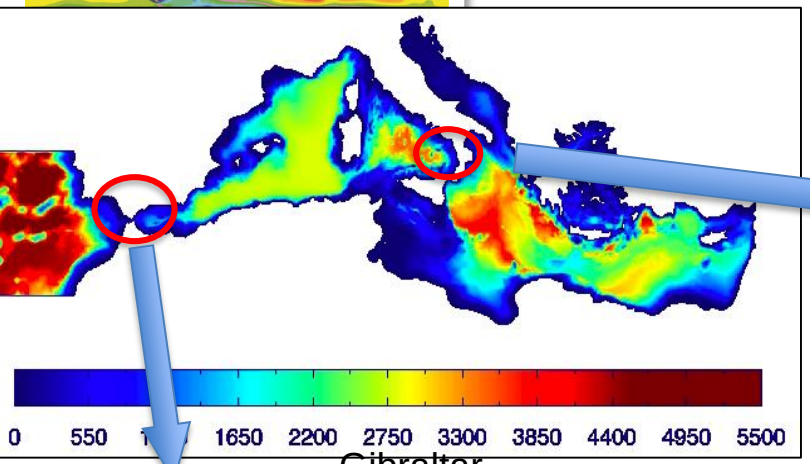
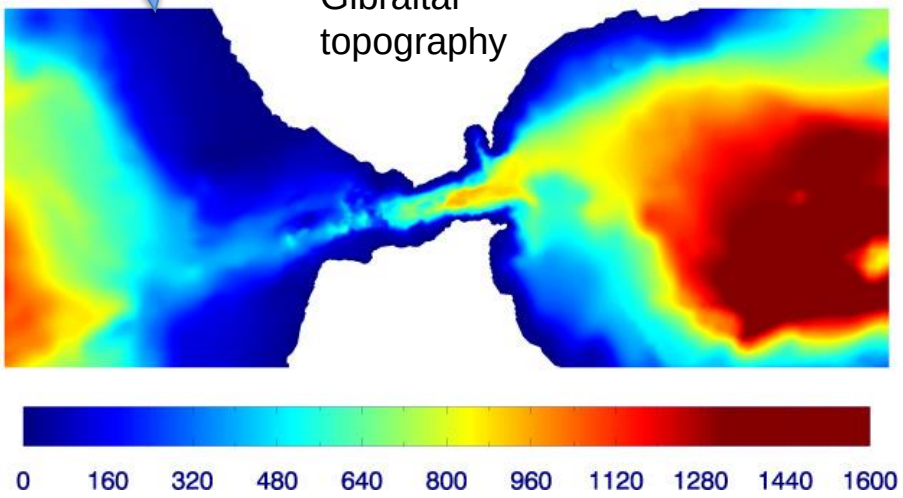
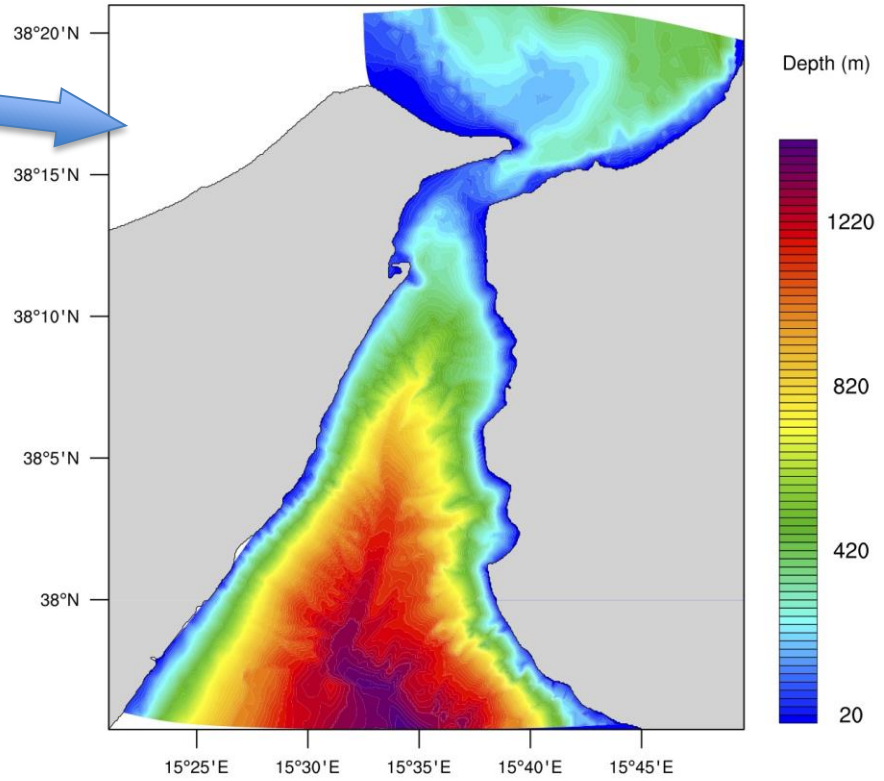


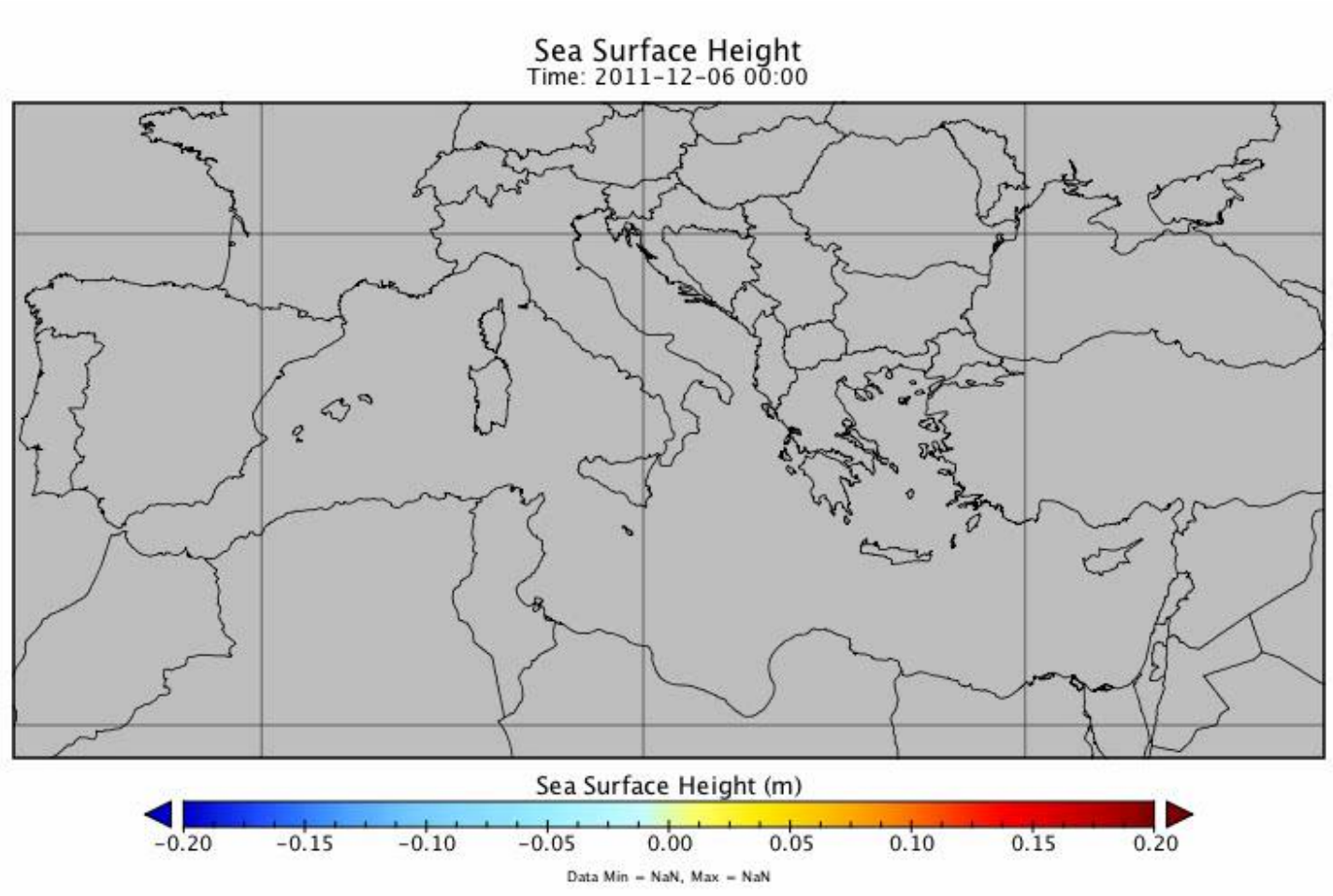
Gibraltar topography



Strait of Messina topography

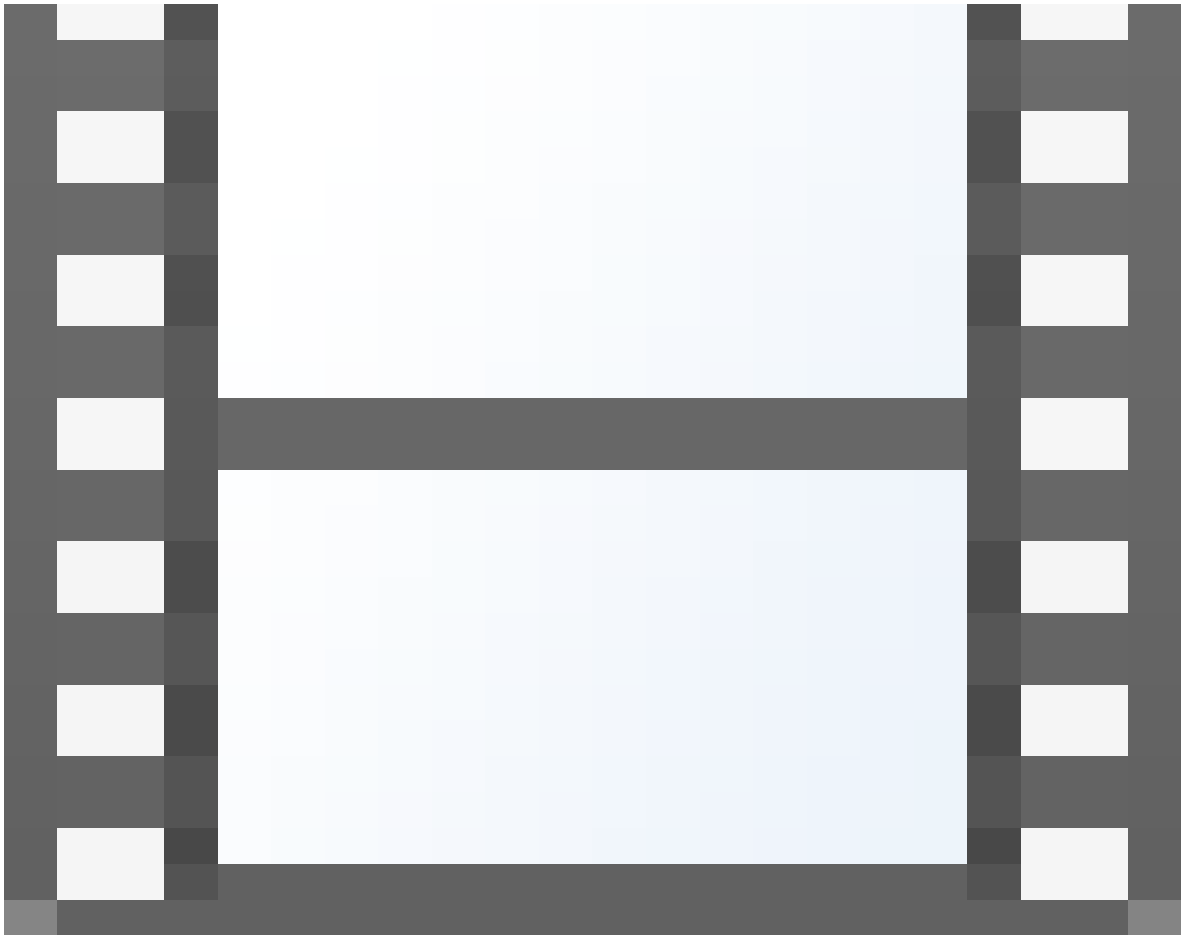


Tides in the Mediterranean

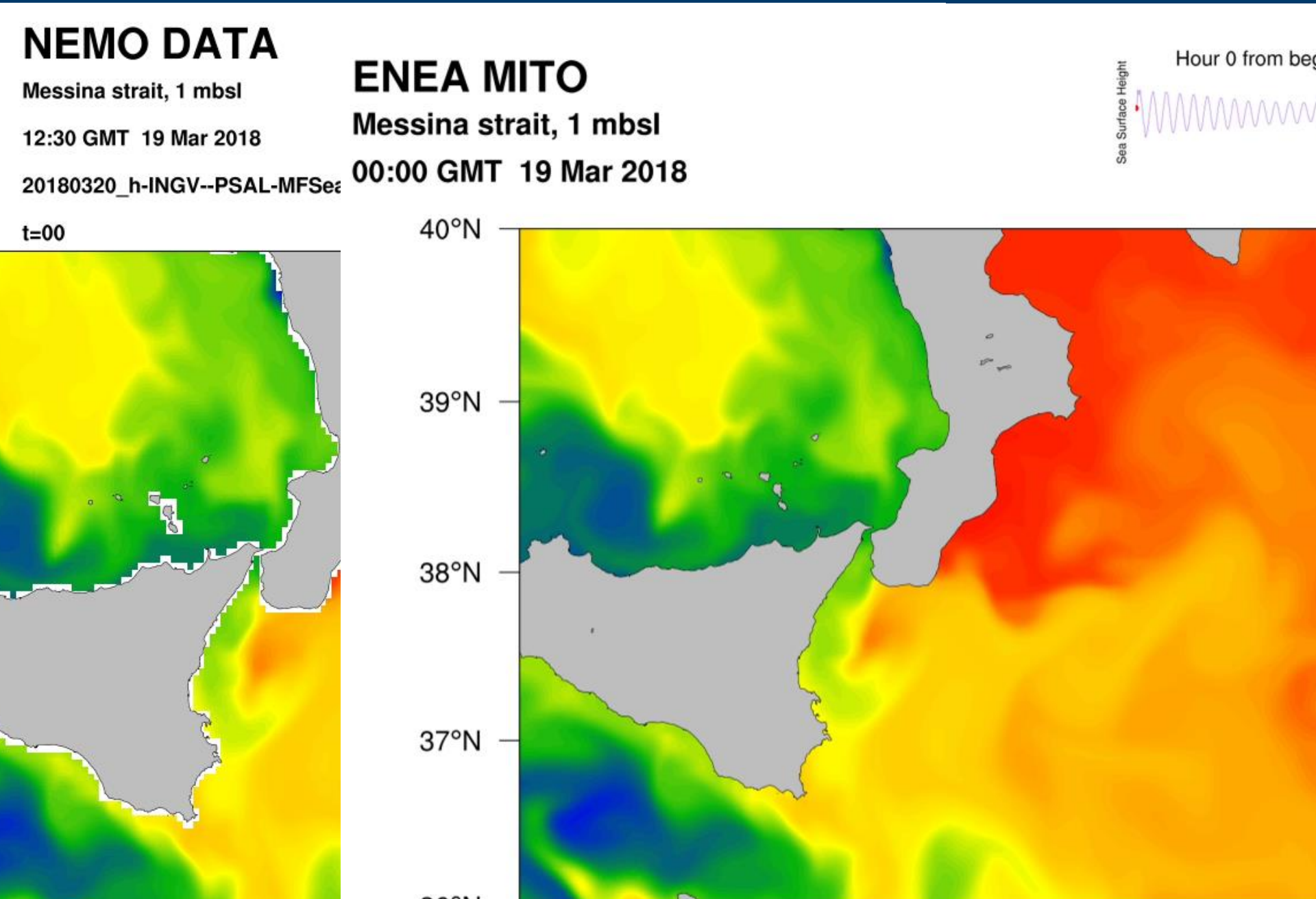


MITgcm – Explicit Tides (M2,S2, K1, O1) – Lateral Tide + Tidal Potential
Average resolution 1/48° (2.3 Km)
Minimum resolution 230m (Gibraltar and Turkish Straits)
100 Vertical Levels
Initialized with Copernicus data!

Tides in the Mediterranean



Tidal energy forecast for the Mediterranean



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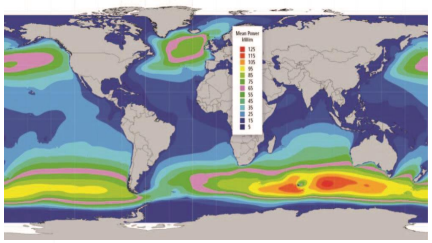
The RE resource in the ocean comes from six distinct sources, each with different origins and requiring different technologies for conversion



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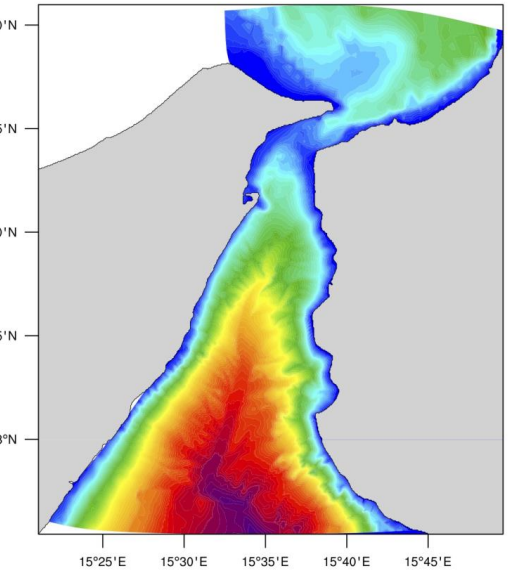

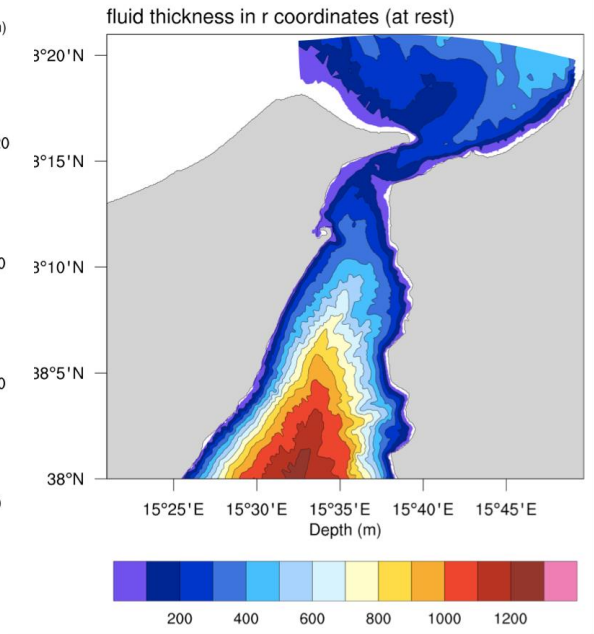

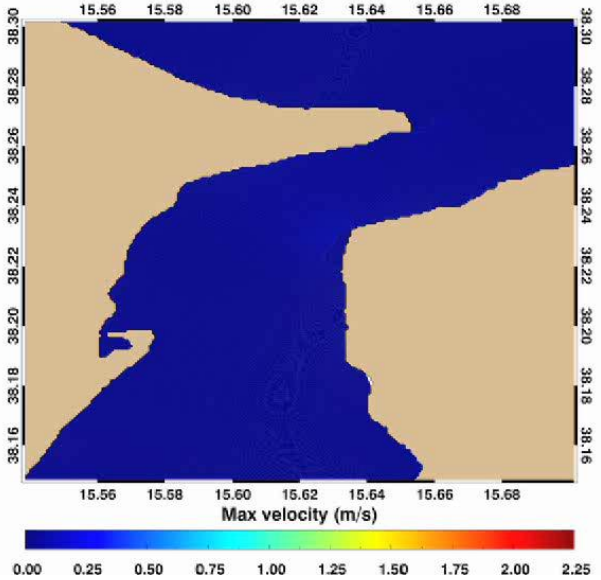

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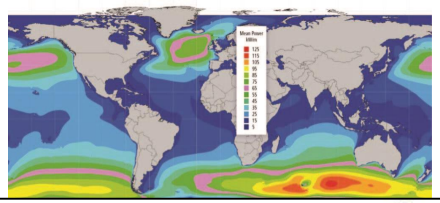

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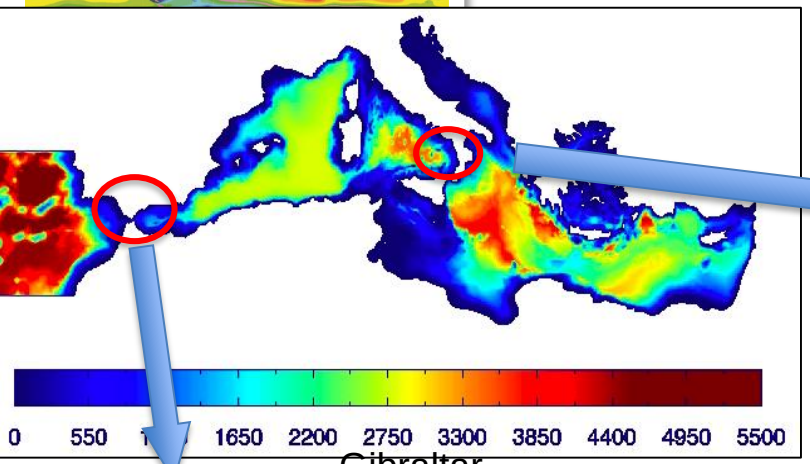

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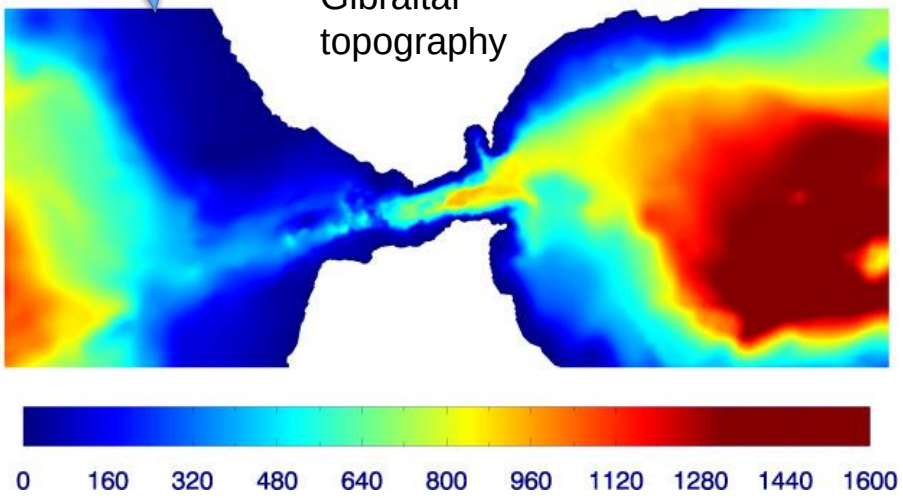

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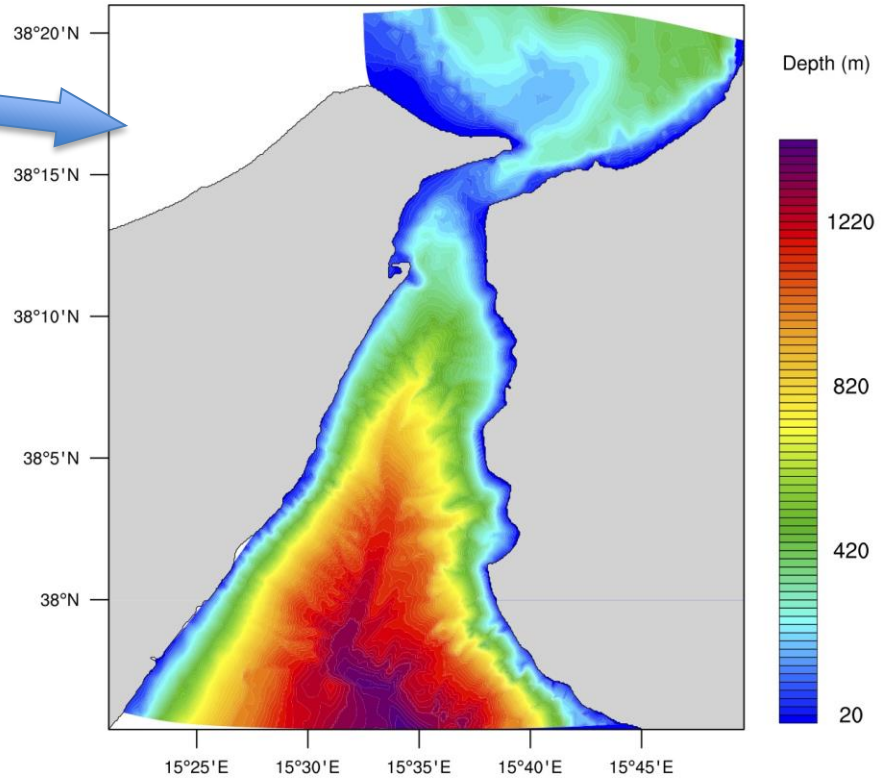

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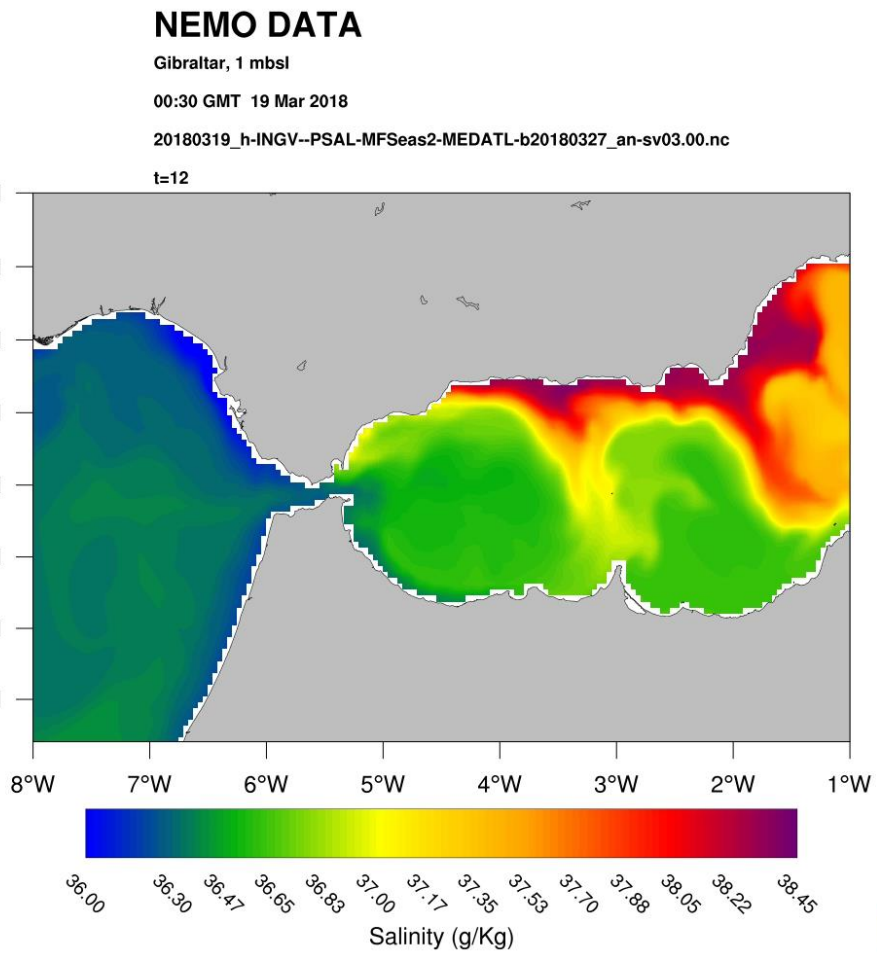

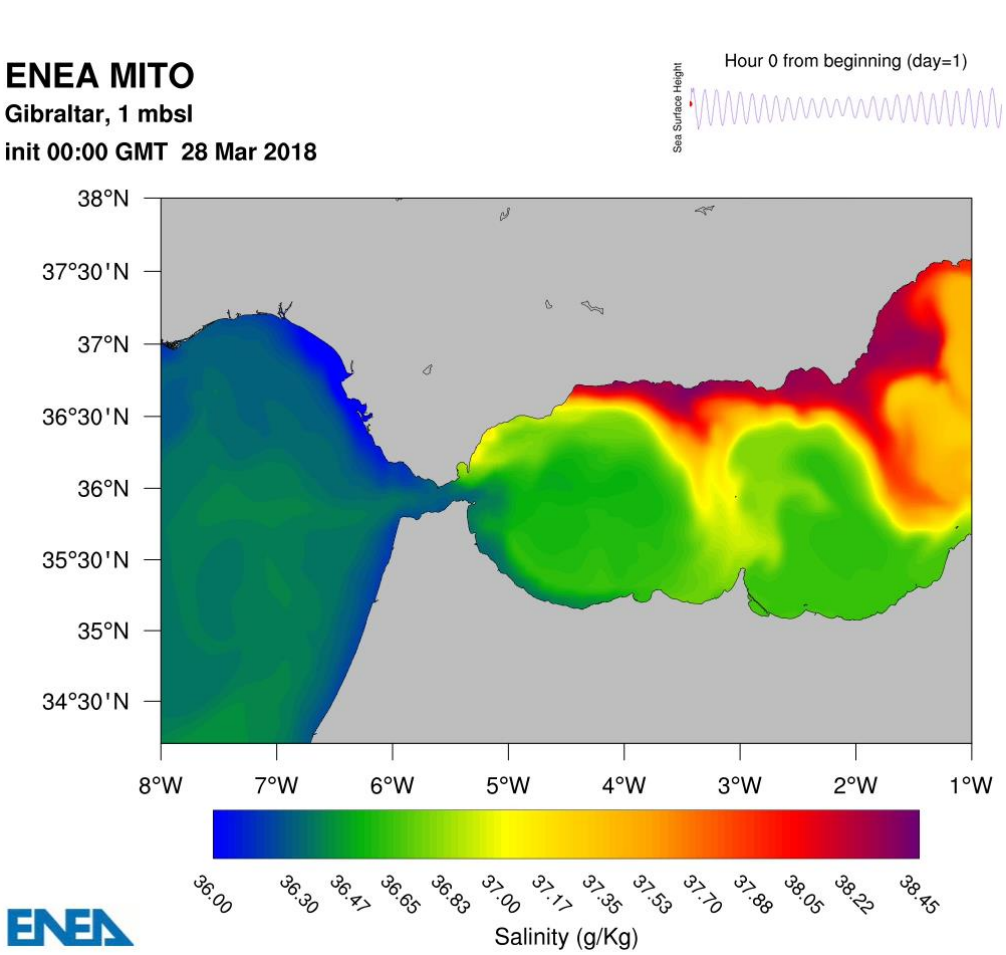

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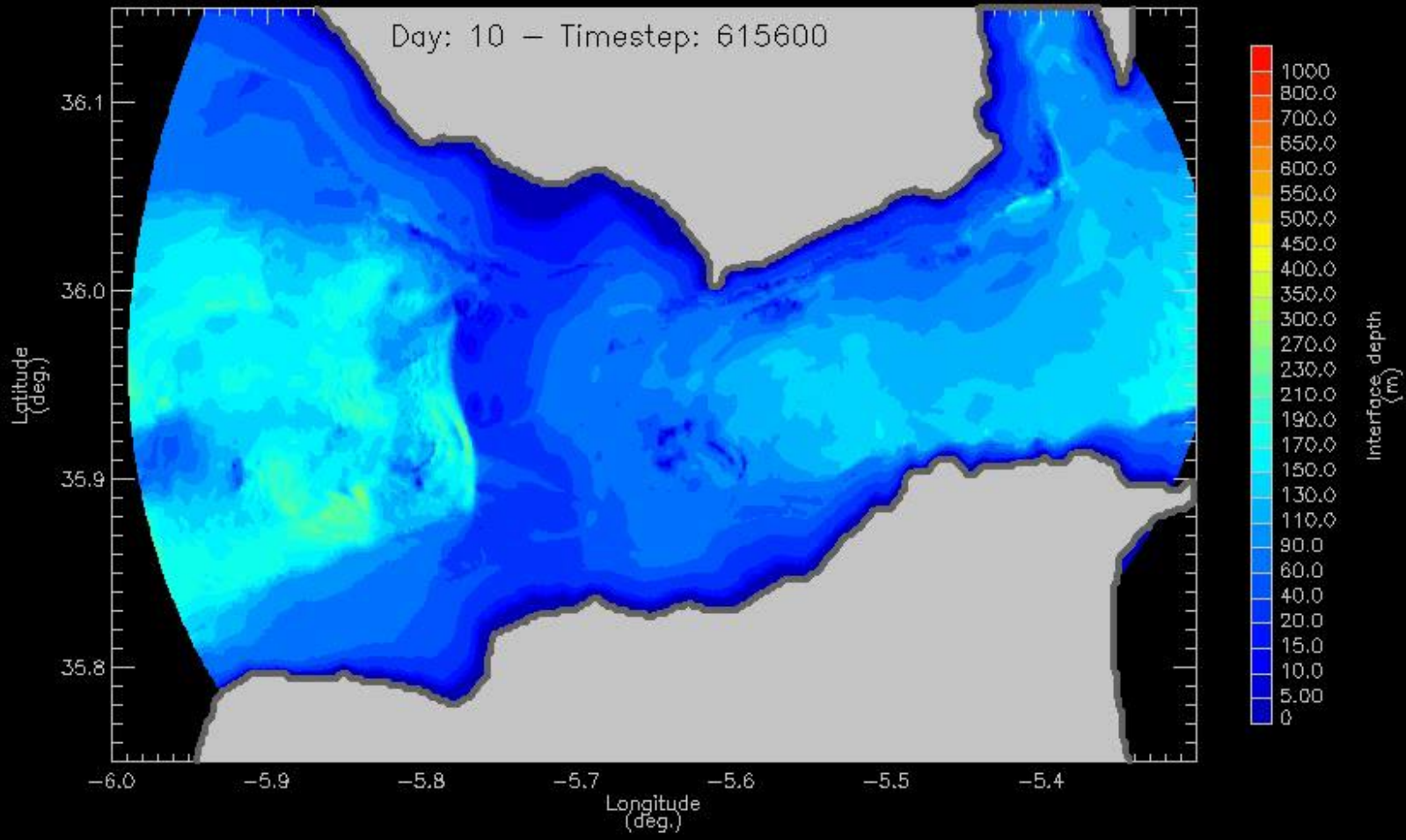

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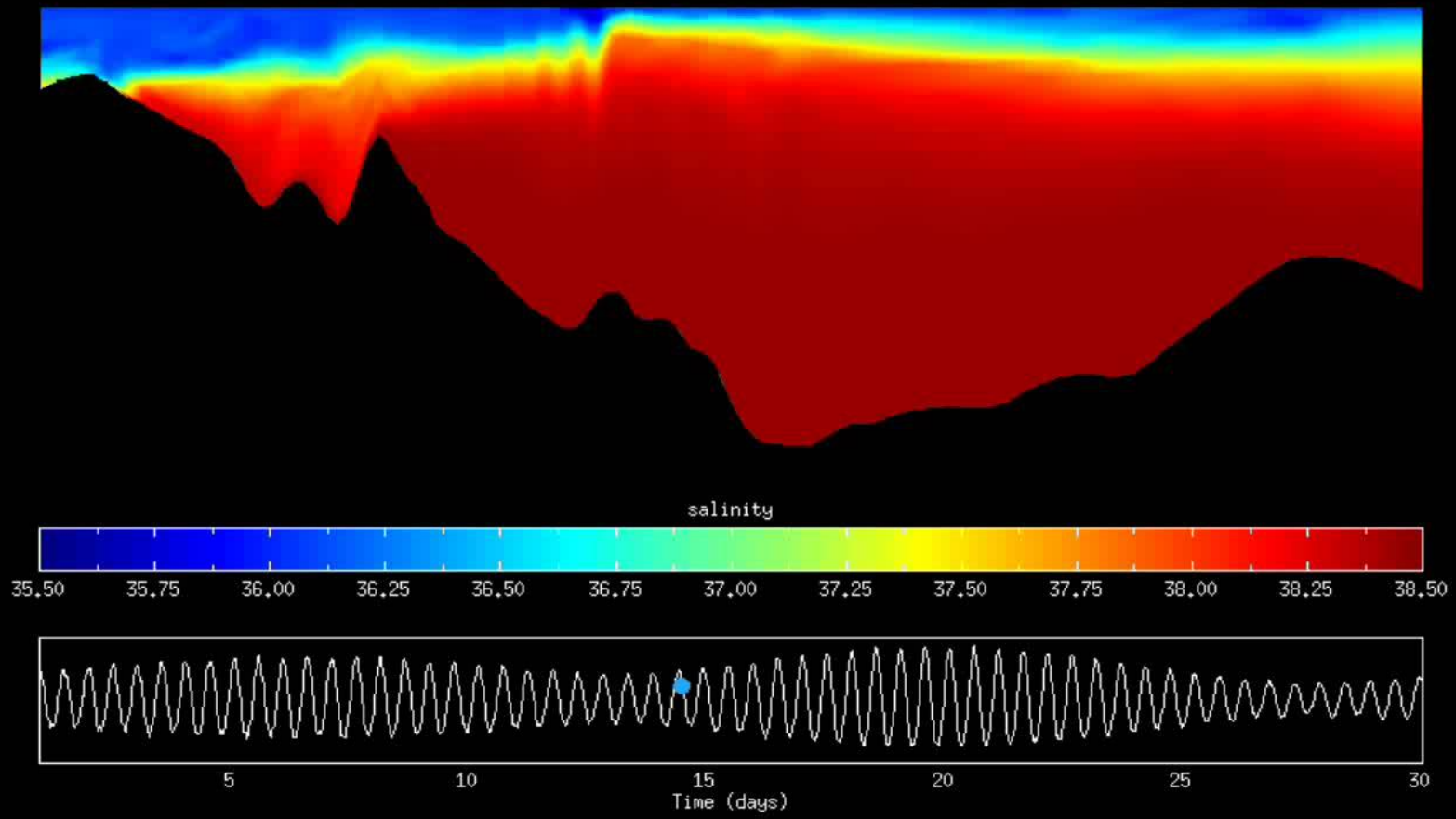

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