

International Coordination Workshop (ICW4) of the Coastal and Shelf Seas Task Team (COSS-TT) & ARCOM Pilot Workshop

Operational oceanographic platform in Thermaikos Gulf (Greece): forecasting and emergency alert system for public use



Yannis Androulidakis, Yannis Krestenitis, Katerina Kombiadou, Christos Makris, Vasillis Baltikas

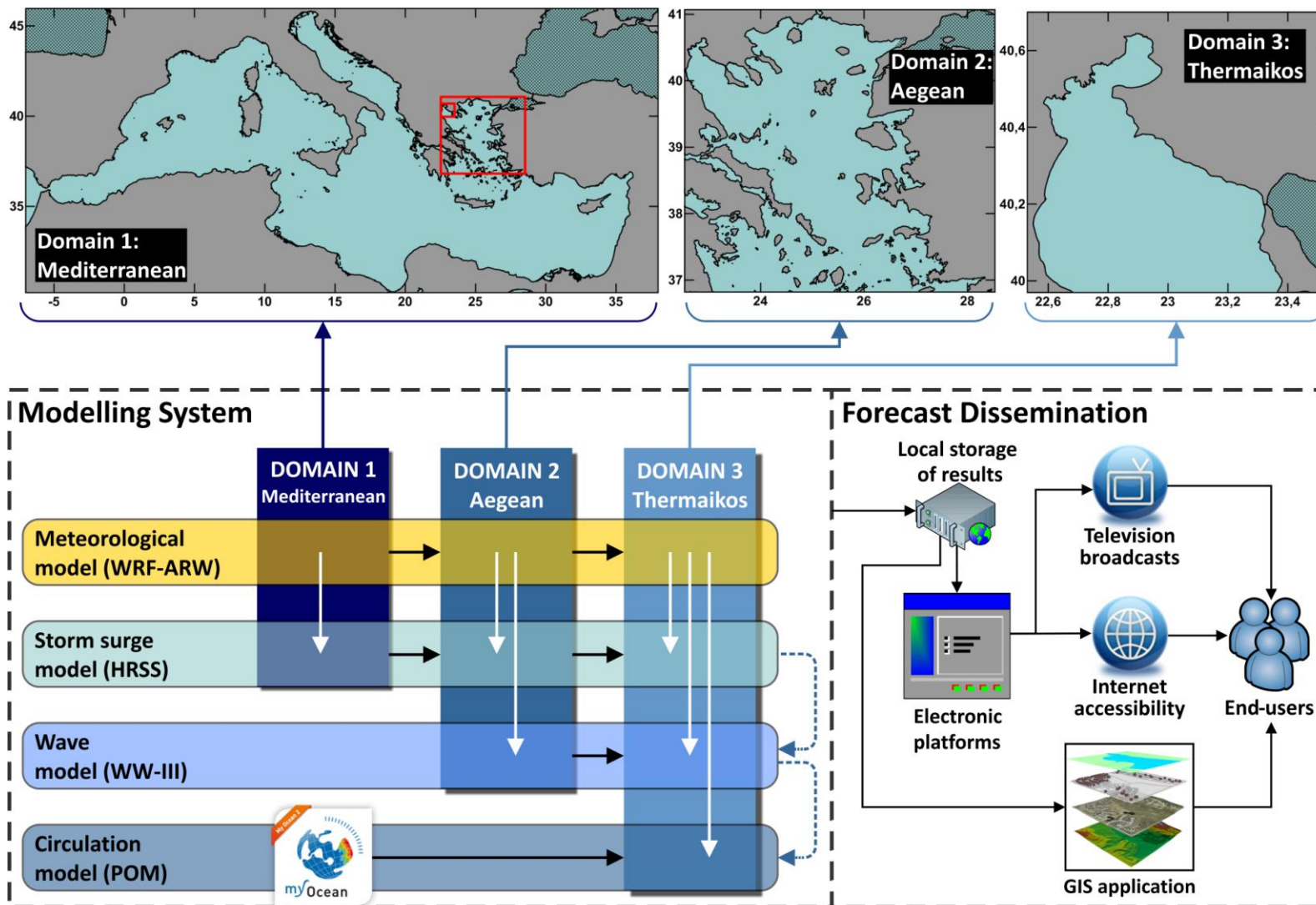
Laboratory of Maritime Engineering and Maritime Works, Civil Engineering Department, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece

31 August – 4 September 2015 Instituto Superior Técnico, Lisbon, Portugal

Project aim and objectives

- ❑ Development of a state-of-the-art forecasting system for wave, circulation and storm surges in the Thermaikos Gulf.
- ❑ Delivery of 3-day forecasts through television broadcasts and internet and GIS applications.
- ❑ Dissemination of high-resolution results that are readily exploitable by the users (fisheries, aquacultures, tourism, sea-related recreational and nautathletic activities etc) and other applications, such as environmental modelling and coastal zone management projects.
- ❑ Delivery of products focused on areas of special interest, like aquacultures and protected areas.
- ❑ Alerting the public and authorities in cases of extreme events related to sea level rise.

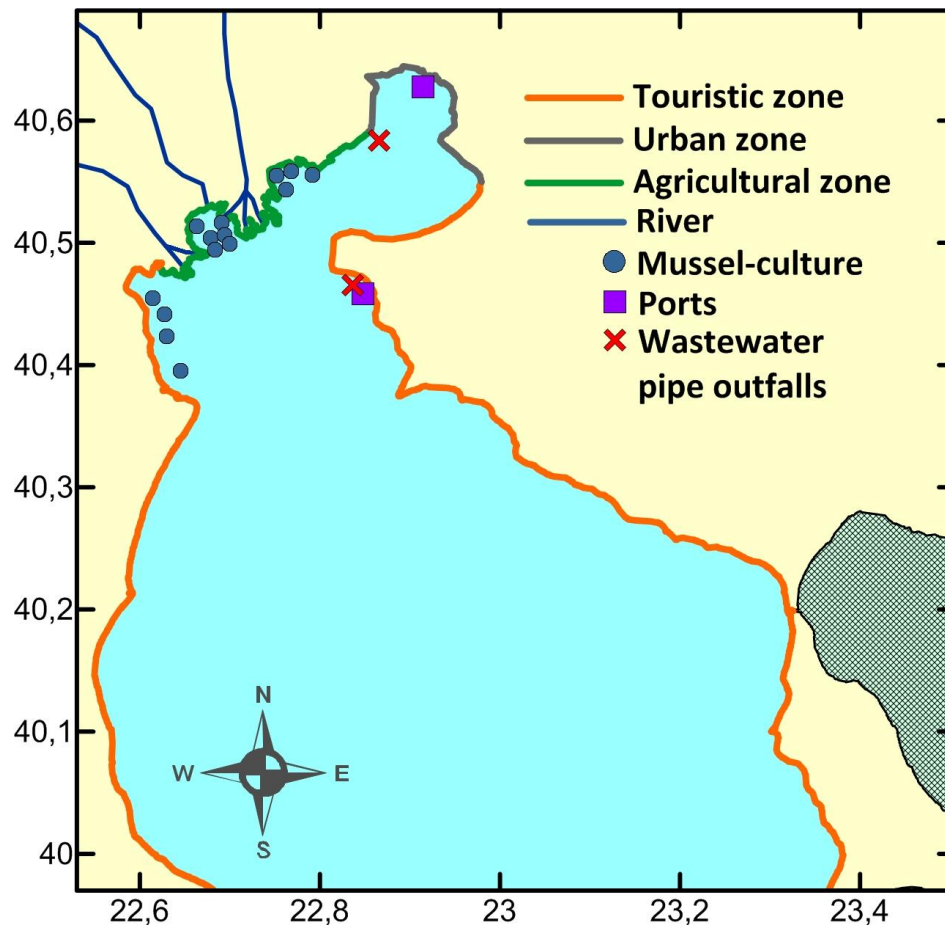
WaveForUs schematic representation



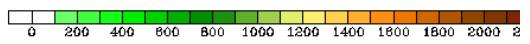
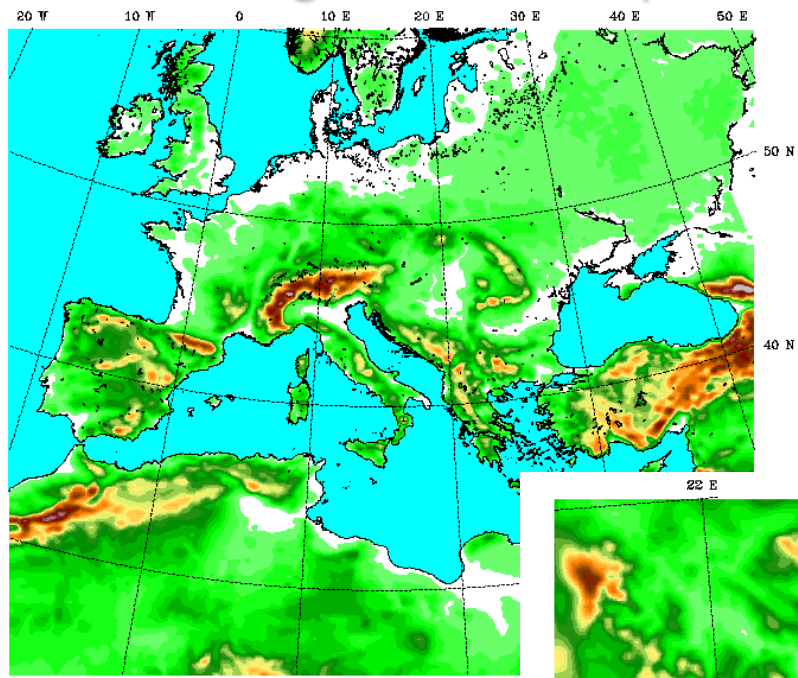
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THERMAIKOS GULF

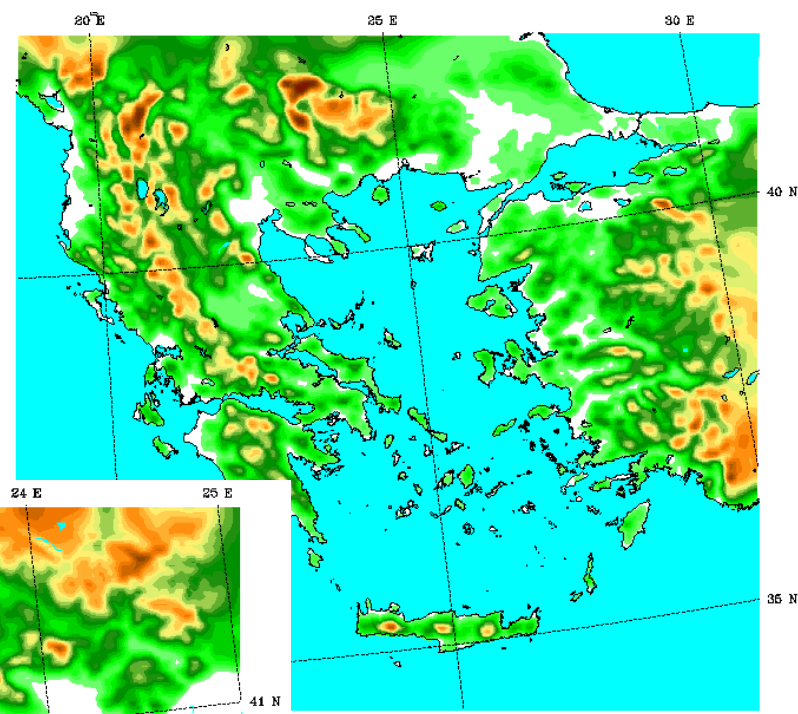
- ❑ 1.5 million population
- ❑ Numerous anthropogenic activities over the coastal zone
- ❑ WaveForUs users:
 - ❑ Professional fishers, aquaculture → *wave and ocean circulation products*
 - ❑ Early warning system of coastal flooding → *storm surge + wave products*
 - ❑ Oil spill accidents → *Circulation products*
 - ❑ Tourism → *Wave and sea temperature products*
 - ❑ Nautathletic activities → *Wave and current products*



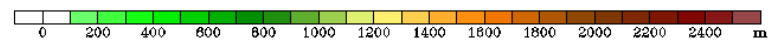
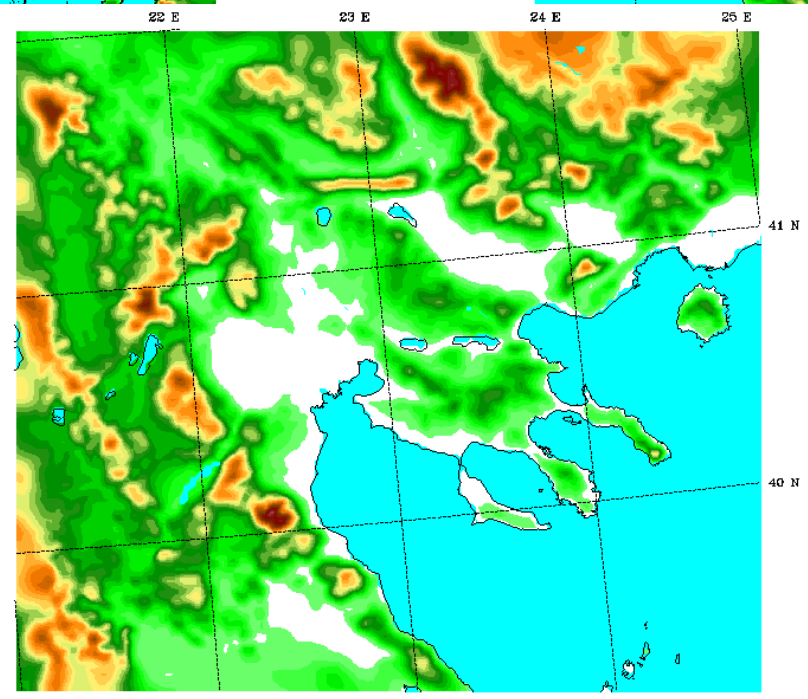
Meteorological model (WRF-ARW)



15km x 15km



km x 5km



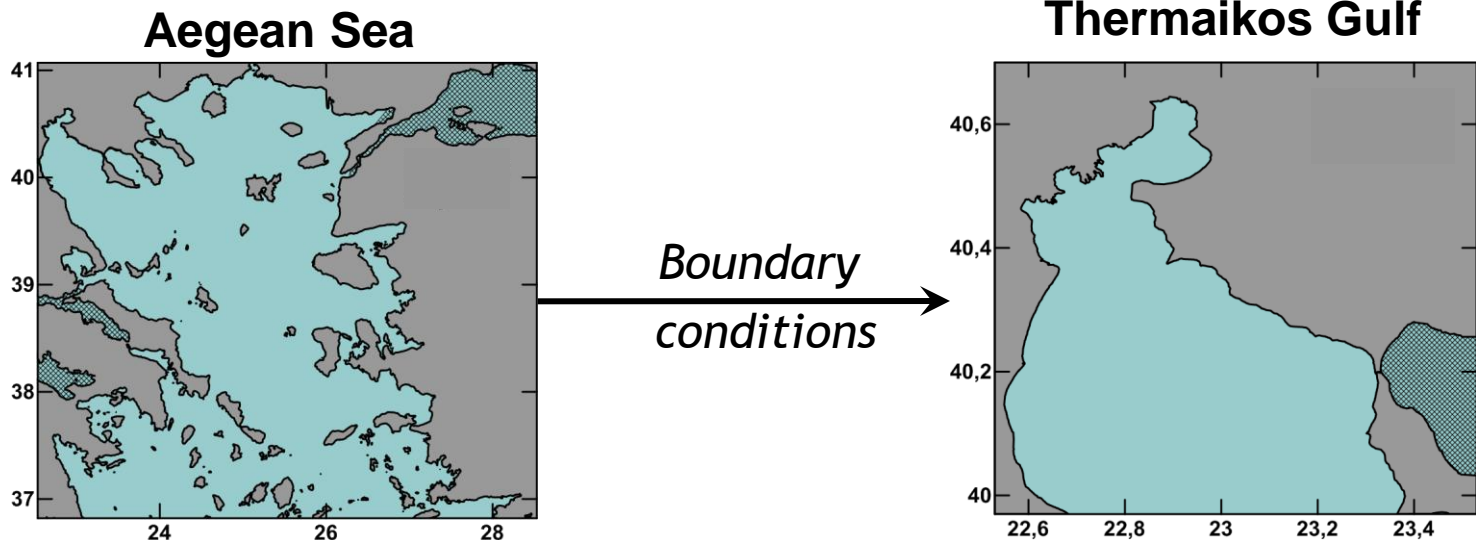
1.7km x 1.7km

Wave model (WaveWatch III: WW-III)

WW-III is a third generation spectral model for the simulation and prognosis of wind-generated wave fields. The governing equations of WW-III include:

- Wave growth and decay due to the action of wind
- Refraction
- Wave breaking
- Bottom friction
- Scattering due to wave-bottom interactions

Model results: **Wave height and direction**

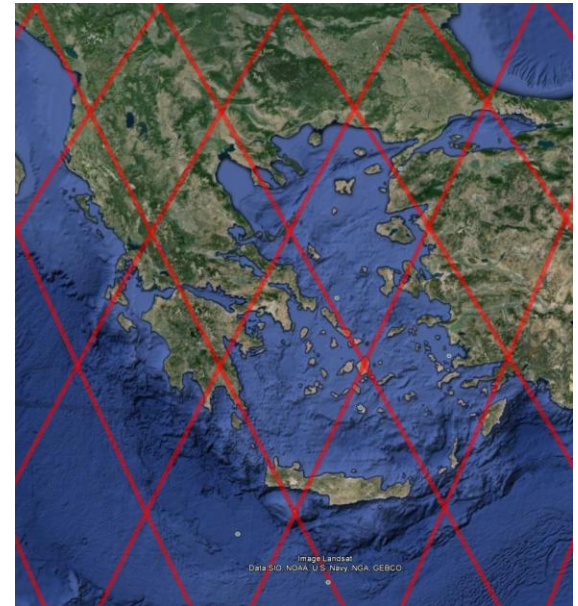
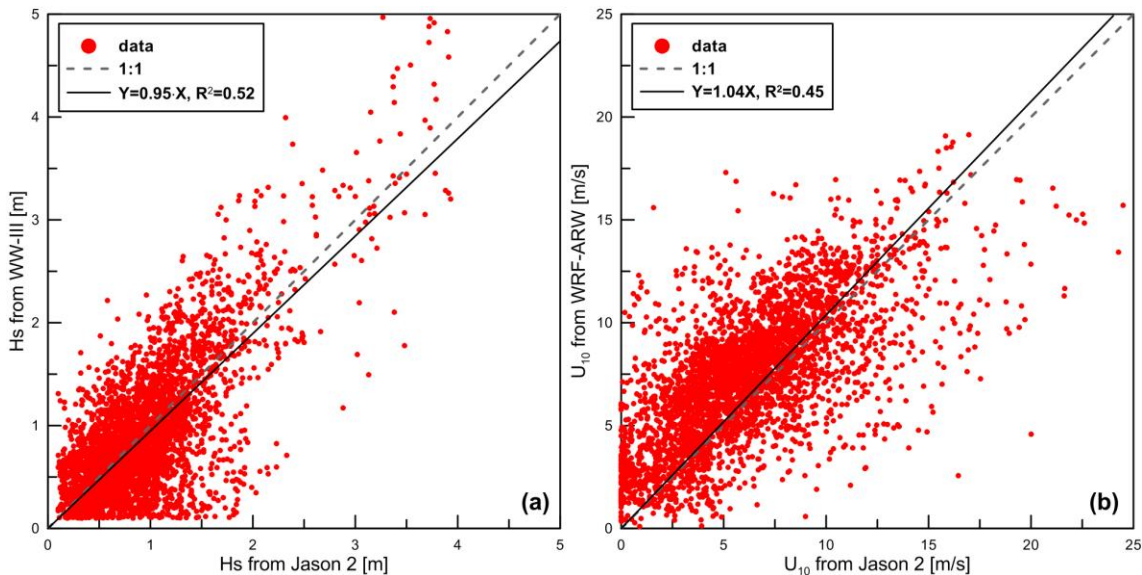


Wave model (WaveWatch III: WW-III)

Model validation using satellite altimetry data

Jason-2 satellite data (after time and space collocation)

Period: 01/03/2013 to 28/02/2014, Domain 2: Aegean Sea



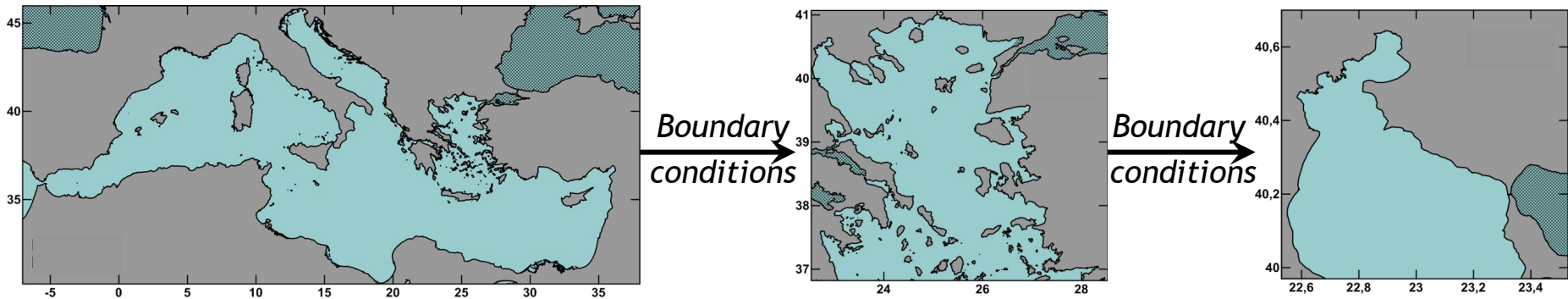
- Linear fit close to a 1:1 relation
- Strongest scattering in relatively low significant wave heights ($H_s < 1.5\text{m}$)
- Model predicts energetic wave conditions effectively
- Self-similar scatter pattern for wind velocities

High Resolution Storm Surge (HRSS) model

HRSS is a 2-dimensional hydrodynamic model that simulates the changes to the mean Sea Level Height (SLH) taking into account:

- Atmospheric forcing (wind and pressure fields)
- Geostrophy
- Astronomical tides, Schwiderski (1980)
- Surface and seabed stresses
- Impact of waves

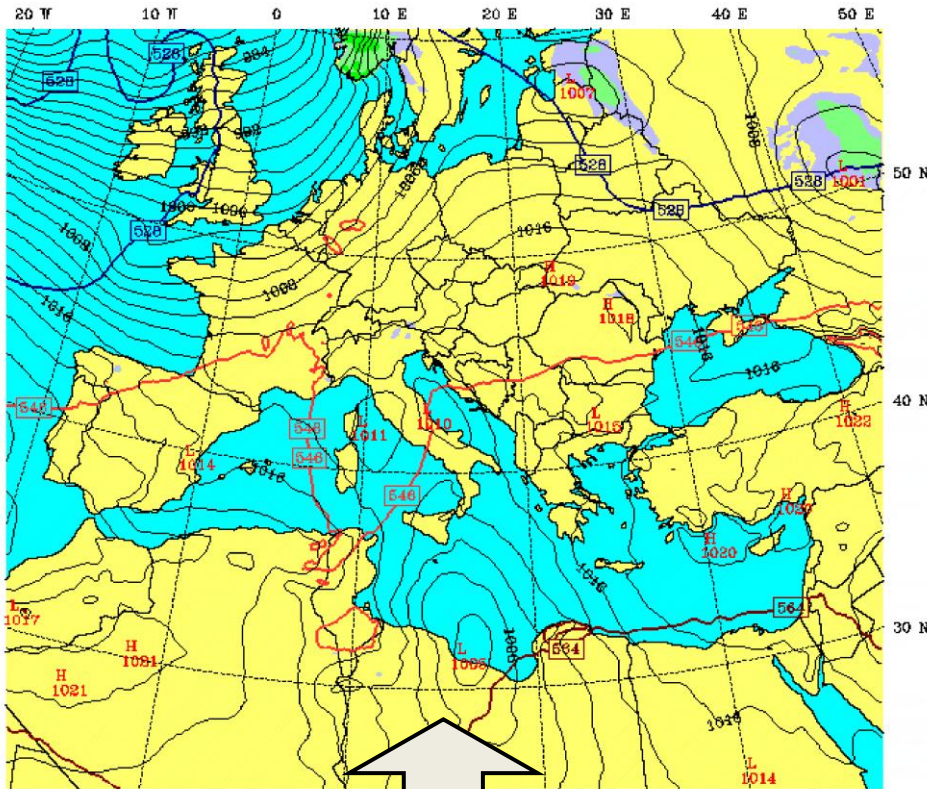
Model results: **SLH & depth averaged currents**



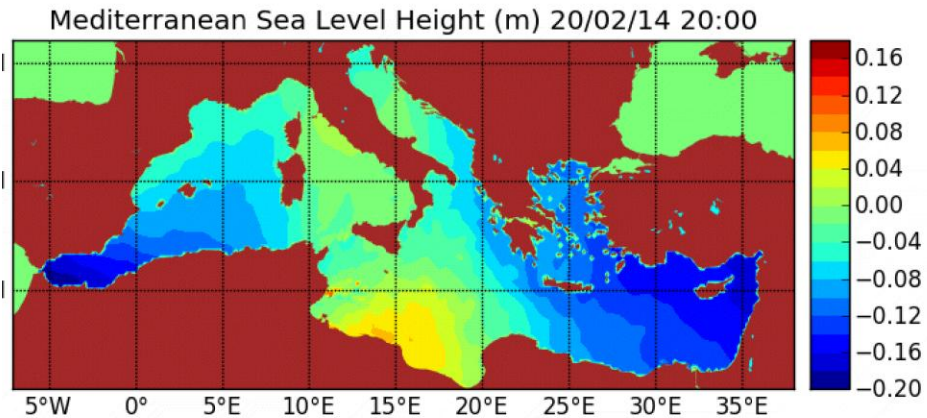
High Resolution Storm Surge (HRSS) model

Storm Surges: Rise of MSL due to combined action of pressure systems and winds

AUTH, Dept. of Met&Clim
Fest: 6.00 h
003hr ACCUMULATED SNOW
Sea-level pressure
Init: 1200 UTC Thu 20 Feb 14
Valid: 1800 UTC Thu 20 Feb 14 (2000 LST Thu 20 Feb 14)



LP → sea level rise
HP → sea level drop

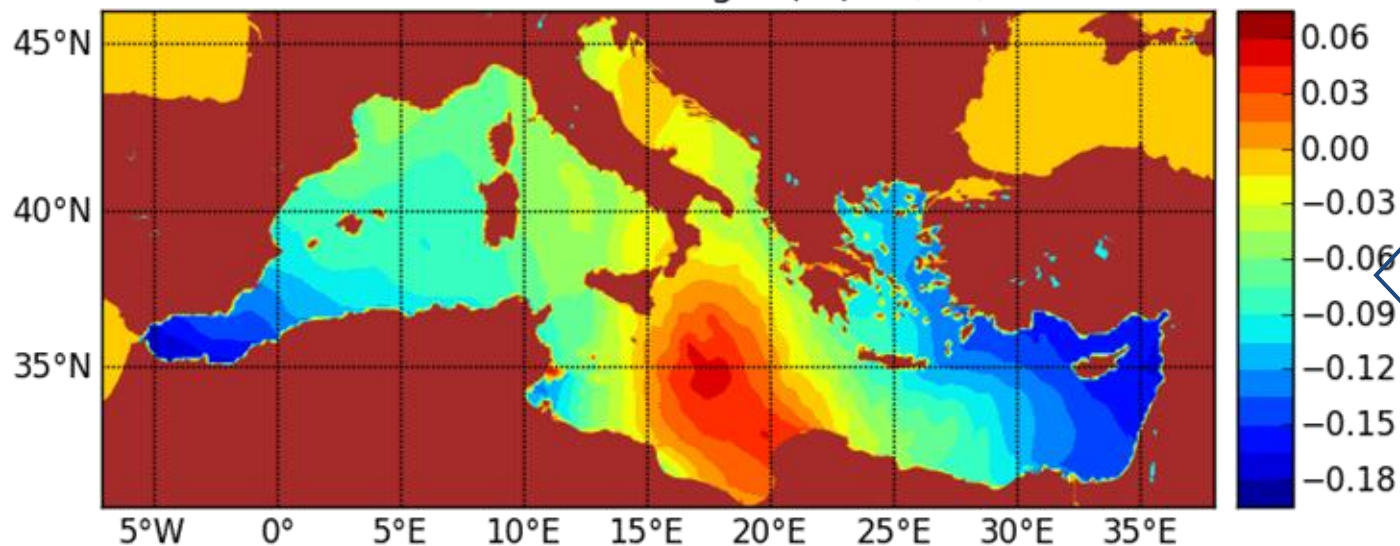


Atmospheric Pressure
WRF-ARW: Mediterranean domain

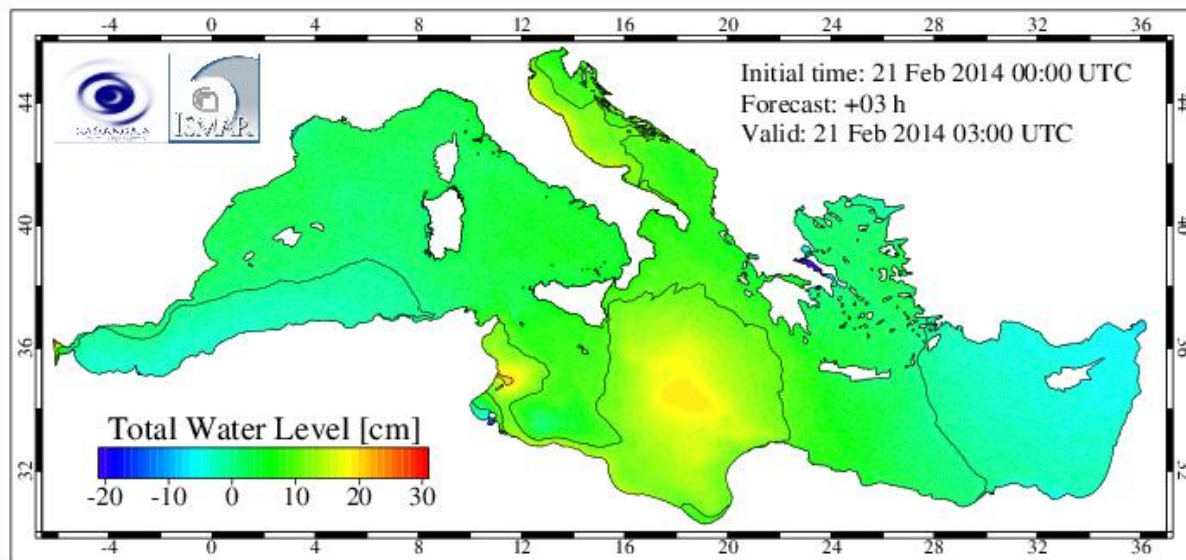
Mean Sea Level (MSL)
HRSS: Mediterranean domain

High Resolution Storm Surge (HRSS) model

Mediterranean Sea Level Height (m) 21/02/14 05:00



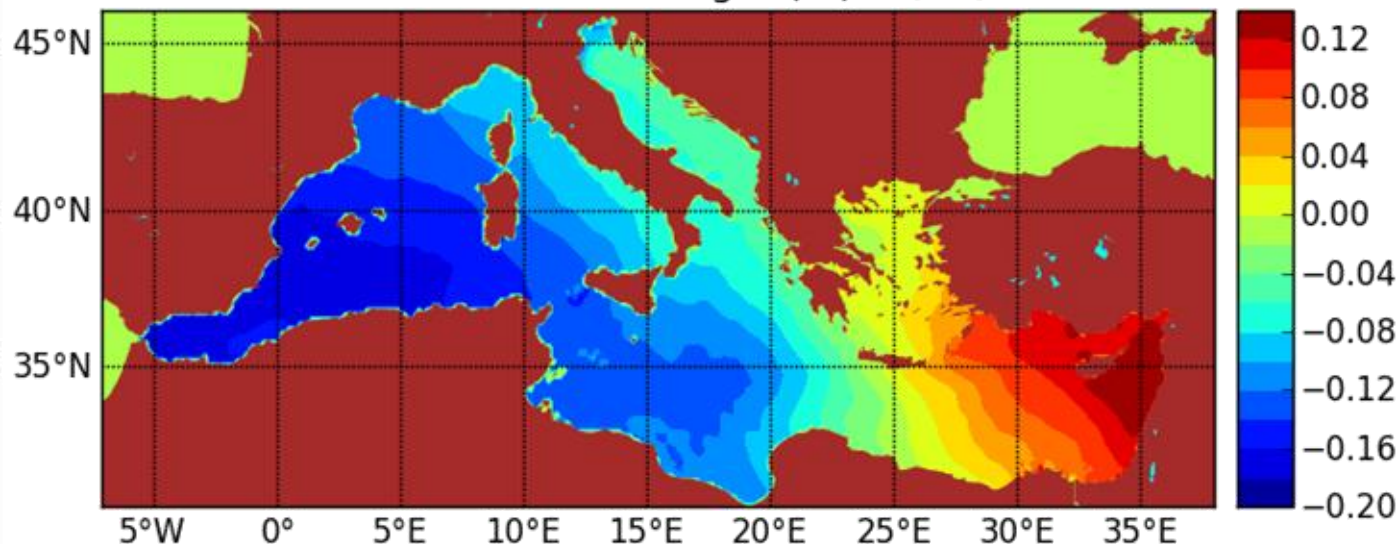
WaveForUs
MSL [m]
21/02/14
03:00UTC



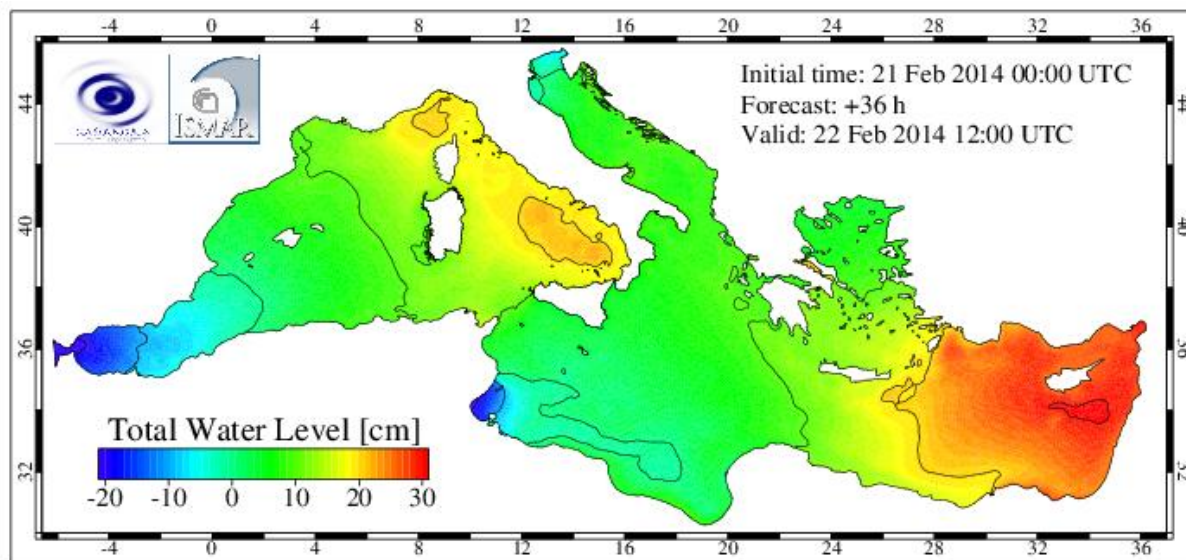
Kassandra
MSL [m]
21/02/14
03:00UTC

High Resolution Storm Surge (HRSS) model

Mediterranean Sea Level Height (m) 22/02/14 14:00



WaveForUs
MSL [m]
22/02/14
12:00UTC



Kassandra
MSL [m]
22/02/14
12:00UTC

Coastal Circulation model (POM)

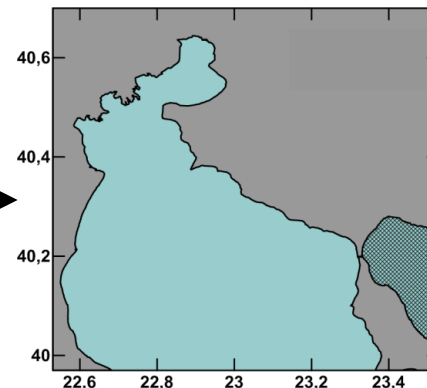
Princeton Ocean Model (POM) is a widely applied and validated model for the simulation of various environments, including coastal circulation and mixing processes in rivers, estuaries, shelves and slopes, lakes, semi-enclosed seas, as well as the global ocean. POM is a three-dimensional, free-surface, terrain following model that can deliver prognoses for:

- Current speed and direction
- Free surface elevation
- Seawater thermohaline properties (temperature, salinity, density)

Input atmospheric fields: wind, pressure, temperature, rainfall, humidity and surface thermal and radiation fluxes



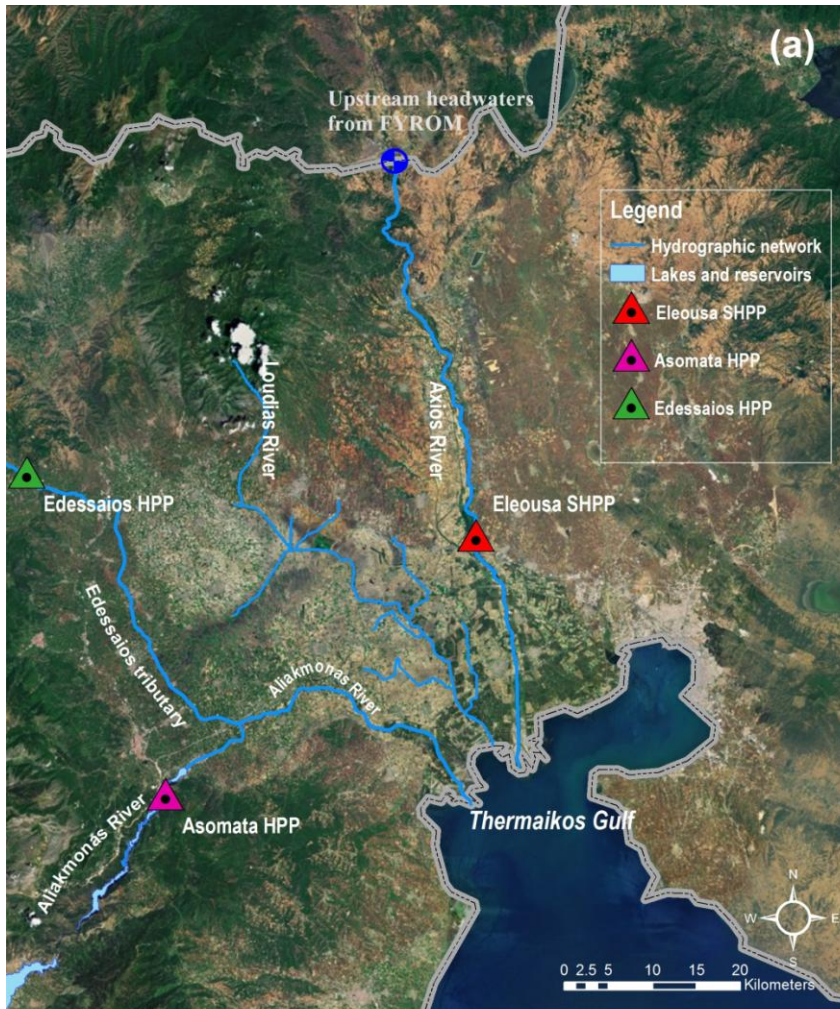
*Boundary
conditions* →



<http://www.myocean.eu/>

Coastal Circulation model (POM)

Daily assimilation of riverine fluxes



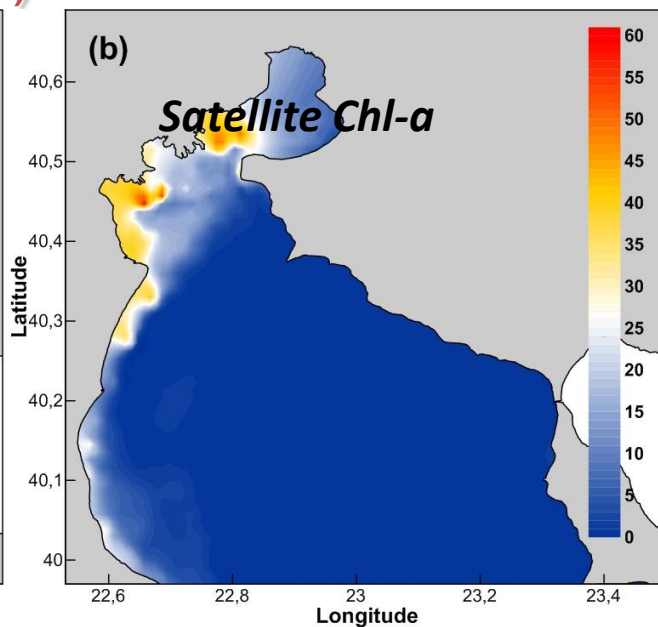
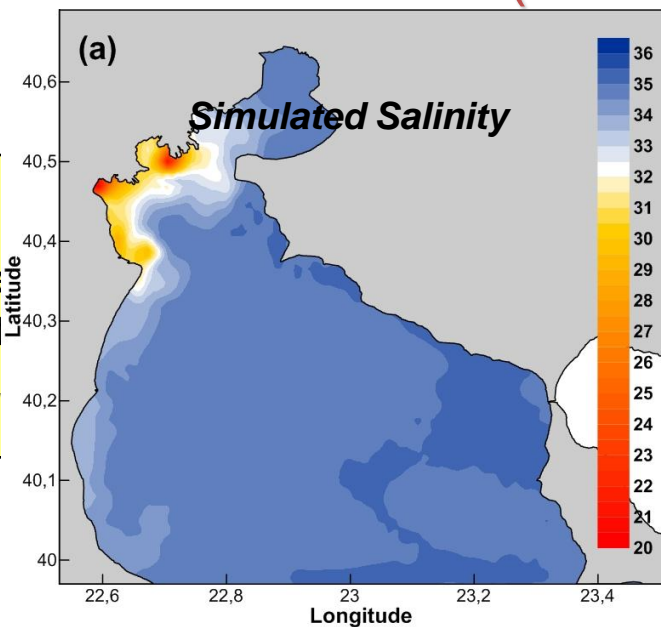
- 3 rivers
- 3 Hydroelectric dams
- Determine the physical characteristics of the enclosed Thermaikos Gulf
- Absence of daily discharge measurements
- Very few historical measurements
- Need for daily outflow rates

Solution

three independent methodologies for the assessment of the river discharges

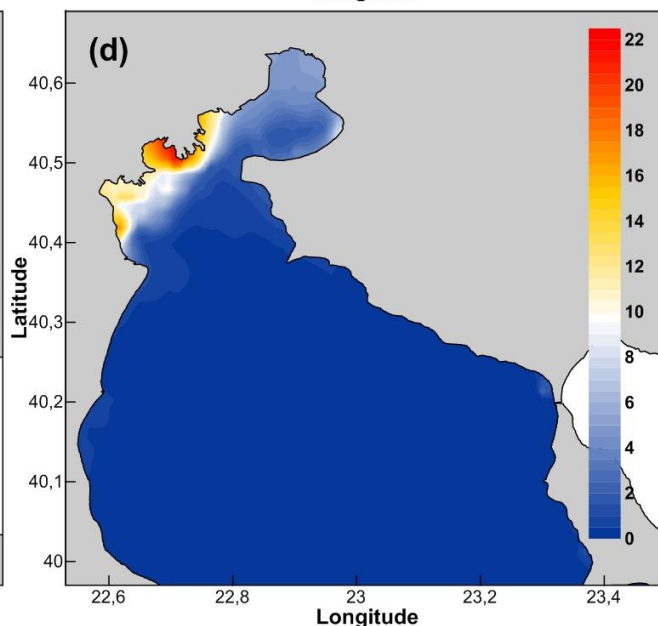
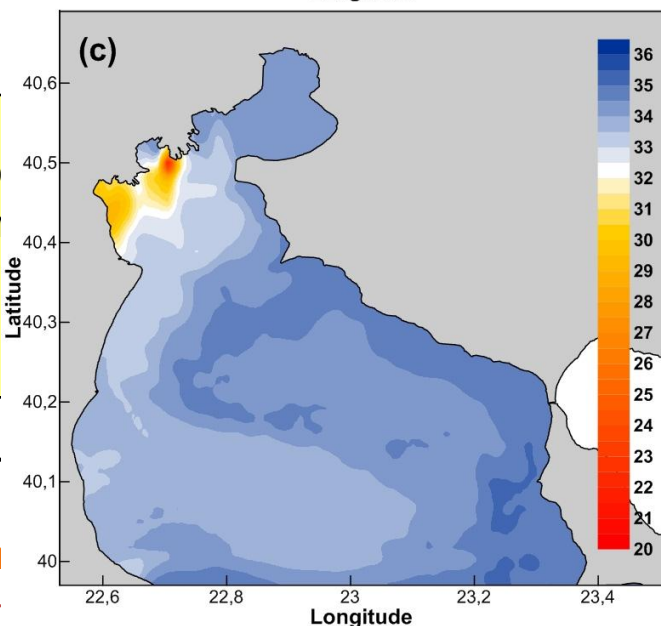
Coastal Circulation model (POM)

Power produced converted to
 $Q = I / (g \Delta \rho)$



of water
 the dam to
 charge
 $\sqrt{2gH}$

Estimation
 from Marine
 Plans of
 drainage



level data
 orders of
 d Greece,
 through a
 level sensor

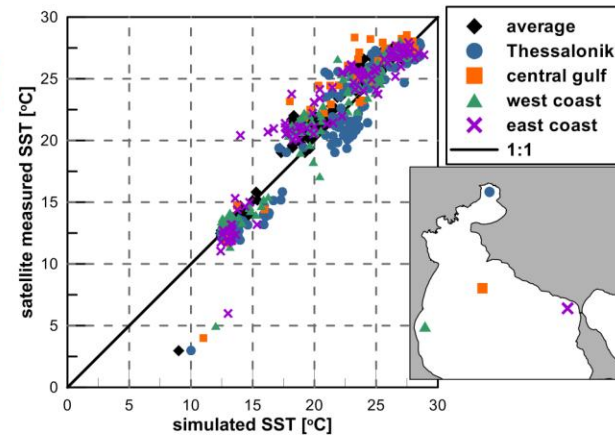
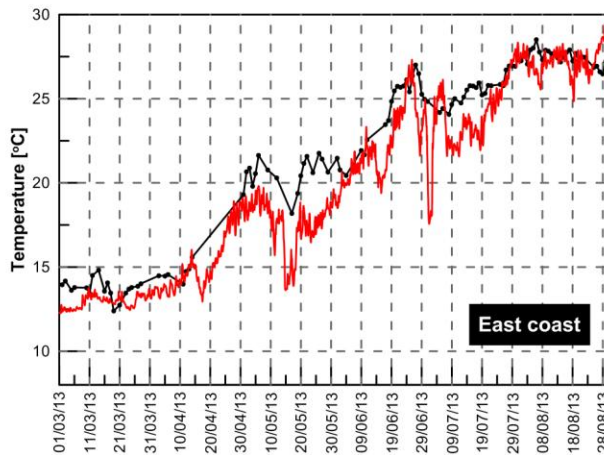
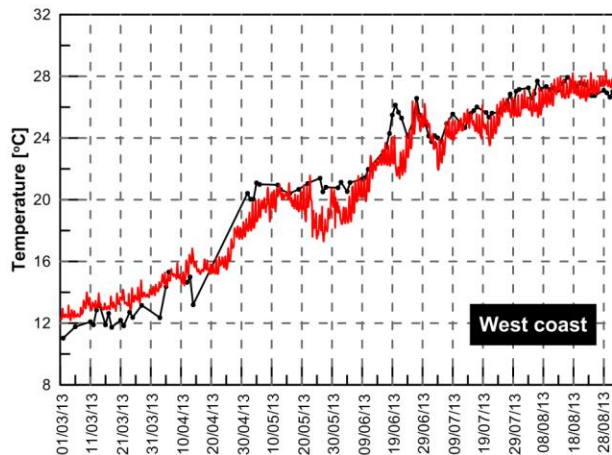
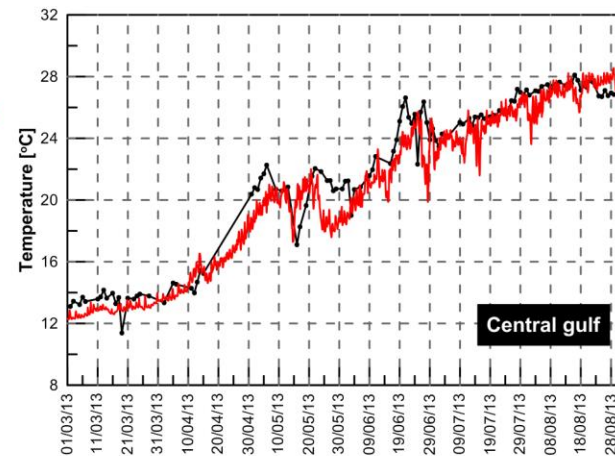
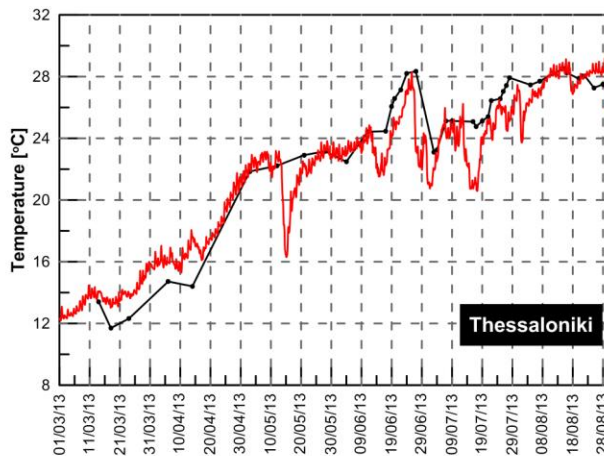
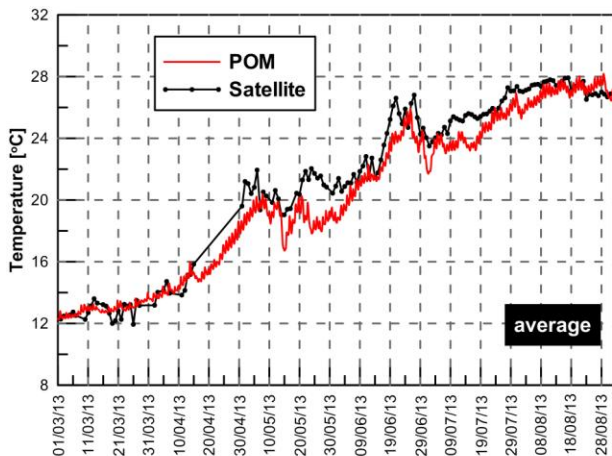
Comparison
 No Riverin
 With Riverin

se of mean
 inity in the
 0.2 - 1.2

01/03 11/03 21/03 31/03 10/04 20/04 30/04 10/05 20/05 30/05 09/06 19/06 29/06 09/07 19/07 29/07 08/08 18/08 28/08

Coastal Circulation model (POM)

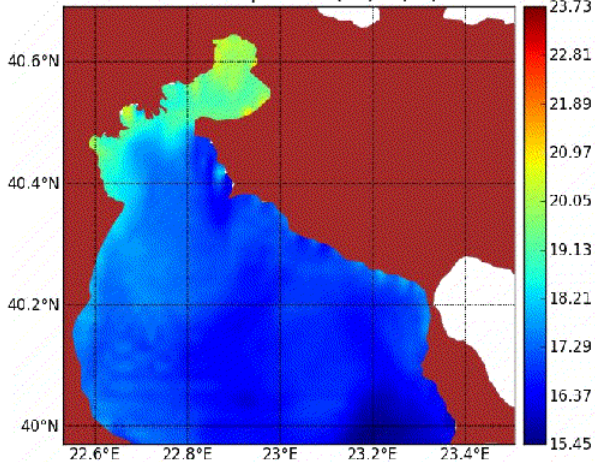
Performance Indicators	Average	Thessaloniki	Central Gulf	East Coast	West Coast
MAE ± StDev [° C]	0.85 ± 0.96	0.61 ± 1.49	0.71 ± 1.11	0.53 ± 1.23	1.15 ± 1.29
MAE ± StDev [%]	3.60 ± 4.56%	1.67 ± 7.15%	3.21 ± 5.35%	1.47 ± 6.79%	5.42 ± 5.87%
RMSE [° C]	1.28	1.59	1.31	1.33	1.73
R²	0.97	0.90	0.95	0.95	0.94
Willmott Skill (WS)	0.98	0.97	0.98	0.98	0.97



Coastal Circulation model (POM)

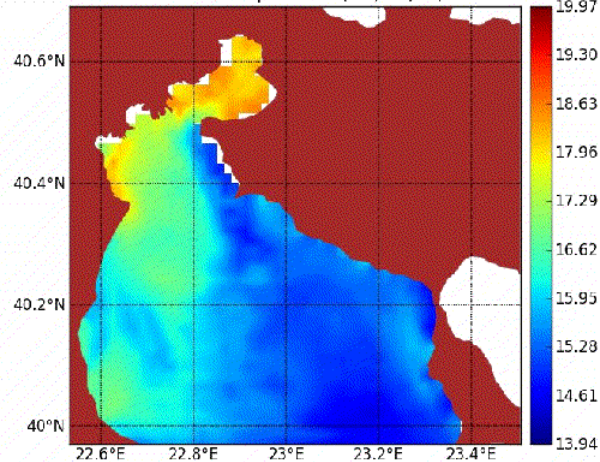
Temperature [°C]

Thermaikos Gulf Temperature (°C) 08/05/15 12:00



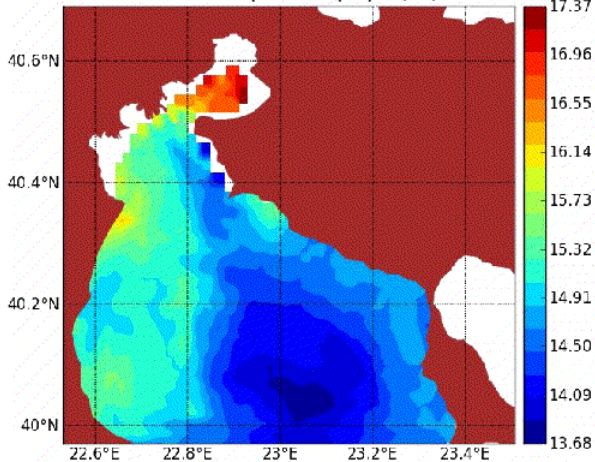
Surface

Thermaikos Gulf Temperature (°C) 08/05/15 12:00



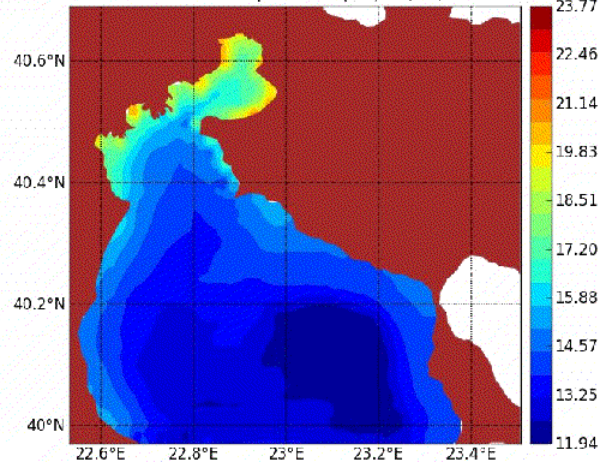
10m

Thermaikos Gulf Temperature (°C) 08/05/15 12:00



20m

Thermaikos Gulf Temperature (°C) 08/05/15 12:00

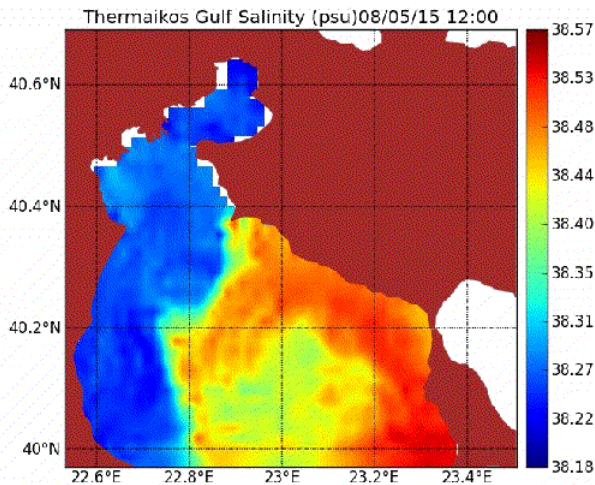
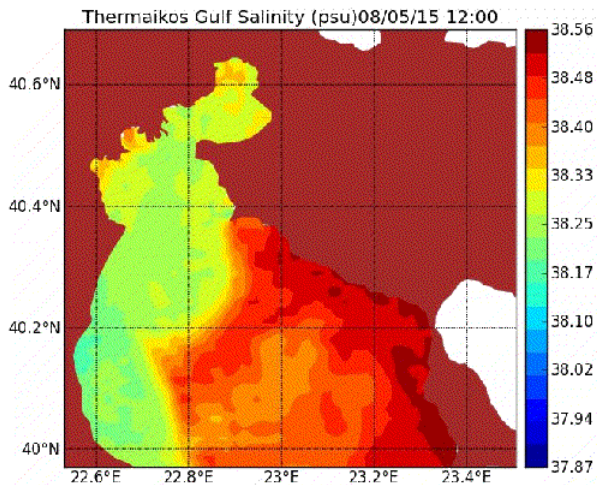


Bottom

Coastal Circulation model (POM)

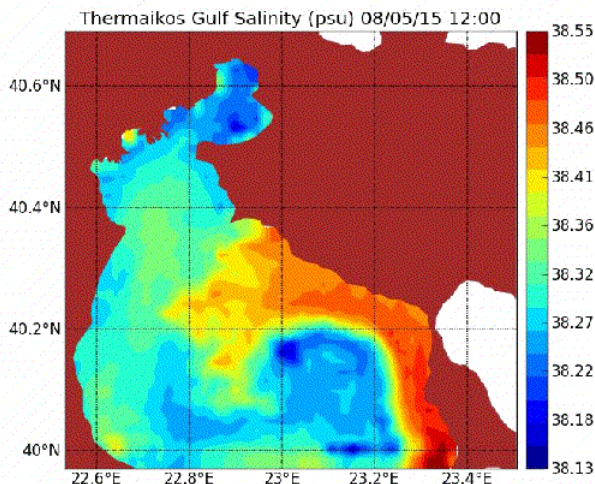
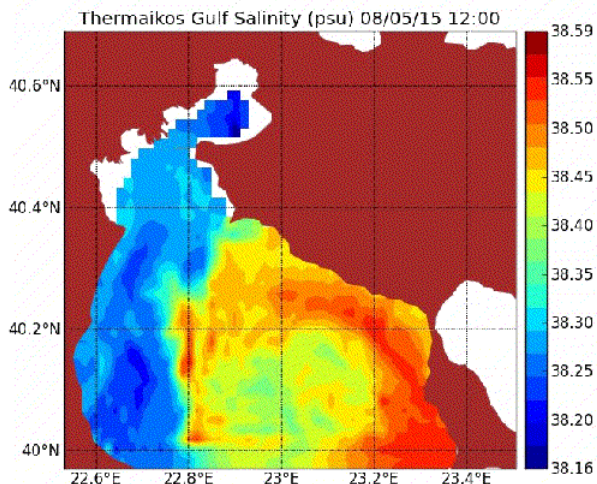
Salinity [%o]

Surface



10m

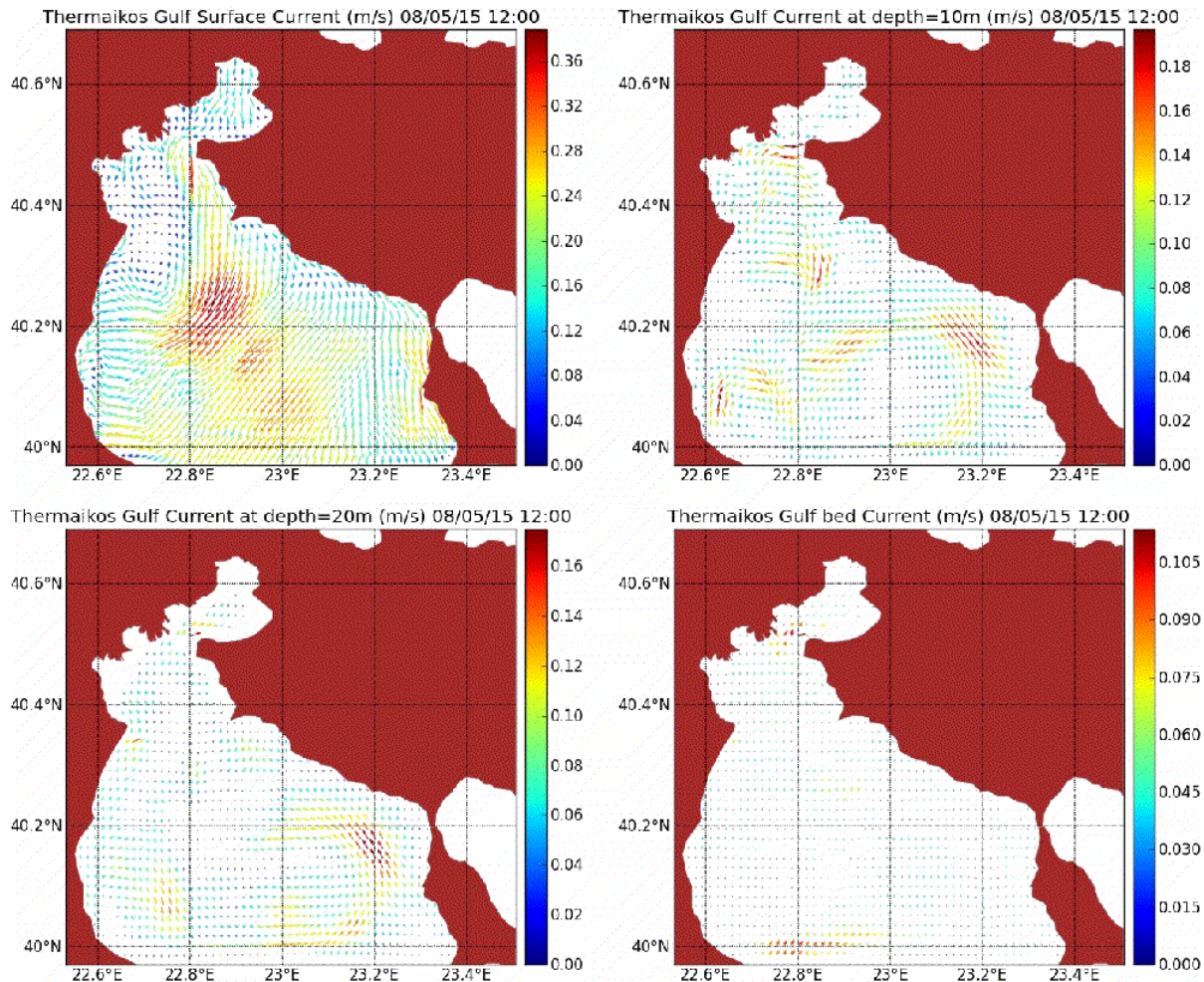
20m



Bottom

Coastal Circulation model (POM)

Currents [m/s]



Surface
Currents

10m

20m

Bottom

Forecast dissemination

Daily 3-day forecasts at **10:30**

<http://wave4us.web.auth.gr/>

TV Broadcasts

The screenshot shows the Wave4us web application interface. At the top, it displays the logo and the text: "A PILOT SYSTEM FOR THE DEVELOPMENT AND DELIVERY OF DAILY WAVE AND CIRCULATION FORECASTS FOR PUBLIC AND EMERGENCY USE IN THE THERMAIKOS GULF". Below this, there are navigation tabs for "the WaveForUs project", "the forecasting system", "partners", "forecast models", and "forecasts". The main content area is titled "3-day sea-state prognoses" and includes a detailed description of the forecasting system and its capabilities. A "Variable selection" dropdown menu is open, showing options like "Temperature", "Mean Sea Level Height", "Significant wave height", "Salinity", and "Current velocities". Below the menu, there is a map of the Thermaikos Gulf showing temperature forecasts for 27/06/15 15:00. The map uses a color scale from 16.86 to 26.32 degrees Celsius. The bottom of the page features logos for the European Union, NSRF 2007-2013, and the Ministry of Education, Lifelong Learning and Religious Affairs.



CW4) of the Coastal and Shelf Seas Task Team
COM Pilot Workshop

Forecast dissemination

Daily 3-day forecasts at **10:30**

<http://coastal.web.auth.gr/>

Aristotle University of Thessaloniki
School of Civil Engineering

Oceanography and Coastal Engineering Group

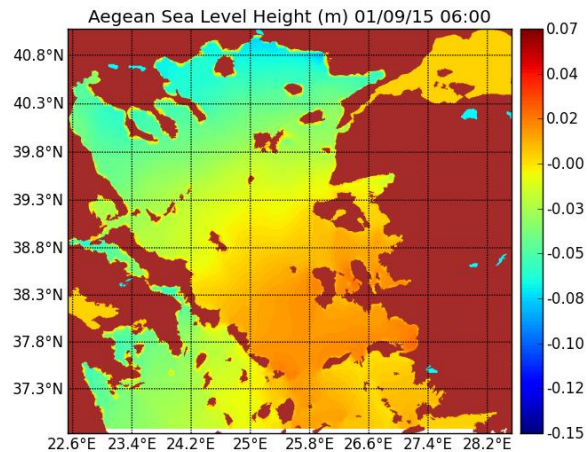


- about us
- Thermaikos Gulf
- Ocean circulation modelling
- Wave modelling
- Sediment transport modelling
- Storm surge modelling
- ICZM
- Monitoring coastal areas
- Educational software
- Links

STORM SURGE MODELLING | AEGEAN SEA FORECASTS (WAVE4US PROJECT)

Using the drop-down menu below, you can view forecasts for the MSLH for the North Aegean Sea from the storm surge model for the period 31/08/2015 12:00 until 03/09/2015 12:00.
The forecast are performed in the framework of the WaveForUs project and the results are updated daily at 10:30 Athens time (UTC/GMT + 2hrs).
Please note that the areas of the Black Sea and Dardanelles strait are excluded from the model calculations.

Date selection menu: 01/09/2015_06:00



Aristotle University of Thessaloniki
School of Civil Engineering

Oceanography and Coastal Engineering Group

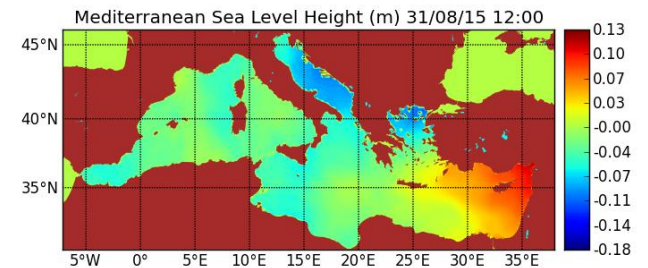


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STORM SURGE MODELLING | MEDITERRANEAN SEA FORECASTS (WAVE4US PROJECT)

Using the drop-down menu below, you can view forecasts for the MSLH for the Mediterranean sea from the storm surge model for the period 31/08/2015 12:00 until 03/09/2015 12:00.
The forecast are performed in the framework of the WaveForUs project and the results are updated daily at 10:30 Athens time (UTC/GMT + 2hrs).
Please note that the areas of the Black Sea and the Atlantic Ocean are excluded from the model calculations.

Date selection menu: 31/08/2015_12:00



Summary

- ❑ WaveForUs is already providing daily forecast results through the program webpage (<http://wave4us.web.auth.gr/>), a web-GIS application and 6 daily television broadcasts.
- ❑ Evaluation of the simulations showed the effectiveness of the sea-state forecasts is quite satisfactory.
- ❑ The WaveForUs forecasting system may be a useful and reliable tool for users and their sea-based activities.
- ❑ On-going work

We are conducting a survey with questionnaires in order

- to evaluate the public response to the WaveForUs system
- to produce more friendly-user products to general public and more useful products to professionals

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The WaveForUs project is funded by the national action 'COOPERATION 2011: Partnerships of Production and Research Institutions in Focused Research and Technology Sectors in the framework of the operational programme 'Competitiveness and Entrepreneurship' (NSRF2007-2013)

The WaveForUs system uses MyOcean (<http://www.myocean.eu/>) products.

Thanks...



Operational programme: "Competitiveness and Entrepreneurship" and Regions in Transition
National Action: "COOPERATION 2011 - Partnerships of Production and Research Institutions
in Focused Research and Technology Sectors"

MINISTRY OF EDUCATION, LIFELONG LEARNING AND RELIGIOUS AFFAIRS - GENERAL SECRETARIAT FOR RESEARCH AND TECHNOLOGY



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