



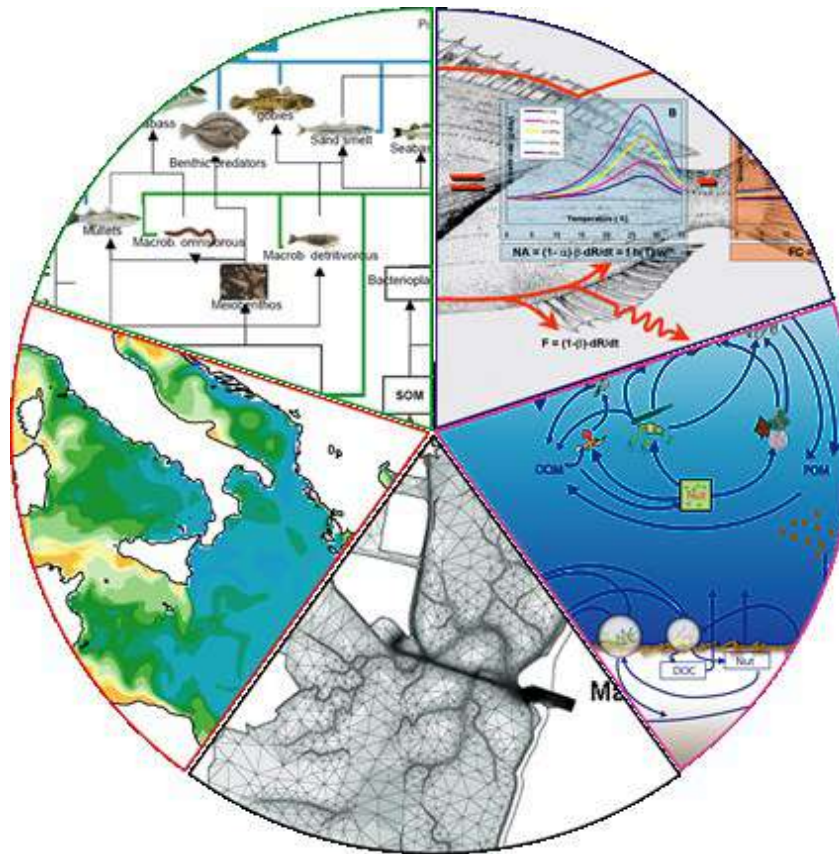
HarmoNization and NetwOrking for contaminant assessment in the Ionian and Adriatic Seas

The use of models for oil spill risk assessment

Donata Melaku Canu, OGS



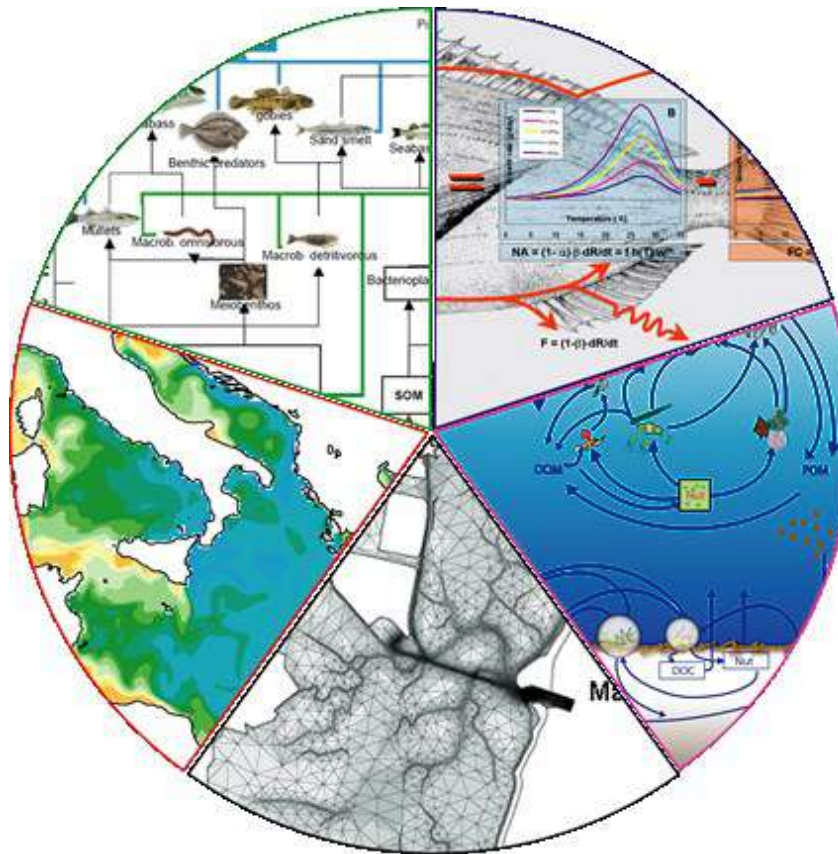
Why do we need models targeting environmental quality



Complex world

Our ability to grasp the complexity and the relative magnitude of the interacting elements of the environment, considering natural variability and human pressures, is limited.

Why do we need models targeting environmental quality

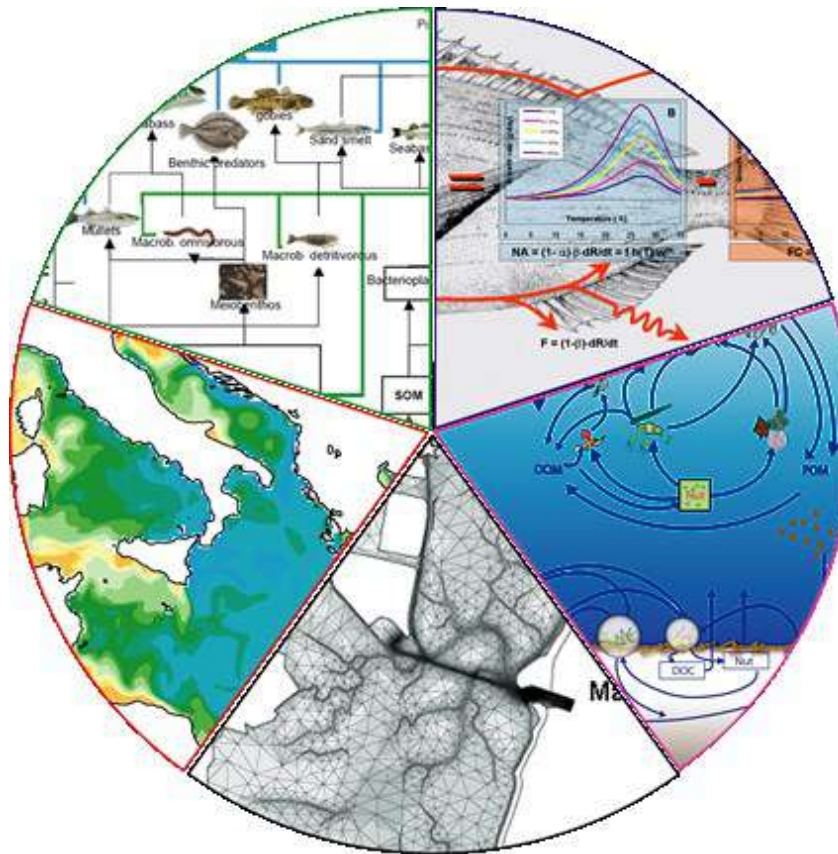


Need to integrate a lot of data and information

partial accessibility of sea

Marine monitoring has improved a lot, also thank to a massive cover of satellites and other drones; measuring in real time and unveiling the inaccessible.

Why do we need models targeting environmental quality



Need to capture spatial and time evolution

Capturing the timing, the evolution is very important. This concept has been implicitly integrated in the environmental legislation targeting marine (MSFD) freshwater, coastal waters, which set quality objectives, but also iterative valuation.

We already use models in our everyday life decisions

? Which is the best way to reach Patras, considering the time of the day/year?

Google maps ----spatial connections, temporal connections

? What I put in my luggage?

Weather forecast ---spatial and temporal connections, physical processes,
occurring at different spatial scales

What can oil spill model tell us?

Where does a specific spill go? -→ Emergency response
Specific simulation, real time, ready for the emergence

Which are the sites with highest probability of oil spill impact? -→ Marine spatial planning

Risk assessment, statistical analysis of hundreds of simulations made using the whole combination of possible events (meteorological, oceanographic, accidental)

Modelling oil spill in Harmonia

Methodological aspects

**Models allow to get site specific assessments
(i.e. which is the correct distance...)**

EIA do not set modelling guidelines:

Scenario analysis

spatial resolution (sea current, meteo)

Oil weathering processes parameteriation

Data need

Risk index method



MAIN OBJECTIVE



GIS layers of contaminant probability in selected sites for Risk assessment

Screening data to select case study areas (sensitivity maps) (IOF and OGS)

Hydrodynamic modelling and comparison with data

Oil spill modelling

Risk index identification (IOF and OGS)

Sea current maps (whole Adriatic-Ionian Sea and case studies)

Oil spill dispersion maps (selected sites)

Risk index of contaminant dispersion (selected sites)

GIS layers of vulnerable marine and coastal zones in case study areas (IOF)

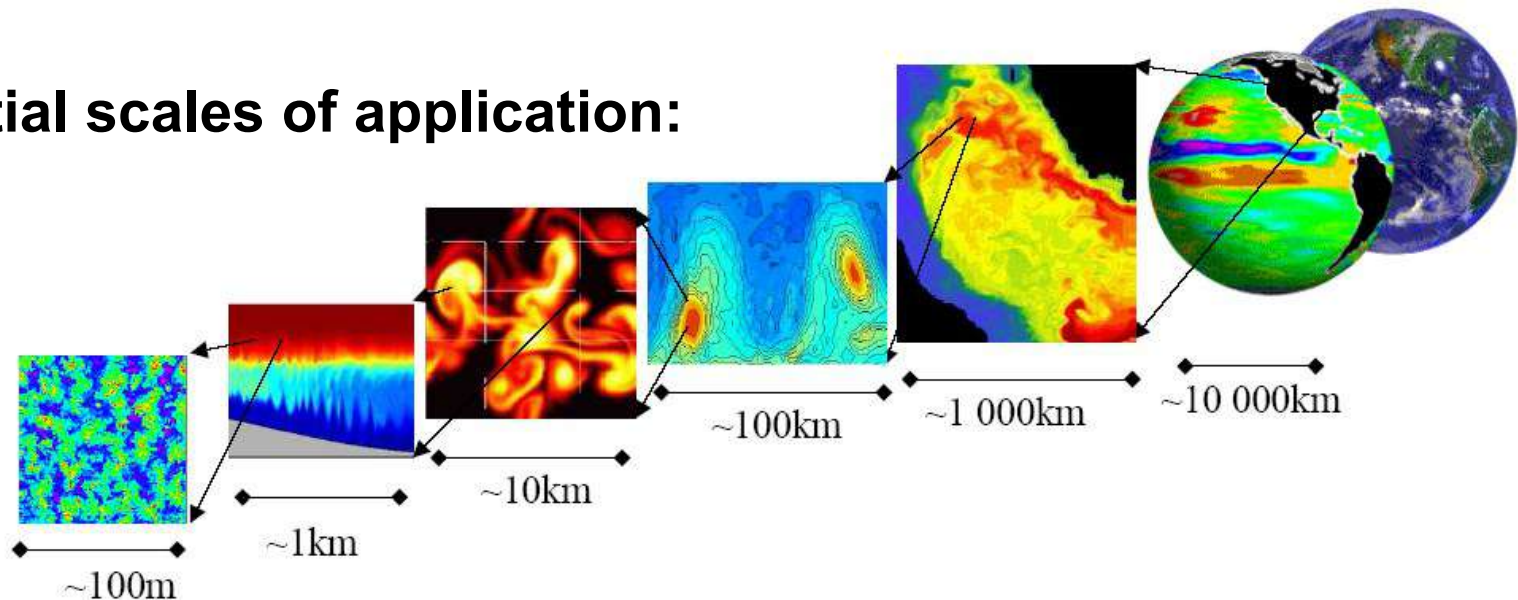


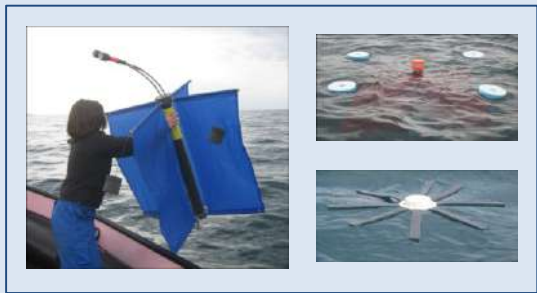
- sea circulation data (surface velocities) Adriatic-Ionian basin and on three selected coastal areas: the Gulf of Trieste, the Bay of Split and the Gulf of Patras.
- production of oil spill density maps of oil spill dispersion scenario of 4 scenario simulations of surface oil spill occurring:
 - 1) From the main routes of oil tankers in the Adriatic Sea;
 - 2) From a tanker accident occurring in the Gulf of Trieste (I);
 - 3) From a tanker accident occurring in the Bay of Split (HR);
 - 4) At an oil platform during discharge operations with FSO.

MITgcm Ocean General Circulation Model [*Marshall et al.*, 1997]

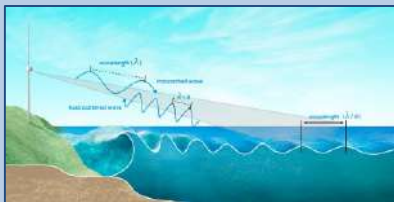
- non hydrostatic
- finite volumes
- open source

Spatial scales of application:

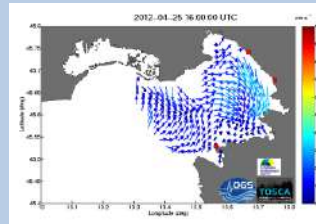




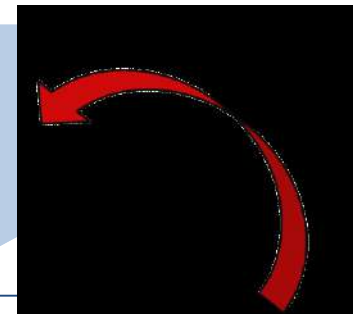
Photos of MAOS group -OGS



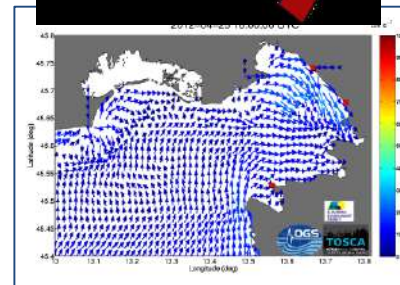
Imagine courtesy of: [//www.medclie.es/](http://www.medclie.es/)



Surface current fields
measured by HF radar

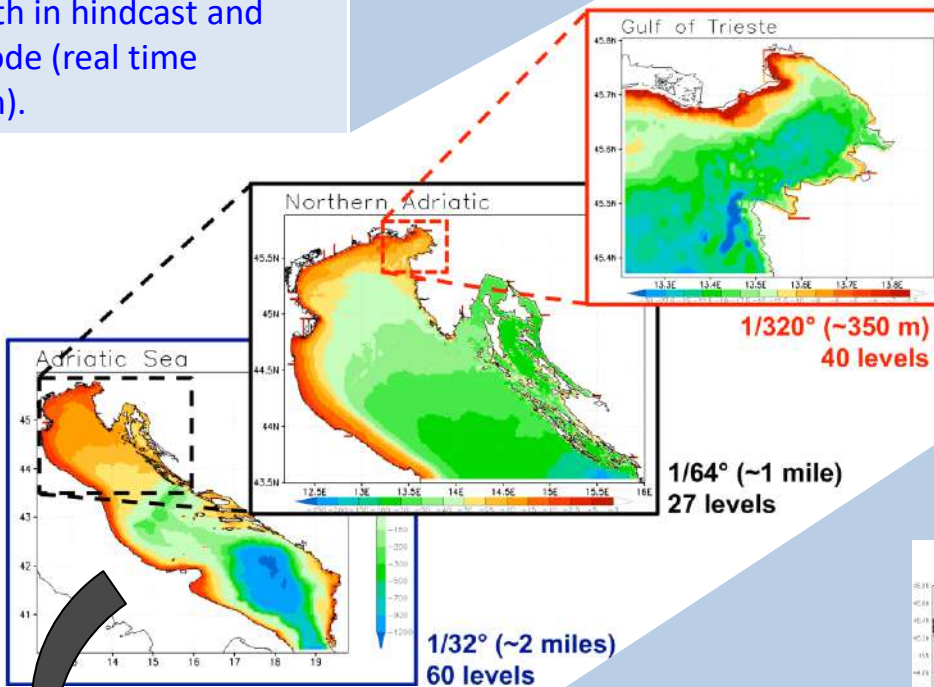
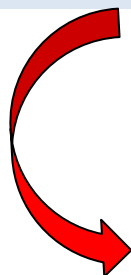


Modelled surface current fields



Model-data comparison

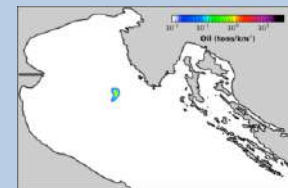
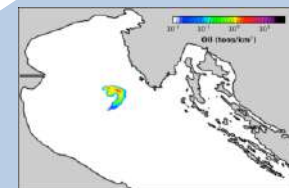
Meteorological and
oceanographic data are
integrated into the hydrodynamic
models, both in hindcast and
forecast mode (real time
assimilation).



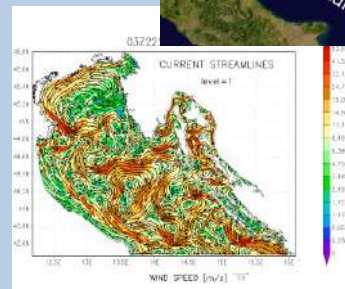
Bathymetry of the Adriatic-Ionian system
used for the numerical analysis performed
with the MITgcm hydrodynamic model.



Oil spill scenario simulated with LTRANS
v.2lev without the weathering module:
snapshot of the surface oil slick.



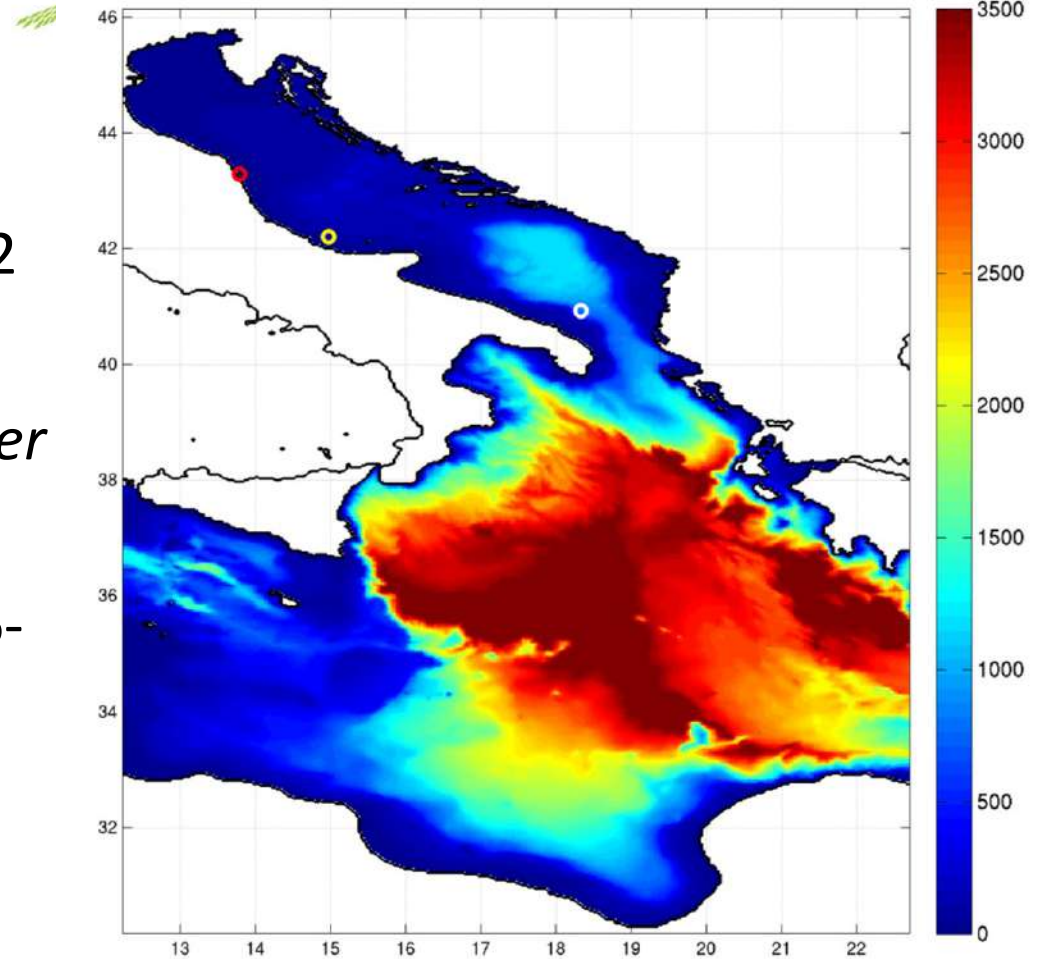
Oil spill scenario simulated with OILTRANS
v.2lev with the weathering module:
snapshot of the surface oil slick.



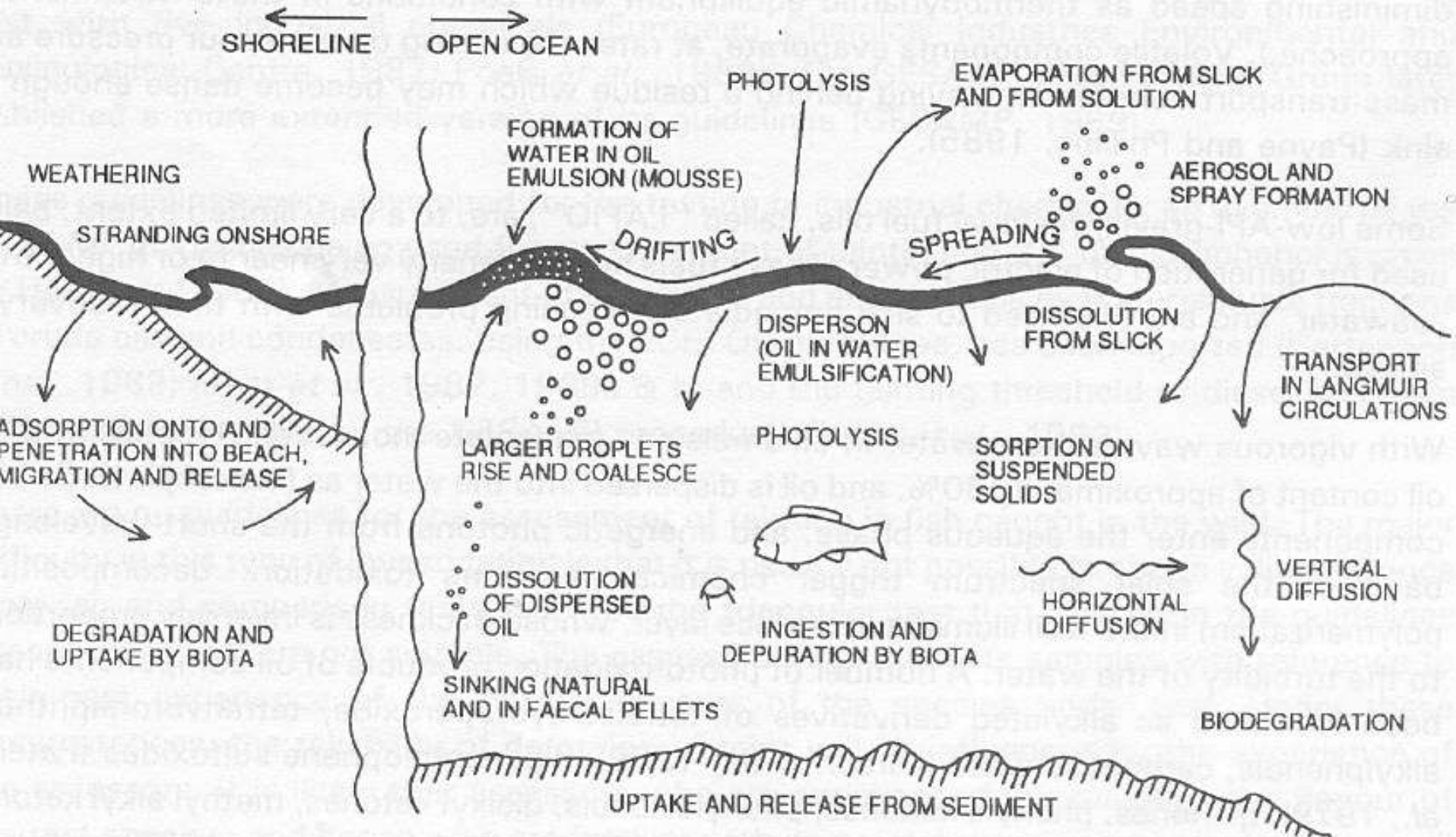
Oil spill models are run using
hydrodynamic model output fields

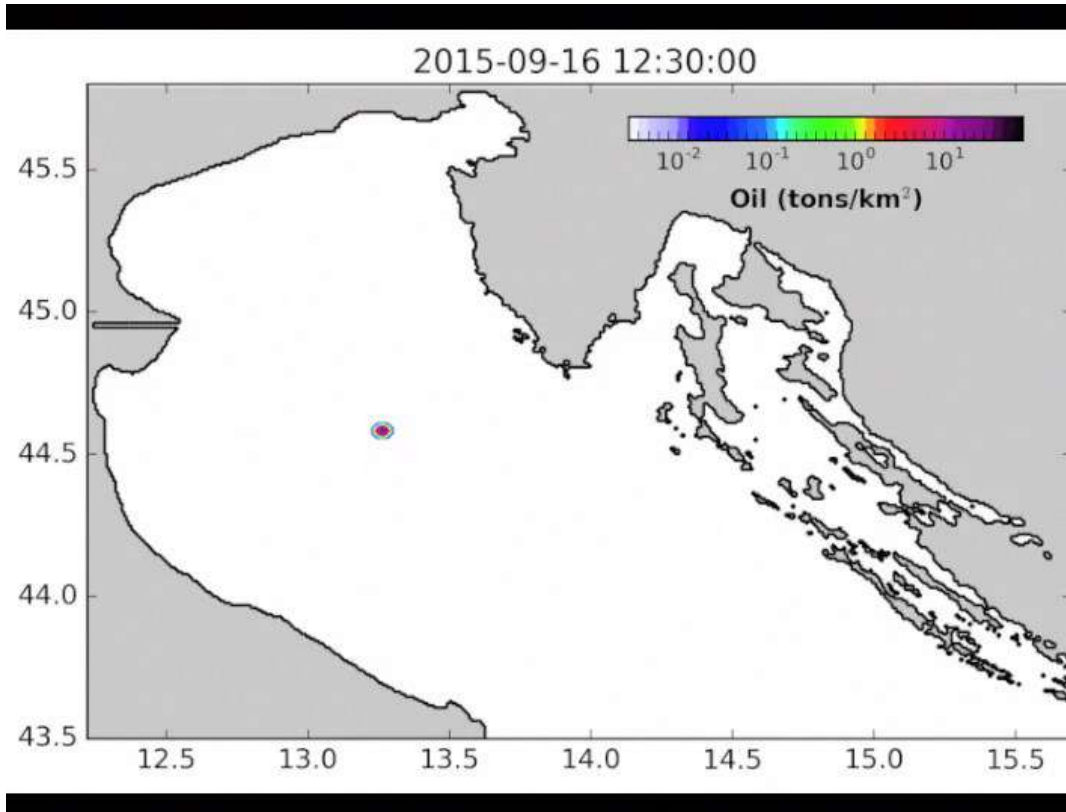


- Adriatic-Ionian
- Spatial resolution $1/32^\circ$ (~ 2 nm)
- *Study sites Nesting at higher resolution*
- Long term simulation 2006-2012
- Time step 200 s
- *spin-up* (45 days)



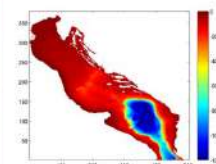
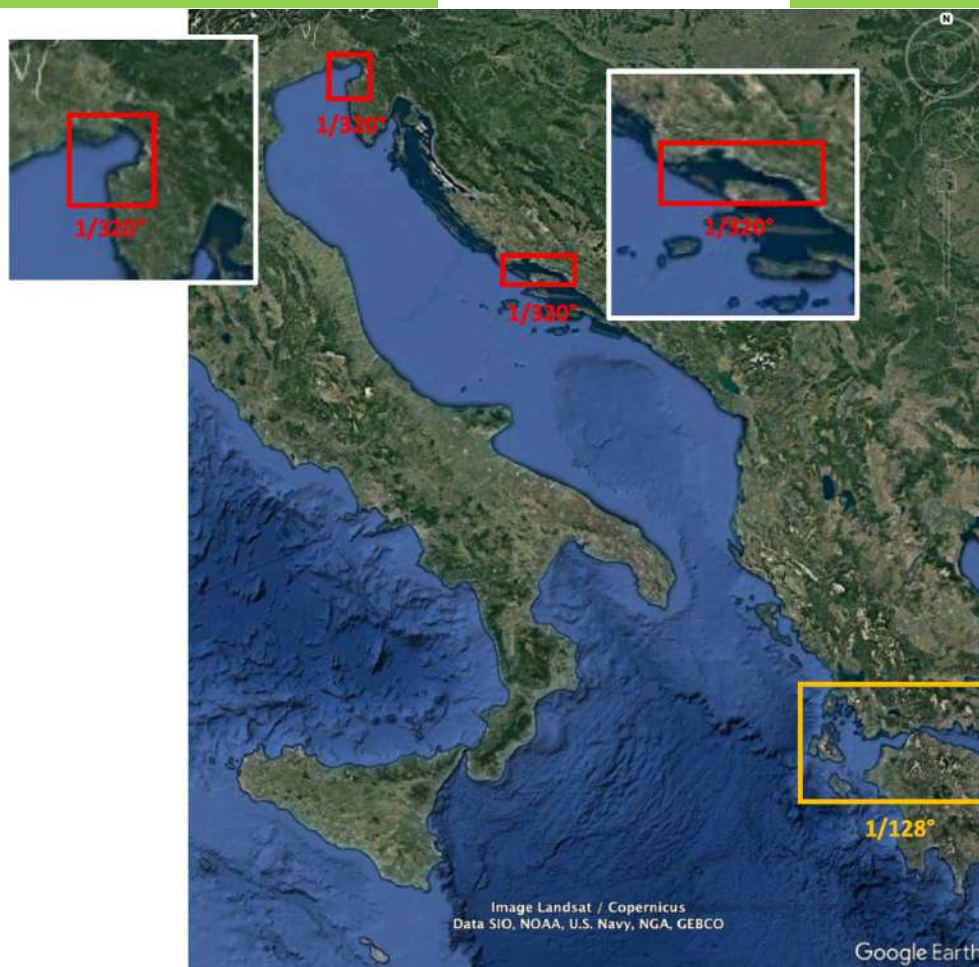
Domain of the MITgcm model ($1/32^\circ$)
Adriatic-Ionian system [Querín et al., 2013;
Querín et al., 2016]



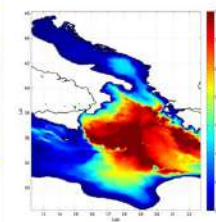


OILTRANS +MITgcm
OILTRANS: API 33.0 Dispersion (Berry, 2011)
Evaporation Fingas

Model domain

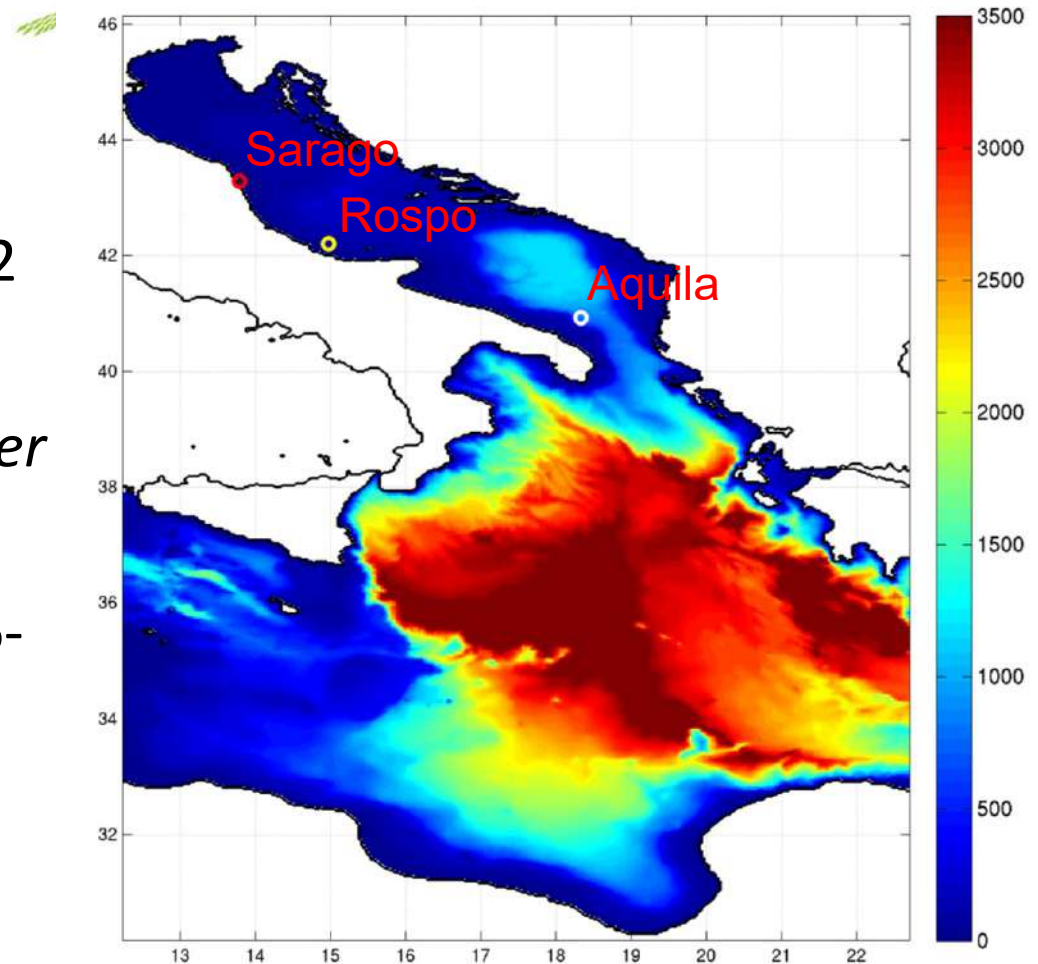


MANTIS: 2006-2012



ADIOS: 2006-2012

- Adriatic-Ionian
- Spatial resolution $1/32^\circ$ (~ 2 nm)
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Domain of the MITgcm model ($1/32^\circ$)
Adriatic-Ionian system [Querin et al., 2013;
Querin et al., 2016]

Adriatic/Ionian Sea period 2007-2012



1/32° resolution

Dataset: 86 text files

- grid coordinates [degrees lon, degrees lat];
 - bathymetry [m];
 - monthly averages of surface velocity from 2007 to 2012 (72 files) [m/s];
 - interannual monthly averages of surface velocity (e.g., average of all 12 months of the period 2007-2012 [m/s].
- u (zonal) and v (meridional) surface velocities in the top layer (0 - 1.5 m). (grid size: 336 x 512 points, 60 vertical levels).



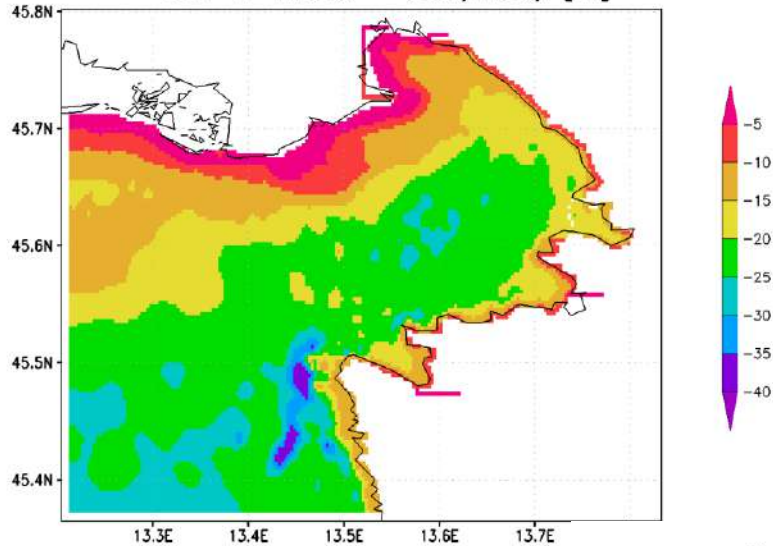
D. Canu

Patras Meeting, 24.10.2019

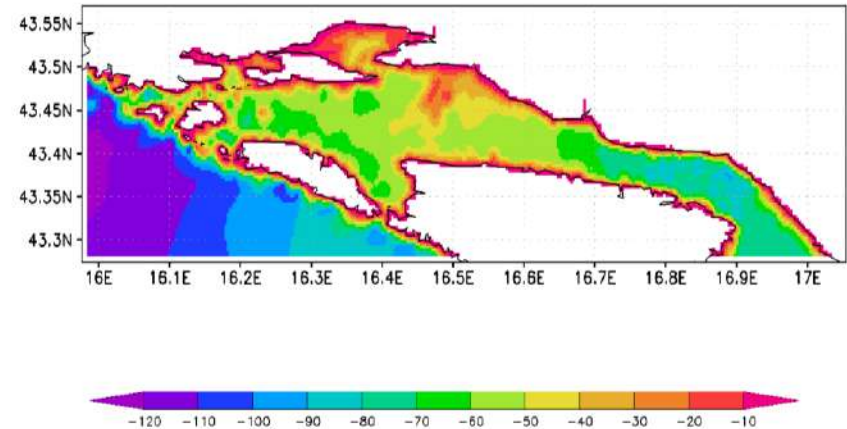
High resolution

Bathymetry

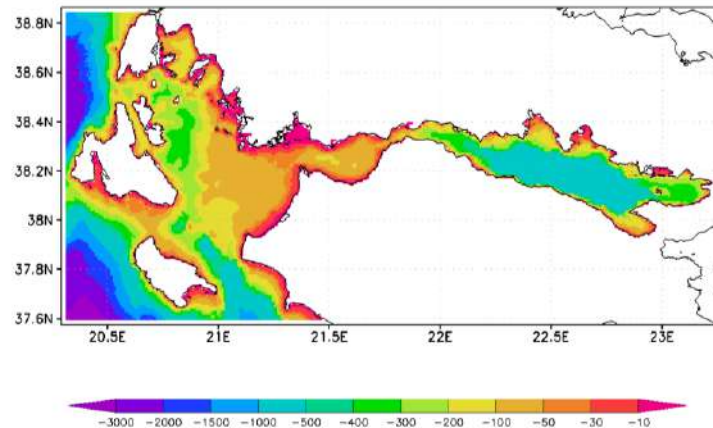
Gulf of Trieste – bathymetry [m]

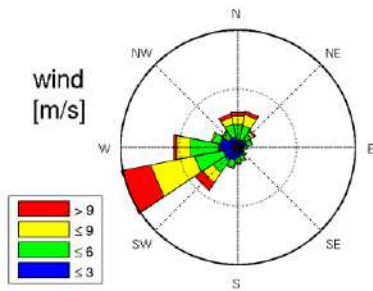
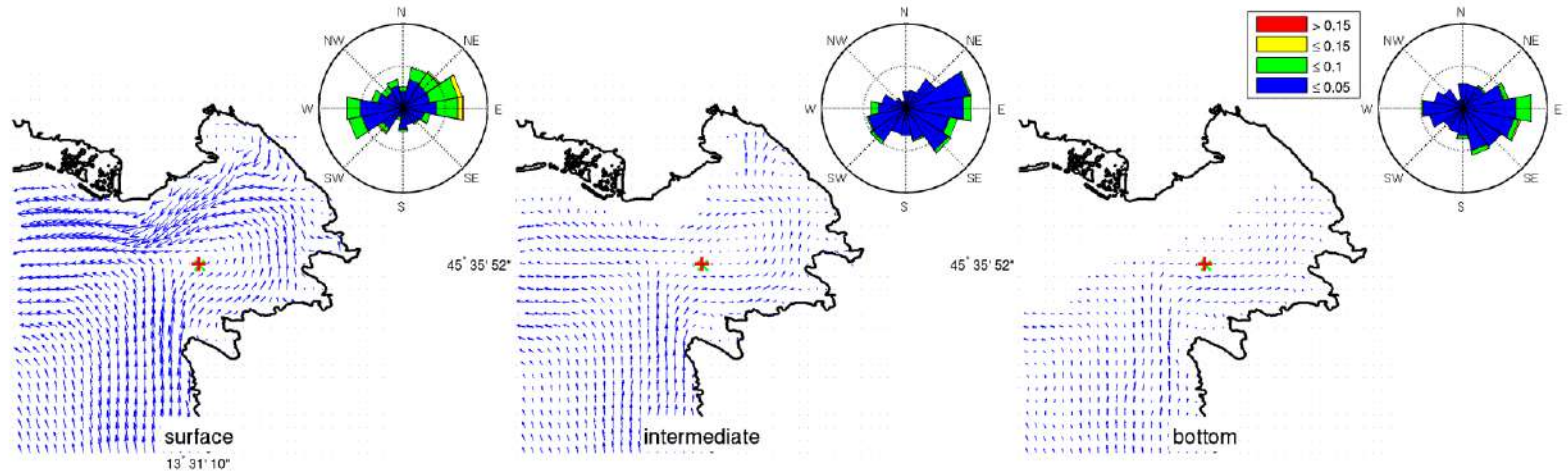


Bay of Split – bathymetry [m]



Gulf of Patras – bathymetry [m]





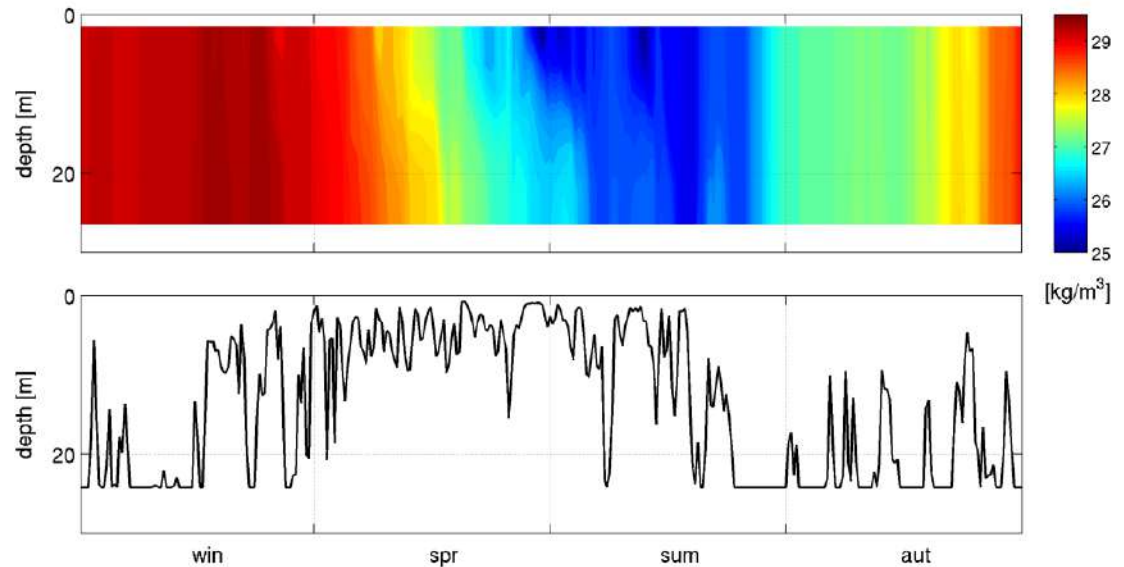
Gulf-of-Trieste

lat: 45°35'43.44"N

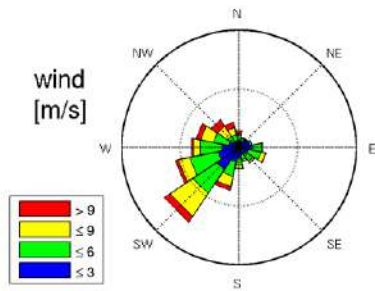
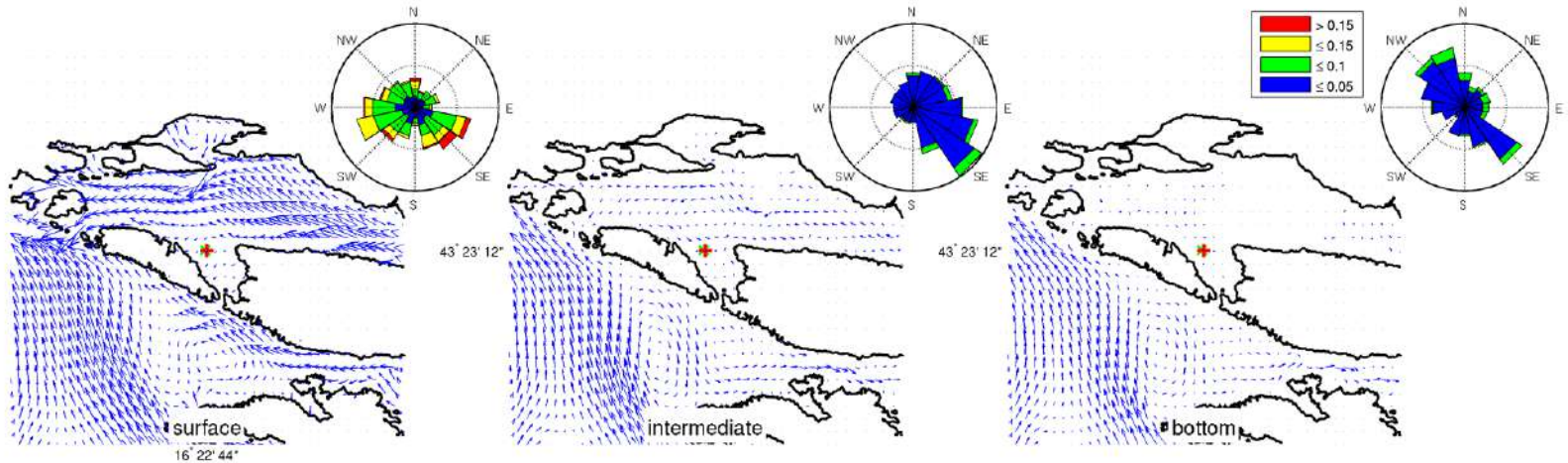
lon: 13°31'15.88"E

model depth: 24.4334 m

yearly average



meteo-oceanographic characterization of the **Gulf of Trieste**



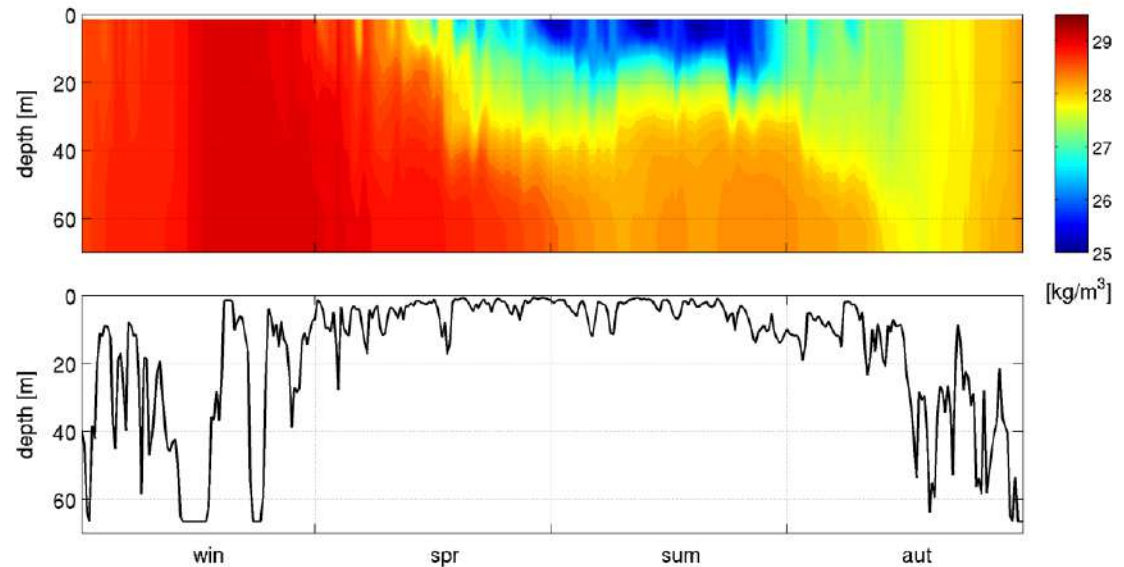
Kastela-Bay

lat: 43°23'14.01"N

lon: 16°22'33.28"E

model depth: 64.2252 m

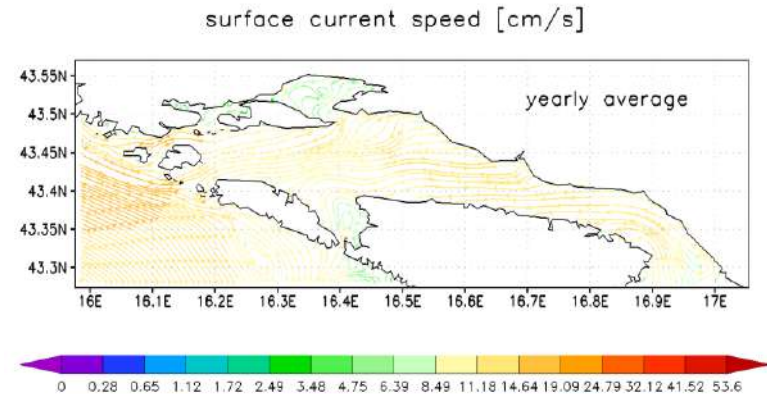
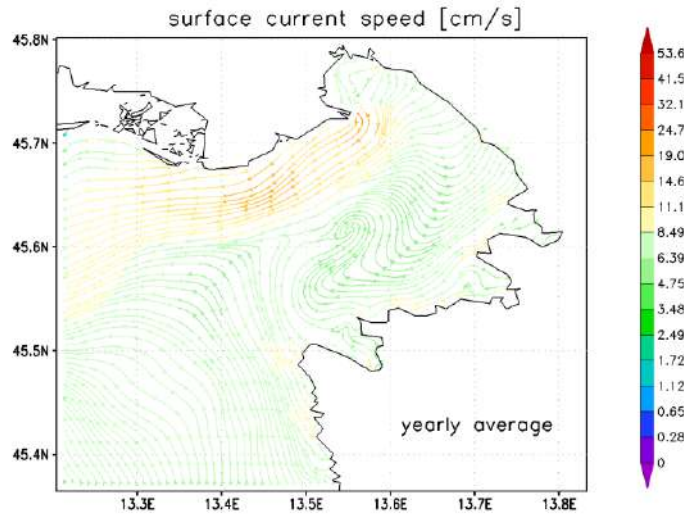
yearly average



meteo-oceanographic characterization of the **Kaštela Bay**

High resolution

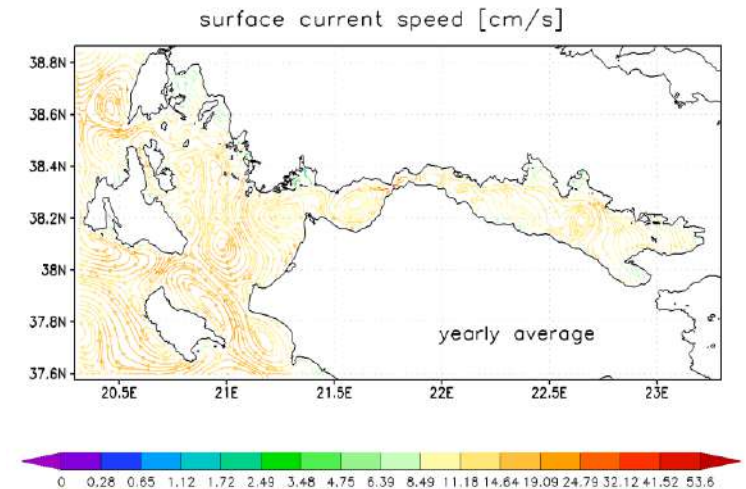
Yearly average current



DATA FILES for the WEBportal:

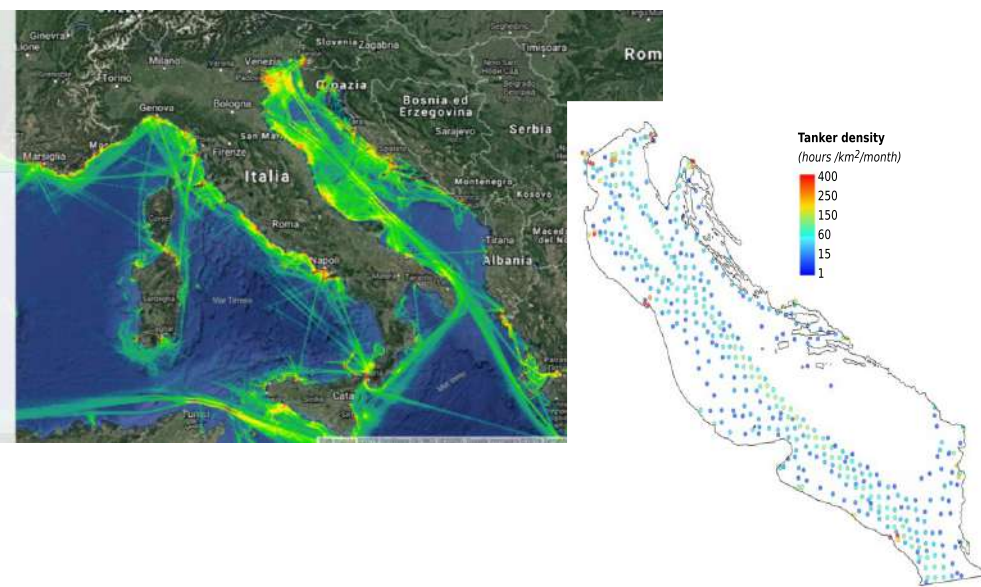
- grid coordinates [degrees lon, degrees lat];
- bathymetry [m];
- monthly averages of surface velocity (12 files) [m/s];
- yearly average of surface velocity [m/s] (Fig. 8).

Surface velocities refer to the u (zonal) and v (meridional) components of water current in the top layer of the model (from 0 to 1.5 m depth).

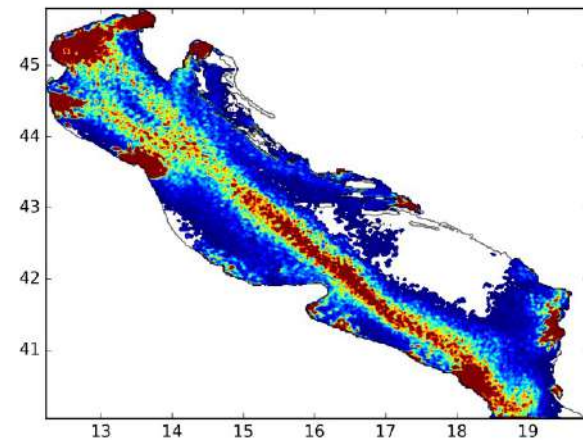


ADRIATIC IONIAN

MAIN SHIPPING ROUTE



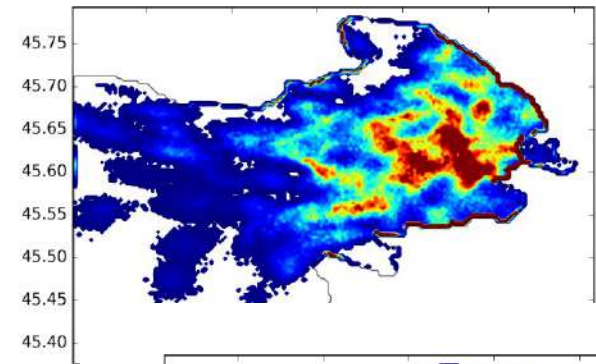
MAIN 24 H AFTER SPILL



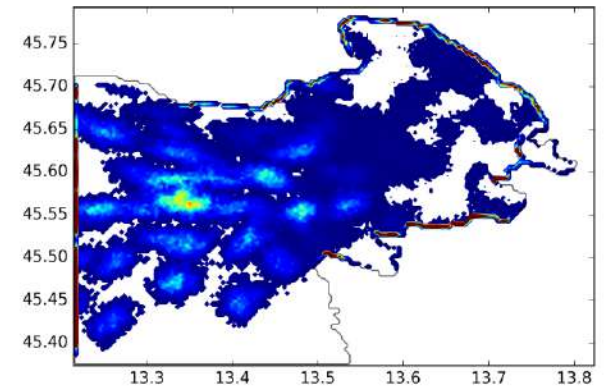
GULF OF TRIESTE

24 H AFTER SPILL

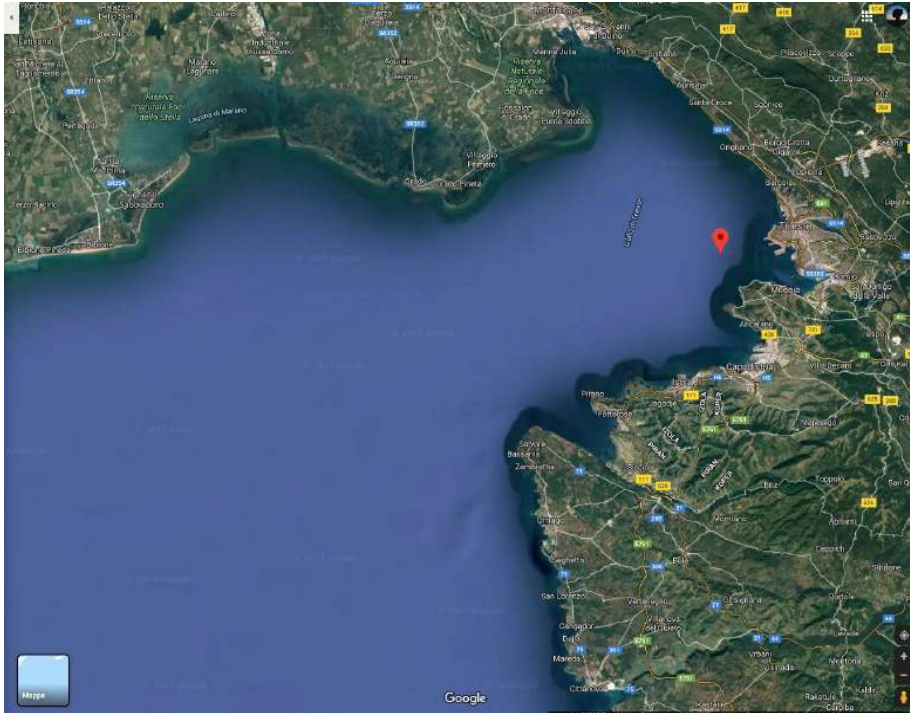
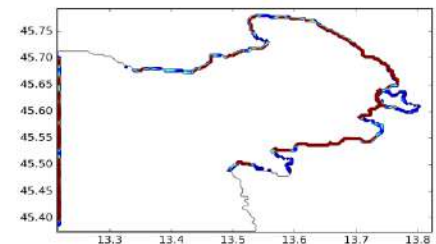
surface



dispersed



slicked



GULF OF TRIESTE



Oil at coast
Movie, for 10 days after



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GULF OF TRIESTE

Oil in the water column
Movie for 10 days after



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GULF OF TRIESTE

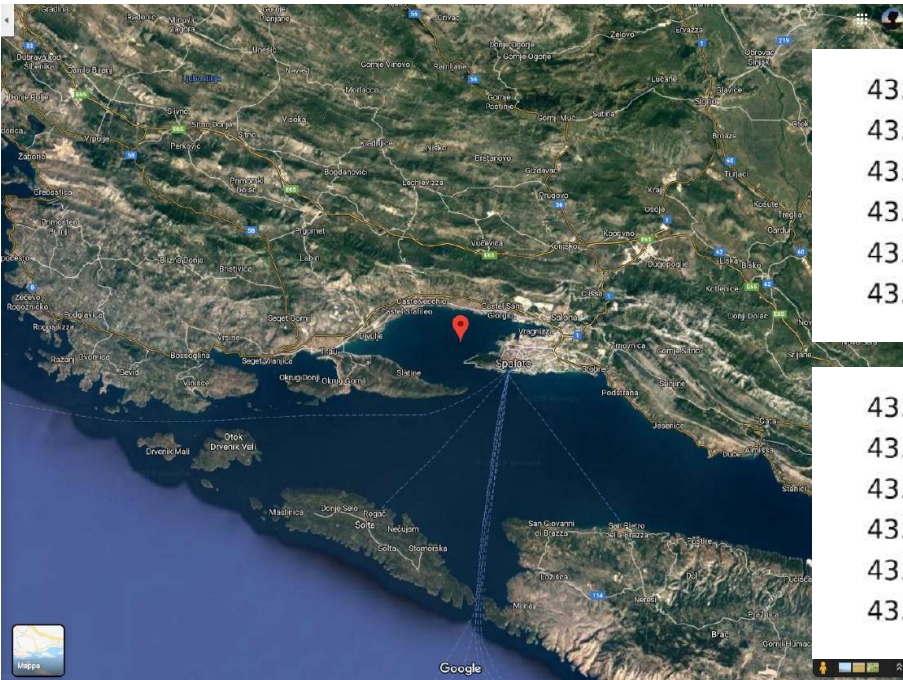


Surface oil
Movie, for 10 days after

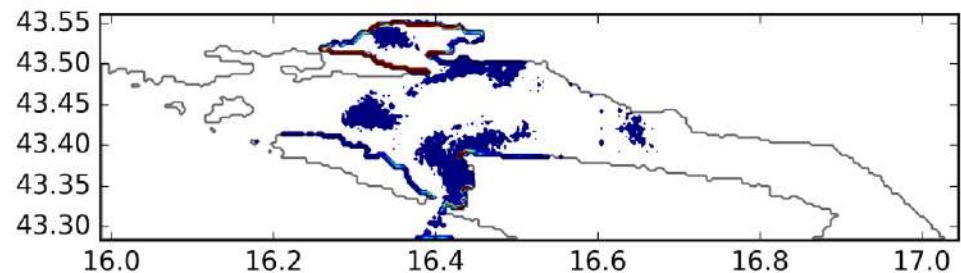
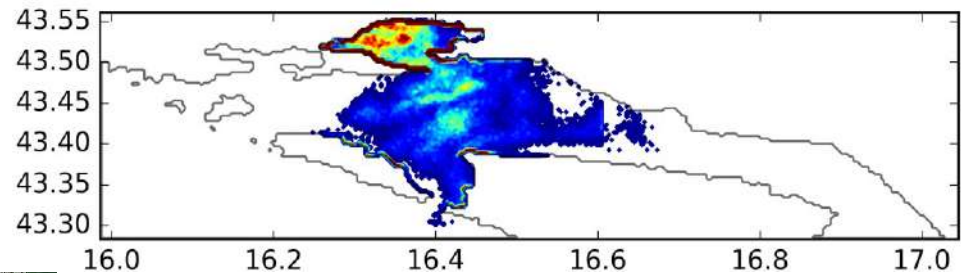


BAY OF SPLIT

24 H AFTER SPILL

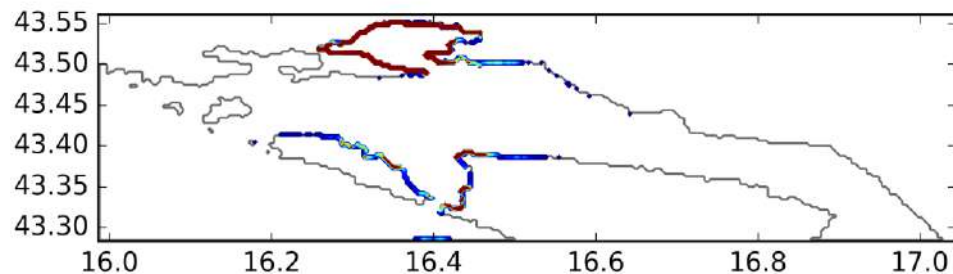


surface



dispersed

slicked



Patras Meeting, 23.10.2019

BAY OF SPLIT



Oil at coast
Movie, for 10 days after



Patras Meeting, 23.10.2019



BAY OF SPLIT



Oil in the water column
Movie, for 10 days after



Patras Meeting, 24.10.2019



BAY OF SPLIT



Surface oil Movie, for 10 days after

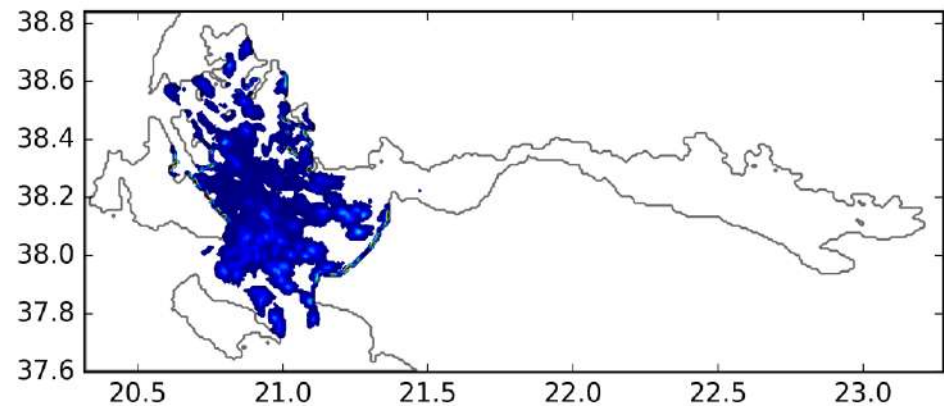
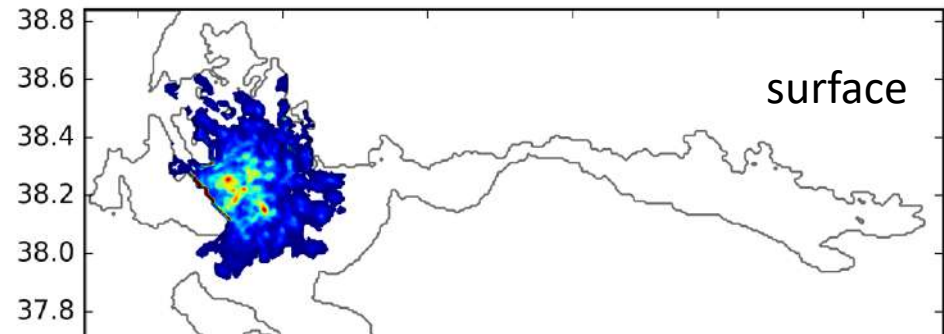
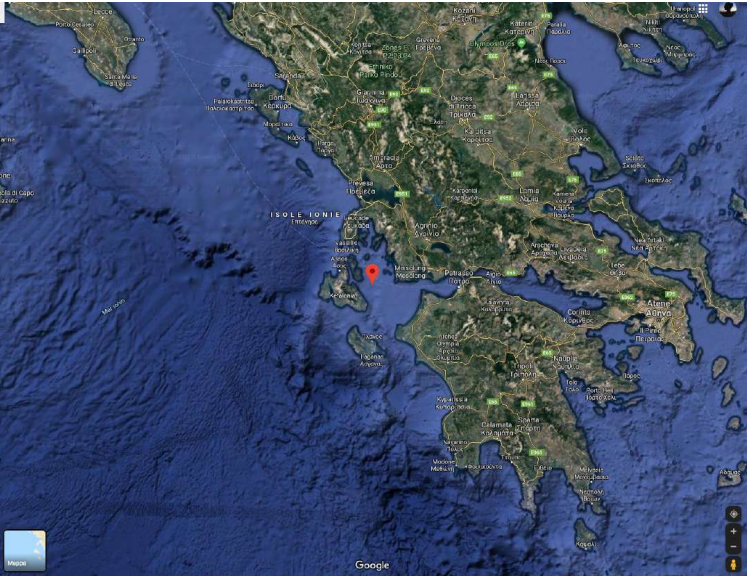


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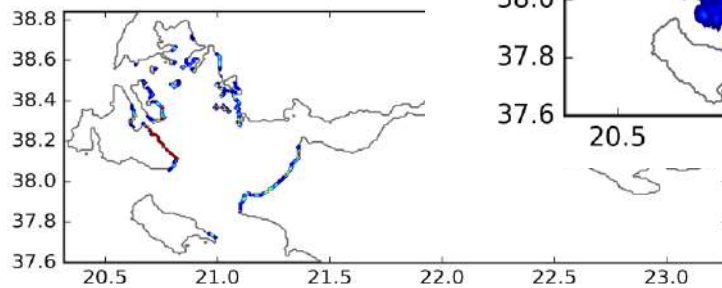


GULF OF PATRAS

24 H AFTER SPILL



slicked

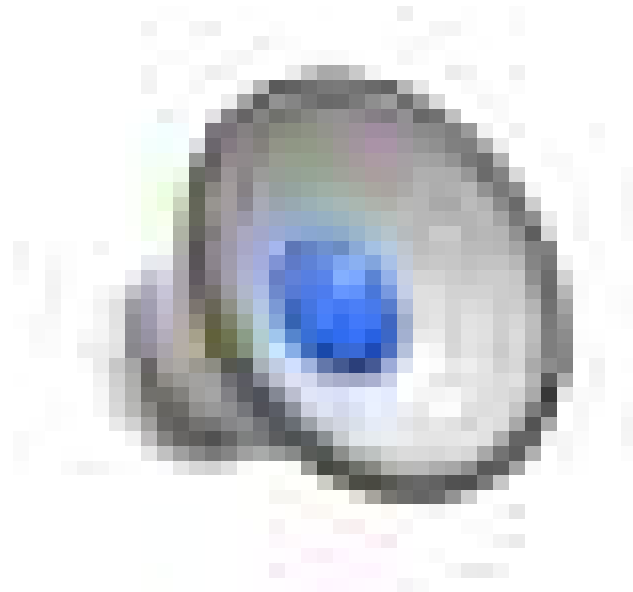


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GULF OF PATRAS



Oil at coast
Movie, for 10 days after



Patras Meeting, 24.10.2019

GULF OF PATRAS



Oil in the water column
Movie, for 10 days after

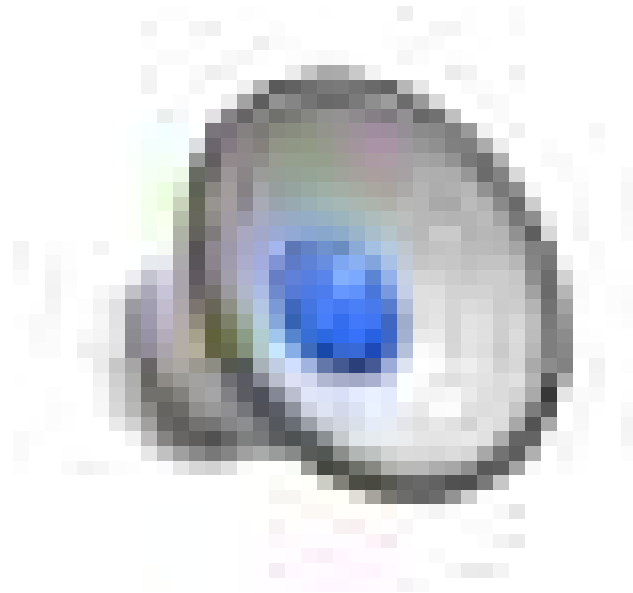


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GULF OF PATRAS



Surface oil
Movie, for 10 days after



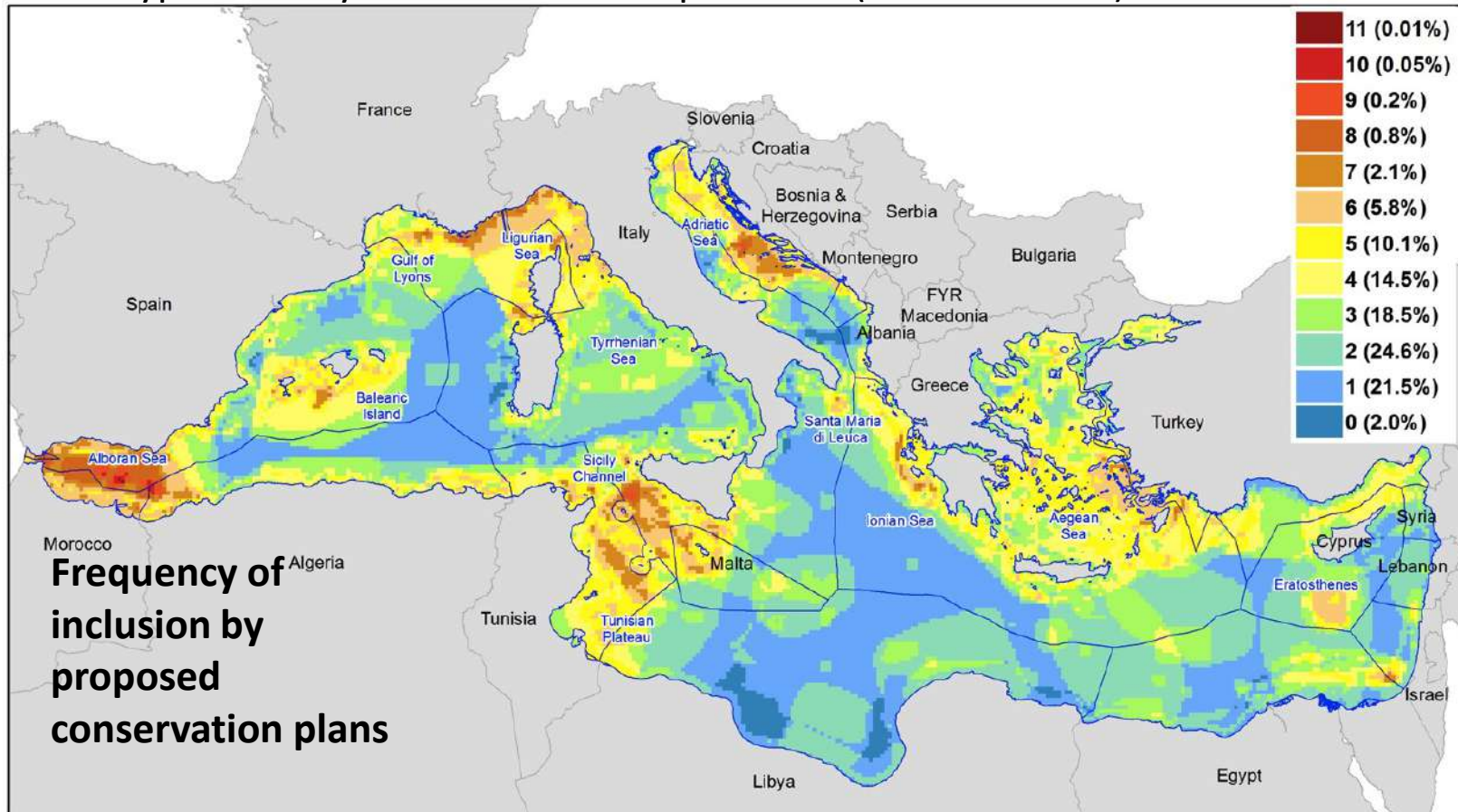
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VULNERABILITY

COASTAL AND MARINE TYPES

How much are the sea and the coast vulnerable?

Whic type of ecosystems we need to preserve?(Prioritization)



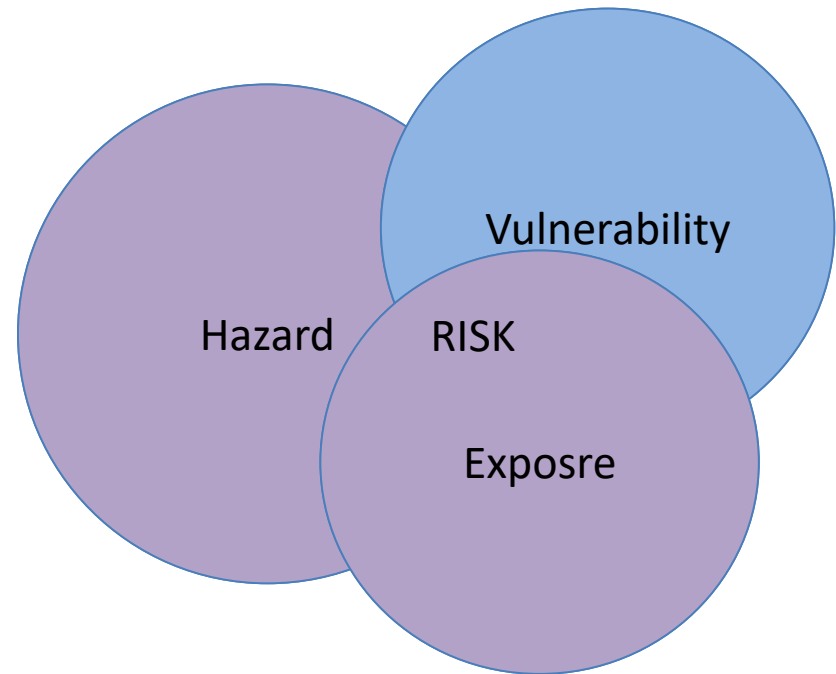
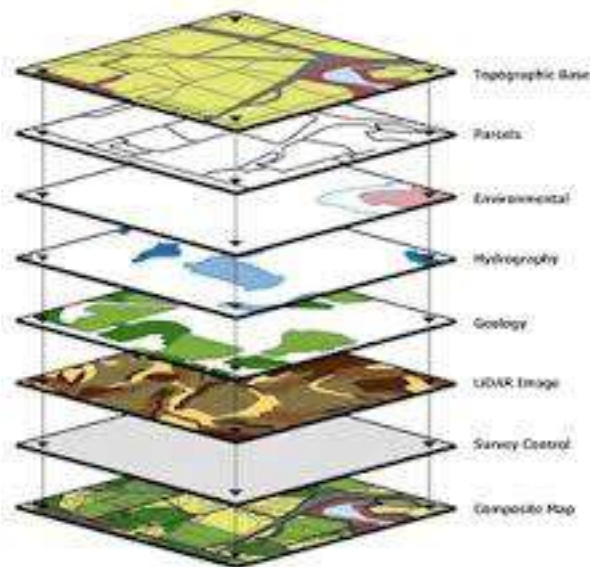
Micheli et al., PLOS ONE. 2013 DOI: 10.1371/journal.pone.0059038

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RISK ASSESSMENT

Combining layer of information

How much are the sea and the coast sites exposed to oil spill contamination?



Micheli et al., PLOS ONE. 2013 DOI: 10.1371/journal.pone.0059038

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Interreg
ADRION **ADRIATIC-IONIAN**
European Regional Development Fund - Instrument for Pre-Accession II Fund



HarmoNIA



Thank you for your attention!

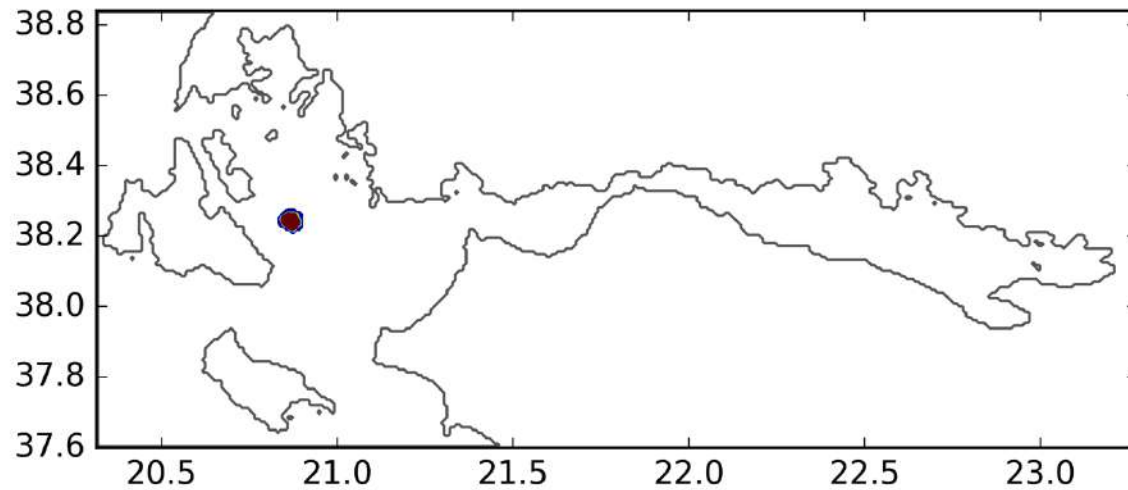


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RISK ASSESSMENT



Combining layer of
information

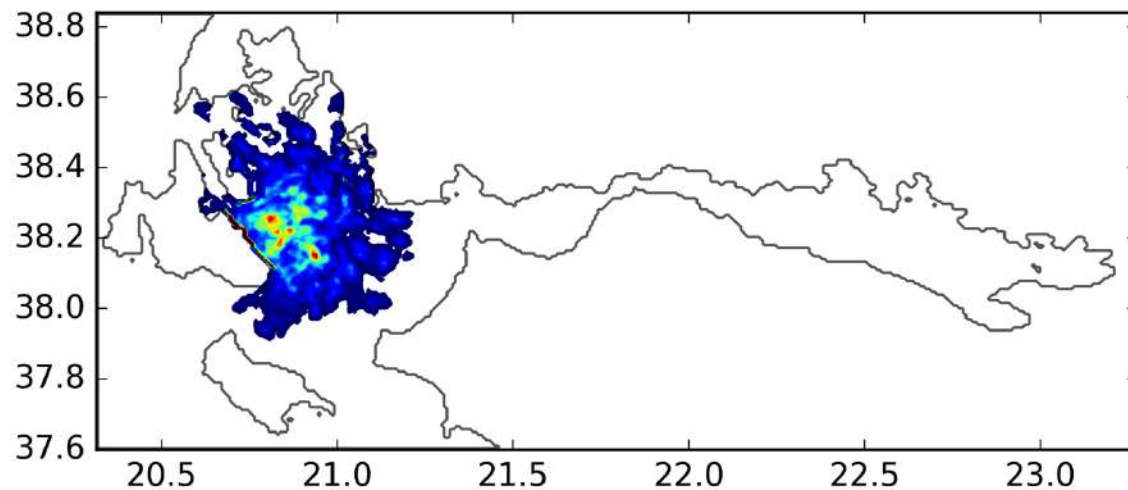


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RISK ASSESSMENT



Combining layer of
information

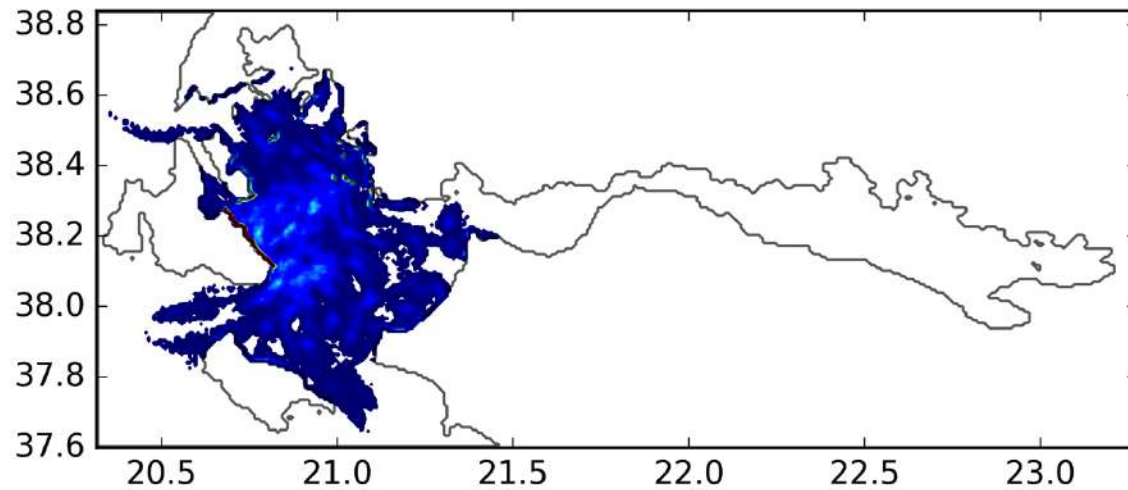


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RISK ASSESSMENT



Combining layer of
information



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