From deep-sea to the beach: a holistic approach to oil and HNS spill risk management

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2 Hidromod

3 Action Modulers

Summary

1. Context; emerging challenges at different scales in the context of spill prevention and response
2. Proposed modelling solution using MOHID
3. Supporting risk managers and decision-makers with an holistic approach; decision support tools using MOHID spill model
4. Final Remarks

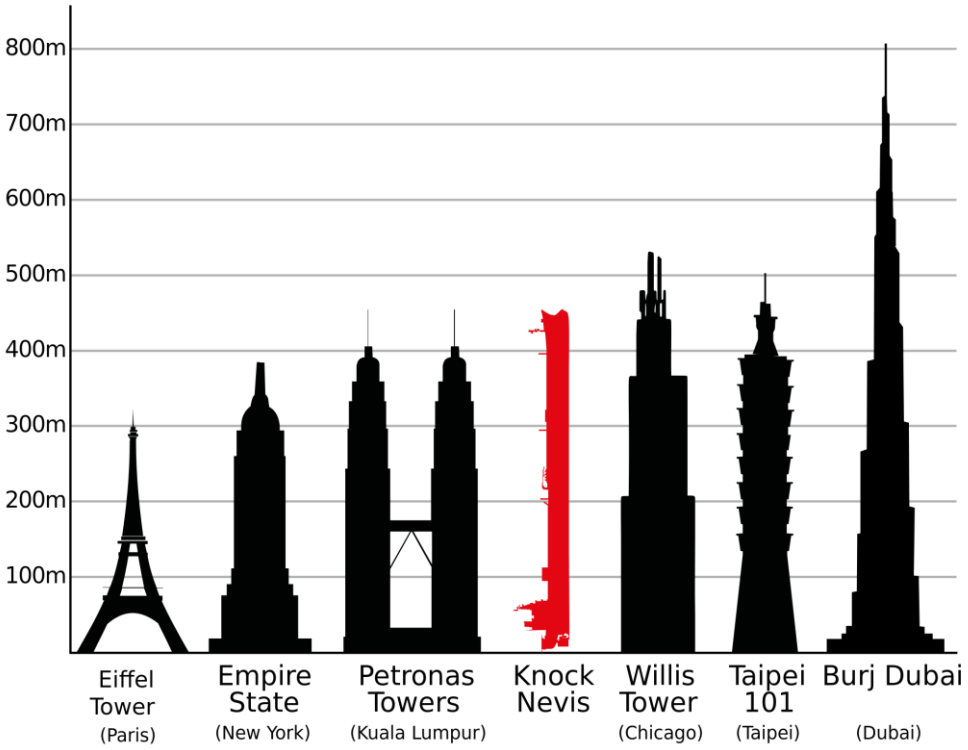
1. Context;
Emerging challenges at different scales in the context of spill prevention and response

Deepwater offshore drilling

Olympus oil rig (Shell,
Gulf of Mexico)

The supertanker era

TI Europe vessel

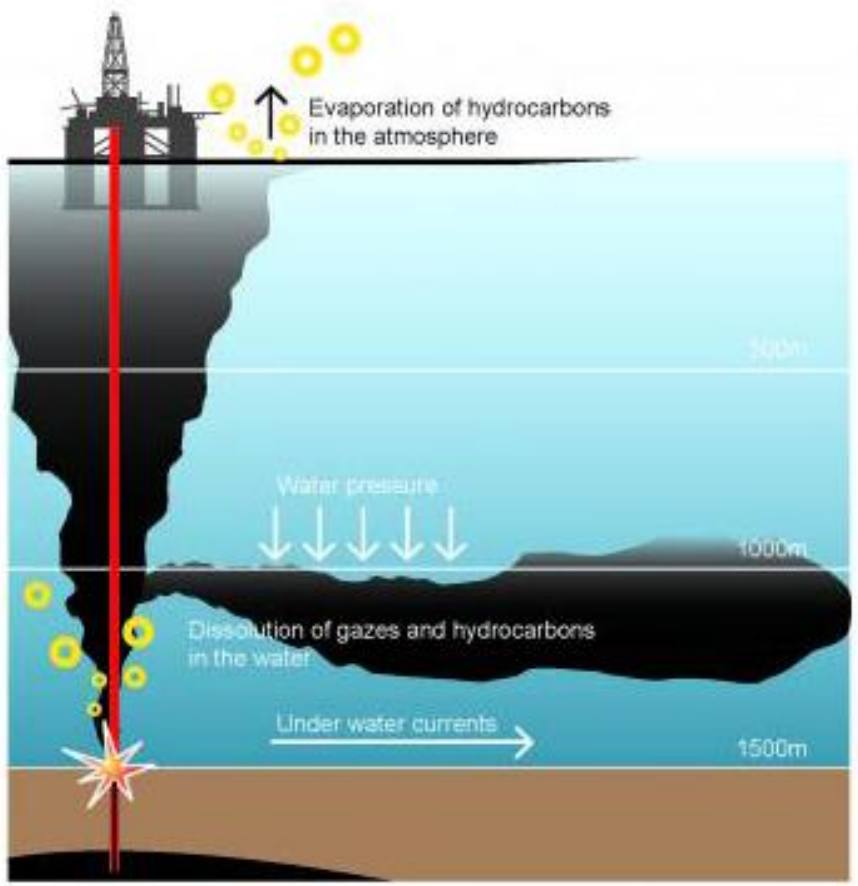


> 2000 Chemicals transported by the sea

'FU SHAN HAI' sinking with a cargo of potash in the Western Baltic Sea, 2003

MSC Flaminia, Atlantic Ocean, 2012

Examples of consequences from oil spills



Deepwater Horizon Spill, Gulf of Mexico, 2010)

2. Proposed modelling solution using MOHID

The modelling solution should be integrated

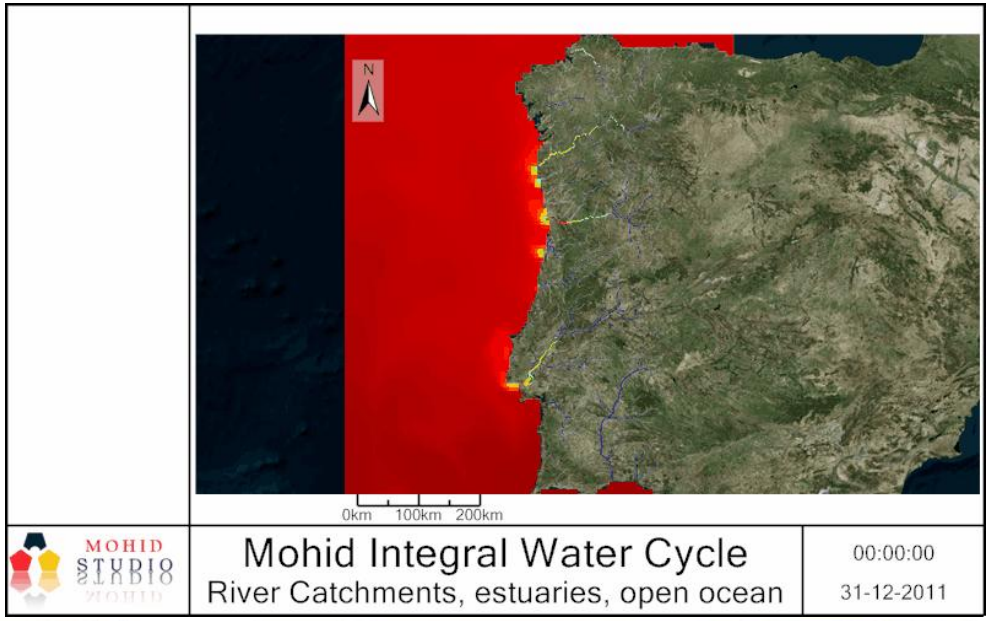
-Using several different modelling tools adapted to each kind of scale, system or spill pollution type potentially reduces response effectiveness

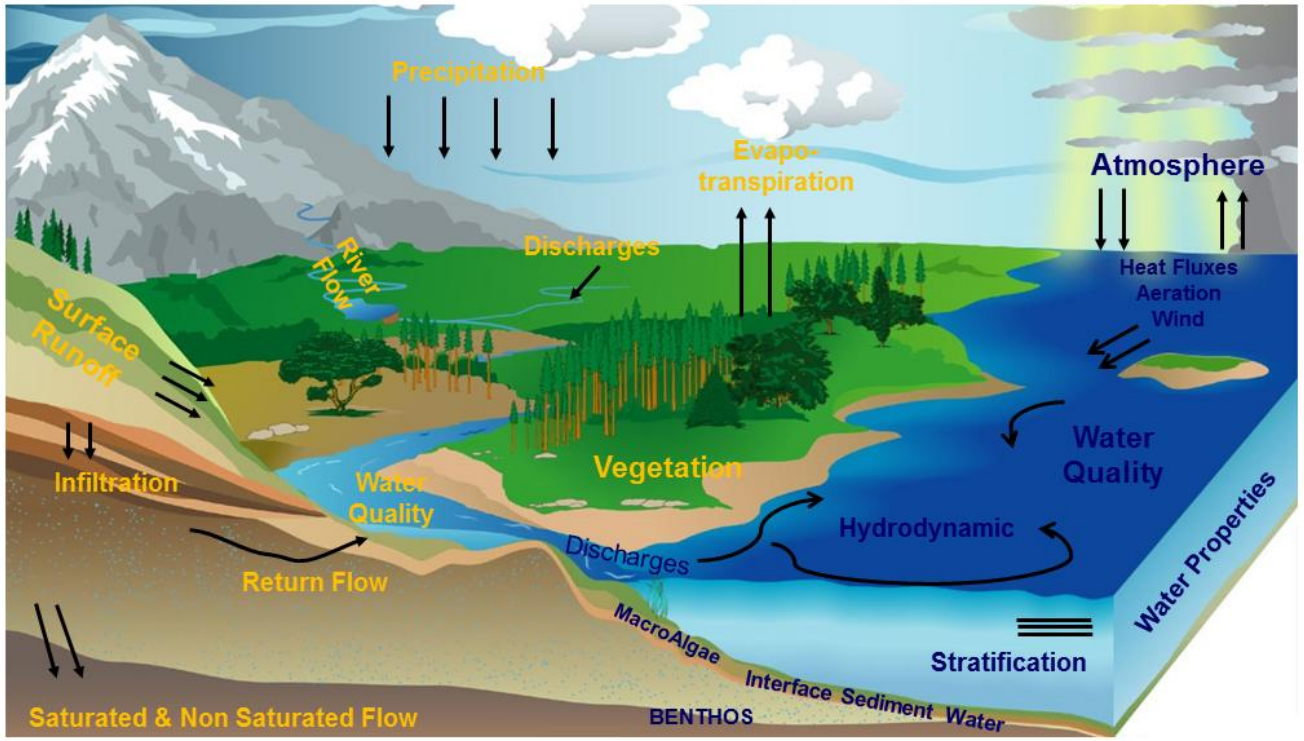
- An integrated approach is more adapted to the needs and technological possibilities nowadays.

MOHID

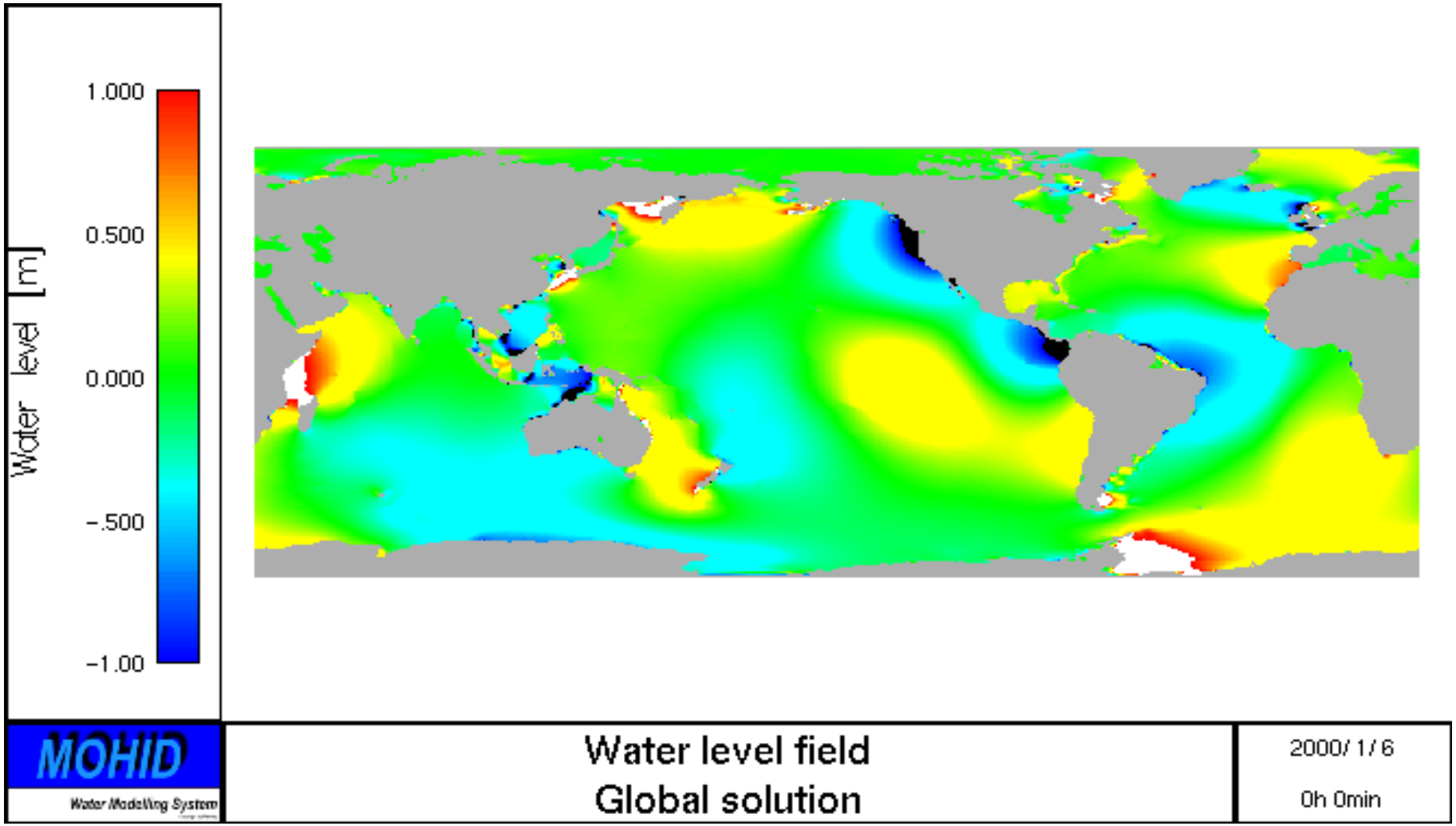
MOHID
Water Modelling System
Copyright by Maretec

- open-source community model
- Both research and engineering purposes
- Windows, linux
- Laptop, desktop, clusters…
- OpenMP, MPI
- Applied by scientific and engineering community all over the world

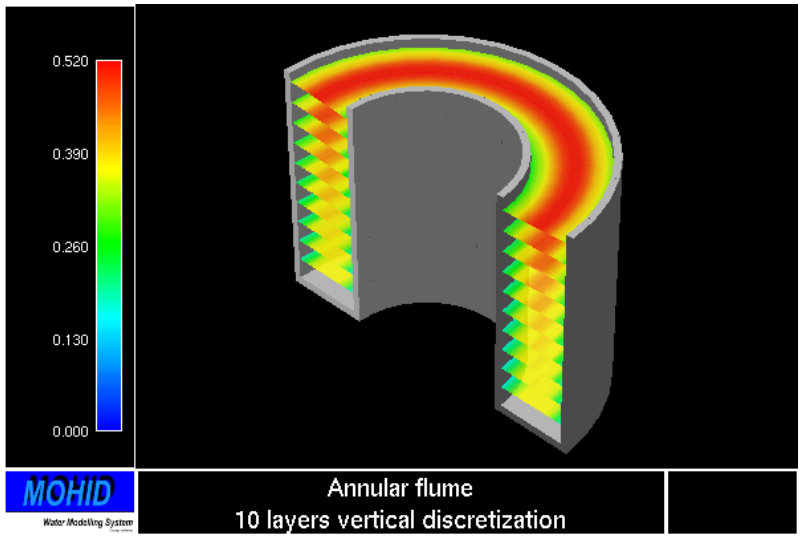


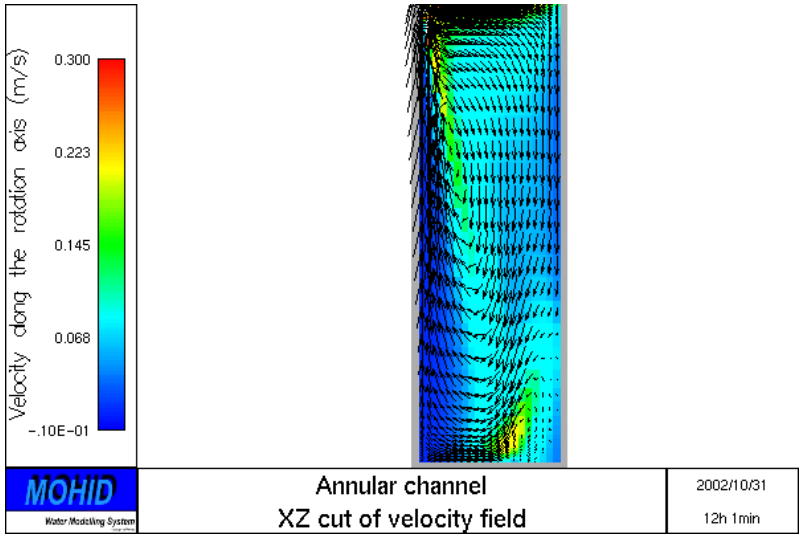


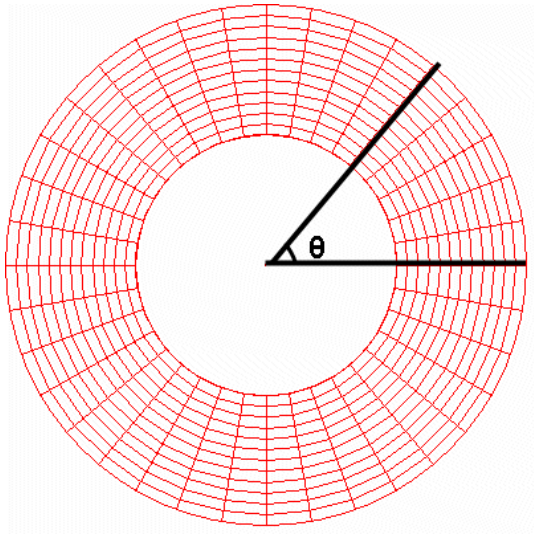
From Global…


1.000
0.500
0.000
-.500
-1.00
Water level [m]
MOHID
Water Modelling System
Water level field
Global solution
2000/ 1/ 6
0h 0min

...to smallest


0.520
0.390
0.260
0.130
0.000
MOHID
Water Modelling System
Annular flume
10 layers vertical discretization


Velocity along the rotation axis (m/s)
0.300
0.223
0.145
0.068
-.10E-01
MOHID
Water Modelling System
Annular channel
XZ cut of velocity field
2002/10/31
12h 1min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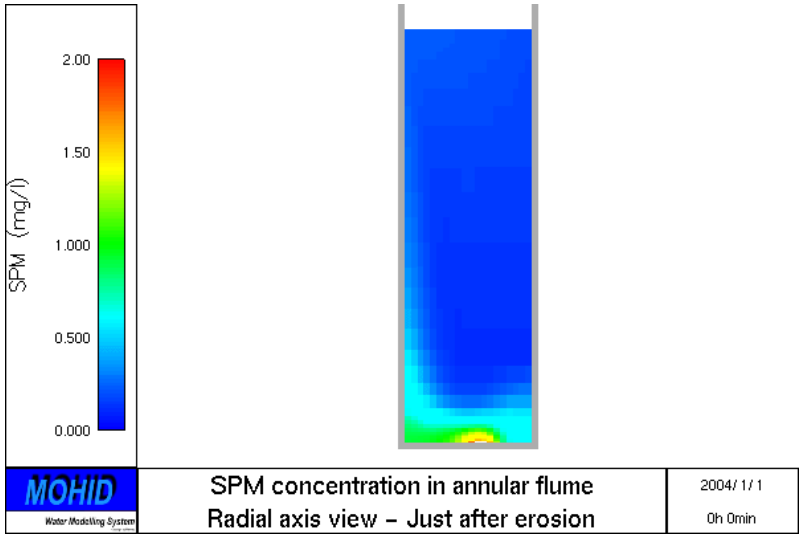
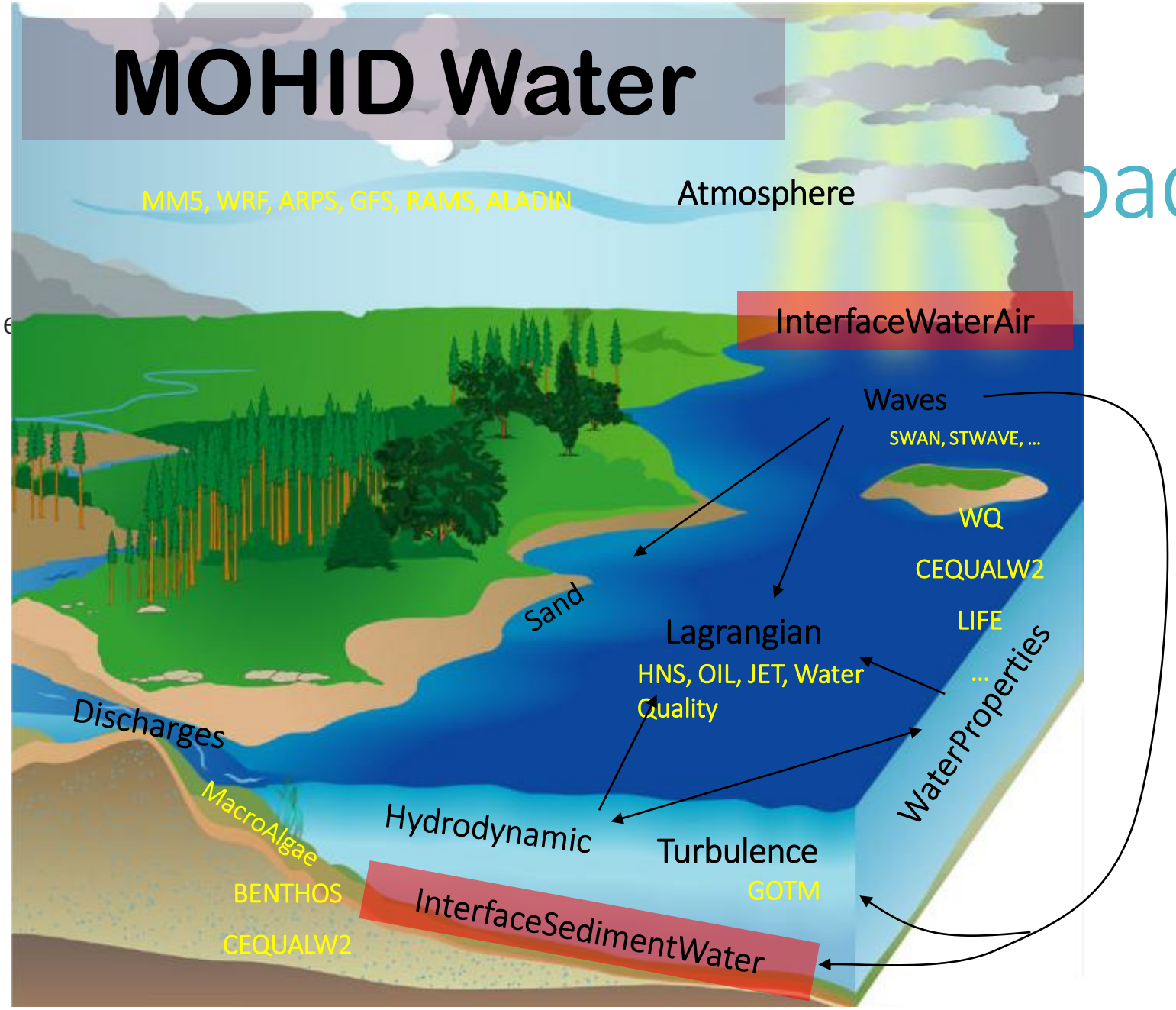
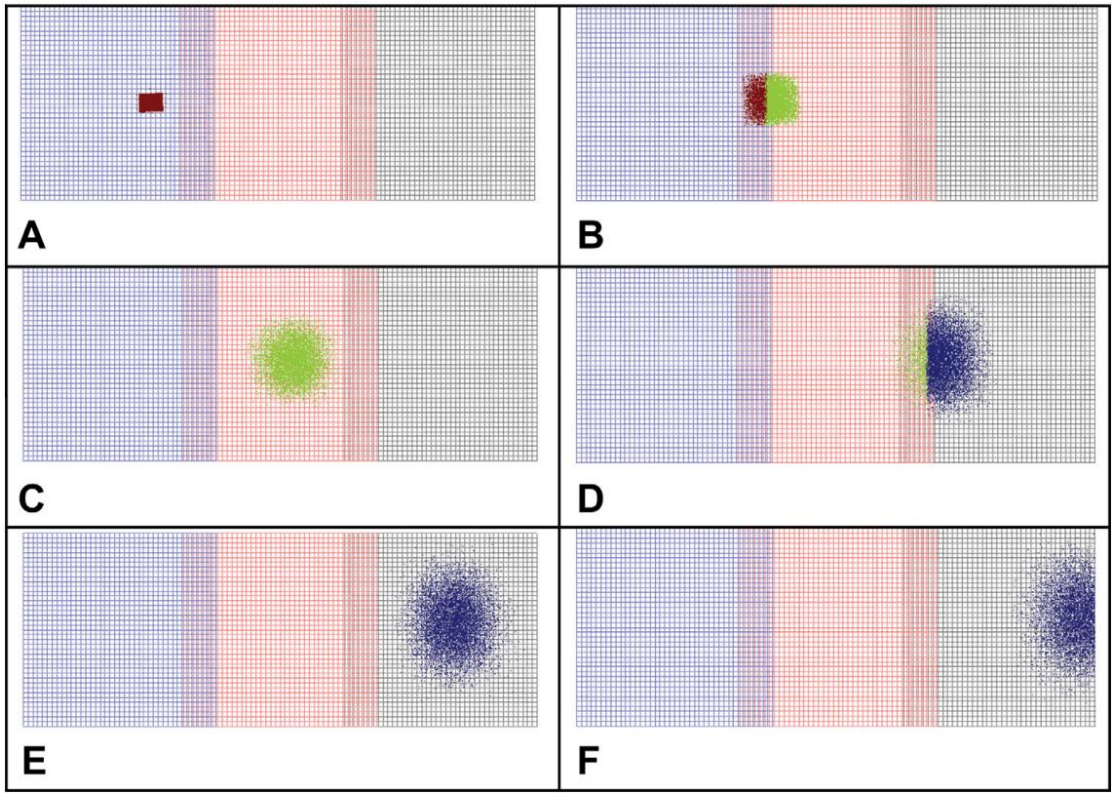

SPM (mg/l)
2.00
1.50
1.000
0.500
0.000
MOHID
Water Modelling System
SPM concentration in annular flume
Radial axis view – Just after erosion
2004/ 1/ 1
0h 0min

Oil and pach

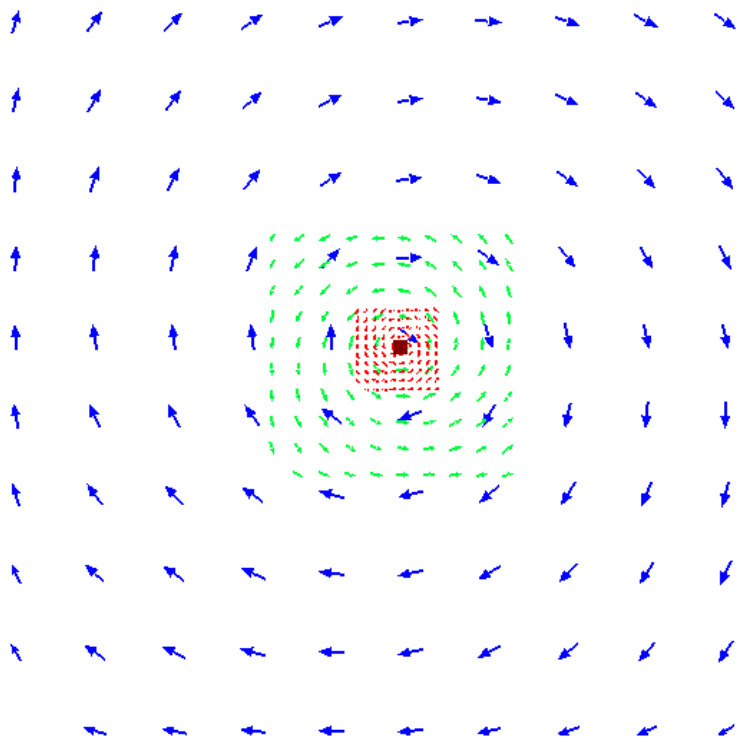
MOHID Water mode



Multi-mesh solution: One simulation; multiple metocean data sources



A cloud of particles being advected across three horizontally aligned grids. (source: Janeiro et al., 2014)



Schematic application in stationary currents field

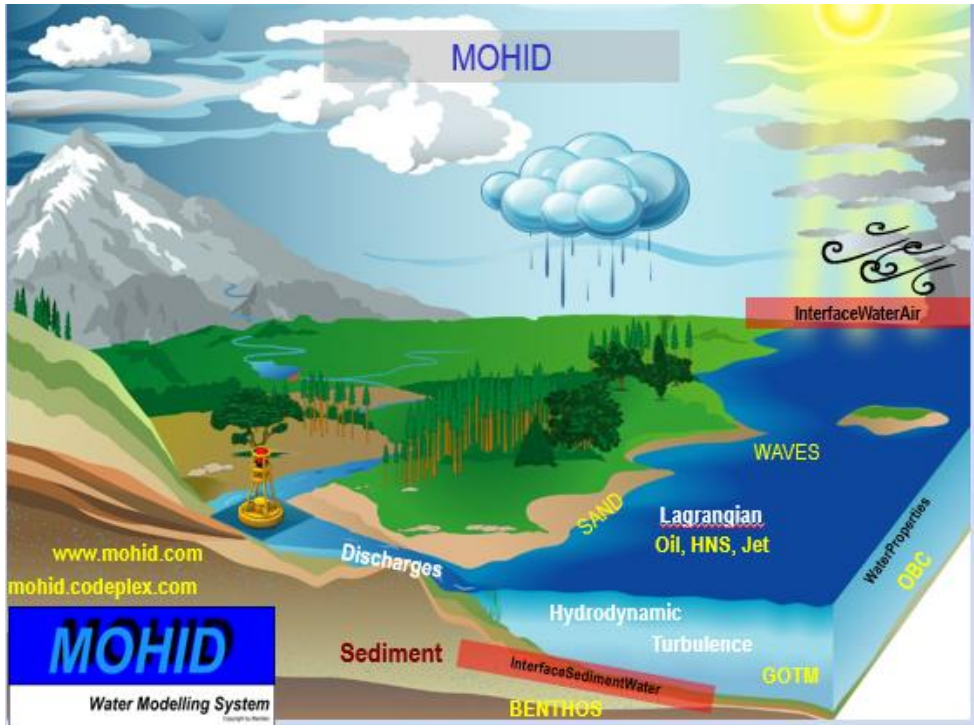
MOHID Oil Spill model

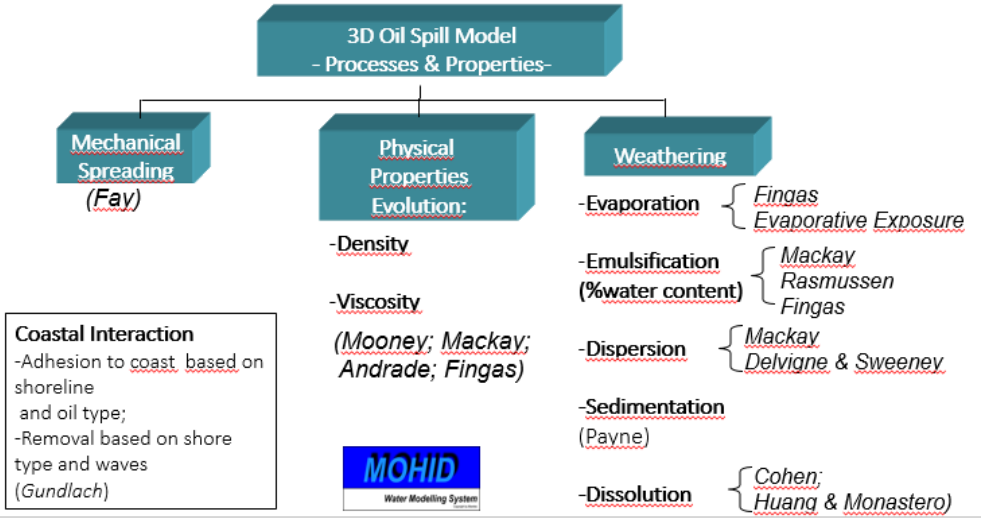
Source code development

EU Projects (ECOOP, EROCIPS, ARCOPOL, ARCOPOL+, ARCOPOLplatform, EASY, EASYCO, DRIFTER, ISDAMP)

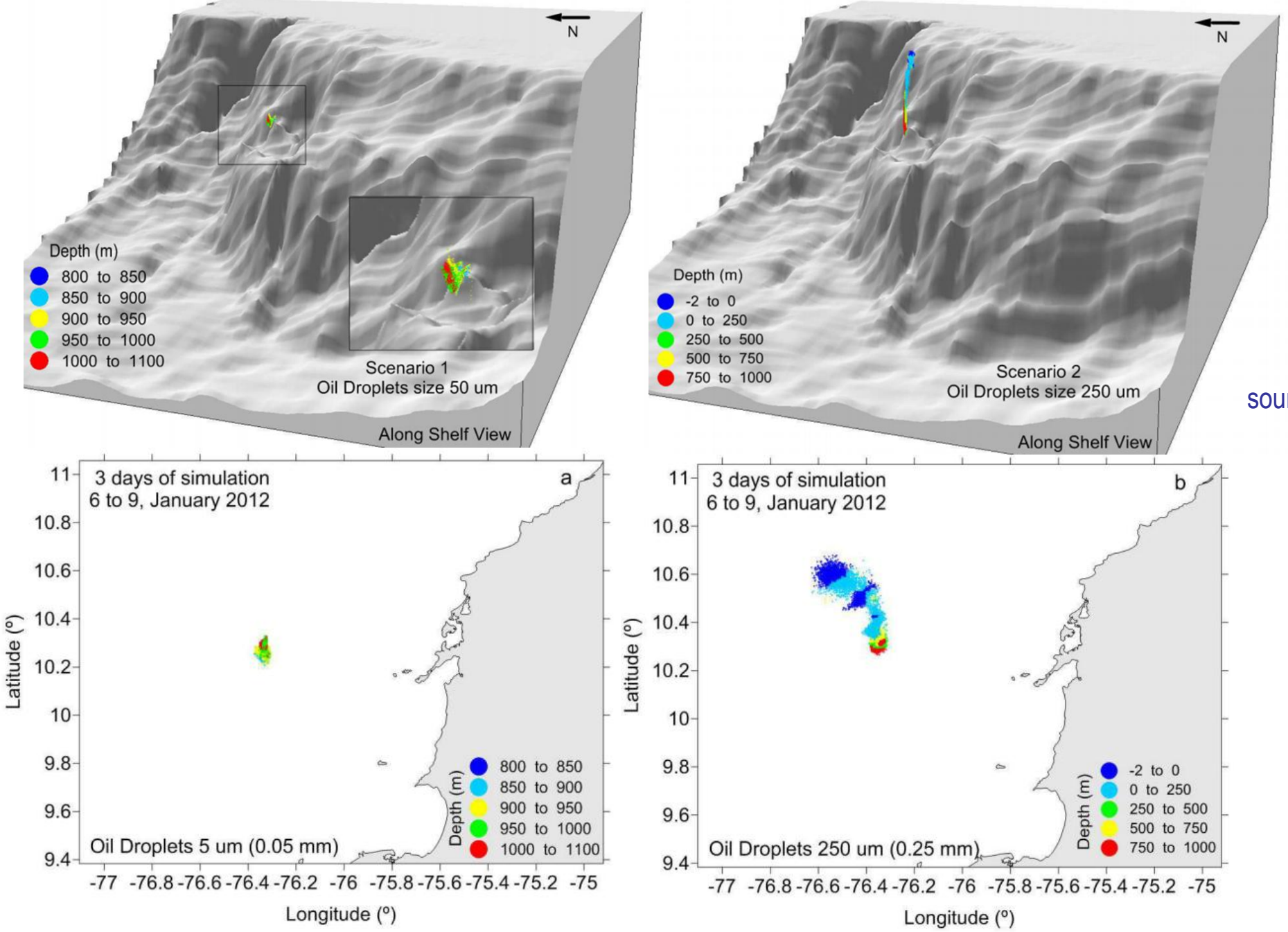
Cooperation with national and local portuguese maritime authorities (exercises, beta testing, and model calibration)

Operational support to real accidents (e.g. Prestige)





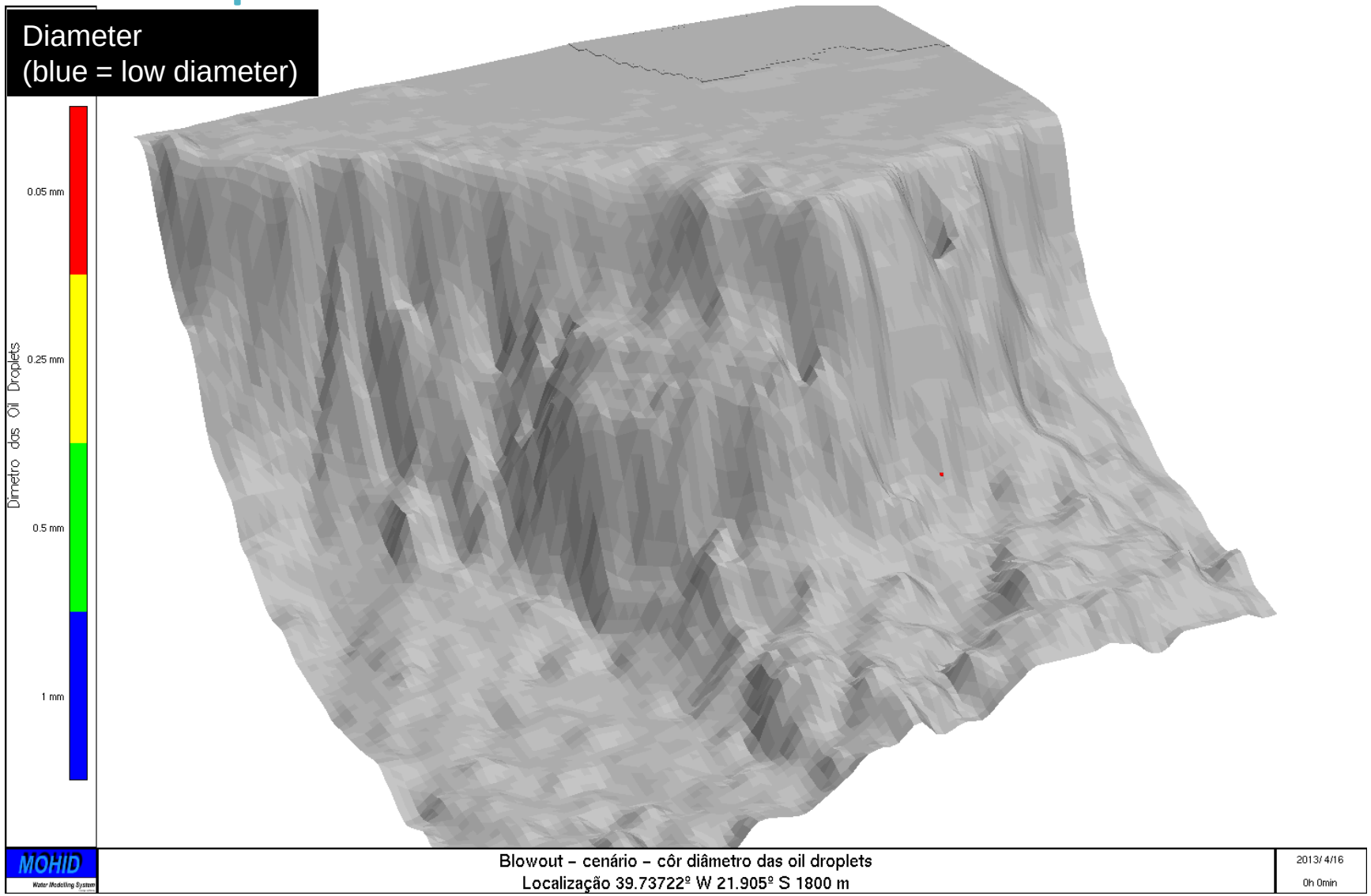
MOHID deep-water oil spills



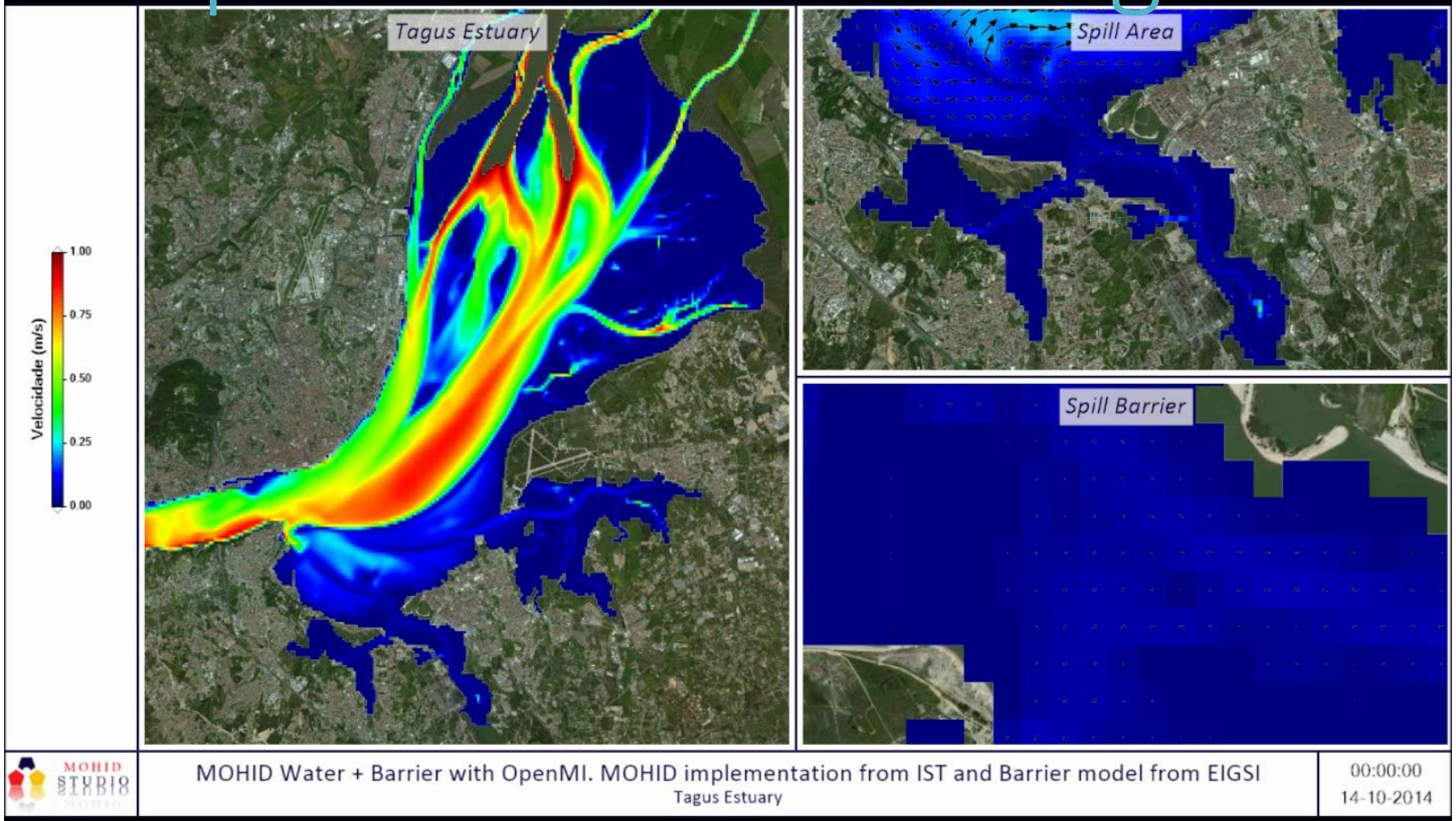
source: Leitão et al., 2013

Blowout simulations in Caribbean Coast (Colombia): Particle depths with different oil droplet diameters. 3D (above) and XY (below) views

Oil Spill Modelling in MOHID
- 3D processes -



Oil spill + Boom modelling



MOHID HNS spill modelling approach

- 3D Lagrangian particle method

- Independent particle phase changes and transport
  - Based on mass balances from different processes (ModuleHNS)

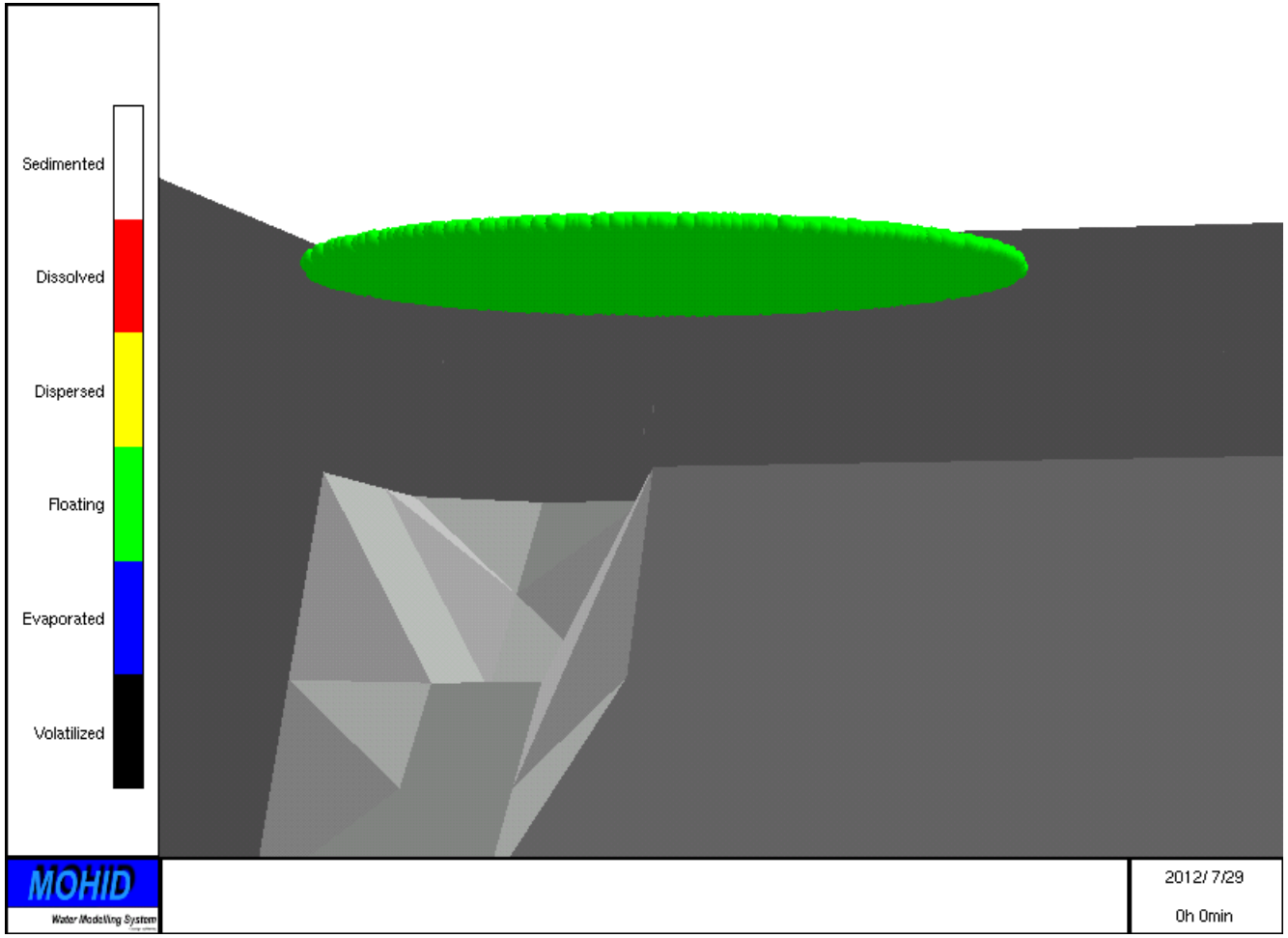
- One chemical per simulation (no chemical mixtures)

- Chemical reactions (with water, oxygen, acids/bases, etc.) not addressed in the model

Phases considered

- Air
  - Evaporated (surface)
  - Volatilized (water column)
- Floating at surface
- Entrained / suspended droplets
- Adsorbed to suspended matter (sedimented)
- Dissolved
- Sunk

- Mass lost -> environmental degradation



Processes considered

- Phase changes
  - Vertical Entrainment (at surface) *
  - Volatilization
    - From surface (evaporation)
    - From water column
  - Dissolution (of entrained / suspended chemical)
  - Adsorption to Sediments
  - Resuspension (of sunk chemical)

- Movement
  - Currents*
  - Spreading
  - Turbulence*
  - Stokes Drift *
  - Buoyancy *
  - Sinking (adsorbed to SPM)

- Degradation
  - From air
  - From water column
  - From sediments

* Same as used in MOHID oil spill model

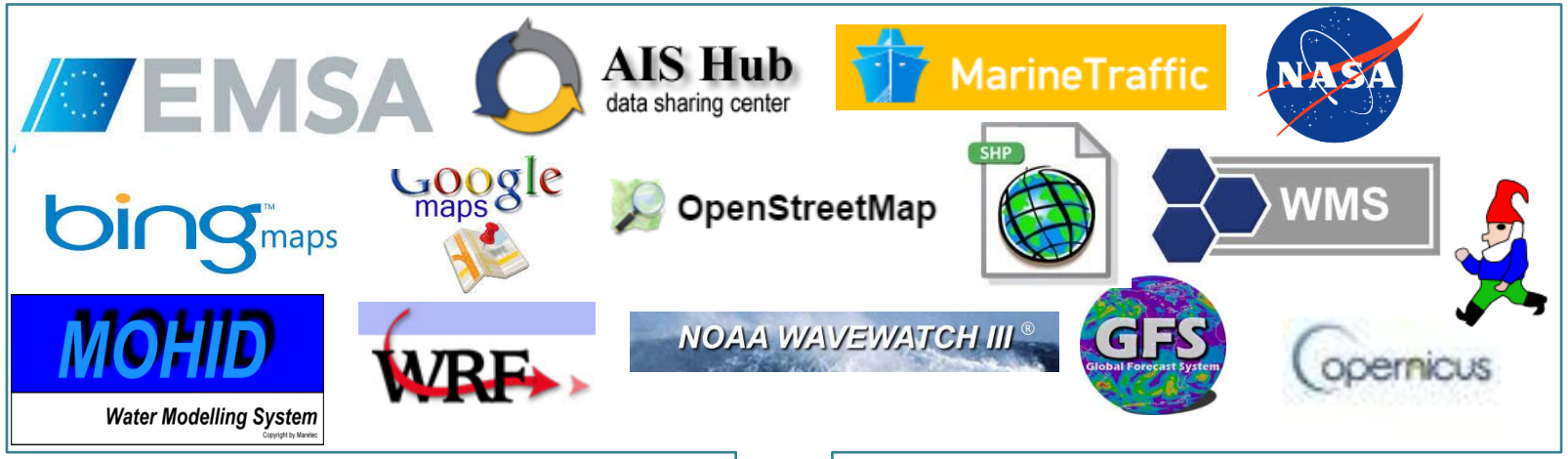
3. Supporting risk managers and decision-makers with an holistic approach; Decision support tools using MOHID spill model

Development strategy

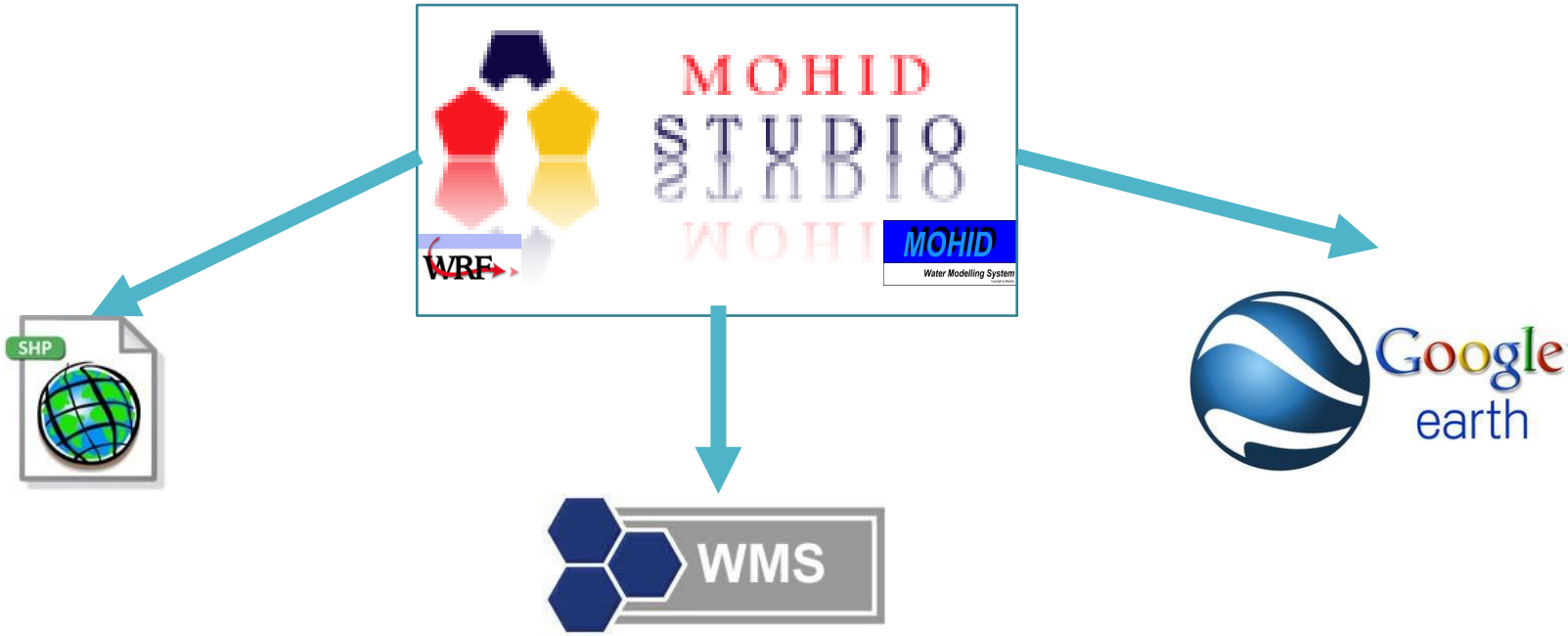
<u>“All in one and one for all”</u>

- Same platform for risk assessment tool, real-time and historic vessel traffic, spill modelling capability, metocean model results, detected satellite images (EMSA’s CSN), NOAA’s online oil products database
- Export risk assessment to multiple platforms: Shapefile, OGC’s WMS, website

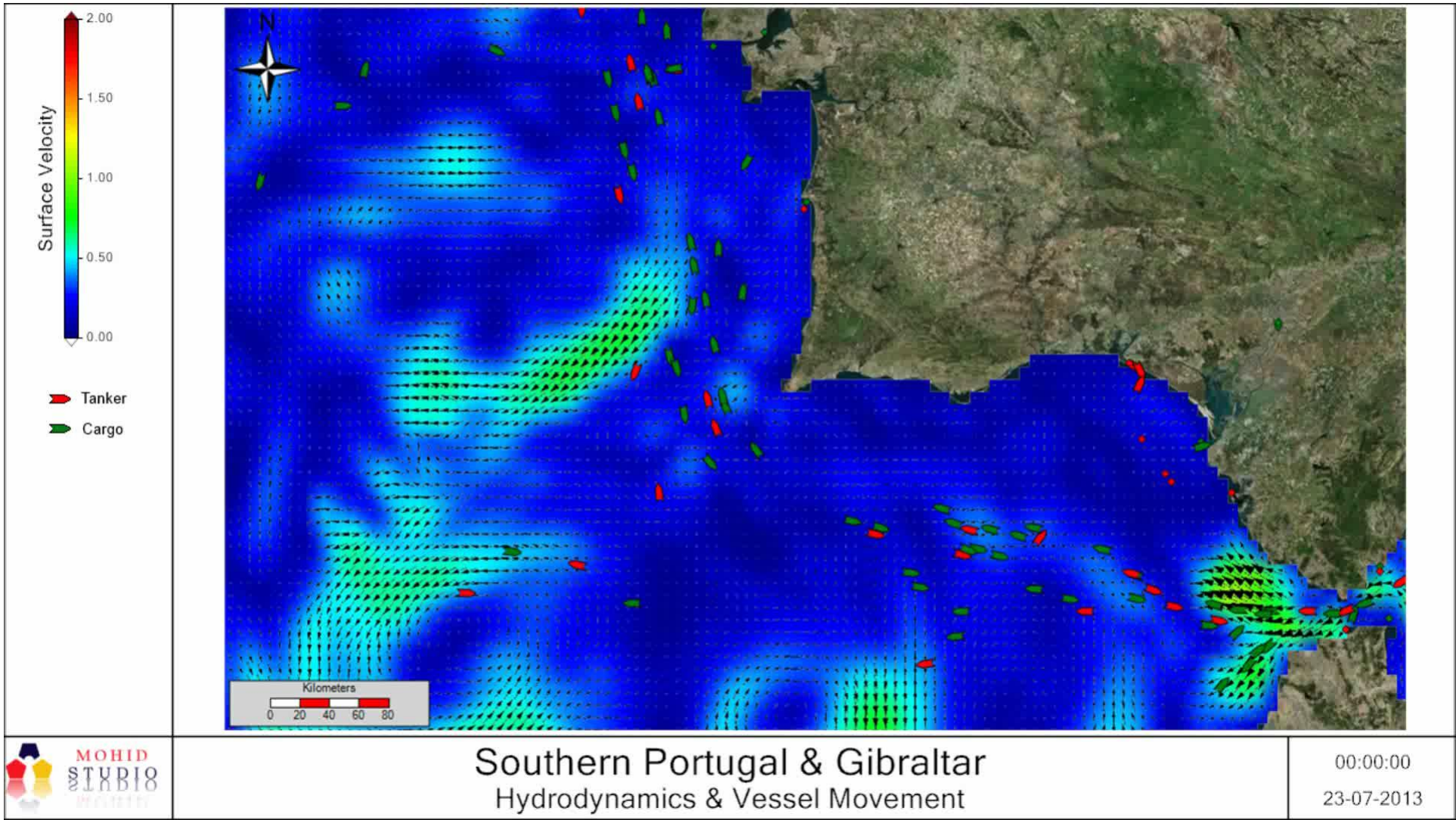
Strategy: All in one and one for all



Strategy: All in one and one for all



Vessels + metocean modelling data



Dynamic Risk Tool

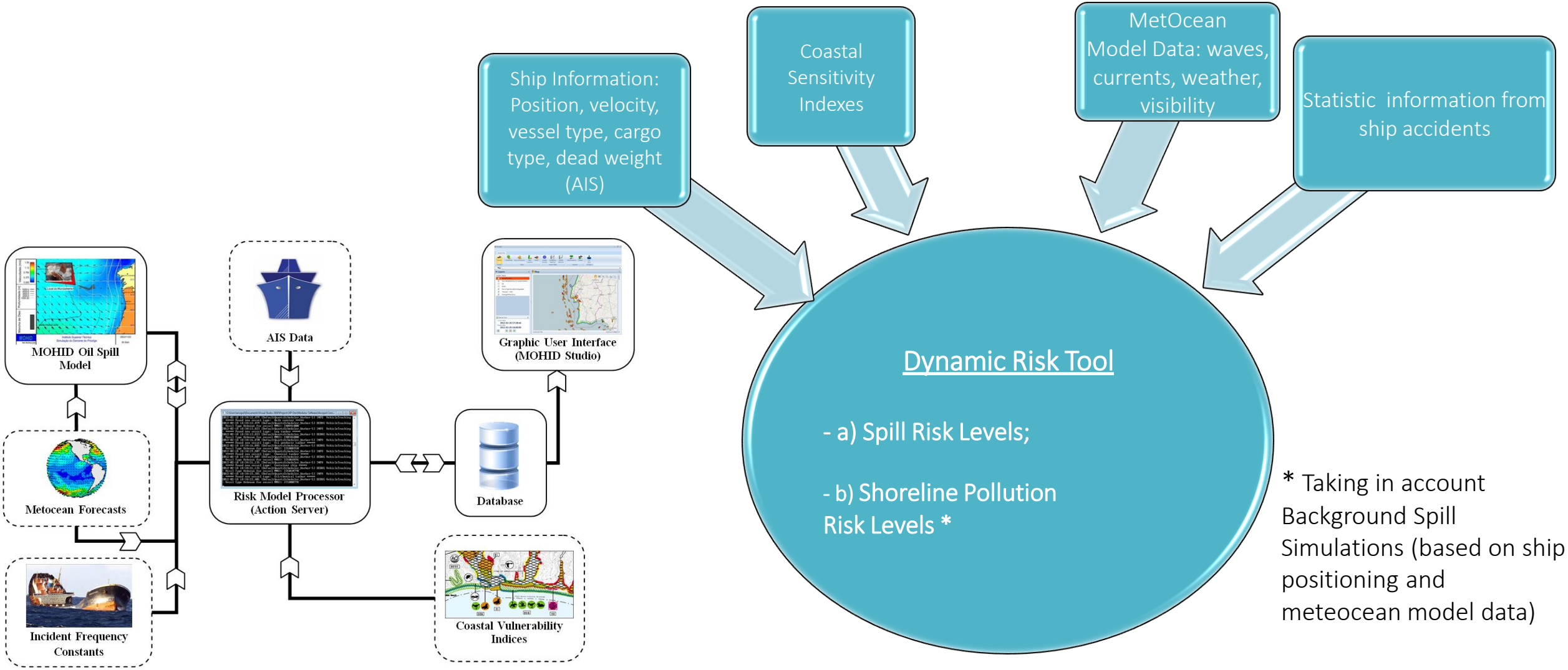
"What is the environmental impact of a potential accident occurring with *that* ship, at *that* location under *those* weather conditions?"

- Dynamic Risk Approach

Static vs. Dynamic Risk

- Static = working with scenarios (good for planning stages)
- Dynamic = using best available forecasts or measured metocean data

Dynamic Risk Tool



Dynamic Risk Tool

MOHID STUDIO

Portuguese Coast

Risk from ships

European Union
European Regional Development Fund

ATLANTIC AREA
Transnational Programme

00:00:00

16-10-2014

Coastal Impact: ship distance from coast

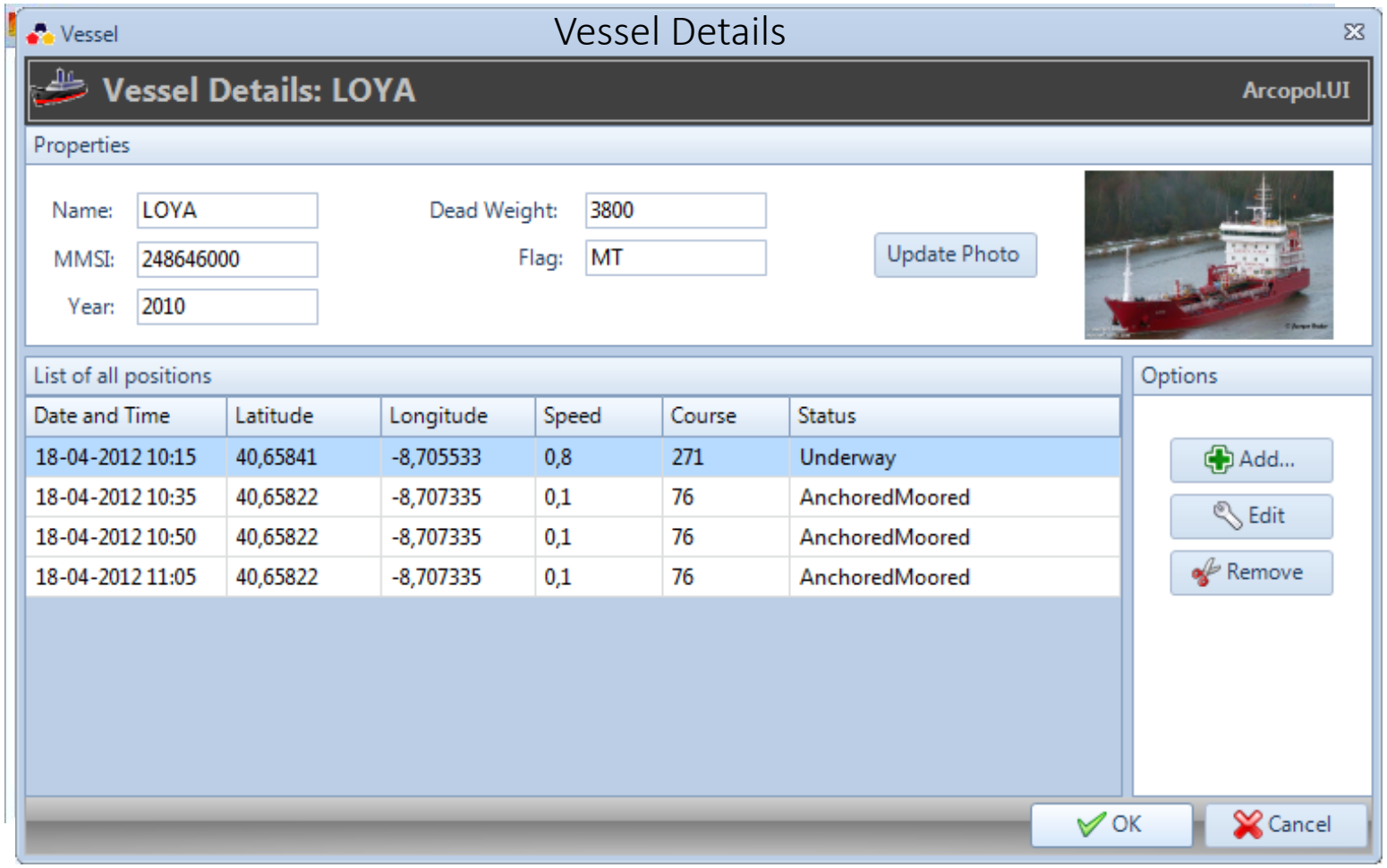
0km 50km 100km

Coastal Impact: based in virtual oil spills from ships (with MOHID)

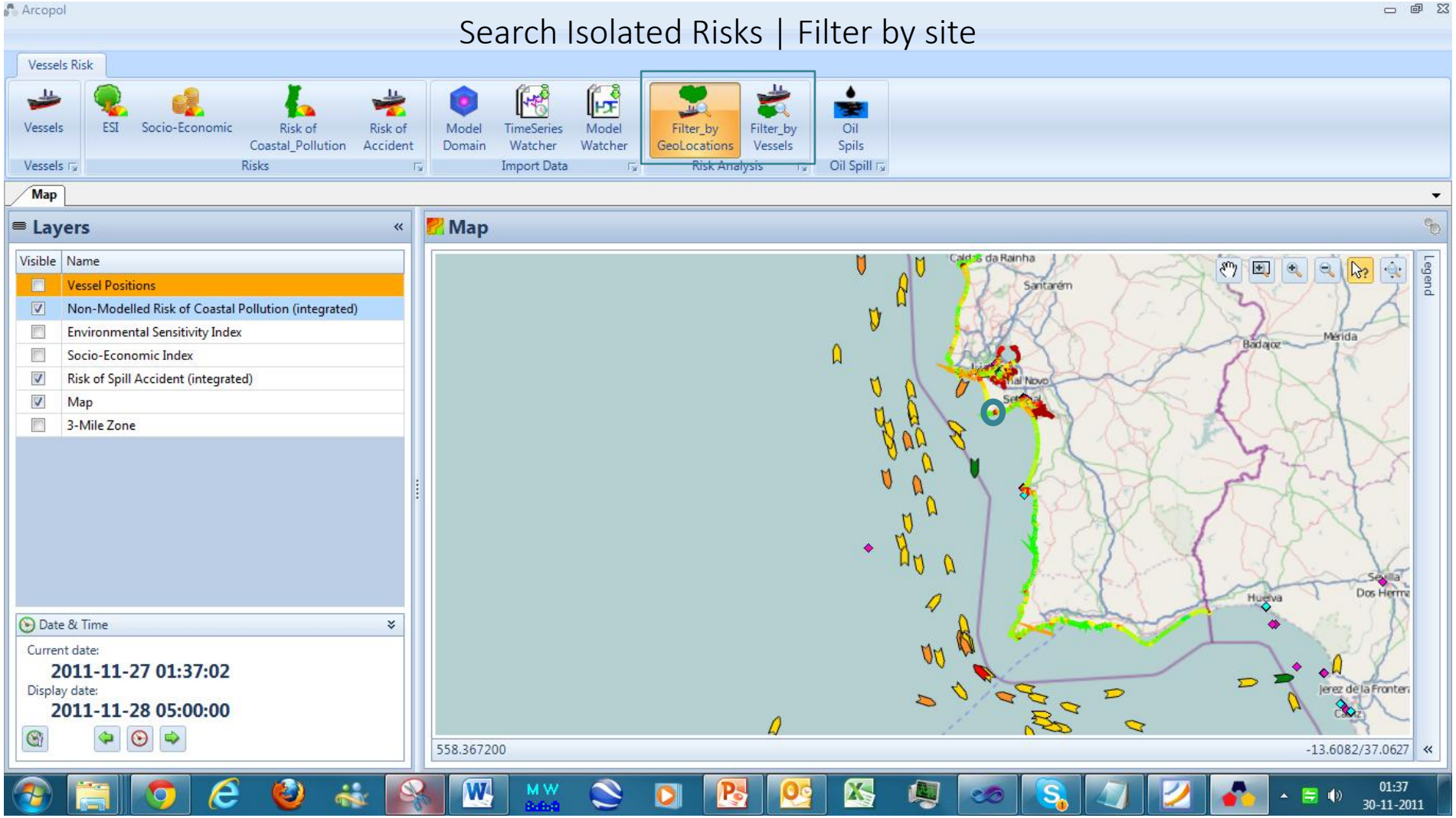
Portuguese
Risk from

Portuguese Coast
Risk from ships

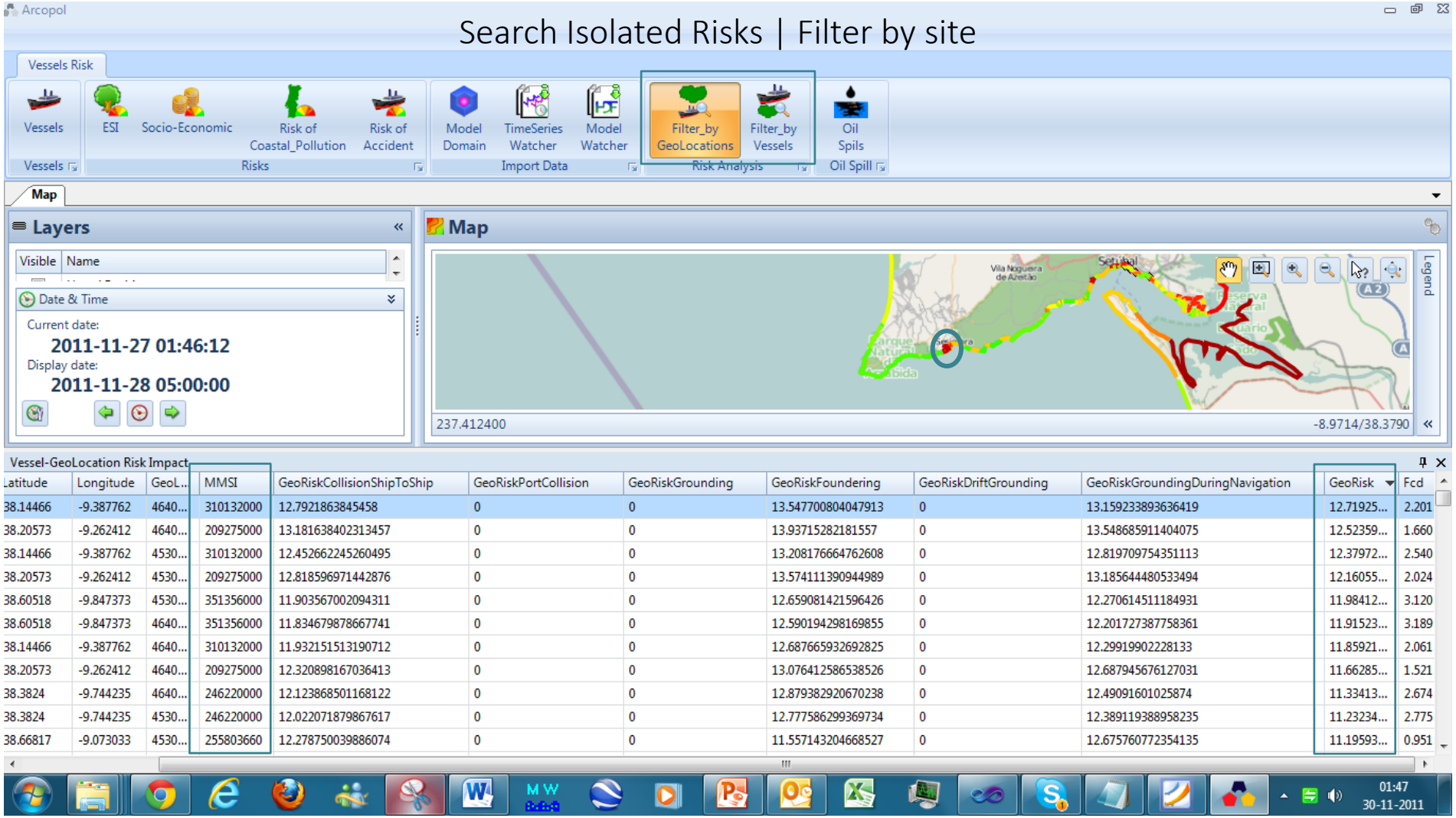
Dynamic Risk Tool



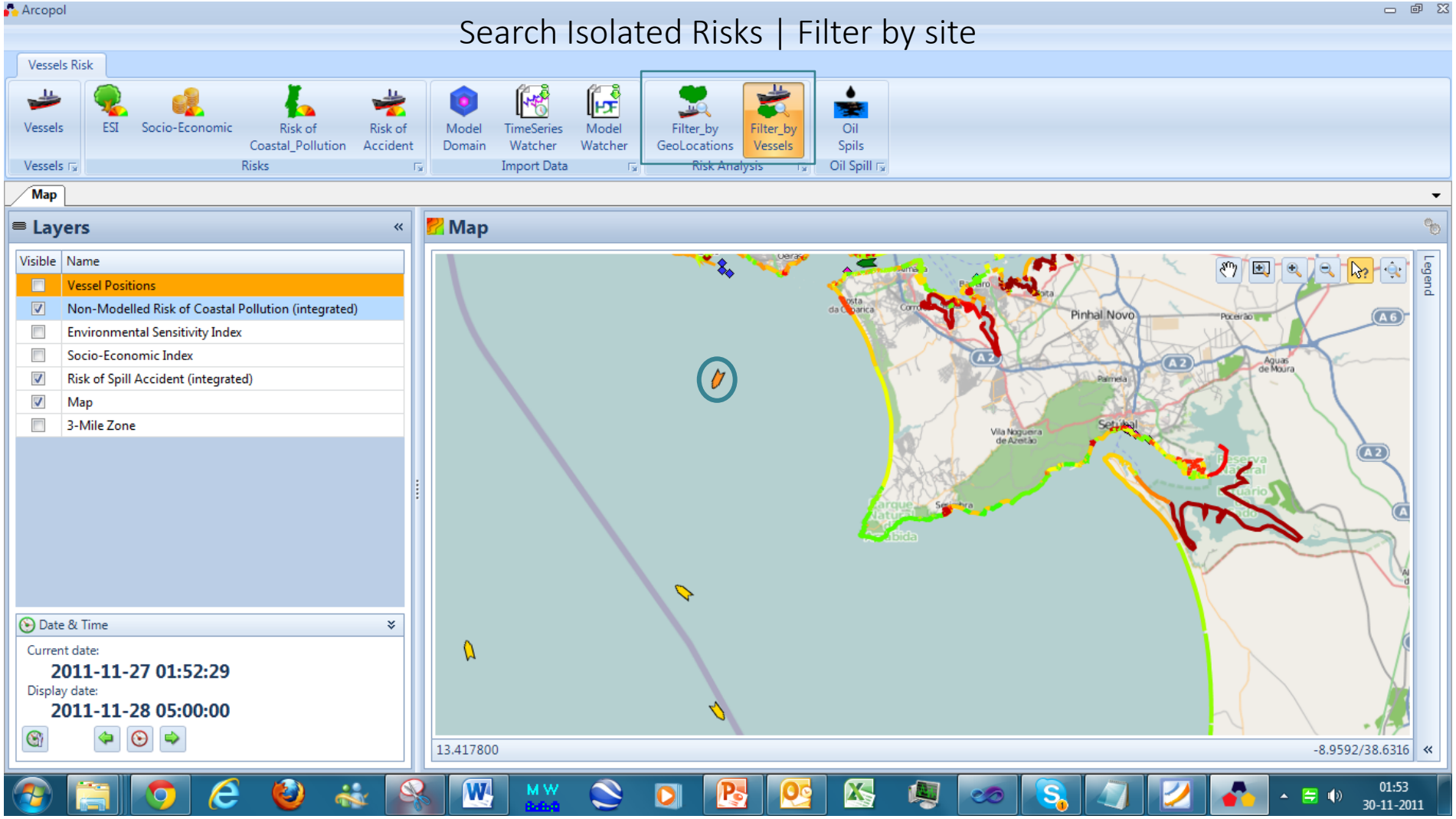
Dynamic Risk Tool



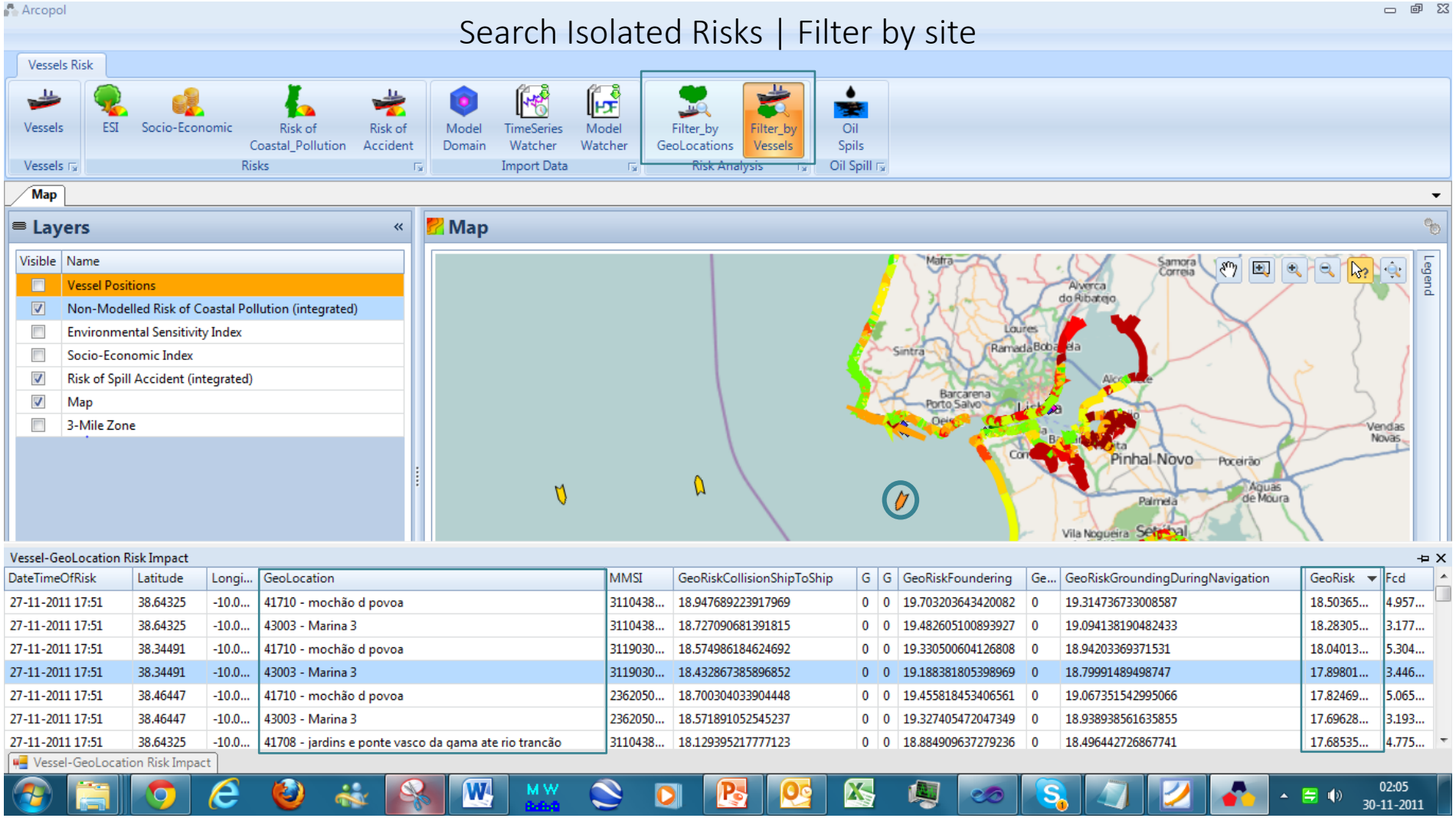
Dynamic Risk Tool



Dynamic Risk Tool



Dynamic Risk Tool

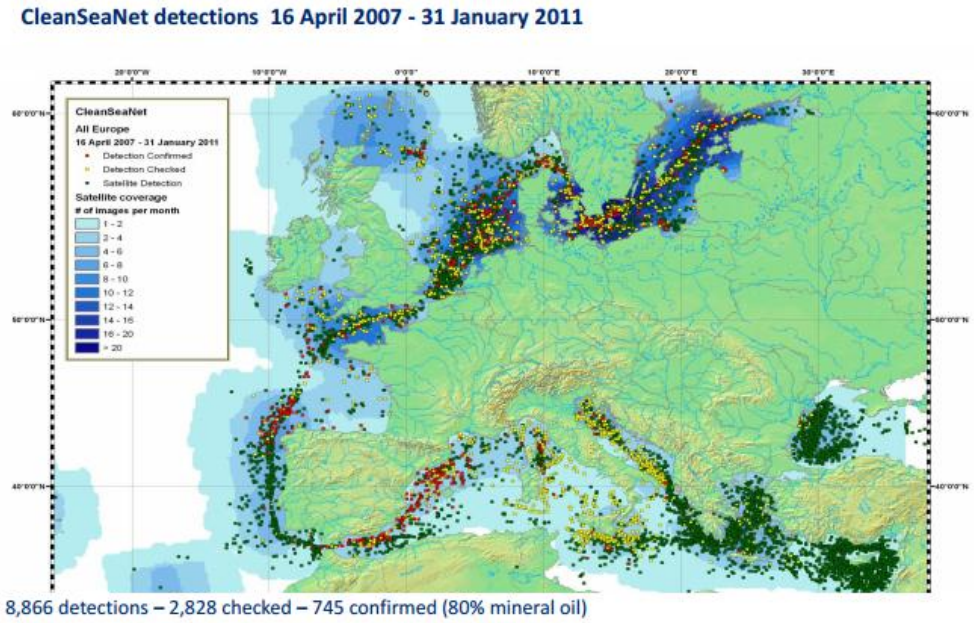


MOHID-CLEANSENET service

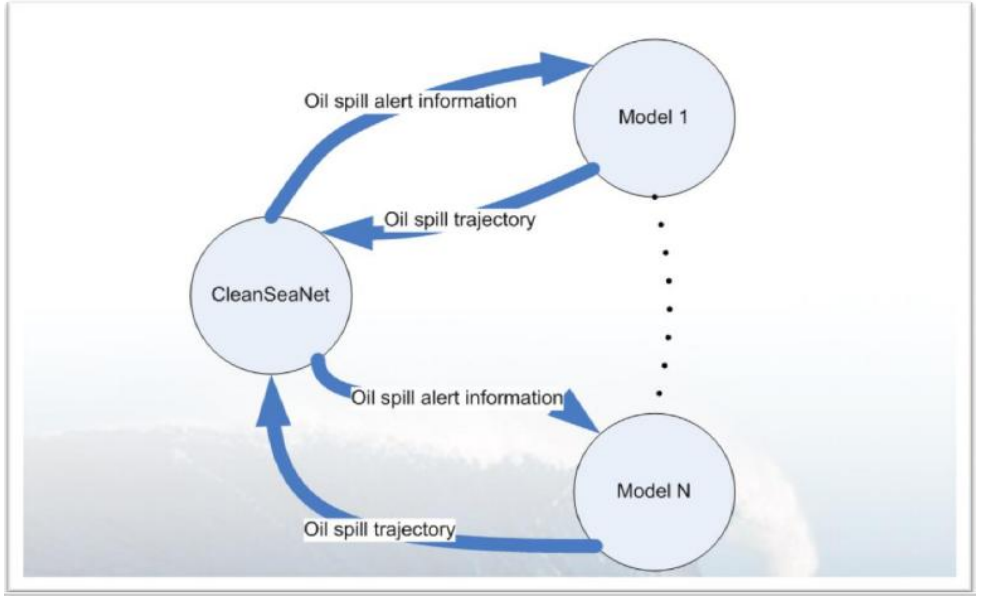
can provide added-value for remote sensing products

E.g.: automatic oil spill forecasting service based on EMSA CLEANSEANET

Near real time service (30min.)



Cooperation agreement EMSA - MARETEC

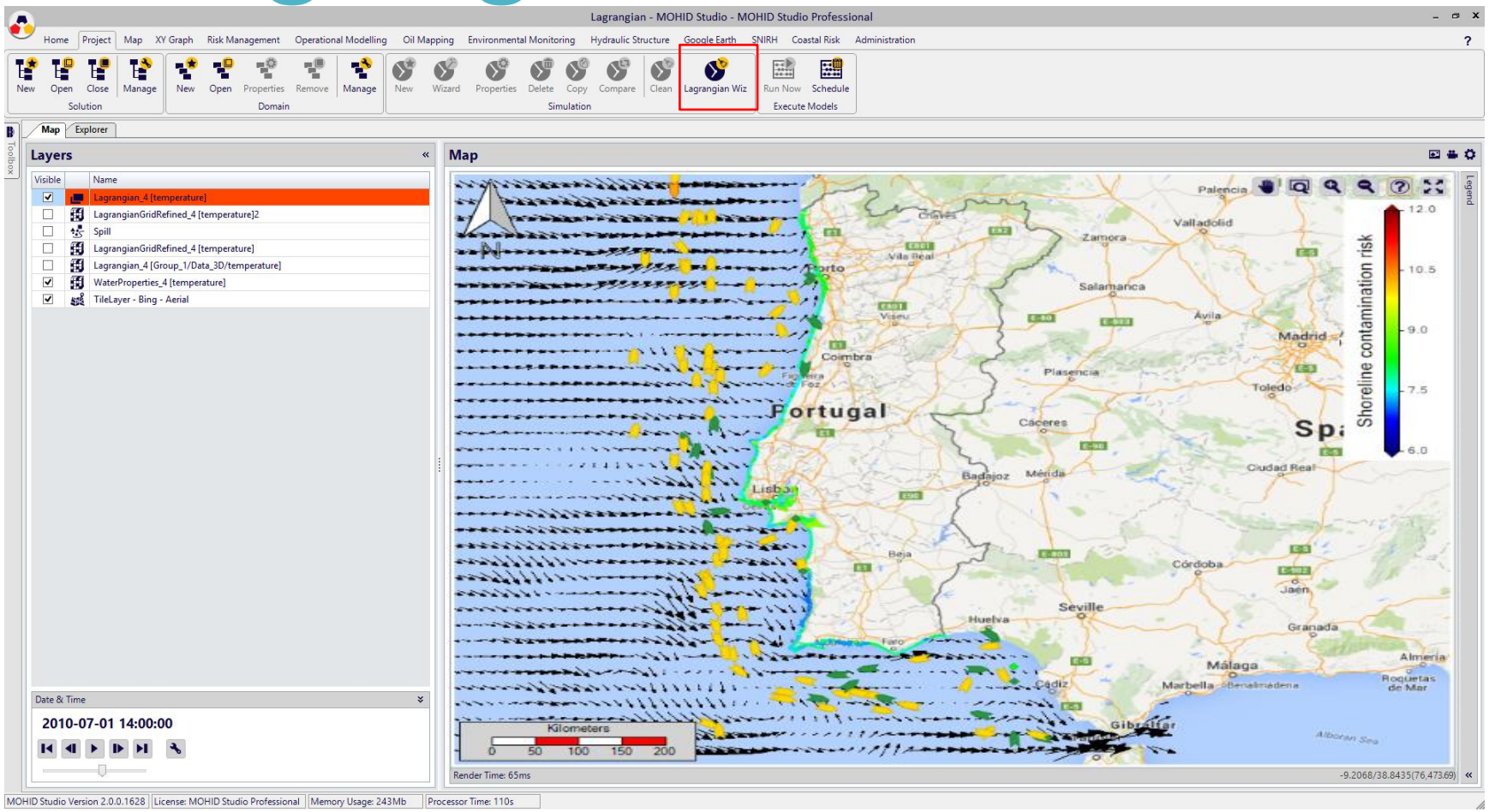


Automatic distribution of oil spill forecasts (backward and forward in time) through end users

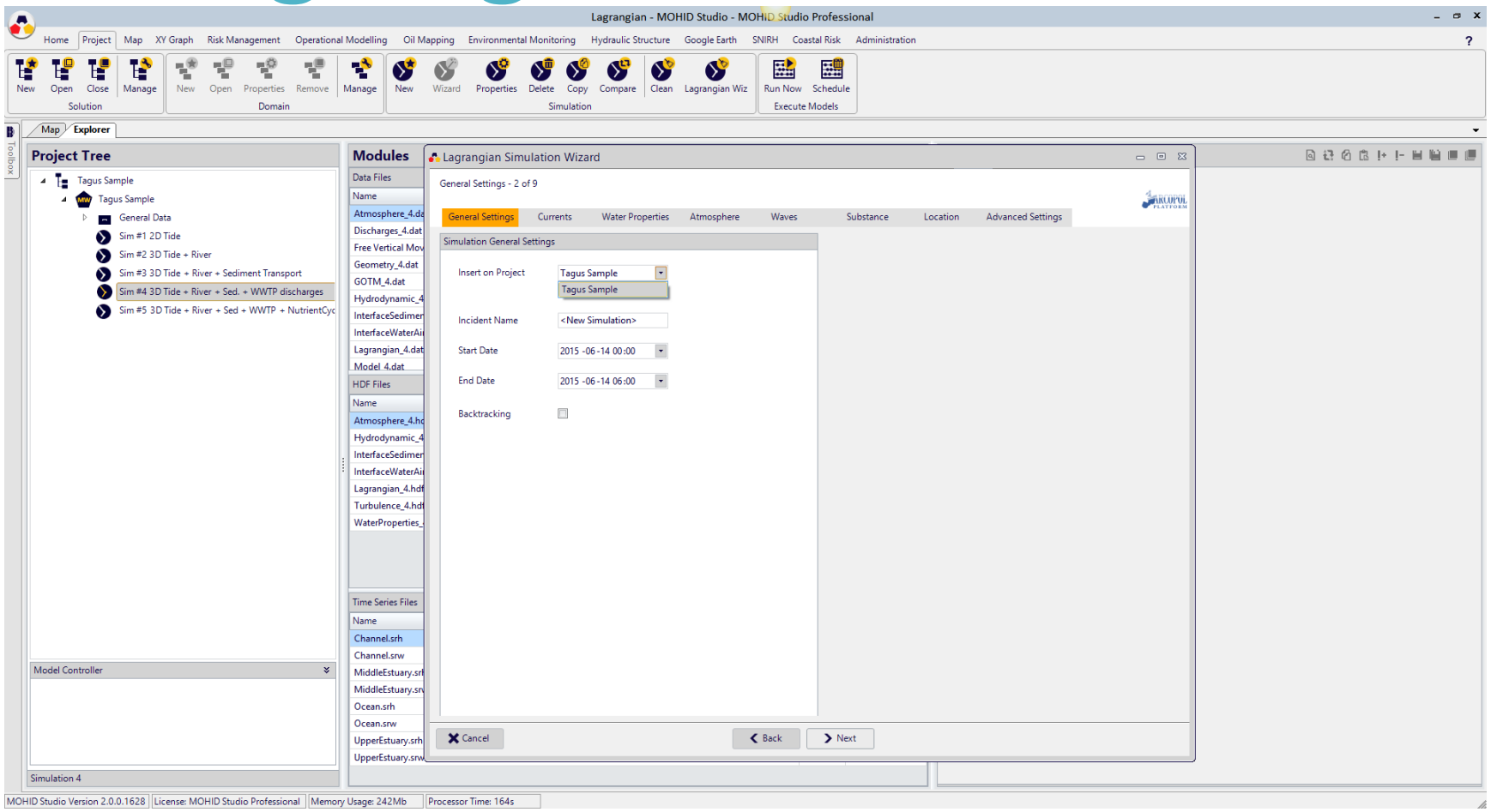
MOHID Lagrangian Wizard (Mohid Studio)

- Imports multiple metocean modelling solutions
- Fully integrated with risk tool
- Chemical spill modelling
- Both water and airborne dispersion modelling
- 3D spill modelling (including blowouts) & profile visualization
- On-demand high resolution outputs

MOHID Lagrangian Wizard



MOHID Lagrangian Wizard



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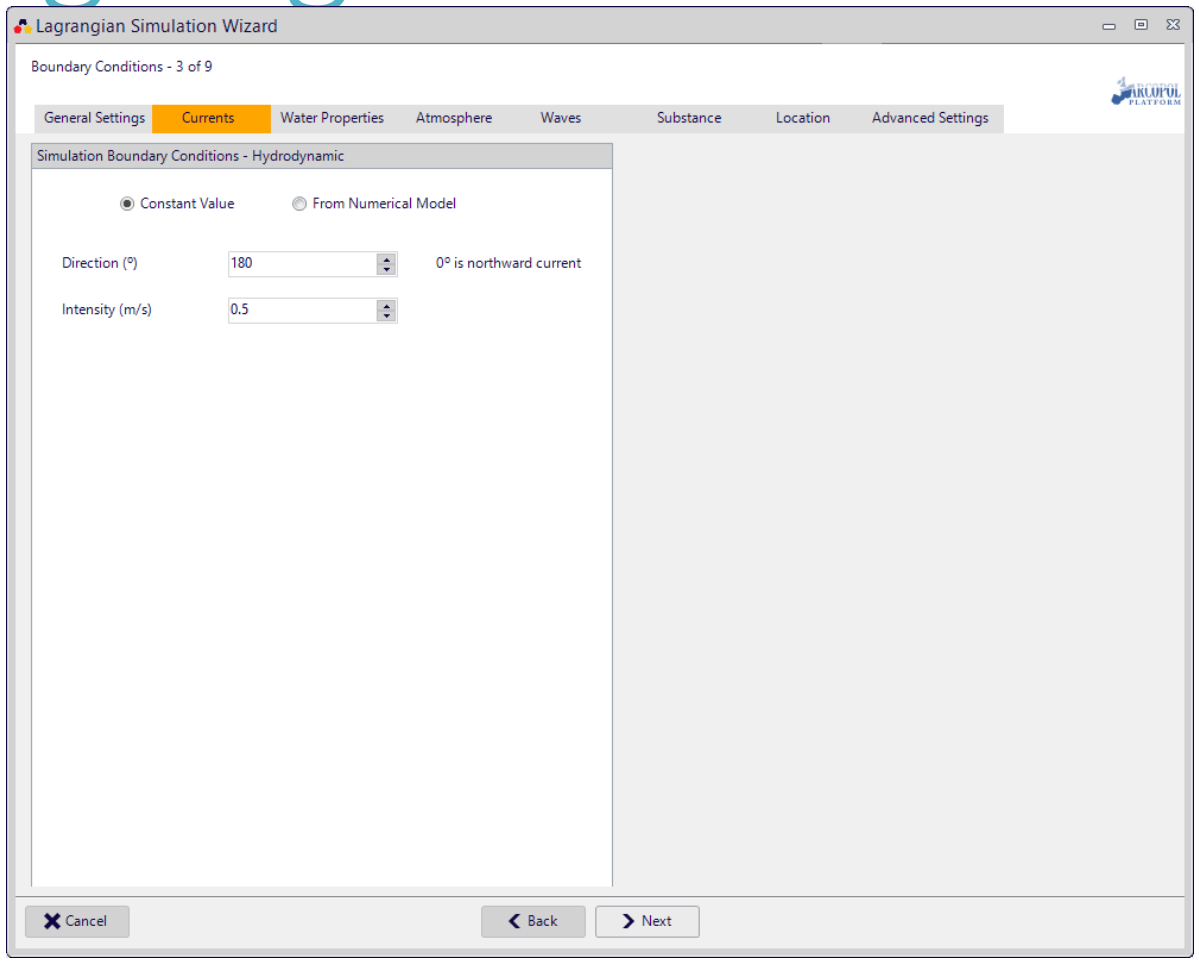

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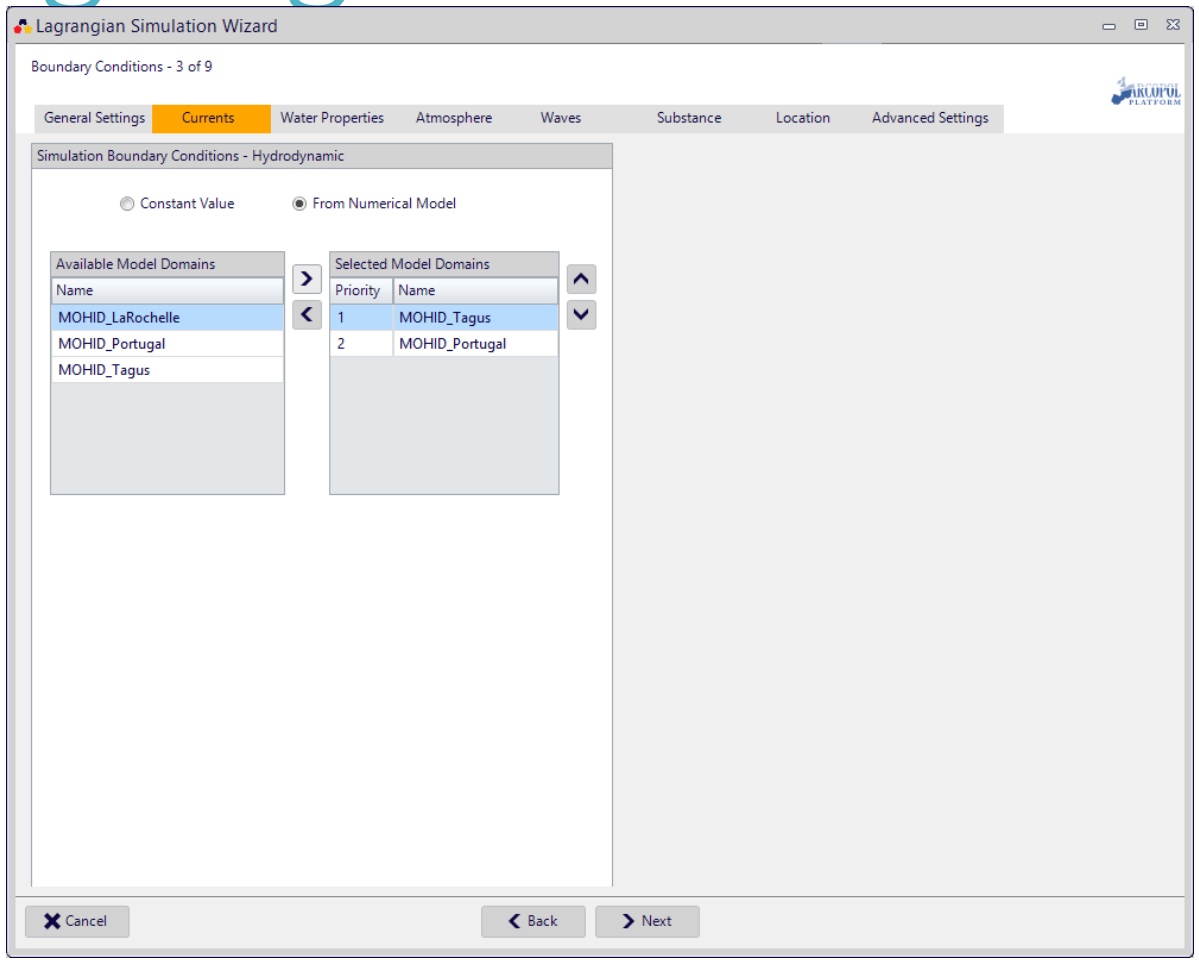

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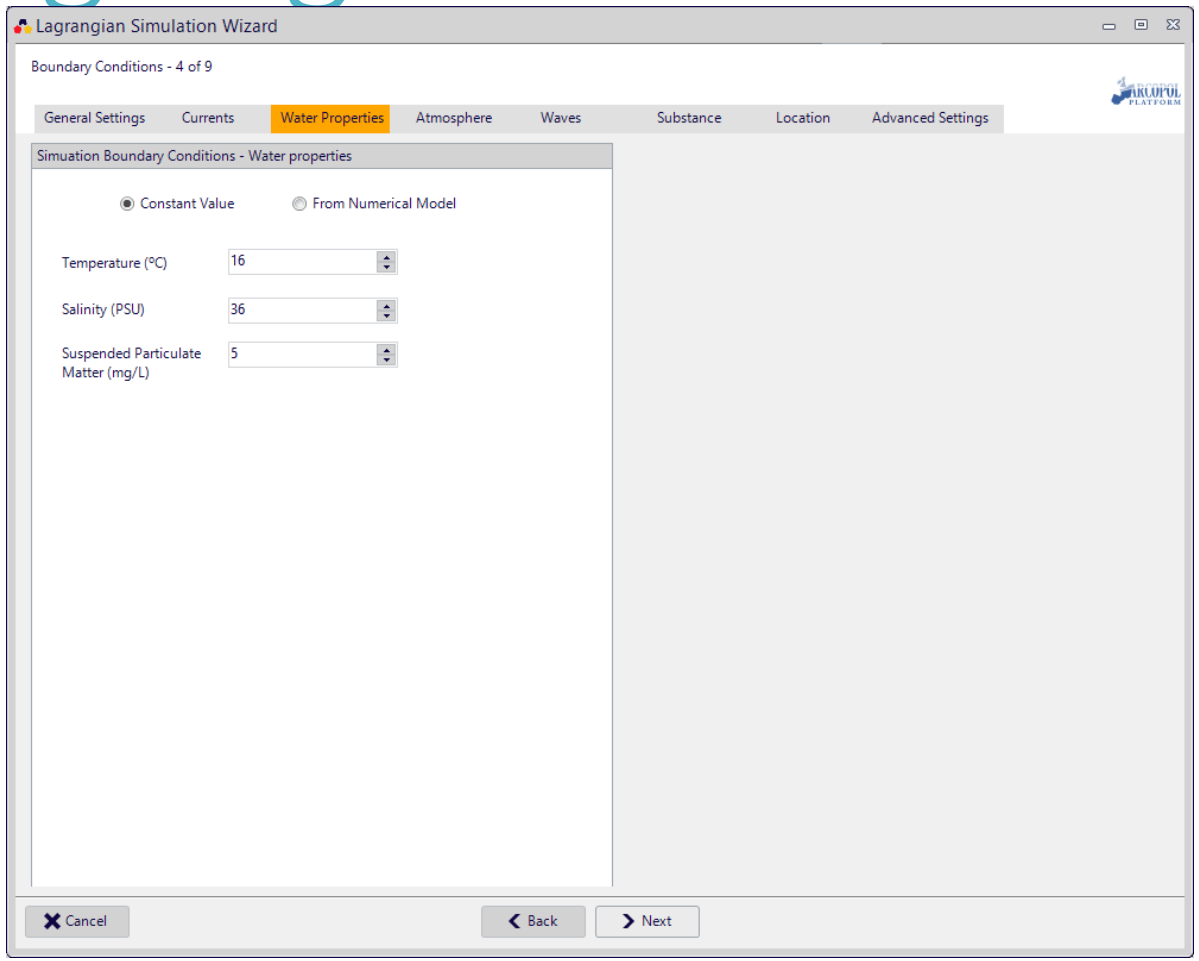

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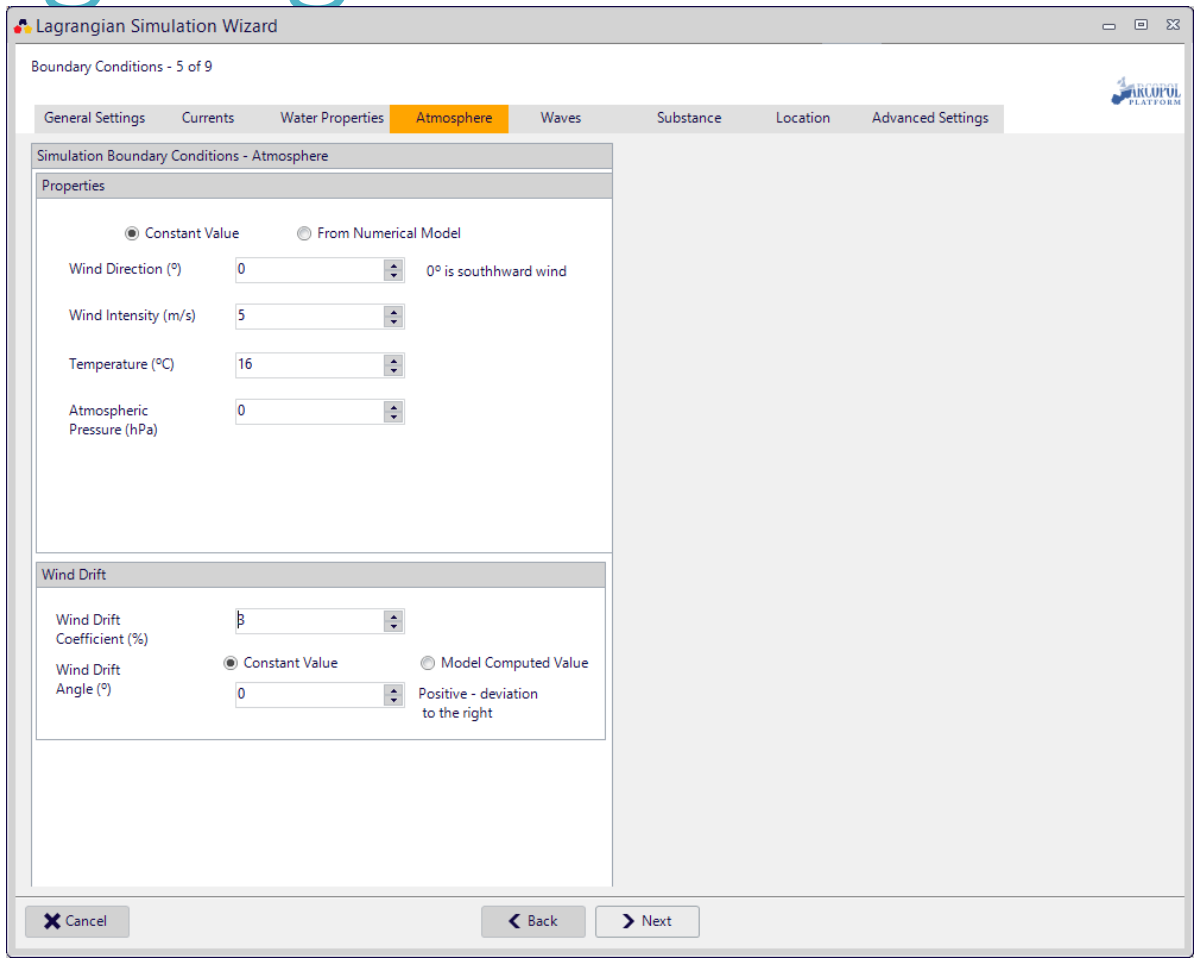

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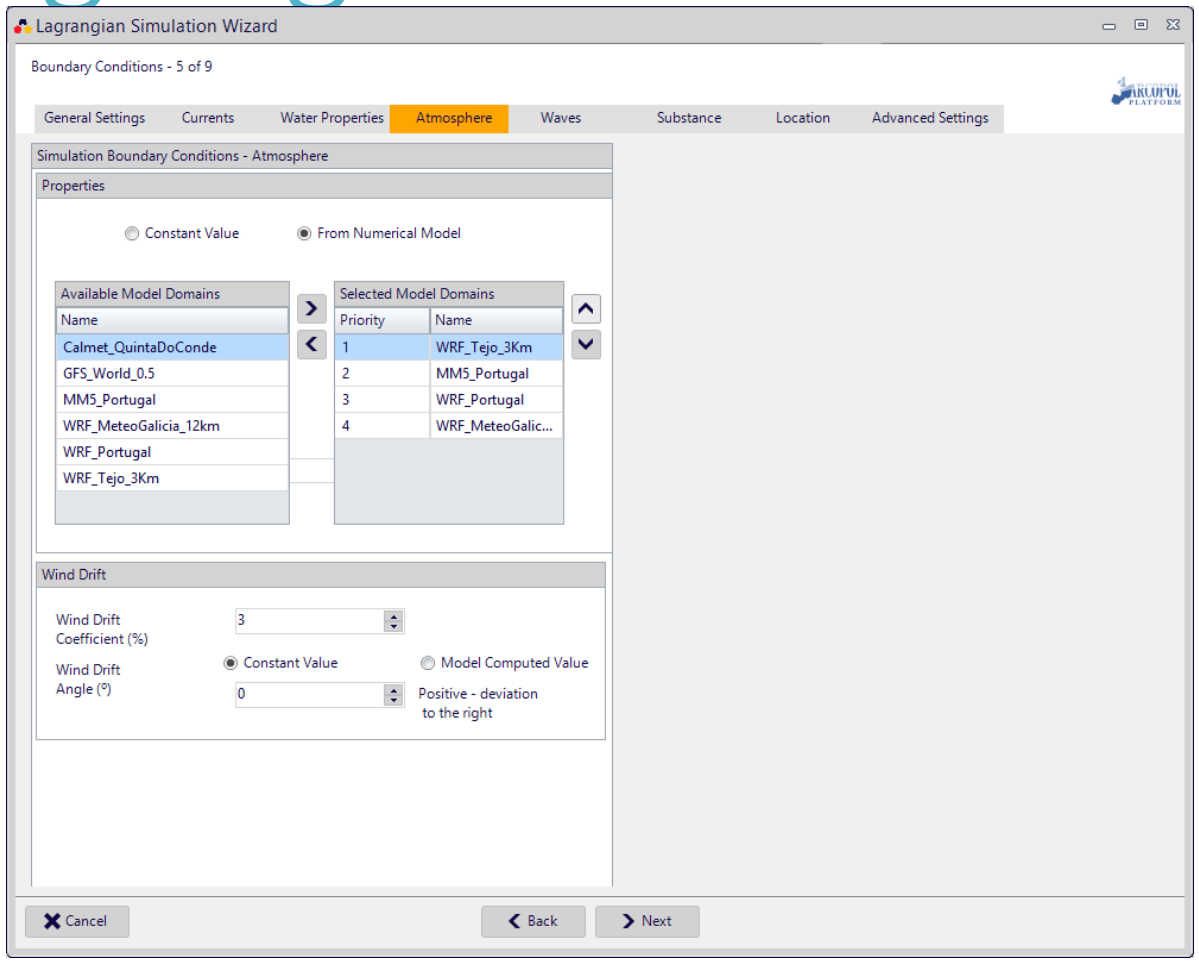

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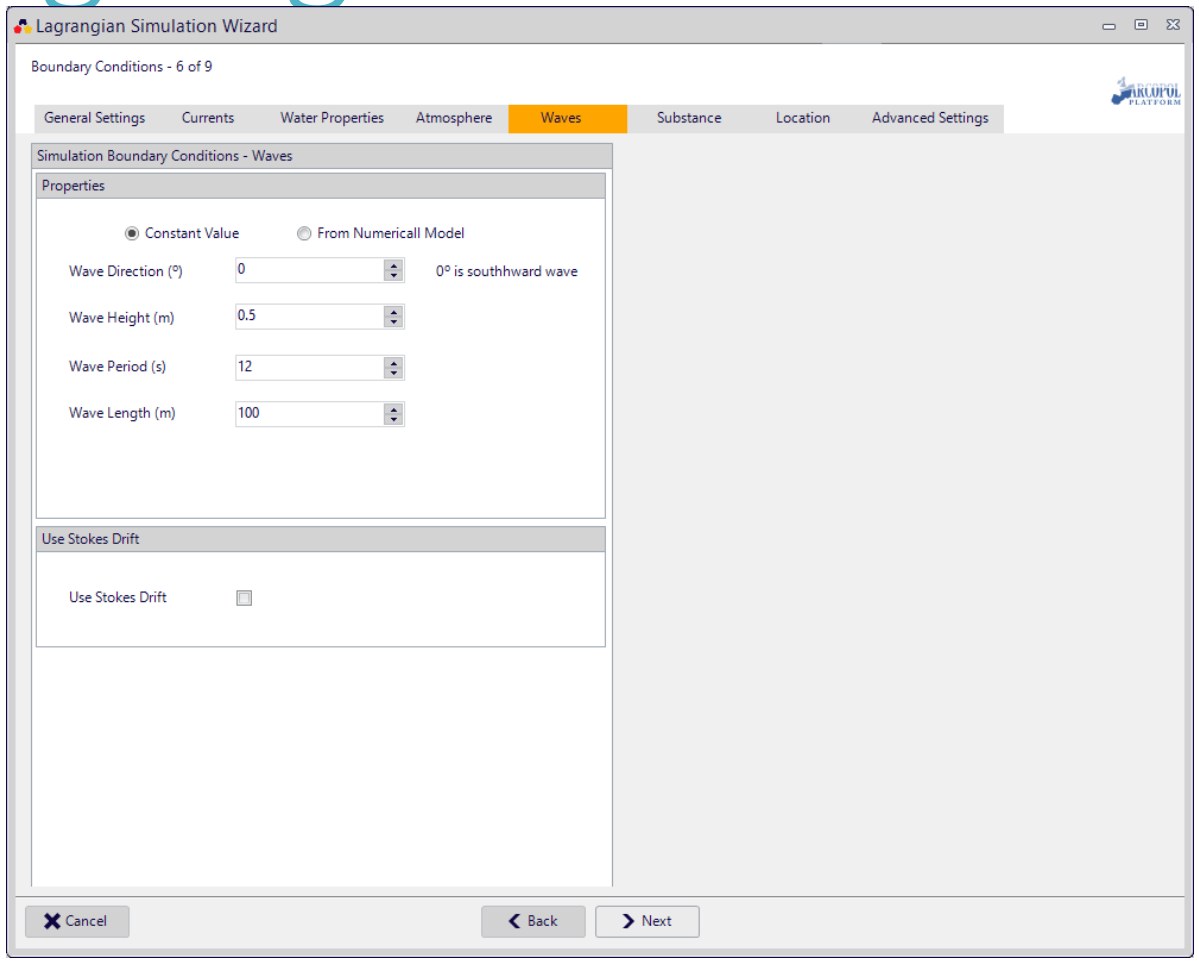
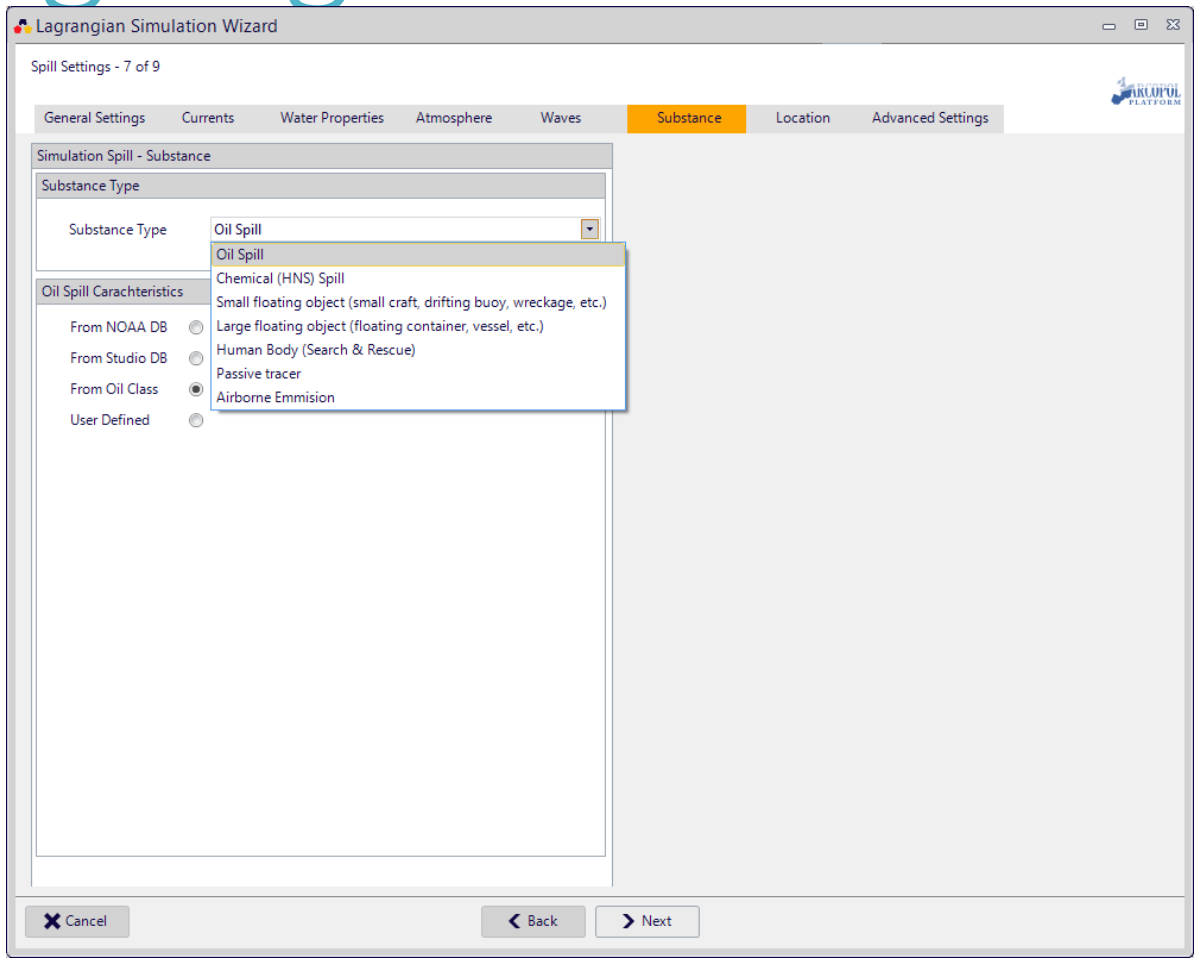


MOHID Lagrangian Wizard



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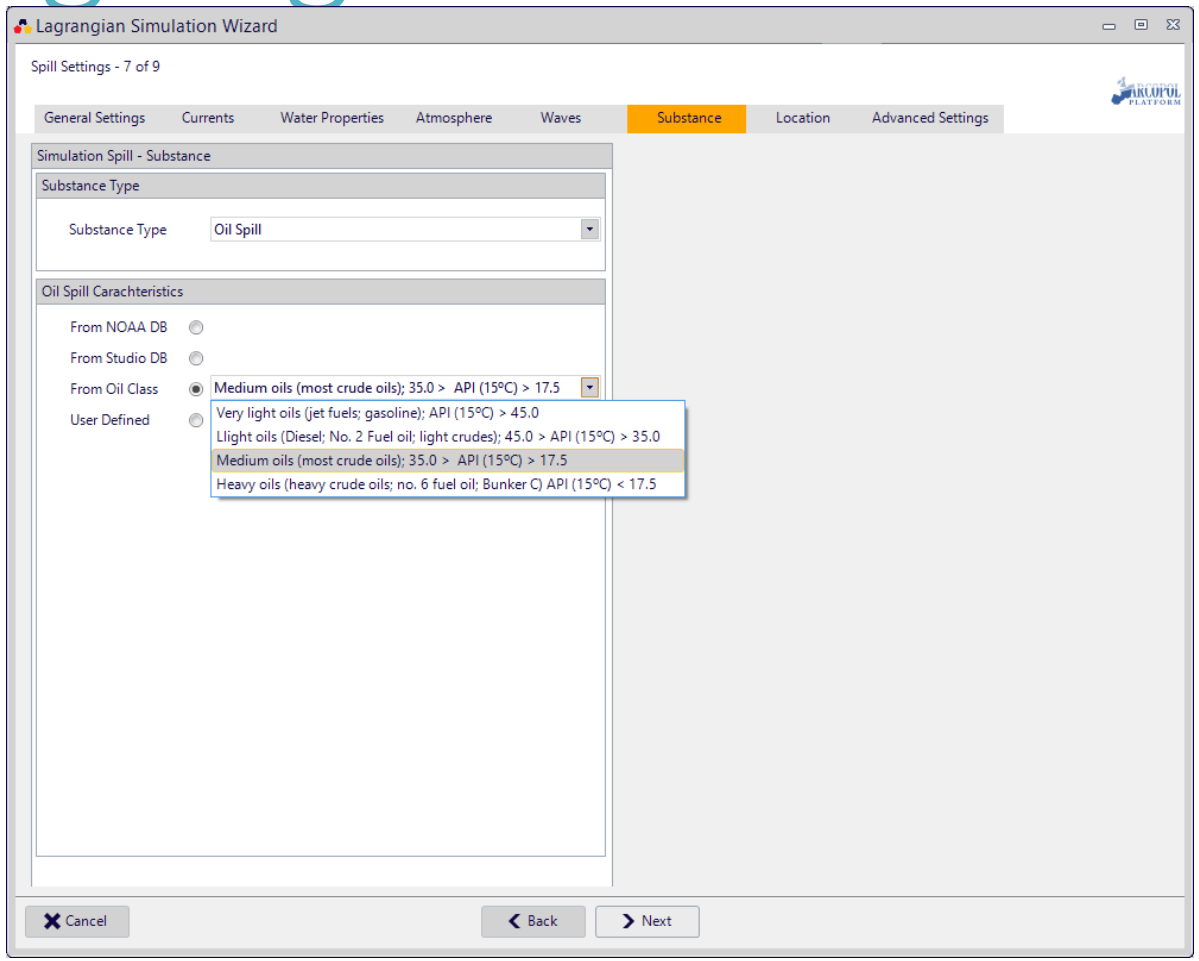

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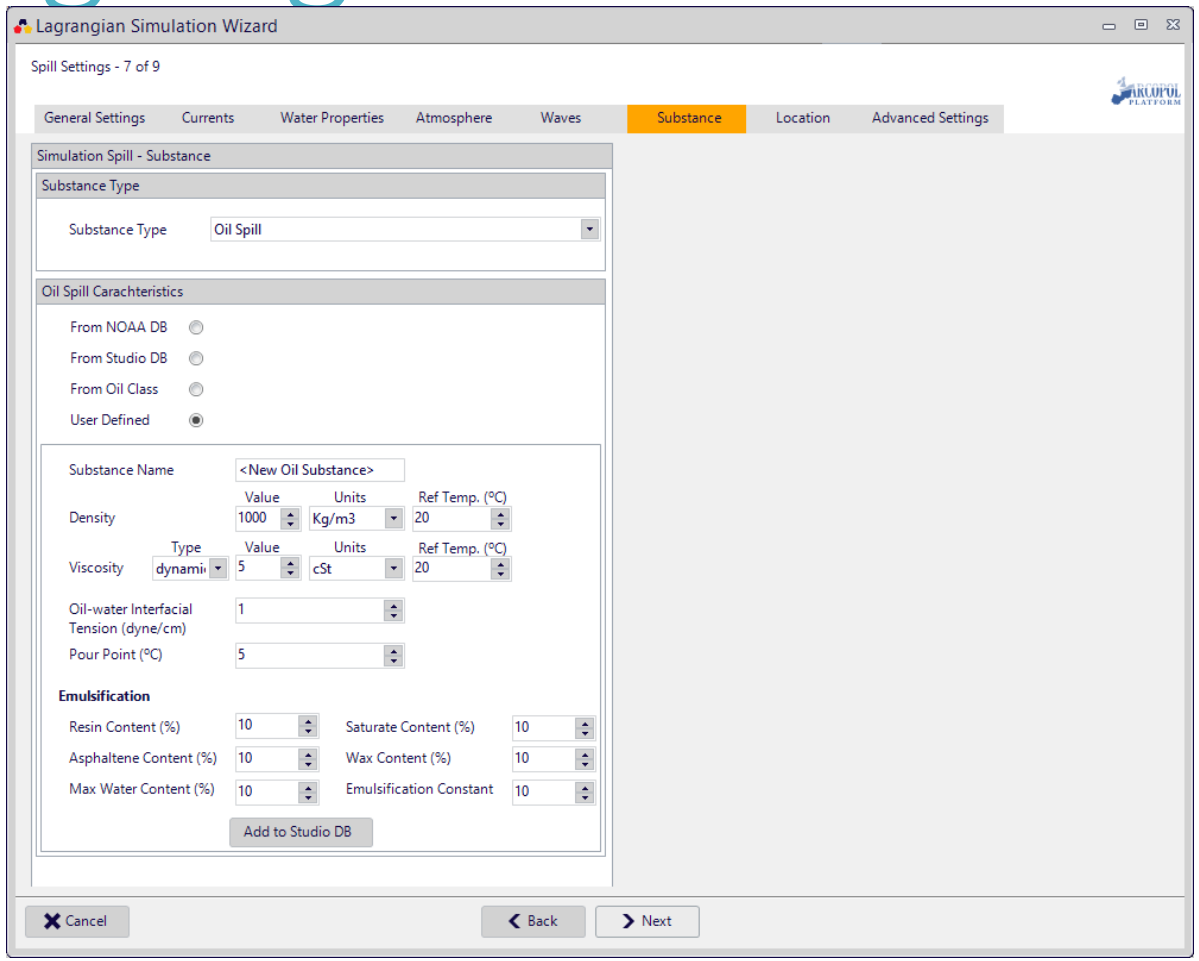

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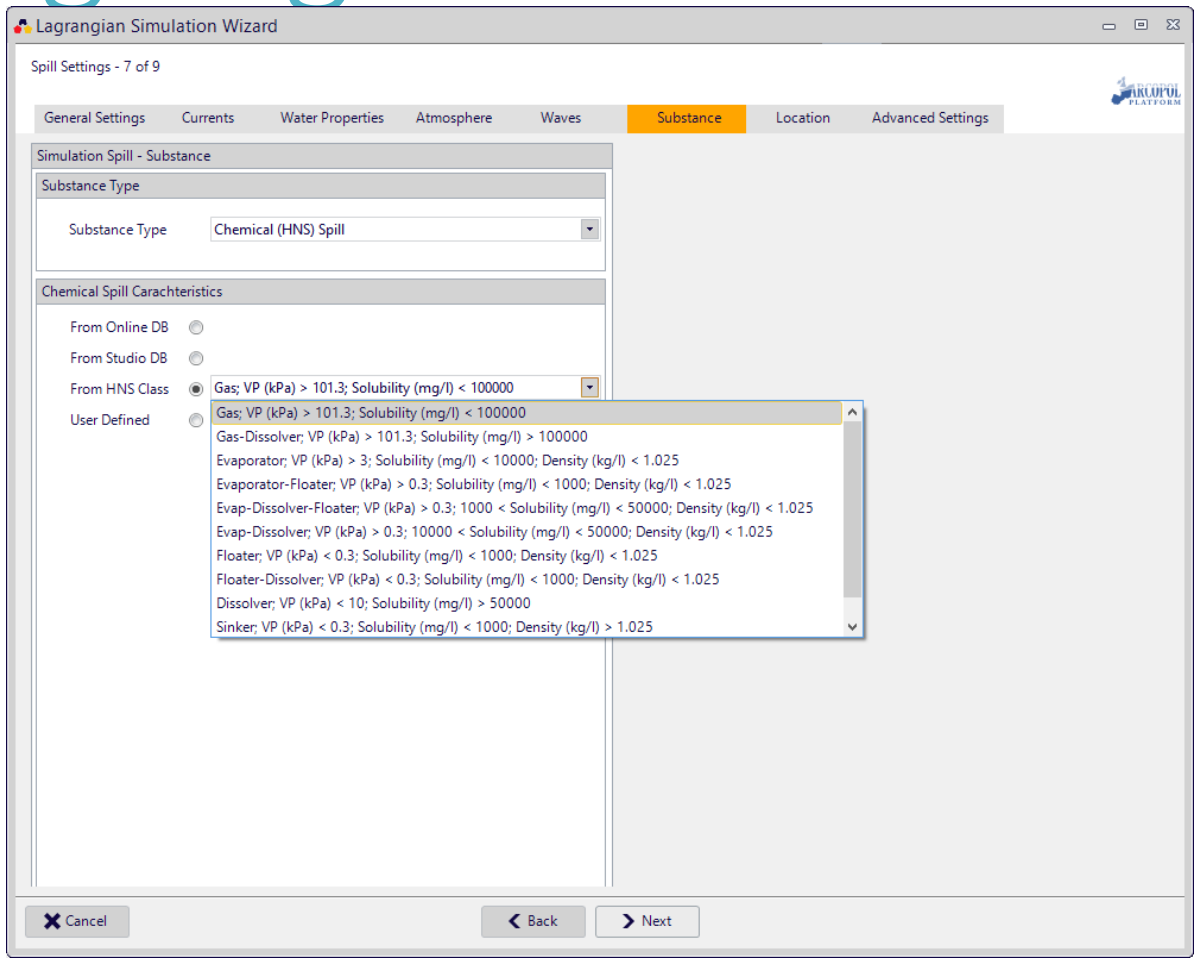

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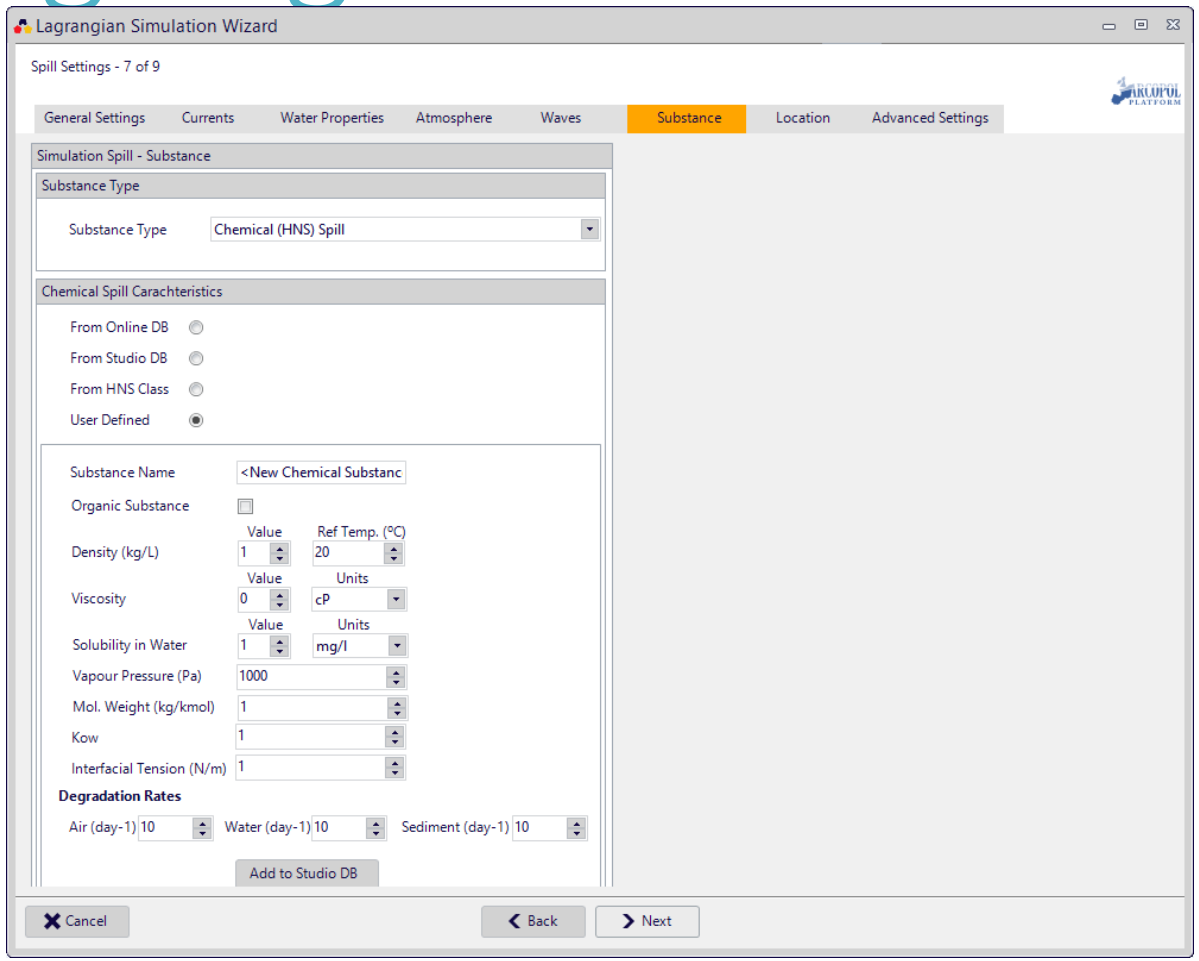

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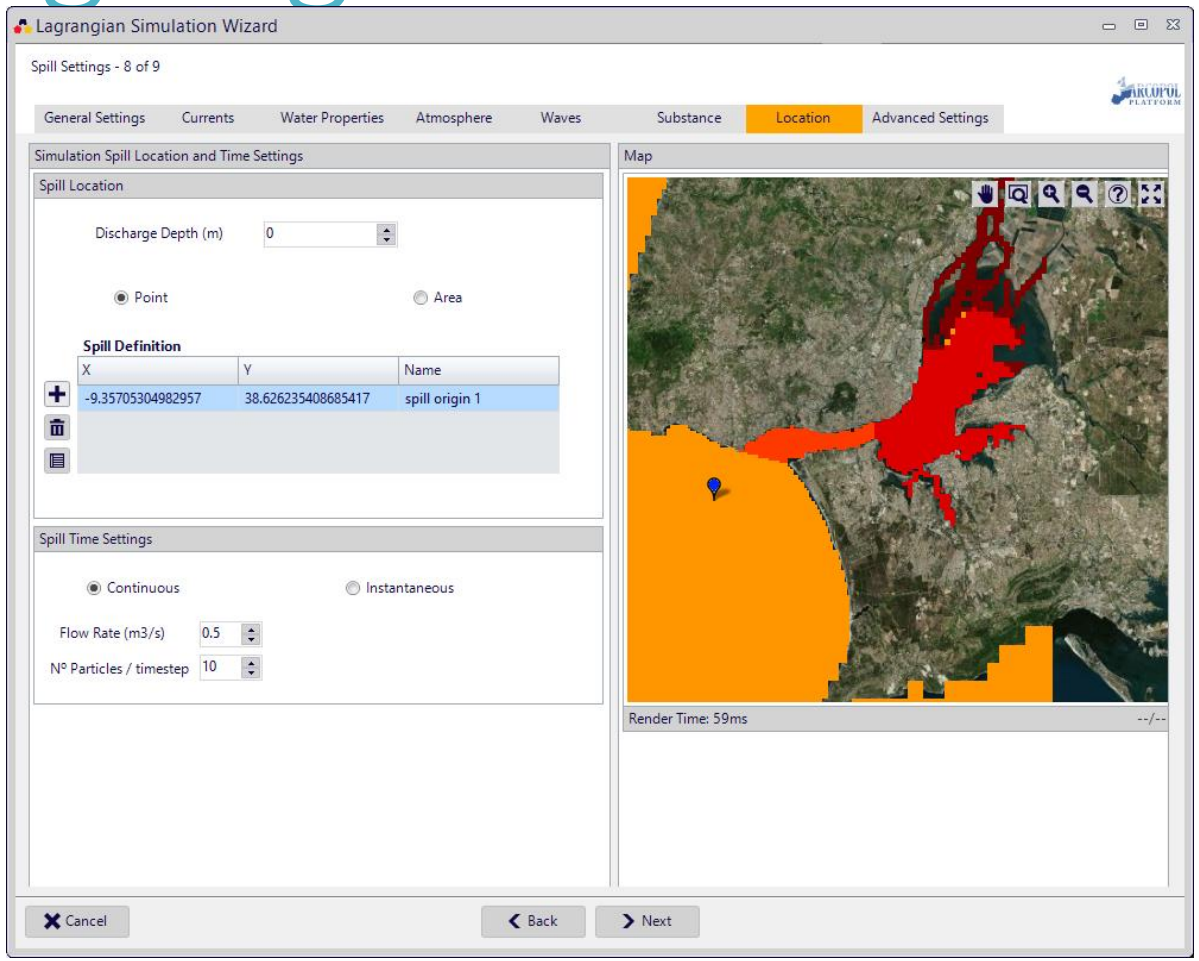

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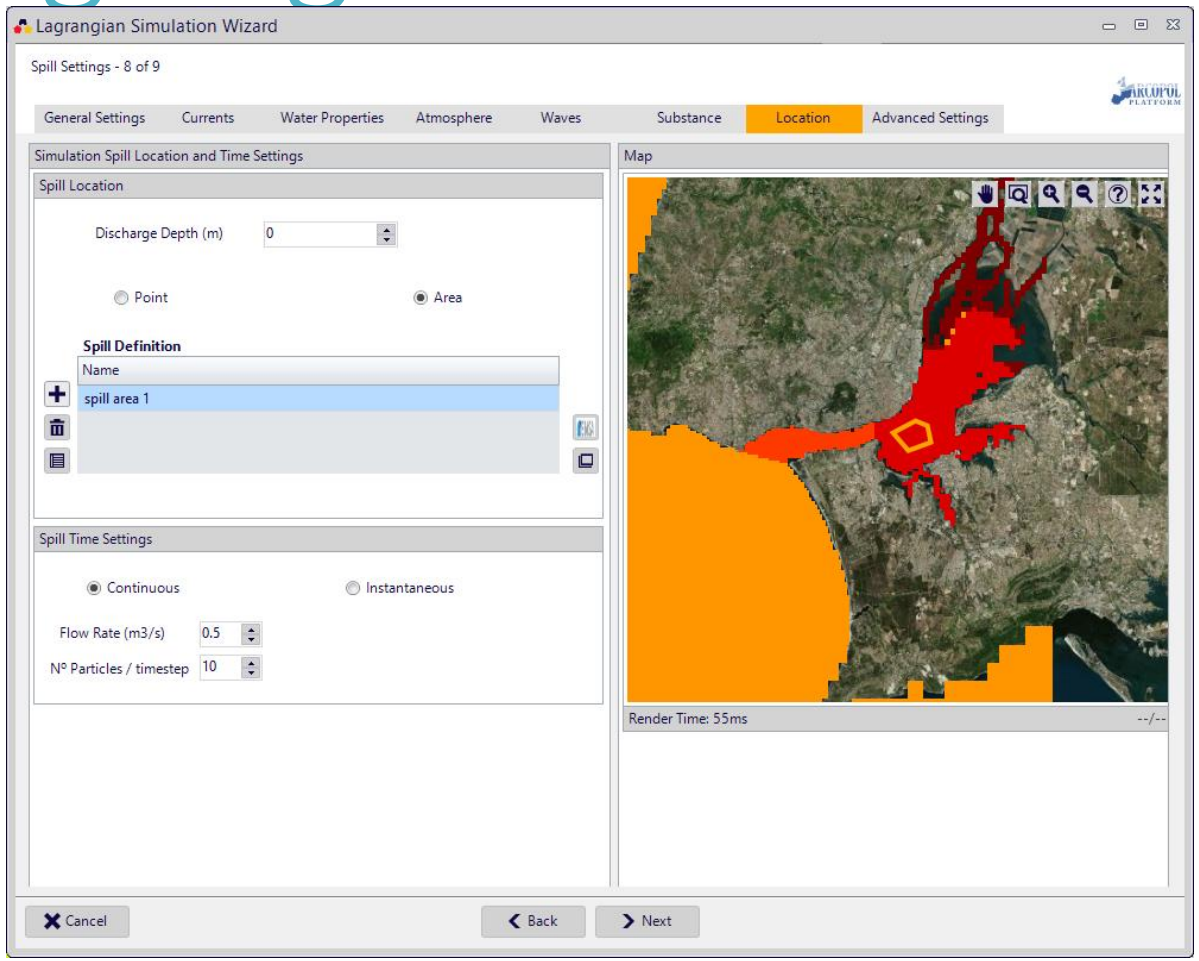

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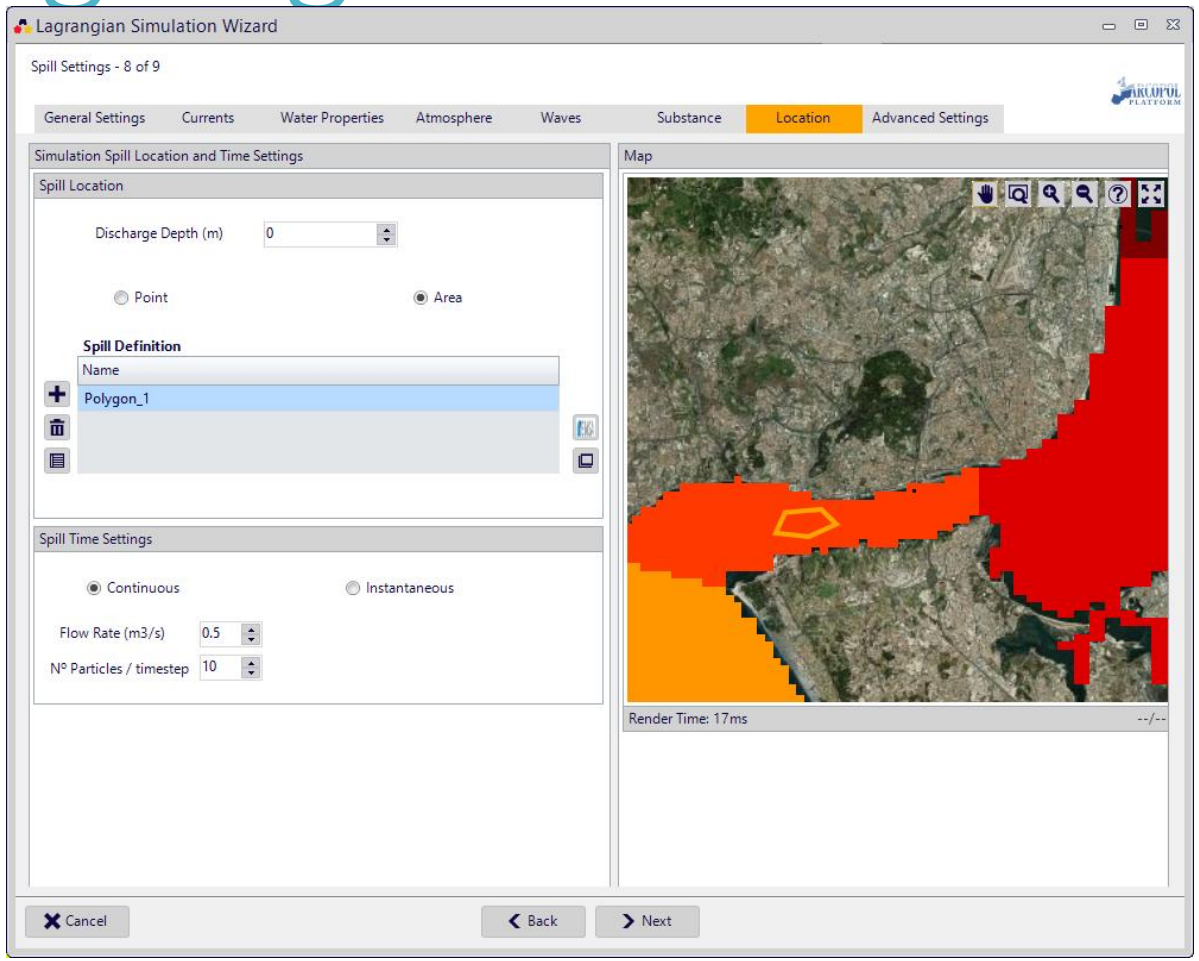

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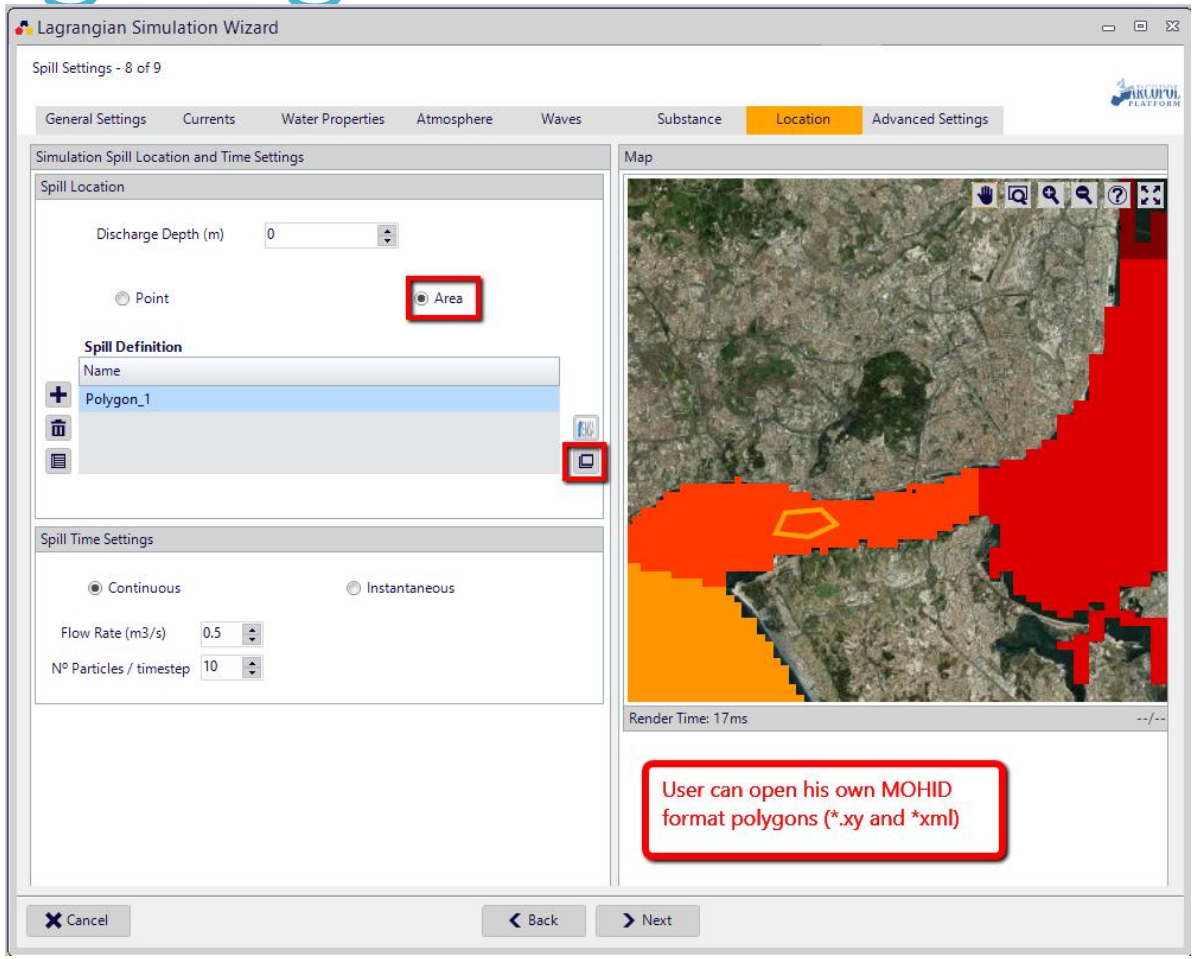

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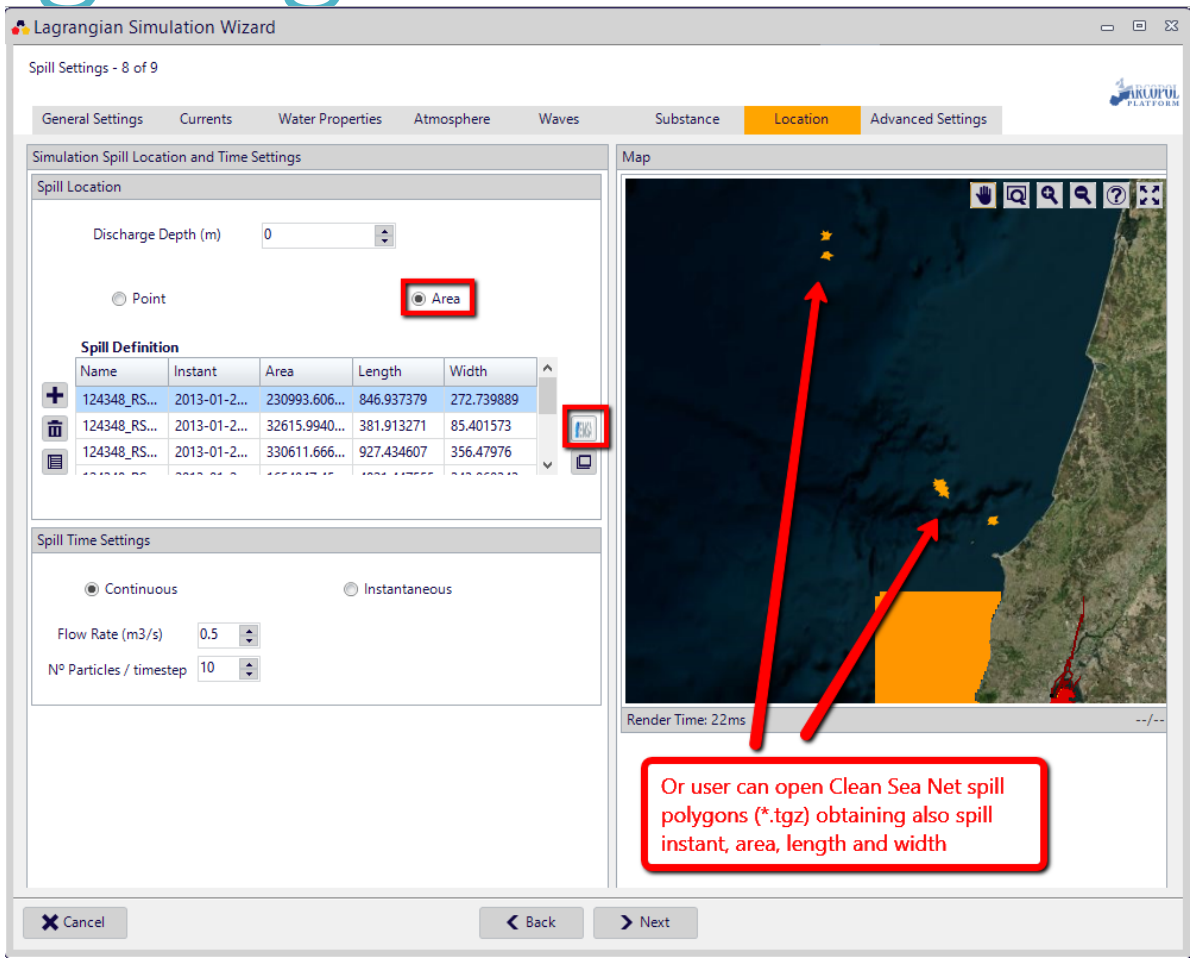

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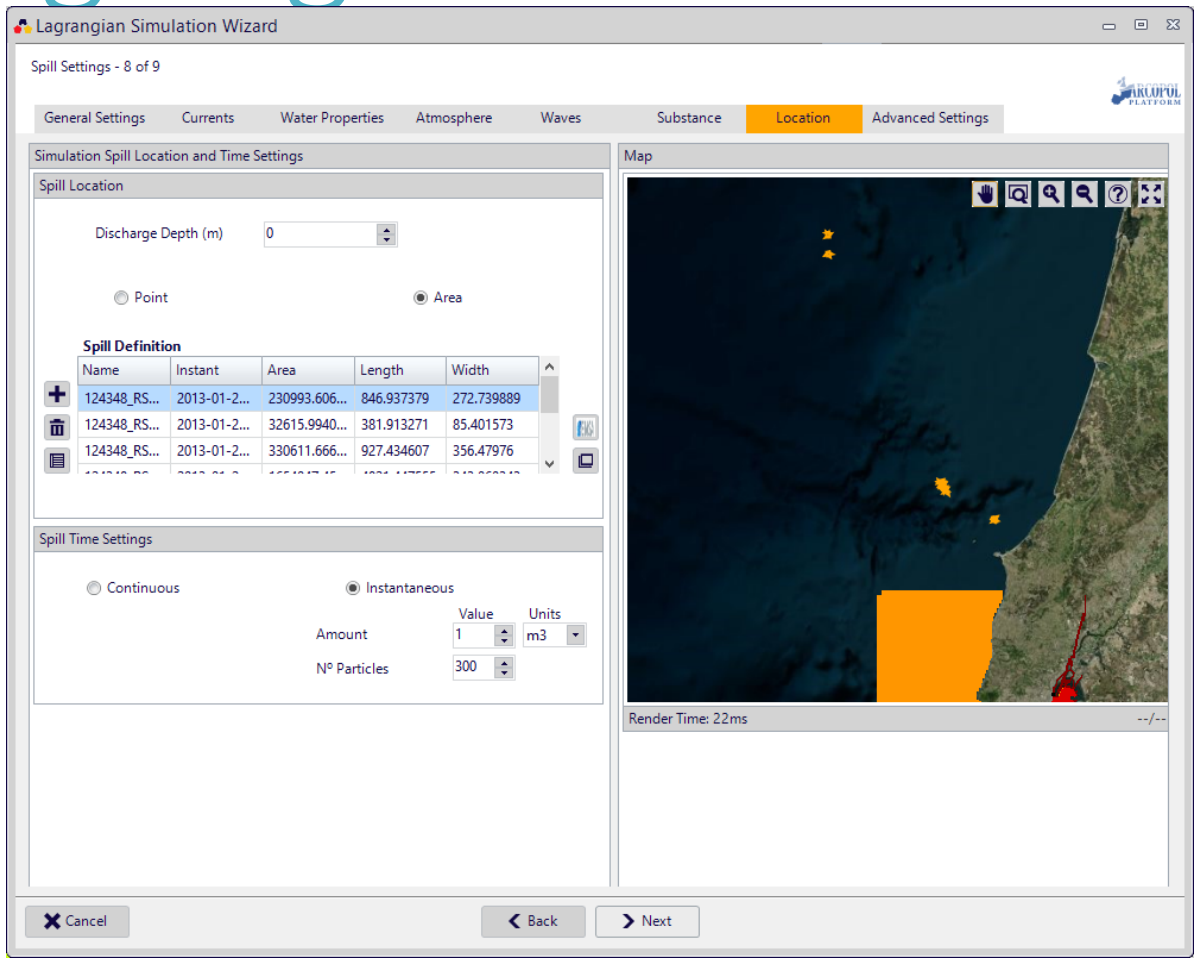
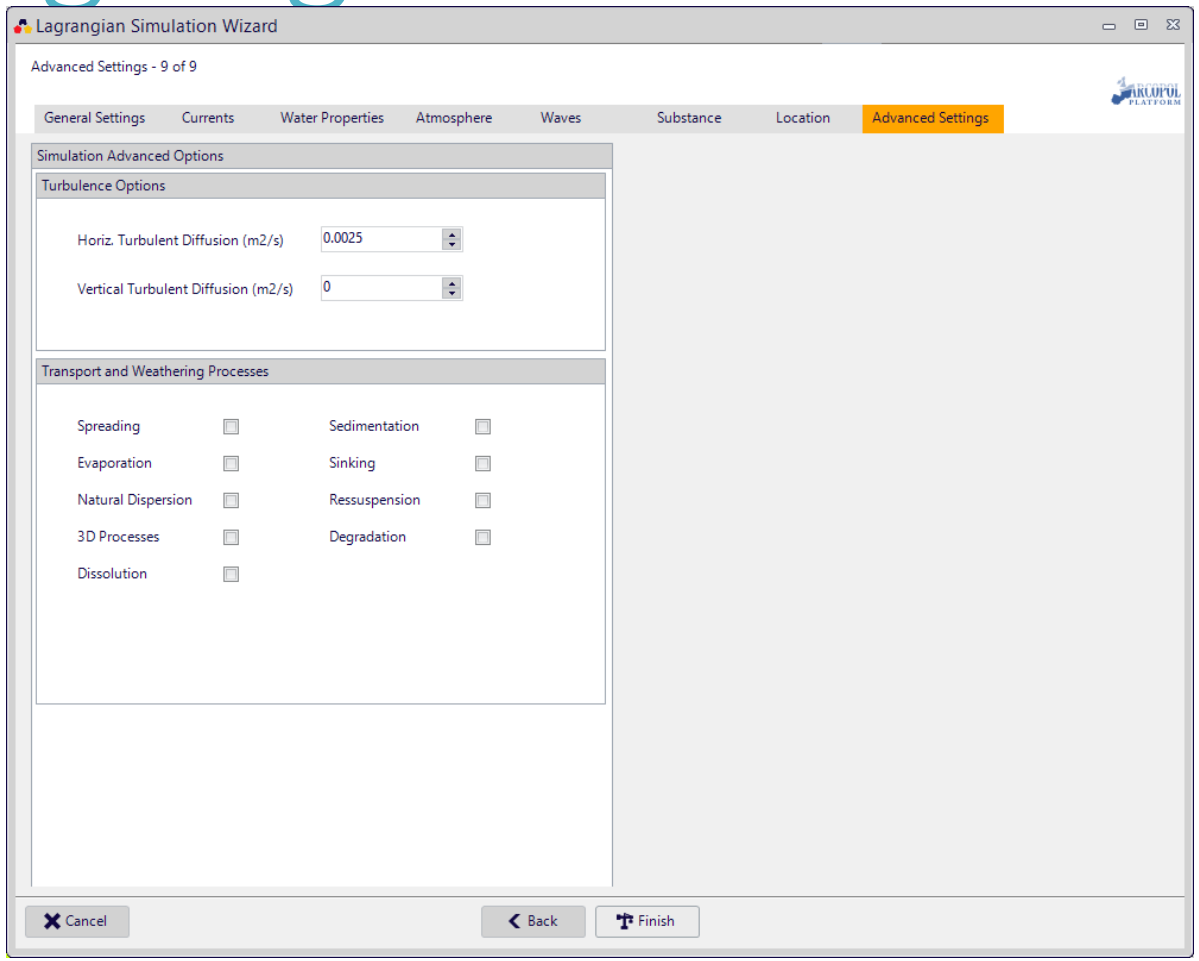


MOHID Lagrangian Wizard



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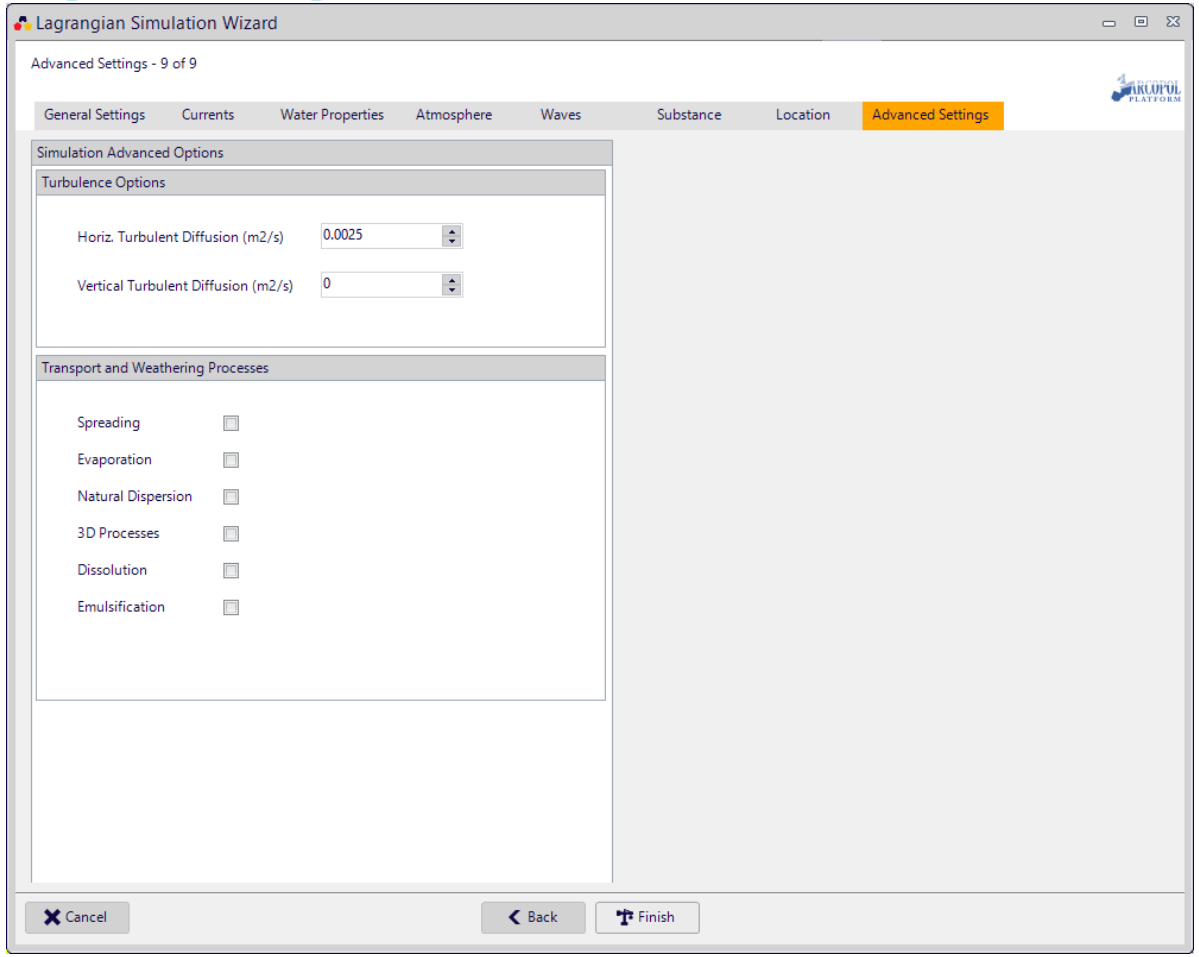
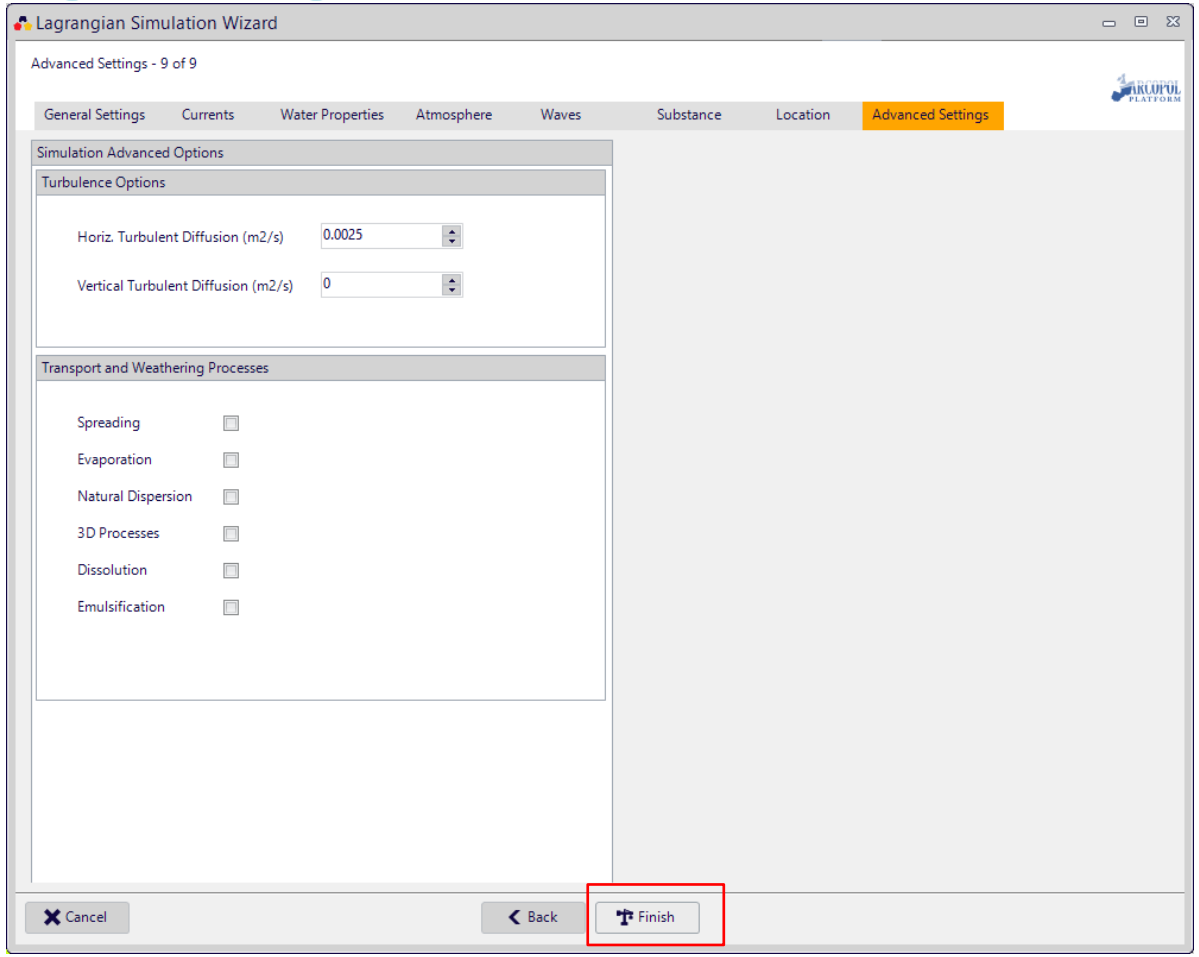
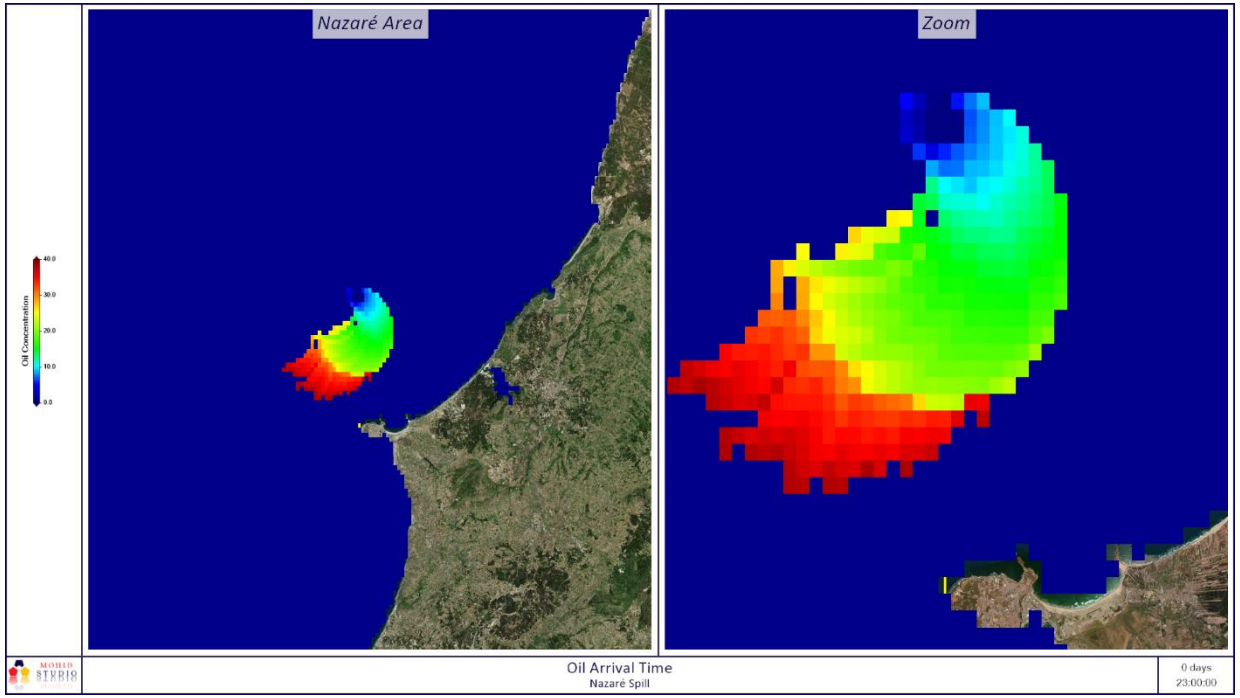


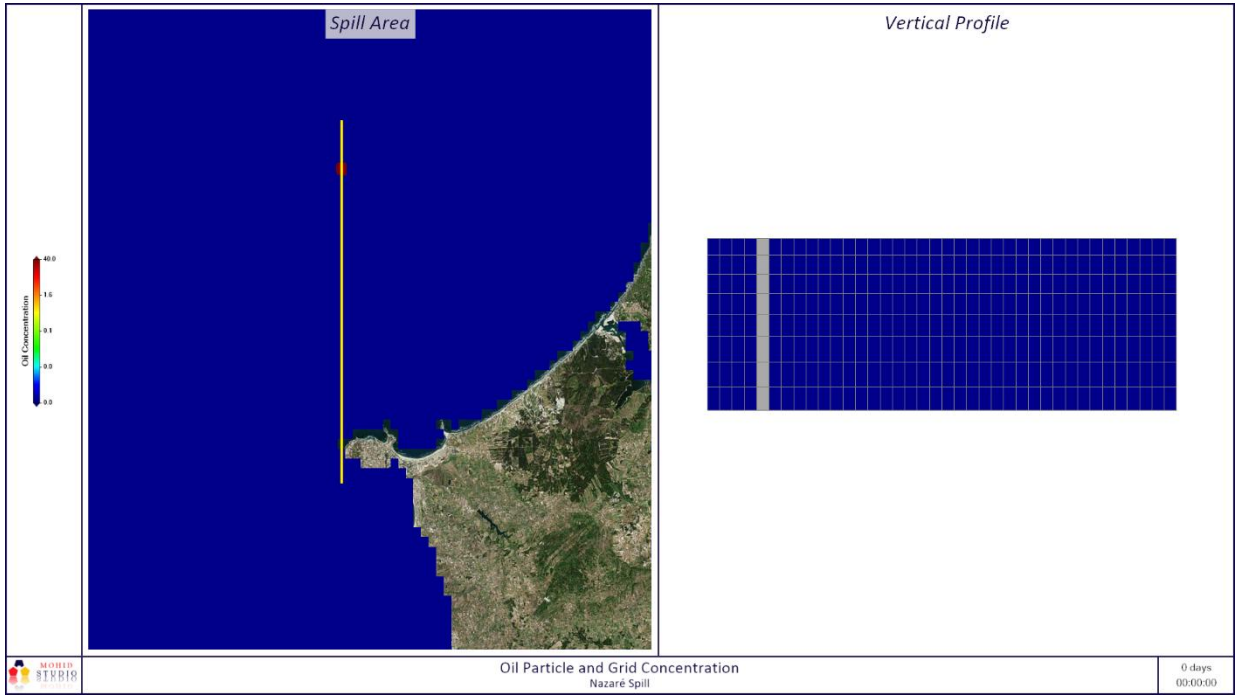
MOHID Lagrangian Wizard



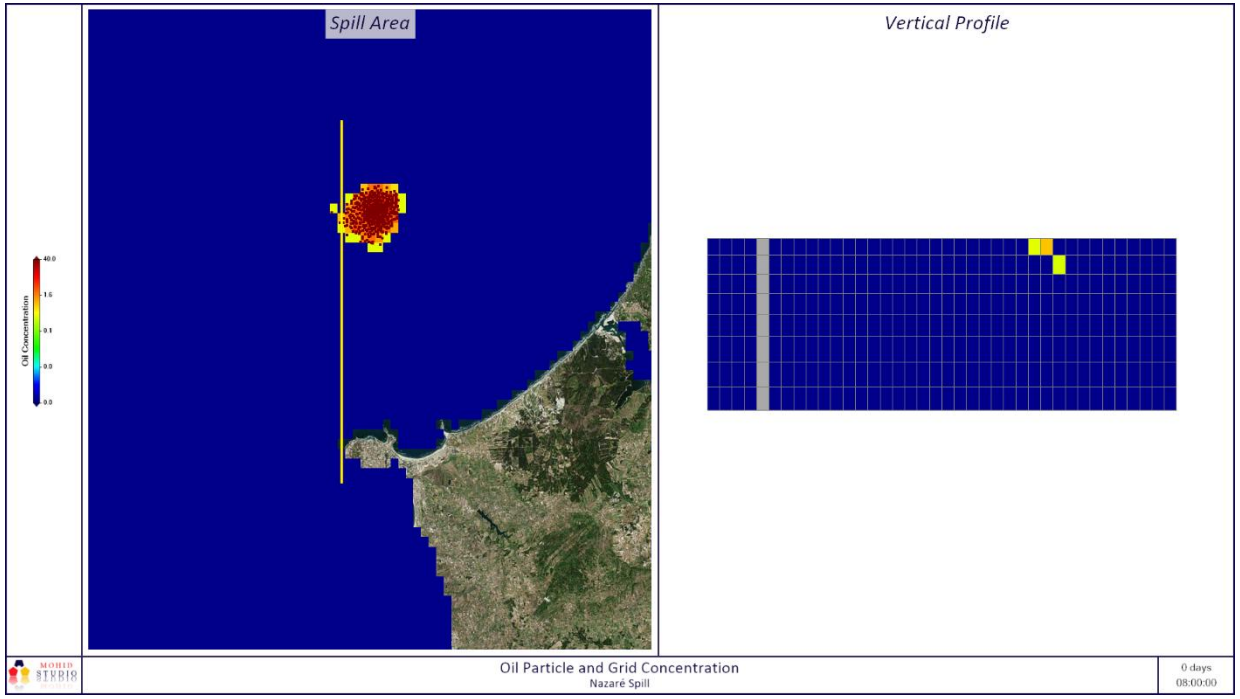
MOHID Lagrangian Wizard
- oil arrival time -



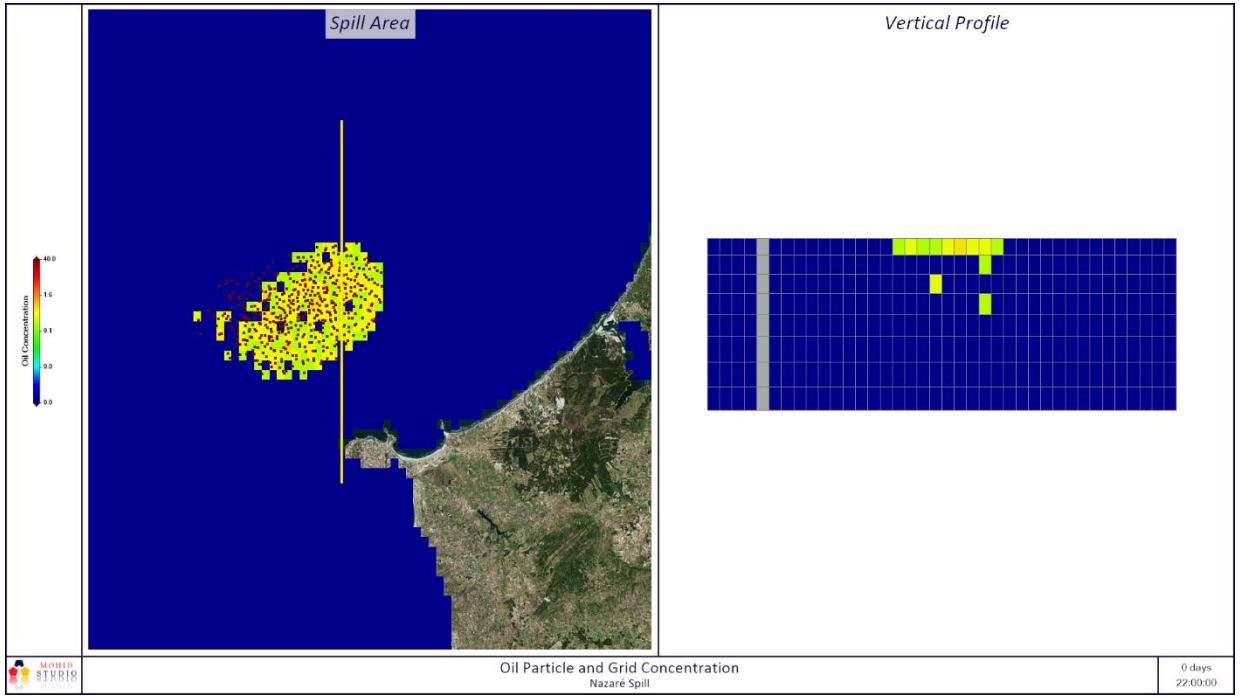
MOHID Lagrangian Wizard
- vertical profile -



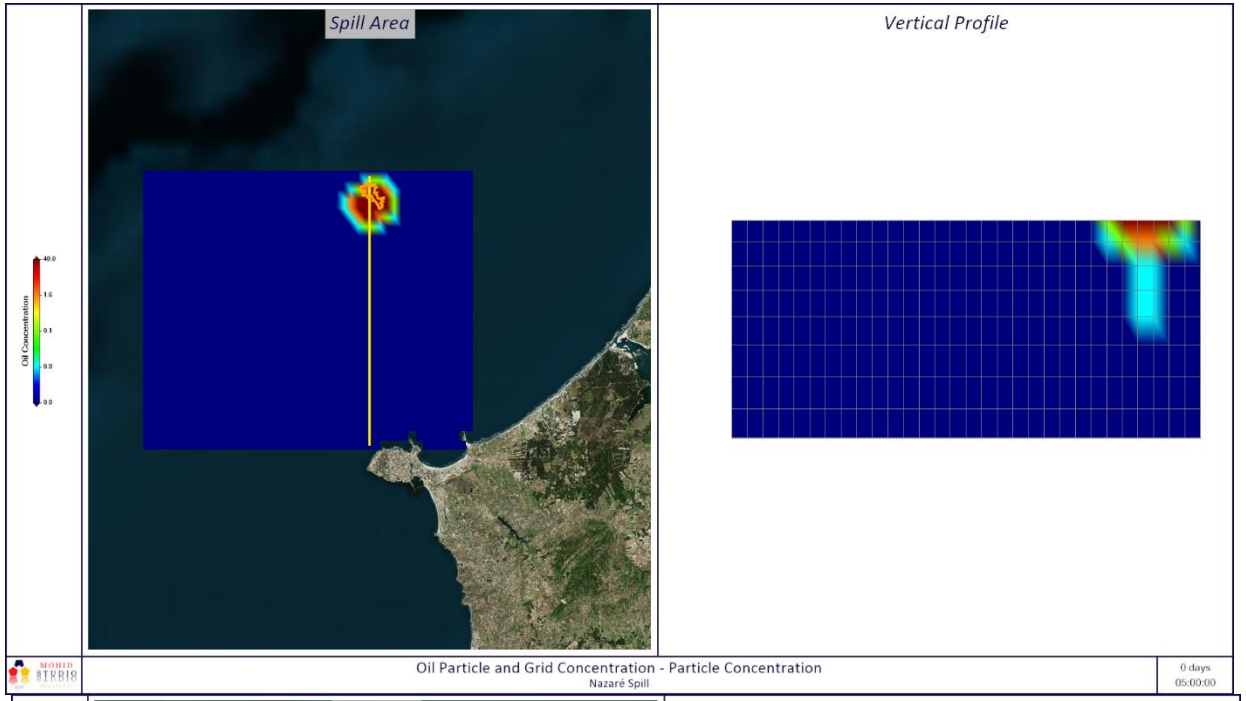
MOHID Lagrangian Wizard
- vertical profile -



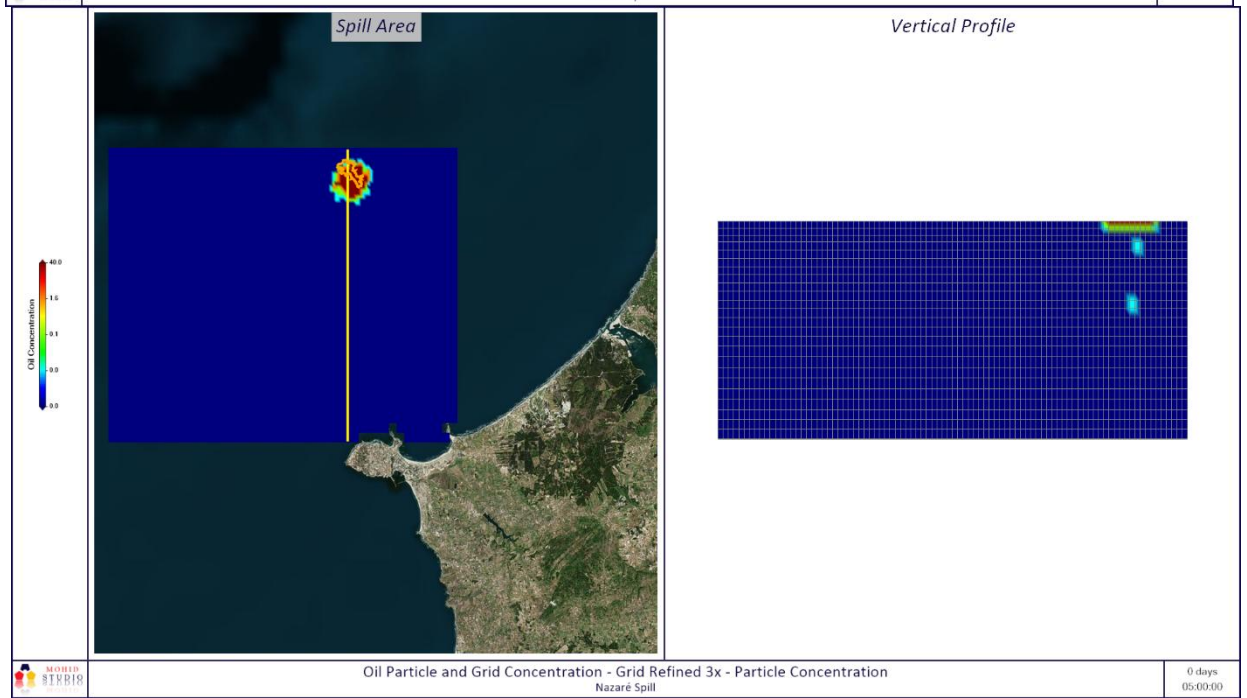
MOHID Lagrangian Wizard
- vertical profile -



Original



3X more resolution



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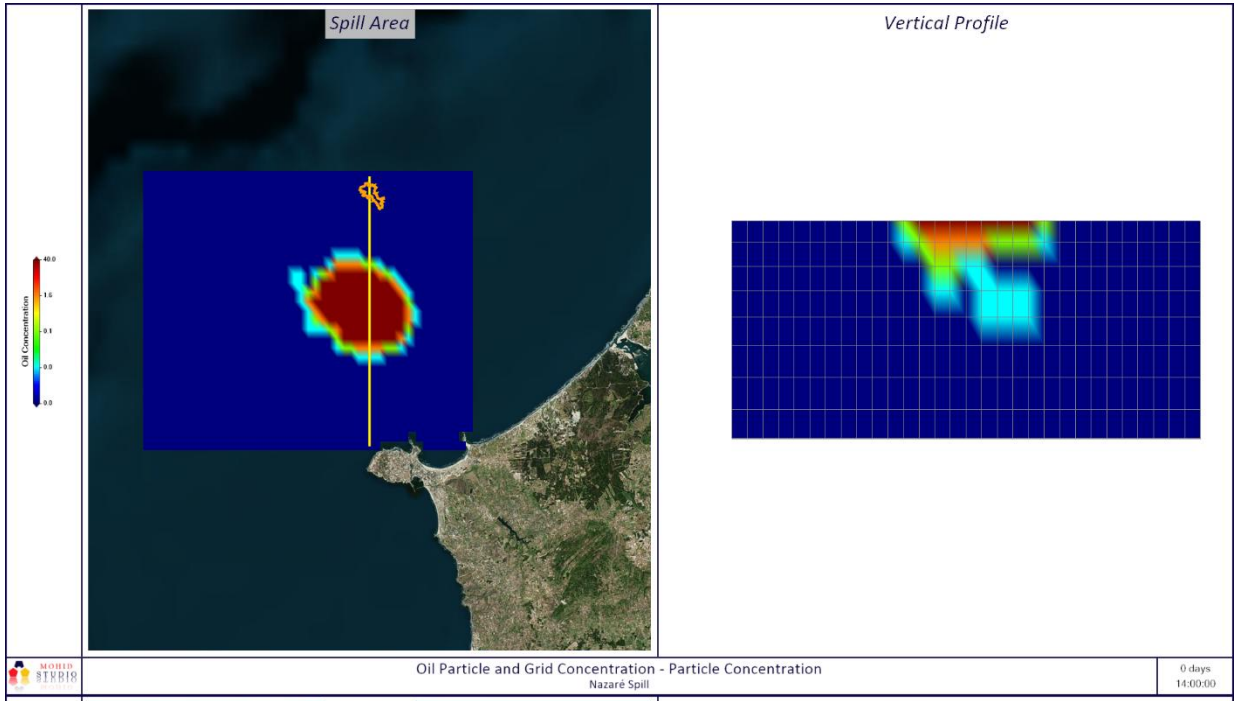

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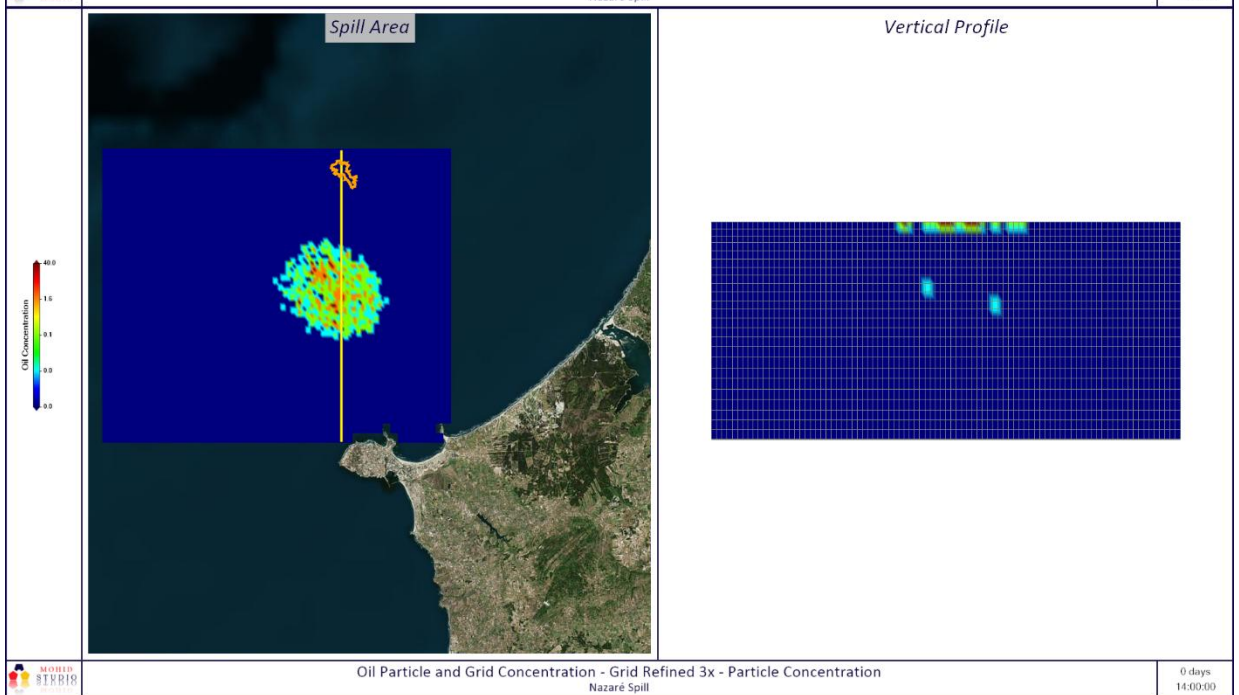

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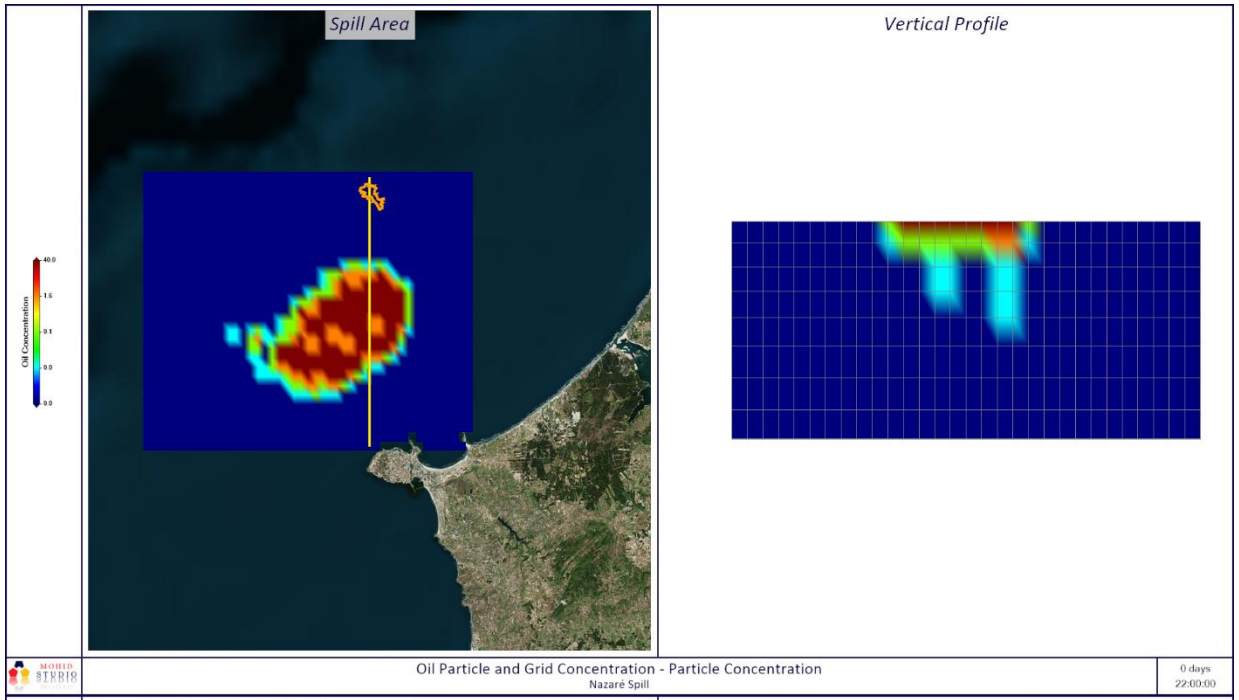

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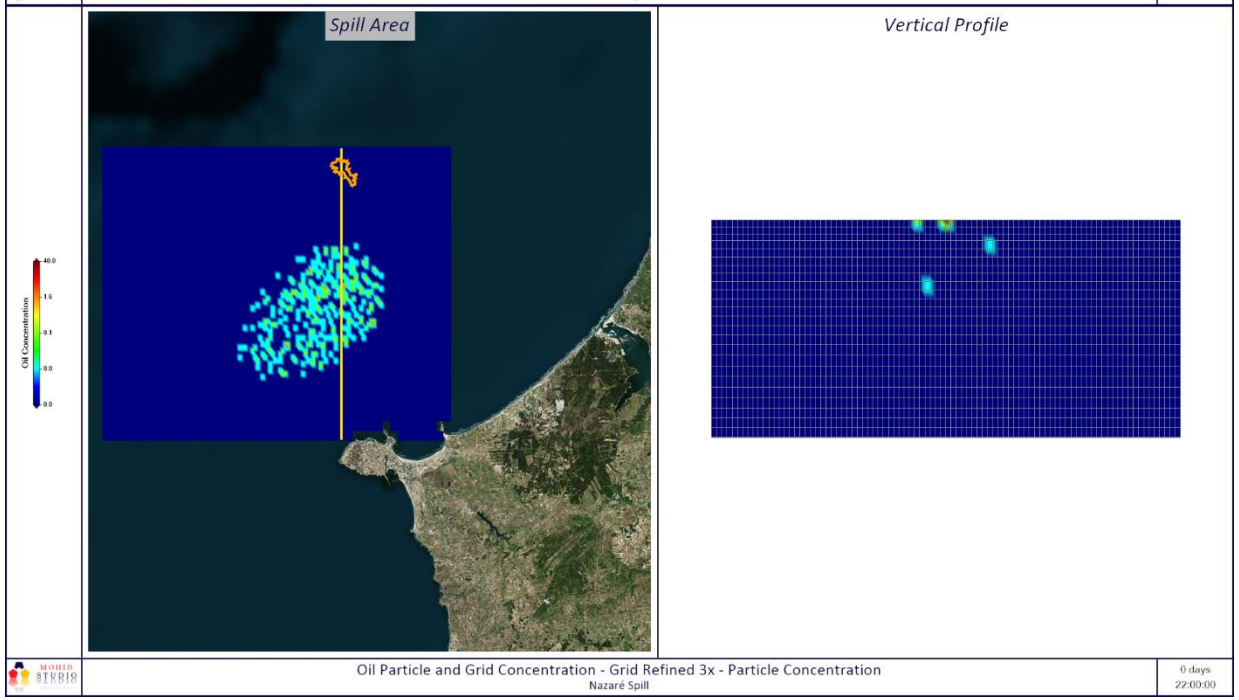
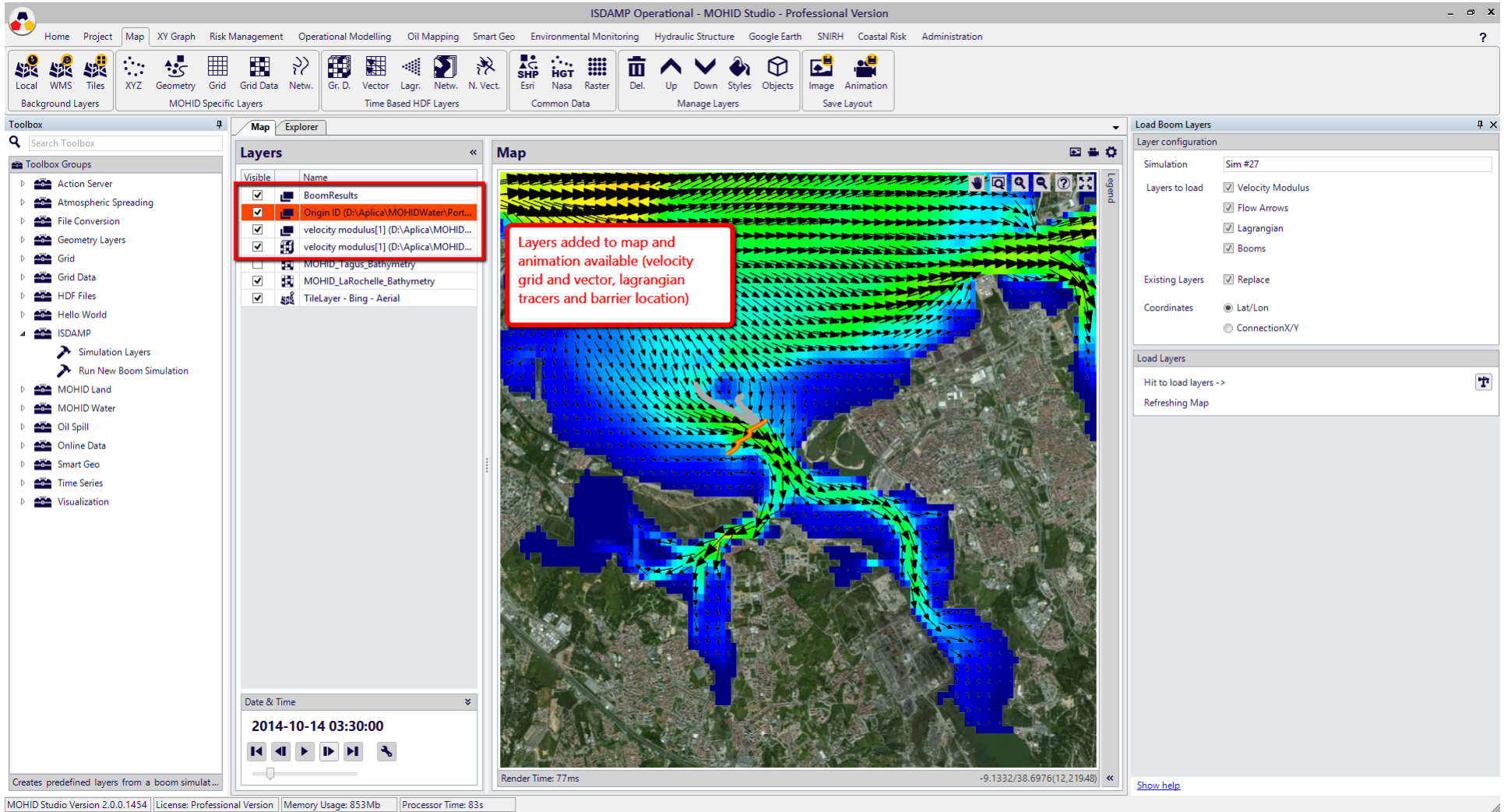
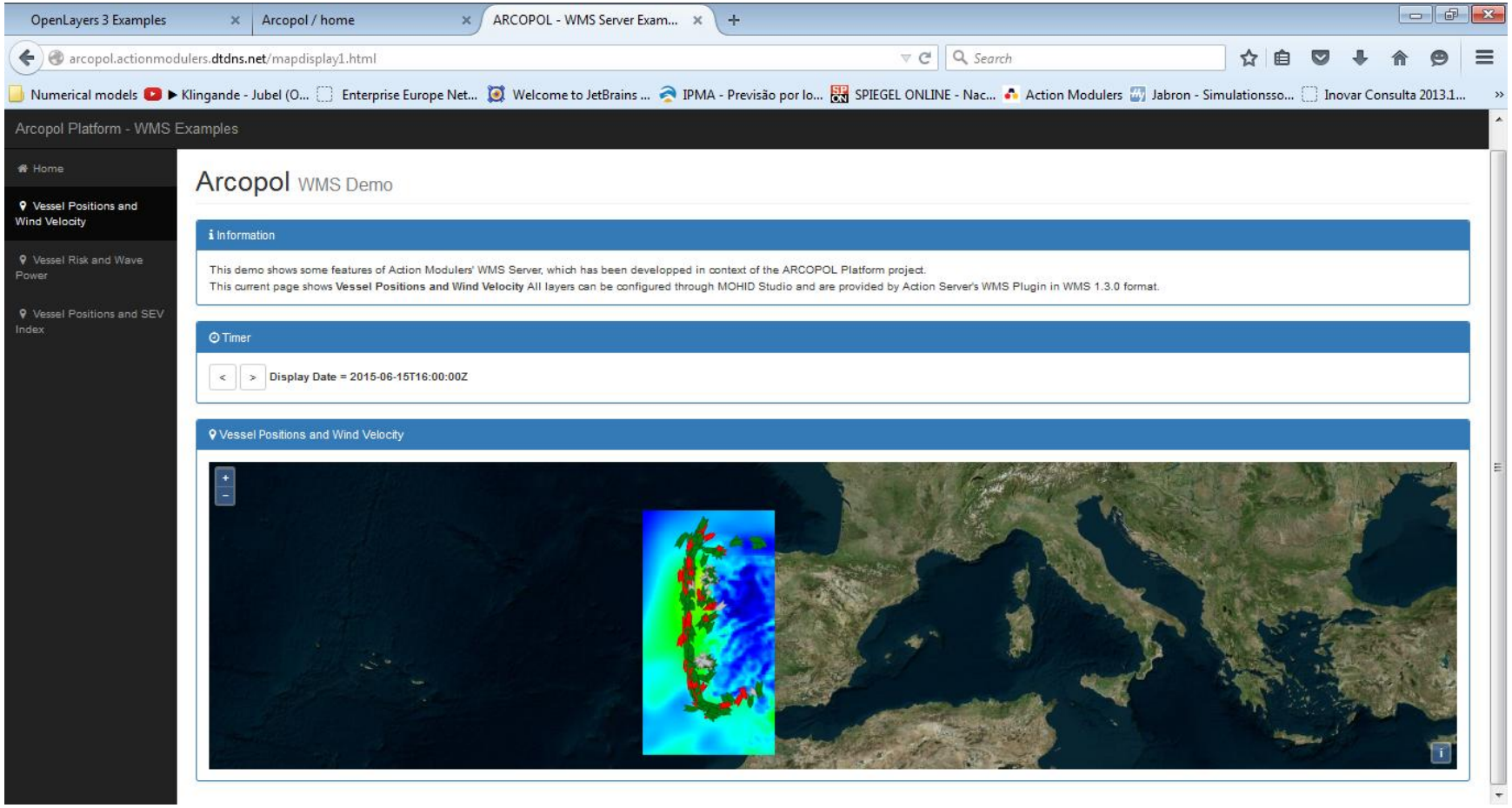


Oil spill + Boom modelling



WMS Server / Demo website

http://arcopol.actionmodulers.dtdns.net/



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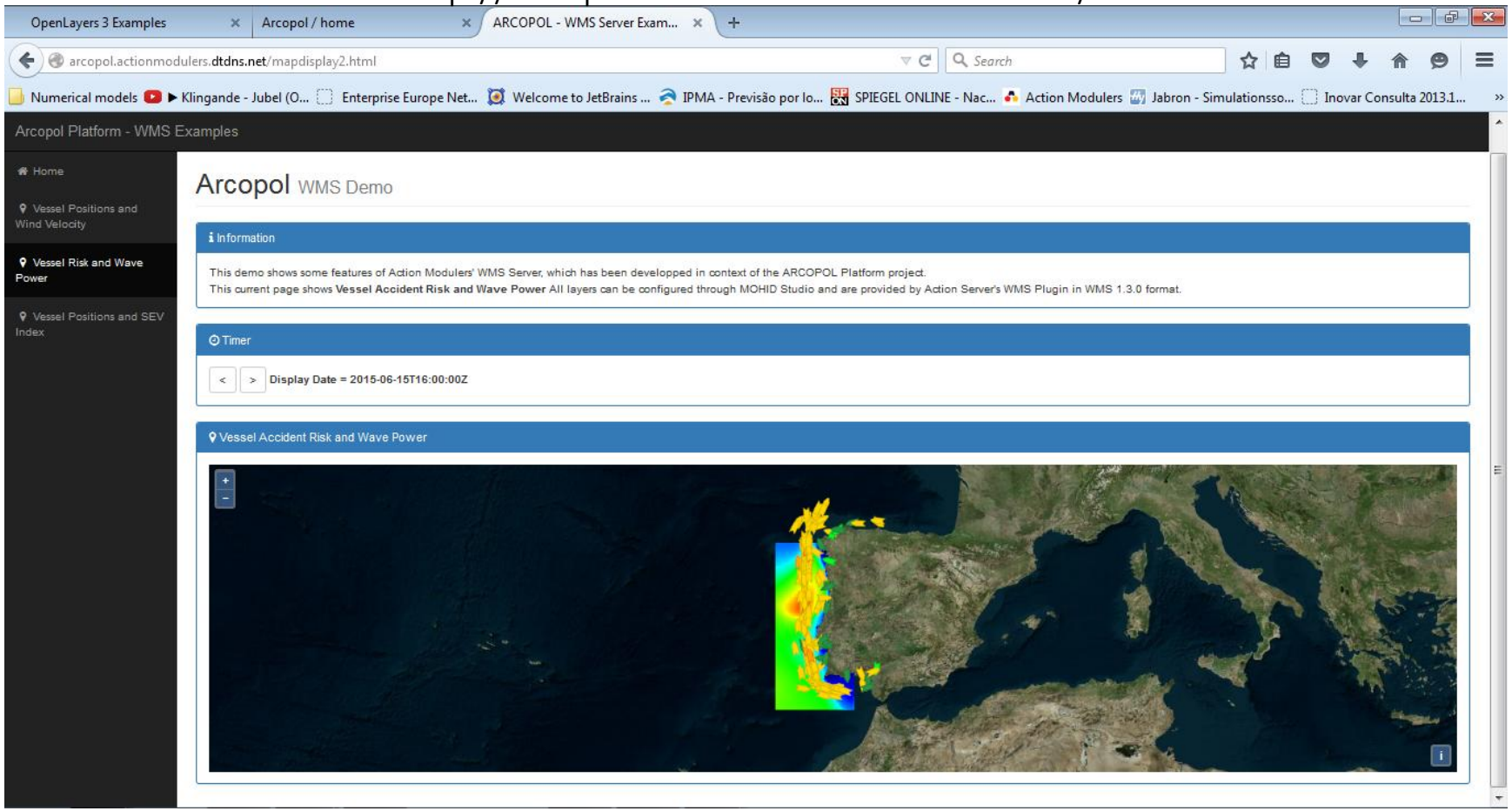

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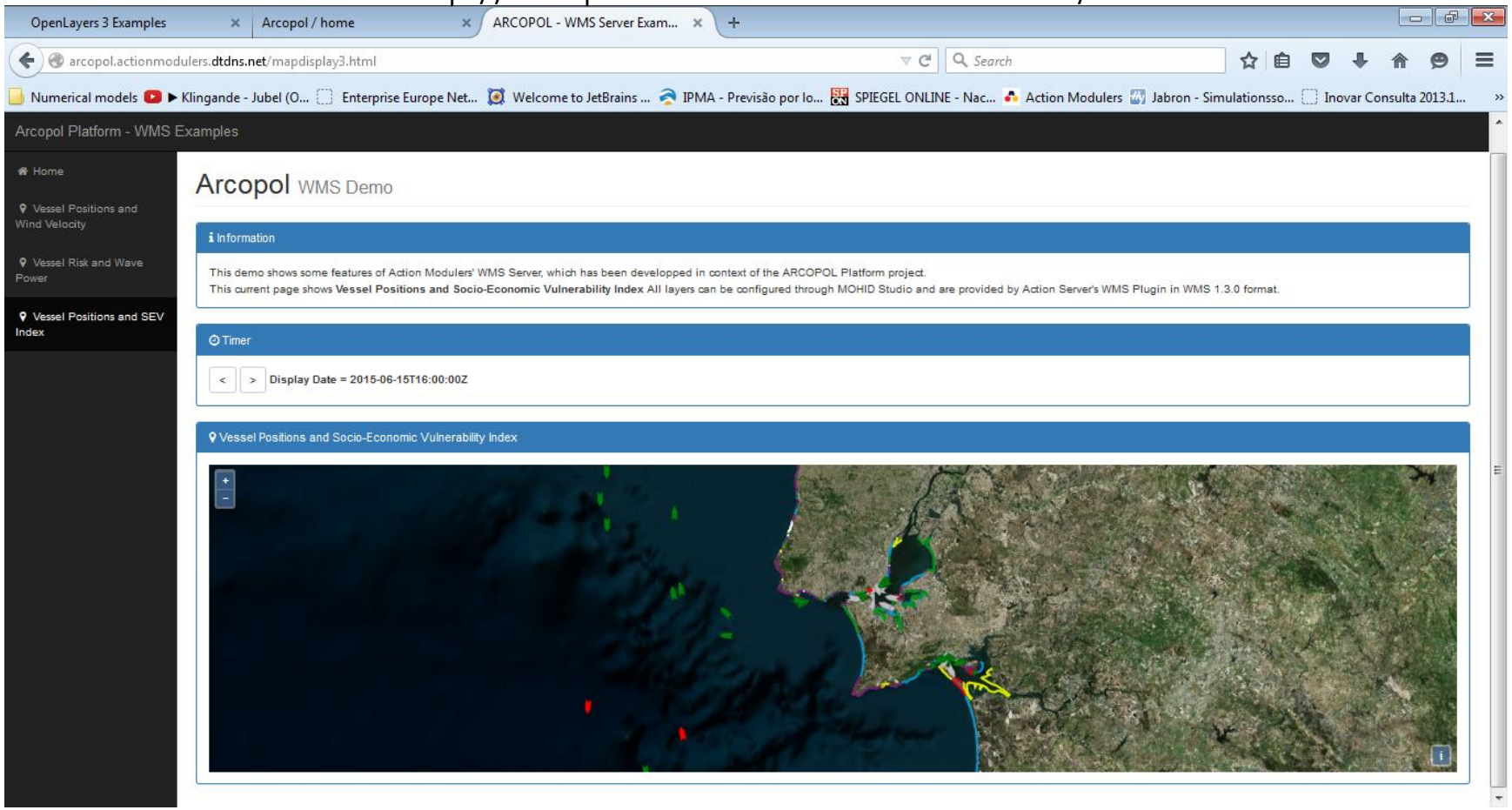
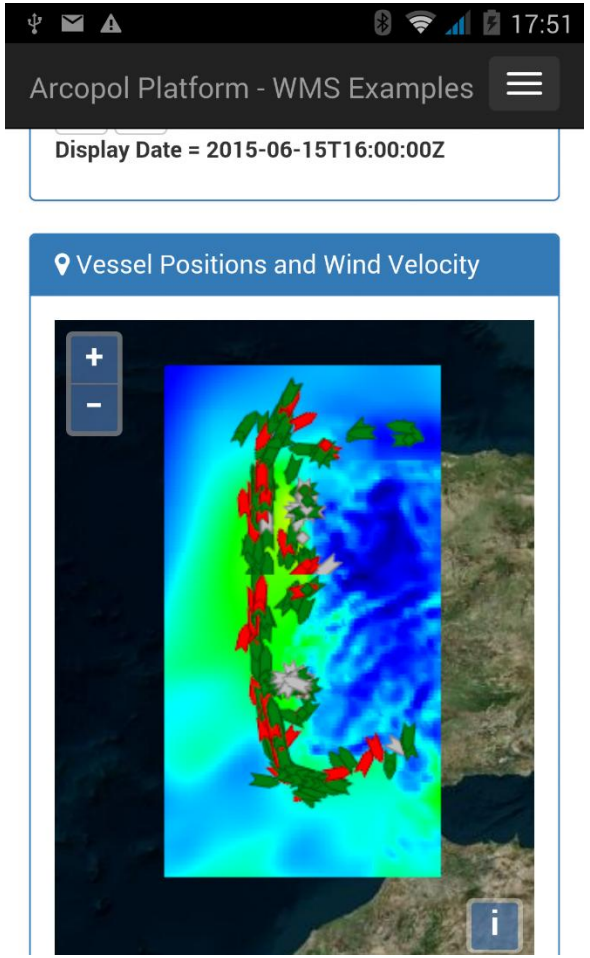


WMS Server / Demo website

http://arcopol.actionmodulers.dtdns.net/

Website with responsive layout: Works perfectly with smartphones



Final Remarks & Future Work

An holistic approach for simulating oil spills is essential to a more effective and robust decision-making

Continuous model validation and software testing process is essential to ensure preparedness

Future challenges:

- Improve deep sea modelling processes of oil & gas;
- integration of multiple model-based decision support tools in an oil spill response COP (common operating picture)

Obrigado!

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