

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

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1 MARETEC – Instituto Superior Técnico

2 Hidromod

3 Action Modulers

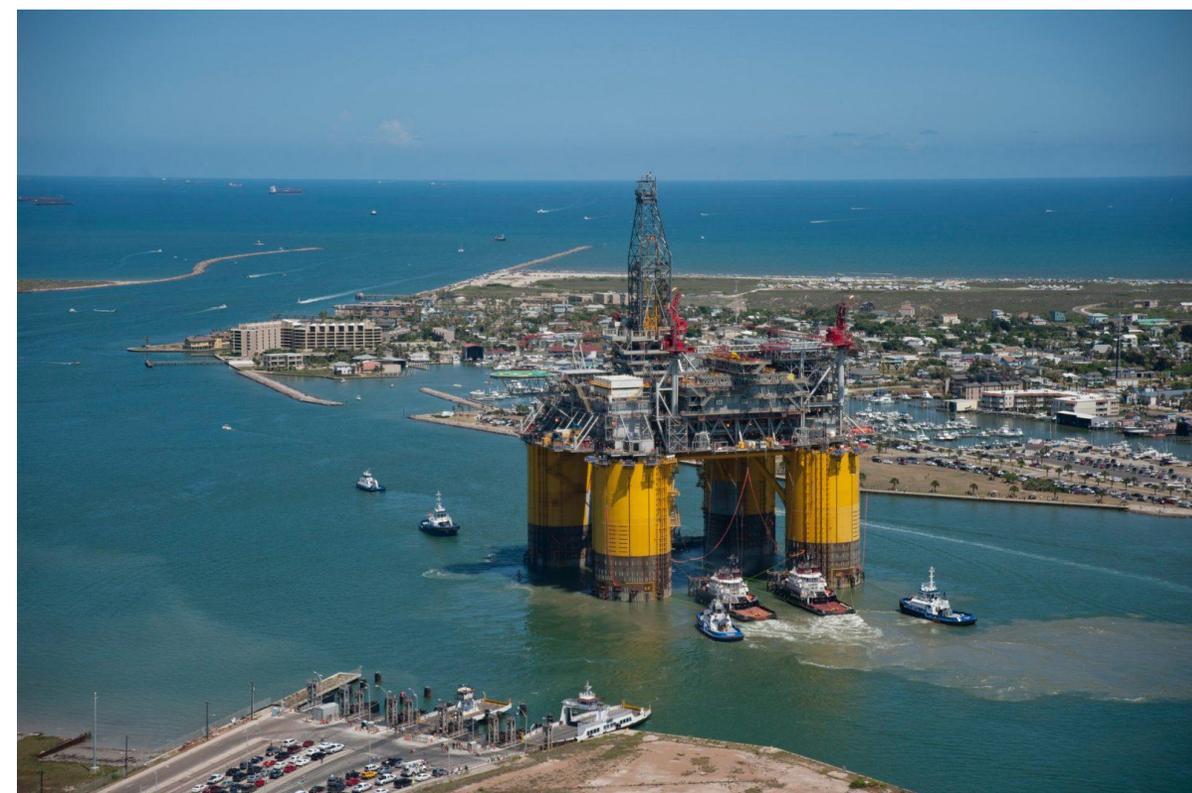
# Summary

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

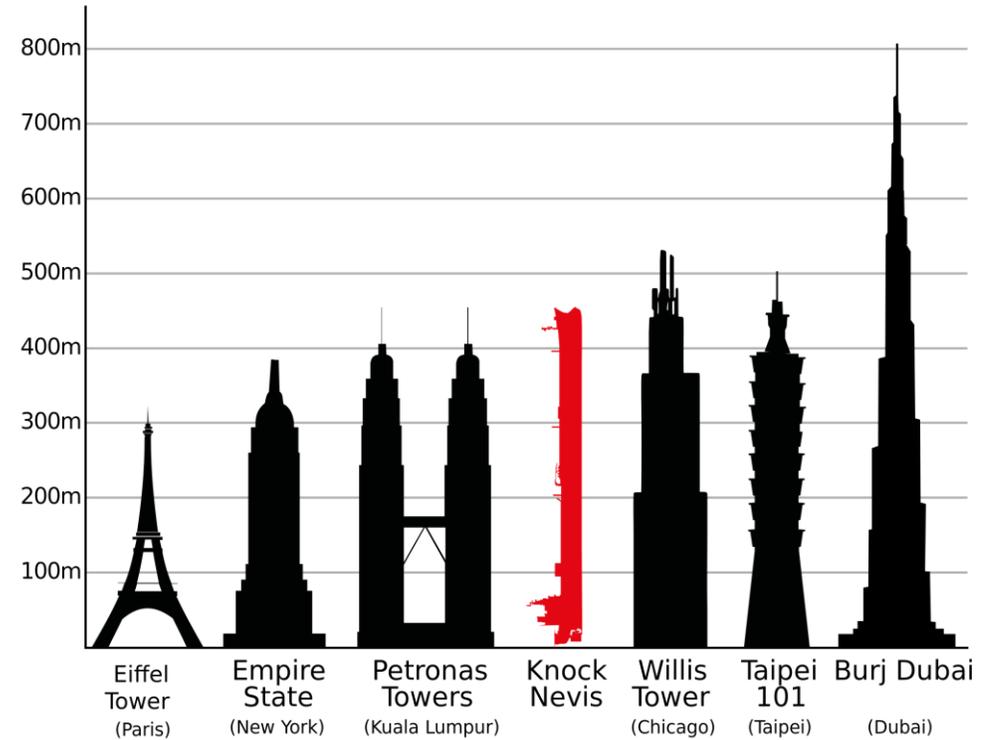


Olympus oil rig (Shell,  
Gulf of Mexico)

# The supertanker era



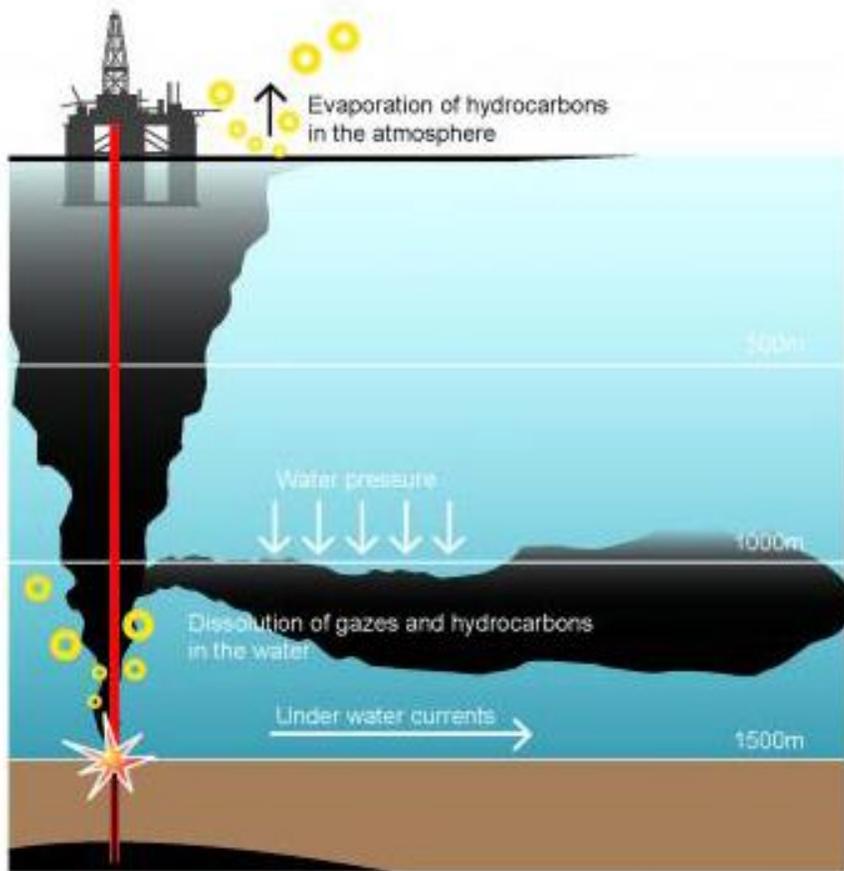
*TI Europe vessel*



# > 2000 Chemicals transported by the sea



# Examples of consequences from oil spills



Deepwater Horizon Spill, Gulf of Mexico, 2010)

## 2. Proposed modelling solution using MOHID

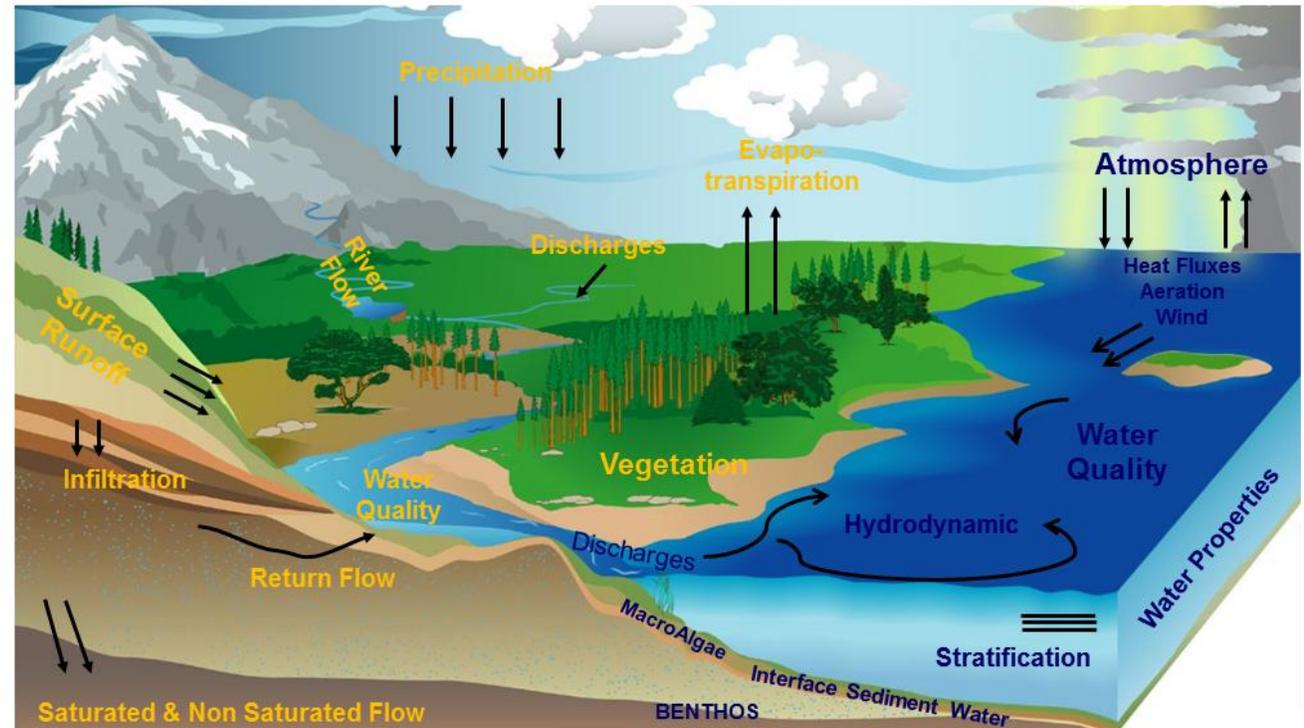
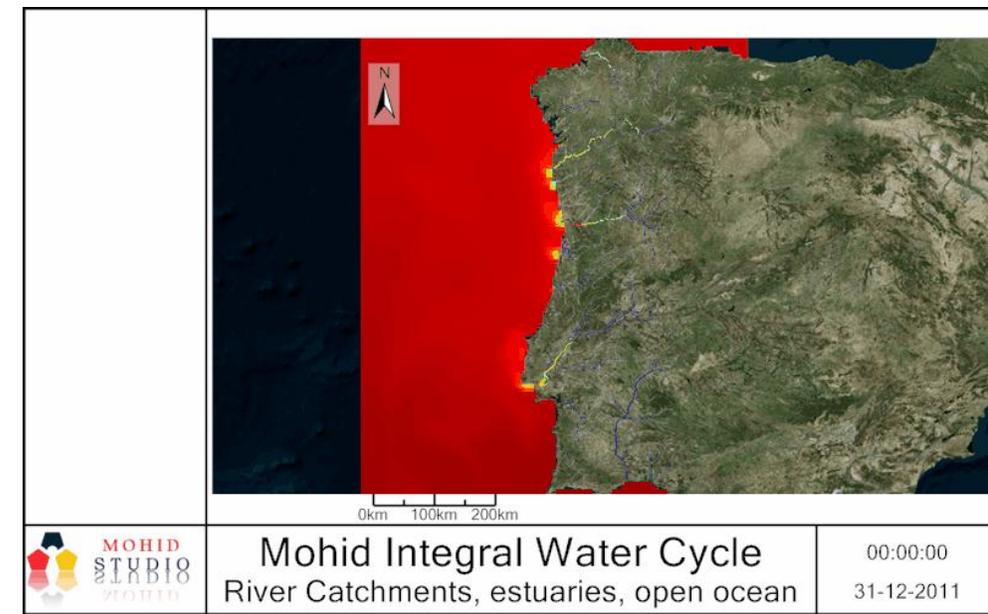
# The modelling solution should be integrated

- 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



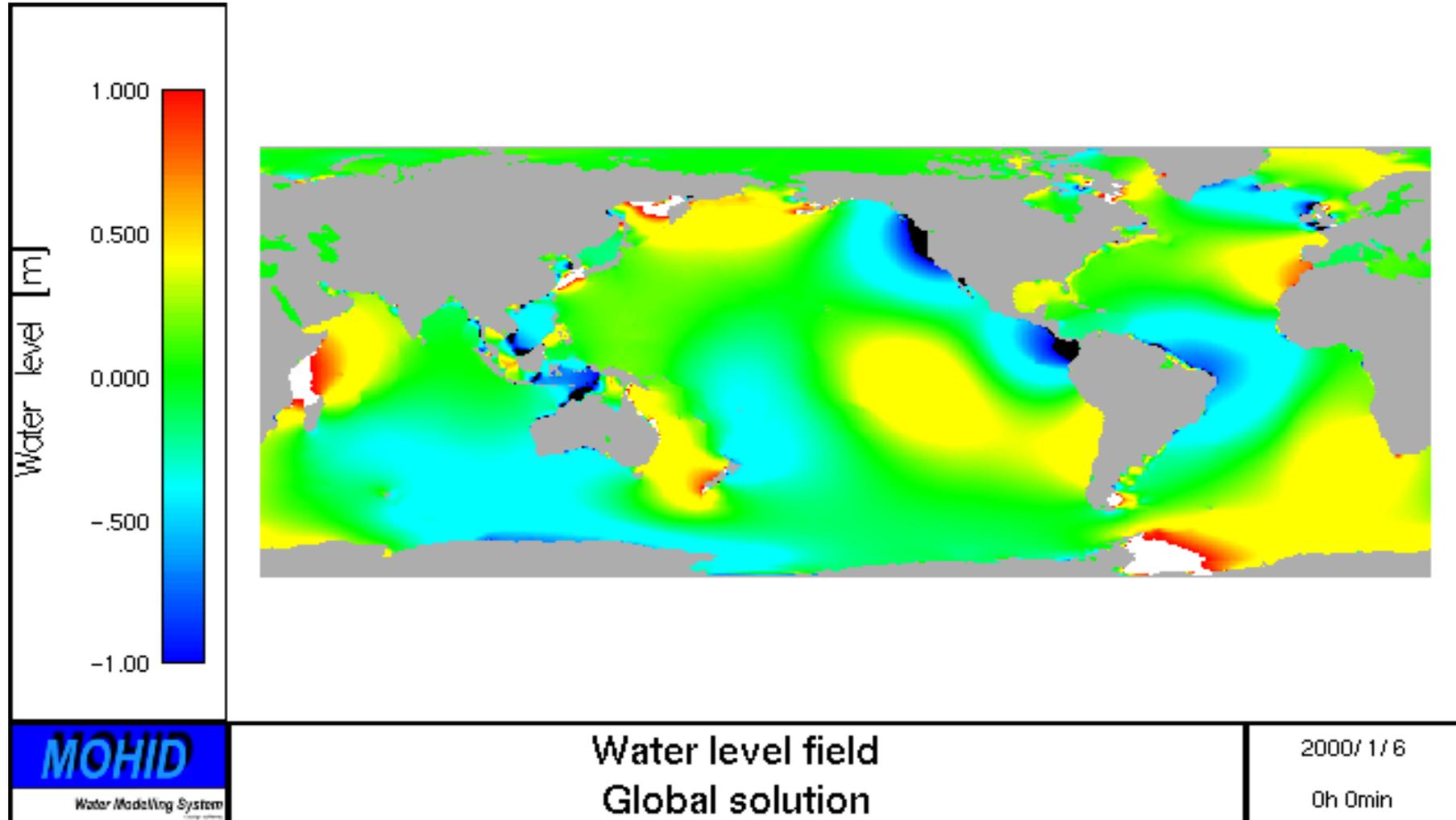
- open-source community model
- Both research and engineering purposes
- Windows, linux
- Laptop, desktop, clusters...
- OpenMP, MPI
- Applied by scientific and engineering community all over the world



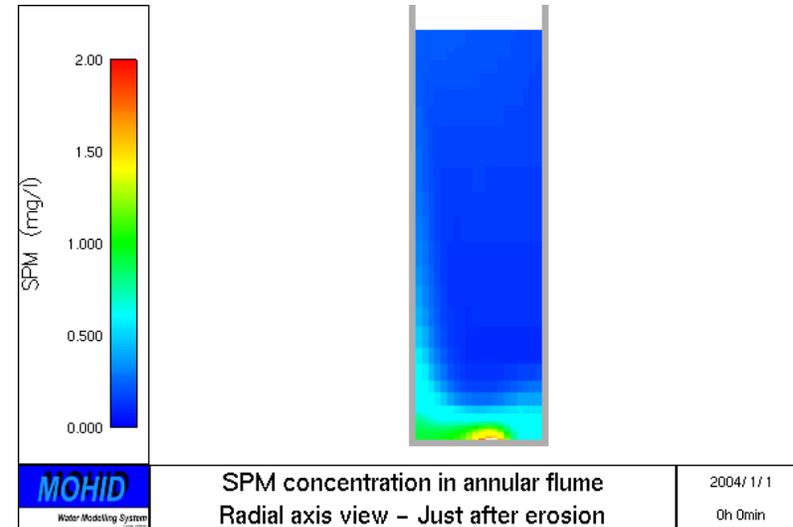
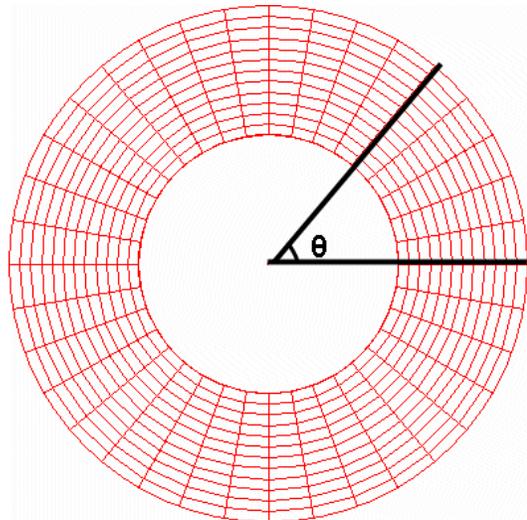
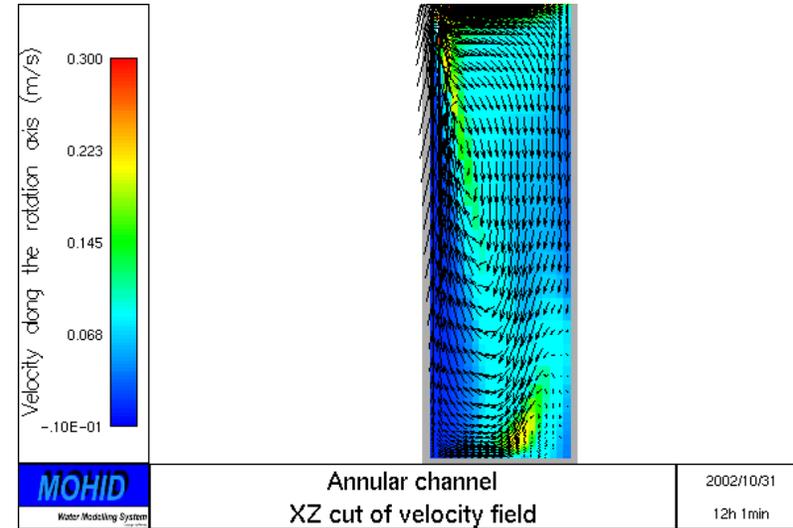
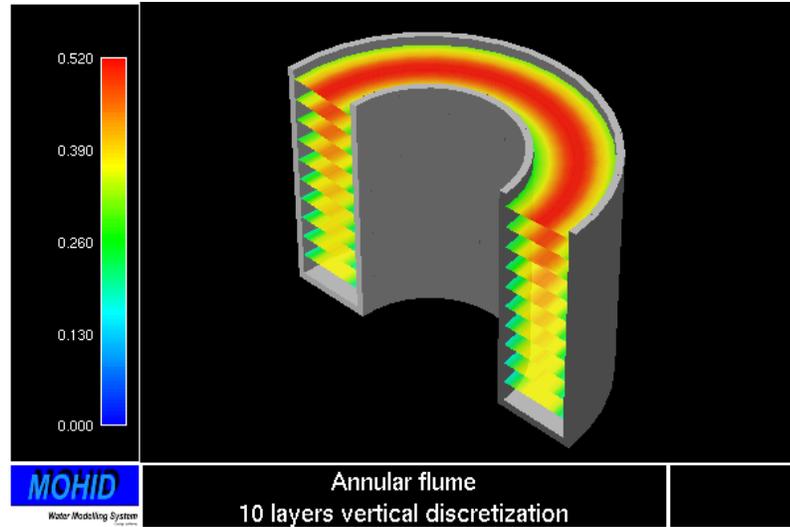
MOHID Land

MOHID Water

# From Global...



# ...to smallest

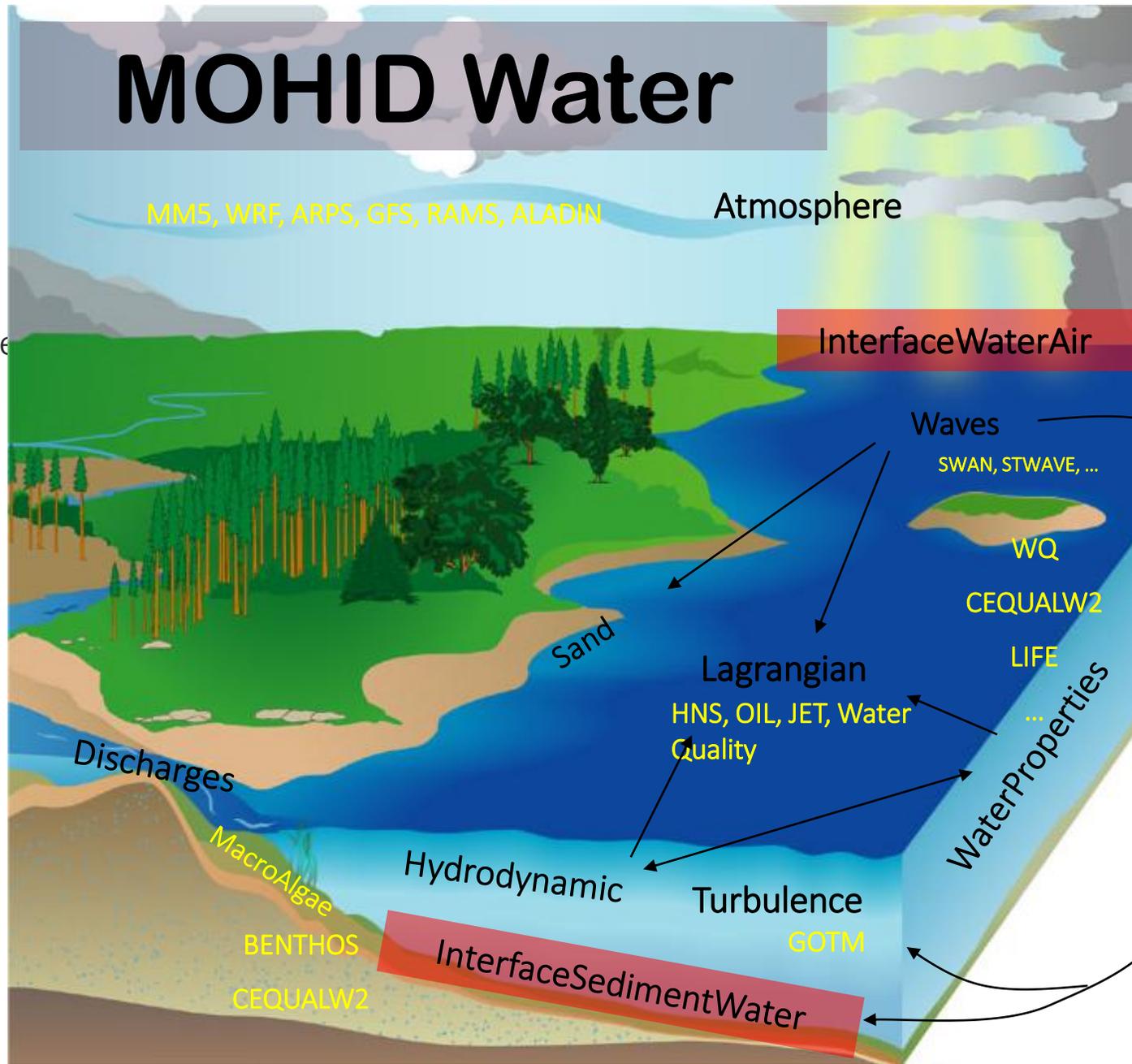


# MOHID Water

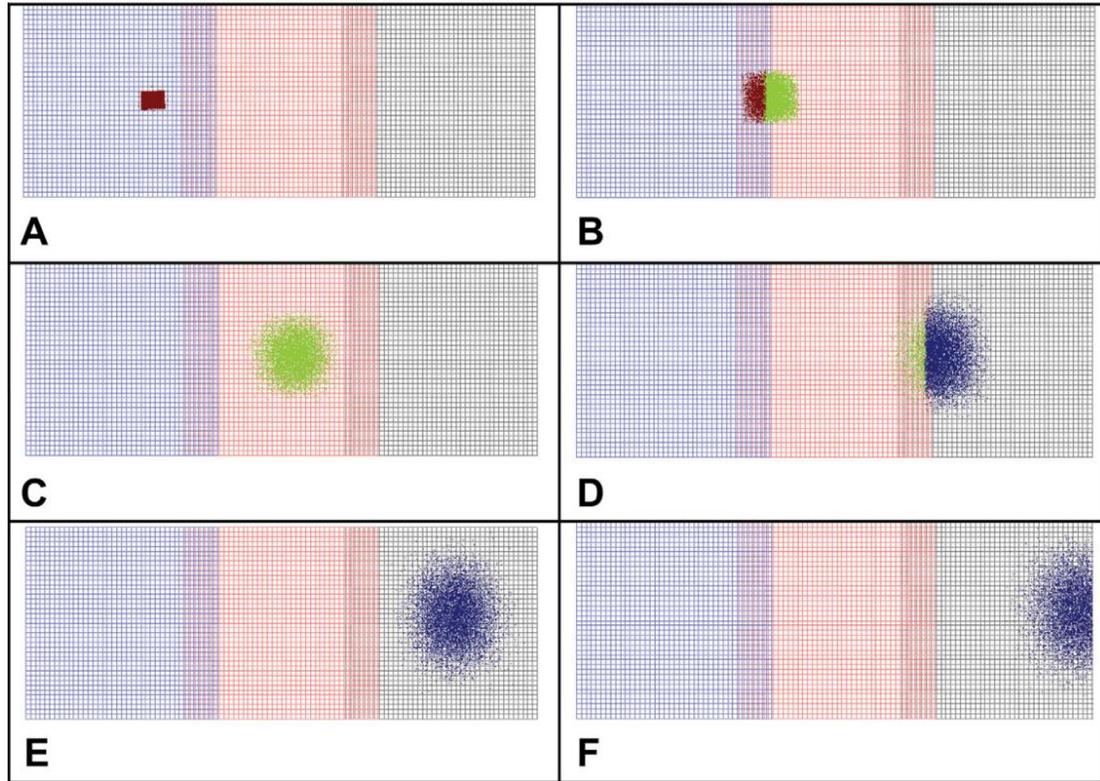
Oil and

oach

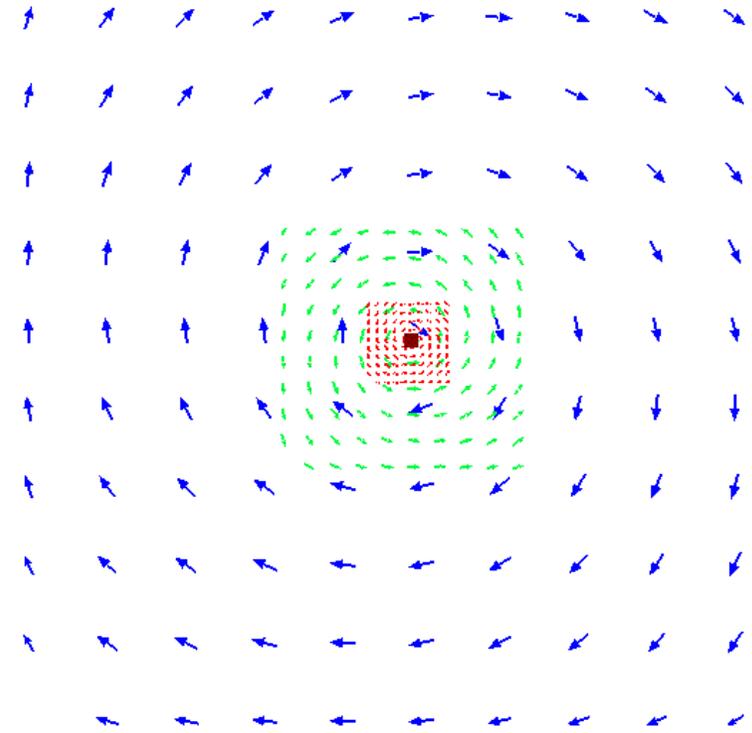
MOHID Water mode



# 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

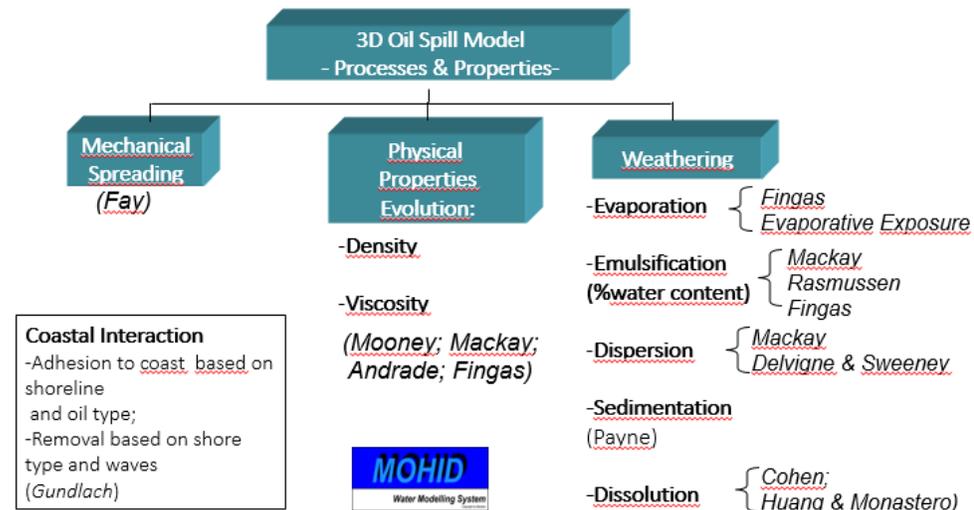
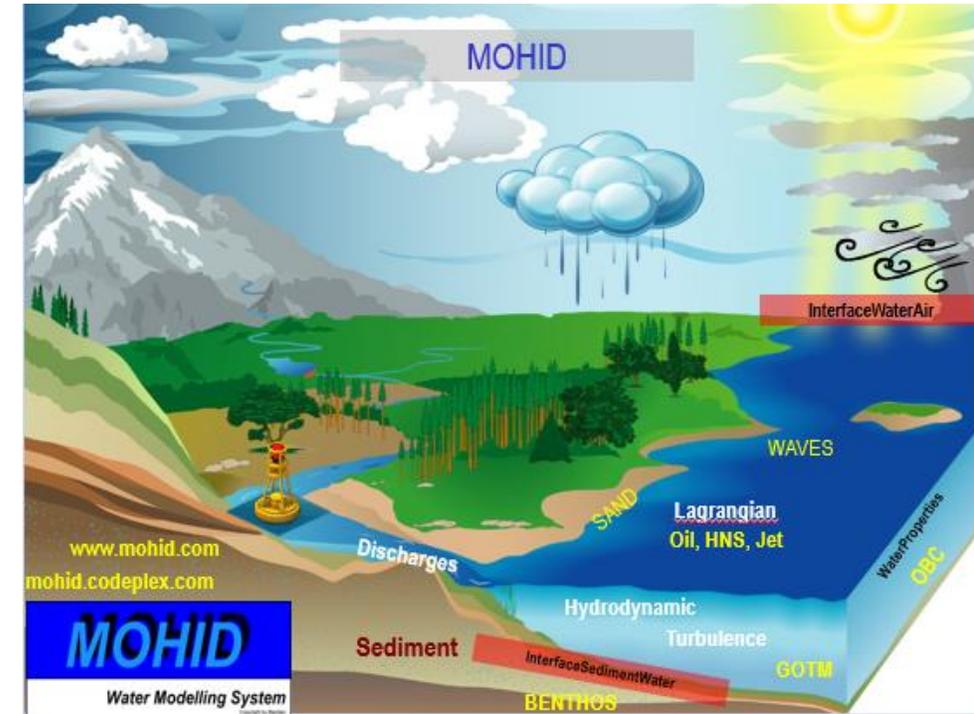
# MOHID Oil Spill model

Source code development

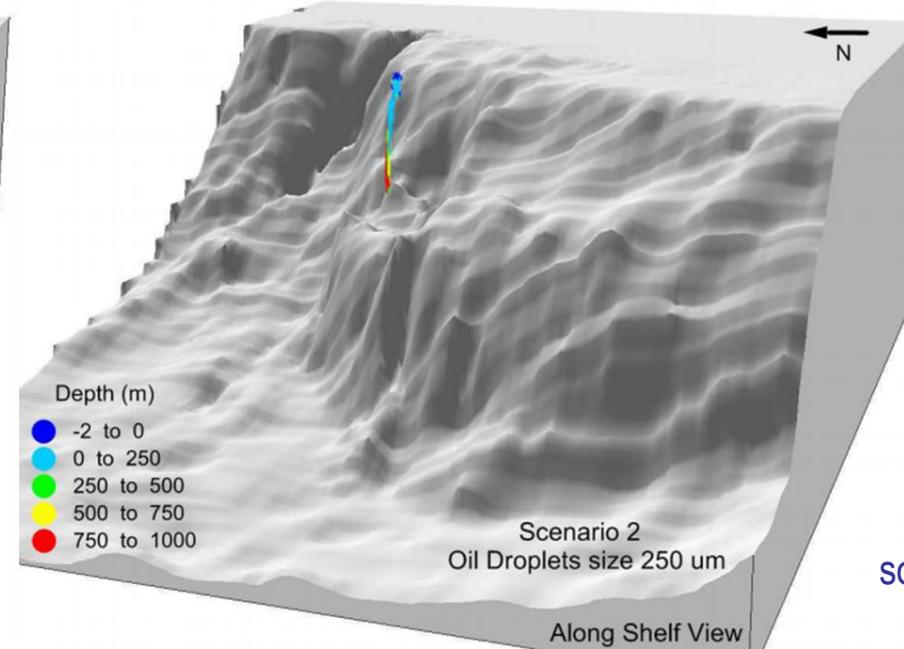
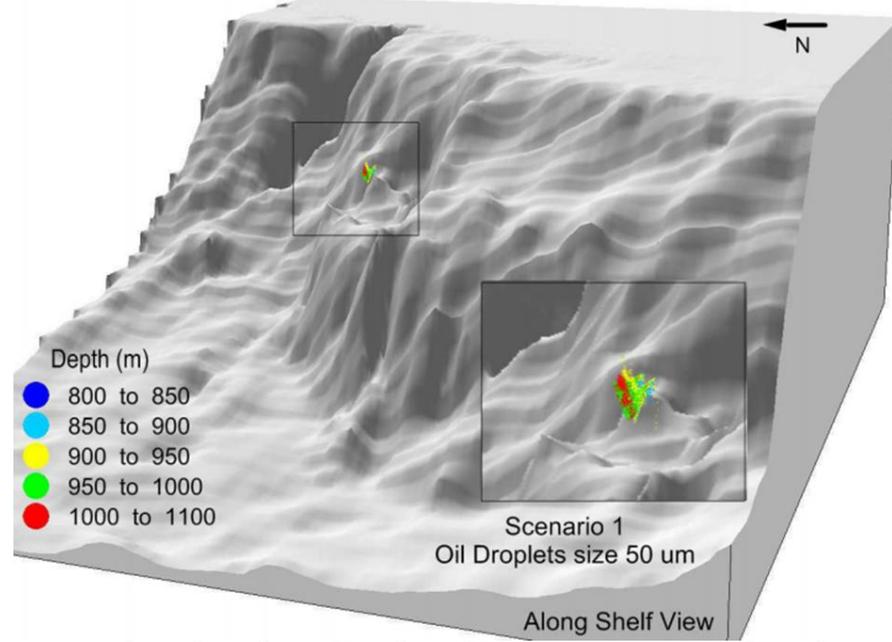
EU Projects (ECOOP, EROCIPS, ARCOPOL, ARCOPOL+, ARCOPOLplatform, EASY, EASYCO, DRIFTER, ISDAMP)

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

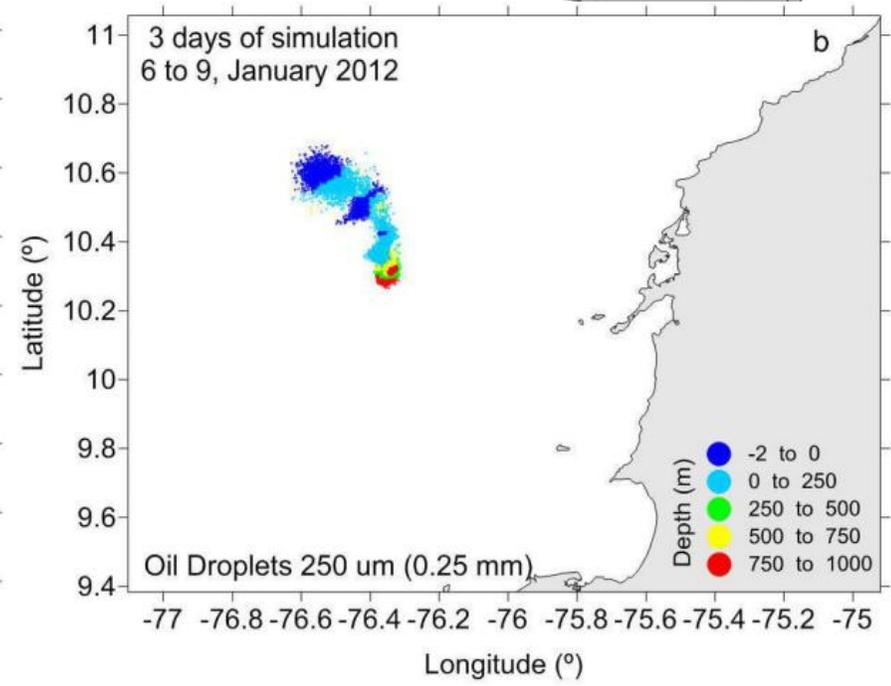
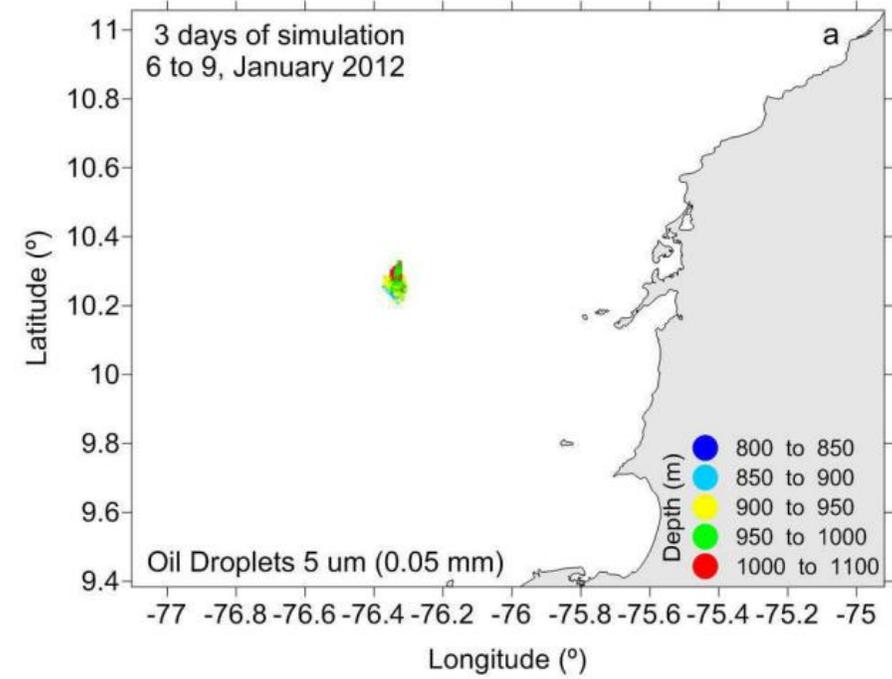
Operational support to real accidents (e.g. Prestige)



MOHID  
deep-water  
oil spills

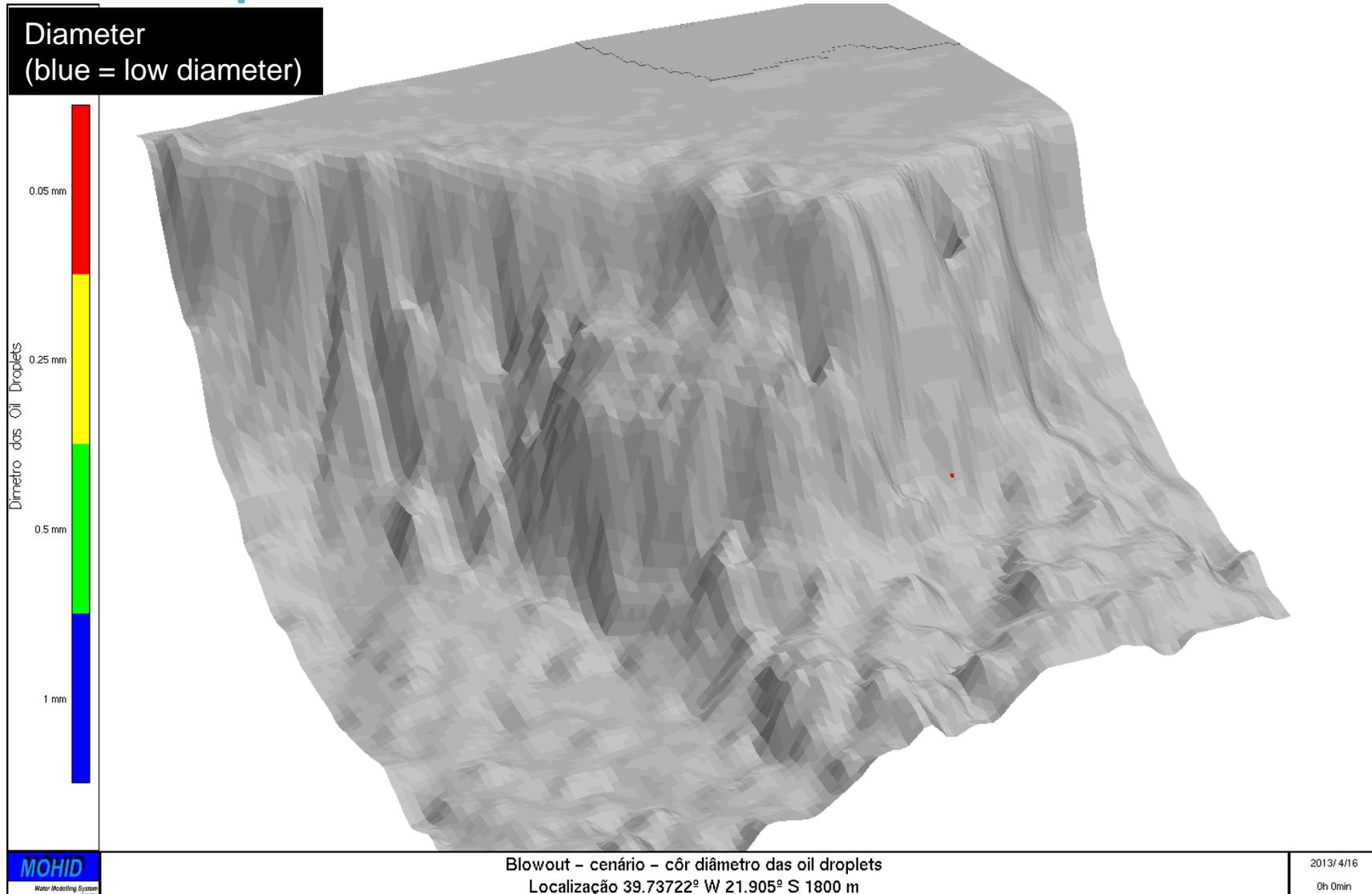


source: Leitão et al., 2013

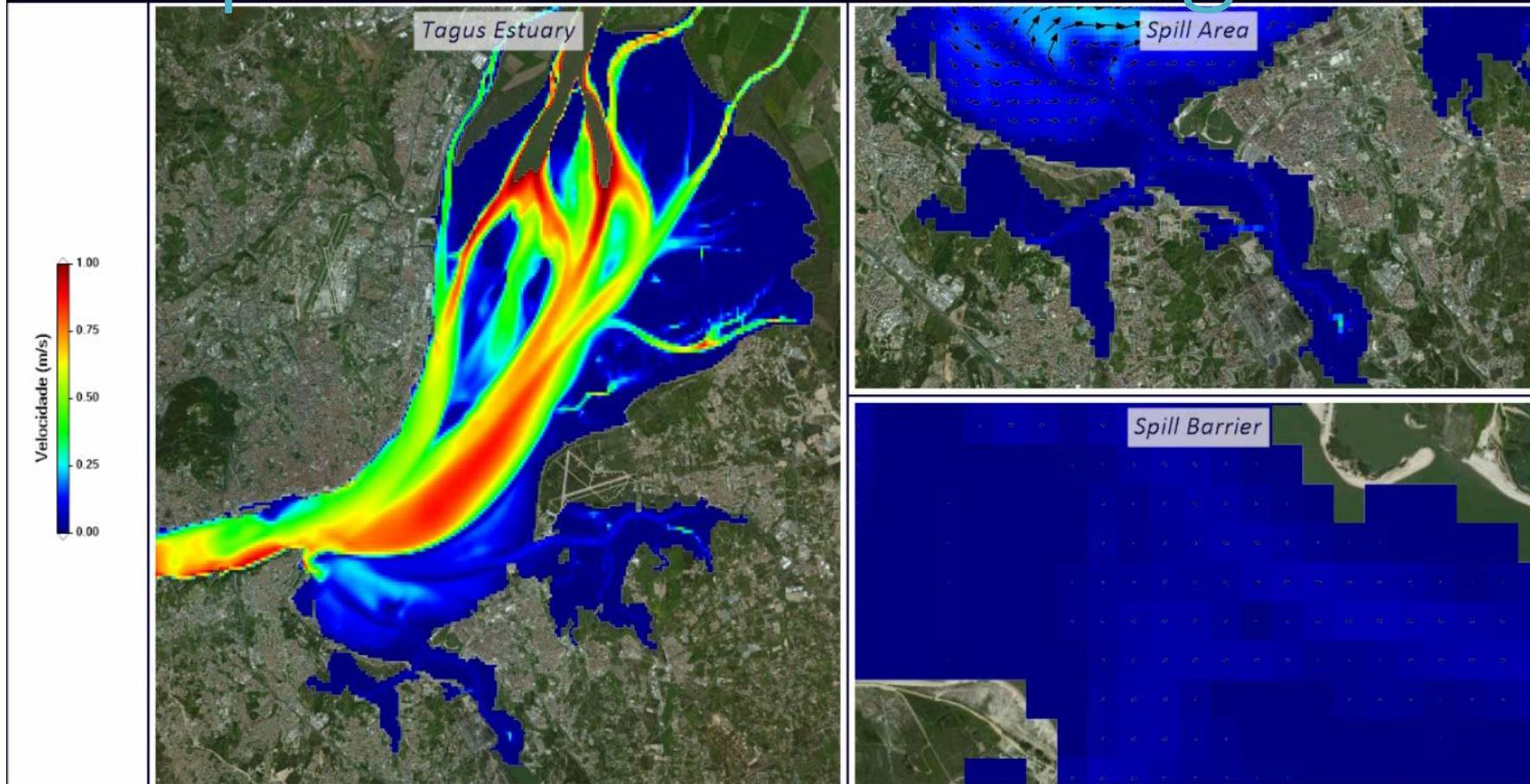


Blowout simulations in Caribbean Coast (Colombia): Particle depths with different oil droplet diameters. 3D (above) and XY (below) views

# Oil Spill Modelling in MOHID - 3D processes -



# Oil spill + Boom modelling



MOHID Water + Barrier with OpenMI. MOHID implementation from IST and Barrier model from EIGSI  
Tagus Estuary

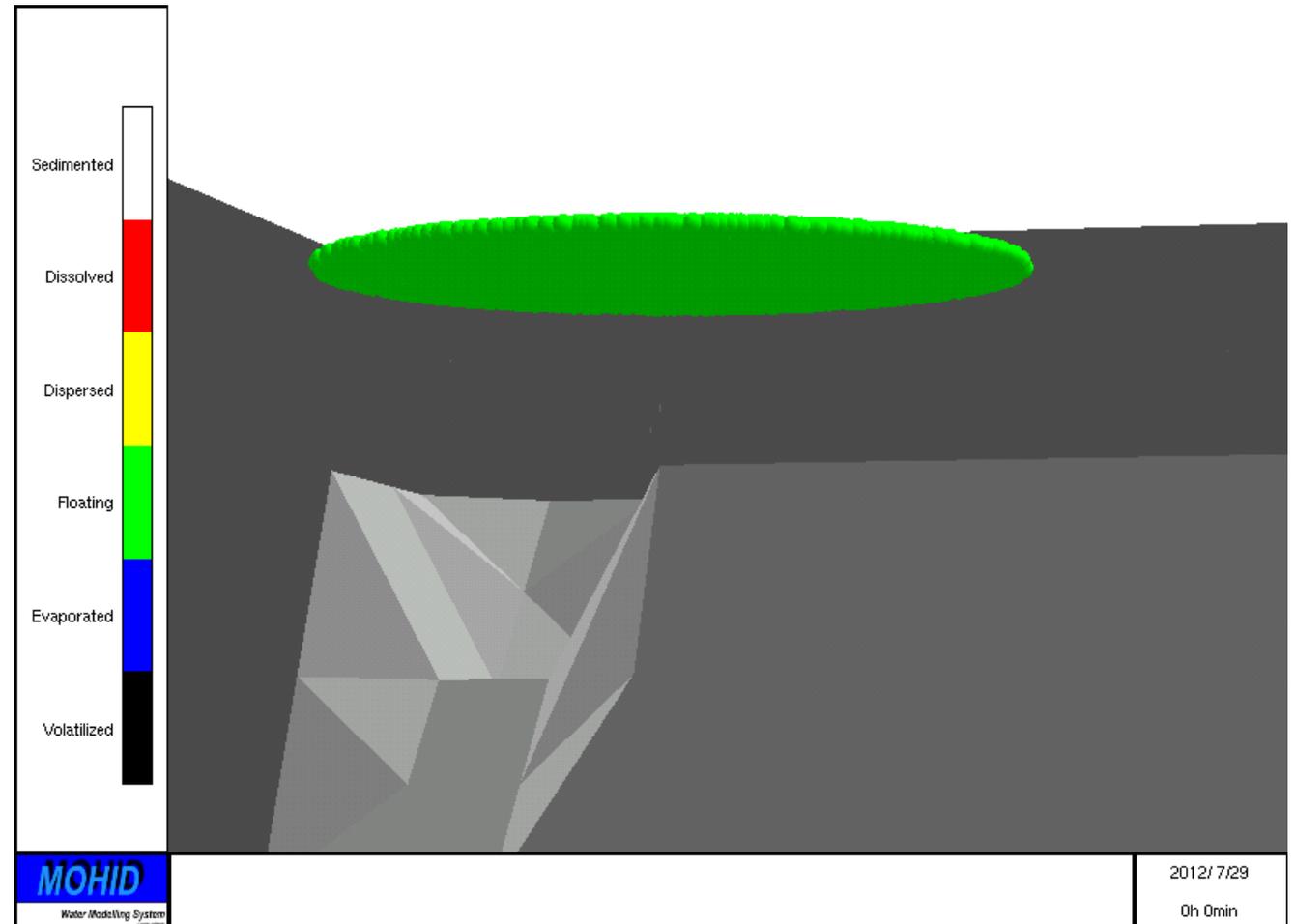
00:00:00  
14-10-2014

# 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

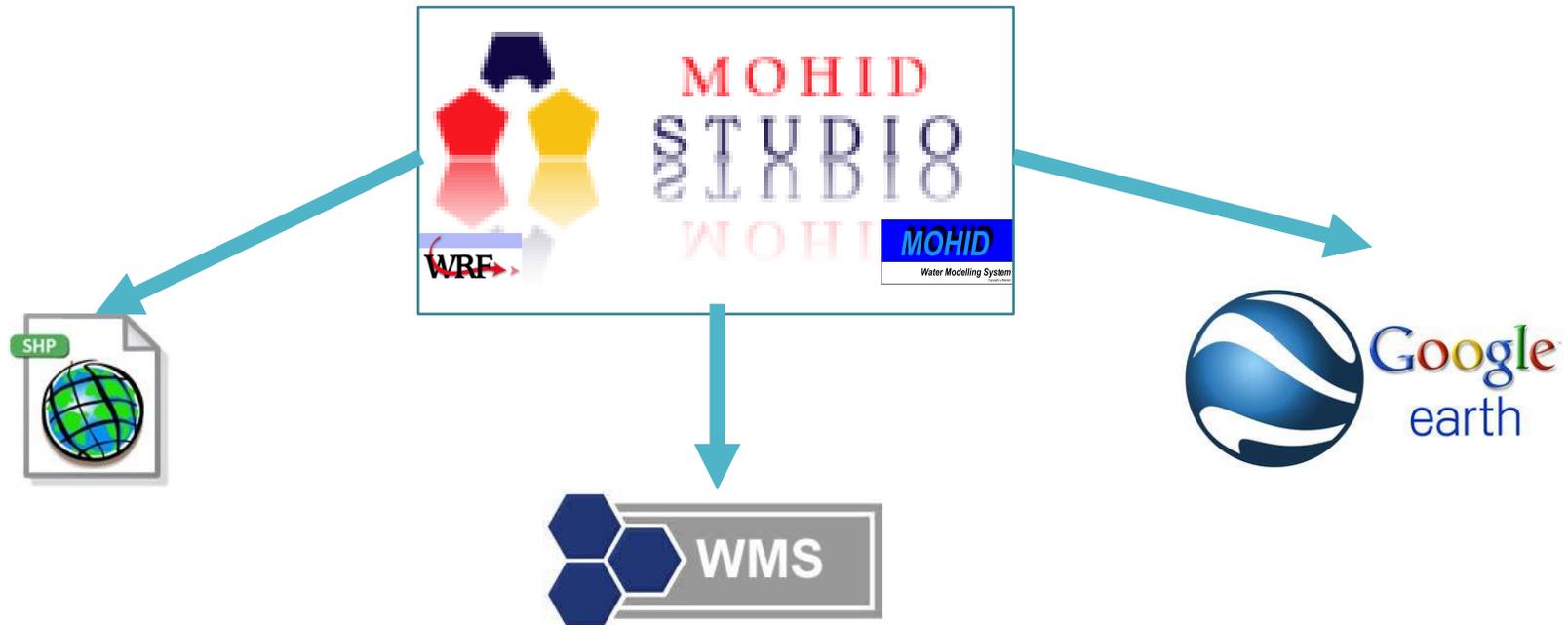
## “All in one and one for all”

- 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

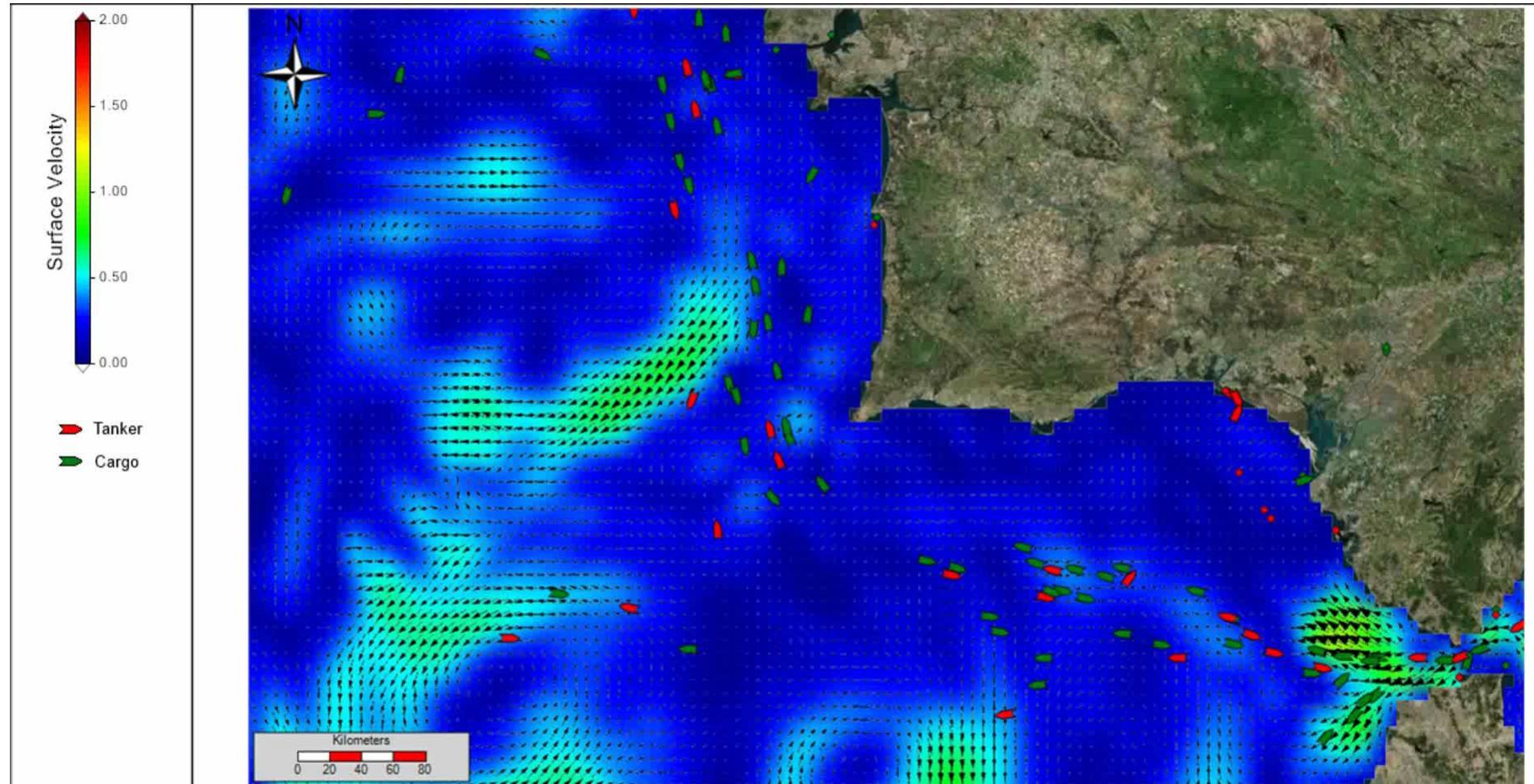
# Strategy: All in one and one for all



# 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?”

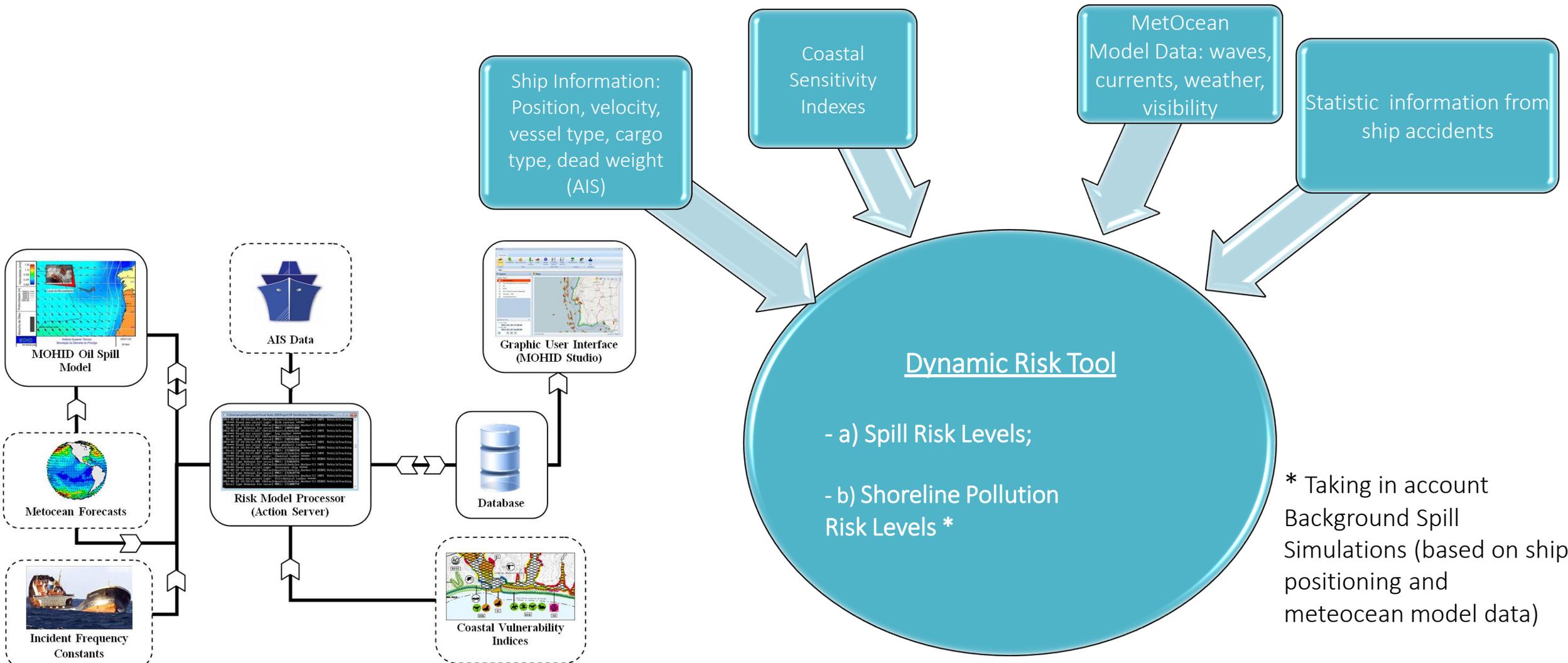
Dynamic Risk Approach

Static vs. Dynamic Risk

Static = working with scenarios (good for planning stages)

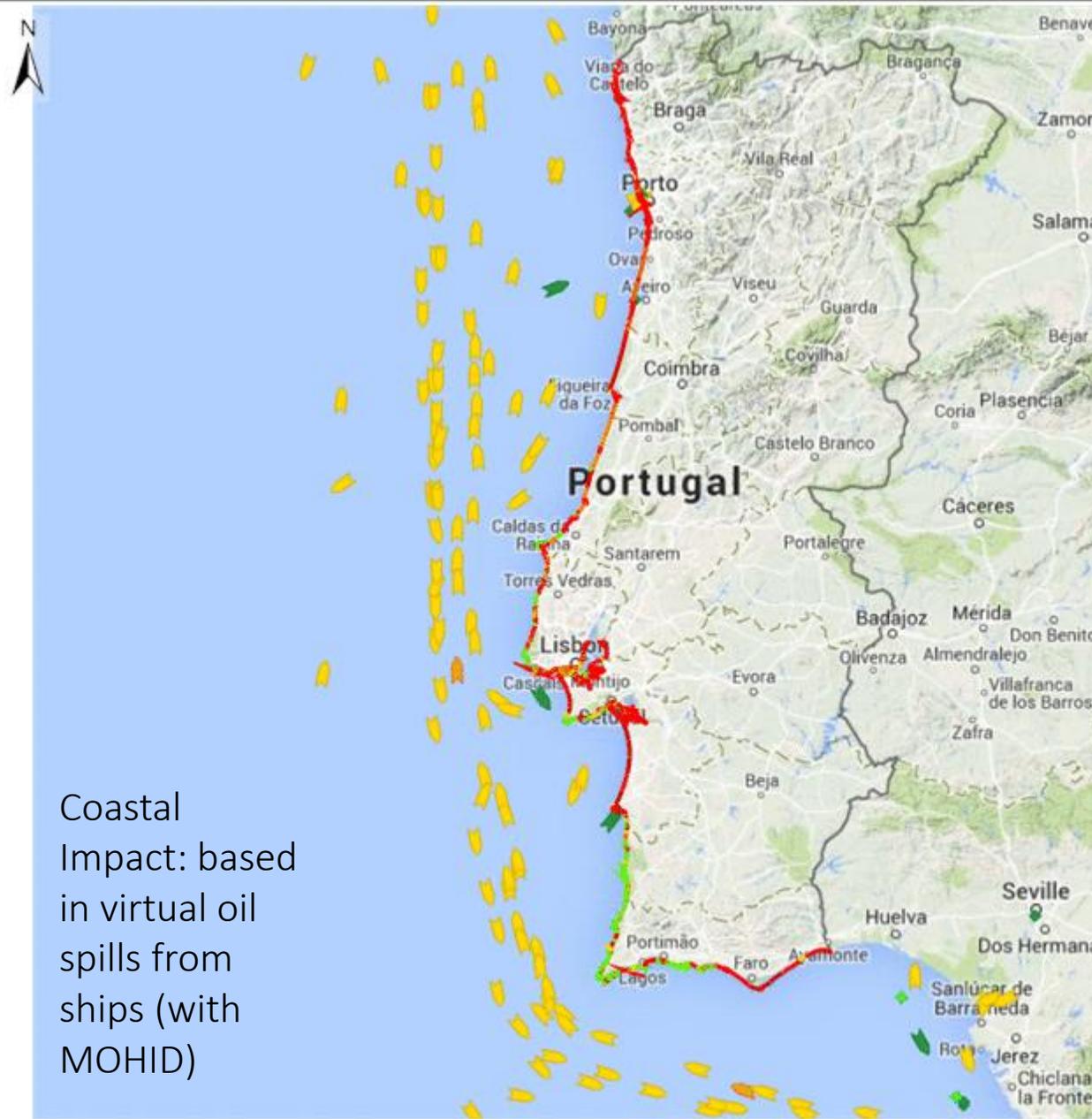
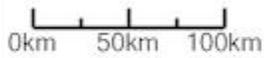
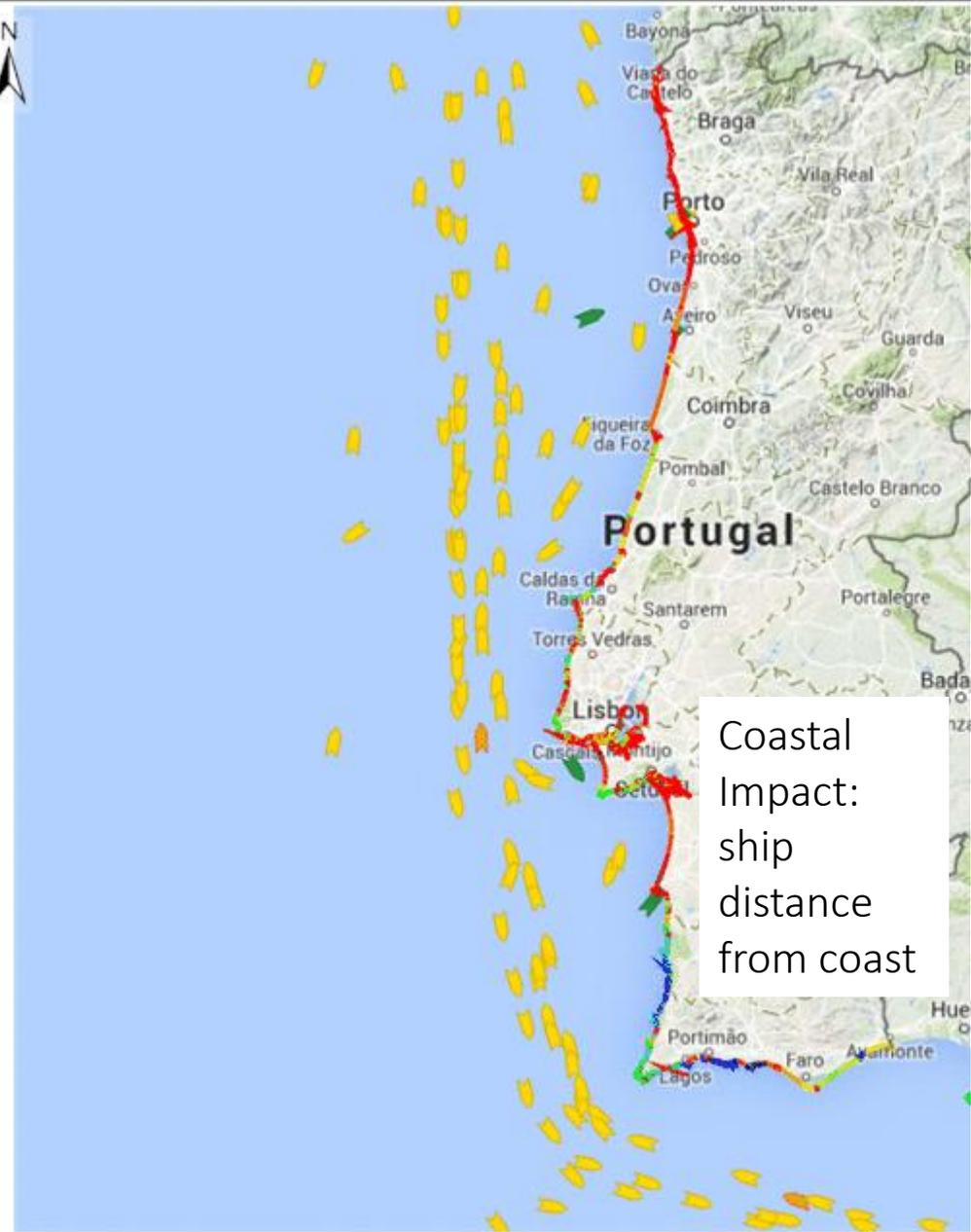
Dynamic = using best available forecasts or measured metocean data

# Dynamic Risk Tool



# Dynamic Risk Tool





Portuguese Risk from ships



Portuguese Coast Risk from ships

# Dynamic Risk Tool

Vessel

## Vessel Details

Vessel Details: LOYA Arcopol.UI

Properties

Name:  Dead Weight:   
MMSI:  Flag:    
Year:



List of all positions

| Date and Time    | Latitude | Longitude | Speed | Course | Status         |
|------------------|----------|-----------|-------|--------|----------------|
| 18-04-2012 10:15 | 40,65841 | -8,705533 | 0,8   | 271    | Underway       |
| 18-04-2012 10:35 | 40,65822 | -8,707335 | 0,1   | 76     | AnchoredMoored |
| 18-04-2012 10:50 | 40,65822 | -8,707335 | 0,1   | 76     | AnchoredMoored |
| 18-04-2012 11:05 | 40,65822 | -8,707335 | 0,1   | 76     | AnchoredMoored |

Options

# Dynamic Risk Tool

Arcopol

## Search Isolated Risks | Filter by site

Vessels Risk

Vessels ESI Socio-Economic Risk of Coastal\_Pollution Risk of Accident Model Domain TimeSeries Watcher Model Watcher Filter\_by GeoLocations Filter\_by Vessels Oil Spills

Map

Layers

| Visible                             | Name  |
|-------------------------------------|---|
| <input type="checkbox"/>            | Vessel Positions                                    |
| <input checked="" type="checkbox"/> | Non-Modelled Risk of Coastal Pollution (integrated) |
| <input type="checkbox"/>            | Environmental Sensitivity Index                     |
| <input type="checkbox"/>            | Socio-Economic Index                                |
| <input checked="" type="checkbox"/> | Risk of Spill Accident (integrated)                 |
| <input checked="" type="checkbox"/> | Map   |
| <input type="checkbox"/>            | 3-Mile Zone   |

Date & Time

Current date: 2011-11-27 01:37:02

Display date: 2011-11-28 05:00:00

Map

558.367200 -13.6082/37.0627

01:37 30-11-2011

# Dynamic Risk Tool

Arcopol

Search Isolated Risks | Filter by site

Vessels Risk

Vessels ESI Socio-Economic Risk of Coastal\_Pollution Risk of Accident Model Domain TimeSeries Watcher Model Watcher Filter\_by GeoLocations Filter\_by Vessels Oil Spills

Map

Layers

Visible Name

Date & Time

Current date: 2011-11-27 01:46:12

Display date: 2011-11-28 05:00:00

Map

237.412400 -8.9714/38.3790

Vessel-GeoLocation Risk Impact

| Latitude | Longitude | GeoL... | MMSI      | GeoRiskCollisionShipToShip | GeoRiskPortCollision | GeoRiskGrounding | GeoRiskFoundering  | GeoRiskDriftGrounding | GeoRiskGroundingDuringNavigation | GeoRisk     | Fcd   |
|----------|-----------|---------|-----------|----------------------------|----------------------|------------------|--------------------|-----------------------|----------------------------------|-------------|-------|
| 38.14466 | -9.387762 | 4640... | 310132000 | 12.7921863845458           | 0                    | 0                | 13.547700804047913 | 0                     | 13.159233893636419               | 12.71925... | 2.201 |
| 38.20573 | -9.262412 | 4640... | 209275000 | 13.181638402313457         | 0                    | 0                | 13.93715282181557  | 0                     | 13.548685911404075               | 12.52359... | 1.660 |
| 38.14466 | -9.387762 | 4530... | 310132000 | 12.452662245260495         | 0                    | 0                | 13.208176664762608 | 0                     | 12.819709754351113               | 12.37972... | 2.540 |
| 38.20573 | -9.262412 | 4530... | 209275000 | 12.818596971442876         | 0                    | 0                | 13.574111390944989 | 0                     | 13.185644480533494               | 12.16055... | 2.024 |
| 38.60518 | -9.847373 | 4530... | 351356000 | 11.903567002094311         | 0                    | 0                | 12.659081421596426 | 0                     | 12.270614511184931               | 11.98412... | 3.120 |
| 38.60518 | -9.847373 | 4640... | 351356000 | 11.834679878667741         | 0                    | 0                | 12.590194298169855 | 0                     | 12.201727387758361               | 11.91523... | 3.189 |
| 38.14466 | -9.387762 | 4640... | 310132000 | 11.932151513190712         | 0                    | 0                | 12.687665932692825 | 0                     | 12.29919902228133                | 11.85921... | 2.061 |
| 38.20573 | -9.262412 | 4640... | 209275000 | 12.320898167036413         | 0                    | 0                | 13.076412586538526 | 0                     | 12.687945676127031               | 11.66285... | 1.521 |
| 38.3824  | -9.744235 | 4640... | 246220000 | 12.123868501168122         | 0                    | 0                | 12.879382920670238 | 0                     | 12.49091601025874                | 11.33413... | 2.674 |
| 38.3824  | -9.744235 | 4530... | 246220000 | 12.022071879867617         | 0                    | 0                | 12.777586299369734 | 0                     | 12.389119388958235               | 11.23234... | 2.775 |
| 38.66817 | -9.073033 | 4530... | 255803660 | 12.278750039886074         | 0                    | 0                | 11.557143204668527 | 0                     | 12.675760772354135               | 11.19593... | 0.951 |

01:47 30-11-2011

# Dynamic Risk Tool

The screenshot displays the Arcopol software interface for risk analysis. The main window title is "Search Isolated Risks | Filter by site". The interface is divided into several sections:

- Top Toolbar:** Contains various analysis tools such as "Vessels Risk", "ESI", "Socio-Economic", "Risk of Coastal Pollution", "Risk of Accident", "Model Domain", "TimeSeries Watcher", "Model Watcher", "Filter\_by GeoLocations", "Filter\_by Vessels", and "Oil Spills".
- Layers Panel (Left):** A list of map layers with checkboxes for visibility. The layers include:
  - Vessel Positions (unchecked)
  - Non-Modelled Risk of Coastal Pollution (integrated) (checked)
  - Environmental Sensitivity Index (unchecked)
  - Socio-Economic Index (unchecked)
  - Risk of Spill Accident (integrated) (checked)
  - Map (checked)
  - 3-Mile Zone (unchecked)
- Date & Time Panel (Bottom Left):** Shows the current date and time as "2011-11-27 01:52:29" and the display date as "2011-11-28 05:00:00".
- Map (Center):** A geographical map showing coastal areas with various risk zones overlaid in different colors (red, yellow, green). A blue circle highlights a specific location on the coast. The map includes labels for locations like "Pinhal Novo", "Setúbal", and "Reserva Natural".
- Legend (Right):** A vertical legend panel for the map layers.

The Windows taskbar at the bottom shows the system clock as 01:53 on 30-11-2011, along with icons for various applications like Internet Explorer, Google Chrome, and Microsoft Word.

# Dynamic Risk Tool

Arcopol

Search Isolated Risks | Filter by site

Vessels Risk

Vessels ESI Socio-Economic Risk of Coastal Pollution Risk of Accident Model Domain TimeSeries Model Watcher Filter\_by GeoLocations Filter\_by Vessels Oil Spills

Map

Layers

- Vessel Positions
- Non-Modelled Risk of Coastal Pollution (integrated)
- Environmental Sensitivity Index
- Socio-Economic Index
- Risk of Spill Accident (integrated)
- Map
- 3-Mile Zone

Vessel-GeoLocation Risk Impact

| DateTimeOfRisk   | Latitude | Longi... | GeoLocation   | MMSI       | GeoRiskCollisionShipToShip | G | G | GeoRiskFoundering  | Ge... | GeoRiskGroundingDuringNavigation | GeoRisk     | Fcd      |
|------------------|----------|----------|---|------------|----------------------------|---|---|--------------------|-------|----------------------------------|-------------|----------|
| 27-11-2011 17:51 | 38.64325 | -10.0... | 41710 - mochão d povoa                                | 3110438... | 18.947689223917969         | 0 | 0 | 19.703203643420082 | 0     | 19.314736733008587               | 18.50365... | 4.957... |
| 27-11-2011 17:51 | 38.64325 | -10.0... | 43003 - Marina 3                                      | 3110438... | 18.727090681391815         | 0 | 0 | 19.482605100893927 | 0     | 19.094138190482433               | 18.28305... | 3.177... |
| 27-11-2011 17:51 | 38.34491 | -10.0... | 41710 - mochão d povoa                                | 3119030... | 18.574986184624692         | 0 | 0 | 19.330500604126808 | 0     | 18.94203369371531                | 18.04013... | 5.304... |
| 27-11-2011 17:51 | 38.34491 | -10.0... | 43003 - Marina 3                                      | 3119030... | 18.432867385896852         | 0 | 0 | 19.188381805398969 | 0     | 18.79991489498747                | 17.89801... | 3.446... |
| 27-11-2011 17:51 | 38.46447 | -10.0... | 41710 - mochão d povoa                                | 2362050... | 18.700304033904448         | 0 | 0 | 19.455818453406561 | 0     | 19.067351542995066               | 17.82469... | 5.065... |
| 27-11-2011 17:51 | 38.46447 | -10.0... | 43003 - Marina 3                                      | 2362050... | 18.571891052545237         | 0 | 0 | 19.327405472047349 | 0     | 18.938938561635855               | 17.69628... | 3.193... |
| 27-11-2011 17:51 | 38.64325 | -10.0... | 41708 - jardins e ponte vasco da gama ate rio trancão | 3110438... | 18.129395217777123         | 0 | 0 | 18.884909637279236 | 0     | 18.496442726867741               | 17.68535... | 4.775... |

Vessel-GeoLocation Risk Impact

02:05  
30-11-2011

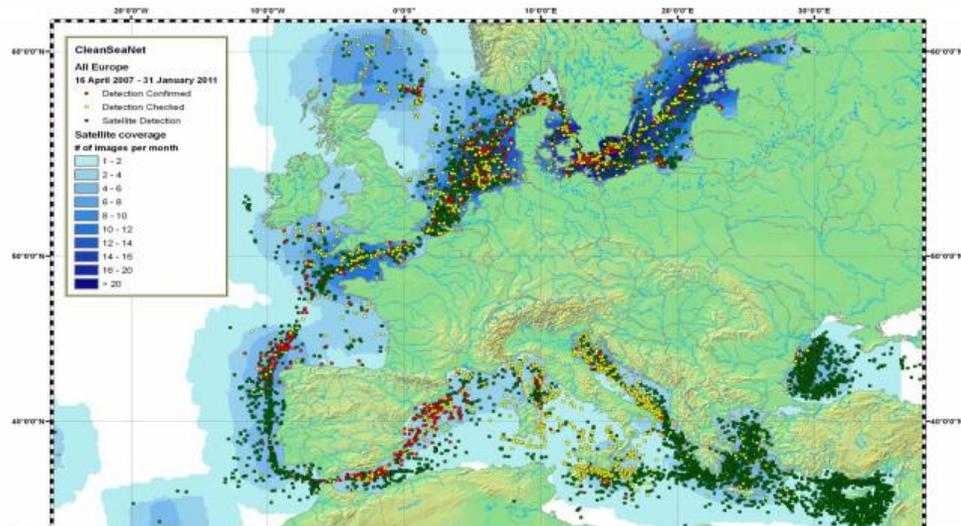
# MOHID-CLEANSENET service

can provide added-value for remote sensing products

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

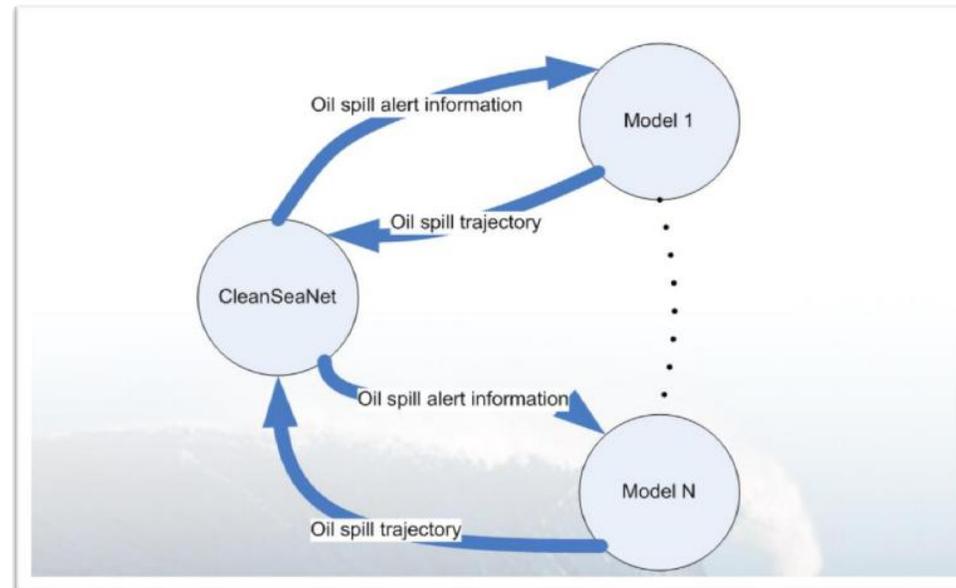
Near real time service (30min.)

CleanSeaNet detections 16 April 2007 - 31 January 2011



8,866 detections – 2,828 checked – 745 confirmed (80% mineral oil)

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

The screenshot displays the MOHID Studio Professional software interface. The title bar reads "Lagrangian - MOHID Studio - MOHID Studio Professional". The menu bar includes: Home, Project, Map, XY Graph, Risk Management, Operational Modelling, Oil Mapping, Environmental Monitoring, Hydraulic Structure, Google Earth, SNIRH, Coastal Risk, and Administration. The toolbar contains various icons for file operations (New, Open, Close, Manage), domain management (New, Open, Properties, Remove, Manage), simulation (New, Wizard, Properties, Delete, Copy, Compare, Clean), and execution (Lagrangian Wiz, Run Now, Schedule). The "Lagrangian Wiz" icon is highlighted with a red box.

The interface is divided into several panels:

- Layers Panel:** Lists the following layers:
  - Lagrangian\_4 [temperature]
  - LagrangianGridRefined\_4 [temperature]2
  - Spill
  - LagrangianGridRefined\_4 [temperature]
  - Lagrangian\_4 [Group\_1/Data\_3D/temperature]
  - WaterProperties\_4 [temperature]
  - TileLayer - Bing - Aerial
- Map Panel:** Shows a map of the Iberian Peninsula (Portugal and Spain) with a Lagrangian model overlay. The overlay consists of a grid of black arrows representing flow direction and yellow dots representing particles. A color scale on the right indicates "Shoreline contamination risk" from 6.0 (blue) to 12.0 (red). A scale bar at the bottom shows 0 to 200 Kilometers. The date and time are set to 2010-07-01 14:00:00. The render time is 65ms.

MOHID Studio Version 2.0.0.1628 | License: MOHID Studio Professional | Memory Usage: 243Mb | Processor Time: 110s

# MOHID Lagrangian Wizard

The screenshot displays the MOHID Studio Professional interface. The main window is titled "Lagrangian - MOHID Studio - MOHID Studio Professional". The menu bar includes: Home, Project, Map, XY Graph, Risk Management, Operational Modelling, Oil Mapping, Environmental Monitoring, Hydraulic Structure, Google Earth, SNIRH, Coastal Risk, and Administration. The toolbar contains icons for Solution (New, Open, Close, Manage), Domain (New, Open, Properties, Remove, Manage), Simulation (New, Wizard, Properties, Delete, Copy, Compare, Clean, Lagrangian Wiz), and Execute Models (Run Now, Schedule).

The interface is divided into several panes:

- Project Tree:** Shows a tree structure under "Tagus Sample" with sub-items: General Data, Sim #1 2D Tide, Sim #2 3D Tide + River, Sim #3 3D Tide + River + Sediment Transport, Sim #4 3D Tide + River + Sed. + WWTP discharges (highlighted), and Sim #5 3D Tide + River + Sed + WWTP + NutrientCyc.
- Modules:** Lists various data files and modules such as Atmosphere\_4.dat, Discharges\_4.dat, Free Vertical Mov, Geometry\_4.dat, GOTM\_4.dat, Hydrodynamic\_4, InterfaceSedimer, InterfaceWaterAir, Lagrangian\_4.dat, Model\_4.dat, HDF Files, Time Series Files, Channel.srh, Channel.srw, MiddleEstuary.srh, MiddleEstuary.srw, Ocean.srh, Ocean.srw, UpperEstuary.srh, and UpperEstuary.srw.
- Lagrangian Simulation Wizard:** A dialog box titled "Lagrangian Simulation Wizard" with "General Settings - 2 of 9" tabs. The "General Settings" tab is active, showing "Simulation General Settings" with the following fields:
  - Insert on Project: Tagus Sample (dropdown)
  - Incident Name: <New Simulation> (text box)
  - Start Date: 2015 -06 -14 00:00 (dropdown)
  - End Date: 2015 -06 -14 06:00 (dropdown)
  - Backtracking:Buttons for "Cancel", "Back", and "Next" are visible at the bottom.

The status bar at the bottom indicates: MOHID Studio Version 2.0.0.1628 | License: MOHID Studio Professional | Memory Usage: 242Mb | Processor Time: 164s

# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Boundary Conditions - 3 of 9

General Settings **Currents** Water Properties Atmosphere Waves Substance Location Advanced Settings

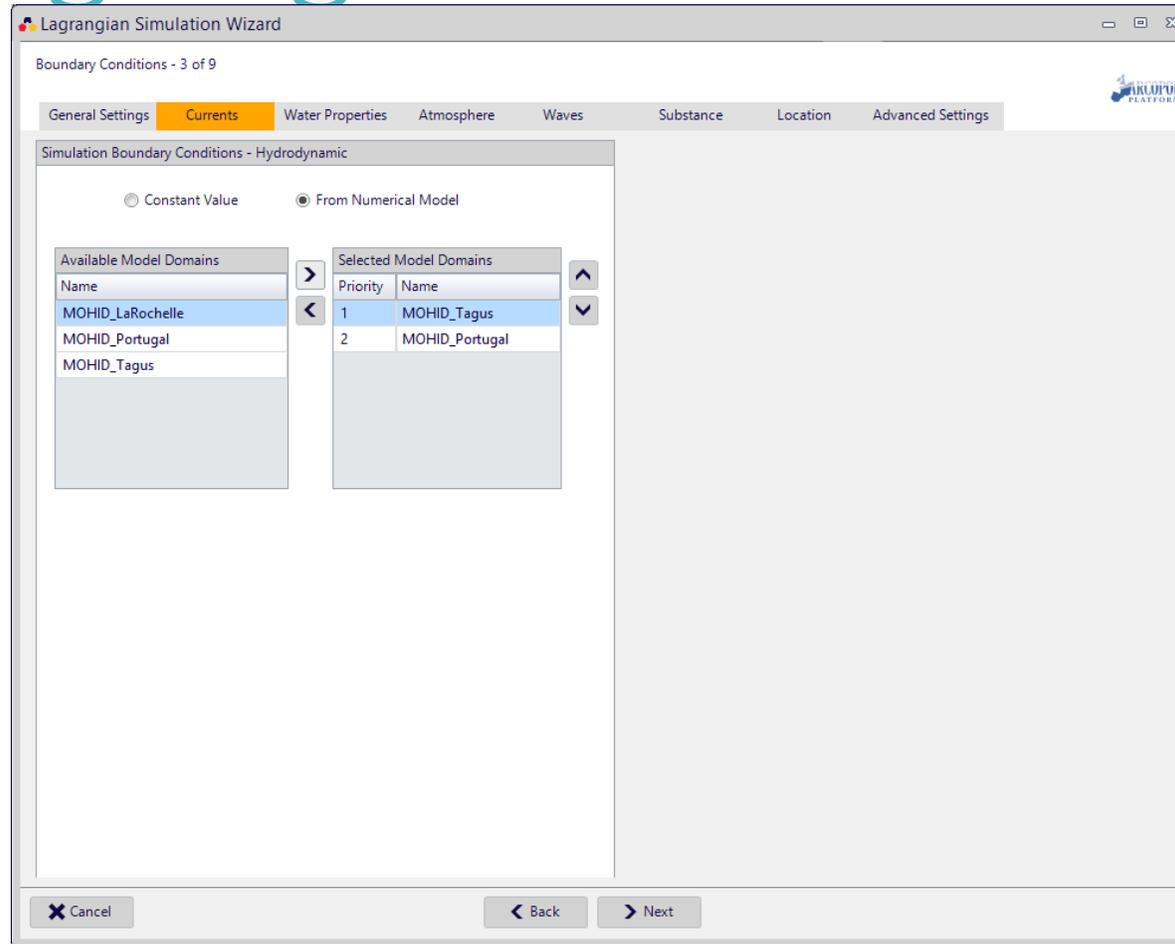
Simulation Boundary Conditions - Hydrodynamic

Constant Value  From Numerical Model

Direction (°)  0° is northward current

Intensity (m/s)

# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard

The screenshot displays the 'Lagrangian Simulation Wizard' window, specifically the 'Boundary Conditions - 4 of 9' step. The 'Water Properties' tab is selected, showing options for 'Constant Value' (selected) and 'From Numerical Model'. Three input fields are visible: Temperature (°C) set to 16, Salinity (PSU) set to 36, and Suspended Particulate Matter (mg/L) set to 5. The interface includes a 'Cancel' button and 'Back'/'Next' navigation buttons.

Boundary Conditions - 4 of 9

General Settings   Currents   **Water Properties**   Atmosphere   Waves   Substance   Location   Advanced Settings

Simulation Boundary Conditions - Water properties

Constant Value    From Numerical Model

Temperature (°C)   16

Salinity (PSU)   36

Suspended Particulate Matter (mg/L)   5

Cancel   < Back   > Next

# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Boundary Conditions - 5 of 9

General Settings   Currents   Water Properties   **Atmosphere**   Waves   Substance   Location   Advanced Settings

Simulation Boundary Conditions - Atmosphere

Properties

Constant Value    From Numerical Model

Wind Direction (°)   0   0° is southward wind

Wind Intensity (m/s)   5

Temperature (°C)   16

Atmospheric Pressure (hPa)   0

Wind Drift

Wind Drift Coefficient (%)   3

Wind Drift Angle (°)   0   Positive - deviation to the right

Constant Value    Model Computed Value

Cancel   < Back   > Next

# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Boundary Conditions - 5 of 9

General Settings   Currents   Water Properties   **Atmosphere**   Waves   Substance   Location   Advanced Settings

Simulation Boundary Conditions - Atmosphere

Properties

Constant Value    From Numerical Model

| Available Model Domains |   | Selected Model Domains |                   |
|-------------------------|---|------------------------|-------------------|
| Name                    |   | Priority               | Name              |
| Calmet_QuintaDoConde    | > | 1                      | WRF_Tejo_3Km      |
| GFS_World_0.5           | < | 2                      | MM5_Portugal      |
| MM5_Portugal            |   | 3                      | WRF_Portugal      |
| WRF_MeteoGalicia_12km   |   | 4                      | WRF_MeteoGalic... |
| WRF_Portugal            |   |                        |                   |
| WRF_Tejo_3Km            |   |                        |                   |

Wind Drift

Wind Drift Coefficient (%)

Wind Drift Angle (°)   Constant Value    Model Computed Value

Positive - deviation to the right

# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Boundary Conditions - 6 of 9

General Settings   Currents   Water Properties   Atmosphere   **Waves**   Substance   Location   Advanced Settings

Simulation Boundary Conditions - Waves

Properties

Constant Value    From Numerical Model

Wave Direction (°)   0   0° is southward wave

Wave Height (m)   0.5

Wave Period (s)   12

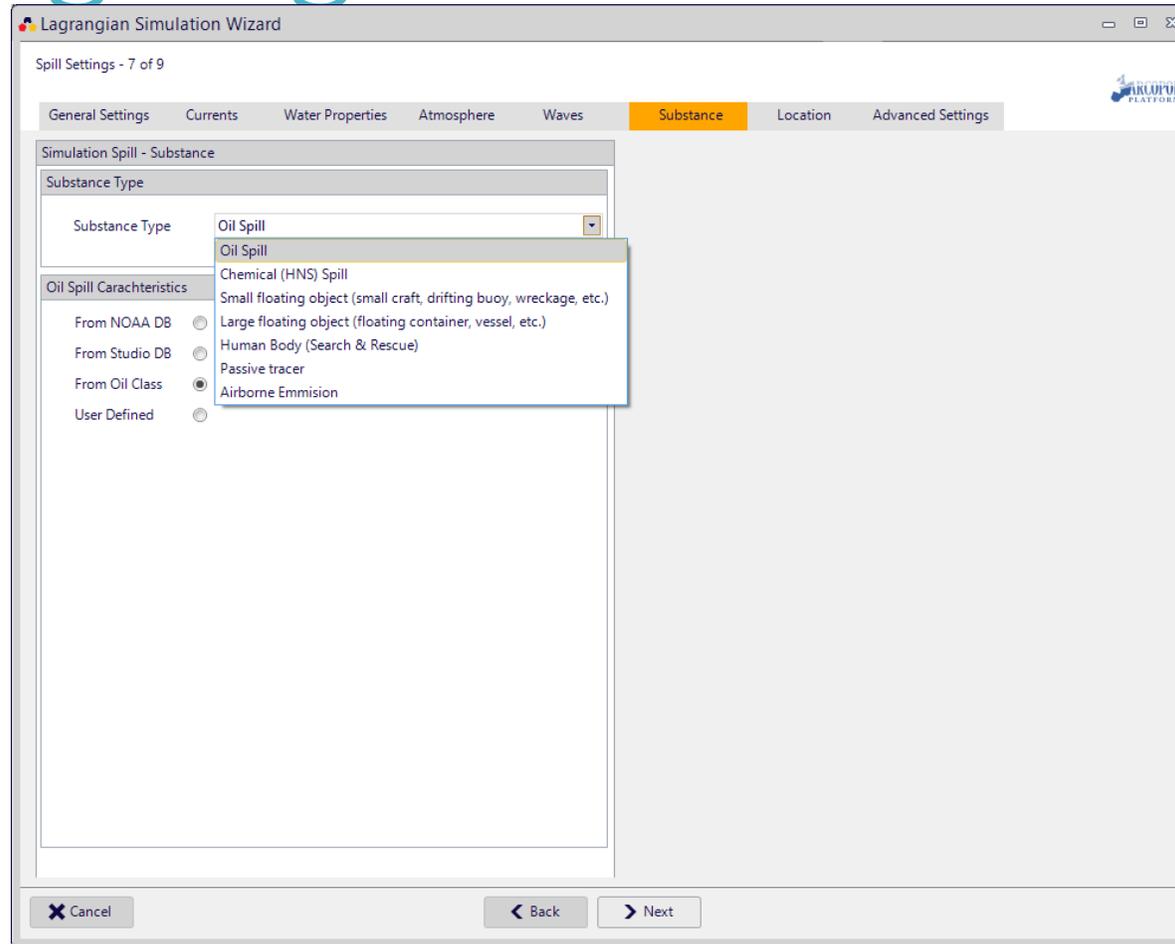
Wave Length (m)   100

Use Stokes Drift

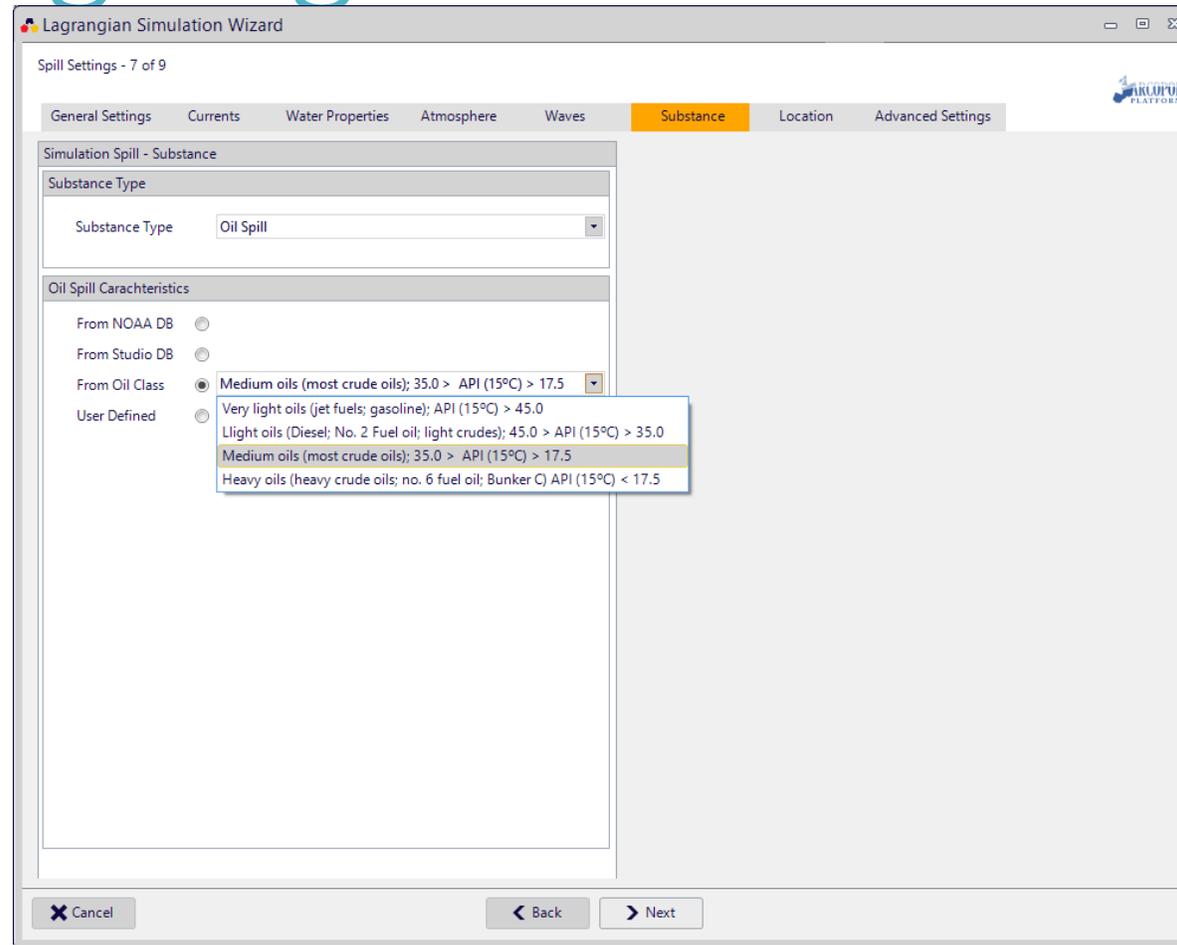
Use Stokes Drift  

Cancel   < Back   > Next

# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Spill Settings - 7 of 9

General Settings   Currents   Water Properties   Atmosphere   Waves   **Substance**   Location   Advanced Settings

Simulation Spill - Substance

Substance Type

Substance Type: Oil Spill

Oil Spill Characteristics

From NOAA DB

From Studio DB

From Oil Class

User Defined

Substance Name: <New Oil Substance>

|           | Value | Units | Ref Temp. (°C) |
|-----------|-------|-------|----------------|
| Density   | 1000  | Kg/m3 | 20             |
| Viscosity | 5     | cSt   | 20             |

Oil-water Interfacial Tension (dyne/cm): 1

Pour Point (°C): 5

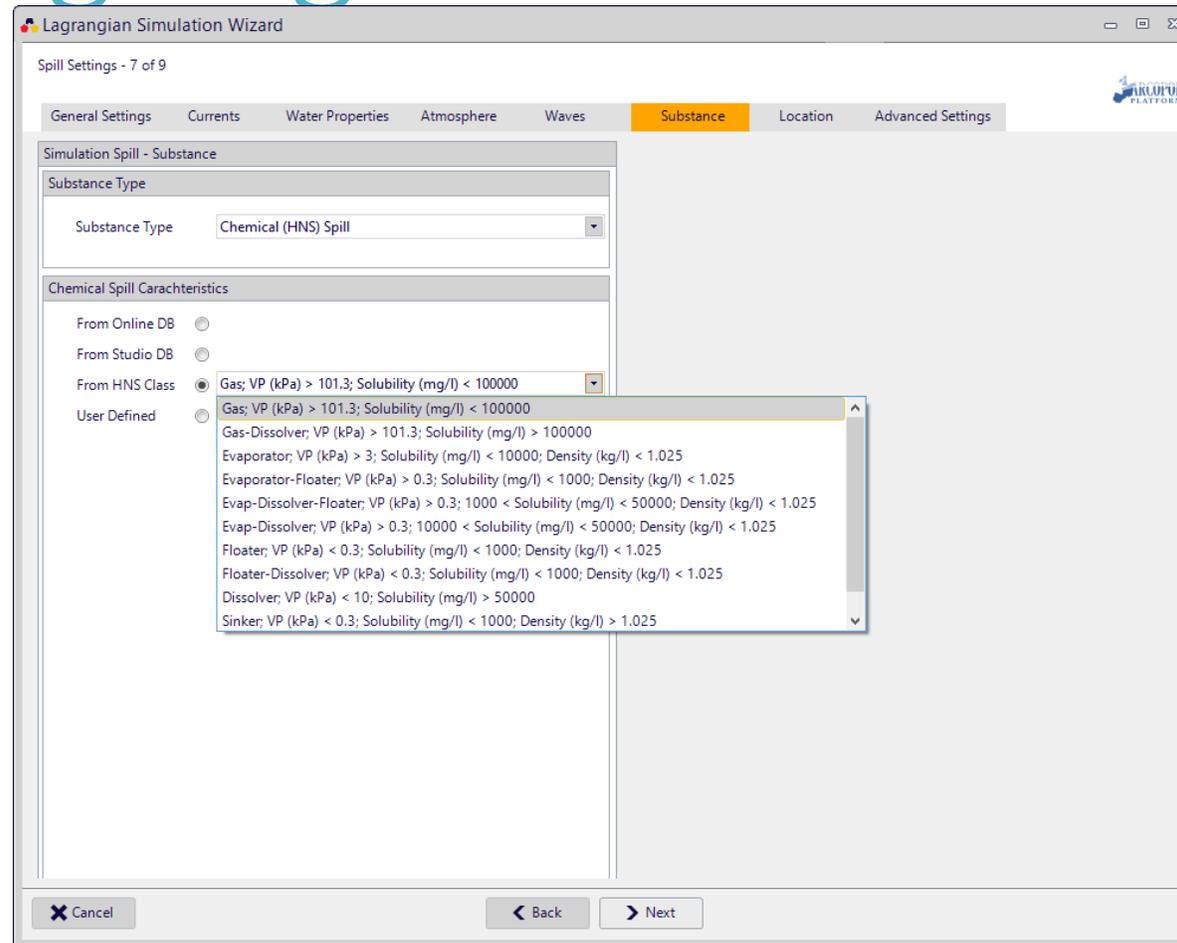
**Emulsification**

|                        |    |                         |    |
|------------------------|----|-------------------------|----|
| Resin Content (%)      | 10 | Saturate Content (%)    | 10 |
| Asphaltene Content (%) | 10 | Wax Content (%)         | 10 |
| Max Water Content (%)  | 10 | Emulsification Constant | 10 |

Add to Studio DB

Cancel   < Back   > Next

# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Spill Settings - 7 of 9

General Settings   Currents   Water Properties   Atmosphere   Waves   **Substance**   Location   Advanced Settings

Simulation Spill - Substance

Substance Type

Substance Type: Chemical (HNS) Spill

Chemical Spill Characteristics

From Online DB

From Studio DB

From HNS Class

User Defined

Substance Name: <New Chemical Substanc

Organic Substance

Density (kg/L): Value 1, Ref Temp. (°C) 20

Viscosity: Value 0, Units cP

Solubility in Water: Value 1, Units mg/l

Vapour Pressure (Pa): 1000

Mol. Weight (kg/kmol): 1

Kow: 1

Interfacial Tension (N/m): 1

Degradation Rates

Air (day-1) 10, Water (day-1) 10, Sediment (day-1) 10

Add to Studio DB

Cancel   Back   Next

# MOHID Lagrangian Wizard

Lagrangian Simulation Wizard

Spill Settings - 8 of 9

General Settings   Currents   Water Properties   Atmosphere   Waves   Substance   **Location**   Advanced Settings

Simulation Spill Location and Time Settings

Spill Location

Discharge Depth (m) 0

Point    Area

**Spill Definition**

| X                 | Y                  | Name           |
|-------------------|--------------------|----------------|
| -9.35705304982957 | 38.626235408685417 | spill origin 1 |

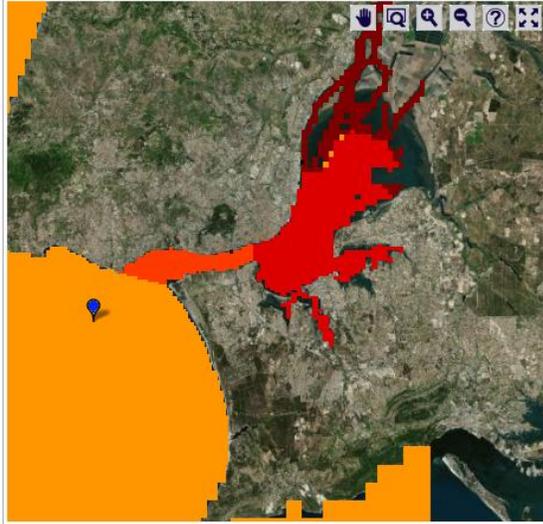
Spill Time Settings

Continuous    Instantaneous

Flow Rate (m3/s) 0.5

N° Particles / timestep 10

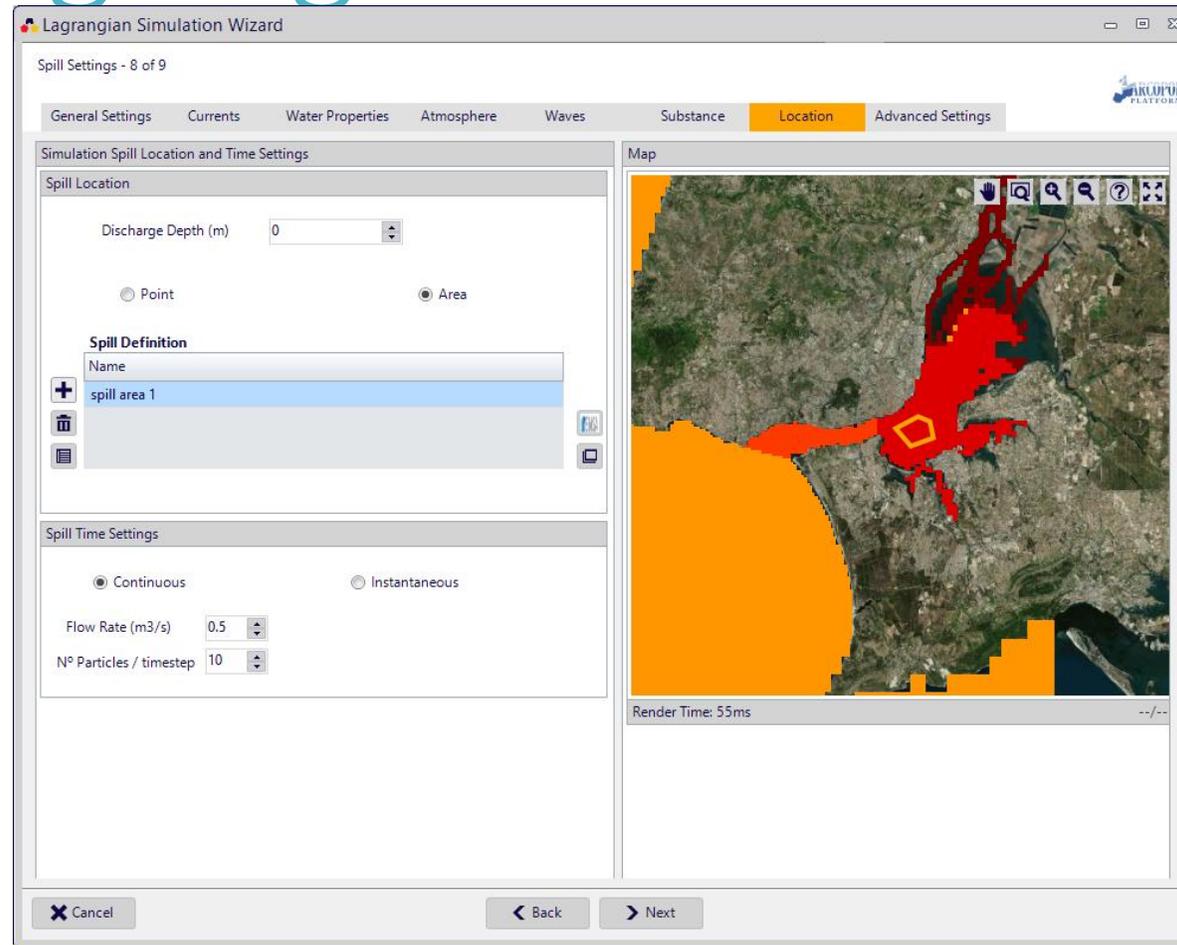
Map



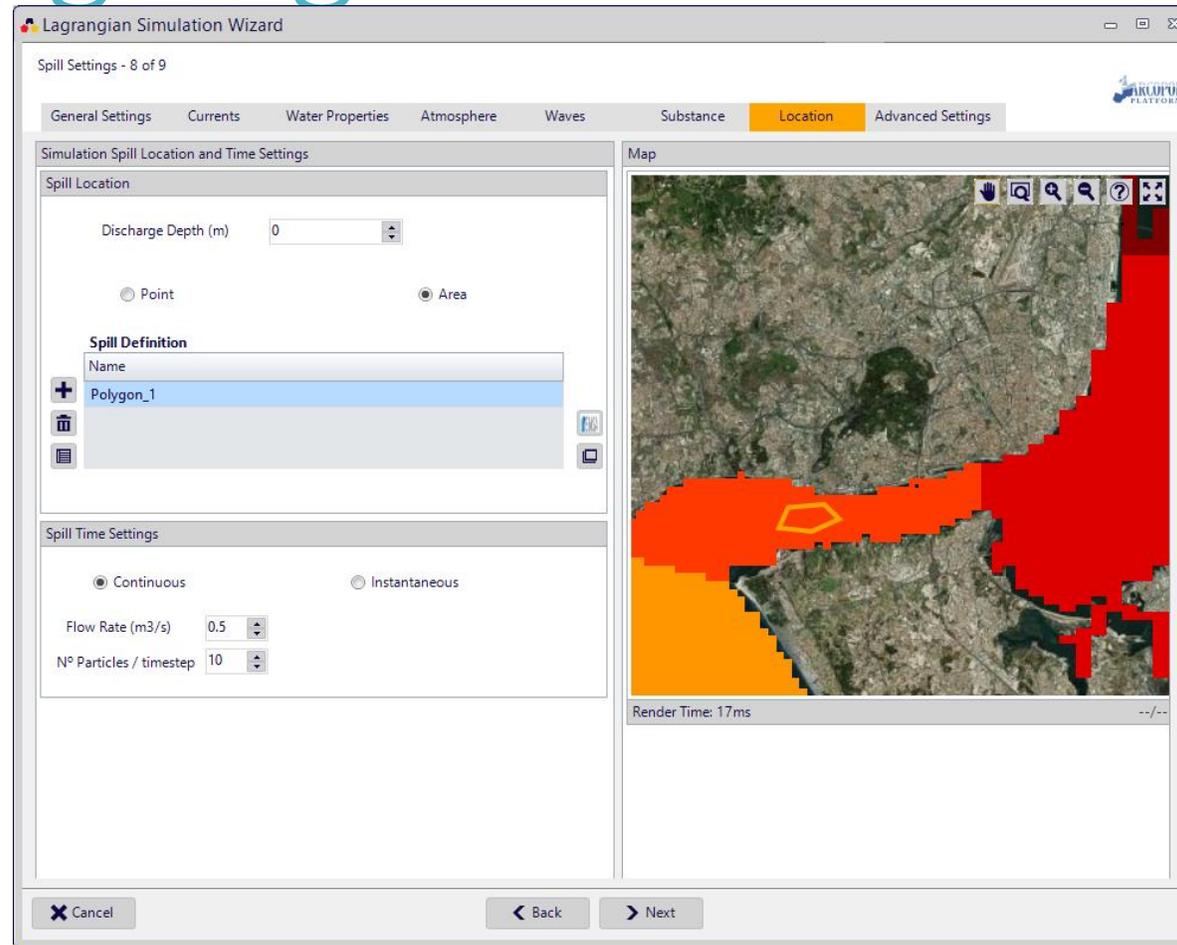
Render Time: 59ms   --/--

Cancel   < Back   > Next

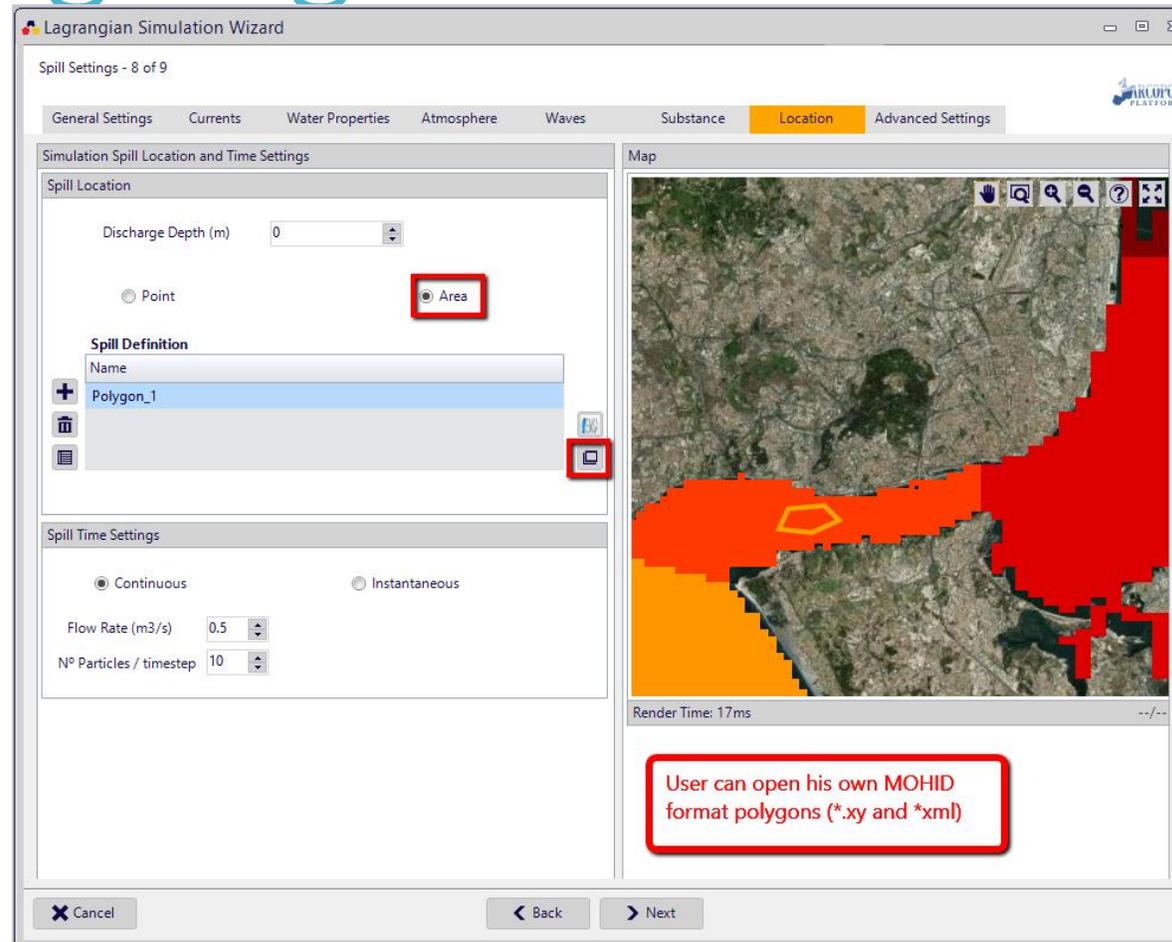
# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard

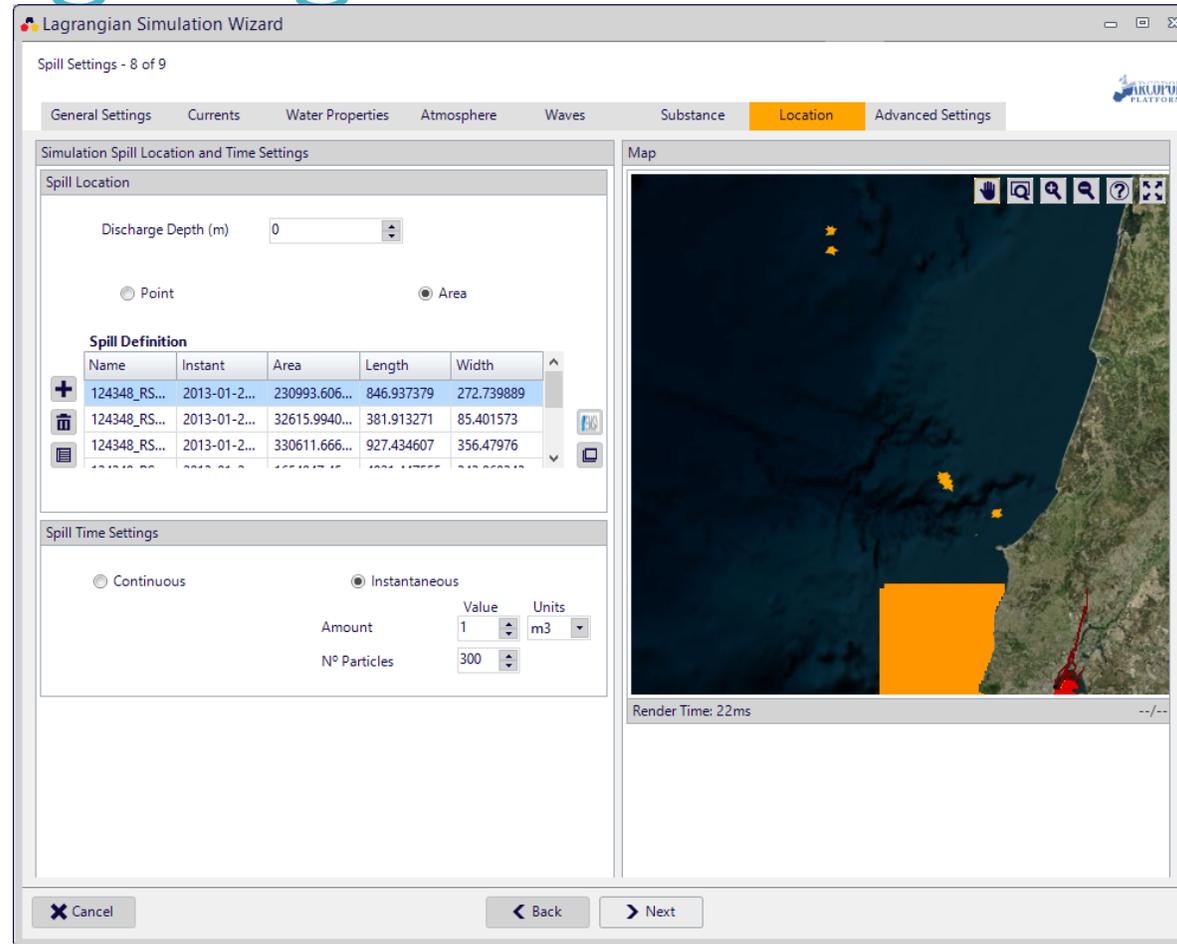
The screenshot displays the 'Lagrangian Simulation Wizard' window, specifically the 'Spill Settings - 8 of 9' step. The interface is divided into several sections:

- General Settings:** Includes tabs for 'General Settings', 'Currents', 'Water Properties', 'Atmosphere', 'Waves', 'Substance', 'Location' (highlighted), and 'Advanced Settings'.
- Simulation Spill Location and Time Settings:**
  - Spill Location:** Features a 'Discharge Depth (m)' dropdown set to 0. Below it, the 'Area' radio button is selected and highlighted with a red box.
  - Spill Definition:** A table with columns for Name, Instant, Area, Length, and Width. The first row is selected, and a red box highlights the 'Area' column. The table data is as follows:

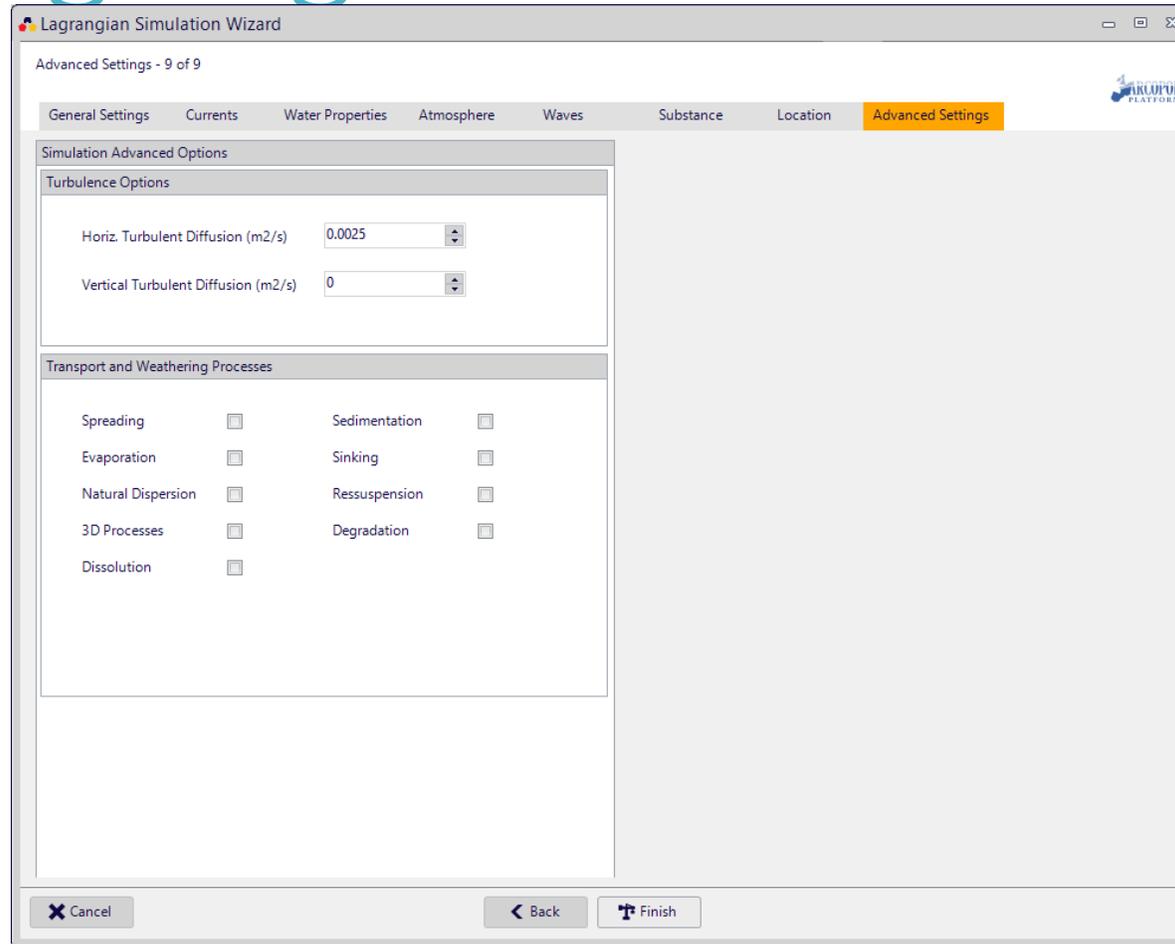
| Name         | Instant      | Area          | Length     | Width      |
|--------------|--------------|---------------|------------|------------|
| 124348_RS... | 2013-01-2... | 230993.606... | 846.937379 | 272.739889 |
| 124348_RS... | 2013-01-2... | 32615.9940... | 381.913271 | 85.401573  |
| 124348_RS... | 2013-01-2... | 330611.666... | 927.434607 | 356.47976  |
  - Spill Time Settings:** Includes radio buttons for 'Continuous' (selected) and 'Instantaneous'. Below are 'Flow Rate (m3/s)' set to 0.5 and 'N° Particles / timestep' set to 10.
- Map:** A satellite map showing a coastal area with a yellow polygon representing the spill location. Two red arrows point from the 'Area' radio button and the 'Area' column in the table to the map. A red box at the bottom of the map contains the text: 'Or user can open Clean Sea Net spill polygons (\*.tgz) obtaining also spill instant, area, length and width'. The map also shows 'Render Time: 22ms' and '--/--'.

At the bottom of the window, there are 'Cancel', 'Back', and 'Next' buttons.

# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard



# MOHID Lagrangian Wizard

The screenshot shows the 'Advanced Settings' window of the MOHID Lagrangian Wizard. The window title is 'Lagrangian Simulation Wizard' and the subtitle is 'Advanced Settings - 9 of 9'. The 'Advanced Settings' tab is selected in the top navigation bar. The main content area is divided into two sections: 'Simulation Advanced Options' and 'Transport and Weathering Processes'. The 'Simulation Advanced Options' section contains 'Turbulence Options' with two spinners: 'Horiz. Turbulent Diffusion (m2/s)' set to 0.0025 and 'Vertical Turbulent Diffusion (m2/s)' set to 0. The 'Transport and Weathering Processes' section contains a list of checkboxes for 'Spreading', 'Evaporation', 'Natural Dispersion', '3D Processes', 'Dissolution', and 'Emulsification', all of which are currently unchecked. At the bottom of the window, there are three buttons: 'Cancel', 'Back', and 'Finish'.

Lagrangian Simulation Wizard

Advanced Settings - 9 of 9

General Settings Currents Water Properties Atmosphere Waves Substance Location **Advanced Settings**

Simulation Advanced Options

Turbulence Options

Horiz. Turbulent Diffusion (m2/s) 0.0025

Vertical Turbulent Diffusion (m2/s) 0

Transport and Weathering Processes

Spreading

Evaporation

Natural Dispersion

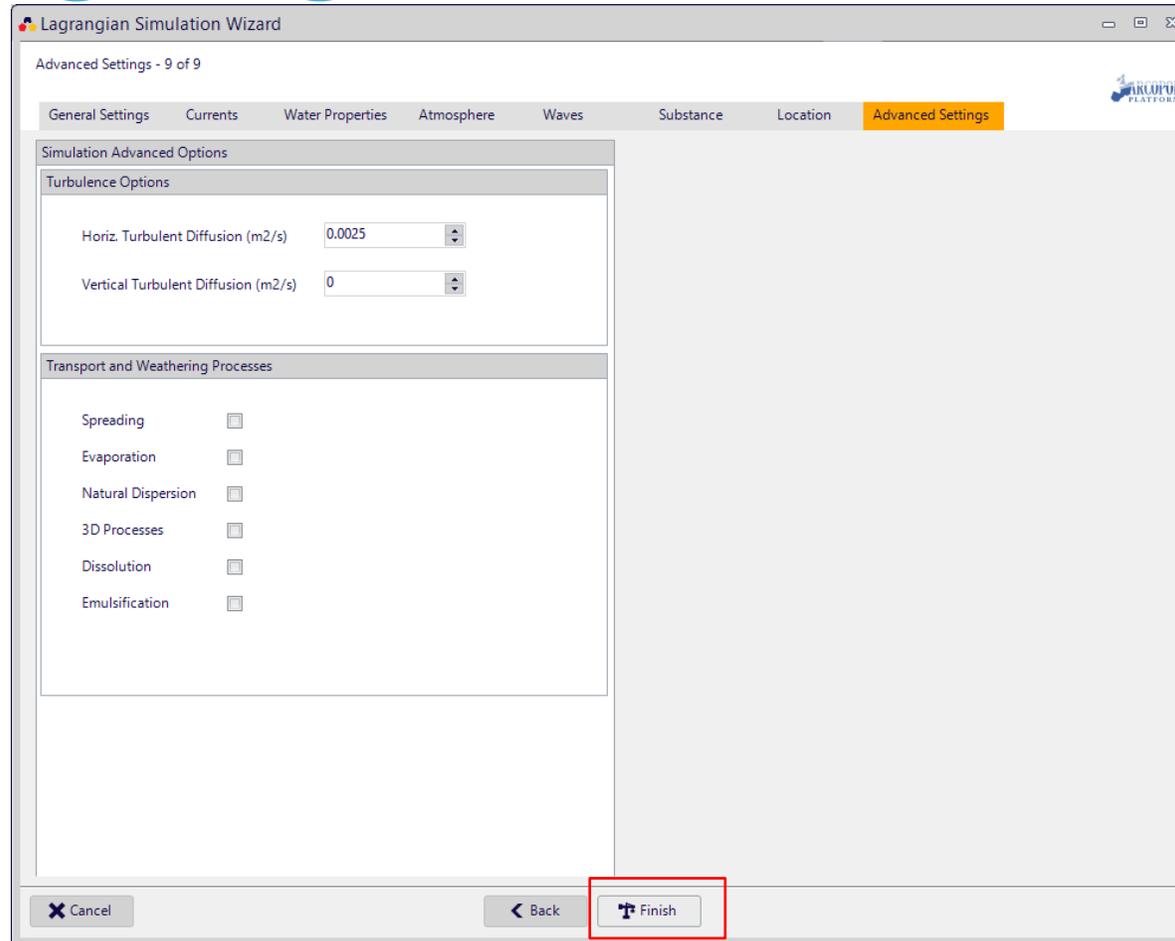
3D Processes

Dissolution

Emulsification

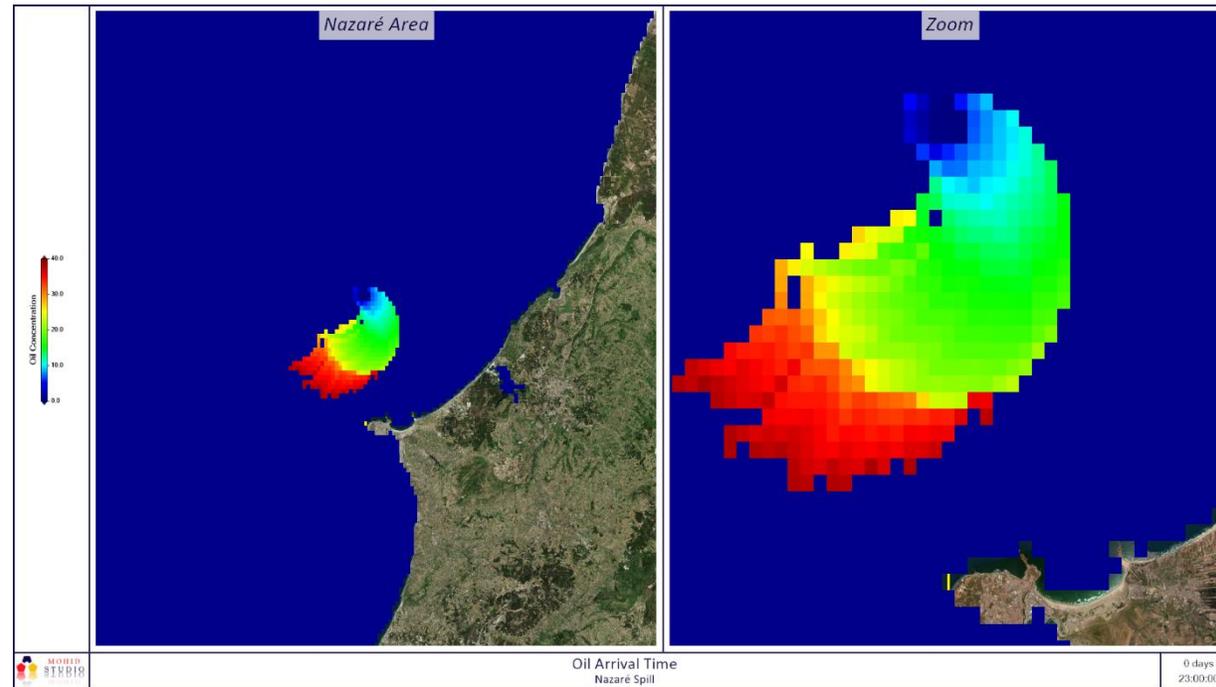
Cancel Back Finish

# MOHID Lagrangian Wizard



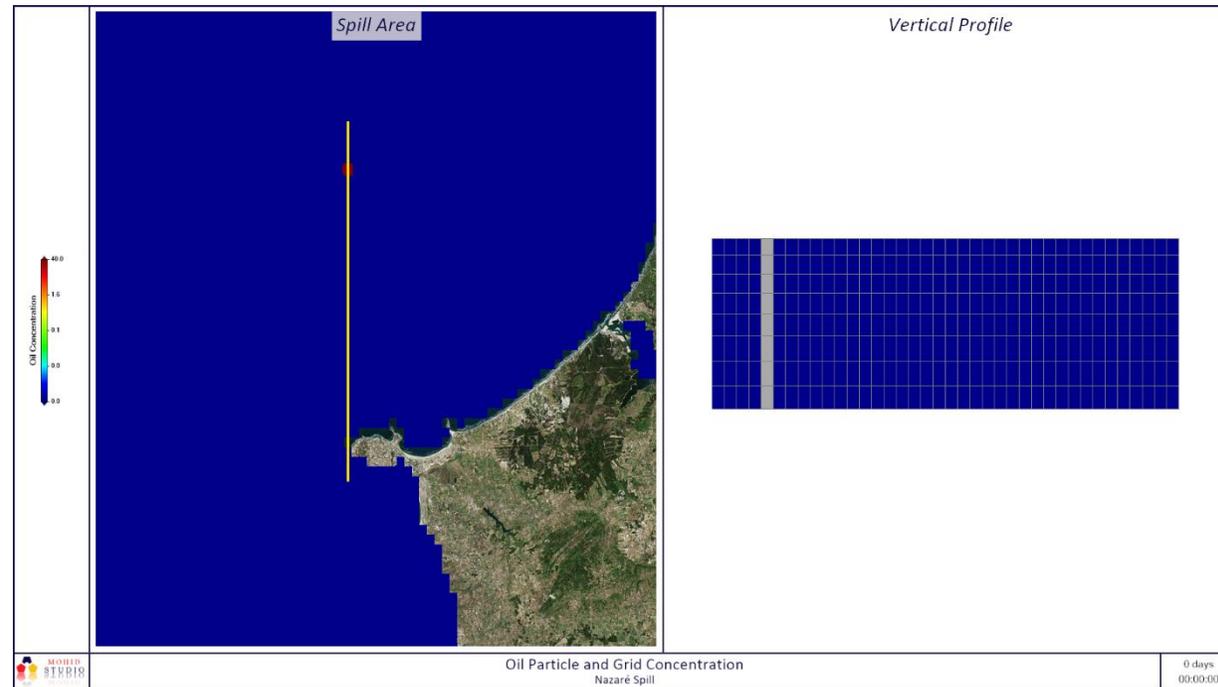
# MOHID Lagrangian Wizard

- oil arrival time -



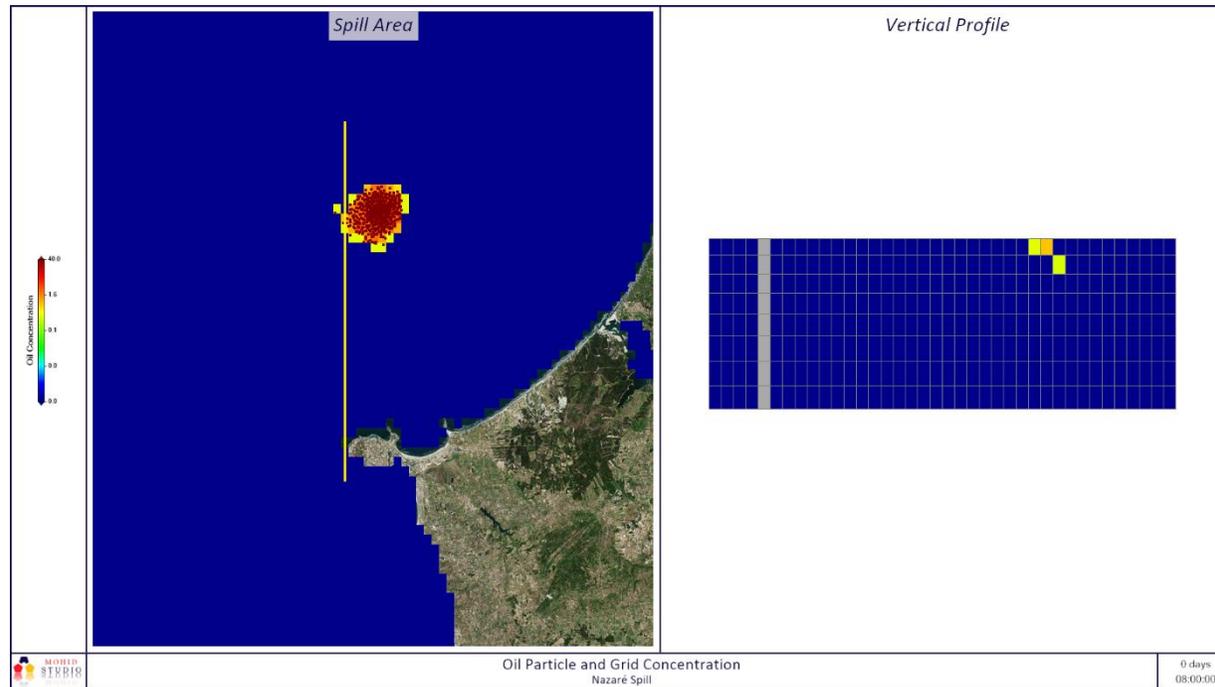
# MOHID Lagrangian Wizard

- vertical profile -

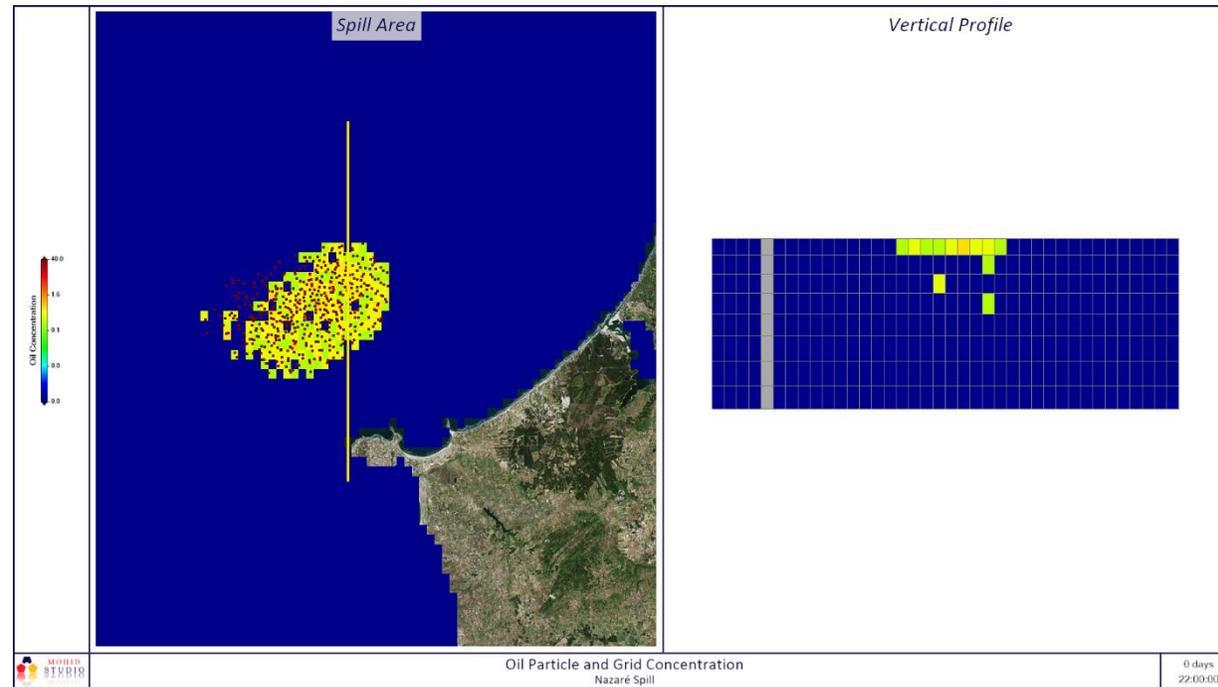


# MOHID Lagrangian Wizard

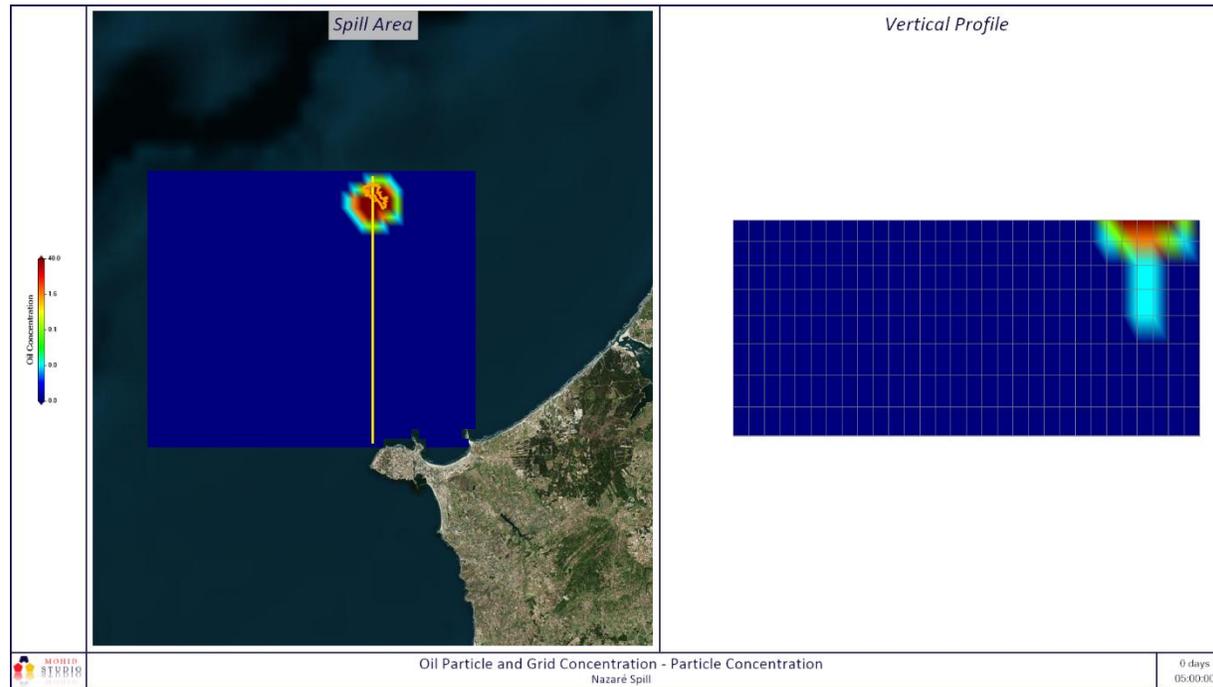
- vertical profile -



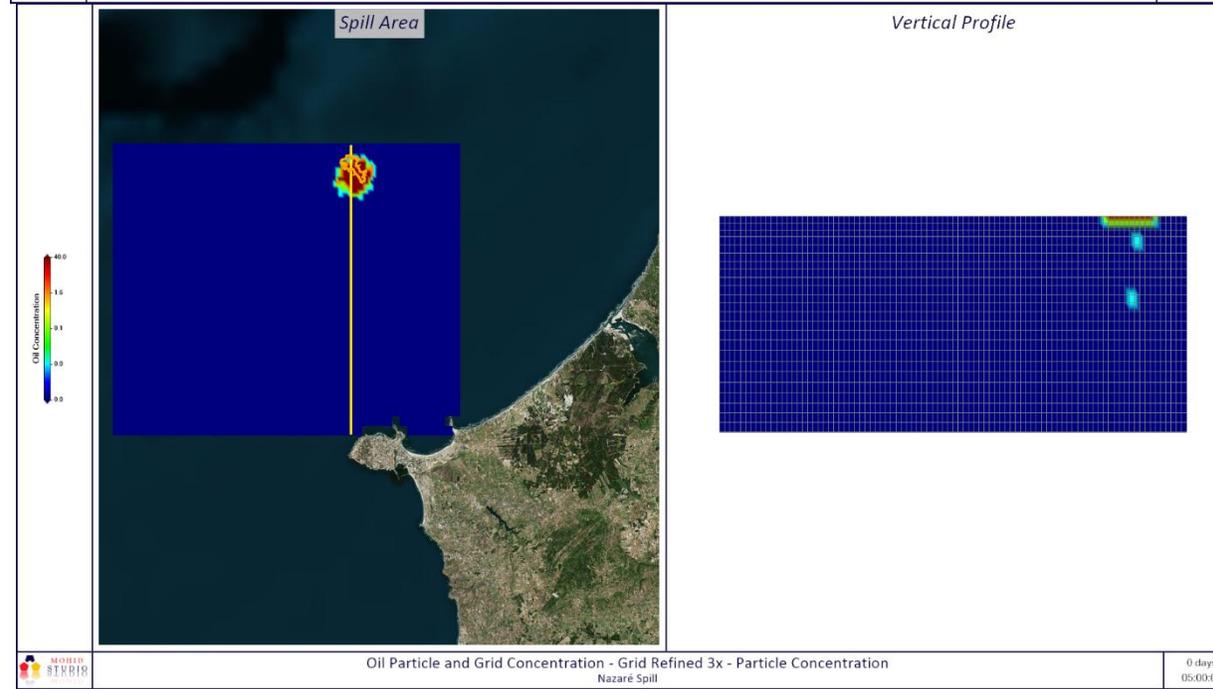
# MOHID Lagrangian Wizard - vertical profile -



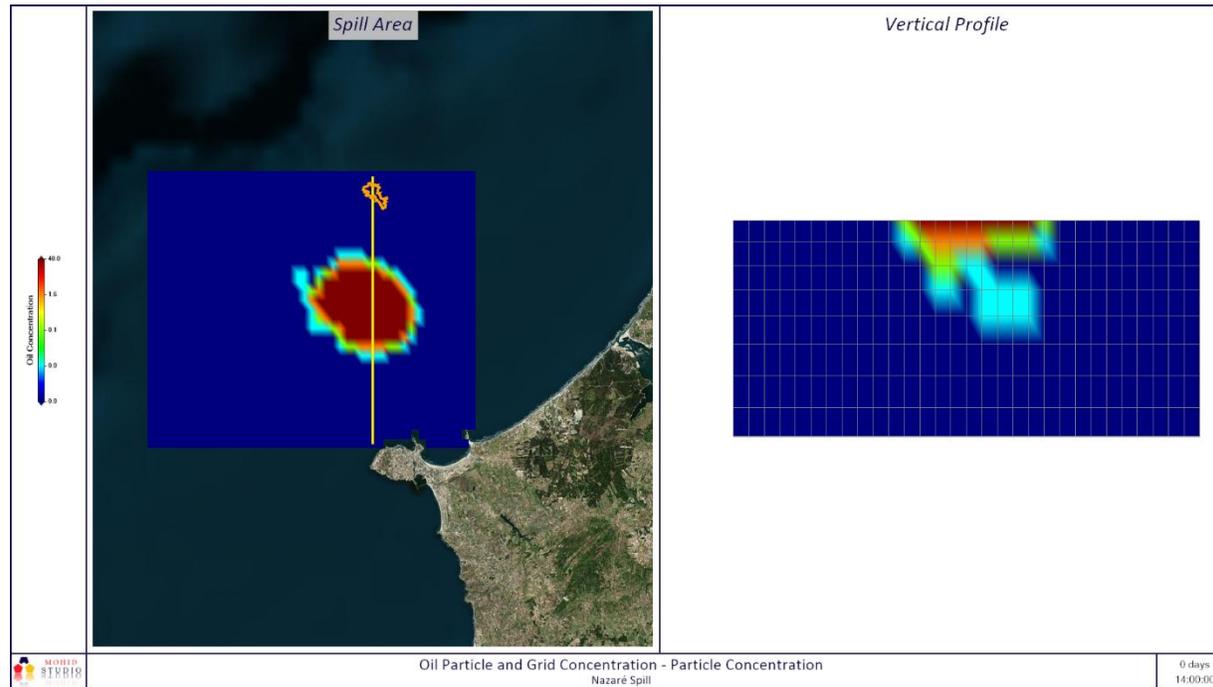
Original



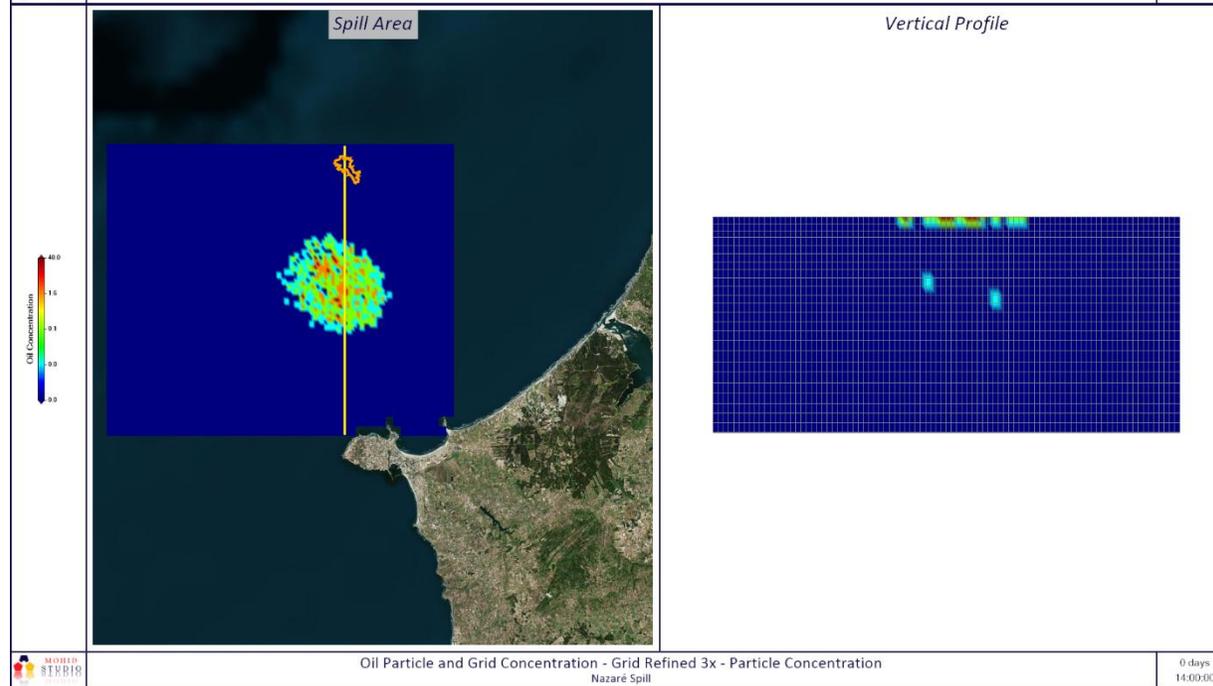
3X more resolution



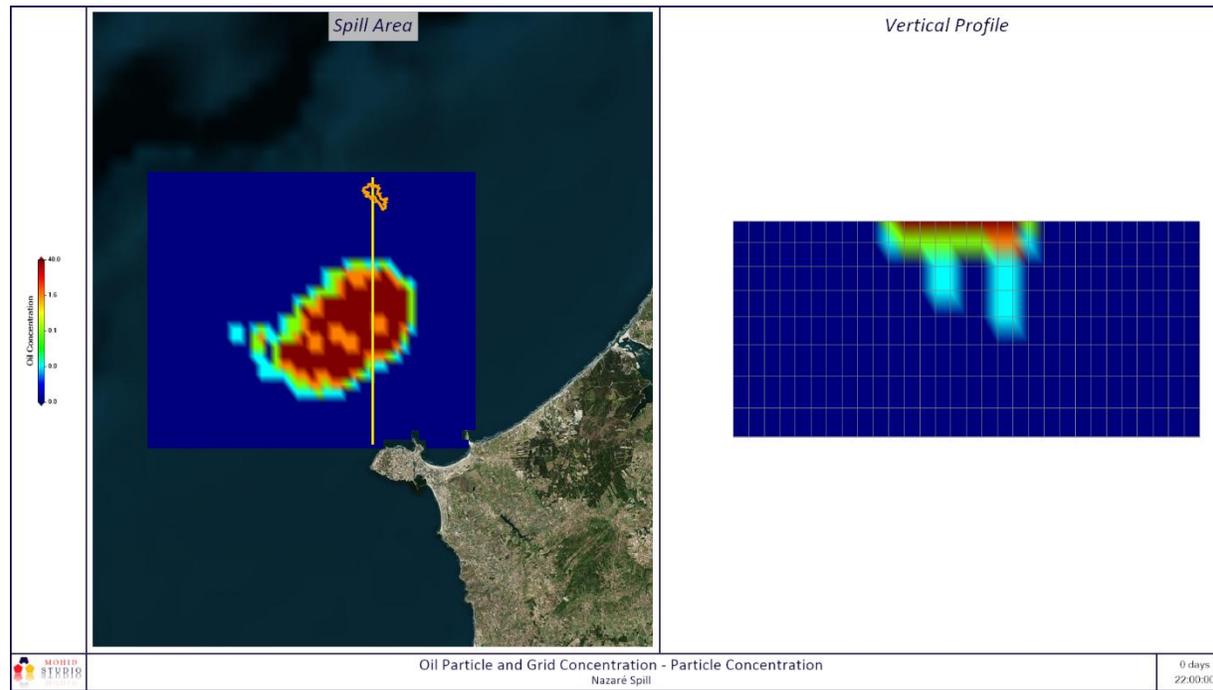
Original



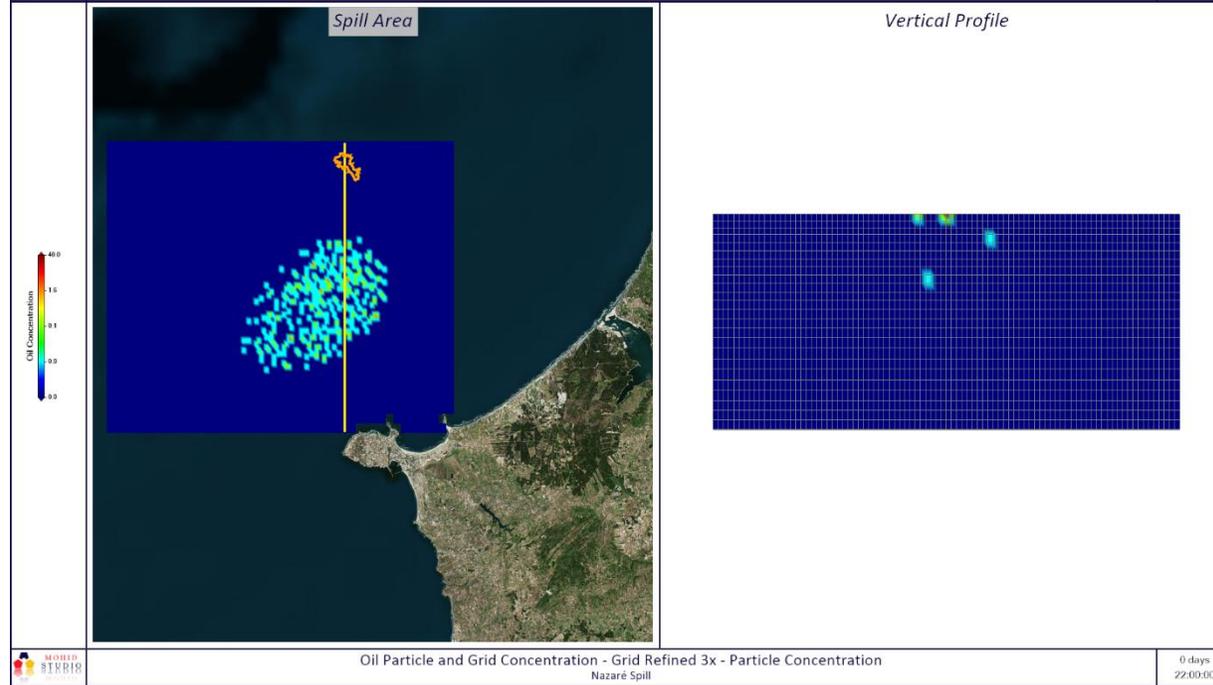
3X more resolution



Original



3X more resolution



# Oil spill + Boom modelling

The screenshot displays the MOHID Studio Professional Version interface. The main map area shows a simulation of an oil spill and boom movement over a coastal region. The spill is represented by a blue area, and the boom is shown as a green and yellow line with arrows indicating its direction. The map is overlaid on a satellite image of the coastline.

**Layers Panel:**

| Visible                             | Name                                    |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | BoomResults                             |
| <input checked="" type="checkbox"/> | Origin ID (D:\Aplica\MOHIDWater\Port... |
| <input checked="" type="checkbox"/> | velocity modulus[1] (D:\Aplica\MOHID... |
| <input checked="" type="checkbox"/> | velocity modulus[1] (D:\Aplica\MOHID... |
| <input checked="" type="checkbox"/> | MOHID_Tagus_bathymetry                  |
| <input checked="" type="checkbox"/> | MOHID_LaRochelle_Bathymetry             |
| <input checked="" type="checkbox"/> | TileLayer - Bing - Aerial               |

**Map Panel:**

Layers added to map and animation available (velocity grid and vector, lagrangian tracers and barrier location)

**Load Boom Layers Panel:**

Layer configuration

Simulation: Sim #27

Layers to load:

- Velocity Modulus
- Flow Arrows
- Lagrangian
- Booms

Existing Layers:

- Replace

Coordinates:

- Lat/Lon
- ConnectionX/Y

Load Layers

Hit to load layers ->

Refreshing Map

**Date & Time:** 2014-10-14 03:30:00

Render Time: 77ms

Coordinates: -9.1332/38.6976(12,21948)

# WMS Server / Demo website

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

OpenLayers 3 Examples x Arcopol / home x ARCOPOL - WMS Server Exam... x +

arcopol.actionmodulers.dtdns.net/mapdisplay1.html

Numerical models Klingande - Jubel (O... Enterprise Europe Net... Welcome to JetBrains ... IPMA - Previsão por lo... SPIEGEL ONLINE - Nac... Action Modulers Jabron - Simulationsso... Inovar Consulta 2013.1...

Arcopol Platform - WMS Examples

Home

Vessel Positions and Wind Velocity

Vessel Risk and Wave Power

Vessel Positions and SEV Index

## Arcopol WMS Demo

**Information**

This demo shows some features of Action Modulers' WMS Server, which has been developed in context of the ARCOPOL Platform project. This current page shows Vessel Positions and Wind Velocity. All layers can be configured through MOHID Studio and are provided by Action Server's WMS Plugin in WMS 1.3.0 format.

**Timer**

< > Display Date = 2015-06-15T16:00:00Z

**Vessel Positions and Wind Velocity**

# WMS Server / Demo website

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

OpenLayers 3 Examples x Arcopol / home x ARCOPOL - WMS Server Exam... x +

arcopol.actionmodulers.dtdns.net/mapdisplay2.html

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Arcopol Platform - WMS Examples

- Home
- Vessel Positions and Wind Velocity
- Vessel Risk and Wave Power
- Vessel Positions and SEV Index

## Arcopol WMS Demo

### Information

This demo shows some features of Action Modulers' WMS Server, which has been developed in context of the ARCOPOL Platform project. This current page shows Vessel Accident Risk and Wave Power All layers can be configured through MOHID Studio and are provided by Action Server's WMS Plugin in WMS 1.3.0 format.

### Timer

Display Date = 2015-06-15T16:00:00Z

### Vessel Accident Risk and Wave Power

# WMS Server / Demo website

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

OpenLayers 3 Examples x Arcopol / home x ARCOPOL - WMS Server Exam... x +

arcopol.actionmodulers.dtdns.net/mapdisplay3.html

Numerical models Klingande - Jubel (O... Enterprise Europe Net... Welcome to JetBrains ... IPMA - Previsão por lo... SPIEGEL ONLINE - Nac... Action Modulers Jabron - Simulationsso... Inovar Consulta 2013.1...

Arcopol Platform - WMS Examples

- Home
- Vessel Positions and Wind Velocity
- Vessel Risk and Wave Power
- Vessel Positions and SEV Index

## Arcopol WMS Demo

### Information

This demo shows some features of Action Modulers' WMS Server, which has been developed in context of the ARCOPOL Platform project. This current page shows Vessel Positions and Socio-Economic Vulnerability Index All layers can be configured through MOHID Studio and are provided by Action Server's WMS Plugin in WMS 1.3.0 format.

### Timer

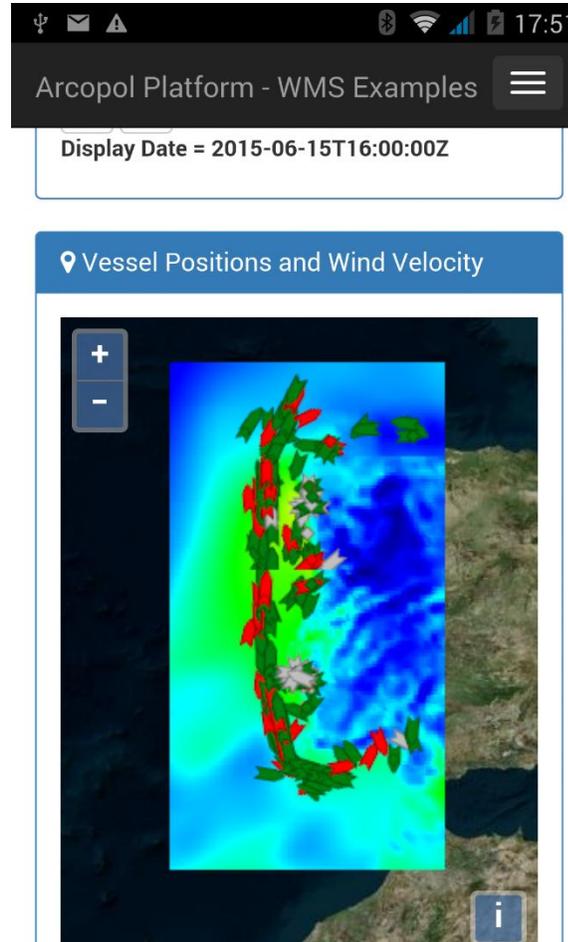
Display Date = 2015-06-15T16:00:00Z

### Vessel Positions and Socio-Economic Vulnerability Index

# 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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