



S I M O

Soluciones Ingeniería Marítima Operacional

Desarrollo de una herramienta de visualización de datos oceanográficos: Modelos y Observaciones

J. Fernandez, J. Lopez, I. Carlos, F. Jerez, F. Hermosilla, M. Espino
SIMO, LIM-UPC, CIIRC

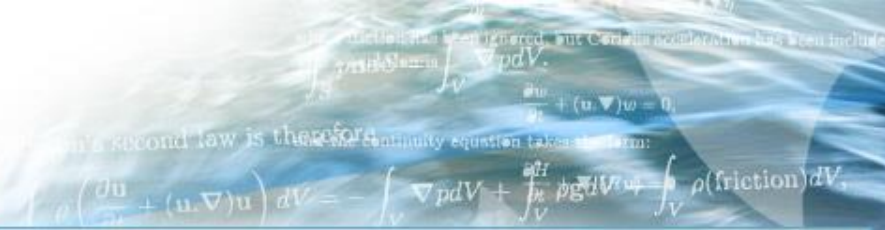




S I M O

Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions



FIELD_AC 7th FRAMEWORK EUROPEAN PROJECT

SIMO: Operational Maritime Engineering Solutions. UPC spin-off company aiming to bridge the gap between research centres and end-users.

- *Ad-hoc* spin-off created within the FIELD_AC framework to assess the feasibility of exploiting an innovative local-scale operational service with a new level of predictions for restricted domains. Three main objectives
 - Find suitable end-users
 - Understand end-users needs
 - Develop tailor-made service





S I M O

Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions



Motivation

- ✓ Difficulty in visualising meteorological, earth observation and oceanographic data binary formats (netCDF, GRIB, HDF5).
- ✓ Difficulty in assessing quality of numerical modelling results – comparison with observational data.
- ✓ Provision of friendly visualization tools of both observation and numerical data to end-users.





S I M O

Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions



Tailor-made Service

- ✓ Data (SOS, THREDDDS...) – including own observational resources in addition to public ones
- ✓ Numerical Model (Wave, Ocean Circulation, Oil Spill...)
- ✓ Visualization tools





S I M O

Soluciones Ingeniería Marítima Operacional

DATA - SOS (Sensor Observation Service)

The Sensor Observation Service aggregates readings from live, in-situ and remote sensors. The service provides an interface to make sensors and sensor data archives accessible via an interoperable web based interface. SOS has three mandatory “core” operations:

- *GetObservation*: provides access to sensor observations and measurement data via a spatio-temporal query that can be filtered.
- *DescribeSensor*: retrieves detailed information about the sensors and processes generating those measurements.
- *GetCapabilities*: provides the means to access SOS service metadata.

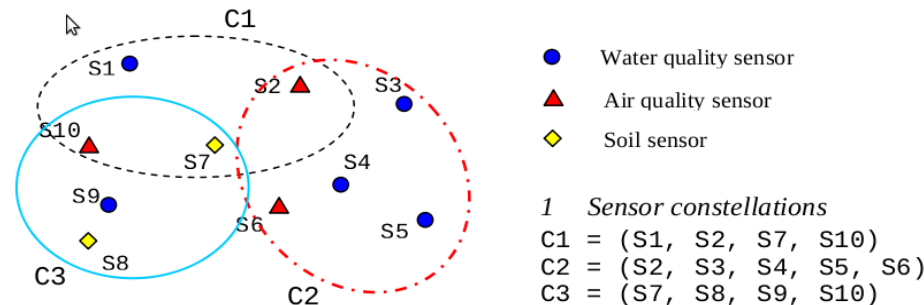


Figure 1-1 General Case for In-Situ Sensors





S I M O

Soluciones Ingeniería Marítima Operacional

DATA - SOS (Sensor Observation Service)

Several optional, non-mandatory operations can also be defined, such as RegisterSensor, InsertObservation, GetResult, GetFeatureOfInterest...

The architecture of a SOS implementation requires:

- POSTGRESQL: database
- POSTGIS: spatial database extension for PostgreSQL
- JAVA SDK: Java Software Development Kit
- APACHE TOMCAT: open source web server and servlet container.

52°North distribution used!!



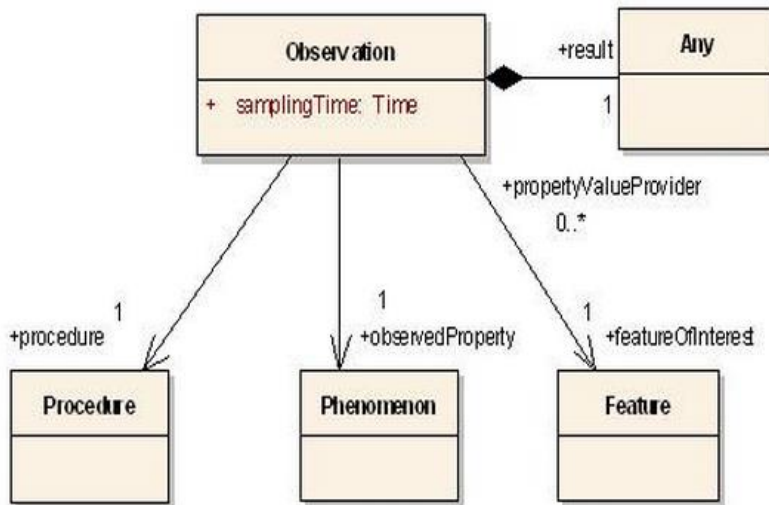


S I M O

Soluciones Ingeniería Marítima Operacional

DATA - SOS (Sensor Observation Service)

Basic Observation Model – O&M Specification



4

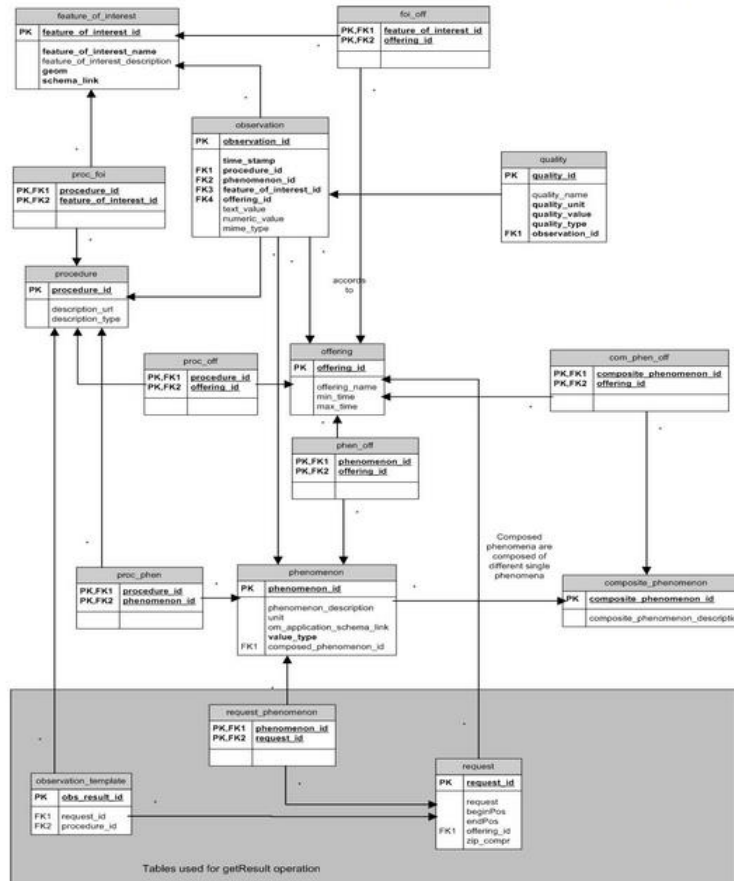


S I M O

Soluciones Ingeniería Marítima Operacional

DATA - SOS (Sensor Observation Service)

52 North SOS Standard Data Model





S I M O

Soluciones Ingeniería Marítima Operacional

DATA – THREDDDS CATALOG

THREDDDS

(Thematic Real-time Environmental Distributed Data Services) is a open-source software that allow the interconnection of data providers with end-

users.  UCAR | COMMUNITY PROGRAMS

Objective:

To simplify the discovery and use of scientific data.

To allow learning and scientific material and publications to reference data





S I M O

Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions



Catalogs are the heart of the THREDDS concept.

They are XML documents that describe on-line datasets.

Catalogs can contain arbitrary metadata, and we have also defined a standard set of metadata to bridge to discovery centers like GCMD, DLESE and NSDL.

Dynamic Catalog Generation

The THREDDS Catalog Generator produces THREDDS catalogs by scanning or crawling one or more local or remote dataset collections. Catalogs can be generated periodically or on demand, using configuration files that control what directories get scanned, and how the catalogs are created.

The TDS uses the Common Data Model to read datasets in various formats, and serves them through OPeNDAP, OGC Web Coverage Service, NetCDF subset, and bulk HTTP file transfer services. The first three allow the user to obtain subsets of the data, which is crucial for large datasets





S I M O

Soluciones Ingeniería Marítima Operacional

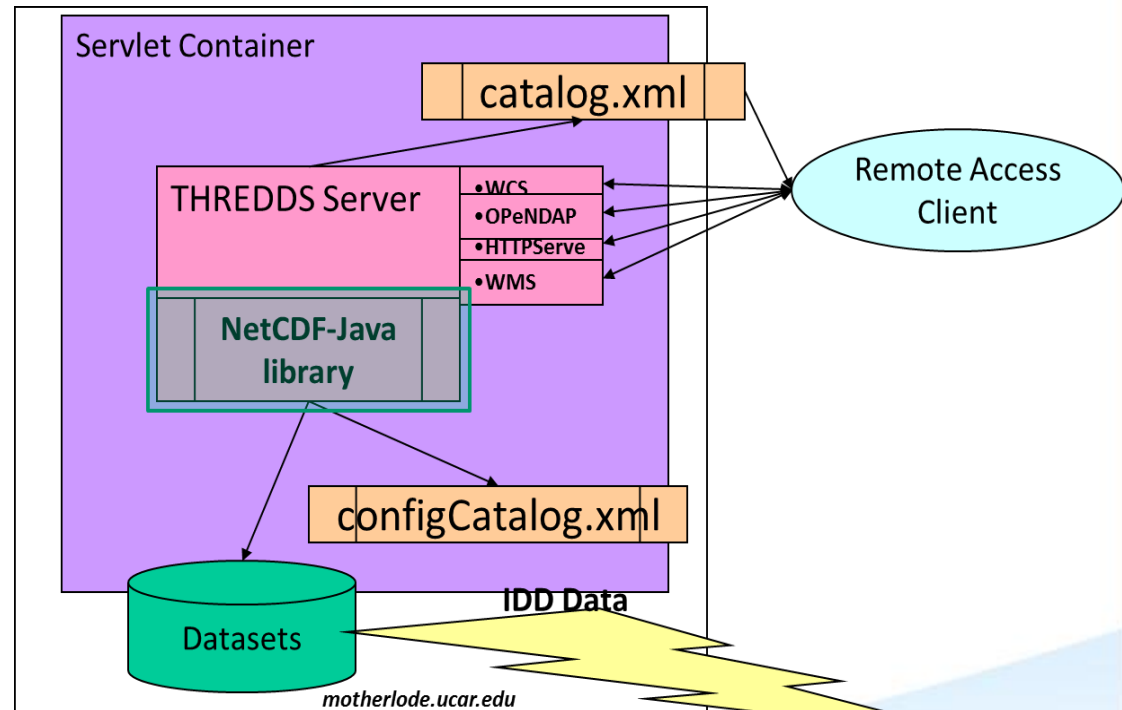
Serves scientific data

Any dataset read by the netCDF-Java library

E.g., netCDF 3&4, HDF 4&5 (and HDF-EOS), GRIB 1&2

Using various data access services

E.g., OPeNDAP, OGC WMS & WCS, NCSS, HTTP










S I M O

Soluciones Ingeniería Marítima Operacional

DATA – THREDDS CATALOG

Dataset	Size	Last Modified
 FIELD_AC		--
 satellite/		--
 Waves/		--
 Meteo/		--
 Currents/		--

[Initial TDS Installation at My Group](#)

THREDDS Data Server [Version 4.2.6 - 20110413.2155] [Documentation](#)



S I M O

Soluciones Ingeniería Marítima Operacional

Operational Engineering Solutions



NUMERICAL MODELS OPERATIONAL IMPLEMENTATIONS

Ocean Circulation models

Operational implementation for the Catalan Sea (ROMS).
Model suite being implemented using FIELD_AC model suite:

- ROMS implementation by LIM/UPC
- MyOcean boundary conditions
- BSC meteo information.
- KUL continental inflows.





S I M O

Soluciones Ingeniería Marítima Operacional

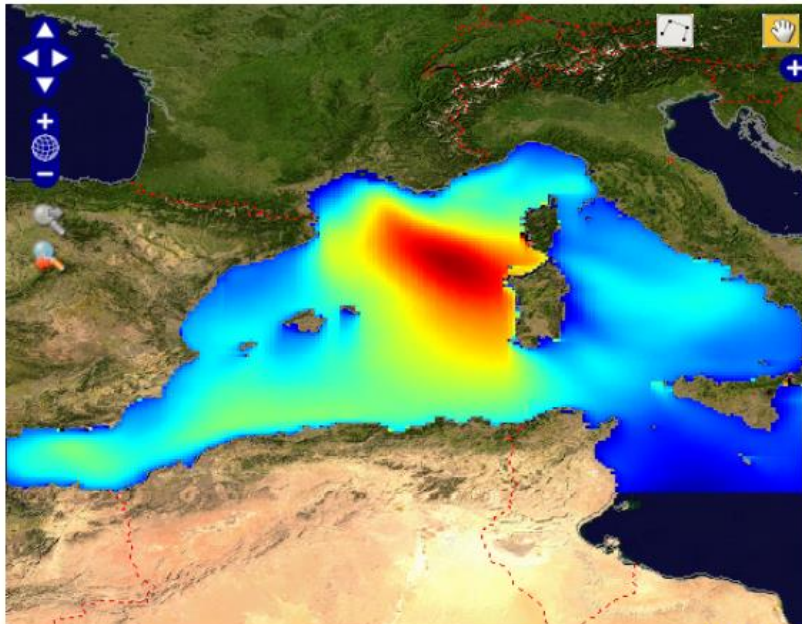
Operational Engineering Solutions



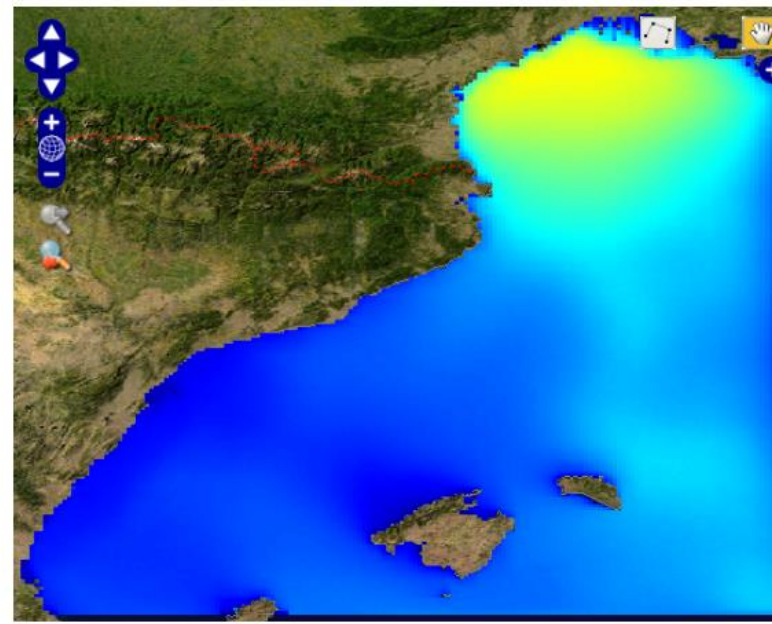
OPERATIONAL IMPLEMENTATIONS

- Wave models

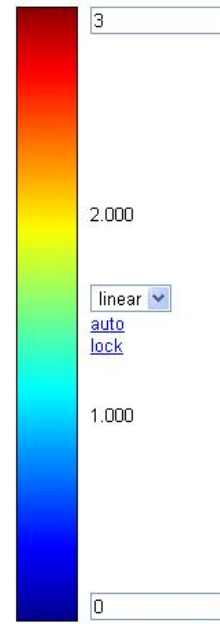
First operational implementations of the FIELD_AC model suite. SWAN 9x9 and 3x3 implementations undertaken.



[Permalink](#) | [email](#)



[Permalink](#) | [email](#)



Transparencia: 100%



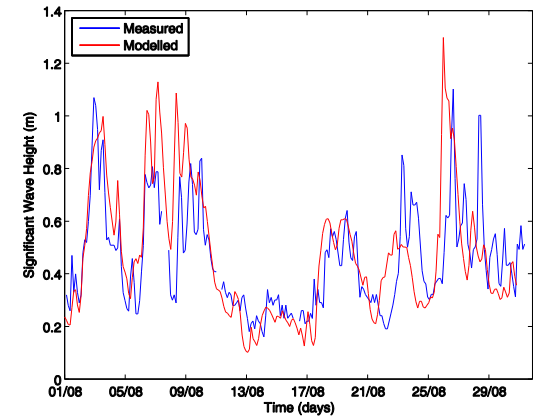
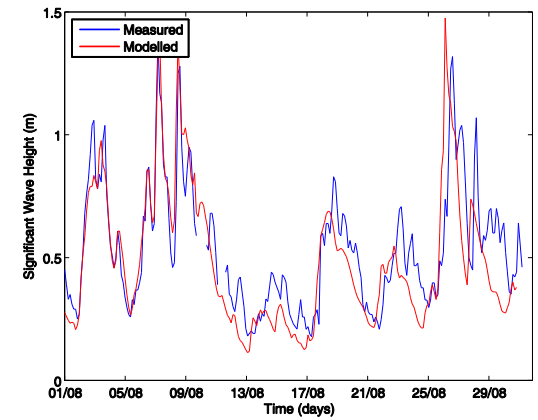
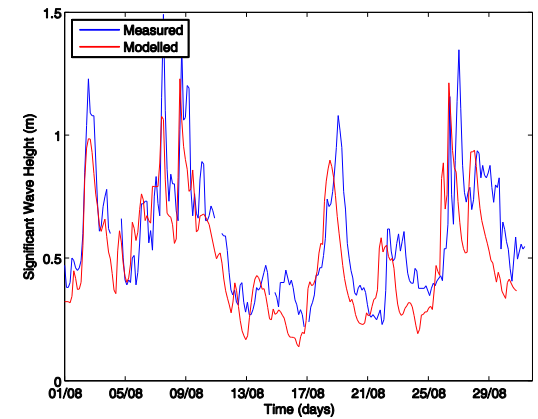
S I M O

Soluciones Ingeniería Marítima Operacional

Superior Technical School of Maritime Engineering

$$\rho \left(\frac{\partial u}{\partial t} + (u \cdot \nabla) u \right) = -\nabla p + \mu \nabla^2 u$$

VALIDATION





S I M O

Soluciones Ingeniería Marítima Operacional

DATABASE

✓ Wave modelling results:

The screenshot displays the SIMO software interface. On the left, a 'Layers' panel lists various data layers, including 'Wave Layers' with 'WA-Significant Wave Height' selected. The main area shows a satellite map of a coastal region with a color-coded wave height overlay. A pop-up window for buoy 'A1F101' is open, showing a line graph of 'Meridional Velocity Cell' data from November to February. The graph shows significant fluctuations between 0.00 and 2.50 m. To the right of the graph is a table of parameters and values.

Parameter	Value
Meridional Velocity Cell13	132.4
Meridional Velocity Cell14	132.4
Meridional Velocity Cell15	132.4
Meridional Velocity Cell16	132.4
Meridional Velocity Cell17	132.4
Meridional Velocity Cell18	132.4
Meridional Velocity Cell19	132.4
Meridional Velocity Cell20	132.4
Meridional Velocity Cell21	132.4
Meridional Velocity Cell22	132.4
Meridional Velocity Cell23	132.4
Meridional Velocity Cell24	132.4
Meridional Velocity Cell25	132.4
SSC from OBS	132.4
SSC Turbidimeter	132.4



S I M O

Soluciones Ingeniería Marítima Operacional

DATABASE

✓ Satellite data:

The screenshot displays the SIMO software interface. On the left, a 'Layers' panel lists various data sources:

- Base Layers:** OS-GEO, Demis WMS, GEBCO Bathymetric Chart
- Wave Layers:** WA-Wind Velocity, WA-Wave Direction, WA-Mean Period, WA-Significant Wave Height
- Ocean Circulation Layers:** SW-Salinity, SW-Temperature
- Satellite Layers:** SAT - YELLOW SUBSTANCE, SAT - TOTAL SUSPENDED MATTER (checked)
- Observation Layers:** FIELD_AC Buoys

The main map area shows a satellite image of the ocean with a red overlay representing the selected satellite data layer. The right-hand side features an 'Information' panel with a calendar for March 2011, a 'Time Selected' field set to 2011-03-01 00:00, and a 'Layer Information' table.

Parameter	Value
Longitude (°)	0
Latitude (°)	0
Hs (m)	0
Tz (s)	0
Dir (°)	0
Winds (m/s)	0
Currents (m/s)	0
Salinity (psu)	0
Temperature...	0



S I M O

Soluciones Ingeniería Marítima Operacional

DATABASE

✓ Comparison:

The screenshot displays the SIMO software interface. On the left, a 'Layers' panel lists various data layers under categories: Base Layers (OS-GEO, Demis WMS, GEBCO Bathymetric Chart), Wave Layers (WA-Wind Velocity, WA-Wave Direction, WA-Mean Period, WA-Significant Wave Height), Ocean Circulation Layers (SW-Salinity, SW-Temperature), Satellite Layers (SAT - YELLOW SUBSTANCE, SAT - TOTAL SUSPENDED MATTER), and Observation Layers (FIELD_AC Buoys). The main map area shows a satellite image of a coastline with a color-coded bathymetric overlay. A 'Comparison' window is open for buoy A1F101, showing a line graph of wave height (Hs) in meters over time. The graph has two data series: a blue line for the first period (01/11 to 01/01) and an orange line for the second period (01/03 to 01/05). The y-axis ranges from -0.5 to 2.5 meters. To the right of the graph is a 'Parameter' list with checkboxes for Hs (m), Tz (s), Dir (°), Winds (m/s), and Currents (m/s). At the bottom of the window, there are fields for 'Initial Day:' and 'Last Day:' and an 'UPDATE!!' button.

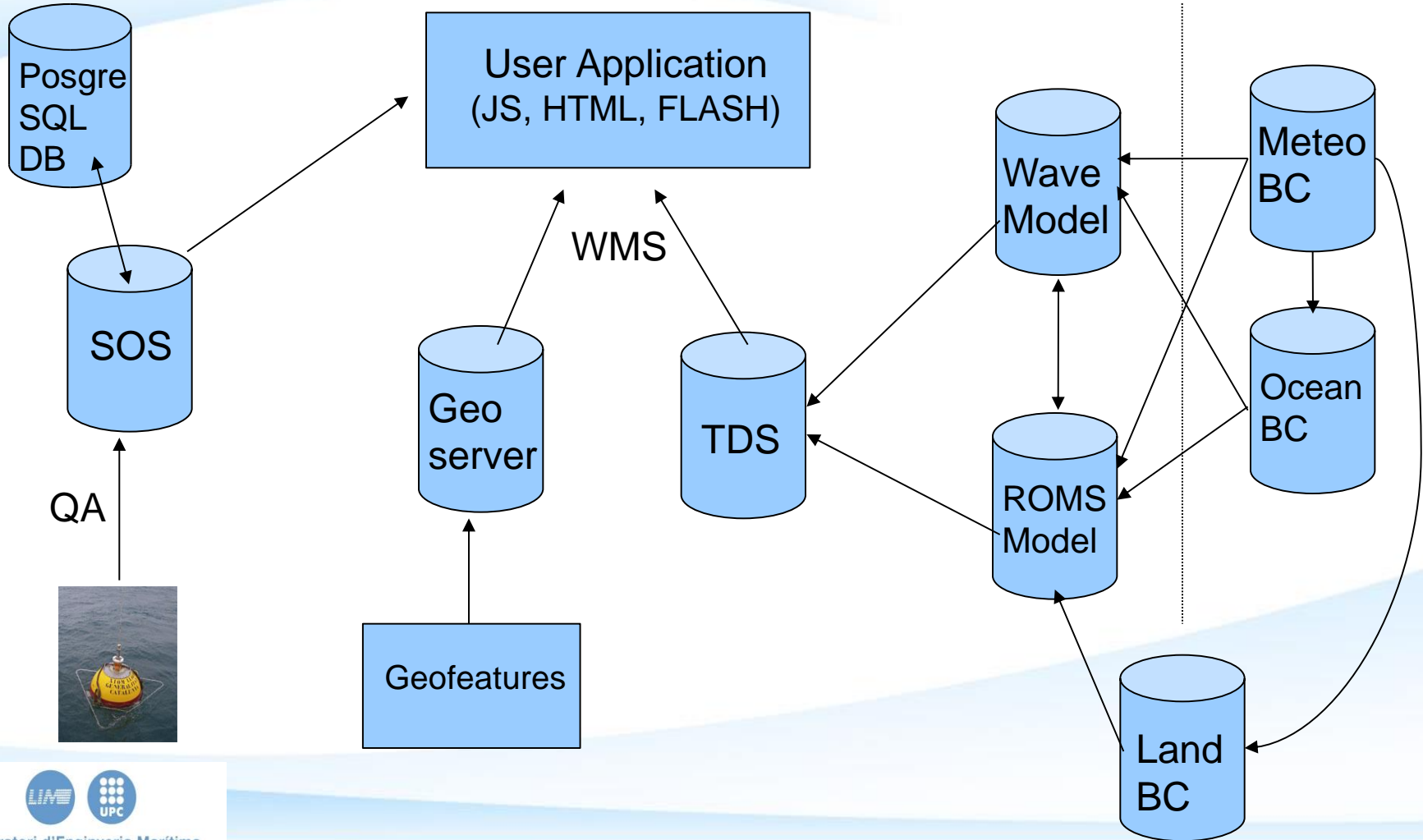


S I M O

Soluciones Ingeniería Marítima Operacional



ARCHITECTURE





S I M O

Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions



APPLICATIONS

Using data from all the different sources, a web-application is being developed using different javascript libraries, html code, flash applications and geoserver:

- **Javascript libraries:** openlayers, geoext, ext.js, jquery...
- **Geoserver**







S I M O

Soluciones Ingeniería Marítima Operacional

FINAL END-USERS APPLICATION

- Openlayers: An opensource js library to load, display and render maps from multiple sources on web pages.  OpenLayers

- Ext JS: a library for building interactive web applications using techniques such as Ajax, DHTML and DOM scripting 

- GeoExt: GeoExt brings together the geospatial know how of OpenLayers with the user interface savvy of Ext JS for building powerful desktop style GIS apps on the web with JavaScript. 





S I M O

Soluciones Ingeniería Marítima Operacional

FINAL END-USERS APPLICATION

- JQuery: fast and concise JavaScript Library that simplifies HTML document traversing, event handling, animating, and Ajax interactions for rapid web development.



- jqplot: open-source charting component that can be used to render data-driven and animated charts in web applications.

- Geoserver: open source software server written in Java that allows users to share and edit geospatial data.





S I M O

Soluciones Ingeniería Marítima Operacional

FINAL APPLICATIONS

- MARINE TOWAGE COMPANY
- MARINE GEOTECHNICAL COMPANY
- OIL SPILL PREDICTION





S I M O

Soluciones Ingeniería Marítima Operacional

...action has been ignored, but Coriolis acceleration has been included

$$\frac{\partial u}{\partial t} + (u \cdot \nabla) u = 0,$$

...second law is therefore

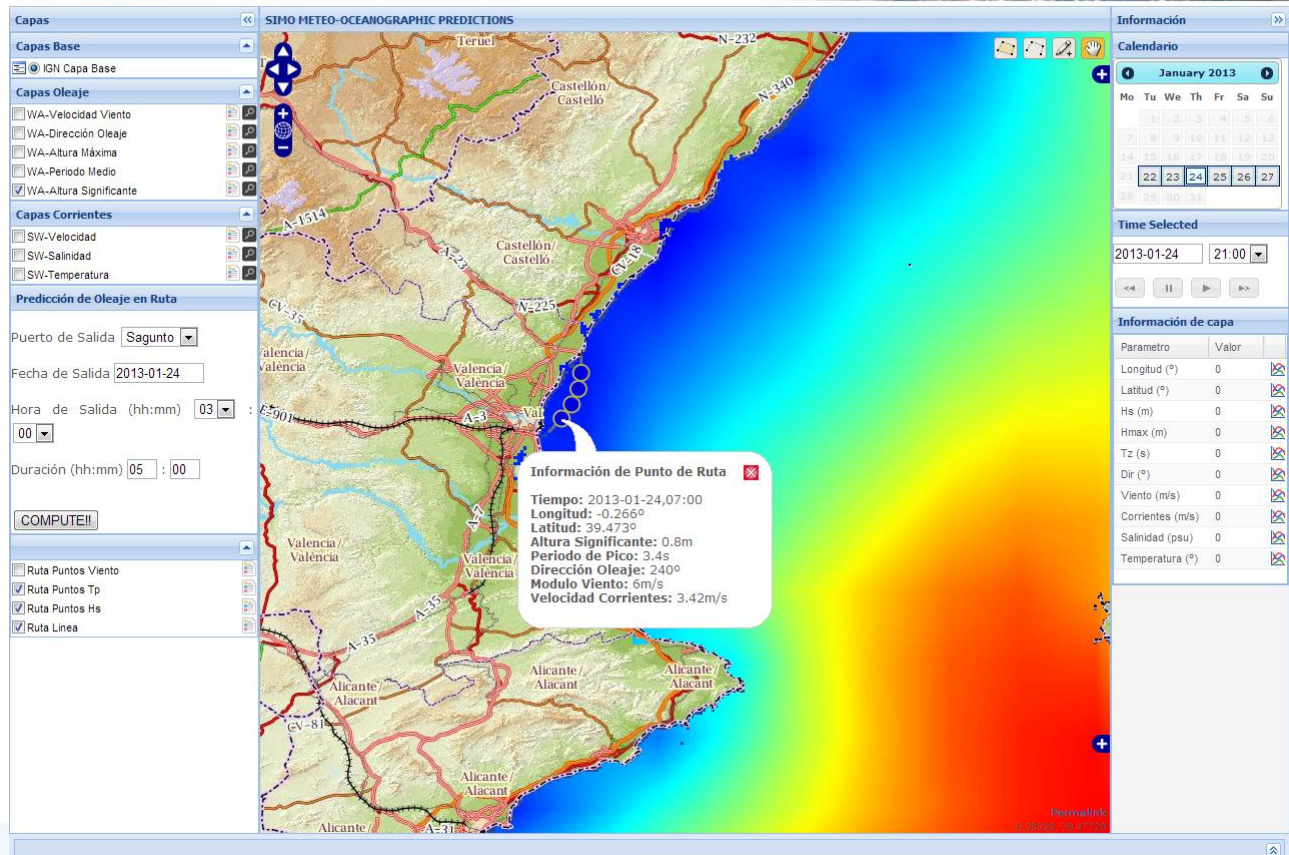
...continuity equation takes the form:

$$\rho \left(\frac{\partial u}{\partial t} + (u \cdot \nabla) u \right) dV = - \int_V \nabla p dV + \int_V \rho g dV + \int_V \rho (\text{friction}) dV,$$

MARINE TOWAGE COMPANY

-Shipment of 25 'caissons' for new Harbour Terminal

-Requirement of wave and wind predictions to ensure safe transport



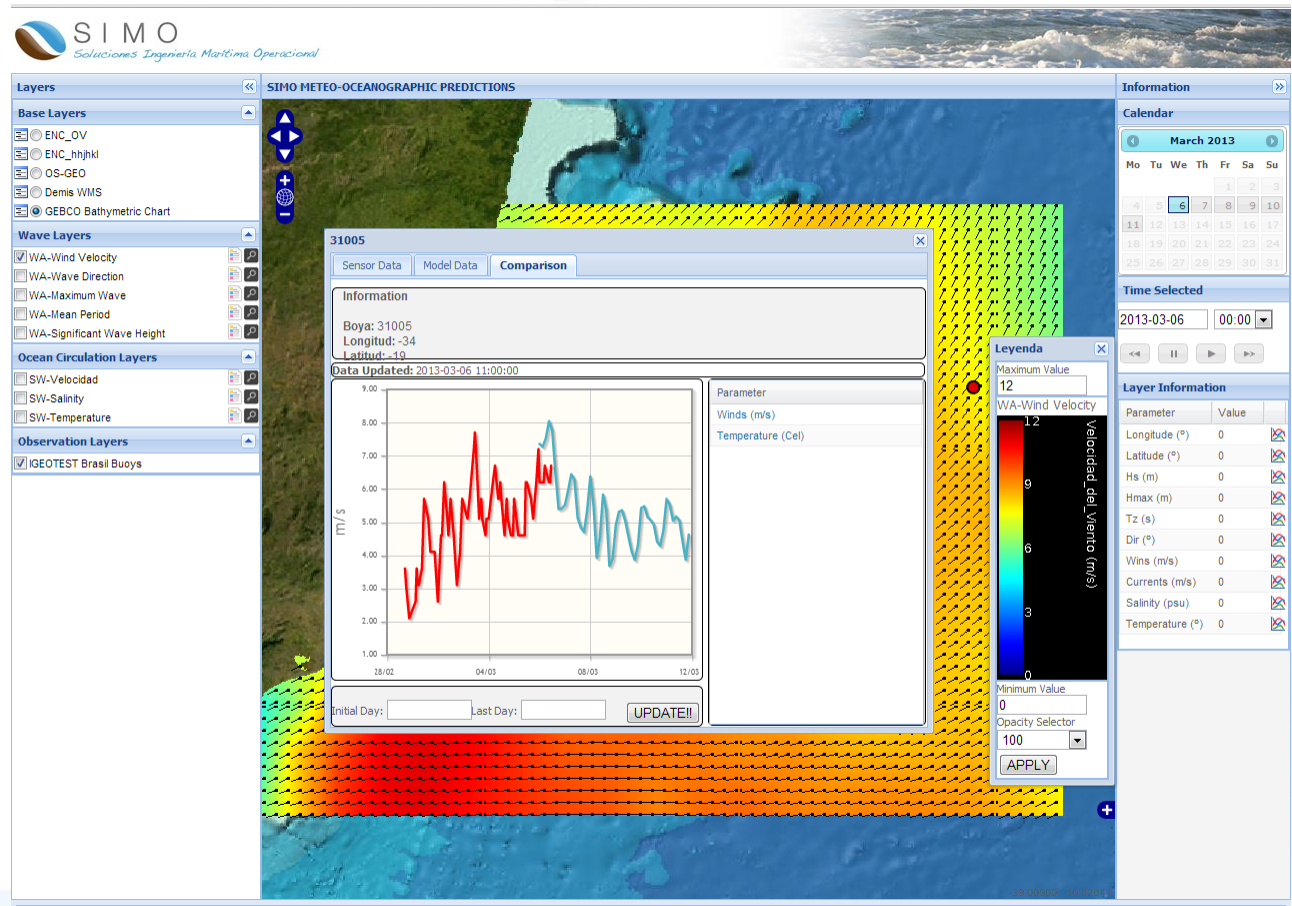


S I M O

Soluciones Ingeniería Marítima Operacional

MARINE GEOTECHNICAL COMPANY

- ✓ Different locations and constant changes (routes).
- ✓ Incorporation of buoy and simulated data (validation)
- ✓ User requirements regarding hosting of visualization tools



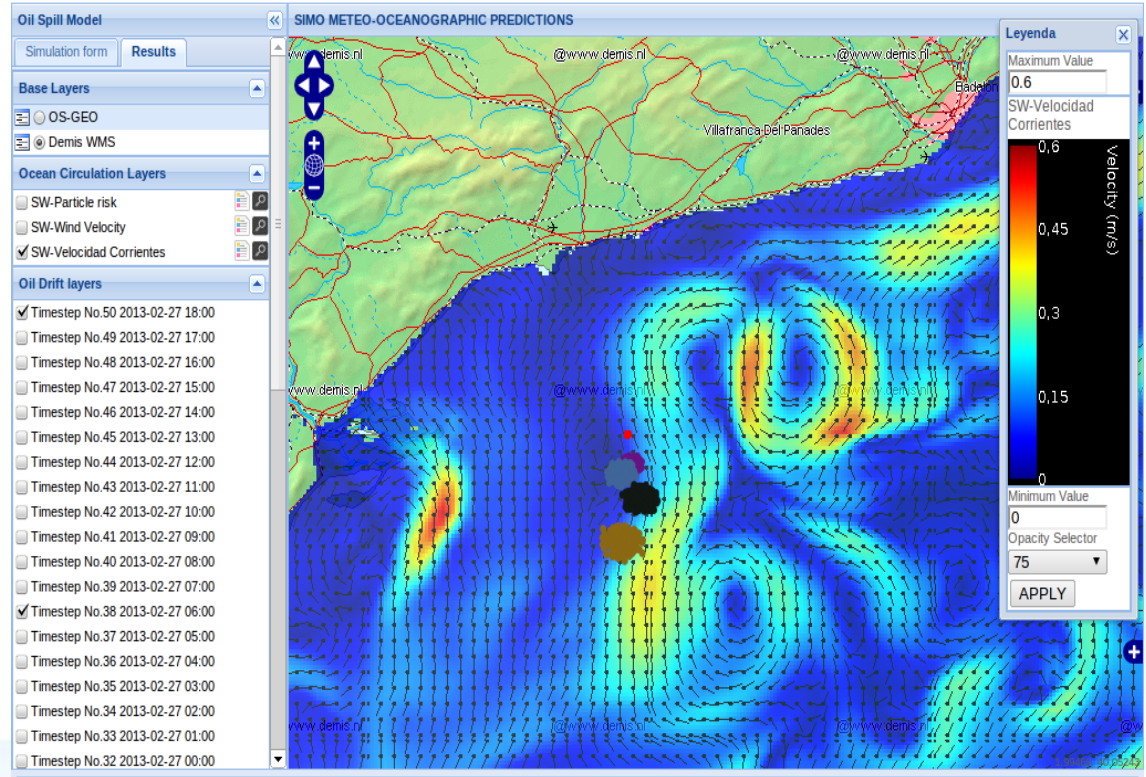


S I M O

Soluciones Ingeniería Marítima Operacional

OIL SPILL PREDICTION

- ✓ A new Numerical model has been developed
- ✓ Weathering processes incorporated
- ✓ Support for decision takers
- ✓ WebGIS application to enter data





S I M O

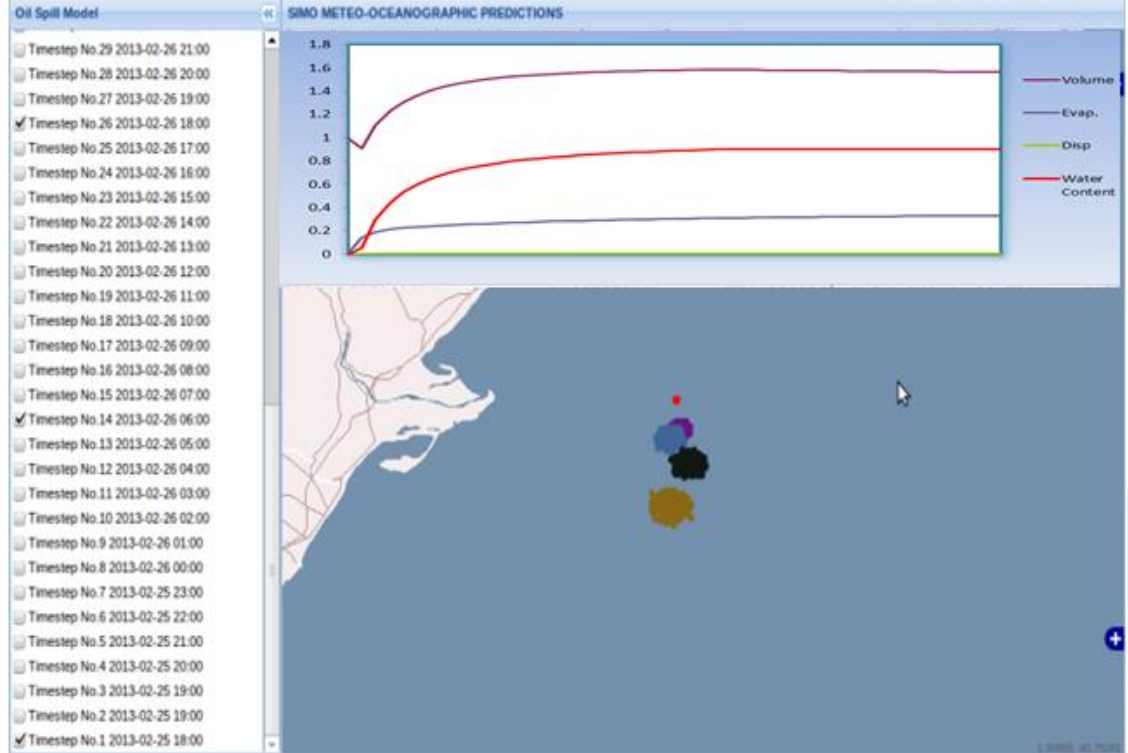
Soluciones Ingeniería Marítima Operacional

Operational Maritime Engineering Solutions

friction has been ignored, but Coriolis acceleration has been included
 $\int_V \rho \mathbf{u} \cdot \nabla p dV$
 $\frac{\partial w}{\partial t} + (\mathbf{u} \cdot \nabla) w = 0$
A second law is therefore
The continuity equation takes the form:
 $\rho \left(\frac{\partial u}{\partial t} + (\mathbf{u} \cdot \nabla) u \right) dV = - \int_V \nabla p dV + \int_V \rho \mathbf{g} dV + \int_V \rho (\text{friction}) dV$

OIL SPILL PREDICTION

- ✓ Results can be analysed easily
- ✓ Possibility of incorporating different mitigation measures (work in progress)





S I M O

Soluciones Ingeniería Marítima Operacional

Soluciones Ingeniería Marítima Operacional

jfernandez@simo.cat