Coastlab12, 2012, Ghent, Belgium. Book of Abstracts of the Fourth International Conference on the Application of Physical Modelling to Port and Coastal Protection. ISBN 978 90 382 2008 6

OSERIT: AN OIL SPILL EVALUATION AND RESPONSE INTEGRATED TOOL

SEBASTIEN LEGRAND [1] & VALERIE DULIERE [1]

[1] *Management Unit of the North Sea Mathematical Models (MUMM), Royal Belgian Institute of Natural Sciences (RBINS) Gulledelle 100, B-1200 Brussels, Belgium. s.legrand@mumm.ac.be, v.duliere@mumm.ac.be.*

1. Introduction

In case of oil pollution of the sea, two combating options are allowed by the Belgian Marine Environment Protection Law. The first option is the mechanical recovery and the secondary option is the use of chemical dispersants. In the latter case, the decision to use dispersants or not is to be taken by the competent authority on the basis of the best information available and of a good scientific understanding of the possible impact.

Currently the decision-making process mainly relies on the "best educated" judgment of the national experts. However, these experts recognize that they cannot access to all the factual and scientific-based elements that could influence their judgment and claim for a tool that could help them to perform the "Net Environmental Benefit Analysis" (NEBA) decision-making process. To meet their request, MUMM is developing a new service called OSERIT: Oil Spill Evaluation and Response Integrated Tool. This web-based tool will gather relevant, scientific based information needed to support the decision-making process in case of oil spilled at sea.

OSERIT targets two categories of users. The first category includes operational users who need to quickly access marine and oil spill drift forecast. The second category of users includes environmental representatives who need to compare several scenarios in order to assess the potential environmental consequences of various combating strategies. To meet this ambitious goal, the new web-based interface interacts with a new 3D oil drift and fate mathematical. This model combines the advantages of the Lagrangian approach for modelling the surface processes and the Eulerian approach to forecast the oil concentration chemically dispersed in the water column.

2. Service definition

The main objective of the research project OSERIT is the development of an integrated tool that gathers relevant, scientific based information provided by the operational oceanography to support the decision-making process of the Belgian Coast Guard Agencies in case of oil pollution. The service was designed from our end-users feedbacks and expectations. It allows coast guard operators to quickly access high resolution short term marine and drift trajectory forecast and environmental representatives to compare several scenarios in order to assess the environmental consequences of the different possible strategies to combat the oil pollution. In addition, both categories of end-users agreed with the fact that OSERIT success will depend on its quickness, reliability, user-friendliness, accessibility and inherent quality (i.e. state-of-the-art system). It should allow visualization and download of required info.

This interface has voluntary been kept as simple and user-friendly as possible. It comes with a flexible input forms, a visualization tool and an export tool. The input form allows users to define the simulation set-up. It automatically adapts itself to a large panel of pre-defined oil release and spill scenarios from instantaneous punctual single release to continuous release from a moving source. The visualization tool allows user to access marine forecast and various diagnostics derived from the drift simulation such as probability maps for search and rescue operation, oil polluted zones, residence time and exposure times in oil-sensitive areas or oil mass balance.

Finally, the export tool allows user to download the results of the selected simulation in various file formats and insert them in their own GIS tool.

The web-based interface can interact with MUMM web server and the new 3D oil drift and fate model installed on the MUMM high performance computer.

3. Model description

The OSERIT model is based on a innovative hybrid Lagrangian-Eulerian method that simulates the 3D drift and fate of oil on the sea surface and in the water column.

The Lagrangian particle module represents a spill of oil by the release of particles and computes the displacement of each particle resulting from the combined actions of winds, ocean currents, Stokes drift, buoyancy, turbulent diffusion, gravity, viscosity and surface tension. More particularly, the turbulent diffusive transport is expressed using the random walk technique following Wang et al. (2008). Particles can move from the surface into the water column through the process of vertical natural dispersion mainly due to the action of breaking waves. Surface oil is then split into smaller droplets that are propelled into the water column. The oil natural dispersion follows the kinetic approach of Tkalich and Chan (2002). The oil entrainment rate from a surface slick to the water column is computed along with droplets intrusion depth. Two different parameterizations have been implemented in OSERIT to simulate the horizontal surface spreading of oil over the water surface mainly due to the combine effect of gravity, inertia, interfacial tension and viscosity. The first method is based on Fay (1970) and approaches the spreading due to gravity-viscous forces by computing random velocities in the range of velocities that are assumed proportional to the diffusion coefficients (Garcia et al. 1999). The second method, also based on Fay (1970), considers the oil slick as an ellipse which elongates along the wind direction (Lehr et al., 1984). The surface horizontal spreading stops when the terminal thickness is reached based on data from McAuliffe (1987), as done in French (2003).

The Eulerian module computes the time-evolution of the oil concentration dispersed into the water column , sing a common advection-diffusion transport equation. One-way with the Lagrangian module, the Eulerian module is used to simulate the evolution of oil chemically dispersed into the water column while the Lagrangian one is used to simulate the drift of non-dispersed oil at the sea surface and in the water column.

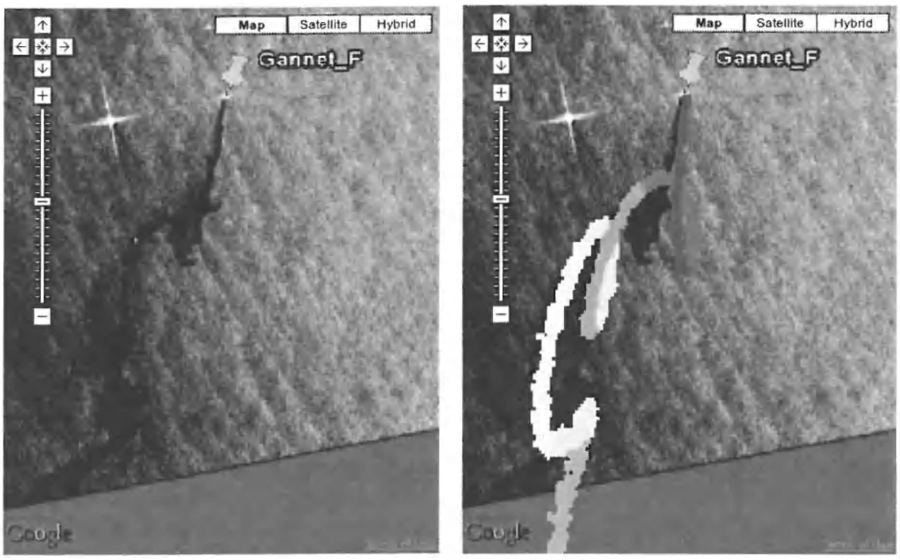

Figure 1. Satellite image taken on August 19th 2011 (5:31 UTC) by the COSMO SkyMed System (left) and the corresponding model estimation of the oil slick position superimposed on the same satellite image (right). The colours on the right panel represent time intervals of 6 hours during which the oil has been released. The dark red part of the slick represents oil that has been released during the 6 hours before the satellite image was taken while the dark blue part of the slick represents oil that has been released between 36 and 48 hours before the satellite image was taken. The Gannet F platform is represented by green drawing pin.

4. Conclusions

The research project OSERIT aims at developing an integrated tool that gathers relevant, scientific based information provided by operational oceanography to support the decision processes of the Belgian coast guards in case of emergencies as oil pollution of the sea. This tool is designed as a one-stop shop service to access currents, temperature, salinity, wind and waves forecast and allows launching, visualizing and downloading both simple and complex 2D and 3D drift simulations. Based on state of the art techniques, a special care has been paid to meet the end-users requirements on the tool quickness, reliability, user-friendliness, accessibility and inherent quality.

The presentation will describe the project achievements, including the service set-up and the model validation as, for instance, the GANNET study case (Figure 1).

Acknowledgments

OSERIT development is funded by the Belgian Federal Science Policy Office (BELSPO) through the contract SD/NS/10A (programme "Science for a Sustainable Development").