# Evaluation of wave and current models from EPEL-GNB 2003 observations

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## Abstract

In the framework of the EPEL program, the SHOM (Service Hydrographique et Oceanographique de la Marine) conducted in February and March 2003 an extensive met-ocean data acquisition campaign in the Normand-Breton Gulf. This data set in a tidal-dominated environment was designed to enhance existing test-beds for sea-state models, with the objective to help chose the components of an operational system for forecasting met-ocean conditions up to the shoreline.

Two bi-dimensional hydrodynamical models, namely TELEMAC-2D (Galland et al. 1991) and MARS-2D (developed at Ifremer in France) and three spectral wave models, namely WAVEWATCH III (Tolman 1991), TOMAWAC (Benoit et al. 1996), and SWAN (Booij et al. 1999) are selected for the comparison: The computational area covers the entire Channel (from 5°15'W to Dover Straits) and it includes a finer model fitting in the triangle St-Malo – Chausey – Granville witch corresponds to the EPEL-GNB area. The wave models are forced with one of the two hydrodynamical models, in order to consider the effects of currents and water levels variations induced on the waves. The wave model parameters are calibrated by running a selection of storm events. At the end of the whole computation, the models are evaluated from the buoy and satellite observations of the EPEL campaign.

## Keywords:

Spectral waves – sea-state - tide – tidal currents – wave-current interaction - modelling

## 1. Introduction

An extensive field experiment has been conducted, in February-March 2003, by SHOM to measure waves, currents and water levels. The aim is to analyse (unsteady) tidal effects on wave propagation and to examine the performances of several spectral wave models under these specific conditions. Section 2 describes the data acquisition campaign. Two hydrodynamical models, presented in section 3, are set-up to model the

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tidal flow dynamics and sea surface elevation fields. Spectral wave modelling is presented in section 4.

## 2. Data acquisition campaign

The EPEL 2003 experiment took place in the western part of La Manche, between Saint-Malo, Chausey and Granville, an area known as the "Golfe Normand-Breton" (GNB). Instruments were moored in 20-50 m water depths (Figure 1). In that area, the highest tidal range is about 13 m, with mean neap tide currents are up to 2 m/s.

The instrumentation used include two directional (DW1 and DW4) and two non-directional Datawell waverider buoys (DW2 and DW3), an AWAC ADCP, and three Aquadopp current-meters. Additional surface current was available from a 47 MHz VHF radar (Cochin et al. 2005). Data from the U.K. Met. Office Channel and Greenwich Lightships were also used. Tidal modulation of wave heights is clearly observed in the EPEL area, more particularly at DW4 (see Figure 4).

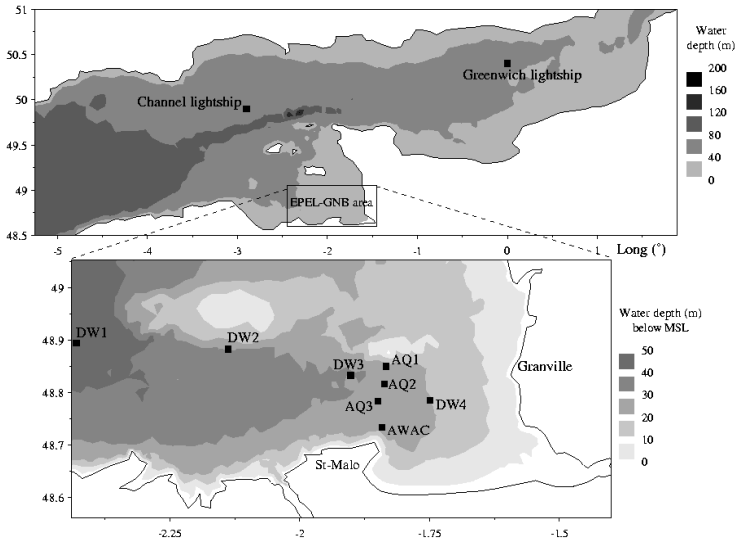


**Figure 1:** Presentation of the EPEL experiment area and measurement positions.

## 3. Tidal flow modelling

The two bi-dimensional (2D) hydro-dynamical models MARS2D and TELEMAC2D were compared. The computational area covers the entire Channel, as presented in Figure 1. Three nested finite difference grids are used for MARS-2D to reach a spatial resolution of 300 m in the EPEL area. TELEMAC-2D is based on an unstructured spatial meshing and uses two grids to reach the same resolution in the EPEL area. Both models are forced with the same tidal conditions at the boundaries.

Currents from MARS-2D were first calibrated and validated with historical data, by fitting (K2, M2, N2, S2) ellipses and reducing the phase mismatch. In the EPEL-GNB area, simulated current velocities were compared to VHF radar measurement to tune the Strickler coefficient for bottom friction (Figure 2). A better fitting of measurement is

obtained for Ux components, rather than for Uy components which are very weak. Similar work on TELEMAC-2D is now under way.

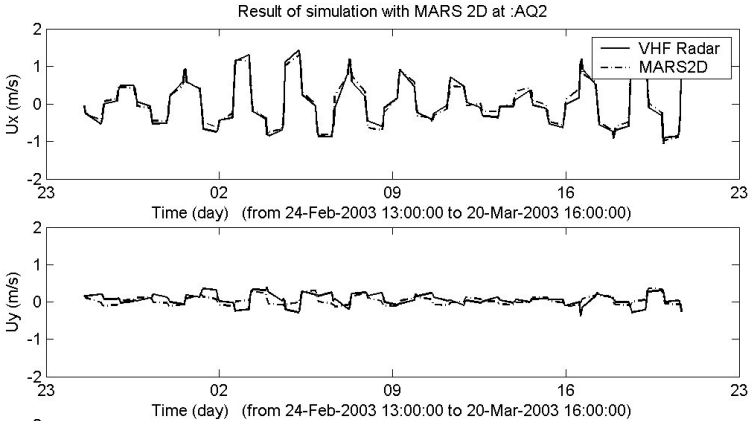


**Figure 2:** Comparison between simulations with MARS-2D and measurement at AQ2 position.

## 4. Wave modelling

Three spectral wave models have been implemented and are currently in validation: TOMAWAC (Benoit *et al*., 1996), SWAN (Booij *et al*., 1999) and WAVEWATCH III (Tolman, 1991). To reach a spatial resolution of 1 km in the EPEL-GNB area, each wave model uses two nested grids. SWAN and WAVEWATCH use the same finite difference grids. As TOMAWAC is based on an unstructured spatial meshing, islands and shallowest regions can be more precisely represented and sensible results are obtained right from the coarser grid. All models use the same spectral grid (36 directions and 31 frequencies on a logarithmic scale from 0.04 to 0.7 Hz).

Wave boundary conditions for La Manche is extracted from the wave atlas built with TOMAWAC oceanic modelling forced by NOAA/NCEP reanalysed winds (Benoit and Lafon, 2004). Aladin wind fields, computed by Météo France on a spatial grid of 0.1° with a time step of 3 hours are used as atmosphere forcing of the wave models. A correction has been applied to the wind fields in order to fit QuikScat measurements during the campaign. The wind field were also validated from UKMO wind data and SAR measurements.

The influence of currents and sea surface elevation variations on spectral wave modelling is currently analysed by introducing the MARS-2D outputs in the wave models. Preliminary results are presented on Figure 3 at the locations of the directional buoys DW1 and DW4. Figure 3 clearly shows that the models reproduce some tidal modulations of the wave heights (particularly at DW4). However, large discrepancies are observed between the different models and work is ongoing to find the sources of these differences.

## 5. Preliminary conclusions – Future work

A careful validation and calibration of forcing fields (winds, currents, open boundary conditions) was performed to reduce potential sources of errors. To understand the

discrepancies observed in the wave models outputs, additional wave simulations, all using the same physics, are planned in order to identify the separate effects of source term parameterizations and numerical schemes.

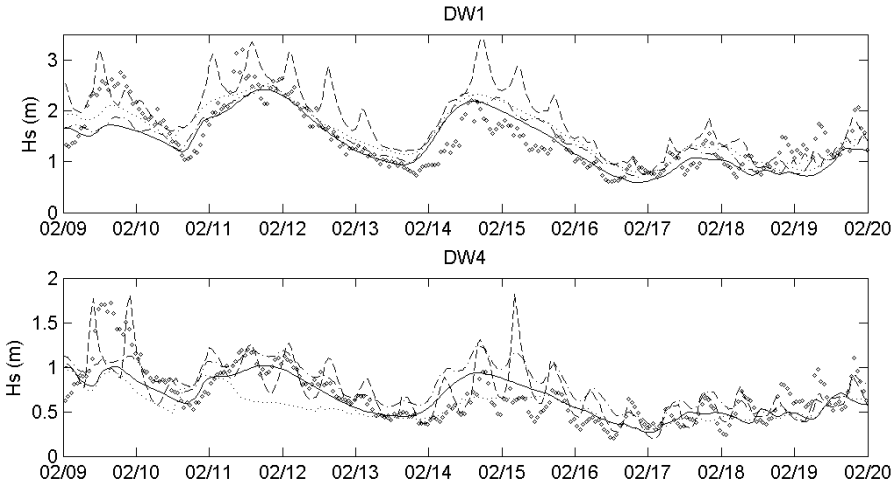


**Figure 3:** Tidal influence on wave propagation.
Diamonds: measurement, continuous / dotted lines: TOMAWAC / SWAN without tidal effect, Dot-dashed / dashed lines: TOMAWAC / SWAN with tidal effects..

## Acknowledgements

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