A METHOD TO PREDICT WAVE CONDITIONS IN ISLAND ENVIRONMENT

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1. INTRODUCTION

In many ocean regions the archipelagoes or even isolated islands provide shelter and this effect has an influence on the wave climate for coasts or ocean areas located in the shadow zones. Incident waves from the deep ocean are blocked by the island boundaries and are refracted over the island shoals. The wave energy is partially dissipated in surf zones or reflected back to the deep ocean. However, many other mechanisms, such as wave diffraction, wave scattering and wave-current interactions spread wave energy into the island lee regions. That is why, the most appropriate way of modeling the wave propagation into such an environment is probably to consider the island matrix both from local and regional perspective.

The availability of realistic data concerning the nearshore wave field is most important in coastal engineer applications, as well as, in many military landing operations. The numerical wave models are nowadays able to produce forecast products of the oceanographic parameters and make available in a useful time scale the environmental support necessary for various rescue and military applications conducting to a rapid environmental assessment of a tactically significant area. In this context the nowcast and forecast techniques based on the interactions between large-scale and high-resolution wave models became more and more common and effective. This is due to the relatively low cost in comparison with the more expensive task of maintaining permanent networks for 'in situ' oceanographic measurements. Moreover, the predictions provided by these models may be significantly improved by an infusion of field collected or remotely sensed data. As a consequence, the directional boys, as well as, some other devices (ADCPs, pressure sensors, etc) are very useful in the process of data assimilation or when making the calibration of the numerical models on specific sites.

The ocean-scale models, WAM (WAve Modeling) and WW3 (Wave Watch III), are based on a detailed physical description of the air/sea interactions and give a statistical description of the time evolution of the sea waves using the spectral action balance equation, Komen et al. (1994). The large-scale wave models have been coupled to the operational atmospheric forecast models and have been made some global and many regional implementations. Predictions of the wave climate near the European coasts of the Atlantic Ocean are available on various Internet sites. As concerns the high-resolution models, the SWAN spectral model seems to be the most effective and that is why it was denoted as the community wave model. SWAN (acronym for Simulation WAves Nearshore) is a phase averaging wave model designed to obtain realistic estimates of wave parameters in coastal areas, lakes and estuaries from given wind, bottom, and current conditions, Holthuijsen et al. (2001). In SWAN the following wave propagation processes are implemented: propagation through geographic space, refraction due to bottom and current variations, shoaling due to bottom and current variations, blocking and reflections by opposing currents, transmission through or blockage by obstacles. The model also accounts for the dissipation effects due to whitecapping, bottom friction and wave breaking. In its last version the SWAN model overpasses the condition of high-resolution model being increased its applicability from a scale of 25 km to almost any scale. However, SWAN does not support oceanic scales being less efficient in this area than WW3 and WAM. Consequently, from this point of view, SWAN can be considered still a high-resolution model but with more extended capacities. As a limitation, SWAN does not account for diffraction. For this reason, in the areas where this phenomenon is relevant might be used also the REF/DIF model, which is a phase-resolving, weakly non-linear, combined refraction-diffraction model that incorporates the effects of shoaling, refraction, energy dissipation and diffraction, Kirby and Dalrymple (1994).

2. UNIFIED ODYSSEY 2002

At the end of January and beginning of February 2002 was held the NATO exercise 'Unified Odyssey 2002'. This application was located in the archipelago of Madeira especially focussed in the southern part of the Porto Santo Island. The Hydrographic Institute of the Portuguese Navy (IH) assured the environmental support for this exercise providing previsions concerning the general characteristics of the wave conditions in the area. These forecast products were based on simulations with the SWAN spectral wave model. The initial forcing conditions, concerning the nowcast and three-day forecast from 12 to 12 hours, where provided by the 'Fleet Numerical Meteorology and Oceanography Center' (FNMOC). Thus the wave parameters came from the WW3 simulations while for the wind was considered the NOGAPS field data. The resolution of the WW3 simulations was of 0.92° in the north direction and 1.25° towards west. However, in the area of the Porto Santo Island this resolution was increased to 0.33° towards north and respectively 0.42° in the west direction. The WW3 spectra message format provided ahead of the spectra data, the following parameters: the position (latitude and longitude), the date-time and τ (forecast hour); significant wave height; maximum wave height; swell direction, height, and period; primary wave direction and period; secondary wave direction and period; wind wave direction, height and period; and white cap probability.

The SWAN simulations were performed both using directly the WW3 spectral files, as well as, parametric boundary conditions. In this last case was usually built a Pierson-Moskowitz spectrum using the WW3 output concerning the significant wave height the period (mean or peak) and the peak direction. The directional standard deviation considered was of about 17 degrees. This value is an average of the directional spreading computed as conventionally for pitch-and-roll buoy data, Kuik (1988). A special attention was paid to the processes and the phenomena associated with the depth-induced wave breaking. These would be a factor of interest in the coastal engineering applications because a great amount of the wave energy is finally dissipated in the nearshore regions determining the geometry and composition of the beaches and influencing the coastal structures and works. A good assessment for the surf-zone conditions it is particularly important also in the military landing operations. For these reasons and starting from the results of the linear theory associated with the SWAN output, were evaluated most of the breaking parameters as the location of the breaking line, the breaking type and the typical wave conditions when the breaking process is going to begin. The tidal effect, which may affect the coastline configuration and consequently some surf parameters, was also accounted.

Beyond the computational strategy and the solutions adopted, the participation to this NATO exercise was an opportunity to develop an original interactive computational tool with functions both for pre and post processing that can be used in any other site, either in island or continental nearshore. This interface denoted by TOTAL WAVE was designed using the MATLAB environment. It was devised in the spirit of the Delft3D package but focused more on the specificity of the coastal wave modeling and as a consequence allows a quick implementation of the model, making a link between the large-scale and high-resolution simulations. Its graphical and numerical outputs assure a better assessment and visualization of the parameters associated with the analysis of the wave conditions all along the process. Three interactive modules compose the interface following the natural succession of operations resulting from the procedure of joining together ocean-scale with high-resolution wave models. The first is for analyzing the large-scale environmental matrix, the second for processing of the bathymetric data and implementing the high-resolution area, and finally the third for post-processing the model results in the output area.

3. THE ENVIRONMENTAL MATRIX FROM REGIONAL PERSPECTIVE

The archipelago of Madeira is located in the Atlantic Ocean about 500 km far from the North African coast and can be integrated approximately in a 1° length square centered with respect to a point with the co-ordinates (32.8°N, 16.8°W). The passage from very deep to shallow water is made suddenly and therefore very strong gradients in terms of depth are present all over Madeira but especially in the vicinity of Porto Santo, which is the second big island of the archipelago (after Madeira itself) and it is located in the north-east part. The bathymetric configuration becomes even more complicate because of some small rocky islands that are surrounding the Porto Santo Island. The 'in situ' data sources placed at that time in the vicinity were a directional buoy in Funchal and a non-directional buoy in Caniçal, both situated in the southern side of the Madeira Island. However, the environmental conditions in the south of the Porto Santo Island, where the NATO exercise took place, are very similar with those from the Funchal area, where the buoy was located. This led to the idea of performing an indirect validation of the results by developing simulations in parallel with the SWAN model both for Porto Santo and Madeira. Finally the results concerning Madeira were compared with the correspondent buoy data.

A digital model for the ocean floor was used as bottom boundary condition. For the general assessment of the wave conditions in the area was first produced a bathymetric map of the archipelago using the geographical system and having a length of about 1.2° and step length of 1.5 km in both directions. This map can be seen in the figure bellow where can be also identified the data sources (WW3 nodes and buoys). Two different coarse bathimetric grids (formatted in Cartesian coordinates) were used for running SWAN, as a result of different bathymetric elevations. In the Porto Santo area this coarse grid has a resolution of 200 m while the high-resolution grid step is of 50m. In the Madeira area, taking into account that the distances involved are greater, the coarse grid step is of 700 m while the high-resolution grid step of 100 m.

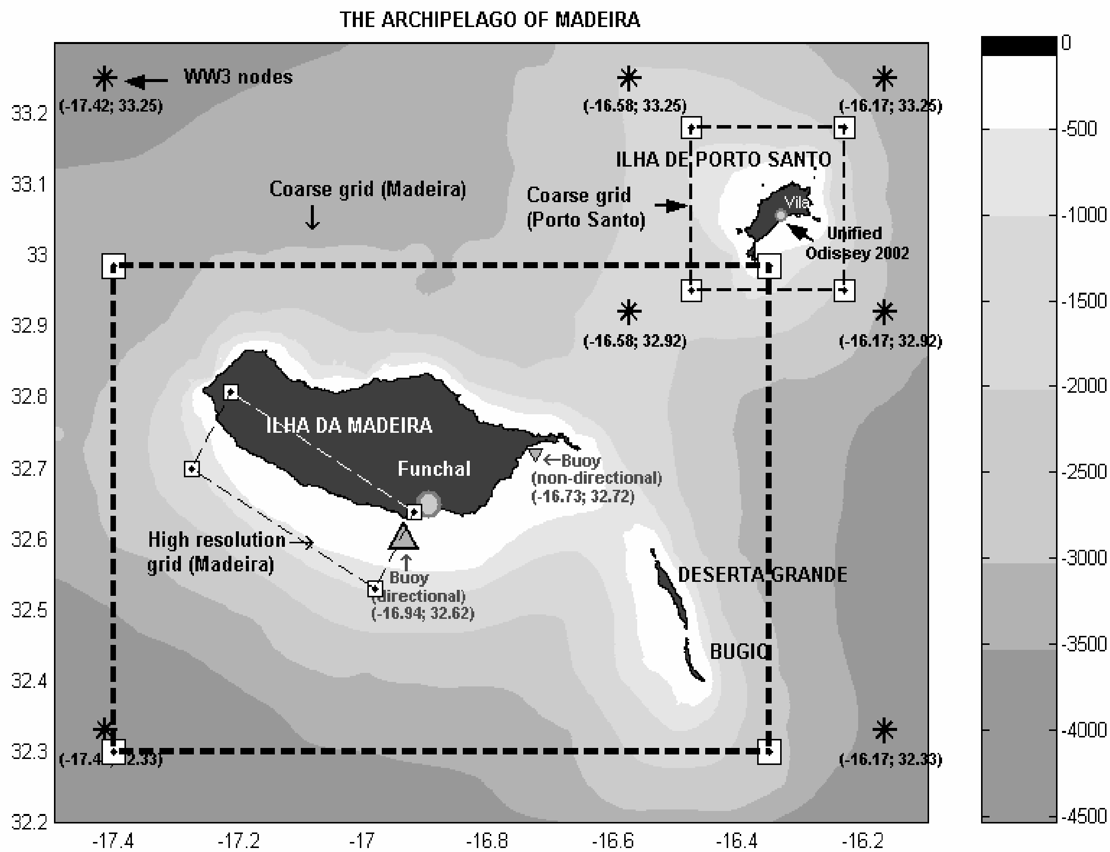

Figure 1
General view of Madeira archipelago – location of the data sources and bathimetric grids

In the wintertime usually the incoming swell is from W/NW with significant wave heights between 2.5 and 5 meters (greater in storm conditions). However, the area of interest is sheltered from the swell, and the combined refraction-diffraction phenomena are governing the physics of the wave propagation. Generally, in this period of the year the meteorological characteristics are dominated by the anticyclone from Azores, which is dislocated south from its usual position (between 30° N and 40° N). The atmospheric circulation in the area may become even more complicate because during the period November-February another anticyclone from Morocco (33° N) affects this region. As a consequence, it is difficult to define a specific wind pattern but strong winds often occur, leading in the sheltered sides of Porto Santo and Madeira to a random alternation between swell and wind in the dominant wave component. The large-scale ocean circulation is dominated in the area by the Canarian current, which follows the SW direction, its intensity being usually about 0.5 knots. The tidal currents are almost non existent in the southern side of Porto Santo.

In order to assure computational effectiveness the interface developed allows an automatic reading of the WW3 data providing a visualization of the environmental matrices in terms of wave vectors, wind vectors and wave periods in parallel both for the entire Madeira archipelago as well as for the high-resolution WW3 area (concerning the Porto Santo Island). Moreover, using the wind vector matrices are produced instantaneously the

SWAN format input wind grids, for both the sites analyzed (Porto Santo and Madeira Islands). At this stage, the interface provides also the available data concerning the ‘in situ’ sources as well as the spectral shape for each WW3 node at the moment of analysis.

4. THE COMPUTATIONAL STRATEGY

The two areas considered are similar even that in the vicinity of the Porto Santo Island the bathymetric gradients are stronger inducing less convergence and definitively requesting more computer time. This especially when activating the triads wave-wave interactions and the exponential growth of wind.

Several series of simulations with the SWAN model were performed to characterize (nowcast) and on the other hand for providing forecast products concerning the dominant features of the arriving waves in the nearshore. For both the cases was adopted the solution of a sequence of two nested runs where the boundary conditions of the second run were retrieved from the first run, performed on a larger area called the coarse run.

In Madeira the SWAN coarse domain had 105 kilometers in the direction pointing east and 75 kilometers in the direction pointing north, with the spatial resolution of 700 meters in both directions (this resolution being in direct relationship with the bathymetric elevations). In this way was covered not only the Madeira area but also the islands Deserta Grande and Bugio located in the south-east side of the archipelago. The fine domain for this case is rotated with 330 degrees counterclockwise from the coarse one and had a computational grid with the length of 36 kilometers (with a 300 meters grid step) in x-direction and 15 kilometers (with a 100 meters grid step) in y-direction. The directional buoy of Funchal is located in the eastern side of this domain and the results of the SWAN simulations were ‘a posteriori’ compared with those registered from the buoy. These comparisons were made mainly in terms of significant wave height, period and direction.

As regards the Porto Santo Island, which was in fact the field of the exercise, the SWAN coarse domain had 35 kilometers in the direction pointing east and 33600 kilometers in the direction pointing north. The spatial resolution was of 200 meters in both directions (this being also in direct relationship with the existent bathymetric elevations). Finally the SWAN fine domain in this case was rotated 45 degrees counterclockwise and had a computational grid with the length 9 kilometers (200 meters step) in the x-direction and 7 kilometers (50 meters step) in the y- direction. For all domains the directional resolution was of 10 degrees covering all the directional range, while the frequency range had 35 frequencies from 0.05 Hz to 0.5 Hz.

The strategy used in the physical parameterization of the simulations was to balance between computational efficiency and numerical accuracy. For this reason the physics is slightly different in the two SWAN runs (the coarse and the high-resolution runs), following in some sense the process of wave generation described by the mechanism of Miles-Phillips. Thus the coarse runs of the model were made in the third-generation mode considering only the linear growth of wind. The more efficient growing mechanism proposed by Miles operates on waves already present and involves an interactive coupling between wind and waves. For this reason in the second run was supposed the third-generation mode considering also the exponential growth of wind. The quadruplet wave-wave interaction, as well as, the dissipations due to whitecapping and depth-induced wave breaking were activated in both runs while the triad wave-wave interaction, which is more time consuming, was usually accounted only in the high-resolution run. The domains used in Porto Santo as well as some wind and swell patterns are presented in figure 2.

For the case of Porto Santo, where the diffraction effect might be more significant than in the first case, was developed an alternative scheme by using also some results from REF/DIF simulations. However the problem of nesting REF/DIF with SWAN is still under development being not completely solved. That is mainly because the REF/DIF model was thought even from the very beginning as a final nearshore stage of the modeling effort for regions where refraction effects and bathymetric interaction are strong and occurring over short distances. Consequently the model requests an extremely high resolution. The solution that was adopted in order to overpass this problem and to account for the propagation of the diffraction effect on larger scales was to interpose a REF/DIF simulation between a sequence of two SWAN runs. In SWAN the nesting procedure means to generate the boundary conditions on the high-resolution area by a previous run on a larger area called the coarse one. This means that the first run provides the 2D spectrum in all the points of the computational grid located on the boundary. The main idea concerning the suggested treatment is to replace in the area affected by diffraction the spectrum given by the SWAN coarse run with a spectrum generated by a REF/DIF run. By this infusion of spectrum it is performed actually a SWAN run which is nested both in SWAN and in REF/DIF, passing in this way the REF/DIF scale limitations and accounting for the diffraction contribution in larger areas.

Moreover a simpler way (but less accurate) would be to built a theoretical 2D spectrum starting from the approaches obtained by using the diffraction diagrams from the Shore Protection Manual. In this case, when accounting for diffraction, was also performed a second coarse run in the vicinity of the left side edge of the island having an increased resolution than the first coarse run.

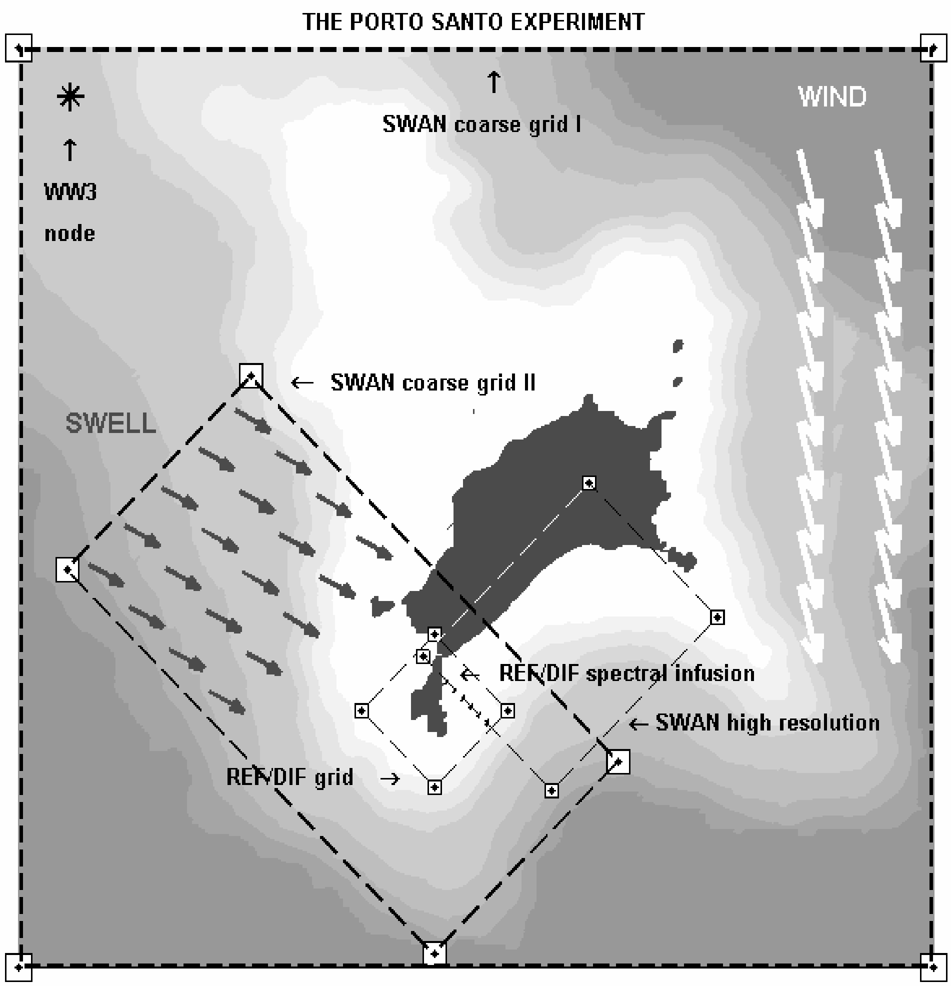

Figure 2
Description of the computational strategy adopted for the Porto Santo area

The interface developed can provide at this level the results concerning the coarse runs either in Porto Santo and Madeira, emphasizing on the field distribution of the wave and wind vectors. The analysis can be made in parallel for the both the sites and for as much cases (in terms of time localization) as they are needed to be seen all together. Thus in figure 3 is presented an example of wave propagation in Porto Santo while in figure 4 the corresponding case for Madeira.

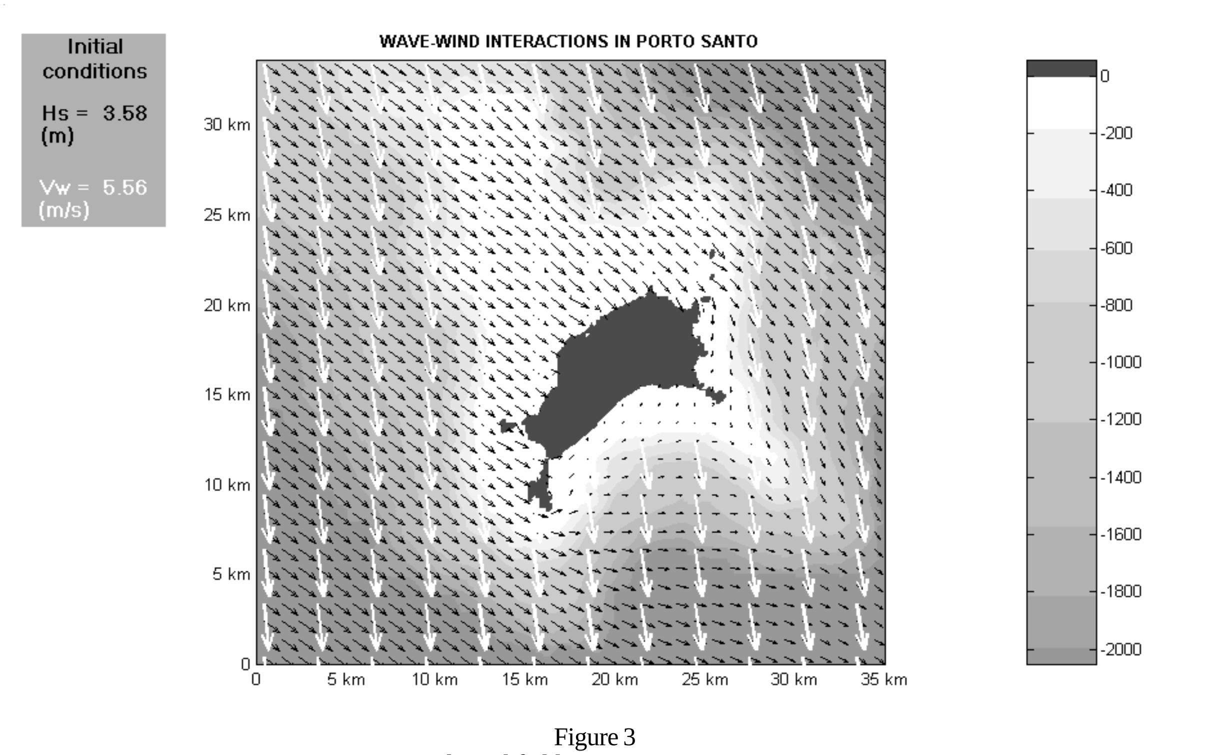

Figure 3
Wave propagation and wind field – Porto Santo: 2002-January-30 - 12.00

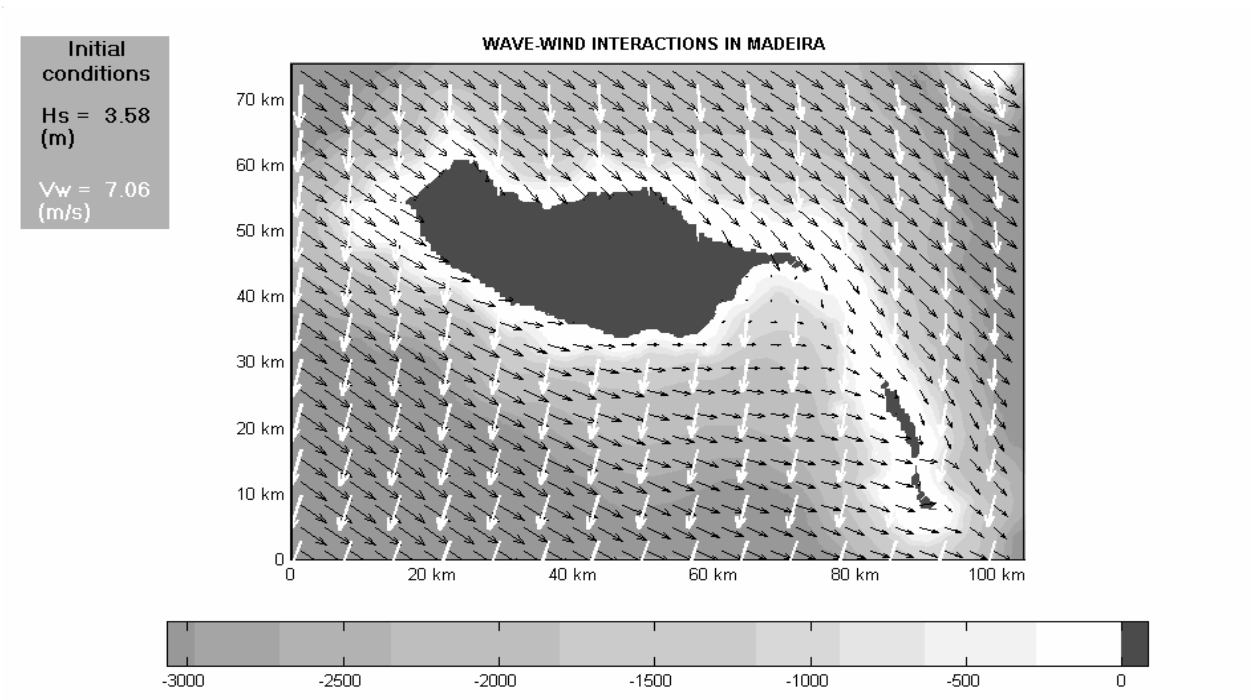

Figure 4
Wave propagation and wind field – Madeira: 2002-January-30 - 12.00

5. THE TREATMENT OF THE BATHYMETRIC DATA

The second module developed concerns the sequential treatment of the bathymetric data in the nerashore, either of islands or continental coasts. The main functions of this pre-processing component are to visualise bathymetries, to generate and reshape grids and on the other hand to plot bathymetric maps and design isomaps.
Usually the measured bathymetry is provided in a three-column file giving the x and y co-ordinates versus the water depth. These data are transformed into a grid-file using the standard interpolation methods and defining the limits in the geographical space as well as the number of grid points in both directions. Once this phase being accomplished the bottom file is transferred into Matlab. The parameters required are the co-ordinates of the origin, the number of meshes (one less than the number of grid points) and their lengths in x and y directions. The first facility introduced by this module is to visualise the spatial bathymetric grid. From this point the next sequence is to provide the bathymetric map of the area, where the land is coloured in brown and the water in various nuances of blue according to the corresponding depth (darker as the depth is increasing). This process is made automatically from the bathymetric grid, however in order to be used for any bottom configuration it was introduced a coefficient (denoted as the shore coefficient). By this coefficient the brown in the colormap is scaled to zero (or a given value) level of the water depth.
After generating the bathymetric map of a larger-scale area can be selected the high-resolution area by using the reshape command. The inputs for this command are the co-ordinates of the new origin, the number of meshes and their length in each direction and the angle of rotation (which is the angle between the initial x axis and the corresponding x axis of the reshaped grid measured counter clockwise). Once introducing this data the new site will be marked as a red rectangle located in the initial field. Obviously, since the resulting bathymetry is obtained by interpolation, the area where is going to be generated the reshaped grid has to be completely enclosed in the initial one. After the location and the characteristics of the new area were defined, the succession followed will be exactly the same as before, first generating the spatial grid and then, via a new shore coefficient, the bathymetric map. Moreover in this final stage can be designed also an isomap, that is a map where the colormap is set by 10 pre defined isolines (and not automatically as in the bathymetric map). For the case of oceanic island (as both Porto Santo and Madeira are) it was introduced the possibility of defining each isoline. In the case of the Porto Santo Island the isolines defined are at 10, 20, 50, 100, 200, 400, 500, 1000, 1500 and respectively 2000 meters. The reason for deigning an isomap it was that this was considered more appropriate than the bathymetric map for the post-processing phase. It was also introduced as a final step in this phase of pre-processing the option of saving the configuration. By this command the bathymetric grid is send, already processed in the adequate format, to the model, while the defined isomap will be saved and sent to the post-processing phase.

6. POST-PROCESSING FACILITIES IN THE HIGH RESOLUTION AREA

After running the model in the high-resolution area, its outputs are processed by a special computational environment, which makes available in real time, and in a user-friendly way, the main wave parameters both in the nearshore and surf zones. As a rule any numerical model provides the outputs requested by the user from the ones that are available. In SWAN this outputs can be divided into three categories: scalars, vectors (usually 2D) and spectral variables (which are described each one by a matrix defined in the space frequency-direction). Besides the grid point co-ordinates and the corresponding depth, the main scalar parameters computed were: the significant wave height *(Hs)*, the wave period *(TM01)*, the wave direction *(q)*, the wavelength *(Wl)*, the wave steepness *(Ste)*, the energy dissipation per unit time *(Diss)*, the normalized frequency width of the spectrum *(Fspr)*, the directional width of the spectrum *(Dspr)* and the bottom velocity *(Ubot)*. The main vectors available are the wave forces *(Fw)*, the energy transport vector *(Tr)* and the wind *(Vw)* and the current *(Vc)* velocities (the last two vectors are the result of interpolation from the input grid). By joining the significant wave height to the wave direction can be also generated the so-called wave vector field. Once being established the frequencies of the spectrum, the 1D spectrum in a point is a vector that gives the variance densities (m^2/Hz) for the corresponding frequencies. The 1D spectrum was computed along lines parallel with the y-axis of the computational grid (i.e. quasi parallel to the shoreline). A matrix having the number of rows equal with the number of frequencies and the number of columns equal with the number of directions considered gives the 2D spectrum in a point. The elements of this matrix will be the corresponding values of the variance density (m^2/Hz·rad). The 2D spectrum was computed only in points and from these points it was built a line normal to the shore.

Since can work also as a database, the post-processing module has in the top of its hierarchy the site. The setting of the area is controlled by the same global variables that are defined in the pre-processing stage. These are the co-ordinates of the grid origin and the length of the grid in x and respectively y directions for both cases (coarse and fine runs). All the bathymetric data are loaded directly from the pre-processing tool where was defined and configured the computational grid for running the model. Other global variables characterising the computational grid are: the length of the grid in frequency space, the length of the grid in directional space, the number of meshes in frequency space and the number of meshes in directional space. Once the site has been set the next option is to choose the case which is going to be analysed. MATLAB associates to each variable in its workspace a matrix and if the grid variables are already delivered by SWAN in a matrix form, the spectral files describing the 1D or 2D spectrum are reconverted into matrices by special subroutines. After loading the case data it is displayed the command window for the selected site.
The actions are controlled by UI-commands. The functions of these commands are to start and control the simulations but there are also some other options as opening html info files, changing the case or the site and developing cumulative or parallel analyse. The simulations are generated by quasi-independent sub-modules, which allow a sequential analysis. As a rule the sub-modules were activated by UI-menu commands while the simulations inside each sub-module were performed using the UI-control commands. First it is available a command that gives in one window all the general characteristics of the high-resolution area. An example is showed in figure 5 referring at the same time moment as figures 3 and 4.

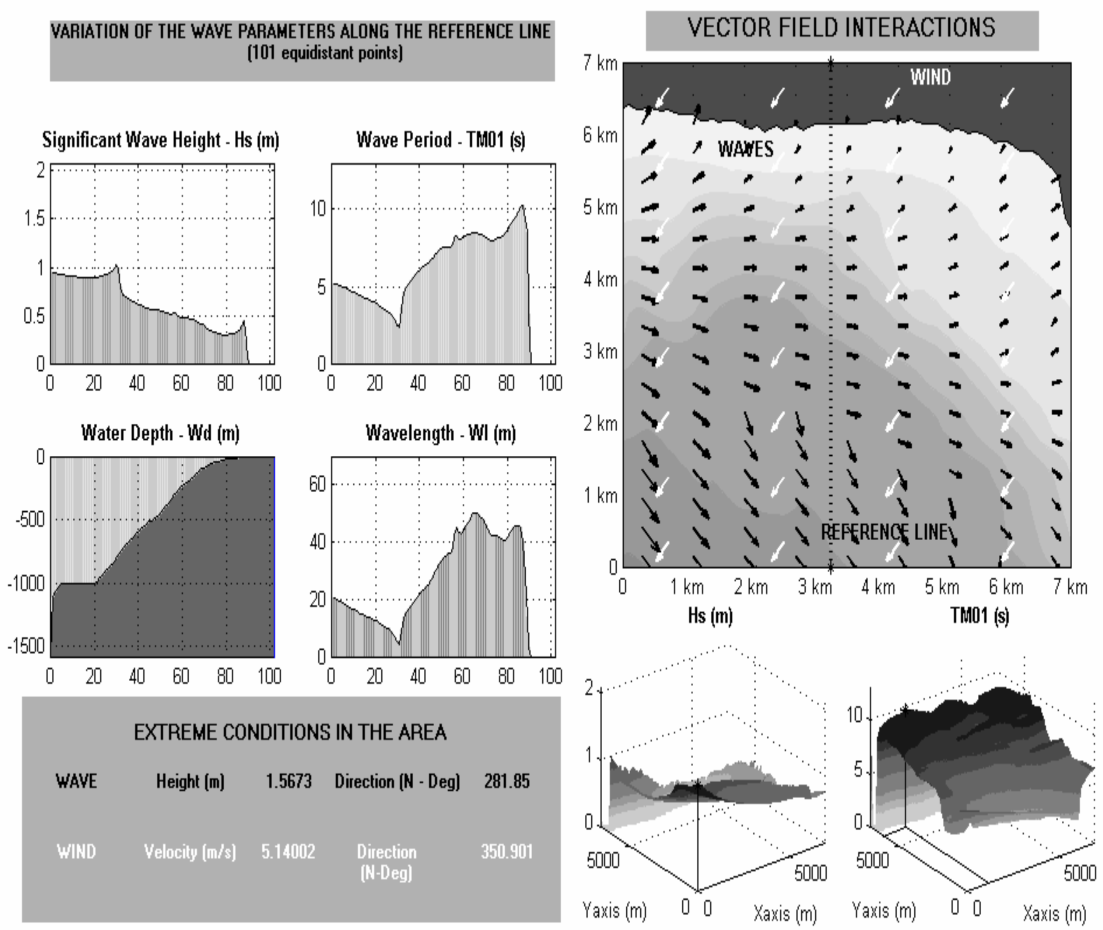

Figure 5
General description of the wave conditions in the high-resolution area
South of Porto Santo: 2002-January-30 - 12.00

In this figure are represented the wave and wind vectors. Alternatively can be visualised also the energy transport, the wave forces and the currents (if present and accounted for them). In the same area it was defined also a reference line, which makes a transversal section through the area (and which can be relocated if necessary. In the left side of the figure are represented the variations of the main wave parameters along the reference line (significant wave height, period, depth and wavelength). The maximum values of the wave and wind are given in the left side of the window while in the right side are represented also the global distributions of the significant wave height and period in the area.

The local data assessment is made using the map of the area and selecting a point, line or isoline. After selecting the location this will remain marked in the ocean field. In the case of a point (figure 6) are provided the significant wave height the period and the local water depth versus the maximum values in the field. It is also represented the wave direction using the Nautical convention, (i.e. the direction where the waves come from, measured clockwise from geographic north). In the case of the lines, or isolines (figure 7), the wave direction is figured directly on the map in some points along the line. It is also given the distribution of the wave height, period, depth and wavelength along the respective path.

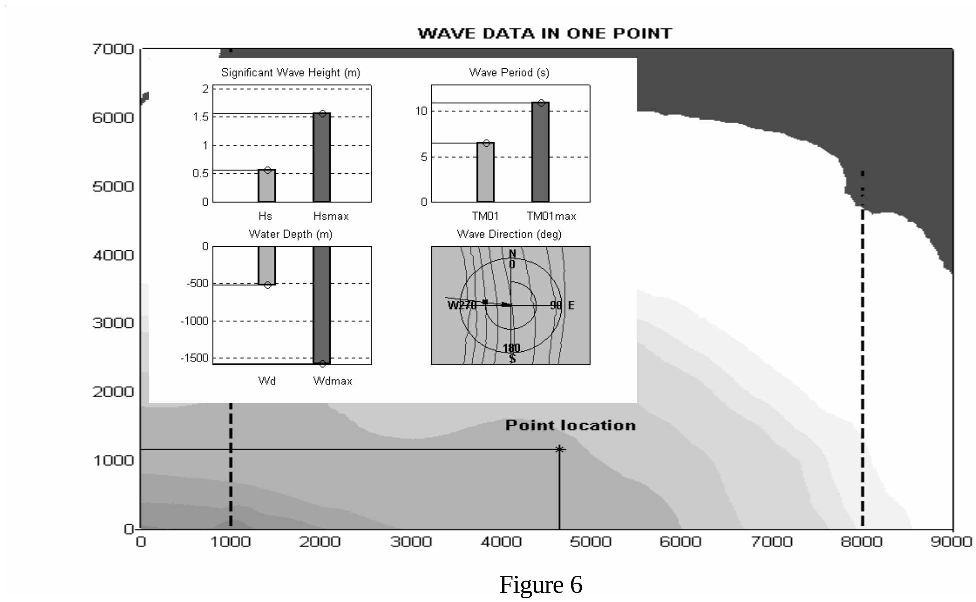

Figure 6
Assessment of wave data in a point - South of Porto Santo: 2002-January-30 - 12.00

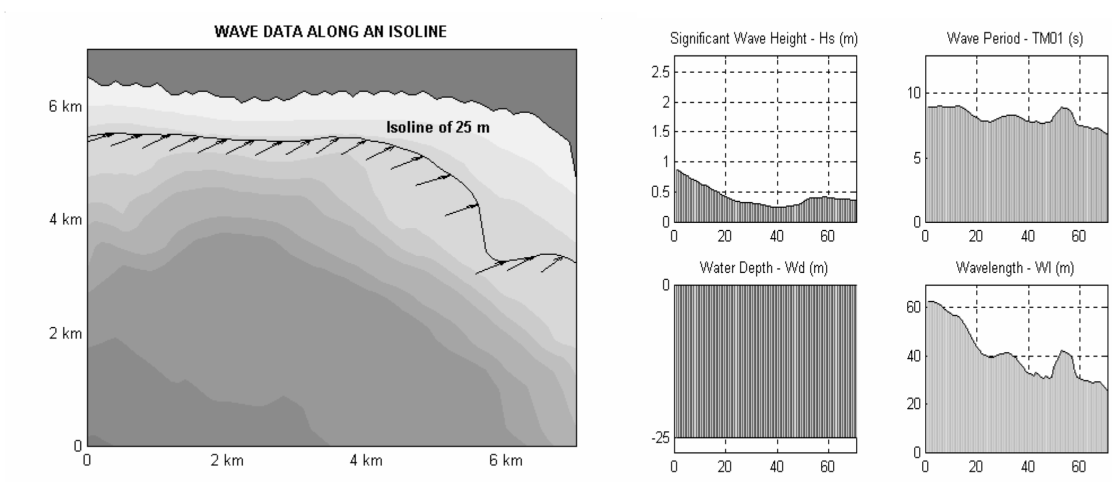

Figure 7
Assessment of wave data along an isoline - South of Porto Santo: 2002-January-30 - 12.00

7. AN ESTIMATION FOR THE BREAKING PARAMETERS

For estimating the process of wave breaking SWAN, uses the spectral ve rsion of Eldeberky and Battjes (1996), expanded to include directions. There were tested three methods for the breaking line identification. The first takes into account the variation towards the shore of the significant wave height and the fact that a local maximum in the variation of the wave height marks the initiation of the breaking process. In terms of energy dissipation the breaking process is associated with a significant increase while the third method takes into account the breaking ratio, which is the ratio between the breakers significant wave height and the breakers depth. The results provided by this methods were rather different and finally was adopted the last method taking into account that all the SWAN simulations were performed using the standard default conditions, that is a constant breaking ratio (0.73). The window providing the breaking characteristics can be seen in figure 8.

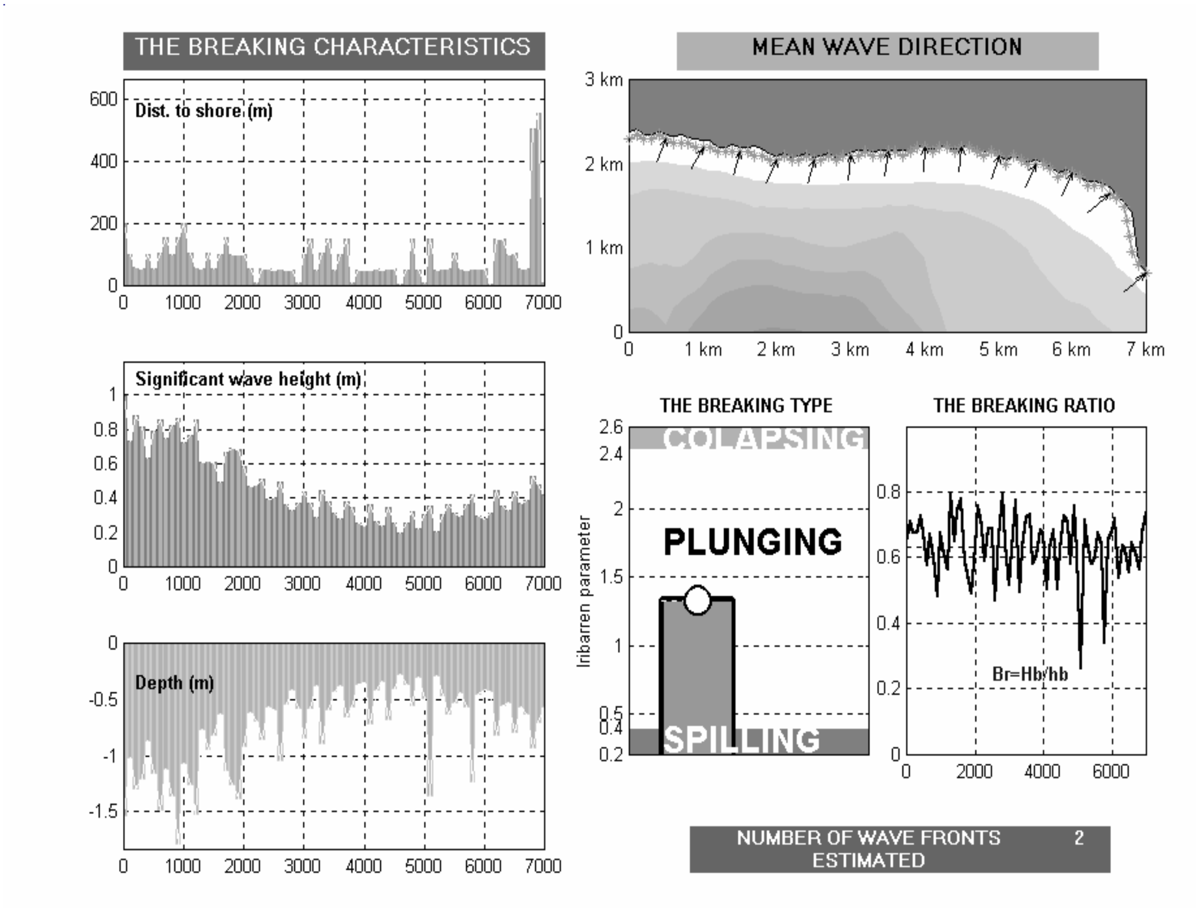

Figure 8
Estimation of the surf-zone conditions - South of Porto Santo: 2002-January-30 - 12.00

Once the breaking line is identified can be evaluated the wave data along its points. In the left-hand side of figure 8 are presented some characteristics of the breaking as the variation in relationship with the shore of the distance where is initiated the wave breaking and the distributions of the significant wave height and the depth on the breaking line. The number of wave fronts in the surf was estimated from the relationship:

$$\sum_{i=1}^{Nf(j)} C(j) T_S(j) \approx S_W(j) \tag{1}$$

j - is the index of the point number on the breaking line; Nf(j) - is the number of fronts; C(j) - is the celerity computed with the relationship given by Thornton and Guza (1983):

$$C(j) \approx 1.15\sqrt{g h_b(j)}, \tag{2}$$

with $h_b(j)$ the water depth. $T_S(j)$ - is the wave period in the surf and $S_W(j)$ - is the surf wideness.
The breaker-type prediction used the deep-water form of the Iribarren number ξ_∞, which combine the beach slope S with the wave steepness.

$$\xi_b = \frac{S}{\left(H_b / L_\infty\right)^{1/2}} \tag{3}$$

In reference to this parameter the breaking-type classification is the following, Komar (1998):

$$\begin{aligned}
&\xi_\infty \leq 0.4 - \text{spilling} \ ; \\
&0.4 < \xi_\infty \leq 2.4 - \text{plunging} \ ; \\
&2.4 < \xi_\infty \leq 3.1 - \text{collapsing} ; \\
&\xi_\infty > 3.1 - \text{surging} \ .
\end{aligned} \tag{4}$$

The wave-induced currents in the nearshore, which might be also an important factor that influences the landing operations, were not specifically estimated. However, were computed the wave forces in the surf and their long shore components might be an indication regarding the possibility of the occurrence for these currents. In this respect the data analysed showed a very small probability concerning the existence of the long shore currents in the period analysed.

8. SOME FINAL CONSIDERATIONS

The predictions concerning the nearshore and surf-zone wave conditions provided in Porto Santo for the NATO application Unified Odyssey 2002 were in general in good concordance with the ‘in situ’ observations made during the exercise. Moreover the indirect validation made by running simultaneously (and with the same physical parameterization) the SWAN model in the region of the Madeira Island gave an extremely good correspondence with the data registered by the buoy from Funchal. However, the buoy data were available only for the last three days of the exercise. Of course an essential factor that has to be mentioned is the good accuracy of the WW3 forecast provided by the ‘Fleet Numerical Meteorology and Oceanography Center’ in the referred period.
The pure refraction scheme (WW3 – SWAN coarse run – SWAN high-resolution) was found computationally effective and gave a good characterization as regards the general wave conditions, either in the nearshore and surf-zone. The more sophisticated diffraction accounting scheme (WW3 – SWAN coarse run – REF/DIF - SWAN high-resolution) is still under development being not yet completely operational from computational point of view. However, the solution adopted for the high-resolution SWAN run of replacing, in some points on the boundary, the genuine spectra with spectral representations accounting for diffraction seems to provide in some cases more relevant information for the description of the wave propagation phenomena in the nearshore.
The exercise from Porto Santo was also a starting point for further studies based on numerical models concerning the wave conditions in the Madeira archipelago. In this case it was changed also the initial objective passing from providing a few days wave forecast for the Southern part of the Porto Santo Island to more complex studies regarding the medium to long term wave climate in the sheltered part of the Madeira Island.
Finally an important outcome resulting from the work presented herewith is the interactive interface developed which is going to be a useful tool in coastal wave modeling.

9. ACKNOWLEDGEMENTS

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