WIND WAVE PREDICTION IN THE NORTHERN ADRIATIC: THE SHALLOW BOUNDARY REGION ALONG THE ITALIAN COASTLINE

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Abstract
An application of a wind wave prediction model along the coast of the Northern Adriatic Sea is described. The model is used to evaluate the wave conditions at 17 locations along the coastline for the whole period of interest. These data are used to study the phenomenon of eutrophication of the coast.
Résumé - On decrit un modèle de prediction de la houle appliqué le long de la côte septentrionale de la mere Adriatique. Le modèle a reproduit les conditions de la houle en 17 localités de la côte, qui ont été successivement utilizées pour étudier l'eutrophization de ce milieu.

The study of eutrophication of the coastal waters and the processes of erosion and sedimentation of the coast of the Northern Adriatic Sea have lead to the development of several physical-mathematical models. Their general aim is a better knowledge of the current field determining the sediment transport along the coast. Close to the coast the current is strongly influenced by the local wave field. To determine this one a suitable already existing model has been used, modifying it according to the local requirements.

To evaluate the wind wave field we use a model previously developed by Cavaleri and Malanotte-Rizzoli (1978) for the Northern Adriatic Sea. This is a physical ray model in which the prediction is made at one point and at a fixed time. Each single wave component is considered as frequency and direction. These components, before reaching the target point, follow a well established path. These paths are straight lines in deep water, but in shallow water the bottom topography forces them to change their direction (refraction phenomenon). These paths or wave rays are evaluated once for ever at the begining of the procedure. Because our aim is to evaluate the wave field up to the coastline, the initial model has been modified to obtain a more detailed determination of wind waves in the most interesting points. For this two different grids has been used, with different resolution, the finer one being used to resolve in greater detail the more complicated coastal bottom topography. The passage from grid to grid is authomatically carried out along the program. The 17 points of interest have been chosen on the map with smaller mashsize (1 Km), according to recurrence of flowering of seaweeds and in those places where erosion and sedimentation are more evident. For each of these points the model supplies a first output. This comprehends a series of refraction diagrams along all the directions offshore and for all the frequencies of a spectrum of wind wave in the Adriatic Sea. After the determination of the wave refraction rays, it is necessary to find out the distribution of the wind field on the sea. This is done using a model that evaluates the wind field starting from the spatial pressure gradients. The pressure are observed, every three hours, at different meteorological stations all over the Adriatic Sea. The geostrophic wind is evaluated as intensity and direction on a map with mash of 30Km and is given in a series of values every 3 hours.

Refraction rays and wind field are necessary for the execution of the last part of the procedure. In this the energy balance equation

$$\frac{\partial E(f,\theta,\underline{x},t)}{\partial t} = S(f,\theta,\underline{x},t)$$

is integrated for each frequency ray by ray. In the equation $E(f,\theta,\underline{x},t)$ is the directional energy density spectrum, in point $\underline{x}$ and time t, f and θ respectively represent frequency and direction. S is the source function and represents the locally created (wind) and dissipated energy.

The generative processes included in the model are the resonance mechanism by Phillips (wind waves linear growth) and the instability mechanism by Miles (exponential growth). The dissipative processes are the bottom friction when the waves run on shallow water, and the breaking (that is dispersion of energy of saturated wave).

After the definition of the source function S, the energy balance equation is integrated along each refraction ray from the last point back to the prediction point. For each target point, the model provides the directional and frequency energy spectrum. These values are tacken off once a day during the most important meteorological periods. Moreover the model provides the values of main direction and its variations with time, the peak frequency and significant wave height. Finally a series of dinamic parameters is evaluated from the previous ones. These are the variation of energy dissipation by breaking near coastline for each meter of decrasing depth, the vertical kinematic diffusion coefficient for conductivity-diffusivity and momentum, and the longshore current generated by wave breaking. All these data are used as input for a parallel model evaluating the current field along the coastline, strongly dependent on the local wave field.