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A MATHEMATICAL MODEL FOR WAVES FORECAST IN THE NORTHERN ADRIATIC SEA

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ABSTRACT

A mathematical model for waves forecast is described. It is based on the ray system. Given the wind field and the bottom topography, the model supplies the waves directional spectrum at a fixed time and position.

RESUME

On décrit un modèle mathématique pour la prévision de la houle, qui se base sur un système de rayons de refraction. A partir du champ de vent et de la topographie du fond,le modèle permet la reconstruction du spectre directionnel de la houle dans une déterminée position dans un certain moment.

Our aim is to describe the characteristics and capability of a mathematical model we have developed for the wind-waves forecast. Two different possibilities for such a model exist : a) the grid system and b) the ray system. Of the two, the first one supplies the final results over the whole area considered, but it is much more computer time consuming. We have chosen the second possibility because the experimental data are actually available only at one fixed position and we are still facing the problem of a full understanding of the physics of the phenomenon.

The ray system is based on the hypothesis of linearity among the different frequencies, i.e. each frequency is treated separately from the others. Wind-waves energy transfer, waves breaking, re raction and shoaling are taken into account. Once the position where we want the forecast is given, for each frequency we send a set of rays in all directions (in practice 10 or 5 degrees interval is used) and we follow

them, by numerical integration of the refraction equations, till when they reach a coast or have run for a long enough distance. This is the geometry of the problem. Then, at a second stage, given the wind field over the area covered by the rays, each ray is singularly traced back point by point while we continuously integrate the energy equations evaluating at each point the corresponding wave height. When the original position is reached, the results from all the rays contain the directional wave energy distribution for that frequency. Such a result for all the frequencies analysed is the waves directional spectrum at a given time and position.

The experimental results used to verify the validity of the model have been obtained from the oceanographic tower of CNR, placed 8 miles offshore in front of Venice, with a 16 m depth. A quite sophisticated recording system is available there ; it includes seven parameters (wave height, two pressure tranducers, two double components electro magnetic current meters at cross angles) whose outputs are recorded on a magnetic tape 4 times a second. The instrument set under water is placed on a cart that slides along two vertical wires till a chosen depth.

A long series of records has been obtained. For each one of them the wind field is obtained by a mathematical model whose input are the atmospheric pressure values on the coast of the Adriatic Sea(the wind values on the tower are used to check the estimate obtained from the model). Once the wind field is known, it is used as input for the main model, whose output is then compared with the experimental results from the tower.

The results are rather encouraging, in the sense that 90% of the forecast are within 20% of the actual recorded value (here we refer to the significant height estimate).

We want to point out that the model can be used everywhere. The only requirements for its application are the knowledge of the bottom topography, if less than 100 m, and of the wind field.