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WAM - THE WAVE MODELING PROJECT - ITS APPLICATION IN THE MEDITERRANEAN SEA

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Our aim is the compact description of a project actually underway within the European Community. The project concerns the development of a very sophisticated wave model, and its application to the daily forecast of wave conditions all over the world. We are mainly concerned with its application in the Mediterranean Sea.

The wave models, if we neglect empirical formulas and abacus, were born in the 1950s, following the increased interest of the sea. Along this line they rapidly developed across the first- and second-generation models, the basic improvement between the two generations being the various attempts to introduce the nonlinearity into the models. So up to the 1970s the various models differed from each other for the more or less sophisticated way by which the real phenomena of wave generation and dissipation were parameterized into the equations. The strongest limit to the introduction of the actual physics, and associated mathematics, into the models was given by the computer time requirements, much larger than any practical availability. But time passes, computers became more powerful and faster, and the problems become more urgent. In the early 1980s it was felt that time had come for the development of a new generation of models. The demand of hindcast and forecast was steadily growing, theory had been developed to a sufficiently high level, the available forces were large enough for a direct attack to the problem.

Since the problem is far beyond the capability of any single group, the natural way was to join for a common approach. The overall group was split into subgroups, to separately attack the various aspects of the problem.

The model is now at an advanced experimental stage, submitting itself to some extensive comparison between its output and experimental results. While only a very compact description is given here, for a thorough discussion (including references) the interested reader is referred to Komen (1986).

The model can be run on both geographical and cartesian coordinates, whose cover and resolution can be chosen directly by the user, the worldwide bottom topography being stored on a reference file. Number of frequencies and directions can be varied according to the requirements. Generation by wind follows Miles' description and later findings, breaking is according to a parameterization by Hasselmann. The key point is the actual evaluation of the nonlinear interactions among the different spectral components. This is taken within acceptable computer limits following the method proposed by S. Hasselmann and K. Hasselmann. Advection is done by an implicit method allowing a 20' time step to be used. The model has been extensively tested on the CRAY X-MP of the ECMWF Center in Reading, U.K. The projects of the Center include the permanent implementation of the WAM model into their system, for a daily forecast of the worldwide wave conditions that parallels the weather forecast.

Within this project, we are mainly interested in the application of WAM to the Mediterranean Sea. We consider this the most severe test for the model. While weather, in particular wind, and wave forecasts are relatively simple in an open area as the ocean, they become extremely keen when a topographically complicated basin is considered, like the Mediterranean Sea. Here the winding borders, the mountain ranges, the varying water temperature throughout the year, the consequently varying air-sea stability conditions, the strong spatial and temporal gradients, all stress a model to its limits.

In the practical approach to such a problem we must be aware of our real capabilities. So the actual weather forecast is such that it would be useless to use a grid step smaller than 50 km. Simply the input information at this scale of the phenomena is not available. This implies some drastic draw backs in the output. For many areas of the Mediterranean Sea (e.g., the Aegean Sea) this resolution is highly insufficient. On the other hand, even if a better meteorological input was available, a higher resolution would be excluded by the excessively growing computer time requirements. So, what is the solution? This is a quite general problem, as it concerns not only waves, but all the models describing the nature, including circulation and weather. In our opinion the solution lies in the nested models. While the general model gives the overall description of the basin, single details can be exploited by using a local high resolution grid using the main output as boundary conditions. Care must be taken about the computer time required by a nested grid. One possibility to avoid this problem could be the local use of simpler models, which one depending on the situation, the keen physical description of the large model becoming less necessary in limited areas. So for the Aegean Sea, with all its small islands, the solution could be a parametric model, while, for taking the results to a shallow water coast, the ray technique would probably be the most suitable one.

When will a wave forecast be available for the Mediterranean Sea? We expect to have the model operative within three years, the actual time being highly dependent on the actual effort we will be able to put into it. We hope to report definite results at the next CIESM Meeting.

References

Komen, G.J., 1986. Recent activities of the WAM Group, In: Advances in Underwater Technology, Ocean Science and Offshore Engineering, Vol. 6, (eds) Graham and Trotman, pp. 121-128.

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THE GIBRALTAR EXPERIMENT 1985-1986

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The Gibraltar Experiment is a study of the dynamics and kinematics of mixing, exchange, and turbulence in the Strait of Gibraltar. The major goals of the experiment are:

o Measure the inflow and outflow through the Strait on time scales from seasonal to tidal;

o Elucidate the dynamical control that the Strait imposes on the Atlantic-Mediterranean exchange, and specifically assess the importance of rotation, friction, mixing and nonlinear processes;

o Develop an adequate method for efficiently monitoring flows through the Strait such that interannual variability can be measured; and

o Increase understanding of the effects of processes in the Strait on the adjacent bodies of water, the Alboran Sea and the Gulf of Cadiz.

The study is being conducted by a consortium of scientists from Spain, Morocco, France, England, Canada and the United States. The field work was planned to provide an extensive instrument array in the Strait for one year (October 1985 to October 1986) with synoptic (mostly shipboard) measurements at various times throughout this period. Moored instruments included mechanical current meters, doppler acoustic profiling current meters, pressure gages, thermistor chains, and meteorological stations. Synoptic measurements included hydrograpghic profilers (CTD), expendable profilers (XBT), doppler acoustic current profiler, acoustic backscatter sonar, microstructure profiler, aircraft synthetic aperature radar and shore based radar.

We will discuss the data set now in hand and give examples of the early results. At this early stage it is clear that a more detailed description of the relevant oceanographic fields has been gathered, and that the investigators should make considerable progress towards achieving the experimental goals.

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