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AN INTERCOMPARISON STUDY BETWEEN THE WAVE MODELS MRI AND MRI-II *

—— A COMPILATION OF RESULTS ——

1. Introduction

In 1981, a wave model intercomparison study was carried out by the SEA WAVE MODELLING PROJECT (SWAMP) Group composed of ten groups from USA, Japan and Europe. The main purpose of the intercomparison study was to test our present understanding of the physics of wind generated surface waves from the view point of wave medelling. Fortunately, the author was able to participate in the intercomparison study with a linear wave model called MRI (Meteorological Research Institute) developed for the routine operation of wave prediction (Uji and Isozaki 1972, Isozaki and Uji 1973 and Uji 1975) and it is now in use for the operation at the Japan Meteorological Agency. The study made clear strong points as well as weakness of MRI relative to models based on the parametric representation of the growth of wind waves (The SWAMP Group 1984 (Part 1), 1982 (Part 2) ; MRI gives always reasonable wave height distribution for any complex wind fields but it is inferior in predicting the spectral form for early growth stages of windsea.

A new wave model MRI-II was developed to overcome the weaknesses of MRI (Uji, 1984). MRI-II inherits both the way of numerical representation of wind wave spectrum and the calculation scheme for wave propagation. The intercomparison between MRI and MRI-II, therefore, is effective to made clear how the difference in basic physical assumptions for wave models produces an effect on predicted wave fields and the results can be useful for further wave model development. Furthermore, it is of great inportance to clarify the characteristics of MRI-II for the use of it in practical operation.

For above reasons, numerical experiments for all the SWAMP test cases are carried out using MRI-II and the results are plotted according to the SWAMP format. Here, all diagrams of MRI-II are collected together with those of MRI. For easy reference to the SWAMP reports, a diagram is numbered as Fig. 15-7. 4-1 i.e., the first numeral 15 shows the sequential number in this text, the second one 7.4 corresponds to the number in the SWAMP (Part 1) for the corresponding diagram and the third one 1 is in the SWAMP (Part 2). When there is no corresponding diagram in the SWAMP Part 1 or Part 2, the second or the third

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numeral is written zero. These diagrams will be more instructive if it will be used in conjunction with the SWAMP reports Part 1 and Part 2.

2. Outline of the models

The evolution of a surface wave fields in space x and time t is governed by the energy balance equation

$$\frac{\partial F}{\partial t}+\mathbf{C}g\cdot\nabla F=S_{net}=S_{in}+S_{nl}+S_{ds}' \qquad (2.1)$$

where $F(\sigma,\theta;x,t)$ is the two-dimensional (2-D) wave spectrum, dependent on angular frequency σ and propagation direction θ, $\mathbf{C}g=\mathbf{C}g(\sigma,\theta)$ is the group velocity, ∇ is the gradient operator in the horizontal plane and the net source function S_{net} is represented as the sum of the input S_{in} from the wind, the non-linear transfer S_{nl} and the dissipation S_{ds}.

However we still do not have full understanding about the physics of energy transfer from wind to waves and the energy dissipation of wind waves and also do not have simple way of calculation for S_{nl}. A wave model, therefore, can have its own assumptions on the physics of wind waves, own parametrization of the source functions and own numerical style of representation of wind waves, so that several kinds of wave model were developed according to its usage.

2.1 MRI wave model

MRI contains four energy transfer processes, namely, linear and exponential wave growth, wave breaking leading to an equilibrium state of Pierson & Moskowitz (P-M) spectrum, frictional dissipation for over-saturated waves and decay of waves due to opposing winds. Neither wave-wave interactions nor shallow water effects are considered.

Wave energy is numerically represented by 352 (16 directions times 22 frequencies) spectral components. A special numerical scheme is used to prevent computational spacial deformation of each wave energy component (Uji and Isozaki, 1972). Equally spacing grids on local Cartesian co-ordinates are employed.

Three stages of the sea state are considered, and the source functions are assumed according to the each stage as follows :

$$S_{net}=(A+BF)\Gamma(\theta-\theta w)\ [1-(F/F_{\infty})^2],\quad |\theta-\theta_w|\leqq 90^\circ,\ \sqrt{2}F_{\infty}=F,$$
$$S_{net}=-D\cdot f^4F,\quad |\theta-\theta_w|\leqq 90^\circ,\ \sqrt{2}F_{\infty}<F,$$
$$S_{net}=-[B\Gamma(\theta-\theta_w)+D\cdot f^4]F,\quad |\theta-\theta_w|>90^\circ, \qquad (2.2)$$

where θw is the wind direction, $F_{\infty}=\Gamma(\theta-\theta_w)\phi_{PM}$ the fully developed 2-D spectrum, ϕ_{PM} the P-M spectrum, $\Gamma(\theta)$ the angular distribution of 2-D spectrum and is assumed to be propor-