WAVEWATCH III

1. Model Description

WAVEWATCH III (Tolman 1997, 1999) is a third generation wave model developed at NOAA/NCEP in the spirit of the WAM model (WAMDIG 1988, Komen *et al*. 1994). It is a further development of the model WAVEWATCH I, as developed at Delft University of Technology (Tolman 1989, 1991) and WAVEWATCH II, developed at NASA, Goddard Space Flight Center (e.g., Tolman 1992). It nevertheless differs from its predecessors on all important points; the governing equations, the models structure, numerical methods and physical parameterizations.

WAVEWATCH III solves the spectral action density balance equation for wavenumber-direction spectra. The implicit assumption of these equations is that the medium (depth and current) as well as the wave field vary on time and space scales that are much larger than the corresponding scales of a single wave.
Furthermore, the physics included in the model do not cover conditions where the waves are severely depth-limited. This implies that the model can generally be applied on spatial scales (grid increments) larger than 1 to 10 km, and outside the surf zone.

2. Model Features

2.1. Physical features:

- The governing equations include refraction and straining of the wave field due to temporal and spatial variations of the mean water depth and the mean current (tides, surges etc.), and wave growth and decay due to the actions of wind, nonlinear resonant interactions, dissipation (`whitecapping') and bottom friction.
- Wave propagation is considered to be linear. Relevant nonlinear effects such as resonant interactions are therefore included in the source terms (physics).
- The model includes several alleviation methods for the Garden Sprinkler Effect (Booij and Holthuijsen 1987, Tolman 2002b).

- The model incudes sub-grid representation of unresolved islands (Tolman 2003).
- The model includes two source term options, the first based on cycles 1 through 3 of the WAM model (WAMDIG 1988), the second based on Tolman and Chalikov (1996). The source term parameterizations are selected at the compile level.
- For research purposes only, the model includes a full nonlinear interaction option.
- The model includes dynamically updated ice coverage.
- The model is prepared for data assimilation, but no data assimilation package is provided.

2.2 Numerical features :

- The model is written in ANSI standard FORTRAN 90, fully modular and fully allocatable.
- The model uses a regularly spaced longitude-latitude grid (longitude and latitude increment do not need to be equal), or s similar Cartesian grid.
- Spectra are discretized using a constant directional increment (covering the entire circle), and a spatially varying wavenumber grid. The latter grid corresponds to an invariant logarithmic intrinsic frequency grid (Tolman and Booij 1998).
- . Both a first order accurate and third order accurate numerical scheme are available to describe wave propagation (Tolman 1995). The propagation scheme is selected at the compile level.
- The source terms are integrated in time using a dynamically adjusted time stepping algorithm, which concentrates computational efforts in conditions with rapid spectral changes (Tolman 1992, 1997, 1999).
- The model can optionally be compiled to included shared memory parallelisms using OpenMP compiler directives.
- The model can optionally be compiled for a distributed memory environment using the Message Passing Interface (MPI, see Tolman 2002a).

2.3. Output options :

- Gridded fields of 18 input and mean wave parameters such as the significant wave height, directions, frequencies etc.

- Output of spectra at selected locations.
- Output of spectra along arbitrary tracks.
- Up to 9 restart files per model run.
- Files with boundary data for up to 9 separate nested runs.
- The model provides binary or ASCII output, as well as output for the GrADS graphical package by means of post processing.

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