US Army Corps of Engineers®
Engineer Research and Development Center

Coastal Inlets Research Program

CMS-Wave

Description

CMS-Wave is a two-dimensional spectral wind-wave generation and transformation model that employs a forward-marching, finite-difference method to solve the wave action conservation equation. Capabilities of CMS-Wave include wave shoaling, refraction, diffraction, reflection, transmission over structures, depth-limited breaking, dissipation, wave-wave interaction, wave-current interaction, and wave-structure interactions. Wave diffraction is implemented as a diffraction term derived from the parabolic wave equation to the energy-balance equation. CMS-Wave can be used in either on a half- or full-plane mode, with primary waves propagating from the seaward boundary toward shore. It can calculate wave run-up, wave setup, and rate of flow overtopping structures. Shoreward and seaward reflection is treated using the mirror reflection principle. For model application with large coverage area, multiple grid nesting involving two or more model grids can be used, in which a larger grid with coarse resolution is used to simulate the regional processes while smaller grid with fine resolution is applied to more complex bathymetry and shoreline geometry in the local area. For applications in large domains and long-term simulations, CMS-Wave can run efficiently in a fast mode with multiple processes to expedite the model computations.

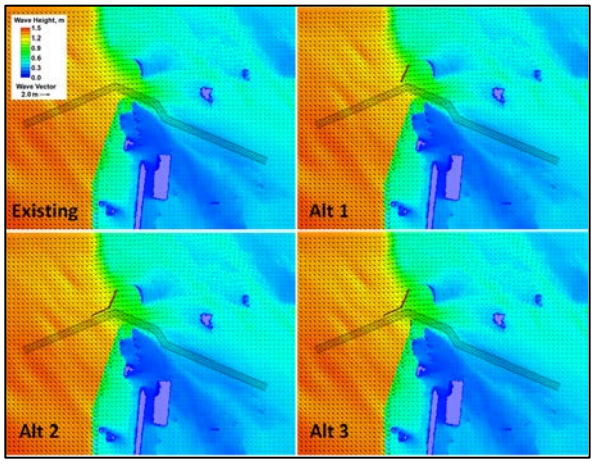

Figure 1. Jetty design alternatives for wave reduction at West Channel of Tangier Island, VA

Issue Addressed

CMS-Wave is designed to address wave processes at coastal inlets and those affecting coastal navigation missions of USACE. The model calculates wave interaction with inlet jetties and breakwaters, including wave reflection, diffraction, transmission, and overtopping; these processes must be calculated for accurate estimations of navigation safety and potential structure breaching or flanking. It helps users to investigate wave propagation across channels and over or through structures where combined diffraction, refraction, and transmission act simultaneously. The model has capabilities to describe wave transformation over broad shallow reefs and porous structures such as jetties. Run-up and overtopping of structures are treated in a phase-averaged engineering approach, including the role of structural surface roughness. Analytical treatment of infra-gravity waves is included for harbor seiching and wave asymmetry which can affect sediment transport estimates. The model can be coupled to the Boussinesq wave model BOUSS-2D for port and harbor applications.

Products

CMS-Wave, a phase-averaged spectral wind-wave generation and transformation model and its interface in the Surface-water Modeling System (SMS).

Application of Products

Ambrose Entrance Channel, Braddock Bay, NY; Tangier Island, Norfolk, VA; Popular Island, MD; Cleveland Harbor, OH; Duluth Harbor, MN; Sand Island, WI; St. Augustine Inlet, Cape Canaveral Harbor, FL; Mississippi Sound, MS; Terrebonne Bay, LA; Galveston Bay, Matagorda Bay, TX; Hilo Harbor, Kikiaola harbor, HI; Dana Point Harbor, Pillar Point Harbor, Ocean Beach, Noyo Harbor, CA; Port Orford, Tillamook Bay, OR; Mouth of Columbia River, OR/WA; Grays Harbor, WA.

Projected Benefits

CMS-Wave helps planners, engineers, and scientists to evaluate wave effects on coastal inlets, navigation and flooding projects to reduce operation and maintenance (O&M) costs. Reliable modeling predictions (verified and validated extensively in field studies) provide more accurate and cost-effective engineering solutions (Figure 2). CMS-Wave provides BOUSS-2D the necessary forcing boundary conditions for optimization of performance of integrated navigation system to improve safety, reliability and operations. These coupled models are used in design, realignment of channels, improvement of navigation operations, design modifications studies for ports, harbors and marinas, rehabilitation of jetties, breakwaters, evaluation of the impacts of engineering activities on port access and utilization affecting safety of coastal navigation (e.g., channel deepening, and jetty modifications), and quantifying the effects of dredge material placement sites on coastal navigation and shorelines.

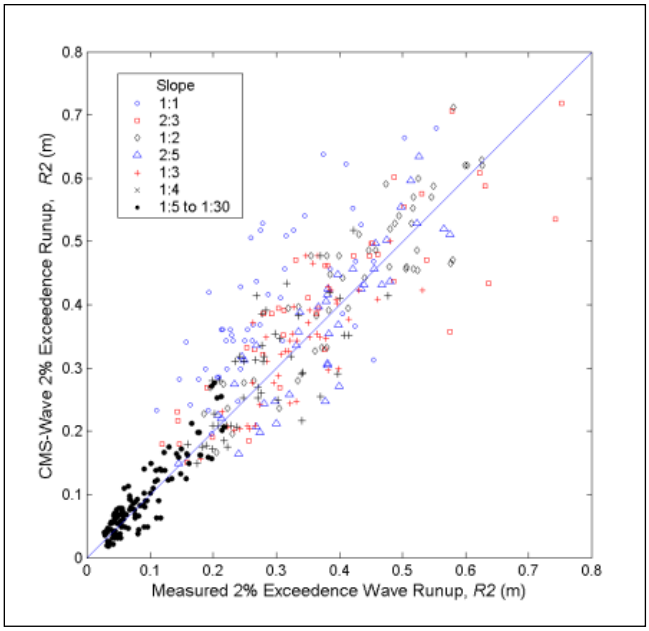

Figure 2. CMS-Wave runup validation

Documentation

Model documentation includes a technical report and a series of technical notes describing model theory, numerics, examples, and step-by-step user's guidance on model interface and example applications. More than a dozen journal and conference papers provide additional information about CMS-Wave capabilities in practical applications and research.

Points of Contact

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CIRP Website

- Please see the CIRP website to download documentation: http://www.erdc.usace.army.mil/Missions/WaterResources/CIRP/Publications.aspx
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