Abstract View

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Numerical Modeling of the Harmonic Constituents of the Tides, with Application to the English Channel

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ABSTRACT

An in-time spectral, finite-element method is proposed for modeling the main astronomical and nonlinear constituents of the tide in any oceanic or shallow-water area. The classical nonlinear hyperbolic problem for long waves is transformed to a set of elliptic modal problems by looking at a multi-periodic solution with basic frequencies deduced from the tide-generating potential development. The method is based on a perturbation technique. Because of the non-analytic formulation of the quadratic bottom friction, a multi-periodic development of these terms is needed. This is realized under a restrictive hypothesis that a dominant wave is present in the studied tidal spectrum. Although the damping terms of friction deduced from this development are of second order, their influence on the real solutions is very important. Thus, a quasi-linearization of these damping terms makes possible a computation of damped solutions, as soon as the first order of approximation, for each wave investigated. Practically, for each order of approximation and each significant frequency, we have to solve a second-order equation of the *Helmholtz* type, which is possible to write under a variational formulation.

A finite-element method is used for the numerical integrations. First, an illustration of the method is presented for the academic case of a wave propagating in a rectangular rotating channel together with its first harmonic produced inside the basin by nonlinear processes. Then a practical application is presented with the computation of some of the main constituents of the tide in the English Channel: the dominant wave M_2 and its first harmonic M_4, and two astronomical constituents, the semidiurnal S_2, and the diurnal K_1. The possibilities offered by the finite-element procedure used appear very attractive for practical investigations of oceanic and shallow-water tides. The computing time requirements are small.

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