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Fully nonlinear simulations of rogue wave generation and properties. Interactions with ocean structures.

Many mechanisms have been proposed to explain the existence of rogue waves in the ocean and their unexpectedly large probability of occurrence, as compared to predictions of Gaussian-based distributions. All of these mechanisms involve some kind of energy focusing process, over a small region of space, whose maximum lasts for a short duration. Nonlinear processes have been shown to further enhance such mechanisms (e.g., Brandini and Grilli, 2002). A short review of these mechanisms will be given, in relation to specific modeling approaches that have been developed, including some by the presenter, to simulate rogue wave generation processes (e.g., frequency focusing, self-focusing/Benjamin-Fair type I instability, type II instability, directional spatial focusing). Another part will describe with more detail the presenter's fully nonlinear three-dimensional (3D) potential flow model of directional energy focusing in a numerical wave tank (NWT), leading to the creation of "extreme" rogue waves (Grilli et al., 2001; Fochesato et al., 2005; Guyenne and Grilli, 2005; Brandini and Grilli, 2001). The latter refers to overturning rogue waves, in which particle velocity and acceleration in the high crest and overturning jet regions can be particularly damaging to ocean structures that would be impacted. [The sensitivity analysis of rogue wave properties to problem parameters, as well as some recent developments improving the model numerical efficiency, will be presented separately by Dr. Dias.] Here, the presenter will introduce a recent application on the impact of a breaking rogue wave, generated by directional focusing, with a vertical cylinder, in which a Navier-Stokes VOF model is initialized using the focused rogue wave computed in the 3D-NWT slightly before it starts overturning.

References:

- Brandini, C. and S.T., Grilli 2001. Modeling of freak wave generation in a 3D-NWT. In Proc. 11th Offshore and Polar Engng. Conf. (ISOPE01, Stavanger, Norway, June 2001), Vol III, 124-131
- Brandini, C. and Grilli, S.T. 2002. Three-dimensional wave focusing in fully nonlinear wave models. In Proc. 4th Intl. Symp. on Ocean Wave Measurement and Analysis (WAVES 2001, San Francisco, USA, Sept. 2001) 1,102-1,111, ASCE Publication.
- Fochesato, C., Grilli, S. and Guyenne P., 2005. Note on non-orthogonality of local curvilinear coordinates in a three-dimensional boundary element method. Intl. J. Numer. Meth. In Fluids, 48, 305-324.
- Grilli, S.T., Guyenne, P. and Dias, F. 2001. A fully nonlinear model for three-dimensional overturning waves over arbitrary bottom. Intl. J. Numer. Meth. In Fluids, 35(7), 829-867.
- Guyenne, P. and Grilli, S.T. 2005. Numerical study of three-dimensional overturning waves in shallow water. J. Fluid Mechanics (in press).

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