Review of paper submitted for publication in Nonlinear Processes in Geophysics

Steep unidirectional wave groups – fully nonlinear simulations vs. experiments

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This paper presents a detailed comparison of results of fully-nonlinear computations with measurements of unidirectional wave groups. The study is of a self-modulating wave train, initialized by the Peregrine solution of the NLS equation. Computational results on evolving wave groups are compared with the available experiments, with both components carried out by these authors. The local surface elevation variation, evolution of envelope shapes, the velocity of propagation of the steepest crests in the group and their relation to the height of the crests were obtained numerically and experimentally. Conditions corresponding to incipient wave breaking were investigated in detail. The results shed additional light on the limits of applicability of the computational results, as well as on mechanisms leading to the breaking of steep waves for this class of 2D nonlinear wave packets.

Overall, the paper is well written and is complemented with clear figures. The computational methodology and experimental details are described in very considerable detail. Potential differences arising from the periodic domain numerical results versus the physical wave tank measurement domain are discussed thoroughly. Issues raised by the authors regarding possible differences in the treatment of the Stokes drift in the model and measurement domains are dealt with critically in the companion reviews. My comments here will focus primarily on the contributions this paper makes to refining present understanding of the precise conditions for incipient wave breaking.

First, it is noted that the authors' focus is limited to the special class known as the 2D Peregrine breather wave packets. The reported results address (i) the limits of applicability of the computational results (ii) mechanisms leading to the breaking of steep waves.

A recent advance of key interest for the onset of breaking is the generic crest slowdown mechanism, which clearly needs to be taken into account in any discussion relating fluid speeds and crest speeds at breaking onset. Crest slowdown was noted by Johannessen and Swan in fully-nonlinear model calculations [Proc. R. Soc. A 457, 971, 2001] and complementary observations [Proc. R. Soc. A 459, 1021, 2003]. A more detailed discussion of this phenomenon and its importance for wave breaking was highlighted recently in the context of focusing 2D and 3D nonlinear unsteady deep water wave packets by Banner et al. [ArXiv 1508.07702, also PRL (2014)], and for 2D nonlinear unsteady deep water wave packets by Kurnia and Von Groesen [Coastal Eng, 93, 55–70,2014], Shemer and Liberzon [ArXiv 1309.7603, also PoF (2014)] and Fedele [EPL, 107, 69001, 2014]. The wording on p.1179, lines 7-10 of the present paper should probably be modified to better reflect the generality and nature of this important advance in knowledge of water wave kinematics.

Towards the end of their paper, the present authors focus on the key (and elusive) issue of the validity of the kinematic condition for breaking onset for the particular case (2D Peregrine breather) under investigation. This very detailed and candid discussion, which runs from line 14 on p.1173 to line 5 on p.1176, is very well documented. From a careful reading of this discussion and inspection of the key figures 9 and 10, it becomes evident that various sources operative lead to residual uncertainties in their companion model and observational assessment. These uncertainties preclude the *conclusive* evidence required for certainty of its validity. Hence I am obliged to recommend that the authors accordingly modify their wording on lines 19-21 of p.1179 of the paper.

New results on this topic that reduce these uncertainties have recently been published for a wider range of cases [Saket et al., ArXiv 1508.07702; Barthelemy et al., ArXiv 1508.06002]. These results provide evidence that questions the validity of the kinematic breaking condition as the primary determinant of breaking onset.

I recommend that this paper should be accepted for publication in NPG following the inclusion of the changes highlighted above.