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Direct numericall simulation of Stokes wave breaking and related dissipation

M. Duval, **D. Astruc**, D. Legendre

Institut de Mécanique des Fluides de Toulouse, UMR 5502 CNRS/INPT/UPS, Allée du Pr. C. Soula, 31400 Toulouse, France (duval@imft.fr, astruc@imft.fr, legendre@imft.fr)

Surface waves breaking occurs in ocean and coastal waters. A detailed knowledge of this process is important for a proper parametrization in large-scale models. The objectives of this studie is first a better understanding of breaking wave mecanisms and second a quantitative estimation of the related dissipation. An incompressible Navier-Stokes single fluid model approach has been used to compute the flow in the liquid and the air above. The numerical tool, called JADIM, solves the single fluid incompressible Navier-Stokes equations using a Volume Of Fluid (VOF) method without interface reconstruction (Duval et al., 2004). The dissipation rate estimation has been selected to avoid non-physical dissipation. A parametrical study have been carried out on Stokes waves, varying the initial wave steepness in the range [0,2;0,6] and the Reynolds number based on the wave length and the wave phase speed in the range [40;10ˆ4]. Capillary effects have been neglected in this study. Breaking and non-breaking waves have been distinguished and a breaking criteria has been established as a fonction of the parametrers. This criteria has been discussed with respect to classical criteria and experimental data. Spilling and plunging breakers have been observed. Three different kinds of plunging breakers have been distinguished in the parameters plane based on the free surface dynamics and on the velocity and vorticity fields. In non-breaking wave cases, the dissipation temporal evolution has been parametrized. In breaking wave cases, two different methods have been used to estimate dissipation. The results are in qualitative agreement with the experimentals values of the dissipation obtained by Duncan (1981, 1983) and Melville (1994), but an influence of viscous effects is observed in our low Reynolds number regimes computations. A parametrization for

the dissipation is proposed for the studied regimes.