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Extreme Vortical Waves Under External Pressure Action

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A vortical model for deep-water freak wave formation is presented. The wind action is simulated by non-uniform pressure on the free surface. The motion of the fluid is described by exact solution of 2D hydrodynamics equations for ideal inviscid fluid in Lagrange variables.
Two types of flows are studied: the breather and freak wave in the field of Gerstner wave.
Fluid particles rotate in circles of different radius and drift current is absent. The pressure on free surface is non-uniform and opposite in phase with the wave profile. It is examined alternating-sign and sign-constant negative distributions of the pressure. Dynamics of free surface and pressure for extreme waves are calculated. Unlike other models the analyzed flows are vortical. The vorticity is located mostly in the neighborhood of their peaks.
For enough large amplitudes it has been found the effect of the wave overturn. The influence of distribution of the pressure and vorticity on appearance and character of the overturn are studied. It has been found that increasing of horizontal velocity of fluid with the height causes the overturn as in the case of simple wave.
It is shown that the height of freak wave depends on the steepness of Gerstner wave. If its value is near to 1, then the height tends to 0. The freak wave can not form on a steep Gerstner flow. For small steepness the ratio between the height of the peak and Gerstner wave amplitude can reach 10 and even more. The wave of maximal amplitude has length from the range 20–60 m.