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3D modelling of interaction of strongly nonlinear internal seiches with a concave lake topography and a phenomenon of the "lake monsters".

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In the freshwater lakes in moderate latitudes stratification occurs as a result of the seasonal warming of the surface water layer. Than the intense wind surges (usually in autumn) tilt the surface and generate long basin-scale low-frequency standing internal waves (seiches). Depending on the initial interface tilt and stratification wide spectra of possible flow regimes can be observed [1]-[2].They varied from small amplitude symmetric seiches to large amplitude nonlinear waves.Nonlinearity leads to an asymmetry of internal waves and appearance of the surge or bore and further disintegration of it on a sequence of solitary waves.
In present study degeneration of the strongly nonlinear internal seiches in elongated lakes with a concave “spoon-like” topography is investigated.Two different three-dimensional non-hydrostatic free-surface numerical models are used to investigate degeneration of large internal waves and its subsequent interaction with the concave lake slope. One of this model is non-hydrostatic model [3] and the other is a well-known MIT model.
At first we consider idealized elongated elliptic-shape lake with the dimension of 5 km X 1 km with the maximal depth 30 m. The stratification in lake is assumed to be given in a form of the tangent function with a density difference between upper and lower layers 2 kgm-3 . It is assumed that motion in such lake is initiated by inclination of thermocline on a certain angle. Than lake adjusts to return to its original state producing internal seiches which begin interacting with a bottom topography. The process of degeneration of internal seiches in the lake with concave ends consist of chain of elementary processes:
1) steeping of long basin scale large amplitude wave, that evolve into internal surge,
2) surge interact with concave lake ends that leads the concentration of the flow and formation of down slope bottom jet along the lake axis,
3) due to cumulative effect local velocity in the jet accelerates up to critical values after which jet sink to maximal depth, then stop and rapidly rising up to surface interacting with thermocline where vortex pair is formed,
4) the just formed vortex pair continue moving in thermocline with a critical speed causing wave wake. This wake is also can be visible on the surface of the lake,
5) the final stage of interaction is the formation of solitons and the second internal mode.
The appearance of surface wake in such idealized elongated elliptic-shape lake was the motivation for carrying further modeling of internal seiches in the real lake. This phenomenon can be the explanation of the fact that number of eyewitness around the world claimed to see “lake monsters” moved rapidly and then submerged leaving a wake. Its usually occur in elongated lakes in moderate latitude with a well defined seasonal termocline. Numerical modeling of the interaction of internal seiche with a North end of the Loch Ness confirms possibility of the supercritical internal jet generation and subsequent internal and surface disturbances. We hypotheses that some of eyewitness and legends on the “lake monsters” can be explained by such observations of suddently occurred surface wake behind disturbance generated by focusing flows by bottom topography.

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