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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Numerical modelling of tsunami wave run-up and breaking within a two-dimensional atmosphere–ocean two-layer model" *by* S. P. Kshevetskii and I. S. Vereschagina

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Dear referee, thank you for your attention to our work. We think the discussion becomes very interesting.

Our answers are given below.

1. Our approach was chosen in order that our model has taken into consideration the following effects:

   - the appearing of mixing in the fluid and generation of turbulence by tsunami

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waves,

- the influence of stratification on tsunami waves,
- the generation of atmospheric waves by tsunami waves.

May be, the title of the paper is not so successful, but the problem is not killed in hands, of course. Traditional approaches do not allow consideration of listed questions in principle, but our model describes these effects.

2. The formation of small-scale waves from the initial wave is visible in the pictures. This is an effect of breaking of the initial wave.

3. The paper called "Numerical modeling...". The computer model describing the effects listed in Item 1, is a new result and gives a new knowledge on tsunami waves. We do not know any other computer model that allows consideration of listed effects, in principle. The detailed investigation of these effects and comparison with experiments will be following questions, because the list of interests is a broad one and in order to start we need a model first of all. The authors have developed such a model.

   The developed model is versatile; the model is applicable to a wide range of problems. The study of certain aspects of tsunami waves is one of possible applications of our model. However, other applications of our model are possible, of course, and the themes of the journal are not limited just to tsunami waves.

4. 1 km is a vertical scale of the disturbance in the atmosphere. It is not huge. There are many such waves in the atmosphere at any time.

   Systematic measurements of atmospheric parameters above the ocean surface are absent. Therefore, the method of comparison with experiments, proposed by the referee, is not constructive.

   However, the experimental observations show that tsunami waves generates internal gravity waves in the atmosphere; these waves propagate up to the heights

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of the ionosphere (up to altitudes about 300 km). The effect of these atmospheric waves, created by tsunami waves, on the electron concentration in the ionosphere is clearly recorded using GPS and GLONAS satellite systems (We can give the literature on the question later).

The vertical propagation of atmospheric waves of such scales and amplitudes as tsunami waves generate has been studied in the paper
Karpov I, Kshevetskii S. Formation of Large Scale Disturbances in the Upper Atmosphere Caused by Acoustic Gravity Wave Sources on the Earth's Surface Geomagnetism and Aeronomy, 2014, Vol. 54, No. 4, pp. 513—522.
It has been shown in the cited paper that such atmospheric disturbances, as tsunami wave generates, propagate in the atmosphere up to altitudes above 100 km; they are dissipated above 100 km and they form upper 100 km some large-scale thermospheric and ionospheric disturbances with horizontal scales of up to 1000 km. These are large effects, and our computations are in good agreement with experimentally observable thermospheric and ionospheric manifestations of tsunami waves.

Therefore, the mixing of the ocean water by tsunami waves and mixing of the atmospheric gas above the tsunami waves has influence on parameters of the thermosphere and the ionosphere. It explains our interest to all these processes. We can include this information in the paper, if it is necessary

We plan to solve the problem within the interval heights from the ocean bottom up to heights of above 300 km in order to connect the ocean processes with thermospheric and ionospheric processes and to investigate experimentally observable correlations of the ionosphere and thermosphere with tsunami waves. However, the preparing of such numerical simulations is very complex, and the more detailed comparison of the theory with experiments requires some time. Step by steps.

5. In this paper, we have chosen a solitary wave as an initial condition. During the

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wave propagation, the wave is transformed into non-solitary wave. Therefore, the words of the referee that a solitary wave paradigm is not good, does not touch our model, in general. The model is a very versatile and flexible one and has a wide range of applicability.

Once more, thank you for attention to our work and for discussions.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 3397, 2014.