

Effect of anomalous generation of low-frequency sound in shallow water by a low-flying helicopter

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Usually at questions of excitement of acoustic waves in water ambience by source, disposed in air, suppose that main energy of such excitement is concentrated in limited area of water ambience directly under source.

The results of experimental studies in coast zone of Pacific ocean and find subsequently acknowledgement for shallow areas of water other coast zones (in particular, Black and Barents), have shown that possible generation of low frequency wave's acoustic energy near the coast line sea under influence of source, residing midair on surface of water with the following its spreading in horizontal direction with small fading on significant distances.

This phenomena for the first time discovered by us in 1982 and named "the effect of coast zone", earlier experimental did not exist and theoretically was not predicted. There were shown that in determined situations is possible certain receiving the low frequency signals from remote sources on shallow water moreover in shaping the field of useful signal, plays the important role a bottom and, probably, parametric re-radiation in horizontal direction of signal to account of nonlinear interaction of modes, agitated in layer.

First statement is founded on the fact, that at excitement of acoustic wave in layer, part of its energy leaves in soil and spreads in him, including, along borders water-soil, and if there is possibility to register such wave, range of finding the low frequency signals on background of noises of ocean can vastly increase.

The second statement on collation of levels of signals is founded, registered experimental, and calculated within the framework of different model presentations, both authors, and beside other leading domestic hydroacoustician.

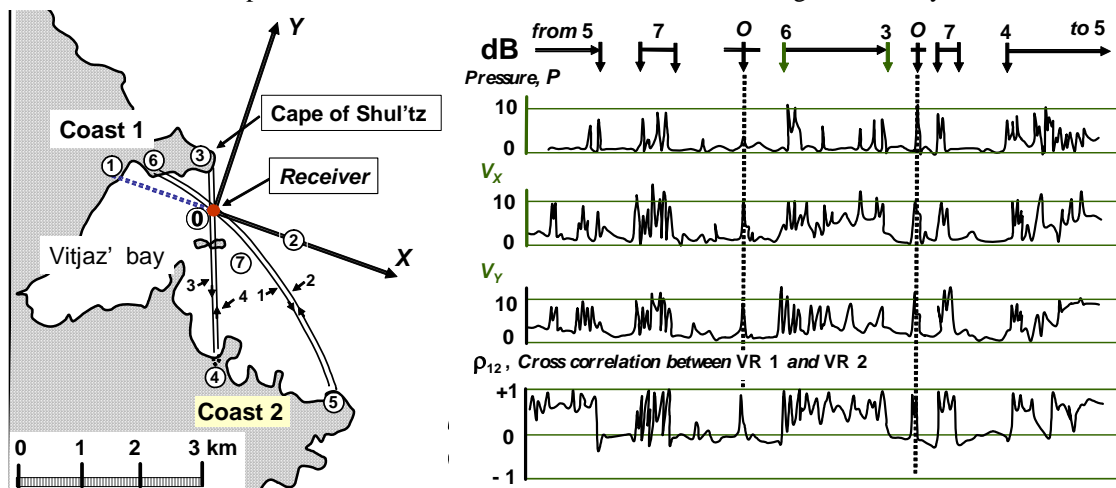


Fig. 1. Scheme of the experiments (at the left) and some of the levels, registered by the pressure receiver and pressure gradient receiver along specified on scheme of the helicopter moving paths (from the right).

The main part of experimental studies was conducted in coast zone of Pacific ocean (fig.1). The receiver system include the sound pressure receiver and two tree-component receivers of the sound pressure gradients, one of the which was situated on height around 1 meter from bottom, second lay on the bottom in silt layer. Two horizontal channels (X and Y) there were oriented as shown in fig.1, channel Z – vertically.

As air source's signal was used the domestic helicopter, moved with constant velocity along axis X systems approximately, and the same way as on given paths on height $h = 50 \dots 100$ meters (on fig.1 these paths are placed the numerals from 1 before 4).

For the high frequency of excitation, as also for deep sea, the signal was registered only when helicopter was above the receiving system directly.

For the low frequencies the receiving system, both on level of acoustic signals, and on level of cross correlation between different components of field safely registered the signals either source finding directly above receiving system, or in completely determined finite number of points along path, enough removed from location of receiving system (1...3 kilometers).

Motion on coast (including flights between points 1, 6, 3 and 5, 4 on fig.1) it is entailed, as this there was be must, by seismo-acoustic waves excitation, certain registered by channels of vector receiver and practically not registered by sound pressure receiver.

The data of fig. 2 (left) illustrate the dependency of registered signals levels from depth of water under source on example of one route (along the X axis). There were the similar dependencies received for all presented paths. The fig.2 (right) presents the depending of registered signals levels on heights near the coast line and on receiving system.

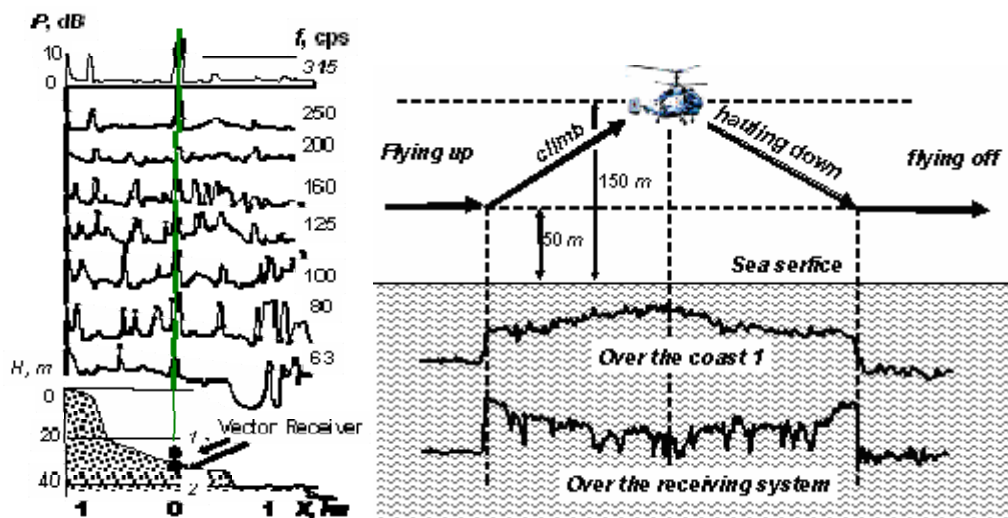


Fig.2. The dependency of levels, registered by the pressure receiver on different low frequencies depending on depths of water under source (at the left) and depending on heights near the coast line and on receiving system (from the right).

The analysis of results, which were obtained by us, as well as collation with similar results, obtained in consequence on shallow areas of water Black and Baltic seas have allowed to select the several reasons of observed registration anomalies of acoustic signal.

1. *Resonance energy generation*, which can exist in layer under definite sign by $H/8$. These effect most is simply explained the first particularity. The effect of resonance excitement most mark for high disposed source, for which generating wave approaches to plane wave. This fact agree with experimental data well, brought on fig.2 (right).

2. *The nonlinear interaction water and bottom modes*. More full account of interaction water and bottom modes partly could be skim with standpoint of physical mechanism observed contradiction. At correlation of velocities water and bottom modes brought on fig.1, there are the happy circumstances for intensive process of transformations of energy between water and bottom modes can be created (except first).

3. *The effects of the sound focusing by bottom*. If a layer of alluvial sorts is presence, it can be formed the specific sound channel. Since velocity of sound in alluvial layer varies within 100-1400 m/s , and for basement rock, it usually forms 1600-2500 m/s , such sound channel turns out to be denominated strong, than in water.

4. *Parametric thermo-acoustic generation of acoustic wave in layer*, spreading nearly horizontally. In considered event a contribution of this effect, sooner completely, must be flat.