

Vadov R.A.

## THE EXPERIMENTAL LAW OF A SOUND FIELD LEVEL DECAY, AS THE INDICATOR OF HYDROLOGICAL CONDITIONS INSTABILITY ALONG INVESTIGATED PATH

Andreyev Acoustics Institute

4 Shvernika ul, Moscow, 117036 Russia

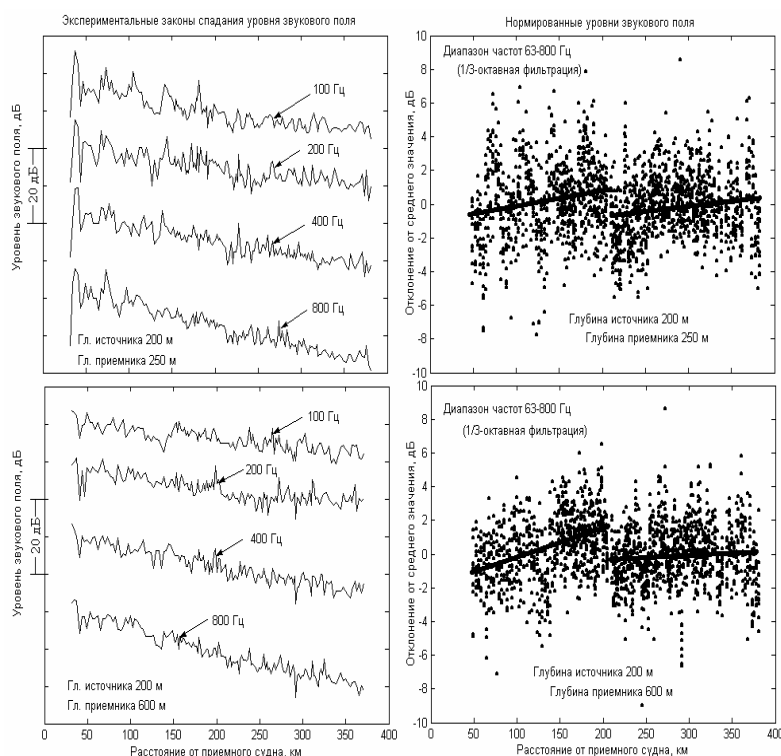
Tel.: 89168689601; Fax: (095) 126 8411; E-mail: vadov@akin.ru

For revealing weak changes in character of a sound field level decay with a distance, caused by influence of the frontal zone crossed by a path of a propagation of explosive signals, it is offered to use normalizing experimental sound field levels with the subsequent joint multifrequency processing the received material. The essence of such normalizing is stated, examples of its successful application are resulted.

From time necessary for carrying out of experience in sea conditions, the success of its performance depends. Experiment on long-range propagation of sound in the underwater sound channel (USC) is some day of work of two research courts. Not a secret, that in some cases it was necessary to interrupt experience on weather conditions, leaving its not completed. By development of the scheme and a technique of statement of an acoustic part of experience the big attention was given minimization of time of its carrying out. Application of the explosive sources completed by detonators of hydrostatic action, has allowed to reduce time of carrying out of this part of experience up to a minimum. Time necessary for obligatory hydrological inspection of a propagation path, was reduced, as a rule, due to reduction of quantity of hydrological stations or due to use breaking temperature probes. Unfortunately, it led to essential decrease in quality of such inspection, especially at complex hydrological conditions in region.

At research of long-range propagation of explosive signals the analysis of experimental laws of field level decay with distance on different frequencies first of all was spent. As has shown an expert, changes of hydrological conditions along a path of propagation lead to the certain changes in character of a sound field level decay. In works [1-5] the experimental materials received in experiences on propagation of a sound on paths, crossing sub arctic front are resulted. Crossing of front, as a rule, leads to the changes of a level of a sound field localized on a distance. Poorly expressed frontal zone leads to its insignificant changes. To revealing

weak changes in character of a sound field level decay with a distance it has been applied and it was repeatedly used normalizing experimental levels of a sound field [4, 5] with the subsequent joint multifrequency processing the received material similar to the route analysis. The essence offered normalizing consists in the following. For the analytical description of the smoothed experimental law of



**Fig.1.** Experimental laws of a sound field level decay with distance on different frequencies at various the receiver depths (at the left) and change normalized levels of a sound field (on the right) at crossing frontal zone (area 40 gr. of north latitude) by a line of propagation.

field level decay functional dependence of a kind is used:

$$E(f, R) = \frac{E_0(f)}{R} \cdot 10^{-0.1 \cdot \beta(f) \cdot R}$$

For each of frequencies (in 1/3-octava strips) on a deviation of the experimental law of a sound field level decay from cylindrical values of exponential attenuations factor  $\beta(f)$  is defined. On each explosion accepted from distance  $R_j$ , for each of frequencies  $f_i$  it is necessary to divide experimental values  $E(f_i, R_j)$  into the corresponding values calculated under the formula resulted above. The received dimensionless attitudes represent the levels of the sound field corrected on the law average on a distance of falling off and normalized on frequency. Their average value (on all file of experimental data) is equal to unit (by definition!).

Let's result some examples of application normalized levels of a sound field at the analysis of the experimental materials received in experiences on distant distribution of explosive signals in complex oceanologic conditions.

1. In the experience lead in area of the fortieth latitudes (the line crossed northern border of sub-arctic front), changes of a level of a sound field have made only 2 дБ [5]. On experimental curves of a sound field level decay on various frequencies such changes remained not noticed.

At the analysis of changes normalizing levels of a sound field at crossing front has been revealed not only the localized difference in a level of a sound field, but also change of factor of attenuation (see fig.1).

In this experience detailed enough hydrological inspection of a path of propagation has been lead. The distance on which noted changes have been revealed, will well be coordinated with a place of crossing by a line (on depth of undermining of charges) inclined border of a frontal zone.

2. In the experience lead in near-Kuril area of Pacific ocean, decrease normalizing level of a sound field on 3-4 дБ with its subsequent restoration (see fig.2) was observed the localized 400-500 km independent of frequency on distance from a source. Constructed on available rather poor (5 hydrological stations on a 900-kilometer line) the field of speed of a sound along a path of propagation in this experience has allowed to explain hydrological materials observable changes of the resulted level by [4] change of hydrological conditions in the middle of a path.

3. More complex hydrological conditions were observed in the experience lead in deep-water part of sea of Okhotsk [6]. In this experience the investigated line settled down within the limits of a southern deep-water hollow (along a ridge of Kuriles), crossing it from northeast on a southwest. Water exchange between sea of Okhotsk and Pacific ocean (through passages), receipt of warm waters of sea of Japan through La Perouse strait lead to essential indignation of the underwater sound channel on this path. The change normalized level of a sound field with distance registered in this experience is presented on fig.3.

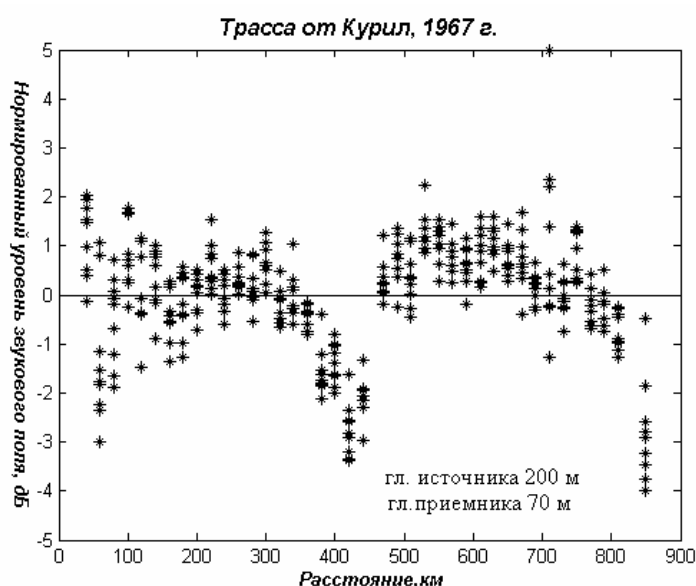


Fig.2. Normalized levels of a sound field at crossing frontal zone in the experience, conducted in near-Kuril area of Pacific ocean.

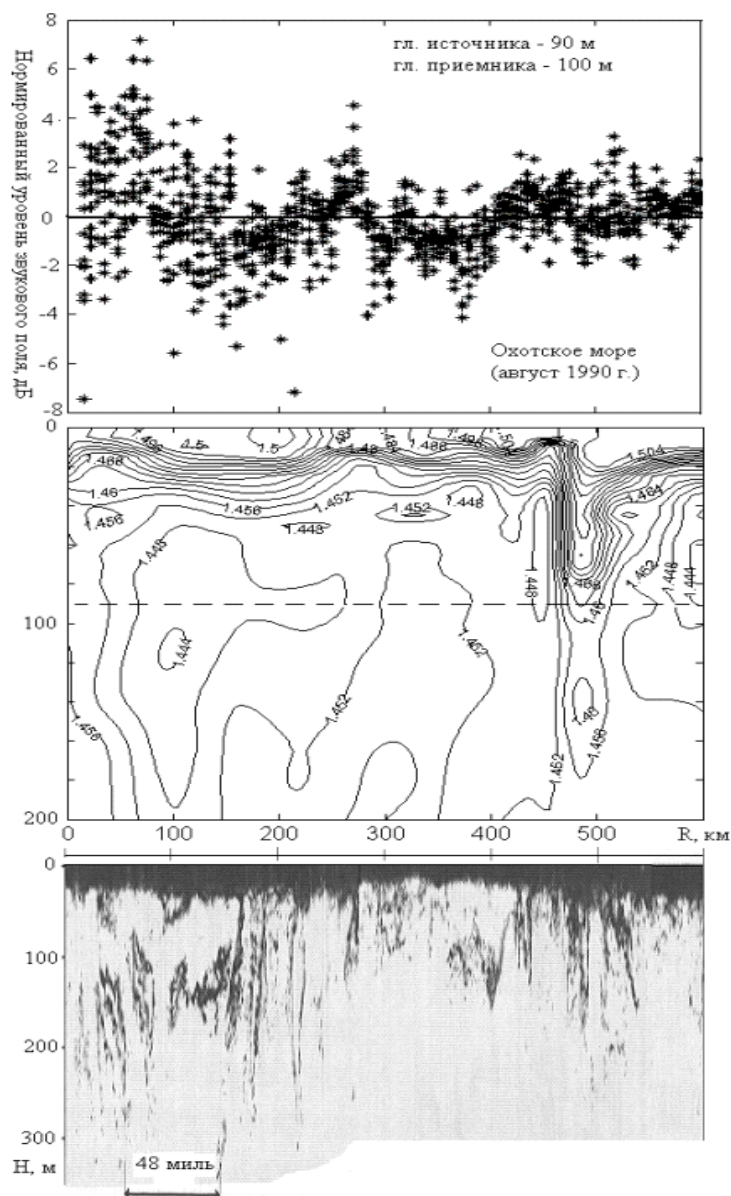
Along the path it is well traced periodic (with the period of 150-200 km) decrease in a level with its subsequent increase within the limits of  $\pm 2-3$  дБ.

In the same figure are presented: a field of speed of the sound, constructed on 15 structures  $c(z)$ , registered directly ahead of carrying out of acoustic experience in different points of a line, and results of continuous high-frequency acoustic sounding heterogeneity of the water environment, executed year later practically along same path by Shevtsov V.P., the employee of Pacific Oceanologic Institute DVO of the Russian Academy of Science [7].

Appreciable correlation of separate details of echo from heterogeneity of the sea environment with corresponding details of a field of sound speed is observed. Introduction of the warm waters acting from sea of Japan is well traced. On distance of  $\sim 500$  km from a reception vessel depth of USC axis is sharp enough increase from 60-80 m up to 200 m and more. To 600 km USC axis comes back to depth of  $\sim 80$  m. Apparently, it and others (not so essential and less appreciable) deviations of USC axis from horizon of undermining of charges (a dashed line on a picture of feald of sound speed) periodic decrease normalized level of a sound field with its subsequent increase are explained.

4. A series of experiences has been lead for revealing features of formation of a sound field of the source removed from coast, in area of a shelf - continental slope. Experiences were spent by a non-conventional technique [8] when the reception vessel laid on distance of  $\sim 300$  km from coast, and radiating vessel moved to coast (perpendicularly to isobaths, corresponding depth of undermining of charges).

On fig.4 results of one of such experiences are adduced. Normalizing of levels was made on the sound field on a deep-water site of a path. So it was possible to reveal essential changes of a level in area of a continental slope - a shelf. Rise on 3-5 дБ was followed with sharp decrease in a level in area of a shelf.

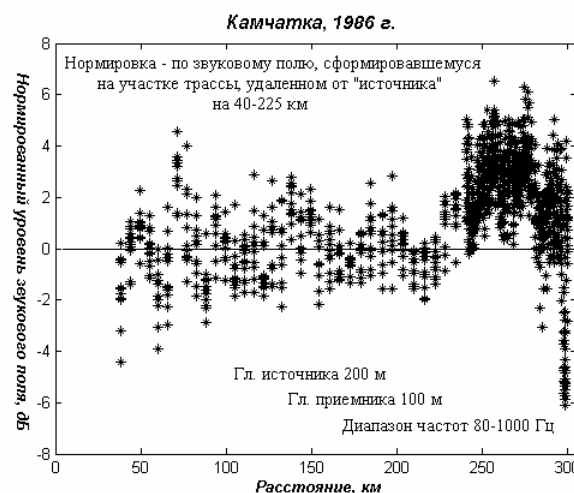


**Fig.3.** Normalized levels of a sound field and a field of speed of a sound in the experience conducted in sea of Okhotsk along the Kuril island ridge. Below - results of continuous acoustic sounding of the water environment executed by Shevtsov V.P. [7] practically along the same line.

In summary it is necessary to note that fact, that in a number of experiences on long-range propagation of the explosive signals executed at weak hydrological maintenance, application of similar processing of experimental materials has revealed similar large-scale changes normalized level of a sound field.

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**Fig. 4.** The normalized levels of a sound field at crossing a continental slope in area of Kamchatka (the reception vessel settled in 300 kms from isobath 200 m).