PREFACE

In 2000, on May 29-31, VIII Brekhovskikh's Ocean Acoustics Workshop was held that was joined with X Session of Russian Acoustical Society. In this forum, acoustitions from Moscow, Nizhnii Novgorod, Taganrog, Voronezh, Vladivostok, and Georgia participated. More than 50 papers were presented. The Workshop program covered nearly all topics of present-day ocean acoustics. The presented papers can be schematically broken up into five groups: sound propagation in the ocean (theory and experiment), acoustic tomography and ocean monitoring, underwater sound scattering, generalization of the experimental data over the World Ocean, techniques and instruments for ocean in-sea studies. In a brief review, we cannot consider all presented papers, therefore we mention several of them in each group. All papers are listed in Contents.

1. Sound propagation in the ocean. The papers on Arctic acoustics are a matter of interest. Underwater acoustic studies in the Arctic Ocean were begun by the Acoustics Institute in the time of USSR, with an expanded spread of work. Later, these studies were carried out in the Institute of General Physics and Institute of Oceanology, both of Russian Academy of Sciences. The results of these works were highly appreciated by the international scientific community. Two factors are most important for sound propagation in the Arctic Ocean: the ice cover and monotone increase in the sound speed as a function of depth, both factors complicating the sound field structure. In the paper of *Kudryashov* and *Kryazhev,* on the basis of computer modeling, the spatial variability is analyzed for the coherence parameter of the sound field in both uniform and irregular Arctic waveguides, under an influence of sound scattering by the rough lower boundary of the ice cover. The effect of the ice cover is also considered by *Krupin* who reports on the dependence of the propagation anomaly on the ice cover thickness for CW sound signals in shallow-water Arctic regions, at frequencies of 0.1 to 1.0 kHz.

In open ocean, the sound field is influenced by large-scale disturbances in the medium parameters. The effects of intense internal waves (solitons) on the sound field is considered by *Serebtyanyi* and *Belov*. In this paper, the wide-angle parabolic equation is used to numerically simulate the influence of intense internal solitons on various parameters of the sound field. In the calculations, data on the soliton-like internal waves are used that has been experimentally obtained at shelves of the Black, Caspian, Barents Seas, the Sea of Japan, and in the coastal region of the Pacific Ocean, near the Kamchatka Peninsular. The soliton-like internal waves produce a specific structure of the sound speed field in the ocean. In the paper of *Katsnel'son* and *Pereselkin,* with the use of the model known as "horizontal rays - vertical modes", formation of dynamic horizontal sound channels is established for a shallow sea where solitons exist. Caused by these channels, focucing and defocusing occur for the rays that propagate at small angles to the front of the internal wave, these phenomena being periodic in time. *Rutenko* reports on experimental and theoretical studies that reveal the effect of short-period internal waves on the interference and mode structures of the sound field on the fixed path at the shelf zone of the Sea of Japan, for both winter and autumn water stratifications. A strong effect of the internal waves is established on the frequency interference structure of the sound field and on the energy distribution between the lower seven modes. In the paper of *Bondar'*, *Bugaev*, and *Rutenko*, the data of in-sea experiments are presented on the changes in the low-frequency sound field, which are caused by the surface tide and tide-associated disturbances in water bulk at the shelf zone. The measurements were carried out on fixed paths that were up to 260 km in length, oriented both along and across isobaths. The experimenters managed to distinguish between the effects of internal and surface tides.

A number of papers are presented on new theoretical methods to calculate ocean sound fields. *Avilov* developed pseudo-differential parabolic equations to describe propagation of seismoacoustic waves in a two-dimensionally inhomogeneous ocean with rigid bottom and presented numerical solutions of these equations. The algorithm is given to calculate the entire sound field - for the waves propagating both forward and backward. A problem is theoretically treated of exciting side waves by a parametric sound source in shallow sea (*Egorychev*, *Zakharov*, *Kurin*, *Kustov*, and *Pronchatov-Rubtsov*).

Several researchers report on in-sea measurements of various characteristics of the underwater sound field: mode content and dispersion relations in shallow- and deep-water oceanic waveguides on paths of different lengths (*Lazarev, Sokolov,* and *Sharonov*); cross-correlation of pulsed broad-band signals with linear frequency modulation at the second shadow zone in the Central Atlantic (*Malyshev*); angular structure of the sound field in the deep ocean (*Baranov*); spatial and temporal variability in the coastal wedge (*Kulakov*).

An important problem of underwater acoustics is the analysis and interpretation of the experimental data. *Vadov* proposes a computer method to separate two signals that are close in their arrival times, provided that the signals propagate to a distant receiver over paths that differ by a single contact with the caustic. The method proved to be highly efficient in analyzing the experimental data obtained earlier.

2. Acoustic tomography and ocean monitoring. In recent years, studies of acoustic tomography and ocean monitoring have been actively developed in many countries, including Russia. The well-known work of Munk and Wunsh (1979) was the starting point. Various ray and mode tomography techniques were proposed. In the paper of *Gavrilov*, which was presented at the joint meeting of the Workshop and Session of Russian Acoustical Society, the state of the art and future prospects for the acoustic ocean thermometry was analyzed. Yet accomplished, current, and future experiments are considered on acoustic tomography in the Pacific, Arctic, Indian, and Atlantic Oceans. *Goncharov* develops a new approach for the acoustic tomography of currents, which is based on matching the unreciprocity of the sound field. By numerical simulations, a feasibility is shown for linearizing the proposed procedure, this significantly accelerating calculations. The effect of inaccuracy in *a priori* information on reconstructing the mean temperature of the water layer is analyzed in the paper of *Virovlyanskii*, *Kazanov*, *Lyubavin*, and *Stromkov*. It is shown that, by omitting a number of the empiric orthonormal functions which are used to parametrize the inhomogeneities, one comes to significant errors. In a number of papers, specific tomography problems are touched upon. Thus, *Aleinik*, *Goncharov*, and *Chepurin* present the data on dynamic acoustic tomography of the interthermoclyne lens observed in 1994, from the scientific research vessel AKADEMIC SERGEI VAVILOV in the North Sea. Thanks for the detailed hydrological measurements and large number of acoustic stations, the differential tomography was implemented in well-established environment. The reconstruction results well agree with the measured parameters of the lens. The paper of *Orlov* is focused on studying the hydrophysical parameters of oceanic waveguides by observing the interference structure of the low-frequency sound fields of broad-band sources. *Furduev* presents a new method to acoustically monitor the medium variability on the propagation path joining two bottom-moored transceivers.

3. Underwater sound scattering. For decades, underwater sound scattering has been a subject of numerous theoretical and experimental studies. Up to date, the physical mechanisms of this phenomenon are well established, and intensity levels of scattering are reliably estimated for different oceanic environments. Theoretical and computer models are developed that relate the acoustic effects to the associated medium parameters: the spectrum of surface waves, structure and relief of the sea floor, characteristics of volume inhomogeneities of hydrophysical and biological nature.

These models allow one to use the experimentally obtained scattered signals for solving the inverse problems - for estimating the medium parameters from these signals. Of course, the reliability and accuracy of solving the inverse problems is higher if the associated models are tested in an independent way - simultaneously or in advance. To this end, the paper of *Belov* should be mentioned: the author proposes to determine the physical properties of bottom sediments in shallow sea by measuring the bottom reflection coefficient. The obtained data are compared with ones that are calculated in another way: from independently measured values of the sediment density and porosity. The same subject is touched in the paper of *Fokin* and *Fokina* who are known to deal with the theory of sound reflection by the stratified sea floor for a long time. By theoretically analyzing frequency dependences of the reflection coefficient and losses caused by sound reflection from the shallow-sea bottom, the authors propose a technique to estimate the physical bottom parameters - for the sediment layer and underlying elastic half-space. The same researchers developed a theory of resonant sound reflection by an elastic layer on an elastic half-space. *Leikin* theoretically treats the feasibility of detecting the coherently scattered waves in the ocean with random inhomogeneities of the refraction index. It is shown that such waves can be detected for the direction of their forward propagation, even if there is no *a priori* information on parameters of the inhomogeneities. This allows one to use the coherently scattered waves for measuring the time trend of the mean temperature on the propagation path.

New experimental data on volume sound scattering in ocean waters (the Pacific Ocean, subtropics) are presented by *Akulichev*, *Bulanov*, and *Popov*. The data analysis shows that, at frequencies of several hundreds of Hz, frequency dependence of the volume scattering coefficient in the sub-surface water layer can be explained by the fractal structure of the scattering inhomogeneities.

Unfortunately, except for the aforementioned results, no other ones are presented that develop the theory of underwater sound scattering or significantly contribute to the body of experimental data on the subject though some papers do contain the information on specific ocean situations.

In addition to solving the inverse problems, the models for underwater sound scattering allow one to interpret and quantitatively estimate complex physical phenomena, as ocean reverberation and prereverberation. In the paper of *Kopyl* and *Lysanov*, some parameters are theoretically estimated and numerically computed for prereverberation caused by scattering of low-frequency sound by the rough ocean surface. The amplification effect is established for volume sound scattering in the presence of caustics in the sub-surface water layer (*Gostev* and *Shvachko*). *Galkin*, *Popov*, *Semenov*, and *Simakina* present the experimental data on reverberation in the Pacific Ocean, near the Kamchatka Peninsular. An interesting explanation is proposed for broaden spectra of the bottom reverberation, which were observed with fixed sound source and receiver; the degree of coherence is estimated for the reverberation signals.

4. Generalization of the in-sea experimental data over the World Ocean. Small number of new experiments on underwater sound scattering, as well as on other subjects of ocean acoustics, is governed by the sharp decrease in a number of scientific sea expeditions carried out in Russia in recent years. This seems to stimulate many works on generalization and classification of archive experimental data collected in various branches of our science, which, for some reasons, were not published earlier.

As the first step in this direction, computer databases are usually created to collect, store, and subsequently use various experimental information that the experimenters posses. A solution of this problem is proposed by *Bondar'*, *Kosyrev*, and *Saltanova* who are developing the database for a wide-scope underwater-acoustics applications, with the use of a number of modern program products. These researchers are now filling the database. Computer databases are being also developed for specific topics of underwater acoustics. Thus, in the paper of *Galybin*, *Tarasov*, and *Tolkachev*, a structure of the database is considered that is to contain experimental information on acoustics of the deep scattering layers (DSL) in the ocean. The method is described and the results are presented of regional classifying the Atlantic Ocean in values of the total column strength - the main acoustic parameter of DSL. The classification is performed at six sound frequencies, from 3 to 20 kHz. With the use of this database, the information was first published on the depth structure of DSL for different ocean regions, and on the effects of some hydrological inhomogeneities on the DSL structure (*Andreeva*, *Galybin*, and *Tarasov*). Another paper that deals with a large body of experimental data is that of *Vadov*, which considers sound absorption and attenuation in ocean regions that differ in their hydrological properties. For the analysis, the database is used that is developed by the author. The paper stands by itself that was presented by *Furduev*. In this paper, a generalized description is given for phenomena that cause fluctuations of underwater ambient noise within different frequency bands of the fluctuations - from 0.001 Hz to several units of Hz. These phenomena include the meteorological environment and propagation conditions within the noise-forming area.

5. Techniques and instruments for in-sea measurements. A number of papers describe parametric acoustic devices for using in in-sea experiments. Here, the paper of *Voronin*, *Tarasov*, and *Timoshenko* should be mentioned. The authors are representatives of the organization that is the advanced one in Russia to develop such instruments. In the paper, features of these devices are considered as applied to studies of random inhomogeneities in the ocean water bulk and floor. Methods are proposed for developing the parametric antenna arrays, and information is reported on the parametric sonars that have been yet constructed. Examples are given of using these devices in oceanic scientific experiments to study the fine structure of waters, fish gatherings, upper layers of the sea floor, etc. In addition to this review, a number of papers are presented on particular topics of improving the efficiency and specifications of various parametric devices (see the papers of *Starchenko* and *Borisov*, for instance).

In the paper of *Varlatov*, *Kosolapkin*, and *Cheranev*, the acquisition and processing system is described for various hydrophysical data. With high resolutions in both time and space, up to a depth of 2000 m, this system synchronously records parameters of currents, sound speed, oxygen content, electrical conductivity of the water, and some other its characteristics. In addition to dedicated sensors, the system contains a computer that real-time processes al the incoming information. Some results of in-sea experiments are also presented. To monitor the position of biological objects within a shallow-sea coastal area, *Bakhirev*, *Bondar'*, and *Ignat'ev* propose to develop a system that consists of underwater parametric antenna arrays and a number of self-contained acoustic and hydrophysical sensors that transmit radio-signals to a coastal radar.

Several papers analyze the efficiency and ways of improvement for acoustic devices that are to be applied to remote acoustic studies of the sea-floor structure (the paper of *Zheleznyi*, *Ostrovskii*, and *Smirnov*, for instance) or acoustic properties of the bottom (*Nosov* and *Postnov*).

The papers presented at each of the six previous Workshops (1980 - 1990) were published by the NAUKA publishing house, edited by academician Brekhovskikh: Ocean Acoustics: State of the Art (1982); Problems of Ocean Acoustics (1984); Acoustic Waves in the Ocean (1987); Acoustics of Oceanic Medium (1989); Acoustics in the Ocean (1992); Oceanic Acoustics (1993). Proceedings of VII Workshop were published by the GEOS publishing house: Ocean Acoustics. Proceedings of Brekhovskikh's Workshop (1998).

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