JPRS L/10171

9 December 1981

USSR Report

EARTH SCIENCES

(FOUO 8/81)

FBIS FOREIGN BROADCAST INFORMATION SERVICE

FOR OFFICIAL USE ONLY

APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000400080025-2

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000400080025-2

JPRS L/10171

9 December 1981

USSR REPORT

EARTH SCIENCES

(FOUO 8/81)

CONTENTS

METEOROLOGY

UDC 551.553.21

COLLECTION OF ARTICLES ON 'MUSSON-77' EXPERIMENT

Moscow METEOROLOGICHESKIYE ISSLEDOVANIYA, NO 24: EKSPERIMENT 'MUSSON-77' in Russian 1981 (signed to press 17 Mar 81) pp 4, 108

[Annotation and table of contents from collection of articles "Meteorological Investigations, No 24: 'Musson-77' Experiment", responsible editors B. S. Chuchkalov and Ye. P. Veselov, candidates of geographical sciences, Izdatel'stvo "Nauka", 900 copies, 108 pages]

[Text] Annotation. The articles give the results of the international experiment "Musson-77," carried out in the Indian Ocean in 1977. The authors examine the circulatory mechanisms for the forming and development of the summer southwesterly monsoon of South Asia, migration of the ICZ, air transport across the equator and conditions for the development of tropical cyclonic disturbances during the development of a monsoon. Studies were made of the structure and energy characteristics of the troposphere, the conditions for the development of cloud cover and precipitation and the distribution of the temperature of the surface water layer in the Arabian Sea and the Bay of Bengal. The collection is intended for geophysicists, meteorologists, oceanologists, climatologists and geographers.

Contents

5303
CSO: 1865/14

UDC 551.509.59

MONOGRAPH ON USE OF HYDROMETEOROLOGICAL DATA IN NATIONAL ECONOMY

Leningrad GIDROMETEOROLOGICHESKAYA INFORMATSIYA V NARODNOM KHOZYAYSTVE in Russian 1980 (signed to press 9 Dec 80) pp 2, 166-167, 174-175

[Annotation, conclusion and table of contents from monograph "Hydrometeorological Information in the National Economy", by Eduard Isaakovich Monokrovich, Gidrometeoizdat, 2600 copies, 176 pages]

[Text] Annotation. Timely allowance for hydrometeorological information makes it possible to lessen the losses from dangerous weather phenomena and make better use of favorable weather conditions in production: save fuel, increase the yield of agricultural crops, reduce the time required for the delivery of freight, etc. How is it possible to estimate the economic effect from the use of this information, and therefore arrive at a reasonable measure of expenditures for collecting these data? What reserves exist for increasing the effectiveness of production by taking such information into account in planning and control? Such questions are examined in this book which is intended for specialists of the Hydrometeorological Service and a wide range of users of hydrometeorological information.

Conclusion. Thus, we have examined some economic results of hydrometeorological support of the national economy, one of the several directions in activity of the USSR State Committee on Hydrometeorology and Environmental Monitoring. Other highly important directions (ensuring human safety during dangerous weather phenomena, monitoring environmental contamination, further study of the atmosphere, ocean, waters of the land and mechanism of climatic change) are not considered here. The social importance of these problems is clear to everyone, although for the time being it is still impossible to evaluate the results of their solution in monetary terms.

However, in order to judge the profitability of operation of Hydrometeorological Service agencies it is sufficient to compare the expenditures on maintaining these agencies with the total economic effect which is attained in branches of the economy highly dependent on the environment due to allowance for hydrometeorological information.

According to the approximate computations made by the author, taking in (by no means completely) only those branches of the national economy of Kazakhstan which are examined in Chapter 2, this effect with the level of productive forces in 1976-1977 was 47-50 million rubles annually. This exceeds the annual expenses in

maintaining the Kazakh Administration of Hydrometeorology and Environmental Monitoring by a factor greater than 3.*

There is reason for believing that the total effect of hydrometeorological servicing of the national economy of the country and the expenditures on maintaining all the agencies of the State Committee on Hydrometeorology and Environmental Monitoring are approximately in the same relationship.

By branches of the national economy of the republic the mentioned sum in millions of rubles per year is distributed in the following way:

Agriculture -- 22-25;
Civil aviation -- 7.0;
Highway traffic and highways -- 5.0;
Electric power -- 4.0;
Construction-erection work -- 1.5;
Railroad transportation -- 1.0;
Water transportation and fishing -- 1.0;
Strip mining of minerals -- 0.5;
Saving in engineering field work and construction planning -- 5.0.

Thus, in Kazakhstan about half of all the economic effect of hydrometeorological servicing is attained in agriculture. Accordingly, it is fitting to recall that in a number of decrees of the Party and the government, issued in different years, the need has been emphasized for improving the hydrometeorological support of precisely this branch.

As indicated by computations, the most valuable kinds of information for the agriculture of Kazakhstan is information relating to available soil moisture reserves at the time of sowing of spring crops, predictions of the last spring and first autumn frosts, weather forecasts during the period of harvesting of grain crops and storm warnings for migratory grazing. In those regions of the country where large areas are occupied by winter crops summaries on the state of winter crops after wintering and recommendations on the areas of their resowing are extremely effective.

A major national economic effect is also obtained by taking into account aviation forecasts for the landing point and the use of regime materials (climatological, hydrological, agroclimatic) in construction planning and in regionalization of the territory of the country.

The determined advantages/expenditures relationship assumes particular importance if still another important circumstance is taken into account. It is well known that the productivity of labor and the profitability of production are dependent to a high degree on the capital investment in the branch, that is, the amount

---

* In the economy of other regions of the country an important role is played by forestry, tourism and other branches which are also highly dependent on the environment.

invested per worker. Whereas in machine building, metallurgy and the chemical industry the capital investment is tens, and in the power industry even hundreds of thousands of rubles per worker, for the Kazakh Administration of Hydrometeorology and Environmental Monitoring it is only 2,500 rubles per worker (it is approximately the same for the other Administrations of Hydrometeorology and Environmental Monitoring). For branches with such a low capital investment such a ratio of the economic effect to operational expenditures is extremely high.

As indicated in the last chapter of this book, the reserves for increasing the effectiveness of use of hydrometeorological information are still very great.

With the realization of these reserves and increase in the volume of production in the serviced branches of the national economy the socioeconomic importance of hydrometeorology will also increase in the future.

Contents

5303
CSO: 1865/238

OCEANOGRAPHY

UDC 528.932.:681.3

AUTOMATING PROCESSING OF SHELF SURVEY MATERIALS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 7, Jul 81 pp 39-41

[Article by V. M. Kamornyy]

[Text] The automation of processing of survey materials from the continental shelf is one of the timely problems in geodetic work. Now a number of programs have been developed which make it possible to solve individual problems in office processing [5]. However, it is preferable to have successive solution of several problems, especially determination of the plane coordinates of depth measurement points and correction of depths and automated compilation of maps of the shelf with use of modern electronic computers in a unified series and automated curve plotters. Such a programmed complex is being developed at Enterprise No 2 in collaboration with one of the institutes of the USSR Academy of Sciences. One of the well-known programs, the "Shel'f," developed at the enterprise, is used in obtaining the coordinates and correcting the depths of measurement points. Another, developed at the institute, is employed in computing and then drafting contours on an automated YeS-7054 curve plotter. Both programs are employed using the RL-1 and FORTRAN-4 algorithmic languages respectively and are used independently of one another.

The basis of the "Shel'f" program is five subprograms which ensure solution of the following problems:
-- input from punched cards and magnetic tape, checking, editing, regrouping and supplementation of initial information;
-- computation of plane coordinates of depth measurement points;
-- correction of depths with the necessary corrections;
-- sorting of the depth measurement points by grid squares and forming of an initial bank of geodetic data for their processing under the second program of the complex -- a program for the plotting of contours;
-- printout of a catalogue of coordinates and depths, transfer of the bank of initial information for each grid square onto magnetic tape.

Simultaneously with the maximum filling of the initial tables with data, the "Shel'f" program makes it possible to process up to 80 000 exposures for 68 grid squares in the course of 10-14 hours.

The initial data used in the computations is the information represented in the form of a three-dimensional matrix $A = \{A_{ijk}\}$ measuring 400 x 5 x 200, which corresponds to the data for 200 runs, each with 400 exposures. Each row of the A matrix represents a set of five parameters

$$Q=\{i, S_1, S_2, Z, \varphi\},$$

where i is the number of the depth measurement point on the run; S_1, S_2 are measured navigation parameters characterizing the location of the depth measurement point; Z is the measured or corrected depth; φ is reference information for computing the echo sounder corrections for the zero position, calibration and for deviation of the rpm of the electric motor or instrument speed of sound in the water to which the echo sounder is adjusted from the nominal value.

The upper plane of the A matrix, that is $\{A_{ijk}\}$, contains reference information for each run, representing a set of values $\{Ng, T_{beg}, T_{end}, V\}$, where Ng is the number of the run (the control runs are given with a minus sign); T_{beg}, T_{end} are the times of beginning and end of the measurements on the run respectively; V is an index characterizing the method for determining the coordinates of the depth measurement points.

The coordinates of the depth measurement points are determined by solution of linear, direct, reverse and polar intersections.

The plane coordinates are determined by the iterations method by solution of the system of equations

$$\begin{cases} a_1\Delta x+b_1\Delta y+l_1=0; \\ a_2\Delta x+b_2\Delta y+l_2=0; \\ x^i=x^{i-1}+\Delta x; \\ y^i=y^{i-1}+\Delta y, \end{cases}$$

where x^i, y^i are the coordinates of the depth measurement point obtained in the i-th iteration; a_j, b_j (j = 1, 2) are the coefficients and free terms, determined by the position lines method for each type of intersection [3].

In determining the coordinates corrections are computed for centering and their reduction at shore posts, and for linear and polar intersections -- meteorological corrections and corrections for reduction of the measured distances to a plane in a Gauss projection. The determined coordinates of the depth measurement points are reduced to the center of the echo sounder vibrators and the accuracy of the plane position of each point is evaluated.

In the office processing process the need frequently arises for plotting the depth at an intermediate point situated on an echogram between the working readings on the survey sheet. An oblique nomogram is used for this purpose. The program provides for computation of the coordinates of these points from a reading taken from the nomogram.

After computing the coordinates an analysis is made of the determined values. This makes it possible to check and reject erroneous data using all the initial information intended for computing the plane coordinates. The constancy of the ship's speed on a run in this case is checked using the condition

$$V_{ij}/V_0 \in [0{,}75 : 1{,}5],$$

where V_{ij} is the ship's speed between the measurement points i, j; V_0 is the ship's mean speed on the run.

The subprogram for the correction of depths provides for obtaining the total echosounder correction, determined by both the calibration method and by computations on the basis of hydrological data, and also computation of the level correction using data from observations at one, two or three level posts. The corrected depth value Z is computed using the formula [2]

$$Z = Z_0 + \Delta Z_{es} + \Delta Z_f,$$

where Z_0 is the measured depth value; ΔZ_{es} is the total echo sounder correction; ΔZ_f is the level correction.

The correction ΔZ_f for the moment of depth measurement is determined using the argument of time T_i from the function F(T, n), obtained by the parabolic interpolation method [1] on the basis of observational data for the level post: readings of sea level n from the adopted zero height and the corresponding moments in time T. In the case of simultaneous observations at two or three level posts the correction ΔZ_f is computed using the method adopted in hydrography [2] with the sole difference that the region of depth measurement is not broken down by zones. This is done using a coefficient representing the ratio of projection of the length of a line from one of the posts to the depth-measuring point on the base connecting the posts to the length of the base itself.

In the case of computations on the basis of hydrogeological data the corrections for the deviation of the actual vertical speed of sound in water ΔZ_V from the computed value to the total echosounder correction ΔZ_{es} includes corrections for the zero position ΔZ_{MO}, deviation of the echosounder electric motor rpm from the nominal value ΔZ_n and settling ΔZ_b; the latter takes into account the correction for the settling of the ship or small boat during movement [2].

The correction ΔZ_V is computed separately for the horizon corresponding to the value of the measured depth according to data from observations at two hydrological stations situated in the region of the point of depth determination on the run. Such operations are carried out for several stations, and especially for those where the interval between the days of observations and the days when depth measurements are made on a particular run is short. Then interpolation is carried out for the point and the moment of measurement of depth. The law of linear interpolation is selected in connection with the fact that the nature of measurement of the vertical speed of sound in the water remains unknown with respect to both time and area.

When determining corrections to the echo sounder readings by the calibration method ΔZ_T, as in the first case the corrections ΔZ_{ss}, ΔZ_0 are applied to ΔZ_{es} [2]. The correction ΔZ_T for the horizon Z_1, corresponding to the measured depth, is determined from the argument Z_1 from the function $\varphi(Z_L, Z)$, obtained by the polynomial approximation method [1] on the basis of the results of calibration: sounding lead readings Z_L and echo sounder readings Z.

The total echosounder error can be obtained both separately and jointly by calibration methods to the stipulated horizon and by computations using hydrological data.

As a result of processing of the initial information for each run exposure it is possible to obtain the set of values

$$Q_2 = \{Ng,\ i,\ x,\ y,\ Z,\ \Delta z_{es}, \Delta z_f\}.$$

Then the depth-measurement points are sorted by survey sheets

$$K \subset K_{ss}.$$

where K is a final set, representing the coordinates of the depth measurement points for all the runs in the work region; K_{ss} is the final set, limited by the frames of the survey sheets.

As a result of sorting, for each survey sheet a set Q_2 is formed which represents a summarized catalogue for all the runs falling within the grid square zone and the set $Q_3 = \{x, y, Z\}$, used in implementing the program for drafting the isolines in the programmed complex. Simultaneously with the set Q_3 a determination is made of the rectangular coordinates of corners of the grid square frames with the points of intersection of the kilometer grid with the frames of the survey sheet being determined in the same operation. In both cases the grid square designation (letter and number) is determined and recorded.

On the basis of the set Q_2, obtained for the survey sheet, a statistical analysis is made of the differences in depths at the points of intersection of the principal and control runs. The depths at the points of intersection of the runs are determined by the linear interpolation method. As a result, for the entire survey sheet the mean square value of the difference in depths at the points of intersection m is determined and the number of points of intersection at which the discrepancies in depths (expressed in percent) fall is established (0 to 1%, from 1 to 2%, etc. and more than 4%). At the same time, using the formula

$$m_h = m_\Delta / \sqrt{2}$$

it is possible to make an approximate estimate of the mean square error in the vertical position of the isolines (contours) m_h for the particular survey sheet, since the differences in depths Δ at the points of intersection of the runs can be represented in the form

$$\Delta = \Delta_Z + \Delta_0 + \Delta_{co} - (\Delta'_Z + \Delta'_0 + \Delta'_{co}),$$

where Δ_Z and Δ'_Z are the random errors in determining the depth readings on the main and control runs respectively; Δ_0, Δ'_0 are the random errors in the reading at the point of intersection due to the generalization of relief obtained on the considered runs; Δ_{co}, Δ'_{co} are the random errors in vertical displacement of the reading for a point of intersection caused by errors in determining the ship's coordinates on runs.

Assuming the considered errors to be independent with mathematical expectations equal to zero, it can be written [4] that

$$M[\Delta^2] = 2 m_h^2.$$

In order to check operation of the "Shel'f" program we carried out a great volume of comparative computations and established that there was a good convergence of the results of manual and computer calculations. Both the coordinates and the depth values converged in the limits established by the current instructions. The "Shel'f" program was used in the processing of several work areas. The introduction of the program for plotting contours for maps of the shelf was initiated.

According to preliminary computations the annual saving from the automated processing of survey materials for the continental shelf under this program is more than 50,000 rubles.

BIBLIOGRAPHY

1. Zhurkin, I.G., Krasikova, M. V., et al., VYCHISLITEL'NAYA MATEMATIKA (Computational Mathematics), Moscow, Nedra, 1976, 225 pages.

2. Kolomiychuk, N. D., GIDROGRAFIYA (Hydrography), Leningrad, GUNiO, 1975.

3. Kougiya, V. A. and Sorokin, A. I., GEODEZICHESKIYE SETI NA MORE (Geodetic Networks at Sea), Moscow, Nedra, 1979, 270 pages.

4. Sorokin, A. I., GIDROGRAFICHESKIYE ISSLEDOVANIYA MIROVOGO OKEANA (Hydrographic Investigations of the World Ocean), Leningrad, Gidrometeoizdat, 1980, 285 pages.

5. Yakhman, V. V., "Complex of Programs for the Automated Processing of Shelf Survey Materials," REF. SB. No 69, SER.: SOVERSHENSTVOVANIYE TEKHNIKI I TEKHNOLOGII TOPOGRAFO-GEODEZICHESKIKH RABOT (Collection of Abstracts No 69, Series: Improvement in Technology and Methods for Topographic-Geodetic Work), Moscow, TsNIIGAiK, pp 15-20, 1979.

5303
CSO: 1865/12

UDC 551.465

SYNOPTIC EXPERIMENT IN THE INDIAN OCEAN

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 258, No 5, 1981 (manuscript received 30 Oct 80) pp 1216-1219

[Article by B. A. Nelepo, academician, Ukrainian Academy of Sciences, V. Ye. Zaika, V. K. Kosnyrev and V. A. Urdenko, Marine Hydrophysical Institute and Institute of Biology of the Southern Seas imeni A. O. Kovalevskiy, Ukrainian Academy of Sciences, Sevastopol']

[Text] Continuing the investigations of synoptic variability of the ocean carried out by the Marine Hydrophysical Institute, Ukrainian Academy of Sciences over a number of years, during the period March-August 1980, in the northwestern part of the Indian Ocean, specialists carried out a large-scale multifactor experiment under the "Program for Multisided Investigation of the Fishing Resoures of the Indian Ocean With Allowance for the Synoptic Eddy Structure" (KIPRIO -- Programma Kompleksnogo Issledovaniya Promyslovykh Resursov Indiyskogo Okeana s Uchetom Sinopticheskoy Vikhrevoy Struktury). Six ships participated in the experiment: "Akademik Vernadskiy," "Mikhail Lomonosov," "Professor Vodyanitskiy," "Chatyr-Dag," "Admiral Vladimirskiy" and "Faddey Bellinsgauzen." The need for investigations of this type was dictated by the following circumstances.

Investigations made under the international POLIMODE program [1] made it possible to establish that as a result of the disturbance of the upper layer of the ocean by moving eddy formations there can be formation of zones of increased biological productivity. Without question, the determination of the quantitative and qualitative relationships between the dynamic characteristics of eddy formations, their energy and capacity to transport substances suspended in solution, on the one hand, and the structure of biocoenoses, on the other hand, will afford a possibility for using information on the synoptic variability of the ocean in the problem of the rational organization of sea fishing in the interests of the national economy.

In order to solve the formulated problem, in March 1980 five ships were used in making a large-scale survey of the region for the purpose of studying background conditions and detecting eddy formations. The survey was made over a period of 17 days in a network of stations with a latitudinal interval of 60 miles and a longitudinal interval of 40 miles (Fig. 1).

During April-May the ships carried out investigations in polygons measuring 120 x 120 miles, studying the detected eddy formations, at the same time setting out buoy stations. In June a repeated large-scale survey was carried out, completing

the research program in the Arabian Sea. The "Mikhail Lomonosov" continued to work in the equatorial part of the region until August.

Work was initiated in the period of ending of the winter monsoon with a wind velocity of 4-8 m/sec, primarily of northerly and northwesterly directions. Most of the work was carried out in the transitional period during calm weather. The final phase of the investigations coincided with the beginning of the summer monsoon with a wind of 10-18 m/sec, whose direction varied from SW to WSW.

An important result of the experiment was a clarification of the characteristics of synoptic variability of hydrological, chemical, optical and biological parameters of the medium. In the large-scale survey it was possible to register dome-like rises and descents of the isotherms with a horizontal scale of 100-300 km (Fig. 2). A total of seven cyclonic and five anticyclonic relatively weak eddy formations were discovered, characterized by change in the height of the 16°C isotherm relative to the background level by 20-60 m. Two microsurveys of a cyclonic eddy carried out later (Fig. 3) indicated that it had moved to the WSW with a velocity of about 9 miles/day. The rise in the isotherms in the eddy zone was observed most clearly in the layer 100-400 m, that is, in the thermocline. In the deeper layers the temperature field disturbances were extremely weak and inadequate for reliable identification.

A distinguishing characteristic of the vertical structure of the eddy formation is a shift of the position of the center as a function of depth. The movement of the eddy in the strongly stratified fluid, whose stratification was caused by interaction of the waters of the Arabian Sea and the waters of the Gulf of Persia and Red Sea waters, acquires specific characteristics in the fields of temperature, salinity, chemical and optical characteristics. For example, the center of the eddy, which could be traced easily due to the anomalously high concentrations of biogens, is displaced at the 200-m horizon by almost 60 miles relative to its position at the 100-m horizon (Fig. 4).

The velocities of orbital movement of the detected eddy formations, determined by direct instrumental measurements and computations by the dynamic method, were 0.1-0.2 m/sec. It was established by T, S analysis that the cold cyclonic eddy had characteristics corresponding to the zone of the Arabian upwelling and accordingly it is possible to postulate the capture of coastal waters by the eddy in the process of its formation and their transport into the open ocean. At the same time, the exceedingly rapid variability of the form of this eddy and its great velocity of movement indicate either a wave nature of the formation, for example, due to the superposing of fast baroclinic Rossby waves, or its instability.

A distinguishing characteristic of the synoptic variability of the ocean in the region of the investigations was the presence of a hydrological front, corresponding with respect to the nature of its positioning to the southern and southeastern periphery of a large-scale cyclonic circulation which during the period of the winter monsoon occupies the northern part of the Arabian Sea. The meandering of this front could be one of the sources of weak eddy formation in the polygon region.

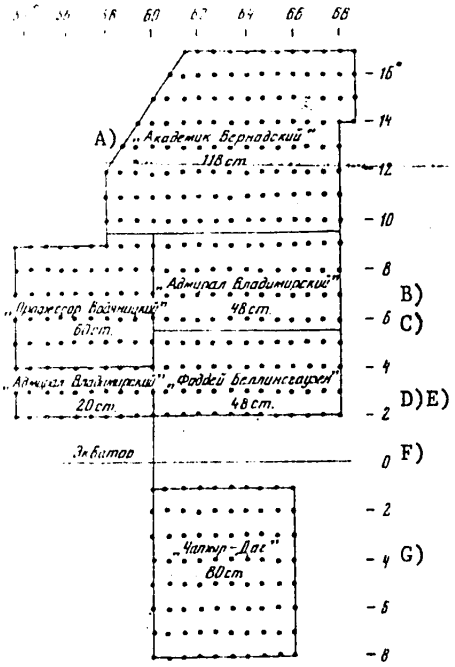

Fig. 1.

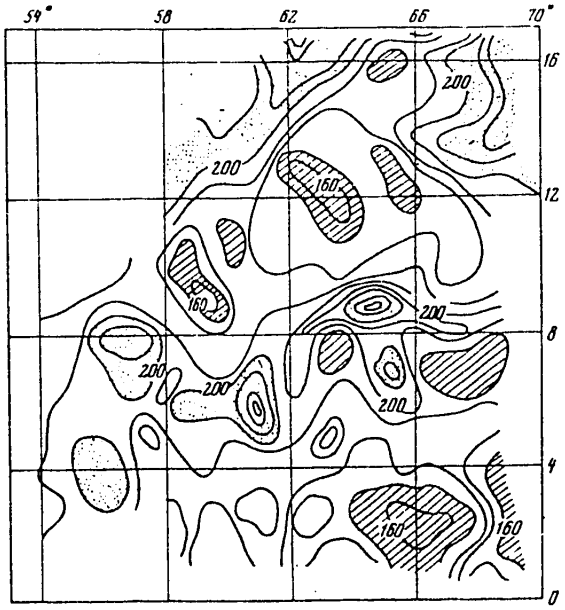

Fig. 2.

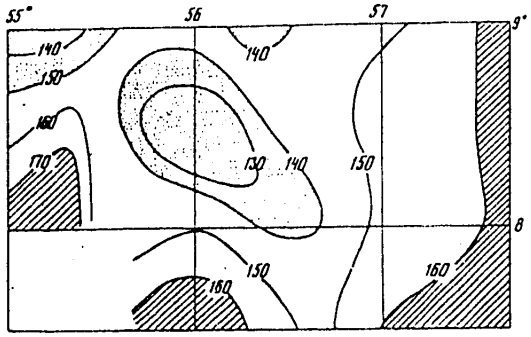

Fig. 3.

KEY:

A) "Akademik Vernadskiy"
118 stations
B) "Admiral Vladimirskiy"
48 stations
C) "Professor Vodyanitskiy"
60 stations
D) "Admiral Vladimirskiy"
20 stations
E) "Faddey Bellinsgauzen"
48 stations
F) Equator
G) "Chatyr-Dag"
80 stations

During the period of development of the summer monsoon there was a cold eddy formation present, having a diameter of about 150 miles with a maximum rise of the 16° isotherm by about 25-30 m. At the ocean surface the eddy could virtually not be traced on the basis of temperature changes, but was registered clearly on the basis of increased salinity values of 36.55°/oo at its center relative to 36.2°/oo in the surrounding waters. Among the biological characteristics it was noted that

there was a considerable spottiness in the distribution of more or less productive zones in the investigated ocean area, which was associated with the characteristics of its dynamic regime and the entry of biogens into the eutrophic layer of the ocean. Primary production in the periods of the winter and summer monsoons was comparable and averaged 2.0-2.5 mgC/m^3 per day at the surface and 40-50 mgC/m^3 per day in the layer 0-100 m. The highest primary production values were observed in the zone where cyclonic eddies were present. With respect to the level of primary production the investigated waters can be classified as oligotrophic and mesotrophic waters. The content of chlorophyll a in the photic layer was characterized by low values, also characteristic of oligotrophic regions of the ocean. The mean concentration of green pigment near the surface did not exceed 0.04 mg/m^3, in the layer 0-100 m -- 10 mg/m^3. The maximum concentration of chlorophyll c was registered during the period of the winter monsoon and was only 8.7 mg/m^3. In summer the content of chlorophyll c in the water was still further reduced.

The principal mass of photosynthetically active phytoplankton in waters undisturbed by eddy movement was concentrated in the layer 0.25 m, whereas the maximum of the vertical distribution of the concentration of chlorophyll a was found in the layer 50-80 m. The depth coincidence of the maximum values of primary production and the content of chlorophyll a was noted only in local circulations, which indicates an increased photosynthetic activity of chlorophyll in the zone of intensified vertical movements and the rising of biogens associated with it. In the lower layers of the eutrophic zone there was a concentration of settling "old" phytoplankton cells in a low physiological state. These cells constituted a considerable part of the detritus forming intensive layers of increased turbidity.

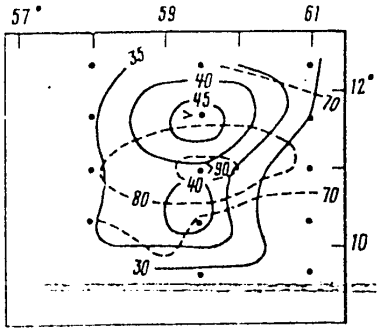

Fig. 4.

In the surface layer the total quantities of bacterioplankton and neuston biomass were commensurable with the quantities characteristic for oligotrophic (with respect to neuston) and mesotrophic (with respect to bacterioplankton) regions of the ocean.

With respect to the level of development of zooplankton the investigated region can be classified as a region of medium productivity. During the period of the winter monsoon the mean biomass of zooplankton was 90 mg/m^3, in the summer 135 mg/m^3; 60-75% of the mentioned quantities are plant-eating zooplankton. A comparison of data on the food requirements of zooplankton with data on primary production reveals that the supply of plant food for zooplankton is only 25-40% of the daily

ration. The unquestionable deficit of plant food is evidence that in the food chain of the biocoenosis an important role is played by detritus, and possibly bacterial flora.

Summarizing the collected information and comparing it with data obtained under the POLIMODE program, it can be established that:
--the eddy field in the northwestern part of the Indian Ocean is subject to extremely rapid variability; the characteristic time scale for the most intensive formations was 50-60 days (100-400 days in the Sargasso Sea);
--the energy level of eddy movements is relatively low, the average density of the available potential energy is $2 \cdot 10^4$ J/m^2, which is an order of magnitude lower than in POLIMODE;
--the rate of movement of eddies is very great, 9 miles/day (2-3 miles/day according to POLIMODE data) and is close to the phase velocity of the first baroclinic mode of the Rossby waves, computed using a linear model;
--the orbital velocities of rotation of the eddies are small (0.6-2.0 m/sec in the Sargasso Sea) and are close to the velocity of their general transport.

Proceeding on the basis of these facts, it can be concluded that during the period of work in the northwestern part of the Indian Ocean there was a weak wave field, against whose background slightly linear eddy formations [2] or nonlinear packets of Rossby waves were propagated. The low eddy activity, together with the strong vertical stratification of water masses, were evidently the principal reasons for the low level of vertical movements, which exerted its influence on the biological productivity indices. However, this influence was manifested only at the lower trophic levels of the ecosystem as a whole.

In conclusion the authors express deep appreciation to the chiefs of the expeditions of the ships participating in the implementation of the Program: L. A. Koveshnikov, O. P. Pelevin, I. G. Chumakov and Yu. T. Shchetinin for furnishing observational data.

BIBLIOGRAPHY

1. SINOPTICHESKIYE VIKHRI V OKEANE (Synoptic Eddies in the Ocean), Kiev, "Naukova Dumka," 1980.

2. Nelepo, B. A. and Korotayev, G. K., MGFI (Marine Hydrophysical Institute), No 3, pp 5-20, 1979.

5303
CSO: 8144/1577

UDC [528.47:534.6]:528.087.4

DIGITAL PROCESSING OF ECHO SIGNALS IN MAPPING OF BOTTOM DEPOSITS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 7, Jul 81 pp 41-45

[Article by A. I. Svechnikov]

[Text] A solution of such a complex problem as the remote classification of bottom deposits and their lithological breakdown is possible by the use of automated systems for the processing and interpretation of the results of measurements made using acoustic apparatus. Such systems must be based on digital computers of a unified series with a high speed of about 50 000-100 000 operations per second and with external devices for the storage and display of the results of processing and interpretation.

In the automated processing of the results of acoustic measurements the need arises for the registry and storage of data on a magnetic carrier, which ensures the simplest relationship between the source of information and units for digital processing and interpretation. The use of analog magnetic recording in registry of the results of acoustic measurements on the shelf makes it possible to obtain a quite simple solution of the problem of accumulation and long-term storage of large volumes of information collected when making studies for the mapping of bottom sediments. The digital processing of magnetic analog records makes it possible to widen the set of procedures for the processing itself, make maximum use of the information included in the echo signal and further develop the method for digital registry of the echo signal.

The input of acoustic data registered on magnetic tape in analog form into a digital computer is accomplished using special or standard computer devices. It is desirable that the information be prepared first, that is, that the analog magnetic records be transformed into a form convenient for input into a digital computer.

A converter of analog magnetic records has been developed in the Geophysics Department of the Leningrad Mining Institute imeni G. V. Plekhanov on the basis of the small "Nairi-K" digital computer (Fig. 1). It includes an analog magnetic recorder, analog-code converter and a control device. An additional control unit is provided for the input and distribution of acoustic data in the memory device of the digital computer.

The analog information received from the magnetic tape, after conversion into a digital code, is fed into the second unit of the digital computer operational memory; in places 1 to 10 there is registry of the value of the echo signal digital

sample, and in places from 19 to 36 -- a constant determining the time of the digital sample. The first digital computer memory unit holds the programs for computing the characteristic criteria in the echo signal and the mass of data for output of information in a volume of 1000 36-digit words.

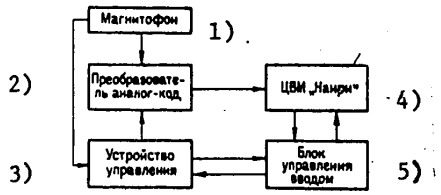

Fig. 1.

KEY:
1. Magnetic recorder
2. Analog-code converter
3. Control device
4. "Nairi" digital computer
5. Input control unit

A modified program command END was used in organizing the regime for input and automated processing of analog information. Since in programming work the first address of a command is rarely used, the command END with a fixed value of the first address (A_1 = 32) serves as a signal for reception and distribution of acoustic information arriving from the analog-digital converter.

Upon the command INPUT FROM MAGNETIC RECORDER the digital computer goes into an interrupted regime (the computer does not execute the command), the computer elements are prepared for the input of data and the input control device is activated. Upon receipt of the signal from the control device the magnetic recorder and analog-digital converter are activated and the information is distributed in the computer operational memory.

After filling of the second unit of the operational memory with information, the magnetic recorder is switched off and the digital computer continues a discontinuous series of commands. In the course of processing of the received data an indicative mass of data is formed for output.

Upon completion of processing of the mass of data fed into the computer another input command is fed. The cycle of input and preliminary processing is repeated. With refilling of the allocated storage space the computer goes into a regime of output of the transformed data: the conversion cycle is completed.

Figure 2 is a functional diagram of the transformation unit with the main connections between the digital computer units in the regime of reception and distribution of the information received from the magnetic tape.

In the regime of input and transformation of analog acoustic information the operation of the digital computer is controlled by signals arriving from the unit for control of the magnetic recorder and fed into the circuit for distribution of control pulses.

The unit for control of the magnetic recorder includes: depth and registry timers, scaling amplifier and circuit for the shaping of control signals. Upon receipt of the signal BEGIN TIME SCANNING, which corresponds in time to the moment of sending of the acoustic signal, the depth timer produces a time series of pulses with a conversion frequency of 50 KHz. The signals from the depth timer are fed from the digital computer summator to the counting input of trigger 20. Thus, by means of the depth timer the summator accomplishes a time scanning of the process of registry of a series of echo signals with an interval of 20μsec. The depth timer is activated using a synchronization pulse arriving from the first track of the magnetic recorder.

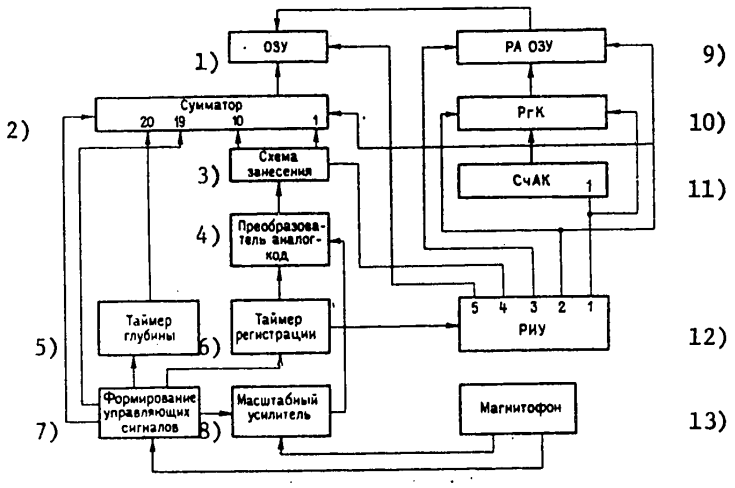

Fig. 2.

KEY:

1. Operational memory
2. Summator
3. Registry circuit
4. Analog-code converter
5. Depth timer
6. Registry timer
7. Shaping of control signals
8. Scaling amplifier
9. Operational memory address register
10. Command register
11. Command address counter
12. Distributor
13. Magnetic recorder

The circuit for shaping the control signals, upon receipt of the signal BEGIN TIME SCANNING, prepares the summator for reception of the next series of echo signals. Trigger 19 of the summator determines the onset of receipt of digital information relating to the next series of echo signals.

Upon the signal BOTTOM, arriving from the first track of the magnetic recorder and determining the time of arrival of the echo signal from the bottom, the registry timer is activated and this monitors the digital transformation time. The registry

timer produces a series of signals which determine the moment of digital sampling in the echo signal and the total number of samples in the transformed series. The repetition rate of these signals is equal to the time quantization level during which there is digital transformation of the analog signal. The signal is fed from the registry timer to the analog-code converter triggering device and to the circuit for the distribution of control pulses.

The echo signals from the second track of the magnetic recorder are fed to a scaling amplifier and from there are sent to the analog-code converter input. In conformity to the internal operating regime of the F-4222 converter (t_{cycle} = 10 μsec), 10μsec from the moment of its triggering a digital sample of echo signals is printed out. Accordingly, by this moment the digital computer control circuits must be ready for its reception and distribution in the operational memory.

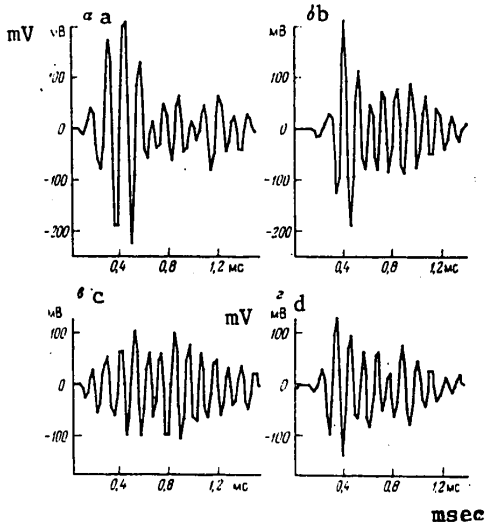

Fig. 3.

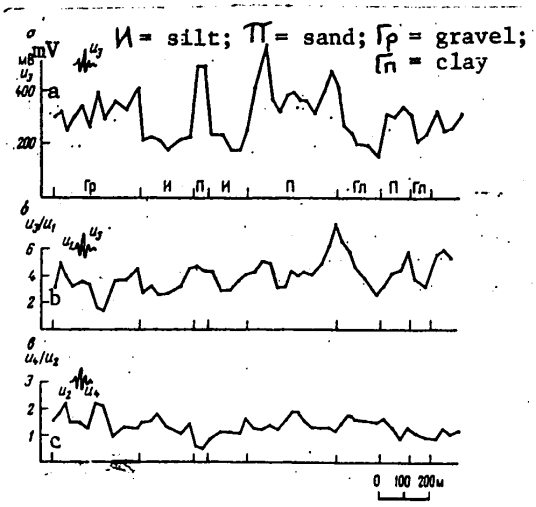

Fig. 4.

The circuit for the distribution of control pulses is a pulse distributor which on the basis of signals from the registry timer produces a series of five pulses; the time shift between two successive outputs is 4μsec. It ensures synchronization and control of individual computer elements in the regime of input of analog information from the magnetic recorder: it prepares the summator for reception of the next echo signal sample, forms the momentary address for the computer memory unit, feeds the digital echo signal sample from the analog-code converter circuit to the summator and shapes a signal for the registry of the summator contents in the operational memory.

We will examine performance of the operation of registry of +1 in the memory unit address register.

The first distributor pulse serves as a signal for the discharge of the command register into the zero storage unit, the transmission of +1 into the command address counter; the second distributor pulse is for preparing the storage unit address register for the next reception and transmission of the contents of the command counter into the command register; the third distributor pulse is for transmission of the contents of the command register to the memory unit address register. The current address of the operational memory used in registry of the next echo signal sample is formed in this way. With the fourth pulse the digital echo signal sample is transmitted to the summator and with the fifth pulse there is registry in the computer memory.

Thus, each signal sample, together with the time, is entered into the computer memory. The indicator of ending of data input is the overfilling of the memory unit address register. In this case the second distributor pulse blocks operation of the circuit: the magnetic recorder is stopped, the 13th element of the command address counter is discharged, code 10 is entered in its place, the depth and registry timers are put into the initial position, and a delayed pulse is sent for the triggering of the central control unit.

The digital computer proceeds to perform the subprogram for processing the introduced mass of data.

The developed unit ensures the conversion, entry into the operational memory of the digital computer and preliminary processing of a series of echo signals in a volume of 2048 digital samples; using the registry timer it is possible to select the necessary fragments from the series arriving during one sounding cycle. The maximum time for registry of the echo signals arriving from the layer of bottom deposits is determined by the duty cycle of the sounding pulse and for a frequency of 10 KHz is 40 msec and for a frequency of 4 KHz is 100 msec.

Figure 3 shows digital representations of the echo signals obtained using the considered unit for four varieties of bottom sediments (gravelly-pebbly, sandy, clayey and silty). The carrier frequency of the duty cycle for the sounding pulse is 9.6 KHz, the quantization interval is 20 μ sec, the registry time is 1.4 msec. Visual observations of the echo signals, registered on magnetic tape, create definite prerequisites for studying the process of interaction of acoustic radiation with bottom sediments and make it possible to clarify the quantitative relationships determining the process of interaction between the sounding pulse and a specific lithological type of bottom material.

An analysis of the digital samples of echo signals, represented in Fig. 3, gives evidence of appreciable differences in the echo signals obtained during the sounding of different types of bottom material with respect to both amplitude level and with respect to shape. It is evident that the represented echo signals can be described using a set of criterial characteristics such as the amplitude value of the envelope, shape factor, spectral characteristics and phase of echo signal first arrival.

Figure 4 shows curves of change in the amplitude value of the echo signal and the change in the envelope shape factors constructed on the basis of the results of preliminary digital processing of the echo signals registered in the process

of carrying out of acoustic investigations along a profile passing through the regions of occurrence of bottom sediments of different lithological composition. Each point on the graph represents the result of averaging of the criterial characteristics for 10 echo signals, which corresponds to a segment of the profile with an extent of about 20 m. Bottom sampling of material was carried out each 100 m and therefore the graphs of criterial characteristics have a great detail, determined by variability of the properties and characteristics of bottom materials within the limits of the profile.

On the basis of a comparison of the graphs of change of the echo signal criterial characteristics shown in Fig. 4 and the results of bottom sampling it was possible to establish definite patterns of change in the characteristics of the echo signal related to change in the type of bottom material.

It must be noted in conclusion that the described unit for the transformation of analog magnetic records and the method for preliminary processing of the echo signal, providing for computation of its criterial characteristics, ensures a considerable compression of acoustic information (on the average by a factor of 30-40 in the case of a 3-4 layer section and a number of criterial characteristics 20) received for final processing.

5303
CSO: 1865/12

UDC 551.456.082

OCEANOGRAPHIC STUDIES OF CARIBBEAN SEA

Sevastopol' OKEANOGRAFICHESKIYE ISSLEDOVANIYA KARIBSKOGO MORYA I PRILEGAYUSHCHIKH RAYONOV in Russian 1980 (signed to press 31 Oct 80) pp 4-6, 119-120

[Annotation, foreword and table of contents from collection of articles "Oceanographic Investigations of Caribbean Sea and Adjacent Regions", responsible editor N. P. Bulgakov, doctor of geographical sciences, Izdatel'stvo Morskogo gidrofizicheskogo instituta, number of copies unknown, 120 pages]

[Text] Annotation. This collection of articles gives the preliminary results of scientific investigations carried out on the 38th voyage of the scientific research ship "Mikhail Lomonosov" within the framework of the MOKARIB international project in a polygon to the south of Jamaica and to the west of Grenada. Materials were obtained on the thermohaline, kinematic, hydrooptical, hydrochemical and hydrobiological characteristics of waters in the least studied part of the Caribbean Sea. Instrumental measurements were made of the temperature and velocity of currents for the purpose of experimental determination of the parameters of internal waves. The results are compared with the values computed from dispersion relationships on the basis of hydrological data. Existing concepts on bottom relief and the size of the strait between Rosalind and Pedro Banks, the direction of deep circulation, water exchange between the Colombian and Yucatan Basins, the nature of the vertical distribution of horizontal current velocity, the index of attenuation of radiation, the distribution of chlorophyll "a" and organic matter are made more precise. The collection of articles is intended for a wide range of professional oceanographers.

Foreword. Expeditionary investigations on the 38th voyage of the scientific research ship "Mikhail Lomonosov" were carried out under two international programs. The first part of the work was carried out in the central and eastern (least studied) parts of the Caribbean Sea within the framework of the program for the international project MOKARIB on the basis of provision 0.74.01.06.06 in the Coordination Plan of the USSR State Committee on Science and Technology, decrees of the Presidium Ukrainian Academy of Sciences and the plan of the Marine Hydrophysical Institute, Academy of Sciences Ukrainian SSR for 1979.

The second part of the expedition was carried out on the shelf on the continental slope of the Guinea People's Revolutionary Republic in accordance with the Intergovernmental Soviet-Guinea Agreement of 3 August 1973 on the establishment of a scientific research center at Conakry.

The voyage lasted from 17 October 1979 through 28 February 1980.

The work program provided for carrying out research in accordance with the plans of institutes of the Ukrainian Academy of Sciences: Marine Hydrophysical Institute, Institute of Biology of Southern Seas, Institute of Strength Problems, Material Science Problems Institute, and also institutes of the USSR Academy of Sciences: Moscow Physical Engineering Institute, Institute of Organic Chemistry. The collection gives the results of preliminary scientific analysis of the first part of the expedition carried out under the MOKARIB program, to the south of Jamaica and to the west of Grenada.

The articles examine problems related to the structure of waters, kinematics, bottom relief structure, characteristics of parameters of internal waves and hydrobiological indices. The data obtained on the voyage made it possible to refine and supplement existing information on the investigated part of the Caribbean Sea. In particular, it was possible to demonstrate the existence of an anticyclonic meander of waters in the Colombian Basin on the basis of actual hydrobiological data for the autumn-winter season, determine the direction of movement of deep North Atlantic waters, and clarify the existence of inversion formations in subantarctic intermediate waters. Continuous measurements of subsurface depths along the ship's track made it possible to detect 30 distinctive depths. The size of the strait between the Pedro and Rosalind Banks, through whose channel the main exchange of waters between the Yucatan and Colombian Basins occurs, has been more precisely determined. The results of measurements of currents in the neighborhood of Grenada indicated that the vertical kinematic structure near the island has a more complex character than was visualized earlier. In accordance with these instrumental measurements the need arises for a further improvement in the theory of circulation in the neighborhood of the island. Oxygen data made it possible to confirm the hypothesis expressed earlier concerning the existence in this part of the sea of water interlayers whose thermohaline indices coincide with the characteristics of 18° water in the Sargasso Sea. Hydrobiological data are of important independent interest from the point of view of investigation of the formation of water productivity. At the same time, they also confirmed and supplemented the conclusions drawn concerning the structure and dynamics of waters. Insofar as we know, the results of the investigation of internal waves presented in the collection of articles constitute the first information based both on data from instrumental measurements of temperature and current velocity fluctuations and the results of computations based on hydrological parameters.

The scientific conclusions are based on observational data obtained on the voyage using instrumentation and apparatus developed at the Marine Hydrophysical Institute: the ISTOK-3 and ISTOK-5 sounding complexes, DISK-2 long-term current velocity meter, RITM instrument intended for the indirect determination of parameters of internal waves from autonomous stations.

N. P. Bulgakov, doctor of geographical sciences, expeditionary head of the 38th voyage of the scientific research ship "Mikhail Lomonosov," participated in the preparation of most of the articles published in this collection. This applies to formulation and solution of problems relating to the thermohaline, hydrochemical and kinematic structures of waters, distribution of the speed of sound and internal waves.

Contents

5303
CSO: 1865/245

UDC 551.463.21

THEORY OF DEPENDENCE OF LOW-FREQUENCY OCEANIC NOISE ON DEPTH

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 259, No 6, 1981 (manuscript received 8 Dec 80) pp 1483-1487

[Article by B. F. Kur'yanov and B. I. Klyachin, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Text] Acoustic noise in the ocean is dependent on a whole series of oceanological conditions determining the processes of generation, propagation, absorption, reflection and scattering of sound by the ocean surface and bottom. Allowance for each of these factors is in itself an extremely complex problem and in its totality the problem seems soluble only by the use of purely computer modeling. Nevertheless, there is an extremely broad range of conditions in the real ocean in which simple solutions can be obtained having a clear physical sense and which can be used in explaining the recently collected experimental data on oceanic noise and in particular, its dependence on depth [1-4].

For solution of the problem we will make the following simplifying assumptions which are satisfied for the deep ocean.

1. The principal noise sources are situated near the free surface of the ocean; they are distributed uniformly over the ocean surface, are incoherent and their radiation has a dipole character.

2. The medium is layered-inhomogeneous and the bottom depth is constant.

3. The speed of sound near the bottom exceeds the speed of sound at the surface; the thickness of the abyssal channel occupies a considerable part of the ocean layer.

4. The computations can be made on the basis of ray representations and the incoherent summation of the contributions of individual rays.

5. For relatively low frequencies (less than 1 KHz) and typical conditions in the open ocean (length of half-cycle about 30 km) it is possible to neglect attenuation in the length of the cycle.

6. Energy losses in the case of reflection from the bottom are considerably greater than the losses in absorption during passage of the ray through the cycle.

In order to make these computations we will use the so-called ray intensity of the diffuse field, which is used extensively in optics and in radiation transfer theory [5]. The diffuse field in the neighborhood of some point r is represented by the totality of plane uncorrelated waves and is described by the function of angular density of intensity I(r,s) (ray intensity), which by definition is the flux of intensity dW in a unit solid angle $d\Omega$ through a unit area in the direction s. The use of postulates 1-3 leads to a dependence of ray intensity only on depth z and the angle with the vertical θ, $I(z, \theta)$. The $I(z, \theta)$ value gives an exhaustive description of all the energy characteristics of noise. In particular, the energy volume density E(z), proportional to noise intensity received by a nondirectional sound detector, is expressed as follows

$$E(z) = \frac{1}{c} \int I(z, \theta) d\Omega \tag{1}$$

(c is the speed of sound), and the spatial correlation function of the field for two points spaced at the distance ρ is the Fourier transform of $I(z, \theta)$

$$B(z, \rho) = \int I(z, \theta) e^{ik\rho} d\Omega;$$

k is the wave vector.

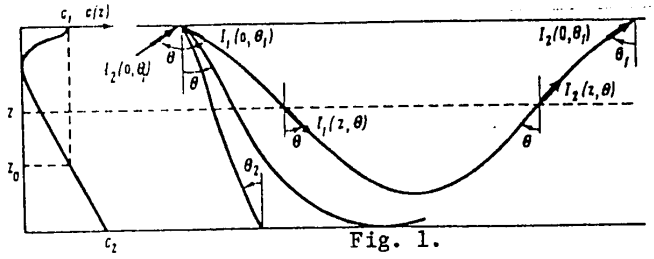

Fig. 1.

In a general case the function $I(z, \theta)$ is described by the radiation transfer equation, which leads to a constancy of ray intensity for a homogeneous medium without scattering and losses. If refraction occurs in the medium it can be demonstrated that the value $c^2(z)I(z,\Theta)$ is conserved along the ray; this is a corollary of the law of flux conservation. For a medium with refraction and absorption the transfer equation will be

$$I(z, \theta) = \left(\frac{c(z')}{c(z)}\right)^2 I(z', \theta') e^{-\alpha S}, \tag{2}$$

where S is the length of the ray between two points at the horizons z and z', α is the absorption coefficient.

We will find the intensity $I(z, \theta)$ of the noise field for a typical oceanic waveguide represented in Fig. 1. We will denote the rays emanating downward and upward by the subscripts 1 and 2 respectively. Then the total intensity of the field emanating from the surface $I_1(0, \theta_1)$ will be the sum of the intensity of the sources $J(\theta_1)$ and the intensity of the mirror-reflected wave $I_2(0, \theta_1)$, reduced to the surface: $I_1(0, \theta_1) = J(\theta_1)+I_2(0, \theta_1)$. But in accordance with (2) $I_2(0, \theta_1) = I_1(0, \theta_1)\exp(-2\alpha S)$, where S is the length of the half-cycle of the ray and hence it follows that $I_1(0, \theta_1) = J(\theta_1)/(1-\exp(-2\alpha S)$. Now it is easy to determine intensities for noise at any depth:

$$I_1(z, \theta) = \left(\frac{c_1}{c(z)}\right)^2 \frac{J(\theta_1)\exp(-\alpha S_1)}{1-\exp(-2\alpha S)}, \quad I_2(z, \theta) =$$
$$= \left(\frac{c_1}{c(z)}\right)^2 \frac{J(\theta_1)\exp(-\alpha(2S - S_1))}{1-\exp(-2\alpha S)}. \tag{3}$$

S_1 is the ray length from the surface to the z horizon. In exactly the same way formulas are derived for rays experiencing bottom reflections:

$$I_1(z, \theta) = \left(\frac{c_1}{c(z)}\right)^2 \frac{J(\theta_1)\exp(-\alpha S_1)}{1-V(\theta_2)\exp(-2\alpha S)}, \tag{4}$$
$$I_2(z, \theta) = \left(\frac{c_1}{c(z)}\right)^2 \frac{J(\theta_1)V(\theta_2)\exp(-\alpha(2S - S_1))}{1-V(\theta_2)\exp(-2\alpha S)};$$

$V(\theta_2)$ is the energy coefficient of reflection from the bottom.

We note that here we have presented a simple derivation of the results in [6, 7]. in which the authors calculated the anisotropy of noise by the summation of an infinite series of sources of surface noise experiencing a different number of reflections from the surface and bottom. In more complex cases, for example, in determining scattering, such an approach leads to insuperable difficulties, at the same time that use of the transfer method for computing the ray intensity makes it possible to solve the problem.

Now we will proceed to a determination of the dependence of noise E(z) on depth, integrating expressions (3), (4) in accordance with (1). Using postulate 5 concerning the smallness of attenuation in the length of the cycle, we will neglect the difference $\exp(-2\alpha S)$ from unity, whereas the denominator of expression (3) will be represented approximately as $2\alpha S$. Then

$$E(z) = \frac{2\pi}{c(z)}\left(\frac{c_1}{c(z)}\right)^2 \left[\int \frac{1+V(\theta_2)}{1-V(\theta_2)} J(\theta_1)\sin\theta\, d\theta + \int \frac{J(\theta_1)\sin\theta d\theta}{\alpha S(\theta)}\right]. \tag{5}$$

The denominator of the first term is the energy coefficient of sound propagation to the bottom and this value is of the order of 1, at the same time that αS can be very small for low frequencies due to the smallness of absorption. Accordingly, for the low frequencies the water rays (rays not experiencing bottom reflections) must give the main contribution to the noise field. Using postulate 3, it is possible to obtain a further simplification, assuming that the beam of water rays is quite narrow and the lengths of the half-cycles $S(\theta)$ have little dependence on the θ angle; this makes it possible to remove the mean value $\bar{S}$ from beneath the integration sign. Next, we proceed in formula (5) from the angular variables θ at the depth z to the θ_1 angles at the surface and we will also use postulate 1 on the dipole character of the sources: $J(\theta_1) = J_0 \cos\theta_1$. Then

$$E(z) = \frac{2\pi}{c(z)} \frac{J_0}{\alpha S} \int_{\theta'}^{\pi/2} \frac{\cos^2\theta_1 \cdot \sin\theta_1\, d\theta_1}{\sqrt{1-(c(z)/c_1)^2\sin^2\theta_1}}. \tag{6}$$

Here θ' is the angle of deflection from the surface for the ray touching the bottom ($\sin\theta' = c_1/c_2$, c_2 is the speed of sound at the bottom). Formula (6) is suitable for depths z less than the critical depth z_0; for depths $z > z_0$ the upper limit is equal to θ'', where $\sin\theta'' = c_1/c(z)$. The integration of expression (6) is reduced to elementary functions:

$$E(z) = \frac{\pi J_0}{\alpha S}\,\frac{c_1}{c_2(z)}\left[1-\left(\frac{c_1}{c_2}\right)^2\right]F_{1,2}(x),$$

$$F_1(x) = \sqrt{1+x^2} - x^2 \ln\frac{1+\sqrt{1+x^2}}{x}, \qquad (7)$$

$$x = \sqrt{\left[\left(\frac{c_1}{c(z)}\right)^2 - 1\right]\Big/\left[1-\left(\frac{c_1}{c_2}\right)^2\right]} \quad z \leqslant z_0,$$

$$F_2(x) = \sqrt{1-x^2} + x^2 \ln\frac{1+\sqrt{1-x^2}}{x},$$

$$x = \sqrt{\left[1-\left(\frac{c_1}{c(z)}\right)^2\right]\Big/\left[1-\left(\frac{c_1}{c_2}\right)^2\right]} \quad z \geqslant z_0.$$

Curves of the universal functions $F_1(x)$ and $F_2(x)$ at a logarithmic scale (in db) are shown in Fig. 2. Using these curves, it is easy to obtain the dependence of noise intensity on depth for an arbitrary speed-of-sound profile c(z). As can be seen from (7), the dependence on depth enters into E(z) only through c(z); hence follows the "law of conjugate depths" [4]: at depths with equal speeds of sound the noise intensities are equal. Figure 3 gives the dependence of noise levels on depth computed using formula (7) according to hydrological data from an experiment carried out by Morris [2] and normalized to the level value at the surface. It should be noted that the results of the numerical experiment, according to formula (5), taking into account the dependence of the length of the half-cycle $S(\theta)$, differ from the computations using formula (7) by not more than 0.2 db. As indicated by Fig. 3, the minimum noise corresponds to the depth of the sound channel axis and the maximum noise corresponds to a depth of the sound channel axis somewhat below the critical depth. Such a behavior is easily explainable by simple physical considerations: due to the smallness of absorption in the length of the cycle the intensity flux W is constant and there is an inflow of the constant energy $W\Delta t$ during a unit time Δt through the horizontal surface for any depth z; this energy penetrates to the depth $\Delta z = c\Delta t \cos\bar{\theta}$ ($\bar{\theta}$ is the mean direction of the beam of water rays). On the axis of the channel $\cos\bar{\theta}$ is maximum and therefore the energy is distributed through a greater volume, that is, the volume density E(z) is minimum.

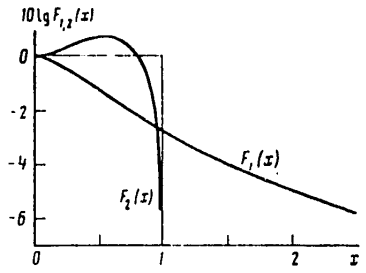

Fig. 2.

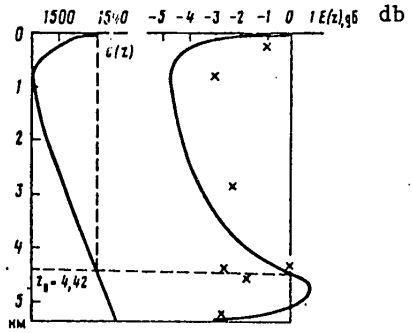

Fig. 3.

When the depth becomes greater than the critical depth, $\cos\bar{\theta}$ decreases and the energy density increases, but with a further increase in depth there is a greater influence from the opposite factor: a decrease in the total intensity flux through the horizon due to bending of the rays arriving from the surface. It also follows from the considerations expressed here, in accordance with formula (7), that the closer the critical depth is to the bottom depth, the narrower will be the beam of water waves and the greater will be the difference in the noise levels at the surface and on the axis of the channel. It should be noted that source [4] gives curves similar to those in Fig. 3 and evidently obtained by the modeling of propagation of the sound of distant sources.

At the present time there is definite experimental data supporting the described model. The small crosses in Fig. 3 represent the results of measurements made by Morris [2] at a frequency of 500 Hz. Although the number of points is obviously inadequate, the general behavior of the dependence is qualitatively described by the theory. There is less attenuation of noise on the channel axis than is predicted by theory, but this can be attributed to the contribution of bottom rays, which, as indicated by numerical integration using formula (5), can make a contribution to the noise at frequencies above 200 Hz, but have no dependence on depth. Measurements of the direction of noise at different depths [2, 3, 8] show that in the upper layer of the ocean noise arrives at angles 13° to the horizon, whereas near the bottom these angles decrease to 4°, which corresponds completely to geometric computations of the angles of arrival of water rays. The systematic excess of the noise levels on the axis of the channel, observed with simultaneous measurements of noise at two remote points with different hydrology [1] and attributed by the authors to different attenuation of noise along the navigated track, can be explained simply within the framework of a model of homogeneous surface noise, attributing it to purely geometric distributions of the speed of sound at these points.

However, the model considered here is inadequate for explaining some observed characteristics of noise. The experiments described in [1-3] show that at frequencies below 200 Hz the decrease in the noise level also continues at depths below the axis of the channel; in addition, on the axis of the channel there is noise in horizontal directions [3], which contradicts the described model and can be attributed to sound scattering. Scattering can also be taken into account by transfer theory methods.

BIBLIOGRAPHY

1. Kibblewhite, A. S., Shooter, J. A. and Watkins, S. L., J. ACOUST. SOC. AM., Vol 60, 1040, 1976.

2. Morris, G. B., IBID., Vol 64(2), 581, 1978.

3. Anderrson, V. C., IBID., Vol 66, 1446, 1979.

4. Weston, IBID., Vol 67(2), 530, 1980.

5. Chandrasekar, S., PERENOS LUCHISTOY ENERGII (Transfer of Radiant Energy), Moscow, IL, 1953.

6. Talham, R. J., J. ACOUST. SOC. AM., Vol 36(8), 1541, 1964.

7. Furduyev, A. F., "Ocean Noise," AKUSTIKA OKEANA (Ocean Acoustics), Moscow, "Nauka," 1974.

8. Morris, G. B., J. ACOUST. SOC. AM., Vol 64(1), 166, 1978.

5303
CSO: 1865/5

UDC 551.446

EXPERIMENTAL INVESTIGATION OF NONLINEAR INTERACTIONS IN THE WIND WAVE SPECTRUM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 258, No 5, 1981 (manuscript received 27 Jan 81) pp 1212-1215

[Article by A. B. Leybo and I. A. Leykin, Institute of Oceanology, USSR Academy of Sciences]

[Text] At the present time extensive use is made of a representation of wind waves as being a stationary Gaussian random process: a surface rise is regarded as the sum of uncorrelated harmonic components with random amplitudes and phases [1]. However, experimental data obtained during recent years [2, 3] give basis for assuming that nonlinear processes play an appreciable role in forming the wave spectrum. In sources [4, 5] the authors proposed nonspectral models in which waves are regarded as a narrow-band nonlinear random process in which all the spectral components are statistically related to the main component.

In this article we describe a quite general method for investigating the interrelationship of the spectral components of waves based on a model of a nonstationary harmonizable random process. As an example we analyzed records of wind waves obtained in a laboratory aerohydrodynamic apparatus.

It is assumed that wind waves can be described as a harmonizable random process

$$X(t) = \int_{-\infty}^{\infty} e^{i\omega t} Z(d\omega), \tag{1}$$

where t is time, ω is the cyclic frequency, Z is a random complex function of frequency. Assuming that the mathematical expectation MX(t) = 0 and examining, with (1) taken into account, moments of higher orders, we introduce a multispectrum of the n-th order

$$S(\omega, \omega_1, \ldots, \omega_{n-1}) d\omega\, d\omega_1 \ldots d\omega_{n-1} \approx M[Z(d\omega_1) \ldots Z(d\omega_2) Z^*(d\omega), \tag{2}$$

where the asterisk denotes complex conjugation.

If nonlinear interactions occur in the process, this is manifested in some sort of dependence between its harmonic components. By insignificantly restricting the universality of the reasonings, we will represent this dependence in the form of a series

$$Z_l = H_l^j Z_j + H_l^{jm} Z_j Z_m + \ldots + \zeta_l. \tag{3}$$

Here $Z_i = Z(d\omega_i)$, H_i^j and H_i^{jm} are constant complex coefficients, ζ_i is random noise and summation is carried out for j, l and m. In order to clarify what terms dominate in expansion (3), we will examine the normalized multispectra or multicoherences, for example

$$Co^2(\omega_l, \omega_j) = \frac{|S(\omega_l, \omega_j)|^2}{S(\omega_l, \omega_l)S(\omega_j, \omega_j)}, \tag{4}$$

$$Co^2(\omega_l, \omega_l, \omega_m) = \frac{|S(\omega_l, \omega_l, \omega_m)|^2}{S(\omega_l, \omega_l)\tilde{S}(\omega_l\ \omega_m)}, \tag{5}$$

where $S(\omega_l, \omega_m) = M|Z_l Z_m|^2$.

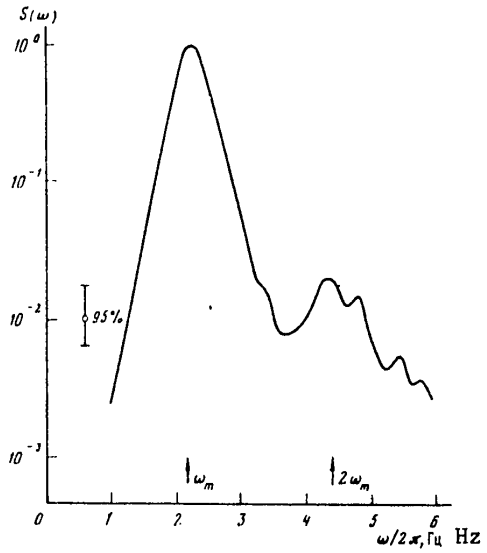

Fig. 1. Frequency spectrum of wind waves.

Similarly it is possible to introduce multicoherency of any order. The multicoherency values indicate the relative role of the corresponding terms in (3). For example, if $Co^2(\omega_i, \omega_l, \omega_m) = 1$, then $Z_i = H^{lm} Z_l Z_m$. With high multicoherency values it is possible to evaluate the coefficients in the expansion (3). In addition, arg $S(\omega_i, \omega_j) = \varphi_j - \varphi_i$, arg $S(\omega_i, \omega_l, \omega_m) = \varphi_m + \varphi_l - \varphi_i$, etc. ($\varphi_i$ = arg Z_i). The physical sense of the multispectrum argument is dependent on the coherent form of the investigated process.

The second-order multicoherence (4) with equal values of the arguments is equal to unity and is symmetric relative to the permutation of its arguments. The third-order multicoherence (5) does not have the property of symmetry and its values on

the diagonal characterize the asymmetry of the probable distribution of the random process.

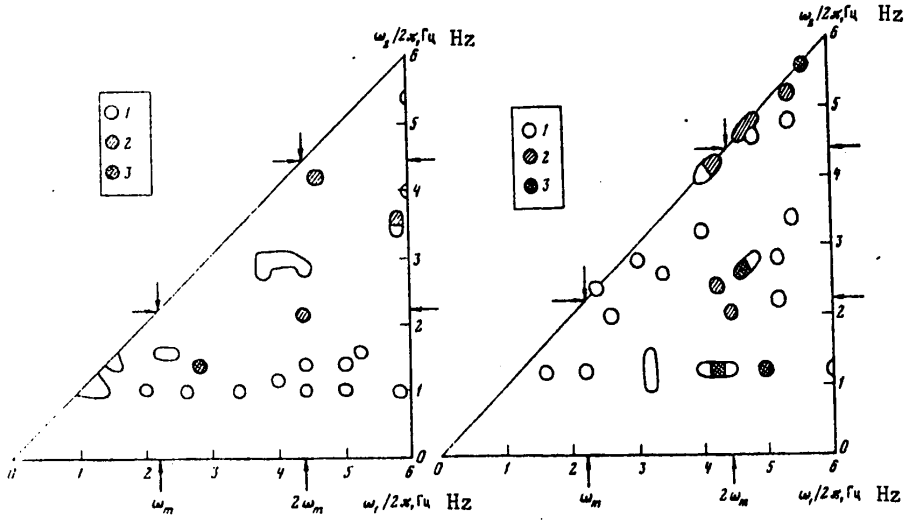

Fig. 2. (at left) Second-order multicoherence function. 1) $0.2 \leqslant Co^2 \leqslant 0.3$; 2) $0.3 \leqslant Co^2 \leqslant 0.4$; 3) $Co^2 > 0.4$.

Fig. 3. (at right). Third-order multicoherence function. 1) $0.3 \leqslant Co^2 \leqslant 0.5$; 2) $0.5 \leqslant Co^2 \leqslant 0.7$; 3) $Co^2 > 0.7$.

In this article we will limit ourselves to an investigation of the correlation between all possible pairs of spectral components, that is, we will examine a multicoherence in the form

$$Co^2(\omega_l, \omega_j) = \frac{|M(Z_l^K) \cdot Z_j^N|^2}{M|Z_l|^{2K} M|Z_j|^{2N}}, \qquad (6)$$

where K and N are natural numbers, (K + N) is the multicoherence order.

Some of the characteristics cited above were examined earlier. For example, in [6] a study was made of the second-order multispectrum (bilinear spectral density). In [7] use was made of second- and third-order multicoherence functions for analysis of a seismogram. However, the bispectrum [8, 9] has come into the widest use; it is obtained from a third-order multispectrum with a stationarity of the process. The bispectrum makes it possible to study only three-wave interactions of the components whose frequencies are related by the condition $\omega = \omega_1 + \omega_2$. Accordingly, probably, attempts to apply the bispectrum to an investigation of wind waves did not give appreciable results [10, 11], although the bispectrum is used successfully in the study of turbulence [12]. We note the following: if the small effect of use of the bispectrum is related to an absence of intensive nonlinear interactions in the process [13], the proposed method will evidently also be ineffective.

If the investigated process is stationary in all sufficiently narrow frequency bands (that is, the components adjacent in frequency are not correlated with one another and energy is transmitted discretely through the spectrum), an evaluation of the multispectral characteristics can be made by analogy with the evaluation of

the characteristics of stationary processes. In this case it is possible to use ordinary statistical evaluation methods: construction of confidence intervals, determination of the significance level, etc.

As an illustration of the possibility of the proposed method we processed several records of wind waves obtained using an aerohydrodynamic apparatus with a wind velocity V = 5.5-8 m/sec (wave fetch 13 m, water depth 0.7 m). A record with a duration of 1 minute (3000 readings with a discreteness interval of 0.02 sec) was broken down into successive segments each with 250 readings, from which we computed periodograms. An evaluation of the frequency energy spectrum $S(\omega)$, as well as the multispectra and multicoherence values, was accomplished by averaging by segments. The number of degrees of freedom was $\nu \simeq 24$ (with a frequency resolution 0.4 Hz), which gives a 95% significance level 0.16 and 0.25 for second- and third-order multicoherence values respectively.

Figures 1-3 show the $S(\omega)$ frequency spectrum (in arbitrary units) and the second- and third-order multicoherence functions for one of the records. In the $S(\omega)$ spectrum, in addition to the main peak at the frequency of the spectral maximum ω_m, there is a peak in the region of the doubled frequency $2\omega_m$. Such a form of the spectrum is typical for laboratory measurements when the ratio of the phase velocity of the waves to wind velocity is small.

The second-order multicoherence function (Fig. 2) is symmetric relative to the diagonal $\omega_1 = \omega_2$, where $Co^2 = 1$. With increasing distance from the diagonal the Co^2 values decrease rapidly. In the region ($\omega_1 = 2\omega_m$, $\omega_2 = \omega_m$) there is a statistically significant maximum with $Co^2 \simeq 0.35$. Significant Co^2 values are also noted on the ridge along the line $\omega_2 \simeq \omega_m/2$.

The third-order multicoherence function (Fig. 3) is asymmetric relative to the diagonal $\omega_1 = \omega_2$. The represented Co^2 values were computed in accordance with (6) with K = 1, N = 2 and correspond to a quadratic interrelationship of the spectral components in the form $Z_1 \sim Z_2^2$. On the diagonal the Co^2 values are different from zero for the regions near ω_m and $2\omega_m$. In the region ($\omega_1 = 2\omega_m$, $\omega_2 = \omega_m$) is a peak with $Co^2 \simeq 0.75$. Large (up to 0.8) Co^2 values are also observed up to the line $\omega_2 \simeq \omega_m/2$.

An examination of the computed second- and third-order multicoherence functions shows that the energy is transmitted discretely through the wave spectrum: only the spectral components of the fundamental and doubled frequencies were statistically significantly related. This correlation is satisfactorily described by the dependence $Z(2\omega_m) \sim Z^2(\omega_m)$, which agrees with the representation of nonlinear surface waves (for example, see [14]). However, the second-order multicoherence is not concentrated on the diagonal $\omega_1 = \omega_2$, and accordingly, the investigated records are not stationary. The $S(\omega)$ frequency spectrum is not dependent on time t (which was checked by a comparison of the $S(\omega)$ spectra, computed for successive segments of the record with invariable wave-generation conditions) and therefore it can be assumed that the investigated records have "internal" or "small-scale" nonstationarity, evidently associated with the periodic (with the period of the fundamental frequency) transmission of energy from the region of the fundamental frequency into the region of doubled frequency.

Thus, the representation of wind waves as a narrow-band nonlinear random process, in which all the spectral components are statistically related to the fundamental component, is not confirmed in our measurements. The investigated wave spectra consist of statistically independent spectral components with a stochastic structure, close to Gaussian, and a clear correlation with the fundamental component (and difference from a Gaussian structure) is observed for the most part in the neighborhood of the doubled frequency (and also, evidently, in the neighborhood of higher-order harmonics, although in this study such an investigation was not carried out). The reason for the appearance of significant second- and third-order multicoherence values on the ridge $\omega_2 \simeq 2\omega_m$ remains unclear and this effect requires further investigations.

It can be hoped that the proposed method will be useful in an investigation of surface and internal waves in the ocean and also in the solution of other problems related to the study of nonlinear random processes.

The authors express appreciation to Professor A. M. Yaglom for valuable comments and also K. V. Pokazeyev and A. D. Rozenberg, who participated in making the measurements.

BIBLIOGRAPHY

1. Krylov, Yu. M., SPEKTRAL'NYYE METODY ISSLEDOVANIYA I RASCHETA VETROVYKH VOLN (Spectral Methods for Investigating and Computing Wind Waves), Gidrometeoizdat, Leningrad, 1966.

2. Ramamonjiarisoa, A. and Coantic, M., C.R., Ser. B., Vol 282, 111, 1976.

3. Yefimov, V. V. and Solov'yev, Yu. P., IZV. AN SSSR: FIZ. ATM. I OKEANA (News of the USSR Academy of Sciences: Physics of the Atmosphere and Ocean), Vol 15, No 11, 1175, 1979.

4. Lake, V. M. and Yuen, H. C., J. FLUID MECH., Vol 88, Part 1, 33, 1978.

5. Molo-Christensen, E. and Ramamonjiarisoa, A., J. GEOPHYS. RES., Vol 83, 4117, 1978.

6. Rytov, S. M., VVEDENIYE V STATISTICHESKUYU RADIOFIZIKU (Introduction to Statistical Radiophysics), CH. 1, SLUCHAYNYYE PROTSESSY (Part 1, Random Processes), Moscow, "Nauka," 1976.

7. Haubrich, R. A., J. GEOPHYS. RES., Vol 70, No 6, 1415, 1965.

8. Tukey, J. W., OCEAN WAVE SPECTRA, N. Y., p 347, 1963.

9. Hasselmann, K., Munk, W. H. and McDonald, G., TIME SERIES ANALYSIS, p 125, 1963.

10. Imasato, N., J. OCEANOGR. SOC. JAPAN, Vol 32, No 6, 253, 1976.

11. Imasato, N. and Kunishi, H., J. OCEANOGR. SOC. JAPAN, Vol 33, 267, 1977.

12. Kim, Y. C., et al., PHYS. FLUIDS., Vol 23, No 2, 1980.

13. McComas, C. H. and Briscoe, M. G., J. FLUID. MECH., Vol 97, Part 7, 205, 1980.

14. Ablowitz, M. J. and Segur, H., J. FLUID MECH., Vol 92, Part 4, 691, 1979.

5303
CSO: 1865/236

UDC 551.465.152:351.466.8

INTERRELATIONSHIP OF FINE STRUCTURE, INTERNAL WAVES AND SMALL-SCALE TURBULENCE

Moscow OKEANOLOGIYA in Russian Vol 21, No 4, Jul-Aug 81 (manuscript received 3 Apr 80) pp 605-612

[Article by V. Z. Dykman and O. A. Kiseleva, Marine Hydrophysical Institute, Academy of Sciences Ukrainian SSR, Sevastopol']

[Text]

Abstract: The article gives the results of experimental studies of the interrelationship between the energy characteristics of internal waves and small-scale turbulence under conditions of a finely stratified ocean and the peculiarities of these characteristics in the zone of action of eddy formations of a synoptic scale.

According to modern concepts, internal waves constitute one of the principal energy sources of small-scale turbulence in the absence of shear currents. The mechanisms for the generation of turbulence can be different [7, 10, 18], and in particular the turbulence can be caused by hydrodynamic instability and the destruction of internal waves [14]. Turbulent and wave movements in the ocean are closely interrelated to local stratification conditions and therefore an effective method for their investigation is determination of different characteristics of the fine vertical structure of hydrophysical fields.

In this article we give the results of experimental investigations of the energy supply of small-scale turbulence and its interrelationship to the field of internal waves. These investigations were carried out within the framework of the POLIMODE program in 1976-1978 on voyages of the scientific research ship "Akademik Vernadskiy." The apparatus used was slid along a supporting-electrical cable [3], being employed for measuring the temperature of sea water with a response of 10^{-3} °C and a spatial resolution of 3.6 cm. The averaged profiles of temperature, salinity and density were obtained from synchronous soundings with the ISTOK hydrological probe [9].

Different opinions now prevail concerning the nature of the fine structure (FS) and microstructure (MS) [6, 7, 11, 15]. The known methods for separating the spectrum of vertical structure scales into the two ranges FS and MS take into account not only the difference in scales, but also the processes participating in their formation. An analysis of the numerous experimental data on the fine vertical structure

of the ocean [6, 11, 15-17] evidently gives basis for assuming that under the conditions prevailing in the open ocean outside the zones of mixing of waters of different origin it is internal waves (IW) which play the principal role in forming of the FS. Microstructure is the smallest-scale variability with scales from 1 m to 1 mm, where molecular processes of viscosity and diffusion already exert an effect and in whose formation small-scale turbulence participates [7, 11, 15].

The minimum FS scales and the maximum MS scales, that is, the position of the boundary between these two structures, must be determined by local conditions. Source [12] gives an empirical expression determining the position of this boundary on the wave number axis $k_{z0} = \beta_0 n$, where $n = \bar{N} \cdot N_0^{-1}$ is the dimensionless Väisälä-Brent frequency, N_0 = 3 cycles/hour, β = 1 cycle/m. The vertical scale

$$L_0 = k_{z_0}^{-1}, \tag{1}$$

thus characterizes the maximum vertical scales of the MS or turbulent formations.

The position of the boundary between the FS and the MS can also be determined from the experimental temperature spectra [1, 2, 5]. In order to determine the type of movement (waves or turbulence) use was made of the following tests and criteria: the form of the spectrum on both sides of this boundary and the test

$$\nu^2 = \overline{\left(\frac{\partial T'}{\partial z} \Big/ \frac{\partial \bar{T}}{\partial z}\right)^2},$$

characterizing the degree of nonlinearity of the process [12] or the weak interactions condition $\nu^2 \ll 1$ and the strong interactions condition $\nu^2 > 1$.

Evaluations of the ν^2 parameter indicated that only for scales greater than 2-5 m is there satisfaction of the weak interactions condition (ν^2 = 0.1-0.2), which corresponds to linear internal waves. In the smaller-scale range ν^2 becomes greater than unity, attaining several tens, as is characteristic of turbulence. An additional characteristic for determining the type of movement can be the probability of local negative density gradients, being a consequence of positive temperature gradients under conditions of stratification which on the average is stable. Small values of the probability $W_{-\Delta\rho_z}$ or $W_{\Delta T_z}$ are evidence of wave movement; high values of these characteristics indicate intensive mixing of a stably stratified fluid and are an indicator of turbulence. The evaluations were made using histograms of the distribution of local temperature gradients.

Investigations of the small-scale vertical structure of the temperature field were made in the Sargasso Sea, where during different time periods anticyclonic and cyclonic eddies were observed. The most detailed survey with an interval of 15 miles to depths of 1,000 m was carried out during the 17th voyage of the scientific research ship "Akademik Vernadskiy" in the zone of a cyclonic eddy [4]. The mean hydrological conditions, against whose background disturbances associated with the passage of eddies were observed, were called "background" conditions. In order to evaluate the influence of eddy formations on small-scale fluctuation processes an analysis was made of quasihomogeneous (constancy of N) layers 280-450 and 550-800 m. Data for these same layers were analyzed under background conditions as a comparison.

Figure 1 shows the characteristic spectrum of temperature $P_{T'}(k)$ and temperature dissipation $P_{T'}(k)\cdot k^2$, obtained using the results of soundings on the 14th voyage of the scientific research ship "Akademik Vernadskiy." The figure illustrates the method for determining the boundaries between the FS and MS and the dependence of its position on the wave numbers axis on local hydrological conditions (on the $\overline{N}$ frequency). It can be noted on the basis of the totality of numerous data that the long-wave part of the spectrum (FS sector) on the average is approximated well by the power law dependence $P_{T'}(k) \sim k^{-n}$, where n = 3, as is characteristic for internal waves [6, 15]. In the short-wave region the steepness of the spectra varies sharply and the exponent assumes values in the range 1-2, as is characteristic for small-scale turbulence (for fluctuations of the scalar value) in all three spectral subintervals: buoyancy, inertial-convective and viscous. In the region of this "break" is the boundary between the FS and the MS, which corresponds to a minimum of the spectrum $P_T(k)\cdot k^2$ (Fig. 1) and the maximum vertical turbulence scale L_{cr}. The level of spectral density of instrumental noise (according to experimental evaluations) is also shown in Fig. 1. Spectral distortions due to "eliasing" were eliminated by averaging of temperature along the vertical base of the sensor (5 cm) and with a discreteness interval (3.6 cm).

It can be noted that the tendency in change of L_{cr} with an increase in $\overline{N}$ is the same as for L_0: the values of these scales, computed using formula (1), decrease with an increase in $\overline{N}$. However, in each specific case these evaluations can differ substantially, which evidently is attributable to the fact that expression (1) does not take into account a number of dynamic factors (for example, shear velocities, etc.) and is dependent only on $\overline{N}$.

Regarding the scale L_{cr} (or L_0) as the maximum vertical turbulence scale, on the basis of the dependences cited in [8] it is possible to obtain evaluations of the rate of influx of kinetic energy ε and the coefficient of vertical turbulent exchange K_z^{max}:

$$\varepsilon = 5.3\cdot 10^{-9}\cdot L_{cr}\cdot \overline{N}^3 \ \text{cm}^2\cdot\text{sec}^{-3}, \tag{2}$$

$$K_z^{max} = 1.74\cdot 10^{-4}\cdot L_{cr}^2\cdot \overline{N} \ \text{cm}^2\cdot\text{sec}^{-1}, \tag{3}$$

where L_{cr} is in cm and $\overline{N}$ is in cycles/hour.

In making evaluations of ε and K_z^{max} it must be remembered that expressions (2) and (3), strictly speaking, are applicable to locally isotropic turbulence, whose existence in our measurements could not be reliably established in each specific case. Whereas the temperature spectrum in the MS range in actuality corresponds to the buoyancy interval, the L_{cr} and K_z^{max} evaluations are known to be too low since the expenditures of kinetic energy on maintaining turbulent movement in this interval should be greater than in the inertial-convective interval [13]. However, this should not be reflected in the basic conclusions from our study.

Since henceforth the analysis of the distributions of the rates of influx of kinetic energy to small-scale turbulence is carried out on the assumption of a predominance of the role of internal waves in this process, it would be useful to determine the interrelationship of the energy characteristics of internal waves and turbulence, as well as their dependence on density stratification conditions, which in the absence of significant shifts of the current velocity field determines the conditions for the existence of internal waves.

According to existing concepts [14], the process of development of local hydrodynamic instability of internal waves is random, and therefore, for determining the statistical interrelationships of the energy and hydrological characteristics it is necessary to average them in time or space greater than the spatial-temporal scales of internal waves. For this purpose use was made of the energy characteristics of internal waves and small-scale turbulence, averaged for a quasihomogeneous layer (constancy of N) on the assumption of a statistical uniformity of the intermittent turbulence. Without question, in each localized center of turbulence the energy of small-scale movement is determined not only by the density field, but also by the current velocity field, which in turn can be determined by the field of internal waves. An analysis of the experimental results indicated that the spatial-temporal averaging procedure is necessary for obtaining stable evaluations.

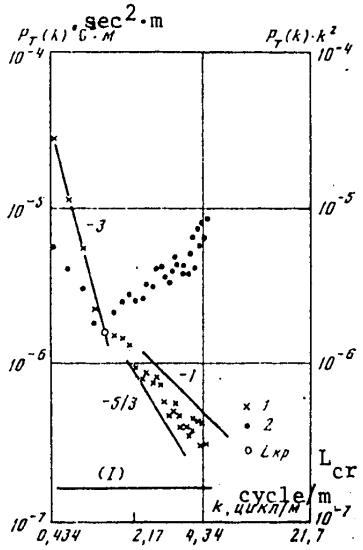

Fig. 1. Spectrum of deviations of temperature from mean profile $P_T(k)$ (1) and corresponding temperature dissipation spectrum $P_T(k)k^2$ (2) for layer 145-210 m and N = 2.7 cycles/hour. (I) -- spectrum of instrument noise $P_{noise}(k)$; L_{cr} -- maximum vertical turbulence scale, equal to 0.86 m.

Small-scale turbulence in the presence of FS evidently exists only in relatively uniform mixed layers with small vertical gradients of temperature and density, alternating with intercalations with considerable gradients of these parameters and therefore for correct evaluations of ε and K_z^{max} in (2) and (3) it is necessary to use not the mean, but the local Väisälä-Brent frequencies in mixed turbulent layers N_{lay}. The Väisälä-Brent frequencies in layers N_{lay} and intercalations N_{inter} were determined from histograms of the distribution of local temperature gradients, making it possible to obtain the mathematical expectation of the gradients $M\partial T/\partial z$, the mean square values of positive $\sigma_{\partial T/\partial z}$ and negative $\sigma_{-\partial T/\partial z}$ deviations of the local gradients from the mean. On the assumption of a linear correlation between temperature and density, which is entirely justified due to the

negligible changes in salinity with depth in the investigated layers of the ocean, we obtained:

$$N_{lay} = N\left(1 - \sqrt{\sigma_{\partial T/\partial z} \cdot M^{-1}_{\partial T/\partial z}}\right);$$
$$N_{inter} = \overline{N}\left(1 + \sqrt{\sigma_{-\partial T/\partial z} \cdot M^{-1}_{\partial T/\partial z}}\right). \quad (4)$$

These dependences are represented in Fig. 2, where the correlation of N_{lay}, N_{inter} and $\overline{N}$ for the particular region and the existing measurement conditions can be represented in the form of empirical linear dependences:

$$N_{lay} = \overline{N}/2.6;\ N_{inter} = 1.7\ \overline{N};\ N_{inter}/N_{lay} = 4.4. \quad (5)$$

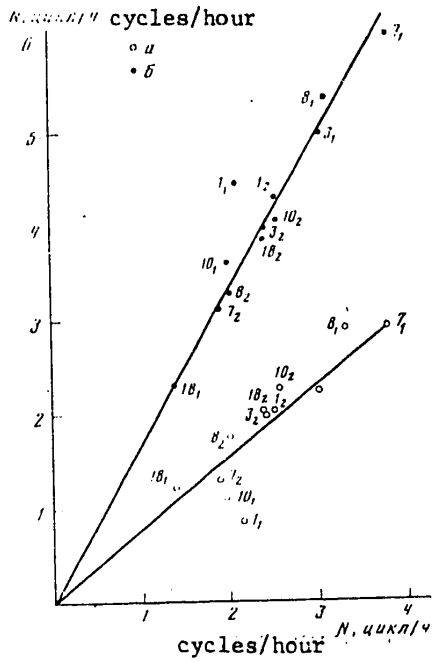

Fig. 2. Dependence of local frequencies in layers N_{lay} (a) and intercalations N_{inter} (b) on mean Väisälä-Brent frequency N. The figures correspond to the conventional numerical designations of the stations; the subscripts correspond to the upper (1) and lower (2) layers.

The use of the $\overline{N}$ value instead of N_{lay} for evaluations of ε and K_z^{max} does then not change the qualitative picture of distribution of these parameters.

Figure 3 illustrates the dependence of the relative values $\overline{N}/N_{lay}$, $N_{inter}/\overline{N}$ and N_{inter}/N_{lay} on the value of the dispersion of vertical displacements σ_ζ^2 in the field of internal waves, evaluated for the "wave" parts of the fine structure

$P_\xi(k) = P_T(k)\cdot(\partial T/\partial z)^{-2}$. With an increase in the amplitude of the vertical displacements of the water layers by internal waves the ratio of the local frequencies N_{inter} and N_{lay} and their difference from the mean value $\bar{N}$ increases appreciably, as is also evidence of the considerable role of IW in the formation of the fine structure of the density field.

Table 1

Distribution of Normalized Dispersion of Vertical Displacements, Characteristics of Small-Scale Turbulence and Väisälä Frequencies With Depth

Investigated parameters	No of layer	Background		Eddy formation		
		No of station				
		1659	1674	1662	1668	1462
$\bar{N}$, cycles/hr	1	15,9	15,6	14,6	15,4	11,4
	2	7,51	7,40	6,76	7,54	4,45
	3	2,95	2,93	2,49	2,92	2,65
σ^2_ξ, м²	1	0,011	0,014	0,025	0,015	0,051
	2	0,098	0,022	0,059	0,092	0,134
	3	0,240	0,105	0,476	0,576	0,544
L_{cr}, m	1	0,18	0,19	0,18	0,21	0,23
	2	0,31	0,35	0,35	0,35	0,58
	3	0,63	0,77	0,58	0,53	0,58
L_0, м	1	0,19	0,19	0,21	0,19	0,26
	2	0,40	0,41	0,44	0,40	0,67
	3	1,01	1,02	1,20	1,03	1,13
$\varepsilon\cdot10^3$, $cm^2\cdot sec^{-3}$	1	6,70	7,29	5,41	8,56	4,17
	2	1,58	2,35	2,01	2,79	1,58
	3	0,54	0,79	0,28	0,37	0,33
K_z^{max}, $cm^2\cdot sec^{-1}$	1	0,87	0,98	0,80	0,19	1,05
	2	1,26	1,41	1,25	1,61	2,61
	3	2,04	3,03	1,46	1,43	1,56

Notes: 1) layer 25-50 m; 2) layer 50-100 m; 3) layer 100-175 m.

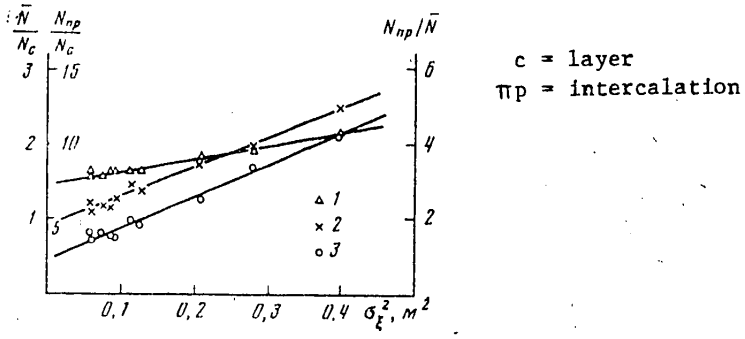

Fig. 3. Dependence N/N_{lay} (1), $N_{inter}/\bar{N}$ (2), N_{inter}/N_{lay} (3). Notations in the text.

In order to explain the influence of synoptic eddies on the process of energy supply of small-scale turbulence in its interrelationship to the field of internal waves it is first necessary to examine the results obtained under background conditions (Table 1, stations 1788, 1789, 1674).

It was noted in [4] that under background conditions in the layers 280-405 m, 550-800 m the potential energy level is virtually identical ($\overset{\circ}{\sigma}_{\xi}{}^{2} \simeq 0.17$ m^2). The rates of influx of kinetic energy to small-scale turbulence ε and the frequency $\overline{N}$ in these layers also differ insignificantly. In a broad range of change of $\overline{N}$ from 2.5 to 15-16 cycles/hour in the upper layer of the ocean 25-200 m (Fig. 4a) the influx of kinetic energy to turbulence varies considerably (from $0.28 \cdot 10^{-3}$ to $8.6 \cdot 10^{-3}$ cm$^2 \cdot$sec^{-3}), increasing with an increase in $\overline{N}$. At the same time, there is a considerable change in the density of potential energy of internal waves, decreasing by more than an order of magnitude with an increase in $\overline{N}$. With respect to the change in the coefficient of vertical turbulent exchange K_z^{max} under background conditions, on the basis of the table and Fig. 4a it can be concluded that large $\overline{N}$ correspond to lesser K_z^{max} and vice versa although the range of change is less (from 1 to 3 cm$^2 \cdot$sec^{-1}).

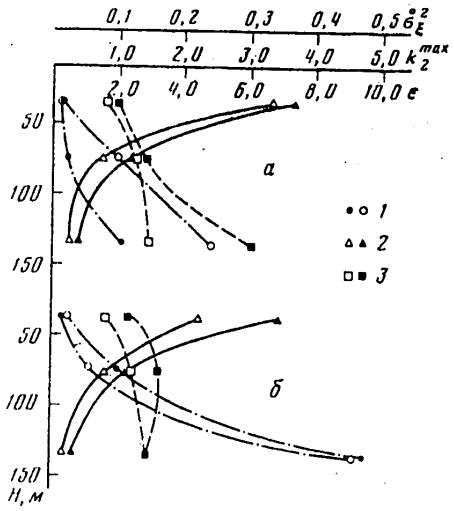

Fig. 4. Change in potential energy $\overset{\circ}{\sigma}_{\xi 2}$ (1), rate of influx of kinetic energy ε (2) and coefficient of vertical turbulent exchange K_z^{max} (3) with depth in layer 25-200 m for a) background stations 1659 and 1674, b) in eddy zone at stations 1662 and 1668.

The distribution of ε and K_z^{max} with depth in the zone of eddy formation can be judged from Fig. 4b and the table. In layers up to 200 m both the mentioned parameters are of the same order of magnitude as under background conditions. The same can also be noted for the layer 550-800 m. The greatest differences in the values of the parameters ε, K_z^{max} and the density of potential energy of IW are observed

in the layer 280-405 m, where ε, K_z^{max} and $\overset{\circ}{\sigma}_\xi^2$ can considerably exceed the background values.

Data on the distribution of ε and K_z^{max} over the area of a cyclonic eddy are given in [4]. In the upper layer 280-405 m the maximum rate of influx of kinetic energy to turbulence is observed in the central part of the eddy, where the level of potential energy of the wave field has a minimum. On the periphery of the eddy ε and K_z^{max} decrease, approaching the background values. It was impossible to obtain the full picture of distribution of ε and K_z^{max} over the area of the eddy for the layer 550-800 m, but available estimates make it possible to conclude that ε and K_z^{max} in this layer as well are close in their values to the background values. Thus, the experimental data indicate that in the layer 280-405 m at the center of a synoptic eddy there is some nucleus for which relatively high values of the coefficient of vertical exchange and an intensive influx of kinetic energy to turbulent formations are characteristic. An indirect but convincing confirmation of the existence of intensive turbulent exchange at the center of the eddy can be the fact of the discovery of a zone of increased biological productivity of the waters here.

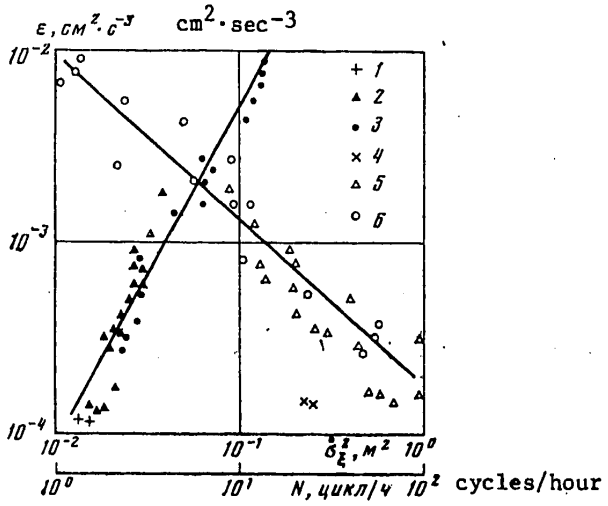

Fig. 5. Dependence of the rate of influx of kinetic energy ε on Väisälä-Brent frequency. 1) background; 2) eddy, layer 280-405 m; 3) data in table. Interrelationship of rate of influx of kinetic energy and potential energy value $\overset{\circ}{\sigma}_\xi^2$; 4) background; 5) eddy, layer 280-405 m; 6) data in table.

An analysis of the results indicated that there is a close correlation between the rate of influx of kinetic energy to turbulence, the density of potential energy of internal waves and local hydrological conditions (Fig. 5). High ε values correspond to lesser $\overset{\circ}{\sigma}_\xi^2$ and vice versa, with an increase in N there is an increase in the energy influx to turbulence and a decrease in the potential energy of internal waves. The range of change in ε and $\overset{\circ}{\sigma}_\xi^2$ is about two orders of magnitude.

In addition to data on ε obtained by the method described above, Fig. 5 gives data from [1]. Estimates of ε_u, obtained by the authors on the basis of measurements for relatively thin layers, have a considerable scatter around the empirical

dependence. After averaging for the range of depths 100-200 and 200-300 m and for four series of soundings the $\bar{\varepsilon}_u$ values correspond well to this dependence. Here we have also shown an estimate, made using the data in [14], for the mean conditions in the ocean.

Such a result can indicate that with an increase in the mean Väisälä-Brent frequency $\bar{N}$ (or the mean density gradients $\partial\rho/\partial z$) in the presence of a fine vertical structure there is an increase in the probability of the occurrence of local shear instability in the intercalations since the local Richardson numbers Ri' are $(N_{inter}/\bar{N})^2$ times less than the mean Ri number [14]. This should lead to an increase in the cases of destruction of unstable internal waves accompanying the formation of "spots" of small-scale turbulence and in general, to an increase in the expenditure of energy from internal waves to turbulence. This, in turn, can be one of the mechanisms of limitation of the amplitude of internal waves, and accordingly, the potential energy of the wave field. It must be noted that the dependence of $\bar{\varepsilon}$ and $\overset{\circ}{\sigma}{}_\xi^2$ on $\bar{N}$ is manifested most clearly in layers with great density gradients ($\bar{N} > 3$ cycles/hour), as is characteristic for the seasonal thermocline and zones of deformation of the density field in eddy formations. The principal difference between the experimental data used by Garrett and Munk for validating a model of the spectrum of IW (GM-75) is that they correspond to the main ocean thermocline, where $\bar{N} \leqslant 3$ cycles/hour. Evidently, only in layers with large density gradients can the mechanism of local hydrodynamic instability of internal waves be operative. In the deeper-lying layers, in zones of small vertical density gradients other mechanisms of wave destruction can be operative (for example, see [18]).

The authors express appreciation to N. A. Panteleyev for discussion of this work.

BIBLIOGRAPHY

1. Belyayev, V. S., Lozovatskiy, I. D. and Ozmidov, R. V., "Features of Small-Scale Turbulence in the Ocean Thermocline," FIZIKA ATMOSFERY I OKEANA (Physics of the Atmosphere and Ocean), Vol 15, No 10, pp 1060-1065, 1979.

2. Dykman, V. Z.,and Panteleyev, N. A., "Correlation Between Fine Structure in the Ocean and Internal Waves and Turbulence," MORSKIYE GIDROFIZICHESKIYE ISSLEDOVANIYA (Marine Hydrophysical Research), No 4, Sevastopol', Izd. MGI, pp 132-147, 1977.

3. Dykman, V. Z., Yefremov, O. I. and Panteleyev, N. A., "Sounding Complex for Investigating the Fine Vertical Structure of the Ocean," EKSPERIMENTAL'NYYE METODY ISSLEDOVANIYA OKEANA (Experimental Methods for Investigating the Ocean), Sevastopol', Izd. MGI, pp 125-136, 1978.

4. Dykman, V. Z., Kiseleva, O. A. and Yefremov, O. I., "Investigations of the Fine Vertical Structure of the Temperature Field in Eddy Formations of a Synoptic Scale," OKEANOLOGIYA (Oceanology), Vol 21, No 3, pp 441-446, 1981.

5. Lozovatskiy, I. D., "Spectrum of Vertical Inhomogeneities of the Temperature Field in the Ocean Thermocline," IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 15, No 11, pp 1188-1198, 1979.

6. Miropol'skiy, Yu. Z. and Filyushkin, B. N., "Investigations of Temperature Fluctuations in the Upper Layer of the Ocean at the Scales of Internal Gravitational Waves," IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 7, No 7, pp 779-797, 1971.

7. Monin, A. S., "Turbulence and Microstructure in the Ocean," USPEKHI FIZICHESKIKH NAUK (Advances in the Physical Sciences), Vol 109, No 2, pp 333-354, 1973.

8. Ozmidov, R. V., GORIZONTAL'NAYA TURBULENTNOST' I TURBULENTNYY OBMEN V OKEANE (Horizontal Turbulence and Turbulent Exchange in the Ocean), Moscow, Nauka, 1968.

9. RUKOVODSTVO PO GIDROLOGICHESKIM RABOTAM V OKEANAKH I MORYAKH (Manual on Hydrological Studies in the Oceans and Seas), Leningrad, Gidrometeoizdat, pp 562-589, 1977.

10. Phillips, O. M., DINAMIKA VERKHNEGO SLOYA OKEANA (Dynamics of the Upper Layer of the Ocean), Moscow, Mir, 1969.

11. Fedorov, K. N., TONKAYA TERMOKHALINNAYA STRUKTURA VOD OKEANA (Fine Thermohaline Structure of Ocean Waters), Leningrad, 1976.

12. Bell, T. H., "Internal Wave-Turbulence Interpretation of Ocean Fine Structure," GEOPHYS. RES. LETTERS, Vol 1, No 6, pp 253-255, 1974.

13. Bolgiano, R., "Turbulent Spectra in Stably Stratified Atmosphere," J. GEOPHYS. RES., Vol 64, No 12, pp 2226-2229, 1959.

14. Garrett, C. and Munk, W., "Oceanic Mixing by Breaking Internal Waves," DEEP SEA RES., 19, No 12, pp 823-832, 1972.

15. Gregg, M. C. and Briscoe, M. C., "Internal Waves, Fine Structure, Microstructure and Mixing in the Ocean," REV. GEOPH. AND SPACE PHYS., Vol 17, No 7, pp 1524-1548, 1979.

16. Gregg, M. C., Cox, C. S. and Hacker, R. W., "Vertical Microstructure Measurements in the Central North Pacific," J. PHYS. OCEANOGRAPHY, Vol 3, No 4, pp 458-469, 1973.

17. Hayes, S. P., Joice, T. M. and Millard, R. C., "Measurement of Vertical Fine Structure in the Sargasso Sea," J. GEOPHYS. RES., Vol 80, No 3, pp 314-319, 1975.

18. Orlansky, J. and Bryan, K., "Formation of the Thermohaline Structure by Large-Amplitude Internal Gravity Waves," J. GEOPHYS. REV., Vol 74, No 28, pp 6975-6983, 1969.

5303
CSO: 1865/242

UDC 550.38;550.37

ARTICLES ON MARINE ELECTROMAGNETIC RESEARCH

Moscow PROBLEMY MORSKIKH ELEKTROMAGNITNYKH ISSLEDOVANIY in Russian 1980 (signed to press 25 Jul 80) pp 2-5

[Annotation and table of contents from collection of articles "Problems in Marine Electromagnetic Investigations", responsible editor M. S. Zhdanov, doctor of physical and mathematical sciences, Institut zemnogo magnetizma, ionosfery i rasprostraneniya radiovoln (IZMIRAN), 300 copies, 190+ pages]

[Text] Annotation. This collection of articles consists of papers presented at the Third All-Union Seminar "Fundamental Problems in Marine Electromagnetic Investigations," held at the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN), USSR Academy of Sciences, in 1980. These are papers containing the results of original investigations of the natural electromagnetic field of the planet, descriptions of methods for its measurement and methods for processing and interpreting the collected data.

The articles discuss the problems involved in the mathematical modeling of two- and three-dimensional electromagnetic fields and also the problems involved in creating specialized data systems for processing geophysical information on an electronic computer.

The authors give an analysis of the possibilities of solution of geological problems by a complex of deep marine geophysical methods: magnetotelluric sounding and measurement of heat flow. A number of studies devoted to analysis of fields of hydrodynamic sources are included.

The collection of articles is of interest for specialists working in the field of geomagnetism and geoelectricity, and also for a wide range of marine geophysicists.

Contents

5303
CSO: 1865/24

TERRESTRIAL GEOPHYSICS

UDC 551.468.551.24+550.838:550.389

MAGNETIC ANOMALIES IN OCEANS AND NEW GLOBAL TECTONICS

Moscow MAGNITNYYE ANOMALII OKEANOV I NOVAYA GLOBAL'NAYA TEKTONIKA in Russian (signed to press 3 Mar 81) pp 2, 212

[Annotation and tables of contents from collection of articles "Magnetic Anomalies in the Oceans and the New Global Tectonics", responsible editor Ye. G. Mirlin, candidate of geological and mineralogical sciences, Izdatel'stvo "Nauka", 700 copies, 215 pages]

[Text] Annotation. The authors of these articles examine the principal patterns of the structure of magnetic field anomalies in the oceans and in transition zones and have ascertained the relationship between the parameters of anomalies and the magnetic properties of rocks on the ocean floor. An analysis is given for modern models of formation of the oceanic magnetically active layer and the processes leading to changes in it. Also examined are the problems involved in the method for the interpretation of data from marine magnetic surveys. Paleotectonic reconstructions of the relative position of the continents in the Mesozoic-Cenozoic are presented. The collection is intended for geophysicists and geologists involved in investigations of the structure of the oceanic earth's crust and its evolution.

Contents

5303
CSO: 1865/19

METHODS FOR AUTOMATING GEOPHYSICAL RESEARCH

Apatity AVTOMATIZATSIYA GEOFIZICHESKIKH ISSLEDOVANIY in Russian 1980 (signed to press 26 Dec 80) pp 2, 151-157

[Annotation and abstracts from collection of articles "Automation of Geophysical Research", responsible editor I. A. Kuz'min, candidate of physical and mathematical sciences, Kol'skiy filial AN SSSR, 300 copies, 157 pages]

[Text] Annotation. The collection of articles "Automation of Geophysical Research" is devoted to the timely problem of automation of the collection and processing of geophysical information and also the description of the apparatus and methods employed in geophysical experiments. The collection includes descriptions of specific technical developments in systems for the automation of scientific research, a system for the input of different types of geophysical information into an electronic computer and autonomous recorders of data on a magnetic tape. Several articles are devoted to the problems involved in computations and specific technical designs of individual recording apparatus components. In general, the collection will be of unquestionable interest for researchers working in the field of automation of scientific research and the description of specific technical innovations may be of substantial assistance to scientific workers in many related fields of science and engineering.

Abstracts

UDC 65.011.56+550.3

AUTOMATION OF SCIENTIFIC RESEARCH IN GEOPHYSICS

[Abstract of article by Kuz'min, I. A.]

[Text] The article examines the requirements imposed on systems for the automation of geophysical research in the field of study of solar-terrestrial relationships. There is a brief review of existing systems for automating the collection and processing of experimental data. The structure and technical aspects of a system for automating geophysical research at the Polar Geophysical Institute, Kola Affiliate, USSR Academy of Sciences, are presented. Figures 6, references 23.

UDC 550.385.37

REGISTRY AND PROCESSING OF GEOMAGNETIC PULSATIONS AT REAL TIME SCALE

[Abstract of article by Yelistratov, V. P. and Negrebetskiy, A. A.]

[Text] An automated system for the collection and processing of geomagnetic data at a real time scale is described. A block diagram and description of operation of a reworked control program and time program are given. A magnetic variation station and the active RC filters which it contains are described, the filter parameters are defined and the practical results of processing of geomagnetic pulsations are presented. Figures 3, references 11.

UDC 681.335+621.39+550.3

INSTRUMENT COMPLEX FOR THE PROCESSING OF ANALOG AND TELEMETRIC INFORMATION OBTAINED IN A GEOPHYSICAL EXPERIMENT

[Abstract of article by Radkevich, V. A. and Perlikov, A. M.]

[Text] An instrument complex for the processing of analog and telemetric information is examined. It was developed at the Polar Geophysical Institute, Kola Affiliate, USSR Academy of Sciences, and is intended for the processing of information transmitted by the radiotelemetric system aboard a balloon in experiment SAMBO, from aboard an artificial earth satellite and received at geophysical observatories. A block diagram is presented and a description of the processing procedures with the ASVT M-4030 and VK "Iskra-1252" computers with use of a device for the decoding of telemetric information is given. The authors describe operation of the decoding unit, which makes it possible to transform an analog signal, FM signal with partial separation of channels using the IRIG standard or a separated FM signal into a digital form and introduce it into an electronic computer. Methods are given for reduction of the analog signal into digital form using an ATsP system and FM signal as well as a discrete frequency meter and the channels of an x-radiation spectrometer. The number of simultaneously operating channels is up to 8; the instrument error is 0.1%. The accuracy in tie-in to the time mark is $\leqslant$ 0.01 sec. The maximum discretization frequency is 20 KHz. The problems involved in long-range development of the instrument complex are considered. Figures 5, references 13.

UDC 550.83.045+681

AUTONOMOUS RECORDERS OF GEOPHYSICAL INFORMATION ON A MAGNETIC CARRIER

[Abstract of article by Deryabin, V. M., Ivanov, A. P., Kazak, B. N., Kuz'min, I. A., Lemnev, V. I. and Makarov, V. I.]

[Text] Different methods for the registry of geophysical information are examined and their comparative characteristics are given, as well as examples of the practical realization of the considered methods. Carriers of geophysical information and registry methods meeting the needs are described. A slow analog magnetic recorder

and a stepped accumulator employing magnetic tape which have been developed are briefly described, as are the principal fields of their application. Figures 2, references 9.

UDC 551.594.5+550.388.8

AUTOMATED COMPLEX FOR THE REGISTRY OF NIGHT AIRGLOW AND PROCESSING OF COLLECTED DATA

[Abstract of article by Solov'yev, V. M., Starkov, G. V. and Yushchenko, V. F.]

[Text] The need for and possibility of creating an automated complex for the registry of night airglow are examined. This complex also processes the collected data. Existing methods and apparatus for the registry and processing of information on auroras are briefly analyzed. Block diagrams of instruments and apparatus for the registry of auroras and processing of the collected data, which have already been developed, are provided. Figures 3, references 8.

UDC 535.241.6

USE OF COHERENT LIGHT SOURCES IN PROCESSING OPTICAL INFORMATION

[Abstract of article by Anokhin, V. V.]

[Text] This is a review of methods for laser beam control applicable to the problems involved in the processing of images, in particular, auroras, on an electronic computer. The problems related to reduction of images taken on photographic film to digital form are analyzed. Figures 3, references 11.

UDC 550.388.2:551.501.8

MODELING OF ELECTROMAGNETIC PROCESSES IN THE AURORAL IONOSPHERE BY NUMERICAL SOLUTION OF THE WAVE EQUATION

[Abstract of article, author not indicated]

[Text] The computation of low-frequency ($f < 10$ KHz) electromagnetic fields in inhomogeneous plasma of the auroral ionosphere is considered. A method for determining fields by means of numerical solution of the boundary-value problem for the wave equation is given. This method is used for investigating ionospheric sources of low-frequency radiation and study of the resonance properties of the earth-ionosphere waveguide. Figures 7, references 6.

UDC 550.388.2:551.594.6

ANALYSIS OF VLF SIGNALS BY DIGITAL METHODS

[Abstract of article by Perlikov, A. M. and Ostapenko, A. A.]

[Text] Methodological problems arising in the analysis of signals in the frequency range $f \leqslant 3$ KHz are analyzed. An experimental apparatus for the input of analog signals into an electronic computer and an algorithm for the spectral-temporal analysis of VLF signals are described. This apparatus has a high resolution. An example of analysis of a model signal, describing a short electronic whistler, is given, as well as the results of processing of an experimental VLF signal of a discrete type. Figures 5, references 9.

UDC 51+550.3

MATHEMATICAL SUPPORT OF A COMPLEX FOR PROCESSING GEOPHYSICAL INFORMATION

[Abstract of article by Radkevich, V. A.]

[Text] The article gives a description of the mathematical support of a complex for the processing of analog and telemetric information obtained in a geophysical experiment. Included is a block diagram of a complex of programs containing primary and scientific processing programs, servicing programs and standard programs. The storage of data is organized on magnetic tapes. A description of the organization of input of information into an electronic computer and the purpose of the programs are given. The complex of programs is introduced into M-4030 and KV "Iskra-1252" computers at the Polar Geophysical Institute, Kola Affiliate, USSR Academy of Sciences. Figures 1, references 6.

UDC 681.17

SURFACE RECEIVING-RECORDING COMPLEX FOR THE SAMBO-79 EXPERIMENT

[Abstract of article by Zhavkov, V. A. and Sushchenko, M. S.]

[Text] The purpose of receiving stations is examined and a block diagram of the equipment is given. The authors describe the apparatus at the receiving points and give a brief description of the operating principle for a receiving point and individual instruments. The technical specifications of the principal units are presented. Figures 2, references 3.

UDC 621.371+621.396.6+550.3

MOBILE COMPLEX OF APPARATUS FOR STUDYING PROPAGATION OF DECAMETER RADIO WAVES

[Abstract of article by Patenchinkov, A. A., Pertsovskiy, R. A., Sazonov, V. A. and Tkachenko, B. V.]

[Text] A mobile receiving-transmitting complex has been developed which makes it possible to organize temporary radio links in the SW range for solution of various

scientific research problems. This complex makes possible the simultaneous radiation and reception of radio waves at several fixed frequencies in both continuous and pulsed regimes. The radioelectronic apparatus installed at the reception point makes it possible to register the following parameters of test radio signals: 1) envelope of a radio signal radiated in a carrier regime; 2) averaged envelope of multimode pulsed signals with resolution along the rays; 3) Doppler frequency shift in one of the receiving channels; 4) absolute signal level at the receiver input; 5) visually monitored data for some signal parameters in any of the receiving channels with the possibility of photoregistry; 6) number of rays of multimode signals, with measurement of their duration and lag time between them; 7) high-quality magnetic record of transformed high-frequency signals at several frequencies simultaneously for their subsequent spectral analysis. The complex also includes a magnetotelluric station making it possible to register the median and short-period variations of the magnetic field in three components, this making it possible to monitor overall geophysical conditions at the reception point. This complex was tested within the framework of the international experiment SAMBO-79, during which it was used in obtaining unique results in the field of slant sounding of the auroral ionosphere. Figures 8, references 2.

UDC 621.396.62

NARROW-BAND SUPERHIGH-FREQUENCY RECEIVER WITH DOUBLE FREQUENCY CONVERSION

[Abstract of article by Beloglazov, M. I.and Shishayev, V. A.]

[Text] The article describes a SHF receiver with compensation of phase changes of heterodyne voltage. The receiver transmission band is $\sim$15 Hz, the amplification factor is 100 db and the level of instrument noise in the passband is less than 0.01 μV. In the temperature range 10-40°C the change in signal delay time is 0.10-0.15 μsec/1°C and the mean change in the amplification factor in this same temperature range is less than 0.5%/1°C. A block diagram of the receiver and circuit diagrams of individual stages are given. Figures 2, references 2.

UDC 621.38+629.1321

SPECIALIZED SIGNAL RECEIVER IN A PRECISE TIME STATION

[Article by Kornilov, I. A.]

[Text] This is a review of the principal methods used in synchronizing precise time services. It emphasizes the prospects for using precise time stations in a geophysical experiment for transmitting time information in a digital code. The author briefly describes a specific receiver used in the territory of Murmanskaya Oblast for the reception of signals of precise time stations situated in the territory of West Germany (77.5 KHz) and Great Britain (60 KHz). Figures 3, references 3.

UDC 621.38+629.1321

RECEIVER OF VLF RADIATIONS FOR BALLOON INVESTIGATIONS

[Abstract of article by Kornilov, N. A.]

[Text] The article concisely sets forth the fundamental principles for constructing a receiver of VLF radiations for balloon investigations. A block diagram of the instrument is provided and its technical specifications are stipulated. In addition to balloon studies, the instrument was also employed in surface VLF investigations. It can operate with both electric and magnetic antennas. Figures 1, references 2.

UDC 535+550.388

WIDE-BAND SPECTRAL CAMERA WITH INTERMEDIATE DISPERSION FOR OBSERVING AURORAS WITH LIGHT BRIGHTNESS AMPLIFIER

[Abstract of article by Sukhoivanenko, P. Ya.]

[Text] A highly sensitive spectral camera has been created with a brightness amplifier for the observation of auroras. The instrument field of view is 100°. The inverse linear dispersion is 150 A/mm. Exposures from 30 to 150 sec are used in surveying the auroral spectra. Figures 3, references 7.

UDC 621.39+591.510

DISCRETE CIRCUIT OF A RECEIVING-RECORDING APPARATUS FOR ATMOSPHERIC OPTICAL SOUNDING

[Abstract of article by Baydalov, S. I and Drozdov, M. Yu.]

[Text] A simple circuit for optical sounding of the atmosphere by the photon counting method with discrete sampling of range and the strobe is described. A threshold response of about $5 \cdot 10^{-19}$ W was attained. The dynamic range of the measured light fluxes is $\sim 10^7$. The shaped counting pulses were normalized with respect to duration and amplitude. The circuit simultaneously provides for direct and inverse outputs. Figures 1, references 5.

UDC 621.314.5

LOW-POWER D-C VOLTAGE CONVERTERS

[Abstract of article by Zhavkov, V. A.]

[Text] The author gives concise recommendations on the choice of circuitry for a low-power converter. The article examines in adequate detail the operation of a converter with a saturating core constructed in a circuit with a grounded collector. A formula is cited which relates the conversion frequency, power voltage and core parameters. A method is given for simplified computation of the specific circuit. Figures 2, references 4.

UDC 621.371

PHASE METER WITH PULSED PHASE DETECTOR WITH RECTANGULAR CHARACTERISTIC FOR RADIO SIGNALS IN THE SUPERLONG-WAVE RANGE

[Abstract of article by Beloglazov, M. I. and Shishayev]

[Text] The article describes a device for measurement of signal phase in the range 10-30 KHz. The authors validate the use of a phase detector with a rectangular characteristic and a signal limiter in the phase meter instead of an AVC system. The requirements imposed on individual parts of the developed device, which ensures the measurement of the phase of superlong-wave signals with an error less than ±1 sec with a signal-to-noise ratio > 0.5 in the band 20-30 Hz, are analyzed. A block diagram of the phase meter is given. Figures 2, references 7.

UDC 621.37

AMPLITUDE LIMITER WITH FLOATING THRESHOLD

[Abstract of article by Galakhov, A. A.]

[Text] A scheme of an amplitude limiter with a floating threshold for reducing the influence of atmospheric noise on the error in registry of VLF radiations is described. Figures 2, references 3.

UDC 621.396.62

ACTIVE FILTER FOR PROCESSING VLF SIGNALS

[Abstract of article by Pershakov, L. A.]

[Text] A scheme is proposed for an active RC filter for very low frequencies. The proposed scheme makes it possible to construct filters with independent regulation of the mean frequency of analysis, the width of the band of analyzed frequencies and the transfer coefficient. Figures 1, references 2.

5303
CSO: 1865/23

UDC 550.34

ABSTRACTS OF ARTICLES ON SEISMIC INSTRUMENTS

Moscow PROBLEMY I METODY SEYSMOMETRII: SEYSMICHESKIYE PRIBORY in Russian No 14, 1981 (signed to press 29 May 81) pp 151-156

[Abstracts from collection of articles "Problems and Methods in Seismometry: Seismic Instruments", responsible editors Ye. S. Borisevich, doctor of technical sciences, and D. P. Kirnos, doctor of physical and mathematical sciences, Izdatel'stvo "Nauka", 950 copies, 156 pages]

[Text] Abstracts

UDC 550.34

ASTATICIZED SEISMOMETER WITH A NEGATIVE FEEDBACK

[Abstract of article by Rykov, A. V.]

[Text] In seismometry the mechanical method of astatization of a seismometer with a rotational type of motion of the inertial mass is widely known and used. A different method is proposed for the astatization of a seismometer which is based on the automatic tracking method which is also applicable to a seismometer with translational linear motion of the inertial mass. Mathematical and experimental models of an astaticized seismometer with use of this method are considered. Figures 1, references 2.

UDC 550.34

DEVELOPMENT OF METHODS AND INSTRUMENTATION FOR SEISMOMETRY IN THE NEAR ZONE IN THE USSR

[Abstract of article by Fremd, V. M.]

[Text] In the USSR work is actively developing on the principal instrumental-methodological directions in the problem of seismometry in the near zone. Routine expeditionary investigations of aftershock activity in the epicentral zones of strong earthquakes are being carried out. The network of instruments for strong movements at seismic stations in active regions has been expanded. The main volume of material is obtained using stand-by galvanometric channels. Methods have been developed for the processing of seismograms of stand-by instruments, including for spectral

analysis and restoration of the true motion of the ground. The new instrumental developments involve the use of magnetic recording and digital registry, the creation of long-period seismographs for strong movements, improvement in piezoelectric seismometers and expansion of the possibilities of the galvanometric channels. Figures 5, tables 1, references 14.

UDC 550.34

INSTRUMENTAL-METHODOLOGICAL COMPLEX FOR STUDYING STRONG EARTHQUAKES

[Abstract of article by Aref'yev, S. S., Grayzer, V. M., Pletnev, K. G., Fremd, V. M. and Shebalin, N. V.]

[Text] The article discusses the problems involved in creating, using and developing the complex, including the seisometric problems, methods for organizing and carrying out observations and computer programs for the processing and interpretation of data to be used in the investigation of strong earthquakes, primarily in their nearest zones. Figures 5, tables 1, references 10.

UDC 550.34

POSSIBILITY OF COMPRESSION (USING THE FREQUENCY CRITERION) OF THE DYNAMIC RANGE OF SIGNALS EXCITED BY EARTHQUAKES

[Abstract of article by Aranovich, Z. I. and Melamud, A. Ya.]

[Text] On the basis of an analysis of the amplitude and frequency characteristics of P-, S- and L-waves excited by close and remote earthquakes it was possible to evaluate the possibility of compression of the dynamic range of these waves (using the frequency criterion) for the purpose of ensuring undistorted registry. It was established that P-, S- and L-waves excited by close and distant earthquakes, depending on epicentral distance, are characterized by different dependences (varying from linear to cubic) of their amplitudes on period. Accordingly, the simultaneous compression of the dynamic range of these waves (using the frequency criterion) is impossible. The desirability of using velocimeters for these purposes is demonstrated. Figures 8, references 9.

UDC 550.34

ANALYSIS OF LONG-PERIOD CHANNELS WITH DIFFERENT TYPES OF CORRECTION

[Abstract of article by Zheleznyak, T. K.]

[Text] A study was made of the influence of different types of correction on the principal characteristics of long-period seismometric channels. Their merits and shortcomings were determined. Figures 2, references 9.

UDC 550.34

DERIVATION OF A CONSTANT OF PHYSICAL SYSTEMS WITH TWO DEGREES OF FREEDOM AND ITS APPLICATION TO A SEISMOGRAPH

[Abstract of article by Mysh, A. G.]

[Text] The author derives a constant for physical systems with two degrees of freedom. An unambiguous relationship is established between the branches of the frequency curves situated on different sides of the mean geometrical frequency. In the example of a seismograph it is shown that it is possible to use the relationships with the constant in obtaining the frequency characteristics, determining the characteristic parameters, direct restructuring or scaling of the frequency curve into a phase curve and in algorithms for pulse calibration of instruments. Figures 5, references 5.

UDC 550.34

PHASE ERRORS IN SEISMOMETRIC ENGINEERING INSTRUMENTATION

[Abstract of article by Tseytlin, S. I.]

[Text] The article examines the phase errors in seismometric engineering instrumentation arising as a result of instability of the characteristic parameters of these instruments, including attenuation and characteristic frequency. The concept of the coefficients of influence of changes in the parameters on the phase error is introduced. A study was made of the frequency characteristics of the coefficients. Recommendations are given on taking into account and decreasing the phase errors of seismometric engineering instrumentation. Figures 5, references 14.

UDC 550.34

CORRECTION OF DISTORTIONS CAUSED BY FLUCTUATIONS IN THE RATE OF TAPE MOVEMENT IN THE MAGNETIC REGISTRY OF SEISMIC SIGNALS

[Abstract of article by Fridman, A. A.]

[Text] It is shown that fluctuations in the rate of tape movement during the registry and reproduction of signals generate additive and multiplicative noise with the frequency of the fluctuations in the rate of tape movement and also lead to parasitic FM of the reproduced signal. The author examines different methods for correction of the errors caused by fluctuations in the rate of tape movement. The article describes the block diagram of an experimental apparatus for investigating the effectiveness of suppression of the influence of fluctuations in the rate of tape movement by means of servocontrol of the rate of tape movement during reproduction using a control signal registered in an individual track. A tape-moving system has been developed; it ensures the registry of considerable disturbances in the frequency range up to 30 Hz with an insignificant lag. The amplitude-frequency characteristic of the system is given. Satisfactory results are ensured with the joint use of difference compensation and servocontrol. Figures 6, references 2.

UDC 550.34

SOME PROBLEMS IN COMPUTING MULTICHANNEL MEASUREMENT SYSTEMS WITH FREQUENCY MODULATION FOR GEOPHYSICAL INVESTIGATIONS

[Abstract of article by Razorenov, A. A.]

[Text] The article deals with the problems involved in computing the extent of the frequency transmission bands of channels and their rational distribution in the frequency range. Graphic dependences are given which facilitate these computations. Figures 5, references 7.

UDC 550.34

INFLUENCE OF THE MUTUAL INDUCTANCE OF COILS IN A MAGNETOELECTRIC CONVERTER ON THE CHARACTERISTICS OF A SEISMOMETER WITH A FEEDBACK

[Abstract of article by Trapeznikov, N. L.]

[Text] The transfer function of a seismometer with a feedback was obtained. It takes into account the mutual inductance of coils in a magnetoelectric converter. An analysis of distortions of the characteristics of an idealized seismometer with a feedback, caused by mutual inductance, is presented. Figures 4, references 7.

UDC 550.34

ORGANIZATION OF A TIME SERVICE IN REGIONAL SEISMIC INVESTIGATIONS

[Abstract of article by Vol'f, A. I., Krylov, G. G., Rayzman, V. I., Chibisov, S. G. and Erenburg, M. S.]

[Text] A time service is proposed and introduced. It ensures a time tie-in of seismic information in regional seismic investigations carried out using autonomous registry stations. The time service is represented by a quartz clock with a rate with a high degree of accuracy. The start-up of the clocks for the autonomous stations and checking of their rate is accomplished using a secondary frequency standard -- portable reference quartz clock. Such an organization of the time service made it possible to form a unified scale tied in to precise time for the clocks of a large group of autonomously operating instruments, to increase the accuracy in determining corrections for clock rate, and to improve the operational characteristics of instrumentation. Figure 1, references 7.

UDC 550.34

TIME SERVICE IN APPARATUS FOR REGIONAL SEISMIC INVESTIGATIONS

[Abstract of article by Vol'f, A. I., Krylov, G. G., Rayzman, V. I., Starodubtsev, I. A. and Chibisov, S. G.]

[Text] The article describes the makeup and operation of the time service in instrument complexes for regional seismic investigations, the "Cherepakha-M" and the RTSS. This service includes the quartz clock of the recording apparatus, a portable reference quartz clock and the time unit at the processing center. The highly precise quartz clock of the recording apparatus forms a binary-decimal time code registered on a magnetic tape synchronously with seismic information and in a minute interval containing information on the year, month, day, hour, minute and second of registry time and also on the number of the apparatus and amplitude level of registry. The reference quartz clock makes it possible to form a unified scale tied in to precise time for a large group of recording apparatus. The time unit at the processing center ensures a visualization of the reproducible time information and automation of operation of processing center systems. Figures 5, references 8.

UDC 550.34

SYSTEM FOR THE COLLECTION, PROCESSING AND STORAGE OF SEISMIC DATA IN A YeS-1030 ELECTRONIC COMPUTER

[Abstract of article by Starovoyt, O. Ye., Zakharova, A. I., Barmin, M. P. and Babkina, V. F.]

[Text] The article gives the first results of work at the "Obninsk" Central Seismic Observatory on the creation, on the basis of a YeS-1030 electronic computer, of a complex ensuring: routine collection, processing and publication of data from YeSSN seismic stations for determining the principal parameters of earthquakes; forming of a catalogue and bulletin of earthquakes on the magnetic tape of an electronic computer with organization of a search for seismological information on interrogation; automated spectral processing of records of body and surface waves in digital form on a magnetic recorder with creation of a system for the accumulation and storage of this information. Figures 3, tables 2.

UDC 550.34

METROLOGICAL SUPPORT OF SEISMIC ENGINEERING MEASUREMENTS

[Abstract of article by Kirnos, D. P., Manokhin, A. Ye., Tokmakov, V. A., Kharin, D. A. and Tseylin, S. I.]

[Text] The article gives a formulation of the problem of metrological support of seismic engineering measurements and points out the timeliness and feasibility of its solution. The priority work required for this purpose is defined. The principal parameters of the necessary means for checking the measurement apparatus

are indicated; a list of the norm-setting and technical documents (All-Union and All-Union State Standards) is given. References 10.

UDC 550.34

CONDITIONS FOR AND EXPERIENCE IN USING SEISMOMETRIC ENGINEERING APPARATUS

[Abstract of article by Kuz'mina, N. V., Tokmakov, V. A. and Kharin, D. A.]

[Text] The article describes the conditions and some results of use of various types of seismometric engineering apparatus for measuring oscillations caused by different sources. The accuracies of different methods for determining instrument parameters are compared with one another. Figures 2, tables 6, references 8.

UDC 550.34

SEF EPICENTRAL SEISMOGRAPH FOR NEAR ZONE OF STRONG EARTHQUAKES

[Abstract of article by Fremd, V. M.]

[Text] The choice of the principal technical specifications of a simplified mechanical seismometer for evaluation of the principal parameters of oscillations in the near zones of strong earthquakes is validated. In the instrument the inertial mass is a recording device. The registry is on paper using a helical pen or "flomaster." The characteristic period of the pendulum is about 1 sec; the damping constant is 0.7. The time of continuous registry is 12 hours. Figures 1, references 2.

UDC 550.34

THREE-COMPONENT PIEZOELECTRIC SEISMIC SWITCH

[Abstract of article by Arakelyan, G. K., Uspenskiy, B. G. and Fremd, V. M.]

[Text] The article describes an instrument consisting of a three-component piezosensor, charge amplifier, comparator, relay logic system and internal power source. The instrument is intended for the combining of industrial antiseismic protection systems. Figures 4, references 11.

UDC 550.34

PZO-1M ELECTROGRAPHIC LIGHT-RAY OSCILLOGRAPH WITH VISIBLE REGISTRY ON A SIMPLE PAPER TAPE

[Abstract of article by Begushin, G. K., Borisevich, Ye. S., Zabelin, M. V., Mosyagina, M. S. and Rozenberg, I. M.]

[Text] This is a detailed description of the unit and the operating principle of the principal functional units and working circuits of the PZO-1M electrographic oscillograph. Figures 4, references 11.

UDC 550.34

DIGITAL ELECTROGRAPHIC DEVICE

[Abstract of article by Borisevich, Ye. S., Begushin, G. K., Mosyagina, M. S. and Mkhitaryan, S. A.]

[Text] The authors describe the operating principle for a digital electrographic oscillograph. The principal expressions are given for determining its basic technical specifications. The article examines the desirability of creating such an instrument and indicates the possible areas of applicability of a digital electrographic oscillograph. Figures 1, references 7.

UDC 535.3

INTERFERENCE INSTRUMENT WITH REFLECTING WEDGE FOR MEASURING MOVEMENTS

[Abstract of article by Kologrivov, V. N.]

[Text] In the automation of geophysical measurements and computer processing of data ever-increasing use is being made of interference-type movement sensors. The article examines the possibilities of a sensor having a substantially higher response and more convenient for automatic measurements than traditional instrumentation. Figures 3, references 3.

UDC 550.34

PULSE CHECKING OF SEISMOMETRIC CHANNELS USING A PRIMARY STANDARD

[Abstract of article by Fremd, V. M.]

[Text] After determining the seismograph constants and forming a channel with stipulated characteristics its response to a calibrated pulse effect is registered. This response is the primary standard with which the responses to a similar effect are compared in the successive channel monitoring operations. It is possible to make a qualitative evaluation of the reasons for change in the form of response in the case of maladjustment of the channel parameters. Figures 1, references 5.

UDC 550.34

TWO-COMPONENT VIBRATIONAL PLATFORM FOR CALIBRATING PENDULUM SEISMOMETERS

[Abstract of article by Fedoseyenko, N. Ye., Deniskov, A. S. and Kastorskiy, S. A.]

[Text] The article describes a two-component vibrational platform for angular and vertical reciprocating oscillations for calibrating, testing and selecting seismic sensors intended for sea and land observations. The use in this apparatus of a compensator of nonlinear distortions made possible a sharp reduction of nonlinear distortions of a vibrational table and a broadening of the range into the region of infralow frequencies with a simultaneous increase in the amplitude of angular oscillatory motions. The vibrational platform has small nonlinear distortions (up to 1%). Figures 3, references 4.

UDC 550.34

ONE METHOD FOR PRODUCING INFRALOW-FREQUENCY MECHANICAL OSCILLATIONS

[Abstract of article by Sarkisyan, R. Ye., Avetisyan, G. R. and Akhsakhalyan, G. A.]

[Text] The article describes a method for obtaining infralow-frequency oscillations when using pendulum vibrational stands. The method is based on the principle of compensation of the rigidity of elastic bonds, that is, the introduction of negative rigidity. Figures 2, references 2.

UDC 550.34

EFFECT OF SIX-COMPONENT OSCILLATIONS OF GROUND (STRUCTURE) ON READINGS OF A SINGLE-COMPONENT PENDULUM-TYPE SEISMOMETER

[Abstract of article by Sheyn, B. N. and Fedorov, S. A.]

[Text] The authors give the derivation of a full formula for a mathematical pendulum which takes into account the contribution of all six components of motion. On the basis of this formula it was possible to evaluate the errors involved in solving the inverse problem of seismometry for earthquakes of 6-9 scale units associated with the influence of the accompanying components of translational and rotational oscillations on single-component seismometers of the pendulum type. Figures 4, tables 3, references 5.

UDC 550.34

FEATURES OF A METHOD FOR MEASURING OSCILLATIONS OF CONSTRUCTION PARTS AND GROUND IN RELATION TO TASKS OF VIBRATIONAL PROTECTION FOR PRECISE TECHNOLOGICAL EQUIPMENT

[Abstract of article by Maksimov, L. S.]

[Text] Practical recommendations are given on some problems related to measurements of oscillations of construction parts and the ground in the designing of kinematic vibrational protection systems: required response and working range of frequencies of vibrographs, choice of type of vibration measurement apparatus and some design solutions, feasible duration of registry of oscillations, use of magnetographs and digital correlators for the analysis of random vibrations. Figures 4, references 3.

UDC 550.34

FIELD TESTS AND RELIABILITY OF PIEZOELECTRIC SYSTEM FOR ACTIVATION OF INDUSTRIAL ANTISEISMIC PROTECTION

[Abstract of article by Arakelyan, G. K. and Fremd, V. M.]

[Text] The article gives the results of field tests of a piezoseismometer with a new electronic unit and three-component piezoelectric seismic switch forming part of an industrial antiseismic protection system. An evaluation of reliability of the seismic switch and the entire system is given. Figures 4, tables 1, references 9.

UDC 550.34

MATCHING DEVICE FOR REGISTRY OF SEISMIC OSCILLATIONS BY PIEZOELECTRIC ACCELEROMETERS

[Abstract of article by Parshakov, Yu. P., Gurov, S. P., Mironov, Yu. M. and Malyarov, I. L.]

[Text] The authors describe a model of matching amplifiers for piezoaccelerometers based on modern integrated circuits. The amplifiers revealed a great stability in operation, reliability and ease of adjustment in tuning during the registry of seismic oscillations in the near zone of shots in models and under industrial conditions. Figures 8, references 3.

UDC 550.34

THYRISTOR VOLTAGE CONVERTER FOR ROTATION OF A SYNCHRONOUS WARREN MOTOR

[Abstract of article by Knyazev, V. V. and Fursov, A. N.]

[Text] The circuitry of a voltage converter for supplying current from storage batteries to a Warren motor is described. Figures 1, references 1.

UDC 550.34

DEVICE FOR GRADUATING EXTENSOMETER

[Abstract of article by Kologrivov, V. N., Yakovlev, A. P. and Latynina, L. A.]

[Text] A small portable device has been developed for the contactless measurement of the graduated displacement of an extensometer, constituting a Michelson interferometer (with unequal arms) with an LG-56 laser as the light source. The device has been tested at seismic stations. Figures 1, references 6.

UDC 550.34

UNIVERSAL GEOPHYSICAL AMPLIFIER

[Abstract of article by Ignatov, B. G., Volodin, A. A. and Zelikman, E. I.]

[Text] A study was made of the problem of developing a universal economical geophysical amplifier fabricated using microcircuits of series 284. In the amplifier special measures are used for contending with cophasal interference and there is a fixed voltage regulator. Smooth filters of the upper and lower frequencies are also built in. The range of frequencies which can be registered is 0.03-5 sec. Figures 2.

UDC 550.34

INVESTIGATIONS OF MEMBRANE PERMEABILITY IN A DEVICE FOR REGISTERING VARIATIONS IN MECHANICAL TERRESTRIAL STRESSES

[Abstract of article by Shporkin, M. I. and Yurovskaya, I. S.]

[Text] An experimental study was made of the change in permeability of rubber fabric membranes for gas and fluid with different membrane tensions. There was a stepped change in permeability with an increase in membrane thickness and insignificant changes in permeability in the temperature range from 3 to 20°C, and also an increase in permeability for fluid with an increase in excess pressure from the direction of the deformation converter cavity. Ways to compensate leakage of the working substance are proposed. Figures 4, references 8.

UDC 550.34

DEVICE FOR MEASURING TOTAL ENERGY OF SEISMIC OSCILLATIONS

[Abstract of article by Aleksandrov, A. L., Zelikman, E. I. and Fremd, V. M.]

[Text] The article describes the schematic diagram of a seismic energy meter in which there is a squaring of oscillations of seismometer signals proportional to velocity, summation of the squares for the three components and integration of the sum. The output signals of the device, proportional to seismic energy, are converted into the pulse repetition rate and the pulses are counted by an electronic counter. Depending on the level of the seismic signals and the setting of the adjustable parameters in this device its continuous autonomous operation from several days to months is possible. Figures 1, references 6.

UDC 550.34

FREQUENCY DIVISION MULTIPLEXING IN THE CIRCUIT OF AN ISMR SEISMOGRAPH

[Abstract of article by Aleksandrov, A. L., Zelikman, E. I. and Fremd, V. M.]

[Text] The article describes the operating principle and circuitry of a device for the multiplexing of the FM channels of a seismograph with magnetic registry. The multiplexing is accomplished by the frequency division of the modulated signals of one of the two channels with subsequent filtering during registry and reproduction. The device makes possible a reduction in the number of channels of the registering magnetograph by half. Figures 3, references 2.

UDC 550.34

ECONOMICAL SYSTEM FOR PRECISE FREQUENCY MODULATION AND DEMODULATION IN SEISMIC APPARATUS

[Abstract of article by Aleksandrov, A. L., Zelikman, E. I. and Fremd, V. M.]

[Text] The operating principle and circuit diagram of a frequency modulator developed for seismographs with magnetic recording are described. The output frequency of the modulator is not dependent on the time constant of the integrator and slow drifts of the comparator zero and reference voltage, which ensures a high conversion accuracy. Figures 4, references 3.

5303
CSO: 1865/16

UDC 550.343.4/6:550.348:550.341:551.1

SEISMICITY AND FOCAL MECHANISMS OF FAR EASTERN EARTHQUAKES

Yuzhno-Sakhalinsk SEYSMICHNOST' I MEKHANIZMY OCHAGOV ZEMLETRYASENIY DAL'NEGO VOSTOKA in Russian 1980 (signed to press 29 Dec 80) pp 2-3

[Annotation and table of contents from collection of articles "Seismicity and Focal Mechanisms of Far Eastern Earthquakes", responsible editor R. Z. Tarakanov, Izdatel'stvo SakhKNII, Novoaleksandrovsk, 400 copies, 103+ pages]

[Text] Annotation. An improved variant of a seismic regionalization map for the Priamur'ye and Primor'ye regions is proposed. The articles give the results of the South Kurile seismological experiment of 1975 with bottom stations. The spatial-temporal distributions of earthquakes and the problem of discriminating transverse faults are also examined. Some results of study of differences in earthquakes producing tsunamis and those not producing tsunamis are presented on the basis of the dynamics of development of their foci in the radiation stage. Data are given on the peculiarities of the focal mechanism in the process of preparation of a strong earthquake. Also considered are seismological investigations by the following methods: three-dimensional modeling, earthquake exchange waves and spatial soundings. The collection is of interest for seismologists, geophysicists and geologists concerned with study of the structure and dynamics of the transition zone from the continent to the ocean.

Contents

5303
CSO: 1865/15

UDC 550.344.3

EXPERIMENTAL STUDIES OF SEISMIC CODA

Moscow EKSPERIMENTAL'NYYE ISSLEDOVANIYA SEYSMICHESKOY KODY in Russian 1981 (signed to press 7 Apr 81) pp 2, 142

[Annotation and table of contents from collection of articles "Experimental Investigations of the Seismic Coda", by T. G. Rautian, V. I. Khalturin, M. S. Zakirov, A. G. Zemtsova, A. P. Proskurin, B. G. Pustovitenko, A. N. Pustovitenko, L. G. Sinel'nikova, A. G. Filina and I. S. Shengeliya, Izdatel'stvo "Nauka", 1550 copies, 143 pages]

[Text] Annotation. The articles describe the results of investigation of the seismic coda on the basis of earthquake records obtained with long-period (SK, SKD), short-period (SKM, VEGIK, SKh) and frequency-selection (ChISS) instruments for a number of seismically active regions: Crimea, Caucasus, Central Asia, Altay, Baykal, Kamchatka, Kuriles and Cuba. The authors have obtained evaluations of the quality and turbidity for the upper layers of the crust (sedimentary layer), lower crust and lithosphere, and mantle. The dependence of these parameters on frequency was obtained. Stable regional characteristics of coda envelopes were defined. Correlations were obtained between the coda level and the magnitudes M_{LH}, m_{PV} and the energy class K for different regions and the fundamental principles of the method for classification of earthquakes on the basis of the seismic coda are examined. A method has been developed for determining the focal spectra of earthquakes on the basis of the spectral composition of the coda obtained using ChISS records. The spectra were determined for earthquakes in different regions of Central Asia. There are three types of focal spectra and these are associated with definite zones. The problem of interpretation of focal spectra is discussed from the point of view of different focal models. Also examined are the methods employed and the results of study of the attenuation of direct waves by means of their normalization to the coda level. The book is intended for seismologists concerned with the problems involved in wave propagation in real media, the method for magnitude classification of earthquakes, seismic regionalization, determination of the focal spectra of earthquakes and the problem of physics of focal processes. Figures 171, tables 20, references 135.

Contents

5303
CSO: 1865/253

COLLECTION OF ARTICLES ON GEOPHYSICAL INSTRUMENTATION

Leningrad GEOFIZICHESKAYA APPARATURA in Russian No 72, 1981 (signed to press 13 Mar 81) pp 188-190

[Table of contents from collection of articles "Geophysical Instrumentation", technical editor A. B. Yashchurzhinskaya, Izdatel'stvo "Nedra", Leningradskoye otdeleniye, 2150 copies, 199 pages]

[Text] Contents

Tsalyuk, M. V., Chelok'yan, R. S., Mel'tser, A. K. and Reznik, P. D.
"Method for Reducing the Electric Noise Level in the Logging of Deep Boreholes" 184

5303
CSO: 1865/250

UDC 621.371+535.2(571.54)

PROPAGATION OF ELECTROMAGNETIC WAVES

Ulan-Ude RASPROSTRANENIYE ELEKTROMAGNITNYKH VOLN in Russian 1980 (signed to press 14 Apr 80) pp 2, 112, 114-119

[Annotation, table of contents and abstracts from collection "Electromagnetic Wave Propagation", edited by N. Ts. Gomboyev, Ch. Ts. Tsydypov and N. B. Chimitdorzhiyev, Uchastok operativnoy poligrafii BF SO AN SSSR, 500 copies, 119 pages]

[Text] Annotation. This collection of articles is devoted to investigations of the propagation of waves in the radio and optical ranges near the earth's surface. A number of studies give the results of experimental determination of the coefficient of refraction in the atmosphere and the electric parameters of the underlying medium in steppe and semidesert regions of the Mongolian People's Republic.

Contents

ABSTRACTS

UDC 621.371:621.396.43

POSSIBILITY OF OBTAINING REGIONS OF A QUASIHOMOGENEOUS FIELD NEAR THE EARTH'S SURFACE

[Abstract of article by Khomyak, Ye. M. and Batoroyev, A. S.]

[Text] A study was made of the possibility of obtaining regions of a homogeneous (with a stipulated error) field from dipole sources of ultrashort waves raised to a low height and with arbitrary values of the reflection coefficients. The spatial position of a cubic region of a quasihomogeneous field and the magnitude of the amplitude error for the field are determined within its limits. The study can be used in antenna measurements based on the use of standard fields. Figures 3, references 3.

UDC 621.391.81:621.396.43

DIFFRACTOR FIELD CHANGE IN THE PRESENCE OF WAVES REFLECTED FROM THE EARTH

[Abstract of article by Chimitdorzhiyev, N. B., Darishapov, D. D. and Dagurov, P. N.]

[Text] The authors give an analysis of the influence of a reflecting discontinuity on diffractor field change. It is shown that the reflection of radio waves from the earth's surface exerts a substantial influence on diffractor field change and signal stability in the passive relaying of radio waves. The results of computations are in good agreement with the experimental data obtained on model lines. The computed statistical distributions of the attenuation factors for diffraction and diffractor radio lines, obtained taking into account waves reflected from the earth, are in satisfactory agreement with the experimental curves of radio signal stability on natural paths. Figures 10, references 15.

UDC 627.371.222.3

RAPID FADINGS ON DIFFRACTION PATHS

[Abstract of article by Dagurov, P. N., Tsybikov, A. Ye. and Chimitdorzhiyev, N. B.]

[Text] The article gives the results of an experimental investigation of rapid fadings on two two-peak diffraction paths with a length more than 100 km. Information is given on the statistical distributions of the intensity of the fadings, their duration and other statistical characteristics. It is noted that the distributions of the intensity of instantaneous fluctuations in two-minute intervals were distributed approximately in conformity to the generalized Rayleigh law with mean K values falling in the range -10 to -12 db. Figures 8, references 8.

UDC 621.371.+550.371

SOME RESULTS OF INVESTIGATIONS OF NATURAL ELECTROMAGNETIC FIELDS IN THE RANGE 20-100 Hz IN TRANSBAYKALIA

[Abstract of article by Tsydypov, Ch. Ts.]

[Text] This paper gives the results of experimental investigations of natural electromagnetic fields in the superlow frequency range. The authors describe the radio measurement apparatus employed and the method for measuring and processing the results. The results are compared with data in the literature for other regions. Figures 4, references 23.

UDC 550.372+621.391.81(519.3)

ELECTRIC PROPERTIES OF ALLUVIAL DEPOSITS IN MONGOLIA IN THE FREQUENCY RANGE 10-1000 KHz

[Abstract of article by Dorzhiyev, V. S. and Ivoylov, Yu. A.]

[Text] The authors give the results of an experimental investigation of the geoelectric sections of alluvial deposits in Mongolia and give resistivity values as a function of the granulometric composition of the deposits and the effective electric properties of the sections in the frequency range 10-1000 KHz. Figures 1, tables 2, references 3.

UDC 550.372+621.391.81(571.54)

EFFECT OF PRECIPITATION ON THE ELECTRIC PROPERTIES OF THE UNDERLYING MEDIUM

[Abstract of article by Advokatov, V. R. and Dorzhiyev, V. S.]

[Text] The results of an experimental evaluation of the influence of precipitation on the parameters of geoelectric sections and the effective electric properties of

the underlying medium in the frequency range 10-1000 KHz under the climatic conditions prevailing in Transbaykalia are cited. Figures 2, tables 3, references 5.

UDC 621.391.81

VERTICAL STRUCTURE OF THE INDEX OF ATMOSPHERIC REFRACTION IN THE STEPPE AND SEMIDESERT REGIONS OF THE MONGOLIAN PEOPLE'S REPUBLIC

[Abstract of article by Damdinsuren, E. and Tsydypov, Ch. Ts.]

[Text] The authors examine the spatial-temporal distributions of the vertical gradient of the dielectric constant of air in the surface layers on the basis of data of network stations for aerological sounding. Some features caused by the specific natural-climatic conditions of the Gobi were discovered: a relatively great variability of the gradient of the atmospheric refraction index, as well as a predominance of reduced refraction. The results of the investigations are compared with data for similar climatic regions of the USSR. Figures 3, tables 2, references 19.

UDC 621.391.81

INVESTIGATION OF THE EFFECTIVE ATMOSPHERIC GRADIENTS UNDER GOBI CONDITIONS

[Abstract of article by Damdinsuren, E., Arsent'yev, I. V. and Danzan, D.]

[Text] The paper gives the results of determination of the effective gradients of the dielectric constant of air under the climatic conditions prevailing in the Gobi (Mongolian People's Republic). An integral distribution curve approximated by a normal law is constructed and its parameters were determined. The authors give a comparison of the statistical distributions of the effective and aerological gradients of the atmospheric dielectric constant. Some characteristics which are caused by the specific climatic features of this region are defined. Figures 4, references 15.

UDC 621.371.24

MEASUREMENT OF DISPERSION OF INTENSITY FLUCTUATIONS IN A PARTIALLY COHERENT LASER BEAM

[Abstract of article by Boronoyev, V. V., Gomboyev, N. Ts., Poplaukhin, V. N. and Trubacheyev, E. A.]

[Text] The results of measurements of the dispersion of intensity fluctuations in a broad partially coherent laser beam on a path with a length of 1,800 m with a fixed value of the initial degree of source coherence are given. It is shown

that the level of saturation of the dispersion of intensity fluctuations in a multimode broad beam is dependent on the initial degree of source coherence and is considerably lower than the corresponding level in a single-mode wide laser beam. Figures 1, references 11.

UDC 551.501.724:551.591.1

DETERMINATION OF THE STRUCTURAL CHARACTERISTIC OF THE INDEX OF ATMOSPHERIC REFRACTION FROM THE BLURRING OF THE IMAGE OF PARALLEL MIRES

[Abstract of article by Batdanov, Zh. P. and Gomboyev, N. Ts.]

[Text] The article describes an apparatus for use in visual determination of the structural characteristic of the atmospheric refraction index C_{ref} from the image blurring of parallel mires. Experimental data are given on the temporal variation of the C_{ref} parameter, as well as histograms and integral distribution curves of the C_{ref} values. A comparison of the results of determination of C_{ref} by the visual method with data on measurement of C_{ref} on the basis of distortion of the spatial coherence of optical radiation indicates their satisfactory agreement. Figures 4, references 11.

UDC 681.41:535.853.68

APPARATUS FOR MEASURING THE ONE-DIMENSIONAL SPECTRUM OF THE COHERENCE FUNCTION FOR AN OPTICAL WAVE AND THE TURBULENCE PARAMETER C^2_{ref}

[Abstract of article by Boronoyev, V. V., Zubritskiy, E. V. and Poplaukhin, V. N.]

[Text] The authors propose an improved apparatus for measuring the one-dimensional spectrum of the second-order spatial coherence function for the field of an optical wave and the structural characteristic of fluctuations of the atmospheric refraction index C^2_{ref} in which a second receiving channel, identical to the first, has been introduced for the purpose of increasing measurement response and accuracy. The photodetectors of these channels are cut into a bridge circuit. This apparatus is intended for investigations of the distribution of the mean intensity of optical radiation in the focal plane of the receiving lens and makes it possible to measure light fluxes of the order of 10^{-3} of the intensity of this flux through a slit at the center of the diffraction pattern. In the case of a one-channel measurement scheme this value is limited to light fluxes not less than 10^{-2}. Figures 2, references 8.

5303
CSO: 1865/237

PHYSICS OF ATMOSPHERE

UDC 550.388

ARTICLES ON SPACE EXPLORATION

Novosibirsk ISSLEDOVANIYE OKOLOZEMNOGO PROSTRANSTVA in Russian 1981 (signed to press 8 May 81) pp 2-3, 66

[Annotation, foreword and table of contents from collection of articles "Investigation of Circumterrestrial Space", responsible editor I. M. Vilenskiy, doctor of physical and mathematical sciences, Institut geologii i geofiziki SO AN SSSR, 500 copies, 67 pages]

[Text] Annotation. The authors of these articles discuss problems related to investigation of some phenomena transpiring in circumterrestrial space. The articles give the results of a theoretical investigation of quasiperiodic disturbances created in the ionosphere by powerful radio waves. The effects caused by the influence of these disturbances on radio wave propagation are discussed. Some aspects of ionospheric propagation of radio waves are examined: a) a rigorous solution is given for the problem of radio wave propagation in a homogeneous anisotropic ionosphere and examples of computations using the developed method for characterizing the propagation of radio waves in the SHF range are given; b) the method for experimental determination of the vertical angles of incidence of short radio waves reflected by the ionosphere is discussed. The problem of modeling of ionospheric winds is examined. Some problems involved in determining the earth's conductivity from electromagnetic variations for depths corresponding to the bottom of the earth's crust and mantle are investigated. Some results of investigation of cosmic ray variations are given.

Foreword. This collection of articles briefly sets forth the results of studies made during recent years (1976-1980) at the Complex Geophysical Observatory of the Institute of Geology and Geophysics, Siberian Department, USSR Academy of Sciences.

The articles give the results of a theoretical examination of problems related to the effect of powerful radio waves on the ionosphere: a) there is a discussion of the effects associated with the development of artificial quasiperiodic inhomogeneities in the ionosphere; b) a theoretical examination is made of the problem of distortion of powerful signals during their interaction with the ionosphere; c) the conditions for nonlinear reradiation of radio waves at combined frequencies by the atmosphere were investigated.

The problem of reconstructing the angular characteristics of radio waves in the short-wave range which are reflected from the ionosphere is examined on the basis of experimental data.

Radio wave absorption in the lower ionosphere was investigated. In contrast to other studies in this field, the problem is discussed using a numerical solution of the full wave equation for an anisotropic inhomogeneous medium.

An algorithm is also given for solving the problem of a model of a wind system in the thermosphere and some examples of the realization of this algorithm for the polar region are cited.

Section II is devoted to geoelectromagnetic investigations. Individual models of an anisotropic conducting medium are examined applicable to magnetotelluric sounding.

Section III gives the results of an analysis of data on cosmic ray variations carried out using the local generation of neutrons effect.

At the end of the collection of articles there is a list of investigations published by observatory specialists during the period 1976-1980 in the field of study of circumterrestrial space and geomagnetism. The authors regret that due to the brevity of exposition the collection of articles gives no bibliographic citations to the studies of other authors.

Contents

5303
CSO: 1865/22

UDC 551.521.3

MONOGRAPH ON SCATTERED RADIATION IN THE EARTH'S UPPER ATMOSPHERE

Leningrad ISSLEDOVANIYE RASSEYANNOGO IZLUCHENIYA VERKNEY ATMOSFERY ZEMLI
in Russian 1981 (signed to press 13 Jan 81) pp 2, 207-208

[Annotation and table of contents from monograph "Investigation of Scattered Radiation of the Earth's Upper Atmosphere", by Arkadiy Yeznikovich Mikirov and Vasiliy Andreyevich Smerkalov, Gidrometeoizdat, 750 copies, 208 pages]

[Text] Annotation. The monograph describes twilight, searchlight, lidar, rocket and satellite methods for optical sounding of the upper atmosphere. Rocket methods are described in more detail because they have been discussed to a lesser degree than the other methods in the Soviet and foreign literature. The book gives the principal results of investigations of scattered radiation of the upper atmosphere by different methods. Also discussed are possible mechanisms of the observed radiation, including the role of molecular and aerosol scattering, the influence of the underlying surface and multiple scattered radiation. The authors examine the problems involved in the use of the collected information on the field of scattered atmospheric radiation for determining its optical characteristics (scattering functions and coefficients, optical thickness, etc.). The monograph is intended for specialists in the field of atmospheric optics and related branches of knowledge in which information on the optical properties of the upper atmosphere and methods for their investigation are used.

Contents

5303
CSO: 1865/247

- END -