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CONTENTS

TERRESTRIAL GEOPHYSICS

UDC 551.322

COMPILATION OF ATLAS OF WORLD SNOW AND ICE RESOURCES

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 1, Jan 83 pp 10-13

UNSIGNED

[Abstract] An Atlas of World Snow and Ice Resources is being compiled by Soviet specialists. This atlas will integrate the vast amount of data on snow and ice accumulated since the early 1950's. It is meant to be an important reference for clarifying the global climatic importance of the snow cover and glaciers and their decisive role in various areas of the earth and for casting light on the nature of polar and high-mountain regions. It will provide a global evaluation of natural ice as a potential source of fresh water and a regional evaluation of the resources, regime, variability and possibilities of exploitation of snow and ice formations. It is proposed that the atlas include about 750 maps at different scales on 300 pages in the format of the Soviet World Atlas. There will be three parts: introductory, regional and applied and 17 specialized sections. The maps will be compiled at 17 different scales. The atlas will be of great international interest, especially for India, Turkey, Afghanistan, some countries in South America, China and Japan. UNESCO regards this as the USSR contribution to the International Hydrological Program. For the first time there will be reliable maps of precipitation, temperature conditions and runoff for the pertinent high mountain areas. Much prevalent information which is inexact will be corrected. Space information will be extensively used in compiling maps of a number of areas. Photographs taken with the MKF-6 camera have provided information on the glaciers of the Pamirs as a standard region and also glacier regions of South American and Central Asia. Work on atlas compilation is being carried out at about 20 institutes of the USSR Academy of Sciences and many other organizations. The first, preparatory stage in work on the atlas was completed in the 10th Five-Year Plan. The second stage has now been initiated and should be completed in the next three years. The deadline for its publication is 1985.
[72-5303]

UDC 551.583

ALL-UNION CONFERENCE ON ANTHROPOGENIC CHANGE IN CLIMATE
(LENINGRAD, 1-3 JUNE 1982)

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 pp 1332-1333

BYUTNER, E. K.

[Abstract] An All-Union Conference on Problems in Anthropogenic Change in Climate, organized by the State Hydrological Institute and the section "Anthropogenic Changes in Climate and Their Consequences" of the Scientific Council on "Study, Monitoring and Evaluation of State of Environment," was held in Leningrad during the period 1-3 June 1982. The conference was attended by more than 100 specialists from 27 scientific research institutes in the country. Twenty-nine reports were presented with discussions of the principal factors causing changes in climate, modeling of the climatic system, statistical analysis of observational data, physical mechanism of recent changes in climate, influence of changes in mean global temperature on the moisture cycle and the productivity of agricultural crops. One of the sessions was completely devoted to recent investigations involving the reconstruction of paleoclimates and a discussion of information on the relationship between changes in mean planetary temperature and the geographic distribution of the temperature and precipitation fields which can be extracted from them. (A few lines are devoted to the subject matter of the individual reports). A resolution adopted at the conference noted that increased attention must be directed to certain directions. These include: empirical and theoretical investigations of the response of regional climatic conditions accompanying modification of the global climatic system; study of role of the ocean as the principal inertial link in anthropogenic changes in climate; study of the influence of recent climate changes on sea and continental ice; reconstructions of paleoclimate for epochs which are possible analogues of future climate. The conferees agreed that there is now adequate basis for developing a forecast of anthropogenic changes in climate for up to 50 years. Such a forecast should contain an evaluation of climate conditions for each decade in this time interval.
[69-5303]

UDC 551.510.535.2:551.55

SPRING-AUTUMN TRANSFORMATIONS OF CIRCULATION REGIME IN METEOR ZONE DETERMINED FROM MULTIYEAR RADAR MEASUREMENTS IN KIRGIZIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 6 Nov 80, after revision 27 Jul 82)
pp 1326-1328

TAKYRBASHEV, M. A. and KARIMOV, K. A., Institute of Physics and Mathematics, Kirgiz Academy of Sciences

[Abstract] The article gives an analysis of the times of development of spring and autumn brief restructurings of the circulation regime in the meteor zone

related to a mean altitude of 93 km on the basis of data from radar measurements of the drifts of meteor trails carried out in Kirgizia during the period from 1964 through 1980. During the considered observation period an analysis was made of the day-to-day variability of the mean diurnal values of the prevailing wind for the zonal (U(EW)) and meridional (V(NS)) components of wind velocity during the periods of spring (March-May) and autumn (September-October) equinoxes. For example, a study was made of the dates of onset and ending of brief spring (BST) and brief autumn (BAT) transformations and also their duration in the entire observation interval from 1964 through 1980. The analysis revealed that during the entire observation period the mean times related to the onset of spring restructurings in circulation at 93 km fall in the period 30-31 March. The mean long-term date of ending of BST falls on 2 May. The mean duration of BST, averaged for the entire observation period, is 33 days. The mean long-term times of onset and ending of autumn transformations at 93 km are 29 September and 10 October respectively; the mean duration is 33 days. The onset of brief spring transformations in the meteor zone falls in the period of the spring equinox with a deviation of 1-2 weeks from this date. Autumn transformations develop 6-7 days after the autumnal equinox. Data from the atlas of maps for the layer 35-60 km (ATLAS VYSOTNYKH KART SLOYA 36-60 KM, TsAO GUGMS, 1975-1979) were used in an analysis of the development of processes of spring-autumn transformations in the atmospheric layer from 25 to 60 km. An analysis of the maps of vertical-temporal development of processes of spring and autumn restructurings for 1975-1979 indicates development of spring-autumn transformations in the entire thickness of the atmosphere. The spring restructuring begins to develop in the upper stratosphere in the stratoregion with subsequent development of this process in both the above- and below-lying layers. In the upper layers at the 93-km level the spring restructuring occurs somewhat later (by 3-5 days) than at the stratopause level, but earlier than in the lower stratosphere at the 25-km level (by 7-14 days). These facts can be used as predictors of processes developing at the levels of the lower stratosphere. The quantitative characteristics of brief spring and autumn transformations in the circulation regime of the lower thermosphere can be used in predicting both processes at the lower levels of the stratosphere and the state of the upper layers of the atmosphere. Tables 1; references: 13 Russian.
[69-5303]

UDC 551.506.2(263):551.55

APPLICATION OF DATA FROM ATLANTIC TROPICAL EXPERIMENT (GATE) FOR WIND FIELD ANALYSIS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 22 Feb 82) pp 1323-1326

RADZHAPOV, M. R., Tashkent Polytechnic Institute

[Abstract] One of the fundamental tasks during GATE was a detailed study of the wind in the low latitudes. The wind analysis makes it possible to determine the ICZ axis and waves in the troposphere. This article gives a series of results from the work, such as the following. The zonal distribution of pressure has the following characteristics: whereas at the earth's surface

and at the 850-mbar surface the minimum falls at 10° latitude, above the 700-mbar surface the minimum falls precisely at the equator. At the 300- and 200-mbar surfaces in the northern hemisphere there is a pressure maximum at latitude 20°. In the southern hemisphere such a maximum is at a latitude of 10° and is manifested at all altitudes, beginning at the 500-mbar surface. In the lower troposphere the curves for all three phases are close to one another, but beginning with the 300-mbar surface the difference becomes more appreciable with altitude. The daily pressure profiles were used in computing the profiles of the zonal geostrophic component of wind velocity. Computations were made for 10, 15, 20, 25° in the northern hemisphere and 10, 15° in the southern hemisphere. In the upper troposphere in the southern hemisphere the zonal flow is for the most part westerly; only in the first phase at the level of the 100-mbar surface is the mean zonal flow easterly. Data were obtained on the vertical profiles of the zonal geostrophic wind, averaged for all three phases. A weak westerly flow in the northern hemisphere is situated at a latitude 25° in the layer 8-13 km, whereas in the southern hemisphere a strong westerly flow is observed at 10° and occupies virtually the entire troposphere above the 500-mbar level. The study reveals that in an analysis of the stability of zonal flow it is necessary to evaluate changes in its characteristics both horizontally and vertically. Figures 2, tables 1; references: 2 Russian.
[69-5303]

UDC 551.582.1(98/99)

DYNAMICS OF MODERN CLIMATE OF POLAR REGIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 4 Jun 82) pp 1269-1277

VOSKRESENSKIY, A. I. and MARSHUNOVA, M. S., Arctic and Antarctic Scientific Research Institute

[Abstract] The article gives an outline of the temporal changes (for the most part during the period 1938-1981) in temperature, cloud cover, duration of the snow-free period, atmospheric transparency, radiation balance, direct and total radiation. Modern cooling in the polar regions is occurring against a background of a decrease in cloud cover and the duration of the snowless period, an increase in the ice content of seas and a decrease in the radiation balance of the surface despite an increase in direct and total radiation. A series of figures and tables reveals much of the picture: Fig 1 -- Temporal changes in mean annual air temperature averaged for moving five-year periods in the Arctic and Antarctica for a series of stations; Fig. 2-- Temporal change in atmospheric transparency coefficient in spring and summer in Arctic and Antarctica; Fig. 3 -- Temporal change in mean annual values of direct and total radiation, temperature, cloud cover, anomalies of duration of snow-free period and radiation balance of surface for Arctic and Antarctica; Fig. 4 -- Annual variation of radiation balance of surface of Kara Sea during different periods; Table 1 -- Atmospheric Transparency Coefficient During Different Periods in Arctic and Antarctica; Table 2 -- Mean Annual Radiation Balance

Values in Kara Sea During Different Periods. The joint analysis of the principal components of the climatic system indicated that the unidirectionality of changes in most hydrometeorological processes at a climatic time scale, characteristic only of the polar regions, intensifies the effect of global changes in climate in these regions. Figures 4, tables 2; references 27: 23 Russian, 4 Western.
[69-5303]

UDC 551.521:551.581

RADIATION ENERGETICS OF CLIMATIC SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 16 Jul 82) pp 1262-1268

GINZBURG, A. S., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] A sufficient quantity of observational data and results of numerical modeling have now been accumulated for characterizing the radiation regime of the atmosphere and the climate system as a whole. The purpose of the author is a discussion of the applicability of simple analytical radiation models for describing the thermal regime of the climatic system and parameterization of radiative heat exchange in numerical models of the theory of climate and a qualitative evaluation of the role of radiation in the formation of modern climate. In this article a study is made of problems in the theory of climate in which the radiation properties of the atmosphere are described by a model of a homogeneous layer. A very simple global climatic model is proposed which is based on the heat balance equation for the surface. It was found that despite the complex spectrum of absorption and reflection of climate system components the characteristic mean values can be used for both qualitative and quantitative evaluations. Despite the strong dependence of the optical dendity of the earth's crust on altitude, in some climatic processes the atmosphere can be regarded as a homogeneous isothermic layer. The model of a homogeneous atmosphere gives the proper values of the mean climatic temperature of the earth's surface and its variability with a change in insolation and the CO_2 content. Together with a constancy in the rate of radiational cooling in latitude the model of an isothermic atmosphere gives the correct latitudinal distribution of mean atmospheric temperature with a stipulated real surface temperature. All this indicates the suitability of using simple radiation models of the atmosphere for the needs of the theory of climate, weather forecasting and the interpretation of observations. Radiational cooling is the least variable type of heat influx to the entire thickness of the atmosphere. It is still not understood why and what interaction of radiation, dynamics, evaporation and condensation in the climatic system evens out the radiational cooling of the atmosphere. Figures 3; references 21: 13 Russian, 8 Western.
[69-5303]

UDC 551.58:551.510.42:551.510.53

STRATOSPHERIC AEROSOL AND ITS INFLUENCE ON EARTH'S CLIMATE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 21 Apr 82) pp 1256-1261

KAUFMAN, Yu. G., KOLOMEYETS, M. P. and KHMELEVTSOV, S. S., Institute of Experimental Meteorology

[Abstract] Using a two-level energy balance model of the earth's thermal regime the authors have evaluated the role of background stratospheric aerosol in the forming of climatic conditions in the year 2000. A model developed by I. M. Alekseyev, et al. (TRUDY IEM, No 28(101), pp 65-80, 1982) was used in computing the changes in surface temperature in different latitude zones caused by the background stratospheric aerosol layer. Use is also made of a model of a stratospheric aerosol layer outlined in this article. A figure shows the change in temperature of the air surface layer computed for the adopted model of a stratospheric aerosol layer. The background aerosol reduces temperature at all latitudes. Cooling in the polar zone is approximately twice as strong as in the equatorial zone, which is attributable to an increase in the particle concentration toward the pole and also an increase in albedo in this region with a decrease in temperature. As an average for the hemisphere, the background aerosol is reducing temperature at the mean annual rate of 0.09 K. With an increase in the background layer by 9% per annum by the year 2000 the decrease in mean temperature will attain 0.6 K. If the increase in the background stratospheric layer with a rate of 9% per year is extrapolated for the next 20 years, the decrease in mean global temperature is more than adequate for compensating the warming due to CO_2. However, the accuracy of such computations is dependent on the accuracy of the following two assumptions: a) the rate of increase in the mass of the background stratospheric layer of aerosol will persist during the next 20 years and b) the thermal regime of the disturbed climatic system can, without substantial errors, be described by the M. I. Budyko energy balance model. Figures 1; references 18: 9 Russian, 9 Western.
[69-5303]

UDC 551.513.1

DYNAMICS OF MOIST ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 30 Jun 82) pp 1241-1246

DYMNIKOV, V. P.

[Abstract] A study was made of the role of macroscale condensation in formation of the principal characteristics of atmospheric circulation in the middle latitudes of the northern hemisphere. A comparative analysis was made of the

results of numerical experiments with and without the inclusion of phase influxes of heat due to macroscale condensation. Two experiments were carried out: one was a control, in which allowance was made for all heat influxes (experiment I) and experiment II, in which the heat influx equation did not include the phase influxes of heat released during macroscale condensation. The computations were made for 90 days and the results were averaged for the last 30 days. The results of the numerical experiments give basis for asserting that the release of latent heat due to macroscale condensation in general leads to the stabilization of the atmosphere in the middle latitudes of the northern hemisphere in winter. The increase in the rate of increase of baroclinically unstable waves in the presence of macroscale condensation does not fully compensate the additional heating of the middle troposphere due to the release of the latent heat of condensation. Although in numerical experiment II there was only an insignificant decrease in the parameter of static stability of the atmosphere in the middle latitudes, it appears that this result is statistically significant since all the additional computations of the parameters characterizing atmospheric circulation in the middle latitudes confirm this shift of the static stability parameter. The results of the numerical experiments also agree well with the assertion that the principal factor determining the temperature gradients in the middle latitudes is macroscale dynamics. Figures 6; references 9: 4 Russian, 5 Western. [69-5303]

UDC 551.577.38

STATISTICS OF DROUGHTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 18, No 11, Nov 82 (manuscript received 4 Jun 82) pp 1207-1214

RAUNER, Yu. L., doctor of geographical sciences (deceased), Geography Institute, USSR Academy of Sciences

[Abstract] During recent years specialists at many research institutes have accomplished much in the climatological generalization of the regime of arid years applicable to the principal grain regions of the USSR and some foreign regions. Research has included the reconstruction of droughts during the preinstrumental period on the basis of historical documents and natural indices. This has resulted in the accumulation of extensive statistical material embodied in catalogues of arid years. These materials are not entirely uniform but they make it possible to reveal new patterns in the multiyear dynamics of droughts. Droughts were defined on the basis of the hydrothermal coefficient (the ratio of the precipitation total during the period with temperatures above 10° to the temperature sum during this same time). The hydrothermal coefficient was used in the form of an expansion in natural orthogonal functions. Systems of drought catalogues were generalized for the main grain regions of the USSR for the instrumental period. A table gives the statistics of groupings of arid years for the 19th and 20th centuries. It is shown, for example, that even for relatively limited areas the appearance

of groups of years with aridity is a relatively rare event. The greatest recurrence--8 2-year groupings for a period of 120 years (1861-1980)--was in the Volga area; the minimum recurrence was in the central chernozem oblasts--3 cases in 110 years. In Western Siberia in a period of 165 years there were 6 2-year and 7 3-year groupings. The most prolonged grouping (5 years in a row) was noted once during the entire period in the Ukraine and in Western Siberia; chronologically they coincided (1920-1924). The author proposes and validates criteria for reconstructing droughts in the past on the basis of indirect moistening indices. In addition, there is a statistical description of a long-period series of droughts in the Dnepr basin during the last 4,000 years. Figures 4, tables 2; references: 5 Russian.
[46-5303]

INFLUENCE OF TROPOSPHERIC AEROSOL ON INTEGRAL ALBEDO OF ATMOSPHERE-UNDERLYING SURFACE SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 3 Jun 82) pp 1199-1206

TARASOVA, T. A. and FEYGEL'SON, Ye. M., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] The authors have developed a general but approximate approach to evaluation of the influence of aerosol on the radiation parameters of the climate system. This approach is based on discrimination of the main parameters of aerosol exerting an influence on solar radiation fluxes, explicit allowance for the quantitative changes in these parameters and the maximum possible separation of effects. The purpose of the study was to create an adequately flexible and simple method for evaluating the influence of variable aerosol in models with few parameters, such as energy balance and numerical climatic models. Emphasis is on the influence of aerosol on the main parameter of the climatic system--albedo. Albedo was computed for a homogeneous atmosphere in a two-flux (δ-Eddington) approximation of the radiation transfer equation. After examining the optical parameters, parameterization of integral albedo of the atmosphere, allowance for water vapor and allowance for the underlying surface, the authors derive quite simple and general approximate dependences of albedo of the cloudless atmosphere on the number and size of aerosol particles, the degree of atmospheric contamination by absorbing particles, water vapor content, albedo of the underlying surface and solar zenith angle. Examples of computations are given. Figures 4, tables 4; references 15: 9 Russian, 6 Western.
[46-5303]

UDC 551.510.42:551.58

FINELY DISPERSE AEROSOL AND CLIMATE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 13 Jul 82) pp 1192-1198

ROZENBERG, G. V., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] The finely disperse fraction of aerosol is sensitive to climatic conditions and in turn exerts a strong and diverse effect on climate. Finely disperse aerosol is characterized by an approximately log-normal distribution of particles by size. In the process of deposition of VAFC (vapors of aerosol-forming compounds) on particles, including dust particles, a sulfate coating is formed on the latter relatively rapidly (1-2 hours) and this determines their activity as condensation and crystallization nuclei in clouds. The presence of the sulfate component ensures the formation of finely disperse but optically dense hazes. During recent years, due to the anthropogenic increase in the content of sulfates in the finely disperse aerosol, their biological activity has begun to assume an appreciable influence, resulting in the poisoning of the vegetation cover by acid rains and the death of forests. In Western Europe this influence is already assuming the magnitude of a climatic disaster. The organic component is less active in climatic respects. The numerous chemical compounds forming it have strong absorption bands, either masked by water vapor or lying in an ineffective spectral region. Its influence on moisture assimilation processes is also small. Regional levels vary substantially and in regions with highly developed industry and agriculture anthropogenic influences can dominate over natural influences. Finely disperse aerosol is inevitably one of the most important agents of the anthropogenic influence on climate. Figures 1; references 19: 18 Russian, 1 Western. [46-5303]

UDC 551.58:551.52:551.558.1

RADIATIVE-CONVECTIVE CLIMATE MODELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 21 Apr 82) pp 1179-1191

KAROL', I. L. and ROZANOV, Ye. V., Main Geophysical Observatory

[Abstract] This is a review of the fundamental assumptions of the component parts and methods for computing the vertical profile of the radiative-equilibrium temperature, taking into account convective adjustment in cases with a supercritical vertical temperature gradient in a horizontally homogeneous atmosphere. The authors give a brief description of methods for taking feedbacks into account in such radiative-convective models and evaluations of their response to changes in external parameters. All the materials presented here confirm that modern radiative-convective models (RCM) constitute a relatively simple but powerful and flexible tool in the theory of

climate. The relatively small expenditure of computer time involved makes it possible to obtain evaluations of nonstationary changes in the multidimensional fields of temperature and energy-bearing fluxes of radiation with different external perturbations of radiation and other factors with an accuracy frequently exceeding the accuracy of similar evaluations of models of general circulation of the atmosphere, which are considerably more complex and unwieldy. A very promising development is the combining of RCM and other models for describing those parts of the climatic system not covered by RCM. The principal shortcoming of RCM is that they do not describe the interlatitudinal transfer of heat by atmospheric movements; this can be overcome by combining RCM with heat balance models explicitly simulating this transfer. The use of hybrid models is considerably expanding the possibilities and reliability of descriptions of climate changes. Tables 3; references 35: 9 Russian, 26 Western.
[46-5303]

UDC 551.513.2

SOME CHARACTERISTICS OF ASYMMETRY OF NORTHERN AND SOUTHERN HEMISPHERE CIRCULATION MECHANISMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 18, No 11, Nov 82 (manuscript received 22 Jun 82) pp 1170-1178

DOBRYSHMAN, Ye. M. and FORTUS, M. I., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] Among the many factors responsible for formation of climate in the northern and southern hemispheres there are two groups which can be discriminated with respect to symmetry relative to the equator. The most important of these is the heat influx from the sun. Its symmetric part is dominant and it governs the quasisymmetric background of zonal mean annual distribution of the main meteorological elements and parameters. The asymmetric part of climate and the general circulation mechanism is governed by three factors: a lesser receipt of heat from the sun at the upper boundary of the atmosphere in the northern hemisphere in comparison with the southern hemisphere as a result of ellipticity of the earth's orbit, the asymmetric distribution of the continents and oceans, relief and nature of the surface of the continents. With these considerations taken into account, on the basis of data for January and June 1979, obtained during the World Meteorological Experiment, a study was made of the characteristics of asymmetry of the zonal distribution of temperature, the horizontal components of wind velocity and the derivatives of the characteristics--mass flow across the equator, kinetic energy and angular momentum. Data on the field of reduced surface pressure for 8 years for the entire earth, on the assumption of zonal statistical homogeneity, are then used in writing empirical orthogonal functions separately for the northern and southern hemispheres and for the entire earth. Figures 7, tables 3; references 8: 5 Russian, 3 Western.
[46-5303]

UDC 551.583.1

EMPIRICAL INVESTIGATION OF CLIMATE RESPONSE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 6 May 82) pp 1159-1169

VINNIKOV, K. Ya. and GROYSMAN, P. Ya., State Hydrological Institute

[Abstract] On the basis of data from meteorological observations made during the last 100 years the authors have obtained empirical evaluations of the latitudinal-seasonal response of surface air temperature to changes in atmospheric transparency (turbidity) and its CO_2 content. The evaluation method was described by the authors in an earlier article (METEOROLOGIYA I GIDROLOGIYA, No 11, pp 30-43, 1981). There is discussion of a broad range of empirical evaluations of the response of mean annual surface temperature in the northern hemisphere to changes in transparency and CO_2 content. These evaluations do not contradict the first empirical evaluations, agree with the most reliable theoretical evaluations and confirm that they are realistic. The patterns of change in latitudinal-seasonal distribution of surface air temperature accompanying the change in mean annual surface temperature in the hemisphere do not depend significantly on whether this is caused by variations in transparency or CO_2 content. The greatest changes in air surface temperature are occurring in the high latitudes during the winter months. The empirical evaluations presented in this paper can find application in an examination of the possible changes in climate in relation to the presently occurring anthropogenic increase in CO_2 content in the earth's atmosphere. Figures 3, tables 3; references 20: 9 Russian, 11 Western.
[46-5303]

UDC 551.513.1:551.58

QUASI-BIENNIAL CYCLE AS PARAMETRIC PHENOMENON IN CLIMATE SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 1 Jun 82) pp 1154-1158

GLEDZER, Ye. B. and OBUKHOV, A. M., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] The authors present a concise review of the results of observations indicating the real existence of a quasi-biennial rhythm of global atmospheric characteristics. The possibility of interpretation of this phenomenon as the parametric division of the frequency of the external effect, the annual variation, is discussed. The data analysis indicates the existence of disruptions of the biennial rhythm each 5-8 years. It is shown that the two-year rhythm of the lower equatorial stratosphere, for example, can be represented as a biennial cycle with disruptions of the cyclicity phase. The phase (such as westerly and easterly for the wind) is displaced by one year with a corresponding disruption. In such an interpretation of data on the biennial equatorial cycle the mean period of the cycle is approximately 26 months. In

actuality, without the disruptions the cycle would be 24 months. A table gives the dates of disruptions of the biennial cycle of velocity of the zonal wind in the lower equatorial stratosphere, as well as the types of disruptions, confirming that the time interval between disruptions is 5-8 years. A model is constructed of a "synthetic" spectrum for a process formed from segments of sine curves with a biennial period, agreeing well with observational data. There is a possibility for objective periodization of series of meteorological elements on the basis of comparison with the variation of the atmospheric biennial rhythm. Figures 3, tables 1; references 17: 15 Russian, 2 Western. [46-5303]

UDC 551.513:551.587

DIAGNOSTIC COMPUTATION AND ANALYSIS OF MEAN CLIMATIC SOURCES FOR NORTHERN HEMISPHERE WINTER CONDITIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 18, No 11, Nov 82 (manuscript received 16 Feb 82) pp 1141-1153

KURBATKIN, G. P. and SINYAYEV, V. N., Computation Center, Siberian Department, USSR Academy of Sciences

[Abstract] This is an analysis of the effect of mean climatic sources on the formation and maintenance of general circulation regimes, beginning with a statistical analysis of mean climatic sources from the point of view of their participation in atmospheric energetics. The authors have constructed a model of general circulation of the atmosphere which includes restrictions on the temporal changes of the first moments of the meteorological fields reproducible by the model. The limiting factors are regarded as the mean climatic sources. In their computation a system of equations is used as a diagnostic system and an archives of a priori meteorological information is also used. The approach to analysis of the mean climatic sources, based on discrimination of the "available" and "unavailable" components, makes possible a correct solution of the problem of system stability. It is made clear that the principal climate-forming factors are the mean effective meridional "pole-equator" temperature gradient on a rotating earth, generating the main dynamic factors, including macroscale eddy fluctuations, and strong temperature contrasts near the eastern shores of the continents, responsible for maintaining azonal atmospheric circulation and the redistribution of fluctuation energy. Figures 5, tables 1; references 6: 4 Russian, 2 Western. [46-5303]

UDC 551.506.21

RESULTS OF GARP FIRST GLOBAL EXPERIMENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 18, No 11, Nov 82 (manuscript received 27 May 82) pp 1123-1140

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[Abstract] This is a review of the meteorological information collected using the elaborate observation system of the GARP First Global Experiment and on the functioning of individual observation systems which were deployed during the course of the experiment. The article also gives details concerning the system for four-dimensional data assimilation employed at the European Center for Medium Range Weather Forecasts (ECMWF) for creating a Level-IIIb data archives. This is followed by an analysis of experiments which were carried out for evaluating the contribution of different FGGE observation systems to an increase in the accuracy of analysis and forecasting in the northern and southern hemispheres. The results of a direct comparison of the satellite observation system and aerological data are presented. Finally, the author gives some results of modeling of general circulation of the atmosphere and there is a discussion of some features of circulation of the tropical atmosphere during the FGGE period. As a result of this work the advance time for successful forecasts in the southern hemisphere increased from 2 to 5 days and in the northern hemisphere from 5 to 5.5 days. It was found that the exclusion of radiosondes and pilot balloons had a negative effect on the quality of forecasts. The "buoy-polar orbital satellite" system was extremely effective in the southern hemisphere. The system of geostationary satellites gave unique information on circulation in the tropical zone. On the average, useful predictability for all situations with the ECMWF forecasting model is 4-6 days. Figures 5, tables 9; references 50: 17 Russian, 33 Western.
[46-5303]

UDC 551.513.1

ZONAL ATMOSPHERIC MODELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 5 Jul 82) pp 1247-1255

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[Abstract] Zonal models of the atmosphere are those in which the independent variables are t, latitude φ and any of the variants of the vertical coordinate σ. Zonal models cannot describe variations of atmospheric structure along a circle of latitude and almost completely preclude the possibility of investigating the geography of climate and general circulation of the atmosphere on a planet with a real morphology. Elimination of one of the dimensionalities results in a problem which is incomparably simpler than three-dimensional modeling. The attractiveness of zonal models is the possibility of carrying

out a great number of numerical experiments on a computer in reasonable time. The principal property of the atmosphere lying at the basis of derivation of the equations of zonal models is an approximate symmetry of many statistical characteristics of the atmospheric thermodynamic regime relative to the planetary axis of rotation. In this article in the derivation of a zonal model the point of departure is an ordinary full system of three-dimensional nonstationary equations of atmospheric dynamics with the independent variables t, λ, φ, $\sigma = p/p_s$, including prognostic equations for the horizontal velocity components u, v, temperature T, moisture content q, surface pressure p_s and diagnostic relationships for vertical velocity σ and a number of additional variables. The characteristics, advantages and shortcomings of such a model are fully discussed, with particular attention to the role of the second moments and the methods for their parameterization. References 16: 10 Russian, 6 Western.
[69-5303]

MONIN ON CURRENT RESEARCH AREAS IN OCEANOLOGY

Yerevan KOMMUNIST in Russian 30 Jan 83 p 4

[A. Monin, corresponding member of the USSR Academy of Sciences, Director of the Institute of Oceanography of the USSR Academy of Sciences imeni P. P. Shirshov: "The Ocean: New Look at the Essence of Currents"]

[Text] Neither the sailor nor the fisherman, nor the researcher have had detailed maps of the sea floor relief until now. This why there is a grain of truth in the fact that we know the ocean floor less than the surface of the opposite side of the moon or the face of Mars, or even Mercury. The needs of science, navigation, and industry require maps compiled not by point and lines, but by areas. The first industrial samples of scanning and multiple-beam fathometers used to obtain the floor relief in a band up to 40 miles wide have all ready been made. The method of acoustic holography is even more promising. It will permit in 10-20 years production of detailed maps of the most important regions of the floor of the World Ocean.

Our oceanologists in recent years have considerably advanced in studying the ocean hydrophysics. One of the recent major discoveries is the synoptic eddies found by the scientists of our institute in the ocean which are similar to those that we observe in the atmosphere. We have successfully developed a theory for this phenomenon. It was found that the previous concepts regarding currents in the ocean as wide and deep "rivers" were simplified. Actually, the main energy of the ocean currents, up to 90 percent is concentrated in the eddies. If we look at their motion indicators which have been averaged for several months, then we arrive at those currents that we have known from our school desks. Our scientists have suggested a number of physical-mathematical models which efford the possibility of predicting the eddy variability of the ocean.

In addition to synoptic, the so-called frontal eddies have been discovered and described. They can be called spiral-twisting eddies. These are split-off branches of such jet currents as the Kuroshio, Oyashio, north Pacific Ocean, and Gulf Stream. Modeling of the eddy perturbations is also important for marine transport, and for development of the biological and energy resources of the ocean.

Finally, the Soviet oceanologists have priority in discovering the deep contradictions, turbulent motion of water in the near-surface layers of the ocean, microcurrents in the water mass caused by variability of temperature and salinity, and thin-layer benthic currents. Study of the so-called internal waves in the ocean which develop because of vertical instability of layers due to a drop in ocean water density has yielded a lot of new facts. The importance of this research is indicated by the following: it is believed that the sudden loss in 1963 of the American nuclear submarine "Thresher" occurred because it became uncontrollable under the influence of an internal wave.

Hydrophysical studies have thus significantly altered our concepts regarding vertical and horizontal circulation of water in the ocean. We are now faced with the task of uniting into a single theory the physical processes occurring in the ocean, including surface wave action. The scientists hope that in the near future surface wave action will be successfully recorded and studied using oceanographic satellites, and an international global network of automatic ocean stations will be created. Using them we will be able to obtain information similar to that which the meteorologists have because of the world meteorological station network.

9035
CSO: 1865/94

MAP COMPILED OF SECTION OF SEA FLOOR OF SEA OF JAPAN

Moscow SOVETSKAYA ROSSIYA in Russian 2 Dec 82 p 4

[Article by S. Korepanov, TASS correspondent for SOVETSKAYA ROSSIYA: "The Bottom Lay on the Map"]

> [Text] The first detailed map of the floor section of the Sea of Japan was created by the specialists of the Main Administration of Geodesy and Cartography of the USSR Council of Ministers and the scientists of the Institute of Marine Biology of the USSR Academy of Sciences.

The oceanologists believe that we know the surface of the moon better than the bottom of the World Ocean. It is paradoxical that in the space age, two-thirds of the earth's surface which is occupied by seas and oceans still remains "terra incognita."

Only the depths are indicated on the modern maps of the World Ocean. The complete map of the sea floor, accurate information about its surface, underwater vegetation and animal world are concerns of the future. It is true that this is not too distant, for the first step has been taken in this direction by the Soviet cartographers who have created a map of the water area of the Zaliv Petra Velikogo.

I glance at the world's first underwater map. It noticeably differs from the standard: unfamiliar designations, some kind of numbers.

"You see the 'manuscript' variant of a basically new type of map," says the head of the laboratory of marine geophysical work of the Central Scientific Research Institute of Geodesy, Aerial Surveying and Cartography B. Malakhov. "Soon maps of the sea and ocean floors will become standard, and quite probably, will be studied in the school in geography courses."

"Why does the map have such a large scale, 1:10,000?"

"This is dictated by the capabilities of the existing apparatus for underwater mapping. Our side-looking sonar makes it possible to obtain acoustic photographs of the sea floor, encompassing in the visual field bands of the floor of 375 meters on both sides during motion of the ship. Imagine how many miles a scientific vessel would have to travel over the gulf in order to photograph an area

of the sea floor 10,000 square kilometers! The work is complicated by the fact that photography from the ship is impossible in the shoals, and we had to install the apparatus on a boat. This is what we did for two years."

"What do these mysterious markers mean?"

"These are the pebble, sand and silt fields. In the same way as we usually mark on the maps mixed forests, taiga, forest-steppe, deserts, here we designate the species and density of marine plants, and microorganisms and animals living on the floor. In compiling the biological load of the map, we were aided by scientists from the Institute of Marine Biology of the Far East Scientific Center of the USSR Academy of Sciences. They calculated the 'animals' using apparatus for taking soil samples. Its readings were monitored by a diver: he was lowered in the marked square, and after outlining a small section of the floor, he computed the average density of the underwater inhabitants per square meter of area."

"Why was precisely this region of the sea selected?"

"Experiments on industrial raising of mussels, oysters, and scallops are conducted here in the water area of the marine preserve of the Institute of Marine Biology. Having our map, the specialist will be able to find out which section of the sea floor is the richest in plants and microorganisms, and where it is better to plant the artificial colonies of scallops and much more."

"Do the workers of the USSR Ministry of the Fish Industry know about your map?"

"The game workers are attentively following our research in this field. After we have fulfilled the order of the biologists, the Pacific Ocean Institute of the Fishing Industry and Oceanography of this ministry has asked us to compile a complete atlas of the floor of the Zaliv Petra Velikogo. The ancient dream of the fishermen will come true, to catch fish with 'open eyes,' that is in the zones where the fish feed."

Fulfillment of the order of the fishermen is only part of the extensive work to develop the World Ocean. Our maps are needed by geologists and power engineers who are faced with using the energy of the tides, and specialists of the most diverse sectors.

9035
CSO: 1865/93

EXPERIMENTAL TANK SIMULATES INTERNAL WAVES

Tallinn SOVETSKAYA ESTONIYA in Russian 15 Feb 83 p 3

[Article by TASS correspondent: "Tank for the Ocean"]

[Text] The scales of the World Ocean and its models which have appeared in one of the laboratories of the Institute of Applied Physics of the USSR Academy of Sciences are incommensurable. However this tank which is several cubic meters in volume can provide the scientist with ideas about the processes occurring in its depths.

The Gorkiy physicists have long been interested in underwater waves which promote mixing of the ocean layers, change in currents, redistribution of energy of the wave action. This is already directly linked with planetary weather, and with guaranteeing navigation safety, and marine industry. In order to study the processes occurring in the water masses, the Gorkiy scientists have created a set of radiophysical apparatus. Using it during the expeditions of the scientific ships "Dmitriy Mendeleyev" and "Vityaz'" studies were made of the interaction of the internal and surface waves.

Nevertheless not all the data can be obtained in the ocean. The extant large basins where models of ocean diesel boats are tested cannot even help here. It is difficult to separate the water in them into layers which differ in density and temperature. The main moving force of the internal waves is hidden precisely in this difference in the opinion of the scientists.

The Gorkiy people found a method of simulating the temperature profile which guarantees the existence of these waves. This will make it possible to work out a technique for producing them during the experiment. On its basis it is planned to build in Gorkiy the world's first basin where this important physical mechanism will operate.

9035
CSO: 1865/92

RADAR SYSTEM FOR MONITORING SEA STATE

Moscow IZVESTIYA in Russian 25 Jan 83 p 3

[Article by S. Krayukhin: "Chasing the Storm"]

> [Text] The diesel boat "Kolkhida" will leave Odessa on an experimental trip on 27 January. The expedition task includes working out a new technical system which makes it possible to rapidly follow the wave action on the water surface, and to find in time sections which are dangerous for navigation. The Leningrad specialists, colleagues of the Main Geophysical Observatory imeni A. I. Voyeykov and the Central Scientific Research Institute of the Navy are on board the ship.

A storm at sea. How much trouble, and sometimes real misfortune it brings to navigators. Mankind has been struggling with the threatening natural elements for more than a century, searching for methods and means of maneuvering and by-passing dangerous zones. Despite the development of science and technology, this problem remains an urgent one even now.

The method suggested by the famous Leningrad specialist in the field of radar, Doctor of technical sciences A. Zagorodnikov can prove promising in predicting navigational safety. The effectiveness of radar surveying from an airplane has already been proven. This was confirmed by the joint Soviet-American experiment. A group under the supervision of the scientists participated in this experiment. Now they are faced with verifying the technical system in a marine expedition and making recommendations for its practical application.

As indicated by the deputy director of the Main Geophysical Observatory V. Stepenko, radar surveying of the sea surface has a number of advantages over the traditional, so-called contact observation method. The radar system makes it possible to significantly expand the observation area. Studies can be done at any time of the day and do not depend on the visibility conditions. There is a great increase in the rapidity of studying the sea wave action on certain sections. The navigators thus obtain in advance the necessary information about the nature of the sea waves, about misfortunes threatening the ship and they can take the necessary measures.

9035
CSO: 1865/92

UDC 550.834.08

STRUCTURE OF TRANSFORMED FAULTS OF CENTRAL ATLANTIC ACCORDING TO DEEP SEISMIC PROFILING DATA

Moscow BYULLETEN' MOSKOVSKOGO OBSHCHESTVA ISPYTATELEY PRIRODY: OTDEL GEOLOGICHESKIY in Russian Vol 58, No 2, Mar-Apr 83
(manuscript received 14 Sep 82) pp 15-29

KOGAN, L. I. and ZONENSHAYN, L. P., Southern Division, Institute of Oceanology, USSR Academy of Sciences, Gelendzhik; Institute of Oceanology, USSR Academy of Sciences, Moscow

[Abstract] Three zones of transformed faults have been studied in the Atlantic Ocean: Atlantis is the northern part of the ocean, Vernadskiy and Romanche in the equatorial zone. Each of these is discussed in detail. These major faults, investigated by deep seismic sounding and the reflected waves methods, have a number of structural elements in common. These include: 1) a block structure of the earth's crust formed by blocks of different size in the second and third layers, the boundaries of the blocks being orthogonal, oriented parallel both to the axis of the mid-oceanic ridge and to the fault; 2) an intense deformation of the second and third layers with the formation of stepped faults with an amplitude of movement 2-3 km; 3) an increase in the thickness of the crust under uplifted bottom sectors and a decrease in depressed sectors where deep mantle rocks lying at a depth of 2-3 km come close to the surface, locally outcropping at the bottom. The deep structure of the zones of transformed faults determines the characteristic forms of relief. The fact that the faults are accompanied by canyons is directly related to the contraction of the upper parts of the crust and accordingly the approach of denser mantle masses to the bottom surface. In some cases (Atlantis fault) this can be attributed to contraction of basalt melts due to wedging-out of the magma hearth in the fault zone. In other cases (Vernadskiy, Romanche faults) there is an important dilatational component, causing partial spreading of the deep matter of the mantle and its rising to the surface. Along the transformed faults there may be a dilatational or compressional component or there will be pure shear, depending on how the fault is oriented relative to the direction of movement of the lithospheric plate, determined from the position of the pole of relative rotation of two adjacent plates. In the Atlantic the Vema fault is an example of a fault with a compressional component. Faults with a compressional component differ from the investigated faults in having a marked asymmetry of the transverse profile, with a major ridge being situated on one side of the fault. Figures 5; references 25: 23 Russian, 2 Western.
[122-5303]

UDC 551.21

SPEED OF SOUND IN ATLANTIC OCEAN BOTTOM DEPOSITS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 269, No 1, Mar 83 (manuscript received 22 Mar 82) pp 223-226

SHURKO, I. I., IL'IN, A. V. and ORLENOK, V. V., Acoustics Institute imeni N. N. Andreyev, Moscow; Kalinin State University

[Abstract] A map of the speed of sound in the surface (thickness up to 1 m) layer of bottom sediments in the Atlantic Ocean was compiled (reproduced in this article in a full-page format). This map was constructed on the basis of an earlier map showing the bottom relief of the Atlantic Ocean, types of bottom sediments and their density (Il'in, A. V., et al., DAN, Vol 241, No 6, 1978). A 3-step scale of V_{sound} values was selected (<1.5, 1.5-1.6,>1.6 km/sec). The map reveals, for example, that in the abyssal sediments of the tropical and temperate latitudes the speed of sound usually does not exceed 1.5 km/sec, but rarely drops below 1.44-1.45 km/sec. With a decrease in bottom depth and as the sediments become coarser the speed of sound increases. In the internal regions of the ocean the V_{sound} values are 1.5-1.6 km/sec. A speed of sound of 1.5-1.6 km/sec is also characteristic for the sediments of three abyssal basins (Caribbean, Norwegian, Mediterranean), although they are characterized by different types of bottom sediments. The highest speed of sound >1.6 km/sec is observed primarily in the coarse-grained deposits of the shelf zone, in some sands and silts increasing to 1.8-2.0 km/sec. Each speed-of-sound gradation is in general associated with a particular type of bottom material and grain size. The speed of sound, it can be said, is controlled by the geographic zonality of sedimentation processes: latitudinal, vertical and circumcontinental. In sediments homogeneous in mineralogical composition it increases with particle size. In the case of a homogeneous granulometric composition it is higher in sediments of terrigenous and volcanic origin than in those of organic origin. Figures 1; references 11: 7 Russian, 4 Western. [116-5303]

UDC 551.511.3:532.527

SOUND RADIATION BY LINES OF EDDIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 2, Feb 83 (manuscript received 6 Apr 82) pp 203-206

GRYANIK, V. M., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] Regular and turbulent eddy movements in a compressible fluid generate acoustic waves. The radiation intensity is essentially dependent on eddy field structure. Some features of this dependence and the nature of change of the eddy field during the radiation process can be traced by examining the radiation of acoustic waves by quasistationary configurations of lines of eddies. An earlier study (V. I. Klyatskiy, IZV. AN SSSR: MZhG, No 6, pp 87-92, 1966) dealt with the radiation of sound by two eddies of equal intensity and

sign. This revealed that the radiation is quadrupole and the radiation intensity is $\sim M^4$ (M is the Mach number); with time, losing energy in radiation, the eddies disperse as $a = a_0(1 + t/\tau)^{1/6}$, where a_0 is the initial distance between eddies, τ is the characteristic time of eddy dispersal. Against this background, the author has investigated sound radiation by two eddies of different intensity and sign. It was found that the radiation intensity is also $\sim M^4$, but is essentially dependent on the relationship between intensity of eddies; not only is the dispersal of the eddies possible, but also their collapse into the center of rotation if the pair is formed by eddies of different signs. Radiation by some stationary configurations of a large number of eddies is also analyzed. Expressions are derived describing dispersal and collapse for different eddy configurations. A system of three eddies is also examined, in a general case with quadrupole radiation and with an intensity $\sim M^4$, although special cases are possible. References 10: 9 Russian, 1 Western.
[115-5303]

UDC 551.465.153

PROPAGATION OF PASSIVE IMPURITY IN OPEN OCEAN EDDY FIELDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 2, Feb 83 (manuscript received 13 Jan 82) pp 185-194

DEMYSHEV, S. G., YEREMEYEV, V. N., IVANOV, L. M. and KNYSH, V. V., Marine Hydrophysical Institute, Ukrainian Academy of Sciences

[Abstract] The results of numerical studies of the diffusion of a passive impurity (PI) in eddy fields at a synoptic scale indicate that interactions of a spot of impurity with one or more eddy formations exert a substantial effect on its further dynamics. This contribution to the total picture of transport of an impurity is decisive not only in formation of the field of concentration of PI in small time intervals (several months), but it also plays a primary role in determining the initial field for more long-term (several years) study of its movement. This article gives the results of numerical experiments for studying the three-dimensional diffusion of a passive impurity from instantaneous point and extended sources in the POLYMODE polygon. The particle method was used in modeling diffusion of the impurity. A physical mechanism of the capture of the PI by an eddy is proposed. In the initial stage of capture the penetration of the impurity into the central part of the eddy formation is caused exclusively by eddy diffusion. Then the diffusional propagation of PI in the direction of the eddy center is intensified by advective movement. In the absence of capture the impurity simply flows around the eddy. The processes of interaction between a PI spot and one or more eddy formations in the open ocean are further examined. The transport of mass by eddy formations is analyzed. The influence of vertical movements of ocean waters on formation of the PI concentration field is then investigated. Figures 8; references 16: 15 Russian, 1 Western.
[115-5303]

GENERALIZED SPECTRA OF BOTTOM SEISMIC NOISE IN WORLD OCEAN

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 5 Jan 82) pp 980-983

OSTROVSKIY, A. A., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] The effective implementation of marine geophysical experiments with use of high-response bottom seismographs requires preliminary information on the level and spectral composition of bottom seismic noise in the work region. This article gives generalized spectra of bottom seismic noise obtained by a comparison of all available data. About 10 studies containing the spectral characteristics of bottom seismic noise have now been published; these give 39 spectra in the frequency range 0.1-100 Hz. In addition to these, in constructing the generalized spectra of bottom noise in the world ocean use was made of the results obtained by the author on various expeditions of the Institute of Oceanology--59 spectra in the frequency range 2-20 Hz. Spectral curves representing the maximum, minimum and statistical mean level of bottom seismic noise were constructed as a result of generalization of 98 spectra; these are represented in Fig. 1. All the curves reveal a distinct maximum at frequencies from 0.15 to 0.4 Hz; the parameters are determined by the characteristics of the sources of storm-induced microseisms. The maxima of the spectra of continental noise fall in the range of periods 5-8 sec, corresponding to periods of storm waves. This indicates a primarily surf generation of microseisms. The picture is less clear for bottom noise: the existence of microseisms from both surf and standing waves can be postulated. In contrast to "continental" spectra, the curves for bottom noise drop off considerably steeper with an increase in frequency; there is also an appreciable rise at frequencies exceeding 10 Hz probably caused by ship noise. These spectral curves can serve as a guide in selecting the principal parameters of bottom seismographs (frequency characteristic, amplification factor). The scatter of bottom noise spectra for some frequencies is 3.5 orders of magnitude, so that the deviation of the real spectrum from the mean spectrum may be considerable. Figures 1, tables 1; references 16: 5 Russian, 11 Western.
[52-5303]

UDC 550.348.432

EXPERIMENTAL STUDY OF BOTTOM SEISMIC NOISE IN OCEAN DURING CYCLONE PASSAGE

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 17 Dec 81) pp 975-979

OSTROVSKIY, A. A. and RYKUNOV, L. N., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] A solution of the problem of the influence of cyclones on bottom seismic noise required the tracing of changes in noise parameters in time intervals of about several days. Only a few studies giving the results of research relating to the influence of weather on the level of bottom noise have

been published. It was possible to register the intensification of bottom noise caused by a local cyclone situated not far from the coast. The registry of noise on the ocean floor was accomplished during the 21st voyage of the "Dmitriy Mendeleyev" in the autumn of 1978. The bottom seismograph was installed in the northwestern basin of the Pacific Ocean at a depth of 5,630 m. The record obtained was sufficiently compact and convenient for making a comparison of variations of bottom noise and weather conditions at the ocean surface. Figure 1 illustrates the influence of hydrometeorological conditions in the ocean on the level and spectral composition of seismic noise; Fig. 2 is a map of the movement of a cyclone causing a noise storm in the region of bottom seismograph placement. An increase in wind and waves during the period 25-26 September 1978 was caused by the passage of a local cyclone, surrounded by three zones of high pressure, over the region. The comparison of all data confirms that the observed increase in bottom noise was caused by the storm. The possibility of an influence of onshore noise was excluded. The noise increase was evidently caused by the nonlinear interaction of storm waves. The influence of hydrometeorological conditions on the level of seismic bottom noise ceases to be significant at frequencies exceeding 3-4 Hz. Figures 3; references 12: 4 Russian, 8 Western.
[52-5303]

UDC 551.463.2(265)

MIGRATING SOUND-SCATTERING LAYER IN EQUATORIAL PACIFIC OCEAN

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 16 Sep 81, after revision 13 Jan 82) pp 951-954

KUZNETSOV, I. L., STEFANOV, S. R. and SAVAGOV, V. I.

[Abstract] On the 24th voyage of the "Dmitriy Mendeleyev" in the central equatorial part of the Pacific Ocean a migrating sound-scattering layer was observed at several stations in thr region of the Cromwell Countercurrent by the echo-sounding method at a frequency of 50 KHz. A typical echogram obtained in the evening indicated a characteristic dependence of the behavior of organisms populating this layer on the level of underwater illumination. During the daytime the layer was at a depth of 440 m and had a thickness of 20 m. It began to rise at 1155 hours. As it rose the thickness of the layer increased and the coefficient of volume scattering decreased. After 1310 hours the breakdown of the sound-scattering layer into two layers becomes conspicuous. Still another layer separates out at 1550 hours. Each layer rises in conformity to its own trajectory. The coefficients of their volume scattering are related as 1:0.2:0.05. At about the same hour the three layers had thicknesses of 30, 25 and 40 m. The rate of ascent of the layer varies in the range 0.6 m/min during the six hours from 1200 to 1800. The behavior of the rising layer can be traced to a depth of 125 m. after which it enters into the thick surface layer and is masked by it. The passage of the migrating layer through the Cromwell Countercurrent, situated in the depth range 75-250 m, is not visually reflected in its behavior. It evidently cannot serve as a current indicator. The rising layer passes through a system of nonmigrating sound-scattering layers, but the existing system of layers is not disrupted. In

many cases with the approach of the layer to the surface it is met by a layer descending at a rate of about 20 m/min. The moment of meeting of the layers with direct and retrograde migrations occurs in an interval $\pm$10 minutes relative to sunset. Figures 3; references: 4 Russian.
[52-5303]

UDC 551.463.5

REASONS FOR APPEARANCE OF MAXIMUM NEAR 700 nm IN SPECTRUM OF RADIATION EMANATING FROM SEA

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 8 Oct 81, after revision 21 Dec 81) pp 945-950

VASIL'KOV, A. P. and KOPELEVICH, O. V., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] The maximum near 700 nm in the emission spectrum emanating from the sea was observed first in the spectral curves of the coefficients of diffuse reflection $R(\lambda)$ by A. Morel and L. Prier. Its presence has been confirmed in other studies. According to Morel, et al., with a concentration of chlorophyll "a" of several $mg \cdot m^{-3}$ on the $R(\lambda)$ curves it is easy to see a minimum at 665 nm and a maximum at 685 nm. For the latter there are two possible explanations: anomalous dispersion in the absorption band and the fluoroescence of chlorophyll. Later H. R. Gordon concluded that chlorophyll fluorescence completely explains the observed increase in $R(\lambda)$ at 685 nm and there is no need to postulate an anomalous dispersion phenomenon. In this article the authors use model computations showing that the observed features in the spectra of outgoing emission in the red region can be explained more simply, without implicating anomalous dispersion or fluorescence. The appearance of this maximum near 700 nm can be fully explained by a simple model in which this maximum is caused by the corresponding minimum in the $\chi(\lambda)$ spectrum arising with chlorophyll concentrations exceeding $\sim$1 $mg \cdot m^{-3}$. The anomalous dispersion phenomenon makes a negligible contribution to the formation of this peak. The observed position of this maximum and the overlapping of the absorption bands and chlorophyll fluorescence in the red region give basis for assuming that fluorescence is not the principal factor in the formation of this peak. Figures 2, tables 1; references 23: 15 Russian, 8 Western.
[52-5303]

UDC 551.468.1

SPECTRUM OF DEFORMING WAVES IN COASTAL ZONE

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 27 Feb 81) pp 941-944

SHADRIN, I. F., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] The spectrum of displacements of the free surface, or the equivalent frequency-angle (two-dimensional) spectrum, is an important characteristic of wind waves. The author here examines the change in the form of the spectrum (in its nonlinear part) of deforming waves over a sloping bottom when the water depth is comparable with wave height. The article gives the results of in situ investigations made in the coastal zones of the Black and Baltic Seas during the period 1967-1974. Each spectrum was obtained by the averaging of several tens of individual spectra. About 150 records were studied; three ranges of relative heights were examined. The spectral changes were analyzed, especially for confirming or refuting the hypothesis that these changes occur as a result of wave interaction. It was found that in the deformed wave field the form of the function is dependent on relative wave height. A function transforming the spectrum is given. The zone of strong wave deformations can be considered a singular filter whose effect is directed to an evening-out of the distribution of wave field energy by frequencies, that is, a tendency of evening-out of the amplitude of the wave harmonics. It is confirmed that wave interaction plays more than a small role in this process. Figures 2; references 17: 14 Russian, 3 Western.
[52-5303]

UDC 551.464

VARIABILITY OF SALINITY IN OCEAN SURFACE LAYER

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
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[Abstract] This is a review of the sources of variability of salinity in the ocean surface layer. It relates only to those mechanisms which are presently known and possibly is not complete. The review makes it possible to visualize clearly the range of synoptic variability of salinity of the surface layer in different regions of the ocean. The maximum variability (of several °/oo) can be expected in the coastal regions of the ocean: in regions of runoff of major rivers, upwellings and melting of ice. Salinity drops of about 1-1.5°/oo are observed on fronts formed by the advection of waters along the peripheries of rings separating from major currents. The effect of precipitation is different depending on the region of its falling. Where precipitation is abundant and

mixing is weak the decrease in salinity near the surface attains 1°/oo or more (this should be observed most frequently in the tropical regions and the low latitudes), but where the mixing extends to a depth of several tens of meters freshening causes a decrease in salinity by not more than 0.1°/oo. A salinity variability of the same order of magnitude can be expected as a result of the nonuniformity of wind mixing, nonuniformity of evaporation and modulation of the surface layer by internal waves. As a result of the greater specific contribution of salinity to water density in comparison with temperature and the slower diffusion of salt in the water in comparison with heat, any purely salinity or thermohaline anomalies are more long-lived than purely thermal anomalies. This applies, in particular, to fronts. An analysis of the latitudinal distribution of the ratio of the contributions of salinity and temperature to water density indicates that the greatest probability of appearance of salinity fronts should be expected in the high latitudes where the freshening influence of the melting of ice and river runoff determines the high variability of salinity and in the low latitudes where the temperature field is rather homogeneous and salinity varies in a wide range due to high evaporation (in the subtropics) and abundant precipitation (in the tropics and equatorial zone). There is basis for assuming that the spatial scales of spottiness of salinity and temperature in the surface layer of the ocean are similar. It is therefore possible to expect sharp drops (0.1-0.5°/oo and frontal gradients of salinity against a generally uniform background approximately each 5-10 km in coastal regions, each 50-100 km in regions of climatic frontal zones in the open ocean (zones of westerly boundary currents and subtropical convergences) and each 500-1,000 km in the central parts of the open ocean. References 36: 18 Russian, 18 Western.
[52-5303]

UDC 551.466.4

SINGLE-PARAMETER APPROXIMATION OF FREQUENCY SPECTRA OF ENERGY-BEARING COMPONENTS OF WIND WAVES

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
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[Abstract] The author demonstrates that the known fact of a decrease in the universal constant α for developing wind waves in describing the high-frequency slopes of the spectra by the Phillips equilibrium spectrum $\tilde{S}_p(\tilde{\omega}) = \alpha\tilde{\omega}^{-5}$ can be eliminated within the framework of the power formula $\tilde{S}(\tilde{\omega}) = b_0\tilde{\omega}^{-n_0}$ with the choice of the exponent $n_0<5$, which compensates the decrease in α with a growth of the waves. On the basis of experimental data on the dependence of α and the dimensionless frequency of the spectral maximum $\tilde{\omega}_m$ on fetch it was possible to evaluate the n_0 value for which $b_0 = \text{const}: n_0 \simeq 3.6$, and then $b_0 \simeq 3.4 \cdot 10^{-5}$.

The resulting parameterization $\tilde{S}(\tilde{\omega}) = b_0\tilde{\omega}^{-n}\theta_s(\tilde{\omega}/\tilde{\omega}_m)$ contains only one parameter changing with the development of waves--the frequency of the spectral maximum $\tilde{\omega}_m$--and is suitable for describing the energy-bearing region of the spectrum of adequately developed waves with $\tilde{\omega}_m < 2\text{-}3$. Figures 2; references 7: 6 Russian, 1 Western.
[52-5303]

UDC 551.463.6:7.021.2

NUMERICAL MODELING OF THERMODYNAMIC WAKE OF TROPICAL CYCLONE IN OCEAN

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 6 Oct 81, after revision 20 Jan 82) pp 902-908

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[Abstract] Until recently there was no reliable information on the lifetime of the wake of a tropical cyclone in the ocean. On the 27th voyage of the "Akademik Kurchatov" it was possible to carry out unique hydrophysical measurements in the wake of tropical cyclone "Ella" on the 1st and 20th days after its passage. It was found that during this time the principal features of the thermal structure of the wake persisted, although the measurements made were inadequate for forming a full idea concerning the dynamic structure induced by "Ella." Accordingly, this article gives the results of a numerical experiment carried out within the framework of a model proposed by the authors and described in detail by them in OKEANOLOGIYA, Vol 21, No 5, pp 794-801, 1981; the authors presented some of the results in DOKLADY AN SSSR, Vol 260, No 4, pp 1005-1006, 1981. The model was formulated for the purpose of investigating the long-term evolution of the thermodynamic wake. This new article gives a more detailed examination of the temporal and spatial variability of the dynamic structure and energetics of the wake. The mathematical model is based on the equation of motion, continuity equation and heat transfer equations in a cylindrical coordinate system on the assumption of axial symmetry, integrated vertically within the limits of the upper quasihomogeneous layer. It was found that under the influence of the tropical cyclone a cyclonic gyre of a synoptic scale is formed in the ocean. The patterns of change in available potential and kinetic energy are analyzed as a function of distance to the axis of symmetry and time. Figures 6; references 14: 10 Russian, 4 Western.
[52-5303]

UDC 551.465.5

WATER CIRCULATION IN NEIGHBORHOOD OF SOMALI UPWELLING DURING WINTER

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 3 Dec 81, after revision 4 Mar 82) pp 896-901

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[Abstract] Along the shores of Somali a strong upwelling is observed only during summer, during the period of the southwesterly monsoon. A dynamic feature of this region is the existence of the Somali Current, one of the most powerful boundary currents in the world ocean, which makes a considerable contribution to heat exchange processes over a considerable area of the world ocean. This region is one of the energy-active zones of the world ocean. The Southern Trades Current is a highly important source of the Somali Current. The equatorial zone was included in the investigated region in order to take its role into account in the numerical computations involved in constructing the mathematical model outlined here. A nonlinear model based on primitive equations of motion was used. The computations were made for the region from 40.5° to 54.5°E and from 4.5°N to 11.5°N on the basis of the mean multiyear density fields for the northern hemisphere, stipulated in a grid with an interval of 1° for 31 standard depth horizons. A series of figures shows the results of the computations. The surface circulation is characterized by a tendency to anticyclonic movement of waters. However, it evidently is not a single extensive anticyclonic circulation but a system of two or three circulations. With increasing depth there is a substantial restructuring of circulation. In contrast to the surface layers, where the general meridional transport of waters is directed to the north, in the deep layers there is a marked predominance of equatorward water transport. In accordance with the strong restructuring of horizontal circulation there is also a qualitative transformation of the vertical velocity field. The zone of coastal upwelling of waters gradually decreases and at a depth of 2,000 m the subsidence of waters occurs in the preponderant part of the coastal region. On the other hand, an extensive zone of subsidence of waters to the south of the equator is replaced in the deep layers by a thick zone of upwelling of waters.
Figures 2; references 10: 2 Russian, 8 Western.
[52-5303]

UDC 551.465.5.7.021.2

NUMERICAL MODELING OF ROSSBY WAVES IN OPEN OCEAN

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 6 Jan 82) pp 886-895

BELOTSERKOVSKIY, S. O. and PANTELEYEV, M. S., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] Two earlier articles by V. M. Kamenkovich, et al. (OKEANOLOGIYA, Vol 21, No 5, pp 773-786, 1981; Vol 22, No 5, pp 719-725, 1982) described and

analyzed a barotropic quasigeostrophic model for the prediction of synoptic eddies in an ocean of constant depth with a "solid cap" at the surface. In this article the authors present a further analysis of this model as a necessary stage in an investigation of the general problem for a baroclinic ocean with a free surface and a variable depth. The article describes numerical modeling of Rossby waves in an open region of the ocean using explicit and implicit (employing filtering) finite-difference schemes. It is postulated that the computational instability developing when using an explicit scheme in the case of high values of the Rossby number is caused by the hydrodynamic instability of the considered current. The paper indicates that the implicit numerical scheme applied in this study is more suitable for the modeling of barotropic instability than an explicit scheme. Barotropic instability undoubtedly plays a major role in the formation of synoptic eddies and it therefore can be expected that the proposed modification of the numerical approach outlined by Kamenkovich, et al. makes it possible to predict currents in the ocean for longer time intervals. Figures 5; references 7: 2 Russian, 5 Western.
[52-5303]

UDC 551.465.3:7.021.2

MATHEMATICAL MODELING OF SYNOPTIC EDDIES IN OCEAN

Moscow OKEANOLOGIYA in Russian Vol 22, No 6, Nov-Dec 82
(manuscript received 8 Oct 80, after revision 18 Dec 81) pp 875-885

NEYELOV, I. A., Leningrad Division, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] The objective of this study was an investigation of the interaction between synoptic eddies and the macroscale flow in the open ocean far from boundary currents. It is assumed that the mean flow is not dependent on longitude and the maximum wavelength of the synoptic disturbances does not exceed some prestipulated value. The condition of periodicity of all the hydrodynamic fields is used in horizontal coordinates. Here the author gives new results obtained using an eddy-resolving model described earlier (Neyelov, I. A., et al., OKEANOLOGIYA, Vol 21, No 1, 1981), with a more complete exposition of the numerical algorithm being given. A three-layer model of mesoscale circulation in the ocean is outlined; a method for numerical solution of the equations is described; the results of integration of the equations for a long time in advance are presented. The energy equations of the model are discussed; evaluations are made of different types of energy and the transitions between them with temporal and zonal averaging. It is shown that the role of different mechanisms of generation of eddies and the macroscale flow is essentially dependent on depth and changes with time. In general there is a transition of potential energy to the kinetic energy of eddy movement and a transition of the latter to the kinetic energy of mean movement. The vertical exchange of kinetic energy occurs for the most part due to the operation of total pressure forces. The baroclinic and barotropic parts of

this work have an identical order of magnitude. The kinetic energy of eddy movement passes from the middle layer into the upper and lower layers, whereas the kinetic energy of mean movement passes successively from the upper layer into the middle and lower layers. The energy characteristics of the model circulation are highly dependent on the vertical coefficient of density diffusion. It follows that there must be a more rigorous parameterization of the vertical flows. Figures 3; references 5: 1 Russian, 4 Western.
[52-5303]

UDC 551.462

PALEOOCEANOGRAPHY OF ARCTIC BASIN IN LATE CENOZOIC TIME AND ITS RELATIONSHIP TO GLOBAL CLIMATES

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 20 Apr 81) pp 112-119

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[Abstract] A sedimentary column was raised from a drift ice platform over the central Arctic basin. The oldest level encompasses sediment accumulated from 4.5 to 2.4 million years ago, rather well sorted red sandy clay containing iron-manganese concretions which make up as much as 60% of the sediment fraction larger than 63 μm. Although the fauna indicate low surface temperatures, other features of the sediment indicate that the structure of Arctic water masses was quite different from today. Biologic productivity was higher than today and carbonate compensation was less. There was no permanent ice cover. A great change in oceanography and climate occurred about 2.4 million years ago at the beginning of iceberg and ice shelf activity in addition to shoreline ice. The global temperature reached its minimum about 0.1 million years ago, causing the beginning of the constant ice cover. The permanent sea ice extended into the North Atlantic approximately to 55°N, and atmospheric circulation changed. The conditions were similar to those of 18,000 years ago. The filling of the Arctic with hypothetical ice masses seems improbable in the light of the data here presented. The deglaciation of the Arctic and subarctic latitudes was apparently simultaneous. However whereas the subarctic regions were liberated of ice at the beginning of the interglaciation, the Arctic ice melted during the temperature maxima. References 40: 1 Russian, 39 Western.
[98-6508]

UDC 551.465.4(261)

EVOLUTION OF MEDIUM SCALE OCEANIC VORTICES SOUTHWEST OF THE AZORES

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 1 Jul 81; after revision 8 Dec 81) pp 5-12

KORT, V. G., KRASNOPEVTSEV, A. Yu. and SHADRIN, I. F., Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] Space-time variability of anticyclonic eddies in the central Atlantic Ocean to the southwest of the Azores as studied from the research vessel "Akademik Kurchatov." Three successive quasisynchronous hydrologic surveys of the water area were performed between 4 May and 15 July, 1980 and three oceanographic buoy stations were set out with water temperature and current recorders. Eddies were found to move southwestward at 5 to 7 nautical miles per day. The eddies were apparently formed as a result of interaction of the western Canary current and the irregular bottom topography. A significant rise in 15°C isotherms was observed to the southeast of the anticyclone, indicating the presence of a cyclonic disturbance centered outside the survey area. Figures 3.
[97-6508]

UDC 551.465.4

MEAN OCEAN CURRENT SPEEDS

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 31 Aug 81) pp 13-16

STEPANOV, V. N., Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] The mean speeds of currents at the surface and in the depth of the ocean were calculated based on a linear diagnostic model, using mean multiannual values of temperature and salinity for 5° trapezoids using all available deep water observation data. The results of the calculations were used to determine the mean multiannual currents throughout the ocean at standard levels from surface to bottom and to construct the field of velocities on the surface of the ocean. The mean speeds consider not only the intensity of individual currents but also the entire variety of water movement in the ocean, including the central areas of macrocirculation systems. Figure 1; references 7: 5 Russian, 2 Western.
[97-6508]

UDC 551.46.08

NUMERICAL MODEL OF WESTERN BLACK SEA CURRENTS

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 3 Aug 81; after revision 21 Mar 82) pp 17-22

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[Abstract] Results are discussed on numerical studies of ocean circulation in the western Black Sea within the framework of the quasigeostrophic approximation and based on the solution of the density diffusion equation. The numerical experiments were based on a data base obtained during the 5th voyage of the "Akademik Orbeli," which performed a quasisynchronous hydrologic survey of the western Black Sea at 0, 10, 20, 40, 60, 80, 100, 200, 500, 1,000, 1,500 and 1,800 m depth between 3 and 10 October, 1976. The values of temperature and salinity obtained (after smoothing and interpolation) were used to create a data base for the density field over a uniform horizontal grid with a spacing of 5 nautical miles. Bottom relief determined by sonar was supplemented by bathometric mapping, while the atmospheric pressure was taken as the average for the fall season. It was concluded that the specific distribution of density at the open boundary, a result of the general hydrologic structure of the sea in the fall season, combines with the bottom relief to form the specific current structure near the Bulgarian coast of the Black Sea. Figures 4; references 5: 4 Russian, 1 Western.
[97-6508]

UDC 551.456

SIMILARITY THEORY FOR OCEANIC BOUNDARY LAYER

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 10 May 81; after revision 26 Apr 82) pp 27-34

ZHOLUDEV, V. D., Kabardino-Balkarsk State University, Nal'chik

[Abstract] Studies of the properties of models of the upper boundary layer of the ocean are undertaken using the similarity principle of physical phenomena considering the properties of full self-similarity with respect to certain similarity criteria of turbulent mixing in the upper quasihomogeneous layer. The thickness of the layer, magnitude of turbulent movements and their intensity, heat flow through the surface of the ocean, mixing and temperature jump at the lower boundary of the layer, Coriolis and buoyancy characteristics are the physical basis upon which the theory is founded. Mechanical and convective mixing are related to observations of the layer in the open ocean. Parameters of the layer as calculated by the theory agree well with those observed in the ocean. Figures 2; references 30: 13 Russian, 17 Western.
[97-6508]

UDC 551.465.4(261)

HYDROLOGIC CHARACTERISTIC GRADIENTS IN TWO MERIDIONAL CROSS SECTIONS OF LOMONOSOV CURRENT

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 15 Oct 81; after revision 10 Mar 82) pp 36-40

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[Abstract] In the spring and summer of 1979, the "Akademik Kurchatov" and "Professor Stokman" undertook hydrologic work along the 28°30' and 18°30' W meridians in the latitude interval from 2°N to 2°S. Hydrologic stations were set out each 20 to 30 nautical miles, with 15 sections performed on each meridian. The specifics of distribution of vertical hydrologic characteristic gradients in the cross section are noted. The distribution of vertical temperature gradients indicates that it is characteristic that areas of elevated vertical gradients form in the thermocline at the northern and southern edges in the boundary edges of the equatorial subsurface counter-current. At the equator there is an area of reduced maximum vertical gradient. Changes between spring and summer in the maximum vertical temperature gradient are slight. This characteristic behavior of temperature gradients may result from two alternative mechanisms: advective transfer of a homogeneous water mass with no significant mixing or rather intensive mixing due to unstable flow with a great velocity gradient. Figures 2; references: 2 Russian.
[97-6508]

UDC 551.465.5(26)

VORTEX FORMATION AND SMALL SCALE PROCESSES IN FORMATION AND DISTRIBUTION OF INTERMEDIATE OCEANIC WATERS

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 9 Sep 81) pp 41-49

KUKSA, V. I., Institute of Oceanography, imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] To answer the question of the reason for formation of the quasi-isohaline layer would be to make a significant approach to understanding the mechanism of formation of the Antarctic intermediate reduced salinity water mass. Observations indicate that in the southern ocean there is a transfrontal exchange which is capable of cooling and freshening the water of the sub-antarctic zone to a greater extent than would occur under the influence of the local interaction between the ocean and the atmosphere alone. The polar frontal zones of the ocean have similar large-scale structural features. The Joyce model allows us to estimate the rates of transfrontal exchange. This model can be applied in the areas of the oceanic thermohaline fronts, where transfrontal exchange of properties occurs. The model can also be used to

explain the quantitative estimates of formation of intermediate waters of reduced salinity and elevated temperature. The important role of vortex formation and small-scale processes in exchange of properties at the polar fronts is becoming increasingly clear, one of the best examples of which is the formation and propagation of the intermediate waters. References 23: 7 Russian, 16 Western.
[97-6508]

UDC 551.465.636

INTERMEDIATE OCEAN WATER TEMPERATURE AND SALINITY STATISTICS

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 16 Oct 81; after revision 21 Dec 81) pp 57-67

GALERKIN, L. I., KUKSA, V. I. and DYADYUNOV, V. N., Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] Statistical temperature and salinity analysis was performed for the ocean surface and several standard depth levels. Application of two-dimensional statistical analysis of data corresponding with isopycnic surfaces allows quantiative evaluation of the fraction and position of these water masses in the structure of the waters of the ocean, as well as judgment of the specifics of propagation and transformation of intermediate water masses from areas of formation right up to the point of their disappearance. This work studies intermediate water masses which are most widespread in the ocean. Their names and density potential isosurfaces corresponding with the cores of the deep water masses are presented. The use of a method based on analysis of the two-dimensional distribution function P(T,S) in its climatic representation has allowed for the first time determination of the spatial specifics of distribution of these characteristics in the cores of the intermediate water masses in the ocean, producing the most reliable T/S indexes yet produced by calculation methods. Figures 2; references 14: 13 Russian, 1 Western.
[97-6508]

UDC 551.465.19

MASS TRANSFER AT LIQUID BOUNDARY OF BOTTOM STRATIFIED CURRENT

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 31 Jul 81; after revision 28 Dec 81) pp 74-79

PYRKIN, Yu. G., SAMOLYUBOV, B. I. and BELOSHAPKOV, A. V., Moscow State University imeni M. V. Lomonosov

[Abstract] Field observations with instruments have established that a dissipative interlayer exists at the upper contact zone of the bottom current, with selective permeability for turbulent formations of various scales. Based on the agreement between ranges of the main energy-carrying and natural frequencies of current speed pulsations, a semiempirical relationship has been derived

to determine the turbulent stress at the liquid boundary. It can also be applied to estimation of this stress under similar hydrodynamic conditions and for analysis of mass transfer processes in the upper contact zone of the bottom current. Figures 4; references 22: 18 Russian, 4 Western.
[97-6508]

UDC 551.465.7:551.464

TRANSFER AND FRACTIONATION OF CHEMICAL AIR BUBBLE ELEMENTS IN THE SEA

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 10 Sep 81; after revision 22 Feb 82) pp 80-84

BEZBORODOV, A. A., YEREMEYEVA, L. V. and LYASHENKO, S. V., Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol'

[Abstract] Processes of transfer of chemical elements through the ocean-atmosphere boundary and their fractionation are flotation processes, dictating the importance of studying the flotation of chemical elements in sea water. The mechanics of the processes are described. An expression is derived for the flow of an individual chemical element toward the surface with rising bubbles. The flow of substances with bubbles is balanced in the ocean by molecular diffusion from the surface downward resulting from the concentration gradient. An equation is derived for the variation in the change in relationship between two elements in the surface layer of the ocean water in comparison with volume. Coefficients are obtained which characterize the fractionation of selected elements as they move from the ocean into the atmosphere. References 10: 7 Russian, 3 Western.
[97-6508]

ELIMINATION OF 'EXCURSIONS' IN HYDROPHYSICAL MEASUREMENT SERIES BY MEDIAN FILTRATION

Moscow OKEANOLOGIYA in Russian Vol 23, No 1, Jan-Feb 83
(manuscript received 19 Feb 82) pp 161-163

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[Abstract] An effective method called median filtration is suggested for elimination of extreme values caused by failures in measuring or recording apparatus. Shortcomings of earlier methods are noted. The application of the method to continuous signals is described. The method of median filtration eliminates a few excessive measurements apparently caused by equipment failures. The overall shape of the smoothed curves thus obtained is not altered. The simple filtration scheme outlined here can be improved in

various ways, depending on the task at hand. For example, a weighted linear or nonlinear combination of several intermediate values of the variable might be used to replace the mean value used in the method. Figure 1; references 5: 3 Russian, 2 Western.
[97-6508]

DRILLING AT ACCESSES TO EARTH'S MANTLE

Moscow PRIRODA in Russian No 1, Jan 83 pp 12-22

[Article by L. N. Shadrin]

[Text] Biographical data on author: Lev Nikolayevich Shadrin, candidate of technical sciences, section head at the All-Union Scientific Research Institute of Organization, Control and Economics of the Petroleum and Gas Industry, USSR Ministry of the Petroleum Industry. Specialist in the field of technology and organization of borehole drilling. His article entitled "How to Penetrate to the Earth's Mantle?" was published in PRIRODA, No 11, 1974.

A truly surprising paradox in the modern scientific and technical revolution is the fact that together with the astonishing flights of space vehicles around the earth, to the moon, Venus, Mars and Jupiter, and finally, still farther, beyond the limits of the solar system, the deep layers of our own home in space still remain terra incognita in the full sense of the word.

Due to data from reference prospecting boreholes geologists have succeeded in making a relatively good study of the surface layer of the earth to a depth of 6-9 km. But these depths do not exceed the limits of the earth's upper envelope -- its crust. Even under the oceans, where the earth's crust is relatively thin, it attains 8-10 km, and under the continents its thickness varies from 25-30 to 50-100 km, depending on the nature of the relief. In order to pass through the entire thickness of the crust and penetrate into the mantle several projects have been developed, the implementation of which will be discussed in the article.

Two Means for Penetrating Into the Deep Layers

In order to penetrate into the earth's deep layers both engineers and scientists have proposed many original technical projects which can be reduced to two major groups: shafts and boreholes.

One of these projects provides for the driving of a 30-km drift whose shaft must consist of vertical and slant segments forming Cyclopean steps.* Such a

* Kromi, U., PROYEKT "MOKHOL" ("Mohole" Project), Moscow, 1967.

shaft, whose construction in the not distant future is in principle entirely possible, could have a multipurpose scientific and practical objective. First of all, it can be used as a long-term laboratory for investigating the composition of rocks, physical and many other parameters of the deep environment within the limits of the earth's crust and upper mantle. In addition, such a mine working could also be used in the commercial output of valuable minerals.

However, the driving and reinforcement of such a deep shaft, and then the work of miners and researchers in it, would involve great difficulties. The principal obstacle, indeed, will be a continuous increase in temperature as the shaft becomes deeper. Suffice it to mention that at the limiting face level of a 30-km shaft the temperature should rise to approximately 900°C. In order to ensure the presence and work of people under such conditions it would be necessary to have self-contained capsules supplied with a powerful heat regulation system, equal in its complexity to the corresponding systems of spaceships and automatic interplanetary stations.

Another danger both for the construction of the shaft itself and for the people working in it is related to the effect of geostatic pressure, increasing directly proportional to the depth and density of the rocks. This gigantic pressure, created by the weight of the superposed rocks, tends to crumple and close up the drift shaft, whose driving disrupts the equilibrium state of the rock mass, which arrived in its equilibrium state during the millions of years of its geological history. In order to reinforce a mine working of a relatively great diameter, such as a 30-km shaft would have, there would be a need for superstrong and exceptionally heat-resistant materials, mass production of which is yet to be mastered.

The drilling of boreholes is another method for penetrating into the deep layers of the earth, an alternative to the driving of superdeep shafts.

But what would a borehole driven to the earth's mantle be like? Without any question its prototype is the ordinary oil well. The difference is the incomparably greater depth, the increased severity of conditions at the face (higher temperatures of the deep layers, pore, hydrostatic and geostatic pressures), increased density of rocks and the appearance of other natural factors whose joint influence aggravates difficulties of a purely technological order associated with the driving of the shaft of a borehole to depths greater than 10 km.

The idea of formulating and then implementing the first stages in the project for superdeep drilling to the earth's mantle was related to a considerable degree to the vigorous development of reconnaissance work and the development of petroleum deposits at sea.

Since 1925, when we began drilling of the first borehole from a wooden pile island in the Caspian Sea, in Bibi-Eybat Bay, and then in 1928-1929, when work began in the coastal waters near the state of California, the first sea bases appeared for the drilling of producing boreholes and the operation of underwater petroleum deposits and the sea petroleum industry of the world has undergone a long path of development. Beginning with the use of coffer dams, coastal

trestles and relatively simple (first wooden and then metal) drilling and operations bases of the island type, already from the mid-1950's sea petroleum workers began to make use of movable semisubmerged and self-lifting drill rigs and also special drilling ships. The use of this technology has afforded new possibilities with respect to acceleration of the rates of exploratory and operational drilling of oil wells in extensive, relatively shallow seas and oceans, which at the present time yield more than 20% of the entire world production of petroleum.

It is interesting to note that all stages in the development of sea petroleum industry technology have been characterized by an exceptionally high rate of scientific and technical progress. Today exploratory and oil production work in the open sea is being carried out by companies in about 50 countries, using floating bases and specially outfitted drilling ships of more than 250 types.

That is why, when in 1957 methods for drilling a superdeep borehole to the Mohorovicic discontinuity were discussed (American "Mohole" project"*), the scales were tipped in the direction of use of a floating drilling platform in the ocean.

In the first stage of implementation of the "Mohole" project in March-April 1961 American scientists were successful in drilling five structural boreholes to a depth of 318 m below the ocean floor where the depth of the water layer is 958 m in the neighborhood of a submarine canyon in the waters near San Diego (California). Thereafter a series of five boreholes with a depth as great as 183 m were drilled in the Pacific Ocean to the east of Guadeloupe Island where the water depth is 3,566 m.

The drilling of all these boreholes was accomplished from aboard a specially re-equipped barge, the "CASS-1," supplied with a drill rig, a system for anchorless holding of the ship at a stipulated point on the sea surface, as well as a complex of equipment for carrying out geophysical investigations in the shaft of an underwater borehole.

Later, for drilling the main 11-12-km borehole which was to penetrate to the earth's mantle near Maui (Hawaiian Islands) where the ocean depth is 5,500 m an enormous sea platform was planned. Without fearing typhoons, this semisubmerged platform is supplied with an automated drill rig with a great load-lifting capacity, screws for self-movement, and also an automated anchorless system for holding this drilling "cruiser" at a stipulated point on the sea surface which was extremely modern for the time at which it was designed. At the same time, hundreds of research, planning, machine-building and petroleum companies were developing high-performance drilling tools, systems for the effective flushing of the borehole, varieties and complexes of geophysical and geochemical methods for investigating the deep medium, methods for accelerating the replacement of worn-out bits and face mechanisms and also solving many other technical and engineering problems.

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* The Mohorovicic discontinuity is the boundary separating the earth's crust from the mantle. It is characterized by a jumplike change in the velocity of longitudinal seismic waves caused by the sharply different physical properties of crustal and mantle rocks.

However, the successfully initiated work on implementation of the American "Mohole" project was interrupted in 1966 as a result of cutoff of its funding, which was evidently caused by mobilization of financial resources in preparation for the "Apollo" space program*.

Superdeep Drilling Industry

In 1961 scientists and specialists of our country validated the technical possibility of penetrating the earth's crust by boreholes to a depth of 15-18 km. As the point of departure in selecting the sites for the drilling of such boreholes the following principle was asserted: superdeep drilling should become a means for studying the most complete possible sections of the continental earth's crust in all its thickness in the most important and characteristic geological regions in the territory of our country. At the same time, provision was made for study of such timely problems as the origin of petroleum and gas, the patterns of their distribution in the strata of sedimentary basins, and also determination of the mechanisms of genesis and accumulation of ore matter in the lower "near-mantle" portions of the earth's crust, which has a direct relationship to the search for and predictive evaluation of mineral deposits.

Proceeding on the basis of the mentioned considerations, it was decided to investigate the continental deep layers of the Soviet Union by five groups of superdeep boreholes, the sites of whose drilling were selected on the Kola Peninsula, in the Kura Lowland of Azerbaijan, in the Urals, in the Caspian Lowland, and also on one of the islands of the Kurile group, where a study will be made of the differentiation of deep matter, especially the structure of the earth's crust at the contact between the continents and ocean, the nature of island arcs, the mechanisms of volcanic processes and seismicity.

At the time of discussion of this program (to all intents and purposes about 20 years ago) neither petroleum workers nor geologists yet had technical means for the drilling of boreholes to a depth of 15-18 km. In 1961 the average depth of operational and exploratory drilling in the Soviet Union was 1,620 and 1,995 m respectively. There were only a handful of boreholes with a depth of 4,000 m. However, many important technical and engineering problems in superdeep drilling at that time did not have even a theoretical solution.

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* Until the late 1970's Americans invariably held the world records for the depth of drilling of both operational and exploratory boreholes. The last drilling record was established in 1974 by the "Lone Star Producing Company" in the neighborhood of the most down-dropped part of the Anadarko (Oklahoma) sedimentary gas-bearing basin when the drilling of the Bert Rogers exploratory borehole was suspended at a depth of 9,583 m.

The importance of the program for superdeep drilling was not limited exclusively to the fact that it was directed to solution of highly important scientific problems. It also had an enormous stimulating influence because it required the mobilization of the intellectual and material resources of many scientific research institutes, planning-design organizations and machine building plants for the very rapid creation of new generations of drilling equipment and industrial-geophysical apparatus in order to prepare gradually the necessary technology and specialists, to accumulate basic experience for implementation of the scientific-technical tasks of superdeep drilling.

For this reason a strategy was developed for the step-by-step increase in the depth of borehole drilling. In the first stage, for the drilling of several boreholes to a depth of 7 km, plans called for the use of then-existing standard drill rigs. Thereafter provision was made for the possibility of a further deepening of the shafts of 7-km boreholes to the intermediate depth of 10-12 km and then to the limiting depth of 15-18 km on the basis of newly created drilling equipment.

Test of Strength on Baltic Shield

The strategy of time correlation of the relatively easy first stage of drilling of boreholes to the 7-km level and the intensive development and construction of more powerful equipment, control-measurement instrumentation and drilling structures, as well as investigation of the subsequent lower intervals of boreholes, already completely justified itself during the first phase of the program for superdeep continental drilling on the Kola Peninsula. There the drilling of a 15-km borehole was begun on 25 May 1970. It was positioned at a distance of 8 km from Zapolyarnyy for the purpose of a many-sided investigation of the deep layers of the Baltic crystalline shield, which is a major structural uplift of the East European Platform and one of the most ancient formations of the earth's crust.

In addition to aspects of a purely geological nature, the Baltic shield, including the territory of the Scandinavian and Kola Peninsulas, Karelia, part of Leningradskaya Oblast, the Baltic republics and the waters of the Baltic Sea, is also interesting because the earth's crust in this extensive region is gradually being uplifted, tending to a position of isostasy, that is, to such a state in which its weight is compensated by the Archimedes force acting from the direction of the denser subcrustal matter -- the substrate. A disruption of this equilibrium occurred at the time of the last glaciation, when under the weight of the ice the northern part of the European continent, like an overloaded barge, subsided into the stony-viscous gulf of the mantle. Becoming free of the load as a result of melting of the ice, the Baltic shield began to rise rapidly (in the geological sense), tending to occupy an equilibrium position. The maximum rate of its rising in the northern part of the region is about 1 cm per year. At first glance it may appear that such a rate is small and cannot be noticed. However, the rising of the ancient shield nevertheless lets itself be known. For example, one of its consequences was an earthquake which occurred on 25 October 1976 in the neighborhood of the Gulf of Finland. The epicenter of this earthquake, registered in the immediate

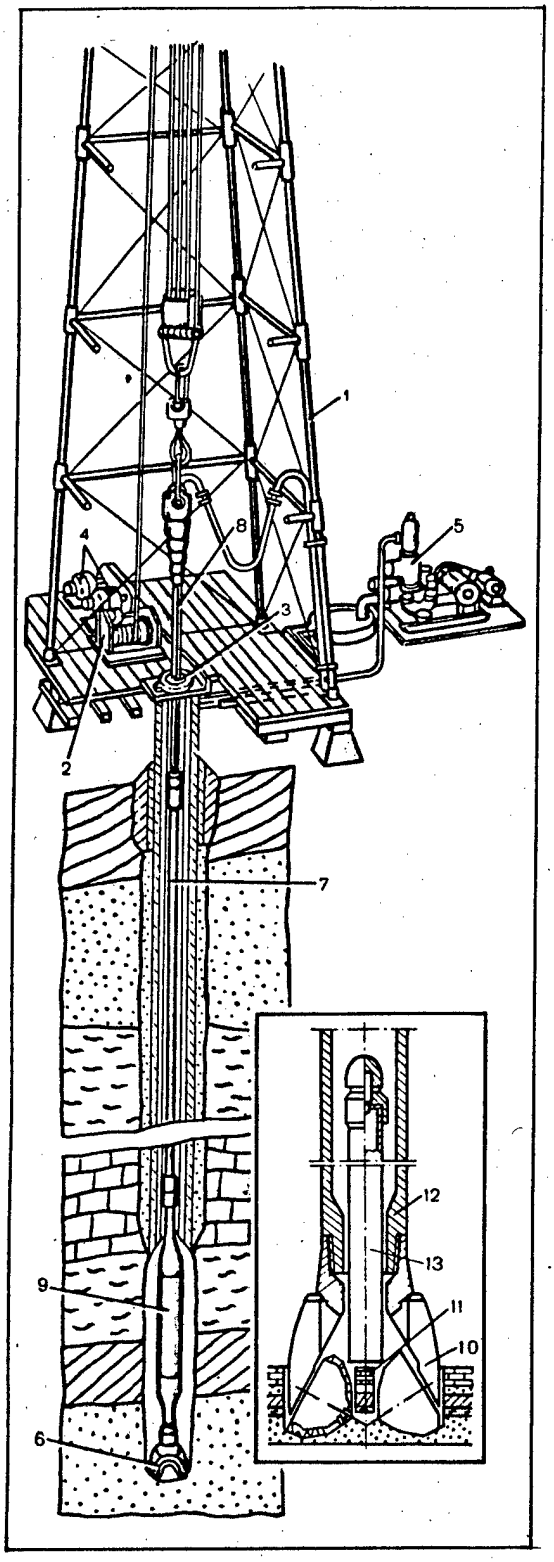

Diagram of drill rig and tool for drilling of deep boreholes. The drill rig is a complex consisting of surface equipment, including a tower [1], winch [2], rotor [3] with drive motor [4], drilling pump [5], and also mechanisms for preparing and purifying drill mud. The drilling is accomplished by a bit which is forced against the face [6]. It is held on the lower end of a column of drilling pipes [7] which can be rotated by means of a drive pipe [8] imparted a torque by the rotor. In another variant, when the bit is rotated by a face motor [9], as in the case of the boreholes on the Kola Peninsula and at Saatly, a bit is attached on the end of the shaft of this motor, which makes it possible to drill a borehole without rotating the multikilometer drilling column. The rock pulverized by the bit is eliminated from the face and is carried from the borehole by a flow of mud ascending between the drilling column and the borehole walls. The mud is fed to the face motor and bit through a hose and a column of drilling pipes. Since the drilling of the Kola borehole is accomplished with the continuous removal of rock samples, among the arsenal of drilling tools used there an important place is occupied by cone bits (see inset). The drilling head [10] of the cone bit destroys the rock along the periphery of the face, leaving an undisturbed core at the center [11]. With increasing depth of the borehole the core enters into a column capsule consisting of a housing [12] and a column pipe [13] with a length of 8-10 m that preserves the core at the time of drilling and during raising to the surface. In the lower part of the column pipe there are core detachers and core holders, and in the upper part a valve which lets through the fluid forced out by the core.

vicinity of the northwestern shores of Estonia, was associated precisely with that part of the Baltic area, where, according to data from geophysical investigations, the most intensive (for this region) uplifting of the shore is occurring, attaining about 3 mm per year.

The far greater rate of uplifting of the Baltic shield in the neighborhood of the Kola Peninsula is evidently attributable to the fact that there, in the north, the thick glacier cover melted much later than the relatively thin layer of ice over the area of the Baltic Sea and in the Baltic regions, which altogether caused the later, and therefore presently observed intensive restoration of the equilibrium state of the northern edge of this extensive region.

The enterprising investigation of the Baltic shield by superdeep drilling is affording a unique possibility for revealing and comprehending the true mechanism of the energetics and dynamics of these vertical movements, and also for evaluating their influence on the tectonics of this shield and similar gigantic formations of the earth's crust.

Superdeep drilling of the Baltic shield for the most part is directed to obtaining a continuous core column and geophysical material for clarification of the geological nature of seismic discontinuities and the reasons for the stratification of the earth's crust with respect to physical parameters, and also for explaining the mechanism of formation and development of the continents, the genesis of granites, the influence of the "basalt" layer on the formation of ore-bearing solutions and the formation of mineral deposits.

In the first stage the drilling of the borehole shaft was accomplished by means of the standard "Uralmash-4E" drill rig so familiar to petroleum workers. The initial interval of the borehole shaft was drilled using a 4-stage multicone bit with a diameter of 920 mm, cased in a 720-mm conductor, to the 40-m level. While drilling the initial shaft with bits having a diameter of 214 mm to the level 5,300 m, the drillers were forced to take measures for eliminating the danger of collapse of the upper part of the borehole, arising as a result of wearing of its walls during countless lowerings and raisings of the drill tool. The upper part of the preliminary shaft below the conductor as far as the 2,000 m level broadened from 214 to 394 mm and was reinforced by a 325-mm cased column, cementing it to the mouth itself.

In order to safeguard this column against the inevitable rubbing through and snapping off a so-called removable safety column with a diameter of 245 mm was lowered within it. Thereafter the drilling of the borehole was continued with core drill bits with a diameter of 214 mm.

An important intermediate level was reached in April 1975 at 7,263 m, at which the drilling of the borehole was temporarily stopped for replacing the surface equipment which had exhausted its lifetime.

A new rig, the "Uralmash BU 15 000," was constructed over the mouth of the temporarily closed borehole in order to drill the next deep interval (7,263-15 000 m). In the very name of the rig the letters designate the limiting depth for

drilling of the borehole. The configuration and size of this complex of drilling equipment, the world's largest, put together in a polar variant, do not fit in with traditional ideas concerning a drill rig. This, to be more exact, is a complex mining plant over which towers the massive prism of a drill rig with the height of a 24-story building. The apparatus, with a load-lifting capacity of 400 tons, is supplied with the country's largest drilling machines, mechanisms and power plants, whose electric power is entirely adequate for illuminating a city the size of an average rayon capital. In order to optimize drilling processes and ensure stability of the borehole shaft, this in essence being a mine working of great extent, use is made of the latest electronic computer technology. It should be noted that in the construction of the unique complex of the Kola borehole it was possible to attain total insulation of the internal rooms of the tower, machine hall, all the working zones, scientific laboratories, workshops and services ensuring the continuous drilling of a borehole, against the arctic cold.

After installation of the new drill rig the drillers reactivated the borehole. The open shaft with a diameter of 214 mm and an extent of 5,263 m, unreinforced by casings, excellently withstood the test of time over the course of 1 1/2 years. Exercising the maximum care possible, the drilling masters lowered the 7-km tool to the face and in October 1976 proceeded to the second stage in the drilling, which as before is carried out with continuous removal of the core. The small core raised to the surface is sawed along the axis. One half is sent for official storage, whereas the second is divided into parts and is sent to the laboratories of scientific research institutes for different investigations.

In November 1981 the face of the Kola borehole passed the 11-km level and continues to penetrate deeper and deeper into the Baltic crystalline shield, which beginning from the surface and almost to a depth of 7 km is represented by Proterozoic rocks with an age greater than 2 billion years, and in the lower part by still more ancient Archean rocks with an age greater than 3 billion years.

At the present time the intermediate objective in drilling of the Kola borehole is a depth of 13 km, after which the last "storming" of the crystalline rock mass to the planned level of 15 km will be undertaken.

Failure of Hypotheses. Checking of Computations

Even now it can be stated that in the course of drilling of the Kola borehole a solution has been obtained for many closely related organizational, scientific and technical problems which arose in the first stage of implementation of the superdeep drilling program. In particular, as a result of intensive scientific and engineering research it was possible to organize the production of effective designs of rock-destroying coring tools, low-speed hydraulic face motors, a unique set of drilling machines and deep measurement apparatus. As a result, in the Soviet Union there has been consolidation of experience in creating high-performance apparatus for penetration into the lower layers of the earth's crust which has no equal in the world.

In the process of drilling of the 11-km shaft (only the upper 2-km interval was strengthened by casings) provision was made for continuous taking of the core and a complex of electrometric measurements is regularly carried out for ensuring the possibility of active regulation of the perpendicularity of the borehole shaft and many-sided investigation of the deep medium both within the borehole and outside it.

As a result of the successful drilling of the Kola borehole since June 1979 (when the last American record, equal to 9,583 m, was passed) the Soviet Union has become the leader in superdeep drilling. The fundamentally new primary information has enriched both the earth sciences and many applied fields having direct importance for the national economy.

The scientific results of drilling have already been reported to the readers of PRIRODA (Nature)*.

A fact of fundamental importance is that at a depth of about 7 km there is no "basalt" layer in this place. Instead of the anticipated sharp jump in the velocities of seismic waves at the postulated Conrad discontinuity it was found that there is a relatively smooth increase in this index from 6.1 km/sec at a depth of about 7,000 m to 6,500-6,600 km/sec at 10,000 m.

Among the discoveries is the detected invariability of slope of layers of ancient rocks at an angle of 45 to 60° in all sections of the borehole -- from the surface to a depth of 11 km. This contradicted data from earlier made deep seismic investigations, according to which the slope of the layers should be gradually flattened out to a horizontal bedding as depth increases, beginning with 4 km.

As is well known, among the geological-technical advantages determining the site of a superdeep borehole on the Kola Peninsula, scientists and planners included the relatively low geothermal gradient -- in the range 1°C/100 m, characteristic for geological structures of the Baltic shield type. This made it possible to compute that at the limiting 15-km borehole level the maximum depth of the deep medium does not exceed 150°C. It is entirely understandable that such a "soft" temperature prediction completely suited both drillers and geophysicists. Indeed, 150°C enters into the range of face temperatures at which drilling and electrometric investigations of petroleum and gas boreholes have already been well mastered.

However, in actuality it was found that such a desirable low geothermal gradient is characteristic only for the upper 3-km interval of the deep layers of the Baltic shield. Then the temperature of the rock mass increases almost twice as rapidly as surmised. In particular, at the levels 7, 8, 10 and 11 km the temperature of the deep medium was equal to 120, 130, 180 and 200°C respectively. The increase in the intensity of the heat field in the lower 3-km interval by 70°C evidently was caused by a powerful heat flow from the mantle.

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* Belousov, V. V., "Program for Study of Deep Layers in the Soviet Union," PRIRODA, No 1, 1982.

If with a further deepening of the borehole the geothermal gradient does not change, at the limiting 15-km level the drillers will expect a "Kola bath" with a temperature of about 280°C.

If we continue to extrapolate the increase in the intensity of the heat field of the deep rock mass to still lower levels, as far as the Mohorovicic discontinuity, at the postulated depth of its position here, about 40 km, a temperature of about 800°C must be anticipated. However, according to the results of the investigations of A. A. Zhamaletdinov*, the temperature of the earth's crust at a depth of 40 km in the neighborhood of the Baltic crystalline shield does not exceed 400°C, which once again corresponds to a mean geothermal gradient 1°C/100 m.

However that may be, such a considerable discrepancy between the predicted and actual rates of temperature increase in the Kola borehole is making scientists and engineers face up to inevitability and in the future they must develop special technical means and technological procedures for overcoming such significant "thermal" problems in superdeep drilling as the considerable decrease in the stability of the walls of the borehole shaft, an increase in the corrosional activity of the deep medium and the temperature phase decomposition of borehole muds with a water base. In addition, at a temperature greater than 200°C there is a considerable deterioration of the strength of bits, a decrease in the efficiency in use of turbo- and electric drills, and the use of Duralumin drill pipe, which has recommended itself so well in the first stages of borehole drilling, is limited.

However, most of all scientists were excited by the collapse of still another hypothesis, according to which it was assumed that in the earth's crust, consisting, hypothetically, of dense, impermeable, crystalline, thick Precambrian rocks, there cannot be any aqueous solutions and exchange gas processes. In actuality, however, at a depth greater than 4.5 km there were found to be zones of tectonic dislocations along which there is continuous circulation of highly mineralized solutions containing bromine, iodine, some heavy metals, bitumens and carbon substances, and also gases -- hydrogen, helium, nitrogen and methane. These gases, released from the rock strata penetrated by the borehole, brilliantly confirm the correctness of the concept of gas, especially helium, breathing of the earth advanced by V. I. Vernadskiy. The applied importance of this concept, that the presence of helium in rocks is evidence of the closeness of deep faults in the earth's crust, was reliably confirmed and the quantity of released gas gives some idea concerning the magnitude of these faults or the size of the intervals represented by fragmented rocks. At depths of 4,500-4,600 m and 6,000-6,500 m the borehole penetrated fragmented rocks whose fragments were cemented by quartz, as well as sulfides of a number of metals (copper, iron, lead, zinc, nickel, cobalt). These discoveries are evidence of active ore formation in the deep layers of the Baltic shield.

An unexpected find in the core material raised to the surface was microfossils -- petrified remnants of organisms which lived about 2 billion years ago. These finds make it possible to conclude that life on the earth developed far earlier than had been surmised up to this time.

Long before the appearance of the mentioned organisms on the planet a hydrosphere was formed and sediments were deposited in the ocean. In the samples raised from the 2-billion-year depth there was fine-grained sand and pebbles which had been rounded in the surf of ancient seas. Intensive investigations of the fossilized microorganisms extracted from the borehole laid the basis for a new direction in science which might be called superdeep paleontology.

From the point of view of the future development of the theory and practice of search for and development of deep ore deposits, a major event was the discovery of a high iron and mica content of the rocks raised from a depth of more than 9,500 m.

Thus, the Kola superdeep borehole has already given geology abundant factual material whose permanent value will more than pay for the outlays invested in this grandiose enterprise.

Having as of 4 April 1982 a face of 11,083 m, this borehole has penetrated into the earth's deep layers farther than all mines and has even exceeded the presently known maximum subsidence of the bottom -- a depth of 11,022 m.

It should be noted that in the region of the Baltic crystalline shield, where the Kola borehole is situated, the thickness of the earth's crust is about 40 km. The planned goal for this borehole, the 15-km level, should be regarded as a general rehearsal for a future, still more daring project providing for the penetration of the entire thickness of the crust and penetration into the earth's upper mantle.

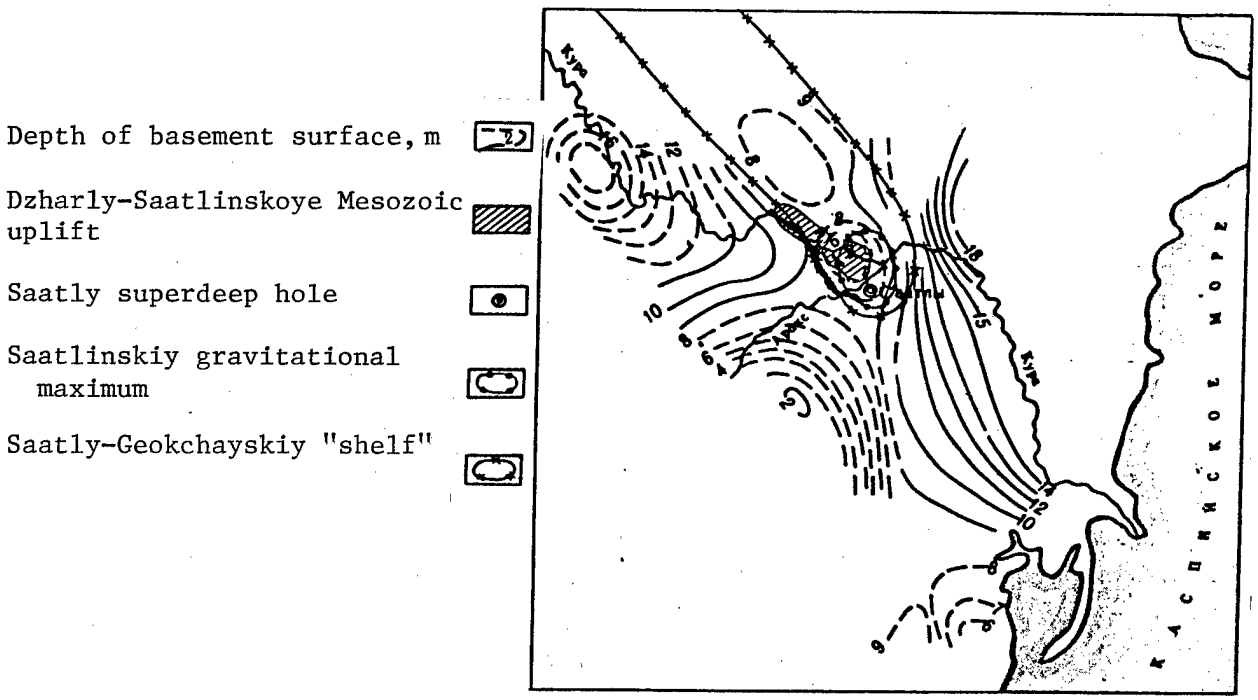
Saatly Variant

Within the framework of the program for superdeep drilling already adopted in the early 1960's, at the present time work is proceeding on the drilling of a superdeep borehole in the Muganskaya Steppe, near the small Azerbaijan city Saatly. The site of drilling of this borehole corresponds to the "epicenter" of the Kura depression, where, according to data from earlier gravimagnetic and then also other geophysical investigations, the characteristic "granite" and "basalt" layers of the earth's crust (and accordingly, the Mohorovicic discontinuity) are locally uplifted to a minimum depth.

In the drilling of the borehole at Saatly use is made of the same complex of drilling equipment, the "Uralmash BU-15 000," as on the Kola Peninsula, but constructed in a subtropical variant. Next to the 68-m tower prism is a building of the factory type which holds complex power equipment, as well as unique drilling machines and mechanisms. Near the drill rig is a well-equipped repair and mechanical workshop, a laboratory for the primary processing and investigation of rock samples, core storage facilities, and finally, a central control panel from which the drilling processes are controlled and monitored.

The drilling of the Saatly borehole was begun on 9 June 1977. In order to ensure the verticality of the most important initial interval of the borehole shaft it was drilled using the jet-turbine drilling method developed by Soviet engineers. For this purpose use was made of coupled jet turbodrills previously

employed only in the drilling of shafts in the coal industry. After construction and calibration of a shaft with a diameter of 730 mm a cased column with a diameter of 508 mm was lowered into the borehole, its lower end extending to the level 1,232 m. Then the annular space between the pipes and the exposed walls of the borehole was filled with a fluid cement solution, after whose hardening the entire 250-ton steel pipe armor was forever bound to the surrounding rock mass. The successful implementation of this operation was an important technical prerequisite for the accident-free drilling of all subsequent borehole intervals.



Sketch map of structure of basement surface in Kura depression in neighborhood of site of Saatly superdeep hole.

Then the drilling of the borehole shaft to the level 3,550 m was with bits 295 mm in diameter. Thereafter, satisfied with the absence of serious technological complications, the borehole shaft was expanded to a diameter of 445 mm.

In mid-October 1978 the drillers of the Saatly Petroleum Prospecting Expedition in the superdeep borehole carried out still another unique operation: the next 2,318-m interval of the open 445-mm shaft was reinforced by a cased column with a diameter of 340 mm. It was lowered to the level 3,550 m and cemented to the mouth.

This new technical column, the upper part of which was equipped with powerful "preventor" apparatus for the timely cessation and elimination of sudden eruptions of petroleum and gas, potentially possible during the driving of an open

shaft of great length characteristic for the Saatly borehole, ensures reliable controllability of drilling processes and the safety of expeditionary personnel in the course of further work.

The level 7,500 m, marking the end of the first stage in drilling of the borehole, was attained in early September 1981 -- 185 days before the deadline.

In comparing the technical-economic results of drilling of the Kola and Saatly boreholes at the time of attaining half the planned depth, 7,500 m, it is interesting to note that at Saatly the indicated level was attained approximately 3 years more rapidly and with far lesser capital expenditures. This was a direct result of the creative exchange of experience between Azerbaijan drillers and their transpolar colleagues.

By 20 September 1982 the Saatly borehole had attained a depth of 8,190 m. After penetration through the stratum of Mesozoic rocks the borehole will enter into the Paleozoic basement.

Due to the use of high-performance and stable bits, developed at the Kiev Institute of Superhard Materials, a relatively high rate of drilling of the Saatly borehole has been attained. Giving due importance to this index, the drillers feel that for superdeep holes the most important requirement is the completeness of removal of core material and the accuracy in alinement of the shaft as it penetrates into the deep layers of the rock mass. At Saatly centering and stabilizing apparatuses installed in the lower part of the drilling column are effectively used for this purpose. In these ways it is possible to keep the deviation of the borehole shaft from the vertical within the limits of the established norm.

The success of Saatly drillers was facilitated by the use of lightened Duralumin pipes, reducer-type turbodrills, automated systems for carrying out lowering-raising operations, for preparing, cleaning and processing mud, and also the method for clearing the borehole shaft from particles of drilled-out rock developed by Azerbaijan engineers.

In the drilling of the Saatly borehole much factual material has already been obtained concerning the structure of the young sedimentary complex of the Kura depression. Rock samples extracted from different depths are investigated in 30 scientific laboratories of the country, including at the Moscow Institute of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements, USSR Ministry of Geology. The results of these investigations have helped in introducing significant corrections to our ideas concerning the structure of the deep layers, the properties of rocks and the characteristics of the deep medium in the Kura depression. In particular, the temperature at a depth of 7,500 m was 133°C, that is, 17° lower than that computed earlier on the basis of a study of the intensity of the heat field in a satellite borehole with a depth of 6,270 m which was drilled 100 m from the mouth of the Saatly superdeep borehole.

Another fact of fundamental importance is that the thicknesses of strata of some types of sedimentary rocks were considerably less in comparison with those computed on the basis of geophysical investigations.

The considerable noncoincidence of measured and computed thicknesses discovered in the Kola and Saatly boreholes raises the problem of the need for a more rigorous evaluation of the results of geophysical investigations in the study of stratification processes in the earth's deep layers.

Upon attaining a depth of 15 km the Saatly borehole will afford direct approaches to an unambiguous solution of problems involved in determining the presence of petroleum and gas and ores in the lower part of the sedimentary-volcanic complex and the crystalline part of the section, which is of both scientific and practical, industrial-economic importance. In particular, the results of these investigations can be used in predicting the presence of ores in some sectors of the Caucasus Mountains similar to one another in structure.

The capability of Soviet industry to create a reliable technical, material and personnel support for the drilling of boreholes with a depth of 10 km or more, convincingly demonstrated on the Kola Peninsula and at Saatly, has made it possible to develop a long-range program for the drilling of about 20 boreholes with a depth of 7-12 km in the most interesting (from the point of view of the anticipated scientific and practical results) regions of the territory of the Soviet Union.

Future superdeep boreholes can be classified into two groups. The first includes boreholes intended for study of the deep structure of regions hypothetically rich in ore minerals. Among these are the Krivoy Rog borehole in the Ukraine, the Tagil borehole in the Urals, the Noril'sk borehole in the northern part of Krasnoyarskiy Kray and the Muruntau borehole in Uzbekistan.

The second group includes boreholes intended for investigating the presence of petroleum and gas in deep sedimentary layers. These include the East Poltava borehole in the Ukraine, the Kochmes borehole in the Pechora Lowland, the Afanas'yevsko-Tritsk borehole in Krasnodarskiy Kray, Tyumen' borehole in Western Siberia and Kenkiyanskaya borehole in the Caspian Lowland.

5303
CSO: 1865/112

TYUMEN SUPERDEEP BOREHOLE

Moscow IZVESTIYA in Russian 23 Feb 83 p 2

[Article by Yu. Perepletkin, in-house correspondent of IZVESTIYA:"Tyumen Superdeep Borehole"]

[Text] The superdeep borehole which will clarify the outlook for oil and gas content of the beds formed 200 million years ago in the Prejurassic age will penetrate 8,000 meters into the depths of West Siberia. The site for the important experiment has been defined: in the Purovskiy region near the Urengoy gas-condensate field.

The Tyumen superdeep borehole not only will help to pinpoint the potential hydrocarbon resources in the region, but will also clarify the reasons for magnetic and gravitational anomalies, will answer many questions for geologists associated with the origin and formation of the West Siberian platform.

Drilling has to be done here under conditions of so called stressed state of the earth's crust. The specialists will drill using the "Uralmash-15,000" unit which demonstrated its advantages at the Kola borehole.

9035
CSO: 1865/94

WORK CONTINUES AT KOLA SUPER-DEEP BOREHOLE

Moscow IZVESTIYA in Russian 16 Feb 83 p 3

[Article by A. Viktorov: "Deepest in the Sea"]

> [Text] On the Kola Peninsula and in Azerbaijan, the expedition of Soviet geologists is drilling deep into the earth's crust. It helps to get to know the distant past of the planet, to clarify the laws governing distribution of minerals at different depths, and to establish temperature and other conditions of their formation.

The collective of the Kola expedition has already reached a depth of over 11,500 meters. This is the highest in the world.

The senior scientific colleague of the All-Union Geological Institute, Doctor of geological-mineralogical sciences E. Nalivkina discussed the course of work and its scientific-practical importance with the IZVESTIYA correspondent.

Scientists and specialists of many scientific research institutions of the country are participating in this work. This is not surprising. It is known that the Kola Peninsula is exceptionally rich in minerals, including apatites, ceramic raw material, mica and many other fields.

Until recently science only had indirect data about the deep structure of the earth's crust and the processes occurring in it. Now for the first time direct accurate information about their features has been obtained. The core samples which have been lifted up relate the geological structure of the earth's crust, the physical-chemical, temperature and other features of rocks at great depths, and the laws governing their formation.

All of this marks the beginning of a new era in studies of the earth's crust and development of its depths. Work on deep drilling continues.

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CORRELATION BETWEEN SEISMIC ACTIVITY AND REGIME OF SURFACE AND GROUND WATER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 83 (manuscript received 19 May 81) pp 96-102

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[Abstract] A comparison of seismological, hydrological and hydrogeological data carried out in a number of seismically active regions of the USSR and some foreign territories shows that to one degree or another a correlation between the water and seismic regimes is observed virtually everywhere. In some regions it is positive: in these regions there is an increase in the frequency of earthquakes and an increase in their energy during periods of a high position of the levels of surface and ground water. In other regions this correlation is negative: activation of seismicity occurs in periods of a low position of water levels. This article gives some results of this comparison. The water regime index in all cases was data on the discharges of rivers having adequately long series of continuous hydrometric observations. Detailed examples of positive and negative correlations between the water and seismic regimes are given. It becomes clear that there is a triggering effect of artificial and natural changes in water levels on the seismic regime. Activation of seismicity occurs always under conditions of an increase in the heads of surface and ground water. This is characteristic for regions with both positive and negative correlation between the water and seismic regimes. In the latter case the activation of seismicity noted during periods of decrease in water levels occurs primarily in those sectors where this decrease is minimum or does not occur at all. The correspondence of temporal variations of seismic activity to intraannual and multiyear changes in levels (discharges) of surface and ground water is the least studied aspect of the problem of the relationships between the water and seismic regimes. This correspondence is manifested in many regions of the world. The triggering effect is attributable to the influence exerted on the tectonically stressed state of the earth's crust by changes in hydrostatic pressure in the water-saturated fissures of zones hydraulically related to surface water-bearing horizons, surface watercourses and water bodies. The relationship between seismicity and intraannual and multiyear regimes of surface and ground waters is of interest for seismic prospecting. Figures 6; 21 references: 19 Russian, 2 Western. [121-5303]

UDC 550.34.016

AMPLITUDE CURVES OF BODY WAVES OF BAYKAL EARTHQUAKES BASED ON RECORDS OF SELF-CONTAINED BOTTOM SEISMOGRAPHS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 83 (manuscript received 22 Jan 82) pp 82-87

BUKINA, K. I., VILLEMSON, L. Kh., KOVACHEV, S. A. and SOLOV'YEV, S. L., Institute of Oceanology, USSR Academy of Sciences; Institute of Earth's Crust, Siberian Department, USSR Academy of Sciences

[Abstract] During 1980 specialists at the Institute of Oceanology and Institute of the Earth's Crust carried out work for registry of earthquakes by self-contained bottom seismic stations in the zone of the Baykal rift. The design of these instruments differs little from those used by other organizations. Seismic waves with frequencies from 5 to 20 Hz were registered in the Baykal zone; a clearly expressed histogram peak fell at 8 Hz. In the course of the work the bottom stations were set out in 20 places. The stations were set out in the central part of Baykal both on the lake bottom and on the shore. A total of 318 earthquakes were registered. The authors compared determinations of the class of earthquakes determined from the records of bottom seismographs and the classes obtained using data from the stationary network of regional stations. This study was made on the basis of data from 76 earthquakes registered simultaneously by the two types of stations. In both cases the energy class was determined using the T. G. Rautian nomogram (TR. TADZHIKSK. IN-TA SEYSMOSTOYKOGO STR-VA I SEYSMOLOGII AN TadzhSSR, No 7, 1960). The problem of the attenuation of seismic waves with an increase in epicentral distance was investigated in detail by A. V. Solonenko in earlier studies. It was found that the amplitude curves constructed on the basis of data from bottom seismographs within the limits of accuracy coincide both with the T. G. Rautian curve and with the curve constructed by A. V. Solonenko with the exception of short epicentral distances. It was found that body waves with a frequency of 8 Hz attenuate in the Baykal zone approximately the same as waves with a frequency of 2 Hz and possibly even more slowly. This is a somewhat unexpected result since it is usually assumed that the absorption coefficient increases with frequency. A similar phenomenon of distant and superdistant propagation of seismic waves at high frequencies was discovered in the Pacific Ocean. It is clear that the T. G. Rautian nomogram requires correction in the range of small epicentral distances ($\Delta<50$ km) due to the great depths of hypocenters of Baykal earthquakes in comparison with Pamir earthquakes. Figures 6, tables 2; references 15: 9 Russian, 6 Western. [121-5303]

UDC 528.27

RESULTS OF NEW INTERNATIONAL COMPARISON OF GRAVIMETERS, SÈVRES, 1981

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 83 (manuscript received 6 Sep 82) pp 43-51

BULANZHE, Yu. D., ARNAUTOV, G. P., KALISH, Ye. N., KORONKEVICH, V. P., STUS', Yu. F., TARASYUK, V. G. and SHCHEGLOV, S. N., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] As a result of the First International Comparison of Absolute Gravimeters at Sèvres in 1981 it was established that modern ballistic gravimeters have an approximately identical accuracy of measurements characterized by a mean square error of about ±9-±10 μgal. The first Soviet ballistic gravimeter, the GABL, was among the best instruments with respect to deviations from the mean and consistency. The agreement of all the instruments participating in the Sèvres comparison and measurements with the GABL gravimeter made at a number of IGSN-71 points in Europe make it possible with full assurance to confirm the change in the measured gravity value at Sèvres during the time 1969-1977 by about 50 μgal, which caused a displacement of the null point for the IGSN-71 system by approximately this same value. Participating in the simultaneous comparison were two gravimeters from the United States and one from the USSR. Somewhat earlier determinations of absolute gravity had been made at Sèvres with a Chinese instrument and somewhat later French and Italian instruments were tested. The convergence of the repeated measurements made at Sèvres with the Italian gravimeter and the GABL instrument makes it possible to assume that under conditions of stationary observations modern ballistic gravimeters make it possible to detect slow changes of gravity of a nontidal character exceeding 4-5 μgal. Figures 2, tables 4; references 9: 1 Russian, 8 Western.
[121-5303]

UDC 550.834

WAVE KINEMATICS IN PIECEWISE-INHOMOGENEOUS MEDIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 83 (manuscript received 28 Aug 81) pp 34-42

PETERSEN, N. V., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] Using mathematical modeling a study was made of the kinematics (rays and travel-time curves) of refracted waves in piecewise-inhomogeneous models with a random distribution of velocity at the points of intersection of an orthogonal grid and with a determined velocity component increasing with depth. A study was made of rays and travel-time curves with different positions of the source and also their mean characteristics and fluctuations. It is shown that the form of the rays and travel-time curves of refracted waves

in models with small-scale velocity fluctuations differs substantially from the case of presence of a vertical velocity gradient only in the model. The law of change in velocity with depth, computed by traditional methods (for a model with a vertical velocity gradient), differs from the determined velocity component in a piecewise-inhomogeneous model. Random velocity inhomogeneities cause not only small-scale fluctuations in the rays and travel-time curves, commensurable with the size of the inhomogeneities, but also change the general form of the rays and the form of the travel-time curves of the first waves. Individual travel-time curves from different sources differ and do not coincide with the stipulated determined travel-time curve. The dependence of the standard deviation of the times of individual travel-time curves from the mean travel-time curve as a function of source-detector distance is close to quadratic. At great distances from the source the change of the value equal to the ratio of the standard deviation of individual travel-time curves to the mean travel-time curve with distance is proportional to the change in the mean value of the contrast of the velocity fluctuations in the interval of maximum ray penetration. The V(z) curves obtained as a result of interpretation of individual travel-time curves can differ substantially from the law $V^{det}(z)$. The mean travel-time curve also differs from the determined travel-time curve. When z = const the time for the mean travel-time curve is less than for the determined travel-time curve. The V(z) curve obtained by interpretation of the mean travel-time curve gives exaggerated velocity values with $z \neq 0$. The difference between V(z) and $V^{det}(z)$ with depth approaches the value $\delta V(z) = \mu(z)V^{det}(z)$ (μ is the so-called contrast of velocity fluctuations). Figures 6, tables 2; references: 7 Russian.
[121-5303]

UDC 550.348.098.2

'DEEP' FOCI OF CAUCASIAN EARTHQUAKES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 83 (manuscript received 19 May 80) pp 22-33

DZHIBLADZE, E. A., Geophysical Institute, Georgian Academy of Sciences

[Abstract] The author reexamines initial data on the 'deep' foci of Caucasian earthquakes, information on which is given in the NEW CATALOGUE OF STRONG EARTHQUAKES IN THE USSR (NOVYY KATALOG SIL'NYKH ZEMLETRYASENIY NA TERRITORII SSSR, Moscow, Nauka, 1977, 535 pages). This article reexamines and gives the results of a new processing of the basic instrumental and macroseismic data on these earthquakes. It is shown that in some cases excessively bold conclusions have been drawn from completely inadequate macroseismic data and in many cases the data have simply been interpreted incorrectly. A table gives a list of Caucasian earthquakes with focal depths $h \geqslant 60$ km which includes the recalculated parameters. The author examines 11 earthquakes separately. All the earlier findings are questionable. All the initial data, according to the existing method for the interpretation of close earthquakes, indicate that the foci in fact lie in the crust, most frequently in the upper part of

the crust, to the bottom of the granite layer. The exaggeration of depths when making determinations on the basis of macroseismic data in attributable to the shortcomings of the nomograms employed, but is also due to the long-prevailing preconception that the foci in the Caucasus region are deep. Therefore, all the data in the mentioned catalogue must be discarded as totally untenable. Figures 4, tables 3; references 46: 43 Russian, 3 Western.
[121-5303]

UDC 550.385:550.37

ANOMALIES OF GEOMAGNETIC VARIATIONS IN NORTHWESTERN EUROPEAN USSR

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 11, Nov 82 (manuscript received 29 Jul 81) pp 101-106

ROKITYANSKIY, I. I., KULIK, S. N., LOGVINOV, I. M. and ROKITYANSKAYA, D. A., Geophysical Institute imeni S. I. Subbotin, Ukrainian Academy of Sciences

[Abstract] In the summer of 1978, as a result of magnetovariation observations carried out in the neighborhood of Lake Ladoga, a strong (doubling of the H-component) anomaly in the behavior of geomagnetic variations was discovered and it was concluded that a conductivity anomaly was present in the crust (Rokityanskiy, I. I., et al., GEOFIZ. ZH. AN UkSSR, Vol 3, No 2, pp 97-99, 1981). Then it was postulated that the Ladoga region and Moscow region anomalies might constitute parts of a unified regional conductivity model (Rokityanskiy, I. I., et al., IZV. AN SSSR: FIZIKA ZEMLI, No 9, pp 107-112, 1977). This article gives a highly detailed description of the field work of 1979-1980 which was carried out to confirm or refute this hypothesis. Figure 1 is a map showing the approximate position of the axes of conductivity anomalies, clearly defining sectors established reliably, those established very approximately and those which are only hypothetical and showing the position of the Valday graben, a key feature in this region. Magnetotelluric soundings were carried out which indicated that the anomaly in the behavior of geomagnetic variations in the considered sector was caused by the Valday graben. It appears that only one continuous anomaly is involved; much has now been done to pinpoint its outlines, but much data remains to be collected to clarify its precise contour, depth and other parameters. Figures 3, tables 1; references: 4 Russian.
[111-5303]

UDC 550.341.4,344.42

EVALUATING TSUNAMI DANGER OF NEAR EARTHQUAKE ON BASIS OF MACROSEISMIC EFFECT

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 11, Nov 82 (manuscript received 11 Dec 81) pp 87-91

SOLOV'YEV, S. L. and POPLAVSKAYA, L. N., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences; Far Eastern Scientific Center, Sakhalin Multidiscipline Scientific Research Institute

[Abstract] A sample containing 124 observations of local manifestations of tsunamis accompanied by sensed earthquakes in the Kurile Islands in 1952-1976 was prepared and subjected to statistical analysis. It was possible to determine the probabilities p(I) of occurrence of tsunamis accompanied by sensed earthquakes with different macroseismic effects. The analysis revealed that the probability of occurrence of tsunamis increases with an increase in the intensity of the macroseismic effect of an earthquake so that beginning with 6-7 scale units the occurrence of tsunamis becomes probable in more than 60% of the cases. During earthquakes accompanied by tremors of 7-8 scale units the appearance of tsunamis is probable in 90% of the cases and the danger of occurrence of tsunamis during earthquakes with a macroseismic effect of 8 or more scale units increases to 99% of the cases. It was established that there is a positive correlation between the observed macroseismic effect of a near earthquake and the mean value of the anticipated local intensity of tsunamis and a negative correlation with the scattering parameters of this mean. In regions experiencing tremors with an intensity less than 6 scale units the probability of occurrence of significant tsunamis decreases sharply. But as a result of the considerable scattering of the mean values of the anticipated local intensity of tsunamis the reliability of prediction of the tsunami danger for these regions decreases sharply. For this reason when observing a macroseismic effect of 5 or less scale units immediate visual observations of the change in sea level must be organized, whereas in the case of 6 or more scale units the evacuation plan should be immediately implemented. Figures 3; tables 3; references: 10 Russian.
[111-5303]

UDC 550.348

PATTERNS OF GROUPING OF EARTHQUAKES IN CRIMEA-BLACK SEA REGION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 11, Nov 82 (manuscript received 1 Feb 82) pp 25-32

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[Abstract] The authors examine different types of grouping of earthquakes: 1) spatial, 2) temporal, 3) spatial-temporal. The latter type includes so-called "remote" foreshocks, in general migrating in the direction of the

future epicenter of the main earthquake, and "remote" aftershocks migrating in the direction from the epicenter. A knowledge of the peculiarities of combining of earthquakes into groups on the basis of spatial-temporal criteria in different parts of a region will make it possible to discriminate zones of earthquake preparation and on the basis of the first tremors of a particular sequence to make approximate evaluations of the time and magnitude of the next events. This is illustrated in the case of the sequence of earthquakes in individual zones of the Crimean region. It was found that the types of sequences of Crimean earthquakes are stably localized in space. Complex sequences--tremors with foreshocks, aftershocks and swarms--gravitate toward the central part of the region. Isolated events are characteristic of the marginal zones of the region where earthquake density is low. The magnitude "steps" and the time interval between the main tremor and the strongest foreshock or aftershock are in direct dependence on the magnitude of the main tremor. On the basis of the grouping of weak earthquakes it was possible to make approximate evaluations of the ratios of the extent of regions of preparation of earthquakes and "quiet" zones. On the average these values are inversely proportional to the ratio of the time between the last "remote" foreshock and the main tremor and the main earthquake and the first "remote" aftershock. Strong earthquakes are associated with regions of the minimum Δr, the distances between the epicenters of successively transpiring weak earthquakes. On the basis of the distribution of zones of "quiet" and the tendencies in change of the r and Δr parameters it is possible to discriminate the postulated sites of preparation of earthquakes with magnitudes $M = 4-5$ in the central part of the region. Figures 4; references 8: 7 Russian, 1 Western.
[111-5303]

UDC 550.343.6

PREDICTING RECURRENCE OF VERY STRONG EARTHQUAKE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 11, Nov 82 (manuscript received 30 Jun 81) pp 3-12

VVEDENSKAYA, A. V., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] In the deep layers of seismically active regions, under the influence of considerable shearing stresses, there is a sudden increase in the density of dislocations in a limited thin region corresponding to the appearance of a local region of plastic flow in the deformed medium and onset of the process of development of an earthquake focus. At the contour of the region of plastic flow (called the inclusion) there is a concentration of stresses, followed by the next stage in focal development, propagation of destruction of the medium beyond the limits of the inclusion. The discontinuity of the process of medium destruction results in discrete radiation of energy, manifested as a train of sign-variable pulses on the seismogram. With this taken into account, it was established that the features of seismograms of very strong earthquakes (duration and magnitude of displacements in the train of sign-variable body wave pulses) are governed by the mechanical properties of the

medium at the focus. This serves as a basis for formulating prognostic criteria of the possibility of a repeated earthquake of the same intensity in a particular region. The analysis of seismic observations presented in this article, interpreted from the point of view of the dislocation theory of destruction of solid bodies, makes clear that the appearance of a repeated earthquake is precluded when there is primarily viscous destruction of the medium at the focus but a recurrence may occur when there is primarily brittle destruction. Figures 4, tables 1; references 6: 5 Russian, 1 Western. [111-5303]

UDC 550.343.6+550.348.098

PREPARATION PROCESSES, INDICATORS AND PRECURSORS OF CRUSTAL EARTHQUAKES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 2, Feb 83 (manuscript received 19 May 82) pp 59-67

GOKHBERG, M. B., GUFEL'D, I. L., DOBROVOL'SKIY, I. P. and NERSESOV, I. L., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] The processes of preparation of an earthquake, taking into account the real properties of the earth's crust and based on an analysis of the behavior of the ensemble of blocks and joints, are analyzed. On the basis of the described model of earthquake preparation and an analysis of the information yield of indicators and precursors the authors propose means for predicting the site and intensity of impending seismic events. The complex of studies for predicting earthquakes must be based on investigations of background seismicity and its anomalies. Investigations of background seismicity include study of the block structure of the region, structural characteristics of the boundaries of the blocks, choice of the most informative sectors for registry of geodetic and geophysical fields, frequency of recurrence of strong earthquakes and determination of regions potentially dangerous in different periods of time. It is very important to determine the spatial position of the boundaries of recent relative movement of blocks. The basis for study of anomalies of the seismic regime includes the investigation of the position and extent of regions of seismic quiet; features of the seismic regime in the zone of consolidation and around it preceding a main rupture; rapid movements or a swarm of weak earthquakes; disturbances of different geophysical fields associated with the consolidation zone and its destruction; relationships of the extent and coordinates of the zone of consolidation and the energy of earthquakes and the position of the main ruptures. In formulating prognostic work it is necessary to take into account a number of methodological characteristics related to the complexity of processes of deformation of the block medium. The manifestation of different indicators (anomalies of geophysical fields, tilts and deformations) is spatially mosaiced and even in the very same seismically active region will be different prior to different events. This requires allowance for the instability of geophysical fields in an analysis of earthquake preparation processes. Another important circumstance is that the anomalous deformation of the medium affects a volume

substantially greater than the consolidation region and outside it the changes in geophysical fields may be more regular. Accordingly, the system of prognostic observations must be constructed over a territory substantially greater than the extent of the anticipated consolidation region. These and the many other concepts presented in the article are useful to consider in predicting the sites and intensities of impending seismic events. Figures 1; references 7: 6 Russian, 1 Western.
[118-5303]

UDC 550.34.01

COMPUTING FIELD OF DISPLACEMENTS IN EPICENTRAL ZONE OF EARTHQUAKE ON BASIS OF DISLOCATION MODEL

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 2, Feb 83 (manuscript received 6 Oct 81) pp 46-58

GRAYZER, V. M., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] The article presents theoretical computations and an analysis of the field of displacements in the epicental (near and intermediate) zone of an earthquake on the basis of the Haskell formulas for a source stipulated in the form of a dislocation in a homogeneous isotropic unbounded absolutely elastic medium. An analysis is given of the fields of stepped P- and S-deviations, as well as the disturbance Laplacian creating the resultant residual displacement of the medium. A program in the ALGOL-60 language was prepared for use with a BESM-6 computer, making it possible to compute displacements by the Haskell formulas for a source stipulated in the form of a dislocation of rectangular form in a homogeneous isotropic elastic unbounded medium. Computations are presented for the contribution of each of the five terms of the Haskell formulas to the total displacement in the near and intermediate zones. The Haskell formulas were used in writing a program for computing the isolines of stepped P- and S-deviations and also the Laplacian of displacement, being component parts of the residual displacement. Computations were made for the isolines of residual displacements and their component parts for cases of shear, rupturing and overthrust in an unbounded medium. The equations derived in this article are applicable for the intermediate zone (at distances several times exceeding the dimensions of the focus) where it is impossible to use the standard Brune-Aki method developed for the distant zone. There is a satisfactory coincidence of the results of computations made using the Press formulas and seismic moment computations made using records for the distant zone. Figures 6; references 18: 7 Russian, 11 Western.
[118-5303]

UDC 550.83

DENSITY INHOMOGENEITIES OF EARTH'S MANTLE. OCEANIC REGIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 2, Feb 83 (manuscript received 28 May 82) pp 21-30

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[Abstract] The article examines the possibility of using the parameter of depth to the "free mantle" for investigating the properties of the lithosphere. It is demonstrated on the basis of a theoretical examination that an analysis of undulations of the "free surface of the mantle," including statistics on the correlation of its depths with the depths to the Moho, gravity anomalies and velocities of longitudinal waves in the mantle, makes it possible to determine the density of the subcrustal mantle and in some cases the thickness of the lithosphere. It was demonstrated in a study of the parameter depth to the "free mantle" in different regions of the Pacific Ocean that: a) the depths to the "free mantle" are stable within definite tectonic structures, each of which has its specific value; b) the theoretical possibilities of using the h parameter for determining mantle density and thickness of the lithosphere can be realized in the presence of an adequate quantity of deep seismic sounding data. It was found that the mantle beneath the mid-oceanic ridges and island arcs has a lesser density in comparison with the mantle of stable regions and the mantle beneath abyssal trenches is denser than the normal oceanic mantle. Estimates were made of the density of the subcrustal mantle and thickness of the lithosphere in stable regions of the oceans and mid-oceanic ridges. It has a dependence on the age of the oceanic crust. The introduction of the parameter depth to the "free surface of the mantle" relates such an integral characteristic as the mean mass of a column of the crust of any region to the density characteristic of the subcrustal layer. The presence of such a relationship not only makes possible a quantitative study of inhomogeneity of the subcrustal layer, but also affords new possibilities for studying these inhomogeneities in combination with the results of various geophysical investigations. It is therefore recommended that the parameter depth to the "free surface of the mantle" be used together with other geophysical parameters for studying the density properties of the lithosphere, for structural and tectonic regionalization of territories. Figures 4, tables 1; references 10: 7 Russian, 3 Western.
[118-5303]

UDC 550.34.016

OBSERVING PERIODS OF EARTH'S FREE OSCILLATIONS WITH LASER DEFORMOMETER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 2, Feb 83 (manuscript received 4 Apr 81) pp 15-20

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[Abstract] The creation of ultrahigh-response instruments for measuring crustal deformations in a wide frequency range on the basis of laser interferometers makes possible a study of the earth's free oscillations on a new basis and is making possible a search for those regions on the earth's surface where these free oscillations cause the greatest crustal deformations. This article gives an analysis of the results obtained with a laser deformometer installed on an island formation in Peter the Great Bay on 17-18 September 1979. The existence of these free oscillations excited by earthquakes with a relatively low magnitude suggests that there is some constant level of free oscillations increasing at the time of significant disturbances such as after the destructive Chilean earthquake of May 1960. The use of laser deformometers makes it possible to ascertain the level of free oscillations on "quiet" days. The analysis of the materials from this series of measurements indicates that the laser deformometer can be employed as the most sensitive seismic detector in a wide frequency range. It is concluded that there is a constant background of seismic oscillations caused by the earth's free oscillations. It is postulated that the background is maintained by weak earthquakes, which according to data for the seismic station Vladivostok occur so frequently that they can be the cause of the observed effect. Figures 2, tables 2; references 15: 7 Russian, 8 Western.
[118-5303]

UDC 550.3

SOVIET-JAPANESE COOPERATION IN GEOPHYSICS

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 1, Jan 83 pp 105-109

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[Abstract] The bilateral cooperation of the USSR and Japan in study of structure of the earth's crust and upper mantle of the northeastern Pacific Ocean began on the initiative of Soviet scientists in 1968. The first stage (1968-1970) was within the framework of the International Upper Mantle Project, whereas the second stage (1971-1978) was within the framework of the International Geodynamic Project. During these years a considerable volume of comparable geological-geophysical data was accumulated on structure of the crust and upper mantle. These materials made it possible to proceed to generalization of the scientific results obtained from different geophysical

projects. One of these was "Geotraverses in the Western Part of the Pacific Ocean," whose objective was construction of a deep section of the crust and upper mantle through the principal structural elements of the transition zone from the Asiatic continent to the Pacific Ocean. The profile selected ran from Lake Khanka in Primor'ye through the Sikhote-Alin', Sea of Japan, Honshu, Japanese Trench and into the Pacific Ocean. The geotraverse with an explanatory text was published in 1982. The data collected in this and other projects indicate that there is a thick asthenospheric lens in the upper mantle of the Sea of Japan. In the upper mantle of adjacent regions of Primor'ye and the Pacific Ocean layers with reduced velocities of propagation of seismic waves are poorly expressed. In the Northwestern Basin of the Pacific Ocean, where the thickness of the lithosphere is 100 km, the mantle becomes denser, so that the asthenospheric layers are absent but there is a layer with somewhat reduced velocities of seismic waves. A rather full picture of the deep structure of the tectonosphere in the zone of transition from the Asiatic continent to the Pacific Ocean is now available as a result of joint investigations of Soviet and Japanese scientists. Such highly productive Soviet-Japanese cooperation in the field of geophysics is continuing. [72-5303]

UDC 550.838

DETERMINING AGE OF OCEANIC CRUST SECOND LAYER FROM MAGNETIC ANOMALIES

Moscow BYULLETEN' MOSKOVSKOGO OBSHCHESTVA ISPYTATELEY PRIRODY: OTDEL GEOLOGICHESKIY in Russian Vol 58, No 2, Mar-Apr 83
(manuscript received 2 Apr 81) pp 3-15

GORDIN, V. M., Institute of Physics of Earth, USSR Academy of Sciences, Moscow

[Abstract] F. J. Vine and D. H. Matthews were the first to demonstrate the possibility of determining the age of the basalts making up the second layer of the oceanic crust on the basis of magnetic anomalies. In 1963 they advanced the now widely accepted hypothesis of formation of the magnetically active layer at the base of the mid-oceanic ridges. Unfortunately, the Vine-Matthews hypothesis was later applied to the formation of sources of virtually all systems of linear anomalies discovered in the oceans and marginal seas. The results of their age identification served as a basis for the global scheme for stratification of the second layer of the crust and numerous paleotectonic reconstructions. The purpose of this article, based on an extensive review of the literature, is an examination of the difficulties and contradictions arising in a determination of the age of oceanic basalts on the basis of magnetic anomalies. For example, it is shown that the problems involved in tracing and identifying linear magnetic anomalies in the seas and oceans are far from solved. Reconstructions are frequently questionable. The breakdown of the total magnetic field into anisotropic (linear) and isotropic components is usually accomplished at the intuitive level without application of formalized methods. The problem of the magnetostratification scale requires the most careful rethinking. The same is true of the mechanism of reversal of polarity of the earth's magnetic field. There

are serious difficulties in the a posteriori evaluation of reliability of magnetostratigraphic datings. The relationship of the ages and amplitudes of identified anomalies requires reexamination. Figures 5; references 52: 22 Russian, 30 Western.
[122 5303]

UDC 550.386

ANOMALOUS CHARACTER OF GEOMAGNETIC VARIATIONS IN SOVIET CARPATHIANS

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Nov-Dec 82
(manuscript received 2 Apr 81) pp 49-56

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[Abstract] The main indicator of an anomalous nature of geomagnetic variations is a change in the sign of the vertical component (H_z) of baylike variations (D_{bay}). The existence of this type of variations in the middle latitudes is related to leakage currents from the polar electrojet. The L'vov Affiliate, Geophysical Institute, Ukrainian Academy of Sciences, has carried out profile observations over the entire territory of the Soviet Carpathians for detecting anomalies in the H_z component. The observational data were processed by the magnetovariation profiling method. The article gives an analysis of anomalousness in the harmonic components of quiet solar-diurnal variations (S_q) and short-period pulsations (P_c) of the geomagnetic field. The results are compared with the corresponding parameters of anomalousness in D_{bay} variations. The L'vov Geomagnetic Observatory was used as a base point. Anomalousness parameters were determined on the basis of observational data for almost 100 field points. It was possible to discriminate three extensive anomalies which were attributable to changes in the thickness of the lithosphere. Individual parameters of the anomalousness of baylike variations and short-period pulsations are analyzed. An intensive localized anomaly is related hypothetically to an increased conductivity of the zone of the deep Transcarpathian fault. Figures 5, tables 1; references: 11 Russian.
[54-5303]

UDC 550.383

AMPLITUDE MODULATION OF SHORT-PERIOD OSCILLATIONS OF EARTH'S ELECTROMAGNETIC FIELD

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Nov-Dec 82
(manuscript received 5 Nov 80) pp 86-89

REPIN, V. N. and GUL'YEL'MI, A. V., "Borok" Geophysical Observatory, Institute of Physics of Earth, USSR Academy of Sciences, Yaroslavskaya Oblast

[Abstract] Investigations of short-period oscillations reveal a wide range of modulation processes. Automodulation is possible, this being associated with

a nonlinear change in the parameters of the medium under the influence of the wave. This change exerts an influence on the wave and changes its parameters, sometimes resulting in modulation instability. The nonlinear Schrödinger equation in its different generalizations can serve as a basis for studying the modulation instability of short-period oscillation of the geoelectromagnetic field. Modulation instability arises if the Lighthill test $\alpha v'_g < 0$ is satisfied. The article examines the modulation instability of short-period oscillations propagating along the earth's external magnetic field, taking into account the finite pressure and anisotropy of plasma. Graphs are computed in the ω-β plane which show the regions of modulation instability. The modified Schrödinger equation is used in deriving a criterion for the stabilization of modulation instability. A study was made of the modulation instability of MHD waves in high-pressure plasma in the case of Pc3 pulsations of the geomagnetic field, since the effects of modulation instability can be expected. Figures 3; references 14: 8 Russian, 6 Western.
[54-5303]

UDC 550.831:551.241(26)

DENSITY INHOMOGENEITY OF UPPER MANTLE UNDER MID-OCEANIC RIDGE

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Nov-Dec 82
(manuscript received 20 Nov 80) pp 33-38

BUR'YANOV, V. B., RUSAKOV, O. M. and SOLOV'YEV, V. D., Geophysical Institute, Ukrainian Academy of Sciences, Kiev

[Abstract] In many studies published during the last 15-20 years the deficit of mass under a mid-oceanic ridge has been attributed in general form to the presence of a body in which density is reduced by an identical value. Such a simplified situation under the rift zone of a ridge does not agree with the factual and theoretical data obtained within the framework of the new global tectonics. Accordingly, the authors analyzed the role of now-known processes which occur at the boundaries of plates and evaluated their contribution to the regional gravitational anomaly associated with a mid-oceanic ridge. A regional residual negative anomaly was discriminated in an investigation of the earth's crust of Sheba Ridge in the Indian Ocean. For the first time all the geological-geophysical processes which can occur under a rift zone were evaluated. A new approach was used in which the gravitational effects from the elements of the model were regarded as anomalous relative to the gravitational influence of a section of the lithosphere with an age of 40 million years. The mass deficit explaining the nature of distribution of the regional free-air anomaly over a mid-oceanic ridge with a low rate of spreading is concentrated for the most part in the upper 65 km of the mantle, that is, above the top of the asthenosphere under the lithosphere of a deep basin with an age of 40 million years. The principal gravitational effect is associated with heating of matter of the asthenosphere uplifted under the ridge where there is a complex vertical and lateral density distribution. The gravitational influence of the partial melting of material and magmatic activity under the axial valley is considerably less (about 15% of the computed total effect). Figures 2; references 18: 7 Russian, 11 Western.
[54-5303]

UDC 550.831.013+550.834.013

DENSITY MODEL OF EARTH'S CRUST ALONG DEEP SEISMIC PROFILE XXV BABANKA-PYATIKHATKI

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Nov-Dec 82
(manuscript received 27 Mar 81) pp 24-32

IL'CHENKO, T. V., KRASOVSKIY, S. S. and KUPRIYENKO, P. Ya., Geophysical Institute, Ukrainian Academy of Sciences, Kiev

[Abstract] In the interpretation of deep seismic sounding materials only in recent years have velocity sections been constructed for representing change in velocity both in depth and in a horizontal direction. At the same time data have been accumulated on the relationship of the density of rocks and the velocity of propagation of elastic oscillations in them. This has made it possible, converting from velocity to density values using some dependences $\rho = f(v_p)$, to construct isodensity sections of the earth's crust. However, it has been noted that with respect to the general function $\rho f(v_p)$ there is a need to introduce corrections depending on the composition of the rocks, their degree of metamorphism and peculiarities of regional tectonics. Therefore, in this article the authors, using data obtained along deep seismic sounding profile XXV with a reliably computed isovelocity section, for the first time in creating a density model made use of the peculiarities of the relationship between density and velocity for blocks with different petrographic composition. The deep seismic sounding investigations were made by the continuous profiling method. The wave field registered along the considered profile in general was typical for the Ukrainian shield. A density model of deep structures along the profile was created in accordance with principles formulated earlier (Krasovskiy, S. S., IZV. AN SSSR: FIZIKA ZEMLI, No 6, pp 38-51, 1979). The construction of a combined seismogravitational model of deep structures with allowance for the heat field and taking into account the gradient-layered increase in velocity and density with depth and using the general statistical dependence of density on velocity and with corrections for the peculiarities of the mineralogical composition of rocks made it possible to obtain information on the deep structure and distribution of physical parameters in the crust and proceed to a petrological interpretation of the geophysical models. The developed method for constructing velocity sections and iteration modeling of gradientally stratified density media using the general dependence $\rho = f(v_p)$ with corrections for the peculiarities of mineralogical composition can be recommended for use in other regions. Figures 4; references: 13 Russian.
[54-5303]

UDC 553.981

STATUS AND PROSPECTS OF DEVELOPMENT OF GEOPHYSICAL RESEARCH IN PETROLEUM- AND GAS-BEARING REGIONS OF UKRAINIAN SSR

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 4, No 6, Nov-Dec 82
(manuscript received 19 Mar 82) pp 6-16

KRIVCHENKOV, B. S. and TURCHANENKO, N. T., Geology Ministry, Ukrainian Academy of Sciences; "Ukrgeofizika" Production Association, Kiev

[Abstract] In this review of the status and development of geophysical research in the Ukraine it is pointed out that during the last two decades all the petroleum geophysics methods employed (especially seismic prospecting) have failed to ensure optimum and effective development of deep drilling. This is partly attributable to the complex structure of the structures being prepared and an increase in their depth, but also to the lag in development and introduction of new progressive methods and apparatus and improved methods for transforming and interpreting geological and geophysical information. None of the projected goals can be achieved without ensuring the delivery of the required numbers of digital apparatus and auxiliary equipment, needed materials, adequate computer facilities and introduction of the needed nonexplosive sources of longitudinal and transverse waves. The presently used nonexplosive sources are not yet characterized by stable operation. It is essential to have a marked increase in their reliability, including a significant broadening of the temperature range of their stable operation. The primary goal in geophysical research in the coming decade is an improvement in the quality of preparation of promising areas for carrying out deep drilling. This can be achieved by increasing the accuracy of geophysical prospecting methods (especially seismic) in the mapping of traps of different types and also implementing the following measures. Introduction of "Progress" stations and a considerable increase in use of digital registry. Use of nonexplosive seismic prospecting. Broadening of the detailed processing of information by an increase in the capabilities of computation centers. Developing new and modernizing existing mathematical support. Processing of refracted wave data by computer and broader combining of this method with the common deep point method. Improvement in borehole seismic investigations and prediction of the velocity characteristics of the space around a borehole, especially at depths greater than 4 km. Further introduction of different areal observation systems for studying complexly structured structures. Study of joint use of longitudinal and transverse waves for solving problems in structural geology. Figures 5; references: 11 Russian.
[54-5303]

UDC 550.834

REQUIREMENTS ON SEISMOACOUSTIC PROFILING APPARATUS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA in Russian No 8, Aug 82 pp 78-82

MIRANDOV, V. L., Soyuzmorniiproyekt

[Abstract] The total range of signals in seismoacoustic profiling (D_0) is 80-90 db. Recently efforts have been made to compress this range by creating special attachments to analog recorders performing the operation of digital automatic amplitude control. In seismoacoustics use has been made of data carriers with a small dynamic range, although there is a need to increase it. The maximum adequate value D_{10} should be equal to D_0. This is now accomplished in complex recorders in the laboratory with the use of multicolor data carriers, which in the future can be used in field apparatus in simplifying the technology for obtaining color images. The maximum adequate D_{10} value must be determined from the conditions of best representation of the physical characteristics of the studied section in the final materials. The article examines the problem of the dynamic range D_1 necessary for true representation of the reflecting properties of the discontinuities. Only the first approximation is considered (a case when there are only single reflections present on the path). The value of the dynamic range $D_{10} = k_{max}/k_{min} = 25\text{-}28$ db can be used as the minimum necessary value in constructing output devices and analog recorders at seismoacoustic profiling stations (k is the reflection coefficient). Other parameters are similarly considered. Figure 1 is a schematic representation of a digital automatic amplitude control apparatus. Its function is compression of the dynamic range when registering signals with a field digital magnetic recorder meeting the requirements of processing and display of data on an analog recorder with which the controlled path will reflect the change in reflectivity of the boundaries in the section. Various problems involved are considered. Figures 2; references: 6 Russian. [60-5303]

UDC 550.831.016(571.6)

METHOD AND RESULTS OF COMPUTATIONS OF SURFACE DEFORMATIONS FROM GRAVITY DATA

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, Nov 82 (manuscript received 24 Feb 82) pp 92-98

MASLOV, L. A. and REYNLIB, E. L., Geophysical Expedition, Far Eastern State University; Institute of Tectonics and Geology, Far Eastern Scientific Center, USSR Academy of Sciences, Khabarovsk

[Abstract] It is postulated that deformation of the medium is caused by the density anomalies distributed in it under the influence of the gravity of a normal earth. The authors examine the problem of determining the mechanical

state of the medium on the basis of data on its external gravitational field. The problem was formulated as follows. The earth's sphericity can be neglected and it is necessary to solve the problem of deformation of a half-space at whose surface the gravity values are known, surface loads are equal to zero and the medium is incompressible. The described method for computing the mechanical state of the crust was tested for the southern part of Khabarovskiy Kray. The initial material for the computations was a small-scale map of Bouguer anomalies averaged in a grid with 50-km sides. It is noted that since the computations were made on the basis of the field of Bouguer anomalies, the mechanical characteristics obtained must be attributed primarily to the lithosphere below the level of the geoid because the influence of the masses above this level was to a considerable degree attenuated by the exclusion of the intermediate layer and the stresses were computed on the basis of the gravity field in the region and can be caused only by endogenous factors making a contribution to the gravity field. The computed values of the relative neotectonic vertical displacements of the geotectonic blocks correspond to those ascertained by geomorphological methods. It was found that regions of modern rising in general are characterized by horizontal dilatational stresses (vertical compression), whereas regions of settling of the crust are characterized by horizontal compressional stresses. It is the compression zones which are seismically active. The method is recommended for use in other regions and the simplified physical model described here can serve as a basis for more complex models. Figures 3; references: 9 Russian.
[59-5303]

UDC 530.311

LONG-RANGE PRECURSORS OF STRONG EARTHQUAKES IN THREE REGIONS OF CENTRAL AND WESTERN EUROPE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 269, No 1, Mar 83 (manuscript received 23 Aug 82) pp 73-75

SHAPOSHNIKOV, V. A.

[Abstract] In the past earthquake precursors have been studied in most cases for regions of high seismicity. However, it is also important to study precursors in regions of moderate and weak seismicity for understanding the mechanism of tectonic movements and because many of these regions are densely populated. The author has therefore investigated the anomalous grouping of earthquakes before the strongest tremors in three regions of Central and Western Europe with a relatively weak seismicity level: 1) juncture of the Alps, Paleozoic complex of Central Europe and the Carpathians; 2) Western and Central Alps and Schwabian-Bavarian plateau, bounded on the west by the Rhine and Rhone grabens; 3) eastern part of Paris Basin and Ardennes. In this article use is made of the notations and terminology employed by V. I. Keylis-Borok, et al. in VYCHISL. SEYSMOLOGIYA, No 13, pp 3-11, 1980; reference to that article is essential for comprehending the materials presented here. The initial data used in the study were taken from the ISC catalogue

for 1964-1976. Normal earthquakes with a focal depth less than or equal to $\overline{H}$ were examined. A search was made for the precursors of strong earthquakes with $M \geqslant M_0$. A "burst of aftershocks" B is diagnosed by the condition $b(e) \geqslant B$, where $b(e)$ is the number of aftershocks in the first e days. It indicates an increase in the probability of a strong earthquake (alarm) in the course of τ subsequent years. Another precursor BG is introduced for using catalogues in which earthquake magnitudes are not indicated or are unreliable. For each of the remaining earthquakes the number bg of subsequent earthquakes in the time interval e and in the distance R is determined. The presence of the precursor BG is determined by the condition $bg \geqslant \overline{B}$. The results of discrimination of the precursor B are given in Fig. 1 and Table 1. These results confirm the good prospects for investigating the anomalous grouping of earthquakes prior to the strongest earthquakes in regions of relatively weak seismicity (although more observational data must be accumulated for evaluating the statistical significance of these precursors). Figures 1, tables 1; references 4: 3 Russian, 1 Western.
[116-5303]

UDC 550.34.16+551.1

INTERACTION OF SMALL-DEFORMATION SEISMIC WAVES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 269, No 1, Mar 83 (manuscript received 3 Aug 82) pp 65-68

NIKOLAYEV, A. V., KHAVROSHKIN, O. B. and TSYPLAKOV, V. V., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow

[Abstract] When using frequency-modulated signals there is a great diversity of waves caused by the interaction of direct, reflected and secondary waves. Frequencies appear in the spectrum of seismic oscillations which are caused by the interaction of waves of different types (longitudinal P, transverse S, and surface Rayleigh waves R. The nonlinear interaction of P-, R- and S-waves begins near the seismic source (it is assumed as a simplification here that the source operates in a harmonic regime at the frequency f). Assuming that the medium near the source is homogeneous, the oscillation regime is steady and each point in the medium participates in oscillations of the frequency f, which can be regarded as a superposition of P-, S- and R-waves. If the medium has nonlinear properties there will be a complex interaction of waves. The authors describe experiments for clarifying the nonlinear properties of the medium and parametrically radiated seismic waves. The apparatus employed included a source of seismic signals (VSH-8 vibrator), a detector of vibrational signals (a seismometer tuned to a frequency of 14 Hz) and an automatic recorder. The experiments were carried out in a low-noise part of the Crimea. The distance between source and detector was 5 km in hilly relief. The source radiated signals of two types--monochromatic at 14 Hz and a linear FM signal at 30-90 Hz. A particular record is cited as an example. A distinguishing feature of this record is the presence of two maxima of the envelope characterized by a relatively rapid increase and slow dropoff of amplitude; the arrival of the first signal is about 8 sec from the time of

start-up of the vibrator, whereas the arrival of the second is 16 sec. This is a manifestation of nonlinear effects, the interaction of seismic waves. Since the interaction effect is proportional to signal amplitude, it is clear that the region of interaction of seismic waves is the near zone of the vibrator where seismic deformations are about 10^{-4}-10^{-5}. Dynamic relationships therefore make it possible to localize the region of wave interaction. The nature of this interaction is determined by an examination of the kinematic relationships--the times of appearance of combination waves. In the near zone of a source the greatest deformations are concentrated in the Rayleigh wave, which attenuates relatively slightly with distance. Deformations of 10^{-5} affect a region with a radius of 30-100 m from the source. The strongest interaction of secondary body waves should occur with the primary Rayleigh wave, most of whose energy is concentrated in the upper 20-m layer. Deformations in the secondary body waves are not greater than 10^{-11}-10^{-13} for the frequency band 0.1 Hz. Figures 1; references: 8 Russian.
[116-5303]

UDC 550.344.5

'NONRAY' EFFECTS IN SEISMIC WAVE PROPAGATION THEORY

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 5, Dec 82 (manuscript received 15 Feb 82) pp 1079-1083

ALEKSEYEV, A. S., corresponding member, USSR Academy of Sciences, Computation Center, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] Phenomena which do not fit in with the ray approximation are categorized as "nonray" phenomena. This includes wave phenomena which can be described either by using successive approximations of a ray series or by broadening the ray concept. Certain phenomena can be classified as "quasiray," whereas others are strictly "nonray." Presently existing concepts concerning the physical nature and classification of types of seismic waves may be inadequate for nonray waves. Numerical methods for determining the total wave field for adequately complex models of inhomogeneous media can be used in analyzing nonray effects. The possibilities of numerical modeling of the full wave field with allowance for nonray phenomena for extensive spatial regions and great propagation times appeared in connection with development of a numerical-analytical method for combining incomplete separation of variables with finite-difference methods for solving reduced problems of lesser dimensionality. Analysis of the numerical results for typical models of inhomogeneous media revealed the existence of intensive nonray waves which do not conform to the laws of geometrical seismics. Under certain conditions these waves dominate on seismograms and application of the laws of geometrical optics to them can result in errors in determining medium structure. Some nonray phenomena arising during wave propagation in a layered medium are discussed. The examination makes no pretense at completeness, the emphasis being on the necessity for taking nonray effects into account. Figures 3; references 15: 12 Russian, 3 Western.
[91-5303]

UDC 550.34.013

CHARACTERISTIC FREQUENCIES AND SEISMOGRAMS OF EARTH'S TORSIONAL OSCILLATIONS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 5, Dec 82
(manuscript received 29 Mar 82) pp 1076-1078

ADAMCHIK, Yu. A., Computation Center, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The author investigated the problem of the characteristic torsional oscillations of a radially inhomogeneous spherical model of the earth with the radius R. The article gives theoretical seismograms of SH waves obtained by summing of series of eigenfunctions. The Bullen B model was selected as the investigated model. It is shown that the use of vector spherical functions and the Fourier transform makes it possible to reduce the appropriate equations of motion to a system of ordinary second-degree differential equations. The equation in the system whose solution is related to torsional oscillations is investigated. An approach is proposed for solving the formulated problem. The difficulties involved are solved by a method based on a combination of numerical and asymptotic approaches. The application of the described method made it possible to compute seismograms of torsional oscillations of the earth shown in Fig. 1 for a source δ-shaped in time but having finite spatial dimensions. The source is stipulated by the formula

$$\mathbf{F}(\vartheta, t)=\begin{cases}\left(\cos^2\left(\frac{\pi}{2}\frac{\vartheta}{\vartheta_0}\right)\Big/\sin^2\vartheta\right)\delta(t)\vec{\varphi}_1, & 0\leqslant\vartheta\leqslant\vartheta_0,\\ 0, & \vartheta_0<\vartheta\leqslant\pi.\end{cases}$$

Here ϑ is the angle, ϑ_0 = const, δ(t) is a Dirac function, t is time, φ_1 is the unit vector of a spherical coordinate system. With the assumption $\Delta = r\vartheta_0$, a value is obtained which characterizes the spatial dimensions of the source. The vector of displacements U(R, ϑ, t) is obtained by the summing of more than $3\cdot10^5$ harmonics in time at each point. Figures 1; references: 5 Russian. [91-5303]

UDC 550.382

ELECTROMAGNETIC SOUNDING OF SEDIMENTARY COVER BY ARTIFICIAL SOURCES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 5, Feb 83
(manuscript received 20 Sep 82) pp 1090-1094

VELIKHOV, Ye. P., academician, DREYZIN, Yu. A. and SHAMRAYEV, I. M., Atomic Energy Institute imeni I. V. Kurchatov, Moscow

[Abstract] An idealized horizontally homogeneous model can be used in interpreting dipole electromagnetic soundings (EMS) only in the case of relatively small spacing (distance between measurement point and field source). However, short spacings require repeated laying out of the cable and operation of a mobile electric power station at sounding points, a burdensome and costly procedure, especially in the taiga and in other inaccessible areas. In studying the structure of the sedimentary mantle it is extremely desirable to use

great spacings. This would enormously reduce costs and otherwise facilitate the work. Electromagnetic mapping with great spacings was carried out on the Kola Peninsula and over the Astrakhanskiy arch with the field being created by electric dipoles with a cable weighing 150 tons fed by powerful (5-40 MW) MHD generators. The article describes a very simple scheme for computing the field with great spacings. The simplicity of the computation of the field of dipoles in a smoothly inhomogeneous layered model and the good correspondence of this model to commonly occurring surface structures make it possible to regard it as a useful generalization of the classic horizontally-homogeneous model and to use it as a basis in the practical interpretation of materials from dipole electromagnetic soundings. Figures 1; references 11: 10 Russian, 1 Western.
[113-5303]

UDC 550.34+47.57

RESULTS OF GENETIC REGIONALIZATION (LONG-RANGE FORECASTING OF SEISMS)

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 5, Feb 83 (manuscript received 30 Nov 82) pp 1178-1181

GUBIN, I. Ye., corresponding member, USSR Academy of Sciences

[Abstract] The long-range forecasting of earthquakes requires determination of the following: 1) seismogenic zones, 2) magnitude and intensity of the maximum tremors anticipated in the zone and the depth of penetration of foci and their extent; 3) width of zone of anticipated propagation of tremors of definite classes from the boundaries of this seismogenic zone; 4) frequency of recurrence of possible maximum and lesser tremors in the zone; 5) sectors of the most probable appearance of the next destructive earthquakes in the zone. For predicting these elements and compiling a seismic regionalization map the author earlier proposed a seismotectonic method (Gubin, I. Ye., DETAL'NOYE SEYSMICHESKOYE RAYONIROVANIYE, Moscow, Nauka, pp 5-26, 1980; ZAKONOMERNOSTI SEYSMICHESKIKH PROYAVLENIY NA TERRITORII TADZHIKISTANA, Moscow, Izd-vo AN SSSR, pp 3-463, 1960). After the publication of these materials within the limits of the investigated territory there have been 8 destructive earthquakes and 10 tremors of 7 scale units, all in earlier defined seismogenic zones. These events are individually described. All occurred in complete accordance with the established objective seismogenic tectonic processes, in conformity to recent processes of lithospheric dynamics. They occurred in zones of seismogenic dislocations. In each zone the length of the foci of the maximum tremors, their extent in depth and magnitude were determined by the geological structure characteristic of the zone. None of these earthquakes occurred in places where such events had occurred in the past; they were at potential foci, between preceding strong tremors. This experience in application of the seismotectonic method of seismic regionalization revealed its high effectiveness and the reliability of the law of seismotectonics serving as its basis. References 15: 14 Russian, 1 Western.
[113-5303]

UDC 548.348

LOW-FREQUENCY OSCILLATIONS OF CRUSTAL SYSTEM OF BLOCKS AFTER EARTHQUAKE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 5, Feb 83
(manuscript received 3 May 82) pp 1087-1089

BELOKOPYTOV, V. A., DOBROVOL'SKIY, I. P., MEDVEDEV, N. I., PEVNEV, A. K. and CHUDNOVSKIY, V. S., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow

[Abstract] In the Garm Geodynamic Polygon long-term pulsed-light rangefinder measurements are made of the distances between fixed marks on bases about 1 km in length. An earthquake of energy class 10 occurred in this area 18 km from the observation point on 12 August 1979. At this time measurements were made on a base intersecting the Vakhshskiy fault at an angle of 45°. Immediately after the earthquake there were considerable fluctuations of the base with an amplitude of about 40 mm which died out approximately 40 minutes later. It was assumed that the record contains information on the actual deformations of the crust and it was deemed possible to relate this to the oscillations of the system of blocks caused by the earthquake. In each sector of the record it is possible to discriminate three frequencies; the closeness of the discriminated frequencies in the different parts of the record suggests that there was a uniformity of the physical process during the entire observation period. For a preliminary mathematical description the authors selected a simple one-dimensional model of three identical concentrated masses. Since computations in the model were made by classical methods only the results are presented. The collected data make it possible to refine the parameters of one of the simplest viscoelastic models of the continuous medium making up the earth's crust. It was found that seismic efficiency, that is, the fraction of elastic potential energy accumulated during earthquake preparation, being transformed into the high-frequency radiation of seismic waves, is 1-3%. How to account for the remaining energy, which exceeds the energy of the earthquake by a factor of 30-99? Yamashita demonstrated theoretically that most of it degrades into heat during friction at the time of displacement along the main rupture. Another part, contend the authors, is responsible for low-frequency oscillations. Weak earthquakes probably are responsible for oscillations of the system of blocks in the neighborhood of the epicenter. The energy of these oscillations may exceed the seismic energy of the earthquake. Figures 3; references 6: 5 Russian, 1 Western.
[113-5303]

UDC 551.242.31(571.651)

OCEANIC OLISTOSTROMES ALONG WESTERN SHORES OF ALEUTIAN DEPRESSION (BERING SEA)

Moscow GEOTEKTONIKA in Russian No 5, Sep-Oct 82
(manuscript received 25 May 81) pp 74-81

BOGDANOV, N. A., VISHNEVSKAYA, V. S., SUKHOV, A. N., FEDORCHUK, A. V. and CHEKHOVICH, V. D., Lithosphere Institute, USSR Academy of Sciences

[Abstract] The authors for the first time describe a zone of oligostromes extending along the western shores of the Aleutian depression (Fig. 1 is a map showing the location of this zone; Fig. 2 is a schematic geological map and sections of this area). The materials presented here indicate that the presence of this single zone of oligostromes along the eastern margin of the Olyutorskiy Range, with rocks primarily of the oceanic crust being present in the olistoliths, is evidence that in the Early Tertiary the Vostochno-Olyutorskiy block of the suboceanic crust moved toward the east. The time of movement of this block probably occurred at the beginning of the Eocene-Middle Oligocene. Its movement is possibly attributable to spreading processes in the axial part of the abyssal Komandorskaya depression. The movement of the Vostochno-Olyutorskiy block led to crumpling of the oceanic crust beneath it and the partial obduction of the upper horizons of the Cretaceous oceanic crust of the Aleutian depression onto the margin of the block. The separation of plates of the oceanic crust into individual fragments and burial in the form of olistoliths in flyschoid strata of a sedimentary wedge forming at the foot of the range led to the formation of the zone of oligostromes along the zone of contact between the Aleutian depression and the suboceanic volcanic range. Figures 4; references 11: 8 Russian, 3 Western.
[61-5303]

UDC 550.831.017

HADAMARD CRITERION FOR SOLUBILITY OF LINEAR INVERSE GRAVIMETRIC PROBLEMS

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 107, No 2, Aug 82 (manuscript received 31 Jul 81) pp 289-292

DEKANOZISHVILI, I. V., Geophysical Institute, Georgian Academy of Sciences

[Abstract] Methods were recently proposed for investigating the nonsingularity of the A matrices arising in the approximation approach to solution of linear problems in gravimetry. One of the adequate conditions for nonsingularity of the A matrices is the Hadamard criterion

$$|a_{ii}| \geqslant \sum_{\substack{j=1 \\ j \neq 1}}^{n} |a_{ij}|, \text{ or } |a_{ii}| \geqslant \sum_{\substack{i=1 \\ i \neq j}}^{n} |a_{ij}|, \qquad (1)\text{-}(2)$$

where a_{ij} are elements of the A matrix; n is its order. For an infinite plane-parallel layer the conditions (1)-(2) are satisfied for the linear inverse problem $V_z \rightarrow a_0$ (determining the density constant on the basis of the vertical derivative of gravity potential), provided that the horizontal dimensions of the bodies for which the density values are sought meet certain conditions. An expression is derived which is suitable for a vertical cylinder. Vertical parallelpipeds require construction of a special table; such a table has been computed and its application and limitations are discussed. Also examined within the framework of the Hadamard approach is solution of the inverse problem $V \rightarrow a_0$ (determining the density constant on the basis of gravity potential). A second table in general corresponds to the first, but for the latter case. Tables 2; references: 2 Russian.
[103-5303]

UDC 550.831:551.24(470.21)

IMPORTANCE OF NORMAL PLANETARY MODEL OF EARTH IN INTERPRETING REGIONAL GRAVITY FIELD

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 107, No 2, Aug 82 (manuscript received 23 Jul 81) pp 285-287

GLAZNEV, V. N. and RAYEVSKIY, A. B., Geological Institute, Kola Affiliate, USSR Academy of Sciences

[Abstract] In constructing a density model of the earth there are difficulties in converting from excess densities obtained as a result of interpretation to absolute densities allowing geological interpretation. For such a conversion it is necessary to stipulate some normal density model of the earth and a normal gravitational field corresponding to it. Such a model and its gravitational field have been formulated at the Geophysical Institute, Georgian Academy of Sciences. This planetary model (PMZ-K) can serve as a basis for a regional interpretation of gravity data. The tie-in of the results of interpretation to any regional density column not reduced to a normal model can lead to incorrect geological conclusions. An example of this was the prediction that the Kola superdeep hole would encounter the "basalt" layer at a depth of 7 km; no such layer had been encountered to a depth of 10.5 km. An interpretation of the results of Kola data in relation to the PMZ-K model shows that there was no justification for such a prediction. Computations are cited to support this conclusion. It is shown that the reason for the erroneous prediction of the depth of the "basalt" layer was an arbitrary choice of the density column, not reduced to the absolute level of the earth's normal gravity field. The PMZ-K model gives a correct prediction. A density model of the crust was constructed for the northeastern part of the Baltic shield and this indicates that the "basalt" layer should be encountered at 17-20 km. Figures 1; references: 4 Russian.
[103-5303]

UDC 550.341

ALLOWANCE FOR INTERFERENCE OF P AND PcP WAVES WHEN DETERMINING CHARACTERISTIC FREQUENCY OF P-WAVE SPECTRA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 12, Dec 82 (submitted for publication 12 Oct 81) pp 46-58

KOGAN, S. Ya. and POLIKARPOVA, L. A., Institute of Physics of Earth imeni O. Yu. Shmidt, USSR Academy of Sciences

[Abstract] In evaluating the parameters of sources of deep-focus earthquakes in the Fiji-Tonga region on the basis of the spectra of longitudinal waves registered in the range of epicentral distances 74-98° it was necessary to determine the degree of their distortion due to the interference of P and PcP waves. At these distances with sources at depths of 530-650 km the time difference in arrival of P and PcP waves is less than 12 sec. The spectra of the P waves in the portion of the record with a duration greater than 12 sec will be distorted by the PcP wave. The distortion of the characteristic parameters of such spectra can be evaluated in the first approximation on the basis of the corresponding distortions of the theoretical spectra of two interfering signals having an identical pulse shape, time shift and ratio of amplitudes. It was found that significant changes in the characteristic parameters of spectra of interfering waves in the case of a ratio of their amplitudes about 0.3 are observed for $\tau \lesssim 5$ sec. In general, at distances 74-98° the PcP wave has the same polarity as the P wave and the lower limit of the ratio of amplitudes of PcP waves to the amplitudes of P waves is 0.15. The proposed method for making allowance for distortions due to the mentioned interference can be used in the case of interference of P and pP waves for surface earthquakes. Figures 4, tables 2; references 9: 6 Russian, 3 Western. [58-5303]

UDC 551.521.3

RESULTS OF STATISTICAL ANALYSIS OF LIGHT BACKSCATTERING WITH MODEL INDICATRICES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
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pp 1328-1331

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[Abstract] In sounding atmospheric aerosol by remote methods it is usually necessary to have a priori stipulation of the normalized radiation scattering indicatrix in the direction of the receiver. The geometry of the remote sounding experiments is usually such that the sounding angles are the scattering angles from the rear hemisphere, close to 180°. The experimenter in solving such problems as the sounding of high-altitude aerosol formations must make a valid choice of some value of the light scattering indicatrix, this usually being the backscattering indicatrix. However, there is no adequate basis for assuming that a scattering angle of 180° is the most suitable of the rear hemisphere angles for sounding for the purpose of determining the volume scattering coefficient in any optical situations. This problem can be solved by studying the variation coefficients of normalized scattering indicatrices characteristic for different aerosol models. The author made an analysis of this problem for the region of sounding scattering angles θ = 120-180° and for determining the range of angles where the variation coefficients are minimum. An analysis was made of 41 groups of computed indicatrices of light scattering by polydisperse systems of spherical nonabsorbing particles. The considered groups included the Junge model, a gamma distribution and a log-normal distribution. The mean normalized scattering indicatrix for each fixed scattering angle from the range θ = 120-180° was computed. All the considered groups of models were divided into two types: hazes and clouds, each of these being considered in detail. It was found that most of the mean scattering indicatrices intersect or are close in value with $\theta \approx 150°$; their variation coefficients are minima in the range of scattering angles θ = 140-160°. This gives basis for hoping for the possibility of an approximate evaluation of the volume scattering coefficient on the basis of the scattering indicatrix value for $\theta \approx 150°$ with a lesser error than on the basis of the indicatrix for θ = 180°. Backscattering can evidently be used in evaluating the volume scattering coefficient in a limited number of cases. There is an angular dependence of the position of the minimum of the variation coefficient on the refractive index. Extrapolations of the scattering indicatrix into the region

of large angles must be accomplished with particular caution. Whereas extrapolation into the region of large scattering angles to some degree can be considered valid for models of the Junge type, for single and multimodal distributions it is unjustified. References 12: 11 Russian, 1 Western.
[69-5303]

UDC 551.521.3

EXPERIMENTAL AND MATHEMATICAL MODELING OF CONDITIONS FOR VISIBILITY OF OBJECTS THROUGH TURBID MEDIUM LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
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pp 1303-1311

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[Abstract] The article outlines, discusses and compares the results of experimental and mathematical modeling of the process of image transmission through a scattering medium. The described investigations were made using the so-called linear-systemic approach to problems in visibility theory, directed to determining the dependence of the characteristics of image quality of objects of different sizes on the position of the scattering layer between the object plane and the optical receiving system. The general basis for this work was given by V. V. Belov, et al. in OPT. LETTERS, Vol 4, No 5, pp 158-160, 1979, entitled "Effect of Multiple Scattering on the Point-Spread Functions and Modulation-Transfer Functions of the Aerosol Atmosphere in Problems of Space Meteorological Photography." Here the authors present and analyze the results of experimental and numerical (by the Monte Carlo method) investigations of the dependence of image quality of plane, homogeneous objects of limited size on the position of a turbid medium layer on the observation path. Both the experiments and mathematical modeling are described in detail. The dependences which were obtained make it possible to evaluate the influence of the position of the scattering layer on the image quality of self-luminescent objects of limited size situated against the background of an absorbing surface. Figures 6; references 10: 9 Russian, 1 Western.
[69-5303]

UDC 551.521.3

ASYMPTOTIC BEHAVIOR OF MEAN RADIATION INTENSITY FOR SOME MODELS OF STOCHASTIC MEDIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 21 Oct 81) pp 1289-1295

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[Abstract] In solving many practical problems involved in optics and the radiation balance a study must be made of the attenuation of radiation during its passage through optically thick media with a random density distribution. The author has therefore determined the asymptotic behavior of mean intensity with increasing distance between the observation point and the source and given a comparison with the asymptotic behavior of intensity in a definite homogeneous medium with averaged density. The investigation is made under the assumption that the scattering indicatrix is greatly elongated forward and therefore it is adequate to use a plane-parallel model of the random density field. The effective length of migration of the trajectory of a quantum along the layer is small in comparison with the corresponding correlation length of the random density field. The asymptotic intensity in a plane layer with an accuracy to a constant factor is determined by solution of the transfer equation in an infinite medium. Accordingly, the author examines an infinite medium and the angular dependence of the source is determined from the characteristic equation of transfer theory. A mathematical model is constructed on this basis which gives the exponential asymptotic behavior of the mean intensity of the radiation passing through a layer whose optical thickness is random. The model is applied specifically in ascertaining the asymptotic behavior of mean intensity for a Poisson model of broken cloud cover.
References: 8 Russian.
[69-5303]

UDC 525.73:551.524.4

REFRACTION IN ATMOSPHERIC SURFACE LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
No 12, Dec 82 (manuscript received 7 Dec 81) pp 1282-1288

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[Abstract] In KOSMICHESKIYE ISSLEDOVANIYA, Vol 14, No 5, pp 691-692, V. I. Moroz pointed out that on the panoramas of the Venusian surface obtained by two Soviet automatic stations in October 1975 the horizon was situated very close, only a hundred or several hundred meters from the stations. He explained that this phenomenon can be attributed to a linear temperature decrease in the lower meter of the atmosphere by approximately 1 K. The temperature decrease with altitude indicates the existence there of convection described by the Monin-Obukhov theory. The author of this article

decided to check to determine to what extent the evaluation of the horizon range made by Moroz corresponds to the precise laws defined by Monin and Obukhov and to clarify the legitimacy of developments of such a theory for terrestrial applications. The article presents the outlines of an analytical theory of refraction in the atmospheric layer in which the profiles of the refractive index are described on the basis of the Monin-Obukhov theory. A quantitative interpretation of surface-layer refraction is made for a plane-parallel atmosphere, adequate for many problems, with easy generalization for a spherically symmetric case. The similarity parameter for refraction under such conditions is found. These results made it possible to develop the Moroz ideas further. The theory and its corollaries explain certain optical phenomena near the earth's surface. Formulas are derived which can be used in describing the "puddles" observed on asphalt during good summer weather, this actually being a reflection of the sky; due to heating of the asphalt convection occurs over it and the horizon seems very close. References 10: 8 Russian, 2 Western.
[69-5303]

UDC 551.521.3

COMPUTING ABSORPTION BY WINGS OF H_2O MONOMER IN WINDOW 8-13 μM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 2, Feb 83 (manuscript received 1 Jan 82) pp 215-219

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[Abstract] Attempts at describing continuum absorption by the far wings of the H_2O monomer have been undertaken repeatedly; this article begins with a review of the literature. The author then presents his own detailed computations of absorption by the wings of the water vapor spectrum for four frequently used contours, using the most complete spectroscopic data available. Then direct experimental data are compared with the results of computations in a broad range of humidities and temperatures both for pure water vapor and for its mixture with nitrogen. Computations of absorption by the H_2O wings were carried out in the frequency range 40-1250 cm^{-1} with an interval $\Delta\nu$ = 10 cm^{-1}. Computations were also made of $K_f(\nu,\theta)$, the absorption coefficient related to the admixed gas (in this case air) in the temperature range 275-375 K for the four different contours. The temperature dependence $K_f(\nu,\theta)$ for the temperature interval 275-375 K is represented in the form $K_f(\nu,\theta) = K_f(\nu, 300\ K)(300/\theta)^n$, where the n parameter is slightly dependent on frequency. It is shown that computations based on the considered contours are not capable of describing all the experimentally established patterns of continuum absorption in the window 8-13 μm. Further experimental investigations are required. Figures 3; references 19: 9 Russian, 10 Western.
[115-5303]

UDC 551.511.3

SMALL ATMOSPHERIC PERTURBATIONS FOR ONE TEMPERATURE STRATIFICATION MODEL

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 2, Feb 83 (manuscript received 7 Aug 81), after revision 29 Jan 82) pp 115-123

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[Abstract] The problem of small perturbations of an atmosphere with a real temperature stratification T(z) has no precise analytical solution; numerical solutions cannot give the full picture of small atmospheric perturbations. The author proposes a search for approximate analytical solutions, in particular, with a dependence of the nature of the perturbations on different parameters of the problem. Other authors have suggested a precise solution using an isothermic stratification and despite its merits the model does not make it possible to examine such important features of atmospheric perturbations as the discrete nature of the characteristic curves of the problem, the decrease in energy density of perturbations in the outer part of the atmosphere and other problems. Other approaches have been suggested but have their shortcomings. Here the author examines small perturbations in an atmosphere whose temperature is constant in the lower part of the atmosphere and increases linearly with altitude in its upper part. The stratification examined is described by the formula $H(z) = H_0 + (z - z_1)\, h\, \theta\, (z - z_1)$, where $\theta\ (x) = 1$ with $x \geqslant 0$ and $\theta\ (x) = 0$ with $x < 0$; the H value is equal to H_0 with $z < z_1$ and increases linearly with altitude with $z > z_1$. Formulas are derived for describing high-frequency acoustic and short-wave gravitational perturbations, as well as low-frequency Lamb waves. These formulas can be regarded as a generalization of the similar formulas frequently used for an isothermic stratification. Figures 1; references 8: 5 Russian, 3 Western. [115-5303]

UDC 551.511.32:551.510.535.2:551.466.81

FEW-COMPONENT MODEL OF INTERACTION OF INTERNAL GRAVITATIONAL WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 2, Feb 83 (manuscript received 28 Dec 81, after revision 3 Mar 82) pp 124-134

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[Abstract] Models with few components, derived from the equations of hydrothermodynamics by the Galerkin method, are extensively used in describing geophysical flows. The author here uses this approach in studying the nonlinear interaction of internal gravitational waves in the special case when one of the waves is represented by a stationary, plane-parallel, periodic in height

flow of a stratified fluid. The secondary regimes arising with a loss of stability of the stationary spatially periodic flow of stratified fluid (with an internal gravitational wave with a vertical wave number much greater than the horizontal wave number) are investigated. The amplitudes of the main flow and the perturbations in the secondary stable regime are computed on the assumption of a low value of both viscosity and thermal conductivity. The values obtained by the author are close to the observed amplitudes of internal gravitational waves in the altitude range 80-120 km, the meteor zone of the atmosphere. Figures 2; references: 6 Russian.
[115-5303]

UDC 551.551.5

EXPERIMENTAL STUDIES OF MICROSCALE TURBULENCE AND TURBULENT EXCHANGE IN MIDDLE LATITUDE CYCLONES AND ANTICYCLONES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 2, Feb 83 (manuscript received 27 Jan 82) pp 135-146

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[Abstract] During 1977-1980 specialists of the Central Aerological Observatory carried out in-flight investigations of turbulence in the entire thickness of the troposphere in three experiments in an IL-18 flying laboratory with instrumentation for measuring the mean values of wind velocity and temperature and also the fluctuating values of temperature, horizontal and vertical components of the wind velocity vector. The flights were made in different regions and at different times in the year. It was found that turbulence even in a relatively small polygon (100 x 100 km) is localized in the form of turbulent spots intermittent with undisturbed zones. A total of about 300 zones were intersected during the flight experiments. In virtually all cases these zones had rather sharp lateral boundaries. Data from synchronous measurements of the vertical w' and horizontal v' wind velocity pulsations and temperature pulsations T' were subjected to correlation and spectral analyses. The correlation functions, pulsation spectra, cross-correlation functions and cospectra were computed for each disturbed zone. A total of 1,800 different spectra were analyzed. It was possible to construct vertical profiles of the rate of dissipation of turbulent energy into heat, the rate of dissipation of temperature fluctuations and the structural characteristics of the field of fluctuating temperature, turbulent fluxes of heat and momentum. Other important characteristics were also registered and analyzed. The vertical and horizontal fluxes of heat in cyclones, especially in the lower half of the troposphere, are considerably greater than in anticyclones. The horizontal heat fluxes in cyclones are several times greater than the vertical fluxes, in the lower half of the troposphere by a factor of 3-4, and in its upper part by a factor of 6-10. In anticyclones this ratio is in the range 1-1.6. Figures 4, tables 6; references 12: 11 Russian, 1 Western.
[115-5303]

UDC 551.501.721:551.521.3

METHODS FOR PASSIVE SOUNDING OF ATMOSPHERIC TRANSPARENCY IN SURFACE LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 2, Feb 83 (manuscript received 18 Jun 81, after revision 31 May 82)
pp 147-155

KABANOV, M. V. and SAKERIN, S. M., Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences

[Abstract] The article gives an analysis of passive methods for sounding atmospheric transparency on horizontal paths in the surface layer in the example of marine measurements (from shore or from aboard a ship). The differential angular method involves use of an approximate expression for the distance to the sighted sea sector and the assumption of orthotropicity of the sea surface. The differential method is applicable if the position of the horizon is governed by appreciable atmospheric turbidity. In the case of high transparencies the method is in principle inapplicable because the position of the horizon and the brightness drop are governed only by the geometry of the experiment and refraction. The method is applicable for low transparencies but has an error up to 30-40%. The integral and logarithmic angular methods are based on measurement of sea brightness with different angles to the horizon. The only assumption is an orthotropicity of the sea surface in the range of several tens of minutes of angle. In the logarithmic angular method the observed sea brightness is measured with two sighting angles. The integral angular method involves measurement of sky brightness over the horizon, sea brightness with some angle below the horizon and the mean brightness in the angle between the direction to the horizon and a stipulated direction. The logarithmic and integral altitude methods are free of the assumption of isotropicity because they are based on measurement of sea brightness with one sighting angle from two altitudes. The logarithmic altitude method is the more complex of the two but is more precise. The article gives the results of tests of these methods. It was found that passive methods are applicable for determining the energy attenuation of optical radiation in the atmospheric surface layer. These methods make possible routine sounding of atmospheric transparency in a broad spectral range and in different azimuthal directions. Figures 4; references 16: 15 Russian, 1 Western.
[115-5303]

UDC 551.521.3

SPECTROSCOPIC MEASUREMENTS OF 'ADDITIONAL ABSORBING MASS' IN CONTINUOUS AND BROKEN CLOUDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 2, Feb 83 (manuscript received 23 Nov 81); after revision 28 Jan 82) pp 156-162

GRECHKO, Ye. I. and DIANOV-KLOKOV, V. I., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] The fact of an influence of multiple scattering processes on the distribution of the radiant energy absorbed within the cloudy atmosphere-ocean system has now been established. The mechanism of this phenomenon is related to lengthening of the paths of photons due to multiple scattering in clouds, resulting in the additional absorption of radiation by atmospheric gases--the appearance of an additional absorbing mass Δm. A study of this effect has been made in both continuous and broken clouds. Study of the effects of lengthening of the path of photons in a broken cloud cover is only beginning. The article describes investigations made on the 29th voyage of the "Professor Zubov," mostly in the Antarctic region. Since the measurements were over the ocean, whose albedo in the used spectral region can be considered equal to zero, it was possible to study effects attributable only to cloud cover. All investigations in broken clouds, in contrast to continuous cloud cover, were made in the equatorial zone of the southern hemisphere. The method for measuring the additional absorbing mass Δm was the same as given by Ye. I. Grechko, et al. in IZV. AN SSSR: FAO, Vol 11, No 2, pp 125-138, 1975. In the Antarctic region 43 investigations of continuous clouds gave Δm values stably grouped around $\overline{\Delta m} = 1.0$ with a dispersion $\sigma(\Delta m) \approx 0.45$. The evaluations indicated that the fraction of radiation in the interval 1-3.5 μm absorbed by the cloudy atmosphere can increase by 30-40% in comparison with that computed without allowance for multiple scattering. The measurements made for broken clouds in the equatorial zone revealed a nonlinear dependence between Δm and the tenths of cloud cover. Figures 3, tables 1; references: 3 Russian. [115-5303]

UDC 551.513

SOME ATMOSPHERIC CIRCULATION PERIODICITIES

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA Vol 24, No 1, Jan-Feb 83 (manuscript received 15 Dec 81) pp 57-62

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[Abstract] The authors made a quantitative analysis of atmospheric circulation separately for different sectors of the earth. This study, made for different altitudes is important for understanding the effect of solar activity on air masses and comprehending the relationship between the upper and lower atmosphere. In the quantitative description of circulation use was made of the Kats

zonal I_{zon} and meridional I_{mer} circulation indices determined for different sectors of the earth for the period March 1977 through December 1979. Two major longitude sectors were considered (Atlantic-European and American). Only the latitude zone 50-70°N was considered. The analysis took in the middle stratosphere and the troposphere. A special method was employed in the statistical processing. Periods of 10 to 35 days were investigated. Several periods were discovered and various hypotheses explaining these phenomena are examined. It was found that at the 10- and 30-mbar levels there are 27-day variations of zonal circulation whose amplitudes exceed the limits of random errors and a period of 25 days also appears. I_{zon} variations occur in anti-phase in the two circulation sectors. At a lower level (500 mbar) the 27-day periodicity disappears in the American sector and weakens considerably in the Atlantic-European sector; the 25-day periods persist in both sectors and their phase becomes identical in both sectors. In meridional circulation there is no 27-day period and the 25-day variation of the I_{mer} index exists only in the American sector. It is shown that a number of the observed periodicities are attributable to the superposing of variations. It is concluded that for any final conclusion concerning the nature of the factors determining atmospheric circulation there is a need for a more precise determination of its characteristic periods. This requires an analysis of the Kats indices on the basis of the greatest volume of statistical data possible and application of spectral analysis methods. Figures 3, tables 2; references 18: 12 Russian, 6 Western.
[104-5303]

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