JPRS 84367

20 September 1983

USSR Report

EARTH SCIENCES

No. 28

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METEOROLOGY

WORLD CLIMATE RESEARCH PROGRAM SUMMARIZED

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 83 pp 22-26

[Article by USSR Academy of Sciences Correponding Member G. S. Golitsyn]

[Text] The climate problem has recently emerged on the leading edge of science. This is why the World Climate Research Program, which is being carried out through the joint efforts of the scientists of different countries, is acquiring special significance.

Climate plays a great role in the lives of people. On one hand almost all sectors of the economy are being developed with a consideration for climatic features, while on the other hand many forms of human activity have an influence on climate. Geological, archeological, and historical data indicate that in the past, fundamental changes occurred in the climate of our planet. Climate is changing today as well. The growing frequency of droughts and floods, the unusually severe or mild winters in different regions of the globe and growth in the atmospheric concentration of carbon dioxide and other impurities of anthropogenic origin that may cause a warming trend are all responsible for the universal attention now being focused on the climate problem. In the last 10-15 years climatology has been transforming from a purely regional statistical system of weather description into an integrated science, and a contribution is being made to its development not only by meteorologists, geographers and oceanologists, but also physicists, mathematicians, biologists and specialists in space exploration.

The Great "Predecessor"

Scientists began preparing the Program of Research on Global Atmospheric Processes (PIGAP) in the 1960s. The program was aimed primarily at improving weather predictions, but another goal was pursued as well--achieving a deeper understanding of the course of climate-forming processes. Numerous national and international regional experiments were conducted in the 1970s within the framework of PIGAP (ZEMLYA I VSELENNAYA, No 3, 1975, p 39.--*Editor*). Processes occurring in the tropical atmosphere above the ocean and interaction between atmosphere and ocean were studied in summer 1974 during the Atlantic Tropical Experiment. Deep convection leading to cloud formation was studied as well.

The experiment, in which 70 countries took part and which was conducted with the assistance of over 50 vessels representing many different countries (more than 10 were Soviet), significantly clarified many details of processes in the tropical atmosphere. In addition to measurements made by vessels, satellite data and data acquired by airborne laboratories played an important role.

The polar experiments POLEX-North and POLEX-South were conducted in the second half of the 1970s on a national basis for the most part, and mainly through the efforts of the USSR and the USA. Their purpose was to study heat and mass exchange processes at high latitudes. At that same time scientists of many countries--primarily the USSR, India, the USA, England and France--performed the large-scale Monsoon Experiment. It purpose was to study the birth and development of monsoons, which bring rain (and life!) to all of South and Southeast Asia.

The experience in organizing and conducting the experiments listed above was found to be invaluable to the conduct of the PIGAP Global Meteorological Experiment. Almost 150 countries participated in it. In 1979, data on the state of the atmosphere and the ocean surface of the entire globe were obtained for the first time. This material demonstrated that there is a fully realistic possibility for lengthening the periods of weather prediction. An especially sizable improvement was made in prediction for the Southern Hemisphere, where information on the state of the Southern Ocean had formerly been almost entirely nonexistent. Moreover PIGAP served as the precursor of the World Climate Research Program.

Creation of the Program, and Its Goals

The scientific principles of the World Climate Research Program were developed at an international conference held in Sweden in summer 1974. The World Climate Conference, held in Geneva in 1979, instructed the World Meteorological Organization and the International Council of Scientific Unions to develop and implement the long-range World Climate Program, which was formerly adopted in June 1979 during the Eighth World Meteorological Congress. The program was initiated on 1 January 1980.

The preliminary plan for the World Climate Research Program, which became the main part of the World Climate Program (its other components are concerned with collecting, storing and utilizing climatic information, and with the influence of climatic changes on society), was developed by the beginning of 1981. The goal of the World Climate Research Program is, first, to try to determine why and where climate may change, and second, to develop the methods of predicting such changes. But at first the limits of climate predictability and the anthropogenic influence upon climate had to be determined. This required deeper investigation of global and regional climate, its changes and the causes behind these changes, development of physicomathematical models of climate and their use to evaluate the sensitivity of climate to possible natural and manmade influences. All of this required exhaustive data on temperature, cloud cover, humidity, precipitation, wind characteristics and pressure. Following meticulous and multifaceted statistical analysis, such data could reveal the relationships between various processes, climatic norms and deviations from them.

Before we can build and debug climate models, we must learn to correctly describe the various processes that make up climate. Climate can be defined as the statistics of weather averaged over some interval of time that is much greater in comparison with the typical time scale of weather phenomena lasting on the order of a week. For the purposes of the World Climate Research Program, periods from several weeks to several decades were chosen as the periods of emphasis, though investigation of processes of greater and lesser scale is not excluded. Areas varying from those having a cross section of 1,000 km to those covering the entire globe were selected to represent the typical spatial scale.

The concept of a climatic system has important significance to climate research. It includes the atmosphere, the ocean, the cryosphere, which contain ice and snow, and dry land. The most variable part of the climatic system is the atmosphere, the "carrier" of weather, in which cyclones and anticyclones, clouds and precipitation form. Interacting with the atmosphere, the oceans exchange heat, moisture and energy with it or with sea ice, with the typical time of this interaction varying from several months to several years. Some components of the atmosphere--ice and snow, which include the continental ice packs of Antarctica and Greenland, mountain glaciers, sea ice and snow cover--vary with the season, or much more slowly. Processes occurring in deep ocean layers take up to hundreds of years and more. And finally, the components of dry land--its topography, vegetation, soil, lakes, rivers and underground water--vary within all time scales.

The climatic system can be described in some approximation today by physico-mathematical models consisting of a large number of equations. Speaking in the language of radio engineering, it is a nonlinear model with numerous feedbacks and with its own "noise," and as is the case with technical devices, in this system we also face the problem of isolating a "useful signal" from a "noise" background--that is, we must isolate real climatic changes from a background of more or less natural fluctuations. To build dependable physico-mathematical models of climate, we must know how to describe processes occurring in individual parts of the climatic system, and the way these parts interact. But even in the best case, many processes are known only qualitatively. It is at their quantitative investigation that the World Climate Research Program is directed.

The Role of Cloud Cover

Two important directions requiring the greatest effort and outlays have been isolated within the World Climate Research Program. The first is radiation and cloud cover, and the second is the ocean as the controlling factor of global cycles of heat, moisture and chemical elements (especially carbon).

Clouds reflect a proportion of solar radiation and "intercept" thermal radiation--that is, on one hand they reduce the influx of energy into the climatic system, while on the other they work like a blanket to warm the earth surface (ZEMLYA I VSELENNAYA, No 4, 1980, p 28.--*Editor*). The question as to what plays the dominant role can be answered only through long-term satellite observations of the quantity and form of clouds, their altitude and their optic

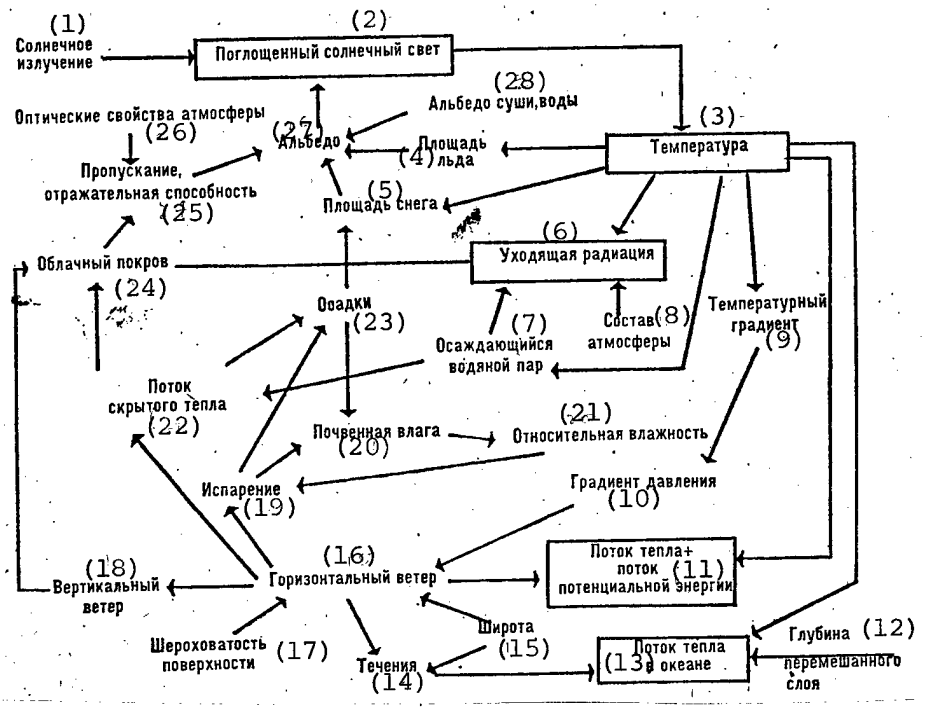
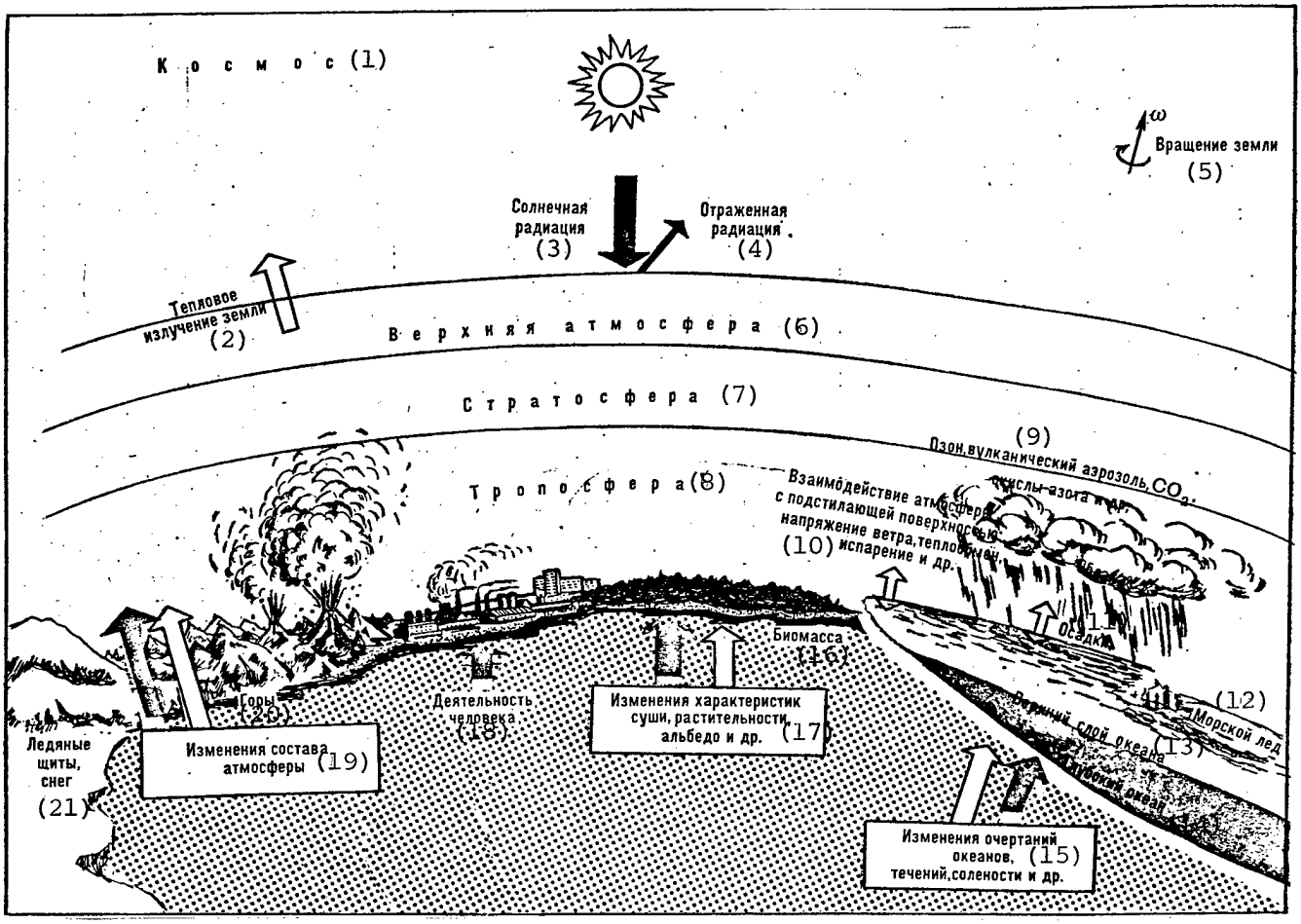


Diagram of the climatic system, consisting of atmosphere, ocean, cryosphere and dry land. Blue arrows--external processes, white arrows--internal processes leading to change in climate.

Key:

1. Solar radiation
2. Absorbed sunlight
3. Temperature
4. Ice surface area
5. Snow surface area
6. Escaping radiation
7. Settling water vapor
8. Composition of atmosphere
9. Temperature gradient
10. Pressure gradient
11. Heat flow+potential energy flow
12. Depth of mixing layer
13. Heat flow in ocean
14. Currents
15. Latitude
16. Horizontal wind
17. Surface roughness
18. Vertical wind
19. Evaporation
20. Soil moisture
21. Relative humidity
22. Latent heat flow
23. Precipitation
24. Cloud cover
25. Transmission, reflectivity
26. Optical properties of the atmosphere
27. Albedo
28. Albedo of dry land, water

properties, and of the components of the radiation balance. Preliminary data show that both functions of clouds seem to mutually compensate each other. However, many scientists validly point out that, first of all, the extent of cloud cover, or the cloud cover index--that is, the proportion of the earth's surface covered by clouds--is only 30 percent accurately known; second, the technique of measuring the components of the radiation balance must be significantly improved.



Action of "Feedbacks" in the Climatic System

Key:

1. Space
2. Earth's thermal radiation
3. Solar radiation
4. Reflected radiation
5. Earth rotation
6. Upper atmosphere
7. Stratosphere
8. Troposphere
9. Ozone, volcanic aerosol, CO_2
10. Interaction of atmosphere with underlying surface, wind intensity, heat exchange, evaporation etc.
11. Precipitation
12. Sea ice
13. Upper layer of ocean
14. Deep ocean
15. Changes in ocean boundaries, currents, salinity etc.
16. Biomass
17. Changes in characteristics of dry land, vegetation, albedo etc.
18. Human activity
19. Changes in composition of atmosphere
20. Mountains
21. Ice pack, snow

The International Satellite Cloud Climatology Project will be implemented in 1983 in order to solve these problems. Several geostationary satellites and a number of satellites with close-to-polar orbits will be used. They will provide information on the spatial distribution of clouds, their form, their optic properties and the moisture they contain. Concurrently the USA will begin a project with the hope of determining the components of the radiation balance. If these projects are carried out, perhaps by the end of the 1980s we will be able to answer the question as to the role played by clouds in the climatic system.

Influence of the Oceans

The oceans are the main source of atmospheric moisture as well as of heat in the cold part of the year (ZEMLYA I VSELENNAYA, No 6, 1979, p 10.--*Editor*). However, processes occurring in the ocean itself and its interaction with the atmosphere are poorly studied, not only quantitatively but even qualitatively in some respects. Ocean modeling is still in its primitive state as compared to atmospheric modeling.

We are not as yet completely clear as to how much heat the ocean carries from the tropics to the high latitudes. According to the estimates this proportion is about half the heat flow in the atmosphere. But this is based only on indirect information that requires verification by direct measurements. In order that direct assessments could be made, we must know the structure of deep oceanic circulation, which is practically unknown on a global scale. There exists the conception of energy-active zones of the ocean, suggested by Academician G. I. Marchuk in the mid-1970s. In such zones the ocean interacts the most actively with the atmosphere, and they play the main role in formation of short-period fluctuations of climate. The Soviet program "Razrezy" ["Cross Sections"] is aimed at studying these ideas. American scientists have been suggesting approximately the same sort of ideas in recent years in relation to the tropical zone of the ocean. International oceanographic programs are now being drawn up with the purpose of answering these questions. These programs are to be implemented in the late 1980s and early 1990s, and they should last a minimum of several years.

Creation of models of water circulation and mixing in the ocean will also require considerable effort. However, real progress would be possible in this area only if we use computers that are significantly more powerful than those used today. Moreover the oceanographic programs mentioned above would have to be basically completed as well.

Sea ice, which covers up to 10 percent of the area of the World Ocean, plays a sizable role in the climatic system. The characteristics of sea ice vary strongly with the season as well as from one year to the next, being an important indicator of climatic changes. By raising the albedo of the earth surface (the coefficient of reflection of solar radiation from the earth surface), sea ice influences exchange of heat and moisture with the atmosphere--that is, it has a noticeable influence on processes occurring in the climatic system. We need to develop the quantitative theory of these processes before we can

determine how sensitive climatic models are to them, and this would require specialized satellite and field observation programs, creation of models to describe the processes and performance of numerical calculations.

The atmosphere actively interacts with the land surface, exchanging heat and moisture with it. Heat exchange is determined by the energy balance on the surface. The quantity of solar radiation reflected from the surface depends on the albedo, which is determined by the nature of the vegetation, the condition of the soil and so on. Thermal radiation from the surface, the flow of heat into soil, the moisture reserve within the latter, evaporation from the land surface and above-ground and underground runoff also depend on these parameters. All of these processes are characterized by enormous spatial and temporal variability, and their quantitative characteristics are poorly known. A special conference conducted in 1981 within the framework of the World Climate Research Program determined the direction for studying these processes, so that they could be included in the climate model.

Gases and Aerosols

Water vapor is given the place of greatest importance in this part of the World Climate Research Program. While it has almost no influence on solar radiation, water vapor is precisely what retains the overwhelming majority of thermal radiation from the earth surface and the atmosphere (ZEMLYA I VSELENNAYA, No 2, 1979, p 36.--*Editor*). Were there not to be any water on earth, its mean temperature would be about 15°C lower. But because water is present, water vapor serves as the main feedback mechanism in the climatic system: The higher the temperature near the surface the more significant is evaporation from it, the more water vapor gets into the atmosphere and the stabler is the "greenhouse effect." Further heating is prevented by formation of a larger quantity of clouds and by reduction of the proportion of solar radiation getting to earth.

The next in importance is an optically active gas--carbon dioxide, which possesses noticeable "greenhouse" properties (ZEMLYA I VSELENNAYA, No 6, 1981, p 19.--*Editor*). Water vapor is significantly intensified by its action. In the last 100 years the concentration of CO_2 in the atmosphere increased by almost 20 percent, bascially owing to the accelerating rate of combustion of mineral fuel. Were this tendency to persist, by the middle of the next century the CO_2 concentration may double, and then the mean global air temperature at the surface would rise by 2-3°C, with greater changes occurring at high latitudes. How the hydrologic cycle changes in this case and what will be the regional changes in climate will have to be clarified using detailed climate models. Paleoclimatic reconstruction for periods warmer than now should also provide additional information.

A special program aimed at obtaining, from observation data, the earliest possible statistically dependable determination of predicted climatic changes is being developed within the framework of the World Climate Research Program. Many indicators of such changes have been proposed. One of them is cooling of

the lower stratosphere, accompanied by warming of air near the ground. The explanation of this effect is as follows. The lower stratosphere absorbs practically no solar radiation, and it is heated by thermal radiation from the troposphere. An atmosphere with a lower CO_2 concentration is less permeable to thermal radiation, and part of the radiation that leaves the troposphere concentrates in higher and colder layers. As a result the intensity of thermal radiation decreases. Therefore the lower stratosphere warms up less if there is more CO_2 in the atmosphere in general.

Methane, ozone, nitric oxides, chlorofluoromethane and other gases are also optically active, though to a lesser degree than CO_2. Many of them have anthropogenic sources. Moreover all of these impurities, upon taking up moisture, enter into diverse chemical reactions, they dissolve in ocean water, and they are absorbed by soil. These natural cycles need further study.

The atmosphere contains a huge number of solid and liquid particles--aerosols. These particles act as condensation centers for moisture, forming cloud droplets. At the same time they reflect solar radiation, and as a rule they absorb insignificant amounts of thermal radiation. Thus aerosol is an important factor of climate. Various estimates made on the basis of models show that were all aerosol to be removed from the atmosphere, it would become about 2°C warmer.

The causes of arisal of aerosol are many. It is generated by seafoam, by dust particles raised from the surface by wind, and by sulfur gases entering the atmosphere during volcanic eruptions. Aerosols of biospheric and anthropogenic origin exist as well. A certain correlation has been discovered between the index of atmospheric turbidity elicited by aerosol and fluctuations in today's climate. There are also certain indications that volcanic activity is associated with changes in paleoclimate. All of this attests to the importance of studying aerosol and to the need for creating aerosol models and assessing the sensitivity of climate to change in aerosol concentration and quality.

In the Future--New Research

The Preliminary Plan of the World Climate Research Program also mentions the problem of sun-earth relationships. However, it has been stated that before including this problem in the World Climate Research Program, the statistical significance of sun-earth relationships to climate in general would have to be critically analyzed.

The World Climate Research Program devotes considerable space to evaluating and using climate models. Models can vary from complete three-dimensional numerical models of the atmosphere and ocean (this includes both processes involved in interactions between ocean and atmosphere, and processes occurring on the land surface) to simple unidimensional zonal models of the energy balance.

The world program devotes great attention to analyzing information already existing and information yet to be obtained. This analysis will make it

possible to evaluate the natural variability of climatic parameters in relation to different spatial and temporal scales, and to clarify statistical relationships between changes in various parameters, which in the final analysis will provide the foundation for verifying numerical climate models and their results.

The program also devotes great attention to obtaining, storing and using data for climate research. These data may be otained--using not only the conventional hydrometeorological network but also satellites--in special observation programs developed in application to the World Climate Research Program (for example oceanological programs, the International Satellite Cloud Climatology Project). A number of parameters (optically active gases, aerosol etc.) will require creation of a special network for their long-term monitoring.

Soviet scientists are taking an active part in drawing up the World Climate Research Program and in conducting and coordinating research within this program. If we can learn to predict climate and its changes and fluctuations, we will not only enrich science, but in the final analysis we may also achieve a tangible payoff for many sectors of the national economy.

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MODEL OF GLOBAL, ZONALLY AVERAGED DISTRIBUTION OF CARBON MONOXIDE CONTENT IN ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 6 Jan 82) pp 3-13

KAROL', I. L. and KUDRYAVTSEV, A. P., Main Geophysical Observatory

[Abstract] Using previously published materials, the authors construct a latitudinally and seasonally averaged model of the atmosphere's carbon monoxide content up to an altitude of 30 km (assuming that the carbon monoxide content above this level is in dynamic equilibrium). They find that the atmosphere's carbon monoxide content in the Northern Hemisphere is about 50% higher than in the Southern Hemisphere, which is undoubtedly the result of the larger percentage of land mass in the former, with its concomitant larger population (which uses machines that produce carbon monoxide), plus a higher concentration of biospheric and photochemical processes. The highest concentrations are seen during the hemispheric winter months, the lowest during the summer months. Figures 10: references 19: 8 Russian, 11 Western.
[88-11746]

UDC 551.558.1

MODULATION OF PARAMETERS OF CONVECTIVE BOUNDARY LAYER BY LARGE-SCALE VERTICAL MOVEMENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 1 Oct 81; after revision 11 Jan 82) pp 14-19

IVANOV, V. N. and INGEL', L. Kh., Institute of Experimental Meteorology

[Abstract] The authors set up an integral model of the lower, quasihomogeneous convective layer of the atmosphere that is limited above by a clearly expressed inversion. After discussing its steady-state characteristics and illustrating them with numerical examples, they then move on to the question of the modulation of these characteristics by transient, large-scale vertical movements. They find that modulation of the vertical velocity does not affect the steady state of the inversion's intensity, but does affect its altitude. These conclusions are also illustrated with numerical examples. References 9: 3 Russian, 6 Western.
[88-11746]

UDC 551.510.42

FORMATION AND DEVELOPMENT OF ATMOSPHERIC AEROSOL: KINETICALLY CAUSED PARAMETERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 1, Jan 83 (manuscript received 3 Mar 82) pp 21-35

ROZENBERG, G. V. (deceased), Institute of Physics of the Atmosphere, USSR Academy of Sciences

[Abstract] Treating the atmospheric aerosol as a continuously occurring process rather than a conservative substance, the author explains the aerosol parameters caused by the kinetics of its formation and intra-atmospheric transformation. After describing the process of atmospheric aerosol formation, he goes into more detail in discussing the following factors that come into play during that process: admixture gas processes, vapors of aerosol-forming compounds, clusters and microdispersed and submicron fractions. He then sets up a kinematic model of the atmospheric aerosol formation, transformation and destruction processes that is simpler than the methods now used to study them. Figures 2; references 15: 11 Russian, 4 Western.
[88-11746]

UDC 551.521.3

EXPERIMENTAL INVESTIGATIONS OF SYSTEMATIC DISTORTIONS OF LASER RADAR SIGNALS IN NEAR ZONE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 1, Jan 83 (manuscript received 3 Apr 81) pp 36-42

KOVALEV, V. A. and IGNATENKO, V. M., Main Geophysical Observatory

[Abstract] On the basis of a series of experiments conducted in 1979 and 1980, the authors study the effect of distorting factors depending on the turbidity of the atmosphere (multiple scattering, in particular) on the geometric factor (a factor that allows for lack of complete coincidence of the axes of a laser radar (lidar) transmitter and receiver). They describe the experimental setup and, using 270 oscillograms obtained in 30 series, they analyze the effect of the meteorological visibility range on the geometric factor. Although they reach no definitive conclusions, they do find that the level of the multiple scattering background reaches a maximum in the near zone, then falls off to some value determined by the lidar's geometry, then begins to increase proportionally to the optical thickness of the layer being sounded in the zone where the laser beam falls entirely within the receiver's viewing field. Figures 3; references 6.
[88-11746]

UDC 551.465.7

DEPENDENCE OF COEFFICIENTS OF RESISTANCE, HEAT TRANSFER, EVAPORATION ON METEOROLOGICAL PARAMETERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 12 Nov 81; after revision 26 Feb 82) pp 85-88

KLAPTSOV, V. M., Institute of Physics of the Atmosphere, USSR Academy of Sciences

[Abstract] Using data available in the literature (214, 189 and 171 measurements for the coefficients of resistance, heat transfer and evaporation, respectively), the author used a program based on multiparametric regressive analysis to determine the average statistical dependence of these coefficients on meteorological fields in an attempt to determine whether they are variables that are functions of meteorological conditions or are constant values. Readings taken immediately above the water and at a height of 10 m were used in the analysis. After setting up equations that allow for various meteorological factors, the author determines that the coefficients of correlation between the values they give and the observed values are 0.41, 0.92 and 0.64 for resistance, heat transfer and evaporation, respectively, so they can be used to evaluate these parameters. Figures 2; references 14: 8 Russian, 6 Western.
[88-11746]

UDC 551.510.42:551.508.91

INVESTIGATION OF SPATIAL IRREGULARITIES IN MICROSTRUCTURE OF LOW-LEVEL AEROSOLS, USING MULTIFREQUENCY LASER RADAR

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 15 Oct 80; after revision 10 Feb 81) pp 90-94

KOSTIN, B. S. and NAATS, I. E., Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences

[Abstract] The authors propose methods for handling data obtained by multifrequency laser sensing of low-level aerosols in the presence of substantial spatial irregularities in the spectrum of particle sizes along the sensing track. Data interpretation is based on the solution of a system of laser radar equations and two integral equations. The conversion of the data is based on the possibility of constructing an inverse regularizing operator for one of the integral equations, which is not difficult if the value of the refractive index and the limits of the spectrum of particle sizes for all points on the track are known. The authors work out the solution of the equations, then illustrate the effectiveness of their methods with examples of the interpretation of data obtained with a three-frequency laser radar. Figures 5; references 6: 4 Russian, 2 Western.
[88-11746]

UDC 551.524.77:551.521.3:535.375.5

METHOD FOR RECOVERING ATMOSPHERIC TEMPERATURE AND ATTENUATION FACTOR PROFILES DURING SENSING ON BASIS OF COMBINATION SCATTERING SPECTRUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 5 Oct 81) pp 94-98

IVANENKO, B. P. and NAATS, I. E., Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences

[Abstract] The authors propose a new approach to determining atmospheric temperature and attenuation factor profiles that is based on a preliminary functional transformation of the original system of laser radar equations that correspond to the selected section of the combination scattering spectrum of N_2 and O_2 and subsequent solution of them for the indicated profiles, using regularizing algorithms for the processing of experimental data. After setting up the mathematical apparatus and discussing the computation of the logarithmic derivatives of laser radar signals, they give the results of numerical experiments they conducted, utilizing their method. By using a third channel, the back scattering coefficient's profile can also be found and, in principle, the method can also be used to distinguish the molecular and aerosol components of scattering. Figures 5; references 8: 4 Russian, 4 Western.
[88-11746]

UDC 551.8.02

CAUSES OF RELATIVE STABILITY OF MEAN EARTH SURFACE TEMPERATURE IN THE GEOLOGICAL PAST

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 270, No 5, Jun 83 (manuscript received 12 Jan 83) pp 1170-1174

KVASOV, D. D., LYAKHIN, Yu. I. and MEL'NICHUK, V. I., Leningrad Department, Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] The mean air temperature at the earth's surface adjusted to sea level has not varied greatly from 15°C throughout geological history, in spite of the constant increase in radiation output by the sun. This article attempts to explain this seeming contradiction. An interaction diagram is presented illustrating the influence of the mean ocean surface temperature on the content of CO_2 in the ocean and the atmosphere, influencing the greenhouse effect. As temperature increases, the content of liquid water droplets in clouds. This increases the albedo of the earth, introducing a negative feedback mechanism preventing rapid temperature increases. The opposite effect prevents excessive decreases. Frozen areas are quickly covered with wind-blown ash and rock and have reduced albedo. Thus, the greenhouse effect in combination with the carbonate system in the ocean can explain the constancy of surface temperature in spite of variations in solar radiation flux. Figure 1; references 15: 10 Russian, 5 Western.
[173-6508]

UDC 551.511.6(213.5)

SPECIFICS OF HEAT EXCHANGE BETWEEN THE OCEAN AND ATMOSPHERE IN THE TROPICS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267, No 6, Dec 82 (manuscript received 15 Jun 82) pp 1334-1336

PUDOV, V. D. and PETRICHENKO, S. A., Institute of Experimental Meteorology, Obninsk, Kaluga Oblast

[Abstract] The "Tayfun-81" expedition of September-December 1981 studied the thermal structure of the 2 meter layer above the water in stations in the South China and Philippine Seas. Synchronous measures of temperature at 5 and humidity at two levels were performed with sensors installed on a floating gradient mast separated from the ship by at least 300 m. Measurements around the clock of mean and pulsation values of temperature and humidity in the layer of atmosphere near the water revealed significant instability in the turbulent exchange of heat and moisture between the sea and the air with direct solar radiation present. The specifics of energy of exchange were observed at wind speeds of 0 to 9 m/s, wave activity of 1 to 4 units (on a scale of 5) in various regions of the South China and Philippine Seas. Figures 2; references 5: 4 Russian, 1 Western.
[162-6508]

UDC 551.510.53

RELATIONSHIP OF MACROCIRCULATION PROCESSES IN THE ATMOSPHERE AT 10 TO 100 KM ABOVE CENTRAL ASIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 19 Jan 82) pp 563-569

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

[Abstract] A brief analysis is made of the most important experimental materials used to study the relationships among macrocirculation characteristics and for construction of empirical models describing these relationships. The experimental materials include aerologic soundings in Central Asia yielding information on thermal and circulation conditions at the 10 to 30 km level, data from rocket soundings yielding information on levels from 30 to 70 km, and an atlas of altitude maps of the 35 to 60 km layers and maps of isotherms presented as appendices to the rocket soundings bulletins published by the Central Aerologic Observatory, data on temperature conditions in the upper stratosphere and mesosphere, data from NOAA and Nimbus-6PMP satellites, and radiometric measurements of meteor wake drift performed at Frunze covering the 86 to 100 km altitude levels. Changes in heat sources in the 30 to 100 km levels are found to cause restructuring of temperature stratification all the way down to 5 km, differing at different latitudes. This causes changes in the temperature difference between latitudes, Multiannual smoothed mean

monthly values of zonal wind are presented for 1964 through 1974 based on data from the Frunze and Dushanbe radiometeor stations. The variations in characteristics of zonal wind agree well with the empirical atmospheric model generated. Variations in thermal conditions in the atmosphere are thus considered to be primarily responsible for variations in multiannual zonal wind flows.
Figures 4; references 11 Russian.
[180-6508]

UDC 551.501.8:551.511

RADAR WIND FIELD DIVERGENCE STUDIES IN CONVECTIVE CLOUDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 6, Jun 83 (manuscript received 1 Feb 82) pp 576-585

IVANOV, A. A., MEL'NICHUK, Yu. V. and MORGOYEV, A. K., Central Aerologic Observatory

[Abstract] One effective means of studying air movements in the clouds is a combination of several coordinated Doppler radar sets. Even one Doppler radar set, however, can give valuable information on air movements in thunderheads. The results of such studies performed in 1978 and 1980 are presented in this article. Two identical Doppler radar sets operating in the 3.2 cm waveband were used, equipped with multichannel apparatus for recording radar data. Twenty values of mean radial velocity of particles reflecting the radio waves were measured on each beam, at intervals of 630 m for one radar and 840 m for the other in 1978, 395 and 410 m in 1980. The longitudinal dimensions of scattering volumes were 50 to 70 m, transverse dimensions about 2°, or 300 to 1000 m, depending on range. Results of comparison of divergence components in the wind fields in thunderheads are presented in graphic form and discussed. Analysis of relationships between two dimensional and one dimensional horizontal divergence components shows that they are statistically related and independent of angle between soundings direction and wind direction. There is a correlation between horizontal divergence and its one dimensional components which can be approximated on the average by a linear equation which remains constant for various thunderhead development conditions. The most intensive movements are ordered vertical flows with air entering and leaving the vertical streams in all directions in the horizontal plane simultaneously. Turbulent movements result only in some increase in the scattering of experimental data. Figures 4; references 6: 2 Russian, 4 Western.
[180-6508]

UDC 551.513.1:551.510.5

INTERCONNECTION OF THERMODYNAMIC TROPOSPHERE AND STRATOSPHERE CONDITIONS IN NONTROPICAL LATITUDES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 24 Feb 82; after revision 15 Apr 82) pp 653-655

KIDIYAROVA, V. G., TARASENKO, D. A. and SHCHERBA, I. A., Central Aerologic Observatory

[Abstract] During the winter the nontropical stratosphere does not have internal energy sources capable of maintaining the observed distribution of weather elements and corresponding thermodynamic processes. The phenomena observed result from influx of additional energy into the stratosphere, the primary source of which is the troposphere. Energy is transferred by a vertical propagation of planetary waves formed in the northern hemisphere troposphere due to large scale orography and thermal heterogeneity of the underlying surface. The troposphere and stratosphere can be looked upon as a medium through which wave perturbations propagate. The purpose of this work is to determine possible changes in the fields of weather elements in the troposphere and stratosphere as a function of conditions of implementation of the dynamic interaction between the troposphere and stratosphere. The initial experimental materials used consisted of observed data from a network of radio sounding stations at 60 to 70°N operating during 1965-1977. Mean monthly distributions of weather parameters were studied for the month of January. The calculations showed the course of zonal circulation of the polar troposphere and stratosphere to be in counter phase from year to year, with an increase in circulation in the troposphere accompanied by a reduction in circulation in the stratosphere. The possibility of interaction between the polar troposphere and stratosphere was estimated quantitatively by calculating the correlation coefficients between distributions of isobaric 500 and 30 mbar surfaces along various circles of latitude. Changes in propagation conditions of planetary waves were found to lead to changes in thermodynamic conditions in both the stratosphere and troposphere. The results of the study indicate not only a major role for large scale fluctuations in the polar troposphere in the dynamics of the terrestrial stratosphere, but also the desirability of utilizing data on stratospheric conditions for analysis of processes in the troposphere. Figures 3; references 7: 5 Russian, 2 Western. [180-6508]

OCEANOGRAPHY

CRUISES OF SCIENTIFIC SHIPS IN SECOND HALF OF 1982 DESCRIBED

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 83 pp 63-64

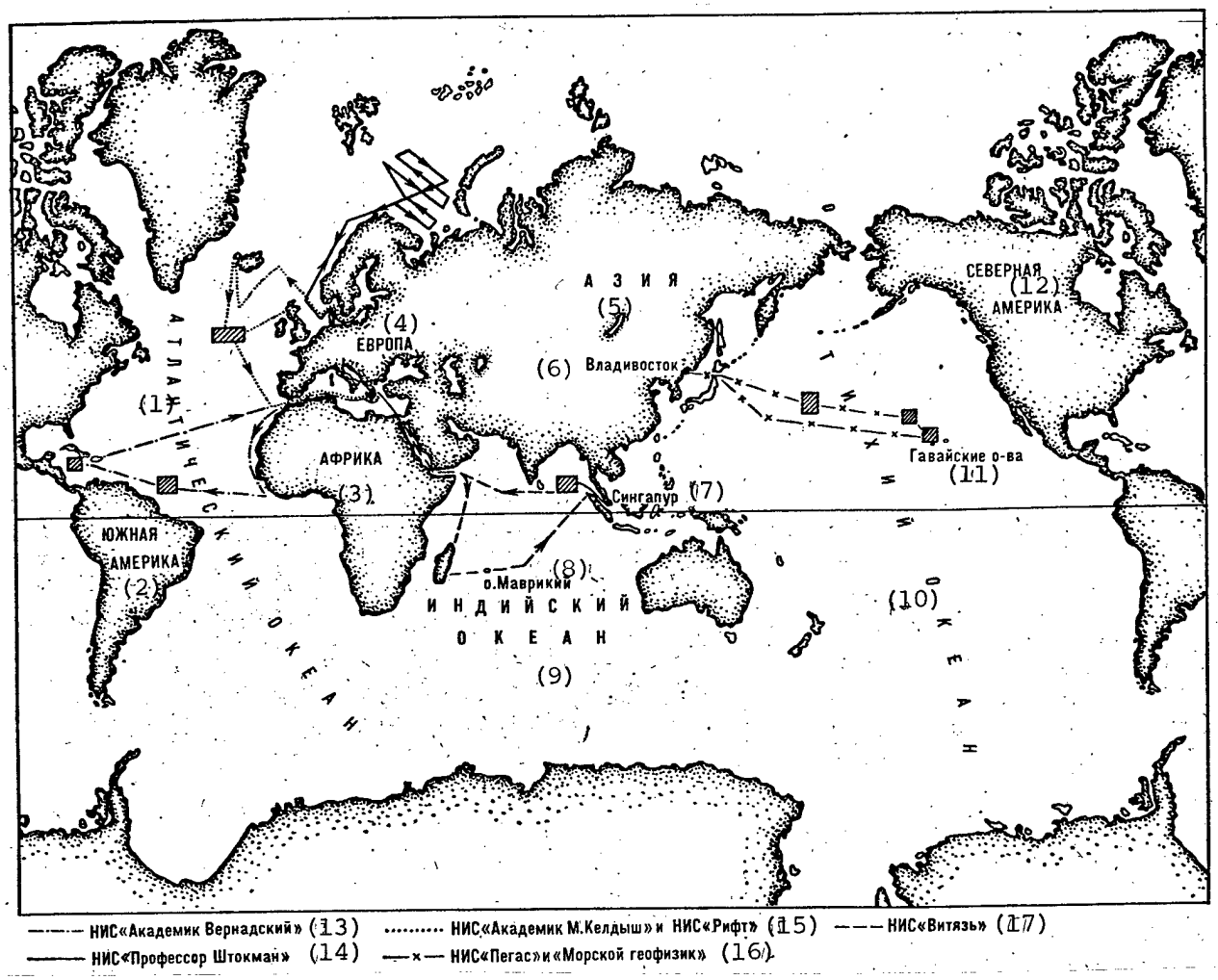
[Article A. A. Goncharenko]

[Text] In the second half of 1982 the scientific research fleet of the USSR Academy of Sciences and the academies of sciences of the union republics continued its study of the World Ocean on the basis of national and international programs within the framework of a single state plan and the plans of various scientific institutions. During this period the fleet was supplemented by new research vessels: the "Vityaz'" and "Akademik Aleksandr Nesmeyanov" with a displacement of 6,400 tons, the "Rift" with a displacement of 1,283 tons and the "Elm" with a displacement of 1,002 tons went into operation.

The vessel "Professor Shtokman" (USSR Academy of Sciences Institute of Oceanology) operated in the Barents and Kara seas. The objective of the expedition was to study geological structures offering promise as petroleum and gas-bearing regions, the deep structure of the earth's crust, the sedimentary mantle and the topography and lithodynamic processes of the continental shelf. Expeditions aboard the vessels "Akademik Mstislav Keldysh" and "Rift" (USSR Academy of Sciences Institute of Oceanology) worked on the basis of a single program in the North Atlantic. They conducted geological, geophysical and biological studies on mid-oceanic ridges and rifts zones.

The Marine Hydrophysical Institute of the Ukrainian SSR Academy of Sciences sent its vessel "Akademik Vernadskiy" into the Atlantic Ocean. The main goal of the trip was to study hydrologic parameters to permit assessment of heat transfer by currents of the tropical Atlantic. Research was also conducted on the conditions under which areas of higher biological productivity form in the Caribbean Sea. An expedition aboard the vessel "Vityaz'" (USSR Academy of Sciences Institute of Oceanology) conducted an integrated study of the characteristics of internal waves in the Indian Ocean.

The Institute of Thermophysics and Electrophysics of the Estonian SSR Academy of Sciences conducted three expeditions on the Baltic Sea in the second half of the year aboard the vessel "Ayu-Dag." The light field above the Baltic Sea and its relationship to the water's chlorophyll content were studied; research was conducted on phenomena of a synoptic scale in the open part of the sea;



Routes traveled by scientific research vessels. Cross-hatched rectangles represent polygons in which research was conducted.

Key:

1. Atlantic Ocean
2. South America
3. Africa
4. Europe
5. Asia
6. Vladivostok
7. Singapore
8. Mauritius
9. Indian Ocean
10. Pacific Ocean
11. Hawaiian Islands
12. North America
13. Scientific research vessel "Akademik Vernadskiy"
14. Scientific research vessel "Professor Shtokman"
15. Scientific research vessels "Akademik M. Keldysh" and "Rift"
16. Scientific research vessels "Pegas" and "Morskoy Geofizik"
17. Scientific research vessel "Vityaz'"

the occurrence of contaminants in the water and in benthic deposits was revealed. An expedition aboard the vessel "Professor Vodyanitskiy" (Institute of Biology of Southern Seas, Ukrainian SSR Academy of Sciences) worked in the Atlantic Ocean. Its goal was to evaluate the influence of ridges on the ocean floor upon the biological structure and productivity of surrounding waters. The nonmagnetic schooner "Zarya" (Institute of Earth Magnetism, Ionosphere and Radio Wave Propagation, USSR Academy of Sciences) conducted a cruise on the Baltic. The expedition investigated the 100-year trend of the earth's magnetic field in the northern part of the Baltic Sea and in the Gulf of Finland, as well as in the southern Baltic.

The hydrologic conditions in the northwest Pacific were studied by the vessel "Professor Bogorov" (Pacific Oceanological Institute, Far East Scientific Center, USSR Academy of Sciences). Propagation of low-frequency sound in areas with complex hydrologic conditions was studied here. An expedition aboard the vessels "Pegas" and "Morskoy Geofizik" (Sakhalin Integrated Scientific Research Institute, Far East Scientific Center, USSR Academy of Sciences) conducted geological and geophysical studies in the northwestern and central parts of the Pacific. The scientists attempted to decode the structure and geological development of key structural regions, and to obtain information on the sedimentary mantle.

The "Akademik Kurchatov" (Institute of Oceanology, USSR Academy of Sciences) conducted research in the North Atlantic on the relationship of the turbulent characteristics of air at the air-water interface, particularly pulsations in temperature and humidity, to meso-scale processes responsible for the former. The extent of variations in the heat balance of the ocean surface observed in periods of a day and several days was clarified. An expedition aboard the new vessel "Akademik Aleksandr Nesmeyanov" (Far East Scientific Center, USSR Academy of Sciences) was conducted in two phases. In the first, on its way from the Baltic Sea to Vladivostok the vessel conducted an incidental study of the structure of the principal hydrophysical, hydrochemical and hydrobiological fields. The second phase involved investigation of the hydrologic and acoustic characteristics and the fine thermohaline structure of the frontal zones of the Northwest Pacific and in the Philippine and South China seas.

11004
CSO: 1865/160

NEW DRILLING SHIP 'VALENTIN SHASHIN' IN BARENTS SEA

Moscow PRAVDA in Russian 2 Jul 83 p 6

[Excerpt of report by V. Chebakov, special 'Pravda' correspondent, on board a drilling ship in the Barents Sea]

[Excerpt] The Barents Sea in the morning hours was defininitely calm. A small swell smoothly rocked our ship which was proceeding at full speed toward the "Valentin Shashin" which, several days ago had begun a routine exploratory drilling on the continental shelf. It was sunny weather and the cold sea winked playfully with its dazzling flashes from green water hillocks. But occasionally, for several minutes a little cloud covered the orange sphere of the unsetting polar sun and the picture would be drastically changed. All of a sudden it became gloomy and grey and snow flakes began whirling around.

Standing on the Captain's bridge, the"Shashin" could be seen for several miles. Actually, not its hull, but only the drilling derrick, a flashing white needle pointing into the blue sky. A polar sea with a drilling derrick is an unusual landscape. But, in our century there is less and less time for wonder. After some five years, seamen encountering a drilling ship in the Arctic probably will not pay it any attention.

When we got closer, the ship was striking by its unusual shape with the drilling derrick in the center of the deck. "Shashin" is drilling a well. That means an instrument has been lowered to the bottom. And the anchor has been raised! The secret turns out to be simple, but we will discuss that later.

"Well, how is it in Murmansk?" asked O. Gusarov, the senior assistant to the captain, as the first thing in meeting me on deck. "We heard by radio that already there is an 11-degree temperature there."

Of medium height, and broad shouldered in an ordinary, but diligently ironed uniform, Gusarov led me to the captain's bridge. He has a thick black beard and dark cunning eyes interestedly watching whether I am keeping up in climbing the steep steps of the ladders behind him. On the bridge it was spacious, light, and even cozy. As on any ship, everything was sparkling clean. In the huge windows with a 180 degree field of view, lay the sea scattered with the white spots of gulls.

"We will begin the excursion with the 'brains' of the ship" said Gusarov inviting me into a cabin adjacent to the bridge. "It is called the dynamic positioning cabin. But, for short, we call it the DiPi."

Here semidarkness and quiet reigned. There is only the muffled patter of a teletype in a corner. In essence this was the computer center. On the right three computers are lined up, next to them is a display, a lighted panel, maps, other electronic instruments and a television monitor.

A. Lavrik, the supervisor of the DiPi became my guide. Only a little over a year ago he, the chief engineer of a scientific research institute, was by nature a dry land man. But when he heard about the new ship - the 'marine geologist' - he was drawn to the sea on interesting work.

"When drilling a well" said Lavrik, "the ship must stay strictly at one point. How is this accomplished in a severe northern sea where wind, waves, and ice are constant companions? It is precisely here that the special qualities of the design of our 'floating geologist' are revealed. First, there are thrusters situated in the bow and stern. Together with the main propellers they permit moving the ship in any direction."

An electronic machine receives the assignment to hold the ship at a specific point. Data about the force of the wind, waves, current, and other necessary information are taken into its memory from sensors installed on the sea bottom. The machine turns on specified propellers and holds the 150-meter long ship on station.

On one table I see a luminous system of coordinates. In the center is a little rhombus representing our ship with a point designating the well. Next to it shine an arrow for the wind direction. I note that the ship is constantly displayed with the bow to the waves. The computer also is watching this.

On the drilling platform, under the interwoven openwork of the derrick stretching 57 meters upward, an icy wind whistled. It was the night watch. The deputy drilling chief, C. Rumyantsev, in overalls and a helemet waited while the next piece of 300-millimeter steel pipe was put on, watched as it was lowered down, and then approached me.

"That's all for today." We went into a cabin. "We will drink some tea and pause for a bit. There, also, we will talk about our work."

For several days here I had been unsuccessful in having a detailed talk with Rumyantsev. At daybreak he is already at the drill and for half the night he is there also. Finally we are sitting in his comfortable cabin settled in armchairs. Sergey brews an aromatic tea.

"It would be a poor leader who did all the work himself. No, I trust in my comrades. It is just that it is interesting to know the whole process thoroughly, down to the smallest details. Actually this is a very new business as is the ship itself. But the crew already has become friendly and united. Everyone is a master of his job. Over their shoulders there is much experience in the Komi ASSR, in Tyumen', and in Baku."

Rumyantsev himself was born in Noril'sk. Eight years ago, upon completing the Kuybyshev Polytechnical Institute, he was sent to Okha, to the "Sakhalinneft" [Sakhalin Petroleum] association. After that he worked on the Far Eastern marine expedition as drill master on a semisubmerged platform.

"Aleksey Shaforostov (we studied and worked together) found out that such ships were being built for the Arctic. And both of us have been here on "Shashin" for more than a year already. At this moment my friend is ashore in Murmansk. The watch for drillers lasts for 15 days and then there is a shift." said Rumyantsev.

"Surely it is difficult for a dry land driller to become a marine one?"

"Is seasickness in the plan?" smiled Sergey. "No, we stand up well to the sea. Yes, and the motion here is only pitching. Our ship stays firmly on station. But, seriously, the work here is complex. Modern engineering permits drilling under a layer of water having a depth up to 300 meters, and into the bottom for up to 6000 meters. The psychology of people changes. How is it on land? On the drill is a pressure guage - yes there are still steam tools. Here there is automation, electronics and television. A drill master can analyze what is going on in the well from the indications of the instruments. The drilling speed is higher than on land. Therefore, a man's relationship to the equipment and to his work as a whole is changed. At sea there are no details that can be given up as hopeless. There cannot be withdrawals or 'shoreside' indulgences. Actually, every now and then the life of the whole ship depends on a man standing watch."

Over several days spent on "Shashin" I observed the work of drillers, geophysicists, laboratory men, divers, electronic technicians, and even of the chef, L. Klimenko, creating culinary wonders. But here, the work of the seamen - of the basic moving force,as they say,on a ship - remained in a shadow, precisely because the ship did not move.

"So it seems at first glance" the captain and director, V. Nerodov, explained to me. "Without the mechanics, electricians, radio operators, and my assistants, the others could do nothing. Take the realm of the senior electrical engineer, Aleksey Petrovich Karatayev. Without his diesel generators, not a meter of the bottom could be drilled. And we could not keep on station. Also the chief engineer, Ivan Andreyevich Khapalkin, has much responsibility - the evaporators, motors, pumps, and thrusters. On such a diesel-electric ship, fitted out with the last word in equipment, only the precise cooperation of all services allows the work to be done. It is not an easy business."

The first drillings on a shelf took place in our country 30 years ago in the Caspian Sea. In recent years the attention of prospectors turned to the coastal waters of the Azov and Black Seas, Sakhalin island, and to the Arctic. But the conditions everywhere are far from identical. The Arctic is the Arctic. The requipements for the ship, the equipment, the specialists, and

for work safety,in the North,are very strict. It is practically necessary for people to start from zero, acquire experience, and study advanced technology. The beginning was made a year ago but that does not mean that all is going like oil - smoothly and simply. Things don't happen that way in the Arctic. In addition to knowledge and intelligence, courage is needed by the crews of the"Valentin Shashin" and the other similar ship "Viktor Muravlenko" which also is for doing exploratory drilling in the Barents Sea.

9136
CSO: 1865/177

BREKHOVSKIKH ON TASKS FOR OCEANOLOGY, NEED FOR INTERNATIONAL COOPERATION

Moscow IZVESTIYA in Russian 17 Feb 83 p 3

[Article by Academician L. Brekhovskikh: "Scientists Investigate the World Ocean"]

[Text] It is difficult to overestimate the role of the world ocean in the life of our planet. Nearly four-fifths of the transport shipments on the globe are made by way of the world ocean and the seas adjoining it. Right now, man takes about 20 percent of his nutritive protein from the ocean.

Gas and oil extraction from the shelf zones of the ocean and the seas accounts for almost one-fourth of the total amount, which figure is increasing rapidly. In the next decade the extraction of such valuable metals as copper, nickel and cobalt from the bottom of the sea will begin. Sea water itself is astonishingly rich in various substances.

It is impossible to make long-term weather forecasts without taking the ocean's effect into consideration. Any change in climate is also determined to a considerable degree by the effect of our planet's watery shell.

With a periodicity of about 5 years, new phenomena appear in the ocean that change our ideas about it substantially. As it has turned out, "rivers" about 100 km wide flow to the east at depths of 200-400 m precisely on the equator in the Atlantic, Indian and Pacific Oceans. At the same time, the surface waters flow to the west. In 1970, Soviet scientists working in the Atlantic discovered the existence of huge eddies measuring 200-300 km across. Their kinetic energy exceeds that of the permanent currents many times.

Comparatively recently it was established that the ocean is essentially a huge layer cake. The thickness of the layers ranges from meters to several tens of meters. The properties of the water are almost constant within the boundaries of a single layer and change abruptly when those boundaries are crossed. The horizontal extent of these layers can be several kilometers.

Discharges of hot, strongly mineralized waters from the bottom have been detected in the areas of the mid-ocean ridges. They contain copper, zinc, iron, silver, cobalt, cadmium and other metals. Bottom organisms of gigantic sizes (such as worms up to a meter in length) have been seen near these underwater geysers. Despite the eternal darkness that rules at great depths, this new form of life is astonishingly multicolored.

In view of the huge complexity of the world ocean, it is necessary to develop a strategy for investigating it, distinguishing the most important problems we will be solving in the next decade and, in particular, in the next 5 years.

Physicists are faced with the problem of determining the nature of synoptic eddies in the ocean and establishing how they arise, how they interact with each other and currents, and how they disappear.

Investigations of the interaction of the ocean and the atmosphere, which is important for long-term weather forecasts and evaluating tendencies toward changes in climate, must be developed intensively. It is necessary to study the exchange of moisture, heat and momentum between the atmosphere and the ocean.

There has been comparatively little research done on the boundary between the ice cap and the open ocean. This zone exerts a great deal of influence on climate in the high latitudes. It is there, also, that the deep waters of the ocean are formed. A correct description of the triple "ice-ocean-atmosphere" interaction is important for our understanding of trends in changes in the terrestrial climate.

Surface wave action, internal waves, turbulence and the ocean's fine layered structure also require further investigation.

The general problem in the field of ocean chemistry is the creation of a quantitative chemical model of the ocean. In order to do this it is necessary to study the entry of chemical substances into the ocean through it surface, bottom and continental boundaries and take into consideration their horizontal transfer and transformation.

The determination of the flow of carbon dioxide from the atmosphere into the ocean is of fundamental importance. The continuous entry of carbon increases the greenhouse effect in the atmosphere and contributes to the warming of the Earth's climate. Part of the carbon dioxide in the atmosphere goes into the ocean, where its concentration is now about 50 times greater than in the atmosphere.

The biologists are faced with a problem of vast importance: the study of life in the ocean, including about 180,000 types of organisms ranging from small bacteria to huge mammals. They must also analyze the effect of pollutants on these organisms.

The contribution of marine biology to fishing oceanology must be an important one. In the last decade this branch of science has been developed very intensively, particularly in the study of the biology of commercially valuable types of fish and their feeding, migration, growth, parasitology and genetics. However, we have not been successful enough in evaluating the degree of reproduction of a school of fish. The solution to this problem is related to an analysis of the general ecological situation: the current pattern, the mixing of waters, the accessibility of nutritive matter, the harmful role of pollution and so on. The biology of new, commercially valuable objects must also be developed.

Marine biology should create a scientific basis for the development of a network of coastal marine "farms" and for the transplantation of several types of fish into new regions.

The biologists, together with the chemists and physicists, are faced with the problem of determining the paths of propagation of ocean pollutants and their chemical transmutation.

The main task of ocean geology and geophysics is to create an overall picture of the structure of the Earth's crust beneath the ocean. This is extremely important for the further exploitation of mineral resources. It is necessary to conduct extensive geological and geophysical exploratory work on the vast expanses of the continental shelf and the open ocean.

Methods for studying the ocean are constantly being improved. Space techniques for investigating it have been developed rapidly in recent years. Apparently only they can eliminate the huge gap between the amount of information about the ocean that is obtained and the amount that is needed.

What can space technology give us? First of all, maps of the ocean surface's temperature. Space techniques can determine this parameter with accuracy to that of a single degree. It is possible to obtain maps of surface wave action (wind-caused ripples, in particular), a map of the surface winds, the vertical structure of the atmosphere over the ocean and so forth. Space altimeters will make it possible to record the real shape of the ocean's surface, which is important for the calculation of marine currents. This same method can be used to detect tsunamis, which are barely noticeable in the open ocean but are capable of causing a great deal of harm when they reach a shore.

From space it is possible to determine the color of sea water and thus find waters that are rich in chlorophyll, which are zones of abundant life. The little-studied polar areas and the boundaries between open water and ice can also be investigated effectively from space.

Another new method for investigating the ocean appeared not too long ago: the test range method. Several ships make synchronous surveys of the physical processes taking place in the ocean and the atmosphere over a large area. A single ship can also be used, but this entails the placement in the ocean of anchored stations with instruments at different depths. These stations can measure ocean characteristics, such as temperature, salinity and currents at different depths for many months.

Remote methods for studying the ocean are being developed extensively. Almost all of them are based on the use of acoustic waves, because they are the only ones that can propagate to significant distances in the ocean. Acoustic methods for studying bottom relief and deep geological structures are being improved. Acoustic methods for searching for fish are becoming ever more efficient. Scattering layers in the ocean that are of a biological nature and underwater ocean noises are being studied. The latter carry a great deal of information about the world of underwater life, the eruptions of distant volcanoes, earthquakes and distant storms.

Deep research vehicles, both manned and automatic, are beginning to be used ever more widely.

The development of deep drilling in the open ocean can yield interesting results, particularly after achieving the capability of significant penetration into hard rock.

In our country, great importance has always been imparted to the study of the ocean. In 1921, V.I. Lenin signed a decree on the formation of a floating scientific research institute on board the ship "Persey." At the present time, Soviet science has at its disposal first-class--possibly the best in the world--research ships on which it is possible to carry out work and process the results of observations over periods of many months on expedition, as is done by our scientists. There are several tens of these ships in our country. The research work is done according to a unified, integrated program entitled "The World Ocean: Investigation and Utilization of Its Resources."

The key factor in the investigation of the ocean for the good of mankind is international cooperation. No single country, no matter how powerful it is, has the capability of allocating a sufficient amount of facilities to learn about the various processes taking place in the atmosphere above the ocean, on the surface of the ocean, in its depths and on the bottom of the ocean. The traditions of international cooperation among scientists studying our planet are ancient ones. It is difficult to overestimate the results produced by international cooperation during the International Geophysical Year, the International Indian Ocean Expedition and work done under the PIGAP [expansion unknown] program. The deep-water drilling project, which opened a new era in the geology of our planet, was also an international one, although it was conducted on an American drilling research ship. Soviet scientists participated actively in this project.

The investigation of the ocean continues. New discoveries await us.

11746
CSO: 1865/86

OPERATION OF 'PAYSIS' SUBMERSIBLE IN NORTH ATLANTIC

Moscow PRAVDA in Russian 4 Jul 83 p 7

[Article by D. Oreshkin, candidate of technical sciences, city of Moscow: "The Expedition Returned: The Atlantic Without Atlantis"]

[Text] For more than two millennia now people's minds have been occupied by the secretly mythical continent which disappeared from the face of the earth "in a single day and a calamitous night." Participants of seabed expeditions are often asked: "Have you found Atlantis yet?"

The comprehensive work by Soviet oceanologists in the North Atlantic refined concepts about the structure of the earth's crust in this region. With respect to Atlantis, its discovery apparently will have to be put off until another time.

Very interesting data were obtained with the help of "Paysis" deep-sea vehicles during the work in the North Atlantic. A. Monin, director of the oceanology institute, USSR AN [Academy of Sciences] corresponding member, comments on the data.

"The seabed is an enormous white spot on our planet's map, but it is being developed almost as rapidly as unexplored lands were developed in the era of the great geographic discoveries. The key to the riddle of continental drift and to many other vague points in the earth's history lies specifically in the ocean. The 'Paysis'--a self-contained submersible vehicle controlled by a crew of three--is capable of submerging to a depth of two kilometers in search of this key. It is fitted with a sonar navigation system, surveillance sonar, fathometer, radio and sonar communications systems, outboard photographic and television cameras, hydrophysical sensors and, finally, a pair of manipulators which can break rock samples weighing up to 100 kg from underwater cliffs or neatly pick fragile branches of corals from the bottom with equal success.

"'Paysis' class vehicles are being used by our institute chiefly for working in the rift zones of the planet where the old earth's crust is cleaving and new crust is originating. In the summer and fall of last year our aquanauts explored the Atlantic seabed in the vicinity of the Reykjanes Ridge and somewhat to the south.

"From the geological standpoint this area represents a rather old rift zone, the expansion of which over 130 million years ago led to the appearance of the North Atlantic and the separation of the continents of our hemisphere. Two 'Paysis' submersibles performed an overall total of 33 dives here, spending over 260 hours under the water. Work was done chiefly at depths of 1,500-2,000 m. Valuable materials were gathered concerning the structure of the underwater ridge, its tectonic activeness was confirmed, and proof of the seabed's movements was obtained."

"The traces of underwater lava flows are made out especially effectively," said A. Sagalevich, chief of the laboratory for scientific operation of manned submersibles, joining the conversation. He was directly in charge of the dives and took part in them. "The molten basalts, entering the cold water at a depth of many hundreds of meters, cooled in the form of spheres up to 1½-2 m in diameter. The layer of sedimentary rock which usually accumulates at great depths is practically absent from them. This means that the spherulitic lavas appeared no more than 4,000-5,000 years ago.

"A long, narrow trough extends right along the crest of the underwater ridge, bounded by escarpments on both sides. The height of the escarpments exceeds 500 m at times. This then is a rift valley. Spherulitic lavas and young volcanic ridges up to 20 km long are situated on its bottom. Molten rock rises here from the interior of the planet and, on cooling, shoves aside the rigid plates of the earth's crust formed earlier. The closer our work came to the ridge's longitudinal axis, the younger was the rock we encountered. As we moved away from the suture of the rift zone there was a perceptible increase in thickness of unconsolidated deposits on the bottom and an increase in their geological age. The process of birth of the earth's surface has been continuing here over many millions of years and is well 'documented' in the annals of preserved deposits. The deep fissures we discovered in the rock, which are up to two meters wide, also serve as evidence of a separation of the plates away from the rift zone."

"The question of an expansion of the seabed has been discussed in scientific literature for more than ten years now," explains A. Monin. "The appearance of newborn basaltic crust beneath the oceans and the movement of lithospheric plates has to be compensated without fail by a compression and destruction of the old crust. Otherwise the globe would be increasing in size continually. It is believed that the basaltic plates are thrust forcefully beneath the edges of land masses and there are remelted as they plunge into the molten interior of the earth. There is for example such a zone where the oceanic crust is buried in the Japan Trough, where the Pacific Ocean bed extends beneath Eurasia. This is accompanied by a build-up of colossal tectonic stresses and as a result gives rise to earthquakes.

"The concept of global plate tectonics rests on reliably established distinctions in the structure of the oceanic and continental crust. But fragments of granites--typical continental rocks alien to the ocean depths--were discovered in studying samples brought up previously from the slopes of the Reykjanes Ridge. Our theoretical concepts of the formation of the Atlantic bed were threatened. The 'Paysis' submersibles were called upon to solve this riddle.

"The aquanauts took more than 150 geological samples in the rift valley and it turned out that all the bedrock here was represented by ordinary oceanic basalts, and the granite boulders fell to the bottom in the Glacial Age, when icebergs carried rocks from Scandinavia and Greenland over the North Atlantic.

"The work of the controlled submersibles also has a great practical significance. The enormous reserves of iron-manganese nodules confined to submarine rifts are drawing the attention of geologists and industrialists of many countries. The content of valuable components exceeding the usual by 5-7 times was registered in some samples brought up by the 'Paysis' submersibles during exploration on the Reykjanes Ridge. The survey and recovery of deep-sea deposits is a matter not of the distant, but of the near future."

In evaluating results of exploration on the Reykjanes Ridge, L. Brekhovskikh, academician-secretary of the Oceanology, Atmospheric Physics, and Geography Department of the USSR AN, noted that only now can we fully imagine capabilities of the "Paysis" class vehicles and understand what their capabilities are. They can do a great deal. This year the study of underwater mountains is to be continued in the South Pacific.

6904
CSO: 1865/174

BREKHOVSKIKH AND MONIN ON CURRENT CONCERNS OF OCEANOLOGISTS

Moscow PRAVDA in Russian 1 Jun 83 p 3

[Article by L. Brekhovskikh, academician-secretary of the division of oceanology, physics of the atmosphere, and geography of the USSR Academy of Sciences, and A. Monin, director of the Institute of Oceanology and corresponding member of the USSR Academy of Sciences: "Facing the Ocean -- Science Widens the Horizons"]

[Text] It is perhaps commonplace to talk of the growing importance of the world ocean in the life of the human race today. Intercontinental shipping, energy and minerals for industry, protein for food, medicines for sick persons, water for the deserts, and recreational conditions for hundreds of thousands of people -- the ocean can provide this and more if we take a proprietary attitude towards its riches. And this is precisely the direction that the resolutions of the 26th CPSU Congress give to scientists and industrial workers engaged in studying and developing the resources of the world ocean.

Along with our successes in meeting these challenges there are a number of problems which continue to concern oceanologists. But, specialists know that the so-called tectonics of the lithospheric plates has been worked out through the efforts of marine geophysicists and geologists from many countries of the world. This is the continental movement theory of A. Wegener, reborn on the basis of contemporary data.

According to the new global tectonics (of course in the most general outline) the rigid outer shell of the earth, the lithosphere, consists of gigantic plates which are 10-80 kilometers thick under the ocean and 200-300 kilometers thick on the continents with horizontal dimensions up to 10,000-15,000 kilometers. These plates are moving relative to one another at rates of several centimeters a year under the effect of convection currents in the thick underlying shell, the earth's mantle. On the ocean floor where the plates are separating fracture lines called rifts occur and volcanic matter flows from them and builds new ocean lithosphere, forming the mid-oceanic ridges. When an oceanic plate moves toward a continental plate, leading to the formation of the deep ocean trenches, the former goes under the latter, causing earthquakes and outpourings of magma that builds up the continental lithosphere. When continental plates collide giant mountain systems grow.

Soviet oceanologists also made an impressive contribution to development of the theory of the tectonics of lithospheric plates. Specifically, following the ideas

of O. Yu. Schmidt, they worked out the theory of the deep processes that cause plate movement, were among the first to clarify the nature of the mid-oceanic ridges, gave a geochemical explanation of basalt magmatism on the ocean floor, developed models of the structure of the oceanic lithospheric plates and their underthrust zones, studied the processes by which oceanic sedimentary rock is drawn under the island arcs and the active frontiers of the continents, and clarified the mechanisms of earthquakes that cause tsunami as well as a number of other important geological processes.

We should note that the new theory does not at all contradict geological findings collected earlier. On the contrary, it has absorbed them and given them new resonance. This theory, which in our view makes it possible not only to explain the primary global geological processes from a uniform standpoint but also calculate many of them quantitatively, has now passed its formative stage. Details and precise determinations have begun to be filled in and, especially important from a practical point of view, the theory can be used in prospecting for and exploring mineral products.

For example, the formation of the very rich deposits of Chilean copper, Bolivian tin, the uranium and gold of South Africa, the large deposits of oil and gas in the Persian Gulf and in the Rocky Mountains of the United States, the diamonds in Yakutia, the bauxites of the Tikhvin deposit, the coal in Western and Eastern Siberia, the phosphorites in Mongolia, and others has been explained using the new views. By the same token the predictive potential of this theory has been confirmed.

It seems to us that the scientific research organizations of the USSR Ministry of geology and other departments are still not using these scientific advances adequately. We would like to see closer creative cooperation between oceanologists and geologists, both scientists and practical workers. It is also alarming that future specialists still receive only a very superficial acquaintance with the tectonics of the lithospheric plates in geological higher educational institutions, which "divorces" our future scientific and practical geological cadres from this theory. It would seem that the USSR Ministry of Higher and Secondary Specialized Education must correct the curricula of the geology schools.

It turned out that the "key" to understanding many primary processes of the earth's geological development, the theory of global tectonics, lay on the ocean floor and it was only possible to get it thanks to the broad studies of oceanologists in all parts of the world ocean. To do this they used specially equipped research ships and also, especially in recent years, manned underwater craft which took researchers directly to the objects under study.

Further development of earth sciences and the needs of industry will demand an expansion of the fleet of underwater research craft in the coming years (there are about 200 of them in the world today, slightly more than 20 in our country). We should add that during scientific voyages researchers experience a shortage of oceanological instruments, technical devices, and specialized ship equipment.

Unfortunately, our country does not have a head enterprise that specializes in supplying ocean researchers with complex equipment. Possibly some large

industrial enterprise or even association must be singled out for this. It would seem that it is time for the Ministry of Shipbuilding Industry, the Ministry of Instrument Making, Automation Equipment, and Control Systems, and the USSR State Committee for Science and Technology to begin work to find a solution to this problem quickly.

There is one more thing. A new profession has emerged in the last few years, hydronaut. It can be said without exaggeration that it is a relative of the profession of cosmonaut. Moreover, the ocean floor has not been studied as thoroughly as the surface of the moon or Mars, even though the ocean holds many secrets which are most directly relevant to our immediate future. We need only mention the hot hydrothermal springs that carry "liquid ore" from the earth's interior, the ocean floor placers of concretions rich in nickel, cobalt, copper, and other ore materials, and the biological secrets hidden in marine animals. We would like to enhance the reputation and prestige of the investigators who penetrate the cold, dark, unpredictable ocean depths which press down with monstrous force. Certainly the most deserving Soviet hydronauts are worthy of national recognition for their outstanding contribution to conquering the ocean and for their heroism.

Incidentally, oceanologists also have an interest in serious cooperation with cosmonauts. In recent decades it has been graphically demonstrated that with aerospace means it is possible to measure enormous areas of the surface of the world ocean at almost the same moment, to determine the characteristics of marine waves, to observe the appearance on the ocean surface of the as yet little-understood internal waves, and to track schools of fish. These opportunities also should be used more fully.

The development of biooceanology has led to significant generalizations on both the theoretical and applied levels in recent years. Marine biologists have developed methods of evaluating the bioproductivity both of particular species of animals and of their communities that inhabit large regions of the ocean. This work can be a realistic basis for planning commercial use.

The transition from static description of life in the ocean to investigation of the dynamics of biological processes made it possible to develop mathematical models of the behavior of sea inhabitants and on this basis it was possible to predict the effect of various factors, including human economic activity, changes in climate, and intensity of commercial exploitation on formation of the biological product. It was also possible to identify the primary groups of ocean fish and clarify their zones of distribution.

The results of these studies make it possible today to put a solid scientific foundation under the future development and planning of exploitation of sea life. We wish the USSR Ministry of Fishing and its scientific research institutions would move more willingly to broaden scientific partnership. Both academy science and the sectorial scientific institutions face complex problems such as developing techniques for mathematical modeling of commercial schools of fish, their introduction in practice, and broad use of "mariculture," which requires a detailed picture of the characteristics of the development and functioning of marine communities and creation of biological products by them.

Essentially what we mean is making the transition from free hunting at sea to a planned fishing industry. But, let us repeat, without the closest coordination of the efforts of specialists from the USSR Academy of Sciences and the Ministry of Fishing it will not be possible to move forward enough to make a worthy contribution to the USSR Food Program.

11,176
CSO: 1865/163

PROCEEDINGS OF HALIFAX OCEANOGRAPHIC ASSEMBLY REPORTED

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 83 pp 42-46

[Article by Doctor of Physicomathematical Sciences K. N. Fedorov: "In the Most Important Directions of Ocean Science"]

[Text] The Joint Oceanographic Assembly was held in August 1982 Halifax (Canada). Such assemblies, which are convened very 5-6 years, have inherited the traditions of the First and Second oceanographic congresses held in New York in 1959 and in Moscow in 1966. All of the principal international oceanographic organizations take part in their preparation, financing and conduct, and the preparations are supervised by the Scientific Committee for Ocean Research (SCORE) of the International Council of Scientific Unions. The Halifax assembly had more than 700 participants. The Soviet delegation was headed by Academician L. M. Brekhovskikh.

The Scientific Program

The most important part of the scientific programs of such assemblies is the plenary lectures, which summarize the main achievements of ocean science in the last few years. Besides them, special symposiums--there are usually about 30 of them--are conducted. Displays with which participants can acquaint themselves in breaks between symposiums and during time off from the meetings are organized simultaneously. International committees, associations and work groups hold their own meetings in the evening and on days off. Given the tight schedule of the assembly's proceedings, if national groups wish to participate in all of the important measures they must contain not less than 10-12 active specialists representing different areas of oceanology. This was about the size of most of the delegations in Halifax, with the scientific groups from Canada and the USA being an exception: The number of specialists from these countries exceeded half of the total number of participants.

The author of the present article was the president of SCORE from 1976 to 1980, which is why he was given the honor of drafting the scientific program of the latest assembly on the basis of requests and proposals from various organizations. Amendments and supplements to the program were then coordinated in the course of the preparations made by the assembly's Scientific Program Committee chaired by SCORE Executive Committee member W. Hay (USA). As a result the program for

the Halifax assembly included general sessions focusing on the following topics: basic achievements in oceanology; ocean and climate; ocean resources; short-lived tracers; paleooceanography; generalizing lectures. The most interesting of the plenary lectures were: "Diapycnic Mixing in the Ocean Water Column" (K. Garret, Canada), "Chemosynthesis in Deep Hydrothermal Springs" (G. Yannash, USA), "Origin of Ocean Basins" (W. Hay, USA).

New Trends in Oceanology

A generation shift among the scientists who usually "set the tone" of scientific discussions was especially noticeable at the Halifax assembly. The audience had grown younger. Many prominent specialists of the senior generation who had actively participated in the proceedings of previous assemblies were unable to attend this time, while others did not display the activity that had been inherent to them formerly. New names took their place on the list of speakers and symposium organizers. Whether or not this trend will persist into the future scientific meetings, the role that will be played in this trend by present financial difficulties associated with inflation, and the degree to which this trend reflects general complication of scientific conceptions in oceanology, it is difficult to say as yet.

Such growth in complexity is highly typical of today's oceanology. For example today, following discovery of synoptic eddies in the ocean (ZEMLYA I VSELENNAYA, No 3, 1979, p 14.--*Editor*), our ideas about ocean currents have completely changed. The recent Soviet-American POLYMODE experiment (ZEMLYA I VSELENNAYA, No 4, 1979, p 63.--*Editor*), a number of other programs and, finally, the abundance of new information provided by artificial earth satellites have significantly expanded the volume of data available on water movement in the ocean. This movement has turned out to be much more complex both on a planetary scale and in its details. Our ideas on water mixing have grown more complex as well. While previously we believed the ocean to be constantly turbulent everywhere, now a different picture is becoming evident. We clearly understand that laminer movement dominates in the separated column of ocean water. Turbulence attenuates quickly in the ocean, and "outbreaks" of turbulence are relatively rare. Of course, the question as to the sources of energy remains fundamental to all ideas concerning the nature of mixing in the water column. We have now learned to distinguish among the diverse processes of local mixing, owing to which heat and salts come to the surface from the deep-lying layers. Laboratory experiments have made it possible to numerically evaluate the effectiveness of these processes.

Recently oceanologists have begun using some short-lived isotopes (for example tritium isotope) and contaminants introduced into the ocean as labels or, as they are now called, tracers. This has made it possible to quantitatively evaluate the effectiveness of the exchange of different gases (CO_2 for example) that occurs between the lower water layers and the surface layers.

Discovery of synthesis of organic substances by bacteria using energy from oxidative reactions (chemosynthesis) in deep thermal springs, discovery of new species of organisms and revelation of unusual forms of symbiosis between

bacteria and invertebrates are all highly interesting, and they are probably not yet the last examples of how our ideas about development of life in the ocean are growing more complex. Finally, our ideas about the origin of the ocean basins have undergone significant evolution in recent years owing to entirely new viewpoints on the tectonics of lithospheric plates. As a result, the combined efforts of geophysicists, geomorphologists, paleoclimatologists and paleooceanologists were directed at answering many of the complex riddles concerning our planet's origin. V. A. Krasheninnikov (USSR) noted in his report to the assembly that owing to this unification of efforts, a general transition from regional schemes to schemes close to global has now taken shape in modern stratigraphy.

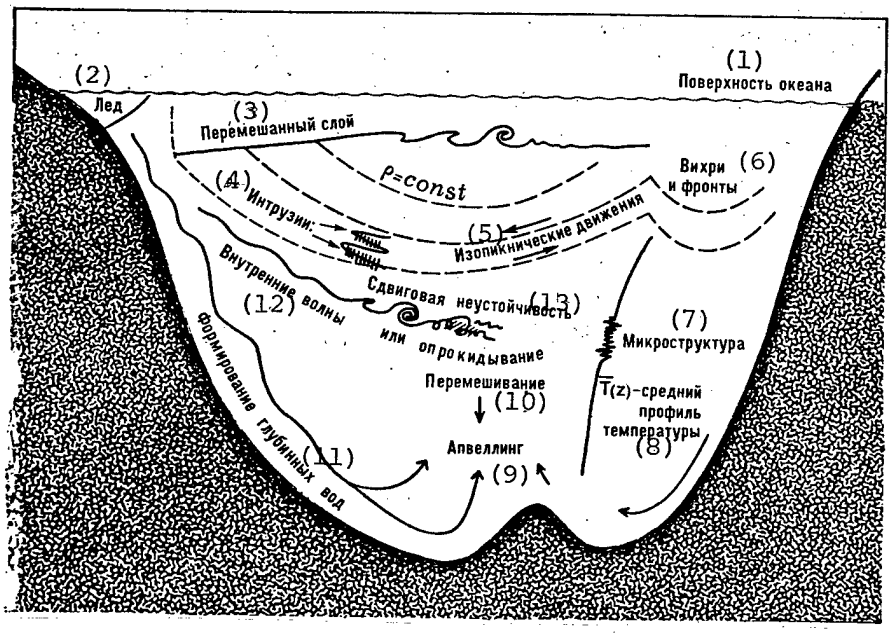
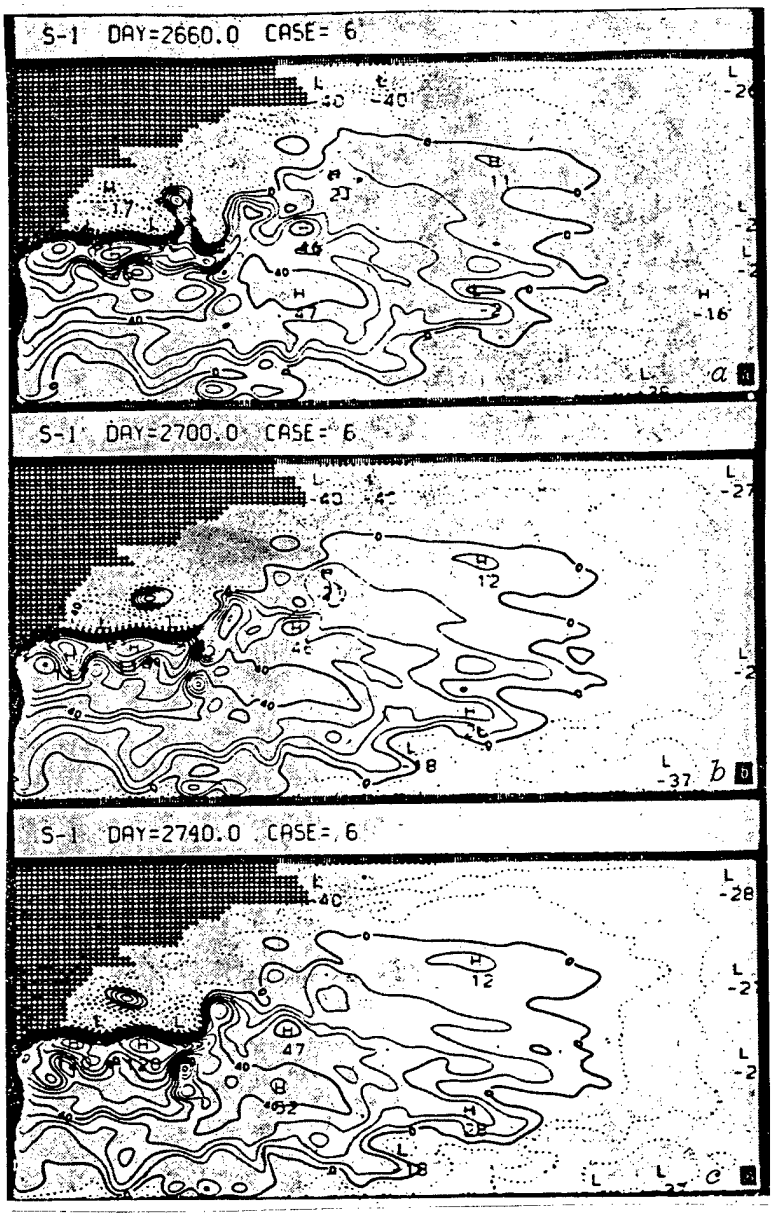


Diagram with which K. Garret (Canada) illustrated his plenary report on diapycnic water mixing (a process of transfer of properties through a surface of equal density, an isopycn, in contrast to "isopycnic" mixing, in which the process occurs along these surfaces). All processes participating in water mixing are diagrammed here in a meridonal cross-section of the ocean.

Key:

1. Ocean surface
2. Ice
3. Mixed layer
4. Intrusions
5. Isopycnic movements
6. Eddies and fronts
7. Microstructure
8. Mean temperature profile
9. Upwelling
10. Mixing
11. Formation of deep-sea waters
12. Internal waves
13. Shear instability or inversion



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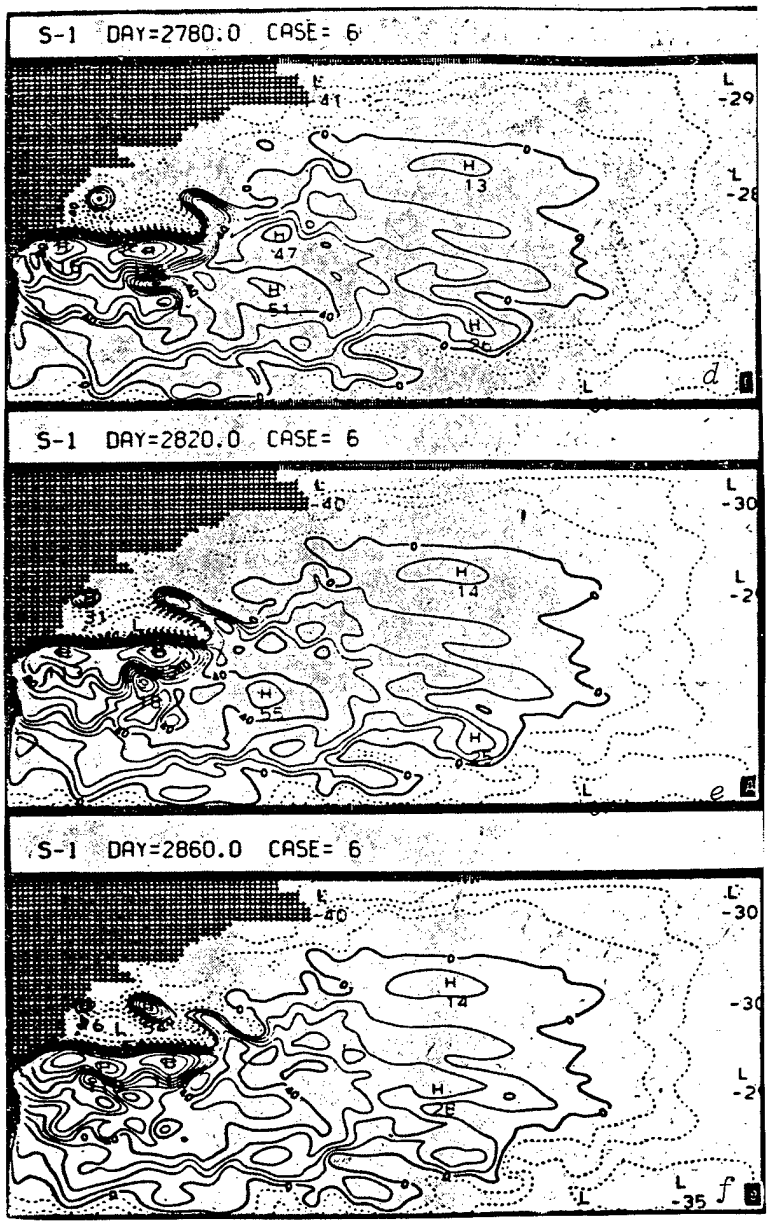

Frames from a film graciously provided by W. Holland to the author of this article. They illustrate experiments with a three-layer numerical model of the Northwest Atlantic. *a-d*--successive frames showing current lines on the ocean surface with an interval of 40 experimental days (from day 2660 to day 2860). Rings can be seen separating from the Gulf Stream (the heavy line in the left part of the frame) and shifting westward.

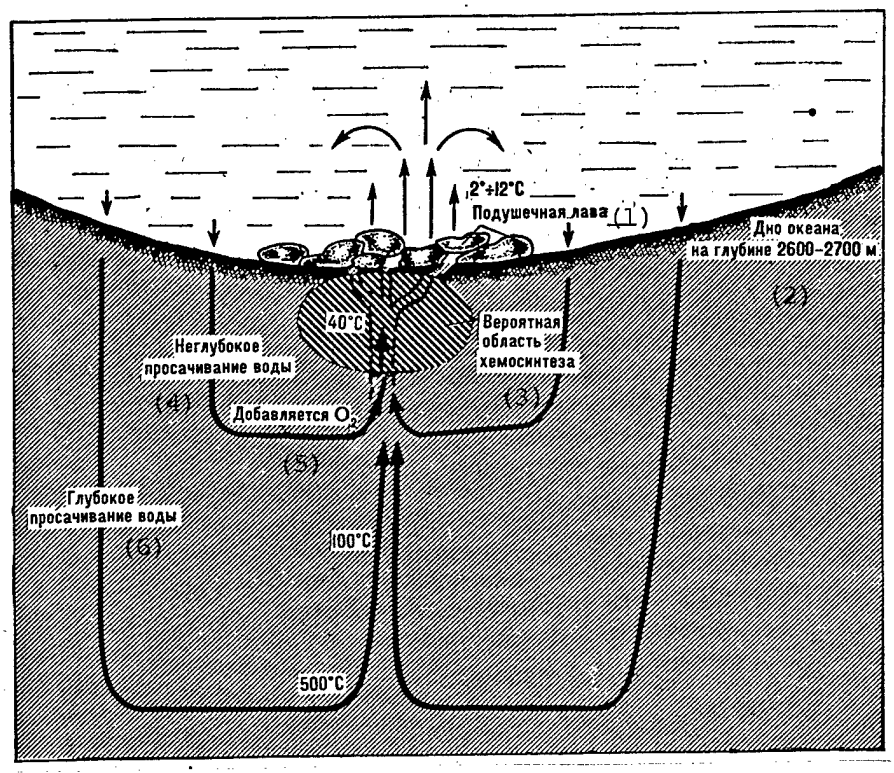

Diagram of a deep thermal spring (from G. Yannash, USA).

Key:

1. Lava pillow
2. Ocean floor at a depth of 2,600-2,700 meters.
3. Probable area of chemosynthesis
4. Shallow water percolation
5. Oxygen is added
6. Deep water percolation

Another trend of modern oceanology also manifested itself with special force in the scientific sessions in Halifax: In recent years the dependence of all scientific disciplines of oceanology on the successes of ocean physics has grown significantly. Plankton specialists are interested in the generation and distribution of "spots" of turbulence, and in the fine structure of the ocean's upper layer. Information on the variability of current systems and their vertical structure is absolutely necessary to numerical simulation of biological communities, and it can be obtained only from hydrophysical models. T. Takahashi (Japan) stated in his report that the behavior of the ocean as a CO_2 reservoir could be fully clarified only if we know all of the laws governing vertical water circulation. Information on interaction between the ocean and atmosphere is needed by geologists and paleooceanologists, because without it, they cannot recreate a plausible geological history of the origin and life of ocean basins in their models. This was the topic of a lecture given by W. Hay (USA). Many laws governing formation of sediments in the ocean cannot be understood without using data on the physical nature of oceanic fronts and on frontal biological communities. But there are purely practical needs as well. As an example the present strategy of squid fishing in the

waters bathing New Zealand is wholly dependent, as M. Bowman (USA) demonstrated, on the results of studying cyclonic eddies in these waters.

Participation in international scientific congresses similar to the Halifax assembly is providing an idea of the level of development of oceanology in different countries. The fact that this is true can be determined from the number of scientific reports that are presented. For example reports presented by U.S. and Canadian scientists at the assembly represented more than half of all of the reports. The great capital investments made by these countries to development of marine sciences in the 1960s doubtlessly had an effect here (in addition to geographic proximity to Halifax). It was just about 20 years ago in Dartmouth that the largest Canadian oceanological center--the Bedford Institute of Oceanology--began working. Today it is a flourishing scientific institution with its own research fleet and a highly promising staff of young scientists.

The Countenance of Today's Oceanology

In recent years oceanologists have actively studied synoptic eddies in the oceans, discovered in the 1970s by Soviet scientists. The results of the Soviet-American POLYMODE experiment have not been completely processed yet, but it is already clear that no less persistent attention will be devoted in the next decade to studying oceanic fronts, the relationship of which to eddies cannot be doubted. A message given by Prof M. Stern (USA) that ocean fronts will be the topic of an annual seminar on geophysical hydrodynamics at the Woods Hole Oceanographic Institution beginning in 1983 was received enthusiastically. This is an extremely timely measure, since we do not as yet have a universally accepted hydrodynamic theory of frontal phenomena in the ocean.

Reports on oceanic fronts occupied a prominent place in the Halifax assembly. Besides the plenary lecture given by K. Garret concerning mixing processes on fronts, there was a special symposium devoted to this problem. Research on fronts in different aspects (including the biological) was also reported at other symposiums. Moreover 18 displays were devoted to them. The dynamics of ocean eddies were also discussed at a special symposium. Specialists unanimously recognized the importance of continuing the study of eddies on a synoptic scale in close association with research on fronts; organization of new international research on Gulf Stream eddies in the second half of the current decade was also recommended.

Because our ideas about the physicochemical characteristics of ocean water have grown more complex due to the presence of eddies and fronts, we must now reexamine the viewpoints on the structure of the animal world in the ocean as well. In his report, O. I. Koblents-Mishka (USSR) pointed out the ways of creating a modern classification of marine ecosystems. The classification must include at least four ranks: the World Ocean community; the communities of planetary and macro-scale cycles; the communities of synoptic eddies; the communities of smaller eddies.

The Halifax assembly demonstrated the increasing role being played by numerical simulation in oceanology. The reports discussed its use to solve various problems:

the variability of climate in connection with the CO_2 problem (K. Brian, USA), climatology of the future (M. Schlesinger, USA), paleoclimatology (E. Barron, USA), prediction of anomalous warming of water by the Peruvian coastline associated with the El Nino phenomenon (G. O'Brien, USA), general oceanic circulation (W. Holland, USA) and multispecific fisheries (G. Shefferd, England and E. Ursin, Denmark). W. Holland showed a special film at the assembly reflecting experiments with a three-layer model of the Northwest Atlantic. This model's reproduction of the Gulf Stream was an impressive spectacle.

The CO_2 problem was actively discussed at meetings held during the assembly. T. Takahashi (Japan) presented the problem in its global scale, and he evaluated the buffer role played by the ocean as a reservoir-accumulator of carbon dioxide entering from the atmosphere. His calculations showed that in the period from 1958 to 1972 the concentration of CO_2 in the ocean increased on the average by the same proportion as in the atmosphere. E. Degens (USA) was the first to offer a global assessment of the role of rivers in the ocean's carbon balance: The concentration of organic carbon varies from 1 to 30 mg/ /liter in 70 percent of the rivers that were analyzed. This means that the total carbon contribution to the ocean by all rivers is 0.2-4 gigatons of organic carbon per year. The rivers have an influence on the ocean's carbon balance also because they carry biogenic elements into the ocean. In just the last 5 years, the quantity of nitrates carried into the ocean by "industrial" rivers such as the Seine and the Rhine increased by a colossal amount--by 20-30 times. As a result plankton production is rising considerably in drainages into the ocean, attaining 1 gigaton per year in Degens' estimate and replenishing humus reserves in the ocean.

Prof R. Revell (USA) presented the assembly with a prediction he made of the influence of carbon dioxide on the earth's climate. It is based on a global model developed by S. Manabe (USA) and an extrapolation of today's CO_2 accumulation rate in the atmosphere. In his opinion this rate decreased somewhat owing to the energy crisis of recent years. Therefore if the concentration of carbon dioxide in the atmosphere does double, as many specialists predict, this would not happen before the year 2080. Mean air temperature at the surface of the earth may rise 2-3°C as a result of the greenhouse effect; this increase would not be the same at different latitudes in the Northern Hemisphere:

+4° at 50° N. Lat.
+6° at 65° N. Lat
+9° at 79° N. Lat (winter)
+4° at 79° N. Lat (summer)

The Arctic Ocean, Revell suggests, will be free of ice in summer, and glacial melting in the western sector of Antarctica will drag on for 200-1,000 years. It is also anticipated that permafrost will gradually disappear from Siberia. The economic consequences of these climatic changes may be very serious in Revell's opinion.

The countenance of today's oceanology would be incomplete without a mention of important discoveries in marine biology and in marine geology and

geophysics. Discoveries in these areas are intimately associated, as if to emphasize the unity of ocean science. It was demonstrated with the new theory of global tectonics that ocean floor spreading is accompanied everywhere by hydrothermal phenomena. This has been confirmed in practice as well. Outflows of thermal waters with a high concentration of salts of various metals, initially discovered in the Red Sea rift (ZEMLYA I VSELENNAYA, No 5, 1980, p 53. --*Editor*), were found in recent years in the Atlantic and in the Pacific. Not only vast deposits of economically valuable metal-containing sediments but also previously unknown biological communities of the highest degree of specialization have been discovered with these springs. These communities were found to be based on chemosynthesizing bacteria thriving in hydrothermal waters. A plenary lecture given by G. Yannash (USA) contained a great deal of interesting information on new forms of life (giant marine tube worms, unusual crabs and mollusks and some previously unknown organisms) discovered in hydrotherms of the Galapagos rift at a depth of about 2,600 meters during recent expeditions by the Woods Hole Oceanographic Institution using the "Alvin" submersible. In turn, these biological discoveries are stimulating the work of geologists studying the ocean's distant past. The possibility is not excluded that thermal springs were highly typical of the aquatic environment of the ocean in the Early Precambrian, and this apparently predetermined a fauna and a nature of benthic deposits totally different from what we see today. Some scientists believe that life arose on earth in the ocean precisely on the basis of chemosynthesis, and that photosynthesizing living organisms arose later.

Being an oceanologist and physicist, the author of this article does not find it easy to fully evaluate the significance of all results of biological, geological and geophysical research on the ocean discussed by the assembly in Halifax. But one thing is doubtlessly clear: This research will provide material to a multitude of scientific publications that will be attentively studied by oceanologists in the next few years.

11004
CSO: 1865/160

NEW OFFSHORE DRILLING SHIP

Moscow PRAVDA in Russian 19 Jun 83 p 2

[Article by supernumerary PRAVDA correspondent V. Ryabchikov: "We Report the Details: Geologists Went to Sea"]

> [Text] Yuzhno-Sakhalinsk, 18 Jun--The diesel-electric ship "Mikhail Mirchink" lay out at the Korsakov port. This is the first vessel in the Far East especially intended for drilling work.

The vessel reinforced the fleet of the Far Eastern Petroleum and Gas Exploration Marine Deep Drilling Expedition engaged in shelf exploration.

"Our diesel-electric ship is the third of those built by Finnish shipbuilders on order from the Soviet Union," says V. Zhizhko, an expedition department chief. "The vessel greatly broadens the capabilities of marine geologists and allows them to conduct prospecting with greater effect. Suffice it to say that now our drillers are capable of drilling underwater holes down to 6½ km deep, and where the depth of the sea reaches 300 m."

An almost 25 m drilling rig rises in the center of the vessel. It is the very same as its dry-land "sisters," but is equipped with a telescopic drill pipe Lowered to the bottom, the pipe allows drilling under water according to all rules of dry-land technology and supplying the drilling fluid continuously, and it reliably protects the hole from the penetration of sea water. A deep-sea diving unit aboard the vessel allows conducting underwater work to a depth of 300 m.

The diesel-electric ship is fitted with a system which keeps the vessel at the necessary point and on a given course, so that traditional anchors are not needed. The system is controlled by three computers.

A helipad is installed at the stern, designed for receiving the MI-8 type rotary-wing craft.

The crew of the diesel-electric ship commanded by experienced seaman Captain-Director G. Milyutin is preparing to go on its first working trip to the western shore of Sakhalin.

The vessel is named in honor of Mikhail Fedorovich Mirchink, well-known petroleum geologist and corresponding member of the USSR Academy of Sciences. He did much to explore and develop oil fields.

6904
CSO: 1865/170

UDC: 550.34.044:551.463.28

CALCULATION OF ACOUSTICAL FIELD IN THE OCEAN FROM A SEISMIC SOURCE CONSIDERING BOTTOM RELIEF

Moscow VULKANOLOGIYA I SEYSMOLOGIYA in Russian No 2, Mar-Apr 83 (manuscript received 4 May 81) pp 84-87

KADYKOV, I. F., Institute of Acoustics, USSR Academy of Sciences

[Abstract] A study is made of the process of forming the hydroacoustic signal of the ocean bottom under complex conditions when there are a number of extended underwater elevations within the framework of the energy approach in order to determine possible specifics of the recorded form of the T phase of earthquake signals in the ocean. For the conditions in question the depth of the earthquake epicenter has no significant infuence on the shape and level of the T phase with a change in earthquake epicenter depth over broad limits. The relatively simple form of representation of the data obtained in this article was possible as a result of significant simplifications of the model of formation of the hydroacoustic signal from a seismic source. However, judging from the satisfactory similarity of results of calculation and recording, these simplifications are apparently justified in the stage of preliminary analysis of the process of formation of an earthquake hydroacoustical signal. Figures 4; references 5: 2 Russian, 3 Western.
[159-6508]

UDC 551.581.1:551.465.15

KINEMATICS OF HORIZONTAL FLOWS IN LANGMUIR CIRCULATION CELLS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 28 Jul 81) pp 60-67

RYANZHIN, S. V., Institute of Limnology, USSR Academy of Sciences

[Abstract] The author uses data from experiments conducted in Lake Ladoga from 1976 to 1980 in order to enlarge on what is presently known about the kinematics of motion in a Langmuir circulation cell. He discusses the distribution of energy in the longitudinal and transverse directions in such cells, the kinematics of horizontal movements, and the components of vorticity in a Langmuir circulation cell. He reaches the following conclusions: 1) current fluctuations in the horizontal plane in a Langmuir circulation cell are

essentially anisotropic, with transverse fluctuations predominating and the anisotropicity decreasing with depth and changing as the wind speed does; 2) the coefficients of horizontal turbulent viscosity behave analogously; 3) the inequality of the longitudinal and vertical velocity components reaches a maximum at half the depth of propagation of the circulation, whereas that of the longitudinal and transverse components reaches a minimum at the same depth; 4) the extremes of the longitudinal and transverse velocity components in a Langmuir circulation cell are shifted relative to each other in the horizontal plane; 5) longitudinal vorticity predominates in Langmuir circulation cells, although transverse and vertical vorticity are also present. Figures 7; references 16: 10 Russian, 6 Western.
[88-11746]

UDC 551.466.4

PARAMETRIC EFFECT OF SOUND ON STEEP GRAVITY WAVES IN WEAK WIND

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 1, Jan 83 (manuscript received 10 Mar 81) pp 82-85

RUVINSKIY, K. D. and FREYDMAN, G. I., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The authors discuss the nonlinear mode of wind-caused waves, using different assumptions from those in other works on the same subject. They share the basic assumption that such waves are limited by excitation of the higher harmonics, but assume that stabilization takes place because of the generation of ripples on their crests rather than excitation of the second harmonic. After formulating the steady-state steepness of gravity waves and ripples as a function of wind velocity, they derive formulas that enable the effect of sound pressure on this steepness for gravity waves with lengths of 3.5-20 cm. Figures 3; references 11: 8 Russian, 3 Western.
[88-11746]

SOME RESULTS OF INVESTIGATION CONDUCTED TO DETERMINE RELATIONSHIPS OF WIND-CAUSED WAVE PHASE VELOCITIES AND LENGTHS IN SHALLOW-WATER ZONE TO THEIR SPECTRAL CHARACTERISTICS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 1, Jan 83 (manuscript received 10 Feb 81) pp 98-100

VAYSBAND, V. B., Institute of Oceanology, USSR Academy of Sciences

[Abstract] Using data from full-scale measurements of wave action and calculated energy frequency spectra, the author attempts to correlate the phase velocity and length of wind-caused waves in shallow water with their specific energy, as manifested by the rise of the agitated sea surface. He concludes

that length is a function of wave energy, then extends to relationship to phase velocity because of the direct functional relationships between it and length. Figures 1; references 1.
[88-11746]

UDC 551.551.2:551.465.7

CHARACTERISTICS OF WEAKLY STRATIFIED WIND FLOW ABOVE WATER SURFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 1 Sep 80; after revision 10 Nov 81) pp 100-102

STREKALOV, S. S. and KRIVITSKIY, S. V., State Planning, Design and Scientific Research Institute of Marine Transportation, USSR Ministry of the Maritime Fleet

[Abstract] Assuming that the effects of weak temperature stratification disappear when a certain wind acceleration or high wind velocity is reached and that the average velocity profile is then governed by a logarithmic law, the authors set up relationships to determine roughness and the resistance factor. The former is a function of the friction rate, acceleration, air's coefficient of kinematic viscosity and free fall acceleration. After several transformations, the authors derive a formula that matches the available full-scale experimental data quite well and that can also be used to determine the coefficient of resistance. Figures 3; references 15: 7 Russian, 8 Western.
[88-11746]

UDC 551.465.536

SPECTRAL ANALYSIS OF CURRENTS, BASED ON DATA FROM LONG-TERM MEASUREMENTS MADE ON BLACK SEA SHELF

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 28 Apr 80; after revision 8 Oct 80) pp 102-107

KRIVOSHEYA, V. G., PLAKHIN, Ye. A., SAVIN, M. T. and TITOV, V. B., Institute of Oceanology, USSR Academy of Sciences

[Abstract] The authors present and discuss the results of a spectral analysis of currents and the mutual analysis of current fields, wind and atmospheric pressure that are based on 3 years' worth of data gathered by a fixed current-measuring buoy at a distance of 4 miles from the shore of the Black Sea. Their analysis is divided into two periods: May-October (summer) and November-April (winter). After establishing the basic scales of the currents' temporal variability, they then analyze the effect on this variability of wind and

atmospheric pressure and find that the effect of the former predominates at the higher frequencies and that of the latter predominates at the lower frequencies. Figures 5; references 5.
[88-11746]

UDC 551.465.153:551.466.61

MIXING OF ADMIXTURE BY TWO-DIMENSIONAL TURBULENCE

Mosvow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 4, Feb 83
(manuscript received 2 Sep 82) pp 975-978

MIRABEL', A. P. and MONIN, A. S., corresponding member, USSR Academy of Sciences, Institute of Oceanology imeni P. P. Shirhosv, USSR Academy of Sciences, Moscow

[Abstract] The authors make a purely mathematical approach to the problem of the spectral density of the concentration of a conservative, passive admixture in a field of isotropic two-dimensional turbulence. They limit themselves to the computation of it in the inertially convective spectral interval in which the rate of spectral transfer of enstrophy and the degree of the admixture field's nonuniformity are constant. They derive equations guaranteeing the existence of solutions for both an instantaneous point source of an admixture and an initial distribution of it in a unit ring. References 7: 2 Russian, 5 Western.
[90-11746]

UDC 551.465

FORMATION OF INTERMEDIATE (LEVANTIAN) WATERS IN THE MEDITERRANEAN SEA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 270, No 5 Jun 83
(manuscript received 30 Nov 82) pp 1216-1220

OVCHINNIKOV, I. M., Southern Division, Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Gelendzhik

[Abstract] During the first half of March of 1977 a uniform hydrologic survey was undertaken in the Eastern Mediterranean basin, yielding very valuable observational materials reflecting the specifics of the winter conditions in the area. The distribution of temperature, salinity, density and circulation of the water in the eastern basin of the Mediterranean are diagrammed. The studies indicate that the winter convection and descending density currents in the cyclonic circulations are the primary source of formation of the intermediate (Levantian) water mass in this area of the Mediterranean. The formation of this water mass is therefore quite local and short-term in nature, similar in its nature to the preliminary phase of formation of deep waters in the north of the western basin. The space and time scales of these phenomena are small: a few dozens of nautical miles, a few days. Whereas earlier it

was presumed that the transfer of Levantian water from east to west might be quite intensive, the latest measurements indicate that these waters do not move in great volumes. Considering that the total flow of this water represents only perhaps 4% of its total volume in the Mediterranean, it is obvious that the loss of the water can be completely recovered by eastern Mediterranean sources in the wintertime. Figure 1; references 9: 6 Russian, 3 Western.
[173-6508]

UDC 551.463:551.465.4

POLOIDAL CIRCULATION IN RINGS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 270, No 5, Jun 83 (manuscript received 27 Nov 82) pp 1213-1216

MONIN, A. S., corresponding member, USSR Academy of Sciences, and FEDOROV, K.N. Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] A classical isopycnic analysis of the circulation in cyclonic and anticyclonic rings which periodically spin off from currents such as the Gulf Stream indicates the presence of a significant poloidal circulation in rings with considerable vertical speed in its ascending and descending branches. In a cold ring the lower portion of this circulation is generally deeper than the layer in which measurements are usually made, i.e., deeper than 1000 m. The actual speeds in the vertical and horizontal branches of the circulation are therefore not yet known. Synoptic studies in the Sargasso Sea have indicated the existence of such poloidal circulations, based on analysis of anomalies in the distribution of temperature and salinity. This indicates that the method of analysis may be very useful in studying anticyclonic rings along the East Australian current, differing from the Gulf Stream in that the rings do not contain areas of "foreign" water. Figures 3; references 5 (Russian).
[173-6508]

UDC 551.465.4

ESTIMATES OF OCEAN WATER TRANSFER INTENSITY

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 31 Aug 81; after revision 14 Sep 82) pp 665-668

STEPANOV, V. N., SHUL'MAN, Ye. I. and GALERKIN, L. I., USSR Academy of Sciences, Institute of Oceanography

[Abstract] The intensity of circulation of water in each of the oceans is compared. The comparison is based on the modulus of velocity averaged over

various levels and in natural layers such as the structural zones. This allows the estimation of the significance of each ocean in the formation of transfer of water throughout the entire ocean. Calculations of mean annual speeds in each 5° trapezoid were based on a linear diagnostic model. Then at each velocity modulus level the area of the trapezoid was determined within the limits of the ocean. In the 0-10 m surface layer the mean speed varies from 10 cm/s in the Atlantic and the Pacific Oceans to 16 cm/s in the Indian Ocean. For the entire ocean it averages 11.5 cm/s. This decreases by a factor of 2 at the lower boundary of the surface waters. As depth increases the mean speeds decrease, and at the bottom (5000 m) are only half as great as at the lower boundary of the surface layer. The mean specific transfer in the 0-5000 m layer is also greatest in the Indian Ocean - 212.6 m^3/s. It is 1.6 times less in the Atlantic, 1.4 and 1.3 times less in the Pacific and in the entire ocean as a whole. References 8 (Russian).
[180-6508]

UDC 551.465.11

MODEL OF NONLINEAR BAROCLINIC OPEN OCEAN EDDY TRANSFORMATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 6, Jun 83 (manuscript received 12 Oct 81; after revision 11 May 82)
pp 646-652

IVANOV, Yu. A. and KUZIN, V. I., USSR Academy of Sciences, Institute of Oceanography, Siberian Division Computer Center

[Abstract] A study is made of the influence of nonlinearity on transformation of a model baroclinic open ocean eddy. The equations of the baroclinic ocean are studied in cartesian coordinates with the x axis directed to the east, y to the north and z vertically downward. A numerical experiment is described, performed using the model described in the article. At the initial moment in time the distribution of pressure was assumed to model formation of an eddy in the ocean. At subsequent moments in time the eddy was transformed according to the rules defined by the numerical model. The qualitative behavior of the eddy coincided with the behavior described in previous works. The initial eddy dispersed, gradually breaking down into a series of secondary eddies in various directions showing a tendency to extend from north to south. Diagrams of density isolines are presented. It is found that consideration of nonlinearity leads to new physical effects in eddy transformation, results of the interaction of the two primary factors acting on the model, the beta effect and density advection. Oscillating processes of exchange of energy between primary and secondary eddies are observed in the baroclinic ocean model as the eddy evolves, at least in some stages.
Figures 2; references 3: 1 Russian, 2 Western.
[180-6508]

UDC 551.511.3:532.52

STABILITY OF ELLIPTICALLY DEFORMED ROTATION OF IDEALLY INCOMPRESSIBLE FLUID IN CORIOLIS FORCE FIELD

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 6, Jun 83 (manuscript received 9 Feb 82) pp 586-594

VLADIMIROV, V. A., TARASOV, V. F. and RYBAK, L. Ya., USSR Academy of Sciences, Siberian Division, Institute of Hydrodynamics

[Abstract] A study is made of the linear problem of stability of the flow of an ideally incompressible fluid with constant vortexing within an elliptical cylinder. The method of successive approximations is used. The analytic results are in qualitative agreement with the conclusions of earlier works, though there are a number of differences in detail. A description is presented of the new method of experimental observation of instability.
Figures 3; references 14: 11 Russian, 3 Western.
[180-6508]

NEW AUTOMATED CENTER FOR EARTHQUAKE PREDICTION

Moscow TRUD in Russian 12 Jun 83 p 4

[Interview with S. Kh. Negmatullayev, chairman of the regional council for earthquake prediction in Central Asia and Kazakhstan, corresponding member of the Tajik SSR Academy of Sciences, director of the Seismic Resistant Construction and Seismology Institute in Dushanbe, by correspondent Yu. Krasnopol'skiy: "Science Conducts a Search: We Hear You, Earth!"; date of interview not given]

> [Text] A computer complex of the first automated earthquake prediction system in the USSR has been set up in Dushanbe. Correspondent Yu. Krasnopol'skiy chats with S. Kh. Negmatullayev, chairman of the regional council for earthquake prediction in Central Asia and Kazakhstan, corresponding member of the Tajik SSR Academy of Sciences, director of the Seismic Resistant Construction and Seismology Institute, about predicting the menacing phenomena.

[Question] Sabit Khabibullayevich, throughout all its history mankind has been powerless before the devastating might of earthquakes. Cities which perished, gigantic seismic sea waves, slumping and fracturing of the earth's crust all are the result of violence of the elements. What can we counter it with today?

[Answer] I can't say that specialists already have learned to predict earthquakes, but we are persistently striving for this. The difficulty in studying subterranean storms lies in the fact that they appear quickly and abate just as quickly. For example the Ashkhabad earthquake lasted only 11 seconds and the city was demolished in this short time interval.

An earthquake is the end result of deep-seated processes which occur in the earth's crust over years and even decades. Figuratively speaking, it is a unique delayed-action detonating mechanism.

[Question] That means the problem is to discover this ominous natural mechanism in time?

[Answer] Not only discover, but also thoroughly learn its nature and determine the place and time when an instantaneous discharge of accumulated forces may occur. The earth is constantly sending us signals of possible danger--we

only have to pick them up and decode them. Specialists call this the forerunner problem.

[Question] So the forerunner apparently is a mysterious earth signal?

[Answer] Mysterious? You're probably right here, although many of the almost 300 known kinds of forerunners no longer present any kind of mystery. For example, changes in the composition of subterranean waters, inclinations of the earth's surface, and its electrical and magnetic potentials all have been studied thoroughly.

But there are truly mysterious phenomena. For example, an acoustic signal is a fundamentally new kind of forerunner recently discovered at our institute. Its nature still has not been established. We know only that any earthquake is preceded by some kind of emission, a certain wave. On encountering some kind of obstacle it is converted into ultrasonic oscillations, and these are what we succeeded in picking up.

We established a curious relationship: The mysterious signal appears each time 54 to 36 hours before the beginning of an earthquake, attains a peak in intensity 18 to 12 hours prior to it, and then gradually subsides. It disappears fully at the moment of the shock. That is the pattern, but we have not yet succeeded in determining what it means.

[Question] Can't you set up an ultrasonic sensor and wait for it to trigger?

[Answer] Everything is not so simple. For example, how can we learn specifically where the oscillations are coming from, how can we pick them up over a vast territory, and how can we single them out in a large city from numerous others of an industrial and everyday nature? Of course we figure on getting much practical benefit from the ultrasonic forerunner, but the problem can be solved only by a scrupulous study of all processes occurring in the crust. The earthquake prediction system is intended for this.

[Question] What tasks will it accomplish?

[Answer] The closer we approach an operational earthquake forecasting, the clearer we realize that we are late in predicting them for now. We have an insufficient amount of initial data. For example, in December 1981, knowing almost for certain that an earthquake would occur not far from Dushanbe, we failed to refine coordinates of the epicenter. The elements outstripped us.

The conclusion was that we needed fundamentally new methods for collecting and analyzing data and we needed rapid, reliable communications. Finally, we needed a powerful computer center with a large-capacity electronic memory. Briefly speaking, this is what our system is. It is being set up under the direction of the USSR AN [Academy of Sciences] Earth Physics Institute imeni O. Yu. Shmidt with the participation of geological, geographic and seismological organizations of the entire region.

[Question] Do you mean Central Asia and Kazakhstan?

[Answer] Yes, they are located in the largest seismological region of the country. Subsequently this region will be covered by a network of observation and measurement points, stations and observatories. All these sites will be "tied" into a single system with a regional center in Dushanbe through their republic centers.

[Question] But the fact is, a network of similar points and stations already has existed for many years.

[Answer] It has, but this is not enough, for I have in mind an enormously denser system which has to cover all zones with seismic danger. In addition, these will be more sophisticated stations which will be able to carry on not only seismic, but also geophysical and geochemical observations. Information will not come from them periodically, as it does now, but continuously.

The Dushanbe-Vakhsh range--the first of a large number of new seismic ranges--already has begun operation. A network of automated measuring points has been set up here which are connected with a prediction station. They function in a continuous mode and have direct access to the system's center, our measurement complex, in which a data collection bank has been set up and is constantly being augmented.

[Question] If instantaneous predictions are a matter of the future, then are scientists already issuing long-range forecasts?

[Answer] Yes. Today we can predict that a strong earthquake will occur in such-and-such an area in a period of 10-15 years. For example, we predicted in advance the 1978 Alayskiy earthquake, the earthquake in northeastern Tajikistan in 1979, that in the South Pamir in 1981 and a number of other earthquakes. Such forecasts have a great practical importance. Knowing that there will be an earthquake in such-and-such an area in 10 years, builders for example decide what type of buildings to construct and how to lay out national economic installations. Without a long-term forecast we would not be able to determine the parameters of the world's tallest 300 m dam of the Nurekskaya GES [hydroelectric power station] or design an even taller one, the Rogunskaya.

According to rough estimates, the economic impact of long-range prediction is more than 300 million rubles annually. By the way, we have succeeded more than once in predicting an earthquake not in 10 years, but 2-3 days before it began.

[Question] Let's fantasize a bit. Can man learn not only to predict earthquakes, but also prevent them?

[Answer] There's nothing impossible in this in principle. The objective will be achieved if we discharge the stress field of the earth's crust by a series of small, safe shocks. A major earthquake would break up into a series of weak ones like a house of cards.

It is possible to "destroy" an earthquake with the help of mechanical vibration. Picture a large-capacity GES with its gigantic spillways. They create vibrations which technically are not so difficult to convert and channel into

the necessary shock. As calculations show, it is possible to control processes within a radius of up to 100 km using the spillways of the Nurekskaya GES.

[Question] One further question. The western press is writing a great deal now about the fact that a number of major earthquakes will occur this year. In particular they are predicting colossal destruction in Tokyo and the death of millions of people. How do you regard such reports? The fact is that a major earthquake recently did occur in Japan.

[Answer] Earthquakes similar to that which recently occurred in Japan are not such a rare phenomenon on our planet. It is not a question of this. They are writing about the possibility of an enormously larger, more catastrophic earthquake. How do I regard these reports? I respect the experience of foreign colleagues with whom we have rather good contacts, but our gear is not located there and so I can neither confirm nor refute these reports. With respect to western press reports I do not preclude the fact that this has the touch of sensationalism.

6904
CSO: 1865/170

UDC 550.348.098.5

DEPENDENCE OF REACTION SPECTRUM ON MAGNITUDE AND EPICENTRAL DISTANCE OF STRONG EARTHQUAKE

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: NAUKI O ZEMLE in Russian
Vol 37, No 1, Jan-Feb 83 (manuscript received 31 Oct 80) pp 57-62

GRIGORYAN, V. G., Order of Red Banner of Labor Institute of Geophysics and Engineering Seismology, Armenian Academy of Sciences

[Abstract] The author has established a correlation between earthquake magnitude and the spectrum of reduced seismic acceleration (reaction spectrum--$\tau(T,\alpha)$), this being of great significance in engineering seismology. The study was made using data on the spectra of reduced seismic accelerations (91 accelerograms were analyzed). The magnitudes of the investigated earthquakes varied in the range 4.3-7.7; epicentral distances ranged from 6 to 260 km; focal depths were between 5 and 20 km. Curves were constructed for the dependence of the reaction spectrum on the magnitude of a strong earthquake for five intervals of epicentral distances: $\Delta \leq 15$, 16-30, 31-60 km for the range of magnitudes 4.3-6.2, and also for distances 61-120 and $\Delta > 120$ km for the range of magnitudes 6.3-7.7. For each range of epicentral distances the dependence $\tau(T,\alpha)$ on magnitude was determined for 12 periods of free oscillations T from 0.1 to 3.0 sec. The expressions derived for the dependence of the reaction spectrum on magnitude M make it possible to construct mean (standard) spectral curves for any M values for the stipulated range of epicentral distances. Then the dependence of reduced seismic acceleration on epicentral distance can be determined; there is a regular dropoff of acceleration levels with an increase in epicentral distance. The derived expressions make it possible to give the most complete statistically validated quantitative characteristics of ground oscillations. Figures 4, tables 4; references 9: 8 Russian, 1 Western.
[157-5303]

UDC 551.35:552.321.323

MAGMATIC COMPLEXES ON SEA OF JAPAN FLOOR

Novosibirsk TIKHOOKEANSKAYA GEOLOGIYA in Russian No 2, Mar-Apr 83
(manuscript received 15 Apr 82) pp 20-25

LELIKOV, Ye. P., S"YEDIN, V. T., YEVLANOV, Yu. B., SVININNIKOV, A. I. and TEREKHOV, Ye. P., Pacific Ocean Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Vladivostok

[Abstract] The floor of the Sea of Japan is characterized by the widespread development of magmatic rocks, granitoids and basaltoids of different age which fall into eight age groups (Archean-Early Proterozoic granites, Late Proterozoic complex, Middle Paleozoic complex, Late Paleozoic granites, etc.). The granitoids play an important role in the structure of bottom sectors characterized by a crust of the subcontinental type constituting major complexes within the limits of submarine rises, the shelf, continental and island slopes. On the other hand, basaltoid volcanism was manifested both within the limits of these same rises and in abyssal depressions with a suboceanic crust. The article is accompanied by a full-page morphostructural map of regionalization of the Sea of Japan floor. Detailed information concerning these magmatic rocks can be found in the cited literature; here the authors emphasize only new results from radioisotopic age determinations, data which are summarized in Tables 1 and 2. In addition, the Cenozoic formations of volcanic origin lying on the rises and in the abyssal depressions with a suboceanic crustal type for the first time have been classified into four series (basalt-liparite orogenic regions, trachyandesite, alkaline-olivine-basalt and alkali-basaltoid), each of which is described. These correspond to continental formations of volcanic origin. A correlation was established between the composition of the volcanites and their tectonic position. The materials presented here indicate that most of the described magmatic complexes are similar to formations on the surrounding land, evidence of a unified structural plan and common regularities in formation of the continental crust and the crust of the marginal sea. It can be postulated that this basin was formed on a continental sialic basement. Figures 1, tables 2; references: 14 Russian.
[155-5303]

UDC 550.837.211:551.24:550.343.4(571.61.64)

PRELIMINARY RESULTS OF STUDY OF DEEP CONDUCTIVITY IN RECENT TECTONICALLY ACTIVE ZONES OF SOUTHERN FAR EAST OF USSR

Novosibirsk TIKHOOKEANSKAYA GEOLOGIYA in Russian No 2, Mar-Apr 83 (manuscript received 26 Jul 82) pp 97-101

MASTYULIN, L. A. and TALTYKIN, Yu. V., Institute of Tectonics and Geophysics, Far Eastern Scientific Center, USSR Academy of Sciences, Khabarovsk

[Abstract] The authors undertook a generalization of data on deep conductivity of the Priamur'ye and Primor'ye regions of the Soviet Far East and sought its relationship to recent tectonic activity of structures in the southern part of the Far East. In these areas there have now been about 120 magnetotelluric soundings, nonuniformly distributed in area in the form of profile intersections of tectonically active zones with an interval of 10-50 km and individual points. The principal results of study of deep structure of the earth by the magnetotelluric and magnetovariation methods have been the discrimination of conducting layers in the crust and upper mantle, determination of the depth to the top of these layers and some evaluations of total longitudinal conductivity. Here the authors examine the nature of the conducting layers and conductivity anomalies in the crust because they can be caused by the lithological composition of sedimentaty and metamorphic complexes. It was found that the relief of tectonically active zones bears a relationship to deep conductivity. The gentlest, smoothed relief is characteristic for sectors where no conductive layer has yet been discovered in the crust and at the top of the upper mantle and there is only some increase of the upper edge of the asthenospheric layer. With an increase in the role of the upper conducting layer and a decrease in the depth of its upper surface there is an increase in the degree of relief differentiation and relative subsidence of the bottoms of grabens. The conducting layer is situated closest to the surface (15-30 km) in the Verkhnepriamurskaya zone, where the relief is highly dissected. Approximately the same picture is observed in the Baykal rift zone, where a conducting layer was detected at 15-20 km. The interrelationships of seismicity, deep conductivity and relief of recent tectonically active zones in the southern Far East made it possible to postulate a possible scheme of their development. Figures 1; references: 13 Russian. [155-5303]

UDC 550.831

CONSTRUCTION OF SPATIAL DISTRIBUTIONS OF MASSES WITH ZERO GRAVITATIONAL EFFECT

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 5, No 3, May-Jun 83
(manuscript received 15 Oct 79) pp 53-56

KOBRUNOV, A. I. and VARFOLOMEYEV, V. A., Ivano-Frankhov Institute of Oil and Gas

[Abstract] The geological interpretation of gravimetric surveys requires the solution of the inverse spatial problem of gravimetry. The transition from two to three-dimensional studies leads to an increase in the volume of computation required and an increase in the influence of instability of the problem on the results of solution. The prospects for effective interpretation of area gravimetric prospecting data are largely related to implementation of a program for development of the theory and methods of equivalent redistribution of formal solutions of the inverse gravimetric prospecting problem. Since the difference in any two mass distributions with corresponding gravitational fields creates a zero field of the force of gravity, one system of equivalent redistribution may consist in successive approximation to a particular formal solution of the inverse problem of gravimetric prospecting for mass distributions creating zero gravitational fields. An obvious approach to solution of the problem is to assign a certain distribution of mass in a given area and use it to calculate the gravitational field relative to which the formal solution is subsequently constructed. This system can be significantly simplified by certain assumptions drawn relative to the area in question in this article. The construction of a class of distributions of masses of zero gravitational effect requires creation of an effective procedure to find a formal solution to the inverse problem of gravimetric prospecting. This article generates such a solution using a particular case of search for a distributed mass with zero gravitational effect. Figures 4; references 2 (Russian).
[166-6508]

UDC 550.389

METHOD OF STUDYING LOCAL VARIATIONS IN THE GEOMAGNETIC FIELD OF THE CRIMEAN PENINSULA

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 5, No 3, May-Jun 83
(manuscript received 10 Aug 81) pp 57-61

ZAVOYSKAYA, I. N., Institute of Geophysics, Ukrainian Academy of Sciences, Kiev

[Abstract] The Crimean Peninsula is of interest in a study of tectonomagnetism because of the presence of seismically active areas, the presence of magnetically active minerals in the rock, the water saturation of certain areas and the island nature of the region, allowing a study of manifestations of coastal electromagnetic effects in geomagnetic variations. The object of

the present study was long-term geomagnetic variations evoked by physical phenomena occurring in the crust with characteristic times of days to years. The specifics of the distribution of field increments were studied over various time intervals--40 years, 1 year, 1 month--over the entire area of the peninsula and mean daily increments in its individual points. All studied points were standardized at the Odessa Magnetic Observatory. The calculated amplitude at geomagnetic characteristics of long-term geomagnetic variations reflect not only a measure of the induction predominance of external field variations, but also all sorts of local factors in fluctuations of the geomagnetic signal. The authors suggest further study of the spatial structure of local specifics of long-term geomagnetic variations, a study of the frequency spectrum of geomagnetic variations at continuous recording points and determination of normal tectonomagnetic characteristics of the medium such as the summary increment (decrement) of the geomagnetic signal with respect to a certain constant assigned point. Figures 2; references 10: 7 Russian, 3 Western.
[166-6508]

UDC 550.385

ESTIMATE OF DISTANCES TO EXTERNAL SOURCES OF GEOMAGNETIC VARIATIONS

Kiev GEOFIZICHESKIY ZHURNAL in Russian Vol 5, No 3, May-Jun 83
(manuscript received 4 Jan 80) pp 74-76

LITINSKIY, V. M., Institute of Geophysics, Ukrainian Academy of Sciences, Kiev

[Abstract] Determination of configurations and locations of geomagnetic variation points is one of the most important problems in the study of the variable geomagnetic field. A method is suggested for determining the distance to points creating magnetic substorms using data on their planetary distribution. Most sources have the form of current rings: the ring current, the vortices of current systems of substorms and surface currents of the magnetosphere are examples. Knowing the radius of current vortices and the gradient of field change, one can estimate the maximum distance of the currents from the surface of the earth. Determination of the distance to external currents is possible based on planetary distribution data on variation amplitudes. In the middle latitudes the maximum distance to the main currents is 5000 km. However, in the auroral zone the maximum distance to the center of gravity of the currents is approximately 300 km. Figures 2; references 3 (Russian).
[166-6508]

UDC 551.35

CURRENT STATUS AND PROSPECTS FOR DEVELOPMENT OF MARINE GEOLOGY IN UKRAINE

Kiev GEOLOGICHESKIY ZHURNAL in Russian Vol 43, No 3, May-Jun 83
(manuscript received 8 Dec 82) pp 33-38

SHNYUKOV, Ye. F., Institute of Geological Sciences, Ukrainian Academy of Sciences

[Abstract] In accordance with resolutions of the party and government, particularly the 26th CPSU Congress, Soviet scientists are actively participating in the study of the ocean. The Ukrainian Academy of Sciences has been involved since 1962. Expeditions have studied the Atlantic, Indian and Pacific Oceans as well as the Antarctic. The material accumulated has included studies on the stratigraphy and lithology of Quaternary deposits of the ocean, particularly the Caribbean region, as well as regional techtonics and geophysics. Metallogenesis in the ocean is briefly discussed. The Institute of Geological Sciences, Ukrainian Academy of Sciences has studied concretions in the Indian and Atlantic Oceans, discovering a new field of concretions in the Indian Ocean and new regions of multilayer concretion strata in the Arabian-Indian Ridge up to 3-5 m thick. Studies of deep hydrocarbon fluids indicate the possibility of rich deep water fishing, which could contribute directly to the USSR food program. Another new trend is the search for fresh water in the Black and Azov Sea water areas. A series of monographs is being written on the main branches of geological studies of the shelf. The problem of the ocean and its mineral resources is scientifically inexhaustible. References 13 (Russian).
[167-6508]

UDC 550.311

COMPARISON OF LARGE-SCALE PECULARITIES IN GEOPHYSICAL FIELDS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 267 No 6, Dec 82
(manuscript received 20 Jun 82) pp 1336-1340

RYKUNOV, A. L., Institute of Terrestrial Physics imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow

[Abstract] An attempt is made to compare large scale specifics of such geophysical fields as the gravitational field, the field of seismic wave velocities, the field of fractures (distribution of earthquakes), thermal fluxes and the magnetic field. The purpose of the work is to determine an acceptable method of distinguishing and comparing their general features. It is noted that in the earth over long periods of time there are movements of nonequilibrium distributed matter encompassing the mantle and the entire core of the planet and not explicitly related to horizontal boundaries with the exception of the mantle-core boundary. Within this movement a definite direction is maintained characterized by an equatorial axis intersecting the surface of the earth at points with longitudes of about 0 and 180°. Figures 2; references 5: 1 Russian, 4 Western.
[162-6508]

UDC 624.131.54:556.3

GLOBAL HYDROGEODEFORMATION FIELD

Moscow SOVETSKAYA GEOLOGIYA in Russian No 5, May 83 pp 116-125

VARTANYAN, G. S., KULIKOV, G. V., All-Union State Institute of Geology

[Abstract] A variety of empirical material indicates a close connection between many parameters of the hydrogeologic conditions of the earth and seismic processes. Variations in hydrodynamic conditions in the earth with seismotectonic stresses have also been reported. The reaction of groundwater in various locations to a single seismic event have been found to vary widely. Groundwater levels have been found to rise and lower in different points during seismically active periods. Based on information on the conditions of groundwater between 1950 and 1974, the authors have studied the general development of the hydrogeodeformation field in several large seismically active areas, utilizing an automated information system for machine processing of initial data and construction of field maps. Study of the hydrogeodeformation field of large regions of the USSR has revealed the specifics of formation and development of short-lived deformation structures, allowing a number of characteristic features of extended geologic regions to be traced. In the overwhelming majority of cases both in mountain folded regions and in platform and shield areas there is a disordered structure of the hydrogeodeformation field, in which areas of extension consisting of isolated box-like structures appear over short periods of time and degenerate among areas of weak compression. The direction of development of the hydrogeodeformation field is different during periods preceeding a powerful earthquake. Individual isometric structures of deformation enlarge in size over short periods of time and, taking on extended shapes, merge to form long (thousands of kilometers) zones. The field becomes oriented. The elongated zones of tension alternate with or intersect extended zones of compression. The greatest order is observed in the field immediately before a powerful earthquake, after which the field becomes once more chaotic. Possible mechanisms are suggested. The analysis presented allows a basically new understanding of processes occurring in the subterranean hydrosphere within folded mountain areas, platforms and shields. Figures 4; references 17: 12 Russian, 5 Western. [168-6508]

UDC 528:061.14(47+57)

FORMATION AND DEVELOPMENT OF STATE GEODETIC SERVICE

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 12, Dec 82 pp 5-12

KASHIN, L. A.

[Abstract] Lenin signed the decree forming the Higher Geodetic Administration on 15 March 1919. This organization, now the Main Administration for Geodesy and Cartography, USSR Council of Ministers, has from its inception been both an operating organization performing geodetic, topographic and cartographic work and a state administrative organization. The history of changing administrative subordination of the organization and of the continuing efforts to survey the entire territory of the Soviet Union are outlined. At present, cartography of the entire nation in 1:25,000 scale is proceeding successfully, of agricultural areas in 1:10,000 scale, and of cities, industrial regions and certain areas of intensive agriculture in 1:5,000-1:2,000 scale. Several new instruments used in field work are illustrated in photographs. Figures 4; references 5 (Russian).
[137-6508]

UDC 550.341.5

ONE IMPORTANT PROPERTY OF SHORT TERM EARTHQUAKE PRECURSORS

Moscow VULKANOLOGIYA I SEYSMOLOGIYA in Russian No 2, Mar-Apr 83
(manuscript received 24 May 81) pp 68-73

MONAKHOV, F. I., deceased, Sakhalin Complex Scientific Research Institute, Far Eastern Scientific Center, USSR Academy of Sciences

[Abstract] Continuous recordings of fluctuations in water level in non-flooded wells on several islands in the Kuril-Sakhalin seismic prediction range has been performed over several years. The materials have firmly established that before earthquakes, when anomalous fluctuations in water level in the wells have been observed, the nature of the observations usually corresponded to a typical graph, presented in figure 1. The graph shows a minimum just before the earthquake. Before a shock both a drop or a rise in the water level may occur depending on the moment of measurement of the level relative to the shock. It is demonstrated that the change in static water level in a well before an earthquake is in counterphase with the change in flow rate and dynamic water level. Hydrogeodynamic, deformation, gas-geodynamic and electric conductivity short term precursors of earthquakes are, with rare exceptions, monotypical in all cases, i.e., before any earthquake and at any location they are the same. This means that the theoretical models of the focus of an earthquake leading to a mosaic field of earth surface deformation during the period of preparation of a seismic shock is in contradiction to the factual data. Figures 5; references 9: 8 Russian, 1 Western.
[159-6508]

UDC 550.834.53

STRUCTURE OF THE KURIL-KAMCHATKA AND ALEUTIAN ISLAND ARCS BASED ON CONTINUOUS SEISMIC PROFILING DATA

Moscow VULKANOLOGIYA I SEYSMOLOGIYA in Russian No 2, Mar-Apr 83
(manuscript received 30 Mar 82) pp 53-67

SELIVERSTOV, N. I., Institute of Vulcanology, Far Eastern Scientific Center, USSR Academy of Sciences

[Abstract] This work reports the results of studies by continuous seismic profiling performed in the summer of 1981 during the 12th voyage of the research vessel "Vulkanalog." The work studied a region including the Kamchatka bay, northern end of the Kuril-Kamchatka and northwestern Aleutian deep water trenches, northern Obruchev elevation, the underwater portion of the Komandorskiy block of the Aleutian Island chain and the southern Komandorskiy trench, and studied this area for the first time by the method of continuous seismic profiling, producing an area diagram which is reproduced in the article. The primary object studied by the method of continuous seismic profiling in the central B modification consists of the comparatively smooth structures of sedimentary masses with slight slope angles of reflecting boundaries, usually less than 10°, in some cases up to 15-20°. The structure of the Aleutian chain and its surroundings is discussed. The origin of the structures in the northwestern terminus of the Aleutian Island arch results from exclusively tectonic processes. The last stage in development of these structures consisted of tectonic transformation of adjacent sectors of the Pacific and Bering plates, occurring in the situation of horizontal compression and apparently right shift between these plates. Previous stages were apparently similar. The structural framework of the northern Kuril-Kamchatka trench on the continental slope side is a depression between arcs and a tectonic arc. In the modern structural plan the strike of the Kuril-Kamchatka Island arc structures to the north is limited by the Aleutian structures. A relationship is established between the distribution of hypocenters of large earthquakes and structures of the northwestern terminus of the Aleutian Island arc. The specifics of the sedimentary structure and its relationship with the basement relief indicate that in the formation of thick sedimentary masses in the Aleutian arc on the Aleutian slope of the Obruchev Rise fragmentary material arriving from the northeast was significant.
Figures 6; references 8: 7 Russian, 1 Western.
[159-6508]

UDC 622.24.085.5

SHELF WELL DRILLING DEVICE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA
in Russian No 6, Jun 83 pp 118-121

BUKALOV, A. A. and PRONKIN, A. P., Moscow Institute of Geologic Prospecting imeni S. Ordzhonikidze

[Abstract] A design is suggested for a device for drilling holes in the continental shelf beneath the sea. The device consists of a pipe string from the drilling support platform or vessel, with a sampler at the bottom of the string, a piston above the sampler isolating the inner space from the fluid outside the pipe. The sampler rests on supports in the lower coupling and is prevented from movement in the pipes. An impact weight moves up and down within the pipe. The sampler and piston are lowered through the pipe string and the fluid in the string is allowed to pass upward through a valve. When the bottom of the string is reached the position fixing device is expanded preventing the sampling device from rising in the pipe string. As the impact bar is then raised a rarefaction is formed. When the bar drops, there is no hydraulic resistance. The bar strikes the piston which moves in the pipe and strikes the sampling device. The liquid above the piston is forced outside the pipe and the impact is transmitted to the pipe string. Withdrawing of the sampler brings up a core sample. Figures 3; references 2 (Russian).
[181-6508]

PHYSICS OF ATMOSPHERE

PROSPECTS FOR SOLAR ELECTRIC POWER STATIONS IN ORBIT

Moscow IZVESTIYA in Russian 25 Feb 83 p 3

[Article by Professor V. Vanke, doctor of physical and mathematical sciences, Moscow State University imeni M.V. Lomonosov: "Electric Power Stations in Orbit"]

> [Text] In science fiction one frequently encounters the following idea: huge space platforms collect the Sun's energy and then transmit it to Earth. This idea is extremely tempting, and right now not only fantasy writers, but also collectives of scientists are developing it. In general, the question of the "direct" utilization of solar energy is not at all new. At first appearance, it can even be said to be elementary. However, there is simply no way it can be answered unambiguously if the subject is large-scale and profitable use of solar energy under terrestrial conditions.

It is easy for any of us to picture the difference between the levels of solar radiation on a hot summer day in the south and during cloudy winter weather in the middle latitudes. Of no less importance are also the daily variations in the intensity of the radiation and wind, moisture and dust. All of this causes substantial difficulties for the technical realization and the possibility of long-term operation of photoelectric and thermal receivers of the rays that our star sends to the Earth.

And so, the following question naturally arises: cannot we, by utilizing contemporary achievements of science and technology, choose a more radical path and place large solar collectors off the Earth, where the flow of solar radiation is constant, and then transmit this energy to Earth? Despite all the seeming fantasticness of this idea, today it is possible to answer this question affirmatively with a considerable degree of confidence. Moreover, space solar electric power stations (SKES) can be regarded as one of the promising paths for the solution of our terrestrial energy problems.

The idea of such stations was already formulated more than 10 years ago. Recently, scientists and engineers from many countries have been working on it thoroughly and comprehensively. Many different versions of space solar electric power stations were proposed. However, they all have main features in common that are of a fundamental nature. In particular, a geostationary orbit has been chosen as the most appropriate one. This is a circular orbit in the Earth's equatorial plane that is about 36,000 km above its surface. The angular rate of motion of a satellite in this orbit equals the Earth's angular rate of rotation. Therefore, it "hangs"

immovably over a certain point on the Earth's surface. Today this orbit is used successfully for (for example) the placement of communication satellites (relay stations) of the "Ekran" [Screen] type.

It is important that because of the natural inclination of the Earth's equatorial plane to the plane of the ecliptic (with an angle of 23.5°), the station will be illuminated by the Sun practically continuously. Only for brief periods (close to the days of the spring and fall equinoxes, and lasting less than 1 percent of the total duration of the year) will a power satellite fall into the Earth's shadow.

It has been established that the economically optimal power of a space solar electric power station lies in the range of 5-10 million kilowatts. For the sake of comparison, let us point out that the capacities of the Bratskaya and Krasnoyarskaya GES's are 4 and 6 million kilowatts, respectively. In order to obtain a capacity of 5 million kilowatts in orbit, it is necessary to have a total solar collector area on the order of 50 km^2.

The solar batteries for space electric power stations are either the silicon variety or are based on gallium arsenide. In both cases, however, there must be pellicular photoelements that are light in weight and low in cost per kilowatt of energy generated, and that can be packed together densely for transport through space.

How can the electrical energy obtained in a geostationary orbit be transmitted to the Earth's surface? In principle, by the same method now used to transmit information from geostationary communication satellites; that is, by using highly focused electromagnetic emissions in the superhigh-frequency (SVCh) band.

Electromagnetic radiation with a wavelength of 10-12 cm passes through the atmosphere quite easily. Neither cloud cover nor even comparatively heavy precipitation affects it. In connection with this, I involuntarily remember a thought expressed 20 years ago by that leading Soviet physicist, Academician P.L. Kapitsa. Similar to the way in which electrical engineering in its early stages solved only communication (telegraph, signaling) problems and then began to be used primarily in power engineering, so did electronics change from the transmission of information to the solution of the most important problems of power engineering as it was developed.

The KPD [efficiency] of the transmission of energy from space to the Earth's surface will be close to unity if the transmitting antenna's diameter is 1 km and the ground receiving system's diameter is on the order of 7-12 km. The station's transmitting antenna must contain a large number of SVCh energy generators with unit capacities ranging from hundreds of watts to several tens of kilowatts.

A special ground complex will carry out the reverse transformation of the incident SVCh beam's energy into direct or alternating current energy. Analysis and experimental data show that the KPD of the reception and reverse transformation of SVCh energy on the Earth's surface can be extremely high, reaching 90 percent. In connection with this, the design of the ground receiving station can be 80 percent transparent to solar rays and precipitation. It can be slightly elevated above the Earth's surface and the area occupied by it can be used, for example, for agricultural crops or energy-intensive industrial complexes. For the countries of Western Europe, with their high population density, the placement of receiving systems over the sea's surface in coastal zones definitely makes sense.

The reader has a right to ask: how safe are SVCh beams? Completely safe. Even in its center, the density of the flow will be lower than the intensity of solar radiation on a cloudless summer day. Besides this, the structure of an SVCh beam is such that its intensity diminishes rapidly towards its edges. At a comparatively short distance from the receiving antenna's edge, the energy flow's density turns out to be lower than the existing standards for the permissible level of extended SVCh irradiation.

This is well and good, but how will these gigantic structures be delivered into space? Actually, the weight of a space electric power station has been estimated to be 50,000-100,000 tons. Economical transport rockets with a lifting capacity of, shall we say, 200-500 tons will be required. All the basic materials can be delivered into space in the form of semifinished items in packaged form. In a certain sense, space is the ideal place for erecting large engineering structures. The force of gravity is not felt there and there are no wind stresses, corrosion and so forth. Using the delivered semifinished materials, several automatic modules will be able to build all the necessary engineering structures. Only at the final stage will a small amount of manual labor on the part of cosmonauts be necessary.

Nevertheless, when can we expect the appearance of the first space solar electric power stations? And how profitable will they turn out to be? According to the estimates of foreign specialists, under certain conditions in the next 10 years it will be possible to create prototypes (with smaller dimensions) of such stations that will make it possible to test experimentally all the basic technical ideas and demonstrate the possibility of building industrial stations. Industrial stations in space can be real in 20-30 years. At that time the cost of their energy can become lower than the predicted cost of electricity from other sources. The proposed operating life of a station is 30 years. In connection with this, it has been calculated that the expenditures for its construction will be recovered after 2-3 years of operation.

How much will space solar electric power stations add to those general problems with which modern power engineering is faced? First of all, their operation is not related to the use of the Earth's limited fuel resources. The Sun will serve as the source of energy. An SVCh beam can be transferred to receiving antennas located thousands or even tens of thousands of kilometers away from the source of the beam's transmission. In connection with this, the KPD of energy transmission will remain unchangingly high. An SKES will not emit any combustion products whatsoever into the atmosphere and, which is extremely important, will reduce to a minimum the thermal pollution of the ecological environment. Ninety percent of the incident SVCh beam's energy will be converted into useful electricity that can be used immediately by consumers.

The commonality of interest in protecting nature on this planet as a whole and the prospects of international and intercontinental cooperation in the distribution of energy can serve as a good foundation for the international joining of efforts to create space solar electric power stations. They will be an important step on the path toward the industrial mastery of near space and will make a weighty contribution to the solution of our planet's energy problems.

11746
CSO: 1865/78

UDC 551.596

GENERATION OF SUBSONIC ATMOSPHERIC OSCILLATIONS DURING SUPERSONIC VERTICAL MOVEMENT OF SOURCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 1, Jan 83 (manuscript received 8 Oct 80; after revision 4 Mar 81) pp 81-82

SLIVINSKIY, A. P.

[Abstract] The author states that the basic contribution to the generation of gravitational and sonic oscillations at supersonic speeds is the energy source, and that the contributions of pulse intensity and mass can be ignored. Using a Fourier representation of the disturbances in an ideal gas in a gravitational field, he concludes that the disturbances are of a quasiharmonic nature. Subsonic oscillations with a period that is approximately the inverse of the (Brent-Vyaysyal') frequency should form at a fixed point inside the Mach cone, with the period decreasing linearly on the cone's generatrix as its radius increases. References 1.
[88-11746]

UDC 551.510.534

NUMERICAL MODELING OF ZONALLY AVERAGED FIELD OF STRATOSPHERIC OZONE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 4, Feb 83 (manuscript received 21 Sep 82) pp 832-835

KONDRAT'YEV, K. Ya., corresponding member, USSR Academy of Sciences, and YANUSHANETS, Yu. B., Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad

[Abstract] The authors set up a numerical model of ozone transfer for the purpose of studying various processes that affect its concentration and attempting to reproduce the observed seasonal latitudinal and altitudinal ozone and temperature fields. The model is based on a system of zonally averaged equations for the evolution of small gas admixtures and temperature potential that are taken from the literature, as are the experimental data. The authors conclude that their model reproduces satisfactorily the latitudinal and meridional pattern of the total ozone concentration and that, in the first approximation, the Chapman cycle in combination with the dynamic factors reproduces the zonally averaged ozone concentration field satisfactorily. However, the effect of nitrogen-hydrogen compounds cannot be determined satisfactorily with the model. Figures 1; references 8: 1 Russian, 7 Western.
[90-11746]

UDC 551.510.535:551.571

WATER VAPOR IN THE THERMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 6, Jun 83 (manuscript received 7 Apr 82) pp 659-661

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Institute of Atmospheric Physics

[Abstract] The moisture content of the air influences many processes in the upper atmosphere. Artificial injection of water vapor in the F2 layer of the ionosphere and simultaneous determination of the critical frequency f_o for the F2 layer at night is an effective means for estimation of the concentration of water vapor at these great altitudes. The elementary processes involved are described using reaction rate coefficients which are presented in a table. Significant changes in f relative to f_o were observed after the injection of thousands of tons of water vapor during launches of the powerful Saturn-5 rockets in the Apollo program. The authors concentrate, however, on more modest long-term diffusion of smaller quantities of water vapor from the dense mesosphere over long periods of time following such launches. Atmospheric circulation and turbulence cause this process to occur not at the launch point but at some distance from it and over a broader area. The values of f_o for F2 at Lindau (51.5°N, 10°E) are used, covering a period of about 5 hours around midnight following Saturn launches. Thanks to the identification of the emission of water vapor ions by Herzberg, a new understanding of the phenomena can be gained. The post-injection value of $[H_2O][\approx 3.5 \cdot 10^4$ H_2O/cm^3 was calculated for the F2 layer of the ionosphere (about 250 km). $[H_2O]$ at the turbopause (about 110 km) can be now estimated as about $6 \cdot 10^6$ H_2O/cm^3 after great injections of water vapor and about 10^5 H_2O/cm^3 under natural conditions.
References 8: 3 Russian, 5 Western.
[180-6508]

UDC 551.510.61:551.507.362.2

SPATIAL STRUCTURE OF AIR DENSITY VARIATIONS BASED ON SCINTILLATION OBSERVATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian
Vol 19, No 6, Jun 83 (manuscript received 29 Jul 82) pp 656-658

GURVICH, A. S., KAN, V., POPOV, L. I., RYUMIN, V. V. and SAVCHENKO, S. A.,
USSR Academy of Sciences, Institute of Atmospheric Physics

[Abstract] Results are presented from studies of atmospheric heterogeneities in the index of refraction performed on the Salyut-6 - Soyuz space craft, based on measurements of fluctuations in light flux from sources in space. Measurements were performed on 30 September 1980 by means of a photoelectric brightness amplifier. The image of Venus from the brightness amplifier screen was recorded by a motion picture camera at 24 frames per

second. Six hundred seventy frames were taken in all of which 512 were processed for analysis. The angle between the orbital plane and the direction of Venus was 64.8°. The perigee of the rays passed through a region with coordinates 40°N, 84°W, with the height of the perigee varying from 20 to 30 km. The horizontal speed of the perigee was about 7.4 km/s, total perigee displacement during observation about 160 km. Modulation of the brightness of Venus due to random focusing and defocusing caused by variations in atmospheric density was converted in the brightness amplifier to modulation of the diameter of the light spot on the screen. The diameter as measured in each frame was converted to an intensity value which was then used to calculate the spectral density of signal power using a fast Fourier transform program. The resulting scintillation spectrum can be used to estimate the vertical dimensions of heterogeneities in the index of refraction, assuming that their horizontal extent is great in comparison to their thickness. The thickness was found to vary from 0.1 to 1.0 km, which agrees with previous estimates based on refraction measurements. The method is an effective means of studying heterogeneities in the index of refraction of the atmosphere. Figure 1; references 6 (Russian).
[180-6508]

UDC 551.521.3

COMPARISON OF RADIATION FLUXES AND HEAT INFLUXES CALCULATED WITH VARIOUS CLEAR SKY TRANSMISSION FUNCTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 1 Oct 81; after revision 2 Aug 82) pp 622-630

VASIL'YEVA, T. I., YEVSEYEVA, M. G. and PODOL'SKAYA, E. L., Leningrad Institute of Hydrometeorology

[Abstract] A comparison is made of the fluxes of short-wave and long-wave radiation and the corresponding radiation temperature changes in the cloudless atmosphere calculated using the most widespread integral transmission functions. Atmospheric models used are mean annual mean zonal vertical temperature, humidity and ozone concentration profiles as well as the albedo of the underlying surface at latitudes of 10, 30, 50 and 70°N as reported in previous works. Aerosol attenutation was not considered in the model. Rayleigh scattering was replaced by reflection of 14.4% of the visible solar radiation at the lower boundary of the ozone layer. The mean solar zenith angle and duration of daylight corresponded to the equinox. Absorption of infrared solar radiation is determined reliably. The difference between calculated and observed long-wave radiation influx reac hes 100% and more. It is impossible even to distinguish two or three transmission functions yielding similar results over the entire band of latitudes and altitudes. Figures 2; references 16: 12 Russian, 4 Western.
[180-6508]

UDC 535.214:620.1.8

METHOD OF OPERATIONAL CORRECTION OF TRANSMISSION FUNCTION IN SOLVING THERMAL ATMOSPHERE PROBING PROBLEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 16 Feb 82) pp 613-621

POKROVSKIY, O. M., BELYAVSKIY, A. I., Main Geophysical Observatory

[Abstract] Indirect methods are most promising for determination of large scale fluctuations in atmospheric optical characteristics. Solution of a complex multicomponent inverse problem can reproduce the vertical profiles of such optically active and variable components as water vapor, aerosols and ozone. This approach allows adjustment of the transmission function by solution of a linear single-component inverse problem with simultaneous data from radiometric measurements and surface aerologic observations of the vertical temperature profile. The solution of the inverse problem in the 15 micrometer CO_2 band is compared with transmission fluctuations resulting from the variations in these components in the troposphere and stratosphere. The mechanisms of absorption of ozone and water vapor allow in many cases an explanation of the behavior of the effectiveness indices, and adjustment of the optical model. The lack of systematic information on the space-time variability of the atmospheric aerosol limits the possibility of deeper representation of the nature and causes of fluctuations in the transmission function in the actual atmosphere during interpretation of satellite observations. Figures 2; references 10: 7 Russian, 3 Western.
[180-6508]

UDC 551.521.3

PROBLEM OF LIGHT SCATTERING BY HORIZONTALLY HETEROGENEOUS CLOUDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 26 Mar 82) pp 603-612

MIRONOVA, G. V., Central Aerologic Observatory

[Abstract] The method of perturbations is used to solve the problem of transmission of scattered light by a cloud layer with horizontal fluctuations in scattering coefficient, represented as a section of a Fourier series. The contribution of single and multiple scattering to the total intensity of scattered light at various scattering angles for various optical thicknesses of the heterogeneous layer is estimated. A study is made of the intensity of scattered light transmitted by a heterogeneous layer as a function of the mean optical thickness of the scattering layer, scattering angle and spectrum of fluctuations of scattering coefficient. An expression is obtained for the mean intensity of single scattered light for two arbitrary angles. The intensity of multiply scattered light is found in a small-angle approximation

for the case when one of the two angles is zero. The variation in intensity of multiply scattered light as a function of the fluctuation spectrum is reduced to a linear combination of solutions obtained for a layer with fluctuations of simple form. It is found that the horizontal distribution of scattered light intensity reflects the distribution of scattering coefficient in the layer only for small optical thicknesses, for which multiple scattering is not very important. Figures 3; references 8: 6 Russian, 2 Western.
[180-6508]

UDC: 551.521.3:551.574.1:535.51

POLARIZATION STRUCTURE OF BACK SCATTERING BY LIQUID DROP AND CRYSTALLINE CLOUDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 19, No 6, Jun 83 (manuscript received 11 Jan 82; after revision 7 Jun 82) pp 595-602

ZUYEV, V. Ye., KREKOV, G. M. and KREKOV, M. M., USSR Academy of Sciences, Siberian Division, Institute of Atmospheric Optics

[Abstract] An attempt is made to solve the problem of remote diagnosis of the phase composition of clouds by using the effects of polarization of echo signals produced by probing pulses. The Monte Carlo method is used to generate a numerical solution of the unsteady transfer vector equation for the clouds, considered to be media with anisotropic scattering centers. The results provide a basis for development of qualitative methods of diagnosis of the phase composition of clouds. Estimates presented in a table can be used to judge the percent content of ice crystals and the geometric aperture conditions under which mixed layers may be found in the depth of a cloud. It is not as yet possible to draw definite conclusions concerning specific or relative values of the concentration of ice crystals in mixed clouds on the basis of the degree of depolarization of back scattered pulses. This question can be answered after preliminary study of the scattering matrices of various forms of crystalline formations and development of effective methods for separation of the multiple scattering background. Figures 3; references 12: 8 Russian, 4 Western.
[180-6508]

CSO: 1865 - END -