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28 June 1977

USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS
 GEOPHYSICS, ASTRONOMY AND SPACE

No. 400

This serial publication contains abstracts of articles from USSR and Eastern Europe scientific and technical journals on the specific subjects reflected in the table of contents.

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I. ASTRONOMY

News

WORK OF LATVIAN RADIOASTRONOMICAL OBSERVATORY

Moscow PRAVDA in Russian 4 May 77 p 2

[Text] On clear moonless nights when only the light from distant stars illuminates our planet, the domes of observatories are opened and astronomers begin their watch...

The sun and stars (red giants) are the main objects of investigations by scientists of the Latvian SSR Academy of Sciences Radioastrophysical Observatory in Baldone. The physical characteristics of stars enable them to judge the structure and nuclear reactions in their interiors. Close cooperation with scientists of other republics is expanding research possibilities. Workers at the observatory are exchanging scientific publications with astronomical institutions of many countries of the world.

[A photograph shows a Schmidt telescope which is one of the main astronomical instruments at the observatory.] [5]

Abstracts of Scientific Articles

ACTIVITY PREDICTION FOR SPECIFIC ACTIVE REGIONS

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2A142

[Abstract of article by Dzh. V. Smit; Moscow, NABLYUDENIYA I PROGNOZ SOLNECH. AKTIVNOSTI, "Mir," 1976, pp 339-351, "Prediction of Activity for Specific Sectors of Active Regions"]

[Text] The author has described a method for the analysis of the structure of the apparent solar disk observed in the H_{α} line for the purpose of predicting flare activity. The basis of the analysis is the method for determining chromospheric magnetic fields using data on the fine structure in H_{α} . The article describes an attempt at prediction of the chromospheric flares only. It was found that 75% of the flares and 93% of all flares with x-ray fluxes corresponding to class M appeared in the small predicted sectors. There was found to be a correlation between the complexity of the neutral line and flare activity and between the length of the neutral line at the active center and the observed activity level. For predicting the importance and type of flare activity in each region the author defined seven classes of prediction in the form of probabilities. There is a discussion of the degree of reliability of predictions used as working methods at the NOAA prediction center at the space research laboratory. At the present time specialists are improving the method for making predictions for a day in advance. One can expect that the use of data on the correlation of special bright flare nuclei in the H_{α} line and radiation in the X, UV- and radio ranges will be effective. Bibliography of 16 items.
[390]

LUNAR POLAR REGIONS DISCUSSED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1977 pp 42-44

[Article by G. A. Burba, "Lunar Polar Regions"]

[Abstract] The lunar polar regions are those situated between the poles and 60° latitude. At the lunar 60th parallel the sun rises above the horizon about 30°, to be more exact -- 23 to 37°, depending on the libration. At the pole it is deflected upward and downward by 7° during librations. Due to such a low solar altitude even small relief irregularities cast very long shadows and the shaded sectors are not heated by the sun. The temperature of the lunar surface in the polar regions is substantially lower than in the equatorial and temperate latitudes because the sun's rays are incident on the surface at a small angle. In craters with very steep slopes near the poles there are probably shaded sectors which are never reached by sunlight. A study of the rocks from such sectors could yield information on the lunar past and indicate whether the moon was always oriented relative the sun as it is at the present time or show how the lunar axis was tilted in the past. The relief of the lunar polar regions is typical for the continental regions. There are large craters with light-colored bottoms and light, uneven sectors prevail between the craters. There are almost no dark plains of the mare type; only a few mare sectors reach beyond the 60th parallel. Dark sectors are also found within several craters in the southern polar region. The polar regions are the least studied parts of the moon. A small sector near the south pole has still not even been photographed. The brightness and color characteristics of the polar regions are the same as for the typical continental sectors of the moon. These regions reflect from 14 to 18% of the light incident upon them. In general, the southern polar region is brighter than the northern polar region. Both regions are close in their color characteristics; they are reddish, like other continental regions. The surface microrelief, formed for the most part by the impacts of micrometeorites, in the polar regions is the same as in other lunar regions. The heat regime of the polar regions is characterized by a relatively small temperature differential from day to night (110° at the pole versus 290° at the equator). This evidently leads to a lesser destruction of rocks in the polar regions. A better study of the lunar polar regions requires use of a satellite flying around the moon in a polar orbit.

[30]

REVIEW OF PAST AND FUTURE ASTROCLIMATE RESEARCH IN USSR

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1977 pp 69-77

[Article by V. G. Khetselius, "Astroclimate Research"]

[Abstract] The full history of astroclimate research in Europe, America, Russia and the Soviet Union is reviewed. The different methods and tools for astroclimate investigations are presented, followed by discussion of the most important work which has recently been done in this direction. For example, since 1961 astroclimate has been studied on the mountain peaks of Central Asia by specialists of the Tashkent Observatory, in 1966 transformed into the Astronomical Institute Academy of Sciences Uzbek

SSR. Observations of the state of the atmosphere are made by the Anderson method. Meteorological elements are determined at the same time. Astroclimate has already been studied at 30 points in the Tien Shan and Pamir-Alay regions. In 1968 the astroclimate group of the Uzbek Astronomical Institute was assigned the task of finding the best site in the USSR with the finest astroclimate characteristics: with the greatest possible number of clear nighttime hours, with the highest transparency factor, with an excellent image quality and a minimum sky background. By late 1969 this work was completed. The most detailed investigations had been carried out in Central Asia. A group of peaks was selected in the Baysuntau Range. These peaks have an elevation of 2,700-2,900 m above sea level. In August 1969 highly detailed work began on Mount Maydanak. During the period July 1970-August 1971 an expedition of the State Astronomical Institute worked on this peak. The principal tool used by the expedition was a two-ray instrument. Particular attention was given to the structural characteristics of the atmospheric surface layer. All instruments prior to use on Maydanak were tested in the Crimea, near Alma-Ata and on Mount Sanglok in Tadzhikistan. Now a high-mountain expedition of the Astronomical Institute is permanently operating on Maydanak. In five years of uninterrupted observations the following astroclimate characteristics of this site have been established: mean image quality in a 20-cm telescope -- about 0.56"; number of clear nighttime hours per year -- 1,900; atmospheric transparency in region 0.36-0.80 μ m -- about 0.82; mean height of inversion layer above peak -- 17-20 m.

[30]

LUNAR REGOLITH FROM MARE CRISIUM

Moscow ZEMLYA I VSELENNAYA in Russian No 1, 1977 pp 18-23

[Article by L. S. Tarasov and A. T. Bazilevskiy, "Regolith from the Mare Crisium"]

[Abstract] As established by geomorphological research, the density of craters on the surface of the Mare Crisium is less than in the adjacent maria. It appears that the basalts of the Mare Crisium may belong to a relatively young volcanic formation forming about three billion years ago. In general, in the stratified column of lunar ground returned by the "Luna-24" one could expect ancient regolith, ejecta from Fahrenheit Crater and an upper, reworked layer containing material from the lower-lying layer and also matter from later small crater formations. The drill rig penetrated into the lunar ground to a depth of about 2 m. However, due to some settling of ground in the column the actual length of the filled ground carrier was 160 cm. After drilling was ended the ground carrier was moved into a special container and the container was introduced into the capsule of the return vehicle. Back on the earth, in the laboratory of the Institute of Geochemistry and Analytical Chemistry, the ground-filled capsule, after its purification and sealing, was placed in a

helium-hold chamber. [The article is accompanied by a series of photographs of the laboratory equipment used in processing the regolith.] It was found that the column cross section is nonuniform. Individual sectors contained a considerable number of relatively large fragments. The upper part of the column was visually rather homogeneous, but in the deep part there are layers differing in color. In general, the color of the ground is brownish-gray, with darker and lighter hues. It is considerably lighter than the ground of the "Luna-16" but substantially darker than the ground returned by the "Luna-20." The lightest-colored layer was coarse-grained matter, possibly of continental origin, present in the deep part of the column in the part of the column most nonuniform in color. It consists of fragments and smaller particles of light-colored crystalline rocks. The nonuniformity of the column was confirmed by magnetometric measurements and x-ray photographs. The latter revealed that even in the apparently uniform part of the column there are layers enriched with large fragments measuring 2-4 mm. A preliminary inspection of the large fragments shows the presence of much magmatic material of the basaltic type and matter close to different varieties of gabbros. The material is different from that in the "Luna-16" sample and was completely dissimilar to the rocks of the continental type returned by the "Luna-20."

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GEODETIC ADJUSTMENT OF RADIO TELESCOPE

Moscow ZEMLYA I VSELENNAYA in Russian No 1, 1977 pp 42-49

[Article by A. G. Belevitin and V. M. Nazarov]

[Abstract] The antenna of the gigantic RATAN-600 radio telescope consists of 895 movable sections (panels). By changing their relative position it is possible to obtain the necessary form of the reflecting surface of the antenna. Geodesists must work constantly in order to check the accuracy of positioning of this antenna and each of its individual panels. This article describes many details of their complex task. Each of the panels is 7.4 m high and 1.94 m wide. The antenna has mechanisms making it possible with a high accuracy to move a panel along the radius for a distance of 1 m, to tilt it in angle of elevation by 52° and rotate it in azimuth by $\pm 4^\circ$. An elaborate geodetic control network is required for the intricate checking and adjustment; this network is described and is illustrated by diagrams and photographs. The elaborate procedures for adjusting a single panel are discussed. Only a few of them are: making sure that all horizontal axes are in the same horizontal plane, carrying out leveling relative to control marks in the vertical network, setting the panel in the stipulated position, setting the zero on the sensor of the angle of rotation of the panel about its azimuthal axis, setting the panel in the zero position along the radius. The work is by no means all within the traditional field of classical geodesy, but the adjusters are nonetheless called "geodesists" since this is the field most akin to their duties.

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II. METEOROLOGY

News

VSEVOLOD BEREZKIN RETURNS FROM VOYAGE

Moscow PRAVDA in Russian 4 May 77 p 6

[Article by A. Khramtsov: "They Studied the Weather"]

[Text] Murmansk, 3 May. The weather ship Vsevolod Berezkin of the Murmansk Administration of the Hydrometeorological Service has returned from a scientific research expedition.

During the 80-day voyage in the Barents, Norwegian and North Seas the participants on the expedition performed complex scientific studies of the temperature condition of the water surface and the degree of its contamination. They also made meteorological observations of the condition of the atmosphere in the water areas. [5]

SYMPOSIUM ON LASER SOUNDING OF ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 13, No 4, 1977 pp 438-439

[Article by V. Ye. Zuyev and G. G. Matviyenko]

[Abstract] The Fourth All-Union Symposium on Laser Sounding of the Atmosphere was held at Tomsk during the period 28-30 June. It was organized by the Institute of Atmospheric Optics Siberian Division USSR Academy of Sciences. The symposium was a continuation of the conferences of Soviet scientists held in Tomsk since 1971 on remote sensing of atmospheric parameters. In contrast to earlier conferences on this problem, the most recent symposium included papers on acoustic sounding. The symposium was attended by 160 scientists from 52 scientific research institutes and agencies. A total of 107 reports were presented. The reports could be grouped in six sections on the following subjects: 1. Laser investigations of atmospheric aerosol,

including industrial contaminations. 2. Laser sounding of clouds and fogs, inverse problems in light scattering. 3. Use of spectroscopic effects in laser sounding of the atmosphere, determination of gas contamination of the atmosphere. 4. Use of acoustic waves for remote determination of atmospheric parameters. 5. Systems for laser and acoustic sounding, automation of processing of measurement results. 6. Determination of turbulence parameters and wind velocity by optical methods. The article cited above gives the names of the speakers, their affiliations, titles of the reports, and in some cases a few lines indicating the substance of the reports. A resolution adopted at the final session indicated that it was desirable to intensify coordination of the research carried out in different institutes in the USSR on the problems of remote sounding of the atmosphere. There should be a broadening of work on the methods for solving inverse problems and determining the possibilities of laser sounding systems. Automated systems must be developed for the registry, processing and storage of measurement information and the creation of lasers with stipulated properties for the purposes of remote sensing. The conferees noted that lidars can now be used on a practical basis for the purpose of determining slant visibility and the lower boundary of clouds and also for routine determination of the mass concentration of industrial aerosol.
[70]

RESEARCH SHIPS SET OUT ON WEATHER EXPEDITION

Moscow PRAVDA in Russian 23 May 77 p 1

[Article by A. Khramtsov: "Expedition of Meteorologists"]

[Text] Murmansk. The "Vsevolod Berezkin" and the "Aysberg," scientific research ships of the Murmansk Directorate of the Hydrometeorological Service, have set out on a long expedition.

The program of the expedition, which will last about three months, includes a wide-ranging complex of research in the North Atlantic. The data obtained will be used for compiling weather forecasts. [4]

Abstracts of Scientific Articles

PREDICTABILITY OF LARGE-SCALE HYDROMETEOROLOGICAL PROCESSES

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 13, No 4, 1977 pp 371-377

[Article by V. Ye. Prival'skiy, Institute of Water Problems USSR Academy of Sciences, "Statistical Predictability of Large-Scale Hydrometeorological Processes"]

[Abstract] Evaluations of parametric models of large-scale processes in the atmosphere and hydrosphere, obtained on the basis of observational data, show that the year-to-year variability of the considered processes with a good approximation is described by a first-order Markov chain with a small autoregression parameter. Accordingly, the limit of statistical predictability of the processes is usually not more than one or two years. Variations in the level of water bodies without outlets have a great stability and can be successfully extrapolated with lead times up to 10 years. The deviations of the models from a first-order Markov series and the maxima in evaluations of spectral density associated with them do not exert an appreciable influence on statistical predictability.

[71]

PROBLEMS IN POLAR CLIMATOLOGY

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977 2B20

[Abstract of article by I. M. Dolgin, A. I. Voskresenskiy and S. S. Marshunova; Leningrad, NATS. PROGRAMMA NAUCH. ISSLED. SSSR V MEZHDUNAR. PROGRAMMAKH PIGAP. POLYARN. EKSPERIMENT-SEVER (POLEKS-SEVER) I POLYARN. EKSPERIMENT-YUG (POLEKS-YUG), 1976, pp 79-86, "Some Problems in Polar Climatology and Ways to Solve Them Within the Framework of the POLEKS Program"]

[Text] In order to determine the "standard actinometric atmosphere" in arctic regions the authors propose obtaining the integral characteristics of incoming solar radiation on an underlying surface, outgoing thermal radiation and detailed radiation characteristics of the free atmosphere. In

investigations of the meteorological regime of the free atmosphere the principal task is an evaluation of the energy characteristics of atmospheric layers with respect to the transfer of atmospheric mass, quantity of heat, moisture and energy fluxes. It is also necessary to take into account the energy characteristics of arctic clouds, inversions and jet streams. Bibliography of seven items.
[390]

LIDAR SOUNDING OF AEROSOL ATMOSPHERE

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2B104

[Abstract of article by Yu. S. Balin, V. P. Galileyskiy, I. V. Samokhvalov and V. S. Shamanayev; Novosibirsk, VOPR. LAZER. ZONDIROVANIYA ATMOSF., "Nauka," 1976, pp 34-45, "Investigation of the Accuracy Characteristics of Some Methods for Lidar Sounding of the Aerosol Atmosphere"]

[Text] The absence of a universal method for solving the optical ranging equation makes it necessary to use approximate methods for its inversion. For the purpose of comparing their effectiveness the authors carried out numerical sounding of a model profile of an atmospheric aerosol and its "restoration" on the basis of the signal "received" by several methods for a real lidar apparatus. In a control experiment the base photometer-transparency meter with a high accuracy determined atmospheric transmission along a horizontal path. The lidar was used in sounding the atmosphere along this same path; processing of the results of measurements was carried out by several methods. On the basis of the results of computed and experimental investigations it was concluded that one method or another is critical with respect to atmospheric inhomogeneity, the signal-to-noise ratio; also examined is the quantitative influence of errors in stipulating the a priori parameters on the accuracy in determining the scattering coefficient; recommendations are given on increasing the accuracy of experimental sounding of the atmosphere. Bibliography of eight items.

[390]

"METEOR" IMAGES OF DUST STORM

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2B121

[Abstract of article by A. A. Grigor'yev, L. S. Ivlev and V. B. Lipatov; Leningrad, PROBLEMY FIZ. ATMOSFERY, No 14, Leningr. Un-t, 1976, pp 75-86, "Analysis of TV Images of a Dust Storm from the Artificial Earth Satellite 'Meteor-4' in the Region of the Northern Ciscaucasian Area"]

[Text] On the basis of a detailed analysis of the distribution of soils and vegetation in this region, the state of the atmosphere and the meteorological situation at the time of observation of the dust storm of 13 June 1971, it is possible to trace the correlation between the development of a storm and the nature of the surface. Also examined is the spatial pattern of change in the intensity of dust turbidity on the basis of the change in the optical density of the image using microphotometric measurements. An attempt is made to evaluate the mass of the transported dust material on the basis of data from microphotometric measurements, changes in the optical aerosol thickness of the atmosphere (ground actinometric measurements), and also data on the mechanical and chemical composition of the soils in the territory of the considered region. Bibliography of six items.

[390]

RESULTS OF MODIFICATION OF HAIL CLOUDS

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2B632

[Abstract of article by I. I. Gayvoronskiy, T. N. Gromova, B. I. Zimin, T. V. Lobodin, I. A. Skorodenok and N. V. Toropova; Leningrad, TRUDY GLAVNOY GEOFIZICHESKOY OBSERVATORII, No 372, 1976, pp 83-94, "Results of Modification of Hail Clouds Using Data from Complex Monitoring of Their Electrical Activity"]

[Text] The results of an analysis of experimental investigations of changes in the thunderstorm activity of well-developed cumulus clouds during their natural development and during artificial modification are presented. For monitoring the change in thunderstorm activity of clouds specialists organized complex observations, including a determination of radar characteristics, measurement of the number of discharges of different types and their registry by means of visual observations, measurement of strength of the electric field and direction finding of thunderstorm discharges. During the period of the expeditionary work of 1973-1974 it was possible to carry out 17 experiments for the modification of clouds from the earth by rockets charged with ice-forming substances. Observations were made of the natural development of thunderstorm clouds. The results of modification can be clearly registered using a radar and thunderstorm recorder with a small effective radius. The other apparatus used in the work can serve as an additional means for evaluating the modification effect. It was possible to establish the time regime for the modification of a thunderstorm cloud for the purpose of reducing (single modification) or extinguishing (multiple modification) its thunderstorm activity. Bibliography of five items.

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III. OCEANOGRAPHY

News

MONOGRAPH ON CURRENT MEASUREMENTS WITH MOORED BUOYS

Moscow IZMERENIYE TECHENIY V OKEANE YAKORNYMI BUYKOVYMI STANTSIYAMI in Russian Izd-vo "Nauka," 1976 74 pages

[Abstract of monograph by V. B. Titov, V. G. Krivosheya and S. T. Mikhaylov, "Measurement of Currents in the Ocean by Moored Buoy Stations"]

[Abstract] Annotation: The authors of this book examine the equipment and measuring apparatus used for deep-water buoys and describe the method for placement and surveying with buoy stations and give an evaluation of the accuracy in measuring currents. Seven tables, 16 illustrations and bibliography of 30 items.

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OPERATION "POLIMODE" DISCUSSED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1977 pp 65-67

[Article by V. G. Kort, "POLIMODE"]

[Abstract] A long-term scientific program for Soviet-American cooperation for joint study of the world ocean was formulated in 1974; it included extensive investigations of the dynamics of vortical disturbances in the ocean, POLIMODE. This program is a logical development of research under the Soviet "Poligon-70" program and the American MODE program. The POLIMODE program provides for observations in two hydrophysical polygons -- northern and southern. For the northern polygon specialists selected a location to the south of the region where the Gulf Stream passes into the North Atlantic Current. In this region scientists have registered very strong water movements. This circumstance ensures investigation of oceanic vortices by the ordinary methods of hydrological surveys which are carried out from expeditionary vessels. The polygon measures approximately 300 x 300 miles. Nineteen autonomous buoy stations will be set out in the polygon. They will have automatic instruments for measuring currents and water temperatures at 5-6 horizons. Continuous operation of the buoy stations for one year is planned. In the northern polygon Soviet buoy stations will operate, and to the south and southeast of it -- 15 American buoy stations. These groups are situated on the two sides of the Mid-Atlantic Ridge. This will make it possible to evaluate the influence of bottom relief on the dynamics of the vortices. The southern polygon will be 150-200 miles to the northeast of the Bahamas. There observations will be made of deep currents at the horizons 700 and 2,000 m using freely drifting acoustic floats. Hydrological surveys will be carried out as well. The Soviet participation in the POLIMODE program will involve use of the scientific research vessels

of the Institute of Oceanology, Marine Hydrophysical Institute, Acoustics Institute and the USSR Hydrographic Expedition. Great Britain, France, West Germany and Canada have expressed a desire to participate in the investigations. The beginning of expeditionary work under the program is planned for the middle of 1977.

[30]

REPORT ON TWENTY-SECOND VOYAGE OF "AKADEMIK KURCHATOV"

Moscow ZEMLYA I VSELENNAYA in Russian No 1, 1977 pp 75-81

[Article by V. G. Neyman, "Twenty-Second Voyage of the Scientific Research Vessel 'Akademik Kurchatov'"]

[Abstract] One of the principal objectives of the 22d voyage of the "Akademik Kurchatov" involved carrying out investigations of the chemical, biological and physical processes in the water layer and in the layers in contact with the atmosphere and bottom. These data were to be used in judging the role of the enumerated processes in formation of the hydrochemical structure of waters in the northwestern part of the Indian Ocean. A second task was study of the diagenesis of recent bottom sediments. A secondary part of the program was hydrophysical observations of temperature, salinity and currents and also the fine thermohaline structure of waters of the uppermost layer of the ocean. The program was implemented by nine detachments and two groups. Among the 80 participants 48 were from the Institute of Oceanology; the expedition was led by V. G. Neyman. Foreign scientists were represented by specialists from Sweden, East Germany and Bulgaria. The voyage began on 14 March 1976 at Odessa, proceeded through the Red Sea (where significant work was done) to Socotra, then to Mombasa and the Comoro Islands, then to Madagascar, Maldives, Ceylon, Arabian Sea, Persian Gulf and then back through the Red Sea. The vessel returned to the homeland on 2 July 1976.

[356]

THEORIES OF GEOGRAPHICAL STRUCTURE OF THE OCEAN

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1977 pp 46-53

[Article by A. D. Dobrovolskiy and V. L. Lebedev, "Geographical Structure of the Ocean"]

[Abstract] This article incorporates the content of two reports presented at the Twenty-Third International Geographical Congress in Moscow in 1976. The authors formulate or redefine a number of concepts useful in an integrated geographical visualization of the world ocean. For example, spatial and functional structures can be distinguished in a unified system. First

of all, two superoceans and eight oceans can be defined and quasigeological and geophysical approaches can be used in their study. The concept of active surfaces, on the other hand, involves a chemical approach and is primarily the chemistry of discontinuities (around each discontinuity a sort of field of increased chemical activity and physical anomalies is created). In accordance with the active surfaces concept, the spatial structure of the ocean has a quasiconcentric or circumboundary character. Large diagrams in the text illustrate the content of these concepts and serve as a basis for the discussion. The biological structure of the ocean is no less important. A map of biological productivity of the ocean is given. It shows that the maxima of development of life gravitate toward the principal oceanic fronts -- the boundaries of the polar and warm oceans, and also toward the equator -- the boundary of the northern and southern oceans defined by Zubov. The question arises of how to integrate all these concepts and patterns. All this is necessary for large-scale regionalization of the ocean, this being essential for modeling processes of spatial interaction, investigations of the cycling of matter in biological systems and analysis of the fate of contaminants and interaction of the ocean and the remainder of the environment.

[30]

INTERVIEW WITH A. MONIN ON OCEANIC RESEARCH

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Feb 77 p 4

[Article by S. Dvoretzkiy, "The Ocean is Rich with Gifts"]

[Summary] A. S. Monin, Director of the Institute of Oceanology, feels that the world economy of the future is first and foremost the economy of the world ocean. This is because of the enormous wealth present in ocean waters, on the sea floor and beneath the bottom. Already 20% of all petroleum is produced from the sea floor, but this is only one of countless resources which can be obtained from the sea. For example, the ferromanganese nodules on the sea floor constitute a reserve of 300-350 billion tons. And the annual increment of these reserves far outstrips the world consumption of iron, manganese and other minerals, such as cobalt. Although most of these deposits are at depths of 4-6 km, specialists already believe that their exploitation will be economically feasible in the future. But the conquest of the sea really requires that man learn to live and work on the sea floor. There are several ways in which the problem can be solved. Man's direct descent under the water is scarcely the answer, it being fraught with so many dangers, difficulties and inefficiencies. But there is another solution -- sea labs. There man can live for a long time and without any complications go outside for work at great depths and the decompression process must be applied only when a prolonged tour of duty is completed. Specialists at the Institute of Oceanology participated in creating the "Chernomor" sea lab, which for seven seasons in a row has operated at

depths as great as 30 m. A nitrogen-oxygen mixture is used for breathing. And now a new on-shore hyperbaric complex is being constructed. It is intended for simulating the submergence of divers to depths greater than 300 m. Another way to solve the problem is to replace man by automatic equipment. Several types of robots have already been developed; they are controlled from aboard a ship. The telecontrolled robots have manipulators which can be used in collecting samples from the bottom and carry out definite work. Now these robots descend to a depth as great as two kilometers and are used for research purposes. And in many cases in the future robots will completely replace man. The third possibility is exploitation of the ocean by the use of manned vehicles. For example, during the past year specialists at the Institute of Oceanology created the "Argus" vehicle which submerges to a depth of 600 m. However, oceanologists must not only develop apparatus and methods; they must study all the physical characteristics of the ocean if it is to be exploited in the interests of all mankind.

[19]

MONOGRAPH ON TELECONTROLLED ROBOTS

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V26K

[Abstract of monograph by V. S. Yastrebov; Leningrad, OKEANOLOGICHESKIYE TELEUPRAVLYAYEMYYE APPARATY I ROBOTY (Oceanological Telecontrolled Apparatus and Robots), Institute of Oceanology USSR Academy of Sciences, "Sudostroyeniye," 1976, 176 pages]

[Text] This is a collection of articles: "Underwater Telecontrolled Apparatus as a Means for Investigating the World Ocean" (V. P. Brovko), "On Structure of Systems for Remote Control of Underwater Vehicles and Manipulators" (V. S. Yastrebov, G. A. Stefanov), "On the Problem of Investigating the Characteristics of a Man Operator in a System for the Remote Control of an Underwater Vehicle" (G. A. Stefanov), "Analysis of Writing of the Control Function in Dependence on the Method for Display of Information and Combinations of Analyzers of an Operator Participating in its Reception and Processing" (G. A. Stefanov); "On the Influence of a Kinematic System for an Underwater Robot-Manipulator on the Complexity of Control Algorithms" (A. A. Mikhaylov), "On Allowance for the Inertial Properties of Camera Tubes of the Vidicon Type in Television Apparatus of Telecontrolled Apparatuses" (V. P. Brovko); "Experimental Investigation of the Interrelationship of the Parameters of Motion of an Underwater Telecontrolled Research Vehicle and Conditions for Work of an Operator" (V. P. Brovko); "Passive Liquid Systems for Underwater Vehicles" (A. V. Smirnov); "Planning of the Actuating Power Mechanisms of Underwater Robot-Manipulators with Throttle Control" (A. I. Ivanov, M. M. Zakharov, A. A. Mikhaylov); "Analysis of the Dynamics of a Towed Cable Line of an Underwater Telecontrolled Apparatus" (V. V. Mikhaylov, A. M. Podrazhanskiy, V. S. Yastrebov),

"Acoustic Systems for the Data Support of Underwater Robot-Manipulators" (Yu. I. Lomonosov, V. A. Sychev); "Underwater Robot-Manipulator with Adaptive Behavior" (M. B. Ignat'yev, V. S. Yastrebov); "Underwater Second-Generation Robot-Manipulators" (A. M. Filatov); "On the Problem of a Method for Developing a System for the Supervisory Control of an Underwater Robot-Manipulator" (A. M. Filatov); "Methods for the Identification of Tactile Images" (V. S. Yastrebov, A. M. Filatov); "On the Problem of Algorithms for the Control of a Striding System for the Movement of a Bottom Robot" (V. V. Mikhaylov). Appendices: 1) Prospects for the Use of Underwater Telecontrolled Apparatus in Scientific and Practical Investigations of the World Ocean"; 2) Expanded Equations for the Dynamic System of an Underwater Telecontrolled Apparatus.

[390]

Abstracts of Scientific Articles

BOTTOM WAVES IN THE OCEAN

Moscow OKEANOLOGIYA in Russian Vol 17, No 2, 1977 pp 210-213

[Article by A. B. Odulo and E. I. Resin, Institute of Oceanology, "Bottom Waves in the Ocean"]

[Abstract] In this paper it is demonstrated that in a rotating stratified fluid over a sloping bottom there can be trapped waves whose amplitude decreases exponentially with increasing distance from the bottom. Rotation and stratification are necessary for the existence of these waves. The formulas and computations presented here show that the Boussinesq approximation is inadequate for their description.

[71]

COMPUTATION OF MESOSCALE CURRENTS IN NORTH ATLANTIC

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian Vol 13, No 4, 1977 pp 429-431

[Article by G. M. Zhikharev and D. G. Seidov, Institute of Oceanology, "Computation of Mesoscale Currents on the Basis of Data from Hydrological Observations in 'Poligon-70' in the North Atlantic"]

[Abstract] It can be postulated that the geostrophic approximation is not justified in computation of mesoscale currents. It was decided to check this hypothesis in numerical computations. The formulation of a model and the carrying out of preliminary computations directed to solution of this problem was undertaken and the results are presented. [The observational data used are not presented because they have already been published.] The hypothesis is not only confirmed, but it is concluded that it is impossible to regard mesoscale movement in the ocean as being even quasigeostrophic.

[70]

TEMPERATURE AND SALINITY OF SURFACE LAYER OF EQUATORIAL ATLANTIC

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V226

[Abstract of article by R. R. Belevich; Moscow, TRUDY GOS. OKEANOGR. IN-TA, No 131, 1976, pp 95-99, "Dependence of Distribution of Temperature and Salinity of the Surface Layer of the Equatorial Atlantic on Characteristics of Water Circulation"]

[Text] A study was made of the peculiarities of the distribution of temperature and salinity of the surface layer, averaged for three stages, on a meridional profile along 23.5°W during the period of the Atlantic Tropical Experiment (June-September 1974, the "S. Dezhnev"). There is a complex nature of the temperature and salinity on the profile. It was possible to define an equatorial region of relatively cold and saline waters and two (northern and southern) equatorial regions of warmer, freshened waters, within which, in turn, there are zones with extremes of characteristics. The distribution of temperature and salinity on the profile was compared with the position of the convergence zones; it is shown that this distribution agrees well with the peculiarities of water distribution. Divergence zones are characterized by relatively cold and saline waters and convergence zones by warmer freshened waters. The freshening influence of precipitation and the existence of a layer of increased salinity in the subsurface waters of the region help this. There is a dependence of the peculiarities of the distribution of temperature and salinity at the surface on the intensity of development of convergence and divergence zones. Comparison with the heat balance shows that the dynamics of the waters is the decisive factor in the formation of water temperature in the equatorial region. Bibliography of seven items.

[390]

ARSENIC AND ANTIMONY IN ATLANTIC WATERS

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V163

[Abstract of article by A. S. Romanov and A. I. Ryabinin; Sevastopol', MOR. GIDROFIZ. ISSLED., No 3(74), 1976, pp 162-172, "Investigation of Arsenic and Antimony in Waters of the Atlantic Ocean"]

[Text] In 1970 and 1972 specialists aboard the "Akademik Vernadskiy" and "Mikhail Lomonosov" carried out an investigation of the spatial structure of the distribution of As and Sb in the central part of the Atlantic Ocean. Quantitative determinations were made after neutron activation and radio-metric analysis. Analysis of the structure of the As and Sb fields was carried out using diagrams of the distribution of the arsenic-salinity and

antimony-salinity coefficients. It was demonstrated on the basis of 405 samples that both elements have an independent distribution of one another, as is indicated by the considerable variation in the values of the arsenic-antimony coefficients. The conclusion that there is a correspondence between the structures of the As and Sb fields to the nature of the distribution of the hydrophysical fields probably reflects the general pattern of behavior of the investigated elements in the world ocean, its individual regions and even "points" if the latter have a complex hydrophysical structure. Therefore, ocean and sea water masses can be characterized by such geochemical indices as the arsenic- and antimony-salinity coefficients; this will make it possible to obtain additional information on the hydrophysical structure of the oceans. The waters of the Atlantic Ocean are appreciably impoverished of As and Sb in a west-to-east direction. Whereas the mean concentrations of both elements in the Caribbean Sea are equal to 6.5 and 0.6 $\mu\text{g/liter}$ respectively, in the central regions of the ocean they are 4.5 and 0.5 $\mu\text{g/liter}$ and in the waters along the shores of Africa the mean As concentration is 2.9 $\mu\text{g/liter}$, Sb -- 0.45 $\mu\text{g/liter}$. Accordingly, the mean concentrations of the elements, obtained for an individual region, cannot serve as a characteristic of the waters in the entire ocean. Therefore it is necessary to make numerous measurements of the concentration of trace elements not only for ascertaining the structure of the fields, but also for obtaining objective data on the values of the mean concentrations and values of the geochemical abundances. Bibliography of five items.

[390]

SEASONAL VARIABILITY OF TEMPERATURE FIELD IN OCEAN

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V136

[Abstract of article by Yu. M. Kuftarkov and V. K. Kosnyrev; Sevastopol', MOR. GIDROFIZ. ISSLED., No 2(73), 1976, pp 5-15, "Model of the Seasonal Variability of the Temperature Field in the Ocean"]

[Text] The article gives a formulation of the problem of nonstationary circulation generated by the wind and nonuniform heating in a basin of planetary scales outside the equatorial zone. The authors use the following simplifications: a) the Boussinesq approximation; b) hydrostaticity; c) water density -- a linear function of density; d) no allowance is made for adiabatic temperature changes; e) the coefficient of turbulent viscosity and the thermal conductivity coefficient are constant and stipulated; f) nonstationary and nonlinear terms are retained only in the heat influx equation. Along the vertical it is possible to discriminate an upper quasi-homogeneous layer in which the temperature is not dependent on depth and the main thermocline and deeps, where the sought-for variables are represented in the form of the product of two functions, one of which

is dependent only on depth and the Coriolis parameter, whereas the second is dependent on horizontal coordinates and on time. The jump layer is modeled by the discontinuity. The thickness of the quasihomogeneous layer is found by integration with depth of the equation for the budget of kinetic energy of turbulence. As a result, the spatially three-dimensional problem is reduced to a system of two-dimensional nonstationary equations complexly tied in to one another. It is proposed that a numerical solution be sought by the iteration method. Bibliography of 20 items.
[390]

HEAT TRANSFER FROM ATLANTIC SURFACE IN DIFFERENT SEASONS

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V131

[Abstract of article by V. M. Bulayeva; Moscow, TRUDY GOS. OKEANOGR. IN-TA, No 131, 1976 pp 40-48, "Role of Individual Hydrometeorological Elements in the Variability of Heat Transfer from the Surface of the North Atlantic in Different Seasons"]

[Text] The author has computed the synchronous correlations between the monthly sums of heat transfer in the neighborhoods of four North Atlantic weather stations and individual hydrometeorological elements exerting an influence on the intensity of the thermal interaction between the ocean and the atmosphere. Analysis of these correlations, obtained separately for each calendar month, made it possible to discriminate the principal factors determining the year-to-year variability of heat transfer in different seasons of the year. During the cold season of the year in all the considered parts of the North Atlantic the variability of the monthly heat transfer sums is determined primarily by air temperature and humidity anomalies. In the neighborhood of weather stations B, J, M the correlation of the heat transfer values with t_a and e is considerably closer than in the Newfoundland focus of interaction (weather station D). During the warm season the intensity of heat transfer as a rule is most closely associated with air humidity (as a result of an increase in the relative role of evaporation in the general heat transfer value). A significant influence of the variability of water temperature on the intensity of heat transfer is manifested only in the neighborhood of station D; this influence plays a decisive role in the regime of heat transfer in individual months of the transition seasons. This is caused by the great amplitude of the year-to-year fluctuations of t_w in the Newfoundland heat transfer center. For the remaining regions there is either no significant correlation of the heat transfer fluctuations with the water temperature anomalies (station M) or this correlation is characteristic for not more than two or three months of the year (stations B and J). In the western regions of the North Atlantic in months of the cold half year the transfer of heat from the ocean surface into the atmosphere was associated also with wind speed anomalies. Bibliography of six items.

[390]

RADIOACTIVE ISOTOPES USED IN OCEANOGRAPHIC RESEARCH

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V31

[Abstract of article by V. N. Yeremeyev and B. A. Nelepo; Sevastopol', MOR. GIDROFIZ. ISSLED., No 3(74), 1976, pp 58-75, "Stable and Radioactive Isotopes in Oceanographic Research"]

[Text] A study has been made of the prospects for use of stable and radioactive isotopes for investigating different oceanographic phenomena. It was possible to determine four types of tracers with whose use it is necessary to take into account their behavior in connection with the specific research problem. The following groups of isotopes are of the greatest interest: 1) stable conservative: O^{18} , D; 2) stable nonconservative Cl^{35} and Cl^{37} ; 3) radioactive conservative Sr^{90} , Cs^{137} , T, Ra^{226} , Rn^{222} and 4) radioactive nonconservative C^{14} and Si^{32} . The authors discuss the problems and specific examples of study of general circulation, processes of large-scale exchange of water masses, hydrological structure and the dynamics of waters, processes of physicochemical interaction on discontinuities, including evaporation and moisture exchange, chemical fractionation at the ocean-atmosphere discontinuity, diffusion processes, sorption-desorption, deep circulation of water in the bottom layers, etc. Also discussed are the possibilities and prospects for studying the patterns of the field of radioactivity of sea water for the purpose of evaluating and predicting radiation conditions. Bibliography of 45 items.

[390]

MAPPING OF ANOMALIES OF SEA WATER CONDUCTIVITY

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V36

[Abstract of article by I. A. Stepanyuk; Leningrad, METODY OKEANOL. ISSLED., 1976, pp 17-24, "Method for Aerial Mapping of Anomalies of the Conductivity of Sea Water"]

[Text] A study was made of the possibility of using the radio comparison and direction finding method, one of the widely used methods in electrical prospecting, for marine conditions for the purpose of determining the boundaries of water masses. Also examined is the method for aerial mapping of horizontal anomalies of the electrical conductivity of sea water, employing the fields of radiobroadcasting stations. Anomalies in conductivity lead to impairments in structure of the radio field and these can be registered during continuous measurements of one of the components of the magnetic force vector. The possibilities of using the radio comparison-direction

finding method have been investigated experimentally by means of a specially designed instrument for measuring the radio field. A circuit diagram of this measuring instrument is given. Field tests of the method were carried out in 1973 during flights of a Yak-12 aircraft over the Gulf of Finland over discontinuities shore-ice, ice-water, old ice-young ice with fragments of old ice and shore-ice. Also considered are test results. During a flight at an altitude of 300 m it was possible to observe distinct minima of the horizontal component of the vector of the magnetic force of the radio field. In the absence of an anomaly this value changed insignificantly; the relative value of the minima was associated with the type of registered discontinuity. Flight at an altitude of 100 m demonstrated that the response of the method increases with a decrease in altitude and the anomaly in the value of the horizontal component of the vector of the magnetic strength of the radio field is manifested with less significant electric conductivity differentials; in such cases the zones of anomalies become broader and are superposed on one another. It is noted that regulation of the signal amplitude and the possibility of selecting a radio broadcasting station make it possible to change response in a broad range and thereby to establish optimum conditions for indicating the discontinuities. The results of these investigations indicated that the method for aerial mapping of horizontal anomalies of conductivity of sea water are promising and can be used successfully in oceanological observations. Bibliography of 19 items.

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RADIO COMPARISON - DIRECTION FINDING METHOD IN OCEANOLOGY

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V37

[Abstract of article by I. A. Stepanyuk and Ye. A. Lepskiy; Leningrad, METODY OKEANOL. ISSLED., 1976, pp 39-44, "Evaluation of the Possibilities of Use of the Radio Comparison - Direction Finding Method for Oceanological Observations"]

[Text] On the basis of the results of laboratory experiments using a specially fabricated model simulating the conditions for the propagation of radio waves over the sea, a study was made of the possibility of aerial mapping of the conductivity of sea water by the radio comparison - direction finding method. The model of the sea sector is a sectioned basin made of vinyl plastic. The electromagnetic field of different frequencies and strengths was created by means of a radiating dipole situated at a definite distance from the basin. The authors use a dipole of different types in the range of magnetic moments 3.7-75.5 A/cm². The results of the experiments make it possible to assume that the radio comparison - direction finding method can be used successfully for the aerial mapping of zones of horizontal anomalies of temperature and salinity of sea water using a relatively simple and compact apparatus, making possible aerial measurements of

one of the components of the vector of strength of the magnetic field of a selected radiobroadcasting station. Bibliography of three items.
[390]

HYDRODYNAMIC STABILITY OF OCEANOLOGICAL PROCESSES

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V69

[Article by V. M. Al'tshuler and M. M. Belyayev; Moscow, TRUDY GOS. OKEANOGR. IN-TA. No 131, 1976, pp 100-108, "Hydrodynamic Stability of Oceanological Processes According to TROPEX-72 Data"]

[Text] On the basis of oceanographic observations carried out during the course of the TROPEX-72 experiment and earlier published studies, the authors give the values and vertical distribution of the Richardson number in the tropical Atlantic. The Ri number is regarded as a criterion of hydrodynamic stability. The investigated processes with a period of three to four days were hydrodynamically stable. Hydrodynamic instability can exist (Woods) only for higher-order waves developing on the crests of detected low-frequency oscillations; accordingly, the prediction of turbulent zones and regions of turbulent mixing for the considered region of the ocean is dependent on these oscillations and is stochastic. It can be postulated that the restructuring of wave processes constantly existing under the influence of external forces is one of the reasons for the mixing of waters. Since with the establishing of a dynamic similarity of movements in the atmosphere and ocean the Froude and Reynolds numbers become equal, the scales of movements in the ocean are two orders of magnitude less than the atmospheric scales. Such a relationship is observed in a comparison of the Ri numbers. The turbulence zones in the ocean should have dimensions from tens of centimeters to hundreds of meters. The discreteness of standard measurements at multiday buoy stations does not make it possible to investigate processes of such scales. Bibliography of 13 items.
[390]

NONLINEAR WAVES IN INHOMOGENEOUS MEDIA

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V111

[Abstract of article by V. M. Volosov; Kiev, KOLEBANIYA NELINEYN. SISTEM, 1976, pp 5-172, "Nonlinear Waves in Inhomogeneous Media. Asymptotic Research Methods with Applications to Oceanological Problems"]

[Text] The article discusses the theory of free nonlinear waves propagating in unbounded media with slowly changing (in time and space) parameters. Emphasis is on a case when the parameter (such as stratification in the ocean) changes along one coordinate (direction). The author presents an asymptotic scheme for solution of problems with an accuracy to the first order of magnitude of a small parameter determining the slow changes in the medium. On the basis of the formulated theory, from a unified point of view the author examines the following problems of importance for oceanology: gravitational-inertia waves; planetary waves; inertial-gyroscopic waves. The article gives an analysis of the Boussinesq and β -plane approximations. Analysis of the influence of the earth's rotation on internal waves is presented. The author briefly examines a general case when inhomogeneity of the medium is dependent on many coordinates. The author gives possible generalizations of the formulated theory for more complex cases. Bibliography of 25 cases.

[390]

COMPUTING LOADS ACTING ON SHIPS DURING MOORING

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V115

[Abstract of article by A. L. Bondarenko, V. S. Bychkov, N. Ye. Skibko and M. M. Usenkov; Leningrad, METODY OKEANOL. ISSLED., 1976, pp 54-64, "Method for Computing Loads Acting on Ships During Mooring"]

[Text] As a result of numerical computations it has been established that the loads arising as a result of tilting of the water surface can have values for ships of a large tonnage which are an order of magnitude greater than from the effect exerted by seiche currents. It is shown that the movements of the ships during mooring have a complex character caused by the superposing of the characteristic oscillations of the ship-mooring line system and forced oscillations. A nonlinear equation of motion of the ship was derived and its solutions were obtained by a numerical method for different variants of mooring of ships; this makes it possible to note ways to create optimum variants for moorline connection of ships during mooring. The conclusion is drawn that ship movements of a "tug" nature can arise when the ship is under the influence of wind waves or swell. Bibliography of seven items.

[390]

TRAJECTORY OF ACOUSTIC RAYS IN INHOMOGENEOUS HYDROLOGICAL MEDIUM

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2V151

[Abstract of article by V. L. Galakhov; Leningrad, METODY OKEANOL. ISSLED., 1976, pp 77-90, "Method for Analytical Computing Acoustic Rays in an Inhomogeneously Stratified Medium"]

[Text] A study was made of the problem of constructing the trajectory of acoustic rays in an inhomogeneously stratified sea medium. The author describes an approximate method for computing the trajectories of acoustic rays, using the so-called equivalent gradient of the speed of sound and making it possible to reduce the multilayer, real distribution of the speed of sound to a single-layer equivalent model. By such a model one understands the fictitious state of the water medium, characterized by a constancy of the vertical gradient of the speed of sound in the entire considered layer of a stipulated thickness in which the horizontal distance, computed using an equivalent model, from the sound source to the point where the acoustic ray emanating from the source at some stipulated angle reaches a stipulated horizon, will be equal to the distance computed from the real linear-broken speed-of-sound profile. It is postulated that there is a fictitious vertical gradient of the speed of sound which is constant in the entire considered water layer and this is assumed to be the indicated equivalent gradient. The author gives a detailed derivation of the formula for computing the equivalent gradient of the speed of sound and presents an evaluation of the accuracy of the results obtained using this formula for computing the trajectory of the acoustic rays. It is shown that there is an advantage to using the equivalent gradient of the speed of sound over the mean weighted value of the gradient, especially in cases when the signs of the gradients in the individual layers are different, that is, when there is an underwater sound channel or layers with a jump in the speed of sound. With the use of the formula for computing the equivalent gradient of the speed of sound it was possible to estimate the role of the individual layers in an inhomogeneously stratified sea medium in the refraction of acoustic rays. It is noted that the use of an equivalent gradient of the speed of sound is useful in computing the speed of sound in an inhomogeneously stratified medium and in determining the anomaly factor in this medium.

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IV. TERRESTRIAL GEOPHYSICS

News

NOTES ON CONTINENTAL DRIFT THEORY

Moscow PRAVDA in Russian 17 Apr 77 p 3

[Article by A. Monin, A. Lisitsyn and O. Sorokhtin, "But Nevertheless the Continents are Moving"]

[Summary] The theory of the tectonics of lithospheric plates is rapidly developing. On the basis of the discoveries of oceanologists, magnetologists and seismologists the theory of continental drift has been found to have real validity. According to the theory of lithospheric plates, the upper, relatively thin (from 10-20 to 100-150 km) rigid shell of the earth, the lithosphere, is underlain by the plastic matter of the mantle. The convective currents of mantle matter have broken the lithosphere into a series of plates which move at the rate of several centimeters per year. Over the course of hundreds of millions of years the displacements of the plates attain thousands of kilometers. In those places where the plates diverge deep faults and rift valleys develop along which hot mantle matter rises upward. Cooling and hardening, it forms new sectors of the lithosphere. In places where the plates approach one another and override one another, the heavier oceanic plates subside into the depths of the mantle and deep trenches are formed, together with chains of volcanoes and zones of earthquakes with deep foci. The important role of these zones was clarified by A. N. Zaritskiy for the first time in 1946. The oceanic crust is formed in the rift valleys of the mid-oceanic ridges due to the outpouring of basaltic lavas and the transformation of mantle rocks at the time of their contact with water. The continental crust is to a large extent the product of secondary reworking and remelting of the oceanic crust. With the active participation of Soviet scientists, during recent years it has become clear that the leading process of geological evolution is the gravitational differentiation of terrestrial matter. The melting out of the heavy fractions from the mantle at the surface of the core leads to a decrease in the density of matter and convective currents develop which serve as a direct cause of movement of lithospheric plates. Within the framework of the new theory it is becoming understandable why diamonds and gold are found in

Brazil, the same as in Africa, and why the petroleum deposits of the north-eastern and eastern coasts of South America correspond to similar petroleum deposits along the west coast of Africa: South America and Africa earlier constituted the continent Gondwana, which split apart about 100 million years ago. The new theory is affording possibilities for predicting earthquakes since it will make it possible to predict the mechanism of deformation of plates in seismically active regions.

[45]

Abstracts of Scientific Articles

INTERPRETATION OF RESULTS OF DEEP MAGNETOVARIAION SOUNDING

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 17, No 2, 1977 pp 315-321

[Article by V. I. Dmitriyev, N. M. Rotanova, O. K. Zakharova and O. N. Balykina, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Goelectric and Geothermal Interpretation of Results of Deep Magnetovariation Sounding"]

[Abstract] The authors propose a general approach to interpretation of the results of deep magnetovariation sounding (DMVS). It is based on solution of the direct and inverse problems in geoelectrics. For solving the formulated problem all the DMVS data are represented in uniform form. Data on the distribution of temperature and conductivity are used for formulating their fundamental mathematical models. The study is based on all known ρ_T Values in the range of periods from several hours to 11 years, obtained from analyses of variations of the natural electromagnetic field. The experimental data and model computations are used in constructing the planetary geoelectric cross section of the earth. As illustrated in the paper, the use of the described method makes it possible to make a geoelectric and geothermal interpretation of the results of global sounding of the earth.

[50]

ACCURACY OF VECTOR AIRBORNE MAGNETOMETER DETERMINED FROM STAND TESTS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 17, No 2, 1977 pp 326-331

[Article by Yu. G. Turbin, V. I. Pochtarev, V. I. Yushchenko, N. V. Aveyseyev, Ye. A. Bugrov, N. G. Ptitsyna, A. Ya. Rotshteyn, M. A. Sergeev and A. D. Cherednichek, Leningrad Division of the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation and Leningrad Institute of Precise Mechanics and Optics, "Accuracy Characteristics of a Vector Airborne Magnetometer Outfit Under Stand Test Conditions"]

[Abstract] Specialists have developed and constructed a vector airborne magnetometer outfit (KAVAM-1) (see N. V. Alekseyev, et al., GEOMAGN. I AERONOMIYA, 16, 1101, 1976). This outfit makes it possible to carry out measurements of the modulus and three independent components of the vector of the earth's magnetic field (EMF) from an aircraft. In March 1974 the outfit underwent laboratory tests and in June of the same year was tested in flight, showing a high accuracy of measurements and reliability in operation. In this outfit the components of the EMF are measured by the method of their incomplete compensation. It contains four quantum magnetometers whose sensors are spatially separated. Three sensors, enclosed inside ring systems, are designed for measuring the components and the fourth is used for measuring the modulus of the EMF. The axes of the ring systems along which the field components are measured are oriented in such a way that a special orthogonal magnetometric coordinate system is formed. The ring systems with the sensors are rigidly coupled to the instrument frame, which is attached within the aircraft. The article gives the derivation of the error equations. The statistical investigation of the measurement errors under stand conditions revealed that the distribution of their random component conforms to a normal law. Quantitative values were obtained for the horizontal component, declination, the vertical component and modulus.

[50]

SOME ASPECTS OF AUTOMATIC PROCESSING OF SEISMOGRAMS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 3, 1977 pp 108-116

[Article by V. P. Ivanchenkov and V. A. Shlotgauer, Tomsk Polytechnic Institute, "Use of Spectral Characteristics for Solving Some Problems in the Automatic Processing of Seismograms"]

[Abstract] The article describes a method for using the spectral characteristics of seismic pulses for detecting and determining the time parameters of reflected waves on seismograms. Analysis of the records of reflected waves observed in different geological regions indicated that their form can be extremely different. But there are a number of peculiarities characteristic of all records: 1) the duration of the reflected wave pulse does not exceed 2-3 predominant wave periods; 2) the pulse has a smooth envelope and the initial and final phases are weaker than the central phase; 3) the pulse has a smoothly increasing first deviation. [These properties are analyzed in detail.] The materials presented in the paper show that the peculiarities of the form of the phase spectrum of the reflected wave pulse can be used successfully in solving a number of problems in the automatic determination of the time position of the waves on seismograms and in the correction of static corrections.

[21]

STRUCTURE OF COASTAL-MARINE PLACERS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 3, 1977 pp 54-61

[Article by L. P. Kashcheyev and P. I. Kushnarev, Moscow Geological Prospecting Institute, "Conditions for Formation and Principal Characteristics of the Structure of Coastal-Marine Placers (Second Article)"]

[Abstract] This is the second article on this subject by the authors (see IZV VUZov, GEOLOGIYA I RAZVEDKA, No 10, 1976). Analysis of the factors involved in the formation of coastal marine placers indicates that their formation requires a combination of the following favorable conditions: 1) presence of bedrock sources or intermediate collectors; 2) favorable present-day climatic conditions or the presence of ancient weathered crusts; 3) an appropriate geomorphological and neotectonic structure of the coast and sea floor; 4) favorable hydrodynamic conditions in the sea. Each of these are discussed. Among the special cases considered are: placers of ilmenite, zircon, rutile, magnetite; placers of titanium-magnetite sands; placers of diamonds and precious stones. It is shown that placers of different minerals reveal a correlation with specific bedrock sources and the peculiarities of such sources determine the scale and extent of the placers. With respect to climatic factors, the best zones are those with moist tropical and subtropical climates where chemical weathering processes transpire intensively. Other factors are considered. Special consideration is given to beach, underwater slope and continental facies.

[21]

EQUIPMENT FOR SAMPLING MARINE PLACERS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 3, 1977 pp 160-162

[Article by I. S. Kalinin, L. I. Popov, V. D. Pronyushkin and S. L. Romanov, Moscow Geological Prospecting Institute, "Vibrating Drilling Equipment for Sampling Sea Placers"]

[Abstract] Drilling is one of the principal methods for obtaining information on bottom sediments. There are several types of samplers of this type for evaluating placers. This article briefly describes two outfits of this type, developed at the All-Union Scientific Research Institute of Marine Geology in collaboration with other organizations. The authors describe the KMO-2 vibrating probe, which weighs 300 kg, and which has a series of advantages in comparison with similar samplers. An annotated diagram is discussed in the text. The VB7 vibrating drill tool, which weighs 1,000 kg and which is effective at a depth of 50 m beneath the water surface, is also discussed. It is highly effective in sampling medium and heavy ground.

[21]

DEVICE FOR MEASURING PARAMETERS OF ELASTIC WAVES

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2G117

[Abstract of article by V. Ivanova, N. Kolev, J. Kostov, S. Pishtalov and S. Stefanov; Budapest, MAGY. GEOFIZ., 17, No 4, 1976, pp 149-153, "Digital Device for Measuring Parameters of Elastic Waves"]

[Text] This digital device for measuring the parameters of elastic waves is designed for determining the velocity of propagation of the coefficient of absorption of elastic waves in samples of cylindrical configuration with a diameter of 30-60 mm and a length of 30-200 mm. The developed apparatus consists of two measuring complexes: a complex for determining the velocity V of propagation of elastic waves, a complex for determining the coefficient α of wave absorption. For determining velocity oscillations are excited in the sample, their frequency is measured and at a known wavelength $V = 2l f_0$ of the sample the existing communication line is used. Attenuating oscillations are created in the sample for determining the absorption coefficient α . By means of a system of measurement converters the decrement of attenuation is converted into a time interval. The result of measurement of N_δ is inversely proportional to the decrement of attenuation δ : $\alpha = K/N$ (the coefficient $K \approx 30$), from which it is possible to determine the attenuation coefficient $\alpha = \delta / 2l_m$ ($l_m = V/f$). The velocity of propagation of elastic waves is determined with an accuracy to $\pm 2\%$ and the attenuation coefficient with an accuracy to $\pm 10\%$ for values of the coefficient greater than 10^{-2} .

[390]

DYNAMIC CHARACTERISTICS OF PS WAVES

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2G207

[Abstract of article by I. V. Pomerantseva and V. P. Dyagel'; Moscow, SOSTOYANIYE I PERSPEKTIVY RAZVITIYA METODOV POPERECH. I OBMEN. VOLN V SEYSMORAZVEDKE, 1976, pp 27-50, "Experimental and Theoretical Study of the Dynamic Characteristics of PS Exchange Waves"]

[Text] On the basis of an analysis of the records of about 600 distant earthquakes registered by "Zemlya" apparatus in the limits of the North German depression, about 400 close and distant earthquakes registered at Tashkent and about 40 registered in the Caspian depression, the authors have studied the dynamic characteristics of P and PS waves. It is noted that the wave fields from distant earthquakes and the initial part of record of the X- and Y-components are formed by single deep PS waves which have a form of the record and a frequency makeup similar to the P waves

forming exchange waves. The ratio of the experimental amplitudes of the single PS waves registered in the X-, Y- components to the amplitudes of the P waves in the Z component varies from 0.1 to 1.0-1.2. The principal influence is exerted on this ratio by the type of discontinuity and the absorbing properties in the covering medium. The PS waves from distant earthquakes are plane-polarized. The displacement of the time of their registry is dependent on the slope of the discontinuity and on the presence of fault zones. Bibliography of eight items.

[390]

SYSTEM FOR PROCESSING AIRBORNE MAGNETOMETER DATA

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977
2D245

[Abstract of article by Yu. I. Kuz'min, A. D. Simonenko, A. V. Boldyrev, R. A. Garanina and V. S. Kramak; Alma-Ata, GEOFIZ. ISSLED. PRI POISKAKH I RAZVEDKE RUD. MESTOROZHD., 1976, pp 104-108, "Automatic System for the Processing of Data from Highly Precise Airborne Magnetometer Surveys [ASOM-AM]"]

[Text] The use of the ASOM-AM is possible when there is apparatus for the registry of field data (the strengths of the magnetic field and the radio-geodetic coordinates of observation points) on computer carriers. At the present time this is possible using the "KORD-M" attachment and a punching device fabricated at the "Kazgeofizpribor" plant. The ASOM-AM includes a number of programs for carrying out individual operations, in particular: 1) checking the operation of the registry apparatus and the exclusion of invalid data ("VVOD-1,2,3); 2) introduction of corrections for the normal field, variations and deviation ("POPR," "VARIA"); 3) route plotter, forming of a numerical model of a plane-table sheet ("RAZM-1," "SORT"); 4) drafting of maps of actual flight lines, maps of curves and isodynamic lines at any scale with any contour interval "POLET," "KARTG," "KARTI"); 5) processing of control flight lines, calculation of the mean square observation error ("KONTR") and other auxiliary operations. The ASOM-AM has demonstrated good stable operation in a model close to real field conditions.

[390]

METHOD FOR DETERMINING MECHANISM OF EARTHQUAKE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 233, No 6, 1977 pp 1076-1078

[Article by S. L. Yunga, Institute of Physics of the Earth, "Determining the Mechanism of an Earthquake from the Arrivals of Longitudinal and Transverse Waves"]

[Abstract] Computation methods for determining the parameters of a source equivalent to an earthquake focus have been examined in a number of earlier studies. This paper gives a formulation of the problem in a form making it possible to obtain an analytical solution. The sought-for parameters are the components of the tensor of the seismic moment M_{ij} in a Cartesian coordinate system. Expressions are derived for finding the M_{ij} components. By using the indeterminate factors method the solution of the problem can be reduced to an investigation of a system of seven linear homogeneous equations.

[62]

REVIEW OF SEISMIC INVESTIGATIONS OF EARTH'S MANTLE

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 3, 1977 pp 94-104

[Article by L. P. Vinnik, A. A. Lukk and I. L. Nersesov, "Seismic Investigations of the Earth's Mantle"]

[Abstract] After presenting an extensive analysis of the status and tendencies in development of seismic investigations of the mantle, the authors propose a complex of measures necessary for progress in this field. There is a need for constructing generalized velocity sections of the mantle to a depth of 500-700 km for large regions and an analysis of the anisotropy of velocities. For solving this problem it is necessary to organize areal seismic observations in a zone with a radius of about 3,000 km during all sufficiently strong industrial explosions in the USSR. Information on the travel times of the principal waves must be supplemented by data from measurements of the angles of emergence of rays at local groups of stations and the results of an analysis of secondary phases. There is a need for developing telemetric systems and systems for the automation of observations for groups of 50-100 seismic detectors over an area of about 10^5 km². The creation of such systems will greatly lower the cost of servicing seismic networks, will broaden the possibilities of processing records and will make their use on a greater scale effective. There must be a changeover to the digital recording of long-period oscillations. In contrast to short-period seismograms, where most of the useful information is included in the arrival time and amplitude of the first wave, an analysis of the long-period seismogram requires numerical processing of

large parts of the record by means of rather complex algorithms. There is a need to develop numerical methods for constructing three-dimensional velocity models on the basis of observations of seismic groups. A timely problem is the development of practical methods for computing wave fields for inhomogeneous media close in their complexity to natural media. It is necessary to create seismic stations for prolonged operation on the sea floor. A network of such stations is necessary, in particular, for progress in understanding the nature of the deep processes transpiring in the transition zone from the ocean to the continent. Detailed investigations to depths of 200-300 km are required. This will require the construction of detailed three-dimensional models of the mantle in key regions. Seismic study of structure of the subcrustal layer of the model must be carried out in combination with gravimetric and geothermal investigations. The objective of theoretical investigations must be the formulation of physical models of tectogenesis based on an analysis of the relationships between structure of the crust, structure of the upper mantle, recent movements and geological structure in regions of modern tectonic activity.

[20]

MULTIZONAL PHOTOGRAPHY FROM SPACE DISCUSSED

Moscow VESTNIK AN SSSR in Russian No 3, 1977 pp 6-20

[Article by Academician R. Z. Sagdeyeva, "Investigation of Earth from Space"]

[Abstract] This article is a comprehensive report on the MKF-6 space photographic system constructed at the "Karl Zeiss Jena" Enterprise in East Germany and which underwent testing aboard the "Soyuz-22" spaceship. It is an outfit having six objectives with a high resolving power, with synchronized shutters and a device for compensating the image shift caused by spaceship motion, magazines with rewinding devices, electronics unit, control panel for the photographic system, reserve control panel, and secondary elements. The system objectives are arranged in two rows symmetrically relative to the principal axis of the camera. The photographs are taken with an areal overlap as great as 80%. Since each area is photographed from three or four points it is possible to obtain three-dimensional photographs. Photographs can be taken in the altitude range 200-400 km. The bulk of this outfit required structural modifications within the "Soyuz-22." A photo compartment with a large window had to be provided. The survey was made over the middle and high latitudes in the USSR, providing photographs of many landscape regions. Four of these color photographs accompany the text and show their great value for studies of mountainous, glacial, water and permafrost features. More than 2,000 high-quality photographs were returned to earth. Each of them shows an area measuring 165 x 115 km with a resolution at the earth's surface of about 10-20 m. The results of preliminary interpretation show that they contain valuable and diversified information on geological features, on agricultural and forestry conditions, on water resources and much else.

[20]

PRESENT AND FUTURE GRAVITATIONAL STUDIES DISCUSSED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, 1977 pp 16-22

[Article by A. M. Mikisha, "How the Gravitational Fields of the Earth and Moon are Studied"]

[Abstract] The classical ground methods for making gravimetric measurements and surveys on the earth are reviewed, including concise information on the theories applied, the instrumentation employed and the nature of gravitational potential. This is followed by discussion of the introduction and development of methods for measuring gravity from artificial earth satellites. Then the author describes the use of artificial lunar satellites for study of the lunar gravity field and presents the most important findings from these first extraterrestrial gravity measurements. Many future experiments have been formulated for carrying out gravity measurements from circumterrestrial orbits, but these involve great difficulties. For example, one plan calls for the launching of a satellite into an orbit as close as possible to the earth's surface. This satellite would be observed from the earth and from two or three synchronous AES which would transmit data to the earth. By tracking the near-earth AES from a synchronous satellite it would be possible to obtain the disturbing gravitational accelerations by the same method which led to the discovery of mascons on the moon. This method could be used in compiling a gravimetric map, of the Pacific Ocean for example, that is, solve a problem which despite the great advances in sea gravimetry still remains unsolved. Another proposal would make it possible to study the fine structure of the earth's gravity field. It has been suggested that two AES be launched into the same orbit about 200 km apart. It would be virtually impossible to ascertain the influence of the lower harmonics on the motion of these satellites, but the influence of the higher harmonics could be determined. In observing such a pair of AES it would be possible to determine a change in velocity of fractions of a meter per second and the relative velocity of the satellites would be a direct measure of the difference in their kinetic energies or gravitational potentials. This would give a sort of continuous profile of gravitational potential, but not at the earth's surface, but at an altitude equal to orbital altitude. These data could be used in computing the gravitational potential at the earth's surface.

[30]

V. UPPER ATMOSPHERE AND SPACE RESEARCH

News

REVIEW OF BOOK ON PHILOSOPHICAL PROBLEMS OF COSMONAUTICS

Moscow PRAVDA in Russian 3 May 77 p 2

[Article by V. Sevast'yanov: "Cosmonautics and Society"]

[Summary] The achievements of cosmonautics in the last 20 years provide a basis for reflections on what sort of place it occupies in the life of contemporary society, what innovations it has introduced in the development of science, technology and social progress and what the prospects are for human activity in space. These and other sociophilosophical problems connected with the opening up of space are examined in a new book by Doctor of Philosophical Sciences Professor A. D. Ursul, called "Mankind, Earth and the Universe (Philosophical Problems of Cosmonautics)."

In this book the development of cosmonautics is traced as an important trend in the scientific and technological revolution and as a new stage in the relations between nature and society. The author shows that the space accomplishments of mankind have a serious philosophical-ideological significance and play a substantial role in the ideological antagonism between socialism and capitalism.

By repudiating the extremes of bourgeois interpretations of the space era, Ursul emphasizes the necessity for an optimum combination of earth and space directions of human activity and the effective use of space for solving the most important national economic problems in the name of the progress of man. The book shows how the conditions of socialism open up broad possibilities for a peaceful and humanistic use of cosmonautics. The achievements of Soviet cosmonautics clearly demonstrate the creative potential of the first socialist state in the world. [5]

TASS ANNOUNCES LAUNCHING OF "KOSMOS-908"

Moscow PRAVDA in Russian 18 May 77 p 3

[TASS Report: "'Kosmos-908'"]

[Abstract] The artificial earth satellite "Kosmos-908" was launched in the Soviet Union on 17 May 1977. The satellite was inserted into an orbit with the following parameters:

- initial period, 89.1 minutes;
- apogee, 307 kilometers;
- perigee, 180 kilometers;
- orbital inclination, 51.8 degrees.

TASS ANNOUNCES LAUNCHING OF "KOSMOS-909"

Moscow PRAVDA in Russian 21 May 77 p 3

[TASS Report: "'Kosmos-909'"]

[Abstract] The artificial earth satellite "Kosmos-909" was launched in the Soviet Union on 19 May 1977. The satellite was inserted into an orbit with the following parameters:

- initial period, 117 minutes;
- apogee, 2,112 kilometers;
- perigee, 981 kilometers;
- orbital inclination, 65.9 degrees.

TASS ANNOUNCES LAUNCHING OF "KOSMOS-910" AND COMPLETION OF MISSION

[TASS Report: "'Kosmos-910'"]

[Abstract] The artificial earth satellite "Kosmos-910" was launched in the Soviet Union on 23 May 1977. The satellite went in orbit with the following parameters:

- initial period, 91 minutes;
- apogee, 506 kilometers;
- perigee, 149 kilometers;
- orbital inclination, 65.1 degrees.

The scientific studies planned in the program have been completed. The information obtained is being processed at the coordination-computation center. [4]

TASS REPORTS "SALYUT-5" STATION COMPLETES ELEVEN MONTHS IN ORBIT

Moscow PRAVDA in Russian 24 May 77 p 2

[TASS Report: "'Salyut-5': Eleven Months in Orbit"]

[Text] Flight Control Center, 23 May. The controlled flight of the "Salyut-5" orbital scientific station has been continuing for eleven months. By 1200 hours Moscow time the station had completed 5,383 revolutions around the earth.

At the present time the parameters of the orbital station are:

- apogee, 269 kilometers;
- perigee, 245 kilometers;
- orbital inclination, 51.6 degrees;
- period of revolution, 89.4 minutes.

In accordance with the program of operation in automatic mode, further tests are continuing with the on-board systems, apparatus, and units of the station under conditions of long-duration space flight. Scientific and technical studies and experiments are also being conducted.

According to telemetry information, all on-board systems, equipment, and scientific apparatus of the station are functioning normally. Microclimate parameters in the station's compartments are within required limits. Atmospheric pressure is 815 mm Hg; temperature is 20°C. The information coming to earth is being processed.

The flight of the "Salyut-5" station continues. [4]

TASS ANNOUNCES LAUNCHING OF "KOSMOS-911"

Moscow PRAVDA in Russian 26 May 77 p 2

[TASS Report: "'Kosmos-911'"]

[Abstract] The artificial earth satellite "Kosmos-911" was launched in the Soviet Union on 25 May 1977. The satellite was inserted into an orbit with the following parameters:

- initial period, 104.9 minutes;
- apogee, 1,018 kilometers;
- perigee, 984 kilometers;
- orbital inclination, 82.9 degrees.

TASS ANNOUNCES LAUNCHING OF "KOSMOS-912" FOR RESOURCE STUDY

Moscow PRAVDA in Russian 27 May 77 p 3

[TASS Report: "'Kosmos-912'"]

[Text] The artificial earth satellite "Kosmos-912" was launched in the Soviet Union on 26 May 1977.

The satellite carries scientific apparatus intended for continuation of studies of the natural resources of the earth in the interests of various branches of the USSR national economy and for international cooperation.

The satellite was inserted into an orbit with the following parameters:

- initial period of revolution, 89 minutes;
- apogee, 257 kilometers;
- perigee, 219 kilometers;
- orbital inclination, 81.4 degrees.

In addition to the scientific apparatus the satellite has a radio system for precise measurement of orbital elements and a radiotelemetry system for transmitting data on the operation of the instruments and scientific apparatus to the earth.

The incoming information is transmitted to the State Scientific Research and Production Center "Priroda" for processing and utilization. [4]

Abstracts of Scientific Articles

ULTRAVIOLET PHOTOMETRY OF MARS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 255-260

[Article by V. A. Krasnopol'skiy, A. A. Krys'ko and V. N. Rogachev, "Ultra-violet Photometry of Mars on the 'Mars-5' Satellite"]

[Abstract] Photometric observations at wavelengths 2800 and 2600 Å at the planetary limb and at the Martian terminator made it possible to detect an ozone layer and two aerosol layers in the planetary atmosphere. The ozone layer has a thickness 7 ± 1.5 km and an altitude 38 ± 2 km; the O_3 concentration at the maximum is 10^{10} cm^{-3} at 0930 LT and $4 \cdot 10^9 \text{ cm}^{-3}$ at 1800 LT. The upper aerosol layer is situated at an altitude of 38 km at 0930 hours and at 60 km at 1800 hours; it is markedly asymmetric; the scale height in the upper part is 2.3 ± 0.2 km and in the lower part is 15 ± 5 km. Its optical thickness is $2 \cdot 10^{-2}$ at 0930 and $2 \cdot 10^{-3}$ at 1800 hours. Evidently the layer consists of ice particles with a radius $\sim 0.1 \mu\text{m}$ and with a concentration at the maximum of 500 cm^{-3} at 0930. The water content in the layer is $3 \cdot 10^{-6} \text{ g/cm}^2$. The lower aerosol layer is situated at 20 km; in this case the albedo of single scattering is $\omega = 0.25$ at 2800 Å and $\omega = 0.4$ at 2600 Å. It disappears toward evening.

[57]

VARIATIONS OF FAST ELECTRONS IN OUTER RADIATION BELT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 208-211

[Article by O. I. Savun, I. N. Senchuro and P. I. Shavrin, "Long-Term Variations of Fast Electrons in the Earth's Outer Radiation Belt"]

[Abstract] During the period July 1968 through September 1970 a number of satellites of the "Molniya-1" series, using a SI-ZBC gas-discharge counter, carried out measurements of the integral fluxes of particles penetrating through the Al layer with a thickness of $3 \text{ g}\cdot\text{cm}^{-2}$. Using data obtained on this same trajectory for particles of the outer and inner radiation belts,

penetrating a shielding of $0.7 \text{ g}\cdot\text{cm}^{-2}$, and also data on proton solar flares, it is possible to discriminate variations in the intensity of electrons with an energy $E_e > 5 \text{ MeV}$ in the outer radiation belt. It was possible to register three major intensity increases for these electrons during the mentioned period (by a factor of 6-7 in comparison with the initial level) with a subsequent exponential dropoff with a characteristic time $\tau \sim 15 \text{ days}$.

[57]

ENTRY OF BALLISTIC FLIGHTCRAFT INTO MARTIAN ATMOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 164-178

[Article by V. P. Karyagin, R. S. Kremnev, K. M. Pichkhadze and V. A. Yaroshevskiy, "Perturbed Motion of Ballistic Flightcraft During Entry into Martian Atmosphere"]

[Abstract] The authors examine the segment of aerodynamic braking of a flightcraft in the Martian atmosphere from a velocity of 6,000 m/sec to the velocity of activation of the parachute system. The necessity for braking in the highly rarefied atmosphere of Mars requires the creation of a frontal shield having a great aerodynamic resistance. Factors important to consider for a configuration of such a type is the stability of uncontrolled motion about the center of mass and also the influence of small asymmetry. It is noted that some results relating to the investigation of such problems have been published and should be consulted in conjunction with this article (see J. D. Nicolaidis, JAS Preprint No 395, 1953; H. Leon, J. AERO-SPACE SCI., 25, No 8, 1958, G. E. Kuzmak, et al., PROC. OF THE XIV INT. ASTR. CONGRESS, Paris, 1963).

[57]

CRITICAL ILLUMINATION OF INSTRUMENTS CARRIED ABOARD SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 269-273

[Article by A. M. Lyzhin and G. A. Sokolov, "Problems in the Critical Illumination of Instruments Carried Aboard Artificial Earth Satellites"]

[Abstract] The authors investigate a class of problems in determining the segments of the orbit of an artificial earth satellite in which the on-board instruments are exposed to critical illumination conditions. The article proposes a method for solving those problems, the basis for which is a reduction of the conditions of critical illumination expressed in vector form to a first-degree trigonometric inequality. This method makes it possible to obtain an explicit solution for a broad range of problems in which the motion of the instrument is unrelated to motion of the earth. For the remaining problems the method can be used for obtaining an approximate solution.

[57]

CHARACTERISTICS OF HIGH-ENERGY PARTICLES DURING INJECTION IN MAGNETOSPHERE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 17, No 2, 1977 pp 259-266

[Article by A. P. Kropotkin, Nuclear Physics Institute, Moscow State University, "Evolution of Fluxes of High-Energy Particles During Their Injection into the Magnetosphere"]

[Abstract] On the assumption that the injection of high-energy particles from the plasma layer of the geomagnetic tail into the inner part of the magnetosphere occurs with conservation of the first two adiabatic invariants the author has derived formulas describing the evolution of the energy spectra and pitch angle distributions of particles during such injection. Also given is an estimate of the flux of particles leaking due to a lowering of the mirror points.

[50]

COMPARISON OF WIND MEASUREMENTS IN FRANCE AND USSR BY METEOR TRAIL OBSERVATION

Moscow REFERATIVNYY ZHURNAL, GEOFIZIKA, SVODNYY TOM in Russian No 2, 1977 2A132

[Abstract of article by I. A. Lysenko, Yu. P. Portnyagin, Zh. L. Fellus, M. Glyass, M. Messebef and A. Spizzikino; Moscow, ISSLED. DINAMICH. PROTSESSOV V VERKHN. ATMOSFERE, Gidrometeoizdat, 1976, pp 84-95, "Comparison and Interpretation of Results of Simultaneous Measurements of the Wind by the Radar Observation of Meteor Trails at Garschy (France) and Obninsk (USSR)"]

[Text] The authors give an analysis of the results of synchronous measurements of wind speeds by the method of radar observation of meteor trails at Obninsk (USSR) and at Garschy (France) in January-February, in March-April, in September-October 1970 and in July 1971. The duration of the period of measurements was about 10 days. It is noted that the behavior of the prevailing wind during these periods over both places was similar. The results of spectral and correlation analysis show the presence of common fluctuations with periods of two or more days. In particular, in July 1971 there was a two-day wave with approximately identical amplitudes and with an appreciable phase shift (about 14 hours). These facts can be regarded as an indication that in the meteor zone there are travelling planetary waves with periods of several days. The article gives a comparison of the amplitudes and phases of wind components measured at Garschy and Obninsk. The possible reasons for the observed differences in these values are discussed. Bibliography of six items.

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RUSSIAN STUDY OF COSMIC RAYS IN STRATOSPHERE

Moscow ZEMLYA I VSELENNAYA in Russian No 1, 1977 pp 4-10

[Article by A. N. Charakhch'yan, "Cosmic Rays in the Stratosphere"]

[Abstract] In 1946 specialists at the Physics Institute USSR Academy of Sciences organized a scientific station at Dolgoprudnyy for the study of stratospheric cosmic rays. During the period 1946-1956 the scientists of this station and the Scientific Research Institute of Nuclear Physics at Moscow State University carried out a major program in this field and obtained fundamental data on primary cosmic rays and on their nuclear component. The director of this research was Academician S. N. Vernov. In 1956-1957 the workers of the two mentioned institutes developed a new method for studying stratospheric cosmic rays. They created a light, simply handled and quite precise instrument. This is the cosmic ray radiosonde, which is carried aloft into the stratosphere by one or two meteorological balloons. Initially the radiosondes were fabricated in the laboratory. Their mass was about 2 kg. Now they are being produced by the "Fizpribor" plant, semiconductors are used and they weigh 600-700 g. The detectors of the number of cosmic ray particles in the radiosondes are gas-discharge counters. The radiosonde is supplied with an altimeter and a radio transmitter. Since 1957 there have been about 30,000 launchings of these radiosondes and the creators of this instrument, A. N. Charakhch'yan, G. A. Bazilevskaya, Yu. I. Stozhkov and T. N. Charakhch'yan were awarded the 1976 Lenin Prize for stratospheric investigations of bursts of cosmic rays on the sun and the processes of solar modulation of galactic cosmic rays. The radiosondes detect changes in the flux of cosmic rays virtually from the earth's surface to altitudes of 30-35 km. This article is accompanied by a photograph of the radiosonde and a block diagram. Every day these cosmic ray radiosondes are launched in the Soviet Union in the regions of Murmansk, Moscow, and Alma-Ata and near Mirnyy in Antarctica. The article gives concise results of the most important characteristics of cosmic ray bursts, the 11-year cycle of galactic cosmic rays and other phenomena studied with the cosmic ray radiosonde.

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"OREOL-2" MASS SPECTROMETER DESCRIBED

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 274-277

[Article by K. V. Grechnev, Yu. A. Shul'chishin and S. V. Vasyukov, "Equipment for the Mass-Spectrometer Experiment"]

[Abstract] The radio-frequency mass spectrometer carried aboard the "Oreol-2" satellite was designed in the form of an individual sealed container having sensors for monitoring the temperature and pressure within it. This UMR-3 instrument was used for measuring the relative concentrations of the

ion components in the mass ranges 1-4 and 8-67 mass units in a regime of direct data transmission and in narrow intervals: ~1 and 14-17 mass units in a storage regime. In both cases the duration of a full measurement cycle was six seconds. The mass spectrometer was designed in the form of four major units: analyzer, electrometric head, electronics unit and control and synchronization unit. The prototype of the UMR-3 was the standard-produced MKh-6407P mass spectrometer, one of whose sensors was used without any improvements, whereas all the electronic components were either subjected to considerable change or totally redesigned. The use of a single analyzer in this instrument (instead of two in the MKh-6407P) made possible a considerable simplification of the process and an improvement in the accuracy in the tie-in of measurements in the range of light and intermediate mass numbers. Synchronization of the instrument was accomplished using second and three-second time marks with a duration of 0.5 sec. In both operating regimes the measurement cycle is divided into two equal intervals: during the first interval measurements were made in the range of light mass numbers and in the course of the second interval -- in the range of intermediate mass numbers.

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GEOPHYSICAL RESULTS OF MASS-SPECTROMETER MEASUREMENTS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 277-285

[Article by V. A. Yershova, L. D. Sivtseva, Zh. Kran'ye, Ye. Blan and Zh. A. Sovo, "Geophysical Results of Mass Spectrometer Measurements"]

[Abstract] The "Oreol-2" satellite was designed for carrying out complex geophysical investigations of the upper atmosphere under the Soviet-French "Arkad-2" program. This paper describes some results of mass-spectrometer measurements of the ion composition along the satellite orbit. The "Oreol-2" was launched on 26 December 1973. Orbital inclination was 74°, perigee altitude was 407 km, apogee altitude was 1,995 km. The satellite was not oriented; the period of rotation about the axis was 6-10 minutes. The instrumentation used was described in an article by K. V. Grechnev, et al. in this same issue of the journal (pp 274-277). In a regime of storage of information along the entire orbit the mass spectrometer registered only hydrogen and oxygen ions. The period of measurement of both components was 6 sec, corresponding to a spatial resolution of about 50 km. This paper gives the results of measurements carried out during the period 7-18 January 1974. Included are data on the revolutions for which the orientation has now been computed. During this period of time the perigee part of the satellite orbit was situated over the high and middle latitudes of the northern hemisphere. Near the magnetic equator in the nighttime hours there was a clear anomalous decrease in the concentration of hydrogen ions by more than an order of magnitude in comparison with magnetic latitudes $\pm 30^\circ$.

During the daytime such an anomaly is not observed. Near the invariant latitude about 60° there is a considerable decrease in the concentration of H^+ ions. Closer to the poles the ion composition is characterized by small-scale irregularities. A predominance of O^+ ions over H^+ ions is characteristic for the high latitudes. The article examines these three latitude regions in greater detail.

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USE OF SHORELINE DATA IN SATELLITE NAVIGATION SYSTEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 15, No 2, 1977 pp 308-310

[Article by Yu. V. Bagdasaryan, I. V. Borisov, E. V. Gaushus, Yu. N. Zybin and O. A. Ivanov, "Use of Shoreline Data in Problems of Autonomous Navigation of Artificial Earth Satellites"]

[Abstract] When the earth's surface is observed from a satellite the need arises for determining whether the satellite at a particular moment is situated over the surface of the world ocean or over the land. This makes it necessary to formulate an algorithm for an electronic computer making it possible to register, store and use data on the nature of the earth's surface observed using automatic instruments. For this purpose the computer permanent memory can contain a geographic map with some hypsometric scale. This problem must be solved taking into account the limited capacity of the on-board computer. A solution for this problem is given. Assume that for each point on the earth's surface, stipulated by the geographic coordinates, it is necessary to ascertain whether this point belongs to the water or the land surface. Assume that the required accuracy is 1° in both coordinates and that the information is registered in the memory in the form of 16-digit binary codes and that the satellite orbital inclination does not exceed 52° . The earth's surface in the latitude range $\pm 52^\circ$ is broken down into squares with sides measuring 1° in latitude and longitude. Each square is assigned a "0" or "1" -- depending on whether the square is water or land. If all the data for the earth's surface in the range $-52^\circ \leq \varphi \leq 52^\circ$, $0 \leq \lambda \leq 300^\circ$ is to be stored in the computer memory, 2,340 memory units will be required for this purpose since one 16-digit memory unit will hold information on 16 squares, that is, information on a square with a side of 4° .

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SOLAR COSMIC RAY INTENSITY CHANGES AND INTERPLANETARY MAGNETIC FIELD CHANGES

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 17, No 2, 1977 pp 198-208

[Article by G. M. Blokh and B. M. Kuzhevskiy, Nuclear Physics Institute, Moscow State University, "Large-Scale Changes in the Intensity of Cosmic Rays Associated with Disturbances of the Interplanetary Magnetic Field"]

[Abstract] A study was made of changes in the intensity of protons and α -particles with $E = 1-4.5$ MeV/nucleon and electrons with $E = 40-500$ keV (measurements made aboard the "Proton" satellites) associated with nonuniformities of the interplanetary magnetic field which cause magnetic storms with a sudden commencement. (A study was made of 28 cases of SC during the period 1972-1973.) The article presents an orderly classification of the changes in the intensity of particles and their correlation with the parameters of the interplanetary magnetic field and chromospheric flares. Table 1 gives some characteristics of SC and their relationship to cosmic ray intensity and magnetic field parameters. The article gives particular attention to the specific cases of 13 May and 10 June 1973 which were characterized by greater amplitude and duration than in the usual cases. With respect to these latter cases, it was found that from March through July 1973 conditions developed on the sun and in interplanetary space for the existence of a virtually stationary picture of the distribution of intensity of solar cosmic rays. In the active region there was multiple generation of particles for the most part with energies $E \leq 10$ MeV. The escape of particles occurred near the boundary of the sector so that the escape of particles was uninterrupted. The sectoral boundaries virtually "locked" the particles within the confines of a single sector.

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EXCESS RADIATION OF SOLAR COSMIC RAYS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 17, No 2, 1977 pp 205-208

[Article by P. I. Shavrin, Nuclear Physics Institute, Moscow State University, "Excess Radiation of Solar Cosmic Rays"]

[Abstract] On the basis of an analysis of the proton flare of 24 January 1971, observed from the "Molniya-1" satellite, it is concluded that there may be a number of mechanisms responsible for the excess radiation of solar cosmic rays. For example, part of the excess radiation can be attributed to the generation of secondary particles in the high latitudes by a primary flux of solar cosmic rays. In addition, the generation of secondary particles can occur in the matter of the satellite; the ratio of the flux of secondary particles to the primary flux should increase with a decrease in geomagnetic latitude. It is not impossible that the mechanisms of formation of the excess radiation of solar cosmic rays and galactic cosmic rays

have the same nature and differ only in quantitative respects, reflecting the differences in the characteristics of the primary spectra. Therefore, systematic satellite observations of solar cosmic rays in the geomagnetic field will yield not only information on the spectra of solar cosmic rays and the state of the magnetosphere, but can also give information on the nature of the excess radiation of galactic cosmic rays.

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FAMILY OF SPATIAL PERIODIC ORBITS AROUND MOON AND PLANETS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 233, No 6, 1977 pp 1068-1071

[Article by M. L. Lidov, Institute of Applied Mathematics, "One Family of Spatial Periodic Orbits Around the Moon and Planets"]

[Abstract] A study was made of the periodic orbits of a spacecraft around the moon and planets. In particular, within the framework of the restricted elliptical three-body problem (earth-moon-spacecraft) it was possible to compute orbits around the moon with the following characteristics: apocenter distance about $70 \cdot 10^3$ km, pericenter distance about $4 \cdot 10^3$ km, period about three days. The trajectory does not withdraw far from the normal to the plane of the lunar orbit. In motion in such orbits the spacecraft will be constantly visible from the earth together with the moon. The three bodies in the considered case are positioned in such a way that the space vehicle can be used for carrying relay apparatus for communication with a station on the far side of the moon. Similarity expressions are approximately correct in the case of a sufficiently small ratio of the masses of the two principal bodies. This makes it possible relatively simply to indicate similar families of periodic orbits in sun-planet-spacecraft systems. There are also periodic orbits with a pericenter close to the planet and an apocenter of the order of the radius of the corresponding sphere of action of the planet. The Hamiltonian of the problem is considered, followed by examinations of periodic orbits in the circular problem, periodic solution of the elliptical problem, and periodic orbits in the planet-sun system.

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GROUND AND LANDSCAPE OF VENUS

Moscow ZEMLYA I VSELENNAYA in Russian No 1, 1977 pp 24-27

[Article by N. N. Krupenio, "Ground and Landscape of Venus"]

[Abstract] The "Venera-8" measured temperature and atmospheric pressure at the Venusian surface, but also the concentration of the isotope K^{40} , as well as the radioactive elements thorium and uranium. Later the "Venera-9"

and "Venera-10" transmitted photopanoramas to the earth together with information on the chemical composition and density of the Venusian ground. With respect to the abundance of the isotope K^{40} , thorium and uranium the ground was close to igneous rocks of the basalt type and resembled the ground of lunar maria. Using the gamma radiation method, measurements of ground density were made at the "Venera-10" landing site. The measurements revealed that the density of the rocky surface on which the densimeter sensor was in contact was 2.8 g/cm^3 . This confirmed the basaltic nature of the Venusian ground. Direct investigations of the Venusian ground confirmed the conclusions drawn earlier from data obtained by remote radiophysical methods. Ground radioastronomical measurements indicated that Venusian ground has a dielectric constant of about 5, which corresponds to a ground density of about $2.4\text{-}2.5 \text{ g/cm}^3$. Radar observations indicated some tendency to an increase in density with depth, which can be a result of the natural compaction of ground under the influence of its own weight. Thus, whereas the first meter of the surface layer of the planet has a mean density of about 2.1 g/cm^3 , the mean density of the first ten meters is approximately 2.3 g/cm^3 . According to "Venera-8" data, the ground density in the landing region is relatively small. But as indicated by the results of determinations of the density of the moon and Mars, the local densities can differ by a factor of more than three. That is why there is nothing surprising in the fact that the actual density at the landing site was lower than the mean planetary level determined by the radar method. Venus has a smoother relief than the moon or Mars. There are no high mountains on the planet. The greatest difference in elevations along a trajectory up to 6,000 km does not exceed 3-4 km, which is approximately three times less than on the moon and four times less than on Mars. Bistatic radar observations revealed two characteristic types of Venusian surface. One of them has a predominance of slopes not greater than 1° , evidently corresponding to the Venusian maria, and another with angles greater than 2° , corresponding to Venusian foothills or mountain regions. With respect to craters, in a relatively small area with a diameter of 1,500 km there were more than ten craters with a diameter from 35 to 160 km. However, the Venusian craters are extremely small in comparison with those on the moon or Mars. The largest of them has a depth of only about 0.5 km.

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COMMENTS ON ACHIEVEMENTS AND FUTURE OF SOVIET COSMONAUTICS

Moscow PRAVDA in Russian 12 Apr 77 p 3

[Unsigned article: "With Daring Orbits"]

[Summary] On the occasion of Soviet Cosmonautics Day, a number of leading Soviet specialists have shared their thoughts on the past and future: V. Shatalov [Director of Soviet Cosmonaut Training] ... Work with orbital stations is being carried on methodically, regularly, all in the proper

sequence. This is the main path in the development of Soviet cosmonautics. However, we are yet to determine the optimum duration of work by cosmonauts. This is a problem of the first order... It is understandable that from stage to stage there has been an increase and there will continue to be an increase in the complexity of the problems which cosmonauts solve in flight; there is a constant increase in the range of their obligations and volume of work. Accordingly, there is a continuous change in the nature and method for the training of crews and those means which are used in ensuring the implementation of the program. In particular, there is a broadening of the range of organizations with which the Cosmonaut Training Center interacts... K. Feoktistov [USSR Flier-Cosmonaut, Professor] ... Automatic vehicles play an important role in exploration of the planets. The exploration of space for peaceful purposes is entering a regular, day-to-day channel. It is necessary to establish a regular, economically profitable space service in the interests of the most different branches of the national economy. At the same time we must intensively continue investigations of the earth's neighborhood, the closest planets and remote worlds for the purpose of obtaining new information which will help in the development of the fundamental sciences... All this requires that spaceships have means for the on-board cycling of matter, especially water and oxygen. There is need for constantly increasing the reliability and duration of operation of all station systems... V. Vereshchetin [Deputy Chairman of the "Interkosmos" Council]... International cooperation is a distinguishing characteristic of the present stage in space conquest. Nine socialist countries have joined together for carrying out the "Interkosmos" program. In addition, there are agreements with the United States, France, India and Sweden. Soviet stations for observing artificial earth satellites are located on the territory of 17 countries. The laboratories of many countries are participating in investigations of samples of lunar ground returned by Soviet space vehicles. Citizens of the socialist countries will participate in manned flights on Soviet spaceships and stations. Instrumentation created by other countries is carried aboard Soviet space vehicles. Foreign satellites are being launched by Soviet carrier-rockets. Such launchings have been carried out in cooperation with France and India. The "Intersputnik" communication system has been established. Catalogues of problems for joint solution have been prepared. Negotiations are being carried out to explore the possibilities of carrying out additional joint manned flights with the United States... V. Zolotukhin [Deputy Director of the Space Research Institute] ...The range of participation of different institutes in the space program continues to broaden and now about 30 institutes are participating in this work. People are coming to have a different understanding of their relationship to the universe... Yu. Kiyenko [Director of the State Scientific Research and Production Center "Priroda"] ... Space technology has made it possible to realize new principles in the investigation of natural resources and the environment, to detect global and regional patterns, detect processes and phenomena which cannot be observed by other methods. There is need for the training of many more skilled specialists in the necessary related fields of science and technology.

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VI. MISCELLANEOUS

News

"SEVER-29" EXPEDITION COMPLETES SPRING OPERATIONS

Moscow PRAVDA in Russian 25 May 77 p 2

[TASS Report: "Home from the Pole"]

[Text] Leningrad. The high-latitude air expedition "Sever-29" has completed its traditional spring phase of scientific operations. Participants in the expedition returned today to Leningrad.

Over a period of two and a half months the expedition logged hundreds of hours in the air and flew more than six hundred thousand kilometers. Groups of scientists were landed at 148 locations on drifting ice in the polar basin. They observed characteristics of ocean waters, the ice cover and the atmosphere. [4]

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