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PLEASE NOTE

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SOVIET BLOC INTERNATIONAL GEOPHYSICAL YEAR INFORMATION

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Satellite Recovery Vehicle Proposed by Moscow Graduate Student

An interesting variation for returning satellites to Earth is reported by R. Grigor'yev, in "Interesting Project," an article in the July issue of Nauka i Zhizn', a Soviet popular science monthly. The method was proposed by K. Sevast'yanov, a Moscow graduate student. This scheme, which is illustrated in the original source, is described as follows.

The satellite is assumed to be moving around the Earth in a slightly elliptical orbit. The apogee is designated as A and the perigee as P. The descent must be made in the plane of the orbit in the direction of the Earth's rotation. The return or recovery trajectory is divided into five parts. When the apparatus is at A, and aligned so that the jet of its combustion chamber is directly counter to the motion of the satellite, a reverse thrust is created. With this, the motor of the apparatus uses approximately half the fuel it had on board.

The reserve of fuel for the first braking is selected according to K. E. Tsiokolskiy's classic formula, providing such a decrease in the satellite's energy which will permit it to pass into a new orbit the perigee of which is designated as P', nearer the Earth. In addition to this, the heating arising as a result of the entry of the apparatus into the upper layers of the atmosphere must not exceed the permissible temperature. In order that the apparatus may be "submerged" in the rarefied atmosphere with less velocity, and consequently with the least heat, the motor must again be switched on at point I (which it reaches before arriving at point P') for achieving a second braking in part I-P' of its trajectory.

An estimate of the amount of fuel necessary for the second braking indicates that its weight is considerably less than the weight of coolant reserves and cooling systems, which are necessary in other recovery methods.

Part P'K of the trajectory is covered in a supersonic glide.

In braking, the angle of attack of the wings of the apparatus is increased so long as this is possible without overheating the shell. As the apparatus gradually drops into the denser layers of the atmosphere, braking becomes more intensive, and the temperature after reaching a maximum begins to abate. Finally, at point K, the velocity of the apparatus has decreased to sonic and in part K-L of the trajectory the usual gliding and landing occur.

Thus the dissipation of a satellite's energy is accomplished with the aid of braking by motor and atmosphere. Therefore, in contrast to a gliding airplane of great range, the wing of which must have a high lift/drag ratio, the proposed recovery apparatus must possess high lifting capacity and frontal resistance. Because of this, the speed of descent from high altitudes is decreased and heating of the apparatus is lessened.

This scheme is presented as one of the possible variations for returning satellites. (Nauka i Zhizn', No 7, Jul 58, p 66)

Simulated Space Flights by Laboratory Animals

"Cosmic Breakfast," by Lieutenant Colonel I. Krestivskiy, recently appearing in Sovetskaya Aviatsiya describes a simulated space flight with animals, as follows:

"'Quiet, an experiment is in progress.' Inscriptions like that in bright letters greet us as soon as we enter the premises of the Institute of Psychology of the Academy of Sciences Ukrainian SSR.

"Prof Nikolay Nikolayevich Sirotinin, Active Member of the Academy of Medical Sciences USSR, politely invites us to come into one of the laboratories. It is dark in the room; illuminators on the 'cosmic ship' and on the instruments which record the action of reduced atmospheric pressure on the living organism are the only lights on. Quiet prevails here.

"A. Z. Kolchinskaya, Senior scientific worker and Candidate of Medical Sciences, informes us that the next 'flight' has just begun. She watches the indicators on the instruments, computes changes in respiration and blood composition, and observes other physiological symptoms in the animal experimented with.

"Altitude is gained. Professor Sirotinin continues to describe his work without removing his eyes from the inspection window of the 'cosmic ship.'

"What seemed to us farfetched before, he said thoughtfully, slowly, and in a quiet tone of voice, is now the order of the day. Scientists of all countries are making preparations now for future cosmic journeys and examine the possibilities of extended stay of living organisms in outer space. The health of astronauts must be maintained and they must be taken care of so that they will be able to operate efficiently for a prolonged period of time: they must be protected from vaccuum and low temperatures and they must have an oxygen supply for breathing. Life presents many important and interesting problems for science to solve.

"The effect of conditions at high altitude are being investigated in many scientific institutes of the world; plants and organisms which are capable of living and developing in space ships are being cultivated. Here we have an aspirant, V. N. Danileyko, who, for the past 2 years has been working on the subject of 'medical security in interplanetary flights."

"The problems of alimentation during interplanetary flight are also of interest.

"It is impossible to take along the large quantities of food and oxygen that are necessary for an extended tour in outer space because their weight would be too great. But a man consumes 600 liters of oxygen and 1 1/2 kilograms of food every 24 hours. Is it possible to replenish oxygen and food while in flight?

"The famous Russian scientist, K. E. Tsiolokovskiy, in the course of his work on the solution of some of the problems of interplanetary flights, came up with a daring idea. This idea consisted of utilizing plants as a source of oxygen and food supply for spacemen. It is precisely that road that many scientists of other countries chose to follow. Carbon dioxide exhaled by man can be used to cultivate plants which release oxygen. The plants can also be used as food.

"If you wish we can treat you to a cosmic breakfast, said Nikolay Nikolayevich.

"Puzzled, we look doubtfully at an unusual food and tasted it cautiously. Our suspicion increases. The food is tasty and nutritious. What is it made of?

"Principally of algae, replied Nikolay Nikolayevich. It contains a large percentage of organic substances and fungi.

"However, there is not much food value in plants for a man going on a trip into outer space. Animal protein is needed. Scientists found it in mollusks which grow on plants. Their requirements are simple and they reproduce rapidly.

"Plants not only supply a solution to the food problem for space travelers, but also replenish the microatmosphere inside the cosmic ship. It is enough to say that 2.3 kilograms of chlorella algae can yield 25 liters of oxygen per hour. It is possible that a whole greenhouse of plants can be cultivated in a space ship and that these plants can be used to absorb carbon dioxide.

"During our stay in the laboratory, we could imagine a flight to a multitude of new worlds.

"Astronauts in a rocket feel as if they are on the ground. A hermetically sealed cabin with an air regeneration system, an altitude helmet, and an anti-G suit can dependably protect man.

"After a rocket overcomes the gravitational force of the Earth and enters its orbit, the astronaut finds himself in a state of weightlessness. Not so long ago it was thought that weightlessness would create disturbances in a human organism. Nothing of the sort! The flight of Layka into space demonstrated that weightlessness does not produce any substantial change in respiration or in the function of the heart.

"While Professor Sirotinin was talking, the experimental animals successfully completed their sojourn in outer space. They began their 'descent.' Lights go on in the laboratory. The heavy hatch of the hermetic cabin is opened. The 'flight' has been completed. All this took place on Earth in an altitude chamber. Recordings, observations, cartograms, and photographs obtained as a result of this 'flight' will make it possible to increase knowledge and to expand scientific horizons. And so, scientists every day are accumulating new knowledge in the realm of physiology and are making their contributions toward preparing astronauts for travel in outer space." (Moscow, Sovetskaya Aviatsiya, 12 Jul 58)

II. UPPER ATMOSPHERE

Electron Concentration of Outer Ionosphere from Sputnik I Data

In a collection of articles on preliminary results of scientific investigations with the aid of the first soviet artificial earth satellites and rockets, Ya. L. Al'pert, E. F. Chudesenko, and B. S. Shapiro, in the first complete report, titled "Results of Investigations of the Outer Region of the Ionosphere According to Observations of the Radio Signals of Sputnik I," describe the method of research in the upper ionosphere with observations of the moments of "radioset" and "radiorise" of the satellite. Results of theoretical calculations of the maximum horizontal distance of the reception of radio signals are given. Calculations are made for a spherical Earth; tabulations of the resulting elliptical integral were made with the high-speed BESM electronic computer of the Academy of Sciences USSR. A parabolic model of the lower ionosphere and the exponential decrease of electron concentration in its outer part were used in the calculations.

For the analysis of the experimental data the parameters of the lower ionosphere, according to observations of the network of ionospheric stations, the altitude of the sputnik, and the maximum distances of the reception of its signals, according to ballistic data and other studies of the trajectories of the satellite's flight, were used.

It was found that the electron concentration of the ionosphere N above its maximum N_m decreases more slowly than it increases up to that altitude N_m. For the model $N_z \sim N_M e^{-Mz}$ the value $x \propto 3.5 \times 10^{-3}$ 1/km is obtained. This gives the number of electrons in the outer part of the ionosphere as 3.6 times more than in its lower part. Extrapolation of the data received from observations for the altitudes $z \sim 300$ to 650-700 km up to $z \sim 3{,}000$ km shows that with $z \sim 2{,}000$-3,000 km, $N \sim 200$-300 electrons/cm^3. A curve of the neutral particles n(z) is drawn according to the lifetime of the electron and the time between the different acts of ionization. The value of $n \sim 1/cm^3$ at these same altitudes. The supposition is expressed that the altitude of "limits" of the atmosphere, that is, the region where it is continuous with interplanetary gas, is of an order of 2,000-3,000 kilometers. (Predvaritel'nyye Itogi Nauchnykh Issledovaniy s Pomoshch'yu Pervykh Sovetskikh Iskusstvennykh Sputnikov Zemli i Raket [Preliminary Results of Scientific Investigations With the Aid of the First Soviet Artificial Earth Satellites and Rockets], No 1, 1958, pp 40-104)

A condensed version of this complete report under the title "On the Results of a Determination of Electron Concentration of the Outer Region of the Ionosphere From Observation on the Radio Signals of Sputnik I" by the same authors and including F. F. Dobryakova appeared in a June issue of Doklady Akademii Nauk SSSR. The full text of this version follows.

The results of observation on the radio signals of a satellite are briefly described. The results are based on a determination of the times of "radiorise" and "radioset" of the satellite. Data were obtained on the distribution of the electron concentration N of the ionosphere above the region of maximum concentration N_M and certain properties of interplanetary gas were deduced from these data.

The following method of investigation was used. We assume that the satellite emits a radio wave of frequency f and passes over the observation point at an altitude higher than N_M of the region F_2, the critical frequency of which is $(2\pi)^2 f_c^2 = \omega_c^2 = (4\pi e^2/\omega^2) N_M - 3.2.10^9 N_M$, for $\omega > \omega_c$. It is convenient to consider two types of trajectories of wave propagation to the observation point. These are distinguished by the relationships $\omega_з : \omega < 1$ and $\omega_з : \omega \geq 1$, where $\omega_з$ is some limiting value of the frequency.

When $\omega_з : \omega < 1$, we have the following picture. If $\omega_c : \omega << 1$, then propagation is obviously quasioptical; that is, the maximum horizontal distance of signal reception r_M from the satellite is equal to R_0, the distance of its optical visibility, and the wave trajectory coincides with the straight line tangent to the Earth at the observation point and joining it with the point of emission ((0) in Figure 1). With an increase in ω_c/ω, the wave trajectory takes the form shown on curves (1) and (2) of Fig 1. In a certain part of the lower ionosphere (the region $z_0 \to z_m$), the wave trajectory (ray) initially tends toward the Earth, that is, the angle θ between the normal to the wave front and the radius vector R drawn from the center of the Earth to the corresponding point increases due to a depression of the wave in the ionosphere. At a certain altitude ($z_0 + z_э$), which is higher than the altitude ($z_0 + z_m$) of the maximum N_M, the value of θ reaches a maximum and then decreases. This indicates that the ray has a point of inflection here. The corresponding values of ($z_0 + z_э$) and $\theta_э$ are functions of the altitude z_0 of the beginning of the layer, its half-thickness z_m, and the ratio ω_c/ω. For given z_0 and z_m the values of $\theta_э$ and $z_э$ increase with an increase in ω_c/ω; r_m also increases and the wave trajectory has a point of tangence at the observation point ($\theta_0 = \pi/2$). Finally, when $\omega = \omega_э$, $\theta_э = \theta_{э m} = \pi/2$; the distance $r_M = r_{Mэ} = R_0 \theta_э$ corresponds to the greatest of its possible values for given z_0, and z_m is the extreme value of the maximum reception distances r_M (curve (э)). The altitude ($z_0 + z_э$), at which $\theta_э = \pi/2$, is as before lower than the altitude of the maximum of the layer ($z_0 + z_m$). It is not difficult to see that for $\omega_э > \omega < \omega_c/\omega$, the maximum distance r_m corresponds to those wave trajectories which have the value $\theta_э = \pi/2$ at the point of inflection of the ray. However, a point of tangency is not possible at the point of inflection and $\theta < \pi/2$ (curves (3), (4), and (5) in Figure 1). With a decrease in ω, the altitude ($z_0 + z_э$) increases and reaches the altitude of the maximum of the layer ($z_0 + z_m$), when $\omega_c : \omega = 1$ and $r_m = 0$. That is, the ionosphere here becomes opaque to waves emitted from the satellite. (Footnote: It should be noted that it is usually assumed in the literature when describing the character of wave trajectories that the change in sign of the curvature of the wave trajectory takes place at all frequencies at the altitude ($z_0 + z_m$) of the maximum of the electron concentration. This is true only for a "plane" earth. On consideration of the sphericity of the Earth, the character of the trajectory changes since it is necessary to use other than the usual formulas to calculate the frequency $\omega_э$, usually called the maximum usable communication frequency (see below).

The particular method used in this work is based on a determination of the maximum distances r_m from experimental data and a comparison of these with the calculated theoretical values. The distances r_M correspond to the radiorise and radioset of the satellite. In these calculations, we are restructed to consideration of the data when $\omega_э < \omega$ and $\theta_э < \pi/2$. The approximations of geometrical optics are applicable. Then

$$r_M = R_0 \theta_0 + \int_0^{z_c - z_0} \frac{dz}{(1 + z_0/R_0 + z/R_0)\sqrt{n^2(z)\,(1 + z_0/R_0 + z/R_0)^2 - 1}} \quad (1)$$

where all notations are as in Figure 2 and $n(z)$ is the coefficient of refraction.

It is necessary to select a form for the function $n^2(z)$ in order to calculate the integral. In the region $z_0 \to z_m$, the best approximation to $n^2(z)$ is a parabola which may be conditionally extended to $1.2z_m$. An exponential law may be chosen to describe the decrease in N(z) in the outer portion of the ionosphere, where electron concentration drops off with height. As a consequence, expression (1) is divided into two integrals in which, respectively,

$$n_1^2(z) = 1 - \frac{2\omega_c^2}{2} \frac{z}{z_m} + \frac{\omega_c^2}{\omega^2} \frac{z^2}{z_m}; \quad n_2^2(z) = 1 - 0.96\frac{\omega_c^2}{\omega^2} e^{-x(z - 1.2z_m)} \quad (2)$$

Analysis of the function under the root sign yields the following quadratic equation for z_ϑ :

$$z^2 + (R_0 + z_0 - 3z_m)\frac{z}{2} + \left(\frac{z_m\omega^2}{2\omega_c^2} - R_0 - z_0\right) \frac{z_m}{2} = 0 \quad (3)$$

The simultaneous solution of the above with the equation

$$\left(1 + \frac{z_0}{R_0} + \frac{z_{\vartheta m}}{R_0}\right)\left(1 - \frac{2\omega_\vartheta^2}{\omega_\vartheta^2} \frac{z_{\vartheta n}}{z_m} + \frac{\omega_c^2}{\omega_\vartheta^2} \frac{z_{\vartheta m}^2}{z_m^2}\right) = 0 \quad (4)$$

determines $\omega_c/\omega_\vartheta$ and $z_{\vartheta m}$, where $\theta = \pi/2$.

The integral (1) is an elliptical equation and was computed by numerical methods on the BESM computer for various values of z_0, z_m, z_c, and ω_c/ω. (Footnote: Analysis of the integral, programing for the BESM, and the calculations were made in collaboration with Z. A. Malina and Ye. P. Nesterova.)

The times of the appearance and disappearance of the radio signals of the satellite were noted from continuous observations. The altitude of the satellite, the coordinates of the point on Earth over which it passed, and its horizontal distance r_M were determined for these times on the basis of ballistic data. After this, charts of the altitudes of the beginning z_0 and the maximum z_m of the region F_2 of the ionosphere and synoptic charts of the isolines of the critical frequencies f_c were constructed especially for these studies and used to determine the values of f_c, z_0, and z_m in the lower part of the ionosphere for each point of time chosen from the observations. Then the experimental values of r_M were compared with the theoretical r_M vs x curve for given values of z_0, z_m, and ω_c. A value of x was then chosen which determined the effective decrease in electron concentration in the region above the maximum concentration N_M for each time of observation.

The signals received from the satellite during 5, 6, and 7 October at six points were analyzed. Only those cases were chosen when pure radiorise or radioset at a frequency of 40 Mc was observed. The following values were most frequently met in the distribution of the parameters of the ionosphere characterizing these particular points: $z_0 \simeq 200$ km, $z_m \simeq 120$ km, $N_M \simeq 1.8.10^6$, and $z_c \simeq 600$-650 km. Local times near the satellite and the latitude of these points oscillated within the limits $t \simeq 07$ hrs 40 min - 09 hrs 40 min and $\phi \simeq$ lat. 20° -45°N.

All the experimental data were processed and the distribution of x was obtained, as shown in Figure 3. The value of x which occurred most frequently was $x \simeq 3.5.10^{-3}$ km^{-1} in the altitude range $z \sim 320$-600 km.

For $z \geqslant 500$-600 km, (the so-called exosphere,) gas temperature need not be less than the temperature at lower levels. The ionization state here is close to quasistationary. (See τ_e, below.) Assuming, therefore, that the same rate of decrease in electron concentration holds at $z > 600$ as at $z \sim 230$-600, we evidently must obtain reduced values of N(z) as compared with the actual values. The values of N(z) for $x = 3.5.10^{-3}$ km^{-1} are given in Table 1 and Figure 4. (Footnote: Added in proof: The two values of N indicated by dots in Figure 4 were measured with a high-altitude rocket -- see Pravda, 27 March 1958. It should also be noted that it was shown in a recently published work that the ratio of the total number of electrons above the maximum of the layer to the number of electrons in the lower half of the layer, i.e., $\int_{z_0+z_m}^{\infty} N\,dz : \int_{z_0}^{z_0+z_m} N\,dz \approxeq 3$ and varies only slightly. This is in good agreement with our data, since for $x \sim 3.5.10^{-3}$, this ratio is of the order of 3.6.)

The second line in Table 1 gives the value of the density n of neutral particles recommended in various works for altitudes up to 400 km (H. K. Kallman, W. B. White, H. E. Newell, J Geophys Res, 61, 513, 1956; D. Horowitz, H. E. Lacow, J. Geophys Res, 62, 57, 1957,) For higher altitudes, the values are computed on the assumption that the barometric formula is applicable, that T here is approximately 2,000°, and that the main gas component is atomic hydrogen, such that the effective altitude $H \sim 100$ km. The third line gives the values for n computed below.

We shall now analyze the data in Table 1.

In the first place, it is evident that under the above assumptions the electron concentration for $z \sim 2{,}000$-$3{,}000$ km varies within the limits 10^{-3}-10^{-2} el/cm^{-3}, as does the number of positive ions. However, the great path lengths, reaching many thousands of kilometers as the particles move away from the Earth, the fact that the gas is irradiated by the Sun, the long lifetime of the electron, the free influx of particles from without, etc., indicate that the gaseous medium here may hardly be considered as the Earth's atmosphere. We therefore can draw the conclusion that the atmosphere at these heights is evidently contiguous with the interplanetary gas. (Footnote: This value for the density of the interplanetary gas was determined from observations on the polarization of zodiacal light [H. Siedentopf, Zs f Astrophys, 32, 19, 1953].)

Secondly, we will estimate the distribution of neutral particles n at $z > 400$ km on the basis of the electron concentration data. The following values may be taken for the amount of ionizing radiation incident on the region F_2 of the ionosphere and for the recombination coefficient α for electrons at various altitudes (M. E. Szendrei, M. W. Elhinmy, J Atm Terr Phys, 9, 118, 1956; Ya. L. Al'pert, V. A. Ginzburg, Ye. L. Feynberg, Rasprostraneniye Radiovoln [Propagation of Radiowaves], 1956):

z_m (km)	S_M (erg/cm^2·sec)	M (cm^3/sec)
~ 320	~ 0.2	$\sim 10^{-10}$
~ 400	~ 0.3	$\sim 10^{-11}$
$z \geq 1{,}000$	$S_\infty \sim 0.6$	$\alpha_\infty \sim 10^{-12}$

Therefore, assuming that photocombination and photoionization are the chief microprocesses in this region of the atmosphere, we find that the lifetimes of an electron $\tau_e = (\alpha N)^{-1}$ sec and the times between different ionization events $\tau_n = (\sigma S/\varepsilon_i)^{-1}$ sec take on the values: ($\sigma_{O_1} \sim 2.10^{-18}$ cm^2 and $\varepsilon_{iO_1} = 13.5$ ev)

z (km)	320	400	1150	1850	2450
τ_n	5.10^7	3.10^7	2.10^7	2.10^7	2.10^7
τ_e	5.10^3	7.10^4	10^7	10^8	10^9

Since $n/N \sim \tau_n/\tau_e$ under quasistationary conditions, we obtain in conclusion the densities of neutral particles given in the third line of Table 1. It can be seen that these values for n are 5-10 times or more greater than the figures in the second line of Table 1. It may therefore be assumed that the values of n also exceed those given in the literature for $z \sim 320$-400 km and that for $z \sim 2,000$-3,000, n is of the order of several units per cm^3.

These conclusions have an important significance for the physics of the outer ionosphere, thus emphasizing the necessity for their further verification by other methods.

Table 1

z (km)	200	320	400	1100	1760	2400	3050
N (el/cm^3)	10^5	$1.8\cdot10^6$	$1.4\cdot10^6$	10^5	10^4	10^3	10^2
n (cm^{-3})	$5\cdot10^9$	$2\cdot10^8$	10^8	10^5	10^2	<1	-
$n \simeq (\tau_n/\tau_e)N$	-	-	$5\cdot10^8$	$2\cdot10^5$	$2\cdot10^3$	20	<1

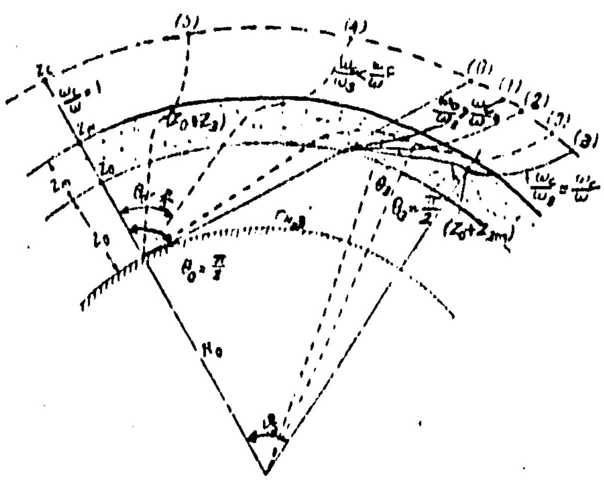

Fig 1

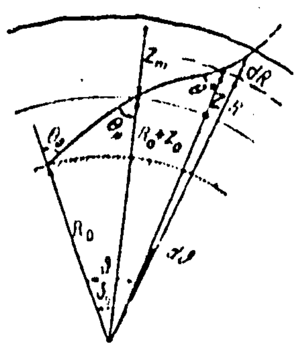

Fig 2

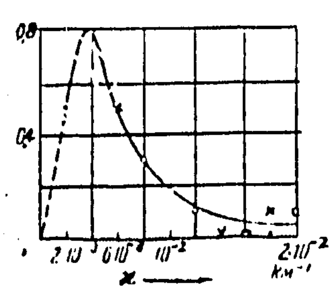

Fig 3

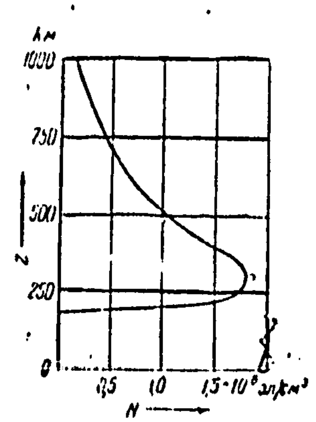

Fig 4

(Moscow, Doklady Akademii Nauk SSSR, Vol 120, No 4, 1 Jun 58, pp 743-746)

Khar'kov Ionosphere Station and Its Work

The ionosphere station developed in the Chair of Principles of Radio Engineering of the Khar'kov Polytechnic Institute is described by V. V. Tolstov and B. G. Bondar' in an article entitled "Measurement of the Drift Velocity of Ionization Heterogeneities (Winds) in the F Region of the Ionosphere." The frequency range of the station is 1.2-1.7 Mc; the impulse, from 2 to 5 kv lasting 50-200 microsec; the repetition frequency, 50 impulses/sec; and time for covering the range, 50 sec. The results of a measurement of the drift velocity of ionization heterogeneities in the F ionosphere region are presented and lead to the drawing of the following conclusions: (1) in the F region of the ionosphere a regular drift of ionization heterogeneities with a velocity from 10 meters/sec and greater is observed; more often a velocity of 80-100 meters/sec is observed; the direction of the drift regularly changes during the day; and (2) in calculating the velocities of the drift of heterogeneities it is desirable to consider the influence of anisotropy of a diffraction chart on the result of measurements; however, in the case of a large number of measurements this work requires the use of computing machines. (Kiev, Mezhdunarodnyy Geofizicheskiy God, Informatsionnyy Byulleten', No 1, 1958, pp 43-50)

[Note: For a complete technical description of the ionosphere station developed at Khar'kov Polytechnic Institute, see Soviet Bloc International Geophysical Year Information for 9 May 1958.]

Nonuniformity of the Earth's Rotation

A. A. Yakovkin of the Main Astronomical Observatory of the Academy of Sciences Ukrainian SSR, in "Nonuniformity of the Earth's Rotation and Ways of Studying It," describes three types of changes in the angular velocity of the Earth's rotation. He shows that the generally accepted method of calculating the Moon's coordinates does not yield (because of the libration effect of the visible radius of the Moon) the coordinates of the Moon's center of mass. Formulas are derived for transition from the center of the figure to the center of mass. An artificial satellite of the Moon would enable us to compute the exact coordinates of the Moon's center of mass from observations of the motion of this satellite. (Kiev, Mezhdunarodnyy Geofizicheskiy God, Informatsionnyy Byulleten', No 1, 1958, pp 7-15)

Results of Radar Observations of Meteors in Khar'kov, July-December 1957

The results of radar observations of meteoric activity conducted by the Khar'kov Polytechnic Institute from July to December 1957 are reported in "Radar Observations of Meteoric Activity," by B. L. Kashcheyev, B. S. Dudnik, M. F. Lagutin, I. A. Lysenko, and V. V. Tolstov. The observations were conducted by a radar method at a frequency of 72 Mc. Over 10,000 meteors were registered. A scheme is discussed which makes possible observation of meteors in the presence of a high level of interference. (Kiev, Mezhdunarodnyy Geofizicheskiy God, Informatsionnyy Byulleten', No 1, 1958, pp 38-42)

Identification of Solar Phenomena With Areas of the Solar Surface

The problem of identification of observed solar phenomena with certain sections of the solar surface responsible for geoeffective corpuscular solar radiation is discussed by E. R. Mustel' in an article titled "Discussion of Possible Sources of Geoactive Particles in the Solar Shell" which appeared in the book Fizika Solnechnykh Korpuskulyarnukh Potokov i ikh Vozdeystviye na Verkhnyuyu Atmosferu Zemli (Physics of Corpuscular Streams and Their Effect on the Upper Atmosphere of the Earth), 1957, 8-37, 38-39, and 76-86.

It is noticed that spectroscopic and radiophysical detection of corpuscular streams is possible only in the vicinity of the Sun because of strong dilution. The solar spots cannot be a source of geoeffective particles, although the effect of their magnetic fields on the corpuscular streams is very strong. The direct comparison of flares and flocculi fields with geomagnetic disturbances, as well as computations of radiation pressure over flares on Ca II atoms, indicate that the radial corpuscular geoeffective streams are generated over the flare areas. A number of statistical laws of geomagnetic disturbances is analyzed. They prove the radiality and stability of corpuscular streams over the flares. The nonradial corpuscular streams moving within limits of a 45° wide solid angle are generated by chromospheric outbursts. Nonradial streams are also generated over large groups of spots.

The assumption by S. K. Vsekhsvyatskiy, G. M. Nikol'skiy, and Ye. A. Ponomarev on the identity of corpuscular geoeffective streams with the observed coronal radiation is discussed. The radiality of corpuscular streams during the years of minimum, the random distribution of corona rays, the jumps in cyclic variations, and the stability of the 27-day recurrence of geomagnetic disturbances contradict, according to the author, the assumption of identity of coronal radiation with geoactive streams. The possibility of a wide velocity dispersion of particles is noted: the minimum velocities may reach 200-300 km/sec. The writer thinks that the concentration of particles near the Earth may vary from several tens of particles in a cm^3 to 25-100 particles/cm^3. S. K. Vsekhsvyatskiy, G. M. Nikol'skiy, and others indicated many difficulties involving this assumption by the writer and sustained the "coronal" assumption of corpuscular streams which was contradicted in reports by E. R. Mustel, V. A. Krat, S. B. Pikel'ner, and others. (Referativnyy Zhurnal -- Astronomiya i Geodesiya, No 7, Jul 58, Abstract No 4449, by E. I. Mogilevskiy)

Relation Between Solar and Geomagnetic Activity

In "Relation Between Solar Activity and Geomagnetic Disturbances," by A. I. Ol', appearing in the book Fizika Solnechnykh Korpuskulyarnukh Potokov i ikh Vozdeystviye na Verkhnyuyu Atmosferu Zemli (Physics of Corpuscular Streams and Their Effect on the Upper Atmosphere of the Earth), 1957, pp 167-173 and 174-177, a brief survey of investigation results of the relationship between the solar and geomagnetic activity obtained during recent years is presented. On the basis of these results the writer makes the following conclusions.

1. Geomagnetic disturbances are accompanied by spot groups, affecting the radio emission of the Sun, while the probability of a geomagnetic disturbance is particularly high when the spots are observed on only one side of the solar equator. The maximum of geomagnetic disturbances occurs 2 days after the above-mentioned spots have passed the central solar meridian. The geomagnetic disturbances occurring at the same time consist in storms with a sudden start or of disturbance not recurring after 27 days.

2. Solar spots not connected with radio emission are accompanied by a quieting down of geomagnetic disturbances.

3. Areas intensifying the emission of the green coronal line lead to a drop in geomagnetic activity.

4. A close bond is found between geomagnetic disturbances and the intensity of the neutron component of cosmic rays with solar areas characterized by unipolar magnetic fields.

The rules mentioned show that in the case of single active areas with an unipolar magnetic field favorable conditions are created for the ejection of corpuscular streams which while passing through the coronal plasma (according to Shklovskiy's assumption) cause radioemission.

The presence of several areas and of a complex magnetic field lead to a deflection of the corpuscular streams. This is the reason why during the passing of such areas through the solar meridian geomagnetic disturbances are not observed. (Referativnyy Zhurnal -- Astronomiya i Geodeziya, No 7, Jul 58, Abstract No 4464, by M. N. Gnevyshev)

Corpuscular Solar Emission

The problems of solar corpuscular radiation and the nature of radiative structural formations of the solar corona and of the dissipation of the solar corona are discussed in an article entitled "Corpuscular Solar Emission," by S. K. Vshekhsvaytskiy, Ye. A Ponomarev, G. M. Nikol'skiy, and V. I. Chernichenko. This article appeared in the book Fizika Solnechnykh Korpuskulyarnukh Potokov i ikh Vozdeystviye na Verkhnyuyu Atmosferu Zemli (Physics of Corpuscular Streams and Their Effect on the Upper Atmosphere of the Earth), 1957, pp 51-57, 57-58, and 76-86. The dissipation of a high temperature nonstationary corona in presence of a directed stream of matter and energy is analyzed, in the case when the distribution function of particles according to velocities is specified by the asymmetric function of the type $f(v) = f_0 + f_1 \cos\varphi$, where f_0 is symmetrical and f_1 the directed part of the distribution function. The losses of the coronal matter in the form of directed corpuscular streams consist, according to the author's computations, of $4 \cdot 10^{36}$ protons/sec or of $2.5 \cdot 10^{20}$ gr/year. This magnitude is of 2-3 orders larger than that computed by other authors (E. R. Mustel', S. B. Pikel'ner, and others) The authors present a number of astrophysical and geophysical data confirming that the observed coronal streams are identical to corpuscular geoeffective streams and that the concentration of particles in solar streams near the Earth is about 10^3 - 10^5 particles/cm^3. (Referativnyy Zhurnal -- Astronomiya i Geodesiya, No 7, Jul 58, Abstract No 4459)

III. ARCTIC AND ANTARCITC

Determining Density of Antarctic Ice and Snow by Gamma-Ray Attenuation

"Results of Using Gamma-Ray Attenuation for Determining Density of Ice and Snow Under Antarctic Conditions," by O. K. Vladimirov and V. A. Chernigov, describes tests conducted by the authors in the area of the Soviet observatory at Mirnyy. A radiometer, type SG-42, manufactured by the "Geologorazvedka" (Geological Exploration) Plant was used as the gamma counter. A 0.1 mg radium standard was used as the gamma-ray source. In determining the density of snow and ice in the natural state, two holes 90 cm deep and 90 cm apart were drilled, the standard being placed at the bottom of one hole and the probe of the counter at the bottom of the other, and readings taken. The determinations were found to be accurate to within ± 0.05 g/cc. (Atomnaya Energiya, Vol 4, No 5, May 58, pp 474-475)

Research Activities and Plans of Arctic Institute

At present the Arctic Institute is the principal scientific organization conducting research in the Arctic. It has scientific observatories in Barentsburg, on Spitsbergen, in Bukhta Tikhaya, on Zemlya Frantsa Iosifa, Ostrov Dikson, in Bukhta Tiksi, and Bukhta Pevek. Every year the institute sends its scientific expeditions into the Arctic. Some of them work continuously throughout the year or for several years; they actually represent small scientific observatories, which conduct research according to an extensive program, principally in almost all fields of the IGY program.

In 1958, expeditionary research in the Arctic began earlier than usual. An expedition on the Lena left for the Arctic in early March. It conducted complex oceanographic research in the Greenland Sea and made hydrological cross sections (razrezy) in accordance with the IGY program. These observations will be repeated in the summer and fall. It may be expected that they will produce interesting data on the water exchange and heat exchange between the Arctic and Atlantic oceans.

Early in April, members of the high-latitude aerial expedition and of the scientific drift stations Severnyy Polyus-6 and Severnyy Polyus-7 flew to the Arctic to replace the staffs at these stations, who had worked there for one year. From April 1957 to March 1958, Soviet scientists in the Central Arctic had conducted extensive observations, including a large volume of work under the IGY program.

With each year of research work in the Central Arctic, the complexity and interrelations of natural processes in the Arctic become more and more apparent. New data on the ice drift have been obtained. The drift of Severnyy Polyus-6, as well as of the surrounding ice, almost coincided with the change in wind speed and direction. However, at the same time there is a general tendency of the ice in the region of the drift to move to the northwest. Even with a more frequent repetition of the prevailing west-southwest winds, the station continued to move steadily, even though slowly, to the northwest under the influence of the permanent currents.

The high-latitude aerial expedition carried out the distribution of "Vekha" radio beacons, equipped with drifting automatic radiometeorological stations (DARMS), in the Central Arctic and the arctic seas. The weather service of the Main Administration of the Northern Sea Route now receives, in addition to information on the ice drift, daily data from vast areas of the Central Arctic on the temperature and pressure of the air and speed and direction of the wind. This has contributed greatly to the information on weather conditions in the more remote regions of the Arctic Ocean and has improved synoptic weather service in the Arctic.

All through 1958, expeditions of aerial ice reconnaissance will conduct operations. During the winter, hydrologists studied the ice along a route extending over 100,000 kilometers. In the summer, during a period of several days, ice conditions will be studied in the whole water area of the Arctic Ocean, adjoining the Eurasian coast.

From June to October, navigational ice reconnaissance will be conducted to provide ships along the Northern Sea Route with data on the condition and distribution of ice on difficult sectors of the route. All expeditions engaged in ice reconnaissance will record processes taking place in the ice cover; this information if required both for navigation and for scientific research work.

The work previously begun on the hydrological survey of arctic seas is being continued in order to obtain the most complete data for the preparation of navigational aids. As in previous years, buoy (beacon) stations with attached self-recording devices for observations of currents are being used extensively, and are left in the sea for autonomous operation for periods ranging from 2 weeks to 2 months.

Three oceanographic expeditions on the ships Toros, Polyarnik, and Lomonosov are working in the Arctic simultaneously. They are studying the hydrological and ice regimes of the Chukchee Sea, East Siberian Sea, Laptev Sea, Kara Sea, and Barents Sea, and are conducting observations under the IGY program.

The long-range plan for the next 7 years provides for about 20 scientific expeditions a year, necessary for solving important problems facing Soviet polar scientists.

Forty years of scientific research in the Arctic have almost been completed. Until now, the main emphasis has been on observations and descriptions of natural processes and the study of mainly those natural phenomena and problems which had to be explained in order to aid the development of navigation along the Northern Sea Route. In this connection most of the efforts were concentrated on the expansion of expeditionary research in the Arctic Ocean for the purpose of collecting observation material and meeting urgent practical requirements, or, in other words, the scientific-operational servicing of navigation on the Northern Sea Route. To some extent this had an effect on the development of theoretical research. Soviet scientists cannot rest on the results achieved thus far. Only the first steps in the study of the Arctic have been taken. Scientists have an immense task ahead of them, both in scope and in the nature of problems involved.

Primary attention should be given to the development and improvement of methods of estimating the ship traffic capacity of the Northern Sea Route and to the improvement of long-range forecasts (i.e., up to 8-10 months in advance) and general (background) forecasts of ice conditions in arctic waters. Reliable methods of long-range ice forecasts would make it possible to make definite plans for shipping along the Northern Sea Route, and to make proper disposition of both the icebreaker and the transport fleet, depending on ice conditions. Also, serious attention should be given to developing methods of short-range forecasts on the concentration and redistribution of ice for 10-15 days in advance. This is necessary for the scientific-operational servicing of arctic navigation.

The Arctic Institute has begun the study of water dynamics of the arctic seas: currents, level and undulation (volneniye), and their interrelations with conditions of formation, destruction, and dynamics of the ice cover, for the purpose of developing methods of compiling ice and hydrological forecasts and preparing navigational aids.

As in previous years, the institute will continue to give serious attention to the study of basic laws of atmospheric circulation over the Arctic and to the extension of forecasts to 8-9 months. At present such forecasts are prepared for 4-5 months in advance and are not adequate for a timely planning of arctic navigation, usually done in December and January.

During 1959-1965, it is expected that ways will be developed of compiling long-range forecasts of the successive changes of types of atmospheric circulation, as well as of related characteristics of the thermobaric and wind field in the Arctic. At the same time, studies will be made of the fluctuation of intensity of atmospheric circulation in various sectors of the Earth and of related peculiarities of the course of processes and weather in the Arctic, as well as minor changes in synoptic processes influencing the weather of the Arctic.

It is planned to begin the study of the effect of general planetary phenomena of a geophysical and heliophysical nature on the water and ice regime of the Arctic Ocean. Among the phenomena determining the rhythm of the atmosphere and oceanosphere of the Earth, the most important are those caused by free oscillations (kolebaniya) of the rotation axis of the Earth and by perennial and perpetual variations of solar activity. According to their nature, all these phenomena are of general planetary importance. Therefore, their study must be conducted on a scale including the planet as a whole, which considerably expands the range of scientific interests of modern arctic oceanography and meteorology. The study of marine and atmospheric processes, which are geophysical by origin and high-latitudinal by the zone of their prevailing occurrence, will make it possible in many ways to find a new approach to the study of ice drift and water circulation of the Arctic Ocean and to form a basis for long-range ice forecasts of arctic seas.

At the same time the study of physics of the atmosphere, the sea, and the ice will be developed. Above all, the physical methods of research must be developed in the field of the study of ice drift, water and heat exchange, and atmospheric circulation.

The method of study of arctic ice drift with the help of radio beacons will be further developed. This method will make it possible to conduct a detailed and, above all, a systematic study of the ice drift within the central area of the ocean and the adjoining seas of the Arctic, thus making it possible not only to discover the basic laws of ice drift in the Arctic during different seasons of the year and during different years, but also to provide a basis for creating new methods of ice forecasting for arctic seas.

The principal attention of the Arctic Institute will be concentrated on the expansion of theoretical research and scientific summarization of the extensive observation materials obtained by numerous expeditions, at both drift stations and polar stations. -- V. V. Frolov and V. M. Pasetskiy, Arctic Scientific Research Institute (Moscow, Priroda, No 8, Aug 58, pp 60-62)

Low-Temperature Readings in Antarctic

In late April and early May 1958, the Soviet interior antarctic stations Komsomol'skaya, Vostok, and Sovetskaya registered the lowest temperatures ever recorded by meteorological stations of the world. For example, the station Vostok in the region of the south geomagnetic pole recorded a temperature of minus 78 degrees C on 3 May, and the station Sovetskaya a temperature of minus 79 degrees C on 9 and 10 May and minus 81 degrees C on 26 and 27 June.

It is interesting to note that until recently the lowest temperature ever registered on the Earth was considered to be minus 74.5 degrees C, recorded at the US , station South Pole in May 1957, and the lowest temperature registered at Soviet antarctic stations (as well as arctic stations) was minus 73.2 degrees C. It is worth noting that the lowest temperatures are observed not at the peak of the antarctic winter, but at its very beginning, and that the climate of Antarctica is colder than that of the Arctic.

During 1957, Soviet scientists expressed their estimates of possible minimum temperatures on the antarctic continent. Estimates of surface radiation and of corresponding temperatures were made on the basis of the theory of radiation balance. These estimates produced the resulting lowest possible temperature in Antarctica, i.e., minus 80 degrees C (± 2 degrees). The temperatures observed at the Soviet stations Komsomol'skaya, Vostok, and Sovetskaya in the first 10 days of May are close to the estimated figures.

In these regions it was hardly to be expected that heavy winds would accompany such low temperatures, especially since some scientists had expressed the opinion that cyclones are not being observed over the central regions of Antarctica. However, recently a cyclone which had passed over Mirnyy penetrated far into the interior of the continent and caused winds of 15 meters per second with a snowstorm at Komsomol'skaya, located 835 kilometers from the coast, and winds of 20 meters per second at Sovetskaya, located 1,420 kilometers from Mirnyy. It may be noted that the occurrence of very strong winds caused by the passage of cyclones is followed by a marked rise in temperature.

The low temperature in the interior of Antarctica make the work at these stations extremely difficult. According to reports from the chiefs of the Soviet antarctic stations, special preheated clothing is used for work under such conditions. However, even this does not protect completely against the severe frost. At temperatures close to minus 70 degrees C, it is impossible to stay outdoors for more than 20 minutes at a time, even with special protective clothing. -- B. V. Shteynberg, Council for Antarctic Research, Academy of Research USSR (Moscow, Priroda, No 8, Aug 58, p 82)

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