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AID Report P-63-61 15 May 1963

PHENOMENA IN THE UPPER ATMOSPHERE

Compilation of Abstracts

AID Work Assigment No. 3
(Report No. 34 in this series)

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FOREWORD

This is the thirty-fourth in a monthly report series reviewing Soviet developments in selected problems in astrophysics and geophysics. It is based on materials received at the Aerospace Information Division in February 1963.

Topics covered in this series are

I. Ionospheric electron concentrations
II. Solar radiation and the ionosphere
III. Van Allen belts and cosmic rays
IV. Telluric currents
V. Atmospheric electricity
VI. Nuclear bursts in the atmosphere
VII. Satellite and missile data
VIII. Arctic and antarctic communications
IX. Meteorology of the upper atmosphere

Materials in this report deal with topics II, IV, V, VII, and IX.

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TOPIC II. SOLAR RADIATION AND THE IONOSPHERE

1) Dvoryashin, A. S., and L. S. Levitskiy. Corpuscular solar radiation on the descending branch of the solar-activity cycle. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 167-177.
QB1.A17642

The introduction provides a short review of empirical and theoretical investigations of the connection between geomagnetic disturbances and active solar regions on the descending branch of the solar activity cycle. Individual comparisons are made between geomagnetic disturbances and active regions on the sun, indicated by flocculi, for the period from Feb 1940 to May 1944. All observed flocculi (active regions) are divided into two groups: flocculi of group I, which at the moment of CMP (central meridian passage) crossed the apparent center of the disk or were adjacent to it; flocculi of group II, for which the heliocentric angle Φ (the distance between the parallel of the apparent center of the disk and the part of the flocculus closest to it) is equal to or exceeds 6°. Group II, in turn, is divided into two subgroups: a) flocculi of subgroup II_f, located in the same hemisphere as the apparent center (the favorable hemisphere), and b) flocculi of subgroup II_u, located in the other hemisphere.

Data on disturbances of the magnetic field were taken from Geomagnetic Indices C and K, 1940-1946, Washington, 1948. The data on flocculi of group I were obtained by E. R. Mustel' as a result of a review of Meudon spectroheliograms; in a number of cases data were obtained from the Kodaikanal and Mount Wilson observatories. Data on the flocculi of group II were taken from: Observatoire de Paris, Section d'Astrophysique à Meudon, Cartes synoptiques de la chromosphère solaire, by L. d'Azambuja and R. Servajean, v. 1, Fasc. IX, Ann. 1940, and 1944, 1952. Geomagnetic and solar data (flocculi of group I) for each rotation of the sun are shown graphically. All flocculus groups are studied by the method of superposed epochs and the following results obtained: 1) a right maximum for the central flocculi is observed at the phase +5 days; and 2) there is no stable regularity for noncentral flocculi. This confirms previous conclusions on the existence of radial corpuscular streams from active regions.

The physical characteristics of slow corpuscular streams from the sun are discussed on the basis of experimental and theoretical data. [Authors' abstract]

2) Gorgolewski, S., J. Hanasz, H. Iwaniszewski, and Z. Turlo. Interferometric investigations of the outer solar corona at the 32.1 Mc band. Acta Astronomica, v. 12, no. 4, 1962, 251-260.

The outer solar corona was investigated at the Nicholas Copernicus University at Torun with a 3-aerial interferometer on the 32.1 Mc or 9.3 m frequency range. During June, September, and October, 1961, the radio sources Taurus A and Virgo A were observed on the E-W base of the three-antenna interferometer. The apparatus had been calibrated before the observations.

The increase of the angular spectrum of the occulted radio source is computed by the formula

$$A = A_0 \exp[-(\varphi/\varphi_0)^2],$$

where A and A_0 are the calibrated amplitudes of the scattered and unscattered radio emission of the Taurus A source, and φ and φ_0 the half widths of the angular spectrum of the scattered and unscattered emission. The measured distribution of the emission intensity of the Taurus A source is like the Gaussian distribution curve. The angular diameter of the Taurus A source changes as a function of the distance from the sun. A measurable scattering of emission is observed at a distance of 45 solar radii.

The occultation curve of the Taurus source is asymmetrical, due to the flattening of the outer corona. The occultation trajectory of the Taurus A source is not parallel to the solar equator. This circumstance makes it possible to conclude that the coronal electron irregularities are more scattered in the equatorial plane and diminish toward the poles.

The minimal angular distance between the sun and the Virgo A source is 58 solar radii. The curve of the Virgo source shows no irregularities in the coronal behavior, indicating that the coronal irregularities in the polar direction do not reach a distance of 58 solar radii.

On 4 June, 1961, a 1.7-fold increase of Taurus A amplitude was observed. This irregular increase of amplitude at a great distance from the sun is explained by sporadic irregularities beyond the corona, which occulted the sources. Such phenomena have also been observed by Vitkevich (reference given), who explained it by focusing the radiation of the Taurus A source on coronal rays. Vitkevich calculated the electron densities in the focusing rays to be equal to $3 \cdot 10^4$ electrons/cm^3 on the 3.5 m wavelength at a distance of 20 solar radii.

Authors' Associations: Astronomical Observatory, Nicholas Copernicus University (Toruń); Astronomical Institute, Polish Academy of Sciences; Astrophysics Laboratory (Toruń).

3) Gopasyuk, S. I. Spot motion connected with solar flares and the possible character of energy exit from flare regions. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 110-119. QB1.A17642

Photographs of the sun in integral light have been obtained during flares observed in the H_α line with the AФР-2 and the solar tower telescope, the focus being equal to 12 meters. It is found that: 1) with the appearance and development of flares a shift of the sunspots is observed in the direction towards the flare knots; 2) the commencement of flare development and that of spot motion coincide with a precision of ± 5 minutes; 3) the spot motion continues for 2 — 3 hours after the termination of the flare in H_α and is probably of a pulsational-translational character. The amplitude of pulsation increases with the importance of the flare. It is shown that: 1) the volume decreases, due to the conversion of magnetic energy to the internal energy of the gas, by a small fraction in comparison to that observed; 2) the mean values of the observed shifts can be explained by the exit of energy in the form of cosmic rays, plasma, and magnetic field from the flare region; 3) taking into account the work of Stepanyan and Vladimirskiy (reference given), it is concluded that during a flare observed in the H_α line, the main fraction of energy is carried away by cosmic rays; 4) after the termination of the flare in H_α and until the end of the spot motion, the energy carried away by "cold" plasma and the magnetic field apparently predominates over the energy of cosmic rays emitted at the same time; and 5) ionization losses of cosmic rays are sufficient for an energy explanation of the observed flare emission in H_α and other spectral lines. [Author's abstract]

4) Kachalov, V. P., M. Z. Khokhlov, V. L. Khokhlova, and A. V. Yakovleva. Ultraviolet Be I lines in the solar spectrum. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 44-51. QB1.A17642

The equivalent widths of the Be I lines λ 2651 and λ 2494 A have been determined from rocket spectrograms. The oscillator strengths of three multiplets of beryllium $\lambda\lambda$ 3321, 2651, and 2494, which have a common lower level 2s2p^{3}P, are considered. The relative Σgf values for these multiplets are found experimentally. The comparison with theoretical values, computed by means of the Bates-Damgaard tables, shows that the latter are inaccurate. It seems most probable that the more precise values of f should lead to a decrease of the Be solar abundance determination in [the works of (1) Greenstein and Tandberg-Hanssen and (2) Goldberg, Müller, and Aller (references given)]. The relative rate of the observed equivalent widths of Be I lines in the solar spectrum points to a decrease of the continuous absorption coefficient from λ 3321 A towards the shorter wavelengths. [Authors' abstract]

5) Kachalov, V. P., and A. V. Yakovleva. The ultraviolet solar spectrum in the region 2470-3100 A. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 5-43. QB1.A17642

The energy spectrum curve of the sun has been obtained from spectrograms taken at a height of about 100 km, the resolution being 0.15 A at 2700-3100 A and 0.3 A at 2400-2700 A. The absolute energy is determined by comparison with a carbon arc crater radiation. The equivalent width of absorption by resonance lines of ionized magnesium is 66 A at 2800 A. A list is given of measured Fraunhofer lines, their identification and a visual estimate of intensity in the region 2632-2900 A. [Authors' abstract]

6) Steshenko, N. V., and V. L. Khokhlova. He I excitation in chromospheric flares. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 120-139. QB1.A17642

The study of 11 emission lines of parahelium and orthohelium in the flare of 30 Aug 1959, and also several lines in the other flares, shows that the optical depth of the helium lines (with the exception of λλ 5876 and 4471) is small in the region λλ 3700-6700 A of flares observed on the solar disk and at the limb. The population of excited He I levels is derived from the energy of the lines, taking into account the optical depth of nontransparent lines. The line widths are used for obtaining the upper limit of kinetic temperature in the He I emission region ($T_{kin} \leqslant 1.7 \cdot 10^4$ °K for the limb flare of 30 Aug 1959 and $T_{kin} \leqslant 2.6 \cdot 10^4$ °K for a flare on the disk), assuming that the line broadening is due only to the thermal velocities of the atoms.

The population of the He I levels at $n_e = 2 \cdot 10^{13}$ cm^{-3} and values of T_e from 10^4 to $3 \cdot 10^4$ °K is computed theoretically. For this purpose the static equilibrium equations and that of ionization equilibrium are solved for parahelium and orthohelium together.

It is shown that at $n_e = 2 \cdot 10^{13}$ and $T_e = 1.7 \cdot 10^4$ exitation by electron impact and recombination can be provided for the observed emission. The possibility of heating of the optical emission region of the flare due to the absorption of X-ray radiation of the flare is considered. The observed flux of X-ray radiation and the energy output of the flare in the ultraviolet and visual spectral regions can be provided for if the color temperature of the core of the flare is ~ $5 \cdot 10^6$ °K. [Authors abstract]

7) Parkhomovskiy, E. Solar postcripts. Izvestiya, 17 March 1963, 3, cols. 6-7.

[This news item has been included as pertinent to the evaluation of the work of M. G. Karimov, reported in AID Work Assignment No. 3, Reports 15, 29, and 30.]

It is reported that Karimov, Director of the Alma-Ata Solar Corona Station of the Astrophysical Institute of the Kazakh Academy of Sciences, regularly falsified the station's monthly reports on photometric observations of the corona. In order to present the greatest possible amount of data at the earliest possible date, Karimov filled out his report for the first 15 days of each month by copying the data from a corresponding report of the Kislovodsk Astronomical Center, and filled in ficticious data from imaginary observations for the second half of the month. The Alma-Ata station gained the reputation of being the first in the world in coronal observations until Karimov's machinations were uncovered. The matter is under investigation by the Astronomical Council in Leningrad and the Kazakh Academy of Sciences.

TOPIC IV. TELLURIC CURRENTS

1) Glebovskiy, Yu. S. On the local magnetic variations and anomalous telluric currents along the coast of Antarctica. IN: Leningrad. Nauchno-issledovatel'skiy institut geologii Arktiki. Trudy, v. 132, 1962 (Geofizicheskiye metody razvedki v Arktike, no. 4), 7-9.

Particularly strong anomalous telluric currents are observed along the coast. The author attempts to explain these anomalous current variations as resulting from a jump in potential caused by the contact of fresh water, coming from thawing ice, with the salt sea water at the coast. The equalization of salinity in the area of contact causes ion motions, which depend upon the state of the ice and the temperature of the sea water. The salt water diffuses into the porous ice, which plays the role of the partition in a galvanic cell. Here strong currents are developed, which flow along the place of contact between the ice and the sea water.

The author recommends that his hypothesis be verified by laboratory experiments on sea water at various temperatures and ice taken from Antarctica. It is suggested that magnetic observatories be built far from the Antarctic coast.

2) Sedova, F. I. On the diurnal distribution of telluric-current pulsations at various latitudes. IN: Akademiya nauk Ukrainskoy SSR. Institut geofiziki. Geofizicheskiy sbornik, no. 2 (4), 1962, 111-114.

The short-period variations of telluric currents are very important in studying the correlations between the electromagnetic phenomena in the earth's crust and the processes in the upper atmosphere. There are two kinds of pulsations: stable oscillations (pc) and variations of the train-like type (pt). Pulsations of the pc type appear in the daytime, with the maximum at noon. Pulsations of the pt type are observed at night, with the maximum at midnight, local time.

The Institute of Geophysics of the Ukrainian Academy of Sciences uses the length of the period as a standard (short period, 3 to 10 sec; medium period, 10 to 40 sec; and long period, 40 to 90 sec). The medium-period pulsations are subdivided into regular-short, with a period of from 10 to 25 seconds, and regular-normal, with a period of from 25 to 40 seconds. Irregular pulsations are discussed separately. Their periods are determined approximately. The duration of pulsations is determined from oscillograms and serves as the mean duration of pulsations per hour, thereby characterizing the degree of disturbance.

Analysis of the mean values shows that the regular pulsations are similar at great distances. Pulsations with a period from 10 to 25 seconds are observed at all stations in the daytime. At several stations the maximum of the mean duration is displaced. The analysis is carried out with respect to latitude and longitude; and the displacement is explained by the fact that the terrestrial magnetic and geographic axes do not coincide.

Pulsations with a period of 3 to 10 sec are observed at night, with their maximum at 2200-2400 hours, local time. During strong disturbances this type of pulsation lasts until the daylight hours.

Thus, two types of stable pulsations have been detected: the diurnal, with a period of 10 to 40 seconds, and the nocturnal, with a period of 3 to 10 seconds. The mean duration per hour of type-pc pulsations increases sharply at 0300-0400 hours, local time. The minimum of pc occurs at local midnight. Results of the harmonic analysis of stable pulsations are given in tabular form.

Author's Association: L'vov Branch, Institute of Geophysics, Academy of Sciences Ukrainian SSR.

TOPIC V. ATMOSPHERIC ELECTRICITY

1) Dvali, Ye. R. Electric field as affected by different cloud and precipitation forms. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osadkov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity). Moscow, Izd-vo AN SSSR, 1961, 249-253. QC921.M4

The influence of clouds on the intensity of the atmospheric electric field near the surface of the earth was estimated by measuring the intensity of the collector installation connected with a mechanical electrograph. Measurements were made in Dusheti (Georgian SSR) in 1957-1958. It was established that stratus and stratocumulus clouds lower the intensity of the field at times to negative values. The mean value of the field intensity on days with stratus clouds was 71 v/m. The greatest lessening of the field intensity was observed in the winter months. With stratus clouds the mean value of field intensity was 63 v/m. With nimbostratus clouds the mean value of field intensity grows and amounts to 107 v/m. In this case the number of hours with a negative field-intensity value is 36% of the total number of hours; the number of hours when the intensity changes sign is about 55%. The field is less disturbed during snowfalls than during rainfall. Fractonimbus clouds in conjunction with nimbostratus clouds decrease the field intensity to 30 v/m. Changes of field intensity, preceding precipitation and remaining for a time after its cessation, are noted. [Abstract taken from: Referativnyy zhurnal: Geofizika, no. 12, 1962, abstract 12B228]

Author's Association: Tbilisi Scientific Research Hydrometeorological Institute.

2) Gdalevich, G. L. Measurement of the electrostatic field intensity at the surface of a rocket in flight through the ionosphere. IN: Akademiya nauk SSSR. Doklady, v. 146, no. 5, 1962, 1064-1067. AS262.S3663

Measurements of the electrostatic field intensity at the surface of vertically ascending geophysical rockets were made in 1957-1958, employing the electrostatic fluxmeter method. The results of three experiments on 9 Sep 1957, 21 Feb 1958, and 27 Aug 1958 were found to differ substantially with respect to electrostatic field intensities. Determinations were made to ascertain whether the changes in the output signal were caused by the current being measured (working current) or by modulated direct currents (interference currents). Only in cases where the working current considerably exceeded the interference currents could the electrostatic field intensity changes be attributed to a true difference of intensity. Since the density of the interference currents was found not to exceed $5 \cdot 10^{-10}$ $a \cdot cm^{-2}$, most of the recorded values were considered true values of the electrostatic field intensity. Examination of the experimental data indicated that: 1) in a large part of the trajectory the electrostatic field intensity at the surface of the rocket varies within the limits of 0.2 and 3 v/cm and corresponds to a negative rocket charge, and 2) there are sectors in which the rocket has a positive charge. The value of the density of the rocket charge, computed on the basis of values obtained for the electrostatic field intensity (assuming that the rocket is a homogeneous conducting cylinder), lies within the limits of $5 \cdot 10^{-5}$ and 10^{-3} $CGSE \cdot cm^{-2}$.

It is concluded that in several instances an external electrostatic field not associated with the presence of the rocket in the ionosphere was recorded. Estimation of the value of the intensity of this external field must be made by taking into account the specifics of the phenomena occurring near the body in the plasma and must be a matter of special examination. The influence of interference currents must as far as possible be eliminated. The Imyanitov-Shvarts method is recommended (reference given).

3) Imyanitov, I. M. Electric structure of thick convective clouds (Cu Cong) and its relation to air movements in the clouds. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osdakov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity). Moscow, Izd-vo AN SSSR, 1961, 225-238. QC921.M4

Measurements of the electrostatic field intensity and the meteorological characteristics of thick cumulus clouds made by aircraft electrostatic fluxmeters have helped describe their basic macroelectric characteristics. In 50% of the cases the mean field intensity in these clouds does not exceed 5 v/cm, and in 90% of the cases it does not exceed 10 v/cm. Change in cloud thickness has little effect on the value of the mean field intensity. The mean fields in cumulus and cumulus congestus clouds are about the same. The extreme values of field intensity in cumulus congestus clouds exceed 10 v/cm in 50% of the cases, and 30 v/cm in 15% of the cases; in isolated instances, intensities of 100 v/cm are noted. The inhomogeneity of electric fields in cumulus congestus is much greater than in cumulus clouds. The mean density of volume charges in clouds, estimated from data on the variation of the electric field in the cloud, does not exceed 1 esu/m^3 in 80% of the cases, the most likely values lying between 10^{-2} and 10^{-1} esu/m^3. Extreme values of the density of volume charges in 75% of the cases exceed $2 \cdot 10^{-1}$ esu/m^3; in 40% of the cases they exceed 1 esu/m^3. Curves of zone-dimension recurrence (in which extreme values of the field, of the electric charge of the aircraft, and of the dimensions of streams in the cloud are noted) coincide in many cases. It is concluded from this that a substantial role is played by air motion in the clouds and by cloud electrification, and that zones with a sharply changing range of drops and water content are present in convective clouds. On the basis of reduced data a schematic electric model of a cumulus cloud is constructed. The cloud can be imagined to be polarized in such a way that a positive charge is in its upper part and a negative one in the lower. On this distribution are superposed zones of positive and negative volume charges, randomly distributed throughout the cloud. The appearance and distribution of these zones are closely connected with the action of streams in the clouds. The mean rate of growth of basic volume charges in these clouds is 10^{-5} to 10^{-3} esu/m^3 sec, which is 2 to 5 orders lower than the rate of charge accumulation in subsequent stages. In this stage of cloud development such a small proportion of the charges later appearing in the thundercloud accumulates that, in the electrical sense, this stage of development does not build up for the next. It may be assumed that the accumulation of charges in the cloud particles in this stage occurs as a result of a conduction current and the carrying-away of the accumulated charges within the cloud by convective motions, and also because of the charging of droplets during evaporation. Mesoinhomogeneities play a substantial role in the development of convective clouds and of electrical processes. [Author's abstract (slightly abridged); taken from: Referativnyy zhurnal: Geofizika, no. 12, 1962, abstract 12Б227]

Author's Association: Main Geophysical Observatory im. A. I. Voyeykov.

4) Imyanitov, I. M., and Ye. V. Chubarina. Electric structure of low nonprecipitating stratus clouds. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 21-34.

During the IGY and IGC in 1958 to 1959 systematic vertical soundings of the intensity of the atmospheric electric field in the USSR were carried out by aircraft. Stratus (St) and stratocumulus (Sc) clouds were investigated. The aircraft soundings were made along elliptical spirals. The recorded data were reduced to mean values and processed.

Investigations were made of 54 St clouds. Their vertical extent ranged from 100 to 1000 m with a mean thickness of 600 m. The mean field intensity $\bar{E}$ was 0.8 v/cm, E_{max} of all clouds 2.2 v/cm, and E_{min} 1.2 v/cm. The results are given in tabular form. The change in the electric field intensity in the cloud layer as a function of height is presented graphically. The mean value of the negative charge of the upper zone is about -10 esu/m^2, while that of the positive charge of the lower zone is about 10 esu/m^2. There are many unipolar clouds with either a positive or a negative charge. The positive charge throughout the entire cloud thickness was 6.9 esu/m^2. The thickness of these clouds was from 500 to 1000 m The negative charge of the cloud in the whole thickness was -6.4 esu/m^2. The intensity vectors of the field at the upper and lower limits were oppositely directed. The state of the stratus clouds has a significant effect on the intensity of the atmospheric electric field. The potential of the atmospheric layer at the height of 6000 m on clear days is 180 kv, but on days with stratus clouds it drops to 110 kv. The potential difference at the upper and lower cloud limits depends upon the thickness of the cloud.

Analysis of 200 stratocumulus clouds studied in 1958 and 1959 shows that their thickness is from 100 to 1800 m and the mean height of the lower limit about 900 m. The mean field intensity is 0.6 v/m; the maximum value for all clouds is 2.4 v/cm, and the minimum value, 1.4 v/cm. The mean field intensity of the stratocumulus does not depend upon the thickness of the cloud. The field intensity has a seasonal character. The mean summer intensity is -1.1 v/cm, and the mean charge 11.3 esu/m^2. In winter the intensity is 0.6 v/cm, and the charge 1.7 esu/m^2. The summer clouds have a predominantly negative field intensity, while the winter clouds have a positive intensity.

Many clouds of this type have a unipolar charge. Forty-one clouds had a positive charge at the upper and lower limits. The mean charge of these clouds was 6.9 esu/m^2. Thirteen clouds were charged negatively, with a mean value of -11 esu/m^2. Stratocumulus clouds diminish the field intensity at ground level, while increasing it at great heights. They change the field direction above the upper cloud limit and create a negative volume charge above the cloud. The atmospheric potential at a height of 6000 m is the same on clear days as on days with stratocumulus clouds, being equal to 180 kv. The potential difference at the upper and lower limits depends upon the thickness of the clouds. Thick clouds are characterized by a negative change in potential.

The authors divide stratus clouds into four main types and develop a formula for determining the field intensity within the clouds. The four types are:

1) positively polarized clouds with a surplus positive charge;
2) negatively polarized clouds with a surplus positive charge;
3) unipolar positively charged clouds; and
4) unipolar negatively charged clouds.

The field intensity as a function of height (within the middle regions of the cloud) can be expressed by the equation

$$E = a + b(z - h) + c(z - h)^2,$$

where a, b, and c are coefficients, z is the coordinate reckoned from the cloud base, and h is the height at which maximum field intensity within the cloud is observed. This equation holds good for all types of clouds. The density of volume charges depends somewhat on the cloud thickness. The aircraft charge depends upon the particle concentration in the cloud.

Comment: Such investigations of charge distribution in these two types of cloud are very important in air navigation and for safety of flight. Knowledge of the field intensity in a cloud helps the pilot to account for the field influence on the compass reading and to correct the flight course.

5) Imyanitov, I. M., and Ye. V. Chubarina. On the structure and origin of the electric field of the atmosphere. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osadkov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity), Moscow, Izd-vo AN SSSR, 1961, 239-248. QC921.M4

Systematic soundings of the electric field of the atmosphere in Leningrad, Kiyev, and Tashkent, made by aircraft equipped with electrostatic fluxmeters, yielded information on the distribution of field intensity, volume charges, and the potential of the electric field up to heights of 6 - 7 km. The steady decrease in field intensity with height on clear days is often interrupted by the appearance of field maxima (usually located in the inversion zone) and by a change in the sign of the field at a height of 3.5 - 4 km. The estimated difference of potential between the earth and the ionosphere is 200 - 220 kv.

The daily variations of potential even at 6 km do not repeat the diurnal unitary variation of the field intensity and are not synchronous at different observation points. The potentials themselves may differ from the mean values by a factor greater than 2. The relative variations of potentials have a tendency to decrease with an increase of height, but above 3.5-4 km the relative variations of potential are greater. At heights of several hundred meters the daily curve of field intensity repeats the unitary variation, though this similarity is not noted either above or below this layer. The results obtained contradict the "spherical capacitor" theory currently accepted, but may be explained by a theory in which the earth and atmosphere create the observed phenomena as they exchange charges. In this theory the external capacitor plate is the troposphere, especially its lower layer. The appearance of the unitary variation only at a certain height is explained by the fact that at this height the fields of local volume charges in the atmosphere, located above and below, compensate each other and permit the field of earth charges to appear. Changes in this field also cause unitary variation. Zones in which charges flow to the earth and zones in which there is an outflow of charges exchange charges in the atmosphere. The level at which the exchange current begins must lie at a height of 3-4 km. [Author's (Imyanitov's) abstract; taken from: Referativnyy zhurnal: Geofizika, no. 12, 1962, abstract 12B226]

Authors' Association: Main Geophysical Observatory im. A. I. Voyeykov.

6) Imyanitov, I. M., and T. V. Lobodin. Investigation of the electric structure of shower and thunderstorm clouds. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 3-20.

The electric charges of thunderstorm and shower clouds were studied with the aid of TU-104 and IL-14 aircraft equipped with a special electronic unit with two sensitivity scales (± 100 and ± 500 v/cm). The records of the instrument could be controlled visually and switched over from one scale to another. The electric field of the aircraft did not influence the records of the instrument.

Flights were performed above and beneath Cb and Cu Cong. clouds. Of 58 cases, 40 showed a negative charge above the cloud, while 18 cases showed a positive charge. The intensity curve of the electric field showed definite maxima and minima. Of 28 flights beneath the clouds, 19 cases showed either positive cloud polarity or the presence of a surplus positive charge. In 16 cases a very complex cloud structure was found; in one sector of the cloud positive charges were measured, and in another sector, negative. Simultaneous flights above and beneath the clouds showed different field intensities with different variations. In some cases the bipolar charges of the clouds are covered with a surplus field. The cloud charge can be determined theoretically by the formula

$$E = \frac{Qx}{(x^2 + r^2)^{3/2}},$$

where E is the field intensity, Q is the cloud charge related to its central point, x is the vertical distance from the aircraft to the central contour line of the cloud, and r is the distance of the point in the contour line from the cloud center. This formula is used for unipolar clouds. For bipolar clouds the formula

$$E = \frac{AQ}{r^n}$$

can be used, where A is a constant and the exponent n is 3 or 4, depending upon the flight path in the cloud. The mean position of the charge center of the cloud was at a height of 6 to 7 km.

The authors explain the appearance of the surplus charge as a result of the carrying-off of the negative charge by the rain droplets and vice versa.

7) Kolokolov, V. P., and K. A. Semenov. Observations of corona discharge from artificial peak points in Voyeykovo. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 53-61. QC801.L46

During the summer seasons of the years 1958 to 1960 the current intensity during corona discharges was measured in Voyeykovo. The current was measured with a device employing a double triode. A peak 60 mm in length and 1 mm in diameter was fastened on a metal pipe on the roof of the building. In 1960 the peak was changed for a standard peak of 50-mm length and 9-mm base diameter.

The current and the intensity of the ground electric field were recorded simultaneously; the sensitivity of the instrument was 10^{-8} amp or more. The corona discharge takes place during thunderstorms and strong showers. The observational data, given in tabular form, also indicate the influence of the wind. The graphs drawn on the basis of the tabulated data show that the relationship between the current of the corona discharge and the potential is quadratic in the case of weak wind, especially with negative currents. With strong winds the relationship is linear. The authors use the Kirkman-Chalmers formula

$$i = K(E - M)(W + C)$$

in a transformed form, where W is taken to be large in comparison with the constant C. Thus, for theoretical computations of the current i, with strong wind,

$$i \simeq AE - B,$$

where A = KW and B = KMW, E is the potential gradient, W the wind velocity, and C, K, and M are constants. The current i, with weak winds, is computed using a transformed Large-Pierce formula in the form

$$i \simeq QE^2 - N,$$

where Q and N are constants containing Pierce's and Large's constants A, V_0, C, and h.

8) Lobodin, T. V. Snowstorm electricity. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 62-77.

The gradient of the electric potential of the atmosphere was measured with the electrostatic fluxmeter designed by the Main Geophysical Observatory. The transmitter of the device was included within a grounded metal screen with a square base. The extreme values of the recorded potential gradient are $E_{min} = -9 \cdot 10^4$ v/m, and $E_{max} = 2.3 \cdot 10^4$ v/m. The gradient value depends upon the wind velocity, the quantity of snow carried over, and the temperature and physical state of the snow.

The potential gradient increases with increased wind velocity, reaching a maximal value at a velocity of 19 m/sec. Beyond this it diminishes quickly, becoming negative at velocities of 25 m/sec and above. The quantity Q of snow carried over by the snowstorm and ground winds is computed by the formula $Q = Av^3$, where A is a constant and v is the wind velocity. The snow data are taken from snowstorm measurements and laboratory experiments.

The dependence of the potential gradient E upon the wind velocity v is computed by the formula

$$E = E_0 + Bv^3,$$

where $E_0 = 140$ v/m and $B = 0.46$. Comparison of the computed results with the observational data makes it possible to conclude: 1) The curves of experimental and computed data agree. 2) The change of the potential gradient is proportional to the change of the snow quantity carried by the snowstorm, with velocities up to 19 m/sec. 3) A change in the potential gradient of one v/m corresponds to a change in the quantity of snow of 2.5 g/m·sec. The potential gradient increases with falling temperature, reaching a maximal value within the temperature range from -20° to -25°C. The gradient diminishes with further decrease in temperature and at -29° attains a negative value.

The mean value of the volume charge ρ is computed by the formula

$$\rho = \frac{E}{2\pi h},$$

where h is the height of the instrument.

A corona discharge is caused during snowstorms by the volume charge of the lower atmospheric layer. The value of the potential gradient and the volume charge are determined by the temperature, the wind velocity, and the physical state of the snow crystals. The same elements determine the intensity and the sign of the corona discharge, which attains its maximum at -29°.

Assuming the change of the field intensity to be caused by the volume charge of the snowstorm, and multiplying the charge value by the area covered by the snowstorm, the charge of the atmosphere can be computed. The earth gains a negative charge during snowstorms, and the corona discharge carries it off. It is thus far impossible to determine the difference between the charged and discharged state of the currents during showstorms. It may be stated, however, that the Arctic and Antarctic regions are sources of terrestrial charges.

The spatial transfer of charges during snowstorms can be computed by the formula expressing the discharge of particles:

$$Q_t = Q_o e^{-4\pi\lambda\rho t},$$

where Q_t is the charge of a particle after expiration of time t and Q_o the particle charge at t = 0, and λ_ρ is the polar conductivity of air. λ_ρ can be set equal to $\lambda/2$, where λ is the conductivity of air.

9) Paromonov, N. A. Electric conductivity of air over the USSR. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 78-82. QC801.L46

The investigations of the electrical conductivity of air in the USSR are based on observational data obtained at 8 stations, using different types of instruments. The stations are: Voyeykovo (near Leningrad), Vysokaya Dubrava (35 km from Sverdlovsk), Irkutsk Station (in Irkutsk), Yuzhno-Sakhalinsk Station (12 km from Yuzhno-Sakhalinsk), Odessa Station (in Odessa), Dusheti (50 km from Tbilisi), and Tashkent Station (near Tashkent).

Data obtained on normal days are processed. Normal days are considered to be days: 1) without thunderstorms, precipitation, fogs, haze, or snowstorms; 2) without strong winds (exceeding 6 m/sec); 3) without low clouds (especially cumulus clouds); 4) without negative or large positive potential gradients exceeding 500 v/m.

The mean values of positive and negative air conductivity and their ratio are given in tabular form. These data show that in the majority of stations positive conductivity predominates over negative, and that the air conductivity is very different in individual stations. The conductivity increases as the geographical latitude decreases.

The annual variations of the positive and negative conductivity show a minimum in winter and a maximum in summer. Peculiarities in the annual variations are found in some stations.

The diurnal variations of air conductivity show two maxima; the main maximum occurs at night or early morning, and the second maximum at noon or in the afternoon hours. Minima appear in the morning and evening.

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TOPIC VII. SATELLITE AND MISSLE DATA

1) Shvarts, Ya. M. On the operating conditions of the electrostatic fluxmeter in the upper atmosphere. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 83-95.
QC801.L46

The reasons for the development of an electrostatic field on the surface of a sounding body in the upper atmosphere or in interplanetary space are: 1) the exterior electrostatic field; 2) the charge of the body; and 3) difference in potential between points on the surface of the body moving within a magnetic field.

Electrification of the sounding body in the upper atmosphere may be caused by the current of thermal ions I_p, the current of thermal electrons I_e, the current of high-energy electrons of the radiation belts I_{er}, and the current of high-energy ions in the radiation belts I_{pr}. The action of solar ultraviolet and X-radiation, and of high-energy electrons and ions, causes the sounding body to emit (1) photoelectrons, creating the current I_{fe}, and (2) secondary electrons, which create the current I_{se}.

At equilibrium the sum of these currents is equal to zero:

$$I_p + I_e + I_{er} + I_{pr} + I_{fe} + I_{se} = 0. \qquad (1)$$

Equilibrium is established when the potential of the body reaches a certain value, differing from the potential of the surrounding plasma. The body is surrounded by a volume charge from which the intensity of the electric field can be determined. Formula (1) relates to an immobile body in interplanetary space filled with plasma. The value of the potential of the body and the thickness of the charge layer are taken from the work of Gringauz, Kurt, and Moroz (reference given). The field intensity is computed and the results given in tabular form for various potentials and concentrations.

A moving body in a magnetic field is characterized by potential differences on its surface, which depend upon the size and shape of the body. The electric field of the sounding body depends on its own charge and the concentration of charged particles in the surrounding space, especially in the ionospheric F2 layer.

The current density in individual parts of the surface of the body cannot be equal to zero in the equilibrium state, when the total current on the sounding body is zero, because of the following factors: 1) the motion of a sounding body with a velocity equal to that of thermal ions, causing an inequality of total current in individual areas on the body; 2) the difference in potential in surface areas, caused by the motion of the body in a magnetic field; 3) the photoemission created by the illumination of the body surface; and 4) the streams in the upper atmosphere.

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TOPIC IX. METEOROLOGY OF THE UPPER ATMOSPHERE

1) Khvostikov, I. A., M. N. Izakov, G. A. Kokin, Yu. V. Kurilova, and N. S. Livshits. Investigation of the stratosphere with meteorological rockets in the USSR. Meteorologiya i gidrologiya, no. 1, 1963, 3-8.

The authors review data obtained by Soviet and non-Soviet rockets at heights of up to 70-80 km on (1) the temperature field as affected by the season, latitude, and longitude; (2) the temperature stratification of the atmosphere; (3) sudden warming of the stratosphere in the Arctic; (4) the thermal regime in the upper stratosphere during the polar night; and (5) some characteristics of stratospheric circulation. In the polar latitudes of the Northern Hemisphere, unlike those of the Southern, longitudinal temperature differences are observed in the upper stratosphere, particularly in autumn. Thus, there is a definite difference between the temperature fields in the upper stratosphere of the Arctic and the Antarctic. The seasonal effects of continents and oceans are believed to be preserved up to a height of 45 km. A comparison of rocket data obtained on Kheys (Hayes) Island and at Fort Churchill shows that at the former temperatures rose 40-50° at heights of about 40 km as early as 19 Jan, while at Fort Churchill no sharp temperature rise occurred until 25 Jan. Thus, the displacement of the warming region at these high altitudes took place in a westerly direction. During the anomalous warming-up period in Jan 1958 in the stratosphere above the Northern Hemisphere, a typical summer distribution of temperatures was established as far north as 50-60°, with a heat zone over the polar region.

Four typical temperature stratification curves are constructed: Type I - temperature drop; Type II - isothermy; Type III - inversion; and Type IV - tropical zone. In the polar latitudes a seasonal change is noted in the type of stratification. In winter Type I prevails, in summer Type III, and in the transition seasons Type II. No such sharp seasonal variation is noted in the middle latitudes. There the inversional and isothermal types occur with a thin isothermal layer for 10 to 20 km. In the tropical latitudes a more complex temperature distribution occurs, with a minimum at 15 km and a sharp inversion up to a height of 30 km.

Winter measurements of temperature on Kheys island show that a stalle temperature inversion prevails in the upper stratosphere during the entire polar night. Even though the atmosphere in winter at heights of 10-45 km is noticeably (10-35°) colder than in summer, the development of the cold takes place before the onset of the polar night; however, only a slight tendency towards cooling is observed.

Seasonal changes in circulation are noted to agree with temperature measurements. The rebuilding of the wind field from the upper levels is analogous to the reversal of horizontal temperature gradients from the upper levels during the transitional seasons. The greater duration of the spring transition of circulation conditions also corresponds to the more protracted redevelopment of the temperature field (as compared with that in autumn).

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BIBLIOGRAPHY

1) Dvali, Ye. R. Electric field as affected by different cloud and precipitation forms. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osadkov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity). Moscow, Izd-vo AN SSSR. 1961, 249-253. QC921.M4

2) Dvoryashin, A. S., and L. S. Levitskiy. Corpuscular solar radiation on the descending branch of the solar-activity cycle. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 167-177. QB1.A17642

3) Gdalevich, G. L. Measurements of the electrostatic field intensity at the surface of a rocket in flight through the ionosphere. IN: Akademiya nauk SSSR. Doklady, v. 146, no. 5, 1962, 1064-1067. AS262.S3663

4) Glebovskiy, Yu. S. On the local magnetic variations and anomalous telluric currents along the coast of Antarctica. IN: Leningrad. Nauchno-issledovatel'skiy institut geologii Arktiki. Trudy, v. 132, 1962 (Geofizicheskiye metody razvedki, no. 4), 7-9.

5) Gopasyuk, S. I. Spot motion connected with solar flares and the possible character of energy exit from flare regions. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 110-119. QB1.A17642

6) Gorgolewski, S., J. Hanasz, H. Iwaniszewski, and Z. Turlo. Interferometric investigations of the outer solar corona at the 32.1 Mc band. Acta astronomica, v. 12, no. 4, 1962.

7) Imyanitov, I. M. Electric structure of thick convective clouds (Cu Cong) and its relation to air movements in the clouds. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osadkov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity). Moscow, Izd-vo AN SSSR, 1961, 225-238. QC921.M4

8) Imyanitov, I. M., and Ye. B. Chubarina. Electric structure of low nonprecipitating stratus clouds. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 21-34. QC801.L46

9) Imyanitov, I. M., and Ye. V. Chubarina. On the structure and origin of the electric field of the atmosphere. IN: Mezhduvedomstvennaya konferentsiya po voprosam issledovaniya oblakov, osadkov i atmosfernogo elektrichestva. Issledovaniya oblakov, osadkov i grozovogo elektrichestva (Investigations of clouds, precipitation, and thunderstorm electricity), Moscow, Izd-vo AN SSSR, 239-248. QC921.M4

10) Imyanitov, I. M., and T. V. Lobodin. Investigation of the electric structure of shower and thunderstorm clouds. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 3-20. QC801.L46

11) Kachalov, V. P., M. Z. Khokhlov, V. L. Khokhlova, and A. V. Yakovleva. Ultraviolet Be I lines in the solar spectrum. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 44-51. QB1.A17642

12) Kachalov, V. P., and A. V. Yakovleva. The ultraviolet solar spectrum in the region 2470-3100 A. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 5-43. QB1.A17642

13) Khvostikov, I. A., M. N. Izakov, G. A. Kokin, Yu. V. Kurilova, and N. S. Livshits. Investigation of the stratosphere with meteorological rockets in the USSR. Meteorologiya i gidrologiya, no. 1, 1963, 3-8. QC851.M27

14) Kolokolov, V. P., and K. A. Semenov. Observations of corona discharge from artificial peak points in Voyeykovo. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 53-61. QC801.L46

15) Lobodin, T. V. Snowstorm electricity. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 62-77. QC801.L46

16) Paramonov, N. A. Electric conductivity of air over the USSR. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 78-82. QC801.L46

17) Parkhomovskiy, E. Solar postscripts. Izvestiya, 17 March 1963, 3.

18) Sedova, F. I. On the diurnal distribution of telluric-current pulsations at various latitudes. IN: Akademiya nauk Ukrainskoy SSR. Institut geofiziki. Geofizicheskiy sbornik, no. 2(4), 1962, 111-114.

19) Shvarts, Ya. M. On the operating conditions of the electrostatic fluxmeter in the upper atmosphere. IN: Leningrad. Glavnaya geofizicheskaya observatoriya. Trudy, no. 136, 1962, 83-95. QC801.L46

20) Steshenko, N. V., and V. L. Khokhlova. He I excitation in chromospheric flares. IN: Akademiya nauk SSSR. Krymskaya astrofizicheskaya observatoriya. Izvestiya, v. 27, 1962, 120-139. QB1.A17642