Bulletin n° 155 Mars-Avril 1966

U. R. S. I.

TABLE DES MATIÈRES — CONTENTS

NOUVELLES DE L'U.R.S.I.

C'est avec un grand plaisir que nous informons nos lecteurs de l'élection comme Membre de l'Académie des Sciences de France, de M. B. Decaux, Vice-Président de l'U.R.S.I.

Nous lui adressons nos plus chaleureuses félicitations.

COLLOQUE INTER-UNIONS SUR LA PHYSIQUE DES PHENOMÈNES SOLEIL-TERRE

BELGRADE 29 AOUT - 2 SEPTEMBRE 1966

La deuxième et dernière annonce du Colloque est sortie de presse et a été distribuée. Les lecteurs désireux d'en obtenir des exemplaires peuvent s'adresser au Dr Ing. D. BAJIC, President du Comité Organisateur E.T.A.N.-U.R.S.I., P. O. B. 356, Belgrade; ou au Secrétaire Général de l'U.R.S.I.

INTER-UNION SYMPOSIUM ON SOLAR-TERRESTRIAL PHYSICS

BELGRADE, AUGUST 29 - SEPTEMBER 2, 1966

The second and final announcement of the Symposium has been issued and circulated. Copies are available by Dr. Ing. D. BAJIC, Chairman, National Arrangements Committee, E.T.A.N.-U.R.S.I., P. O. B. 356, Belgrade; or by the Secretary General of U.R.S.I.

XIVth GENERAL ASSEMBLY

Progress in Radio Science 1960-1963

Volume V. — Radio Astronomy

Le Volume V de la série «Progress in Radio Science » 1960-1963 est édité par E. Herbays, Secrétaire Général de l'U.R.S.I., en collaboration avec J. W. Warwick, R. Coutrez et R. Gonze. La Monographie rend compte de l'activité scientifique de la Commission V au cours de la XIV^{e} Assemblée Générale de l'U.R.S.I. à Tokyo, en septembre 1963. Les sujets suivants ont été discutés :

1. Radioastronomie de la Galaxie,
2. Radiosources,
3. Radioastronomie du Soleil Calme,
4. Radioastronomie du Soleil Actif,
5. Radioastronomie du Système Solaire,
6. Techniques d'observation et Mesures en Radioastronomie.

Pour chacun de ces sujets, une communication a fait le point de la situation. Le texte intégral de ces communications a été reproduit, suivi d'un compte rendu des discussions et d'un résumé des communications plus courtes, qui ont été présentées. La dernière session a été consacrée à des Sujets Divers en Radioastronomie et traite plus particulièrement des Appareillages.

Ce livre est publié chez Elsevier Publishing Company (Amsterdam, Londres, New York). Des exemplaires gratuits ont été envoyés aux Membres du Bureau, aux Comités Nationaux ainsi qu'aux Membres du Bureau de la Commission V. Des exemplaires supplémentaires peuvent être commandés par les Comités Nationaux au Secrétariat Général de l'U.R.S.I. L'ouvrage peut être obtenu chez Elsevier Publishing Company.

* * *

Volume V of the series « Progress in Radio Science » 1960-1963 is edited by E. Herbays, Secretary General of U.R.S.I., in collaboration with J. W. Warwick, R. Coutrez and R. Gonze. This Monograph gives an account of the scientific activities of Commission V during the XIVth General Assembly of U.R.S.I., Tokyo, September 1963. The following subjects were discussed :

1. Radio Astronomy of the Galaxy,
2. Radio Sources,
3. Radio Astronomy of the Quiet Sun,
4. Radio Astronomy of the Active Sun,
5. Radio Astronomy of the Solar System,
6. Observational Techniques and Measurements in Radio Astronomy.

A review paper has been presented for each subject. These papers are given in full and are followed by proceedings of the discussions and résumés of shorter papers subsequently contributed. The last session has been devoted to Miscellaneous Subjects in Radio Astronomy, dealing more particularly with Instrumentation.

The book is published by Elsevier Publishing Company (Amsterdam, London, New York). Free copies have been distributed to the Officers of the Board, National Committees and Officers of Commission V. Supplementary copies may be ordered by National Committees at the General Secretariat of U.R.S.I. The volume is also available at Elsevier Publishing Company.

NATIONAL COMMITTEES

Argentina

PUBLICATION

The Argentine National Committee has issued the circular nº 1/65 which contains in Spanish language information on the International Geophysical Calendar for 1966 issued by I.U.W.D.S.

Belgique

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U. S. A.

Radio Science

The January 1966 issue of *Radio Science* (Vol. 1, N° 1) besides the membership of the U.S. National Committee and a descriptive notice on U.R.S.I., contains the following papers :

— Impedance of a radio-frequency plasma probe with an absorptive surface, K. G. BALMAIN.

COMMISSIONS AND COMMITTEES

Commission II on Radio and Troposphere

SYMPOSIUM ON PLANETAXY ATMOSPHERES AND SURFACES

PUERTO RICO, MAY 24-27, 1965

The proceedings of the meeting have been published in a special issue of *Radio Science*, Vol. 69D, N° 12, December 1965. The invited papers and contributions published in that issue are :

I Session : JUPITER, AS OBSERVED AT LONG RADIO WAVES.

A. Invited Paper.
The Decametric Radio Emissions of Jupiter, G. R. A. ELLIS.

B. Short Contributions.

1. Results of Recent Investigations of Jupiter's Decametric Radiation, T. D. CARR *et al.*
2. Results from C.S.I.R.O., Sydney, Australia, O. B. SLEE and C. S. HIGGINS.
3. Frequency and Polarization Structure of Jupiter's Decametric Emission on a 10-millisecond scale, J. W. WARWICK and M. A. GORDON.

II Session : JUPITER, AS OBSERVED AT SHORT RADIO WAVES.

A. Invited Paper.
Jupiter, as Observed at Short Radio Wavelengths, J. A. Roberts.

B. Short Contributions.

1. An Interferometric Study of Jupiter at 10 and 21 cm, G. L. Berge.

2. Dependence of Jupiter's Decimeter Radiation on the Electron Distribution in its Van Allen Belts, K. S. THORNE.
3. Observations of Jupiter at 8.6 mm, J. E. GIBSON.
4. Simultaneous Observations of Jupiter on Three Frequencies, I. N. KAZES.
5. A Report of Measurements, D. BARBER and J. F. R. GOWER.

III Session : PASSIVE RADIO OBSERVATIONS OF VENUS, SATURN, MERCURY, MARS AND URANUS.

A. Invited Paper.
Passive Radio Observations of Mercury, Venus, Mars, Saturn and Uranus, A. H. BARRETT.

B. Short Contributions.

1. Mars, Venus at 70-cm Wavelength, H. E. HARDEBECK.
2. Radio Observations of Mercury, Venus, Mars, Saturn and Uranus, K. I. KELLERMANN.
3. The Observations of Radio Emission from the Planets Mercury, Mars and Saturn at wavelength of 8 mm, A. E. SALOMONOVITCH.
4. A Search for the 1.36 cm Water Vapor Line in Venus, F. D. DRAKE.
5. Radiation of Venus at the 13.5 Water Vapor Line, J. E. GIBSON and H. H. CORBETT.
6. Observations of the 1.35 cm Water Vapor Line in Venus, W. J. WELCH.
7. Observations of Mars at 12.5 cm Wavelength. D. O. MUHLEMAN and T. SATO.
8. On the Nature of the Cloud Layer of Venus, A. E. BASHARINOV and B. G. KUTUZA.
9. An analysis of Microwave Observations of Venus, C. SAGAN and J. B. POLLACK.

IV Session : PASSIVE RADIO OBSERVATIONS OF THE MOON.

A. Invited Paper.
Investigation of the Surfaces of the Moon and Planets by the Thermal Radiation, V. S. TROITSKY.

B. Short Contıibutions.

1. Polarization of Thermal Radiation of the Moon at 14.5 Gc/s, P. G. MEZGER.
2. Linear Polarization of Lunar Emission, R. D. DAVIES and F. F. GARDNER.
3. The Effects of Roughness on the Polarization of Thermal Emission from a Surface, T. HAGFORS and J. MORIELLO.
4. Measurements of Lunar Radio Brightness Distribution and Certain Properties of its Surface Layer, A. E. SALOMONOVICH.

V Session : RADAR OBSERVATIONS OF THE PLANETS.

A. Invited Paper.
A Review of Radar Studies of Planetary Surfaces, G. H. PETTENGILL.

B. Short Contributions.

1. Preliminary Venus Radar Results, R. M. GOLDSTEIN.
2. Preliminary Mars Radar Results, R. M. GOLDSTEIN.
3. Recent Arecibo Observations of Mercury, G. H. PETTENGILL.
4. Recent Arecibo Observations of Mars and Jupiter, R. B. DYCE.
5. Radio Evidence on the Structure and Composition of the Martian Surface, C. SAGAN and J. B. POLLACK.
6. Radar Scattering from Venus and Mercury at 12.5 cm, D. O. MUHLEMAN.
7. Application of Planetary Measurements to Planetary Radius and Rotation Rate Determinations, I. I. SHAPIRO.
8. Radar Observations of Venus in the Soviet Union in 1964, V. A. KOTELNIKOV.

VI Session : RADAR OBSERVATIONS OF THE MOON.

A. Invited Paper.
Radar Studies of the Moon, J. V. EVANS.

B. Short Contributions.

1. Decameter-wave Radar Studies of the Lunar Surface, J. R. DAVIS *et al.*

2. Lunar Mapping by Coherent Pulse Analysis, T. W. THOMPSON.
3. Interpretation of the Angular Dependence of Backscattering from the Moon and Venus, P. BECKMANN and W. K. KLEMPERER.
4. A Note on the Radio Reflectivity of the Lunar Surface, A. GIRAUD.
5. Moon Distance Measurement by Laser, A. ORSZAG.

The discussions following the presentation of invited papers and some other contributions are also published.

Commission III

SPACE RESEARCH ACTIVITIES IN THE U. S. A

Excerpts from the condensed version of the report submitted to COSPAR at its eighth meeting, Argentina, May 1965 (*COSPAR Information Bulletin*, n° 28, November 1965).

6. — Ionospheric Physics

4.1. — *Satellite and Space Probe Program.*

Central Radio Propagation Laboratory of the National Bureau of Standards. CRPL is participating in the international topside-sounder program by analyzing Alouette swept-frequency data and by having operational and scientific responsibility for the fixed-frequency topside sounder, Explorer XX. This latter satellite (also known as TOPSI or S-48, launched by NASA into a 1000-km polar orbit on 25 August 1964) carries sounding experiment for six frequencies between 1.50 and 7.22 Mc/s. Current study includes : ducted propagation to the conjugate reflection points, sheets of thin irregularities discovered in the arctic regions, the excitation mechanism of plasma resonances, longitude variations of the occurrence of irregularities, the association of irregularities with other geophysical phenomena, etc. The topside soundings are coordinated with other observations, e.g., all-sky auroral cameras, incoherent scatter sounders, conventional ionosondes, and backscatter radars. The first CRPL report on this work (Science, 146(3642), 391-395) depicted a wide variety of topside ionospheric conditions, including normal echoes, ordinary and extraordinary mode penetrations, sporadic-E effects, and plasma resonance. These early observations have yielded new information on the geographical distributions of ionospheric phenomena.

Beacon transmitters on board the OGO-1 satellite radiate CW signals at frequencies of 40 010 and 360 090 Mc/s (with 20.0 and 200.0 kc/s modulation) in order to measure electron content in the exosphere beneath the satellite.

Ionospheric irregularities are being mapped by a three-station 150-km base line system of Faraday receivers monitoring transmitters on the Polar Ionosphere Beacon satellite (Explorer XXII, launched in October 1964). The receivers continuously monitor polarization orientation.

U. S. Army Electronics Laboratories, Fort Monmouth. The Ionosphere Beacon satellite radiates coherent signals at 20, 40, 41, and 360 Mc/s. At USAEL, satellite propagation studies of simultaneous Doppler, Faraday rotation, hybrid methods combining the two, and topside and bottomside ionogram integration have been combined. Diurnal electron content contours obtained from simultaneous Doppler-slopes techniques reveal the existence of ionization-content enhancement in the period following midnight, resulting perhaps from a downward electron flux at 1000 km altitude. When combined, results from diurnal contours of bottomside and topside electron densities point to the same effect.

Special studies of anomalous Doppler signal reception on high frequencies have yielded data concerning the effective radio horizon for an Earth receiving station, and on some controlling factors in beyond-the-horizon HF propagation conditions (i.e., the extent and requisite conditions of ionosphere cavity signal-propagation modes).

The same group of investigators is operating a station to receive the Alouette satellite sounder data (and later ISI satellites), with attention to the effects of magnetic disturbances on the electron densities of the topside ionosphere. Studies of electron-density values during magnetically quiet days at fixed altitudes along various latitudes reveal a well-stratified ionosphere between 35° and 45° North Latitude but a sharp increase of electron densities south of 35° North Latitude.

University of Illinois has continued to use the Faraday rotation and scintillation of satellite radio signals to obtain total electron content for the periods from September 1958 to June 1959 and from July 1961 to April 1964. Size and height of irregularities, and the thickness of the regions have been measured. The character of the scintillation, and thus probably of the ionospheric irregularities that cause them, varies with geomagnetic latitude, season of the year, time of day, and phase of the sunspot cycle. Strong scintillation occurs simultaneously with red auroral arcs.

Stanford University is continuing studies of whistler-mode propagation and resonance phenomena at VLF, particularly the propagation of VLF waves in a multicomponent plasma. The intial impetus for this investigation was provided by the discovery of the subprotonospheric (SP) whistler, which enters the ionosphere, propagates to a height of approximately 100 km, and is then reflected back to lower heights.

Investigation of the broadband records from the Alouette I and Injun III satellites showed evidence for the existence of ion and electron-ion resonances. The « Alouette Hiss Band » and the related triggering of the band appear to be closely related to the lower hybrid resonance, an electron-ion resonance for propagation perpendicular to the magnetic field. Simultaneous measurements of the lower hybrid frequency and of electron density yield an effective mass of the ion constituents, with the lightest ions having the greatest effect. As far as is known, the lower hybrid resonance has not been previously observed either in the ionosphere or in laboratory plasmas.

Injun III observations and occasional Alouette observations show what appears to be triggering of emissions at the hydrogen-ion gyrofrequency by atmospherics propagating up to the satellite. This may be a propagation effect associated with the presence of more than one ion.

Other research at Stanford University includes : (1) correlation studies of a variety of geophysical phenomena observed in the Antarctic; (2) study of VLF noise observed on the OGO-1 satellite; (3) study of the relation between the « knee » in the equatorial electron-density profile and PC4 and PC5 micropulsation periods; (4) investigation of large-scale movements of magnetospheric ionization with whistler data obtained during continuous recordings.

A joint report with the State University of Iowa describes a new VLF phenomenon, the proton-whistler. It appears on a frequency-time spectrogram as a tone that stars right after the reception of a short fractional-hop-whistler at the satellite, first rises rapidly in frequency, then asymptotically approaches the proton gyro-frequency in the plasma surrounding the satellite. The proton-whistler may simply be a dispersed form of the original lightning impulse, the dispersion resulting from the effect of ions on the propagation of an electromagnetic wave. It is found that, in addition to the right-hand polarized whistler mode, the left-hand polarized mode (ion-cyclotron wave) is also a possible mode of propagation for certain ranges of frequencies and altitudes. The Iowa-Stanford work shows that the proton-whistler is an ion-cyclotron wave that occurs through a polarization reversal process. The « crossover » frequency can be measured from spectrograms of proton-whistlers and can be used to determine the fractional concentration of protons in the plasma surrounding the satellite. Near the altitude and frequencies for which polarization reversal occurs, the right-hand polarized wave and the ion-cyclotron wave may be strongly coupled. For frequencies near the ion gyrofrequencies, this coupling process would play an important part in determining what regions of the ionosphere are accessible to waves from a given source location.

The Pennsylvania State University Ionospheric Research Laboratory is conducting a number of studies related to ionospheric and propagation characteristics, using satellite signals, including dispersive Doppler recordings, equatorial observations, differential Faraday rotations, scintillation effects, and sunrise phenomena.

AF Cambridge Research Laboratories. The first ORBIS (for Orbiting Radio Beacon Ionospheric Satellite) for an HF ducting experiment was successfully launched on 18 November 1964 into a low polar orbit. Preliminary results show the following effects : (1) fairly strong signals were received almost daily at or after local dawn from the north and northwest from regions as far as Alaska, when the satellite was far below the horizon; (2) signals were received from the south and southeast almost daily about the time of local midnight, over distances sometimes as much as 6500 km; (3) the signal sometimes faded when the satellite was in sight. These effects were observed in Sputnik III records and may be due to grazing ionospheric angles and irregular patches of higher electron density.

4.2 — *Rocket Programs.*

University of Illinois, University of Michigan, University of Birmingham (UK), *and Geophysics Corporation of America.* A cooperative rocket research program involving these institutions was undertaken to study the D and lower E regions of the ionosphere as part of a joint I.Q.S.Y. program. Seven successful flights were made during 1964 : one in April, three in July, and two in November from Wallops Island, Virginia; and one from the NASA shipborne mobile-launch facility in the Atlantic, in November. (Similar flights were also made on the shipborne expedition in the Eastern Pacific in early 1965). The April flight, at solar zenith angle of 60°, measured electron densities varying from 10 to 10^5 cm^{-3} over the height range of 60-160 km by a radiopropagation technique. Other parameters measured on the same payload included electron and positive-ion current, collision frequency, and ultraviolet solar flux. The July series centered around sunrise, and established the relative roles of photo-ionization and photodetachment in the formation of the C and D layers. The November series extended these studies to sunset conditions. The July series accidentally coincided with the occurrence of a sequential sporadic E over Wallops Island, and a detailed study of the electron-density height profile is proving fruitful.

A modification of the radio propagation technique has been developed for use at the magnetic equator, and two of the 10 flights scheduled in early 1965 were conducted at that location as part of the NASA mobile-launch expedition mentioned above.

Lockheed Missile and Space Company. In October 1964, a sounding rocket launched from Wallops Island, Virigina, at approximately midnight measured the ion concentration, composition, and temperature profile from 260 km to nearly 1000 km. Ion-concentration data obtained for a four-day period in late 1963 by a polar-orbiting satellite shows the presence of a prominent ion-concentration trough at all longitudes in the mid-latitude region of both the Northern and Southern Hemispheres at night. These troughs are geomagnetically controlled, with their centers near L = 3.5, and occur just on the low-latitude side of the auroral zones. The shape and width of these troughs vary, and appear to depend upon the position and intensity of the energetic particles deposited in the auroral zone, becoming narrower for greater fluxes. A point-by-point comparison of the ion data and precipitated energetic particles shows that auroral-zone particles help to maintain the night ionsphere there.

Analysis of ion-trap data obtained in 1962 from an oriented polar-orbiting satellite has yielded data on ion temperature, heavy-ion concentration, and electron temperature. Ion temperatures for the equator, in the F-maximum region, are 1100-1200° K, as expected for the neutral atmosphere, but ion temperatures in the northern and southern auroral zones at a height of about 300 km are rather high (3000-4000° K). Heavy-particle concentrations show unusual structure and are more prominent in the auroral zone than previously supposed.

Air Force Cambridge Research Laboratory. AFCRL studies of natural and artificial perturbations of the ionosphere have included :

(1) Theoretical studies of plasma-neutral interactions that result in formation in the ionosphere of moving layers of radio-frequency-reflecting irregularities.

(2) Controlled chemical releases, from rockets, to determine characteristics of the undisturbed ionosphere, including winds and turbulence generated by natural energy sources, the effects of sudden injection of energy by explosive releases, and the degree of modification that can be achieved by releases of active chemicals.

(3) Line-of-sight studies, of both optical emissions and radio-frequency reflections of large-rocket launches, to define a model of the ionospheric disturbance associated with such launches.

(4) Studies of long-range, over-the-horizon radio transmissions, analyzing the variations in received signal characteristics, relating these variations to natural and artificial disturbances, and attempting to localize the height and character of the perturbations along the transmission path.

AFCRL has investigated temperatures and densities of positive ions, negative ions, and electrons in the lower ionosphere at heights between 50 and 200 km in both daytime and nighttime by rocket flights at middle and high latitudes. On both day and night flights, sharp, thin layers of ionization are observed in the vicinity of 100 km; these are presumably sporadic E. The relative importance of wind magnitude and direction and of the influence of meteoritic or other ions on the occurrence of this phenomena is being investigated. In the D region, in the vicinity of 65 km, positive- and negative-ion layers are normally observed, but no electron maximum is found. Rate coefficients for associative and collisional detachment and for radiative attachment to molecular oxygen have been deduced.

The results of nighttime charge-density measurements between 240 and 1875 km show that atomic oxygen is the principal ionic constituent below 530 km and that ionized hydrogen is the major constituent above 550 km. An upper limit is placed on the helium-ion distribution, which attains its maximum value at 550 km. At this level, it appears to constitute a maximum of about 7 % of the total ion density.

A new value for the ion-atom interchange coefficient for the production of NO^+ has been obtained from the variations with time of change densities in the altitude region 280 to 800 km; the coefficient is found to vary between 2 and 4 $\times$ $10^{-12}cm^3sec^{-1}$. The analysis also shows that diffusion of charged particles under the influence of the Earths' magnetic field acts as a source of these particles below 300 km at night. The diffusion term changes sign slightly above this level.

The diurnal variations of electron temperatures and of ion and electron densities have been determined from satellite measurements in the F region. Large diurnal variations of electron temperatures are observed between 200 and 330 km. The electron temperature is found to increase by about 2000° K within a few hours of sunrise and reaches a minimum shortly before sunrise. Over the latitude range of $\pm$ 75°, variations of temperature with local time are greater than the variations with latitude. Below 200 km, the amplitude of the diurnal variation of the electron temperature decreases rapidly with decreasing height.

In the equatorial and auroral regions, other significant changes in temperature and charge density occur and are superimposed upon the diurnal variation.

Application of the experimental results to determine the most important electron heating and cooling processes in the lower F region shows that, in the daytime above 230 km, excitation of atomic oxygen to the D level, collisions with molecular nitrogen, and elastic collisions with atomic oxygen all have comparable effects on electron cooling. Below 200 km, collisions with molecular nitrogen constitute the principal cooling process.

Comparison of the heat input to the ionosphere required to maintain the observed differences between the electron and neutral-gas temperature with the heat fluxes shows that the solar flux is sufficient to explain these temperature differences.

University of New Hampshire. For an investigation of the equatorial electrojet, in late January 1964, four rocket-borne magnetometers were launched near the magnetic equator at Trivandrum. Electrical current in the ionosphere was observed on two flights before local noon; a current of smaller intensity was recorded near 15 h local time; no measurable current was detected at 19 h local time. The current extended vertically between 100 and 130 km, with the most intense layer between 110 and 120 km.

Four more magnetometers were flown at and slightly north of the electrojet in the Pacific on the NASA shipborne expedition off the coast of Peru, in an attempt to measure the Sq current system near the equator but outside of the electrojet.

Ballistic Research Laboratories. The BRL program for development of gun-launched atmospheric probes was continued during 1964. A series of firing of the 5-inch gun took place at Wallops Island in March, July, and October . Wind measurements were performed. The development of the 7-inch-gun probe system was begun in 1964, with a series of horizontal tests in May, June, and November. The first vertical tests of the 7-inch system took place at Wallops Island in December 1964 and January 1965. The tests were highly successful, with eight out of ten probes going to the programmed height. At Barbados Islands, British West Indies, the testing of the 16-inch-gun sytem continued, with wind measurements and tests of various telemetry units.

As part of the BRL ionosphere measurement program, four rockets were launched at Ft. Churchill, Canada, to measure the Earth's magnetic field electron density and temperature, and ion density to an altitude of 800 km. Two rockets were launched 90 seconds apart, and 36 hours later another pair of rockets was launched. In each pair, proton-precession magnetometers were flown on one rocket for low-altitude measurements (to 160 km), and magnetometers, Langmuir probes, and two-frequency beacons were flown on the other for high-altitude measurements (to 800 km).

4.3 — *Ground-based Studies Related to Rocket and Satellite Research.*

CRPL has continued its cooperative program to provide ionospheric soundings as control data for nearly all rocket launchings at Atlantic and Pacific missile ranges, with emphasis on nondeviative absorption measurements in the polar regions. These have been interpreted in terms of electron-density profiles for PCA and certain auroral absorption events.

At Stanford University, work has continued on magnetospheric electron density measurements and wave-particle interactions, with emphasis on : (i) the whistler method; (ii) field-line distribution of electrons; (iii) electron-density analysis based on VLF emissions; (iv) multiphase periodic VLF emissions; and (v) association between VLF emissions and flickering auroras. A series of seasonal studies of the « knee » in the magnetospheric electron-density profile has also been conducted, with whistler data recorded during July 1963 at Eights Station, Antarctica, and supporting data from Byrd Station, Antarctica, and from Quebec City and Great Whale, Canada, in the conjugate region; these programs have greatly benefited from the cooperation of the Defence Research Telecommunications Establishment, Ottawa, Canada, which made available data from the VLF and sounder experiments on Alouette I.

Also in 1964, a survey of the solar-cycle dependence of electron content was completed and the interpretation of topside-sounder profiles has been undertaken.

The U. S. Army Electronics Laboratories and the University of Illinois have continued their joint study of the Faraday rotation of lunar radio echoes in an effort to derive diurnal, seasonal, and secular variations in the ionospheric content.

Pennsylvania State University is continuing a variety of ground-based studies of significance to rocket and satellite research. In addition, interest continues in upper-atmosphere mass spectrometry, F-region aeronomy, and upper-atmosphere electrodynamics.

4.4. — *Radar Incoherent-Backscatter Studies of Upper Ionosphere.*

Arecibo Ionospheric Observatory of Cornell University, in Puerto Rico, is using the 300-m spherical-surface antenna for a number of experiments, including : (i) density fluctuations and traveling irregularities; (ii) spectrum measurements; (iii) the upper F-region; and (iv) fine-structure studies.

A separate investigation has been started to determine whether the sporadic E layers observed with an ionospheric sounder are field-aligned. Preliminary data reduction indicates that they are not.

Jicamarca Radar Observatory of CRPL/NBS has during the past year continued its incoherent backscatter observations to obtain electron density, electron and ion temperatures, and ionic composition of the equatorial ionosphere near Lima, Peru. Approximately two dozen calibration comparisons have been carried out between Jicamarca profiles and topside measurements from four satellites.

Millstone Hill Station of the Lincoln Laboratory (MIT) has used its radar to continue ground-based observations of the electron density and ion temperature of the F region.

4.5 — *Theoretical Research.*

AFCRL workers have derived coupled-wave equations that describe the propagation of magnetohydronamic waves in a plasma that varies with altitude. Their theoretical studies include plasma-neutral gas interactions, and mechanisms for generating the observed neutral winds in the ionosphere, the production of an electron-depleted region (or « hole ») in the ionosphere, the dynamics of a single charged particle moving in an axially magnetostatic field.

At the University of Illinois, the operation of radio-frequency and direct-current probes in the ionosphere is being studied and the role of energetic photoelectrons in heating the ionosphere and the protonosphere are under laboratory and theoretical study.

The ionosphere group at Stanford University has conducted studies of fundamental wave-particle interactions, including : (i) fundamentals of VLF emission generation mechanisms, with emphasis on high-altitude ionospheric emissions; (ii) whistler propagation in a thermal magnetosphere; (iii) wave-particle gyroresonance interaction in the Earth's outer ionosphere; and (iv) direct traveling-wave amplification of whistler-mode signals by means of a gyrating electron stream (a traveling-wave gyroresonance instability).

CRPL investigators report that measurements of reaction rates have shown conclusively that helium ions in the ionosphere are lost by reaction with molecular nitrogen rather than with molecular oxygen, in contrast to previous theories, a result that upsets the current basis for a steady state helium atmosphere.

CRPL scientists have also studied the electrostatic coupling between the ionosphere and the outer magnetosphere (including their effectiveness in forming ionospheric irregularities, the effect of electrostatic fields on acceleration of electrons, etc.). The shape of a model magnetosphere in which the pressure of the magnetic field inside is balanced by the pressure of the solar wind outside has been investigated in detail.

Douglas Aircraft Company scientists have computed the relationship between production rates and electron densities in the lower ionosphere (usually expressed in terms of an effective recombination cœfficient) for solar cosmic ray events.

Pennsylvania State University ionosphere scientists are actively pursuing a series of studies on plasma physics, wave propagation, and electromagnetics.

4.6. — *The Ionospheres of Other Planets.*

CRPL has constructed theoretical models of the atmospheres and ionospheres of Mars and Venus, including the variation of maximum electron density as a function of upper-atmosphere composition. AFCRL has developed a small quadrupole mass-spectrometer system for use on a Mariner-type probe to sample the atmosphere of Mars, which makes accurate analytical measurements of the composition.

Space Research in the U. S. S. R.

Excerpts from the report submitted to COSPAR at its eighth meeting, Argentina, May 1965 (*COSPAR Information Bulletin*, n° 28, November 1965).

II. — Investigations of the Earth's Upper Atmosphere including the Ionosphere

1. From the satellites *Electron* 1, *Electron* 2, *Electron* 3 *and Electron* 4 *mass-spectrometric investigations of the ionic composition of the atmosphere were conducted* in the height range 400-3000 km (17R). It was established that in the period of the solar activity minimum the concentration of molecular ions NO^+, O_2^+ and N_2^+ at heights from 400 to 500 km is at least one order of magnitude lower than in the period of the maximum. It is also established that at all the heights under investigation helium ions constitute a small portion of the overall ion concentration and that nowhere are they predominant ions. The equality of concentrations of atomic oxygen ions and atomic hydrogen ions is reached at heights of the order of 900 km.

2. Ionospheric investigations by means of coherent radio waves were continued by the method of analyzing continuous records of the differences of the Doppler shifts of their frequency $\delta\Phi$ (15R, 16R).

Earlier some results of such investigations were obtained from satellites of the Cosmos series to the height $z_c \sim 450$ km. In 1964 experiments of such a kind were conducted from scientific stations Electron 1 and Electron 3. The « Mayak » beacons were used at them which emitted on coherent frequencies 20.005, 30.0075 and 90.0225 Mc/s. The completed stage of processing the data obtained led to some new results (15R, 16R).

The altitude, or more precisely, the time-altitude variations of electron concentration $N_c(z_c, t)$ were plotted which describe the change of the local value N_c with height at different instants of time from February to March, 1964, in the vicinity of midday (approximately $\pm$ 1 hour). Individual values of N_c for which this dependence is obtained refer not only to different days, times and heights, but also to different geographic points which are separated on the horizontal from each other by $\pm$ (100-200) km from the observation point.

In good agreement with each other in the range of heights from 430 to 1100 km for three observation points, for which the corresponding data are obtained, the values of N_c (z_c,t) form a quasiperiodic curve with maxima and minima alternating each 120-160 km (see Fig. 1). The first maximum N_c (z_c,t) obtained earlier by the same method above the ionosphere main maximum N_mF_2 described in the paper submitted to the 5th COSPAR Meeting agrees well with these data.

For the height range from 1100 to 2000 km the number of the data used is insignificant and refers only to one observation point (Tbilisi). Here N_i slowly decreases with height and varies within limits (1-2) $\cdot$ 10^4 which exceeds several times some values at these heights previously published in the literature. It should also be noted that the smoothed-averaged variation N_c (z_c, t) agrees with different altitude curves of N(z) published in the literature. At the same time one maximum is displayed on it at a height $z \sim 800$ km and the minimum at $z \sim 600$ km. The appropriate Nc(z,t) curve is shown in Fig. 2 where it is compared with the results obtained in Lima (Peru) by the method of incoherent radio wave scattering and over Singapore through the satellite Alouette.

The dependence $N_c(z_c,t)$ shown in Fig. 1 at first glance contradicts almost smooth height curves N(z) observed, for instance, for the short time of measurements during a single launching of the high-altitude rocket. However, as we see, data given in Fig. 1 have absolutely other content (see 15R and 16R). Naturally further verification of the repeatedness of these results is required.

From $\delta\Phi$ (t) curves investigations were made of the size spectra W (ρ_o) of inhomogenous formations of the ionosphere, their altitude and latitude dependence, and also spectra W (N-N_o) of the deviation of electron concentration N of these inhomogeneities from the undisturbed value N_o. Also in good agreement between themselves it is obtained for all points that in the whole altitude range the spectrum W (ρ_o) (see Fig. 3) has two stable maxima : a weakly pronounced maximum at $\rho_m \sim 7$—10 km and a sharply pronounced maximum at $\rho_o \sim 15$—30 km. The maximum known earlier is revealed at $\rho_m \sim 2$—4 km. Large-scale inhomogenous formations are observed up to the values $\rho_o \sim 400$ km. Inhomogeneity of the ionosphere is generally observed not at all latitudes with equal probability (see Fig. 1).

3. Investigations of the *upper atmosphere density* from satellite drag were continued (11R). The study of the orbit evolution of 16 Soviet satellites made it possible to obtain data on the atmospheric density at heights from 170 to 300 km in the years of the

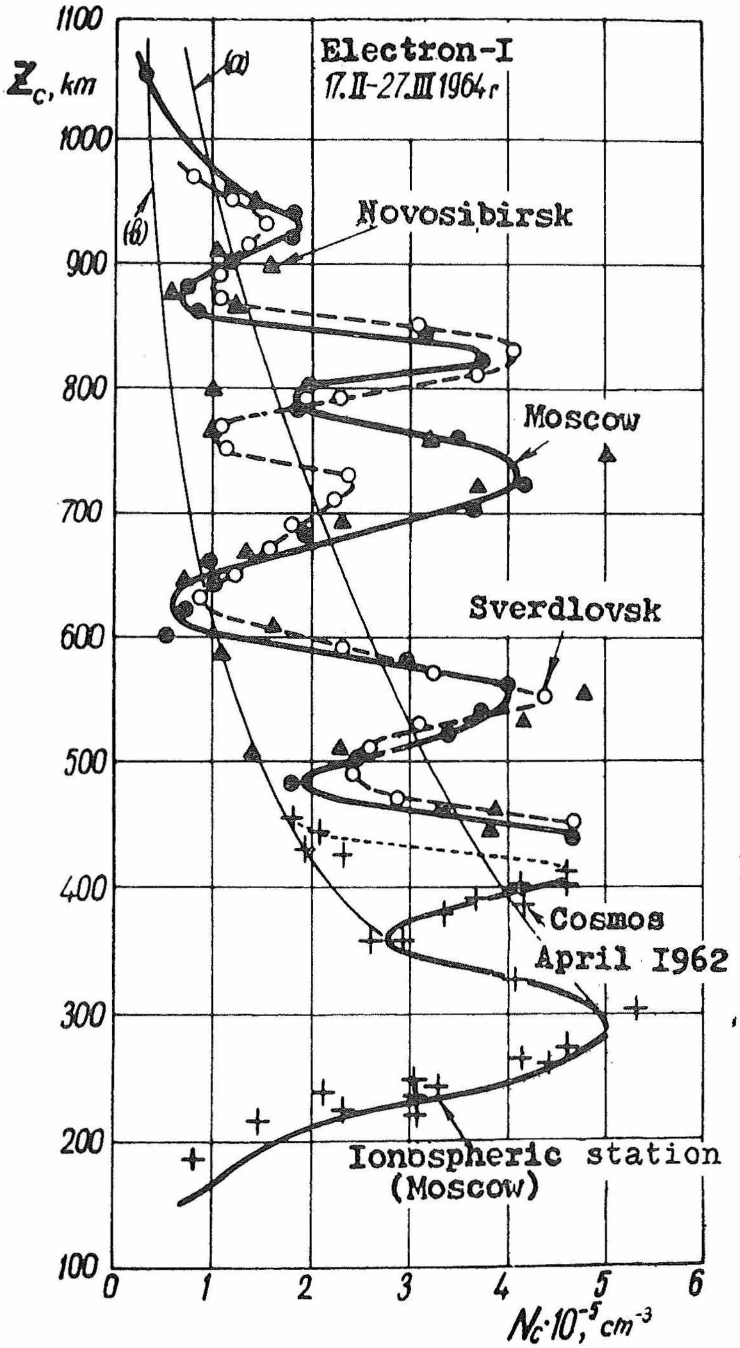
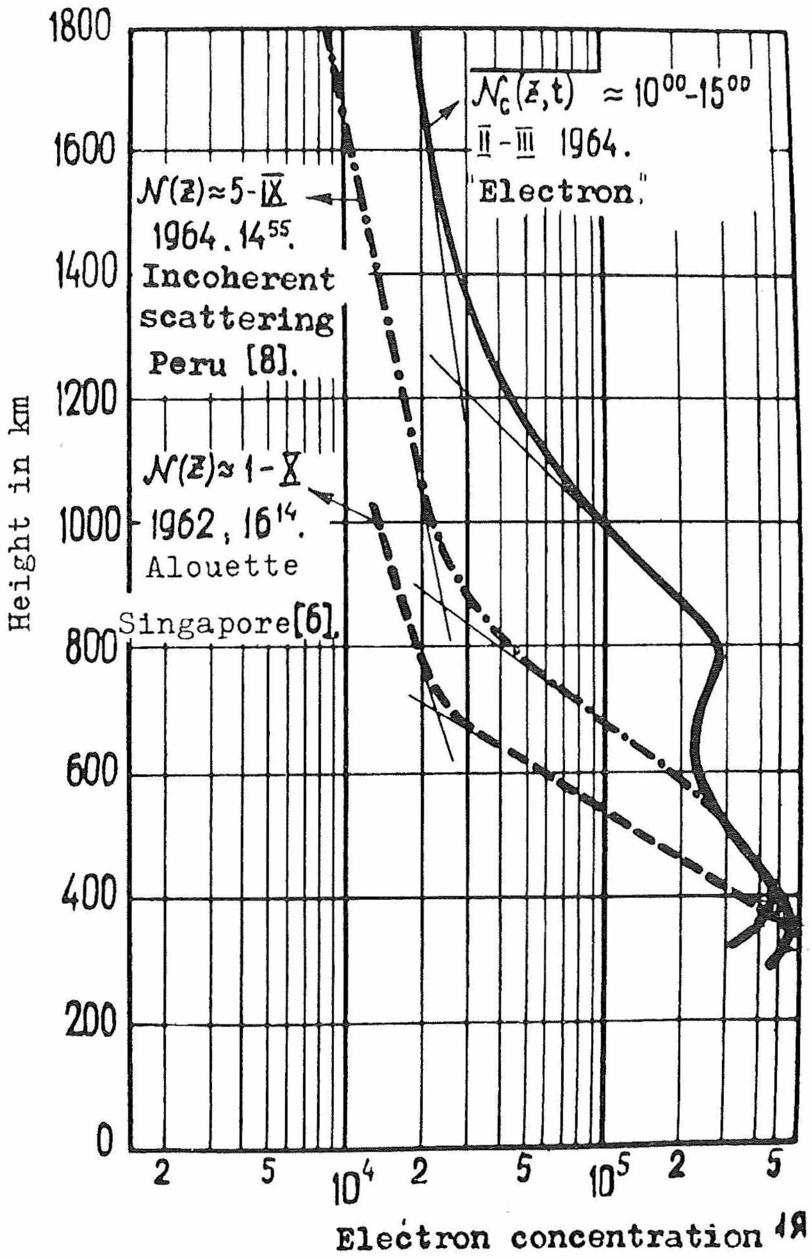
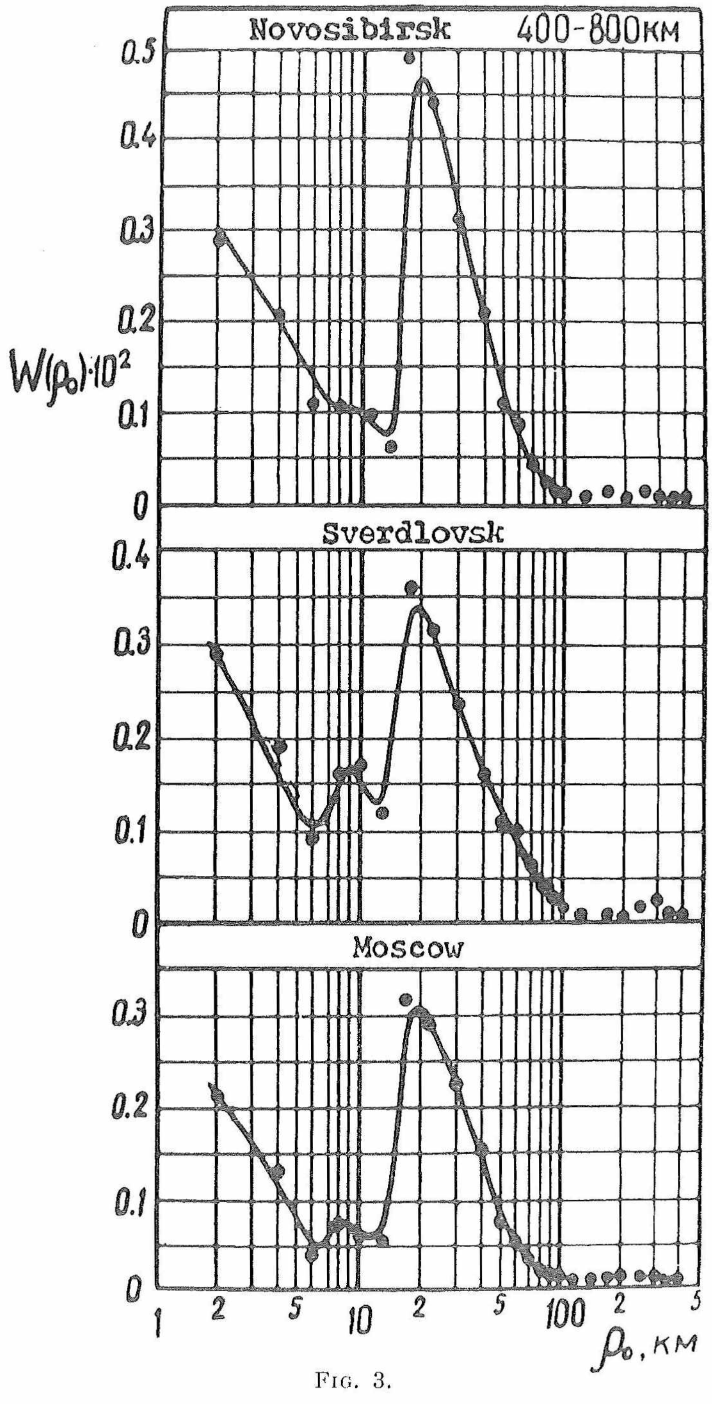

Electron-I
17.II-27.III 1964 г
(a)
(b)
Novosibirsk
Moscow
Sverdlovsk
Cosmos
April 1962
Ionospheric station
(Moscow)
Z_c, km
1100
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6
N_c·10^-5, cm^-3

FIG. 1.



1800
1600
1400
1200
1000
800
600
400
200
0
Height in km
$N_c(z,t) \approx 10^{00}$-15^{00}
II-III 1964.
"Electron."
N(z)≈5-IX
1964. 14^55.
Incoherent
scattering
Peru [8].
N(z)≈1-X
1962, 16^14.
Alouette
Singapore[6].
2
5
10^4
2
5
10^5
2
5
Electron concentration

FIG. 2.



Novosibirsk
400-800км
Sverdlovsk
Moscow
W(ρ₀)·10²
0.5
0.4
0.3
0.2
0.1
0
0.4
0.3
0.2
0.1
0
0.3
0.2
0.1
0
1
2
5
10
2
5
100
2
5
ρ₀, км

Fig. 3.

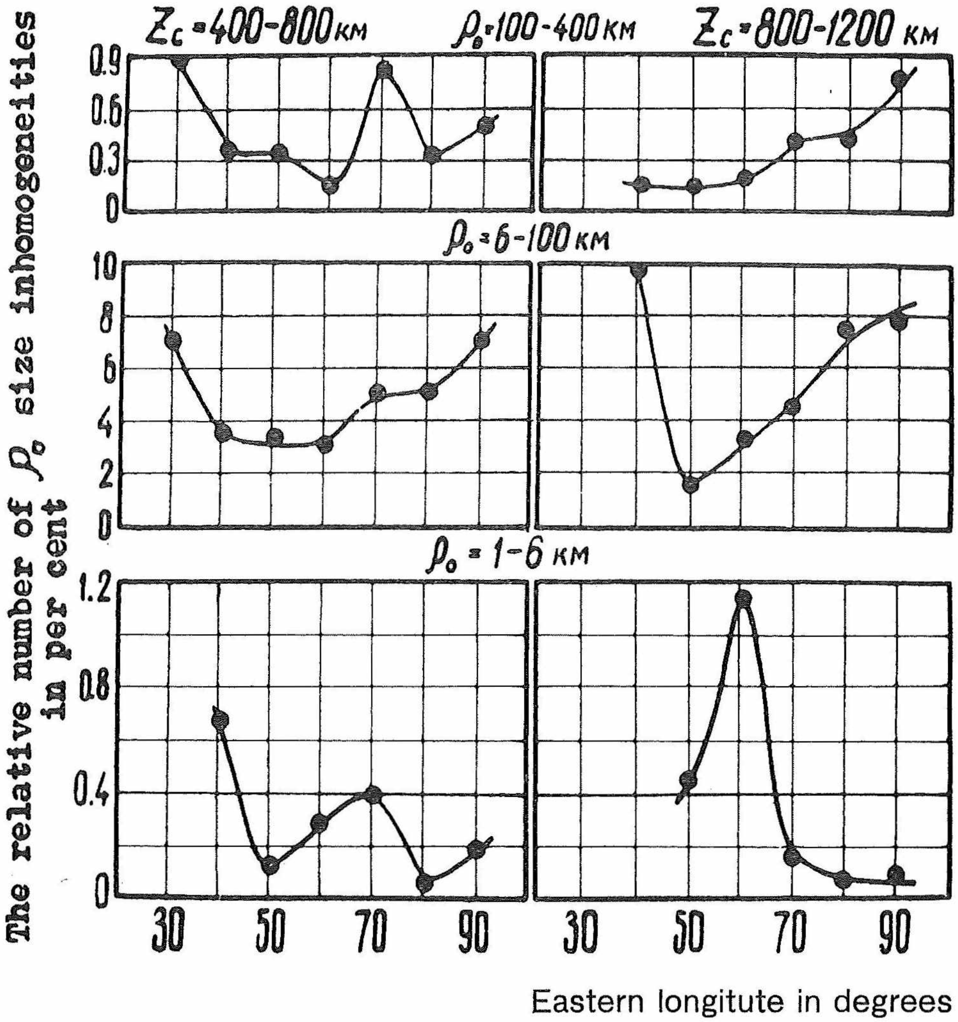


Fig. 4.

solar activity minimum, and from the more extensive material the distributions of the density ρ are obtained for mean diurnal, maximal day and minimal night conditions (Fig. 5). A correlation of the density with decimetric solar radio emission is confirmed in the indicated period. Diurnal variations for this period of time constituted approximately 30 per cent near 200 km and reached factor 2 at 300 km. The change of the average atmosphere density at 200 km comprises about 2 times as compared to 1958 and reaches factor 3.5 at 300 km.

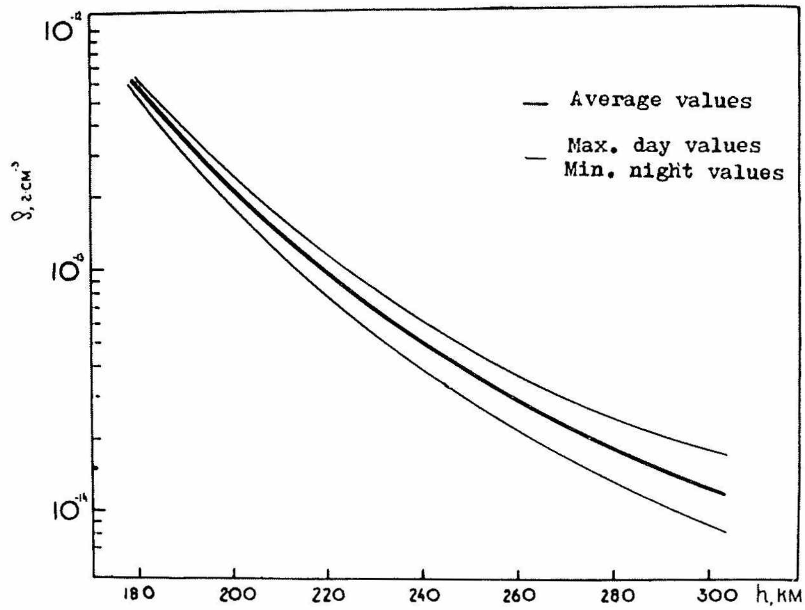


FIG. 5.

The obtained dependences of the density distributions on the flux of the solar decimetric radio emission permit one to some approximation to determine the atmosphere density between 180 and 300 km with the further change of solar activity.

4. Processing of manometric studies of the *atmosphere density* performed from geophysical rockets in 1963 (12R) showed that at the height of the order of 300 km the density fell approximately by factor 10, as compared to 1958 (including diurnal variations). On the basis of the same data the existence of inversions of scale heights is observed in the height range from 140 to 170 km and from 220 to 270 km whose cause may be specific features in the height variation of the atmosphere temperature and composition.

5. Calculations were made for comparison of experimental data about the upper atmosphere structure with theoretical models which showed the possibility of improving the determinations of variations of the density, temperature and the composition of the thermosphere with the time of the day and the solar cycle (14R). Some peculiarities are observed in the temperature altitude variation and a great change of the diurnal

amplitude of the exospheric temperature with the solar cycle.

6. Some sections of the problem about diurnal and semidiurnal *tide variations* of the upper atmosphere structural parameters have been solved for the spherical rotating Earth. To some approximation, amplitudes and phases of the temperature, pressure and density have been obtained for semidiurnal and diurnal tide fluctuations. At a height of 120 km the amplitude of the pressure semidiurnal fluctuations is about 20 per cent.

7. A detailed comparison of all available rocket experiments aimed at measuring the *electron concentration* made it possible to find diurnal, and seasonal variations of n_e and its variations depending on solar activity at heights from 100 to 200 km and to construct empirical models of n_e distributions under different conditions (18R). After theoretical analysis of mechanisms of ionization of the region D of the ionosphere it was established that, alongside X-rays, a considerable contribution is made to this ionization by corpuscles (electrons with $E > 10$ keV). Corpuscular radiation is apparently the agent which supports the night ionization of the atmosphere during the period of maximum solar activity.

9. Profiles have been determined of *electron concentration in the upper ionosphere at heights from 2000 to 12000-15000 km* with the use of the record of the output signal level of the cosmic radio emission receiver on a frequency of 1525 kcs mounted on the satellite Electron 2 (3R). With the entry of the satellite into the ionosphere the output voltage of radioreceivers decreased due to the change of the parameters of the receiving antenna. 26 curves were obtained. At a height of 2000 km the value of electron concentration at different geographic latitudes varies from $0.5 \cdot 10^4$ to 10^4 el/cm^3 and with the increase of height drops gradually to the value 10^3 el/m^3 at heights from 10 000 to 15 000 km. With the crossing of the geomagnetic equator by the satellite at a height of 14 000 km for the longitude 280° the electron concentration maximum was observed with the value of $4 \cdot 10^3$ el/cm^3.

In the process of conducting measurements of cosmic radiation on the Electron 2 satellite on both operating frequencies 725 and 1525 kcs sporadic radioemission was discovered which by one-two orders of magnitude exceeds the level of cosmic radio emission. The appearance and intensity of sporadic radioemission depend on geomagnetic coordinates. Radio-emission reaches the maximum at geomagnetic latitudes 40-50° and is absent at the geomagnetic equator. This radio-emission correlates well with the presence of fluxes of soft electrons with energies above 100ev in the outer radiation belt. Similar sporadic radio-emission was also detected while conducting the experiment aboard Electron 4. The data of this experiment are being processed.

10. *Investigations of the ionosphere regular structure* were made by the method of measuring the phase differences of coherent frequencies 20, 30 and 90 Mcs and by measurements of polarization fadings of the signal on the frequency of 20 Mcs. Results of observations from satellites Cosmos 1, Cosmos 2 and Explorer 7 have shown that the magnitude of the integral of the electron concentration up to the satellite height $\int_0^{7c} Nd\Xi$ changed from 0.1 to $1.7 \cdot 10^{13}$ el/cm^2 as a function of the satellite height and the time of day. Comparison with the data of vertical sounding of the ionosphere made it possible to obtain the exponent index x in supposition that the electron concentration above the maximum of the layer F recedes by the exponential law. The average value $x = 5 \cdot 10^{-3}$km^{-1}. From February to March 1964 observations of coherent signals of the satellite Electron 1 were carried out. In total about 90 records of the phase difference of signals were processed from 8 to 17 h. local time. The exponential x reached values $5 \div 6 \cdot 10^{-3}$ km^{-1} at 11 h., smoothly fell to $2 \div 3 \cdot 10^{-3}$ km^{-1} in morning and evening hours. For weak solar activity (the Wolf number $W < 30$) the index x was somewhat larger than for strong activity ($W > 30$). A sharp fall of electron concentration above the maximum of the F_2 layer continues approximately up to heights 700-1000 km. At larger heights the velocity of the change of electron concentration with height significantly falls.

11. *Investigation of small-scale inhomogeneities of the ionosphere* was made from December 1961 from records of twinkling of signals of satellites Explorer 7, Discoverer 36, Cosmos 1, 2, Electron 1. Measurements were made on the frequency of 20 Mcs by means of three spaced antennas. On the basis of the measurements conducted it is shown that small-scale inhomogeneities at night hours may be observed in the F-layer to heights $500 \div 600$ km. Most frequently they are recorded at heights $250 \div 350$ km. On the average the height of inhomogeneities corresponds to the

height of the maximum of F_2-layer. The sizes of the inhomogeneities responsible for twinkling of the satellite signals are in the main of the order 1 ÷ 2 km. During ionospheric disturbances, inhomogeneities with sizes 200 ÷ 600 m were also recorded. Rather frequently inhomogeneities were localized in the limited regions of the ionosphere with horizontal sizes from several tens km to several hundreds km. In some cases at heights of 250 ÷ 350 km lens inhomogeneities were fixed. At day hours, besides inhomogeneities with the height z $\lesssim$ 200 ÷ 300 km, inhomogeneities were observed at heights of 100-200 km. The sizes of the inhomogeneities at heights 100-200 km are on the order of 1 ÷ 2 km. At altitudes of 200 ÷ 300 km inhomogeneities were observed both with sizes up to 4 ÷ 6 km and to 400 ÷ 600 m. The parameters of large-scale inhomogeneities with sizes from 10 km to 100 ÷ 300 km have been determined.

INDICES D'ACTIVITE SOLAIRE POUR LA PROPAGATION IONOSPHERIQUE

(Extrait du *Journal des Télécommunications*, Vol. 33, n° 1, janvier 1966)

Les tableaux ci-après, contenant les valeurs des indices fondamentaux de la propagation ionosphérique, ont été établis par le secrétariat spécialisé du Comité consultatif international des radiocommunications (C.C.I.R.), conformément à la Résolution 4, l'Avis 371 et le Rapport 246 du C.C.I.R.

Remarque : De nombreux détails sur les indices ionosphériques sont contenus dans une publication récente : *Advances in radio research*, volume 2, éditée par J. A. Saxton (Academic Press, London et New York, 1964). Il s'agit de la contribution de C. M. Minnis, intitulée *Ionospheric indices*, p. 1-36, de l'ouvrage en question.

VALEURS OBSERVÉES :

● R_{12} (moyenne glissante sur douze mois du nombre de taches solaires):

Mois / Année	1	2	3	4	5	6	7	8	9	10	11	12
1964	19	18	15	13	11	10	10	10	10	10	10	11
1965	12	12	12	13	15	15						

● I_{F2} (indice ionosphérique) :

Mois (année 1964).

1	2	3	4	5	6	7	8	9	10	11	12
0(2)*	6(2)*	20(2)*	14(2)*	1(2)*	-3(1)*	1(1)*	-3(1)*	4(1)*	3(1)*	-3(1)*	-4(1)*

Mois (année 1965).

1	2	3	4	5	6	7	8	9	10	11	12
7(1)*	5(1)*	20(1)*	18(1)*	10(1)*	15(1)*	17(1)*	12(1)*	9(1)*	6(1)*	6(1)*	-1(1)*

(*) Les chiffres entre parenthèses indiquent le nombre de valeurs de foF_2 qui ne sont pas encore parvenues au secrétariat du C.C.I.R. et dont on n'a donc pas tenu compte dans le calcul de l'indice I_{F2}. Pour plus de détails, voir *Journal des Télécommunications* (avril 1964, page 119).

Par rapport aux données contenues dans le Rapport 246 du C.C.I.R., une station de sondages ionosphériques a cessé de fonctionner — celle de Porto Rico (en juin 1963). Les valeurs de I_{F2} contenant entre parenthèses le chiffre (1) sont donc depuis le mois de juin 1963 les valeurs définitives de l'indice I_{F2}. En outre, la station de Fairbanks (College) n'a pas fonctionné pendant la période août-octobre 1963. Pour cette période les valeurs définitives de l'indice I_{F2} sont celles contenant le chiffre (2) entre parenthèses.

● ∅ (flux du bruit solaire moyen mensuel) *** :

Année \ Mois	1	2	3	4	5	6	7	8	9	10	11	12
1964	74	76	75	73	69	69	67	69	70	73	73	78
1965	78	75	74	72	78	77	74	75	76	80	76	76

(**) Renseignements obligeamment fournis par le « National Research Council », Ottawa.

PRÉVISIONS POUR LES MOIS A VENIR (1er JANVIER 1966) *** :

● R_{12}

Année \ Mois	1	2	3	4	5	6
1966	22	23	24	26	28	30

(***) Renseignements obligeamment fournis par le professeur Waldmeier, Observatoire fédéral de Zurich.
Estimation de l'erreur sur les prévisions de R_{12} : $\pm$ 10.

● I_{F_2} ****

Année \ Mois	1	2	3	4	5	6
1966	25	28	31	35	38	(42)

(****) Renseignements obligeamment fournis par le « Department of Scientific and Industrial Research, Radio and Space Research Station », Slough.
La valeur prévue six mois à l'avance est donnée entre parenthèses.

Estimation de l'erreur sur les prévisions de I_{F_2} :

Mois (1966)	1	2	3	4	5	6
Maximum	+14.5	+15	+15.6	+15	+14	+12
Minimum	—11	—13	—15.5	—17	—18.5	—19

SOLAR INDICES FOR IONOSPHERIC PROPAGATION

(Reprint from *Telecommunication Journal*, vol. 33, nº 1, January 1966)

The following Tables, giving values of the basic indices for ionospheric propagation have been prepared by the Specialized

Secretariat of the International Radio Consultative Committee (C.C.I.R.) in accordance with C.C.I.R. Resolution 4, Recommendation 371, and Report 246.

Note : A considerable amount of information on ionospheric indices will be found in an article by C. M. Minnis, entitled *Ionospheric indices* on pages 1-36 of the recent publication *Advances in radio research*, volume 2, edited by J. A. Saxton (Academic Press, London and New York, 1964).

PARAMETERS :

● R_{12} (smoothed mean, over twelve months, of the number of sunspots observed) :

Year \ Month	1	2	3	4	5	6	7	8	9	10	11	12
1964	19	18	15	13	11	10	10	10	10	10	10	11
1965	12	12	12	13	15	15						

● I_{F2} (ionospheric index) :

Month (year 1964).

1	2	3	4	5	6	7	8	9	10	11	12
0(2)*	6(2)*	20(2)*	14(2)*	1(2)*	–3(1)*	1(1)*	–3(1)*	4(1)*	3(1)*	–3(1)*	–4(1)*

Month (year 1965).

1	2	3	4	5	6	7	8	9	10	11	12
7(1)*	5(1)*	20(1)*	18(1)*	10(1)*	15(1)*	17(1)*	12(1)*	9(1)*	6(1)*	6(1)*	–1(1)

(*) The figures in brackets represent the number of values of foF_2 which have not yet reached the C.C.I.R. Secretariat, and which have not therefore been taken into account in the calculation of I_{F2}. For further details, see the *Telecommunication Journal*, April 1964, page 119.

With regard to the data contained in C.C.I.R. Report 246, one ionospheric sounding station has ceased to operate — Puerto Rico (in June 1963). The values of I_{F_2} that include the figure (1) in brackets are therefore, as from the month of June 1963, definitive values for I_{F_2}. Furthermore the sounding station Fairbanks (College) did not operate during the period August-October 1963. For this period the definitive values of I_{F_2} are those including the figure (2) in brackets.

● $\varnothing$ (monthly mean value of solar noise flux) ** :

Year \ Month	1	2	3	4	5	6	7	8	9	10	11	12
1964	74	76	75	73	69	69	67	69	70	73	73	78
1965	78	75	74	72	78	77	74	75	76	80	76	76

(**) Data kindly supplied by the National Research Council, Ottawa.

FORECASTS FOR THE NEXT FEW MONTHS (1 JANUARY 1966) *** :

● R_{12}

Year \ Month	1	2	3	4	5	6
1966	22	23	24	26	28	30

(***) Data kindly supplied by Professor Waldmeier, Federal Observatory, Zurich.

Estimated error in forecasts of R_{12} : $\pm$ 10.

● I_{12} ****

Year \ Month	1	2	3	4	5	6
1966	25	28	31	35	38	(42)

(****) Data kindly supplied by the Department of Scientific and Industrial Research, Radio and Space Research Station, Slough.

The figure in brackets is the value forecast six months in advance.

Estimate of the error in I_{F_2} predictions :

Year \ Month	1	2	3	4	5	6
Maximum	+14.5	+15	+15.6	+15	+14	+12
Minimum	—11	—13	—15.5	—17	—18.5	—19

Commission V

SPACE RESEARCH ACTIVITIES IN THE U. S. A.

Excerpts from the condensed version of the report submitted to COSPAR at its eighth meeting, Argentina, May 1965 *COSPAR Information Bulletin, n° 28, November 1965*).

Space radio astronomy. Work in this field during 1964 has been chiefly limited to design and development. At the Goddard Space Flight Center (NASA), the behaviour of radio-frequency antennas and probes embedded in a plasma has been studied experimentally to develop accurate and reliable instrumentation and techniques for spaceborne radio astronomy. At North-eastern University, problems have been investigated concerning the operation, in the plasma-space environment, of long travelling-wave antennas, of large antennas with separate elements, and of radio interferometers. Sweep-frequency receivers built at the University of Michigan to measure cosmic radio noise in the 2-4 Mc/s region are scheduled to fly on the NASA Orbiting Geo-physical Observatories, OGO-B, C, and D. A University of Michigan fixed-frequency receiver operating at 2 and 4 Mc/s on OGO-1 is designed primarily to detect solar bursts, but will receive radiation from other sources as well. Similar experiments are being designed at Harvard University. The Advanced Technology Corporation is designing and developing satellite instrumentation for millimeter and sub-millimeter radio astronomy, offering the possibility of closing the spectrum gap between the infrared region and the high-frequency end of the radio spectrum.

The Kitt Peak National Observatory continues with its deve-opment of a remotely controlled telescope. The techniques involved are of interest for application to orbiting astronomical telescopes and also in connection with automated ground-based astronomical work. The telescope is expected to go into operation during 1965, performing the UBV photometry on stars brighter than seventh magnitude.

Recent spectroscopic observations with the 200-inch Hale telescope at Palomar indicate that the carbon-isotope ratio C^{12}/C^{13} in the tail of the comet Keya is quite close to the terrestrial value. This finding tends to link comets more closely to the Earth and other planetary bodies, and sheds further light on the origin of the solar system.

2.4. — *Radar and Radio Observations of the Quiet Sun.*

MIT (Lincoln Laboratory later Center for Space Research). Radar observations of the Sun at 7.9-meter wavelength were continued throughout most of 1964 with the MIT Lincoln Laboratory solar radar located near El Campo, Texas. (Journal of Research, NBS, 68D, 565, 1964.) Operation of the solar radar system after 1 January 1965 was arranged by the Center for Space Research at MIT.

The breadth and shifts of the observed Doppler spectra indicated apparent large randomly oriented motions in the coronal atmosphere, with a mean velocity of 70 km/s, accompanied by a consistently outward solar wind (Ap. J. 140, 377, 1964; Science 146, 1671, 1964; Trans. IEEE 8, 210, 1964). These motions are relatively independent of the solar rotational cycle and are a fundamental characteristic of the quiet Sun. These ground-based studies also indicate that the long-term trend of the average total strength of the solar radar echoes was toward smaller radar cross sections as the minimum of the solar activity was approached. Attempts to relate the echo strength to other indices of solar activity have been unsuccessful. Studies of the 1964 data are continuing.

Obervations of the Sun at 1.18 *cm wavelength.* During December 1962, observations were made of Venus, the Sun, the Moon, and Tau A at 1.18-cm wavelength (f = 25.5 Gc/sec). The brightness temperature of the Sun at this frequency was 8870 $\pm$ 980° K.

Arecibo Ionospheric Observatory. With the facilities at the Arecibo Ionospheric Observatory, echoes from the Sun should be detected at 430 Mc/s if there are strong magnetic fields or sharp discontinuities in the solar atmosphere. No echoes were detected, which implies that on the Sun, at least in the quiet phase of its 11-year cycle, strongly magnetized regions and atmospheric discontinuities are rare.

New solar radio telescope. A radio solar facility to observe the Sun daily at 611 Mc/s and 1420 Mc/s and to monitor burst activity is being established during 1965 at the Sagamore Hill Radio Observatory, Hamilton, Massachusetts. Regular 3-cm measurements will continue. The study of the correlation of optical flares, centimetric bursts, and Type IV bursts with geophysical events such as proton showers and the increase of cosmic-ray-energy polar-cap absorption, etc., will be emphasized.

The Aerospace Corporation ground-based solar program, designed to help understand flare production, is nearing completion of its first year of operation. The relationship of solar magnetic fields to various forms of solar activity is being investigated; data include temporal changes in strong solar magnetic fields, recorded by means of a compact solar telescope and spectroheliograph modified for time-lapse photography of solar magnetic fields; calcium K and Hα spectroheliograms for correlative purposes and for studies of chromospheric structure and kinematics, etc. It is expected that, by October 1965, time-lapse photography of solar magnetic fields will furnish an entirely new form of solar data.

During 1965, the Electronics Research Laboratory of Aerospace Corporation made high-resolution radiometric observations of the Sun at a wavelength of 3.2 mm. At this wavelength, the quiet chromosphere has a brightness temperature of 6400° K $\pm$ 215, somewhat higher in some active regions. A regular schedule of solar mapping at 3.2 mm has been initiated for correlation with Hα observations and with magnetograms.

Space Radio Research Committee

Space Research Activities in the U. S. A.

COSPAR has published in COSPAR Information Bulletin, n° 28, November 1965 a condensed version of the full report submitted to COSPAR at its eighth meeting, held at Mar del Plata, Argentina, in May 1965, by the Space Science Board of the U. S. National Academy of Sciences, covering space research activities in the United States of America during the previous year. The full report is itself a greatly condensed compilation of reports from numerous organizations and individuals engaged in space science. A copy of the full report may be had by addressing the Space Science Board, National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington, D. C. 20418, U. S. A. (see p. 13).

Space Research Activities in the U. S. S. R.

The above mentioned issue of the COSPAR Information Bulletin contains the full version of the report submitted to the eighth meeting of COSPAR by the U. S. S. R. Research Committee (see p. 23).

I.U.W.D.S.

Synoptic Codes for Solar and Geophysical Data — 1965

The I.U.W.D.S. has issued a new code booklet revising and updating the synoptic codes in use for the interchange of solar and geophysical data. It supersedes the 1963 edition.

Attention should be called particularly to the new code UFLAG. This code provides for solar flares to be reported by the new importance classification scheme adopted January 1, 1966 by the International Astronomical Union. The new code UACTA is useful for reporting active solar regions by including information on both calcium plage and sunspot activity. The new code UEVTA permits one to report an outstanding event combining information on the solar flare with the accompanying radio noise and ionospheric events. The code USOXA permits the reporting of solar x-ray events as observed by the solar radiation satellites.

Observatories can put the new codes into operation upon receipt of the booklet. The new booklet should be in use certainly not later than the end of February. Additional copies of the code booklet are available from Miss J. Virginia Lincoln, Deputy Secretary I.U.W.D.S. Steering Committee, E.S.S.A., Boulder, Colorado 80302, U. S. A., or Mr. Paul Simon, Acting Secretary, I.U.W.D.S. Steering Committee, Service des Ursigrammes et Jours Mondiaux, Observatoire de Meudon (Seine et Oise), France; or the Secretary General of U.R.S.I., 7 place Emile Danco, Brussels 18, Belgium.

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Services Available from the Center

(Operated 24 hours every day)

The Telecommunications and Space Disturbance Services Center is a field station of the Space Disturbances Laboratory, Institute for Telecommunication Sciences and Aeronomy (Boulder, Colorado), under the Environmental Science Services Administration, U. S. Department of Commerce. It was formerly called the C.R.P.L. Forecast Center of the Central Radio Propagation Laboratory, National Bureau of Standards, U. S. Department of Commerce, until the transfer of C.R.P.L. to E.S.S.A. on October 11, 1965. A principal function of the Center is the forecasting of high frequency radio propagation conditions over high latitude transmission paths. Also, under the auspices of the International Ursigram and World Days Service (I.U.W.D.S.) it serves as the Western Hemisphere Regional Warning Center for providing solar-geophysical data and Geophysical Alerts to scientific institutions in the western hemisphere. It also serves as the World Warning Agency (cable adress AGIWARN) and is charged with the responsibility for assessing solar and geophysical phenomena and originating daily alerts in connection with the worldwide geophysical alert program for the I.U.W.D.S. This daily alert is introduced into the World Meteorological Organization and AGIWARN communication networks and is given worldwide dissemination. Under the auspices of the Committee on Space Research (COSPAR), and supported in this endeavor by the National Aeronautics and Space Administration, AGIWARN also serves as a Satellite Regional Warning Center for introducing into the SPACEWARN communications network messages concerning launch announcements, orbital elements and tracking information for artificial earth satellites and deep space probes.

The following paragraphs list established messages distributed telegraphically from this Center and contain brief descriptions of the information in each message. Many of the messages, possibly in slightly different form, are also distributed by mail (including air mail) and/or by telephone. Additional information concerning these services may be obtained from this office.

I. — Radio Propagation Forecasts.

1. *ADFHL* (Advance Forecast High Latitude Circuits) — Forecasts of radio propagation conditions on typical high latitude transmission paths and of geomagnetic indices; issued weekly (Wednesday), and supplemented whenever circumstances warrant. Although this service is distributed by teletype when rapid notification is desirable, primary distribution is by air mail (identified as the CRPL-Jc Report). The mail version carries also a forescast of geomagnetic activity, a review of radio propagation conditions, general solar activity and geomagnetic activity during the previous week. Telephone distribution also is made locally.
2. *MTAFO* (Medium-term Forecast Atlantic Area) — Forecasts of radio propagation conditions over North Atlantic paths only for the next Greenwich day; issued daily at about 2000 Universal Time (UT or CGT). Distribution is accomplished by teletype and, locally, by telephone.
3. *STAFO* (Short-term Forecast Atlantic Area) — Forecasts of North Atlantic radio propagation conditions; issued every six hours for the subsequent six-hour period. These forecasts are distributed by teletype, and locally by telephone, and are broadcast by Radio Station WWV.
4. *GEOCAST* (Geomagnetic Activity Forecast) — General forecast of geomagnetic activity for the following Greenwich day, issued about 1900 UT each day. Distribution is by teletype; telephone may be used locally.

II. — Solar-Geophysical Data Messages.

1. *WASHAGI* (Data Summary Message) — Daily data message, sent telegraphically at about 1800 UT, which contains a summary of the most important solar activity and geophysical

data collected during the previous 24 hours. These data, in synoptic codes, include reports of outstanding solar flares and radio noise events, important absorption events, cosmic ray events, geomagnetic activity, sunspots, etc. Although the primary method of distribution is via teletype, mail distribution is available if rapid delivery is not required.

2. *WASHFLAR* (Important Flare Report) — Message issued immediately upon receipt at this office of a report (less than 24 hours old) of an importance 3 or 4 solar flare; also issued immediately if an importance 2 flare is reported while still in progress. This message is distributed by teletype to individuals or institutions who require rapid notification of the occurrence of these events. For other users, these flare reports are contained in the daily WASHAGI message. These reports are usually in coded form.

3. *WASHION* (Ionospheric data) — Daily message, issued telegraphically about 1800 UT, which gives the critical frequency of the local (Washington) ionosphere (F_2 layer) at six-hour intervals within the previous 24 hours. The message is in synoptic code.

4. *WASHMAG* (Geomagnetic Data) — Daily telegraphic message issued shortly after the end of each Greenwich day, providing indices of geomagnetic activity for the preceding 24 hours. The message, in coded form, contains a daily A-index and 3-hour K-figures. (Similar information, covering a slightly different time period, is provided in the daily WASHAGI message described above). These geomagnetic observations are made locally (Washington area).

III. — Solar-Geophysical Alerts for IUWDS Program.

1. *AGIWARN* (ADALERT) — (Advance Geophysical Alert) — Regional Alert issued immediately upon receipt at this office of a report (usually from a Western Hemisphere observatory) of a significant solar flare; or of a significant cosmic ray increase or decrease; or after the recognition of the existence of a significant geomagnetic storm. These Alerts also may be issued on the basis of unusually high solar activity or extremely quiet

magnetic conditions. They are identified by code words, respectively, as SOLFLARE, COSMIC EVENT, MAGSTORM, SOLACTIVITY or MAGCALME. Distribution is primarily by teletype but may be accomplished locally by telephone.

2. *GEOALERT* (World-wide Geophysical Alert) — Alert message issued daily at 0400 UT. Positive alerts are issued following the occurrence of a cosmic ray increase; during a significant geomagnetic disturbance; upon determination of the existence of a significant warming in the stratosphere; during periods of an unusually high level of solar activity; in periods of extremely low geomagnetic activity; or when a significant geomagnetic disturbance is expected to begin within the following 24 hours. They are identified by code words, respectively, as COSMIC EVENT, MAGSTORM, STRATWARM, SOLACTIVITY or MAGCALME. When no positive alert exists, the word « NIL » is employed. The primary distribution method for these Alerts is via the World Meteorological Organization (WMO) network. In the United States the WMO is accomplished through the U. S. Federal Aviation Agency's Service C teletype network which is operated for the U. S. Weather Bureau. For those who require these Alerts but have no reasonable access to Weather Bureau (or WMO) circuits, direct telegraphic service is offered by AGIWARN when the Alert is positive. This direct service is initiated at about 1300 UT. Telephone service is available in the Washington area.

3. *ADALERTPRESTO* (Rapid Flare Alert) — Special Alert issued immediately on the basis of the probable occurrence of an important flare as indicated by recordings of 10 cm solar radio noise. This is intended as an extremely rapid warning system for cosmic ray studies. Whenever feasible, telephone or direct TWX service is employed for distribution.

4. *STRATALERT* (Winter Stratospheric Warming Alert) — Regional Alerts issued daily from each hemisphere during its winter season. The U. S. Weather Bureau is the originating agency for these Alerts in the northern hemisphere. The International Antarctic Analysis Center (I.A.A.C.) Melbourne, Australia is the originating agency for these Alerts in the southern hemisphere. Coded messages are introduced into the

Service C network at about 1800 UT. Upon request, arrangements can be made for distribution telegraphically from AGIWARN.

IV. — Artificial Earth Satellite Information.

SPACEWARN — messages relating to launch information, orbital elements, ephemerides for optical observations and reports of tracking observations, distributed when appropriate to interested observatories and scientific organizations. Launching announcements are plain language messages which announce the launch of satellites from the United States or other countries. Messages containing the code word « SATOR » are coded messages carrying modified orbital elements for prediction purposes. These two types of messages are released by an agency or agencies within the launching country and are introduced into the SPACEWARN network by AGIWARN for the benefit of Western Hemisphere stations. Currently SATOR messages are distributed in this hemisphere for US-launched satellites only. Telegraphic or mail distribution is offered. Messages containing the code words SATAT (for communication of the ephemeris for optical observations at individual stations) and SATEV (for reports of tracking observations) are special messages and usually are not handled by AGIWARN.

The above services are available currently at no cost to the subscriber if military (usually military establishments only) or government teletype systems can be utilized. If the subscriber's desires or communication facilities are such that commercial TWX or Western Union systems must be used, the services are then available at the cost of transmitting the messages (collect). Note that the government teletype channel operates on a daytime schedule, five days a week; night, weekend or holiday messages delivered by this system are held at AGIWARN until the following normal work day, except that upon request the weekend-holiday-night messages will be distributed at the normal time, collect, via TWX or Western Union.

Any of the following addresses may be used to transmit communications to this office by electrical means.

Telephone Alexandria, Va., Area Code 703, 780-1444 or 780-1436.
Cable and Radiogram : AGIWARN WASHINGTON.
Telegraphic : AGIWARN.
WUX WASH DC TWX 703-339-5771.
TWX : 703-339-5771.
Teletype : AGIWARN BUSTAN FT BELVOIR VA.

December 27, 1965.

INTER-UNION COMMISSIONS

Inter-Union Commission on Frequency Allocations for Radio Astronomy and Space Science

THE REGISTRATION OF FREQUENCIES FOR RADIO ASTRONOMY

(*Doc. I.U.C.A.F.*/87)

The present memorandum is being addressed to radio astronomers with the object of assisting them to secure improved protection from interference in the several bands of radio frequencies allocated to radio astronomy in the current Radio Regulations (1963) of the International Telecommunication Union.

1. — The International Registration of Frequencies.

As a result of the circulation of two requests (Documents I.U.C.A.F./73 and 79) during 1965, this Inter-Union Commission (I.U.C.A.F.) has received reports of the frequencies in use at many radio observatories : these are listed in Table I. We hope that these have been submitted also to all the relevant national administrations, who will ask for their registration with the International Frequency Registration Board (I.F.R.B.). At this time only those detailed in Table II have reached the I.F.R.B. at Geneva.

We would emphasize that no complaints about interference can be dealt with by the I.F.R.B. unless the frequencies in use appear on their register. Radio astronomers may like to ask their respective National Administrations to ensure that their registrations have been received by the I.F.R.B.

In the lists we have received there appear several entries of frequencies outside the allocated bands. No protection is available for these frequencies, and I.U.C.A.F. suggests that their registration with I.F.R.B. should only be contemplated if there is a strong scientific reason for their use. For example, observa-

TABLE I

Summary of details of Radioastronomy Observatories reported to I.U.C.A.F. up to 20th December 1965

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	Frequencies in Mc/s in use for Observations in Class B
Australia	C.S.I.R.O. Sydney	Culgoora, N.S.W.	158.5	80
		Culgoora, N.S.W.	5 to 2 000 (swept)	
Australia	C.S.I.R.O. Sydney	Parkes, N.S.W.	—	153 408 610 960 1 405 1 410 1 420 1 665 2 650 5 000 473 1 400
Australia	University of Sydney	Molonglo, Hoskinstown N.S.W.	These could be A or B	111.27 408
		Fleurs, St. Marys N.S.W.	These could be A or B	14.15 20 30 48 85 726.5 1 423
Australia	C.S.I.R.O. et et R.C.A., N.Y.	Bothwell, TAS.	2.1	—
	University of Tasmania	Llanherne, TAS.	—	0.004 (4 kc/s)

TABLE I (*continued*)

Country	Adminis-tration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class	
			A	B
Australia	University of Tasmania	Llanherne, TAS.	—	18.5 24.5 28.0 40.0 *20.0 to 40.0 *18.0 to 20.0 *20.0 to 200 *Spectrum Analysers
		Sorell		9.6
Canada	Dominion Radio Astrophysical Observatory	Penticton	10.030 22.250	408 1 413.5 2 695
Canada	National Research Council	Algonquin	22.5 to 117.5 } 20 bands 74 2 830 2 770	1 400 2 800 3 200 6 600 10 690 13 500 31 250
Canada	Queen's University	Kingston, Ontario	—	146 222 858
France	Observatoire de Paris — Meudon	Nançay	169 408 9 150	408 610 1 413 2 695 4 995 10 690
Germany	Heinrich Hertz Institute of German Academy of Science (D.D.R.)	Berlin-Adlershof	3 453 3 487 9 456 9 522 }	775-beginning in 1966

TABLE I (*continued*)

Country	Adminis-tration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	B
Germany	Heinrich Hertz Institute of German Academy of Science (D.D.R.)	Aussenstelle, Neustrelitz	557-beginning in 1966 1 457 1 523 1 967 2 033 9 106 9 172	
Italy	Bologna University	Bologna	—	408
Japan	University of Kyoto	Kyoto	300	—
Japan	University of Niigata	Niigata	500	—
Japan	National Science Museum	Tokyo	6 440 6 560	—
Japan	Radio Research Laboratories	Kashima	—	1 666 4 170
	Radio Research Laboratories	Hiraiso	201 500	—
Japan	Nagoya University	Toyokawa	1 000 2 000 3 690 3 810 4 000 2 000 4 000 4 995 9 340 9 460 9 415	2 695 4 995 9 415 15 375
Japan	University of Tokyo	Nobeyama	25 38 58 74	

TABLE I (*continued*)

Country	Adminis-tration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	B
			114	—
			160	
			227.5	
			408	
			612	
			2 695	
			4 995	
			15 375	
Japan	University of Tokyo	Mitaka	227.5	
			326	
			403	
			612	
			800	
			300-800 (spectral receiver)	
			2 695	1 420.4
			10 690	1 666
			19 320	2 695
			19 380	4 995
			31 340	10 690
			31 460	19 350
Poland	N. Copernicus University	Piwnice	32.5	
			127 2 Antenna Systems	
			327	
United Kingdom	University of Manchester	Jodrell Bank	—	151.5
				408
				610
				1 420
				1 400-1 425
				1 664.4-1 668.4
				2 695
				4 995
				10 690
United Kingdom	University of Cambridge	Cambridge		13.05
				26.5
				(or 26.3)

TABLE I (*continued*)

Country	Adminis-tration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	Frequencies in Mc/s in use for Observations in Class B
				38.0 81.5 151.5 408 610 1 413.5 2 695 4 995
U. S. A.	University of Texas	Austin, Texas	35 000 70 000 94 000 140,000	
	Stanford University	Stanford California	3 292.4	425 2 926 3 074 3 213 3 343 3 470 10 690
U. S. A.	Ohio State University	Delaware, Ohio	—	1 415
U. S. A.	California Institute of Techno-logy	Bigpine, California	—	74 611 960 1 420 1 665 2 840 10 690
U. S. A.	Massachu-setts Insti-tute of Technology	Haystack, Tyngsboro, Mass.	—	1 420 1 610 } OH line 1 666 } OH line 1 720 } OH line 5 000 8 000 15 500 35 000

TABLE I (*continued*)

Country	Adminis-tration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class	
			A	B
U. S. A.	University of Colorado	Boulder, Colorado	8.927 17.985 36.1 7.6 to 41	
U. S. A.	Harvard University	Radio Astronomy Station, Fort Davis, Texas	63 (25-100 sweep)	210 (100-320 sweep 920 } 980 } 5 000
Netherlands	Sterrewacht Leiden	Dwingeloo	*—	408 465 610 820 1 418 1 420.4
Netherlands	PTT and Utrecht University	Nera Nederhorst den Berg	136 196 255 610 2 980 9 600	—

tions might be attempted at the frequency of a unique spectral line or to explore the variation of polarisation of background radiation at frequencies spaced closer than one octave.

The I.U.C.A.F. is anxious to keep in touch with all observational work, and welcomes reports of all frequencies in use, including those unsuitable for registration with I.F.R.B.

2. — REPORTS OF INTERFERENCE.

Interference to radio-astronomical observation should normally be dealt with by the appropriate national administration in each country, who will if necessary ask for help from the I.F.R.B. It is most important to record as many details as possible in all

TABLE II

Frequencies in Use at Radio Astronomy Observatories as notified to the International Frequency Registration Board (I.F.R.B.) up to 30th November 1965

Country	Radio Astronomy Station	Frequencies in Mc/s notified in Class	
		A	B
Canada	Algonquin	25 38 73.5 74 2 695	10 690 31 400
France	Nançay	169 408 (2 bandwidths)	408 610 1 413 2 695 4 995 10 690
Poland	Piwnice	32.5 127 (2 bandwidths) 327	—
Puerto Rico	Arecibo	—	73.8
U. S. A.	Stanford, Cal.	—	10 690
U. S. A.	Delaware, Ohio	—	610 1 415 2 695
U. S. A.	Bigpine, Cal.	—	74 1 420 1 665 10 690
U. S. A.	Tyngsboro, Mass.	—	1 413.5. 1 665.3 1 667.4
U. S. A.	Danville, Ill.	73.8	—
U. S. A.	Derwood, Md	—	1 420.5

TABLE II (*continued*)

Country	Radio Astronomy Station	Frequencies in Mc/s notified in Class	
		A	B
U. S. A.	Gainesville Fla.	73.8	—
U. S. A.	Green Bank, Va.	—	405 1 420 2 695 (2 bandwidths)
U. S. A.	Hamilton, Mass.	—	1 420 (2 bandwidths) 1 667
U. S. A.	Harvard, Mass.	—	1 665 1 667
U. S. A.	Houghton, Mich.	73.8	—
U. S. A.	Maryland Pt. Md.	—	1 420.405 10 690 15 375 19 350
U. S. A.	Washington D.C.	—	31 400

cases of interference. The I.F.R.B. has not so far been informed of any cases of interference, even though many radio astronomers have said that they have suffered badly from interference.

3. — OBSERVATIONS IN THE STANDARD FREQUENCY BANDS AT 5, 10, 15, 20 AND 25 Mc/s.

This Inter-Union Commission (I.U.C.A.F.) draws attention to the provision for the use of the guard bands around the standard frequencies detailed above. Bandwidths of ± 5 Kc/s are available at the two lowest frequencies (5 and 10 Mc/s) and of ± 10 Kc/s at the other three. The frequency band around 15 Mc/s, which is 20 Kc/s wide, is particularly suitable since it fits well into the harmonic series in use for radio astronomy. While observations at these lower frequencies are becoming increasingly important, we are unable to ask for clear bands unless we can show that these bands are not wide enough, or are unusable because of interference. If you want to obtain allocations at any frequency below 30 Mc/s, you should :

(*a*) Report interference in the guard bands to your National Administration and send an account of your experience in the matter to I.U.C.A.F.

(*b*) Make a case, through I.U.C.A.F. and through the National Administrations, for an allocation in a suitable frequency range with an adequate bandwidth for the observations you wish to make.

4. — Frequency Allocations.

The International Radio Consultative Committee (C.C.I.R.), which prepares technical information for the I.T.U., will meet in Oslo in June 1966. National Administrations have submitted reports concerning such questions as the allocation of frequencies for observation of the OH lines at 1665 and 1667 Mc/s. I.U.C.A.F. will be represented at the meeting, and will submit a report on the scientific requirements of Radio Astronomy. We shall be working from the following points of view :

(*a*) The frequency bands for observations below 1000 Mc/s should follow as closely as possible, the approximately harmonic series already proposed by I.U.C.A.F. They should also be world-wide, since lunar occultations which are of increasing importance, are very difficult to observe in the presence of interference reflected from the moon.

(*b*) While we shall continue to press for the protection of the band 406-410 Mc/s, which is widely in use, we shall suggest that an exclusive allocation at 322-327 Mc/s covering the Deuterium line, would eventually be more appropriate to our needs.

(*c*) We shall point out that observations are being made only with great difficulty at frequencies below 30 Mc/s. (These frequencies were not considered by the EARC at Geneva in 1959). We expect to make requests for allocations at a later meeting.

(*d*) *OH lines.* We shall strongly support the C.C.I.R. draft reports L8(c)IV, which presents the case for the existing allocation of 4 Mc/s to be extended to 10 Mc/s; and we shall indicate the reasons why the allocation should be made on an exclusive basis. We shall not at this time suggest that such protection should be sought for any additional line frequencies, since we believe that we should only ask for an allocation at any line when it becomes clear that a long programme of astronomical observation will be undertaken. We would welcome any information about such programmes, and we are prepared to support any good cases that can be made out for protection.

5. — MEETINGS OF I.U.C.A.F.

The Commission meets about once per year, or more frequently, if necessary. Recent meetings were held in Bonn (January 1965), and in Rome (December, 1965). We expect to hold ad hoc meetings in Oslo during the C.C.I.R. meeting, June 22-July 22 1966.

I.U.C.A.F. will also discuss with C.C.I.R. some requests from Space Research authorities for the strenghtening of protection in certain frequency bands. We shall be prepared to consider any further requests for assistance from radio astronomers.

F. G. SMITH.
R. L. SMITH-ROSE.

30th December 1965.

PROTECTION OF FREQUENCIES USED FOR RADIOASTRONOMICAL MEASUREMENTS RECOMMENDATION L.8.a (IV)

Contribution from the I.U.C.A.F. to the XIth Plenary Assembly, C.C.I.R., Oslo, 1966

(*Doc. I.U.C.A.F./*90)

1. — GENERAL.

While it is realised that it is not the function of C.C.I.R. to consider the assignment of frequencies for any radio Services, the Inter-Union Commission on the Allocation of Frequencies for Radio Astronomy and Space Science (I.U.C.A.F.) is very appreciative of the manner in which it is allowed to co-operate as an observer in the Assemblies of C.C.I.R., and particularly to participate in the work of Study Group IV. Delegates to the C.C.I.R. will recall that the I.U.C.A.F. is representative of the three bodies, the International Scientific Radio Union (U.R.S.I.), the International Astronomical Union (I.A.U.) and the International Committee on Space Research (C.O.S.P.A.R.), all of which are coordinated through the International Council of Scientific Unions (I.C.S.U.). These bodies are concerned with the use of radio frequencies for scientific research as distinct from their application to all types of practical radio communications.

It is a fortunate and very happy arrangement that several individual members of I.U.C.A.F. participate through their national administrations in the work of Study Groups IV and V of C.C.I.R.; and as a result much of the contribution which I.U.C.A.F. can make is achieved through these national groups.

Following the publication of the Final Acts of the Extraordinary Administrative Radio Conference (Geneva, 1963), the I.U.C.A.F. has collaborated with the International Frequency Registration Board (I.F.R.B.) in compiling technical information concerning Stations in the Radio Astronomy and Space Research Services throughout the world. While an appreciable response has already been achieved, this work is proceeding on a continuing basis; and it should result in the compilation of a comprehensive catalogue of the details of the various observations and stations engaged in these branches of scientific radio.

2. — Revision of Recommendation L8a (replacing No. 314).

This Recommendation is considered to be very important in providing the technical basis for securing an adequate protection of the various frequencies used for radioastronomy which, it may be recalled, is concerned with the study by reception alone of the naturally occurring radiations at a number of frequency bands throughout the spectrum. Many of these radiations result in an extremely low field strength at the surface of the earth, and their detection and study calls for the use of the most advanced techniques in radio reception.

The following changes are proposed to the indicated paragraphs of Recommendation L8a, on pp. 24 and 25 of Part I of the « Conclusions of the Interim Meeting of Study Group IV — Monte Carlo, 1965 ».

A. — *Amend the last line of considering (k) to read :*

« .... spectrum, particularly at frequencies below 1000 Mc/s, and for an increased bandwidth at some higher frequencies ».

B. — *Recommends* 3, *line* 4.

Insert between « bands » and « which » the words : « of the order of 10 Mc/s in width ».

C. — *Recommends* 4.

Include 15 and 25 Mc/s in accordance with footnote 204 (Geneva 1959).

D. — *Recommends* 4.

Add the following after « ..... reception in radioastronomy » : « however, a single allocation of 50 to 100 kc/s bandwidth in the vicinity of 15 Mc/s would be preferred by the radioastronomers ».

R. L. Smith-Rose

Secretary-General I.U.C.A.F.

Inter-Union Commission on Radiometeorology

International Colloquium on the Fine-Scale Structure of the Atmosphere and its Relation to Radio Wave Propagation

The full Report of this meeting held in Moscow from 15 to 22 June, 1965 is published as Supplement to this Information Bulletin (nº 155, March-April).

Supplementary copies may be obtained at the General Secretariat of U.R.S.I., 7 place Emile Danco, Bruxelles 18, Belgium.

Inter-Union Commission on Solar and Terrestrial Relationships (I.U.C.S.T.R.)

A meeting of the Inter-Union Commission on Solar and Terrestrial Relationships (I.U.C.S.T.R.) will be held in Belgrade on Thursday-Friday, August 25-26, 1966.

The provisional programme will be :

August 25, a.m. (Thursday) Business meeting of the Commission. Corresponding members are invited.

p.m. Individual contributions on solar-terrestrial relations. Open.

August 26, a.m. Open discussion on « The suitability of solar data for terrestrial correlations ».

(i) Slowly varying phenomena. Active Areas.

(ii) Rapidly varying phenomena. Flares.

(iii) Phenomena not obviously associated with active areas.

p.m. Address by Dr. E. G. Bowen (Sydney) : « The influence of incoming planetary particles and their association with solar activity ». Open.

The meetings will be held at the premises of the Faculty of Technology, Karnegijeva Street 4, Belgrade, Yugoslavia. It is not expected that the proceedings will be published in full.

Further information available by Prof. C. W. Allen, President I.U.C.S.T.R., University of London Observatory, Mill Hill Park, London N. W. 7, England.

COSPAR

Information Bulletin

Nº 28, November 1965, of the COSPAR Information Bulletin has been issued, and contains the Reports of National Institutions on Space Research activities of U. S. A. and U. S. S. R. presented at the Eighth Plenary Meeting of COSPAR, Argentina, May 1965.

International Cooperation in Space Research

Solar Activity governs the Earth's Upper Atmosphere

The results of space investigations in the region of study of the Upper Atmosphere are now presented by a group of international specialists. This work, giving the results in the form of a model of the Upper Atmosphere, has just appeared as a 330 page book entitled « COSPAR International Reference Atmosphere 1965 » (abbreviation C.I.R.A. 1965), this 1965 edition revising and bringing up to date that published in 1961 with the same title.

The preparation of this book has taken nearly three years and is the result of painstaking work done by the COSPAR specialized Working Group chaired by Professor Wolfgang Priester, Director of the Institute of Astrophysics and Space Research of Bonn University. Twenty-three scientists from nine countries, of whom seven are from the U. S. A. and five from the Soviet Union, belong to this Group. Professor Maurice Roy, President of COSPAR, wrote the foreword to the book.

This Upper Atmosphere model is the end product of the detailed analysis of several hundreds of thousands of measurements obtained by means of artificial satellites and rockets launched from 1957 to 1964.

One of the most important features brought to light by the progress in our knowledge of the Earth's Upper Atmosphere (altitudes from 200-800 km) is the considerable importance of fluctuations, in particular of density and temperature, correlated to solar phenomena and governed by solar activity. Thus the temperature of the Earth's atmosphere at a height of 500 km fluctuates from 500° C during the sunspot minimum to 1800° C during the sunspot maximum.

Of course these high temperatures are associated with an extremely rarefied atmosphere and thus astronauts protected only by their spacesuits can endure them.

The fluctuations of temperature and density can be clearly observed during the lifetime of satellites. The air-drag on satellites, which is slight but continuous, is a hundred times greater during periods of sunspot maximum (1958, 1959) than during periods of lesser solar activity (1963, 1964).

During recent years a variety of solar influences on the Earth's Upper Atmosphere have been discovered with the help of satellite measurements.

On this long-period temperature fluctuation of 1300° C during a solar cycle of about 11 years are superimposed short-period variations and a daily change in temperature of many hundred degrees Celsius at an altitude of 500 km.

Also when eruptions on the sun occur the Earth's Upper Atmosphere reacts to them after about 2 days with jumps in temperature increase of as much as 300° C or more.

These are the results, very varied in nature and locality, of observations made by means of satellites up until very recently, which C.I.R.A. 1965 condenses and interprets, thereby supplying first class documentation for those who today are interested, from different standpoints, in the properties of the Upper Atmosphere.

330 pages — 7 1/2 × 9 3/4 — Guilders 27. — (54 s.; $ 7.50).

The book is published by the North-Holland Cy, P. O. Box 103, Amsterdam C.

I.C.S.U. ABSTRACTING BOARD

The I.C.S.U. Abstracting Board has issued a « Preliminary Survey of the activities of I.C.S.U., Scientific Unions, Special and Scientific Committees and Commissions of I.C.S.U. in the field of Scientific Information ».

The survey has been drafted to fulfil one of the recommendations drafted in January 1965, by an I.C.S.U. Working Group to envisage how the I.C.S.U. Abstracting Board could help I.C.S.U. in the problems related with the dissemination of Scientific Information.

The recommendation reads as follows :

« I.C.S.U. Abstracting Board should act as a clearing house for steps taken in the field of Scientific Information by I.C.S.U., its constituent Unions, Special and Scientific Committees or Commissions of I.C.S.U. To perform this task, the I.C.S.U. Abstracting Board will keep itself informed of the activities of I.C.S.U. its constituent Unions, Special and Scientific Committees or Commissions in the field of Scientific Information (work of the more than thirty Commissions on Publications, Symbols, Units, Nomenclature, Terminology, Codification, Notations, Bibliographical Data, etc.) by undertaking a regular programme of consultation with these bodies.

This programme of consultation could be achieved by means of questionnaires ».

To implement this recommendation, I.C.S.U. Abstracting Board undertook a first preliminary survey of the activities of the various Commissions which, inside the I.C.S.U. bodies are dealing with some aspect of the dissemination of Scientific Information.

UNION INTERNATIONALE DES TÉLÉCOMMUNICATIONS

Portrait de Sir Edward Appleton

L'Union Internationale des Télécommunications (U.I.T.) a fait graver les traits d'un des grand hommes des télécommunications : Edward Appleton.

Ce portrait est une eau-forte, tirée sur papier de luxe à 1200 exemplaires. Chaque épreuve mesure 23 × 17 cm, marges comprises.

Par ailleurs, l'U.I.T. dispose encore, dans la série des portraits des grands hommes des télécommunications, d'un petit nombre de portraits de Morse, de Marconi, de Gauss et Weber, de Hughes, de Baudot, de Maxwell, du Général Ferrié, de Siemens, de Popov, d'Ampère, de Bell, de Hertz, d'Erlang, de Teslan, de Faraday, de Fresnel, de Heaviside, de Pupin, de Kelvin, de Lorentz, d'Armstrong, de Lord Rayleigh, de Kirchoff, de Lodge, d'Edison, de Sommerfeld, de de Forest, de van der Pol, de von Karman et de Poulsen.

Ces gravures peuvent être obtenues au Secrétariat Général de l'Union Internationale des Télécommunications, Place des Nations, 1211-Genève 20, Suisse, contre l'envoi de la somme de 3 francs suisses l'exemplaire, frais de port et d'emballage compris.

Portrait of Sir Edward Appleton

The International Telecommunication Union (I.T.U.) has had an etching made of the portrait of an eminent figure in telecommunications : Edward Appleton.

1200 copies of this etching have been produced on de luxe paper; it measures 23 × 17 cm, including margins.

The I.T.U. has still in the series of eminent personalities in the field of telecommunications, a few portraits of Morse, Marconi, Gauss and Weber, Hughes, Baudot, Maxwell, General Ferrié, Siemens, Popov, Ampère, Bell, Hertz, Erlang, Tesla, Faraday, Fresnel, Heaviside, Pupin, Kelvin, Lorentz, Armstrong, Lord Rayleigh, Kirchoff, Lodge, Edison, Sommerfeld, de Forest, van der Pol, von Karman and Poulsen.

These etchings may be obtained from the General Secretariat of the International Telecommunication Union, place des Nations, 1211-Geneva 20, Switzerland, on remittance of 3 Swiss francs per copy, carriage paid.

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