UNION RADIO SCIENTIFIQUE INTERNATIONALE
INTERNATIONAL SCIENTIFIC RADIO UNION

U.R.S.I.

INFORMATION BULLETIN D'INFORMATION

nº 124 - Jan.-Fév. 1960

Publié avec l'aide financière de l'UNESCO par le Secrétaire Général de l'URSI
7, place Émile Danco - Bruxelles 18
(Belgique)

nº 124 Jan.-Fév. 1961

U. R. S. I.

TABLE DES MATIÈRES — CONTENTS

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

Nous avons le plaisir d'annoncer à nos lecteurs qu'au cours de réunion de janvier 1961, le Comité International de Géophysique I.G.) a élu à sa présidence le Professeur W. J. G. Beynon. Nous ıhaitons au Professeur Beynon un plein succès dans sa nouvelle he.

U.R.S.I. NEWS

We have the pleasure to inform our readers that the International mmittee on Geophysics (C.I.G.), at its January 1961 meeting, cted Professor W. J. G. Beynon to the Presidency. We wish ery success in his new functions to Professor Beynon.

XIII^{e} ASSEMBLÉE GÉNÉRALE

Comptes Rendus

Le fascicule 8 du Volume XII (Administration et divers) est sorti de presse. Des exemplaires ont été envoyés aux Comités Nationaux qui ont informé le Secrétaire Général de leurs besoins.

Des exemplaires supplémentaires du fascicule 8 peuvent être obtenus au Secrétariat Général de l'U.R.S.I. au prix unitaire de F. B. 140, $ 2.8 ou £ 1, port compris. Pour les commandes parvenant par l'intermédiaire des Comités Nationaux, ce prix est ramené à F. B. 100, ou $ 2, ou £ 15/.

XIIIth GENERAL ASSEMBLY

Proceedings

Part 8 of Volume XII (Administration and Miscellaneous) has been issued. Copies have been forwarded to National Committees which have informed the Secretary General of their requirements.

Supplementary copies are available at the General Secretariat at the price of B. F. 140, or $ 2.8, or £ 1, per copy (postage included). This price is reduced to B. F. 100, or $ 2, or £ 15/, for orders coming through the National Committees.

References

The following papers have been published in « Wireless World ».

- Scientific Radio Conference, U.R.S.I. and International Radio Conference by Dr. R. L. Smith-Rose, Jan. 1961, p. 10.
- Active satellites — Prospects for world-wide communication systems (Paper presented at the XIIIth General Assembly), L. Polack (Feb. 1961, p. 52).

NATIONAL COMMITTEES

Japan

RADIO RESEARCH LABORATORIES

We want to call the attention of our readers to a booklet issued y the Japanese Ministry of Posts and Telecommunications : Radio Research Laboratories ». This booklet contains information n the following items :

utline of the Radio Research Laboratories.
istory of ionospheric observation in Japan.
bservations and studies of the ionosphere.
tudies in ionospheric propagation.
esearches on tropospheric propagation.
tudies of millimetric waves.
tudies of communication systems.
tandard frequencies.
adio forecasts and forewarnings.
roadcasting of Ursigrams.
ervice for and research on radio apparatus and devices.
ublications and periodicals.
Vorld Data Center C2 for the ionosphere.
onospheric observations at Showa Base, Antarctic.
tructure of Radio Research Laboratories.

United Kingdom

MEMBERSHIP

National Committee for Scientific Radio

Chairman : Professor W. J. G. Beynon.

Ex officio :

Director of Radio Research (D.S.I.R.).
Physical Secretary, Royal Society.

Foreign Secretary, Royal Society.
Dr. R. L. SMITH-ROSE (*President of the Union*).

Royal Society (4) :

(2) Sir Edward APPLETON,
(1) Professor H. M. BARLOW,
(2) Dr. L. ESSEN,
(1) Sir Bernard LOVELL.

Radio-Research Board (1) : (2) Mr. F. HORNER.

Institution of Electrical Engineers (2) :

(2) Dr. J. A. SAXTON,
(1) Dr. R. L. SMITH-ROSE.

Institute of Physics and Physical Society (2) :

(2) Professor W. J. G. BEYNON,
(1) Sir Harrie MASSEY.

Meteorological Office (1) : (1) Dr. G. D. ROBINSON.

Ministry of Aviation (1) : (2) Dr. J. S. MCPETRIE.

British Joint Communications-Electronics Board (1) : (1) The *Chairman.*

Royal Society of Edinburgh (2) :

(2) Professor W. E. J. FARVIS.
(1) Professor R. V. JONES.

Post Office, Chief Engineer's Branch (1) : (1) Mr. H. STANESBY.

British Broadcasting Corporation (1) : (1) Mr. W. Proctor WILSON.

National Physical Laboratory (1) : (2) Mr. J. M. STEELE.

Additional Members :

(1) Professor C. W. OATLEY,
(1) Dr. F. G. SMITH.

---

(1) To retire 31 December 1963,
(2) To retire 31 December 1966.

United States National Committee

1961 U.R.S.I.-I.R.E. SPRING MEETING

R.S.I.-I.R.E. joint spring meeting will be held at George-iversity in Washington, D. C., May 1-4. The I.R.E. ıal Groups on Antennas and Propagation, Circuit Theory, on Theory, Instrumentation, and Microwave Theory and es will serve as cosponsors.

nited States National Committee will hold its business on Sunday evening, April 30. A combined technical evoted to a discussion of topics on space is scheduled for morning and afternoon, May 1 ; the Commissions will hold iness sessions on Monday evening.

ollowing Commissions are planning to hold one or more sessions on May 2, 3 and 4 :

sion 1. — Radio Measurement Methods and Standards : W. BEATTY, *Chairman.*

sion 2. — Tropospheric Radio Propagation: Irvin H. Gerks, *irman.*

sion 3. — Ionospheric Radio Propagation: L. A. MANNING, *irman.*

sion 4. — Radio Noise of Terrestrial Origin : William CRICHLOW, *Chairman.*

ssion 5. — Radio Astronomy : A. E. LILLEY, *Chairman.*

ssion 6. — Radio Waves and Circuits : John I. BOHNERT, *airman.*

ssion 7. — Radio Electronics : Marvin CHODOROW, *Chair-an.*

COURSE IN RADIO PROPAGATION

Central Radio Propagation Laboratory, Boulder, Colorado, A., organizes a three week course in Radio Propagation from 1 to August 18, 1961.

course is designed to provide a discussion of the funda-ls of radio propagation, the latest advances in the state of the art, and the application of this knowledge to the design and development of communication systems. Tropospheric Propagation and Ionospheric Propagation will be considered in two separate sections which may be taken individually or in succession. Details of this course may be obtained from the Educational Director at the address given below.

The course will consider communication via the entire range of useable radio frequencies and will extend into the modes of propagation which are being explored for the future. In both sections the continuing emphasis will be on those elements of propagation which affect system design and frequency allocation.

Further details of the course and registration forms will be available March 1, 1961, from : Edmund H. Brown, Educational Director, Boulder Laboratories, National Bureau of Standards, Boulder, Colorado.

COMMISSIONS

Commission I
On Radio Measurements and Standards

CONFERENCE ON STANDARDS AND ELECTRONICS MEASUREMENTS
Boulder, February 1962

The 1962 Conference on Standards and Electronic Measurements will be held August 14, 15, and 16, at the Boulder Laboratories of the National Bureau of Standards.

This is the third in a series of biennial conferences being sponsored by the Radio Standards Laboratory of the National Bureau of Standards, the Professional Group on Instrumentation of the Institute of Radio Engineers, and the Instrumentation Division of the American Institute of Electrical Engineers. Previous conferences (1958 and 1960) each attracted more than 800 participants from industry, university, and government laboratories throughout the world.

The technical program will cover the entire useful frequency spectrum, from direct current through microwaves, with emphasis upon the more fundamental aspects of standards and measurements. It will include consideration of the most urgent current problems and also the expected needs of the future.

Further information may be obtained from : Dr. John M. Richardson, Chief, Radio Standards Laboratory, National Bureau of Standards, Boulder, Colorado.

* * *

Jack R. Craddock, Technical Information Officer, Hillcrest 2-2161, ext. 245.

Commission III. — On Ionospheric Radio

N(h) WORKING GROUP
REPORT TO THE XIIIth GENERAL ASSEMBLY
London 1960

CONTENTS

ACKNOWLEDGEMENTS

The Chairman of the N(*h*) Group wishes to acknowledge with gratitude the advice and assistance of the following in connection with the work of the N(*h*) Group.

Sir Edward V. APPLETON,	Dr. D. F. MARTYN,
Professor W. J. G. BEYNON,	Mr. J. A. RATCLIFFE,
Colonel E. HERBAYS,	Mr. A. H. SHAPLEY.

---

* Printed separately.

would like also to acknowledge the co-operation of the ɔers of the Group, the Consultants and the organization ı financed the visits of members to the Group's meetings.

1. — Preamble

1.1. — *Formation of the N(h) Working Group and Terms of Reference*

e Working Party was formed as a Group in Commission III .R.S.I. at the U.R.S.I.-A.G.I. Committee in Edinburgh, ıst 1958 (*U.R.S.I. Information Bulletin*, No. 112, p.12).

ıe Terms of Reference were circulated to all members by the ɘtary General in his letter of 22nd October 1958. They are :

) To produce a Report for the 1960 General Assembly of .S.I. on what has been done in connection with the deter-ıtion of electron density profiles from $h'(f)$ curves.

) To draft recommendations for future work in this field of arch.

1.2. — *Membership*

: of Members :

hairman : Dr. J. O. Thomas, Cavendish Laboratory, Cambridge, ɡland.

'ice-Chairman : Mr. J. E. Jackson, Code 9212, National Aero-tics and Space Administration, Goddard Space Flight Center, 5 Overlook Avenue S. W., Washington 25, D. C., U. S. A.

Secretary : Mr. M. D. Vickers, D.S.I.R. Radio Research Station, ugh, Bucks, England.

W. Becker, Max Planck Institut, Lindau am Harz, Germany.

. R. A. Duncan, C.S.I.R.O. Radio Research Laboratories, Camden, N.S.W., Australia.

. R. D. Egan, Radio Propagation Laboratory, Stanford University, Stanford, California, U. S. A.

. G. A. M. King, D.S.I.R. Geophysical Observatory, P. O. Box 2111, Christchurch, New Zealand.

. B. Maehlum, Division of Telecommunication, Norwegian Defence Research Establishment, Lilleström, Norway.

Dr. E. R. SCHMERLING, Department of Electrical Engineering, Pennsylvania State University, State College, Pennsylvania, U. S. A.

Mr. J. W. WRIGHT : National Bureau of Standards, Boulder, Colorado, U. S. A.

Principal Consultants :

Dr. K. BOWLES, National Bureau of Standards, Boulder, Colorado, U. S. A.

Dr. DRIATSKY, Arctic and Antarctic Research Institute, Leningrad, U. S. S. R.

Dr. J. M. KELSO, Space Technology Laboratories Inc., P. O. Box 95001, Los Angeles 45, California, U. S. A.

Dr. KESSENICK, c/o The Soviet I.G.Y., Committee, Molodezhnaya 3, Moscow B-296, U. S. S. R.

Mr. A. H. SHAPLEY, National Bureau of Standards, Boulder, Colorado, U. S. A.

Dr. T. E. VAN ZANDT, National Bureau of Standards, Boulder, Colorado, U. S. A.

1.3. — *Programme of Work*

1.3.1. — An indication of the main fields covered by the Working Group is given by the terms of reference of a number of sub-groups which have been formed to be responsible for some of the different aspects of the work. These are as follows :

Sub-Group A (*Chairman* : Dr. W. BECKER).

1. To keep under review both machine and manual methods of converting $h'(f)$ curves to $N(h)$ profiles, and the techniques for carrying out the calculations.

2. To consider the problems associated with the accuracy of $N(h)$ work and the standards of accuracy to be recommended.

(1) 3. To produce and publish accurate standard $h'(f)$ curves corresponding to accurately known assumed $N(h)$ profiles.

(1) 4. To produce and publish accurate standard tables of group refractive index (μ').

---

(1) These calculations are being carried out on electronic digital computers by Dr. W. BECKER, in Germany, Miss A. R. ROBBINS, Cavendish Laboratory, Cambridge and Mr. M. D. VICKERS, D.S.I.R. Radio Research Station, Slough, Bucks.

Sub-Group B (*Chairman* : Dr. E. R. Schmerling).

To prepare a report on the co-ordination and comparison of N(h) results derived from rocket, satellite, radar back-scatter, and other experiments with those derived from $h'(f)$-N(h) calculations.

Sub-Group C (*Chairman* : Mr. J. W. Wright).

1. To prepare recommendations about the future nature and extent of $h'(f)$-N(h) work, and in particular :

2. To make suggestions about places for which records should be analysed, stating, in each case, why the particular station should be chosen.

The membership of the sub-groups is as follows :

Sub-Group A :

Dr. W. Becker (*Chairman*),
Miss A. R. Robbins,
Dr. E. R. Schmerling,
* Dr. J. E. Titheridge,
Mr. M. D. Vickers.

Sub-Group B :

Dr. E. R. Schmerling (*Chairman*),
* Dr. K. Bowles,
* Dr. O. K. Garriott,
Dr. J. E. Jackson,
* Dr. J. M. Kelso,
* Dr. J. Nisbet,
Dr. J. O. Thomas,
* Dr. T. E. van Zandt.

Sub-Group C :

Mr. J. W. Wright (*Chairman*),
* Mrs. S. A. Croom,
Dr. R. A. Duncan,
Mr. G. A. M. King,
Dr. E. R. Schmerling,
* Dr. T. E. van Zandt,
Mr. M. D. Vickers.

---

* Consultant.

1.3.2. — The Working Group, by correspondence and in meetings, has been mainly concerned with the presentation and discussion of new research work in the fields outlined above.

A list of the main papers presented and discussed is given in §5.

1.3.3. — The Group has also been concerned with the co-ordination of the N(h) work in progress at different observatories so that programmes of N(h) reduction are not duplicated. The way in which N(h) data could be presented in a useful, uniform, and economic manner has also been a concern of the Group.

1.4. — *Relationship with other Committees*

1.4.1. — The N(h) Group was constituted as a small working party in Commission III of U.R.S.I. It was not meant as a necessarily internationally representative group. It acts as an advisory body concerned with the *research* aspects of the problem of determining ionospheric electron densities.

1.4.2. — The side of the work concerned with *routine* N(h) reductions at ionospheric observatories is carried out by the World Wide Soundings Committee which in the past has provided a platform for the discussion of ionospheric problems by representatives of the different countries concerned.

2. — *The reduction of $h'(f)$ curves to N(h) profiles*

2.1. — *Methods of Calculation*

As the result of developments which have recently been made in methods of calculating N(h) profiles from observed $h'(f)$ curves, electron distributions are now being deduced as a routine at a number of observatories. The methods, both machine and manual, allow for the effect of the earth's magnetic field and make no « a priori » assumptions about the distribution other than that it increases monotonically with increasing height.

A general survey of the methods available has been given by Thomas (*Proc. I. R. E.*, **47**, 162, 1959). Full details of a typical machine method have been given by Thomas and Vickers (D.S.I.R. Radio Research Special Report No. 28, 1958) and of a typical manual method by Schmerling and Ventrice (*J.A.T.P.*, **14**, 259, 1959).

ble 1 shows some of the most important methods now in use. ·ences and a full Bibliography of methods of reducing $h'(f)$ ·s to $N(h)$ profiles are given in § 9.1 and 9.2.

2.2. — *Publication of Results*

ıere is general agreement that the best method of presenting esults is in the form of tables giving, for each hour, the electron ity, N, at a series of fixed heights in the ionosphere ($N(t)$ es). The calculation may be programmed for an electronic al computer so that the output from the computer is in a suitable for direct publication. Table 2 shows the output ·-routine layout for the $h'(f)$-$N(h)$ conversion programme in the British I.G.Y. $N(h)$ survey being carried out by ers at the D.S.I.R. Radio Research Station, Slough. The ıine time used in this particular programme for the conversion ıe $h'(f)$ record is about 20 seconds. It should be noted that the meters hmF2, NmF2, etc. given at the bottom of the table are matically computed and printed by the machine.

ıbles of this kind (sometimes together with tables and curves *verage* $N(t)$ data) are now published by some observatories as utine. Examples are :

les of Ionospheric Electron Density : Talara, Huancayo, Panama and Washington 1957-1958, Pennsylvania State University Research Reports, E. R. SCHMERLING.

les of Ionospheric Electron Density for Selected Days during the I.G.Y. at Slough, Port Stanley, Singapore and Ibadan. D.S.I.R., Special Publications : 1958-1959.

ly $N(h)$ Results for Puerto Rico. C.R.P.L., Bulletins Series F. 1959.

. list of these publications is given in § 9.6. A list of papers cerned with $N(h)$ results is given in § 9.6 and 9.7. Some of the n results which have been obtained recently are reviewed in the ·er given in § 7 of this Report.

Model Methods	Integral Equation Methods		
	Direct	Lamination	
NO FIELD	NO FIELD	WIHT FIELD	
Parabolic N(*h*)		*Manual*	*Machine*
Appleton and Beynon (1940)	Appleton (1930)	Murray and Hoag (1937)	Schmerling (1957*a*)
	de Groot (1930)		Thomas, Haselgrove and Robbins (1958)
Booker and Seaton (1940)	Pekeris (1940)	Budden (1954)	
	Rydbeck (1940)	King (1954, 1956)	Thomas and Vickers (1958)
Ratcliffe (1951)	Manning (1947)	Jackson (1956)	
Beynon and Thomas (1956)	Kelso (1952)	Titheridge (1959, *a*, *b*)	Duncan (1958)
	Schmerling and Thomas (1956)		
Chapman N(*h*)		Becker (1959)	Storey (1960)
Pierce (1947)			
Jaeger (1947)	WITH FIELD		
Guha (1949)	Rydbeck (1942*b*, *c*)		
	Whale (1951)		
Other distributions	Kelso (1954 : 1957)		
Appleton (1928 : 1930)	Shinn (1954*a*)		
Ratcliffe (1951)	Schmerling (1957*b* : 1958)		
	Ventrice and Schmerling (1958)		
WITH FIELD			
Shinn and Whale (1952)	Wright and Norton (1959*a*,*b*)		
Shinn (1953*a*)			
Becker (1956)			

TABLE 1. — *Examples of methods of converting h'(f) to N(h) curves. A complete bibliography is given at the end of the Report*

Slough, September 1, 1957

LOCAL MEAN TIME

h(km)	0000	0100	0200	0300	0400	0500	0600	0700
320						10.37		
310						9.98		5.66
300						9.52	4.02	5.57
290					10.80	8.94	3.96	5.42
280		5.79			10.42	8.33	3.89	5.18
270		5.49		7.77	9.84	7.67	3.78	4.92
260		5.07		7.25	9.10	7.00	3.67	4.58
250		4.52		6.44	8.17	6.34	3.55	4.19
240		3.84	14.74	5.36	7.25	5.75	3.42	3.76
230		3.04	14.11	4.24	6.34	5.18	3.29	3.35
220		2.12	13.28	3.24	5.48	4.65	3.17	2.99
210	4.26	1.02	12.19	2.48	4.73	4.19	3.05	2.67
200	3.74		10.82	1.96	4.15	3.84	2.92	2.36
190	2.84		9.10	1.60	3.68	3.51	2.77	2.08
180	1.54		7.17	1.34	3.29	3.10	2.59	1.83
170			5.00	1.14	2.92	2.74	2.37	1.62
160			2.69	0.99	2.55	2.37	2.12	1.42
150			0.12	0.88	2.11	2.01	1.87	1.26
140				0.80	1.81	1.69	1.66	1.13
130				0.74	1.66	1.51	1.52	1.04
120				0.32	1.27	1.35	1.12	0.98
110								0.66
*hm*F2	219	285	248	279	296	324	301	319
N*m*F2	4.47	5.91	15.01	8.14	10.96	10.50	4.03	5.74
ho	174	201	150	120	120	115	120	110
No	0.12	0.06	0.12	0.32	1.27	0.78	1.12	0.66

TABLE 2. — N(*h*) *data calculated by an electronic digital computer. Values of* $N \times 10^{-5}$ *are shown in* cm^{-3}.

2.3. — *Reading the h'(f) records*

Scaling procedures for both manual and machine calculations are simple and rapid. About 5-15 minutes is required for reading the data from the $h'(f)$ record.

2.4. — *Digitizing techniques*

The use of a digitizing equipment with a direct « punched tape » or « punched card » output removes the need for reading the record and subsequently transferring the data on to tapes or cards by means of a keyboard perforator.

Such a system is, for example, in routine use in connection with the $h'(f)$-$N(h)$ programme being carried out at the D. S. I. R. Radio Research Station, Slough.

2.5. — *Accuracy*

The $N(h)$ profiles calculated from day-time $h'(f)$ records are probably sufficiently accurate for most purposes for which $N(h, t)$ data are required at the present time. In general the published day-time mean $N(t)$ curves are usually quoted as being correct to about 5 per cent., and the height accuracy is of the order of ± 10 km.

Considerable errors arise at night, however, because of lack of information about the virtual heights at low frequencies. The errors are particularly serious near sunrise and sunset.

To some extent, it is possible to remove these limitations by making use of observations on the Extraordinary and Ordinary waves simultaneously. Improved $h'(f)$ recording techniques for the low frequency end of the $h'(f)$ record are an essential requirement in this respect.

2.6. — *Costs*

It is very difficult to estimate the cost of carrying out the kind of analysis involved in producing an $N(h)$ curve from an $h'(f)$ curve. However, given an $h'(f)$ record (on film or paper) and excluding publication expenses, it appears that, on average, the cost of producing an $N(h)$ curve is in the region of 5 to 10 shillings, or about one dollar.

3. — Scope and Nature of Programmes of $h'(f)$-$N(h)$ Reduction

The following types of programme of reduction of $h'(f)$ curves to $N(h)$ profiles are in progress. Complete details of $N(h)$ work in progress at different observatories are given in § 6.

1. Surveys in which selected $h'(f)$ curves for a given station are analyzed to give average results for three seasons at different

epochs of the sunspot cycle. Such a programme is designed to give a first order picture of the ionosphere for typical conditions. A reasonable scale would be : 24 profiles per day × 10 quiet days per month × ; 3 seasons × 2 epochs of the solar cycle.

Surveys of this kind are being carried out by Dr. E. R. Schmerling at the Pennsylvania State University, Mr. M. D. Vickers at the Radio Research Station, Slough, Bucks., and Dr. J. O. Thomas at the Cavendish Laboratory, Cambridge.

Experience has shown that at least 10 Quiet Days per month are required to give reliable averages.

2. Routine production of profiles as an extension of the current ionosphere soundings programme.

A programme of this kind is being carried out at the National Bureau of Standards, Boulder, Colorado, by Mr. J. W. Wright. Regular hourly N(h) data are published together with quiet and disturbed average electron densities calculated for a series of heights in the ionosphere for each month.

Such a programme provides the only way of studying short-term variations in N(h) data. It is possible that useful information may be derived about unpredictable events in the ionosphere.

3. Routine production on a world wide basis of a single N(h) datum. The Working Group has *recommended* that h'_mF2, the height of maximum electron density in the F2 layer, should be measured every hour and the results published as a routine. This recommendation is considered more fully in § 4, below.

4. — Recommendations of the N(h) Working Group

4.1. — *Importance of $h'(f)$-$N(h)$ reductions*

The Group considers that programme of reduction of $h'(f)$ records to N(h) profiles of the kind described in § 3 of this Report will continue to form an important contribution to our knowledge of the ionosphere for many years.

4.2. — *Sunspot minimum $N(h)$ data*

The Group draws attention to the fact that at the present time no extensive N(h) data are available for low sunspot-number epochs of the solar cycle. It recommends that reductions of $h'(f)$

curves to N(h) profiles should be made for sunspot minimum years to complete surveys carried out during the I.G.Y. (sunspot maximum).

4.3. — *Disturbed Days*

The Group notes that most of the N(h) profiles so far published are for International Quiet Days. The Group considers that it is important to produce N(h) data for International Disturbed Days.

4.4. — *Routine N(h) Work by observatories under the aegis of the World Wide Soundings Committee*

A request was received from the Chairman of the World Wide Soundings Committee for information about the possible nature and extent of N(h) work which ought to be undertaken on a world wide basis by ionospheric observatories as a routine.

Possible methods and programmes have been considered by the Group, and the following points were examined in detail :

(i) The possibility of recommending a particular machine or manual method for use on a world wide basis.

(ii) The extent to which, bearing in mind the high cost involved, it was desirable to undertake N(h) work on a routine basis in relation to the value of the information which would be obtained.

(iii) The possibility and usefulness of measuring a single N(h) datum as a routine.

The following were considered :

h_mF2 : the height of the maximum electron density in the F2 region.

h_mF1 : the height of the maximum electron density in the F1 region.

$h(N = .9N_m)$: the height at which the electron density is 0.9 times N_mF2.

$h(N = .5N_m)$: the height at which the electron density is 0.5 times N_mF2.

$h(f_N = 6.0$ Mc/s$)$: the height of reflection corresponding to a plasma frequency $f_N = 6.0$ Mc/s.

Bearing in mind that :

) new methods are continually being developed for reducing $h'(f)$ data to $N(h)$ data,

) the existing $N(h)$ curves are highly inaccurate at night,

) the high cost in money and labour of this work makes large reduction programmes difficult for all but the largest organisations,

the general feeling in the Working Group was that, of the large mber of proposals considered, the Working Group could only stify with firm facts the following recommendations to the World ide Soundings Committee :

I. The $N(h)$ Group, taking into consideration the wide variety machine methods, programming techniques, « read-in » routines d scaling routines now in use, considers that there would be no lue at the present time in recommending to the World Wide undings Committee that any one particular machine method ould be chosen in preference to any other as being most suitable routine $N(h)$ reductions.

II. The $N(h)$ Group recommends to the World Wide Soundings mmittee that efforts should be made to measure, as a routine, ery hour, on a world-wide basis, the height of maximum electron nsity, h_mF2, in the F2 layer. A number of manual methods, ted below, are available for $h'(f)$-$N(h)$ reduction. Of these (1), and (3) are particularly suitable for routine use at ionospheric servatories.

) Kelso Coefficients (suitable only for low latitude stations). *J. Geophys. Res.*, 1952, **57**, 357.

) Shinn Kelso Coefficients. *Proc. I. R. E.*, 1959, **47**, No. 2, 162.

) Schmerling Coefficients. *J. Atmosph. Terr. Phys.*, 1959, **14**, 249.

) King Coefficients. *J. Atmosph. Terr. Phys.*, 1957, **11**, 209.

) Titheridge Coefficients. *J. Atmosph. Terr. Phys.*, 1960, **17**, 96.

Two methods, based upon the sets of ten point coefficients of inn-Kelso (2) and of Schmerling (3) give results of comparable curacy. The $N(h)$ Group recommends that either of these ethods be applied at field stations where possible to make available h_mF2 values on a world wide basis.

4.5. — *Ionogram Quality*

It was agreed that there is a great need to improve the quality of ionograms particularly with regard to the low frequency response of recorders. This is of extreme importance for N(*h*) work.

4.6. — *h'(f) Recorders at Rocket Launching Sites*

The N(*h*) Working Group recommended.

4.6.1. — That Ionospheric Observatories equipped with automatic *h'(f)* recorders should be installed at all Rocket Launching Sites ;

4.6.2. — In particular, that as a matter of urgency an *h'(f)* recorder should be provided in the near future at the new launching site of Wallops Island.

It was agreed that these recommendations should be brought to the attention of U.R.S.I. Commission III, the World Wide Soundings Committee and the bodies responsible for ionospheric research for the areas concerned.

4.7. — *Nomenclature, Terminology and Usage*

The N(*h*) Group recommends that :

4.7.1. — *h'(f)*-N(*h*) *Reduction* (should be used to refer to). The conversion of *h'(f)* data to N(*h*) data.

N(h) Analysis (should be used to refer to). The further processing of N(*h*) data to give useful information.

4.7.2. — It was agreed that the words « true-height » or « true-height analysis » or « true-height calculation » should *not* be used and it was recommended that : « The reduction of *h'(f)* data to N(*h*) data corresponded to the calculation of real heights from virtual heights »,
and that the symbols :

h' (should be used to refer to) *virtual* height,

h (should be used to refer to) *real* height.

It should be emphasized that in *h'(f)*-N(*h*) reduction reference should always be made to the accuracy to which the *virtual height* was observed and also to the estimated accuracy of the *computed real height*.

4.8. — *Publication of N(h) Data*

The Group endorse the view expressed by the U.R.S.I.-A.G.I. Committee meeting at Edinburgh 1958 that 12 copies of each publication of N(h) data should be sent, as a routine, to the World Data Centres at Slough, Boulder, Tokyo and Moscow.

4.9. — *Rocket Day*

It was considered that it would be desirable to announce in advance to interested organizations the dates on which rocket flights were being planned. It is suggested that these might be designated « Rocket Days » and that efforts should be made to reduce ionograms from stations near rocket launching sites at times of rocket launchings.

4.10. — *Checks on the Accuracy of Calculations*

4.10.1. — The Working Group emphasizes the need for checking with known standards and cross-checking with other workers the accuracy of $h'(f)$-N(h) reductions.

4.10.2. — The Working Group is in agreement that it is necessary to produce and to publish accurate $h'(f)$ curves corresponding to assumed models. These $h'(f)$ curves could then be used to test the accuracy of the method of calculation in use at the observatory since the deduced N(h) profile should be in agreement with the assumed model. Curves of this kind are being prepared and will be published by the N(h) Group.

4.11. — *Co-ordination with other N(h) data*

It was agreed that it was of extreme importance to examine results obtained from rocket, satellite and radar back-scatter experiments and to compare them with vertical incidence data. A report concerned with this aspect of the work is given in § 8.

Note. — *The above recommendations have been endorsed or included in recommendations submitted to the General Assembly by Commission III, U.R.S.I./A.G.I. Committee and W.W.S.C.*

5. — Scientific Papers Presented and Discussed

Dr. W. Becker :

1. Methods of $h'(f)$-N(h) analysis used at Lindau.

   The use of models in N(h) work especially when applied to layer maxima.

2. On $h'(f)$-N(h) work in Europe.

Dr. K. Bowles :

1. N(h) profiles observed by the V.H.F. radar back-scatter technique.

   It was first thought that scattering was due to electrons; however, the Doppler frequency shift is much less than it ought to be assuming a reasonable ionospheric temperature. It is now suggested that scattering is due to coupling between ions and electrons. The bandwidth is known to be less than 9 kc/s. By measuring this bandwidth accurately it might be possible to find out what atomic species are causing the scattering at all heights in the ionosphere.

S. A. Croom, A. R. Robbins and J. O. Thomas :

1. The results of the Cambridge Quiet Day N(h) Survey.

   The variation over the world of the electron densities at a series of fixed heights is given as a function of magnetic dip. At the greatest heights considered the anomaly in N is the well-known « double hump » with maxima 20° North and South of the magnetic equator. As lower heights are considered these humps move progressively north and south.

Dr. R. Duncan :

1. The N(h) reduction method used in Australia.

   The computer input routine allows the readings of virtual height and frequency to be taken at the most convenient places.

Dr. R. Egan :

1. The interpretation of ionospherically propagated ground back-scatter echoes in terms of layer heights and shapes.

   Results obtained by this method are in agreement with those obtained by vertical incidence sounding, Mr. J. E. Jackson :

1. Rocket N(h) results at Fort Churchill.

2. N.A.S.A. effort in the field of ionospheric research with special reference to N(h) data.

(*a*) *Rockets and Satellites.*

The following flights would include N(h) measurements :

Rocket	Range	Agency	Launching Site
2 Javelins	1000 miles	Jackson Berning	Wallops Is. Ft. Churchill
2 Scouts	10,000 miles	Jackson	Wallops Is.
2 Aerobee Hi's	—	Jackson	Ft. Churchill (9-9-59/12-9-59)
2 Nike Asps	—	Univ. of Michigan	
2 Juno II (Satellites)	200-800 miles	—	Atlantic missile range

The working frequencies for satellites will be : 20, 40, 41, 108, 360 and 960 Mc/s.

(*b*) *Top-side Sounders*

Spot frequency ionosondes were being designed at C.R.P.L. Canada and the U.K. were concentrating on sweep frequency types.

3. Techniques for the measurement of ionospheric electron densities from rockets and satellites.

A new device called the R. F. probe was described. This enables measurements of electron density to be made directly by measuring the capacitance of a rocket borne antenna.

Dr. J. M. Kelso :

1. Recent satellite N(h) work.

By measuring the Doppler shift $\int Ndh$ between satellite and earth could be estimated. Measurement of Faraday rotation would give $\int Ndh$ between earth and ionosphere (the earth's magnetic field being limited to ionospheric heights). Hence $\int Ndh$ in the exosphere might be estimated.

Dr. G. A. M. King :

1. Effects of non-vertical propagation.

2. Notes on N(h) analysis.

3. The calculation of N(h) curves in New Zealand.

   Allowance is made in these calculations for curved interpolation over frequency intervals near the layer maxima.

Dr. B. Landmark and Dr. F. Lied :

1. Electron density profiles in the E layer deduced from a study of ionospheric cross-modulation.

Mr. B. Maehlum :

1. The Norwegian $h'(f)$-N(h) digital computer programme.

Dr. E. R. Schmerling :

1. The Pennsylvania State University I.G.Y. N(h) survey.

2. Thickness and height changes in region F.

   Simple N(h) parameters as guides to physical changes in the ionosphere.

3. Attempts to find consistent ionospheric parameters for region F.

   An attempt to derive consistent values of q_0, H and h_0 for F2 was made using N(h) results for the 75th meridian chain of stations.

Mr. A. H. Shapley :

1. The present and future extent of the world -wide $h'(f)$ soundings network.

   The network is run on the basis of international co-operation. Properly planned experiments would yield much valuable information and already had done so in the fields of equatorial spread F, sporadic E and absorption work.

Dr. J. O. Thomas :

1. Recent work at the Cavendish Laboratory on the calculation of N(h) profiles from $h'(f)$ records. Part I.

   J. E. Titheridge's work on extraordinary trace and its use in increasing the accuracy of N(h) profiles.

2. Recent work at the Cavendish Laboratory on the calculation of N(h) profiles from $h'(f)$ records. Part II.

Titheridge's method applied to $h'(f)$ records indicated that :

(i) neglect of low lying ionization at night might lead to the lower part of N(h) curves being too high by 50 km.

(ii) average E-F valley widths were 10 km. for Slough and Watheroo with a depth of 0.1 NmE.

Dr. T. E. van Zandt :

1. *On Top-side Sounders.*

C.R.P.L. is considering sounding on 4 or 6 fixed frequencies. A sweep-frequency recorder with a sweep-time of 15 seconds is being developed in Canada.

The possible shapes of the $h'(f)$ curves which would be obtained above the F layer maximum were discussed.

2. On matrix residues in the $h'(f)$-N(h) calculation.

Mr. M. D. Vickers :

1. Digitizer techniques for coding $h'(f)$ records and their relation to the British I.G.Y. N(h) programme.

2. The use of N(h) profiles in communication research.

Using a full ray-tracing technique on N(h) profiles it was found that the M factors were approximately the same as those obtained from the normal much simpler parabolic layer approach.

3. Some results on N(h) profiles and their application to specific ionospheric problems.

Mr. J. W. Wright :

1. The N(h) programme at Boulder.

The variation of electron density with height, for both below and above the F-region maximum electron density, has been calculated for the 75th meridian chain of stations in the equatorial belt.

2. Notes on N(h) analysis.

3. Special features of $h'(f)$ curves at high latitudes.

The third magneto-ionic component may be used to give an estimate of the width and depth of the E-F valley.

6. — Survey of N(h) work completed or in progress at various observatories

Sponsoring Country and References	Computer	Completed or in Progress		
		Station	Mag. Dip	Times
AUSTRALIA *C.S.I.R.O.* (*Camden*) (DUNCAN) DUNCAN. — *J. Geophys. Res.*, **63**, 491, 1958	SILLIAC	Brisbane Australian stations	—57	Selected days 1956. 5 I.Q.D.s (*) and 5 I.D.D.s/mth for 1958.
NEW ZEALAND *D.S.I.R.* (*Christchurch*) (KING)	Manual	Christchurch	—69	1 quiet day/month at 03, 09, 12, 15, 21, 24 hrs, for 1954-1958.
KING and CUMMACK. — *J. Atmosph. Terr. Phys.*, **8**, 270, 1956 KING. — *J. Atmosph. Terr. Phys.*, **11**, 209, 1957 MASON. — *N. Z. Jour. Geol. and Geophys.*, **1**, 519, 1958		Rarotonga Maui Huancayo	—40 38 2	Selected days.
		Christchurch Campbell Is. Antarctic	—69 —76	1 quiet day/mth 03, 09, 12, 15, 21, and 24 hrs.
NORWAY *Norwegian Defence Research Establishment* (MAEHLUM)	Mercury	Kjeller Tromsö Longyearbyen Spitzbergen	73 78 82	Selected days.

(*) I.Q.D. = International Quiet Day; [illegible]

Sponsoring Country and References	Computer	Completed or in Progress		
		Station	Mag. Dip.	Times
UNITED KINGDOM *Cavendish Laboratory, Cambridge* (THOMAS)	EDSAC I and II	Slough	67	Hourly. Six months 3 seasons in high and low solar activity
THOMAS. — *Proc. I.R.E.*, **47**, 162, 1959 THOMAS, HASELGROVE and ROBBINS (1957); CROOM, ROBBINS and THOMAS (1959). — Tables of Ionospheric Density, Series B N^{os} 1, 2, 3 and 4		Maui Watheroo Huancayo	38 —64 2	Hourly. 10 I.Q.D.s, 3 seasons in high and low solar activity.
CROOM, ROBBINS and THOMAS. — *Nature* **184**, 2003, 1959		13 stations High, medium and low latitudes		Selected hours. 10 I.Q.D.s 3 seasons in high solar activity (I.G.Y.)
CROOM, ROBBINS and THOMAS. — *Nature* **185**, 902, 1960		Selected stations		Disturbed days.
D.S.I.R. (*Slough*) (VICKERS) SMITH-ROSE. — *J. Geophys. Res.*, **63**, 570, 1958	Pegasus	Slough Singapore Ibadan Falkland Is.	68 —17 6 —46	I. G. Y. Survey Hourly 3 R.W.D.s + 10 I.Q.D.s/mth and 10 I.Q.D.s for 3 months low solar activity

Sponsoring Country and References	Computer	Completed or in Progress		
		Station	Mag. Dip	Times
UNITED STATES				
C.R.P.L. Boulder (WRIGHT)	IBM 650	11 stations in N. America		Selected days. Oct. 1957.
KNECHT and SCHLITT. — N.B.S. Boulder Labs. Rep. N° 5587		Talara	13	Selected days in Oct. 1957.
WRIGHT, VAN ZANDT and STONEHOCKER. — N.B.S. Boulder Labs. Rep. N° 5590		Chiclayo	9	
WRIGHT. — *J. Geophys. Res.*, **64**, 1631, 1959		Chimbote	7	
WRIGHT and FINE. — N.B.S. Tech. Note 40		Huancayo	2	
		La Paz	—5	
		75th Meridian Chain. ($\pm$12 stations)		Hourly : every day 1959.
National Bureau of Standards. — *C.R.P.L. Bulletins*, Series F (Puerto Rico. N(h) results) 1959 onwards		Peurto Rico		10 I.Q.D.s : 3 months. Max. and min. solar activity.
		10 stations (mid. and low lat.)		Bi-hourly. 2-5 days each month. I.G.Y.
		12 stations (mid. and low lat.)		Hourly, quiet days. March 1958.
N.R.L. (JACKSON) JACKSON. — *J. Geophys. Res.*, **61**, 107, 1956	**Manual**	***h'(f)* and N(*h*) profiles produced for comparison with rocket results.**		

Sponsoring Country and References	Computer	Completed or in Progress		
		Station	Mag. Dip	Times
UNITED STATES (*continued*) *Pennsylvania State University* (SCHMERLING) SCHMERLING. — Ionospheric Electron Densities 1957-58 Penn. State Univ. U.S.N.C.-I.G.Y., Proj. 69	Pennstac	Panama Talara Washington Huancayo	39 13 71 2	I.G.Y. Hourly. I.Q.D.s and R.W.D.s for each month.
Stanford (EGAN)	IBM 650	N(*h*) profiles produced in connection with backscatter work.		
		One high lat. station One low lat. station		I.G.Y. Selected days. 1958.
GERMANY (BECKER)	·	Lindau. Routine N(*h*) Special studies and « Valley » problems		Since June 1959.

The following Countries and Organisations have some N(h) work planned :

Country	Description
GERMANY	
Ionosphärenstation Breisach	
(RAWER)	I.G.Y. limited programme started.
YUGOSLAVIA	
Institute « Mihailo Pupin »	N(h) planned for 1960-61.
(BAJIC)	
BELGIUM	
Institut Royal Météréologique	N(h) planned.
(BOSSY)	
CZECHOSLOVAKIA	
(MRAZEK)	Regular analysis planned 1960.
ITALY	
Instituto Geofisico e Geodetico Genoa	I.G.Y. results in progress.
(BOSSOLASCO)	
FRANCE	
Centre National d'études des Télécommunications	N(h) profiles for I.G.Y., R.W.D.s.
(LEPECHINSKY)	for their stations.
(HAUBERT)	Rabat.
HUNGARY	
Central Institute of Meteorology Budapest	N(h) analysis planned.
(BEKEFFY)	

7. — SURVEY OF N(h) RESULTS (J. O. THOMAS)

A brief survey of N(h) results will be printed separately and presented at a meeting of the General Assembly of U.R.S.I., London 1960.

8. — COMPARISON OF N(h) PROFILES FROM IONOGRAM REDUCTION WITH THOSE OBTAINED BY OTHER METHODS (E. R. SCHMERLING)

Printed separately.

9. — CONVERSION OF $h'(f)$ RECORDS TO N(h) PROFILES

Bibliography

The references are arranged as follows :

9.1. — *Model, or comparison methods of calculations*

9.1.1. — *Neglecting the effect of the earth's magnetic field.*

Parabolic, linear and square law layers, Chapman layers.

9.1.2. — *Allowing for the effect of the earth's magnetic field.*

9.2. — *Integral equation methods of calculation : Analytical solution.*

9.2.1. — *Neglecting the effect of the earth's field.*

9.2.2. — *Allowing for the effect of the earth's field.*

9.3. — *Integral equation methods of calculation : Numerical or lamination methods.*

9.3.1. — *Manual methods.*

9.3.2. — *Machine methods.*

9.4. — *« Valley » ambiguity.*

9.5. — *Group refractive index calculations, etc.*

9.6. — *Results of real height analyses.*

9.7. — *Survey articles.*

9.8. — *Miscellaneous.*

* * *

9.1. — *Model, or comparison methods of calculation*

9.1.1. — *Neglecting the effect of the earth's magnetic field.*

Parabolic, linear and square law layers.

APPLETON, E. V. — Some notes on wireless methods in investigating the electrical structure of the upper atmosphere. I. *Proc. Phys. Soc.*, 1928, **41**, 43.

APPLETON, E. V. — *Bakerian lecture*, Regularities and irregularities in the ionosphere. I. *Proc. Roy. Soc.*, 1937, **162**A, 451.

APPLETON, E. V. and BEYNON, W. J. G. — The application of ionospheric data to radio communication problems. *Proc. Phys. Soc.*, 1940, **52**, 518.

APPLETON, E. V. and NAISMITH, R. — Normal and abnormal region E ionization. *Proc. Phys. Soc.*, 1940, **52**, 402.

BECKER, W. — The analysis of observations on the ionosphere. *A.E.U.*, 1950, **4**, 391.

BEYNON, W. J. G. and THOMAS, J. O. — The calculation of the true heights of reflection of radio waves in the ionosphere. *J. Atmos. Terr. Phys.*, 1956, **9**, 184.

BOOKER, H. G. and SEATON, S. L. — Relation between actual and virtual ionospheric height. *Phys. Rev.*, 1940, **57**, 87.

RATCLIFFE, J. A. — A quick method for analysing ionospheric records. *J. Geophys. Res.*, 1951, **56**, 463.

RYDBECK, O. E. H. — The reflection of electromagnetic waves from a parabolic friction free ionized layer. *J. App. Phys.*, 1942*a*, **13**, 577.

SHIMAZAKI, T. — World-wide daily variations in the height of the maximum electron density in the ionospheric F2 layer. *J. Radio Res. Lab.*, 1955, **2**, 85.

Chapman layers.

GUHA, U. C. — Analysis of virtual height-frequency records. *J. Geophys. Res.*, 1949, **54**, 355.

JAEGER, J. C. — Equivalent path and absorption in an ionospheric region. *Proc. Phys. Soc.*, 1947, **59**, 87.

PIERCE, J. A. — The true height of an ionospheric layer. *Phys. Rev.*, 1947, **71**, 698.

9.1.2. — *Allowing for the effect of the earth's magnetic field.*

ARGENCE, E. and MAYOT, M. — A method for the determination of the true heights of ionospheric layers, allowing for the effect of the earth's magnetic field. I. Using an approximation for the refractive index (ordinary ray). *J. Geophys. Res.*, 1953*a*, **58**, 147.

ARGENCE, E. and MAYOT, M. — As above — II. Using the exact value of the refractive index (ordinary ray). *J. Geophys. Res.*, 1953*b*, **58**, 493.

ARGENCE, E. and MAYOT, M. — Determination of the height and semi-thickness of a regular ionospheric layer taking into account the effect of the earth's magnetic field (ordinary and extraordinary rays). *C. R. Acad. Sci. Paris*, 1954, **238**, 1721.

BECKER, W. — A method for the routine evaluation of the true distribution of the electron density in an ionospheric layer, from the ionograms of this layer. *A.E.U.*, 1956, **10**, 207.

MARIANI, F. — Electron density in the upper atmosphere and the interpretation of *h'(f)* curves. *Ann. Geofis.*, 1953, **6**, 21.

SHINN, D. H. — The analysis of ionospheric records (ordinary ray). I. *J. Atmosph. Terr. Phys.*, 1953*a*, **4**, 240.

SHINN, D. H. and WHALE, H. A. — Group velocities and group heights from the magneto-ionic theory. *J. Atmosph. Terr. Phys.*, 1952, **2**, 85.

9.2. — *Integral equation methods of calculation : Analytical solutions*

9.2.1. — *Neglecting the effect of the earth's field.*

APPLETON, E. V. — Some notes on wireless methods of investigating the electrical structure of the upper atmosphere. *Proc. Phys. Soc.*, 1930, **42**, 321.

DE GROOT, W. — Some remarks on the analogy of certain cases of propagation of electromagnetic waves and the motion of a particle in a potential field. *Phil. Mag.*, 1930, **10**, 521.

KELSO, J. M. — * A procedure for the determination of the vertical distribution of the electron density in the ionosphere. *J. Geophys. Res.*, 1952, **57**, 357, and Penn. State Univ. Ionosph. Res. Sci. Rpt. N° 19.

KRAUS, L. — * Discussion of Kelso paper above. *J. Geophys. Res.*, 1953, **58**, 551.

MANNING, L. A. — The determination of ionospheric electron distribution. *Proc. I.R.E.*, 1947, **35**, 1203.

MANNING, L. A. — * Discussion of Kelso paper above. *J. Geophys. Res.*, 1953, **58**, 117.

NAKATA, Y. — *Rep. Jap. Res. Radio Wave Propag.*, 1946, **1**, ref. 29E.

PEKERIS, C. L. — The vertical distribution of ionization in the upper atmosphere. *Terr. Mag. Atmos. Elect.*, 1940, **45**, 205.

RYDBECK, O. E. H. — The propagation of electromagnetic waves in an ionized medium and the calculation of the true height of the ionized layers of the atmosphere. *Phil. Mag.*, 1940, **30**, 282.

SCHMERLING, E. R. and THOMAS, J. O. — The distribution of electrons in the undisturbed F2-layer of the ionosphere. *Phil. Trans.*, 1956, **248**, 75.

SHINN, D. H. — * Further remarks on Kelso's paper. *J. Geophys. Res.*, 1953*b*, **58**, 416.

9.2.2. — *Allowing for the effect of the earth's field.*

ARGENCE, E. — Methods of calculating the true heights of the layers of the ionosphere. *Zeits. f. Geophys.*, 1954, **20**, 91.

KELSO, J. M. — The determination of the electron density distribution of an ionosphere layer in the presence of an external magnetic field. *J. Atmosph. Terr. Phys.*, 1954, **5**, 11.

KELSO, J. M. — The calculation of ionospheric electron density distributions. *J. Atmosph. Terr. Phys.*, 1957, **10**, 103.

RYDBECK, O. E. H. — Further notes on the electron density distribution of the upper atmosphere. *Terr. Mag. Atmos. Elect.*, 1942*b*, **47**, 219.

RYDBECK, O. E. H. — A theoretical survey of the possibilities of determining the distribution of the free electrons in the upper atmosphere. *Trans. Chalmers Tech.* N° 3, 1942*c*.

SCHMERLING, E. R. — An easily applied method for the reduction of $h'(f)$ records to N(h) profiles including the effects of the earths' magnetic field. Penn. State Univ. Ionosph. Res. Rpt. 96, 1957*b* and *J. Atmosph. Terr. Phys.*, 1958, **12**, 8.

SCHMERLING, E. R. and VENTRICE, C. A. — Coefficients for rapid reduction of $h'(f)$ records to N(h) profiles without computing aids. *J. Atmosph. Terr. Phys.*, 1959, **14**, 249.

SHINN, D. H. — Private communication, 1954*a*.

WHALE, H. A. — Determination of electron densities in the ionosphere from experimental $h'(f)$ curves. *J. Atmosph. Terr. Phys.*, 1951, **1**, 244.

---

* Further Remarks on Kelso's papers.

9.3. — *Integral equation methods of calculation* *Numerical or lamination methods (with field)*

9.3.1. — *Manual methods.*

BECKER, W. — Die Bestimmung der wahren Verteilung der Elektronendichte in der Ionosphäre. II. *A.E.U.*, 1959, **13**, 26.

BECKER, W. — Das Vergleichsverfahren der station Lindau/Harz zur Bestimmung der wahren Verteilung der Elektronendichte in der Ionosphäre. *A.E.U.*, 1959, **13**, 49.

BECKER, W. — New methods and some results concerning true ionospheric height calculations. *J. Atmosph. Terr. Phys.*, 1959, **16**, 67.

BUDDEN, K. G. — A method for determining the variation of electron density with height (N(*h*) curves) from curves of equivalent height versus frequency *h'*(*f*). Rep. Camb. Conf. Ionosph. Phys., 1954 (Phys. Soc. Lond.), p. 332.

JACKSON, J. E. — A new method of obtaining electron density profiles from *h'*(*f*) records. *J. Geophys. Res.*, 1956, **61**, 107.

KING, G. A. M. — Electron distribution in the ionosphere. *J. Atmos. Terr. Phys.*, 1954, **5**, 245.

KING, G. A. M. — Electron distribution in the ionosphere. *J. Atmos. Terr. Phys.*, 1956, **8**, 184.

MURRAY, F. H. and HOAG, J. B. — Heights of reflection of radio waves in the ionosphere. *Phys. Rev.*, 1937, **51**, 333.

MURRAY, F. H. — Erratum : Heights of reflection of radio waves in the ionosphere. *Phys. Rev.*, 1937, **51**, 779.

TITHERIDGE, J. E. — The calculation of real and virtual heights of reflection in the ionosphere. *J. Atmos. Terr. Phys.*, 1959*a*, **17**, 96.

TITHERIDGE, J. E. — The use of the extraordinary ray in the analysis of ionospheric records. *J. Atmos. Terr. Phys.*, 1959*b*, **17**, 110.

WRIGHT, J. W. and NORTON, R. B. — Facilities for convenient manual reduction of ionograms. N.B.S. Tech. Note, 1959*a*, 14.

WRIGHT, J. W. and NORTON, R. B. — Manual reduction of *h'*(*f*) records. N.B.S. Rpt., 1959*b*, 6031.

9.3.2. — *Machine methods.*

DUNCAN, R. A. — Computations of electron density distributions in the ionosphere making full allowance for the geomagnetic field. *J. Geophys. Res.*, 1958, **63**, 491.

HASELGROVE, J. — Private communication, 1956.

SCHMERLING, E. R. — The reduction of *h'*(*f*) records to electron density heights profiles. Penn. State Univ. Ionosph. Res. Sci. Rept. N° 94, 1957.

STOREY, L. R. O. — The joint use of the ordinary and extraordinary virtual height curves in determining ionospheric layer profiles. N.B.S.J. Res. 64D, 1960, N° 2, 111.

THOMAS, J. O., HASELGROVE, J. and ROBBINS, A. R. — The electron distribution in the ionosphere over Slough. I. Quiet days. *J. Atmos. Terr. Phys.*, 1958, **12**, 46.

THOMAS, J. O. and VICKERS, M. D. — The conversion of ionospheric virtual height — frequency curves to electron density — height profiles. D.S.I.R. Radio Research Spec. Rpt., 1958, N° 28.

9.4. — *« Valley » ambiguity*

HOLLINGWORTH, J. — The structure of the ionosphere. *Proc. Phys. Soc.*, 1935, **47**, 843.

MANNING, L. A. — The reliability of ionospheric height determination. *Proc. I.R.E.*, 1949, **37**, 599.

PIGGOTT, W. R. — On the interpretation of the apparent ionization distribution in the ionosphere. *J. Atmos. Terr. Phys.*, 1954, **5**, 201.

9.5. — *Group refractive index calculations, etc.*

APPLETON, E. V. — Wireless studies of the ionosphere. *J. Inst. Elect. Engrs.*, 1932, **71**, 642.

BAJPAI, R. R. and MATHUR, K. B. — Group velocity curves for radio-wave propagation in the ionosphere. *Indian J. Phys.*, 1937, **11**, 165.

BECKER, W. — Tabulations of group velocities of ordinary echoes at vertical incidence in the ionosphere. *A.E.U.*, 1957, **11**, 166.

GOUBAU, G. — Connection between the apparent and the true height of the ionosphere allowing for magnetic bi-refringence. *Hochfrequ. u. Elek.*, 1934*a*, **44**, 17.

GOUBAU, G. — The connection between virtual and true height in the ionosphere. *Hochfrequ. u. Elek.*, 1934*b*, **44**, 138.

GOUBAU, G. — On the dispersion theory of the ionosphere. *Hochfrequ. u. Elek.*, 1935, **45**, 179.

MECHTLY, E. A. — A computer program for obtaining refractive indices and polarization from the Appleton-Hartree equations and magneto-ionic tables for Cape Canaveral. Penn. State, Sci. Rpt., 1959, N° 116.

MILLINGTON, G. — Attenuation and group retardation in the ionosphere. *Proc. Phys. Soc.*, 1938, **50**, 561.

SHINN, D. H. — Tables of group refractive index in the ionosphere for the ordinary ray. Rep. Camb. Conf. Ionosph. Phys. (Phys. Soc. Lond.), 1954*b*, p. 402.

TAYLOR, M. — The Appleton-Hartree formula and dispersion curves for the propagation of electromagnetic waves through an ionized medium in the presence of an external magnetic field. *Proc. Phys. Soc.*, 1933, **45**, 245.

de Voogt, A. H. — The analysis of ionospheric reflections. *Tijds. Nederland Radiogen.*, 1948, **13**, 183 ; 1949, **14**, 73.

Whale, H. A. and Stanley, J. P. — Group and phase velocities from the magneto-ionic theory. *J. Atmosph. Terr. Phys.*, 1950, **1**, 82.

9.6. — *Results of real height analyses*

Becker, W. — New methods and some results concerning true ionospheric height calculations. *J. Atmosph. Terr. Phys.*, 1959, **16**, 67.

Bjelland, B., Hult, O., Landmark, B. and Lied, F. — The D region of the ionosphere. *Nature*, 1959, **184**, 4691, Sipp. 13, 973.

Chandra, S., Gibbons, J. J. and Schmerling, E. R. — Vertical transport of electrons in the F region. Penn. State Sci. Rpt., 1959, 124.

Croom, S. A., Robbins, A. R. and Thomas, J. O. — Tables of Ionospheric Electron Density Watheroo, Maui, Huancayo. Series B, 1959, Nos 2, 3 et 4, Radio Grp., Cavendish Laboratory, Cambridge.

Cromm, S. A., Robbins, A. R. and Thomas, J. O. — Two anomalies in the behaviour of the F2-layer of the ionosphere. *Nature*, 1959, **184**, 2003.

Croom, S. A., Robbins, A. R. and Thomas, J. O. — Variation of electron density in the ionosphere with magnetic dip. *Nature*, 1960, **185**, 902.

D.S.I.R. Radio Research Station. — Tables of ionospheric electron density for selected days during the I.G.Y. at Slough, Port Stanley, Port Lockroy and Ibadan, 1958-59.

King, G. A. M. and Cummack, C. H. — Electron distribution in the ionosphere. *J. Atmosph. Terr. Phys.*, 1956, **8**, 270.

Knecht, R. W. and Schlitt, D. W. — Early results from the equatorial close-spaced chain of ionospheric vertical sounding stations. N.B.S. Boulder Labs. Rep., 1958, No 5587.

Ratcliffe, J. A. — Some regularities in the F2 region of the ionosphere. *J. Geophys. Res.*, 1951, **56**, 487.

Ratcliffe, J. A., Robbins, A. R. and Thomas, J. O. — Movements in the quiet F-layer over Slough. *J. Atmosph. Terr. Phys.*, 1959, **15**, 21.

Rawer, K. — Hauteur et épaisseur vraies de la couche ionosphérique E. *Ann. Geophys.*, 1959, **15**, 547.

Schmerling, E. R. — Ionospheric electron densities for Washington, Panama, Talara and Huancayo 1957-58. Penn. State Univ. Ionosph. Res. U.S.N.C.-I.G.Y.-Project, 1958, Nos 6, 9.

Schmerling, E. R. and Thomas, J. O. — Tables of F2-Layer Electron Density on International Quiet Days - Slough, Watheroo, Huancayo. Radio Grp. Cavendish Laboratory, 1955, Series A No 1, Cambridge.

Thomas, J. O. and Robbins, A. R. — Tables of F2-Layer Electron Density on International Quiet Days - Port Stanley, Maui. Radio Grp. Cavendish Laboratory, Cambridge, 1955, Series A No 2.

THOMAS, J. O., HASELGROVE, J. and ROBBINS, A. R. — Tables of Ionospheric Electron Density, Slough (England). Radio Grp. Cavendish Laboratory, Cambridge, 1957, Series B N° 1.

THOMAS, J. O. and ROBBINS, A. R. — The Electron distribution in the ionosphere over Slough. II. Disturbed days. *J. Atmosph. Terr. Phys.*, 1958, **13**, 131.

TITHERIDGE, J. E. — Ionization below the night-time F-layer. *J. Atmosph. Terr. Phys.*, 1959, **17**, 126.

WACHTEL, I. S. and WHITE, G. R. — True heights of the F2-layer. *J. Geophys. Res.*, 1949, **54**, 239.

WRIGHT, J. W., VAN ZANDT, T. E. and STONEHOCKER, G. H. — Data on Ionospheric Electron Densities. I. Tables and Isoionic maps for selected times in October 1957. N.B.S. Boulder Labs. Rep., 1958, N° 5590.

WRIGHT, J. W. — Note on quiet day vertical cross-section of the ionosphere along 75° W geographic meridian. *J. Geophys. Res.*, 1959, **64**, 1631.

WRIGHT, J. W. and FINE, L. A. — Mean electron density variations of the quiet ionosphere (75° W meridian chain). N.B.S. Tech. Note, 1960, 40.

WRIGHT, J. W. — A model of the F region above h_{max} F2. *J. Geophys. Res.*, 1960, **65**, 185.

VAN ZANDT, T. E., NORTON, R. B. and STONEHOCKER, G. — Danger Island (1958) eclipse results. *J. Geophys. Res.* (to be published), 1960.

National Bureau of Standards 1959 onwards. — Daily N(*h*) results for Puerto Rico from February 1959 onwards. *C.R.P.L. Bulletins*, Series F.

9.7. — *Survey articles*

BECKER, W. — The calculation of the true distribution of the electron density in the ionosphere. I. *A.E.U.*, 1955, **9**, 277.

GRAWERT, G. and LASSEN, H. — The interpretation of ionospheric observations. *Zeit. Angew. Phys.*, 1954, **6**, 136.

KING, G. A. M. — Relation between virtual and actual heights in the ionosphere. *J. Atmos. Terr. Phys.*, 1957, **11**, 209.

RATCLIFFE, J. A. — Recent trends in the theory of the ionosphere. *Phys. Soc., Year Book*, 1959, p. 1.

SAHA, A. K. — On the determination of electron density distribution in the ionospheric regions from *h'*(*f*) curves. *Ind. J. Phys.*, 1956, **30**, 464.

THOMAS, J. O. — The distribution of electrons in the ionosphere. *Proc. I.R.E.*, 1959, **47**, 162.

WRIGHT, J. W., KNECHT, R. W. and DAVIES, K. — Methods of true-height analysis. *Annals of the I.G.Y.*, 1957, **3**, 62.

9.8. — *Miscellaneous*

HIRSH, A. J. — The electron density distribution in the F region of the ionosphere. *J. Atmosph. Terr. Phys.*, 1959, **17**, 86.

KELSO, J. M. — The determination of the electron density in interplanetary space. *J. Atmosph. Terr. Phys.*, 1959, **16**, 357.

LYON, A. J. and MOORAT, A. J. C. — Accurate height measurements using an ionospheric recorder. *J. Atmosph. Terr. Phys.*, 1956, **8**, 309.

MUNRO, G. H. and HEISLER, L. H. — Cusp type anomalies in variable frequency ionospheric records. *Aust. J. Phys.*, 1956, **9**, 343.

PIGGOTT, W. R. — A rapid method of obtaining accurate virtual heights from an ionogram. *J. Atmosph. Terr. Phys.*, 1959, **14**, 175.

SCHMERLING, E. R. — Height and thickness parameters for region F of the ionosphere. *J. Geophys. Res.*, 1960, **65**, 1072.

SEDDON, J. C., PICKAR, A. D. and JACKSON, J. E. — Continuous electron density measurements up to 200 km. *J, Geophys. Res.*, 1954, **59**, **513**.

WATTS, J. M. and BROWN, J. S. — Some results of sweep-frequency investigation in the low frequency band. *J. Geophys. Res.*, 1954, **59**, 71.

WATTS, J. M. — Interpretation of some features of low-frequency ionograms. *J. Atmosph. Terr. Phys.*, 1959, **15**, 73.

YONEZAWA, T., TAKAHACHI, H. and ARIMA, Y. — A theoretical consideration of electron and ion distributions in the lower portion of the ionosphere. *J.R.R.L.*, 1959, **6**, 21.

Commission III. — Radioélectricité Ionosphérique

GROUPE DE TRAVAIL N(h)

Recommandations Finales

1. — IMPORTANCE DES RÉDUCTIONS $h'(f)$-$N(h)$

Le Groupe considère que les programmes de réduction des enregistrements $h'(f)$ aux profils $N(h)$ continueront à représenter une importante contribution à notre connaissance de l'ionosphère pour de longues années.

2. — DONNÉES $N(h)$ RELATIVES AU MINIMUM SOLAIRE

Le Groupe attire l'attention sur le fait qu'il n'existe à présent aucune donnée $N(h)$ extensive se rapportant à la période de faible activité des taches au cours du cycle solaire. Il recommande que les réductions des courbes $h'(f)$ en profils $N(h)$ soient faites pour les années de minimum de taches afin de compléter la surveillance déjà effectuée pendant l'A.G.I. (maximum des taches).

3. — Journées perturbées

Le Groupe note que la plupart des profils N(h) déjà publiés se rapporte aux Journées Internationales calmes. Le Groupe considère qu'il est important d'obtenir des données N(h) pour les Journées Internationales perturbées.

4. — Travaux de routine sur N(h) effectués par les observatoires sous l'égide du Comité des Sondages a l'Echelle Mondiale

Le Président du Comité des Sondages à l'Echelle Mondiale a reçu une demande concernant les informations sur la nature possible et l'étendue des travaux N(h) qui doivent être effectués sur une base mondiale de routine par les observatoires ionosphériques.

Les méthodes et les programmes possibles ont été étudiés par le Groupe et les points suivants ont été examinés en détail :

1. La possibilité de recommander une méthode particulière, manuelle ou mécanique, applicable sur une base mondiale.
2. L'extension qu'il est désirable de donner au travail N(h) sur une base de routine comparativement à la valeur de l'information qui pourrait en être déduite, en tenant compte du coût élevé impliqué.
3. La possibilité et l'utilité de mesurer une donnée N(h) isolée sur une base de routine.

Les données suivantes ont été envisagées :

h_mF2 : altitude du maximum de la densité électronique dans la région F2.

h_mF1 : altitude du maximum de la densité électronique dans la région F1.

h(N = 9N) : altitude à laquelle la densité électronique vaut 0.9 × N_mF2.

h(N = 5 N) : altitude à laquelle la densité électronique vaut 0.5 × N_mF2.

$h(f_N$ = 6.0 MHz) : altitude de réflexion correspondant à une fréquence de plasma f_N = 6.0 MHz.

Attendu que :

de nouvelles méthodes sont continuellement réalisées pour réduire les données $h'(f)$ en données $N(h)$,

les courbes $N(h)$ existantes sont très imprécises pour les conditions nocturnes,

le coût élevé en argent et en travail de cette entreprise rend difficiles les programmes étendus de réduction sauf peut-être pour les organismes les plus importants,

le sentiment général du Groupe de Travail est que dans le grand nombre des propositions considérées, le Groupe.peut seulement justifier les recommandations suivantes au Comité des Sondages à l'Echelle Mondiale :

I. Compte tenu de la grande variété des méthodes mécaniques, des techniques de programmation, des techniques de lecture et des techniques de réduction actuellement utilisées, le Groupe $N(h)$ considère qu'il n'y aurait pas d'intérêt à recommander à présent au Comité des Sondages à l'Echelle Mondiale une méthode particulière de réduction au moyen de machines, de préférence à toute autre déjà utilisée, pour les réductions $N(h)$ de routine.

II. Le Groupe $N(h)$ recommande au Comité des Sondages à l'Echelle Mondiale que des efforts soient apportés pour mesurer sur une base de routine, toutes les heures et mondialement, l'altitude du maximum de densité électronique h_mF2 dans la couche F2. Plusieurs méthodes manuelles dont la liste est donnée ci-dessous, peuvent être utilisées pour les réductions $h'(f)$-$N(h)$. Parmi ces méthodes (1), (2) et (3) sont particulièrement souhaitables pour les travaux de routine aux observatoires ionosphériques.

(1) Coefficients de Kelso, applicables seulement aux stations de basse altitude. *J. Geophys. Res.*, 1952, **57**, 357.

(2) Coefficients de Shinn Kelso. *Proc. I. R. E.*, 1959, **47**, N° 2, 162.

(3) Coefficients de Schmerling. *J. Atmosph. Terr. Phys.*, 1959, **14**, 249.

(4) Coefficients de King. *J. Atmosph. Terr. Phys.*, 1957, **11**, 209.

(5) Coefficients de Titheridge. *J. Atmosph. Terr. Phys.*, 1960, **17**, 96.

Deux méthodes basées sur les ensembles de 10 points, les coefficients de Shinn Kelso (2) et de Schmerling (3) fournissent des résultats de précision comparables. Le Groupe $N(h)$ recommande que l'une ou l'autre de ces méthodes soient appliquées aux stations de campagne où il est possible d'obtenir des données h_mF2 sur une base mondiale.

5. — Qualité des ionogrammes

Le Groupe reconnaît le grand besoin d'améliorer la qualité des ionogrammes, particulièrement en ce qui concerne la réponse des enregistrements aux basses fréquences. Cette recommandation est d'une importance extrême pour les travaux N(h).

6. — Enregistreurs $h'(f)$ aux sites de lancement de fusées

Le Groupe de Travail N(h) recommande :

6.1. que des observatoires ionosphériques équipés d'enregistreurs automatiques $h'(f)$ soient installés à tous les sites de lancement de fusées ;

6.2. en particulier, que d'urgence un enregistreur $h'(f)$ soit établi dans le proche avenir au nouveau site de lancement de l'Ile Wallops.

Le Groupe est d'avis que ces recommandations soient portées à l'attention de la Commission III de l'U.R.S.I., du Comité des Sondages à l'Echelle Mondiale, et des organismes responsables de la recherche ionosphérique dans les régions considérées.

7. — Nomenclature. Terminologie et usages

Le Groupe N(h) recommande :

7.1. que l'expression « réduction $h'(f)$-N(h) » soit utilisée pour signifier : la conversion des données $h'(f)$ en données N(h), que l'expression « analyse N(h) » soit utilisée pour signifier : les travaux ultérieurs sur les données N(h) afin d'obtenir des informations utiles.

7.2. que les termes « hauteur réelle » ou « analyse des hauteurs réelles » ou « calculs des hauteurs réelles », ne soient pas utilisés ; il est recommandé que : « la réduction des données $h'(f)$ en données N(h) corresponde au calcul des hauteurs réelles à partir de hauteurs virtuelles ».

et que les symboles :

— h' soit utilisé pour signifier hauteur *virtuelle*,

— h soit utilisé pour signifier hauteur *réelle*.

Il doit être souligné que dans la réduction $h'(f)$-N(h), il devrait toujours être fait mention de la précision avec laquelle les *hauteurs virtuelles* ont été observées et également de la précision estimée pour les calculs des *hauteurs réelles*.

8. — Publications des données N(h)

Le Groupe appuie les vues exprimées par le Comité U.R.S.I.-A.G.I. à la réunion d'Edinburgh en 1958 pour que 12 copies de chaque publication des données N(h) soient envoyées d'une manière courante aux Centres Mondiaux de Données de Slough, Boulder, Tokyo et Moscou.

9. — Journées des fusées

Le Groupe considère qu'il serait désirable d'annoncer à l'avance aux organisations intéressées les dates où l'on compte effectuer des lancements de fusées. Il est suggéré que ces dates soient désignées par « Journées des Fusées » et que des efforts soient apportés pour réduire les ionogrammes des stations situées dans le voisinage des sites de lancement et obtenus lors des vols.

10. — Contrôle de la précision des calculs

10.1. — Le Groupe de Travail souligne la nécessité de contrôler au moyen des méthodes connues la précision des réductions $h'(f)$-N(h) et d'effectuer des contrôles avec d'autres chercheurs.

10.2. — Le Groupe de Travail est d'accord sur la nécessité d'obtenir et de publier des courbes précises $h'(f)$ correspondant à des modèles hypothétiques. Ces courbes $h'(f)$ pourront alors être utilisées pour contrôler la précision des méthodes de calcul utilisées dans les observatoires, étant donné que les profils N(h) déduits doivent être en bonne correspondance avec le modèle supposé. De telles courbes sont en préparation et seront publiées par le Groupe N(h).

II. — COORDINATION AVEC D'AUTRES DONNÉES (N(*h*)

Le Groupe est d'accord sur l'importance extrême d'examiner les expériences au moyen de fusées, de satellites et de radars (rétro-diffusion) et de comparer ces résultats à ceux des sondages à incidence verticale.

Note. — *Les recommandations ci-dessus ont été acceptées ou sont incluses dans les recommandations soumises à l'Assemblée Générale par la Commission III, par le Comité de l'U.R.S.I.-A.G.I. et par le Comité des Sondages à l'Echelle Mondiale.*

* * *

DAILY VALUES OF THE E-LAYER INDEX J_E FOR 1960

by Dr. C. M. MINNIS, R.R.S., Slough

The critical frequency of the E-layer of the ionosphere is closely controlled by the intensity of ionizing radiation from the sun. A method for calculating a daily radiation index, using these critical frequencies, has been described by Minnis and Bazzard (1) and the daily values for the period 1st July 1957-31st December 1959 were included in *U.R.S.I. Bulletin* No. 120, pp. 10-15.

The values for 1960 have now been calculated and are given in Table 1. The standard deviation of the erratic errors in J_E is estimated to be about 2 percent, but the errors may be greater than usual on days when intense E*s* ionization or equipment faults reduced the number of readings. When such errors seem likely to exceed 3 per cent, the value of J_E is enclosed in brackets.

The index values in Table 1 were calculated by Mr. G. H. Bazzard and Mrs. M. D. Vickers.

REFERENCE

1. MINNIS, C. M. and BAZZARD, G. H. — *J. Atmosph. Terr. Phys.*, **17**, 57, 1959.

Daily Values of E-layer Index J_E

1960

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	252	277	231	—	170	—	260	232	221	164	—	165
2	257	270	204	—	215	247	288	223	235	179	(200)	199
3	290	287	202	—	239	—	245	224	234	—	(181)	—
4	—	284	197	243	248	—	—	232	225	195	171	233
5	246	247	213	250	234	—	—	(259)	204	199	194	281
6	—	253	189	240	(231)	272	264	—	230	162	181	236
7	(286)	(266)	209	249	206	289	267	234	253	—	213	(235)
8	(258)	256	219	232	203	275	267	—	258	—	—	—
9	—	270	(207)	(223)	—	(277)	268	231	248	207	198	206
10	268	232	212	244	246	294	(276)	(224)	261	—	(221)	—
11	245	226	(200)	232	289	282	277	—	284	239	227	211
12	—	229	208	231	282	297	216	—	308	214	226	218
13	265	220	227	238	296	263	—	287	301	(225)	176	157
14	242	198	227	249	248	274	—	—	(323)	230	(229)	185
15	246	215	244	245	261	244	224	313	328	230	219	—
16	—	212	210	236	219	241	197	(344)	311	219	163	(180)
17	254	209	201	213	(229)	—	237	265	294	253	182	(189)
18	262	210	204	250	235	236	222	293	296	—	198	(178)
19	239	204	227	270	220	231	—	(268)	296	189	198	—
20	227	202	215	266	227	231	256	283	295	207	176	165
21	218	215	218	(265)	224	—	(267)	(251)	284	196	183	160
22	225	227	240	250	(238)	(210)	—	266	235	—	172	136
23	255	224	244	251	214	(217)	(260)	251	250	176	150	160
24	252	—	258	229	223	(229)	286	274	253	(186)	168	170
25	309	227	242	(209)	218	(254)	264	(250)	238	160	175	175
26	—	247	269	215	—	(232)	—	249	—	149	185	172
27	306	251	288	200	(219)	222	(232)	(250)	(216)	169	176	156
28	306	235	259	186	—	242	261	—	208	171	173	153
29	302	233	268	210	264	257	(248)	[illegible]	[illegible]	(237)	[illegible]	—
30	263	—	278	183	237	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]		[illegible]		[illegible]		[illegible]	[illegible]		[illegible]		[illegible]

AN ATLAS OF OBLIQUE-INCIDENCE IONOGRAMS

by Vaughn AGY, Kenneth DAVIES and Roger SALAMAN

(June 24, 1960)

N. B. S. Technical Note n° 31

The atlas is intended to serve a twofold purpose : First, to provide a reasonably comprehensive introduction to this type of ionogram for those workers who are not now familiar with them, and second, to present records which illustrate the various propagation characteristics of the specific paths used by the National Bureau of Standards. An analytical study of the technique and the experimental results was given by Agy and Davies. To date, NBS sweep-frequency experiments have been carried out over two approximately east-west paths : Washington, D.C.—St. Louis, Mo. (about 1,150 km) and Washington, D.C.—Boulder, Colo. (about 2,370 km). A vertical incidence ionosonde was operated at the path midpoint in each case.

The atlas is divided into four parts, namely : 1. Introduction ; 2. Washington—St. Louis routine records ; 3. Washington-Boulder routine records ; and 4. Washington-Boulder experimental records.

The introduction contains a discussion of the equipement together with charts necessary for the identification of certain modes of propagation and a brief description of the records.

The next two sections illustrate diurnal and seasonal variations, layer formation and disappearance, spread echo, MUF extension and several other phenomena of interest. The magnetic *K* figures are included to provide a basis for judging the effect of magnetic disturbance. The accompanying figure is a sample page from the section dealing with the Washington-Boulder path.

The final section is devoted to various short term experiments over the Washington-Boulder path. Expanded time-delay and frequency scales were used as well as shorter pulse durations than in the previous cases. Equipment effects such as pulse width and receiver gain are considered. Detailed sequences of oblique ionograms during magnetic storms are shown together with the midpoint vertical-incidence ionograms. A sequence of *A*-scan records is presented which shows how the field strength varied near the MUF during one sweep.

DOCUMENTATION

Nous tenons à la disposition des personnes intéressées aux activités de la Commission III des exemplaires des documents ci-après :

— D. Lépéchinsky, S. Cartron, A. Frean, J. P. Legrand. — Note sur les black-outs ionosphériques observées en Terre Adélie.

— D. Lépéchinsky et I. Vignal. — Note sur les mesures des vents ionosphériques à Domont (Seine), France, en 1956, 1957 et 1958.

— G. Pillet. — Anomalies dans les mesures de l'absorption ionosphérique.

— P. Villa. — Note sur les satellites ionosphériques préliminaires de l'éclipse solaire du 2 octobre 1959, obtenus dans les stations de Tamanrasset, Bangui et Dakar.

BIBLIOGRAPHY

Attention of the readers is called to the NBS Boulder Laboratories Technical Note n° 82, entitled « A Survey of Spread F » by F. N. Glover.

In this work, examples of spread-F forms occurring at different latitudes are presented, illustrating the classification of spread into range type and frequency type. The occurrence patterns of spread-F at different latitudes are correlated with other geophysical phenomena. Magnetic latitude and time within the sunspot cycle appreciably affect the pattern of spread occurrence. Instrumental techniques and their advantages for spread studies are outlined. The principal theoretical explanations of spread-F are summarized. A single mechanism need not be postulated as responsible for all types of spread occurrence or at all latitudes.

Commission V. — On Radio Astronomy

PROTECTING FREQUENCIES FOR RADIO ASTRONOMY

by Dr. John W. FINDLAY

Chairman of U.R.S.I. Sub-Commission Ve
on Radio Frequency Allocation for Radio Astronomy

On December 21st 1959, in Geneva, Switzerland, at the end of four months closely argued technical discussions among 800 delegates, the representatives of 101 countries signed the final acts of the Administrative Radio Conference of the International Telecommunications Union. These decisions, after ratification by the governments of the signatory countries, will come into force on May 1st 1961.

Although these Radio Regulations represent a treaty between nations to govern the whole practice of radio communications, there was one aspect of the Geneva conference which was of vital interest to radio astronomers. For the first time in the history of the science radio astronomers had asked the conference to reserve certain frequency bands throughout the radio frequency spectrum for their sole use. As a result the conference had embodied in the text of its final regulations allocations of frequencies for radio astronomers to use. In this article I intend to outline first the needs of radio astronomy, as the scientists from various countries see them, then to sketch the steps which the scientists were able to take to make their needs known and lastly to describe and evaluate the results as they appeared in the Conference draft Regulations.

* * *

Radio astronomy was born in the years 1930-1932 when Karl Jansky at the Bell Telephone Laboratories at Holmdel, New Jersey, first heard and identified radio signals coming from the milky way. Although there was notable pioneer work by Grote, Reber and Southworth, it was not until the end of the war in 1945 that many scientists took up the study of the radio waves apparently emitted from the sun, from objects within our own galaxy and from objects at great distances from our own galaxy.

The science has always been one of listening. Although radar reflexions from meteors, the moon, Venus and the sun have been detected, these experiments are more correctly described as radar astronomy. The power available on earth from even the strong radio sources is till minute when compared with the powers available in good radio communication systems. A very imposing illustrative figure, which is only correct to an order of magnitude, is that if all the energy which has so far been collected by all radio astronomers since 1945 and used for their observations were added up it would be about equal to 1 erg of work-or about the work done in lifting 1 milligram through 1 cm.

Since the extreme faintness of the signals that radio astronomers can detect has such a strong bearing on the need for protecting some frequency bands for the use of radio astronomy, it is worth while setting out in more detail what the instrumental limits of radio astronomy appear to be. First, the signals from radio sources are in general very broad band noise signals. There are exceptions to this statement, most particularly in the case of the hydrogen-line radiation. But even here the signals are spread over a band of almost 1 Mc/s and are noise like in character. To detect such signals the radio astronomer is faced with the task of identifying them in the presence of the noise like signals which are generated in the radio receivers he uses. This separation is usually done in the simplest possible way. A radio telescope, simply a large antenna and a radio receiver, is pointed at the radio source and the receiver output measured. Then the telescope is pointed away from the source (towards what we will assume to be a non-radiating background) and the receiver output again measured. The difference is a measurement of the power received from the source. In good receivers today, of conventional design but not using parametric amplifiers or masers, the noise generated in the receiver may be 1000 times the power from the source we are trying to detect, and so an experiment of the kind just described involves the detection and measurement of only a 0.1 % change in the output of the receiver.

* * *

Let us define some more precise terms before taking the argument further. We have referred to the power received by an antenna from a distant radio source. We could get an exactly equal noise power input into our receiver if we connected to it a resistance which reproduced precisely the antenna radiation resistance and then we heated this resistance to some temperature T_A °K. We can choose T_a such that the receiver gets the same power from the Johnson noise due to the random motion of the electrons in the resistor as the antenna receives from the radio source.

When we have adjusted T_A and measured it in degrees on the absolute temperature scale, we define T_A as the « antenna temperature » of our system when observing the radio source. One minor practical point needs mentioning. We have assumed the antenna receives power only from the radio source, while in practice of course an actual antenna receives signals also from neighboring warm objects such as the ground.

We can now continue the discussion to show the kind of sensitivities already achieved in radio astronomy receivers by listing the smallest changes in antenna temperature they are able to detect. To do this we must consider briefly the noise generated in the receiver itself. In any practical receiver noise is generated by the electron tubes and resistors in the receiver. We can represent this receiver noise in a very simple way by saying that the noise made in the receiver is equivalent to the extra noise we should get by heating a resistor at the receiver input by an additional T_{eff} °K.

This defines T_{eff}, which we call the effective temperature of the receiver. Physically what we are doing is to say that our imperfect noisy receiver connect to a source at T_A behaves just like a perfect noiseless receiver connected to a source at $(T_A + T_{eff})$°K, and that T_{eff} °K is a measure of the noise generated in our imperfect receiver. Readers familiar with the definition of the noise figure of a receiver will recognise that T_{eff} and the noise figure (F) are related by the expression :

$$T_{eff} = (F - 1) \times 290° \text{ K}$$

Radio astronomers generally prefer to refer to the noiseless of their receivers by quoting T_{eff} and not the noise figure.

* * *

Let us now list some of the receivers which radio astronomers are using and expect to use and say what performance they have. Table I is such a list of receivers. In it there is first a group of

« conventional » receivers. By this is meant receivers whose performance is established by quite a long period of practical experience. There follow some « novel » receivers, either maser receivers or parametric amplifier receivers. Masers and parametric amplifiers have been used in radio astronomy experiments as well as in other applications and it is possible to assess fairly well how they behave.

The third column of the table gives figures for T_{eff} for the various receivers. In all cases this is quite well known. We have, in estimating T_{eff}, included a figure to allow for the losses in circulators or waveguide runs that are needed in a practical installation. The next column, the minimum change of antenna temperature which the receiver can detect, is less easy to determine accurately. This depends in a calculable way on the values of T_{eff}, the bandwidth and integration time used in the experiment. The uncertainties in estimating this quantity arises from several practical considerations, such as the gain stability of the receiver and its sensitivity to small impedance changes at its input. For the conventional receivers the figures in this column are based on experience. For the « novel » receivers they include some judgments of the probable practical performances of such devices.

Having established reasonable values for the minimum changes of antenna temperature that the receivers can detect, we can then calculate what are the corresponding minimum power levels from the Johnson formula.

The last column of Table I brings us to the heart of the argument. Let us suppose we have a receiver connected to a large radio telescope and are making radio astronomical observations. We can detect changes in antenna temperature and in power levels as shown in Table I. But, if the radio telescope can pick up interfering signals of about the same magnitude or larger from radio stations on earth it will be very difficult for the radio astronomer to make his observations. Let us assume we have a radio telescope of 140-feet in diameter, such as is now being built at the National Radio Astronomy Observatory at Green Bank, West Virginia.

The collecting area of the parabolic dish of this instrument will be approximately 860 square meters. If an interfering signal from a CW transmitter has the field strength given in the last column of Table I it will just equal the smallest radio astronomy signal the antenna and receiver can detect. The last column of Table I may therefore, be thought of as the largest interfering signal that radio astronomers at Green Bank can tolerate.

* * *

The field strengths arrived at in this way are strikingly minute to those working in communications and radar technology. There are two factors which may in practice permit radio astronomers to tolerate somewhat larger interfering signals than those given in Table I.

First, in compiling Table I, it has been assumed that the 140-foot telescope is pointed at the same time at the radio source in the sky and at the interfering source on the ground. As long as interfering sources remain on the ground, and are not carried by aircraft, missiles, satellites or space vehicles, this assumption is not true. Interfering signals from ground-based sources do not enter the telescope in its primary beam, but leak in through the « side-lobes » of the instrument. Unfortunately, no radio telescope can be built which does not have these side-lobes, although as the instruments get larger it is more and more important to reduce these side lobes as much as possible. Good design seems to permit of the side lobe sensitivity of a good radio telescope being some 10,000 times less in power gathering ability as compared with the main beam. Thus, if all the interfering sources were on the ground it would be permissable to raise the levels of the lowest tolerable signals by 10,000 times in power or 100 times in field strength.

The second fact which permits the raising of the tolerable interference levels applies only to frequencies lower than about 400 Mc/s — a wavelength of 75 cm. In this range of frequencies, the sky itself is a radio source. The sky is brightest at low radio frequencies and gets darker at higher frequencies. Thus, a radio telescope pointed at the sky collects noise and has an antenna temperature. Table II gives some values for this antenna temperature. The sky background is not uniform, it is brightest generally toward the milky-way and brightest of all in the direction of the center of our galaxy of stars, towards the constellation of Sagittarius.

This sky brightness limits the ultimate sensitivity of a radio telescope in two ways. First, it means that however good the receiver may be in having a low effective temperature, the sky

Type of Receiver	Frequency and Bandwidth	Effective Temperature T_{eff}° K	Smallest detectable change in antenna temperature	Smallest detectable change in input power level watts	Field strength at a 140 foot telescope giving the same change in power (μV per meter)
Ewen-Knight EK/H11-X2C Travelling Wave Tube Receiver	8000 Mc ±500 Mc	3000° K	0.01° K	1.38×10^{-16}	7.8×10^{-3} μv/m
Ewen-Knight EK/H11-H11-S2CA Travelling Wave Tube Receiver	3000 Mc ±100 Mc	1500° K	0.01° K	2.77×10^{-17}	3.5×10^{-3} μv/m
Airborne Instruments Laboratory H-line Radiometer	1400 Mc ±500 kc	1200° K	0.5° K	6.90×10^{-18}	1.75×10^{-3} μv/m
NRAO Total Power Receiver	400 Mc ±1 Mc	400° K	0.1° K	2.77×10^{-19}	1.1×10^{-3} μv/m
An X-band Maser	9000 Mc ±10 Mc	50° K	0.001° K	2.77×10^{-19}	$3.5 \times 10\mu^{4}$ μv/m
An S-band Maser	3000 Mc ±5 Mc	50° K	0.002° K	2.77×10^{-19}	3.5×10^{-4} μv/m
A Parametric Amplifier for the H-line	1420 Mc ±500 kc	200° K	0.02° K	2.77×10^{-19}	3.5×10^{-4} μv/m
A parametric amplifier	**400 Mc ±500 kc**	**150° K**	**0.02° K**	2.77×10^{-19}	3.5×10^{-4} μv/m

TABLE II

Approximate antenna temperatures of a radio telescope directed to the hottest and coldest parts of the sky

Frequency	Antenna Temperature of Telescope	
	Hottest sky area	Coldest sky area
20 Mc/s	250,000° K	32,000° K
40 Mc/s	61,000° K	6,200° K
60 Mc/s	27,000° K	2,400° K
100 Mc/s	8,500° K	700° K
200 Mc/s	1,800° K	120° K
400 Mc/s	300° K	20° K
600 Mc/s	140° K	7° K

TABLE III

Noise fluctuations due to the sky back-ground and their equivalent field strengths for a 140-foot telescope

Frequency	Statistical fluctuations in antenna temperature		Field strength at 140′ telescope giving same change in power	
	Hot Sky	Cold Sky	Hot Sky	Cold Sky
20 Mc/s	25° K	3.2° K	1.2×10^{-2} μv/m	4.5×10^{-3} μv/m
40 Mc/s	6.1° K	.62° K	6.1×10^{-3} μv/m	2.0×10^{-3} μv/m
60 Mc/s	2.7° K	.24° K	4.0×10^{-3} μv/m	1.2×10^{-3} μv/m
100 Mc/s	.85° K	.07° K	2.3×10^{-3} μv/m	6.5×10^{-4} μv/m
200 Mc/s	.18° K	.012° K	1.0×10^{-3} μv/m	2.7×10^{-4} μv/m
400 Mc/s	.03° K	.002° K	4.3×10^{-4} μv/m	1.1×10^{-4} μv/m
600 Mc/s	.014° K	.007° K	3.0×10^{-4} μv/m	6.5×10^{-5} μv/m

background adds noise to the system and this noise may mask the observation of weak sources. Secondly, the sky background is not uniform, and in some experiments, such as measuring a point source against the background, this non-uniformity may obscure the results.

It is difficult to assess exactly the lower limit of sensitivity that the sky background sets to radio astronomy. A lower limit may be estimated by considering the statistical fluctuation of the noise that the sky radiation introduces into the receiver. This has been done in Table III, for the hottest and coldest sky temperatures, on the assumption that the receiver has a bandwidth of 1 Mc/s and that observations are integrated over a time of 100 seconds. Table III gives the equivalent smallest detectable power level corresponding to these noise fluctuations. Exactly as in Table I, we have then assumed we are observing with a 140-foot telescope and the final two columns of Table III give the field strength of interfering signals at the telescope which would equal the noise fluctuations due to sky background.

The combination of the estimates of receiver sensitivity summarised in Table I and the estimates of the limiting fluctuations from the sky background given in Table III can now be combined in a diagram showing the vulnerability of radio-astronomical observations to outside interference. This is done in Figure I, where the maximum tolerable interfering field strength is plotted against frequency for the number of possible situations that has been considered. The first thing to note from Figure I is that one can define a level of interference which is quite destructive of present-day radio-astronomy, in that such interference, entering even the side lobes of a 140-foot radio telescope, prevents the full use of present day receivers. This level is defined by Curve A.

Curve B shows the level of interference which will be intolerable in the near future for interfering sources in the main beam of a 140-foot telescope. If we assume that we are using a dish larger than 140-feet — the maximum of permissable interference would shift to lower values than shown in Curve B. Since at present a radio telescope of 1000 feet in diameter is being planned for erection in Puerto Rico and a group of scientists is considering the need for an instrument of diameter of the order of 2000 feet, it is clear that the future of the science is going to require that interfering signals be kept at least at the level of Curve B of Figure I.

* * *

Let us now briefly consider what man-made sources of interference can harm radio astronomy. To do this we will accept

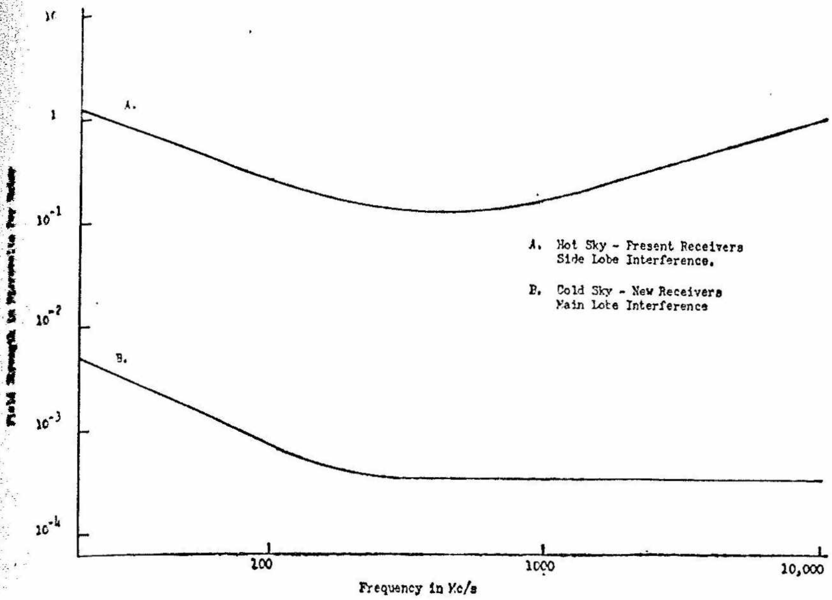

FIG. I. — Tolerable interference levels for the N. R. A. O. 140′ telescope

Curve B of Figure 1 as representing the maximum toterable levels of interference.

First, consider the direct radiation from a transmitter to the radio telescope. Assume we have at a distance of γ kilometers transmitter radiating a Power P watts directly toward the radio telescope. Practically, this might be a transmitter in a space vehicle in the sky above the telescope. Such a transmitter would give a field in microvolts per meter of

$$\text{Field} = 5.49 \frac{P}{\gamma} \times 10^3 \text{ microvolts per meter.}$$

If we set this field just equal to the maximum tolerable field given by Curve B of Figure I, we arrive at Figure II, which shows how far away an interfering transmitter has to be before it no longer interfers with radio astronomy. The result is not unexpected — even a small radiated power of 10 milliwatts gives an interfering signal at ranges of 100,000 to a million kilometers from the radio telescope.

* * *

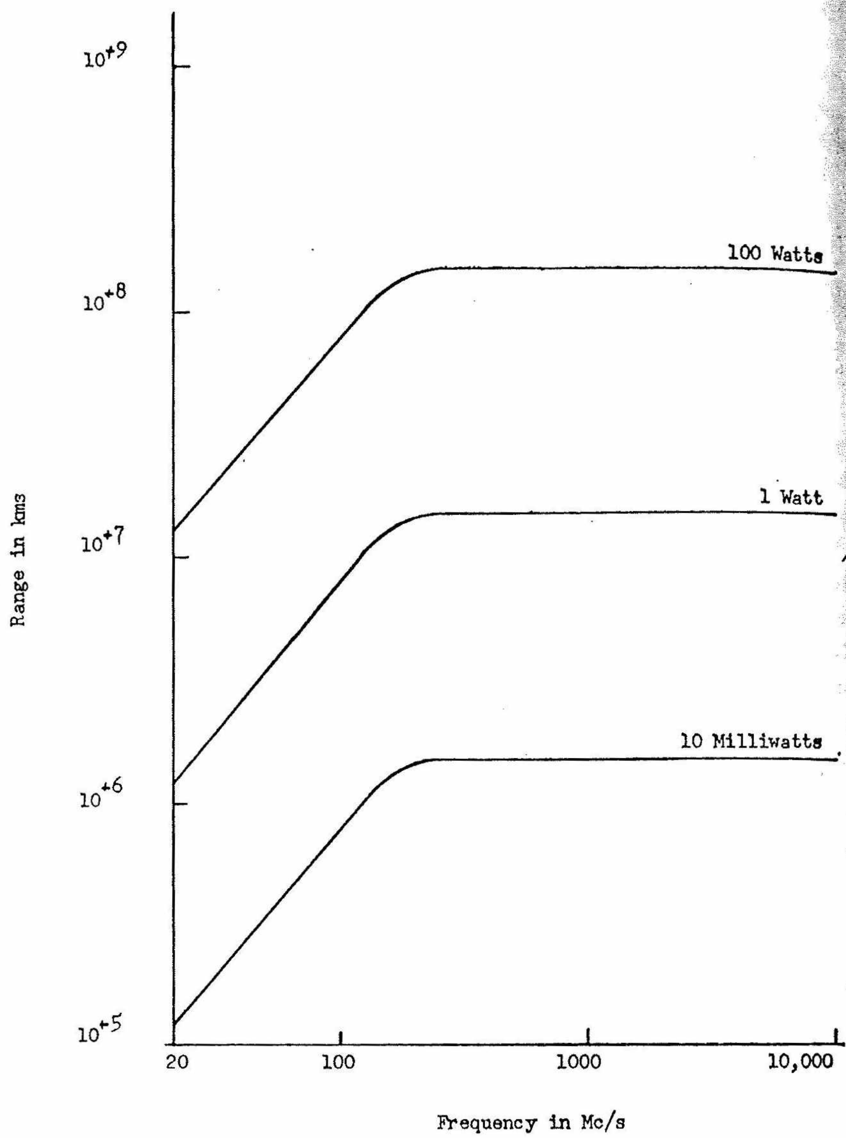

FIG. II. — Range at which free-Space transmissions interfere with the 140-foot telescope.

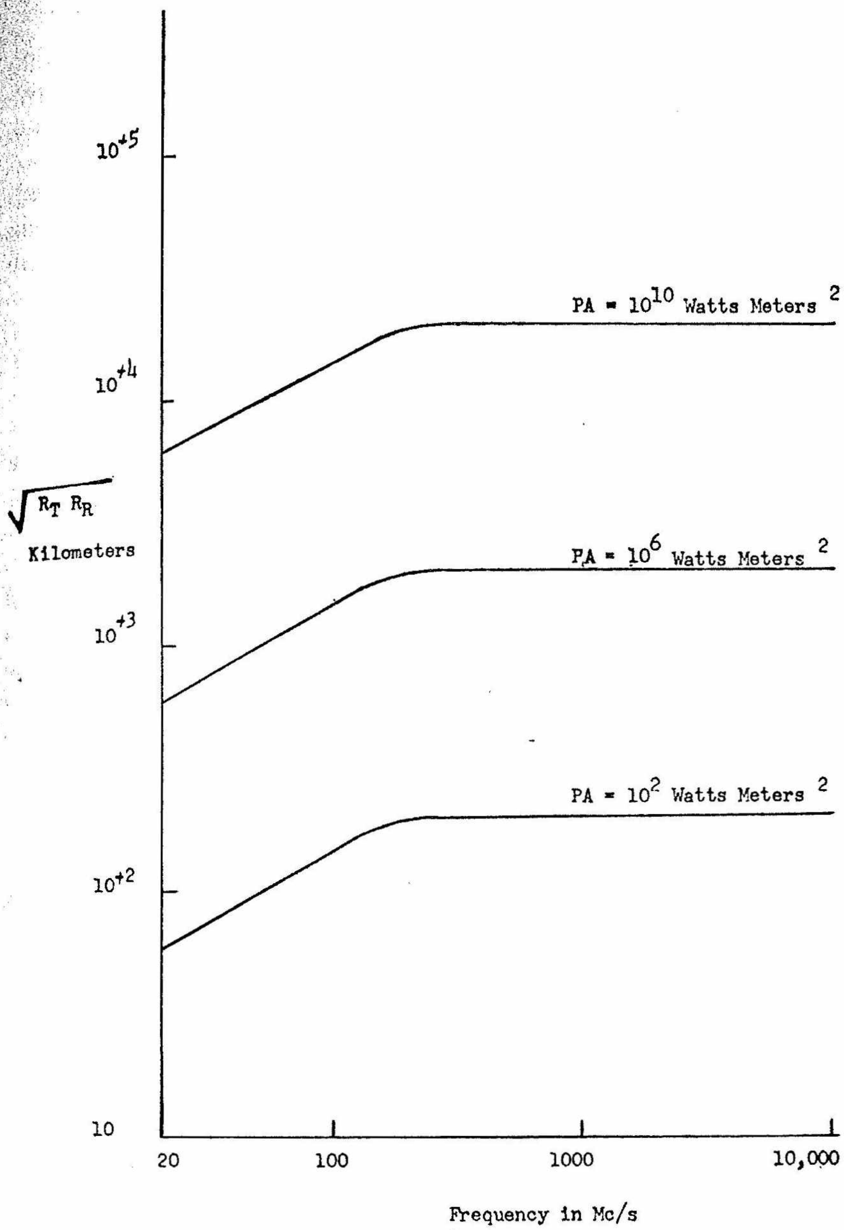

FIG. III. — Root range product for scattering of a transmitter of power P watts from a scatterer of area A Sq. Meters and the 140-foot radio telescope.

$R\mu$ = Range, transmitter to scatterer.

$R\mu$ = Range, receiver to scatterer.

A second possible source of interference might come from radio signals transmitted from the ground which strike an object in the sky, such as an aeroplane, a missile or a satellite, and are then scattered back to the ground. If we assume we have a transmitter radiating P watts toward an object in the sky whose scattering cross section is A square meters, and that the distances from the transmitter and radio telescope to the scattering objects are γ_1, γ_2 kilometers respectively, the field at the radio telescope is given by :

$$\text{Field} = 1.55 \frac{\sqrt{PA}}{\gamma_1 \gamma_2} \text{microvolts per meter.}$$

Figure III, derived from Curve B of Figure I, shows how the value of $\sqrt{\gamma_1, \gamma_2}$ depends on various values of transmitted power and scattering cross section. Orders of magnitude of values for scattering cross section areas are that a missile may be as small as 1 sq. meter, an aircraft 10 to 100 sq. meters and a spherical reflector used as a passive communications satellite as large as 1000 sq. meters. Radiated power from ground stations may be as high at 10^7 watts. A number of interesting quantitative cases can be seen from this Figure. A television station may radiate 100 kw watts toward an aircraft of scattering cross-section of 10 sq. meters. If this happens, the aircraft will scatter an intolerable signal into a radio telescope even if the transmitter is 1000 kms from the aircraft and the aircraft is 500 kms from the radio telescope.

If the same aircraft is only 10 kms from the radio telescope a radio transmitter 200 kms away of only 20 milliwatts will scatter an intolerable signal from the aircraft into the radio telescope.

A satellite of only 1 sq. meter scattering cross section in an orbit 300 miles up will scatter an intolerable signal to a radio telescope if it is illuminated by a radio transmitter of only 3 Kw on the ground 300 miles from the satellite.

* * *

The last possible source of radio interference to radio astronomy is also the oldest — radio signals propagated over the ground from transmitter to the radiotelescope. Here we need only consider signals whose frequency is high enough not to be propagated by normal ionospheric reflexion, since signals of lower frequency are propagated with such small loss as to make it almost impossible to make radio astronomical measurements on frequencies where long distance ionospheric propagation can be maintained.

Radio astronomers have generally attempted to choose sites for their main observatories as far as possible from sources of man-made noise and to be as well shielded as possible by neighboring hills from radio signals propagated either directly over the ground or by scattering in the lower atmosphere. Figure IV shows the land profiles through the site of the National Radio Astronomy Observatory, at Green Bank, West Virginia, and demonstrates clearly the excellence of the shielding provided by multiple mountain ranges, particularly in the East and West directions toward the populous regions of the East Coast and the Ohio Valley. Despite this excellent shielding, however, some 20 signals can be detected at Green Bank in the frequency range from 40 Mc/s to 2000 Mc/s from T/V stations, F/M Broadcasting stations and large fixed ground radar installations.

* * *

It was a consideration of all these potential and actual sources of interference which led radio-astronomers to consider what their minimum needs were if their science were to survive and to grow. The radio frequency spectrum from a few Mc/s up to tens of thousands of Mc/s can be used by radio astronomy. The low frequency limits of this spectrum is set by the earth's ionosphere, which only permits frequencies of between about 4 Mc/s and 30 Mc/s to escape from the earth, the exact frequency depending on the hour, season and epoch in the sunspot cycle. The upper limit of frequency is set by absorption of the radio waves by atmospheric gases. This limit is not clearly defined, but useful atmospheric « windows » exist up to 38 kMc (a wavelength of 8 mms).

At one frequency near 1420 Mc (21 cms) there exists the naturally occurring radiation from the atoms of neutral hydrogen. This radiation is emitted as a line or monochromatic radiation of very well known frequency (1420.4 Mc/s) but when it is received the measured frequency is changed due to the relative motions of the source of radiation and the observer. The hydrogen-line radiation has been extensively used to study the structure of our own galaxy.

Other lines have been predicted to occur from the Deuterium

FIGURE IV

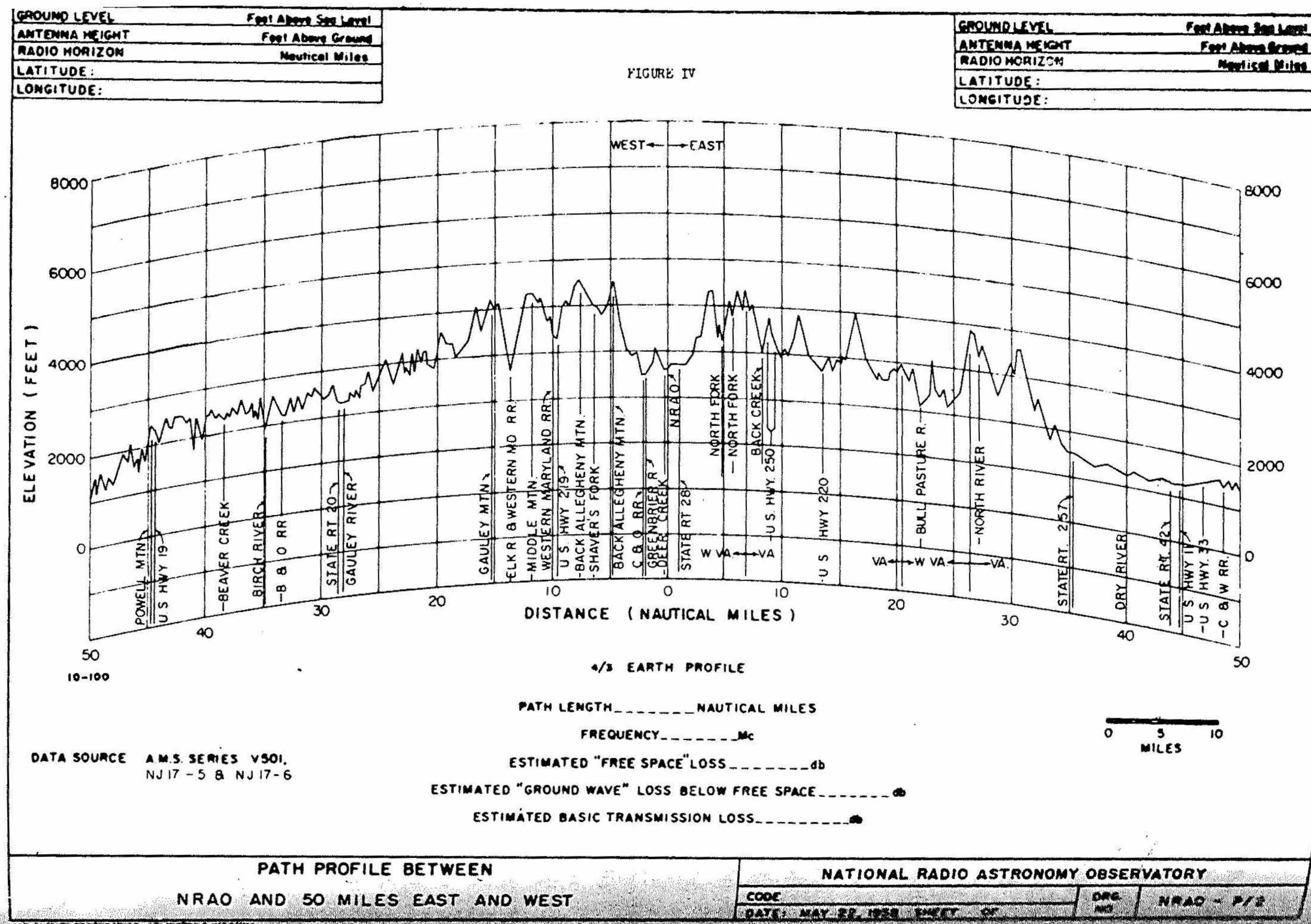

Fig. IV.

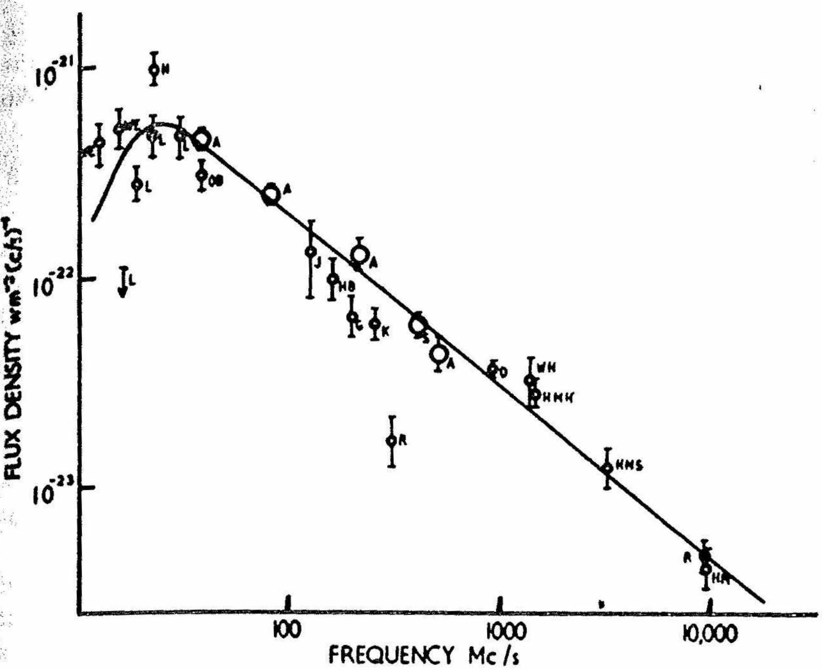

FIG. V. — The spectrum of the radio source in Cassiopeia. From G. R. Whitfield « The Spectra of Radio Stars ». M. N. R. A. S., **117**, 680, 1957.

atoms at 327 Mc (heavy hydrogen) and from the OH radical at 1667 Mc, but despite careful searches these have not yet been discovered.

Radio astronomers study the hydrogen line radiation and also the continuum radiation which all sources emit over the whole available range of the spectrum. An extremely valuable piece of information about any source is the way in which its intensity varies with the radio frequency. Figure V shows the spectrum of the source in Cassiopeia A as it is known at present. Similar information is available on only a few other sources, yet many must be measured before theories of the mechanism of production of radio waves can be properly tested. It may also be possible, from such spectra, to obtain regular patterns in the statistics of radio sources similar in kind to the well-known Hertzsprung-Russel diagram of optical astronomy.

It is clear, therefore, that radio astronomers need to be able to observe both in the vicinity of naturally occurring lines such as the hydrogen line and also at various points throughout the radio frequency spectrum.

* * *

The need for specific frequencies for observations by radio astronomers had been discussed for some years in international meetings of U.R.S.I. (The International Union for Scientific Radio) and I.A.U. (The International Astronomical Union). When it was known that there would be the Administrative Radio Conference at Geneva in the last four months of 1959, both U.R.S.I. and I.A.U. acted to prepare for the Conference. U.R.S.I. set up a Sub-Commission of internationally chosen scientists at the Geneva Assembly held at Boulder, Colorado in September 1957, and the I.A.U. re-inforced and made more precise the needs of radio astronomy during its meeting at Moscow in 1958.

The first step to be taken was to agree on the scientific needs of radio astronomy. This was done at the C.C.I.R. (International Radio Consultative Committee) at its meeting in Los Angeles in the spring of 1959. The C.C.I.R. at that meeting recommended :

1. that radio astronomers should be encouraged to choose sites as free as possible from interference ;
2. that Administrations should afford all practicable protection to the frequencies used by radio astronomers in their own and neighbouring countries ;
3. that particular care should be taken to give complete international protection from interference to observations of emissions known or thought to occur in the following bands :

Line	*Line frequency* (*Mc/s*)	*Band to be protected* (*Mc/s*)
Deuterium	327.4	322- 329
Hydrogen	1420.4	1400-1427
OH	1667	1645-1675

4. that the bands allocated for standard frequency and time signal emissions at 2.5, 5.0, 10.0 and 20.0 Mc/s should not include anything other than the standard frequency and time signal emissions, thus permitting their use for reception in radio astronomy ;

5. that consideration be given to securing adequate international protection of a number of narrow frequency bands throughout the spectrum above 30 Mc/s for the purpose of reception in radio astronomy (see Note);

6. that Administrations, in seeking to afford protection to particular radio astronomical observations, should take all practicable steps to reduce to the absolute minimum amplitude harmonic radiations falling within bands of frequencies to be protected for radio astronomy.

Note. — Radio astronomers in a number of countries have indicated their desire to use for this purpose one frequency band at each of the following approximate positions (not necessarily in harmonic relation):

Frequency (Mc/s)	*Bandwidth (Mc/s)*
40	± 0.75
80	± 1.0
160	± 2.0
640	± 2.5
2560	± 5.0
5120	±10.0
10240	±10.0

The C.C.I.R. has the task of advising the International Telecommunication Union and the Administrative Radio Conference, but it does not have the responsibility of making frequency allocations. The C.C.I.R. Recommendation was therefore used by radio astronomers as the basis for working within their own administrations toward getting agreement at the Geneva Conference.

* * *

The Geneva Radio Conference worked for four months before completing its task. After the initial organization phase, the first three months were taken up with the detailed work of the various Committees, with the objective or reaching as much agreement as possible on the hundreds of proposals which had been referred to each. The work of these Committees then was twice reviewed by the Conference in Plenary Session, and the Final Acts eventually were signed just before Christmas, to become effective May 1, 1961.

The needs of radio astronomy were considered almost entirely by Committee IV on Frequency Allocations, under the Chairmanship of Mr. Gunnar Pedersen of the Danish Delegation. This Committee was divided into Working Groups, Sub-Working Groups, and Sub-sub-Working Groups. International scientific organizations such as the I.A.U. and U.R.S.I. were invited to send observers to the I.T.U. Administrative Radio Conference, and I.A.U., U.R.S.I. and C.O.S.P.A.R. (The Committee on Space Research) joined in sharing a full-time observer at Geneva. The heaviest burden of providing this observer fell on the Leiden Observatory (which provided C. Seeger, Prof. Oort and Prof. Van der Hulst) and in addition Prof. Beynon from Aberystwyth (Great Britain), Prof. Denisse from Meudon (France) Prof. R. Coutrez from Uccle (Belgium and U.R.S.I. General Secretariat) and Dr. Findlay from N.R.A.O. (U. S. A.) (Chairman of U.R.S.I. Sub-Commission Ve on Radio Frequency Allocation for Radio Astronomy) all served as observers.

The work of the Conference was detailed and difficult, particularly in Committee IV. The radio-frequency spectrum was last allocated at a similar Conference held in Atlantic City in 1947; this full Conference was followed by a special implementing Conference at Geneva in 1951. Since this allocation, pressure on the available frequency space had increased enormously. Radio astronomy and space science appeared for the first time with requests for frequency allocations on a world-wide basis. It was this request for world-wide clearance which made the allocation problem so severe. In the frequencies above 50 Mc there had hitherto been no great pressure for world-wide conformity except in the interests of standardization, since propagation of such frequencies around the world was generally not a problem. Only ships and aircraft covered large areas of the world and thus needed world-wide frequency conformity.

With the advent of satellites and space probes, however, the situation had changed rapidly. Radio astronomers could not co-exist with other users in the same frequency bands if these other users were to be flying overhead or even if they were so located that they could illuminate objects flying overhead. The needs of space science also seemed to call for world frequency allocation, and it also seemed to be incompatible for space science and radio astronomy to share frequencies. Frequencies had been fully allocated up to 10,500 Mc/s at Atlantic City and largei nvestments had been made in equipment based on those allocations,

* * *

The Conference attacked the problems set by the needs of Radio Astronomy with energy and interest. Specific proposals for solving the Radio Astronomy needs were advanced by the delegations of the Netherlands, Great Britain, U. S. A., the U. S. S. R. and Belgium. All these proposals came from the respective administrations, and all reflected to a greater or less extent the success with which the scientists had made their needs known and got them accepted within their Governments. A special group was set up under the Chairmanship of Lieutenant Commandor van der Willigen of the Netherlands to work out the details of the radio astronomy frequency allocations. The official delegates to the Conference made very full use of the presence of the I.A.U./U.R.S.I./C.O.S.P.A.R. observers in working out the terms of the final agreement. The results finally agreed showed the difficulties that had been found in making space in an already overcrowded radio-frequency spectrum.

* * *

The first result to be noted is that the Conference defined the terms radio astronomy and the radio astronomy service, and thus recognized the existence of radio astronomy as a radio service, equivalent to other services such as broadcasting. This is a change of status, in that there has always in the past been a doubt that, since radio astronomers do not generally transmit radio waves, they might have no rights in the radio spectrum. They now have rights just as users of other radio services have rights.

* * *

The Conference actions, which concern radio astronomy, are summarized in the following Table IV. For purposes of frequency allocations the World is divided into three Regions. These regions may be approximately described by :

Region 1. Europe, including the U. S. S. R. and Turkey, Africa and Arabia.

Region 2. The North and South American continents.

Region 3. Asia, including the Chinese Republic and India, Australia and New Zealand.

In addition to the actions summarized in this Table, the Conference adopted two Recommendations on the subject of radio astronomy, Nos. 30 and 31. These recommend : (1) that administrations take all practicable steps to safeguard the standard frequency guardbands from interference, and (2) that administrations consider further the needs of radio astronomy before the next Administrative Radio Conference. In particular, the possibility of making a firm allocation in the range 37-41 Mc should be specially considered, and that in the meantime administrations should avoid as far as possible making assignments in 38.0 ± 0.25 Mc, and 40.68 ± 25 Mc, which are used already by radio astronomers. Administrations should leave 606-614 Mc as free as possible for radio astronomy and all administrations should report to the I.T.U. the locations of radio astronomy observatories in their countries and those of the allocated bands that are in use at each observatory.

* * *

Radio astronomers feel that, although the results of the Geneva Conference fall far short of the ideal that was stated in the original C.C.I.R. Recommendation, a very considerable step has been taken in the protection of the science from further encroachment. There is much that radio-astronomers will do as a result of the Conference.

First, in planning new equipment and experiments there will be a natural move to use the frequency bands already protected. Within the degree of protection already proposed, efforts will be made in all countries to achieve as much local protection from interference by asking Administrations to reduce as far as is practicable the interfering signals at the main radio-astronomy observatories. The Conference stressed the importance of clearing the guard-bands of the standard frequency and time signal transmissions at other signals and radio astronomers, since they now have a direct interest, will press for this to be done. Although the next full Administrative Radio Conference will not take place before 1965 there is already a proposal for an Extraordinary

TABLE IV

Table IV

Summary of frequency allocations for use by Radio Astronomy

Frequency	Allocations	Notes
2495 kc- 2505 kc 4995 kc- 5005 kc 9995 kc-10,005 kc 14,990 kc-15,010 kc 19,990 kc-20,010 kc 24,990 kc-25,010 kc	The standard frequency guard-bands at 2.5 Mc/s, 5 Mc/s, 10 Mc/s, 15 Mc/s, 20 Mc/s and 25 Mc/s may be used by the radio astronomy service. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other. In Region 1 only 2498-2502 kc of the 2.5 Mc band may be used by the radio astronomy service.	The bands 10,003-10,005 kc and 19,990-20,010 kc are also allocated on a secondary basis to the space and earth-space services for research purposes.
73-74.6 Mc	In Region 2, the band 73-74.6 Mc/s may be used by the radio astronomy service. Administrations assigning frequencies to stations of services to which this band is allocated should take all practicable measures to avoid harmful interference to radio astronomy observations.	73-74.6 Mc is primarily assigned as follows : *Region* 1. Fixed, mobile except aeronautical mobile. *Region* 2 : Fixed, mobile, broadcast. *Region* 3. Fixed, mobile.
79.75-80.25 Mc	The band 79.75-80.25 Mc/s is also allocated in Regions 1 and 3 (except Korea, India and Japan) to the radio astronomy service. In making assignments to stations of other services to which this band is allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	79.75-80.25 Mc is primarily allocated as follows : *Region* 1. Fixed, mobile except aeronautical mobile. *Region* 2. Fixed, mobile, broadcast. *Region* 3. Fixed, mobile, aeronautical radio navigation.

Frequency	Allocations	Notes
150-153 Mc	In Region 1, the band 150-153 Mc/s is also allocated to the radio astronomy service. In making assignments to new stations of other services to which this band is allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	150-153 Mc is primarily allocated as follows : *Region* 1. 146-151 Mc fixed, mobile, except aeronautical mobile (R) 151-154 Mc as 146-151 Mc plus meteorological aids. *Regions* 2 *and* 3. Fixed, mobile.
322-329 Mc	Radio astronomy observations on the Deuterium line (322-329 Mc/s) are carried out in a number of countries under national arrangements. Administrations should bear in mind the needs of the radio astronomy service in their future planning of this band.	235-328.6 Mc is allocated world-wide to fixed and mobile. 328.6-335.4 is allocated world-wide to aeronautical radio navigation.
404-410 Mc	The band 404-410 Mc/s in Regions 2 and 3 and the band 406-410 Mc/s in Region 1 are also allocated to the radio astronomy service. An appropriate continuous band within these limits shall be designated on a national or area basis. In making assignments to stations of other services to which these bands are allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	The band 404-410 Mc is primarily assigned as follows : 401-406 Mc. World-wide to meteorological aids, fixed, mobile, except aeronautical mobile. 406-420 Mc. World-wide to fixed and mobile, except aeronautical mobile.

Frequency	Allocation	Notes
606-614 Mc	In Region 1 and 3, the band 606-614 Mc/s may be used by the radio astronomy service until such time as it is required for use by other services to which this band is allocated. During this period administrations should take all practicable measures to avoid harmful interference to radio astronomy observations.	The band is primarily allocated as follows : *Region* 1 *and* 2. Broadcasting *Region* 3. 585-610 Mc radio navigation. 610-890 Mc fixed mobile, broadcasting.
1400-1427 Mc	Allocated world-wide to radio astronomy service except in Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U. S. S. R., the band 1400-1427 Mc/s is also allocated to the fixed service and the mobile, except aeronautical mobile service.	In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U. S. S. R. the bands 1600-1690 Mc/s, 3165-3195 Mc/s, 4800-4810 Mc/s, 5800-5815 Mc/s and 8680-8700 Mc/s are also used for radio astronomy observations.
2690-2700 Mc	The bands 2690-2700 Mc/s and 4990-5000 Mc/s are also allocated to the radio astronomy service. In making assignments to stations of other services to which these bands are allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	The band 2550-2700 Mc is primarily assigned world-wide to fixed and mobile services.

Frequency	Allocations	Notes
4990-5000 Mc	The bands 2690-2700 Mc/s and 4990-5000 Mc/s are also allocated to the radio astronomy service. In making assignments to stations of other services to which these bands are allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from harmful interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	The band 4400-5000 Mc is primarily assigned world-wide to fixed and mobile services.
10,680-10,700 Mc 15,350-15,400 Mc 19,300-19,400 Mc 31,300-31,500 Mc	The bands 10.68-10.7 Gc/s, 15.35-15.4 Gc/s, 19.3-19.4 Gc/s and 31.3-31.5 Gc/s are also allocated to the radio astronomy service. In making assignments to stations of other services to which these bands are allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference. The radio astronomy service shall be protected from interference from services operating in other bands in accordance with the provisions of these Regulations, only to the extent that these services are protected from each other.	The bands are primarily assigned world-wide as follows : 10,550-10,700 Mc. Fixed, mobile, radio location. 15,250-15,400 Mc. Fixed, mobile. 17,700-21,000 Mc. Fixed, mobile. 25,250-31,500 Mc. Fixed, mobile.
Above 40,000 Mc	No allocations made by this Conference.	

Administrative Radio Conference in 1963 to deal with the problems of space science. If considerable progress can be made within the various member countries of the I.T.U. it would perhaps be possible to ask that the needs of radio astronomy be further considered at that time.

* * *

The work that has been done by scientists, representatives of National and International Scientific Unions and members of Governments in achieving the results outlined in this report cannot easily be acknowledged in detail. The total result has been achieved by the efforts of a large number of people. All these have earned the gratitude of the community of radio astronomers for their efforts.

I would nevertheless like to add acknowledge for the helps given by the U.R.S.I. Secretariat and particularly by the Secretary General, Colonel Herbays.

NEEDLE COMMUNICATION BELTS

Preliminary Conclusions

of a study made by H. C. van de Hulst and L. Volders of the interference with optical astronomy which may be caused by the needle communication belts proposed by W. E. Morrow Jr.

1. Pertinent data on this project have been published by W. E. Morrow Jr. in a mimeographed paper : Orbital Scatter Communication, presented at the U.R.S.I. Assembly, Sept. 1960.

2. The data on number, size and weight, etc., given by M. are consistent within about five percent. Those relevant to the optical scattering are : needle length $= 2$ cm, diameter $= 25$ microns, average geom. cross-section $= 3.9 \times 10^{-3}$ cm^2, number density $=$ 20 per km^3, thickness belt (measured radially from the earth's centre) $= 70$ km, height of belt above earth $= 5000$ km.

3. These data refer to a certain moment, 200 days from launch. M. assumes that at that time the width perpendicular to the earth radius is 15 km so that the belt is seen by scattered sunlight as a belt about 00.°2 wide. At a later time it will be fainter and wider.

4. The angle from the zenith does not matter much ; the length of the line of sight cutting through the belt is only 1.2 times larger

at the horizon than at the zenith. The angle from the sun (elongation ε) matters only in as much as the phase function, including diffraction, is anisotropic.

5. Morrow's estimate of the average optical scattering cross-section 1.5×10^{-3} cm² amounts to assuming an albedo 0.38, which is a reasonable value.

6. Using this value of the optical cross-section, isotropic scattering, and the number density and thickness quoted, the visual (surface) brightness of the belt is 3.0 stars of the 10th magnitude per sq. degree in the zenith, independent of elongation. This confirms neither M's original estimate (0.005) nor the value given in the errata sheet (30).

7. Expressed in the same units the estimates of natural light are :

star light and diffuse galactic light (at gal. poles) in Milky Way, average 10 × brighter	30-40
airglow in zenith, average near horizon correspondingly brighter	200
zodiacal light in main cone (elongation 50°)	500
in faintest part of zodiacal belt (el. 135°)	50
near pole of ecliptic	5?

8. It thus appears that the sunlight scattered from the proposed belt of needles would not spoil now feasible photometry of faint astronomical sources by more than 5 or 10 percent, and that only in a limited area of the sky.

9. However, the following considerations show that the actual situation is far more serious.

A. Measurements of colour, or degree of polarization will be more strongly affected because the colour and polarization of the light scattered by these needles is apt to differ strongly from the natural values where subtle nuances (e.g. 1 % polarization) are not uncommon.

B. The assumptions can be changed : making the albedo 1 increases the light by a factor 2.6 ; adding diffraction raises the brightness in the 1° elongation region (outer corona) where it remains well below the natural light. Assuming Lambert's reflection law raises the brightness at large elongation by 8/3. *Making the needles fall apart in dust grains with diameter 2.5 micron raises the brightness of reflected light at any elongation by a factor* 10.

10. By far the worst prospect is that an experiment like this might be followed by frequent other ones using more and bigger needles. The signal to noise ratio of the proposed experiment is not even good enough for normal communication purposes. Hence there may be pressure upon using 10 or 100 times as many needles in normal operation. This would make the brightness intolerably high for any astronomical work concerned with the faint objects in the sky, which range from the zodiacal light to the distant spiral nebulae.

17 October 1960.

CEINTURES DE COMMUNICATION « AIGUILLES »

Conclusions préliminaires

(traduction)

d'une Etude par H. C. VAN DE HULST et L. VOLDERS sur les dangers possibles du projet de ceintures de communication « Aiguilles » proposé par W. E. Morrow, Jr. pour l'astronomie optique

1. Des données pertinentes sur ce projet ont été publiées par W. E. Morrow, Jr. dans une communication miméographiée « Orbital Scatter Communication » présentée à la XIII^e Assemblée Générale de l'U.R.S.I., septembre 1960.

2. Les données sur le nombre, la dimension, le poids, etc., fournies par Morrow sont consistantes à 5 % près. Celles qui se rapportent à la diffusion optique sont :

longueur des aiguilles $= 2$ cm ;
leur diamètre $= 25$ microns ;
section transversale moyenne géométrique $= 3{,}9.10^{-3}$ cm^2 ;
densité numérique $= 20$ par km^3 ;
épaisseur de la ceinture (mesurée radialement à partir du centre de la Terre) $= 70$ km ;
altitude de la ceinture au-dessus de la surface terrestre $= 5000$ km.

3. Ces données se rapportent à une certaine époque, 200 jours après le lancement. Morrow suppose qu'à cette époque l'épaisseur mesurée perpendiculairement au rayon terrestre est 15 km, de sorte que la ceinture se présentera, en vue du Soleil, comme une bande de 0,2° de large. Plus tard, elle sera plus faible et plus large.

4. L'angle au zénith n'est pas important ; la longueur du rayon visuel intercepté par la ceinture est seulement 1,2 fois plus grande à l'horizon qu'au zénith. L'angle à partir du Soleil (élongation 3) importe seulement pour autant que la fonction de phase, comprenant la diffraction, est anisotrope.

5. Les estimations de Morrow pour la section efficace moyenne de diffusion optique ($1{,}5.10^{-3}$ cm^2) conduisent à un albedo de 0,38, ce qui est une valeur raisonnable.

6. En utilisant cette valeur de la section efficace optique, une diffusion isotrope, la densité numérique et l'épaisseur citées, la brillance superficielle de la ceinture équivaut à 3.0 étoiles de 10e magnitude par degré carré au zénith, indépendamment de l'élongation. Ceci ne confirme ni l'estimation originale de Morrow (0.005), ni la valeur donnée dans l'erratum (30).

7. Exprimées dans les mêmes unités, les estimations de la lumière naturelle sont les suivantes :

lumière stellaire et lumière galactique diffuse (aux pôles galactiques) dans la Voie Lactée, en moyenne 10 fois plus	30-40
lumière du ciel nocturne au zénith (en moyenne) à l'horizon, plus intense d'une manière correspondante	200
lumière zodiacale dans le cône principal (élongation 50°) ...	500
dans la région la moins brillante de la ceinture zodiacale (élongation 135°)	50
près du pôle écliptique	5?

8. Il apparaît donc que la lumière solaire diffusée par la ceinture proposée ne gênerait pas la photométrie actuelle des sources astronomiques faibles de plus de 5 à 10 % ; et cela seulement dans une région limitée du ciel.

9. Cependant, les considérations suivantes montrent que la situation actuelle est bien plus sérieuse.

A. Les mesures de la couleur et du degré de polarisation seront bien plus influencées, parce que la couleur et la polarisation de la lumière diffusée par ces aiguilles diffèrent fortement des valeurs naturelles où des nuances subtiles (par exemple 1 % de polarisation) sont fréquentes.

B. Les hypothèses peuvent être changées ; en supposant un albedo = 1, la lumière diffusée est multipliée par 2.6 ; ajouter la diffraction augmente la brillance dans la région d'élongation 1° (couronne extérieure) où celle-ci reste bien inférieure à la lumière naturelle. En supposant une loi de réflexion suivant Lambert, la brillance aux grandes élongations est multipliée par 8/3. *En supposant que les aiguilles se réduisent progressivement à des grains de poussière d'un diamètre de 2,5 microns, la brillance de la lumière diffusée à n'importe quelle élongation est multipliée par 10.*

10. La perspective certainement la plus dangereuse est qu'une expérience de cette sorte pourra être suivie par de nombreuses autres expériences utilisant des aiguilles plus nombreuses et plus grosses. Le rapport signal-bruit de l'expérience proposée n'est même pas assez bon pour les buts normaux de communication. En conséquence, il y aura une pression pour utiliser 10 ou 100 fois plus d'aiguilles. Ceci rendra la brillance intolérable pour tout travail astronomique se rapportant aux sources faibles, depuis la lumière zodiacale jusqu'aux nébuleuses spirales distantes.

17 octobre 1960.

Commission VI. — On Radio Waves and Circuits

SYMPOSIUM ON ELECTROMAGNETIC THEORY AND ANTENNAS

First Announcement - Call for Papers

A « Symposium on Electromagnetic Theory and Antennas » will be held at the Technical University of Denmark, Copenhagen, from Monday, June 25th to Saturday, June 30th 1962, both days inclusive. This will be a continuation of three previous symposia, namely the « Symposium on Microwave Optics » held at McGill University, Montreal, Canada in 1953, the « Symposium on Electromagnetic Wave Theory » held at the University of Michigan, Ann Arbor, Michigan, U. S. A. in 1955, and the « Symposium on Electromagnetic Theory » held at Toronto University, Toronto, Canada in 1959. The symposium will be open to any interested person from any country.

The symposium will be devoted to subjects of current importance in electromagnetic theory and its applications. Papers dealing with the following subjects are encouraged :

Electromagnetic fields in anisotropic media, such as plasmas and ferrites,

Diffraction theory,

Scattering in random media,

Quasi-static electromagnetic problems,

Theory of broad-band antennas,

Antenna pattern synthesis.

Most of the technical sessions will be opened with an invited, introductory paper and will then be followed by a series of shorter papers with interspaced discussions. It is expected that the U. S. S. R. delegation will undertake the complete arrangement of two of the technical sessions.

Papers to be considered for presentation should be sent to the Technical Program Committee at the above address. These should be in the form of a three page summary containing not less than 800 and not more than 1200 words. They should be carefully written as they will form the basis of selection. While it will not be possible to accept all the papers, every effort will be made to include as much material as possible. The deadline for receipt of these summaries is December 1st, 1961. However, it would be desirable that as many papers as possible reach Copenhagen at a considerably earlier date. It is mandatory that papers be presented (in English or French) by the author or by one of the authors in the case of multiple authorship.

Summaries of all accepted papers will be duplicated and sent to all those who have preregistered for the symposium. The final manuscripts will not be needed until the symposium itself. An editorial board will select those papers which are to be published in full in the proceedings. It is expected that the remainder will be published in the form of summaries.

Further information about the symposium will be available upon request to H. Lottrup Knudsen, Secretary, Symposium on Electromagnetic Theory and Antennas, Oster Voldgade 10 G, Copenhagen K, Denmark.

Comité U.R.S.I.-C.I.G.

COMITÉ DES SONDAGES IONOSPHÉRIQUES A L'ÉCHELLE MONDIALE

Nous donnons ci-après la liste des adresses auxquelles sont envoyées les lettres circulaires du W.W.S.C.

Dans le but de compléter et de reviser cette liste, nous serions reconnaissants de recevoir les additifs et correctifs à cette liste. Ces renseignements peuvent être envoyés soit à M. A. H. Shapley, Président du Comité, National Bureau of Standards, Boulder Laboratories, Boulder, Colorado, U. S. A., soit au Secrétaire Général de l'U.R.S.I.

U.R.S.I.-C.I.G. Committee

WORLD WIDE SOUNDINGS COMMITTEE

We are publishing hereunder the list of addresses to which W.W.S.C. circular letters are sent.

In order to complete and to keep this list up-to-date, we would appreciate to be informed of any modifications and additions to be brought to this list.

Such information should be sent either to Mr. A. H. Shapley, Chairman of the W.W.S.C., National Bureau of Standards, Boulder Laboratories, Boulder, Colorado, U. S. A. or to the Secretary General of U.R.S.I.

Mr. R. W. Knecht, 82.00, National Bureau of Standards, Boulder, Colorado, U. S. A.

Mr. J. A. Ratcliffe, Radio Research Station, Ditton Park, Slough, Bucks, Englann.

Dr. N. V. Pushkov, Izmiran, Moskovskaya obl., Leninskii r.n, P/O Vatutenki, U. S. S. R.

Mr. D. Lepechinsky, Laboratorire National de Radioélectricité, 196, rue de Paris, Bagneux (Seine), France.

Dr. F. Lied, Norwegian Defense Research Est., Division of Telecommunication, Kjeller, Lillestrom, Norway.

Mr. Frank T. DAVIES, D.R.T.E., Defence Research Board, Shirley Bay, Ottawa, Ontario, Canada.

Dr. H. UYEDA, Director Radio Research Laboratories, Ministry Posts and Telecommunica., Kokubunji P. O. Koganei-Shi, Tokyo, Japan.

Dr. W. G. BAKER, Ionosphere Prediction Service, 5, Hickson Road, Millers Point, N.S.W., Australia.

Dr. J. W. BEAGLEY, P. O. Box 2111, Geophysical Observatory, D.S.I.R., Christchurch, New-Zealand.

Lt. Jose A. RODRIGUEZ, Tte, de Navio IE, Liara, Av. Gral. San Martin 327, Vicente Lopez (Prov. Bs. As), Argentina.

Mr. R. A. LINDQUIST, Forsvarets Forskigsanstatt, Avdeining 3, Stockholm 80, Sweden.

Prof. Walter DIEMINGER, Max-Planck Institut für Physik der Ionosphere, Lindau über Nordheim, German Federal Republic.

Dr. E. A. LAUTER, Director, Observatorium für Ionosphäre, Schlosstrasse 4, Ostseebad, Kühlungsborn, Germany.

Dr. A. P. MITRA, National Physical Laboratory, Hillside Road, New-Delhi 12, India.

Chef de la Section Géophysique, c/o Service Météorologique, Léopoldville, Congo.

Dr. L. BOSSY, I.R.M., 3 Avenue Circulaire, Brussels 18, Belgium.

Dr. PETER, L. M. VAN BERKEL, Neherlaboratory, Neth. Ptt, St. Paulusstraat, 4, Leidschendam, Netherlands.

Mr. J. HEWITT, Director, Natl. Institute for Telecommunications Research, P. O. Box 10319, Johannesburg, South Africa.

Rev. E. GALDON, S. J., Observatorio del Ebro, Apartado 9, Tortosa, Spain.

Prof. Maurizio GIORGI, Consiglio Nationale delle Richerche, Piazzale delle Scienze, 7, Roma, Italy.

Mr. S. M. OSTROW, I.G.Y. World Data Center A, Airglow and Ionosphere, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, U. S. A.

World Data Center B2, Ionosphere, Ulitza Chkalova 64, Moscow 4, U. S. S. R.

World Data Center C1, Ionosphere, Radio Research Station, Ditton Park, Slough, Bucks, United Kingdom.

World Data Center C2, Ionosphere, Radio Research Laboratories, Ministry of Postal Services, Kokubunji, P. O., Tokyo, Japan.

Prof. Otto BURKARD, Inst. Meteorologie und Geophysik, Universität Graz, Graz, Austria.

Prof. Luiz de Queroz ORSINI, Depto de Fisica, Ecola Polit., Universidade de Sao Paulo, Cidade Universitaria-Butanta, Sao Paulo, Brazil.

Sr. Ing. Carolos A. NUNEZ, Direction General de Telecommunicaciones de la S.C.O.P., Avenue Universidad y Xola, Mexico, D.F.

Officer in Charge, Laboratoire Ionosphère, Institut Scientifique Chérifien, Avenue Biarnay, Rabat, Morocco.

Dr. Fung. CHIEN, Director, Radio Wave Research Labs. c/o Electrical Engineering Dept., National Taiwan University, Taipei, Taiwan, China.

Dr. N. ROBINSON, Head, Solar Radiation Laboratory, Israel Institute of Technology, Haifa, Israel.

Dr. Karl Rawer, Ionosphären-Institut, Breisach/U. Rhein, German Federal Republic.

Dr. Ing. Dejan BAJIC, Ionospheric Observatory, Institute «Mihailo Pupin», P. O. Box 906, Beograd, Jugoslavia.

Office of the Director, Swiss Post-Telegraph and Telephone Administration, Radio Svc, Spesichergasse 6, Berne, Switzerland.

Office of the Director, Finnish Academy of Sciences and Letters, Helsinki, Finland.

Dr. Jiri MRAZEK, Institute of Geophysics, C.A.S., Bocni II, Praha-Sporilov, Czechoslovakia.

Mr. H. A. Lotfy, Meteorological Department, Koubri El Koubba, Cairo, Egypt.

Prof. Jean TREKKALINOS, Massalias 4, Athens, Greece.

Director, Pakistan Meteorological Service, Blocks 1-2, Karachi, Pakistan.

Dr. H. Amorim FERREIRA, Servico Meteorological Nacion., Largo de Santa Isabel, Lisboa, Portugal.

Prof. S. MANCZARSKI, Palac Kultury i Nauki, Warszawa, Poland.
Prof. Dr. L. EGYED, Muzeum Korut 4/*a*, Budapest VIII, Hungary.
Director of Ionospheric Station, College of Technology, Kumasi, Ghana.
Mr. Sandro RADICELLA, Universidad Nacional de Tucuman, Estacion Ionosferica, San Miguel de Tucuman (R. A.), Argentina.
Prof. M. BOSSOLOSCO, Instituto Geofisico, Universita, Genova, Italy.
Instituto Nazionale Di (Servizio Ionosferico) Geofisica, Citta Universitaria, Roma, Italy.

DOCUMENTATION

Nous signalons à l'attention de nos lecteurs un article publié par le Professeur J. Lugeon dans les « Annalen der Schweizerischen Meteorologischen Zentralanstaltes » (1959) et intitulé « L'écho-sondage de l'Ionosphère ».

BIBLIOGRAPHY

We call the attention of interested readers to a paper entitled « *Design of Panoramic Recorders* » by L. H. Heisler and L. D. Wilson, Radio Research Board Laboratory, Electrical Engineering School, University of Sydney.

The authors consider in detail the design of ionosondes. In particular, they discuss the design specifications and the many electronic techniques required for construction of panoramic type ionosondes, and finally they describe a recorder which features many of these principles. This recorder is readily transportable, economic to construct, and has the additional facility of electronic scan over any portion of the frequency range 1.5 to 20 Mc/s.

Copies of this paper are available at the General Secretariat.

Comité pour l'Attribution de Fréquences Radioélectriques pour des Buts Scientifiques

BIBLIOGRAPHIE

Nous tenons à attirer l'attention des membres du Comité sur un article publié dans le Journal des Télécommunications, nº 1, Vol. 28, janvier 1961, par Andrew G. Haley et intitulé « Données préliminaires justifiant la réunion, en 1963, d'une Conférence Administrative Extraordinaire des Radiocommunications sur les Communications Spatiales ».

Committee on Frequency Allocations for Scientific Purposes

BIBLIOGRAPHY

We should like to call the attention of the members of this Committee to a paper published in Telecommunication Journal, nº 1, Vol. 28, January 1961, by Andrew G. Haley : « Developments leading to and need for the 1963 Extraordinary Administrative Radio Conference on Space Communications ».

Committee on Space Radio Research

BIBLIOGRAPHY

We call the attention of the members of the Committee to the publication on « Approximate Positions of Artificial Satellites obtained with the Baker-Nunn Schmidt Camera (3) » issued by the Japanese National Committee for the I.G.Y., Science Council of Japan (June 1960).

CONFERENCE ON ELECTRONIC TECHNOLOGY

This conference jointly sponsored by the Professional Group on Aeronautical and Navigational Electronics and the Dayton Section of the I.R.E., with the participation of the Institute of Aerospace Sciences, will be held at Wright-Patterson Air Force Base on -810 May, 1961.

Additional details on the Conference may be obtained by contacting 1916 Naecon Publicity, 4663 Hedgewood Avenue, Dayton 16, Ohio, U. S. A.

PERMANENT SERVICES

C.C.U.-I.W.D.S.

JOINT MEETING OF THE CENTRAL COMMITTEE ON URSIGRAMS AND OF THE I.W.D.S. STEERING COMMITTEE

held in London, University College, Monday Sept. 12, 1960, 0700 p.m. during the XIIIth General Assembly of U.R.S.I.

Were present : for C.C.U. :

Dr. R. L. Smith-Rose, Chairman of the European Regional Committee,

Dr. H. Uyeda, Chairman of the Western Pacific Regional Committee,

Mr. A. H. Shapley, Chairman of the Western Hemisphere Regional Committee,

Prof. R. Coutrez, Secretary of the C.C.U.,
and the following representatives of Ursigram organizations in regional groupings (invited) : Dr. S. Gejer and Dr. Malmgrén (Sweden), Dr. J. F. Denisse and Dr. D. Lépéchinsky (France), Dr. Neubauer (Netherlands).

For I.W.D.S. :

Mr. A. H. Shapley for U.R.S.I.,

Dr. J. F. Denisse for I.A.U.,

Prof. R. Coutrez (Secretary of the I.W.D.S.).
Mr. A. H. Shapley was invited to take the chair.

The aims of the meeting were as follows :

1) status of work for C.C.U.,

2) final approval of the draft Geophysical Calendar 1961, and approval of the work done for the Calendar Record 1960.

1. — Preliminary Meeting of the I.W.D.S. Committee

A preliminary meeting of the I.W.D.S. Steering Committee was held in London Sept. 9, 0500 p. m., with a partial representation as follows :

Prof. M. Nicolet for I.U.G.G.,

Dr. J. F. Denisse for I.A.U.;

Prof. R. Coutrez, Secretary.

At this session, the following results were reached :

a) the final draft of the International Geophysical Calendar 1961 as established by Mr. A. H. Shapley and collaborators was approved ;

b) the I.W.D.S. Steering Committee agreed on the work carried on by the C.R.P.L. to draft a Calendar Record of significant events for 1960.

2. — Approval of the International Geophysical Calendar 1961

The present meeting endorsed the approval of the International Geophysical Calendar 1961. In accordance with a request of the Chairman of the Eurasian Regional Group on Ursigrams, it was decided *a*) to invite Mr. A. H. Shapley to draft a short text explaining the reasons and the use of this Calendar, and *b*) to ask the Secretary General of U.R.S.I. to publish the text together with the Calendar. Besides the ordinary distribution, which should be made by the same way as for the International Calendar 1960, it was decided to invite the Secretary General of U.R.S.I. to publish the Calendar in the *U.R.S.I. Information Bulletin* and in other periodicals as may seem appropriate to ensure broad diffusion.

3. — Interchange of data by Ursigrams

After having considered the present status of interchange by telegrams, it was decided by the C.C.U. to review the list of priorities given in Resolution 5 of the European Committee on Ursigrams (see *U.R.S.I. Information Bulletin*, nº 119, pp. 55-56). In this list, all items placed above « Solar Corona (Yellow Line 5694) » should be considered as *first priority* items ; all items below « Ionospheric propagation quality figures » should be considered as *second* *priority.* However the following exceptions should be made : *a*) Localization of Solar radio sources : first priority ; *b*) Solar flare patrol hours : out of priority.

It was also decided that P.A.B.S.B. Code should replace P.A.B.S.A. in first priority ; this will have the advantage to include polar cap absorption measurements in the interchange. Stockholm will send absorption measurements to Nera and Darmstadt. Fairbanks measurements will go to Japan and to Europe.

It was decided to give first priority to Pralo Code.

Concerning Urani, it was recognized that values of solar radio flux on short wavelengths are immediately needed in Japan, but that such values are less needed in Western Hemisphere and European Regions. As a single list of priorities should be made for interchange, it was decided not to give first priority, for the time being, to Urani Code.

4. — Schedule of interchange Telegrams

The situation was reviewed. Concerning MosTok, it was considered that this interchange is needed and should continue. Conversely, TokMos interchange made through a long chain of stations gives rise to delays exceeding 24 hours, so that these telegrams should be dropped if it does not imply a reduction of rapid information to Europe and Western Hemisphere. It was decided to invite the C.R.P.L. to investigate whether Japanese high priority data could reach Moscow faster, and to take steps with Dr. Pushkov for confirmation.

Considering that suspension of work on Sundays in Ursigram centres imply other delays, it was decided to arrange interchange in order that telegrams could get to stations early on Monday morning, and to cancel telegrams if this is not practicable.

5. — Station Indicators

After having considered the amendments to be made in the provisional list published in the Manual of Ursigram Codes, it was decided by the C.C.U. to invite the C.R.P.L. to establish a new master list and to communicate it for replacement of the previous list in the Manual. This list should be approved by correspondence between members of C.C.U. The Committee considered advisable that, in the preparation of this new list, indicators should be grouped by countries.

6. — Prediction of S.W.I.

Account taken of the fact that prediction of S.W.I. is important for rocket and other observations, the C.C.U. expressed the opinion that some work for such prediction should be encouraged, and that the situation should be revised yearly.

As concerns satellite predictions, Mr. A. H. Shapley was invited to undertake consultation with rocket and satellite organizations in order to investigate the possibilities of reducing the length of prediction messages, so that saturation of Ursigram channels can be avoided.

Mr. Shapley, on the other hand, was invited to continue in C.I.G. to encourage satellite communications through such channels.

The C.C.U. noted also with interest the proposals made to C.I.G. by Prof. Ellison and Minnaert for *plans of future cooperation in solar research*, as formally approved by C.I.G. in its meeting on July 25-Aug. 6 held in Helsinki (XIIth General Assembly of I.U.G.G.). Note has been taken by the I.W.D.S. Steering Committee that the draft Calendar for 1961 has been circulated to C.I.G. during this Assembly.

7. — Approval of Ursigrams Codes

In accordance with Resolution 5. *b*), reached by the C.C.U. in its Brussels meeting on September 4th, 1959, and account taken of comments received, it was resolved by C.C.U. at the present meeting to formally approve the provisional codes (beginning by the letter P). It was also resolved that these codes should be promoted as interchange codes.

The Secretary of C.C.U. was invited to take the necessary arrangements with the Secretary General of U.R.S.I. for the publication of such codes in the Manual of Ursigram Codes.

8. — Western Pacific Region

The C.C.U. considered with great interest the report of Dr. Uyeda on the establishment of the Western Pacific Regional Committee on Ursigrams in accordance with Resolution 13 and with Resolution 7 reached respectively on May 14-15, 1959, and September 4, 1959, at the joint meetings of C.C.U.-I.W.D.S. Dr. Uyeda was commended for his activity. The setting up of this Regional Committee was unanimously approved by the C.C.U.

Owing to the difficulties in assuring equal rights for the countries adhering to the Ursigram networks, it was decided to invite the Secretary of the C.C.U. to make suitable changes to the terms of reference of Ursigram networks as published in the *Information Bulletin* and accepted, with amendments, by the European Regional Committee on Ursigrams in its Brussels meeting on January 28-29, 1960 (see *U.R.S.I. Information Bulletin*, n° 119, pp. 51-54).

Consequently, par A. 3 of these terms of reference should read as follows :

« A.3. Membership of a Regional Committee is as follows :

a) replace in par. (*a*) the term *Members* by *Official Members*.

b) replace in par. (*b*) the terms *Consultants appointed by the Regional Committee* by *Unofficial Members nominated by the countries and appointed by the Regional Committee, one member for each country.*

Add in par. (*b*) : *Official Members and Unofficial Members will have equal rights in Regional Committees for decisions relating to scientific actions and communication of data.*

9. — European Regional Network

It was decided by the C.C.U. to ask E.R.C.U. to appoint a spokesman for details on Ursigram Codes. The name of Dr. de Feiter was suggested.

10. — Next Meeting of C.C.U. and of I.W.D.S.

The next meeting of the C.C.U. will be held in Tokyo, 1961, just before or after the Symposium on the Earth's Storms (sept. 3-9, 1961). Dr. Uyeda has been invited to take steps to organize this session.

The next meeting of the I.W.D.S. Steering Committee will be held in Europe, in Naples during the next C.O.S.P.A.R. meeting, or in Brussels immediately before this meeting.

In concluding the session, Mr. A. H. Shapley recalled the great impulse given to the Ursigram activities by the late Rev. Father P. Lejay, who has done so much and whose loss was deeply experienced by all of us. In return, Dr. J. F. Denisse and Prof. R. Coutrez congratulated Mr. A. H. Shapley for his continuing interest and vigorous action for the development of such international activities. The session was closed at 10.30 p. m.

International World Day Service

Circular Memorandum to National Warning Contacts and Regional Warning Centers

PLAN FOR GEOPHYSICAL ALERTS AND SPECIAL WORLD INTERVALS 1961-62

Herewith is description of the plan for Geophysical Alerts and Special World Intervals for 1961 and 1962 or until further notice. These declarations of *Advance Alerts*, *GEOALERTS* and *S.W.I.* are intended to assist the world-wide coordination of geophysical observations of phenomena which are significantly influenced by solar and geomagnetic disturbance. The plan is very similar to but supersedes the plan for 1960 (see our circular memorandum of January 5, 1960) and for the I.G.Y. period (see I.G.Y. Annals, Vol. VII). The one significant change - the re-introduction of « Predicted » S.W.I.-is explained in Appendix I.

Your assistance is requested to give this material circulation among solar and geophysical organizations and stations. Additional copies are available on request. Comments will be welcomed by the I.W.D.S.

J. V. Lincoln, General Supervision, J. M. Weldon, Head, I.W.D.S. World Warning Agency, Box 178, Ft. Belvoir (Virginia) U. S. A.

A. H. Shapley, Spokesman I.W.D.S. Steering Committee c/o National Bureau of Standards Boulder (Colorado), U. S. A.
February 27, 1961.

« Predicted » Special World Intervals

In 1959 and 1960, the Alert-S.W.I. plan called for the World Warning Agency to begin an S.W.I. only after a major geophysical disturbance had started. The I.W.D.S. Steering Committee decided at its meeting in London, September 12, 1960, to return to something like the I.G.Y. plan when S.W.I. were started *in anticipation of* a geophysical disturbance ; that is, declarations on the basis of a *prediction* that a disturbance would start a few hours later.

Thus, for the international « Geophysical Alert » message issued by the World Warning Agency at 1600 UT on appropriate days, there will be another category of message which will be used occasionally when circumstances are suitable. This message will read « Start predicted S.W.I. ». Geophysical stations which are conducting appropriate experiments are urged to start their S.W.I. program or observing schedule immediately upon receipt of the message because there is a strong possibility that an important disturbance will start in the next few hours. If the expected disturbance does not come, a subsequent Geoalert message will say « Finish Predicted S.W.I. ».

The « Predicted S.W.I.» will be declared by the World Warning Agency after consideration of the recommendations of the various Regional Warning Centers (R.W.C.). The detailed plan under which R.W.C. send advice to the World Warning Agency is given below.

Operating Plan for « Predicted SWI »

The R.W.C.s. will continue to send Adalert messages to the World Warning Agency (as well as other R.W.C.s.) to serve as advice for the issuance of GEOALERTS and S.W.I. under the scheme which operated throughout 1959-1960. However, the R.W.C. are also invited to send to the World Warning Agency recommendations that a « PREDICTED S.W.I. » begin at the following 1600 UT, whenever they believe the circumstances are suitable. The World Warning Agency will take the recommendations from all R.W.C.s. into consideration, and if the Centers are in general agreement that a « PREDICTED S.W.I. » would be desirable, such a declaration will be made at 1600 U.T.

In some cases, it may be practical for the R.W.C. to include the recommendation in the regular daily data interchange message or in an ADALERT message. Otherwise, a special message should be transmitted.

The I.G.Y. *Advice Code* should be used (Code 4.1.10 in *Annals of I.G.Y.*, Vol. VII, p. 63). It is copied below with non-applicable parts omitted.

Code word : A.D.V. for A.D.V.ice.

Symbolic form : A.D.V.aa bbccc (ddddd) HHmme.

aa = warning center giving advice.

AN	— Anchorage	NE	— Nederhorst
BO	— Boulder	PA	— Paris (B.I.F.)
DA	— Darmstadt	ST	— Stockholm
KO	— Kokubunji	SY	— Sydney.
MO	— Moscow.		

bb = type of notification
IN — Special World Interval (S.W.I.)

cc = advice
BEG — begin
CON — continue
FIN — finish

ddddd = when desired, strength of opinion given.
FORTE — strong
PIANO — weak

HHmm = UT when advice given.

e = always a Z

Sample : ADVKO INBEG FORTE 0245Z

PLAN FOR GEOPHYSICAL ALERTS AND SPECIAL WORLD INTERVALS, 1961-62

issued by

WORLD WARNING AGENCY
International World Day Service
International Council of Scientific Unions
Issued February 27, 1961

I. — Summary

(1) An *Alert* is issued as soon as possible after an exceptional solar or geophysical event has occurred or started. Advance

Alerts (ADALERT) are issued by any Regional Warning Center (R.W.C.) as listed in Section VI, below; they are distributed immediately by telegram or radio to geophysical stations in the region and to the other R.W.C. Geophysical Alerts (GEOALERT) for world-wide distribution are issued at 1600 UT by the World Warning Agency (A.G.I.W.A.R.N.). There are four different kinds of Alerts-Solar Flare, Magnetic Storm, Cosmic Ray and Aurora, with stated criteria for each. The Alert message gives simply the nature and time of the event. The Alert serves to aid the observing programs at geophysical stations.

(2) *A Special World Interval* (S.W.I.) is declared only by the World Warning Agency. The information is included in the GEOALERT message, issued only at 1600 UT. If the S.W.I. is based on a prediction of geomagnetic and auroral disturbance, the words « PREDICTED S.W.I. » will be used; otherwise it can be assumed the geomagnetic and associated activity is already in progress when the receipt of the message at the geophysical station. The S.W.I. is considered to end when a subsequent GEOALERT message is received stating « Finish S.W.I. ». Many geophysical stations carry out special observing programs during S.W.I.

(3) *Communications.* — It is assumed that geophysical stations interested in receiving alerts have communication channels by telegraph or radio broadcast from one of the four Regional Warning Centers (R.W.C.) or Associate R.W.C.s. Alternatively, geophysical stations may have access to an outlet of the meteorological telecommunications network coordinated by W.M.O. (Note that only the Geoalert (international) messages issued at 1600 UT are carried on the meteorological network). Geophysical stations which have not established suitable communication channels should get in touch with the appropriate R.W.C. (see section V, below). Geophysical stations which have problems with communication channels should get in touch with their R.W.C. or with the World Warning Agency.

II. — General

(1) This plan supersedes those set forth for 1960, for I.G.C. 1959 and for I.G.Y. It will remain in effect at least through 1962, although there is a possibility that some minor modifications will

have to be made in a supplementary bulletin from the World Warning Agency on account of changes in the level of solar activity.

(2) This activity is coordinated by the International World Day Service (I.W.D.S.) of the International Council of Scientific Unions which is administered by the International Scientific Radio Union (U.R.S.I.). The members of the I.W.D.S. Steering Committee are A. H. Shapley, I.W.D.S. Spokesman (U.R.S.I.); M. Nicolet (International Union of Geodesy and Geophysics); J. F. Denisse (International Astronomical Union); and R. Coutrez, Secretary (U.R.S.I., 7, Place Emile Danco, Brussels). It has been worked out jointly with the U.R.S.I. Central Committee on Ursigrams (C.C.U.) which coordinates the telegraphic collection, interchange and distribution of summaries of current solar and geophysical data. The members of the C.C.U. and the regions they represent are N. V. Pushkov (U. S. S. R., Eurasia), R. L. Smith-Rose (U. K., Western Europe); H. Uyeda (Japan, Western Pacific), A. H. Shapley (U.S.A., Western Hemisphere) and R. Coutrez, Secretary (U.R.S.I.). The arrangements for distribution of Geoalert messages have been worked out in cooperation with the W.M.O. The changes in the plan for 1961-1962 over that for 1960, namely the re-introduction of « Predicted S.W.I. », were decided at a joint I.W.D.S.-C.C.U. meeting in London, September 12, 1960.

(3) This description of the plan for Geophysical Alerts and Special World Intervals is issued by James M. Weldon, Head, I.W.D.S. World Warning Agency under the general supervision of J. V. Lincoln in association with A. H. Shapley, I.W.D.S. Spokesman. Questions concerning the plan should be addressed to the I.W.D.S. World Warning Agency, Box 178, Ft. Belvoir (Virginia). U. S. A.

III. — Advance Alerts (ADALERTS)

(1) *General.* — Any Regional Warning Center may issue an « Advance Alert » as soon as the outstanding solar or geophysical phenomenon is recognized and the R.W.C. is satisfied it meets the stated criteria. The Advance Alert message is to be in standard text form and includes identification of the originator and the nature and time of the event. It should be (*a*) distributed promptly within the region as may be practical, and (*b*) promptly sent to each of the other R.W.C. for their information and action in case

the event was missed by stations in their region. These prompt Advance Alert messages serve to aid the observing programs at individual geophysical stations. They also serve as advice to the World Warning Agency on the declaration of world-wide Alerts.

(2) *Criteria.* — The R.W.C. use the following criteria for the four kinds of Advance Alerts :

Solar Flare Alert — this warning will be issued whenever a solar flare of median importance 2 plus or greater has been reported. There will be only one alert issued per flare and only one a day at most.

Magnetic Storm Alert — this warning will be issued whenever a significant magnetic storm (K figure 5 or greater at a middle latitude station) has begun.

Cosmic Ray Alert — this warning will be issued whenever a very outstanding change in cosmic ray flux has been observed — increase or decrease.

Aurora Alert — this warning will be issued whenever a magnetic storm in middle latitudes has reached at least K-figure 7 intensity or whenever selected auroral stations report the presence of outstanding aurora.

(3) *Message Forms.* — The text for Advance Alert messages will include station reporting event, nature of event and time of event. See Section V for meaning of artificial words. Sample texts are :

(*a*) ADALERT KOKUBUNJI SOFLARE 280010Z

(This means a solar flare event of importance two plus or greater was observed by Kokubunji at 0010 UT on the 28th day of the month.)

(*b*) ADALERT NIZMIR MAGSTORM 291900Z

(This means NIZMIR recorded beginning of significant magnetic storm, with K figures of 5 or greater, at 1900 UT on the 29th day of the month.)

(*c*) ADALERT ZUGSPITZE COSRAY DECREASE 061130Z

(This means the nominal time of an unusual cosmic ray flux decrease recorded at Zugspitze was 1130 UT on the 6th day of the month.)

(*d*) ADALERT CORNELL AURORA OBSERVED 070230Z

(This means outstanding aurora was observed by Cornell University, U. S. A. at 0230 UT on the 7th day of the month.)

(*e*) ADALERT AGIWARN AURORA PROBABLE MAGSTORM 070230Z

(This means beginning of significant magnetic storm with K figures of 7 or greater was recorded at AGIWARN at 0230 UT on the 7th day of the month. Auroral displays should be expected.)

IV. — GEOALERTS, Including SWI

(1) *General.* — Only the World Warning Agency issues declarations of world-wide Geophysical Alerts and Special World Intervals. These declarations are made at 1600 UT on any day when the course of solar and geophysical activity makes a declaration appropriate. The declaration of a world-wide Alert is made after consideration of Advance Alerts which may have been issued by one or more R.W.C. The declarations concerning S.W.I. are made after consideration of advice received from R.W.C.s. All messages begin with the words « GEOALERT NOxxx », where xxx is the serial number of GEOALERT messages issued.

(2) *GEOALERT.* — World-wide Geophysical Alerts may be declared in one or more of the following categories : Magnetic Storm, Cosmic Ray Increase, Aurora. The criteria are the same as given for Advance Alerts in the preceding section. The Alert message is in standard text (with abbreviations as given in Section V below) specifying the nature and time of the event. Samples of possible messages are as follows :

(*a*) GEOALERT NO135 MAGSTORM 051000Z

(This is the 135th world-wide geophysical alert issued. A magnetic storm with K figures of 5 or more started at 1000 UT on the 5th day of the month).

(*b*) GEOALERT NO015 AURORA PROBABLE MAGSTORM 100716Z.

(This is the 15th world-wide geophysical alert issued. A magnetic storm with K figures of 7 or more started at 0716 UT on the 10th day of the month ; auroral displays should be expected).

(*c*) GEOALERT N0010 COSRAY INCREASE 061825Z

(This is the 10th world-wide geophysical alert issued. The nominal time of an unusual cosmic ray flux increase was at 1825 UT on the 6th day of the month).

(*d*) GEOALERT N0022 AURORA 120940Z

(This is the 22nd world-wide geophysical alert issued. Outstanding aurora was observed at 0940 UT on the 12th day of the month. Stations to the west should expect to observe aurora).

(3) *Special World Intervals.* — A GEOALERT message is issued to start an S.W.I. and then every day thereafter to continue the S.W.I. and finally to finish the S.W.I. An S.W.I. usually lasts one or two days. The S.W.I. may be based on a prediction that important geomagnetic and associated activity will start in the next few hours; in this case the words « PREDICTED S.W.I. » will be used until the activity starts. Otherwise, an S.W.I. may be declared on the basis that important geomagnetic and associated activity is already in progress ; in this case the term « S.W.I. » will be used alone. The S.W.I. interval itself is considered to start when the « START S.W.I. » or « START PREDICTED S.W.I.» message is received by the geophysical station. The S.W.I. is considered to be finished by 2359 UT of the day the « FINISH S.W.I. » or « FINISH PREDICTED S.W.I. » message is issued. Samples of possible messages are as follows :

(*a*) GEOALERT N0031 MAGSTORM 051000Z START SWI 051600Z

(This is the 31st world-wide geophysical alert issued. A significant magnetic storm started at 1000 UT on the 5th day of the month, Start Special World Interval programs as suggested for discipline on receipt of message).

(*b*) GEOALERT N0032 CONTINUE SWI 061600Z

(This is the 32nd world-wide geophysical alert issued. The Special World Interval continues for another day).

(*c*) GEOALERT N0033 FINISH SWI 072359Z

(This is the 33rd world-wide geophysical alert issued. The Special World Interval finishes at 2359 UT on day of issue of message).

(*d*) GEOALERT N0050 START PREDICTED SWI 1011600Z

(This is the 50th world-wide geophysical alert and was issued by the World Warning Agency at 1600 UT on the 10th day of the month. Upon receipt of message, a Special World Interval is to be started. Station should conduct the S.W.I. program appropriate to their geophysical discipline. A major geomagnetic storm is predicted).

(*e*) GEOALERT N0051 MAGSTORM 102314Z CONTINUE SWI 111600Z

(This is the 51st world-wide geophysical alert issued. A magnetic storm with K figures of 5 or more started at 2314 UT on the 10th day of the month. Thus, the predicted Special World Interval started by GEOALERT N0050 was successful and the S.W.I. is declared on the 11th day of the month at 1600 UT to continue for another day. *Note* : word « predicted » not used with S.W.I. *after* a magnetic storm begins).

(*f*) GEOALERT N0052 FINISH SWI 122359Z

(This is the 52nd world-wide geophysical alert issued at 1600 UT on the 12th day of the month. The Special World Interval finishes at 2359 UT on day of issue of the message, i. e. at 2359 UT on the 12th day of the month).

(*g*) GEOALERT N0051 CONTINUE PREDICTED SWI 111600Z

(This is the 51st world-wide geophysical alert. A major geomagnetic storm is still predicted).

(*h*) GEOALERT N0051 FINISH PREDICTED SWI 111600Z

(This is the 51st world-wide geophysical alert. No major magnetic storm began after case (*d*) above which started a « PREDICTED S.W.I. » or case (*g*) which continued a « PREDICTED S.W.I. ». No longer high probability major geomagnetic storm will begin, therefore, finish Special World Interval programs upon receipt of message).

(4) *Communications Channels* :

(*a*) *Meteorological Telecommunications Network.* — GEOALERT messages are delivered at 1600 UT to the (W.M.O.) meteorological telecommunications network at Washington, U. S. A. The message is then distributed throughout the world in accordance with plans developed by W.M.O. Geophysical stations may make arrangements with a nearby meteorological station for receiving the messages. *Note* : On days when there is no GEOALERT message issued, the meteorological network will carry a message IGC KWWA XX/XXXXZ NEGATIVE.

(*b*) *Distribution by Regional Warning Centers.* — The World Warning Agency also sends GEOALERT messages at 1600 UT by telegram to each R.W.C. There is then further distribution within each region according to plans made by the R.W.C. for that region.

(*c*) *Radio Broadcasts.* — The general content of GEOALERT messages is indicated by a symbol broadcast in Morse code on WWV and WWVH repeatedly twice each hour. The time of broadcast is at 1604 and 1634 minutes past each hour on WWV and at 1714 and 1744 minutes past each hour on WWVH. The symbols, *sent in very slow and deliberate code*, are as follows :

A.G.I. EEEEE
. - - - . . . . state of « No World-wide Alert »
A.G.I. AAAA
. - - - . . . . - . - . - . - state of « World-wide Alert »
A.G.I. 3 extra long dashes
. - - - . . . ——— ——— ——— S.W.I. in progress

Similar broadcasts are made in the various regions.

V. — Abbreviations Used in Telegraphic Messages

In order to shorten messages for economy and faster service, the following artificial words and conventions are used :

ADALERT	for Advance Geophysical Alert
GEOALERT	for World-wide Geophysical Alert
SOFLARE	for Solar Flare
COSRAY	for Cosmic Ray
MAGSTORM	for Magnetic Storm
AURORA PROBABLE	for Magnetic Storm with K figure 7 or greater
S.W.I.	for Special World Interval

NO for Number (with the number given in ciphers rather than in words — for example N0169). Only the GEOALERT messages are numbered and these are numbered consecutively. ADALERT messages are not numbered since they can come from many independent sources.

VI. — Regional Warning Centers

The addresses for the various R.W.C. are given below to enable geophysical stations to establish suitable communication channels.

1. — I.W.D.S. World Warning Agency

Mail : Box 178, Ft. Belvoir, Virginia, U. S. A.

Telephone : Washington, D. C., SOuth 5-6411 or SOuth 5-8436

Cable and Radiogram (Commercial) : AGIWARN WASHINGTON

Telegraphic (Commercial) : NORTH ATLANTIC RADIO WARNING SERVICE WUX WASH DC

TWX : Engleside Va. 556

Telex : WN0086

Government Teletype : AGIWARN BUSTAN FT BELVOIR VA

Operating Organization : North Atlantic Radio Warning Service
C.R.P.L., National Bureau of Standards
Box 178, Ft. Belvoir, Va., U. S. A.
(E. J. Wiewara, Engineer-in-Charge)

In Charge : James M. Weldon, Head, World Warning Agency, Box 178, Ft. Belvoir, Va., U. S. A.

General Supervision : Miss J. Virginia Lincoln, Radio Warning Services Section National Bureau of Standards, Boulder, Colorado, U. S. A.

2. — Regional Warning Centers

2.1. — *Western Europe*

Dutch Section

Mail :	Radio Receiving Station NERA Nederhorst den Berg Netherlands
Telegraph :	A.G.I. NEDERHORSTDENBERG
Telex :	Amsterdam 12308
Supervisory :	F. R. Neubauer
Immediate Charge :	L. D. De Feiter

Paris Section

Mail :	Jours Mondiaux, 196, rue de Paris, Bagneux (Seine), France.
Telegraph :	GENTELABO PARIS
Telex :	20055
Telephone :	ALesia 31-17
Supervisory :	D. Lepechinsky
Immediate Charge :	A. Delouf

Darmstadt Section

Mail :	Fernmeldetechnisches Zentralamt (T.T.Z.) Rheinstrasse 110, Darmstadt, Federal German Republic
Telegraph :	IONOSPHARE DARMSTADT
Telex :	419291
Telephone :	Darmstadt 8041
Supervisory :	B. Beckmann
Immediate charge :	G. Richter

2.2. — *Eurasia*

Mail :	Institute of Terrestrial Magnetism, Ionosphere and Radio Propagation (IZMIRAN) Moscow, U. S. S. R.
Telegraph :	NIZMIR MOSCOW
Telephone :	
Supervisory :	N. V. Pushkov
Immediate charge :	L. N. Liakhova

2.3. — *Western Pacific*

Mail :	Radio Research Laboratories, Kokubunji, P. O., Koganei-shi, Tokyo, Japan
Telegrams :	A.G.I. KOKUBUNJI
Telephone :	
Supervisory :	U. Uyeda
Immediate charge :	T. Takiguchi

2.4. — *Western Hemisphere*

Mail :	I.W.D.S. World Warning Agency, National Bureau of Standards, Box 178, Ft. Belvoir, Virginia, U. S. A.
Telegraph :	NORTH ATLANTIC RADIO WARNING SERVICE WUX WASH DC
Cable :	AGIWARN WASHINGTON
TWX :	Engleside Va. 556
Telex :	WN0086
Telephone :	Washington, D. C. SOuth 5-6411 or SOuth 5-8436
Supervisory :	Miss J. Virginia Lincoln (N.B.S., Boulder, Colorado)
Immediate charge :	James M. Weldon

3. — Associate Regional Warning Centers

3.1. — *Australasia*

Mail :	5 Hickson Road, Millers Point, N. S. W. Australia.
Telegraph :	IPSO SYDNEY
Telephone :	B0537
Supervisory :	W. G. Baker
Immediate charge :	F. E. Cook

3.2. — *Alaska*

Mail :	North Pacific Radio Warning Service, National Bureau of Standards, Box 1119, Anchorage, Alaska.

Telegraph :	BUSTAN ELMENDORF AFB ALASKA
Telephone :	Elmendorf Air Force Base, Alaska, Skyline 3-2211.
Supervisory :	J. V. Lincoln (NBS, Boulder, Colorado)
Immediate charge :	L. W. Honea

3.4. — *Sweden*

Mail :	The Royal Board of Swedish Telecommunications, Brunkebergstorg, 2, Stockholm 16,
Telegraph :	I.G.Y. CENTRE STOCKHOLM
Telex :	0800-1530 UT : 1208 (RADIOGEN STH) All other hours : 1209 (RADIOGEN STH)
Telephone :	0800-1530 UT : Stockholm 44 97 40 All other hours : Stockholm 10 01 76 (ask for Supervisor)
Supervisory :	Sven Gejer
Immediate charge :	

INTER-UNION COMMITTEES

Inter-Union Committee on Radio Meteorology

MINUTES OF A PRELIMINARY MEETING OF THE COMMITTEE in London on 14th September, 1960

Present :

U.R.S.I.	*I.U.G.G.*
Dr. R. Lhermitte (France),	Prof. J. S. Marshall (Canada),
Dr. J. A. Saxton (U. K.),	M. P. Misme (France),
Dr. R. L. Smith-Rose (U. K.),	Prof. P. A. Sheppard (U. K.),
Dr. A. T. Waterman (U. S. A.),	
Professor W. E. Gordon (representing Dr. R. Bolgiano (U. S. A.)).	

Mr. B. R. Bean (U. S. A.), Dr. A. M. Oboukhov (U. S. S. R.) and Dr. Y. Ogura (Japan), nominees of I.U.G.G.; and Dr. R. Bolgiano (U. S. A.), and Dr. I. Imai (Japan), nominees of U.R.S.I., did not attend the XIIIth General Assembly of U.R.S.I., and were unable to be present at the meeting.

1. It was reported that the membership of the Committee is to be as follows :

Appointed by U.R.S.I. : Dr. R. Bolgiano, Dr. I. Imai (alternate Dr. K. Naito), Dr. J. A. Saxton, Dr. R. L. Smith-Rose, M. J. Voge (alternate Dr. R. Lhermitte) and Dr. A. T. Waterman.

Appointed by I.U.G.G. : Mr. B. R. Bean, Professor J. S. Marshall, M. P. Misme, Dr. A. M. Oboukhov, Dr. Y. Ogura and Professor P. A. Sheppard.

2. The members present unanimously elected Professor J. S. Marshall as Chairman of the Committee, and Dr. J. A. Saxton as Secretary.

3. The Committee reviewed the instructions contained in the agreement between U.R.S.I. and I.U.G.G. concerning its terms of reference and method of functioning.

4. An invitation from the French members to hold the first formal meeting of the Committee in Paris in the Spring of 1961 was accepted, subject to approval being given by the Parent Union (U.R.S.I.). It was tentatively agreed that the agenda should include : a discussion of the work of the Committee and planning of symposia, the presentation of scientific papers on work in France and possibly on closely related work elsewhere, and visits to conveniently located centres of research. The meeting should last three or four days, and scientific topics for discussion should be limited to those of immediate relevance to either (i) work in France or (ii) a particular proposal for a symposium.

5. It was agreed that permission should be sought for the appointment as a consultant for a period of one year of Mr. F. J. HEWITT (Union of South Africa).

COMITÉS INTER-UNIONS

Comité Inter-Union de Radiométéorologie

PROCÈS-VERBAL DE LA RÉUNION PRÉLIMINAIRE DU COMITÉ

Londres, 14 septembre 1960

Etaient présents :

U.R.S.I.

Dr R. LHERMITTE (France),
Dr J. A. SAXTON (Royaume-Uni),
Dr R. L. SMITH-ROSE (Royaume-Uni),
Dr A. T. WATERMAN (E. U. A.),
Prof. W. E. GORDON (représentant le Dr R. BOLGIANO, E. U. A.).

U.G.G.I.

Prof. J. S. MARSHALL (Canada),
M. P. MISME (France),
Prof. P. A. SHEPPARD (Royaume-Uni)

Mr. B. R. Bean (E. U. A.), le Dr A. M. Obukhov (U. R. R. S.) et le Dr Y. Ogura (Japon), représentant l'U.G.G.I. ; et le Dr R. Bolgiano (E. U. A.) et le Dr I. Imai (Japon), représentant l'U.R.S.I., n'assistaient pas à la XIIIe Assemblée Générale de l'U.R.S.I. et ne purent participer à la réunion.

1. Il a été annoncé que la composition du Comité serait la suivante :

Désignés par l'U.R.S.I. : Dr R. Bolgiano, Dr I. Imai (suppléant Dr K. Naito), Dr J. A. Saxton, Dr R. L. Smith-Rose, M. J. Voge (suppléant Dr R. Lhermitte) et Dr A. T. Waterman.

Désignés par l'U.G.G.I. : M. B. R. Bean, Prof. J. S. Marshall, M. P. Misme, Dr A. M. Obukhov, Dr Y. Ogura et Prof. P. A. Sheppard.

2. Les membres élirent à l'unanimité le Prof. J. S. Marshall à la présidence du Comité et le Dr J. A. Saxton, comme Secrétaire.

3. Le Comité considéra les instructions contenues dans l'accord passé entre l'U.R.S.I. et l'U.G.G.I. et relatives à son mandat et au mode de fonctionnement.

4. Le Comité accepta, moyennant l'approbation de l'Union mère (U.R.S.I.) l'invitation faite par les Membres français de tenir la première réunion officielle du Comité à Paris pendant le printemps de 1961. Il fut décidé provisoirement que l'ordre du jour comporterait : une discussion sur le travail du Comité et les projets de symposia, la présentation de communications sur les travaux effectués en France et, éventuellement, sur des travaux étroitement associés et effectués ailleurs ; des visites à des centres de recherches facilement accessibles. La réunion doit durer trois ou quatre jours et les sujets scientifiques qui seront discutés devront se rapporter directement soit (i) aux travaux en France ou bien (ii) à une proposition particulière en vue d'un symposium.

5. Il a été décidé de solliciter l'autorisation de désigner M. F. J. Hewitt (Union Sud-Africaine) comme Membre Consultatif pour une période d'un an.

Comité Inter-Union pour l'Attribution de Fréquences Radioélectriques pour la Radioastronomie et la Science Spatiale (I.U.C.A.F.)

BIBLIOGRAPHIE

Nous tenons à attirer l'attention des membres du Comité sur un article publié dans le Journal des Télécommunications, n° 1, Vol. 28, janvier 1961, par Andrew G. Haley et intitulé « Données préliminaires justifiant la réunion, en 1963, d'une Conférence Administrative Extraordinaire des Radiocommunications sur les Communications Spatiales ».

Inter-Union Committee on Allocations of Frequencies for Radio Astronomy and Space Science (I.U.C.A.F.)

BIBLIOGRAPHY

We should like to call the attention of the members of this Committee to a paper published in Telecommunication Journal, n° 1, Vol. 28, January 1961, by Andrew H. Galey : « Developments leading to and need for the 1963 Extraordinary Administrative Radio Conference on Space Communications ».

I. C. S. U.

IXe Assemblée Générale du Conseil International des Unions Scientifiques

La IXe Assemblée Générale du Conseil se tiendra à Assembly Hall, University of London School of Pharmacy, Brunswick Square, London W. C. 1, du 25 au 28 septembre 1961.

Durant cette Assemblée, le Conseil sera l'hôte de la Royal Society of London, Burlington House, London W.1.

L'ordre du jour de l'Assemblée Générale, ainsi que d'autres documents s'y rapportant, seront distribués en temps utile, conformément aux Statuts du Conseil.

Appel en faveur du Fonds Spécial de l'I.C.S.U.

Le Bureau du Conseil International des Unions Scientifiques s'est réuni récemment à La Haye. Le Bureau s'est vu dans l'obligation de se pencher très sérieusement sur la situation financière de l'I.C.S.U., suite aux rigoureuses mesures financières prises par le Comité Exécutif au cours de sa réunion de Lisbonne, en octobre 1960. L'état des finances s'étant révélé désastreux à l'époque, le Comité Exécutif a été contraint, pour faire face aux difficultés, de fermer l'Office des Publications, d'arrêter la publication de la Revue de l'I.C.S.U., d'écourter une réunion en Australie et de refuser de financer certaines entreprises scientifiques importantes.

Ce qui revêt un caractère particulièrement sérieux, c'est que le Fonds Spécial, qui avait été créé grâce à des dons faits pour satisfaire aux besoins courants de certains programmes scientifiques du Conseil, s'est trouvé pratiquement épuisé ; par ailleurs, les cotisations nationales ne suffisent pas pour couvrir les dépenses courantes et pour poursuivre les activités de l'I.C.S.U. à leur niveau actuel. Il est évident, cependant, que ces activités doivent prendre de l'expansion. Des projets intéressants sont en cours, qui nécessitent de l'aide, comme, par exemple, le financement pour le développement du Projet de l'Océan Indien (S.C.O.R.), ainsi que la mise en œuvre d'un nouveau projet important en biologie.

Il convient de souligner que de telles entreprises ne peuvent être amorcées que par l'I.C.S.U., étant donné son caractère d'organisme réellement international, groupant des unions scientifiques et, de ce fait, des savants.

Nous avons reçu une offre financière très généreuse de la part de l'Académie des Sciences des Etats-Unis d'Amérique, mais si généreuse qu'elle soit, elle ne suffit pas à assurer nos activités dans un avenir immédiat. Il est vrai, toutefois, que cette offre nous permet de soutenir provisoirement, au minimum, notre travail, et de poursuivre en l'améliorant la publication de la Revue de l'I.C.S.U. ce qui, nous semble-t-il, revêt une grande importance pour la diffusion et la connaissance de nos activités. Mais, ce n'est là qu'une partie de notre tâche. L'I.C.S.U. doit faire face à des demandes extraordinaires visant au financement d'activités scientifiques internationales, dont les projets sus-mentionnés relatifs à l'Océan Indien et à la biologie ne constituent que deux exemples particuliers.

Le Fonds Spécial de l'I.C.S.U. est une source qui permet de répondre à ces demandes et d'avancer les moyens financiers nécessaires pour la mise sur pied de Comités Spéciaux ainsi que d'autres activités nécessaires et souhaitables de l'I.C.S.U., et cela jusqu'au moment où, ayant atteint un certain degré d'organisation, ils sont à même de les rembourser en puisant dans leurs propres ressources. Ce Fonds Spécial de l'I.C.S.U. est essentiel ; sans lui le Conseil ne pourrait remplir son rôle — promouvoir la science à travers la collaboration internationale.

Dans la situation où nous nous trouvons — le Fonds Spécial de l'I.C.S.U. étant réduit à sa plus simple expression — un membre déjà nous a offert son aide. Nous voulons espérer que d'autres membres se présenteront de même pour combler le déficit dans nos finances et pour nous permettre, à nous vos représentants, d'accomplir notre tâche en faveur de cette grande cause qu'est la Science Mondiale.

Rudolph PETERS, *Président*,
N. HERLOFSON, *Secrétaire Général*
E. HERBAYS, *Trésorier*

Le 7 février 1961.

Aux Membres Nationaux de l'I.C.S.U.

I. C. S. U.

IXth General Assembly of the International Council of Scientific Unions

The Ninth General Assembly of the Council will be held in the Assembly Hall, University of London School of Pharmacy, Brunswick Square, London W. C. 1, England, on September 25-28, 1961.

The Council's hosts at the General Assembly will be the Royal Society of London, Burlington House, London W. 1.

The Agenda for the General Assembly and other documents will be distributed in due course in accordance with the Statutes of the Council.

Appeal for the I.C.S.U. Special Fund

The Bureau of the International Council of Scientific Unions met recently in The Hague. The Bureau has been forced to consider the financial position of I.C.S.U. very carefully, following upón the stringent financial measures which the Executive Board had to take at its meeting in Lisbon in October 1960. The financial position was then so bad, that to meet the difficulties, the Board was obliged to close the Publications Office, to decide to discontinue the I.C.S.U. Review, to curtail a meeting in Australia and to withhold finance from some important scientific enterprises.

A particularly serious feature is that the Special Fund, which has been created from free donations to meet the current needs of certain specified scientific projects of the Council, is virtually exhausted ; at the same time there is not enough finance from our National dues to meet current expenses and the activities of I.C.S.U. on their present scale. It is clear that these activities must be expanded. Valuable projects are in progress which need support ; one may instance finance for the proper development of the Indian Ocean project (S.C.O.R.), and for the initiation of an important new biological project.

It must be emphasised that enterprises of this kind can only be started by I.C.S.U., because of its truly international constitution of scientific unions, and therefore of scientists.

We have obtained a most generous offer of finance from the United States Academy of Science; but generous as this is, it is not really sufficient for our extended operations in the immediate future. With this offer it is true that we are able temporarily to support at the barest minimum some of our work, and to continue the I.C.S.U. Review in an improved form, which we feel to be very important for our Public Relations. But this is only part of our task. I.C.S.U. faces unusual and compelling requests to finance international scientific activities, of which the need for support of Oceanic or Biological projects are but a few specific examples.

To meet such requests, the I.C.S.U. Special Fund provides a source from which money can be advanced to finance the initial functions of Special Committees and other necessary and desirable activities of I.C.S.U., until they can be reimbursed from their own funds after they have achieved some degree of organization. This fund is essential; without it I.C.S.U. cannot fulfil its function of advancing science through international collaboration.

In the situation in which we find ourselves, with the I.C.S.U. Special Fund reduced to a small sum, one member has come forward with help. We hope most sincerely that others will now come forward to bridge the gap in our finances and so make it possible for us, your elected representatives, to fulfil our tasks for World Science.

(*sgd*) Rudolph PETERS, *President*,
N. HERLOFSON, *Secretary-General*
E. HERBAYS, *Treasurer*.

February 7, 1961.

To : the National Members of I.C.S.U.

INTERNATIONAL COMMITTEE ON GEOPHYSICS

Report of Working Group on Solar Activity Minimum Program

Present :

Prof. W. J. G. Beynon (*Chairman*).
Prof. J. Bartels,
Prof. W. Dieminger,
Prof. M. A. Ellison,
Prof. M. G. J. Minnaert,
Dr. M. Nicolet,
M. A. H. Shapley,
Dr. S. Vernov,
Mr. M. Baker (*Secretary*),

1. — Introduction

The formal proposal for a programme of geophysical research at the time of the next sunspot minimum epoch was made at a meeting of C.I.G. in August 1960. The need for such an enterprise in the radio field was discussed by the U.R.S.I.-A.G.I. Committee at its 1958 meeting in Edinburgh, and again by the U.R.S.I.-C.I.G. Committee meeting in London in September 1960.

The case for a renewed geophysical effort in certain disciplines at a period of minimum solar activity is abundantly clear. In the disciplines of geomagnetism, aurora and airglow, ionosphere, aeronomy, solar activity, cosmic rays and space research the results obtained during the maximum solar activity period of the I.G.Y. can only be brought to full fruition by a complementary, if smaller programme, at the forthcoming period of minimum activity. In making proposals and developing plans for the renewed effort, C.I.G. wishes to make it clear that it is conscious of its responsibility for satisfactorily completing the great I.G.Y. enterprise of 1957-58. Whilst the resources and energies of C.I.G. are currently being brought to bear on the problems of completing the collection analysis and publication of the scientific results of the

I.G.Y., at the same time it invites the interest and support of all nations in the complementary enterprise at the next period of minimum solar activity.

It is to be emphasized that the sunspot minimum programme is not to be regarded merely as a smaller scale repetition of the I.G.Y. but it is intended that full advantage shall be taken of the new knowledge of solar-terrestrial relation-ship gained during the I.G.Y. and also of the improved and new techniques for geophysical research which have been, and will be, developed in the intervening years.

C.I.G. invites all those stations which helped to ensure the great success of the I.G.Y. and every other nation to cooperate again in the complementary effort in those branches of geophysics which are profoundly influenced by solar phenomena.

2. — Title for the minimum activity project

The group considered a number of proposals for the title of the sunspot minimum project and finally adopted : « The International Year of the Quiet Sun : 1964-65 » (I.Q.S.Y.).

It was further agreed that the group concerned with planning this project should be termed « The I.Q.S.Y. Committee of the C.I.G. ».

3. — Proposed date for the project (I.Q.S.Y.)

In selecting dates for the commencement and termination of the enterprise the Committee appreciated the difficulties inherent in predicting, with certainty, the dates of minimum solar activity and the additional complication that the minimum of magnetic activity is delayed on that of solar activity by some months. After a full discussion of the problem, in which consideration was given to communications received from Prof. M. Waldmeier and Miss J. V. Lincoln, the Committee agreed that the project should be planned for the period 1 April 1964 to 31 December 65.

In fixing the date of the beginning of I.Q.S.Y. the semi-annual wave in geomagnetic activity was taken into account. The start in April makes it more likely that a few of the particularly quiet intervals to be expected around the June solstice will be covered.

4. — Disciplines and Reporters for I.Q.S.Y.

It was agreed that the following disciplines should be included in I.Q.S.Y. The names of the corresponding reporters are also indicated together with the relevant International Union, Association or Committee.

I.	World Days	I.W.D.S.-U.R.S.I.	Mr. A. H. Shapley
XV.	Aeronomy	I.U.G.G.-I.A.G.A.	Dr. M. Nicolet
III.	Geomagnetism	I.U.G.G.-I.A.G.A.	Dr. V. Laursen
IV.	Airglow & Aurora	I.U.G.G.-I.A.G.A.	Dr. C. T. Elvey
V.	Ionosphere	U.R.S.I.	Prof. W. Dieminger
VI.	Solar Activity	I.A.U.	Prof. M. A. Ellison
VII.	Cosmic Rays	I.U.P.A.P.	Dr. S. Vernov
XI.	Space Research	C.O.S.P.A.R.	Prof. J. Bartels

In the case of meteorology the Committee noted that the International Association of Meteorology and Atmospheric Physics (I.A.M.A.P.) had expressed the following opinion on the sunspot minimum meteorological observations : « The present routine measurements in the field of meteorology are completely sufficient for studying possible changes in the general circulation, ozone distribution, etc., No recommendations for extra or special observations are made ».

In noting this opinion the I.Q.S.Y. Committee of C.I.G. records that some meteorological data will be an essential complement to certain other geophysical observations planned for I.Q.S.Y., and expresses the hope that these meteorological data will be readily accessible to interested workers in other fields.

5. — Preliminary Programmes for I.Q.S.Y. 1964-65

I. — World Days

(1) The World Days program was initiated under the auspices of C.S.A.G.I. for 1957-59 and has continued since then under the auspices of the International World Day Service. For the I.Q.S.Y., it is anticipated that the World Days activities will be similar to that of the I.G.Y., I.G.C. 1959 and the interim years as outlined in the following paragraph.

(2) *International Geophysical Calendar.* — It is expected that a calendar for 1964 and 1965 will be issued long in advance and will include (*a*) Regular World Days (R.W.D.) one principal and two others consecutively each month, in mid-month, mid-week and preferring moonless nights for I.Q.S.Y. programs which are suitable for execution on one or three days each month throughout the I.Q.S.Y., (*b*) Regular World Interval (R.W.I.), 10 consecutive days each quarter including the equinox and solstical days, for I.Q.S.Y. programs appropriate to this kind of coverage ; (*c*) World Meteorological (Rocket) Intervals, 10 consecutive days each quarter, set approximately one month after equinox and solstice, for I.Q.S.Y. program, for which the change of (meteorological) seasons are important ; and miscellaneous days such as days of solar eclipses, principal days of meteor activity, etc. The calendars for the I.Q.S.Y. period, 1964-65, should be issued and distributed at the latest by mid 1963. The I.W.D.S. is invited to take appropriate action in consultation with C.I.G.-I.Q.S.Y. Reporters and C.O.S.P.A.R.

(3) *Alerts.* — The I.W.D.S. system of geo-alerts and solar-alerts, both advance and regular, regional and worldwide, should be in operation during I.Q.S.Y. The cooperation of the meteorological communication network coordinated by W.M.O. and of the various meteorological communication networks is invited for the prompt distribution of Alert messages to stations participating in the program for I.Q.S.Y. These alerts are prompt notifications to participating stations that a specific outstanding solar or geophysical event has occurred. The stations are thus alerted to modify or extend their programs as appropriate to the discipline involved.

(4) *Special World Intervals.* — S.W.I. should be called from time to time on an immediate schedule. These may be, as appropriate, in anticipation of or immediately after recognition of unusually significant geophysical or geomagnetic disturbances during which it will be clearly desirable that certain geophysical station take more detailed observations appropriate to their program or undertake special experiments such as rocket or balloon flights. These S.W.I. should be called by the World Warning Agency, after appropriate advice from other scientific groups, and declared at a

stated time of day (e. q. 1600 UT, as during I.G.Y.) over the communications network coordinated by W.M.O. and over other facilities. The S.W.I. should take effect upon receipt of message and last until a terminating message is received. The message should specify whether the S.W.I. is based on prediction or on actual commencement of disturbance.

(5) *Rapid Interchange of Solar-Geophysical Data.* — The arrangements for rapid interchange of significant data by telegram or similar means, should be continued in effect during I.Q.S.Y. as arranged by the U.R.S.I. Central Committee on Ursigrams. The selection of the level of solar-geophysical activity appropriate to be thus interchanged should be adapted to the stage of the solar activity cycle. Cooperating observatories in the I.Q.S.Y. program are invited to participate in supplying relevant data by telegram. I.Q.S.Y. stations are invited to avail themselves of the telegraphic summaries where their observing programs or immediate researches will benefit by knowledge of current solar and geophysical activity.

(6) *A Calendar Record.* — Should be compiled under I.W.D.S. auspices for publication as soon as practical after the I.Q.S.Y. observing period. It should follow the general pattern of the I.G.Y. Calendar Record and take into account experience in the interim. The continued cooperation of discipline reporters, subreporters and institutions involved is invited.

III. — Geomagnetism

Time-variations of the geomagnetic field and of earth-currents provide valuable basic information on solar influences on the Earth, exerted by means of solar wave radiation as well as by the impact of clouds of solar gas (corpuscular radiation). Important links exist between these variations and other phenomenae such as aurora, ionospheric conditions and cosmic radiation ; also, the structures of the outer atmosphere and of the radiation belts change distinctly with geomagnetic activity. Geomagnetic time-variations are so sensitive to solar influences that these variations will give unique and reliable continuous information on solar influences during the intervals of minimum solar activity.

The I.G.Y. having provided excellent data on conditions during sunspot maximum, it is imperative to supplement that enterprise by observations to be carried out during I.Q.S.Y. at a level at least comparable to the program of the I.G.Y., at ground observatories as well as in space. The network of stations should be supplemented by additional stations, in particular in and inside the auroral zone where geomagnetic activity responds clearly to weak solar corpuscular radiation.

Special attention should be given to observations of rapid variations of earth-currents and of the geomagnetic field in the range of 0.1 to 15 sec. periods, using rapid-run registration with a time-resolution of not less than 30 mm/minute. Special storm variometers should be installed to record magnetic storms, in their general course as well as in their fine structure, as clearly and completely as possible, in order to avoid loss or illegibility of records during the most interesting geophysical intervals.

The I.Q.S.Y. with its low level of geomagnetic activity will provide excellent working conditions for the great enterprise of the International World Magnetic Survey.

IV. — Aurora and Airglow

The observation and study of airglow was first done extensively during the solar maximum conditions of the I.G.Y. It is important to ascertain the extent to which the airglow during solar minimum activity may be different from that at solar maximum activity. A great advantage of airglow observations at minimum activity is that there will be little or no contamination from auroral light.

On the other hand, during solar minimum activity, one can expect a great change in the aurora over that at maximum activity. Not only will the geographical range of displays and their duration be markedly less, but the character of the auroral forms themselves will be changed from that seen at maximum solar activity. There is a strong belief on the part of some auroral scientists that many of the differences in character of the individual auroral forms may be directly associated with the differences in the extent of the earth's atmosphere at solar minimum and maximum epochs. It is therefore urged that rocket and satellite observations of the density of the high atmosphere be made an integral part of the program during minimum solar activity.

Since this program is one of international cooperation, those problems should be stressed which require for their solution the collaboration of several nations. The problems requiring extensive data collecting should be kept to a minimum, thus minimizing the load of routine work on the scientific personnel of the nations. Scientists should be urged to develop individual research tasks which will serve as supporting research for the broader problems. This plan will encourage the initiative and originality of the individual scientists.

Airglow.

The following recommendations for airglow research for I.Q.S.Y. have been submitted by a working group under auspices of I.A.G.A. and C.I.G. of those currently most actively engaged in such research.

A. It is recommended that the priority of emission to be observed in the near future should be : 6300A, OH bands, 5577A and 5893 A (Na-D).

B. Airglow Emissions 6300A, 5577A and 5893A (Na-D) — There should be further observations of these airglow emissions with object of determining whether differences exist between solar minimum and maximum activities, particularly extending the chains of stations into polar regions to obtain photometric data as free as possible from auroral contamination.

C. OH Emission Bands — With the aid of a simple photometer one should determine the latitudinal distribution of the OH bands by a minimum of two chains of stations.

D. It is recommended that systematic observations be made from aircraft for the study of the geographical distribution of the 6300 arcs and other airglow features.

E. Ground stations for the study of airglow should be arranged in long meridional chains at similar longitudes. It is particularly urged that such chains be established in the tropics and in the southern hemisphere.

F. It is recommended that spectrographic temperature measurements of OH be made concurrently with photometric measurements of absolute intensity. Temperature measurements of atomic lines by interferometric methods are also suggested.

G. The problem of Na-D twilight is of particular importance because the excitation mechanism is well understood. A useful arrangement for the study of gross changes with latitude would be a chain of stations separated approximately 10° in latitude.

H. It is recommended that a serious effort be made to improve the absolute calibration of airglow emissions by developing laboratory standards.

I. The continued study of airglow emission heights by rocket methods should be encouraged, at several latitudes, with special emphasis on the 6300 radiation.

J. Attention is called to the possibility of using the all-sky cameras for the photography of upper atmosphere features in low latitudes. This may be accomplished by relatively long exposures in integrated light or in monochromatic light.

K. Individual Researches — Such as spectroscopic investigations, temperature determinations, etc.

Aurora and Related Phenomena.

1. Geographic Distribution of Aurorae — During solar minimum activity it is improbable that many aurorae will be incident in geomagnetic latitudes less than 60°. The distribution of the aurorae as functions of time and geography can be adequately accomplished with a relatively small group of all-sky cameras. The 160° lens cameras which are available are very satisfactory for determining location of aurorae within 80° of the zenith. Uniform exposures once per minute should be made so that the film may be reduced by viewing by projection techniques at several frames per second. I.G.Y. experience has shown this technique to be efficacious for study of the morphology of auroral displays with bright and faint form including the detection of faint arcs.

2. Conjugate Point Observations — I.G.Y. and more recent experimental work pertaining to trapped particles in the geomagnetic field indicate that a major effort of the auroral program and all other related programs should be devoted to observations at conjugate points — the ends of magnetic field lines. Since it may be difficult to determine the locations of the field lines at 100 km

levels or even at the surface, it may be necessary to have a small close-spaced network of stations at one or two of the selected conjugate points. A minimum of four pairs of conjugate points are urged and the following observations are suggested each pair of conjugate points being equipped with identical or closely comparable equipment :

(*a*) Auroral distribution with all-sky camera (See note under *d*).

(*b*) Meridian spectrograph (See note under *d*).

(*c*) Parallactic photography for auroral heights (see note under *d*).

(*d*) Recording zenith photometer sensitive at, say, wavelength 3914A, with time resolution to at least a second (note : auroral observations will be limited necesarily to the equinoxes).

(*e*) Auroral radar at suitable frequency.

(*f*) Ionospheric absorption by cosmic radio noise method at one or more suitable frequencies.

(*g*) Geomagnetic variations in H, D, and Z.

(*h*) Magnetic fluctuations (coil), 10 cycles per second, with time resolution of 0.01 sec., on a sampling or a full program.

(*i*) Ionograms.

(*j*) Radiation measurement from high latitude balloons (30 km).

(*k*) Cosmic ray neutron monitor.

One of the conjugate points of each pair should be located, if possible, at an existing observatory specializing in upper atmospheric research.

3. Individual Research — Individual scientists should be encouraged to pursue their own ideas concerning other observational programs.

V. — Ionosphere

1. As a result of the I.G.Y. program in ionosphere, there already exist in the scientific literature the most comprehensive description and discussion of the ionosphere for any period in history. This was a period of solar maximum activity. Since the ionization is produced mainly by ultraviolet light and X-rays from the sun, the state of the ionosphere is changed very distinctly as these solar fluxes change from solar maximum to solar minimum. The

type and intensity of ionospheric disturbances are also quite diffe-rent at the two extremes of the solar cycle. Thus to extract the full potential of the extensive and successful ionospheric work of I.G.Y. and I.G.C., there is need for a companion and comparable program at solar minimum.

2. The first priority of the I.Q.S.Y. program in ionosphere should be the production of data for direct comparison with I.G.Y. and I.G.C. data. In some sub-disciplines the networks of stations may not need to be as complete as for the I.G.Y. in order to determine and study the solar cycle effects. But in all cases, care must be taken that the observations during I.Q.S.Y. are taken, reduced and published in a way that they may be discussed jointly with the I.G.Y. body of data.

3. The second priority of the program should be the exploitation of new techniques and the following up of new knowledge of the ionosphere gained during and since the I.G.Y. Again the emphasis should be on ionospheric studies where change in solar activity is an important factor. Such experiments, including those with rockets and satellites will both be important to present researches and be a reference to which future experiments of this kind can be compared.

4. The ionospheric program to be prepared for I.Q.S.Y. may be divided into sub-disciplines, somewhat as for I.G.Y., as given below. In most cases the U.R.S.I.-C.I.G. Committee has already designated « sub-reporters » for these component points of the program. For experiment in these sub-disciplines to be fully effective needs to be a degree of coordination to assume compatibility and compara-bility of results ; it is the task of the sub-reporters to take steps to try to arrange for this degree of uniformity in the programs undertaken for I.Q.S.Y.

Vertical incidence soundings.

Oblique incidence pulse transmissions.

Absorption A-1 (pulse at vertical incidence).

Absorption A-2 (extra terrestrial noise).

Absorption A-3 (cw fieldstrength).

Drift D-1 (pulse fading).

Drift D-2 (meteors).

Drift D-3 (scintillations).

Radar aurora.

Whistler and VLF emission.

Backscatter B-1 fixed frequency,
B-2 multifrequency.

Forward scatter.

Scatter sounding.

Atmospheric noise.

Rockets and satellites.

5. A number of important problems in ionospheric physics which are mostly unsolved seem especially appropriate for study during I.Q.S.Y.

They will depend on work done in several of the sub-disciplines mentioned above. The list of problems is naturally incomplete and is intended to be suggestive.

(*a*) The upper side of the F-region is now accessible to measurement in several ways, both from the ground and by rockets and satellites. This study of the F-region electron content as a whole and its time and geographic variations should perhaps be a major effort of I.Q.S.Y., taking as it does close cooperation of ground and space techniques and stations.

(*b*) Geomagnetic control of the ionosphere has taken on new significance with the improved understanding of the role of the magnetic field in aligning and guiding electrons. Coordinated observations at magnetically conjugate stations takes on increased importance in the ionospheric discipline as well as for aurora.

(*c*) The lower ionosphere, 50 to 100 km, is still not too well understood. Particular effort seems necessary to improve the understanding of absorption processes and work during the relatively simple conditions of minimum solar activity may help. There is an opportunity to bring together the potentialities of various improved ground-based techniques with those of the newer rocket methods.

(*d*) It is one of the major results of I.G.Y. and I.G.C. that the ionosphere cannot be regarded as a medium in quasiequilibrium at least during disturbed conditions. Thus the dynamic processes in the ionosphere are of paramount interest. Obviously a pertinent picture of those processes can be obtained only from a knowledge of true motions in the ionosphere. These in turn may be derived from the temporal variations of N(*h*) — profiles and simultaneous drift observations. It is very important that these also be calibrated against drift measurements by meteor and rocket techniques.

(*e*) The physics and chemistry of the formation and maintainance of the regular ionospheric layers remains an important problem although great progress have been made from the N(*h*) and rocket programs of the I.G.Y. A complementary program in I.Q.S.Y. will be most important especially since the conditions will be relatively undisturbed and the F1 layer will be more prominent. The broad geographic coverage of the vertical sounding network will be of great advantage in this work.

(*f*) The state and development of the ionosphere over the polar caps may hold the key to understanding many ionospheric processes. Here comparison of solar maximum and minimum data will help. Readjustment of station networks in view of I.G.Y. results and introduction of additional experiments at such stations should be considered.

(*g*) Irregularities in electron distribution in the very high ionosphere or exosphere have become better recognized as a result of I.G.Y. and subsequent effort. It seems certain that very significant solar cycle effects will be found in this part of the ionosphere although the detailed motions of such changes can hardly be imagined.

6. Bearing in mind that data taken during I.Q.S.Y. must be comparable to that of I.G.Y., every possible effort should be made to improve the techniques and instrumentation used for ionospheric observations. In particular an increase in accuracy of measurement seems possible in vertical soundings and in techniques in absorption, drifts and U.L.F. recordings.

7. The U.R.S.I.-C.I.G. Committee is developing more detailed program outlines for the various sub-disciplines. It is appropriate for suggestions to come from the international scientific community so that the balance of emphasis can be representative of the present state of the science.

VI. — Solar Activity

The sun has not been studied in general with the same interest and completeness during the minima of solar activity as during the maxima. After the abundant results of the I.G.Y., corresponding observations at minimum should provide the necessary complement and standard for comparison. The quiet sun forms the easiest starting point for theoretical studies and gives the opportunity to investigate individual disturbances which at other times are often too complex.

1. It is recommended that the observations set out in the Permanent Solar Programme (see below) be continued during the I.Q.S.Y.

In particular, the importance is emphasized of having in operation an efficient solar patrol with adequate coverage, and it is desirable that the new stations planned for the solar patrol should be brought into operation well beforehand.

2. In the investigation of the ultra violet and X-radiation of the sun from rockets and satellites, absolute measurements would be of special importance during I.Q.S.Y. for the determination of the energy distribution in the short-wave spectrum. Spectroheliograms and X-ray pictures would be valuable when the disk is free from disturbed regions.

3. Likewise, in the investigation of solar radio emissions absolute measurements of the flux are needed in different frequencies.

4. Absolute measurements of the coronal radiation and spectrum during eclipses will be especially valuable in order to ascertain the properties of the typical minimum corona and the differences between this and the maximum corona, as yet insufficiently known.

International Co-operation in Solar Physics and Future Role of the Data Centres.

Permanent programme.

The programme set out below is based on discussions between the Reporter and Professor Severny (President of Commission 10, I.A.U.), the U. S. S. R. National Committee on Solar Physics; the staff of the McMath-Hulbert Observatory; the U. A. R. Observatory, Sacramento Peak, and members of the High Altitude Observatory, Boulder, and others including the Honorary President of C.I.G., Prof. Sydney Chapman.

1. — Solar Patrol. There was unanimous agreement on the need for continuation of the solar patrol, especially during next

sunspot minimum (1964-65), in view of the needs of geomagnetic, upper atmospheric and space research.

The patrol coverage is weak in the longitudes 2-6 hours. The Reporter is taking steps to strengthen the coverage in the longitudes.

2. — Solar Patrol Reports. We would request these solar patrol stations (cinematographic) to send carbon copies to W.D.C.'s-A, B and C of their tabulations of : (*a*) Beginning and ending times of patrol coverage with normal frequency of exposures. (*b*) Tabulations of flares, active prominence regions etc.

In fact, most of the I.G.Y.-I.G.C. *visual* stations continue to send copies of their monthly reports to the three W.D.C.'s.

3. — Types of Data and Changes. (*a*) Information about sudden ionospheric disturbances (S.I.D.'s) should be collected by the solar activity W.D.C.'s. An attempt should be made to obtain monthly reports and/or microfilms of the original records from the many stations which are recording but are not reporting such phenomena. (*b*) The Special Sunspot Number programme should be dropped once the examination and analysis of the I.G.Y. figures have been completed at C.R.P.L. (*c*) We hope to see continued : (i) The publication of sunspot magnetic field data (polarities and field strengths) for the post-I.G.Y. period on the same basis as for I.G.Y. (ii) The publication of quick reports of the magnetic classification of sunspot groups, similar to those which were formerly published by Mount Wilson in P.A.S.P.

4. *Solar Radio Emission.* — Satisfactory arrangements have now been completed for N.E.R.A. to take over this important DC from Sydney. It is expected that this will lead to some simplifications and improvements in the handling of the data and the editing of them for the *Quarterly Bulletin.*

Many stations are now recording solar radio emissions by means of swept frequency receivers. A 24-hour patrol has probably been achieved, but few of them are reducing the results of their observations for monthly submission to the W.D.C.'s. We hope that Dr. Fokker at N.E.R.A. will endeavour to make the collection more complete.

5. *Monitoring of Data Received.* — We feel that the Data Centres should be invited to act in an advisory capacity so as to promote

and achieve greater uniformity in the recording of solar data. At present they collect data but offer no comments.

It would be very helpful if the Centres could give advice on such matters as, analysis of patrol films, classification of flares and prominences, coronal intensity scales etc. This they would be willing to do if they were given authority by, say, the Presidents of Commissions 10 and 11, I.A.U. and the Reporter.

6. *Ultraviolet and X-Rays.* — Investigation of the short-wave end of the solar spectrum, making full use of the new rocket and satellite techniques, promises results of outstanding importance. Spectroheliograms in Hd, He 584 etc. and X-ray pictures of the sun should be obtained in order to study the distribution of these radiations over the solar disk. Radiation shorter than 1A accompanying major flares is of special interest. Further details are given in paragraph 1 of the Aeronomy Program.

7. *Quarterly Bulletin of Solar Activity.* — Many suggestions have been put forward for alterations of, or improvements to, the *Q. B.* Among these are the following :

(a) The publication delay of 2 years should, if possible, be reduced.

(b) Indices for faculae and prominences should be introduced.

(c) Flare list : Instead of every observation of an individual flare being given as now, a definitive list might be substituted (similar to the McMath-Hulbert Working List of Flares prepared for I.G.Y.). The records from each station would still remain available at the W.D.C.'s.

(d) Definitive coronal maps for each day rather than the complete observations of all stations.

(e) The Meudon synoptic charts of dark filaments might be incorporated.

(f) Data on solar X-ray events should be entered when available.

(g) Data on the white corona, as recorded at H.A.O. Climax.

Such points as these could, we feel, be best discussed at a meeting in Berkeley specially convened by Commission 10 I.A.U. for this purpose.

8. *Daily Maps of the Sun.*

(i) We regard it as highly important that the Fraunhofer maps should continue publication for some years. The Japanese and

Meudon Daily Maps, inaugurated for the I.G.Y., have ceased. The Fraunhofer Institute has indicated its willingness to continue publication of these maps after 1961 if the necessary financial support can be made available.

(ii) The publication should be considered of daily calcium ($K_{2,3}$) spectroheliograms.

9. *Solar Activity Alerts and Rapid Interchange of Data on Outstanding Phenomena.* It is noted that these activities are being co-ordinated by the I.C.S.U. International World Days Service and U.R.S.I. Central Committee on Ursigrams, which groups have a correspondent to C.I.G. Solar activity observatories are invited to co-operate in these phases of the work.

VII. — Cosmic Rays

Investigations of cosmic rays have to be conducted on a broad programme. It is specially recommended that the international network of cosmic rays stations continue its regular observations both during I.Q.S.Y. and in the interval between the solar activity maximum and the solar activity minimum periods. It is necessary because some types of cosmic ray variations may depend in a complicated manner up on the solar activity. That is why the collection and the publication of cosmic ray data for the period 1960-1965 should be at the same level as was reached in 1958-1959. Investigations at high altitudes have to be developed on a large scale.

The following observations are recommended :

1. Investigations of the energy-spectrum and composition (mass-spectrum) of primary low energy cosmic rays, which will be helpful in the determination of the true spectrum of the particles in the galaxy. Measurements must be carried out at higher latitudes as far as possible and at considerable altitudes (balloons, rockets and satellites) as cut off rigidities of primary particles can change during I.Q.S.Y.

The question of the cosmic ray « knee » has not been cleared up. It is an effect which varies between sunspot maximum and sunspot minimum.

2. Determination of the location of the cosmic ray equator. As yet, the reason for the difference between the measured location of the equator and that calculated theoretically is not clear. Researches at solar activity minimum will be helpful in finding out, whether the Earth's magnetic dipole interacts with the plasma surrounding the Earth since the solar corpuscular radiation will become weaker and such an interaction with the plasma will then perhaps, be detected.

3. Research of the sideral diurnal variations of cosmic rays with the help of crossed telescopes, at ground and underground, directed to the North, South, West and East, would permit the elimination of meteorological effects i. e. the temperature variation, which creates a false sideral variation because of the presence of seasonal changes of the solar diurnal wave.

4. Investigations of the radiation belts and especially of the outer belt, which changes very much, with solar activity. Investigations of the positions of the belts in space, determinations of the nature of the particles constituting the belts, and the energy distribution of these particles have to be conducted in order to compare these data with similar results obtained during solar activity maximum period. Great interest will be attached to the following investigations during I.S.Q.Y.

(*a*) Determinations of the boundaries of the inner and the outer belts.

(*b*) Measurements of the maximal radiation intensity in the belts and the location of these maxima in space.

(*c*) Investigations of the energy spectrum of the electrons, especially in the region of highest energies (that is of the order of several MeV).

5. Since the solar variation of primary cosmic ray intensity might be very small during this period, there is a good chance to investigate atmospheric effects on cosmic ray intensities.

XI. — Space Research

In the discipline programs outlined above several references are made to geophysical experiments requiring the use of balloons, rockets, satellites and space probes. The C.O.S.P.A.R. representative at the I.Q.S.Y. Committee, Prof. J. Bartels will transmit these proposals to C.O.S.P.A.R. for their consideration. The general resolutions attached to the report contain a reference to C.O.S.P.A.R. participation in the I.Q.S.Y.

In addition the following suggestions are made by the C.I.G.-I.Q.S.Y. Committee for a space research programme during I.Q.S.Y.

(i) studies of the zodiacal light, intensity or polarisation in order to determine the distribution of dust, etc. in interplanatory space and in the neighbourhood of the earth.

(ii) measurement of magnetic field intensities and variations in interplanetary space.

(iii) studies of phenomena in the terrestrial atmosphere associated with hydromagnetic waves.

XV. — Aeronomy

The disturbing effects of solar activity which frequently occurred during the I.G.Y. 1957-58 led to considerable new knowledge in aeronomy. In like manner the period of solar minimum activity will be of equal importance for aeronomy studies because further knowledge will certainly be gained from scientific data obtained during an interval free from the disturbing effects of solar activity.

One great advantage of observations at minimum activity is that there is a possibility of obtaining physical parameters with considerable more precision than at other times, and such data are essential for calibration purposes.

Aeronomy problems require extensive data on pressure (p), density, concentrations of various constituents (n_i), positive and negative ions ($n+$ and n^-) and electron concentrations (n_e). New techniques must be introduced to obtain vertical distributions of mean molecular mass (M) and temperature (T). Spectral observations of extreme ultraviolet of the sun should be included so as to obtain complete solar data.

In the light of the programmes suggested for the other I.Q.S.Y. disciplines, the following additional suggestions are made :

1. *Solar ultraviolet and X-ray radiations measurements from rockets and satellites.*

Considering that for aeronomy studies, it is necessary to know :

(i) absolute values of solar energies (atmospheric heating),

(ii) the spectral distribution (number of photons),

(iii) the atmospheric absorption of solar radiation for various spectral ranges (active effects in the atmosphere),

(iv) the specific absorptions by various constituents (ionization, dissociation).

and to distinguish :

(v) the real solar significance of the various solar indices,

it is recommended that :

(i) solar ultraviolet spectra be obtained by rockets through the terrestrial atmosphere up to the zeroth optical depths,

(ii) absolute intensities of lines be measured in the whole ultraviolet spectrum to obtain the spectrum of a quiet sun for comparison with that during disturbed conditions,

(iii) the solar ultraviolet spectrum be monitored from satellites to insure a good knowledge of relative variations of the principal radiations,

(iv) Various X-ray spectral ranges be monitored from satellites in comparison with specific ultraviolet radiations.

2. *Other observations.*

Considering that new methods are available for a better knowledge of physicals parameters, the following observations are also suggested :

2.1. Detailed observations by small rockets in the mesosphere and lower thermosphere to obtain *p*, T and *ne*.

2.2. Measurement by rockets in the thermosphere below 250 km using optical means (X-ray — Ultraviolet filters) to obtain concentrations of various constituents and total density, concurrently with direct measurement of total density.

2.3. Direct measurement of temperature by methods such as Doppler effect in sodium clouds up to highest altitudes in connection with, if possible, the spectroscopic measurements.

2.4. Ionospheric measurement by rockets of various positive ions (principal and minor ones) connected with vertical distribution of electronic concentration obtained from ionograms, and if possible from rocket measurements.

2.5. Sodium clouds related to the sporadic E layer and the structure of the lower thermosphere.

2.6. Airglow data leading to determination of the altitudes of principal emissions.

2.7. Rapid survey (i.e. by airplane) of airglow phenomena such as arcs of red and green lines of oxygen to be related to the ionospheric F region.

2.8. Rocket observations near the perigee of satellites, allowing a comparison of the various parameters obtained by the two methods.

2.9. Precise satellite observations for the study of the atmospheric drag to obtain the vertical distributions of density with its diurnal, seasonal and geographical variations during very quiet solar conditions.

2.10. Analysis of the energy spectrum and space distribution of radiation belts to determine relationship with upper atmosphere variations.

Paris, January 1961.

COMITÉ INTERNATIONAL DE GÉOPHYSIQUE

Rapport du Groupe de Travail pour le Programme du Minimum d'Activité Solaire

(*Résumé*)

Ce Groupe de Travail s'est réuni sous la présidence du Prof. J. G. W. Beynon.

1. — Introduction

Une proposition pour l'établissement d'un programme de recherches géophysiques pendant la prochaine période de minimum de taches solaires fut présentée à la réunion du C.I.G. en août 1960. Le besoin d'un tel projet pour la radioélectricité avait été discuté par le Comité de l'U.R.S.I. pour l'A.G.I. lors de sa réunion d'Edimbourg en 1958 et a été examiné à nouveau par le Comité de l'U.R.S.I. pour la Coopération Internationale en Géophysique lors d'une réunion tenue à Londres en septembre 1960.

Il est évident que pour certaines disciplines les résultats obtenus pendant la période d'activité solaire maximum couvrant la durée de l'A.G.I. ne peuvent être complets que s'ils sont comparés à des résultats obtenus au cours d'une période d'activité minimum.

2. — Titre à donner au projet d'activité minimale

Il est décidé d'appeler ce projet « Année Internationale du Soleil Calme 1964-65 » (International Year of Quiet Sun 1964-65 (I.Q.S.Y.).

Le groupe chargé de l'établissement du projet s'appellera « le Comité du C.I.G. pour l'I.Q.S.Y. ».

3. — Date proposée pour le projet

Il est proposé de prévoir la période du 1er avril 1964 au 31 décembre 1965.

I.	Journées Mondiales	I.W.D.S.(U.R.S.I.)	M. A. H. SHAPLEY
XV.	Aéronomie	U.G.G.I.-I.A.G.A.	Dr M. NICOLET
III.	Géomagnétisme	U.G.G.I.-I.A.G.A.	Dr V. LAURSEN
IV.	Lueur nocturne et Aurores	U.G.G.I.-I.A.G.A.	Dr C. T. ELVEY
V.	Ionosphère	U.R.S.I.	Prof. W. DIEMINGER
VI.	Activité Solaire	U.A.I.	Prof. M.A. ELLISON
VII.	Rayons Cosmiques	U.I.P.P.A.	Dr S. VERNOV
XI.	Recherches Spatiales	C.O.S.P.A.R.	Prof. J. BARTELS

4. — Disciplines et Rapporteurs pour l'I.Q.S.Y. 1964-1965

I. — JOURNÉES MONDIALES

(1) On prévoit que les activités pendant les Journées Mondiales seront semblables à celles déployées pendant l'A.G.I., l'I.G.C. 1959 et les années précédant l'I.Q.S.Y.

(2) Calendrier Géophysique International — On prévoit que le Calendrier pour 1964 et 1965 sera publié suffisamment tôt et qu'il

contiendra : (*a*) Des Journées Mondiales Régulières (R.W.D.) : une principale et deux autres consécutives chaque mois, au milieu du mois et d'une semaine ; (*b*) Des Intervalles Mondiaux Réguliers (R.W.I.), 10 jours consécutifs chaque trimestre y compris les jours d'équinoxe et de solstice ; (*c*) Des Intervalles Météorologiques Mondiaux (Fusées), 10 jours consécutifs chaque trimestre environ un mois après les équinoxes et les solstices. L'I.W.D.S. est invité à prendre, après consultation avec les Rapporteurs de l'I.Q.S.Y. et le C.O.S.P.A.R., les mesures pour publier au plus tard vers la mi 1963 les calendriers couvrant la période de l'I.Q.S.Y.

(3) Alertes : Le dispositif de l'I.W.D.S. pour les alertes géophysiques et solaires, tant régulières que régionales et mondiales, devrait fonctionner pendant l'I.Q.S.Y.

(4) Intervalles Mondiaux Spéciaux — De tels intervalles devraient être annoncés de temps en temps.

(5) Echange rapide des données géophysiques et solaires. Les dispositions pour l'échange rapide des données devraient rester en vigueur suivant les modalités instaurées par le Comité Central des Ursigrammes de l'U.R.S.I.

(6) Calendrier post facto (Calendar Record) — l'I.W.D.S. est invité à publier dès que possible après la période des observations un tel calendrier pour l'I.Q.S.Y.

V. — Ionosphère

1. Le programme des recherches ionosphériques pendant l'A.G.I. a permis d'établir une description très complète de l'ionosphère. Toutefois les perturbations ionosphériques se produisant au cours d'une période de grande activité solaire ne sont pas les mêmes que celles observées pendant les périodes de faible activité solaire. Pour obtenir tout le bénéfice des résultats obtenus au cours de l'A.G.I. et de la I.G.C. 1959 il serait souhaitable de les comparer aux résultats obtenus au cours d'une période de faible activité solaire.

2. Dans le programme ionosphérique de l'I.Q.S.Y., la première priorité devrait être donnée à la production de données pouvant être comparées à celles de l'A.G.I. et de 1959. Pour certaines disciplines les réseaux de stations ne doivent pas être aussi complets

que ceux ayant fonctionné pendant l'A.G.I. et pendant 1959. Il convient toutefois de veiller à ce que les observations effectuées pendant l'I.Q.S.Y. soient conduites, réduites et publiées de façon à pouvoir être discutées avec les données de l'A.G.I.

3. La deuxième priorité devrait être l'exploitation des nouvelles méthodes et des nouvelles connaissances acquises pendant et depuis l'A.G.I. Les études des phénomènes plus sensibles aux variations de l'activité solaires ainsi que les expériences avec fusées et satellites pourraient servir de base pour les recherches futures.

4. Le programme ionosphérique à préparer pour l'I.Q.S.Y. peut être divisé en sous-disciplines comme indiqué ci-après. Dans la plupart des cas le Comité U.R.S.I.-C.I.G. a déjà désigné des « sous-rapporteurs » pour ces diverses subdivisions du programme. Pour les expériences dans ces sous-disciplines il convient d'avoir une certaines coordination pour que les résultats soient compatibles et comparables ; il appartient aux sous-rapporteurs de prendre les mesures pour atteindre cette uniformité dans les programmes suivis pendant l'I.Q.S.Y.

Sondages à incidence verticale.

Emissions d'impulsions à incidence verticale.

Absorption A-1 (impulsion à incidence verticale).

Absorption A-2 (bruit d'origine extra-terrestre).

Absorption A-3 (intensité en ondes entretenues).

Mouvement D-1 (évanouissement d'impulsions).

Mouvement D-2 (météores).

Mouvement D-3 (scintillations).

Aurores par radar.

Siffleurs et émissions en très basses fréquences.

Rétro-dispersion B-1 fréquence fixe.
B-2 multifréquences.

Dispersion directe.

Sondage par dispersion.

Bruits atmosphériques.

Fusées et satellites.

5. Un certain nombre de problèmes importants de la physiq ionosphérique semblent particulièrement appropriés aux étud pendant l'I.Q.S.Y. Ils dépendront des travaux effectués da plusieurs des sous-disciplines mentionnées ci-dessus. La liste après est donnée à titre de suggestion.

(*a*) La face supérieure de l'ionosphère est devenue accessil et peut être mesurée de différentes façons tant à partir du que par fusées et satellites. Il semble que l'étude du contenu électrons de la région F en son ensemble et de ses variations da le temps et l'espace pourrait peut-être être l'effort principal l'I.Q.S.Y.

(*b*) Le rapport entre le géomagnétisme et l'ionosphère a pris u nouvelle signification avec la récente interprétation du rôle champ magnétique sur la répartition des électrons. Des observatio en des points conjugués magnétiquement prennent une certai importance tant pour l'étude de l'ionosphère que pour les aurores.

(*c*) La partie inférieure de l'ionosphère, de 50 à 100 km, n'est p encore suffisamment connue. Il semble que de nouveaux effoı soient nécessaires pour améliorer la connaissance des phénomèn d'absorption ; dans ce but, une aide pourrait être apportée par d travaux au cours des conditions relativement simples de la pério de minimum d'activité solaire. Ce serait également une opport nité de rassembler les possibilités actuelles des techniques terrestr et celles des méthodes plus neuves employant des fusées.

(*d*) Un des principaux résultats acquis pendant l'A.G.I. et I.G.C. est que l'ionosphère ne peut être considérée comme ı milieu en quasi-équilibre, tout au moins au cours de conditio perturbées. C'est pourquoi les processus dynamiques dans l'ion sphère sont d'un intérêt capital. Il est évident que seule la connai sance des mouvements réels dans l'ionosphère peut donner u image convenable de ces processus. Ces mouvements, à leur tou peuvent être déduits des variations dans le temps de N(*h*) et d'obse vations simultanées des mouvements.

(*e*) La physique et la chimie de la formation et de la conservatic des couches ionosphériques régulières restent un grand problèn bien que de grands progrès aient été réalisés grâce aux programm de N(*h*) et des fusées pendant l'A.G.I. Un programme compléme taire de l'I.Q.S.Y. aura une importance particulière étant don que les conditions seront relativement calmes et que la couche F sera plus prédominante. Le grand recouvrement géographique du réseau de sondage à incidence verticale présentera de grands avantages pour ces travaux.

(*f*) L'état et le développement de l'ionosphère au-dessus des calottes polaires peuvent contenir la clé de nombreux problèmes ionosphériques. Ici une aide peut être obtenue de la comparaison des données solaires, pour le maximum et pour le minimum. Il conviendrait de revoir la composition des réseaux de stations et le programme des observations en tenant compte des résultats de l'A.G.I.

(*g*) Un des résultats de l'A.G.I. et des efforts qui ont suivi a été une meilleure connaissance de la distribution des électrons dans l'ionosphère supérieure et dans l'exosphère. Il paraît certain que des effets significatifs du cycle solaire pourront être trouvés dans cette partie de l'ionosphère bien que les mouvements détaillés des changements sont difficilement imaginables.

6. En tenant compte que les données recueillies pendant l'I.Q.S.Y. doivent être comparables à celles de l'A.G.I., des efforts doivent être faits pour améliorer les méthodes et les instruments utilisés pour les observations ionosphériques. En particulier il semble possible d'augmenter la précision des mesures dans les sondages à incidence verticale et dans les méthodes d'enregistrement pour l'absorption, les mouvements et les ultra basses fréquences.

7. Le Comité U.R.S.I.-C.I.G. établit des programmes plus détaillés pour les différentes sous-disciplines. Il est souhaitable que des suggestions viennent de la communauté scientifique internationale de façon que les questions figurant dans ces programmes représentent l'état actuel de la science.

XI. — Recherches Spatiales

Dans les programmes esquissés pour les diverses disciplines, on mentionne à diverses reprises l'emploi de ballons, de fusées, de satellites et de véhicules de l'espace. Le Professeur Bartels, représentant du C.O.S.P.A.R. au sein du Comité de l'I.Q.S.Y. transmettra ces propositions au C.O.S.P.A.R. Les résolutions générales accompagnant le rapport contiennent une mention au sujet de la participation du C.O.S.P.A.R. à l'I.Q.S.Y.

En outre, des suggestions sont émises par le Comité de l'I.Q.S. en vue de l'établissement d'un programme de recherches spatia pendant l'I.Q.S.Y. ; une des suggestions concerne les études d phénomènes de l'atmosphère terrestre associés aux ondes hyd magnétiques.

XV. — Aéronomie

Dans le programme relatif à cette discipline peuvent être signal à l'attention de l'U.R.S.I. les points ci-après :

— Mesures ionosphériques par fusées des différents ions positi reliés à la distribution verticale de la concentration électroniqu

— Nuages de sodium dans la couche sporadique E et structure d la basse thermosphère ; etc.

Paris, janvier 1961.

I. G. Y.

Bibliography

We call the attention of scientific workers interested in the I.G.Y. activities to the following publication « Japanese Contribution to the I.G.Y. » Vol. II, issued in March 1960 by the Japanese National Committee for the I.G.Y., Science Council of Japan.

The information on the ionospheric observations during I.G.Y. and I.G.C., supplementing to the previous volume of the « Japanese Contribution to the I. G.Y.» contains the following items :

1. Vertical incidence sounding.
2. Absorption measurements.
3. Drift measurements.
4. Atmospheric radio noise measurements.
5. Whistler observations.
6. Back-scatter observations.

Besides, the part devoted to solar activities contains some information on radio astronomical observations.

The following items connected with U.R.S.I. activities should also be mentioned :

Part VIII — Longitude and latitude.
— Time determination and keeping.
— Determination of travel time of radio signals.
— Measurement of Doppler shift in received signals.

Part IX. — Rockets and satellites.
— Orbital tracking of satellites.
— Doppler and Faraday effects.

* * *

We call the attention of the Members of Commissions IV and V to « I.G.Y. Data on Atmospherics, Whistlers and Solar Radio

Emissions », Vol. IV, June 1, June 30, 1959 » issued by the Japanese National Committee for the I.G.Y., Science Council of Japan.

* * *

The following publications have been issued by the Japanese National Committee of Japan :

— Absolute intensity of night airglow during the I.G.Y. (Nov. 1959).
— Compilation of Data in Japan for Atmospheric Radio Noise during the I.G.Y. (March 1960).

* * *

The following publication of the Annals of the I.G.Y. has been issued under the auspices of C.I.G. :

« Vol. XII, Part I, First Results of I.G.Y. Rocket and Satellite Research », Pergamon Press, London.

INTERNATIONAL ASTRONOMICAL UNION

XIth General Assembly, Berkeley, 15-24 August 1961

(a) Preliminary Programme — The Preliminary Programme for the General Assembly, containing a formal invitation to attend, has been circulated to every Member of the Union by the U. S. Organizing Committee. This gives full particulars of the main meetings, of living accommodation, of optional excursions and trips, and of other arrangements required to enable participants to plan their journeys.

A more detailed programme, which will include a time-table of all meetings during the General Assembly, will be available on registration.

(b) Scientific meetings — The Three Invited Discourses will be given as follows :

nº 1 on « Origin, Composition and Dynamics of the Geomagnetically-Trapped Corpuscular Radiation », by Professor J. A. VAN ALLEN.

nº 2 on « Stellar Evolution » by Professor M. SCHWARZSCHILD.

nº 3 on « Problems of Extra-Galactic Research » by Professor V. A. AMBARTSUMIAN.

Particulars of the Joint Discussions will be given in a later Information Bulletin.

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

Proceedings of the General Assemblies

The Proceedings of the following General Assemblies have been published and can be obtained from the General Secretary of I.U.G.G., 140, rue de Grenelle, Paris 7e, except for those that are out of print :

1st General Assembly, 1922, Rome (out of print).
2nd General Assembly, 1924, Madrid.
3rd General Assembly, 1927, Prague.
4th General Assembly, 1930, Stockholm (out of print).
5th General Assembly, 1933, Lisbonne (out of print).
6th General Assembly, 1936, Edinburgh.
7th General Assembly, 1939, Washington.
8th General Assembly, 1948, Oslo.
9th General Assembly, 1951, Bruxelles (out of print).
10th General Assembly, 1954, Rome.
11th General Assembly, 1957, Toronto.

In addition there is the « Report of the Union for the War years 1939-1945, with the Proceedings of the Executive Committee of the Union, Oxford, December 1945, and the Extraordinary Assembly, Cambridge, July 1946.

The Proceedings of the XIIth General Assembly, held in Helsinki, Finland, from 26 July to 6 August 1960, will be published during January 1961.

All the above publications are available at the price of $ 2,00, 15/-, NF 10.

UNESCO

Liste spéciale des Organisations Internationales non-gouvernementales avec lesquelles l'Unesco entretient des relations non officielles

Special List of International Non-governmental Organizations with which Unesco maintains informal relations

Parmi les organisations mentionnées dans la liste figurent les organisations membres du Conseil International des Unions Scientifiques ci-après :

Amongst the organizations mentioned in the list are the Member Organizations of the International Council of Scientific Union as listed hereunder :

Union Astronomique Internationale
International Astronomical Union

Mr. D. H. Sadler, Secretary, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, UK.

Union Géographique Internationale
International Geographical Union

Freiestrasse 30, Zurich 32.

Union Mathématique Internationale
International Mathematical Union

Prof. B. Eckmann, Secrétaire, Ecole Polytechnique fédérale, Zurich.

Union Radio Scientifique Internationale
International Scientific Radio Union.

7, place Emile Danco, Bruxelles.

Union Internationale de Biochimie.
International Union of Biochemistry

Prof. K. Linderstrom-Land, President, Carlsberg Laboratorium, 10, Gl. Carlsbergvej, Copenhague-Valby.

Union Internationale des Sciences Biologiques

International Union of Biological Sciences

Prof. R. ULRICH, Secrétaire, 1, rue Victor Cousin, Paris 5e.

Union Internationale de Cristallographie

International Union of Crystallography

c/o Dr. D. W. SMITS, Secretary-General, Laboratorium voor Anorganische en Physische Chemie, Bloemsingel 10, Groningen (Netherlands).

Union Géodésique et Géophysique Internationale

International Union of Geodesy and Geophysics

c/o M. l'Ingénieur Général G. LACLAVÈRE, Secrétaire Général, 53, avenue de Breteuil, Paris 7e.

Union Internationale d'Histoire et de Philosophie des Sciences

International Union of the History and Philosophy of Sciences

c/o Professeur René TATON, 64, rue Gay-Lussac, Paris 5e.

Union Internationale des Sciences Physiologiques

International Union of Physiological Sciences

University of Minnesota, Department of Physiology, The Medical School, Minneapolis 14, Minn. (U. S. A.).

Union Internationale de Chimie Pure et Appliquée

International Union of Pure and Applied Chemistry

c/o Dr. R. MORF, Secrétaire Général, Sandoz, Bâle 13.

Union Internationale de Physique Pure et Appliquée

International Union of Pure and Applied Physics

Prof. P. Fleury, Secrétaire Général, 3, boulevard Pasteur, Paris 15e.

Union Internationale de Mécanique Théorique et Appliquée

International Union of Theoretical and Applied Mechanics

c/o Prof. F. H. VAN DEN DUNGEN, Secrétaire Général, 41, rue de l'Arbalète, Boitsfort, Bruxelles.

U. I. T.

Conférence européenne de radiodiffusion sur ondes métriques et décimétriques

(Extrait du *Journal U.I.T.*, n° 11, 1960)

On se rappellera qu'en 1952 s'est tenue à Stockholm une conférence qui avait pour mission d'élaborer un accord et des plans pour l'assignation des fréquences de la bande des ondes métriques aux stations de radiodiffusion et de télévision situées dans la zone européenne de radiodiffusion.

Etant donné qu'en Europe, à cette époque, la radiodiffusion et la télévision sur ondes métriques n'en étaient qu'à leur premier stade de développement; les plans établis par cette conférence ne pouvaient avoir qu'un caractère provisoire et devaient faire l'objet d'une revision en temps utile.

Depuis lors, une évolution notable s'est produite dans le domaine de la radiodiffusion sur ondes décimétriques, et le moment est venu d'établir des plans qui permettront d'utiliser rationnellement cette bande de fréquences dans la zone européenne.

En présence de cette situation, le Gouvernement Suédois a récemment invité — par l'intermédiaire du Secrétariat général de l'U.I.T. — les administrations des P.T.T. des pays de la zone européenne de radiodiffusion à participer à une conférence dont l'ordre du jour sera le suivant :

1. *Radiodiffusion sur ondes métriques* :

(*a*) Examiner la situation actuelle dans la zone européenne de radiodiffusion ;

(*b*) prendre, à la lumière de cet examen, toutes mesures qui se révèlent indispensables ou qui sont nécessaires à la suite de l'entrée en vigueur du Règlement des radiocommunications de Genève, 1959.

2. *Radiodiffusion sur ondes décimétriques.* — Etablir des accords et des plans associés relatifs à la radiodiffusion sur ondes décimétriques dans la zone européenne.

Cette conférence se tiendra à l'hôtel Malmen, Stockholm, du 26 mai au 22 juin 1961.

I. T. U.

European VHF-UHF Broadcasting Conference

(Reprint from the *Journal U.I.T.*, n° 11, 1960)

It will be recalled that in 1952, a Conference was held in Stockholm to draw up an agreement and frequency plans for the assignment of very high frequencies to sound and television broadcasting stations in the European Broadcasting Area.

Since at that time VHF sound and television broadcasting in Europe was in an early stage of development, the plans drawn up by that Conference were to be regarded as preliminary and subject to review at an appropriate time.

In the meantime developments have also been taking place in UHF broadcasting, and the stage has been reached where it is advisable to establish plans for its use in Europe on an orderly basis.

Under these conditions, the Swedish Government, acting through the General Secretariat, has recently invited Administrations of the European Broadcasting Area to attend a Conference having the following agenda :

1. *VHF Broadcasting* :

(*a*) To examine the present situation in the European Broadcasting Area ;

(*b*) To take any steps which, in the light of such examination, prove to be essential, or are necessary as a result of the entry into force of the Radio Regulations, Geneva, 1959.

2. *U.H.F. Broadcasting.* — To establish agreements and associated plans for the use of U.H.F. broadcasting in the European Area.

This Conference will be held in the Malmen Hotel, Stockholm, from 26 May to 22 June, 1961.

ORGANISATION MÉTÉOROLOGIQUE MONDIALE

Troisième Session de l'Association Régionale VI (Europe)

Le compte rendu de cette session tenue à Madrid du 24 septembre au 14 octobre 1960, et à laquelle l'U.R.S.I. était représentée par le Prof. Dr. J. Balta-Elias, a été publié dans le Bulletin de l'O.M.M., Vol. X, n° 1, janvier 1961.

WORLD METEOROLOGICAL ORGANIZATION

Third Session of the Regional Association VI (Europe)

The Proceedings of this session which took place in Madrid from September 24 to October 14, 1960, have been published in the Bulletin of the W.M.O., Vol. X, n° 1, January 1961. U.R.S.I. was represented at this session by Prof. Dr. J. Balta-Elias.

BIBLIOGRAPHIE

Commission Electronique Internationale

Publication 117-2. *Première édition.* — Symboles graphiques recommandés, 2e partie : Machines, transformateurs, piles et accumulateurs.

Publication 50(50). *Deuxième édition.* — Vocabulaire Electronique International, Groupe 50 ; Electrochimie et Electrométallurgie.

Liste des Publications de la C.E.I.

Ces publications sont en vente au Bureau Central de la C.E.I., au prix de Fr. s. 6 l'exemplaire, plus frais de port, pour la Publication 117-2, et de Fr. s. 12 l'exemplaire, plus frais de port, pour la Publication 50(50) et de Fr. s. 1, plus frais de port, pour la liste des Publications de la C.E.I.

BIBLIOGRAPHY

International Electrotechnical Commission

Publication 117-2. *First edition.* — Recommended graphical symbols, Part 2 ; Machines, transformers, primary cells and accumulators.

Publication 50(50). *Second edition.* — International Electrotechnical Vocabulary, Group 50 : Electrochemistry and Electrometallurgy.

List of I.E.C. Publications.

These publications are on sale at the Central Office of the I.E.C., at the price of Sw. Fr. 6 per copy, plus postage, for Publication 117-2 ; Sw. Fr. 12 per copy, plus postage, for Publication 50(50), and Sw. Fr. 1, plus postage for the List of I.E.C. Publications.