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U. R. S. I.

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Prix de l'URSI - Triennat 1966-1968

Les Comités nationaux de l'URSI ont été récemment invités à présenter leurs candidats aux trois prix de l'URSI, qui seront décernés en 1969 à la XVIe Assemblée générale.

La Médaille d'Or Balth. van der Pol sera attribuée pour des travaux éminents effectués dans un des domaines de la recherche radioélectrique pendant la période 1966-1968. Pour la Médaille d'Or J.H. Dellinger, ces travaux devront avoir été réalisés dans le domaine de la propagation des ondes radioélectriques.

Le Lauréat du Prix Appleton sera appelé à présenter, au cours de l'Assemblée générale de 1969, une Conférence consacrée aux progrès récents en physique ionosphérique et, bien entendu, il devra avoir travaillé lui-même dans ce domaine de la recherche.

Seuls les Comités nationaux de l'URSI peuvent présenter des candidats à ces prix et, donc, toutes les suggestions relatives à des candidats éventuels doivent leur être soumises. La date limite pour la réception des propositions au Secrétariat de l'URSI à Bruxelles est fixée au 15 juillet 1968.

IONOSPHERIC RESEARCH AFTER THE IQSY

by

Prof. Dr. W. DIEMINGER (Lindau)
Vice-President of URSI,
IQSY Reporter for Ionosphere.

As a result of the world-wide cooperation during the IGY, a good understanding of the characteristics and variations of the ionosphere between 100 km and the F2-layer peak was attained. The hypothesis that ion production and loss processes essentially controlled the quasistationary state of the F-layer was still accepted in 1960.

Tne knowledge of the ionosphere above the F-layer peak at the end of the IGY was based on only a few observations which showed that the electron density decreased only slowly with increasing height. However, little information was available on the variations in the structure of the topside ionosphere at different geographic and geomagnetic latitudes.

During the IGY, studies of the ionosphere below 100 km were not so successful. Because of the difficulties of the observations, these were undertaken at only a few ground stations and it was not possible to obtain a world-wide picture from them.

Observations of drifts were restricted to only a few isolated places and thus no world-wide picture emerged.

Observations with rockets and satellites during the IGY gave most valuable information about ionospheric parameters which could have been obtained in no other way and which were of decisive importance; the observational techniques were, however, still very primitive and the number of launches was too small to permit synoptic observations to be planned. Moreover there was often too little coordination with ground based observations.

One of the most important steps forward during the IGY was, without doubt, the establishment of an international organisation for the coordination of the observations and the collection of typical data. This laid a new foundation for future cooperation in geophysics. The International Geophysical Calendars and the World Data Centres represent permanent results of the IGY.

When a comparison is made between the situations at the end of the

IQSY and of the IGY, it must be remembered that perhaps less than half of the new knowledge acquired during IQSY depended on sunspot minimum conditions. The greater proportion emerged from the evaluation of the IGY results and the improvement of observational techniques especially in rockets and satellites. This does not in any way minimise the importance of the IQSY, but rather it emphasises the role of the IGY as the starting point of a new era in geophysics and in ionospheric research.

As a result of the observations of the diurnal variations in many different places, it is no longer possible to propose a quasistatic model of the F-layer. This is confirmed by the daily variations at unusual stations such as Halley Bay which show no normal dependence of critical frequency or layer height on the solar zenith angle. The theory of this phenomenon seems clear, namely that the coupling between the neutral atmosphere, electrons and ions is related to the magnetic and electric fields, even if some of the details still require investigation.

One of the main aims of the IQSY was to study the ionosphere under conditions which were not complicated by a high level of solar activity. An example was the variation of the critical frequency of the Fl-layer in subequatorial latitudes. During sunspot maximum, the variation of critical frequency is not simply related to the solar zenith angle but is asymmetric with respect to noon although at sunspot minimum the Fl-layer behaves as normally at these latitudes as at higher latitudes.

Most important of all, the knowledge of the ionosphere above the F-layer peak has been improved. It is known, from topside sounders and from the improved interpretation of Thomson scatter observations, that the structure of the topside is equally as complex as that of the lower side. The instability of the boundary of the auroral zone and of the geomagnetically controlled equatorial trough are surprising facts. Certainly it is not yet possible to separate time and space dependent variations and to understand the fine structure (details) in the auroral zone.

The new knowledge about the boundary between the magnetosphere and interplanetary space has shown that external energy in the form of gravity waves is transferred into the ionosphere. It is fairly certain that, in general, gravity waves play an important role in the energy balance and the dynamics of the ionosphere, even if their existence has been clearly demonstrated by experimental methods on only one occasion.

Even though no satisfactory network of ionospheric observations under 100 km was established, nevertheless important results about the electron density profile between 60 and 100 km and its time and space variations were obtained. In this way it was confirmed that the so called "winter anomaly„ in absorption is caused by an appreciable increase in the electron concentration in the D-layer. A coupling with stratospheric events is assumed to exist, although the origin of this dependence is not yet known. The region in which the winter anomaly occurs in the Northern Hemisphere extends from 35° to 60° latitude.

A full explanation of the sporadic E-layer did not emerge during the IQSY, even though simultaneous meteorological and ionospheric observations strongly suggest that in many cases wind shears play an important role.

As for observations of the lower ionosphere, it was also not possible to establish a world-wide network of ionospheric drift stations. The observations made at a few places show that tidal movements are important but that there is no obvious fundamental difference between the drift at high and low solar activity. On the whole, the results on drifts in the E-layer inspire much more confidence than those for the F-layer in which on the other hand measurements would be especially valuable for confirming theoretical ideas.

It should be possible to make important advances in the theory of layer formation now that, after the end of the IQSY, large quantities of data are available which make clear the influence of the local time and of the solar cycle. In addition, measurements were made over a broad frequency range of the intensity of the ionizing solar radiation and of the electron and ion temperatures in the ionosphere.

Speculations about an appreciable flow of charged particles between the exosphere and the ionosphere could certainly not be confirmed, but it seems that such a flow exists.

The roles of heat conduction and convection between energetic photoelectrons, ions and neutral gas was studied and their application to the F-layer initiated. The hypothesis that, in addition to electric fields, movements of neutral gases play an important role in the F-region has been strengthened and thereby the equatorial anomaly and the maintenance of night time ionisation explained.

For radiocommunications, the IQSY has led to improved ionospheric forecasts. The discovery of the declination effect in the F-layer and the dependence of scattering near the MUF made it possible for better agreement between predicted and actual values to be achieved.

For the post-IQSY period, there remains a wide range of important problems to be resolved; the coupling between the ionosphere and the regions above and below it is one of the problems that must be solved if the atmosphere as a whole is to be understood. The way in which the energy of the solar wind reacts on the ionosphere and the role played by the radiation belts is only partially understood. The interactions between the mesosphere and the ionosphere are also of interest in both meteorology and aeronomy. The methods of observation must be adapted so that, instead of long-term synoptic programmes, more emphasis is placed on special investigations of shorter duration. It would certainly be a mistake if the world-wide network of observing stations were to be materially reduced. But the quality of the vertical indicence stations must be improved so that sufficient accurate electron density profiles can be obtained from their records.

A most important lesson of the IQSY is that rocket observations have only a very limited value unless there are sufficient simultaneous observations of different kinds from nearby ground stations. This led, during the IQSY, to an important strengthening of cooperative interdisciplinary work which should be regarded as essential during the past IQSY period.

18 January 1968.

PUBLICATIONS

Reflex Klystron Circuits

" The operation of the reflex klystron oscillator has already been studied by many authors. In several papers, the operating conditions of klystron oscillators with single-cavity load, and problems of power, electronic and mechanical tuning, etc. are also dealt with. Single-cavity klystron modulators have also been studied by a few authors. The principal problems in this field are already solved. On the other hand, many aspects concerning the operation, design and adjustment of the coupled-cavity klystron oscillators and modulators are so far but little understood, and papers in this field provide only qualitative results.

„ This book ([1]) presents a new, unified treatment of the circuits associated mainly with coupled-cavity klystron oscillators and modulators. The transfer characteristics of the circuits are evaluated in terms of circuit parameters. Circuit operation is analysed and useful design formulae derived. Processes within the klystron tube itself are not dealt with and only circuit applications are treated. „

* * *

Activities of Abstracting and Indexing Services in 1965

" As indicated by its title, this Report ([2]) gives detailed information about the main abstracting and indexing services which are members of the ICSU Abstracting Board: Referativnyi Zhurnal, Bulletin Signalétique, Chemical Abstracts Service, Biological Abstracts, Physikalische Berichte, Chemisches Zentralblatt, Astronomischer Jahresberichte. The number of periodicals scrutinized, non-periodical literature covered, number of abstracts published, abstracting and indexing practices, use of computers, etc. are described and compared with comments.

([1]) Tibor Berceli; *Reflex Klystron Circuits,* 138 pp, $6.50 (Akadémiai Kiado, Budapest, 1967).

([2]) *Compared Activities of the Main Abstracting and Indexing Services covering Physics, Chemistry and Biology during the Year 1965;* 83 pages, US $5.00 plus mailing charges (ICSU Abstracting Board, 17 rue Mirabeau, Paris 16, France, December 1967).

Geophysical Measurements

Nearly 11 years ago, the opening of the IGY observational programme marked the beginning of an unprecedented series of cooperative geophysical measurements in all parts of the world. Although the First and Second Polar Years were regarded as prototypes of the IGY, the much larger scale of the programmes and the greatly increased international participation during 1957-1958 made the IGY stand out as a landmark in science.

One of the most successful features of the IGY was the way in which the programmes of measurement and the techniques employed were coordinated and unified in such a way as to ensure that all the data obtained would be comparable with each other. The resulting IGY Manuals laid down common standards to which observers in all countries could adhere. In the light of the experience gained during and after the IGY, the Discipline Reporters of the Special Committee for the IQSY found it necessary to revise and modify the material given in the IGY Manuals. The new IQSY Instruction Manuals were widely used during 1964-1965, as were the IGY Manuals in the 1957-1958 period.

After the IGY it soon became clear that geophysical observers recognized the value of maintaining certain programmes of measurement on a long-term basis, and they continued to use those recommended in the IGY Manuals. The experience after the IQSY has been similar and the Inter-Union Commission for Solar-Terrestrial Physics has recently stressed the essential role which synoptic programmes will play in the series of special projects at present being planned for the next few years.

The IQSY Instruction Manuals will provide an essential basic guide to the recommended types of synoptic programme. For this reason their recent publication, in collected form, as the first volume in Annals of the IQSY is opportune ([1]). In addition to reproducing the text of the IQSY Manuals, this volume includes also the text of the WMO/IQSY Reports, on meteorological measurements, which formed the counterpart of the IQSY Manuals on a number of geophysical and astronomical programmes of measurement. It is worth noting that the instructions for the successful Proton Flare Project have also been reproduced even though they were not issued in the series of IQSY Manuals. Highly organised

([1]) *Annals of the IQSY,* Vol.1. Geophysical Measurements: Techniques, Observational Schedules and Treatment of Data; Ed. C.M. Minnis, XVIII and 398 pp. (The MIT Press, Cambridge, Mass., and London, England, 1968).

projects of this type, having limited objectives and restricted specialist participation, seem likely to be of increasing importance in future international cooperative programmes in which several of the URSI Commissions will be able to make valuable contributions.

Collaboration URSI - CCIR

L'URSI déploie à l'heure actuelle des efforts tout particuliers en vue de l'étude attentive des différents problèmes qui lui ont été renvoyés par le CCIR. Un certain nombre de petits groupes de travail et de chercheurs ont présenté des documents relatifs aux Rapports, aux Questions et aux Programmes d'Etudes du CCIR. Ces documents font actuellement l'objet d'une dernière rédaction à Bruxelles avant d'être soumis à l'approbation du Bureau de l'URSI; ils seront ensuite officiellement transmis au CCIR à la fin du mois de février 1968.

Les Commissions d'Etudes V, VI et VII du CCIR se réuniront à Boulder, Colorado, en juillet 1968 et l'on espère qu'il sera possible de former un groupe non-officiel de conseillers de l'URSI. Les membres des Comités nationaux de l'Union qui projettent d'assister aux réunions de Boulder, en tant que membres de délégations nationales ou en toute autre qualité, et qui accepteraient de faire partie de ce groupe non-officiel, sont instamment priés d'en informer d'avance le Secrétaire général de l'URSI.

26 février 1968.

Meetings

URSI - CIG and URSI - STP Committees

The Minutes of the last meeting of the URSI-CIG Committee are reproduced below. The Committee terminated at the end of 1967 and was replaced by he URSI-STP Committee which will provide the necessary link between URSI and the Inter-Union Commission for Solar-Terrestrial Physics. The terms of reference of the new Committee, as agreed at the General Assembly of URSI in 1966, are given in the Appendix which follows the Minutes of the URSI-CIG Committee meeting.

MINUTES OF SEVENTH MEETING

The seventh and final meeting of the URSI-CIG Committee was held in London on 21 July 1967 during the IQSY/COSPAR Assembly. The following members were present:

Prof. W.J.G. Beynon (*Chairman*)
Mr. G.M. Brown (*Secretary*)
Prof. W. Dieminger
Prof. C.O. Hines
Prof. E.A. Lauter
Mr. W.R. Piggott
Prof. K. Rawer
Mr. A.H. Shapley

and the following attended by invitation:

Prof. S.A. Bowhill
Mr. F. Du Castel
Prof. J.W. Dungey
Mr. R.W. Knecht
Dr. Mednikova
Dr. G.M. Pillet

The main purpose of the meeting was to receive interim reports on the activities of certain Working Groups set up on the recommendation of URSI Commission III at the Munich Assembly and asked to report at the time of the London IQSY Assembly. The occasion was also taken to consider other matters arising from the Minutes of the last meeting of the Committee.

1. — Working Group Interim Reports

(*a*) *On Topside Ducting* (Reference: Rec. III.3, Munich, 1966).

Mr. F. du Castel, secretary of the Working Group, presented the first draft of a report on propagation by ducting above the ionization maximum of the F region. This report was to be submitted to Dr. J.H. Chapman for comment, and the final version would be agreed by Mr. Piggott, Mr. du Castel and Dr. Chapman. This would constitute URSI's reply to CCIR Question 316 (VI) (Doc. VI/1025, Oslo, 1966) and would be communicated to CCIR via Prof. Beynon by February 1968. The Working Group would revise the reply, if nesessary, for final presentation at the XVI General Assembly of URSI.

(*b*) *On the Distribution and Location of Ionosphere Sounding Stations* (Reference: Rec. III.5, Munich, 1966).

Mr. W.R. Piggott reported that he had sent out various documents and a questionnaire, and the replies so far received showed much uniformity on most points. There was a general feeling that the vertical soundings network was now about the right size, although there are particular areas where more stations and more intensive work are needed. For most networks the situation is now organized to such an extent that the people who design the equipment, operate the equipment, and use the data are almost completely independent. There is a need for a semi-automatic ionosonde which would provide reliable and usable data under normal conditions at difficult locations.

Prof. K. Rawer pointed out that from the CCIR viewpoint it is important to have long-lived stations. Some stations ought to be maintained for periods of the order of a century. At present there is a real lack of long-term synoptic observations. The use of topside data also needs consideration: there is a wealth of data but it is not suitable for CCIR purposes in its present form.

Prof. S.A. Bowhill recommended a closer liaison between closely spaced stations, especially in areas of particular interest, so that one station might be able to deputise for another which was temporarily out of action.

It was agreed that Mr. Piggott would prepare a report, including detailed recommendations, in time for submission to the meeting of CCIR Study Group VI scheduled for the summer of 1968.

(*c*) *On the Need and Practicability of a Reference Ionosphere* (Reference: Rec. III.6, Munich, 1966).

Prof. S.A. Bowhill stated that discussions were to be held during the COSPAR Meeting following the IQSY Assembly, and a report would be prepared subsequently.

(*d*) *On the Analysis and Reduction of Ionospheric Drift Data* (Reference: Rec. III.7, Munich, 1966)

No report was available in the absence of Prof. R.W. Wright, but it was known that Prof. Wright had been active in circulating a questionnaire, and also that he was hoping to arrange for a meeting of the members of the Working Group at the time of the Symposium on Ionospheric Drifts planned in association with the IAGA Assembly in September 1967.

(*e*) *On the Analysis and Reduction of Ionospheric Absorption Data* (Reference: Rec. III.10, Munich, 1966)

Prof. K. Rawer undertook to contact Drs. Schwentek and Belrose to invite them to prepare the texts for methods A3 and A4 respectively, suggested in the Commission III Resolution. Prof. Lauter stated that he would try to prepare his A3 manual by February 1968.

Mr. A.H. Shapley reported that Dr. C.G. Little wished to be relieved of the office of Reporter for A2, and it was agreed that Dr. G.C. Reid be invited to serve in his place. Dr. A.P. Mitra had been approached and agreed to help draft a new A2 manual. Prof. Rawer agreed to look into the possibility of preparing a new A1 manual.

2. — Publications

Mr. A.H. Shapley reported that plans for the publication of the *Revised Atlas of Ionograms* were proceeding. It would be published as an international communication from WDC (Boulder).

It was also stated that the *N(h) Monograph* was due to be published in either the October or November issue of the journal " Radio Science ".

The Chairman expressed the appreciation of the Committee to ESSA, Boulder, for the production of this very valuable monograph.

Mr. G.M. Brown reported that he had prepared the *Index to all IGY Ionospheric Data* published in the " IGY Annals „ as requested at the last meeting of the Committee. This had been circulated to all members, and published in *URSI Information Bulletin* No. 160 (Jan-Feb. 1967), pp. 48-54.

Prof. K. Rawer stated that his collection of *Details of IQSY Ionosondes* was almost complete, and it was hoped to publish it in the final number of " IQSY Notes „. If this proves impossible it would appear either in the URSI Information Bulletin or in the Revised Atlas of Ionograms.

3. — Sub-Committee on Data Processing

Prof. K. Rawer stated that Dr. Bibl was preparing a report which would be circulated to the members for comment. A final report would be prepared by the time of the XVI General Assembly of URSI.

4. — Post-IQSY Studies

Prof. W. Dieminger mentioned two further proposals for special post-IQSY study, concerned with the South American geomagnetic anomaly and the equatorial anomaly. There are German and French plans to make detailed ocean and airborne ionosonde studies of the equatorial anomaly at the next period of sunspot maximum. It was agreed that details of specific proposals with regard to vertical sounding special studies and/or particular stations should be sent direct to the Vertical Soundings Reporter, Mr. W.R. Piggott.

5. — URSI-STP Committee

Prof. W.J.G. Beynon stated that this was the last meeting of the URSI-CIG Committee as such. He reminded members of the actions taken by the URSI Executive Committee at the XV General Assembly in Munich, by which the URSI-CIG Committee would be terminated at the end of 1967 when the CIG and the Special Committee for the IQSY were dissolved, and a new URSI-STP Committee would be formed to maintain liaison with the IUCSTP. Prof. Beynon gave details of the terms of reference and of the membership of the new Committee, and of its Sub-Committees. These are reproduced in the Appendix below.

Geoffrey M. Brown
Secretary

APPENDIX

URSI COMMITTEE ON SOLAR TERRESTRIAL PHYSICS (URSI-STP Committee)

The URSI Executive Committee, meeting during the XV General Assembly of URSI in Munich in September 1966, agreed that the URSI-CIG Committee should be dissolved in 1967 at the time of dissolution of the CIG and of the Special Committee for the IQSY. It was further agreed that a new URSI Committee on Solar Terrestrial Physics, to be known as the URSI-STP Committee, be formed to provide the necessary liaison with the ICSU Inter-Union Commission on Solar Terrestrial Physics (IUCSTP), with the terms of reference and membership as set out below. The URSI-STP Committee is empowered to establish Sub-Committees on such topics as may be specified from time to time.

Terms of Reference

1. To cooperate with the IUCSTP in all matters relating to URSI in the field of solar terrestrial physics.
2. To coordinate the activities of those URSI Commissions which are especially concerned in the field of solar terrestrial physics.
3. To deal with all matters referring to the IGY and IQSY formerly considered by the URSI-CIG Committee, including the flow of data to WDCs and the publication of data, including the IGY and IQSY data, in the field of radio science.
4. To integrate URSI special programmes of research to be planned under the IUCSTP, and to coordinate and present the views of URSI on symposia in the solar terrestrial physics field.

Membership

The formal members of the URSI-STP Committee shall be

(i) A Chairman and Secretary.
(ii) The Chairmen and Vice-Chairmen of Commissions II, III, IV, V and VIII.
(iii) The Chairmen of the Sub-Committees of the URSI-STP Committee.
(iv) Members of the IUCSTP who are active in URSI.

The Chairman of the URSI-STP Committee shall be nominated by the Executive Committee. It is suggested that when appropriate one of the Vice-Presidents of URSI should be nominated for this office.

The Members of the Committee as constituted from 1 January 1968 will be:

Prof. W.J.G. Beynon (*Chairman*)
Mr. G.M. Brown (*Secretary*)
Dr. G.M. Allcock
Dr. J.E. Blum
Prof. H.G. Booker
Prof. J.W. Dungey
Prof. W.E. Gordon
Prof. C.O. Hines
Mr. F. Horner
Dr. C.A. Muller
Dr. K. Rawer
Dr. R. Rivault
Dr. J.A. Saxton
Mr. A.H. Shapley

Sub-Committees

Initially, three Sub-Committees of the URSI-STP Committee are established, with the following membership.

Sub-Committee on "*Ionosphere* „

K. Rawer (*Chairman*)
S. Bowhill
W. Dieminger
E.A. Lauter
C.G. Little
W.R. Piggott
A.H. Shapley
R.W. Wright

Sub-Committee on "Synoptic Whistlers„

G.M. Allcock (*Chairman*)
R. Barrington
W. Campbell
D. Clarence
R. Gendrin
R.A. Helliwell
F. Horner
A. Kimpara
E.A. Lauter
Y. Likhter
J. Lokken
M.G. Morgan
J. Mrazek
R. Rivault
V.A. Troitskaya
E. Ungstrup
H.C. Webster

Sub-Committee on "Radio Science Data Centres„

A.H. Shapley (*Chairman*)
N.P. Benkova
I. Kasuya
J. W. King

URSI—STP COMMITTEE

Working Group on Ionospheric Drift Reduction

At the General Assembly of URSI in Munich in 1966 Commission III recommended that the URSI-STP Committee set up a small continuing Working Group under the Chairmanship of Prof. R.W.H. Wright to study and make recommendations on the analysis and reduction problems encountered in the various methods of measuring ionospheric drifts. The detailed terms of reference of the Working Group are set out in the Annex to Recommendation III.7 published in *URSI Information Bulletin* No. 159, p. 26-27.

The Working Group held its first meeting in Appenzell, Switzerland, on October 5-6, 1967, immediately following the URSI-IAGA Symposium on Upper Atmospheric Winds, Waves, and Ionospheric Drifts held in St. Gallen, Switzerland, on October 3-4, 1967. Six of the seven members of the Working Group were present, together with twelve additional consultants.

The meetings were divided into four half-day sessions devoted to the following topics: Report on the conclusions of the St. Gallen URSI/IAGA Symposium; Consideration of method D1; Description of some D1 results and the minimum programme for a D1 station; Special experiments and recommendations. The general conclusion drawn from the papers presented at the Symposium was that although the evidence for the existence of *winds* was convincing for the lower ionosphere, probably up to the turbopause, there was strong evidence for *waves* above this level. Prof. Hines summarized the theoretical position, and outlined the various sources of atmospheric gravity waves. Mr. J.W. Wright gave a summary of the different methods of analysis used in the D1 method, and these were discussed in detail, together with the results of specific experiments carried out by members. Outline requirements for routine station operation using both the similar fades and the full correlation methods were drawn up. The various comparisons possible between the different methods D1, D2, D3, D4, and chemical trail experiments were discussed and certain worthwhile special experiments were recommended.

A full report on the meetings and the details of the Recommendations agreed by the Working Group will be prepared by Professor Wright and published in a later issue of the *URSI Information Bulletin*.

Geoffrey M. Brown
Secretary, URSI-STP Committee

Inter-Union Commission on Radio Meteorology

REPORT OF BUSINESS MEETINGS 28 AND 30 SEPT. 1967 AT XIV GENERAL ASSEMBLY OF UGGI — LUCERNE, SWITZERLAND

1. — Participants

Present: R. Bolgiano, Jr. (*President*), D. Atlas (*Secretary*), B.R. Bean, K. Brocks, F. Eklund, J.S. Marshall, T. Asai (representing Naito), E.T. Pierce, G.D. Robinson and J.A. Saxton.

Absent: V.I. Tatarsky, P. Misme

2. — Installation of New Officers

Profs Bolgiano and Atlas were installed as President and Secretary, respectively.

A unanimous vote was made to express appreciation to the outgoing officers, Prof. Marshall and Dr. Saxton, for their considerable efforts on behalf of IUCRM during the years 1960-1967. The accomplishments of the Commission during that period are due in large part to their initiative.

3. — Major Activities : 1963-1967

(*a*) Participation in Comm. II Scientific Program — XIV General Assembly — URSI, Tokyo, Sept. 1963.

(*b*) 1964 World Conference on Radio Meteorology (with the 11th Weather Radar Conference) — Boulder, Colo., Sept. 1964.

(*c*) Colloquium on the Fine-Scale Structure of the Atmosphere and its Interaction with Electromagnetic Waves. Moscow, June 1965.

(*d*) Participation in Comm. II Scientific Program. XV General Assembly — URSI, Munich, September 1966.

(*e*) Convening of special session on Radar Measurements of Precipitation — XIV General Assembly — UGGI, Lucerne, Sept. 1967.

Principal Comments

It was generally agreed that the 1964 Boulder Conference was superior to the 1953 Texas Conference on Radio Meteorology with respect to interdisciplinary contacts and cross-fertilization. However, the lack of a more restricted scientific focus tended to diffuse the interest somewhat. The 1965 Moscow Conference was thought to be more successful in this regard. It focused essentially on a single topic and brought both atmospheric and radio scientists together in a more intimate contact and comprehensive coverage of mutual interest. One objection to the Moscow meeting was the great delay in communicating the results to the community at large. Although a fairly comprehensive summary of the conference appeared in the April 1966 Supplement to *URSI Bulletin* No 155, this bulletin is not widely available. However, Drs A.M. Yaglom and V.I. Tatarsky of the Institute of Atmospheric Physics, USSR Academy of Sciences, took the initiative to edit and produce a complete proceedings of the conference, which has now been published. IUCRM expresses its appreciation to the USSR Academy of Sciences and to Drs Yaglom and Tatarsky for this fine volume. (The volume is entitled " Atmospheric Turbulence and Radio Wave Propagation ,,, Nauka Publishing House, Moscow. It is suggested that requests for the Proceedings be made through our Soviet Member, Dr. V.I. Tatarsky, Institute of Atmospheric Physics, Pizhevsky 3, Moscow Zh-17, USSR).

4. — TERMS OF REFERENCE OF IUCRM AND RELATIONSHIP TO PARENT BODIES

(*a*) *Broad Objectives:* The Commission reviewed the objectives of IUCRM with particular regard to those set down at the 1961 Paris meeting. It was agreed that the realms of concern should remain essentially the same except that " radio propagation ,, should now be considered to be " electromagnetic propagation ,, and " meteorology ,, should be defined to include the " dynamics and physics of the fluid atmosphere up to the turbopause (approx. 100-110 km) ,,, the level below which mixing processes control the composition, and above which diffusion is dominant. Prof. Marshall voiced the opinion that our concern should be with coherent EM waves. However, subsequent discussion indicated that radiometric and incoherent optical techniques were rightfully within our scope of interest. Restated accordingly, the Commission is concerned primarily with:

A. aspects of meteorology (as defined above) which affect the propagation of electromagnetic waves in the earth's atmosphere and through planetary atmospheres, and

B. application of electromagnetic techniques to meteorology.

The Commission wishes to draw attention to the advances in understanding of a wide range of atmospheric phenomena, especially on the small and medium scales, to which remote EM sensors may be expected to contribute significantly in the near future. These include measurements of temperature and density (especially from satellites), winds, and clear air turbulence, among others. (It was recognized that the Commission's name did not now fully reflect the increased scope of concern, but no action was taken to change it).

(*b*) *Relationships to Parent Unions:* For purposes of clarification, Dr. Saxton noted that URSI is concerned primarily with electromagnetic wave phenomena in the broadest sense, and URSI Commission II was explicitly concerned with propagation through non-ionized media. On the other hand, IAMAP (UGGI) is broadly concerned with all aspects of meteorology and atmospheric physics, and deals with EM techniques only insofar as they constitute methods for probing the atmosphere. Thus, it was the explicit task of IUCRM to bridge the gap between the realms of interest of the two parent unions. In particular, it is our task to assist the EM scientists of URSI in understanding the atmospheric influences on propagation, and to assist atmospheric scientists in employing EM techniques as a means of probing the atmosphere. Recognizing the limitations of IUCRM, and the fact that certain realms of scientific activity which are valid interests of the Commission (such as atmospheric electricity and aeronomy) were being adequately covered by various commissions of the parent unions, Prof. Bolgiano recommended that IUCRM could contribute most significantly, at the present time, by emphasizing the common interests of URSI Commission II and IAMAP.

Dr. Saxton also noted our relationship to CCIR (International Consultative Committee for Radio). In essence, CCIR looks to the scientific unions (and to IUCRM) for assistance and guidance in areas of basic research.

(*c*) *Scientific Advances since 1961:* In order better to define the specific areas of interest of IUCRM, note was made of some of the most important advances in the last six years. Among the most prominent are developments in the following:

1. Space communications
2. Meteorological satellites
3. Methods for remote probing of planetary atmospheres (especially from satellites)
4. Lasers and the entire realm of coherent light
5. Millimeter wave techniques
6. Direct and (ground-based) remote sensing techniques, i.e., refractometry, constant level balloons, etc.

7. Knowledge of tropospheric-ionospheric coupling, with special regard to the role of gravity waves
8. EM path-length and phase measurement techniques as applied to geodesy and atmospheric research
9. Radiometric techniques (due especially to new millimeter wave components at wavelengths around the atmospheric absorption bands)
10. Ultra-powerful multi-wavelength radar techniques for probing the clear atmosphere
11. Phase-coherent techniques in tropo-scatter research
12. Computer techniques applicable to all of the above.

(*d*) *Specific Scientific Terms of Reference:* After some discussion it was decided to include the following topics as those with which IUCRM should be concerned:

A. — Meteorological Effects on EM Propagation

1. The structure of refractivity (including spectral distribution, intensity, and geometrical patterns) at all wavelengths.
   (i) systematic synoptic and climatic patterns of refractivity such as those associated with stratified layers and fronts;
   (ii) quasi-systematic patterns such as those associated with air mass convection and cumulus-cloud regimes;
   (iii) random patterns as envisaged in turbulent scattering;
   (iv) special patterns as associated with gust and sea breeze fronts, convective cloud boundaries, etc.
2. The distribution of absorbing and scattering media affecting all wavelengths (down to and including optical); i.e., gaseous constituents, aerosols, dust, clouds, rain, and hail.
3. Electrical storms and atmospheric electricity (See Notes 1 & 4).
4. Tropospheric-Ionospheric coupling (See Note 2)
5. Atmospheric effects on space communications
6. Winds, turbulence, and convective motions in the fluid atmosphere.

B. — Meteorological Applications of EM Techniques

1. Microwave refractometers and other fine-scale, rapid response instruments for the measurement of atmospheric refractivity, temperature, humidity, and their spectral characteristics.
2. Radar observations in relation to
   (i) precipitation physics;

(ii) lightning and thunderstorm electrification (see Note 3);

(iii) refractivity structures in the clear atmosphere;

(iv) winds and turbulence, by Doppler techniques, using both natural and artificial tracers.

3. Location of lightning and thunderstorms by EM techniques (see Notes 3 & 4).
4. Radiometry — Infrared to microwaves.
5. Meteorological interpretation of propagation phenomena in terms of refractivity structure and motions.
6. Meteorological interpretation of absorption, scatter, and emission phenomena in terms of the structure and intensity of refractivity, clouds, precipitation, aerosols, gaseous constituents, etc.
7. Planetary atmospheric experiments.
8. Coherent optical and sub-millimeter techniques.

Statements elaborating upon some of the above terms of reference are presented in the following notes. These notes are included to provide the full context of our deliberations.

NOTE 1, Item A-3: Electrical Storms and Atmospheric Electricity (Statement by Dr. E.T. Pierce)

The 1961 reference to " lightning (by the interferences it creates) „ was concerned with the complications in the reception of radio signals produced by the radio noise emitted by lightning. It is now becoming increasingly evident that radio emissions are generated by thunderstorms even when lightning is not occurring. Such noise is also emitted from highly electrified shower clouds which never develop into thunderstorms. Hence the broader term " Electrical Storm „ rather than " Lightning „. A secondary reason for the change is that it permits consideration of possible coupling effects in which the massive convection of a thunderstorm causes movements of the ionosphere above.

The inclusion of " Atmospheric Electricity „ in our new terms of reference is in recognition of the fact that the ions in the atmosphere at altitudes below some 50 km do influence radio propagation. This has been shown to be so, for instance, as regards VLF propagation and the characteristics of the Schumann resonances. There are likely to be further examples in the future of ways in which aspects of atmospheric electricity affect radio propagation.

NOTE 2, Item A-4: Tropospheric-Ionospheric Coupling (Statement by Dr. G.D. Robinson)

In the past few years indications have been found of interaction between the neutral lower atmosphere and the ionosphere. The formation and movements of the dynamical systems of the lower stratosphere responsible for the " sudden warming „ phenomenon are known to be closely correlated with certain features of ionospheric propagation. Sequential soundings by rockets sometimes show variations of atmospheric temperature and motion on the time scale of tropospheric weather systems, through the whole depth of the atmosphere to the upper limit of the soundings at about 65 km. Tidal and more transient internal waves propagating from below may have an influence on ionospheric phenomena such as sporadic-E. It therefore seems appropriate for the Commission to concern itself with the interaction of the lower atmosphere with the ionosphere: this implies interest in the state and motion of the atmosphere up to the turbopause and in processes for which the electromagnetic terms in the dynamical equations are negligible.

Exploration of the state of the stratosphere and mesosphere by EM radiation is increasing in importance. Examples are: (1) Detection of atmospheric inhomogeneities and turbulence by means of high power radar. (2) Temperature determination from the emission spectra of CO_2 and O_2 in the infrared and microwave regions as recorded by satellites. (3) Determination of the distribution of H_2O by this method. (4) Determination of the distribution of ozone from the absorption and scattering of solar radiation as observed by satellite. (5) Distribution of dust and density, and perhaps the distribution of H_2O by light scattering using laser-beams. The study and advancement of these techniques is an appropriate task of the Commission.

NOTE 3, Items B-2 (ii) and B-3: Radar and EM Techniques for Location and Studies of Lightning and Thunderstorm Electrification (Statement by Dr. E.T. Pierce)

Under Section B of its terms of reference, the IUCRM is concerned with the application of EM techniques to meteorology. Item B-2 (ii) covers radar studies of lightning. Although this field has been very inactive in the past few years it is recommended (following Prof. Marshall's lead) that B-2 (ii) be retained. This is because interest in lightning observations by radar should be encouraged and in any case, it is salutary for weather radar researchers to be reminded of the possible complications due to lightning.

Previously, Item B-3 read:

Radio-location of lightning

(i) by normal sferics techniques

(ii) by radar receivers.

It is now suggested that this should be changed to: Location of lightning and thunderstorms by electromagnetic techniques. The inclusion of thunderstorms is based upon some developing techniques (e.g., satellite-borne instrumentation) which are aimed at establishing the positions of thundery areas rather than locating individual flashes. The more general term, electromagnetic techniques, is preferred because of the possibility of optical sensors. No subdivisions are included under the new heading because of the large number of techniques presently being investigated. Among the more important of these are normal sferics networks, satellite sensors at VLF, HF, and UHF, and lightning-flash counters.

NOTE 4, Items A-3, B-2 (ii), and B-3 Role of the IUCRM in Reference to Atmospheric Electricity (Statement by Dr. E.T. Pierce)

There are two organizations presently giving signs of considerable activity in general and specific areas of Atmospheric Electricity. The first, associated with the UGGI, is the Joint Committee of Atmospheric Electricity (JCAE); this is a joint committee between IAMAP and IAGA (International Association for Geomagnetism and Aeronomy). The JCAE has a program covering all aspects of Atmospheric Electricity; it is systematically organized into nine (9) working groups. A conference under JCAE sponsorship is to be held in Tokyo, May 12-18, 1968.

The second association is Commission VIII of URSI on " Radio Noise of Terrestrial Origin „. Radio noise was dealt with in URSI by Commission IV until 1963. At the Tokyo General Assembly of URSI (1963), radio noise studies were degraded to the level of a sub-commission — IV.1. However, at the URSI General Assembly at Munich (1966) full commission status (Commission VIII) was restored. Commission VIII is on a semi-probationary status; presumably it has to demonstrate some signs of activity by the next General Assembly of URSI (Canada, 1969) in order that its status be maintained.

As far as can be assessed at present, these two organizations should be dealing adequately for the next few years with the topics in Atmospheric

Electricity of interest to the IUCRM. It is accordingly recommended that the role of the IUCRM in these areas, would be limited to a watching brief; we should encourage, coordinate, and suggest where and when appropriate, but do nothing more for the time being. One member (E.T. Pierce) of the IUCRM, is also a member of the JCAE, and US representative on Commission VIII of URSI; this should facilitate liaison.

5. — Mechanisms of Operation

The following mechanisms were thought to be the most useful means of fulfilling the Commission's objectives:

(*a*) Sponsorship of conferences and specialized colloquia both on broad and limited areas of radio meteorology. This includes the participation in meetings organized by institutions not directly associated with URSI or UGGI (subject to the conditions indicated in Note 5 below) by the convening of special sessions on topics of direct concern to IUCRM.

(*b*) The commissioning of survey papers and special reports or the assumption of organizational or editorial responsibility for monographs.

(*c*) The preparation of resolutions dealing with major problems to draw attention of the international scientific community to: (1) new opportunities for advancing knowledge, (2) special or major needs of scientific workers in the field, (3) notable gaps in our knowledge requiring emphasis, (4) educational requirements, and the like.

(*d*) The rapid exchange of scientific information prior to publication by means of periodic news-bulletins, and the preparation of an up-to-date bibliography on topics of IUCRM concern. However, the commission recognizes its limited capacity to undertake such a task and decided only to include any pertinent information in circular correspondence among its members.

(*e*) The preparation of a comprehensive list of institutes and research workers in the areas of special interest to IUCRM.

NOTE 5. Joint Participation of IUCRM in Meetings

IUCRM welcomes association with other organizations, including national groups or institutions, in the arrangement of the conferences and symposia, with the objective of enhancing the international participation in such meetings. However, if a national organization accepts the Commission as a full co-sponsoring partner, it must place no restriction on the nature of the Commission's participation unacceptable to it as a whole. In particular, no restrictions with regard to international representation can be made.

6. — Action Taken

In addition to the establishment of the revised terms of reference, the Commission took the following action.

(*a*) Accepted the invitation of Prof. J.S. Marshall to co-sponsor one or more sessions to be held at the 13th Weather Radar Conference (Mc Gill University, Montreal, Aug. 19-23, 1968) dealing with remote sensing techniques. Drs Atlas, Marshall and Saxton were appointed an ad hoc committee to coordinate IUCRM's participation. Dr. Marshall was designated chairman.

(*b*) Appointed Drs Bean and Bolgiano as an ad hoc committee to investigate possible IUCRM participation in the next Boulder Conference on the Atmospheric Effects on Optical Propagation.

(*c*) Voted to convene a specialized colloquium, with limited participation, on the Properties of the Spectra of Meteorological Variables Determined by Various Means (See Note 6 below). Probable time — 3rd week of June 1969, Place — 1st choice: Stockholm; 2nd choice: Slough, England. Drs Bean, Eklund, and John Lane (consultant) were appointed as the organizing committee, with Bean as chairman. Dr. Bean will seek to add Drs A.M. Yaglom or N. Vinnichenko (USSR) and Swinbank (Australia) to the organizing committee. The request to Drs Yaglom or Vinnichenko preferably should be made through our Soviet representative, Dr. Tatarsky. Dr. Bean will advise the Secretary of the amount of funds to be requested from URSI for expenses related to the meeting.

NOTE 6. Specialized Colloquium. Properties of the Spectra of Meteorological Variables Determined by Various Means

The radio meteorologist is concerned with the fine structure of the troposphere, particularly with regards to humidity, to a degree of precision not normally called for in atmospheric studies. The result of this concern is a growing body of observational and theoretical results which allows us to speak to the question: " What are the spectral properties of atmospheric temperature, humidity, refractive index and wind under varying conditions of height, underlying terrain, and atmospheric stability? „ It will be particularly important to search for relationships of these spectral properties to the profiles of the mean quantities, thus allowing a degree of prediction, from the normally available meteorological measurements especially in layers. An additional question concerns the relationship of these measurements at a point in space to the integrated values obtained by various radio, optical, and infrared techniques.

It is therefore proposed that a work shop of 20 to 25 people convene in a retreat for one week to ten days for consideration of these questions with the subsequent publication of a proceedings with the minimum possible delay.

(*d*) Recommended consideration of a conference on atmospheric radiometry to be held in 1970. No action was taken.

(*e*) Voted to appoint Mr. John Lane (England) and Dr. W.C. Swinbank (Australia) as long-term (3 year) consultants to IUCRM. Also recommended Drs. A.A. Chernikov (USSR), Colin Hines (Canada), Earl Gossard (USA), Marx Brook (USA) and Dr. Fred Horner (England) as *possible* consultants, but action was not completed. The need was expressed for a specialist-consultant in laser propagation. (Recommendations are solicited.)

(*f*) Resolutions

(1) Adopted the following resolution initiated by Prof. J.S. Marshall:

Resolution: Radar Returns from Birds and Insects

Radio meteorologists, particularly in the use of weather radar, sometimes observe birds and clouds of insects, seldom by intention. At times these biological targets are helpful as meteorological tracers, while at other times they are undesirable items of background noise. The use of this sort of observation by biologists is much less developed than, say, radar observations of precipitation. The Inter-Union Commission on Radio Meteorology might logically eschew responsibility for such targets, because its terms of reference do not extend to the biological. At this stage, however, it will be for the general good of the Commission to adopt a constructive attitude toward the exploitation of radar, and possibly of radio observations, for information about birds and insects.

Be it RESOLVED that the Commission adopt a helpful attitude toward radar ornithology and radar entomology, and take initiative in these matters. Be it further RESOLVED that URSI should notify the appropriate biological union(s) of this attitude.

(2) Deferred action on a resolution by Prof. D. Atlas concerning the need for major new facilities for radar and tropo-scatter probing of the

clear atmosphere. The resolution will be redrafted and submitted to IUCRM members for comment and modification and subsequent vote by mail. (Reproduced below.)

7. — ITEMS NOTED

(*a*) The Commission was advised that the US National Academy of Sciences is considering the convening of a 1968 study (working) group on long range needs in remote atmospheric probing. The Commission President stands ready to offer the services of IUCRM in the form of guidance and participation provided the results of the study are open to all nations.

(*b*) The Commission took note of the Advanced Summer Study Institute in Radio Meteorology to be held in Canada some time prior to the URSI 1969 conference. However, IUCRM declined participation because the Institute is restricted to a limited group of nations.

(*c*) The Commission noted the following pertinent meetings to be held in 1968:

(1) Conference on Atmospheric Electricity — Tokyo — May 12-18, 1968 under sponsorship of the Joint Commission on Atmospheric Electricity of IAMAP and IAGA.

(2) Meeting on radiation measurement techniques being planned by the Radiation Commission of IAMAP for August or September 1968 in Bergen, Norway.

(3) 13th Weather Radar Conference, McGill Univ., Montreal, Canada, Aug. 19-23, 1968.

(*d*) Dr. Saxton will be in touch with us shortly regarding our suggestions for the URSI Commission II program for the 1969 General Assembly in Canada.

Respectfully submitted,
David Atlas
Secretary, IUCRM

* * *

Resolution: On the Need for Major New Facilities for Remote Atmospheric Probing and Radio Meteorology

The Inter-Union Commission on Radio Meteorology

noting:

(1) that great progress has been made during the past decade in the appli-

cation of radio and radar techniques to atmospheric probing and that these techniques now provide a most powerful tool for research in atmospheric physics; and

(2) That prominent amongst these techniques is the use of high-resolution multi-wavelength radars for the detection, mapping and measurement of fine- and medium-scale patterns of refractivity in the clear atmosphere and, using Doppler methods, for the remote measurement of atmospheric motions. Further, that the measurement of both clear air refractivity structures and their motions is facilitated by the use of advanced bistatic tropospheric-scatter systems employing phase-coherence for Doppler measurements and multipath delay discrimination to provide fine spatial resolution;

and believing

that it is important that these techniques should be exploited to the maximum extent possible in the pursuit of a fuller understanding of the physics of the lower atmosphere and that equipment designed primarily for such applications is necessary:

therefore resolves:

to request the parent unions URSI-UGGI to give their strong support to research programmes based on the radio and radar techniques described above and to encourage on as wide a scale as possible the provision of the necessary facilities.

Conférence sur les Mesures par Lasers

24-26 septembre 1968, Varsovie, Pologne

Première Annonce

Sur l'invitation du Comité national polonais de l'URSI et de l'Académie polonaise des Sciences se tiendra à Varsovie du 24 au 26 septembre 1968 la Conférence sur les Mesures par Lasers, sous le patronage de la Commission I de l'URSI.

Les sujets des débats seront les suivants:

1. Mesure des caractéristiques physiques des matériaux de lasers, modulation, etc.

2. Mesure des propriétés de radiation des lasers.

3. Application des lasers aux étalons et aux constantes physiques.

Information concernant l'organisation de la Conférence:

Les droits d'inscription à la Conférence sont de $ 30 environ par personne. Pour tout autre renseignement s'adresser au:

Secrétaire du Comité d'Organisation, Dr.S.Hahn,
Comité national polonais de l'URSI,
Świetokrzyska 21,
Varsovie, Pologne.

Standard Frequencies and Time Signals from Station ZUO

(Information, dated 27 February 1968, provided by the South African National Committee for URSI)

Radio transmissions of standard frequencies and time signals were commenced from the Republic Observatory, Johannesburg, in 1950. Since then the accuracy has been steadily improved, and from 1st January 1961 it was found possible to maintain the time signals within approximately 1 millisecond of those of the other coordinated stations. Frequencies were kept within about 10 parts in 10^{10} until October 1966, when a caesium beam standard was installed which, together with an adjustable continuous phase shifter, made it possible to keep the deviation within 2 parts in 10^{10}. As from 1st April 1967 the carrier frequencies have been derived directly from the caesium beam standard, and they therefore have now the same accuracy as the standard itself.

The present characteristics of the transmissions are as follows :

TRANSMITTERS

from Johannesburg	(Lat. 26° 11' S., Long. 28° 4' E.)
(*a*) 10 MHz. Carrier power: 250 watt.	Antenna: Horizontal full wave
(*b*) 100 MHz. Carrier power: 50 watt.	Antenna: Omnidirectional
from Olifantsfontein	(Lat. 25° 58' S., Long. 28° 14' E.)
(*c*) 5 MHz. Carrier power: 4 kilowatt.	Antenna: Quadrupole.

OPERATION

Transmissions are continuous, except for an interruption between 15 and 20 minutes past each hour.

STANDARD RADIO FREQUENCIES

All carrier frequencies are derived from the caesium beam frequency standard at the Republic Observatory and are broadcast without offset.

STANDARD TIME INTERVALS AND TIME SIGNALS

The 5 and 10 MHz transmitters are amplitude-modulated by the time signals and morse code announcements.

Time signals consist of one pulse every second, each pulse consisting of 5 cycles of 1000 Hz tone. The first pulse in every minute is lengthened to about ½ second. They are derived from the same caesium standard which controls the carrier frequencies.

Morse code announcements are made during the minute preceding each quarter hour. They consist of the call sign ZUO (repeated 3 times) and the Universal Time at the next minute. In every case the beginning of a time pulse indicates the correct time. The morse code tone frequency is 606.06 Hz. On 5 and 10 MHz double side band modulation is employed, modulation of the first half cycle of each pulse being positive.

The 100 MHz transmitter is primarily intended as a link between the Republic Observatory and Olifantsfontein, but a useful signal can be received in many parts of the Johannesburg-Pretoria area. It is frequency-modulated by a 100 kHz subcarrier, which in turn is amplitude-modulated by the time signals and morse code announcements. The 100 kHz sub-carrier controls the carrier frequency of the 5 MHz transmitter. The delay of the pulses on 5 MHz with respect to those on 10 MHz is of the order of 0.2 millisecond.

STANDARD AUDIO FREQUENCIES

No continuous frequencies are broadcast, but in many cases the interrupted 1000 Hz tone which constitutes the time signal pulses may be used as a standard frequency.

ACCURACY

On 18th November 1966 the ZUO time signals were compared with those of a portable caesium clock from the U.S. Naval Observatory (Washington), and were phased to coincide to within a microsecond. On the same occasion the frequency of the local caesium beam standard was found to be 6×10^{-12} low with respect to the USNO standard.

This was repeated on 9th October 1967 by the Hewlett-Packard Company, and again in February 1968 by the U.S. Coast and Geodetic Survey. These comparisons, as well as those made daily with stabilized VLF transmissions from GBR, NBA and Omega-Trinidad, indicate that the frequency of the ZUO standard has not changed by more than 1 part in 10^{12} since November 1966.

Time signals are on the Coordinated Universal Time Scale (UTC) which is derived from a frequency which is offset by a predetermined amount from the caesium beam frequency, so as to make UTC correspond as closely as possible to UT2. During 1966 and 1967 the offset remains -300 parts in 10^{10}.

The offset frequency which controls the ZUO time signals is derived directly from the caesium beam standard by means of a continuous phase shifter.

Time signals of coordinated stations are kept within 1 millisecond of each other. To keep UTC in agreement with UT2, a step adjustment of 100 milliseconds may occasionally be made. Such an adjustment will be made at 00hUT on the first day of the month, and will be made simultaneously at all stations.

Standard time intervals have the same accuracy as the carrier frequencies (taking into account offset), with an additional uncertainity of 1 microsecond.

Corrections à ajouter aux résultats publiés par le BIH

pour les rapporter au système de 1968
(communiquées par le Bureau International de l'Heure)

Depuis 1968, 1er janvier, le BIH rapporte les résultats à l'Origine Conventionnelle Internationale. Les résultats antérieurs, depuis 1955, avaient été affectés par les changements suivants:
— changements d'origine pour les coordonnées du pôle (1959 et 1968),
— passage du FK3 au FK4 (1962),
— corrections des longitudes (1962, 1968),
— correction de la constante de l'aberration (1968),
— modifications de la constitution de l'observatoire moyen.

On donne ici les corrections à ajouter aux résultats publiés pour la période 1955-1967, afin de les rendre homogènes avec ceux publiés à partir de 1968.

Etant donné la petitesse de ces corrections, elles peuvent être considérées comme invariables durant chaque année, sauf pendant l'intervalle août 1958-février 1959, où elles devront être interpolées.

(T.S.V.P.)

Année	Centièmes d'année	Date commune	Corrections à ajouter			Explications
			XOCI-YBIH	YOCI-YBIH	à TU1 ou TU2 publiés	
1955			+0",048	+0",043	+0,s0025	
1956			"	"	+ 24	
1957			"	"	+ 24	
1958	00 à 60		"	"	+ 24	
	65	août 26,3	+ 50	+ 62	+ 15	
	70	sept. 13,5	+ 52	+ 80	+ 07	
	75	oct. 1,8	+ 54	+ 99	— 02	
	80	20,1	+ 56	+ 117	— 10	
	85	nov. 7,3	+ 58	+ 136	— 18	Passage du pôle de
	90	25,6	+ 60	+ 154	— 27	Cecchini au pôle moyen
	95	déc. 13,9	+ 62	+ 173	— 35	de la date.
1959	00	jan. 1,1	+ 64	"	— 27	
	05	19,4	+ 66	"	— 28	
	10	fév. 6,6	+ 68	"	— 28	
	15 à 95		+ 70	"	— 28	
1960			+ 67	+ 183	— 32	
1961			+ 62	+ 194	— 37	Adoption du FK4
					———	et de nouvelles
1962			+ 55	+ 203	+ 04	longitudes.
1963			+ 47	+ 211	+ 03	
1964			+ 40	+ 218	+ 04	
1965			+ 31	+ 224	+ 05	
1966			+ 22	+ 229	+ 34	Adoption de l'Origine
1967	00 à 45		+ 12	+ 232	+ 20	Conventionnelle Interna-
	50 à 95		+ 7	+ 233	+ 20	tionale, de nouvelles
			———	———	———*	longitudes, d'une nou-
1968			0	0	0	velle valeur de la cons-
						tante de l'aberration.