Bulletin n° 167 Juin 1968

U. R. S. I.

TABLE DES MATIERES — CONTENTS

MEETINGS

Réunion du Bureau de l'URSI (mars 1968)

(see English text p. 16)

Les membres du Bureau de l'URSI se sont réunis à Bruxelles les 25 et 28 mars 1968. Un résumé des principales décisions est donné ci-après.

Secrétariat de l'URSI

A l'heure actuelle le personnel du Secrétariat se compose uniquement du Secrétaire général p.i. (Dr. C.M. Minnis) et de la Secrétaire administrative (Mlle Y. Bogitch). Il a été décidé que les bureaux seraient fermés pendant deux semaines pour permettre au personnel de prendre des vacances.

Commémoration du Col. Herbays

Le Professeur Dieminger (président) ainsi que les Professeurs Beynon et Groszkowski ont été invités à former un comité restreint qui présentera au Bureau des recommandations sur la manière dont pourraient être commémorées les activités de l'ancien Secrétaire général.

Participation de jeunes chercheurs à la XVI^e Assemblée générale

Le Bureau a décidé de prendre des dispositions pour encourager la participation d'un nombre accru de jeunes chercheurs (25 — 35 ans) à l'Assemblée générale. Le Président, le Prof. Koga et le Secrétaire général p.i. présenteront des propositions sur les mesures pratiques à prendre dans ce sens. Les Comités nationaux de l'URSI seront invités à inclure des jeunes scientifiques dans leurs délégations. En outre, l'Union elle-même couvrira les frais de la participation d'un certain nombre de jeunes chercheurs en provenance de pays en cours de développement; une somme de $10.000 a été provisoirement allouée à cet effet.

Sondage de l'Atmosphère au moyen des Ondes électromagnétiques

Le Bureau a recommandé que l'Assemblée d'Ottawa consacre une attention particulière à ce sujet et passe en revue les nombreuses manières dont la radiation électromagnétique est utilisée pour sonder l'atmosphère, ainsi que les divergences qui apparaissent dans les résultats obtenus au moyen des différentes techniques.

Le Prof. W.E. Gordon (Vice-président de la Commission II) a accepté de présider un Groupe d'études international de l'URSI, qui examinera plus spécialement la question du sondage des régions ionisées. Pour sa part, la Commission inter-Unions de Radiométéorologie (IUCRM) a déjà entamé une étude extensive de ce genre se rapportant surtout à l'atmosphère neutre. Il a été proposé que le Groupe d'études de l'URSI et l'IUCRM présentent des rapports sur le sujet général du sondage de l'atmosphère le 21 août 1969, au cours d'une séance commune où toutes les Commissions de l'URSI seront représentées. Les Commissions consacreront une attention plus détaillée à ce même sujet au cours de leurs séances individuelles.

Bulletin d'Information de l'URSI

Au cours de 1968 paraîtront quatre numéros du Bulletin. Dans le cas où l'abondance des informations l'exigerait, des numéros supplémentaires seront publiés.

Relations URSI—CCIR

Le Secrétaire général p.i. a remplacé le Dr. D. Bailey comme Coordonnateur URSI—CCIR. En application des décisions prises en 1966, l'URSI a patronné l'élaboration d'un certain nombre de documents relatifs aux problèmes et aux questions renvoyés à l'Union par le CCIR. Ceux-ci ont été transmis au CCIR en mars 1968 et seront examinés par les Commissions d'études du CCIR au cours de leurs réunions de Boulder (EUA) en juillet 1968. Les membres des Comités nationaux de l'URSI qui assisteront à ces réunions seront invités à former un petit groupe consultatif non-officiel de l'URSI.

Prix de l'URSI

En février 1968, les Comités nationaux ont été invités à présenter leurs candidats aux Médailles d'Or Balth. van der Pol et J.H. Dellinger, qui seront remises à l'Assemblée d'Ottawa. Le Bureau élira les lauréats parmi les candidats qui auront été présentés avant le 15 juillet 1968.

Le Lauréat et Conférencier Appleton sera choisi, parmi les candidats présentés par les Comités nationaux, par un Comité composé du Prof. Dieminger (président), des Profs Hines et Booker (présidents des Commissions III et IV) et du Prof. Barlow (président du Comité national du Royaume-Uni).

Finances

Les comptes provisoires pour 1967 ont été approuvés par le Bureau; ces comptes ont été vérifiés depuis lors par l'expert comptable. Un rapport complet sur les finances de l'Union pour la période 1966-68 sera présenté à l'Assemblée d'Ottawa.

Colloques et conférences organisés par l'URSI ou d'autres organismes

Des subsides ont été alloués pour l'organisation de neuf colloques et conférences pendant les années 1968 et 1969, ainsi que pour les frais de voyage de représentants de l'URSI se rendant à d'autres réunions.

Comité URSI—STP

Ce Comité se réunira probablement en 1968 pour examiner le rôle à jouer par l'URSI dans les programmes projetés par la Commission inter-Unions de Physique Solaire-Terrestre (IUCSTP).

Commission inter—Unions de Radiométéorologie (IUCRM)

Le Bureau a approuvé les modifications au mandat proposées par la Commission et en suite desquelles l'IUCRM consacrera ses activités non plus seulement à la propagation radioélectrique mais aussi à la propagation dans les autres parties du spectre électromagnétique.

Commission inter—Unions pour l'Attribution de Fréquences à la Radioastronomie et à la Science Spatiale (IUCAF)

La Commission V de l'URSI a approuvé une proposition émanant de l'IUCAF et visant à ce qu'une bande de 2 MHz dans la gamme des 404-410 MHz soit requise à l'échelle mondiale pour les besoins exclusifs des radioastronomes.

Comité de l'URSI pour la Recherche Spatiale

Il a été décidé de constituer un Comité pour la Recherche Spatiale pour remplacer l'ancien Comité des Recherches radioélectriques dans l'Espace qui avait été dissous en 1966. Le nouveau Comité sera composé du représentant de l'URSI au Conseil exécutif du COSPAR (Prof. Silver) et des représentants de l'URSI au Groupe de travail II du COSPAR (Profs Booker, Bowhill, Gringauz, Hines et Maeda).

Revision des Statuts

Certaines modifications aux Statuts de l'Union avaient fait l'objet de brèves discussions à l'Assemblée de Munich en 1966. Une version révisée des Statuts sera préparée pour approbation par l'Assemblée d'Ottawa. Le projet en sera envoyé à tous les Comités nationaux pour commentaires bien avant l'Assemblée.

Progress in Radio Science

Le Bureau a discuté les problèmes relatifs à la publication de Progress in Radio Science à la lumière des points de vue exprimés par le Comité de Coordination. Il a été décidé de consulter les Comités nationaux sur l'utilité de la publication de ces volumes à l'avenir.

XVIe Assemblée générale, Ottawa 1969

Les décisions concernant l'Assemblée, prises par le Bureau et par le Comité de Coordination au cours des réunions des 26 et 27 mars 1968, ont déjà été portées à la connaissance des Comités nationaux. Elles sont reproduites ci-dessous.

Réunion suivante du Bureau

Le Bureau se réunira à Bruxelles en février 1969.

XVI^{e} ASSEMBLÉE GÉNÉRALE DE L'URSI

OTTAWA, 18—28 AOUT 1969

1. — INTRODUCTION

La XV^{e} Assemblée générale a accepté en 1966 l'invitation du Comité national canadien de l'URSI et, en conséquence, la XVI^{e} Assemblée générale de l'Union se tiendra à Ottawa, à l'Université Carleton, en août 1969. Plusieurs réunions administratives auront lieu à la fin de la semaine précédant l'ouverture officielle de l'Assemblée, le lundi 18 août. La séance plénière de clôture se déroulera dans la soirée du jeudi 28 août.

Le programme de l'Assemblée de 1969 a été le point principal à l'ordre du jour des séances du Comité de Coordination et du Bureau de l'URSI, qui se sont réunis à Bruxelles du 25 au 28 mars dernier, et auxquelles assistait également le Dr. R.S. Rettie, Président du Comité organisateur canadien. Les décisions les plus importantes sont résumées dans les Sections suivantes du présent document.

2. — THÈME GÉNÉRAL DE L'ASSEMBLÉE

L'URSI réalise ses objectifs principalement à travers les activités de ses huit différentes Commissions. Toutefois le Comité de Coordination a recommandé que lorsque cela serait jugé opportun, priorité serait donnée à Ottawa aux séances conjointement organisées et présentant un intérêt commun à deux ou plusieurs Commissions. Onze séances communes ont été inscrites au programme provisoire (voir Annexe).

En outre, un après-midi sera consacré à une séance générale des huit Commissions, ayant pour thème « Le Sondage de l'Atmosphère au moyen d'Ondes électromagnétiques ». Il est prévu de présenter, au cours de cette séance, les résultats des études critiques portant sur les principaux aspects de ce sujet qui englobera la troposphère, la stratosphère, la basse et la haute ionosphère et la magnétosphère. Les techniques utilisées pour le sondage ainsi que les résultats obtenus et leurs implications théoriques seront passés en revue. Une attention particulière sera consacrée aux cas où différentes techniques semblent conduire à des résultats divergents.

Il est reconnu que la Commission inter-Unions de Radiométéorologie (IUCRM) constitue le forum approprié pour traiter les aspects du sondage qui portent sur les régions non-ionisées de l'atmosphère. Les Professeurs Bolgiano et Atlas (respectivement Président et Secrétaire de l'IUCRM) se sont déclarés prêts à apporter leur contribution à l'étude projetée. Pour sa part, le Prof. Gordon (Vice-Président de la Commission II de l'URSI) a accepté la présidence d'un Groupe de Travail international de l'URSI, qui étudiera particulièrement les techniques et résultats ayant trait au sondage des régions ionisées. L'IUCRM et le Groupe de Travail du Prof. Gordon établiront en commun le programme de la séance générale.

En outre, nombre de sujets sélectionnés pour les séances individuelles des Commissions sont directement ou indirectement liés au thème central de la propagation des ondes électromagnétiques.

3. — Séances scientifiques

En réponse à l'appel lancé par le Président, de nombreux Comités nationaux ont fait connaître, en 1967 et au début de 1968, leurs vues sur l'organisation du programme scientifique de l'Assemblée d'Ottawa. L'opinion généralement acceptée est que les Assemblées générales et les colloques scientifiques ont des objectifs différents. Une Assemblée générale de l'URSI fournit l'occasion d'effectuer une vaste revue critique des récents développements intervenus dans les différents domaines de la radioélectricité scientifique, mais aussi d'établir les plans des activités scientifiques futures dans le but, plus spécialement, de combler les lacunes existant dans nos connaissances actuelles. Par ailleurs, le colloque offre avant tout à un certain nombre d'experts la possibilité de présenter les résultats de leurs recherches dans un domaine assez limité.

Ce point de vue a été adopté par le Bureau et par le Comité de Coordination. En conséquence, toutes les communications qui figureront au programme scientifique d'Ottawa seront des exposés de synthèse présentés par des conférenciers spécialement invités par les Présidents des Commissions. Chaque conférencier sera invité *a*) à passer en revue, d'un point de vue critique plutôt que général, les développements intervenus dans la période triennale suivant l'Assemblée de Munich, *b*) à formuler, à partir de cet aperçu, des suggestions relatives aux programmes scientifiques futurs, *c*) à essayer d'identifier les domaines principaux où se font sentir des lacunes, *d*) à suggérer les types de recherches qui permettraient de combler ces lacunes.

Il sera sérieusement déconseillé aux conférenciers de présenter un historique plus ou moins complet de séries d'expériences couronnées de succès.

En dehors des exposés de synthèse par les conférenciers spécialement invités, toute autre présentation officielle de communications sera exclue. On espère toutefois que les exposés de synthèse renfermeront nombre d'idées et de suggestions controversables susceptibles de stimuler les discussions qui suivront chacun de ces exposés. Les participants à ces discussions seront invités à limiter leurs remarques aux questions se rapportant directement au sujet de la séance; de préférence, ces remarques porteront sur l'ensemble du sujet et non pas exclusivement sur des contributions personnelles.

4. — Election des Membres du Bureau

Les noms du Président et des membres du Bureau nouvellement élus seront annoncés à Ottawa au cours de la Séance plénière d'ouverture, le lundi 18 août dans la matinée. Le Comité exécutif procédera aux élections dans la matinée du samedi 16 août. Les Comités nationaux de l'URSI seront invités à soumettre les noms de leurs candidats au Secrétaire général pour le 28 février 1969 au plus tard. Toutes les propositions reçues à cette date seront portées à la connaissance des Comités nationaux plusieurs mois avant l'Assemblée et elles seront accompagnées des recommandations que le Bureau pourrait formuler au sujet de ses nouveaux membres.

Pendant toute la durée de l'Assemblée, le Président et les Membres du Bureau nouvellement élus travailleront en étroite collaboration avec les Membres sortants; il est espéré que, grâce à l'expérience qu'ils pourront ainsi acquérir, le transfert des responsabilités s'effectuera plus facilement que par le passé.

5. — Séance plénière d'ouverture

La séance plénière d'ouverture se tiendra dans le centre d'Ottawa, après la cérémonie de la « Relève de la Garde » à laquelle les délégués seront conviés.

Le Président a exprimé son intention d'inclure dans son discours inaugural un aperçu des activités particulièrement importantes que les Comités nationaux de l'URSI auront déployés depuis l'Assemblée de 1966. Pour pouvoir préparer cet aperçu, il devra être en possession de tous les Rapports nationaux au plus tard pour le 15 mai 1969.

6. — Séance plénière de clôture

Résolutions — La tâche principale de la séance plénière de clôture sera de confirmer les résolutions présentées par le Comité exécutif. Les mesures nécessaires seront prises pour que les délégués soient en possession des textes des résolutions avant l'ouverture de la séance plénière. A cet effet, les Présidents des Commissions devront soumettre leurs projets de résolutions au Comité de Rédaction le plus tôt possible pendant l'Assemblée. Par ailleurs, le Comité exécutif devra se réunir dès le début de la deuxième semaine pour examiner les résolutions déjà préparées.

7. — Discours du Président sortant et du Président nouvellement élu

Le Président sortant prononcera son discours principal au cours de la séance plénière d'ouverture. A la séance de clôture, il se bornera à faire quelques remarques avant de céder la parole au nouveau Président.

Le nouveau Président passera en revue les travaux de l'Assemblée; pour ce faire, il se basera sur les rapports qui auront été préparés à son intention par les Présidents des Commissions. En outre, il aura eu l'occasion, pendant toute la durée de l'Assemblée, d'assister aux séances des Commissions et de se procurer des informations de première main sur nombre de sujets. Ce discours prendra la place des rapports qui étaient présentés séparément, auparavant, par chacun des Présidents des Commissions.

8. — Soirée des Lauréats

Dans la soirée du mardi 19 août, une séance spéciale sera organisée au cours de laquelle les Médailles d'Or Balth. van der Pol et Dellinger seront remises aux lauréats qui prononceront de brèves allocutions.

Cette cérémonie sera suivie par la remise du Prix Appleton dont le lauréat présentera la Conférence commémorative Appleton, consacrée aux récents développements de la physique ionosphérique.

9. — Rapports de mise au point

Chaque Commission établira un Groupe de travail restreint dès le début de l'Assemblée. Ce Groupe sera invité à préparer un rapport qui fera le point des sujets discutés pendant les séances scientifiques de la Commission. Il a été recommandé *a*) que ces rapports renferment l'essence des discussions, *b*) qu'ils mettent l'accent sur les problèmes non encore résolus et formulent des suggestions en vue de leur solution, *c*) qu'ils contiennent des propositions relatives aux programmes scientifiques et autres activités pour la période triennale précédant l'Assemblée de 1972.

Il ne sera pas demandé aux Présidents des Commissions de présenter des rapports oraux à la séance plénière de clôture. Ils auront donc la possibilité de se consacrer à la rédaction définitive des Rapports de mise au point, avec l'aide des membres des Groupes de travail.

Chaque Commission tiendra dans la matinée du jeudi 28 août une Séance récapitulative au cours de laquelle les Rapports de mise au point seront présentés et discutés dans leurs grandes lignes. Dans l'après-midi du même jour chaque Commission se réunira pour examiner les Sujets nouveaux.

10. — Documents qui seront préparés avant le début de l'Assemblée

10.1 — Annonces diffusées par le Comité organisateur canadien

Les Première et Deuxième Annonces seront diffusées par le Comité organisateur canadien respectivement en juin 1968 et en février 1969 (ces deux dates sont approximatives). Elles contiendront tous les renseignements généraux susceptibles d'intéresser les participants: hôtels, excursions, réceptions et arrangements qui seront pris à Ottawa et à l'Université Carleton. Elles renfermeront également le programme provisoire des séances plénières, des séances scientifiques et des séances des Comités de l'URSI.

10.2 — Brochure contenant les résumés des exposés de synthèse

Les auteurs des exposés de synthèse seront invités à fournir à l'avance des résumés de 300-500 mots. Ces résumés seront tous publiés dans une brochure dont un exemplaire sera remis à chaque délégué lors de son inscription à Ottawa.

Le texte intégral des exposés de synthèse ne sera pas distribué pendant l'Assemblée.

10.3 — Rapports des Comités nationaux

Il est généralement reconnu que les Rapports des Comités nationaux constituent l'un des aspects essentiels des Assemblées générales de l'URSI et que, idéalement, des exemplaires de ces rapports devraient pouvoir être distribués à tous les délégués. Néanmoins, pour les Assemblées précédentes de l'URSI, il n'avait pas été possible d'obtenir des exemplaires de ces rapports en temps voulu, c'est-à-dire bien avant l'Assemblée, et donc de disposer sur place de plusieurs centaines d'exemplaires. Un nouvel arrangement sera mis au point pour Ottawa et on espère ainsi résoudre ce problème.

On a en effet l'intention de fournir un certain nombre d'exemplaires de tous les Rapports nationaux à chaque délégation présente à Ottawa. Dans ce but les Comités nationaux seront invités à envoyer un exemplaire de leurs rapports à Ottawa au plus tard pour le 15 mai 1969. Ces rapports ne pourront être reproduits que si la longueur moyenne du texte des différentes sections correspondant aux huit Commissions ne dépasse pas les 3.500 mots y compris les tables, figures, diagrammes, références, etc.

Les Comités nationaux devront également fournir pour le 15 mai 1969 des exemplaires de leurs rapports à l'intention:

a) du Président qui donnera, dans son discours inaugural, un bref aperçu des principales activités des Comités nationaux;

b) des Présidents des Commissions pour la préparation des rapports qu'ils présenteront aux réunions de leurs Commissions respectives;

c) du Secrétariat de l'URSI à Bruxelles.

Il est à espérer que tous les Comités nationaux prendront les mesures voulues pour que leurs Rapports puissent être distribués dès le début de mai 1969, comme indiqué ci-dessus. Dans le cas où cela devrait s'avérer impossible pour quelque raison que ce fût, les Comités nationaux seront invités à expédier 50 exemplaires de leurs Rapports directement à Ottawa ou bien de les faire parvenir par les soins de leurs délégations.

10.4 — Liste des délégués

On sait que l'un des aspects les plus importants de l'Assemblée générale est l'occasion qui est fournie aux spécialistes de se rencontrer et de discuter des problèmes et intérêts communs. Afin que ces contacts puissent s'établir le plus rapidement possible, il sera demandé aux Comités nationaux de faire connaître d'avance les noms de leurs délégués avec brève indication de leurs domaines d'intérêt scientifique. Ceci est particulièrement important pour les jeunes délégués dont les noms pourraient ne pas être encore bien connus. Des exemplaires de cette liste seront remis aux participants au moment de l'inscription.

11. — Participation de jeunes chercheurs à la XVIe Assemblée générale

A plusieurs occasions le Bureau de l'Union a exprimé son souci du fait que, souvent, les délégations envoyées aux Assemblées ne comprenaient que peu de jeunes scientifiques actifs de la catégorie d'âge 25-32 ans. Il est estimé que les Comités nationaux devraient inclure dans leurs délégations quelques jeunes scientifiques qui auraient ainsi la possibilité de se familiariser avec les questions de l'organisation internationale de la science.

Le Bureau de l'URSI a décidé de fournir une certaine somme pour permettre à quelques jeunes scientifiques de pays en voie de développement d'assister à l'Assemblée d'Ottawa et il espère que les Comités nationaux de tous les pays membres étudieront les mesures qu'ils pourraient prendre dans ce sens pour leurs propres délégations.

ANNEXE

Sujets sélectionnés pour les séances scientifiques, etc.

Introduction

1. Le thème principal de la XVI^{e} Assemblée générale de l'URSI sera « Le Sondage de l'Atmosphère au moyen d'Ondes électromagnétiques ». Toutes les Commissions se réuniront le 21 août en une séance commune au cours de laquelle seront présentés des rapports spéciaux consacrés à ce sujet.

2. Les sujets choisis pour les séances communes et les séances individuelles sont donnés ci-dessous.

3. L'Assemblée sera officiellement ouverte dans la matinée du lundi 18 août 1969; la séance de clôture se tiendra dans la soirée du jeudi 28 août. Le Comité exécutif se réunira dans la matinée du samedi 16 août pour procéder à l'élection du nouveau Président et des nouveaux membres du Bureau.

4. Les Médailles d'Or Balth. van der Pol et Dellinger seront remises dans la soirée du mardi 19 août. Cette cérémonie sera suivie par la Conférence commémorative Appleton.

5. Le Comité organisateur canadien a l'intention d'organiser des excursions le vendredi 29 août.

Sujets sélectionnés pour les séances individuelles des Commissions

I–1 Emissions de fréquences étalon (Bande 4 ou VLF)
I–2 Mesures d'intensité de champ et d'atténuation
I–3 Mesures aux fréquences radioélectriques et sur ondes millimétriques
I–4 Applications des mesures radioélectriques

II–1 Atmosphères planétaires
II–2 Diffusion et diffraction par des surfaces irrégulières
II–3 Modèles de la Troposphère, et propagation spatiale et terrestre
II–4 Rapport sur le Colloque de l'IUCRM sur les spectres des variables météorologiques
II–5 Radiométrie expérimentale

III–1 Diffusion incohérente (de Thomson)
III–2 Interaction stratosphère-ionosphère
III–3 Rôle de l'URSI dans l'expansion géographique des recherches ionosphériques

III-4 Propagation radioélectrique (problèmes non-résolus)
III-5 Dynamique de la région F

IV-1 Propagation et émissions ELF dans la magnétosphère
IV-2 Période de réflexion entre points miroirs et perturbations ULF, y compris la stabilité de la magnétopause
IV-3 Problèmes non-résolus et programmes futurs
IV-4 Champs électriques à courant quasi-continu
IV-5 Ondes dans l'espace interplanétaire et leurs effets sur la magnétosphère

V-1 Interférométrie à très grande base
V-2 Cartographie du Soleil et de régions particulières
V-3 Observations spectrales des sources galactiques et extragalactiques
V-4 Activité courante des divers groupes de Radioastronomie
V-5 Variations des sources extragalactiques, sources particulières et polarisation
V-6 Observations en ondes millimétriques et à très basse fréquence

VI-1 Guides d'ondes à faible perte
VI-2 Codage avec et sans information réciproque
VI-3 Communications en ondes millimétriques et submillimétriques et en optique *a*) dans l'atmosphère, *b*) guidées (lignes de transmission)
VI-4 Antennes
VI-5 Théorie de l'Information
VI-6 Technique optimale dans la théorie des circuits

VII-1 « Bulk effects » dans les semi-conducteurs
VII-2 Emetteurs et récepteurs Laser: comparaison des différents systèmes
VII-3 Dispositifs supraconducteurs

VIII-1 Etendue du spectre et structure des atmosphériques
VIII-2 Localisation des sources d'atmosphériques
VIII-3 Propriétés statistiques du bruit
VIII-4 Bruit ELF
VIII-5 Bruits industriels

Sujets sélectionnés pour les séances communes à plusieurs Commissions

Remarque: Dans la liste ci-dessous, les Commissions sont indiquées en ordre numérique. Du point de vue organisation, il importera que les Présidents des Commissions désignent la Commission responsable pour le programme de chacune de ces séances.

I/V/VIII–1	Mesures de bruit
I/VII–1	Etalons de fréquence en électronique quantique
I/VII–2	Mesures par Lasers
II/VI–1	Propagation aux fréquences supérieures à 10 GHz
II/VII–1	Théorie de la radiométrie
III/IV–1	Propagation des sifflements; mesure de la distribution de la densité électronique par toutes techniques
III/IV–2	Emissions VLF, et toutes instabilités en relation avec les électrons
III/VI/VII–1	Résonances de plasma
III/VIII–1	Atmosphériques, y compris sifflements, dans la basse ionosphère
VI/VII–1	Ordinateurs en Science radioélectrique
VI/VII–2	Enregistrements magnétiques

Chaque Commission organisera également une Séance récapitulative et une Séance consacrée aux Sujets nouveaux.

23 avril 1968.

Meeting of URSI Board of Officers (March 1968)

The Board of Officers of URSI met in Brussels on 25 and 28 March 1968. The principal decisions are summarised below.

URSI Secretariat

The staff of the Secretariat now consists only of the Acting Secretary General (Dr. C.M. Minnis) and the Administrative Secretary (Mlle Y. Bogitch). The Board agreed that the office should be closed for a holiday period of two weeks.

Memorial to Col. Herbays

Professor Dieminger (Chairman) with Profs Beynon and Groszkowski were asked to act as a small committee and to make recommendations to the Board concerning the possible form of a memorial to the late Secretary General.

Young Scientists at the XVI General Assembly

The Board has decided to take action to encourage the attendance of a greater number of young scientists (25-35 years) at the General Assembly. The President, Prof. Koga and the Acting Secretary General will make proposals regarding the practical steps which can be taken. URSI National Committees will be encouraged to include young scientists in their delegations. In addition the Union itself will support the attendance of a number of young scientists from developing countries and $10,000 has been provisionally allocated for this purpose.

Probing the Atmosphere using Electromagnetic Waves

The Board recommended that, at the Ottawa Assembly, special attention should be given to a review of the many ways in which electromagnetic radiation is used to probe the atmosphere, and of discrepancies which have emerged from the results obtained by different techniques.

Prof. W.E. Gordon (Vice-Chairman, Commission II) has agreed to be Chairman of an international URSI Study Group which will consider, particularly, probing of the ionized regions. IUCRM has already begun an extensive study of this kind with special reference to the neutral atmosphere. It is proposed that the URSI study group and IUCRM shall together present reports on the general topic of probing on 21 August 1969 during a special session at which all the URSI Commissions will be represented. The same topic will receive more detailed attention in the separate sessions organised by Commissions.

URSI Information Bulletin

It is proposed to publish four numbers of the Bulletin in 1968, unless the amount of material for publication makes it necessary to publish additional numbers.

URSI—CCIR Relations

The Acting Secretary General has replaced Dr. D. Bailey as URSI-CCIR Coordinator. As a result of preliminary action taken in 1966, URSI sponsored the preparation of documents relating to problems and questions referred to URSI by CCIR. These were transmitted to CCIR in March 1968 and will be considered at the CCIR Study Group Meetings in Boulder (USA) in July 1968. Members of URSI National Committees who attend these Meetings will be invited to form an informal URSI advisory group in Boulder.

URSI Awards

In February 1968, National Committees were invited to submit nominations for the Balth. van der Pol and the J.H. Dellinger Gold Medals which will be presented at the Ottawa Assembly. The Board will later vote on the nominations received before 15 July 1968.

The Appleton Lecturer and Prizewinner will be selected, from nominations received from National Committees, by a Committee consisting of Prof. Dieminger (Chairman); Profs Hines and Booker (Chairmen of Commissions III and IV) and Prof. Barlow (President of the UK National Committee).

Finances

The provisional accounts for 1967 were approved by the Board and the audited accounts have since been completed. A full report on the finances of the Union for the period 1966-1968 will be presented at the Ottawa Assembly.

URSI and Other Symposia, Meetings, etc.

Grants were approved for the support of the organization of nine Symposia and other meetings during the years 1968 and 1969 and for the attendance of URSI representatives at these and several other meetings.

URSI—STP Committee

This Committee will meet, probably in 1968, to consider URSI's role in the programmes being planned by the Inter-Union Commission on Solar-Terrestrial Physics (IUCSTP).

Inter-Union Commission on Radio Meteorology (IUCRM)

The Board approved the proposed change in the terms of reference according to which the Commission will deal not only with radio propagation but with propagation in other parts of the spectrum.

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

URSI Commission V has approved a proposal from IUCAF whereby a 2 MHz band in the range 404-410 MHz would be sought for the exclusive use of radioastronomers on a world-wide basis.

URSI Committee for Space Research

It was agreed to form a Committee for Space Research to replace the former Space Radio Research Committee which was dissolved in 1966. The new Committee will consist of the URSI Representative on the COSPAR Executive Council (Prof. Silver) and the representatives on COSPAR Working Group 2 (Profs Booker, Bowhill, Gringauz, Hines and Maeda)

Revision of Statutes

Several revisions to the Statutes were discussed briefly at the Munich Assembly in 1966. It is intended to prepare a revised version of the Statutes for submission to the Ottawa Assembly. The draft text will be sent to all National Committees for comment well before the Assembly.

Progress in Radio Science

The problems relating to the publication of Progress in Radio Science were discussed in the light of the views expressed by the Coordinating Committee. It was agreed that the National Committees should be consulted about future policy.

XVI General Assembly. Ottawa 1969

The decisions, relating to the Assembly, made by the Board, and by the Coordinating Committee at its meetings on 26 and 27 March, have already been circulated to National Committees and are reproduced below.

Next Meeting

The Board of Officers will meet in Brussels in February 1969.

THE XVI GENERAL ASSEMBLY OF URSI

OTTAWA, 18-28 AUGUST 1969

1. — Introduction

At the XV General Assembly in 1966, the invitation of the Canadian National Committee for URSI was accepted and, in consequence, the XVI General Assembly will be held in Ottawa, at Carleton University, in August 1969. Several administrative meetings will be held at the end of the week preceding the Assembly which will be formally opened on Monday, 18 August. The Closing Plenary Meeting will be held on the evening of Thursday, 28 August.

The programme for the 1969 Assembly was the main item on the agenda for the meetings of the URSI Coordinating Committee and of the Board of Officers, both of which met in Brussels from 25-28 March 1968 and at which Dr. R.S. Rettie, the Chairman of the Canadian General Arrangements Committee, was also present. The principal decisions made during these meetings are summarised in the remaining Sections of this document.

2. — General Theme for the Assembly

URSI realises its aims mainly through the activities of its eight separate Commissions. However, the Coordinating Committee recommended that, when it seemed appropriate at Ottawa, priority was to be given to the scientific sessions which will be jointly organised by, and of common interest to, two or more Commissions. Eleven joint sessions have been included in the provisional programme (See Annex).

In addition, on one afternoon, all the eight Commissions will join for a session on « Probing the Atmosphere by Electromagnetic Waves ». During this session it is intended to present the results of critical studies of the main features of this subject which is understood to cover the troposphere, stratosphere, lower and upper ionosphere, and the magnetosphere. The techniques used in the probing and also the results obtained, with their theoretical implications, will be reviewed. Special attention will be paid to instances of discordant results which appear to be given by different techniques.

It is recognized that the Inter-Union Commission on Radio Meteorology (IUCRM) is the appropriate body to deal with those aspects of probing which refer to the non-ionized regions of the atmosphere. Professors Bolgiano and Atlas (President and Secretary of IUCRM) have expressed their willingness to contribute to the proposed study. Professor Gordon (Vice-Chairman, URSI Commission II) has agreed to be Chairman of an international URSI Working Group which will study particularly the techniques and results relevant to probing the ionized regions. Both IUCRM and Professor Gordon's Working Group will jointly plan the programme for the joint session on probing.

Quite apart from this joint session, many of the topics selected for the individual Commissions are directly or indirectly relevant to the general topic of electromagnetic wave propagation.

3. — Scientific Sessions

Many National Committees responded, in 1967 and early 1968, to the President's request for their views on the organisation of the scientific programme for the Ottawa Assembly. The generally accepted opinion is that General Assemblies and Scientific Symposia have different objectives. An URSI General Assembly is an occasion for making a broad critical review of recent progress in the different branches of radio science and also for making plans for future scientific activities, especially those designed to fill present gaps in our knowledge. In contrast a symposium is primarily an occasion when a number of key individuals can present accounts of their research work in a fairly limited field.

This opinion has been accepted by the Board of Officers and the Coordinating Committee. In consequence all the papers in the scientific programme at Ottawa will be review papers and they will be presented by speakers specially invited by the Chairmen of Commissions. Each speaker will be asked a) to concentrate on a critical, rather than a general, review of progress in the three years since the Munich Assembly; b) to use this review as the basis for suggestions regarding future scientific programmes; c) to try to identify the most important areas in which knowledge is lacking; d) to suggest what types of investigation are required to fill these gaps.

The speakers will be strongly discouraged from presenting more or less comprehensive historical lists of successful experiments.

Apart from the review papers to be presented by the invited speakers, there will be no other formal presentations of papers. However, it is hoped that the review papers will contain provocative and controversial ideas and suggestions, and that these will stimulate responses from the delegates present during the discussion period which will follow each review paper. Those who contribute to these discussions will be expected to confine their remarks to questions of direct relevance to the subject of the session; these remarks should preferably relate to the subject as a whole and not exclusively to the speaker's personal contribution to recent progress.

4. — Election of the Board of Officers

The new President and members of the Board of Officers will be announced in Ottawa at the Opening Plenary Meeting on Monday morning, 18 August. The elections will take place at a meeting of the Executive Committee on Saturday morning, 16 August. The URSI National Committees will be asked to submit their nominations for the new Officers to the Secretary General not later than 28 February 1969. All the nominations received by this date will be circulated to the National Committees several months before the Assembly, together with any recommendations which the Board of Officers may wish to make regarding the new Officers.

During the whole of the Assembly, the newly elected President and Officers will work closely with the outgoing Officers and it is expected that the experience gained by them will ensure a smoother transfer of responsibility than has been possible in the past.

5. — Opening Plenary Meeting

The Opening Plenary Meeting will be held in central Ottawa after the ceremony of « Changing the Guard » which delegates will be invited to attend.

The President has expressed his intention of including, in his opening address, a summary of the outstanding activities of the URSI National Committees since the 1966 Assembly. In order to enable him to prepare this Summary, it will be necessary for him to receive a copy of each National Report not later than 15 May 1969.

6. — Closing Plenary Meeting

Resolutions — The principal business of the Closing Plenary Meeting will be to endorse the Resolutions submitted by the Executive Committee. It is intended to make arrangements which will ensure that the Resolutions will be available, in the form of documents, to delegates before the Plenary Meeting begins. If these arrangements are to be successful, it will be necessary for the Commission Chairmen to submit their resolutions to the Drafting Committee as early as possible during the Assembly and for the Executive Committee to meet during the early part of the second week in order to consider those Resolutions which are already available.

7. — Addresses by the Outgoing and Incoming Presidents

The principal address by the outgoing President will be presented at the Opening Plenary Meeting. At the Closing Plenary Meeting, he will make only some brief remarks before asking the incoming President to speak.

The new President will review the work of the Assembly just completed, and he will base his address on informal summaries which will be prepared for him by the Commission Chairmen. In addition, during the whole of the Assembly, he will have had opportunities to attend meetings of at least some of the Commissions and to acquire first-hand information about a number of topics. This address will take the place of the separate reports which have been given at past Assemblies by each of the Commission Chairmen.

8. — Awards Evening

The Balth. van der Pol and the Dellinger Gold Medals will be presented at a special evening session on Tuesday, 19 August, and the two medallists will make brief replies.

These presentations will be followed by the introduction of the winner of the Appleton Prize who will then deliver the Appleton Memorial Lecture on recent advances in ionospheric physics.

9. — Status Reports

It is intended that each Commission shall establish a small Working Group at the beginning of the Assembly. This Group will be asked to prepare a report on the current status of the topics discussed during the scientific sessions of its parent Commission. It has been recommended *a*) that these reports shall contain the essence of the discussions; *b*) that they shall give some emphasis to outstanding problems and suggestions for the solution of these problems; *c*) that they shall include proposals for scientific programmes and related activities during the three-year period preceding the 1972 Assembly.

The Commission Chairmen will not be required to present verbal reports at the Closing Plenary Meeting. They will, therefore, have an opportunity to concentrate on the completion of the Status Reports with the assistance of the members of their Working Groups.

Each Commission will hold a Summary Session on the morning of Thursday, 28 August, at which the principal features of the Status Reports will be presented and discussed. This Session will be followed, in each Commission, by the afternoon session on New Topics.

10. — Advance Documents

10.1 — Announcements from Canadian General Arrangements Committee

The First and Second Announcements will be sent out by the Canadian General Arrangements Committee in June 1968 and February 1969 (both dates are approximate). These will contain general information for intending delegates about hotel accommodation, tours, social events and other arrangements in Ottawa and at Carleton University. They will include also the provisional time-table for the Plenary Meetings, Scientific Sessions, and meetings of other URSI Committees.

10.2 — Book of Abstracts

Each of the speakers who will be invited to present the review papers will be asked to submit, in advance, a summary containing 300-500 words. These summaries will all be published in a booklet copies of which will be available to all delegates when they register in Ottawa.

Copies of the full text of the review papers will not be available during the Assembly.

10.3 — Reports from National Committees

There is general agreement that the Reports prepared by National Committees for URSI constitute an important feature of URSI General Assemblies and that, ideally, copies should be available for all delegates. In actual practice, the problem of obtaining copies of these Reports well before the Assembly and of providing several hundred copies at the place of the Assembly has not been solved at past Assemblies and it is intended to try a new arrangement at Ottawa.

It is intended to make a few copies of all the National Reports available to each of the National Delegations present in Ottawa. To enable this to be done, each National Committee will be asked to send a copy of its Report to Ottawa, for reproduction, not later than 15 May 1969. It will be possible to reproduce these Reports only if the average length of the Sections which refer to the eight Commissions does not exceed 3,500 words including Tables, Figures, Diagrams, References, etc.

In addition copies of National Reports will be required by 15 May 1969 for:

(*a*) the President, who will review briefly the main activities of the National Committees in his opening address on 18 August;

(*b*) the Chairmen of Commissions, who will require information for the preparation of their reports which they must present at the Commission meetings;

(*c*) the URSI Secretariat in Brussels.

It is hoped that all National Committees will ensure that their Reports are ready for distribution, as indicated above, in early May 1969. If for any reason this is not possible, National Committees will be requested to send 50 copies of their reports direct to Ottawa or to send them with their delegations to the Assembly.

10.4 — Lists of Delegates

It is well known that one of the most valuable features of the General Assembly is the opportunity provided for active scientists to meet informally and to discuss their common scientific interests and problems. So as to allow such contacts to be made as early as possible during the Assembly, it is intended to invite National Committees to submit the names of their delegates in advance and also to add a very brief indication of the main current scientific interests or activities of each delegate, particularly of the younger delegates whose names may not yet be well known. It is intended to make copies of this annotated advance list of delegates available to delegates on registration.

11. — Young Scientists at the XVI General Assembly

On several occasions the Board of Officers has expressed some concern at the fact that many delegations to URSI Assemblies contain few of the younger active scientists in the approximate age group 25-32 years. It is felt that National Committees should introduce some of their younger scientists to questions relating to the international organisation of science and that they should include some of them in their delegations.

The Board of Officers has agreed to provide funds which will enable young scientists from some of the developing countries to attend the Ottawa Assembly and it is hoped that the National Committees of all countries will consider what action they can take in relation to their own delegations.

ANNEX

Topics for Scientific Sessions etc., XVI General Assembly

Introduction

1. The main theme of the XVI General Assembly of URSI will be " Probing the Atmosphere by means of Electromagnetic Waves ". All Commissions will meet jointly on 21 August when several special reports on this topic will be presented.

2. The topics which will be reviewed at the Joint Sessions and at the sessions organised by individual Commissions are listed below.

3. The Assembly will be formally opened on Monday morning, 18 August 1969 and the Closing Plenary Meeting will be held during the evening of Thursday, 28 August. There will, however, be an important meeting of the Executive Committee on Saturday morning, 16 August, at which the new President and Officers will be elected.

4. The Balth. van der Pol and Dellinger Gold Medals will be presented on the evening of Tuesday, 19 August. These presentations will be followed by the Appleton Memorial Lecture.

5. The Canadian General Arrangements Committee intends to organize several all-day tours probably on Friday, 29 August.

Topics for Sessions organised entirely by one Commission

I–1 Standard Frequency Transmissions (VLF)
I–2 Fieldstrength and Attenuation Measurement
I–3 R.F. and mm Wave Measurements
I–4 Applications of Radio Measurements

II–1 Planetary Atmospheres
II–2 Scattering and Diffraction by Irregular Surfaces
II–3 Models of the Troposphere, and Space and Terrestrial Propagation
II–4 Report on IUCRM Symposium on Spectra of Meteorological Variables
II–5 Experimental Radiometry

III–1 Incoherent (Thomson) Scattering
III–2 Stratosphere-Ionosphere Coupling
III–3 URSI's role in the geographic extension of ionospheric research
III–4 Radio Propagation (Unsolved Problems)
III–5 F—Region Dynamics

IV–1 ELF Propagation and Emissions in the Magnetosphere

IV–2 Bounce Resonance and ULF Disturbances, including stability of the Magnetopause
IV–3 Unsolved Problems and Future Programmes
IV–4 Quasi-DC Electric Fields
IV–5 Waves in Interplanetary Space and their Effects on the Magnetosphere

V–1 Long Base-Line Interferometry
V–2 Mapping of the Sun and Peculiar Regions
V–3 Spectral Observations of Galactic and Extragalactic Sources
V–4 Current Activity of Various Radioastronomy Groups
V–5 Variations of Extragalactic Sources, Peculiar Sources and Polarization
V–6 Observations at mm Wavelengths and at VLF

VI–1 Low-loss Waveguides
VI–2 Coding with and without Feedback
VI–3 Communications at mm, sub-mm and Optical Wavelengths (*a*) in the Atmosphere (*b*) with Guidance (Transmission Lines)
VI–4 Antennas
VI–5 Information Theory
VI–6 Optimization Techniques in Network Theory

VII–1 Bulk Effects in Semi-conductors
VII–2 Laser Transmitters and Receivers: Comparison of Various Systems
VII–3 Superconducting Devices

VIII–1 Spectrum and Structure of Atmospherics
VIII–2 Location of Thunderstorms
VIII–3 Statistical Properties of Noise
VIII–4 ELF Noise
VIII–5 Man-made Noise

Topics for Sessions Jointly Organised by Several Commissions

Note: In the following list, the Commissions are indicated in numerical order. It will be important, from the organisational point of view, for the interested Chairmen of Commissions to decide which Commission will be responsible for planning each of the Joint Sessions.

I/V/VIII–1 Noise Measurements
I/VII–1 Quantum Electronic Frequency Standards
I/VII–2 Measurements Using Lasers

II/VI–1	Propagation at Frequencies Greater than 10 GHz
II/VII–1	Theory of Radiometry
III/IV–1	Whistler Propagation; Electron Density Distribution Measured by All Techniques
III/IV–2	VLF Emissions, and All Instabilities Involving Electrons
III/VI/VII–1	Plasma Resonances
III/VIII–1	Atmospherics, Including Whistlers, in the Lower Ionosphere
VI/VII–1	Computers in Radio Science
VI/VII–2	Magnetic Recordings

Each Commission will also have a Summary Session and one on New Topics.

16 April 1968.

Alexandr Stepanovitch Popov: Moscow 1968

The President of the A.S. Popov Society for Radiotechnology, Electronics and Radiocommunications (Professor V.I. Siforov) invited URSI to send a representative to the XXIV Scientific Session of the Society to be held in Moscow during 14-16 May 1968. In the absence of the President of URSI at the COSPAR Meeting in Tokyo, URSI was represented by the Acting Secretary General.

Unfortunately, owing to illness, Professor Siforov could not be present and his place at the Plenary Meetings was taken by Prof. Govyadinov (Vice-President).

After the Opening Plenary Meeting, the delegates were divided into groups according to their main interests, and during the specialist sessions over 300 papers were presented. The topics of most interest to URSI were probably: information theory; antennas and waveguides; semiconductors, ferrites and microelectronics, quantum electronics, and computers. However the 25 Sections included also such topics as the radio aspects of cybernetics, economic questions, biological and psychology problems, etc.

The 600 participants included delegates from Bulgaria, Czechoslovakia, Finland, France, German Democratic Republic, Hungary, Poland, USA, USSR and Yugoslavia. In addition to URSI, the Comité Consultatif des Radiocommunications was represented and Dr. M. Joachim of the Secretariat in Geneva described the application of the Atlas computer to the preparation of ionospheric forecasts for radiocommunications.

At the Closing Plenary Meeting foreign delegations expressed their greetings. The Acting Secretary General of URSI made the following remarks (English translation):

" First I must apologise for the absence of the President of the International Scientific Radio Union (Professor Silver) who is in Tokyo for the annual meeting of the International Committee on Space Research. However, I am honoured to be asked to represent our Union at this meeting and to convey our cordial greetings to Professor Siforov, and to all who have come here to honour the memory of Aleksandr Stepanovitch Popov.

My previous visits to Moscow were at the invitation of Professor Belous-sov and the members of the Soviet Geophysical Committee with whom I have worked closely for the last five years. This visit is my first since I took up my duties with URSI in January this year and I think it is very appropriate that I have come back to Moscow at the invitation of the Popov Society.

For more than 10 years the Soviet Union has been a member of URSI and Soviet scientists have made many contributions to the work of our different Commissions. Until recently, Academician Prokhorov was one of our Vice-Presidents and at present Prof. Zhabotinskii is Vice-Chairman of our Commission on Radio Measurements and Standards. This visit has given me an opportunity of meeting them and some of the other radio scientists in the Soviet Union who are maintaining the traditions in radio research established by Popov more than 70 years ago.

In conclusion may I express to the Popov Society my appreciation of the excellent arrangements made for this meeting and of the many papers presented „.

The Closing Session was followed by a Banquet at the Praga Restaurant.

URSI-CIG Working Party on Ionospheric Drift Analysis

held at
Appenzell, Switzerland
October 5-6, 1967

Present:

K. Bibl	C.O. Hines	R. Rastogi
G. Brown	D. Jones	K. Rawer (*Member*)
L.S. Fedor	G.S. Kent (*Secretary*)	A. Spizzichino (*Member*)
E. Harnischmacher	W. Pfister (*Member*)	K. Sprenger (*Member*)
A. Haubert	W.R. Piggott (*Member*)	J.W. Wright
F. Hibberd	M. Pitteway	R.W. Wright (*Chairman*)

SUMMARIES OF DISCUSSIONS

Session 1. — Thursday, October 5, 1967 (Morning)

Review of the Proceedings of the Symposium held at St. Gallen on Upper Atmospheric Winds, Waves and Ionospheric Drifts October 3-4, 1967

There was general agreement on the usefulness of the D1 method in the E region with some reservations about the effects of waves on the results obtained from the method. The usefulness of the D1 method in the F region was in more doubt. However, there is evidence of differences between the TID observations, which are generally accepted to record wave motion, and the results of the D1 method in the F region.

There were divided views about future activities. General agreement was expressed on the great need for more intensive studies of the methods of analysis and for additional comparisons with other more direct methods of movement measurement. It was also clear that a great deal of stress was laid upon the need for phase and amplitude measurements with a full analysis at several stations.

Session 2. — Thursday, October 5, 1967 (Afternoon)

A Discussion of the Methods of Analysis for Fading Records used in the D1 Method

No agreement could be reached over the relative advantages of the simple forms of analysis, such as similar fades, and the more complex treatment through correlation analysis. Some felt that similar fades required less work and therefore a more complete statistical study could be undertaken without excessive work. In addition, the " factor of two „ problem seemed to indicate that the correlation method, as normally applied, gave answers which were too small, and consequently that the higher values from the similar fade treatment were closer to the results of more direct methods.

On the other hand, others maintained that the correlation analysis provided much more information regarding the diffraction pattern, and that it was the only method so far available which could recognise the changing diffraction pattern and allow for it in the analysis. At the same time it was realised that a full correlation analysis should be three dimensional, but as yet a complete examination of the theory and the applicability of the assumptions involved has not been carried out.

Some reservations were expressed regarding the influence of wave-like structures in the ionosphere on both the above methods. Advocates of the spectral analysis approach pointed out its advantages but, as yet, it seems that an inadequate amount of work has been done in this field.

It was particularly clear that the relation between the movements of the diffraction pattern on the ground and the movements of the ionosphere (the step which involves the " factor of two „) is held in suspicion by several workers. No explanation is at present available for the (rather limited) experimental results which have been presented to suggest that the " factor of two „ is in error.

Session 3. — Friday, October 6, 1967 (Morning)

Continuation of Discussion on Methods of Analysis, and an Examination of the Requirements for a Routine Station

This session was concerned with the reliability and consistency of fading records, and with the recommendations for the operation of a routine drifts station using a similar fades analysis. It began with a discussion of the consistency of consecutive fading records. There was considerable disagreement, but it appeared likely that the consistency does, in fact, vary considerably with latitude and season. It was noted that a similar fades analysis may be carried out using average time drifts or average vectors, or by an optical comparison and that this introduces further differences between stations.

Recommendations were put forward for the operation of a station using a similar-fades analysis technique. The major factor in these recommendations was the necessity for large numbers of regular measurements. Selection rules for records were suggested and debated in detail. It was also pointed out that a good echo-height determination was a very necessary adjunct to drifts measurements and that stations should be encouraged to make as accurate a measurement of this parameter as possible.

Session 4. — Friday, October 6, 1967 (Afternoon)

A Continuation of the Needs of Routine Stations and a Discussion of Special Experiments

The first part of this session was concerned with the form of presentation of drifts data. It was agreed that stations should be encouraged to produce monthly data sheets showing the amplitude and direction of all measurements made.

The committee then debated the recommendations for a station doing a full correlation analysis. Considerable disagreement arose, particularly with regard to the relative values of different experimental and analysis methods. Dr. Pfister was asked to prepare a review of correlation analysis methods.

The final subject debated was that of the intercomparison of drift results obtained by different methods. It was agreed that there had been insufficient simultaneous measurements of drifts by different methods and a list of experiments of importance was prepared.

RECOMMENDATIONS ACCEPTED AT THE MEETING

1. It was agreed:
   1.1 that the D1 method of measuring ionospheric drifts, when properly interpreted, can provide direct information regarding the circulation of the neutral wind in the D and E regions of the ionosphere, or ionospheric meteorology.
   1.2 that similar measurements in the lower F region provide valuable data regarding the dynamic processes in the F region which are relevant to the electrodynamic drifts, the neutral wind movements, and oscillatory processes in the F region and below.

2. It was recommended:
   2.1 that the present programme in drift studies should be continued and other stations encouraged to commence such studies in order to provide a more comprehensive world-wide synoptic survey of the movements measured.
   2.2 that all stations should be urged to record the important ancillary parameters required to give physical significance to the observations, and to treat and analyse their data in compatible forms

as described in the appendix to these recommendations which will be published later.

2.3 that certain stations should undertake intensive studies of the various methods of analysis in order to provide a comparison of these methods and an assessment of both their accuracy of representation of the actual conditions prevailing, and the physical significance of the parameters which evolve.

2.4 that further experiments should be carried out to intercompare the various methods of measurement of motion in the upper atmosphere such as spaced receivers ground transmitter (D1), meteor measurements (D2), spaced receivers extra-terrestrial radio source (D3), widely spaced receivers (D4), partial reflection studies (D5), chemical trail studies and Thomson scatter measurements.

R.W. Wright

25 April 1967.

International Ursigram and World Days Service (IUWDS)

In July 1967 in London, there were meetings of the representatives of the Regional Warning Centres and of the IUWDS Steering Committee. The Minutes of these Meetings were circulated to the members under cover of IUWDS Circular Letter RWC-103 dated 5 April 1968. They are reproduced below.

MINUTES OF THE IUWDS MEETING OF REPRESENTATIVES OF THE REGIONAL WARNING CENTERS LONDON, JULY 24, 1967

The following were present:

Representatives:

Mr. A. H. Shapley, IUWDS Chairman
Mr. R. Doeker, representing K. D. Boggs, IUWDS World Warning Agency
Dr. P. Simon, Paris Section, European RWC and Secretary, IUWDS
Dr. B. Beckmann, Darmstadt Section, European RWC
Prof. M. Huruhata, representing Dr. Uyeda, Western Pacific RWC (Kokubunji)
Mrs. R. A. Zevakina, Eurasian RWC (Moscow)
Miss J. V. Lincoln, Deputy Sec'y., IUWDS Western Hemisphere RWC (Ft. Belvoir)
Mr. F. Cook, Australian RWC (Sydney)
Dr. A. P. Mitra, Indian Associate RWC (New Delhi)
Mr. P. Triska, Czechoslovakian Associate RWC (Praha)

Observers:

Dr. J. C. Bhattacharya, Kodaikanal Observatory, India
Major T. D. Damon, Air Weather Service, USA
Dr. H. Leinbach, ESSA Boulder, USA

Absent were:

Mr. H. Van Lohuizen, NERA Section, European RWC
Mr. P. Akerlind, Swedish RWC (Stockholm)
Mr. E. S. Kazimirovsky, Siberian RWC Irkutsk

The chairman opened the meeting at 0930. This was the first meeting of persons who are actually operating the prediction centers; of the 12 centers, Kokubunji was represented by Prof. M. Huruhata; Irkutsk, Stockholm and NERA were not represented, but the large attendance should result in many accomplishments during the meeting. After having recalled the different activities of the IUWDS and bringing to mind the growing interest manifested in these services, Mr. Shapley excused himself and asked the Secretaries to conduct the detailed work of this meeting.

The secretary presented a report. The IUWDS provides a common work. Personal contacts greatly facilitate this collaboration. It is the interest of this meeting, and this justified his recent visits to NERA, Darmstadt, Ft. Belvoir and Boulder.

During the last years a certain number of *new facts* have intervened:

(1) A growing interest in *solar activity* related to space research and solar research and for astronauts. Despite the telecommunications satellites, *ionospheric prediction* has not lost its interest.

(2) Since the IGY the very marked development of our *knowledge of solar activity* has furnished scientific elements for prediction.

(3) The *development*, sometimes of major proportions, of certain *forecast centers* (Boulder, etc.) has been accomplished.

These facts can modify profoundly our methods of operation:

(*a*) It appears necessary because of differences in techniques, to form specialized regional centers, certain ones having charge of solar forecasts, others of ionospheric forecasts.

(*b*) The actual methods permit exchange of information in synthesized form in seeking to describe totally each *solar center of activity and each solar-geophysical event* more than by putting side by side the observations obtained by different techniques. This at the same time reduces the necessary amount of exchanges between centers and distribution to institutions.

(*c*) We have need of more *precision*: both in our forecasts (importance of event, position, effects, time) and in the reports (descriptions of events or of centers).

Our meeting ought to permit us to find these common elements which are necessary for the realization of all this progress. After some discussion, the meeting passed to the agenda (See Circular Letter RWC-96).

I. A. 2. — Antarctic Messages

The secretary explained how Meudon has been led to prepare these very short messages for geophysicists taking part in programs in very isolated sites. These GEOSOL messages, described in a document distributed to participants, combine useful indices of solar or geophysical activity, the description of the solar disk in terms of solar-terrestrial relations, forecasts and alerts. After a year of experience with SPARMO and different research workers, it appears possible to do a regular distribution for the benefit of Antarctic stations. It requires comments of delegates having to do with this proposition in SCAR.

In course of the discussion, it quickly appeared that this proposition also was interesting to the regional centers. In the interest of IUWDS, it ought to assure a wide distribution of these GEOSOL messages introducing them in interchange messages. The problem of speed of liaison rests, however, predominantly on those which concern Arctic and Antarctic zones.

I. A. 1. — IMPROVEMENT IN STANDARD FREQUENCY BROADCASTS OF IUWDS (Proposal contained in Circular Letter RWC-99). The single symbol transmitted in the past will be replaced by three distinct symbols. By the introduction of simple conventions, quite a bit of information will be given on forecasts and on reports of solar or geophysical events. The new scheme will start on January 1, 1968. (The details as finally adopted are fully covered in Circular Letter RWC-101).

III. B. — ADVICE FOR WORLD—WIDE ALERTS

It appears indispensable to make known to the WWA the observations used in the advice, and to the customers those observations which were the basis for the Adalerts or Geoalerts. On the basis of a document distributed to participants, a new list of symbols to use in the Advice message has been established taking account of different suggestions. It will be the subject of a future circular letter.

II. C. — CODES—TYPE AND FORMAT

A discussion was opened, based on Circular Letter RWC-98, on modifications to make the codes in use take account of the actual situation: for example, the indicators of the stations are arbitrary; the different codes do not permit precise indication of the new frequencies used in radio astronomy and do not give a fine enough scale to report flux measurements; it is difficult to describe cosmic events, etc. A certain number of suggestions were made. A revised Code Booklet should be published in 1968 to take account of these improvements.

II. B. — SCHEDULE OF DAILY INTERCHANGE MESSAGES

After discussion, it has been recognized that there was not great interest in modifying the present arrangements.

II. A. — Content of Daily Interchange Messages

The principal comments were on the lack of daily ionospheric data.

IV. A. — Astrogram Service

This has given, in general, satisfaction except for centers not having a 24-hour service.

IV. B. — SPACEWARN Service

Modifications to this service are proposed each year in COSPAR Working Group III. This service seems to give satisfaction.

I. B. 1. — How do we Advertise our Services within Region?

The centers described their efforts to make themselves known: manuals, information leaflets, circular letters, national committee meetings.

I. C. — Distribution of Less Frequent Reports

According to the centers, there are reports weekly, every ten days, monthly or occasional ones (on an active center).

III. A. — Regional Forecast Types and Users

In general, most of the RWC are for short-term ionospheric forecasts (from several hours to several days ahead) based on the mission of the sponsoring organization. Some RWC are only for solar activity forecasts.

The meeting adjourned at 1600 hours to permit the meeting of the Steering Committee to begin.

P. Simon.

MINUTES OF IUWDS STEERING COMMITTEE SIXTH MEETING LONDON, JULY 24, 1967

The following were present:

Member:

A. H. Shapley, Chairman
P. Simon, Secretary
J.V. Lincoln, Deputy Secretary
A. P. Mitra, URSI
R. A. Zevakina, Eurasian Region
R. L. Smith-Rose, European Region
F. E. Cook, Australasian Region
M. Huruhata, representing H. Uyeda, Western Pacific Region

Liaison:

J.P. Legrand, SPARMO

Observer:

C. Clark, National Science Foundation
R. W. Knecht, ESSA, Boulder, Colorado
G. W. Kronebach, WMO

Absent were:

Colonel E. Herbays, Secretary General URSI
M. Nicolet, IUGG
R. Michard, IAU
J. F. Gabites, WMO
M. Fournier d'Albe, UNESCO

The chairman opened the meeting at 1600. He excused those absent and recalled in a few words the role of IUWDS: Geophysical Calendars, rapid exchange of data, alerts, forecasts, assistance to COSPAR, IAU, etc., .., and publication of " Calendar Records „.

Most of the finances come from national funds; FAGS gives $3000 to $4000 per year for publications and for some travel for coordination of activities. As time goes on, the IUWDS seems to take on more and more importance.

INTERNATIONAL SOLAR TERRESTRIAL SERVICE

This service had its origin in a resolution of IUCSTR at its final meeting in Belgrade (September 1966). The IUCSTP created an *ad hoc* committee, formed of WDC representatives (A. H. Shapley, chairman, N.V. Pushkov, T. Nagata) with C. M. Minnis, secretary.

Dr. Pushkov and Mr. Shapley circulated in March 1967 their first commentaries defining this service: coordination of observations, exchange of short-term data, forecasts, alerts, technical publications related to the observations, definitive publication of data, etc... Such a service would cover, in particular, activities already performed by a certain number of services coordinated in FAGS: IUWDS, Service of Geomagnetic Indices, Quarterly Bulletin of IAU, and SPARMO. It is because of this that we ought to take a position vis-à-vis the creation of this service.

Actually, the situation of the ISTS has been defined little by little; at Prague in March 1967: the idea of a secretariat common to ISTS and IUCSTP has been set aside.

Here in London, on 19 July, a meeting devoted to the fundamental problem of coordination of routine observations was attended by about 50 persons.

Finally, among the comments received, the principal problem raised was that of financial resources.

Having opened the discussion, the chairman set up the balance of activities which justify the existence of a permanent secretariat for ISTS; the disappearance of the IQSY Committee after that of IGY; the probably disappearance of IQSY NOTES with all the immediate consequences of disappearance of organs of coordination.

A long discussion was opened in which all present took part; because of the magnitude of the problem, it was impossible to arrive at definite propositions. Two points of view clearly appeared: IUWDS could play a fundamental role in the realization of this project, but in the immediate future it ought to take account of extraordinary evolutions that have come into play in the solar-terrestrial field. It ought to adapt its statutes to the actual situation. This would permit IUWDS in useful time to play its role plainly in ISTS when decisions will be defined on this subjet.

The secretary is, therefore, charged to propose a revised terms of reference for IUWDS and to ask by correspondence for discussion on this proposal.

Future Financing of IUWDS Work

This problem has been raised following a note from the Standing Finance Committee of ICSU expressing its reservations on its intention to continue subventions to permanent services. If such an attitude were confirmed, it would pose in turn the problem of finding other sources of funds; a brief discussion indicated that this matter would create a difficult problem.

Other Business

The secretariat of IUWDS ought to revise the World Days program and prepare a new code booklet.

IUCSTP has not yet responded to the resolution we adopted at Belgrade.

The meeting adjourned at 1830. The next meeting will take place in 1968 at a place and time which seems the most appropriate to unite easily the members of the Steering Committee.

P. Simon.

THE INTERNATIONAL URSIGRAM AND WORLD DAYS SERVICE

Report on Activities during 1967

(see French text p. 45)

The International Ursigram and World Days Service (IUWDS) is one of the Permanent Services of the Federation of Astronomical and Geophysical Services (FAGS), through which it receives subventions from UNESCO for part of its activities and publications. It is administered by the International Union for Scientific Radio (URSI) in association with the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (IUGG).

The aim of the Service is to facilitate *a close and permanent cooperation* between all scientists interested in solar activity and the geophysical phenomena caused by it.

A continuous patrol of solar and geophysical activity can be achieved only with the voluntary cooperation of all the interested observatories and institutes. The IUWDS organizes this cooperation through its *regional and associate centres,* each of which collects information within a region and receives information from other regional centres. As a result of this organisation, information about most of the phenomena observed is made available throughout the world within a few hours after the event. The data are transmitted by the quickest possible means and they can be used by any observatory or organisation requiring them for routine activities, for a special experiment, or for the coordination of an international project.

In its simplest form the information is issued as a series of daily messages (*Ursigrams*) which are themselves broadcast by radio from stations in Europe and Japan. They include, in coded form, a description of the principal solar observations (photosphere, chromosphere, corona, radio, solar events), geomagnetic observations, ionospheric data (critical frequencies), cosmic data (cosmic rays, polar cap absorption, etc...) and so on. Their contents vary according to the needs expressed by the users.

Beginning in 1967, new types of message have been sent out daily: solar and geophysical activity is described and predictions are given in plain language in the Boulder Space Distrubance Forecasts (SDF), and in semi-code in the Meudon GEOSOL messages.

The first of these (*SDF*) includes 1000 to 1500 symbols; the first part (A) describes the solar disk and any evidence of activity (flares, geomagnetic storms, cosmic events); the second (B) gives a prediction of the activity expected in each active region. In the third part (C), the probability of occurrence of some type of event (for example, a proton flare) is given, part (D) gives the predicted and observed values of certain fundamental data (10 cm flux, geomagnetic activity).

The second message (GEOSOL) is much shorter (150 to 200 symbols) and it begins with a series of indices characterising the preceding day (Wolf number, 10 cm flux, geomagnetic activity, cosmic rays, flares). If necessary, major events are reported (important flares, geomagnetic storms, cosmic events). Then the solar disk is described in terms of predictions of activity in four types of active region: quiet, flare, active, and proton flare. Finally an overall prediction is given in the form of one or more alerts corresponding to different observational programmes.

These messages tend to vary in accordance with current scientific and technical programmes. The information is provided in the form of a synthesis (or a diagnosis) prepared by experienced scientists who give the essential details in the form most easily usuable by the experimenters. The arrangements are fairly flexible and can always be adapted to suit new circumstances.

Another service makes use of the *standard frequency transmitters* (WWV and WWVH) for the transmission, in symbolic form once per hour from each transmitter, of four types of information relating to alerts or to important events. The conventional signals used are described in Circular RWC-99 copies of which are available from the Secretaries of IUWDS.

In addition to these standard messages, which are sent out regularly by the various regional centres, there are also *special messages* which are sent out, on a temporary basis, for particular experiments. In these cases, the interested regional centres make arrangements, on either a local or a world-wide basis, for the establishment of new links and for the collection of new data in such a way that the information required can be made available when it is needed. For example, IUWDS has participated in the provision of information for flights of manned satellites; for programming satellites in flight; for the launch of rockets designed to make observations of the sun, the ionosphere etc... for the release of balloons for solar observations or for coordinated measurements of particles, radiation etc... In each case, the scientists in charge of the regional centres must take carefully organised plans taking into account the very different conditions of each experiment or project.

It has already been pointed out that the centres provide both data and *predictions*; in the second case the results represent activity actually in progress. For the prediction of propagation conditions, the main problem is to assemble the data in sufficient numbers and quickly enough to enable the trends and their variations to be recognized. For solar activity, the predictions are based on a detailed study of the characteristics of each active region; the problem of the quality of the observations and the method of transmitting the data are key factors.

The different IUWDS centres cooperate in the issue of a *world Geoalert* the object of which is, since 1 January 1967, to predict the solar active regions that are most likely to produce flares or proton events. At present, the final solar observational data are available only for the first six months of 1967. During this period, *44 of the 57 Geoalerts sent out* (80%) *were correct*; the four groups of most active spots for this period have thus actually been announced before their activity became evident. More generally, the average number of flares on an *alert day* was about twice as great as on a day without an alert. In fact, half the flares were correctly predicted, although it can be estimated that this figure would rise to 80% for the flarers that could actually have been predicted.

The proposed objective, *the prediction of flares with their position*, has been attained in a satisfactory manner even though it can not yet be claimed that all flares can be predicted. Bearing in mind that these results refer only to the first six months of operation of this scheme, it is expected that better results will be obtained in future and, in particular, that it will be possible soon to predict the *flares that cause geophysical effects* which, as a matter of fact, occur less frequently.

As an organisation, the Permanent Service has assisted COSPAR and IAU at irregular intervals. COSPAR has the responsibility of *listing all satellites and space probes* and of providing, for interested organisations, the orbital elements of satellites and information on the method of operation of those which can be used for international observations. In practice the World Warning Service of IUWDS at Fort Belvoir is mainly responsible for assembling the information on behalf of COSPAR and for sending it out by telegram or by circular letter (once every fortnight) according to the different requirements.

The IAU *Astronomical Telegram Service*, at present the responsibility of the Smithsonian Observatory at Cambridge (Mass.), is intended for the announcement of observations of comets, novae or any other unexpected object likely to interest astronomers. The IUWDS is responsible for the transmission of the telegrams; 28 have been sent in connection with the discovery of 14 comets and a satellite of Saturn, and also to give information about six novae or supernovae.

Two of the more routine tasks of IUWDS are to assist in planning simultaneous observations, and to publish, at the same time, observations relating to several very different disciplines. In both cases this is a new type of coordination which no other organisation undertakes.

The first task is achieved by the publication of the *International Geophysical Calendar* in numerous journals and by sending copies of it to many observatories. It designates in advance, according to the frequency with which observations are to be taken, one day per week (RGD), three days per month (RWD), two weeks per season (WGI) and some other days during the year; these periods are all particularly appropriate to ionospheric observations, the launch of meteorological rockets, and any other local measurements which should be made preferably at the same time as similar measurements elsewhere.

The *Abbreviated Calendar Record* assembles the various solar and geophysical observations for each day. For the years 1960 to 1965, the final version of the Calendar will be published in 1968 as Annals of the IQSY, Volume 2.

The *overall organisation of the Service* was described in detail in 1967 in IQSY Notes No. 19 (" 1966-1967 World Days Programme„). This booklet can be obtained without charge from the Secretary of IUWDS (Dr P. SIMON, Observatoire, 92 Meudon, France). It describes the organisation of the World Days, the scientific programmes recommended for such days and periods, the organisation of the different centres, the various activities of the Service, and, finally, very complete information on the world and regional centres, the national representatives and the membership of the IUWDS Steering Committee. These details will, without doubt, have to be modified to some extent so as to take account of the requirements of the IUCSTP projects.

At the IQSY Assembly in London in July 1967, the individuals responsible for most of the regional centres met in order to study the problems that IUWDS will meet as a result of the future projects being planned by IUCSTP. Fresh progress will certainly be made as a result of these projects.

Meudon, 28 February 1968.
P. SIMON
IUWDS, *Secretary.*

LE SERVICE INTERNATIONAL DES URSIGRAMMES ET JOURS MONDIAUX

Rapport sur les activités de 1967

Le service International des Ursigrammes et Jours Mondiaux (IUWDS) est un *service permanent* de l'Union Radio Scientifique Internationale (URSI), en association avec l'Union Astronomique Internationale (UAI) et l'Union Internationale de Géodésie et Géophysique (UIGG). L'IUWDS adhère à la Fédération des Services d'Astronomie et de Géophysique (FAGS); par son intermédiaire, il reçoit des subventions de l'UNESCO pour une partie de ses activités et de ses publications.

Le service s'attache à réaliser une *cooperation immédiate et permanente* entre tous les scientifiques intéressés par l'activité solaire et ses conséquences géophysiques. Comme service permanent l'IUWDS apporte aussi son concours à l'UAI et au COSPAR pour certaines activités de routine.

La surveillance continue de l'activité solaire et géophysique ne peut se réaliser que par une *coopération volontaire* de tous les observatoires et instituts qui y sont intéressés. L'IUWDS organise cette coopération grâce à ses centres régionaux ou à ses centres associés: chacun d'entre eux collecte ses informations dans une région et reçoit celles recueillies par les autres centres régionaux. Grâce à cette organisation, la plupart des phénomènes observés sont connus *dans le monde entier quelques heures après l'événement.*

Cette transmission de données s'effectue par les moyens les plus rapides: elle permet d'assister tout observatoire ou toute organisation ayant besoin de ces informations soit pour une activité de routine soit pour l'exécution d'un projet scientifique spécial, soit encore pour la coordination d'un projet international.

Dans sa forme la plus simple, l'information apparaît dans des messages quotidiens, les *Ursigrammes* qui sont même radiodiffusés par des stations de service en Europe et au Japon. Ils comprennent, sous forme codée, une description des principales observations solaires (photosphère, chromosphère, couronne, radio, événements), géomagnétiques, ionosphériques (fréquences critiques), cosmiques (rayonnement cosmique, absorption polaire, etc...) etc... Leur contenu varie selon les besoins exprimés par les utilisateurs.

Depuis 1967 de nouveaux types de message sont diffusés quotidiennement. En langage clair (Space Disturbance Forecast de Boulder) ou semi codé (message GEOSOL de Meudon) les activités solaires et géophysiques y sont décrites et des prévisions y sont établies.

Le premier message (*SDF*) comporte de 1000 à 1500 signes: la première partie (A) décrit le disque solaire et les manifestations d'activité (éruptions, orages géomagnétiques, événements cosmiques), la seconde (B) établit la prévision d'activité pour chaque centre d'activité. Dans une troisième partie (C) sont les probabilités d'observer un type d'événement (éruption à protons par exemple) et, pour conclure, (D) on fournit les valeurs observées et prévues de certaines données fondamentales (flux 10cm, activité géomagnétique).

Le second (*GEOSOL*), beaucoup plus court (150 à 200 signes), commence par fournir une série d'indices caractérisant la journée précédente (nombre de Wolf, flux 10cm, activité géomagnétique, rayonnement cosmique, éruptions). Eventuellement sont rapportés les événements majeurs (éruption importante, orage géomagnétique, événement cosmique). Le disque solaire est ensuite décrit en termes de prévision d'activité selon quatre catégories de centres: calme, éruptif, actif et à protons. Enfin un diagnostic global est fourni sous forme d'alertes correspondant à différents programmes scientifiques.

Ces messages montrent une nouvelle tendance correspondant aux possibilités existant soit sur le plan scientifique soit sur le plan technique. L'information y est fournie sous forme de *synthèse* (ou *de diagnostic*) établie par des scientifiques compétents; ceux-ci fournissent des éléments de décision sous une forme plus facilement utilisable par les expérimentateurs. L'ensemble reste assez souple et peut toujours s'adapter à de nouvelles circonstances.

Notons encore l'utilisation des *émetteurs de signaux horaires* (WWV et WWVH) pour la diffusion, sous forme symbolique, une fois par heure sur chaque émetteur, de quatre informations relatives soit à des alertes soit à des événements importants. Les conventions utilisées sont décrites dans la circulaire RWC-99 disponible auprès des secrétaires de l'IUWDS.

A ces messages standard dont la diffusion est effectuée régulièrement par les différents centres régionaux, il faut ajouter les *messages spéciaux* envoyés temporairement pour certaines expériences: à cette occasion les centres régionaux intéressés organisent localement ou sur le plan mondial de nouvelles liaisons, collectent de nouvelles données de façon à fournir en temps utile les informations nécessaires. Parmi les expériences ainsi assistées et connues du secrétaire de l'IUWDS, citons les vols de satellite habités, la programmation en vol des satellites, les tirs de fusées pour des observations solaires, ionosphériques, etc... les envols de ballons pour des observations solaires, pour des mesures coordonnées de particules et de rayonnement, etc... Dans chaque cas les scientifiques dirigeant les centres régionaux doivent organiser soigneusement ces campagnes pour tenir compte des conditions très différentes des expériences.

On a pu remarquer que les centres fournissent des données et des *prévisions*. En ce dernier domaine les résultats obtenus sont en net progrès. En ce qui concerne les conditions de propagation le problème est surtout de réunir les données en nombre suffisant et assez rapidement pour suivre l'évolution des tendances. Pour l'activité solaire, actuellement la prévision est établie à partir d'une étude détaillée des composantes de chaque centre d'activité: le problème de la qualité de l'observation et de la forme de transmission des données devient crucial.

Les différents centres de l'IUWDS collaborent à une Géoalerte mondiale qui s'est donné pour objet, depuis le 1er janvier 1967, de prévoir les centres solaires les plus éruptifs ou devant donner des événements à protons. On ne dispose actuellement des observations solaires définitives que pour les six premiers mois de 1967. Pendant cette période pour 57 Géoalertes diffusées, 44 étaient correctes, soit 80%: *les quatre groupes de taches* les plus éruptifs pour cette période ont été ainsi signalés pratiquement avant que leur activité ne se manifeste. De façon plus globale il y a eu, en moyenne, deux fois plus d'éruptions pendant un jour à alerte que pendant un jour sans alerte. En fait la moitié des éruptions ont été effectivement prévues à l'avance alors que l'on peut estimer à 80% la proportion des éruptions actuellement prévisibles.

Le but proposé, prévoir les éruptions avec leur position, a été atteint de façon satisfaisante, bien que l'on ne puisse songer actuellement à prévoir toutes les éruptions. Compte tenu du fait qu'il ne s'agit que des six premiers mois de cette entreprise, on peut penser que des résultats meilleurs seront obtenus à l'avenir et, en particulier, que l'on pourra bientôt prévoir les éruptions à effets géophysiques qui, en définitive, ne sont pas les plus nombreuses.

De façon organique, mais épisodique, le service permanent prête son concours au COSPAR et à l'UAI.

Le COSPAR a la tâche *d'identifier tous les satellites* et *toutes les sondes spatiales* et de fournir aux organismes intéressés les éléments de calcul des orbites des satellites et des renseignements sur le fonctionnement de ceux qui peuvent donner lieu à une observation internationale. En fait c'est le centre mondial de l'IUWDS à Fort Belvoir qui joue alors le rôle essentiel en centralisant les informations pour le compte du COSPAR et en les diffusant par télégramme ou par lettre circulaire (tous les quinze jours) selon l'intérêt des expériences.

Le service des *Télégrammes Astronomiques* de l'UAI, actuellement à la charge du Smithsonian Observatory de Cambridge (Massachusetts), a pour but d'annoncer les observations de comètes, de novae et en général de tout objet imprévu pouvant intéresser les astronomes. L'IUWDS est chargé de la transmission par télégramme des informations: 28 télégrammes ont ainsi été émis pour signaler, en particulier, la découverte de 14 comètes, d'un satellite de Saturne et pour donner des informations sur 6 novae ou supernovae.

Une tâche plus routinière est celle de favoriser certaines *observations simultanées* ou de *publier simultanément* des observations relatives à des disciplines très différentes. Dans l'un et l'autre cas, il s'agit d'une coordination originale qui n'est assurée par aucun autre organisme.

Le premier but est atteint par la publication du *Calendrier Géophysique International* dans de nombreuses revues ou par sa diffusion à de nombreux observatoires. Il prévoit, suivant le rythme des observations, un jour par semaine (RGD), trois jours par mois (RWD), deux semaines par saison (WGI) et quelques autres jours répartis dans l'année, tous particulièrement propres aux observations ionosphériques, au tir de fusées météorologiques et à toutes mesures locales qui peuvent bénéficier d'une simultanéité avec d'autres observations.

L'« *Abbreviated Calendar Record* » rassemble pour chaque jour les diverses observations solaires et géophysiques. Pour les années 1960 à 1965, l'édition définitive est en cours d'impression aux « Annales de l'IQSY ».

L'ensemble de l'organisation du service a été décrit en détail cette année dans le N° 19 des IQSY Notes sous le titre « 1966-1967 World Day Program » Ce fascicule est disponible sans frais auprès du Secrétaire de l'IUWDS (Dr P. *SIMON*, Observatoire 92 MEUDON — FRANCE). Il décrit l'organisation des Jours Mondiaux, les programmes scientifiques recommandés pour ces jours ou périodes, l'organisation des divers centres, les diverses activités du service et, pour conclure, il donne des informations très complètes sur les centres mondiaux et régionaux, les représentants nationaux et la composition du comité de direction. Cette organisation sera sans doute modifiée sensiblement pour tenir compte des projets de l'IUCSTP.

Cet été, à Londres, pendant l'assemblée générale de l'IQSY, les responsables de la plupart des centres régionaux se sont réunis pour étudier les problèmes de l'IUWDS en vue des prochains projets de coopération préparés par l'IUCSTP. Une nouvelle étape sera certainement réalisée à cette occasion.

Meudon, le 28 février 1968

P. SIMON

Secrétaire de l'IUWDS.

MEMBRES OFFICIELS DES COMMISSIONS DE L'URSI

Les listes des membres officiels des Commissions de l'URSI ont été publiées dans le N° 165 du *Bulletin d'Information* (pp 7 à 27). Les modifications et additions suivantes ont été notifiées au Secrétariat avant le 21 mai 1968.

Commission I on Radio Standards and Measurements

Austria: Dipl. Ing. Walter Stiefler, Bundesamt für Eich- und Vermessungswesen, A-1160 Wien, Arltgasse 35

France: J. Uebersfeld, Professeur à la Faculté des Sciences, Tour 12, 9 quai Saint-Bernard, 75 - Paris - 5

Finlande: Prof. Dr. Teuvo Kohonen, Technical University of Helsinki, Otaniemi,

Sweden: Mr. P. O. Lundbom, Head of Division Instruments and Standards, Research Institute of National Defence, Dept. 3, Stockholm 80

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Commission II on Radio and Non-Ionized Media

Austria: Univ. Prof. Dr. Ferdinand Steinhauser, Zentralanstalt für Meteorologie und Geodynamik, A-1190 Wien, Hohe Warte 38

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Commission V on Radio Astronomy

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Argentina: Dr. Carlos Varsavsky, Instituto Argentino de Radioastronomia, C. Correo 5, Villa Elisa (BA)

Finland: Prof. Dr. Jaako Tuominen, University of Helsinki, E. Hesperiankatu 4, Helsinki 10

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ESSA Research Laboratoires (ERL) Boulder, Colorado

On 15 February 1968, several changes were announced in the staffing of the Research Laboratories (ERL) of the Environmental Science Services Administration at Boulder, Colorado.

Mr. R. W. Knecht has been appointed Deputy to the Director, Dr. G. S. Benton. Dr. C. G. Little has been appointed Director of the new Wave Propagation Laboratory of ERL and consultant to Dr. Benton. Dr. R. J. Slutz replaces Mr. Knecht as acting Director of the Space Disturbances Laboratory.

Mr. Knecht and Dr. Little have been particularly active in URSI Commission III for many years.

Comité Consultatif International des Radiocommunications (CCIR)

At its last Plenary Assembly in Oslo in 1966, CCIR referred a number of its Reports, Questions and Study Programmes to URSI. These were briefly considered at the URSI General Assembly in Munich in September 1966 and preliminary steps were taken for the preparation of URSI responses by individuals or small groups of people with the necessary detailed knowledge.

The URSI responses relating to CCIR Study Groups V, VI and VII were submitted to CCIR in March 1968 and have since been reproduced as CCIR documents which will be considered at the Study Group Meetings to be held in Boulder, Colo. in July 1968.

The URSI Board of Officers recently recommended that the text of the URSI documents should be reproduced in the Information Bulletin. The documents in question are as follows:

Reference Number	
URSI	*CCIR*
R29 (68)	V/9
R30 (68)	V/10
R31 (68)	V/11
R4 (68)	VI/5
R17 (68)	VI/6
R22 (68)	VI/7
R26 (68)	VI/8
R35 (68)	VI/9
R25 (68)	VII/3 and 5

These documents were first submitted to the URSI Board of Officers and the appropriate Commission Chairmen and represent official URSI communications to CCIR. However it is appropriate here to acknowledge the commendable efforts made by the original authors and their collaborators which ensured that the text was ready in time for the March 1968 deadline: F. du Castel (France), L. Essen (UK), T. R. Hartz (Canada), W. R. Piggott (UK), K. Rawer (Germany), J. A. Saxton (UK), J. D. Whitehead (Australia).

DEFINITION OF TERMS RELATING TO PROPAGATION IN THE TROPOSPHERE

CCIR Recommendation 310-1

A working party of URSI Commission II appointed by the Chairman of the Commission to consider Recommendation 310-1 makes the following comments.

TERM NO. 2: " TROPOPAUSE „

The definition should in fact be " the boundary between the troposphere and stratosphere „; this would then require a definition of the stratosphere. In practice, however, the position of the tropopause is sometimes difficult to determine and multiple tropopauses can occur at times. The WMO definition of the *first* tropopause is " the lowest level at which the lapse rate decreases to 2°C/km or less, provided also that the average lapse rate between this level and all higher levels within 2 km does not exceed 2°C/km. „ It is therefore not strictly true to say (as in the CCIR definition) " above which the temperature usually increases slightly with respect to height, or remains constant. „ For the present purpose it may be sufficient to say " above which the temperature usually does not decrease with increasing height „, but it may be desirable to add an indication that the strict WMO definition is more complicated.

TERM NO. 3: " TEMPERATURE INVERSION „

Delete " In the troposphere „.

TERM NO. 4: " MIXING RATIO „

The official WMO definition is " the ratio of the mass of water vapour to the mass of dry air with which the water vapour is associated„. The units are therefore gm/gm. There could be a note in parenthesis: " (frequently expressed in gm/kgm) „.

TERM NO. 5: " RELATIVE HUMIDITY „

It is strictly necessary to say whether the relative humidity is expressed with respect to water or ice. The definition could thus read:
" *Relative humidity with respect to water(ice).* Ratio in per cent of the vapour pressure of water vapour in moist air to the saturation vapour pressure with respect to water (ice) at the same temperature and pressure „.
According to the WMO definition, it is *always* expressed in per cent.

TERM NO. 17: " SUPER REFRACTION „

Why not simply substitute " or negative „ instead of " and may increase negatively „?

TERM NO. 21: " EFFECTIVE EARTH RADIUS „

In the parenthetical last sentence of the definition, insert the word " radio„ between the words " standard „ and " atmosphere „ so as to maintain consistency with term n° 13.

TERM NO. 27: " TRAPPED PROPAGATION „

Is this a good term to use? In fact it is the waves associated with a mode (or modes) which are trapped. A " mode „ should then perhaps be defined separately.

TERM NO. 28: " TRANS-HORIZON PROPAGATION „

Should not waves trapped within a duct be included?

28 February 1968

CONSTANTS IN THE EQUATION FOR THE RADIO REFRACTIVE INDEX

CCIR Report 232 (Question 2/V)

The following comments on Report 232 result from the deliberations of a working party constituted by the Chairman of URSI Commission II.

1. URSI would agree that the formula for the radio refractive index proposed in CCIR Report 232 is adequate for use in most radio propagation problems, the single exception being its use in problems involving the accurate determination or knowledge of the velocity of propagation.
2. The CCIR and URSI/IUGG formulae differ mainly because of the different values used for the refractive index of water vapour. It is considered that the measurements on which the URSI/IUGG formula is based are the most accurate so far made; they have a standard deviation one-tenth of any others. Since URSI would wish to have a formula applicable to accurate velocity determinations as well as to other propagation problems, it would therefore prefer to retain the URSI/IUGG formula rather than adopt that proposed by CCIR.

28 February 1968.

INFLUENCE OF THE NON-IONIZED REGIONS OF THE ATMOSPHERE ON WAVE PROPAGATION (RADIO-METEOROLOGY)

CCIR Question 2/V

A working party of URSI Commission II has studied Question 2/V and made various comments. The problems posed by the Question are very difficult and there are differing views in URSI concerning the degree to which it is worth while devoting very great effort to an attempt to find a comprehensive solution for them. Thus, those members of URSI who are basically meteorologists adopt a somewhat pessimistic attitude to the problems, though they would doubtless say it is realistic; on the other hand, members who have become interested in radio-meteorology through radio physics and engineering take a more optimistic view of the value of the studies proposed in Question 2/V. However, it would not help the CCIR if this divergence of opinion were concealed and in the circumstances the Chairman of URSI Commission II, who co-ordinated the activities of the working party, considers it desirable to indicate, in the remainder of this document, the range of views expressed.

1. The slow progress in understanding those factors which affect the transmission of short radio waves through the lower atmosphere can be attributed to:

(*a*) the lack of instrumentation for observing fluctuations in temperature, humidity, wind velocity, pressure, etc., which, on the one hand, will resolve in space down to 1 cm and in time down to 0.1 second and, on the other hand, will permit simultaneous observations over a volume of atmosphere which extends many tens of metres in each direction, and over periods of many hours;

(*b*) the need for a clear statement of the boundary conditions that accompany experimental observations, so as to permit a useful comparison between similar investigations by different workers;

(*c*) the poor liaison between the fluid dynamicist, the micro-meteorologist and the radio scientist.

At present our knowledge of the patterns of convection and advection which serve as vehicles for heat and humidity is extremely crude. Further, we do not know which boundary conditions (e. g. surface roughness, wind shear, vertical and horizontal temperature gradients, humidity gradients, heat flux, etc.) are significant in describing an experimental setting. Nor is there common agreement on the meaning of terms used to describe air structure, e. g. turbulence. After some clarification of the model of the troposphere has been achieved, there is need for assistance from the mathematician in the provision of an appropriate statistical description of a medium which is a composite of turbulence, turbulent layers, laminar flow, convective cells, convective plumes, internal waves, etc.

It seems useful to mention several points of detail. Paragraph 1 of the Question is useful only if it is asked after each new experiment, since the " most appropriate „ methods and instruments will change with each improvement in knowledge of air structure.

In paragraph 2, why does the Question specify only vertical gradient? Horizontal gradients (e. g. at cloud and thermal boundaries) may be significant, especially in satellite communication.

Concerning the Annex, paragraph 1: Air flow patterns (wind-shear, convection) are an intimate part of the thermodynamics of the troposphere. Some statement concerning wind-shear over distances of the order of 10 m should be added.

2. The usefulness of the great quantity of data requested in the Annex of Question 2/V is definitely limited.

Various studies have shown that the data obtained with radiosondes are useful only for the longer wavelengths where refraction, controlled by the gross features of the atmosphere, is more important than scattering. The fine details of the structure of the atmosphere are not given by radiosondes and deserve more study than is suggested in the Question.

Five years of continuous data at distances not more than 10 m apart represents a data collection programme of tremendous magnitude. If the limited usefulness of the final results is admitted, it would appear that the effort might be more productive if it were devoted to the examination of fewer situations in greater detail.

3. Concerning paragraph(b): it would be entirely realistic and fair to say that *on any occasion* and *for any path* the detailed structure of the field will always be insufficiently known to explain *all* the details of radiowave propagation.

Concerning paragraph 2: no amount of climatology will completely solve the specific problem. Accordingly, the effort devoted to achieving a climatology should not be carried too far and it would probably not be justified to ask for more than:

(i) the broadest possible description; this is probably already available from existing reviews of tropospheric vertical profiles;

(ii) a statement of the implications of special investigations which have been carried out (e. g. that on the Rye tower);

(iii) a comprehensive bibliography.

In fact it could be said that the principles of tropospheric transmission are well understood (at least from the meteorologist's point of view), that a near-infinite diversity of special cases is to be expected, and that as much codification as is possible and desirable has already occurred.

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28 February 1968.

PROPAGATION DES ONDES DECAMETRIQUES PAR GUIDAGE AU-DESSUS DU MAXIMUM D'IONISATION DE LA REGION F

(Question 5/VI; Rapport 341 du CCIR)

Le Rapport suivant a été préparé par un petit Groupe de Travail établi par la Commission III de l'URSI. Il pourrait remplacer le Rapport 341 (Documents d'Oslo 1966 (CCIR), Vol.II, p.33). Les conséquences pratiques de la propagation des ondes par guidage au-dessus de la couche F ne peuvent être évaluées avec assez de précision et donc aucune réponse utile à la Question 5/VI ne peut être donnée à présent.

1. Résultats d'observation

Les données expérimentales, qui ont conduit à considérer une propagation guidée des ondes décamétriques dans l'ionosphère supérieure, proviennent d'observations au sol ou en engins spatiaux.

Les premières hypothèses sur un tel mode de propagation semblent avoir été émises presque simultanément par Wagner [1] en 1928 et Pedersen [2] en 1929. Mais c'est seulement en 1959 qu'Obayashi [3], et en 1961 que Gallet *et al* [4] reprirent une interprétation en ce sens d'observations avec un radar décamétrique d'échos à long retard. D'autres observations avec radar décamétrique soit semblèrent confirmer ces observations (Du Castel [5], soit au contraire parurent les infirmer (Budden *et al.* [6], Thomas *et al.* [7]). De toutes façons la méthode radar utilisée ne permettait pas d'affirmer que les échos observés provenaient d'une réflexion dans l'hémisphère conjugué avec propagation guidée le long du champ magnétique.

Aussi des observations par liaison entre points conjugués furent-elles entreprises ultérieurement. Une expérience effectuée en avion (Gassman *et al*) [8] n'apporta pas de résultats concluants, en raison de la faible durée des observations. Une autre expérience, de liaison à 9 MHz entre zones conjuguées de France et d'Afrique du Sud (Du Castel [9] et Petit [10]) permit de mettre en évidence des temps de propagation des signaux pouvant être interprétés par une propagation guidée. Elle permit en outre de critiquer l'interprétation des résultats obtenus par radar, du fait de la non correlation entre l'observation d'échos et de signaux à long retard.

Cependant les techniques spatiales permettaient d'autres observations. De premières expériences de sondage à fréquence fixe en fusée (Knecht *et al.*) [11] montrèrent un guidage dans l'ionosphère supérieure associé à la présence du phénomène F diffus. L'existence d'un guidage dans l'ionosphère supérieure devait être bientôt confirmé par les observations des satellites sondeurs ionosphériques. Les ionogrammes en contre haut du satellite Alouette (1962 beta alpha), à fréquence variable, montraient des traces de propagation non zénithale, interprétées comme dues à une propagation guidée pouvant conduire à une réflexion jusque dans l'hémisphère opposé (Muldrew [12], Calvert *et al.*[13], du Castel [14], Dyson [15]). Les observations du satellite Explorer XX (1964-51 A), à fréquence fixe, montraient également des traces interprétées de la même manière (Loftus *et al*).[16].

2. *Interprétation des observations*

La théorie du guidage d'un rayonnement, à une fréquence supérieure à celle du plasma, par une irregularité d'ionisation présente le long d'une ligne de force du champ-magnétique terrestre, a fait l'objet des travaux de Voge [17], Booker [18], Du Castel [19] et Walker [20]. Les résultats diffèrent quelque peu, en raison notamment du modèle d'irrégularité choisi; en particulier pour les uns intervient la variation relative d'ionisation, pour les autres sa variation absolue. Ils permettent cependant de relier les observations de propagation guidée à la structure des irrégularités guidantes.

Les diverses méthodes d'observation citées conduisent d'ailleurs à des résultats qui accusent certains désaccords. Les plus complets proviennent des observations en contre haut d'Explorer XX (Loftus *et al.*)[16]. Des cas de guidage conjugué n'y ont été observés que pour des ondes de fréquence inférieure à 4 MHz. Ils conduisent, d'après le modèle de Booker [18], à un accroissement relatif d'ionisation dans l'irrégularité, lorsqu'elle est présente tout le long de la ligne de force, centré sur une valeur moyenne de l'ordre de 2% et ne dépassant pas 8%. Les dimensions transversales des irrégularités seraient centrées sur 4 km avec une valeur maximum de 30 km. Le phénomène intéresserait les latitudes magnétiques d'inclinaison inférieure à 60^{o}. Il présenterait un maximum diurne vers le lever du soleil et un maximum secondaire plus faible au début de la nuit. Les observations d'Alouette n'ont pas donné lieu à des résultats statistiques. On peut cependant noter que des échos guidés conjugués ont été observés à des fréquences plus élevées et que la variation diurne est quelque peu différente (Muldrew)[12].

Quant aux observations en contre-bas, sur liaison entre points conjugués à 9 MHz (Petit)[10], elles correspondraient, d'après le modèle de Du Castel [19], à des irrégularités d'amplitude voisine de 200 él. cm^3, présentes pendant environ 0,1 % du temps, principalement sur des lignes de force de paramètre voisin de 1,3 avec un maximum en fin de nuit vers 03 h (TL).

L'apparent désaccord entre certains résultats provient certainement pour une part de la nature différente des méthodes utilisées. En particulier, des observations radar, en satellite, d'échos guidés supposent une réflexion sur l'ionosphère conjuguée; des observations par liaison entre points conjugués supposent une double traversée de l'ionosphère. Dans l'un et l'autre cas, le trajet de propagation guidée peut d'ailleurs correspondre à une ligne de force de latitude inférieure à celle du point d'observation (mode combiné), ce qui complique l'interprétation des résultats.

3. *Conséquences des observations*

L'existence, dans l'ionosphère supérieure aux latitudes moyennes, d'irrégularités d'ionisation, susceptibles de guider des ondes décamétriques le long des lignes de force du champ magnétique terrestre, semble un fait démontré. Un ordre de grandeur de leurs dimensions, de l'ordre de quelques pour cent en variation d'ionisation et voisines du kilomètre en extension transversale, peut être avancé. La fréquence d'apparition du phénomène serait inférieure au pour cent, avec au moins un maximum en fin de nuit. D'autres précisions sur le phénomène ne peuvent encore être apportées, en l'absence de résultats d'observation cohérents en nombre suffisant.

D'un point de vue géophysique, l'existence du phénomène n'a encore donné lieu à aucune interprétation définitive. D'un point de vue des radiocommunications, ses conséquences pratiques ne peuvent encore être évaluées avec assez de précision. Des deux points de vue, l'intérêt du phénomène est cependant certain et il est souhaitable que d'autres résultats expérimentaux puissent être apportés, fondés aussi bien sur les observations de satellites sondeurs ionosphériques que sur des observations de liaisons entre points conjugués.

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22 janvier 1968.

THE ACQUISITION OF IONOSPHERIC DATA FOR PREDICTIONS

CCIR Opinion 22, Question 2/VI, Study Programme 2A/VI

INTRODUCTION

At the General Assembly of URSI in 1966, a small Working Group was established to study Question 2/VI and the related Study Programme 2A/VI and Opinion 22. In January 1968, the Convener of the Group prepared a series of documents dealing with different aspects of the various CCIR problems and including a number of informal suggestions and recommendations based on his earlier consultations. These documents were submitted to URSI and in February 1968 were combined, with minor editorial changes, in the URSI Secretariat so that they formed the present single coherent document.

Section 1 is concerned with the general problem of trying to ensure closer cooperation between communications engineers and ionospheric physicists. It refers briefly also to the topics discussed in more detail in the remainder of the document:

Section 2: Sites for new fixed ionosondes
Section 3: Acquisition of additional data by automatic equipment and satellites
Section 4: Reliability of data
Section 5: Treatment of spread-F
Section 6: Use of existing top-side data
Section 7: Use of top and bottom-side sounders in satellites.

1. — COMMUNICATION BETWEEN ENGINEERS AND IONOSPHERIC PHYSICISTS

1.1 — INTRODUCTION

Those problems encountered by CCIR which relate to ionospheric propagation have been considered in the past and have provoked relatively little response. An attempt has been made to identify the main reasons for this and to make constructive suggestions for the future.

1.2. — JOINT SYMPOSIA

Many scientists engaged in ionospheric projects have little knowledge of CCIR problems and little interest in them. In general they are trained for, and are most interested in, specific problems which can be solved by ad hoc experiments or by using relatively limited samples of data; they lack the desire to work on long-term morphological studies or on problems involving large masses of data.

Also, as individuals, they find serious difficulties in communicating effectively with the engineers on practical problems: e. g. this often arises as a result of the different meanings of scientific and technical terms as used by physicists and engineers. Experience with symposia attended by scientists, engineers and administrators of circuit networks shows that a symposium at which the topics are limited to a fairly narrow field is very valuable for breaking down these barriers of communication, for exciting interest in the problems and for showing where new advances are possible. This is especially so when the symposium is held at a location where all the participants are brought into close contact outside the formal session periods. Such symposia must be planned with a mixed audience in mind and care must be taken to ensure that all the groups are fairly well represented.

It is possible that some of the regional scientific symposia on ionospheric problems could be valuable for the same purpose if suitable engineers could be persuaded to attend; for example, the Conferences on Equatorial Aeronomy are largely concerned with the morphology of phenomena observed at low latitudes and often of direct concern to low-latitude communications; symposia on the Antarctic ionospheric phenomena are directly concerned with high-latitude problems and are often equally applicable to both polar caps.

Scientific symposia or specialised courses on specialised fields occasionally contain much of direct interest to CCIR; the publications referring to several recent symposia are listed under Ref. 1. Some of the papers given on these occasions probably reach CCIR through joint representatives, but it would be worth while to ask the appropriate CCIR working group in the host country, or from some other country with active interest in the field, to summarise the main points of interest and to report to CCIR. Some national working groups in CCIR Study Group VI do not search for this type of information effectively.

URSI seems to be the most appropriate Union for the promotion of suitable symposia, but it has difficulties in identifying suitable experts, with some experience of CCIR problems, who could contribute to the symposia. URSI and CCIR should consider what joint action could be taken to solve this difficulty and should consider, in particular,

(*a*) the promotion of symposia of the type described above;
(*b*) the addition of a practical problems section to the programmes for selected regional symposia and other such meet ings;

(*c*) the encouragement of administrations to send suitable participants to these meetings so that both the scientific and the practical aspects can be considered, as suggested above;

(*d*) the extraction of the appropriate information, from scientific symposia, on subjects which can affect radio communications.

1.3. — Cooperation between Scientists and Engineers

There is much interest among scientists about the extent of the geographical areas in which particular ionospheric phenomena are found, such as the diurnal, seasonal and solar cycle variations. This type of question can, therefore, often be answered by scientists in such a way as to give information of direct value to CCIR. In many cases a considerable literature already exists and much active work is continuing. Again there appears to be a serious lack of communication; many of the scientists involved believe that CCIR has not fully exploited the data already available and they are, therefore, unwilling to spend time summarising new data for CCIR, and many do not realise that morphological data acquired for scientific objectives also have practical applications. For example, studies of the incidence of equatorial spread-F and its connection with the electrojet automatically provide the statistical characteristics of spread-F which are needed for studies of the incidence of equatorial " flutter „. Similarly, the links between high-latitude spread-F, sporadic-E, blackouts, geomagnetism, aurora and the magnetosphere also give the corresponding information on the incidence of these phenomena as they affect radio communications.

It is believed that maps showing where particular phenomena occur, with probabilities where possible, would be of considerable value operationally and that CCIR should consider this point.

Owing to lack of communication and to specialisation, the question " What is the incidence of sporadic-E over the world? „ is unlikely to provoke many responses. However, more limited questions such as " What is the incidence of the storm types of Es at high latitudes? „ may provoke responses from groups interested in radar aurora, or in particle effects as detected by satellites and ground stations, as well as from ionospheric workers engaged in more usual studies.

1.4. — Special Experiments and Studies

Most CCIR problems require long-term study and also more data for their solution, but very few scientists are interested in obtaining such data primarily for CCIR purposes. However most scientists try to take advantage of current possibilities, for example by studying polar cap events in sunspot maximum years and other problems in minimum years. Thus it appears advantageous to stress particular problems at particular epochs in the solar cycle, but it must be remembered that most new experiments take a few years to mount successfully, particularly when linked with space techniques. It is suggested that CCIR and URSI should use their joint knowledge of likely fields of active interest in the selection of a limited number of relatively short-term projects for intensive study.

Many groups both inside and outside CCIR have stressed the potential value, for CCIR problems, of the use of data obtained by specialised techniques such as auroral radar, back scatter, oblique incidence soundings, and topside soundings. Despite the work done by special working groups very little, if any, of these data have been applied to CCIR problems, and several reasons appear to be responsible for this.

a) In many cases the equipment in use is technically inefficient; in consequence the available manpower in the group is already fully extended in obtaining and analysing the limited samples of data needed for purely scientific purposes. In addition, the samples available or the duration of the experiment are usually too limited to give synoptic data comparable to those usually used for prediction work and it is doubtful whether attempts to exploit such data are worth the effort.

(*b*) In other cases the equipment is capable of obtaining adequate samples of data but its use is limited by the time needed to analyse the data. In these cases valuable data could be made available by operating the equipment regularly and by introducing a highly simplified and rapid analysis for the majority of the records obtained. In general the groups are poorly equipped for such work and they would not consider undertaking it without outside pressure and possibly aid. If it is to be successful, the handling of data must be as simple and as efficient as possible; with manual analysis this probably means selecting one parameter only for regular tabulation.

(*c*) It is frequently impractical to maintain a special experiment during both the solar maximum and minimum epochs. This limitation often applies also to conventional vertical incidence soundings when they are planned for a specific scientific objective. Special techniques for the incorporation of data obtained during limited periods in the numerical prediction process need to be developed further before it is justifiable to ask for detailed data from what would normally be relatively short-term experiments. It is believed that it is essential to develop such methods and to publicise the fact that data for even a one-year period can be used operationally in some instances. At present it appears that the scientists are sometimes asked to produce data which cannot be used operationally.

1.5. — Use of Existing Data

It is considered that a number of significant improvements in HF predictions, particularly at high latitudes, could be made by using data already collected during the IGY and IQSY, provided that the central predicting organisations were prepared to incorporate such new data and, if necessary, adopt improved methods of analysis or presentation. The analysis would involve considerable data handling problems and would need close collaboration between groups holding ionospheric data in the form of punched cards or tapes so as to minimise punching problems. The main problems are to obtain guidance from competent scientists with wide experience in this field, to arrange for the direction of detailed analyses which would not normally be of interest to such scientists, and to plan the actual handling of large quantities of data. It appears possible to break down the problems into a series of specific projects, applicable to limited geographical areas, each of which could be solved to the extent needed to give worthwhile results within one or two years. Some specific projects of this type include:

(*a*) The prediction of absorption, and the probability of absorption events, in the auroral and winter anomaly zones.

(*b*) The improvement of basic world-wide absorption data, although this is not likely to give as large improvements as (*a*).

(*c*) The prediction of sporadic-E at high latitudes. This would result in major changes in frequency usage for about one third of the hours.

(d) The prediction of the probable availability of bands of frequency usable for communications at high latitudes during disturbed conditions. Such predictions would take advantage of regularly occurring abnormal reflecting layers which are common in winter, in particular during disturbed conditions.

In general these problems involve the use of computers and are worth studying only if the data handling problems can be solved by international cooperation.

It is considered that significant improvements in the basic data for numerical prediction are likely to result only from the establishment of a project for the design of equipments intended especially to solve CCIR problems. For example, most of the desirable sites for ionosondes, which do not involve serious logistic difficulties, have already been occupied. Extending the network therefore implies the development of simplified automatic equipments capable of operating unattended for long periods, or the use of ship, aircraft or satellite sounders, or both. These matters are discussed in Sections 2, 3, 6 and 7.

SITES FOR NEW FIXED IONOSONDES

2.1 — SELECTION OF SITES

Within the limitations of available data the simplest method of surveying the probable most valuable sites for new stations is to construct local time contour charts of foF2 at different epochs and seasons, and to look for the areas where the gradient of foF2 seems likely to change rapidly with position. This procedure gives high priority to the area within about $\pm$ 20^{o} of the magnetic equator, and to the subauroral zones and, in general, low priority to temperate latitude zones, though there is evidence for anomalies in certain areas.

A main objective in planning new stations should be to establish interpolation and extrapolation rules so that wide areas can be monitored with the fewest possible stations. It is important also to find the best compromise between the logistical difficulties in establishing and maintaining a new station, its usefulness for determining base levels from which the extrapolations can be made, and its possible value for local scientific studies or for the interpretation of the behaviour of particular circuits.

2.2 — SPECIFIC SUGGESTIONS

There are special scientific interests in establishing stations in the equatorial anomaly zone, in the South Atlantic magnetic anomaly zone in the Antarctic and in the subauroral zone. Detailed cases have been made for the stations in or near following areas:

Macquarie Island; Jarvis Island (or Christmas Island); South Georgia (S.Atlantic); Easter Island; Roi Baudoin.

Several scientific groups have supported proposals for stations near:
Adak (or Unalaska); Ascension Island (or St.Helena);
Azores; Invercargill; Libya; Victoria B.C.

Other scientific groups have suggested that it would be valuable to have stations near:
South Philippines (near dip equator); Addis Ababa; Dar es Salaam;
Wadi Halfa (Sudan); Gough Island (or Marion Island).

2.3 — COUNTERSUGGESTIONS

There is, however, considerable doubt as to the economic justification for attempting to establish many new conventional stations especially in locations where other basic facilities do not already exist. Automatic stations and mobile stations should first be considered.

It is felt that the basic network needed for prediction purposes will form a good basis for short-term predictions provided that long-established stations are kept operating for this purpose after their value for long-term predictions has become minimal. However it is believed that much of the apparently irregular behaviour of the ionosphere is probably associated with ionospheric meteorological systems which would require a much closer network of stations than that needed for long-term predictions. Again it is felt that new types of equipment are needed rather than additional conventional fixed stations.

ACQUISITION OF ADDITIONAL IONOSPHERIC DATA FOR COMMUNICATIONS

3.1 — GENERAL

CCIR ionospheric problems are related to three main objectives:

(a) Improvements in long-term predictions. Here the main weaknesses are the lack of data in large areas, and inaccuracies in the description of gradients where conditions change rapidly with position.

(b) Better forecasts of disturbances and of frequency changes required to enable communications to be maintained on a short-time basis.

(c) The design and use of high reliability circuits in circumstances where considerable sophistication is possible and economically useful.

While data obtained for any of these can, in principle, be used in other applications, the costs of obtaining them rise rapidly with complexity.

3.2 — TECHNIQUES

For F-region predictions it is necessary to know the critical frequency, foF2, and the height of maximum electron density, hmF2, or a parameter giving equivalent information such as M(3000)F2 or MUF(3000)F2. In addition there is need for measurements of sporadic-E. The ionosphere has been sampled at reasonable spacings over about one third of the earth but filling the remaining gaps by deploying conventional ionosondes would be very expensive.

There is a possibility that cheap, reliable semi-automatic equipment could be designed so as to give very limited information of the types required. It would probably not be usable when ionospheric conditions were very complex but it would nevertheless fill most CCIR requirements during fairly normal conditions.

According to local conditions, either recordings on magnetic tape of the required parameters would be made for, say, one month, or the data could be sent back by telemetry at more frequent intervals. There is evidence to show that the top frequency of spread-F is the important parameter for CCIR purposes and this could be recorded relatively easily when the critical frequency was not observable.

Worthwhile data could probably be obtained cheaply by satellite methods also, but again the instrumentation and the orbit could be very different from those chosen for scientific studies.

A preliminary suggestion would be to measure the following at, say, every 100 km along the path:

(a) critical frequency or top frequency of spread echoes
(b) plasma frequency at the satellite
(c) a single height parameter
(d) possibly sporadic-E in certain areas.

The amount of data collected per orbit could easily be handled by a solid-state memory system or by a very simple tape recorder, and telemetered to the ground at convenient intervals.

3.3 — COMBINATION OF TECHNIQUES

In some cases it would be possible to combine techniques so as to give useful data for prediction purposes. Thus the two independent F-region parameters could be measured combining satellite measurements of critical frequency with either oblique incidence MUF measurements or oblique incidence back-scatter measurements. Such combinations would need careful organisation so that the data were properly linked together and analysed.

However, it would be very easy to waste much effort for little return because this type of analysis is worthwhile only where the original data are reasonably complete and can be obtained from the records with reasonable certainty. Most data obtained primarily for scientific purposes are too incomplete to be exploited effectively for prediction purposes by the use of methods at present available.

The use of the oblique incidence measurements mentioned above for sporadic-E studies needs stressing. Such data exist but have seldom been collected in a form suitable for use by CCIR.

3.4 — FORECAST NETWORKS

Discussions are in progress at present on the desirability of setting up forecasting networks and some have, in fact, been set up and operated for a year or more. Initially these would be based on conventional ionosonde stations but the use of simplified automatic stations in the future appears very promising. The costs of maintaining an adequate watch, and ensuring quick reduction of data and transmission to central bureaux are high at conventional stations. If such systems are operationally justified, the cost of setting up subsidiary stations to give a more effective network would probably be small compared with the primary costs of the service. Effective forecasting is almost sure to demand a larger network than is at present active.

3.5 — SOPHISTICATED SYSTEMS

Several groups are developing or deploying sophisticated systems for improving radio communications. These include the operational use of oblique-incidence sounders or back-scatter equipments for monitoring the frequency bands available for long range circuits, systems for analysing multipath distortion and recombining the components so as to eliminate the distortion, systems for making allowances for frequency shifts due to the ionosphere etc. The cost of such systems is usually very large compared with the cost of conventional sounding networks. The important points here appear to be:-

(a) to ensure that the data obtained are tabulated in a usable form for prediction purposes;

(b) to use the data regionally to give local forecast services.

Particulary (b) would appear to promise a larger return in terms of the efficient use of the hf spectrum for a marginal increase in cost.

4. — RELIABILITY OF DATA USED IN NUMERICAL ANALYSIS FOR PREDICTION PURPOSES

4.1 — RELIABILITY OF MEDIANS

A brief review has been made of the reliability of the median data used in prediction work. The results disclosed give cause for concern and there is an urgent need to improve the reliability and for CCIR to consider whether published predictions based on these data are likely to be seriously in error.

Experience with ionospheric data shows that monthly medians based on less than half the maximum possible count are liable to be in error, and that those based on less than one third are often more representative of abnormal conditions than of the average behaviour for the month. A comparison between sample IGY and IQSY data shows a significant decrease in the completeness of the data per station for the latter period, despite the fact that special efforts were made to obtain good data in both periods.

4.2 — RESULTS OF STUDY

The result of a study of the counts for foF2 at a typical sample of 135 stations for wich data were readily available for June and December 1958 (IGY) are as follows:-

(*a*) At 65 stations the median count was less than 15 for at least one hour in one of the two months, i.e. approximately half; 23 stations failed to meet this criterion in both months.

(*b*) For these 65 stations the mean number of hours in one month affected was 10, (median 8), i.e. the majority of these stations gave doubtful data for long periods of time in particular months.

(*c*) Three quarters of these stations showed counts of 10 or less for mean durations of 12 hours (median 6 hours).

(*d*) The distribution of the stations with doubtful data is particularly unfortunate since they are concentrated partly in the Southern hemisphere where the network is inadequate even if all stations were good, and partly in the equatorial zone where there are steep gradients of ionisation.

The best operated stations in most of the difficult zones meet the criterion of counts 15 or more for all or nearly all months; occasionally a coincidence of a major repair in a difficult month causes an exception. There appears to be no ionospheric reason why almost all stations should not be able to meet this criterion regularly since some of the good stations are using very obsolete equipment.

4.3. — SUGGESTED ACTION

It appears that the most important causes for poor data are inadequate design and maintenance of equipment, and inadequate training and checking of the analysis staff; both of these could be minimised fairly cheaply by the availability of expert advice at the stations. It is recommended that selected experts be financed to visit the stations and to give advice on these matters.

There are occasions and locations where the primary difficulty is incompatibility between the data preferred by the scientists and that needed for prediction purposes. The most important of these is the case when equatorial and other spread F, polar spurs and similar phenomena are present. It is felt that the most satisfactory solution would be the adoption of an additional new ionospheric parameter for use mainly in prediction work. However, it would be unwise to make a firm recommendation unless it was reasonably certain that the revised data would in fact be used in practice. It will be necessary for CCIR to decide whether this is possible and whether the practical improvement would justify the extra work needed at the stations. Some of the points to be considered are summarised in Sect. 5.

5. — THE TREATMENT OF SPREAD-F

5.1. — CHOICE OF PARAMETERS

Theoretical investigations and practical tests both suggest that when spread-F, field-aligned irregularities, polar spurs, etc. are present, the MUF is more closely associated with the highest frequency on which reflections are seen than with the critical frequency of the regular layer embedded in the abnormal structure.

This highest frequency (top frequency of spread, fxFs) depends on equipment characteristics, geometry of reflection, form and spatial distribution of irregularities, as well as on the electron density in the irregularities; hence it is a very crude parameter for scientific work and it is little used by scientists, who prefer the critical frequency of the F layer, foF2, which has an exact physical meaning, or parameters associated with the range of frequency over which spread-F is seen.

The ratio of fxFs to foF2 is often very large, (3 or more in both equatorial and high latitude zones) and, even when it is small, fxFs is appreciably greater than foF2 so that tables of fxFs and foF2 are incompatible with each other for the hours when spread-F occurs.

Thus the possibilities are:

(*a*) to keep the long-established reduction rules for ionograms as at present and only to measure foF2.

(*b*) to change the reduction rules, so that fxFs is measured instead of foF2 when spread-F is present.

(*c*) to measure both fxFs and foF2 and to tabulate them separately.

Alternative (*b*) is scientifically objectionable since incompatible phenomena are lumped under one heading. Moreover, the rules needed to make the parameter continuous when little spread is present would restrict the number of values of foF2 to cases when there was no spread-F, a sample too small and too unrepresentative for scientific work. Alternative (*c*) would involve discussions on the adoption of suitable rules and the need to persuade administrations to evaluate the new parameter. Strong evidence that the data are needed, and would be used, would be required to make this alternative practical.

The scientific case for producing a parameter such as fxFs, if suitable rules can be devised, is very strong. Its use could make big differences in the predicted values of MUF at high and low latitudes, and smaller but significant differences for some months almost everywhere at night when such differences are important.

It must be remembered that foF2 will continue to be needed for scientific purposes when spread-F is present and that at many stations it must be evaluated for the determination of M(3000)F2.

5.2. — RULES FOR FXFS

The obvious simple rule is that fxFs will be the top frequency of spread-F traces as seen at the station, modified by additional criteria to be agreed.

This will usually correspond to an extraordinary ray reflection but when absorption is high it is more likely to be an ordinary ray. Do we need rules for identifying high absorption, as for Es? In these cases do we add fH/2 (qualifying letter symbol preferably O, but possibly J, and descriptive letter B)?

To what extent are traces which are clearly oblique to be included? In general, fxFs will represent the densest sample in an appreciable area around the station. At many stations a polar or equatorial spur is first seen at ranges of 700 km or so and it gradually spreads overhead. In these cases the high value of fxFs applies to a location up to 500 km away from the station, but the fact that it is seen makes it likely that it will be effective for MUF purposes through skew paths. The scientific approach would be as follows:

(*a*) each station monitors an area round the station;
(*b*) for fxFs the highest critical frequency in this area is the most important factor;
(*c*) typical spacing between stations might be about 5^{o} at high latitudes suggesting a sample radius of 2.5^{o} or about 250 km;
(*d*) movements of the reflection point for skew paths up to 500 km appear to be possible in practice reasonably frequently;
(*e*) a practical conservative rule consistent with this would be to include all traces spread in range up to 1.5 x h'F.

No investigations have been made to see whether the numbers above are optimum; they are representative of a few cases in the literature and should be modified to take into account prediction procedures.

What is the best method of getting a representative MUF factor to correspond to fxFs in the absence of an MUF factor based on foF2, and when is such a factor justified? At temperate latitudes, tests show that MUF's deduced from fxFs fit smoothly onto those deduced from foF2, but this can be expected only when the spread-F seen is essentially centred on the station.

It is felt that it is most important to evaluate fxFs even if the associated MUF factors are not properly determined. It is recommended that the problem of MUF factors be referred to a group of workers with experience in this type of problem, including those interested in both scientific and communications problems.

The above rules are discussed on the assumption that fxFs is tabulated separately. If tabulated with foF2 it would be necessary to use the ordinary wave component, foFs, throughout so as to maintain continuity with foF2; i.e. (fxFs - fH/2) would be tabulated when spread-F was present and the O-mode could not be used directly. The statistics of spread-F are such that most stations would probably prefer to reduce fxFs rather than foFs, so as to avoid frequent subtraction of fH/2. The parameter published in prediction maps for zero distance also corresponds to fxF2 or fxFs.

5.3. — Conclusion

The treatment of spread-F is a controversial subject and the opinions expressed above may be subject to modification as research progresses.

6. — USE OF EXISTING TOPSIDE IONOSONDE DATA

6.1. — Availability of Data

Very considerable quantities of topside sounder data (2, 3) exist in forms usable with computers; for example, Hagg's Alosyn booklets, printed from computer outputs, contain between 3.10^4 and 4.10^4 values for foF2 or fxF2 obtained between September 1962 and April 1964, and other groups have also collected data in similar forms. In principle these might be used for ionospheric prediction purposes as already suggested by CCIR. At present the most important application of the data would be to test whether the prediction techniques are adequate, particularly in areas where ground-based data are sparse. It is probable that height data would be too inaccurate for this purpose so that the analysis ought initially to be limited to studies of foF2 or fxF2, probably spread-F and, possibly in certain areas, sporadic-E.

The topside sounders give, in great detail, the variation of foF2 with position and, by comparisons made between successive orbits, longitude changes at constant local times. The main difficulties in using such data arise because of the large localised day-to-day changes in the ionosphere and the effectively limited sampling resulting from the close association between the local time of a pass and the season. The best techniques for using such data for prediction purposes have not been worked out, though it should be remembered that conventional mapping also makes use of data with little statistical weight (e.g. night-time data where spread-F is common).

6.2. — Applications of Data

In principle, topside sounder data could be used to improve predictions of ionospheric conditions in three main ways:

(*a*) to establish the mean gradients of critical frequency at constant local time in the zones in which the data are obtained, so as to control the extrapolation from actual ground-based stations into unmonitored areas.

(*b*) to delineate more accurately than at present the mean shape of the variations with position where these are changing rapidly.

(*c*) to establish coordinate systems which would enable data interpolation and extrapolation rules to be expressed in the simplest possible way, both for analysis and, ultimately, for use in practical numerical prediction procedures.

In addition, the data could be used to introduce a new concept, where conditions change rapidly with position and time, namely the median of the highest values of critical frequency or MUF in a given area.

Localised features, such as the equatorial peaks in foF2 or the high-latitude peaks and troughs, not only change in intensity from day-to-day but are also found at different latitudes on different days. Thus there are regions where the statistical median morphology of foF2 differs appreciably from the morphology of a typical day which has close to median conditions for most of the earth. At present we can only use the former but, with proper exploitation of topside data, we could use whichever was most appropriate to practical problems. Where the day-to-day movement of a peak at any constant local time is limited to a few degrees, one would expect the median moving with the peak to be more significant than the median at constant position for practical communications problems. We then desire to know:

(*a*) the most probable or the median position of a peak (or trough)

(*b*) the most probable or the median value of foF2 at the peak.

If successful, such an analysis would also give the relations between the statistics for areas and for fixed stations, thus enabling the technique to be extended to other areas. Typical Alouette data suggest that the gradients for the anomalies near the dip equator are appreciably greater than those given in the prediction maps, and that medians at fixed position are likely to be very inadequate guides to propagation conditions at high latitudes.

Topside sounder data are most easily understood by constructing latitude-longitude charts at constant local time. Where gradients are small, parameters for equivalent " interpolated „ stations can readily be established by averaging over an area. Where gradients are large, it may be better to use magnetic coordinates. There should be enough data from the 75°W meridian chain of ground based stations to test the effects of different methods of analysis, and most of the Alouette data are centred near this meridian.

6.3. — Practical Problems

The amount of work needed to exploit existing topside data is clearly large and the effort could only be justified if it was likely to be used to improve predictions by a significant amount. From the scientific point of view there appears to be an a priori case for believing that adequate improvements could be made which would justify the work. The CCIR should, therefore, consider whether any such improvements could be incorporated in existing prediction systems and, if not, whether it is desirable to investigate whether the systems could be modified to use new data. Two points in particular need attention:

(*a*) The introduction of steep gradients in local areas where, in general, the gradients are more simply expressed in magnetic than in geographic coordinates.

(*b*) The use of data which are available only for limited parts of the solar cycle.

One of the main limitations to the use of topside soundings for CCIR purposes is that large samples of data are needed. The analysis of ionograms is time consuming, but it may be possible to adapt the technique of direct recording of ionospheric characteristics (4,5) to the output of the telemetry so as to obtain directly either fxF2 or the top frequency of spread-F, whichever is greater, which are the parameters immediately required. The successful exploitation of this possibility would greatly increase the amount of data available and, if automatic digitisation was also added, would largely eliminate the existing data analysis problem.

The success of a project to use topside sounder data for prediction purposes would depend on whether certain conditions could be met:

(*a*) Direction of the work by someone with considerable experience in top and bottom side ionospheric data.

(*b*) Access to the topside data and to at least selected bottomside data in a form suitable for computer use.

(*c*) Close collaboration with an organisation responsible for the use of existing prediction programmes so as to ensure that predictions can be tested and that the final output is compatible with the routine production of predictions.

The key problem is to find the leader to direct the work.

7. — USE OF IONOSONDES IN SATELLITES

7.1. — GENERAL CONSIDERATIONS

It is very important to survey ionospheric behaviour in the areas not at present covered by the existing network. However, this is unlikely to be possible using ground based stations alone and the possibility of carrying out a survey by means of a satellite should be considered seriously. The results of such a survey, if sufficiently detailed to provide statistically significant data, would be directly applicable to checking the accuracy of existing predictions for areas without sounders, and also for showing in which areas more detailed work with ground stations would be most effective.

There appear to be two attractive solutions which are as follows:

(*a*) To design and fly an ionosonde-based survey satellite giving a few simple parameters with analysis of the data on the satellite. This solution simplifies the problem of obtaining data from all parts of the world, minimises the amount of information to be stored between passes and telemetered, and provides data in a form directly usable with computers. As there is relatively little redundancy the output would be interesting mainly to those involved in prediction problems or in problems of the world morphology of the F region.

(*b*) To design and fly a bottomside satellite with an ionosonde and with storage of complete ionograms over each orbit. This solution is attractive to the scientists since it could solve many problems, but it produces a much more complicated data handling problem than (a). It is unlikely that automatic selection and analysis of parameters would be possible in this case and thus the difficult problem of ionogram interpretation and reduction would have to be considered.

If the solution of the CCIR problems is sufficiently important to justify the effort, there seems little doubt that the simpler solution would be preferable. If it is necessary to add scientific requirements for this justification, the scientific case for a bottomside sounder with auxiliary experiments appears to be very strong. From the CCIR point of view the additional information needed by the scientists would seriously limit the useful life of a satellite since it would require the use of wide band recording equipment, and it would greatly increase the difficulties in handling the large amounts of data needed for statistically meaningful conclusions.

Outline suggestions for possible satellites are given in Sects 7.2 and 7.3.

7.2. — A SIMPLE TOPSIDE SOUNDER SATELLITE FOR SURVEYS

7.2.1. — *Design*

The highly successful Alouette topside sounder satellites have been used to study the ionosphere mainly in areas where real time reception of the observations is possible, and the data have been applied mainly to detailed studies of particular ionospheric phenomena. In principle, particularly by the addition of new analysis methods applied to existing tapes, much of the data could be studied with different objectives in mind: a world survey, morphological studies and frequency predictions. However such an exercise would be very incomplete in coverage and frequently inadequate in accuracy; and it is probable that the effort needed would be better used in producing a satellite specifically designed for the purpose.

There is a real need for a survey satellite capable of recording the variations with position and time of as many as possible of the following parameters:

(*a*) the critical frequency of the F2 layer, or the top frequency of spread-F when this exceeds fxF2;

(*b*) a measure of the height of the maximum of the F2 layer;

(*c*) the electron density at the satellite;

(*d*) the top frequency of Es when this exceeds foF2.

Possibly an additional simple parameter for check purposes would be desirable though most of the interpretation difficulties could be identified by comparing (a) and (c). Data affected by such difficulties would normally be rejected.

The required parameters should be identified and measured in digital forms in the satellite, stored in a magnetic memory or simple tape recorder, and replayed on command.

The need for convenience of interpretation and accuracy in height measurements indicates a circular orbit between say 450 and 650 km height. The inclination depends on choice of immediate objective; for example, a detailed survey of the more important unmonitored areas could be made with a high inclination orbit, while wider coverage in space but less detailed time coverage would be given by a polar orbit.

7.2.2. — *Treatment of Data*

The critical problem is likely to be the handling of data obtained. Hence the output should be suitable for computer analysis, the immediate output being in the form of maps of each parameter as a function of latitude and longitude at effectively constant local time for each latitude.

The project could be carried out using a modified Alouette I type ionosonde fitted with additional analysis equipment giving the equivalent of the well known « Direct measurement of Ionospheric parameters „ (4,5). The minimum frequency could with advantage be increased.

The top frequencies could be identified by the method used on the ground and changes in the height of the maximum measured by a modification of the technique of Bibl and Rawer for the direct measurement of MUF. This would need some calibration against ground stations so as to give absolute values.

The storage capacity needed depends on the compromise between simplicity of analysis procedure in the satellite, accuracy required, and difficulty in storing all data obtained in an orbit. Adequate position accuracy could be achieved using about 400 words per parameter per orbit, each word comprising about 16 bits for the simplest system or about 8-10 bits for a reasonably economic system. The scientific value of the satellite could be increased by adding electron density and temperature probes, an accelerometer, or any of the other devices for monitoring conditions at the satellite up to the limits imposed by the need for the storage system to operate for as long a period as possible.

7.2.3 *Operational Objectives*

The operational objectives of the satellite can be summarised as follows:

(*a*) to establish what happens to fxF2, and if possible to hmF2, in unmonitored areas of the world.

(*b*) to establish the extrapolation and interpolation rules for the main regular changes in critical frequency and height of the F2 layer.

(*c*) to show where key monitoring stations should be maintained or established.

(*d*) to provide data for new methods of prediction in areas where the ionosphere is not horizontally stratified (i. e. where peaks or troughs in maximum density are common).

(*e*) to detect excess Es particularly in unmonitored zones.

At present such data are available only for a small fraction of the surface of the earth. In particular our knowledge of ocean, desert and high latitude areas is very inadequate.

7.3. — Bottomside sounding by satellite

The development of controllable rockets (e.g. using plasma jet and radioactive motors) will soon make it possible to maintain a satellite in orbit for periods of about one year at heights near the maximum of the F2 layer at about 250 km. Even lower heights may be possible if current rates of development are maintained. Such a facility could provide important scientific and operational data about the ionosphere and, in particular, the F and Es layers.

7.3.1. — *F layer studies*

The behaviour of the F layer as a whole is largely determined by phenomena which are most important below the height of maximum electron density in the F2 layer, hmF2. Thus the rates of ion production and dissipation are greatest at about 170 km and it is important to know as many as possible of the parameters involved. Owing to the presence of ionisation at lower levels, it is difficult to establish the electron density distribution with height, N(h), with sufficient accuracy to test physical theories by ground based measurements. There is little accurate information about the density of the air at these heights, or about the wind systems generated by the variations of pressure with position. The temperatures of the electrons and ions can be measured, with some difficulty, at a limited number of points on the earth, but there are no detailed measures showing how these change with position and time for most of the ionosphere. Similarly there is a serious lack of actual measurements either of the photoionising radiation actually being absorbed where the ion production is large, or of possible soft particle radiation.

There are obvious advantages in measuring the physical parameters at levels where the production and loss rates in the F region are large and a satellite intended to exploit these possibilities could contain the following devices:

(*a*) A topside sounder similar to that used in Alouette I, but less sensitive to man-made interference and with the maximum and minimum frequencies limited to the band likely to be usable when the satellite is flown. If possible a tape recorder should be used to record ionograms in regions where no real time telemetry is possible.

(*b*) Probes for the measurement of local electron and ion density and temperature.
(*c*) An ion mass spectrometer capable of distinguishing between the most important positive ions likely to be present at the height of the satellite.
(*d*) An accelerometer for measuring the neutral air density as a function of position along the satellite path, which could also be used, if desired, to control the rocket motor.
(*e*) Detectors for the main photoionising radiations thought to be important in the F region.
(*f*) Low energy particle detectors (range 100 eV-10 keV) to identify areas where such particles are important.

In addition to the primary objectives of measuring the parameters affecting the F region at the satellite and studying how these affect the maximum electron density and height of the F2 layer, comparisons with ground based ionograms would provide tests of the accuracy of standard N(h) procedures and would show when ground based measures of N(h) can be trusted.

Operationally an ionosonde flown below hmF2 could not only give detailed data on the critical frequency variations with position, but also badly needed reliable data on the height of the layer and hence on the maximum usable frequency.

7.3.2. — *Es studies*

With the topside sounder it is possible to detect fEs only when it exceeds foF2. Bottomside studies are limited by the differences in performance of different ionosondes and the resulting lack of complete compatibility of the data obtained at different places. An even greater limitation is the lack of a suitable network of stations; in most of the world the scale of the network greatly exceeds the scale of Es phenomena and hence the morphology of Es cannot be established adequately.

A bottomside satellite sounder could detect Es whenever foEs exceeded the local plasma frequency at the satellite. In general this would be less than foF2, the amount depending critically on the actual height of the satellite. Preliminary estimates suggest that a satellite flying at or below 200 km would give a reasonable estimate of the morphology of the denser types of Es, with sufficient detail to permit some cross calibration of different ground based ionosondes and thus some improvement in the use of existing ground based data.

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7 February 1968

PREDICTION OF SPORADIC-E IONIZATION
(CCIR Study Programme 4A/VI)

The interest of CCIR in sporadic-E ionization arises from the role played by this ionospheric layer in the propagation of radio waves in the HF and VHF bands; this is the subject of Question 4/VI. However, the present document is not concerned with the provision of immediate answers to this Question because, it is believed that improved predictions are likely to be achieved only after a better understanding of the physical mechanisms responsible for the formation of Es has been gained. This, in turn, should lead to more informed interpretations of the characteristics of Es layers, and their occurrence and geographical distribution and, in due course, to better predictions.

Although a great deal of research has already been carried out, which relates either directly or indirectly to the physics of sporadic-E ionization, there is no up-to-date review of this work which would allow the overall situation to be examined. The present document has been written so as to fill this gap; it results from a Resolution [1], adopted by the XV General Assembly of URSI in 1966, which invited Dr. J.D. Whitehead of the University of Queensland, Australia, to study the scientific and technical literature on the physical basis of sporadic-E and any potential applications to the prediction problem.

The full text of Dr. Whitehead's extensive Report includes brief reviews of and critical comments on the many detailed questions involved in research on sporadic-E ionization. The tentative conclusions drawn from the Report have been collected together by Dr. Whitehead and are reproduced in Annex IA. In addition, he has prepared a list of questions which specify subjects on which further research seems desirable at present, and a list of recommendations relating to future action by those actively involved in experimental and theoretical studies of sporadic-E. The Questions and Recommendations are reproduced in Annex IB.

At the URSI Assembly mentioned above, some formal comments were made in the hope that they would stimulate increased attention to the problem of the physical basis of sporadic-E and its prediction [1]. It was recommended that these comments also should be transmitted to CCIR and they are reproduced in Annex II.

REFERENCE

1. *URSI Information Bulletin, 159,* 23-24 (1966).

ANNEX IA

Tentative Conclusions Regarding the Characteristics of Sporadic-E Ionization (The numbers at the left refer to the corresponding paragraphs in Dr. Whitehead's full Report).

1. *Sporadic E Layers in General*
   These may be divided into three types: temperate zone, equatorial zone and auroral zone.

2. *Temperate Zone Sporadic-E*

2.1 fEs increases by $\sim$ 0.1% per unit sunspot number.

2.2 At low latitudes fEs increases, and at higher latitudes decreases, with magnetic activity. The magnetic field decreases by $\sim$ 5 gamma and inclines towards the west by $\sim$ 0.2' arc during prolonged sporadic-E.

2.3 Whilst the occurrence of Es during the day is most probable where the hozirontal field is greatest, this is not true during the night.

2.4 The lunar tidal amplitude of foEs is $\sim$ 0.3 Mc/s.

2.5 The occurrence of Es is weakly associated with the behaviour of the F-region.

2.6, 2.7, 2.8 More data are required to establish the association with airflow, nuclear explosions and meteors. Even " meteoric „ Es may not be caused by meteors.

2.9 There is no established association between Es and thunderstorms or weather.

2.10 Sporadic E clouds occu in rall sizes from 1000 km to a few metres. VHF radio waves may be specularly reflected or scattered. In the latter case, backscatter is observed from field-aligned irregularities. Transparent Es may be due to vertical and/or horizontal fine structure.

2.11 Clouds of Es tend to drift towards the equator at about 80 m sec^{-1}.

2.12 Sporadic-E near 105-115 km is probably associated with negative EW linear shear; that near 95 km is not.

2.13 Sequential Es is the result of a layer which moves downwards at $\sim$ 1 m sec^{-1}- and increases in electron density as it does so.

2.14 Es occurs usually in the form of layers 500 m to 2 km in thickness.

2.15 The electron temperature in sporadic E layers is not known.

2.16 The metallic ions in E region have total contents of $\sim 10^{10}$ cm^{-2}, and may form layers with peak densities of $\sim 10^4$ cm^{-3}. It is not known whether this is the usual form of sporadic-E.

2.17 MUF is probably related to fEs by the secant law for specular reflection, but scattering occurs at higher frequencies.

2.18 Wind shear and the consequent convergence of ionization is the most probable cause of sporadic-E, but the role of the metallic ions and the electron temperature variations is not clear.

2.19 Other ways of producing a convergence of ionization are less effective than the wind shear.

2.20 Gradients and the resulting instabilities do not give thin layers, but may cause the fine structure.

2.21, 2.22 Turbulence and ionization by energetic particles probably do not play significant roles.

2.23 The neutral wind is associated with shears up to 100 m sec^{-1} km^{-1}; the vertical wavelength is a few km at 105 km, and perhaps 70% of the total movement is due to tidal or general drift and is, therefore, predictable in principle.

2.24 In order to improve possibilities of predicting sporadic-E using theory, it will be necessary for the theory itself to be more firmly established. Horizontal gradients of the geomagnetic field at ground level may be associated with sporadic E. Using the wind-shear theory and knowing the tidal shears and background ionization, it may be possible to make significant improvements in the prediction of sporadic-E.

3. *Equatorial Sporadic-E*

This occurs within about 4^0 of the dip equator, as a belt which varies in width and slightly in position.

3.1 The equatorial current belt (electrojet) strengthens and narrows at high sunspot number. The sporadic-E belt could do likewise, but this has not been confirmed.

3.2 The values of fEs decrease during magnetic activity.

3.3 The irregularities in Es which reflect HF waves move westwards (daytime) at about 60 m sec^{-1}. The irregularities which scatter VHF waves may be represented in terms of plane waves moving at 400 m sec^{-1} along their normals and westward.

3.4 The lunar tidal amplitude in fEs is 0.3 Mc/s and the times of appearance and disappearance have a pronounced lunar tide of 30 minutes.

3.5 Farley's two-stream plasma instability accounts for the VHF oblique incidence scattering.

3.6 The instability resulting from ionization gradients may be important for the HF vertical incidence scattering.

3.7 Other suggestions by Whitehead (sound waves) and Piddington (gradient in neutral gas) are not satisfactory.

3.8 Equatorial sporadic-E is predictable and should be included in MUF calculation for trans-equatorial communications.

4. *Auroral sporadic-E*

This occurs mainly at night at geomagnetic latitudes greater than $\sim 60°$ with a maximum near 69°.

A thick sporadically-occurring layer called " night-E „ is observed besides the thin layer and slant-Es.

4.1 The solar cycle variation in auroral Es is not clear.

4.2 The relationship between radio aurora (scattering of VHF radio waves) and visual aurora is not clear and requires further investigation.

4.3, 4.4 Auroral Es and radio aurora occur more frequently during magnetic activity, particularly bay disturbances of both signs. Auroral Es has been noticed to follow the sudden commencement associated with solar flare.

4.5 The velocity of movement is typically ~ 600 m sec^{-1} but may attain 3000 m sec^{-1}. The direction is westwards in the evening and eastwards in the early morning; the time of reversal is 2100-0200 LMT. The Doppler velocity is of the same order as that deduced from range and time measurements but is by no means identical with it.

4.6 Radio aurora occurs at heights around 110 km but the spread in heights is uncertain.

4.7 Rocket measurements indicate electron densities of 10^5 - 10^6 el cm^{-3} and temperatures of 2000°-1800°K but much more information is required.

4.8, 4.9 The irregularities are field-aligned (with an aspect ratio of 10:1); the smaller their transverse dimensions, the more aligned they become. It is not possible to determine from the present radio measurements whether the reflection is critical or not.

4.10 No information is available directly relating particle dumping to radio aurora or sporadic-E.

4.11 There seems to be no information on the relationship between vertical incidence sporadic-E and radio aurora.

4.12 There appear to be at least two ways of energising particles in the magnetosphere: by instabilities which provide the energy by the destruction of magnetic energy, or by wave-particle resonance interaction.

4.13 Farley's two-stream plasma instability seems to be the most promising of the theories developed to explain the production of irregularities in radio aurora once the ionization is already present.

4.14 The production of auroral Es and radio aurora requires primarily a study of the magnetosphere which would give the basic pattern of particle dumping and electric fields. Such a study could be performed using satellites at present in orbit or planned for the near future.

ANNEX IB

Principal questions and recommendations relating to Sporadic-E

1. What causes the year-to-year variations in sporadic-E?
2. What controls the night-time overall distribution of sporadic-E?
3. Does the wind-shear theory correctly explain the lunar tide in temperate zone Es?
4. What is the relationship between airglow and temperate zone Es?
5. What role is played by meteors either in providing ionization, or as reservoirs of metallic atoms?

6. Is the weather at ground level related to sporadic-E?
7. Is non-blanketing sporadic-E due to vertical or horizontal structure, or to both?
8. What is the relationship between sporadic-E layers and electron temperatures?
9. Is there any association between temperate and equatorial zone sporadic-E and the horizontal *gradient* of the earth's magnetic field? Use of the gradient changes partially eliminates the effect of the distant ring current.
10. What magnetospheric conditions lead to the dumping of particles into the ionosphere?
11. Is there an association between VHF emissions, radio aurora and night-E?
12. Ionosondes should be capable of distinguishing between and separately recording the O and X-rays.
13. In experiments to test the wind-shear theory, measurements of the in situ magnetic field should be attempted. It is also vital that the electron density, winds or currents should be measured at the same time and the same place.
14. More experiments on the ion composition of the E-region, in both the presence and the absence of sporadic-E, should be carried out. It is important that the height resolution be better than 1 km.
15. More oblique incidence ionosondes should be operated with, in addition, a vertical incidence ionosonde at the midpoint so as to establish the relationships between the two sets of observations.
16. It is important to establish the characteristics of the tidal and the steady neutral air winds, and particularly the shears associated with them.
17. The solar cycle variation of auroral Es requires further investigation.
18. It is essential to establish the relationship between VHF radio aurora and vertical incidence HF sporadic-E.
19. The relationship between night-E and magnetic activity requires further investigations.
20. The simultaneous velocities of radio aurora and meteor trails at the same place and *height* should be measured.
21. More rocket experiments designed to measure the electron density and temperature in radio-auroral and auroral sporadic-E regions are required. Very fine spatial resolution would permit the determination of the peak electron densities in radio aurora.

22. The association between dumping of say 1 keV electrons and auroral sporadic-E and radio aurora should be investigated.
23. Electron drift measurements may be required to test the two-stream plasma instability for auroral regions.
24. In order to test the same ideas, the NS and EW transverse dimensions of the irregularities should be measured, possibly by VHF scattering received at a rocket.

ANNEX II

Annex to Recommendation III. 4 — Physical Nature of Sporadic E [4]

(*a*) URSI was a co-sponsor with COSPAR of a scientific symposium in Vienna, May 1966, which dealt with wind shears in the E region and other basic points central to the better understanding of the physical processes which lead to sporadic E [1];

(*b*) There have been other recent organized scientific activities on the problems of sporadic E, notably the conference at Estes Park [2], which has recently been summarized in the literature, as well as a book length collection of detailed papers [3], and other such activities are in planning stage;

(*c*) The physical nature or natures of sporadic E is a current topic of considerable interest in scientific circles, and the importance of the subject for practical telecommunications should provide additional incentive for scientists to give attention to this aspect of ionospheric physics and aeronomy;

(*d*) The requirement of CCIR for a system for prediction of sporadic E is an important and logical extension of the basic scientific studies and indeed the degree of success of any prediction system is the ultimate verification of the understanding of the physical processes responsible for sporadic-E.

15 February 1968.

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RADIO NOISE WITHIN AND ABOVE THE IONOSPHERE

(Question 7/VI, Report 342)

1. — INTRODUCTION

The radio noise levels observable at an ionospheric satellite depend on the properties of the medium surrounding the space-craft in several different ways. The local ionosphere controls the antenna impedance and, as well, the propagation conditions for radio waves in the vicinity of the satellite which determine the effective angular aperture of the antenna for radiation from distant sources. The local ionospheric conditions also enter into the mechanisms for noise generation near the space-craft. Accordingly, ionospheric influences are of paramount importance in any considerations of radio noise levels at satellite heights, and the present report has been prepared with this fact in mind. The most obvious departure from convention will be seen in connection with the location of a space-craft within the ionosphere; this is specified here in terms of magnetic field strength and electron number density rather than latitude and height. (Because of a demonstrated dependence on energetic charged particles in the case of some of the noise bands, an additional desirable location parameter might well be the McIlwain L parameter). As a consequence, the radio noise bands are described, not according to the observing frequency, but rather in terms of frequency relative to the characteristic frequencies of the local ionosphere. The different noise types, along with their properties and probable origins, can only be distinguished in this fashion.

This report covers the frequency range of potential interest for radio services above the F-layer maximum for which ionospheric shielding from the earth is desirable. Generally speaking this includes the frequencies between about 10 kHz and 20 MHz.

2. — COSMIC NOISE

Included here are the galactic, and possibly extra-galactic, noise emissions that are observable above the limiting frequency for extra-ordinary wave propagation at the space-craft. This limiting frequency is termed f_{XS} and is defined by

$$[(f_H^2/4) + f_N^2]^{1/2} + f_H/2$$

In the usual ionospheric terminology this corresponds to the condition $X = 1 - Y$, where $X = f_N^2/f^2$, and $Y = f_H/f$; f_N(the plasma frequency)

$= (Ne^2/4\pi^2\varepsilon_0 m)^{1/2}$; f_H (the electron gyro-frequency) $= eB_0/2\pi m$; and $f =$ the observing frequency.

At frequencies above about 10 MHz the cosmic noise levels are fairly well established on the basis of measurements made with ground-based equipment (12). Measurements have been made from a number of rockets and satellites at fixed frequencies below 10 MHz, (1-7) and several sweep-frequency receivers have been used in the Ariel and Alouette satellites (8, 13, 14, 25) to determine the galactic noise spectrum. These results are summarized in Table 1 and are consistent with results obtained by Ellis et al (9) with ground-based equipment during selected ionospheric conditions. Some variation of the noise level has been noted in the satellite and rocket results for different regions of the galaxy but, since the antenna aperture in most cases exceeded 2π steradians, this factor is not large and is probably comparable with the experimental uncertainties.

The galactic brightness temperatures, or antenna temperatures, of Table 1 can be converted to brightness in units of $W.\ m^{-2}.Hz^{-1}.sterad^{-1}$ through the relation:

$$B = 2kT_A/\lambda^2$$

where λ is the wavelength and k is Boltzmann's constant.

For the indicated frequency range and for a space-craft antenna with a broad effective aperture (15), the noise temperatures shown in Table 1 are the minimum galactic values that are observable within or above the ionosphere. In those cases where values significantly higher than this have been observed in this same frequency range, some additional sources of noise or interference is to be sought.

3. — Solar and Planetary Noise

Radio noise emissions of solar origin have been observed sporadically at frequencies greater than f_{XS} with the Alouette satellites (14, 16) and with the Zond 3 space-craft (17). In the latter case, noise bursts were observed at frequencies of 2, 0.21, and 0.02 MHz and some of these could be clearly associated with ground observations of solar bursts. The sweep-frequency receivers in the Alouette satellites have recorded numerous solar noise events of various spectral types, including long duration noise storms, and the maximum noise level observed for type III and type IV events is approximately $10^{-17} W.m^{-2}.Hz^{-1}$.

Observations of enhanced noise emissions from the planet Jupiter have been reported by Slysh at frequencies of 210 and 270 kHz (6). He identified the source on the basis of the variation of intensity with distance, the presence of interference lobes, and a reduced signal on occultation by the moon, and reported the average flux density at 200 kHz as 3 x $10^{-18}W.m^{-2}.Hz^{-1}$. This type of emission was observed for a six-month period with the Zond 3 space-craft, and the location of this and the Venera 2 vehicles was such that the emissions were clearly at frequencies greater than f_{XS}.

4. — Ionospheric Noise at Very Low Frequencies

A number of measurements have been made with VLF receivers in rockets and satellites, and the results show some considerable variation both with time and with position of the space-craft. For present purposes consideration will be restricted to frequencies less than the local electron gyro-frequency, f_H, and greater than the local lower-hybrid resonance, f_{LHR}. This latter frequency is defined by

$$f_{LHR}^{-2} = 1836 (f_N^{-2} + f_H^{-2}) m_{eff},$$

where $m_{eff} = (\Sigma A_i m_p/m_i)^{-1}$, and A_i and m_i are the fractional abundance and mass of each ionic constituent, and m_p is the proton mass. In general, f_{LHR} is not greater than about 10 kHz for the ionospheric regions of interest.

A noise intensity at 18 kHz of about 2.6 x $10^{-15}W.m^{-2}.Hz^{-1}$ was estimated from the reported electric field intensities in the Lofti I satellite (18, 19). The Injun III satellite results show typical average spectral densities at 8.8 kHz of about $10^{-14}W.m^{-2}.Hz^{-1}$, and maximum values of about $10^{-12}W.m^{-2}.Hz^{-1}$ (10). Ogo II results show a peak in the noise spectrum in the general vicinity of 10 kHz with typical intensities in the 10^{-15} to 10^{-14} $W.m^{-2}.Hz^{-1}$ range and peak intensities of the order of 10^{-12} $W.m^{-2}.Hz^{-1}$ (20). The Alouette II data about 10 kHz show similar results; some 10% of the observed intensities exceed a value of 10^{-14} $W.m^{-2}.Hz^{-1}$, and the peak intensities are some two orders of magnitude higher (21). These reports usually describe the noise as broad band, but apparently it is restricted to frequencies greater than f_{LHR} and because of this association has been termed " lower hybrid resonance noise " by some authors (22, 23). However, there seems little reason to believe that this noise differs fundamentally from what some authors have termed " VLF hiss " (10); the apparent steep intensity fall-off with increasing frequency from a maximum near 10 kHz, observed by Ogo II and in a recent rocket experiment, (11, 20) has probably been responsible for the association of this type of noise primarily with the resonance.

These results are summarized in Table 2 (upper half) which indicates the trend of the spectral values obtained by Shawhan and Gurnett (11) in a rocket experiment at middle latitudes during a geomagnetic storm. These values are about 10 times greater than those given by observations made by other workers near 10 kHz during the more typical average conditions. The extremely high intensities (10^{-12} $W.m^{-2}.Hz^{-1}$ near 10 kHz) encountered on occasion at high latitudes are associated with energetic particle influx into the atmosphere (10).

Anomalously high noise levels have been reported at frequencies greater than 100 kHz, but still below f_H, even at middle latitudes. Walsh et al. observed intense noise at 750 kHz in a rocket flight (1), and the Ariel II satellite reported similar results below f_H with no definite low-frequency cut off (24). The Alouette II results show a broad band of noise extending upward from the receiver limit at about 100 kHz to a cut-off frequency that varies somewhat with occasion but which does not exceed 0.9 f_H. The intensity varies widely, but the maximum values have been recorded in two zones: at sub-auroral and at high latitudes; at 200 kHz these are of the order of 10^{-17} $W.m^{-2}.Hz^{-1}$ (25, 26). Here too, an association with the energetic particle flux seems to be implied.

Also shown in Table 2 (lower half) for comparison is the cosmic noise spectrum for frequencies greater than f_{XS}. The brightness temperature values from Table 1 have been converted to flux density for this purpose by means of the relation:

$$S = 8\pi \ kT/\lambda^2$$

which applies in the case of high altitude satellites where the effective antenna aperture is approximately 4π steradians. Here k is Boltzmann's constant and λ is the radio wavelength.

5. — Ionospheric Noise at Frequencies Between F_H and F_{XS}

Walsh et al. (1) observed unexpectedly high noise levels at 0.75, 1.225, and 2.0 MHz, during the course of a rocket flight, which they were able to link to certain properties of the ionosphere. In particular, they showed that intense noise enhancements occurred when the receiver frequency was between the local plasma frequency, f_N, and the local upper-hybrid frequency, f_T. This latter frequency is defined by the relation

$$f_T^2 = f_N^2 + f_H^2.$$

Harvey (24, 27) reported a similar observation for Ariel II satellite, and showed that the intensity of the noise was related to the energetic particle flux in the inner Van Allen radiation belt. He reported, as well, that another anomalously intense noise band, also related to the energetic particle flux, was observable in the frequency range below the local plasma frequency and above the extraordinary wave cut-off frequency, f_{ZS}, at the satellite. f_{ZS} corresponds to the condition $X = 1 + Y$ in the usual ionospheric terminology; it is defined by the relation

$$f_{ZS} = [(f_H^2/4) + f_H^2]^{1/2} - f_H/2.$$

The Alouette II results clearly show both of these noise bands in a large percentage of the records, but they indicate that the greatest intensities occur at high latitudes (above about 50° geomagnetic) and that there is a direct dependence of the noise intensity on the degree of irregularity of the local ionosphere (26). The anomalously high noise levels obtained by Benediktov et al. (4) at 725 and 1525 kHz are probably also in one or both of these categories, and an association with the particle flux was noted in that case.

An additional noise band appears in a great many of the Alouette II recordings at frequencies below f_{ZS} and above f_H (although this latter limit is not always a firm one) in those situations where f_{ZS} is greater than f_H (26). This frequency range will not support electro-magnetic wave propagation, and consequently the observations could perhaps be viewed as arising in a local source: for example, one involving the interaction of the satellite itself and the medium.

It would seem likely that the observations of intense noise made by Huguenin et al. (2) at 700 kHz can probably be included in this frequency range. The same conclusion might also apply to the observations at 210 kHz made by Slysh with the Zond 2 space-craft (5).

It is difficult to arrive at estimates of the absolute intensities for the three noise types included in this section because of uncertainties regarding the antenna impedance. Benediktov et al. reported values two or three orders of magnitude above the expected cosmic noise level, and similar values were quoted by Walsh et al.

6. — Interference of Terrestrial Origin

Interference from ground-based HF transmitters can be received at a space-craft at frequencies above the ionospheric penetration frequency, or critical frequency as it is more conventionally termed. This critical frequency varies with geographic region, time of day, season, and sunspot epoch; it may be as low as 0.5 MHz at night in certain latitudes, or greater than 15 MHz in equatorial regions by day. As a consequence, a high altitude satellite can expect the propagation of strong interference from the ground within this frequency range. Measurements on such signals have shown them to exceed the cosmic noise level by more than 50 dB (25, 28). Even in relatively narrow frequency gaps between terrestrial transmitters, the peak values of interference from atmospherics may exceed the galactic level by significant amounts over major thunderstorm areas of the globe (28, 29).

A second type of man-made interference for satellite reception is now recognized. Because of the non-linear behaviour of the ionospheric plasma surrounding the space-craft, discrete radio signals can give rise to beat frequencies or intermodulation products. The beat mechanism involves various combinations of the frequencies of these discrete signals which may be radiated by the satellite itself and at frequencies harmonically related to such radiations, or which may occur at ionospheric resonance frequencies that are excited in some (non-linear) fashion by satellite emissions; the signals may even come from ground-based transmitters. Numerous examples of this form of interference appear in the Alouette I and Alouette II recordings at frequencies well below the ionospheric critical frequency. Some of these effects can perhaps be attributed to very oblique propagation from the ground at the observed frequency, or to beats produced in the receiving equipment itself. However, in many cases such explanations are implausible and it has been concluded that a significant portion of the observed beat frequencies are produced in the ionospheric plasma near the space-craft (25, 30, 31).

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In response to a request of Commission IV at the XV General Assembly of URSI (1966) the above report was prepared (in its original form) by Dr. T.R. Hartz (Canada), Chairman of a working group on radio noise environment in space-craft.

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TABLE 1. — Cosmic background noise (in terms of antenna temperature) observed with receivers in space-craft.

f (MHz)	T (10^6 deg K)
0.5	27
1.0	18
2.0	9
3.0	5.0
5.0	1.8
10.0	0.45

TABLE 2. — The spectrum of the radio flux density observed in space vehicles at (top) frequencies below the local electron gyro-frequency, during a geomagnetic storm, (bottom) frequencies above the limit for extraordinary wave propagation.

	f (MHz)	Flux density (W. m^{-2} Hz^{-1})
$f < f_H$	0.01	1. 10^{-13}
	0.02	3. 10^{-14}
	0.04	1. 10^{-15}
	0.06	1. 10^{-17}
$f > f_{XS}$	0.4	2. 10^{-20}
	1	8. 10^{-20}
	2	1.5 10^{-19}
	4	2. 10^{-19}
	6	2. 10^{-19}
	10	1.8 10^{-19}
	20	1. 10^{-19}

Note. — Tables 1 and 2 represent smooth curves drawn through experimentally determined points on the original graphs.

23 February 1968.

FADING OF SIGNALS PROPAGATED BY THE IONOSPHERE
CCIR Report 266-1 (Study Programme 16A/VI)

Introduction

Report 266-1 gives a detailed description of observations relating to fading and, in addition, an outline of the relevant theoretical approaches and methods. It seems probable that observational data can be obtained more easily through channels available to CCIR.

The following comments on Sections 2, 4 and 6 of Report 266-1 are submitted for possible incorporation in a revised report.

Section 2. — Causes of fading

The causes of fading listed at the beginning of Report 266-1 are the main reasons for fading in ionospheric ground-to-ground communications. For space communications the phenomenon of *scintillation* should perhaps be included. Observations exist using radio-stars as sources (1, 2), but there is now an increasing volume of data obtained from satellites (3, 4).

It is felt that *focusing and defocusing effects* (5, 6, 7, 8), produced by ionospheric irregularities, as mentioned, merit more intensive study for the following reasons:

(*a*) Since the phenomena show considerable regularity, it may be that statistical random theory is not the right approach for describing them.

(*b*) Relevant information is being gathered with different scientific radio observations such as backscatter (9), radioastronomical methods (10, 11), and direct recording of ionospheric characteristics such as MUF and virtual height (12). The latter technique demonstrates a clear difference between night and day, with more and " sharper „ irregularities during the day.

(*c*) Theories have been advanced which start from the viewpoint of plasma physics (13), or which consider acoustic gravity waves as a possible physical cause (14).

(*d*) Since the phenomenon is not really statistical in nature, it may be of some interest when fieldstrengths are estimated.

Scientific radio observations of a different kind produce data allowing better separation of the different causes of fading than is the case with cw-waves, obliquely incident on the ionosphere, as used in communications. In particular, there is the pulse method which is more and more often applied at oblique incidence (see Rep. 249-1). Results are probably already available at CCIR.

SECTION 4. — SEVERITY AND RAPIDITY OF SHORT PERIOD FADING

Para 4.1 *Severity of fading.* — The weak point of the present *theory* stems from the fact that the phenomena producing fading variability are usually supposed to be random. Unfortunately, this applies only to certain classes of fading, and not to all of them. For short-period variations the hypothesis is probably acceptable and, in fact, the theory presented is mainly concerned with the effects of phase and polarization changes. However, the longer lasting fades and field increases due to ionospheric irregularities have considerable practical interest for radio operators, but these are only superficially described by the present theories. A different theoretical approach seems to be needed.

Para 4.2 *Rapidity of fading.* — This criticism applies also to the application of notions like fading rapidity to longer lasting phenomena which are, however, not covered under para 5 (Long-period variations). The autocorrelation method, extensively applied, could perhaps be a helpful tool for studying phenomena which can be described as being between regular and random, such as focusing and defocusing.

The influence of the geomagnetic latitude could possibly be described when using existing data on the occurrence of spread-F. In addition to equatorial spread-F (mentioned in the Report 266-1) (15), there is another maximum at high latitudes, near the auroral zones. Observations show rather particular conditions of severe phase perturbation over a small percentage of time (16, 17).

SECTION 6. — CORRELATION OF SIGNALS

Para 6.1 *Space diversity reception.* — Better information on the relative importance of different causes of fading, and the relative merits of diversity in reducing the effects can be obtained with the pulse method which avoids multi-component interference. Using pulses at oblique incidence, and making comparisons with simultaneous cw propagation, it has been shown that spatial diversity is mainly useful against fading produced by interfering components (including ordinary and extraordinary modes), but is not really useful against other longer-lasting kinds of fading (18).

Relevant data at vertical incidence are now obtained as a by-product of ionospheric drift observations with the D1-method (19); height changes of the reflecting layer produce very typical " exploding „ and " imploding „ fading patterns on the ground.

A new theoretical approach for a random fan of rays plus one specular component has been published (20).

Para 6.3 *Frequency correlation.* — At vertical incidence the frequency selectivity of fading has been investigated using the pulse method (21). Typical differences between reflections from different layers are announced.

The well-known method of the Doppler-effect (frequency changes due to height changes of the reflecting layers) (22) has been applied using more sophisticated techniques and with higher sensitivity (23). The method promises to produce useful data also for fading analysis.

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4 March 1968

STUDIES AND EXPERIMENTS CONCERNED WITH TIME-SIGNAL EMISSIONS

CCIR Opinion 26

1. — The XV General Assembly of URSI (September 1966) endorsed the following Opinion expressed by URSI Commission I (on Radio Measurements and Standards):

" Opinion I.1

The URSI acknowledges the cooperation of the IAU and of the CCIR in connection with standard frequency transmissions and time signals, and notes the resolutions taken at Hamburg in 1964 and at Oslo in 1966. It notes also with satisfaction the interim adoption of an atomic unit of time by the CIPM in 1964. It is however the opinion of URSI that all the methods of operating standard frequency services which have been proposed contain defects which will cause increasing difficulties as the use of the services extends; and that these services must inevitably develop toward a system of uniform atomic time and constant frequency. This would necessitate the provision of some form of correction for those requiring astronomical time „.

2. — In September 1967, a Meeting was convened in Brussels by the Chairman of URSI Commission I to consider the coordination of standard frequency transmissions in the European Area.

The following Conclusions were agreed unanimously:

1. — *Type of emission*

The most suitable standard frequency and time service will be provided by transmitters operating continuously in the lower part of the LF band. The transmitters should operate on their nominal values of frequency, i.e. without offset. The timing pulses should consist of carrier interruptions of precise duration, preferably of 100 ms, the minutes, hours and twelve hours being indicated by a double, triple and quadruple interruptions, respectively.

The HF stations will continue to provide a satisfactory service of time signal dissemination to an accuracy of a few tenths of a millisecond.

The VLF stations provide an additional source of standard frequencies and time signals.

2. — *Number of LF stations*

Existing experience has shown that the effective range of LF transmission for frequency and time measurements is about 800 km under normal conditions. The whole of the area could be served by several suitably situated medium power stations.

The stations at present in operation, namely OMA (50 kHz), MSF (60 kHz), HGB (75 kHz) and DCF 77 (77.5 kHz), provide an adequate coverage. Further measurements of phase and signal strength are needed to ascertain with more confidence the useful range under all conditions.

3. — *Preferred time scale*

The UTC system now widely in use can only be regarded as an interim solution since it does not exploit fully the second defined by means of an atomic transition. The advantages of dispensing with frequency offsets and steps adjustments are overwhelming and there seems to be no scientific reason why this should not be done immediately. Delaying the transition to an atomic time scale will only increase the difficulties and cost of a change which is inevitable.

The CCDS (Comité Consultatif pour la Définition de la Seconde) of the CIPM (Comité International des Poids et Mesures) has recommended that a meeting of specialists should be called to consider the full implications of adopting the atomic unit based on the new definition of the second. It is hoped that this meeting will be convened in the very near future and that it will then be possible to decide on a definite date (e. g. January Ist, 1970) on which all stations, or at least all those represented here, would adopt atomic time with a common origin. Some of the advantages of using atomic time and constant frequency (without offset) are listed below:

(*a*) Measurements of time interval and frequency can be made immediately without the need to apply subsequent corrections.
(*b*) The possibility of confusion is avoided by the use of a single unit. The simultaneous use of two different time units (AT and UTC), one of which may be changed in value, is bound to lead to confusion (a common mistake is to express frequency in terms of the UTC unit).
(*c*) The coherence of the carrier and the time pulses is preserved.
(*d*) Frequency and time transmissions without discontinuities make possible the automatic setting of clocks without undue complication and simplify and increase the reliability of all applications of atomic clocks (e. g. anti-collision navigation systems).
(*e*) Corrections will be required only for variable quantities such as the time of rotation of the earth. The present system of changing the unit to agree with the variable period of the earth's rotation is no longer acceptable.

4. — *Continuous cooperation*

The continued cooperation of stations in the European Area is essential.

In accordance with these Conclusions, the Chairman of URSI Commission I has written to the President of CIPM to ask whether a meeting could be convened by CIPM to which all interested parties would be invited. An initial discussion meeting at BIPM has been called for 30-31 May 1968.

22 February 1968.

PUBLICATIONS

Comptes Rendus de la XVe Assemblée générale de l'URSI Munich, 5 - 15 septembre 1966

Les Comptes rendus de la XV^{e} Assemblée générale ont été publiés en huit fascicules. Des exemplaires peuvent être obtenus auprès du:

Secrétariat de l'URSI, 7, place Emile Danco, Bruxelles 18, Belgique.

Les prix indiqués ci-dessous comprennent les frais d'expédition par courrier ordinaire.

Vol.XIV	*Titre du fascicule*	*Prix*	
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Fas. 1	Mesures et étalons radioélectriques	50	1.00
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Les fascicules sont numérotés suivant les numéros des Commissions, à l'exception du Fascicule 8. Les activités de l'ancienne Sous-commission IVa (actuellement Commission VIII) sont incluses au Fascicule 4.

Proceedings of the XV General Assembly of URSI
Munich 5 - 15 Sept. 1966

The proceedings of the XV General Assembly have been published in eight parts. Copies are available from:

URSI Secretariat, 7, place Emile Danco, Bruxelles, 18 Belgium.

The prices shown below include surface mail postage.

Vol. XIV	*Title of Part*	*Price*	
		Belgian Francs	*US$*
Part 1	Radio Standards and Measurements	50	1.00
Part 2	Radio and Non-Ionized Media	75	1.50
Part 3	Ionosphere	125	2.50
Part 4	Magnetosphere and Radio Noise of Terrestrial Origin	100	2.00
Part 5	Radio Astronomy	75	1.50
Part 6	Radio Waves and Circuits	150	3.00
Part 7	Radio Electronics	100	2.00
Part 8	Administration and Miscellaneous Activities	75	1.50
Reduced price for Parts 1-8 complete		675	13.50

The Parts are numbered according to the numbers of the Commissions except for Part 8. The activities of the former Sub-Commission IVa (now Commission VIII) are included in Part 4.

Electromagnetic Wave Theory : Delft 1965

In September 1965, a Symposium on Electromagnetic Wave Theory was held in Delft, Netherlands with the joint sponsorship of URSI, the Netherlands National Committee for URSI, the Technological University of Delft, and the Netherlands Electronic and Radio Society. The programme was arranged by an international committee under Dr. F. L. Stumpers, Chairman of URSI Commission VI.

Nearly 200 papers were presented during the 6 days, including 80 by speakers invited especially by the organizers. All the papers were in English except for 12 in French. The subdivisions of the main topic (with the number of papers in each) are as follows:

A. Wave Propagation (27)

B. Waveguides (16)

C. Overmoded and Beam Waveguides: Surface Waves (18)

D. Propagation in Non-Linear Media (24)

E. Antennas (46)

F. Scattering and Diffraction (48)

G. Statistical Optics and Coherence (18)

The text of the papers with diagrams and illustrations has been published in two volumes [1] edited by Professor John Brown.

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(1) J. Brown (Ed.) Electromagnetic Wave Theory
Part 1 : xvi + pp 1-542
Part 2 : viii + pp 543-1100
(1967 Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Braunschweig).