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IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

Ionosphere Station Information Bulletin No. 29**

* Under the auspices of Commission G Working Group G.1 of the International Union of Radio Science (URSI).

** Issued on behalf of INAG by World Data Center A for Solar-Terrestrial Physics, National Oceanic and Atmospheric Administration, Boulder, Colorado 80303, U.S.A. The Bulletin is distributed to stations by the same channels (but in the reverse direction) as their data ultimately flow to WDC-A. Others wishing to be on the distribution list should notify WDC-A.

I. Introduction

by

W. R. Piggott, Chairman

In this Bulletin we report on the work of the INAG meetings held at Alpbach, May 25, 1978, Leningrad, July 24-26, 1978, and Helsinki, August 1-4, 1978. In view of the need to keep all analyses uniform until the end of IMS, it was decided that there should be no changes to the scaling rules other than clarification until the end of the IMS, at present December 1979. This gives time for a further collection of views on the post-IMS recommended data interchange and its associated analysis and reduction rules. Many of those attending the INAG meetings felt that they did not have an adequate knowledge of the arguments for and against the possible changes. I hope to meet this point using a series of short notes in the next few INAG Bulletins and hope that you will help by raising questions whenever you feel that I have lost a point or given a distorted view. If there is no consensus, INAG will have to make the decisions as best it can.

The results of the INAG questionnaire show that there is a remarkably strong interest in maintaining a large vertical incidence network after the IMS, in fact, of the 97 stations listed in replies, 83 will definitely continue and a further 7 may continue. Inquiries about the possible future of the remainder suggest that up to about one third may or will continue but that their future depends critically on whether a cheap, reliable observatory ionosonde can be produced and, in many cases, whether money to purchase such equipment can be obtained. Unfortunately, no replies have been received from a number of stations at important geophysical locations, in particular, at low magnetic latitudes. The IMS has generated more interest in high latitude ionospheric studies and some groups would like to revise the High Latitude Supplement to encourage further work. The most important practical problem in the immediate future in this zone is the future of the Canadian Ionospheric Stations after 1980. *There is little local interest in the data from these stations in Canada so that the justification for their future must come from foreign users. If you wish to use these stations in the future, you must make representations or they will disappear.*

It appears to your Chairman that the time is probably ripe for renewed interest in equatorial phenomena, particularly during the coming solar maximum study period. However, this was not supported at the INAG meetings so we propose to take no action until requested by those interested in low latitude phenomena.

You should all have received the revised version of the first four chapters of the Handbook, circulated as UAG Report 23A, July 1978. I would like to take this opportunity to thank, on your behalf, those who contributed to this volume and to WDC-A for Solar-Terrestrial Physics for publishing it. (See Foreword.) The corrections have been included in the Russian translation of the whole Handbook which is now available (published by Science, Moscow, 1978).

It has been decided to manufacture the Australian 4A ionosonde commercially. It will be known as the IPS-42. For more details see p. 11 of this bulletin.

It is often suggested that INAG should take more notice of the possibility of advanced digital types of ionosondes and that the reduction rules should be modified to take into account the possibilities of using these in new ways. This suggestion appears to be premature. While such sounders have been extensively used for research purposes, so far, no-one has attempted to exploit them fully for synoptic purposes. In fact, most synoptic data taken by such ionosondes have been deduced using conventional procedures and rules. Thus there is no experience yet on which to base any revised convention. There are, however, real difficulties in the appearance of ionograms taken on ionosondes with short time constant differentiating circuits or with preselection of significant signals which need special attention. INAG would like to encourage direct comparisions between ionograms taken using such methods and conventional ionograms. These could be discussed in Uncle Roy's Column.

The report of URSI/IAGA on Needs for Ionosondes in the 1980's, has now been accepted by both URSI and IAGA. The results of our questionnaire show that there is much support for most of the proposals from those remaining ionosonde stations. Thus we can look forward to the continued existence of an important VI network. I hope you will all be encouraged by this tribute to the usefulness of your work.

Your Chairman must again apologize for the delay in publishing this Bulletin. Once more pressure on his time has meant that he could not meet the deadlines despite help from Messrs. Conkright and Rodger. It is now likely that he will be retiring from his present job toward the end of 1979 and should then be less pressed for time. The final revision of this Bulletin is being made on RRS Bransfield in Antarctic waters. Any errors should be put down to the effect of swell!

II. Ad hoc Meeting, Alpbach, Austria, May 25, 1978

Participants:	
J. Dudeney (Chairman, alternate for W.R. Piggott)	UK
J.V. Lincoln (Vice Chairman and Secretary)	USA
J.A. Gledhill	South Africa
R. Haggard	South Africa
Y. Sahai	Brazil
K.B. Serafimov	Bulgaria
N.M. Sheibh	Pakistan
J.H.A. Sobral	Brazil
B.A. Tinsley	USA
P. Vila	France

1. Introduction

The chairman stressed the need for users of ionospheric data to comment on their needs, on the problems raised by INAG, and on the status of VI stations known to them. He then informed the group of the status of the revision of the first four chapters of the Handbook (published July 1978, as UAG-23A).

2. Status of Network

France: A station is to be installed at La Reunion, Madagascar. Terre Adelie, Antarctica, will continue at least to the end of the IMS.

Pakistan: There is no station in Pakistan.

Bulgaria: The Sofia station continues to operate as does a station at a site on the Black Sea. These use the Bulgarian design IRX59 ionosonde of which more than 20 have been built. Two are believed to be in Vietnam.

South Africa: All South African stations are to continue with Chirp sounders being used at SANAE and Grahamstown. The South African group are currently constructing a miniaturised airborne ionosonde which will be controlled by a microprocessor. In addition to the conventional parameters, this machine will be capable of measuring Doppler shift and angle of arrival. A note on this new ionosonde is given on p. 25 of this Bulletin.

Brazil: There are no routine scalings being made at Fortaleza or Paulista, but these ionosondes are used for scientific research. A number of attendees expressed interest in data from Paramaribo and its conjugate location.

USA: All stations are expected to continue. An ionosonde has been sent to Argentina for installation at San Juan. The Australian 4B ionosondes will shortly be under test for use in routine monitoring of the ionosphere, as the United States is considering replacement of their model 'C' type ionosondes.

UK: Slough is to continue. *A final decision regarding the future of the Port Stanley ionosonde is still to be made. Anyone wishing to influence the decision should write to the Chairman of INAG, or to the Director of the Appleton Laboratory, Ditton Park, Slough SL3 9JX, UK. South Georgia will close at the end of 1978. However, this decision may be reconsidered if strong interest is shown by the international community. Please write expressing any such interest to the Chairman of INAG (Dr. W.R. Piggott), British Antarctic Survey, Madingley Road, Cambridge CB3 OET, UK.* An Australian 4A ionosonde is at present operating alongside the conventional Union Radio at Argentine Islands. A new NOAA digital ionosonde is being acquired by the British Antarctic Survey and will be deployed at Halley Bay in 1980/81.

The remaining topics on the Agenda of the Alpbach meeting were covered in as much, or greater detail at the Helsinki INAG meeting. Therefore, in order to save space, they are only listed below:

1. Discussion on the need for a training manual.
2. Call for response to the questionnaire in INAG 27 and 28 on scaling rules.
3. Future of INAG, and the future of the Bulletin.
4. A reminder of the French group's interest in exchanging a month's data of high latitude ionograms (see INAG 27, p. 11).

III. Minutes of INAG Meeting Held in Leningrad, 24-28 July, 1978

Participants: W.R. Piggott - Chairman of INAG
Dr. N.V. Mednikova - Member of INAG
Dr. A.S. Besprozvannaya - Member of INAG
Mrs. Anna Minevick
Mrs. A.N. Suckhodolskaya
Dr. T.I. Shchuka

1. Status of Network

In addition to the conventional network which is operating well, the USSR is developing a new digital ionosonde which will have similar capabilities to the NOAA advanced ionospheric sounder. The USSR machine, called BASIS, will be deployed at the regional centers or at large institutes for studying ionospheric physics and radiowave propagation. The existing network will continue to operate.

Concern was expressed over the possible closure of several of the Southern Hemisphere stations, particularly Port Stanley, and those which are magnetically conjugate to Northern Stations. The Canadian chain formed an essential part of the intensive Northern Hemisphere network and its loss would leave an important gap in the network.

2. World Data Centre B2

The importance of data exchange with stations outside the USSR and with the other world data centers was emphasized.

3. INAG

The work of INAG has been greatly appreciated in the USSR. Particular thanks were paid to the enthusiasm of the Chairman, Dr. W.R. Piggott, and Miss J.V. Lincoln. Every hope was expressed that INAG would continue.

4. Handbooks

The second edition of the URSI Handbook of Ionogram Interpretation and Reduction, including all corrections in UAG-23A, has been translated into Russian and has proved to be very valuable. If future editions are to be produced by the network it was hoped that more ionograms would be included, particularly covering spread F, Es types and tilted layers.

The meeting felt strongly that the High Latitude Supplement had helped clarify the analysis of high latitude ionograms but that further revision was needed. In particular it would be worthwhile to attempt to identify magnetospheric-ionospheric interactions more clearly, stressing the characteristic patterns found. Probably the most efficient procedure would be to initiate discussion in the INAG Bulletin followed by an international workshop to prepare the Document.

Patterns

The objective would include using ionogram patterns as scientific diagnostic tools to help identify the morphology of the physical processes present.

Thus, for example, the times when particular patterns were seen at stations could become important rather than the detailed description of the ionogram given by the conventional analysis.

Problems in ionogram interpretation unique to low latitudes are sufficiently great for the possibility of a low latitude handbook to be considered very seriously.

5. Training

It was felt that INAG should not be responsible for a training manual. The responsibility for this should lie with national centers. The Russian group supported the recommendations of the French group to hold a special Workshop on Interpretation of High Latitude Ionograms and suggested that the IMS special study period 1-15th December 1977 would be an appropriate period.

6. Ionogram Reduction

(a) Auroral Es.

There was a discussion on auroral Es and in particular on the value of distinguishing between auroral Es overhead, which gives multiple reflections and that at oblique, which does not. The auroral Es rules had been modified before the IMS to make this distinction clearer, particularly at the request of scientists using rocket and satellite data. The Chairman stated that the tighter rules were giving trouble to many scalers and that experience with the data showed that the gain in precision was not worthwhile. The generating particle streams moved rapidly in time and there was little evidence that the distinction was used by scientists. The group, who have been using these data intensively agreed and recommended that the words "auroral Es cannot blanket" be removed. This is, in effect, a revision of the rules as set out in the IGY.

(b) Particle E - retardation Es

A similar discussion on the scaling of particle E (Es-k) and retardation Es (Es-r) brought out the point that this distinction is not important for the difficult case where Es-k blankets the F layer. The difference between foEs type r, and foE type k is then usually negligible. However, in the other cases where both types are present, it was important to maintain the distinction. In particular Es-k shows that the thick E layer is overhead and thus is an indicator of local particle activity. On nomenclature, it appeared that the scalers would prefer to use Es-r when total blanketing was present as there was usually a slight diffuse trace present at foEs though physically foE-K was more appropriate. The Chairman mentioned that a few stations see clear thick layer traces in these circumstances and would therefore prefer foE-K and that, in any case, the use of r would remove the highest values of foE-K from the foE table. It had to be remembered that the average user of the tables was less expert than the scalers. In the USSR "auroral E" is used to denote Es-k and Es-r taken together.

(c) Es typing

Es typing was essential at least at high latitude stations. Temperate latitude types could be greatly simplified, e.g. by combining high cusp, low and flat, but this would involve writing a special rule so that the low types of Es with foEs < foE were omitted in the future. The case for continuing to record the latter was weak, the data often misleading and its study should be left to specialists using original ionograms.

(d) fxI

It was felt that fxI is a valuable parameter, particularly at high latitudes where ridges are common. The Chairman pointed out that some equipments with electronic preselection or fast differentiation gave ionograms which were difficult to analyze. However, its use in research is important.

(e) Polar spurs and Es-a

The difficulties in identifying polar spurs when Es-a was present, or vice versa, was discussed. The only practical distinction appeared to be the variation in time. In most cases the polar spur changes height relatively slowly, Es-a very fast.

(f) Spread-F classification

It would be valuable to study the types of ionogram associated with the auroral oval, equatorial edge of trough, daytime cusp region, precipitation zones, etc., and classify them accordingly. These problems could justify a special High Latitude Workshop.

(g) INAG Membership

Dr. Besprozvannaya and Dr. Mednikova were still in a position to contribute to INAG work.

IV. INAG Meeting at Helsinki, 1-4 August, 1978

Participants:

Dr. W.R. Piggott	UK	Chairman of INAG
Mlle. G.M. Pillet	France	Member of INAG, Acting Secretary
R.O. Conkright	USA	Alternate for J.V. Lincoln (Secretary)
J.R. Dudeney	UK	Alternate for W.R. Piggott
Prof. O. Awe	Nigeria	
Dr. L. Bossy	Belgium	
Dr. H. Derblom	Sweden	
Dr. V. Ferberov	USSR	
Fr. E. Galdon	Spain	
Dr. J. Gledhill	South Africa	
Dr. T. Gulyaeva	USSR	
Dr. R. Hanbaba	France	
Dr. G.W. Haydon	USA	
Prof. R. Hunsucker	USA	
Dr. W. Ireland	New Zealand	
Dr. L. B. Kohawohe	Nigeria	

Dr. L.F. McNamara	Australia
Prof. M.G. Morgan	USA
Dr. I.E. Owolabi	Nigeria
Dr. T. Partanen	Finland
Dr. A. Paul	USA
Dr. A.W.V. Poole	South Africa
Dr. K. Rawer	German Federal Republic
Mr. G. Rosen	Sweden
Dr. H. Schwentek	German Federal Republic
Dr. K. Sinno	Japan
Dr. M. Sylvain	France
Dr. T. Turunen	Finland
Dr. R.W. Vice	South Africa
Dr. H.J. Vesseur	Netherlands
Dr. A.W. Wernik	Poland
Mr. J.W. Wright	USA

Written submissions were received from the INAG meetings held at Alpbach and Leningrad.

There were at least 32 representatives from 18 countries who attended at least one of two formal sessions. This is an increase in both the number of participants and the countries represented compared to the previous General Assembly of URSI, held in Lima, and an encouraging sign of the continued importance of the contribution of INAG. In addition several individuals had discussions with the Chairman at other times in the meeting. Their views are included below.

Vote of Thanks

The INAG Working Group thanked the organizers of the URSI General Assembly for the arrangements which were made for the sessions of INAG.

The Chairman paid tribute to all those who have helped in the running of INAG, to WDC-A for Solar-Terrestrial Physics for its secretarial and financial help, particularly to Miss J.V. Lincoln and those involved in the publication of the bulletins, the High Latitude Supplement, and the revision of the first four chapters of the Handbook (UAG-23A). Thanks were also expressed to those who have been involved in the translation of the INAG Bulletins and WDC-A UAG series, and to all INAG members.

Dr. Victor Mesterman has resigned as a member of INAG as he was no longer in a position to help effectively. The meeting expressed its regret at this decision and passed a vote of thanks to Dr. Mesterman for his help in the past.

Reports of Meetings

The Chairman reported that eight meetings had been held with official INAG representation since the last General Assembly:

Uppsala	Oct. 28-30 1975	INAG 22, p. 5-7
Geneva	Feb. 12 1976	INAG 23, p. 2-9
Boulder	June 11 1976	INAG 25, p. 2-5
Cambridge	July 19 1976	INAG 25, p. 6-7
Seattle	Aug. 30 1977	INAG 26, p. 2-7
Geneva	Jan. 5-6 1978	INAG 27, p. 2-14
Archangel	Mar. 6-10 1978	INAG 28, p. 19-25
Leningrad	July 24-28 1978	

Inspection of the list of participants showed very little overlap, showing that the INAG policy of holding meetings whenever practical was effective in bringing INAG matters to a wide audience.

Eight INAG Bulletins had been published in the three years. This was less than called for at Lima, (12 issues), mainly because the Chairman was not able to put in the time needed to prepare more bulletins. INAG members had also contributed to the URSI/IAGA Working Group on the future of the ionospheric network but had not taken a lead since it was desirable that this should be as far as possible representative of the users of the data.

Future of INAG

The meeting felt that its actions during the last three years have demonstrated that INAG has still a most important role to play in the future of the VI network and that it should be continued for another three years. To be effective it was essential that the INAG Bulletin continue to be published, circulated and translated as in the past. The following recommendation to ask URSI for continued financial support was passed to Commission G that:

INAG has been asked by the V.I. network to thank URSI for its financial support of the INAG Bulletin, and to state that this Bulletin is essential for maintaining and improving the quality of the data from the network. INAG draws the attention of Commission G to the need for continued financial support so that this Bulletin can be published for the next three years.

This recommendation gained support of the Commission with the condition that those capable of showing support by providing a contribution of $10 US for the issues for three years continue to do so. If this support stops, the grants from URSI and WDC-A for Solar-Terrestrial Physics will stop also. *Thus if you feel that INAG should continue to exist please maintain your support.*

Future of the V.I. network

The Chairman reported on the results of the questionnaire which had been published in both INAG 27 and 28, on the future of the ionosonde network after the end of the International Magnetospheric Study (IMS), in December 1979.

Replies representing 97 stations had been received up to the end of the meeting. These were from 25 single stations and 8 networks. Of these, 86 stations are expected to remain open and 8 will definitely close. These are: Dourbes, Raratonga, Djibouti, Popayan, La Paz, South Georgia, Cocos Is., Port Moresby.

The future of several important stations is known to be uncertain: At risk are the Canadian chain, the German chain, and Port Stanley. *Those wishing to see these stations continue should make suitable representations.*

The Chairman expressed doubt on the position of the low latitude groups of stations. (No replies had been received from most low latitude stations). This point of view was challenged by the participants, in particular from India, where several stations were still operating. INAG will try to investigate how efficient the low latitude network still is, by seeing how many successful observations are made in some months selected at random and will report in a future Bulletin.

Many replies expressed interest in suggesting new sites for ionosondes or stressed the importance of reopening stations which have already ceased operation. There are both financial and equipment constraints on these proposals and it is highly unlikely that all 27 new sites proposed will come into being.

There was a lengthy discussion on the Report of the URSI/IAGA Joint Working Group on "Needs for Ionosondes in the 1980's" (INAG 26, p. 7-14). Most of those present felt that the report, while on the whole good, understressed some particular points and that the response of the community to the INAG questionnaire showed that there was more support for an ongoing network than had been expected. Reasons were given for keeping the European close network in being despite it not being mentioned in the Report. Unfortunately, several key stations in this network are threatened by closure, in particular the stations at Lindau and Freiburg, and Dourbes are definitely closing.

The Chairman stated that the proposed closure of the Canadian chain had caused much dismay among those working on High Latitude problems and would leave an irreparable gap over the most active zone in the Northern Hemisphere. The loss of published data from College, Alaska, was also causing difficulties.

Some participants felt that the Report had not stressed the possibilities of advanced digital sounders sufficiently and that centers of research or communications should be encouraged to acquire and use such instruments. However, the majority felt that the main part of the network would require relatively simple reliable observatory sounders in greater numbers. There was much support inside and outside INAG for the further development of advanced ionospheric sounders. The Chairman announced that URSI Commission G has set up a new working group (International Digital Ionosonde Group, IDIG) with J. Dudeney as Chairman. There was a consensus in support of advanced sounders to be placed at major research institutes as proposed by NOAA and the USSR. Assuming, as seems probable, that the Finance Committee of URSI again agrees to make a contribution so that the Bulletin can be produced, INAG would ask all those receiving the Bulletin to contribute $10 US as a subscription to the cost of publication for the next three years. However, the Bulletin will continue to be made available free of charge for those who cannot contribute. WDC-A for Solar-Terrestrial Physics has again offered to help with the printing and distributions of the Bulletin. The Chairman would like to thank all concerned with the work at WDC-A for Solar-Terrestrial Physics on your behalf.

Review of INAG Publications

The URSI Handbook of Ionogram Interpretation and Reduction, 2nd edition, which was published in November 1972, has contributed greatly to the increased reliability of reduction and homogenity of data throughout the world. It was apparent from the feedback from groups all over the world that minor corrections and clarifications which have been published in various bulletins were making it difficult to use the Handbook effectively. It was therefore decided to republish the first four chapters as UAG-23A. This incorporated all corrections published earlier, and some expansion of sections. WDC-A for Solar-Terrestrial Physics staff must again be thanked for their work.

The High Latitude Supplement (UAG-50) was published shortly after the Lima meeting. It has provided stimulus to various groups especially those working at high latitudes and provided a good basis for discussion of problems.

As already announced (INAG 26, p. 19-20) translations of the High Latitude Supplement into Spanish and Japanese have been published and can be obtained on request. The publication of a translation into Russian was announced at the Leningrad meeting and is also available. On behalf of the network, the meeting passed votes of thanks to all those involved in these translations and felt that the effort would be well rewarded by the increase in efficiency.

While primarily written to solve high latitude problems, UAG-50 contains many discussions, with ionograms, on phenomena seen at temperate and even low latitudes and deserves wider circulation than to High Latitude stations only. Interest in UAG-50 has provoked the suggestion that a low latitude supplement may be useful. (*Your comments on this idea would be appreciated*).

In view of the widely expressed interest in the High Latitude Supplement, the meeting proposed the following recommendation:

that the High Latitude Supplement has enabled many problems to be identified, but it is now desirable for the rules needed for the identification of magnetospheric phenomena by means of ionograms to be clarified and codified. INAG therefore recommends:

(a) that specific phenomena be discussed in the INAG Bulletin.
(b) that changes in the International Rules for data reduction and interchange proposed by INAG take effect from January 1, 1980.

Parameters to be reduced - scaling rules

There was much discussion on the possible changes to the rules and to parameters to be interchanged. Any changes which may result must not come into operation until January 1980 so that all IMS data will be consistent.

At the meeting and at previous INAG meetings there would appear to be three identifiable groups:

(i) a group who wants to keep the parameters as at present;
(ii) a group who wants some simplifications, particularly for certain parameters;
(iii) a group who wants major changes in parameters to be analyzed.

Not all groups have been represented at the recent INAG meetings. *It is important to let your Chairman know your views so that a consensus of opinion may be formed.* Of course, in practice, each group makes its own decision whether or not to follow the recommendations but the majority try to follow the International Rules.

The demand for parameters depends on the active interest at the date when the inquiry is made. Thus, for example, the demand at high latitudes where there is much active research is essentially for all conventional parameters with some simplifications of particular distinctions. The opposite position is to eliminate all parameters:

(a) which behave regularly, e.g. foE, foF1, h'E;
(b) which are not always meaningful, e.g. fmin, fm2;
(c) which can be misleading, e.g. h'F2; or
(d) which are falling out of general use, e.g. Es types.

This leaves foF2, M(3000)F2 and possibly one Es parameter as the desirable interchange. Is such a restricted circulation likely to meet future research needs when supplemented by existing data? *We need your views.* Obviously if the data could be restricted in this way, the design of ionosondes could be simplified to give these parameters directly, consequently running and training costs would be reduced.

It is clear that there will not be a true consensus so the practical problem is to lay down alternative programs which could meet the varying needs of stations in different parts of the world. There has been little or no discussion of the proposal to reduce the recommended interchange to about 3 parameters. Is this acceptable say at temperate latitudes where the behavior of most parameters is rather regular? The experiment was tried some years ago at certain Australian stations. It would be interesting to know why some of these reverted to more standard procedures. However, if the majority wanted to try this solution it would not be worth while simplifying the parameters which would be omitted. Thus the decision affects other discussions.

On the assumption that some simplification is desirable some obvious proposals would be to simplify Es, the parameters of which give most operators much difficulty.

Some particular simplifications which have had preliminary discussion are:

(i) To classify all temperate latitude Es types as flat-f, eliminating the distinctions, high, cusp, low and flat (night). Keep Es typing for high latitude use only. Eliminate h'Es and either foEs or fbEs. This would cut training and analysis time appreciably at most stations.

(ii) To restrict the analysis of certain phenomena to the zones where they occur regularly. This prevents the detection of rare phenomena (e.g. equatorial aurora in aurora studies) but could be justified by the saving in training effort and analysis time. Are such phenomena recognized at present?

(iii) Eliminate fmin tabulations. This loses a check on ionosonde performance which is valuable at stations with equipment troubles (an important fraction) but saves much meaningless tabulation.

(iv) Omit Es-k values from foE table. Mixed Es-k, Es-r traces are then identified by the fbEs table (fbEs = foE-K) and foEs table (foEs gives value for Es-r trace).

(v) Use the most nearly overhead trace for evaluating foEs when Es-a is present. Ladder traces are oblique.

(vi) Discontinue use of letters M and T which are seldom if ever used at present.

(vii) Tighten foF1 rules so that DL, EL no longer are permitted. foF1 only tabulated when h'F2 is uniquely defined.

(viii) Ignore all low Es traces with foEs < foE.

(ix) At low and temperate latitudes omit either foEs or fbEs tabulations unless CCIR objects.

(x) Ignore range spreading (This is an optional parameter at present so no action is required by INAG.)

Training

A considerable amount of time was spent discussing this subject. It was generally accepted by all present at the meetings that there was a considerable need for training at all latitudes. The problem, which must be resolved, is to decide on the best ways for this help to be given. Many ideas were discussed such to produce zonal training manuals, or to ask the Chairman to tour the world. The former appears to have some merit where the number of different types of ionosonde is relatively small. A start could be made by asking training groups to make a copy of their local training documents, with illustrative ionograms and send it to the Chairman for modification as needed and wider circulation. There was support for the idea that training should be the responsibility of national centers, but that training courses should be more widely advertised. The most practical solution, at least in the short term, would be to expand the appropriate sections in the INAG Bulletin such as Uncle Roy's Column and the Correspondence Course Column. A greater effort will be made to include ionograms and scaling in the Bulletin to illustrate the ways in which the line drawings in UAG-23 and UAG-23A may be applied in practice. *In any such exercise, the correspondence must be in both directions, from the Chairman of INAG to the operators and feedback from the operators on the content of previous articles and providing example ionograms.*

International Digital Ionosonde Group (IDIG)

A new URSI Working Group was formed at the URSI General Assembly to co-ordinate those working on digital ionosondes. This body will be called the International Digital Ionosonde Group (IDIG). As many of the areas for discussion by those involved in ionospheric work overlap with those of INAG, it was decided that part of the INAG Bulletin should be used to distribute IDIG information. A report on the first meeting of IDIG will be found on page 29 of this Bulletin.

Further points made included the following:

(a) The need to maintain the present network particularly in those areas of special interest, e.g., high latitudes, equatorial latitudes, chains of stations at different longitudes and stations with long sequences of accurate data.

(b) The need to add other facilities to at least selected stations in the network, e.g., total electron content, A1 absorption, atmospheric noise, drifts.

(c) The advantage of installing close nets of stations temporarily for special experiments. Scientists cannot expect a world network to meet all needs either for stations or for parameters measured.

(d) The need to maintain the relatively sparse Southern Hemisphere network.

It was felt that URSI/IAGA group should be kept in existence with the object of making ionosondes more useful for studying geophysical and aeronomical problems, to encourage the development of satellite and ground based observations in particular to study high latitude problems. It could profitably organize a workshop on such problems.

Ionosondes

The consensus view was definitely that advanced techniques, such as the advanced ionospheric sounders produced in USA, or USSR BASIS equipment, were only suitable for strong research or operational institutes which had the ability to make them work and use them effectively. These should be supplemented by a relatively large number of comparatively cheap observatory type ionosondes. It was desirable to make the data computer compatible at the earliest possible stage and this could be done conveniently by combining a conventional solid state ionosonde with a data entry system using a small microprocessor. Experiments had already shown that this was a cheap, reliable technique which would probably cost even less in the future. The system used in BAS was briefly described by Dr. Dudeney.

There was much interest in the field of cheap, reliable ionosondes which can be used in the routine monitoring program. It is estimated that up to 50 of these types of equipments may be required in the next few years. Most of the new ionosondes, such as the IS-14 and the Australian 4A have been described in recent INAG Bulletins. It was reported that the Australian 4A ionosonde is to be built commercially and will be called the IPS-42 (see p. 11 of this Bulletin). The IS-14 has already been thoroughly tested in the field (INAG 28, p. 7).

INAG Bulletin

The INAG Bulletin obviously forms one of the most important aspects of the work of the group. A review of the content of recent INAG Bulletins has shown a wide range of topics covered. Requests were received for more ionogram interpretation with illustrations by line drawings. Other aspects which could receive more space are short scientific articles relevant to INAG, special attention to high and low latitude ionograms, and the publication of teaching aids.

It takes much time for the Chairman to search for ionograms or choose subjects for discussion in the Bulletin. He, therefore, appeals to all and in particular to INAG members, to send him material. Especially welcome would be notes on current problems which he can expand and any interesting ionograms. *Many groups have asked for illustrative ionograms to be published in the Bulletin to supplement the Handbook. Why not send some of yours?*

Future INAG membership

The INAG membership will need to be reviewed and changes will be announced when they have been approved by the current INAG membership and URSI.

V. The Australian Ionosonde Operators' Conference, 1978

The 1978 ionosonde operators' conference was held in Sydney from 24 to 26 May. All stations in the Australian network were represented, along with a representative from the group who operate the Mundaring ionosonde in New Zealand. At the conference there was a review of the scaling rules and their interpretation as a consequence of using the IPS 4A ionosonde (see INAG 18, p. 35-36). Discussions on the recent technical and scientific progress made by IPS (Ionospheric Prediction Service) were held and some indications of future work also given.

The complete removal of all radio station interference bands on ionograms produced by the 4A has led to some difficulties in scaling, particularly in deciding which is the appropriate descriptive letter when gaps in the trace appear. B, C, S, or Y may all be possibilities. The 4A ionosonde has been modified to monitor background noise. The AGC output is now monitored and displayed in the first 50km of the ionogram. Interference appears as a spike on the AGC, and these increases can be related to gaps in the ionogram. This has greatly reduced the number of practical difficulties in the interpretation.

The 4A ionosonde receiver signal processing technique has helped the operator to resolve the main trace when spread F is present. However it was decided that a series of ionograms displaying spread F should be collected and scaled so that any inconsistences or difficulties in scaling can be established.

The IPS 4A ionosonde is to be manufactured and marketed by KEL Aerospace Pty Ltd., as the IPS 42 ionosonde. For orders placed by the end of 1978, the price has been guaranteed to be under 16,500 Australian Dollars (approximately $18,150 U.S.). Any further inquiries should be directed to:

KEL Aerospace
Box 250
Malvern 3144
Australia.

Presently there are 14 such ionosondes either being routinely operated in the Australian network, or under test at other locations.

VI. Corrections to UAG-23A

Although great care was taken with the proofreading of the reprint of the first four chapters of the Revised Handbook (UAG-23A), some small errors have been noted by Dr. David Cole and others, as follows:

Section 2.72, Table 1, p. 48. foE in 9B should read "250-H".

Section 2.75, Fig. B, p. 54. Observations: "M(3000)F2" should be replaced by "M(3000)F1".

Section 4.6. Fig. 4.20, p. 122. should read "(fbEs) is equal to foE2, . . ."

Explanatory note: Section 2.72, Fig. 2.12. Example 5 shows the enhancement of the F1 cusp in the vicinity of the critical frequency. This distortion to the trace has been caused by stratification travelling down through the F region. The descriptive letter H is used with foF1 to indicate the presence of the phenomenon although it has not significantly affected the measurement.

VII. The F2 Lacuna Problem

Lacuna problems have been discussed in INAG 8, p. 2; 9, p. 5-10; 12, p. 10-14; 14, p. 6; 18/19, p. 7; 27, p. 34-35; 28, p. 13-17. It is now time to concentrate attention on the F2 lacuna problem and to try to resolve whether it is a true phenomenon or a misinterpretation of G conditions.

There appears to be some disagreement between the groups on whether F2 lacuna can exist as a separate phenomenon. If it does, it probably demands a different explanation to that for F1 lacuna, and it is also probable that total lacuna, which both groups agree occur, represents cases where both mechanisms are present. This is a problem for the experts - it is unlikely that those who seldom see lacuna phenomena can distinguish between F2 lacuna and G condition. However, it is important scientifically and if agreement can be reached, F2 lacuna are likely to form yet another magnetospheric-ionospheric phenomenon which can be studied effectively using ionograms.

In considering the controversy, it should be remembered that lacuna is a gain-sensitive phenomenon so the appearance on the ionogram is to some extent dependent on the signal-to-noise ratio at the station. When this is very high some weak residual and very spread traces can usually be seen.

Having looked at a number of sequences showing F2 lacuna, it appears to me that it is likely that the phenomenon actually occurs and is not a G condition misinterpreted. Some pictures and text provided by Dr. Sylvain are reproduced below so that others can consider some of the evidence and do further work if their interest is aroused. I am, however, doubtful, about the physical explanations suggested to account for the phenomenon. It seems to me to be likely that lacuna denote the presence of intense turbulence, such as is generated by ion-acoustic waves. If F2 lacuna really exist, the physical explanation appropriate for F1 lacuna probably cannot apply and we must seek a new mechanism.

The best evidence to establish the reality and properties of F2 lacuna is given by a close sequence of ionograms, preferably more frequently than 1/4 hourly. During periods showing G phenomena (foF2<foF1) foF2 and h'F2 show rapid changes in time usually closely linked with associated magnetic field changes. When F2 lacuna is present the traces become spread and weakened, often to extinction, with little or no change in foF2 and h'F2.

We reproduce below comments on INAG 27, p. 34-35, provided by Mr. J. K. Olesen and a short paper forwarded by Dr. Sylvain.

Comments on F2 lacuna - INAG 27, p. 34-35

by

J. K. Olesen

As you know, we have in several papers described the geographical and temporal occurrence patterns of SEC - of which lacuna is an important part, i.e., same occurrence shortly speaking as high electric fields, high conductivity and high currents, that means maximum in auroral oval and polar cap during the summer day and auroral events - (in addition to the slant Es and spreadiness part of SEC occurring at the equator). Also, I feel, we have shown it to be likely, if not proved, that the cause of SEC, similarly to what others have shown for the equatorial slant Es, is an E-region plasma instability with 'abnormal damping' (defocussing) attached to it, which above foE decreases with increasing frequency, and thus making the partial or total lacuna, while this model cannot give an F2 lacuna. On the basis of the above model the F2 trace can disappear (with the F1 still there) only if the sensitivity of the ionosonde happens to be marginal, so that the abnormal damping, although less at F2 frequencies than at F1, is still high enough at F2 to suppress the echoes there. Naturally one could use Y for F2 but it would not be 'physically' correct, I should rather prefer R or C, in order not to destroy the meaning of Y.

One fact adds to the chance that the above discussed F2 obscuration occurs, namely the well known fact that the foF2 decreases during severe disturbances (like the SEC with lacuna). This might bring the foF2 very close to foF1 whereby the F1 refractive absorption might contribute to the F2 obscuration.

However, more important is naturally, that there is a very big chance, that foF2 drops below foF1, i.e., a G condition, which I think we have in the big majority of cases of missing F2 trace during SEC.

I do not find, that the valuable investigations of the problem as reported in INAG 27-28 by our French colleagues prove that there is any real F2 lacuna, i.e., a condition where the F2 damping is higher than at F1 - frequencies. In Mme.Cartron's Fig. 3, INAG 28, I believe that curve a on foF2-medians is wrong and curve b the correct one.

If I am wrong, a long series of results must be reconsidered. I should be happy to do this if convincing evidence forced me to do so. The only possibility, I can see, would be a top-side ionogram taken simultaneously with a ground-based "F2-lacuna-ionogram!"

F2 LACUNAS and G CONDITION

by

Dr. Sylvain

1. Introduction

The question of the relevance of the notion of F2 lacuna and of the rules to apply when scaling ionograms without echoes from the F2 layer has been under debate for several years. I would like in this paper to summarize (with objectivity) the present state of theoretical works, which, I think, have not yet been successful, and deduce from that what seems to be a careful behavior as to ionogram reduction.

2. Outline of the problem

Let us recall that the F lacuna concept came out from our works on ionograms from Dumont d'Urville (Terre Adélie) station. The F lacuna is defined as the disappearance on the ionograms of echoes from the F layer when normal traces from the E layer are present. As this disappearance can affect echoes from the F1 layer, from the F2 layer, or from the F layer as a whole, and as the three types of ionograms appear to be manifestations of the same phenomenon (for instance, one observes frequently a change of type from one ionogram to the next one) we have called them F1 lacuna, F2 lacuna and total lacuna [Cartron, 1962; Lebeau, 1966; Vassal et al., 1976; Sylvain et al., 1978].

The G condition, known for a long time, is defined as a situation with an electronic density in the F2 layer lower than the peak density in the F1 layer: the F2 layer is no longer observable on bottomside ionograms. It is clear that a G condition and what we call F2 lacuna give identical ionograms. The difference lies in this, that the assumption of a G condition implies a knowledge of the reason why there are no traces from the F2 layer whereas the definition of the F2 lacuna implies no a priori interpretation.

3. Present state of the interpretation

Our study of lacunas led us to propose an interpretative model based on the assumption of large scale irregularities of the electronic density in the F layer, with horizontal gradients. In these conditions, the waves coming back to the sounder after reflection at ionospheric levels propagate obliquely and are thus weakened, first by a longer path in the absorbing part of the ionosphere, and second due to the directivity of the antenna of the sounder which has its maximum of sensitivity oriented towards the zenith. With such a model, we may conceive a F2 lacuna in the absence of a G condition.

To my knowledge, the Danish group of J. K. Olesen is the only other group which has worked much on the question. Starting from the study of slant sporadic E and looking for secondary criteria of this phenomenon (slant E condition or SEC), they have defined the "E-F height gap" which corresponds more or less to what we call F1 and total lacuna [Olsen and Rybner, 1958; Olsen, 1972]. Olesen's interpretation of the phenomenon is a double stream instability in the upper part of the E layer which, according to its intensity, would affect a more or less extended range of altitudes. The instability on which is based this model must affect the F1 layer and there cannot be a "F2 lacuna". Olesen's position is then logically that the absence of F2 traces is a G condition [Primohal et al., 1974; Olesen et al., 1975; Primohal et al., 1975].

Thus, the lack of agreement concerns the question to know if the absence of echoes from the F2 layer on ionograms is, or not, necessarily due to the occurrence of a G condition. It is a scientific problem but its solution would allow us to overcome logically all scaling difficulties.

At that point of the exposition, I would like to make two comments: the first one is that we are not yet able to consider that the lacuna or SEC phenomenon is well understood. Our model, as well as that from Olesen, appear to me as working models, the validity of which has not been proved and both of them could be erroneous. To show their weaknesses would be easy but is not relevant here.

My second point is that even if it would be demonstrated that a F2 lacuna is always a G condition (I show in 4 hereafter it is far from being the case), the concept of F2 lacuna, which would then be useless to the scaler would still keep interest for the scientist. In fact, G conditions associated with magnetic storms are well known. The events we call F2 lacunas, which are closely correlated to F1 and total lacunas are obviously quite different: a satisfactory explanation of the F-lacuna phenomenon (or of the SEC phenomenon) should take into account the associated G conditions, and these particular G conditions could perfectly be called F2 lacunas.

4. Experimental evidence of the existence of F2 lacunas

Discarding the question of physical interpretation to consider experimental results, I think there are three observations in favor of the existence of F2 lacunas not associated with G conditions.

4.1 Soundings with changing gain

Routine ionospheric measurements at Dumont d'Urville comprise gain runs at the hours: medium gain at the hour, high gain one minute earlier, low gain one minute later, with a difference of 15 dB between low and medium gain and of 10 dB between medium and high gain. It happens that a low or medium gain ionogram exhibits a F2 lacuna whereas on the ionogram at higher gain recorded at one minute interval, the F2-layer traces are present and show that foF2>foF1. An example of this situation is given in Fig. 1. If we don't admit the possibility for the ionosphere to change drastically in less than one minute, we must admit it is possible to have an ionogram without F2-layer echoes not associated with a G condition.

The "URSI Handbook of Ionogram Interpretation and Reduction" recommends, in order to avoid this difficulty to determine G conditions with the help of higher gain ionograms. Nevertheless, the fact that the decision depends on the characteristics of the equipment does not seem to be a perfectly satisfactory solution.

4.2 Observation of sequences

To try to overcome the problem, it can be helpful to consider the sequence of ionograms. Unfortunately, things are not always very clear. An example is given on Fig. 2. We have plotted the critical frequencies foF1 and foF2 determined on 15 min. ionograms and indicated F1, the F2 and the total lacunas observed on the five minute ionograms (the quality of these ionograms does not allow scaling of the parameters). If the F2 lacuna observed at 0855 on December 6, 1966, is probably a G condition (there is a regular decrease of foF2 from 0800), what is there to say about that at 1055 when (foF2-foF1) is almost 3 MHz at 1100.

To get a better temporal description, we made during two months a series of one minute ionograms at high gain. A sequence is given on Fig. 3 (December 9, 1975 from 0044 to 0055 UT). The F2 lacuna at 0048 is

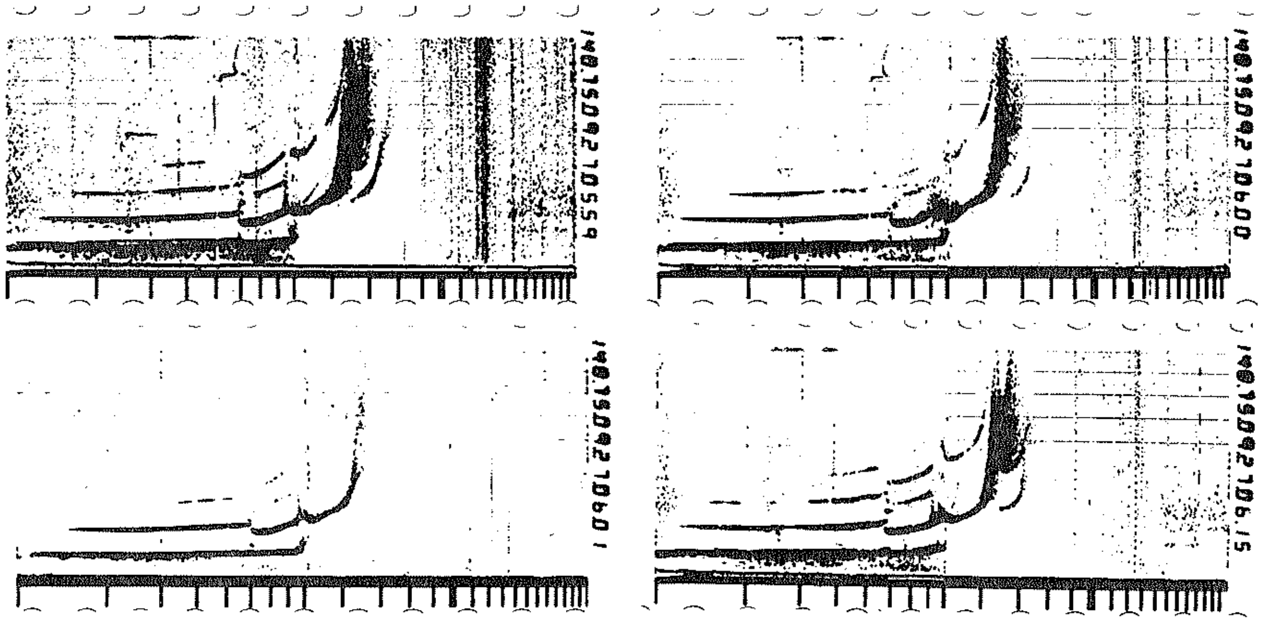


Fig. 1

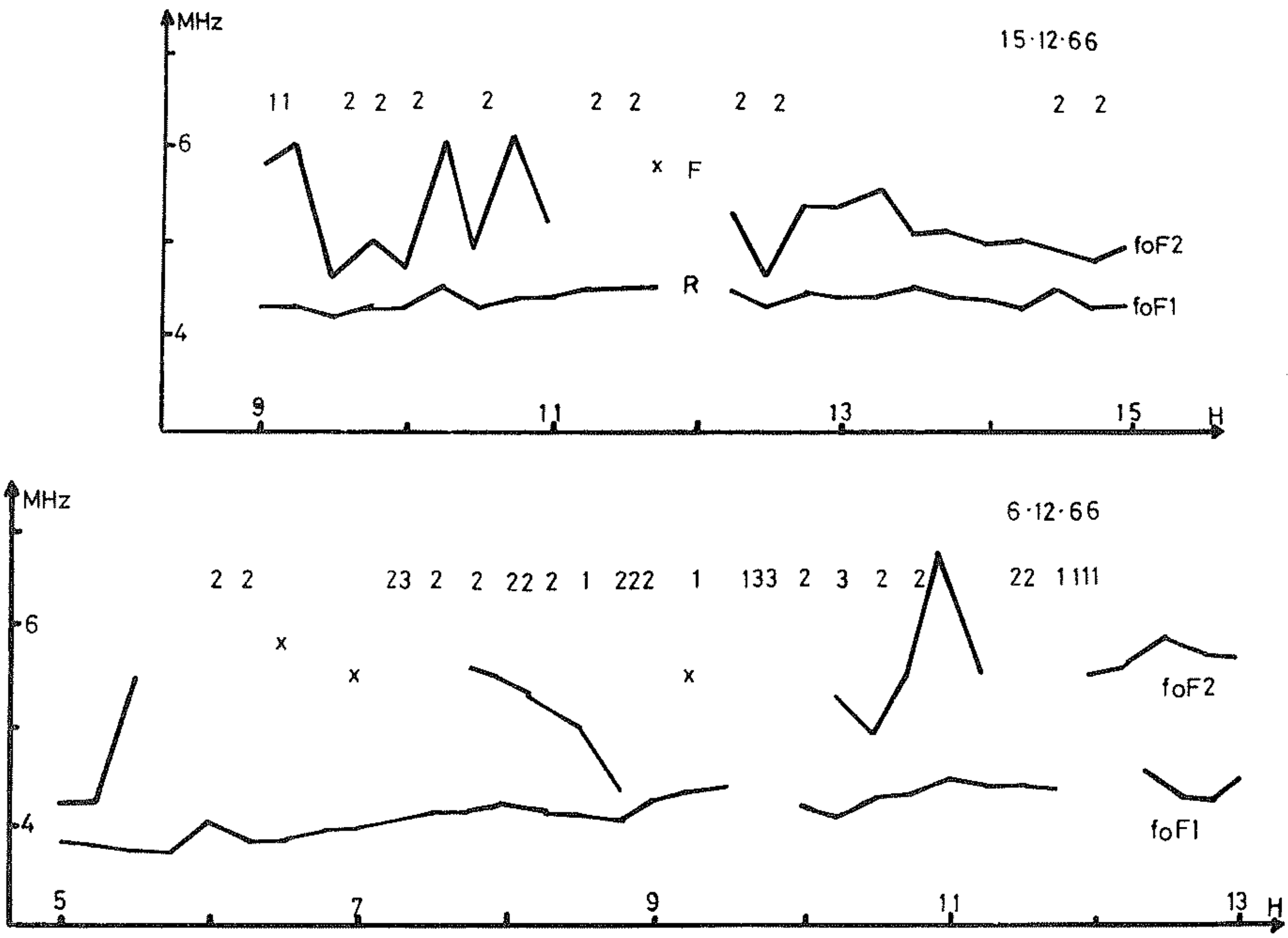
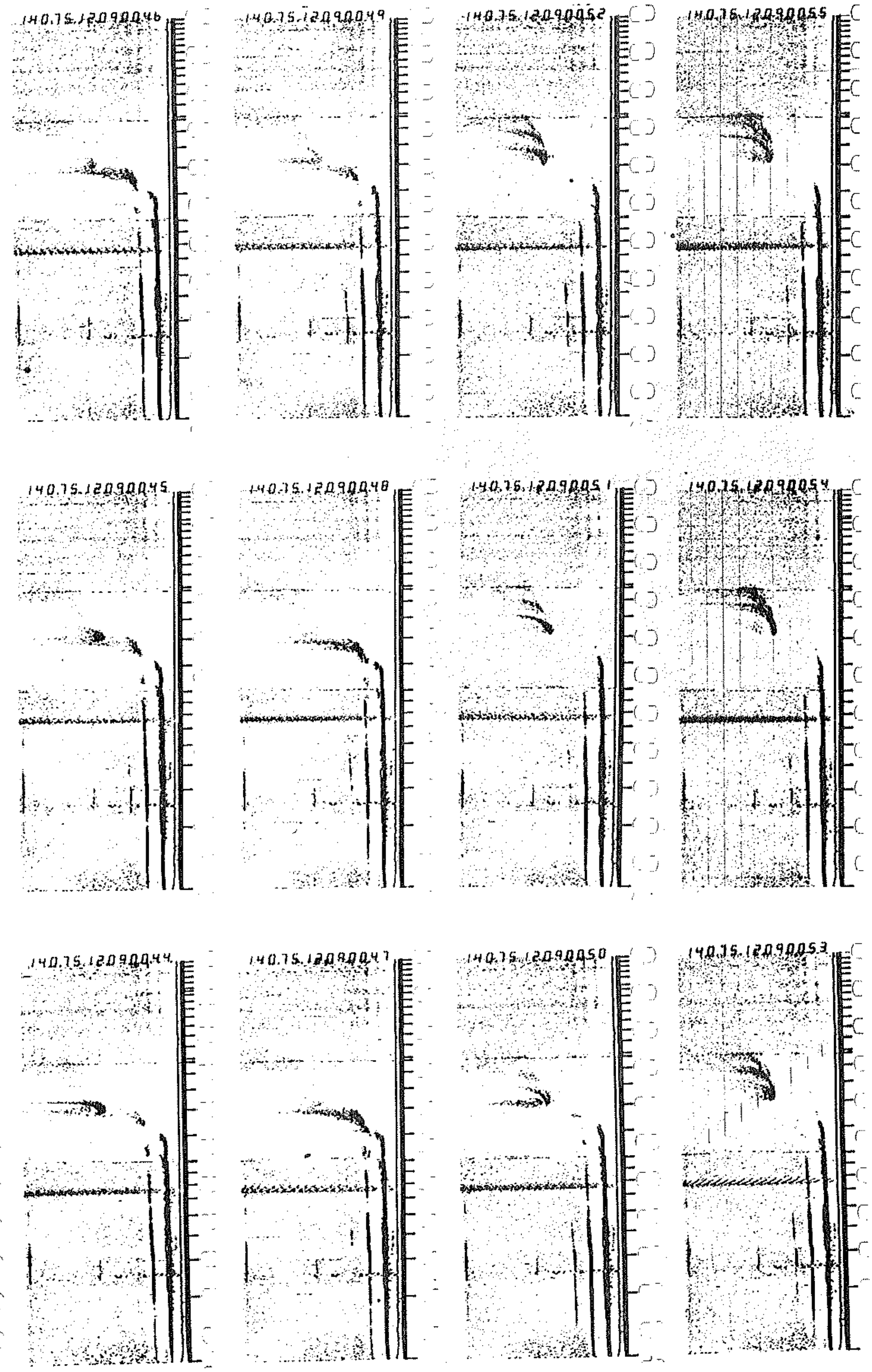

MHz
15·12·66
11 2 2 2 2 2 2 2 2 2 2
6
4
x F
R
foF2
foF1
9
11
13
15
H
MHz
6·12·66
2 2 23 2 2 22 2 1 222 1 133 2 3 2 2 22 1111
6
4
x
x
x
foF2
foF1
5
7
9
11
13
H

Fig. 2


140.75.12090046
140.75.12090049
140.75.12090052
140.75.12090055
140.75.12090045
140.75.12090048
140.75.12090051
140.75.12090054
140.75.12090044
140.75.12090047
140.75.12090050
140.75.12090053

preceded at 0046 and 0047, and followed at 0049 and 0050 by ionograms with weak echoes from the F2 layer, but showing clearly foF2>foF1. After 0051, echoes from the F2 layer become normal while a F1 lacuna occurs.

Again, if we don't admit a very important variation of the electron density in less than one minute, we have to admit the existence of F2 lacunas not associated with G conditions.

4.3 Comparison with topside ionograms

The third experimental evidence is brought by topside ionograms. When foF2<foF1 (G condition) the F1 layer can be seen on topside ionograms; the F2 layer then appears as a stratification and produces on the ionogram a characteristic loop (Fig. 4).

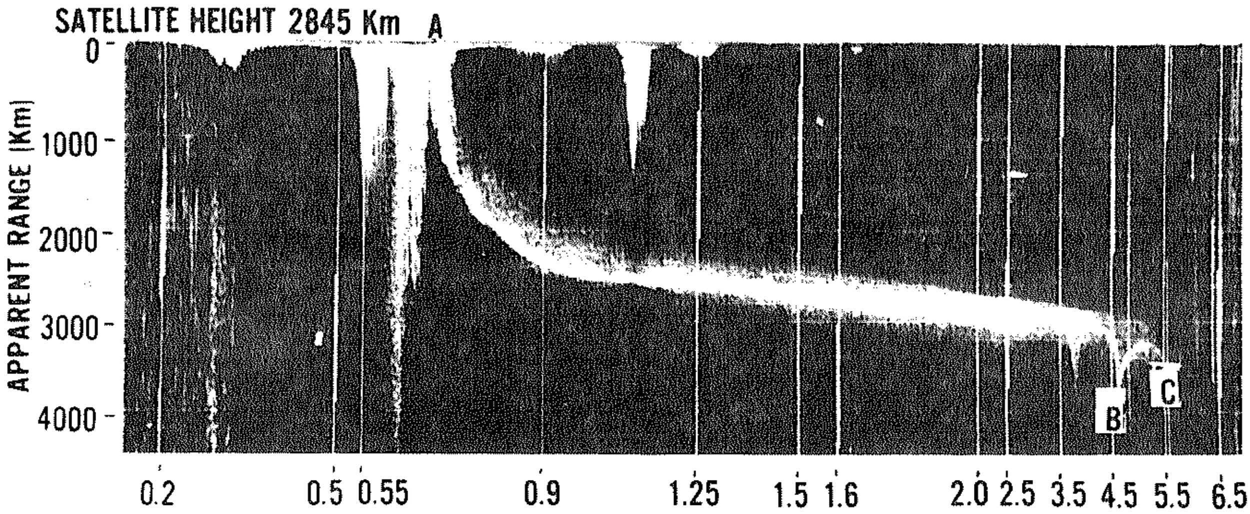


FIGURE 4 9 July 1966, 1655.33 GMT (64°N, 128°W)

Ionogram obtained with the Alouette 2 satellite. The abscissa gives the frequencies of successive radio-wave pulses transmitted from the satellite, the ordinate the delay time of the reflected signals in terms of the radar range of the reflecting layer. The traces AB and AC, the so-called reflection traces, are the successive reflected signals propagated with the two possible directions of polarization, returning from successively lower levels of the ionosphere with successively higher electron density. B and C give the critical or penetration frequencies corresponding to the maximum of the electron density. The loops at the high-frequency end of the reflection traces correspond to an unusual change in the gradient of the electron density.

(From HERZBERG and NELMS, 1969)

G conditions observed on topside ionograms have been studied by Herzberg et al. [1969]. As lacunas, it appears to be a day phenomenon observed at invariant latitude greater than 70°. But there are sensible discrepancies. Generally speaking, F2 lacunas, as observed on bottomside ionograms, seem to be much more common than G conditions observed on topside ionograms. A G condition has an extent of a few hundreds km with a smooth variation of foF2 on both sides; on the contrary, observations of data from several stations show [Sylvain and Cartron, 1978] that F lacunas frequently occur simultaneously in the whole polar cap. Lastly, topside ionograms from ISIS 2 made near Dumont d'Urville station at the time when F2 lacunas were observed on bottomside ionograms at the station did not show the presence of G condition.

5. Discussion and Conclusions

At high latitude stations, the absence of F2-layer echoes on the ionogram is a common event. To consider it as a F2 lacuna (descriptive letter Y) or as a G condition (descriptive letter G) is not unimportant. S. Cartron has shown (INAG Bulletin 28) the differences resulting in the monthly medians.

Of course, it would be desirable to base the scaling rules on a physical understanding of what happens. Unfortunately, the theory in its present state does not seem to be able to help us much. As experimental results lead one to think that the absence of F2-layer traces could be due not only to G condition, I consider a careful position would consist in the use of letter G when there is some evidence of a G condition (for instance a regular decrease of foF2 on the previous sequence) and that of letter Y, which is partly admission of ignorance, in other cases. The reintroduction of the concept of F2 lacuna in the revision of the first chapters of the URSI Handbook goes in this direction and I agree strongly.

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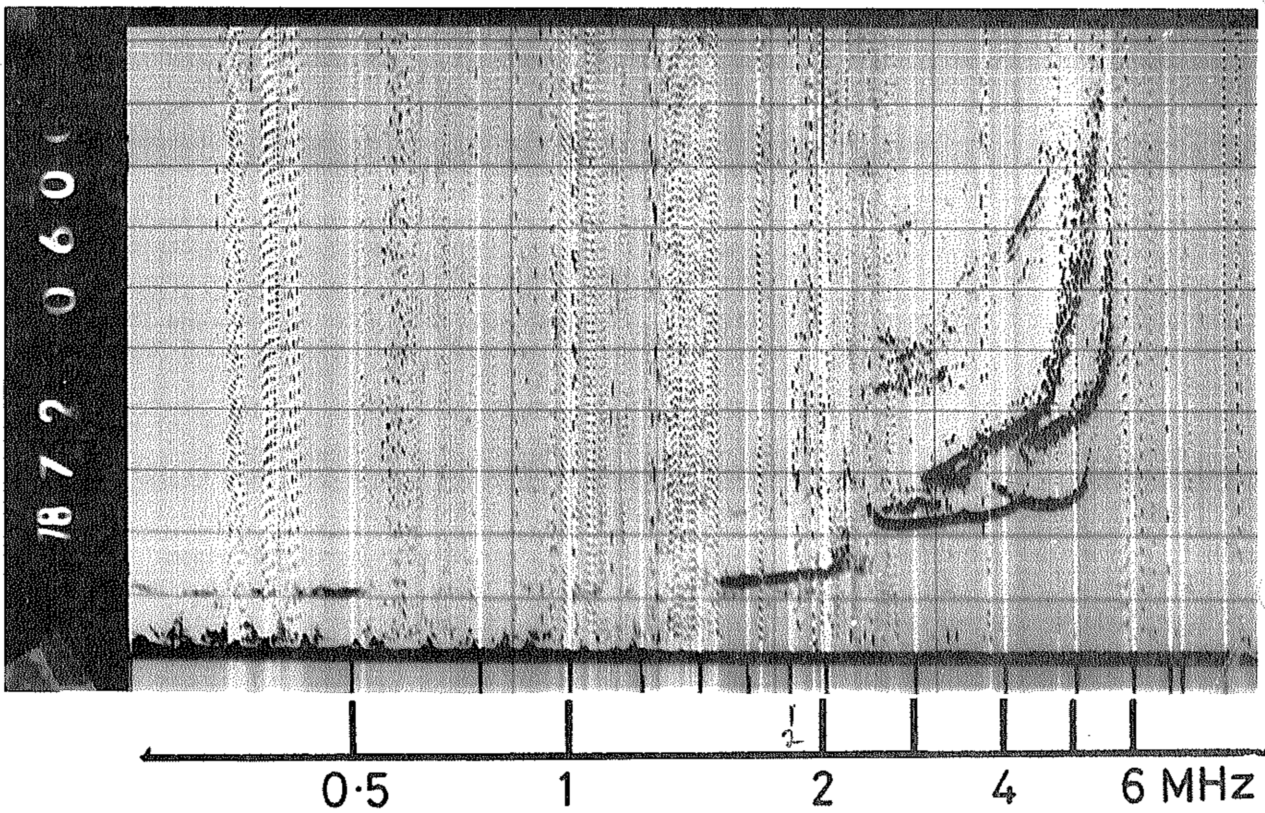
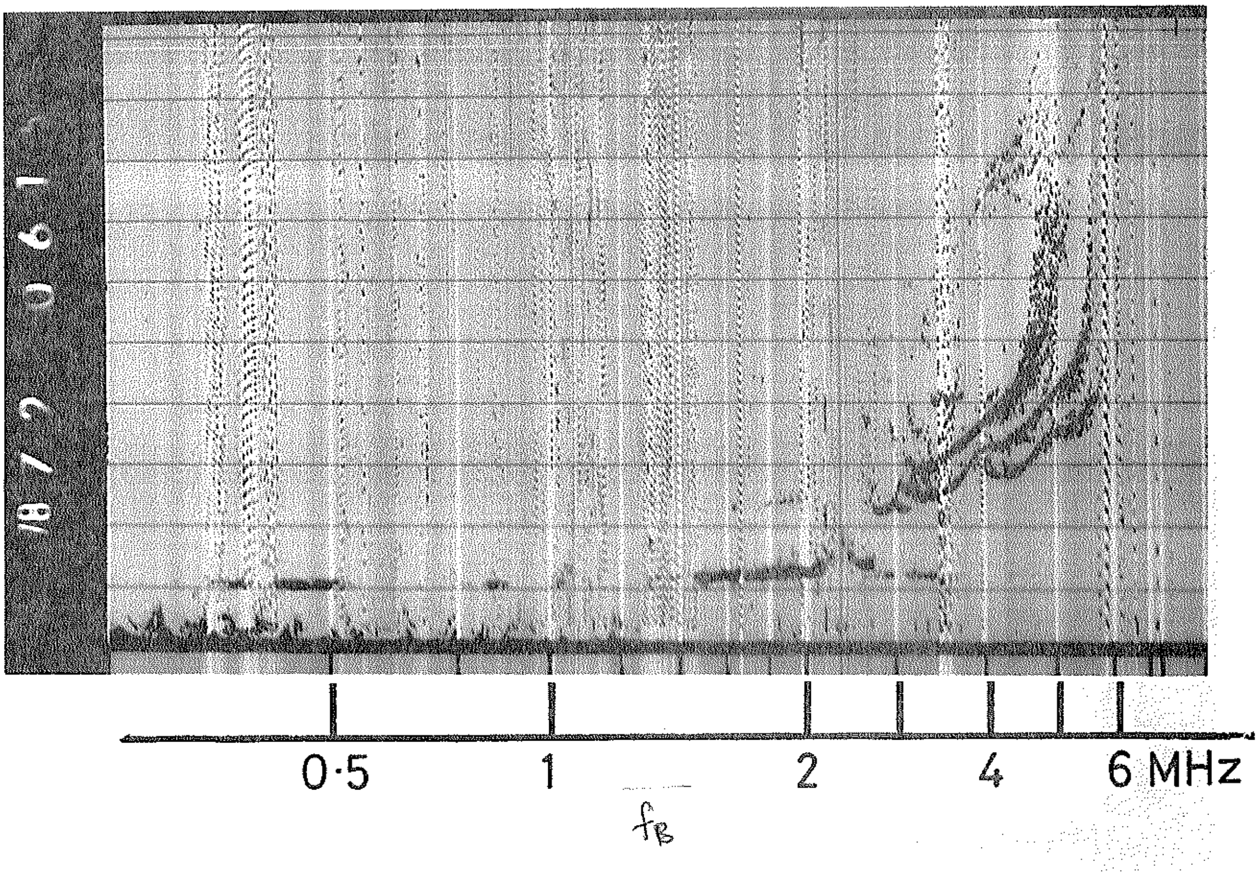
VIII. Uncle Roy's Column

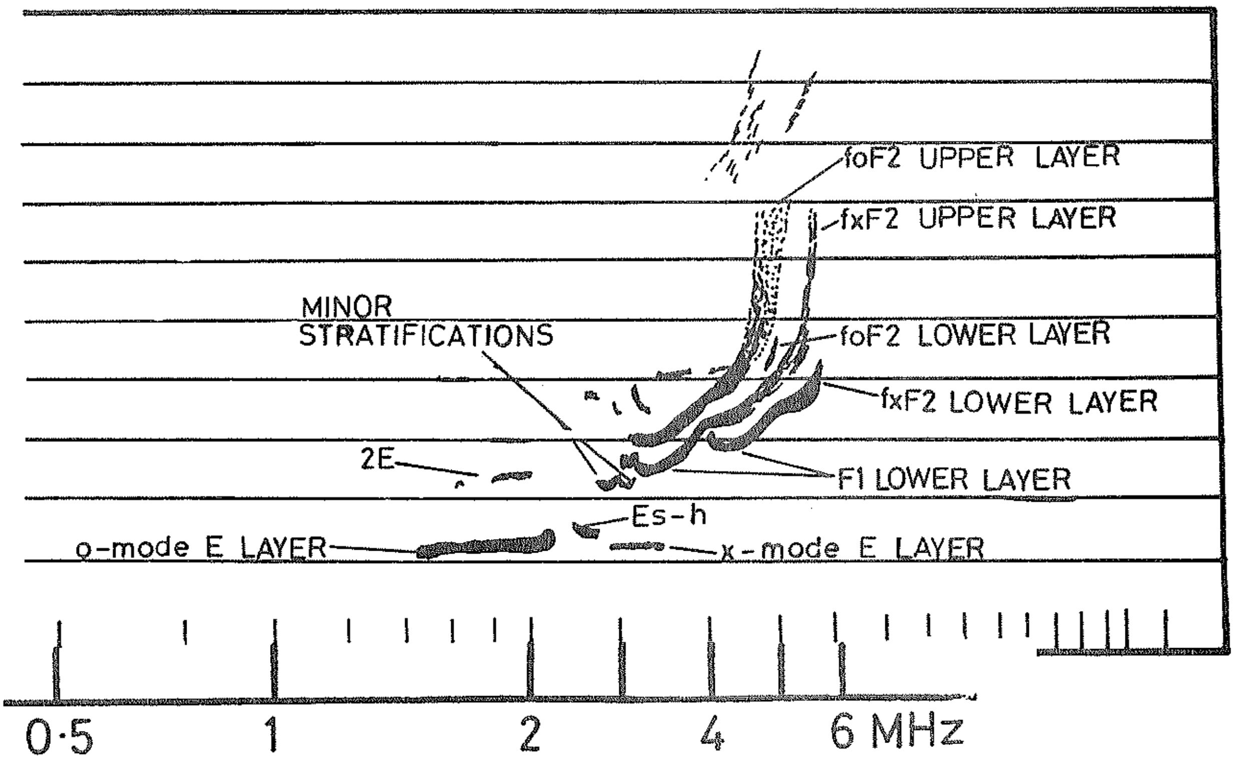
The ionograms shown below are taken from an interesting sequence recorded every 15 minutes, on the 23rd July 1978 at Ottawa, Canada. These have been supplied by Mr. P.K. Brown. I am very pleased to receive this example as a result of the request in UAG-50, p. 167, where similar ionograms were published.

0600 In earlier ionograms, ionospheric conditions had been relatively stable with foE increasing slowly, as would be expected as the sun rises. The F trace at 0545 shows h'F at 250 km and h'F2 at 280 km with foF1 at 3.5 MHz and foF2 at 4.8 MHz with slight frequency spread in the vicinity of the critical frequency. On the 0600 ionogram, the E trace is relatively unaffected, as is the upper part of the F2 trace but the lower part of the trace is significantly changed, h'F increasing from 250 to near 280 km and the F1 cusp becoming less marked. In addition a completely new F trace appears with h'F at 210 km. A weak second order of this trace at the lower frequencies suggests that this part of the trace is nearly overhead though the main part of this lower thinner layer is clearly oblique. Note that the trace for this layer shows no spread in contrast to that of the old trace and, in particular, that of the 2F traces.

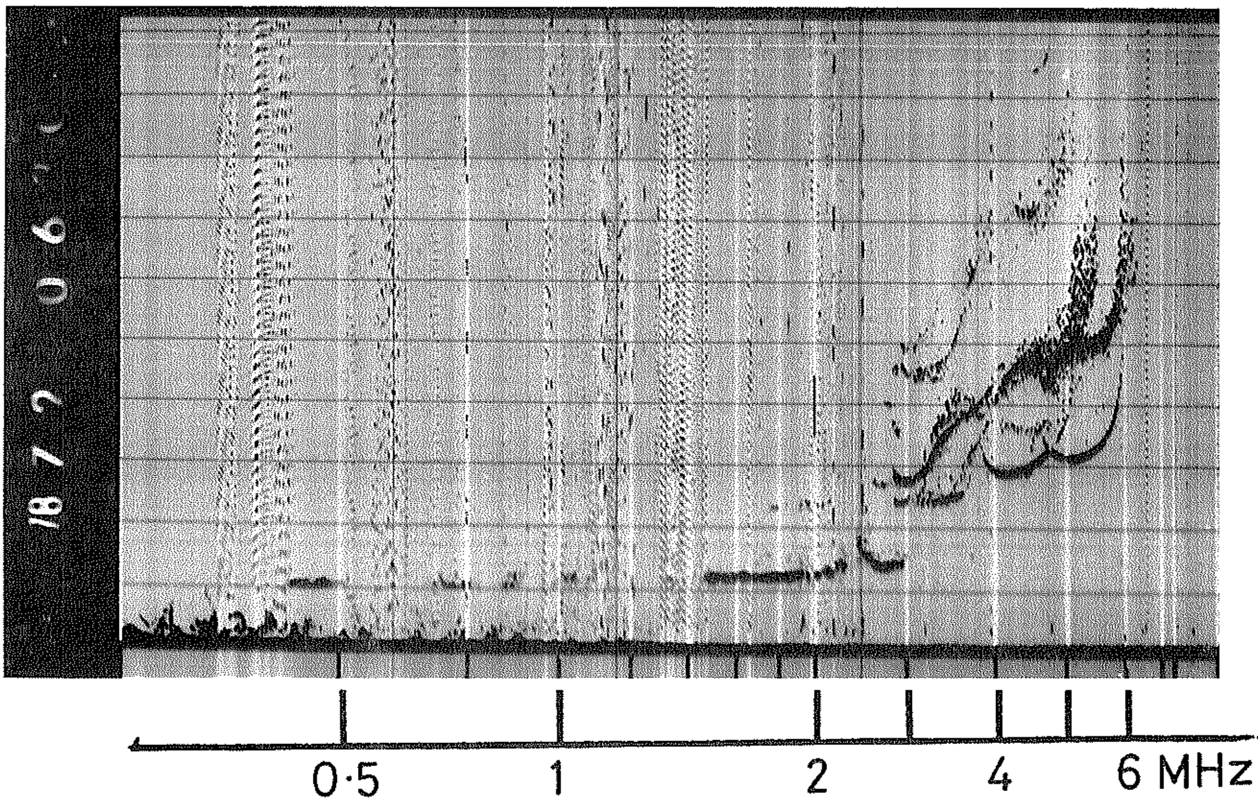


0615 The weak second order trace confirms that the E layer is horizontal. The F layer is complex but but the line drawing beneath clarifies the two F traces present. The lower F layer shows a relatively pronounced cusp of the F1 layer. There are no second order F traces present to establish which layer is overhead, but the rise in h'F suggests that the lower F layer is more oblique than it was at 0600. The wide differences between o and x traces suggest that a significant North-South gradient is present.


0·5
1
2
4
6 MHz
f_B


foF2 UPPER LAYER
fxF2 UPPER LAYER
MINOR STRATIFICATIONS
foF2 LOWER LAYER
fxF2 LOWER LAYER
2E
F1 LOWER LAYER
Es-h
o-mode E LAYER
x-mode E LAYER
0·5
1
2
4
6 MHz

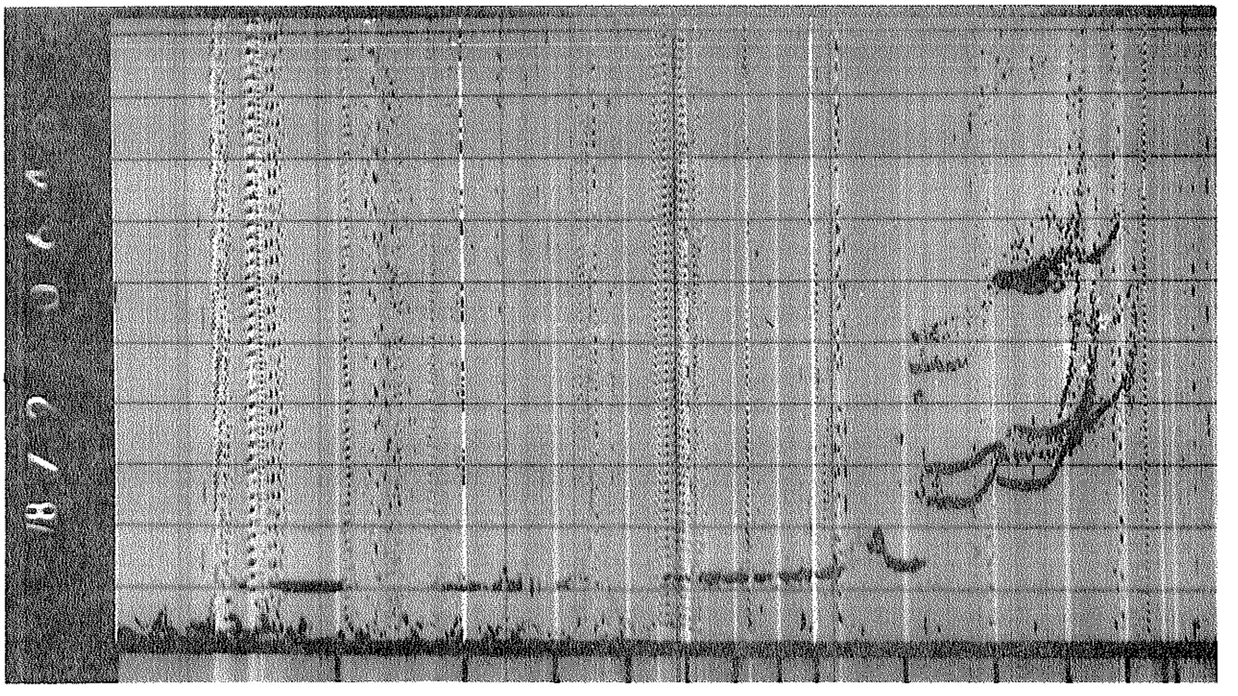
0630 This ionogram shows more similarities to the layer at 0600 than at 0615 but there is clear evidence of tilt shown by the second order traces. The lower F layer has thickened considerably and the the upper layer is showing greater evidence of the F1 layer. The second order F traces show that neither layer is overhead. Both E and Es are overhead and the high type Es layer just visible at 0615 is now more dense. Making some crude estimates and using simple geometry, the tilts in the F region are probably in the order of 30°.

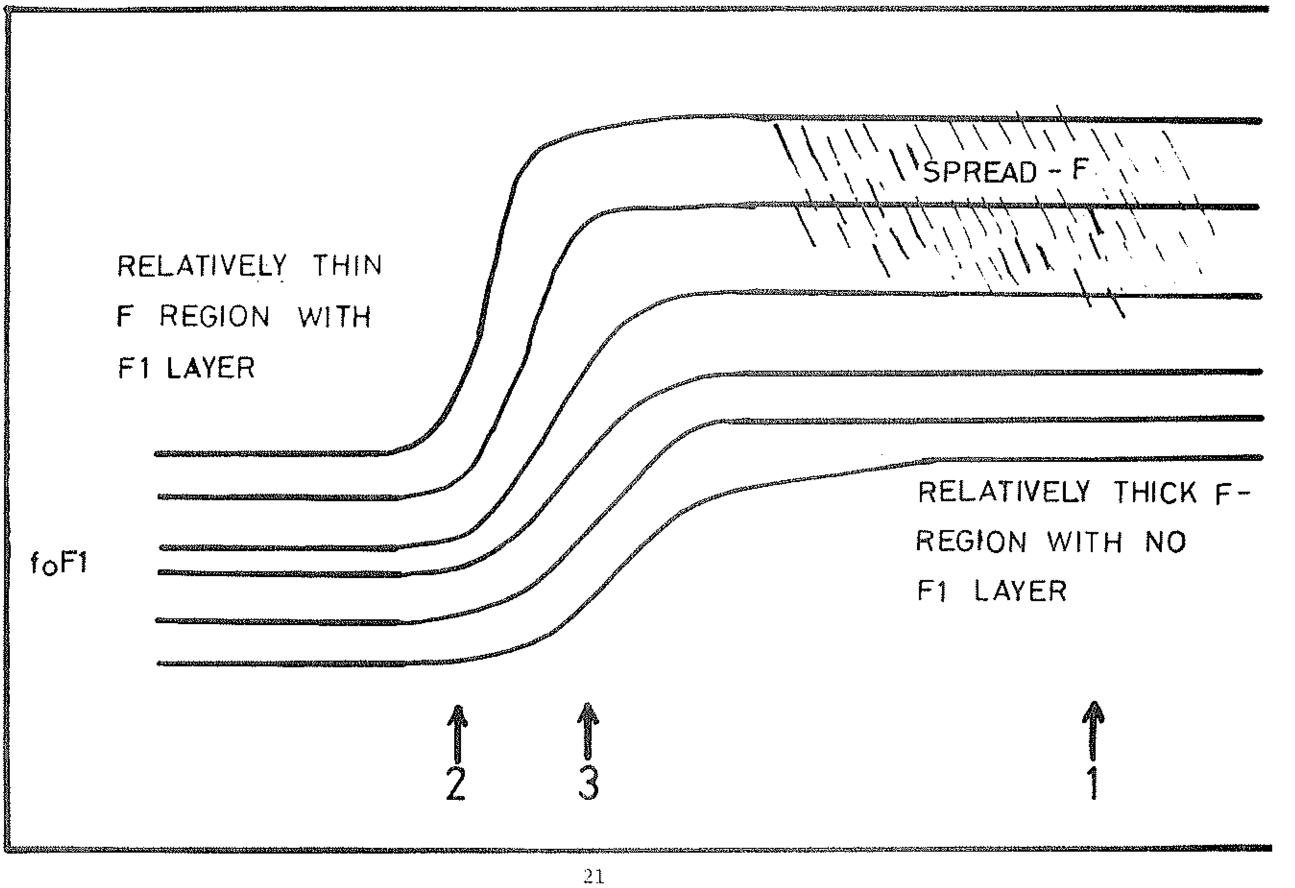


0645 The lower F layer trace is close to overhead with 2 x h'F being approximately equal to h'F for the second order. However, the effects of a small tilt are still apparent as fminF > fmin2F. The o trace of the lower F2 trace is very weak in comparison to that of the x wave again suggesting that a N-S tilt exists. The upper F2-layer trace shows least spread F in the whole sequence.

Both this sequence of ionograms and the one reproduced on p. 166 of UAG-50 are very unusual, the one illustrated here being particularly uncommon because it lasts about 1 hour. A new, lower F layer is established near overhead but after 0700 the original F layer returns. The critical frequencies of both F layers in this sequence are approximately the same. Solar radiation must be the principal production mechanism at this time and is probably controlling the maximum electron concentration.

The difference in the amount of spread F between the upper and lower layer may be an important clue toward an explanation of the observed phenomena. There is obviously a large F layer tilt throughout the sequence. A simplified schematic diagram of what may be happening is given in the sketch,


18/2 064


SPREAD - F
RELATIVELY THIN F REGION WITH F1 LAYER
f_oF1
RELATIVELY THICK F-REGION WITH NO F1 LAYER
2
3
1

The location of the ionosonde relative to the tilted zone is roughly near position 1 at 0545. For the 0600, 0630 and 0645 ionograms it is probably near the position 2 and the 0615 position is indicated by 3. After 0645 the station reverts back to the 0545 position 1. While the perturbation could be the effect of a very large slow moving travelling ionospheric disturbance, it is more likely that we are seeing the boundary between the normal quiet mid-latitude ionosphere, indicated by the lower F layer and phenomena associated with one edge of the auroral oval. The clean lower trace suggests that this trace is outside the oval. It would be necessary to compare the shapes of the two layers on this sequence with those obtained on quiet and disturbed magnetic days when it could be definitely established on which side of the auroral oval the station was situated.

From the scaling point of view, there are few difficulties after it is established which layer is more overhead. The descriptive letter Y on the h'F parameters could indicate the presence of the severe F-layer tilt. Large changes in the appearance of the F1 cusp with time normally occur when there are tilts present near foF1, a very small tilt can change the ionogram patterns significantly.

IX. Correspondence Course

Scaling of fmin, foEs and fbEs in the presence of interference at night.

Interference caused by medium wave radio stations can cause severe problems in the analysis and interpretation of ionograms. The difficulties are usually significantly worse at night when the absorption of radio waves is much lower than during the daytime under normal ionospheric conditions. Much of the information in the frequency range of 0.5 to 1.6 MHz can be severely affected. Some diagrammatical examples are given below to illustrate how foEs, fbEs and fmin may be scaled under these conditions. The accuracy rules for ionospheric measurements are defined by limits within certain percentage errors, or as multiples of the scaling accuracy, Δ, whichever is the greater (see p. 29, UAG-23 and p. 31, UAG-23A). At low frequencies, the Δ limitations are always larger. This has been used extensively in these examples.

1. Interference extends over a wide frequency range (0.7 to 1.4 MHz). A value for fmin should be tabulated in this case (see UAG-23, p. 76, UAG-23A, p. 89); it should be qualified by E and described by S. The normal accuracy rules do not apply in this case. foEs and fbEs are scaled in accordance with section 4.25 UAG-23 or 23A (see also INAG 28, p. 10-11).

2. A strong echo is observed disappearing into the interference at 1.4 MHz, No echoes are observed below 1 MHz. fmin must therefore lie between 1.0 and 1.4 MHz and should be scaled as the central frequency of the interference, qualified by U(±2Δ) and described by S. When no normal or particle E layer is present, and no Es is observed, foEs and fbEs are numerically identical to fmin, and qualified by E. The descriptive letter B or S may be appropriate in these circumstances, but the former has been preferred because absorption of the ionosonde transmitted wave is more important.

3. In this example, an Es layer disappears into the interference at 0.9 MHz and an F-layer trace appears at 1.4 MHz, all information between 0.9 and 1.4 MHz being lost. Three alternative scalings are given. In each case the qualifying letter D or E has been used to indicate doubt within limits of +5Δ or -5Δ (0.5 MHz) respectively. Use whichever is likely to contribute most effectively to the median value.

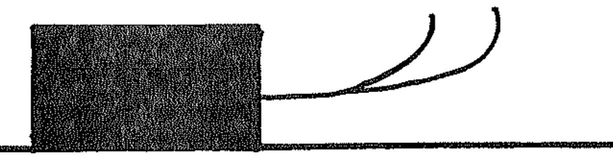
4. Frequently a small part of an Es trace can be seen on the ionogram where the radio interference is relatively weak. This is used to give fmin. The scaling of all other parameters is identical to example 3.

5. When a short Es trace extends just beyond the interference band the problem is whether the top frequency of the Es layer is ordinary or extraordinary. If the top frequency is close to the gyrofrequency (within about 0.4 MHz) an o-mode trace is the most likely, otherwise x-mode (see 6). This can usually be confirmed by comparing the strengths of the o and x traces from the F region at a similar frequency. In the case shown the Es-layer blanketing frequency is less than the top frequency of the interference and is scaled as 014ES.

6. The relative strength of the o and x echoes from the F region shows that the top frequency of the Es layer is most likely to be extraordinary wave. foEs can then be deduced by subtracting half the gyrofrequency (fB/2 = 0.6 MHz). This is an unusual case with foEs numerically less than a limit value of fmin. The blanketing frequency of the Es layer must be equal to or less than foEs and is scaled as (foEs)ES. The difference in height between the o and x traces of Es at night is usually less than the reading accuracy for height measures but this is not certain. Most information is given by (h'x)US though S as a replacement letter is acceptable and in accord with the normal rule. It is always dangerous to extrapolate h'F from h'Fx or h'F2 from h'F2x and this is forbidden by the rules.

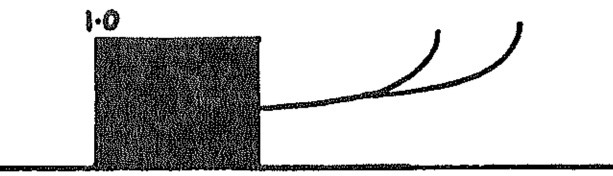
SCALING OF fmin, foEs and fbEs in the presence of interference at night.

1



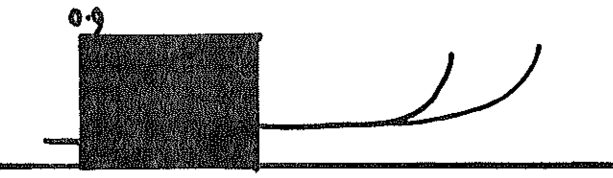
fmin = 014ES
foEs = 014ES
fbEs = 014ES
Es type = -
h'Es = S

2



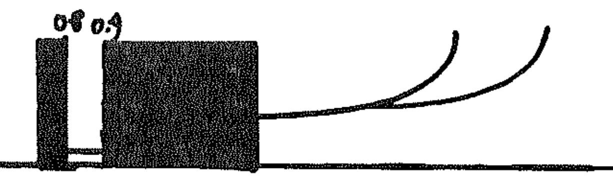
fmin = 012US
foEs = 012EB
fbEs = 012EB
Es types= -
h'Es = B

3



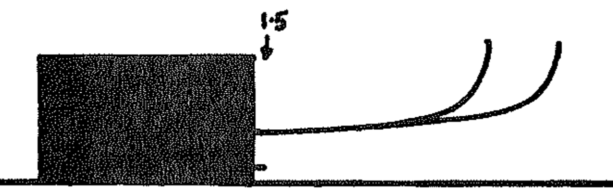
fmin = 007
foEs = 009DS or 014ES or 014ES
fbEs = 009DS or 009DS or 014ES
Es type = f1
h'Es = 110

4



fmin = 008ES
foEs = 009DS or 014ES or 014ES
fbEs = 009DS or 009DS or 014ES
Es type = f1
h'Es = 110-S

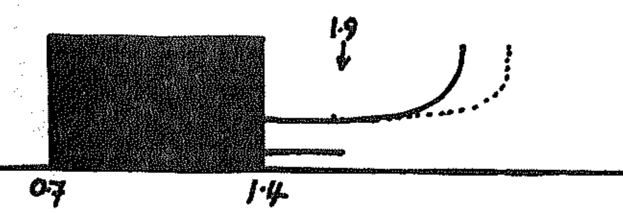
5



fmin = 014ES
foEs = 015
fbEs = 014ES
Es type = f1
h'Es = 110-S

Note:- Close to gyro frequency O mode most likely at 015.

6



fmin = 014ES
foEs = 013JS
fbEs = 013ES
Es types= f1
h'Es = 110US

X. Meteors and their Effects on the Ionosphere

by

A.S. Rodger

Meteors which are trapped by the earth's gravitational field, heat up due to friction with the atmosphere as they fall to earth. The light given off in this process can be visible to the naked eye on clear nights, and can be seen as trails which are given the name shooting stars. As the meteors traverse the E region of the ionosphere they create dense columns of ionization; both the atmosphere close to the meteor is ionized, and some of the constituents of the meteor itself are ionized. The latter form the principal source of metallic ions such as magnesium and iron in the ionosphere.

Metallic ions have very long lifetimes in the ionosphere compared with the normal ionic species created by solar radiation. These metallic ions may be swept together by winds in the ionosphere or by electrical fields. This is one type of production mechanism which can generate sporadic E layers. Abnormal increases in foEs have been reported at the times of some of the greater meteor showers.

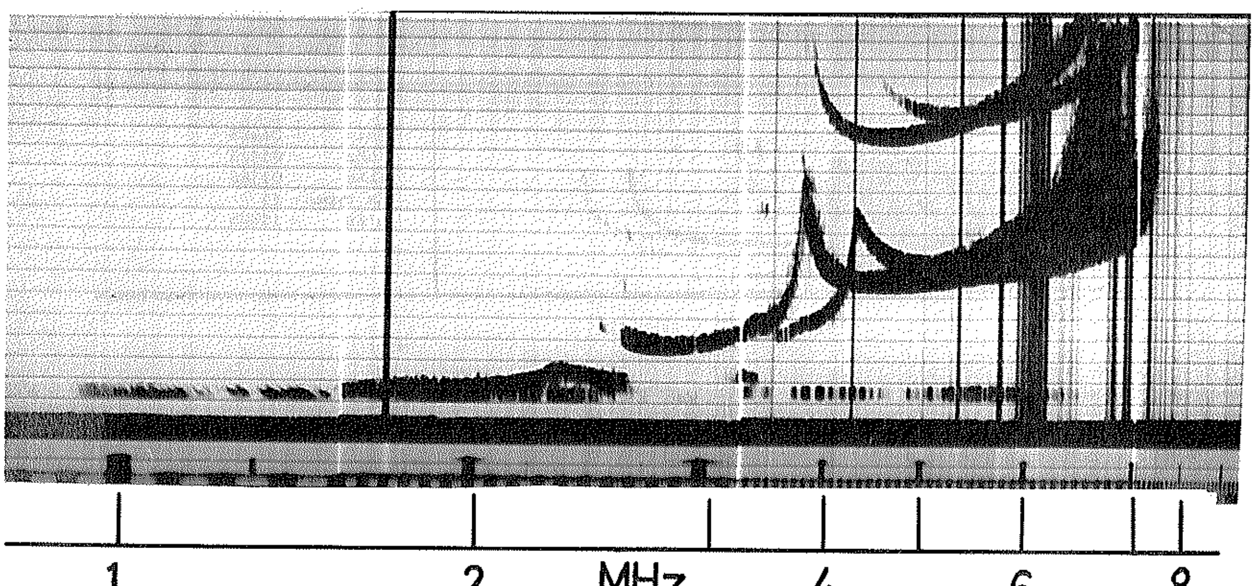
It has been estimated on average about 10 tons per day of meteoric debris are entering the atmosphere. This is not a regular phenomenon but is very variable. The dates and times of the ten largest meteor showers are given below. Meteor traces on ionograms are most likely during these showers.

Shower	Dates of Detectable Meteors	Approx. Local Mean Time
Quadrantids	1 January - 4 January	
Eta Aquarids	21 April - 12 May	0735
Arietids	29 May - 19 June	1000
Zeta Perseids	1 June - 17 June	1100
Beta Taurids	24 June - 5 July	1115
Southern Delta Aquarids	21 July - 15 August	0210
Northern Delta Aquarids	15 July - 18 August	0210
Perseids	25 July - 17 August	0540
Geminids	7 December - 15 December	0205
Ursids	7 December - 24 December	0825

These dense trails of ionization caused by meteors have been used as reflectors for HF and VHF waves for communication purposes. Although these meteor traces last for a very short time, current technology allows much information to be transmitted by this means during the life of a single trail.

It is possible to detect these trails of ionization with a conventional ionosonde. A meteor usually gives a weak trace often extending to relatively high frequencies and often showing regular beats in amplitude with frequency. Most traces have very short lifetimes, typically in the order of one minute, as diffusion and recombination processes at E-region heights are relatively rapid. An example below shows a meteor trace extending from 3.2 MHz to 6.4 MHz at 105 km. For scaling purposes these echoes are neglected under the rule which allows weak and intermittent traces to be ignored (UAG-23, p. 27, UAG-23A, p. 29).

Ionogram from Argentine Islands showing meteor trace taken at 0945 UT on 12 October, 1977.



XI. Low Frequency Ionograms

From time to time INAG has reviewed the need for more instructions for the analysis of low frequency ionograms. While there has been some demand for this, in practice the groups involved have not provided the necessary master ionograms for interpretation and publication.

The object of this note is to discover whether there is any demand for such a publication. The current rules were published in the IQSY Instruction Manual for the Ionosphere. This is now out of print but the text could be reproduced in the INAG Bulletin if there are users of low frequency ionosondes who do not have it.

No action will be taken unless you request it.

XII. INAG Meeting, Australia, December 1979

As stated in INAG 27, p. 15, it is intended to hold an INAG meeting in Australia in association with the IAGA General Assembly, Canberra, December 2-15, 1979. No arrangements have been finalized as yet, but information will be given as soon as possible. Please send further items for the provisional Agenda to the Chairman, or Dr. D. Cole.

Agenda

1. Chairman's Introduction.
2. Discussion on Helsinki Report.
3. Actions needed on 'Needs for Ionosondes in the 1980's'.
4. Action on proposed new stations and closure of existing stations.
5. Training problems. Use of Handbooks.
6. Equatorial station networks problems.
7. Changes in parameters, letter symbols and programs.
8. Status of network.
9. Status of new ionosondes.
10. High Latitude Working Group.
11. International Digital Ionosonde Group.
12. Discussion of Australia's training and interpretation problems.

At Helsinki some participants regretted that a preliminary meeting had not been arranged for detailed discussion of VI problems before the Assembly. *Do those proposing to attend Canberra wish for such a meeting either instead of or as well as a meeting during the Assembly?*

XIII. "Microbal" - The Rhodes University Portable Ionosonde

In an attempt to improve the overall signal-to-noise ratio of a coded-pulse, vertical-incidence ionosonde, it was proposed that a binary code should be sought which could be transmitted cyclically, in an on-off keyed mode. Reception of incoming signals would be confined to the transmitter off-times, the relevant delay-time information being extracted by a digital, cyclic cross-correlation process. The only code which could be found which yielded a practicable cross-correlation function under these conditions was the well-known M-sequence (maximum-length or linear feedback shift-register sequence), although an additional, spurious ambiguity appeared in the correlation function. This ambiguity was easily removed, however, by "inverting" the M-sequence which results in the spurious echo being inverted as well. Another interesting feature of the ionosonde is a signal "averaging" or "summing" device. The instrument should be ready for testing before the end of 1978.

XIV. Station Notes

Scott Base - Raratonga. The decision, INAG 27, p. 17-18, on whether to close Raratonga or Scott Base has now been decided. Raratonga will be closed and Scott Base continue to operate. This decision is in accord with comments made by the international community, and enhances the importance of Tahiti.

Canadian chain. The Canadian stations at Ottawa, Churchill and Resolute will remain in operation until the end of 1980. St. John's will be reopened in September 1979 and operate to the end of 1980. (St. John's is magnetically conjugate to Halley Bay, Antarctica).

The future of these stations will be reviewed in 1980.

New Station - L'ile de La Reunion. It is intended to move the ionosonde from the closed station at Djibouti to L'ile de La Reunion. Further details will be given when this station is working.

Brisbane closure

Do we get all this data.

USSR Network of Stations (short review by A.N. Sukhodolskaya and T. I. Shchuka) The current USSR ionosphere vertical sounding network includes 34 operational stations, supervised by various governmental agencies. These stations are listed in the table.

The ionospheric stations are equipped with two types of ionosondes: AIS and SP-3, which are described in Report UAG-10 "Atlas of Ionograms," 1970.

In accordance with the recommendations of the Third Consolidated Guide to International Data Exchange through the WDC, 1973, standard 15-minute observations are carried out at the stations. In addition high latitude stations make observations at 01 (high receiver gain), at 05, 55 and 59 (low receiver gain) minutes after every hour.

Initial standard scaling of ionograms results in f plots, and daily tables of hourly values for all days as well as monthly tables of ionospheric parameters. These are made manually at the stations in accordance with report UAG-23 "Handbook of Ionogram Interpretation and Reduction Second Edition, 1972." Antarctic data reduction is performed at the Arctic and Antarctic Research Institute in Leningrad.

At present some of the USSR ionospheric stations have started to introduce computer programs for compiling the monthly tables of ionospheric parameters and the calculation of median and quartile values.

All monthly tables of all standard characteristics, f plots (for all the days) and ionograms (for Regular World Days) are sent to the WDC-B. These data from 20 stations are regularly sent to the other three WDCs, while the data of 12 additional stations are sent only as requested (see Table). World Data Center - B also sends the data, as requested to various organizations and scientists.

Station	International Exchange		Participate in the operational service	Median values are publ. in Cosm. Reviews	Notes
	regular	on request			
1. Alma-Ata	+		+	+	
2. Arkhangel		+	+		
3. Ashkhabad	+		+	+	
4. Cape Schmidt	+		+		
5. Dixon	+		+		
6. Dyushanbe		+			Observations not by standard program
7. Gorky	+			+	
8. Heiss Island	+		+		
9. Irkutsk	+		+	+	
10. Kaliningrad		+			
11. Karaganda		+			
12. Khabarovsk	+		+		
13. Kiev		+	+		
14. Leningrad	+		+	+	
15. Magadan		+	+		
16. Moscow	+		+	+	Hourly values are given in Cosmic Reviews
17. Murmansk	+		+	+	
18. Norilsk		+	+		
19. Novokazalinsk		+			
20. Novosibirsk		+	+		
21. Petropavlovsk Kamch		+	+		
22. Podkamennaya Tunguska		+	+		
23. Provideniya Bay	+				Started May 1977
24. Rostov	+			+	
25. Salekhard	+		+	+	
26. Sverdlovsk	+		+	+	
27. Taskent		+			
28. Tbilisi	+			+	
29. Tixie Bay	+				
30. Tomsk	+			+	
31. Volgograd					Does not participate in the exchange
32. Yakutsk	+		+	+	
33. Molodezhnaya (Antarctica)					Does not participate in the exchange
34. Vostok, Antarctica	+				

The majority of ionospheric stations submit their data to the WDC-B with a delay of no longer than half a year, though for some stations, particularly high latitude stations (Antarctic stations) this delay may be more than one year.

Hourly values of the ionospheric parameters of the Moscow Station and median values of some other stations (see Table) are regularly published in "Cosmic Reviews" by the Institute of Earth's Magnetism and Radio Wave Propagation (Moscow) in the co-authorship with the Institute of Applied Geophysics (Moscow).

Twenty-two USSR ionospheric stations participate in the Operational Service. The values of main ionospheric parameters scaled visually are transmitted every hour or once in three hours to the Forecasting Center of the Institute of Applied Geophysics (Moscow) and to the Regional Forecasting Centers. These data are used for the analysis of the ionospheric conditions and the forecast of radio wave propagation conditions. They are included in information currently exchanged with other forecasting centers via IUWDS.

Regularly (once in two/three years) seminars on ionogram interpretation and reduction are held, where specialists concerned with ionogram reduction are instructed, and complex cases of data interpretation are discussed.

No significant changes in the USSR ionospheric network are contemplated for the near future, though some stations may shorten their observational program (Ashkhabad, Cape Schmidt, Murmansk, Petropavlovsk-Kamchatsky, Khabarovsk, Tixie Bay).

We are interested to hear from the concerned ionosphere researchers if the exclusion of the above-mentioned stations from the international exchange system prejudice their investigations. We also wish to know if it is desirable to include some stations now supplying data only on request in the regular international exchange.

XV. Notes from WDC's

WDC-A for STP. There has been no response to the appeal for information on pre-IGY data. If you have any such data please inform your WDC of its existence and, if possible, indicate the amount of data available. Such data are now very valuable and should be made available if at all possible. If you have such data, but no means of duplicating it, please inform INAG or the WDC's so that attempts can be made to solve your problems.

All WDC's. The accuracy of the WDC catalogs of stations and data depends on your checking that the information given is correct. It is not unknown for material to be lost in the post. Please check your entries in the catalogue of your local WDC. WDC-A for STP makes a special plea to all to check the accuracy of UAG-54 which is widely used as a standard reference.

XVI. URSI Recommendations

C.7 URSI Publications

The URSI Council,

noting the recommendations made by the Publications Committee;

recommends

1. that the URSI Information Bulletin continue to be published in its present form, that the December issue in each year should take the form of an URSI Yearbook, and that a copy of the September 1978 issue be sent to all registered participants at the XIXth General Assembly;
2. that a new edition of the URSI Brochure be prepared and widely circulated;
3. that the INAG Bulletin (Ionospheric Network Advisory Group) be continued and that the Treasurer be invited to consider an increase in the annual grant to the National Oceanic and Atmospheric Administration (NOAA);
4. that consideration be given to the possible need for a Supplement to the International Reference Ionosphere 1978 containing a set of typical profiles;
5. that the Proceedings of URSI General Assemblies, Vol. XVIII be published in the same format as Vol. XVII;
6. that, in accordance with the views expressed by the Board of Officers, URSI should not consider launching an URSI journal covering the same ground as Radio Science;
7. that Review of Radio Science 1978-80 be published in 1981, with Prof. Bowhill as General Editor, and that the efforts be followed up and expanded to increase the number of copies sold in 1980-81.

Commission G - Ionospheric Radio and Propagation

G.1 World Network of Ionosondes

Commission G,

considering

(a) that modern communication and navigational systems, even when using UHF, require information from ionosondes on the structure and variability of the ionosphere;

(b) that the ionosondes now in operation also make important contributions to studies of upper atmospheric physics on a global scale, and to the description of the terrestrial environment now needed in multidisciplinary scientific projects;

(c) that vertical incidence ionospheric sounding stations are established and maintained mainly in support of national research programmes and radiocommunication services;

(d) that the closing of existing stations can materially affect the value of the contributions made by the network to international science and radio communications;

(e) that the advanced ionospheric sounders that have been available for a few years are enabling important advances to be made in ionospheric research;

recommends

1. that national administrations responsible for the maintenance of ionosondes by invited to bear in mind the contributions which their stations make to the advancement of science at international level, and to the needs of the International Telecommunication Union;
2. that any changes in the present world network of ionosondes should, as far as possible, take into account the basic criteria given in the Annex to this Resolution;
3. that national administrations should be invited to consult the Ionospheric Network Advisory Group (INAG) of the International Union of Radio Science before making any changes in the status of existing stations;
4. that national administrations, when considering the replacement of equipment approaching obsolescence, consider the advantages of replacing that equipment by advanced digital instrumentation.

ANNEX

Ionosonde stations that satisfy one or more of the following criteria are especially valuable;

a) those that have an unbroken run of good-quality data extending over some decades, particularly in view of their potential use for monitoring long-term and man-made changes;
b) those forming part of 'chains' generally north-south, which can be used to study the propagation and development of large-scale geophysical disturbances;
c) those in geophysically interesting regions such as the polar cap, the auroral zone, and the vicinity of the magnetic equator;
d) those that are remote from other stations, are magnetically conjugate to other stations, or are in the Southern Hemisphere;
e) those operated in conjunction with well-instrumented geophysical observations and special research facilities;
f) those forming part of a regional group of stations providing data for specific aeronomic or propagation research.

G.3 INAG Bulletin

Commission G,

recognising the important rôle of the INAG Bulletin (Ionospheric Network Advisory Group) in maintaining the world network of ionospheric stations, and the quality of the data acquired by the network;

appreciating the fact that some financial support for the Bulletin is provided by WDC-A and some national administrations;

recommends that URSI continue to support the publication of the Bulletin for the next three years.

G.8 Working Groups

Commission G

recommends that the following Working Groups be constituted or reconstituted, as appropriate, within Commission G:

G-1 Ionospheric Network Advisory Group (INAG). Chairman: W.R. Piggott; Vice-Chairman: J.V. Lincoln.

G-2 Data processing in ionospheric research. Chairman: J.W. Wright.

G-3 Southern Hemisphere Atmospheric Studies Group (SHASG) Co-Chairmen: J.A. Gledhill and S. Radicella.

G-4 International Reference Ionosphere (IRI). Chairman: K. Rawer.

G-5 True-height reduction techniques. Chairman: L.F. McNamara.

G-6 Ionospheric knowledge needed to improve radiocommunication. Chairman: C.M. Rush.

G-7 Ionospheric mapping. Chairman: E. Neske.

G-8 Incoherent scatter. Chairman: P. Bauer.

G-9 Abnormal ionospheric propagation. Chairman: C.G. McCue.

G-10 International Digital Ionosonde Group (IDIG). Chairman: J. R. Dudeney; Vice Chairmen: K. Bibl and J.W. Wright.

G-11 Panel on Southern Hemisphere Incoherent Scatter Facility. Chairman: J.A. Gledhill.

XVII. The International Digital Ionosonde Group

Chairman:

Dr. J. R. Dudeney
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Madingley Road
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United Kingdom.

Vice Chairmen:

Mr. J.W. Wright
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US Department of Commerce
National Oceanic and Atmospheric Administration
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Dr. K. Bibl
Center for Atmospheric Research
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History

The purpose of the International Digital Ionosonde Group (IDIG) is to provide a forum through which groups involved with digital sounders can be kept informed of each other's activities, exchange ideas and co-ordinate operations. It is in the nature of digital sounders that they offer great potential for further development, and that such developments are likely to be achieved through use of the sounders themselves. IDIG will not concern itself with the topics traditionally covered by INAG but will concentrate on the special features and enhanced capabilities of the digital equipments.

IDIG was started by J.W. Wright informally in October 1976, but remained without official status until the recent URSI General Assembly held in Helsinki. (A list of individuals responding to the first circular as interested in IDIG is attached). An informal meeting (attendance list also annexed) was held during the Helsinki Assembly, at which it was agreed that IDIG would benefit from URSI patronage and should therefore become a working group of Commission G. This proposal was subsequently endorsed by Commission G and IDIG became Working Group G.10, with Chairman J.R. Dudeney and Vice-Chairmen J.W. Wright and K. Bibl. The first formal meeting of the group was held in Helsinki on 7 August. A report of this meeting is given below.

Report of the IDIG Meeting, Helsinki, 7 August, 1978

1. Introduction

The new Working Group Chairman, Dr. Dudeney, introduced himself and the new Vice-Chairmen, J.W. Wright and K. Bibl, and briefly reviewed the events leading up to the formal adoption of IDIG into URSI.

2. Aims of the Group

Mr. Wright was invited to review the aims of IDIG. He pointed out that the main purpose of the group was to provide a means of communication between groups operating digital ionosondes and allow them to exchange ideas, discuss problems and identify areas of collaboration. There followed a brief discussion out of which the suggestion developed that IDIG should prepare a document to inform people of the capabilities of digital sounders.

3. Reports of Users of Digital Sounders

Dr. Bossy reported that his group had been operating digital sounders for the last five years (the type developed by Dr. Bibl at Lowell Institute) and there were instruments operating at Dourbes, Breisach, Turino, Rome and Sicily. He reported that the systems were displaying amplitude and that the internationally recognized parameters were scaled in nearly real time (less than 15 minutes after sounding). He reported that it is planned to develop the systems to give angle-of-arrival information.

Dr. Bibl commented that Lowell type instruments were also in use at Goose Bay, Millstone Hill, Fort Monmouth and Cape Kennedy. There was also an instrument mounted in an American Air Force Geophysical Laboratory aircraft and a second generation instrument at Kwajalein.

Mr. Wright reported that the Dynasonde prototype instrument had reached a kind of software plateau through the preceding three years of development. It had defined basic modes of data acquisition, noise rejection, data display and encoding; now included were the spaced-antenna capabilities of the 'Kinesonde'. These developments are now the basis for the assembly of an entirely hew hardware configuration designed at NOAA under Mr. R.N. Grubb. Six examples of the new system are now underway, of which one would stay at Boulder, under NOAA control, one would be a mobile instrument, one has gone to the Max Planck Institute, Lindau, and the remaining three are for the British Antarctic Survey, Utah State University and White Sands Missile Range, respectively, The Kinesonde is presently active at Las Vegas and could be shared with interested scientists.

Dr. Piggott reported that the USSR were developing a digital sounder on the lines of the NOAA instrument whose designation was BASIS, but no details of this instrument are yet known.

Professor Gledhill commented that there were two Barry Chirp Sounders currently operated by the South Africans and it was intended that these should be developed to give a fully digital capability. Mr. Wright reported that the Norwegians were also developing a digital sounder along the lines of the NOAA instrument. It was pointed out that the Australian 4A was to be developed by the inclusion of a microprocessor control system.

4. Concept, Specifications and Future of the NOAA Sounder and the Digisonde

Mr. Wright gave a brief review of the key features of the new NOAA sounder. He was followed by Dr. Bibl who spoke about the Lowell Digisonde. (Chairman's note: a detailed paper on the latter has been published entitled "The universal digital ionosonde", Bibl and Reinisch, 1978, Radio Science 13, pp. 519-530; also a paper on the NOAA sounder was presented at Helsinki and will be written up for publication.)

5. Relation to the World Wide Network

Dr. Piggott, Chairman of INAG, commented that he did not think that IDIG would cut across the areas of interest in INAG, although there would clearly be matters of interest to both groups. It was therefore desirable for there to be close liaison, and this could be happily taken care of since the Chairman of IDIG was also closely involved with INAG. Dr. Piggott offered to make space available in the INAG Bulletin for circulating IDIG news and articles.

6. Possibilities for Co-operation

The Chairman pointed out that it was probably premature for the meeting to discuss collaborations in any detail and that probably what was required was a survey to find out what equipments and programmes were in being or planned. This was agreed.

7. Any Other Business

There being no other business the meeting was closed.

IDIG Chairman's Comments

(a) Survey

At the Helsinki meeting it was suggested that a survey be carried out to identify the level of interest in digital sounders and the status of equipment development. *You are therefore asked to fill in and return the attached questionnaire. I ask those colleagues who have already responded to Bill Wright's earlier circular to bear with me and respond again so that a complete up-to-date picture is obtained.* The future mailing list will be composed of the replies received. A report of the outcome will be circulated in a further INAG Bulletin.

(b) Information Document

The Helsinki meeting also identified a need for a document explaining the capabilities of digital sounders. I will be raising the question of how best to do this with Bill Wright and Klaus Bibl and ask for your views at this stage. A first step in producing such a document will be to prepare a bibliography of relevant publications. Therefore, I would be grateful to receive any information, or copies of reprints, you think are relevant.

(c) Date of Next Meeting

It is my intention to hold an informal meeting of the group in Australia this December, taking advantage of the captive audience at the IUGG General Assembly. Please let me know your views. (See questionnaire attached).

IDIG-I

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List of Attendees at the Meetings held in Helsinki, August 1978

H.J. Albrecht	F.R.G.	
W. Becker	F.R.G	
*K. Bibl	U.S.A.	Vice Chairman IDIG
*L. Bossy	Belguim	
A. Brekke	Norway	
*R. Conkright	U.S.A	
*K. Davies	U.S.A.	
*J.R. Dudeney	U.K.	Chairman IDIG
*W.G. Elford	Australia	
+C. Ellyett	Australia	
+V. Ferberov	U.S.S.R.	
*J.A. Gledhill	South Africa	
+T.L. Gulyaeva	U.S.S.R.	
O. Holt	Norway	
*R.D. Hunsucker	U.S.A.	
W. Ireland	New Zealand	
*T.B. Jones	U.K.	
J.W. King	U.K.	Chairman Commission G.
H. Laine	Finland	
*L. McNamara	Australia	
E. Neske	F.R.G.	
*W.R. Piggott	U.K.	Chairman INAG
M. Pitteway	U.K.	
A.W.V. Poole	South Africa	
+K. Rawer	F.R.G.	
G. Rosen	Sweden	
H. Schwentek	F.R.G.	
*K. Toman	U.S.A.	
*H. Vesseur	Netherlands	
R.A. Vincent	Australia	
A.W. Wernik	Poland	
*J.W. Wright	U.S.A.	Vice Chairman IDIG

*Attended both meetings.

+Attended first official meeting.

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