IONOSPHERIC NETWORK ADVISORY GROUP (INAG)

Ionosphere Station Information Bulletin No. 12

Note: page numbers are incorrect because, among other things, the page and font sizes were changed.

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

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I. Introduction

by

W. R. Piggott, Chairman

The main contents of this Bulletin will inform you of the discussions and actions during the INAG meeting held during the XVII General Assembly of URSI at Warsaw, August 1972. Two four—hour open sessions were held together with a number of small working discussions and there were two closed meetings for the INAG members present.

In all 42 participants attended one or both of the open sessions. These came from twenty countries.

The INAG members found this support most encouraging and hope that all those attending found at least some parts of the meetings interesting and informative.

The consensus of opinion was that INAG had filled a need, was doing a useful job and should continue. This view was adopted both by our parent committee, the URSI—STP committee before its dissolution, and by our new parent, Commission III of URSI.

The General Assembly of URSI at Warsaw was preoccupied by the great debate on the future prospects for URSI and discussions on reorganization of URSI to meet the demands of current and future international cooperation involving radio science. Full details of this will be found in the URSI Information Bulletins and Report on the General Assembly.

In the past the Commissions of URSI have been rather inactive between General Assemblies. Those projects which needed action between Assemblies have been delegated by the Commissions to the URSI/CIG and later URSI/STP Committee, chaired by Professor W. J. G. Beynon. In particular, since the dissolution of the World Wide Soundings Committee after the end of the IGY/IGC, the URSI Consultants for the monitoring networks, the specialized working groups for ionosphere, drifts, data handling, etc., have reported to these Committees.

- In practice the active membership of URSI/CIG and URSI/STP remained constant for many years and was mainly made up of those with active interest in network problems. The Committee did a very valuable job for the networks in providing a forum where this type of problem could be discussed with the aid of highly experienced experts and in providing a continuity of policy which was invaluable.

At Warsaw, the Commissions decided to become more active between General Assemblies and felt that they should take a more direct and active part in the organizing and operation of the Working Groups. The URSI/STP Committee in its old form was therefore dissolved and its Working Groups and Consultants transferred to the Commissions. In particular Commission III set up the ten new Working Groups to be discussed in the next issue. Each Working Group will have a small committee of between 5 and 10 members responsible for initiating the work of the group, obtaining the consensus of opinion

for any action, preparing meetings, seminars, symposia and making annual reports to Commission III. The concept is rather similar to that of INAG. It is hoped that every interested scientist, administrator or station operator will feel encouraged to take an active part in the work of these groups.

In the new organization, the present INAG will become the working committee for Commission III Working Group III.1 which will be known as INAG. It is suggested that the Working Group might consist of three cooperating sections:

(a) INAG members (the old INAG),
(b) INAG consultants,
(c) INAG representatives.

As in the past INAG members will be selected in their personal capacity but membership has to be confirmed by Commission III. At present INAG policy is to select its members from those with adequate experience in INAG problems so as to get both as wide a geographic coverage as possible and provide adequate expert judgment on INAG's problems. Members are expected to resign if they find it impossible to be active in INAG work and may resign for personal reasons. In general membership should change only slowly with time.

Invitations to become INAG Consultants can be made by any INAG member needing help but must be confirmed by INAG. An INAG Consultant volunteers to work on particular problems for INAG and this is a responsible position capable of giving considerable prestige where the work is done well. The list of Consultants will change when problems are solved or new problems attempted.

Anyone can become a representative on Working Group III.1 by notifying the Secretary of INAG and it is hoped that at least one representative from each country will join the Group. It is only necessary to be interested in the use or production of synoptic data from the V.I. network. Such representatives will receive the INAG Bulletin. All those at present receiving the Bulletin will be regarded as representatives.

INAG hopes that both old and new representatives on Working Group III.1 will help to create an informed public opinion to guide the international policy of INAG and through it of the networks, to encourage special experiments in their countries, to inform INAG of the use of network data in their country and to contribute comments or short articles for the Bulletin.

As much of INAG's work is highly specialized, Commission III, following the precedent set by URSI/CIG and URSI/STP, has delegated to INAG the right to make recommendations on specific points in V.I. soundings on its behalf and to examine proposals for international cooperation involving the V.I. network. This part of INAG's work will continue unaltered by the transfer to Commission III.

The main operational job of INAG in the immediate future will be the collection of material and preparation of the High Latitude Supplement of the Handbook. There should also be discussion of any clarifications needed when you have used the new Handbook which is published in a form that will allow clarification in the future.

A seminar to discuss high latitude ionogram problems was held August 18—25, 1971, at Kaliningrad,
U.S.S.R. The main conclusions are described in this Bulletin and will be commented on in the next Bulletin.

A meeting of INAG was held at Boulder on November 9, 1972. It is proposed, subject to the agreement of absent INAG members and URSI Commission III, to invite Mr. L. Petrie to become a member of INAG. Parts of the Handbook involving problems discussed at Warsaw were reviewed and the text frozen so that publication could proceed immediately. The U.S.S.R. proposals, operation of INAG and Handbook High Latitude supplement were discussed. The need for new ionosondes was reviewed with special attention to possible optimum compromises between cost and facilities provided. Further details will be given in the next bulletin.

II. Report of Meetings of INAG Held at Warsaw 27—28 August 1972

The meeting passed a vote of thanks for the valuable work dome for the network and for INAG by the two members, Dr. C. A. M. King (New Zealand) and Professor C. M. Stanley (College, Alaska) who have recently resigned from INAG. It was announced that Dr. Padula—Pintos (Argentina) had been proposed as an INAG member and that this nomination had been confirmed by the Chairman of URSI/STP. INAG now becomes the Committee for URSI Commission III Working Group III.1 with Chairman W. R. Piggott (U.K.) and Vice Chairman J. V. Lincoln (U.S.A.). Changes in its membership will, in future, be confirmed by the Chairman of Commission III. Otherwise URSI wishes the INAG to continue to operate as in the past. In practice the change offers some possibilities for widening the range of people who can influence INAG proposals.

The Chairman opened the meeting with a brief review of the history and objectives of INAG and the state of the network, The number of stations contributing synoptic data has increased by about 7% since the Brussels meeting. This increase is largely due to new stations set up to monitor ionospheric phenomena needed primarily for use in studying phenomena in other disciplines. He pointed out that the type of phenomena found at a station depends on geographic and magnetic factors at that station and that theory could often be tested most effectively by using data from stations selected according to these factors.

Operation and Policy of INAG

The operation of INAG was considered. INAG exists primarily to serve the stations of the network and most of its work so far has been directed to this end. Identifying and solving this type of problem is best carried out in specialized meetings where those active or knowledgeable can discuss the problems in detail. It is advantageous to hold such meetings in conjunction with international or regional symposia, so as to minimize travel costs, but they need undivided attention. Thus they should be held before or after such meetings. Experience at the URSI General Assembly at Warsaw showed that it was possible to reach participants from many countries and organizations, e.g., this INAG meeting was attended by 42 participants from 20 countries, a broader participation than for any other INAG meeting.

The enormous advantages of a meeting of this type are that it encourages input from those who had not contributed to the specialized INAG discussions, clarifies points of misunderstanding, enables disagreements to be aired and helps the Administrations to understand why proposals have been made and their value. In theory these can be done through the INAG Bulletin, but in practice this only partially meets the need. However, the detailed proposals discussed for formal approval occupied much time and were too technical for some participants.

It was agreed that it was not practical to get all INAG members and suitable consultants together at one meeting and that *INAG should attempt to organize regional meetings* so as to get as wide a participation as possible. *In particular INAG should organize a meeting to be held immediately before the next C.C.I.R. meeting of Study Group 6 in Geneva, January or February 1974.* The Director General of CCIR has offered accommodations for this meeting which will be mainly concerned with two problems:

(a) High Latitude Supplement to Handbook
(b) criticism and clarification of Second Edition of Handbook

INAG invites proposals for any particular points or problems which you would like discussed at this meeting. Full details will be given as soon as available.

The implications of a proposal to turn INAG into Commission III Working Group III.1 were discussed. It was felt essential that the present non—national organization be maintained but that it would be valuable to supplement this organization with national scientists and others who would accept responsibility for improving contact between INAG and the scientists of their nation.

INAG and the second edition of the URSI Handbook were criticized on the grounds that they did not give sufficient leadership where modern research could be exploited. So far as the past is concerned, INAG feels that this criticism is not justified — INAG's primary job was to help the network and only to introduce new projects where it was clear that there was widespread public opinion in favor of a change. For the future, the formation of Commission III Working Group III.1 offers a convenient forum for meeting this point.

In the past progress has been made in three steps:

(a) individual scientists do ad hoc investigations,
(b) parallel investigations are set up in other parts of the world,
(c) a network is organized to obtain data systematically.

Each step has provided the facts needed to justify the next step. However, there seems to be a break-down in this system and it may be that Commission III Working Group III.1 should consider whether any action is needed for the future. INAG has always been willing to provide a forum for such discussions both in meetings and in its Bulletin.

The discussion showed that the consensus of opinion was that INAG had proved useful and should be continued with its main stress on helping the V.I. network.

A general discussion on the future use of V.I. network data brought out the need to keep the rules and procedures under review so that the most useful data were produced. The need for more high quality stations to provide accurate profile data was stressed. The consensus of opinion was that there was need for better liaison between scientists and INAG so that future problems were recognized in time for public opinion to be formed. The use of the scientific literature to promote this opinion was discussed. The main point at issue was whether it would be preferable to produce some monthly median profile parameters instead of some of the conventional parameters now produced. Unless there is a general consensus in favour of a change, it is possible to destroy the intercomparison of data in regional chains or networks —— at present very few stations measure any profile parameters other than the simple and rather misleading, hp. *This will need further discussion and INAG would like to hear your views.*

Finance. Financing the Bulletin was discussed. The contribution from URSI only partially pays for the cost of reproducing and distributing the English version and there are difficulties in financing the Spanish, French and Russian versions. The possibility of making a charge for the Bulletin was discussed but was felt to be impractical. Methods of saving costs were discussed including issuing - fewer editions per year. It was decided to cut out the detailed abstracts in the Bulletin, giving only a summary of references and stations used in the references. INAG will explore the possibility of getting the master stencils cut in Institutions in Spanish and Russian speaking countries in which case these editions could be duplicated and circulated from World Data Center A for Solar—Terrestrial Physics, if necessary.

The French edition is causing no problems at present as it is supported by the G.R.I. in France (Mlle. Pillet), In the U.S.S.R. the main difficulty is long publication delays —— up to two years after manuscript is prepared.

The problems of financing stations in difficulties were taken up by Commission III and a recommendation passed to attempt to help the African stations. The general problem of some central finance for the network was discussed, but it was clear that it is most improbable that any action will be taken. In particular, WMO is only willing to help the V.I. network by providing facilities which do not involve extra expenditure.

The possibility of getting help from UNESCO for regional training schemes was raised. At present the main difficulty is to obtain suitably qualified instructors for such schemes.

Monitoring of Data Accuracy. The central problem is one of finance, monitoring costs money which is not easily available. Many scientists prefer to get the original ionograms and analyze then themselves, but even then find that many are useless. The possibility that the WDCs could examine samples of data before issue to users was discussed but is again limited by manpower and finance.

Electron Density Profiles and Profile Parameters

There was considerable discussion on electron density profile problems and in particular, on techniques which could be used synoptically at stations to provide profile data, In the past such work

has been mainly confined to one or two groups and has not been taken up by individual stations. Three proposals were made:

(a) Use of Titheridge's polynomial method to give height of maximum scale height of electron density distribution near maximum, total subpeak content and rather crude estimates of true height at

five or six points in the profile. This involves measuring h' at five or six sample frequencies and is suitable for use with a small computer or for manual calculation. (The method is described with full details in the second edition of the Handbook.)

(b) The construction of median h'f curves for each hour of each month (or selected hours) and their analysis to give a monthly median profile or profile parameters (this is also described in the Handbook). Where desired such median h'f curves, if prepared according to definite rules, could be analyzed centrally using an advanced computer program. It is hoped to publish details shortly.

(c) Production of profiles using conventional parameters (foF2, M(3000)F2, h'F2, foF1, M(3000)Fl, h'F, foE, h'E) together with three additional measurements:

(1) Frequency at which h'F2 is measured
(2) Frequency at which h'F is measured
(3) Maximum virtual height of o mode at F1 cusp.

The use of electron density profiles was discussed and the need for average profiles for practical and scientific use was stressed. The median h'f technique appeared to be the most efficient means of meeting this need. The significance of a median profile was the same as the significance of a median tabulated value——it showed the central value of the distribution, but need not have occurred on any one day. The need for actual profiles on particular days, particularly quiet days, was also stressed. It was pointed out that facilities at stations are limited so that when something extra is requested it is normally necessary to decide to omit some current work. This can cause conflict between different groups which will need to be settled for the general good.

INAG is anxious to find out how much interest there is in using and making profile data, it cannot make proposals for the network as a whole unless it is clear that there is adequate justification.

A large project for obtaining profiles for selected days was discussed in the Commission III meetings attended by those also present at the INAG meeting and this project received Commission III support (Recommendation 111.1).

In view of the apparently large interest, INAG has provisionally allocated computer codes for the parameters needed in electron density analysis.

High Latitude Problems

Mlle. Pillet produced a draft booklet showing ionograms taken at Terre Adelie. This was intended to start argument on problems, not to give optimum answers at this stage. The Chairman also showed a set of ionograms from Narssarssuaq and Thule provided by the Danish group. *It was agreed that the*

JEST members should invite Consultants to prepare similar collections and to provide material for an Atlas of High Latitude Ionograms to be published as part of the High Latitude Supplement of the Handbook. Those willing to volunteer are asked to communicate with their nearest INAG member or with the Secretary or Chairman of INAG. In view of the current interest in ionosphere—magnetosphere interrelations urgent action is needed. (see also INAG—4 p.5, INAG—5 p. 4—8.)

Spread F Classification

The consensus of opinion was that a spread F classification system would be useful. The object of such a system should be to show simply when and where interesting phenomena occurred. Some experiments were needed before the I.M.S. so that a satisfactory system would have been developed by the time this started. A simple system was suggested with four classes:

F = frequency spread present (little or no range spread)
R = range spread present (little or no frequency spread)
N = mixed frequency and range spread present
0 = oblique structures, in particular, polar spurs, "replacement' layers and similar patterns.

It was agreed to add a brief description of this system to the Handbook to act as a guide for voluntary experiments at the station. *It was suggested that National Representatives on Commission III Working Group III. 1 (INAG) should make a special effort to find out what had been done on spread F in their countries and to report to INAG as soon as possible.*

The use of twin sets of receiving antennas as a polarimeter for measuring the angle of arrival of spread F was stated to be simple and easy to set up.

A discussion of the gain sensitivity of spread F resulted in a proposal to INAG to consider a symbol for use with fl at high latitude stations to show when it was gain sensitive. This is a matter of distinguishing between rapid and slow variations of scattering with frequency.

Low Frequency Ionograms

It was decided that the current rules are adequate. The main difficulty is in getting adequate traces at low frequencies. The need to tabulate any data on foE seen at night was stressed as was the failure of the approximations fx = fo + fB/2, fz = fo — fB/2 below the gyro frequency. The correct equations, as given in the Handbook 2nd edition, should always be used.

f plots: Symbol for ftEs

The U.S.S.R. requested INAG to consider introducing a symbol to denote foEs or fxEs on f plots so as to allow studies of differences between foEs and fbEs. The philosophy of the f—plot would suggest that fxEs should be shown as it normally gives the top frequency but this could cause some error when the separation fxEs — foEs was abnormal (usually high absorption). It was agreed that a suitable symbol would be a triangle Δ (open) for fxEs, ▲ (closed) if the interpretation was doubtful or was based on an o—mode trace. *INAG should discuss the possibilities in the Bulletin noting that the*

variability of foEs was of great practical as well as scientific interest and that quarter-hourly data were needed.

Lacuna. There were both public and private discussions on Lacuna problems. These were at first somewhat confused as an important letter from J. Olesen on this subject had not reached the Chairman of INAG and thus the conclusions of his investigations into the subject were not available. The discussion disclosed a difference of opinion on whether "F2 Lacuna" (INAG—9, pp. 5—11) really occurred or was a G condition and on the simplified description and interpretation of the phenomenon. The distinction between "quasi—Lacuna" and normal spread F conditions was also made much clearer. *As a result of these discussions a new text would be prepared and published for further comment in the INAG Bulletin and a simplified provisional text would be included in the Handbook to encourage further study of the phenomena.* (The proposed text is reproduced elsewhere in this Bulletin.)

dfS, The difficulties due to the lack of an international standard procedure for measuring dfS, the frequency range of frequency—type spread, were discussed and the meeting felt that *INAG should initiate a discussion in the INAG Bulletin and then establish a definite convention and procedure.*

Adoption of INAG Proposals

The meeting discussed and formally adopted the following INAG proposals:

1. Change in accuracy rules as given in INAG—9, p. 2, 3, and INAG—8, p. 7.

2. fxI as given in INAG—1, p. 9—11 and INAG—8, p. 6, but with modifications and clarifications as given in the Handbook. The main new point was the use of fxI = fzI + fB at night in sunspot minimum years.

3. Use of Q in h'F tables to denote presence of range spread traces at high and low latitudes. INAG—4, p. 5, para. A4, INAG—8, p. 2.

4. Use of q on f—plots to denote range spread traces. INAG—4, p. 5, para. A4, INAG—8, pJ3, para. 7.

5. Definition of night E, use of letter K in tables of foEs, fbEs, adoption of k as an Es type. INAG—4, p.6, para. D, INAG—5, p. 3, para. 5, INAG—9, p. 4.

6. New rules for measuring fbEs when total blanketing present—use of qualifying letter A. INAG—4, p. 4, INAG—8, p.5, INAG—9, p. 4. The consensus of opinion was that rules (a) (b) INAG—9, p. 4 would be adequate and rule (c) should be left to the stations to be used if desired locally.

7. Lacuna proposals. It was agreed that a text be worked out by the experts present and agreed with the Chairman and be adopted as the provisional rules for letter symbol Y.

8. An additional computer code for total electron content.

9. The meeting discussed and formally passed the Recommendation on Davao, and those adopted with minor change of words by Commission III, namely Recommendations III.4, III.11, III.17, and III.18.

Subject to the approval of the absent members of INAG it was decided to ask Professor V. Padula—Pintos to become a member of INAG. This proposal was unanimously approved by those present.

Attendance at INAG Meetings 27, 28 August 1972

INAG Members

W.R. Piggott (Chairman)	U.K.
J. V. Lincoln (Secretary)	U.S.A.
G. Pillet	France
N. V. Mednikova	U.S.S.R.
V. Padula—Pintos	Argentina (acting member INAG)

		27th	28th
E. Galdon	Spain	x	x
G. Mck. Allcock	New Zealand	x	x
J. A. Gledhill	South Africa	x	x
L. F. McNamara	Australia	x	x
P. Simon	France	x	
B. Andergard	Finland	x	x
R. Lindquist	Sweden	x	x
H. J. A. Vesseur	Netherlands	x	x
W.	Becker	GFR	x
S. Borowski	Poland	x	x
W.	T. Ross	USA	x
A. K. Paul	USA	x	
S. Taubenheim	GDR	x	x
H. Pfau	GDR	x	
M.Sylvain	France	x	x
0. Rue	Sweden	x	
E. S. Kazimirovsky	USSR	x	x
S. A. Bowhill	USA	x	
J. K. Olesen	Denmark	x	x
M.Joachim	Czechoslavakia	x	
Bossy		Belgium	x
R. Eyfrig	GFR	x	x
B. Beckmann	GFR	x	
A. P. Mitra	India	x	
C. A. Reddy	India	x	
K. Rawer	GFR	x	
K. Sprenger	GDR		x
J. W. Wright	USA	x	x
U. Hence	GDR		x

Tzeolilina		USSR	x
Tushetsova		USSR	x
Z. Klos	Poland		x
Z. C. Rapoport	USSR		x
R. L. Smith-Rose	UK		x
P. F. Checcacci	Italy		x
R. Rau	Poland		x

III. URSI Commission III and INAG Recommendations Adopted at Warsaw

The following recommendations are of special interest:

INAG, acting on behalf of Commission III, investigated the desirability of a station at Davao, Philippines, and passed the following recommendation which was endorsed by Commission III.

INAG Recommendation on Station at DAVAO, Philippines

noting that the importance of setting up a station near the magnetic equator in the longitude of the Philippines has long been recognized, that URSI Commission III had recommended this,

and considering

that the importance of obtaining accurate data from this area has increased, in particular for use in studies of transequatorial propagation between Japan and Australia, for radio prediction purposes, for comparisons between the properties of the equatorial ionosphere at different longitudes, near the magnetic equator, and for use with satellite airglow studies at these latitudes,

recommends

that a special effort be made to install an ionosonde near DAVAO of a type capable of giving reliable and accurate data.

The following Commission III recommendations directly affect INAG and the networks and are reproduced as passed at Warsaw with the original numbering. The full set will be given in the next INAG Bulletin when the final texts, as amended by the URSI Council, have been published in the URSI Information Bulletin.

Rec. III.1

Electron Density Profiles

Commission III,

considering

a) that large numbers of hourly ionograms have already been and are still being reduced to profiles of electron—density versus true height;

b) that assistance from ionospheric groups not already engaged in such reductions would enable the number of available profiles to be increased;

c) that such an increase would assist in providing important information required for the International Reference Ionosphere and for a better understanding of the dynamics of the ionosphere, namely, how the profiles vary with geographical location, time and solar activity;

d) that ionograms for the IGY and IQSY are widely available;

strongly recommends

1. that all available hourly ionograms be reduced with high accuracy for the following quietest sequences in each month:

	Date (UT)	
	1958	1964
March	27, 28, 29	17, 18, 19
June	16, 17, 18	16, 17, 18
September	12, 13, 14	13, 14, 15
December	10, 11, 12	10, 11, 12

2. that the data so reduced should include virtual height, and the calculated electron density profiles, and be sent to a World Data Centre, preferably on magnetic tape together with the format used.

Note: This program was originated by Dr. J. S. Nisbet, Pennsylvania State University, University Park, Pennsylvania 16802, U.S.A.

(Dr. J. S. Nisbet has asked INAG for help on this project.)

Rec. 111.4

Translation of URSI Handbook

Commission III,

considering that there is an urgent need for the second edition of the URSI Handbook of Ionogram Interpretation and Reduction to be made available in the French, Russian and Spanish language, in addition to English,

recommends

1. that national organizations make every effort to provide these translations and to publish them as soon as possible;

2. that this recommendation be brought to the attention of:

— Comité national francais de radioélectricité scientifique (France),
— World Data Center B (USSR),
— Comite Radio—cientifico Argentino (Argentina).

Rec. 111.5

Solar Events August 1972

Commission III,

considering that the period 2—8 August 1972 was characterized by exceptional solar and geophysical events,

recommends

1. that the period 26 July — 14 August 1972 be declared a Retrospective World Interval,

2. that those who are able to undertake only limited analyses of data concentrate their efforts on the period 2 — 8 August 1972.

Rec. 111.11

Reduction of Ionograms

Commission III,

considering the increased importance of ensuring that consistent and reliable data can be obtained from ionograms for scientific and practical purposes on a world—wide basis,

adopts the revised rules, recommended after full discussion by INAG and concerning, in particular, the conventions relating to accuracy rules, fxI, night—E, lacuna and oblique—incidence traces;

notes that these rules will be summarized in the URSI Information Bulletin and described fully in the second edition of the "URSI Handbook on Ionogram Interpretation and Reduction."

Rec. 111.17

Training Programme

URSI Commission III,

considering that the quality of the data from the vertical incidence network is often diminished by misunderstanding of the international recommendations and inadequate training of station operators,

draws the attention of administrations to the need for better training and to the advantages of promoting regional training courses and interchanging training aids,

and offers the cooperation of INAG in coordinating and guiding such efforts.

Rec. 111.18

INAG Meeting

UESI Commission III,

considering

a) that the vertical incidence network has an important contribution to make for future major international projects and for the synoptic monitoring of the ionosphere;

b) that it is important to provide expert and informed guidance to the network; recommends

l~ that INAG arrange at least one meeting with consultants in conjunction with an appropriate international meeting, e.g., CCIR;

2. that INAG arrange a meeting with consultants immediately before and in conjunction with the next General Assembly of URSI;

3. that the Administrations be requested to send experienced representatives to these meetings;

4. that the Member Committees of URSI encourage activities to promote the solution of problems relating to the vertical incidence network on a national and regional basis.

IV. Lacuna Phenomena

There was much discussion of Lacuna phenomena use of letter Y at the INAG meeting at Warsaw, as a result of which some modifications have been made to clarify the rules. In particular, it became clear that there were strong disagreements between the experts as to whether the P2—Lacuna really exists or whether it is really a G phenomenon. This, of course, influences the median values of foF2. INAG feels that the distinction between F2—Lacuna and G conditions is too difficult for use generally

until the phenomenon is more thoroughly understood and so reference to F2—Lacuna is now withdrawn. For expert groups who are sure that the F2—Lacuna phenomenon exists and can recognize it, the use of T instead of G is allowed as a local convention. The clarifications made at Warsaw have enabled the rules to be simplified and the simplified version for use of letter T is reproduced below.

As the original work on Lacuna and slant Es published by J. K. Olesen is not easily available, he has written a short summary of his interpretation and analysis for the INAG Bulletin and this is reproduced as section V of this issue. Olesen's work suggests that Lacuna and slant Es are closely associated with zones of activity along the auroral oval. It is also generally agreed that the phenomenon is common near both the North and South magnetic dip poles.

Revised Description of Lacuna Phenomena

Under certain circumstances, traces reflected from a certain range of true height disappear although the remaining traces show that the absorption is either normal or only slightly increased. The name Lacuna (lacune in French) has been proposed for this phenomenon, Lacuna being the Latin word for 'gap'. The explanation of Lacuna is still controversial though it is generally agreed that the reflected signal is greatly weakened by scattering or defocussing processes occurring over a limited range of reflection heights. When the equipment sensitivity is high or the phenomenon weak it is possible to see weak reflections spread in frequency and height over parts of the range where normal reflections have disappeared.

Lacuna appears to be closely associated with activity along the auroral oval and is also found at the magnetic poles. It may therefore prove to be a useful tool for studying activity in these zones. It is also closely associated with slant Es seem at high latitudes and has been discussed under the title Slant E condition (J. K. Olesen, AGARD CP97, 1972, pp. 27.1—27.19, NATO Paris).

The distinguishing feature of Lacuna is that the amplitude of signals reflected from a certain range of heights is abnormally small. In contrast absorption causes greater losses on the lower frequencies and on the x—mode relative to the o—mode traces. Similarly when Lacuna affects a trace near a critical frequency the signal suddenly disappears or reappears at normal strength, abnormal absorption would cause a gradual change with frequency. When absorption is low, slant Es is common during Lacuna. The F traces disappear suddenly when Lacuna occurs and reappear suddenly, with relatively little change in shape over the interval. In practice the Lacuna is most often seen on the F1 trace, causing a gap from foE to foF1 (sometimes the E—trace retardation is also cut off giving a trace at normal height but looking like an Es trace). This is called Fl Lacuna. It can effect all F—layer traces —— total F—Lacuna. When the sensitivity is high, weak diffuse traces can be detected over part or all of the perturbed height range.

The presence of Lacuna phenomena is indicated by letter Y. Care must be taken to distinguish between Lacuna and the effects of increased absorption and of blanketing by Es. (See Figure 1, p. 12)

Use of Y

Y—Lacuna phenomena, severe layer tilt present.

Lacuna Letter Y is used to show the presence of wide gaps in the trace pattern due to the Lacuna phenomenon. When the parameter is missing it is used as a replacement letter. It is necessary to distinguish the proper use of Y from that of A, B, F and H. The provisional rules are:

A — When blanketing sporadic E appears to be present always use A.

B — The distinction between the presence of high absorption (B) and Lacuna CY) is based on the fact that absorption causes greater weakening on the low frequencies than on the high and affects the x trace to a greater extent than the o trace whereas Lacuna causes an abnormal weakening of traces reflected from a given range of heights only.

1. If fmin is given by an E trace and there is a wide gap in the traces at higher frequencies, or they are missing, Lacuna is present use letter Y (see H below).

2. If fmin is approximately equal to foF1 and any of the following conditions are obeyed, Lacuna is present:

    a. The x—mode trace is visible.
    b. The second order o—mode trace is visible.
    c. fm2, the value of fmin for the second order F trace is the same as fmin within the accuracy rule for an unqualified reading (strong confirmation).

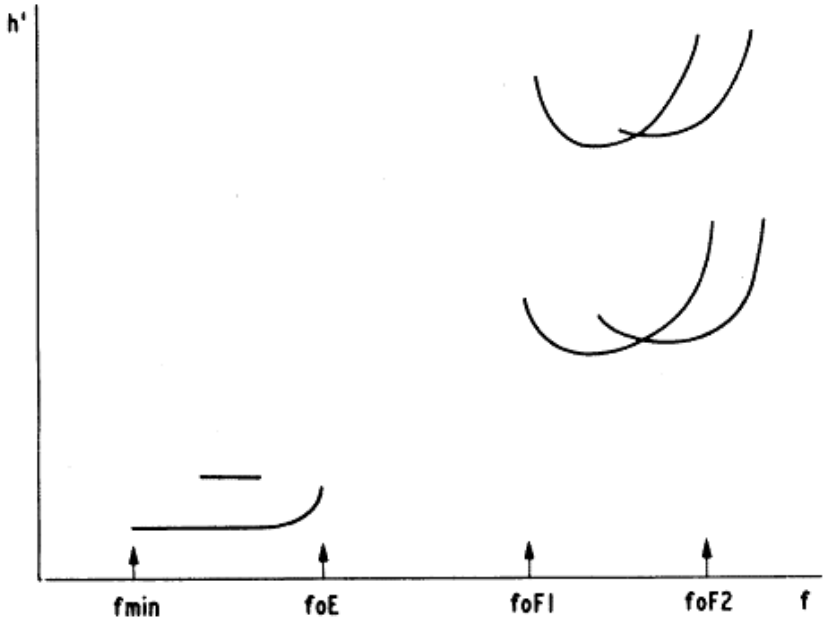


Figure 1. F1 or partial Lacuna

(a) fmin and multiple traces normal. Therefore not due to abnormal absorption.
(b) sudden appearance of F2 trace. Therefore not due to retardation absorption.
(c) retarded part of E trace missing but E trace height normal. This is not Es.
(d) a weak diffuse o-mode trace may also be visible over part of the missing F1 trace when sensitivity is high or the Lacuna is weak. It is usually strongest near foF1.

In this case
All E parameters are replaced by B
h'F1 and M(3000)F1 are replaced by Y
fmin is given by (fmin)EY
foF1 is given by (foF1)UY.

3. If no traces are seen use letter B even when sequence suggests Y may be present.

F — When weak scattered F—layer traces are seem but there is evidence that Lacuna is present Y should

be preferred to F.

1. If the upper end of the E trace is suddenly cut off below the normal value of foE and the F traces simultaneously become weak and scattered use Y not F.

2. If the F2 trace is normal but the F1 trace is weak and scattered use Y not F. The E trace is most likely to be cut off but may be nearly complete.

3. If part of the F1 trace is missing, fmin being given by an F trace, and the remainder is weak and scattered use Y not F.

4. The presence of slant Es with any of the above conditions confirms that Y should be used.

H —When there is a gap between the normal E trace and the F trace, the lower part of the F trace showing retardation, use H not Y. (This restricts the use of Y to cases where large tilts are present and may be reconsidered later by INAG.)

Severe Layer Tilts Present. There are two important cases:

1. Large tilts affecting apparent value of fbEs. If fbEs is greater than foEs, use fbEs = (foEs)UY.

2. Abnormal pattern near foF2: When the F layer is very tilted, the trace rises in the normal manner to a frequency near the expected value of foF2 (as shown by sequence) and then turns over so as to run horizontally. When the signal—to—noise ratio is good it stops suddenly. In this case the wave has been replaced at oblique incidence and the value of foF2 overhead is certainly less than the limit frequency observed. This is probably true in all cases when the trace is concave downwards; the residual doubt is less important than obtaining a numerical limit. Use the top frequency observed qualified by E and described by Y. This procedure can only be used when there is independent evidence of tilt or curvature. Convex or linear traces are more likely to be normal traces which are absorbed, UR, DR, or R, when tilt is not present. These conditions nay last several hours but are usually short lived. A similar effect can be caused by inadequate antennas or ionosonde, letter symbol C, and this possibility should be considered if the condition is seen regularly. Suitable figures have been provided in the Handbook. (Figs. 3.31 and 3.32 reproduced below.)

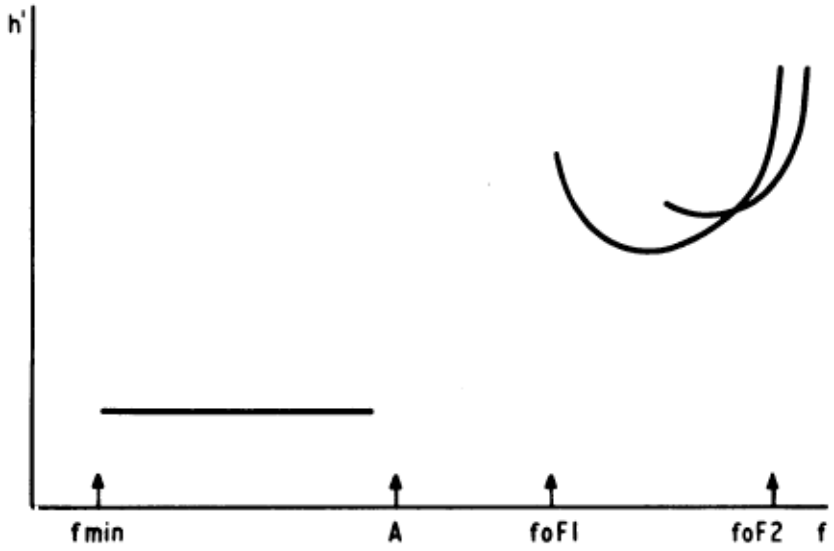


Fig. 3.32 F1 or partial Lacuna

F1 trace is missing
fmin given by Emin
foE would be expected at A
(if foE observed (foE)UY)

foE replaced by Y (unless observed)
h'F replaced by Y
foF1 given by (foF1)UY
M(3000)F1 replaced by Y

Note: F2 trace appears suddenly at approximately foF1.

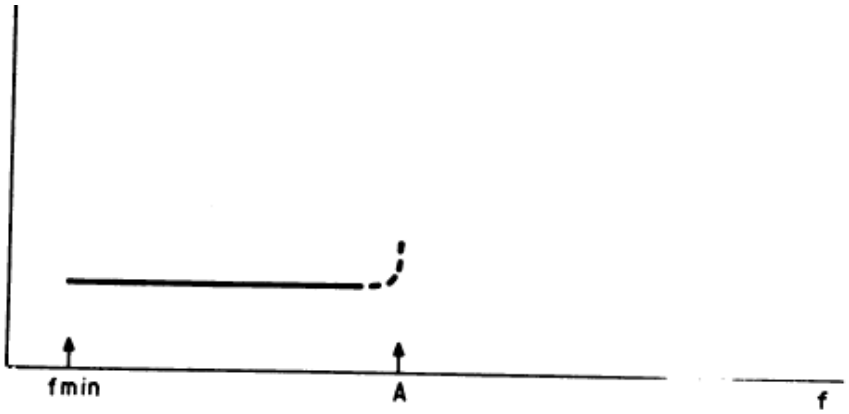


Fig. 3.31 Total F Lacuna

The F1 and F2 traces are missing.

fmin is given by an E trace
foE would be expected at A

h'Es: G. foEs, fbEs: G (preferable (foE)EG)
All F parameters replaced by Y. foE replaced by Y

Note similar pattern can occur with group retardation on E trace as shown by dots in which case foE is tabulated as (foE)UY.

V. Slant E Condition — SEC — Phenomenon

Contribution from J. K. Olesen, Ionosphere Laboratory, do Technical University, 2800 Lyngby, Denmark, prepared September 6, 1972

When high currents exist in the equatorial and polar E regions an instability is believed to arise (possibly the so—called two—stream instability and/or gradient—drift instability). According to relevant theories then ionacoustic waves and field aligned irregularities occur, supposedly from near the "middle" of the E region and upwards through the F regions. In polar regions the occurrence is correlated with that of magnetic disturbance, i.e., maximum in the summer and along the auroral oval.

The SEC has several consequences as to ionogram appearance because the ionosonde waves of frequencies higher than those reflected in the lower part of the E region are affected in an abnormal way when they reach the irregularity region.

Depending upon several factors such as the size and the age of the event, the sensitivity of the equipment, the quality of the antenna, the degree of absorption, etc., the ionogram appearance will be affected and one or more of the following criteria may be seen:

1. A slant Es trace from oblique E—region echoes generated by a suitable combination of refraction and backscattering in normals to the field aligned irregularities.

2. An E—F height gap (lacuna) in the ionogram, corresponding to the defocussing instability region from which no echoes are seen from somewhere close to the upturn of E—region traces (E or Es) and upwards through the F region, sometimes all the way up to the F2 ionization maximum (so that no echoes are seen at all, except those from the lower E regions).

3. Decrease of foF2 and increase of h'F2.

4. Increased spreadiness, often of a special fine—grained type, in the same height interval as mentioned under item 2 above (through upper—E, F1, F2); especially spreadiness in the lower Fl region above the "gap" is typical for SEC.

5. Oblique traces which before and during the event appear on the high frequency side of the foF1 and foF2 upturns, descending from there towards lower heights as the frequency is increased. At the end of and after the event, the oblique traces tend to appear with constant height as a function of frequency, a height that usually decreases with time.

6. For weak SEC events some of or all the above characteristics might be missing, but a lack of normal retardations in the upper E and lower Fl regions might reveal a weak SEC.

7. SEC may be present under various degrees of absorption and often during no noticeable absorption. However, there are indications that very frequently, maybe usually, a SEC is hidden under a black—out condition.

8. SEC seems to have close relations to several other geophysical phenomena, e.g., magnetic and auroral disturbances, elf and vlf emissions, scintillation, fading and scatter phenomena.

The criteria mentioned above are illustrated in Fig. 2a, b, and c in reference 3 below, as shown on the following pages, as well as possible propagation principles.

References:

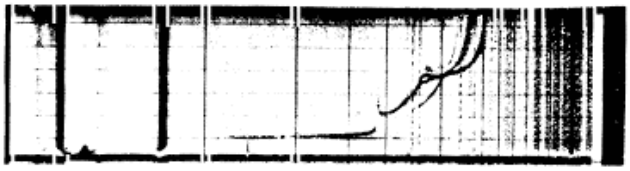
1. J. K. Olesen (1957): Slant Es Ionospheric disturbance at Godhavm and its correlation with magnetic activity. Internal Ionosphere Laboratory Report R lA — July 1, 1957.

2. J. K. Olesen and J. Rybner (1958): same title — with Appendix: Note on the occurrence of Slant Es at Narssarssuaq, published in AGAEflograph 34: Sporadic E Ionization, Ed. B. Landmark, printed by NATO, Paris 1958.

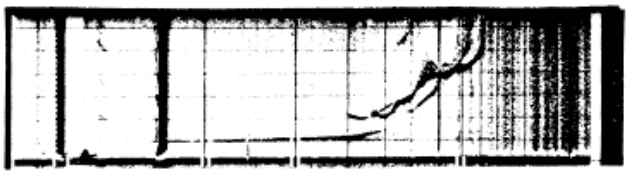
3. J. K. Olesen (1971): On the polar Slant E Condition, its identification, morphology and relationship to other electrojet phenomena. Presented at NATO—AGARD—EWPP—meeting, Lindau, Sept. 1971,
published in AGAED—CP 97, pp. 27.1—27.19, January 1972.

4. 31 references given in (3).

INAG-12 November 1972

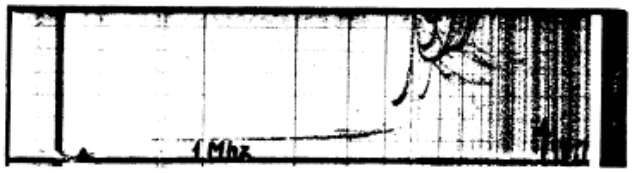


1254 hr.
No S.E.C.
Retardation traces in E and F1 at foE

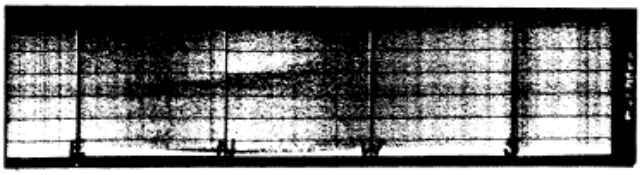


1324 hr.
S.E.C. event starts
No foE retardation trace.
F1 stratification

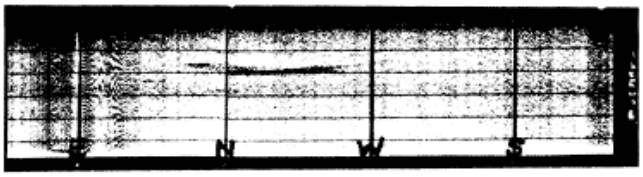
1349 hr.
S.E.C. early phase
Oblique F echoes.
Decrease foF2 starts
F1-F2 height separation increases.



1434 hr.
S.E.C. well developed
No echoes from upper E and lower F1 (E-F1 height gap).
Oblique E region echc



1438 hr.
Backscatter record
Echo from NNW geogr. 350-400 km.

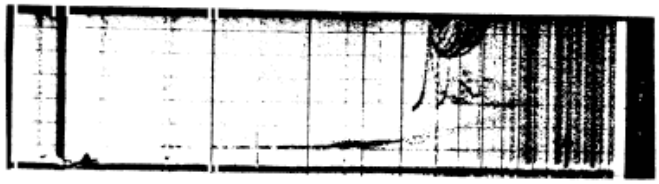


1442 hr.
Backscatter record
Echo NNW geogr. 400-450 km.

Fig. 2 a

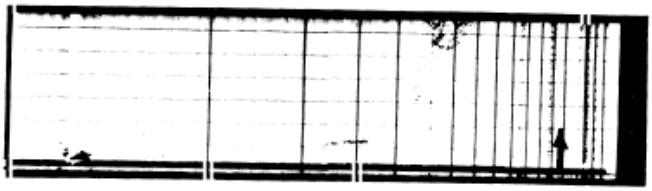
Typical daytime Slant E Condition (S.E.C.) at Lannion, June 17, 1970. (45°N.H). Ionograms are 0.25 - 20 Mhz, 0-600 km.
19.7 Mhz backscatter record have once distance range, azimuth is calibrated geographical from left to right, antenna elevation 3c°.

INAG-12 November 1972



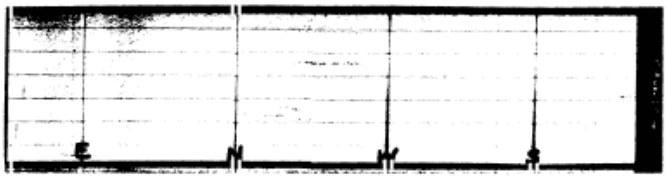
1444 hr.
S.E.C. continues
Oblique upper E region echoes.

1457 hr.
S.E.C. continues
High gain-, expanded scale-record.
Note F1-z-echo.

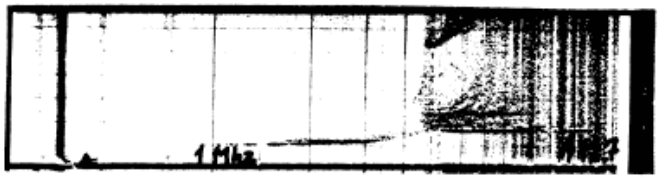


1458 hr.
S.E.C. continues
Low gain record.
Notice: no slant trace but E-F height gap present.

1534 hr.
S.E.C. continues
Constant range F-echoes increase.
foF2 decrease continues.



1542 hr.
Backscatter record
Echoes NE, NW and SE, various distances



1544 hr.
Low constant range echoes.
E-F1 height gap increase.

Fig.2 b

Typical daytime Slant E Condition (S.E.C.) at Narssarssuaq, June 17, 1970, continued.

Text see Fig. 2 a

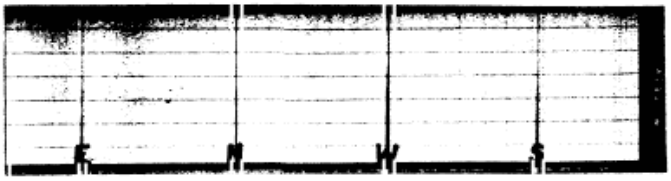
INAG-12 November 1972

1659 hr.

S.E.C. ends. Last record with distinct slant trace. Notice clear F1 trace.

1734 hr.

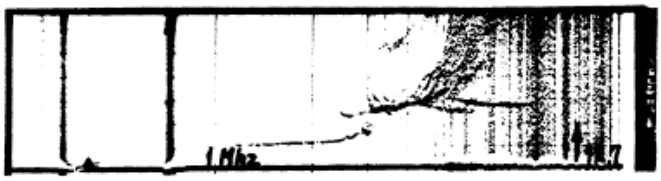
S.E.C. over at Narssarssuaq - constant range and other oblique after-effects present. Possibly start new disturbance.



1742 hr.

S.E.C. over.

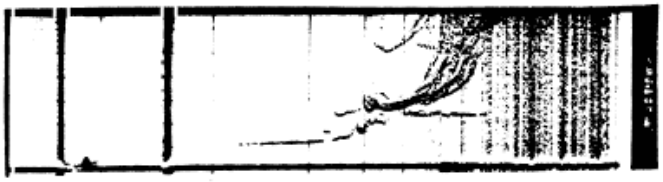
Backscatter record. Echoes NE, 280-350 km.



1744 hr.

S.E.C. over.

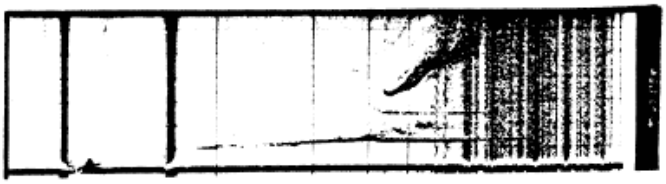
Constant range and other oblique after-effects



1749 hr.

S.E.C. over.

Constant range and other oblique after-effects.



1924 hr.

S.E.C. over.

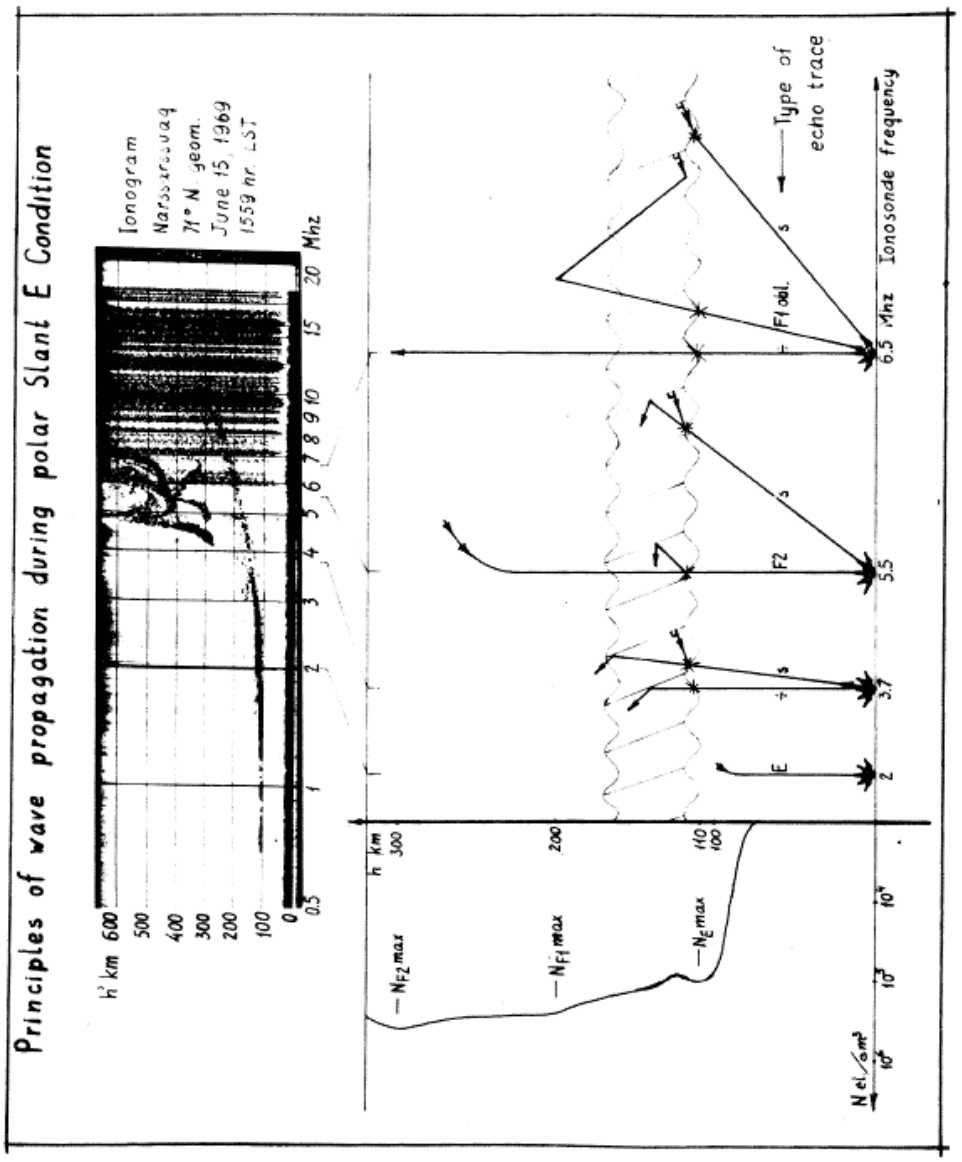
New disturbances start

Fig. 2 c

Typical daytime Slant E Condition (S.E.C.) at Narssarssuaq, June 17, 1970, continued.

Text see Fig. 2 a

INAG-12 November 1972



VI. Report to INAG during XVII URSI General Assembly for period 1969—1972

N. V. Mednikova

Two members of INAG, N. V. Mednikova and A. S. Besprozvannaya, organized and conducted a seminar on vertical soundings of the ionosphere at Kaliningrad, USSR, from August 18—25, 1971. The seminar lasted one week. It was attended by more than 40 scientists and operators from Geophysical Institutions and Ionospheric Observatories.

The main purposes of this seminar were: (1) to discuss problems of maintenance of the equipments;
(2) to discuss the present practices of interpretation of ionograms; (3) to describe the use of vertical incidence in the study of ionospheric physics. Reports were given and discussed in the seminar on: (1) the characteristics common to observations of the high latitude ionosphere and the difficulties of interpreting high latitude ionograms; (2) the characteristics common to observations of the mid—latitude ionosphere and the difficulties of interpreting mid—latitude ionograms; and (3) equipment suitable for vertical soundings.

The discussion showed that vertical soundings of the ionosphere could be used both to study problems in practical radio wave propagation and for the solution of present day problems in ionospheric physics.

All ionospheric stations of the Soviet Union take observations every 15 minutes. In general the analysis of the ionograms was done well and in accordance with URSI rules. However, it was clear that there were some disagreements between the operators and the scientists on details of scaling techniques.

The participants of the seminar decided for improvement of the work at the stations it was necessary (1) that the stations should send monthly station reports of the ionosonde operation including information on power, sensitivity, frequency markers, height markers, etc. (a standard form is supplied to the stations for these reports); (2) that a two—weeks course on interpretation and reduction of ionograms and on equipment operation be held every two years; (3) that the exchange of personnel between stations including operators, scientists and engineers be arranged for periods of 3—8 months; and (4) that the participants of the seminar believed it was very undesirable that some administrations wished to reduce the amount of data scaled and sent to the World Data Centre (ie., tabulations, N(h) profiles, etc.) since this practice would reduce the usefulness of the data available at the World Data Centre for scientific studies needing long sequences of data.

Participants of the seminar discussed and clarified a set of questions on the interpretation of ionograms and accepted a set of recommendations which are not in conflict with international rules. Those questions were on the cases of full blanketing by Es; on difficulties of determining foE when E—layer is present; on the cases when h'F > h'F2; or when h'E2 > h'F, etc.

Questions and proposals were raised for discussion at the XVII URSI General Assembly INAG meeting in Warsaw. Those were the following: (1) in order to have more numerical values of foF2, where there is spread F that does not give the possibility of determining foF2 or fxF2 even with uncertainty, but nevertheless the trace has a rather clear high frequency edge, one should use the value of the high frequency edge of spread trace with symbols EF. (But when we have complex ionograms with oblique traces such reductions are not recommended.)

(2) to classify Es night as one of the types Es — k and to write the numerical values of night E not in table of regular E layer but in table of Es layer, ie., to include the numerical values of night E simultaneously in fbEs, and the values h'E in the table of h'Es. To follow the numerical values of night E write descriptive letter E. On f plots in these cases it is necessary to plot the values of fbEs with o (open circle).

In the cases when the values of fbEs in the presence Es — r are determined with the help of retardation on the low edge of the trace of F2—layer, the value of fbEs in table must have descriptive E also, and on the f plot use o (open circle). (Such cases may be when the night E is blanketed by Es layer of type r.)

In connection with the above, the participants did not agree that it is necessary to divide the types of Es into two groups —— certain and uncertain. They recommended to keep the previous rules and show the types of Es by • (closed circle) on f plots.

(3) For the stations which cannot give the accuracy of determining foE with an accuracy of 0.05 MHz (for example, for some high latitude stations or stations which have ionosondes of low quality, it is permitted to scale foE with an accuracy of 0.1 MHz). In either case the accuracy should be noted on the tabulations.

(4) Operators would prefer to consider the total range of uncertainty rather than the deviations from the most probable value, and have asked INAG to consider this possibility.

(5) The participants feel strongly that the parameters M(3000)F2 and M(3000)F1 must always be determined using the standard transmission curve methods and should not be deduced from hp values.

(6) The participants think it is not necessary to submit form 7G containing notes on the measurements to the World Data Center.

(7) It is necessary to scale hp and to send these tables to the World Data Center with their medians and quartiles.

(8) They ask INAG to give additional rules on techniques of interpretation and scaling of characteristics measured from E2 or F0.5 traces in order to standardize the scaling of these

characteristics at different stations. They wished to encourage the scaling of these parameters on a voluntary basis.

VII. Scientific Program for Vertical Incidence Sounding Program used on International Geophysical Calendars

INAG approved the scientific program for vertical incidence soundings for 1973 as presented on the Planning Edition of the International Geophysical Calendar for 1973. However, it was agreed that the text should be modified for the 1974 Calendar. In particular, the recommendations concerning profile parameters should be carefully considered. The 1973 text is repeated below.

"Ionospheric Phenomena. Special attention is continuing on particular events which cannot be forecast in advance with reasonable certainty. These will be identified by Retrospective World Intervals. The importance of obtaining full observational coverage is therefore stressed even if it is possible to analyze the detailed data only for the chosen events, In the case of vertical incidence soundings, the need to obtain quarter—hourly ionograms at as many stations as possible is particularly stressed and takes priority over recommendation (a) below when both are not practical.

"For the vertical incidence (VI) sounding program, the summary recommendations are (a) soundings to be made at five minute intervals on RWDs for stations normally making observations every quarter hour; all other stations are recommended to make at least quarter—hourly observations on RWDs; (b) f plots are made for high latitude stations and for the so—called "representative" stations at lower latitudes for all days (i.e., including RWDs and WGIs), (Continuous records of ionospheric parameters are acceptable in place of f plots at temperate and low latitude stations); (c) profile parameters hc, qc or recommended similar parameters to be determined and sent to WDCs for RWDs for all stations except those undertaking full profile programs or producing monthly median profiles; (d) copies of hourly ionograms with appropriate scales for RWDs are to be sent to WDCs; (e) stations in the eclipse zone and its conjugate area should take continuous observations on solar eclipse days and special observations on adjacent days. See also recommendations under Airglow and Auroral Phenomena."

Recommendations for its modification are solicited.

VIII. Literature Citations

As stated in Section II above abstracts of articles using vertical incidence data will no longer be given in the interest of economy. The summary below will give the journal, volume number, page number and list of stations used in the publications as evidence of the use of the V.I. network.

J. Atmos. and Terr. Physics, 1972, Vol. 34, page 365 (Kiruna, Sodankyla, Lule~, Lycksele, Nurmijarvi, Uppsala, Miedzesyn); page 387 (Leicester); page 401 (Boulder, Huancayo, Wallops Is., Pt. Arguello); p. 513 (Kiruna); p. 525 (Grand Bahanals., Washington, Ottawa, Huancayo, Talara, Bogota, Jamaica); p. 947 (Freiburg); p. 969 (Woomera); p. 1097 (Moscow); p. 1037 (Garchy); p.. 1109 (Arecibo); p. 1145

(world net near equator); p. 1163 (Canberra, Petropavlovsk, Capetown, Poitiers, Hobart, Magadan, Kerguelen, Sogra, Marion Is., Lindau, Townaville, Kokubunji); p. 1379 (Slough, Washington, Maui, Singapore, Johannesburg, Capetown, Port Stanley); p. 1385 (Oslo, Slough, Washington, Maui, Singapore, Johannesburg, Canberra, Port Stanley); p. 1537 (Huancayo).

Planet. Space Science. 1971, Vol. 19, page 1349 (Huancayo, Puerto Rico); page 1505 (Ahmedabad, Hyderabad, Delhi).

Annales de G6ophysique, 1971, Vol. 27,page 359 (Resolute Bay, Eureka, Baker Lake, Churchill, Winnipeg,
Ottawa, St. John's, Washington, San Francisco, White Sands, Grand Bahama, Puerto Rico, Panama, Paramaribo, Bogota, Talara, Huancayo, LaPaz, SaoPaulo, Tucuman, Buenos Aires, Concepcion, Port Stanley,
Port Lockroy,Ellsworth, South Pole); Vol. 27, page 469 (Worldwide net); Vol. 28, p. 28 (Thumba).

J. Geonag. & Geoelec., 1971, Vol. 23, p. 133 (Yamagawa, Kokubunji, Akita, Ft. Belvoir); p. 181 (Huancayo).

J. Radio Res. Lab., Japan, 1971, Vol. 18, p. 245 (' Tsumeb, Watheroo, Sterling, Akita, Wallops Is., Kagoshima, Ft. Churchill, Tamagawa, Boulder, Wakkanai, Thule, Resolute Bay, Godhavm, Narssarssuaq,
College, Winnipeg, St. John's, Ottawa, Ft. Monmouth, White Sands, Cape Kennedy, Grand Bahama, San Salvador, Mexico City, Bogota, Talara, Huancayo, La Paz, Buenos Aires, Concepcion, Byrd).

Ann. Acad. Scient. Fennicas, 1963, Vol. VI Physics, page 127 (Sodankyla). Proc. Indian Acad. Sciences, 1971, Vol. LXXIV, page 62 (Kodaikanal).

Radio Science, 1970, Vol. 5, p. 773 (Thumba, Okinawa, Manila, Bangkok, Singapore, Port Moresby, Cocos Is., Townaville, Brisbane, Mundaring, Hobart, Mawson, Wilkes, Byrd, South Pole, Maui, Tahiti, Resolute Bay, Churchill, Godhavn, Narssarssuaq, Winnipeg, St. John's, Boulder, Wallops Is.,
White Sands, Mexico City, Jamaica, Bogota, Huancayo, Concepcion, Buenos Aires, North Pole, Dakar, Ouagadougoii,' Djibouti); Vol. 7, p. 193 (Hawaii, College, Boulder, Washington, White Sands);
p. 367 (Wallops Is.).

Leningrad Izd—vo Nauka, 1971, Ten papers in Morphology and Physics of the Polar Ionosphere (Murmanak, Loparskaya, 1{eiss Is., Salekhard).

Trudy Sektora lonosfery Akad. Nauk Kazakhskoy SSR, 1971, eleven papers in Ionospheric Physics and Radio Wave Propagation (Alma Ata, Karaganda, Novokazalinak).

Bulletin Soviet Antarctic Expeditions, 1970, No. 78, page 54 (Vostok).

Results of Studies on International Geophysical Projects, 1972, No. 20, Ionospheric Investigations, Izd—vo "Nauka" (stations 2O~4Oo geomagnetic north latitude, mid—latitude stations, Thilisi, Rostov—on—Don, and others).

Geomag. and Aeronomy, 1972, Vol. XII, p. 122 (Moscow); p. 129 (Tiksi Bay, Batagay, Zyryanka, Yakutsk); p. 230 (Alouette 1); p. 337 (shipboard Yu. M. Shokal'sky and Zarya); p. 335 (Washington, Panama, Talara, Huancayo, Slough, Ibadan, Port Stanley, Moscow, Puerto Rico); p. 453 (network at high latitudes).

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