# IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

## Ionosphere Station Information Bulletin No. 17 **



* Under the auspices of Commission III Working Group 111.1 of the International Union of Radio Science (INAG).

** Issued on behalf of INAG by World Data Center A for Solar-Terrestrial Physics, National Oceanic and Atmospheric Administration, Boulder, Colorado 80302, 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

The INAG meeting at Geneva discussed a wide range of problems with particular emphasis on problems of interest to C.C.I.R. As this was one of the two main meetings of INAG called for by URSI Commission III, it is fully reported in this issue. For convenience of future reference the topics have been numbered and indexed.

The next full meeting of INAG will be held in Lima, Peru, immediately before the General Assembly of URSI. The dates will be 7th-8th August 1975 and the exact place will be announced later. Please take early action to obtain permission and funds to attend. INAG needs representatives from as many countries as possible so that the proposals made at Geneva can be discussed effectively and, if thought adequate, adopted.

I wish to draw your attention to the Spanish and French editions of the Handbook and, in particular to the need to let INAG know how many copies are likely to be needed (topic 6). I feel that you may wish to confirm the note of thanks to those who voluntarily took on the immense job of translating it made at Geneva. If so please inform your representative at Lima.

It is with much pleasure that INAG welcomes the numerous new stations which have been opened in the last two or three years. Because you are relatively inexperienced, your problems show most clearly where help is needed. We hope that you will use the INAG organization and thus help others as well as yourselves.

Possibly the most interesting new proposal made to INAG at Geneva is the use of F-layer letter symbols to show F types which are present in conventional h'F, foF2, fxI tables (topic 10 with changes discussed in topic 9). This eliminates the need for an F-type table. On further thought since the meeting, it seems to me that the difficulty that the mixed type, M, would disappear could be overcome by adopting letter L, for use in the foF2 table only, as an indicator of the presence of a mixed type of spread F. My analogue with the normal measuring of L the extended measuring could include distinction between range and frequency spread not possible because pattern varies continuously with frequency. This suggestion would, of course, involve changing M into L as well as 5 into P in section 12.34, p 282, of the Handbook. The advantages and disadvantages of the proposal to put types into the standard tables are fully discussed in topic 10. Clearly there are both gains and losses. INAG needs your views so that a decision can be based on a consensus of opinion.

I wish to draw your attention to topic 12, the proposed change of name of 'Night E' to 'Particle E'. This appears to be less controversial than the previous item. If you have objections please let INAG know as soon as possible. If there are no objections before the date of the Lima meeting this proposal is likely to be accepted.

*Proposals for the High Latitude Supplement (topic 13) are also the subject of a special note in this Bulletin.* The resources available to INAG do not allow any serious editing of your contributions which should, therefore, be in a form suitable for reproduction without editing. *Please note that action is needed now if your contribution is to be published.*

## II. INAG Meeting, Geneva, January 31-February 4

### Participants

| | | |
|---|---|---|
| W. R. Piggott | (Chairman) | UK |
| J. V. Lincoln | (Vice Chairman and Secretary) | USA |
| L. E. Petrie | (INAG member) | Canada |
| G. Pillet | (INAG member) | France |
| M. Joachim | (C.C.I.R.) | |
| A. M. Bourdila | | France |
| C. Davoust | | France |
| R. Lindquist | | Sweden |
| C. G. McCue | | Australia |
| I. Mesterman | | Argentina |
| T. Turunen | | Finland |



An INAG meeting was held in the ITU tower at Geneva on January 31, February 1 and February 4, 1974. Informal discussions with members and participants were held on February 2 and 3. A joint meeting with C.C.I.R. Interim Working Party 6/1 (IWP 6/1) was held on February 4 (afternoon session). Those listed above attended one or more INAG sessions. In addition members of IWP 6/1 took part in the joint session in which the Chairman reported on matters of special interest to C.C.I.R. which had been discussed by INAG.

## 1. Introduction

The Chairman thanks the Director of C.C.I.R., Mr. J. W. Herbstreit, on behalf of INAG, for providing a very comfortable room and facilities for the INAG meeting and thanked Dr. M. Joachim for his help in the arrangements.

Dr. M. Joachim welcomed INAG on behalf of the Director of C.C.I.R.

The Chairman gave a brief summary of the status of INAG as Working Group 1 of Commission III of URSI and mentioned that cooperation with other WG's of URSI had so far proved disappointing. It was agreed that a new approach should be made to the Chairmen of these Working Groups. However the main work of INAG, to help the VI network, was proceeding well.

The Chairman reported with regret that he had received a letter of resignation from INAG member, Prof. V. H. Padula Pintos. Prof. Padula Pintos found that he was no longer able to give the time to INAG matters which membership involved. The meeting unanimously passed a vote of thanks to Prof. Padula Pintos for his help in the past. The INAG members present decided to ask Dr. I. Mesterman (LIARA, Argentina) to act as a temporary member of INAG until a replacement for Prof. Padula Pintos could be agreed by the full INAG Membership and URSI Commission III.

## 2. The Network

A review of the data flow to WDC-A showed that the number of stations listed as having provided data for 1973 was 44 greater than for 1972. As it is usual for a significant number of stations to produce data two or more years late, the true strength of the network is probably well above the 157 stations listed. This means that the network is now stronger than in the IGY and has been growing exceptionally fast recently. This increase in interest in making VI soundings seems to be greatest for new purposes, e.g. providing data for satellite and rocket studies, airglow and meteorology. In some countries there are communication requirements which have resulted in new stations being set up. Preliminary plans for the I.M.S. suggest that the growth will be maintained despite the probable loss of some long established stations.

## 3. Index Stations and Changes in Stations

Dr. Joachim drew attention to C.C.I.R.'s interest in maintaining the 13 stations used by C.C.I.R. to provide indices of changes in solar activity. He drew attention to the C.C.I.R. Recommendation 371-1 and Opinion 23-1 unanimously passed at New Delhi.

Mr. Piggott reviewed the position of the threatened stations. The continuance of Slough is now confirmed but Port Stanley has some difficulties which will probably be solved by cooperation between British Antarctic Survey and Appleton Laboratory. College, Alaska, continues to make ionograms but these are analyzed only upon special request. There are difficulties in financing Huancayo which may be solved, in time, by local effort. This station has been widely used by scientists who would regret its loss. Mr. McCue stressed the importance of Maui as a standard station and stated that the I.P.S. needed 12 stations, 6 in each hemisphere, well spaced in longitude, for the T index. Some existing standard stations could be replaced by alternate ones with long sequences of accurate data. However, Manila has a special position for I.P.S. propagation experiments.

The following probable changes were also reported:

Fort Archambault will close February 1974.

Cocas Is. will probably close due to logistic difficulties, but will probably be replaced by a new station at Port Darwin equipped for 01 as well as VI observations.

Brisbane may close due to financial difficulties.

A new station is running at Tangerang Indonesia with joint Australian-Indonesian collaboration. It is hoped to install a new Australian ionosonde in 1975.



The I.P.S. is organizing oblique incidence soundings in addition to VI to solve C.C.I.R. problems in the theater.

## 4. Gain Sensitive Parameters

Mr. Turunen reported on his experiments in which an ionosonde at Sodankyla was modified to show the characteristics of several normal types of ionosonde. The values of foEs and fbEs for the different modes of operation were compared and considerably differences found. He had devised a modification which enabled him to measure the partial reflection loss in sporadic E relative to a totally reflected signal. At low losses the frequency characteristics varied linearly and slowly with scattering loss in dB, but for losses greater than 60 dB they varied greatly with loss in dB. Boundary reflections were seen with losses of about 100 dB. This work, which is important to both INAG and C.C.I.R., will be reported more fully in future issues of this bulletin. fbEs, which is a fairly well defined parameter at temperate latitudes, is controlled by scatter and tilt phenomena at high latitudes and can thus vary appreciably with available sensitivity, e.g. by 0.5 MHz. The work will be extended to study spread F. The results showed clearly that the high sensitivity ionosondes, show additional traces which are due to different reflecting mechanisms than those seen by low sensitivity ionosondes. This is of great interest to C.C.I.R.

## 5. New Australian Ionosonde

Mr. McCue reported that the I.P.S. had successfully developed a reliable new ionosonde based on solid state devices apart from the cathode ray tube and output tubes. Circuits and details will be made freely available. The cost of parts, including 16 mm camera, is 3500 Australian dollars. The films from this equipment are acceptable to the WDC's and can be projected to give normal accuracy. Some samples were given to the Chairman. The equipment is suitable for operation by unskilled technicians. In the Australian network some central analysis will be adopted so as to raise analysis standards.

INAG has no means of testing or comparing commercial or laboratory built ionosondes and cannot express any views on their reliability or usefulness. *Any comments on the advantages or disadvantages of particular ionosondes based on your experience could be useful to other groups.*

## 6. Status of Handbook Translations

Dr. Mesterman brought draft copies of the Spanish translation of the Handbook and stated that these only needed minor corrections, as given in INAG-16, before the final edition would be ready. The Chairman, on behalf of INAG and the VI network, thanked Dr. Mesterman and his colleagues at LIARA, Argentina, for successfully completing this very large task. He was sure that it would greatly help the stations whose scalers spoke Spanish.

*All groups who desire to obtain a copy of the Spanish Edition are requested to write to*

*Dr. I. Mesterman*
*Aw. Libertador 327*
*Vicente Lopez*
*Buenos Aires*
*Argentina*

*Dr. Mesterman stated that he was planning an international scalers training and discussion course to be held between July and December 1974 in Argentina and that all participants would receive a free copy of the Handbook in Spanish. Any difficulties would be discussed at this meeting.*

Mlle. Pillet stated that the French edition would be published in two parts. Part 1, which will be ready first will give the first eight chapters, i.e. those most often used by scalers.

Mlle. Pillet stated that the draft of the French translation was complete apart from minor corrections which would be discussed in this meeting. The final edition would be started in the next month.
*Those desiring a copy of the French edition are requested to inform:*

*Mlle G. Pillet*
*Groupe de Pecherches lonospheriques*
*3 Avenue de la Republique*
*92131 Issy- les-Moulineaux*
*Prance*





— *A partial translation, covering the scaling rules, has been made in Finnish. For further information apply to:*

*Mr. T. Turunen*
*Sodankyla Geophysical Observatory*
*Sodankyla*
*Finland*

Translations are being made in Russian and Japanese but the current status is unknown.
Note by Chairman.

It is very important that those producing the translations of the Handbook be informed how many people require them so that a decision can be made of the number to be produced. *If you want a translation please write as soon as possible to the addresses given.*

## *1.* Handbook Amendments

The following errata were found and the corrections agreed:

(1) p. 8, 1st para, line 3: Delete: "frequency (Fig. 1.3)." Insert: "frequency when above fB (Fig. 1.3)." Delete: "In certain circumstances ... 1.05 below." Insert new text:

"Since the conditions of reflection for the two components are different, each produces its own h'(f) pattern. These are similar but displaced in frequency, the extraordinary ray having the higher critical frequency above fB (Fig. 1.3). The magnetoelectronic theory shows that the reflection levels of the two modes (o and x) depend on the ratio of the exploring frequency f to the gyrofrequency fB. These are given below, where $X = fN^2/f^2$ and $Y = fB/f$

| | |
|---|---|
| If f < fB ordinary mode : X = 1 | extraordinary mode : X = 1 + Y |
| If f > fB ordinary mode : X = 1 | extraordinary mode : X = 1 - Y |

For any set of circumstances, there can only be two characteristic modes but, because of coupling, there may be more than two characteristic traces.

For ionogram reduction it is more convenient to denote the traces according to the conditions of reflection:

| | |
|---|---|
| Reflection at X = 1 | 0-trace |
| at X = 1 -Y | x-trace |
| at X.= 1 + Y | z-trace (or third magnetoionic component) |

Near the gyrofrequency the x-mode trace shows a special type of retardation (Fig. 1.4(a) and Fig. 1.5) which does not correspond to a critical frequency. As the x-mode is more strongly absorbed than the o-mode, the retardation near fB is only seen when absorption is small. This trace is called an x-trace. The patterns which would be expected as the ordinary wave critical frequency for changes from fo » fB to fo ≅ fb and fo < fB are shown schematically on Fig. 1.4."

(2) § 1.04 - Unchanged except deletion of the 5 lines "When conditions allow reflection . .. .schematically in Fig. 1.4"

(3) p. 32, section 2.3, letter Y: delete existing text and insert: "Y - Lacuna phenomena or severe layer tilt present."

(4) p. 56, Fig. 3.5 (iv): delete existing text and insert:

"(iv) If there is little doubt that ftEs is foEs, i.e. that the x mode is absorbed foEs = (ftEs)-B

If doubt exists, for example if ftEs - fmin is large

foEs = (ftEs)MB

see section 4.3 for details.
In both cases fbEs = (ftEs)AA."

(5) p. 104, Table 4.2: line 4 delete: OOOJX, insert: OOOJA
line 11 delete: 067JX, insert: 067JA





(6) p. 126, section 5.21, first paragraph, line 10: for clarity delete: "with..., and involve" and insert: "but involve."

(7) p. 152, section 6.6, first paragraph, line 3: delete: "Es trace," insert: "Es layer" (see also "8. Notes on Handbook" below).

(8) p. 183, section 8.4, see INAG-16, p 17 correction for after (iv), Insert:(v), delete: "-at the lower accuracy possible it is unlikely to be significantly changed."

## 8. Notes on Handbook

Fig. 4.10, p. 97. The question was asked "Why are two forms given for foEs?" This case illustrates the rule that the more important letter must always be used. If foEs < foE it is important to use -G so that the median value is obtained correctly.

Fig. 4.13, p. 99. In this case, foEs = (ftEs -fB/2)JA.

Fig 6.15, p. 153-3. f—plot representation of fbEs. The original intention was to link values of fbEs which could be ascribed to the same reflecting layer. Thus, with sequential Es, the Es trace appears first as a high type, becomes a cusp type and may become a low type. Such a sequence should be linked. If two different structures are present on successive ionograms the lack of continuity is shown by a break in the line. The question arose because the example Fig. 6.15 shows Es type changing but no break in the lines joining fbEs. In practice different stations have used slightly different conventions, some obeying the original rules, as given above, and some linking all adjacent cases with fbEs numerical. There is some doubt whether the rule is worthwhile. *Do you have views on this?*

## 9. Proposals for Changes in Letter Symbols

### Letter P

There was a considerable discussion on the use of Letter P. There are two different problems.

(i) P as a descriptive letter.

It was proposed that Letter P should be used, as a local rule, to denote parameters whose values had been perturbed by man-made phenomena. This arose because the high power transmitter at Boulder often causes serious perturbations in the standard parameters circulated from the Boulder station. *It was decided to approve this use of P as a local rule and to invite general discussion in the INAG Bulletin on whether it should be adopted at the Lima meeting of INAG as an international descriptive letter.* Draft Definition P - Value non-representative of ionospheric conditions because the ionosphere has been modified by man-made phenomena. *Your comments on the proposed draft definition and usage are requested.*

The use descriptive letter P to denote values which have been greatly perturbed by natural forces was also discussed. This use is to confirm that apparently odd values have been transcribed correctly, e.g. abnormally dense low F layer (in sunspot minimum h'F may be as low as 100 km at night at some localities). This proposal had little support and has been dropped.

(ii) P to denote SPUR type spread F

*The proposal is to change the symbol for spur type spread P (current symbol 5) to P.*

The proposal is essential to enable types to be denoted by descriptive letters (see spread F type discussion below) in standard tables, thus eliminating the need for a type F table, and has the advantage of making the use of the letters more uniform. Thus P could be used also to show cases where foF2 was doubtful because it was hidden by a spur trace. The letter P in this case would refer to the old name Polar Spur for Spur phenomena. This proposal had unanimous support at the meeting. *it is recommended that it is used in preference to S where stations are experimenting with the use of type letters in standard tables. INAG* formally proposes that type letter S be replaced by type letter P in future to denote the presence of spurs, *invites comments on this proposal* and, if it meets general acceptance, will ratify this use at the Lima meeting. *If this proposal is adopted letter P must be added on p. 32, 53, 73 of the Handbook.*

## 10. Tabulation of Spread F Types with Standard Parameters

- The Australian network suggests that a table for spread F types could be avoided if the type letters were used instead of the normal descriptive letters as follows:





Frequency spread. Use descriptive letter F in foF2 table.

Range spread. Use descriptive letter Q in h'F table.

Spurs. Use descriptive letter P in fxI table.

Mixed type would disappear in this scheme and its presence would be noted by F in the foF2 table. Q in the h'F table. Thus the distinction between simultaneous frequency spread traces and range spread traces and the continuous band characteristic of M type would be lost. (This might be overcome by extending the meaning of L to include spread which shows no distinction F/Q. - Chairman)

The proposal has the merit of removing a special table for spread F types and thus of encouraging the use of spread F typing. These are important points. It has the disadvantage mentioned above and the more serious disadvantage that if a spread type is present it is impossible to denote the cause of any uncertainty where qualifying letters are in use. Thus it is common for a value to be doubtful because of interference (letter 5), tilt, or stratification (letter H) when spread F is present.

*INAG wishes to encourage stations to try this scheme on an experimental basis so as to establish a consensus of opinion as to whether it should be adopted or not. Please send INAG your opinions. For this purpose, letter P must be adopted to denote spur types.*

The feeling at INAG was that the use of a separate spread F-type table was clearly preferable but that the extra work involved would be likely to prevent many groups from cooperating or would compel the omission of some other parameter.

## 11. Frequency Spread and Range Spread

While there are strict accuracy rules for the use of UF, the use of the descriptive letter alone -F has never been refined. Thus some stations use it when any spread is seen, others only when the spread is broad but not broad enough to justify UF. Counting the number of F's is widely used to explore spread F activity. The Australian group proposes that -F should *always* be used when the frequency spread exceeds 0.2 MHz and never be used when it is less than this. Similarly, frequency spread should be shown in the type table when it exceeds this limit.

In principle, INAG strongly supports this proposal, the only controversial question being whether the limit chosen is satisfactory. INAG wishes to have your views on this point. If there is no controversy, INAG proposes that the clarification be considered for ratification at Lima.

The same problem arises with the use of Q to denote the presence of range spread. In this case the natural criterion will vary with the pulse width used in the ionosonde and possibly with the degree of differentiation used. Clearly the choice of a standard will be more controversial.

INAG suggests, for discussion, that range spread be regarded as present when the height range of the spread trace exceeds twice the height range of a normal trace. Where differentiation is used, the reference height range includes the dead range above the recorded trace. In this case normal trace means the width of the recorded trace and dead zone which would be expected if no scatter were present.
*Again your comments are requested so that a decision can be made at Lima.*

INAG wishes to draw attention to a difficulty which occurs when groups adopt local rules for use of letter, particularly in spread F, which are in conflict with the international use. Unless such rules are described in the Bulletin the data are incomprehensible to workers in other groups. *It would save much confusion if groups could notify INAG of such proposals before adopting them for use in published data.*

## 12. Night E - Particle E

A detailed discussion of the night E phenomenon showed that much misunderstanding is being generated by the name 'Night E'. This is the traditional name for the phenomenon but is misleading to those with low frequency ionosondes who can see the normal E at night. It is also difficult for new scalers as the phenomenon can occur by day or by night. It was agreed that the Handbook definitions and descriptions were adequate and that it was essential to distinguish between the presence of a thick, totally reflecting layer and scattering or thin layers.

*The INAG meeting unanimously agreed that the name should be changed and suggested that the name 'Particle E' be used in the future for the phenomena originally called 'night E.* ' This proposal will be ratified, if approved, by the INAG meeting at Lima. *If you have objections or alternative suggestions please inform INAG as soon as possible.*



*The proposal is that 'Particle E' be inserted and 'night E' deleted wherever 'night E' appears in the Handbook, in particular, on p. 17, §§ 1.15; p. 31, letter K; p. 6'9, letter K; p. 90, §§ 4.24; p. 91, p. 92, p. 110, letter k.*

A possible physical definition of particle E is that it is a thick layer formed below the F layer directly or indirectly by the action of ionizing particles and having a critical frequency greater than that of the normal E layer. For scaling purposes the descriptive definition given in the Handbook is quite adequate. *INAG would like to know whether you desire the descriptive definition to be supplemented by a physical one, so as to be consistent with the other layer definitions. Please let us know your preferences.*

## 13. High Latitude Supplement

A considerable discussion took place on the contents and format of the High Latitude Supplement. The need for urgent action was stressed. No attempt would be made to make different contributions compatible in form but the interpretation of all published material would have to conform accurately to the Handbook rules. As different equipments have different efficiencies it was agreed that a small sample of normal ionograms be requested from those contributing. As this is a voluntary effort, the Chairman should have the right to select from the contributed material so as to maintain a fair balance between phenomena and should request examples of particular phenomena which had been omitted.

In order to increase the chance that an adequate compilation could be obtained in time it was proposed that INAG invite a number of people in different countries to act as INAG consultants for the purpose of collecting and preparing material for the Supplement. Such consultants would volunteer to produce material by the date specified. This would not preclude the collection of material by other workers who could send their material either to the local consultant or to the Chairman of INAG, whichever was the more convenient to them. The names and affiliations of those contributing would be published in the Supplement.

The consensus was that ionograms should be selected primarily on grounds of value for training scalers and could be based on the Handbook figures. A good index would be needed as many ionograms would illustrate more than one point. Each group would be invited to select ionograms which gave the most trouble in their theater, particularly when training. The need for adequate frequency and height scales, f plot representation of the ionogram (as in Chapter 6 of the Handbook) and for the appropriate scaled values to be listed was stressed.

Sample collections were discussed and it was noted that in some cases the analysis was not consistent with the Handbook rules. It is likely that the main collection will disclose other cases where the rules have been misunderstood. The Chairman was requested to examine all contributions and draw attention to any discrepancies.

A provisional list of possible consultants was prepared and the Chairman requested to write to those suggested. *There are likely to be some gaps and proposals for a few additional names are requested. Please confirm that your nominee is willing to serve and send the name and address to the Chairman of INAG.*

## 14. INAG Bulletin

The meeting unanimously agreed that the INAG Bulletin was useful and met a real need. More contributions were needed from individual stations and networks, particularly to start discussions on difficulties in training. It would be useful to have short notes on all training exercises listing the main difficulties disclosed by them.

The policy of providing short notes on fields associated with VI sounding was thought useful, particularly as the requirements of the I.M.S. may involve starting some new measurements in these fields at existing stations. Recent developments have greatly increased the scientific value of absorption measurements for which there is also a strong C.C.I.R. demand. The VI network is interested to have short notes on new developments in equipment or techniques.

*There is a need for plans for the I.M.S., even if provisional, to be circulated so that administrations can consider them and suggest how they can be implemented.* Short notes on special experiments carried out to assist in I.M.S. studies should be included.



## 15. Development in Argentina

In response to the previous item Dr. Mesterman reported

(a) That it is proposed to hold a special international training course for scalers in Argentina in 1974.

(b) That a chain of A1 (pulse) absorption stations would be set up between Buenos Aires and Belgrano Base, Antarctica, in collaboration with the Max Planck Institute Lindau Harz. Details would be announced in a future Bulletin.

(c) Work is starting on the new Geophysical Institute at Ushuaia. This will be partly a Geophysical Observatory with ionosonde, riometer, VLF atmospheric noise, satellite receiving station, etc., and partly a research center.

## 16. History of Stations

A number of complaints have been received that changes in equipment, display characteristics and data evaluated have occurred at stations and are not documented. Many of the ionograms held by Data enters have non-standard frequency laws and frequency or height calibrations causing much extra work and, in general, absence of copies of the M(3000) factor curves prevents checking the factors.

WDC-A has started a file of station histories and requests all groups to send particulars of their current equipments and, where known, dates of changes in equipment for use in this file. At present most stations are represented by blank sheets.

As many stations have needed time to apply new rules there is a special difficulty at present of knowing whether data were taken under old or new rules. INAG wishes to stress the importance of informing the WDCs, or at least WDC-A, of the dates from which particular rules were adopted at each station. In most cases there will be a general change when the new Handbook came into use but in some cases particular rules were adopted at other dates. *Please send this information while you still remember it.*

## 17. Program of Observations for International Geophysical Calendar

A review of station practice showed that there was considerably more activity on RWDs than on normal days. Thus incoherent scatter observations were mainly concentrated on these days. Many stations which took quarter hourly ionograms and scaled at hourly intervals, scaled all ionograms on RWDs. Many stations could not maintain a more complete program owing to interference difficulties, but those who could do so wished to have 5 minute or less intervals recommended. The need to report periods of more complete coverage to WDCs was stressed. At present it is not possible for scientists to find out when such data exist.

## 18. Electron Density Profiles

INAG has received requests for information on:

(i) Types of electron density programs available and sources of information on them.

(ii) Programs suitable for use for simple specific types of analysis, e.g. total electron content, hmF2. Mr. McCue stated that the URSI Commission III Working Group 3.6.2 of which he was Chairman had completed a critical survey of all existing types of programs and was considering certain new techniques. The Chairman requested that the Recommendations of this WG be made available to INAG, and, in particular, that the list of programs and sources be provided as soon as possible.

The Secretary of INAG reported on the progress of the project to analyze a large sample block of ionograms. New techniques had greatly reduced the cost of computing N(h) profiles from ionograms and this was likely to fall further. Present costs for good ionograms are $5 per profile in quantities up to 50 and $3 each for all over 50. Over 21,000 had been computed but the resultant profiles needed checking for uniformity.

The Chairman reviewed the C.C.I.R. requirements for N(h) information. This had developed out of a need to take account of layer tilts when making predictions. In the first instance a cheap and rapid method of mapping hmF2 over the world was needed. The best way of getting this seemed to be to use M(3000) data suitably corrected for underlying ionization. A scheme for this was being put up to .C.I.R. The next priority was to obtain and map a parameter which gave a first approximation to the





curvature of the F2 layer. (Proposals based on the Bradley-Dudeney technique have now been accepted for study by C.C.I.R. — Chairman).

Perturbations of satellite communications by the ionosphere were also important. The most useful parameter was the total electron content as shown by Beacon experiments but the electron content up to hmF2 was very useful where no other data were available. Unfortunately this is difficult to measure with adequate accuracy as small frequency errors cause large changes in the apparent curvature near the maximum of the layer. It is necessary to fit for constant curvature ($d^2N/dh^2 = - 2N_0/ym^2$ for a parabolic fit), either by a computer or graphical method (Handbook section 10.4 qc).

$$hp = \frac{1490}{M} - 176.$$

For a mirror reflection with no underlying ionization

$$hm = \frac{a}{\sqrt{M^2 - 1}} - b$$

which gives

$$hm = \frac{1500}{M} - 176.$$

The Chairman drew attention to research problems in which C.C.I.R. needed further help and suggested that groups with ray tracing computer programs could clarify these problems by finding relations between vertical and oblique propagation as shown by ray trace and conventional computation from sliders. Owing to the late development of suitable computer programs much of the basic research had never been done, e.g. no one knew the best methods of using standard VI parameters for oblique propagation prediction, how wrong M(3000) could be in normal or extreme conditions, whether backscatter could give useful N(h) information, etc.

## 19. M(3000) and hmF2

There was a general discussion on the significance of M(3000) factors and their relations with hmF2. The Chairman pointed out that the M(3000) factors were established in 1943 on the basis of an arbitrary comparison of different partial solutions to the problem of predicting MUFs. It contains hidden assumptions about the corrections appropriate for the curvature of the ionosphere and for an average arbitrary amount of underlying ionization. Shimazaki's relation between hp and M(3000), M, contains similar assumptions.

Inevitably the use of the standard factor curve will give errors in the deduced MUF when the ionosphere differs from that implicitly implied, e.g. at night or near the magnetic equator. Recent work on the relations between M(3000) and hmF2 show that the adopted factor curve is not optimum. In particular the type of N(h) profile necessary to make hm deduced from M(3000) fit hm deduced directly tends to show more underlying ionization than is physically present. This difficulty was foreseen in 1943 and it is surprising that it has taken 30 years before it started to be a nuisance.

In general, the changes in M(3000) tend to be appreciably less than the changes in foF2 so that errors in the former are relatively unimportant. However in the Southern Hemisphere M(3000) can vary diurnally over a sufficiently large range for the discrepancies to be noticeable. The errors are partially hidden by mapping errors which tend to degrade the data.

The consensus view was that it would be valuable if a research group could make a reappraisal of the optimum M(3000) factor curve and publish their conclusions. This would enable the probable gain from using a modified curve to be estimated and weighed against the disruption of long sequences of data based on the current method.

Unfortunately not all administrators use the standard relation -changes have crept in and have not been reported -so that some groups who believe that they are using the standard factors are in fact not using them. *INAG would like to know how often this has occurred and requests all groups to check their overlays against the master factors (Handbook p. 21) and report any differences.* If this situation is widespread it may be worthwhile to adopt a new factor curve in the near future, otherwise it is probably best to keep to the old factors.

Modern ray tracing techniques enable M(3000) to be deduced from arbitrary N(h) profiles and thus compared with the results given by the corresponding ionogram and any specific factor curve.

## 20. Mapping of Parameters Needed by C.C.I.R.

Preliminary tests had shown the value of fxI when spread was present. Signals reflected in spread conditions showed severe fading and often Doppler shifts. It was difficult to introduce fxI data into prediction schemes until enough data had been obtained to show its variation with solar cycle.





A general discussion on mapping problems drew attention to the following main points:

(a) The use of IGY data for sunspot maximum caused errors due to saturation effects at the high sunspot number effective (~ 200). It would be better to re-calculate using the next cycle when R was about 100.

(b) The systematic shift of the magnetic field had caused a shift in the position of some anomalies which was not detectable. Again updating is the best solution.

(c) The Es situation was still very unsatisfactory. In some parts of the world the statistics were based on Es as seen by normal ionosondes, at others by high sensitivity ionosondes which could record very weak reflections. These should be treated separately. (See 4 above.)

(d) M(3000), after suitable connection, appears to provide a valuable measure of hmF2 for ray tracing applications. Further development of the technique is possible if needed.

C.C.I.R. IWP6/1 drew particular attention to the need to produce adequate maps of D-region variations and pointed out that A1 absorption data on single frequencies can now be interpreted, with foE, to provide suitable data. INAG should encourage the production of absorption data.

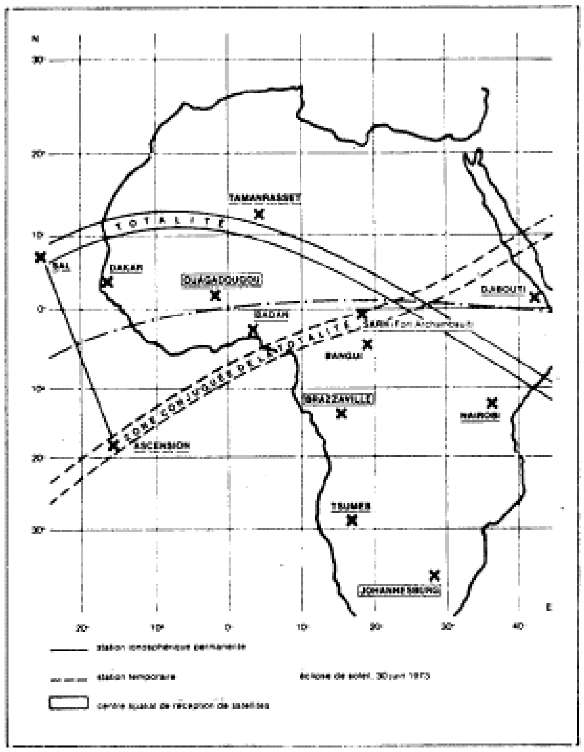
## III. Solar Eclipse 30 June 1973 French Ionospheric Observations

The purpose of these observations was to study the magnetic and ionospheric disturbances in the tropical region during solar eclipse.

The number of recordings at the French ionospheric stations of QUAGADOUGOU, SARH - FORT ARCHAMBAULT, DAKAR, DJIBOUTI were increased during the eclipse period. Furthermore, on June 30 and on the three first days of July, ionograms were recorded at TAMANRASSET by a Fayrey ionosonde lent to Constantine University. A polarimeter was set up in DAKAR for measuring the total electron content. These ground-based measurement will be complemented by those obtained from topside sounders ISIS I and II and AEROS A (about 50 passings between June 18 and July 8).

Temporary stations (underlined --), permanent stations (underlined -) and stations receiving satellite data (boxed) are shown in the figure together with the magnetic equator -•- and the zone of totality and its conjugate.

In order to study the ionospheric F region heating by the photoelectron flux coming from the magnetically conjugate region, a Cossor ionosonde



was temporarily installed on SAL Island (Cape Verde) (within the totality zone) and a 5P35/16 ionosonde on ASCENSION Island (non-eclipsed). A strong dissymetry of the heating was expected between the upper F2 region in the Atlantic North and South tropical zones. But the magnetic storm of the 28, 29, 30 June suppressed the normal structure, reducing and delaying the eclipse perturbation. Nevertheless a sudden diminution of the maximum ionization was observed at Ascension between 1225 and 1325 UT while no decrease was observed at Tamanrasset and Sal.

More frequent ionospheric drift measurements (18 antennas array) were made at SARH in order to study the equatorial electrojet, together with the slow and rapid magnetic variations recorded at BANGUI, BOUCA (Central Africa), SARH and AM TIMAM (Chad) by the ORSTOM group, and with backscatter measurements carried out on 20 MHz at SARH by M. Crochet (Institut de Physique du Globe de Paris) in cooperation with Dr. Balsley on 50 MHz (NOAA, USA). They intended to study the local disturbance of the ionospheric electric currents in connection with the eclipse.

All these experiments have been successful and a large quantity of data was collected thanks to the very close collaboration between technicians and research workers.

Nevertheless, the magnetic storm which developed at the eclipse time but was unexpected in this period of “Quiet Sun”, will make the interpretation of the data more difficult. However, these data will be of great value for the study of the disturbed equatorial ionosphere.

## IV. XVIII URSI General Assembly Lima, Peru, August 1975

As already announced, the XVIII General Assembly of URSI will be held in Lima at the invitation of Dr. A. Giesecke and the URSI Committee in Peru. The Opening and Closing Plenary Meetings will take place on Monday 11 and Tuesday 19 August 1975. Between these dates as much time as possible will be allocated to the scientific sessions organized by the Commissions.

As in Warsaw, the dates for the meetings of the URSI Council have been arranged so as to leave members of the Council and of the Board of Officers free to participate in almost all the scientific session. The provisional time-table is shown below.

It is proposed also to arrange three symposia just before or during the Assembly:

Symposium A: Remote sensing of the Earth’s surface by radio waves and its applications to the needs of developing countries.

Symposium B: The use of satellites for educational broadcasting.

Symposium C: Applications of radio methods in the biological sciences.

The First Announcement concerning the Assembly and local arrangements in Lima will be sent to all Member Committees in May 1974.

Provisional Timetable

| August 1975. | |
|---|---|
| Friday 8 | Board of Officers (morning) |
| | URSI Council (afternoon) |
| Saturday 9 | URSI Council (all day) |
| Sunday 10 | Chairmen of Commissions (morning) |
| | Registration for Assembly (all day) |

| | |
|---|---|
| Monday 11 | Registration for Assembly (all day) |
| | Opening Plenary Meeting (morning) |
| | Commissions: business meetings (afternoon) |
| Tuesday 12 | Commissions and Working Groups (all day) |
| Wednesday 13 | Commissions and Working Groups (all day) |
| Thursday 14 | Commissions and Working Groups (all day) |



| | |
|---|---|
| Friday 15 | Commissions and Working Groups (all day) |
| Saturday 16 | Free |
| Sunday 17 | Free |
| Monday 18 | Commissions and Working Groups (all day) |
| Tuesday 19 | Commissions and Working Groups (morning) |
| | Closing Plenary Meeting (afternoon) |
| Wednesday 20 | Board of Officers (new) (morning) |

## V. Beacon Satellites Moscow, 1974

COSPAR, with URSI as co-sponsor, will organise a Symposium on Beacon Satellite Investigations of Ionospheric Structure, and ATS-F Data. The Symposium will be held from 30 September to 4 October 1974 in Moscow with the approval of the Academy of Sciences of the USSR. Local arrangements are being made by Prof. Al'pert and Dr. Sinel'nekov.

Intending participants are invited to make contact with the Chairman of the Programme Committee:

Dr. R. Leitinger,
Institut fUr Metorologie und Geophysik
der Universitat Graz,
Halbarthgasse 1
A-8010 Graz, Austria.

It is intended that the emphasis shall be on discussions rather than on the formal presentation of papers.

## VI. The Measure of M(3000) Factors

The factor M(3000) has long been used to predict oblique incidence MUF from vertical incidence critical frequencies. It is essentially an indirect method of measuring the apparent height of the maximum electron density of the reflecting layer, hm. This is higher than the true height by an amount depending on the retardation in the underlying ionization. The same height can be obtained by fitting theoretical h'f curves to the observed trace at frequencies close to the critical frequency, e.g. above 0.9 foF2. In general hpF2, the vertical height at 0.834 foF2, is measured at a lower fraction of foF2 and is therefore more sensitive to the effects of underlying ionization.

Thus M(3000) should be our best sample parameter for estimating the apparent height of maximum density. Where the true height of maximum is required there is no alternative but to make true height analyses. However, over limited zones, such analyses can show simple approximate methods of correcting from apparent to true height of maximum - a process that is much faster than always using true height analysis.

In the early days much work was done to find relations between M(3000), hm, and the true height of maximum density. This was crippled by lack of sufficient computer power. The time is now ripe for a reconsideration of these problems. The relations vary with the average shape of the ionosphere, which is often remarkably constant.

The development of ray tracing methods has increased the need for accurate knowledge of the properties of M(3000), hm and the true height of maximum density.

In general any horizontal gradient in the electron density near the maximum will cause lateral deviation, deviation, an increase in the apparent value of hm and hence a decrease in M(3000). Thus travelling disturbances, sunrise tilts and proximity to a ridge of ionization can cause errors. True height analysis is subject to similar errors in these circumstances.

Errors due to the time of flight through the receiver, i.e. setting up the height scale correctly should normally be less than 5 km but can easily reach 15 km if care is not taken. A change in height of 5 km is normally roughly equivalent to a change of 0.05 M(3000) factor.



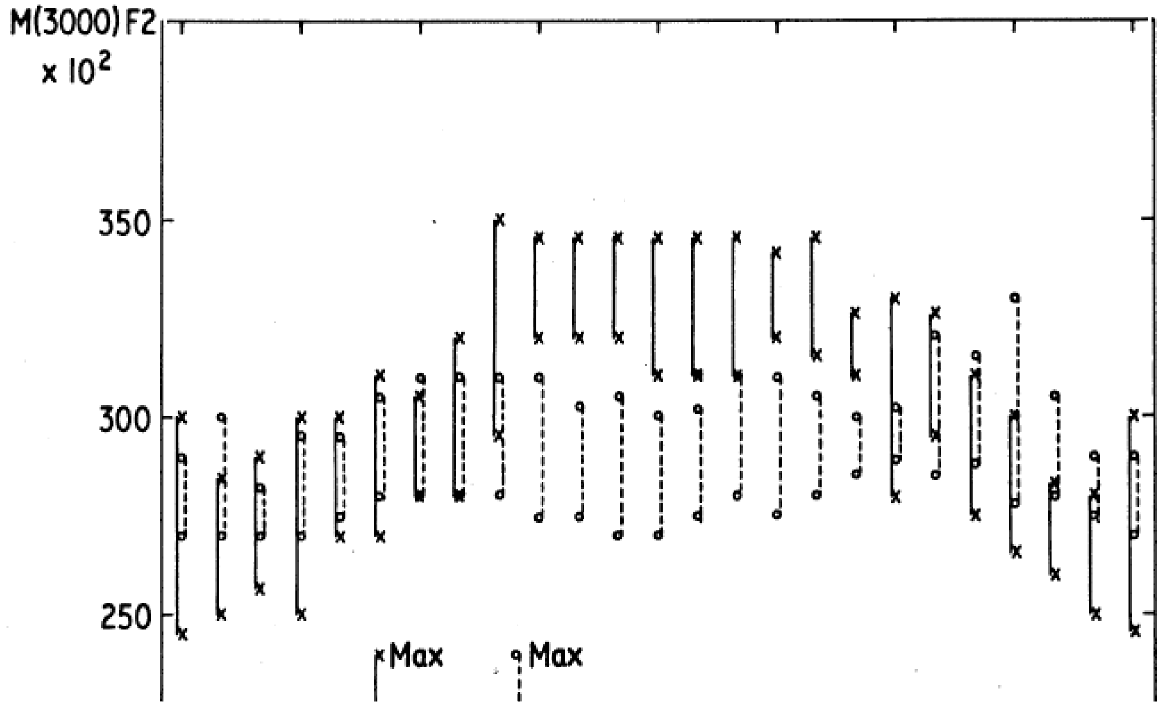

Apart from factors mentioned above there is no reason to expect that errors in individual measurements will be systematic. These are not likely to be significantly greater than errors in measuring foF2. Thus median values should be reliable to the reading accuracy except when systematic tilts are present.

A brief study has been made of published M(3000)F2 factors for 18 stations in Western Europe within ± 5° of 50° latitude. This suggests that the theoretical accuracies are not being obtained in practice.

The statistics show that, except near sunrise and sunset, there is no evidence for any systematic change in M(3000)F2 over the area which is significant compared with the random discrepancies between stations.

These also do not appear to be systematic though occasionally a station shows abnormally high or low values for a month or two. In the figure, which shows the extreme range of M(3000)F2 monthly median values for each hour in December and June, the extremes are almost all due to different stations at different hours. The median value of the extreme discrepancy for all hours is 0.275 in June and 0.35 in December, a value comparable to the whole variation with longitude for constant LMT at this latitude.

It is clear that M(3000)F2 values are not being produced with adequate accuracy for scientific or practical purposes but the reason is not clear. Further work is needed. The causes are most likely to be instrumental or in the reduction, e.g. use of sliders which do not correspond to the frequency and height scales of the ionogram, incorrect matching of the height scales at the contact frequency, incorrect setting of the zero height reference, too few scale divisions on the M(3000) scale (0.1 intervals are desirable). It is most likely that many operators do not realize that large errors are possible unless M(3000) is measured properly.




An index for frequency spread as proposed by B.H. Briggs [J.A.T.P. *12* (1), 34, 1958] has been used together with a house rule that a trace is considered to be spread when the amount of frequency spread is equal to or greater than 0.2 MHz.

| | |
|---|---|
| Traces with a spread of less than 0.2 MHz | index 1, and the foF2 value is not described with an F. |
| Traces with a spread of greater than 0.2 MHz, but less than fB/2 | index 2 |
| Traces with a spread of greater than fB/2 | index 3 |

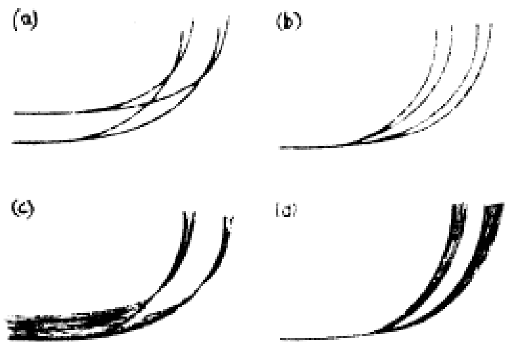



*Figure 1. Ionogram sketches of (a) resolved range-spreading: (b) resolved frequency-spreading; (c) unresolved range-spreading; (d) unresolved frequency-spreading.*

While these indices may be of value to some researchers, as well as the tabulation of resolved and unresolved traces and the classification of a number of types of Spread-F, discussions at this station would suggest that the primary need is to have indicated on the published data sheets the fact that spread structure exists, both frequency range or mixed; also to make the use of the spread symbol F as uniform as possible.

Inconsistencies in the use of the letter F is referred to in the Handbook, p. 281, and this probably occurs because operators have different ideas on just how much spread is significant. To fix a value of spread trace width as mentioned above (0.2 MHz) should remove this inconsistency.

Type δ - Range spread; both the unresolved and resolved types of range spread have been tabulated giving the extent of the vertical spread in kilometers to the nearest 25 km. In the past occurrence of range spread was noted in the h'F column, but as h'F is now not scaled, the fact that range spread has occurred is not indicated on the published data sheets. As with symbol F, uniformity between stations should be strived for in the use of symbol Q for range spreading.

The proposal as outlined in 12.34 of the Handbook appears to be a good one from an operator's viewpoint as there is no difficulty in classifying types F, Q or M, and it would seem that is would meet the need of ionospheric workers in Brisbane.

Figure 2, shows the occurrence at Brisbane, for the winter months May, June and July 1973 of the four types of Spread-F shown in Fig. 1.





## VIII. Comment on Note, "Medians - Replacement Letters" INAG-16

by

S. M. Ostrow
National Geophysical and Solar-Terrestrial Data Center, NOAA
Boulder, Colorado 80302

Under some conditions, R. W. Smith's suggestion given in INAG-16, page 5, that G for M(3000)F2 be replaced by a value less than the corresponding M(3000)F1 would introduce difficulties about as bad as the problem it is intended to ameliorate. In local summer daytime at mid-latitude stations, for low levels of solar activity M(3000)F1 is commonly 15% or more greater than the corresponding M(3000)F2. Under these conditions, the suggested substitution will often introduce a "less than" value greater than the median M(3000)F2, which would be troublesome. For the same conditions, MUF(3000)F1 is often appreciably greater than MUF(3000)F2, and the suggested substitution will cause the same sort of problem.

A simple way to solve the problem which is consistent with current conventions is available. Include cases of G for M(3000)F2 or MUF(3000)F2 in deriving the first trial median. For convenience, they can be treated as values less than the smallest numerical value. In most cases, when this is done, a second trial median will not be necessary. This is the procedure used in the NOAA median computer program, as well as in manual median counting. Therefore, I believe the current conventions on inclusion of G for M(3000)F2 and MUF(3000)F2 in median counts should be retained without change.

I see no objection to the other modifications suggested by Smith.

## IX. Notes from Stations Australian Network

Mr. McCue has provided the following notes and questions raised by the Australian Network. Spread F Types:

1. We do not believe any complex classification (such as Penndorf's) is workable at present. We suggest either,

   (a) 3 types F, Q, 5, with X where there is no spreading. (INAG Bulletin 15) In this case M is not really necessary, or

   (b) These type letters are added to normal scaling (i.e. F to foF2 column, Q to h'F column, X to fxI column). S could not be used (already means interference) and another letter would have to be chosen.

2. All stations, except in Antarctica, have been scaling spread F as an ‘Es type-scaling for one year starting January 1, 1973. Classification has been frequency spread, range spread, resolved, unresolved, and a measure of spread width. (See this Bulletin, Section VII.)

Oblique Sounding:

1. If the Australian network goes partly over to oblique sounding will participants of I.M.S. (1976-8) be affected (e.g. no Es type available).

High Latitude Supplement:

1. Ionograms, both normal seasonal and unusual conditions, have been collected for Casey and Mawson and scaled according to the URSI Handbook 1972. Comments will be added and sent to INAG high latitude supplement group.

2. A system will be set up to alternately receive vertical and oblique echoes at Mawson. We hope the results will help interpret the normal ionograms.

IF2 Index:

1. The IPS in Australia uses the T index which in many ways is similar to IF2.





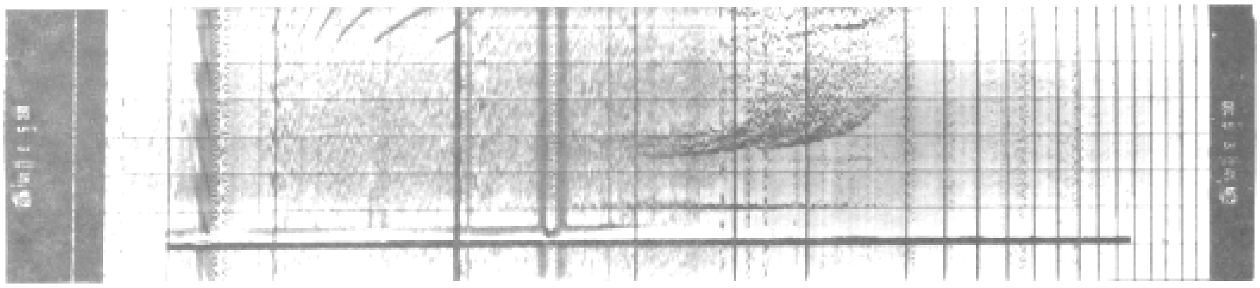
2. To calculate monthly index we require at least 12 stations, 5 in each hemisphere, evenly spaced. (Polar stations are not used.)

3. Of the IF2 ionospheric stations (College, Huancayo, Manila, Maui, and Slough) likely to close in the near future, we put little weight on Huancayo but Maui can hardly be replaced. Other stations can only close if their long term data can be replaced by a similarly long running station.

   Manila has a special position for IPS transequatorial propagation experiments. It may be possible next year to supply a new IPS ionosonde to Manila.

Thule

J. Taagholt writes that at Thule AB (76° geographic North, 88° geomagnetic North) the weather condition on November 20, 1973, was good, when our aircraft took off for Sondy and McGuire AFB. The temperature was about -2O° centigrade (-4° Fahrenheit) and it was calm. Arriving at Sondre Stromfjord about 1000 km south of Thule, I could really feel I was in the Arctic, the temperature had decreased to -35° centigrade (-31° Fahrenheit) and the wind was about 20 knots, I was received at the terminal by three colleagues just arrived from Copenhagen, and we all now started on the installation of the new vertical sounder just arrived from Boulder. A new building - a former icetrailer, used at the top of the Greenland Icecap - was bought from the Danish Meteorological Institute for housing the scientific instru-ments for ground recording such as fluxgate magnetometer, riometer, backscatter and vertical sounder at the Danish rocket launch site. The main power cable was not yet connected to the trailer, so a rubber cable was placed on the snow to the nearest building, giving us some light and some power to an electric heater, which brought the indoor temperature up to -2O° centigrade. Although we felt it relative warm on getting into the building, after working some hours at that temperature we really understood, why it was called an icetrailer! A big truck arrived with the vertical sounder, a modified C3, and then hard work started to get the sounder through the door, half-broad the sounder! After some days work I returned to Copenhagen leaving behind - with a bad conscience - 3 poor engineers, Neble Jensen, Stig Jaegerlund and Kjeld Jensen with hard inhuman and nearly impossible work. I was proud, when I learned by telegram, as seen by the enclosed ionogram taken December 5, 1973, at Sondre Stromfjord, Greenland, Denmark, that now again they had done what seemed to be impossible. This was just as at Qanaq, 130 km North of Thule AB, October 1972 when members of the staff of the Danish Ionosphere Laboratory had, during the arctic winter, installed the vertical sounder and brought it into operation.







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For your comments to the Chairman:

<u>Note</u>: Upon folding this sheet it may be stapled/sealed with tape and you will find Mr. Piggott's return address centered for mailing.

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