# IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

## Ionosphere Station Information Bulletin No. 4**

## I. Introduction

This issue of INAG is largely concerned with reporting to you the proceedings of the Seminar on High Latitude Ionogram Interpretation and Reduction held in Leningrad in May 1970, to enable you to criticize and make alternative or additional suggestions. Some of the proposals are admittedly controversial, and we are anxious to promote discussion so that an informed general opinion can be reached.

In view of the difficulties disclosed at Leningrad, Professor Rawer and I are proposing to try to make a Supplement to the URSI Handbook dealing in more detail with high latitude problems. We would be most grateful if you could send us any material which could be used to prepare this supplement as soon as possible. It is, however, clear that each group operating high latitude ionosondes should also hold a set of standard ionograms made by their own ionosondes, which illustrate the international text. Most new operators find that it is difficult to recognize the standard patterns without some local guidance using actual ionograms.

It is with great pleasure that we can announce the publication of a new Atlas of Ionograms, edited by A. H. Shapley, (May 1970). This is Report UAG-10 in the series issued by World Data Center A, Upper Atmosphere Geophysics, and a copy is enclosed with this Bulletin. A short description is given elsewhere. I am sure that you would like me to thank Mr. A. H. Shapley and his helpers on your behalf for producing this Atlas in such a convenient and economical form. We hope to publish the new edition of the URSI Handbook of Ionogram Interpretation and Reduction in the same series.

A complete list of UAG Reports is given in another section. You may find UAG-4, the Abbreviated Calendar Record for 1966-7 (which is continued in STP Notes with approximately 6 months delay) and UAG-6, International Geophysical Calendars 1957-69 (1971 due to be issued soon) of special value for identifying periods useful for special analysis. UAG-5, 8 and 9 collect data from many disciplines for three particular events. It is interesting to find out what happened at your station on these occasions!

Partly as a result of IUCSTP working groups and partly as a result of local regional efforts, a number of regional projects for studying particular phenomena are now active or being promoted. The Southern Hemisphere Ionospheric Studies Group (SHISG), Convenor Professor S. M. Radicella, Universidad Nacional de la Plata, Calle 1, esq. 47 La Plata Bs. As. Argentina was reported in INAG-2. In this Bulletin we reprint the announcements of two world projects, Ionospheric Storm Project and Winter Anomaly in Ionospheric Absorption. If you are not already in contact and wish to collaborate, you will find the addresses to which you should write. IUCSTP Working Group 10 (Dr. C. O. Hines, Dept. of Physics, University of Toronto, Toronto, Canada) is promoting regional groups to study gravity wave phenomena using a wide range of techniques and to attempt to solve problems identified by the theoretical groups. Potentially, ionospheric measurements of travelling disturbances using ionosondes, drift measuring equipment, field strength, absorption partial reflection or incoherent scatter techniques could be used, particularly where a group of relatively closely spaced stations exist which could work together. The recording of ionospheric characteristics by the Nakata and Bibl techniques could be very powerful for these purposes. Dr. C. O. Hines wishes to inquire whether any ionospheric groups are interested in collaborating in these studies. INAG would be pleased to help by putting you into contact with each other or in other ways. Suggestions for possible coordinators would be helpful. If you are interested, why not volunteer? All international cooperative efforts depend, for success, on people who are expert and actively interested in a specific project getting together and defining the project. Those less interested are often willing to help if told exactly what is needed.

As a result of a European Regional Meeting on Ionospheric Research held at Lindau/Harz, several European special study groups have been organized. In particular Dr. L. Bossy is acting as coordinator for Es studies in Europe, and Professor W. Stoffregen for studies of the Polar Ionosphere in the European Sector. The general feeling of those participating seems to be that the Regional Meeting was well worthwhile and should be repeated in the future.

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* Under the auspices of the Solar-Terrestrial Physics Committee of the International Union of Radio Science (URSI/STP Committee).

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Ionospheric workers interested in Antarctic research who attended the URSI General Assembly at Ottawa last August also had a valuable session discussing Antarctic problems.

Several people have written to comment on the problems raised in previous INAG Bulletins and these were also discussed to some extent at Leningrad. When more comments are available, we hope to publish a digest of them all, possibly in the next issue. Do not be left out!

W. R. Piggott
Chairman, INAG and URSI/STP VI Consultant

## II. Seminar on High Latitude Ionograms, Leningrad, May 1970
By W. R. Piggott

At the invitation of the STP and COSPAR National Committees of the U.S.S.R., a seminar on High Latitude Ionogram Interpretation and Reduction was held in Leningrad during the period 18-23 May 1970. There were six formal sessions, jointly chaired by Dr. A. S. Besprozvannaya and W. R. Piggott, and a number of informal discussions. In all at least 34 people attended one or more sessions (a few did not sign the attendance sheets). The main proposals of the Seminar and list of participants and papers presented, are given in the appendices to this report.

The main objectives of the Seminar were as follows:

(a) To review the practice of high latitude ionogram interpretation and analysis and identify difficulties causing incompatibility between different blocks of data

(b) To review the use of high latitude ionograms for scientific purposes, particularly for monitoring phenomena in the ionosphere and magnetosphere, and to make proposals for any changes needed to facilitate such studies.

The formal sessions included short presentations of studies using high latitude ionogram data, profusely illustrated by sample ionograms, followed by discussions on the papers and general discussions on their implications for future research. The discussions were concentrated on two main fields:

(a) Sporadic E problems

(b) F region problems.

The papers and discussions showed clearly that the morphology of the high latitude ionosphere displayed marked regularities in behavior which could be studied effectively by vertical sounding methods, but that such studies were gravely hampered by differences in procedure in different countries. Thus, for example, the average number of numerical values of foF2 varied between 10% and over 90% of that possible, these changes occurring at national boundaries.

The general view of those at the Seminar was that these difficulties could be adequately overcome with more attention to training of operators and improvements in the Handbook. Probably some occasions will arise in the future when the data from particular stations will not be reliable, but sample checks on the ionograms can be used to identify such occasions. It was generally agreed that such checks are essential for data from high latitude stations. If the majority of stations give satisfactory data the remainder are usually self classifying.

The Arctic and Antarctic Institute of the U.S.S.R. had prepared a special Handbook for high latitude ionogram analyses [1967] which formed a good basis for the detailed discussions, particularly in the informal meetings. Despite this, there was considerable difficulty in making certain that the key features of particular types of ionograms were properly understood by all participants and it is clear that detailed examination of ionograms is essential before an informed public opinion can be established.

The main difficulties in interpretation are caused by the rapid variations of ionospheric structure with position and time. The international rules are greatly biased by temperate latitude experience, where it is usually justified to interpret assuming that the ionosphere is near-horizontally stratified. At high latitudes this is frequently not true and the rules applicable to a tilted or curved ionosphere differ fundamentally from those for a flat ionosphere. The appropriate procedure is, therefore, to look first for evidence of layer tilt and thus decide which type of rule is applicable. All participants agreed that an effort should be made to rewrite the international rules from this point of view. INAG and the Editors of the URSI Handbook were asked to take the necessary action.

There was also a discussion on phenomena peculiar to high latitudes. The properties of both the magnetosphere and ionosphere show significant differences in the polar cap, auroral and sub-auroral zone and at lower latitudes. These can easily be detected by the corresponding changes in type of ionogram seen in these zones, e.g. the plasmapause trough had been described in the vertical sounding literature before it was discovered by satellite means. Detailed discussions were concentrated on the following points:

(a) Identification of plasmapause trough and high latitude ridges of ionization.

(b) Identification of the irregular, dense polar cap F region structure and interpretation when both this and the normal F layer are giving ionogram traces.

(c) Use of sporadic E and night E as indicators of particle activity.

As the Seminar was not fully representative of all groups working with high latitude ionograms, its conclusions are set out as a series of proposals intended to provoke international discussion during the next year. This will be followed by a special meeting under URSI/STP auspices to decide final action. It is most important that you let your views be known and challenge points with which you do not agree as soon as possible so as to allow time for the evidence for and against to be collected and sent to you well before the proposed meeting. Once new agreements are made, any changes or additions cannot be modified for a considerable period.

Sporadic E problems

Two formal sessions were entirely devoted to problems involving sporadic E and night E. These may be grouped into four families.

(a) Sporadic E type r and night E.

(b) Other types of storm or particle associated Es, in particular, Es type a.

(c) Temperate latitude types seen at high latitudes.

(d) Use of fbEs.

Strong evidence was presented that night E and Es type r were physically closely associated and could change rapidly from one to the other.

The Seminar felt that these should be combined and entered in the Es tables but that night E should also be included on f-plots and in normal E tables both when obviously present and when partially screened by Es type r. This maintains continuity with current practice so that long term synoptic changes can still be observed using past and future data. There was much debate on these points at first but eventually opinion became unanimous.

Many cases were shown where different operators had interpreted diffuse Es reflections in different ways, sometimes ignoring them under the oblique incidence rule, sometimes classifying as Es type a. Reanalysis of ionograms suggested that a uniform procedure would give a physically significant regular variation with corrected magnetic latitude which was nearly independent of longitude. All agreed that the current description of Es type a was inadequate as a guide to high latitude operators and it was felt that a collection of different classes of Es type a should be made. The consensus was that all types of diffuse Es other than type r are probably best classified as Es type a and that the rules should be altered accordingly. The problem of Es type(f) traces associated with magnetic activity was also discussed. Physically the sequence Es type a, flat, a is often seen in these circumstances and those studying particle effects would like to have such cases identified. In many examples, the height changes slightly with frequency, although the trace appears solid and due to a near totally reflecting layer. The distinction may not be clear enough for operators and a wider study of the phenomenon using ionograms from many stations is needed to establish whether it is or not. Unless it is, no action is possible to meet the scientists' desires.

Considerable discussion occurred on methods of simplifying the work of operators and avoiding distinctions which were hard to make and of little importance and many suggestions were made. Those which appeared reasonable compromises between the detail needed by the scientists and the ease of analysis are included in the proposals.

The distinctions between Es types high, cusp and, at night, flat are less useful and more difficult to make at high latitudes than at lower and there was a majority in favor of combining these, at least at high latitudes. The minority objected to this proposal strongly.

Technically the situation is confused by Es type low, which is often a partial reflection from a steep gradient in the E layer or a z-mode reflection from E. There are good reasons to believe that these traces represent a different physical phenomenon than other types of Es and their inclusion can seriously modify the Es medians when foEs for Es type ℓ is less than foE. It appears feasible to re-write the rules so that these types of Es ℓ are treated separately, in which case the daytime types h, c and night type f could be combined to give one "temperate latitude" class of Es. These problems will be discussed further in future INAG bulletins and your views are invited.

There was much discussion on the value of fbEs and of possible modifications which would make it more valuable. At present its usefulness is limited by the absence of numerical values when fbEs is greater than foF2. Both for scientific and practical purposes this is a serious limitation. If this limitation could be removed it is likely that fbEs would be more valuable than foEs.

Most participants had experience in use of fbEs for Es type r and held strongly that the rule should be altered for this type so that a numerical value was obtained. This is a sectional view and it seems likely that other types of Es should be involved if the rules are changed.

Two proposals were put forward.

(a) Use median or most probable value of foF2, e.g. foF2 D.A.

(b) Use foEs, or foEs modified by appearance of higher orders, e.g. foEs A.A. (see INAG Bulletin No. 2).

Informal views on the usefulness and disadvantages of these and other alternatives should be widely discussed bearing in mind that the scientist needs a frequency representing a probable maximum electron density and the radio engineer needs a top frequency representing a near totally reflecting layer. In general only those who study ionograms have clear views on the best approximation to use and the type of rule needed to define it.

F-region problems

The F-region points were mainly concerned with wide differences in the scaling practice in different countries, with the problem of analysis and tabulation when two or more F-region structures were present and problems of identifying and measuring parameters needed for research and for practical applications.

Comparisons between ionograms and tabulated data were made for a wide group of representative stations and disturbing differences were found between stations controlled by different administrations. This brought out clearly the need for more precise instructions at high latitude stations and, in many cases, more care in analysis.

A serious problem at a number of stations was the presence of two or more structures in the F region. These had widely different critical frequencies and the median observed often depended on the number of times each structure was observed and not on the critical frequencies present. The scientist was interested in the actual and median values for each structure separately but not in a mixture of the two. Many of these difficulties would be overcome by the new parameter, fxI, and, when this was properly understood, it received strong support from all present. The general feeling was that the parameter was very important for high latitude studies but that the apparent virtual height of the trace used to obtain fxI, h'I, should also be included among high latitude parameters.

Those using the data were strongly in favor of separate tabulations of the data from each of the two structures. This has been the practice of some stations where these phenomena are important, at least for the years where both were common at the station. The data then fit well with satellite observations which suggest that these structures move with time and from day to day but represent relatively permanent features of the ionosphere.

In the general discussion it became clear that two different phenomena were present:

(a) Oblique reflections from ridges of ionization when the station was near the plasmapause trough (auroral and sub-auroral stations).

(b) Irregularly occurring, relatively short lived abnormal F-region structures in the polar cap (polar cap stations).

The types of ionogram traces seen in these cases were widely different and there was a need for identifying at least one of them by the use of a descriptive letter. In the U.S.S.R. the polar cap type was identified by descriptive letter Q.

There was much discussion on the significance of range spreading as opposed to frequency spreading including references to the Australian work on this subject. It was felt that a symbol to show that range spreading was present could be very valuable though there was some confusion between range spreading as seen near the equator, as described by King and Bowman, and that due to the relatively thin dense structures found in the polar cap. These were not fully resolved in the time available, the consensus appeared to be that range spreading should be identified and that the polar cap phenomenon should be separately identified. It was generally felt that special experiments should be tried at high latitude stations to discover whether the analysis of King and Bowman can safely be applied everywhere or whether there are exceptions which need further study. The general view was that these analyses provided a good basis for revision of high latitude reduction procedures and should be included in the instructions for operators at high latitude stations. The spread F classification due to Penndorf could also be used, either in its present form or after modification in the light of recent analysis, and would also be valuable to operators and scientists. A classification of multiple structures above (f3S) and below (f2S) the normal F layer structure was described and used to show regular changes in position with solar cycle and time. INAG was requested to examine these points in more detail and to present a case.

## APPENDIX 1

### Proposals of the Seminar on the Interpretation of High Latitude Ionograms (Leningrad May 1970)

A. Research in the U.S.S.R. using the tabular data from the vertical incidence network shows that at high latitudes there are often great discrepancies between scaling practices in different countries and sometimes between successive operators at the same station. This seriously hampers the use of the data for scientific purposes. Re-examination of the ionograms shows many cases where operators have used the replacement letter F although a numerical value could have been evaluated.

The Seminar on the Interpretation of High Latitude Ionograms, S.I.H.L.I., proposes the following additions or alterations to the instructions in the Handbook to rectify this situation.

1. That a new supplement or chapter to the Handbook be prepared with many examples of high latitude scaling practice, so that operators can treat similar cases in a uniform way in all countries and that research and analysis groups be requested to contribute material for this purpose.

2. That the scaling rules be rewritten so that the overhead trace can be more easily identified by operators and that a clear distinction be made between the interpretation when the ionosphere is near-horizontally stratified and when it is tilted. Rules to show the operator when tilt is present should be adopted.

3. That detailed instructions be prepared to enable the operators to identify the most near-vertical reflection when the station is under a trough.

4. That a distinction be made between frequency and range spreading for both tabular and f-plot data. It is proposed that the low latitude regional f-plot convention [Handbook Chapter 5.6 b] might be adopted for use throughout the world and extended to tabular data. In this, the letter Y is placed on the f-plot at the top frequency, fxI, of the range spread traces. This would replace the local rule of using letter F for this purpose which has been adopted at some high latitude stations. Cases of range spread traces in tabular data of fxI should be identified by descriptive letter Y and the international definition of Y altered accordingly. Examples of the use should be included in the Handbook. An alternative is to reintroduce the symbol Q for this case.

5. That the classification of spread F traces proposed by Penndorf be examined in detail and a spread F classification be included in the Handbook.

B. An examination of ionograms shows that some operators do not understand the instructions in the Handbook.

The S.I.H.L.I. stresses the need for adequate training of operators for stations at high latitudes and recommends that formal courses for these people be arranged. It suggests that arrangements might be made among countries using the same language to teach at one place.

The S.I.H.L.I. stresses the need for interchange of teaching materials among all groups so that uniform methods may be used and requests that a digest of such material be added to the Handbook.

The S.I.H.L.I. suggests that each group collects an Atlas of Ionograms for teaching purposes and sends copies of this material to I.N.A.G. so that any differences in interpretation can be clarified.

C. The Seminar suggests that the definition of Es types a and r be revised in due course and suggests that they take account of the following texts:

(a) Es type a (auroral)

This pattern has either a flat, well-defined or gradually rising lower edge with stratified and diffuse (spread) traces present above it. These are sometimes observed for several hundred kilometers of virtual height. In the period of enhanced auroral activity this pattern can display considerable changes.

(b) Es type r (retardation)

The trace of this type displays group retardation at its high-frequency end, which is not always present at the low frequency end of the F-region trace. This type can be either transparent, or partially or fully blanketing.

D. Results of the analysis of retardation Es and night E show that the present tabulation of these phenomena is inconvenient and increases the work at the stations. On successive ionograms, Es type r can be replaced by night E or vice versa and these are tabulated in different tables.

The Seminar proposes:

(a) That night E be classified with Es type r and that its parameters be entered in the Es tabulations, e.g. values of night foE are placed in both of the tables of foEs and fbEs; h'E iw placed with h'Es.

(b) That values of night E, foE, in the foEs and fbEs tables be identified by a descriptive letter E or a suitable alternative. Note if E is adopted there may be confusion when qualifying letter E is needed (--EE means below the lowest frequency recorded).

(c) That the current practice of entering night E in the foE tables be made voluntary.

(d) That where night E is tabulated, values of foE deduced using the retardation of the low frequency end of the F trace (Esr trace present) should be included in the foE table as well as in the fbEs table.

Some consequential changes are needed in the f-plot:

(i) Open circles representing adjacent foE values should be linked together with adjacent conventional fbEs values (solid dots) whenever fbEs = foE

(ii) That an open circle (foE value) be entered at the value of foE deduced from group retardation at the low frequency end of the F trace when foEs > foE (Es type r traces with retardation at fbEs).

E. There is good evidence that the most nearly vertical trace can be identified when the station is below an ionospheric trough. This has been done by measuring the angle of arrival [e.g. Bowman, C. G., Plan. Space Sci., 1969, 17, 777-796]. Once the characteristic sequence is recognized at a station, analysis presents relatively little difficulty.

The Seminar felt that Bowman's results were likely to be widely applicable but that experiments ought to be made at other high latitude stations to establish which were the most nearly vertically reflected traces, e.g. by using Rawer and Suchy's method [Handbuch der Physik, Springer-Verlag, XLIX/2, section 22, p 216 and "Physics of Ionosphere" 1955 (Physical Soc.) p 113-118] and recommends that similar experiments be attempted. The results will be valuable in themselves and for training operators in routine analysis at the stations. It should not be difficult to set up and do this type of experiment.

The Seminar stresses the value of continuous recording of ionospheric parameters and in particular of recording virtual height with time [URSI Handbook of Ionogram Interpretation, section 5.4.31, h'recording] at high latitude stations.

F. The Seminar draws attention to difficulties due to the practice of some stations of publishing only a few parameters. In particular fbEs is used widely but is not always available and at high latitudes the Es types are also valuable guides to the physical situation.

G. The Seminar welcomes the introduction of the parameter, fxI and proposes that fxI be made a primary parameter for analysis and circulation. The Seminar draws attention to the great value of the parameter h'I at high latitudes and proposes that this should be analyzed and circulated by all stations where two or more F layer structures are observed. h'I should be measured for the trace giving fxI.

H. The Seminar noted that the magnetosphere shows very different types of behavior over the polar cap, in the auroral zone, and at lower latitudes and that there are also special features in the vertical incidence ionograms obtained from these zones. In particular the Seminar noted that dramatic changes in foF2 occurred in the polar cap which are due to the presence of two structures in the F region at this time [Hill and Penndorf, Arctic Scientific Report No. 3, 1959, AVCO]. The Seminar also noted that the plasmapause trough was observed in vertical soundings data many years ago. ["Some problems in interpretation at high latitude", G. N. Gorbushina, 1965]. The Seminar proposes that special experiments should be encouraged and to link all these phenomena with phenomena seen in the magnetosphere and to search for other abnormalities in these zones.

I. The Seminar draws attention

(a) to the difficulty that Es type a may closely resemble Es type f when absorption is large and proposes that operators consider the high gain ionogram in this case. For Es type a this will often show much more range spreading whereas Es type f will show little or no increase in range spreading.

(b) to the difficulty that Es type r and night E are closely similar in appearance when fbEs > foF2 and proposes the criterion that the trace of the night E is not gain sensitive whereas that of Es r weakens at the higher frequencies when the gain is decreased.

J. The Seminar draws attention to the fact that many f-plots are not sufficiently legible when photographed on 35 mm film and requests administrations to examine the standard of reproduction for their material.

K. The Seminar draws attention to the difficulties which arise when the higher layers are fully blanketed by sporadic E. At present there is a total loss of numerical information on fbEs which is needed for both scientific and practical purposes.

The Seminar feels that in the case of Es type r there is justification for using the approximation fbEs = foEs A.A. The qualifying letter A only shows that the value was deduced from foEs. Thus the symbols AA are not taken into account when evaluating the median value of fbEs.

When the trace above an Es type r trace shows group retardation at the low frequency end, the value of fbEs is given by the lowest frequency of this trace described by letter E or an alternative to be decided. In this case fbEs is an foE determined by a night E layer and fbEs is shown as an open circle on the f-plot.

The Seminar draws attention to the need to decide a procedure to deduce fbEs for other types of Es which totally blanket the higher layers.

L. The Seminar suggests that the following recommendations and clarifications be considered when the accuracy rules are next revised:

In the case of a trace with a large spread, when the critical frequency cannot be resolved by the trace of the first echo with an error less than 2 per cent (or Δ), the accuracy evaluation should be made in the following way:

(a) With usable multiple echoes the accuracy of scaling is evaluated by the extrapolation error to the vertical for the multiple trace in accordance with the general rules of extrapolation given in the Handbook.

(b) An foF2 value deduced using the inside edge is always considered as doubtful at high latitudes and is tabulated with the qualifying letter U.

(c) When the lower boundary of h'f trace shows a discontinuity in slope the lower limit of foF2 value is determined from this and tabulated with the qualifying letter D (a diagram will be needed to illustrate this case).

(d) Using Z-component foF2 value is considered doubtful and is always tabulated with the qualifying letter Z.

(e) Numerical value of foF2 is not determined if it is impossible to distinguish the normal echo from oblique or spread traces, and the above mentioned features or scaling error exceed 10 per cent. In this case, foF2 is determined by means of f-plot interpolation when possible or otherwise by replacing its numerical value by letter F (present practice).

[The text of L represents the U.S.S.R. opinion subject to discussion with other groups and has not been modified by discussion.]

## APPENDIX 2

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| | |
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## SEMINAR PAPERS PRESENTED

### THE INTERPRETATION AND ANALYSIS OF HIGH-LATITUDE IONOGRAMS

Piggott, W. R. — Some Problems in Es Analysis

Shchuka, T. I. — Classification of Sporadic Echoes in the E-Region

Results are given of a comparison of sporadic E-region ionization as shown by data obtained at high latitude stations for the winters of 1958 and 1963-64. The interpretation of Es types at different stations is not identical, examples are presented demonstrating that this difference is not caused by the change of ionospheric parameters in different regions.

The main reason for these discrepancies in the reduced data may be attributed to uncertainty in the classification of the various types of sporadic ionization characteristic of the high latitudes.

The suggestion is made to combine type Esr and night-E into one type of sporadic ionization with group retardation. The definition of the Esa associated with the auroral display should be widened to include all types of diffuse Es patterns.

Kurilov, V. A. — To the Physics Substantiation of Es Echo Interpretation

Eight of the nine international types of Es echoes are observed at high latitudes.

Geophysical conditions were examined when these different types of E echoes were observed.

In the main, one can choose three types of Es echoes: diffusive, flat and those with retardation.

Possible mechanisms of Es echoes are considered shortly.

Besprozvannaya, A. S. — On the Practice of foF2 Reduction in the Presence of Diffuse Echoes of F2 Layer

Results of a comparison of foF2 for a number of high latitude stations when diffuse and oblique echoes are present are given using data for September and December 1958.

The reduced data are shown to differ considerably. Evidence is given showing that the difference between various regions is due to different methods of data reduction rather than to a change of ionospheric parameters. Some examples of ionogram analysis are given illustrating the variation in foF2 determination at high latitude stations. The data discrepancies are attributed to use of different accuracy standards, recommended in the Handbook. It is shown that at those stations where the accuracy rule is strictly and formally observed, the numerical foF2 values for the nocturnal ionosphere are absent in more than 80 per cent of the cases observed. While at those stations where the accuracy restrictions are somewhat decreased using the means recommended in the Handbook for selection of the main trace, foF2 values failed to be measured numerically only in 3-5 per cent of the cases. Similar small per cent of failure is observed where the accuracy rules are completely neglected. In this case the same value of foF2 can refer to a wide range of ionogram pattern, destroying its value as a measure of critical frequency. Practically the reduction of data comes to a f-spread determination with arbitrary rules.

Besprozvannaya, A. S. — The Reduction of F-Spread Echoes in the Auroral Zone

The time-space distribution of the electron density in the F2 layer shows the presence of two blanketing structures in the night ionosphere near the auroral zone. One of them corresponds to the residual night time ionization, in origin similar to the mid latitude ionosphere, while the other is the reflection from abnormal ionization, caused by the injection of the charged particles.

The Handbook rules for determination of foF2 parameter recommend that when these two structures occur simultaneously the observer should select one of them to be the main trace which is reduced and tabulated.

Following this recommendation:

a) The observer completely ignores the information on the other trace, whose electron density may many times exceed the ionization of the main trace.

b) Thus the interpretation becomes subjective, wholly depending on the skill of an operator and complexity of the ionogram, which in turn is dependent on the ionospheric conditions. The selection of the main trace would not always be correct.

c) It appears impossible to revise the operator's choice when a planetary study of the phenomena is undertaken.

Therefore some changes should be introduced in the practice of reduction and tabulation when two blanketing structures occur simultaneously.

Besprozvannaya, A. S.

F-Spread Reduction at the Stations of the Near-Pole Zone

At a number of stations in the near-Pole zone abnormal traces are observed at the height of F2 layer. These traces can be considered neither oblique, nor similar to usual traces of a thick layer. The top frequencies of these traces in most cases considerably exceed the thick layer critical frequency.

Some preliminary studies have revealed certain characteristic features of these traces:

a) They occur irregularly in time, that is these traces can be observed on ionograms for a period of several minutes or for several hours.

b) The absence of distinct group retardation at the top frequenc of the traces except in a few cases. The top frequencies are dependent on the gain similar to Es.

c) The traces can blanket the normal trace or be present with it so that both types are observed simultaneously.

Different stations treat these traces in different ways so that there is no uniformity in the data tabulated.

Piggott, W. R.

Some Problems of High-Latitude Ionogram Interpretation

Gassmann, G. J.

Auroral Es and Night E

Kurilov, V. A. and Zherebtsov, G. A.

Dynamics of Es Formation During Aurorae

Kurilov, V. A.

On the Space Location of Es Formation at High Latitudes

Maps of the type of Es echoes at constant time were made using the data of the large net of high latitudinal ionosphere stations. It turned out that the types of Es echoes are very often different even in one hour zone /15°/ especially in periods when aurora were present. This shows that the space extent of Es formations is small. Very often, different Es echo types correspond to the same continuous form of aurora.

In addition samples of echoes were selected for nearby ionosphere stations in Scandinavia. When Es type r traces are seen at stations in the center of the chain, diffuse Es traces are observed to the north, but flat ones to the south of these stations.

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## Local Rules

The Seminar at Leningrad disclosed a number of local rules or conventions which are in use at certain stations or chains of stations but are not known generally. The URSI Handbook allows and encourages the use of such rules provided that they are described and the descriptions circulated with the data and that they do not conflict with the requirement that similar data from different stations be compatible. INAG wishes to draw attention to the need for appropriate comments in books of data where special rules or conventions are adopted.

In some cases, the local rules appear to be due to a misunderstanding of the Handbook and are not really needed but in others they facilitate the study of particular phenomena or meet widespread needs. In these cases it is worthwhile to describe them in this Bulletin with the object of getting international agreement and publication for wider use.

A particular example is the use of descriptive letter Q at high latitude stations in the U.S.S.R. to identify a particular type of range spread trace seen at high latitudes near the magnetic pole. Your comments on this usage are invited together with suggestions for other conventions which could be useful. In effect the Leningrad Seminar proposed that night E and Es type r be combined and that a the diffuse types of high latitude Es trace be denoted by type a. The latter is the practice at ma stations and both could be adopted if this is generally desired. INAG would like to start a discussion on these points in the next Bulletin.

## III. Ionospheric Storm Project

A "Dear Colleague" letter was circulated April 14, 1970 by Dr. C. Taieb of the Groupe de Recherches Ionospheriques, CNET, 3, avenue de la Republique, 92 Issy-les-Moulineaux, France, requesting participation in a program recommended by the URSI General Assembly in 1969. The program is planned during September through November 1970. The behavior of the ionosphere is to be studied by observations made at frequent intervals, when a magnetic storm is expected, in areas affected by the storm.

The participating ionosphere stations are to provide ionograms: one every 5 to 15 minutes. Listed below are the participating stations who are called to operate at the highest possible rate (for instance 1 ionogram per five minutes if possible):

American Region: Wallops Island, Grand Bahama Is., Kingston, Huancayo, La Paz, Concepcion, Port Stanley, South Georgia, Halley Bay, Argentine Is.

Europe-Africa Region: Tromsoe, Kiruna (+ Esrange+Emmaboda), Sodankyla (+ Kevo+Ivalo+Oulu), Nurmijarvi, DeBilt, Lindau, Slough, Pruhonice + Panska Ves, Graz, Garchy, Schwarzenburg, Genova, Roma (+ L'Aquila -Castel Tesino), Tortosa, Haifa, Tamanrasset, Ougadougou, Fort Archambault, Ibadan (+ Tegina+Sokoto), Nairobi, Binza, Tsumeb, Sanae

Japanese Region: Wakkanai, Akita, Tokyo, Yamagawa, Hiraiso, Kashima, New Delhi, Singapore

Australian Region: All Australian stations, All New Zealand stations, Terre Adelie, Kerguelen Is.

USSR Region: All USSR stations

Incoherent scatter: Jicamarca, Malvern, Saint Santin, Millstone Hill

Stations should be ready to start making special observations upon receipt of a storm warning message from Dr. P. Simon of the Forecast Center at Meudon using the IUWDS system. The address of Meudon Center is:

Dr. P. Simon, Centre de Prevision, Observatoire, 92 Meudon, France
For Telex: 25312 CNET AGI MEUDO
For Telegram: SIMON TX 25312 CNET AGI MEUDON FRANCE

The expected date and time of the start of a 7-day period of observations will be sent by telex, telephone or radio to the stations. If prediction is correct, a second message will be sent confirming that the observation program is to be continued for seven days. If prediction is incorrect, a second message will postpone the start. A second prediction will be made, but if it too proves incorrect, the project will be canceled.

The messages will originate at any time between 0800 and 1500 UT during one of the four first days of the week. Near August 15 a preliminary message will be sent in order to check the system and to evaluate the delay between the departure of the message and its receipt. The content of the messages for the start of the program will be:

The storm warning message: "ISP alert magnetic storm expected on JJ close to HH please start immediately the ISP program Meudon JJ/HH"

followed by Confirmation of the storm: "ISP message SSC has been reported JJ/HHmm ISP program will be completed on JJ at HH Meudon JJ/HH"

or, Postponement of the program: "ISP message not any event reported at this date please stop ISP program and cancel the alert Meudon JJ/HH".

The collected data will be sent to individuals, each responsible for a region of the world:

American Meridian from North Pole to South Pole
Mr. A. H. Shapley, ESSA Research Laboratories, Boulder, Colorado USA 80302
Euro-African Meridian
Dr. C. Taieb, CNET - GRI, Ave. de la Republique, 92 Issy-les-Moulineaux, France
Australia and the adjacent part of Antarctica
Mr. C. G. McCue, Assistant-Director, Ionospheric Prediction Service Division, Commonwealth Center, Chifley Square, Sydney NSW 2000, Australia
Asian Meridian including India and South East Asia
Dr. I. Kasuya, Chief of Radio Wave Division, Radio Research Laboratories, Ministry of Posts and Telecommunication, 4-2-1, Nukuikita-Machi, Koganei-shi, Tokyo 184, Japan
USSR
Dr. N. Benkova, IZMIRAN, Moscow, USSR.

Ionosphere stations are to send tabulations of ionospheric parameters (using the usual international rules) and to provide copies of ionograms. The collected data from each of the five regions will then be at the disposal of scientists who wish to study them.

IV. Winter Anomaly in Ionospheric Absorption; Stratosphere-Ionosphere Coupling

Recommendation III.14 (URSI Inf. Bull., No. 172) referred to the desirability of coordinated studies of the winter anomaly and related phenomena.

All those who are interested in participating in these studies are invited to make contact with one of the area organizers below.

Europe: Dr. H. Schwentek, Max-Planck-Institut für Aeronomie, Institut für Ionospharen-Physik, 3411 Lindau, Germany.

North America: Dr. J. B. Gregory, Institute of Space and Atmospheric Studies, University of Saskatchewan, Saskatoon, Canada.

Australia/New Zealand: Dr. I. A. Bourne, Physics Department, RAAF Academy, Melbourne University, Parkville, Victoria, Australia.

South Atlantic: Mr. W. R. Piggott, Radio and Space Research Station, Ditton Park, Slough, Bucks, United Kingdom.

The programme as a whole is being coordinated by: Professor W.J.G. Beynon, Department of Physics, University College of Wales, Aberystwyth, Cards., United Kingdom.

V. Notes from INAG Members

G. M. Stanley

An attempt is being made to obtain a wider data base for examination of the morphology of the F region and in particular the anomalous evening increase in foF2. Although the use of Kp as a measure of magnetic conditions is very useful, there is a lack of flexibility that we are attempting to overcome. Our first step has been to attempt to construct foF2 vs time curves for the "normal" ionosphere. It has been found convenient to use data from a given station when Kp $\leq$ 1+ for the three hour period under consideration with a further restriction that the 3-hour period preceding Kp $\leq$ 1. All other periods are discarded. The mean values of the data thus selected are then used to make foF2 vs apparent solar time plots. Figure 1 compares the mean values with the median values of two stations. It may be seen that there are only small differences between the curves for the two stations but that many more values are used to construct the mean thus giving considerably more confidence in the results. Figure 2 is an example of the comparison of mean values of foF2 at six stations between L=2 and L=3 over a range of about 150° in longitude. Clear evidence of the evening increase in foF2 of all stations at nearly the same apparent solar time is seen.

The work is continuing and further attempts to obtain a better selection criterion are being made.

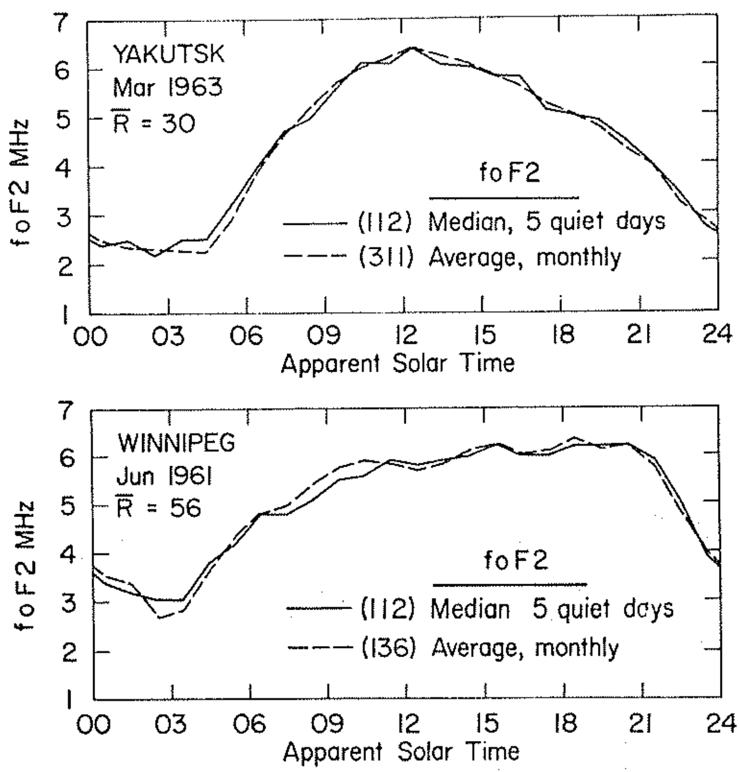


Fig. 1

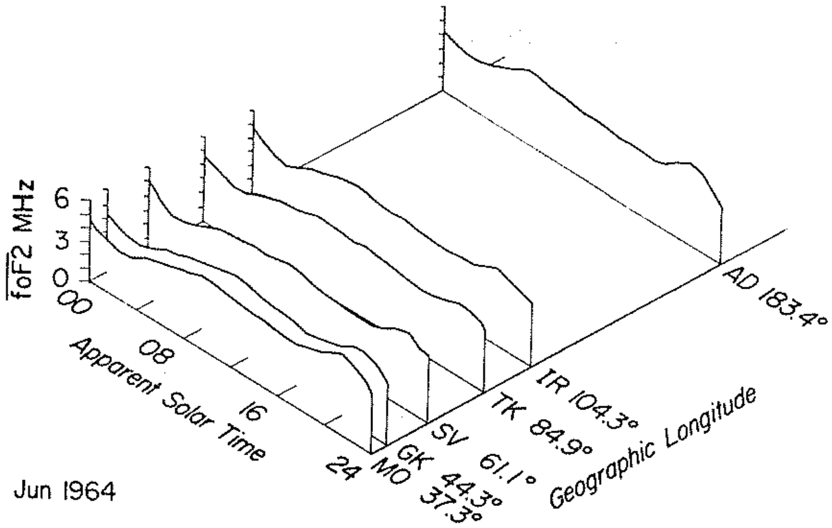


Fig. 2

## VI. Notes from WDCs

World Data Center A - Upper Atmosphere Geophysics, ESSA, Boulder, Colorado, USA 80302

An analysis of our latest data catalogue indicates in a rough fashion the rate of flow of ionospheric data from time of observation to time of receipt of scalings or ionogram copies at the Data Center.

| Year | Number of Stations reporting |
|---|---|
| 1967 | 129 |
| 1968 | 123 |
| 1969 | 84 |
| 1970 | 26 |

This status was as of March 1970 the time the catalogue manuscript was prepared. Thus, it would appear that it takes about two years for the Data Center to receive all the data that are probably to be sent. Can't we do better than that?

The first of a new series of data booklets has been received -- Ionospheric Data in Korea, January 1970, Vol. 1, No. 1, issued in June 1970 by the Radio Research Laboratory, Ministry of Communications, Seoul, Korea.

In the next INAG Bulletin we hope to give a fairly complete statistical breakdown of the use of ionospheric data by the scientists requesting data from us. There were 205 requests for ionosphere vertical soundings during a recent 10-month period.

World Data Centre Cl, Radio and Space Research Station, Ditton Park, Slough, Bucks, England

Ionosphere data for Slough, Singapore and Port Stanley for the three years 1967 to 1969 are now available on a magnetic tape. A copy of this tape will shortly be sent to World Data Center A.

## VII. Notes from or about Stations

### Christchurch

A major change in the organization of the Geophysical Observatory is being made at present. In 1969 the New Zealand Magnetic Survey was incorporated in the Observatory but still occupied the old Magnetic Observatory buildings in the Botanic Gardens. These buildings date back to the early years of this century when magnetic recordings were first made in Christchurch and several historic sites are included in the grounds. Now, the staff and equipment are being removed to the Geophysical Observatory offices which are in a building in the city. The old observatory buildings are now in the hands of the Christchurch City Council. It is hoped that the Council will see fit to preserve those sites of early scientific work which have been marked in the observatory grounds. These include a pier on which special calibrating observations were made prior to the departure of Captain R. F. Scott's 1911 expedition to Antarctica and an International Gravity Station. The physical integration of the two groups will enable a closer cooperation between those studying ionospheric effects and those more interested in magnetic and earth current phenomena.

There exists a strong possibility that the ionospheric station at Christchurch may be moved from its present very isolated position at Godley Head to the grounds of the Magnetic Observatory at Amberley. Although the prospect of moving the ionosonde is not a pleasing one, we feel that the advantages to be gained, administrative as well as scientific, make the move worthwhile.

### New Zealand Ionosonde Equipment

The following list gives the location, type of equipment in use, and frequency range covered for the six stations operated by New Zealand:

| Station | Equipment | Frequency Range MHz |
|---|---|---|
| Auckland | C-2/3 | 0.75 - 25.0 |
| Campbell Island | C4 | 1.0 - 25.0 |
| Christchurch | N.Z. P2 | 1.0 - 22.0 |
| Raoul Island | Cossar 7562c Mk II | 1.6 - 20.0 |
| Rarotonga | N.Z. P2 | 1.0 - 22.0 |
| Scott Base | N.Z. P2 | 1.0 - 22.0 |

### College

One of the serious problems concerning ionosonde operation (that of interference) is often approached by removal of the station to a site remote from the urban areas. This approach, however, is satisfactory only if the site is attended on a full-time basis. One possible solution to loss of data and excessive travel time is to monitor the output and take data at a more convenient location. To this end, we are constructing a minimum microwave system between the sounder location at Sheep Creek (near College) to the new Geophysical Institute building on the campus of the University. We plan to transmit the video output of the ionosonde receiver via wideband microwave (approx. 1800 MHz) and to monitor and record the ionosonde data at the main Geophysical Institute. We expect the system to be in operation about mid-September 1970 and will report on the results in a later INAG Bulletin. Should the system be as useful as anticipated it will be described in detail.

We have increased our sounding schedule by one sweep per hour and now record at 58 minutes a normal gain sounding with range of 1400 km.

### Jamaica

Beginning with May 1970 a Jamaica sounder is again in routine operation. It was necessary for them to acquire another sounder after the disastrous fire of November 13, 1968. Ionograms and f-plots have been received at World Data Center A. Weekly reports are being sent on schedule to the Prediction Services of the Institute for Telecommunication Sciences at ESSA, Boulder, Colorado.

### Manila

Just after the last INAG Bulletin was in press a letter from Father Hennessey brought the sad news of a serious robbery at their ionosonde station near Manila. To quote from his letter: "Robbers came to our station at Balara, posed as friends, gained entry, tied up the night attendant and made off with many valuable items. --Along with other items this is quite a haul and a mighty big loss to us. Furtunately no one was injured, and the operation of the ionosonde continues. However, the film on hand is beyond the expiration date".

Fortunately the Ionospheric Radio Group of the Institute for Telecommunication Sciences, ESSA, Boulder, Colorado was able to locate surplus electronic test gear which was repaired and sent to Manila to fill their most essential needs, and a fresh film supply was airmailed to them.

Nairobi

A report of "Ionospheric Research at Nairobi 1963-1970" has been received at World Data Center A. The Ionospheric Research Group at University College Nairobi, now under the direction of Professor N. J. Skinner, was founded by Professor A. N. Hunter in 1963. The station is near Wilson Airport on the Langata road about five miles from the College in an area of about 100 acres. The equipment operated comprise:

Union Radio Mark II Ionosonde
Sylvania Oblique Back-Scatter Sounder
Receiving and recording equipment for transmissions from orbiting and geostationary earth satellites on 20, 40, 41 and 136 MHz
Equipment for measuring horizontal drifts in the ionosphere
Geomagnetic observatory with Lacour variometers for continuous recording of H, D and Z; and QHM and BMZ magnetometers for absolute determinations.

The ionosonde operates automatically on an hourly schedule. Ionograms are available from January 1, 1964. Many research investigations have been published, especially on equatorial aeronomy, and from participation as a member of the Joint Satellite Studies Group.

Popayan

Ionograms and hourly value scalings for several days in May and June 1970 have been received from Popayan, Columbia by the Ionospheric Data Review Group at ESSA, Boulder, Colorado for comments and advice on correct caling procedures. The ionosonde was formerly at Bogota and is in the process of being put into systematic eration to continue monitoring and study of the peak of the equatorial anomaly and to participate in the th west meridian chain of stations.

Port Stanley

The new Magnetic AB ionosonde is now in use with improved antennas and is giving excellent ionograms. The high signal to noise ratio now available enables a weak trace Es type low to be observed below the E trace in daytime. This shows the same type of behavior as the weak low Es traces seen at Slough many years ago and described in the literature by R. Naismith under the name "Meteoric E reflections". For this trace foEs is often about 2.5 MHz remaining remarkably constant throughout the day and from day to day. It is, of course, a different physical phenomenon to the other types of Es seen at this station and we have decided to exclude it from the Es tabulations (except type) using the Rule which rejects weak, partial reflection type traces.

South Georgia

We are pleased to announce that regular observations started on July 1st 1970 and that all International parameters will be analyzed and published in due course. As this station can only be reached during a limited season, the data will be published in yearly blocks. We hope to make median values of at least foF2 and M3000F2 available by radio link each month.

Singapore

This station will be closed in mid 1971. Meanwhile observations are being maintained and published.

## VIII. Comment on Spread-F by Professor N. J. Skinner

"I have been interested to read the bulletins issued by I.N.A.G. during the past few months. Since my arrival in Nairobi last September I have been working on Spread-F using the Nairobi ionograms for 1964-70, and I think that I am now fairly clear about the pattern of Spread-F occurrence. A recent paper by G.A.M. King, 'Spread-F on ionograms', J.A.T.P. (1970) 32 209-221 has cast doubts on the interpretation of Spread-F in terms of scattering from small irregularities and I wonder if this could be raised for discussion in the I.N.A.G. bulletin. King maintains that the Spread-F configuration on ionograms is due entirely to total reflections from tilted surfaces of ionization. He considers that ionosondes are too insensitive to receive weak partial reflections. I personnaly cannot agree with this view. The very high correlation of Spread-F with scintillation of signals from radio stars and satellites is strongly suggestive of an irregularity mechanism - King does not discuss scintillation at all in his paper. Furthermore, the fact that ionosondes can depict q-type Es, (a weak partial reflection phenomena), indicates that they would not be too insensitive to receive similar weak signals scattered from the F region. Obviously total reflections from tilted surfaces can broaden the F region trace but I would think that irregularities are also necessary to explain properly the Spread-F structure that is seen on ionograms. I would be most interested to hear your views on this, and also the views of other workers."

## IX. Ionospheric Data Publications of the French Stations of G.R.I.

The ionospheric data of the G.R.I. stations have been published in monthly booklets containing the hourly values and the monthly medians of the ionospheric parameters, which have been sent to many groups for many years.

Because of the long delay and the high cost of these publications, the Groupe de Recherches Ionospheriques intends to discontinue them. The list of the monthly booklets which have been published are as follows:

| | | |
|---|---|---|
| Bangui | through | December 1964 |
| Garchy | " | March 1968 |
| Tamanrasset | " | December 1966 |
| Kerguelen | " | December 1966 |
| Terre Adelie | " | September 1965 |

The data obtained thereafter have been sent, in "computer sheets" to the World Data Centers A and C1 (Boulder and Slough). Thus they are available for interested people and organizations. They can also be obtained directly upon request to Groupe de Recherches Ionospheriques - C.N.E.T. 3, avenue de la Republique - 92 - ISSY-LES-MOULINEAUX (France). The list of the ionospheric data now filed at GRI on magnetic tapes and computer sheets is as follows:

| | | | |
|---|---|---|---|
| Bangui | January 1965 | to March 1966 | inclusive |
| Garchy | April 1968 | to June 1969 | " |
| Poitiers | January 1968 | to June 1969 | " |
| Tamanrasset | March 1966 | to October 1969 | " |
| Terre Adelie | March 1964 | to November 1967 | " |
| Kerguelen | April 1965 | to June 1968 | " |
| Ouagadougou | June 1966 | to November 1969 | " |
| Fort-Archambault | January 1969 | to July 1969 | " |

With the exception of Bangui (closed), the above stations are still operating, and their data will be available on microfilm or computer sheets. The reduced data are the hourly values and the monthly medians of the 13 international ionospheric parameters, but it should be noted that most of the stations produce ionograms every 15 or 5 minutes.

The regular data (with the exception of Kerguelen and Terre Adelie) are available with a 4-month delay (exceptionally 2 months) after the recording time, and can be mailed two days after the request has been received.

## X. Vertically Upward Moving Ionospheric Disturbances at Magnetic Equator

R. G. Rastogi has recently published a paper in Nature, 225 (No. 5229), 258-259, January 17, 1970. Using Thumba ionograms he describes a transient phenomenon which seems to occur frequently and to be peculiar to the equatorial ionosphere. The Thumba ionograms show a small disturbance which originates in the E-region in the morning hours and moves up through the F1 and F2 regions with a vertical velocity the order of 16 m/s. The disturbance crosses foF2 near noon, when typically the height of foF2 is greatly increased. Rastogi encourages other stations near the magnetic equator to check their ionograms for such a phenomenon. He hopes to study the Kodaikanal records himself. The vertical motion of this kink in the h'-f trace agrees in magnitude with other measurements of vertical drift velocity associated with electrodynamic lift over the equator.

## XI. Atlas of Ionograms, UAG-10

The new Atlas of Ionograms includes a Foreword and a brief historical Introduction together with lists of stations together with dip, geographic and geomagnetic coordinates arranged in order of dip, geographic latitude and geomagnetic latitudes, a geographic map of stations and a chart for translating geographic into geomagnetic coordinates or vice versa. The main part of the Atlas is divided into three sections and an index, arranged by station name, gives the equipment in use and ionograms reproduced for each station. The first section of 11 pages gives details of 29 ionosondes, the stations at which they are known to have been used and a typical ionogram with frequency and height scales identified. The second section gives ionograms for mid June, mid September and mid December 1961 at midnight for stations arranged in order of dip magnitude followed by the same periods at noon. Thus ionograms for stations with the same dip in both hemispheres are found together, facilitating comparison between similar types of ionogram taken on different equipments. In some cases not all seasons are represented. There are 285 midnight ionograms and 287 noon ionograms in this section which occupies 174 pages. The third section shows special phenomena and miscellaneous ionograms including 42 ionograms illustrating Es types, a sequence of 28 ionograms showing sequential Es, 14 ionograms showing E stratification, E at sunrise and meteoric phenomena. Spread F and replacement layer sequences (46 ionograms) are given for high and equatorial latitudes. Other special sequences shown include a pre-sunrise sequence, effects of layer tilt and travelling disturbances, lunar stratification development (56 ionograms), solar eclipse effects and nuclear explosion perturbations (12 ionograms). The final sub-section gives some examples of N(h) analysis showing some common sources of error (5 ionograms) and an example of median N(h) determination, each with the corresponding N(h) profile. Cross-references to these ionograms will be given in the new edition of the URSI Handbook as well as the existing references to Annals of the IGY Volume III part I which contains a large number of ionograms.

There is an enormous amount of work involved in collecting, mounting and reproducing over 780 ionograms for this book and the editor and his co-workers should be congratulated on having completed this monumental task despite the pressure of many other commitments. The Atlas will undoubtedly be of much use to all workers with ionograms and will help them to recognize the widely different phenomena found in different parts of the world. With the greatly increased use of tabular data, it is advisable for research workers to look at ionograms from different theatres so as to recognize the limitations likely to be present. As with the original Atlas, long out of print, this is an indispensable aid for training people to interpret and reduce ionograms correctly. (W. R. Piggott)

## XII. Item of Miscellaneous Interest

INAG Bulletins Nos. 1 and 2 have been translated into French, thanks to Mlle. G. Pillet of CNET and Mlle. Bogitch of the URSI Secretariat. Copies were sent to the French stations of GRI and DPI, and to Rabat, Tortosa, Kinshasa, Lwiro and Dourbes. Any other stations desiring French versions should contact Mlle. G. Pillet, Groupe de Recherches Ionospheriques, 3, avenue de la Republique, Issy-les-Moulineaux, France.

## XIII. Recent Publications of Particular Interest

Lenhart, K. G., "Ground Observations of the Solar Event of February 25, 1969" in Intercorrelated Satellite Observations Related to Solar Events, 382-504, edited by V. Manno and D. E. Page, D. Reidel Publishing Co., Dordrecht-Holland, 1970.

World Data Center A - Upper Atmosphere Geophysics Reports UAG

These reports have a limited free distribution. These reports are for sale through the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402. Subscription price: $9.00 annually for domestic mailing, $11.50 for foreign mailing. Single issue price will vary. Order by catalog number in brackets. Checks and money orders in U.S. currency made payable to the Superintendent of Documents should accompany the request. These reports cover a variety of subjects and are issued on an irregular schedule. The first of these are now available.

Upper Atmosphere Geophysics Report UAG-1
"IQSY Night Airglow Data" by L. L. Smith, F. E. Roach and J. M. McKennan of Aeronomy Laboratory, ESSA Research Laboratories, July 1968, single copy price $1.75. [Catalog No. C52.16/2:1]

Upper Atmosphere Geophysics Report UAG-2
"A Reevaluation of Solar Flares, 1964-1966" by Helen W. Dodson and E. Ruth Hedeman of McMath-Hulbert Observatory, The University of Michigan, August 1968, single copy price 30 cents. [Catalog No. C52.16/2:2]

Upper Atmosphere Geophysics Report UAG-3
"Observations of Jupiter's Sporadic Radio Emission in the Range 7.6-41 MHz, 6 July 1966 through 8 September 1968" by James W. Warwick and George A. Dulk, Department of Astro-Geophysics, University of Colorado, October 1968, single copy price 30 cents. [Catalog No. C52.16/2:3]

Upper Atmosphere Geophysics Report UAG-4
"Abbreviated Calendar Record 1966-1967" by J. Virginia Lincoln, Hope I. Leighton and Dorothy K. Kropp of Aeronomy and Space Data Center, Space Disturbances Laboratory, ESSA Research Laboratories, January 1969, single copy price $1.25. [Catalog No. C52.16/2:4]

Upper Atmosphere Geophysics Report UAG-5
"Data on Solar Event of May 23, 1967 and its Geophysical Effects" compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA, February 1969, single copy price 65 cents. [Catalog No. C52.16/2:5]

Upper Atmosphere Geophysics Report UAG-6
"International Geophysical Calendars 1957-1969" by A. H. Shapley and J. Virginia Lincoln, ESSA Research Laboratories, March 1969, single copy price 30 cents. [Catalog No. C52.16/2:6]

Upper Atmosphere Geophysics Report UAG-7
"Observations of the Solar Electron Corona: February 1964 - January 1968" by Richard T. Hansen, High Altitude Observatory, Boulder, Colorado and Kamuela, Hawaii, October 1969, single copy price 15 cents. [Catalog No. C52.16/2:7]

Upper Atmosphere Geophysics Report UAG-8, Parts 1 and 2
"Data on Solar-Geophysical Activity October 24 - November 6, 1968" compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA, March 1970, single copy price $1.75. Part 1 [Catalog No. C52.16/2:8/1], Part 2 [Catalog No. C52.16/2:8/2]

Upper Atmosphere Geophysics Report UAG-9
"Data on Cosmic Ray Event of November 18, 1968 and Associated Phenomena" compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA, April 1970, single copy price 55 cents. [Catalog No. C52.16/2:9]

Upper Atmosphere Geophysics Report UAG-10
"Atlas of Ionograms" edited by A. H. Shapley, ESSA Research Laboratories, May 1970, single copy price $1.50. [Catalog No. C52.16/2:10]

Upper Atmosphere Geophysics Report UAG-11
"Catalogue of Data on Solar-Terrestrial Physics", compiled by J. Virginia Lincoln and H. Patricia Smith, World Data Center A, Upper Atmosphere Geophysics, ESSA, June 1970, single copy price $1.50. [Catalog No. [C52.16/2:11]

## XIV. Literature Citations

A partial list of research papers utilizing ionosonde data is presented. After the references are given an abstract plus the stations whose data were used and, in some cases, the time period covered:

HIGASHIMURA, MASAICHI
KENJI SINNO and
YACHIYO HIRUKAWA — 1969 — Analysis of Long-Term Observations of Ionospheric Absorption Measurement (II) -- Observations in the Northern Hemisphere, J. Radio Research Laboratories Japan, 16, No. 85/86, 139-147.

The long-term ionospheric absorption measurement at the stations in the northern hemisphere are analyzed during the period from the IGY to the IQSY.

Characteristics of the yearly, seasonal variations and the latitudinal distributions of absorption are as follows:

(1) Yearly variations of observations at several stations are proportional to the solar activities in the same way as at Kokubunji.
(2) Power of cos $\chi$ in seasonal variations is inversely proportional to the solar activities.
(3) Latitudinal distribution of absorption is derived from various stations in the northern hemisphere.
(4) Linear relation between f min and the absorption gives a useful tool for investigation of the abnormal absorption phenomena associated with the geomagnetic disturbances and stratospheric warming.

(Kokubunji, Ashkabad, Alma Ata, Ottawa, Rostov, Freiburg, De Bilt, Moscow, Churchill, Kjeller, Baker Lake, Tromso, Dixon, Resolute Bay)

NISIZAKI, RYO and
MIKITOSHI NAGAYAMA — 1969 — Analysis of Observational Data Obtained by Alouette II, J. Radio Research Laboratories Japan, 16, Nos. 87/88, 227-234.

The critical frequencies, foF2, from Alouette II ionograms recorded at Kashima Station were compared with foF2 observed mainly at four Japanese ground stations (Wakkanai, Akita, Kokubunji and Yamagawa) and also at Taipei and Manila. Such comparison was performed for the period from

October, 1966, to September, 1967, as to the topside data obtained by observation while the sub-satellite points lay within the area in geographical latitude ± 1° and geographical longitude ± 25° of a certain ground station. The ground based foF2 to be compared with the topside data was derived by the use of 15-minute interval f-plots data of the nearest ground station. The frequency differences between the two lie within ± 0.5 MHz in 90% of the total cases, and there can be seen a tendency that foF2 from the topside sounding is less than that from the ground observation by about 100 kHz on an average.

Further, data on comparison of the F2 layer critical frequencies appearing in the ISIS Report and the CCIR Report were examined in more detail and several characteristics in comparison were in discussion.

(Wakkanai, Akita, Kokubunji, Yamagawa, Taipei and Manila) (Anchorage, Townsville, Canberra)

RASTOGI, R. G. 1970 New Type of Ionospheric Disturbance, Nature, 225, 258-259.

Describes a new type of vertically moving disturbance peculiar to the equatorial ionosphere.

(Thumba)

SERAFIMOV, K., N. GORINOV and TSV. RAL'CHOVSKIY 1969 Concerning a Local Anomaly in Radio Wave Propagation, Geomagnetism and Aeronomy, IX, No. 4, 545-549.

A local anomaly in radio wave propagation in the Balchik Bay (Bulgaria) was investigated on the basis of shipboard, ionospheric, and other measurements. The field strength of radio waves in the HF range was found to decrease tenfold compared to normal conditions. The absorption of surface radio waves corresponds to a strong gravity anomaly and a weak magnetic anomaly.

(Sofia and Michurni)

TAO, KAZUHIKO 1965 World-Wide Maps of the Occurrence Percentage of Spread F in Years of High and Low Sunspot Numbers, J. Radio Research Laboratories Japan, 12, No. 64, 317-356.

Contour maps of the occurrence percentage of spread F were drawn by the use of the ionosonde data obtained in 1954 and during the IGY. The most frequent occurrence time and area of spread F are very clear on the contour maps. In years of high sunspot number, the occurrence area of spread F is restricted to high latitudes and the equatorial area. During the years of low sunspot number, there are also many occurrences of spread F in middle latitudes in addition to high and low latitudes.

This kind of contour map may be useful for consideration of several problems such as where and when F scatter propagation and scintillations of radio waves from radio stars and satellites are expected to occur most frequently from the geographical point of view.

(American Zone - 27 stations, Asia-Australia - 20 stations, Europe-Africa - 12 stations, USSR Zone - 4 stations, Antarctic - 6 stations)

TAO, KAZUHIKO, FUMIO OCHI, MAKOTO YAMAOKA, SHOJI WATANABE, CHIYOMATSU WATANABE and KASUO TANOHATA 1970 Experimental Results of VHF Trans-Equatorial Propagation, J. Radio Research Laboratories Japan, 17, No. 89, 83-101.

As a part of the IQSY programs, the Radio Research Laboratories conducted the VHF propagation test on three fixed frequencies in the trans-equatorial path between Japan and Australia in collaboration with the Department of Supply in Australia. From the observational results of T.E.P. signals on 32, 48 and 72 MHz waves for the period of about half a cycle of solar activity (1965 to 1968), it was found that the trans-equatorial propagation occurred during a large part of the day except a few hours in the morning at the frequency of 32 MHz even in years of low sunspot numbers. The hours of reception are expected to increase with solar activities.

As for the frequencies of 48 and 72 MHz, trans-equatorial propagation occurs mostly at night in equinoctial seasons. It seems that the propagational mode at night differs from that in the daytime, and these modes are closely associated with the anomaly in the equatorial ionosphere. It is suggested that both the layer tilt and scattering processes may affect this type of trans-equatorial propagation.

(Compared with Manila spread F, foF2 ⩾8MHz, and foEs ≥4MHz)