IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*
Ionosphere Station Information Bulletin No. 32**

*Under the auspices of Commission G Working Group 6.1 of the International Union of Radio Science (URSI).

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I. Introduction

by

W.R. Piggott, Chairman

Although I apparently have more free time since my retirement, in practice I am finding it more difficult to deal with INAG matters. It is much slower to write out texts by hand and revise them from manuscript than to dictate the draft and revise a typed script. As you will have noticed, the chance of error is also greater when manuscripts written in the UK are typed for publication in the USA. However, I feel that I owe you yet another apology for the delay in writing and publishing this Bulletin.

Another problem which is becoming critical is the loss of sponsorship for me to travel to INAG meetings. This has always been rather difficult and I have had to miss several important meetings in the past but, owing to the generosity of the British Antarctic Survey, I have been able to attend one or occasionally two meetings per year at their expense and combine travel for them with visits to V.I. groups. I would like to take the opportunity to thank B.A.S. and its parent body, The Natural Environment Research Council, for their support during the last six years and the Appleton Laboratory and its parent body, The Science Research Council, for similar support during the previous quarter century. I feel that the well being of the present and past vertical incidence networks owes much to this aid and that I shall have your support in expressing these thanks to them.

Turning to the future, we are, I think, approaching a crisis in INAG which will need to be resolved at the next URSI General Assembly at Washington in August 1981. Several difficulties will come to a head then. Firstly, an energetic and able Secretary, Miss Virginia Lincoln, has now retired from her job with NOAA and will not be able to continue helping INAG when her current part-time support of WDC-A ends in a few months time. Few realize the immense amount of work she has put in on your behalf, initially in provoking me to write Bulletins, in translating my writing into readable American, and finally in producing and circulating the Bulletin, Handbooks, Supplements, Atlas and other INAG material. Together with Alan Shapley she has found ways of helping to finance these publications and to make them generally available. It is not clear how this gap can be filled. Secondly, the financial crisis is causing reviews of expenditure in most countries and in most organizations often with the loss of worthwhile facilities. Unless there is a clear case for its continuance this could effect INAG. Thirdly, I feel that, as INAG is a Working Group of Commission G of URSI, its chairman should be present at URSI General Assemblies and at the majority of INAG meetings between Assemblies. Unless I can find funding to make this possible, I feel that a new Chairman should be found soon so that he can act on behalf of INAG at Washington.

If you wish INAG to continue you will need to say so through your National URSI representatives. I would welcome your suggestions on the best way of making this possible. As you all know our Bulletin is mainly financed by NOAA through WDC-A with a grant from URSI and some subscriptions ($10 for three years supply) from users. The latter represent a very small fraction of our circulation; a fact which leaves us open to the criticism that the Bulletin is not valued (by its users). With the current severe pressure on funds we must expect this point to be raised. Unfortunately many of the groups most interested find it difficult to obtain foreign exchange or even UNESCO coupons which can be used for this purpose. If you are in a position to make a subscription please do - your action may help to save the INAG Bulletin for the whole network.

As mentioned above Miss Virginia Lincoln will be finally retiring in the near future. Apart from INAG, many of you will have used her WDC-A catalog and the other publications in the UAG series or have been helped by her work as Secretary of the IUWDS, in the preparation of the yearly calendar. If you would like your name included in a formal resolution of thanks to her please inform the Chairman. (21 Hillingdon Rd, Uxbridge Middlesex UB10 0AD UK) or you may prefer to write to her direct to WDC-A, NOAA, 325 Broadway, Boulder, Colorado 80303, USA.

II. Informal INAG Meeting--Lillehammer 13 May 1980

The Chairman called a meeting to discuss INAG problems during the Advanced Study Institute on Exploration of the Polar Atmosphere held at Lillehammer, Norway 5-16th May 1980. This was attended by 13 high-latitude experts from seven countries, some of whom were not directly concerned with VI scaling problems.

The Chairman gave a brief introduction on the purposes and organization of INAG, the VI network and the use of the network studying high-latitude problems.

Handbook. The consensus was that the existing Handbook was generally satisfactory and should not be replaced but that there were special difficulties in two cases:

(a) the training of new staff,

(b) users of data needed a short description of the main definitions and limitations of data. The meeting suggested that these should be solved by:

(i) Preparing a new introduction to the Handbook with ionograms for mutual training.

(ii) Writing a short paper suitable for guiding scientific users of the data.

The possibility of identifying the main points in a supplementary index was also considered. The advantages and disadvantages of providing a shortened analysis were both important - but it was critical to keep the analysis rules as uniform as possible for long periods and to make sure that trained scalers used the Handbook High Latitude Supplement.

The main requirements identified were:

(a) More sequences in time showing the development of high latitude phenomena.

(b) The establishment of a common nomenclature for particular phenomena.

(c) A section on the effects of equipment on the appearance of ionograms. The great differences between ionograms at Tromso and Kiruna were given as an example.

There was a strong view that more comparisons should be made between incoherent scatter data and ionograms at high latitudes in particular using data from Chatanika and EISCAT (when operating) before making final changes in scaling practice. Prof. Hunsucker (USA) announced tht there would be a High Latitude Symposium in the summer of 1982, probably at College, Alaska. Data from the Chatanika incoherent scatter facility, conventional ionograms and from the new NOAA digital ionosonde would be discussed at length. A preliminary workshop on high latitude ionograms was needed. The possibility of holding this at Kiruna, which is convenient for the Scandinavian and Leningrad groups, was briefly discussed. The Chairman should make contact with Prof. Hultqvist if this should be followed up. INAG would like to have views on this possibility particularly if attendance at Edinburgh and Washington is inadequate.

Simplification of Rules.

The outcome of the questionnaire INAG 27, p. 37-40 was discussed. The importance of keeping the distinction between thin and thick region layers for modelling problems was stressed.

There were advantages in keeping the main high latitude types distinct until the physical causes were better understood. The use of incoherent scatter data to interpret the physical significance of foEs, fbEs was considered valuable.

The scalers present felt that there were few difficulties in scaling fxI, but it was important to find out whether anyone was using the data obtained. The Chairman would take this up at Geneva.

The situation of spread-F scaling, at present experimental and optional, should be reviewed. Some present felt that the use of L for mixed types of spread F could be dropped as the descriptive letters for range spread, Q, used with h'F, h'F2, and the frequency spread letter F, used with foF2, fxI automatically indicated mixed types. Letter P, mainly with fxI, was important as there is much active research on this phenomenon.

Stations

The temporary VI stations at Cape Parry and Sachs Harbor were now closed. There was serious difficulty in getting replacements for the obsolete ionosondes and the group at NOAA had been cut for financial reasons.

A new small ionosonde would be provided for use in Greenland.

III. INAG Meeting in Geneva, Switzerland, 20-21 June 1980

Chairman's Note. There has long been close relations between the Consultative Committee for International Radio, C.C.I.R., and the URSI or Intercommission bodies responsible for advising the vertical incidence network of sounding stations with a two way flow of questions, advice and recommendations. Originally much of the VI network was financed by organizations interested in practical radio communications and the data obtained were widely used to improve these.

With the development of large computerized programs for producing predictions of radio frequency conditions, it has become relatively difficult to introduce new material without incurring a disproportionate effort. Thus it is generally necessary to wait until a considerable quantity of new information is available before a reanalysis is justified. This is rather discouraging to those involved in obtaining new data or developing new theories, both groups would like to see their work used immediately, but do not realize the cost involved.

It appears to me that a case can now be made out for a reexamination of the data bases for the prediction schemes. There are large accumulations of new data, wind and particle theories can give considerable guidance on the best ways of extrapolating to those parts of the world where no synoptic data are available, and the observations obtained from satellites could be used to validate the extrapolation rules. Furthermore fxI data, which could considerably change predictions when spread F or spurs are present, are now available from at least 83 stations, many covering both solar maximum and solar minimum conditions. The potential value of these developments do not appear to be widely recognized and there is a great need for them to be demonstrated.

As the ionosonde sweeps through a major part of the spectrum used for practical ionospheric radio communications, it also provides a monitor of the use of these frequencies. Despite the wide use of satellite links this has not decreased, in fact in some parts of the world, particularly in equatorial regions, in the Southern Hemisphere the interference level has increased dramatically in the last 10 years. This appears to be due to new users, particularly in developing countries and in the mobile classes - HF communication can be remarkably cheap and easy to maintain. Thus there is still a market for good guidance systems - in fact it is more important where the users are relatively unskilled and lack the support of large rich organizations. In my opinion it is time that the community sold itself. It is getting difficult for me to attend scientific meetings

since I retired as there is no organization to finance such visits and I must therefore appeal to you to take the needed actions.

The INAG meetings held in conjunction with the CCIR working parties, most involved with the use of VI data, form a convenient link with CCIR Study Group 6. In general they have to be held while the Working Groups are also holding meetings so that the attendance is relatively small, but this is overcome by holding a joint session with the Working Groups. Previous meetings of this type are reported in INAG 17, p. 2-11 (1974); INAG 23, p. 2-8 (1976); INAG 27 p. 2-14 (1978). Additional unreported work is often done by INAG members or consultants who are also members of the Working Groups.

Geneva Meetings 1980

An INAG meeting was held on June 20th, 1980, in the conference center in the ITU complex, CIGG, and followed by a joint session with the CCIR Working Groups on June 21st, 1980, attended, on behalf of INAG by the Chairman and Secretary.

Participants:

W.R. Piggott	U.K.	Chairman of INAG
J.V. Lincoln	U.S.A.	Secretary of INAG
B. Andergard	Finland	
L.W. Barclay		CCIR Study Group 6
D.G. Cole	Australia	
A. Giraldez	Argentina	
T. Kelly	Australia	
G. Pillet	France	
A. Rodger	U.K.	
T. Turunen	Finland	
N. Wakai	Japan (representing INAG)	

Votes of Thanks

A vote of thanks was carried by acclamation to the Director of CCIR, Dr. Richard Kirby, for providing the facilities and for helping to organize the INAG meeting. The meeting passed a vote of thanks to Dr. David Cole for organizing and chairing the INAG meeting in Canberra.

Chairman's Introduction

The Chairman welcomed the participants and stressed that the discussions should mainly be directed to matters of interest to CCIR. He would present the points raised to the CCIR Working Groups on Saturday June 21, 1980. He then summarized the work of the ad hoc meeting at Lillehammer, Norway, 13 May 1980 (this Bulletin pp. 2-3) and drew attention to the main conclusions. If a simplified introduction for training purposes was to be prepared soon it was essential that groups with suitable ionograms send copies together with line drawings showing the interpretation by April 1st, 1981.

With the aid of financial support from IAGA and from KEL Aerospace Pty, the Chairman would attend the Equatorial Aeronomy Conference in Puerto Rico July 1980 (this Bulletin p. 17). He would lead a session on the interpretation of low latitude ionograms and point out their value for scientists using other techniques.

Chairman's visit to People's Republic of China

The Chairman reported on his visit to the People's Republic of China, Feb. 25 - March 24, 1980, at the invitation of the Academia Sinica (see also INAG 31 p. 24). The objects of this visit were to explore the possibilities of China joining the international data exchange organizations, particularly on ionosphere, to link the Chinese workers in our fields with INAG, to discuss the growth points in ionospheric sciences and to help with problems, particularly of interpretation of ionograms.

The program included visits to the VI ionospheric sounding stations at Beijing (Peking) and Wuhan (Wuchang) where the equipments were demonstrated and discussions on equipment problems and ionogram interpretation were included. These were ten formal lectures, each lasting about 3½ hours, and six discussion meetings at Beijing, and two similar formal lectures and five discussion meetings at Wuhan. The latter included many ionogram sequences and discussions on low latitude ionogram problems involving several groups. The Space Physics Department and Radio Propagation Laboratory of Wuhan University are active in many ionospheric fields, including transequatorial oblique incidence sounding, backscatter, beacon observations, whistlers, movements of equatorial ridges and gravity waves. The Wuhan ionospheric station is manned and operated by the Institute of Radio Wave Propagation, but is in the field buildings of the Academy of Sciences Institute of Physics which is also very active in ionospheric and magnetospheric research. There are more active ionospheric workers in each of these than at Beijing where most of the work is theoretical and analytical. The Beijing work on ionospheric storms, using data collected on an institute-to-institute interchange, is particularly interesting.

The URSI Handbook, or its revised form (UAG-23 and UAG-23A) had been translated into Chinese and used for training. It was in course of publication but was not yet available at the stations. Discussions with scalers at Beijing and Wuhan showed that they had a good understanding of the international rules and were able to recognize

and discuss difficult points. The quality of these ionograms was excellent, the main difficulty being too much interference at night. Frequency scales were linear with 1 MHz markers (100 kHz for one equipment at Wuhan), the height scale approximately linear with 700 km maximum. This is rather short for the more southerly equatorial zone stations. Unfortunately a severe attack of influenza prevented me from visiting the Institute of Radio Wave Propagation at Xinxiang which is responsible for all of the synoptic stations, the training of analysis staff and the applications of the data to practical problems. Some senior members of this institute attended the lectures and discussion meetings in Beijing and asked many questions. The scope of the organization is very similar to that of the CRPL of Boulder or the Radio Research Organization at Slough after the 1939 war.

The discussions on International cooperation aroused much interest, and A.H. Shapley, Chairman of Monsee, will be visiting China in October 1980 and will be discussing the practical problems in more detail. There was much interest on the part of individual scientists and engineers to reestablish contact with foreign workers in ionospheric fields and a number of Chinese scientists are now working in other countries to help establish such links.

Simplified Handbook

The Chairman outlined the points made in previous meetings (INAG-31, p. 4 (see also p. 14), INAG-29, 3-9).

Wakai presented a Japanese document with many line drawings. The Chairman on behalf of INAG thanked the Japanese for starting this work and preparing the draft and requested that a copy be sent to him. An English translation would be most useful if it could be prepared easily. The participants requested that the ionograms from which the line drawings had been made should also be reproduced. The Chairman would publish an excerpt in the Bulletin on receipt of a master.

Revision of High Latitude Supplement

It was felt that one or more workshops would be needed to obtain an agreed interpretation and nomenclature for the most important high latitude phenomena. The possibilities had been discussed in INAG-31 p. 11. So far insufficient positive replies to the questionnaire had been received to enable arrangements to be made and financial limitations might restrict the attendance of the Chairman. If you have not replied please do so as soon as possible. The Chairman said that, although the physical causes were different, very similar ionogram patterns were also common in the magnetic dip tropical zone. Large tilts, field-aligned irregularities (spread F and slant Es were seen in both theaters).

Standardization of Ionosonde Operation

Dr. Turunen opened a discussion on the need to standardize the effective sensitivity of ionosondes. He presented results from a series of investigations which showed how the data from gain sensitive parameters could change fundamentally when the sensitivity was changed by large amounts. These points were generally agreed to be correct though there might be difficulty in improving uniformity at many stations. The Finnish ionosonde was designed to solve the problem. The IPS-42 ionosonde also showed sensitivity (AGC output) which might be used to help the interpretation. The most useful evaluations of gain sensitive parameters occur when the effective sensitivity is about 26 dB below the strength of the totally reflected trace.

The Chairman pointed out that the network was made up of a collection of independent groups, each with its own problems and limitations, and that it was not in practice possible to improve compatibility greatly. Most ionosondes give reasonably compatible data from gain sensitive parameters when operating correctly because their effective sensitivity (about 30 dB) is similar. Difficulties arise with two classes of instruments:

(a) Those with inadequate sensitivity or inadequate antennas.

(b) Those with very high sensitivity.

For class (a) the nongain sensitive parameters are also often inadequate and action to improve them is necessary.

For class (b) the ionosonde often sees additional phenomena, e.g. the boundary or steep gradient reflections at about -50 dB relative to the main trace as described by Dr. Turunen. This had affected the Slough foEs data for many years. A reduction in sensitivity makes the data more consistent with those from other stations. The weak Es signal as at Slough has been called meteoric Es in the literature.

Dr. Turunen stressed the advantages of using echo controlled sensitivity rather than the conventional noise controlled technique. This was accepted and it was recommended that this point be brought to the attention of ionosonde designers and should be considered for use in new ionosondes.

CCIR Problems

The Chairman pointed out that there had been little development of the standard CCIR methods of predicting radio wave propagation owing to the large effort needed for such an exercise. Current predictions were based mainly on IGY and pre-IGY data. Since then changes in the permanent field of the Earth had introduced significant shifts, of a few degrees in latitude and longitude, in the position of the zones at large gradient. This was most

important at high and low magnetic dip latitudes. The Southern Hemisphere was also less like the North than shown by the CCIR analysis. A much better description was now possible with the aid of theory, satellite data and new stations.

fxI. Over 80 stations had measured fxI, many for both solar maximum and solar minimum conditions. As pointed out at previous INAG meetings little appears to have been done with the data obtained. The parameter appears to have been easy to analyze at most stations, difficulties have arisen where the ionosonde was operating below normal, and also with some of the new types of equipment using electronic preselection of the recorded signal. This may be due to the deep fading present which results in some pulses being rejected intermittently. Further development is needed if the parameter is to continue at these stations.

The Chairman described some of the scientific work which had been done using fxI, particularly in giving numerical measures of spread F and showing the presence of polar spurs. For communications both were important, the former because the MUF could be up to twice as great as that given by foF2 and could be evaluated when foF2 was not measurable. The latter because oblique soundings showed that a ridge anywhere near the oblique path took control of the actual MUF. Lindau - Sodankyla in sunspot maximum years showed MUF's three times those expected from foF2 whenever a ridge was present, even when it was northwest of Sodankyla.

The importance of fxI at low latitudes was stressed as to give numerical data for the night periods when foF2 is normally not measurable. The assumption that the MUF factor, which also cannot be measured, is the same as that for a layer at the same height, appears adequate but should be checked by oblique incidence measurements.

The usefulness of fxI was not generally recognized and it was important to interest scientists and engineers in it.

The meeting agreed that the case should be put to CCIR with a recommendation for study. The Chairman should also interest scientists in this problem.

Several INAG meetings have expressed the view that the parameter should be withdrawn unless use was clearly being made of it. The meeting requested that this opinion be brought to the attention of CCIR.

Es. The Chairman reviewed the opinions expressed in the questionnaire and in previous meetings. There was a significant group who wanted to leave the system as it is but othere were having real difficulty in training those scaling Es parameters. As it took some years before any change became generally accepted it was necessary that new names and symbols should be adopted if changes were made. If changes were to be made, the consensus appeared to be that it would be worthwhile to simplify the Es types.

foEs fbEs h'Es. Despite item limitations, there was a case for continuing foEs, fbEs, h'Es. foEs was most likely to give misleading data at particular stations as stressed by Turunen, and fbEs probably was most significant physically. The views of CCIR should be sought. In previous joint meetings they had wanted both foEs and fbEs. If the types were simplified h'Es would be needed as a substitute and was also a good guide to show probable interpretation when foEs data appeared anomalous.

Es types. Some gain in training could be obtained with relatively little loss by combining the classical mid-latitude types h c l f under a new symbol with new rules for Es as discussed in previous meetings. A discussion on symbols showed that 'm' was likely to be confused with meteoric Es and meteor echoes, 'f' was not liked but the participants felt that 'w' 'worldwide' would be appropriate. The classical Es types h c l f occur at all latitudes, sometimes superimposed on more specialized types. Groups using computing programs for ionospheric data are requested to write to the Chairman if the proposal to introduce 'w' would cause difficulties, leaving in mind that many stations will continue to use h c l f. This proposal should be brought to the attention of CCIR. It was likely that the CCIR interest would be geographical rather than involve height, e.g. to distinguish the three main sets of Es phenomena: types:

(1)	q	low latitude
(2)	h c l f or w	worldwide
(3)	a r k	particle phenomena

The CCIR requirement to identify dense sheets of Es was best not using foEs and fbEs. Attention should be drawn to the existence of large variations of Es type q with longitude.

There was general agreement that the distinction between oblique and overhead particle activity was not being used for scientific purposes and could be dropped. This would remove the need for accurately distinguishing between Es type r and Es type k in the difficult cases. Similarly the distinction between non-blanketing Es type a and type a with blanketing, now classified as a and f, could be dropped.

Other Changes

M, T The meeting supported the proposal to drop descriptive and qualifying letters M and T.

foF1. In the future foF1 should only be tabulated when the ionogram shows a peak near foF1, h'F2 numerical. When foF1 is not clearly indicated by a peak on the ionogram, there are difficulties with the use of D and E. Physically the most important feature of the electron density distribution would be the point of inflection, but this is not given by the apparent value of foF1. As shown in INAG 27, p. 26-27, the critical frequency corresponds to an electron density greater than the inflection density whereas the ionogram rules imply that it is less. Such values are thus misleading for the scientist and of no value to the communications engineer and should not be

recorded. Owing to the very tiny change in slope needed to distort an ionogram trace, the loss of information on the presence of an F1 ledge is much more apparent than real. foF1 values given by a peak are reliable within the accuracy rules as shown in INAG 27, p. 26-27.

Status of Networks

While seven or eight stations have been closed in the last year several new stations are known to have opened and the inquiries showed interest in opening or reopening stations at 25 locations if and when equipment and finance become available. If, as appears likely, the Chinese stations join the network the amount of data available each year will increase to a new peak.

Canadian There was a serious danger that the Canadian stations would close at the end of 1980. Data from these were being used by several groups for magnetospheric-ionospheric studies and the stations were definitely needed for these purposes. New work was planned using St. John's, Newfoundland, as a conjugate pair with Halley Bay, Antarctica. Churchill and Ottawa were important for the study of storm effects at lower latitudes as they monitored the sector where exceptionally many storms were generated. There was much active work on polar cap phenomena, particularly cleft precipitation for which Resolute Bay was important.

The stations formed part of the important 75° chain.

The meeting unanimously agreed that the Canadian stations were important and requested the Chairman to draw this to the attention of the Canadian members of the I.W.P.'s.

The following corrections and additions to the Canberra statements, INAG 31, p. 2-3 were contributed:

Hong Kong The antennas have been reconstructed and operation restored. Data are only analyzed on request. There was much need for a new station south of Hong Kong and the Chinese network.

France Add Ougadougou, Dakar, Poitiers. Garchy is operating but the data are only reduced to special requests. Ile de Reunion may restart with new equipment in about one year's time.

60°W chain There was interest in forming a N-S chain near 60°W filling the gap left by the desolution of the southern part of the 75°W chain. A new station was needed between Tucuman and Huancayo to complete this chain and study TIDs and ridge movements in this sector (Chairman. This need also became evident in the discussions at Puerto Rico).

Argentina San Juan started on May 1, 1980, and sends data to WDC-A.

Belgrano is being moved and probably will not be active for two years.

Tucuman and Ushuaia are operating normally.

Trelew is not operating. The ionosonde at Buenos Aires is being rebuilt and the station is temporarily closed.

Germany The stations at Lindau and Freiburg (Breisach) had closed.

Japan Dr. Wakai reported that the Japanese network would continue. Special care is taken to maintain continuity of analysis. By April 1981 Kokubunji (Tokyo) will have improved timing and synchronization so that the VI data can be supplemented by oblique incidence recordings as a service for Japanese communication organizations. By April 1982 two more ionosondes will be converted and the remaining two by April 1983.

Malaysia Kuala Lompur With Australian help it is hoped to install an IPS-42 at Kuala Lompur.

Saudi Arabia Jedda The Institute of Meteorology at Jedda expects to purchase three IPS-42 ionosondes, mainly for TID studies, and wishes to cooperate with INAG.

U.K. Add S. Uist is recording regularly with 15 minute sequences on RWD's. The data are reduced but not published. Available on request for special purposes.

Netherlands De Bilt De Bilt is acquiring an IPS-42 ionosonde and will continue to operate when this is installed.

Equatorial Stations

Dr. Giraldez drew attention to the peculiar behavior of the data from Togo and asked whether more information about this station could be obtained. Will anyone with the required information please write to the Chairman? He proposed the formation of an Equatorial Working Group to consider low latitude problems in the way the high latitudes had been treated. The Chairman pointed out that he had suggested this several times in INAG Bulletins but that there had been no response. The Chairman would explore the proposal at the Conference at Puerto Rico. There was little chance of worthwhile work unless he could get help from others interested, particularly in selecting ionograms.

Key stations. The proposal to identify a chain of key stations was considered but in view of past experience was rejected as impractical.

Ionosonde Developments

Argentina is building a digital ionosonde.

Australia Mr. Kelly reported that the six improved KEL ionosondes are being deployed and that a complete DBD-42 digitized ionosonde receiver and microprocessor (see p. 12) will be installed at La Trobe with remote consoles at Melbourne and Sydney so that the data were available in real time to those users within 1000 km. He hoped to demonstrate a remote console at the URSI General Assembly at Washington in 1981, using data in real time from La Trobe in Australia. He also reported that Australian companies were very active in the design and supply of antennas suitable for ionospheric and radio propagation studies.

NOAA had produced a report on the comparison of the IPS-42 and standard ionosonde. These were some differences on the M(3000)F2 data partly due to the standard NOAA slides not being exactly equivalent to the international standard. There appeared to be a 6 km height discrepancy present in one or the other ionosonde. The signal-to-noise ratio available in the IPS-42 above 8 MHz might be low. foF2 did not allow a proper check on this. Otherwise the ionograms appeared equally good on both equipments. Mr. Kelly briefly outlined the developments in the equipment since these tests.

Production of Digital Data

There was a general discussion on:

(a) methods of producing digital data from standard ionograms,
(b) what data from research ionosondes should be put into the WDC's.

The meeting strongly recommended that conventional ionosonde data be put into computer format at the time of scaling whenever possible. This had great advantages in accuracy and cost. As analysis techniques grew more elaborate, the importance of computer compatible output also grew. Several countries were now using ionospheric data entry systems based on small microprocessors successfully. These were relatively cheap. The DBD-42 enabled existing ionosondes to be converted to digital output relatively cheaply. More experience was needed with existing digital ionosondes whose inherent advantages had not been explored adequately. It would probably be best to develope regional analyses using simple parameters until the proper balance in quality and types of data to be interchanged was established. Close contact should be kept with IDIG on these problems though IDIG was likely to be mostly concerned with advanced research projects.

The importance of keeping a mixed system with manual control of the automatic systems was stressed. It is difficult to and inefficient to try to make a computer do pattern recognition in difficult cases.

There was a real danger that sufficient attention would not be given to quick retrieval of the relatively simple types of data which were most used and it was important to identify new parameters of this type obtainable from research equipments.

The IDIG meeting, symposium and Prof. T. Jones request (see p. 11) were announced. The problems would also be considered at the IPS Operators Conference (see p. 19).

International Geophysical Calendar for 1981. See Handbook Chapter 9, p. 191-193.

The Secretary presented the draft calendar for 1981 and requested comments.

The meeting felt that the program for RWDs, etc., should be reviewed. Few, if any, stations had operated more frequently than every quarter hour (plus three ionograms at the hour at high latitudes) and this should be made the standard recommendation. With the current financial difficulties, the cost of duplicating ionograms was also a serious problem. However it was very important that a reasonable sample of ionograms be available at WDCs for use by scientists and to check ionosonde behavior and interpretation. Film costs could be cut by converting to 16-mm, with possibly some loss of accuracy depending on the quality of the optics, film employed and spot size on the oscilloscope. Most groups would, however, remain with existing 35-mm recorders and their costs could only be reduced by less duplication.

The meeting felt that stations in difficulties should be requested to send ionograms for Priority Regular World Days (PRWD) only or in the worst case Quarterly World Days (QWD). The latter did not really provide an adequate sample but was better than no ionograms.

There was a discussion on the N(h) items in the Calendar although there had been an upsurge in interest in N(h) data requests for ionograms to be sent to Dr. McNamara had had no response and few stations were making very systematic N(h) measurements. The Handbook Chapter 10 was now rather obsolete but there did not appear any demand for a revision. The most recent review is in UAG-68 'A comparative study of methods of electron density profile analysis' Sept. 1978 by Dr. L.F. McNamara.

Zurich Sunspot Numbers

The Chairman briefly reviewed the history and use of Zurich (Wolf) sunspot numbers. The decision to terminate these seemed to be irrevocable. This was unfortunate since, for the first time, the sunspot number had differed greatly from other indices of solar activity during this solar maximum. The Zurich records and techniques would be transferred so that Uccle could prepare a solar index based on Locarno and Uccle observations. The IAU will be asked to evaluate the success and usefulness of these indices after about three years. It is particularly important to maintain the mixed solar wind/solar radiation indices based on the behavior of the F2 layer during this period (e.g. I_{F2}) and the 10 cm noise indices of radiation.

Joint Meeting with IWP 6/1 Study Group 6 of CCIR. A joint meeting with International Working Party 6.1, the Chairman of IWP 6/3 and Mr. L.W. Barclay CCIR was held in the ITU tower 21 June 1980. The Chairman reviewed the interactions of CCIR and INAG, summarized the main points which INAG wished to raise and invited discussion.

The IWP requested:

(a) A list of stations which had measured fxI.
(b) A short report on how they might use fxI.

Following the evaluation of the usefulness of fxI, it might be possible to encourage an Administration to study its application for mapping propagation conditions.

The IWP's needed time to consider their replies but expressed the following views; subject to reconsideration:

(i) That foEs and fbEs were both needed for prediction of propagation involving Es.

(ii) That fewer Es types would be adequate to meet CCIR needs, in particular distinction between the three main groups, high, temperate and low latitude Es.

(iii) IWP 6/1 was particularly interested in the dense types of Es and how to identify their presence from the tabulations.

(iv) IWP 6/1 would welcome a report on ionosonde sensitivity problems particularly as these effect foEs and fbEs and needed guidance on how to use the existing tabulations for communnications purposes.

(v) Advice was needed by CCIR on the use of foF1 in communications since the MUF was often determined by foF1 in daytime summer.

(vi) The CCIR was concerned on the status and continuation of the I_{F2} group of stations and would wish for INAG support for their maintenance.

(vii) The distribution of stations producing fxI data was an essential factor in its practical application. Data would be regional for several longitude zones with special needs in the equatorial spread F zone and the plasma pause ridge zone.

Mr. Barclay (CCIR Study Group 6) stated that CCIR would try to obtain a consensus view on the matter raised by INAG and would inform the Chairman at INAG by resolution to URSI or letters as seemed appropriate.

The IWP thanked the INAG representatives and the many participants in INAG meetings who have considered the problems raised.

IV. Report of A.H. Shapley Visit to People's Republic of China

by

A.H. Shapley

On my visit to China in October 1980 I had the opportunity to visit briefly the ionosonde station at Beijing and Wuhan. The Beijing station is on the grounds of The University of Beijing on the edge of the city, under the responsibility of Dr. Hsiao Tso. Their ionosonde, of Chinese manufacture, dates from about 1960. At Wuhan, the ionosonde is operated by the Institution of Physics, Academia Sinica, Dr. P.N. Wei, and is in a rural setting. They use an Australian IPS-42, with an IGY-era ionosonde of Hungarian manufacture as backup. Both stations were impressive. especially compared to the station at Trinidad which I ran by myself for several months in 1945 or the ones I supervised in the 1950s. I believe they produce good standard data.

A scientist from the Institute of Space Physics, Dr. H.M. Chiu, will soon go for an extended working visit to the University of Lowell, USA, to gain actual experience using a digital ionosonde. We hope he can also spend some time at WDC-A which he visited for a few days in 1979.

The purpose of my trip was to discuss mechanisms for data exchange in all STP disciplines and some other areas of geophysics. I think some progress was made and there certainly seemed to be a deep-seated desire to find ways to cooperate. My formal talks were well-attended and the ensuing group discussions covered many aspects of data sharing practices under URSI, IUGG and IAU auspices. I was impressed that many Chinese scientists were only

beginning to appreciate that much of modern data exchange, including that in ionospheric physics, was with unpublished data, often tagged "preliminary". I told them the science is progressing so fast that there is not time for the traditional definitive review and printing of data from monitoring observations, and in most cases it is also no longer economical.

I hope my visit was a useful supplement to that of Dr. Piggott and others and that we are nearing the time of regular data exchange with ionosonde stations in China.

V. USSR Vertical Incidence Sounding Workshop October 1978

Dr. Besprozvannaya has contributed the following notes on the Vertical Incidence Soundings Workshop organized by the National Geophysical Committee and held at Alma Ata in October 1978. This was attended by specialists from the USSR, German Democratic Republic, Czechoslovakia and Bulgaria. The workshop program covered three main topics: research papers and discussions on the use of ionospheric data for the study of the ionosphere/magnetosphere system and radio wave propagation conditions; laboratory sessions on ionogram interpretation and reduction according to the URSI Handbook, 1972; discussion on the methods of calculation of N(h) profiles from ground based data and on the mechanization of the ionospheric processed products, their collection and exchange.

The workshop noted with satisfaction the increase in the use of the data of the World vertical sounding network for space studies and for upper atmosphere aeronomy; the growing importance of the vertical sounding data for ground and space radio systems; refinement of the methods of ionogram calculation and correspondingly more extensive use of N(h) profiles both in research and operation; the importance of the Russian edition of the URSI Handbook. Successful publication was due to the efforts of IZMIRAN (Dr. Mednikova, N.V.) and WDC-B2 (Sukhodolskaya, A.N.). The meeting also noted with satisfaction the translation of the High Latitude Supplement by Shchuka (Arctic and Antarctic Research Institute Leningrad) and WDC-B2.

The workshop made the following recommendations:

- to promote more extensive use of ground based observations for the monitoring of the upper atmosphere and outer space,
- to promote the use of ionospheric data along with satellite and rocket data in geophysical projects
- to widen the scope of studies drawing from the ionograms additional information on aeronomic parameters of the ionosphere and magnetosphere
- to adopt the URSI Handbook as the main document in order to firmly establish single practices in the interpretation and reduction of ionograms
- to contribute to wider participation of the Soviet and COMICON specialists in research and methodological activities aimed at the development of the World Network of stations of vertical ionospheric soundings and to ask the Soviet Geophysical Committee to sponsor the translation of the INAG Bulletin into Russian.
- to invite agencies supervising ionospheric observations to make efforts to obtain for the network new ionosondes meeting the requirements of research and operations
- to form under the ionospheric section of the Soviet Geophysical Committee a Working Group of calculation of N(h) profiles and digitizing ionospheric data for computers.

The workshop also discussed the INAG questionnaire on the future operation of the VI network (INAG 27, p. 37-40) and has provided a consensus view from the stations represented. They were against making scaling of Es types optional but felt that if changes were made the least damaging would be to combine h, c, l, f into a temperate latitude class and to combine k and r. They suggest omitting letter symbols M, P, T and ceasing to measure M(3000)F1. If ionosondes become available it is planned to supplement the auroral zone network and deploy new stations in the Soviet East region.

The following comments from a letter from Dr. Bezprozvannaya appear to represent the views of many active workers:

"There are two tendencies in the answers to the questionnaire which give me concern:

1. Suggestion that the scaling of Es types be made optional
2. Objections to introducing the scaling of spread F types and fxI parameters

Perhaps these proposals are acceptable for temperate and low latitudes (though I doubt it, since you pointed out that South American ionograms showed Es type c), but it would be a step backwards. Mr. Wright in his letter justly states that "the workers who developed incoherent scatter worked directly almost single-mindedly, to develop systems which could exhaust the information content of their received signals. Ionosonde developers, alas, have not seemed to consider it their business to do so, but have aimed mainly at circulating h'f parameters only.

"We should improve this situation as much as possible and to get maximum information from ionosonde data. Thus, even a qualitative characteristics of reflection types would be an essential contribution.

"I feel there's no need to give reasons in favour of classification of sporadic Es and F2. All our efforts should be directed to perfect it, achieving identity and possible maximum of objectivity of the information obtained."

Rather similar opinions have been expressed by some other individuals. It is difficult for the Chairman to know what the consensus is. Should INAG make changes in the rules or not? We have been very slow as it is a good principle not to alter rules unless a clear majority want this to happen.

The Chairman must apologize for the delay in publishing this material which unfortunately was filed while I was absent and not brought to his attention.

VI. IDIG Business Meeting URSI General Assembly, Washington, August 1981

The International Digital Ionosonde Group would hold a meeting during the URSI General Assembly at Washington August 1981. Proposals for items for the Agenda should be sent to the Chairman Dr. J.R. Dudeney at

British Antarctic Survey
Madingley Road
Cambridge CB3 OET
England

Symposium on Aeronomical Studies using Digital Ionospheric Sounders, Washington, August 1981

A half-day session has been allocated for a Symposium with the above title at the forthcoming URSI General Assembly in Washington (August 1981) as part of the Commission G program. The provisional date for this session is Thursday, 13th August, in the morning. The convenor is Dr. J.R. Dudeney, and the Co-convenor is Dr. K. Davies.

The main thrust of this Symposium will be on significant scientific results obtained with the new sounders, but input on new hardware or software concepts will also be appropriate.

Contributed papers of length 20 minutes are invited. Please send abstracts to the convenors, and to Dr. B. Hultqvist, Chairman of Commission G, by the 1st December, 1980.

Dr. J.R. Dudeney
British Antarctic Survey
Madingley Road,

Dr. K. Davies,
Space Environment Laboratory
NOAA, 325 Broadway
Boulder,
Colorado 80303
USA

Dr. B. Hultqvist
Kiruna Geophysical Institute
S-981 01 Kiruna,
Sweden

Prof. T.B. Jones is collecting material for a review paper for the above symposium. Those with suitable material are asked to send it to him at

Dept. of Physics
University of Leicester
University Road
Leicester
LE1 7RH
England

VII. XX URSI General Assembly, Washington 1981

The following proposed scientific sessions may involve vertical sounding data

1. "Influence of the ionosphere on radio systems" Commission G 1 day
2. "Equatorial ionospheric irregularities" Commision G, H 1 day
3. "Radio investigations of the high latitude ionosphere (including early EISCAT data)." Commission G, H 1 day
4. "Aeronomy studies using digital ionospheric sounders" Commission G 1/2 day

VIII. COSPAR Budapest 14 June 1980

The following Decision of the Executive Council of COSPAR should be of interest to the VI network:

Decision No 5/80, proposed by the representatives of IUGG and URSI, endorsed by COSPAR ISC C and supported by the representative of IAU.

COSPAR,

Recognizing the serious limitations in accuracy for advanced radio location methods that arise from the largely variable effects of ionospheric refraction, and

considering that these limitations are of increasing importance for the application of such methods in radio astronomy, geodesy and radio location of satellites, in particular with the new techniques of very long baseline interferometry,

strongly recommends that satellite launching agencies continuously provide radio beacons on appropriate geostationary satellites, and

further recommends that long-term routine measurements of the ionospheric total electron content be continued or initiated at ground stations in all countries

IX. International Reference Ionosphere

The preparation of an International Reference Ionosphere (IRI) is the responsibility of a joint URSI/COSPAR Committee whose Chairman and Vice-Chairman are Prof. K. Rawer (FR Germany) and Dr. A.D. Danilov (USSR) respectively.

During the COSPAR Meeting in Budapest, a Workshop, sponsored by URSI and COSPAR, was held from 11-13 June 1980. The objectives were (a) to make comparisons between actual measurements of various ionospheric parameters and the values predicted by the present provisional IRI, and (b) to discuss proposed improvements to the provisional IRI.

During the five sessions, nearly 40 papers were presented, and the lively discussions in most of the sessions indicated the considerable interest that has been aroused by the IRI project. The papers covered not only profiles of electron and ion densities, but also those of electron and ion temperature. It was meritable that considerable attention should be given also to the ionic structure of the ionosphere and to certain aspects of the very complex photochemical processes, which play such an important role at many levels in the atmosphere. The Proceedings of the Workshop will be published early in 1981 in the UAG Series.

Following the publication by URSI in 1978 of International Reference Ionosphere 1978 (compiled by Rawer, Ramakrishnan and Bilitza), a second edition (including revisions and typical profiles) is due to appear in 1980 in the UAG Series published by World Data Centre A, Boulder, Colorado.

It is proposed to prepare another revised and updated version of IRI in 1982; this will take account of the discussions held in Budapest, and any additional new information that may become available before the end of 1981.

Proposals or suggestions for improvements in IRI should be addressed to:

Professor K. Rawer
Herrenstrasse 43
D - 7801 March-Hungstetten
Fed. Rep. of Germany

or

Dr. A.D. Danilov
Institute of Applied Geophysics
Hydrometeorological Service
6 Pavlik Morozov ul
Moscow, USSR

X. INAG Meetings 1981

The response from the questionnaire INAG 3 (p. 29) has been rather disappointing only 14 replies have reached the Chairman.

Of them the majority would prefer a meeting during the URSI General Assembly at Washington with support for a Workshop on High Latitude Ionogram Interpretation immediately before this meeting. INAG will try to arrange these, but this may prove difficult if the Chairman is unable to attend.

There was relatively less support for meetings in Edinburgh, but those attending IAGA would not be attending URSI and vice versa. Thus the Washington meetings would have to take precedence. If the Chairman cannot attend Washington he will organize meetings at Edinburgh.

XI. New Equipments

If you become aware of any new equipment of interest to the VI Network please arrange for the Chairman to be informed. It is INAG policy to publish short articles on such equipments. However INAG does not have facilities to test equipment and cannot therefore confirm that the equipment behaves correctly. INAG would welcome users comments on new equipments for guidance of other potential users.

(a) The KEL DBD-42 Digital Ionosonde Receiver

The KEL Aerospace Pty Ltd, manufacturers of the IPS-42 portable ionosonde (INAG 31, p. 19), have announced the production of a new Digital Ionosonde Receiver which can be interfaced with any type of conventional ionosonde to

produce digital ionosonde data. Thus provides a cheap way of updating existing ionosondes and gaining the extra accuracy and convenience provided by digital recording. The prototype of this equipment has been interfaced with a 1950 C4 ionosonde (USA) and has been operated for several years with it. The following notes have been abstracted from the manufacturer's literature. The cost of the basic system including microprocessor and graphics terminal for display of the data is 10900$ Australian (as at June 1980).

Further details can be obtained from:

K.E.L. Aerospace Pty Ltd
1227 Malvern Road
Malvern
Victoria 3144
Australia

(i) The DBD-42 system

The DBD-42 add-on digital receiver system allows the conventional ionosonde to operate normally (and hence obtain a film ionogram) but provides a second receiver in which the time delay is recorded digitally to a high degree of accuracy. The largest errors which arise in the conventional ionosonde are reduced by allowing both the ground pulse and the echo to pass through the receiver and AGCing them to the same level. The ground pulse starts a counter after it has passed through the receiver and the echo stops it, to obtain a measure of the group delay digitally. This is implemented to give a measurement of accuracy of 100 m. In addition to this, random errors (and errors due to closely spaced echoes) may be reduced by editing the data in real time. The simplest editing procedure (e.g. pulse coincidence technique) is affected on-line using a microprocessor, before the digital ionogram is stored on tape (or disk). The system is designed so that both an ordinary (o), and extra-ordinary (x) ray ionogram are obtained and up to two echoes on any given frequency for each ray may be recorded if present.

(ii) SPECIFICATIONS

FREQUENCY RANGE:	1 to 20 MHz.
SWEEP RATE:	Automatically adjusts to the transmitter p.r.f.
PULSE WIDTH RANGE:	25 to 200 μsec.
SOUNDING TIMES:	Automatically responds to transmitter operating times.
GROUP DELAY ACCURACY:	100 m.
FREQUENCY ACCURACY:	1 kHz.
RF INPUT IMPEDANCE:	Nominally 75 ohms unbalanced, optional 300 ohm and 600 ohm.
ANTENNA REQUIREMENTS:	For o and x ray separation, cross 90° antennae required, otherwise existing ionosonde receiving antenna.
STANDBY POWER SUPPLY:	Nickel cadmium cells for internal clock.
DISPLAY TYPE:	Real time digital frequency and group height display on first echo, and internal clock.
IONOGRAM DISPLAY:	Optional real time CRT ionogram display.
DATA LOGGING:	Self contained cassette system. Two echoes per frequency for both o and x ray signals. Optional floppy disk recording system.
REMOTE DATA DISPLAY:	Optional self contained cassette system identical to data logging recorder with serial ASCII input-output.
EDITING:	Pre-editing of group height data by microprocessor using pulse coincidence to eliminate noise.
CONTROL SYSTEM:	High performance microprocessor control.
ENVIRONMENT:	0° to 55°C, <95% relative humidity.
POWER REQUIREMENTS:	115 or 240 VAC $\pm$10%, 50 to 60 Hz, 100W.
SIZE:	Height 13.4 cm (5.25"), width 48.3 cm (19"), depth 35.6 cm (14").

The manufacturer's claim the following advantages for the system:

ADVANTAGES OF A DIGITAL ADD-ON RECEIVER SYSTEM

1. The add-on system is very easy to add to a conventional ionosonde - only two pick-up coils are required to be attached to the transmitter unit of the ionosonde and these in no way interfere with the normal ionosonde function.

2. It is a very low cost system.

3. It allows you to obtain the normal pictorial ionogram as well as an accurate digital ionogram. This means that it is a simple matter to do further detailed (computer) analysis using the digital data if the conventional ionogram indicates it is worthwhile.

4. Manual scaling of digital ionograms may not be required.

5. Depending on ionospheric conditions the accuracy of the group height measurements may be ± 100 m (for sporadic E reflections) to ± 500 m for reflections from the F-region cusp.

6. State of the art circuitry is used in the add-on equipment which gives it compactness, reliability and adaptability.

7. o and x ray data are recorded separately.

8. An analysis may be effected on the site (immediately) or at a central computer facility.

9. The basic editing package in the microprocessor is provided to give the h'-f data on tape (or disk) and software is provided (in FORTRAN) to get the data from the tape (or disk).

(b) IPS-42 Ionosonde

Ionosondes, such as the IPS-42, with electronic preselection of the significant signals demand that the input signal is adequate to operate the preselection circuits. This implies that the design of the antennas can have a significant effect on the performance of the equipment. It should be noted that the Australian stations use relatively large antennas and that the comparisons made at Boulder (INAG 31, p. 19) also involved large antennas. Inadequate antennas can have a much more drastic effect on the performance of these systems than on conventional ionosondes.

(c) High Power Pulse Transmitters

Numerous pulse transmitters each giving 50-100 kw are being manufactured to produce systems for studying the atmosphere by the partial reflection technique. Ten to twenty such equipments, phase locked, are used to give effective power outputs in the Megawatt range

Relatively small modifications appear necessary to change the frequency of these equipments to make them suitable for ionospheric soundings needing medium power, say 50 kw, e.g. for partial reflection measurements of the D region or meteor wind measurements. The manufacturer is prepared to make one to particular needs for approximately 10,000 $ U.S. and there is a discount for duplicates ordered together. For further particulars apply to:

Tycho Technology
Box 1716, Boulder County
Colorado 80306
U.S.A.

The main difficulty in producing medium power transmitters is to find suitable tubes at reasonable price. The new market mentioned above should solve this problem.

XII. Uncle Roy's Column

I must apologize for the delay in publishing some contributions which have been due to the inevitable confusion in moving my papers after retirement. They will be included in the next INAG Bulletin.

Uncle Roy's Column

Intermediate layer structures near dawn. White Sands 20 Jan 1980.

The following sequence contributed by Irene Brophy, WDC-A, is a particularly good example of the type of complexity in the E region conversion near sunrise, other examples are given in The High Latitude Supplement Fig. 2.23, p. 59 and Fig. 103, p. 200.

From the point of view of scalers, there is little difficulty (Revised Handbook 114, p. 19 and Fig. 1.12, p. 20) as the rules are quite clear, the lowest cusp should be sized to measure foE and there is no F-layer stratification (no $foF_{0.5}$), the F trace being smooth. The ionograms show three E3 or intermediate traces which we shall call E2, E3, E4.

Physically the pattern corresponds to a very thick E layer with slight, probably closely spaced stratifications near its maximum. The separate cusps show that the electron density gradient becomes vertical at each stratification. The large differences in the virtual heights of the o and x traces show the presence of much retardation in the E layer but the relations between the first and second order heights suggest that the layer is horizontally stratified. This is rather unusual at sunrise, but depends on the direction and rate of movement of the sunrise terminator (dawnline) which in this case is slow.

The effect of group retardation is shown very dramatically in the 0830 ionogram where the virtual height of E4 is less than that of E3. The true height of E4 must be above that of E3 as can be checked by an electron density calculation. Note that the separations foE3-foE2 and foE2-foE decrease with time whereas foE4-foE3 increases. This suggests that the stratifications are generated by a balance between slowly changing factors.

The regularity of the changes in virtual height and critical frequency with time make it most unlikely that they are due to travelling disturbances which would first affect E4, then E3, then E2 and finally to E.

Physically there are only two critical frequencies which are important, the conventional foE and foE4, the critical frequency of the maximum electron density in the E region. Relatively little work has been done on these, but their study would provide a relatively easy exercise. The interpretation in terms of physical processes is, however, difficult.

At this time of day the F layer often shows a considerable tail on which is superposed E-layer electron production. When the layer is first reformed in the morning the electron density, N, is in equilibrium with the rate of electron production, q, giving a relatively thin layer for each ionizing wavelength. Later N is proportional to the square root of q giving a much thicker layer. Mathematically, in general:

$$dN/dt = q - \alpha N^2$$

and near dawn the rate of loss is relatively small

so $$dN/dt = q$$

and $$N = \int q \, dT$$

Latter dN/dt becomes small and

$$q = \alpha N^2$$

giving $N = \sqrt{q/\alpha}$ the usual equation for E and F1 layers. The production parameter q varies with solar zenith angle, χ roughly as cos χ (near sunrise and sunset, when $\chi > 75°$ it is essential to allow for the curvature of the atmosphere and the Chapman function should be used $Ch(R\chi) \fallingdotseq \sec\chi$ for $\chi < 75°$, a point usually missed in the literature.

The scale height, H, which modified q, and the recombination coefficient, α, both vary with height, H increasing and α decreasing at greater heights. The critical frequencies are usually greater than would be expected from the simple theory and stratifications more evident than might be expected.

Patterns similar to those shown have been analyzed by Jones and Hart (J.A.T.P. 1972, 34, p. 387-400) and compared with N(h) profiles and incoherent scatter data, all of which agree that the stratifications are only separated by small amounts typically 1-3 km and more recently by Dr. Turunen, and in the USSR.

The most regular stratification can often be identified by comparing ionograms on different days at the same solar zenith angle (approximately constant LMT at the solstices).

As the height of the E layers decrease a second phenomenon can be seen, namely the formation of a low Es with well defined actual frequencies. This shows first at 0800, in the noise, but is clear at 0815 when foEs=fbEs=018. The second order trace is clear and shows that the Es is too thin to give observable retardation but thick enough for foEs=fbEs. By 0830 its critical frequency has increased almost 2 MHz, still well below foE. As has been stressed before this structure is usually remarkably regular and has a quite different morphology to other types of Es. In these examples h'E is clearly greater than h'Es (the existence of the Es trace can be shown in the h'E table by adding -A to the height, e.g. at 0815 h'E=115-A. When the sun is higher the main E trace moves down and the distinction is no longer possible.

I would like to know whether you prefer the ionogram interpretation given alone, as in previous Uncle Roy Columns, or would like them to be complemented by some physical interpretion as in this example?

XIII. Sixth International Symposium on Equatorial Aeronomy Aquadilla, Puerto Rico 17-24 July 1980

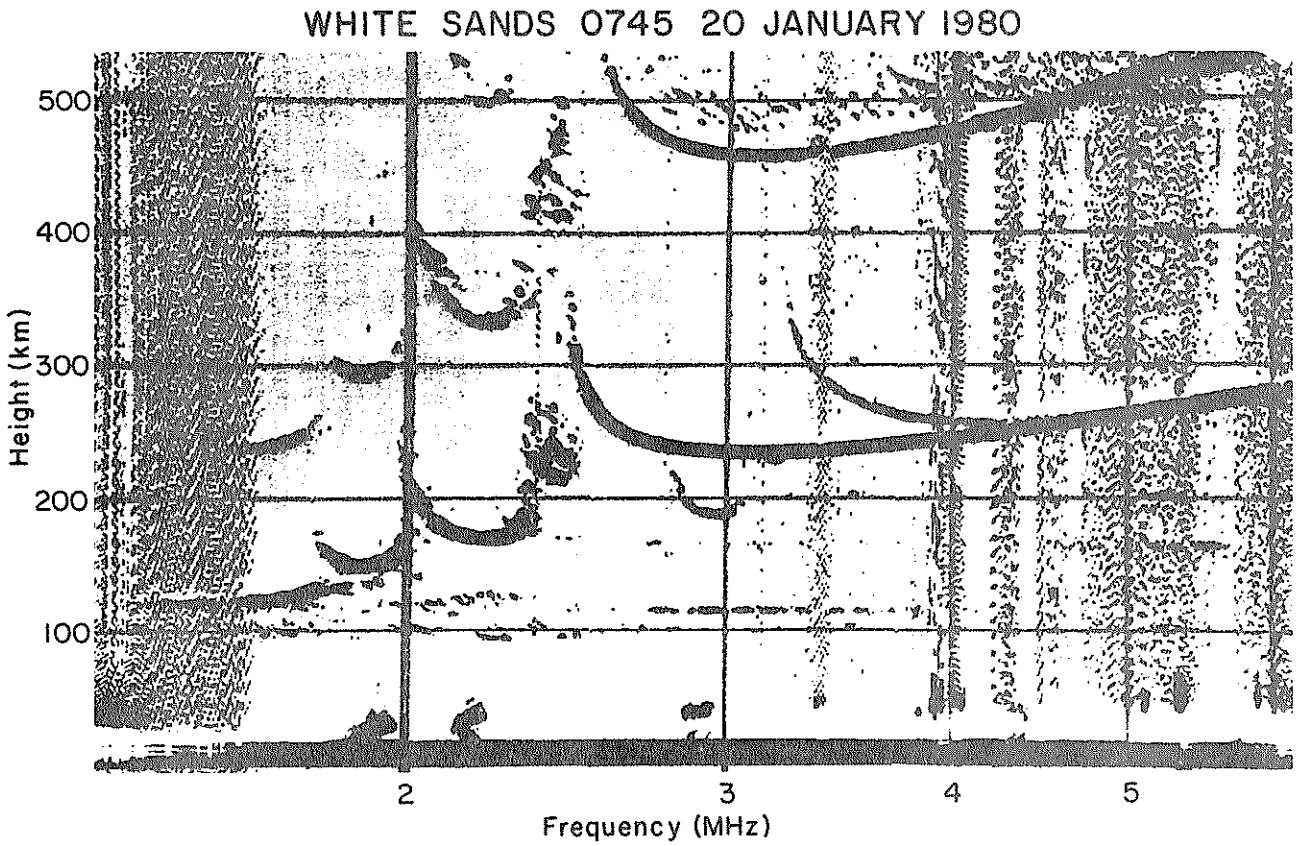
The Chairman attended the Sixth International Symposium on Equatorial Aeronomy at the invitation of the Symposium organizers and with financial support from IAGA and KEL Aerospace Pty to whom he wishes to return thanks. The reason for this support was that several leading scientists felt that inadequate attention was being given to low latitude ionogram data and that this would be a good opportunity to interest some of the many Equatorial scientists in their possibilities. Some members of INAG (including the Chairman) have also felt that low latitude ionograms deserved further study but there has been little interest from the groups involved.

INAG display

A display of INAG material; the Handbooks, Atlas, High Latitude Supplement and INAG Bulletins were set up throughout the meeting together with ionograms showing equatorial ledges, tilt effects, etc., and generated much interest - many of the scientists present were quite unaware of the use of ionograms.

VI Session

A special evening session was set aside for INAG and VI problems and attended by over 50 of the participants. The Chairman reviewed the information available from ionograms in some detail, especially discussing the significance of the abnormal ionogram patterns seen at low latitudes, methods of identifying tilts in the reflecting layers, field aligned irregularities and equatorial spread F and the use of ionosondes to study the movements of the equatorial anomaly ridges and the presence of subsidiary ridges. This aroused much interest. The consensus was that someone interested in the interpretation of ionograms should take the lead by publishing a paper showing the possibilities after which there would probably be more support. Several members of the Symposium expressed support for existing or proposed stations.


WHITE SANDS 0745 20 JANUARY 1980
500
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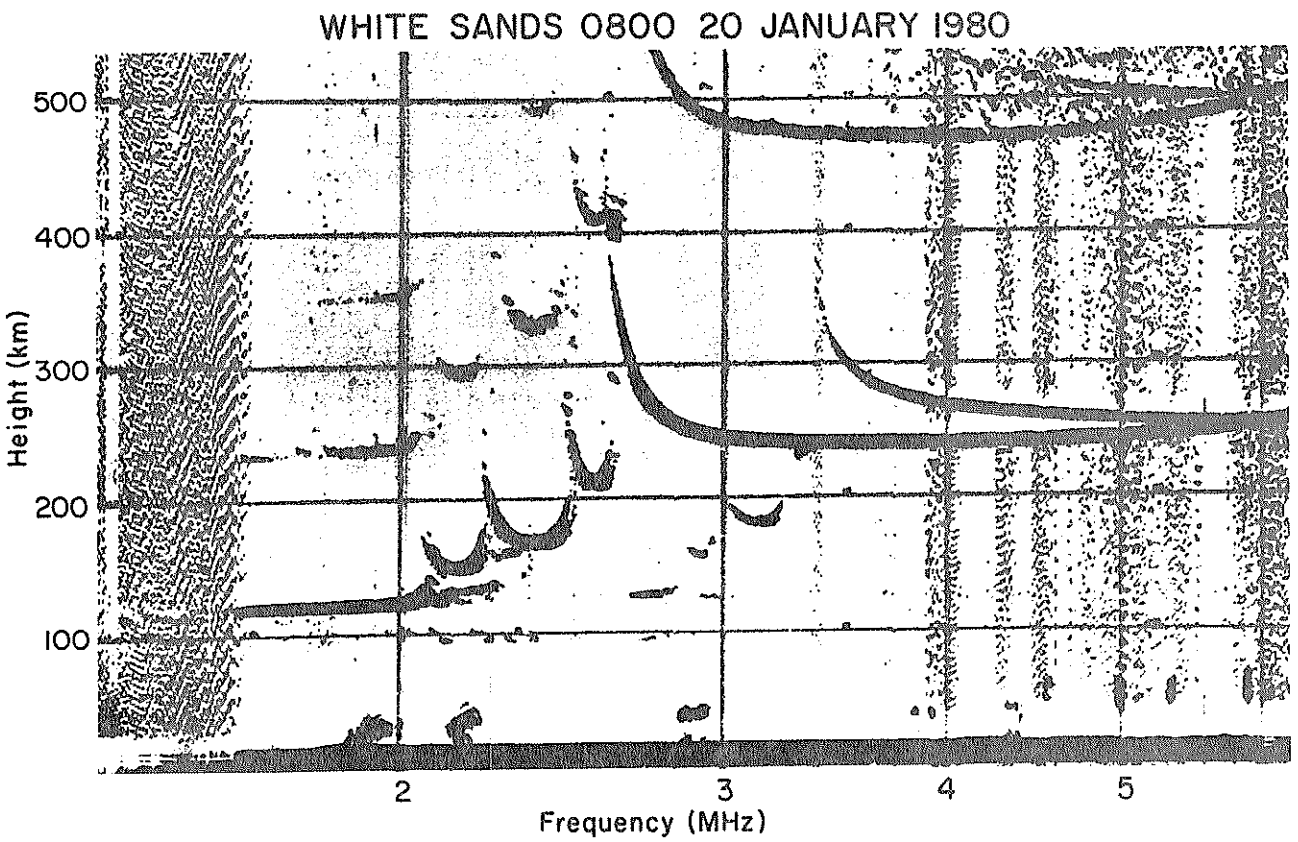
200
100
Height (km)
2
3
4
5
Frequency (MHz)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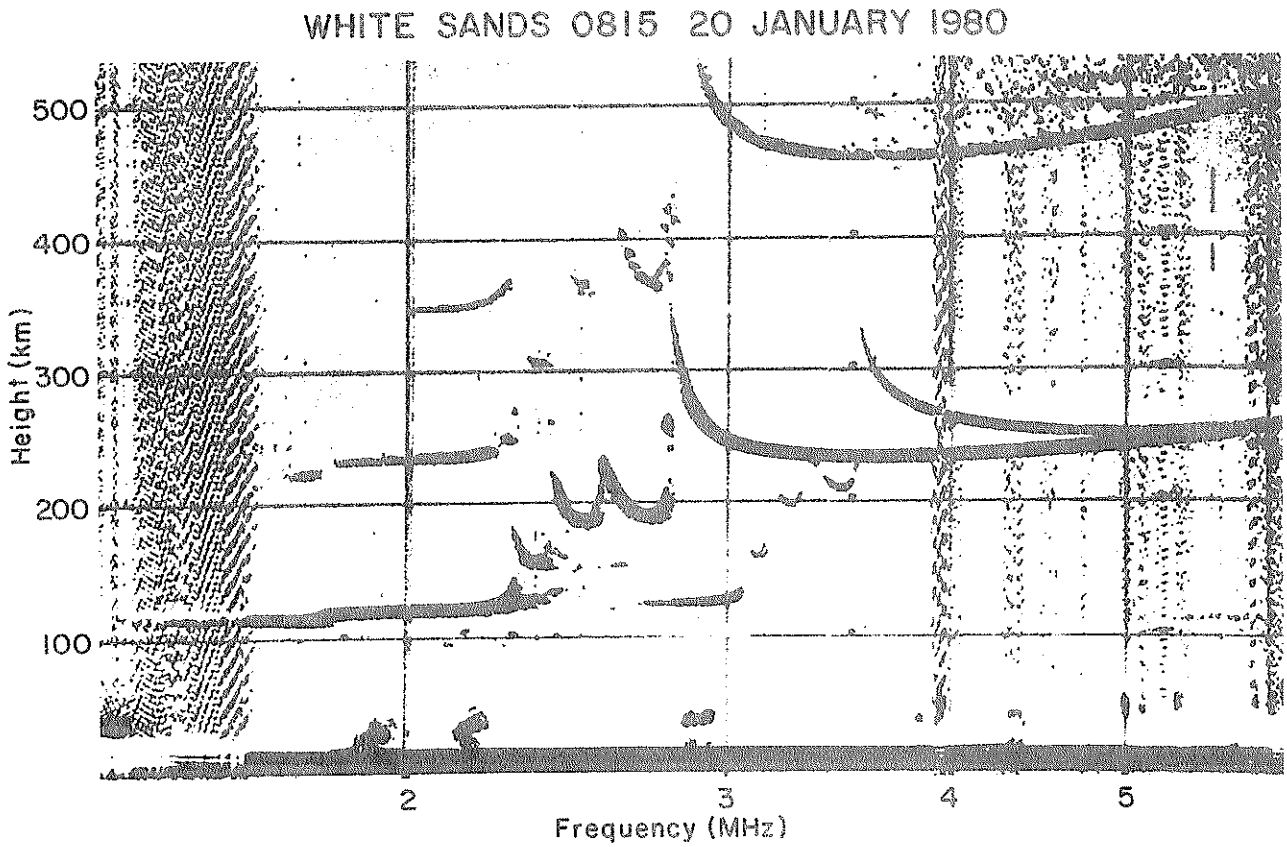
Frequency (MHz)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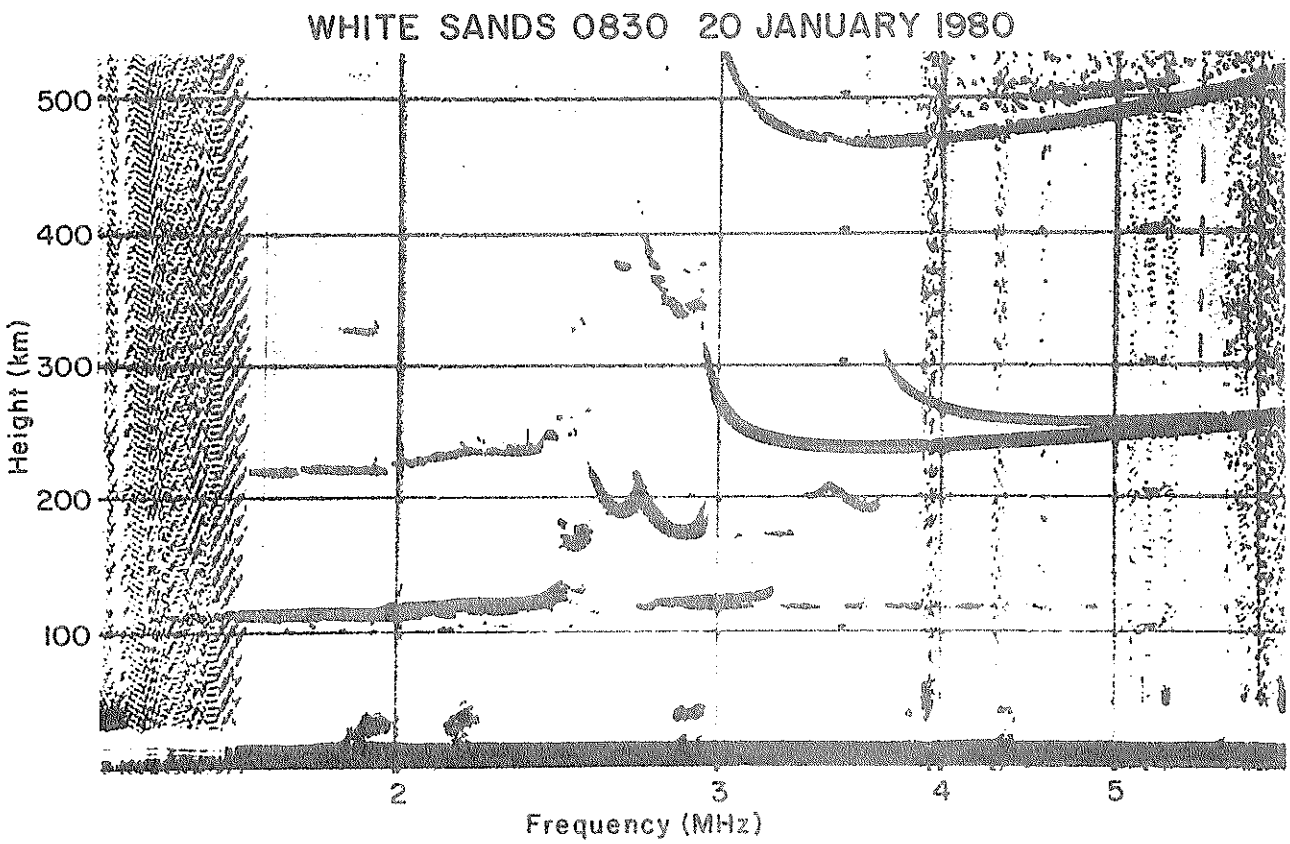
Frequency (MHz)


WHITE SANDS 0830 20 JANUARY 1980
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Height (km)
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Frequency (MHz)

Spread F

The use of ionosondes to identify the initiating phenomena which cause spread F appeared promising. Equatorial spread F starts at the extreme bottom of the F layer bubbles forming in the region whose buoyancy carries them upwards throughout the layer. Rapid difussion along the field lines generates strong field-aligned irregularities with large electron density changes. These are, of course, nearly horizontal in contrast with the similar but near vertical field-aligned irregularities seen at high latitudes. These problems were being intensively studied by the incoherent scatter radars at Jicamarca and Arecibo as it was very unlikely that incoherent scatter radar could be put at other longitudes, ionosondes should be used to fill the gaps. However more work comparing ionogram and incoherent scatter data of the existing stations was most desirable. The incoherent scatter scientists have large and active programs and need the support of scientists who can scale and interpret the ionograms.

Ridges and Tilts

Tilts similar to those at the plasmapause trough and ridges are found at low latitudes but the relatively slow motion of the ridges enables the detail of the change in tilts to be studied easily. Since the magnetic field was nearly horizontal, variations of foF2 with latitude should show up as changes in electron density with height at stations between the Appleton anomaly peaks. Thus the so called 'lunar layer' where part of the F ionization appears to move outwards at certain lunar hours should be reinterpreted as a lunar controlled horizontal movement of a subsidiary ridge. Subsidiary ridges are observed both inside and outside the main peaks of the equatorial F-layer anomaly but have been little studied as they appeared to need a close net of stations. Proper use of the data, taking account of changes in slope of the h'f patterns and evidence of tilt, should enable new work without such a network. The importance of linking low latitude phenomena with those at higher latitude was stressed together with the importance of data from the Southern Hemisphere which is more effected by wind and electronic field perturbations and is thus likely to be critical in the equatorial zone.

Network of VI Stations

A review of the equatorial network showed that, within 30° of the magnetic equator, there had been 55 VI stations operating at some epoch. Of these not more than 22 are contributing data to the WDCs at present and at many of these the data are very poor quality. The equipments mostly C2, C3, C4s are obsolete and many stations have financial difficulties, partly due to the value of the data not being recognized. A display of KEL publications aroused some interest. In a few cases, where a well thought out case had been prepared, local initiative had been successful in getting International support.

The following information was contributed by the participants:

North Africa. Prof. M. Crochet, University of Toulon, was interested in purchasing new equipment for deployment in North Africa where France was offering scientific and technical support.

India. 14 stations are in operation, of which two have modern equipment but several new ionosondes, including IPS-42s are on order. If successful in this theater a further five might be ordered.

Indian chain extension. When the stations in India were operating properly the Indian group would like to set up a new station in the Indian Ocean zone and would like to see a station set up in Ceylon.

East Asia Chains. The Chairman gave attention to the good chains of stations in Japan, Hong Kong, Taiwan and on the mainland of China and put the case for a new station south of Hong Kong as proposed at Geneva. This received general support scientifically. It would first be necessary to generate local interest at a suitable site and then look for a source of funds. Dr. Walker, Hong Kong University was requested to initiate action.

South American Chains. The participants supported the proposal for a new station in the 60°W chain (see Geneva report p. 7).

Low Latitude Ionogram Working Party

The proposals from the Geneva INAG meeting to set up a low latitude working party similar to that for The High Latitude and prepare a Low Latitude Supplement was considered. The work on this in the USSR was not known to the participants. The consensus view was that too few people were at present active and that an effort be made to get more Low Latitude ionogram interpretation for scientific purposes into the general literature first.

The Chairman of INAG would be prepared to collaborate with anyone wishing to do this.

CCIR Problems

The Chairman briefly reviewed the CCIR needs at low latitudes. While more accurate evaluation of the latitude variations of foF2, hmF2 and layer shape were needed for ray tracing purposes the large tilts in practice usually enabled transequatorial propagation with very skew paths. Thus the peak values of foF2 were most important. These could be deduced by satellite or from extrapolations and interpolations from reasonably close spaced chains of stations even when the peak was narrower than the station spacing. The extremely rapid fading, similar to auroral zone fading, was the main limitation at night when equatorial spread F was present. This degraded the cir-

cuits reflected in the equatorial spread F zones very greatly but did not prevent severe interference to other services - the signals were large.

The value of HF communications to developing countries at low latitudes was also stressed. These form the cheapest and, in practice, most reliable means of communication demanding less technical support for successful operation than more efficient satellite and VHF techniques but can only be used effectively if the basic predictions are reasonably accurate. There has been a considerable increase in such usage and trouble should be anticipated in two or three years when the present abnormally wide usable bands are restricted to those appropriate at solar minimum. The new users will then be in considerable difficulty.

Resolutions of Interest to the VI Network

The International Symposium on Equatorial Aeronomy (ISEA), in its formal planning session, passed the following resolution:

1980/3. The ISEA is concerned with the loss in number and quality of ionospheric sounding stations near the equator in recent years. There is an obvious and growing need for replacement of aging equipment and for new provisions of technical and scientific assistance at sites located in developing countries. The ISEA requests the attention of responsible world organizations such as URSI's INAG and CCIR to the establishment of a high quality minimal size network of sounding stations to serve the equatorial communications and scientific research needs.

XIV. Station Notes

Sofia and Michurin.

Prof. K. Serafimov informs us that the station at Sofia (42°41N 23°21E) uses a Hungarian IRX-59 ionosonde and the station at Michurin uses a Russian automatic ionospheric sounder.

XV. Atlas of Ionosphere for Regional Use - San Juan - Republic of Argentina

The Center of Regional Investigations, San Juan, Republic of Argentina has prepared in the Spanish language an "Atlas of Ionograms for Regional Use" by Marta Mosert de Gonzales and Leila Kurban. It consists of selected San Juan ionograms and recommended interpretation and reduction. Section I-A presents daytime ionograms, Section I-B night-time ionograms, Section II-A mid-day ionograms by season, Section II-B midnight ionograms by season, Section III-A "L" condition in F region, Section III-B multiple stratifications, Section III-C sequential Es. The URSI Handbook of Ionogram Interpretation and Reduction (Reports UAG-23 and 23A) was used for the general rules, but with modifications adapting them to regional requirements.

XVI. Correction Australian Ionosonde Operators Conference - Chairman

Unfortunately two lines were accidentally omitted after line 2 when retyping my note on the Australian Ionosonde Operators Conference reported on p. 10, INAG 29 with the result that the station at Mundaring, Perth, Australia, appears to be operated by New Zealand. This is, of course, wrong and I am greatly obliged to Dr. D.G. Cole for pointing out the omission.

XVII. Australian Operators Conference

There would be an operators conference in Sydney on August 7-8th, 1980, for IPS operators of ionosondes and others interested. The agenda would include problems of digitizing ionograms, computer handling of data. Research using the Australian data would be discussed.

XVIII. World Data Centers

At World Data Center A for Solar-Terrestrial Physics the catalog information for ionospheric vertical soundings, in a format resembling Report UAG-54, is now in computer form updated through October 1980. This permits rapid reporting of available data upon request.

The Catalog of Data in World Data Center C2 for Ionosphere No. 28 has been issued June 30, 1980, containing data from July 1, 1957, to March 31, 1980.

XIX. Obituaries

Dr. Yuichiro Aono.

Chairman Note. It is with much regret that we have to announce the death of Dr. Yuichiro Aono after a very long illness. Dr. Aono was a founder member of the World Wide Soundings Committee (Wine, Women and Song Committee) and played an important part in the preparation of the First Edition of our Handbook but was forced to retire before the formation of INAG. He was both a very able colleague and a most amusing man, adding a special contribution to the formation of a truly international cooperation in ionospheric synoptic measurements. I remember our collaboration as one of the most enjoyable parts of my life. The following is abstracted from the URSI Information Bulletin and IAGA News.

YUICHIRO AONO
1916-1979

Dr. Yuichiro Aono, the former deputy director of the Radio Research Laboratories in Tokyo, passed away on 20 May 1979, at the age of 63, after a long fight against diseases caused by cerebral apoplexy. He was appointed the technical official of the Radio Physics Commission, Ministry of Education (present RRL's antecedent) in 1941, devoting his efforts to the study of the ionosphere and radio wave propagation. He contributed very much to the development of automatic ionospheric sounder and invention of direct monitoring apparatus of the transmitter waveform. His scientific papers cover a variety of subjects such as the world distribution of ionospheric parameters, HF wave propagation, Antarctic research associated with high latitude ionosphere, rocket-borne ion probes, construction of large parabolic antenna for space research and telecommunications, etc. In addition to his scientific contributions, his administrative service is also to be noted. He was an active representative of the ionosphere discipline from the preparatory stage of the International Geophysical Year; he served as a member of the Special Committee of World-Wide Ionospheric Soundings of URSI as well as an executive member of the International Ursigram and World Days Service.

Lucile S. Hayden

The many friends of Mrs. Lucile S. Hayden will be saddened by the news of her death on July 26, 1980. Mrs. Hayden joined the CRPL in May 1954 in Boulder, Colorado. Throughout her career until her retirement in June 1973, she was supervisor of the Ionosphere Data Review and Research Group. Lucile became known worldwide for her skill in interpreting ionograms. She trained scientists in ionogram scaling for the U.S. Antarctic program. She was a consultant to INAG for many years. A major contribution of hers was the detail work done in the preparation of the "Atlas of Ionograms", Report UAG-10 edited by A.H. Shapley in 1970. For the 2nd Edition of the "URSI Handbook of Ionogram Interpretation and Reduction", edited by W.R. Piggott and K. Rawer in 1972, she rendered many services. In addition to providing critical comments and making numerous suggestions while checking the manuscript, she proofread the whole text carefully taking into account the large number of cross references. The ionospheric world has lost one of its strong workers.