IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

IONOSPHERIC STATION INFORMATION BULLETIN No. 46**

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

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1. Dr W R Piggott

by J A Gledhill, Chairman

With the retirement of Roy Piggott as Chairman of INAG at the XXI General Assembly of URSI in Florence, an era lasting since the inception of INAG in 1969 came to an end. Roy was proposed as first Chairman at the Ottawa Meeting of URSI in that year and his deep experience in all fields of ionospheric work has been evident ever since. None will forget the authoritative way in which he would dissect the core from a query and produce an answer that often surprised those present. The respect with which the ionospheric community regarded his opinions can be gauged by the number of ionograms sent to him for comment, especially since 1976 when he introduced 'Uncle Roy's Column' into this Bulletin. Always generous with his time, he would be happy to spend hours discussing topics such as the best antenna system for a particular site, the effect of ionosonde characteristics on the measured parameters, the significance of fmin or how to distinguish oblique traces on ionograms. I am sure that he is still prepared to do the same, perhaps a little more so since his retirement as Chairman of INAG! He has promised his continuing advice as Reporter for Ionogram Interpretation and Scaling Rules, together with Ray Haggard, our new Executive Secretary. Can we expect a small variation, to 'Uncle Ray's Column'? Not, we all hope, for a long time to come, for we all look forward to the continuation of Roy's interest and expert advice.

Roy produced the first of the INAG Bulletins in October 1969 and, with help from Virginia Lincoln and many others, he was responsible for 45 issues, containing over 1000 pages; more than a large book or, if you prefer, 64 pages a year. It is no secret that Roy wrote much of this himself. Looking over these issues of the Bulletin, one gets an impression of the broad field of competence he showed. Perhaps nowhere else is this so evident as in the long controversies about spread-F and Es types, matters that are by no means settled yet.

Under Roy's Chairmanship there appeared two editions of the URSI Handbook of Ionogram Interpretation, the Atlas of Ionograms and the High Latitude Supplement, among a host of less arduous publications. He visited fifteen ionosonde stations in South America, from the Equator to Antarctica, on INAG business in 1970 (while Genevieve Pillet did the same in Africa). The effects of these visits were very stimulating to the staff of these, often remote, stations, as we at Rhodes University found when he visited us in 1976.

In paying this tribute to the work of our ex-Chairman it is not too much to say that Roy Piggott was INAG. He was to be found all over the world conducting formal or informal meetings, holding discussions late into the night and examining ionograms that people had brought with them. He started the INAG tradition of holding a meeting with whoever was interested at any international or national gathering at which he was present, a tradition that your new Committee will do its best to follow, though it will be very difficult to emulate Roy's record. We are most appreciative of Roy's unstinting devotion to INAG, its welfare and its problems and we are very glad that he remains with us as a Reporter. A heartfelt thankyou, Roy.

2. INAG Meeting, Sydney, February 1985

by J A Gledhill, Chairman

An INAG Meeting was held on 13 February 1985 during the URSI-IPS Conference on the Ionosphere and Radio Wave Propagation. The attendance list was signed by 17 people from 7 countries, though there were several others present who did not sign.

The Chairman, Prof J A Gledhill, gave a short introduction.

The items for discussion included a document by Dr A Feldstein on a proposed scheme for interchange of N(h) data on computer tapes. It was agreed to include this in the next INAG Bulletin for discussion (see pp 6, 7 of this issue).

Dr P Wilkinson had submitted a very long document on the scaling conventions in use at IPS. Copies have been sent to Dr W R Piggott and Dr R Conkright. Comments will be eventually included in the Bulletin.

Ionosonde station network

In the general discussion that followed, Dr B M Reddy expressed concern over the closing of ionosonde stations. In India, for example, the number has decreased from 11 to 5 in the last few years. He suggested that INAG draw up a document urging not only the continuation of existing stations, but also the reopening of those that have been closed and encouraging the institution of new ones.

He was supported by Dr J R Dudeney who felt that it may be time for the ionosonde community to produce a successor to the report drawn up under the guidance of Dr H Rishbeth a few years ago. Since then there has been an increase in the number of ionospheric communication links. It should also deal with the world-wide distribution of vertical incidence ionosondes, indicating especially the areas where the lack of data was most acute (see Item 14, p 12 of this issue).

Oblique incidence studies

The Chairman suggested that it may be worthwhile asking those who have knowledge of existing and planned oblique incidence ionosonde links to inform INAG of their existence and characteristics and to encourage them, if possible, to send in at least MOF's and LOF's to the WDC's. Dr B Reinisch pointed out that there were several oblique incidence links using existing ionosondes. Dr G Pillet said that CCIR was to issue a document on the use of the ionosphere in propagation experiments. This will be discussed at its September meeting.

Finance

Dr Reinisch asked that a formal document asking for subscriptions to the fund for support of the Bulletin should be sent to those who may be able to pay. A flyer in the Bulletin was suggested. The Chairman undertook to look into this.

(In later telephonic conversation with Dr Conkright it was agreed not to send out the document with the Bulletin, since no Bulletin could be produced in the absence of the fund. Dr Conkright agreed to send a bill to each of those who had indicated the possibility of support.)

General

Mr T Kelly suggested that it would be appropriate for INAG to organise a Workshop on some of the important issues raised at the meeting.

3. The URSI-IPS Conference on radiowave propagation and the ionosphere, Ionospheric Prediction Centre, Australia

by D G Cole

The third Australian Conference on the Ionosphere and Radiowave Propagation was held at the School of Electrical Engineering, University of Sydney, during 11 to 15 February. Jointly sponsored by the International Union of Radio Science and the Department of Science Ionospheric Prediction Service (IPS), the Conference was attended by approximately 100 delegates. Twenty percent of the attendees were from outside Australia, representing Indonesia, India, the UK and the USA, New Zealand, France, the Federal Republic of Germany, Fiji and South Africa. Representative interests ranged from pure ionospheric research, through directed research and equipment development to specific applications and technology employed in areas ranging from defence to the needs of developing countries.

Approximately seventy papers spread throughout six symposia covered three main areas of discussion: knowledge of the ionosphere and its behaviour, techniques used and required for current and future support of systems connected with the ionosphere, and applications of electromagnetic wave propagation involving intra- and trans-ionospheric paths.

Current knowledge of the ionosphere focussed on deficiencies in understanding the irregularities that occur in the equatorial and polar regions. Even in mid-latitude regions, although there is now a good inset perspective of the F-region, it was pointed out that-there are still no short-term (hours) predictive schemes available (eg to predict the occurrence of the spread-F phenomenon other than on a statistical basis). There are also days when the ionosphere/ magnetosphere regime appears quiet although critical frequencies deviate significantly from current predicted values, with no mechanism yet identified. However, in the polar and equatorial regions, the understanding of disturbance initiators requires considerable further study. Problems within the equatorial region were addressed at length by a strong Indian contingent. The value of low-cost satellite beacon studies for scintillation and ionospheric electron content measurements was emphasised.

There was much discussion on the nature of Travelling Ionospheric Disturbances (TIDs) with a paper by David Whitehead (University of Queensland) arguing that there is as yet no unambiguous evidence that such irregularities do in fact travel!

In the area of techniques required both for research and for the support of ionospheric user systems, there was virtually unanimous agreement on the need for extensive real-time data acquisition together with automated data processing and scaling. Jack Gledhill (Rhodes University, South Africa) took pains to demonstrate that the older ionosondes can still provide almost state-of-the-art research information. However, they do so only at the expense of a large labour involvement. (This, of course, may not be significant in certain areas of the world, and can be used to achieve very worthwhile results.) In the area of user involvement and applications technology, real time frequency management of multiple circuit paths is becoming imperative.

Bodo Reinisch (University of Lowell, USA) presented a brief description of, and results from, the new class of digital ionosondes now being deployed at diverse selected sites around the world. These digital ionospheric sounders have the capability to separate the ordinary (o) and extraordinary (x) propagation modes, to measure direction of arrival of the returned echo, to perform Doppler analysis on all received signals, and to carry out limited ionogram scaling using a software package called ARTIST.

Presentation of the processed data is made using colour displays which effectively allow the simultaneous representation of 4 field parameters. Processed data and scaled parameters are available in near-real-time through remote interrogation.

Gil Webster (IPS, Sydney) reported on the development of a multi-station remote ionospheric data acquisition facility for the Australasian region. This facility, when completed, will allow user interrogation for real time frequency management purposes.

Terry Kelly of KEL Aerospace (Sydney) provided an impressive practical demonstration of their DBD43 remote access digital sonde capability. This locally developed system was used to display to conference participants the current state of the ionosphere over Sydney and then Boulder, Colorado, USA. All data acquisition was through the normal dial-up telephone network.

A number of papers addressed the large ionospheric research instruments now operating in Australia and elsewhere around the world. It was emphasised that the cost and spatial extent of these devices has invariably involved multi-national participation. The need for more of these larger facilities in the southern hemisphere was stressed. Such experiments could include high power coherent VHF or incoherent UHF radar scatter techniques to investigate irregularities, or an even higher power ionospheric heating facility to enable the conduct of 'controlled' ionospheric experiments. A proposal for a facility of the last kind is ASTIDGE (an Australian Travelling Ionospheric Disturbance Generator).

The fundamental tool of the ionospheric forecaster is an ionospheric model. John Dudeney reviewed the status of modelling. This review included the IRI, the Dudeney model and other models each suited to particular applications with corresponding limitations.

The largest attendance at the Conference was to the symposia dealing with practical applications of ionospheric radio propagation and its associated technology. A strong representation from the Australian Defence department, including the Defence Research Centre, Salisbury, emphasised the continuing need for, and the expanded use of high frequency communications within the Australian military forces. The use of high frequency circuits to carry traffic at speeds up to at least 2400 baud was stressed, together with the requirements and techniques needed to engineer and manage such circuits. Once again, the emphasis was on real-time channel evaluation leading to direct and immediate circuit management.

Peter George and Zeb Jeffery (Andrew Antennas, Adelaide) presented papers relating to the development of reliable HF direction finding techniques for search and rescue efforts.

Of great interest was the presentation of papers from the Project Jindalee group working on the Australian OTH-B radar. These papers included a discussion of the real-time frequency management system which was developed to support the main radar, detection of meteor echoes by multiple ionospheric paths, and the use of the radar to provide sea-state and wind information to the Australian Bureau of Meteorology. Such information could be particularly important in providing increased knowledge of tropical cyclone development and movement.

The great importance of HF communications to developing countries was espoused by Dr Koeswadi (Government Aerospace Research Centre, Indonesia) and Jim Wilkinson (South Pacific Bureau of Economic Cooperation).

The latter speaker made a particular plea for small research projects, techniques and equipment to help improve the use and reliability of high frequency communications and broadcasting within the South Pacific island groups.

The conference symposia were a good mixture of invited reviews and contributed papers. Two group discussions were also held both to examine past progress in understanding ionospheric processes, and to set goals for future research directions and anticipated applications needs. There was strong support for a formal worldwide ionospheric study period to encourage international cooperation and take advantage of interdisciplinary investigations with other related global studies. This matter will be taken up at an International level by Keith Cole (La Trobe University). Research during this period should involve not only the latest ground and space-based techniques, but should encompass intensive data reduction periods from the widely distributed ionospheric monitors already available. A short meeting of INAG took place during the conference under the Chairmanship of Jack Gledhill. Conference proceedings will be published by IPS. Inquiries should be directed to the Assistant Secretary, IPS, P 0 Box 702, Darlinghurst, 2010, Australia.

(Note: the proceedings are to appear in a special issue of Radio Science, with Peter Dyson as Guest Editor.)

4. New Digisonde Installations

Prof Bodo W Reinisch reports that during August 1984, David Kitrosser was at La Trobe University in Melbourne, Australia, to start operation of a Digisonde 256. During November 1984, the US Army in Fort Monmouth, NJ, started operation of a new Digisonde 256 updating the model 128. Oblique propagation experiments, using the 256's, between Fort Monmouth and the University of Lowell/GTE were scheduled to start during February 1985, as well as the transatlantic experiment between Slough (England), Dourbes (Belgium) and Lowell.

In November 1984, Dr Klaus Bibl and David Kitrosser were in Beijing to start the operation of Dr Xu's DGS 256, and install seven receiving antennae.

A full 256 system was planned for installation during May 1985 in Newfoundland, Canada, with remote control and remote data output for the Air Force Geophysics Laboratory.

By year's end six stations should be performing routine automatic scaling viz Goose Bay, Labrador; Slough, England; Argentina, Newfoundland; Dourbes, Belgium; Fort Monmouth, New Jersey and Melbourne, Australia.

5. Indonesian Stations

INAG has been informed of the location of 2 Indonesian ionospheric observatories where recordings are made of ionospheric vertical soundings, absorption - method Al (pulse echo) - and ionospheric drifts.

Station name	Geographic		Geomagnetic	
	Lat.°S	Long.°E	Lat.°S	Long.°E
Pameungpeuk	07° 40' 08"	107° 10' 46"	19° 10'	176° 13'
Biak	01° 08' 39"	136° 02' 46"	12° 20'	205° 39' 36"

Further information may be obtained from

J Soegijo
Aerospace Research Centre
Indonesian National Institute of Aeronautics and Space
P 0 Box 26
Bandung
Indonesia

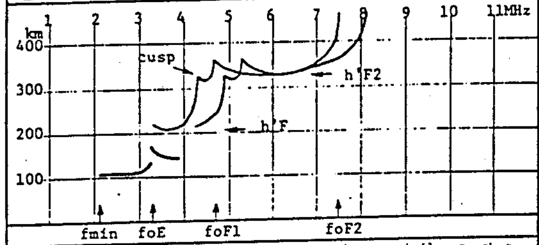
6. Japanese Manual of Ionogram Scaling

The manual starts with a brief description of a typical ionogram and the qualifying and descriptive letters used during data reduction, plus the associated accuracy rules. Thereafter the manual treats each of the 13 scaled ionospheric parameters separately, adhering to the philosophy of interpretation and the scaling practices recommended by the URSI Handbook of Ionogram Interpretation and Reduction, Second Edition, 1972 UAG-23) and the revised edition (UAG-23A).

Each section is preceded by a concise definition of the parameter, the scaling accuracy and special pointers concerning that parameter. This is followed by examples of typical observations with the correctly scaled value of the parameter indicated on the left hand page with the corresponding explanations on the right hand page (see example on page 5).

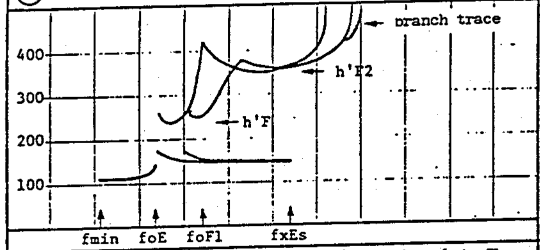
foF1 - 3

(9) The cusps by another stratification than the regular one are seen in the F1 traces



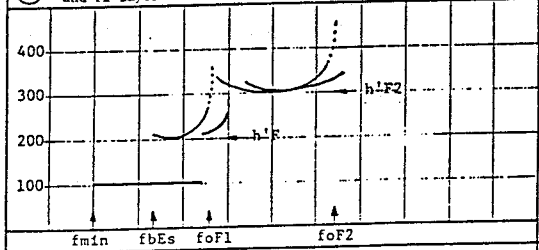
fmin	21
foE	325
h'E	105
foEs	39
fxEs	
h'Es	140
Es type	hl
fbEs	G
foF1	47H
h'F	205
h'F2	330
foF2	75
fxI	

(10) The shape of the ordinary component is not similar to that of the extraordinary one



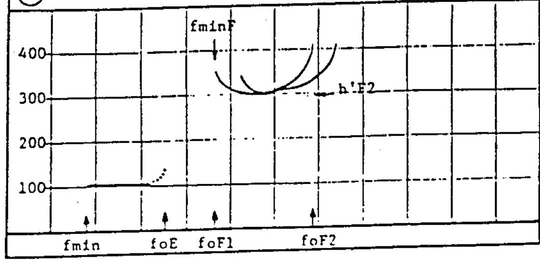
fmin	21
foE	335
h'E	110
foEs	J 58A
fxEs	64
h'Es	145
Es type	hl
fbEs	G
foF1	U 44H
h'F	235
h'F2	350
foF2	72
fxI	80

(11) The trace is weak near the critical frequencies of the F1 and F2 layers



fmin	20
foE	A
h'E	A
foEs	J 33A
fxEs	44
h'Es	100
Es type	ℓ1
fbEs	33
foF1	46R
h'F	200
h'F2	300
foF2	74R
fxI	

(12) The F1 trace is missing (Lacuna Effect)



fmin	18
foE	Y
h'E	100
foEs	Y
fxEs	
h'Es	Y
Es type	
fbEs	Y
foF1	U 46Y
h'F	Y
h'F2	295
foF2	69
fxI	

72

foF1 - 3

(9)

Observation : There is another cusp at 4.3 MHz than foF1 (4.7 MHz) in the ordinary wave trace (4.9 MHz for the extraordinary wave trace). Es is of the h type.

Interpretation : This kind of small cusp which seems to be caused by the oblique reflection or the TID tends to appear in the vicinity of foF2 and move to the lower frequency range with the passage of time. The incidence of the cusp in upper frequency range of F1 trace is expressed by marking the numerical value with the letters UH.

foF1 = (foF1) UH = 47 UH

Reference : When the cusp appears at the lower frequency range of the F1 trace, there would be no direct influence foF1, but on h'F. Therefore, only h'F is indicated with the letter H.

(10)

Observation : The shape of the ordinary and extraordinary components of the F1 trace is different each other. In addition, the F2 extraordinary wave trace shows a branch trace near the critical frequency.

Interpretation : The slant reflection causes the discrepancy in the shape of two component traces. Since it is interpreted that foF1 is doubtful, foF1 is expressed in a numerical value accompanied by the qualifying letter U and the descriptive letter H.

foF1 = (foF1) UH = 44 UH

(11)

Observation : Upper parts (dotted curves) of the F1 and F2 layer traces disappear. The trace in the E region is only the ℓ type Es.

Interpretation : Disappeared part of the trace is considered to suffer from the deviative absorption (letter R). Since the deviative absorption increases with the frequency, the trace usually becomes weak towards higher frequency. Depending on the frequency gap of the disappeared part, the scaling of foF1 based on the accuracy rules is made.

foF1 = (foF1) R, (foF1) UR, (upper end of trace) DR, or only the letter R.

In this Case, foF1 = 46 R.

(12)

Observation : No trace is recorded in the frequency range from 3.2 MHz to 4.6 MHz. The lower part of the F2 trace suffers from the retardation.

Interpretation : This is a typical example of the F1 Lacuna. Since the ionogram is obtained in the daytime, the trace in the E region is of the normal E layer and foE is inferred from the mean diurnal trend to a certain degree. foF1 can be scaled from the retardation at the lower end of F2 trace with some ambiguity. Therefore it is expressed with the qualifying letter U (doubtful) and the descriptive letter Y (Lacuna).

foF1 = (fminF) UY = 46 UY

Reference : The F1 Lacuna which extends from the normal E layer region up to the highest part of the F1 layer in this Case is characterized by sudden disappearance of traces on the ionogram (As for the details of Lacuna, see R.H. pp.53 ~ 57.)

73

The manual with its pleasing layout will be a definite asset in the training of ionogram scalers and its authors, N Wakai, H Ohyama and T Koizumi of the Radio Research Laboratories, Japan are to be congratulated on producing an excellent publication.

The authors have invited users to comment and provide suggestions for incorporation and improvement of the manual.

7. The measurement of M(3000)F2

by A S Rodger and S C Linton, British Antarctic
Survey, UK

It has been suggested (INAG 38, p8) that it may be possible to determine a value for the ratio M(3000)F2 by measuring MUF(3000) from the extraordinary (x mode) trace and dividing it by fxF2 rather by the agreed method which uses ordinary (o-mode) traces only (see UAG-23A, p23). This note reports on a detailed comparison of M(3000)F2 determined using both the o and x-mode traces separately from the same ionogram. It shows that no significant error will be introduced if the x-mode is used. Thus, it may be possible to obtain more numerical values of M(3000)F2 in cases where there is severe station interference of equipment failure, preventing the measurement of foF2 or MUF(3000)F2.

The parameters foF2, fxF2 and MUF(3000)F2 both for the o- and x-mode traces were measured from the Argentine Islands ionograms at the local hours 00, 06, 12, and 18 LT for the months of May, June, July, August and December 1983. The M(3000)F2 was evaluated separately for the two polarisations, then compared. An example for June 1983 is shown in Fig. 1. The data for all the hours analysed have been included and the line representing equal values of M(3000)F2 has been drawn. It can seen that nearly all values lie within +0.05, which is the scaling accuracy of the M(3000) parameter. For each month, and the entire data set, the lines of best fit and the correlation co-efficients have been evaluated and are shown in the Table.

Month	Gradient	Intercept	Correlation co-efficient
May	1.04	-0.11	0.99
June	1.04	-0.13	0.99
July	1.05	-0.15	0.98
August	1.08	-0.26	0.97
December	0.99	0.03	0.97
All data	1.05	-0.16	0.98

If the two M(3000) values were exactly equal, then the gradient would be 1.00, the intercept 0.00 and the correlation co-efficient 1.00. Thus, the values quoted in the table show no significant departures from the ideal. The scatter in the data reflects that there are minor inconsistencies in measuring the critical frequencies and the MUF values, possibly due to the ionogram scaler or caused by small north-south tilts in the ionosphere. When the data were considered separately for the four local hours analysed, the values of Mo(3000)F2 and Mx(3000)F2 were also found to be equal, with similar gradients, intercepts and correlation co-efficients as the monthly analysis.

The data set used in this study is representative of a wide range of different conditions e g foF2 was both close to and well away from the electron gyro-frequency (1.2 MHz at Argentine Islands), the difference between hx'F was both large and small. An illustration of the range of the combinations of foF2 and (hx'F - ho'F) used in this analysis are shown in Fig 2.

The conclusion that can be drawn from this work is that M(3000)F2 could be evaluated from either o- or x-modes with equal accuracy. Thus, it should be possible to evaluate (M300O)F2 more often than in the past. It is suggested that an appropriate modification should be made to the existing scaling rules. A value of M(3000)F2 determined using the x-mode trace should be qualified by J and described by the most appropriate letter to indicate why the measurement could not be made from the o-mode trace. Further work is required to determine whether a similar ruling for the scaling of M(3000)F1 could be made.

8. Preliminary format for representing N(h) profiles in digital form on magnetic tape

by A Feldstein, WDC B2, Moscow, USSR

With a view to preparing a revised form of the "Guide to International Data Exchange Through WDCs" we have prepared the following draft format and would be only too pleased to receive comments on its improvement.

Every ionogram (ie every N(h) profile) corresponds to the physical block of fixed length 2400 bytes. The length of a logical record is 120 bytes.

Positions	Format	Description
1 - 20	A 20	Station name
21 - 25	A 5	Station code
26 - 29	I 4	Geographical colatitude x10^1 (with tenths degrees precision). It varies from 0° over the north pole to 180° over the south pole
30 - 33	I 4	Geographical east longitude x10^1 (with tenths degrees precision) It varies from 0° to 360°
34 - 37	I 4	Year
38 - 39	I 2	Month
40 - 41	I 2	Day

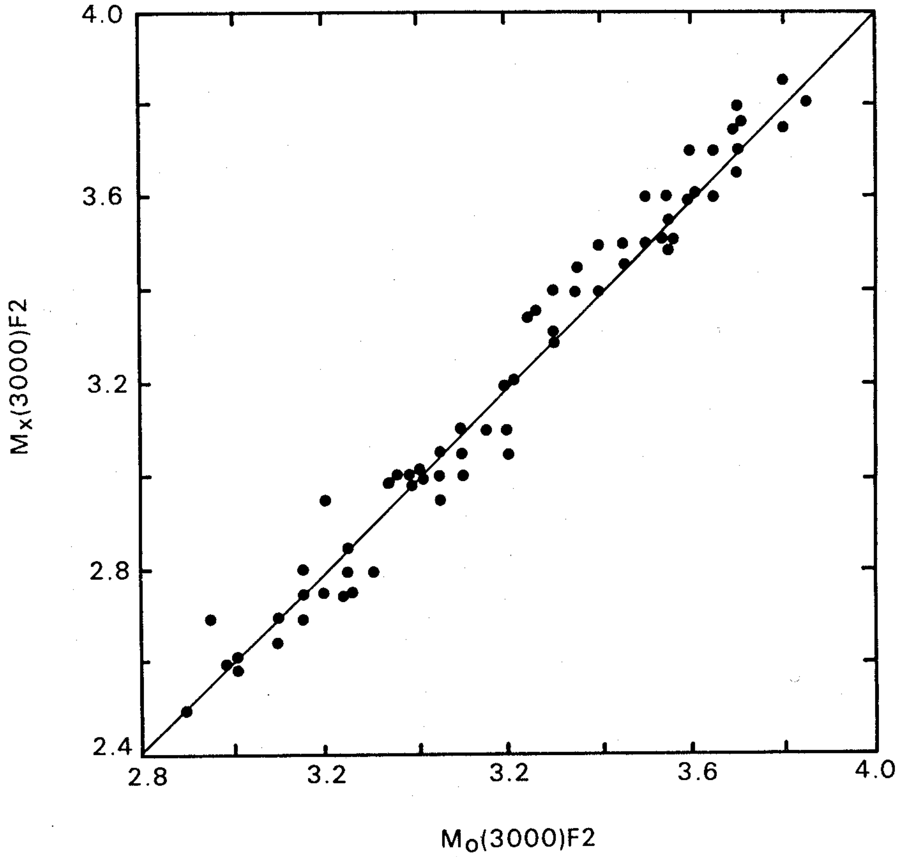


Fig. 1 Comparison of the M(3000) F2 parameter determined using o-mode and x-mode traces on the same ionogram. The figure includes data for 00, 06, 12 and 18 LT from Argentine Islands, Antarctica for June 1983.

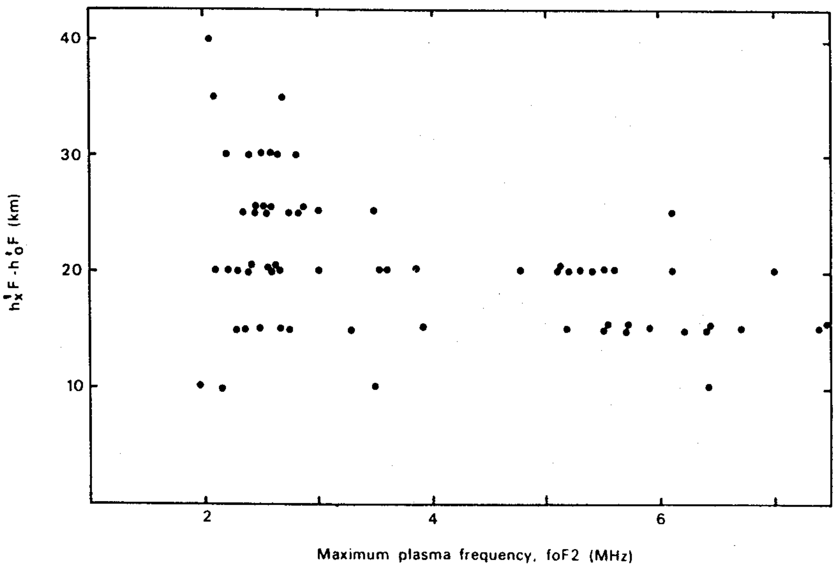


Fig. 2 The difference between the virtual heights of the x- and o-mode F-region traces (hx'F - ho'F) as a function of the maximum plasma frequency of the F-layer, foF2.

42 -	45	I 4	Universal time x10^2 (with hundredths pieces of hour precision)
46 -	49	I 4	Local time x10^2 (with hundredths pieces of hour precision)

50 - 51	A	2	Method of N(h)-profile computing
52 - 120			Blank (reserve)
121 - 12	I	5	Gyrofrequency f_H at 200 km, MHz ($x10^3$)
126 - 130	I	5	Magnetic dip angle, degrees ($x10^2$)
131 - 135	I	5	N_mE, cm^{-3} ($x10^{-3}$)
136 - 140	I	5	h_mE, km ($x10^2$)
141 - 145	I	5	N_mF1, cm^{-3} ($x10^{-3}$)
146 - 150	I	5	h_mF1, km ($x10^2$)
151 - 155	I	5	N_mF2, cm^{-3} ($x10^{-3}$)
156 - 160	I	5	h_mF2, km ($x10^2$)
161 - 165	I	5	F2 half width, km ($x10^2$)
166 - 170	I	5	Total electron content (TEC), cm^{-2} ($x10^{-10}$)
171 - 240			Blank (reserve)
241 - 244	I	4	Height h (km)
245 - 249	I	5	Electron density at this height (cm^{-3})
250 - 252	I	3	Scale height H_{sc} at this height (km)

There will be not more than 100 of such sets from three works (height, density, scale height), ie, the profile is approximated not more than 100 points. All points of the computed N(h) profile are arranged in accordance with height increasing, height and density steps are arbitrary (see appendix). The whole set of values occupies 1200 positions (from 241 till 1440) and if it contains less then 100 points the last word is delimiter: h=9999.

1441 - 1445	I	5	Ordinary wave frequency MHz ($x10^3$) f_o
1446 – 1450	I	5	Virtual height at this frequency km ($x10^1$)

There will be not more than 48 of such pairs (frequency, height), ie they occupy 4 logical records (positions 1441-1920). If amount of pairs is less than 48 the last word will be delimiter: f_o=99999.

1921 - 1925	I	5	Extraordinary wave frequency, MHz($x10^3$) f_x
1926 - 1930	I	5	Virtual height at this frequency, km ($x10^1$)
2396 - 2400	I	5	Virtual height, km ($x10^1$)

Again we have not more than 48 of such pairs and delimiter: f_x = 99999. Extraordinary wave data occupy positions 1921-2400.

Appendix

1. Every method of N(h) profile computing has its own code (positions 50,51). It is necessary to elaborate the rules to confer code.

2. Reserve in first and second logical records is used in dependence with method of N(h) profile computing. All included parameters ought to be described in tape documentation.

3. We use arbitrary step of points disposition along with help of interpolation. However it is desirable during preparing the tape to use uniform step along height (10 km) or along electron density (0,5 order of quantity). Additional points along the profile may be the points of the beginning (at frequency f_{min}) and the end (at frequency f_{max}) or any other characteristic points.

4. This format was worked out with the help of IZMIRAN and CISTP(GDR) colleagues and will be used for a rather small N(h) profile data base during the severe magnetic storm of February 1974.

9. Global Ionospheric Study (GIS), A discussion paper presented at the URSI-IPS Conference, Sydney.

This is reproduced for comment.

by K D Cole and C H Liu

Recognising

(i) the increase of interest in the ionosphere;

ii) the increase in the number and complexity of ionospheric techniques and instruments;

(iii) the need to understand not only local ionospheric processes better but to understand better the influence of the lower atmosphere, the magnetosphere and the solar variability on the ionosphere;

(iv) the special needs to develop further understanding of all global regions of the ionosphere viz. polar cap, auroral zone, mid-latitude and equatorial and their interactions;

(v) the need to understand not only the physics but also the chemistry and dynamics of the ionosphere and its coupling to the neutral atmosphere;

(vi) the impact of ionospheric research on plasma physics;

(vii) the possibility of controlled experiments on the ionosphere; and

(viii) the asymmetries of the ionosphere, atmosphere and geomagnetic field;

this meeting recommends that there is a need in the not too distant future for a global ionospheric study (GIS) by all possible techniques. The study should be international, interdisciplinary and take advantage of the possibility of other programs, eg, MAC, PAD, STETS, SIV or solar physics programs that may be in place.

Essentially the justification for an international and interdisciplinary program is that much local ionospheric behaviour is determined by coupling (electrically to) the distant ionosphere and solar wind, coupling dynamically and electrodynamically to higher and lower levels of the atmosphere, and chemically to the neutral gas. To have full understanding of the ionosphere we must understand these couplings.

The new techniques are:

(i) digital ionosondes;

(ii) the back scatter systems;

(iii) controlled experiments such as heating and modification;

(iv) in situ measurements from satellites;

(v) new data analysis techniques;

(vi) other radio and optical techniques;

(vii) Space Shuttle.

There is also a need for a low altitude (E region) polar orbit (short life) satellite.

The ionosphere has been overlooked in the scheme of international geophysical programs, eg, IMS, MAP, SMM. However these programs, especially IMS and to a lesser extent MAP, have made those communities of scientists aware of the importance of understanding the ionosphere, eg, in the case of Birkeland currents, their control by the ionosphere in providing a "load". Moreover, generally speaking, the ionosphere is a most important electrodynamic boundary in the complete plasma system of the earth and nearby space.

Keith Cole has been charged by the Bureau of SCOSTEP with the responsibility of sounding opinions amongst the community of solar-terrestrial scientists to see if a GIS is generally supported and felt necessary. He will report to the Bureau the findings from a survey of groups of scientists such as present here and from scientists individually world wide.

He would appreciate either an expression of opinion of the meeting as a whole or from individual scientists. His address is: Prof K D Cole, School of Physical Science, La Trobe University, Bundoora, Victoria 3083, Australia.

10. OSTMUF - A maximum usable frequency prediction program for microcomputers

A simplified MUF-prediction program, taken from QST, Dec. 82, "Minimuf 3.5", R B Rose, NOSC, is now available on magnetic tape, mini-diskette, or in document form. Originally written in BASIC for the TRS-80 microcomputer, modified versions have been written for the IBM-PC, Vector, and Apple-compatible microcomputers.

The HF sky-wave channel for radio communication is generally described as being bound by the lowest usable frequency (LUF) and the maximum usable frequency (MUF). The closer to MUF one operates, the more efficient the communications channel becomes. Because of MUF's variability on a day-to-day basis, controlled by ever-changing levels of solar activity and illumination along the path, and because sometimes it is vastly different than long-term predictions would show, a simplified MUF-prediction algorithm is a very useful tool. Given the date, transmitter and receiver locations, and the solar flux index or sunspot number count, an hourly output can be determined. The flux values can be acquired from WWV transmissions at 18 minutes after each hour. A conversion option from 10.7-cm flux to sunspot number is incorporated into the program. Another option has been added that allows the generated hourly-MUF values to be written to a data file. This allows utilisation of graphics packages, ie ENERGRAPHICS as well as other uses requiring instant recall of data in stored format.

As reported by QST, verification has been done with over 4700 test points of observable maximum usable frequencies measuring over 23 different HF-sounder paths. This algorithm was found to have an rms error of approximately 3.8 MHz. Current users find it useful from 2 to 50 MHz for MUF predictions out to 6000 miles. Accuracy degrades for ranges of less then 250 miles.

Upon request, specify adapted microcomputer version and medium of exchange. Full documentation accompanied; costs as follows:

Vector & compatibles	-	$30-00
IBM-PC & compatibles	-	$30-00
Apple & compatibles	-	$30-00
TRS-80 & compatibles	-	$30-00

Address your inquiries to Ray Conkright at (303) 497 6468 (FTS 320-6468) or write to the National Geophysical Data Centre, Solar-Terrestrial Physics Division (E/GC2), 325 Broadway, Boulder, Colorado 80303 USA. With your written request please include a check or money order payable in US currency to COMMERCE, NOAA/NGDC. Payment may be made through American Express, MasterCard or VISA credit cards. Please include the correct name of credit card holder, card number and expiration date. Prices are subject to change.

11. Report of the GRAZ meeting (on 3 July 1984) of URSI-G4/COSPAR Task Group on IRI

by D Bilitza, L Bossy and K Rawer

The greater part of the discussion concentrated on the forthcoming IRI (International Reference Ionosphere).

General decisions taken were as follows,

1. Although a "main stream" computing program is certainly needed ("official IRI") the possibility of admitting a choice between different subprograms shall be admitted, for example, descriptive subprograms which are only valid in a certain geographic or altitude region; the nomenclature must, however, clearly show which set of subprograms was applied.

2. It was reconfirmed that the mapping problem should not directly be dealt with in the group. However URSI shall be asked to restart a discussion on this subject. A working group on this problem was established by URSI-G.

3. The decision of the Stara Zagora Workshop was reconfirmed according to which a global description of average ionospheric (plasma) drifts should be given by a computer program in the IRI program family. E Kazimirovsky (Irkutsk, USSR) was nominated reporter on this subject (see his paper in the proceedings of Stara Zagora and of Graz in Adv. Space Res.)

As for the individual tasks in the IRI frame the following recommendations were accepted:

4. Electron density profiles to be described by LAY functions independent in three altitude ranges (Rawer's proposal of 1982).

   4.1 Topside (reporter D Bilitza)

   Better description for sunlight hours at low latitudes by a continuous function of the modified dip (MODIP) so improving the crude description of Bent's.

   Introduce a third member in the height dependence in order to obtain a better description at altitudes above 1000 km.

   4.2 Middle Atmosphere ie between the F2-and E-peaks (reporter T L Gulyaeva)

   Use more information for profile analysis of ionograms and mark characteristic points (as proposed by the reporter). Use at least 3, possibly 4 members in the height-dependent formula.

   4.3 Lower ionosphere (reporter Y V Ramanamurty)

   Reproduce the 80 km stratification but disregard others which are only occasionally observed, or unstable.

   Use 3 members provisionally, disregarding the C-layer.

5. Temperature profiles (reporter D Bilitza)

   At present done by "Epstein transition" functions.

   5.1 Ion temperature

   No new inputs received. Agreement with neutral temperature at low altitudes still asked for by COSPAR but new CIRA profile not yet established.

   5.2 Electron temperature

   Try to combine different data base (see paper Bilitza-Brace-Theis to come out in Adv. Space Res.). Compare with data measured in recent USSR satellites (see papers by Chasovitin et al. and by Smilauer et al. in the same proceedings). Mainly describe the average profile without taking account of electron density variations but specify a relation between temperature and density variations so as to be able to take account of it whenever actual density data are at hand.

6. Ion composition profiles

   Interchange of proposed new profile formulas (eg paper by Danilov et al. in the same proceedings) between WDC's-A and -B. As for the lower ionosphere try to establish descriptive formulas for positive clusters as a whole and ratio of negative to total ions (see paper by Kopp in the same proceedings).

The proceedings of the Graz 1984 Workshop are in print:
Adv. Space Res. vol 5.

As a basis for future discussion one of us (D B) has established a new program tape (IRI 9) which takes into account some of the above desiderata.

The discussion is to be continued at a workshop on IRI to be held October 28 - 31 at Louvain-la-Neuve (Belgium).

12. Guide to International Data Exchange

by Henry Rishbeth

INAG Bulletin number 45 contained a draft of the Ionosphere section of the new WDC Guide, now in preparation, and planned for distribution in 1987. This draft was prepared at a meeting of WDC and INAG, held at the Rutherford Appleton Laboratory, UK, in July/August 1984. Some modifications have been made to the text of the Ionosphere section in response to comments and suggestions made by WDCs, members of INAG, and the scientific community. The fact that the comments were not numerous suggests that the community is on the whole satisfied with the proposals.

The main part of this document, dealing with Vertical Incidence Soundings, is essentially complete. A few sections (oblique incidence sounding, total electron content, scintillations and meteor winds) remain to be completed. Professor Gledhill, Chairman of INAG, has given approval for the vertical incidence section of the new Ionosphere Guide and it may now be regarded as being in force. INAG is also being asked to make recommendations for the "Oblique Incidence" section of the Guide.

The complete new edition of the "Guide to International Data Exchange" is being written by a Task Group of the ICSU Panel for World Data Centres. It is intended to take account of today's circumstances in which World Data Centres and their many suppliers of data, actually have to operate - instead of the more idealised circumstances in which the early editions of the Guide were written. It is scheduled to be completed and distributed in 1987.

13. Report of the INAG Meeting, Prague, Czechoslovakia

A short INAG meeting was held on 15 August 1985 during the IAGA General Assembly in Prague, Czechoslovakia. The meeting was attended by 18 people representing 10 countries.

Participants:

T Kelly	Australia
Ts P Dachev	Bulgaria
R Koleva	Bulgaria
F Blahak	Czechoslovakia
J Boska	Czechoslovakia
K Kubat	Czechoslovakia
P Perglerova	Czechoslovakia
P Triska	Czechoslovakia
M Kivinen	Finland
A Ronta	Finland
G 0 Walker	Hong Kong
R Haggard	South Africa
(INAG Secretary and Chairman for the meeting)	
A W V Poole	South Africa
(Assistant Secretary for the meeting)	
C F Alberca	Spain
J 0 Cardus	Spain
M Pinnock	UK
J H Allen	USA
E S Kazimirovsky	USSR

Apologies:

D G Cole	Australia
P J Wilkinson	Australia
J A Gledhill	South Africa
(INAG Chairman)	
M Hapgood	UK

1. Chairman's Introduction

The Chairman welcomed the participants and thanked them for making the effort to attend the meeting at such a late hour in the evening, he further reported that every effort would be made to hold the meeting earlier during future symposia since many participants had expressed regret at having the INAG meeting slotted in at the end of the Assembly when many participants had already departed.

2. WDC Guide to International Data Exchange

The Chairman circulated copies of the draft Guide to International Data Exchange - Ionosphere, drawn up by the ICSU Panel on World Data Centres and edited by M A Hapgood and H Rishbeth. He further reported that the section of the Guide dealing with vertical incidence soundings had been approved by J A Gledhill, the INAG Chairman.

The Chairman noted that section 3.2 – Oblique Incidence Sounding of the draft Guide was outdated and suggested that a sub-committee of INAG should be established to find out as much information as possible concerning existing oblique incidence links and which parameters should be scaled. He further noted that oblique incidence soundings, though often neglected, could be a powerful tool for the researcher in that inaccessible areas could be covered using oblique incidence ionosondes and hence obtain information of the overhead ionosphere parameters there by means of comparison with conventional ionosondes on board ship or airborne ionosondes thus providing practical information which would improve communications besides the science that would be obtained from such experiments.

Unfortunately, there were no active researchers in the field amongst the attendees and T Kelly suggested that the Japanese be approached to co-ordinate the oblique incidence network since he believed they were very active in this field. T Kelly added that Kel Aerospace were working towards developing an oblique incidence facility on the new IPS 42's.

3. <u>INAG Bulletin 46</u>

R Haggard reported that INAG 46 was at last becoming a reality after the INAG Chairman had secured bridging finance to purchase a word processor on which to produce the Bulletin, since there had been several hitches concerning the voluntary contributions promised by several institutions. He also requested that institutions which wished to contribute towards the production costs of INAG Bulletin should forward their contributions direct to R Conkright. M Pinnock informed the meeting that British Antarctic Survey was very willing to contribute towards production costs but required an invoice before payment could be effected. J H Allen volunteered the services of his institute to assist in terms of receiving contributions and the issuing of invoices.

The INAG Secretary and Editor of the INAG Bulletin made an appeal for material for the Bulletin such as articles of interest to the community, station news and interesting or puzzling ionograms for interpretation, since no Bulletin can be produced without input from the user community. (Address on front cover.)

4. <u>Ionosondes for the 1990's</u>

A document entitled "Ionosondes for the 1990's" compiled by H Rishbeth and J A Gledhill was distributed to all participants for comments and possible additions especially on the proposed questions for consideration, a copy of the document follows this report.

T Kelly commented that there was a vast amount of overlap between the questions posed by the document and the MONSEE questionnaire, J Allen suggested that INAG could possibly obtain the responses for the MONSEE Bulletin update from MONSEE and collate them for the present questionnaire adding that the IGBP (International Geosphere-Biosphere Program) would need ground based data and that it was very appropriate to consider the questionnaire with these requirements in mind. J Allen also drew the attention of INAG to the fact that C H Liu was in the process of preparing an STP newsletter which would be mailed to 3,600 recipients and suggested that the document be forwarded to C H Liu by September 1985 for inclusion. M Pinnock suggested that a further question be added to the document concerning the additional support instrumentation required by an ionosonde station.

Another suggested question the document should address itself to was the type of ionosonde operated at the particular station and the data format (tapes, etc). T. Kelly suggested an additional subset d for question 6, viz. the importance of real time information for prediction services.

P Triska commented that the circulated document was extremely timely, in view of the proposed Global Ionosphere and Aeronomy Study period (GIAS), which would require a global network of ionosondes.

5. <u>New Stations and Station News</u>

D G Cole and P J Wilkinson informed the meeting by telex that a new ionosonde station has been operating at Davis, Antarctica since January 1985.

P Triska reported that the Prague ionosonde had been replaced by an IPS 42 ionosonde in September 1984 and that, in spite of radio frequency interference, the quality of ionograms had improved by an order of magnitude. In the past, only synoptic data was produced but with improved data quality they plan to use this data as a support for the Intercosmos programme.

6. <u>Semi Automatic Scaling</u>

P J Wilkinson in a telex to the Chairman promised to prepare an article for INAG on the IPS validity tables for scaling letter usage at a later date.

7. <u>Japanese Scaling Manual</u>

The Chairman drew the attention of attendees to the Japanese Scaling Manual and commented that IPS Radio and Space Services were using the manual to supplement their own normal training programme and have found it very useful.

British Antarctic Survey and Rhodes University have likewise used the manual to supplement their own programmes.

P Triska proposed that INAG formally thank Dr Wakai and his co-workers for producing the English edition of the manual. This proposal was readily seconded by M. Pinnock and the many other users present.

8. <u>General</u>

T Kelly suggested the formation of a users' group within the INAG community using IPS machines and stated that his organisation was willing to act as a collating agency; thus, the users as a whole would benefit from the experiences of other users. He further requested that INAG distribute agendas for future meetings well in advance so that attendees could prepare themselves more fully and hence provide far more positive input in the form of working sessions. This proposal was supported by G 0 Walker, who proposed that at the next INAG meeting an actual workshop be held, where participants could present ionograms for interpretation, etc.

14. Ionosondes for the 1990s

by H. Rishbeth (URSI & SCOSTEP) and J A Gledhill (INAG)

During the next few years, data from ground-based ionosondes will be needed for a number of international scientific programmes, culminating in the International Solar-Terrestrial Physics Programme of the early 1990s. The scientific community needs to ensure that an adequate network of ionosondes remains in existence. Your help is requested.

The ionosonde network took shape in the 1940s and became well coordinated at the time of the International Geophysical Year of 1957-58. Since then a network of 100-150 sounders -- now coordinated by the URSI Ionospheric Network Advisory Group -- has served ionospheric research in general, and provided support for several major international programmes. In 1977 an ad-hoc Working Group, set up under the auspices of URSI and IAGA, published a report on "Needs for Ionosondes in the 1980s", which appeared in INAG Bulletin No. 26 and in URSI and IAGA publications. The Working Group concluded that a substantial need for ionosonde data would remain after the International Magnetospheric Study, which was then in progress.

Since 1977 the ionosonde network has been largely revitalised with modern instruments, including a number of advanced digital sounders. Today, about 100 stations still send data to the World Data Centres, and there is a continuing demand for ionosonde data, both for scientific research and for communication purposes.

It seems timely to make a new survey of the scientific needs for ionosonde data. The 'network' is not an internationally organised project; it is a widespread collection of instruments funded by various agencies, largely to meet the practical needs of radio communications. All these agencies require the case for continued operation to be re-made from time to time. We ask members of the scientific community to take a little time to consider their own needs for ionosonde data, and to give their opinions on the operation of the ionosonde network generally. If you gave details of your ionosonde in reply to the MONSEE questionnaire, you need not repeat them, but please respond to the other questions.

Replies to the attached questions would be particularly helpful to us, but we would be glad to receive more detailed comments and suggestions from anyone. From the responses we will compile a report to be sent to appropriate national and international organisations by June 1986. We would appreciate receiving your reply by 1 March 1986. Please send it to: Dr H Rishbeth (R25), Rutherford Appleton Laboratory, Chilton, DIDCOT, Oxfordshire, OXII OQX, United Kingdom.

IONOSONDE QUESTIONNAIRE 1985

1. What are your own (or your group's) needs for ionosonde data in the next few years? We would like specific comments on sites or regions, in relation to (a) your participation, in particular, national or international projects (please specify); (b) your work in general.

2. What other national or international research programmes do you know of (even if you are not taking part), which may need ionosonde data in the next few years, say 1986-1990? Please give names -- or at least acronyms of actual and possible programmes known to you, and of the agencies responsible for them.

3. Ionosondes are largely operated for the benefit of radio communication. If your work is in this field, what use do you make of data from ionosondes other than those supported by your own organisation?

4. If you operate an ionosonde:

a. What type is it?

b. Where is it located?

c. How often does it operate?

d. For how long do you expect it to continue?

e. Is it used in conjunction with other instruments (such as an incoherent scatter radar)?

f. In what form is the data produced?

9. Are the data sent to a WDC, and if so, in what form?

h. If not, could the data be sent to a WDC?

i. Would you be willing to send hourly values of scaled parameters to WDCs in digital form?

5. Do you ever request ionosonde data from a WDC, and if so, on what scale?

6. Please comment on the actual or potential usefulness to your work. of:

a. Oblique incidence soundings

b. Phase or directional information from sounders

c. North-south or other chains of stations

d. Real-time information for prediction purposes.

7. Please make any other comments you may have, in particular pointing out any specific problems or needs of which you are aware.