IONOSONDE NETWORK ADVISORY GROUP (INAG)*

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*Under the auspices of Commission G, Working Group G.1 of the International Union of Radio Science (URSI)
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Issued by IPS Radio and Space Services on behalf of INAG.
People wishing to be placed on a mailing list to receive this Bulletin should notify the INAG Chair, Phil Wilkinson, or the INAG Secretary, Ray Conkright, WDC-A for STP, NOAA, Boulder, Colorado 80303, USA.

1. OBITUARY

SERGEJ CHAVADAROV

(24.02.1898-30.12.1992)

Contributed by: N. Danilkin

Professor Sergej Savelijevich Chavdarov, the former Head of the Ionospheric Radio and Propagation Department of Rostov-on-Don University (Russia), passed away on December 30, at the age of 94. The ionospheric world has lost one of its strong workers. He was a founder of the Rostov-on-Don Ionospheric School and one of the pioneers of ionospheric investigations in the world. He constructed the second ionosonde (1938) and the first absorption station (1939) in Russia. Sergej Chavdarov contributed very much to the development of Physics Education. His scientific papers cover a variety of subjects such as the physics, characteristics and global distribution of Es-layer, absorption in the D-region, construction of equipment for measuring ionospheric radio wave absorption, etc. In addition to his scientific contributions, he gave notable administrative and pedagogical service. His lectures and expositions amply demonstrated his great gifts of clear thinking and clear writing, and many of his lectures provided a first introduction to radio propagation and the ionosphere. Many of his pupils became famous scientists and good teachers.

Chavdarov was a physicist first and foremost. He was a person who was very faithful to science. His investigation of the 1941 Solar Eclipse serves as an example of this. It was war time, but it was also an extremely nice Solar Eclipse. Its ionospheric effect was great and long lived. The eclipse took place on September 21 and that day the German Troops attacked the city of Rostov-on-Don. Sergej Chavdarov was carrying out his measurement in the heat of battle. He finished his experiment accurately, destroyed the equipment and hid the results. After that he mounted his bicycle and left the city in the last line. After the war, this measurement was published.

Sergej Chavdarov retired in 1975, but for a long time he was a very good adviser for his numerous young colleagues and friends. Conversation with him never failed to be stimulating. His good and large scientific private library was presented by him to students. Not only his daughter Nadja, who supported him faithfully, and his grandson Sergej, but also his many friends and colleagues will cherish his memory and will miss the companionship and warmth of Sergej Chavdarov's personality.

2. Comments from the Chair

As always, my thanks to the people who have supplied articles and comments for the Bulletin. Special thanks are due to Dr John Caruana, of IPS, who proof read this copy of the Bulletin.

Several of the articles in this Bulletin discuss opening new stations and station networks, extensions to old networks and upgrading old networks, reminding us all that there is still an important future ahead for ionosondes. Each of these networks is different in operation, uses different ionosondes and different computer scaling software.

In the last Bulletin (INAG-58) there was a call for nominations for the positions of Chair and Secretary of INAG. If I receive more than one nomination for a person, I enter their names into a ballot for the positions mentioned. Since Ray and I were the only people in the ballot to record more than one nomination (several people did nominate both of us for our respective positions) I have recommended to the Commission G Chair, Prof. Wernik, that an election of officers is not required.

My thanks to the people who completed the questionnaire on the Bulletin. I would have liked more replies, but those that came in were welcome and helpful. An analysis of their opinions appears later in the Bulletin. Meanwhile, anybody who has not yet completed the questionnaire in INAG-58, please do so. The information will be useful to me.

I hope everybody has noticed that INAG now has an ISSN number. This is recorded on the front of the Bulletin. My thanks to Vivian To, of IPS, for arranging this for me.

One thing that would help me greatly in preparing the Bulletin would be for contributors of articles to send me the following items.

- a hard copy version of the text of their article, together with all the figures.

- an ascii file of the text on a 5¼" or a 3½" floppy disk. Those who are able, could send the file by email to my INTERNET address **phil@ips.oz.au.**

- If you are able to produce a Word for Windows (IBM PC version) file, I can also handle it.

Finally, 40 papers were offered for the INAG sponsored session at the URSI General Assembly, *Ionosonde Networks and Stations*. A list of these papers appears later in the Bulletin. Ray and I will make up a UAG report from these papers. Please note the publication details in the article.

3. Comments from readers

3.1. Gerd Prölss, Bonn University

Gerd has written several papers on ionospheric storms and has made use of ionosonde data along with satellite data. He made the following comments about data from ionospheric stations.

"As a frequent user of ionosonde data, I want to thank all those people who collect these data, make these data available to us and contribute to the maintenance of the global network of ionosonde stations. Without their effort, much of my research work could not have been carried out. Thank you very much indeed.

To make better use of the information contained in ionograms, they should be reduced to real height profiles. In the past, WDC-A (R. Conkright, G. Talarski) offered a service at a reasonable price. I would like to add that they did an excellent job. I have now been informed that this service has been discontinued, and should it be resumed, it will be at a significantly higher price. One way out of this dilemma would be for users to reduce the ionograms themselves (using, for example, the POLAN program of Titheridge). There is, however, one lesson I have learned from the INAG Bulletins, namely that reducing ionograms can be quite a tricky business which requires a great deal of experience. I thus prefer to let experts do the job.

Therefore my suggestion is that the World Data Centers continue to offer an ionogram reduction service at a reasonable price. Considering that labor costs in the Eastern European countries are lower than in the West, I wonder whether WDC-A (Boulder) and WDC-B2 (Moscow) could jointly offer such a service."

Unfortunately, I have had this letter for some time now, so the respective labor costs may not be so favourable now. It is always good to hear from our "Users" and I welcome more comments of this type. A big effort goes into manually preparing scaled ionospheric data and this is often not given the recognition it deserves.

3.2. Alan Roger, BAS.

Alan wrote regarding the introduction of the scaling letter, the slash (/). Alan writes:

"I am very concerned over the philosophy underlying the proposed use of / for a variety of computer scaling tasks. My concerns are two fold.

i. The proposals that you are making are only applicable in the very short term. Most stations will make the transition rapidly and in practise, few will ever check their data by hand.

ii. I am most concerned that INAG is not insisting upon computer algorithms making an estimate of uncertainly for the parameters they determine. Many use curve fitting techniques and thus it would be relatively trivial to give an estimate of the 'goodness of fit' of the data to the curve, and thus determine accuracy."

Alan continues with some examples of his experience with one automatic scaling system that fails to handle HF interference bands.

I agree with Alan's concerns and I think they should be shared by all. However, I do not think it is all that easy to determine an error estimate. Those of us who have had experience with automatic scaling systems already realise they do not scale ionograms better than a person. Part of the reason for introducing the slash / was to increase the amount of computer scaled data available to people. However, I for one, feel that these data are not much use without ready access to the ionograms from which they were obtained. Hopefully, as CD-ROMs become more common, digital ionograms will be exchanged freely using this, or a similar medium. The problem is not small. I welcome all comments and discussion on computer scaling of ionograms. I feel it is one of the most important issues facing the INAG community.

3.3. Dr John Dudeney, BAS.

John has written to advise INAG that "the magnetometer and ionosonde station at Faraday station (65°S, 64°W), also known as the Argentine Islands, will be closed as a manned station from March 1996. The magnetometers and ionosonde currently sited there will cease operation then.

The closure of this station is a consequence of a wide ranging reappraisal of the whole of the British Antarctic Survey (BAS) programme. For the solar terrestrial physics work this has resulted in focussing field activity at Halley Station and at unmanned sites poleward of Halley."

John goes on to acknowledge the importance of the Faraday data sets and points out that BAS will explore the possibility of placing automated equipment at Faraday. He hopes to report on this further at the IAGA and URSI Assemblies.

3.4. Errata - from INAG-57

In "Equatorial Electrojet and counter electrojet" some words have been misplaced at the bottom of column 2, page 14. This is a "fingers" problem I have with my word processor at times. I apologise to anybody who became confused by the article. The double underlined words are in the wrong position. They should be deleted from the position where they are underlined and placed where they now appear in **bold**.

> "The presence of Esq traces on the equatorial ionograms and VHF backscatter radar echoes from E region due to westward drift of electrons during daytime are considered evidence of an eastward electric field (Fig.3 and 4). The disappearance of Esq irregularities in the ionograms and absence of radar signals due to eastward drift of electrons during counter electrojet times are considered as the presence of a westward electric field, if a proper evidence for **a** westward electric field. However, **in the presence of a westward electric field, if a proper** electron density gradient (negative electron density gradient) is present at E region heights, VHF backscatter radar signals can be observed. The negative electron density gradient necessary for the gradient drift instability to become operative during counter electrojet conditions is provided, on certain occasions, by another type of sporadic E layer known as blanketing Esq layers. The generation mechanism of Esq layers is given below."

4. A New Ionosonde Station - France TELECOM Research Center opens a new station in Africa.

by R Hanbaba
CNET
FRANCE

November 1st 1992 was a great day for French CNET (Telecommunications National Research Center). It has opened a new sounding station in Korhogo (lat. 9.27N; long. 5.38W), Ivory Coast, Africa.

About 630 km (400 miles) north of Abidojan, the capital city, lost in deep savanna, there stands the station. It is part of the main international project for the study of the Equatorial Electrojet. But so far, it is the first and only proof that both France and Africa are involved in this IEEY project. But more is to come soon; 10 magnetometers from Timbuktu to Abidjan, HF radar and a Fabry-Perot interferometer in Korhogo.

The main investments were made by the CNET, with the help of the French Government and based on a student exchange programme with Ivory Coast National University. Moreover, we are now training the Ivorians to interpret ionograms and run the station and in two months' time, they should be able not only to obtain but also to treat quarter hourly digitised images.

As Korhogo will become a main center for our measurement campaign, we are arranging to have it run as reliably as requested by scientists.

Now the work is yet to come from a scientific point of view, as we are collecting a lot of data. Long live the Korhogo station!

Details of the other French stations are given in the following tables.

The French network

Station name	Station latitude	Station longitude	Dates of operations
Lannion	48.75N	356.55E	01/1971 to present
Poitiers	46.57N	0.35E	07/1948 to present
Dakar	14.76N	342.58E	05/1949 to present
Ouagadougou	12.37N	358.47E	05/1966 to present
Korhogo	9.27N	354.62E	11/1992 to present
La Réunion	21.20S	55.60E	10/1981 to present
Tahiti	17.73S	210.68E	12/1957 to present
Kerguélen	49.35S	70.24E	02/1953 to present
Terre-Adélie	66.66S	140.02E	02/1951 to present

Station name	Lannion - Poitiers - Dakar Ouagadougou - Korhogo La Réunion - Tahiti	Kerguélen Terre - Adélie
instrument	IPS 42 + DBD43	R4F
raw data	magnetic tape cartridges or optical disk	film 35 mm/m
data reduction	scaling according to international rules	
regular reduced data after	1 month	1 or 2 years
recordings	15 minute	15 minute (5 minute recordings for 3 days centered on RWD)
form of available data : - ionograms	floppy disk or magnetic tape (CNET format : a floppy disk containing exec files indispensable to display ionograms is available)	film 35 mn
- monthly tables of median and hourly values	microfiche	
- median and hourly values	floppy disk or magnetic tape (URSI / Commission G format)	

5. Ionosonde Network In Pakistan

Pakistan Space & Upper Atmosphere Research Commission (SUPARCO) presently operates three ionospheric sounders in Pakistan, located at Karachi (24.95 N, 67.14 E), Multan (30.18 N, 71.48 E) and Islamabad (33.75 N, 72.87 E). Two of these are Digital Sounders while the third is an Analog Sounder. The two Digital Sounders, Digisonde (DGS-256), were procured from the University of LOWELL, Centre for Atmospheric Research (ULCAR), USA and were commissioned, at Karachi and Islamabad in March 1987 and December 1992, respectively. Since then, the two Digital Sounders have been operating at Karachi and Islamabad acquiring the ionospheric data at these stations at 15-minute intervals. Prior to the commissioning of a Digisonde at Karachi, the PIR-9 Sounder was shifted to Multan in March 1987, where it has been in operation ever since. Also, prior to commissioning the second Digisonde at Islamabad in December 1992, an Analog Sounder PIR-9B operated there for about 1½ decades. There is now a proposal to shift the PIR-9B Sounder to Quetta (30.22 N, 67.02 E) where a survey of the site for an ionospheric station has already been completed.

It is noteworthy that the two Digisondes, one each at Karachi and Islamabad, cover the southern and northern parts of the ionosphere over Pakistan, while the PIR-9 Sounder at Multan covers the central-east part. The ionosonde at Quetta will cover the central-west part of the ionosphere over Pakistan. Thus, the ionospheric station at Quetta, combined with the three existing stations, would provide a full coverage of the ionosphere over the country. The ionospheric station at Quetta will also enable one to carry out latitudinal studies of the ionosphere for Quetta and Karachi, and longitudinal studies for Quetta and Multan.

The salient features of Digital/Analog Sounders are given below :

DIGISONDE DGS-256 (MADE IN USA)

Peak Power Output: 10 kW
Pulse Width: 66 μsec at 200 Hz; 66 or 133 μsec at 50 & 100 Hz.
Pulse Repetition Rate: 50 Hz, 100 Hz and 200 Hz.
Frequency Sweep/Range: Logarithmic and Linear 0.5-30 MHz.
Sweep Duration: 20 sec to several minutes depending on frequency sweep, step size and frequency repetition rate.
Transmitting Antenna: Fixed high frequency broadband rhombic antenna of 600 ohms impedance.
Receiving Antennas: 2 x 7 Turnstile loops
Recording Method: Magnetic tape recorder, dot matrix printer and an automatic real time ionogram scalar for true height analysis (ARTIST) for on-line Data Post-processing.

PIR-9 and PIR-9B (MADE IN JAPAN)
Peak Power Output: 10 kW (Nominal)
Pulse Width: 50 to 100 u-sec (Variable)
Pulse Repetition Frequency: Line Frequency 50 Hz
Frequency Sweep/Range: 0.55 to 20 MHz
Sweep Time: 20 sec.
Transmit/Receive Antenna: Crossed delta with 45 meter central mast.
Recording Method: 35 mm Camera.

6. Digital Ionospheric Sounding System (DISS)

Major Cecilia A. Askue,
United States Air Force
Learmonth Solar Observatory, Learmonth, Western Australia
AUSTRALIA

In 1985, the United States Air Force (USAF) Air Weather Service installed the first Digital Ionospheric Sounding System (DISS) in Newfoundland, Canada, initiating a worldwide network of 19 such systems intended to provide real-time communication support for US defence customers. To date, 13 of the systems are operational in Canada, Greenland, the US, Puerto Rico, Bermuda and Australia. When the network is complete, DISS sites are planned to operate in Italy, the United Kingdom and Korea as well. The following paragraphs describe the configuration of the DISS, management of the DISS network, and use of DISS data in real-time and research modes.

At the heart of each DISS is a Digisonde 256 vertical incidence ionosonde developed in the US by the University of Lowell Center for Atmospheric Research. The ionosonde system consists of a variable-power pulse transmitter, a wideband high frequency (HF) transmit antenna, seven circularly polarised receiving antennas, and associated transformers, switches, cabling and peripheral recording devices. In addition, the ionosonde system employs a dedicated computer to automatically scale ionospheric data using the Automatic Real-Time Ionogram Scaling with True Height (ARTIST) algorithm. A dial-up capability, via modem, and global connectivity through the Air Weather Service's Automated Weather Network complete the DISS.

In terms of system specifications, the ionosonde pulses the ionosphere over a frequency range of 0.5 to 30 MHz at a power level of between 1 kW and 10 kW. Pulse length, frequency size step, and pulse repetition rate are selectable. The sweep duration and scheduling are also variable to meet changing needs. Typically, USAF DISS ionosondes sound the ionosphere for about 5 minutes every half hour.

The USAF Air Weather Service is fielding the DISS to help meet its requirement to provide global space environmental support to US defence customers. Day-to-day management of the DISS network is a function of the Air Force Space Forecast Centre (AFSFC), an agency of the Air Weather Service. Located near Colorado Springs, Colorado, the AFSFC is the hub of space environmental support for the US defence community. The AFSFC uses data from the DISS in both a real-time (warning) mode for its operational customers and in a research mode for development of better ionospheric specification and forecast models.

In real time, military planners and decision makers receive AFSFC products based on ionospheric observations to support a variety of missions. The DISS network, as employed by the AFSFC, provides data used in preparation of these mission-tailored forecast and warning products. For example, users of HF communications depend on quality forecasts and warnings of ionospheric irregularities to schedule transmission times and choose optimum frequencies. Other users of ionospheric information include satellite system managers, radar operators and systems designers.

The ionospheric data requirements of operational, or real-time, customers undergo continuous scrutiny by AFSFC forecasters, as they seek better ways to specify and predict ionospheric composition and behaviour. The major portion of that effort involves production of improved ionospheric models and the development of a set of integrated space environmental models. Present ionospheric models at the AFSFC use climatological data based on effective sunspot number for initial characterisation of the northern hemisphere ionosphere. Then, due in part to sparsity of real-time southern hemisphere ionospheric data, the current models represent that half of the ionosphere, corrected for seasonal differences, as a mirror image of its northern hemisphere counterpart. Information from the DISS, including its Australian component, is vital for adjusting this representation to include observed anomalies before inserting it into a diagnostic or prognostic model. The ultimate goal is to link improved ionospheric simulations, using physically-based interfaces, to improved models of the neutral atmosphere, the magnetosphere and the interplanetary medium through integrated space environmental models.

In summary, the USAF Air Weather Service is installing 19 automated Digital Ionospheric Sounding Systems worldwide, each capable of providing scaled ionograms in real time. The AFSFC, an Air Weather Service agency, uses data from the ionosondes to provide mission-tailored ionospheric support to HF radio communication and frequency management, satellite systems, radar operations and systems design. In addition, the AFSFC is steering an aggressive effort to develop improved models of the space environment, including the ionosphere. The result of this on-going research will be more accurate operational support to US defence customers.

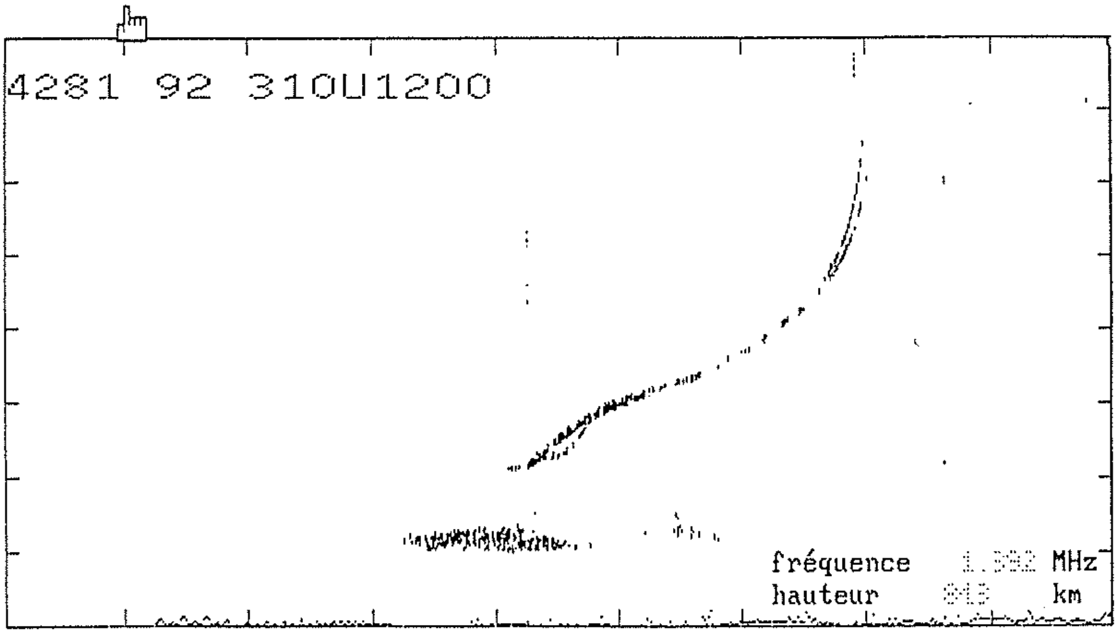
7. French Participation In The International Equatorial Electrojet Year (AIEE)

by R Hanbaba
CNET
FRANCE

A number of research groups have now joined the IEEY campaign according to their respective fields of interest, either by experimental surveys, or by more intensive modelling and analysis of the equatorial electrojet.

VISUALISATION D'IONOGRAMME

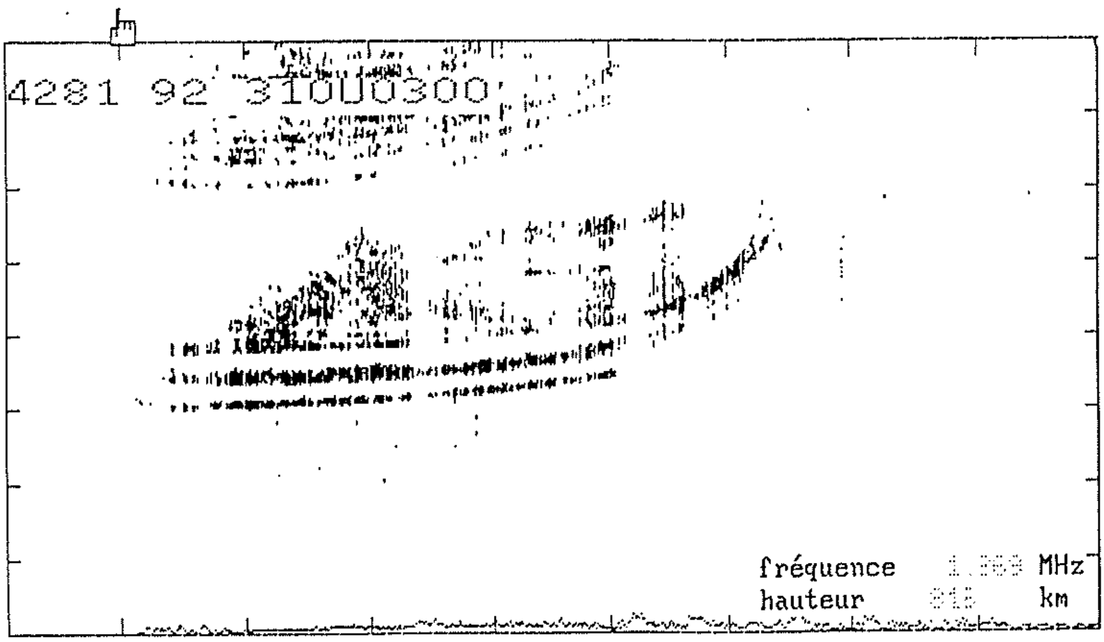
Iono suivant Défilement AR Défilement AV Impression Retour



fmin h'E foE tyEs h'Es foEs fbEs h'F foF1 m3F1 h'F2 foF2 m3F2 fxi
31 A402 AQ 103 47JA 41 210 H L L L111 250

VISUALISATION D'IONOGRAMME

Iono suivant Défilement AR Défilement AV Impression Retour



fmin h'E foE tyEs h'Es foEs fbEs h'F foF1 m3F1 h'F2 foF2 m3F2 fxi
16ES S 16ES 16ES301 Q 91 S241 S 71 Q

The French contribution will aim at:

⇒ acquiring an equatorial database during the IEEY : magnetometers, HF radars, ionosondes
⇒ analysing the data in relation to other networks and from other programmes
⇒ producing databases for selected events
⇒ modelling global current systems and validating the models for the whole set of IEEY experiments.

The objective for the "Service des Previsions Ionospheriques" (CNET) is to improve the prediction of ionospheric HF propagation and to build simulation models based on the physical properties of the ionosphere, especially during its disturbance phases. Within the framework of the IEEY, three ionosondes are operating:

Dakar (Senegal), Ouagadougou (Burkina Faso) and Korhogo (Ivory Coast).

Details on the new sounding station at Korhogo are provided in a newsletter from F. Jullien, student at "Telecom Paris", who deployed the ionosonde (see section 4).

The figure shows two ionograms recorded at different times November 5, 1992. The normal recording interval is 15 minutes, but sometimes 5 minute recordings are made. Ionograms are scaled at the station. A new and flexible operating system is used and the data are recorded on optical disk.

8. SIN, the Swedish Ionosonde Network

Bengt Lundborg[1], Christer Jurén[2], Ove Klang[3] and Eugen Veszelei[1]

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Abstract

The three vertical ionosondes operated by the Swedish Institute of Space Physics on a regular, routine basis have recently been modernised and integrated with a data network. The new ionosondes function as coherent radars and can also be accessed by external users for scanning of ionograms for radio communication planning and studies of the ionospheric channel.

8.1. Introduction

The history of Swedish ionosounding activities has been described in an earlier INAG bulletin [H. Derblom, INAG 56]. To our knowledge, the first more or less regular ionospheric sounding in Sweden started in 1948 in Kiruna under the leadership of O. Rydbeck from the Chalmers Technical University (CTH), Gothenburg. Prior to that, W. Stoffregen at the High Tension Research Institute of Uppsala University in 1942 developed an ionosonde and published critical frequency data for the ionosphere above Uppsala for a period during 1942–1943. Regular soundings have been carried out in Uppsala since 1952 when W. Stoffregen founded the Uppsala Ionospheric Observatory (UIO). In 1956 UIO located an additional ionospheric observatory in Lycksele, half way between the existing stations in Kiruna and Uppsala (see figure 1).

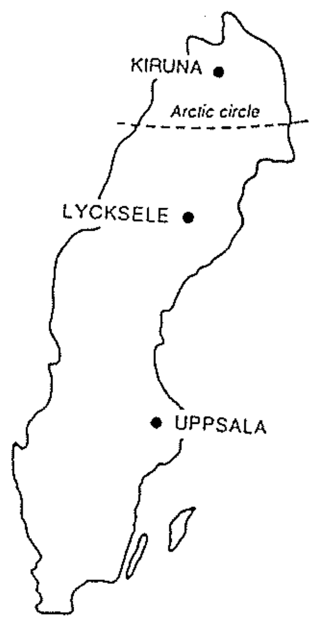

Fig. 1. Location of the three Swedish vertical ionosondes.

The organisational affiliation of these ionosondes (Fig. 1) has shifted with time; presently they are all operated by the Swedish Institute of Space Physics (IRF). They have been recently modernised and integrated with a data network to a new system baptised SIN, the Swedish Ionosonde Network.

The renewal of the Swedish ionosondes has been carried out in close cooperation between personnel from the computer group in Kiruna and observatory staff at the three stations. In the new network all ionosondes are almost identically equipped as follows:

state of the ionosphere should be of significant importance for frequency selection in HF communication.

The excellent capacity obtained with the transputer technology makes the system suitable for future expansions. Our plans involve pulse coding for improved resolution and signal-to-noise ratio, FFT for Doppler and spread measurements and interferometry for measurements of angle of

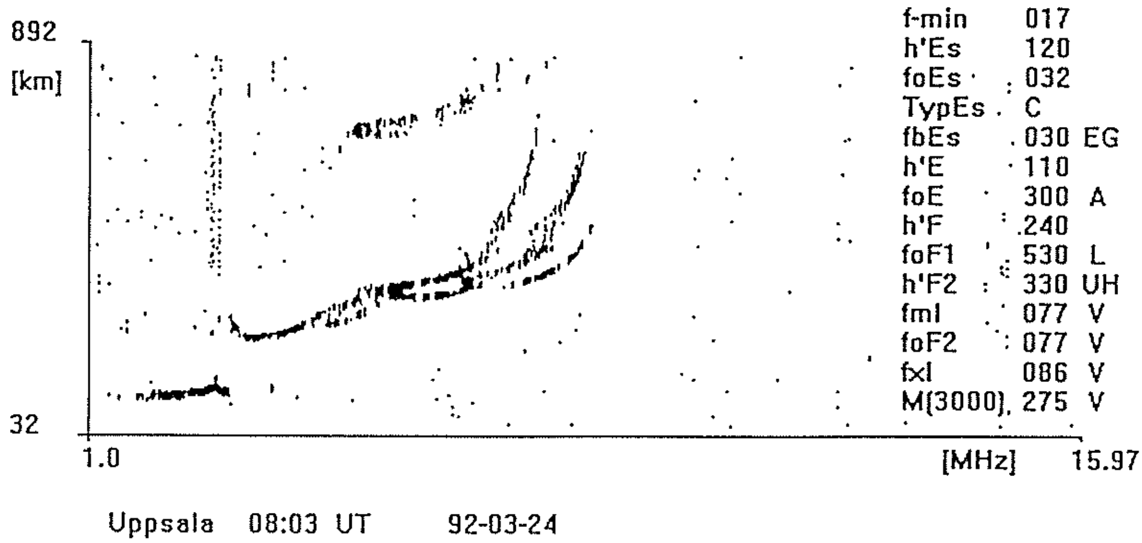

Fig. 2. Typical ionogram, virtual height h' versus frequency f, taken in Uppsala. The graph shows the computer screen for the interpretation program (Sec. 5) after scaling is completed.

- 800 W commercially built solid state transmitters (SRT).
- Receivers of Finnish design (T. Turunen).
- PC extended with a transputer-based unit constructed in Kiruna.
- Data communication between the stations via SUNET or phone line.
- Ionogram interpretation program for semi-automatic scaling.
- Ionogram data base at IRF Kiruna.
- Access to the network for external users.

A traditional ionogram presents returned signal power in a virtual height h' versus frequency f diagram (Fig. 2). However, the upgrading of the ionosondes also includes the possibility of running them in special modes. The ionosondes operate as coherent radars, and hence the phase of the echoes can be used for the accurate determination of ionospheric vertical motion and in detailed studies of the transfer function of the ionospheric channel. The access to near real-time information about the

arrival. For a somewhat more detailed description of the system we refer to [Lundborg et al., 1992].

8.2. HF equipment

The three ionosonde sites are uniformly equipped except for the antennas. Common for all sites, however, is that four wide band antennas, of vertical delta or horizontal loop type, are used. The frequency range 0.5–16 MHz is covered with two sets of antennas with switching between them at an intermediate frequency. In each of the bands, separate antennas are used for transmission and reception in order to reduce cross-talk.

The indoor part of the ionosonde system consists of an In-Quadrature-phase homodyne receiver, a solid state high power transmitter, a synthesised frequency generator, a phasing unit and a rack-mounted PC for control, signal analysis and data storage.

The received signal is attenuated in the AGC unit and subsequently adjusted by the computer so that the sampled signal is neither saturated nor too weak. Reception is presently confined to the frequency interval 1–16 MHz. The intermediate frequency is 21.4 MHz with a bandwidth of approximately 2 MHz. An option will be introduced to reduce this bandwidth to 30 kHz and then the receiver will allow operation down to the limit 0.5 MHz set by the transmitter and the antennas. The detector is of a conventional I-Q type with DC coupled basebands. The outputs from the receiver are amplified and frequency limited, with anti-aliasing filters, to a bandwidth of 20 kHz and connected to the A/D converter plug-in unit inside the rack-mounted PC. These signals are sampled with 8 bits per channel, up to a 1 MHz sampling rate.

The transmitter is a commercial, solid-state, high power transmitter with a total output power of 800 W, which can be operated in continuous mode or can be pulsed with pulse lengths down to 10 microseconds.

The phasing unit supports the transmitter and receiver with signals in such a way that the ionosonde system works phase coherently. Hence the use of the I-Q detector with its ability to detect both power and phase of the signal.

8.3. Ionosonde computer

The local computer system at each ionosonde is built in three modules, programmed in a coherent way and located within the ionosonde PC cabinet:

- The communication module is a program running in an ordinary PC.
- The computational module is a parallel program running on a cluster of five transputers with an optional signal processor. All software is defined and programmed in Occam – a very advanced parallel language.
- The controlling module is placed in a field-programmable logic consisting of two Xilinx-3030. This module is tight coupled to the computational module.

The whole system is totally reprogrammable, enabling quick alterations of the measurement process and efficient handling of the maintenance of the three ionosondes.

8.4. Communication and remote operation

The physical communication between Kiruna and Uppsala takes place via SUNET, the Swedish

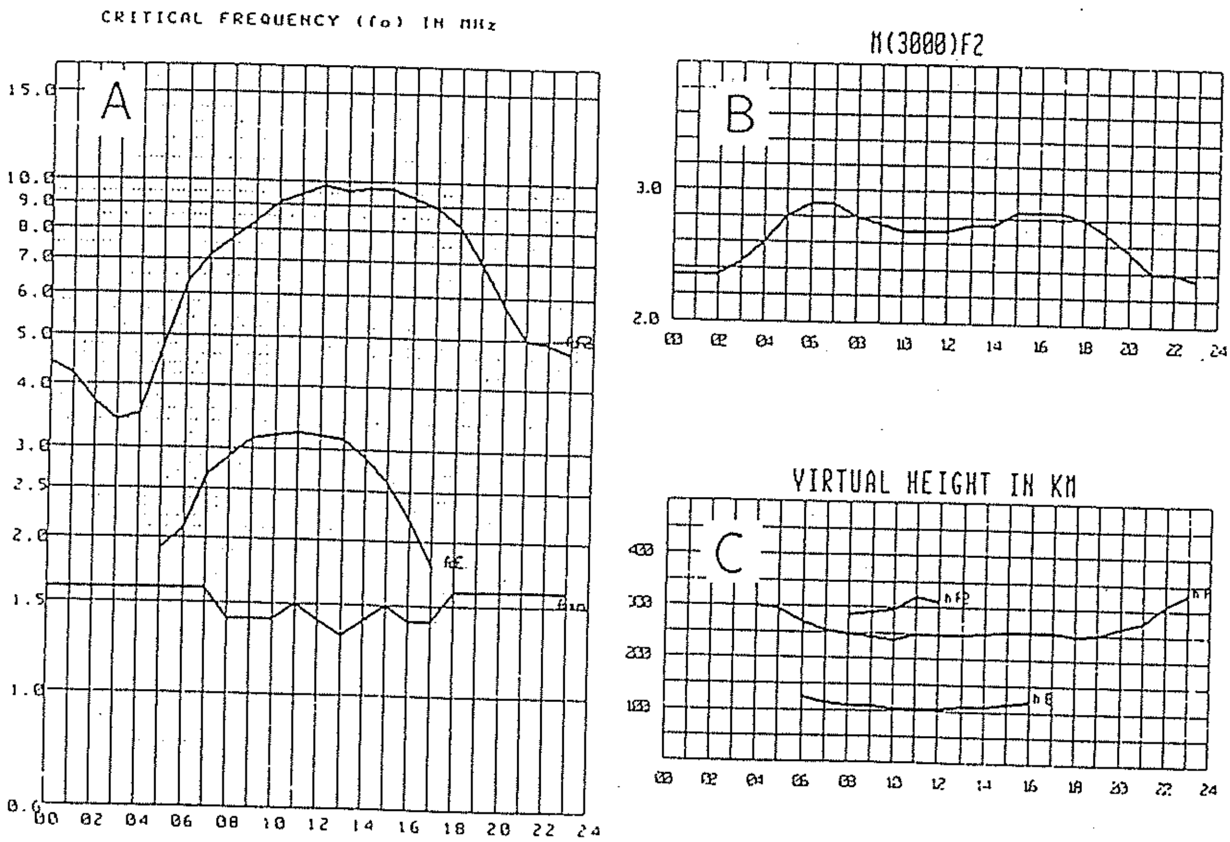

Fig. 3. Monthly medians for some of the ionospheric parameters in Uppsala, March 1992. In A we see from top to bottom the critical frequency of the F2 and E layers and the lowest observed frequency. Panel B shows the MUF factor for the F layer over 3000 km. Panel C shows from top to bottom the virtual heights of the F2, F and E layers.

University Computer Network. Lycksele is connected to Kiruna via modems and a phone line. Users (inside as well as outside IRF) can access the network via SUNET or dial-up modem connections in Kiruna or Uppsala.

The easiest way to access the network is via the ready-made client programs supported by IRF. Matching programs for the users' computers will be available from IRF. With these programs one can control all three ionosondes from one terminal and display the results.

So called passive users have limited access to the network and can only passively read newly recorded, locally stored, standard ionograms or scan the data base in Kiruna.

Active users can also command the ionosondes to perform various kinds of measurements, such as ionograms over selected parts of the h'f-surface. Also, more general collections of sounding pulses can be defined by the user; this includes setting all parameters connected with sampling and processing of the reflected signals. We refer to [Jurén, 1992] for examples of the special capabilities of the new ionosondes.

8.5. Ionogram interpretation

Regular ionograms are taken automatically at each of the stations every hour on the hour. Scaling is made by trained operators using a dedicated application under Smalltalk/Windows. The appearance of the computer screen after the scaling is completed is shown for a typical case in Fig. 2. The scaling has resulted in the data shown to the right in the graph. The scaling terminology and accuracy conform with international recommendations [Piggott and Rawer, 1972].

Scaled data are presented in *Ionospheric Data Sweden*, a data report published monthly by IRF. The report contains hourly values of 14 parameters with monthly medians and graphs from the three stations; see Fig. 3 for examples. These parameters are also stored in the joint observatory data base in Kiruna together with the regular ionograms.

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9. COST - PRIME (Prediction and retrospective ionospheric modelling over Europe)

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Some years ago a pilot study was initiated in Western Europe by the US military, aimed at collecting ionosonde data in support of improved army communications. However, after a considerable period of inactivity this finally lapsed, leaving the various European groups that had agreed to participate in the ionosonde data collection with the feeling that they wished to pursue a collaborative sounding and mapping project on their own initiative. At a meeting of a number of interested parties held in Rome in October 1988 a plan of campaign was conceived and I was invited to chair the group. We decided to coordinate our ionosonde measurements, to try to undertake data collection over certain oblique paths and to address the possibility of generating improved regional long-term maps and models which are more accurate than those available globally via such bodies as the CCIR, URSI and the COSPAR-IRI Task Group. The geographical area of interest was taken to be between latitudes of 35-55° N and longitudes of 10° W - 30° E (Fig 1).

We also recognised the need to be able to generate 'snapshot' maps of ionospheric characteristics for specific epochs for which measurements exist, for use in the interpretation of certain types of advanced HF radio systems and to be able to compose the associated electron-density models, including the topside to quantify ionospheric effects on Earth-space links. There also had to be a forecast element to the work, it was argued, since some groups were funded specifically to carry out forecasting activities. So in deference to our French-speaking colleagues, the acronym PRIME

(Prediction and Retrospective Ionospheric Modelling over Europe) was coined.

A specially convened planning meeting attended by 8 participants was held in Paris in June 1989 to be followed by Workshops, at which results were

which they have groups with an interest. A small central secretariat is maintained, but essentially each country provides its own funding.

We decided on balance that there were benefits in belonging to COST and in due course our

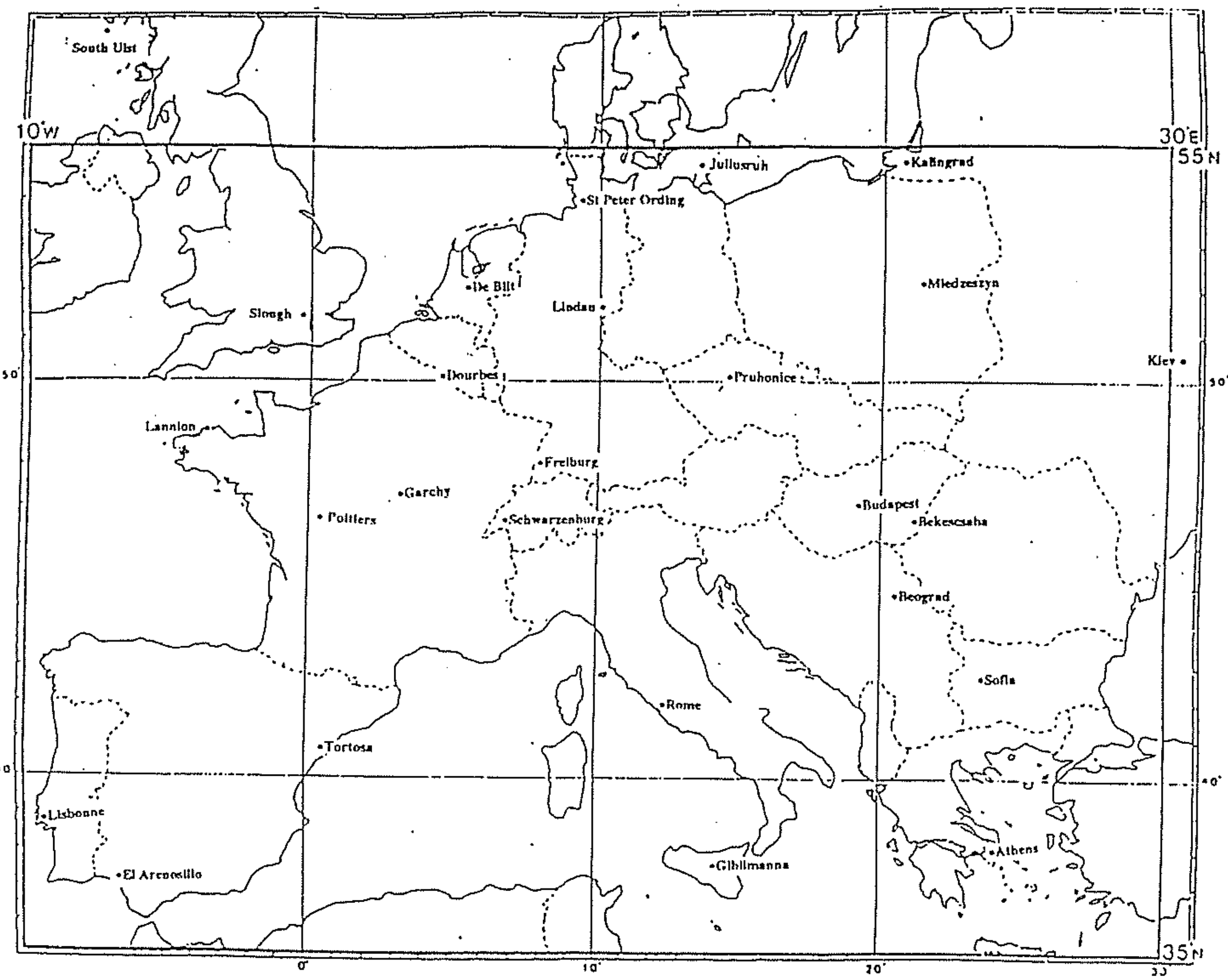

Fig 1 Map showing the PRIME area of Europe. Also indicated are the locations of vertical-incidence ionosondes contributing to the data bank. In addition data from Uppsala, Central Sweden are being collected and used

presented, in Athens (April 1990, with 16 participants) and Rome (January 1991, with 26 participants). So the work gathered momentum and the number of people taking part grew. Meanwhile we became aware of the existence of EEC sponsored projects under the auspices of COST, which stands for 'Cooperation in Scientific and Technological Research'. COST provides a formal framework for EEC and specific other countries to work together on common research topics, to help enhance the European technological base. Member States participate on a project-by-project basis, taking part in those investigations in

proposals were accepted by the committee that oversees telecommunications projects. We then needed four countries to sign up before formal project start could be initiated, and this happened in May 1991. We were designated project COST 238 and given a four-year lifetime from that date. Since then many more countries and groups have joined. Meanwhile COST projects have been opened to Central and Eastern European countries and we have attracted the interest and involvement of several institutes from these regions, demonstrating the evident international nature of ionospheric research. Our current numbers now include more than 50 practising scientists from 25 groups in 16 countries (Table 1).

The work is organised as a series of 45 separate Work Packages structured within five Working Groups. Each Organisation contributes to those Groups in which it has expertise and interest. The five Groups are:
(i) vertical-incidence ionosondes, (Chairman R Hanbaba, CNET, France)
(ii) oblique-incidence ionosondes, (Chairman J-C Jodogne, Royal Meteorological Institute, Belgium)
(iii) instantaneous mapping, (Chairman I Stanislawska, Space Research Centre, Poland)
(iv) forecasting (Chairman J Cooper, Deutsche Telekom, Germany) and
(v) monthly median mapping and modelling (Joint-Chairmen, Lj R Cander, RAL, UK and B Zolesi, National Institute for Geophysics, Italy).

The aims are to produce:
(i) expressions for the model height profile form between heights of 50-1000 km parametric in terms of mapped parameters;
(ii) sets of once-and-for-all maps for each month at reference solar epochs of foF2, M(3000)F2 and TEC, together with a specification of the means of interpolation/extrapolation between them;
(iii) forecasting algorithms up to 24-hours ahead of the present;
(iv) spatial-interpolation algorithms valid for any location within the PRIME area making use of measured data for the same epoch or data sets within the previous 48 hours recorded at locations where vertical-incidence ionosondes are currently operative to produce so-called 'instantaneous maps;
(v) guidance on the preferred disposition of existing or new vertical-incidence ionosondes within the PRIME area and sounding sequences needed in order to achieve cost-effective maps for advanced radio-systems data interpretation.

These features will be embodied in a final program for microcomputer evaluation. In this brief account it is possible only to mention the highlights of work in progress.

Fuller reviews have been presented (Bradley, 1990; 1992; 1993). Central to many studies, a digital data base is being assembled on optical disk of all available hourly vertical-incidence ionospheric characteristics from the 26 stations within and close to the PRIME area (Fig. 1). In some cases measurements have been continuous over 4 solar cycles. About 15 ionosonde stations continue to function, with 13 operated by organisations participating in the project. The data base is located at the CNET, Lannion, France. Approximately 40% of past data have been digitised to date and a full catalogue produced (Hanbaba, 1993). Campaign coordinated rapid sounding ionosonde measurements for a week or more at a time are being undertaken under a range of seasonal and disturbance states to study storm signatures and for spectral analyses as an aid to spatial mapping on individual occasions.

Oblique-incidence ionosondes are being deployed over a number of paths to provide additional midpath information by ionogram inversion for use in map testing. A link between Dourbes, Belgium and Roquetes, Spain has been set up with transmissions in both directions between Digisonde 256 equipments. A Digisonde has been procured at El Arenosillo, Spain for linking to Dourbes and Roquetes. Two chirpsounder receivers in Sweden have monitored various matched European transmitters. Transmissions from Xinxiang, China have been recorded in Rome, Italy.

Several approaches to instantaneous mapping are being pursued, in some cases involving the generation of synthesised screen-point values in regions devoid of measurements. Different techniques are possible depending on whether measured data are available from previous epochs. If not, the use of predicted values derived for effective sunspot numbers is favoured. Single-station models provide estimates at nearby locations. Standard computer contouring methods developed for geographical topography and geological mapping are being studied. Particularly attractive is the method of Kriging which follows regionalised variable theory with data point weighting given in terms of the semi-variogram expressing the degree of correlation between neighbouring areas. Thereby the changing correlation distances on separate occasions are taken into account.

A variety of forecasting techniques is being considered based on extrapolation of past measurement data sets or identification of precursor solar and geophysical parameters that can be used in operational forecasting. Attention has been paid to seeking to establish quiet-day reference conditions and the deviations from these as a function of various disturbance indices. Undisturbed-day criteria are being considered and a catalogue of past ionospherically quiet days formulated. The characteristics of individual ionospheric storms have been studied and significant latitudinal changes in their patterns identified. Other investigations have included spectral studies of periodic ionospheric fluctuations, storm predictability using combined solar flare and radio-burst information, ionospheric dependence on the IMF and regression relations for weekly and daily forecasting of foF2.

A number of long-term smoothed mapping procedures have been developed within the project following different empirical approaches. These include SIRM (Zolesi et al, 1993), ASHA (De Santis et al , 1992) and EOF (Singer and Taubenheim, 1990). These were considered in depth at a Workshop held in Rome in January 1991 (Zolesi, 1992). Separate studies have demonstrated that over Europe mapping should be in terms of geographic latitude and Universal Time. Examination of several indices of solar-cycle variation supports adoption of a parabolic dependence on smoothed sunspot number. Revised versions of the existing mapping procedures or a completely new mapping formulation are likely in the coming period.

International efforts directed at electron-density height profile specification are coordinated through the IRI and via the URSI Ionospheric Informatics Working Group. PRIME members participate actively in both these groups with objectives to develop a single model for the whole world. A joint URSI/PRIME Workshop with emphasis on Validation of Ionospheric Models (VIM) was held at Roquetes, Spain in May 1992. (Alberca, 1992) The Di Giovanni-Radicella (DGR) model (1990) has been developed, refined and compared in limited tests with the IRI-90 model. Further tests are planned.

The future holds many uncertainties. A method of map testing has been formulated involving weighting factors to allow for different types of testing data with varying accuracies, spatial and temporal sampling. As well as the oblique-incidence ionosonde measurements and some vertical incidence ionosonde measurements, a data base of topside sounder and plasma-probe results is being compiled. A Workshop held in Graz, Austria in May 1993 gave particular consideration to the use of TEC measurements and whether these can be employed for map testing. It is clearly not going to be easy to choose one of the mapping methods from among the several contenders and there are going to be a number of disappointed participants whatever we do. Accordingly, we are concentrating very carefully on agreeing the steps to follow before the exercise is undertaken - a standard testing data base, a standard testing procedure and a single figure-of-merit for overall accuracy judgement.

The coming period must also see decisions on the model electron-density profile to adopt, the spatial smoothing to apply in instantaneous mapping and the forecasting procedures to pursue. A method of interfacing the PRIME area and global maps, probably via transitional buffer zones is needed. The computer program embodying all of these aspects will need to be produced. Hence there are exciting times ahead. Because we are now half-way through the project we have had to limit participation from new groups. Let us hope that the present large team produces a worthwhile end-product to justify the significant expenditure of effort involved.

<u>Table 1 Participating Institutes</u>

University of Graz, Austria
Royal Meteorological Institute, Belgium
Geophysical Institute, Bulgaria
R J Ritter, Switzerland
Deutsche Telekom, Germany
University of Rostock, Germany
Observatori de l'Ebre, Spain
Instituto Nacional de Tecnica Aerospacial, Spain
Centre National d'Études des Télécommunications, France
University of Thessaloniki, Greece
Athens National Observatory, Greece
National Institute for Geophysics, Italy
International Centre for Theoretical Physics, m Trieste, Italy
National Research Council, IROE, Florence, Italy
Netherlands Foundation for Research in Astronomy, Netherlands
Eindhoven University of Technology, Netherlands
Space Research Centre, Poland
National Defence Research Establishment, Sweden
Institute of Space Physics, Sweden
Middle East Technical University, Turkey
Rutherford Appleton Laboratory, UK
Geomagnetic Institute, Serbia
Institute of Ionospheric and Terrestrial Magnetism, Russia
Institute for Applied Geophysics, Russia
Academy of Sciences, Czech Republic

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10. Some Evidence Supporting Short-Term Forecasting Of Mid-Latitude Ionospheric Disturbance Conditions

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The occurrence of spread-F in mid-latitude regions has been shown (1,2,3) to depend critically on geomagnetic activity at specific local times (LT) at the recording ionosonde station. Activity in the early evening hours influences the level of spread-F occurrence in the hours which follow, due to delayed changes to the upper-atmosphere neutral-particle density (UA-NPD) resulting from the geomagnetic activity. Also (for whatever reason) enhanced geomagnetic activity in the early morning hours has been shown (2,3,4) to be associated with increased spread-F occurrence after a delay of a few days. Delayed D-region absorption events in sub-auroral regions seem likely to be responsible, resulting in the generation of atmospheric gravity waves (AGWs) with appropriately large wave amplitudes (2). These AGWs are responsible in turn for the travelling ionospheric disturbances (TIDs) which are associated with spread-F occurrences. Changes to the UA-NPD associated with fluctuations in the 10.7 cm solar flux also have an influence on mid-latitude spread-F occurrence (3).

As a result of these experimental results, the most favourable conditions for the generation of spread-F structures in mid-latitudes would seem to be enhanced geomagnetic activity in the <u>early morning</u> hours (LT) on a specific date coupled with conditions of low-level geomagnetic activity in the <u>early evening</u> hours of the nights the delayed spread-F occurrence is expected. When geomagnetic activity is low a few hours before times when spread-F is normally recorded, the

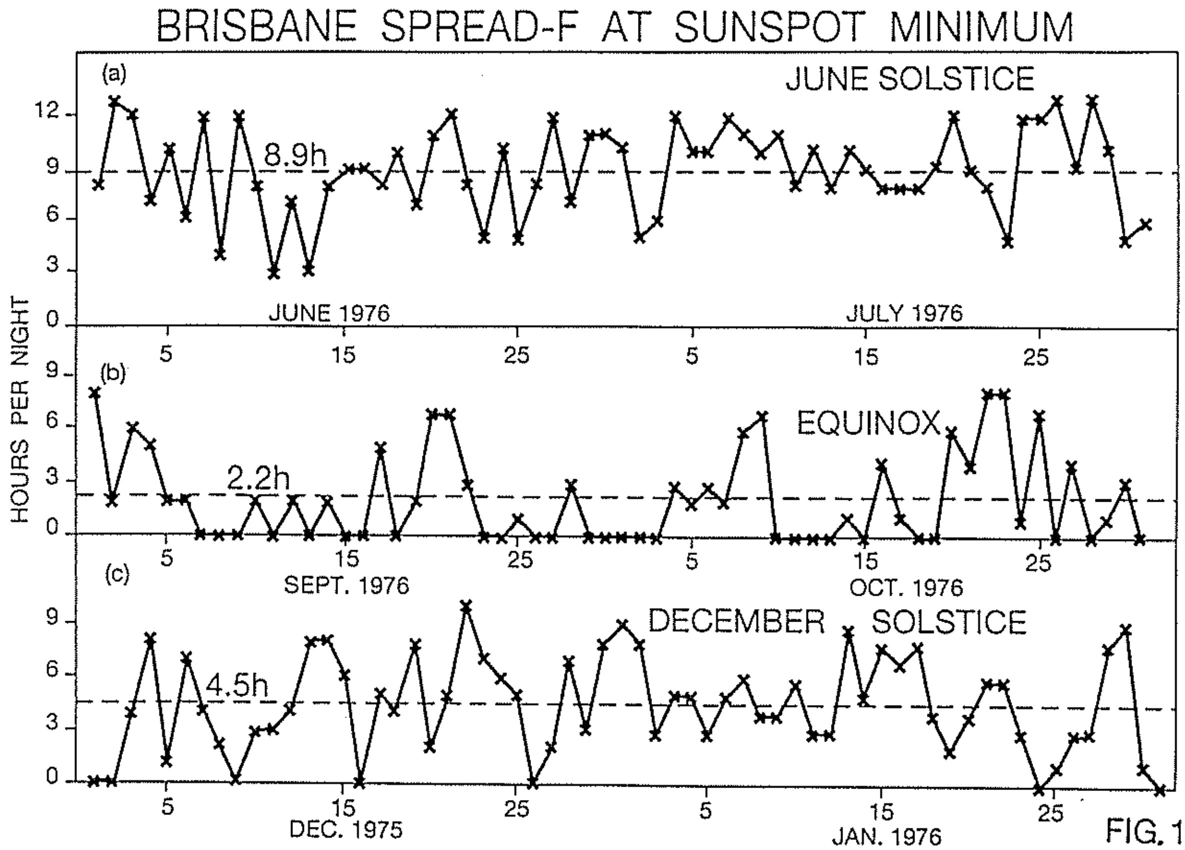
BRISBANE SPREAD-F AT SUNSPOT MINIMUM
(a)
JUNE SOLSTICE
8.9h
JUNE 1976
JULY 1976
HOURS PER NIGHT
(b)
EQUINOX
2.2h
SEPT. 1976
OCT. 1976
(c)
DECEMBER SOLSTICE
4.5h
DEC. 1975
JAN. 1976

FIG. 1.

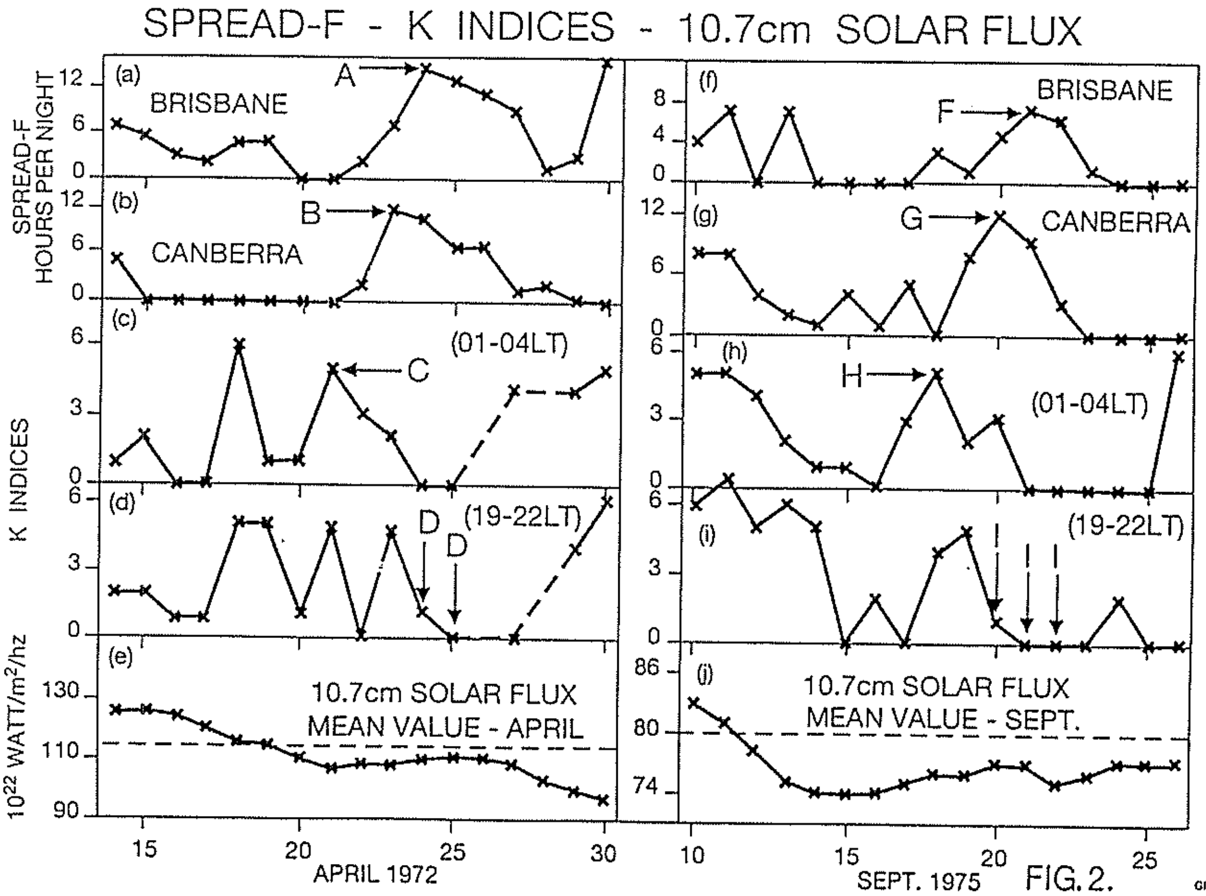
SPREAD-F - K INDICES - 10.7cm SOLAR FLUX
SPREAD-F HOURS PER NIGHT
(a) BRISBANE
A
(b) CANBERRA
B
K INDICES
(c)
(01-04LT)
C
(d)
(19-22LT)
D
D
(e)
10.7cm SOLAR FLUX
MEAN VALUE - APRIL
10^{22} WATT/m^2/hz
APRIL 1972
(f) BRISBANE
F
(g) CANBERRA
G
(h)
H
(01-04LT)
(i)
(19-22LT)
(j)
10.7cm SOLAR FLUX
MEAN VALUE - SEPT.
SEPT. 1975

FIG. 2.

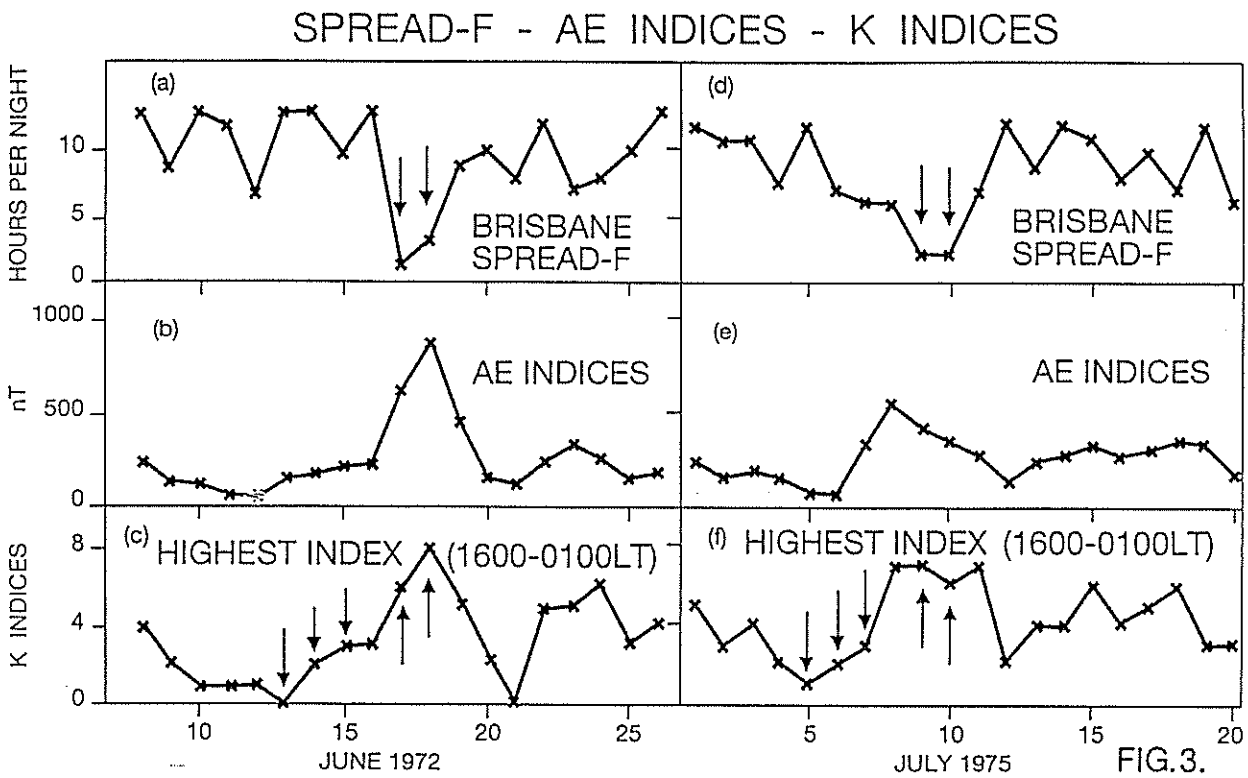

FIG.3.

recording of this phenomenon is less likely to be prevented by increases in the UA-NPD which will occur for higher levels of activity. Increases in the UA-NPD may prevent TID wave amplitudes becoming large enough due to AGWs propagating to higher ionospheric levels, to allow spread-F to be recorded (5). Control events, representative of these favourable conditions, have been determined from Macquarie Island K indices in order to investigate statistically the probability of spread-F being observed at two Australian stations (Brisbane and Canberra). Macquarie Island is in the same longitude zone as these ionosonde stations.

This present article is concerned primarily with the presentation of a few specific examples which illustrate these relationships. Figure 1 indicates (see dashed lines) average levels of spread-F occurrence at Brisbane for sunspot-minimum periods for (a) June-solstice months (b) equinoctial months and (c) December-solstice months. Average occurrence levels (quoted in hours per night) are found to be consistent with an inverse relationship with the semi-annual variation of the UA-NPD 5. However, it can be seen that, from night to night, significant changes can occur in this level of activity due, it seems likely, to the short-term effects just discussed. Figure 2 illustrates two examples of enhanced spread-F occurrence at both Brisbane and Canberra with delays of a few days after early morning (01-04LT) geomagnetic activity combined with suppressed geomagnetic activity in the early evening (19-22LT) hours a few days after the early-morning increases (as discussed earlier). Also, the 10.7 cm solar flux is shown to be below the average monthly level on both occasions. Figure 3 illustrates two occasions when the level of Brisbane spread-F occurrence is reduced significantly. Associated AE indices and Macquarie Island K indices are also plotted. Since the UA-NPD can increase to several times its initial value in the hours following severe geomagnetic conditions (6), it is not surprising that at these times, AGW wave amplitudes are not able to grow (at F 2- layer levels) sufficiently to allow spread-F to be recorded (5). Consequently, although, as Figure 1 shows, during some seasons spread-F at Brisbane is frequently recorded all night long, nevertheless even at these times increases in the UA-NPD can reduce the occurrence rate to a very-low level (Figure 3) on some nights.

Although the statistical analyses are not complete, preliminary results show that the spread-F occurrence rate at Brisbane is increased by almost 30 percent following the control events which were defined earlier. Similarly, following enhanced geomagnetic activity before midnight, statistically spread-F occurrence (at Brisbane) is suppressed by about 30 per cent in the hours which follow on the same nights as the enhanced activity is recorded. Of course isolated occasions can be found (see Figures 2 and 3) where the effects are more pronounced than indicated from statistical information. Thus, if it is important to know in advance what the level of spread-F occurrence might be (relative to the expected level for the season) on any particular night, it is proposed that real-time monitoring of geomagnetic activity at an auroral-zone station in the same longitude zone should be helpful. Reasonable estimates probably can then be made of expected changes in nighttime disturbance conditions. Of less importance, but still exerting some measure of influence, is the 27-day variation of the 10.7 solar flux due to the rotation of the sun (6).

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11. A survey of Bulletin Readers

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11.1. Introduction

In the last INAG Bulletin a survey sheet was distributed and a moderate number of readers responded. While more responses would have been appreciated, those that did come in are probably representative of INAG Bulletin readers.

The questionnaire was not constructed to obtain a graded response to the various topics surveyed; rather, it was intended to gauge reactions to comparable, but not equivalent propositions. While there were clear individual answers, there was surprisingly good agreement between the different responses.

The rest of this article outlines the conclusions that can be drawn from the responses. The results from all the returned surveys were accumulated according to the different rankings people used. Where only one rank was given, this was treated as a high priority. Where people ranked some of the classifications but deliberately left others blank, I assumed they were strongly opposed to the potential response and counted it separately.

I am still interested in hearing from others who did not respond to the questionnaire.

11.2. Value of articles

Four categories were offered for ranking. Two were positive, two were regarded as negative. This category was the most polarised of the questionnaire.

Over 90% of the respondents felt the articles in the Bulletin are of the right level of interest making this the clearest of all the categories polled. People also file the Bulletin after receiving it.

By contrast, 50% of the respondents did not put any rank down for the other two responses suggesting they disagreed with the propositions: that the articles in the Bulletin are of limited interest and that, in general, they are not more complex that usually read.

11.3. Preferences in Articles

Very few people left any of the fields blank in this category, indicating they were familiar with the articles and had clear interests.

Over 80% were interested in articles on applications for ionosondes, the second highest single item return in the questionnaire. Of equal interest, after this category, was the operation of other ionosonde networks and the interpretation of difficult ionograms. There have been almost no articles in this last category over the last five years and it must be regarded as a weak area in the Bulletin at present. Since there is real interest here, please give a thought to preparing articles on interesting and difficult ionograms. I will obviously be seeking more articles on ionosonde applications.

Surprisingly, training aids for manual scaling and the history of ionosondes are of less interest. Training aids was left blank by 20% of the respondents indicating a lack of interest. This could be related to an expressed interest in computer scaling methods. The history of ionosonde networks is, I feel, an important topic for INAG. Changes to the network will be reflected in the data and the Bulletin is a useful method of recording this history. While it appears less interesting for readers, I still want to receive articles on this topic as I regard it an important function of INAG to record this information.

11.4. Impact of articles

It was difficult to separate the top four responses. Most people have found the Bulletin interesting and occasionally very useful. This was closely followed by people who found the articles encouraging and who have had their ideas changed as a result of reading the bulletin. By contrast, there was strong rejection of the idea that the Bulletin had no impact. Over 30% failed to rank this possibility.

11.5. Influences affecting authors

Obtaining articles for the Bulletin is a constant problem. The next three categories were to give me some insight into ways I might explore to obtain more articles.

Over 50% felt that if people were told what type of article to write, they would be more likely to contribute something. I have hoped that myself, but it is still a difficult exercise. Anyone who has an interest in reading the Bulletin has a contribution to make.

There was a feeling that more people would be willing to write for the Bulletin if they felt it was read widely and their articles would influence people. I can understand this but I feel it is worth remembering that although the circulation of INAG is small, it is not insignificant. Over 200 Bulletins are distributed and some are read by more than one person. These 200+ people have all, in the last four years, said they wish to receive the Bulletin. That is a good captive audience. Second, a clear majority (over 75%) of readers polled are influenced by what they read and 30% reject outright that the Bulletin does not affect them. I feel these are a good basis for authors to feel their work is gaining the attention they would like it to get.

There were mixed feelings about broadening the subject area. Some were in favour, some rejected the possibility. From my perspective, that is good, as I have no plans to broaden the Bulletin at present and am happy to have no mandate to do it. There is a place for broadening the scope, but I would find it difficult to do at present.

Formal refereeing was rejected. While some could see the value, one person felt this may place the Bulletin in competition with the published journals.

11.6. Reasons for not contributing articles

I have treated the next two categories together. A large number of people rejected all these items. That was disappointing as this is the section where I hoped to gain some insight into why people find it hard to contribute to the Bulletin. Equal numbers felt they had nothing of interest to contribute and had never thought of asking somebody else to contribute. No other responses stood out.

11.7. General comments on past articles

All the articles that have appeared in the Bulletin over the last four years received at least one mention as one of the two most useful articles in the Bulletin. Hopefully, this will further reinforce in prospective writer's minds that the audience is diverse and you are likely to appeal to somebody among the readership.

A number of people stated that all the articles were worthwhile and none were rated as "least useful". That is a good result for the past authors and a very good indicator of an interested audience for prospective writers.

11.8. Summary

Based on the responses I received, the Bulletin is interesting for its readers for a variety of reasons. All articles have been acclaimed by at least one person. This should encourage prospective writers. The Bulletin has a diverse and interested audience who will possibly be more likely to read your comments here than in the formal literature.

For those who have not yet completed the questionnaire, a copy is included with the Bulletin. Please fill it in and send it to me.

I look forward to receiving your contributions!

12. Digisonde Low Power Operation

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IPS Radio and Space Services
AUSTRALIA

In the last two years we have experienced several failures of the high-power/high-voltage sections of a D-256 type digital ionosonde at this Observatory. The fact that these failures occurred in the Pulse Power Supply, the Delay Line Chassis or the Final Power Amplifier led us to explore a low power mode of operation for this unit.

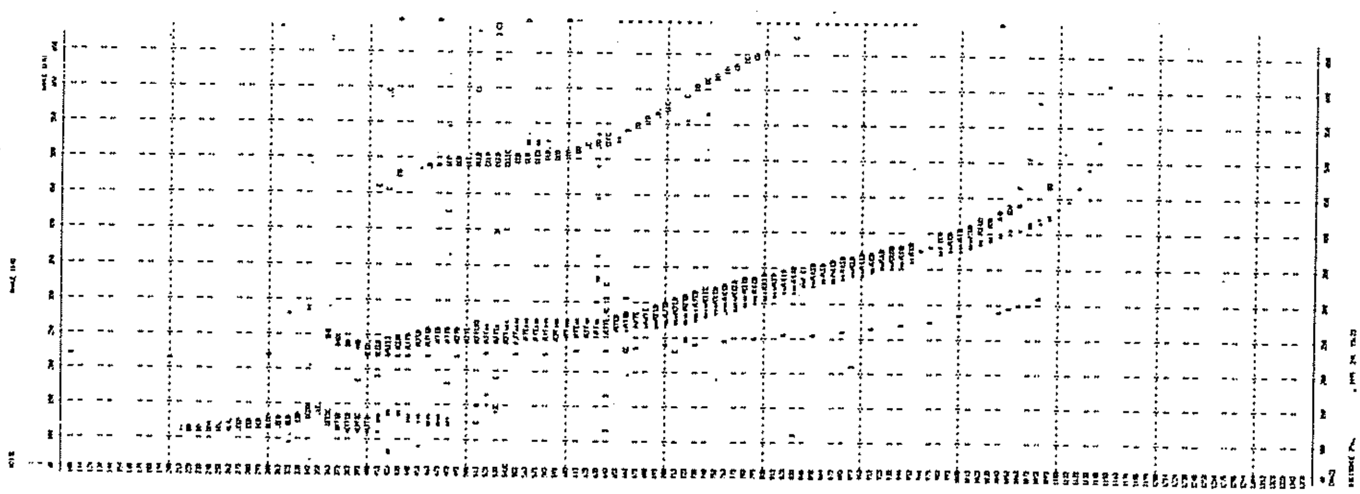
The criteria adopted for the design mandated not only low cost of any additional equipment, but also required no hardware alteration of the existing equipment. In other words, reconfiguration of the Digisonde had to be accomplished purely by the recabling of existing units together with any additional fabricated hardware.

The final design consists of a small low power pulsing unit (LPPU) that is used to pulse the two intermediate power amplifiers (IPAs). Output from the second IPA is fed directly to the transmit antenna. The LPPU is triggered by a small trigger pulse output from the transceiver/processor. The result is a transmit peak pulse power of around 100W which has been found to give satisfactory ionograms for a large percentage of the time at the low interference environment that we enjoy at Learmonth. A representative ionogram produced from this configuration is shown in figure 1. Once the LPPU has been fabricated, equipment reconfiguration between the high and low power modes of operation can be accomplished in less than 5 minutes.

Circuit and constructional details of the LPPU are discussed in the next few paragraphs. Equipment reconfiguration notes then follow.

The circuit diagram of the low power pulsing unit is given in figure 2. The design is built around a low-cost plastic-package HEXFET transistor switch (an IRFP150FI) which has an extremely low turn-on resistance (less than 0.1 ohm). This is ideally suited to the application, and can deliver a 20 amp pulse to the intermediate power amplifiers without the need for a heat sink.

The DC power source for the unit is provided by a transformer and bridge rectifier combination to



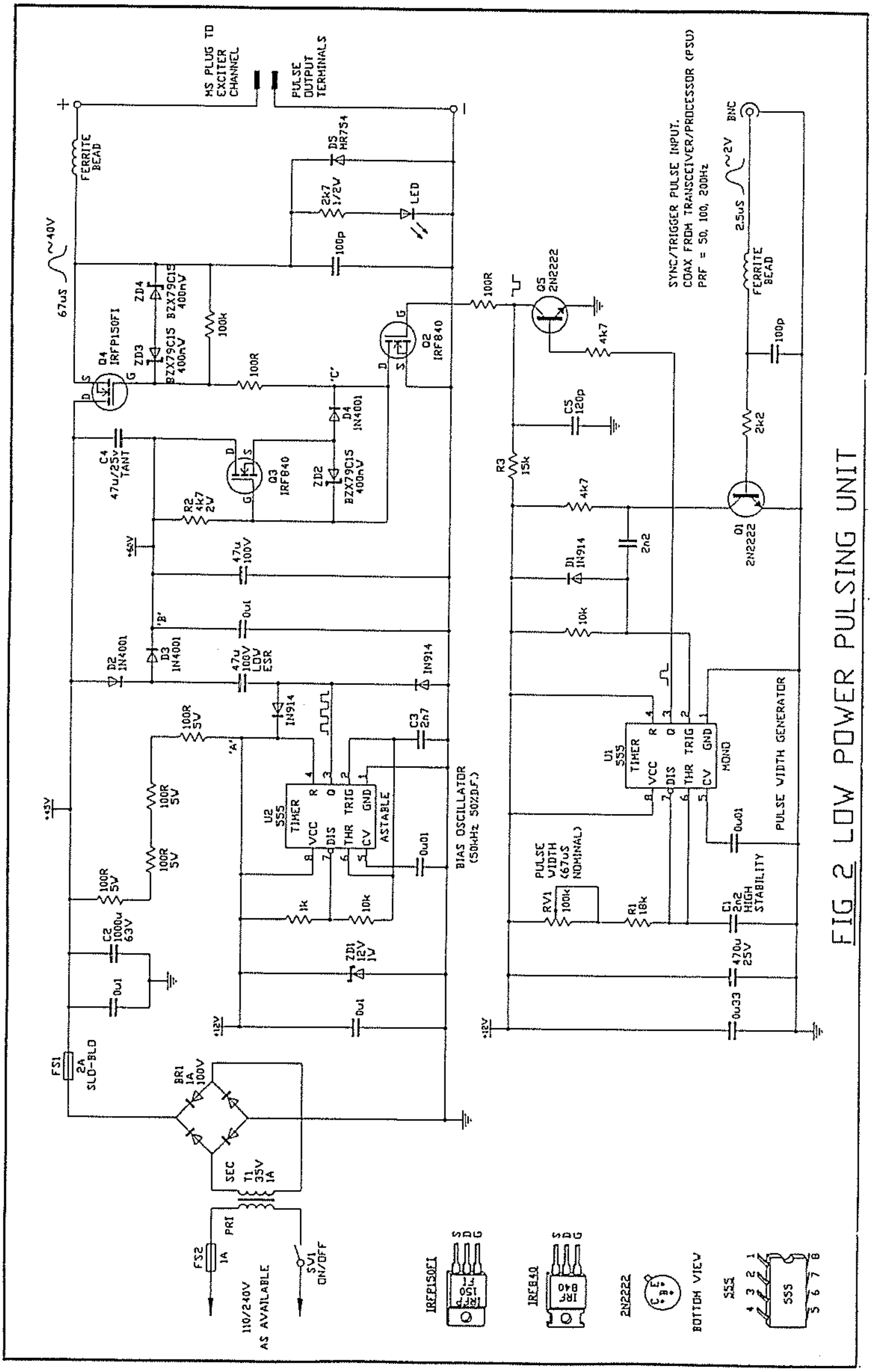


FIG 2 LOW POWER PULSING UNIT

charge the storage capacitor C2. This must have a minimum value of at least 1000 microfarad to ensure a pulse droop of less than a few percent (assuming a 67 microsecond pulse - a 133 us pulse would require at least twice this value). This capacitor should be selected for high ripple current duty and preferably a low effective series resistance (ESR). During the pulse period, it is C2 that supplies the energy to the intermediate power amplifiers. The pulse current through Q4 may reach 20 amps. However, the actual supply requirements to charge C2 only require less than 1 amp. Because of the high currents through C2 to the pulse output terminals, the wiring from this capacitor to these points should be formed from discrete wiring or PCB tracks that have enough copper to provide a low impedance path in this part of the circuit.

In the particular unit constructed at Learmonth, it was decided to use the 45 volt single supply to also provide a regulated 12 volt line to power the pulse logic circuitry (Q1 and U1) and the small bias generator (U2). However, a separate low voltage winding (say 12Vrms) on T1 could be used to perform this function via a 7812 IC regulator, and thus eliminate the resistor dropping chain between the 45 volt line and the 12 volt zener diode (ZD1). This would eliminate the greatest source of heat dissipation in the unit, and thus potentially increase the unit reliability. However, if this approach is adopted, a bleed resistor of say 10 kilohms should be wired across C2.

To ensure that the main pulsing FET (ie Q4) is fully turned on during the pulsing time, it is necessary to raise the gate to at least 8 volts above the drain terminal. This requires a small bias voltage to be added on top of the main 45 volt supply. This is provided by U2 which is run as an astable multivibrator, producing an approximately square waveform at a frequency of around 50 kilohertz. The output from pin 3 is then rectified by D2 and D3 producing about 12 volts DC across C4, and thus raising point B to a potential of just under 60 volts. These two diodes should be selected for fast switching action.

The trigger input to the LPPU is from the digisonde transceiver/processor. It is a small pulse of about 2 volts in amplitude and 2.5 us duration. This is amplified and inverted by Q1 so that it will reliably trigger the monostable U1. This 555 integrated circuit produces an output pulse whose duration is determined by RV1, R1 and C1. RV1 has sufficient range so that it can be set to produce either a 67 or 133 us pulse as required. These are the two standard pulse durations used in normal digisonde operation. It would even be possible to install a logic operated relay to switch in two preset resistance values instead of RV1. These could be operated under the digisonde computer control, an appropriate signal being available from the "PML" connector of the processor transceiver. (The same signal is also available in the transmitter rack at the antenna switching unit).

The 12 volt amplitude output pulse from U1 is inverted by Q5 and is then used to control the gate signal to Q4 via the 'totem pole' configuration of Q2 and Q3. In the quiescent state, the output of U1 is low. The high output from Q5 then ensures that Q2 is turned on, pulling point C, and the gate of Q4 low. No energy is supplied to the output in this condition. When U1 is pulsed high (upon receipt of the digisonde trigger), the Q5 collector goes low, turning off Q2. The gate voltage on Q3 then rises via R2, turning this transistor on, and lifting point C to a voltage sufficiently high to turn on Q4. In this condition, a pulse of up to 20 amp is supplied to the IPAs in the digisonde exciter chassis. Note that the turn on time of the pulse is essentially controlled by R2 and the associated interelectrode capacities of Q3 and associated circuit strays. The turn off time is controlled by the network R3, C5. Thus these three components can be adjusted to shape the pulse and provide a more 'gaussian' curve rather than a rectangular pulse which would create more adjacent channel interference from the sounder.

The LED provides a convenient visual indication to a human observer that the device is in fact pulsing correctly. The ferrite beads shown on some of the lines provide a degree of RF filtering, whereas the zener diodes ZD2,3,4 provide gate protection for the three FETs additional to the internal protection that comes with these devices.

The configuration of the digisonde to operate with the LPPU in low power mode is basically a matter of changing three cables. The first cable change is to unplug the trigger pulse cable from the processor/transceiver at the pulse power supply. This is then plugged into the trigger input of the LPPU. The second step is to remove the cable supplying the 45 volt pulses from the delay line chassis to the exciter chassis. This can simply be unplugged at the exciter chassis end. A new cable from the pulse output of the LPPU to the exciter

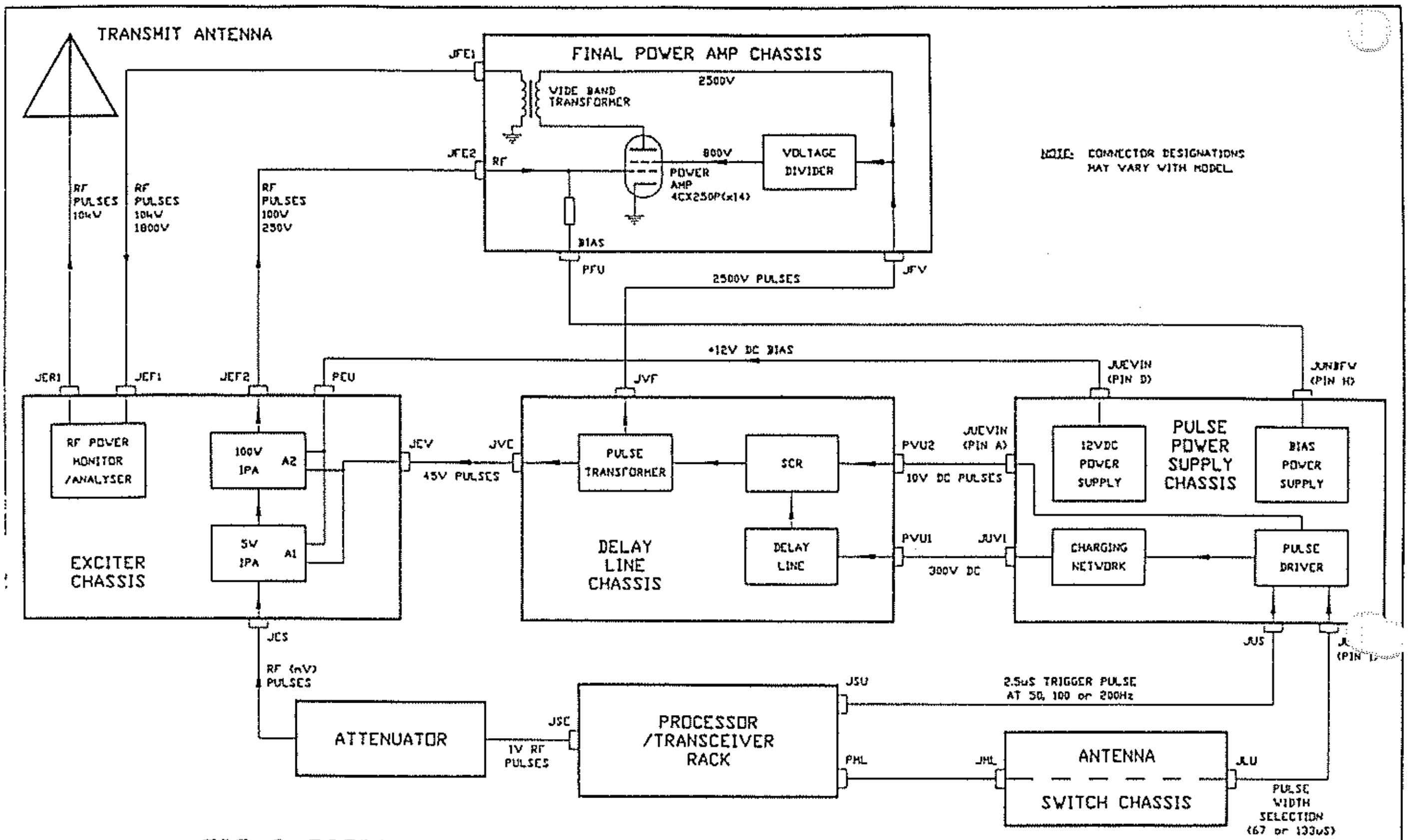


FIG 3 DIGISONDE NORMAL HIGH POWER CONFIGURATION

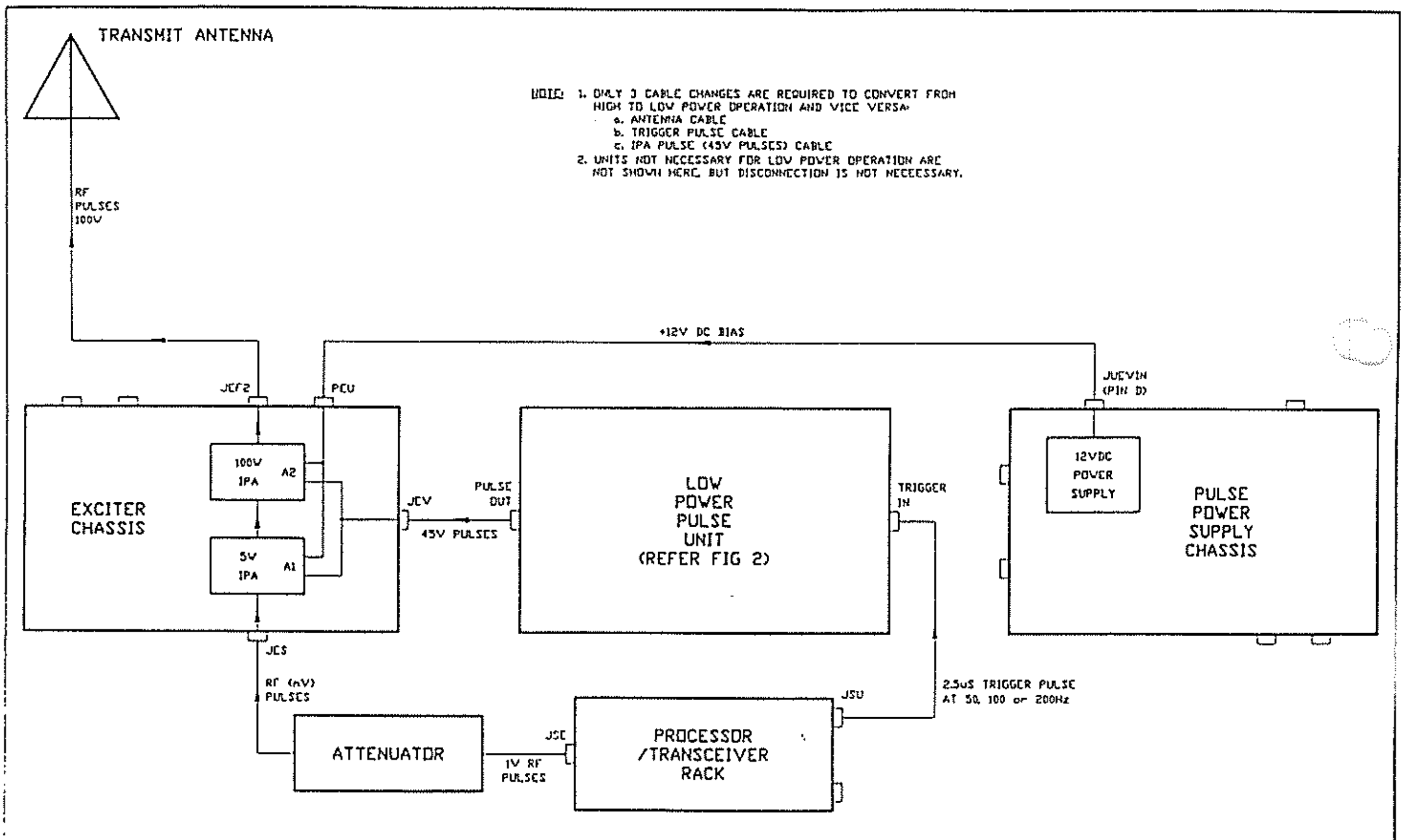


FIG 4 DIGISONDE LOW POWER TRANSMITTER RECONFIGURATION

chassis is then installed. Finally, the cable from the transmit antenna is unplugged from the exciter chassis (the output from the final power amplifier goes through the RF power analyst located in the exciter chassis), and connected to the output of the 100 watt IPA, also in the exciter chassis. This output would normally be connected to the RF input of the final power amplifier. Figure 3 shows the original and high power configuration of the relevant digisonde units. Figure 4 shows the reconfiguration for low power operation. Switching back to normal high power operation is simply a matter of reversing the 3 basic reconnections described above.

It might be noted that in the low power mode, of the three high power chassis (Final Power Amplifier, Pulse Power Supply and Delay Line Chassis), only the small 12V power supply in the Pulse Power Supply is used. All the other equipment is redundant in this mode. Provision of an additional 12 volt supply (which provides a bias voltage for the IPAs) would allow all three of these units to be removed from the transmitter rack for maintenance. There is then no (dangerous) high voltage or high power equipment anywhere in the system.

Measurements reveal that the output power in this low power mode of operation is around 100 watts. RFI caused to nearby equipment is virtually undetectable more than 500 metres away from the transmitting antenna.

In limited tests conducted by switching back and forth between high and low power, values of fmin were typically no more than 0.5 MHz higher in the low power mode, and foF2 values were within 0.2 MHz. These tests were conducted during periods of quiet solar X-ray activity. Early morning hours, when the intensity of distant ionospherically propagated HF activity was high, were the only times when the low power proved less than desirable to obtain a good quality ionogram. Low power representations of the E-region are typically much less crowded and confused than those we experience at the 10 kW level. It should be mentioned, however, that Learmonth is a very low RF noise environment, and results at other locations may not be as favourable.

I would be pleased to correspond about this low power reconfiguration with others who are interested in experimenting in this area. In conclusion I must thank Brian Allen of the Australian Project Services for advice and discussions about the circuitry, and for the generous supply of the HEXFETs used in the final configuration.

13. URSI Workshop G6: Ionosonde networks and stations

P J Wilkinson

INAG is sponsoring a symposium at the forthcoming URSI General Assembly, in Kyoto, Japan. A good number of papers have been offered for the symposium, but it is clear that many of these will not be presented as poster papers because the authors have already indicated to me that they are having problems obtaining travel funding. Because of this, Ray Conkright and I have decided that all papers that have been offered for the symposium will be eligible for publication in a UAG report that we will be producing immediately after the General Asembly. Below are details regarding the submission of papers for publication followed by a list of the papers that have been accepted for the symposium.

Details on availability of the UAG report will be published in a future INAG Bulletin.

13.1. Publication Details

1. Papers (text plus diagrams) will be restricted to a maximum of 6 A4 pages.

2. Since nearly all the abstracts received appear to have been prepared on word processors, I expect all authors are able to submit an ascii file of the text of their papers. Please send me a 5.25" or 3.5" disk containing an ASCII text file of your paper, with all embedded commands removed. Since I can also handle text prepared in Word for Windows and Wordperfect, please include these files on the disk if you can produce them.

3. Accompanying the disk, please send me two hard copies of your article. One copy will be used for refereeing the paper. The other will be used to ensure that the positioning of the diagrams is clear and to eliminate any problems encountered in interpreting the disk files.

4. All figures submitted should be of good quality, be reproducible in black and white and have legible captions, scales and text.

5. Include the names of at least two potential referees.

6. Send the paper, together with the disks, to:

Phil Wilkinson,
IPS Radio and Space Services,
P O Box 5606,
West Chatswood, NSW 2057,
AUSTRALIA

by November 30, 1993.

13.2. Poster paper format for Kyoto

For those presenting poster papers at Kyoto, the poster session will be held in the "Event Hall". Each poster is to be presented on a separate poster board with a paper number. The poster board has a title area with width 90cm by 30 cm in height where the title, affiliation and names of authors are to be poster, and a presentation area of width 120cm by 150cm in height. Thumb tacks and mending tape are available from the staff. The poster sessions are scheduled on August 30 and posters can remain on display until 3 PM on September 1.

13.3. Oral papers

Below are listed the papers that will be delivered orally and lead the discussion during the workshop. The papers are listed in the order in which they will be presented.

Alexander V. Shirochkov
Arctic and Antarctic Research Institute, Saint-Petersburg, 199397, RUSSIA
The Russian High-latitude Ionosonde Network: Its History, Current Status and Perspectives

S.A. Pulinets
Institute of Terrestrial Magnetism, IZMIRAN, Troitsk, Moscow Region, 142092, RUSSIA
Automisation of Vertical Ionograms Processing and Interpretation

Duncan C. Baker
Department of Electrical and Electronic Engineering, University of Pretoria, Pretoria 0002 SOUTH AFRICA
Ionosonde Stations in Southern Africa - A Review of Current Status and Future Propsects

Jurgen Buchau and Terence W. Bullett
Phillips Laboratory, Geophysics Directorate, HANSCOM AFB MA USA
Allan E. Ronn,
Space Forecast Center, Falcon AFB, Colorado, USA
Jeffrey Carson,
HQ, Air Weather Service, Scott AFB, Illinios, USA
The Digital Ionospheric Sounding System (DISS) Network of the US Air Force Weather Service

Bruce Ward, Fred Earl,
HF Radar Division, Defence Science and Technology Organisation, P.O. Box 1500, Salisbury, SA 5108, AUSTRALIA
Stuart Bickerstaff,
Telecom Australia, 6 Winterton Road, Clayton, VIC 3168, AUSTRALIA
Alan Hartley,
Marconi Radar Systems, 18 Winterton Road, Clayton VIC 3168, AUSTRALIA
A Real-time Ionospheric Sounding Network for Over-the-Horizon Radar

Peter A. Bradley and Michael I. Dick
Rutherford Appleton Laboratory, Building 25, Chilton, Didcot, Oxon OX11 0QX, UNITED KINGDOM
Use of Real-time Ionosonde Data to Improve Regional Ionospheric Models for HF Over-the-Horizon Radar and Passive Single-site Target Location

Seiji Igi
Hiraiso Solar Terrestrial Research Center, CRL 3601, Isozaki, Nakaminato, Ibaraki 311-12, JAPAN
Automatic Ionogram Processing System in Japan

Kenneth J.W. Lynn
Communications Division, Defence Science and Technology Organisation, P.O. Box 1500, Salisbury SA 5108, AUSTRALIA
The Application of Ionosondes to HF Real-Time Frequency Management in Northern Australia

13.4. Poster papers

Below are the poster papers. They are listed according to their code numbers allocated by the Japanese Organising Committee.

John E. Titheridge
Physics Department, University of Auckland, Private Bag, AUCKLAND, NZ

Collection and Processing of Digital Ionograms from a Conventional Ionosonde

Bodo W. Reinisch
University of Massachusetts, Lowell, Center for Atmospheric Research, 450 Aiken Street, Lowell, MA USA
The Digisonde Network and the Need for Databasing

H. Soicher and F.J. Gorman
U.S. Army Communications-Electronics Command, Fort Monmouth, NJ 07703-5203, USA
E.E. Tsedilina and O.V. Weitsman
Department of Geophysics and Planetary Sciences, Tel Aviv University, Ramat Aviv, 69978, ISRAEL
Variability of Ionospheric Parameters and their Gradients at Midlatitudes near the Maximum of the Solar Cycle

Peter A. Bradley and Michael I. Dick
Rutherford Appleton Laboratory, Building 25, Chilton, Didcot, Oxon OX11 0QX, UNITED KINGDOM
Use of Ground-Based and Satellite Data in an Improved Procedure for Testing the Accuracy of Ionospheric Maps

Vladimir G. Galushko
Institute of Radio Astronomy, Ukrainian Academy of Sciences, 4 Ksrasnoznamennaya Street, Karkov, 310002, UKRAINE
Restoration of the Ionosphere Electron Density Profile from the Data of Frequency - and - Angular Sounding

Tan Zixun
Wuhan Institute of Physics, Academia Sinica, Wuhan, Hubei 430071, P.R. CHINA
The Equatorial Anomaly in the Ionospheric E-region

T.L. Gulyaeva
IZMIRAN, Academy of Sciences, Troitsk, Moscow Region, 142092, RUSSIA
Vertical Incidence Sounding Database and Its Products

Weixing Wan
Wuhan Ionospheric Observatory, Chinese Academy of Sciences, Wuhan 430071, P.R. CHINA
Phase Velocity Estimation of Non-unique Gravity Waves from HF Doppler Shifts and Arrival Angles

Bakhitzhan Dj. Chakenov and Alla P. Chakenova
Ionospheric Institute, Alma-Ata 480068, KAZAKHSTAN
Ionogram Interpretation as Image Recognition

P.F. Denisenko, N.V. Nastasyina and V.I. Vodolazkin
Institute of Physics, Rostov State University, 194 Stachky Avenue, Rostov-on-Don, 344104, RUSSIA
Using Ionosonde for Regular Observation of Irregularities of Electron Density

Donat V. Blagoveshchensky
Institution of Aviation Instrument Making, 67 Hertsen Street, St. Petersburg, RUSSIA 190000
Vladimir M. Vistavnoy
Arctic and Antarctic Research Institute, 38 Bering Street, St. Petersburg, RUSSIA, 199397
Ionosphere Oblique Sounding with Analysis of Signal Level

Zhang Shunrong, Huang Xin-yu and Su Yuanzhi
Wuhan Institute of Physics, Chinese Academy of Sciences, P.O. Box 72003, Wuhan 430072, P.R. CHINA
Derived Ionospheric Drifts near the F2 Layer Peak from Ionosonde Data

Cao Chong, Dai Kailiang, Quan Kunhai
China Research Institute of Radiowave Propagation, Xinxiang, Henan, 453003, P R CHINA
Shen Changshou
Department of Physics, Beijing University, P R CHINA
International Reference Ionosphere (IRI) in China

K. Bibl, D.F. Kitrosser
University of Massachusetts, Lowell, MA 01854 USA
J. & C. Jodogne
Royal Meteorological Institute of Belgium, B-1180 Bruxelles, BELGIUM
L.F. Alberca
Observatori de l'Ebre, 43520 Roquetes (Tarragona), SPAIN
Routine Precision Group Height Measurements for the Study of E-Region Valley and for Bistatic HF Sounding

B.O. Vugmeister and V.V. Radionov
Institute of Solar-Terrestrial Physics, 664033, Irkutsk, P.O. Box 4026, RUSSIA
Semi-Automatic Interpretation of Ionograms

A.D. Akchyurin, R.G. Minullin, V.I. Nazarenko, O.N. Sherstyukov, A.L. Sapaev
Kazan State University, Physics Faculty, Kazan 8, Lenin Street, 18, RUSSIA
The Ionospheric Complex "Cyclon"
and
The Routine Diagnosis of Ionosphere for the Short-term Forecast of S.W. and U.S.W. Propagation

Kenro Nozaki and Yoshiyuki Makita
Communications Research Laboratory, 4-2-1 Nukui-kita Koganei, Tokyo 184 JAPAN
Application of FM/CW Techniques to Ionosondes

Kiyoshi Igarashi and Hisao Kato
Communications Research Laboratory, 4-2-1 Nukui-kitamachi Koganei-shi, Tokyo 184 JAPAN
Solar Cycle Variations and Latitudinal Dependence on the Mid-Latitude Spread F Occurrence Around Japan

M. Kunitake, K. Ohtaka, T. Tanaka, H. Ishibashi, K. Igarashi
Communications Research Laboratory, 4-2-1 Nukui-kita, Koganei, Tokyo 184 JAPAN
M. Hayakawa
The University of Electro Communications
T. Ono
National Institute of Polar Research
A. Morioka and H. Oya
Tohoku University
Ionospheric Tomography Campaign May-July 1992 in Japan

Terry D. Kelly and David J. Rowntree
KEL Aerospace Pty Ltd, 231 High Street, Ashburton VIC 3147, AUSTRALIA
Some Initial Results with a New Advanced Digital Ionosonde

Nicolaj P. Danilkin and Sergey V. Zhuravlev
Federov Institute of Applied Geophysics, 9 Rostokinskaya, Moscow, RUSSIA
Incorporation of Satellite Sounding into the Ionosonde Network

N. Blaunstein, N. Filipp, V. Ivanov, M. Pasoari,, E. Plohotniuk, V. Shumaev, V. Ureadov
Baltsy University 279200, Moldova, Baltsy, Pushkin Str. 38,
Ionosphere Prognosis Using Ionosound with Linear-Frequency Modulated Signals

Valery A. Shaptsev and Lev S. Terekhov
Russian Academy of Science, Mira Avenue, 19
Omsk, 644050, RUSSIA
On Deployment of a Modern Standard Ionospheric Station at Russia's Geographical Center

Nikolay A. Zabotin and Gennadi A. Zhbankov
Institute of Physics, Rostov State University, 194 Stackey Avenue, Rostov-on-Don 344104, RUSSIA
Interference Mechanism of Polarization Distortions of the Signals of Vertical Sounding of the Ionosphere

Weixing Wan
Wuhan Ionospheric Observatory, P O Box 72003, Wuhan 430072, P. R. CHINA
Ionospheric Gravity Waves Detected from Digisonde Drift Measurements

Allon W.V. Poole
Hermann Ohlthaver Institute for Aeronomy, Rhodes University, Grahamstown 6140, SOUTH AFRICA
Towards a Semi-automatic Ionogram Scaling Program to Provide Model Parameters Rather Than Traditional Scaling Parameters

John MacDougall
Dept. of Electrical Engineering, University of Western Ontario, London, Ont., CANADA N6A 5B9
The Canadian Advanced Digital Ionosonde: Design and Results

The following papers were late arriving and could not be accepted for the symposium.

Davorka P. Grubor
Geomagnetic Institute, 11306 Grocka, Belgrade, YUGOSLAVIA
Vertical Ionograms as a Tool in HF Pulse Propagation Analysis

Gordon G. Bowman
Department of Physics, The University of Queensland, Brisbane, QLD 4072, AUSTRALIA
Some Evidence Supporting Short-term Forecasting of Mid-Latitude Ionospheric Disturbance Conditions

F.T. Berkey, L. & C. Tsai and G.S. Stiles
Utah State University, Logan, Utah, USA
Simplified Numerical Procedures Applied to the True-Height Analysis of Ionograms

14. THE NEW IPS-71 ADVANCED DIGITAL IONOSONDE

Terry D. Kelly, KEL Aerospace Pty Ltd, AUSTRALIA

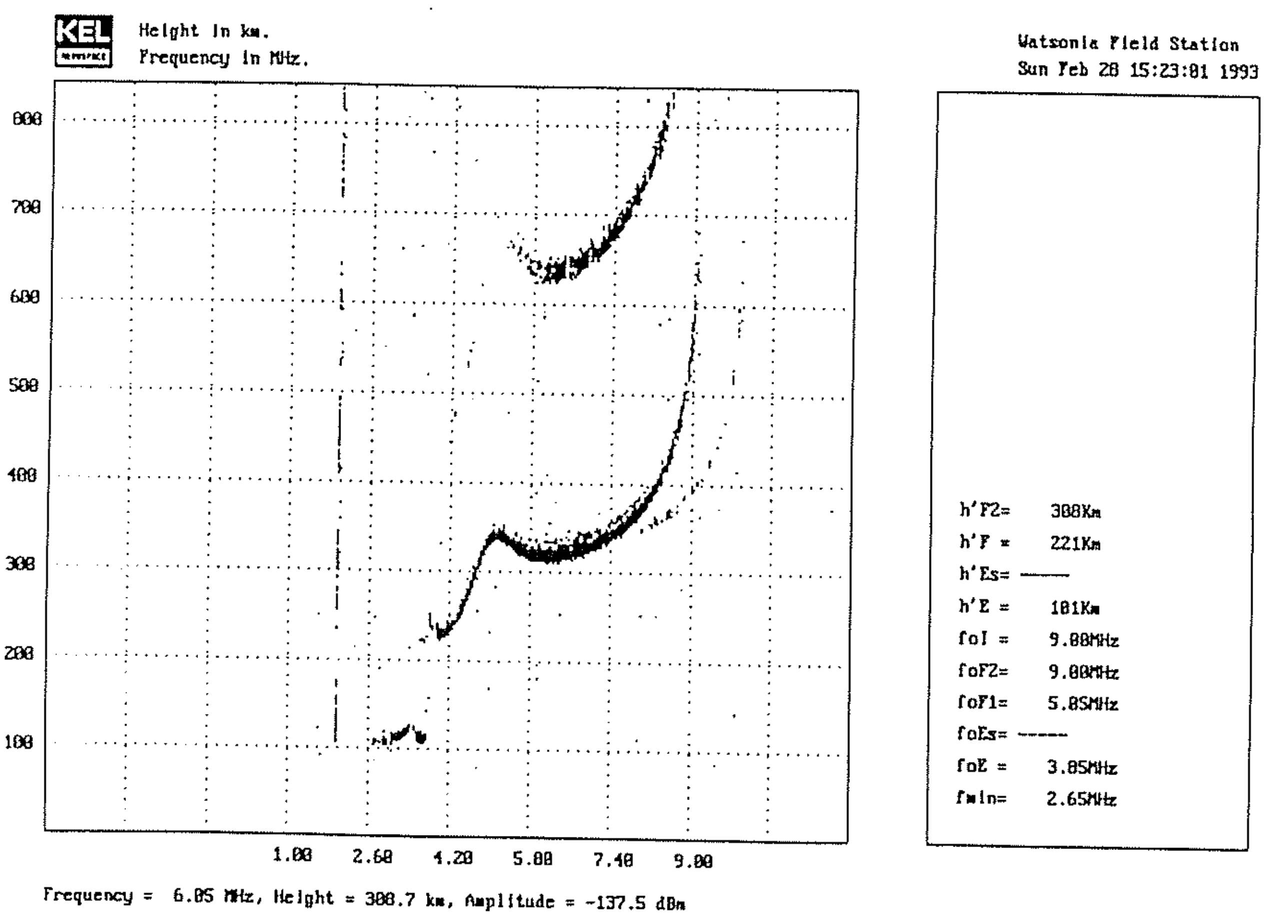
The long wait for a modern, low cost Advanced Digital Ionosonde from KEL Aerospace is over. KEL Aerospace is pleased to report the delivery of their new IPS-71 Advanced Digital Ionosonde to the Australian Defence Science & Technology Organisation (DSTO), complete with the new Doppler Interleaving feature which allows the fastest possible measurement of multi-frequency (and multi-height) Doppler in the ionosphere.

With more than 80 of the earlier model of IPS-42, 4A and 4B Ionosondes working in 25 countries around the world, KEL anticipates a lot of interest in the state-of-the-art IPS-71 Advanced Digital Ionosonde.

KEL Aerospace already have won orders for the supply of the IPS-71 to the Australian Defence Department (DSTO) for HF communications research applications, to the 'Jindalee' Project Contractor (Telecom Australia) for investigations into Frequency Management for the Australian OTH Radar project (JORN), and two IPS-71's to the University of Texas for use on a US

Figure 1: A Conventional Ionogram With O/X Separation

⇒ This ionogram may be taken in approximately 20 seconds.
⇒ Frequencies, Range, Pulses/Channel and Noise Thresholds all may be varied by the Operator.
⇒ Accurate Amplitudes are clearly displayed in colour both on the screen of the PC and on colour print outs.
⇒ The autoscaled results are at the right of the ionogram.



government research project studying ionospheric tomography. KEL is planning to deliver approximately 100 of these new sounders worldwide during the next few years.

After developing a strong capability in the demanding area of OTH Radar Receiver design engineering, KEL has now produced a world-class ionosonde with exceptionally high performance levels in the key areas of phase coherence, low internal noise and high IMD intercept points (for 2nd and 3rd Order Intermodulation Distortion) performance, which is essential in areas such as Europe which suffer from very high levels of HF interference.

In co-operation with Australian Defence research scientists and leading university researchers, KEL has developed a 'User Friendly' software interface which is highly intuitive and which allows the user to quickly and easily perform all necessary functions with this ionosonde, generally without even reading the operating manual.

Features of the IPS-71 include:

- Conventional Ionograms (with accurate complex amplitude)
- Doppler Ionograms (to study ionospheric dynamics, TID's, etc)
- Phase Sounding (for precision group height & structure)
- Surveillance Sounding (an important diagnostic tool)
- Remote Control
- SMARTIST-II Auto-Scaling
- Data Printing & Editing Software

Optional features include:

- Angle & Direction of Arrival (Software & Antenna System) including: Skymapping, Tilt and Drift.
- SMARTPOL-II Auto True Height Software
- Oblique Sounding (Software, Antennae & GPS Synchronisation)
- Remote Control Station Software

In its most basic configuration the IPS-71 produces amplitude, Doppler, phase and surveillance data, yet its price is similar to that of the earlier IPS42/DBD43 Ionosonde Systems which only measured virtual height and frequency.

The IPS-71 may be connected to a simple, pre-existing double delta antenna (exactly as used by the IPS-42), or it may be connected to a triple-delta to obtain O/X separation of echoes, or thirdly, to a small array of four crossed-loop receiving antennae to obtain Angle and Direction of Arrival information using phase interferometry.

The IPS-71 is controlled by, and stores all data in the PC DOS environment. Data files are compressed to provide economical data storage and to enable low cost data transmission over long distances for near real-time data acquisition. Remote communications are achieved also in the PC environment, using IPS-71 Remote Control software operating on a PC, with standard modems.

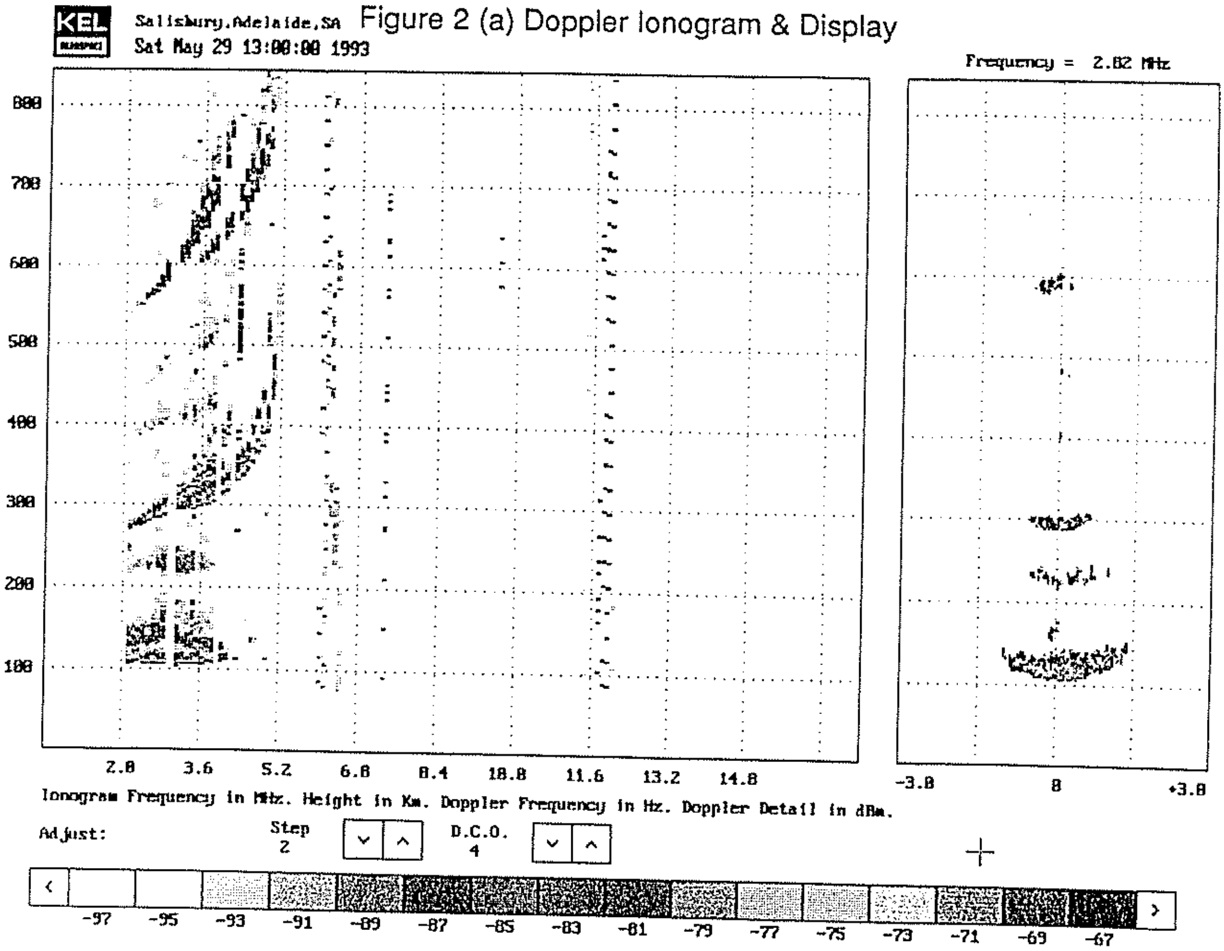
Ionograms are displayed with SVGA resolution using the VESA standard which offers high speed and high resolution for colour displays of Amplitude, Doppler, Phase and other parameters.

Colour printing is possible, using economical HP Colour DeskJet plain paper printers. Black & White printing is possible using HP DeskJet or LaserJet printers. (The ionograms displayed here were supplied in colour, but colour printing is too expensive for the Bulletin; PJW)

Acquisition of Conventional, Doppler and Phase Ionograms may be pre-programmed, using the IPS-71 'Timer' which will schedule soundings at required times and intervals. Autoscaling may be performed in real time. The IPS-71 may be optionally configured such that one group of remote callers could have access only to autoscaled results whilst a second group of authorised callers may have access to the actual Ionogram data and a third group could have complete remote control of the IPS-71.

Certain HF frequencies may be banned, according to the regulatory requirements of each country. A typical list of banned frequencies is supplied as part of the software with each IPS-71 and is readily accessible by the User, in a standard text file. The User may add, delete or modify the list of banned frequencies as required. It should be noted however that the 2KW pulse power of the IPS-71 is utilised for less than 0.5% of the time. Furthermore the IPS-71 'linear' transmitter has a specially 'shaped' pulse which is designed to minimise interference. These very high performance characteristics of the IPS-71 all contribute toward the highest possible level of environmental compatibility in the radio spectrum.

Figure 2 (a) Doppler Ionogram & Display



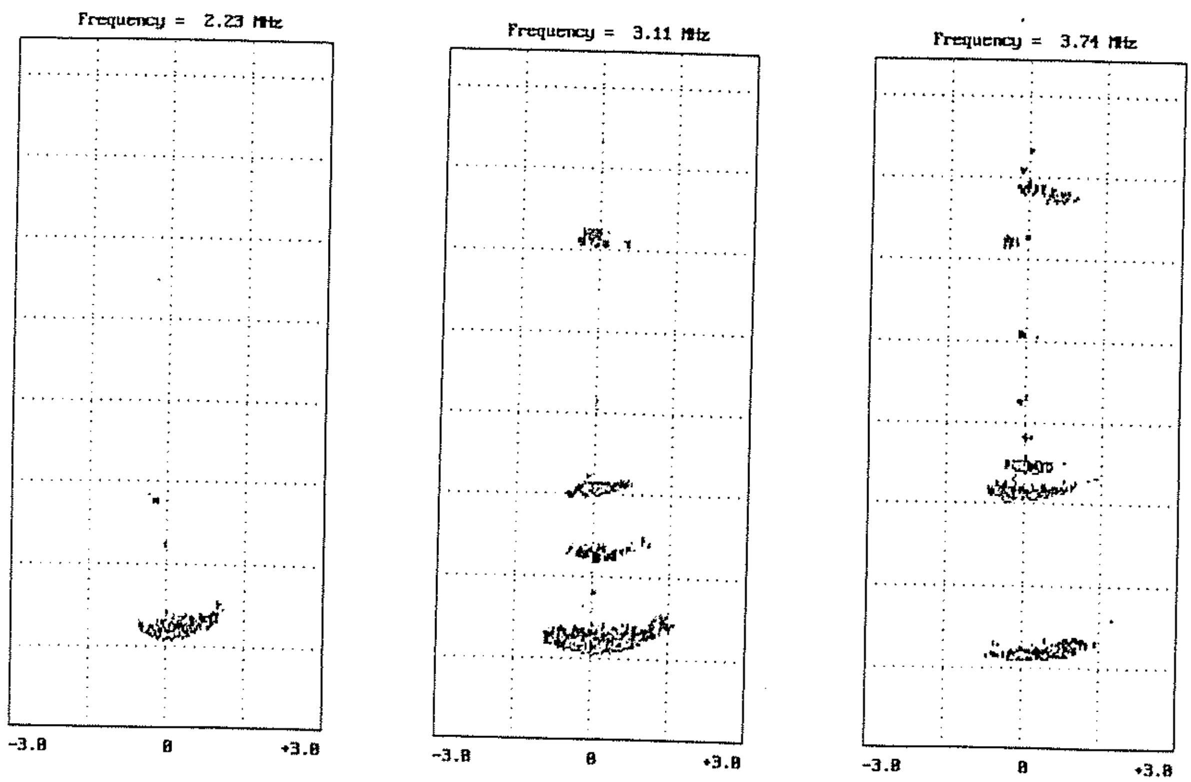
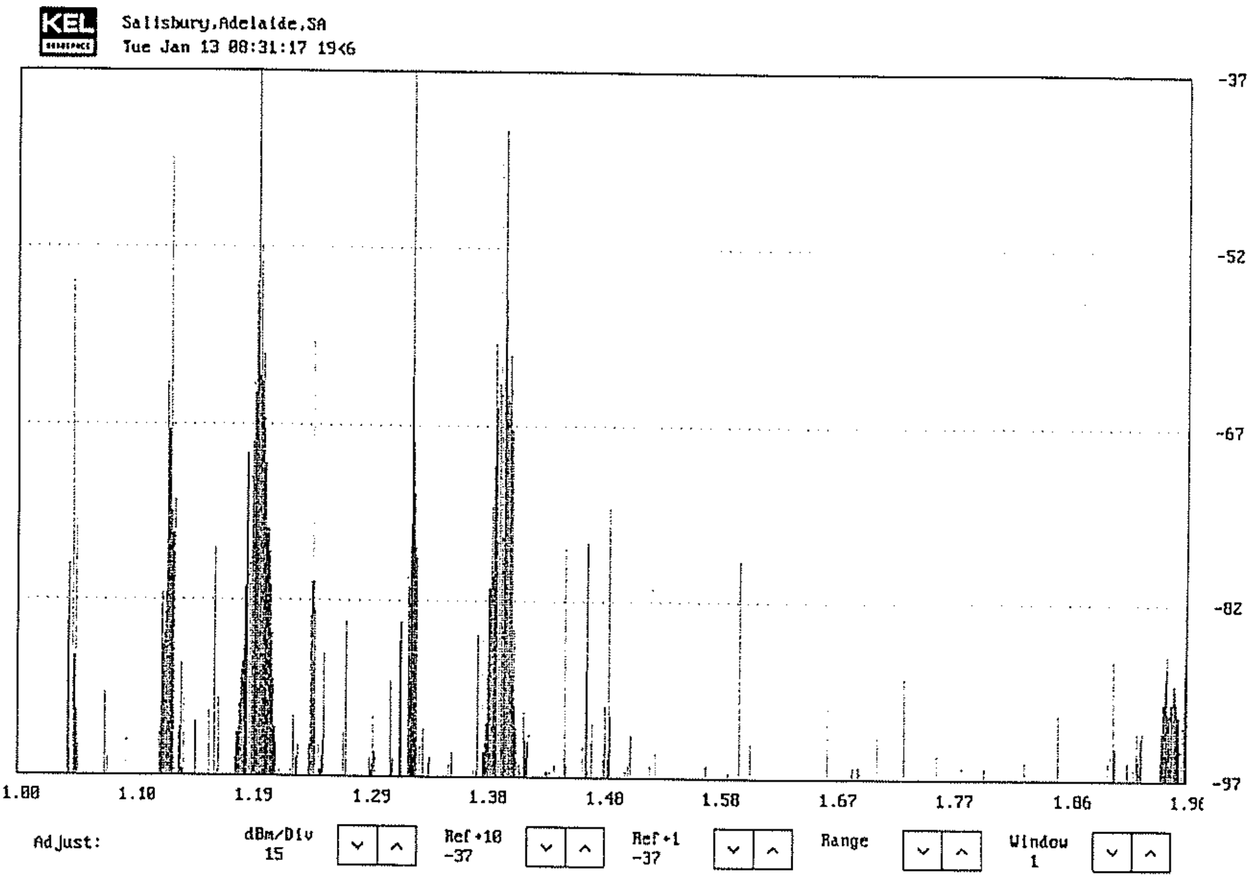


Figure 2 (b) 3 more Doppler Windows

Figure 3: Surveillance Sounding:

This is an excellent means of locally or remotely monitoring the HF environment and of confirming the correct operation of the Receiver, Frequency Synthesiser and Signal Processing parts of the IPS-71. By monitoring the accurate amplitudes of local ground wave interference and by regularly monitoring the amplitudes of sky wave interference it is possible to build a valuable understanding of the local HF environment.



Surveillance Frequency in MHz. Amplitude in dBm.

Display Formats of the IPS-71 are shown in figures 1 to 3.

Figure 1 shows a conventional ionogram with O/X separation. Ionograms such as this can be collected in approximately 20 seconds. Frequencies, range, pulses/channel and noise thresholds all may be varied by the operator. Accurate amplitudes are clearly displayed in colour both on the screen of the PC and on colour print outs. The autoscaled results are at the right of the ionogram.

A Doppler ionogram is shown in figure 2(a). The display comprises an 'Amplitude Ionogram' on the left and a 'Doppler Window' on the right. The 'Doppler window' may be displayed for any channel on which a sounding occurred. In figure 2a, for instance, the 'Doppler window' displays the Doppler measured for the first frequency recorded, 2.02 MHz, written at the top of the window display.

Figure 2(b), below figure 2(a), displays three more 'Doppler Windows' for three other sample frequencies. In all these examples, the Doppler shift axis extends from zero Doppler shift to ± 3.0 Hz. The actual frequency at which the Doppler shift is being measured is indicated at the top of each Doppler window. A histogram display is also available, showing the amplitude versus Doppler shift for each range bin for any selected frequency.

Amplitudes can be clearly displayed as coloured pixels, which are positioned according to the range and the Doppler Shift for each data point.

Figure 3 shows an example of Surveillance Sounding. This mode of operation is a means of locally or remotely monitoring the HF environment and of confirming the correct operation of the Receiver, Frequency Synthesiser and Signal Processing parts of the IPS-71. By monitoring the accurate amplitudes of local ground wave interference and by regularly monitoring the amplitudes of sky wave interference it is possible to build a valuable understanding of the local HF environment.

A 'Portable Advanced Digital Ionosonde System' (PADIS)

If 'portability' is a requirement then the IPS-71 certainly may be regarded as a 'Portable Advanced Digital Ionosonde System'. The IPS-71 is housed completely in a small functional cabinet and is built to modern commercial standards, with ruggedised features including triple lightning protection on the Transmitter and Receiver, extra high quality Connectors, heat-sensing Air Cooling System and tough construction.

KEL Aerospace has been manufacturing Ionosondes professionally for worldwide clients since the late 1970's. The IPS-42 and DBD-43 have operated successfully in many countries and they have earned a first class reputation for reliability and performance. The IPS-71 now is a Portable Advanced Digital Ionosonde System for the 1990's and beyond, designed and built on the basis of KEL Aerospace's long experience in manufacturing, installing and supporting ionospheric monitoring systems throughout the world.

Availability:

KEL Aerospace is now manufacturing IPS-71 Advanced Digital Ionosonde Systems and delivering them to clients in Australia and overseas. Availability typically is 3-4 months, depending on the level of orders at any one time. For further details you may contact:

Terry D. Kelly
KEL Aerospace Pty Ltd
231 High Street,
Ashburton,
Victoria, 3147
AUSTRALIA

Telephone: +61 (3) 889-0022
Facsimile: +61 (3) 889-0006

Questionnaire for Readers of the INAG Bulletin

Please number the items in each question in order of importance to you. 1 is most important.

A. Articles and notes in the Bulletin are:

_ about the right level of interest.

_ more complex than I usually read.

_ generally of limited interest to me.

_ I file the Bulletin as a reference.

B. I would like to see more articles on

_ how other networks operate.

_ the history of ionosondes and ionosonde networks.

_ how to use ionosondes in applications.

_ training aids for manual scaling.

_ interpretation of difficult and interesting ionograms.

C. Articles I have read in INAG have

_ never affected me or my work.

_ have changed some of my ideas.

_ have been a source of encouragement.

_ have occasionally been very useful.

_ generally been interesting and helpful.

D. More articles would be written for INAG

_ if people were told what type of article they should write.

_ if the articles were refereed.

_ if the subject area were broadened.

_ if people felt the Bulletin was re widely.

_ if people felt the articles influence opinions.

E. I don't write articles for INAG because

_ I have never been asked to.

_ I don't think I can write anything that would interest readers of the Bulletin.

_ I'm always too busy.

_ I don't think it is important enough compared with my other responsibilities.

_ My English is poor.

_ I don't like writing.

F. I don't ask other people working for me to write articles for INAG because

_ it never occurred to me to do so.

_ there is nobody I could ask to write an article.

_ I have, but they refused.

_ I have and they never got around to it.

_ I have and they did.

G. What were the two most useful articles or notes published in the Bulletin during the last three years?

H. What were the least useful articles or notes?

I. Name one person who you feel would write a good article for the Bulletin.