IONOSONDE NETWORK ADVISORY GROUP (INAG)*

Ionospheric Station Information Bulletin No. 57**

CONTENTS

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OBITUARIES

NATILIYA P. BENKOVA (1912-1992)

Contributed by : Dr. A. Feldstein and Dr. Z. Rapoport

On June 3 of 1992 Doctor of Science (phys.-math.), full Professor Nataliya Pavlovna Benkova passed away. She was a gifted scholar and broadly-educated person, who devoted her whole life to science. She was born on May 30, 1912 near Kazan, a town on the Volga River, in the family of a prominent painter. After graduating from Kazan State University in 1934 she began her scientific career, at first in the Main Geophysical Observatory in Pavlovsk, near St.Petersburg. There she was engaged in the development of forecasts for geomagnetic disturbances responsible for disrupting radio communications in high-latitudes. When the Scientific Research Institute of Terrestrial Magnetism (later IZMIRAN) was created, she began work there as chief of the Forecast and Information Department. Her Ph.D. and D.Sc. theses were devoted to modelling the Earth's main geomagnetic field and spatial-temporal variations of the geomagnetic field. Then she changed to ionospheric research. As soon as the Ionospheric Department of the Institute appeared, Dr. Benkova became its Chief. For quite a while she also served as IZMIRAN Deputy Director. She participated actively in the organisation of ionospheric research in the USSR, creating a network of vertical incidence ionospheric ground stations. She was a leader of many international and national projects in the fields of the ionosphere and ionosphere-magnetosphere interactions. Prof. Benkova was the author of more than 200 publications and 2 monographs. Her numerous disciples work all over the country and abroad and most current ionospheric researchers in the former USSR are either her pupils or pupils of her pupils. Our science has suffered an irreplaceable loss, not only of a prominent scientist, but a person of extremely high culture, encyclopedian knowledge and a big heart. Her colleagues win remember her forever.

CLARENCE GORDON McCUE (1927-1992)

contributed by : Dr. D. G. Cole

Any subject, radio physics as much as any, is dependent on its adherents and its human face. That face is made up of the characters that support and stride its boundaries. Clarrie McCue was one of those characters that made the subject all the more interesting for being part of it. Born in Sydney, Clarrie gained a bursary to Waverley College and went on to Sydney University where he gained a Master of Science in physics. During one of his vacations he asked for and was given a temporary job at the Ionospheric Prediction Service where later he played one of the main parts of his life.

After gaining his MSc Clarrie went to work at the recently formed Australian Commonwealth Department of Defence Weapons Research Establishment (WRE). The spirit at the time was young, active and ambitious and he joined a group of scientists who were the vanguard of the new era after the war. Australia's relationship with Great Britain was such that several of the scientists were selected to spend two years at laboratories in England where they worked alongside British scientists and learnt the trade. Needless to say, Clarrie took in a great deal at the Slough Radio and Ionospheric Laboratory; working with Roy Piggott and setting up contacts that were to remain with him all his career.

On returning to WRE Adelaide, Clarrie worked with Ross Trehame, Doug Fyfe and Peter George, on several ionospheric monitoring projects, in Singapore and later with the Japanese on Trans Equatorial Propagation between Yamagawa and Australia.

During his period at WRE Clarrie took time off to teach at the Duntroon military college for a two year period. When he felt that time was right to move on from WRE, he accepted, in 1967, the directorship of the Ionospheric Prediction Service, then part of the Commonwealth Government Department of the Interior.

Through dedicated hard work, sheer belief in his cause, and the use of a forcefully beneficent character, Clarrie moved IPS forward to become a major group within international organisations, as well as being responsible for most Australian government HF prediction advice. One curious feature of Clarrie's reign at IPS was that he never allowed any advertising of the services. Either customers heard of IPS from word of mouth or they were not sufficiently government oriented to know of IPS. Most of IPS public relations came from Clarrie. He was never one to be backward in speaking of his work and building up confidence in his staff. Clarrie was a great talker, interesting and well versed in many topics, never lost for a word, and keen to pass across his opinions.

An example of this was the meeting with Terry Kelly on a flight to Melbourne. IPS had designed an ionosonde that had attracted the interest of many groups around the world. The overseas groups had wanted to buy the equipment from IPS, but IPS was not in the business of building ionosondes for the world. After a market survey, IPS realised that there was sufficient demand for the ionosonde to be built and sold. An Australian company was needed. On a flight to Melbourne the meeting between Clarrie and Terry Kelly sealed the deal that formed KEL Aerospace, and set up the basis for the IPS-42 to become the most used ionosonde worldwide. This liaison probably did much to maintain the world ionospheric monitoring network for research and user applications.

Well known in Defence and civil HF Propagation circles overseas, Clarrie has provided over the years a gateway for other scientists inside Australia to acquaint themselves with international science and for foreign researchers to find out about Australian work. Clarrie never stinted his acquaintances their fair share of interaction with other groups; he encouraged it.

Clarrie was instrumental in setting up international agreements between Chinese and Australian ionospheric organisations for data exchange, the US and Australia solar observatories for joint observing programs, and he was active in CCIR (International Radio Consultative Committee) advising the International Telecommunications Union, a scientific organ of the United Nations.

In 1979, Clarrie was chosen to head the Australian Antarctic Division for the Department of Science. With his customary relish, Clarrie learnt all there was to know of Antarctic science, its logistics, its problems and its people.

Clarrie retired in 1985 to take up activities on behalf of the Catholic Church. Whereas in Adelaide he had been instrumental in building Churches, his retirement to the Central Coast of NSW gave him the opportunity to became a catechist to the local schools, treasurer of the Wyong Church, and helper and friend to the many who knew him. Not only his wife Daphne, who supported him so faithfully, and his four surviving children but also his many friends and colleagues will miss the companionship and warmth of Clarrie's personality.

COMMENTS FROM THE CHAIR

This bulletin starts out with a sad reminder for us: Professor Benkova, of Russia, and Clarrie McCue, of Australia, have both passed away since the appearance of our last Bulletin. We all grow older, but at the same time we often forget the mortality of others until it is too late to tell them of the debt we owe them. Both our departed scientists am remembered by many as the people who gave them their first start.

I would like to thank Alan Rodger for Chairing the INAG meeting held over a year ago at the 1991 Vienna IUGG meeting and for producing the report in this Bulletin. Several important issues are raised in Alan's report and I would like to reiterate some of them here.

But first; and always first for anybody producing an INAG Bulletin, my thanks to the people who have contributed articles, notes and thoughts. These are always needed and without them, no Bulletin can appear.

When the INAG Bulletin was first produced, under Dr. Roy Piggott's hand, one of its objectives was to bind the disparate ionosonde stations together into a cohesive network - cohesive enough to contribute to global science. This endeavour is ongoing and now the Ionosonde Network is in danger of becoming fragmented across many new issues: e.g., economics, modernisation, commercialisation. I would like to comment on these issues briefly. Obviously, there has to be an interplay between the different areas and our role is to ensure that the interplay is productive and positive for all parties concerned.

The economics of an ionosonde network is made up of many components and it would be a too easy to assume 0 the problems can be solved by obtaining more money. I feel the most important resource for an ionospheric network is the people who operate it. In June of this year, IPS farewelled our last ionosonde operator with over 25 years service, Arthur Drury, and took the opportunity to hold a small function which was attended by the other retired operators, George Goldstone and Ivan Bozic, as well as by Peter Davies and Clarrie McCue. Arthur will now join Ivan, George and Peter as a contractor, scaling our ionosonde data and running our ionosonde stations. Finding new people of this calibre, training them and then employing them full time running an ionosonde station is no longer an economic proposition. Routine ionosonde stations, such as IPS operates, no longer require a M time operator but the level of skill required is hard to find in a part-time employment pool. More important, it is hard to make the task a full time job with sufficient challenge for the person concerned.

However, in some cases, finance is a major problem and networks need to show they are "relevant". Leo McNamara's article on the use of ionosonde data aiding single site location direction finding is one possible use for ionospheric data. However, for the data to be timely, they must be supplied in near real time. At IPS, we feel making data available to customers in real time may be a useful way of demonstrating the relevance of an ionosonde network. Our 5A ionosonde, designed to meet this need, was described in the last INAG Bulletin. Other ionosondes are capable of this mode of operation.

At the same time as financial pressure is threatening networks with closure, there is the ever present problem of maintenance and, often, modernisation. Old equipment becomes harder to maintain and new equipment is sought. At IPS we have found it becomes steadily more difficult to maintain old equipment, even old solid state equipment although we expect to keep our older ionosondes in operation as we phase in the new digital ionosondes. Modernising, coupled with a search for relevance places a dual pressure on networks to obtain digital ionosondes capable of a great deal more data handling than earlier systems allowed. This has lead to claims and counter claims as to what a digital ionosonde is and the more vexed problem of what constitutes an adequate digital sounder. This discussion overshadows an important issue for the network as a whole - not every group can afford to replace all their ionosondes. It is likely that film based ionosondes will continue in operation for some time to come and people in the network should seek to support them wherever they can. Dr. Abdu, in his short note, reminds us that older style ionosondes will not be abandoned, even when a more expensive digital ionosonde has been purchased.

For the Ionosonde Network to be a supportive community, it must seek to help those who have maintenance problems. This may be achieved in two ways. First, and most important, help with the supply of spare parts. Wherever there is an old ionosonde not being used, there is a collection of spare parts waiting to be distributed. Second, and possibly even more important, don't make the obvious comparisons between the older ionosondes and the more modem computer controlled ones. This can undermine confidence in the conventional ionosonde station. It is far harder to reopen a closed station than refurbish an old station. Those fortunate enough to have good data access should seek to support the others thereby enhancing the total size of the network. To build a complete picture of the global ionosphere, we need a larger network. Remember, you can never record today's events again. If you need spare parts, or you have a potential supply, please write a brief note for the INAG Bulletin indicating your situation.

Modem digital ionosondes have also brought a data problem. Now that many ionograms are being scaled digitally, the question arises as to whether the various computer scaling programs can be trusted; are there potentially better methods not yet tried, and can a program replace the capable scaler in recognising unusual features? Several problems are raised in Alan Rodger's article on the INAG meeting in Vienna. This is an important issue as much data are being collected for real time applications where computer scaling is now accurate enough to supply useful answers. However, few would claim this same data am suitable for archiving without a manual validation step. We need to reassure each other we recognise this important step is taking place regularly. By now, all computer scaled data should be recorded with a slash / in the descriptive and qualifying letter positions to indicate this is only computer scaled data. The slash is replaced by a blank or the appropriate scaling letter after the manual validation step.

Modem digital ionosondes offer huge advantages in developing our science. One of the main impetuses for a major upgrade is to develop a better research program. I look forward to receiving notes describing successes in this area. But I also like to remind people that much can still be achieved with more modest routine ionosondes.

Dr. Somayajulu has supplied a paper in this Bulletin discussing the counter electrojet and it includes examples of the effects seen on ionograms recorded with an EPS-42 ionosonde. Another area where all ionosondes can contribute is in the collation of a global archive of ionosonde data. Professor Danilkin, in his article, reminds us that we can change the ionosphere. It may well be that lower atmosphere climate changes will eventually be detected in the thermosphere; but Professor Danilkin proposes a change we hear mentioned less often: in-situ changes of the global ionosphere due to man-made activities in space. Today's measurements may be tomorrow's baseline for change and the more long data set locations we have, the better equipped we will be to understand the changes. Routine scaled data from conventional ionosondes will play a major role here.

These are just a few ideas and thoughts that passed through my mind as I scanned the articles and comments I had for this issue of the INAG Bulletin. In closing, I would like to remind you about the INAG membership. We now have over 190 members who have expressed a real interest in this field. It is in our hands to develop the global network, exploit its past data and enhance its future value. The global ionosonde network is as mortal as the people associated with it. We are the people who give our data archives a meaning for future generations of scientists. If, like Professor Danilkin, we believe it is important to understand what the ionosphere is doing, we need to make real efforts now to support each other. We need to discuss all issues widely.

In addition to the ever present reminder that this discussion can take place in the INAG Bulletin, I would like to also remind everyone that **INAG is convening a Workshop** at the Kyoto URSI Meeting in 1993. I hope these and many more issues will be discussed at that meeting. The principal objective of the Workshop is to highlight the relevance of ionosonde networks now and in the future. Please consider presenting a paper at URSI, next year and **send in your registration immediately.** Forms are included in this Bulletin.

I look forward to hearing from you.

Phil Wilkinson
Chair, INAG.

IONOSONDE NETWORK ADVISORY GROUP MEETING: VIENNA, 19 AUGUST 1991.

REPORTER: Alan Rodger

1. Introduction

A brief INAG meeting was held on the 19 August 1991 during the IUGG meeting in Vienna. Neither of the INAG office bearers could be present, but Dr P J Wilkinson provided detailed notes for A S Rodger who chaired the meeting. Those who signed the attendance sheet are listed below.

M A Abdu	Brazil
A Abtout	Algeria
L F Alberca	Spain
H Chandra	India
R D Hunsucker	USA
V P Kim	USSR
K Marubashi	Japan
H Rishbeth	UK
A S Rodger	UK
K Seraftmov	Bulgaria
W Singer	Germany
P Vila	France
G 0 Walker	Hong Kong
A W Wernik	Poland

2. Membership of INAG

The meeting was informed that the membership list had been completely revised. INAG now contains about 170 active members representing nearly 40 countries. Those present at the meeting were asked to check the new membership list and indicate any amendments.

3. The INAG Bulletin

An INAG Bulletin is produced about once per annum. This is a considerable reduction compared with a decade ago when three issues were published each year. One major reason for this reduction is that the members of the INAG community are not writing as many notes or articles as they have in the past. **INAG welcomes notes about** any topic concerned with ionosondes e.g., new equipment, interesting ionograms, scaling problems, and historical notes. Those who do not have English as their first language will be given any assistance they wish in writing notes by contacting the Chairman of INAG.

4. URSI Symposium in Kyoto

Professor A W Wernik (Chairman of Commission G) explained that there would be a workshop/symposium during the URSI meeting in Kyoto (see note in this Bulletin) focusing upon technical and managerial aspects of running ionosonde networks, rather than the science that accrues from the data. The meeting suggested that the following issues might be included in the workshop program:

- how to make the network even more cost effective,
- computer scaling of ionograms, and
- exploring ways in which the importance of the ionosonde networks can be presented effectively to funding agencies.

5. Reports from the networks

(a) UK

The Advanced Ionospheric Sounder at Halley has been refurbished. The old computer has been replaced with a 386 pc. A new and more flexible operating system is now used, and the data are now recorded on optical disk. The South Uist ionosonde has been moved to Lerwick. Port Stanley, Argentine Islands and Slough continue to operate normally.

(b) USSR

Details provided to the meeting were published in the last bulletin.

(c) China

Details provided to the meeting were given in the last bulletin. It was hoped that the recent establishment of a World Data Centre in China will make Chinese ionosonde data more readily available to a much wider community.

(d) Brazil

A digisonde 256 has been installed and is operational at Paulista.

Dr Abdu described the plans for an International Equatorial Year which lasts for 18 months from September 1991. It will involve many ionosondes and other instruments all round the world at equatorial latitudes.' Dr Abdu also stressed that the C4 ionosonde that he operates is in desperate need of spares. He requested anyone with an old C4 ionosonde who could provide spares to please write to him (INPE, C.P. 515, 12201 S J Campos, Sao Paulo, Brazil) or the Chairman of INAG.

(e) India

A Kel 51 has been deployed at Amahabad.

(f) Spain

A digisonde 256 has been deployed at El Arenosillo.

(g) Germany

A Polish-made digital ionosonde was deployed in Germany during 1990. The normal recording interval is 15 minutes, but sometimes a 5 minute program is run.

(h) Norway

A Polish-made digital ionosonde will be deployed at Spitzbergen in 1992.

(i) USA

The Digisonde 256 ionosonde at College is now operated by the US Air Force; they also undertake the scaling of the data.

(j) Japan

Japan will close two (Akita and Yamagawa) of their five stations. However both these stations am likely to run on a voluntary basis for the next two years. Digital scaling of ionograms has not met with success and has ceased. Only Kokubunji data are scaled by hand.

6. Archiving of ionosonde data

Professor Henry Rishbeth made a plea for INAG to identify the stations with the longest data sets, and to ensure that these stations archive their data very carefully so it would be possible to carry out studies of secular and global change in the future. For such studies it would be very valuable if old hand-written worksheets could be transferred easily into digital form (e.g., with the use of optical scanning devices). **Any group which has developed such techniques is requested to inform the Chairman of INAG.**

7. Computer scaling of ionosonde data

The computer scaling of ionograms is an important issue for INAG to discuss. The critical element is the algorithm used to determine the various traces on an ionogram. Several groups have developed the necessary methods but none are as good as the human eye, yet. Can better routines be developed? Some of the other issues that INAG needs to address are listed below

- Are all the parameters that are currently routinely measured from conventional ionograms required in the future?
- Are there new parameters that should be measured?
- Which parameters are essential for long term studies of the ionosphere?
- Should all descriptive letters be used for digital scaling; if not, which ones should be retained?
- A new set of quantitative uncertainty flags could be defined to replace qualifying letters for use with digital data.

Some of these points were discussed during the 6 years that the International Digital Ionosonde Group (IDIG) was in existence but no firm decisions were made at that time.

9. Any other business

Professor Henry Rishbeth reported that the UK was assessing the priorities for Solar Terrestrial Physics monitoring. The exercise was trying to define the instruments and the locations that were essential for long term studies of the solar terrestrial system. However it is recognised that many equipments are operated for local requirements. The meeting was reminded of the criteria, against which the value of individual station could be measured, that were drawn up in the report 'Needs for Ionosondes in the 1980s' and published in INAG 26,pp9-14. These criteria are equally valid in the 1990s.

CONFERENCE REPORT

8th National Workshop on Ionospheric Monitoring

by S. Pulinets
Moscow, Russia.

The 8th National Workshop on Ionospheric Monitoring was held on Oct. 3-5, 1991 at Rostov on-Don University camp near Black Sea (Abrau Diurso). The papers presented were divided to three groups:

- Hardware, software and ionospheric monitoring automation
- New aspects of ionospheric data interpretation
- Ionospheric physics and modelling

The main concern of most participants was how the ionospheric network could be maintained in the collapse of the Soviet economic conditions. Automation of routine operations of the ionospheric monitoring equipment is the only possible way to lower the costs of ionospheric stations.

A wider international cooperation can attract more young scientists to this field of ionospheric investigations.

The Workshop program

I. Hardware, software and monitoring automation.

Pulinets, Introductory remarks of the Program Committee.

Pulinets, Global ionospheric monitoring, international cooperation and the state of the Soviet network of ionospheric stations.

Pogoda, Ionospheric diagnostics: main problems of systematic approach.

Checha, A. V. Shirochkov, The development of polar ionosphere investigation and predictions using a ground-based network and an operative data bank.

Akchurin, R. G. Minullin, V. I. Nazarenko, A.L. Sapaev, 0. N. Sherstiukov, "Cyclon" ionospheric complex with automatic ionogram processing.

Drobzhev, M. Z. Kaliev, Yu. G. Litvinov, A. F. Yakovets, Multi frequency Doppler technique for studying ionospheric wave disturbances.

Novikov, S. M. Sokolnikov, Yu. N. Elizariev, Ionospheric monitoring automation.

Galkin, Software packet "TRACER" for automatic ionogram extraction and interpretation

Galkin, On the automatic processing and interpretation of reverse oblique ionograms

Denisenko, Yu. I. Faer, N. E. Sheidakov, The effective collision electron frequency diagnostics in F-region by Appleton technique.

Zasenko, A. V. Zavorin, N. V. Ilyin, A. V. Medvedev, A. I. Orlov, I. I. Orlov, B. G. Shpynev, The thin structure of signals reflected from the ionosphere.

Zachateisky, S. N. Mukasheva, Calibration of the integral electron content signal measured from a geostationary satellite.

II. New aspects of ionospheric data interpretation.

Denisenko, Inversed problem of the vertical ionospheric sounding.

Sotsky, Peculiarities of the vertical electron distribution reconstruction using model dependencies.

Besprozvannaya, 0. M. Pirog, T. 1. Shchuka, Standard N(h) profiles calculations by the Norilsk meridional chain of ionospheric stations data.

Beliaev, A. A. Bezotosnyi, A. E. Epishova, P. E. Kozina, M. M. Konoplianko, B. I. Murgozhin, V. M. Somsikov, V. I. Drobzhev, Wave disturbances diagnostics in the vertical sounding data.

Vodolazkin, Reverse problem of the vertical effective collision frequency profile reconstruction.

B. D. Chakenov, Ionogram interpretation as a image recognition problem.

III. Ionospheric physics and modelling.

Ben'kova, N. A. Kochenova, M. D. Fligel, E. F. Koz1ov, H. I. Samorokin, Structure of the sub auroral ionosphere: observations and model representation.

Shchepkin, G. P. Kushnarenko, G. N. Kuznetsova, A. I. Freizon, Semi empirical generalisation of the electron concentration data obtained from N(h) profiles for the 200 km height.

Kushnarenko, L. A. Shchepkin, L. N. Leshchenko, The results of F1 layer processing under low solar activity conditions.

Drobzhev, I.D. Kozin, A. D. Kolodin, V. K. Kravchenko, B. I. Nurgozhin, On the short term variations of ionospheric parameters during space vehicle launches

Drobzhev, B. T. Zhumbaev, V. V. Kazakov, P. E. Kozina, V. K. Kravchenko, B. I. Nurgozhin, On ionospheric conditions during the Zaisan earthquake.

Gontarev, B. I. Nurgozhin, B. K. Osipov, B. V. Troitsky, Static measurements of the Integral electron content dynamics by in the Kazakhstan region.

BRIEF INTRODUCTION TO WUHAN IONOSPHERIC OBSERVATORY

Huang Xinyu and Zhang Shunrong

Wuhan Institute of Physics, The Chinese Academy of Sciences

Wuhan Ionospheric Observatory (30.5 degrees N, 114.4 degrees E), of the Chinese Academy of Sciences, was established in 1957 to take an active part in the IGY (1957-58). It grew out of the Ionospheric Laboratory under the jurisdiction of Wuhan University, which began ionospheric observations, using a manual ionosonde, in 1947. Now, as a department of the Wuhan Institute of Physics, the Observatory contains the following sections:

I. Ionospheric Vertical Sounding Station

Automatic ionosondes have continuously operated since 1957, with their routine programs of taking a record every 15 minutes or 5 minutes as needed. The ionospheric parameters and their monthly medians are compiled and printed in both tabular and graphical formats. The Observatory has accumulated continuous ionospheric data for more than three solar cycles, and Dr W. R. Piggott has commended these data for their reliability and good quality during his visits. Recently a new imported DGS-256 from Lowell University in the USA has been installed and will be put into routine operation in 1993.

II. Monitoring Network of Ionospheric AGW Disturbances

The network is made up of 3 stations with the spatial distances of about 100krn separation. Two sets of observational instruments, Satellite Beacon and HF Doppler Receivers, are used at each station. This system not only records the variations of some important ionospheric parameters such as TEC, but also makes it possible to determine the velocity vector of TIDs and the orientation and location of the disturbance source. More than 10 years of TEC and other recordings are now available.

III. LF and VLF Receiving Station

More than 10 years data have been obtained from Loran-C and VLF transmissions and BF absorption instruments.

There are now about 30 personnel in our observatory. Besides maintaining and developing the equipment and handling the real-time experimental records, they are engaged in scientific research on the mainstream areas of the morphological regularities of the ionospheric structure and ionospheric atmospheric gravity wave disturbances and their effects on radio wave propagation. They are also developing radio diagnostic techniques for ionospheric disturbances as well as increasing the ability for obtaining and predicting ionospheric information. Substantial advances have been made in these areas and hundreds of academic papers published in domestic and foreign publications.

The Observatory is authorised to award Masters and Doctoral degrees. In recent years it has been training and educating a good number of fully qualified young scientists and technicians, most of whom have been sent or are staying in foreign institutions for training or participation in research work. Moreover, our observatory also takes great interest in international interchanges and co operation. Many famous scientists have visited our observatory since 1978, including H G Booker, K Rawer, W R Piggott, H Rishbeth, B W Reinisch and K C Yeh.

For enough financial support from departments concerned, and especially, no lack of successors, the observatory will be developing progressively in the future,

THE ROLE OF THE IONOSONDE IN SSL SYSTEMS

Leo F McNamara
Andrew Government Systems

This Note draws attention to a growing use of vertical incidence ionosondes that is quite different from their normal use - determining the location of an HF transmitter. Ionosondes am starting to appear in the most unusual places, bringing with them the possibility of useful and interesting observations from these places, as wen as the potential for their use as a research and teaching tool in countries which would not normally have such opportunities.

In contrast with traditional HF direction finding systems which work by measuring just the azimuth of the signals at two or more sites, and then using triangulation procedures, Single Station Location (SSL) systems also measure the elevation angle. They then model the propagation of the radio waves through the ionosphere, back along their observed incoming direction until they hit the earth again. If the job is done well, and the ionosphere is not in too pathological a state, the point at which the rays hit the ground will be a good estimate of the actual location of the transmitter.

The accuracy of these position estimates will clearly depend on how well the ionosphere and the radiowave propagation are modelled. Those of you who have studied ionograms extensively will appreciate the great variability of the ionosphere, as it is manifested in the ionograms. We can therefore appreciate the need to monitor the ionosphere in real time if we am going to take account of it in applications such as SSL.

SSL systems contain two essential elements - a system to measure the angles of arrival (azimuth and elevation), and a system to monitor the ionosphere at the same time, i.e., an ionosonde. The ANDREW angle of arrival system (called SKYLOC™) is an interferometer system which uses 7 antennas arranged in a 75 meter L- shaped array. The ANDREW ionosonde TILTSONDE™ is a discrete-step chirp sounder with an output power of 5 to 10 watts - high-power pulsed sounders are not very popular at surveillance sites trying to work signals which am already often below the local noise levels! The TILTSONDE™ transmitter and receiver are co-located with SKYLOC™. TILTSONDE™ also measures the angle of arrival of its returning signals, using a 3-element array, 45 m in length.

SKYLOC™ applies a series of rigorous tests to the measured phase differences and amplitudes, saving the data only when the incoming wavefront is planar, or very nearly so. The variability of the ionosphere makes it difficult to quote an accuracy figure for the measured angles of arrival, but the measurement errors appear to be much less than one degree except at very low elevation angles.

The method adopted for the determination of the position of the HF transmitter being monitored depends on the range of the transmitter from the DF site, which affects the observed elevation angle. Three methods are used, depending on the elevation angle 6:

1. Short Ranges ë > 75° Tilt Correction

2. Medium Ranges 30° < ë < 75° Classical SSL

3. Long Ranges ë < 30° SMART SSL

Each of these method relies on different aspects of the local ionogram, or of features of the ionosonde.

The easiest transmitters to locate are those at medium ranges, which means those about 200 to 800 km away. For these ranges, it is possible to model the propagation as reflection from a horizontal mirror at the appropriate height. For a flat earth, the range to the transmitter is simply

D = 2 h / tan ë,

with a little added complexity for a curved earth. We already know ë, since we have just measured it, so the only unknown is h. This is where the ionosonde comes in. Application of the Secant Law, Breit and Tuve's Theorem and Martyn's Equivalent Path Theorem [Davies, Ionospheric Radio, 1990, Section 6.3.1] leads to what is known as the Classical SSL method of range estimation. The application of the SSL method proceeds as follows (McNamara, The Ionosphere: Communications, Surveillance and Direction Finding, 1991):-

1. The incoming signal at the frequency f is observed to have an elevation angle ë.

2. The secant law is used to calculate the equivalent vertical frequency, f_V, which is defined by the Secant Law.

3. The virtual height h'(f_V) is obtained from a local vertical incidence ionogram, at the frequency f_V.

4. The signal is assumed to have travelled a triangular path, with an elevation angle ë, and with reflection occurring at an altitude equal to h'(f_V).

5. The range to the transmitter, TR, is then simply 2h/tan ë.

Thus for medium-range transmitters, the ionogram is used to provide the height of the effective mirror.

The Classical SSL method is also used for short-range transmitters, but for these ranges account is also taken of the effects on the calculated position estimates of small-scale tilts existing in the ionosphere at the reflection height. These tilts are measured in real time by TILTSONDE™. Neglect of the tilts can cause the measured azimuth to be as much as 180° out, which is scientifically intriguing and operationally very disturbing. In general, a lateral tilt (across the actual circuit) can cause an azimuthal error of 3.49 (h/D) per degree of tilt. For a 100 km circuit, and a 300 km reflection height, the error will be 10.5° per degree of tilt. A longitudinal tilt can cause a range error of -1.7/cos ë percent, per degree of tilt. If ë = 85° (circuit length of around 50 km), the percentage range error will be 20% per degree of tilt.

For long-range transmitters, the local VI ionogram cannot be used directly, since it would not usually be a good representation of the ionogram at the circuit midpoint, which could be 500 km or more away. Instead, the local ionogram is used to "update" a synoptic model of the ionosphere, so that the model reproduces as many as possible of the observed features of the local ionogram. The changes made to the model at the ionosonde site are also made (in an appropriate fashion) at points back along the observed azimuth, yielding an updated model of the ionosphere along that path. Radio waves are then ray traced (or re-traced) in simulation back along their observed incoming direction through the ionospheric model until they hit the earth again. Within the ambiguity of the number of hops for the actual mode, the point where the rays bit the earth is the estimated location of the transmitter. This method of position estimation is known as the SMART SSL™ (Synoptic Modelling And Ray Tracing) method. Virtually all of the parameters normally scaled or derived from an ionogram, including the h'(f) trace and derived N(h) profile, can be used to update the synoptic model.

Real-time ionospheric sounding, both in terms of VI ionosondes and tilt measurements, thus play a fundamentally important role in the SSL method of determining the location of an HF transmitter. As SSL systems proliferate, so will ionosondes, and INAG members should be alert to the possibilities of obtaining valuable ionospheric data from such systems. This will not be an easy task, since most of the SSL applications use the ionospheric observations only in real time, and have no requirement to save them. Those of us who were involved with the installation of the USAF AWS network of Digisondes know some of the problems and frustration which will be encountered.

It is therefore suggested that INAG members should get involved at an early stage, and try to convince the relevant agencies of the national value of their ionosondes as a research and teaching tool, as well as their value to the international community. Some of the data will be classified, because it would not take too much effort to work out why an SSL system was deployed at a given location. However such restrictions should not apply to organisations concerned mainly with the enforcement of frequency regulations.

INTERNATIONAL GLOBAL REAL-TIME SATELLITE-BASED IONOSONDE SYSTEM AS A PART OF THE IONOSPHERIC NETWORK

by Prof. Nicolaj Danilkin,
Fedorov Institute of Applied Geophysics,
Moscow, Russia.

The statement that the ionospheric medium occupies a key position in the system controlling processes taking place in the near-Earth space and the atmosphere has already become traditional (Rishbeth and Kohl, 1976; Wright and Paul, 1981). It serves as a sensitive detector for processes both in the magnetosphere, where the vertical current system leads to ionospheric heating, and in the neutral atmosphere, and even in the Earth's crust, as oscillating processes travelling upwards through the atmosphere are magnified due to the decreasing atmospheric density, and am transferred to the upper conductive ionospheric layers where they are easily observed. The reason why radiosounding now, and in the future, will occupy a key position in the system of ionospheric monitoring and prediction is simple and rests on a fundamental basis: resonant radio wave reflections from the main ionospheric component, electrons, contain all the significant information, making this the best method of making measurements.

However, the current worldwide ionospheric network (whose representatives cooperate within URSI Working Group 1, INAG), although based on the above mentioned principle, does not completely meet the ever increasing requirements of mankind.

The network's limitations are well known:

1. It is helpless when radiowaves are heavily absorbed in the ionospheric D-region.

2. The network is inhomogeneous. In some places the absence of stations is irreplaceable (e.g., near the planet's poles and over the oceans).

3. Monitoring the topside ionosphere is impossible, but its role will increase as transionospheric radiocommunication lines are developed and variations in ionospheric disturbances limit the possibilities for their practical application.

4. The network does not allow horizontal ionisation gradients to be measured accurately.

5. The network is unable to trace the movement of local ionospheric disturbances and plasma waves.

It is useful to consider the geophysical need and, assuming its validity, the social accessibility of adding the current network of ground-based ionospheric stations to satellite ionosondes.

Let us consider the capabilities of a combined ground-based space system. In so doing we assume that the network data feeds continuously, in real time, into an ionospheric mathematical model which then produces answers to applied problems. Data are obtained when use is made of all four possible methods of radiosounding: ground-based vertical, transionospheric and vertical and inclined topside soundings.

Thus one may think of a radiosounding system as the basis for developing a technique for global ionospheric control.

Analysis has shown that a system of four satellites with on-board ionosondes, added to the ground based network of ionospheric stations, removes the first four of five limitations cited for the ground based network.
I think it obvious that for some reason or other mankind some day will continuously monitor the state and changes in the near-Earth space and, in the first place, the ionosphere. Scientists concerned with geophysics, from my point of

view, should wish to bring this moment about as soon as possible, for it cannot come too early, but its delay is quite possible. The history of the "ozone hole" is similar to the "ionospheric holes" that are more understandable to us. Starting with American lunar rocket launches, huge holes in the ionosphere were formed but were not detected by the ionospheric network. This is only a weak illustration that the current system is unable to monitor man's future attacks on his Environment. Therefore it seems timely to consider how to complement the available ionospheric station network with space ionosondes.

To use satellite radiosounding for monitoring the near-polar ionosphere is particularly desirable. First, monitoring from below is very often impossible due to total radiowave absorption while monitoring from above offers no difficulties.
Second, in both the Arctic and Antarctic regions it is difficult to locate ground-based stations. Third, satellites (in low eccentricity orbits) can pass over both poles; so four satellites can provide practically continuous monitoring of the most inaccessible and complex parts of the ionosphere thereby defining its entire dynamics.

There are well known limitations of topside and transionospheric radiosounding; e.g., repeated soundings at one location are not possible and here are no data below the F region peak. These may be compensated for by simultaneously sounding from above and from below the ionosphere, and, at the same time, making a series of inclined transionospheric soundings (satellite - Earth) and inclined soundings (satellite - satellite).

On the whole, a 21st century ionospheric network may be thought of as operating on a radiosounding basis and consisting of ground-based and on-board ionosondes arranged so that all four kinds of radiosounding are being realised : bottomside, inclined, topside and transionospheric.

Ground-based stations would operate in accordance with a standard program. When one of the satellites, with an on-board ionosonde, appears within range of a ground station, ionograms from topside sounding are received over a communications channel, independent of the round-based one. The ground-based ionosonde is synchronised using on-board ionosonde pulses and outgoing transionograms (Earth - satellite) are recorded on the spacecraft, together with topside sounding ionograms, and then are transmitted over the radio channel, at fixed frequency (e.g., 137 MHz), to the ground-based ionospheric station. Incoming transionograms (satellite - Earth) are also recorded at the ground-based ionospheric station either by a receiving unit in the ionosonde or by a separate receiver.

Processing topside ionograms is well understood and transionograms, using both outgoing and incoming recordings, have been tested experimentally and offer no methodology difficulties. It is likely that recording and partial processing of ionograms will take place on board spacecrafts before transmission to the Information Processing Centres situated in different regions of our planet.

At present it is possible, on an experimental basis, in some regions of the planet, to incorporate the system of topside and transionospheric sounding into an operational practice for ionospheric services. It may also be useful for countries which at present have no ionospheric stations of their own. In this case, a simple unit costing less than an ionospheric station and having no transmitter can partially substitute for the ionospheric station.

Summarising, I think it is possible and desirable to establish an international satellite system for ionospheric monitoring by making use of current conversion of space technology taking place in Russia.

EQUATORIAL ELECTROJET AND COUNTER ELECTROJET.

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Trivandrum 695 022
INDIA

The equatorial electrojet is an enhanced eastward current in the E region (95-125 km) during daytime in the vicinity of the dip equator. The existence of such an intense current system was proposed by Sydney Chapman in 1951 to account for the abnormal enhancement of regular solar daily variation, Sq, in the horizontal component (H) of the earth's magnetic field at equatorial latitudes along all longitude sectors. Near the magnetic dip equator, the earth's magnetic field is nearly horizontal and northward whereas the electric field originating in the global wind dynamo is eastward. In a magnetoplasma with perpendicular electric and magnetic fields.

Pedersen currents flow parallel to that component of electric field normal to the magnetic field and Hall currents flow perpendicular to both electric and magnetic fields. The flow of Hall current is inhibited by the presence of ionospheric boundaries in the vertical direction, leading to the build up of vertical polarization electric field which opposes the flow of Hall current. Baker and Martyn in 1953 have shown that the inhibition of vertical Hall current flow by the relatively low conducting layers above and below the dynamo region (100-150 km) enhances the east-west ionospheric conductivity near the magnetic equator, explaining the existence of the Equatorial electrojet compatible with the observed enhancement of Sq(H) in the Equatorial electrojet region (Fig. 1). One of the most interesting aspects of the Equatorial electrojet is the reversal of the direction of the normal eastward flow of current in the morning and evening hours, on some quiet days, as indicated by the horizontal component of the earth's magnetic field dropping below the nightime level. This reversal of the normal eastward flow of electrojet current was given the name *equatorial counter electrojet* by Gouin in 1962 (Fig.2). The event lasts for about three hours and the maximum negative value of the horizontal component of the earth's magnetic field (H) below the nightime level usually occurs between 1500 and 1600 LT. On certain days, the H value decreases (around 1500 and 1600 LT) without going to the nightime field level, and is referred to as a partial counter electrojet (Fig.3).

The intense electrojet currents and the geometry of electric and magnetic fields at the dip equator give rise to some interesting plasma instabilities which cause field aligned irregularities in electron density with scale sizes ranging from about a metre to a few kilometres. The predominant equatorial E region irregularity is sporadic E (Esq). 'Me electron density irregularities give rise to backscatter signals from BF and VHF radars and the Doppler frequency variations of the backscatter echoes have been effectively used to identify the magnitude and direction of the east-west electric field in the Equatorial electrojet (Fig.3). These irregularities also give rise to strong reflections in the (2-10 MHz range) E region and the ionograms show a well defined lower edge lying between 100 and 110km, with diffuse echoes above the principal echo in a typical triangular configuration (Fig.4) Most of the Equatorial electrojet electron density irregularities are believed to be the result of two plasma instability mechanisms known as two stream instability and gradient drift instability. Two stream instability renders the electrojet plasma unstable when the electron drift relative to the ions exceeds the local ion-acoustic speed of about 360 m/s. This instability which operates under strong electrojet conditions (1000-1300 Local Time) is considered as responsible for the type I echoes seen with the VHF backscatter radar. The gradient drift instability, on the other hand, sets in when and wherever the gradient in electron density has a component parallel to the ambient electric field. The type II echoes seen with VHF radar and the equatorial sporadic E configuration commonly seen on equatorial ionograms are attributed to irregularities generated by the gradient drift instability.

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 westward electric field.

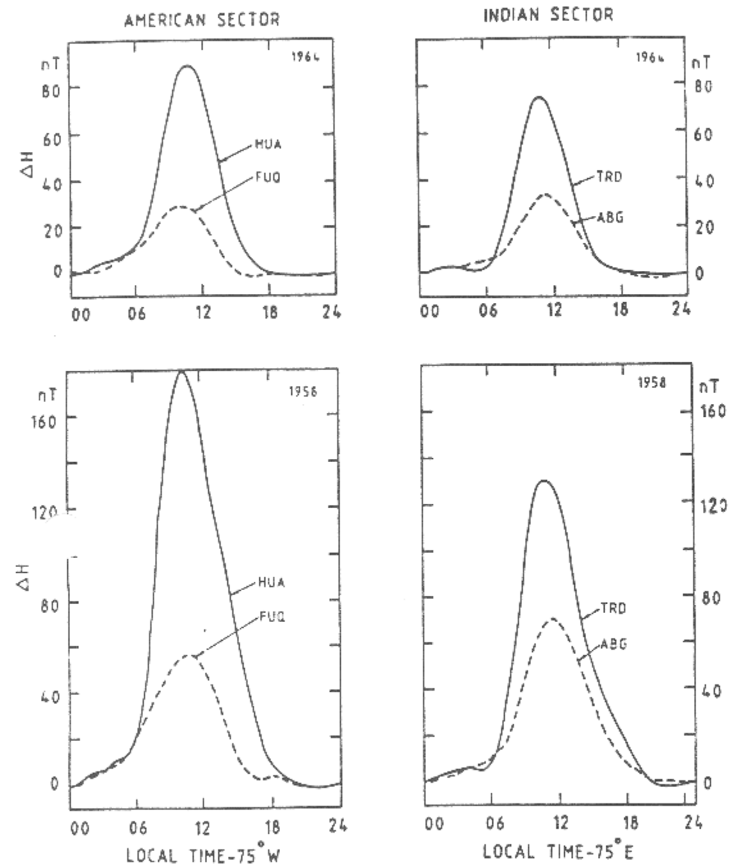

Figure 1

The diurnal variation of the horizontal component of the earth's magnetic field (H) for 'lie sunspot maximum (1958-1959) and sunspot minimum years (1964-1965) is displayed for the Indian and American sectors. The stations for the American sector are Huancayo (Geog. Lat.12° S, Geog. Long. 75° W) an electrojet station and Fuquene (Geog. Lat. 5° N, Geog. Long. 73° W) a station far removed from electrojet effects. Similar variations are shown for the Indian sector using the electrojet station Trivandrum (Geog. Lat 8° N, Geog. Long. 77° E) and the non electrojet station, Alibag (Geog. Lat. 18.5° N, Geog. Long. 72° E). The large increase in the electrojet strength at Huancayo and Trivandrum is clearly seen during both sunspot maximum and minimum years.

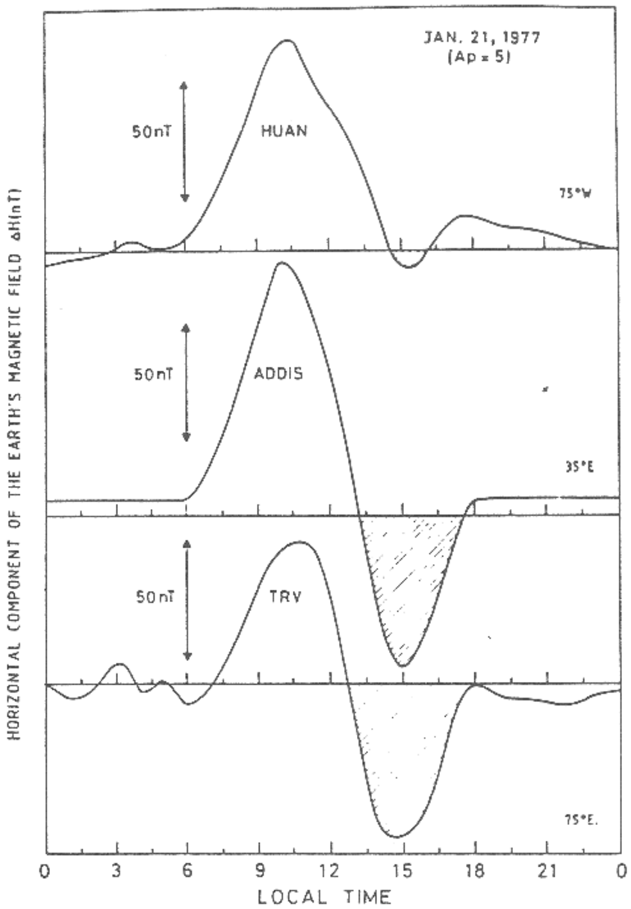

FIGURE 2

The diurnal variations of the horizontal component of the earth's magnetic field (H) at the three equatorial stations Trivandrum (77° E), Huancaya (75° W) and Addis Ababa (35° E) show the counter electrojet signature on January 21, 1977. The counter electrojet event is observed at all three stations at similar local times for each electrojet station. This is consistent with a pattern fixed with respect to sun or moon so that each station sees it in its appropriate time zone as the earth rotates. However, the intensity of the counter electrojet event (defined as the amount, in nanotesta, that H goes down below its nightime level) varies from station to station.

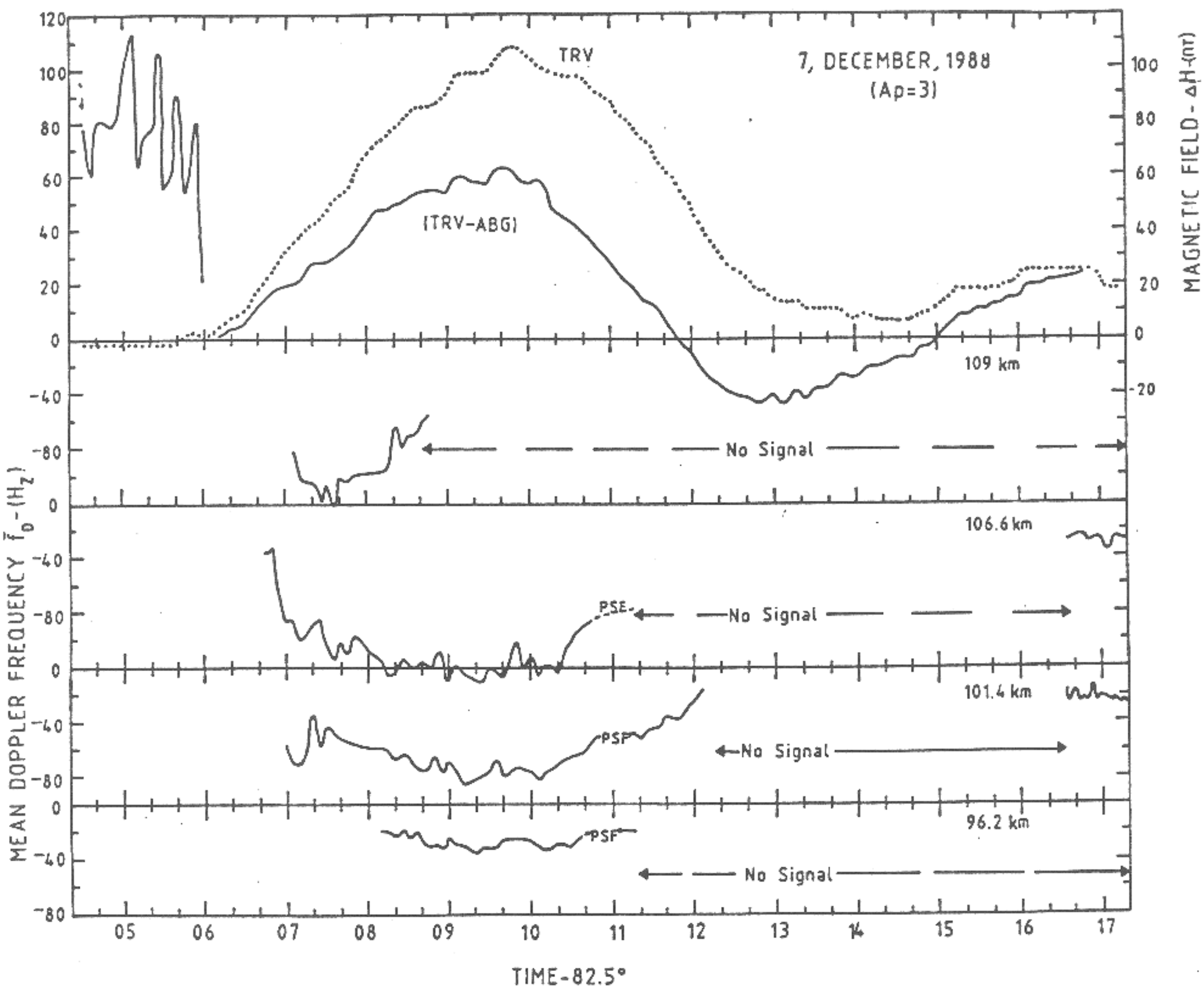

FIGURE 3

Bottom : This shows the height and time variation of the mean Doppler frequency of the VHF backscatter radar signals on December 7, 1988. The VHF backscatter radar operates at 54.95 MHz (pulsewidth - 20 micro-seconds) and hence is sensitive to 2.7m scale irregularities. The beam width of the Yagi array is about 4 degrees in the east-west direction, which corresponds to a height resolution of 6 km at 100 km altitude. However, the received signals were sampled at 20 microsecond intervals to provide a range gate sampling at 2.6 km intervals. The observed negative Doppler frequency variations correspond to the westward (eastward) movement of the electron -density irregularities in the presence of the eastward (westward) electric field. The absence of backscatter signals from 1115-1615 LT shows that the electric field is reversed to westward direction.

Top : This shows the time variation of the horizontal component of the earth's magnetic field at Trivandrum. The curve H (TRV - ABG) shows the difference in the diurnal pattern of H between electrojet station Trivandrum and nonelectrojet station Alibag, gives the electrojet strength. When H (TRV - ABG) becomes negative it is taken as a partial counter electrojet.

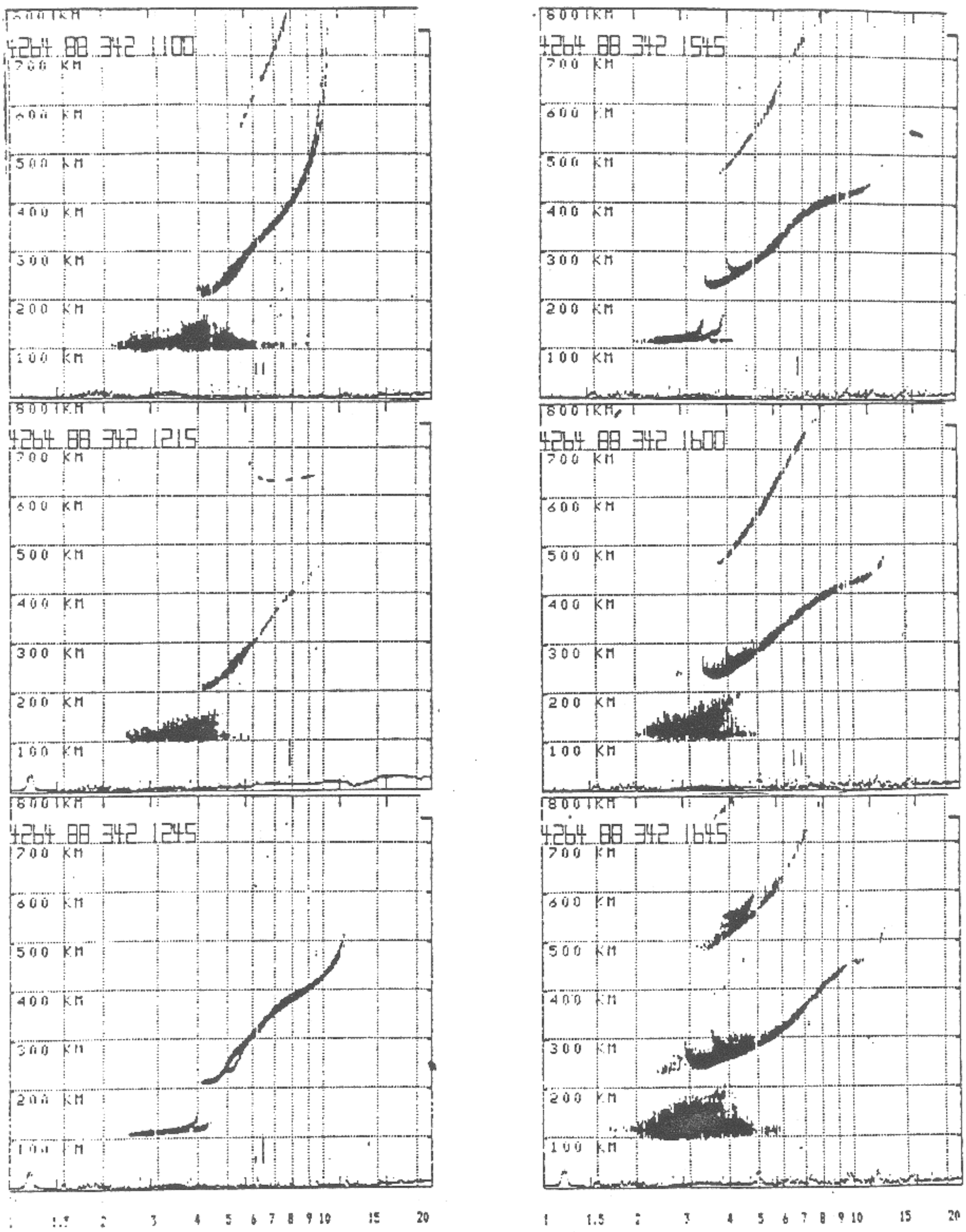

FIGURE 4

This figure shows a series of ionograms recorded at quarter hourly intervals on December 7, 1988 (Ap=3). Note the disappearance of Esq between 1245 and 1545 IST (Indian Standard Time - 82.5° E), when H (TRV - ABG) shown in Fig.3 was below the nightime level. This is also the time when VHF backscatter signals were absent (see Fig.3 on the previous page). The Esq irregularities are again observed in the later ionograms eg. 1645 IST.

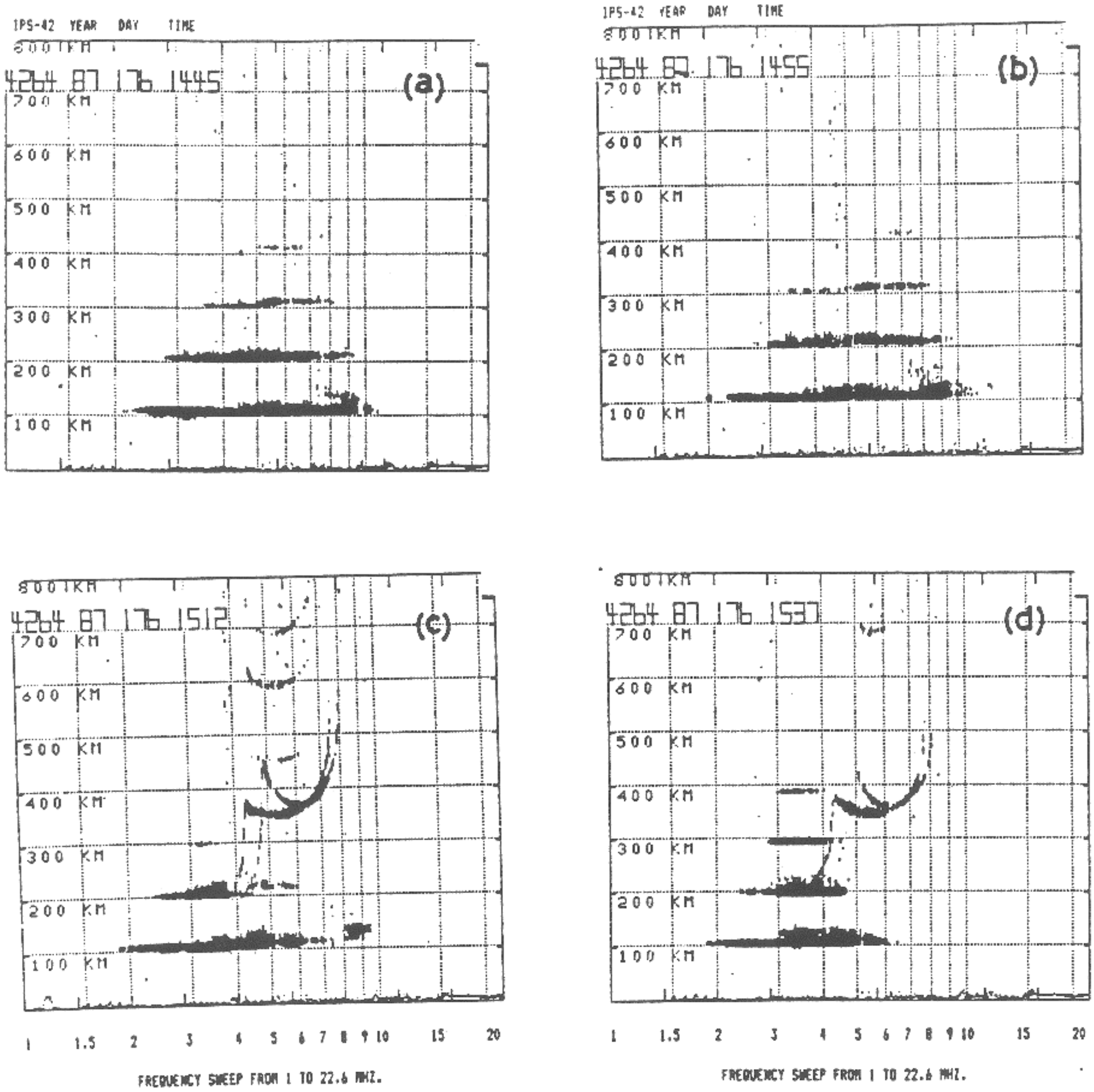

FIGURE 5

This figure shows a series of ionograms recorded at different times during the counter electrojet event of June 25, 1987. The ionogram in Fig.5(a) shows the blanketing Es layers (Esb) with a sharp boundary at 100 km. The maximum reflected frequency exceeds 10 MHz and at least three multiple echoes can be identified. The F region reflections are blanketed completely. Esb layers provide very sharp vertical gradients in electron density. However, the ionogram. at 1537 (d) shows Esb layer with multiple reflection as well as diffuse Esq trace.

However, in 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.

At the magnetic equator, local east-west winds with significant vertical shears can interact with electrojet plasma and generate substantial wind induced polarization electric fields perpendicular to the geomagnetic field in the magnetic
meridional plane. These wind generated electric fields can modify the vertical and latitudinal structure of the electrojet current and also results in ionisation convergence and divergence and formation of thin ionisation layers known as

blanketing sporadic E layers with abnormal gradients in electron density (Fig.5). These blanketing sporadic E layers are normally observed during summer months only and they are absent during winter months.

It is generally believed that the diurnal S_1(1,-2), the semi-diurnal S_2(2,2) and S_2(2,4) tidal modes are responsible for the generation of the dynamo region electric fields necessary to drive the normal Sq current system and the normal Equatorial electrojet in daytime. However, the abnormal combination(s) of tidal modes responsible for the generation of counter electrojet are yet to be identified. Thus, the occurrence of counter electrojet events have focussed our attention on the possible large variability of tidal winds in the dynamo region.

SHORT NOTES FROM MEMBERS

DR M. A. Abdu writes:

a. AN IONOSONDE AT A NEW MAGNETIC EQUATORIAL SITE IN BRAZIL

An ionosonde type J5-Magnetic AB has been installed at a new site, Sao Luiz (2.5°S, 44.5°W,) in the state of Maranhao, in Brazil. Sao Luiz is located within 0.5 degrees from the Equatorial Electrojet centre. Hopefully this ionosonde will soon be replaced by a digital equipment in the near future. The Sao Luiz ionosonde for the present will be operated in campaign mode participating in all the experimental campaigns of the IEEY(International Equatorial Electrojet Year) and of the EITS(Equatorial Ionosphere-Thermosphere System) project of the STEP. The other two sounders that are in routine operation in Brazil are: a Digisonde 256 system at Cachoeira Paulista (22.5°S,45°W) and an old C4 ionosonde at Fortaleza (6°S,38°W).

b. THE IEEY

The next **coordinated IEEY-EITS/STEP Campaign** is scheduled for September 1-30 1992.

c. A CALL FOR HELP

The C4 ionosonde that has been in operation at Fortaleza since 1975 is facing a crisis for its continuing operation due to the non availability of spare parts and components. The continuity of operation of this ionosonde is of great interest to the scientific community , especially to fill the gap in ground based data sets for international coordinated experimental campaigns. One way of extending the life of this ionosonde will be by the use of parts and components from other C4 or similar sounders whose operations have been terminated in recent years. The purpose of this note is to request those who have access to such equipments to consider the possibility of supporting the continued operation of Fortaleza ionosonde until it is replaced by modem equipment. Such support could guarantee the continuity of ionospheric data availability from the Fortaleza station. Those who are in a position to collaborate may please contact:

M. A. Abdu;
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12201 Sao Jose dos Campos;
Sao Paulo; Brazil.
FAX: 011-51-123-218743;
E-mail: INPEDAE@BRFAPESP.BITNET.

FROM PRIME:

QUIET AND DISTURBED MAGNETIC CONDITIONS - A DATABASE.

Forward from Dr Justin Cooper, Deutsche
Bundespost Telekom, taken from the COST 238
Annual Report.

A voting procedure to distinguish quiet and disturbed geomagnetic conditions has been made available to COST 238. A hierarchy of quiet and disturbed conditions is obtained over several time scales. With this approach, it is possible to examine coincidences between solar, geomagnetic and ionospheric disturbances and thus interpret global and local disturbance features. A data base of quiet and disturbed periods would allow study of their long-term variations, opening the possibility of their prediction.

This comment in the forward to the COST 238 Annual Report refers to a paper by Dr. T. Gulyaeva and the abstract of this paper appears here.

VOTING PROCEDURE FOR DISTINCTION OF GEOMAGNETIC QUIET AND DISTURBED CONDITIONS IN IONOSPHERIC DATA ANALYSIS AND MODELLING.

By Dr. T. L. Gulyaeva
Institute of Terrestrial Magnetism
Ionosphere and Radio Wave Propagation
Russian Academy of Sciences
142092 Troitsk, Moscow Region, RUSSIA.

A properly weighted histogram distortion measure is proposed to be taken as a disturbance evaluation of data of different time scales for any index in any field. This approach is applied to produce a measure of disturbances in a long-term data base of geomagnetic indices and ionospheric vertical incidence sounding characteristics. Comparison between half-diurnal diagrams of disturbances for different parameters is realised with a voting procedure. Depending on the thresholds accepted, 'quiet' periods in the ionosphere amount from 15 to about 50% of the time per year while 30 to 50% of the ionospheric disturbances detected with the proposed technique include all the storm periods defined with another statistical procedure used earlier at IRPL, NBS, Washington DC.

CALL FOR PAPERS

URSI XXIVth GENERAL ASSEMBLY KYOTO,JAPAN

25 August to 2 September 1993.

G.6 Ionosonde Networks and Stations

CALL FOR PAPERS

INAG is sponsoring a Workshop during the 24th URSI General Assembly in Kyoto, next year. This is **your** workshop for you to promote the continued use of ionosonde data and ionosonde networks in the present world. If you see a value for your network, or a value for an ionosonde input to your research program,

this Workshop is for you.

Below is some idea of the expected scope of the workshop. Its objective is to discuss the many issues facing ionosonde networks in the present economic climate. Many of these issues have been raised in recent INAG Bulletins, some issues are as old as the network - all are of direct interest to this workshop. Please give this workshop your serious attention.

Ionosonde measurements give long time series of the near space environment; can support a range of applications from over the horizon radar to HF radio; networks can give regional pictures of the ionosphere and offer the potential for regional forecasts of the near space environment. This session will be devoted to the acquisition, use and value of ionosonde data, the ionosonde technique and ionogram interpretation.

Papers on the use of ionosondes, now and in the past, are welcomed and should reach the Convenor,
Dr. P. J Wilkinson, **by 15 January 1993.**

Convenor: Dr. P. J. Wilkinson
IPS Radio and Space Services
P 0 Box 5606, West Chatswood
NSW 2057, AUSTRALIA
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email (internet): phil@ips.oz.au

INAG—57 REQUEST FORM FOR FURTHER INFORMATION October 1992

XXIVth GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF RADIO SCIENCE (URSI)

URSI '93 Kyoto

Kyoto International Conference Hall, Kyoto Japan
August 25 – September 2, 1993

Name: ______________________________ Title: __________
Family name / Other names

Institution: ______________________________

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I intend to participate in the following Symposium/Symposia: __________
Session Code(s)

Date: __________ Signature: __________

Registration form will be sent to you with the Second Announcement in April/May 1993.

.... (cut here) ....

Please return the above form BEFORE January 15, 1993
if you are interested in receiving further information, to:

Prof. I. Kimura
Secretariat, URSI-GA Kyoto
c/o Center for Academic Societies, Osaka
14th floor, Senri Life Science Center Bldg.
1-4-2 Shinsenri Higashi-machi
Toyonaka, OSAKA 565
JAPAN

INSTRUCTION FOR ABSTRACT

**XXIVth GENERAL ASSEMBLY
OF THE INTERNATIONAL UNION
OF RADIO SCIENCE (URSI)**

The reverse side of this sheet shows an example of the Abstract. Major guidelines for the format of the Abstract are as follows:

1. The One-Page Abstract must be typed on a A4-size (=21cm x 29.7cm) white bond pa per, in 12pt (= 10 pitch/inch) (preferably) and single spaced on one side only, within a 17cm x 25cm area. Authors are requested to make full use of the one-page space to make the Abstract as informative as possible. The top and the left margins should be 2 cm.

2. The manuscript will be reduced by 71% (i.e., 50% in area) and offset printed. Papers exceeding the one-page limit or the 17cm x 25cm area limit may not be printed in the Abstract Book.

3. The first line must be the Session Code and the Session Title of the Symposium where you intend to present the paper. Papers with no Session Code and Session Title on the top line of the Abstract will be automatically rejected.

4. Put the title of the paper after the Session Code and Session Title, leaving one blank line above and below, and also 2.5cm extra space for tile paper number on the left. Capitalize each word of the title except for articles, conjunctions, etc, The title may be set in a bold typeface, but should not be in a larger size than 14pt.

5. Author's name and affiliation, address, telephone and telefax numbers (if available) must follow the title.

6. Start the first line of the text after leaving one blank line. Section title should be underlined or set in a bold typeface. Leave one blank line above each section title.

7. Indent each paragraph by a few characters. Do not leave blank lines between paragraphs.

8. Clear tables and line drawings can be included in the Abstract.

9. The literature should be quoted by numbers, and a complete reference list should be provided at the end of tile Abstract.

Session Code   Session Title   2cm

H7: Waves in Plasmas

2.5cm

Measurements of Wave Normal Direction of the Omega Signals by a Scientific Satellite

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Introduction

2cm

VLF instruments on board a satellite which was launched in February, 1989 have observed various VLF waves, such as Omega signals transmitted from the ground. In the present paper, some of the results for measurements of the wave normal direction of Omega signals are introduced, which are compared with those calculated by ray tracing.

Measurements of wave normal direction of Omega Signals

The VLF instruments on board are composed of a wide band receiver for frequencies less than 14 kHz and Poynting flux analyser for frequency less than 12.75 kHz with a 50 Hz bandwidth. For E field measurements, two pairs of 60 m tip-to-tip wire antennas perpendicular to the satellite spin axis directing to the sun are used. For B field measurements, three orthogonal loop antennas are used. Fig. 1 shows an outside view of VLF wave sensors on board the satellite.

The procedure to determine wave normal (K vector) direction for the satellite data was described in the paper written in detail by Yamamoto et al. [1]. For Omega signals, in most cases one plane wave assumption is valid, so that Means' method [2] is a relevant method to determine wave normal direction.

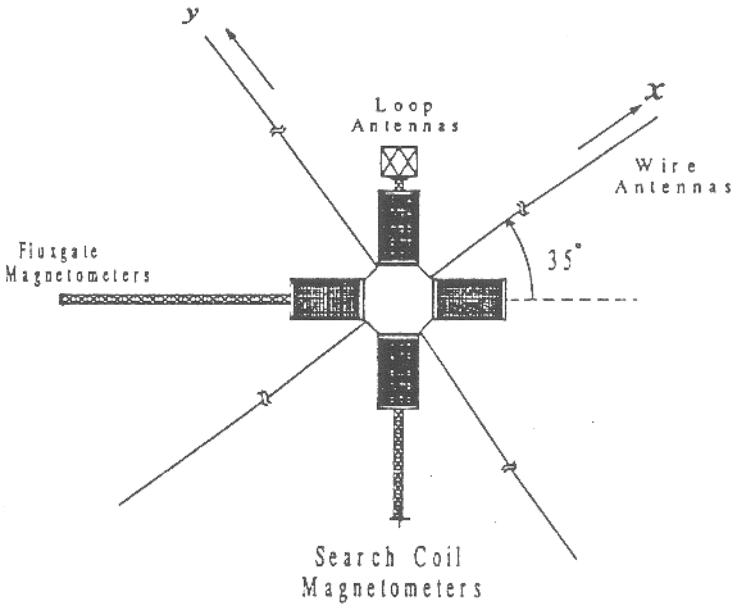

Fig. 1 VLF sensors on board the satellite

25cm

Discussion and conclusions

The results of K vector measurements of Omega signals are not always understood by a simple non-ducted ray tracing in the magnetosphere, because the K vector direction is sometimes deviates so much from those predicted by ray tracing. It appears that the magnetospheric density profile changes greatly day by day.

References

[1] M. Yamamoto and Y. Ito, Geophys. Res. Lettrs., 18, 325, 1991
[2] J. D. Means, J. Geophys. Res., 77, 5551, 1972

EXTRACTS FROM REVIEWS OF

"The Ionosphere: **Communications, Surveillance and Direction Finding"**

by Leo F McNamara

Krieger Publishing Co.
Malabar, Florida 1991

"This book is an exciting new addition to the literature of High Frequency (HF) radiowave propagation. It should be helpful to the military, commercial, and the amateur users of the high frequency radio spectrum. I would also recommend parts of it to ionospheric physicists so that they can gain an understanding of many of the problems in the 'real world' of HF propagation ... Since most of this book is almost completely devoid of complex formulas it can be used even by non-engineering majors. Shortwave radio listeners, non-technical radio amateurs, military and commercial HF radio systems planners, and the like also could greatly benefit from reading this book." - J. A. Klobuchar, Air Force Phillips Lab, *Ionospheric Physics* Division, Hanscom Air Force Base, Massachusetts.

"I have read this text with great interest and I regard it as the best, most comprehensive and up-to date in its field. The choice of topics is excellent ... all of current importance and McNamara has incorporated results and techniques from recent research into the text ... will be very useful to both students and practitioners in the fields covered, particularly as it provides some basic ionospheric physics for users of HF and, at the same time outlines problems in HF applications which are of interest to both engineers and physicists. Having taught courses in ionospheric radio wave propagation for over twenty years, I intend to recommend this text to students because of its excellent coverage of the topic." - Professor Peter L. Dyson, Department of Physics, La Trobe University, Victoria, Australia.

"This book by Dr. Leo McNamara seeks to provide link material for the radio user who will benefit from knowledge of the medium with which his system must contend and the scientist who should be made conscious of the operational information...I commend the book for its refreshing accounts, particularly on target location, from an international expert who has both a scientific background and operational experience of the problems encountered in practice. His explanations of the best ways of mitigating these should enable users to improve their system performances." - Peter A. Bradley, Rutherford Appleton lab., Science & Engineering Research Council, United Kingdom.

"Finally, there is an intelligent book on ionospheric radio for the applications engineer ... McNamara's book gives an excellent introduction to all the different aspects of HF radio: ionospheric research, communications, propagation, prediction, channel evaluation, direction finding, and over-the –horizon radar ... I predict McNamara's book will be on the desk of every radio engineer. To scientists and graduate students this book offers a good summary on the subject matter; the extensive list of references at the end of each chapter directs the reader to source information and mathematical derivations. Radio amateurs will enjoy reading many sections in this book since the author succeeds in explaining a difficult subject without the excessive use of mathematics." - Professor Bodo W. Reinisch, University of Massachusetts Lowell, School of Electrical Engineering.

International Geophysical Calendar 1993

(See other side for information on use of this Calendar)

	S	M	T	W	T	F	S
						1	2
	3	4	5	6	7	8	9
JANUARY	10	11	12	13	14	15	16
	17	18	19	20*+	21*+	22+	23+
	24+	25+	26+	27+	28+	29+	30+
	31	1	2	3	4	5	6
FEBRUARY	7	8	9	10	11	12	13
	14	15	16	17*	18*	19	20
	21	22	23	24	25	26	27
	28	1	2	3	4	5	6
MARCH	7	8	9	10	11	12	13
	14	15	16	17*+	18*+	19	20
	21	22	23	24	25	26	27
	28	29	30	31	1	2	3
	4	5	6	7	8	9	10
APRIL	11	12	13	14	15	16	17
	18	19	20	21*	22*	23	24
	25	26	27	28	29	30	1
	2	3	4	5	6	7	8
MAY	9	10	11	12	13	14	15
	16	17	18+	19*+	20*	21	22
	23	24	25	26	27	28	29
	30	31	1	2	3	4	5
JUNE	6	7	8	9	10	11	12
	13	14	15+	16*+	17*	18	19
	20	21	22	23	24	25	26
	27	28	29	30			
	S	M	T	W	T	F	S

S	M	T	W	T	F	S	
				1	2	3	
4	5	6	7	8	9	10	JULY
11	12	13	14	15	16	17	
18	19	20*+	21*+	22	23	24	
25	26	27	28	29	30	31	
1	2	3	4	5	6	7	AUGUST
8	9	10	11	12	13	14	
15	16	17*	18*	19	20	21	
22	23	24	25	26	27	28	
29	30	31	1	2	3	4	
5	6	7	8	9	10	11	SEPTEMBER
12	13	14	15	16	17	18	
19	20	21*	22*	23	24	25	
26	27	28	29	30	1	2	
3	4	5	6	7	8	9	OCTOBER
10	11	12	13	14	15	16	
17	18+	19‡	20*	21	22	23	
24	25	26	27	28	29	30	
31	1	2	3	4	5	6	NOVEMBER
7	8	9+	10+	11	12	13	
14	15	16*	17	18	19	20	
21	22	23	24	25	26	27	
28	29	30	1	2	3	4	
5	6	7+	8+	9	10	11	DECEMBER
12	13	14*	15*	16	17	18	
19	20	21	22	23	24	25	
26	27	28	29	30	31	1	1994
2	3	4	5	6	7	8	JANUARY
9	10	11*+	12*	13+	14+	15	
16	17	18	19	20	21	22	
23	24	25	26	27	28	29	
30	31						
S	M	T	W	T	F	S	

(19) Regular World Day (RWD)

(20) Priority Regular World Day (PRWD)

17 Quarterly World Day (QWD) also a PRWD and RWD

6 Regular Geophysical Day (RGD)

15 16 World Geophysical Interval (WGI)

26+ Incoherent Scatter Coordinated Observation Day

21 Day of Solar Eclipse

[21 22] Airglow and Aurora Period

20 * Dark Moon Geophysical Day (DMGD)

NOTES on other dates and programs of interest:

1. Days with unusual meteor shower activity are: Northern Hemisphere Jan 3; Apr 21-23; May 4-5; Jun 4-12, 26-29; Aug 10-15; Oct 20-23; Nov 16-18; Dec 12-14, 22-23, 1993; Jan 3-4, 1994. Southern Hemisphere Apr 23; May 4-5; Jun 4-12, 26-29; Jul 28-29; Oct 21-23; Nov 16-18; Dec 12-14, 1993.

2. SOLTIP (Solar connection with Transient Interplanetary Processes). Observing Program 1990-1995: solar-generated phenomena and their propagation throughout the heliosphere. (See Explanations.)

3. FLARES22 (FLAre RESearch at solar cyclĕ 22 max). Observing Program 1990-1995: basic physical processes of transient solar activity and its coupling with solar-terrestrial environment. (See Explanations.)

4. GAW (Global Atmosphere Watch). WMO program to measure atmospheric composition -- early warning system to detect changes in atmospheric concentrations of greenhouse gases, ozone, and pollutants (acid rain and dust particles).

5. Day intervals that IMP 8 satellite is in the solar wind (begin and end days are generally partial days): 28 Dec 1992-5 Jan 1993; 9-17 Jan; 21-30 Jan; 3-12 Feb; 16-24 Feb; 1-9 Mar; 14-21 Mar; 26 Mar-3 Apr; 8-15 Apr; 20-27 Apr; 2-10 May; 15-22 May; 28 May-4 Jun; 9-17 Jun; 22-29 Jun; 4-12 Jul; 17-24 Jul; 30 Jul-5 Aug; 12-18 Aug; 24-30 Aug; 6-12 Sep; 18-25 Sep; 1-7 Oct; 14-20 Oct; 26 Oct-1 Nov; 8-14 Nov; 20-27 Nov; 2-10 Dec; 15-22 Dec; 27 Dec 1993-4 Jan 1994. Note that there will not necessarily be total IMP 8 data monitoring coverage during these intervals. (Information kindly provided by the WDC-A for Rockets and Satellites, NASA GSFC, Greenbelt, MD 20771 U.S.A.).

6. + Incoherent Scatter Coordinated Observations Days (see Explanations) starting at 1600 UT on the first day of the intervals indicated, and ending at 1600 UT on the last day of the intervals: 20-30 Jan 1993 CADITS/MLTCS; 17-18 Mar; 18-19 May; 15-16 Jun SUNDIAL; 20-21 Jul; 18-19 Oct; 9-10 Nov GISMOS; 7-8 Dec; 11-14 Jan 1994 GISMOS

where CADITS= Coupling and Dynamics of the Ionosphere-Thermosphere System;
GISMOS= Global Ionospheric Simultaneous Measurements of Substorms;
MLTCS= Mesosphere, Lower-Thermosphere Coupling Study;
SUNDIAL= Coordinated study of the ionosphere/magnetosphere.

OPERATIONAL EDITION, September 1992

EXPLANATIONS

This Calendar continues the series begun for the IGY years 1957-58, and is issued annually to recommend dates for solar and geophysical observations which cannot be carried out continuously. Thus, the amount of observational data in existence tends to be larger on Calendar days. The recommendations on data reduction and especially the flow of data to **World Data Centers (WDCs)** in many instances emphasize Calendar days. The Calendar is prepared by the **International Ursigram and World Days Service (IUWDS)** with the advice of spokesmen for the various scientific disciplines.

The **Solar Eclipses** are:

a.) *21 May 1993* (partial) visible in N. America northwest of line that passes from mid-Baja, CA through Buffalo, NY; in Europe northeast of line crossing from England-Scotland border through southern Poland; and in northeastern Asia. *Maximum magnitude* is 0.74.

b.) *13 November 1993* (partial) visible near sunrise in all of Australia and New Zealand except for northern rims; near sunset in S. America south of middle of Chile and Argentina; in Antarctica where maximum magnitude is 0.93. (Description by Dr. Jay Pasachoff)

Meteor Showers (selected by R. Hawkes, Canada) include important visual showers and also unusual showers observable mainly by radio and radar techniques. These can be studied for their own geophysical effects or may be "geophysical noise" to other experiments. The dates are given in Note 1 under the Calendar.

Definitions:

Time	= Universal Time (UT);
Regular Geophysical Days (RGD)	= each Wednesday;
Regular World Days (RWD)	= Tuesday, Wednesday and Thursday near the middle of the month (see calendar);
Priority Regular World Days (PRWD)	= the Wednesday RWD;
Quarterly World Days (QWD)	= PRWD in the WGI;
World Geophysical Intervals (WGI)	= 14 consecutive days each season (see calendar);
ALERTS	= occurrence of unusual solar or geophysical conditions, broadcast once daily soon after 0400 UT;
STRATWARM	= stratospheric warmings;
Retrospective World Intervals (RWI)	= intervals selected by MONSEE for study.

For more detailed explanations of the definitions, please see one of the following or contact H. Coffey (address below): IUWDS Synoptic Codes for Solar and Geophysical Data; Solar-Geophysical Data, November issue; URSI Information Bulletin; COSPAR Information Bulletin; IAGA News; IUGG Chronicle; WMO Bulletin; IAU Information Bulletin; Journal of the Radio Research Laboratories (Japan); Geomagnetism and Aeronomy (Russia); Journal of Atmospheric and Terrestrial Physics (UK); EOS Magazine (AGU/USA).

Priority recommended programs for measurements not made continuously (in addition to unusual **ALERT** periods):

Aurora and Airglow — Observation periods are New Moon periods, especially the 7 day intervals on the calendar;

Atmospheric Electricity — Observation periods are the **RGD** each Wednesday, beginning on 6 January 1993 at 0000 UT, 13 January at 0600 UT, 20 January at 1200 UT, 27 January at 1800 UT, etc. *Minimum program is* **PRWDs**.

Geomagnetic Phenomena — At minimum, need observation periods and data reduction on **RWDs** and during **MAGSTORM Alerts.**

Ionospheric Phenomena — Quarter-hourly ionograms; more frequently on **RWDs**, particularly at high latitude sites; f-plots on **RWDs**; hourly ionograms to **WDCs** on **QWDs**; continuous observations for solar eclipse in the eclipse zone. See **Airglow and Aurora.**

Incoherent Scatter — Observations on Incoherent Scatter Coordinated Days; also intensive series on **WGIs** or **Airglow and Aurora** periods. **Special programs:** Dr. J. Holt, M.I.T. Haystack Observatory, Route 40, Westford, MA 01886 U.S.A., URSI Working Group G.5 (617)981-5625; e-mail AMES::"jmh@chaos.haystack.edu".

Ionospheric Drifts — During weeks with **RWDs**.

Traveling Ionosphere Disturbances — special periods, probably **PRWD** or **RWDs**.

Ionospheric Absorption — Half-hourly on **RWDs**; continuous on solar eclipse days for stations in eclipse zone and conjugate area. Daily measurements during Absorption Winter Anomaly at temperate latitude stations (Oct-Mar Northern Hemisphere; Apr-Sep Southern Hemisphere).

Backscatter and Forward Scatter — **RWDs** at least.

Mesospheric D region electron densities — **RGD** around noon.

ELF Noise Measurements of earth-ionosphere cavity resonances — **WGIs.**

All Programs — *Appropriate intensive observations during unusual meteor activity.*

Meteorology — Especially on **RGDs**. On **WGIs** and **STRATWARM** Alert Intervals, please monitor on Mondays and Fridays as well as Wednesdays.

GAW (Global Atmosphere Watch) — WMO program to integrate monitoring of atmospheric composition. Early warning system of changes in atmospheric concentrations of greenhouse gases, ozone, and pollutants (acid rain and dust particles). WMO, 41 avenue Giuseppe-Motta, P.O. Box 2300, 1211 Geneva 2, Switzerland.

Solar Phenomena — Solar eclipse days, **RWDs**, and during **PROTON/FLARE ALERTS.**

FLARES22 (FLAre RESearch at the maximum of solar cycle 22) — observations of basic physical processes of transient solar activity and its coupling with the solar-terrestrial environment, including times of the various solar **ALERTS**. Coordinate satellite and ground-based observations. Contact *Dr. M. Machado*, Dept of Physics, Univ of Alabama, Huntsville, AL 35899 USA. (205)895-6676, SPAN SSL::MACHADO; FAX (205)895-6790.

SOLTIP (SOlar connection with Transient Interplanetary Processes) -- *1990-95 observations and analyses of solar-generated phenomena propagating through heliosphere, including times following the various solar* **ALERTS.** Includes Interplanetary Scintillation observations of radio galaxies and telemetry signals to/from interplanetary spacecraft. Also coordination of spacecraft IMP8, ICE, Giotto, Sakigake, Voyager 1/2, Pioneer 10/11, Ulysses, Relict, Wind, SOHO, Galileo and ACE. Contact Dr. M. Dryer, NOAA R/E/SE, 325 Broadway, Boulder, CO 80303 USA. (303)497-3978; SPAN e-mail address *SELVAX::MDRYER; FAX (303)497-3645.*

Space Research, Interplanetary Phenomena, Cosmic Rays, Aeronomy — QWDs, RWD, and **Airglow and Aurora** periods.

The **International Ursigram and World Days Service (IUWDS)** is a permanent scientific service of the International Union of Radio Science (URSI), with the participation of the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics IUGG). IUWDS adheres to the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) of the International Council of Scientific Unions (ICSU). The IUWDS coordinates the international aspects of the world days program and rapid data interchange.

This Calendar for 1993 has been drawn up by H.E. Coffey, of the IUWDS Steering Committee, in association with spokesmen for the various scientific disciplines in SCOSTEP, IAGA, URSI and other ICSU organizations. Similar Calendars are issued annually beginning with the IGY, 1957-58, and are published in various widely available scientific publications.

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Additional copies are available upon request to IUWDS Chairman, Dr. Richard Thompson, IPS Radio and Space Services, Department of **Administrative Services, P.O. Box 5606, West Chatswood, NSW 2057, Australia, Fax number (61)(2)414 8331, e-mail richard@ips.oz..au or IUWDS Secretary for World Days, Miss Helen Coffey, WDC-A for Solar-Terrestrial Physics, NOAA E/GC2, 325 Broadway, Boulder, Colorado 80303, USA, Fax number (303)497-6513, e-mail 34367::hcoffey.**