IONOSONDE NETWORK ADVISORY GROUP (INAG) *

Ionospheric Station Information Bulletin No 54 **

CONTENTS

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

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Issued on behalf of INAG by the World Data Center A for Solar Terrestrial Physics, National Oceanic and Administration, Boulder, Colorado 80303, USA. Others wishing to be on the mailing list should notify WDC-A of the INAG Chair.

November 1989

1. A COMMENT FROM THE CHAIR

A number of important issues are raised in the minutes of the INAG meeting. I would like to draw your attention to one in particular; the INAG mailing list. As I have already said, the mailing list is being remade. If you wish to remain on it you must notify me. The full list is reproduced in this issue again with the names of those who have responded bolded. If your name is not printed in bold type and you wish to continue receiving the INAG bulletin, contact me now.

This issue also carries a report on the Ionospheric Informatics workshop held at Lowell, on ionospheric data exchange formats. As more data are recorded and processed digitally, more versatile data formats will become essential. One consequence of this meeting is a new scaling letter, the slash (/) has been proposed. It will mainly be used by automatic scaling systems and has the meaning "another letter may be more appropriate in this position, but at best an incomplete attempt has been made to find one". If you have any thoughts on this matter, please write a note for the bulletin.

Finally, I would like to focus your attention on what it means to maintain an ionosonde network and archive the data over the next 10 to 20 years. Very important decisions will be made on this subject during the next 10 years which will critically affect the long term ionospheric climate record. It is important that we consider what is required **now**. I hope you will all read the notes by Dr. Rishbeth and myself carefully and respond to them quickly. I would hope we can have some reasonable idea of how we expect to face these issues by the next URSI General Assembly. I look forward to putting your comments in the next INAG bulletin. Remember, this is **your** bulletin. I will compile a note from your comments. You need not write a lot. You may disagree with parts of an article, agree with other parts, but have no coherent feelings. Put it down in a letter and share your uncertainties and misgivings. If enough are open in this way, we can be assured positive results will follow.

Send all comments and contributions to:

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2. MINUTES OF INAG MEETING; IAGA, JULY 25 1989

Minutes prepared by R. Haggard, Secretary

Present:

T Kelly	Australia
R Stening	Australia
P Wilkinson - Chair	Australia
M A Abdu	Brazil
O Rasmussen	Denmark
E Kataja	Finland
G O Walker	Hong Kong
T Ishimine	Japan
R Haggard - Secretary	South Africa
A W V Poole	South Africa
L F Alberca	Spain
Y-N Huang	Taiwan
S Pulinets	Union of Soviet Socialist Republics
J Dudeney	United Kingdom
H Rishbeth	United Kingdom
A Rodger	United Kingdom
S A Simmons	United Kingdom
D M Willis	United KIngdom
R Hunsucker	United States of America
B Reinisch	United States of America

The new Chair of INAG introduced himself to the assembled members and welcomed all present.

2.1 INAG Mailing and Master Station Lists

He drew attention to the latest edition of INAG Bulletin 53 concerning the INAG mailing list and briefly informed the meeting that the mailing list is reproduced in the bulletin and that if members do not respond, their names would be purged from the mailing list. Each member is expected to notify the Chair of their continued interest and secondly, to supply any names that have been omitted from the mailing list. The mailing list will be reproduced in future bulletins and those members that have responded, will be in bold type. Any member who has not responded by the next URSI General Assembly will be removed from the mailing list.

Also reproduced in INAG Bulletin 53 is a master station list and code names of each station as well as alternate station names. Members were asked to check these and to notify the chair of any omissions or errors, and supply any additional information they thought fit.

2.2 WITS

The Chair also spoke briefly about the need to accumulate data for the WITS campaign and gave a brief overview of WITS activities and wondered what input INAG could make to ensure the availability of data more rapidly than at present.

2.3 Informatics Workshop

The informatics workshop held in Boston during July 1989, was reported on by Reinisch. A report of this workshop can be found in the next section of the bulletin.

2.4 Key Stations

The Chair then addressed the need for key stations and the problems and requirements of such stations. Long term monitoring of the ionosphere would be a prime requirement and it would be tragic if stations that have been operating for 50 years should close down, since they form part of the base line for the global ionospheric record. It is very important that the data be archived in a readily usable form and conforming to the scaling requirements as set out in the USRI conventions as described in the "URSI Handbook of Ionogram Interpretation and Reduction" UAG23 and UAG23A. The archiving of data presents a space problem and magnetic tape or optical disc storage should be considered.

It is also important that the station be supported nationally and that an interest in the data at the local scientific level be high to ensure good quality data. A commitment to use modern sounding equipment would be of great use but funding for operating these stations indefinitely will pose problems.

Naturally the data should be reduced fairly rapidly and be freely available to researchers for example - through World Data Centres.

Further, the locations of the key stations would also be very important and the modellers should make an input as to which locations should be preserved and where new stations should be located, especially in the regions where there is a paucity of ionosondes.

A working group report is to be drawn up for the next URSI General Assembly presenting the above ideas. The Chair exhorted members to send in contributions as soon as possible so that he can draw up a draft which can be circulated for further comment and input before a final draft is completed and published in INAG ready for presentation at the URSI General Assembly in Prague.

2.5 Computer Scaling of Ionograms

The Chair noted that four systems for scaling ionograms by computer have been reported in the INAG Bulletins viz: Artist, CRL, Kel Aerospace, and IPS systems. At present none are perfect but as more ionograms are tested by the systems their methods will improve and manual scaling can eventually be replaced.

Before this happens, several techniques will have to be devised such as integrating scaling letters into the automatic scaling methods and using the information from preceding ionograms. A need also exists to integrate real height analysis into the automatic scaling routines which would then be able to produce electron density profiles. An essential feature may be some sort of flagging mechanism to denote problem ionograms, e.g. sporadic E.

Reinisch commented that these things can be achieved but required considerable manpower and finance.

2.6 URSI General Assembly - Prague

The Chair of Commission G of URSI, Dr. Henry Rishbeth, welcomed Phil Wilkinson as the new Chair of INAG, which, he pointed out, is a senior working group in URSI Commission G. He also commented that at the URSI General Assembly, the working group would need to be reconstituted.

One of the areas URSI would have to address will be ionospheric modeling with special emphasis on N(h) profiles and the E-F valley problem. The URSI General Assembly programme papers would be concerned with technique, science and propagation. He further stated that he would accept papers on a short time scale so as to enable the inclusion of the latest results.

The new Guide to WDC Part II has just been printed and would soon be distributed.

Dr J. Allen, World Data Center A for Solar Terrestrial Physics, informed the group that the second WDC-A CD-ROM of data was being assembled for production later this year and eventual distribution next year. This CD-ROM will contain some hourly ionospheric data.

There being no further business the meeting closed at 2150.

3. URSI WORKING GROUP G.4 IONOSPHERIC INFORMATICS WORKSHOP

International Workshop on Digital Ionospheric Data Formatting for World Data Center Archiving
by P. J. Wilkinson

17-20 July, 1989, University of Lowell, U.S.A.

Present:

NAME	ORGANIZATION
M.A. Abdu	INPE/Brazil
Inez S. Batista	INPE
Dieter Bilitza	NASA/NSSDC
Jurgen Buchau	GL/LIS
Michael Buonsanto	M.I.T.
Ray Conkright	NDCA/STP
A.Ya. Feldstein	World Data Center B2
Matthew Fox	Boston University
Robert R. Gamache	Center for Atmospheric Research
Seiji Igi	Communications Research Laboratory
J.C. Jodogne	Institut Royal Meteorologique
Terry Kelly	KEL Aerospace Pty Ltd.
William T. Kersey	Center for Atmospheric Research
David F. Kitrosser	Center for Atmospheric Research
Adolf K. Paul	Naval Ocean Systems Center
Ram Gopal Rastogi	Indian Institute of Geomagnetism
Bodo W. Reinisch - Chair	Center for Atmospheric Research
Edward P Szuszczewicz	SAIC
Yuri S. Tyupkin	Soviet Geophysical Committee
Phil Wilkinson	IPS Radio and Space Services

The principal objective of the meeting was to define areas of consensus among the various groups and make recommendations for handling digital ionospheric data. Once the types of data had been defined, areas of agreement followed rapidly.

Five types of data were identified which could be archived.

· Raw Ionograms
The format used to store raw ionograms will be system specific and it is inappropriate to attempt to recommend specific formats that should be used.

Raw ionograms will have to be accompanied by a decoding program when exchanged or archived in a WDC.

· Processed or Scaled Ionograms
These data will result from computer scaling ionograms. At this stage the accuracy will depend entirely on the scaling software which will not be able to handle unlikely ionograms with predictable results. A standard format could be developed here, but at this stage it is not essential.

· Edited or Validated Ionograms
These are data from Step 2 that have been checked manually. The same format comments apply, although these data are now more valuable.

· Tabulated Characteristics
This group of data includes the recommended URSI characteristics and is the set of data generally regarded as useful for characterising ionograms for synoptic studies.

The WDC format for archiving hourly tabulated data exists already.

· Deduced Data
Real height electron density profiles could also be archived, however, the meeting felt there was sufficient discussion over different approaches to this analysis that a firm recommendation was unlikely to be helpful at present.

Of these five types, a format was only recommended for the fourth category and the draft form is given in table 1. Further minor revision is possible. The format is a significant departure from those previously used for ionospheric data in that the first block contains header information and must be interpreted correctly for the rest of the data to be read. This feature gives the format the necessary flexibility for handling the variable data rate.

A reasonable quantity of data archived will come from autoscaling systems and these systems will probably not add descriptive and qualifying letters indicating data accuracy. This lead to the proposal that these data must be easily recognized if no manual validation has taken place. Four steps were proposed.

- not validated, tabulated characteristics coming from an autoscaling program will contain a slash (/) in both the qualifying and descriptive letter positions.
- if the autoscaling program also generates scaling letters, these will be entered in the appropriate positions, overwriting the slash.
- — An autoscaling program will never enter a blank into either of the letter positions.
- when the tabulated data are validated, the slash is replaced by the appropriate scaling letter, which in most cases will be a blank. Thus the absence of slashes will confirm

Table 1. Database Structure for Flexible Data Rates

Block #	Format	Description
1	A20	Station Name
1	A5	Station code
1	I4	Time Longitude E
1	I4	Station Latitude N
1	I4	Station Longitude E
1	I4	Year
1	I2	Month
1	A10	Data type: manual/autoscaled
1	A20	Ionosonde system
1	I2	Number of characteristics
1	40(A4)	List of characteristics
1	40(I2)	List of corresponding URSI codes
1	40A6	Units used for the characteristics
1	I2	Number of days in month, M
1	31(I4)	Number of measurements for each of the M days, Nm
2	ΣNm(I6)	The Nm sample times Hh:Mm:Ss
.	..	for each of the M days
J	N(I3,2A1)	The N1 values of characteristic 1 for day 1
.	..	...repeated for each of the M days
.	24(I3,2A1)	Medians
.	24(I2)	The counts for the medians
.	24(I3,2A1)	Upper Quartiles (UQ)
.	24(I3,2A1)	Lower Quartiles(LQ)
.	24(I3,2A1)	Upper Deciles
.	24(I3)	Range(UQ-LQ)
.	24(I3,2A1)	Lower Deciles

DEVICE	MANUFACTURER	CAPACITY	STANDARDS	MEDIA	DRIVE COST	MEDIA COST	SOFTWARE REQUIRED
DAT Digital Audio Tape	Exabyte Sony Phillips	2 GB	interface level only	8x4 cm cartridge	$2000	$15	DOS Drivers
QIC Quarter Inch Cartridge	Archive Wangtek Cipher Data Tallgrass	150 MB 300 MB	all	DC-600	$1000	$30	DOS Drivers
FLOPPY TAPE	Irwin Mag.	80 MB	none	DC-2000	$800	$30	none
	Wongtek Archive Mountain Comp	100 MB	all				
DIGITAL CASSETTE	Teac JVC	300 MB ? may be due soon 150 MB	some	DC-60	$600	$15	none
CD-ROM	Tandy LMS Sony Phillips	600 MB -1 GB	all	CD	$1000 playback		none
					$7000 record	$150	
VHS Digital Tape	Digidata Honeywell	2.5 GB	none	VHS Tape	$5000	$10	none
WORM Write once Read Many	Maxtor Sony IBI Hitachi	800 MB -1 GB	interface level only	Optical Disk	$3000	$200	none
OPTICAL DISK	Ricoh Sony Maxtor Phillips	1-2 GB	interface level only	Optical Disk	$3000	$200	none
BERNOULLI BOX	IO MEGA	20 MB	interface level only		$3000		none
REMOVABLE HARD DISK	I2 Interface	40 MB					

Table 2. Summary of magnetic media considered for long term WDC data storage.

that the data has been validated.

- When only a few days out of a month have been validated, it will be up to the researcher to note the presence or absence of slashes. Some thought may have to be given to median calculations for this type of data, and experience should indicate the most appropriate course of action to take.

This leads to the recommendation that a new scaling letter, the slash, be introduced to indicate that no attempt has been made to determine scaling letters for the position occupied by the slash. Introducing this new letter appeared a better course to take than to use an entire new set of letters to indicate autoscaled not validated scaling letter assignments. A suggestion was also made to enter a slash in the letter position when validated data held in analogue form is digitised.

A data archive format based on digisonde data processing without scaling letters, encompassing categories 2, 3 and 5, was offered as an example and this will be given in a later INAG bulletin.

Data media were also discussed. The meeting hoped to make some recommendations on which media are likely to be most useful in the longer term. However, although many different types were considered, the likely successor to 9-track magnetic tape could not be identified. This conclusion was based on the personal experience of those present which reinforced the results of a study carried out at Lowell by Kitrosser and Regan. Their results are reproduced in table 2. The meeting felt that this question should be reconsidered at a later date.

All agreed the meeting was particularly useful, covering a number of practical issues of concern. Good weather, a very pleasant eat-out at Prof. Reinisch's house and an interesting tour of ULCAR all contributed to a most enjoyable meeting.

4. COMMENTS ON 2 ARTICLES ON LACUNA BY SUZANNE CARTRON AND PAUL VILA IN INAG BULLETIN 52

J.K. Olesen

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Danish Meteorological Institute
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May 26 1989

I should like to express my appreciation for the efforts made by our French colleagues on their continued studies of lacuna phenomenon. Having been involved in related studies for more than 35 years I almost feel a "professional obligation" to accept the invitation to comment on the subjects treated in the articles and inform on observations made and study results obtained in our part of the world. On the other hand I feel that I have previously covered so many pages of INAG Bulletins on lacuna material (see e.g. Bull. No. 50,31,29,14,12 and also High Lat. Suppl. UAG-50, pp. 227-237 and 251-253) that I must now endeavour to limit myself to a kind of summary.

The routine scaling made at our 3 main observatories in Greenland: Narsarsuaq at 68°, Godhavn at 77° and Thule (Qanaq) at 86° INVL. includes the daily sheet indication of lacuna by descriptive letter Y and of slant Es (Es-s) occurrence by letter s in addition to the f-plot indication of Es-s. I emphasize that according to our model (see below) Y is used only for trace gaps starting in the upper E-region and from there extending upwards. Thus we do not accept the concept "F2 lacuna", but only F1-lacuna (partial or total) and F1 + F2-lacuna (partial or total), all of those cases with lacuna starting at the upper E-region.

In addition to the routine scaling we have, as evident from my previous contributions mentioned above, utilized several special experiments/data: ground-based (coherent and incoherent scatter) balloon, rocket and satellite for statistical and other studies on lacuna, including those based on several campaigns at our observatory at Søndre Stromfjord (75° INVL.). Briefly, as described previously at several occasions (see e.g. Bull. No. 50) we maintain (as a proven fact now!) that lacuna is the result of abnormal E-region absorption occurring above the station, caused by elevated electron temperatures resulting from strong Hall currents (high E-field and conductivity) causing a plasma instability whose inherent drifting field-aligned electron density enhancements in the E-region are the source of the obliquely propagated Slant Es backscatter echoes. We have called this complex of phenomena and its ionogram signatures the polar Slant Es (or E) Condition -SEC- and since it has often been overlooked, I emphasize: the SEC concept includes

SLANT E CONDITION - SEC

Station	Hour 45° WMT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
THULE, 86° INVL	Jan.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
	Mar.	0	0	0	0	0	0	0	3	7	7	10	13	23	20	10	7	13	3	3	0	0	3	0	0
	Apr.	7	3	3	7	3	10	13	27	13	30	53	53	47	43	20	17	3	7	7	13	0	3	3	7
	Maj	7	0	7	13	30	43	57	60	73	80	93	83	83	80	60	40	43	27	30	27	7	10	0	0
	Jun.	0	3	0	40	43	60	53	47	63	60	77	60	70	47	53	43	33	30	27	10	17	3	0	10
	Jul.	0	3	0	3	30	33	47	67	63	77	87	77	63	37	20	20	13	13	10	13	3	0	0	3
	Aug.	0	3	3	7	10	10	17	17	40	33	60	63	67	53	20	20	10	7	3	3	3	0	0	3
	Sep.	0	3	3	0	3	3	3	3	0	10	10	13	30	23	13	10	3	0	0	0	0	0	3	0
	Okt.	0	0	0	0	0	0	0	0	3	7	7	13	0	0	3	0	0	0	0	0	0	0	0	0
	Nov.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GODHAVN, 77° INVL	Jan.	0	0	0	0	0	0	0	0	0	0	10	17	17	10	0	0	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	3	7	17	17	20	10	17	20	0	0	0	0	0	0	0	0
	Mar.	0	0	0	0	0	0	0	10	47	53	60	63	47	37	30	17	0	0	0	0	0	0	0	0
	Apr.	0	0	0	0	3	7	10	10	47	60	60	63	63	40	20	7	0	0	0	3	0	0	0	0
	Maj	0	0	0	0	0	7	10	27	43	47	43	50	20	20	3	0	0	0	0	0	0	0	0	0
	Jun.	3	0	0	0	3	13	30	37	60	50	60	63	47	47	20	7	10	0	0	0	0	0	0	0
	Jul.	0	0	0	0	3	10	37	37	63	43	53	37	37	40	20	20	0	3	0	0	0	0	0	0
	Aug.	0	0	0	0	3	10	3	27	30	50	50	53	40	37	20	17	10	0	0	0	0	3	0	0
	Sep.	3	3	0	0	0	0	0	3	30	27	40	40	20	27	17	3	3	0	0	0	0	0	3	1
	Okt.	0	3	0	0	0	7	0	0	17	30	33	43	33	17	20	20	7	0	0	0	3	0	0	7
	Nov.	0	0	0	0	0	0	0	0	0	7	17	10	20	7	3	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	3	7	3	3	7	10	10	3	3	0	0	0	0	0	0	0	0
NARSARSUAQ, 68° INVL	Jan.	3	10	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Feb.	3	13	3	3	0	0	0	0	0	0	0	0	0	3	7	10	20	30	27	20	3	3	0	0
	Mar.	13	17	13	23	3	7	0	0	0	0	0	0	10	17	33	47	60	40	20	0	0	3	0	0
	Apr.	13	13	13	7	7	0	7	7	0	0	0	0	13	13	30	43	33	33	13	13	3	7	0	0
	Maj	13	20	17	10	0	3	10	0	0	0	0	3	10	17	30	43	47	43	40	10	0	0	7	3
	Jun.	3	27	27	33	10	17	17	7	0	0	0	0	3	17	10	27	43	40	23	10	0	0	0	7
	Jul.	0	17	20	17	7	7	7	7	0	0	0	0	0	13	17	17	27	33	20	7	3	0	3	7
	Aug.	17	17	13	20	13	10	7	7	7	0	0	0	3	20	33	60	50	23	20	13	3	3	0	3
	Sep.	10	17	20	40	17	10	0	0	0	7	7	3	3	7	23	40	53	33	17	17	7	0	7	7
	Okt.	33	27	23	40	23	20	13	0	7	10	7	10	13	13	20	37	33	20	13	7	7	3	7	33
	Nov.	10	27	27	23	3	27	7	7	0	7	3	0	7	13	20	33	30	33	33	13	10	7	13	10
	Dec.	23	27	27	17	20	20	7	0	0	0	0	0	7	3	13	33	33	70	57	37	10	17	10	13

Fig.1a. Full hour SEC observations on percentage of days of each month at each of the 24 hours - for 1974, a high SEC-activity year.

SLANT E CONDITION - SEC

Station	Hour: 45° WMT	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
THULE, 86° INVL.	Jan.	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mar.	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	3	0	0	0	0	0
	Apr.	0	0	0	0	0	0	0	3	3	7	7	13	3	0	0	0	3	0	3	0	0	0	0	0
	Maj	0	0	0	0	0	3	7	7	13	17	13	20	27	20	30	20	13	3	3	3	7	3	3	0
	Jun.	0	0	0	10	7	20	17	27	27	3	17	20	20	13	13	13	0	3	3	0	0	3	0	0
	Jul.	0	0	0	0	0	0	10	30	20	20	40	37	27	27	10	7	0	0	0	0	0	0	0	0
	Aug.	0	0	0	0	0	0	3	10	17	37	33	30	23	17	17	7	3	3	0	0	0	0	0	0
	Sep.	0	0	0	0	0	0	0	0	0	10	13	17	10	27	17	7	0	0	0	0	0	0	0	0
	Okt.	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	0	0	0	0	0	0
	Nov.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GODHAVN, 77° INVL.	Jan.	0	0	0	0	0	0	0	0	0	3	0	0	3	0	7	3	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	3	3	0	0	7	3	3	3	0	0	0	0	0	0	0	0
	Mar.	0	0	0	0	0	0	0	3	7	13	20	13	20	10	10	3	0	0	0	0	0	0	0	0
	Apr.	0	0	0	0	3	0	0	23	17	27	17	10	23	20	17	17	0	0	0	0	0	0	0	0
	Maj	0	0	0	0	0	17	30	43	43	37	17	13	10	20	17	7	3	7	3	0	0	0	0	0
	Jun.	0	0	0	0	7	27	37	50	40	50	33	33	33	23	33	13	7	0	0	0	0	0	0	0
	Jul.	0	0	0	0	0	17	20	40	23	13	17	17	20	30	30	23	13	7	0	0	0	0	0	0
	Aug.	0	0	0	0	0	3	10	20	23	7	20	20	33	43	30	17	0	0	0	0	0	0	0	0
	Sep.	0	0	0	0	0	0	0	0	10	7	20	20	40	47	23	3	0	0	0	0	0	0	0	0
	Okt.	0	0	0	0	0	0	0	0	0	7	7	13	10	7	0	0	0	0	0	0	0	0	0	0
	Nov.	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
NARSARSUAQ, 68° INVL.	Jan.	0	0	10	10	3	0	0	7	0	0	0	0	0	3	7	13	3	10	3	0	0	0	0	10
	Feb.	0	7	7	0	0	7	0	0	0	0	0	0	7	7	13	10	17	0	0	0	0	0	0	0
	Mar.	3	0	7	3	7	3	3	3	3	0	3	0	3	3	10	3	10	3	0	0	0	0	0	0
	Apr.	0	10	7	7	0	0	0	0	0	0	0	0	3	7	17	27	23	20	7	7	3	0	3	0
	Maj	3	7	7	0	0	0	7	0	0	0	0	3	3	0	7	23	23	20	10	0	0	0	0	7
	Jun.	0	0	0	3	0	0	0	0	0	3	0	3	10	17	20	27	13	7	20	3	0	0	0	0
	Jul.	0	0	3	3	0	0	0	0	0	0	0	0	0	0	3	7	23	7	3	10	0	0	0	0
	Aug.	0	0	0	7	0	0	0	0	0	0	0	0	0	3	3	10	20	7	10	7	0	3	0	0
	Sep.	0	0	0	0	0	0	0	0	0	3	0	0	0	3	10	30	7	3	3	0	0	0	0	0
	Okt.	0	0	3	0	0	0	3	0	0	3	0	0	0	3	7	10	17	13	10	3	0	0	0	3
	Nov.	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	7	10	3	0	0	0	0
	Dec.	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	13	7	0	0	3	0	0	0	0

Fig.1b. Full hour SEC observations on percentage of days of each month at each of the 24 hours - for 1980, a low SEC-activity year.

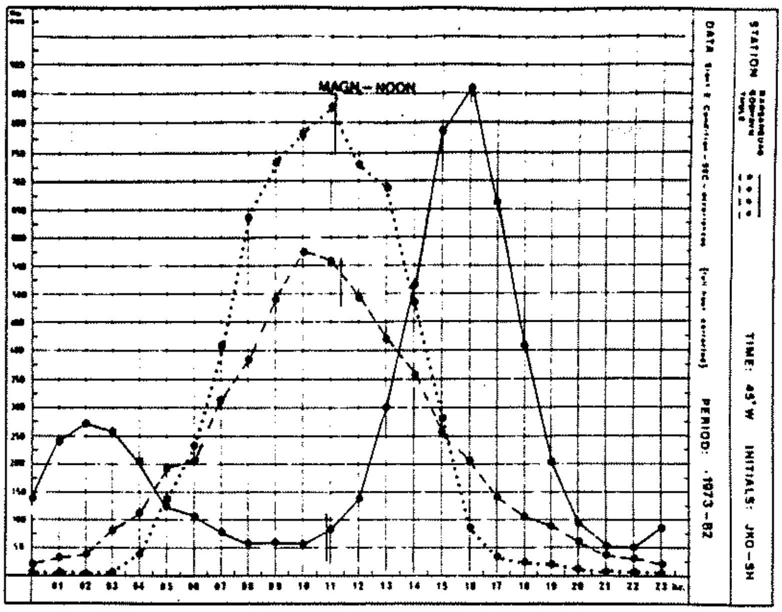

Fig.2. Average 24-hour SEC occurrence distribution at three observatories 1973-82. (From Olesen et al., 1988).

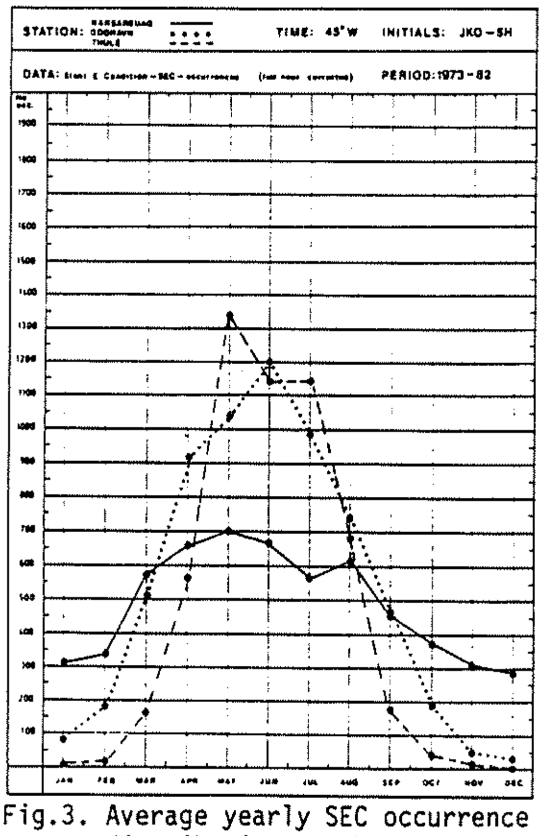

Fig.3. Average yearly SEC occurrence distribution at three observatories 1973-82.(From Olesen et al.,1988).

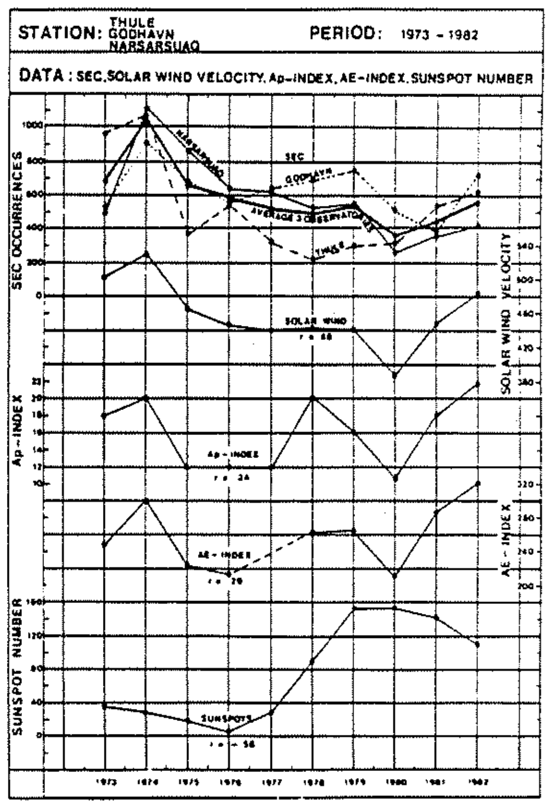

Fig.4. Long term variation of SEC occurrence at three observatories and the correlation with solar wind velocity, Ap AE and sunspot number indices (From Olesen et al., 1988).

lacuna in addition to the slant Es trace as well as some other secondary ionogram trace configurations (ref. UAG-50, p. 234, item 1-8).

Just as a curiosity: the reason why we in our 1958 publication chose the name "Slant Es Condition" for lacuna and Es-s was that the trace gap had not been discovered or described before, so we just invented it as a follower to the then well-known slant Es under the designation "height interval of missing reflection" for short: "height gap". Not until 1971 was the designation lacuna invented for that same feature. At this time we had the pleasure of discussions with Mme Cartron at our laboratory during her study visit here in 1961 inspired by our 1958 publication (ref. Olesen and Rybner, 1958).

As an example of one of our special studies of SEC and one which is along the lines of the Cartron-Vila proposals I may mention our recent 10-year, 3 station statistical study of SEC and its long term correlation with other ionospheric activity signatures (Olesen et al., 1988). We realise that polar lacuna / Slant Es / SEC occurrence problems are already well explored - see e.g. UAG-50 p. 232-233 with temporal (daily, yearly, 3 stations) and geographical (14 stations) occurrence distributions known, but we decided to make this special long term study.

SEC ionogram signatures are dependent on equipment sensitivity, ionospheric absorption, degree of event etc. which add to the usual subjectivity introduced by different people scaling the ionograms. For the years 1973-82 SEC ionogram scaling from our three main observatories have been made by the same person, Mrs. Inge Primdahl; our SEC analysis expert.

These data have been used to give a reliable picture of daily and yearly variation of the occurrence frequency of SEC. The only modification we have made to the monthly sums of hourly occurrences is that for each full hour of a particular month the sum was corrected for occurrences of strong absorption or missing ionograms by increasing the observed number of SEC proportionally. The results are shown in figures 1-3, which demonstrate that the SEC instability mechanism depends on E-region current/conductivity. This gives the depicted summer maximum for all three stations as well as the 24-hour distributions with one or two maxima and at times, all determined by the station location relative to the auroral electrojets and their polar cap return paths (ref. e.g. UAG-50, pp. 232-233).

We also wanted to study the long term relationship to other activity signatures such as solar wind velocity, sunspot numbers, AP and AE. The results, Fig. 4, show that, unexpectedly, sunspot number is not the key factor in SEC generation, rather the solar wind velocity is. This is yet another indication that SEC generation is heavily influenced by the electric field which is determined by the product of solar wind velocity and interplanetary magnetic field.

I hope the above note is a reasonable response to the Cartron-Vila request for lacuna results from other stations. As to various other items in their articles I may add the following.

I agree with the criticism of the Y symbol also covering "a strongly tilted layer" in addition to lacuna. As seen in Bull. 14, p. 6, I already mentioned it in my March 16, 1973 letter to Dr. Piggott who answered that he was inclined to agree, but that other INAG representatives disagreed and that as tilts and lacuna did not often occur in the same region, he would await further comments before changes were made. I must say that I am a little confused by this statement on tilt-lacuna geographical separation along with the French opposition towards the tilt mixing of Y, since I thought that the French model included large scale electron density irregularities (tilts ?) as the source of lacuna - in contrast to our E-region plasma instability model.

Furthermore, unlike Cartron-Vila, I maintain that lacuna recognition should not be made exclusively on the basis of traces remaining in the ionogram, but also on traces which are absent - and, with the use of all existing relevant evidence, on the reason for the absence, i.e. a reliable model, if such a model exists. As the unlucky consequence of not doing so I regard the F2 lacuna concept, which is not possible in our E-region plasma instability model for lacuna. Including an F2 lacuna concept in the Y signature reflects in my opinion an unsatisfactory mixing of mechanisms similar to the tilt-Y mixing problem discussed above.

I agree (F2 lacuna interpretation, p. 8) that the G condition is only one among various possible causes to account for missing F2 traces. But I disagree when it seems that Cartron-Vila are very restrictive in their G recognition procedures. If you require an absolute positive indication of foF2 decreases and increases and require this proven by ionograms each 5 minutes or less in order to scale "G" and you scale "Y" in all other cases of F2 absence, you will naturally get a very small, G/Y occurrence proportion, but it is incorrect. I certainly hope that my interpretation of the French procedure is wrong.

Just as a matter of form: It seems to me that our recent publication: Olesen et al., 1986, is not quoted correctly, I do not recognize the stated citations (p. 12: Conclusions and outlook).

As to the proposal on the invention of a lacuna occurrence index I am afraid that - although I should like to encourage advances in lacuna studies - my personal feeling is, as evident from my statements above, that polar lacuna (incl. Es-s/SEC) is rather well explored as to average statistical temporal and geophysical occurrence distributions and also as far as the rough features of the source mechanism are concerned. And while I find that lacuna is affected by too many different factors to make it an unambiguous index I naturally agree that all observatories should be encouraged to watch the occurrence pattern and make all possible statistical surveys on the SEC data for the station, especially in order to record any deviation from the expected average.

In this connection the mid-latitude observations of slant Es with or without lacuna deserve some special attention, ref. the reports on the following observation locations: Wuchang, China, 30°, ref. al. INAG-35, p. 8: report by Piggott and also paper by Tan Zi-xun et al. in JATP, 47-8, pp. 959-963, 1983. Australia, various stations 19-43°S, ref. INAG-39, pp. 8-9, report by P.J. Wilkinson and a very useful list of study items by Alan Rodger. , Yugoslavia, 44°38', ref. INAG-43/44, p. 20-21, report by D.P. Grubor and comments by Alan Rodger.

I think that on top of this, more fruitful aspects for study would be the detailed study of the source mechanism, e.g. by more advanced coherent and incoherent spectral radar measurements and various balloon and in situ rocket and satellite studies of lacuna/Es-s/SEC.

Finally, for Dumont d'Urville station, I would recommend finding out why so few slant Es and lacuna are seen at that station contrary to other high latitude stations. My own guess is that the reason is either 1) an extremely perfect vertical antenna radiation pattern without low elevation sidelobes, either due to antenna construction, to the ground mirror or the possible screening by surrounding mountains, or 2) low equipment sensitivity, in particular towards higher frequencies. This last possibility could explain both the lack of an Es-s trace and also the frequent failure for F2 to appear when a G conditions is unlikely, especially as these are scaled as F2-lacunas at Dumont d'Urville. (Very relevant comments on this subject and other SEC related items may be found in letter of G.A.M. King, New Zealand, to Mme Cartron, CNET, reproduced in INAG-6, Feb. 1971, p.18).

In conclusion I once again thank our French friends for their initiative in the hope that my comments are read in the same positive spirit in which they were written. And as the absolute last words from me: Since Danish State regulations require that I retire on a pension Feb. 1., 1990, I should like to take this last opportunity to thank all my INAG colleagues for many very pleasant professional and social contacts during many years. I expect, however, that my interest in the ionospheric radar/physics field shall not stop suddenly so should someone have an interesting task suitable for me, then do not hesitate to contact me!

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5. POLAR LACUNA - SCALING RULES AND PHYSICAL INTERPRETATION

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5.1 Introduction

The articles describing the statistical occurrence patterns of lacuna and proposing changes to the ionogram scaling rules by Mme Suzanne Cartron and Paul Vila (INAG Bulletin 52, 8-13) raise several interesting questions which are addressed here.

5.2 Scaling rules

The ionosonde community spends considerable time, effort and money producing brief numerical descriptions from the digital and analogue ionograms from many stations round the world. There is a very diverse set of reasons why this scaling is necessary. One of the objectives, albeit of minor importance at some stations, is that scientific analysis and research is possible from examination of these data.

Some phenomenological studies of an ionospheric phenomena can be carried out from routinely-scaled ionogram parameters over an extended time-scale. There are many examples of such studies in the half century of ionospheric research ranging from the occurrence of spread-F at one station to the global distribution of sporadic E. Often, it is essential to study an ionospheric feature over a solar cycle (11 years) or more. The researcher hopes that the ionosonde used to collect the data does not alter its sensitivity or performance over that period. Another key element for the successful study is that the scaling rules do not change otherwise unacceptable discontinuities may be introduced into the data.

The rules for ionogram interpretation and reduction have been relatively stable since the IAGA and URSI meetings in 1981. In the preceding decade, there had been many minor and some major changes to the rules, with the publication of the second edition of the Handbook of Ionogram Interpretation and Reduction (UAG-23) (1972), the High Latitude Supplement (UAG- 50) (1975) and the revised edition of the first four chapter of UAG-23 in 1978 (UAG-23A).

There is an increasing number of ionosondes producing digital ionograms. Whilst there are still many difficulties in the automatic scaling of these ionograms (e.g. Gilbert and Smith, 1988), there is little doubt that the majority of those currently scaling ionosonde data will do this automatically within the next decade. There is little likelihood that many of the parameters scaled by computer method will be compatible with those generated by present manual methods. Qualifying and descriptive letters as we know them today will soon be a feature of the past. Thus with these points in mind, it is suggested that we do not make any minor changes to the scaling rules, as suggested by the French Group, and we keep a status quo until the community develops the necessary new rules for automatically-scaled ionograms. It is most important for INAG to take a strong lead in determining the guide-lines for automatic ionogram reduction. During the years whilst the International Digital Ionosonde Group (IDIG) was in existence, some effort to address this question was made but perhaps it was premature to expect firm decisions to be made then. It is now a matter of urgency for INAG to reconsider this matter and come to a consensus view. However this topic will not be addressed further here.

5.3 The physical interpretation of lacuna

Mme Carton and Monsieur Vila imply that lacuna and a severely tilted F layer are fundamentally different phenomena as their ionogram signatures are different; the former causes an absence of traces on ionograms, whilst the latter gives additional traces. They also do not clearly explain the relationship between slant Es and lacuna, which is widely reported in the literature. A possible unifying description of all these phenomena is provided for further discussion. Under the special circumstances, it will be shown that lacuna and a severely tilted layer can arise from the same physical phenomenon and therefore the use of the letter Y for scaling both occasions is appropriate.

There is little doubt that lacuna and its associated phenomena occur predominantly at very high latitudes (where the dip angle approaches 90°) around local noon in summer. At these very high latitudes, there are frequently large, transient electric fields, often 100 mVm_{-1}. These electric fields are thought to be associated with occasions when the Earth's magnetic field is briefly linked to that of the solar wind (Flux Transfer Events, FTEs) (Southwood, 1987; Lockwood and Cowley, 1988; Sandholt et al., 1989), or when there are pressure variations of the solar wind impacting upon the magnetosphere (Sibeck et al., 1989). There is still some doubt over the spatial dimension of these events but most evidence suggests that they are at least a hundred kilometres both in latitude and longitude.

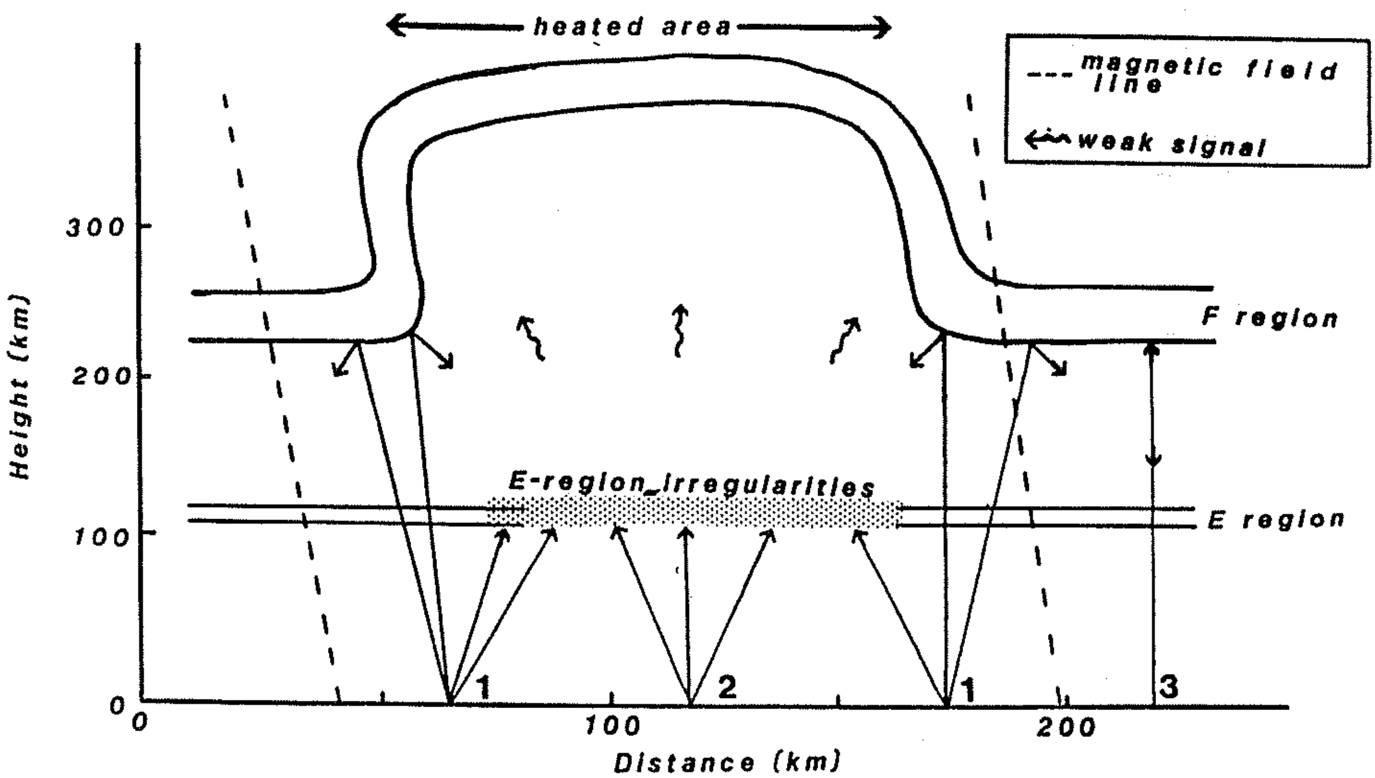
One effect of this electric field in the E-region will be to drive the plasma unstable causing ionospheric irregularities. Those with scales >1 kilometre can be detected by ionosondes. The ionogram signature of this process will be slant Es are illustrated by Rodger and Pinnock, 1986, and Dudeney and Rodger (1985). There is evidence that these layers of irregularities are regions where the electron temperature is elevated and this may cause some 'anomalous' attenuation of the h.f. radio waves.

The other major ionospheric consequence of these events is Joule heating. Its magnitude depends upon the square of the electric field and the Pedersen conductivity, σ_P (i.e. Joule heating $=\sigma_P \cdot E^2$). Pedersen conductivity normally peaks about 140 km altitude during sunlit conditions. At very high latitudes it can be two orders of magnitude greater during summer solstice at noon compared with winter. Hence there will be a very significant seasonal variation in the effectiveness of Joule heating by this process.

Table 1: Summary of characteristics on the E and F regions

	E layer	F layer
Station 1	normal E layer but slant Es present	very severely tilted F2 lacuna owing to defocussing
Station 2	(a) high absorption in E layer upper E-trace absent.	F1 and F2 traces absent; total lacuna F3
	(b) moderate E-layer absorption slant Es may be present	F1 layer missing; F2 present (F1 lacuna)
	(c) weak absorption; E-layer normal, Es-s may be present	additional F traces on ionogram; highly tilted F-layer
Station 3	normal	normal

Figure 1: The spatial distribution of iso-ionic contours resulting from a significant Joule heating event.



The consequences of this Joule heating initially will be to cause adiabatic expansion of the neutral atmosphere. The ionosphere at high latitudes will also respond in a similar manner with the plasma being confined to expand along the geomagnetic field lines. Figure 1 illustrates in two dimensions, the contours of equal ionisation (iso-ionic contours) immediately after (within 10 minutes) a Joule heating event has occurred. It is well accepted that foF2 forms at a fixed pressure, not at a fixed altitude (Rishbeth, 1986), and therefore foF2 will not change initially as a result of the heating but the height of the layer, and especially the height of maximum electron concentration (hmF2) will increase.

The ionosonde may record a wide variety of ionogram signatures depending upon exactly where it is located with respect to the new structure and upon the magnitude of the Joule heating. A few possible radio wave ray traces and consequent ionograms are illustrated in Figure 1. For stations located at positions 1, the F region traces will show some defocussing leading to weak or a complete absence of F-region traces. The effects of the defocussing will be larger with increasing altitude. For station 2, the anomalous absorption may be sufficiently large that upper E- and F- region traces are very weak or absent (complete or F3 lacuna). If the absorption is less intense, the F2 traces will be observed (absorption proportional to frequency -2) which is often referred to as F1 lacuna. Finally if the absorption is minimal, reflections from the sides of the heated volume will be possible leading to additional traces on the ionogram (titled F-layer - letter Y). These effects are summarised in Table 1.

The electric field events are normally short lived, as are the consequent ionospheric effects. E-region instabilities will quench within seconds. The adiabatic expansion of the thermosphere at the onset of the event and its contraction after the event occur quickly compared with the time between 15 minute ionograms. If the events last more than 15 minutes, composition changes in the neutral atmosphere can begin to occur. These would result in due course in the foF2 values being slightly lower at the end of the event than at the beginning - a factor that is sometimes reported.

In summary, many features of the lacuna and slant Es phenomenology can be adequately explained by the single unifying processes, namely the effects of a large transient electric field when Pedersen conductivity is high. More quantitative modelling of processes involved is necessary. Also further observations by ionosondes with a direction-of-arrival capability and with high time resolution (ionograms every minute) would be particularly useful.

5.4 References

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6. WHY KEEP IONOSONDES?

Thoughts by the Commission Chairman, Dr Rishbeth, arising from the discussion at the INAG meeting at Exeter on 25 July 1989.

6.1 Radio communications via the ionosphere

Aren't they still important for many purposes? If so (and even if adaptive systems exist, that can do their own sounding in real time) don't we need to monitor the daily, seasonal, annual and solar cycle variations of the ionosphere? Even if the daily, seasonal, and annual variations are by now thought to be well known, surely solar-cycle variations need to be monitored for purposes of predictions and frequency planning? Speak up, users!

6.2 Science

The ionosphere is a good "tracer" for the upper atmosphere (essentially because the plasma is more easily detected than the air) Many "sophisticated" experiments (radars, spacecraft, rockets) need the support of ionosonde data. How useful are ionosondes as fairly cheap monitors of atmospheric waves, storm effects, etc, etc? Some people (I'd like to think I'm one) are still doing new science with old ionosonde data. And writing papers... It's suspected that the ionosphere responds differently to solar activity (as measured by conventional indices) in different solar cycles. Why? Doesn't this tell us something about the Sun, as well as the earth?

6.3 Secular changes in the ionosphere

If they exist, don't we need to know about them? Secular changes of the geomagnetic field will have some effect on the ionosphere. Could the ionosphere be affected by pollution? Think of spacecraft launches: they've caused effects in the ionosphere, even if only temporary. But how about the hundreds of shuttle launches that were proposed to deploy the Solar Power Satellites, or might be needed to assemble a large space station? Could all that contamination do lasting damage to the ionosphere?

6.4 Short-term events

Earthquakes. Thunderstorms. Volcanoes. Big bangs.

It's not far-fetched to believe that these can affect the ionosphere. If they do, doesn't ionospheric monitoring give us a way of monitoring them, and maybe helping us to understand their effects? Big storms, too: what about Father Gherzi's work in the forties about weather conditions and the ionosphere? (There are some refs, though I haven't been able to study them: Nature 165 38 (1950), Geofisica Pura E Applicata 44, 188 (1959)). I'm told that the ship captains believed in him! We should remember such things as these, even if we don't want to revive the sun-weather hoo-ha of the seventies.

6.5 Summary

Let's try to think of other ways that ionosondes matter. Maybe the arguments boil down to this: the ionosphere is an important part of of the Earth's environment, and ought to be monitored just for that reason. We don't know that the ionosphere is undergoing secular change, or that it's vulnerable to man-made pollution. Nor can we be certain that it isn't. Other parts of our environment have certainly been affected by man's activities. Should changes in the ionosphere ever be discovered, our generation would rightly be criticized if we'd failed to record and preserve relevant data.

So: we do not conclude that any ionosonde station that is running now, or ever ran in the past, must keep going for all time. But we can conclude that "the community" (whoever they may be) needs to set the tasks that "the network" (whatever that may be) really must fulfil, and define the pattern of stations essential for the purpose. Obviously there won't be agreement, but let's have a debate. My guess is that some overall consensus might emerge, but there'll be "special interests" who will argue strongly for extra stations to meet their own needs (and maybe for fewer elsewhere). Or is the whole concept of a "global network" outmoded?

Someone drew my attention to the URSI-IAGA report on "The Needs for Ionosondes in the 1980s". I'd quite forgotten about it, but maybe some of its points - e.g the criteria for identifying the most valuable stations - are still valid, ten years on. Let's have some more ideas and opinions, and try to find some way of securing the future of whatever monitoring network we really need.

7. BASE LINE IONOSONDE STATIONS: REQUIREMENTS

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7.1 Introduction.

The purpose of this note is to open discussion on how best we can support the long term climate record of the ionosphere.

The present climate record, in its fullest form, should contain all the ionograms recorded to date. Of these ionograms, many are now lost forever and only the hourly ionograms were scaled regularly. In many cases these scaled data are only archived in printed form. Also, data scaled before the IGY did not have the benefit of internationally agreed scaling conventions. Thus the data record is already patchy and some data are bound to have been lost.

The primary building block for this data set is the ionosonde station. This paper discusses how ionosonde stations support the creation and maintenance of a world climate record for the ionosphere. The ideas presented here are intended for discussion. INAG must have some point of view on this topic and to date very little has been said.

While the ionosonde station is regarded as the integral component, we need to preserve a co-operative framework for the stations so that the long-term data set is most effective. For instance, while data will be collected at many sites currently used, new sites will be established and older sites, even important ones, will close. It is vital that continuity is maintained within the data set as a whole, which implies at the very least, local stations are linked in some fashion. One approach to this is to regard all the smaller station data sets threaded together by referencing them to the longer established stations. These long established stations are the base line stations for the data set. The longer they remain operational, the more reliable the climate record.

Several topics about ionosonde stations need to be considered including location, the station equipment, scaled data and original records. Each of these is highlighted below. Although I assume the primary reason for station closure is financial pressure driving competing scientific priorities, I will not consider this issue. Instead, other issues will be raised, problems will be highlighted and areas where more information is needed are indicated. The final task of setting priorities will always be a local problem.

7.2 Station Location.

Are some locations more important than others? Here, at least two different issues arise. Should some priority be given to current stations and should new priorities be set if ionospheric modelling results identify regions that are more sensitive for long-term studies?

First; long established stations are obviously attractive and every effort should be made to support the continued existence of these stations with long reliable data series associated with them. These stations are our present base line stations and give our present collected records greater significance. They should be identified and efforts made to intercompare the data collected at them to establish levels of redundancy, if any. In the near future, these stations will have special significance and should be supported wherever possible.

In planning for the more distant future, other issues may become important. For instance; what about regions where data are sparse? Just because we have no data does not mean these regions are not important. They may become more interesting when ionospheric modelling is considered. Modelling may give us a clearer impression of the locations likely to supply critical data. However, it seems unlikely that new potential base line stations will be established in the current economic climate.

Where do modellers feel stations would be most valuable for testing models? Would the dip equator or dip pole be more interesting than a long data set for a good mid latitude site? And if so, how much more interesting? If our aim is to monitor climate, then our primary motive will be to detect climate changes - we therefore need to know which regions are most susceptible to change. Do model sensitivity studies suggest locations of greater interest than those where data have already been obtained?

7.3 Station equipment

All stations are important and networks should ensure that good records are kept, identifying changes in equipment and staff. These records are particularly important for the base line stations.

The most important base line stations will be those that are established and operational. The rest of this section considers these in more detail.

"Established and operational" implies supported nationally with no requirement for international funding. It is most unlikely that long term international support will be found for ionosonde stations although that may be a recommendation to come from an appraisal of our requirements.

Provided there is local interest in the data at a scientific level or, at least, at an application level then the station is likely to continue operating successfully. Active interest in the data is more important for base line stations as it implies more thoughtful checking procedures will be applied. In the longer term there must also be a capacity and commitment to use modern sounders at base line stations. This could seem a high threshold now, but it will be more realistic within 10 years. At this stage, the emphasis is on commitment and capacity - not ownership of a modern sounder. Digital sounder records are also probably easier to exchange between researchers, which will ensures additional monitoring of the data processing.

7.4 Scaled data

Scaled data appear in three forms: manual scaling sheets, data books and digital data. Of these, few networks will have preserved the original scaling sheets. Many will have data books available and in many cases these are the primary source of data from stations. At present URSI Working Group 4 (Ionospheric Informatics) is establishing the extent of scaled data available. digitally However, it is already clear that the majority of the scaled data is still in hard copy form.

In most cases, scaled data will be the only important contribution stations make to the ionospheric climate record. However, for base line stations, the capacity to check these data becomes more important, as discussed in the next section.

Consistent scaling techniques are vital. For any data to be useful as a long term resource the scaling must conform with the URSI (INAG) conventions - UAG 23/UAG 23A. Where data were collected and scaled prior to the IGY, there may be a case for re-scaling the early records at proposed base line stations. In the future, it is likely that computer scaled data will prevail. We have yet to see if present scaling conventions can be maintained as the network becomes more reliant on computer scaled ionograms. Long term homogeneity of the data set could be a major problem.

Finally, all scaled data, particularly from base line stations, should be available for research, at least through WDCs.

7.5 Original Records

Original records should be kept, if at all possible. This is particularly important for the base line stations where these records would be needed to verify scaled data. The capacity to rescale the data will ensure homogeneity of data and is important for long data sets. Thus, for base line stations, all original records should still exist, be in good condition, and be available for research.

This is likely to pose problems. There are many types of analogue record and some are difficult and expensive to store. INAG needs to offer sensible recommendations here. With paper records, the volume must be considered. Is there any value in storing these records? INAG should say what this value is and recommend some action. Early nitrate film records may now be deteriorating, possibly dangerously, and copying can be expensive. This form of data record probably needs attending to now. Even the more modern 35mm safety film records pose problems; again, the sheer volume makes storage expensive. Probably the cheapest and easiest data form to store at present are the 16mm safety film records.

Future ionosondes will produce digital records, but these pose their own special problems at present. I think most people look optimistically towards the day when digital methods will solve our data storage problems, but currently 16mm film is possibly easiest to handle.

We could speculate on the possible future approach to data archiving. The film records could all be processed and stored digitally. That is attractive for nitrate film, which will need processing anyway; but processing may be extended to 35mm and even 16mm records because it improves accessibility of the data. Computer scaling of all ionograms becomes possible. However, is this satisfactory for archiving even if the data are readily accessed, rescaled and copies are available: on tape, microfiche, paper and film? How important are the original records? Early records should have less interference on them. Should we try and preserve all the detail or use a resolution of 1Km X 0.05 MHz ? Does fine structure have historical importance; for example, spread F and sporadic E? How do we handle gain sensitive information in long time series?

7.6 Some examples

Some indication of the size of the ionosphere climate data set can be gained from table 1, based on median data held at IPS. Here, representative regions have been displayed along with all the available station data. The regions are the southern hemisphere; Europe; Asia; North America and then all the data for the world. It gives a measure of the data available for study.

Prior to 1945 few data are available for regional studies - only North America stands out as viable. Not unexpectedly, the early climate record depends on a few well known stations. The bulk of the data were recorded subsequent to 1956, so scaling techniques should be reasonably homogeneous. Finally, all regions show a fall off in the available data since 1970, particularly in the North American region which ceased publishing the F-books of data in the early 1970s. Similar reductions in the amount of magnetic data available through WDCs were noted at the recent Scientific Assembly of IAGA at Exeter, 1989. The cost of handling the data is no longer a small consideration in operating any geophysical observatory. Clearly now is the right time to establish which stations should be preserved.

In the second example, data associated with the New Zealand ionosonde network give an indication of the problems a network is faced with when forced to close quickly. At the outset, it was not clear who would be willing to accept responsibility for the past data recorded by the network, nor whether there was any support for the ionosonde. Fortunately, a solution was found, as the letter to INAG, bulletin 52, from Cass Roper outlines. However, note what this solution amounts to. The volume of data is from only a modest sized network and is itemised in table 2.

If your network had to close in a years time, what would happen to your data? Your solution may help others; let INAG hear it.

7.7 Summary

The future of the data collected in the world-wide ionosonde network should concern all of us. As we move towards a computer based network, now is the

TABLE 1 An indication of the global median data archive using the Australian ionospheric data archive.

Year	S. hemi	Europe	Asia	N. America	World
37	0	0	7	12	19
38	44	13	12	12	81
39	48	27	12	12	99
40	49	36	12	12	109
41	42	49	12	29	132
42	41	30	22	53	146
43	59	43	44	71	217
44	86	65	52	126	329
45	121	81	55	155	412
46	133	79	115	170	497
47	127	76	137	204	544
48	122	110	155	190	577
49	132	153	170	225	680
50	150	176	183	259	768
51	166	221	192	267	846
52	217	278	199	274	968
53	246	281	213	272	1012
54	254	298	216	241	1009
55	261	293	239	228	1021
56	275	327	254	242	1098
57	352	397	272	280	1301
58	458	478	287	317	1540
59	415	462	288	273	1438
60	398	442	290	262	1392
61	408	436	308	248	1400
62	401	427	294	246	1368
63	410	433	293	242	1378
64	430	469	310	274	1483
65	437	480	323	262	1502
66	451	469	311	220	1451
67	445	439	294	217	1395
68	449	459	314	194	1416
69	410	444	299	175	1328
70	374	429	276	173	1252
71	395	425	263	176	1259
72	368	423	223	163	1177
73	381	386	218	148	1133
74	364	356	220	138	1078
75	343	318	206	106	973
76	330	311	183	94	918
77	325	316	200	71	912
78	321	312	254	75	962
79	275	299	246	72	892
80	254	303	240	80	877
81	249	278	244	67	838
82	256	257	204	66	783
83	271	251	235	53	810
84	283	240	231	32	786
85	261	197	220	36	714
86	190	248	255	27	720
87	158	242	228	23	651
88	144	189	157	35	525

TABLE 2: New Zealand ionosonde archive.

STATION	PAPER	FILM	SCALED DATA	MAGNETIC
Pitcairn	1943-44			
Rarotonga	1945-49	1955-80	1948-80 (Es) 1954-80 (rest)	1970-80
Christchurch		1974 -	1943 - (Es) 1949 - (rest)	1970-86
Campbell Island	1943 - 54	1954 - 86	1954-86	1970-86
Cape Hallet		1957-64	1957-64	
Scott Base		1957-	1957 -	1978-86

Some statistics:

i. the paper ionograms occupy 10 cubic meters.

ii. The drawers of film occupy 20 cubic meters.

iii. There are data requests about six times a year.

right time to consider how to preserve our analogue records. If we don't ensure these records are preserved now, then the last 50 years of data is likely to be lost. Certainly the full impact of these data will be reduced.

All data are important, but special support is needed for base line stations so they can continue to exist "forever". They will be the base line for the ionospheric climate record and all ionospheric data, independent of base line status, will be archived.

INAG should produce a draft report for next URSI General Assembly presenting these ideas, with the objective of establishing a framework for identifying base line stations.

TIMETABLE:

IAGA 1989	exploratory discussion on the topic
January	contributors comments sent to me; assembled and returned to contributors
February	contributors consider all comments, revise their own thoughts if necessary, and return to me.
April	FIRST DRAFT: organised from this, annotated and returned to contributors
May	Comments on draft returned
URSI GA	Final draft completed and published in INAG

I welcome all comments on this very important subject. Please send me your thoughts by December, 1989.

8. INAG MAILING LIST

As promised, here is the INAG mailng list with the names of those who have already responded shown in bold type. If you wish to continue to receive INAG bulletins, please notify me.

I have noted all address changes that I have been advised of but these changes will not be activated for this mailing.

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ZAIRE
Service de Geophysique, Mr. Kashala L. Mbayabo, Mondondo Moimanyinga

If your name is not among the first set of names for your country, and you wish to continue receiving INAG, contact me **as soon as possible.** My address:

Dr Phil Wilkinson, Chair INAG
IPS Radio and Space Services

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AUSTRALIA.

9. INTERNATIONAL GEOPHYSICAL CALENDAR - 1990

The 1990 International Geophysical Calendar is reproduced here. I would ask you all to take special note of the campaign periods indicated in the calendar. Some of these are outlined in section 5 describing the incoherent scatter world days. Whenever possible, you should try and make additional soundings for all campaigns. They mainly link in with the normal world day programme. I would also draw attention to the normal ionosonde sounding program indicated in the accompanying Explanation sheet for the calendar.

International Geophysical Calendar 1990

(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	10	11	12	13
JANUARY	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
FEBRUARY	11	12+	13+	14+	15+	16+	17+
	18	19	20	21*+	22*+	23+	24
	25	26	27	28	1	2	3
	4	5	6	7	8	9	10
MARCH	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	12	13	14
APRIL	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	12
MAY	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
JUNE	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	11	12	13	14	JULY
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	AUGUST
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	12	13	14	15	SEPTEMBER
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	12	13	OCTOBER
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	NOVEMBER
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	12	13	14	15	DECEMBER
16	17+	18*+	19*+	20	21	22	
23	24	25	26	27	28	29	
30	31	1	2	3	4	5	1991
6	7	8	9	10	11+	12+	JANUARY
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	

(16) Regular World Day (RWD)

(21) Priority Regular World Day (PRWD)

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

[3] Regular Geophysical Day (RGD)

[15 16] World Geophysical Interval (WGI)

28+ Incoherent Scatter Coordinated Observation Day

[26] Day of Solar Eclipse

[25 26] Airglow and Aurora Period

24* Dark Moon Geophysical Day (DMGD)

NOTES:

1. Days with unusual meteor shower activity are: Northern Hemisphere Jan 3,4; Apr 22-23; May 4-5; Jun 8-12; Jul 28-29; Aug 10-14; Oct 21-22; Nov 2-3, 17-18; Dec 12-16, 22-23, 1990; Jan 3-4, 1991. Southern Hemisphere May 4-5; Jun 8-12; Jul 26-30; Oct 21-22; Nov 2-3, 17-18; Dec 5-7, 12-16, 1990.

2. Solar Interplanetary Variability (SIV) Observing Program 1988 - 1989 concludes with in-depth data analysis in 1990.

3. Day intervals that IMP 8 satellite is in the solar wind (begin and end days are generally partial days): 29 Dec 1989-5 Jan 1990; 10-17 Jan; 23-30 Jan; 4-11 Feb; 17-24 Feb; 2-9 Mar; 15-22 Mar; 27 Mar-3 Apr; 9-16 Apr; 22-28 Apr; 4-11 May; 17-23 May; 30 May-5 Jun; 11-18 Jun; 24 Jun-1 Jul; 7-13 Jul; 19-26 Jul; 1-8 Aug; 13-20 Aug; 25 Aug-2 Sep; 7-15 Sep; 19-27 Sep; 2-10 Oct; 15-23 Oct; 28 Oct-4 Nov; 9-17 Nov; 22-29 Nov; 4-11 Dec; 16-24 Dec; 29 Dec-5 Jan 1991.

   There will not 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.).

4. + Incoherent Scatter programs start at 1600 UT on the first day of the intervals indicated, and end at 1600 UT on the last day of the intervals.

5. Incoherent Scatter world days: 24-25 Jan 1990; 12-17 Feb LTCS/WAGS; 21-23 Feb GISMOS; 20-21 Mar; 21-22 May; 25-29 Jun GITCAD/SUNDIAL/WAGS; 20-21 Sep; 13-15 Nov DELITE; 17-19 Dec DELITE; 11-12 Jan 1991.

where DELITE= Dynamics Explorer - Lower Ionosphere-Thermosphere Emissions;
GISMOS= Global Ionospheric Simultaneous Measurements of Substorms;
GITCAD= Global Ionosphere-Thermosphere Coupling and Dynamics;
LTCS= Lower Thermosphere Coupling Study;
SUNDIAL= Coordinated study of the ionosphere/magnetosphere;
WAGS= Worldwide Acoustics Gravity Wave Study.

OPERATIONAL EDITION, September 1989

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.) *26 January 1990* (annular) beginning in Antarctica and ending in the South Atlantic. Partial phases visible on the South Island of New Zealand and much of South America.

b.) *22 July 1990* (total) begins in Finalnd, then along northern coasts of Europe and Asia. Totality path 130 miles wide at maximum, duration 2 min 33 s; Sun at about 40 degrees altitude. Totality crosses Alaska's Aleutian Islands. Partial phases in northeastern Europe, northwestern North America, northern Asia, and Hawaiian Islands.

Meteor Showers (selected by P.M. Millman, Ottawa) include important visual showers and also unusual showers observable mainly by radio and radar techniques. The dates for Northern Hemisphere meteor showers are: Jan 3, 4; Apr 22-23; May 4-5; Jun 8-12; Jul 28-29; Aug 10-14; Oct 21-22; Nov 2-3, 17-18; Dec 12-16, 22-23, 1990; and Jan 3-4, 1991. The dates for Southern Hemisphere meteor showers are: May 4-5; Jun 8-12; Jul 26-30; Oct 21-22; Nov 2-3, 17-18; and Dec 5-7, 12-16, 1990.

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): *Solar-Geophysical Data*, November issue; *URSI Information Bulletin*; *COSPAR Information Bulletin*; *IAGA News*; *IUGG Chronicle*; *WMO Bulletin*; *IAU Information Bulletin*; *Solar-Terrestrial EnvironmentalResearch in Japan*; *Journal of the Radio Research Laboratories* (Japan); *Geomagnetism and Aeronomy* (USSR); *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 3 January 1990 at 0000 UT, 10 January at 0600 UT, 17 January at 1200 UT, 24 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. V. Wickwar, Utah State Univ., Center for Atmospheric and Space Sciences, Logan, UT 84322-4405 U.S.A., URSI Working Group G.5 (801)750-3641.

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** a round 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.

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

Solar Interplanetary Variability (SIV) — observations of transition phenomena solar minimum to solar maximum (1988-1989), with in-depth analysis in 1990. Contact Dr. E.J. Smith, JPL, MS169/506, 4800 Oak Grove Dr., Pasadena, CA 91109 U.S.A.

Transient Interplanetary Phenomena (TIP) - 1990-95 observations and analyses of solar-generated phenomena propagating through heliosphere. Includes IPS observations of remote 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 and SOHO. Contact Dr. M. Dryer, NOAA R/E/SE, 325 Broadway, Boulder, CO 80303 USA.

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

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Published for the International Council of Scientific Unions and with financial assistance of UNESCO.

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