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IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

Ionosphere Station Information Bulletin No. 3**

I. Introduction

It is proposed to hold an ad hoc meeting on high latitude ionogram interpretation during the COSPAR/STP meetings in Leningrad, May 1970, together with detailed discussions amongst any present who are specialized in this field. This will be followed up, in probably about one year's time, by an official URSI meeting to decide whether any changes in international rules are desirable. The Chairman of INAG will attend these meetings and would like to receive any comments or problems you would like to have raised. We hope that the discussion will identify the main problems so that possible solutions can be tried out in the next year and an informed public opinion established on any controversial points.

At present there are serious differences in practice at different high latitude stations particularly when oblique or spread echoes are present; this seriously restricts the use of routine data for high latitude studies.

Some of the problems which need discussion are:

1. The extent to which it is practical to train staff for high latitude ionogram analysis so that the data are uniform. Some workers think that it is essential to re-analyze all ionograms by the scientist interested; others feel that more detailed rules with examples would be adequate for most purposes if monitored from time to time.
2. Revision of Es types at high latitudes and relation between these and night E.
3. Analysis of diffuse Es traces, particularly Es a, Es r and some types of Es f.
4. Role and rules for fbEs (see also INAG-2 Bulletin, pages 9-10)
5. Interpretation of oblique and spread F traces.
6. Classification of spread F traces.
7. Revision and clarification of rules for determining the main trace in the presence of oblique and scattered traces.
8. Presentation and exchange of VI sounding data.

It is important to discuss the use of standard parameters in current and future research and the use of rocket and satellite data both to aid the interpretation of the ionograms and to identify parameters needed from ground based stations to expedite space research.

If you have views on any of these subjects or other high latitude problems please send them, with reprints, copies of ionograms or preferably slides or negatives to make slides, if available, as soon as possible to the Chairman or Secretary of INAG or to Madam N. V. Mednikova, as is most convenient to you. The addresses are given on page 2.

Many of the problems involved have already been raised in replies to the inquiries for revision of the URSI Handbook of Ionogram Interpretation and Reduction and these will be presented to those present at Leningrad for further discussion.

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* Under the auspices of the Solar-Terrestrial Physics Committee of the International Union of Radio Science (URSI/STP Committee).

** Issued on behalf of INAG by World Data Center A, Upper Atmosphere Geophysics, Environmental Science Services Administration, Boulder, Colorado 80302, U.S.A. The bulletin is distributed to stations by the same channels (but in the reverse direction) as their data ultimately flow to WDC-A. Others wishing to be on the distribution list should notify WDC-A.

There is a strong feeling in the Network that rules should not be changed frequently, in fact that they should not be changed at all unless the advantages are clear. It is, therefore, essential that your views are known as early as possible and in any case not later than the URSI meeting. INAG cannot take into account opinions which have not been put forward in time. We shall try to keep you informed through future issues of this bulletin so that you have every opportunity to contribute or object to any proposals and we hope that, as before in the IGY, it will be possible for everyone to agree that the right compromises have been made. Please remember that your INAG is a voluntary group of rather busy people who can only give your opinions full discussion if you allow them enough time.

W. R. Piggott
Chairman, INAG and URSI/STP VI Consultant

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The acceptance of these INAG bulletins has been such that the first two editions are now out of print. We, of course, can and will still make copies of them available upon request. I have been informed that French translations of these two bulletins, INAG-1 and INAG-2, will be available by the end of April. Anyone interested in receiving the French documents are requested to notify Mlle. G. Pillet, Groupe de Recherches Ionospheriques, 3 Avenue de la Republique, Issy-les-Moulineaux (Seine), France, as to the number of copies desired.

II. F-Region Disturbance Index
by W. R. Piggott

The very large day to day and month to month changes in geophysical disturbance during the IGY provoked a number of scientists to ask for an index of F-region disturbance similar to the well known C or K indices for magnetic disturbance. The fact that ionospheric storms are often delayed relative to magnetic activity, at least in some sectors of the world and often last longer than magnetic activity suggest that such an index might be a valuable addition to existing geophysical indices.

An F-region disturbance index was first published for the IGY (Piggott 1959) and has since been included in the Calendar Record Notes (see references) in an abbreviated form. This was originally devised to be an index of ionospheric storminess. A battery of criteria was used, each of which measured a common feature of large ionospheric storms and the degree of storminess was classified according to the number of criteria found, weighted crudely by size. The criteria used were changed with latitude and season, and at low latitude stations with lunar epoch.

The principles of the index have been maintained as described for the IGY throughout the series though the actual stations used have changed with time, and it has proved necessary to drop some or all of the low latitude stations. For the IGY a numerical index was used (loc. cit.), but this was replaced by a series of comments for the Provisional Calendar Record, only the most disturbed periods being noted. Later, very quiet periods were also added.

Recently a numerical index has been reestablished, taking advantage of the speeding up of data interchange which has occurred. This is based, usually, on between 10 and 15 stations well spread in hemisphere and longitude with emphasis on stations in the subauroral zones.

The number code is as follows:

0 very quiet
1 quiet
2 relatively quiet
3 uncertain
4 average
5 slightly disturbed some sectors
6 slightly disturbed
7 disturbed
8 very disturbed
9 extremely disturbed.

For analysis purposes 6-9 represent definite disturbances, 5 a disturbance starting or ending on the day involved and 0-2 the quietest days. 9 is only used two or three times in a solar cycle, and 3 is not used in solar maximum years.

In any typical month there are usually one or two days which are borderline and could be misplaced by one unit of scale, particularly when data from one or more stations are late. The mode of analysis tends to decrease the contrast between quiet and disturbed months to some extent also.

During recent years the battery of criteria has been split into two halves, showing separately the factors which affect foF2 and factors affecting hmF2. These are given equal weight in deciding the degree of disturbance so as to maintain continuity in the index. In general the correlation between the two halves is not very high, some sectors showing effects in one, others in the other, and both varying with season.

During the IGY it was possible to arrange all days in order of decreasing disturbance, but in solar minimum years this cannot be done objectively. Many apparently quiet days show peculiar F-region phenomena which may make them non-typical to a comparable extent to the difference between conventionally disturbed (storm) days and quiet days. A special code has been provided for such occasions called "uncertain". In most cases these days show some typically quiet day phenomena, but the overall behavior of the F region is peculiar in a way not similar to the effects associated with magnetic storm. For this reason the criteria for low index values are not well defined in sunspot minimum years. Lower index values then tend to pick days which closely resemble the median behavior.

The correlation with magnetic activity is quite marked, as would be expected, for extreme conditions but is not so high for intermediate cases.

Values of the index for 1968 (slightly revised with late data) are given in the table together with provisional values for 1969 as published to date.

The index is still essentially an index of F2-layer storminess. It might be more useful to consider all types of F2 variability either by modifying the index (which would destroy its continuity with the past) or by supplementing it with a different one.

<u>Your comments on this point and on whether the index is useful to you would be very welcome.</u>

REFERENCE

PIGGOTT, W. R. — A daily index of F2 layer disturbance during the IGY, <u>Proc. URSI IGY Symposium Brussels, September 1959</u>, Elsevier, (Ed. W.J.G. Beynon), 116-123

The abbreviated Calendar Record Notes are published in:

1. IQSY Notes
2. STP Notes
3. Solar-Geophysical Data (Formerly CRPL-F part B)
4. Upper Atmosphere Geophysics Report UAG-4,

and can be obtained from World Data Center A, Upper Atmosphere Geophysics, ESSA, Boulder, Colorado 80302, U.S.A.

F2 Disturbance Index - 1968

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	8	5	4	8	4	4	6	2	6	6	8	5
2	8	7	4	7	5	7	4	1	5	8	8	4
3	6	7	7	6	2	6	7	7	7	7	8	7
4	4	7	6	5	1	5	5	4	4	4	8	8
5	5	5	7	6	0	2	4	4	4	1	5	8
6	7	1	2	8	1	1	4	7	5	2	4	4
7	4	4	1	4	8	1	2	6	7	4	7	2
8	4	4	1	1	6	4	4	4	8	5	4	5
9	1	6	1	1	6	4	2	4	5	4	8	2
10	4	7	4	2	6	7	8	4	1	4	6	4
11	4	8	4	1	5	9	8	2	2	2	7	4
12	4	7	4	4	4	8	7	2	7	8	2	4
13	6	5	4	8	4	8	6	4	8	7	4	2
14	5	4	6	7	2	8	8	8	7	5	1	2
15	5	4	8	6	4	6	5	8	7	2	2	4
16	6	2	8	4	4	4	4	8	5	2	6	5
17	4	4	6	4	5	6	1	8	4	4	7	4
18	4	6	4	1	5	4	4	7	2	2	7	4
19	4	5	4	1	7	7	4	6	4	4	5	5
20	6	6	4	0	8	5	4	2	2	2	6	4
21	4	5	2	2	8	1	4	2	4	1	5	7
22	4	4	2	4	8	2	8	2	4	1	2	6
23	2	2	2	5	7	2	6	5	7	2	4	7
24	2	4	7	4	8	1	1	7	4	5	4	4
25	4	4	6	4	4	1	2	4	1	4	5	7
26	4	4	5	8	2	4	4	2	1	1	5	4
27	5	5	6	8	2	5	5	2	2	4	4	7
28	5	7	6	5	4	1	4	1	4	4	4	4
29	7	6	7	6	6	4	2	1	1	7	4	4
30	4		7	4	5	7	4	1	4	8	4	4
31	4		7		4		1	7		8		6

Provisional F2 Disturbance Index - 1969

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	5	4	4	5	4	4	6	2	2			
2	4	8	2	5	5	2	4	2	1			
3	1	9	1	5	6	4	1	6	2			
4	4	7	2	4	3	1	2	6	2			
5	0	6	4	4	4	1	1	6	6			
6	2	5	4	2	2	1	2	4	7			
7	6	4	5	5	1	5	4	5	6			
8	5	5	4	4	0	6	5	5	7			
9	2	1	2	6	4	6	6	6	5			
10	2	5	1	4	4	5	5	6	4			
11	2	8	4	5	2	4	4	2	6			
12	6	7	7	3	3	7	6	7	4			
13	4	5	4	7	8	8	7	4	1			
14	5	4	2	7	8	8	6	3	5			
15	7	7	7	6	9	7	4	0	8			
16	5	5	6	4	8	8	5	2	5			
17	7	2	7	5	8	7	5	5	5			
18	7	1	5	5	7	1	1	5	6			
19	6	2	6	1	5	2	1	6	4			
20	5	5	8	2	4	5	0	6	4			
21	2	4	7	3	7	1	4	5	2			
22	1	4	7	5	5	1	5	4	2			
23	1	6	7	3	4	1	5	4	4			
24	6	5	9	4	2	5	2	1	4			
25	8	6	8	1	2	5	2	0	4			
26	8	7	5	2	1	4	7	4	2			
27	7	8	4	6	1	2	8	8	1			
28	4	8	4	8	2	1	6	5	8			
29	4		7	7	3	0	2	3	8			
30	4		5	8	4	0	2	3	8			
31	4		4		6		5	4				

III. URSI/STP Committee Actions

The minutes of the URSI/STP Committee meeting held during the XVI General Assembly of URSI in Ottawa on 18, 20 and 28 August 1969 have been published by URSI as document URSI/STP(3). For information the portion concerned with the "Working Group on Ionosphere" is quoted below:

"3.1 Ionsonde Network

The Chairman summarized the developments that had led to the meeting of those responsible for the operation of vertical sounding stations which had been held, under the auspices of the URSI-STP Committee, in London in January 1969 during the First General Meeting of IUCSTP. A detailed report on this meeting, which covered representatives from about 70 ionosonde stations, together with other supporting material, has been prepared by Mr. A. H. Shapley and Mr. W. R. Piggott and is being distributed to all stations through WDC-A. The first part of this report, covering the London meeting, is published as Appendix I to these Minutes.

After a full discussion of the various problems associated with the ionospheric vertical incidence soundings network, it was appreciated that these were of such a magnitude that it was becoming increasingly difficult for them to be dealt with by the Vertical Incidence Consultant, Mr. Piggott, alone. It was agreed to establish a small group known as the Ionospheric Network Advisory Group (INAG), under the Chairmanship of Mr. Piggott, to give advice to stations and administrations. The final membership of this Group was to be agreed by the Chairman; details are given in URSI Information Bulletin No. 173, p. 32, 1969. The Group would constitute an authoritative body to which stations could address their problems, and to which administrations should refer when questions arise concerning the continuance or closure of stations, and the deployment or redeployment of equipment and personnel. It was also felt very desirable that the Group establish a direct contact with stations through the circulation of a Station Information Bulletin which might be distributed through the mechanism already in operation for the flow of data from stations to WDCs. In this way, relevant material from such publications as the URSI Information Bulletin, STP Notes and IAGA News, together with other communications from the Advisory Group, could reach the stations more speedily and effectively than when transmitted via the Member Committees of URSI.

It was agreed to refer the question of the revision of the "accuracy rules" in ionogram scalings (mentioned in Section 2(c) of Appendix I) to the INAG. A majority of stations is opposed to a change unless it is deemed very necessary.

Workers who have comments on the proposed spread-F parameter (Rec. 12 in Section 3.3, Appendix I) are invited to submit them directly to Mr. W. R. Piggott. It was agreed that there were dangers and serious inaccuracies in using ionosondes to monitor ionospheric absorption (Rec.15) but, in view of the absence of any absorption network at the present time, carefully controlled data have a distinct value.

The need for personal visits to ionosonde stations of experts capable of giving advice, checking scaling procedures, etc., was again emphasized. It was learned that the Australian network of 13 stations now employed a full-time member of staff to circulate in this way. In order to help organizations with a small number of stations, UNESCO has agreed to finance two tours of an expert, each to cover the stations in an area of continental size. It was agreed that this offer should be accepted, and that the Chairman should make the necessary arrangements with UNESCO through Dr. Fournier d'Albe.

The question of a follow-up meeting to the London meeting was discussed. A suggestion that there should be regular meetings of station administrators, at 18-month intervals to discuss the scientific needs regarding operation and location, was regarded as unrealistic. While the London meeting had proved very useful, it was doubtful whether regular meetings of this sort would be supported so well. It was finally agreed that the Chairman would seek the opinion of network operators on the need for another meeting.

3.2 International Reference Ionosphere

Prof. Rawer presented a progress report, outlining the problems being tackled. Separate coordinators have been designated according to techniques and/or topics (e.g. incoherent scatter, probes, ion composition, etc.). Following a long discussion in Ottawa, it had been agreed to adopt estimates of electron temperatures from incoherent scatter measurements rather than from probe measurements. The main group concerned with the IRI would meet again in Leningrad in May 1970, and it was thought that a Commission III symposium on the topic might ultimately be proposed.

3.3 Absorption

It was agreed that Dr. J. Taubenheim should be appointed URSI-STP Consultant on Absorption Methods A1, A2 and A3, in succession to Prof. Rawer and Dr. Reid, and that he should also become a member of the Working Group on Ionosphere.

A proposal that a further Working Group be established on "D-region Synoptic Monitoring" was discussed. Since the absorption network has decreased rather than increased, there is a need for new simple absorption measurements by those concerned with propagation problems. Moreover, method A1 does not really provide the right kind of data for aeronomists. It was felt that those involved in the compilation of the IRI would have to assess the value of the different methods available for D-region monitoring, and that therefore it might be best to await the results before deciding on the need for a Working Group. The Chairman agreed to discuss the matter with the Absorption Consultant and make a decision.

3.4 Publications

Progress on the Absorption Manual continues, but a few papers are still outstanding. It will cover all the methods, A1, A2, A3 and A4, and it was also proposed to include a note on a new technique whereby absorption measurements can be made by comparing records of ordinary and extraordinary signal strength from satellites.

The manuscript for the revised Atlas of Ionograms is complete, but a certain amount of editing remains to be done. It is hoped to publish it within a few months.

A meeting was to be arranged to discuss the preparation of a new edition of the URSI Handbook of Ionogram Interpretation and Reduction (Piggott and Rawer) which is now out of print. It was possible that this would be published by WDC-A."

IV. Notes by INAG Members

Mlle. G. Pillet

From January 15 to February 15, 1970 I was able, thanks to the generous support of UNESCO, to visit the ionosonde stations of Tamanrasset (Algeria), Rabat (Morocco), Dakar (Senegal), Ouagadougou (Republic of Upper Volta), Ibadan and Zaria (Nigeria), Kinshasa-Binza and Lwiro (Democratic Republic of Congo) and Nairobi (Kenya). The report of this trip will soon be submitted to the Secretary General of URSI and will be published by UNESCO.

Dr. I. Kasuya

Recently, we have had information from Mr. Pil Seon Rim of the Radio Research Laboratory, Ministry of Communications, Seoul, Republic of Korea, that they have started vertical incidence soundings at Anyang near Seoul. They have sent us a few days of VI ionograms for May to September (except July) 1967, and for March and July to December 1969. I introduced this information to Mr. Shapley of IUCSTP Working Group 1 on Monitoring of the Solar-Terrestrial Environment. Mr. Shapley then provided background information and references to Mr. Rim on how to participate in the international exchange of data as part of the worldwide ionospheric sounding network.

J. Turner

The Australian Ionospheric Prediction Service has recently distributed a new edition of their "Handbook for Use with Ionospheric Prediction Services" IPS-H5, issued December 1969. The handbooks contain information about the services available and how to use them together with some backgraound information to assist in the understanding of the use of these services. The Table of Contents is as follows:

HANDBOOK FOR USE WITH IONOSPHERIC PREDICTION SERVICES
TABLE OF CONTENTS

Table of Contents (Continued)

Copies of the Handbook may be obtained from C. G. McCue, Assistant Director, Ionospheric Prediction Service Division, Commonwealth Centre, Chifley Square, Sydney, N.S.W. 2000 Australia. The sections 4.1 and 4.2, which are of most interest to INAG are quoted below:

"4.1 Australian vertical incidence sounding stations

The instrument used to obtain vertical incidence ionospheric data is called an ionosonde. The ionosondes at the Division's stations are programmed to make automatic sounding sweeps every 15 minutes. The results of these soundings are recorded on photographic film and are called ionograms. The ionosondes operate on the time of a standard meridian (longitude zero or an integral number of 15° from the zero meridian) and the first ionogram of each hour is made at the start of the first minute of that hour. The ionosondes operated by the other Departments use similar schedules.

The basic information about the vertical incidence sounding stations which form the Australian network is given in the Tables 9 to 24. Most of the information applies to the period after 1957 as generally data since then are more uniform and reliable. Details of some stations which have ceased to operate are included for completeness.

IONOSPHERE VERTICAL SOUNDINGS STATIONS

STATION	GEOGRAPHIC LAT	LONG EAST	REPORT TIME	EQUIPMENT USED	OPEN - CLOSE DATES
USHUAIA	-54.80	291.70	60W	TRIO-2AUT.	11/1957 -
VANIMO	-02.70	141.30	15E	NA	7/1964 -
VICTORIA	48.40	236.60	120W	NA	7/1957 - 1/1959
VOSTOK	-78.40	106.90	105E	NA	3/1958 -
WAKKANAI	45.40	141.70	135E	NA	3/1947 -
WALLOPS IS.	37.90	284.50	75W	1.0-25.0 MHZ	7/1963
WASHINGTON	38.70	282.90	75W	1.0-25.0 MHZ	6/1931
WHITE SANDS	32.30	253.50	105W	1.0-25.0 MHZ	6/1964
WILKES	-66.90	110.50	UT	C4	7/1957 - 1/1969
WINNIPEG	49.80	265.60	90W	1.0-16 MHZ	5/1951
WOOMERA	-31.00	136.30	135E	URR MARK 2	5/1961
YAKUTSK	62.00	129.60	135E	NA	2/1957 -
YAMAGAWA	31.20	130.60	135E	NA	12/1946 -
YELLOWKNIFE	62.40	245.60	105W	NA	11/1957 - 1/1959
YUZHNO SAKHALI	47.00	143.00	150E	1.0-18.0 MHZ	3/1957
ZARIA	11.85	07.65	NA	NA	NA
ZARYA SHIP	SHIP.	NA	NA	NA	(8/1959)-(11/1964)
	14.70	342.60	15W	NA	5/1949 -

VII. Notes on Sporadic E

by W. R. Piggott

Sporadic E causes more controversy than any other parameter regularly observed with ionograms, largely because it can be caused by a number of different processes and the relative importance of these varies with position, season, time of day, epoch in the solar cycle and level of magnetic activity. At stations which are fortunate enough to have one dominant process it is natural to wish to describe the phenomenon in terms applicable to that process. Thus, for example, at Port Stanley (Falkland Islands) most of the Es seen is of the sequential Es type usually ascribed to travelling disturbance phenomena. In contrast at Slough this process is only clearly present on about one day in five.

There seems little doubt that the methods of analysis worked out for the IGY have fully justified themselves and have helped our knowledge of the morphology of Es very considerably. Are they still useful for the future or should they be simplified or replaced? Should the rules be clarified in any way? These are the questions we wish to consider during the next year and the answers preferred must depend on the views of the scientific community as a whole.

Sporadic E is often found to give more trouble than any other phenomena seen on ionograms (other than faults due to the equipment!) and to involve the greatest difficulties in training and monitoring the data. This is largely because a very wide range of traces can be seen which merge with each other. Operators sometimes select particular points as critical, ignoring all the others, with disastrous effects. To start discussion, we first consider some of the types which, physically, can be extremes of a continuous sequence.

It is impossible to satisfy everyone at the same time. For example the distinction cusp and high Es (c and h) can really only be learnt by experience and operators would feel happier if they did not have to make it.

Thus we have to weigh up the scientific advantages of maintaining the distinction with the practical difficulties of making it. Physically high Es has advantages in identifying days on which sequential Es (travelling disturbance phenomena) are present. It does not classify all Es which form part of the sequence, the final stages are usually cusp and sometimes even low. In contrast cusp Es occurs frequently on days where sequential Es is absent. At some stations, e.g. Port Stanley, sequential Es is the most common Es phenomenon and there is little loss in mixing in other causes, at others, e.g. Slough, sequential Es is only seen on about 10% of days and cannot be studied from routine data unless the distinction h, c is maintained. Do we now have enough knowledge of this type to justify dropping the distinction in future, except perhaps at new stations or for special investigations? If so we can combine h and c, if not we must keep the distinction.

A similar point arises between Es types a and r which are often limit cases of a continuous sequence in time. What are your views? Physically the a, r sequence culminates, at some stations, in night E. There is, therefore, a case to consider whether this should be tabulated with Es. From the practical point of view the distinction Es: night E is very important and any attempt to blur it could have serious additional repercussions. These are so great that INAG members feel that the suggestion is not practical. Probably the best solution is to note that night E is usually present when Es r is seen and foE can and should be read from the group retardation at the lower frequency end of the next higher reflection. This night E shows the overhead condition, Es r is often a mixture of either cloud reflections imbedded in the night E or oblique reflections from night E type layers or clouds seen at oblique incidence. INAG is interested in the question of which of these is most common? At present this is controversial and may vary with position. If you have data showing the preferred interpretation at your station please let us know, with or without examples.

VIII. Literature Citations

A partial list of research papers utilizing ionosonde data is presented. After the references are given an abstract plus the stations whose data were used and, in some cases, the time period covered:

HOFFMAN, J. H., C. Y. JOHNSON, J. C. HOLMES and J. M. YOUNG — 1969 — Daytime Midlatitude Ion Composition Measurements, J. Geophys. Res. 74, 6281-90.

An Argo D-4 (Javelin) rocket was launched from Wallops Island, Virginia, at 1828 GMT, Aug. 15, 1966 to rendezvous with a pass of the Explorer 31 and Alouette 2 satellites. The rocket reached an altitude of 720 km while the satellites were at 970 km. Identical magnetic mass spectrometers on the rocket and Explorer 31 satellite measured the composition of the ionosphere while the Alouette 2 topside sounder provided electron concentration profiles. Ten different ion species were observed. 0+ is the dominant constituent from 200 km to 1000 km with H+ 5% and He+ less than 1% of the 0+. The chemical equilibrium relation between H+ and 0+ gives a value for the neutral hydrogen concentration of 6.2×10^4 at 250 km and a neutral gas temperature of 940°K. From the He+ concentration at 400 km a rate coefficient for the He+ loss reaction with N_2 of $1.2 \times 10^{-9} cm^3 sec^{-1}$ is calculated. The NO+ and O_2+ scale heights from 200 to 300 km agree with those of N_2 and O_2 giving credence to the ion chemistry involved. In comparing the results from this rocket flight with those of other types of mass spectrometers flown in a similar time period, it is seen that the major discrepancy lines in the n(H+) measurements, the present result being lowest. The in-flight calibration tends to indicate that a mass spectrometer is more sensitive to light mass ions than to 0+. This phenomenon may account for the discrepancy noted. (Wallops Island)

GOLDBERG, R. A. and L. J. BLUMLE — 1970 — Positive Ion Composition from a Rocket-borne Mass Spectrometer, J. Geophys. Res. 75, 133-142.

On March 15, 1968 at 1411 LMT, a Nike Tomahawk was launched from Wallops Island, Virginia, carrying a quadrupole mass spectrometer for measurements of positive ion composition in the ionosphere. The instrument was enclosed in a vacuum system principally controlled by a titanium getter pump and marks the first attempt to use this technique for rocket experiments. A CW radio propagation experiment plus ground-based ionosonde results enabled the reduction of the data to absolute values. On upleg, the spectrometer was opened at 98 km and provided well-resolved spectra in the ram direction up to an apogee of 303 km, slightly above the F_2 peak. The sweep range from 13 to 49 amu enabled all major constituents to be determined, and the high sensitivity of the spectrometer allowed many minor constituents, having densities as low as $2\text{-}5/cm^3$, to be detected. On downleg, measurements were restricted to wake composition, but values obtained at higher altitudes were similar to those seen on upleg. Upon entry into the D region, the vacuum system permitted spectra to be obtained to 68 km. D-region results between 80 and 68 km show a predominance of 19+ and 37+ ions, possibly due to complex water clusters, marking the first independent observation in agreement with the earlier results of others. (Wallops Island)

BATES, HOWARD F. — 1970 — HF Propagation through the auroral curtain, J. Geophys. Res. 75, 143-151.

Forward-oblique ionograms made on the path from Thule, Greenland, to College, Alaska in 1963-1964 were studied to determine whether HF signals propagating through the auroral curtain were adversely affected by scattering or blanketing effects. The location of the aurora was determined by an HF radar at College. Neither scatter from the auroral curtain nor blanketing by the auroral-E layer was found to significantly affect the 1F forward-oblique propagation mode on the Thule-College path. Higher-order modes and spread signals diminished appreciably at the onset of an auroral disturbance and reappeared with the decay of the disturbance. The disappearance or marked attenuation of the 1F mode on the Thule-College path was almost always found to be caused by an increase in auroral absorption and not by blanketing or scattering effects. Although auroral-E critical frequencies near 65° magnetic latitude were frequently above 5 MHz, they were rarely above