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DEPARTMENT OF PHYSICS

Ionospheric Group

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Summary Report

Contract No. AF61(052)-909 21st November, 1966

Summary Report No.1

Ionospheric Research Using Satellites

17th November 1965 - 17th November 1966

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PHYSICS DEPARTMENT

UNIVERSITY COLLEGE NAIROBI, KENYA.

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ABSTRACT

Results are presented for total content at Nairobi since October 1964, and for Addis Ababa and Dar es Salaam since June 1966. Latitude variation of total content is being studied using three spaced receiving stations on similar longitudes; preliminary results are presented for the period July/August 1966. Study of irregularities has been commenced using scintillations of transmissions from B.E.-B and B.E.-C. and the heights of these irregularities will be determined from transmissions from B.E.-B. using spaced aerials. One of us (A.R.Webster) has made a study of geometric errors in Faraday reduction. Other work includes the determination of ionospheric parameters by means of an ionosonde, investigations on the shape, size & speed of irregularities, by a spaced aerial technique, and recording of the variations of the earth's magnetic field. Future plans include continuation of the above work, development of automatic Faraday null reading equipment and possibly the addition of one or two other stations for the study of the latitude variation of scintillations and total content.

CONTENTS

1. Introduction

The ionospheric and geomagnetic station at Nairobi has been operated since the beginning of the I.Q.S.Y.(January,1964) by members of the Physics Department, University College Nairobi. The 20, 40 and 41 Mc/s transmissions from the satellite BE-B have been received and recorded on a regular basis at Nairobi since shortly after launch in October 1964, and those from the satellite BE-C since June 1966. In general, two close passes per day from each of these satellites give reducible records. Additionally, data is being collected from equipment operating at Addis Ababa and Dar-es-Salaam. At Addis Ababa, a transistorised 40 Mc/s receiver (loaned by Centro Micronde) and ancillary equipment was installed in June 1965 and is kindly operated by Dr.P.Gouin. Mr.F.Hibbard is at present recording on 41 Mc/s at University College, Dar es Salaam and will shortly add facilities to record the 41 Mc/s transmission. At the moment, all data is sent to Nairobi for processing. The geographic coordinates of the three stations are as follows: Addis Ababa, 9.03°N, 38.42°E; Nairobi, 1.32°S, 36.80°E; Dar es Salaam, 6.51°S, 39.18°E. The geomagnetic equator at these longitudes is almost parallel to the geographic equator and situated at about 9.5°N - that is, just north of Addis Ababa.

The research work supported by this contract involves ionospheric studies using radio transmissions from artificial satellites and particular emphasis is being placed on total electron content and scintillation studies. Total electron content (Nt) - that is, the electron density integrated from the ground to the satellite - is derived from the rotation of the plane of polarisation of the received signal as the position of the satellite changes. This rotation, arising from the passage of the radio wave through the ionosphere, results in "Faraday" fading of a record obtained via a linearly polarised aerial (Fig.1).

In addition to Faraday fading, irregular fadings - referred to as scintillations - are sometimes observed (Fig. 1), which may or may not be of amplitude comparable to that of the regular pattern; on occasions, the scintillation fading is strong enough to obliterate completely the Faraday pattern. Scintillations arise from the presence of irregularities in electron density within the ionosphere and the dimensions and movements of these irregularities are being studied by other members of the ionospheric group using ground based techniques, Other ionospheric observations, not directly involving satellites, include routine vertical incidence sounding at hourly intervals and subsequent to each recorded satellite pass, in order to obtain other relevant ionospheric parameters, and recording of the variation of three components of the earth's magnetic field to provide relevant magnetic data.

II. Analysis and experimental Results

(a) Routine Total Electron Content at Nairobi

Faraday rotation of a plane polarised radio wave occurs when the wave passes through a magneto-ionic medium - that is, a plasma containing free electrons and situated in a magnetic field. The ionosphere constituted such a medium and the rotation (ω) in radians is given by,

$$\omega = \frac{K}{f^2} \quad M\,Nt \qquad -(1)$$

where f is the frequency in c/s and M is a magnetic factor which includes cos θ , θ being the angle between the local magnetic field line and the direction of the ray path. This expression strictly only applies when θ is not close to $\pi/_2$ radians, but it can be shown that at the point where θ $\pi/_2$ no rotation of the plane of polarisation should take place. On either side of this position the direction of rotation is in the opposite sense. On differentiating equation 1,

$$\frac{d\omega}{dt} = \frac{K}{f^2} \left(N_t \frac{dM}{dt} + M \frac{dN_t}{dt} \right) \qquad -(2)$$

which gives rise to the observed fading pattern. Due to the geographic location of Nairobi, equation 2 is the easier expression to use in the evaluation of Nt, although a method based on equation 1 could be used. In equation 2, the constant K and the quantities M and $\frac{dM}{dt}$ are readily determinable from magnetic data kindly supplied by NASA. However, two unknown quantities remain; namely, the required parameter Nt and the quantity $\frac{dNt}{dt}$ which is related to the gradient in total electron content along the line of the satellite passage. Fortunately, the influence of this quantity can be minimised by taking an average of $\frac{d\omega}{dt}$ on either side of the position where $\theta = \pi/_2$, since at this point the sign of the second term in equation 2 reverses while that of the first term remains unaltered. Complete cancellation of the term in dNt/dt depends on the above mentioned gradient remaining sensibly constant over the short time interval involved in the averaging process.

On this basis, all reducible records obtained from BE-B up to October, 1966, have been analysed and a value for total electron content derived for each case. Here, the values obtained apply strictly to the region of the ionosphere for which the condition $\theta = \pi/_2$ applies. This region varies in longitude for different satellite passes but changes little in latitude so that the results apply to a narrow latitude range centred about 5^{0}S of Nairobi. Fig.2 shows the values so obtained, plotted as a function of time of day and month of year with N and S bound passes plotted separately. An inventory of all recorded BE-B passes is also given in Appendix 1.

The form of the diurnal variation of total electron content is clearly seen and some seasonal changes seem to occur, although these latter features are somewhat masked by the lack of resolution caused by the long period (approximately three months) needed to obtain a complete diurnal variation. This situation, should be alleviated to some extent by the use of records from BE-C, which will reduce the period necessary to obtain a complete diurnal variation.

To date, these records have not been reduced on a regular basis, but it is hoped that all outstanding records will be dealt with in the near future.

(b) Variation of Total Electron Content with Latitude

Prior to the commencement of this contract a number of passes of BE-B, recorded at Nairobi, had been analysed in order to determine the variation of total content with latitude. This variation is of great interest in equatorial regions because of the existence of a minimum in the peak electron density - the equatorial anomaly - near the magnetic dip equator. In general these records showed an increase in total content north of Nairobi in the day time but there was no evidence for a trough near the magnetic equator. However, it was felt that, although Nairobi is well situated for the study of variations of total content with latitude near the magnetic equator, the latitude coverage of a single station is insufficient. In addition, values obtained at low elevation angles are inaccurate unless a much more sophisticated method of analysis can be employed together with a detailed knowledge of the structure of the ionosphere over the whole latitude range. East Africa offers the possibility of a number of stations having a large latitude coverage with little longitude variation, so that a single pass of a satellite in a nearly polar orbit (such as BE-B) may be recorded at all stations. With the present three stations the subionospheric latitude range of 15°N to 12°S can be investigated and this may be extended by the addition of a fourth station in the future.

The variation of total electron content with latitude can be obtained from equation (1) of the previous section, providing that the total rotation angle ωc can be determined unambiguously. ω can be obtained by counting the nulls in an amplitude record, starting from the transverse point; the transverse point is that point on the record corresponding to a satellite position for which the effective value of θ is 90° and both ω and M should be zero there. At high latitude stations this region does not appear on the record and a method using two frequencies is commonly in use to determine ω. However, for equatorial stations this region can be identified on most records and the two frequency method becomes unnecessary, or even undesirable. It is not possible to attain absolute accuracy in the experimental values of ω nor in the calculated values of MSO that large errors may be introduced near the transverse region because the quotient ω/M becomes zero at one point and infinity at another. To overcome this difficulty the measured values of ω are being adjusted graphically (or on a computor) to pass through the same origin as M. Values of ω at any other point are then obtained by counting nulls from this origin. In cases when the transverse region cannot be identified this is located by using the nearest coincidence between the nulls on records at 40 and 41 Mc/s. In a few cases it has been necessary to calculate the position of the transverse point using the tabulated values of M together with the satellite ephemeris.

Figure 3 shows the latitude variation in total content as computed for the north going pass 8799. The agreement between the overlapping portions of the records is very satisfactory for this pass and it remains to be seen to what extent this agreement is maintained for other passes. Figure 4. shows the latitude variation of total content, averaged over the records from the three stations, for five passes. Two of these have also been analysed by Mr.E.Golton, of the Radio and Space Research Establishment, Slough, England, using a full ray tracing programme in order to allow for refraction. The curves obtained are in good general agreement with those of Figure 4. for which only the first order method described above was used. Figure 5. further shows the total content corresponding to the transverse points of the stations, obtained by the method described in Section (a) above, for all records during the period July 1st to August 28th, 1966, and Appendix 11. gives an inventory of all such passes.

The preliminary results from this spaced station experiment do not show a day time anomalous though in total content at the magnetic equator. This appears to conflict with results obtained at Zaria by Skinner (1965) for a period of low sunspot activity. However, the present results are few in number and more study is required before definite conclusions can be drawn. Certainly the large amount of analysis required cannot be carried out by manual methods and steps are being taken to reduce all future observations, which are successfully recorded at all three stations, on a computor.

(c) Scintillations

A study of the occurence of scintillations on Faraday rotation records is now in progress using past records obtained from the 40/41 Mc/s transmissions of BE-B and BE-C. Initially, this work is being restricted to the time of occurence of heavy scintillations and the distribution in latitude of the irregularities which cause them. Up to the present time, only records obtained at Nairobi have been used and, although not yet in a form suitable for presentation, some general features are becoming apparent. In particular, the temperal occurence of heavy scintillation has, perhaps, the expected form - that is, a fairly regular appearance of this phenomenon between about midnight and sunrise, while records obtained during daylight hours are relatively free of scintillations. There seems to be little seasonal variation in this pattern, although further work is required before this point becomes reasonably certain. Some latitude dependance of irregularity occurence seems to exist, but again, further study is necessary before definite conclusions can be reached.

In addition to the above programme, it is hoped that in the near future some information on the height distribution of irregularities will be obtained. In principle, height determination is reasonably straightforward when transmissions from fast moving satellites are used. A layer of irregularities in electron density can act as a diffracting screen to the radio transmissions, resulting in a diffraction pattern of signal strength at the ground.

This pattern moves in the opposite direction to that of the satellite with a speed which is related simply to the height and speed of the satellite and the irregularity height. A comparison of fading records from aerials set along the satellite track, and separated by a few hundred metres, leads to an estimate of the speed of the diffraction pattern along the ground - and hence the irregularity height - from the time delay between similar features appearing on both records. Typical values here might be a time delay of 0.1 seconds with a separation of 600 metres. The equipment necessary for this experiment has been set up and only a few minor modifications are necessary before commencement.

(d) <u>Other Measurements</u>

To obtain a more complete picture of the local ionosphere than can be obtained by the use of transmissions from beacon satellites alone, a vertical incidence sounder (ionosonde) is operated on a regular hourly basis; additional records are automatically obtained from this instrument immediately following each recorded satellite pass. Each record (ionogram) gives a fairly complete picture of the electron density profile up to, and including, the height of maximum ionisation. This height ceiling limits the usefulness of the instrument if used alone, but when combined with the satellite observations a fairly detailed overall picture emerges. A diurnal plot of electron density (Nm) at the height of maximum ionisation is shown in Fig. 6 ; this is presented on a seasonal basis for comparison with total electron content   It can be seen that the broad features are the same in each case, but significant differences in detail occur. These differences indicate changes in the electron density profile.

To return for a moment to section 2(a), the evaluation of total electron content depends critically on the magnetic factor M. The value of this factor which is inserted in the relevant expression depends, to some extent, on the height above ground. In choosing this height, it is desirable to take into consideration the height (h_m) of maximum ionisation. The value of h_m is readily determined from an ionogram and this can vary considerably over a 24 hour period. Fig. 7 shows the monthly median values of h_m; the large diurnal variation a certain times of the year is apparent. The use of an average value for h_m - and hence for the height chosen for the evaluation of the M factor - may introduce substantial errors in the inferred value of total electron content. For this reason, the actual value of h_m at the time of the satellite pass is used where possible.

III. Equipment

The Nairobi ionospheric and magnetic stations at present include the following equipment:-

(a) 3 component magnetic observatory
(b) Vertical incidence ionosonde
(c) Pulsed Transmitter and receiving equipment for the study of irregularities by the Spaced Aerial Method.
(d) Receiving equpment for satellite transmissions on 20, 40, 41 Mc/s.
(e) Receiving equipment for spaced aerial reception of satellites transmission on 41 Mc/s.
(f) 136 Mc/s rotating aerial for use with synchronous satellites.
(g) Automatic null measurement.

In addition Nairobi, Addis Ababa and Dar es Salaam are operating the following jointly:-

(h) Addis Ababa - 40 Mc/s Satellite receiver
(i) Dar es Salaam - 41 Mc/s satellite receiver (shortly to be extended to include 40 Mc/s.)

Addis Ababa also operates:-

(j) 3 component magnetic observatory
(k) Riometer.

The equipment directly relevant to ionospheric studies using satellites is described in more detail below.

(d) <u>20, 40 and 41 Mc/s Satellite receivers at Nairobi.</u>

At Nairobi the 20 Mc/s transmissions are received on a simple dipole aerial orientated NS and situated a quarter wavelength above ground. A Hatfield balance to unbalance transformer is used to feed a Racal (RA 17L) receiver. The 40 and 41 Mc/s transmissions are received on a common folded dipole aerial at present orientated EW and situated a quarter wavelength above ground. A balun and matching unit, constructed of 70 ohm coaxial cable, is used together with a 70 ohm coaxial feeder to a Tapetone (TC 40) converter. This is common to both frequencies which are then separated to feed two Collins (R-388) receivers.

Originally, two separate Kelvin Hughes pen recorders were used with electrosensitive paper. These were not very satisfactory for the following reasons:-

(i) the 20 Mc/s record was separated from the 40 and 41 Mc/s records;

(ii) Separate time markers were needed on both records;

(iii) there were insufficient channels for the other records which are required.

(iv) Sparking of the writing points could cause electrical interference on the receivers.

A Sefram recorder has been used for some months but this has given trouble with flooding of ink, or failure to write, by the pens. The system is being replaced by the six channel Sanborn recorder purchased under this contract together with one two channel

Kelvin Hughes recorder to give the following:-

(A) Sanborn Recorder. (Speed 2.0 mm/sec)

Marker channels		Second and minute markers
Signal channels	(1)	20 Mc/s.
	(2)	40 Mc/s High amplitude
	(3)	41 Mc/s High amplitude
	(4)	40 Mc/s Low "
	(5)	40 Mc/s Distant aerial.

(B) Kelvin Hughes two Channel Recorder (speed 2 cm/sec)

Marker channels		Second and minute markers
Signal	(1)	40 Mc/s from local aerial
	(2)	40 Mc/s from distant aerial.

The 40 and 41 Mc/s outputs are recorded at high level in order to give very sharp nulls for ease of measurement. However, this a results in loss of recording of scintillations due to saturation, so that a second lower amplitude recording is necessary. The Sanborn recordings are for 15 minutes on each transit. The Elliott recorder is switched on for 1 minute only near closest approach.

A programming unit has been constructed for automatic operation of the equipment. Four passes can be set in advance and minute and second marker signals are supplied to the pen recorders. The second marks are derived from a Rubidium oscillator whifh is used in connection with other equipment installed at the main College site.

The accuracy of the timing system is checked by daily recording of either BBC or W.W.V. time signals.

(b) 40 Mc/s Satellite receiver at Addis Ababa

A single channel transistorised satellite receiver (type kindly lent by Centro Micronde is being used together with a single channel Kelvin Hughes recorder. Signals are from a folded dipole with a coaxial cable balancing and matching Second and Minute time markers are taken from the crystal clock of the Coast and Geodetic Seismic recording equipment already installed at the observatory. A I.R.C. 'Supervisor' timer is used for automatic operation which can be programmed two days check.

(i) 40/41 Mc/s equipment at Dar es Salaam

At present this equipment is mannually operated although a timing unit will be added. An Ameco convertor is used with a dipole aerial and an AR 88 receiver for reception on 41 Mc/s. Timing markers all derived from the mains with a speed of ± 10 seconds. The transverse region in these records is fairly frequently difficult to identify so that a 40 Mc/s channel is being installed, using similar equipment. No suitable two channel pen recorder was available so that the station is changing to the Photron recorder loaned to Nairobi by the Cambridge Research Laboratories.

(j) Spaced Aerial Measurements at Nairobi

A second 40 Mc/s folded dipole aerial has been erected about 600 meters away from the first so that the two aerials lie along the direction of travel a north bound BE-B pass. A battery operated head amplifier is used together with a low loss coaxial cable and a Tapetone (201) converter. A third aerial will be installed for recording south bound passes if the existing system proves satisfactory.

It was originally intended to use 20 Mc /s for spaced aerial work but heavy interference from a commercial station has made this frequency useless for much of the time. Because of receiver shortage it is, at present, necessary to use the Racal receiver, normally required for 20 Mc/s, for the second aerial. This is a handicap since the 20 Mc/s record is most useful for Faraday analysis during the slow fading at night; this is also the time when scintillations are most common.

(k) A 16dB broadside dipole array has been constructed to rotate at one revolution per minute for recording transmissions on 136 Mc/s from Early Bird. Again shortage of receivers necessitates using the Racal receiver together with the Tapetone (202) convertor. Because of the poor signal/noise ratio a phase switch has been construoted but there has not been opportunity to test this equipment.

(l) The labour involved in measuring Faraday nulls is considerable and an attempt is being made to construct apparatus to reduce many records automatically.

It is proposed to record the signal on a tape recorder as well as on a pen recorder. If the pen record is free from heavy scintillations and interference the tape recording will be used, in conjunction with a digital counter and high speed paper punch, to produce a digital record of the times between adjacent nulls.

IV Future Plans

(a) Total Electron Content

Routine total content measurements will be continued, using the four close passes per day available from satellites BE-B and BE-C, with a view to determining the changes caused by increasing sunspot activity. Some evidence of an increase in maximum total content with this activity is given by Fig. 2., and it is hoped to continue this until at least sunspot maximum. Should a suitably placed synchronous satellite be available in the future, attempts will be made to obtain a detailed picture of the diurnal variation of total electron content.

(b) Latitude Variation of Total Electron Content

This experiment is now beyond the initial stages and it is proposed that some priority be given to the project, at least until a more complete picture is obtained. Once this stage is reached the position will be re-assessed and the possibility (and desirability) of equiping a fourth station at Asmara, Ethiopia (15° 20' N 38° E), investigated.

(c) Irregularities

A study of irregularities, by way of the resultant scintillation fading, has now been started with the object of determining:

(a) their height and lateral distribution,
(b) the frequency of occurrence
(c) the mechanism of formation.

Initial studies are limited to records obtained from BE-B and BE-C at Nairobi but this will later be extended to include the records from Addis Ababa and Dar es Salaam. If desirable, height measuring equipment may be added at these stations. As for total electron content, a suitably placed synchronous satellite would be most useful in this project. When sufficient results are obtained, the possibility of correlating these with the results obtained from the ground based experiment will be looked into. As mentioned previously, this latter experiment will give information on the size and movement of the irregularities

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HUNTER, A.N., KELLEHER, R.F., Brazil Conference - September, 1965.

HUNTER, A.N., Boston Conference - October, 1965.

HUNTER, A.N., WEBSTER, A.R., Joint Satellite Studies Group Conference - October, 1966.

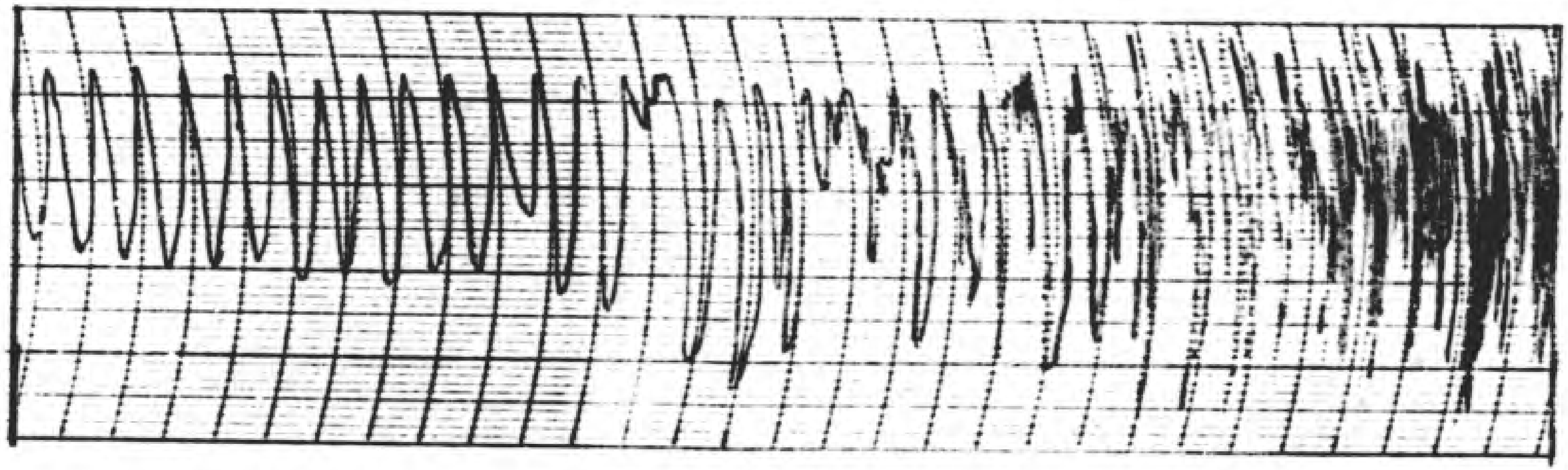


Fig. 1.

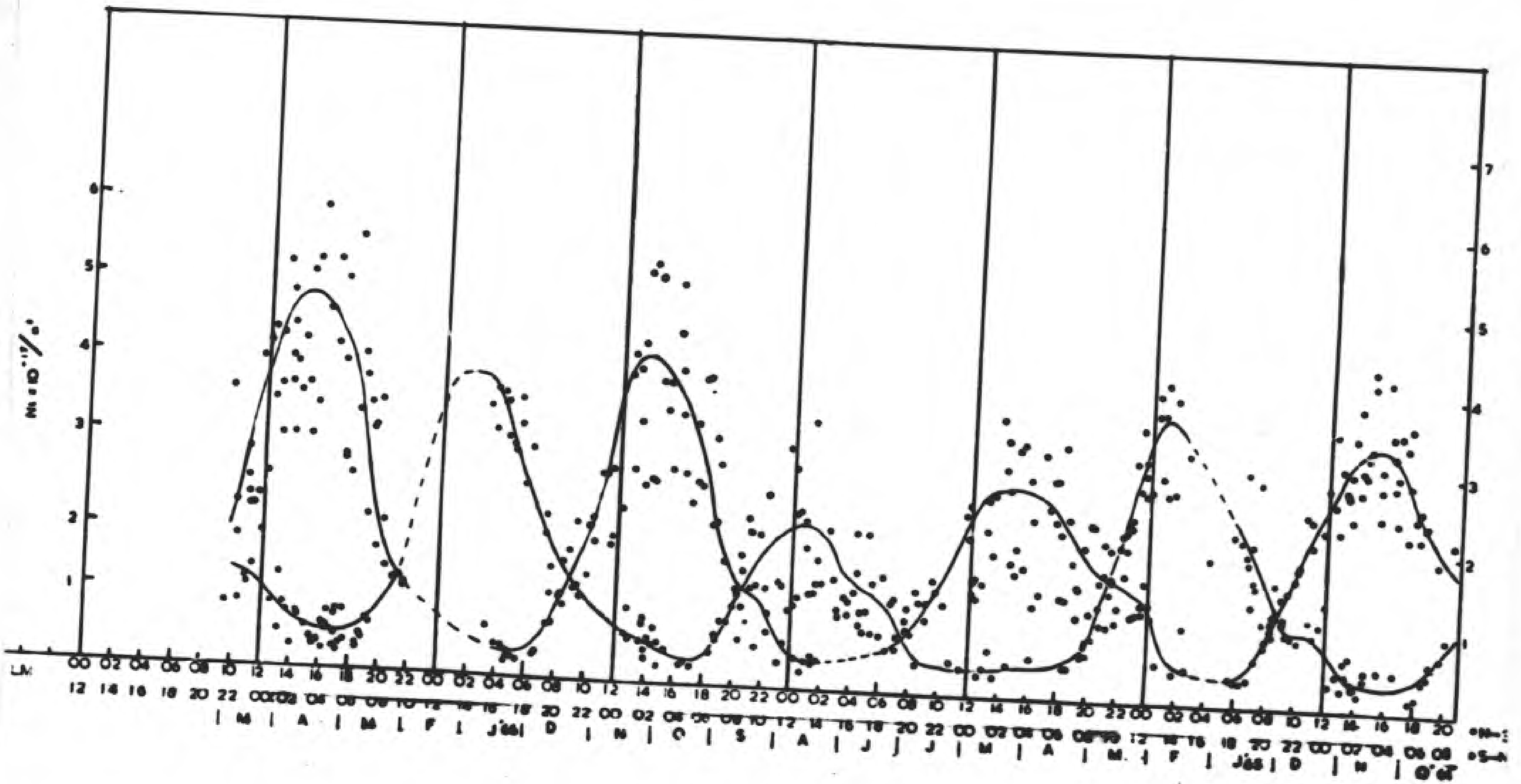
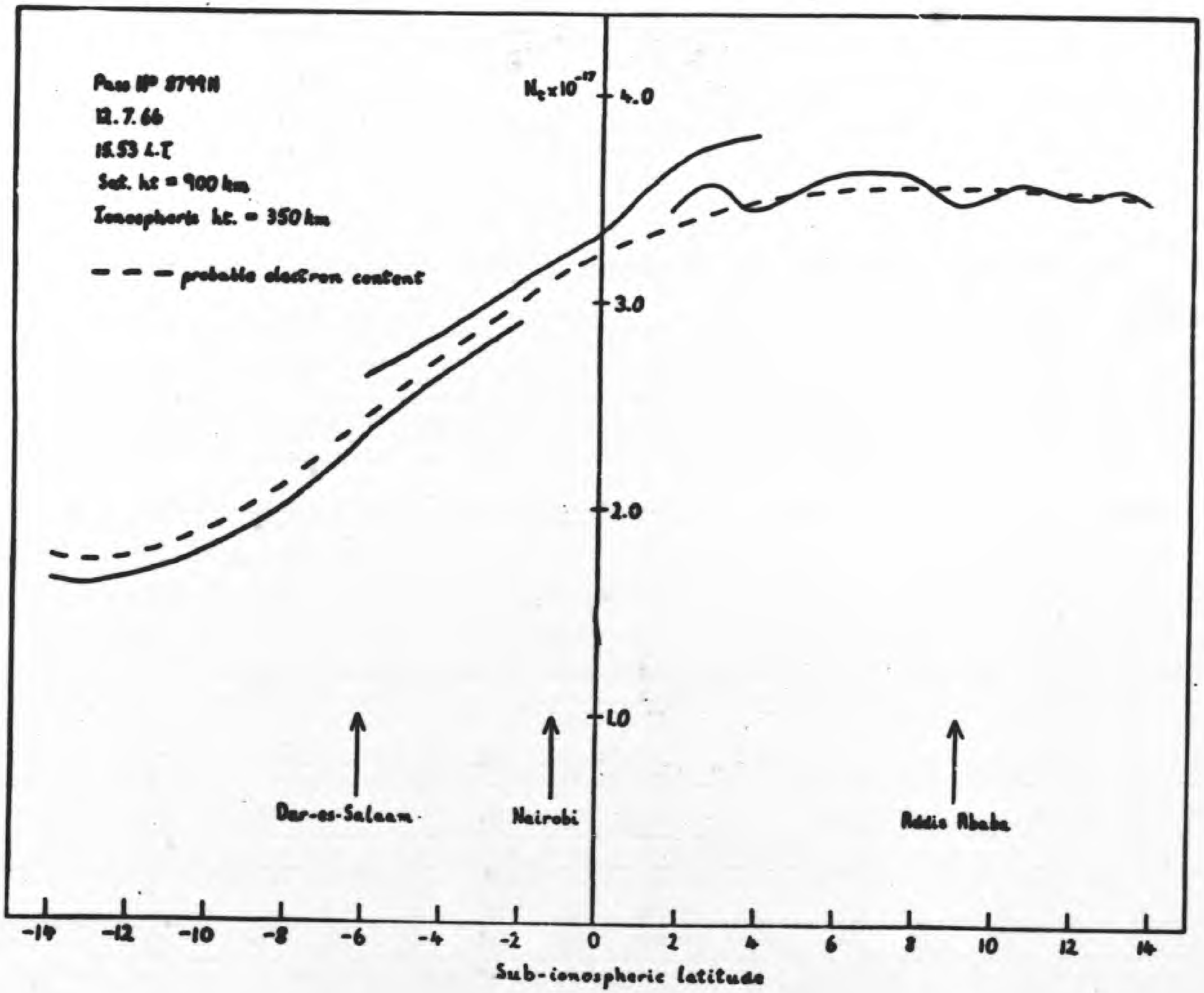


Fig. 2



12.7.66
Sat. ht = 900 km
Ionospheric ht. = 350 km
probable electron content
$N_t \times 10^{-17}$
4.0
3.0
2.0
1.0
Dar-es-Salaam
Nairobi
Addis Ababa
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
Sub-ionospheric latitude

Fig. 3.

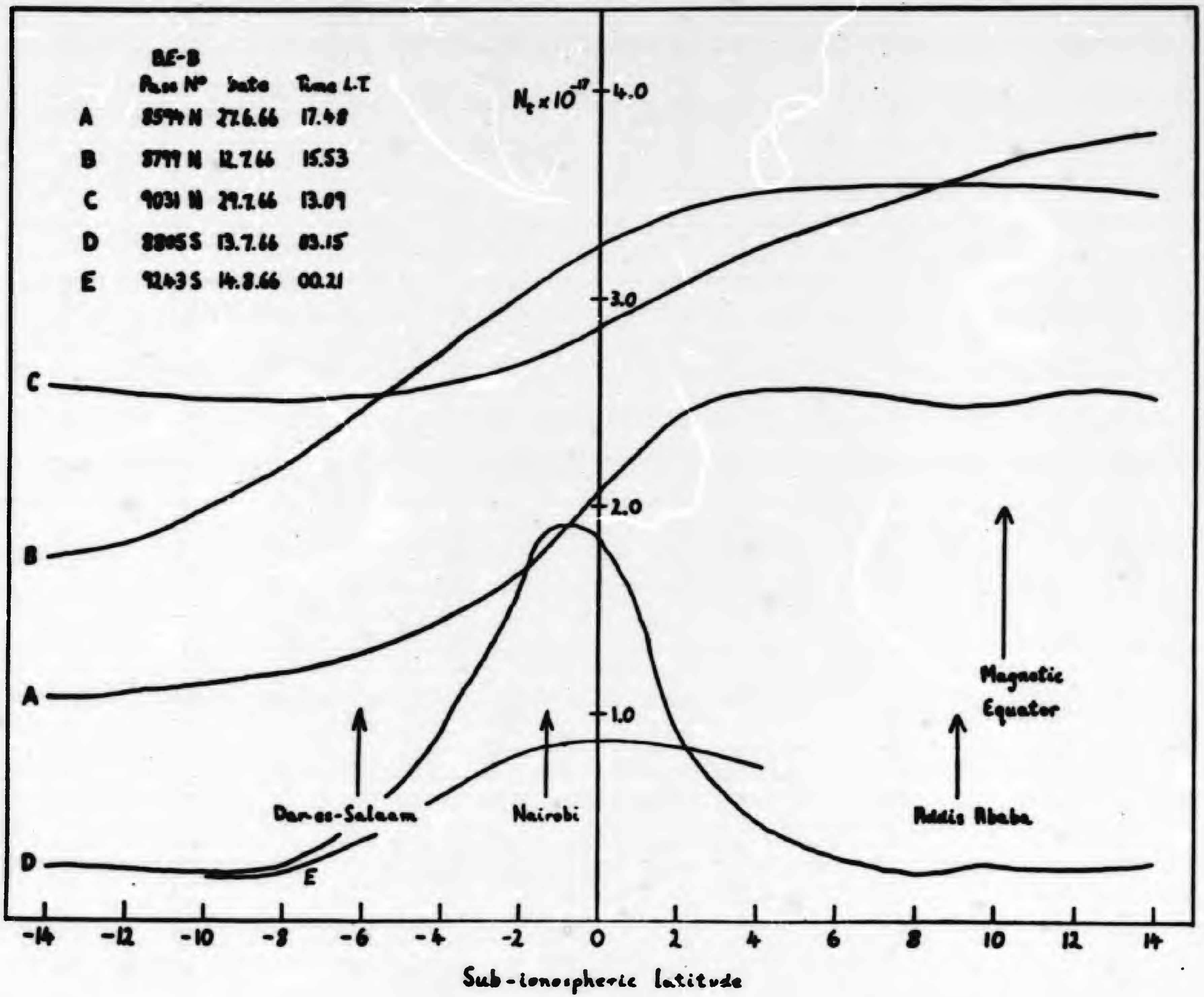
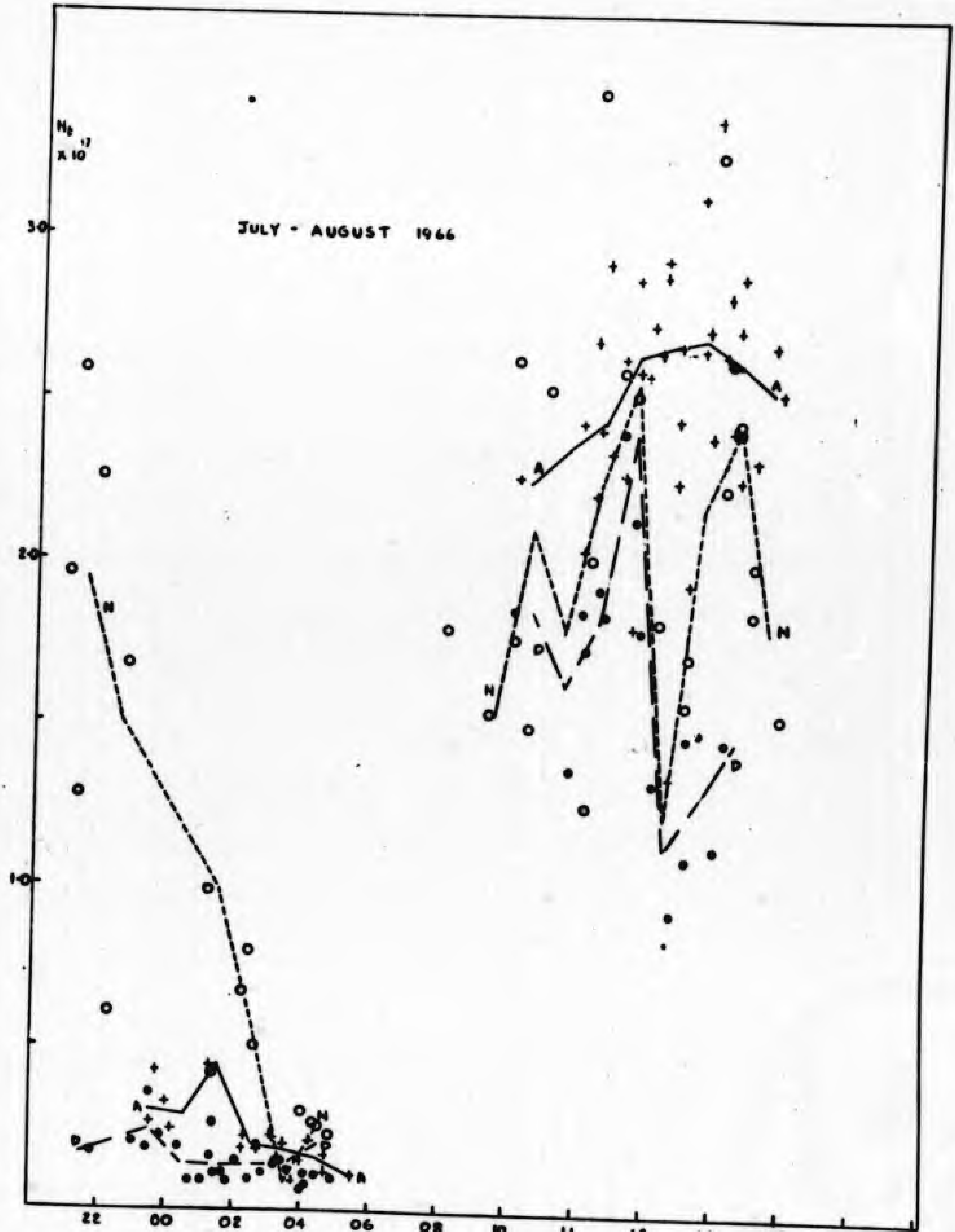
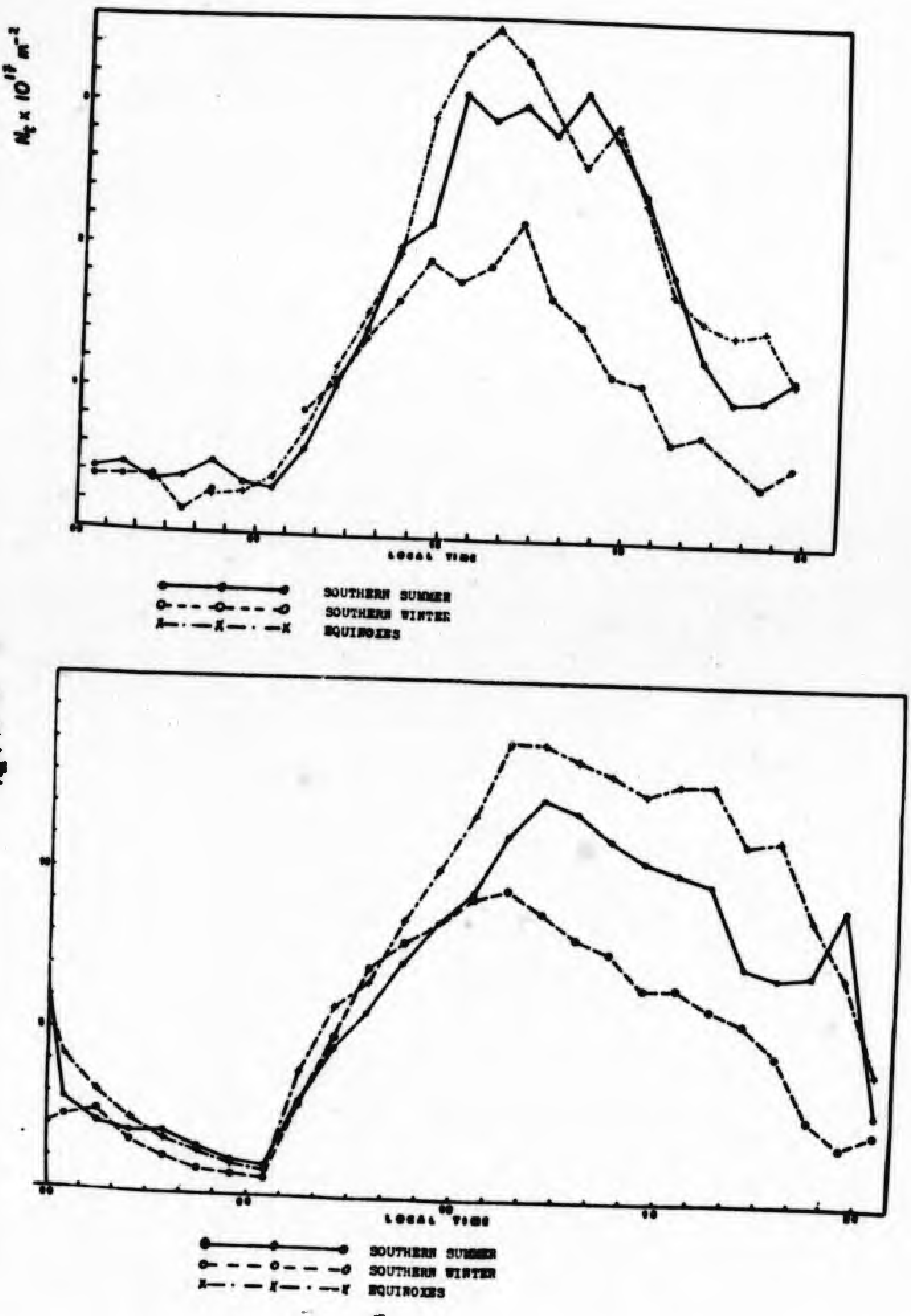

BE-B
Pass Nº Date Time L.T
A 8594 N 27.6.66 17.48
B 8799 N 12.7.66 15.53
C 9031 N 29.7.66 13.09
D 8805 S 13.7.66 03.15
E 9243 S 14.8.66 00.21
$N_t \times 10^{-17}$
4.0
3.0
2.0
1.0
C
B
A
D
E
Dar-es-Salaam
Nairobi
Addis Ababa
Magnetic Equator
-14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14
Sub-ionospheric latitude

Fig. 4.



N_t x 10^{17}
JULY - AUGUST 1966
30
20
10
22
00
02
04
06
08
10
11
14
16
18
20
N
A
D

Fig. 5.



N_t x 10^17 m^-2
LOCAL TIME
SOUTHERN SUMMER
SOUTHERN WINTER
EQUINOXES
N_m x 10^10 m^-3
LOCAL TIME
SOUTHERN SUMMER
SOUTHERN WINTER
EQUINOXES

Fig 6.

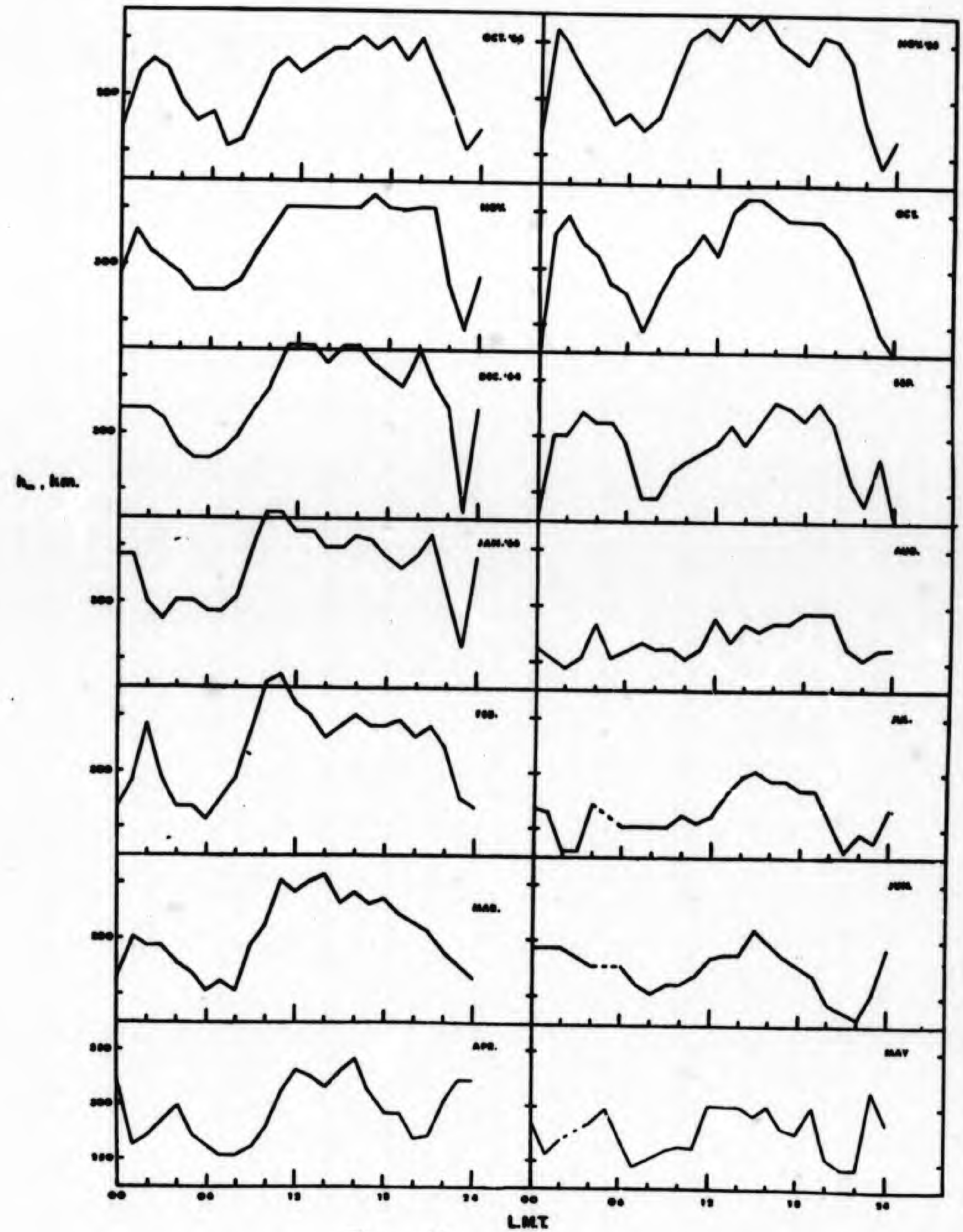


Fig. 7.

NAIROBI ELECTRON CONTENT

NOTE: Pass No. N = N-bound S = S-bound. For N-bound, the number refers to the pass which starts as the equator is crossed.

Time: L.T. = U.T. + 3 hours. Time is equator crossing to nearest minute.

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Oct. 1964	10	2 N	08.53	
	10	8 S	20.15	
	11	15 N	07.36	0.7
	11	22 S	20.42	2.15
	12	29 N	08.03	0.94
	12	35 S	19.25	
	13	42 N	05.47	
	13	43 N	08.30	1.03
	13	49 S	19.52	
	14	56 N	07.13	
	14	62 S	18.34	
	14	63 S	20.19	2.88
	15	70 N	07.41	0.72
	15	76 S	19.02	
	16	83 N	06.23	
	16	90 S	19.29	1.91
	17	97 N	06.51	0.48
	17	103 S	18.12	2.55
	18	111 N	07.18	0.61
	18	117 S	18.39	2.36
	19	124 N	06.01	
	19	131 S	19.07	
	20	138 N	06.24	
	20	144 S	19.49	
	21	152 N	06.55	0.64
	21	158 S	18.16	2.25
	22	165 N	05.39	
	22	172 S	18.44	2.38
	23	179 N	05.05	0.20
	23	185 S	17.26	2.20
	24	193 N	06.33	0.42
	24	199 S	17.54	2.89
	25	206 N	05.15	
	25	213 S	18.21	2.58
	26	220 N	05.43	0.17
	26	226 S	17.04	3.6
	27	234 N	06.10	0.18
	27	240 S	17.31	3.63

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Oct. 1964	28	247 N	04.53	
	28	254 S	17.59	2.48
	29	261 N	05.20	
	29	267 S	15.41	3.00
	30	275 N	05.47	3.12
	30	281 S	17.09	2.46
	31	288 N	05.30	
	31	295 S	17.36	2.90
Nov. 1964	1	302		
	1	308 S	16.18	3.54
	2	316		
	2	322 S	16.46	2.42
	3	329		
	3	336 S	17.13	3.39
	4	343		
	4	349		
	5	357		
	5	363 S	16.23	3.26
	6	377 S	16.51	3.54
	7	390 S	15.33	2.46
	8	398 N	04.39	0.50
	8	404 S	16.01	4.16
	9	418 S	16.28	2.81
	10	431 S	15.11	
	11	445 S	15.38	2.84
	12	459 S	16.05	3.12
	13	472 S	14.48	3.35
	15	493 N	02.37	0.41
	15	500 S	15.43	3.10
	16	507 N	03.04	0.25
	16	513 S	14.25	3.06
	17	521 N	03.31	0.52
	17	527 S	14.53	4.35
	19	548 N	02.41	0.51
	20	562 N	03.09	
	20	568 S	14.30	2.19
	21	575 N	01.51	0.3[illegible]
	21	582 S	14.57	3.23
	22	589 N	02.19	0.22
	22	595 S	13.40	3.02
	23	609 S	14.07	3.85
	24	616 N	01.28	0.45
	24	623 S	14.35	3.00
	25	630 N	01.56	0.29
	25	636 S	13.17	2.80
	26	650 S	13.45	2.43
	27	664 S	14.12	2.79
	28	667 S	12.55	2.26
	29	685 N	02.01	0.31

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Nov. 1964	29	691 S	13.22	2.78
	30	705 S	13.50	3.48
Dec.1964	1	712 N	01.10	0.27
	1	718 S	12.32	3.53
	2	726 N	01.38	0.68
	2	732 S	13.00	3.09
	3	739 N	00.20	0.33
	3	746 S	13.27	2.76
	4	753 N	00.48	0.45
	4	759 S	12.10	2.84
	5	767 N	01.15	0.61
	5	773 S	12.37	2.60
	5	780 N	23.58	1.33
	8	821 N	23.35	1.07
	10	841 S	11.24	2.2
	11	855 S	11.52	2.16
	11	862 N	25.12	0.93
	12	868 S	10.34	2.43
	12	878 N	23.39	1.3
	13	882 S	11.02	2.40
	14	896 S	11.29	2.0
	15	909 S	10.12	1.78
	16	923 S	10.39	1.52
	17	937 S	11.06	2.08
	18	958 N	22.54	1.14
	19	964 S	10.16	1.83
	20	978 S	10.44	2.47
	22	1005 S	09.54	1.9
	23	1019.S	10.21	2.0
	23	1026 N	21.41	1.1
	24	1032 S	09.04	1.41
	24	1040 N	22.09	0.87
	25	1046 S	09.31	1.49
	26	1060 S	09.59	1.64
	27	1073 S	08.41	1.19
	27	1081 N	21.50	0.92
	28	1087 S	09.09	1.09
	28	1094 N	20.28	1.17
	29	1101 S	09.36	1.4
	20	1122 N	21.23	0.95
Jan.1965	1	1142 S	09.13	1.16
	1	1149 N	20.33	
	2	1155 S	07.56	
	2	1163 N	21.00	
	3	1169 S	08.23	1.01
	3	1176 N	19.43	1.09
	4	1183 S	08.51	1.25
	4	1190 N	20.10	
	5	1196 S	07.33	
	5	1204 N	20.38	1.57
	6	1210 S	08.01	0.86

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Jan.1965	6	1217 N	19.20	1.52
	7	1224 S	08.28	0.92
	7	1231 N	19.48	
	8	1237 S	07.11	
	8	1245 N	20.15	1.10
	9	1251 S	07.38	
	9	1258 N	18.58	
	10	1265 S	08.15	
	10	1272 N	19.25	
	11	1278 S	06.48	
	11	1286 N	19.52	
	12	1292 S	07.15	
	12	1299 N	18.35	2.99
	13	1306 S	07.43	
	13	1313 N	19.02	2.16
	14	1319 S	06.25	0.32
	14	1327 N	19.30	2.86
	15	1333 S	06.53	0.35
	15	1340 N	18.12	3.1
	16	1347 S	07.20	0.59
	16	1354 N	18.40	1.94
	17	1360 S	06.08	0.33
	17	1368 N	19.07	1.61
	18	1374 S	06.30	0.31
	18	1381 N	17.50	2.17
	19	1388 S	06.57	
	19	1395 N	18.17	2.11
	20	1401 S	05.40	0.36
	20	1409 N	18.44	1.83
	21	1415 S	06.17	
	21	1422 N	17.27	
	22	1429 S	06.35	
	22	1436 N	17.54	
	23	1450 ?	18.22	
Feb.1965	6	1641 N	16.01	1.87
	10	1695 N	14.21	0.98
	12	1715 S	02.10	
	14	1750 N	14.25	2.58
	17	1784 S	02.42	0.46
	18	1805 N	14.30	3.20
	19	1811 S	01.52	0.57
	19	1818 N	13.13	2.66
	20	1825 S	02.19	0.79
	20	1832 N	13.40	3.90
	22	1859 N	12.50	2.90
	24	1887 N	13.45	2.70
	25	1900 N	12.28	3.69
	26	1914 N	12.55	3.70
	27	1928 N	13.24	2.35
	28	1934 S	00.44	0.49

Date		BE-B Pass No.	Time L.T	Content x 10^{-17}
Mar. 1965				
	1	1955 N	12.32	3.95
	1	1961 S	23.53	1.52
	2	1969 N	13.00	4.10
	3	1975 S	00.21	1.28
	3	1982 N	11.42	2.92
	4	2002 S	23.31	1.24
	5	2010 N	12.38	3.36
Midnight	5 & 6	2016 S	23.59	1.58
	7	2037 N	11.47	3.10
	8	2051 N	12.14	2.73
	8	2057 S	23.36	1.03
	9	2064 N	10.57	2.23
Midnight	9 & 10	2071 S	00.03	1.27
	10	2078 N	11.25	2.72
	11	2092 N	11.52	2.66
	11	2098 S	23.13	1.12
	12	2105 N	10.35	1.95
	12	2112 S	23.41	1.13
	13	2119 N	11.02	2.36
	14	2133 N	11.29	3.51
	14	2139 S	22.50	1.10
	15	2146 N	10.12	1.96
	16	2160 N	10.39	1.98
	16	2166 S	22.00	1.20
	17	2174 N	11.07	3.08
	17	2180 S	22.29	1.61
	19	2201 N	10.16	2.14
	19	2207 S	21.38	1.55
	20	2215 N	10.44	2.28
	21	2228 N	09.26	1.38
	21	2235 S	22.32	2.61
	22	2242 N	09.54	1.12
	22	2248 S	21.15	2.01
	23	2262 S	21.42	1.59
	24	2269 N	09.04	1.62
	25	2283 N	09.31	1.94
	26	2296 N	08.14	2.25
	26	2303 S	21.20	0.94
	27	2310 N	08.41	1.21
	28	2330 S	20.28	2.22
	29	2337 N	07.51	0.73
	29	2344 S	20.57	0.97
	30	2357 S	19.39	2.07
	31	2365 N	08.46	1.52
Apr.1965	2	2392 N	07.56	0.75
	2	2398 S	19.18	1.45
	3	2406 N	08.23	0.80
	4	2426 S	20.12	1.12
	5	2433 N	07.33	0.61
	5	2439 S	18.54	1.09

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Mar. 1965				
	1	1955 N	12.32	3.95
	1	1961 S	23.53	1.52
	2	1969 N	13.00	4.10
	3	1975 S	00.21	1.28
	3	1982 N	11.42	2.92
	4	2002 S	23.31	1.24
	5	2010 N	12.36	3.36
Midnight	5 & 6	2016 S	23.59	1.58
	7	2037 N	11.47	3.10
	8	2051 N	12.14	2.73
	8	2057 S	23.36	1.03
	9	2064 N	10.57	2.23
Midnight	9 & 10	2071 S	00.03	1.27
	10	2078 N	11.25	2.72
	11	2092 N	11.52	2.66
	11	2098 S	23.13	1.12
	12	2105 N	10.35	1.95
	12	2112 S	23.41	1.13
	13	2119 N	11.02	2.36
	14	2133 N	11.29	3.51
	14	2139 S	22.50	1.10
	15	2146 N	10.12	1.96
	16	2160 N	10.39	1.98
	16	2166 S	22.00	1.20
	17	2174 N	11.07	3.08
	17	2180 S	22.29	1.61
	19	2201 N	10.16	2.14
	19	2207 S	21.38	1.55
	20	2215 N	10.44	2.28
	21	2228 N	09.26	1.38
	21	2235 S	22.32	2.61
	22	2242 N	09.54	1.12
	22	2248 S	21.15	2.01
	23	2262 S	21.42	1.59
	24	2269 N	09.04	1.62
	25	2283 N	09.31	1.94
	26	2296 N	08.14	2.25
	26	2303 S	21.20	0.94
	27	2310 N	08.41	1.21
	28	2330 S	20.28	2.22
	29	2337 N	07.51	0.73
	29	2344 S	20.57	0.97
	30	2357 S	19.39	2.07
	31	2365 N	08.46	1.52
Apr.1965	2	2392 N	07.56	0.75
	2	2398 S	19.18	1.45
	3	2406 N	08.23	0.80
	4	2426 S	20.12	1.12
	5	2433 N	07.33	0.61
	5	2439 S	18.54	1.09

Date		BE-B Pass No.	Time U.T.	Content x 10^{-17}
Apr.1965	6	2447 N	08.00	0.58
	6	2453 S	19.21	1.04
	7	2467 S	19.49	1.95
	8	2481 S	18.31	1.27
	9	2488 N	07.37	0.58
	10	2508 S	19.26	1.45
	11	2521 S	18.09	2.11
	13	2549 S	19.03	1.75
	14	2562 S	17.46	2.80
	15	2570 N	06.52	0.41
	15	2576 S	18.14	1.29
	16	2590 S	18.41	2.32
	17	2603 S	17.23	2.44
	18	2611 N	06.29	0.18
	18	2617 S	17.51	2.29
	19	2631 S	18.18	3.24
	20	2638 N	05.39	0.10
	20	2644 S	17.01	3.13
	22	2672 S	17.55	2.81
	23	2679 N	05.16	0.264
	24	2693 N	05.44	0.67
	26	2726 S	16.16	2.78
	27	2740 S	16.43	1.34
	30	2781 S	16.20	1.17
May 1965	1	2795 S	16.48	1.65
	5	2849 S	15.08	1.57
	6	2857 N	04.13	0.51
	6	2863 S	15.35	3.25
	7	2877 S	16.02	2.81
	8	2884 N	03.23	0.11
	8	2890 S	14.45	2.67
	9	2904 S	15.12	1.90
	10	2918 S	15.40	1.67
	11	2931 S	14.22	2.92
	12	2945 S	14.50	1.72
	13	2959 S	15.17	3.18
	14	2972 S	13.60	2.9
	14	2966 N	02.37	0.41
	15	2986 S	14.27	3.28
	16	2993 N	01.47	0.26
	16	2999 S	13.09	2.13
	17	3013 S	13.37	1.81
	18	3027 S	14.04	3.54
	19	3034 N	01.24	0.60
	19	3040 S	12.47	2.04
	20	3054 S	13.14	2.52
	21	3068 S	13.42	2.59
	22	3075 N	01.01	0.37
	25	3122 S	12.01	2.49
	26	3136 S	12.29	1.52
	27	3150 S	12.56	1.44
	28	3157 N	00.16	0.27

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
May 1965				
	28	3163 S	11.39	1.70
	29	3171 N	00.43	0.29
	29	3177 S	12.06	1.32
	30	3191 S	12.34	1.25
	30	3198 N	23.53	0.30
June'65	1	3218 S	11.43	2.31
	2	3232 S	12.11	1.46
	2	3239 N	23.31	0.43
	4	3266 N	22.41	0.41
	5	3273 S	11.48	2.02
	9	3327 S	10.08	1.77
	9	3335 N	23.13	1.19
	10	3341 S	10.35	1.97
	11	3355 S	11.03	
	12	3368 S	09.45	1.32
	15	3417 N	22.27	0.41
	15	3409 S	09.23	1.06
	16	3423 S	09.50	2.64
	17	3437 S	10.17	1.18
	19	3464 S	09.27	0.99
	22	3512 N	20.24	0.39
	22	3505 S	09.05	0.97
	23	3519 S	09.31	1.46
	23	3526 N	20.51	
	25	3546 S	08.41	1.18
	26	3560 S	09.09	1.19
	26	3567 N	20.29	1 3
	27	3573 S	07.51	1.10
	28	3594 N	19.39	0.55
	29	3608 N	20.06	0.58
	30	3622 N	20.33	
July 1965	1	3628 S	07.56	0.93
	2	3642 S	08.23	1.30
	4	3676 N	18.53	0.55
	5	3683 S	08.00	0.78
	6	3696 S	06.43	1.76
	6	3704 N	19.48	0.83
	7	3710 S	07.10	0.58
	8	3731 N	18.58	1.21
	12	3786 N	19.03	0.72
	14	3813 N	18.13	1.48
	15	3827 N	18.40	1.15
	16	3840 N	17.23	1.28
	17	3854 N	17.50	0.73
	17	3846 S	04.44	0.22
	18	3867 N	16.33	0.87
	19	3881 N	17.00	1.02
	20	3895 N	17.27	0.78
	21	3908 N	16.10	1.27

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
May 1965				
	28	3163 S	11.39	1.70
	29	3171 N	00.43	0.29
	29	3177 S	12.06	1.32
	30	3191 S	12.34	1.25
	30	3198 N	23.53	0.30
June'65	1	3218 S	11.43	2.31
	2	3232 S	12.11	1.46
	2	3239 N	23.31	0.43
	4	3266 N	22.41	0.41
	5	3273 S	11.48	2.02
	9	3327 S	10.08	1.77
	9	3335 N	23.13	1.19
	10	3341 S	10.35	1.97
	11	3355 S	11.03	
	12	3368 S	09.45	1.32
	15	3417 N	22.27	0.41
	15	3409 S	09.23	1.06
	16	3423 S	09.50	2.64
	17	3437 S	10.17	1.18
	19	3464 S	09.27	0.92
	22	3512 N	20.24	0.39
	22	3505 S	09.05	0.97
	23	3519 S	09.31	1.46
	23	3526 N	20.51	
	25	3546 S	08.41	1.18
	26	3560 S	09.09	1.19
	26	3567 N	20.29	1 3
	27	3573 S	07.51	1.10
	28	3594 N	19.39	0.55
	29	3608 N	20.06	0.58
	30	3622 N	20.33	
July 1965	1	3628 S	07.56	0.93
	2	3642 S	08.23	1.30
	4	3676 N	18.53	0.55
	5	3683 S	08.00	0.78
	6	3696 S	06.43	1.76
	6	3704 N	19.48	0.83
	7	3710 S	07.10	0.58
	8	3731 N	18.58	1.21
	12	3786 N	19.03	0.72
	14	3813 N	18.13	1.48
	15	3827 N	18.40	1.15
	16	3840 N	17.23	1.28
	17	3854 N	17.50	0.73
	17	3846 S	04.44	0.22
	18	3867 N	16.33	0.87
	19	3881 N	17.00	1.02
	20	3895 N	17.27	0.78
	21	3908 N	16.10	1.27

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
July 1965	22	3922 N	16.37	1.02
	23	3936 N	17.05	2.01
	24	3942 S	04.26	0.19
	24	3949 N	15.47	0.98
	25	3956 S	04.53	0.27
	25	3963 N	16.15	2.03
	26	3977 N	16.42	0.78
	28	4004 N	15.52	1.15
	29	4018 N	16.19	1.52
	30	4031 N	15.02	1.01
	31	4045 N	15.29	1.19
Aug.1965	1	4059 N	15.56	1.7
	2	4065 S	03.18	0.20
	2	4072 N	14.39	0.96
	3	4079 S	03.45	0.18
	3	4086 N	15.06	0.95
	10	4182 N	14.48	1.42
	10	4188 S	02.09	0.20
	11	4195 N	13.31	1.23
	12	4202 S	02.37	0.53
	12	4209 N	13.58	1.20
	13	4223 N	14.26	2.06
	14	4229 S	01.47	0.38
	14	4236 N	13.08	1.37
	15	4243 S	02.14	0.48
	15	4250 N	13.35	1.37
	16	4256 S	00.57	0.35
	16	4264 N	14.03	1.1
	17	4270 S	01.24	0.26
	18	4284 S	01.51	0.36
	18	4291 N	13.13	1.22
	19	4305 N	13.40	1.66
	20	4211 S	01.01	0.30
	20	4313 N	12.23	1.16
	21	4325 S	01.28	0.41
	21	4332 N	12.50	2.03
	22	4338 S	00.11	0.50
	22	4346 N	13.17	2.72
	23	4352 S	00.38	0.21
	23	4359 N	12.00	1.06
	24	4373 N	12.27	2.28
	24	4379 S	23.48	0.43
	25	4387 N	12.54	1.81
	26	4393 S	00.15	0.39
	26	4400 N	11.37	3.10
	27	4407 S	00.43	0.59
	27	4414 N	12.04	2.82

Date	BE-B Pass No.	Time L.T.	Content x 10^{-17}
Aug.1965			
27	4420 S	23.25	0.32
29	4441 N	11.14	1.32
30	4448 S	00.20	0.36
30	4455 N	11.41	1.07
31	4469 N	12.09	2.25
31	4475 S	23.30	0.60
Sept.1965			
3	4509 N	10.02	
3	4516 S	23.07	0.33
5	4537 N	10.56	1.39
5	4543 S	22.17	
7	4564 N	10.06	1.29
8	458[illegible] S	21.54	
9	4591 N	09.16	
9	4598 S	22.22	0.93
10	4605 N	09.43	1.46
11	4619 N	10.10	2.48
11	4625 S	21.32	0.51
12	4632 N	08.53	2.17
14	4666 S	21.08	
15	4673 N	08.30	1.01
15	4680 S	21.35	2.33
16	4687 N	08.58	
16	4693 S	20.18	
17	4701 N	09.25	
17	4707 S	20.45	
19	4728 N	08.35	1.49
20	4742 N	09.02	1.25
20	4748 S	20.24	0.60
21	4762 S	20.00	0.97
22	4769 N	08.12	1.19
22	4775 S	19.34	2.36
23	4783 N	08.39	
23	4789 S	20.01	
24	4796 N	07.22	
24	4803 S	20.28	1.70
25	4810 N	07.49	1.01
25	4816 S	19.11	
26	4824 N	08.16	1.23
26	4830 S	19.39	
27	4837 N	06.59	
27	4844 S	20.06	1.26
28	4851 N	07.26	0.83
28	4857 S	18.48	2.10
29	4865 N	07.53	
29	4871 S	19.16	1.60
30	4878 N	06.36	
30	4885 S	19.43	

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Oct.1965	3	4926 S	19.21	
	4	4933 N	06.41	0.68
	4	4939 S	18.03	3.93
	5	4947 N	07.08	0.83
	5	4953 S	18.30	2.06
	6	4960 N	05.50	0.30
	6	4967 S	18.58	2.83
	7	4974 N	06.18	0.42
	7	4980 S	17.40	2.57
	8	4988 N	08.45	0.61
	9	5008 S	18.35	3.18
	10	5015 N	05.55	0.26
	10	5021 S	17.18	3.35
	11	5029 N	06.22	
	11	5035 S	17.45	3.95
	12	5042 N	05.05	
	14	5076 S	17.22	2.61
	15	5083 N	04.42	0.28
	16	5097 N	05.09	0.23
	17	5117 S	16.59	2.32
	18	5124 N	04.19	
	18	5131 S	17.27	
	19	5138 N	04.48	
	19	5144 S	16.09	4.12
	20	5152 N	05.14	
	20	5158 S	16.37	2.71
	21	5165 N	03.57	
	22	5179 N	04.24	0.26
	22	5185 S	15.47	
	23	5193 N	04.51	
	23	5199 S	16.14	3.47
	24	5209 N	03.34	
	24	5213 S	16.41	
	25	5220 N	04.01	
	25	5226 S	15.24	3.86
	26	5240 S	15.52	5.23
	29	5281 S	15.39	2.97
	30	5288 N	02.49	0.53
	30	5295 S	15.56	4.53
	31	5302 N	03.16	0.40
	31	5308 S	14.34	2.58
Nov.1965	1	5315 N	01.58	0.42
	1	5322 S	15.06	3.51
	2	5329 N	02.26	0.50
	2	5335 S	13.48	2.52
	3	5343 N	02.53	0.22
	3	5349 S	14.16	2.61
	4	5356 N	01.36	0.59
	4	5363 S	14.43	3.88
	5	5370 N	02.03	0.31
	5	5376 S	13.25	3.37

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Nov.1965	6	5384 N	02.30	0.71
	7	5404 S	14.20	5.21
	8	5411 N	01.40	0.76
	8	5417 S	13.03	2.74
	9	5425 N	02.08	0.59
	9	5431 S	13.30	4.36
	10	5445 S	13.58	5.35
	11	5452 N	01.18	0.98
	11	5458 S	12.40	3.95
	12	5466 N	01.45	0.83
	13	5486 S	13.35	5.27
	14	5493 N	00.55	0.57
	15	5513 S	12.45	4.21
	16	5527 S	13.12	4.01
	17	5534 N	00.32	0.63
	17	5540 S	11.54	
	18	5554 S	12.21	2.61
	18	5561 N	23.42	1.87
	20	5575 N	00.09	
	20	5581 S	11.31	
	21	5589 N	00.36	
	21	5595 S	11.59	2.68
	21	5602 N	23.19	
	24	5636 S	11.36	2.74
	24	5643 N	22.56	
	25	5650 S	12.03	2.79
	26	5663 S	10.45	3.26
	26	5671 N	23.51	0.92
	27	5677 S	11.13	2.67
	27	5684 N	22.34	
	28	5691 S	11.37	1.76
	28	5698 N	23.01	
	29	5704 S	10.23	2.11
	29	5712 N	23.28	
	30	5718 S	10.50	3.05
	30	5725 N	22.11	
Dec.1965	1	5732 S	11.17	
	1	5739 N	22.38	
	2	5745 S	10.00	1.36
	2	5753 N	23.06	
	3	5759 S	10.27	1.80
	7	5821 N	21.53	1.14
	8	5827 S	09.14	2.04
	8	5835 N	22.20	
	10	5855 S	10.09	1.99
	10	5862 N	21.30	1.08
	11	5868 S	08.51	1.67
	11	5876 N	21.57	
	12	5882 S	09.19	1.23
	12	5889 S	20.40	
	13	5896 S	09.46	
	13	5903 N	21.07	1.29

Date	BE-B Pass No.	Time L.T.	Content x 10^{-17}
Dec. 1965			
14	5909 S	08.28	0.97
14	5917 N	21.34	
15	5923 S	08.56	
20	5999 N	20.49	
21	6005 S	08.10	1.0[illegible]
21	6012 N	19.31	1.16
22	6019 S	08.38	1.45
22	6026 N	19.59	
23	6 032 S	07.20	0.71
23	6040 N	20.26	1.52
24	6046 S	07.47	0.74
24	6053 N	19.09	1.87
25	6060 S	08.15	1.12
25	6067 N	19.36	1.44
28	6108 N	19.13	2.11
29	6114 S	06.34	0.31
Jan.1966 2	6 169 S	06.39	0.36
6	6231 N	18.05	2.96
7	6237 S	05.26	0.23
8	6258 N	17.14	3.59
9	6264 S	04.36	0.20
9	6272 N	17.42	2.49
10	6278 S	05.03	0.28
10	6285 N	16.24	3.54
11	6299 N	16.52	3.00
12	6313 N	17.19	3.26
13	6319 S	04.40	0.35
15	6354 N	1[illegible].56	2.93
16	6367 N	15.39	3.70
17	6374 S	04.45	0.27
17	6381 N	16.06	3.65
18	6387 S	03.27	0.66
18	6395 N	16.33	3.18
19	6401 S	03.55	0.43
19	6408 N	15.16	3.48
20	6415 S	04.22	0.73
20	6422 N	15.43	3.18
21	6436 N	16.11	3.53
Mar.1966 3	7002 S	21.46	1.25
9	7078 N	09.38	1.12
10	7091 N	08.20	1.36
11	7111 S	20.11	1.94
12	7119 N	09.14	1.25
14	7152 S	19.48	1.60
15	7160 N	08.52	1.22
18	7207 S	19.51	3.51
19	7214 N	07.11	0.67
20	7234 S	19.01	2.01

Date	BE-B Pass No.	Time L.T.	Content x 10^{-17}
Mar.1966 21	7242 N	08.06	0.96
21	7248 S	19.29	3.12
22	7255 N	06.48	0.48
23	7269 N	07.16	0.64
23	7275 S	18.38	4.07
24	7283 N	07.43	
24	7289 S	19.06	3.46
25	7296 N	06.26	0.31
25	7303 S	19.33	3.17
26	7310 N	06.53	0.42
27	7324 N	07.20	
27	7330 S	18.43	3.81
28	7337 N	06.03	
Apr.1966 1	7398 S	17.30	2.73
2	7412 S	17.57	2.54
3	7419 N	05.17	0.25
3	7426 S	18.25	3.35
4	7433 N	05.45	
5	7453 S	17.35	2.79
6	7460 N	04.55	0.46
6	7467 S	18.02	5.57
7	7474 N	05.22	0.34
7	7480 S	16.45	4.19
8	7488 N	05.49	0.39
8	7494 S	17.12	3.99
9	7501 N	04.32	0.74
10	7515 N	04.59	0.30
10	7521 S	16.20	
11	7529 N	05.27	0.77
11	7535 S	16.47	5.27
12	7542 N	04.09	0.59
12	7549 S	17.15	5.01
13	7556 N	04.37	0.53
13	7562 S	15.57	4.62
14	7570 N	05.04	0.77
15	7583 N	03.47	0.37
16	7597 N	04.14	0.25
16	7603 S	15.36	3.48
17	7611 N	04.31	0.70
18	7624 N	18.23	0.35
19	7638 N	03.51	0.37
19	7644 S	15.13	5.16
20	7651 N	02.33	0.68
20	7658 S	15.40	5.93
21	7665 N	03.01	0.56
21	7671 S	14.23	3.58
22	7679 N	03.28	0.40
22	7685 S	14.40	3.69
23	7692 N	02.11	0.31
24	7706 N	02.38	
24	7712 S	14.00	3.93

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Apr.1966	25	7720 N	03.05	
	25	7726 S	14.27	4.05
	26	7733 N	01.48	
	26	7740 S	14.54	5.20
	27	7753 S	13.36	4.85
	28	7761 N	02.42	
	28	7767 S	14.04	3.03
	29	7774 N	01.25	
	29	7781 S	14.31	3.99
	30	7788 N	01.52	1.02
	30	7794 S	13.14	2.98
May,1966	1	7802 N	02.19	0.72
	1	7808 S	13.42	3.68
	2	7822 S	13.09	3.02
	3	7829 N	01.30	
	3	7835 S	12.51	3.63
	4	7843 N	01.57	
	4	7849 S	13.18	5.21
	5	7856 N	00.39	0.83
	5	7863 S	13.46	4.42
	6	7870 N	01.07	1.21
	6	7876 S	12.28	4.37
	7	7884 N	01.34	0.83
	7	7890 S	12.55	4.30
	8	7897 N	00.17	
	8	7904 S	13.23	3.69
	9	7911 N	00.44	
	9	7917 S	12.05	2.54
	10	7925 N	01.11	0.49
	10	7931 S	12.32	
	10	7938 N	23.54	
	11	7945 S	13.00	3.84
	12	7952 N	00.45	0.74
	12	7958 S	11.42	3.98
	13	7966 N	00.48	0.84
	13	7972 S	12.10	4.21
	14	7986 S	12.37	3.26
	14	7993 N	23.59	0.67
	15	7999 S	11.19	1.30
	16	8013 S	11.47	2.22
	17	8027 S	12.14	2.53
	18	8040 S	10.57	2.45
	19	8048 N	00.13	0.86
	19	8061 N	22.45	
	20	8068 S	11.51	1.75
	20	8075 N	23.13	0.36
	21	8081 S	10.34	2.83
	21	8089 N	23.40	

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
May, 1966	22	8095 S	11.01	2.23
	22	8102 N	22.23	0.86
	23	8109 S	11.28	2.28
	23	8116 N	22.50	1.15
	24	8122 S	10.11	2.13
	26	8150 S	11.05	2.48
	26	8157 N	20.23	1.70
	27	8163 S	09.48	3.59
	27	8171 N	22.54	1.09
	28	8177 S	10.15	1.70
	28	8184 N	21.37	0.82
June'66	4	8273 S	09.56	
	4	8280 N	21.18	
	6	8307 N	20.29	
	7	8314 S	09.34	
	7	8321 N	20.55	
	22	8526 N	19.04	
	24	8553 N	18.11	
	25	8567 N	18.36	
	26	8573 S	05.59	
	26	8580 N	17.20	
	27	8594 N	17.48	
	29	8621 N	16.57	
	30	8635 N	17.25	

NAIROBI

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
July 1966	1	8649 N	17.50	1.54
	2	8662 N	16.33	2.42
	3	8676 N	17.00	1.86
	4	8682 S	04.24	0.27
	5	8696 S	04.53	0.24
	6	8717 N	16.37	2.44
	7	8723 S	04.02	0.30
	7	8731 N	17.04	2.05
	8	8744 N	15.49	3.26
	12	8792 S	04.35	0.26
	14	8826 N	15.02	1.57
	18	8881 N	15.05	1.72
	19	8887 S	02.32	0.50
	20	8908 N	14.15	1.83
	21	8915 S	03.24	0.80
	21	8922 N	14.41	0.62
	24	8963 N		2.05
	26	8983 S	02.12	0.67
	26	8990 N	13.30	2.53
	27	9004 N		2.95
	28	9010 S	01.23	0.42
	29			
August 1966	4	9113 N	12.20	3.46
	8	9161 S	01.10	.99
	8	9168 N	12.25	2.02
	13	9236 N	11.15	1.80
	15	9264 N	12.10	1.25
	19	9318 N	10.25	1.50
	20	9338 S	22.15	.61
	20	9332 N	10.55	2.54
	21	9352 S	22.47	1.68
	22	9359 N	10.05	2.63
	22	9365 S	21.25	2.59
	25	9406 S	21.05	1.96
	26	9414 N	10.10	1.77
	26	9420 S	21.30	1.28
	27	9434 S	22.00	2.26
	28	9441 N	09.20	1.54

DAR ES SALAAM

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
July, 1966	3	8669 S	03.53	
	7	8723 S	04.02	.060
	9	8751 S	04.57	.099
	10	8764 S	03.39	.120
	11	8778 S	04.07	.11
	11	8785 N	15.25	1.49
	12	8792 S	04.30	.104
	13	8805 S	03.10	.143
	13	8813 N	16.12	1.46
	15	8833 S	04.11	.079
	16	8846 S	02.53	.116
	16	8854 N	15.58	1.13
	17	8860 S	03.20	.143
	17	8867 N	14.41	.923
	18	8881 N	15.07	1.10
	19	8887 S	02.30	.092
	20	8908 N	14.10	1.33
	21	8915 S	03.25	.150
	22	8928 S	02.07	.149
	22	8936 N	15.05	1.470
	25	8969 S	01.45	.117
	26	8983 S		.224
	26	8990 N	13.31	2.14
	27	8997 S	02.39	.20
	28	9010 S	01.22	.160
Aug. 1966	1	9065 S	01.26	.266
	1	9072 N	12.40	1.85
	2	9079 S	01.53	.083
	3	9100 N	13.40	1.80
	5	9120 S	01.30	.105
	6	9141 N	13.10	2.41
	7	9154 N	11.59	1.86
	8	9161 S	01.0[illegible]	.087
	11	9202 S	00.44	.090
	12	9215 S	23.27	.191
	12	9223 N	12.30	1.93
	13	9229 S	23.54	.266
	14	9243 S	00.25	.196
	14	9250 N	11.41	1.37
	15	9264 N	12.05	1.74
	15	9256 S	23.04	.203
	16	9270 S	23.31	.360
	18	9304 N	10.01	1.86
	20	9324 S	21.50	.174

ADDIS ABABA

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
July, 1966	1	8649 N	17.45	2.54
	2	8662 S	16.25	2.73
	3	8669 S	05.30	.107
	3	8676 N	16.15	2.42
	4	8690 N	17.25	2.68
	5	8696 S	04.40	.113
	5	8703 N	16.05	2.65
	6	8717 N	16.35	2.27
	7	8723 S	03.50	.084
	7	8732 N	17.00	2.33
	8	8737 S	04.15	.209
	8	8744 N	15.45	2.40
	9	8751 S	04.45	.170
	9	8758 N	16.10	2.83
	10	8772 N	16.35	2.89
	11	8785 N	15.20	3.13
	12	8786 N	15.45	3.37
	13	8805 S	03.05	.233
	13	8813 N	16.15	2.63
	14	8819 S	03.30	2.02
	15	8833 S	04.00	.146
	15	8840 N	15.25	2.67
	16	8846 S	02.40	.187
	17	8867 N	14.35	1.35
	18	8881 N	15.00	2.66
	19	8887 S	02.15	.191
	19	8895 N	15.30	2.73
	20	8908 N	14.10	2.66
	21	8915 S	03.10	.227
	21	8922 N	14.40	2.26
	22	8928 S		.214
	22	8936 N	15.05	1.95
	23	8942 S	02.20	.227
	23	8949 N	13.50	2.59
	24	8963 N	14.15	2.89
	25	8977 N	14.40	2.45
	26	8990 N	13.25	2.81
	28	9018 N	14.20	2.94
	29	9024 S		.870
	30	9045 N	13.30	2.88
	31	9059 N	13.55	2.74
Aug.1966	1	9065 S	01.15	.445
	1	9072 N	12.40	2.93
	2	9086 N	13.05	2.64
	3	9100 N	13.35	2.60
	4	9113 N	12.15	2.69
	5	9127 N	14.45	2.68
	6	9133 S	00.00	.334
	6	9141 N	13.10	2.28
	7	9154 N	11.55	2.44

Date		BE-B Pass No.	Time L.T.	Content x 10^{-17}
Aug.1966	8	9168 N	12.20	2.22
	8	9174 S	23.55	.2[illegible]8
	9	9182 N	12.50	2.35
	11	9209 N	12.00	2.05
	11	9215 S	23.15	.23
	12	9223 N	12.25	2.42
	12	9229 S	23.40	.428
	13	9236 N	11.05	2.27

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11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY Air Force Cambridge Research Laboratories through the European Office of Aerospace Research, (OAR).

13 ABSTRACT

Results are presented for total content at Nairobi since October 1964, and for Addis Ababa and Dar es Salaam since June 1966. Latitude variation of total content is being studied using three spaced receiving stations on similar longitudes; preliminary results are presented for the period July/August 1966. Study of irregularities has been commenced using scintillations of transmissions from B.E.-B and B.E.-C and the heights of these irregularities will be determined from transmissions from B.E.-B using spaced aerials. One of us (A.R.Webster) has made a study of geometric errors in Faraday reduction. Other work includes the determination of ionospheric parameters by means of an Ionosonde, investigations on the shape, size and speed of irregularities, by a spaced aerial technique, and recording of the variations of the earth's magnetic field. Future plans include continuation of the above work, development of automatic Faraday null reading equipment and possibly the addition of one or two other stations for the study of the latitude variation of scintillations and total content.

DD FORM 1 JAN 64 1473

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Total Electron Content, Faraday Rotation, Irregularities, Scintillations, Ionospheric Parameters, Latitude Variation, Magnetic Observatory, Ionosonde, Equipment.						

INSTRUCTIONS