VARIATIONS IN IONOSPHERIC *F*-REGION CHARACTERISTICS*

By N. M. Brice†

It is well known that *F*-region characteristics in the undisturbed ionosphere change with season and with sunspot activity and that these effects are greatest at high geomagnetic latitudes (Maeda 1955; Martyn 1955).

h'f records have been obtained at Macquarie Island (geomagnetic latitude 60 °S., local magnetic dip angle 78°) since 1950 and some of these were examined to study the above changes.

Method of Analysis

At the suggestion of Dr. D. F. Martyn, some Macquarie Island *h'f* records were scaled and electron density versus true height (N,h) curves computed on Silliac (School of Physics, University of Sydney) using the programme of Duncan (1958). Records were chosen near midday and midnight, summer and winter, and at sunspot maximum (S. max.) and sunspot minimum (S. min.) activity.

During sunspot minimum, no records were obtainable at night in winter, owing to very low critical frequencies, spread echoes, or noise.

* Manuscript received August 13, 1958.

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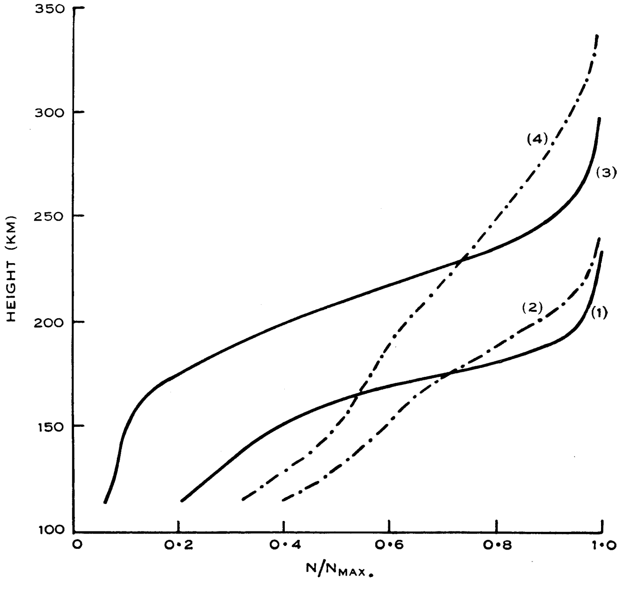

Fig. 1 (*a*).—Day. (1) Winter sunspot minimum, (2) summer sunspot minimum, (3) winter sunspot maximum, (4) summer sunspot maximum.

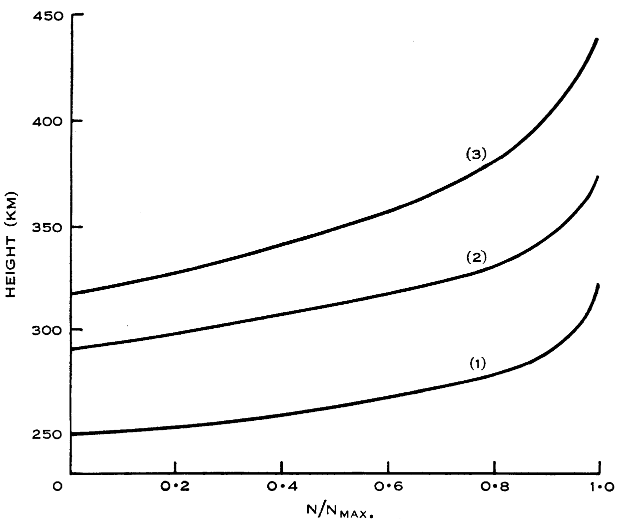

Fig. 1 (*b*).—Night. (1) Summer sunspot minimum, (2) winter sunspot maximum, (3) summer sunspot maximum.

Some uncertainty of true height occurred in the E region, as no frequencies less than $1 \cdot 22$ times the gyro frequency in the F region (i.e. below $2 \cdot 05$ Mc/s) could be used on this programme (Duncan 1958). However, the effect of this at F-region heights is negligible. It was assumed that no substantial trough in electron density occurred between layers, and records were restricted as far as possible to magnetically quiet days.

Between six and ten records were used for each period and a mean curve was obtained by plotting $N/N_{\mathrm{max.}}$ against true height for each record and averaging heights. According to Schmerling and Thomas (1956), this is sufficient to show the character of the (N,h) profile, and inspection of the curves showed a strong similarity of shape between the mean curve and the individual curves used in each period.

Results

Figure 1 shows the mean curves for the periods examined and Table 1 gives some parameters derived from the (N,h) curves.

In this presentation $h_{\mathrm{max.}}$ and $N_{\mathrm{max.}}$ refer to the height and electron density at the level of maximum ionization, and S. max. and S. min. to observations at maximum and minimum sunspot activity respectively.

Chief features of interest are :

(*a*) *Heights.*—(i) Heights of the maximum electron density of both F_1 and F_2 layers are greater at S. max. than S. min. (ii) $h_{\mathrm{max.}}$ is greater at night than during the day at all epochs (Mitra 1952). (iii) $h_{\mathrm{max.}}$ is greater in summer than in winter. By day this effect is more pronounced at S. max. than S. min.

(*b*) *Total Electron Content below* $\mathrm{N}_{\mathrm{max.}}$.—(i) The excess of electron content in summer over that in winter is due equally to increases in low height ionization (E and F_1 layers) and in F-region thickness and to a less extent to greater $N_{\mathrm{max.}}$. (ii) At night (S. max.) the summer increase is due to greater $N_{\mathrm{max.}}$ and increased thickness of the layer. (iii) By day (S. max.) despite the summer increase in F_2 thickness and in E and F_1 ionization, the total electron content is greater in winter due to the greatly increased value of $N_{\mathrm{max.}}$.

(*c*) *Scale Heights.*—The difference between $h_{\mathrm{max.}}$ and the height at $0 \cdot 698N_{\mathrm{max.}}$ (corresponding to one scale height of a Chapman layer) and between $h_{\mathrm{max.}}$ and the height at $0 \cdot 958N_{\mathrm{max.}}$ (or $0 \cdot 4$ scale heights) were found. From these it is seen that (i) by night the profiles are not incompatible with Chapman layers ; (ii) by day in winter, the curvature of the profile approaching $N_{\mathrm{max.}}$ increases more rapidly than expected for a Chapman layer, whereas in summer it increases less rapidly than expected (at S. max.) or fits a Chapman layer (at S. min.).

Discussion

These curves are, to the best of the author's knowledge, the first high southern latitude (N,h) profiles calculated. While no attempt is made to discuss the implications of the results, it is felt that they will be of assistance to those working

TABLE 1

PARAMETERS DERIVED FROM THE (N,h) CURVES

Period	Average Height of F_1 Maximum Ionization (km)	Height F_2 (km)	F Region Thickness (km)	$N_{max.}$ ($\times 10^6$ cm^{-3})	Total Electron Content below $N_{max.}$ ($\times 10^{12}$ cm^{-2})	Chapman Scale Height at $Z = -1$ (km)	Chapman Scale Height at Nose (km)
Summer Sunspot Minimum Day ..	169	240	124	0·338	3·3	66	65
Winter Sunspot Minimum Day ..		235	115	0·328	2·7	60	90
Summer Sunspot Maximum Day ..	202	338	219	0·606	9·9	119	85
Winter Sunspot Maximum Day ..		298	175	1·772	16·4	73	85
Summer Sunspot Minimum Night ..		320	71	0·112	0·6	49	55
Summer Sunspot Maximum Night ..		437	121	0·456	3·3	72	66
Winter Sunspot Maximum Night ..		372	81	0·211	1·2	51	55

on the theory of the quiet ionosphere. They certainly substantiate King's statement (1957) that h_pF_2* is meaningless during the day.

Acknowledgment is due to the Ionospheric Prediction Service, Department of the Interior, for the loan of the records which were obtained in cooperation

* h_pF_2, defined as the virtual height at 0·834 of the critical frequency, is commonly used as the real height of $N_{max.}$. This is only correct for a parabolic (N,h) profile.

with Antarctic Division, Department of External Affairs. The author wishes to express his thanks also to Dr. D. F. Martyn, F.R.S., and Mr. R. A. Duncan (Radio Research Laboratories) and Dr. J. A. Thomas (University of Queensland) for advice and assistance with this work and to Professor H. Messel (University of Sydney) for permission to use Silliac.

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