Seasonal Variation of f_0F2 and Abnormal Ionization in F Region at Syowa Base in Antarctica

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昭和基地における F2 層長期変化及び特異現象について

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要 旨

昭和34年2月11日より35年1月16日に至る第3次越冬期間の電離層資料をもとにして，主としてF領域についての解析をおこなった.

その第1は f_0F2 の年間の変化をみると，f_0F2 の最大値が正午より大幅におくれていることに着目し，その特性を南北両オーロラ地帯の資料と比較した．その結果 f_0F2 最大値の正午からの遅れは磁気経度と密接な関係を有し，又南北両極のF2層の変化は，対蹠点間で良い対応を示し，同経緯度にある局間では対応の悪いことが明らかになった.

その第2は従来オーロラ反射と思われていたF領域における異常電離は昭和基地のイオノグラムの中にしばしば出現し，その特性，出現頻度をしらべると，Es 層と非常に似通っており，今後 Fs 層として電離層特性の中に加えた方が便利であろうと考える.

Introduction

This paper provides the results with some analyses of the vertical sounding at Syowa Base (69°00′S, 39°35′E) for one year from February 1959 through January 1960.

Sounding schedule closely followed the observing programme recommended for IGC.

Soundings were taken every 15 minutes on ordinary days and every 5 minutes on Regular World Days, during Special World Intervals and for 12 hours of nights in winter.

At first the correspondency of the monthly median values of f_0F2 between Arctic and Antarctic regions is discussed.

Secondly, it is proposed that the abnormal ionization in F region which is certainly recognized to be due to neither oblique echo nor transient should be listed in the monthly table of ionospheric characteristics in high latitude.

Correspondency of f_0F2 between both regions Arctic and Antarctic

The diurnal variations of the monthly median values of f_0F2 in each month from

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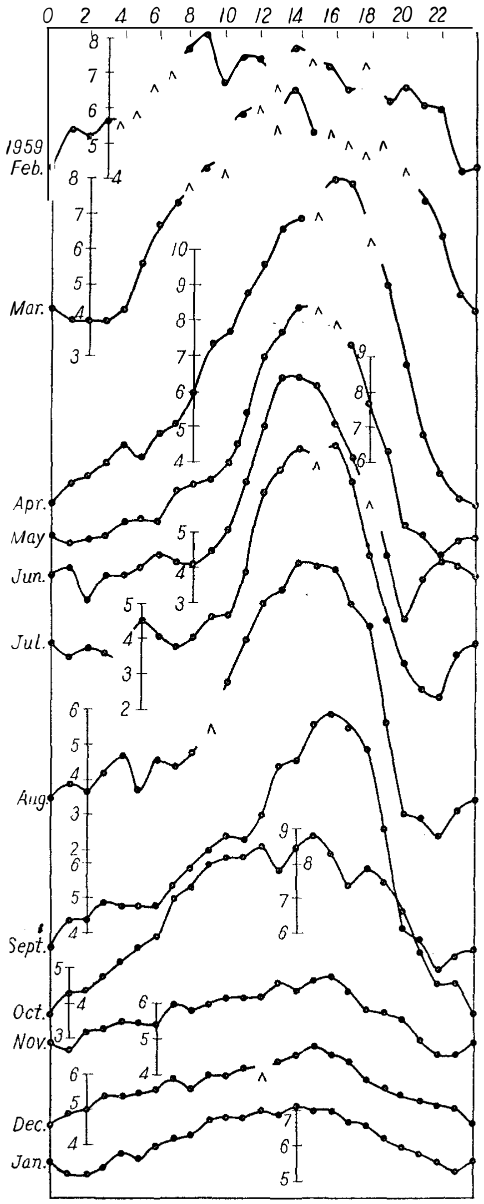

Fig. 1. Monthly median values of f_0F2 at Syowa Base.

February 1959 through January 1960 at Syowa Base are shown in Fig. 1. In this figure we can easily find that the maximum value of f_0F2 appeared at the time systematically delayed from noon with seasons except summer.

Investigating the data at stations in Arctic and Antarctic auroral zone, there seems to exist such a fixed delay time consistent at each station, especially in equinoctial seasons.

The above delay time and the shape of the diurnal variation of f_0F2 at Syowa Base were compared with those at Fairbanks, near the antipode to Syowa Base, and at Kiruna, the conjugate point with the same magnetic latitude and longitude with Syowa Base.

The diurnal variations of f_0F2 at these stations are shown in Fig. 2. Better correspondence is seen between the stations that are situated symmetrically to each

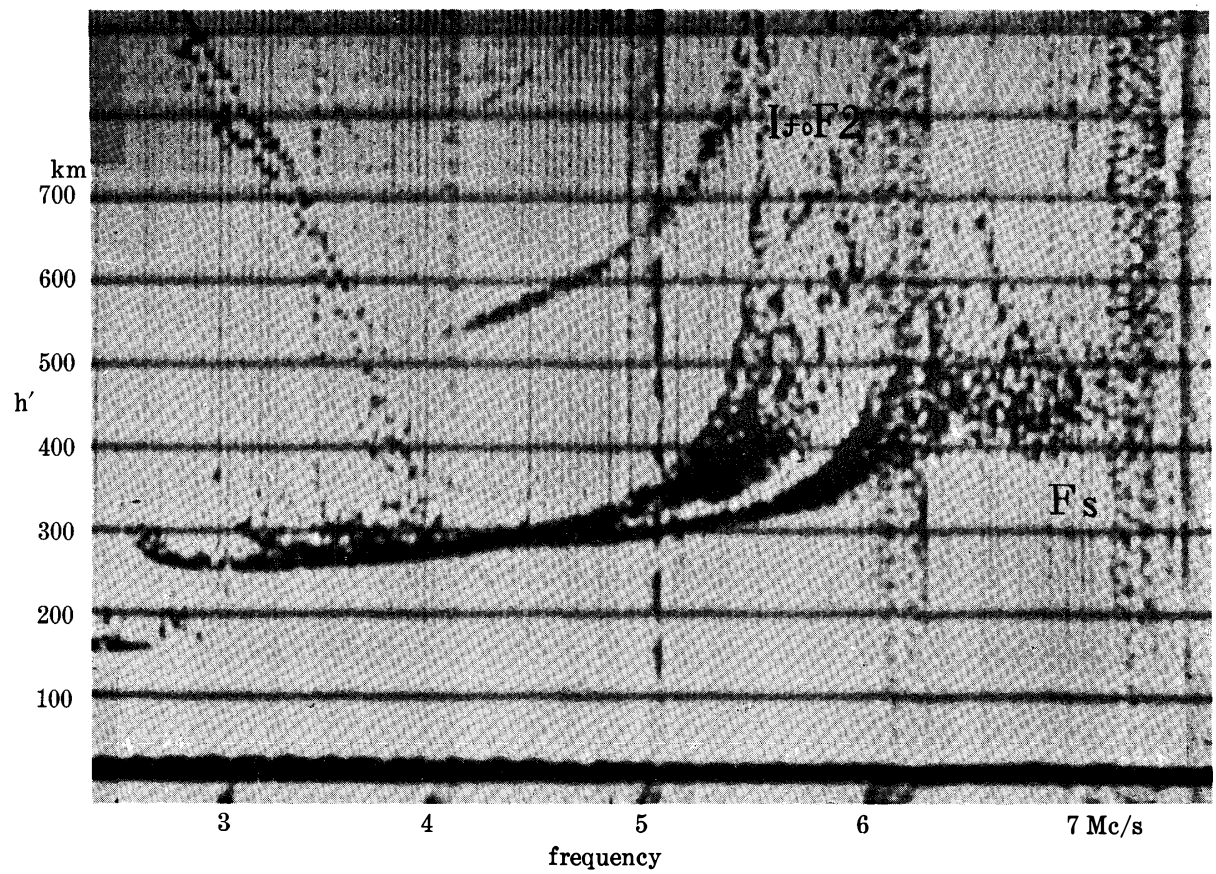

Photo 1 (a). An example of h-type Fs.

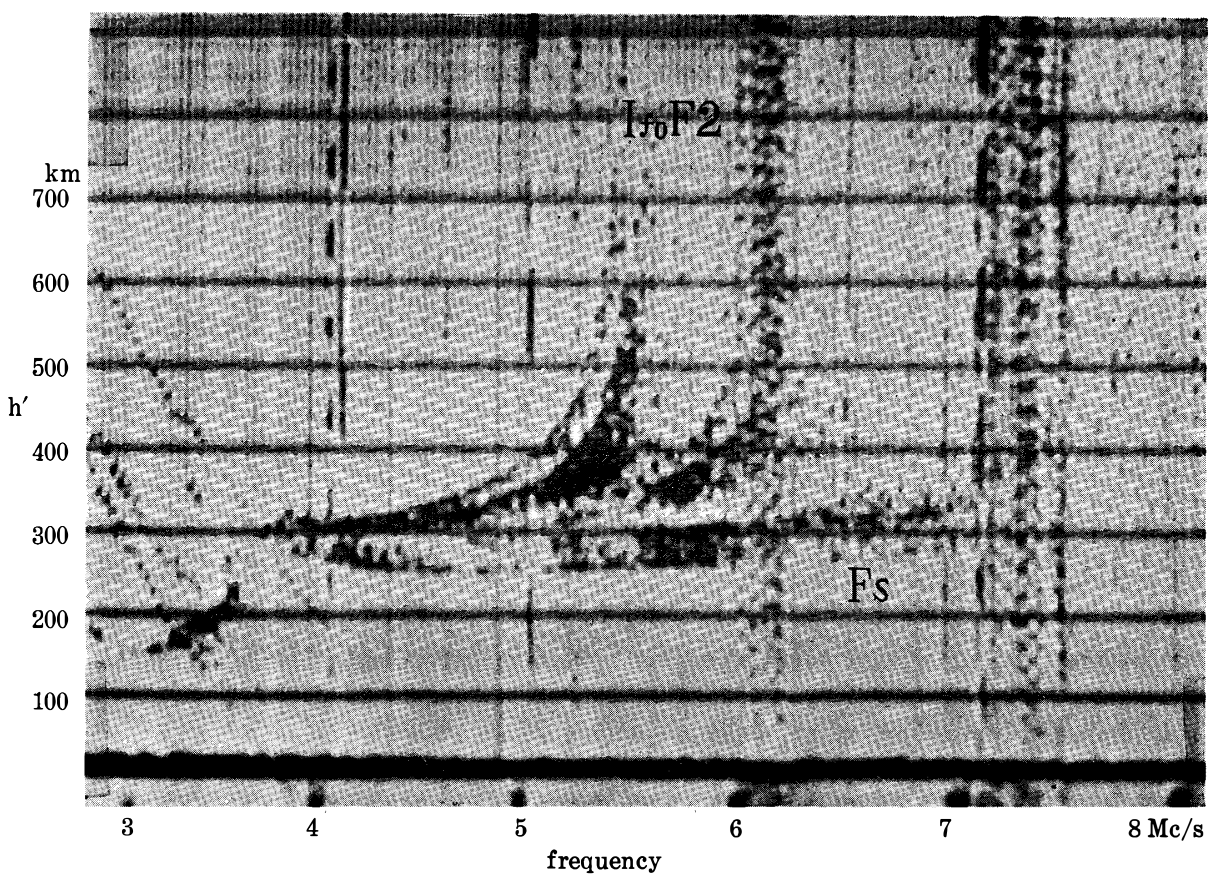

Photo 1 (b). An example of l-type Fs.

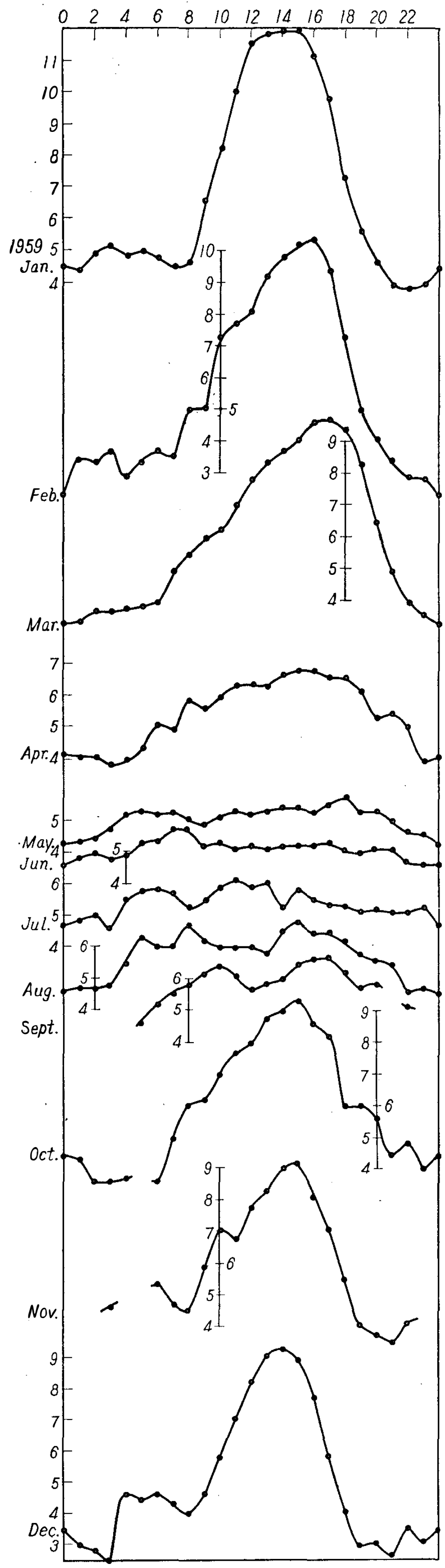

Fig. 2 (a). Monthly median values of f_0F2 at Fairbanks.

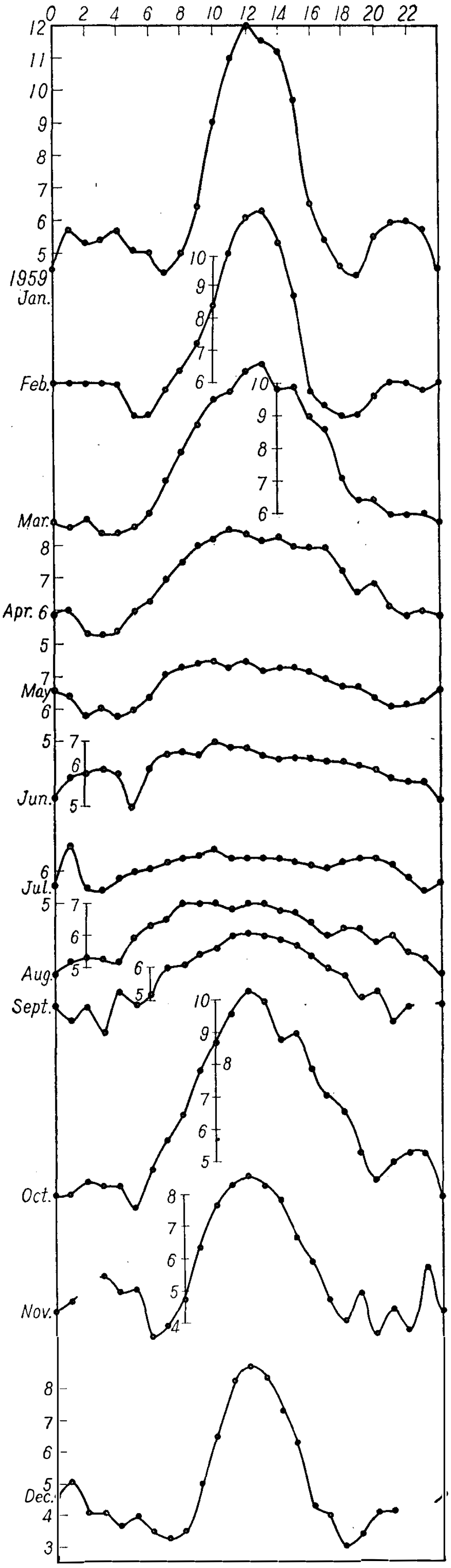

Fig. 2 (b). Monthly median values of f_0F2 at Kiruna.

other about the geomagnetic axis than between those stations conjugate with each other.

Using this relation, stations in southern auroral zone were inverted to the sites in the northern hemisphere with the same latitude and with the longitude 180° apart, to get the corresponding longitudinal effect on the delay time of f_0F2 maximum.

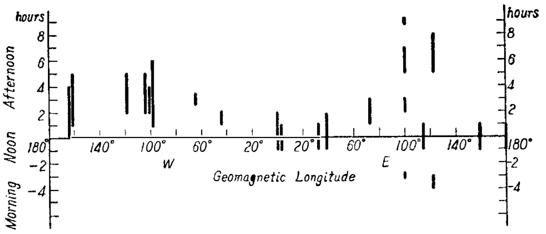

Fig. 3. Longitudinal effect with delay time of maximum of f_0F2.

This is shown in Fig. 3, geomagnetic longitude being in abscissa and the delay time from noon in ordinate. Geomagnetic longitudes are defined as the geomagnetic meridians among which that containing geomagnetic and geographic south poles is the 0° meridian. It will be recognized in the figure that at 90°W the delay time becomes maximum, even though not so clear at 90°E, and minimum down to zeronear 0° and 180°.

Fig. 3 may provide many suggestions on the formation of F2 layer. Even by simple consideration, it is obvious that although the delay time of E and F1 layers have a simple correlation with the zenith angle of the sun, that of F2 layer has a complex correlation with the solar zenith angle and the geomagnetic longitude.

Abnormal ionization in F region

For reduction of f_0F2 in high latitude it is difficult to distinguish the true F2 layer critical frequencies from those affected by oblique and transient echoes. Abnormal traces, however, which are considered to be neither normal nor oblique and transient, were very often found in the ionograms observed at Syowa Base. They have the following characteristics:

1) Lower part of the trace is subject to retardation by E region ionization.
2) The traces continue at least about 30 minutes; that is not similar with the transient layers.
3) The virtual height of the trace does not change so rapidly in the sequence of the ionograms.
4) The trace has the virtual height lower than that of normal F which is decided by f-plot.

The abnormal traces mentioned above will be as Fs layer.

The distributions of occurrence times of Fs and Es with local time are shown in Fig. 4 (a) and (b) respectively. They are quite in good coincidence, but it does

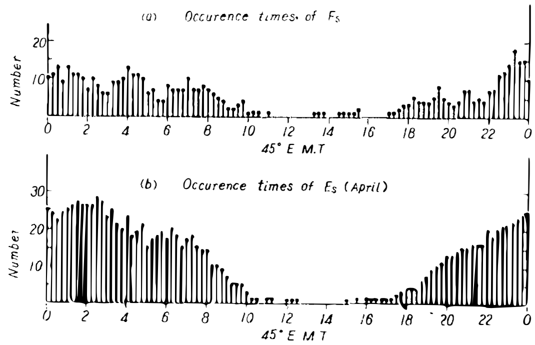

Fig. 4. The distributions of occurrence times of Fs and Es with local time.

not mean that Fs and Es always appear simultaneously.

On the contrary, Fs traces generally appear just before or after the time when Es ionization or polar black-out comes into sight.

The relation between the frequency of occurrence of Fs layer and the virtual height is shown in Fig. 5, although the data used for the analysis are sampled every 5 days in each month.

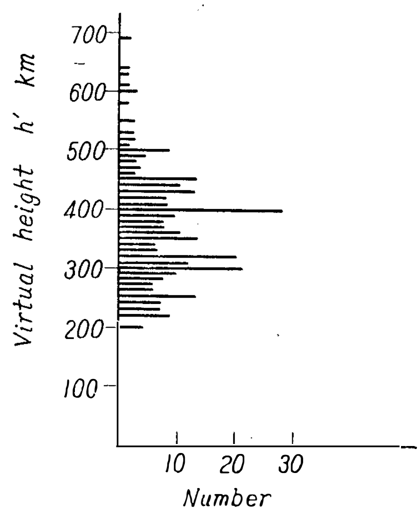

Fig. 5. Distribution of occurrence times of Fs with the virtual height.

Two examples of Fs traces are shown in Photo 1. As for the classification of the type of Fs, it is recommended that symbols now adopted for reduction of Es are here applied. For example, (a) and (b) in Photo 1 may be classified as h and l respectively.

When interpreting Fs traces, attention should be drawn to the similar characters as Es, for example, partial transparency, power dependence of top frequency and so on. Besides, the type of the occurrence distribution of Fs suggests that Fs would be formed by the corpuscular incidence into the ionosphere.