



SPORADIC E, SPREAD-F AND SOME IONOSPHERIC OSCILLATORY PHENOMENA IN THE FAR EAST

Xin-Yu Huang and Shun-Rong Zhang

Wuhan Ionospheric Observatory, Wuhan Institute of Physics, Chinese Academy of Sciences, P.O. Box 71010, 430071 Wuhan, P.R. China

ABSTRACT

By using the ionosonde data from China, Japan and Papua New Guinea, Sporadic E, Spread-F and the ionospheric profile behaviours are investigated. Distinct from earlier investigations the center of occurrence of Es is found near 105°E, 33°N. It is also suggested that the spread-F and the scatter Es morphology as well as the profile oscillation may be associated with the AGW activity over South China.

SPORADIC-E

Earlier Es-contour maps show an occurrence maximum centered in Southern Japan /1/. With data for June of 1969, 1975, 1981 and 1986 from 10 Chinese and 6 Japanese stations we could show (Figure 1) that this maximum lies in Central China /2/, near Chongqing (29.5°N, 106.4°E) and Lanzhou (36.0°N, 103.9°E), as shown in Figure 1. Since no data from China were used in the earlier investigations we exclude a shift of the center with time feeling that it had always the position we have found now. We note that the 1985 International Geomagnetic Reference Field (IGRF-85) reveals at the ionospheric height a much stronger horizontal intensity of the geomagnetic field over South China than that over the surrounding areas, and the center of this so-call geomagnetic anomaly is situated at the region of the maximum Es occurrence with only a slight southward displacement. According to theoretical considerations for the relationship between Es occurrence and the horizontal field intensity /3/, it seems that the high Es occurrence in Chongqing and Lanzhou may be due to the geomagnetic anomaly.

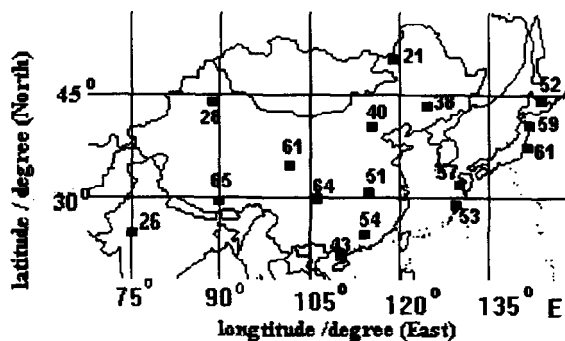


Fig. 1 Occurrence (in percent) of foEs exceeding 5 MHz for June of 1969, 1975, 1981 and 1986. (The plot was produced according to the data shown in the Figure 1b of /2/).

It is also interesting to note that, several types of Es (equatorial Es, auroral Es and slant Es), which are characterized by scatter traces and considered to appear usually in equatorial or polar regions and rarely at other latitudes are frequently observed on ionograms at Wuchang, a representative station of lower mid-latitude in East Asia. The scatter type of Es is generally considered to be relevant to the plasma instabilities excited by various processes. Moreover, it seems that the same origin may be also associated with spread-F in South China as discussed below.

SPREAD-F

The analysis of the ionogram data from Port Moresby (9.4°S, 147.2°E), Papua New Guinea and 7 East Asian stations (Wakkanai, Akita, Kokubunji, Yamagawa, Wuchang, Okinawa and Singapore) indicates that in the East Asian-Oceanian Sector, spread-F appears more often after mid-night than before /4/, as illustrated in Figure 2. This is quite distinct from other regions, namely: American sector, Euro-African sector and Central Asian-Indian subcontinent semi-sector, where spread-F is found to be present more often before midnight /5/.

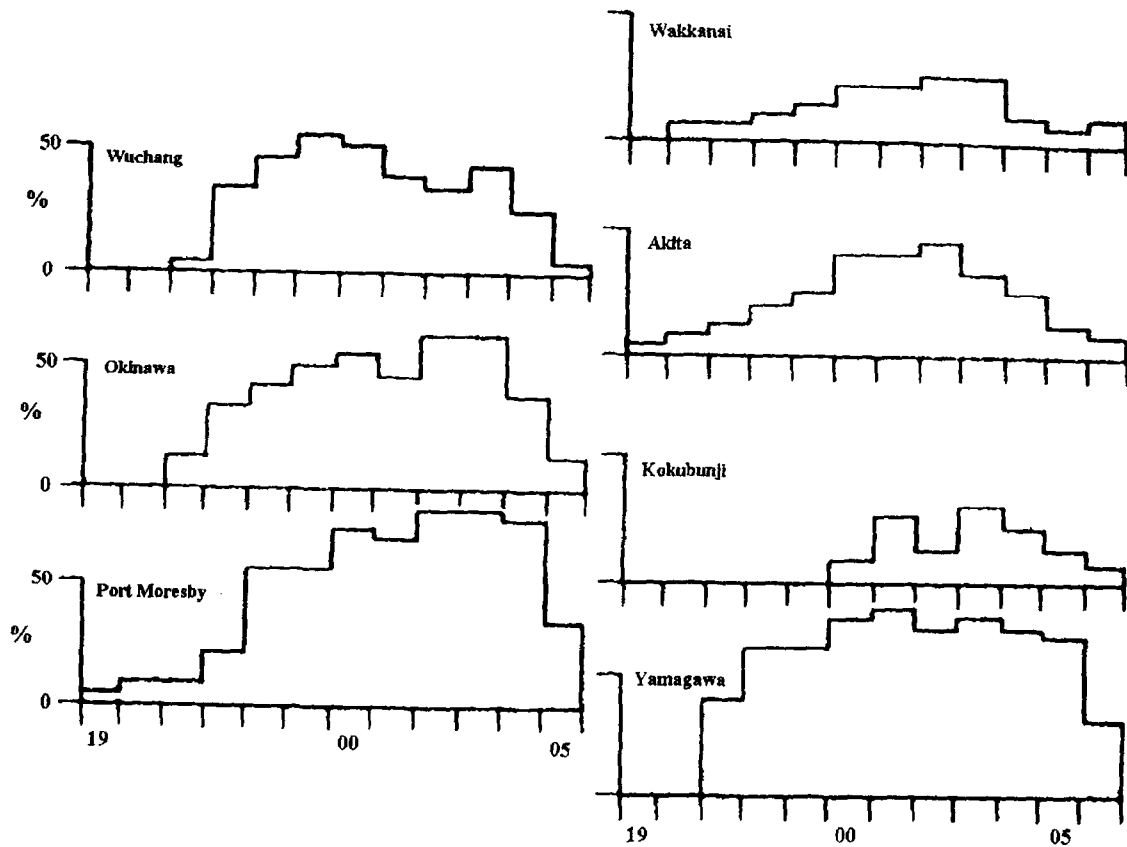


Fig. 2 Percentage occurrence of nighttime spread-F for May 27 - June 19, 1983 at stations of Wakkanai (45.4°N, 141.7°E), Akita (39.7°N, 140.0°E), Kokubunji (35.7°N, 139.5°E), Yamagawa (31.2°N, 130.6°E), Wuchang (30.5°N, 114.4°E), Okinawa (26.3°N, 127.8°E), and Port Moresby (45.4°N, 141.7°E). (after /4/).

On the other hand, the behaviour of Spread-F is distinct in the north and the south of China /6/. In the south, the occurrence rate is similar to that of Es, i.e., higher in summer than in winter, whereas in the north, it is higher in winter. Accordingly, it is expected that there are different source mechanism active in the two areas. In fact, in North China, spread-F appears always accompanied by a geomagnetic storm. In South China, it occurs 2 hours later than over Wuchang when it has been onset over the southern station Haikou (20.2°N, 110.3°E). Thus it seems that the observed spread-F in South China may be generated as a indirect result of an atmospheric gravity wave (AGW) excited near the equatorial area and travelling from south to north. Moreover, previous authors pointed out that spread-F is generally associated with the strong VHF scintillation, which results from plasma instabilities. These facts lead to a conclusion that the instabilities possibly existing frequently in South China and generating the spread-F and the scatter Es may be relevant to the AGW activity in the region. The AGW may also induce the ionospheric profile oscillations as demonstrated below.

IONOSPHERIC OSCILLATORY PROFILES

A set of ionosonde data for Wuchang in 1964, 1965 (low solar activity years) and 1994 (high solar activity year) is analysed using the inversion technique shown in /7, 8/. It appears that, by day for 1/3 of all cases considered, quasi-periodical fluctuations of the peak parameters (foF2 and hmF2) can be identified clearly with a period of 2 to 4 h. The whole F-region profile is found to be rarefied and compressed alternately and exhibit the feature of oscillations. Figure 3 give such examples of the oscillatory profiles for 5th March 1964.

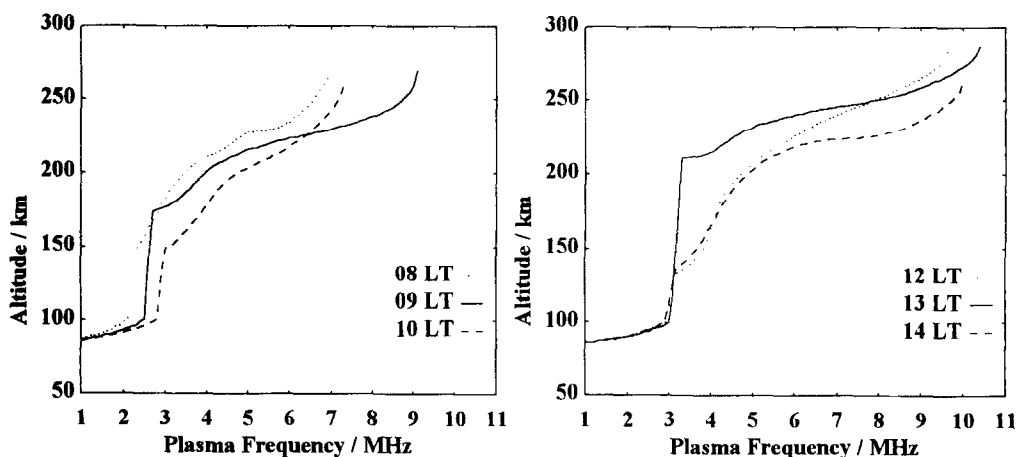


Fig. 3 A case of oscillatory profiles for 5th March 1965. The left panel is for 08-10 LT, where the F-layer thickness becomes greater and smaller, and the right for 12-14 LT, where the thicknesses becomes smaller and greater..

CONCLUSIONS

In East Asia, transient phenomena like Es and spread-F show features that are distinct from those at other longitudes. In particular the occurrence center of sporadic E now found at about 33°N, 105°E differs from earlier statements by at least 25° in longitude. Many experimental facts suggest a local disturbance source over South China responsible of the AGWs, due to which, the scatter Es and spread-F morphology may be produced by excited plasma instabilities, and the oscillations of the electron density profiles may be also induced.

ACKNOWLEDGEMENTS

We thank Dr. Zan-Ju Li (Wuhan Ionospheric Observatory, China) and Prof. Tian-Xi Huang (Wuhan University, China) for their useful suggestions and assistance in preparing the manuscript of this paper. They have also provided original plot for the compilation of the Figures 1 and 2. We are also grateful to Prof. K. Rawer and the referee for the help with English wording and the critical comments in evaluating this paper. This work were supported by National Natural Science Funds of China.

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