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Types of Ionospheric SF at Low Latitude: Digisonde Observation

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Irregularities are common phenomenon in the ionosphere. They have different types in different lays and can be measured with various instruments. Digisonde is a good instrument to measure the ionospheric irregularities, such as the E-lay irregularity sporadic-E (Es) and F-lays irregularity spread-F (SF). It has an advantage of not only clearly showing the Es and SF in their ionograms, but also giving Es and SF types that corresponds to different physics mechanism in the ionosphere. In the handbook of URSI, according to the Didisonde ionogram, the ionospheric irregularity SF observed wherever are divided into four types, i. e, frequency SF, range SF, mixed SF, and branch SF.

Using the data obtained with Digisonde at low latitude stations Hainan (109.1°E, dip.19.5°N), Vanimo (141.3°E, dip.11°S), Acsension IS (345.6°E, dip. 2.3°S), and Tucumán station (294.6°E, dip. 15.5°S), we mainly studied the types of SF at low latitude ionosphere. The results show that branch SF has never observed in these low latitude stations. However, a new type of SF, named strong range SF (SSF) which is drawn from the range SF, has often taken place at these low latitude stations. In the Digisonde ionogram, the SSF has characteristics that diffuse echoes extend from the low frequency to the high frequency, which make the ionospheric critical frequency foF2 is not definable.

Furthermore, the SSF often took place from 1800 to 2300 LT and had a maximum occurrence in the period of 2000 to 2200 LT. That is just in the period of peak occurrence of low latitude scintillation. While the other types of SF could take place from 18:00 to 08:00(+1) LT. The SSF had a maximum occurrence in the equinoxes and the summer, which is the same as the scintillations. The results also show that the SSF had closer correlation to scintillation in these stations. We also checked the data from high latitude and found that the SSF were never observed at high latitude station. It implies the SSF can only be observed at low latitude.

We also analyzed the Cosmic satellite *in-situ* date of Equatorial Plasma Bubbles (EPBs), it shows when the Cosmic flied over the low latitude station Hainan and Vanimo, the EPBs could be observed by Cosmic, and SSF and scintillations could be observed in the ground station concurrently. Since the ionospheric scintillation at low latitude is caused by the Equatorial Plasma Bubbles (EPBs), therefore, the SSF should also be results from the EPBs.

Therefore, we suggest that, in the low latitude region, the ionospheric SF be divided into four types, i.e., frequency SF, mixed SF, range SF and strong range SF, which is different from the SF types described in the URSI's Handbook. In the high latitude region, the ionospheric SF can be still divided for types, i.e., frequency SF, mixed SF, range SF and range SF, which is same types described in the URSI's Handbook. However, this needs to be further studied with the further observation.

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