



Study of nighttime Medium Scale Travelling Ionospheric Disturbances (MSTIDs) in the ionospheric F-region using all-sky imager and digisonde data

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ABSTRACT

The plasma irregularities are characterized by an abrupt variation in the ionospheric plasma density at F-region. The ionospheric irregularities may manifest as Travelling Ionospheric Disturbances (TIDs), Plasma Bubbles, Blobs and Brightness Waves. Some irregularities can affect the propagation of electromagnetic waves in the ionosphere, interfering in the transmission of radio signals used in telecommunications and positioning systems such as GPS and satellite navigation. This work presents a study of nighttime Medium Scale Travelling Ionospheric Disturbances (MSTIDs) using all-sky images in the OI 630.0 nm emission obtained with an all-sky imager installed at the Southern Space Observatory (29.4° S, 53.8° W) in São Martinho da Serra, RS. Also, data of a digisonde installed at Falkland Islands (51.4° S, 57.5° W), were analysed for the present study. We present events of MSTIDs and the effects of the ionization on its propagation in the nighttime ionosphere.

The single-band events may simply indicate such a long horizontal wavelength that only a fraction of a cycle fits in the field of view. As point out by Garcia et al., (2000), the Perkins instability (Perkins, 1973) has two serious deficiencies. First, the growth rate is small, on the order of $10^{-4} s^{-1}$. Second, the real part of the frequency has the wrong sign. The only robust result is the direction of k , which is quite unusual, being at a significant angle to the magnetic meridian. Nonetheless, this latter attribute of the theory is so significant that Perkins mechanism remains actively in vogue as an explanation.

1. INTRODUCTION

Hines (1960) postulated that the TIDs frequently seen in ionosphere data are mainly caused by AGWs gravity waves in the thermosphere. All-sky imaging system measurements of MSTIDs which we refer to here as Dark Band Structures (DBS) are comparatively rare. Probably, these dark band structures with Perkins plasma instability are generated at medium latitudes. Our observations of the MSTID/DBS are not related to geomagnetic disturbed conditions. It is important to note that, unlike equatorial spread F, these structures are not aligned with the magnetic meridian but rather are aligned from NW to SE in the northern hemisphere (GARCIA et al., 2000) and SW to NE in the south (PIMENTA et al., 2008). Even more importantly, these structures appear simultaneously at the conjugate location, which is definitive evidence that they are electrified. Using all-sky images in the OI 630 nm emission, we investigate the occurrence of MSTIDs events in the Brazilian sector during ascending phase of solar activity period.

2. METHODOLOGY

All-sky images of the OI 630.0 nm emission, detected by an all-sky imager installed at the Southern Space Observatory - SSO/CRS/INPE-MCTI, in São Martinho da Serra, RS (29.3° S, 53.8° W), which is in the central region of the South Atlantic Magnetic Anomaly, were analyzed along with data from a digisonde, installed in the Falkland Islands (51.4° S, 57.5° W).

3. OBSERVATIONS AND RESULTS

The observations are presented in Figures 1 and 3, as sequences of images "all-sky", of the OI 630 nm emission, with Figures 2 and 4 for the digisonde temporal variation of ionospheric parameters.

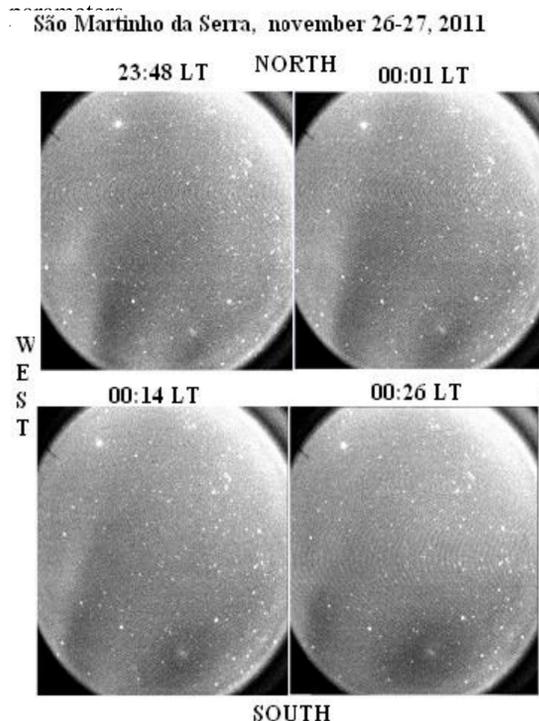


Figure 1- A sequence of images all-sky of the OI 630 nm, that illustrates the passage of MSTIDs over SSO, São Martinho da Serra. This is a night geomagnetically calm, whose Kp index shows the following variation: 1-, 0, 1, 1, 1, 1-, 1, 2-.

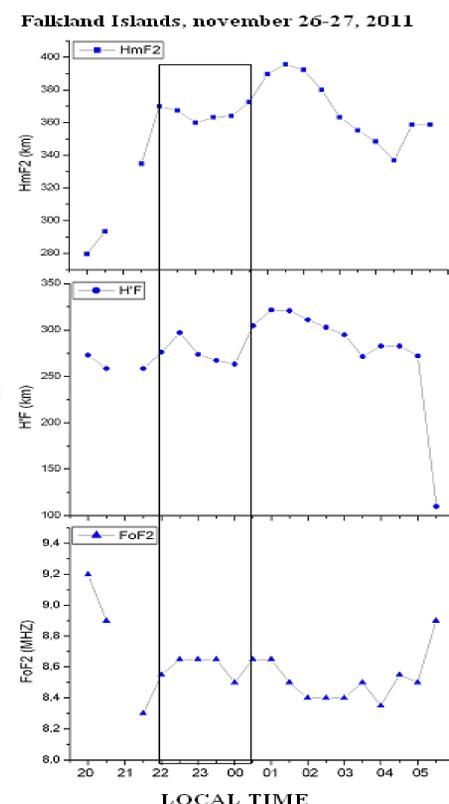


Figure 2- Temporal variation of ionospheric parameters h'F, hmF2 and foF2 for night of 26-27/11/2011, digisonde installed at Falkland Islands (51.4° S, 57.5° W).

São Martinho da Serra, december 26-27, 2011

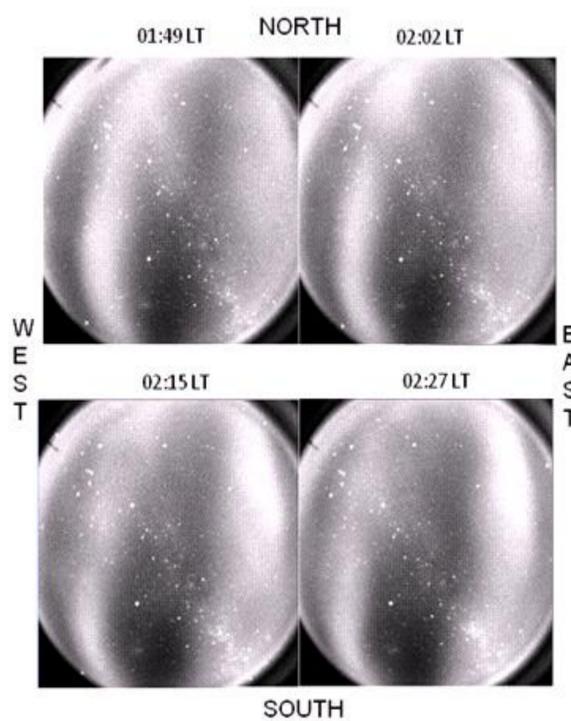


Figure 3- A sequence of images all-sky of the OI 630 nm, the night of 26-27/12/2011, that illustrates the passage of MSTIDs over SSO São Martinho da Serra during the ascending phase of the solar cycle. This is a night geomagnetically calm, whose Kp index shows the following variation: 0, 0, 0+, 0, 0, 0+, 0+, 0.

Falkland Islands, december 26-27, 2011

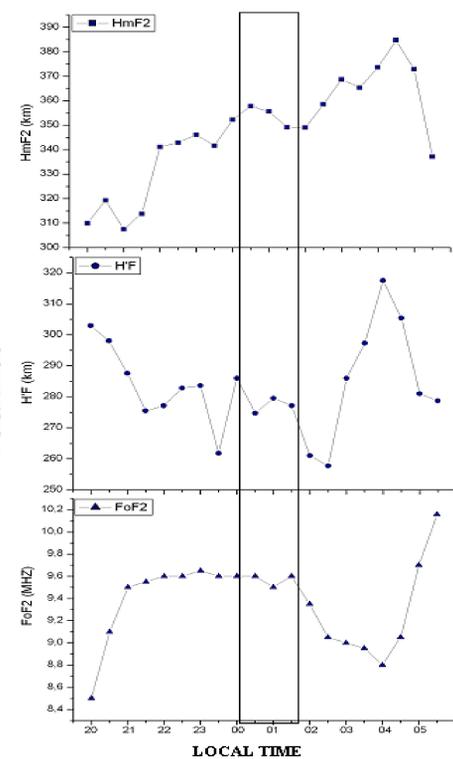


Figure 4- Temporal variation of ionospheric parameters h'F, hmF2 and foF2 for night of 26-27/12/2011, digisonde installed at Falkland Islands (51.4° S, 57.5° W). In a simultaneous analysis of data, there is an abrupt increase in the height of the peak and the base layer F and subsequently decreasing electron density spot.

4. SUMMARY

- 1- It should be pointed out that these thermospheric events are not related to geomagnetic disturbed conditions.
- 2- MSTIDs observed in the Brazilian medium latitudes propagate from southeast to northwest, aligned with direction southwest/northeast. The phenomenon have their origin at medium latitudes in the southern hemisphere, probably generated by the Perkins instability mechanism.

5. REFERENCES

- 1- Garcia, J.F., Taylor, J.M., Kelley, M.C., Two-dimensional spectral analysis of mesospheric airglow image data, Applied Optics, v.36, n.29, p.7374-7385, 1997.
- 2- Pimenta, A. A.; Kelley, M.; Sahai, Y. Bittencourt, J. A.; Fagundes, P. R. Thermospheric dark band structures observed in all-sky OI 630 nm emission images over the Brazilian low-latitude sector. Journal of Geophysical Research-Space Physics, v. 113, n.1, 2008.

6. ACKNOWLEDGEMENTS

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