Characteristics of equatorial nighttime spread F - an analysis on season-longitude, solar activity and triggering causes

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Abstract

To understand global variability and triggering mechanisms of ionospheric nighttime equatorial spread F (ESF), we analyzed measurements from satellite and a ground-based GPS station. In this study we present seasonal-longitudinal as well as monthly variability of ESF occurrence for solar minimum and yearly variations of ESF occurrence for solar maximum and minimum periods. One of the long standing open questions in the study of ESF is what exactly initiates the Rayleigh-Taylor (RT) plasma instability growth, is the focus of this work. Zonal background eastward electric field, E × B upward plasma drift speed and east-west interplanetary electric field (IEF y) patterns are found to be critically important in understanding plasma irregularity development. In addition to particular patterns observed on these parameters, an increase in post-sunset plasma density just before the onset of ESF occurrence is observed in our measurements. We showed, for the first time, that monthly and seasonal ESF variability can be defined in terms of the rate of change of solar flux F10.7 index. We also found that ESF occurrence are better correlated with rate of change of F10.7 index for months in equinox seasons than for months in solstice seasons for the years between 2013 and 2016. Moreover ESF formation is found to be different for days in equinox and solstice seasons.

Key words: ESF, zonal eastward electric field, E × B, F10.7

Introduction

Equatorial spread F (ESF) is electron density irregularity observed in the nighttime ionosphere of the equatorial region. It has been an active research topic in space science studies due to its impact on radio communications since its first discovery by Booker and Wells (1938). Although ESF has been substantially studied, the exact triggering causes of its formation and its variability are not known very well.

Data analysis

Ground-based GPS data from a geomagnetic dip equatorial station and satellite data from CNOFS, Swarm and high-resolution OMNI solar wind data are used in our study.

Result and discussion

Figure 1 depicts yearly variation of vertical total electron content (VTEC) and night time spread F occurrence using the ground-based GPS station at the dip geomagnetic equatorial station in association with solar radiation flux level for the years between 2013 and 2016. It shows monthly variations of VTEC, rate of TEC index (ROTI) and F10.7 at different hours for these periods of years.

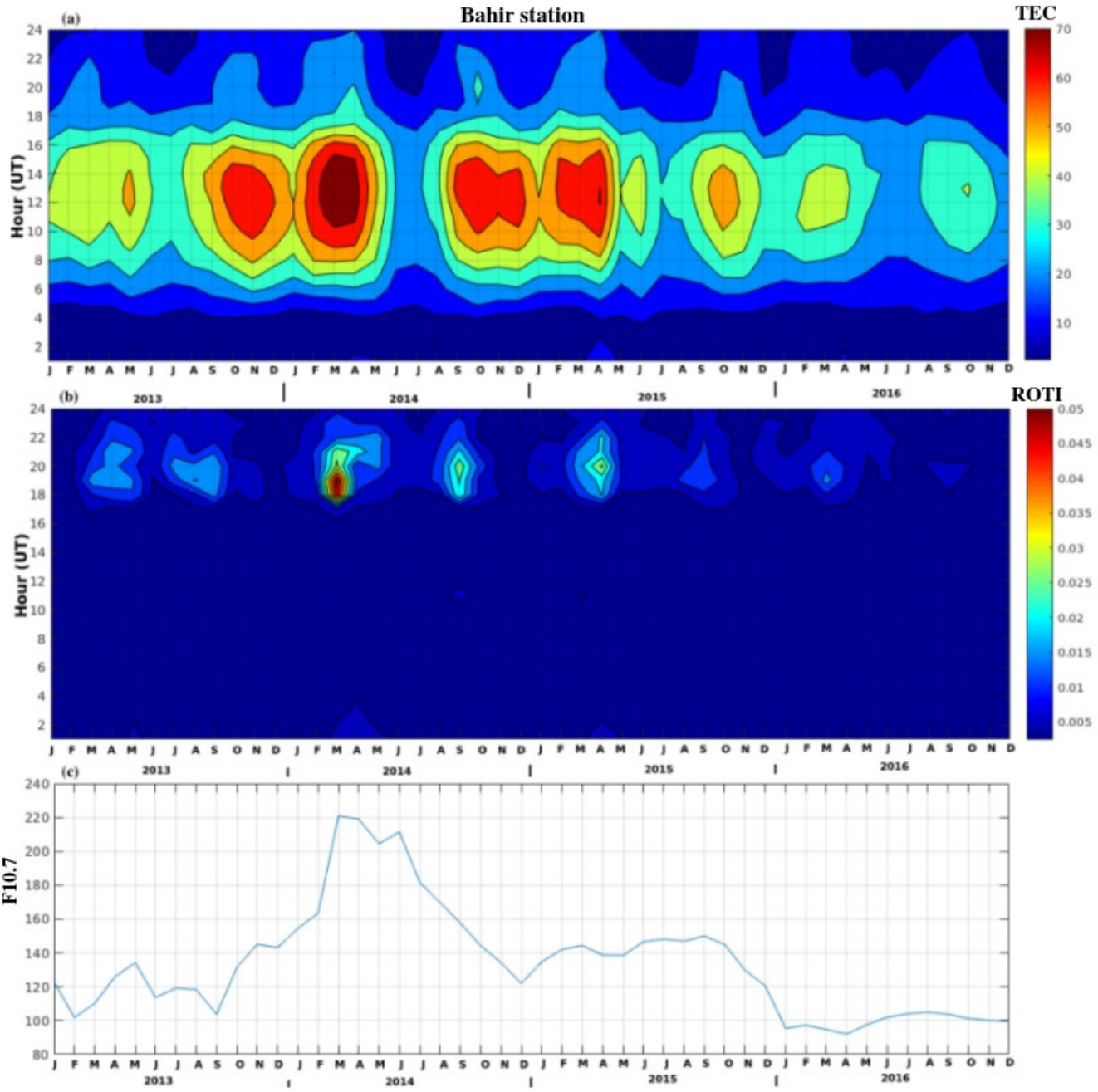

Figure 1: TEC, ROTI and F10.7 for the years between 2013 and 2016 .

Conclusion

The post-sunset equatorial spread F occurrences measured from ROTI are well correlated with interplanetary electric field (IEFy), solar flux F10.7 and sunspot number R for months in equinox seasons than for months in solstice seasons for years between 2013 and 2016.

Reference

Booker, H. and Wells, H. (1938). Scattering of radio waves by the f-region of the ionosphere. Terrestrial Magnetism and Atmospheric Electricity, 43(3):249–256.