

Onset and evolution of ESF plumes observed using the EAR and Sanya VHF radar in Southeast Asia

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Abstract

The F region plasma irregularities with scale sizes from meters to hundreds of kilometers in the equatorial and low latitude ionosphere are commonly referred to as the equatorial spread-F (ESF), which produce ionospheric scintillations that often profoundly impact satellite communication and navigation systems. In this study, the onset and evolution characteristics of the ESF over the two sites Sanya (18.4°N, 109.6°E; dip lat 12.8°N) and Kototabang (0.2°S, 100.3°E; dip lat 10.4°S) separated in longitude by about 1000 km were simultaneously investigated. The development of ESF activity was identified using GPS scintillation and VHF coherent radar echo measurements from the same site, together with the range type spread-F in ionograms. Additionally, the radar beam steering measurements in east–west direction were used to characterize the longitudinal difference in establishing the initial conditions for ESF development since recent observations revealed that the ESF do not always occur following the appearance of the large-scale wave structure at a single site [1]. The radar beam steering measurements reveal frequent occurrences of multiple plumes over both sites. It is found that some plume structures initiated within the radar scanned area, followed by others drifting from the west of the radar beam over both stations. A tracing analysis on the onset locations of plasma plumes reveals spatially well-separated backscatter plumes, with a maximum east-west wavelength of about 1000 km, periodically generated in longitudes between 85°E and 110°E. The postsunset backscatter plumes seen by the Sanya VHF radar are found to be due to the passage of sunset plumes initiated around the longitude of EAR [2]. Most interestingly, the EAR measurements show occasionally multiple plume structures that developed successively in the radar scanned area with east-west separation of ~50 km, with however no sunset plasma plume over Sanya. Colocated ionogram measurements show that spread F irregularities occurred mainly in the bottomside F region at Sanya, whereas satellite traces in ionograms that are indications of large-scale wave structures were observed at both stations. Possible causes for the longitudinal difference in the characteristics of radar backscatter plumes producing ionospheric scintillations are discussed.

References

1. Li, G., B. Ning, M. A. Abdu, W. Wan, and L. Hu, "Precursor signatures and evolution of post-sunset equatorial spread-F observed over Sanya", *J. Geophys. Res.*, 117, 2012, doi:10.1029/2012JA017820.
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