ONSET OF F-REGION PLASMA PLUMES OBSERVED WITH THE EQUATORIAL ATMOSPHERE RADAR IN INDONESIA

Fukao Shoichiro
Kyoto University Gokasho Kyoto Uji Japan

Abstract:

This paper discusses onset conditions of plasma plumes associated with 47-MHz coherent backscatter from low-latitude F region. The observations were made with the Equatorial Atmosphere Radar (EAR) located on the geographic equator in West Sumatra, Indonesia (0.20S, 100.32E; dip latitude: 10.36S). The peak output power of EAR is 100 kW, and the diameter of its antenna array is approximately 110 m. The active phased array system of EAR enables to steer the antenna beam over a wide azimuth sector on a pulse-to-pulse basis. The EAR is sensitive to 3-m scale plasma irregularities, and suitable for studies of equatorial spread F (ESF) or plasma bubbles. As the EAR is located at about 10 degrees south from the geomagnetic equator, the geomagnetic field line that passes an altitude of 300 km (500 km) over the EAR reaches its apex altitude approximately 520 km (780 km) over the geomagnetic equator.The unique capability of EAR is applied to investigations on spatial structure of plasma bubbles and associated plasma plumes. Most notably, plumes are shown to appear and rapidly grow while traversing, usually, from west to east across the scanned azimuth sector. Comparison of horizontal distribution of plumes with images of 630-nm airglow depletion demonstrates that plumes occur within airglow-depleted region. The onset of tiny plumes over the EAR mostly coincides with sunset time at the altitude of the apex of the geomagnetic field line connected with the observed area of EAR. This feature is caused by rapid enhancement of the evening zonal electric field and damping of 3-m scale irregularities by the solar radiation prior to the apex sunset.Tracing each plume back along a certain altitude across the azimuth sector, zonal transverse speed of plumes is derived. The speed gradually decreased with time after sunset, which reflects diurnal variation of tidal electric field in the nighttime. Assuming that all plumes were generated at sunset time, they were traced back to their initial positions with observed times at the EAR site and zonal transverse speeds taken into consideration. The initial positions were, in general, limited within 1000 km west from the EAR. Plumes generated in farther distance may not reserve 3-m scale irregularities during traveling. Separation between plume potions is approximately 400-500 km that may correspond to wavelength of seeding gravity waves.