OPTICAL AND RADIO MEASUREMENTS OF EQUATORIAL PLASMA BUBBLES OVER INDONESIA

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Abstract:

We have operated an all-sky airglow imager and three single-frequency GPS receivers at the Equatorial Atmosphere Radar (EAR) site (0.20S, 100.32E; geomagnetic latitude 10.6S) in West Sumatra, Indonesia since October 2002 and January 2003, respectively. Using these instruments, we have obtained following observational results about quatorial plasma bubbles.

(1) We have conducted coordinated observations of the 47-MHz EAR and the all-sky airglow imager on the night of April 1, 2003. Spatial distributions of backscatter were obtained by performing east-west scans with the EAR. A 630-nm airglow depletion caused by plasma bubbles was simultaneously observed with the all-sky airglow imager. Both the backscatter region and airglow depletion had band-like structure elongated in the meridional direction with zonal width of about 100 km. Comparing the FAI structures with the airglow depletions, we found that FAI occurred within the entire airglow-depleted region. The most intense backscatter was coincident with regions of deepest depletion in plasma density. This result indicates that 3-meter-scale FAI would be collocated with the larger-scale irregularities generated by the low-frequency-drift instability. Backscatter intensity decreased with time constant of approximately 20 min while amplitude of the airglow depletion was almost unchangeable for 1 hour. This result suggests that the small-scale plasma structures decay earlier than large-scale structures, and is consistent with the observations reported in the previous literature. Details of this result are reported by Otsuka et al., GRL, 2004.

(2) A radio signal passing through small-scale irregularities in the ionospheric electron density fluctuates in amplitude and phase since the irregularities act as diffraction gratings. This phenomenon is known as the \\\"scintillation\\\". The GPS receivers sampled GPS signal intensity at 20 Hz. An analysis of the scintillation index (S4) obtained in two years (2003--2004) revealed that the scintillation often occurred at 2000--0100 LT in March--April and September--October and that their occurrence rate was higher in March--April than in September--October. The scintillation was not observed after 0100 LT, probably due to decay of small-scale irregularities causing scintillation. Mutual distance of the three GPS antennas are 100-150 m. Drift velocity of the onospheric irregularities were measured using cross-correlation analysis with time series of the GPS signal intensity obtained from the three receivers. The cross-correlation was calculated every 1 minute from the time series with a length of 1 min. Apparent drift velocity in the direction parallel to alignment of each pair of the GPS antennas was

inferred from the maximum correlation time.Combining the apparent velocity in three directions, we estimated zonal and meridional components of the drift velocity, assuming that the ionospheric irregularity had a plane wave structure.Intense scintillations occurred at 2030-2200 LT on April 20, 2004. Airglow depletions caused by plasma bubbles were simultaneously observed in 630-nm airglow images at the EAR site. The bubbles moved eastward with a velocity similar to the drift velocity of the cintillation region, indicating that the irregularities which caused the scintillations were embedded within the bubbles.