Movement of equatorial plasma bubbles observed by three spaced GPS receivers and an all-sky airglow imager in Indonesia

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

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 ionospheric 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.
Eastward drift velocities obtained from the GPS receivers were
compared with that of plasma plasma bubbles observed in 630-nm airglow
images with the all-sky imagers at the EAR site.