Daytime zonal drifts in the ionospheric E and 150 km regions estimated using EAR observations

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Content:

Introduction to daytime 150 km echoes

Zonal drift at 150 km and E region

Comparison with C/NOFS

Summary
Introduction

Equatorial/Low latitude plasma drifts play important role in low latitude electrodynamic processes.

Plasma drifts are mostly driven by E and F region dynamo electric field.

These drifts are especially needed for forecasting low latitude ionospheric weather required for communication and navigation applications.
Equatorial Atmospheric Radar (EAR)
Kototabang, Indonesia (0.2° S, 100.32° E, mag. lat. 10.36° S)

Frequency: 47 MHz
Peak power: 100 kW
Aperture: 10000 m² (circular)
Antenna: 560 3-element Yagi
Beam width: 3.4°

Experimental specifications

Pulse width: 64 μs (with 8 μs baud)
IPP: 1600 μs
No. of Coh. Int.: 8
No. of FFT: 256
No. of Incoh. Int: 5
Beam positions: Az:165° Ze:21.8°; Az:180° Ze:21.2°; Az:195° Ze:21.9°
Daytime 150 km and E region echoes observed using the EAR

- Over Kototabang, 150 km echoes occur in the same height region as that of the equator.
- Height variations of the echoes display solar zenith angle dependence (forenoon descent and after ascent).
- E region echoes display descending pattern reminiscent of tidal wind.
- SNR of 150 km echoes are ~15 dB above the noise.
- E region echoes are about 30 dB higher than the 150 km echoes.
Zonal drift estimated using conjugate beams (Azimuth 165° and 195°)

\[ V_{\text{zonal}} = \frac{(V_{\text{east}} - V_{\text{west}})}{2 \sin \alpha} \]

\( \alpha \) is the angle between the southward beam and east/west beam.
3-Beam observations of 150 km echoes and zonal drift

Zonal drifts are westward and are less than 40 m/s
Day-to-day variations of zonal drift at 150 km

Zonal drift varies on a day-to-day basis

Day-to-day variation in zonal drift is 10 m/s
Seasonal variations of zonal drift at 150 km

Zonal drifts are westward and below 50 m/s.

Seasonal mean drifts are well within 30 m/s.

Zonal drifts are usually smaller in the morning and afternoon hours than those observed during noon hours (11-13 LT).
Altitudinal variations of zonal drift

Zonal drifts sometimes vary with height even within the narrow 150 km echoing region.

At lower altitudes drifts could be small westward or eastward.
3-Beam observations of E-Region echoes and zonal drift

Zonal drifts are both eastward and westward.

Generally the high altitude echoes have westward drift while the low altitude echoes show eastward drift.
E region zonal drifts are predominantly westward at higher altitude and eastward at lower altitude and are in the range of -40 m/s to +40 m/s.
Comparison of drifts at 150 km region and E region (100-110 km)

Seasonal mean zonal drifts in the 100-110 km of the E region and those of 150 km are westward on all seasons.

There is a very good agreement between the two.
Comparison of drifts at 150 km region and E region ~95 km

Seasonal mean zonal drifts at ~95 km are eastward in all seasons while those at 150 km are westward.

The low latitude E region drifts appear to be governed by eastward wind.
Comparison with C/NOFS (CINDI-IVM)

C/NOFS at ~450 km

150 km region over the EAR connects to 350 km over the magnetic equator.

150 km echo drifts are sometimes smaller than those of C/NOFS.
At other times, they are larger than those of C/NOFS.
Summary:

✔ Zonal drifts in the 140-160 km region are generally westward with occasional eastward drift at lower altitudes.

✔ Zonal drifts are mostly within 20 m/s eastward to 50 m/s westward.

✔ E region zonal drifts are predominantly westward at higher altitude (>100 km) and agree with the 150 km drifts.

✔ E region drifts are eastward at lower altitude (<95 km) and are possibly due to neutral wind effect.

✔ E region zonal drifts are in the range of -40 m/s to +40 m/s.

✔ 150 km zonal drifts do not agree with those of C/NOFS. More comparison is required.
Thank you