ZONAL ASYMMETRY OF DAYTIME E-REGION AND 150-KM ECHOES OBSERVED BY EQUATORIAL ATMOSPHERE RADAR IN INDONESIA

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Abstract

The 47-MHz Equatorial Atmosphere Radar (EAR) in West Sumatra, Indonesia (0.20°S, 100.32°E, -10.14° dip latitude) has the unique capability of rapid beam scanning on a pulse-to-pulse basis. We conducted an experiment for daytime E-region and 150-km echoes with EAR by using eight radar beams with azimuth angles from 135° to 240° (every 15°). Although the strength of echoes below 100 km are uniform among these beams, the upper E-region echoes show strong zonal asymmetry; stronger echoes in the east beams which is opposite to the results in equatorial regions.

1. Introduction

The so-called "150-km echoes" observed in the daytime equatorial ionosphere have been least understood for more than 40 years. They were studied with the Jicamarca VHF radar for the most part and also observed by other radars installed in the equatorial regions. Recently, 150-km echoes were observed with the Gadanki MST radar in India (6.3° dip latitude), which is the first observation outside the equatorial electrojet belt[1], and with the Equatorial Atmosphere Radar (EAR) in Indonesia (-10.14° dip latitude)[2]. We will report further results of daytime E-region and 150-km echoes observed with EAR and discuss zonal asymmetry of these echoes.

2. Observational Results

The 47-MHz Equatorial Atmosphere Radar (EAR) in West Sumatra, Indonesia (0.20°S, 100.32°E, -10.14° dip latitude) has the unique capability of rapid beam scanning on a pulse-to-pulse basis. Eight-beam observation was conducted for 21 days between October and December 2007. Azimuth angles were chosen every 15° from 135° to 240° and zenith angles were set to be perpendicular to the geomagnetic field at an altitude of 150 km. Range resolution is 1.2 km with an 8-bit complementary code and time resolution is 344 s for each beam. The low time resolution is due to the interruption by stratospheric observation. We obtained 150-km echoes on 13 days during the period. One example is shown in Figure 1. The intensity of 150-km echoes is the strongest in the azimuth angle of 165° and very weak in the three west beams (210°-240°). On the other hand, the altitude of the echoes is higher in the west beams. Zonal drift velocity estimated by assuming uniform velocity field is westward with an amplitude of 20-50 m s^{-1}. Another interesting feature is the zonal asymmetry of E-region irregularities between 100 km and 120 km altitudes in the morning hours. The echo intensity decreases monotonically with looking at westward directions. Figure 2 shows averaged signal-to-noise ratio (SNR) in each beam for 13 days between October and December in 2007. The features mentioned above are clearly seen in this figure.

3. Discussion and Summary

We have detected 150-km echoes with EAR frequently and proved that they actually exist at the location of 10° off the dip equator. The major characteristics in RTI plots, that is, morning decent, afternoon ascent and westward drift velocity, are common to those in the equatorial regions. However, the zonal asymmetry of echo intensity is opposite to the equatorial observations at Pohnpei[3]. The different dip and declination angles of magnetic field may cause the opposite characteristics between these sites. The zonal asymmetry of daytime E-region echoes is also a new finding with EAR. They are likely to be type-2 irregularities considering the spectra of these echoes, but the asymmetry is opposite to those from the equatorial electrojet. They will be addressed in a future study.

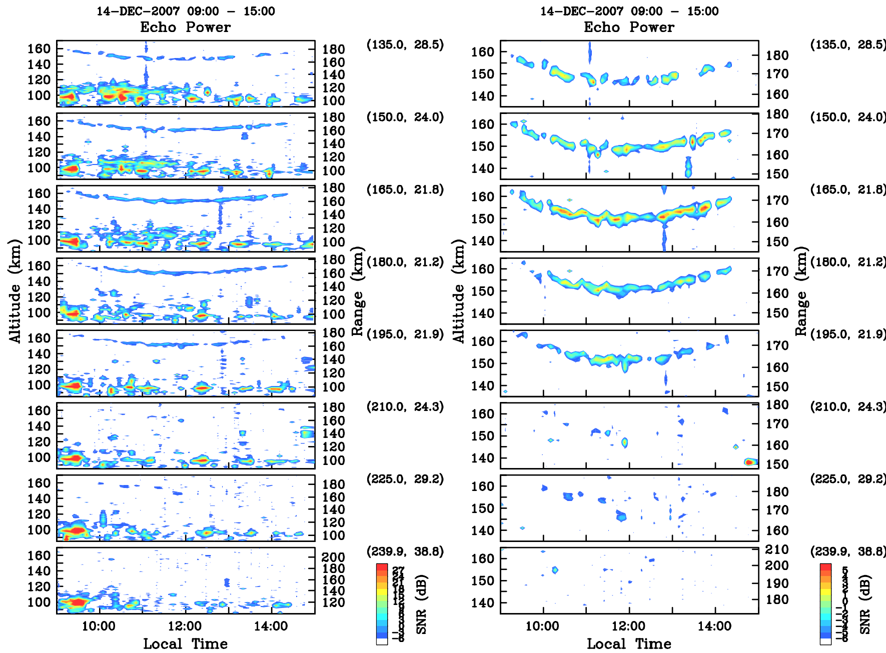

Figure 1: (left) Range-time-intensity plots of irregularity echoes on December 14, 2007. (right) Same as the left panel but the expansion of 150-km echoes.

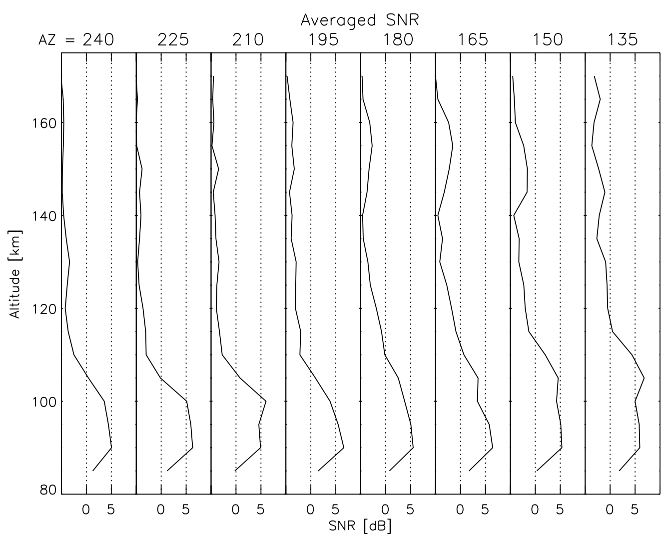

Figure 2: Averaged signal-to-noise ratio (SNR) in each beam for 13 days between October and December in 2007.

4. References

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