Seasonal variation of layering and wave activity in 150-km echoes at Jicamarca

Gerald LEHMACHER[(1)] and Abhishek DESAI[(1)]

(1) Department of Physics and Astronomy, Clemson University, Clemson, SC 29631, USA; glehmac@clemson.edu

Daytime VHF echoes from the F_1 region (from ~130 to 200 km) are an everyday, normal occurrence in the tropical ionosphere. They have been first discovered over 50 years ago at Jicamarca, Peru [1], but are still poorly understood. The vast majority of the echoes possess characteristics similar to incoherent scatter (IS), i. e., they have wide spectra and are highly magnetic-aspect sensitive, but their radar cross section is about 10 dB enhanced compared to the level expected from IS theory [2]. Their Doppler velocities track the plasma motion in the lower F region, such as the equatorial fountain effect. Recent modeling suggests that photoelectrons may play an important role in transferring energy to the plasma and eventually enhance the thermal ion line [3].

The 150-km echoes exhibit a very regular “necklace” pattern with descent in the morning and ascent in the afternoon (e.g., [4]) suggesting a close relationship with electron density. Many vertically stacked layers are present separated by narrow, “forbidden” regions of no backscatter. We have found that the characteristic arrangement of these layers is the same every day, but shifts vertically depending on the season; this may indicate special resonance conditions for the backscatter process. In addition, the necklace pattern is strongly modulated by quasi-random neutral gravity waves at apparent periods of 10 to 15 minutes. The modulations occur in all vertical layers with only small phase differences, which indicates propagation at long vertical wavelengths. Similar wave activity has been observed more directly in the lower F region plasma density by dynasondes, at Jicamarca and, studied in greater detail, at midlatitudes (e.g., [5]). Occasionally, the pattern is disrupted by waveforms with large amplitudes of up to 10 km.

We will present properties of the layer fine structure (vertical extent, number of layers, thickness) and daily and seasonal variation at Jicamarca from more than 25 days of high-resolution observations in 2014 to 2016. These will be compared to local ionosonde parameters. We will characterize the gravity wave content using Fourier and wavelet transforms, with the purpose to identify nonlinearities and seasonal variability.

References

[1] Balsley, B. B. (1964), J. Geophys. Res., 69, 1925–1930.
[2] Chau, J. L. and E. Kudeki (2013), Geophys. Res. Lett., 40, 4509–4514.
[3] Oppenheim, M. M., and Y. S. Dimant (2016), Geophys. Res. Lett., 43, 3637–3644.
[4] Kudeki, E. and C. D. Fawcett (1993), Geophys. Res. Lett., 20, 1987.
[5] Negrea, C. and N. A. Zabotin (2016), Radio Sci., 51, 213–222.