High-resolution mesospheric echoes at Jicamarca for probing small scale dynamics in the equatorial region

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Daytime VHF echoes from the D region (from ~55 to 85 km) are an everyday, normal occurrence in the tropical mesosphere. They have been first reported from Urbana, Illinois at midlatitudes [1], and observations with the high-power, large-aperture Jicamarca radar followed soon, with the introduction [2] "Although the D region is the closest to the earth of the ionospheric regions, it is widely recognized as a difficult region to study." While there has been immense progress in rocket, radar, lidar, and satellite techniques designed for the mesosphere, this layer is still nicknamed "ignorosphere". The Jicamarca echoes have helped starting mesosphere-stratosphere-troposphere (MST) radar science [3], but to date there have been only very few comprehensive studies to better understand the connections between D region ion chemistry, temperature structure, and turbulence activity.

Mesospheric echoes at Jicamarca have been used for mean wind and gravity wave (GW) momentum flux measurements in the equatorial region [4], where semi-annual oscillations and atmospheric tides form a highly variable background for the propagation of long-period inertia GW superimposed with a continuous stream of short-period, possibly ducted waves. Frequently, unstable wind shears allow for the formation of Kelvin-Helmholtz (KH) billow fields, or deep, quasi-adiabatic layers may endure for many hours capped by stable inversion zones. Spectral width and radar reflectivity estimates can help determine turbulent energy dissipation rates, however, anisotropy and inhomogeneity at 10 to 100 meter scales in the radar volume or perhaps Fresnel scatter may sometimes compromise the estimation.

Since 2004, we have collected about 50 days mesospheric backscatter with the highest sensitivity and resolution currently possible at Jicamarca. We typically used four fixed beams, close to zenith, up to 1.5 MW peak power, and 64-baud complementary-coded pulses for nominally 150 m range resolution. Recently, improved spectral fitting has led to better 1-min wind estimates, and 8-sec range-time-intensity (RTI) plots reveal more details of KH billows crossing the beams. We will present seasonal variability of winds and layer occurrence and examine open questions.

References

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