Scale analysis of pre- and post-midnight ESF bubbles at storm time and quiet time

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This paper investigates intermediate scale plasma structures observed by ROCSAT-1 in the equatorial F region. The empirical mode decomposition (EMD) method of Hilbert-Huang transform (HHT) technique is utilized to develop a procedure of scale analysis that allows the mutually correlated components in velocity, density and relative density gradient to be identified and extracted. Comparing the three data sets, good match in wave form is found for velocity and density in scales between kilometers and hundred meters. It implies that there are electric fields proportional to density fluctuation $-\delta$N/N in the form similar to what is expected for the Rayleigh Taylor instability. In smaller scales, velocity and density don't correlate to each other more, the good match is then found in velocity and density gradient. This is the manifestation of the Boltzmann relation. By studying the cases in post-midnight and pre-midnight under storm time and quiet time, we find the one-to-one match hold although it is known that ESF bubbles can be driven by different mechanisms under different conditions. In other words, the spatial structures of electric field in the intermediate scale will always be correlated to the density structures in a manner of δE $\sim -\delta$N/N, independent of the mechanisms driving the ESF bubbles. It is interesting to note that the relation $\delta \mathrm{V}_z \sim \delta$N/N for irregularities in scale of kilometers holds only for ESF occurs within +-5 dip latitude, while the Boltzmann relation ($\delta \mathrm{V}_z$ proportional to δlnN) holds for small scale irregularities occurrs without such a restriction.