Recent Progress in our Understanding of the Farley-Buneman Instability

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The Farley-Buneman Instability (FBI) has been a constant subject of investigation owing to its very common occurrence in the ionospheric E region. It has been thoroughly probed by radars and in situ rocket instrumentation. Linear and nonlinear kinetic as well as fluid theories of various complexities have been advanced over the years and have led to much progress in understanding various aspect of the turbulence (e.g. [1,2]) This presentation will focus primarily on a most recent approach to the nonlinear investigation of the FBI that has evolved from the concept of intermittency whereby the electric field inside finite size elongated structures becomes weaker than the ambient electric field as the amplitude of the structures grows. The maximum amplitude for the structures is reached when they move at the threshold speed of the instability (usually but not always the ion-acoustic speed). This theory explains why radars usually observe structures moving at the ion-acoustic speed in the plasma flow direction, and why structures are seen in all directions, including directions for which linear theory predicts stability. In combination with the nonlocal character of the instability at high latitude along the geomagnetic field, it also explains why the electrons are heated by the unstable waves and by what amount. From the new calculations we can extract new expressions for the anomalous resistivity of the unstable E region and extract new the ion mobility coefficients in that same region. An example of how density profiles evolve with the electric field strength is provided in Figure 1. These are raw profiles that should be multiplied by the "packing ratio" which should be of order 0.2. It should be noted that the profiles disagree with observed profiles at lower altitudes. It is strongly suspected that the reason for the discrepancy is rooted in the effects of plasma density gradients, which lower the instability threshold speed and allow structures to be observed lower down.

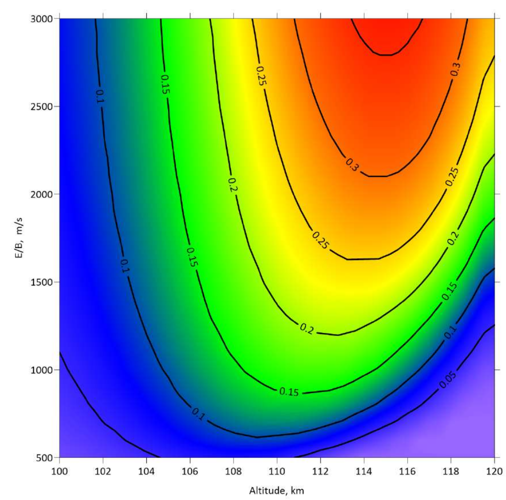

Figure 1. Computed maximum amplitude reached by individual FB structures as functions of altitude and magnitude of E/B. For a comparison with observations of broadband densities, the numbers should be multiplied by the packing ratio which should be of the order of 0.2.

References

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