A comparison of rocket observations and numerical simulations of Farley-Buneman turbulence in the E-region

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We have conducted a comparison between ROSE4 auroral rocket observations of E-region plasma turbulence and 2D numerical plasma simulations. We find good agreement between the observations and the simulations, and argue that the much of the nonlinear dynamics can be accounted for in a 2-D numerical model, i.e. a plane perpendicular to a locally homogeneous magnetic field. Such an argument suggests that it is not necessary to rely on neutral turbulence, parallel electric fields, or large scale plasma gradients to explain the spectral characteristics and observed strongly intermittent nature of the fluctuations. We find much of the structure is driven by secondary instabilities that develop on the large scale gradients of the largest amplitude waves, and the small scale dynamics are strongly influenced by these secondary instabilities.

We compare potential variations obtained at a single position in the numerical simulations with two point potential-difference signals. The two point observations are suitable for comparison with data obtained by instrumented rockets.
We can demonstrate a significant reduction in the amount of information concerning the plasma turbulence when the latter signal is used for analysis. In particular we show that the bicoherence estimate is strongly affected. The conclusions have implications for studies of low frequency ionospheric fluctuations in the E and F regions by instrumented rockets, and also for other methods relying on difference measurements, using two probes with large separation.

Our simulation analysis also resolves a long standing controversy concerning the phase velocities of Farley-Buneman waves. We find that at wavelengths greater then a 1-3 meters that the simulated phase velocity is near the ion-acoustic velocity, but that the velocity reaches that predicted by linear theory at shorter wavelengths.