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Power law scaling of electric field fluctuations in the greater cusp and magnetotail implied by HF radar observations of F-region Doppler velocity

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Akasofu's solar wind ε parameter describes the coupling of solar wind energy to the magnetosphere and ionosphere. Analysis of fluctuations in ε using model independent scaling techniques including the peaks of probability density functions (PDFs) and generalised structure functions (GSF) show the fluctuations were self-affine (mono-fractal, single exponent scaling) over 9 octaves of time scale from ~46 s to ~9.1 h. However, the power law scaling exponent α is a function of the fluctuation bin size, so caution is required when comparing the exponents for different data sets sampled in different ways. The same generic scaling techniques revealed the organisation and functional form of concurrent fluctuations in magnetospheric electric fields implied by SuperDARN HF radar measurements of line-of-sight Doppler velocity, v_{LOS}, made in the high-latitude austral ionosphere. The PDFs of v_{LOS} fluctuations were calculated for time scales between 1 min and 256 min, and were sorted into noon sector results obtained with the Halley radar, and midnight sector results obtained with the TIGER radar. The PDFs were further sorted according to the orientation of the interplanetary magnetic field, as well as ionospheric regions of high and low Doppler spectral width, which roughly correspond to regions of open and closed magnetic flux, respectively. The v_{LOS} fluctuations were most self-affine (i.e. like the solar wind ε parameter) on open field lines in the noon sector ionosphere (i.e. the greater cusp), but suggested multi-fractal behaviour on closed field lines in the midnight sector (i.e. the central plasma sheet). Long tails in the PDFs imply that "microbursts" in ionospheric convection occur far more frequently, especially on open field lines, than can be captured using the effective Nyquist frequency and volume resolution of SuperDARN radars.

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