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Solar cycle dependence in the statistical and correlation properties of geomagnetic indices and the solar wind driver

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Scaling and a departure from Gaussian statistics has been identified as a key property of magnetospheric energy release as seen in geomagnetic indices derived from ground based magnetometer observations. These long time-series can be readily compared with those of in- situ observations from spacecraft that monitor the solar wind driver.

We will compare quantitative evidence of correlation, scaling and departures from Gaussian statistics in the fluctuations in the solar wind, with that seen in geomagnetic indices AU and AL and in the epsilon parameter that characterizes energy inflow and driving of the magnetosphere by the solar wind.

On timescales shorter than the characteristic substorm timescale, fluctuations in the indices show a characteristic power law power spectrum and scaling in their non- Gaussian probability density functionss. Dividing the data into intervals of solar maximum and minimum reveals that whereas fluctuations in epsilon and AU change their properties with the solar cycle, fluctuations in AL do not. These quantitative statistical measures place strong statistical constraints on the propagation of information from these below- substorm scale fluctuations from the solar wind to the magnetosphere as seen by the indices. Scaling of fractal type also offers the possibility of (nonlinear, or fractional stochastic differential equations) Fokker- Planck models (analogous to Black-Scholes type models for stock and option price dynamics) for these timeseries which we will discuss.

Direct nonlinear measures of correlation such as Mutual Information (MI) can also be used to characterize the driving of the geomagnetic indices by the solar wind. We discuss how MI can be used to identify the optimal solar wind driving parameter in a model independent manner.