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Quantifying how space climate varies with the solar cycle

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Quantifying the large scale dynamic response of the magnetosphere to solar wind driving is central to our understanding of solar wind-magnetosphere coupling. This dynamic response is complex, with the ‘state’ of the magnetosphere affecting its response to the driver. Auroral geomagnetic indices coupled with in-situ solar wind monitors provide a comprehensive dataset, spanning several solar cycles. We can characterize these observations in terms of ‘space climate’ by quantifying how the statistical properties of ensembles of these observed variables vary between different phases of the solar cycle.
We present novel comparative statistical techniques which characterize secular changes in the distribution of geomagnetic indices (AE AU AL) and of the driver as captured by solar wind Poynting flux. We first threshold these timeseries to generate a sequence of ‘bursts’ or events and find the distributions of event size, duration and interval. For the indices, these distributions are multicomponent and we investigate how the different components depend on solar cycle and how their functional form relates to physically motivated stochastic processes. We also investigate the effect on our techniques of the selection process by which the indices are constructed from single magnetometer station data.
Our formalism provides quantitative insight into the relative importance of internal and driven magnetospheric dynamics in determining space climate at different points in the solar cycle. By quantifying secular changes in distributions of these variables, we also can parameterize the exceedence likelihood of events of a given size and how this is changing, with implications for space weather applications.