Geophysical Research Abstracts
Vol. 19, EGU2017-3347, 2017
EGU General Assembly 2017

Solar cycle dependence of the distribution of solar wind in-situ plasma parameters, and how this drives solar wind-magnetosphere coupling parameters.

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Climate is the statistical distribution of observed weather and we thus expect the climate of space weather to vary with the solar cycle of activity. The 11-year solar cycle is irregular, with each cycle exhibiting a unique duration and peak activity. The distinct activity of each cycle is then coupled from the Sun to the Earth's magnetosphere via the solar wind, leading to long-term trends in the statistics of space weather. Here, we introduce the data quantile-quantile (DQQ) plot as a model-independent method for tracing solar cycle changes in the likelihood of observing a given energy flow in the solar wind. We apply the method to 1-minute resolution Wind data spanning the minima and maxima of cycles 23 and 24 [1]. We consider in-situ solar wind plasma parameters in fast and slow solar wind such as the magnetic energy density and the Poynting flux and how these influence commonly used solar wind-magnetosphere coupling functions such as Akasofu's ε parameter. The core of the plasma parameter distributions retains a log-normal functional form simply varying in amplitude with the solar cycles, in agreement with previous work [e.g. 2] and suggestive of a multiplicative underlying physical process consistent with turbulence. The DQQ method also identifies the threshold energy flux at which solar wind plasma parameters depart from the lognormal regime; this 'extremal' component exhibits its own dependence on the solar cycle which is distinct between fast and slow wind. How the solar wind plasma parameter distributions vary, and how this variation is reflected in that of the solar wind-magnetosphere coupling functions, is different between fast and slow solar wind. We can use this approach to compare different solar wind-magnetosphere coupling parameters to determine which, and under what conditions, are most sensitive to these solar cycle solar wind changes.

[1] Tindale, E., and S.C. Chapman (2016), Geophys. Res. Lett., 43(11), doi: 10.1002/2016GL068920.
[2] Burlaga, L.F., and A.J. Lazarus (2000), J. Geophys. Res., 105(A2), doi: 10.1029/1999JA900442.