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Solar wind driving and the dynamical magnetospheric response – data analytics approaches to observations across space and time

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The wealth of space weather and solar terrestrial physics observations that are now available both across space and time are increasingly becoming a data analytics challenge. Two approaches are highlighted here.
Long term observations are now available over multiple solar cycles, so that the space climate effects of the variability between each unique solar cycle can be investigated statistically [1,2,3]. The occurrence rate of large events, and the power level of fluctuations both correlate with overall solar activity, albeit in a non-trivial manner. Solar (F10.7), solar wind (dynamic pressure, convection electric field) and magnetospheric response (AE, Dst) parameters vary with the different activity levels of each solar cycle maximum but we have found certain properties of the statistical distribution which are reproducible from one solar maximum to the next. Characterizing observations of the past heliospheric climate in this manner may assist prediction of that of the next solar cycle.
Space weather effects are monitored by 100+ magnetometer stations in the auroral region. These data are multi-point in space and extended in time, so in principle are ideal for study using dynamical networks. Whilst networks are in widespread use in the data analytics of societal and commercial data, there are additional challenges in their application to physical time series which we will discuss. We are able to construct dynamical networks of the SuperMAG set of over a hundred ground based magnetometers [4,5] which observe transient dynamics of the auroral current system. Spatio-temporal patterns of correlation between the magnetometer time-series can be quantified by (time dependent) network parameters. Cross-correlation lags can be used to construct directed networks which give directions and timescales for propagation. This offers the possibility of characterizing detailed spatio-temporal pattern by a few parameters, so that many events can then be compared with each other and with theoretical predictions.
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