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Dynamical directed networks constructed from SuperMAG ground based magnetometer observations of geomagnetic substorms

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Identifying the full spatio-temporal evolution of the substorm ionospheric current system is now possible utilising the full set of 100+ magnetometers collated by SuperMAG to construct a dynamical network [1,2]. We use this magnetometer data to obtain dynamical directed networks for isolated substorms for the first time. Directed networks flag correlation between vector magnetic field perturbations seen at each pair of magnetometers (a network connection) and determine the time lag at which correlation is maximal. If we assume spatial correlation reflects ionospheric current patterns, the network properties test different models of current systems evolution during a substorm. We focus on network connections (patterns of spatial correlation) within and between three specific regions in the nightside that are associated with substorm related ionospheric current systems. These regions are centred on the onset location and east and west of it. We select two substorms which have at least seven magnetometers in each of these regions and we find a time-sequence of the emergence of spatial correlation which in turn provides information on the formation and dynamics of ionospheric current patterns. We can then test for the uniqueness of this result looking across a larger set of (40+) substorms.

[1] J. Dods, S. C. Chapman, and J. W. Gjerloev, Network Analysis of Geomagnetic Substorms Using the SuperMAG Database of Ground Based Magnetometer Stations, J. Geophys. Res., 120, doi:10.1002/2015JA021456 (2015)
[2] J. Dods, S. C. Chapman, J. W. Gjerloev, Characterising the Ionospheric Current Pattern Response to Southward and Northward IMF Turnings with Dynamical SuperMAG Correlation Networks, J. Geophys. Res., 122, doi:10.1002/2016JA023686. (2017)