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On the Ensemble Transfer Entropy Analysis of Non-Stationary Geophysical Time Series: The Case of Magnetospheric Response

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The fundamental question what causes what has always been the motivating motto for natural sciences, being the study of causality a crucial point for characterizing dynamical relationships. In the framework of complex dynamical systems, both linear statistical tools and Granger causality models drastically fail to detect causal relationships between time series, while a powerful model-free statistical framework is offered by the information theory.

Here we discuss how to deal with the problem of measuring causal information in non-stationary complex systems by considering a local estimation of the information-theoretic functionals via an ensemble-based statistics. Then, its application for investigating the dynamical coupling and relationships between the solar wind and the Earth's magnetosphere is also presented.