Complex system perspectives of geospace electromagnetic environment research

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Learning from successful applications of methods originating in statistical mechanics or information theory in one scientific field (e.g. atmospheric physics or weather) can provide important insights or conceptual ideas for other areas (e.g. space sciences) or even stimulate new research questions and approaches. For instance, quantification and attribution of dynamical complexity in output time series of nonlinear dynamical systems is a key challenge across scientific disciplines. Especially in the field of space physics, an early and accurate detection of characteristic dissimilarity between normal and abnormal states (e.g. pre-storm activity vs. magnetic storms) has the potential to vastly improve space weather diagnosis and, consequently, the mitigation of space weather hazards. This presentation reports on the progress of a largely interdisciplinary International Team, combining expertise from both space physics and nonlinear physics communities, which was selected for funding by the International Space Science Institute (ISSI) in 2019. The Team attempts to combine advanced mathematical tools and identify key directions for future methodological progress relevant to space weather forecasting using Swarm, SuperMAG,
and other space/ground datasets. By utilizing a variety of complementary modern complex systems based approaches, an entirely novel view on nonlinear magnetospheric variability is obtained. Taken together, the multiplicity of recently developed approaches in the field of nonlinear time series analysis offers great potential for uncovering relevant yet complex processes interlinking different geospace subsystems, variables and spatio-temporal scales. The Team provides a first-time systematic assessment of these techniques and their applicability in the context of geomagnetic variability.