Complexity, turbulence and stochasticity in geospace plasma environment: role on predictability

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The geospace plasma environment is a nonequilibrium system characterized by a complex dynamics in response to the variations of the interplanetary conditions (solar wind and interplanetary magnetic field) [1, 2, 3]. This complex character manifests in turbulent, stochastic and near criticality fluctuations of magnetic field and plasma parameters in almost all the magnetospheric and ionospheric regions, as well as, in proxies of the geomagnetic activity (e.g., geomagnetic indices). For instance, in 2017 Alberti et al. [4] evidenced that the fluctuations at distinct timescales of some geomagnetic indices differently respond to the changes of the interplanetary conditions during magnetic storms, being representative of different processes occurring in the plasma geospace. Now, one of the main features of these fluctuations is their multiscale and self-similar nature that in many different situations may strongly influence the homogeneity of the plasma environment generating multiscale plasma structures, whose dynamics acts on the evolution of the overall geospace plasma environment especially during the occurrence of magnetic storms and magnetospheric substorms.

The understanding and modelling of the multiscale and complex character of the magnetosphere–ionosphere (MI) dynamics is crucial for developing reliable models capable of correctly forecasting the effects of a solar disturbance [5]. Indeed, the dynamical complexity of the geospace plasma environment has a number of crucial effects on the predictability of the magnetosphere-ionosphere, limiting *de-facto* the capability of forecasting the geospace plasma status at certain spatio-temporal scales.

Here, we present an overview on the complex dynamics of the geospace plasma environment as monitored by a set of geomagnetic indices, and *in-situ* measurements, and discuss the impact of the multiscale character of the magnetosphere-ionosphere dynamics on limiting the forecast horizon of the geospace plasma dynamics. The latter point is examined by applying concepts from the theory of dynamical systems, such as the correlation dimension D_2, the Kolmogorov entropy K_2 [6], etc.

References

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