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Vertical TEC predictability at different time scales

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Starting from the idea that ionospheric models may have “missing physics processes” in their formulation, it is important to understand how much stochastic behavior is present in the time series of ionospheric parameters. This has very much to do with the *intrinsic predictability* of the ionosphere, i.e. how periodical its behavior is and how important the chaotic and “stochastic” (or pseudo-stochastic) components are.
As the Earth’s ionosphere is a system with dynamics structured on several time- and space-scales, it should be expected that its predictability may depend on the scale at which the system is observed. In this research, the question of how chaotic and how predictable the time series of *vertical total electron content* (vTEC) are, depending on the time scale at which they are observed, is considered. The selection of time-scales in the vTEC series is operated via a simple Empirical Mode Decomposition (EMD), while the regularity study is done by applying tools of dynamical system theory to the different so-obtained components.
The correlation dimension D_2 and the Kolmogorov entropy rate K_2 for each EMD component of the vTEC time series are taken into account, at different latitudes in both northern and southern hemispheres and during both high and low solar activity periods.
The quantity D_2 measures the degree of chaos and dynamical complexity: the larger D_2 is, the higher is the number of dynamical variables needed to describe the process involved. Instead, K_2 is a proxy of the speed of destruction of the mutual information between the signal and a delayed copy of it, so that $(K_2)^{-1}$ is a sort of maximum time horizon for predictability. The values of D_2 and K_2 are calculated as depending on the scale at which the signal is observed, so that the chaoticity degree as a function of time-scale is diagnosed.
The values of the vTEC D_2 and K_2 depending on the time scale, location and solar activity give a quantitative indication of the measure of chaos and predictability of the Earth ionosphere parameter under study. The values of D_2 and K_2 obtained in this study confirms the expected reduction of predictability going from the time scale of a day to that of minutes. It is found that this trend does not depend on the solar activity level.
Conclusions are drawn from the point of view of what one may learn about the Space Weather physics through these tools, and the possible applications in term of ionospheric modeling.