Temporal resolution impacts in autoregressive forecasts of Geomagnetic indices

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Abstract:

The Solar-Wind-Magnetosphere-Ionosphere (SWMI) system is a complex dynamic nonlinear multidimensional system. Data of solar wind (SW) is collected from the Lagrangian L1 point and several Geomagnetic Indices (GI) are established to describe the magnetosphere at ground level. As humanity relies more and more on technologies sensitive to the moods of the Sun, there is an increasing necessity to accurately forecast space weather.

The multidimensional aspect of the system involves effects that operate at different time resolutions. In addition, the time delay between increasing SW activity at L1 and the response of the magnetosphere might not be constant, which makes prediction very challenging. Models that have the capability of making long-term predictions are interesting in the sense they describe the dynamics of the system in a more robust way. Therefore, in this work, instead of looking only at the usual one-step forecasts we will focus our attention on a longer term prediction in an iterated way, where the prediction is used as the input for the next step,

$$\widehat{x}_{t+\tau} = NN(\widehat{x}_t, ..., \widehat{x}_{t-n\tau}, I_t, ..., I_{t-m\tau})$$

where NN is the model function, $\widehat{x}$ is the target index estimated by the model, I stands for one or several SW drivers, n and m correspond to the time window input of the target and driver, respectively. τ indicates the time resolution considered for the model.

Our models are based on Feed Forward Neural Networks (NN), trained to compute a one-step forecast and optimized for iterated predictions. In this study, the targets are the GI SYM-H and the drivers are SWs (magnetic field, speed, pressure, and temperature). We train our model at different time resolutions during selected geomagnetic storms and compare their prediction power in iterated fashion. We also propose a method to optimize the model through an accurate entry selection instead.

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