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Real-time Dst prediction based on nonlinear black box model of the magnetosphere

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We developed two independent Dst forecasting techniques. The first approach is statistical. We build a linear regression relationship between Dst and solar wind parameters and previous Dst values. We used the regressors, with statistical significance, determined by F-test, greater than 90%. All the regressors are physical and no fitting parameters were used. This relationship was used to predict Dst 1 hour ahead with prediction efficiency (PE) of 0.975, linear correlation coefficient (LC) of 0.987 and RMS of 3.76 nT over the complete interval, 3 hours ahead with PE = 0.899 and LC = 0.906, and 9 hours ahead with PE = 0.652 and LC = 0.798. The simplicity of the developed model allows using it for real-time Dst prediction. The regression coefficients must be determined only once, and then only a ridiculously simple calculation is to be done every 1 hour. The second approach is dynamical-information. It uses the black-box model to describe magnetospheric dynamics in terms of local Lyapunov exponents, which characterize the sensitivity of plasma dynamics to geomagnetic disturbances. We propose nonlinear discrete dynamical models of magnetospheric plasma, which provide space weather forecasting. Our approach to the reconstruction of the dynamical model is based upon the application of multiobjective learning algorithms to identification of model's structure and parameters. A forecasting algorithm based on Lyapunov exponents is also proposed. For their effective use, we propose two methods of structure and parameter identification: genetic optimization and nonlinear optimization with constraints. The proposed techniques provide an efficient method to get the optimal difference equation model of chaotic systems. Our approach allows forecasting Dst-index 9 hours ahead in absence of abnormal disturbances in the solar wind. The linear correlation of the predicted value of the first local Lyapunov exponent with the mea-

sured one is about 99% for 1-hour prediction.