Effective local models for Dst forecasting

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Abstract

A globally averaged measure of the magnetic storm induced by the solar wind-magnetosphere coupling intensification, is usually characterized by the Dst index [1], constructed from mid-latitude ground stations. Intense storms, defined by Dst values below -100 nT, have been identified as the cause of extensive damage to many ground and space-based systems, and as such, their understanding is crucial to space weather studies [2]. Such effects include fluctuating magnetic fields generated on the ground, which can destabilize electric power transmission systems. In space, changes in the magnetosphere can produce energetic particle fluxes that affect satellites, sometimes causing irreparable damage to the electronics on board. Here, we develop a forecasting approach based on fitting an *effective local model (ELM)*, *i.e.*, an ODE, testing different objective functions. Particular importance is given to the error propagation with the length of the prediction.

ELM approach

We take a fairly general ODE model, which is linear with variable coefficients,

$$y'' + p(x)\, y' + q(x)\, y = r(x),$$

where the aim is to find the best functions p, q and r, to provide the best forecasts forward in time. In the figure we show an example, with a perfect result, where we plot the expected (blue dots) versus the forecasted Dst (red line) results.

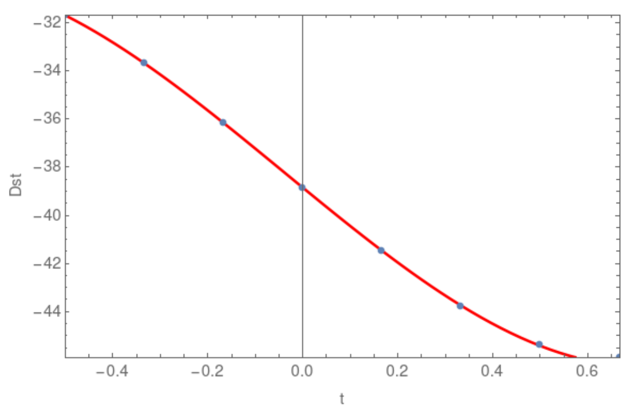

Figure: Dst forecast forward in time by fitting an ELM backward in time. To the right of the vertical line, corresponds to a forecast.

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References:

[1] https://omniweb.gsfc.nasa.gov/html/ow_data.html
[2] J. A. Valdivia et al., Journal of Geophysical Research, Vol. 104, No. A6, pags. 12,239-12,250, June 1, 1999