# Study of Great Geomagnetic storms by reconstructing data using the method of Singular Valued Decomposition

JunmiGogoi*, KalyanBhuyan
Department of Physics, Dibrugarh University, Dibrugarh, Assam-786004, India
saikiajunmigogoi@gmail.com and kalyanbhuyan@gmail.com

The earth-space environment is linked with many linear and nonlinear processes. So in order to understand the nonlinearly evolving dynamical system of sun-earth connection and magnetosphere-ionosphere coupling the ionospheric parameter i.e. critical frequency of F2 layer (foF2), is meant to be one of the most important parameters that can cover communication at a specific transmission frequency. Time Series is a sequential set of data which can be measured over time where missing observations are very common issue. And so in order to vanquish the problem of missing data we are estimating the missing value of foF2 data for various stations by the technique of Singular Value Decomposition (SVD). Hourly foF2 data from three ionosonde stations and corresponding solar flux f10.7 has been used in this technique to obtain the empirical orthogonal functions (EOF) u1 and u2. And then correlation between u1 and u2 domain with respect to various solar parameters has been checked. First the method has been tested for available data in which the correlation with the reconstructed data has been found to be greater than 92%. After that the method has been tested for partially filled data in which the correlation is found out to be greater than 95% (fig.1). So by using this method a new series of foF2 data has been created. The u1 and u2 domain has been again found out by the SVD method. Here the correlation of the u1 domain with respect few solar parameters have been found to be quite significant (fig.2). The gap of the time series data has been filled by the reconstructed data and then it has been used to study all the great geomagnetic storms (GGS) Dst≤−200 nT occurring from 1957 to 2006 which includes 5 solar cycles viz. 19, 20, 21, 22 and 23. Simultaneously the foF2 data has also been collected from IRI model to study those great geomagnetic storms for comparison. The spectral analysis of solar flux f10.7, u1-u2 domain, sunspot number SSN etc. has also been carried out to check the periodicity if any. Fig.3 is an example showing the rotational periodicities of the sun i.e. 27 days periodicity.
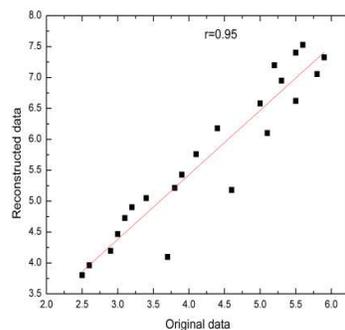
Figure 1. Correlation between reconstructed data and available data.
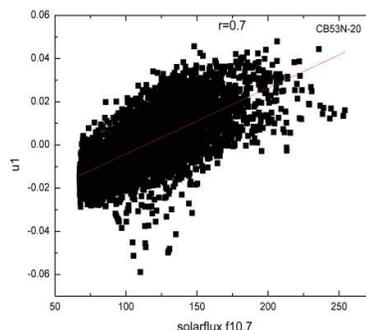
Figure 2. Correlation between u1 domain and f10.7 sfu
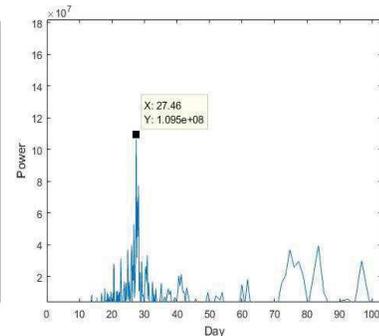
Figure 3. f10.7 sfu showing the 27day of periodicity which is the time period of solar rotation

References

1. E. A,D.-H. Zhang, Z. Xiao, Y.-Q. Hao1, A. J. Ridley, and M. Moldwin, "Modeling ionospheric *fo*F2 by using empirical orthogonal function analysis," Ann. Geophys., 29, 1501–1515, 2011, doi:10.5194/angeo-29-1501-2011.

2. Guiming Le. Ziyu Cai. Huaning. Yuting Zhu, "Solar cycle distribution of great geomagnetic storms", Astrophys Space Sci (2012) 339:151−156 DOI 10.1007/s10509-011-0960-y

3. Jakob Jakobsen, Per Knudsen · Anna B. O. Jensen, "Analysis of local ionospheric time varying characteristics with singular value decomposition", J Geod (2010) 84:449–456, DOI 10.1007/s00190-010-0378-2 review