Forecasting Dst Version Document

UPOS-AB3-05

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Version 2.0

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Table of Contents

1 Introduction

1.1 Overview

The primary purpose of the Dst Forecast system is to provide AFWA the capability to predict Dst. Dst (disturbance storm time index) is an hourly index that gives a measure of the strength of the ring current that, in turn, provides a measure of the geomagnetic storm [Dessler and Parker, 1959]. Because of its global nature, Dst is often used as one of the several indices that represent the state of the magnetosphere. Other indices include AE and Kp (http://sd-www.jhuapl.edu/UPOS/ForecastingKP). When energetic ions are injected into the Earth's inner magnetosphere, they drift westward around the Earth, forming the ring current. The Dst is derived from a composite of the H component of several low-latitude ground magnetometers after the quiet day H component has been removed [Kivelson and Russel, 1995]. The increase in the ring current, which usually occurs during a magnetic storm, reduces the horizontal (H) component of the magnetic field near the equatorial region on the surface of the Earth. Hence, the Dst is depressed or reduced during periods of magnetic disturbances, typically in the time scale of a few hours. This is followed by a recovery or an increase in Dst that is gradual, in the order of several days. The storm morphologies and Dst behavior during magnetic storms has been the subject of many studies [e.g., Mayaud, 1980; Kamide et al., 1997; Akasofu and Chapman, 1972].

Many models for the near-Earth space environment need Dst to predict various parameters such as Magnetospheric Specification Forecast Model [Freeman et al., 1993], T96 magnetic field model [Tsyganenko and Stern, 1996], etc. Unfortunately, Dst indices are published with significant time delay. The purpose of the Forecasting Dst project is to provide a predicted Dst using inputs from the ACE satellite.

The Forecasting Dst application consists of a series of scripts and programs that download data from the NOAA Space Weather and World Data Center for Geomagnetism sites, process the data into one hour averages, input the data into a neural network, and create images of the ACE data and forecasted Dst. The user can then view these images via a web browser.

1.2 Summary of Architecture

The system architecture is based on software that is currently used for similar purposes at JHU/APL. Figure 1.1 shows a diagram of the architecture and data flow.

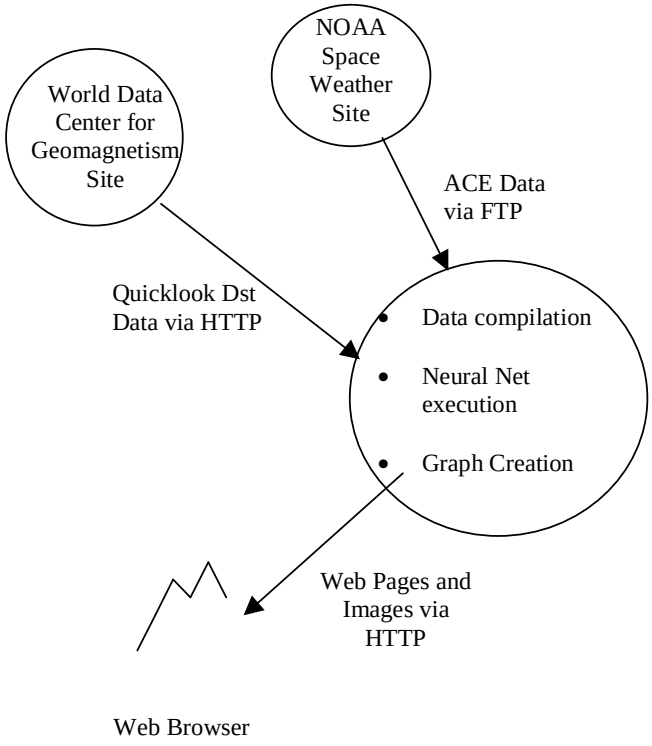

Figure 1.1: Architecture and Data Flow, Dst Forecast Software System

Once the Dst Forecasting system is started, it runs in the background. A perl script downloads the ACE data from the NOAA Space Weather site and the Quicklook Dst from the Geomagnetism site, compiles this data into 1-hour averages, and then feeds the data into a neural network. The results from this algorithm are then displayed on a web page along with the graphs of the IMF values and solar wind data.

1.3 Statement of purpose

Section 1 describes the scope of the Forecasting Dst software system.

Section 2 lists Referenced Documents

Section 3 provides a detailed description of the contents of Version 2.0 of the Forecasting Dst software system.

2 Referenced Documents

Akasofu, S.-I. and S. Chapman, On the asymmetric development of magnetic storm field in low and middle latitudes, Planet. Space Sci., 12, 607, 1964.

Akasofu, S.-I. and S. Chapman, Solar Terrestrial Physics, Oxford University Press, Oxford, 1972.

Billings, S. A. and Voon, Correlation based validity tests for nonlinear models, Int. J. Control, 44, 235-244, 1986.

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Detman, T. and J. A. Joselyn, Real-time Kp predictions from ACE real time solar wind, in Solar Wind Nine, edited by S. R. Habbal, R. Esser, J. V. Hollweg, and P. A. Isenberg, pp. 729-732, The American Institute of Physics, 1-56396-865-7, 1999.

Freeman, J. W., R. A. Wolf, R. W. Spiro, and B. Hausman, B. Bales, R. Hilmer, A. Nagai, and R. Lambour, Magnetospheric specification model development code documentation scientific description, and software documentation, Rice University for AF Geophysics Laboratory, contract F19628-90-0012, July, 1993.

Gussenhoven, M. S., D. A. Hardy, and M. Heinemann, The equatorward boundary of auroral ion precipitation, J. Geophys. Res., 92, 3273-3283, 1987.

Hardy, D. A., M. S. Gussenhoven, R. Raistrick, and W. J. McNeil, Statistical and functional representations of the pattern of auroral energy flux, number flux, and conductivity, J. Geophys. Res., 92, 12275-12294, 1987.

Kamide et al., Current understanding of magnetic storms: Storm/substorm relationships, J. Geophys. Res., 103, 17,705-17,728, 1997.

Kivelson, M. G. and C. T. Russel, Introduction to space physics, 456-457, Cambridge University Press, 1995.

Mayaud, P. N., Derivation, meaning, and use of geomagnetic indices, Geophysical Monograph, 22, AGU, Washington D. C., 1980.

Sugiura, M., Hourly values of equatorial Dst for the IGY, Ann. Int. Geophys. Year, 35, 9, Pergamon Press, Oxford, 1964.

Swain, A. K., S. A. Billings, P. K. Stansby, and M. Baker, Accurate prediction of nonlinear wave forces: Part I Fixed Cylinder, J. Mechanical Systems and Signal Processing, 12, 449-485.

Swain, A. K., S. A. Billings, P. K. Stansby, and M. Baker, Accurate prediction of nonlinear wave forces: Part II Fixed Cylinder, J. Mechanical Systems and Signal Processing, 12, 487-498.

Tsyganenko, N. A., and D. P. Stern, Modeling the global magnetic field of the large-scale Birkeland current systems, J. Geophys. Res., 101, 27,187, 1996.

3 Version Description

3.1 Inventory of Materials Released

The software system is being released on a single CD ROM labeled Forecasting Dst Software Version 2.0.

The documentation that supports this version is listed below and has been delivered with the installation of the system.

- Forecasting Dst Functional Requirements Document, UPOS-AB3-01, Version 2.0, J.Schofield and S. Wing, August 2004.

- Forecasting Dst User's Guide, UPOS-AB3-02, Version 2.0, J.Schofield and S. Wing, August 2004.

- Forecasting Dst Design Document, UPOS-AB3-03, Version 2.0, J.Schofield and S. Wing, August 2004.

- Forecasting Dst Support Plan, UPOS-AB3-04, Version 2.0, J.Schofield and S. Wing, August 2004.

- Forecasting Dst Version Description, UPOS-AB3-05, Version 2.0, J.Schofield and S. Wing, August 2004.

- Forecasting Dst Test Plan, UPOS-AB3-06, Version 2.0, J.Schofield and S. Wing, August 2004.

3.2 Inventory of Software Components

Appendix B contains the complete list of directories and files being delivered as Version 2.0 of the Forecasting Dst software system.

3.3 Changes Installed

Version 2.0 of the Forecasting Dst software system uses most of the same software for the data processing and plotting component as Version 1.0 of the system (e.g. perl scripts, rplot, c programs) with a few modifications. For the prediction component of the system, however, a new Java software piece has been developed to run a new set of neural network models and the UCB algorithm. This software replaces the Version 1.0 software that ran the neural network and UCB algorithms.

3.4 Related Documents

All documents pertinent to Version 2.0 of the Forecasting Dst software system are included in the release.

3.5 Install Instructions

A UNIX system administrator will need to perform the installation and the acceptance testing for the UNIX version of the Forecasting Dst software system.

Appendix A Acronyms and Abbreviations

Acronym	Definition
ACE	Advanced Composition Explorer
AE	Auroral Electrojet Index
AFWA	Air Force Weather Agency
APL	Applied Physics Laboratory of Johns Hopkins University
ASCII	American Standard Code for Information Interchange
Bx	X component of the Interplanetary Magnetic Field
By	Y component of the Interplanetary Magnetic Field
Bz	Z component of the Interplanetary Magnetic Field
Dst	Disturbance Storm Time Index
GIF	Graphic Interchange Format
HTML	Hypertext Markup Language
IMF	Interplanetary Magnetic Field
JHU	Johns Hopkins University
MAG	Magnetometer (ACE Instrument)
NOAA	National Oceanic and Atmospheric Administration
SWEPAM	Solar Wind Electron, Proton, and Alpha Monitor (ACE Instrument)
UCB	University of California at Berkeley
UPOS	University Partnering for Operational Support
VBs	Solar wind electric field

Appendix B Inventory of Software Contents of Version 2.0

UNIX SOFTWARE

Directory /project/upos/ForecastingDst			
dat/	512	perl/	512
history/	512	rplot/	512
nn/	512	txt/	1024
Total of 6 directories, 3584 bytes.			
Directory /project/upos/ForecastingDst/dat			
(none, until system is run)	0		
Directory /project/upos/ForecastingDst/history			
plots/	512		
Total of 1 directory, 512 bytes.			
Directory /project/upos/ForecastingDst/history/plots			
(none, until system is run)	0		
Directory /project/upos/ForecastingDst/nn			
transformer/	512	weightRepos/	512
urls/	512	dstPredictor.jar	634475
Total of 3 directories, 1 file, 636011 bytes.			
Directory /project/upos/ForecastingDst/nn/transformer			
Transformer.txt	577	Transformer_now.txt	577
Total of 2 files, 1154 bytes.			
Directory /project/upos/ForecastingDst/nn/urls			
urls_for_data.prop	787		
Total of 1 file, 787 bytes.			
Directory /project/upos/ForecastingDst/nn/weightRepos			
dstWeights.txt	5970	dstWeights_future.txt	5960
Total of 2 files, 11930 bytes.			
Directory /project/upos/ForecastingDst/perl			
ace.csh	2193	copyPlots.pl	3105
ace.pl	1189	createHist.pl	2584
aceSubs.pl	26151	ftp.pl	1653
cleanHist.pl	1710		
Total of 7 files, 38585 bytes.			
Directory /project/upos/ForecastingDst/rplot			
bin/	512	tables/	512
pdst/	1024	usr/	512
Total of 4 directories, 2560 bytes.			
Directory /project/upos/ForecastingDst/rplot/bin			
rplot	123200		
Total of 1 file, 123200 bytes.			
Directory /project/upos/ForecastingDst/rplot/pdst			
data/	1024	script/	512
rplot/	512		
Total of 3 directories, 2048 bytes.			
Directory /project/upos/ForecastingDst/rplot/pdst/data			
day.jtime	15	timestamp	76
day.xlabels_bottom	330	week.jtime	22
day.xlabels_top	303	week.xlabels_bottom	540
imf_labels_day	127	week.xlabels_top	492

imf_labels_week	124		
Total of 9 files, 2029 bytes.			
Directory /project/upos/ForecastingDst/rplot/pdst/rplot			
day_density.rp	765	week_density.rp	743
day_imf.rp	781	week_imf.rp	754
day_dst_1hr.rp	723	week_dst_1hr.rp	701
day_dst_4hr.rp	787	week_dst_4hr.rp	767
day_speed.rp	753	week_speed.rp	730
timestamp.rp	161		
Total of 11 files, 7665 bytes.			
Directory /project/upos/ForecastingDst/rplot/pdst/script			
arrange_imf_labels.pl	2036	plot_week.pl	1009
day_julian_to_hour.pl	1600	week_julian_to_day.pl	1487
plot_day.pl	1557		
Total of 5 files, 7689 bytes.			
Directory /project/upos/ForecastingDst/rplot/tables			
general/	512		
Total of 1 directory, 512 bytes.			
Directory /project/upos/ForecastingDst/rplot/tables/general			
fonts/	1024		
Total of 1 directory, 1024 bytes			
Directory /project/upos/ForecastingDst/rplot/tables/general/fonts			
Helvetica-Bold.14.fnt	26052	Symbol.18.fnt	33884
Helvetica.10.fnt	16564	Symbol.24.fnt	51580
Helvetica.12.fnt	21100	Symbol.8.fnt	13620
Helvetica.14.fnt	23964	Times-Roman.10.fnt	15772
Helvetica.20.fnt	34412	Times-Roman.12.fnt	21844
Helvetica.24.fnt	34412	Times-Roman.14.fnt	23828
Helvetica.34.fnt	83844	Times-Roman.20.fnt	33012
Helvetica.8.fnt	13636	Times-Roman.24.fnt	50644
Symbol.10.fnt	15932	Times-Roman.34.fnt	75692
Symbol.12.fnt	21540	Times-Roman.8.fnt	12644
Symbol.14.fnt	24460		
Total of 21 files, 648436 bytes.			
Directory /project/upos/ForecastingDst/rplot/usr			
bin/	512		
Total of 1 directory, 512 bytes.			
Directory /project/upos/ForecastingDst/rplot/usr/bin			
filter_forecast	6692		
Total of 1 file, 6692 bytes.			
Directory /project/upos/ForecastingDst/txt			
(none, until system is run)	0		
Grand total of 20 directories, 61 files, ~2 MB.			