Operational Auroral Boundary and Particle Precipitation Nowcasting Software Version Description

Document Number UPOS-A53-04

M. M. Hopkins

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Version 1.0

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1 Scope

1.1 Identification

The Auroral Boundary and Particle Precipitation Nowcasting software system has been developed by the Space Department of the Johns Hopkins University Applied Physics Laboratory and adapted to run on Air Force Space Weather Center (AFSWC) facilities. Its purpose is to provide AFSWC the capability to monitor the auroral oval position. Specifically it tracks the equatorward and poleward edges using multi-point measurements whenever possible. Additionally, the software provides a one hour forecast of auroral power based on the particle precipitation data and calculates an equivalent instantaneous Kp, using the polar cap size and the ion isotropy boundary. This is Version 1.0.

1.2 System Overview

The input to the system is the DMSP particle data available from the database at AFSWC. The main output is a pair of images depicting the geographic position of the auroral oval for either or both the northern and southern hemispheres, depending on data availability, along with the inferred Kp and a “green light/yellow light” forecast.

The system architecture is based on software that is currently used for similar purposes at JHU/APL. Modifications of this software were made to accommodate AFSWC input and output and scheduling requirements. Figure 1. Architecture and Data Flow, Auroral Boundary Software System shows a diagram of the architecture and data flow. The components shown in this figure map into the software units delivered. An executive script initiated by the AFSWC scheduler manages the environment and the execution of the software system according to AFSWC requirements.

The first process, Data Selection, extracts the DMSP position and particle data from the AFSWC relational database, formats it, and provides it as input into the second process. This second process, the Boundary Detection, identifies the auroral oval boundaries along with certain key indicators of the state of geomagnetic activity. In particular, it identifies the equatorward and poleward edges of the aurora as well as the ion isotropic boundary (b2i). The locations of the boundaries determined in the Boundary Detection process are then fed into the third process. This third process, the Oval Determination, first uses the boundary information to determine the shape of the auroral oval in geomagnetic coordinates. It then uses the PACE (or more formally, the Altitude Adjusted Corrected Geomagnetic Coordinate-AACGM) model to transform the geomagnetic coordinates to geographic coordinates, and finally uses these coordinates to produce GIF files.

The Data Selection software was developed specifically to meet the AFSWC requirement to interface with their existing database. The greater part of the Boundary Detection software exists and is currently in use at JHU/APL for research purposes. This component was simplified to acquire existing data directly from the AFSWC satellite database and eliminate unneeded calculations.

Both the Oval determination and the PACE model are fully implemented and required comparatively modest modification to meet AFSWC requirements. The Generation of Graphics software was developed specifically to meet AFSWC requirements for content and for format to be compatible with existing graphics output capability.

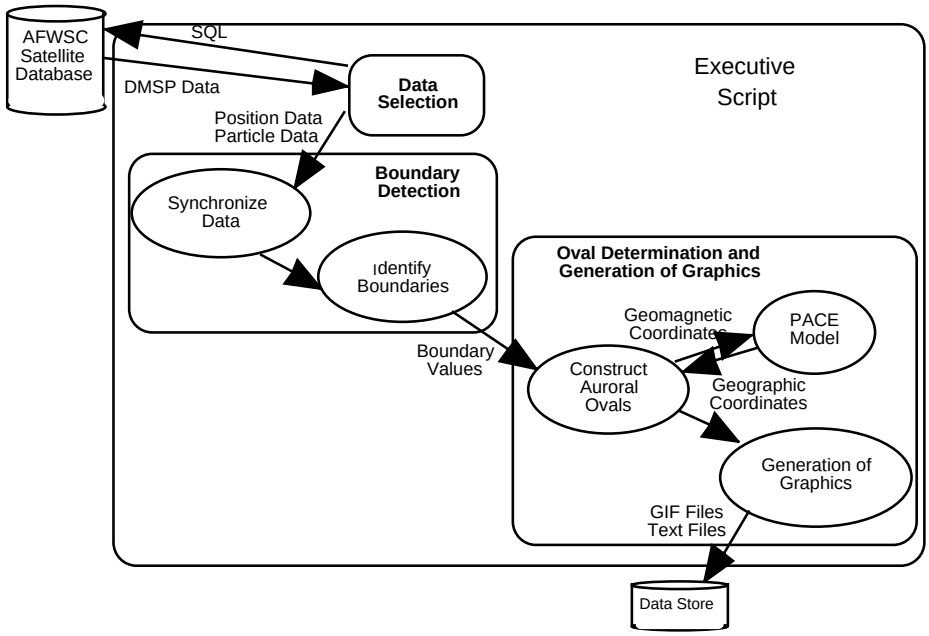

Figure 1. Architecture and Data Flow, Auroral Boundary Software System

An executive script will coordinate the execution of the processes listed above, and will perform routine cleanup of temporary files. The running of the script will be scheduled via software running at AFSWC. There is no custom graphical user interface. AFSWC may use existing software or commercial packages to display the content of the GIF files.

1.3 Document Overview

Section 1 describes the scope of the Operational Auroral Boundary and Particle Precipitation Nowcasting software system.

Section 2 lists Referenced Documents.

Section 3 provides a detailed description of the contents of Version 1.0 of the Operational Auroral Boundary and Particle Precipitation Nowcasting software system.

2 Referenced Documents

- 50th Weather Squadron, Falcon AFB, CO 80912-7160, Satellite database specification (SAT_DB) for the 50th Weather Squadron, 9 July 1996,

3 Version Description

3.1 Inventory of Materials Released

This software system is being released on a single 4 mm DAT tape labeled Auroral Boundaries Version 1.0.

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

- Operational Auroral Boundary and Particle Precipitation Nowcasting Functional Requirements Document, UPOS-A53-02, Version 1.1, 15 March 2000

- Test Plan for the Operational Auroral Boundary and Particle Precipitation Nowcasting Program, Version 1.1, D. B. LaVallee, 7 January 1000

- Operational Auroral Boundary and Particle Precipitation Nowcasting Program Test Report, D. B. LaVallee, TBS

- Operational Auroral Boundary and Particle Precipitation Nowcasting User's Guide, UPOS-A53-01, Version 1.0, L. M. Hasselbarth, 13 March 2000

- Operational Auroral Boundary and Particle Precipitation Nowcasting Support Plan, UPOS-A53-03, R. DeMajistre, Draft, January 2000

- Operational Auroral Boundary and Particle Precipitation Nowcasting Software Version Description, UPOS-A53-04, Version 1.0, M. M. Hopkins, 22 March 2000

3.2 Inventory of Software Contents

Appendix B contains the complete list of directories and files being delivered as Version 1.0 of the Auroral Boundary and Particle Precipitation Nowcasting software system.

3.3 Changes Installed

This is the initial delivery of the software system.

3.4 Adaptation Data

The database and its access are unique to the AFSWC site. The test data and the database queries are based on the document cited in Section 2 Referenced Documents. Specifically, this software system accesses the three database table listed below.

- location
- ssj4_particles
- sat_cross_ref

3.5 Related Documents

All documents pertinent to Version 1.0 of the Operational Auroral Boundary and Particle Precipitation Nowcasting software system are included in the release.

3.6 Installation Instructions

A system administrator and a database administrator need to be available to monitor the installation and the acceptance testing. The installation script is below.

```
$!*********************************************************
******
$! The following commands create the specified "TARGET"
directory
$! and extract the UPOS source code from tape placing the
files
$! into the "TARGET" directory.
$! The UPOS_INSTALL procedure creates the UPOS Auroral
Boundary  $! Directory structure and builds the programs
that comprise the
$! Boundary detection and display system.
$! The RUN_UPOS_AURORAL  procedure then executes the newly
built
$! software system for input data corresponding to the
indicated $! time period.
$!
$!*********************************************************
******
$!
$BACKUP MKB400:UPOSRC.SAV/REWIND [.TARGET]
$SET DEF "TARGET"
$@UPOS_INSTALL
$SET DEF [.SCRIPTS]
$! Execute a test case
$@RUN_UPOS_AURORAL "1999-5-5 10:00:00.0" 2
$!
```

3.7 Possible Problems and Known Errors

4 Notes

APPENDIXES

A. Acronyms and Abbreviations

Acronym	Definition
AFCCC	Air Force Combat Climatology Center
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AFSCN	Air Force Satellite Control Network
AFSPACECOM	Air Force Space Command
AFWA	Air Force Weather Agency
AFWIN	Air Force Weather Information Network
AF/XOW	Air Force Director of Weather
APL	Applied Physics Laboratory of Johns Hopkins University
ASPAM	Atmospheric Slant Path Analysis Model
AVHRR	Advanced Very High Resolution Radiometer
AVN	Aviation Model
AVO	Alaska Volcano Observatory
BATS	Biosphere-Atmosphere Transfer Scheme
CLASS	Canadian Land Surface Scheme
COE	Common Operating Environment
DII	Defense Information Infrastructure
DMSP	Defense Meteorological Satellite Program
ECMWF	European Centre for Medium-Range Weather Forecasts
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FSL	Forecast Systems Laboratory
FTP	File Transfer Protocol
GI	Geophysical Institute
GIF	Graphic Interchange Format
GMT	Generic Mapping Tools
GOLD	Geophysical On-Line Data
GRIB	Gridded Binary
HLBL	High Latitude Boundary Layer
IMF	Interplanetary Magnetic Field

Acronym	Definition
JHU	Johns Hopkins University
LAN	Local Area Network
LAPS	Local Analysis and Prediction System
LSM	Land Surface Model
MM5	Fifth Generation Mesoscale Model
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
netCDF	Network Common Data Form
NGDC	National Geophysical Data Center
NGM	Nested Grid Forecast Model
NOGAPS	Navy Operational Global Atmospheric Prediction System
NWP	Numerical Weather Prediction
OWS	Operational Weather Squadron
PBL	Planetary Boundary Layer
PCA	Polar Cap Absorption
PFRR	Poker Flat Research Range
SABER	Sounding of the Atmosphere using Broadband Emission Radiometry
SD	Space Department of the Applied Physics Laboratory
SDP	Software Development Plan
SEC	Space Environment Center
SEE	Solar EUV Experiment
SEON	Solar Electro-optical Observing Network
SFOC	Spaceflight Operations Center
STP	Solar Terrestrial Physics
SWOC	Space Weather Operations Center (Offutt)
SWXS	Space Weather Squadron
Tcl	Tool Command Language
Tk	Toolkit
Tix	Tk Interface Extension
UAF	University of Alaska, Fairbanks
UCAR	University Corporation for Atmospheric Research
UPOS	University Partnering for Operational Support
WDC	World Data Center
WF	Weather Flight
WMO	World Meteorological Organization
XDR	External Data Representation

B. Inventory of Software Contents of Version 1.0

Directory UPOS_1:[PROJECT.UPOS]			
BIN.DIR;1	1	COMPILE_CNVCOORD.C|	4
DEASSIGN.COM;8	1	INSTALL_CNVCOORD_L|	2
INSTALL_CONTOUR.CO|	2	INSTALL_DAYSIDE.CO|	8
INSTALL_INCL.COM;1	3	INSTALL_NIGHTSIDE.|	6
INSTALL_PREPROCESS|	2	INSTALL_UPOS_IDL.C|	1
INSTALL_UTILITIES.|	3	PRODUCTS.DIR;1	1
SCRIPTS.DIR;1	1	SRC.DIR;1	1
TEMP.DIR;1	1	UPOS_INSTALL.COM;1	6
Total of 16 files, 43 blocks.			
Directory UPOS_1:[PROJECT.UPOS.BIN]			
DAYID.EXE;1	171	MERG_PF.EXE;1	21
NIGHTB.EXE;1	158	SPLIT_FILES.EXE;1	32
UPOS_IDL_PROGRAM.S|	697		
Total of 5 files, 1079 blocks.			
Directory UPOS_1:[PROJECT.UPOS.PRODUCTS]			
ASCII.DIR;1	1	ERROR.DIR;1	1
GIF.DIR;1	1		
Total of 3 files, 3 blocks.			
Directory UPOS_1:[PROJECT.UPOS.PRODUCTS.ASCII]			
F1299125.ASC;1	3	F1299125.DAY;1	6
F1399125.ASC;1	3	F1399125.DAY;1	6
F1499125.ASC;1	0	F1499125.DAY;1	1
NORTHOVAL.TXT;1	53	NORTHOVAL_1999_125|	53
SOUTHOVAL.TXT;1	53	SOUTHOVAL_1999_125|	53
UPOS_HISTORY.ASC;1	1		
Total of 1 file, 16 blocks.			
Directory UPOS_1:[PROJECT.UPOS.PRODUCTS.ERROR]			
ERROR.LOG;1	16		
Total of 1 file, 16 blocks.			
Directory UPOS_1:[PROJECT.UPOS.PRODUCTS.GIF]			
B2I_HISTORY.GIF;1	8	FLUX_HISTORY;1	9
NORTHOVAL_GEO.GIF;|	20	NORTHOVAL_GEO_1999|	20
NORTHOVAL_MAG.GIF;|	14	NORTHOVAL_MAG_1999|	14
SOUTHOVAL_GEO.GIF;|	15	SOUTHOVAL_GEO_1999|	15
SOUTHOVAL_MAG.GIF;|	14	SOUTHOVAL_MAG_1999|	14
Total of 10 files, 143 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SCRIPTS]			
CLEANUP_FILES.COM;|	5	CREATE_SQL.COM;1	18
DEASSIGN_UPOS_LOGI|	3	HISTORICAL_CLEANUP|	7

INIT_UPOS_LOGICALS|	5	RUN_UPOS_AURORAL.C|	10
Total of 6 files, 48 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC]			
BOUNDARY.DIR;1	1	CONTOUR.DIR;1	1
IDL.DIR;1	5	PACE.DIR;1	1
PREPROCESS.DIR;1	1		
Total of 5 files, 9 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.BOUNDARY]			
DAYSIDE.DIR;1	3	INC.DIR;1	2
NIGHTSIDE.DIR;1	4	UTILITIES.DIR;1	1
Total of 4 files, 10 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.BOUNDARY.DAYSIDE]			
BPS_ID.F;1	9	CNTS2FLUX.F;1	3
COMPUTE_PEAK.F;1	4	CPS_ID.F;1	15
CUSP_ID.F;1	14	CUTOFF.F;1	5
DAYID.F;1	9	GET_INDEX.F;1	3
LLBL_ID.F;1	10	MANTLE_ID.F;1	13
MODIFIED_CNTS2FLUX.F|	5	OOPEN_LLBL_ID.F;1	10
PHPR.F;1	6	PR_ID.F;1	4
RAD_ID.F;1	6	SORT_REGIONS.F;1	58
ZERO_DAY_BOUNDARIE|	3		
Total of 17 files, 193 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.BOUNDARY.INC]			
ALT_FILE.CMN;1	1	ARCS.PAR;1	4
ARC_IO.INC;1	1	BIG_BUFFER.CMN;1	2
BOUNDARIES.INC;1	1	DAYBOUNDS.INC;1	2
DMSP_CATALOG.INC;1	2	ENERGY.CMN;1	1
FACTORS.ASC;1	52	FRAME.CMN;1	1
GEOFACTORS.CMN;1	1	GEOFACTORS.INC;1	24
MASKS.INC;1	1	MHS.INC;1	1
ONE_SEC.CMN;1	1	ORBIT.INC;1	1
OUTPUT.INC;1	1	O_FACTORS.ASC;1	41
PARMS.INC;1	1	SAT_FACTS.CMN;1	2
STRUCT.INC;1	1		
Total of 21 files, 142 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.BOUNDARY.DAYSIDE]			
B12.F;1	44	B2A_ID.F;1	4
B3_ID.F;1	3	B456.F;1	34
B4S.F;1	5	FIND_PEAK.F;1	1
IS_DISCRETE.F;1	7	JENP.F;1	1
NEXT_NITE_XING.F;1	13	NIGHTB.F;1	19
NIGHT_PHPR.F;1	25	TEST_2PEAK.F;1	3
TESTMONO.F;1	3		
Total of 13 files, 162 blocks.			

Directory UPOS_1:[PROJECT.UPOS.SRC.BOUNDARY.UTILITIES]			
ADVANCE.F;1	1	AFSFC_MHS_STUB.F;1	3
AVE_REGION.F;1	8	BACKUP.F;1	1
COPY_INT2.F;1	3	COPY_REAL4.F;1	1
FILL_BUFFER.F;1	3	GET_ONE.F;1	3
GET_SAT_FACTS.F;1	7	JEP.F;1	1
JIP.F;1	1	MOVE_END.F;1	1
MOVE_START.F;1	1	MOVE_UT.F;1	1
NEW_GETDSK.F;1	11	NEXT_PASS.F;1	12
OPEN_FILE.F;1	3	S2H.F;1	1
UAVE_REGION.F;1	8	UT2HMS.F;1	1
Total of 20 files, 69 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.CONTOUR]			
BUILD_MCON_IDL.COM|	1	CALL_CNVCOORD_IDL.|	5
CFIND_COLOR_INDICE|	19	DRAW_MAG_CONTOUR.P|	16
GET_AACGM_MODEL_YR|	2	GET_FNAME_WIDGET.P|	7
LAUNCH_MAGCONTOUR.|	1	MAGCONTOUR.COM;1	2
MAGCONTOUR_HELP.TX|	9	MAG_CONTOUR.PRO;1	44
MAP_COUNTRY_LABELS|	5	SELECT_COLOR.PRO;1	6
SETUP.COM;1	1	WWW.MAGCONTOUR.PRO|	6
Total of 14 files, 124 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.IDL]			
B2I_TO_KP_CONVERT.|	3	CALC_MTD.PRO;1	3
CALL_CNVCOORD_IDL.|	5	CALL_MLT.PRO;1	5
CNVCOORD.PRO;1	15	CNVCOORD_FORTRAN.P|	14
COORD_INTERP.PRO;1	4	CORRECT_TRACK_PREV\	4
CREATE_DATE_STRING|	3	DAYSIDE_ORDER.PRO;|	3
DMSP_LOCATE_INTERP|	4	DS_OV_INIT.PRO;1	3
EQN_OF_TIME.PRO;1	6	FINDFLUX.PRO;1	4
FIND_COLOR_INDICES|	19	FIT_BOUND_EQ.PRO;1	21
FIT_BOUND_POL.PRO;|	4	FIT_OVAL_SPLINE.PR|	9
GETSPLINEPOINTS.PR|	11	GET_DSB_FILE.PRO;1	18
GET_JDAY.PRO;1	2	GET_MODEL_YEAR.PRO|	3
GET_NSB_FILE.PRO;1	4	LAUNCH_UPOS.PRO;1	1
LL2RB.PRO;1	6	MAG_TO_GEO.PRO;1	4
MATSOLVE.PRO;1	2	MLT_TO_MLONG.PRO;1	4
NIGHTSIDE_ORDER.PR|	4	NS_OV_INIT.PRO;1	2
OPEN_WINDOWS.PRO;1	3	OVAL_FILL.PRO;1	5
POLREC.PRO;1	4	POLREC3D.PRO;1	4
PS_PORT.PRO;1	1	RB2LL.PRO;1	7
RD_NSB_REC.PRO;1	4	READ_DSB_PASS.PRO;|	5
RD_NSB_REC.PRO;1	4	READ_DSB_PASS.PRO;|	5
READ_NSB.PRO;1	4	RECOMBINE_TRACKS.P|	19
RECPOL.PRO;1	5	RECPOL3D.PRO;1	5
ROT_3D.PRO;1	7	SOLAR_LOC.PRO;1	6

STR_REPLACE.PRO;1	2	TEST_CNVCOORDF_LIB.|	5
TEST_FLUX_PLOTS.PR|	1	UPOS_B2I_PLOT.PRO;|	7
UPOS_BOUNDARY_TRAC|	8	UPOS_CONVERT_FIT_P|	7
UPOS_CREATE_OVAL_D|	11	UPOS_DRAW_OVAL.PRO|	18
UPOS_FIT_OVAL_SPLI|	10	UPOS_FLUX_PLOT.PRO|	9
UPOS_GET_DAYTRACKS|	2	UPOS_HISTORY_REC_S|	2
UPOS_HISTORY_TIMES|	3	UPOS_KEEP_B2I_FLUX|	7
UPOS_OVALS.PRO;1	14	UPOS_OVALS_GET_FIT|	10
UPOS_OVAL_ANNOTATE|	12	UPOS_PATH_FROM_TRA|	9
UPOS_PLOT_CROSSING|	10	UPO_PLOT_HISTORY.|	7
UPOS_READ_B2I_FLUX|	3	UPOS_READ_PREV_OVA|	3
UPOS_WRITE_OVALS.P|	5	YDN2MD.PRO;1	5
YS_TIME_TICKS.PRO|	2		
Total of 69 files, 441 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.PACE]			
ASCII.DIR;1	1	LIB.DIR;1	3
Total of 2 files, 4 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.PACE.ASCII]			
AACGM_CCOEFFS1975.A|	120	AACGM_CCOEFFS1980.A|	120
AACGM_CCOEFFS1985.A|	120	AACGM_CCOEFFS1990.A|	120
AACGM_CCOEFFS1995.A|	120		
Total of 5 files, 600 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.PACE.LIB]			
AACGM_INIT_VMS.F;1	6	ALTITUDE_TO_CGM.F;|	6
CGM_TO_ALTITUDE.F;|	7	CNVCOORD.F;1	9
CNVCOORD_F.F;1	6	CNVCOORD_IDO_VMS.C|	9
CNVCOORD_LIB.EXE;1	63	CNVCOORD_PREP_VMS.|	5
CNV_SEC_MDHMS.F;1	4	EQN_OF_TIME.F;1	5
FLOAT_PASS_TEST.C|	1	MLT.F;1	9
MLT1.F;1	4	RYLM.F;1	16
SFC_CONVERT_GEO_CO|	74	SFC_PUT_USER_MSG.F|	4
SOLAR_LOC.F;1	5		
Total of 17 files, 233 blocks.			
Directory UPOS_1:[PROJECT.UPOS.SRC.PREPROCESS]			
ARC_BREAK.F;1	7	MERG_PF.F;1	7
SPLIT_FILES.F;1	16		
Total of 3 files, 30 blocks.			
Directory UPOS_1:[PROJECT.UPOS.TEMP]			
DAYSIDE.DIR;1	1	DB_OUT.DIR;1	1
NIGHTSIDE.DIR;1	1	TTEST.DIR;1	1
Total of 4 file, 4 blocks.			
Directory UPOS_1:[PROJECT.UPOS.TEMP.DB_OUT]			
F1299125.FXD;1	2732	F1299125.LOC;1	225
F1299125.POS;1	925	F1299125.SSJ4;1	3832

F1399125.FXD;1	2223	F1399125.LOC;1	189
F1399125.POS;1	753	F1399125.SSJ4;1	3120
F1499125.FXD;1	1238	F1499125.LOC;1	102
F1499125.POS;1	419	F1499125.SSJ4;1	1740
LOCATION.LST;1	603	PARTICLE.LST;1	14267
Total of 14 files, 32368 blocks			
Directory UPOS_1:[PROJECT.UPOS.TEMP.TEST]			
LOCATION.LST;1	603	PARTICLE.LST;1	14267
Total of 2 files, 14870 blocks.			
Grand total of 22 directories, 262 files, 50823 blocks.			