PAUL SCHERRER INSTITUT

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THE RADIATION ENVIRONMENT MONITOR

SCIENTIFIC DATA EXTRACTION

Part II

REM–CDF database

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Contents

1 Introduction

For more than two years now (December 1996) the Radiation Environment Monitors aboard STRV–1B and Mir are accumulating data. In order to make this data available to a larger community, a data format is used which is portable across various computer platforms and allows easy access. The Common Data Format, CDF developed by the National Space Science Data Center, NSSDC, fulfills these requirements and is used to store the REM data.

A brief definition of CDF is given by the developers themselves:

> The National Space Science Data Center's (NSSDC) Common Data Format (CDF) is a self-describing data abstraction for the storage and manipulation of multidimensional data in a discipline-independent fashion. When one first hears the term "Common Data Format" one intuitively thinks of data formats in the traditional (i.e. messy/convoluted storage of data on disk or tape) sense of the word. Although CDF has its own internal self describing format, it consists of more than just a data format. CDF is a scientific data management package (known as the "CDF Library") which allows programmers and application developers to manage and manipulate scalar, vector, and multi-dimensional data arrays. The irony of the term "FORMAT" is that the actual data format which CDF utilizes is completely transparent to the user and accessible through a consistent set of interface (known as the "CDF Interface") routines. Therefore, programmers are not burdened with performing low level I/O's to physically format and unformat the data file. This is all done for them. The development of CDF arose out of the recognition by the NSSDC for a class of data models that is matched to the structure of scientific data and the applications (i.e. statistical and numerical methods, visualization, and management) they serve.

CDF is available for various platforms and operating systems:
DEC Alpha/OSF1 & OpenVMS, DECstation/ULTRIX & VMS, HP 9000 series/HP-UX, IBM PC MS-DOS/Windows, Linux & QNX, IBM RS600 series/AIX, Macintosh, NeXT/Mach, SGI Iris, Power series and Indigo/IRIX, Sun/SunOS & SOLARIS, VAX/VMS

The Common Data Format software is available via internet on

http://nssdc.gsfc.nasa.gov/cdf/cdf_home.html

and comes along with a complete set of documentation. Readers not familiar with CDF are referred to the address mentioned above for practical informations.

In this document we describe the REM specific definitions. It shall allow a CDF user to extract and manipulate the REM–CDF database. Detailed information on the various data items can be found in the reports listed in section 3.

2 REM–CDF database

The REM–CDF database consists of a set of CDF files. For each instrument there exist two files per calendar day. One file contains the raw data and the other file contains reduced and supplementary data. Each file has a set of global attributes and a set of variables. Only zVariables, no rVariables are used. Single file format and network decoding is applied.

2.1 File naming

All filenames are eight characters long and have the three character extension "cdf". STRV–REM files start with an "s" and Mir–REM files, with an "m". The second character defines whether the file contains raw ("A") or reduced ("B") data. The last six characters are digits and represent the day of observation ("yymmdd"). The file naming is summarized in the following table

STRV–1B	Mir	comments
sAyymmdd.cdf	mAyymmdd.cdf	Raw data, yy: year, mm: month, dd: day
sByymmdd.cdf	mByymmdd.cdf	Reduced and supplementary data

3 Data set definition

In this section the content of the REM–CDF files are described. This information can also be extracted directly from the CDF files with the CDF command *"skeletontable"* (see CDF User's Guide [1] for more information).

Each file contains a number of "GLOBAL attributes". This is information which is common to all data on the file. The data is contained in "VARIABLES" each for which "VARIABLE attributes" exist. The VARIABLE attributes contain information which specifies the data in a variable.

Information on how the data has been obtained from the raw REM observation files can be found in the following documents

Description	DOCUMENT	
	STRV–1B	Mir
Extraction of count rates and housekeeping data	STRV DATA PREPROCESSING [2]	MIR DATA PREPROCESSING [3]
Determination of observation time	DETERMINATION OF THE STRV–1B OBSERVATION TIMES [4]	DETERMINATION OF THE MIR OBSERVATION TIMES [5]
Deadtime correction and spectral deconvolution	SCIENTIFIC DATA EXTRACTION [6]	
Determination of orbit	STRV–1B AND MIR ORBIT DETERMINATION [7]	
Calculation of magnetic field and L–values	uses routines of the TRAPPED RADIATION SOFTWARE [8]	

3.1 STRV–REM

3.1.1 sAyymmdd.cdf

HEADER	
DATA ENCODING	NETWORK
MAJORITY	ROW
FORMAT	SINGLE

GLOBAL attributes

Attribute Name	Entry Number	Data Type	Value	Comment
TITLE	1	CDF_CHAR	Radiation Environment Monitor	
MISSION_ID	1	CDF_CHAR	STRV–1B	
INSTRUMENT_ID	1	CDF_CHAR	REM	
OBS_DATE	1	CDF_CHAR	dd-mmm-yy	Date of observation, dd: day, mmm: month, yy: year
OBS_CLOCK	1	CDF_FLOAT		difference between 01-Jan-92, 00:00:00 and dd-mmm-yy, 00:00:00 in seconds
OBS_NUM	1	CDF_UINT4		number of real data accumulations
TEST_NUM	1	CDF_UINT4		number of testpulser accumulations
REMARKS	1	CDF_CHAR		
	2	CDF_CHAR		
	3	CDF_CHAR		

VARIABLE attributes

Attribute Name	Data Type	Values	Comments
FIELDNAME	CDF_CHAR		Description of variable
UNITS	CDF_CHAR		Units of variable values
FILLVAL	CDF_DOUBLE	-999.9	Variable is set to this value when data is missing

VARIABLES

Variable Name	Data Type	Number Elements	Dims	Sizes	Record Variance	Dimension Variances	Units	Comment
zVariables								
TIME	CDF_DOUBLE	1	1	1	T	F	[sec]	Central time[1] of real data accumulations, time elapsed since start of day which is given by the global attribute OBS_DATE
ACC_TIME	CDF_DOUBLE	1	1	1	T	T	[sec]	Accumulation times of real data accumulations
CHANNELS	CDF_DOUBLE	1	1	32	T	T	[Hz]	Count rate in each channel for real data accumulations
TEMPERATURES	CDF_DOUBLE	1	1	4	T	T	[°C]	Detector temperatures for real data accumulations
VOLTAGES	CDF_DOUBLE	1	1	4	T	T	[%]	Detector voltages for real data accumulations in % of nominal value
TEST_TIME	CDF_DOUBLE	1	1	1	T	T	[sec]	As TIME but for testpulser accumulations
TEST_ACCT	CDF_DOUBLE	1	1	1	T	T	[sec]	As ACC_TIME but for testpulser accumulations
TEST_CH	CDF_DOUBLE	1	1	32	T	T	[Hz]	As CHANNELS but for testpulser accumulations
TEST_TEMP	CDF_DOUBLE	1	1	4	T	T	[°C]	As TEMPERATURES but for testpulser accumulations

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Variable Name	Data Type	Number Elements	Dims	Sizes	Record Variance	Dimension Variances	Units	Comment
TEST_VOLT	CDF_DOUBLE	1	1	4	T	T	[%]	As VOLTAGES but for testpulser accumulations

[1] Start time + 1/2 accumulation time

3.1.2 sByymmdd.cdf

HEADER	
DATA ENCODING	NETWORK
MAJORITY	ROW
FORMAT	SINGLE

GLOBAL attributes

Attribute Name	Entry Number	Data Type	Value	Comment
TITLE	1	CDF_CHAR	Radiation Environment Monitor	
MISSION_ID	1	CDF_CHAR	STRV-1B	
INSTRUMENT_ID	1	CDF_CHAR	REM	
OBS_DATE	1	CDF_CHAR	dd-mmm-yy	Date of observation, dd: day, mmm: month, yy: year
OBS_CLOCK	1	CDF_FLOAT		difference between 01-Jan-92, 00:00:00 and dd-mmm-yy, 00:00:00 in seconds
OBS_NUM	1	CDF_UINT4		number of real data accumulations
DRM_VERS	1	CDF_CHAR	Sep,95	Version of the Detector Response Matrix used for deconvolution
PF_NUM	1	CDF_UINT4	6	number of proton energy bins
ENE_P	1	CDF_FLOAT	24.0, 40.0, 65.0, 110.0, 175.0, 300.0, 600.0	limits of proton energy bins
EF_NUM	1	CDF_UINT4	3	number of electron energy bins
ENE_E	1	CDF_FLOAT	1.2, 2.0, 3.2, 5.0	limits of electron energy bins
NORAD	1	CDF_CHAR		NORAD elements, 1st line

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Attribute Name	Entry Number	Data Type	Value	Comment
	2	CDF_CHAR		NORAD elements, 2nd line
COORD_SYS	1	CDF_CHAR	ECI	Coordinate system used for orbit calculation
BLTIME	1	CDF_UINT4	1995	Epoch of internal magnetic field model (as used in UNIRAD [8])
B_MODEL	1	CDF_CHAR	DGRF/IGRF	Internal magnetic field model
OUTER	1	CDF_CHAR	Tsyganenko 1989	External magnetic field model
VALUE_KP	1	CDF_UINT4	0	KP value used for external magnetic field model
REMARKS	1	CDF_CHAR		
	2	CDF_CHAR		
	3	CDF_CHAR		

VARIABLE attributes

Attribute Name	Data Type	Value	Comment
FIELDNAME	CDF_CHAR		Description of variable
UNITS	CDF_CHAR		Units of variable values
FILLVAL	CDF_DOUBLE	-999.9	Variable is set to this value when data is missing

VARIABLES

Variable Name	Data Type	Number Elements	Dims	Sizes	Record Variance	Dimension Variances	Units	Comment
zVariables								
TIME	CDF_DOUBLE	1	1	1	T	F	[sec]	Central time[2] of real data accumulations, time elapsed since start of day which is given by the global attribute OBS_DATE
DTCF	CDF_DOUBLE	1	1	2	T	T	[1]	Deadtime correction factor, ≥ 1
P_FLUX	CDF_DOUBLE	1	2	6/2	T	T/T	$Hz/cm^2/MeV$	Differential proton flux in the energy bins defined by the global attribute ENE_P
E_FLUX	CDF_DOUBLE	1	2	3/2	T	T/T	$Hz/cm^2/MeV$	Differential electron flux in the energy bins defined by the global attribute ENE_E
ORBIT	CDF_DOUBLE	1	1	3	T	T	[km]	Position of the satellite at time TIME, coordinate system defined by global variable COORD_SYS
MAGNETIC	CDF_DOUBLE	1	1	2	T	T	[Gauss/R_E]	Magnetic field and L–value at position of satellite

[2]Start time + 1/2 accumulation time

3.2 Mir–REM

3.2.1 mAyymmdd.cdf

HEADER	
DATA ENCODING	NETWORK
MAJORITY	ROW
FORMAT	SINGLE

GLOBAL attributes

Attribute Name	Entry Number	Data Type	Value	Comment
TITLE	1	CDF_CHAR	Radiation Environment Monitor	
MISSION_ID	1	CDF_CHAR	MIR	
INSTRUMENT_ID	1	CDF_CHAR	REM	
OBS_DATE	1	CDF_CHAR	dd-mmm-yy	Date of observation, dd: day, mmm: month, yy: year
OBS_CLOCK	1	CDF_FLOAT		difference between 01-Jan-92, 00:00:00 and dd-mmm-yy, 00:00:00 in seconds
OBS_NUM	1	CDF_UINT4		number of real data accumulations
TEST_NUM	1	CDF_UINT4		number of testpulser accumulations
REMARKS	1	CDF_CHAR		
	2	CDF_CHAR		
	3	CDF_CHAR		

VARIABLE attributes

Attribute Name	Data Type	Value	Comment
FIELDNAME	CDF_CHAR		Description of variable
UNITS	CDF_CHAR		Units of variable values

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Attribute Name	Data Type	Value	Comment
FILLVAL	CDF_DOUBLE	-999.9	Variable is set to this value when data is missing

VARIABLES

Variable Name	Data Type	Number Elements	Dims	Sizes	Record Variance	Dimension Variances	Units	Comment
zVariables								
TIME	CDF_DOUBLE	1	1	1	T	F	[sec]	Central time[3] of real data accumulations, time elapsed since start of day which is given by the global attribute OBS_DATE
ACC_TIME	CDF_DOUBLE	1	1	1	T	T	[sec]	Accumulation times of real data accumulations
CHANNELS	CDF_DOUBLE	1	1	32	T	T	[Hz]	Count rate in each channel for real data accumulations
TEMPERATURES	CDF_DOUBLE	1	1	4	T	T	[°C]	Detector temperatures for real data accumulations
VOLTAGES	CDF_DOUBLE	1	1	4	T	T	[%]	Detector voltages for real data accumulations in % of nominal value
TEST_TIME	CDF_DOUBLE	1	1	1	T	T	[sec]	As TIME but for testpulser accumulations
TEST_ACCT	CDF_DOUBLE	1	1	1	T	T	[sec]	As ACC_TIME but for testpulser accumulations
TEST_CH	CDF_DOUBLE	1	1	32	T	T	[Hz]	As CHANNELS but for testpulser accumulations
TEST_TEMP	CDF_DOUBLE	1	1	4	T	T	[°C]	As TEMPERATURES but for testpulser accumulations
TEST_VOLT	CDF_DOUBLE	1	1	4	T	T	[%]	As VOLTAGES but for testpulser accumulations

[3] Start time + 1/2 accumulation time

3.2.2 mByymmdd.cdf

HEADER	
DATA ENCODING	NETWORK
MAJORITY	ROW
FORMAT	SINGLE

GLOBAL attributes

Attribute Name	Entry Number	Data Type	Value	Comment
TITLE	1	CDF_CHAR	Radiation Environment Monitor	
MISSION_ID	1	CDF_CHAR	STRV-1B	
INSTRUMENT_ID	1	CDF_CHAR	REM	
OBS_DATE	1	CDF_CHAR	dd-mmm-yy	Date of observation, dd: day, mmm: month, yy: year
OBS_CLOCK	1	CDF_FLOAT		difference between 01-Jan-92, 00:00:00 and dd-mmm-yy, 00:00:00 in seconds
OBS_NUM	1	CDF_UINT4		number of real data accumulations
NORAD	1	CDF_CHAR		NORAD elements, 1st line
	2	CDF_CHAR		NORAD elements, 2nd line
COORD_SYS	1	CDF_CHAR	ECI	Coordinate system used for orbit calculation
BLTIME	1	CDF_UINT4	1995	Epoch of internal magnetic field model (as used in UNIRAD [8])
B_MODEL	1	CDF_CHAR	DGRF/IGRF	Internal magnetic field model
OUTER	1	CDF_CHAR	Tsyganenko 1989	External magnetic field model

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Attribute Name	Entry Number	Data Type	Value	Comment
VALUE_KP	1	CDF_UINT4	0	KP value used for external magnetic field model
REMARKS	1	CDF_CHAR		
	2	CDF_CHAR		
	3	CDF_CHAR		

VARIABLE attributes

Attribute Name	Data Type	Value	Comment
FIELDNAME	CDF_CHAR		Description of variable
UNITS	CDF_CHAR		Units of variable values
FILLVAL	CDF_DOUBLE	-999.9	Variable is set to this value when data is missing

VARIABLES

Variable Name	Data Type	Number Elements	Dims	Sizes	Record Variance	Dimension Variances	Units	Comment
zVariables								
TIME	CDF_DOUBLE	1	1	1	T	F	[sec]	Central time[4] of real data accumulations, time elapsed since start of day which is given by the global attribute OBS_DATE
ORBIT	CDF_DOUBLE	1	1	3	T	T	[km]	Position of the satellite at time TIME, coordinate system defined by global variable COORD_SYS
MAGNETIC	CDF_DOUBLE	1	1	2	T	T	[Gauss/R_E]	Magnetic field and L–value at position of satellite
ATTITUDE	CDF_DOUBLE	1	1	2	T	T	[Degrees]	Orientation (α, δ) of REM detector axis with respect to Absolute Coordinate System, ACS (see [9] for details)

[4]Start time + 1/2 accumulation time

References

[1] National Space Data Center. CDF User's Guide. Technical Report , NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771 (U.S.A.), 1995.

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[5] Bühler, P. Determination of the MIR–REM observation times, Revised Version. Technical report, Paul Scherrer Institut, November 1996.

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[7] Bühler, P. STRV–1B and MIR orbit determination. Technical report, Paul Scherrer Institut, March 1996.

[8] Heynderickx, D., Kruglanski, M., Lemaire. Trapped Radiation Software, User Manual. Technical report, Belgian Institute for Space Aeronomy, Ringlaan 3, B–1180 Brussels, Belgium, November 1996.

[9] Lebedev, O., Antonov, V. Shvetz, N., Adams, L., Zehnder, A. Final report on results of REM experiment preparation and realisation on MIR station. Technical report, Rocket and Space Corporation ENERGIA, 1995.