DEMETER Microsatellite

SCIENTIFIC MISSION CENTER

DATA PRODUCT DESCRIPTION

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ACRONYMS

ADV	Velocity Analyzer of IAP instrument
APID	Application Process IDentifier
APR	Retarding potential analyzer of IAP instrument
BANT	Processing module of th science payload (Boîtier d'Acquisition, de Numérisation et de Traitement)
CCC	Centre de Commande Contrôle
CCSDS	Consultative Committee for Space Data Systems
CDPP	Centre de Données en Physique des Plasmas
CESR	Centre d'Etudes Spatiales des Rayonnements
CETP	Centre d'Etudes des Environnements Terrestre et Planétaires
SMC	Science Mission Center (Centre de Mission Scientifique) DEMETER
CNES	Centre National d'Etudes Spatiales
CNRS	Centre National de la Recherche Scientifique
DEMETER	Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions
DSP	Digital Signal Processor
ELF	Extreme Low Frequency
ESTEC	European Space Technical Centre
FTP	File Transfer Protocol
HF	High Frequency
IAP	Plasma Analyzer Instrument (Instrument Analyseur de Plasma)
ICE	Electric Field Instrument (Instrument Capteur Electrique)
IDP	Particle spectrometer Instrument (Instrument Détecteur de Particules)
IMSC	Instrument Magnétomètre Search-Coil
IPGP	Institut de Physique du Globe de Paris
ISL	Langmuir Probe Instrument (Instrument Sonde de Langmuir)
LPCE	Laboratoire de Physique et Chimie de l'Environnement
MTB	Magneto Torquer Bar
NA	Non Applicable
PNG	Portable Network Graphics
PS	PostScript
QL	QuickLook
QV	QuickView
RNF	Neural Network experiment (Réseau de Neurones Formel)
TBC	To Be Confirmed
TBD	To Be Defined
ULF	Ultra Low Frequency
VLF	Very Low Frequency
µC	Microcontroller

MODIFICATIONS

Edition	Revision	Date	Comments
0	0	06/06/2001	Draft1 version
0	0	12/06/2001	Draft2 version (comments M. Parrot)
0	1	24/10/2001	Draft3 version following ALCATEL software specifications draft document
1	0	30/01/2002	Comments on data formats from CDPP integrated; Comments on orbital and attitude parameters from J.C. Kosik (CNES) integrated; User-defined quicklook suppressed; Modifications of data blocks; Modifications of data formats;
1	1	22/03/2002	Comments from IAP experimenters; Comments from RNF experimenters;
1	2	22/05/2002	All the filenames are in capital letters; Image format is PostScript instead of PNG; At level-1, all the data experiments have included the block 3 (orbital parameters) and block 4 (attitude) ; The CCSDS date format has been added in the experiment level-1 data, orbit and attitude archive files; All the data formats at level-1 have been modified; The orbit and attitude data formats have been modified;
1	3	19/07/2002	HF Electric field power spectrum format: field number 10 is now field 8. ORBIT_EPHEMERIS format: solar position is now in field 15 and geomagnetic parameters from field 16 to 28. P_ORBIT_NUMBERS format: new ASCII format.
2	0	18/12/2002	Modification of attitude parameters of the common block 3 in paragraph 3.4.3 (matrices from satellite to GEI and from satellite to local geomagnetic suppressed). Sun position in the geographic coordinate

			system (instead of GEI). Modification of the contents of the ATTITUDE_<startdate>_<enddate> file in paragraph 5.2.3 (orbit number added, quaternions in J2000 added, matrice from satellite to GEI suppressed). Modification of the contents of the P_ORBIT_NUMBERS file in paragraph 5.3.2 (Mission event added, event number 11 added). Examples QV and QL added. Description of coordinate systems added.
2	1	02/04/2004	Warning on the use of ICE and IMSC level-1 waveform data. Modification of the RNF level-1 data format. P_ORBIT_NUMBERS file updated. Information of attitude interpolation. Coordinate transformation.
3	0	11/03/2005	All document updated Distribution list suppressed, file available on Demeter data server Quaternions from J2000 to satellite Transformation from ADV coordinate system to satellite Predicted orbital parameter file added Quicklook description added Summary files added Data related events file added Modifications of the data units of plasma parameters (cm^{-3}, K) Magnetometer data description added Solar panel position data added
3	1	25/05/2005	RNF frame explanation updated Calibration of the magnetometer data added
3	2	12/10/2005	Modification of the transformation matrix from ICE sensor system to satellite system Items added in 'data_related_events' file
3	3	17/06/2006	Correction error documentation in paragraph A2.2.1 about transformation matrices from ICE sensor to satellite Correction error documentation paragraph 5.7.4 about the time interval taken into account in SEISMIC_EVENTS file ([-2, +2] year interval for all earthquakes) References of PSS articles describing the instruments added

PLAN

1. INTRODUCTION

This document describes the data and the associated products available at the DEMETER Science Mission Center (SMC) located at LPCE/CNRS (Orléans, France).
The web server address is: http://demeter.cnrs-orleans.fr

The DEMETER mission center is described in DR4. The five instruments of the Demeter scientific payload, the IMSC magnetic field instrument, the ICE electric field instrument, the IAP plasma analyzer, the IDP electron spectrometer, the ISL Langmuir probes, and the common electronic data processing module are described in DR5 (IMSC and BANT), DR6 (ICE), DR7 (IAP), DR8 (IDP) and DR9 (ISL). Advices on how to use the data and the auto-compatibility among the instruments and between instrument and satellite are given in DR10.

1.1. Data processing levels

The data are classified according to the processing level:

- Level-0 (N0) processing converts telemetry raw data into experiment raw data,
- Level-0' (N0') processing allows a quick diagnosis of the experiment behavior,
- Level-1 (N1) processing transforms the experiment raw data into calibated data,
- Level-2 (N2) processing presents high resolution displays.

1.2. SMC product summary

The DEMETER SMC products are:

- Data at level-0
  - Decommutation report
  - Error data files
  - Experiment raw data
  - Technological raw data

- Data at level-0'
  - Good health report
  - Quickview image
  - Quicklook image

- Data at level-1
  - Calibrated data

- Data at level-2
  - High resolution plots
  - Custom-made images

- Auxiliary data
  - Orbit number definition, satellite and mission events
  - Data related events
  - Predicted orbital parameters
  - Determined orbital parameters
  - Attitude parameters

- Seismic events
- Science mode summary
- Navigation magnetometer data
- Solar panel position

- Tools
  - Software
  - Documentation

All these products can be downloaded on the data server, according to the user type. The rights are summarized in Table 1.

The experiment data files are organized per data identifier (APID) and per half-orbit since DEMETER science payload performs measurements in the invariant latitude interval [-65°, +65°].
The half-orbits are noted "*nnnnn.s*" with:
- "*nnnnn*" the orbit number,
- "*s*" the direction, 0 for downward and 1 for upward.

1.3. Rights to data access

To access to the data server, *Login* and *Password* will be required for the user types 'Experimenter', 'Co-Investigator' and 'Guest-Investigator'. The user rights are summarized in Table 1.

	Experimenter	Co-Investigator	Guest-Investigator	Public
Level-0 decommutation report	x			
Level-0 error data files	x			
Level-0 raw data	x	x		
Level-0' good health report	x			
Level-0' Quickview	x	x		
Level-0' Quicklook	x	x	x	x
Level-1 calibrated data	x	x	x	
Level-2 high resolution plots	x	x	x	
Orbital parameters	x	x	x	
Attitude parameters	x	x	x	
Navigation magnetometer data	x	x	x	
Solar panel position data	x	x	x	
Mission, satellite data-related events	x	x	x	
Seismic events file	x	x	x	
Summary files	x	x	x	x
Orbit display	x	x	x	x
Software download	x	x	x	x

Table 1. Summary of user rights.

1.4. Data conventions

- Convention applied to binary files
  The encoding of integer is Big Endian (most significant byte, least significant byte, 2-complement);
  The encoding of real numbers corresponds to the IEEE format;
  The type I*1 means Byte 8 bits;
  The type I*2 means Integer 16 bits;
  The type I*4 means Long Integer 32 bits;
  The type R*4 means Float 32 bits;
  The type A*n* means ASCII chain of *n* characters;

- Convention for character chains
  The ASCII character chains are left-aligned. For example, a type A3 for the text "HF" will be stored as "HF ".

2. LEVEL-0 DATA FILES

2.1. Level-0 data definition

Level-0 data are raw data generated from the DEMETER general decommutation software. The CCSDS format applied to the data packets for the down link has been removed by the decommutation software. So, the DEMETER data at level-0 are identical to the ones at the output of every experiment onboard.

2.2. Level-0 experiment raw data

The six scientific experiments (five payload instruments plus the neural network) and the BANT electronic module produce data at level-0. There is one data file per data identifier (APID) and per half-orbit.

The onboard data identifier (APID) list is given in Table N0-1.

APID	Experiment	Data type	Data description	Mode
1124	BANT	‘Init’	Onboard computer (DSP and µC) tests	
1125	BANT	‘Echo TC’	Commands echoed by µC	
1126	BANT	'Event'	Onboard events and anomaly reports	
1127	BANT	'Dump'	E2PROM and/or RAM DSP memory dumps	
1128	BANT	'Trace DSP'	DSP software trace	
1129	ICE	ULFe "WF"	Waveforms of four electric field probes in the ULF range	Burst and Survey
1130	ICE	ELFe "WF"	Waveforms of three electric field components in the ELF range	Burst
1131	ICE	VLFe "WF"	Waveform of one electric field component in the VLF range	Burst
1132	ICE	VLFe "SP"	Spectrum of one electric field component in the VLF range	Burst and Survey
1133	ICE	HFe "WF"	Waveform of one electric field component in the HF range	Burst
1134	ICE	HFe "SP"	Spectrum of one electric field component in the HF range	Burst and Survey
1135	IMSC	ELFb "WF"	Waveforms of three magnetic field components in the ELF range	Burst
1136	IMSC	VLFb "WF"	Waveform of one magnetic field component in the VLF range	Burst
1137	IMSC	VLFb "SP"	Spectrum of one magnetic field component in the VLF range	Burst and Survey
1138	RNF		Detection results of the neural network	Burst and Survey
1139	IAP		Data of IAP experiment in Burst mode	Burst
1140	IAP		Data of IAP experiment in Survey mode	Survey
1141	IDP		Data of IDP experiment in Burst mode	Burst
1142	IDP		Data of IDP experiment in Survey mode	Survey
1143	ISL		Data of ISL experiment in Burst mode	Burst

1144	ISL		Data of ISL experiment in Survey mode	Survey
1145	ISL		ISL control surface mode	

Table N0-1. List of onboard data identifiers.

The level-0 data files are named as:

DMT_N0_<apid>_<nnnnns>_<start_date>_<end_date>.DAT

- <apid>: data identifier;
- <nnnnns>: half-orbit number, "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward);
- <start_date>: date of the first data sample as "yyyymmdd_hhmnss";
- <end_date>: date of the last data sample as "yyyymmdd_hhmnss".

The data formats are identical to those given at the onboard experiment output; they are described in DR1.

The level-0 data are available only for experimenters.

2.2.1. Scientific raw data

The scientific raw data are from the six experiments; they have the identifiers from 1129 to 1144.

2.2.2. Technological raw data

The technological raw data from the BANT module have the identifiers from 1124 to 1128 and the ISL control surface data have the identifier 1145.

2.3. Decommutation report

The decommutation software generates a report file (text format) containing the details of the decommutation results as number of data packets, errors found, statistics, ….

The name of the report file is:

DMT_N0_<start_nnnnns>_<end_ nnnnns >.REP

- <start_ nnnnns >: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the first orbit processed;
- <end_ nnnnns >: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the last orbit processed.

An example of decommutation file is given in Table N0-2.

```
Raw Telemetry : ...action/2005_01_17_14_47_421177233773/IN/  732249126
bytes

Decommutation version : 3.2

First orbit     :  028700     20050115_19_0206
```

```
Last  orbit     :  028931     20050117_09_4030

Lost of synchronization      : 0
Number of wrong APID         : 0
#CCSDS pack. with null orbit : 0

APID          CCSDS         CCSDS                CCSDS        DEMETER
              read         missing               to err       output

1124            837             0                 0              93
1125            351             0                 0              39
1126            300             0                75              25
1127              0             0                 0               0
1128              0             0                 0               0
1129          44946         59472                 0            4994
1130         209601         82584                18           23287
1131        1117044        196425                18          124114
1132          72018         57843                 0            8002
1133          27845        104419                 8            3093
1134          72018         57843                 0            8002
1135         209620         82556                28           23288
1136        1116965        196504                47          124102
1137          72023         57829                14            8001
1138              0             0                 0               0
1139          12312         61596                 0            1368
1140          60272         30952                 8            6696
1141           7128         64305                 0             792
1142           9432         32472                 0            1048
1143           7002         32040                 0             778
1144          36963         31644                 0            4107
1145              0             0                 0               0

------------------------------------------------------------------------
total      3076677       1148484               216          341829
```

Table N0-2. Example of decommutation report.

2.4. Error data files

All the data on which the decommutation software has detected errors (missing packets, unknown identifier, …) are stored into global error files.

The name of the error data files produced by decommutation software is:

DMT_N0_<start_ nnnnns >_<end_ nnnnns >.ERR

- <start_nnnnns>: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the first orbit processed;
- <end_ nnnnns >: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the last orbit processed.

After decommutation, tests of time coherence are performed. The packets with incoherent time (time not increasing for example) are stored, per half-orbit, into an error file with the name:

DMT_SEG_<start_ nnnnns >_<end_ nnnnns >.ERR

- <start_nnnnns>: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the first orbit processed;
- <end_ nnnnns >: half-orbit number as "nnnnns" with "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward) of the last orbit processed.

3. LEVEL-0' DATA FILES

3.1. Level-0' definition

Level-0' processing has three main goals:

- to allow the experimenter to rapidly know the behavior of the science payload and thus to react on the next commanding plan; two files are produced to that effect, the 'good health' report and the quickview image;
- to get an overview of the science DEMETER payload results;
- to help for the data selection with the quicklook that gives a quick presentation over one half-orbit data.

The difference between quickview (QV) and quicklook (QL) is that, for quickview, no orbit and no earthquake information are given.

3.2. 'Good health' report

The 'good health' software component generates a report file (text format) containing the results of a set of elementary tests :

- presence of the onboard processor initializations (Init µC, Init DSP and Echo TC),
- checking of the date/time coherence,
- comparison of the house-keeping temperature values with normal working thresholds,
- test of the voltage value of the IFCU board,
- checking of the onboard memories (µC and DSP),
- checking of the main DSP algorithms (FFT, windowing),
- analysis of 'Event' file that reports the onboard events,
- validation of the patch mode,
- analysis of the DSP memory dump data.

Concerning the presentation of the test results, the reports are organized per half-orbit number and the result of each test is classified as OK or NOK. Then, the final result for the full scientific payload and for the studied half-orbit is given as OK or NOK.

The name of the 'good health' report file is:

DMT_BS_<nnnnns>.REP

- <nnnnns>: half-orbit number, "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward);

An example of 'good health' report is given in Table N0'-1.

```
Programme de bonne sante de DEMETER V1.5

Orbit 031611 :
--------------
PAQUETS DEMARRAGE : ...................................................... OK
     Echo TC : ........................................................... OK
     DMT_N0_1125_031611_20050204_195830_20050204_202800.DAT
     Init Micro-C : ...................................................... OK
     Init Systeme DSP : .................................................. OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT
```

```
VERIF DATE : .......................................................... OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT (15 enrs  0 erreur)
TEST HK : ............................................................. OK
     DMT_N0_1129_031611_20050204_195837_20050204_203151.DAT (301 enrs  0 erreur)
VERIF TENSION IFCU : .................................................. OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT (15 enrs  0 erreur)
TEST RAM micro-C : .................................................... OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT (15 enrs  0 erreur)
INIT SYSTEME DSP : .................................................... OK
     EEPROM : ......................................................... OK
     RAM : ............................................................ OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT (15 enrs  0 erreur)
INIT TRAITEMENT DSP : ................................................. OK
     SINUS : .......................................................... OK
     FEN : ............................................................ OK
     FFT : ............................................................ OK
     DMT_N0_1124_031611_20050204_195830_20050204_202801.DAT (15 enrs  0 erreur)
TEST EVENEMENTS DE BORD : ............................................. OK
     DMT_N0_1126_031611_20050204_200130_20050204_203200.DAT (6 enrs  0 erreur)
TEST DUMP : ........................................................... NA
     NUM PAQUETS : .................................................... NA
     NB PAQUETS : ..................................................... NA
     VERSION DSP : .................................................... NA
Pas de fichier N0
TEST PATCH : .......................................................... NA
     DMT_N0_1125_031611_20050204_195830_20050204_202800.DAT
     DMT_N0_1126_031611_20050204_200130_20050204_203200.DAT

TEST 1/2 ORBITE : ..................................................... OK
```

Table N0'-1. Example of 'good health' report.

3.3. Quickview image

The quickview gives an overall presentation of the data. An example is given in Figure N0'-1. All the scientific experiments are presented in a portrait image (format PostScript). One QV image represents half-orbit data with a low time resolution of several seconds, resolution depending on the experiments. The QV image is available during about 24 hours (temporary storage) as long as the quicklook is not produced; then QV is replaced by the standard QL.

The QV is composed of the 13 elementary frames. It can be considered as a pre-quicklook image since the experiment frames are identical. The difference between quickview and quicklook concerns the addition of a seismic frame and of orbital parameters in the quicklook. Quickview and quicklook frames are described in the next section.

The QV name is:

DMT_QV_<nnnnns>.PS

- <nnnnns>: half-orbit number, "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward);

The quickview is only available for experimenters.

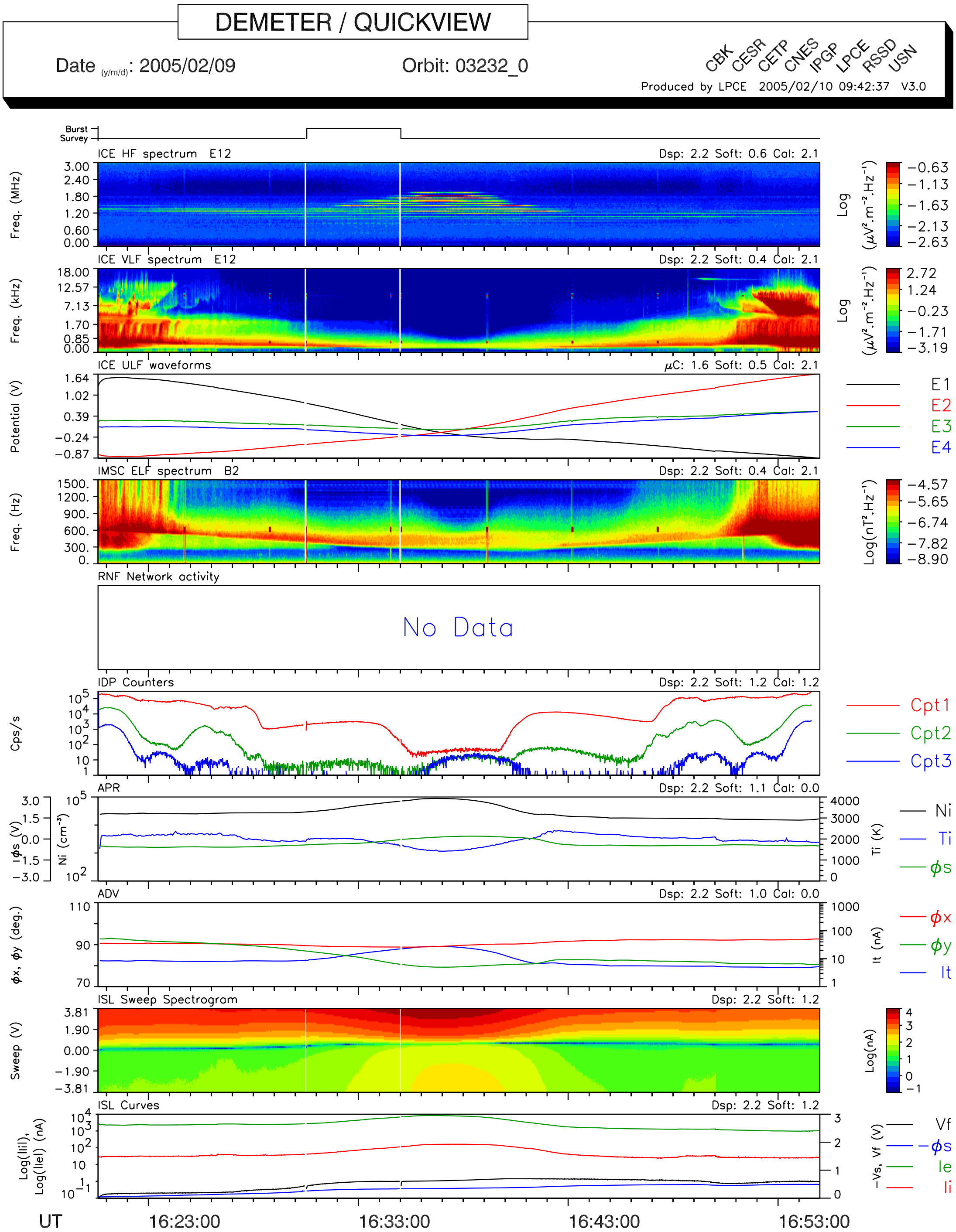


Figure N0'-1. Example of quickview image.

3.4. Quicklook image

As said in the previous section, the standard quicklook (QL) image is made from the QV experiment frames plus a 14th frame containing earthquake events and with in addition information on the orbital parameters. An example of quicklook is given in Figure N0'-2.

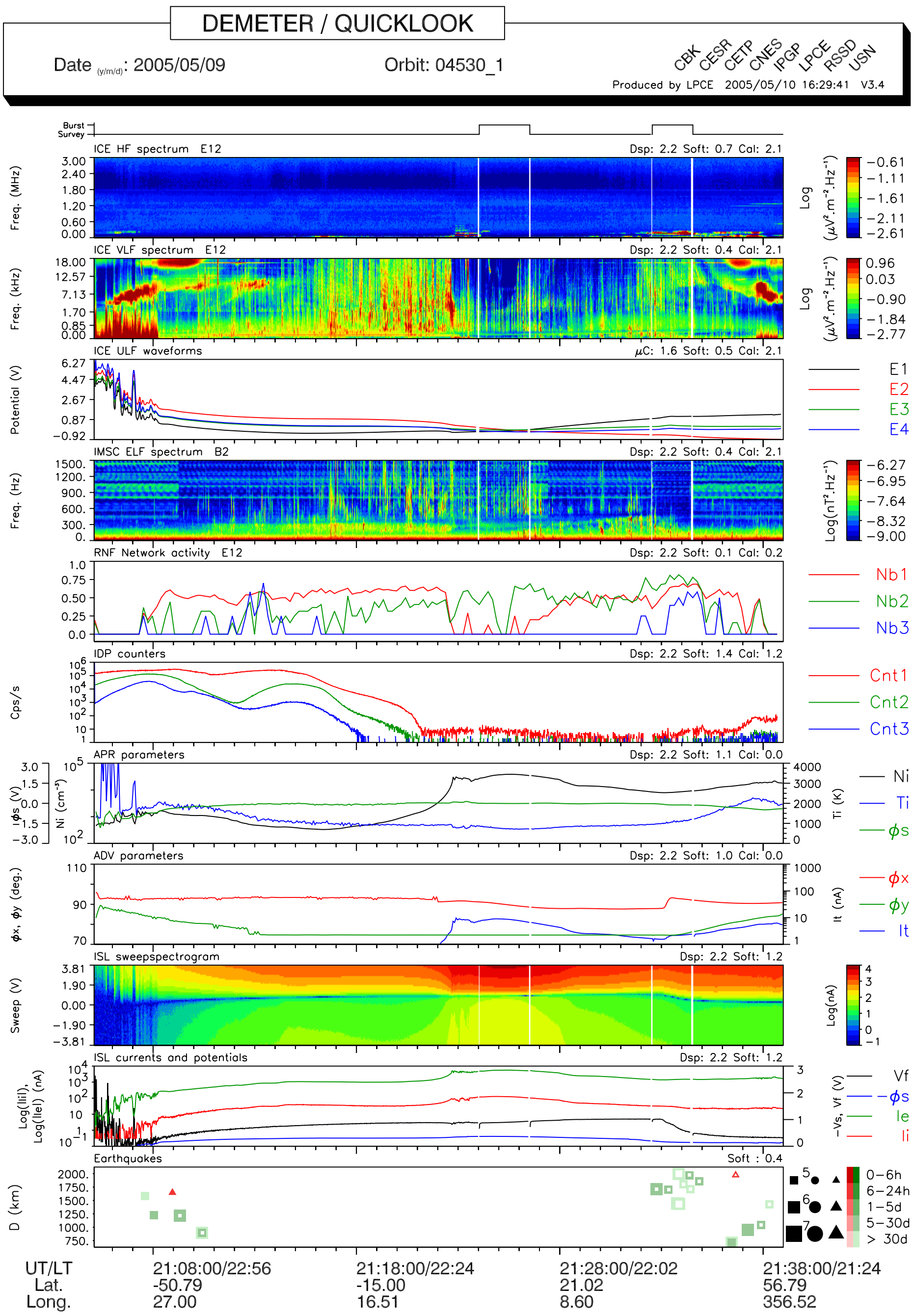
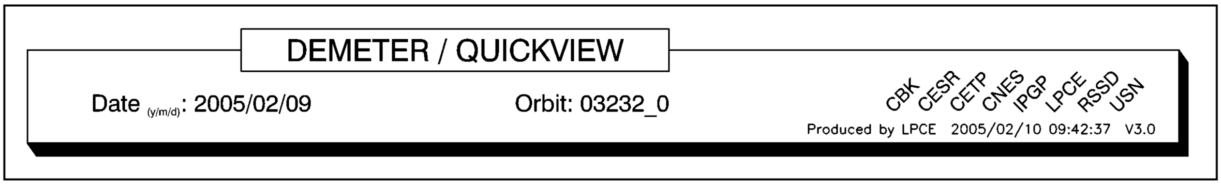


Figure N0'-2. Example of standard quicklook image.

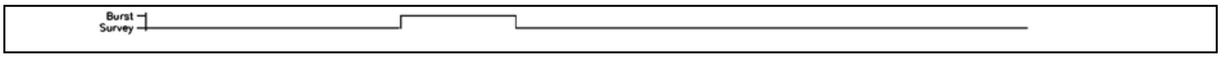
The 14 elementary frames that compose the standard QL are:

- **<u>Frame 1: header frame</u>**



  - date (yyyy/mm/dd);
  - orbit number;
  - involved institutes;
  - date and version of QL creation.

- **<u>Frame 2: operational mode</u>**



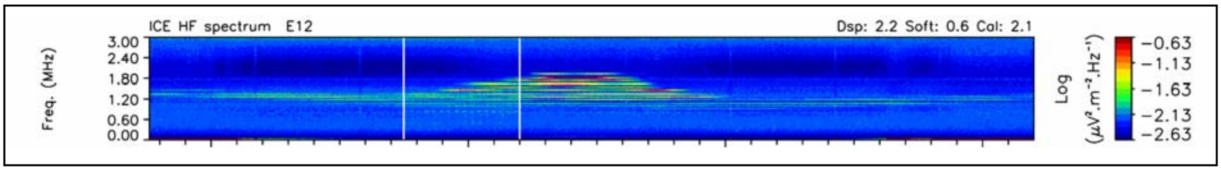
  - survey mode;
  - burst mode.

- **<u>Frame 3: abscissa label frame</u>**

UT/LT	16:23:00/10:46	16:33:00/10:19	16:43:00/09:56	16:53:00/09:05
Lat.	42.90	7.09	-28.83	-64.24
Long.	275.63	266.42	258.32	242.93

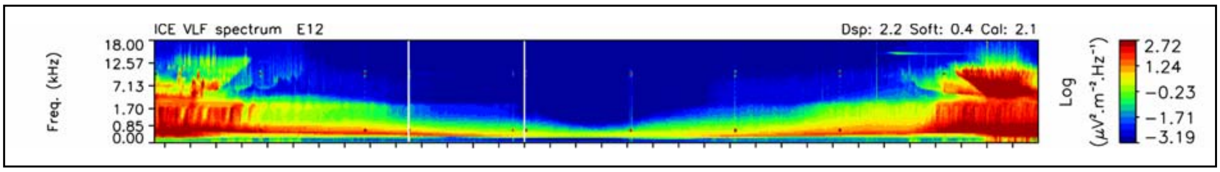
  - UT and local times;
  - geocentric latitude and longitude.

- **<u>Frame 4: spectrogram of one component of the HF electric field (onboard computed)</u>**



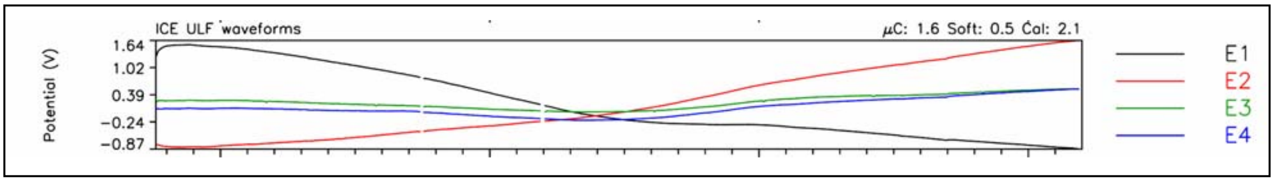
  - title: ICE HF spectrogram;
  - current component indicated at the top on the left of the frame (E12 in the example);
  - versions of the onboard software, of the ground processing software and of the ICE HF calibration file given at the top and on the right side of the frame (DSP: 2.2, Soft: 0.6, Cal: 2.1 in the example above);
  - frequency interval [3.5 kHz – 3007 kHz] covered with 77 frequency components;
  - frequency resolution: 39.06 kHz (averaging over 12 frequency spectral components);
  - time resolution: 2.048 s;
  - power unit: log(µV^2 m^{-2} Hz^{-1});
  - *Note: interferences arisen from the satellite power converter and regulator associated with the solar panel are observed on dayside; see paragraph 6.1 for details.*

- **<u>Frame 5: spectrogram of one component of the VLF electric field (onboard computed)</u>**



- title: ICE VLF spectrogram;
- current component indicated at the top on the left of the frame, same component as the HF spectrogram (E12 in the example);
- versions of the onboard software, of the ground processing software and of the ICE VLF calibration file given at the top and on the right side of the frame (DSP: 2.2, Soft: 0.4, Cal: 2.1 in the example below);
- frequency interval [19.5 Hz – 18 kHz];
- frequency resolution: 78 Hz in the interval [19.5 Hz - 1.7 kHz] with 4 Fourier components averaged and 312 Hz in the interval [1.7 kHz - 18 kHz] with 16 Fourier components averaged;
- time resolution: 2.048 s;
- power unit: log(µV^2 m^{-2} Hz^{-1}).

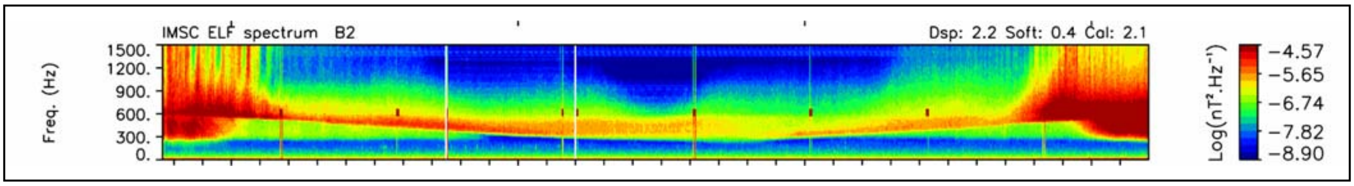
- **<u>Frame 6: potentials of the four electrodes E1, E2, E3 and E4</u>**



- title: ICE ULF waveforms;
- versions of the onboard software, of the ground processing software and of the ICE ULF calibration file given at the top on the right side of the frame (µC: 1.6, Soft: 0.5, Cal: 2.1 in the example);
- time resolution : 1.64 s (one sample over 64);
- potential unit is Volt;

*Note: the data are calibrated over 256 samples without trend (**V^B$_0$**) removing; this causes the regular step that can be observed on the waveform.*

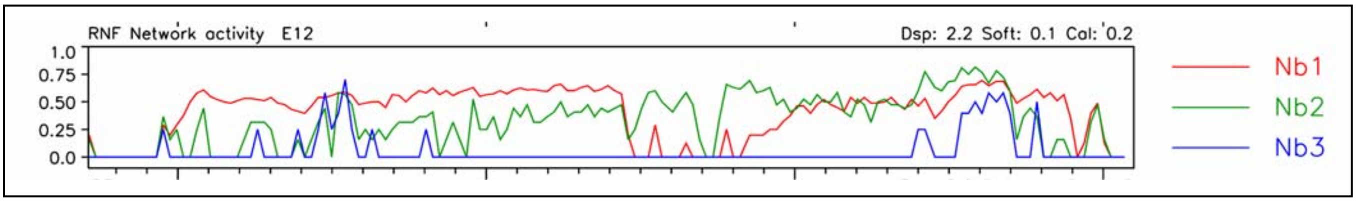
- **<u>Frame 7: spectrogram of one component of the VLF magnetic field (onboard computed)</u>**



- title: IMSC VLF spectrogram;
- selected component indicated at the top on the left of the frame (B2 in the example);

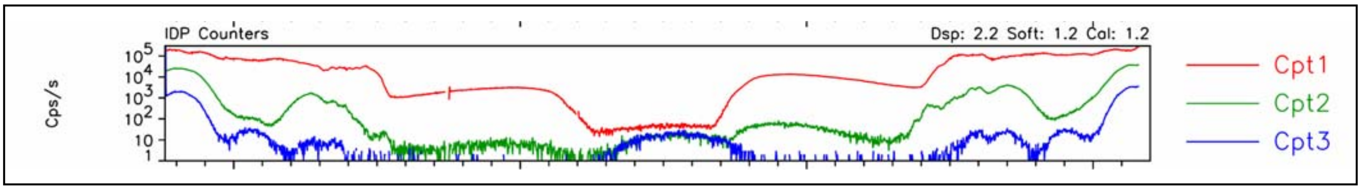
- versions of the onboard and ground processing software and of the ICE VLF calibration file given at the top on the right side of the frame (DSP: 2.2, Soft: 0.4, Cal: 2.1 in the example);
- frequency interval [19.5 Hz – 1.5 kHz] covered with 77 Fourier components;
- frequency resolution: 19.5 Hz;
- time resolution: 2.048 s;
- power unit: log(nT^2 Hz^{-1}).

▪ **<u>Frame 8: results of the neural network</u>**



- title: RNF activity;
- wave component on which the neural network is applied indicated at the top on the left of the frame (B2 in the example);
- versions of the onboard and ground processing software and of the RNF calibration file given at the top on the right side of the frame (DSP: 2.2, Soft: 0.0, Cal: 0.1 in the example);
- the RNF activity is represented by the 3 normalized quantities Nb1, Nb2, Nb3. They are linked to the number of whistler detections performed by the RNF during a time interval of 13.107 s. The RNF activity is equal to 0 if the number of detections is below a given threshold and equal to 1 when the RNF is continuously detecting whistlers :
  - o Nb1 is related to the number of whistler detections associated with value of the dispersion parameter in the range [0 s$^{1/2}$ – 12.6 s$^{1/2}$];
  - o Nb2 is related to the number of whistler detections associated with value of the dispersion parameter in the range [10 s$^{1/2}$ – 50.4 s$^{1/2}$];
  - o Nb3 is related to the number of whistler detections associated with value of the dispersion parameter in the range [40 s$^{1/2}$ – 202 s$^{1/2}$].

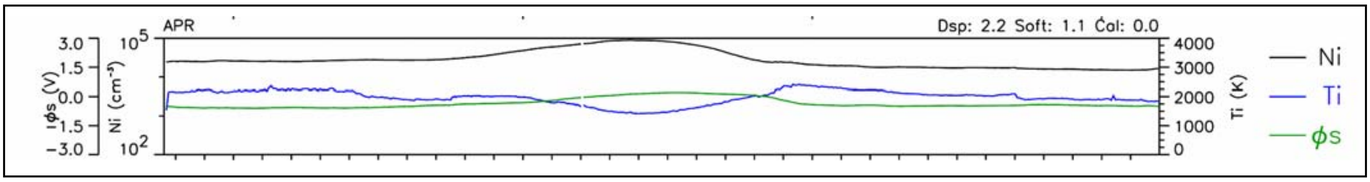
▪ **<u>Frame 9: electron counters</u>**



- title: IDP counters;
- versions of the onboard and ground processing software and of the IDP calibration file given at the top on the right side of the frame (DSP: 2.2, Soft: 1.2, Cal: 1.2 in the example);
- number of counts per second in 3 energy bands represented with a logarithmic scale between 1 and 500 000:
  - cnt1 from 90.7 keV to 526.8 keV,
  - cnt2 from 526.8 keV to 971.8 keV,
  - cnt3 from 971.8 keV to 2342.4 keV;

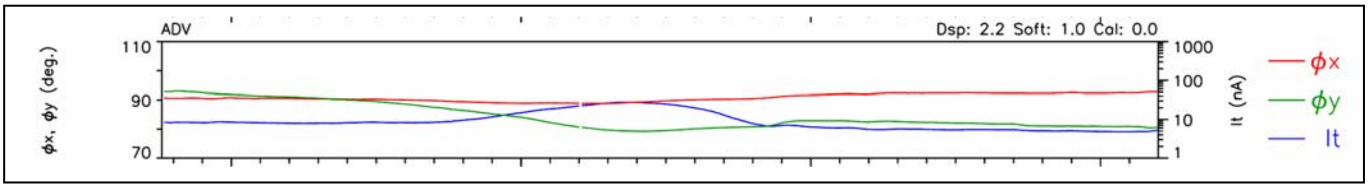
- time resolution: 1 s;
- *Note: the energy bands are selected by command among channel 0 to channel 255; the values given above are the ones currently used, channels [2 – 51] for Cnt1, channels [51 – 101] for Cnt2, channels [101 – 255] for Cnt3.*

- **Frame 10: ion density and temperature, satellite potential given by IAP/APR detector**



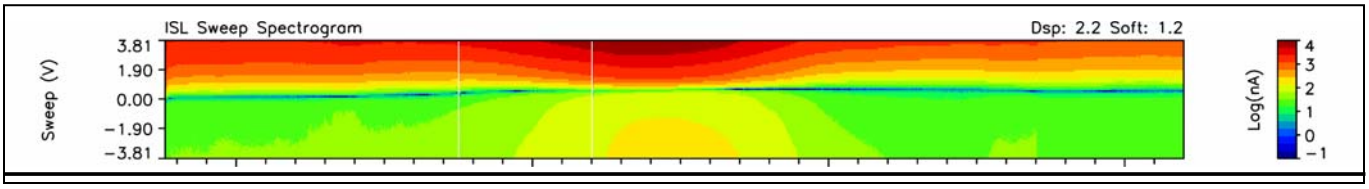
- title: APR parameters;
- versions of the onboard and ground processing software and of the IAP calibration file given at the top on the right side of the frame (DSP: 2.2, Soft: 1.1, Cal: 0.0 in the example);
- averaged ion density, ion temperature and satellite potential:
  - Ni, ion density in cm^{-3},
  - Ti, ion temperature in K,
  - Φs, potential in V;
- time resolution: 2.32 s in Burst mode or 4.43 s in Survey mode.

- **Frame 11: plasma velocity given by the IAP/ADV detector**



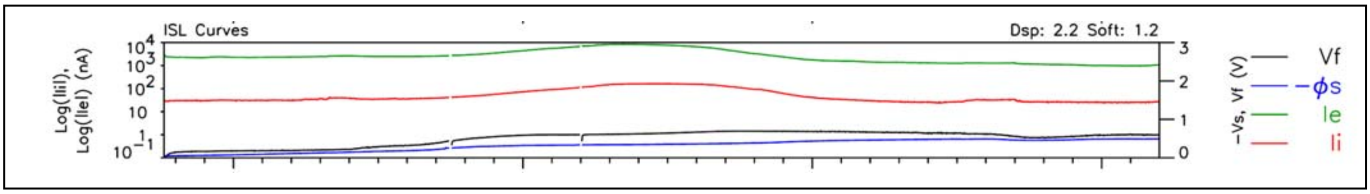
- title: ADV parameters;
- versions of the onboard and ground processing software and of the IAP calibration file given at the top on the right side of the frame (DSP: 2.2, Soft: 1.0, Cal: 0.0 in the example);
- total current It expressed in nA;
- angles of the velocity respect to satellite frame:
  - Φx, angle of deviation of the ion bulk velocity in the satellite frame from the X-axis in the plan XOZ (vertical plan) of satellite,
  - Φy, angle of deviation of the ion bulk velocity in the satellite frame from the Y-axis in the plan YOZ (horizontal plan) of satellite, if there is not plasma motion perpendicular to the satellite velocity, both Φx and Φy equal 90°;
- time resolution: 2.32 s in Burst mode or 4.43 s in Survey mode.

- **Frame 12: ISL sweep spectrogram**



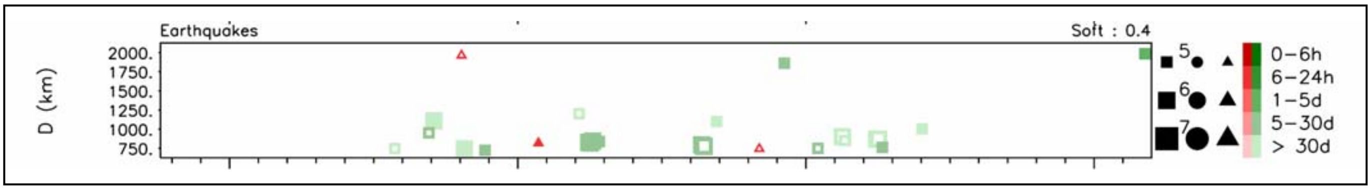
- title: ISL sweep spectrogram;
- versions of the onboard and ground processing software given at the top on the right side of the frame (DSP: 2.2, Soft: 1.2 in the example);
- spectrogram of the Langmuir probe sweeps:
  - sweep voltages in V (64 values, one over two plotted),
  - collected current in log(nA);
- time resolution: 2 s.

- **Frame 13: parameters deduced from ISL measurements**



- title: ISL currents and potentials;
- versions of the onboard and ground processing software given at the top on the right side of the frame (DSP: 2.2, Soft: 1.2 in the example);
- currents and potentials:
  - Vf, floating potential in V,
  - Φs, potential in V (-Φs is displayed),
  - Ie, electron current in nA (log|Ie| is displayed),
  - Ii, ion current in nA (log|Ii| is displayed);
- time resolution: 1 s.

- **Frame 14: earthquake information**



- title: Earthquakes;
- version of the ground processing software given at the top on the right side of the frame (Soft: 0.4 in the example);
- distances between the epicenter and the satellite, from 750 km up to 2000 km, displayed with a linear scale in ordinate; distance Dm between epicenter and satellite, distance Dmc between conjugate point of the epicenter and the satellite (see Figure Aux-2);
- color scale:
  - time interval between the earthquake and Demeter orbit (relative to Dm or Dmc), green for post-seismic events, red for pre-seismic events, blue for the current half-orbit,
  - color gradation from > 30 days up to [0 – 6h] interval;
- symbols:
  - filled green square for post-seismic events (corresponding to Dm),
  - filled red triangle for pre-seismic events (corresponding to Dm),

- filled blue circle for earthquakes occurring during the half-orbit (corresponding to Dm),
- empty green square for post-seismic events (corresponding to Dmc),
- empty red triangle for pre-seismic events (corresponding to Dmc),
- empty blue circle for earthquakes occurring during the half-orbit (corresponding to Dmc);

- magnitude:
  - 3 symbol sizes corresponding to earthquakes of magnitude [5 - 6], [6 - 7], [7 -];
- Note: when the earthquake occurs during the half-orbit and when the minimum distance is realized during this half-orbit, then a blue line connects the circle (earthquake position) and the triangle or square (minimum distance) .

The quicklook is available for all public (no login required).

The QL name is:

DMT_QL_<nnnnns>.PS

- <nnnnns>: half-orbit number, "nnnnn" the orbit number and "s" the sub-orbit type ("0" downward and "1" upward);

4. LEVEL-1 SCIENCE DATA

3.1. Level-1 definition

Level-1 science data correspond to calibrated data. Auxiliary information have been added to make the data files consistent and to facilitate the higher level processing.

3.2. Level-1 experiment data

There is one data file per data identifier and per half-orbit. The data identifiers are given in Table N1-1.

The data files are named as:

DMT_N1_<apid>_<start_date>_<end_date>.DAT

- <apid>: data identifier;
- <start_date>: date of the first data sample as "yyyymmdd_hhmnss";
- <end_date>: date of the last data sample as "yyyymmdd_hhmnss".

The orbit number is not given in the filename since the file can have more than one half-orbit.

APID	Experiment	Data type	Data description	Mode
1129	ICE	ULFe "WF"	Waveforms of three electric field components in the ULF range	Burst and Survey
1130	ICE	ELFe "WF"	Waveforms of three electric field components in the ELF range	Burst
1131	ICE	VLFe "WF"	Waveform of one electric field component in the VLF range	Burst
1132	ICE	VLFe "SP"	Spectra of one electric field component in the VLF range	Burst and Survey
1133	ICE	HFe "WF"	Waveform of one electric field component in the HF range	Burst
1134	ICE	HFe "SP"	Spectra of one electric field component in the HF range	Burst and Survey
1135	IMSC	ELFb "WF"	Waveforms of three magnetic field components in the ELF range	Burst
1136	IMSC	VLFb "WF"	Waveform of one magnetic field component in the VLF range	Burst
1137	IMSC	VLFb "SP"	Spectra of one magnetic field component in the VLF range	Burst and Survey
1138	RNF		Detection results of the neural network	Burst and Survey
1139	IAP		Data of IAP experiment	Burst
1140	IAP		Data of IAP experiment	Survey
1141	IDP		Data of IDP experiment	Burst
1142	IDP		Data of IDP experiment	Survey
1143	ISL		Data of ISL experiment	Burst
1144	ISL		Data of ISL experiment	Survey

Table N1-1. List of level-1 data identifiers.

3.3. Level-1 data file structure

The level-1 data files are organized with a constant time structure as presented in Table N1-2. It is composed of four successive data blocks, each block containing parameters useful to make science. The size of each block is constant per data type.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-2. General structure of level-1 data files.

Four different blocks have been defined (Table N1-3).

Block number	**Description**
1	General header
2	Orbital and geomagnetic parameters
3	Attitude parameters
4	Experiment data

Table N1-3. Level-1 data block types.

3.4. Common block descriptions

3.4.1. Common block 1: General header

Block 1: General Header					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Standard CCSDS date
1	I*1	1	1		P field (decimal value = 76)
2	I*3	1	3		Number of days from 01/01/1950
3	I*4	1	4		Number of milliseconds in the day
					Time and orbit information
4	I*2	7	14		UT time of the first point of the data array as: year, month, day, hour, minute, second, millisecond (year as 20xx)
5	I*2	1	2		Orbit number
6	I*2	1	2		Sub-orbit type: 0: downward, 1: upward
7	A8	1	8		Telemetry station: "TOULOUSE"
					Code and calibration versions
8	I*1	1	1		Version (edition number) of the processing software: from 0 to 9
9	I*1	1	1		Sub-version (revision number) of the processing

					software: from 0 to 9
10	I*1	1	1		Version (edition number) of the calibration file: from 0 to 9
11	I*1	1	1		Sub-version (revision number) of the calibration file: from 0 to 63

Table N1-4. Common block 1: general header.

3.4.2. Common block 2: Orbital and Geomagnetic Parameters

Block 2: Orbital and Geomagnetic Parameters					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Orbital parameters
1	R*4	1	4	degree	Geocentric latitude (-90°, +90°)
2	R*4	1	4	degree	Geocentric longitude (0°, 360°)
3	R*4	1	4	km	Altitude
4	R*4	1	4	hour	Local time of the first point of the data array (0, 24h)
					Geomagnetic parameters
5	R*4	1	4	degree	Geomagnetic latitude (-90°, +90°)
6	R*4	1	4	degree	Geomagnetic longitude (0°, +360°)
7	R*4	1	4	hour	Magnetic local time of the first point
8	R*4	1	4	degree	Invariant latitude (-90°, +90°)
9	R*4	1	4		Mc Ilwain parameter L (0, 999)
10	R*4	1	4	degree	Geocentric latitude of the conjugate point at the satellite altitude (-90°, +90°)
11	R*4	1	4	degree	Geocentric longitude of the conjugate point at the satellite altitude (0°, +360°)
12	R*4	1	4	degree	Geocentric latitude of North conjugate point at altitude 110 km (-90°, +90°)
13	R*4	1	4	degree	Geocentric longitude of North conjugate point at altitude 110 km (0°, +360°)
14	R*4	1	4	degree	Geocentric latitude of South conjugate point at altitude 110 km (-90°, +90°)
15	R*4	1	4	degree	Geocentric longitude of South conjugate point at altitude 110 km (0°, +360°)
16	R*4	3	12	nT	Components of the magnetic field model at the satellite point (geographic coordinate system)
17	R*4	1	4	Hz	Proton gyrofrequency at satellite point
					Solar parameters
18	R*4	3	12		Solar position, Xs, Ys, Zs in the geographic coordinate system
					Code version
19	I*1	1	1		Version (edition number) of the software

					component: from 0 to 9
20	I*1	1	1		Sub-version (revision number) of the software component: from 0 to 9

Table N1-5. Common block 2: orbital and geomagnetic parameters.

3.4.3. Common block 3: Attitude Parameters

Block 3: Attitude Parameters					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Attitude parameters
1	R*4	9	36		$M_{sat2geo}$: Matrix from satellite coordinate system to geographic coordinate system
2	R*4	9	36		$M_{geo2lgm}$: Matrix from geographic coordinate system to local geomagnetic coordinate system
3	I*2	1	2		Quality index of attitude parameters
					Code version
4	I*1	1	1		Version (edition number) of the software component: from 0 to 9
5	I*1	1	1		Sub-version (revision number) of the software component: from 0 to 9

Table N1-6. Common block 3: attitude parameters.

Note: The elements of the matrix $\begin{matrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{matrix}$ are stored as a_{11}, a_{12}, a_{13}, a_{21}, a_{22}, a_{23}, a_{31}, a_{32}, a_{33} where i is the raw index and j the column index of the element a_{ij}.

The different coordinate systems are detailed in Annex A.

3.5. Level-1 science data description

3.5.1. Waveform of the ULF Electric Field (APID 1129)

Experiment: ***ICE***.
Data type: ***Waveform of the 3 components of the electric field in the ULF range***.

The level-1 file structure of "ULF Electric Waveforms" is given in Table N1-7.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-7. Structure of the "ULF electric waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-8. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 3 components of the electric field in the ULF range					
Filename: ***DMT_N1_1129_<nnnnns>_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "ULF ELECTRIC WAVEFORM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor ", "Satellite" or "B0field "
4	R*4	9	36		$M_{sen2sat}$: Matrix from sensor coordinate system to satellite coordinate system (dependent of the sensor configuration)
5	A16	1	16		Data unit: "V/m "
6	R*4	1	4	Hz	Sampling frequency: 39.0625
7	I*2	1	2		Sample data number per component: 256
8	R*4	1	4	s	Time duration of one data array: 256 / 39.0625
					First component waveform
9	A3	1	3		First component name: "E12" in sensor coordinate system "Ex " in the other coordinate systems
10	R*4	256	1024	mV/m	Waveform sample array of the first component
					Second component waveform
11	A3	1	3		Second component name: "Eij", i, j are the sensor numbers "Eij" in sensor coordinate system, i, j are the sensor numbers

					"Ey " in the other coordinate systems
12	R*4	256	1024	mV/m	Waveform sample array of the second component
					Third component waveform
13	A3	1	3		Third component name: "E34" in sensor coordinate system "Ez " in the other coordinate systems
14	R*4	256	1024	mV/m	Waveform sample array of the third component
					Probe E1 sensor potential
15	A3	1	3		Probe 1 name: "E1 "
16	R*4	256	1024	V	Potential array of the E1 probe
					Probe E2 sensor potential
17	A3	1	3		Probe 2 name: "E2 "
18	R*4	256	1024	V	Potential array of the E2 probe
					Probe E3 sensor potential
19	A3	1	3		Probe 3 name: "E3 "
20	R*4	256	1024	V	Potential array of the E3 probe
					Probe E4 sensor potential
21	A3	1	3		Probe 4 name: "E4 "
22	R*4	256	1024	V	Potential array of the E4 probe

Table N1-8. Block 4: ULF electric waveform.

3.5.2. Waveform of the ELF Electric Field (APID 1130)

Experiment: ***ICE***.
Data type: ***Waveform of the 3 components of the electric field in the ELF range***.

The level-1 file structure of "ELF Electric Waveform" is given in Table N1-9.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-9. Structure of the "ELF electric waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-10. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 3 components of the electric field in the ELF range					
Filename: ***DMT_N1_1130_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "ELF ELECTRIC WAVEFORM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor ", "Satellite" or "B0field "
4	R*4	9	36		$M_{sen2sat}$: Matrix from sensor coordinate system to satellite coordinate system (dependent of the sensor configuration)
5	A16	1	16		Data unit: "µV/m "
6	R*4	1	4	Hz	Sampling frequency: 2500.
7	I*2	1	2		Sample data number per component: 4096
8	R*4	1	4	s	Time duration of one data array: 4096 / 2500
					First component data waveform
9	A3	1	3		First component name: "E12" in sensor coordinate system "Ex " in the other coordinate systems
10	R*4	4096	16384	µV/m	Waveform sample array of the first component
					Second component data waveform
11	A3	1	3		Second component name: "Eij" in sensor coordinate system, i, j are the sensor numbers "Ey " in the other coordinate systems
12	R*4	4096	16384	µV/m	Waveform sample array of the second component
					Third component data waveform
13	A3	1	3		Third component name: "E34" in sensor coordinate system "Ez " in the other coordinate systems
14	R*4	4096	16384	µV/m	Waveform sample array of the third component

Table N1-10. Block 4: ELF electric waveform.

3.5.3. Waveform of the VLF Electric Field (APID 1131)

Experiment: ***ICE***.
Data type: ***Waveform of 1 component of the electric field in the VLF range***.

The level-1 file structure of "VLF Electric Waveform" is given in Table N1-11.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-11. Structure of the "VLF electric waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-12. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 1 component of the electric field in the VLF range					
Filename: ***DMT_N1_1131_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "VLF ELECTRIC WAVEFORM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A16	1	16		Data unit: "µV/m "
5	R*4	1	4	Hz	Sampling frequency: 40000.
6	I*2	1	2		Sample data number per component: 8192
7	R*4	1	4	s	Time duration of one data array: 8192 / 40000
					Waveform data
8	A3	1	3		Component name: "Eij", i, j are the sensor numbers
9	R*4	8192	32768	µV/m	Waveform sample array

Table N1-12. Block 4: VLF electric spectrum.

3.5.4. Power spectrum of the VLF Electric Field (APID 1132)

Experiment: ***ICE***.
Data type: ***Power spectrum of 1 component of the electric field in the VLF range***.

The level-1 file structure of "VLF Electric Spectrum" is given in Table N1-13.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-13. Structure of the "VLF electric spectrum" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-14. The conversion from raw data to calibrated data is detailed in DR3.

Power spectrum of 1 component of the electric field in the VLF range					
Filename: ***DMT_N1_1132_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "VLF ELECTRIC SPECTRUM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A3	1	3		Component name: "Eij", i, j are the sensor numbers
5	A16	1	16		Data unit: "log(µV^2/m^2/Hz)"
6	I*1	1	1		Number of consecutive spectra (Nb): 2 or 8 (1)
7	I*2	1	2		Number of spectrum frequencies (Nbf): 1024 or 256
8	R*4	1	4	s	Total time duration of Nb spectra: 16.384, 4.096 or 1.024 s
9	R*4	1	4	Hz	Frequency resolution: 19.53125 or 78.125
10	R*4	2	8	Hz	Frequency range: [19.53125 or 78.125 - 20000].
11	I*2	7	14		UT time of the first spectrum as: year, month, day, hour, minute, second, millisecond (2)
					Power spectrum data
12	R*4	Nbf	Nbf*4	log(µV^2/m^2/Hz)	Power array of the first spectrum
…	…	…	…	…	….
12 + (Nb-1)	R*4	Nbf	Nbf*4	log(µV^2/m^2/Hz)	Power array of the Nbth spectrum

Table N1-14. Block 4: VLF electric spectrum.

(1) The parameters of the 3 different spectrum types are summarized below:

Spectrum type	*Spectrum number in the data format (Nb)*	*Frequency number per spectrum (Nbf)*	*Total time duration*	*Duration of one spectrum*	*Number of averaged spectra (onboard)*	*Number of averaged frequencies (onboard)*
Type 0	2	1024	4.096 s	2.048 s	40	1
Type 1	2	1024	1.024 s	0.512 s	10	1
Type 2	8	256	16.384 s	2.048 s	40	4

(2) Only the time of the first spectrum is given in the data format (field 11). The UT time of each spectrum can be computed by adding the time of the first one plus the spectrum duration. The elementary spectrum duration is obtained from the division of the total duration (field 8) by the spectrum number (field 6).

3.5.5. Waveform of the HF Electric Field (APID 1133)

Experiment: ***ICE***.
Data type: ***Waveform of 1 component of the electric field in the HF range***.

The level-1 file structure of "HF Electric Waveform" is given in Table N1-15.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-15. Structure of the "HF electric waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-16. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 1 component of the electric field in the HF range					
Filename: ***DMT_N1_1133_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "HF ELECTRIC WAVEFORM "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A16	1	16		Data unit: "μV/m "
5	R*4	1	4	kHz	Sampling frequency: 6666.6667
6	I*2	1	2		Sample data number per component: 4096
7	R*4	1	4	ms	Time duration of one data array: 4096 / 6666.6667
					Waveform data
8	A3	1	3		Component name: "Eij", i, j are the sensor numbers
9	R*4	4096	16384	μV/m	Waveform sample array (1)

Table N1-16. Block 4: HF electric waveform.

(1) The phase of the electric field is only known up to 3 MHz. Above this frequency, the phase is not valid.

3.5.6. Power spectrum of the HF Electric Field (APID 1134)

Experiment: ***ICE***.
Data type: ***Power spectrum of 1 component of the electric field in the HF range***.

The level-1 file structure of "HF Electric Spectrum" is given in Table N1-17.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-17. Structure of the "HF electric spectrum" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-18. The conversion from raw data to calibrated data is detailed in DR3.

Power spectrum of 1 component of the electric field in the HF range					
Filename: ***DMT_N1_1134_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "HF ELECTRIC SPECTRUM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A3	1	3		Component name: "Eij", i, j are the sensor numbers
5	A16	1	16		Data unit: "log(µV^2/m^2/Hz)"
6	I*1	1	1		Number of consecutive spectra (Nb): 2 or 8 (1)
7	I*2	1	2		Number of spectrum frequencies (Nbf): 1024 or 256
8	R*4	1	4	s	Total time duration of Nb spectra: 16.384, 4.096 or 1.024
9	R*4	1	4	kHz	Frequency resolution: 3.255 or 13.021
10	R*4	2	8	kHz	Frequency range: [3.255 or 13.021 - 3333.3333]
11	I*2	7	14		UT time of the first spectrum as: year, month, day, hour, minute, second, millisecond (2)
					Power spectrum data
12	R*4	Nbf	Nbf*4	log(µV^2/ m^2/Hz)	Power array of the first spectrum
…	…	…	…	…	….
12 + (Nb-1)	R*4	Nbf	Nbf*4	log(µV^2/ m^2/Hz)	Power array of the Nbth spectrum

Table N1-18. Block 4: HF electric spectrum.

(1) The parameters of the 3 different spectrum types are summarized below:

Spectrum type	*Spectrum number in the data format (Nb)*	*Frequency number per spectrum (Nbf)*	*Total time duration*	*Duration of one spectrum*	*Number of averaged spectra (onboard)*	*Number of averaged frequencies (onboard)*
Type 0	2	1024	4.096 s	2.048 s	40	1
Type 1	2	1024	1.024 s	0.512 s	10	1
Type 2	8	256	16.384 s	2.048 s	40	4

(2) Only the time of the first spectrum is given in the data format (field 11). The UT time of each spectrum can be computed by adding the time of the first one plus the spectrum duration. The elementary spectrum duration is obtained from the division of the total duration (field 8) by the spectrum number (field 6).

3.5.7. Waveform of the ELF Magnetic Field (APID 1135)

Experiment: ***IMSC***.
Data type: ***Waveform of 3 components of the magnetic field in the ELF range***.

The level-1 file structure of "ELF Magnetic Waveform" is given in Table N1-19.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-19. Structure of the "ELF magnetic waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-20. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 3 components of the magnetic field in the ELF range					
Filename: ***DMT_N1_1135_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "ELF MAGNETIC WAVEFORM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor ", "Satellite" or "B0field "
4	R*4	9	36		$M_{sen2sat}$: Matrix from sensor coordinate system to satellite coordinate system
5	A16	1	16		Data unit: "nT "
6	R*4	1	4	Hz	Sampling frequency: "2500."
7	I*2	1	2		Sample data number per component: 4096
8	R*4	1	4	s	Time duration of one data array: 4096 / 2500
					First component waveform
9	A3	1	3		First component name: "B1 " in sensor coordinate system "Bx " in the other coordinate systems
10	R*4	4096	16384	nT	Waveform sample array of the first component
					Second component waveform
11	A3	1	3		Second component name: "B2 " in sensor coordinate system "By " in the other coordinate systems
12	R*4	4096	16384	nT	Waveform sample array of the second component
					Third component waveform
13	A3	1	3		Third component name: "B3 " in sensor coordinate system

					"Bz " in the other coordinate systems
14	R*4	4096	16384	nT	Waveform sample array of the third component

Table N1-20. Block 4: ELF magnetic waveform.

3.5.8. Waveform of the VLF Magnetic Field (APID 1136)

Experiment: ***IMSC***.
Data type: ***Waveform of 1 component of the magnetic field in the VLF range***.

The level-1 file structure of "VLF Magnetic Waveform" is given in Table N1-21.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-21. Structure of the "VLF magnetic waveform" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-22. The conversion from raw data to calibrated data is detailed in DR3.

Waveform of 1 component of the magnetic field in the VLF range					
Filename: ***DMT_N1_1136_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "VLF MAGNETIC WAVEFORM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A16	1	16		Data unit: "nT "
5	R*4	1	4	Hz	Sampling frequency: 40000.
6	I*2	1	2		Sample data number per component: 8192
7	R*4	1	4	s	Time duration of one data array: 8192 / 40000
					Waveform data
8	A3	1	3		Component name: "Bi ", i is the sensor number
9	R*4	8192	32768	nT	Waveform sample array

Table N1-22. Block 4: VLF magnetic waveform.

3.5.9. Power spectrum of the VLF Magnetic Field (APID 1137)

Experiment: ***IMSC***.
Data type: ***Power spectrum of 1 component of the magnetic field in the VLF range***.

The level-1 file structure of "VLF Magnetic Spectrum" is given in Table N1-23.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-23. Structure of the "VLF magnetic spectrum" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-24. The conversion from raw data to calibrated data is detailed in DR3.

Power spectrum of 1 component of the magnetic field in the VLF range					
Filename: ***DMT_N1_1137_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "VLF MAGNETIC SPECTRUM"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	A9	1	9		Data coordinate system: "Sensor "
4	A3	1	3		Component name: "Bi ", i is the sensor number
5	A16	1	16		Data unit: "log(nT^2/Hz) "
6	I*1	1	1		Number of consecutive spectra (Nb): 2 or 8 (1)
7	I*2	1	2		Number of spectrum frequencies (Nbf): 1024 or 256
8	R*4	1	4	s	Total time duration of Nb spectra: 16.384, 4.096 or 1.024
9	R*4	1	4	Hz	Frequency resolution: 19.53125 or 78.125
10	R*4	2	8	Hz	Frequency range: [19.53125 or 78.125 - 20000]
11	I*2	7	14		UT time of the first spectrum as: year, month, day, hour, minute, second, millisecond (2)
					Power spectrum data
12	R*4	Nbf	Nbf*4	log(nT^2/Hz)	Power array of the first spectrum
…	…	…	…	…	….
12 + (Nb-1)	R*4	Nbf	Nbf*4	log(nT^2/Hz)	Power array of the Nbth spectrum

Table N1-24. Block 4: VLF magnetic spectrum.

(1) The parameters of the 3 different spectrum types are summarized below:

Spectrum type	*Spectrum number in the data format (Nb)*	*Frequency number per spectrum (Nbf)*	*Total time duration*	*Duration of one spectrum*	*Number of averaged spectra (onboard)*	*Number of averaged frequencies (onboard)*
Type 0	2	1024	4.096 s	2.048 s	40	1
Type 1	2	1024	1.024 s	0.512 s	10	1
Type 2	8	256	16.384 s	2.048 s	40	4

(2) Only the time of the first spectrum is given in the data format (field 11). The UT time of each spectrum can be computed by adding the time of the first one plus the spectrum duration. The elementary spectrum duration is obtained from the division of the total duration (field 8) by the spectrum number (field 6).

3.5.10. Neural network results (APID 1138)

Experiment: ***RNF***.
Data type: ***Results of event detection from the neural network***.

The level-1 file structure of "RNF detection results" is given in Table N1-25.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-25. Structure of the "RNF results" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.

The data block 4 is detailed in Table N1-26.

RNF results					
Filename: ***DMT_N1_1138_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A21	1	21		Data type: "Neural Network "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	I*1	1	1		Data sub-type: 0 or 1 (0: 3D spectrogram, 1: 2D curves)
4	A20	1	20		Study title: "WHISTLER "
5	A3	1	3		Component name: "Eij" or "Bi "
6	R*4	1	4	s	Time resolution (*dt*)
7	I*1	1	1		Class number (*Nbclasses*): from 1 to 20
8	I*1	1	1		Number of spectra (*Nbs*)when '3D spectrogram' sub-type Number of plot points (*Nbp*) when '2D curves' sub-type Value from 1 to 128
9	I*1	1	1		0 when '3D spectrogram' sub-type Number of curves *Nbc* when '2D curves' sub-type, from 0 to 5
					Class description
10	A10	1	10		Unit name for the class ranges
11	R*4	20	80		Minimum ranges for the classes Di (filled by 0 when *Nbclasses* < 20)
12	R*4	20	80		Maximum ranges for the classes Di (filled by 0 when *Nbclasses* < 20)
					Spectrogram intensity
13	I*1	128	128		Spectrum validity: 0 = not valid, 1 = valid
14	I*1	128*20	2560		*Nbs* vectors of *Nbclasses* elements when '3D

					spectrogram' sub-type; the vectors are set in the order V_0, V_1, …, V_{Nbs-1} *Nbc* vectors of *Nbp* elements when '2D curves' sub-type; the vectors are set in the order C_0, C_1, …, C_{Nbc-1} The field is completed by 0.
					Spectrogram uncertainty (time resolution)
15	I*1	128*20	2560		*Nbs* vectors of *Nbclasses* elements when '3D spectrogram' sub-type; the vectors are set in the order V_0, V_1, …, V_{Nbs-1} *Nbc* vectors of *Nbp* elements when '2D curves' sub-type; the vectors are set in the order C_0, C_1, …, C_{Nbc-1} The field is completed by 0.

Table N1-26. Block 4: RNF detection results.

3.5.11. Ion characteristics (APID 1139)

Experiment: ***IAP***.
Data type: ***Ion density, temperature and velocity***.

The level-1 file structure of "Ion characteristics" is in Table N1-27.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-27. Structure of the "IAP Burst" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-28.

Density, temperature and velocity of low energy ions					
Filename: ***DMT_N1_1139_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "IAP BURST "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Time resolution
4	A6	1	6		Density unit: "cm^-3 "
5	A6	1	6		Temperature unit: "K "
6	A6	1	6		Velocity unit: "m/s "
7	A6	1	6		Potential unit: "V "
8	A6	1	6		Angle unit: "degree"
					Density and temperature
9	R*4	1	4	cm^-3	H+ density
10	R*4	1	4	cm^-3	He+ density
11	R*4	1	4	cm^-3	O+ density
12	R*4	1	4	K	Ions temperature
					Plasma velocity
13	R*4	1	4	ms^-1	Ions velocity along the satellite Oz axis
14	R*4	1	4	degree	Angle between the ion velocity and –Oz axis of satellite
15	R*4	1	4	degree	Angle between projection of the ions velocity on the plane xOy and axis Ox of satellite
					Satellite potential
16	R*4	1	4	V	Satellite potential

Table N1-28. Block 4: IAP Burst results.

3.5.12. Ion characteristics (APID 1140)

Experiment: ***IAP***.
Data type: ***Ion density, temperature and velocity***.

The level-1 file structure of "Ion characteristics" is given in Table N1-29.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-29. Structure of the "IAP Survey" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-30.

Density, temperature and velocity of low energy ions					
Filename: ***DMT_N1_1140_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "IAP SURVEY "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Time resolution
4	A6	1	6		Density unit: "cm^-3 "
5	A6	1	6		Temperature unit: "K "
6	A6	1	6		Velocity unit: "m/s "
7	A6	1	6		Potential unit: "V "
8	A6	1	6		Angle unit: "degree"
					Density and temperature
9	R*4	1	4	cm^-3	H+ density
10	R*4	1	4	cm^-3	He+ density
11	R*4	1	4	cm^-3	O+ density
12	R*4	1	4	K	Ions temperature
					Plasma velocity
13	R*4	1	4	ms^-1	Ions velocity along the satellite Oz axis
14	R*4	1	4	degree	Angle between the ion velocity and –Oz axis of satellite
15	R*4	1	4	degree	Angle between projection of the ions velocity on the plane xOy and axis Ox of satellite
					Satellite potential
16	R*4	1	4	V	Satellite potential

Table N1-30. Block 4: IAP Survey results.

3.5.13. Energetic electron flux (APID 1141)

Experiment: ***IDP***.
Data type: ***Energetic electron spectrum***.

The level-1 file structure of "Energetic Electron Spectrum" is given in Table N1-31.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-31. Structure of the "IDP Burst" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-32.

Spectrum of energetic electrons					
Filename: ***DMT_N1_1141_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "IDP BURST "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Time resolution (one spectrum / second)
4	R*4	1	4	V	Polarisation voltage
5	R*4	1	4	keV	Discrimination level
6	A20	1	20		Spectrum data unit: "elec/cm^2/s/ster/keV"
7	A6	1	6		Pitch angle unit: "degree"
					Electron spectra
8	R*4	256	1024	elec/cm^2/s/ster/keV	Data array of spectrum n°1
9	R*4	256	1024	elec/cm^2/s/ster/keV	Data array of spectrum n°2
10	R*4	256	1024	elec/cm^2/s/ster/keV	Data array of spectrum n°3
11	R*4	256	1024	elec/cm^2/s/ster/keV	Data array of spectrum n°4
					Energy table
12	R*4	256	1024	keV	Energy table
					Pitch angle data
13	R*4	1	4	degree	Pitch angle (from 0 to 180°)

Table N1-32. Block 4: IDP Burst results.

3.5.14. Energetic electron counters (APID 1142)

Experiment: ***IDP***.
Data type: ***Energetic electron counter and spectrum***.

The level-1 file structure of "Energetic Electron Counters" is given in Table N1-33.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-33. Structure of the "IDP Survey" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-34.

Counters of energetic electrons					
Filename: ***DMT_N1_1142_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "IDP SURVEY"
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Spectrum time resolution
4	R*4	1	4	s	Counters time resolution
5	R*4	1	4	V	Polarisation voltage
6	R*4	1	4	keV	Discrimination level
7	R*4	1	4	keV	Threshold low interval 1
8	R*4	1	4	keV	Threshold low interval 2
9	R*4	1	4	keV	Threshold low interval 3
10	R*4	1	4	keV	Threshold high interval 3
11	A20	1	20		Spectrum data unit: "elec/cm^2/s/ster/keV"
12	A6	1	6		Pitch angle unit: "degree"
					Counters and spectrum data
13	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
14	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #1
15	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
16	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #2
17	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]

18	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #3
19	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
20	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #4
21	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
22	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #5
23	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
24	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #6
25	I*4	12	48		4 x [counter #1 value counter #2 value counter #3 value]
26	R*4	128	512	elec/cm^2/s/ster/keV	Data array of spectrum #7
					Energy table
27	R*4	128	512	keV	Energy table
					Pitch angle data
28	R*4	1	4	degree	Pitch angle (from 0 to 180°)

Table N1-34. Block 4: IDP Survey results.

3.5.15. Langmuir probe data (APID 1143)

Experiment: ***ISL***.
Data type: ***Electron and ion densities, electron temperature and potentials***.

The level-1 file structure of "Langmuir probe data" is given in Table N1-35.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-35. Structure of the "ISL Burst" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-36.

Langmuir probe results					
Filename: ***DMT_N1_1143_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "ISL BURST "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Time resolution
4	A5	1	5		Density unit: "cm^-3"
5	A5	1	5		Temperature unit: "K "
6	A5	1	5		Potential unit: "V "
					Plasma parameters
7	R*4	1	4	cm^-3	Electron density
8	R*4	1	4	cm^-3	Ion density
9	R*4	1	4	K	Electron temperature
10	R*4	1	4	V	Plasma potential
11	R*4	1	4	V	Floating potential
12	R*4	1	4	V	Satellite potential

Table N1-36. Block 4: ISL Burst results.

3.5.16. Langmuir probe data (APID 1144)

Experiment: ***ISL***.
Data type: ***Electron and ion densities, electron temperature and potentials***.

The level-1 file structure of "Langmuir probe data" is given in Table N1-37.

Time T_1				*Time T_2*				
block 1	block 2	block 3	block 4	block 1	block 2	block 3	block 4	…

Table N1-37. Structure of the "ISL Survey" data file.

The structures of the data blocks from 1 to 3 are detailed in section 3.4.
The data block 4 is detailed in Table N1-38.

Langmuir probe results					
Filename: ***DMT_N1_1144_< nnnnns >_<start_date>_<end_date>.DAT***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Data header
1	A10	1	10		Data type: "ISL SURVEY "
2	I*1	32	32		House-Keepings and Status (see DR1)
3	R*4	1	4	s	Time resolution
4	A5	1	5		Density unit: "cm^-3"
5	A5	1	5		Temperature unit: "K "
6	A5	1	5		Potential unit: "V "
					Plasma parameters
7	R*4	1	4	cm^-3	Electron density
8	R*4	1	4	cm^-3	Ion density
9	R*4	1	4	K	Electron temperature
10	R*4	1	4	V	Plasma potential
11	R*4	1	4	V	Floating potential
12	R*4	1	4	V	Satellite potential

Table N1-38. Block 4: ISL Survey results.

4. LEVEL-2 SCIENCE DATA

4.1. Level-2 definition

Level-2 data processing corresponds to high resolution plots of the calibrated data. The level-2 image is created by the user itself on the data server which gives facilities to personalize the output image. A better naming would have been level-1' since no data computation is performed.

4.2. Level-2 experiment image

The level-2 image name is:

N2_<start_date>_<end_date>_<login_name>.PS

- <start_date>: date of the first data sample as "yyyymmdd_hhmnss";
- <end_date>: date of the last data sample as "yyyymmdd_hhmnss";
- <login_name>: user name entered to log in.

Note that the image is not stored in the Mission Center since created on request. The name of the image is only used for image transfer.

4.2. Level-2 image building

The successive steps to build a level-2 image are :

1) **Select an half orbit number or a time interval inside an half orbit.** Note that it is not possible to create a level-2 image with data selected on more than one half-orbit.
   1.1) Reduce the data selection with coordinates of a geographical zone (latitude and longitude) to get data corresponding to the flying over this zone;
   1.2) Reduce the data selection according to earthquake characteristics (magnitude, depth, latitude and longitude, …);

2) **Select a configuration saved previously (if existing).** If the user has more than one configuration registered, he has to remember what are the parameters of each configuration.

3) **Select the instrument.**

4) **Select the parameters to be plotted among the full list.**

5) **Configure the plot (scales, abscissa parameters) and the output page.** The user configuration can be saved at this step.

6) **Plot is displayed.**

4.3. Level-2 image example

An example of level-2 image is given in Figure N2-1.

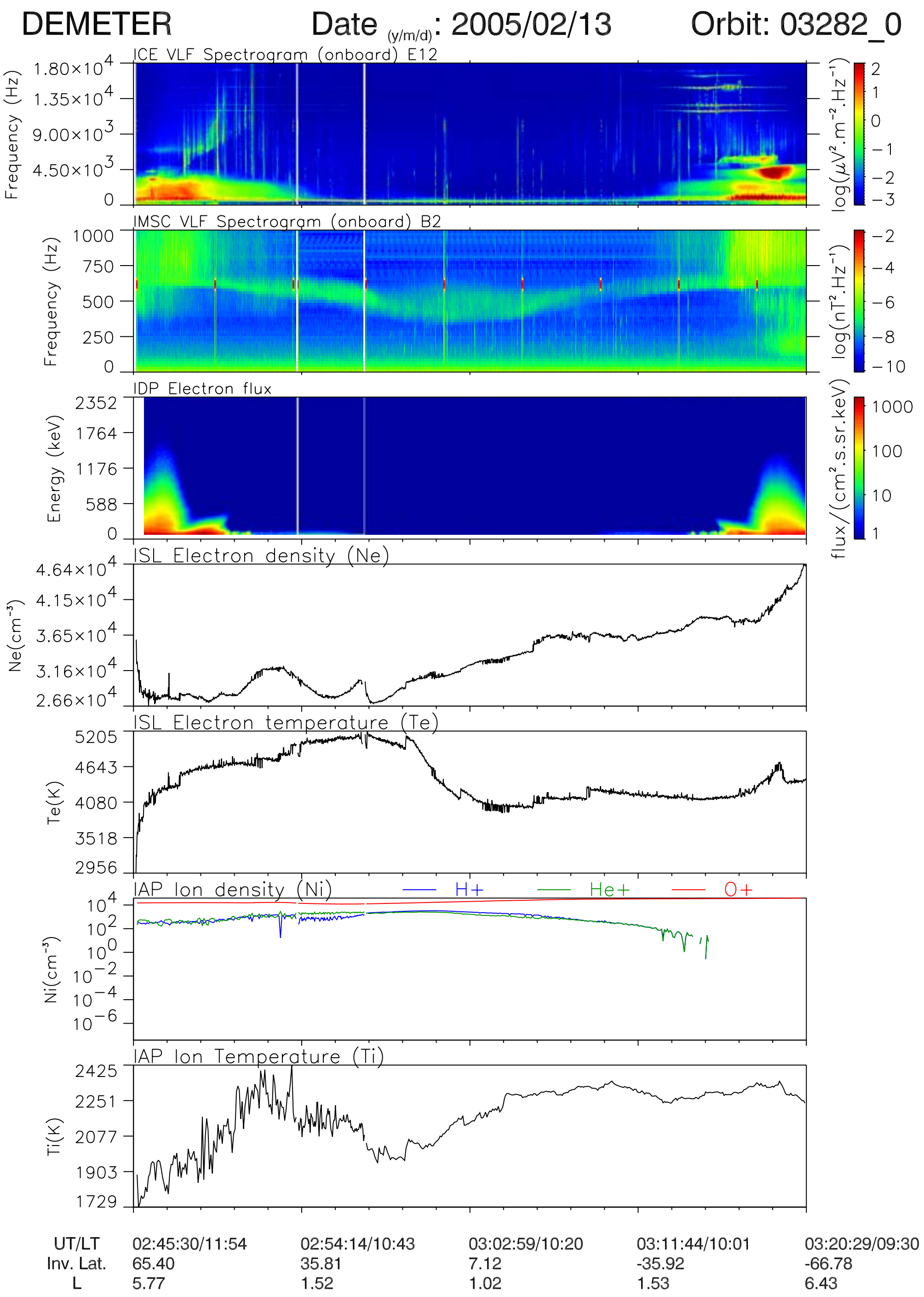


Figure N2-1. Example of level-2 image generated on the data server.

5. AUXILIARY DATA

5.1. Demeter events - Orbit numbers

5.1.1. Contents

The orbit number file contains the times of the beginning and of the end of one half-orbit; this file has been created with predicted orbital parameters (about 1 m maximum difference with determined parameters).

5.1.2. Filename

The orbit number file is named as:

P_ORBIT_NUMBERS

5.1.3. File description

All the values are separated by a tabulation character.

P_ORBIT_NUMBERS				
Field number	Type	Array dim.	Size (bytes)	Description
				Information type
1	ASCII	1	5	EVENT for the orbit events ORBIT for the orbit and sub-orbit numbers SPROG for the programmation days
				Date of the event
2	ASCII	1	23	STRING Format is YYYY/MM/DD HH:MN:SS.MS
				Class of event
3	ASCII	1	1	M: mission event O: orbital event S: satellite event
				Event number
4	ASCII (I2)	1	2	For EVENT, ORBIT and SPROG information: - For mission event class (M): 1: Beginning of programmation day - For orbital event class (O): 3: Light → penombra transition time 4: Penombra → shadow transition time 5: Shadow → penombra transition time 6: Penombra → light transition time

				7: Day → night transition time 8: Night → day transition time 9: Time of shifting into quadrature position (satellite – Sun – Earth) 10: Time of shifting into subsolary position 11: Time of shifting into anti-subsolary position 12: Time of Sun eclipse by moon 13: +90° orbit position pass time 14: - 90° orbit position pass time - For satellite event class (S): 15: Maneuver beginning (start of turn attitude maneuver for the µsat) 16: Maneuver end (stop of turn attitude maneuver for the µsat) 33: Start of MTB activation period 34: End of MTB activation period
				Orbit number (this information is only available when information type is "ORBIT")
5	ASCII (I5)	1	5	orbit number
6	ASCII (I1)	1	1	orbit sub-number
				Event description
7	ASCII	1	<40	Event description text

Table AUX-1. Description of the 'P_ORBIT_NUMBERS' file.

For the 2 years DEMETER mission, the estimated total volume for the 'P_ORBIT_NUMBERS' file is about a few tens of MBytes.

5.1.4. Example of P_ORBIT_NUMBERS file

Extract of P_ORBIT_NUMBERS file from half-orbit 592.1 to half-orbit 594.0.

```
...
ORBIT    2004/08/12 04:09:45.877    O    14    592    1    Start upwards half-orbit, position -
90
EVENT    2004/08/12 04:12:05.516    O     3    Transition Light-->Penombra
EVENT    2004/08/12 04:12:15.372    O     4    Transition Penombra-->Shadow
EVENT    2004/08/12 04:13:04.976    S    34    End of MTB activation period, Science Payload ON
EVENT    2004/08/12 04:22:33.977    S    33    Start of MTB activation period
EVENT    2004/08/12 04:24:15.277    S    34    End of MTB activation period
EVENT    2004/08/12 04:28:56.794    O    11    Shifting into antisubsolary position
EVENT    2004/08/12 04:33:45.776    S    33    Start of MTB activation period
EVENT    2004/08/12 04:35:26.177    S    34    End of MTB activation period
EVENT    2004/08/12 04:44:54.677    S    33    Start of MTB activation period
EVENT    2004/08/12 04:45:40.763    O     5    Transition Shadow-->Penombra
EVENT    2004/08/12 04:45:50.594    O     6    Transition Penombra-->Light
EVENT    2004/08/12 04:46:35.376    S    34    End of MTB activation period
EVENT    2004/08/12 04:50:48.577    S    33    Start of MTB activation period, Science Payload OFF
```

```
EVENT    2004/08/12 04:53:41.216    O    8     Transition Night-->Day
EVENT    2004/08/12 04:53:42.754    O    9     Shifting into quadrature position
ORBIT    2004/08/12 04:59:16.656    O    13      593     0         Start downwards half-orbit,
position +90
EVENT    2004/08/12 05:02:34.976    S    34    End of MTB activation period, Science Payload ON
EVENT    2004/08/12 05:13:25.077    S    33    Start of MTB activation period
EVENT    2004/08/12 05:15:05.177    S    34    End of MTB activation period
EVENT    2004/08/12 05:18:20.739    O    10    Shifting into subsolary position
EVENT    2004/08/12 05:24:30.577    S    33    Start of MTB activation period
EVENT    2004/08/12 05:26:10.377    S    34    End of MTB activation period
EVENT    2004/08/12 05:35:38.777    S    33    Start of MTB activation period
EVENT    2004/08/12 05:37:20.077    S    34    End of MTB activation period
EVENT    2004/08/12 05:40:51.977    S    33    Start of MTB activation period, Science Payload OFF
EVENT    2004/08/12 05:43:03.937    O    7     Transition Day-->Night
EVENT    2004/08/12 05:43:05.380    O    9     Shifting into quadrature position
ORBIT    2004/08/12 05:48:47.489    O    14      593     1         Start upwards half-orbit, position -
90
EVENT    2004/08/12 05:51:07.597    O    3     Transition Light-->Penombra
EVENT    2004/08/12 05:51:17.454    O    4     Transition Penombra-->Shadow
EVENT    2004/08/12 05:52:04.177    S    34    End of MTB activation period, Science Payload ON
EVENT    2004/08/12 06:00:10.777    S    33    Start of MTB activation period
EVENT    2004/08/12 06:01:52.476    S    34    End of MTB activation period
EVENT    2004/08/12 06:07:58.835    O    11    Shifting into antisubsolary position
EVENT    2004/08/12 06:11:23.776    S    33    Start of MTB activation period
EVENT    2004/08/12 06:13:04.177    S    34    End of MTB activation period
EVENT    2004/08/12 06:22:32.577    S    33    Start of MTB activation period
EVENT    2004/08/12 06:24:13.076    S    34    End of MTB activation period
EVENT    2004/08/12 06:24:42.803    O    5     Transition Shadow-->Penombra
EVENT    2004/08/12 06:24:52.631    O    6     Transition Penombra-->Light
EVENT    2004/08/12 06:31:22.777    S    33    Start of MTB activation period, Science Payload OFF
EVENT    2004/08/12 06:32:43.184    O    8     Transition Night-->Day
EVENT    2004/08/12 06:32:44.719    O    9     Shifting into quadrature position
ORBIT    2004/08/12 06:38:18.226    O    13      594     0         Start downwards half-orbit,
position +90
EVENT    2004/08/12 06:41:46.669    S    34    End of MTB activation period, Science Payload ON
EVENT    2004/08/12 06:49:39.169    S    33    Start of MTB activation period
EVENT    2004/08/12 06:51:19.768    S    34    End of MTB activation period
EVENT    2004/08/12 06:57:22.636    O    10    Shifting into subsolary position
EVENT    2004/08/12 07:00:45.869    S    33    Start of MTB activation period
EVENT    2004/08/12 07:02:25.569    S    34    End of MTB activation period
EVENT    2004/08/12 07:11:52.468    S    33    Start of MTB activation period
EVENT    2004/08/12 07:13:33.069    S    34    End of MTB activation period
EVENT    2004/08/12 07:21:36.768    S    33    Start of MTB activation period, Science Payload OFF
EVENT    2004/08/12 07:22:05.878    O    7     Transition Day-->Night
EVENT    2004/08/12 07:22:07.321    O    9     Shifting into quadrature position
...
```

5.2. Demeter events - Data related events

5.2.1. Contents

The data related event file contains all the events, satellite, ground facilities, …., that can affect or corrupt the Demeter data. For example, when the magneto-torquers are switched on, interferences appear on the IMSC data. Such information is reported in this file.

5.2.2. Filename

The file is named as:

DATA_RELATED_EVENTS

5.2.3. File description

Code:

- ATT: attitude maneuver
- COM: commissioning data
- GPS: GPS status
- MAN: satellite maneuver
- MTB: magneto-torquers working
- ORB: orbital parameter anomaly
- SEU: event detected in DSP memory
- SOP: solar panels rotating
- TUC: Time jump for investigation

Start_orbit, end_orbit:

- first orbit number for the event
- last orbit number for the event

Start_time, end_time:

- start time for the event
- end time for the event

Type:

- A: all the orbit
- P: partially on the orbit

Event_comments:

- brief description of the event

5.2.4. Example of DATA_RELATED_EVENTS file

Code	Start_orbit	End_orbit	Start_date	End_date	Type	Event_comments
COM	00042.0	00042.0	2004/07/05 08:00:31	2004/07/05 08:06:03	A	Commissioning, BANT validation
COM	00056.0	00056.0	2004/07/06 07:05:49	2004/07/06 07:09:54	A	Commissioning, IMSC and ISL validations
….						
MTB	00987.1	00987.1	2004/09/08 08:10:07	2004/09/08 08:49:17	A	MTB ON all the orbit
MTB	01176.1	01190.0	2004/09/21 08:04:34	2004/09/22 08:41.31	A	MTB ON all the orbits

…						
MTB	01877.1	01877.1	2004/11/08 13:05:00	2004/11/08 13:43:00	A	MTB ON all the orbit
MTB	01889.1	01889.1	2004/11/09 08:49:00	2004/11/09 09:30:00	A	MTB ON all the orbit
SEU	00801.0	00801.0	2004/08/26 12:46:27	2004/08/26 13:02:48	P	SEU DSP memory
SEU	00998.1	00998.1	2004/09/09 02:30:56	2004/09/09 02:38:00	P	SEU DSP memory
…						
SEU	03054.0	03054.0	2005/01/28 11:09:51	2005/01/28 11:11:30	P	SEU DSP memory
SEU	03150.1	03150.1	2005/02/04 01:55:45	2005/02/04 02:08:30	P	SEU DSP memory
SOP	01176.1	01190.0	2004/09/21 08:04:34	2004/09/22 08:41.31	A	Solar panels in rotation
SOP	01278.1	01292.1	2004/09/28 08:25:18	2004/09/29 08:11:29	A	Solar panels in rotation
…						
SOP	01483.0	01496.0	2004/10/12 09:56:56	2004/10/13 08:12:25	A	Solar panels in rotation
SOP	01584.1	01585.1	2004/10/19 09:27:25	2004/10/19 11:47:34	A	Solar panels in rotation
GPS	01300.1	01306.0	2004/09/29 20:46:36	2004/09/30 06:26:37	A	GPS operational
GPS	02733.0	02762.1	2005/01/06 08:48:00	2005/01/08 09:20:00	A	GPS OFF, switching on and operational at 09:20:00
ATT	01310.1	01326.0	2004/09/30 13:19:00	2004/10/01 16:17:00	A	Attitude maneuver around Z axis (800s), 0° --> -12°
ATT	01326.1	01326.1	2004/10/01 16:17:00	2004/10/01 16:32:00	A	Attitude maneuver around Z axis (800s), -12° --> 0°
…						
ATT	03120.0	03133.1	2005/02/01 23:30:00	2005/02/02 21:40:00	A	Attitude maneuver around Z axis (800s), 0° --> -12°
ATT	03133.1	03133.1	2005/02/02 21:40:00	2005/02/02 21:53:20	P	Attitude maneuver around Z axis (800s), -12° --> 0°
ORB	01830.1	01859.1	2004/11/05 07:48:00	2004/11/07 08:00:00	A	Predicted orbital parameters instead determined

5.3. Orbital parameters – Determined parameters

5.3.1. Contents

The orbital and geomagnetic parameters are

- the position and velocity of the satellite versus the time in the geographic coordinate system,
- the geocentric latitude, geocentric longitude and local time,
- the geomagnetic latitude, geomagnetic longitude, magnetic local time, invariant latitude, Mc Ilwain parameter,
- the position of the Sun.

The time resolution is 30 seconds. Interpolation has been done to get this resolution (raw values every 3 minutes)

Note that the given latitude is named geocentric latitude to make difference with the geodetic latitude; the geodetic latitude takes into account that the shape of the Earth that is an oblate spheroid and not a sphere.

5.3.2. Filename

The orbit ephemeris files are named as:

ORBIT_EPHEMERIS_<start_date>_<end_date>

- <start_date>: date of the first orbital parameter as "yyyymmdd_hhmnss",
- <end_date>: date of the last orbital parameter as "yyyymmdd_hhmnss".

5.3.3. File description

ORBIT EPHEMERIS					
Filename: ***ORBIT_EPHEMERIS_<start_date>_<end_date>***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Standard CCSDS date
1	I*1	1	1		P field (decimal value = 76)
2	I*3	1	3		Number of days from 01/01/1950
3	I*4	1	4		Number of milliseconds in the day
					Time and orbit information
4	I*2	7	14		UT time of the orbital parameters as: year, month, day, hour, minute, second, millisecond
5	I*2	1	2		Orbit number
6	I*2	1	2		Orbit sub-number (0: downward, 1: upward)
					Satellite position and velocity
7	R*4	3	12	m	Position in the geographic coordinate system
8	R*4	3	12	m/s	Velocity in the geographic coordinate system

9	R*4	3	12	m	Position in the GEI coordinate system
10	R*4	3	12	m/s	Velocity in the GEI coordinate system
					Orbital parameters
11	R*4	1	4	degree	Geocentric latitude (from -90° to +90°)
12	R*4	1	4	degree	Geocentric longitude (from 0° to +360°)
13	R*4	1	4	km	Altitude
14	R*4	1	4	hour	Local time of the first point of the data array (0, 24h)
					Solar position
15	R*4	3	12		Solar position, Xs, Ys, Zs in the geographic coordinate system
					Geomagnetic parameters
16	R*4	1	4	degree	Geomagnetic latitude (-90°, +90°)
17	R*4	1	4	degree	Geomagnetic longitude (0°, +360°)
18	R*4	1	4	hour	Magnetic local time of the first point
19	R*4	1	4	degree	Invariant latitude (-90°, +90°)
20	R*4	1	4		Mc Ilwain parameter L (0, 999)
21	R*4	1	4	degree	Geocentric latitude of the conjugate point at the satellite altitude (-90°, +90°)
22	R*4	1	4	degree	Geocentric longitude of the conjugate point at the satellite altitude (0°, +360°)
23	R*4	1	4	degree	Geocentric latitude of North conjugate point at altitude 110 km (-90°, +90°)
24	R*4	1	4	degree	Geocentric longitude of North conjugate point at altitude 110 km (0°, +360°)
25	R*4	1	4	degree	Geocentric latitude of South conjugate point at altitude 110 km (-90°, +90°)
26	R*4	1	4	degree	Geocentric longitude of South conjugate point at altitude 110 km (0°, +360°)
27	R*4	3	12	nT	Components of the magnetic field model at the satellite point (geographic coordinate system)
28	R*4	1	4	Hz	Proton gyrofrequency at satellite point

Table AUX-2. Description of the 'ORBIT_EPHEMERIS' file.

When the geomagnetic latitude is upper than +75° or lower than -75° (North and South pole regions), the geomagnetic parameters are set to 99999.00

For the 2 years DEMETER mission, the total volume for the orbital parameters is about 340 Mbytes; thus, 12 'ORBIT_EPHEMERIS' files will be necessary to store these parameters (file size limited to 30 Mbytes). The size is 162 bytes per time.

5.3.4. Parameter definitions

The parameters are defined in the MAGLIB library (DR2).

- **Coordinate systems**: the coordinate systems are detailed in Annex A.

- **Position**: the x, y and z components of the position vector.

- **Velocity**: the Vx, Vy and Vz components of the velocity vector. The velocity components in the GEO frame take into account the Earth rotation (correction of Vx and Vy).

- **Geographic latitude and longitude**: the latitude and longitude are the geographic (geocentric) ones. See Annex A to get the explanation of geographic and geodetic latitudes.

- **Altitude**: the altitude takes into account the fact that the Earth is oblate.

- **Geomagnetic latitude and longitude**: the transformation from geographic system to dipole system is first realized. Then, transformation in the dipole coordinate system from Cartesian to spherical coordinates gives the geomagnetic latitude and longitude. Note that this definition is not unique.

- **Magnetic local time**: the transformation from geographic system to solar magnetic system is first realized. Then, one computes the solar magnetic longitude φ_{SM} ($\varphi_{SM} = \varphi_D - \varphi_{D0}$, where φ_D is the geomagnetic longitude of the point and φ_{D0} is the geomagnetic longitude of the Sun). The MLT is defined by $MLT = \left(\frac{\varphi_{SM}}{15}\right)_h + 12h$

- **Mc Ilwain parameter**: The L parameter is calculated using the internal and external magnetic field models. Kp index is set to 0, 0+ in the Tsyganenko model. The definition is the one of Galperin (see DR2)

- **Invariant latitude**: The invariant latitude Λ_0 is computed from the L parameter with $\cos^2 \Lambda_0 = \frac{1}{L}$.

- **Internal magnetic field model**: the internal geomagnetic field is calculated using the IGRF 2000 coefficients extrapolated 2005. The model achieves a precision of about 20 nT.

- **External magnetic field model**: The external magnetic field model uses is the Tsyganenko 1989 model.

- **Conjugate points** : they are calculated using the internal and external magnetic field models. Kp index is set to 2-, 2, 2+ in the Tsyganenko model.

- **Proton gyrofrequency**: $f_{H^+} = 0.01525 \times Bnt$, where Bnt is the modulus of the internal magnetic field computed with the IGRF model.

5.4. Orbital parameters - Predicted parameters

5.4.1. Contents

The file contains the predicted orbital parameters for three weeks. Every 3 days, the file is updated with a new prediction.

5.4.2. Filename

The orbital parameter file is named as:
P_ORBIT_PARAMETERS

5.4.3. File description

All the values are separated by a tabulation character.

P_ORBIT_PARAMETERS		
Field number	Format	Description
1	F16.10	Julian time
2	I5	Year
3	I3	Day
4	I3	Month
5	I3	Hour
6	I3	Minute
7	I3	Second
8	I4	Millisecond
9	I6	Orbit number
10	I2	Sub-orbit number (0: downward, 1:upward)
11	F8.2	Altitude (km)
12	F8.2	Geographic latitude (degree)
13	F8.2	Geographic longitude (degree)

Table AUX-3. Description of the 'P_ORBIT_PARAMETERS' file.

5.4.4. Example of P_ORBIT_PARAMETERS file

```
19916.3333333333 2004  7 12  8  0  0   0   144 0  729.75   74.84   65.69
19916.3336805556 2004  7 12  8  0 30   0   144 0  729.22   73.30   62.09
19916.3340277778 2004  7 12  8  1  0   0   144 0  728.65   71.70   59.06
19916.3343750000 2004  7 12  8  1 30   0   144 0  728.05   70.07   56.50
19916.3347222222 2004  7 12  8  2  0   0   144 0  727.43   68.41   54.29
19916.3350694444 2004  7 12  8  2 30   0   144 0  726.77   66.73   52.36
19916.3354166667 2004  7 12  8  3  0   0   144 0  726.10   65.02   50.67
19916.3357638889 2004  7 12  8  3 30   0   144 0  725.40   63.31   49.17
```

```
 19916.3361111111 2004  7 12  8  4  0   0   144 0  724.67   61.58   47.82
 19916.3364583333 2004  7 12  8  4 30   0   144 0  723.93   59.84   46.60
 19916.3368055556 2004  7 12  8  5  0   0   144 0  723.17   58.10   45.49
 19916.3371527778 2004  7 12  8  5 30   0   144 0  722.40   56.34   44.47
 19916.3375000000 2004  7 12  8  6  0   0   144 0  721.62   54.58   43.53
 19916.3378472222 2004  7 12  8  6 30   0   144 0  720.82   52.82   42.66
 19916.3381944444 2004  7 12  8  7  0   0   144 0  720.02   51.05   41.85
 19916.3385416667 2004  7 12  8  7 30   0   144 0  719.21   49.28   41.09
 19916.3388888889 2004  7 12  8  8  0   0   144 0  718.40   47.50   40.37
 19916.3392361111 2004  7 12  8  8 30   0   144 0  717.58   45.72   39.69
 19916.3395833333 2004  7 12  8  9  0   0   144 0  716.77   43.94   39.04
 19916.3399305556 2004  7 12  8  9 30   0   144 0  715.97   42.15   38.43
 19916.3402777778 2004  7 12  8 10  0   0   144 0  715.17   40.37   37.84
…
```

5.5. Attitude

5.5.1. Contents

The attitude file contains the elements of the matrices that allow the transformations from the satellite coordinate system to the geographic coordinate system and from the geographic coordinate system to the local geomagnetic coordinate system.
The time resolution is 250 milliseconds.

The attitude parameters are computed from the quaternions given by the stellar sensor. Interpolation is done by the CNES ground segment to get values every 250 ms (the raw values given by the stellar sensor and digitized by the satellite onboard computer were not regularly time-spaced). A quality index is attached to the attitude values.

5.5.2. Filename

The attitude files are named as:

ATTITUDE_<start_date>_<end_date>

- <start_date>: date of the first attitude parameters as "yyyymmdd_hhmnss",
- <end_date>: date of the last attitude parameters as "yyyymmdd_hhmnss".

5.5.3. File description

ATTITUDE					
Filename: ***ATTITUDE_<start_date>_<end_date>***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Standard CCSDS date
1	I*1	1	1		P field (decimal value = 76)
2	I*3	1	3		Number of days from 01/01/1950
3	I*4	1	4		Number of milliseconds in the day
					Time and quality information
4	I*2	7	14		UT time of the attitude parameters as: year, month, day, hour, minute, second, millisecond
5	I*2	1	2		Orbit number
6	I*2	1	2		Orbit sub-number (0: downward, 1: upward)
7	I*2	1	2		Data quality: 0: NOK 1: OK 2: CMS interpolation
					Quaternions
8	R*4	4	16		Attitude quaternions in the J2000 coordinate system (from J2000 to satellite)

					Coordinate change matrices
9	R*4	9	36		$M_{sat2geo}$: Matrix from satellite coordinate system to geographic coordinate system
10	R*4	9	36		$M_{geo2lgm}$: Matrix from geographic coordinate system to local geomagnetic coordinate system

Table AUX-4. Description of the 'ATTITUDE' file.

For the 2 years DEMETER mission, the total volume for the attitude parameters is about 30000 Mbytes; thus, 700 'ATTITUDE' files will be necessary to store these parameters (file size limited to 42 Mbytes). The size is 116 bytes per time value (every 250 ms).

5.6. Science mode summary

5.6.1. Contents

The summary files give, per APID from 1129 to 1144 (i.e. per data type), the start and end times of the scientific modes for each Demeter orbit.

5.6.2. Filename

The filename on the data server is of the type:
DMT_SUMMARY_APID_aaaa_<start_orbit>_<end_orbit>_<start_time_<end_time>
where aaaa is the APID number from 1129 to 1144 (see list in paragraph 3.2).

5.6.3. File description

The summary files are described in Table AUX-5.

SUMMARY FILE	
Column number	Description
1	Half orbit number
2	Mode (Survey, Burst or All)
3	Data start time
4	Data end time

Table AUX-5. Description of the summary files.

5.6.4. Example of summary file

This example is the beginning of the file for APID 1129 (ICE ULF data).

```
# POSSIBLES MODES :
#    BURST
#    SURVEY
#    ALL (BURST OR SURVEY : depends on APID)
42.0    ALL      2004-07-05 08:00:31      2004-07-05 08:02:36
42.0    ALL      2004-07-05 08:02:38      2004-07-05 08:02:51
42.0    ALL      2004-07-05 08:03:48      2004-07-05 08:05:53
57.0    ALL      2004-07-06 08:36:34      2004-07-06 08:37:06
57.0    ALL      2004-07-06 08:37:18      2004-07-06 08:41:14
86.0    ALL      2004-07-08 08:29:07      2004-07-08 08:29:40
86.0    ALL      2004-07-08 08:29:51      2004-07-08 08:33:47
196.0   ALL      2004-07-15 21:56:52      2004-07-15 22:08:39
….
```

5.7. Seismic events

5.7.1. Contents

The seismic events file contains all the earthquake information relative to the DEMETER orbit parameters.

5.7.2. Filename

The seismic events files are named as:

SEISMIC_EVENTS_<start_date>_<end_date>

- <start_date>: date of the first earthquake as "yyyymmdd_hhmnss",
- <end_date>: date of the last earthquake as "yyyymmdd_hhmnss".

5.7.3. File structure

The seismic events file is organized by earthquake (magnitude greater than 5) and time.
The structure is given in Table AUX-6.

Earthquake time T_1						*Earthquake time T_2*						
block 1	block 2	block 3	block 4_1	block 4_2	…	block 1	block 2	block 3	block 4_1	block 4_2	…	…

Table AUX-6. Structure of the 'SEISMIC EVENTS' file.

Four different blocks are defined (Table AUX-7)

Block number	**Data description**
1	Earthquake coordinates for magnitude (mag) greater than 5.
2	Geomagnetic parameters at time of the earthquakes; The model of Earth magnetic field used to compute the geomagnetic parameters is IGRF2000.
3	DEMETER orbits according to the earthquakes, direct distances between epicenter and orbit.
4	Pre- and post-seismic information; The minimum distances are computed for every earthquake within the following parameters: - direct distance between epicenter and orbit lower than 2000 km, - time interval [-2, +2] months for earthquake with mag $\geq$ 7, - time interval [-2, +2] months for earthquake with 6 $\leq$ mag < 7, - time interval [-2, +2] months for earthquake with 5 $\leq$ mag < 6.

Table AUX-7. Block type description of the 'SEISMIC EVENTS' file.

Note: A bug has been found in the generation of the seismic events file. Before half-orbit 1.0, the time interval is [-1, +2] months whatever the earthquake magnitude. After half-orbit xxxx, all is nominal as specified in Table AUX-7.

5.7.4. File description

Seismic events: Earthquake geomagnetic parameters					
Filename: ***SEISMIC_EVENTS_<start_date>_<end_date>***					
Field number	Type	Array dim.	Size (bytes)	Unit	Description
					Block 1: Earthquake coordinates
1	I*2	1	2		Earthquake number
2	I*2	6	12		Time of the earthquake processing update as: year, month, day, hour, minute, second
3	I*2	6	12		UT time of the earthquake as: year, month, day, hour, minute, second
4	R*4	1	4	degree	Geocentric latitude of the epicenter (from -90° to +90°)
5	R*4	1	4	degree	Geocentric longitude of the epicenter (from 0° to 360°)
6	R*4	1	4		Magnitude
7	R*4	1	4	km	Depth
8	A1	1	1		Determination quality index (a letter, "X" if not defined)
9	A1	1	1		Determination origin (a letter, N=Neic)
					Block 2: Geomagnetic parameters at time of the earthquakes
10	R*4	1	4	degree	Geomagnetic latitude (from -90° to +90°)
11	R*4	1	4	degree	Geomagnetic longitude (from 0° to 360°)
12	R*4	1	4	hour	Magnetic local time
13	R*4	1	4		Mc Ilwain parameter L
14	R*4	1	4	degree	Geocentric latitude of conjugate point (from -90° to +90°)
15	R*4	1	4	degree	Geocentric longitude of conjugate point (from 0° to 360°)
16	R*4	1	4	degree	Geocentric latitude of North conjugate point at the satellite altitude (from -90° to +90°)
17	R*4	1	4	degree	Geocentric longitude of North conjugate point at the satellite altitude (from 0° to 360°)
18	R*4	1	4	degree	Geocentric latitude of South conjugate point at the satellite altitude (from -90° to +90°)
19	R*4	1	4	degree	Geocentric longitude of South conjugate point at the satellite altitude (from 0° to 360°)
					Block 3: DEMETER orbits according to the earthquakes
20	I*2	1	2		Orbit number at the earthquake time
21	I*2	1	2		Orbit sub-number (0: downward, 1: upward)
22	R*4	1	4	km	Distance d_1 between the epicenter and the satellite at the earthquake time
23	R*4	1	4	km	Distance d_2 between the conjugate point of the epicenter and the satellite at the earthquake time

24	R*4	1	4	km	Distance d_3 between the North conjugate point at the satellite altitude (750 km) and the satellite at the earthquake time
25	R*4	1	4	km	Distance d_4 between the South conjugate point at the satellite altitude (750 km) and the satellite at the earthquake time
26	I*2	1	2		Number of blocks 4
					Block 4: Pre- and post-seismic information
27	I*2	1	2		Orbit number at the time t_m
28	I*2	1	2		Orbit sub-number (0: downward, 1: upward)
29	R*4	1	4	km	Distance minimum d_m between the epicenter and the satellite (< 2000 km)
30	I*2	6	12		Time t_m (UT) when the satellite is at the distance d_m as year, month, day, hour, minute, second
31	R*4	1	4	km	Distance minimum d_{mc} between the conjugate point of the epicenter and the satellite (< 2000 km)
32	I*2	6	12		Time t_{mc} (UT) when the satellite is at the distance d_{mc} as year, month, day, hour, minute, second
33	R*4	1	4	km	Distance minimum d_{mcN} between North conjugate point at the satellite altitude (750 km) and the satellite
34	I*2	6	12		Time t_{mcN} (UT) when the satellite is at the distance d_{mcN} as year, month, day, hour, minute, second
35	R*4	1	4	km	Distance minimum d_{mcS} between South conjugate point at the satellite altitude (750 km) and the satellite
36	I*2	6	12		Time t_{mcS} (UT) when the satellite is at the distance d_{mcS} as year, month, day, hour, minute, second

Table AUX-8. Block description of the 'SEISMIC EVENTS' file. See Figures AUX-1 and AUX-2 for definition of distances.

Note: the distances are validated and stored only when the distances d_m or d_{mc} are lower than 2000 km.

For 2-year mission, the estimation of total file volume is:

- *Earthquakes: 8085 events (USGS 5-year data) → 4.43 events / day*
- *Blocks 1 to 3: 106 bytes*
- *Block 4: 68 bytes*
  4 orbits with encounter a day
  during 240 days, 960 times
- *Per event: 65386 bytes*
- *For 2-year mission, about 208 Mbytes → 7 'SEISMIC-_EVENTS' files will be necessary to store these parameters (file size limited to 30 Mo).*

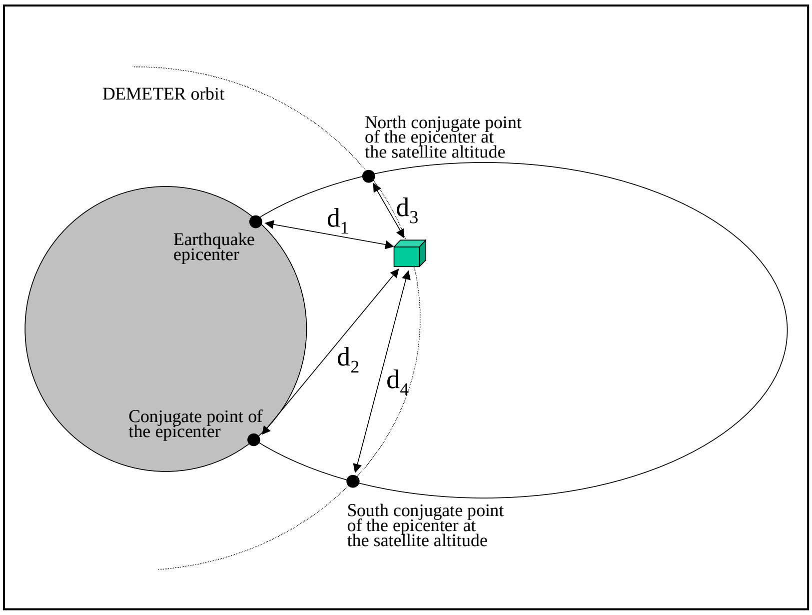


Figure AUX-1. Distance and conjugate point definitions.

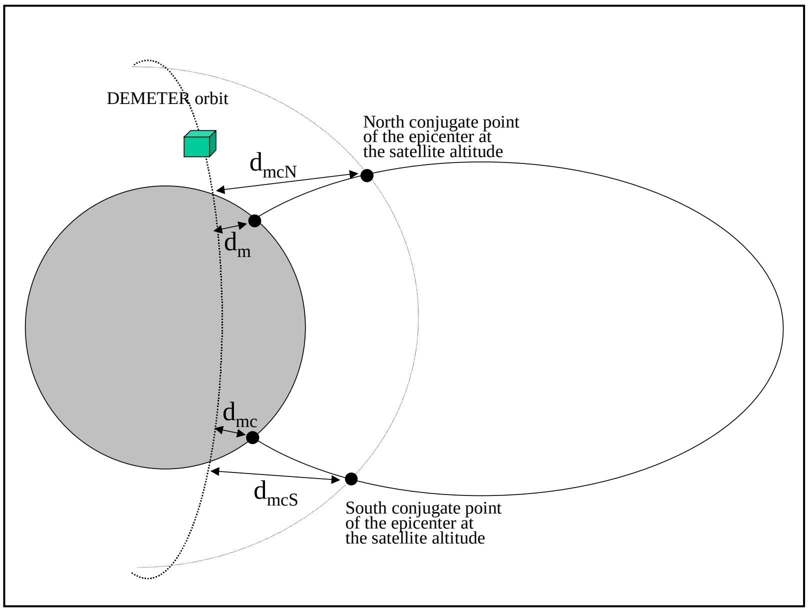


Figure AUX-2. Minimum distance definitions.

5.8. Magnetometer data

5.8.1. Contents

The data from the navigation magnetometer are available on the server (not from the beginning of the mission). The three components are given in the magnetometer coordinate system. The next section explains how to perform the conversion in the satellite coordinate system.

5.8.2. Filename

The filename on the data server is of the type:
R_PARAM_HKTMR_DMT_OUTMAG_<request_time>
where < request _time> is the time of the request made on the CNES database.

Be careful that it is not the time of the first sample given in the file. Usually, the request made at date D extracts data from dates D-2 to D-1. For example, in the example of section 5.8.4, the time of the request is 2004/11/09 07:14:38 and the time first point of the file 2004/11/07 07:57:00, the time of the last one 2004/11/08 08:00:00. This forces the user to probably transfer several files before getting the wished one.

5.8.3. File description

The file starts with six lines of comments (# Parameters, # Start date, # End date, # Parameter unit, # Minimum value, # Maximum value). Then, each line gives the values of the three components according to the format done in Table AUX-9.

MAGNETOMETER DATA	
Parameters	Description
1	Date as YYYY/MM/DD
2	Time as HH:MN:SS.MLS
3	Component X raw value
4	Component X in Volts
5	Tag for X validity (2007 is OK)
6	Component Y raw value
7	Component Y in Volts
8	Tag for Y validity (2007 is OK)
9	Component Z raw value
10	Component Z in Volts
11	Tag for Z validity (2007 is OK)
12-23	Dummy

Table AUX-9. Description of the magnetometer data.

5.8.4. File example

The example given in Table AUX-10 corresponds to the file R_PARAM_HKTMR_DMT_OUTMAG_2004_11_09_07_14_38. The magnetometer data (in Volts) have been set in bold.

```
# Parameters :  OUTMAGX   OUTMAGY   OUTMAGZ   VALID14   VALID15   VALID16
# Start date :  2004/11/07 07:57:00
# End date : 2004/11/08 08:00:00
# Parameter unit : V  V  V
# Minimum value :  -0.813648 -4.729659 -2.792651
# Maximum value :  1.170604  4.908136  2.645669
2004/11/07 07:57:00.677  28679 0.624672  2007  57550 -4.125984 2007  12533 -0.908136 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:01.678  28679 0.624672  2007  49358 -4.136483 2007  12533 -0.908136 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:02.677  24583 0.619423  2007  53454 -4.131234 2007  12533 -0.908136 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:03.677  24583 0.619423  2007  49358 -4.136483 2007  12533 -0.908136 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:04.679  24583 0.619423  2007  49358 -4.136483 2007  16629 -0.902887 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:05.677  24583 0.619423  2007  45262 -4.141732 2007  16629 -0.902887 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
2004/11/07 07:57:06.677  24583 0.619423  2007  45262 -4.141732 2007  16629 -0.902887 2007  0
   Mes Valide  2007  0  Mes Valide  2007  0  Mes Valide  2007
….
```

Table AUX-10. Example of magnetometer data file.

5.8.5. Conversion from Volts to Teslas

The coordinate system of the magnetometer are approximately as:

$X_{MAG} = Y_{SAT}$
$Y_{MAG} = - X_{SAT}$
$Z_{MAG} = Z_{SAT}$

The conversion from magnetometer coordinate system (MAG) to satellite coordinate system (SAT) is given by the matrix R_{magsat} applied on corrected components of the magnetometer (due to misalignments of about 3°) such as:

$$\begin{pmatrix} X_{SAT} \\ Y_{SAT} \\ Z_{SAT} \end{pmatrix} = \left[R_{magsat}\right] \begin{pmatrix} X_{MAG} \\ Y_{MAG} \\ Z_{MAG} \end{pmatrix} - \begin{pmatrix} BiasX \\ BiasY \\ BiasZ \end{pmatrix}$$

with $R_{magsat} = \begin{bmatrix} 0.012002E^{-5} & -0.960764E^{-5} & 0.031092E^{-5} \\ 1.028803E^{-5} & 0.003247E^{-5} & 0.002722E^{-5} \\ -0.013201E^{-5} & -0.024275E^{-5} & 1.017009E^{-5} \end{bmatrix}$ and $\begin{cases} BiasX = 2.1521E^{-7}T \\ BiasY = 6.8954E^{-7}T \\ BiasZ = -7.4061E^{-8}T \end{cases}$

$\begin{pmatrix} X_{MAG} \\ Y_{MAG} \\ Z_{MAG} \end{pmatrix}$ is expressed in Volts and, after conversion, $\begin{pmatrix} X_{SAT} \\ Y_{SAT} \\ Z_{SAT} \end{pmatrix}$ is in Teslas

For example, the values at 07:57:00 in the example above are $\begin{pmatrix} X_{MAG} = 0.62467\ V \\ Y_{MAG} = -4.12598\ V \\ Z_{MAG} = -0.90813\ V \end{pmatrix}$. After conversion, the values in the satellite system are $\begin{pmatrix} X_{SAT} = 39218\ nT \\ Y_{SAT} = 5578\ nT \\ Z_{SAT} = -8243\ nT \end{pmatrix}$.

5.9. Solar panel position

5.9.1. Contents

The solar panel position is available on the server, not from the beginning of the mission. The solar panel can rotate to maximize the solar acquisition flux. During the Demeter scientific modes, the panel is nominally fixed. The given parameter is the rotation angle with respect to the base position.

5.9.2. Filename

The filename on the data server is of the type:

R_PARAM_HKTMR_DMT_GSCONSIGNE_GSBETALU_<request_time>

where < request _time> is the time of the request made on the CNES database.

Be careful that it is not the time of the first sample given in the file. Usually, the request made at date D extracts data from dates D-2 to D-1. For example, in the example of section 5.9.4, the time of the request is 2005/03/04 03:06:09 and the time first point of the file 2005/03/02 07:57:33, the time of the last one 2005/03/03 07:59:34. This forces the user to probably transfer several files before getting the wished one.

5.9.3. File description

The file starts with six lines of comments (# Parameters, # Start date, # End date, # Parameter unit, # Minimum value, # Maximum value). Then, each line gives the values of the angle as detailed in Table AUX-11.

SOLAR PANEL ANGLE	
Parameters	Description
1	Date as YYYY/MM/DD
2	Time as HH:MN:SS.MLS
3	Raw value of the angle
4	Angle in degree
5	Tag for validity (2007 is OK)

Table AUX-11. Description of the magnetometer data.

5.9.4. File example

The example given in Table AUX-12 corresponds to the file R_PARAM_HKTMR_DMT_GSCONSIGNE_GSBETALU_2005_03_04_03_06_09.

```
# Parameter :   GSBETALU
# Start date :  2005/03/02 07:57:00
# End date : 2005/03/03 08:00:00
# Parameter Unit : deg
# Minimum value :  0.000000
# Maximum value :  359.993469
2005/03/02 07:57:33.978  2147483647   354.038757   2007
```

```
2005/03/02 07:57:37.979  1971236931   352.987946   2007
2005/03/02 07:58:07.979  2147483647   3.145966     2007
2005/03/02 07:58:37.979  2147483647   13.654266    2007
2005/03/02 07:59:07.978  2147483647   25.913940    2007
2005/03/02 07:59:38.979  1893995842   37.473083    2007
2005/03/02 08:00:08.979  2147483647   48.331635    2007
2005/03/02 08:00:38.982  680554306    59.890778    2007
2005/03/02 08:01:08.979  1491504706   71.449890    2007
2005/03/02 08:01:26.980  2147483647   78.105164    2007
….
```

Table AUX-12. Example of data file containing the solar panel angle.

6. TOOLS

Software allowing to read binary data files and Demeter documentation are downloadable on the server.

6.1. Software

- ***rd_dmt_attitude.pro***
  - to read the binary attitude parameter file (ATTITUDE_<start_date>_<end_date> file, see paragraph 5.5), to select and extract the wished output parameters and to write them into an ASCII file;
  - written in IDL; for the users who have not an IDL license, a version using the IDL virtual machine is also available (.sav instead of .pro);

- ***rd_dmt_orbit.pro***
  - to read the binary orbital parameter file (ORBIT_EPHEMERIS_<start_date>_<end_date> file, see paragraph 5.3), to select and extract the whished output parameters and to write them into an ASCII file;
  - written in IDL; for the users who have not an IDL license, a version using the IDL virtual machine is also available (.sav instead of .pro);

- ***rd_dmt_seismic_events.pro***
  - to read the binary seismic events file (SEISMIC_EVENTS_<start_date>_<end_date> file, see paragraph 5.7), to select and extract the whished output parameters and to write them into an ASCII file;
  - written in IDL; for the users who have not an IDL license, a version using the IDL virtual machine is also available (.sav instead of .pro);

- ***rd_dmt_n1.pro***
  - to read the binary level-1 data file (DMT_N1_<apid>_<nnnnns>_<start_date>_<end_date>.DAT file, see paragraph 5.5), to select and extract the wished output parameters and to write them into an ASCII file;
  - written in IDL; for the users who have not an IDL license, a version using the IDL virtual machine is also available (.sav instead of .pro);

- ***swan.pro***
  - to process the waveform data from ICE and IMSC experiment;
  - interface procedures developed to read level 0 and level 1 waveform data;
  - SWAN takes into account the time discontinuities;
  - possibility to perform high-order analysis;

- ***prassadco.pro***
  - to analyze multicomponent measurements of electromagnetic waves;
  - to process ICE and IMSC ELF waveform data;
  - to estimate the polarization and propagation parameters.

6.2. Documentation

Available on the server:

- "Data Product Description" document (this document)
- "Data User Guide"

ANNEX A. COORDINATE SYSTEMS

A.1. Introduction

The wave data (ICE and IMSC) are measured in the sensor systems (sensor 'electric' for ICE, sensor 'magnetic' for IMSC).
When only one component is available (TBF or HF bandwidth), no transformation is possible; the data will remain into the sensor frame.
When three components are available (UBF or EBF bandwidth), data can be transformed in an other coordinate system; the proposed choice is:

satellite,
geographic (geocentric),
local geomagnetic.

But if one antenna component failed, the transformation will be no more possible and the data will be kept in the sensor system.

For the wave instruments, the choice of the final data coordinate system must be indicated into the instrument calibration file which is required for the ground data processing.

DEMETER orbit and attitude data from control center are available in the geocentric equatorial inertial system for epoch known as J2000.0, which is 12:00 UT1 on 1 January 2000.

A.2. Coordinate systems for DEMETER

A.2.1. Introduction

All the coordinate systems are right-handed and all except the electric sensor coordinate system are orthogonal.

The different coordinate systems necessary for DEMETER are given in Figure AN-1.

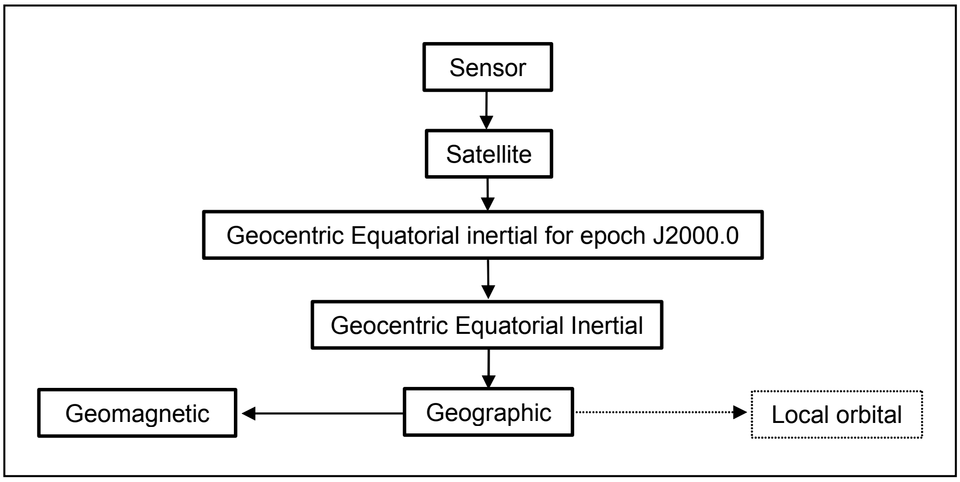


Figure AN-1. Coordinate transformations.

The transformation from satellite coordinate system to geographic coordinate system is computed as "Satellite" → "GEI$_{2000}$" → "GEI" → "Geographic".

The definitions of the coordinate systems used for DEMETER are given in the next sections.

A.2.2. Sensor coordinate system

The sensor coordinate system is defined by the main axes of the instrument. Electric and magnetic instruments have their own axes.

A.2.2.1. Electric sensor

The sphere coordinates given in this section are computed from mechanical studies taking into consideration a nominal deployment of the booms, i.e. 4150 mm for each sensor. The cable lengths measured during the deployment are : 4150 mm for E1, 4150 mm for E2, 4150 mm for E3 and 4192 mm for E4. The difference is 1%, so we decided to not modify the coordinates given by the mechanical studies.

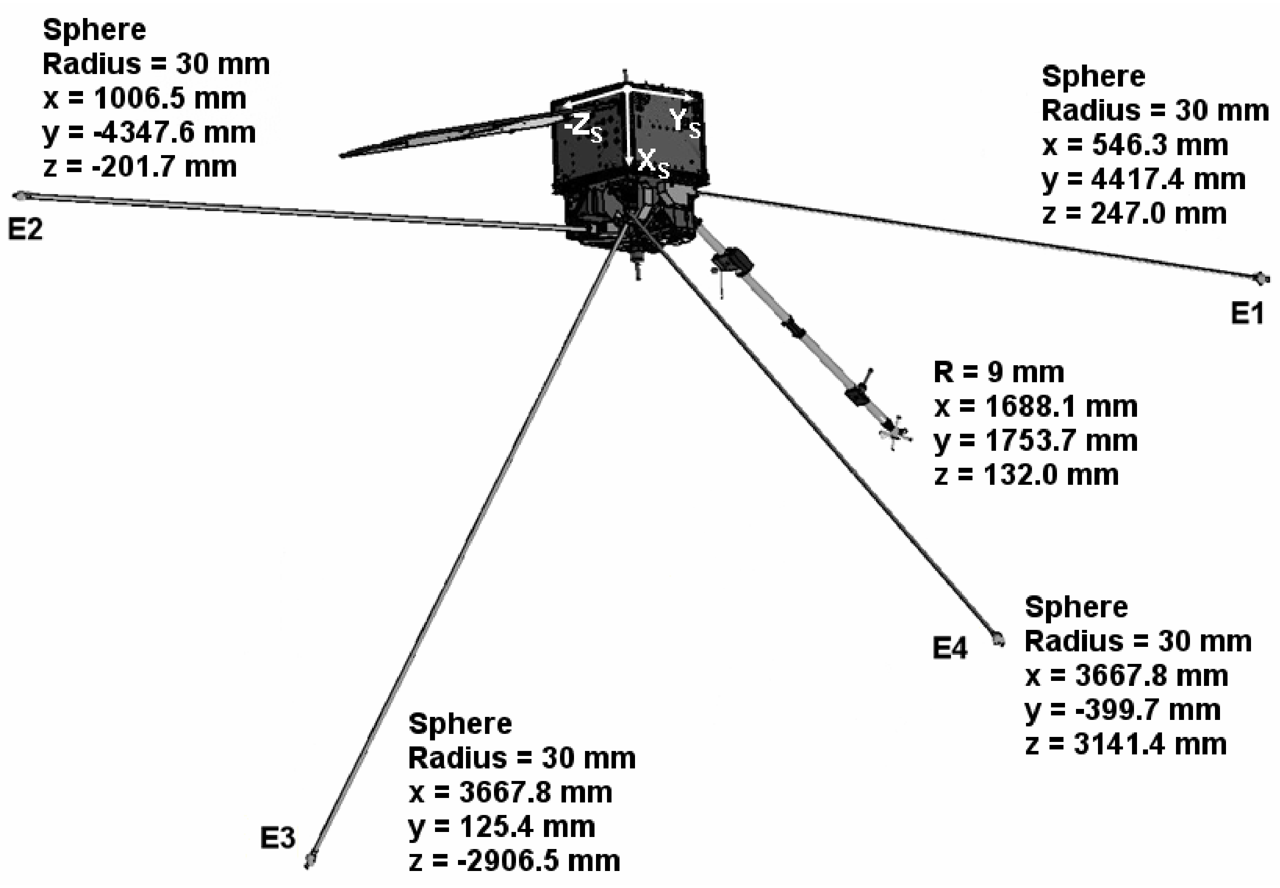


Figure AN-1. Electric sensor location.

The distances among the sensors are:

- d_{12} = 8.788 m
- d_{13} = 6.173 m
- d_{34} = 6.071 m
- d_{14} = 6.428 m
- d_{23} = 5.866 m
- d_{24} = 5.818 m

The sensor locations in the satellite system are:

E1: x = 546 mm
y = 4417 mm
z = 247 mm

E2: x = 1006 mm
y = -4348 mm
z = -202 mm

E3: x = 3668 mm
y = 125 mm
z = -2906 mm

E4: x = 3668 mm
y = -400 mm
z = 3141 mm

Let us consider the transformation matrix $M_{sensat} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$ from the ICE sensor system to the satellite coordinate system, $\begin{pmatrix} X_c \\ Y_c \\ Z_c \end{pmatrix}$ being the coordinates of the electric field in the ICE sensor system and $\begin{pmatrix} X_s \\ Y_s \\ Z_s \end{pmatrix}$ the coordinates of the field in the satellite system. The transformation is performed by the relation

$$\begin{pmatrix} X_s \\ Y_s \\ Z_s \end{pmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{pmatrix} X_c \\ Y_c \\ Z_c \end{pmatrix}$$

The normalized coordinates of the electric field vectors are :

$$\overrightarrow{E_{12}} = \begin{pmatrix} 0.0523546 \\ -0.997322 \\ -0.0510609 \end{pmatrix} \quad \overrightarrow{E_{13}} = \begin{pmatrix} 0.505645 \\ -0.695253 \\ -0.510828 \end{pmatrix} \quad \overrightarrow{E_{14}} = \begin{pmatrix} 0.485569 \\ -0.749333 \\ 0.450247 \end{pmatrix}$$

$$\overrightarrow{E_{23}} = \begin{pmatrix} 0.453715 \\ 0.762576 \\ -0.461108 \end{pmatrix} \quad \overrightarrow{E_{24}} = \begin{pmatrix} 0.457458 \\ 0.678606 \\ 0.574653 \end{pmatrix} \quad \overrightarrow{E_{34}} = \begin{pmatrix} 4.02167\text{e}-08 \\ -0.0864999 \\ 0.996252 \end{pmatrix}$$

The transformation matrices, according to the different sensor possibilities are:

$$\begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix} = \begin{bmatrix} -1.5810 & 2.1414 & 1.0169 \\ -1.0809 & 0.1119 & 0.0020 \\ -0.0938 & 0.0097 & 1.0039 \end{bmatrix} \begin{pmatrix} E_{12} \\ E_{13} \\ E_{34} \end{pmatrix}$$

$$\begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix} = \begin{bmatrix} -1.5810 & 2.2299 & -1.0888 \\ -1.0809 & 0.1165 & -0.1081 \\ -0.0938 & 0.0101 & 0.9944 \end{bmatrix} \begin{pmatrix} E_{12} \\ E_{14} \\ E_{34} \end{pmatrix}$$

$$\begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix} = \begin{bmatrix} 1.4676 & 2.0347 & 1.0169 \\ -0.9215 & 0.1063 & 0.0020 \\ -0.0800 & 0.0092 & 1.0039 \end{bmatrix} \begin{pmatrix} E_{12} \\ E_{23} \\ E_{34} \end{pmatrix}$$

$$\begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix} = \begin{bmatrix} 1.4676 & 2.0180 & -1.0888 \\ -0.9215 & 0.1055 & -0.1081 \\ -0.0800 & 0.0091 & 0.9944 \end{bmatrix} \begin{pmatrix} E_{12} \\ E_{24} \\ E_{34} \end{pmatrix}$$

A.2.2.2. Magnetic sensor

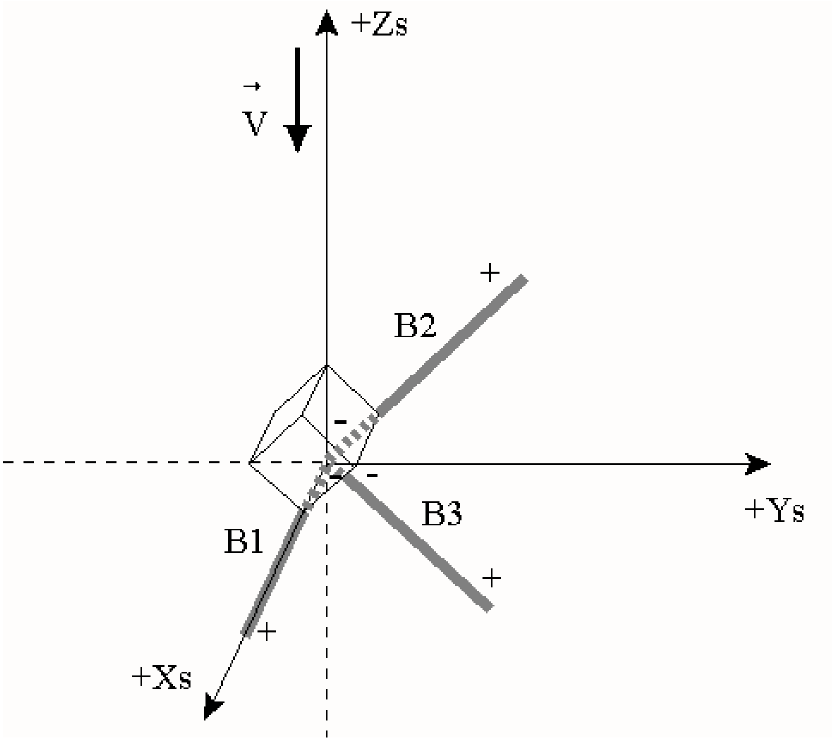


Figure AN-2. Magnetic sensor location.

The sensor locations in the satellite system are:

- B1: parallel to Xs axis
- B2: in the YsZs plane, 45° from the axes +Ys and +Zs
- B3: in the YsZs plane, 45° from the axes +Ys and -Zs

The sensor location in the satellite system is:

X = 1688.09 mm
Y = 1753.69 mm
Z = 132.0 mm

The transformation matrix between IMSC sensor system and satellite coordinate system is:

$$\begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = \begin{bmatrix} 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.7071 & 0.7071 \\ 0.0000 & 0.7071 & -0.7071 \end{bmatrix} \begin{pmatrix} B_1 \\ B_2 \\ B_3 \end{pmatrix}$$

A.2.2.3. ADV instrument

The ADV instrument is not fully aligned with the axes of the satellite. The quaternions from satellite coordinate system to ADV coordinate system are:

q0 = 0.99999940793401
q1 = -0.00005046457836
q2 = 0.00003131501935
q3 = -0.00108655617536

The transformation matrix between satellite and ADV coordinate systems is:

$$M_{sat2adv} = \begin{bmatrix} 0.9999976368 & -0.0021731142 & -0.0000625203 \\ 0.0021731079 & 0.9999976337 & -0.0001009971 \\ 0.0000627397 & 0.0001008610 & 0.99999999929 \end{bmatrix}$$

A.2.2.4. ISL instrument

The position of the spherical probe in the satellite system is:

X = 878.96 mm
Y = 612.32 mm
Z = -29.0 mm

A.2.3. Satellite coordinate system

The satellite coordinate system (Figure AN-3) is defined with the main inertia satellite axes. They are:

+Xs Nadir (Earth direction),
+Ys along the normal to the orbit,
-Zs along the velocity vector.

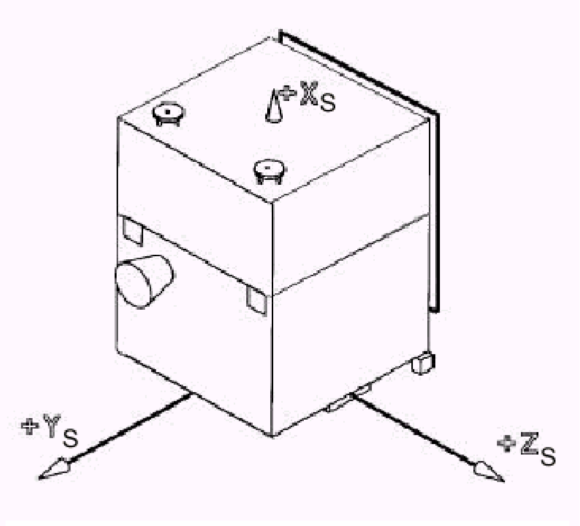


Figure AN-3. Satellite coordinate system.

A.2.4. GEI coordinate system

The Geocentric Equatorial Inertial (GEI) coordinate system (Figure AN-4) is defined by:

- origin O at the centre of the Earth,
- X_I is the intersection of the equator plane and the ecliptic plane and is pointing towards the Sun position at the vernal equinox (towards the first point of Aries),
- Z_I is parallel to the rotation axis of the Earth (positive to the North),
- Y_I is defined through the cross product $Y_I = Z_I \wedge X_I$.

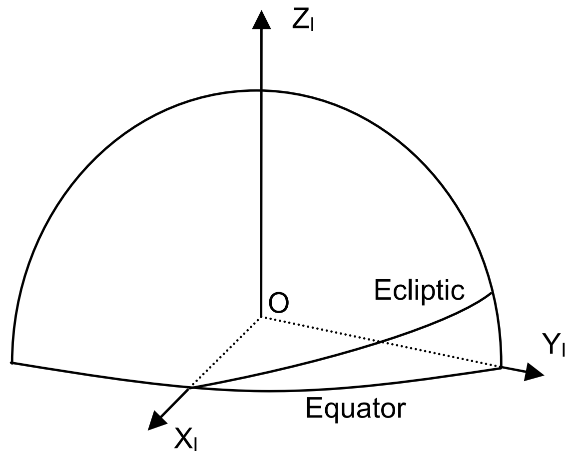


Figure AN-4. GEI coordinate system.

This system is at first order fixed with respect to the distant stars. However, GEI is subject to second order change with time owing to the various slow motions of the Earth's rotation axis with respect to the fixed stars. Thus for GEI coordinates, we must specify the date (named as epoch) to which the coordinate system applies

A.2.5. GEI J2000 coordinate system

The Geocentric Equatorial Inertial J2000 coordinate system is defined with the standard astronomical epoch known as J2000.0, which is 12:00 UT1 on 1 January 2000. The transformation from GEI2000 to GEI is a precession correction. Note that for Demeter, the transformation from UT1 to UTC has been neglected.

A.2.6. Geographic (geocentric) coordinate system

The geographic (GEO) coordinate system (Figure AN-5) is convenient for specifying the location of ground stations and ground-based experiments.
It is defined by:

- X_G axis towards the intersection of the Equator and the Greenwich meridian,
- Z_G axis parallel to the Earth's rotation axis (positive to the North),
- Y_G is defined through the cross product $Y_G = Z_G \wedge X_G$.

α_G is termed Greenwich mean sideral time.

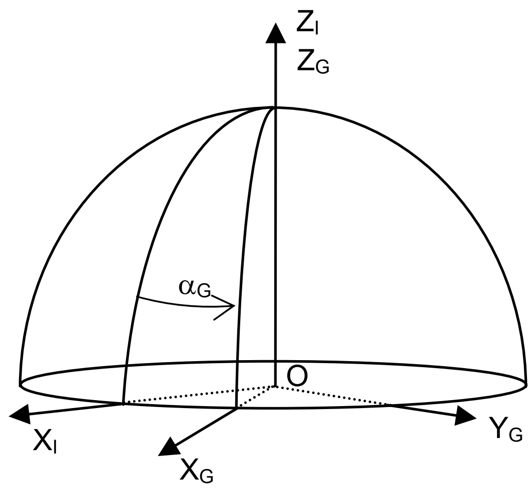


Figure AN-5. GEO coordinate system.

Note: When GEO coordinates are expressed
geocentric latitude by astronomers and geogra
geodetic latitude used in normal map-making.
the equatorial plane and the local normal to th
a radius vector because the shape of the Earth

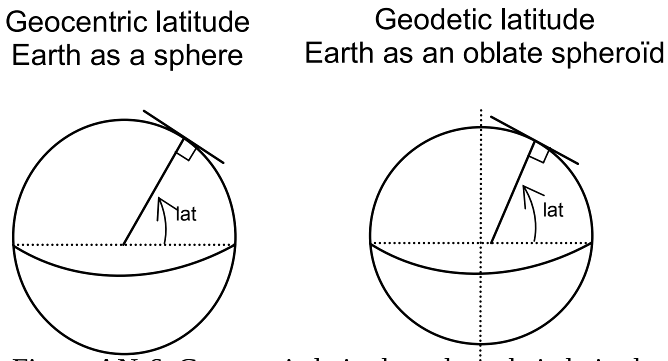


Figure AN-6. Geocentric latitude and geodetic latitude.

A.2.7. Local geomagnetic coordinate system

The local geomagnetic (LGM) coordinate system (Figure AN-6.) is defined versus the Earth magnetic field vector $\vec{B}_0$:

- origin S at the centre of the satellite,
- Z_B is parallel to the $\vec{B}_0$ field vector,
- $Y_B = (Z_B \wedge \overrightarrow{POS}) / |Z_B \wedge \overrightarrow{POS}|$,
- $X_B = Y_B \wedge Z_B$ (located in the plane $[\overrightarrow{POS}, \vec{B}_0]$.

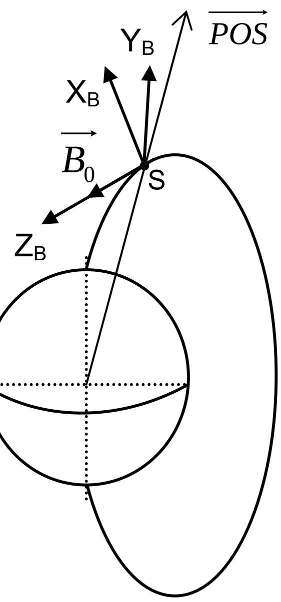


Figure AN-7. Local geomagnetic system.

A.2.8. Local orbital system

The local orbital system (Figure AN-8) is defined by:

- origin S at the centre of the satellite,
- SZ_{ol} is the downward geocentric,
- SX_{ol} is perpendicular to Z_{ol} in the orbit plane and directed to the same sense of the velocity vector,
- Y_{ol} terminates the trihedron.

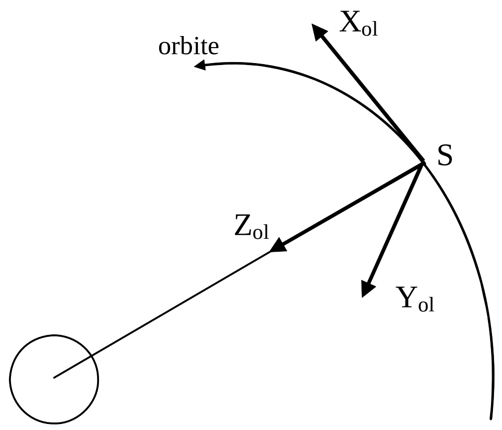


Figure AN-8. Local orbital coordinate system.

This system is not used for Demeter.

A.3. Coordinate transformations

The conversion from GEI to GEO is given by the rotation matrix R_{IG}:

$$R_{IG} = \begin{bmatrix} \cos\alpha_G & \sin\alpha_G & 0 \\ -\sin\alpha_G & \cos\alpha_G & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad \begin{pmatrix} X_{GEO} \\ Y_{GEO} \\ Z_{GEO} \end{pmatrix} = [R_{IG}] \begin{pmatrix} X_{GEI} \\ Y_{GEI} \\ Z_{GEI} \end{pmatrix}$$

From satellite to geographic:

$$\begin{pmatrix} X_{GEO} \\ Y_{GEO} \\ Z_{GEO} \end{pmatrix} = [R_{sat2geo}] \begin{pmatrix} X_{SAT} \\ Y_{SAT} \\ Z_{SAT} \end{pmatrix}$$

From geographic to local geomagnetic:

$$\begin{pmatrix} X_{LMG} \\ Y_{LMG} \\ Z_{LMG} \end{pmatrix} = [R_{geo2\lg m}] \begin{pmatrix} X_{GEO} \\ Y_{GEO} \\ Z_{GEO} \end{pmatrix}$$

From satellite to local geomagnetic:

$$\begin{pmatrix} X_{LGM} \\ Y_{LGM} \\ Z_{LGM} \end{pmatrix} = [R_{geo2\lg m}][R_{sat2geo}] \begin{pmatrix} X_{SAT} \\ Y_{SAT} \\ Z_{SAT} \end{pmatrix}$$