GEOS S300 ULF DATA

and

GEOS AUXILIARY DATA

Decommutation, Calibration and Visualisation programs

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Part I : GEOS S300 ULF DATA

1. Introduction

GEOS-1 and GEOS-2 spacecraft have provided, between April 1977 and January 1983, a lot of data, in particular in the ULF range (0.01-11.5 Hz). Initial decommutation program has been made by CNES in 1977, providing data in volts in the spinning system of the ULF antennas. Before any scientific exploitation, a deconvolution method, allowing the calibration of the ULF data in the spinning system of the satellite, and then in any geographic or magnetic system, has been developed in CRPE (Centre de Recherche en Physique des Environnements Terrestre et Planétaires). Then, using the information of the "Despin channels", which gives information on the DC magnetic field in the spinning plane, a second method combining the Despin channels and the ULF channels has been developed in the years 1982-1984, allowing the comparison between the ULF search coil data and the high resolution DC magnetometer data. The document "deconvolution method used for calibration of the GEOS ULF data" (to be written) will describe in details these two methods. In this document, we present the "CALIULF" program which uses and applies these methods and which produces a "result" file containing in ascii code the ULF data at different levels of processing, the lowest level being the telemetry records, and the higher level being the combination of the ULF and Despin channels, calibrated in nT, and given in a fixed, non-spinning, geographic system.

This program, taking into account the two despin channels, is issued from a first version, written in 1982 in FORTRAN IV on the CDC NOS-BE 60 bits system, and then converted these last years in FORTRAN 77 running on Sparc stations with 32 bits words. The details on pre-existing different versions is given in comments in the FORTRAN code. This current version is now the only one existing program allowing the calibration of the ULF data, and remains the only one program to be maintain in the next years, in the frame of the "Centre de Données de la Physique des Plasmas" (CDPP), which now archives data of french experiments in Plasma Physics.

The "CALIULF" program needs 2 libraries for its use: First, the "GEOSDECOLIB" library, written now in FORTRAN 77 language, 32 bits system, which contains all the different modules necessary to extract the data contained in the binary raw data existing files and to put them into 32 bits standard words. Secondly, the "GEOSCALCLIB" library, which contains all the scientific modules necessary to compute and convert the data, at any levels of processing, for calibration and change of coordinate system. Details on these two libraries are given in annexe 1.

2. Binary raw data

2-a) Definition

The binary raw data consist now in binary files, made by CNES, which are an image of the original magnetic tape, with a standardized CCSDS date and time binary field preceding each data block. These data contain both the ULF data of the S300 search coil experiment, and the S331 magnetometer data, given with a low time resolution (88 seconds for GEOS-1, and 5.5 seconds for GEOS-2).

2-b) Accessibility

ULF raw data are available in the frame of the CDPP server. The list of all the archived files available from the CDPP is given in annexe 4.

Data can be requested on any time interval. The archived files will be then strictly cut to cover the specified time interval.

3. Decommutation and Calibration Program « CALIULF »

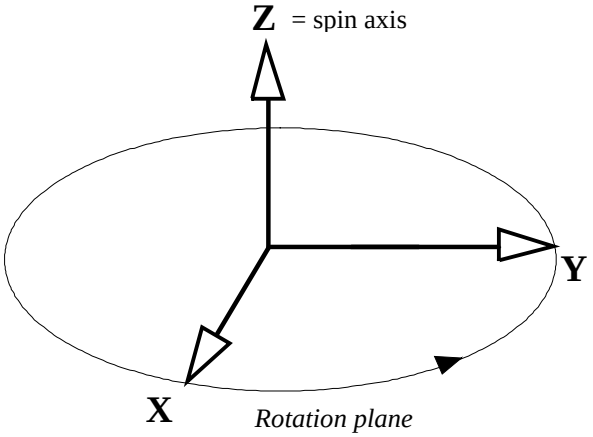
3-a) Role and Utility

The goal of the "CALIULF" program is to read the raw data binary files, extracts the physical data, converts them in volts, and apply the transfer function to obtain the ULF waves in nanoTesla (nT), by using a special deconvolution method (see the document "deconvolution method used for calibration of the GEOS ULF data", to be written). These calibrated data are available in the spinning system of the satellites, or in a fixed system called "fixed meridian spacecraft", where the Z axis is along the spin axis of the spacecraft, and the X axis is contained in the geographic meridian plane. Two other systems are available, the geographic VDH system, or the "magnetic strength line system" where the Z axis is along the magnetic field line defined by the DC magnetometer. All these systems are described in details in the next section.

A second level of processing combines the ULF data and the Despin channels data to obtain the upper level of the ULF data (see the document "deconvolution method used for calibration of the GEOS ULF data"). This method allows us to rebuild 2 components of the DC magnetic field, by using the amplitude and the phase of the two Despin x and y channels, roughly very close to a pure sine curve, and adding this information to the purely ULF data. These two components, which are included in the rotation plane, can be compared to the data of the S331 magnetometer experiments. The magnetometer data are available via the CALIULF program, but with a low time resolution (see section 3-c).

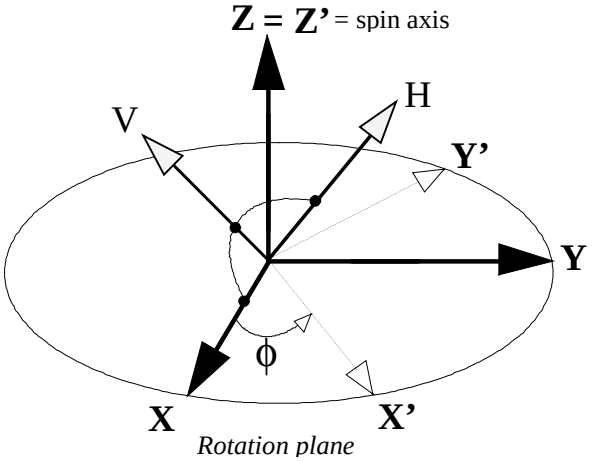
3-b) Description of the used coordinate systems

- ***The "spinning" coordinate system:***



The **X,Y,Z** axis are the axis of the 3 ULF antennas, which are very close from the geometric axis of the spacecraft (less than 0.1-0.5 degrees, see the precise values of the spin axis tilt in the auxiliary data).
The **X** and **Y** axis define the rotation plane of the spacecraft.

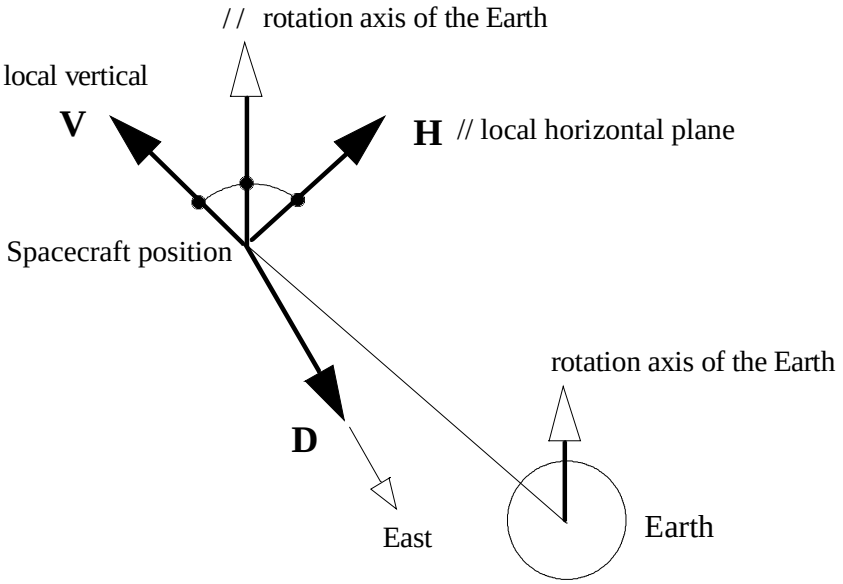
- ***The "fixed meridian spacecraft" coordinate system:***



The **Z**-axis is the spin axis of the spacecraft;
The **X'** and **Y'** axis are the rotating antennas, and define the rotation plane; there are the axis of the spinning coordinate system defined above.
The **V**-axis is the outwards local vertical, from the Earth to the spacecraft.
The **H**-axis is parallel to the horizontal local plane, positive to the North.
The **V**-**H** plane is a geographic meridian plane. See the more complete definition of the VDH system below.
ϕ is the azimuthal angle of the X' axis, and varies as $2\pi f_s t$

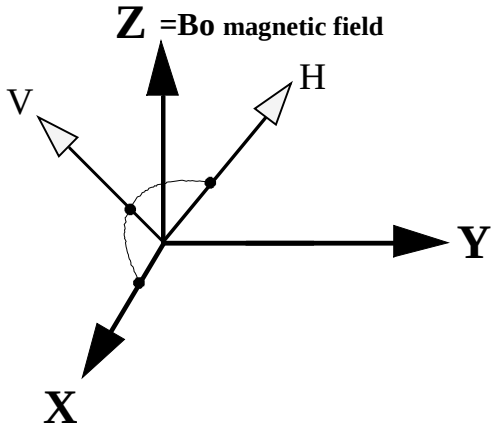
The **X**-axis correspond to the position of the **X'**-axis at the time where **X'** cross the geographic meridian plane, outward.

- ***The VDH coordinate system:***



The V-axis is the outwards local vertical, to the spacecraft.
The H-axis is parallel to the horizontal local plane, positive to the North.
The V-H plane is a geographic meridian plane. The D-axis is azimuthal, eastwards.

- ***The Magnetic Strength Line coordinate system:***



The **Z**-axis is along the DC local magnetic field;
The **V**-axis is the outwards local vertical, from the Earth to the spacecraft.
The **H**-axis is parallel to the horizontal local plane, positive to the North.
The **V-H** plane is a geographic meridian plane.

The **X**-axis is perpendicular to the Z axis, and included in the local geographic meridian plane, outward.

All these system are local coordinate systems, which are dependent of the position of the spacecraft from the Earth.

3-c) Description of the caliulf.in file containing the input parameters

The CALIULF program reads a file, named caliulf.in, localised in the working directory, and containing the input necessary parameters for its execution. An example of this file is given below.

Example of caliulf.in file:

```
/data1/ida/robert/geos/geosdata/UBF_19780827_011043
28 08 1978     # date day month year
 9 14 40       # hour minute second
44             # duration in second (may be rounded)
1024           # number of points for the wave forms (2**N, 512 - 65 536)
0.1 11.5       # frequency limits, Hz, for the filtration
0              # output status: 0 normal, 1 for details on caliulf.out file
*              # panel status: * for all the panels
                 (then visualisation by visuulf.pro program available)
               # or list of selected panels such as 6,10,14,15
```

The first line indicates the localisation of the binary ULF data file. The two following lines correspond to the asked date and time corresponding to the beginning of the analysed period. The beginning time must be rounded, because the ULF data are packed by a group of 4 Low Speed Format (LSF) corresponding to 4 x 1.37601 seconds, so the start time will be rounded around 5.504 seconds.

The duration parameter corresponds to the total period to be analysed, while the number of points of the wave forms corresponds to the window of the signal where the Fast Fourier Transforms (FFT) will be applied to process the signal and correct the effects of the non linear transfer function of the antennas. It is also the period of the data which will be written on the caliulf.resu file (see next sections). One must notice that over 1/16 of this window, on each side, a weighting function is applied, so the two short portions of time at the beginning and at the end of each wave form could be not fully significant (see the document “deconvolution method used for calibration of the GEOS ULF data”). The time sampling of the wave forms being 43.0003 millisecond, a wave form of 1024 points corresponds to 44.032 seconds, the minimum being 5.504 seconds (N=128) and the maximum being 2818.07, as around 47 minutes (N= 65536). Note that the elimination of the sine signal at the spin frequency is impossible for N< 512. In case of a given N less than 128 or greater than 65536, the 128 or 65536 values are assumed.

If the total duration asked is greater than the duration of the wave forms, defined by N, a next window or sequence is taken into account, and the true total duration corresponds to the number of taken wave forms, such as N_w = (asked duration)/(wave form duration).

The frequency limit parameters are used by the deconvolution method, which involves FFT, frequency filtration and change of coordinate system, taking into account that the value of the spin frequency is inside the ULF frequency range. Frequency bounds are given in the spinning coordinate system, and F1 cannot be less than 0.1 Hz, because the transfer function of the ULF antennas is equal to zero at F=0. The given values in this example cover the maximum that we can expect of these data. So the user can choose values inside the [0.1 – 11.5] interval, but not outside.

Output status: 0 is recommended, to have a limited size of the caliulf.out file. If the execution of the program shows some anomalies, the value of 1 will give much more information on the .out file, in particular for all the sequences.

There exists 14 levels of processing. The last parameter corresponds to the different required levels of processing. Theses levels are explained in the caliulf.resu section. The symbol " * " will leave to have in the caliulf.resu file all the 14 levels of ULF processing, and the 2 levels corresponding to the magnetometer data. This option is necessary for using the visuulf.pro IDL procedure which visualise all these data in a standard graphical form (see section 4). An example of theses plots is given in annexe 4, where one can see the definition and the difference of the different levels of processing or different coordinate systems used.

If the user does not need the standard visuulf.pro procedure, does not want the intermediate levels of processing, and wants only for example the highest level of ULF data, and the corresponding magnetometer data, he only set this parameter to " 14,15 ", and will get into the caliulf.resu file only these two kinds of data. Then, he could use his own procedure to read the .resu file, visualise it, or apply his own process (see the description of the caliulf.resu file in next section).

3-d) Example of caliulf.out file describing the execution of the run

An example of caliulf.out file is given in annexe 2. This file gives precise informations about the data, the exact time of the TM formats, the position of the antennas and the DC magnetic field in different coordinate systems, the sense of rotation of the spacecraft, etc. It also shows the different steps of the data processing and is useful for checking the correct execution of the program. Since the CALIULF program and its libraries have been developed long years ago mainly by the author or other Frenchmen, in the CRPE and then the CETP, French laboratories, all the output comments are in French, and we are very sorry to present in the file the results in this language.

3-e) Description of the caliulf.resu file containing the calibrated data

An example of the caliulf.resu file is given in annexe 3. This file contains the results of the caliulf.exe program. It is in ascii format, to be commonly used by any software, in any language, on any machine. This file contains all the ULF data, corresponding to a given date and time period, with 14 levels of processing. It is completed by the DC magnetometer data, in two coordinate systems.

- ***Header:***

Titles, input parameters deduced from the caliulf.in file, number of GEOS (1 or 2), number of sequences, selected panels (1 for yes), starting date and time. It is completed by the direction of the antennas in the VDH system at the starting time, the spin frequency and period, and particularly the coordinate in the VDH of the geographic meridian system used in many panels.

- ***data sets:***

The header is followed by 16 groups of data, corresponding to the 16 panels plotted by the visuulf.pro procedure (see section 4 and annexe 4). Each set of data contains a sub-header with the time resolution (sampling period), the number of curves of the group or panel, and

the number of points. This sub-header is necessary for writing any reading program, and is used by the visuulf.pro graphical procedure. The description of these 16 groups is given below (see also annexe 4).

1) XYZ Telemetry data:
First level of the ULF data, in TM units, in the [0-255] interval. Time resolution is always 0.0430003 seconds

2) Gains of the pre-amplificators of the antennas:
Two curves. The X-Y gains, in the spinning plane, are the same. The Z gain can be different. The small rounded symbol indicate the time resolution (always 1 Low Speed Format, so 1.37601 second).

3) XYZ data gain-corrected:
Telemetry data, after gain correction. Data in volts, in the spinning coordinate system of the antennas. $\Delta t=0.0430003$.

4) XYZ data gain-corrected, in SC fixed system:
Same, but in a fixed coordinate system, where Z is along the Z antenna, and X is in the geographic meridian (see section 3-b). $\Delta t=0.0430003$.

5) XY despin channels in spinning system:
The X and Y despin channels correspond to the main part of the DC magnetic field signal which is induced by the rotation of the X-Y antennas in the local DC magnetic field and detected by the search coils. This signal is removed by the hardware system from the initial signal of the antenna, in order to reduce the dynamic of the telemetry. The despin signals are mainly formed by a sine signal at the spinning frequency. Data in volts, with $\Delta t=0.0430003$.

6) XY despin channels in SC fixed system:
Same, but in a fixed coordinate system, so the signals correspond roughly to the 2 DC magnetic field components of the DC magnetic field in this system.

7) XY ULF + despin data in spinning system:
The ULF and despin data are added, to reconstruct the full initial signals of the antennas. Data in volts, with $\Delta t=0.0430003$.

8) XY ULF + despin data in SC fixed system:
Same, but in a fixed coordinate system, so the signals correspond to the 2 DC magnetic field components and the ULF data in this system. Data in volts, with $\Delta t=0.0430003$.

9) XYZ calibrated data, in nT, in spinning system:
These data correspond to the #3 data level after deconvolution for removing the effect of the transfer function of the antennas. The data correspond to the ULF range only, in nT.

10) XYZ calibrated data, as 9, in nT, in SC fixed system:
Same, but in a fixed coordinate system. Since the Z component is already fixed, only the X-Y components are given.

11) XYZ calibrated data, in nT, in VDH system:
Same as 9, but in the VDH coordinate system. Each component is a mixture of the 3 others in the preceding system.

12) XYZ calibrated data, in NT, in strength line system:
Same as 11, but in the magnetic strength line coordinate system (see section 3-b). The DC magnetic field is deduced from the magnetometer data, and is kept constant during the whole duration of the wave form (over all the N points).

13) XYZ ULF+despin data, in nT, in spinning system:
These data correspond to the #7 data level where the deconvolution method is applied, to correct the effect of the transfer function of the antennas, both on the ULF range and the despin channels. A sine signal, at the spin frequency, with amplitude and phase computed from the whole signal, is subtracted to avoid a saturation of the signals in the spinning system by the sine induced by the strong DC magnetic field.

14) XYZ ULF+despin data, in nT, in SC fixed system:
Same as 13, but in the fixed system. The sine signal at spin frequency is taken into account before the change of coordinate, so the signal is not centered around zero, and have a significant offset, corresponding to the DC magnetic field. These data correspond to the highest level of processing, since we have in a fixed system the calibrated ULF data, with the two X and Y components of the DC magnetic field. These data can be compared to the DC magnetometer data, given in the next panels.

15) XYZ DC magnetic field, in nT, in SC fixed system:
These data are deduced from the magnetometer data, and computed in the same SC fixed coordinate system. The time resolution is 4 LSF, so 5.50404 seconds. A comparison with some sample of the high time resolution data of the magnetometer has shown a good agreement between the X-Y components of the magnetometer and the level 14 of the ULF data, which have nevertheless a more higher frequency range.

16) XYZ DC magnetic field, in nT, in VDH fixed system:
Same as 15, but in the VDH system.

3-f) Instruction for use

- ***Installation on a new machine***

For the installation of the software on a new machine, for instance in the CDPP directory, the following directories and files are requested:

CDPP/geoslibs:

geosdecolib.f
geosdecolib.make
geoscalclib.f
geoscalclib.make

The execution of the shell scripts geosdecolib.make and geoscalclib.make will produce the object files geosdecolib.o and geoscalclib.o. The *make files are given below ; a Fortran 77 compilator is requested.

geosdecolib.make:

```
echo
echo compil de geosdecolib.f, creation du .o
echo
f77 -c -C -ansi  geosdecolib.f
```

geoscalclib.make:

```
echo
echo compil de la geoscalclib.f, creation du .o
echo
f77 -c -C       geoscalclib.f
```

CDPP/caliulf:

caliulf.f
caliulf.make

The execution of the shell script caliulf.make will produce the object file caliulf.o and the executable file caliulf.exe. The caliulf.make file is given below, the F77 compilator is requested.

caliulf.make:

```
echo compil de caliulf.f
f77 -c -C caliulf.f
echo
echo link de caliulf.o avec les bibli geos
f77 -C caliulf.o ../geoslibs/geosdecolib.o \
                 ../geoslibs/geoscalclib.o -o caliulf.exe
```

- ***Running the caliulf.exe program***

After installation as above, the caliulf.exe program must be existing. The caliulf.in file must be included for providing to the program all the input parameters (see section above). It is useful, rather that executing directly the caliulf.exe program, to run the shell script caliulf.bat program, whose the content is listed below:

caliulf.bat:

```
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo caliulf.bat : Calibration of GEOS ULF data
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
echo "Running caliulf.exe with parameters of caliulf.in"
echo "-------------------------------------------------"
echo
echo "Please wait ..."
caliulf.exe
echo
echo "Proceedings of execution are in caliulf.out"
echo "Results are in caliulf.resu"
echo "Visualization available with visuulf.bat"
echo
echo "end of caliulf.bat"
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
```

This shell script file allows the user to get some comments during the execution of caliulf.exe. After running, the following files will occur :

caliulf.out → describes the execution of caliulf.exe (see section 3-d above)
caliulf.resu → contents the results of the different data processing asked (see section 3-e above)

4. Visualisation program « VISUULF »

4-a) Role and Utility

When the user indicates a " * " in the caliulf.in file, he ask for having all the data in the caliulf.resu file. These data correspond to the 14 levels of ULF data processing and the 2 levels of DC magnetic field indicated in the description of the caliulf.resu file (see section above). In order to have a complete view of the different levels and coordinate systems, it is useful to dispose of a standard graphical procedure, which produce directly a plot of all these data. It is the role of the visuulf.pro IDL (or PV-Wave) procedure, which reads the caliulf.resu file and produces groups of 4 PostScript files, named `visuulf_s1_f1.ps`, … `visuulf_s1_f4.ps`, corresponding to the 4 frames of the sequence number `1`. If `N` sequences are present in the caliulf.resu file (see above the description of the caliulf.in file), `N` groups of `visuulf_sN_fM.ps` are produced (`M`=1,4). This procedure works only with the " * " option in the caliulf.in file.

4-b) Example of produced visualisation

Annexe 4 gives an example of the print-out of the 4 PostScript files created by the visuulf.pro procedure. Each panel corresponds to the different levels generated in the caliulf.in file. The title of each panel indicates the type of plotted data, and the coordinate system used.

4-c) Instruction for use

- ***Installation on a new machine***

The following files must be simply existing:

CDPP/caliulf/visuulf.pro
CDPP/caliulf/visuulf.bat

- ***Running the visuulf.pro procedure***

The machine must have a IDL or a PV-Wave license. The visuulf.pro PV-Wave procedure is running by executing the visuulf.bat shell script given below:

visuulf.bat:

```
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo visuulf.bat : Visualization of GEOS ULF data
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
echo "File caliulf.resu must be existing"
echo "(this file is created by caliulf.bat)"
echo
#
echo "Running PV-Waves for data visualization"
echo "---------------------------------------"
echo
  wave    <<!!
.run visuulf.pro
visuulf
caliulf.resu
!!
echo
echo "end of visuulf.bat"
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
```

The visuulf.pro procedure reads the caliulf.resu file, and plots the corresponding data into PostScript files.

Part II : GEOS AUXILIARY DATA

1. Introduction

GEOS-1 and GEOS-2 spacecraft have provided, between April 1977 and January 1983, a lot of data, for many different experiments, such as the ULF data described in part I. For all these experiments, the named “auxiliary data”, or DAVL meaning in french “Données Auxiliaires Variant Lentement”, consists in a set of data available for all the experiments. CNES has recently created a single file for all the DAVL of each satellite. In this part, we present the “CALIAUX” program which read these data, converts them into physical values, and produces a “result” file containing in ascii code these data.

The actual version of this program is unique for providing the auxiliary data, converted in physical units, and given in ASCII form. It remains the only program to be maintained in the next years, in the frame of the “Centre de Données pour la Physique des Plasmas” (CDPP), directed by CNES and CNRS, which now archives data of the Space Plasma Physics.

2. Binary raw data

2-a) Definition

The binary raw auxiliary data consist now in binary files, which are an image of the original magnetic tape, in which the original date and time fields have been replaced by CCSDS standardized date and time binary fields. A description of these binary auxiliary data is available in the documentation section of the CDPP server.

Description of the ASCII format of these data, as an output of the CALIAUX software, is given in section 3-e.

2-b) Accessibility

Auxiliary raw data are available in the frame of the CDPP server

The user is allowed to request these data for any time interval. He can also request for both the experiment data and the auxiliary data over the same time interval.

3. Decommutation and Calibration Program « CALIAUX »

3-a) Role and Utility

The goal of the "CALIAUX" program is to read the raw data binary files, and taking into account the original format, to transform them into classical physical units, and writing them into an ASCII file.

3-b) Description of the caliaux.in file containing the input parameters

The CALIAUX program reads a file, named caliaux.in, localised in the working directory, and containing the necessary input parameters for its execution. An example of this file is given below.

Example of caliaux.in file:

```
/data1/ida/robert/geos/geosdata/DAVL-GEOS1
21 12 1977      # date dd mm yy
00 01 30        # time hh mm ss
03.0            # duration in days
```

The first line indicates the localisation of the binary Auxiliary data file. The two following lines correspond to the asked date and time corresponding to the beginning of the analysed period. The beginning time must be rounded, because the Auxiliary data are packed by groups of 64 Low Speed Format (LSF) corresponding to 64 x 1.37601 seconds, so the start time will be rounded around 88.065 seconds. In order to avoid a starting period just before the asked day, it is recommended to set the start time to 00:01:30 second.

The duration parameter corresponds to the time interval to be calibrated, in decimal days. If the user wants to use the standard graphical visuaux.pro procedure (see section 4), which plots these data day by day into a PostScript file, this time interval must be an integer. If the user does not needs it, and wants to get only the caliaux.resu file on a given period, he can use a decimal day. Then he could use his own procedure to read the caliaux.resu file, visualise it, or apply any process (see the description of the caliaux.resu file in next section).

3-c) Example of caliaux.out file describing the execution of the run

An example of caliaux.out file is given in annexe 6. This file gives some information about the data, the exact time of the TM formats, the sense of rotation of the spacecraft, the number of blocks, etc. The first and last block of the given period is printed. Since the CALIAUX program and its libraries have been developed long years ago mainly by the author or other Frenchmen, in the CRPE and then the CETP, French laboratories, all the output comments are in French, and we are very sorry to present in the file the results in this language.

3-d) Description of the caliaux.resu file containing the calibrated data

An example of the caliaux.resu file is given in annexe 7. This file contains the results of the caliaux.exe program. It is in ascii format, to be commonly used by any software, in any language, on any machine. This file contains all the Auxiliary data, corresponding to a given date and time period, converted into physical units. The VDH coordinate system used for the vectors data is described in part I, § 3-b.

The header of the file is made by titles, by input parameters deduced from the caliaux.in file, by number of GEOS (1 or 2), number of blocks, starting date and time. It is completed by the title of each parameters.

The header is followed by all the data, given by group of two lines, as described below:

1) nrec:	Number of records read from the binary file. Into the caliulf.resu file, the parameters corresponding to one record is written on 2 lines.
2) nJul:	Number of Julian days from 1/1/1950 (1/1/1950 → nJul=0).
3) millisec:	Millisecond of the day.
4) num lsf:	Number of Low Speed Format (LSF). Must be a multiple of 16.
5) lat:	Latitude of the Spacecraft in degrees (accuracy: 1/100 degree).
6) long:	Longitude of the Spacecraft in degrees (accuracy: 1/100 degree).
7) R km:	Distance of the Spacecraft to the center of the Earth, in km (accuracy: 10 km).
8) sunsat:	Angle between the two lines Earth-centre to satellite and Sun to Earth-centre (i.e eclipse at zero angle), in degrees (accuracy: 1/100 degree).
9) rasc:	Right ascension of the spin axis tilt in spacecraft coordinate, in degrees (accuracy: 1/100 degree).
10) decli:	Declination of the spin axis tilt in spacecraft coordinate, in degrees (accuracy: 1/100 degree).
11) Qua:	Quality of the data (0=good).
12) SpinX:	Component X of the spin axis in VDH system (accuracy: for digits after point)

13)SpinYc: Component Y of the spin axis in VDH system
(accuracy: for digits after point)

14) SpinZ: Component Z of the spin axis in VDH system
(accuracy: for digits after point)

15) Dip_X: Component X of the magnetic dipole axis in VDH system
(accuracy: for digits after point)

16) Dip_Y: Component Y of the magnetic dipole axis in VDH system
(accuracy: for digits after point)

17) Dip_Z: Component Z of the magnetic dipole axis in VDH system
(accuracy: for digits after point)

18) Sun_X: Component X of the Sun axis in VDH system
(accuracy: for digits after point)

19) Sun_Y: Component Y of the Sun axis in VDH system
(accuracy: for digits after point)

20) Sun_Z: Component Z of the Sun axis in VDH system
(accuracy: for digits after point)

3-e) Instruction for use

- ***Installation on a new machine***

For the installation of the software on a new machine, the following directories and files are requested:

CDPP/geoslibs:

geosdecolib.f
geosdecolib.make
geoscalclib.f
geoscalclib.make

The geoscalclib and geosdecolib are described in detail in part I of this document.

The execution of the shell scripts geosdecolib.make and geoscalclib.make will produce the object files geosdecolib.o and geoscalclib.o. The *make files are given below ; a Fortran 77 compilator is requested.

geosdecolib.make:

```
echo
echo compil de geosdecolib.f, creation du .o
echo
f77 -c -C -ansi  geosdecolib.f
```

geoscalclib.make:

```
echo
echo compil de la geoscalclib.f, creation du .o
echo
f77 -c -C       geoscalclib.f
```

CDPP/caliaux:

caliaux.f
caliaux.make

The execution of the shell script caliaux.make will produce the object file caliaux.o and the executable file caliaux.exe. The caliaux.make file is given below, the Fortran 77 compilator is requested.

caliaux.make:

```
echo compil de caliaux.f
f77 -c -C caliaux.f
echo
echo link de caliaux.o avec les bibli geos
f77 -C caliaux.o ../geoslibs/geosdecolib.o \
                 ../geoslibs/geoscalclib.o -o caliaux.exe
```

- ***Running the caliaux.exe program***

After installation as above, the caliaux.exe program must be existing. The caliaux.in file must be present to indicate to the program all the input parameters (see section above). It is useful, rather that executing directly the caliaux.exe program, to run the shell script caliaux.bat program, the content of which is listed below:

caliaux.bat:

```
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo caliaux.bat : Calibration of GEOS auxiliary data
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
echo "Running caliaux.exe with parameters of caliaux.in"
echo "-------------------------------------------------"
echo
echo "Please wait ..."
caliaux.exe
echo
echo "Proceedings of execution are in caliaux.out"
echo "Results are in caliaux.resu"
echo "Visualization by 24H period available with visuaux.bat"
echo
echo "end of caliaux.bat"
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
```

This shell script file allows the user to have some comments during the execution of caliaux.exe. After running, the following files will occur :

caliaux.out → describes the execution of caliaux.exe (see section 3-d above)
caliaux.resu → contents the results of the different data processing asked (see section 3-e above)

4. Visualisation program « VISUAUX »

4-a) Role and Utility

It is useful to dispose of a standard graphical procedure, which produces directly a plot of all the Auxiliary data. It is the role of the visuaux.pro IDL (or PV-Wave) procedure, which read the caliaux.resu file and produces a PostScript file containing all the plots of the auxiliary data, with a page per day.

4-b) Example of produced visualisation

Annexe 8 gives an example of the print-out of a PostScript files produced by the visuaux.pro procedure. Each panel corresponds to the different types of data existing in the caliaux.in file.

4-c) Instruction for use

- ***Installation on a new machine***

The following files must be simply existing:

CDPP/caliaux/visuaux.pro
CDPP/caliaux/visuaux.bat

- ***Running the visuaux.pro procedure***

The machine must have a IDL or a PV-Wave license. The visuaux.pro PV-Wave procedure is running by executing the visuaux.bat shell script given below:

visuaux.bat:

```
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo visuaux.bat : Visualization of GEOS auxiliary data
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
echo "File caliaux.resu must be existing"
echo "(this file is created by caliaux.bat)"
echo
#
echo "Running PV-Waves for data visualization"
echo "---------------------------------------"
```

```
echo
  wave    <<!!
.run visuaux.pro
visuaux
caliaux.resu
!!
echo
echo "end of visuaux.bat"
echo
echo XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
echo
```

The visuaux.pro procedure reads the caliaux.resu file, and plots the corresponding data into PostScript file.

Annexe 1: GEOSCALCLIB and GEOSDECOLIB libraries

The GEOSCALCLIB and the GEOSDECOLIB libraries are written in FORTRAN77, with lower characters, and consist in a serie of subroutines and functions. Since it has been developed long years ago mainly by myself or other Frenchmen of CRPE and then CETP, a French laboratory, all the comments are in French, and we are very sorry to present here the internal documentation code in this language. In order to list and comment the code, each module (subroutine or function) contains a pack of 3 lines of comments, just after the declaration of the modules, such as this example given below:

```
C
      subroutine vdhxyz(x,y,z,a1,a2,a3,v,d,h,bzero)
C
C     ------------------------------------------------------------------
C **  categorie: astronomie et changement de base
C **  objet    : passage du repere satellite tournant au repere vdh
C **  auteur   : P. Robert CRPE 1977-1984
C     ------------------------------------------------------------------
C
```

This block of comments allows to define the category of the subroutine : here the subroutine is a part of the category “astronomy and change of coordinate systems”, see below. The second comment indicates the role of this module : here the module allows the user to convert a vector of the spinning coordinate system to the VDH coordinates. The third and last comment gives the author, his origin, and the date of creation of the module. These conventions are used for the two libraries, even if the decommutation library has been re-written recently.

This block, always existing for each module, is used by an external documentation program, developed for the management of this kind of codes, which produces a summary of the documentation, and which can be useful for any further developments. A header summarises the size of the code (number or lines), the number of different types (subroutines of function), and the different categories of modules. Then the list of modules is given, for each category, with their i/o arguments, a short summary of their role and authors issued from the key comments, and the line position of the module in the code. The results are given above.

A1-a) GEOSCALCLIB library

Header

```
DOCMOD: DOCUMENTATION OF FORTRAN MODULE SOURCE

     adapted to GEOS/UBF fortran codes, PR 96
-------------------------------------------------

file source: geoscalclib.f

nb. of lines     : 3195
nb. of function  :    3
nb. of subroutine:   70
nb. of program   :    0
                   ____
nb. of modules   :   73

nb. of categories:    4

    1  astronomie et changement de base
     2  mathematiques & traitement du signal
     3  manipulation de tableaux
     4  depouillement specifique GEOS/UBF
```

list of modules for each category:

category: astronomie et changement de base (11 modules)

type	module	arguments	objet	auteur	ligne
subr	calheur	(mill,ih,im,is,imil)	calcul ih,im,is,imil depuis les millisec. du jour	P. Robert CETP 1998	264
subr	caljj50	(iday,imonth,iyear,njj50)	calcul le nombre de jour julien depuis le 1/1/1950= 0	P. Robert CETP 1996	288
subr	carsph	(r,tet,phi,x,y,z)	conversion de coordonnees spheriques en cartesiennes	P. Robert CRPE 1977-1984	706
subr	cdfdot	(iyear,idoty,imonth,iday)	calcule la date depuis l'annee et le jour de l'annee	P. Robert CRPE 1993	725
subr	cdfjj50	(njj50,imonth,iday,iyear)	calcule la date depuis le nb de jour julien 1/1/1950=0	P. Robert CRPE 1993	780
subr	cleapy	(iyear,ileap)	compute_leap_year with ileap=1 for leap year, 0 if not	P. Robert CETP 1996	962
subr	codoty	(imonth,iday,iyear,idoty)	compute_day_of_the_year with idoty=1 for january 1	P. Robert CETP 1996	1007
subr	rot	(x,y,tet)	rotation sur x et y de centre 0 et d'angle teta	P. Robert CRPE 1977-1984	2562
subr	sphcar	(x,y,z,r,tet,phi)	conversion de coordonnees cartesiennes en spheriques	P. Robert CRPE 1977-1984	2751
subr	vdhxyz	(x,y,z,a1,a2,a3,v,d,h,bzero)	passage du repere satellite tournant au repere vdh	P. Robert CRPE 1977-1984	2968
subr	xyzvdh	(v,d,h,a1,a2,a3,x,y,z,bzero)	passage du repere vdh au repere satellite tournant	P. Robert CRPE 1977-1984	3103

category: mathematiques & traitement du signal (9 modules)

type	module	arguments	objet	auteur(s)	ligne
func	gauss	(x,xmoy,sig)	calcule pour x la fonction de gauss g(x,xmoyen,sigma)	P. Robert CRPE 1977-1984	81
func	porte	(x,x1,x2)	calcule pour x la fonction porte(x,x1,x2)	P. Robert CRPE 1977-1984	117
subr	apm180	(deg)	recadrage entre +/- 180 d"un angle en degres	P. Robert CRPE 1977-1984	200
subr	apobor	(s,nbp)	apodisation aux bornes d'une forme d'onde complexe	P. Robert CRPE 1977-1984	220
subr	bornint	(i,i1,i2)	borne une valeur entiere i entre 2 autres i1 et i2	P. Robert CRPE 1977-1984	247
subr	calsin	(sig,n,fe,fs,as,phi)	calcul d'une sinusoide contenue dans un signal	P. Robert CRPE 1977-1984	588
subr	fftpat	(s,n,ind)	fft directe ou inverse (ind=1/2) sans table de sinus	Cooley/Tuquey/Capellini/Robert 1980	2152
subr	modpha	(s,rm,rp)	calcule le module et la phase (degre) d un nb. complexe	P. Robert CRPE 1977-1984	2345
subr	sinuso	(a,f,phi,fe,x,n)	charge x(n) par une sinusoide (phi en degres)	P. Robert CRPE 1977-1984	2725

category: manipulation de tableaux (10 modules)

type	module	arguments	objet	auteur	ligne
subr	add1t	(a,t1,t2,n)	additionne 1 tableau pondere t2(i)=a*t1(i)+t2(i)	P. Robert CRPE 1977-1984	134
subr	add2t	(a,t1,b,t2,t3,n)	additionne 2 tableaux ponderes t3(i)=a*t1(i)+b*t2(i)	P. Robert CRPE 1977-1984	156
subr	addxt	(x,t,n)	additionne un reel a un tableau	P. Robert CRPE 1977-1984	178
subr	sdt1t2	(s,ta1,ta2,nbp)	met le cmplx s(n) dans ta1(n) et ta2(n)	P. Robert CRPE 1977-1984	2648
subr	strady	(s,tra,y,nbp)	met le cmplx s(n) et le real tra(n) dans y(3,n)	P. Robert CRPE 1977-1984	2778
subr	t1dt2	(t1,t2,n)	met t1(n) dans t2(n)	P. Robert CRPE 1977-1984	2802
subr	t1t2ds	(ta1,ta2,s,nbp)	met ta1(n) et ta2(n) dans le cmplx s(n)	P. Robert CRPE 1977-1984	2824
subr	t1t2t3dy	(ta1,ta2,ta3,y,nbp)	met ta1(n), t2(n) et ta3(n) dans y(3,n)	P. Robert CETP 1996	2847
subr	ydstra	(y,s,tra,nbp)	met y(3,n) dans le cmplx s(n) et le real tra(n)	P. Robert CRPE 1977-1984	3148
subr	ydt1t2t3	(y,ta1,ta2,ta3,nbp)	met y(3,n) dans ta1(n),ta2(n) et ta3(n)	P. Robert CETP 1996	3171

category: depouillement specifique GEOS/UBF (41 modules)

type	module	arguments	objet	auteur	ligne
func	gepy	(x)	fonction module du gain de l antenne electrique e y	P. Robert CRPE 1977-1984	100
subr	calbxyz	(phi,fe,fspin,rotdeg)	calcul du champ statique dans le repere fixe meridien	P. Robert CETP 1997	334
subr	calgeos	(njd50,igeos)	calcule le num. du satellite (1 ou 2)	P. Robert CRPE 1977-1984	396
subr	calphi	(lsf1,teta,phi,lsfphi,fe)	calcul du teta et phi rafraichi pour un lsf1 donne	P. Robert CRPE 1977-1984	429
subr	calrot	(rotdeg)	calcul de l'angle de rot. entre x et le merid. geog	P. Robert CRPE 1977-1984	521
subr	calsinu	(x,n,fs,fe,a,pha,texte)	calcule ampli. & phase de la sinusoide de spin (calsin)	P. Robert CETP 1996	653
subr	caltemp	(njul50,milduj,jj,mm,ian,ih,im,is,ims)	calcul le temps du format courant	P. Robert CETP 1998	690
subr	chbavdh	(s,tra,nbp,fe,fspin)	chang. base formes d'onde sat. tournant au repere vdh	P. Robert CRPE 1977-1984	823
subr	chbaxyb	(s,tra,nbp,fe,fspin,tet,phi)	chang. base formes d'onde sat. tournant au repere xyb	P. Robert CRPE 1977-1984	870
subr	consaux	(nubloc,nbblo,njj,mil,lsf,njjp,milp,lsfp,nbbm)	verifie et complete la consecutivite des blocs des DAVL	P. Robert CETP 1999	1056
subr	consecf	(lsf1,lsf2,lsfp,lsf11)	test de consecutivite des formes d'ondes	P. Robert CRPE 1977-1984	1117
subr	constim	(nubloc,nbblo,njj,mil,lsf,njjp,milp,lsfp,nbbm)	verifie la consecutivite du temps des blocs des DAVL	P. Robert CETP 1999	1153
subr	correch	(s,nbp,fe,j)	correction des retards d echantillonage des voies xyz	P. Robert CRPE 1977-1984	1203
subr	corrga	(s,n,df,ip)	correction des grains d antenne sur tableau s(n)	P. Robert CRPE 1977-1984	1243
subr	deconvo	(s,tra,y,nbp,f1,f2,fe)	deconvolution des formes d'onde x y z	P. Robert CRPE 1977-1984	1285
subr	despin	(s,tra,n,fe,fs,idespi,ax,ay,az,phix,phiy,phiz)	despinage des formes d'onde s et tra (algo. demod)	P. Robert CRPE 1977-1984	1365
subr	ebdsvdh	ecriture des donnees du champ mag. Stat. dans le VDH		P. Robert CRPE 1977-1984	1491
subr	ebdsxyz		ecriture des donnees du champ statique ds XYZ sat.mer.	P. Robert CETP 1997	1531
subr	ecdavl	(nu,nb,jc,mil,lsf,rla,rlo,rkm,c,d,s,sts,as,de,iq)	ecriture sur fich. resu d'un bloc de davl	P. Robert CETP 1998	1571
subr	eentaux	(igeos,indata,nbbloc)	ecriture sur . resu de l'entete aux. (date, positionn.)	P. Robert CETP 1996	1635
subr	eentubf	(igeos,indata,nbseq)	ecriture sur . resu de l'entete UBF (date, positionn.)	P. Robert CETP 1996	1680
subr	efinpro	(com)	ecriture du status de fin normale pour le fichier .out	P. Robert CETP 1996	1731
subr	enumseq	(iwrite,nbseq)	ecriture du numero de sequence pour le fichier .out	P. Robert CETP 1996	1760
subr	etab2	(ta1,ta2,nbp,res,ipan,com)	ecriture sur fich. resu de ta1(nbp) et ta2(nbp)	P. Robert CETP 1996	1800
subr	etab3	(ta1,ta2,ta3,nbp,res,ipan,com)	ecriture sur fich. resu de ta1(nbp), ta2(nbp), ta3(nbp)	P. Robert CETP 1996	1858
subr	etabs	(s,nbp,res,ipan,com)	ecriture sur fich. resu de xy en volt rep. fixe	P. Robert CETP 1996	1917
subr	etabst	(s,tra,nbp,res,ipan,com)	ecriture sur fich. resu de y(3,nbp)	P. Robert CETP 1996	1975
subr	etaby	(y,nbp,res,ipan,com)	ecriture sur fich. resu de y(3,nbp)	P. Robert CETP 1996	2034
subr	etemseq	(njul50,jj,mm,ian,ih,im,is,ims)	ecriture sur fich. resu du temps de la sequence	P. Robert CETP 1998	2092
subr	fftdiru	(s,nbp)	calcul une fft directe d un complexe s(n)	P. Robert CRPE 1977-1984	2120
subr	fftinvu	(s,nbp)	calcul une fft inverse	P. Robert CRPE 1977-1984	2153
subr	filtond	(s,n,df,f1,f2)	filtrage dune forme donde	P. Robert CRPE 1977-1984	2255
subr	longut	(mot,nc)	calcul de la longueur utile d'une chaine de caracteres	P. Robert CETP 1998	2293
subr	longsb	(mot,nc)	calcul de la longueur sans blanc d'une chaine de carac.	P. Robert CETP 1998	2320
subr	mophafs	(cgfs,rfs,phafs)	module et phase de la fonction de transfert a fspin	P. Robert CETP 1996	2373
subr	psatmer	(rotdeg)	calcule les axes du repere meridien dans le VDH	P. Robert CETP 1997	2409
subr	psatvdh		calcule la direction des antennes dans le vdh au lsf1	P. Robert CRPE 1977-1984	2490
subr	rotfix	(s,nbp,fe,fspin,rotdeg)	passage d"un repere en rotation a un repere fixe	P. Robert CRPE 1977-1984	2586
subr	sensrot	(njul50,s)	calcule le sens de rotation du satellite	P. Robert CRPE 1977-1984	2672
subr	titpart	(nompar)	titre de la partie pour le fichier resultat .out	P. Robert CETP 1996	2872
subr	titcali	(nompro)	titre/entete de caliulf pour le fichier resultat .out	P. Robert CETP 1998	2896
subr	titauxi	(nompro)	titre/entete de caliaux pour le fichier resultat .out	P. Robert CETP 1998	2933
subr	verifcb	(phi)	verifie les calculs de changement de base	P. Robert CRPE 1977-1984	3012

A1-b) GEOSDECOLIB library

This library has been many times re-written, since it contains the modules allowing the extraction of the data from the binary data files, and thus, depends on the hardware of the computer. It contains only one no standard Fortran 77 function, the ”and” function, which is nevertheless available on most machines, such as SUN 32 bits workstation where this last version has been developed.

Header

```
-------------------------------------------------
DOCMOD: DOCUMENTATION OF FORTRAN MODULE SOURCE

adapted to GEOS/UBF fortran codes, PR 96
-------------------------------------------------

file source: geosdecolib.f

nb. of lines     : 1044

nb. of function  :    1
nb. of subroutine:    8
nb. of program   :    0
                      ____
nb. of modules   :    9


nb. of categories:    1

  1  decommutation GEOS/UBF

-------------------------------------------------
```

list of modules for each category:

only one category: decommutation GEOS/UBF (9 modules)

type	module	arguments	objet	auteur(s)	ligne
subr	aconde	(nbp,y,ux,uy,uz,dx,dy,lsf1,lsf2,fe,fspin)	acquisition et decom. des donnees UBF	PR,MR,OCJ, refait PR 1996, revu 98	62
subr	detmls	(lsf,jc,mj,fe,ib,ig,idx,idy,bvdh,bz,tet,phi,a,fs)	lecture et decom. d'un bloc de 4 LSF TMLS	PR,MR,OCJ, revu PR 1996, reecrit 98	266
subr	dedavl	(jcn,mil,lsf,rla,rlo,rkm,c,d,s,sts,asc,dec,iq)	lecture et decom. d'un bloc de DAVL	P. Robert, CETP 1998	490
subr	dedate	(natfic,ient,j,mill,its)	decommutation de la datation des blocs	O. Coeur-Joly CETP 1995, refait PR 98	663
subr	lebloc	(ifc,nos,nol,itab,ieof)	lecture d'un bloc de donnees TMLS ou DAVL	P. Robert, CETP 1998	717
subr	posfic	(natfic,njul50)	positionnement sur le fichier tmls ou davl	O. Coeur-Joly CETP 1995, refait PR 98	748
subr	tramil	(mill,ih,im,is,imil)	transforme les millisec. du jour en ih,im,is,imil	O. Coeur-Joly CETP 1995, verifie PR 98	977
subr	isigne	(mot, nbit)	inversion de signe si mot > 2**(nbit-1)	O. Coeur-Joly CETP 1995, verifie PR 98	1000
func	ipicmo	(mot, nbit)	extrait les nbit premiers bits de mot	O. Coeur-Joly CETP 1995, revu PR 98	1020

Annexe 2: Example of caliulf.out file

```
                          GEOS-1 / GEOS-2

                          CALIULF V 4.0

      Decommutation et calibration de tous les parametres des donnees UBF

                                              P.Robert, CETP, Juin     1996
                                                        revu  Avril    1997
                                                        revu  Fevrier  1998
                                          Version pour le CDPP, Decembre 1998

 lfulfin:

 nom du fichier de donnees UBF ? (path complet)
 /data1/ida/robert/geos/geosdata/UBF_19780827_011043

 Date (jj,mm,aa) ? [27,04,1977]
   28  8  1978
 Heure de debut (hh,mn,ss) ? [15,00,00]
   9  14  40
 Duree de la periode (nb entier de sec.) ? [90]
   40
 Nb de points d'une F.O. (-> res. spec.) ? [2048]
   1024
 Bornes en frequence / deconvolution ? [0.5,11.5]
     1.00000E-01    11.5000
 Detail de chaque sequence sur .out (1=oui) ? [0]
   0
 Panels a selectionner pour le .resu [6,10,14 ou *]
 *

 resume des parametres d'entree:
 28 08 1978 09 14 40    40  1024   0.1  11.5 0 *

 soit   1 sequences de     44.0323 sec.
 ------------------------------------------------------------------------------
 calgeos:

 GEOS-1/2:  GEOS-2
 ------------------------------------------------------------------------------
 sensrot:

 sens de rotation= electron
 ------------------------------------------------------------------------------
 posfic: positionnement sur fichier de type tmls

         debut fichier : njul50,ih,im,is     =  10465  1 10 43

         fichier correspondant a GEOS-2
         nombre de records:      32479
         taille en octets :   31699504

         fin fichier   :                     =  10467  3  4 51
         demande       :                     =  10466  9 14 40
         fait          : njul50,ih,im,is,imil=  10466  9 14 40 862
 ------------------------------------------------------------------------------
 eentubf:

 Donnees UBF GEOS - Resultats de Caliulf.exe
 parametre d'entree: 28 08 1978 09 14 40    40  1024   0.1  11.5 0 *
 GEOS:  2
 Nombre de sequences :   1
 Status des panels retenus:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
                             1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
 Nombre de panels:  16
```

```
================================================================================
 enumseq:    sequence numero  1 ////////////////////////////////////////////
 ------------------------------------------------------------------------------
 aconde:

 tranche de signal numero  1
 acquisition des formes d'onde x y z sur 1024 points
 valeurs corrigees des gains de pre-ampli
 unites de sortie: volts
 nombre de groupe de 4 LSF:  8
  1 datation:  18523572 10466  9 14 40 862 Gxz| 25- 25| 25- 25| 25- 25| 25- 25
  2 datation:  18523576 10466  9 14 46 366 Gxz| 25- 25| 25- 25| 25- 25| 25- 25
  3 datation:  18523580 10466  9 14 51 870 Gxz| 25- 25| 25- 25| 25- 25| 25- 25
  4 datation:  18523584 10466  9 14 57 375 Gxz| 25- 25| 25- 25| 25- 25| 25- 25
  5 datation:  18523588 10466  9 15  2 879 Gxz| 25- 25|  5-  5|  5-  5|  5-  5
  6 datation:  18523592 10466  9 15  8 383 Gxz|  5-  5|  5-  5|  5-  5|  5-  5
  7 datation:  18523596 10466  9 15 13 887 Gxz|  5-  5|  5-  5|  5-  5|  5-  5
  8 datation:  18523600 10466  9 15 19 391 Gxz|  5-  5|  5-  5|  5-  5|  5-  5

 premier lsf:    18523572     dernier lsf:    18523603
 Duree:    44.03 sec.
 ------------------------------------------------------------------------------
 consec: verification de la consecutivite des formats dans la sequence  1

 ------------------------------------------------------------------------------
 ebdsvdh:

 donnees magnetometre S331 dans le VDH

       lsf          Bv       Bd       Bh          Br     Btet     Bphi
  18523572    -10.000   57.700  -95.900    112.366  148.590   99.832
  18523576     -3.600   47.600  -97.500    108.559  153.914   94.325
  18523580     -2.600   42.200 -109.600    117.472  158.905   93.526
  18523584      9.000   35.600 -120.200    125.684  163.013   75.812
  18523588     -7.000   39.600 -133.300    139.234  163.212  100.024
  18523592    -33.300   37.600 -124.400    134.157  158.014  131.529
  18523596     24.400  119.600 -114.900    167.635  133.268   78.469
  18523600    -16.200   81.000 -107.100    135.255  142.358  101.310
 ------------------------------------------------------------------------------
 psatvdh:

 position des antennes dans le vdh au format  18523572

                 V           D           H          r          teta       phi
   axe x=    -0.80313    -0.59580    -0.00226     1.000    90.130  -143.430
   axe y=     0.59580    -0.80312    -0.00393     1.000    90.225   -53.430
   axe z=     0.00052    -0.00451     0.99999     1.000     0.259   -83.370
 ------------------------------------------------------------------------------
 calphi:

 fspin= 0.169815 Hz   Tspin=  5.88877 s
 teta= 148.888
 phi=-116.583 au debut du lsf  18523572 calcule depuis phi=-132.068
                      au lsf  18523572 avec To= 0.253E+00
                      bphi(1)=-132.068  dphi=  15.485
 ------------------------------------------------------------------------------
 verifcb:

 verification des changements de base au format  18523572

 B xyz lu directement (phi non defini)          B xyz=  -38.901  -43.101  -96.203
                                                B mod=  112.366
                                                teta =  148.888
                                                phi  = -132.068

 vrai phi rafraichi calcule par calphi: phi= -116.583

 B xyz lu avec phi corrige (valeurs exactes)    B xyz=  -25.982  -51.923  -96.203
                                                B mod=  112.366
                                                teta =  148.888
                                                phi  = -116.583
```

```
B vdh lu directement                              B vdh=  -10.000   57.700  -95.900
                                                  B mod=  112.366
                                                  teta =  148.590
                                                  phi  =   99.832

B xyz recalcule par vdh et les angles d'euler B xyz=  -26.129  -51.921  -96.164
                                                  B mod=  112.366
                                                  teta =  148.850
                                                  phi  = -116.714

B vdh recalcule par xyz et les angles d'euler B vdh=  -10.120   57.614  -95.939
                                                  B mod=  112.366
                                                  teta =  148.629
                                                  phi  =   99.962

angles d'Euler au format  18523572       a1,a2,a3= -150.060    0.260    6.630
--------------------------------------------------------------------------------
calrot:

les phases sont relatives a x dans le plan du meridien geographique
correction=   143.430 deg.
--------------------------------------------------------------------------------
psatmer:

position des antennes dans le repere meridien
(interpollee depuis le lsf1=  18523572)

                    V           D           H         r         teta       phi
  axe x.mer=     1.00000     0.00000    -0.00052     1.000    90.030     0.000
  axe y.mer=     0.00000     0.99999     0.00451     1.000    89.742    90.000
  axe z.mer=     0.00052    -0.00451     0.99999     1.000     0.259   -83.370
--------------------------------------------------------------------------------
calbxyz:

changement de base sur B331 repere sat. tournant -> repere satellite fixe
              x meridien   rotdeg=  143.4   nb4lsf=    8   fs= 0.16981
--------------------------------------------------------------------------------
ebdsxyz:

donnees magnetometre S331 dans XYZ sat/meridien

      lsf          Bv       Bd       Bh          Br     Btet     Bphi
 18523572    -10.069   57.181  -96.203    112.366  148.888   99.987
 18523576     -3.720   47.024  -97.775    108.559  154.245   94.523
 18523580     -2.749   41.625 -109.816    117.472  159.200   93.779
 18523584      9.084   35.017 -120.365    125.684  163.272   75.457
 18523588     -7.191   38.921 -133.490    139.234  163.485  100.468
 18523592    -33.431   37.057 -124.528    134.157  158.160  132.055
 18523596     24.253  119.080 -115.469    167.635  133.536   78.488
 18523600    -16.444   80.464 -107.466    135.255  142.612  101.550
--------------------------------------------------------------------------------
mophafs:

amplitude=    0.002280  phase=   89.163651

________________________________________________________________________________
partie 1: telemesure
--------------------------------------------------------------------------------
etaby

 1) XYZ Telemetry data
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
--------------------------------------------------------------------------------
etab2:

 2) Gains XY and Z
resolution (s):  1.3760099
Nb. de courbes:    2
Nb. de points :   32
```

```
------------------------------------------------------------------------------
etab3:

 3) XYZ volt, SC spinning system
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
------------------------------------------------------------------------------
rotfix:

changement de base sur les formes d'onde,repere final=repere sat. fixe
              x meridien   rotdeg=  143.4   nbp= 1024   fs= 0.16981
------------------------------------------------------------------------------
etabs:

 4) XY volt, SC fixed system with X in geo. meridian
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024

_____________________________________________________________________________
partie 2: UBF et Despins bruts
------------------------------------------------------------------------------
etab2:

 5) DX,DY volt, SC spinning system
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024
------------------------------------------------------------------------------
rotfix:

changement de base sur les formes d'onde,repere final=repere sat. fixe
              x meridien   rotdeg=  143.4   nbp= 1024   fs= 0.16981
------------------------------------------------------------------------------
etabs:

 6) DX,DY volt, SC fixed system with X in geo. meridian
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024
------------------------------------------------------------------------------
etab2:

 7) X+DX,Y+DY volt, SC spinning system
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024
------------------------------------------------------------------------------
rotfix:

changement de base sur les formes d'onde,repere final=repere sat. fixe
              x meridien   rotdeg=  143.4   nbp= 1024   fs= 0.16981
------------------------------------------------------------------------------
etabs:

 8) X+DX,Y+DY volt, SC fixed system with X in geo. meridian
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024

_____________________________________________________________________________
partie 3: UBF deconvolues
------------------------------------------------------------------------------
despin:

despinage des formes d'ondes,avec fs=  0.16981 et fe= 23.25565
amplitudes:    0.019808    0.019526    0.002689
phases (d):  -42.055084   49.369930   61.343052
------------------------------------------------------------------------------
```

```
deconvo:

deconvolution des 3 formes d’onde- t.f. directe
         fft directe effectuee
correction des gains d’antenne effectuee en module et en phase
filtrage de la forme d’onde entre      0.100 et    11.500 Hz
correction du retard d’echantillonnage de la voie 1
         fft inverse effectuee
         fft directe effectuee
correction des gains d’antenne effectuee en module et en phase
filtrage de la forme d’onde entre      0.100 et    11.500 Hz
correction du retard d’echantillonnage de la voie 2
         fft inverse effectuee
         fft directe effectuee
correction des gains d’antenne effectuee en module et en phase
filtrage de la forme d’onde entre      0.100 et    11.500 Hz
correction du retard d’echantillonnage de la voie 3
         fft inverse effectuee
t.f. inverse- retour au domaine temps
--------------------------------------------------------------------------------
etabst

 9) XYZ nT, SC spinning system
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
--------------------------------------------------------------------------------
rotfix:

changement de base sur les formes d’onde,repere final=repere sat. fixe
              x meridien   rotdeg=  143.4   nbp= 1024   fs= 0.16981
--------------------------------------------------------------------------------
etabs:

10) XYZ nT, SC fixed system with X in geo. meridian
resolution (s):  0.0430003
Nb. de courbes:    2
Nb. de points : 1024
--------------------------------------------------------------------------------
chbavdh:

changement de base sur les formes d’onde,repere final = repere vdh
--------------------------------------------------------------------------------
etabst

11) XYZ nT, VDH system
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
--------------------------------------------------------------------------------
chbaxyb:

changement de base sur les formes d’onde,repere final = repere magnetique xyb
--------------------------------------------------------------------------------
etabst

12) XYZ nT, XYB strengh line system
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024

_______________________________________________________________________________
partie 4: UBF + Despins deconvolues
--------------------------------------------------------------------------------
calsinu:

spin de X         amplitude=  0.019808   phase=  -42.055 deg.
--------------------------------------------------------------------------------
calsinu:

spin de Y         amplitude=  0.019526   phase=   49.370 deg.
```

```
------------------------------------------------------------------------------
calsinu:

spin de Z         amplitude=  0.002689   phase=   61.343 deg.
------------------------------------------------------------------------------
calsinu:

spin de DX        amplitude=  0.109538   phase=  -60.162 deg.
------------------------------------------------------------------------------
calsinu:

spin de DY        amplitude=  0.108372   phase=   28.370 deg.
------------------------------------------------------------------------------
calsinu:

spin de X+DX      amplitude=  0.128513   phase=  -57.416 deg.
------------------------------------------------------------------------------
calsinu:

spin de Y+DY      amplitude=  0.126794   phase=   31.534 deg.
------------------------------------------------------------------------------
calsinu:

spin de Z         amplitude=  0.002689   phase=   61.343 deg.
------------------------------------------------------------------------------
calsinu:

spin de X+DX-Sin  amplitude=  0.005941   phase=   31.472 deg.
------------------------------------------------------------------------------
calsinu:

spin de Y+DY-Sin  amplitude=  0.003865   phase=  146.796 deg.
------------------------------------------------------------------------------
deconvo:

deconvolution des 3 formes d'onde- t.f. directe
         fft directe effectuee
correction des gains d'antenne effectuee en module et en phase
filtrage de la forme d'onde entre      0.100 et    11.500 Hz
correction du retard d'echantillonnage de la voie 1
         fft inverse effectuee
         fft directe effectuee
correction des gains d'antenne effectuee en module et en phase
filtrage de la forme d'onde entre      0.100 et    11.500 Hz
correction du retard d'echantillonnage de la voie 2
         fft inverse effectuee
         fft directe effectuee
correction des gains d'antenne effectuee en module et en phase
filtrage de la forme d'onde entre      0.100 et    11.500 Hz
correction du retard d'echantillonnage de la voie 3
         fft inverse effectuee
t.f. inverse- retour au domaine temps
------------------------------------------------------------------------------
calsinu:

spin de -X+DX decon.  amplitude=  2.476671   phase=  -65.693 deg.
------------------------------------------------------------------------------
calsinu:

spin de -Y+DY decon.  amplitude=  2.791475   phase=   29.321 deg.
------------------------------------------------------------------------------
calsinu:

spin de -Z+0  decon.  amplitude=  1.696915   phase=  -22.704 deg.
------------------------------------------------------------------------------
etab3:

13) ULF+Di-Fs nT, SC spinning system
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
```

```
--------------------------------------------------------------------------------
rotfix:

changement de base sur les formes d'onde,repere final=repere sat. fixe
              x meridien   rotdeg=  143.4   nbp= 1024   fs= 0.16981
--------------------------------------------------------------------------------
etab3:

14) ULF+Despins nT, SC fixed system with X in geo. meridian (Z14=Z13)
resolution (s):  0.0430003
Nb. de courbes:    3
Nb. de points : 1024
--------------------------------------------------------------------------------
etab3:

15) continuous mag. field, nT, SC fixed system with X in geo. meridian
resolution (s):  5.5040398
Nb. de courbes:    3
Nb. de points :    8
--------------------------------------------------------------------------------
etab3:

16) continuous mag. field, nT, VDH system
resolution (s):  5.5040398
Nb. de courbes:    3
Nb. de points :    8


================================================================================
efinpro:  fin normale de caliulf ////////////////////////////////////////////
================================================================================
```

Annexe 3: Example of caliulf.resu file

```
GEOS S300 ULF Data - Results of Caliulf.exe
Input Parameters:
28 08 1978 09 14 40    40  1024   0.1  11.5 0 *
GEOS:
  2
Number of sequencies:
  1
Status of selected panels :
  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
Number of panels:
 16
Starting date (njul50,iday,imonth,iyear)
10466 28  8 1978
Starting Time (ih, im, is, ims)
  9 14 40 862
Antenna direction at t=0 in VDH system:
        V           D           H          r        theta     phi
    -0.80313    -0.59580    -0.00226     1.000    90.130  -143.430
     0.59580    -0.80312    -0.00393     1.000    90.225   -53.430
     0.00052    -0.00451     0.99999     1.000     0.259   -83.370
Spin frequency (Hz) and Spin period (s) :
 0.169815   5.88877
Axes of geo. meridian system in VDH:
        V           D           H          r        theta     phi
     1.00000     0.00000    -0.00052     1.000    90.030     0.000
     0.00000     0.99999     0.00451     1.000    89.742    90.000
     0.00052    -0.00451     0.99999     1.000     0.259   -83.370
 1) XYZ Telemetry data
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
  151.000000   85.000000  104.000000
  148.000000   98.000000   98.000000
  149.000000  106.000000  105.000000
  154.000000  108.000000  126.000000
  ..................... total of 3*1024 data
 2) Gains XY and Z
resolution (s):
  1.3760099
Number of curves:
    2
Number of points :
   32
   25.000000   25.000000
   25.000000   25.000000
  ..................... total of 2*32 data
 3) XYZ volt, SC spinning system
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
   -0.020800    0.032000    0.016800
   -0.018400    0.021600    0.021600
  ..................... total of 3*1024 data
```

```
4) XY volt, SC fixed system with X in geo. meridian
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
    0.035771   -0.013307
    0.027911   -0.005110
  ..................... total of 2*1024 data
 5) DX,DY volt, SC spinning system
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
   -0.098000    0.040000
   -0.094000    0.046000
  ..................... total of 2*1024 data
 6) DX,DY volt, SC fixed system with X in geo. meridian
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
    0.102539    0.026264
    0.101919    0.023761
  ..................... total of 2*1024 data
 7) X+DX,Y+DY volt, SC spinning system
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
   -0.118800    0.072000
   -0.112400    0.067600
  ..................... total of 2*1024 data
 8) X+DX,Y+DY volt, SC fixed system with X in geo. meridian
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
    0.138310    0.012956
    0.129829    0.018651
  ..................... total of 2*1024 data
 9) XYZ nT, SC spinning system
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
   -9.363985    0.214724    3.385161
   -9.253702    0.451304    3.339678
  ..................... total of 3*1024 data

10) XYZ nT, SC fixed system with X in geo. meridian
resolution (s):
  0.0430003
Number of curves:
    2
Number of points :
 1024
    7.648420    5.406662
    7.456457    5.498721
  ..................... total of 2*1024 data
```

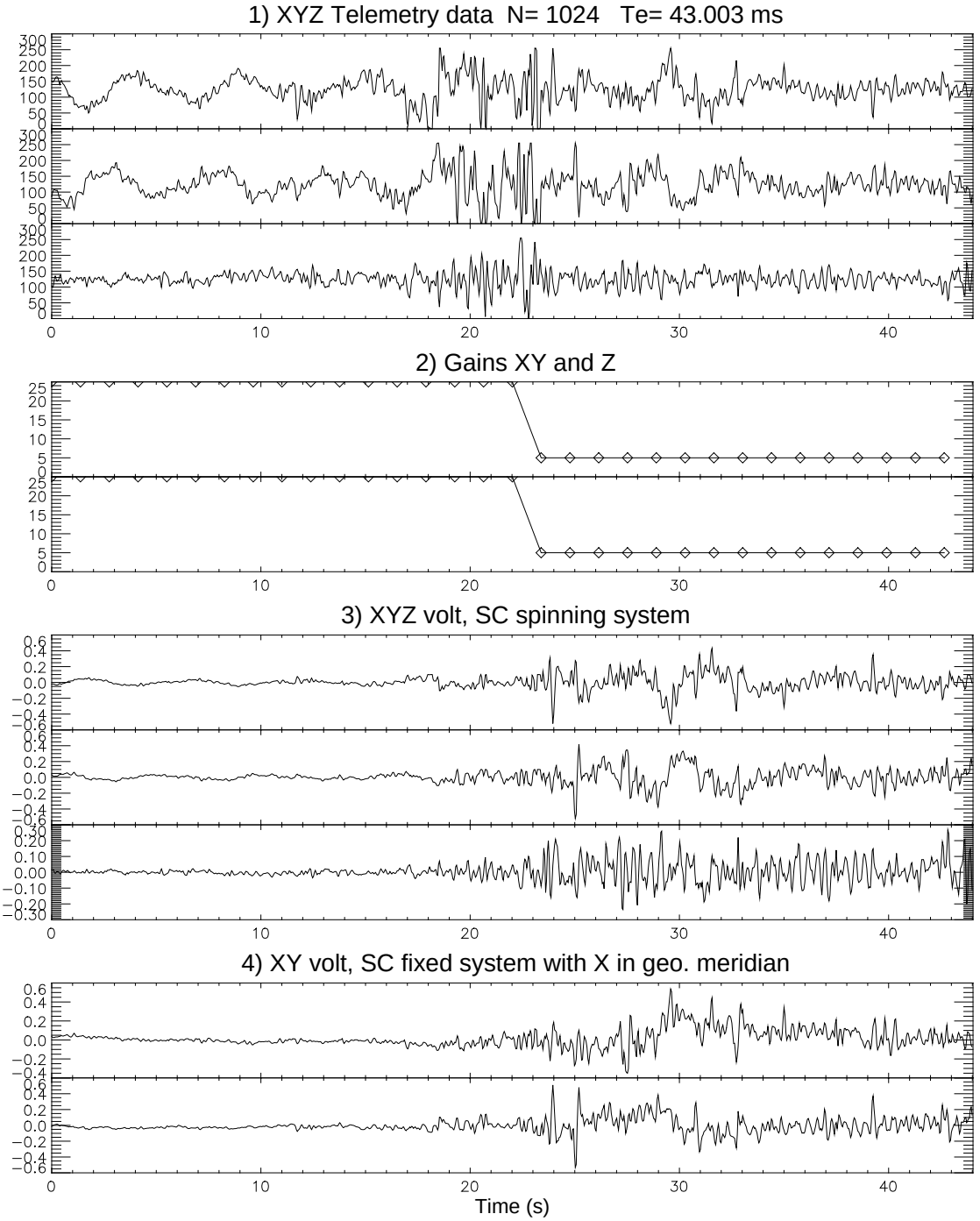
```
11) XYZ nT, VDH system
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
    7.650204    5.391349    3.405490
    7.458218    5.483612    3.360522
  ..................... total of 3*1024 data
12) XYZ nT, XYB strengh line system
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
    7.606159   -6.375210   -0.832280
    7.422702   -6.431157   -0.729290
  ..................... total of 3*1024 data
13) ULF+Di-Fs nT, SC spinning system
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
   -8.553311    5.523035    3.581485
   -8.330996    5.702818    3.535944
  ..................... total of 3*1024 data
14) ULF+Despins nT, SC fixed system with X in geo. meridian (Z14=Z13)
resolution (s):
  0.0430003
Number of curves:
    3
Number of points :
 1024
    7.063542   56.933361    3.581485
    6.963902   57.118820    3.535944
  ..................... total of 3*1024 data
15) continuous mag. field, nT, SC fixed system with X in geo. meridian
resolution (s):
  5.5040398
Number of curves:
    3
Number of points :
    8
  -10.069319   57.180893  -96.203194
   -3.720074   47.024006  -97.774605
  ..................... total of 3*8 data
16) continuous mag. field, nT, VDH system
resolution (s):
  5.5040398
Number of curves:
    3
Number of points :
    8
  -10.000000   57.700001  -95.900002
   -3.600000   47.599998  -97.500000
  ..................... total of 3*8 data
```

Annexe 4: Example of ULF visualisation data

A4-a) Example of PostScript file corresponding to frame 1 (visuulf_s1_f1.ps):

GEOS-2 / ULF-S300 | day 10466: 28/August/1978 09:14:40.862

Frame 1: ULF telemetry data and gain-corrected data in Volt



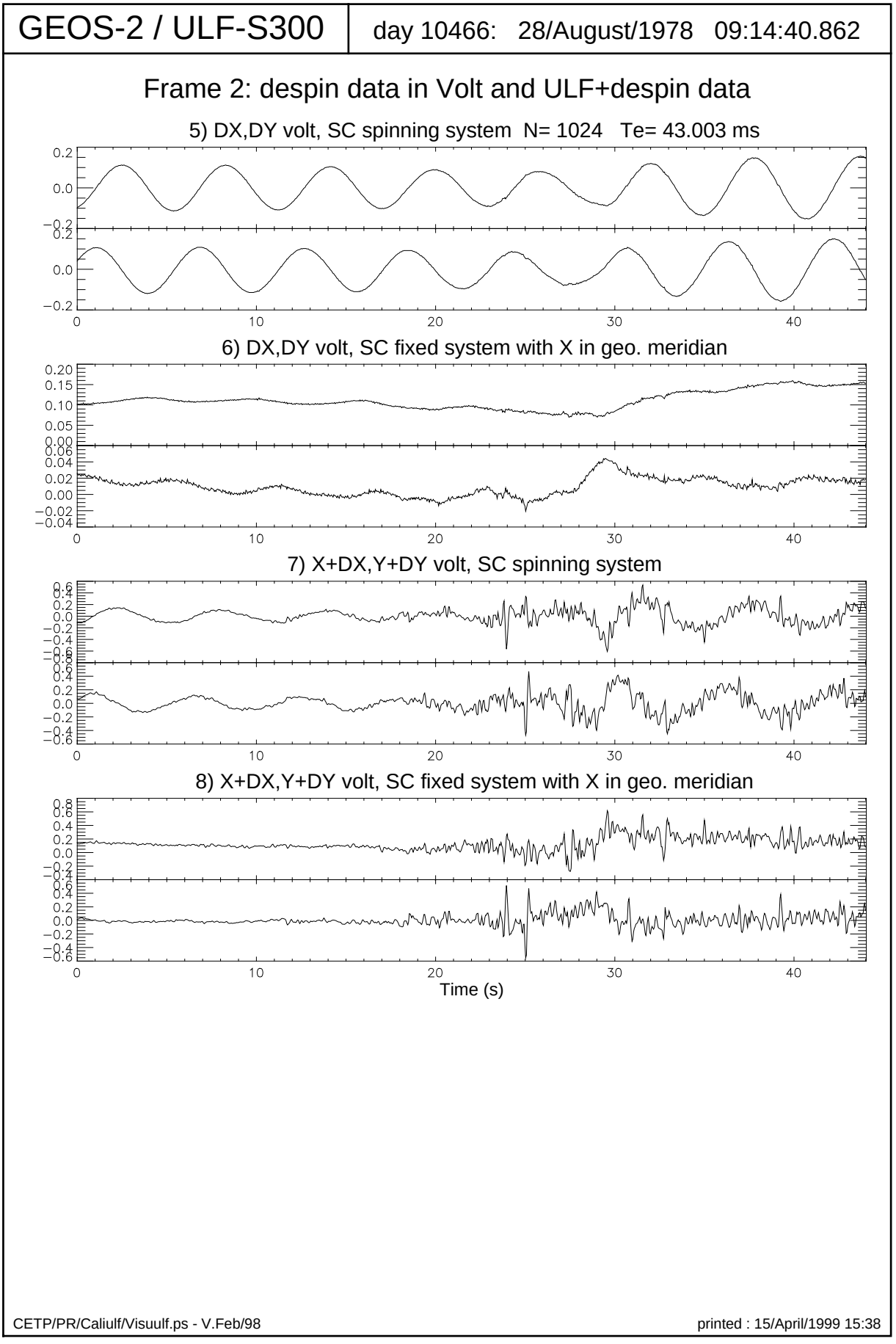
SpaceCraft fixed system in VDH:

	V	D	H	R	Theta	Phi
Xsc:	1.00000	0.00000	-0.00052	1.000	90.030	0.000
Ysc:	0.00000	0.99999	0.00451	1.000	89.742	90.000
Zsc:	0.00052	-0.00451	0.99999	1.000	0.259	-83.370

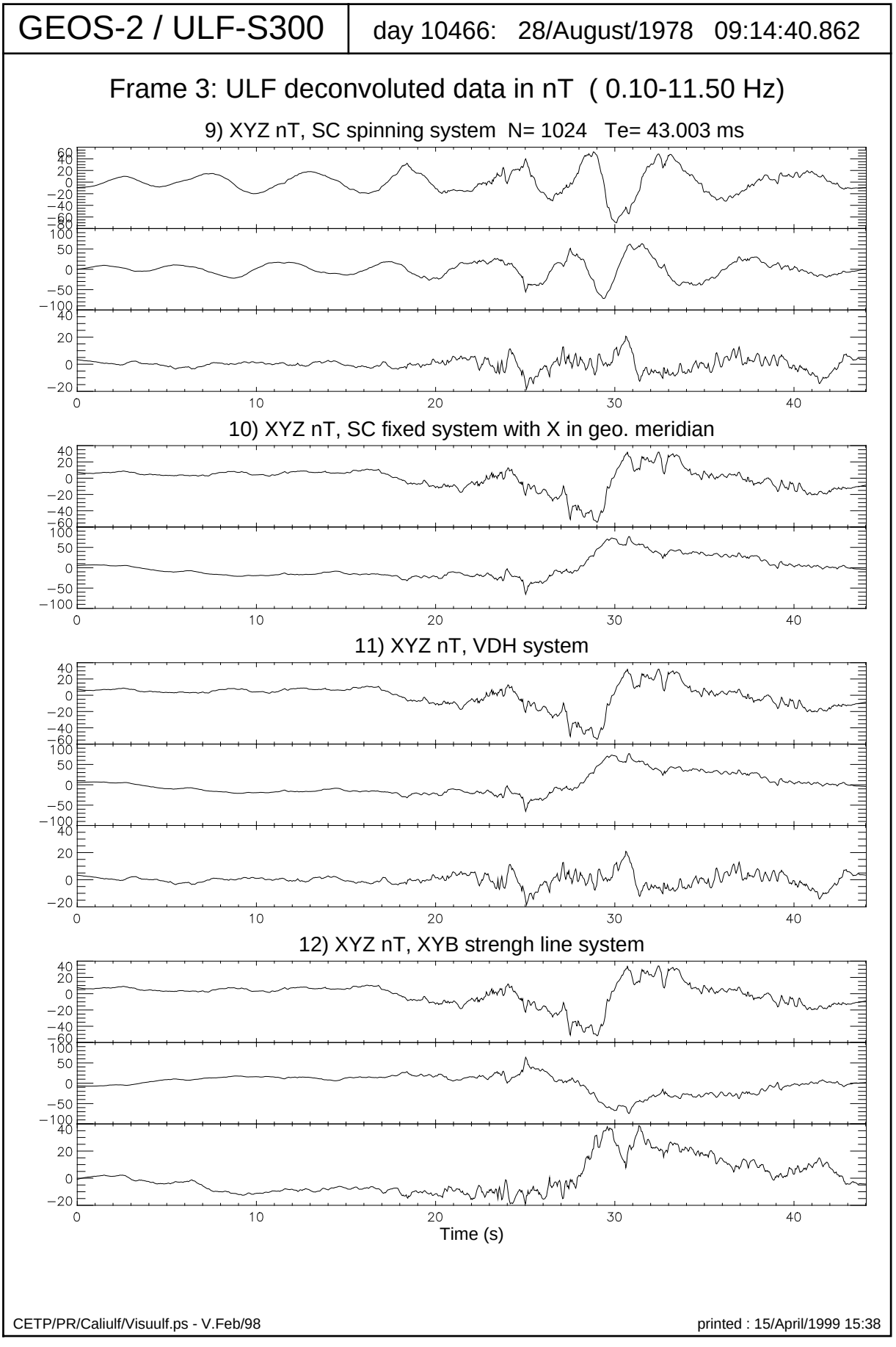
Spin frequency= 0.169815

CETP/PR/Caliulf/Visuulf.ps - V.Feb/98 printed : 15/April/1999 15:38

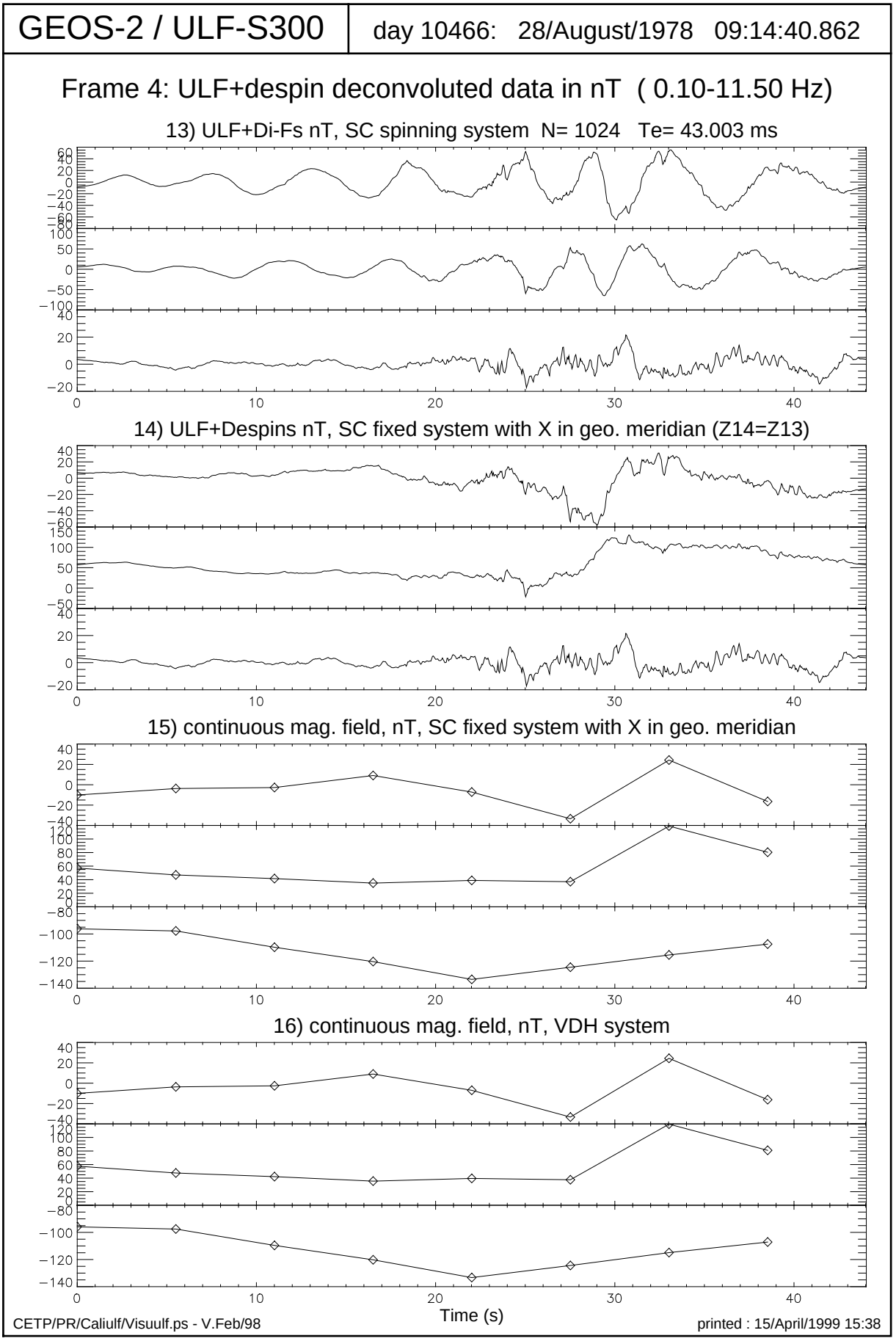
A4-b) Example of PostScript file corresponding to frame 2 (visuulf_s1_f2.ps):



A4-c) Example of PostScript file corresponding to frame 3 (visuulf_s1_f3.ps):



A4-d) Example of PostScript file corresponding to frame 4 (visuulf_s1_f4.ps):



Annexe 5: List of ULF files available from CDPP

The name of the GEOS-1 and GEOS-2 ULF data files available from the CDPP server are given below. The name contains the date and time of the beginning data period, for instance the `UBF_19770427_164141` files correspond to the data period from `1977/04/27-16:41:41`. The complete period is explained beside each name, and the size of each file, in Kbytes, is also given. The total size of the data sets are about 2.312 Go for GEOS-1 and 17.097 Go for GEOS-2.

A5-a) GEOS-1 Data Files

File names of a data set
Data set name : UBF_GEOS1
Ultra Low Frequency magnetic field data from GEOS1

Name	From	To	Size (Kb)
UBF_19770427_164141	1977/04/27-16:41:41	1977/05/06-16:15:55	26464
UBF_19770506_161030	1977/05/06-16:10:30	1977/05/12-19:02:24	29037
UBF_19770512_185659	1977/05/12-18:56:59	1977/05/18-21:08:30	29218
UBF_19770519_125416	1977/05/19-12:54:16	1977/05/24-18:43:04	28122
UBF_19770524_183739	1977/05/24-18:37:39	1977/05/31-15:06:18	28945
UBF_19770531_150053	1977/05/31-15:00:53	1977/06/06-14:56:38	30833
UBF_19770606_145113	1977/06/06-14:51:13	1977/06/12-14:46:57	30309
UBF_19770612_144133	1977/06/12-14:41:33	1977/06/17-19:34:34	30275
UBF_19770618_105338	1977/06/18-10:53:38	1977/06/22-18:25:42	25910
UBF_19770622_182017	1977/06/22-18:20:17	1977/06/28-18:16:04	29260
UBF_19770628_181039	1977/06/28-18:10:39	1977/07/03-18:37:21	27063
UBF_19770703_183157	1977/07/03-18:31:57	1977/07/08-18:58:39	29416
UBF_19770708_185314	1977/07/08-18:53:14	1977/07/13-16:23:50	29729
UBF_19770713_161825	1977/07/13-16:18:25	1977/07/18-16:45:08	29503
UBF_19770718_163943	1977/07/18-16:39:43	1977/07/23-17:06:26	30924
UBF_19770723_170101	1977/07/23-17:01:01	1977/07/28-17:27:45	30896
UBF_19770728_172220	1977/07/28-17:22:20	1977/08/02-11:56:46	26112
UBF_19770802_115122	1977/08/02-11:51:22	1977/08/07-18:10:20	29747
UBF_19770807_180455	1977/08/07-18:04:55	1977/08/13-12:08:24	30085
UBF_19770813_120259	1977/08/13-12:02:59	1977/08/14-16:36:02	8569
UBF_19770814_142810	1977/08/14-14:28:10	1977/08/19-09:02:38	29024
UBF_19770819_085713	1977/08/19-08:57:13	1977/08/23-09:54:53	26152
UBF_19770823_094929	1977/08/23-09:49:29	1977/08/27-16:39:25	30004
UBF_19770827_163400	1977/08/27-16:34:00	1977/09/01-14:04:34	30897
UBF_19770901_135910	1977/09/01-13:59:10	1977/09/06-11:29:45	30408
UBF_19770906_112420	1977/09/06-11:24:20	1977/09/12-14:16:13	25620
UBF_19770912_141048	1977/09/12-14:10:48	1977/09/17-14:37:31	31063
UBF_19770917_143206	1977/09/17-14:32:06	1977/09/22-14:58:49	29410
UBF_19770922_145325	1977/09/22-14:53:25	1977/09/27-06:31:44	27303
UBF_19770927_062619	1977/09/27-06:26:19	1977/10/02-12:45:17	29959
UBF_19771002_123952	1977/10/02-12:39:52	1977/10/07-04:18:13	25513
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A5-b) GEOS-2 Data Files

File names of a data set
Data set name : UBF_GEOS2
Ultra Low Frequency magnetic field data from GEOS2

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UBF_19790719_215518	1979/07/19-21:55:18	1979/07/21-23:54:56	31688
UBF_19790721_234932	1979/07/21-23:49:32	1979/07/24-01:49:10	31783

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UBF_19790726_033758	1979/07/26-03:37:58	1979/07/28-06:26:07	31705
UBF_19790728_062042	1979/07/28-06:20:42	1979/07/30-08:20:20	31750
UBF_19790730_081456	1979/07/30-08:14:56	1979/08/01-10:14:34	31664
UBF_19790801_100909	1979/08/01-10:09:09	1979/08/03-12:08:47	31695
UBF_19790803_120322	1979/08/03-12:03:22	1979/08/05-14:03:01	31656
UBF_19790805_135736	1979/08/05-13:57:36	1979/08/07-15:57:14	31857
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UBF_19790813_213430	1979/08/13-21:34:30	1979/08/15-23:34:08	31666
UBF_19790815_232843	1979/08/15-23:28:43	1979/08/18-01:28:21	31113
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UBF_19790820_031710	1979/08/20-03:17:10	1979/08/22-05:16:48	31700
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UBF_19790824_070537	1979/08/24-07:05:37	1979/08/26-09:05:15	31765
UBF_19790826_085950	1979/08/26-08:59:50	1979/08/28-10:59:29	31529
UBF_19790828_105404	1979/08/28-10:54:04	1979/08/30-12:53:42	31723
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UBF_19790901_151430	1979/09/01-15:14:30	1979/09/03-17:14:08	31789
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UBF_19791024_151058	1979/10/24-15:10:58	1979/10/26-17:10:37	31809
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UBF_19800608_163138	1980/06/08-16:31:38	1980/06/10-18:31:16	31141
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UBF_19810615_215147	1981/06/15-21:51:47	1981/06/19-20:55:05	31857
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UBF_19810623_185809	1981/06/23-18:58:09	1981/06/27-18:36:03	31857
UBF_19810627_183038	1981/06/27-18:30:38	1981/07/01-19:25:36	31857
UBF_19810701_192011	1981/07/01-19:20:11	1981/07/05-07:06:51	31857

UBF_19810705_070126	1981/07/05-07:01:26	1981/07/08-20:25:54	31857
UBF_19810708_202029	1981/07/08-20:20:29	1981/07/12-18:24:04	31857
UBF_19810712_181839	1981/07/12-18:18:39	1981/07/15-18:12:52	31857
UBF_19810715_180728	1981/07/15-18:07:28	1981/07/19-16:08:50	31857
UBF_19810719_160325	1981/07/19-16:03:25	1981/07/23-16:41:29	31857
UBF_19810723_163604	1981/07/23-16:36:04	1981/07/26-16:41:19	31857
UBF_19810726_163554	1981/07/26-16:35:54	1981/07/30-03:29:05	31857
UBF_19810730_032340	1981/07/30-03:23:40	1981/08/02-13:36:04	31857
UBF_19810802_133039	1981/08/02-13:30:39	1981/08/06-00:20:38	31857
UBF_19810806_001514	1981/08/06-00:15:14	1981/08/09-22:07:55	31857
UBF_19810809_220230	1981/08/09-22:02:30	1981/08/12-22:18:40	31857
UBF_19810812_221315	1981/08/12-22:13:15	1981/08/16-19:38:05	31857
UBF_19810816_193240	1981/08/16-19:32:40	1981/08/20-17:22:55	31857
UBF_19810820_171730	1981/08/20-17:17:30	1981/08/23-19:37:30	31850
UBF_19810823_193205	1981/08/23-19:32:05	1981/08/27-17:48:59	31857
UBF_19810827_174334	1981/08/27-17:43:34	1981/08/31-22:59:57	31857
UBF_19810831_225432	1981/08/31-22:54:32	1981/09/05-00:40:12	31857
UBF_19810905_003447	1981/09/05-00:34:47	1981/09/08-02:45:52	31719
UBF_19810908_024028	1981/09/08-02:40:28	1981/09/13-00:42:01	31857
UBF_19810913_003636	1981/09/13-00:36:36	1981/09/16-15:41:09	31857
UBF_19810916_153544	1981/09/16-15:35:44	1981/09/20-19:39:58	31857
UBF_19810920_193433	1981/09/20-19:34:33	1981/09/25-16:45:37	31857
UBF_19810925_164012	1981/09/25-16:40:12	1981/09/28-12:19:53	31857
UBF_19810928_121429	1981/09/28-12:14:29	1981/10/02-19:25:49	31857
UBF_19811002_192024	1981/10/02-19:20:24	1981/10/06-03:37:15	31857
UBF_19811006_033151	1981/10/06-03:31:51	1981/10/10-20:24:04	31857
UBF_19811010_201839	1981/10/10-20:18:39	1981/10/14-07:12:32	31857
UBF_19811014_070707	1981/10/14-07:07:07	1981/10/17-18:10:39	31857
UBF_19811017_180514	1981/10/17-18:05:14	1981/10/21-17:34:28	31857
UBF_19811021_172904	1981/10/21-17:29:04	1981/10/24-17:52:05	31857
UBF_19811024_174640	1981/10/24-17:46:40	1981/10/29-16:33:20	31857
UBF_19811029_162755	1981/10/29-16:27:55	1981/11/02-04:13:27	31857
UBF_19811102_040802	1981/11/02-04:08:02	1981/11/06-02:16:29	31857
UBF_19811106_021104	1981/11/06-02:11:04	1981/11/09-02:16:41	31857
UBF_19811109_021116	1981/11/09-02:11:16	1981/11/12-22:19:51	31857
UBF_19811112_221426	1981/11/12-22:14:26	1981/11/16-21:37:10	31857
UBF_19811116_213145	1981/11/16-21:31:45	1981/11/19-22:15:05	31857
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UBF_19811123_210911	1981/11/23-21:09:11	1981/11/27-19:55:00	31857
UBF_19811127_194935	1981/11/27-19:49:35	1981/11/30-19:59:26	31857
UBF_19811130_195401	1981/11/30-19:54:01	1981/12/04-18:52:15	31857
UBF_19811204_184650	1981/12/04-18:46:50	1981/12/07-18:58:26	31857
UBF_19811207_185301	1981/12/07-18:53:01	1981/12/11-18:45:12	31857
UBF_19811211_183947	1981/12/11-18:39:47	1981/12/15-17:06:30	31850
UBF_19811215_170105	1981/12/15-17:01:05	1981/12/18-17:21:14	31857
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UBF_19811227_030847	1981/12/27-03:08:47	1981/12/30-03:28:21	31857
UBF_19811230_032257	1981/12/30-03:22:57	1982/01/03-01:13:54	31857
UBF_19820103_010829	1982/01/03-01:08:29	1982/01/06-20:52:08	31857
UBF_19820110_083056	1982/01/10-08:30:56	1982/01/13-19:53:48	31857
UBF_19820113_194823	1982/01/13-19:48:23	1982/01/17-17:53:03	31857
UBF_19820117_174738	1982/01/17-17:47:38	1982/01/20-19:22:07	31857
UBF_19820120_191643	1982/01/20-19:16:43	1982/01/24-18:12:27	31857
UBF_19820124_180702	1982/01/24-18:07:02	1982/01/28-17:09:40	31857
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UBF_19820212_043027	1982/02/12-04:30:27	1982/02/13-05:10:04	8493
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UBF_19820227_005522	1982/02/27-00:55:22	1982/03/01-16:45:51	31857
UBF_19820301_164026	1982/03/01-16:40:26	1982/03/05-18:58:32	31857
UBF_19820305_185308	1982/03/05-18:53:08	1982/03/08-02:24:07	31857
UBF_19820308_021842	1982/03/08-02:18:42	1982/03/15-08:07:56	31857
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UBF_19820326_044754	1982/03/26-04:47:54	1982/03/30-20:24:48	31857
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UBF_19820418_224538	1982/04/18-22:45:38	1982/04/21-01:30:33	31857
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UBF_19820426_043411	1982/04/26-04:34:11	1982/04/30-03:03:03	31857
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UBF_19820612_230706	1982/06/12-23:07:06	1982/06/16-11:39:10	31857
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UBF_19820630_162801	1982/06/30-16:28:01	1982/07/02-19:47:18	31857
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UBF_19820722_185711	1982/07/22-18:57:11	1982/07/25-00:50:15	31857
UBF_19820725_004450	1982/07/25-00:44:50	1982/07/27-04:47:39	31857
UBF_19820729_145719	1982/07/29-14:57:19	1982/07/31-17:10:09	31857
UBF_19820731_170445	1982/07/31-17:04:45	1982/08/02-21:03:00	31857
UBF_19820802_205735	1982/08/02-20:57:35	1982/08/05-12:39:03	31857
UBF_19820805_123338	1982/08/05-12:33:38	1982/08/07-20:07:35	31857
UBF_19820807_200210	1982/08/07-20:02:10	1982/08/09-22:41:55	31857
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UBF_19820821_220521	1982/08/21-22:05:21	1982/08/24-00:24:38	31857
UBF_19820824_001913	1982/08/24-00:19:13	1982/08/27-08:30:37	31853
UBF_19820827_082512	1982/08/27-08:25:12	1982/08/29-12:11:37	31857
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UBF_19820905_121736	1982/09/05-12:17:36	1982/09/09-17:08:47	31857
UBF_19820909_170322	1982/09/09-17:03:22	1982/09/12-15:17:52	31857
UBF_19820912_151228	1982/09/12-15:12:28	1982/09/16-07:22:28	31857
UBF_19820916_071703	1982/09/16-07:17:03	1982/09/19-16:51:27	31855
UBF_19820919_164603	1982/09/19-16:46:03	1982/09/23-13:17:12	31578
UBF_19820923_131148	1982/09/23-13:11:48	1982/09/26-04:08:30	31857
UBF_19820926_040314	1982/09/26-04:03:14	1982/09/29-13:24:48	31857
UBF_19821003_014330	1982/10/03-01:43:30	1982/10/06-12:48:41	31857
UBF_19821006_124316	1982/10/06-12:43:16	1982/10/10-00:40:11	31857
UBF_19821010_003446	1982/10/10-00:34:46	1982/10/12-02:44:17	31857
UBF_19821014_063002	1982/10/14-06:30:02	1982/10/16-09:21:56	31857
UBF_19821016_091631	1982/10/16-09:16:31	1982/10/18-20:54:18	31857
UBF_19821018_204853	1982/10/18-20:48:53	1982/10/21-01:06:59	31857
UBF_19821021_010134	1982/10/21-01:01:34	1982/10/23-07:46:13	31857
UBF_19821023_074048	1982/10/23-07:40:48	1982/10/25-09:43:00	31857
UBF_19821027_124327	1982/10/27-12:43:27	1982/10/29-14:59:47	31857
UBF_19821029_145422	1982/10/29-14:54:22	1982/10/31-16:56:17	31857
UBF_19821031_165052	1982/10/31-16:50:52	1982/11/02-23:33:56	31857
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UBF_19821109_090718	1982/11/09-09:07:18	1982/11/11-12:28:31	31857
UBF_19821115_183117	1982/11/15-18:31:17	1982/11/17-20:48:34	31857

UBF_19821117_204309	1982/11/17-20:43:09	1982/11/19-22:55:28	31857
UBF_19821119_225003	1982/11/19-22:50:03	1982/11/22-00:49:54	31857
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UBF_19821126_043627	1982/11/26-04:36:27	1982/11/28-06:38:12	31857
UBF_19821202_104457	1982/12/02-10:44:57	1982/12/04-12:55:50	31857
UBF_19821204_125025	1982/12/04-12:50:25	1982/12/07-07:13:18	31857
UBF_19821207_070754	1982/12/07-07:07:54	1982/12/09-10:00:52	31857
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UBF_19821213_145157	1982/12/13-14:51:57	1982/12/15-17:05:24	31857
UBF_19821215_165959	1982/12/15-16:59:59	1982/12/17-19:05:41	31857
UBF_19821217_190016	1982/12/17-19:00:16	1982/12/19-21:12:57	31857
UBF_19821219_210732	1982/12/19-21:07:32	1982/12/23-02:42:56	31857
UBF_19821225_045010	1982/12/25-04:50:10	1982/12/27-06:59:38	31857
UBF_19821227_065413	1982/12/27-06:54:13	1982/12/29-08:58:47	31857
UBF_19821229_085322	1982/12/29-08:53:22	1982/12/31-11:04:38	31857
UBF_19821231_105914	1982/12/31-10:59:14	1983/01/02-13:04:10	31857
UBF_19830104_175729	1983/01/04-17:57:29	1983/01/06-19:57:25	31857
UBF_19830110_234117	1983/01/10-23:41:17	1983/01/13-02:47:47	31857
UBF_19830117_100033	1983/01/17-10:00:33	1983/01/19-13:57:51	32332
UBF_19830119_135226	1983/01/19-13:52:26	1983/01/21-17:12:36	31857
UBF_19830121_170711	1983/01/21-17:07:11	1983/01/23-20:02:04	31857
UBF_19830123_195639	1983/01/23-19:56:39	1983/01/25-22:17:07	31857
UBF_19830125_221143	1983/01/25-22:11:43	1983/01/28-00:14:15	31857
UBF_19830128_000850	1983/01/28-00:08:50	1983/01/30-02:31:40	31857
UBF_19830130_022615	1983/01/30-02:26:15	1983/01/31-22:02:46	26584

Annexe 6: Example of caliaux.out file

```
                              GEOS-1 / GEOS-2

                              CALIAUX V 2.0

          Decommutation et calibration des donnees auxiliaires

                                                P.Robert, CETP, Fevrier  1996
                                           Version pour le CDPP, Aout    1999

 lfauxin:

 Nom du fichier de donnees auxiliaires ?
 /data1/ida/robert/geos/geosdata/DAVL-GEOS1

 Date (jj,mm,aa) ? [27,04,1977]
   21  12  1977
 Heure de debut (hh,mn,ss) ? [15,00,00]
   0  1  30
 Duree de la periode (jours) ? [3]
     3.00000

 resume des parametres d'entree:
 21 12 1977 00 01 30    3.00

 soit   2943 blocs de     88.0646 sec.
 ------------------------------------------------------------------------------
 calgeos:

 GEOS-1/2:  GEOS-1
 ------------------------------------------------------------------------------
 sensrot:

 sens de rotation= proton
 ------------------------------------------------------------------------------
 posfic: positionnement sur fichier de type davl

         debut fichier : njul50,ih,im,is     =   9978 14 56 56

         fichier correspondant a GEOS-1
         nombre de records:     399240
         taille en octets :   25551360

         fin fichier   :                     =  10400 23 10 20
         demande       :                     =  10216  0  1 30
         fait          : njul50,ih,im,is,imil=  10216  0  1 21 774
 ------------------------------------------------------------------------------
 eentaux:

 Donnees Auxiliaires GEOS - Resultats de caliaux.exe
 parametre d'entree: 21 12 1977 00 01 30    3.00
 GEOS:     1
 Nombre de blocs :   2943
 ------------------------------------------------------------------------------
 ecdavl: premier bloc

 nrec  nJul  millisec   num lsf   lat    long   R km  sunsat   rasc   decli Qua
    1 10216     81774  22346944  20.65   54.40 32750.  51.24   0.00    3.93   0

       SpinX   SpinY   SpinZ    Dip_X   Dip_Y   Dip_Z    Sun_X   Sun_Y   Sun_Z
      -0.0013 -0.0998 -0.9948   0.2409 -0.1628  0.9567  -0.6259  0.7564 -0.1891
-------------------------------------------------------------------------------
    3 10216    258305  22347072   constime: milt,idif=       257905      -400
    4 10216    345974  22347136   constime: milt,idif=       346369       395
```

```
  83 10216   7303078  22352192   constime: milt,idif=      7303173        95
  84 10216   7391240  22352256   constime: milt,idif=      7391142       -98
 359 10216  31609089  22369856   constime: milt,idif=     31609164        75
 390 10216  34339168  22371840   constime: milt,idif=     34339073       -95
 936 10216  82422994  22406784   constime: milt,idif=     82422112      -882
 940 10216  82774368  22407040   constime: milt,idif=     82775258       890
 941 10216  82863326  22407104   constime: milt,idif=     82862432      -894
 944 10216  83126624  22407296   constime: milt,idif=     83127523       899
 950 10216  83655923  22407680   constime: milt,idif=     83655008      -915
1337 10217  31337134  22432448   constime: milt,idif=     31337228        94
1350 10217  32482068  22433280   constime: milt,idif=     32481966      -102
1925 10217  83118405  22470080   constime: milt,idif=     83118868       463
2299 10218  29654769  22494016   constime: milt,idif=     29654870       101
2310 10218  30623581  22494720   constime: milt,idif=     30623473      -108
2901 10218  82670318  22532544   constime: milt,idif=     82669405      -913
--------------------------------------------------------------------------------
ecdavl: dernier bloc

nrec  nJul  millisec   num lsf   lat    long   R km  sunsat   rasc   decli Qua
2943 10218  86369096  22535232  21.43   54.09 33600.  50.06   0.00    3.78   0

      SpinX   SpinY   SpinZ    Dip_X   Dip_Y   Dip_Z    Sun_X   Sun_Y   Sun_Z
     -0.0197 -0.1146 -0.9930   0.2547 -0.1634  0.9530  -0.6419  0.7463 -0.1751


================================================================================
efinpro:  fin normale de caliaux` ////////////////////////////////////////////
================================================================================
```

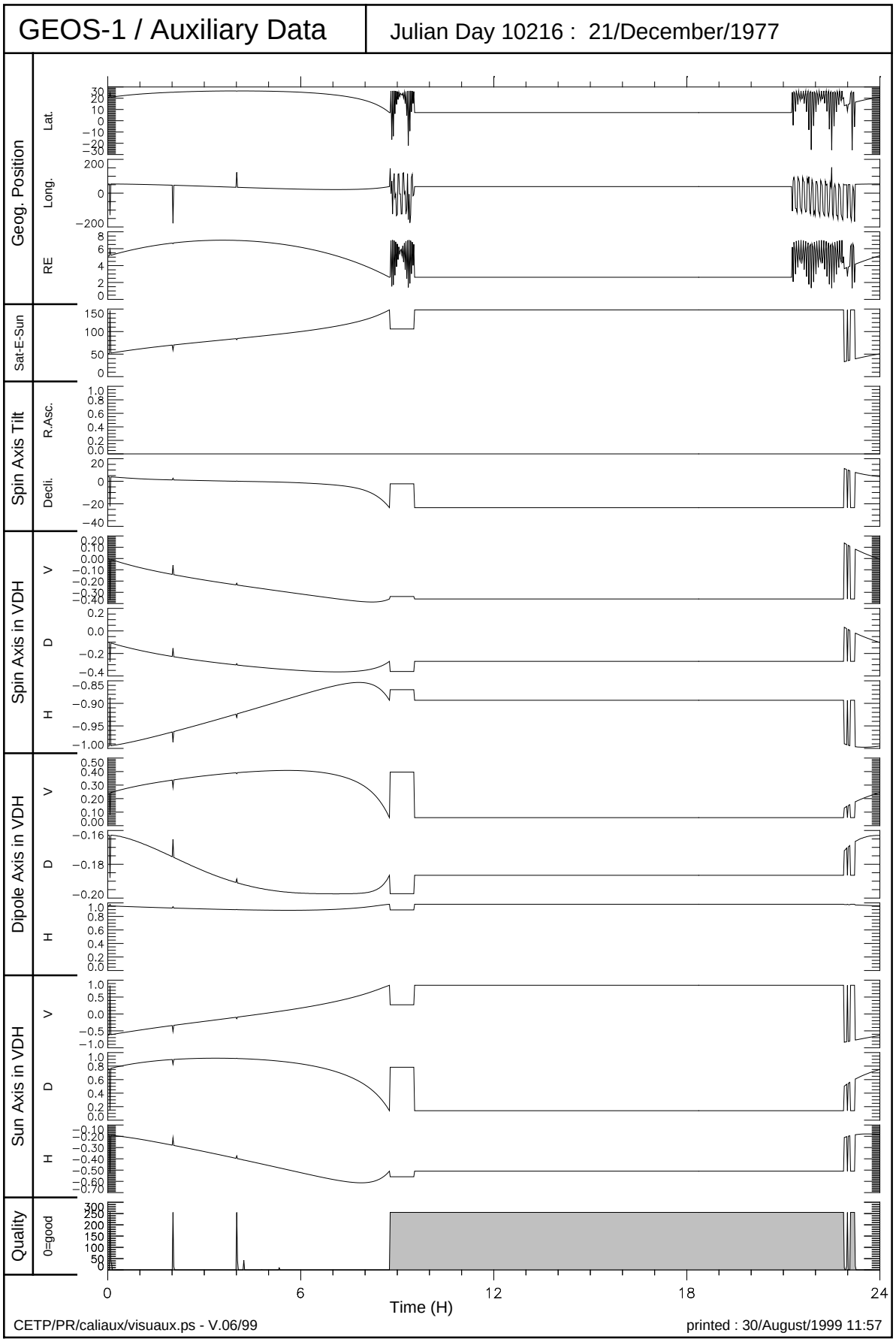
Annexe 7: Example of caliaux.resu file

```
GEOS Auxiliary Data - Results of caliaux.exe
Input Parameters:
21 12 1977 00 01 30    3.00
GEOS:
     1
Number of blocs:
  2943
Starting date (njul50,iday,imonth,iyear)
10216 21 12 1977
Starting Time (ih, im, is, ims)
  0  1 21 774
 nrec  nJul  millisec   num lsf   lat    long   R km  sunsat   rasc   decli Qua
       SpinX   SpinY   SpinZ    Dip_X   Dip_Y   Dip_Z    Sun_X   Sun_Y   Sun_Z
    1 10216     81774  22346944  20.65   54.40 32750.  51.24   0.00    3.93   0
      -0.0013 -0.0998 -0.9948   0.2409 -0.1628  0.9567  -0.6259  0.7564 -0.1891
    2 10216    169841  22347008  20.75   54.40 32930.  51.55   0.00    3.90   0
      -0.0036 -0.1020 -0.9946   0.2425 -0.1628  0.9563  -0.6217  0.7597 -0.1898
    3 10216    258305  22347072  24.76 -129.57 37700. 146.93   0.00  -22.16 255
      -0.3713 -0.2742 -0.8868   0.0842 -0.1880  0.9785   0.8379  0.1430 -0.5265
    4 10216    345974  22347136  20.99   54.38 33380.  52.34   0.00    3.82  38
      -0.0095 -0.1077 -0.9940   0.2467 -0.1628  0.9552  -0.6108  0.7680 -0.1916
    5 10216    434040  22347200  21.07   54.37 33520.  52.58   0.00    3.79  27
      -0.0113 -0.1095 -0.9938   0.2480 -0.1628  0.9549  -0.6074  0.7706 -0.1922
    6 10216    522105  22347264  21.12   54.36 33620.  52.75   0.00    3.77   0
      -0.0126 -0.1107 -0.9936   0.2489 -0.1628  0.9547  -0.6051  0.7723 -0.1926
    7 10216    610171  22347328  21.22   54.34 33790.  53.05   0.00    3.73   0
      -0.0148 -0.1128 -0.9933   0.2505 -0.1629  0.9542  -0.6010  0.7753 -0.1933
    8 10216    698237  22347392  21.31   54.32 33960.  53.33   0.00    3.69   0
      -0.0170 -0.1149 -0.9931   0.2521 -0.1629  0.9538  -0.5970  0.7782 -0.1940
    9 10216    786303  22347456  21.40   54.29 34120.  53.62   0.00    3.64   0
      -0.0192 -0.1169 -0.9928   0.2536 -0.1630  0.9534  -0.5930  0.7811 -0.1948
   10 10216    874369  22347520  21.49   54.26 34290.  53.90   0.00    3.60   0
      -0.0214 -0.1190 -0.9925   0.2552 -0.1630  0.9530  -0.5891  0.7839 -0.1955

 . . . . . .

 2931 10218  85312303  22534464  20.18   54.09 31450.  46.34   0.00    4.72   0
       0.0090 -0.0878 -0.9959   0.2339 -0.1634  0.9583  -0.6902  0.7032 -0.1698
 2932 10218  85400369  22534528  20.30   54.11 31630.  46.67   0.00    4.63   0
       0.0064 -0.0902 -0.9957   0.2358 -0.1633  0.9579  -0.6861  0.7072 -0.1701
 2933 10218  85488435  22534592  20.41   54.13 31820.  46.99   0.00    4.54   0
       0.0039 -0.0925 -0.9955   0.2376 -0.1633  0.9574  -0.6820  0.7110 -0.1704
 2934 10218  85576501  22534656  20.52   54.14 32010.  47.31   0.00    4.46   0
       0.0014 -0.0948 -0.9953   0.2394 -0.1633  0.9570  -0.6779  0.7149 -0.1707
 2935 10218  85664567  22534720  20.63   54.15 32190.  47.63   0.00    4.37   0
      -0.0009 -0.0971 -0.9951   0.2412 -0.1632  0.9566  -0.6738  0.7186 -0.1711
 2936 10218  85752633  22534784  20.74   54.15 32370.  47.94   0.00    4.29   0
      -0.0033 -0.0994 -0.9949   0.2430 -0.1632  0.9561  -0.6697  0.7223 -0.1715
 2937 10218  85840699  22534848  20.84   54.16 32550.  48.25   0.00    4.21   0
      -0.0057 -0.1017 -0.9946   0.2447 -0.1632  0.9557  -0.6657  0.7259 -0.1719
 2938 10218  85928766  22534912  20.94   54.15 32730.  48.56   0.00    4.14   0
      -0.0081 -0.1039 -0.9944   0.2464 -0.1632  0.9552  -0.6617  0.7295 -0.1724
 2939 10218  86016832  22534976  21.04   54.15 32910.  48.86   0.00    4.06   0
      -0.0105 -0.1061 -0.9941   0.2481 -0.1633  0.9548  -0.6577  0.7330 -0.1729
 2940 10218  86104898  22535040  21.14   54.14 33080.  49.17   0.00    3.99   0
      -0.0128 -0.1082 -0.9939   0.2498 -0.1633  0.9543  -0.6537  0.7364 -0.1734
 2941 10218  86192964  22535104  21.24   54.13 33260.  49.47   0.00    3.92   0
      -0.0151 -0.1104 -0.9936   0.2514 -0.1633  0.9539  -0.6497  0.7398 -0.1740
 2942 10218  86281030  22535168  21.33   54.11 33430.  49.76   0.00    3.85   0
      -0.0174 -0.1125 -0.9933   0.2531 -0.1633  0.9535  -0.6458  0.7431 -0.1745
 2943 10218  86369096  22535232  21.43   54.09 33600.  50.06   0.00    3.78   0
      -0.0197 -0.1146 -0.9930   0.2547 -0.1634  0.9530  -0.6419  0.7463 -0.1751
```

Annexe 8: Example of Auxiliary visualisation data



NOTES