R O S E T T A

FLIGHT REPORTS
of RPC–MAG

RO–IGEP–TR–0029

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Report of the

Third Earth Swing by (EAR3)

Time period: November 09 - 17, 2009

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Contents

1 Introduction

ROSETTA's third Earth Swing by (EAR3, ESB3) took place in the time interval November, 09 – 17, 2009. RPC-MAG was switched on from 2009-11-09T19:42:18 until 2009-11-17T17:15:00. The instrument performance was excellent.

This document gives a brief description of the executed activities and shows the obtained data. Housekeeping data (Temperature of the OB & IB sensor, Filter Stages A & B, Filter configuration register, Reference voltage, negative and positive 5V supply voltage, and the coarse HK sampled magnetic field data of the OB sensor) are presented as well as magnetic field science data of the OB and IB sensor in the activated modes. Magnetic field data are plotted in s/c coordinates and ECLIPJ2000 coordinates if not otherwise stated. They are calibrated according to the results of the ground calibration and the results of the inflight temperature model 009 using the actual flight data. Sensitivity, Misalignment, and Temperature effects are taken into account. The s/c residual field is not subtracted.

The data quality will be assessed and a comparison between OB and IB sensor will be presented in section 4.

Magnetic field data in GSE-coordinates are plotted in chapter 5. The detected magnetosphereic regions and plasma boundaries are presented in section 6.

The close Earth Swing by was a unique chance to check and improve the calibration of the instrument and to compare the measured field with a theoretical model (POMME) of the earth. These investigations will be presented in chapter 7.

Also the comparison of our magnetic field data with data measured by different spacecrafts (e.g WIND & ACE) can give information about the data quality. A comparison to the WIND & ACE data can be found in section 8.

The spectra of the magnetic field data measured by the OB sensor are plotted in section 9. As usual an influence of ROSETTAs reaction wheels (refer to section 10) can be seen in Burstmode.

A temperature profile for the whole Earth Swing by is shown in section 11.

The LANDER Magnetometer ROMAP was NOT switched on at this Swing by, so no data comparison between these two instruments can be made this time.

At the end of the Swing by a remaining Interference Test between MAG and LAP has been executed. This test took place from November 16, 15:00 until November 17, 17:15. The results can be found in in the Report RO-IGEP-TR0030.

2 The Swing by Geometry

This section gives an overview about the trajectory during the Swing by. ROSETTA approached through the night side within 5 days (November 9 until November 13), had its closest approach on November 13 at 07:45:30, and left through magnetopause and bow shock and the dayside. The closest approach distance to the Earth's surface was 2840 km.

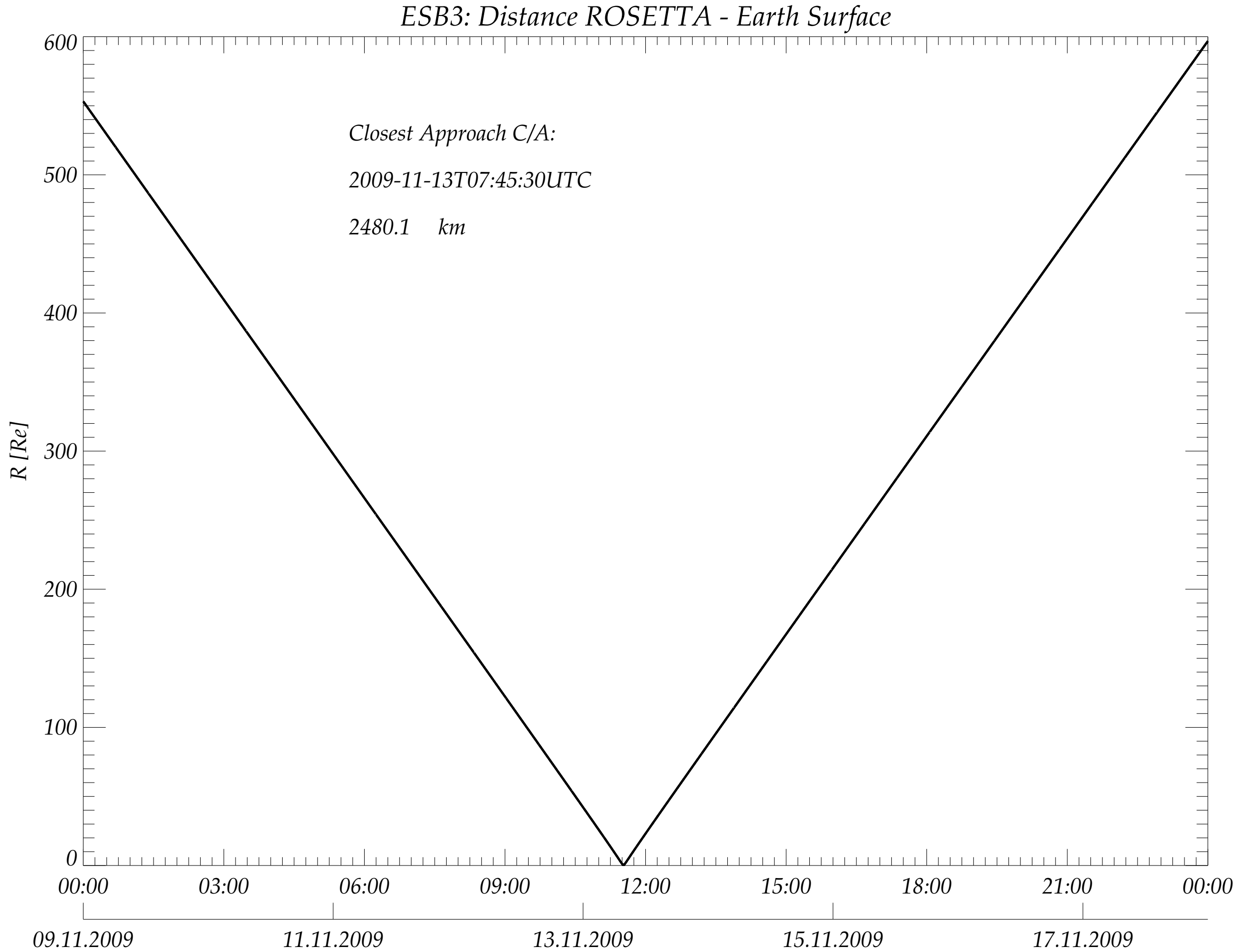


Figure 1: ROSETTA'S Distance to the EARTH'S Surface

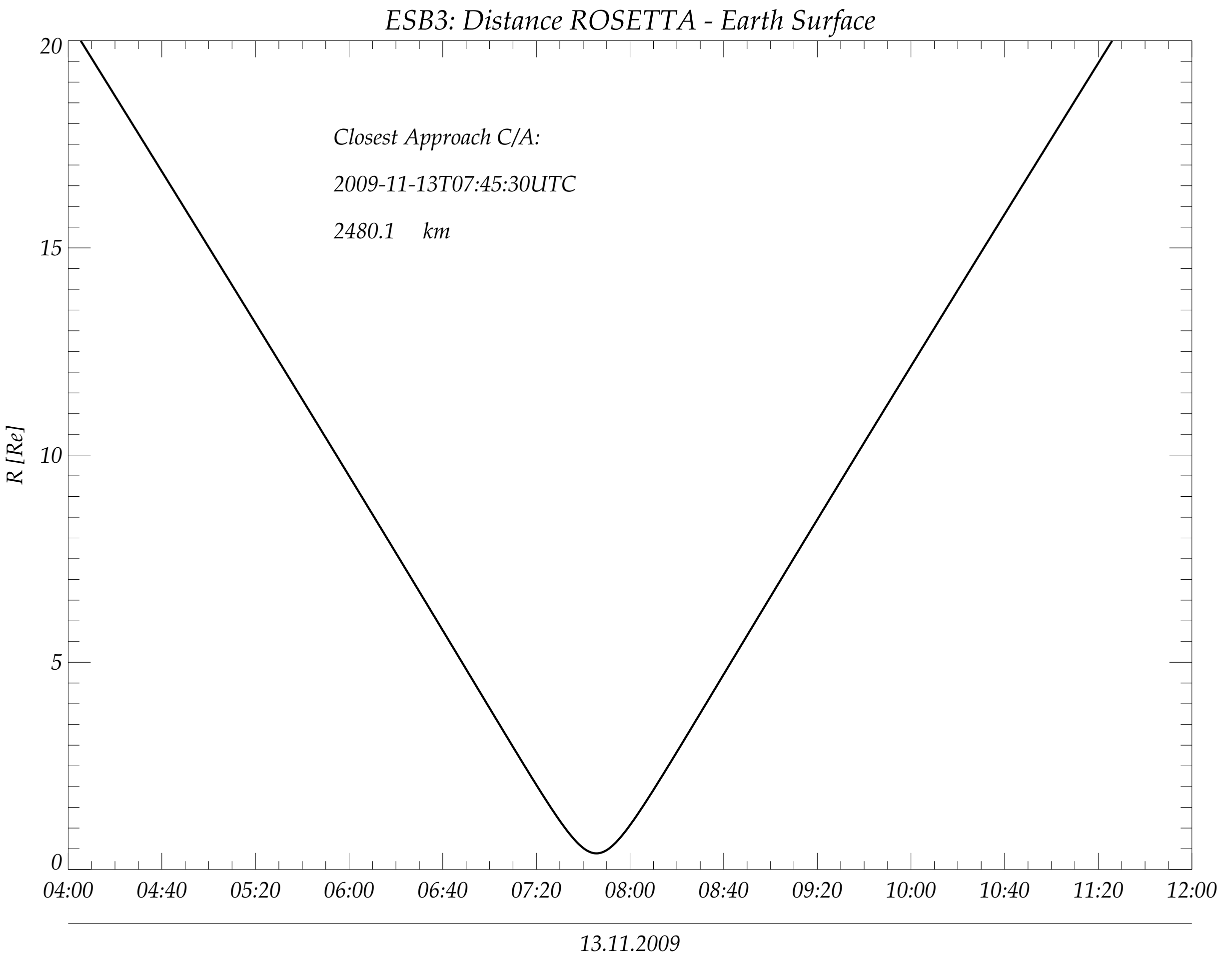


Figure 2: ROSETTA'S Distance to the EARTH'S Surface - zoomed view

The Figures 3 and 4 show the trajectory of ROSETTA in the plasma regime in the vicinity of the Earth. The used coordinate system is GSM (Geocentered Solar Magnetic), the black lines represent magnetic field lines derived from the Tsyganenko model, the dotted black line is the Bow Shock, the red line represents the magnetopause. The tick marks on ROSETTA's blue colored trajectory are two-hourly spaced. The magnetopause has been modelled using a dynamic pressure of 1.17nPa. This value has been derived from WIND and ACE measurements at that observing time. Refer to section 6 for a comparison with the measured data onboard ROSETTA.

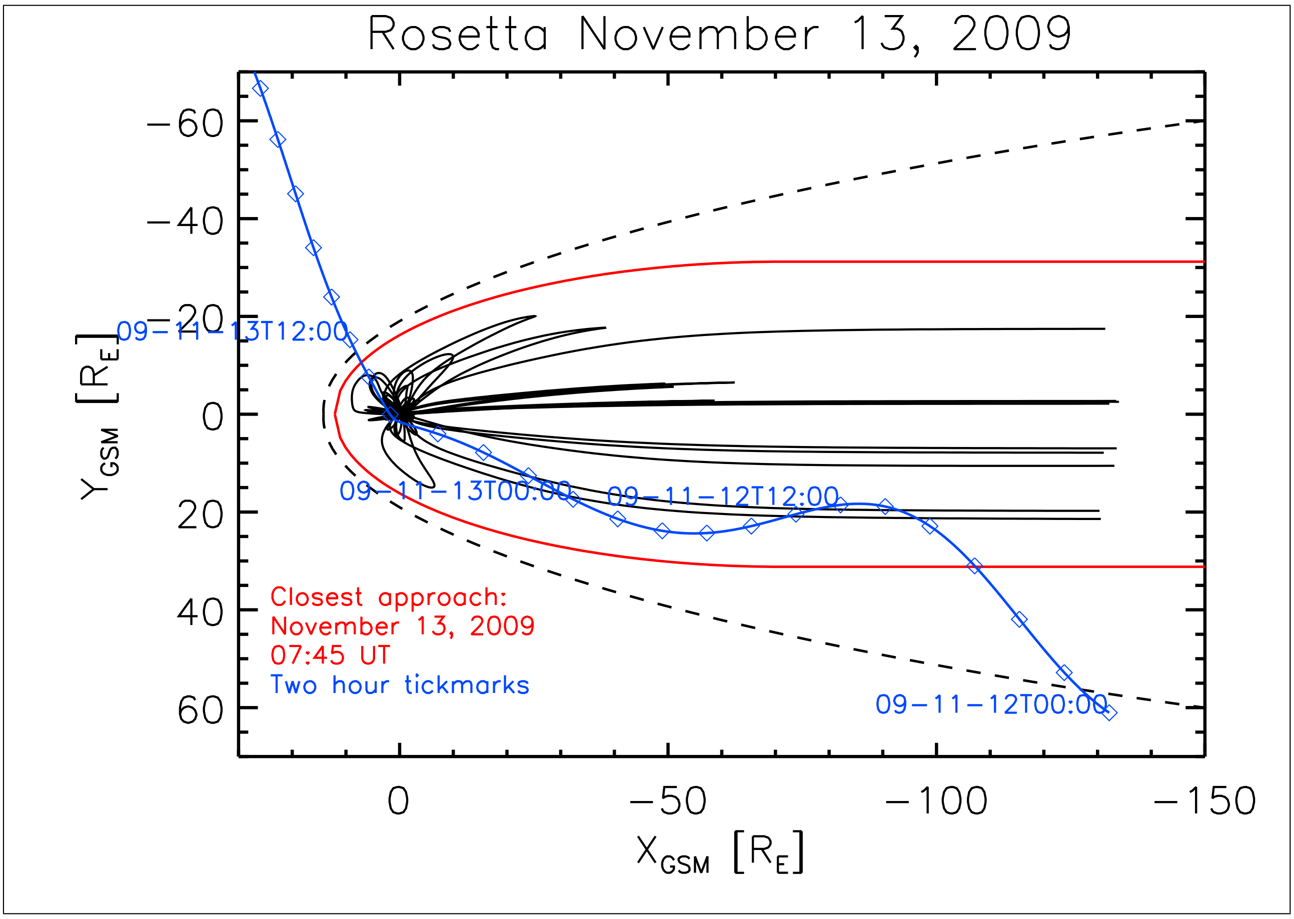


Figure 3: ROSETTA'S Swing by Trajectory in GSM coordinates: XY–Plane

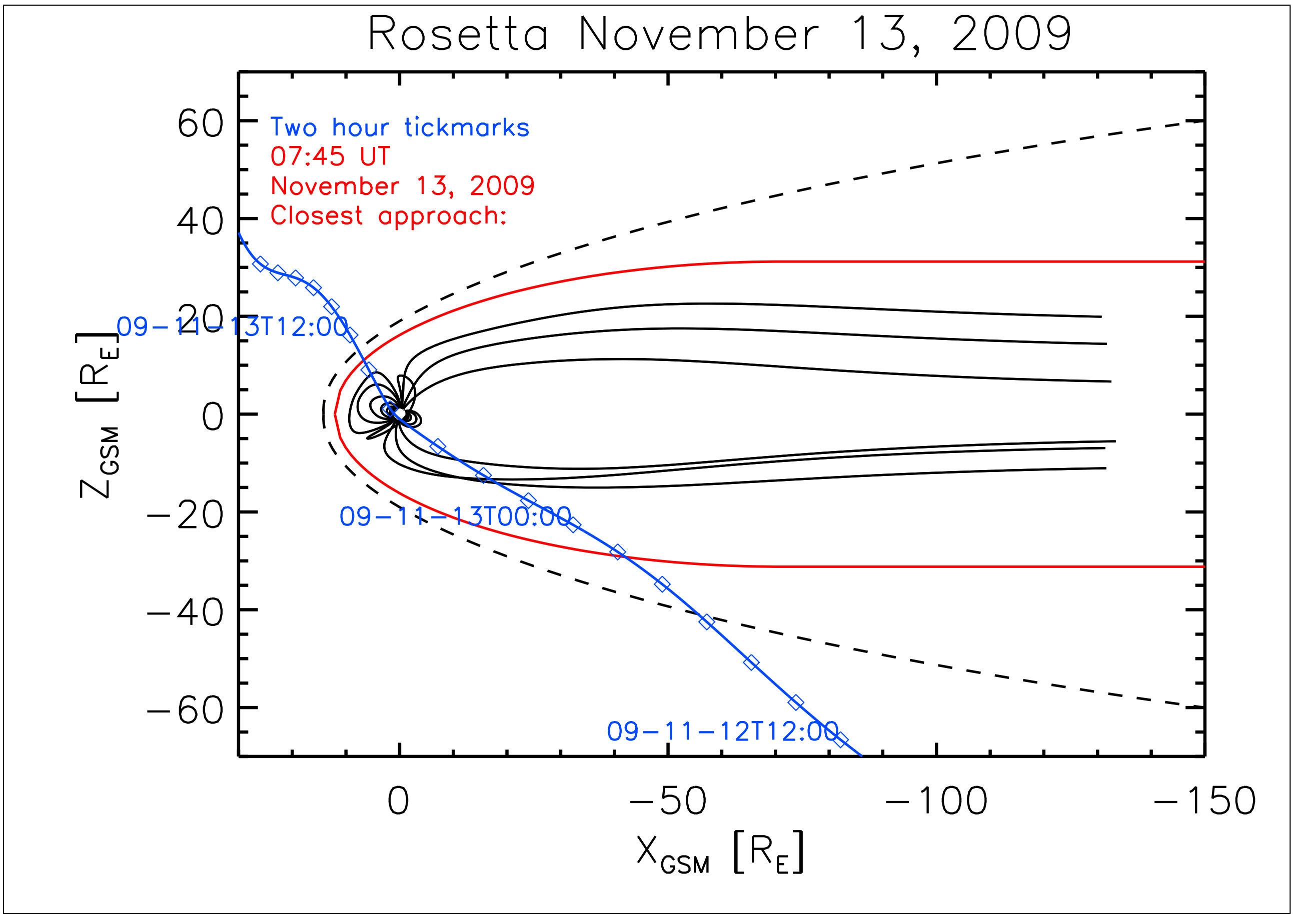


Figure 4: ROSETTA'S Swing by Trajectory in GSM coordinates: XZ–Plane

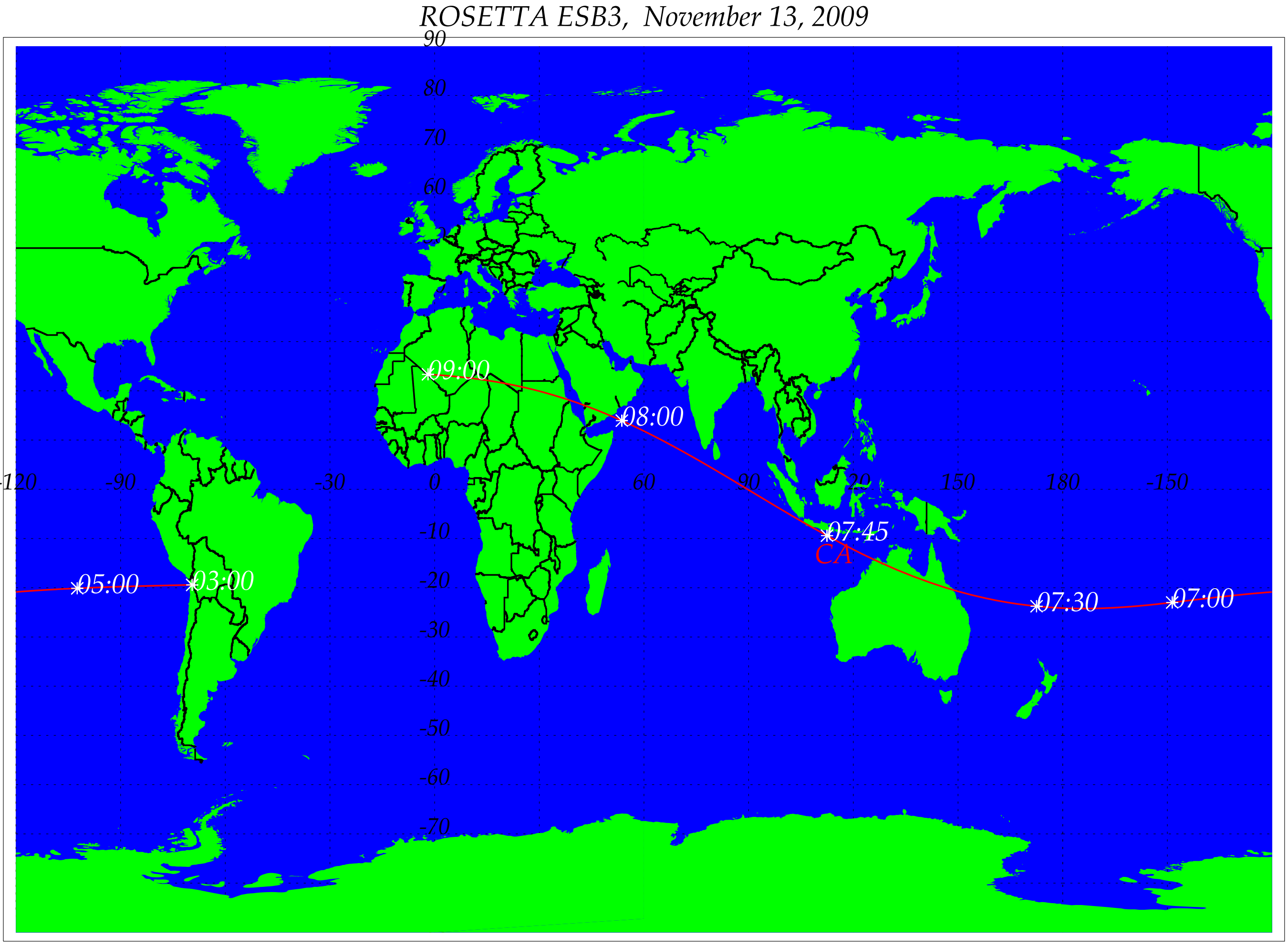


Figure 5: ROSETTA'S Ground Track during the Swing by

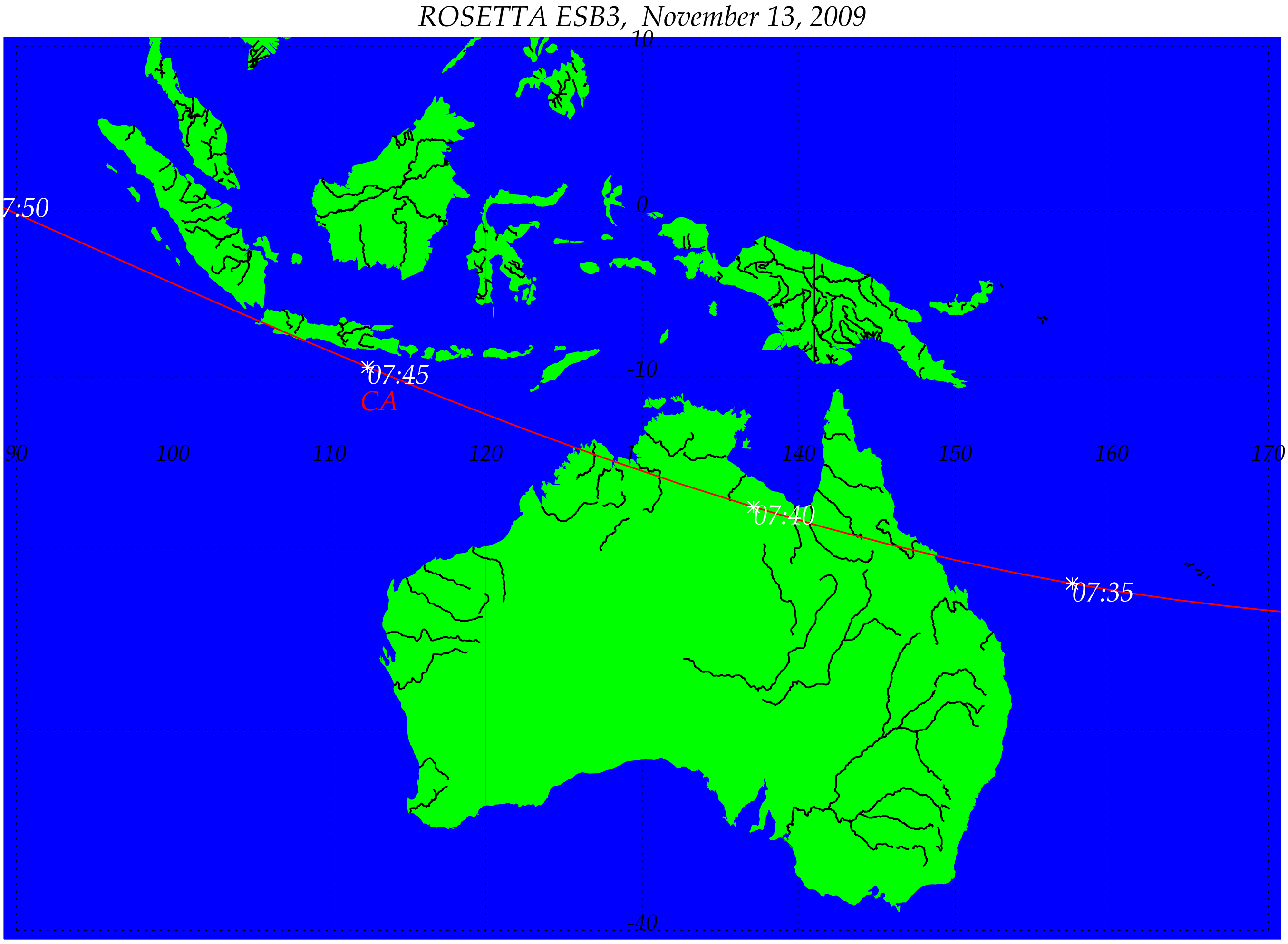


Figure 6: ROSETTA'S Ground Track during the Swing by (Zoomed)

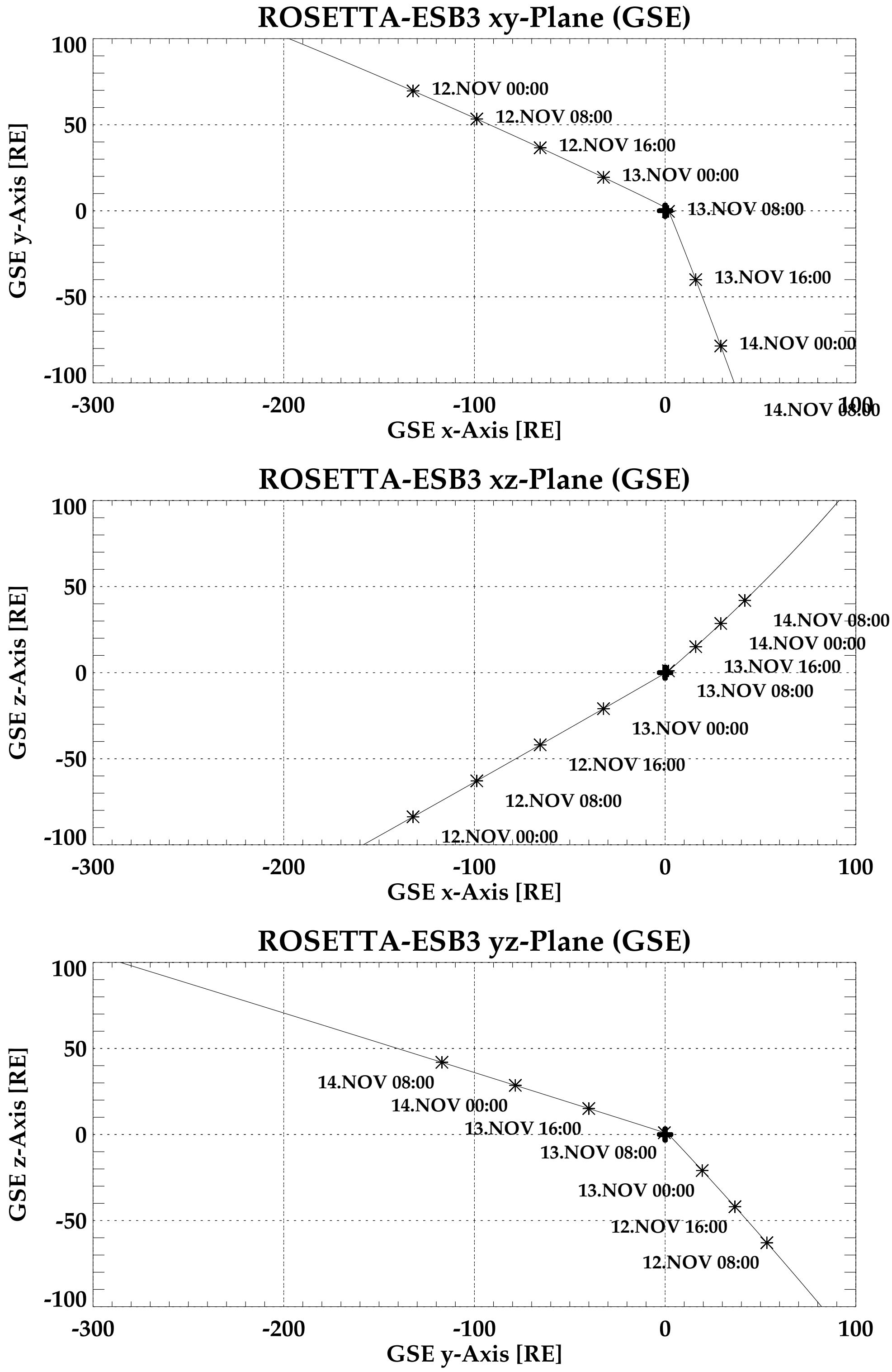


Figure 7: ROSETTA'S Trajectory in GSE coordiantes during the Swing by

3 Activities and data plots of ESB3

This chapter presents all relevant data /data types measured by RPCMAG day by day:

- Housekeeping data (HK).
- Magnetic field of the OB sensor, sampled with 16 bit in the HK stream.
- Calibrated LEVEL_B data (s/c coordinates) of the IB and OB sensor with the original sampling frequency.
- Calibrated LEVEL_C data (ECLIPJ2000 coordinates) of the IB and OB sensor with the original sampling frequency.

3.1 November 09, 2009:

3.1.1 Actions

MAG was switched on immediately after PIU and set to HK mode at 19:40:42. The normal mode SID 2 was set at 20:00:00. All commands passed smoothly and the instrument followed in the expected way.

3.2 Plots of Calibrated Data

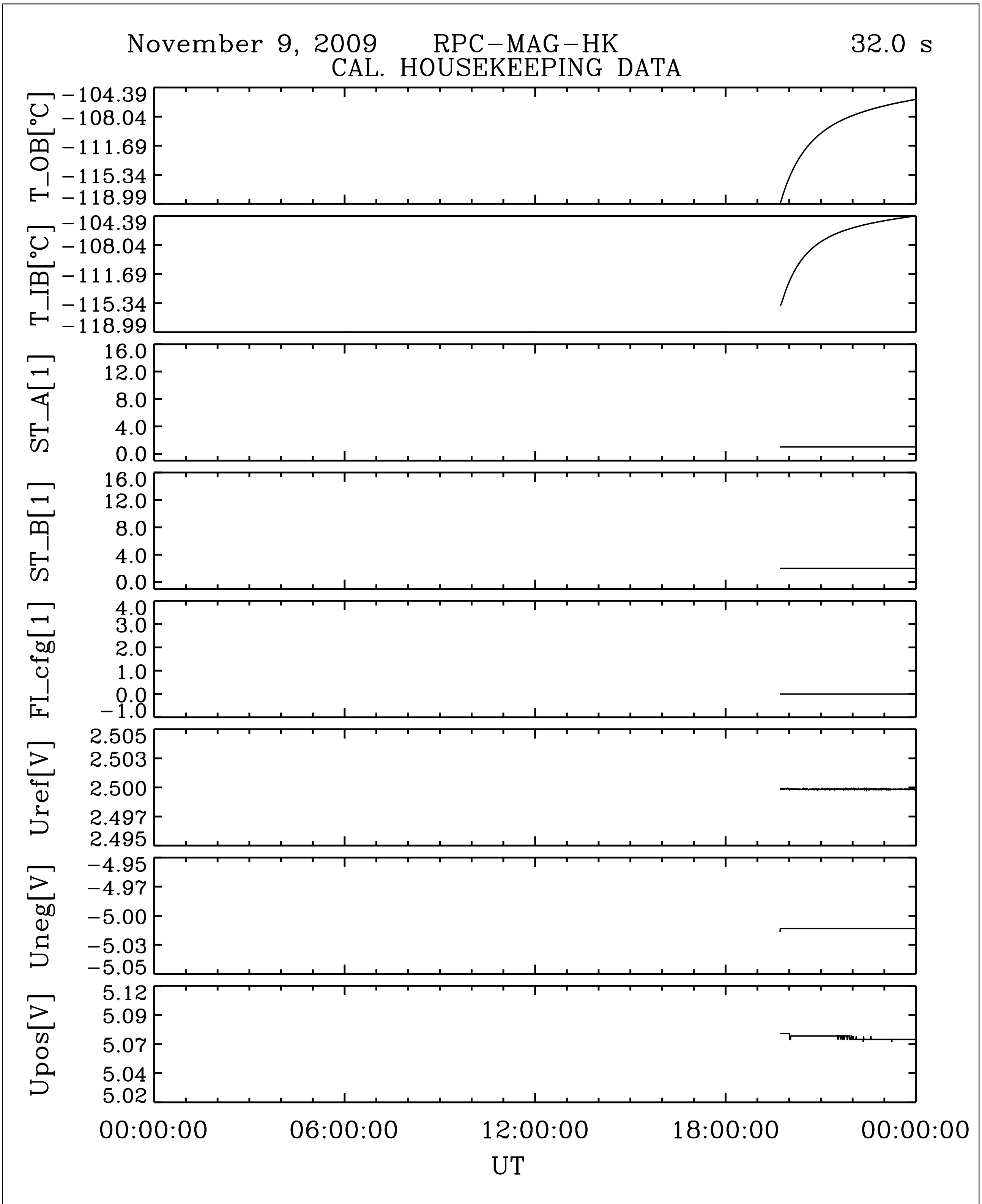


Figure 8: File: RPCMAG091109T1942_CLA_HK_P0000_2400

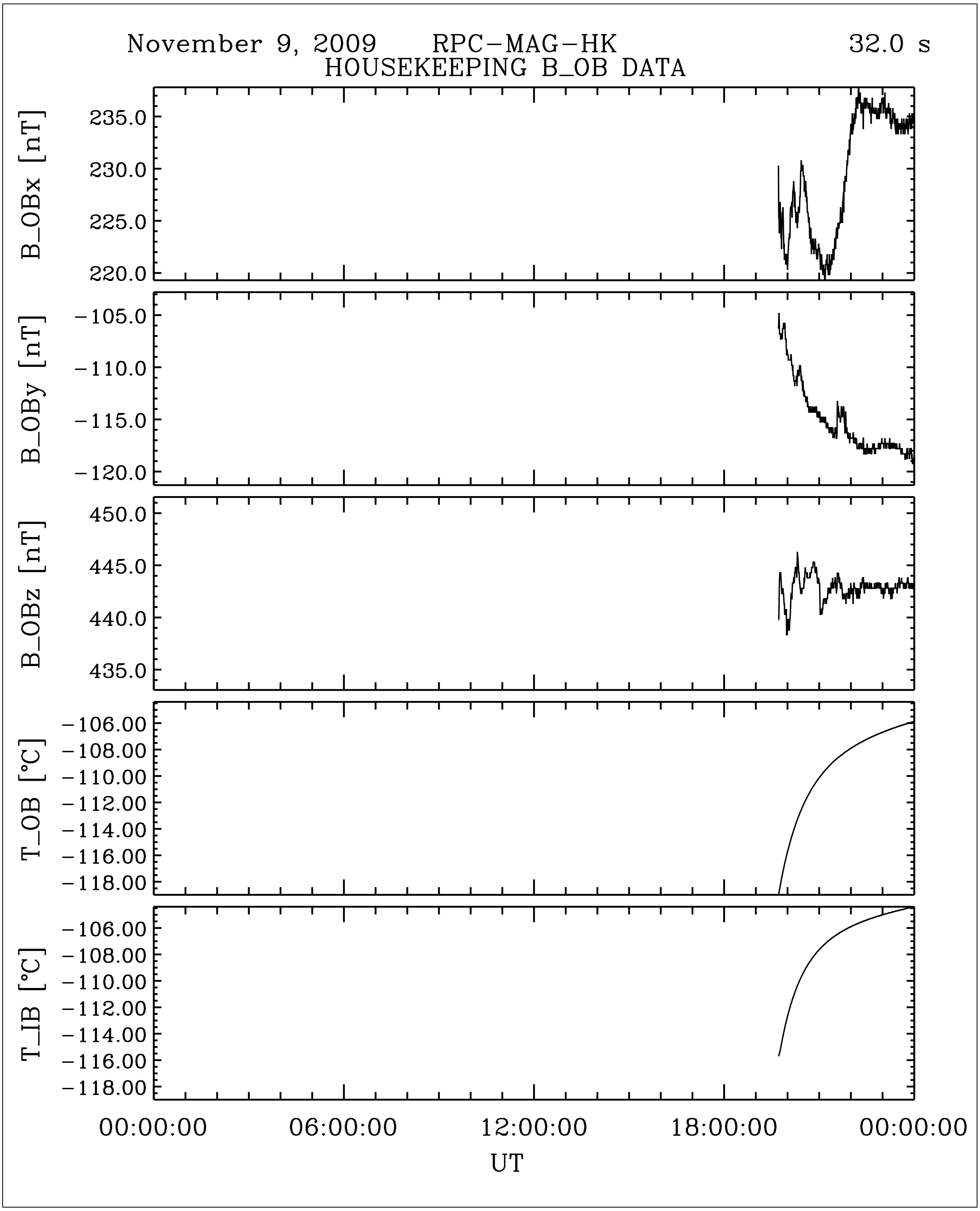


Figure 9: File: RPCMAG091109T1942_CLA_HK_B_P0000_2400

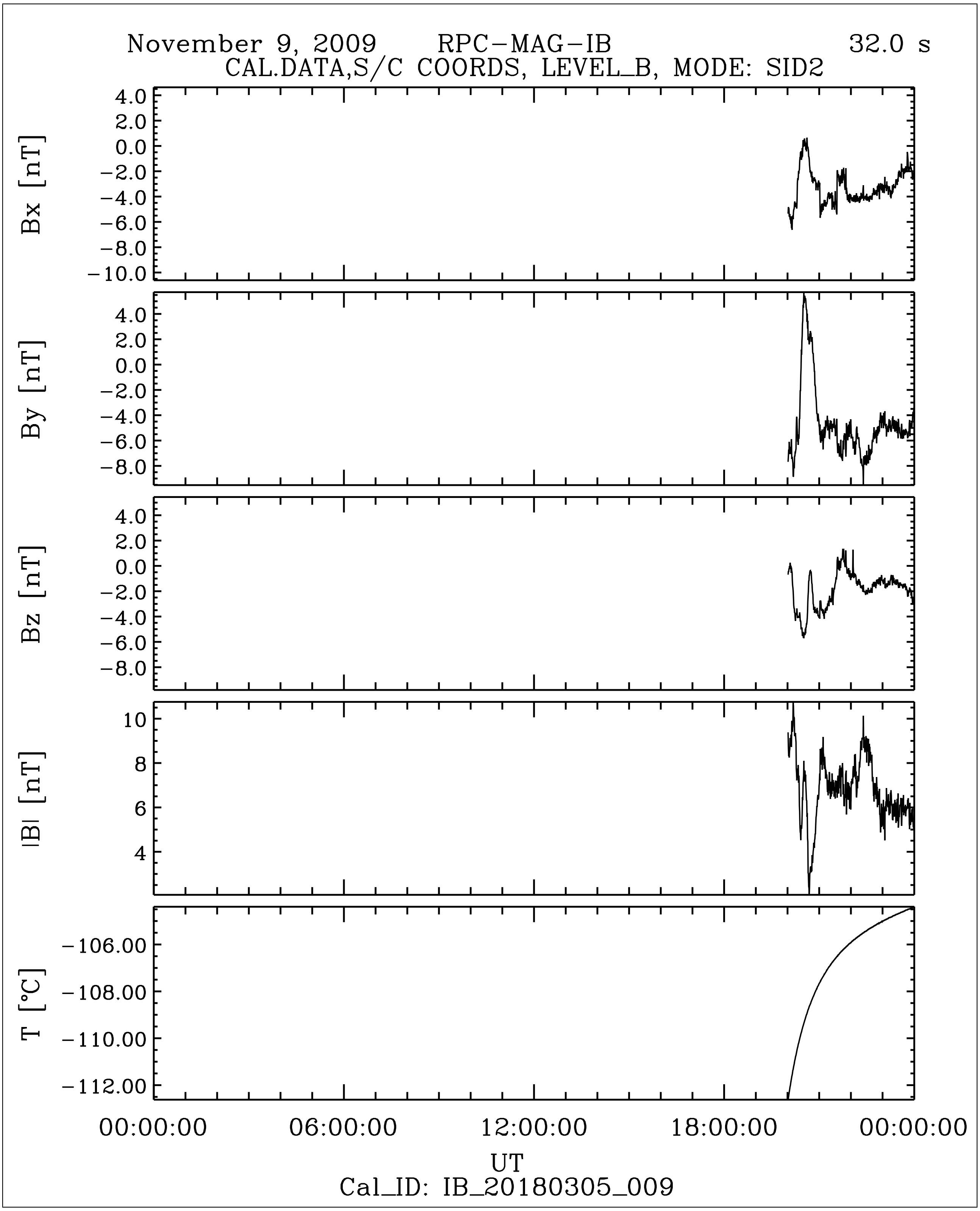


Figure 10: File: RPCMAG091109T2000_CLB_IB_M2_T0000_2400_009

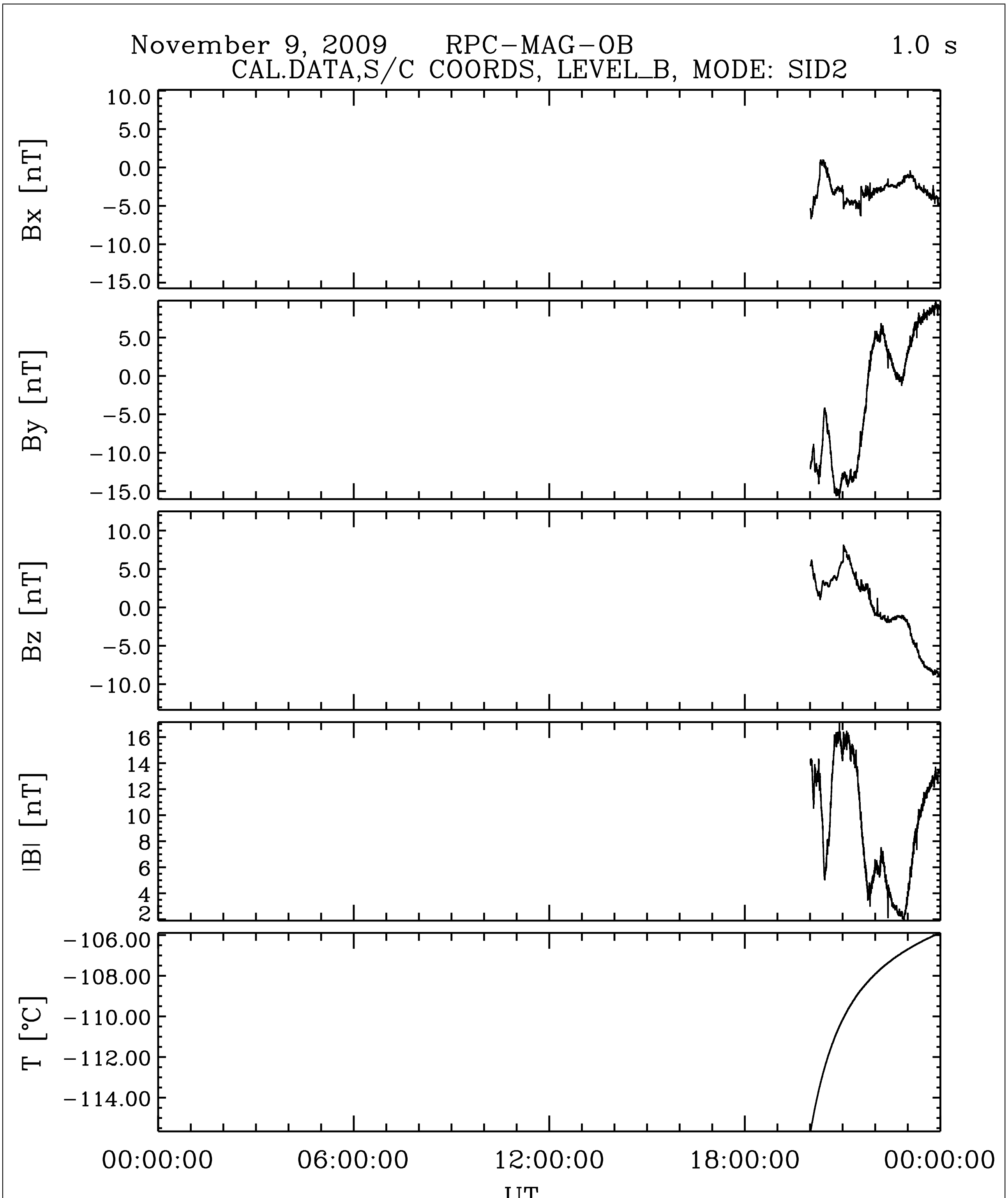


Figure 11: File: RPCMAG091109T2000_CLB_OB_M2_T0000_2400_009

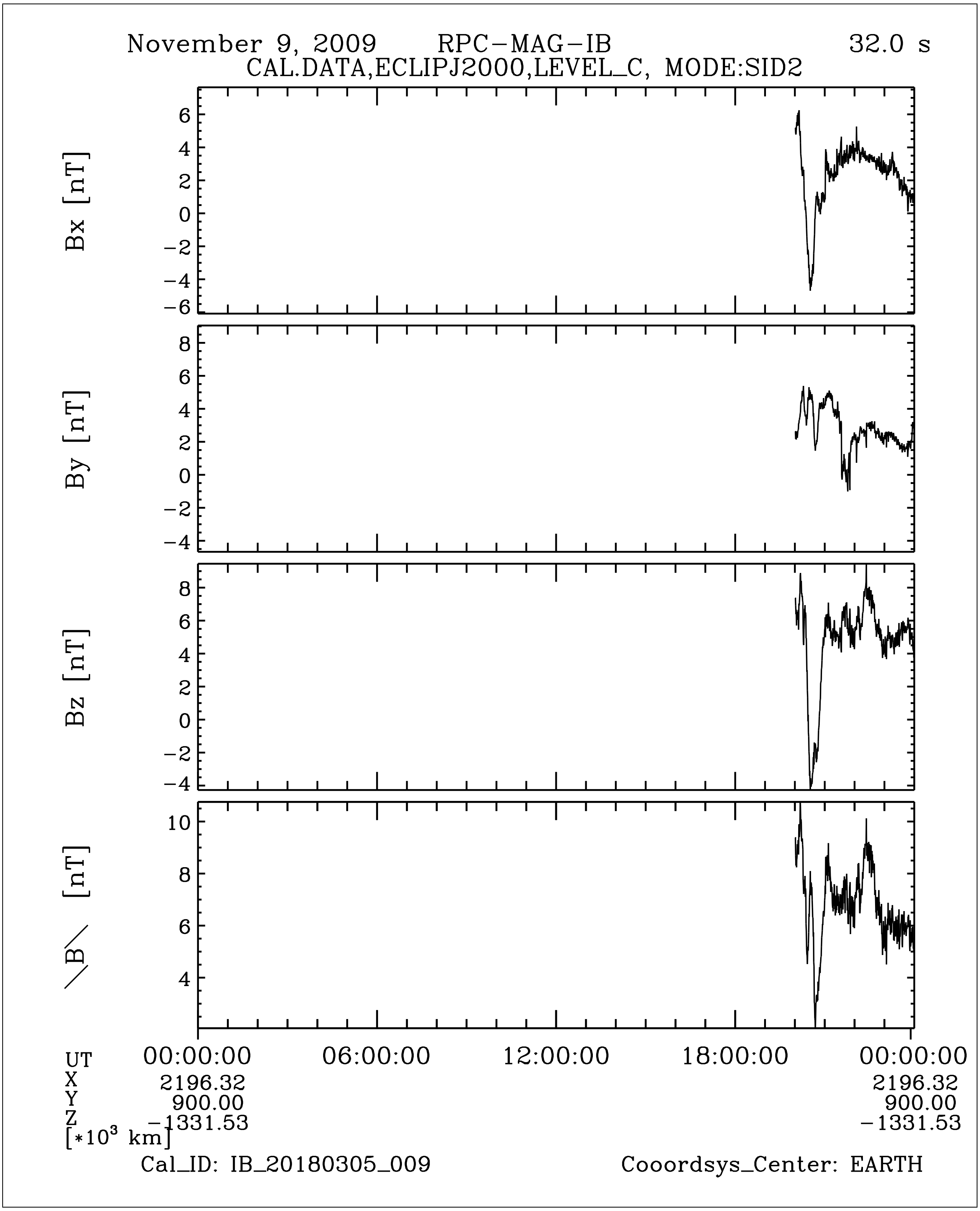


Figure 12: File: RPCMAG091109T2000_CLC_IB_M2_T0000_2400_009

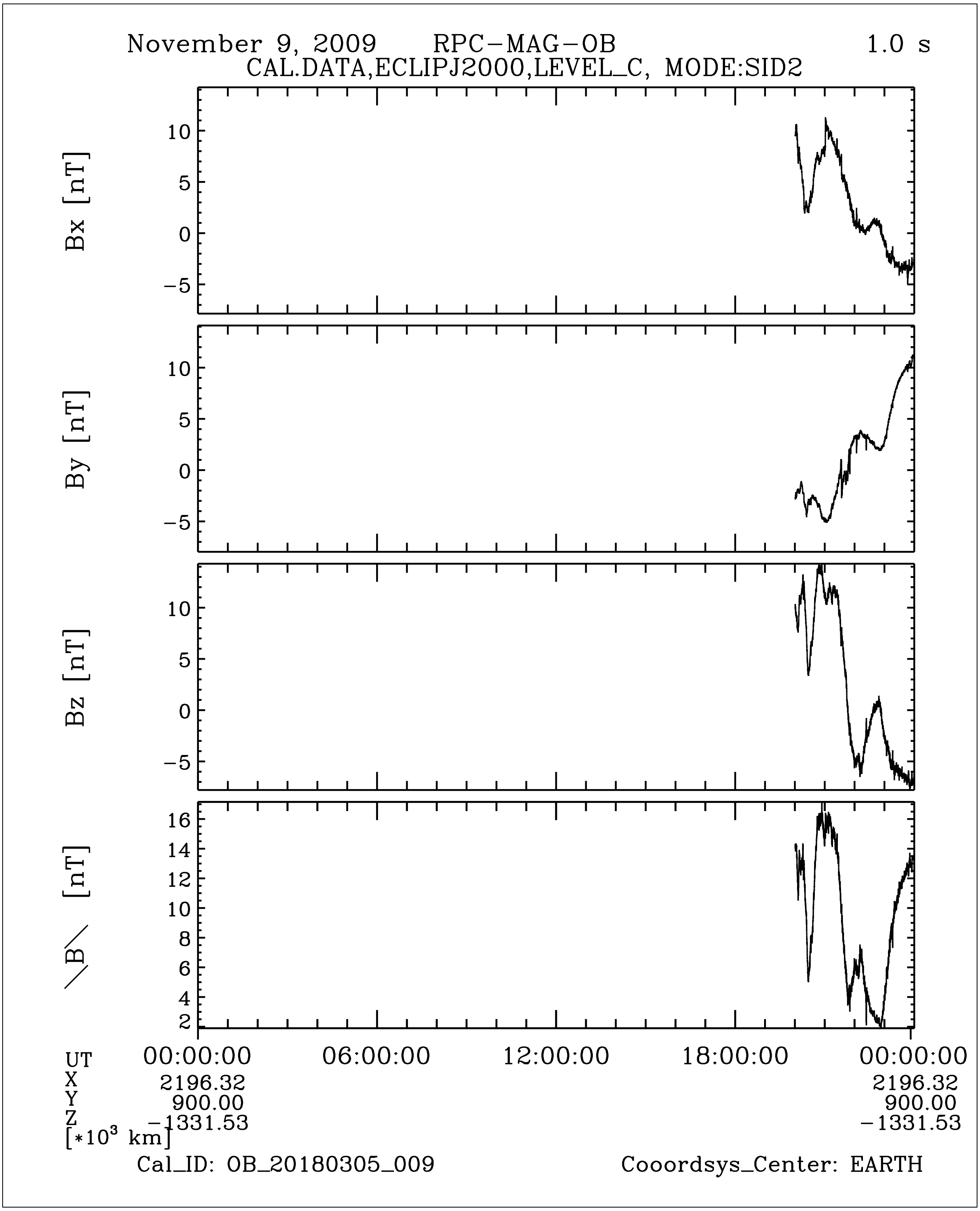


Figure 13: File: RPCMAG091109T2000_CLC_OB_M2_T0000_2400_009

3.3 November 10, 2009:

3.3.1 Actions

MAG stayed in SID 2. No problems occurred.

3.3.2 Plots of Calibrated Data

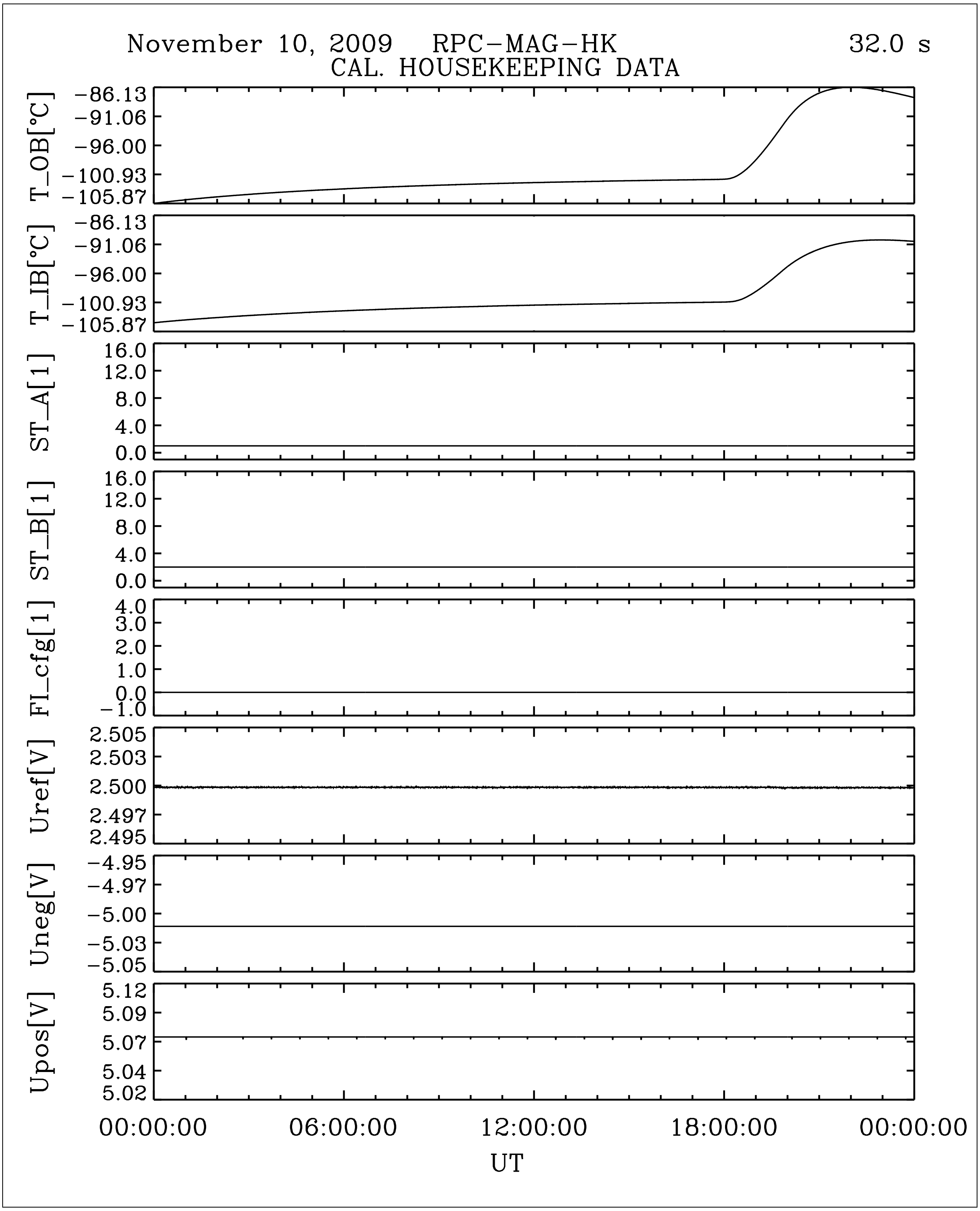


Figure 14: File: RPCMAG091110T0000_CLA_HK_P0000_2400

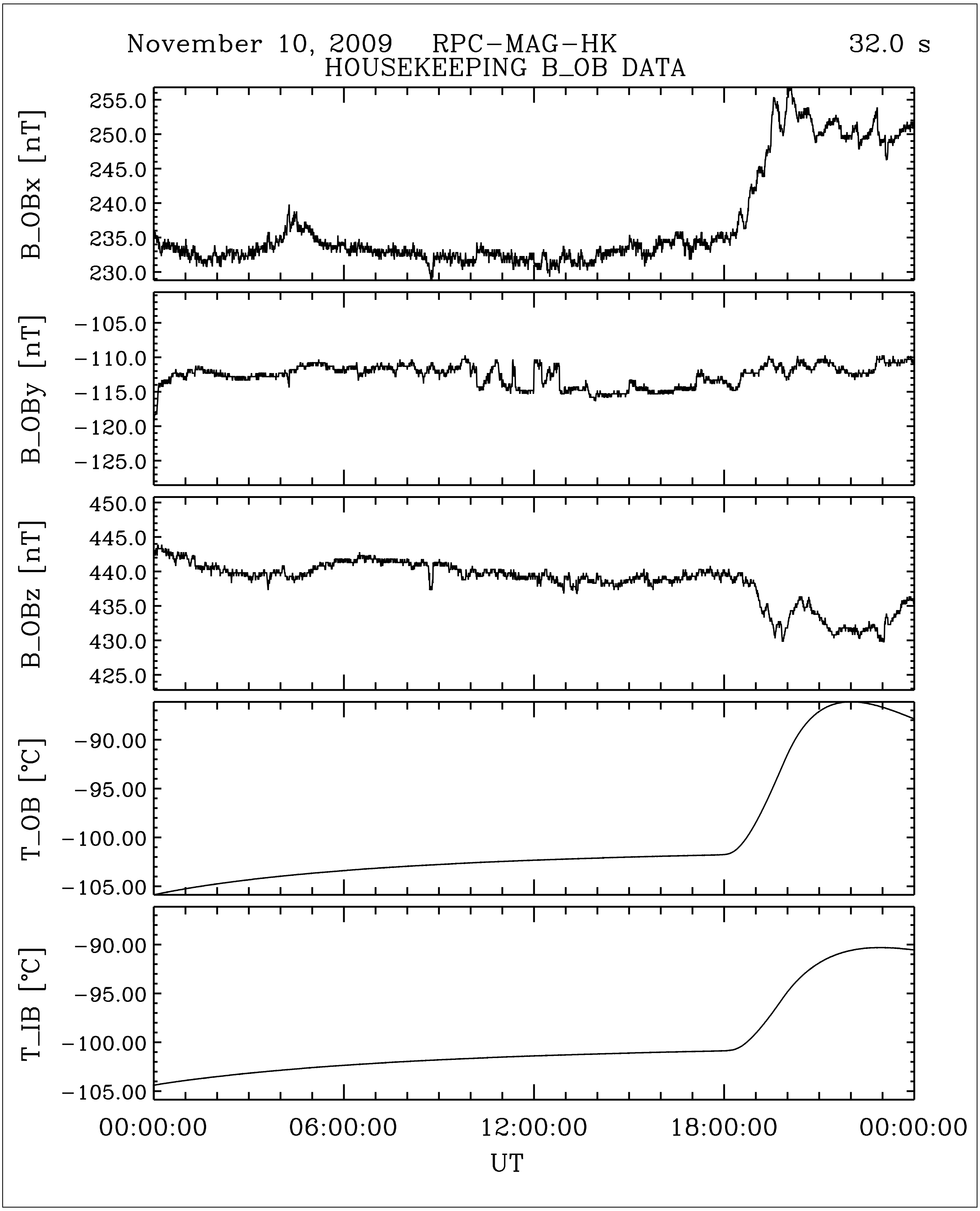


Figure 15: File: RPCMAG091110T0000_CLA_HK_B_P0000_2400

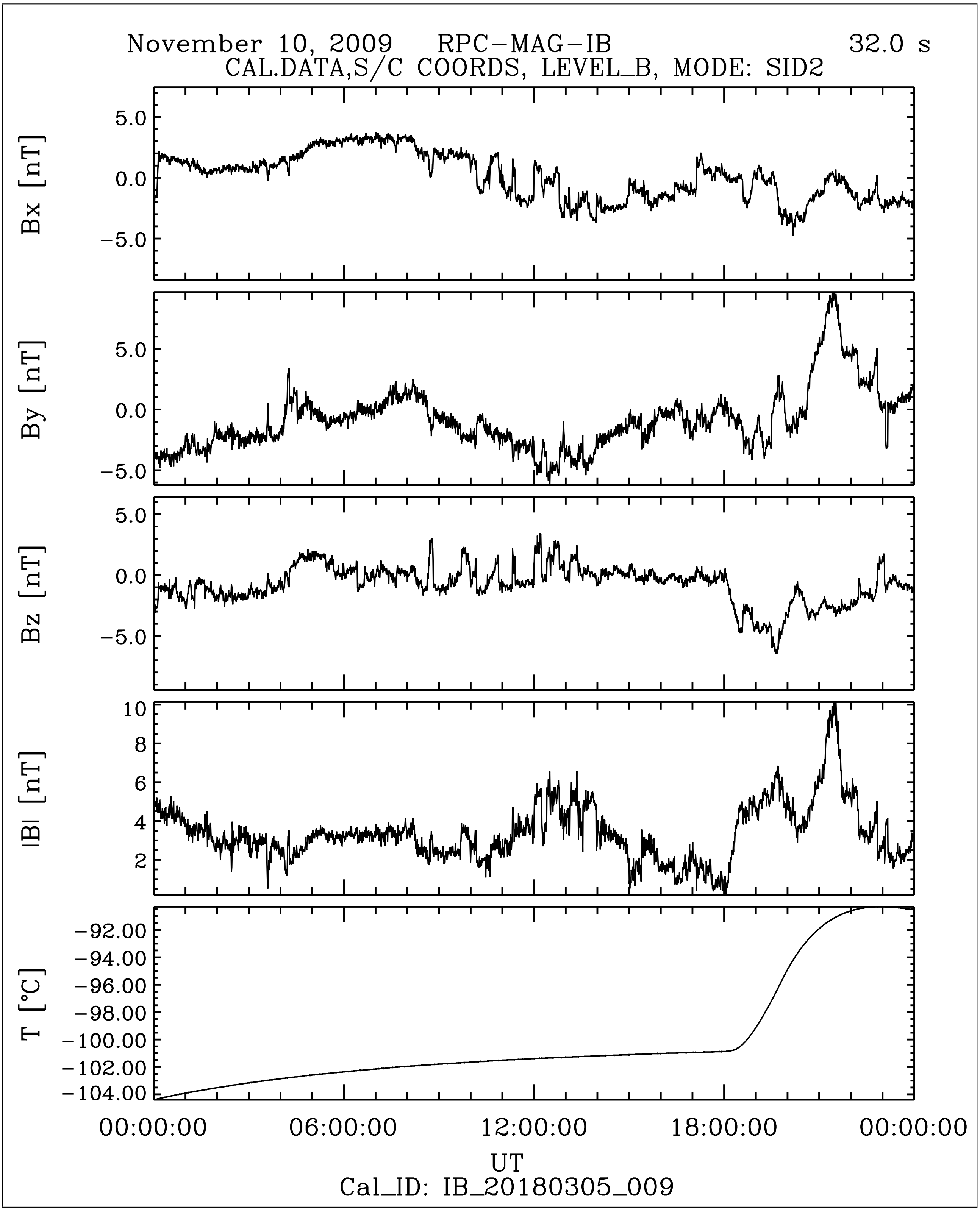


Figure 16: File: RPCMAG091110T0000_CLB_IB_M2_T0000_2400_009

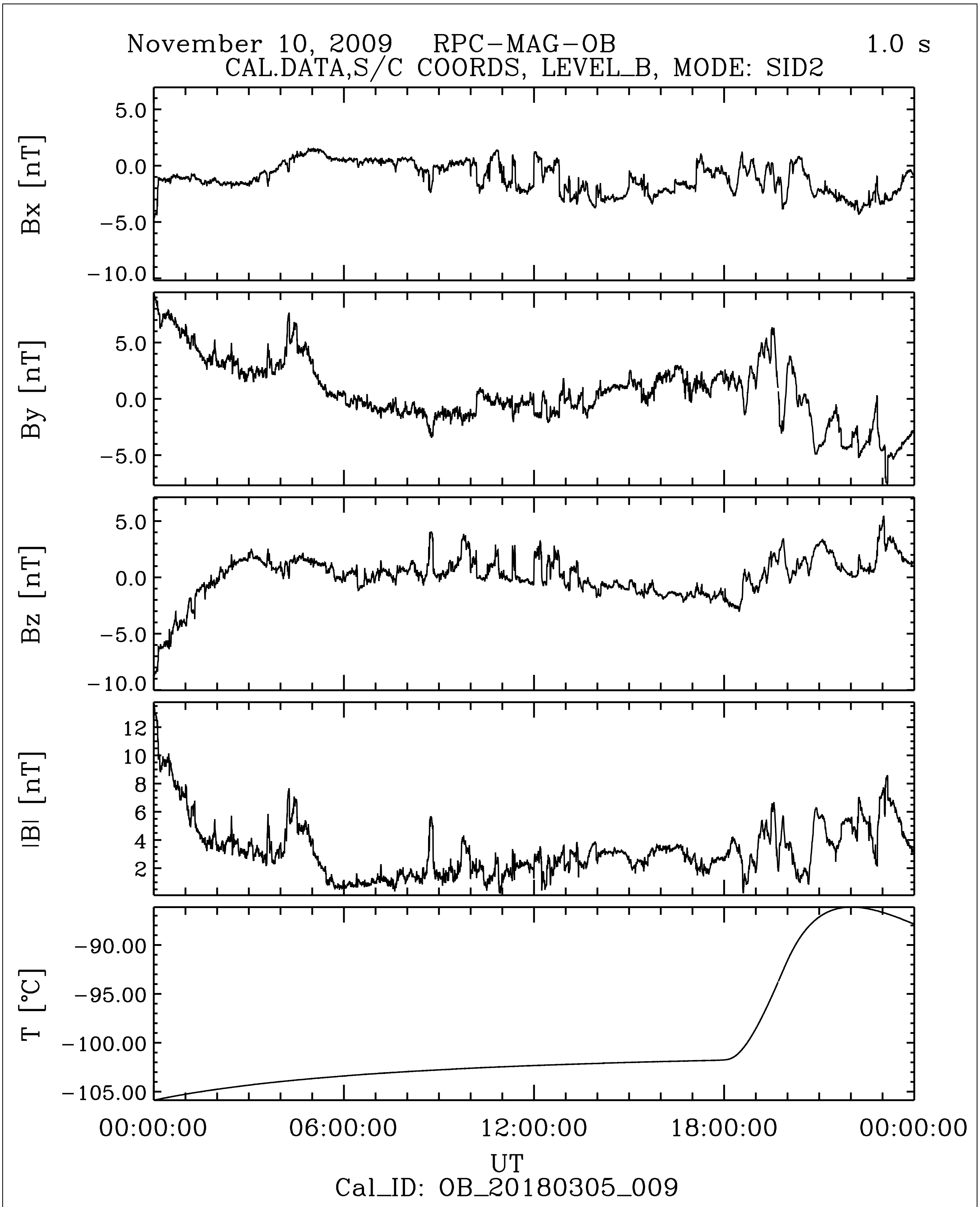


Figure 17: File: RPCMAG091110T0000_CLB_OB_M2_T0000_2400_009

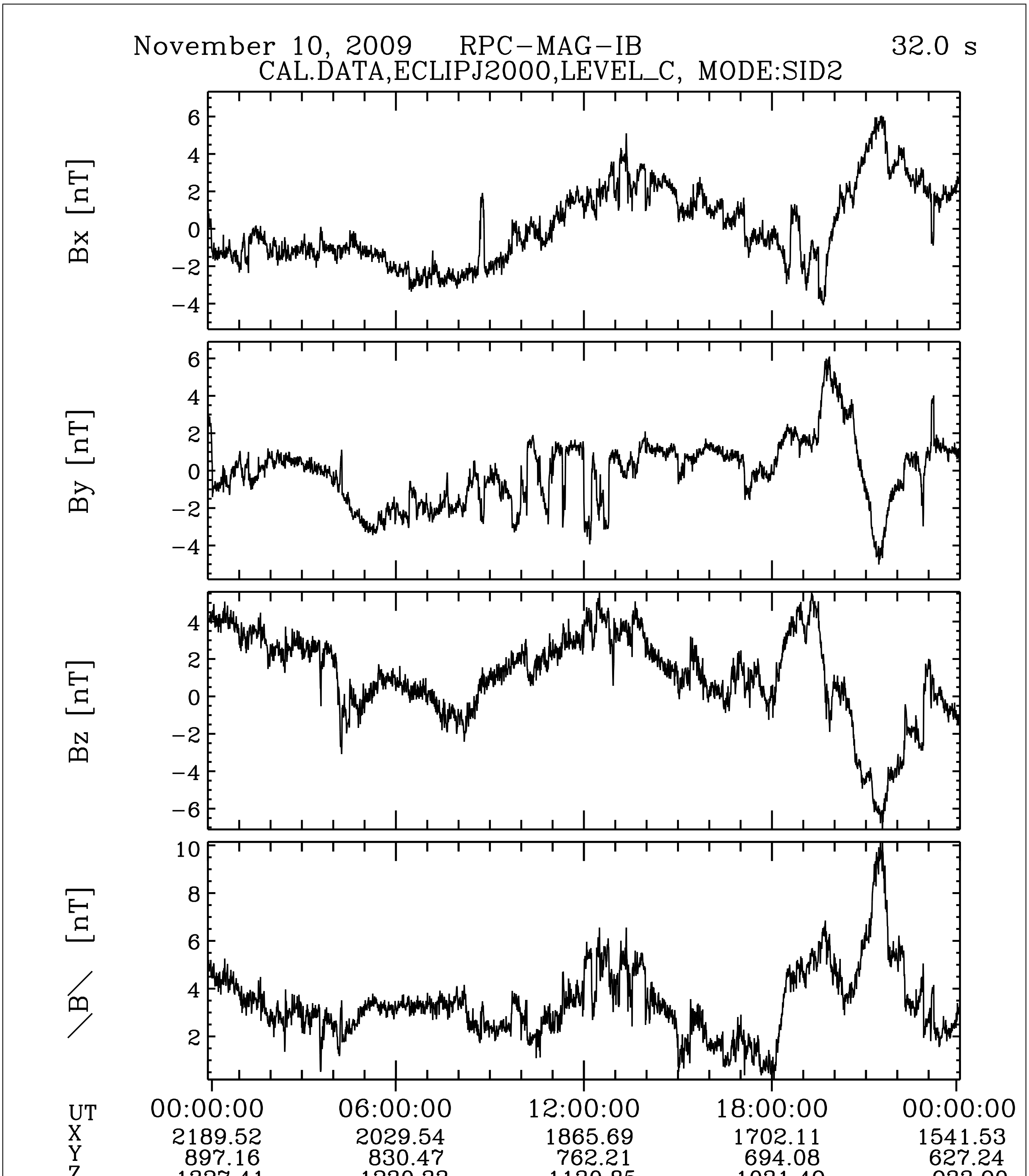


Figure 18: File: RPCMAG091110T0000_CLC_IB_M2_T0000_2400_009

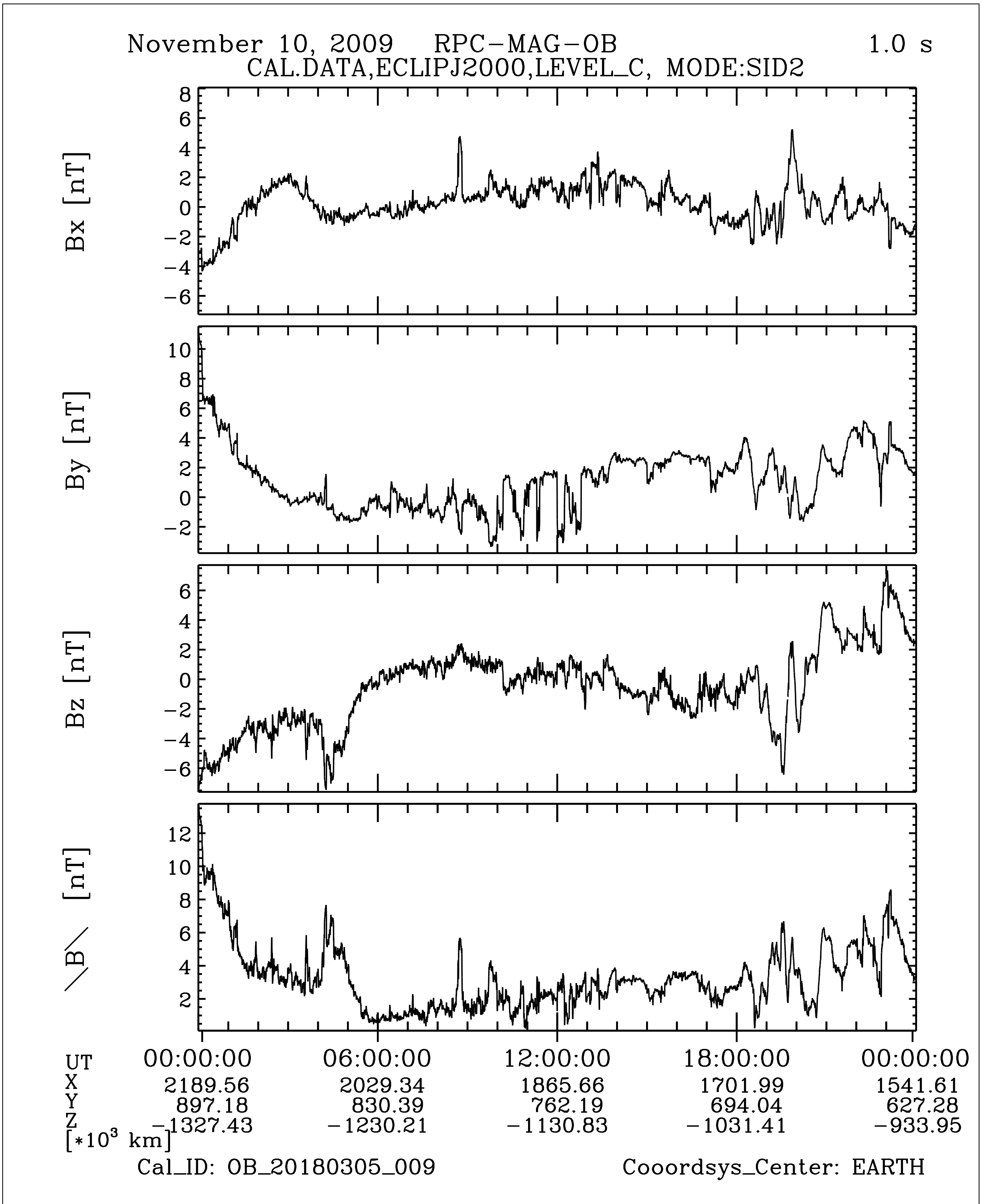


Figure 19: File: RPCMAG091110T0000_CLC_OB_M2_T0000_2400_009

3.4 November 11, 2009:

3.4.1 Actions

MAG stayed in SID 2. No problems occurred.

3.4.2 Plots of Calibrated Data

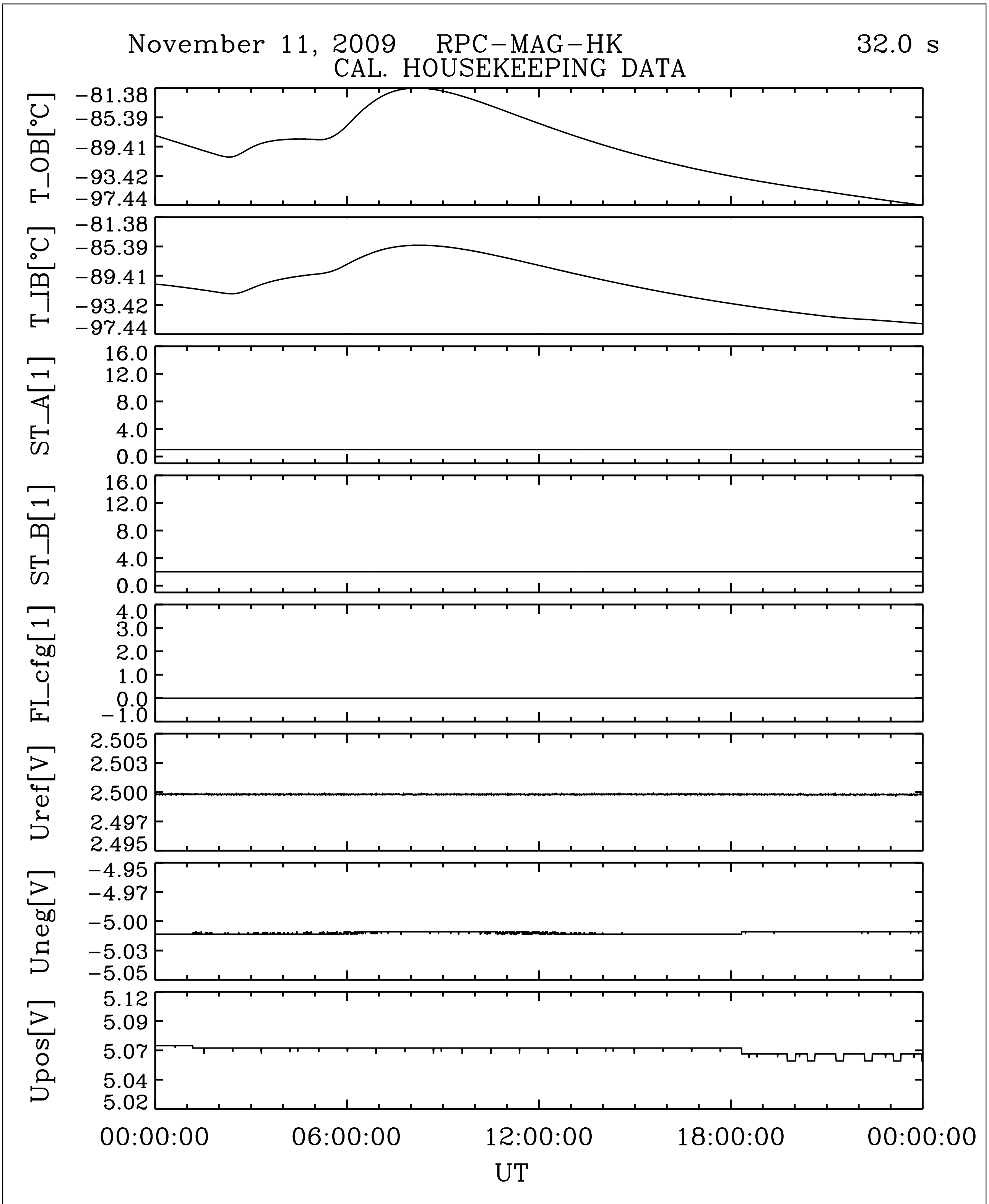


Figure 20: File: RPCMAG091111T0000_CLA_HK_P0000_2400

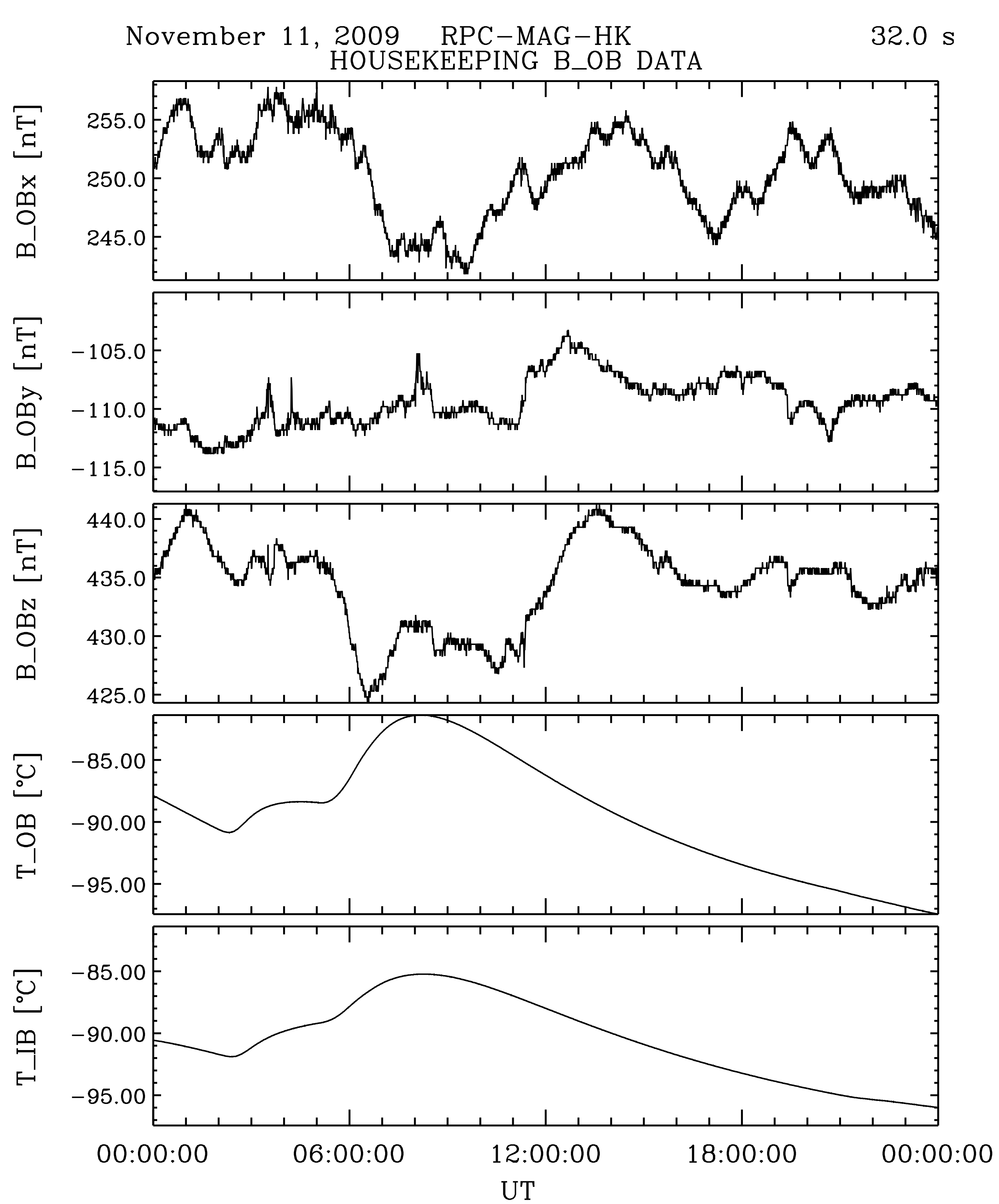


Figure 21: File: RPCMAG091111T0000_CLA_HK_B_P0000_2400

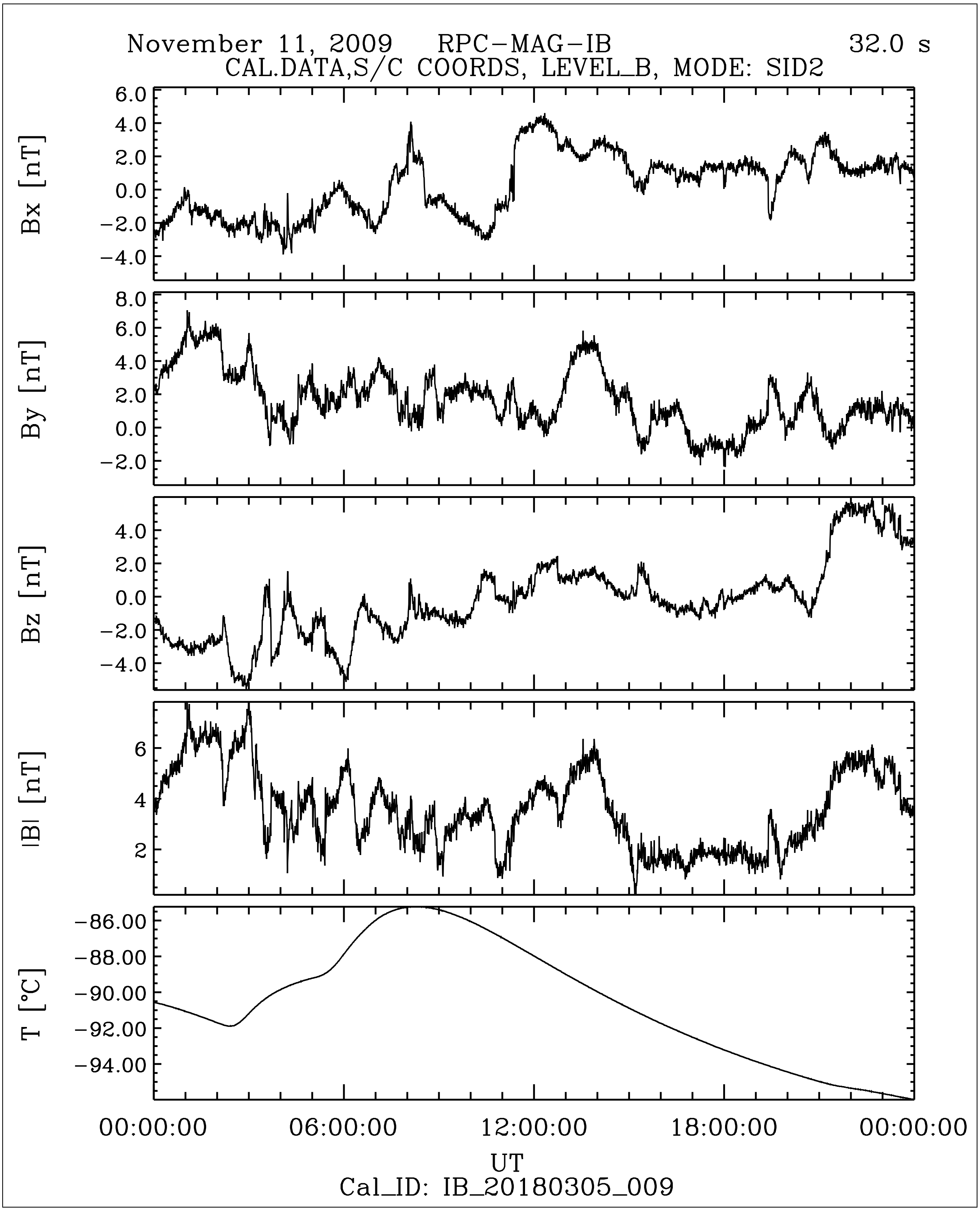
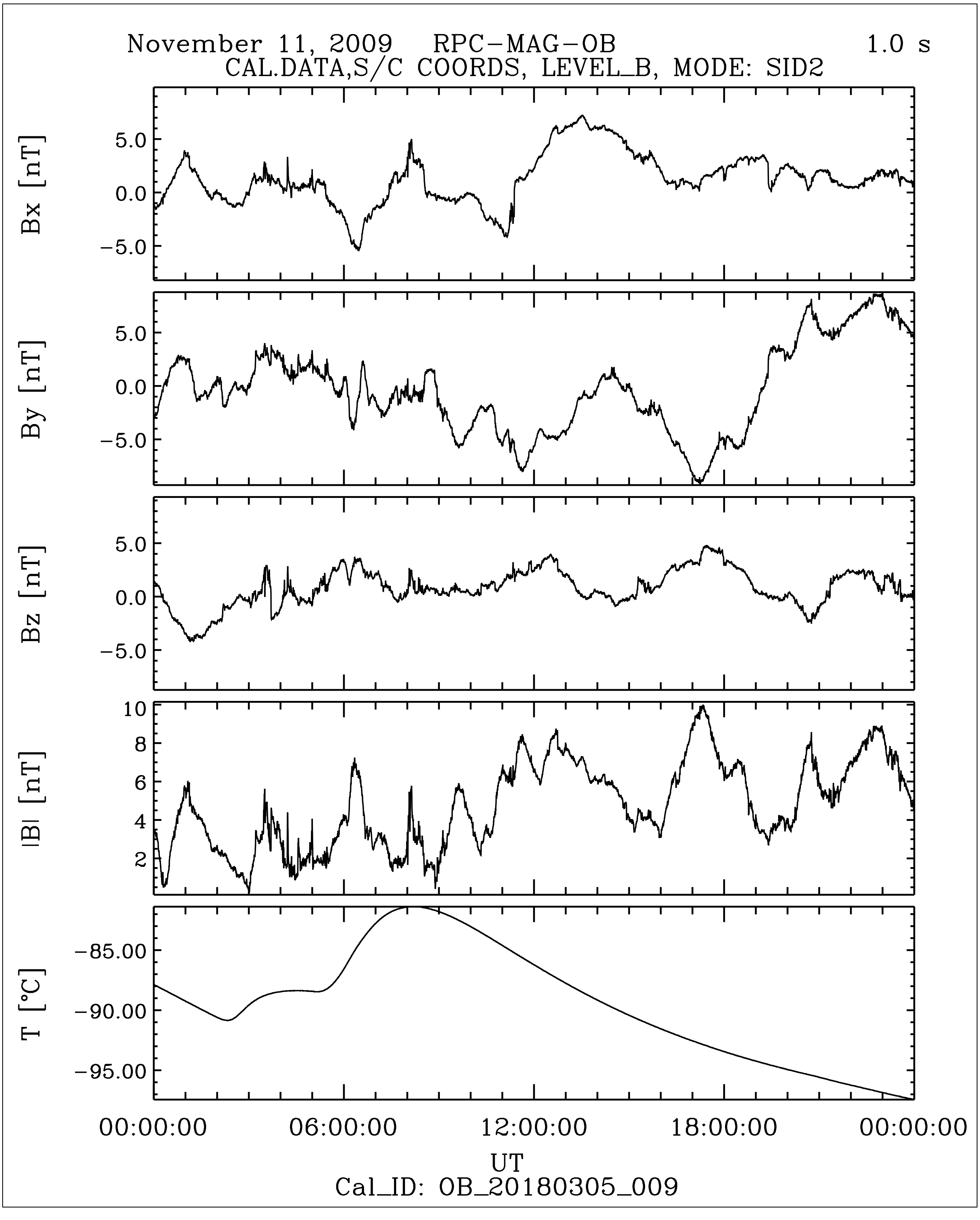


Figure 22: File: RPCMAG091111T0000_CLB_IB_M2_T0000_2400_009



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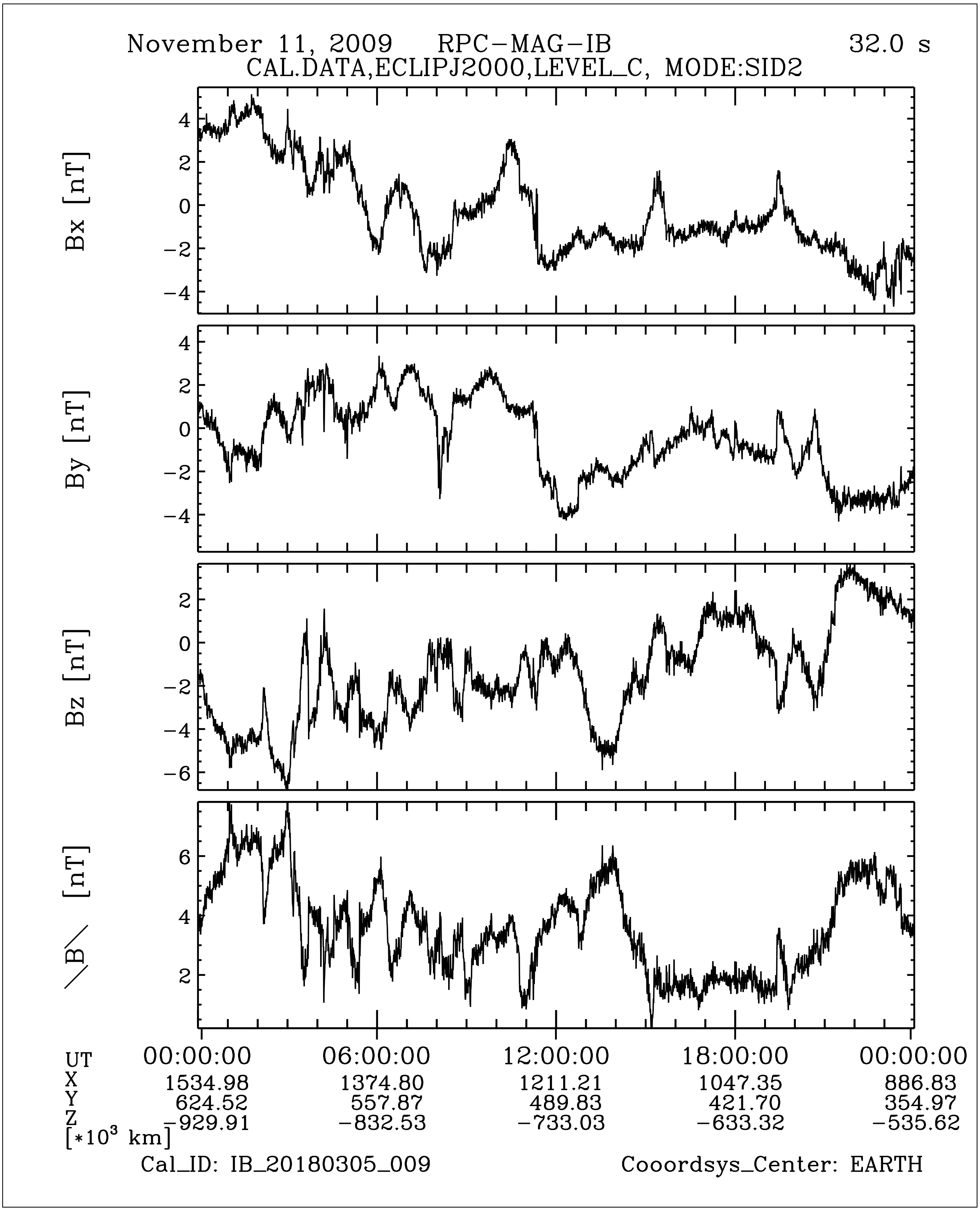

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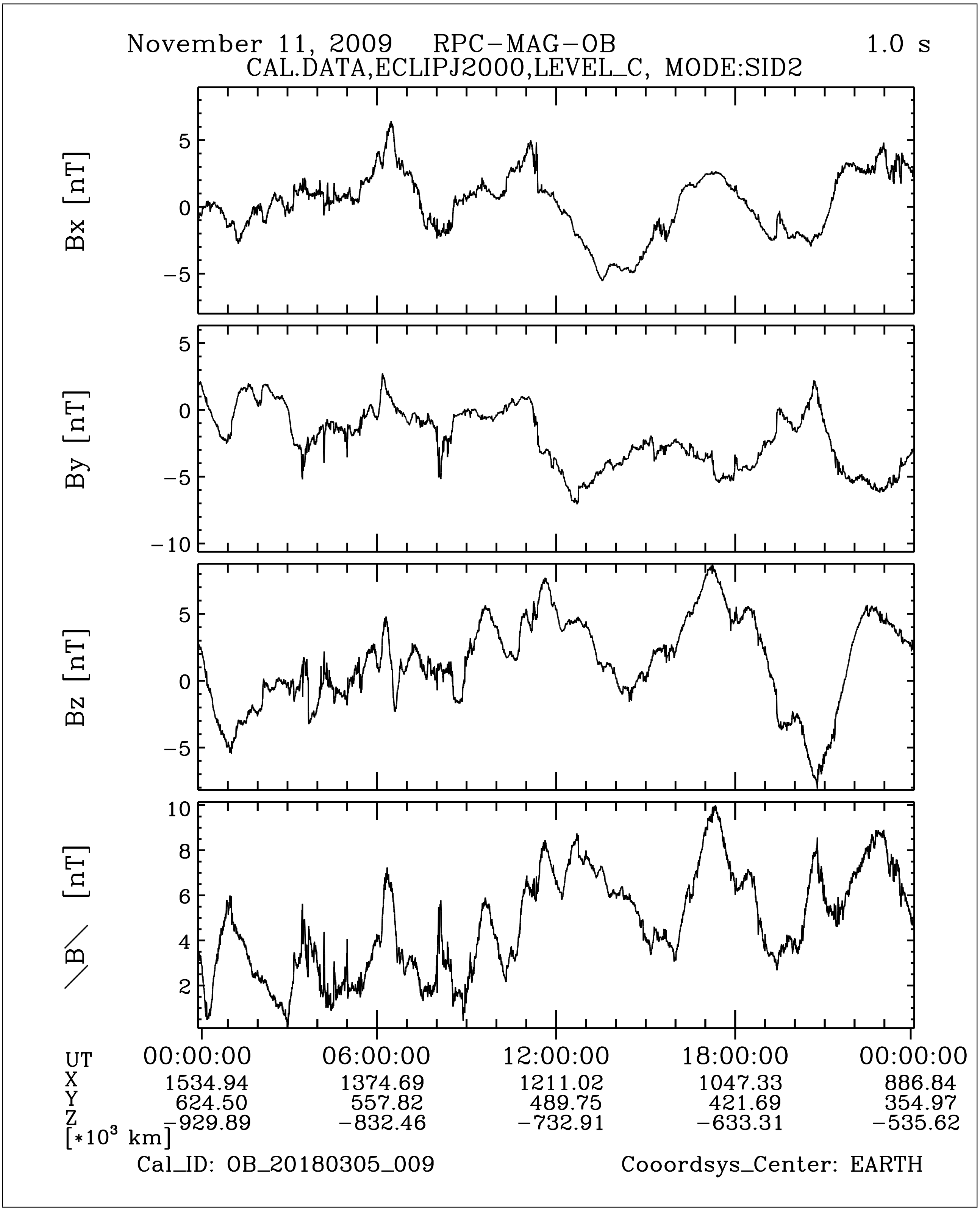

Figure 25: File: RPCMAG091111T0000_CLC_OB_M2_T0000_2400_009

3.5 November 12, 2009:

3.5.1 Actions

MAG stayed in SID 2 until 12:45. Then the BURST mode SID3 was activated. No problems occurred.

3.5.2 Plots of Calibrated Data

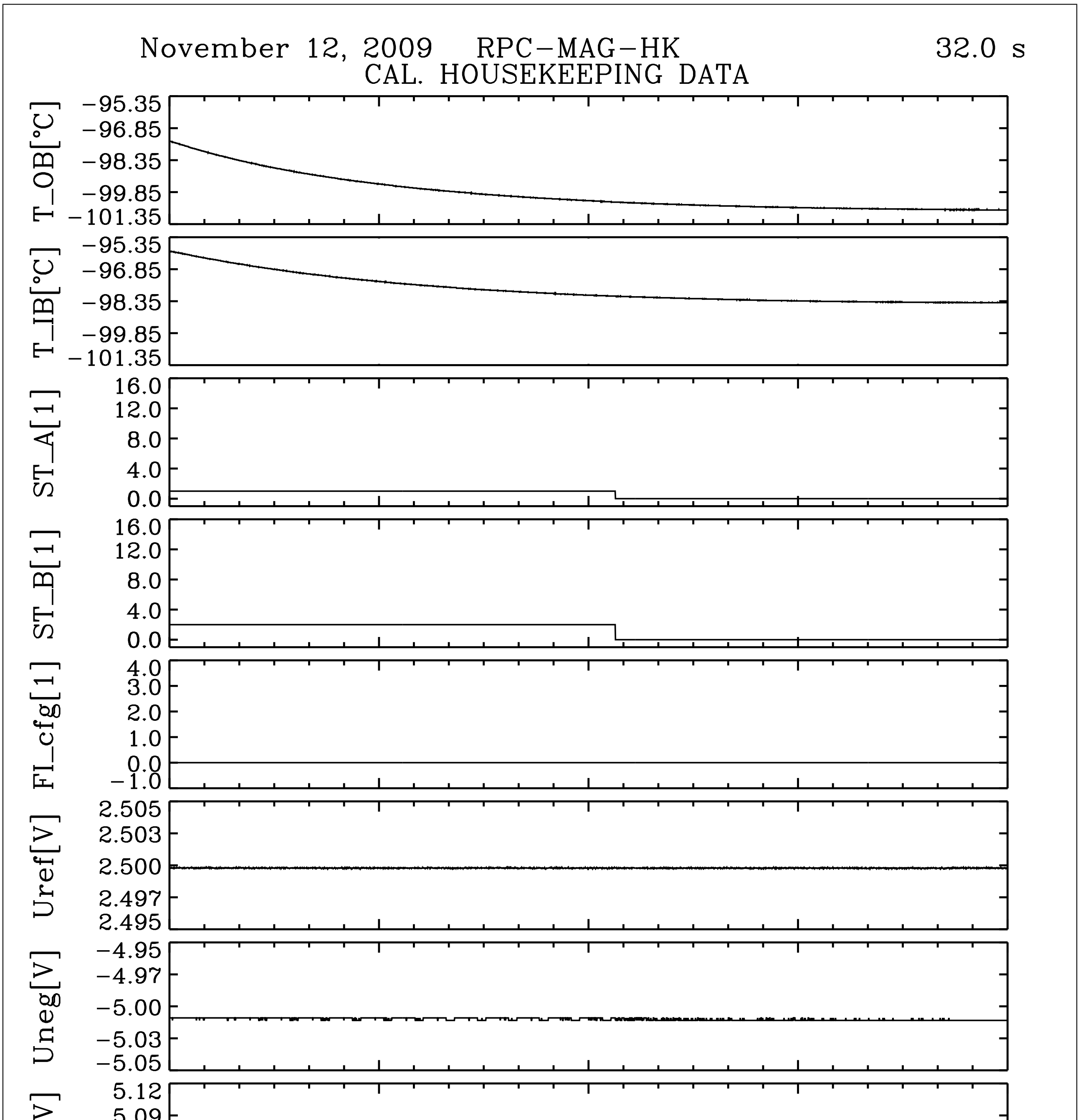

Figure 26: File: RPCMAG091112T0000_CLA_HK_P0000_2400

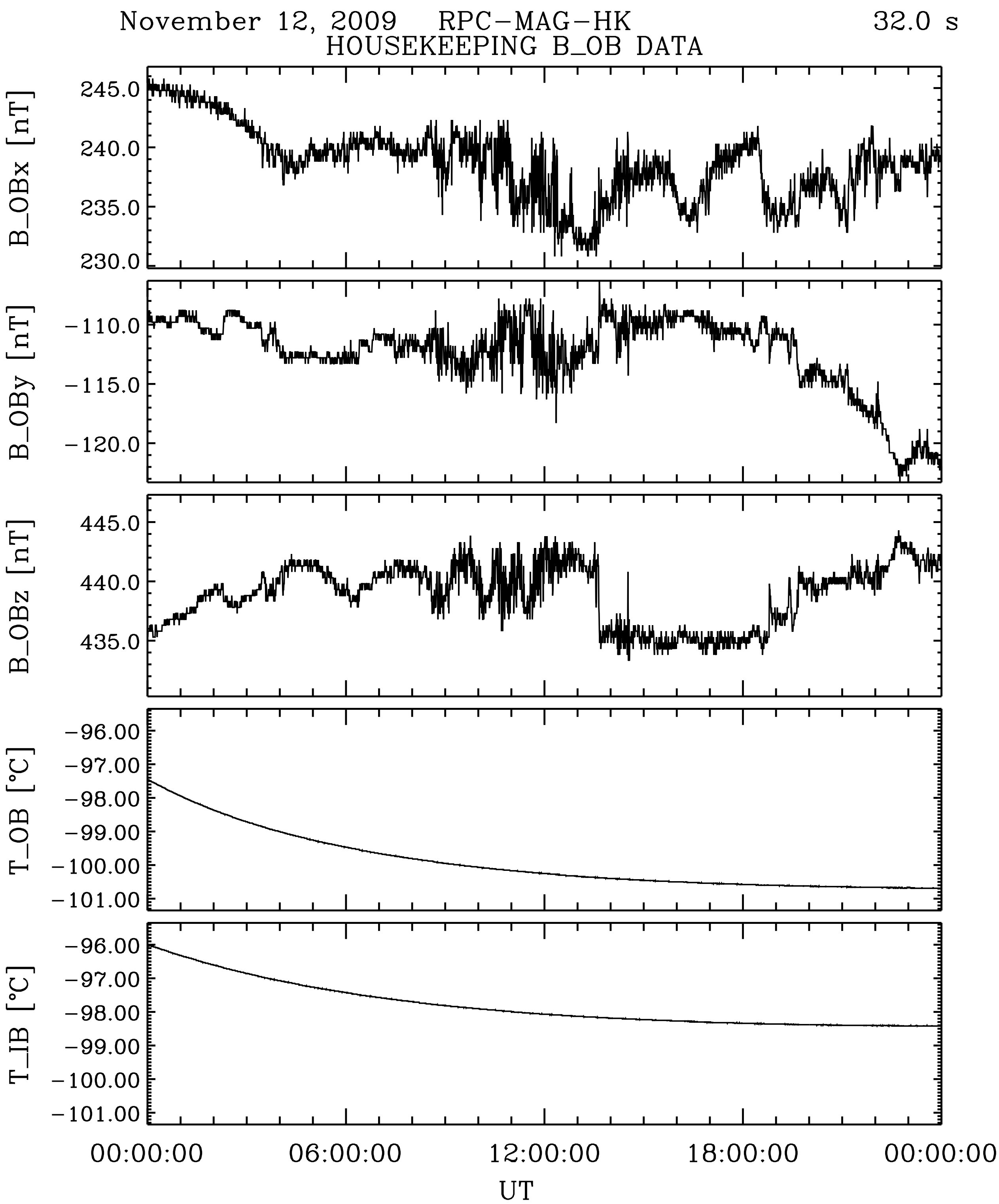

Figure 27: File: RPCMAG091112T0000_CLA_HK_B_P0000_2400

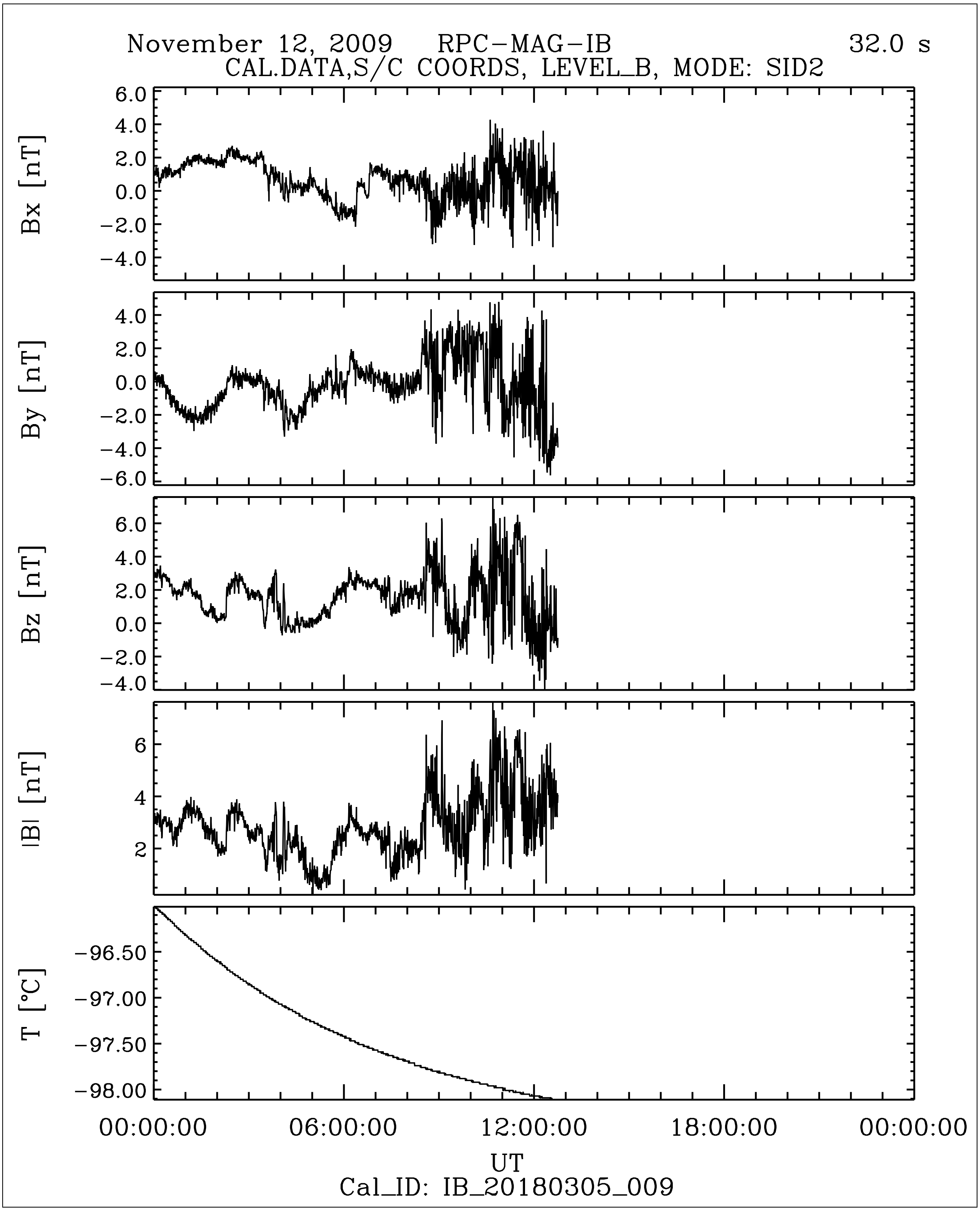

Figure 28: File: RPCMAG091112T0000_CLB_IB_M2_T0000_2400_009

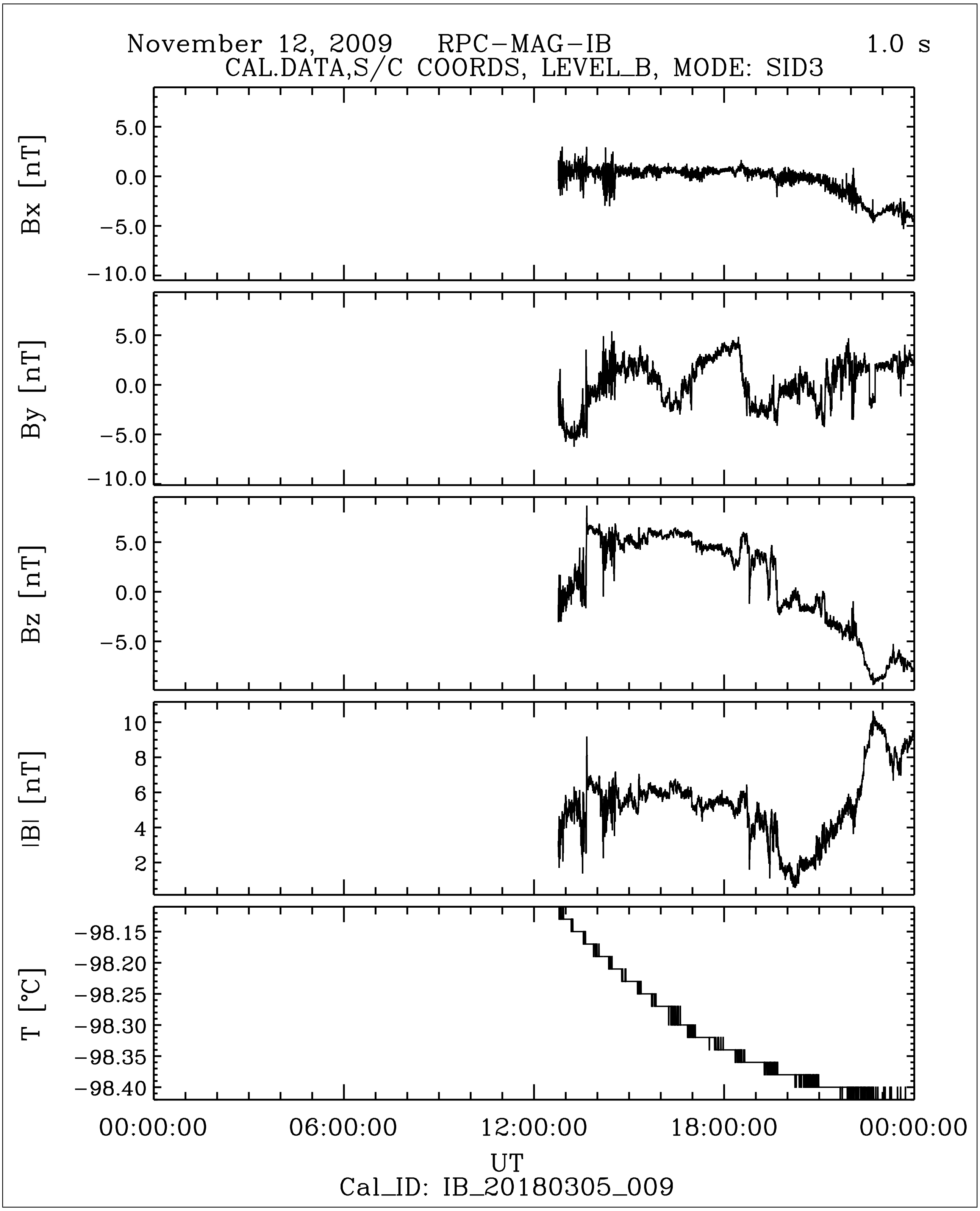

Figure 29: File: RPCMAG091112T1246_CLB_IB_M3_T0000_2400_009

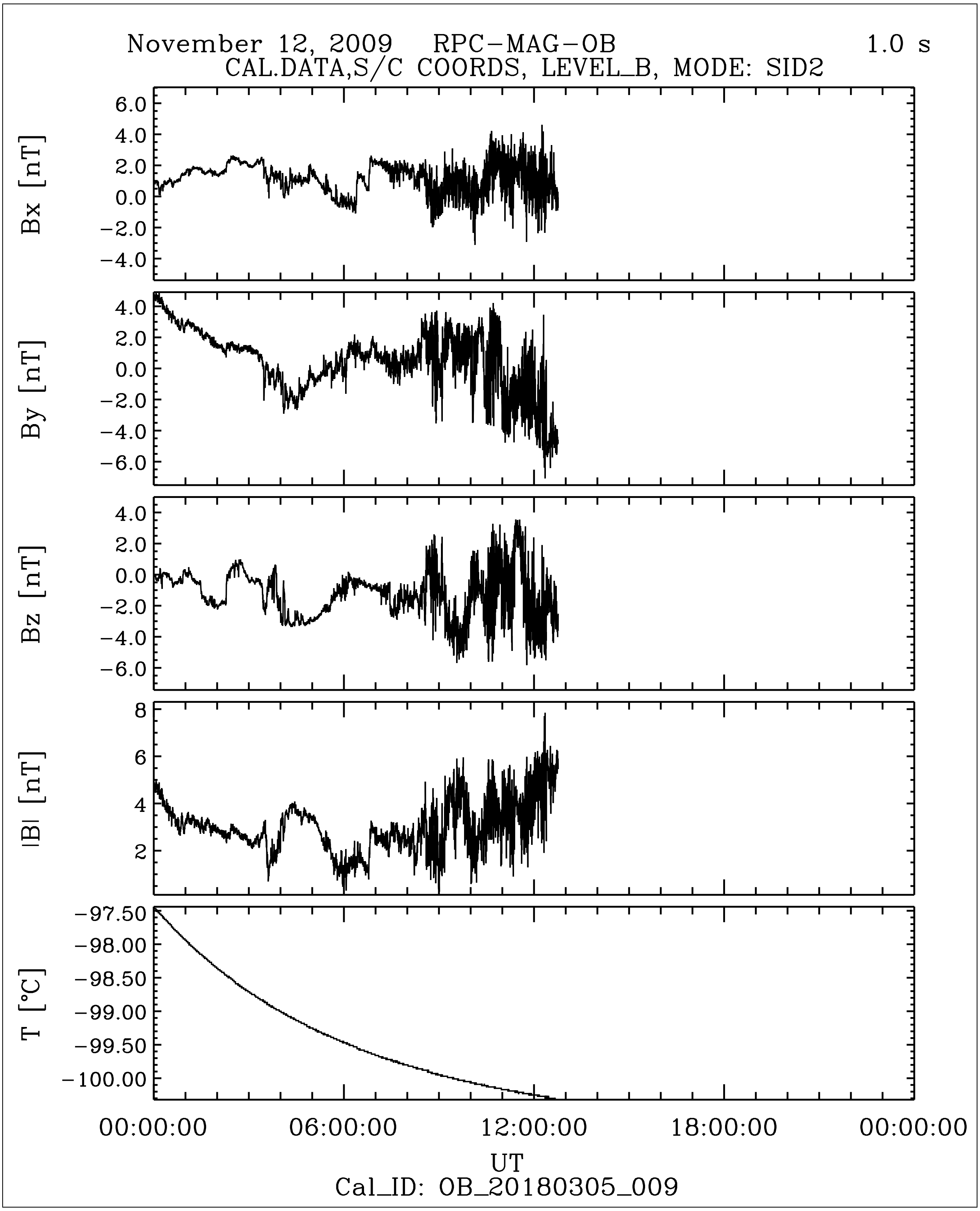

Figure 30: File: RPCMAG091112T0000_CLB_OB_M2_T0000_2400_009

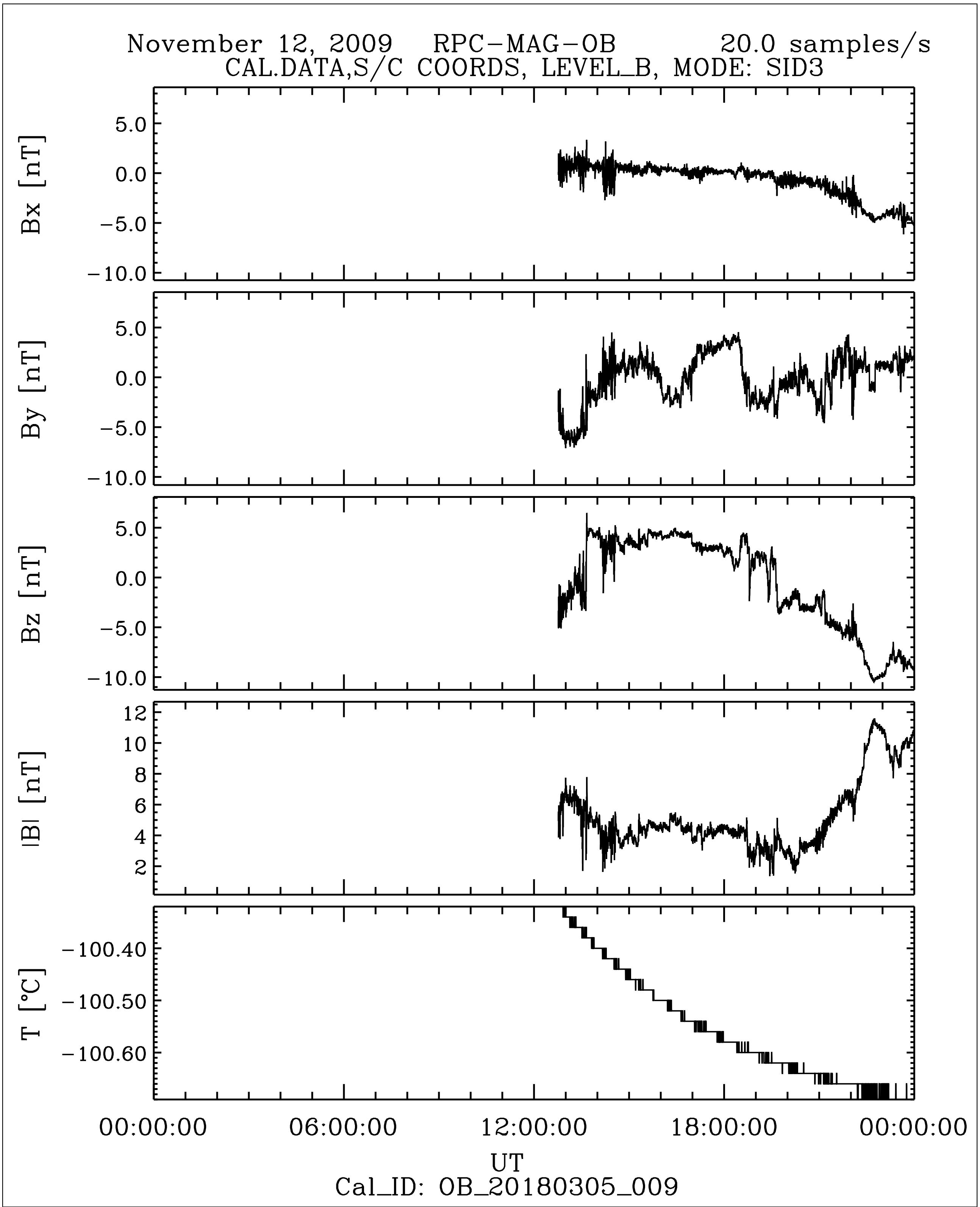

Figure 31: File: RPCMAG091112T1246_CLB_OB_M3_T0000_2400_009

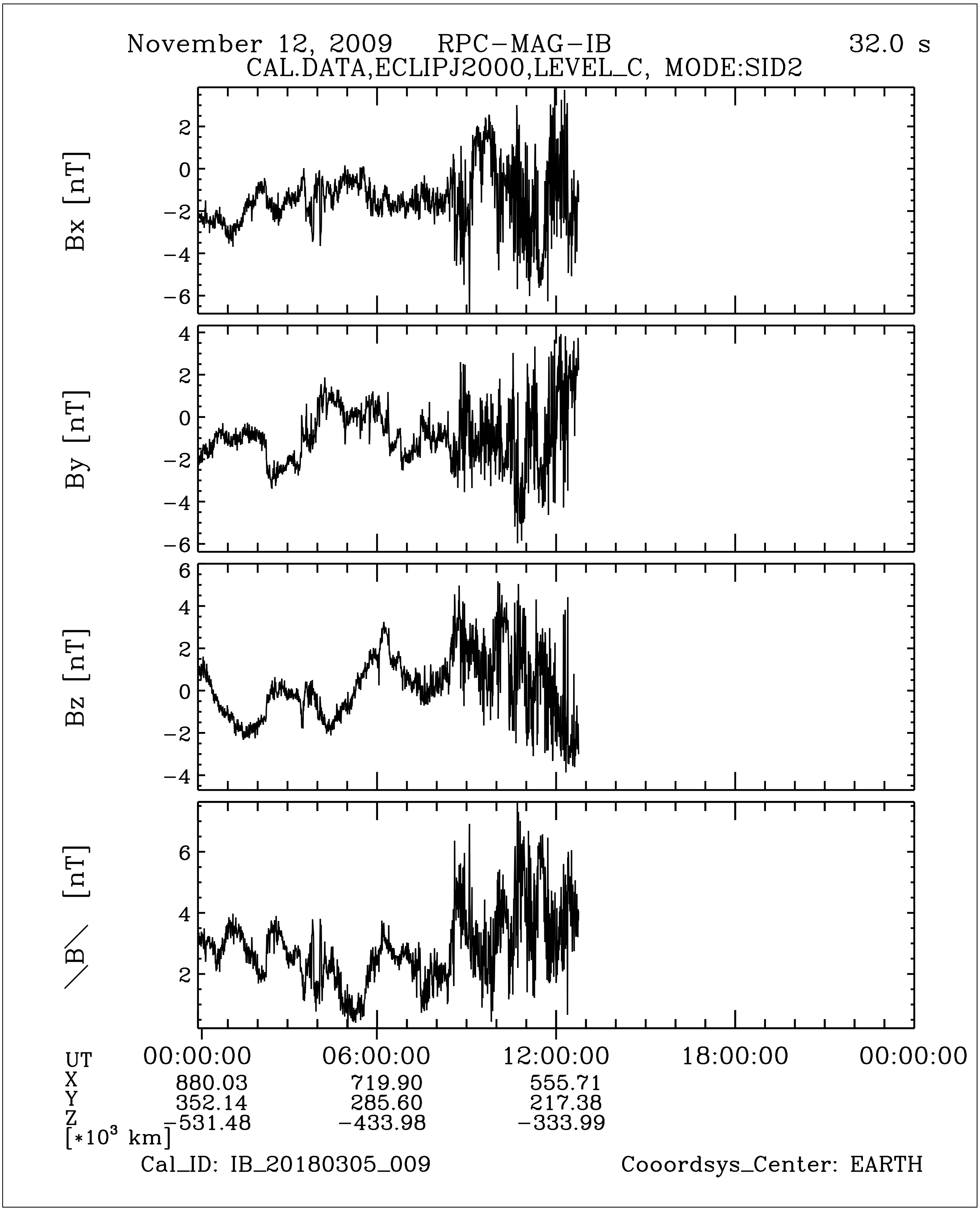

Figure 32: File: RPCMAG091112T0000_CLC_IB_M2_T0000_2400_009

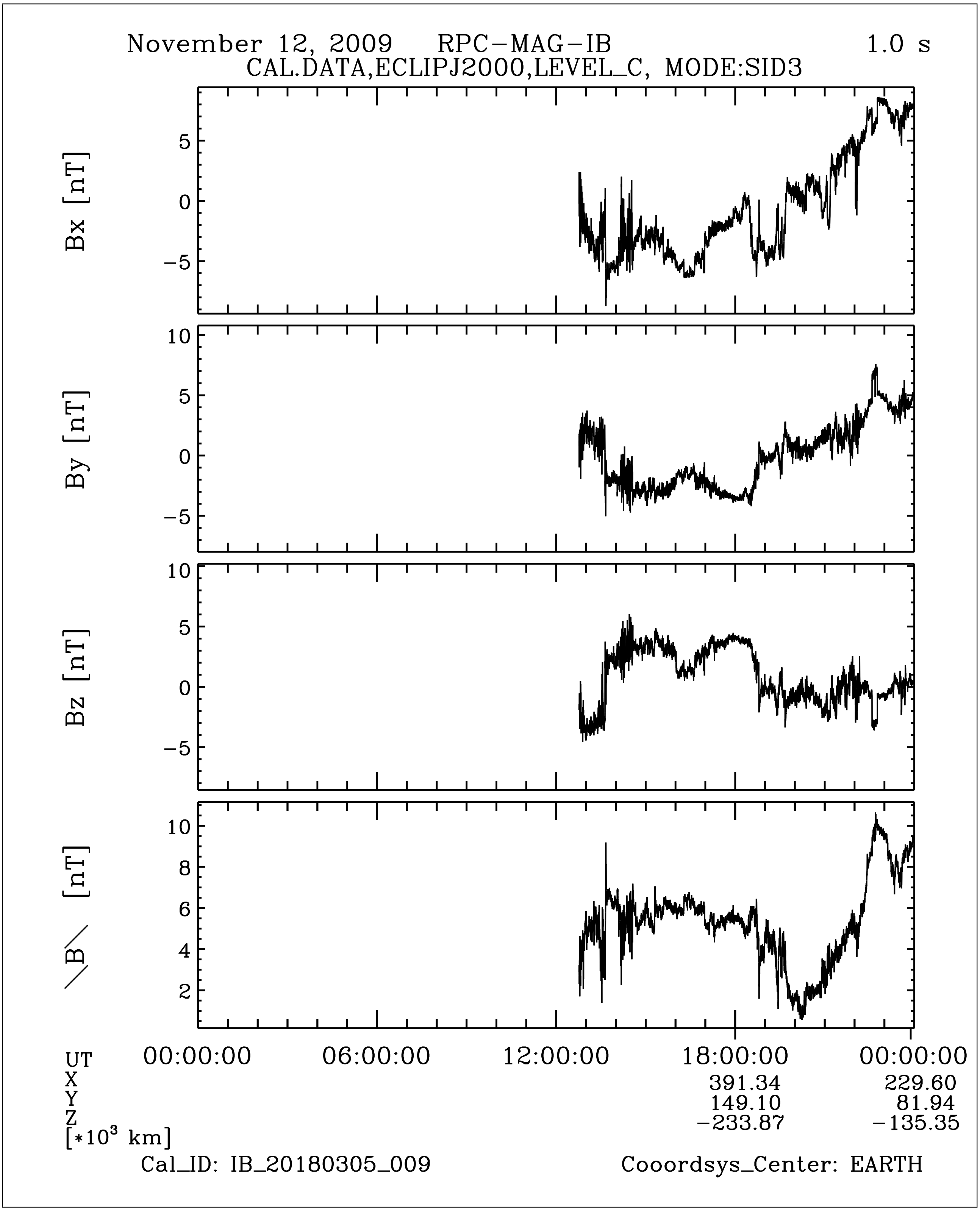

Figure 33: File: RPCMAG091112T1246_CLC_IB_M3_T0000_2400_009

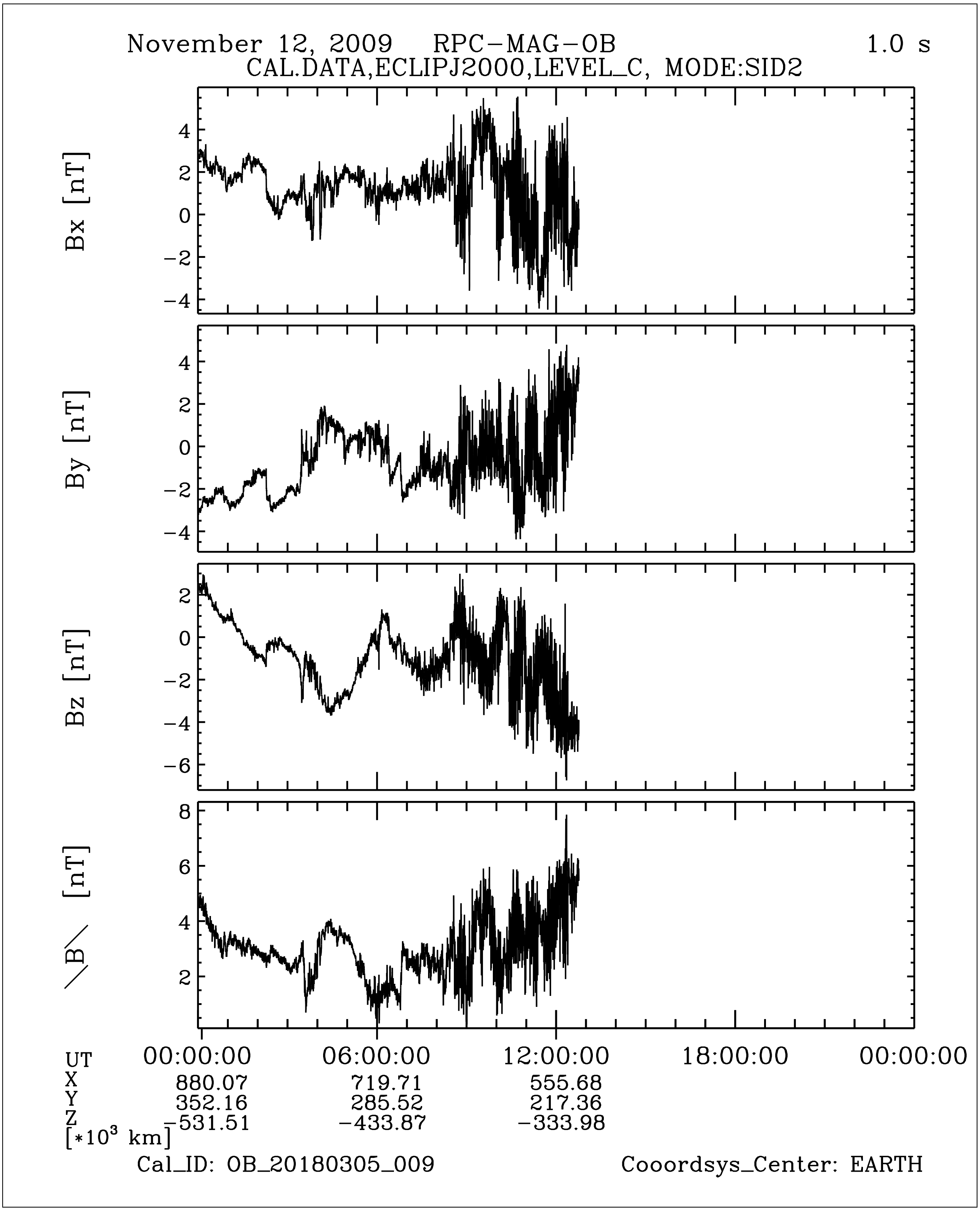

Figure 34: File: RPCMAG091112T0000_CLC_OB_M2_T0000_2400_009

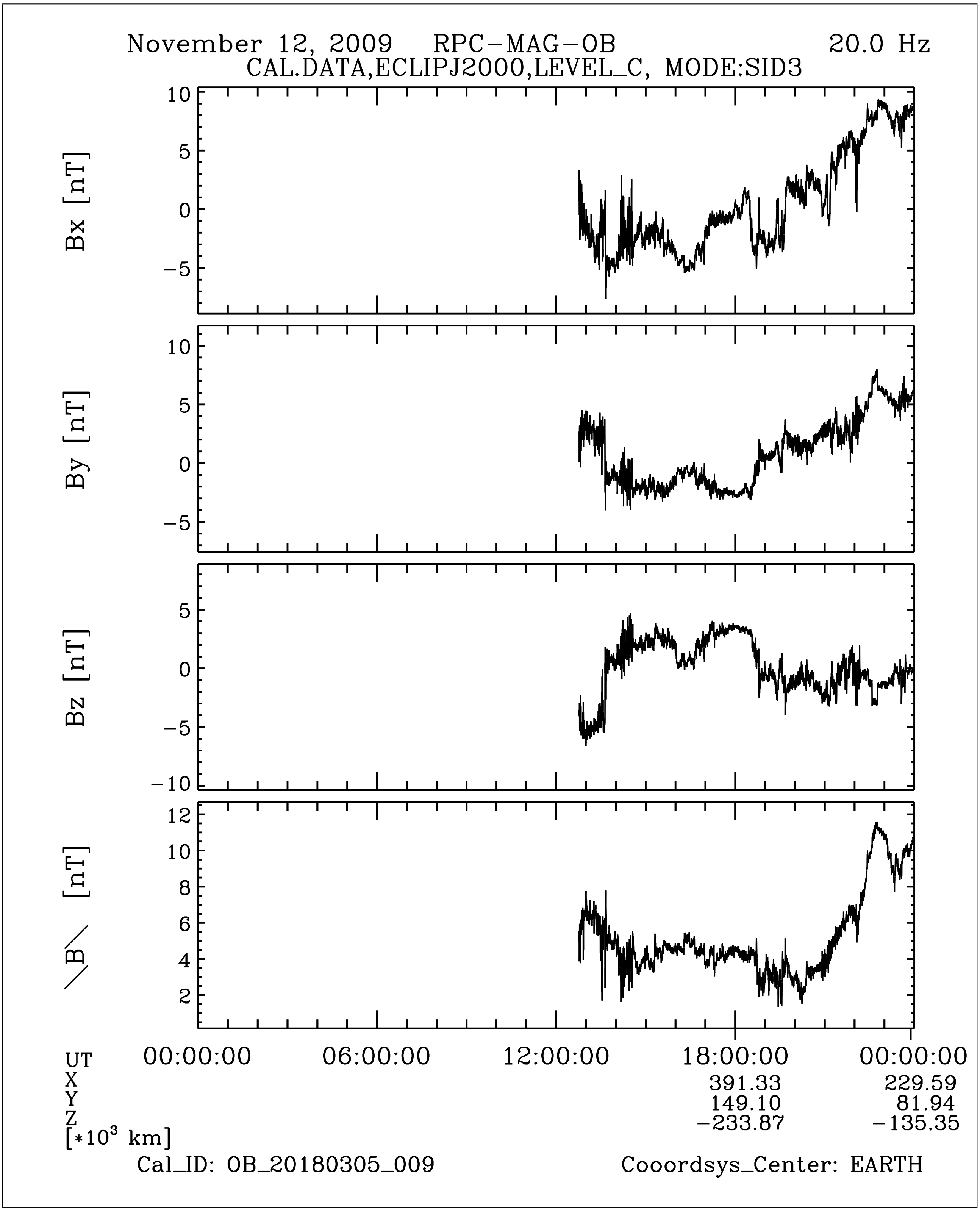

Figure 35: File: RPCMAG091112T1246_CLC_OB_M3_T0000_2400_009

3.6 November 13, 2009:

3.6.1 Actions

MAG stayed nominally in SID 3 until 12:45. Then the instrument was set back to NORMAL mode SID2.
The closest approach (C/A) happened at 07:45:30 in a distance of 2481 km to the surface of the Earth.
No problems occurred.

3.6.2 Plots of Calibrated Data

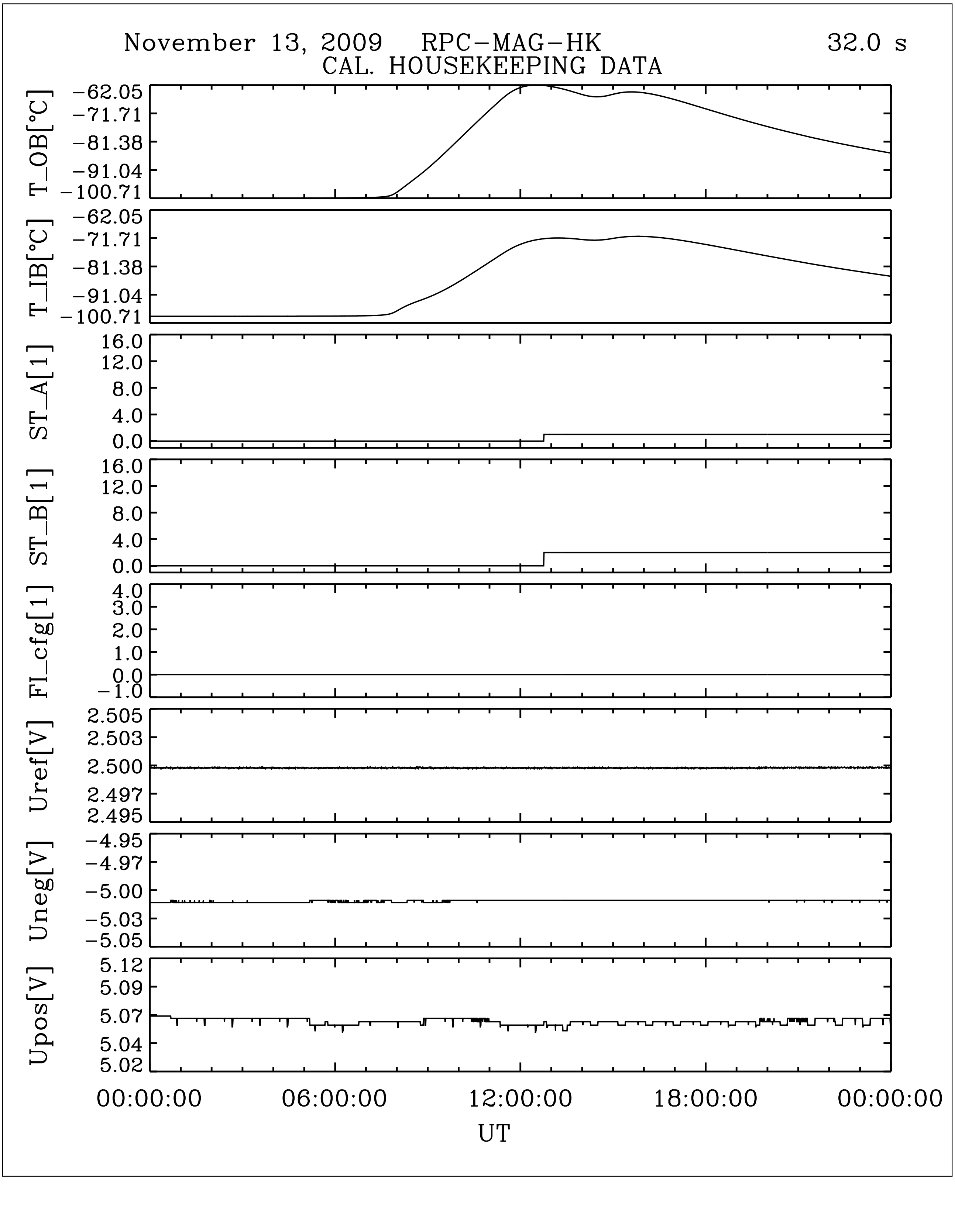

Figure 36: File: RPCMAG091113T0000_CLA_HK_P0000_2400

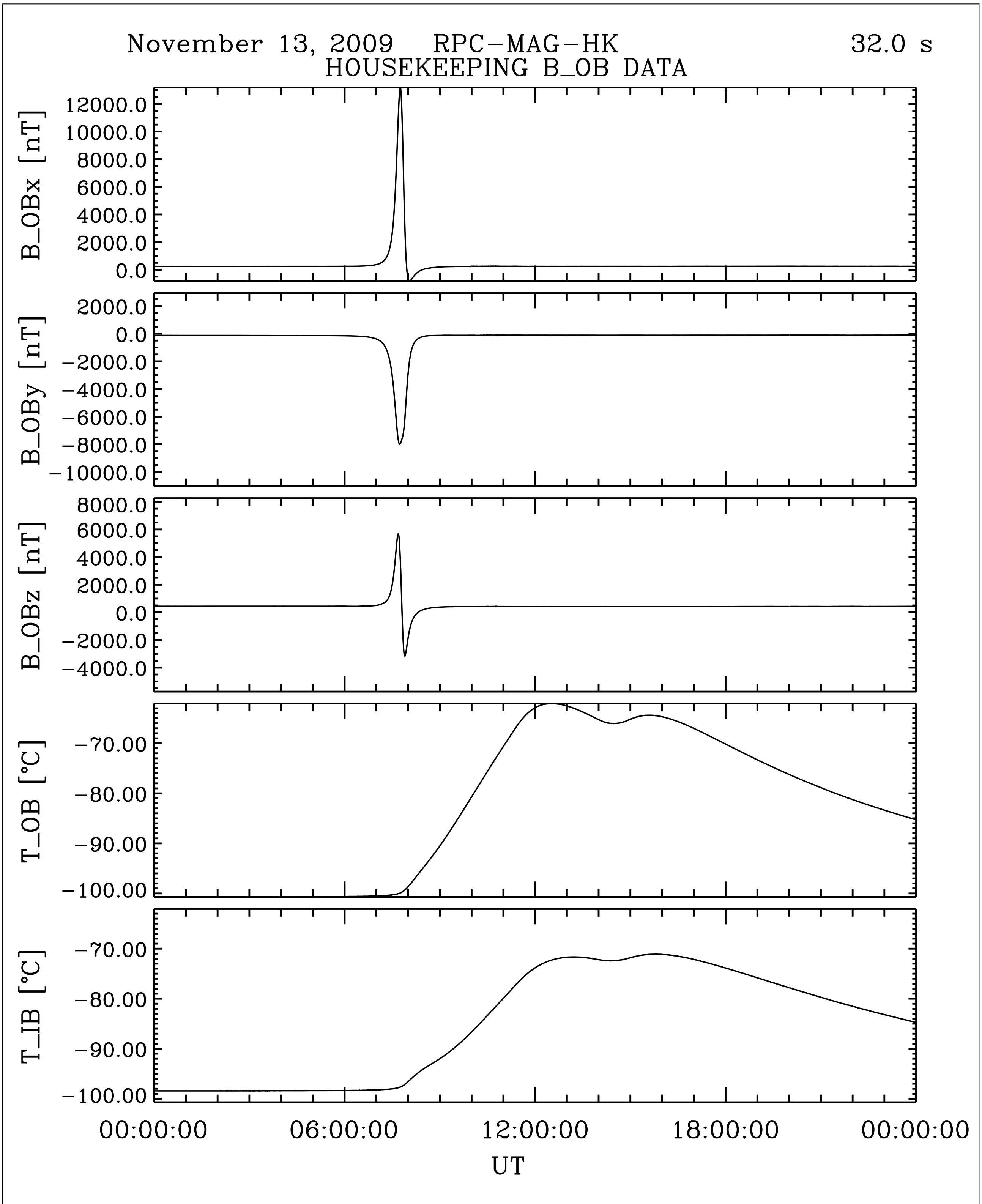

Figure 37: File: RPCMAG091113T0000_CLA_HK_B_P0000_2400

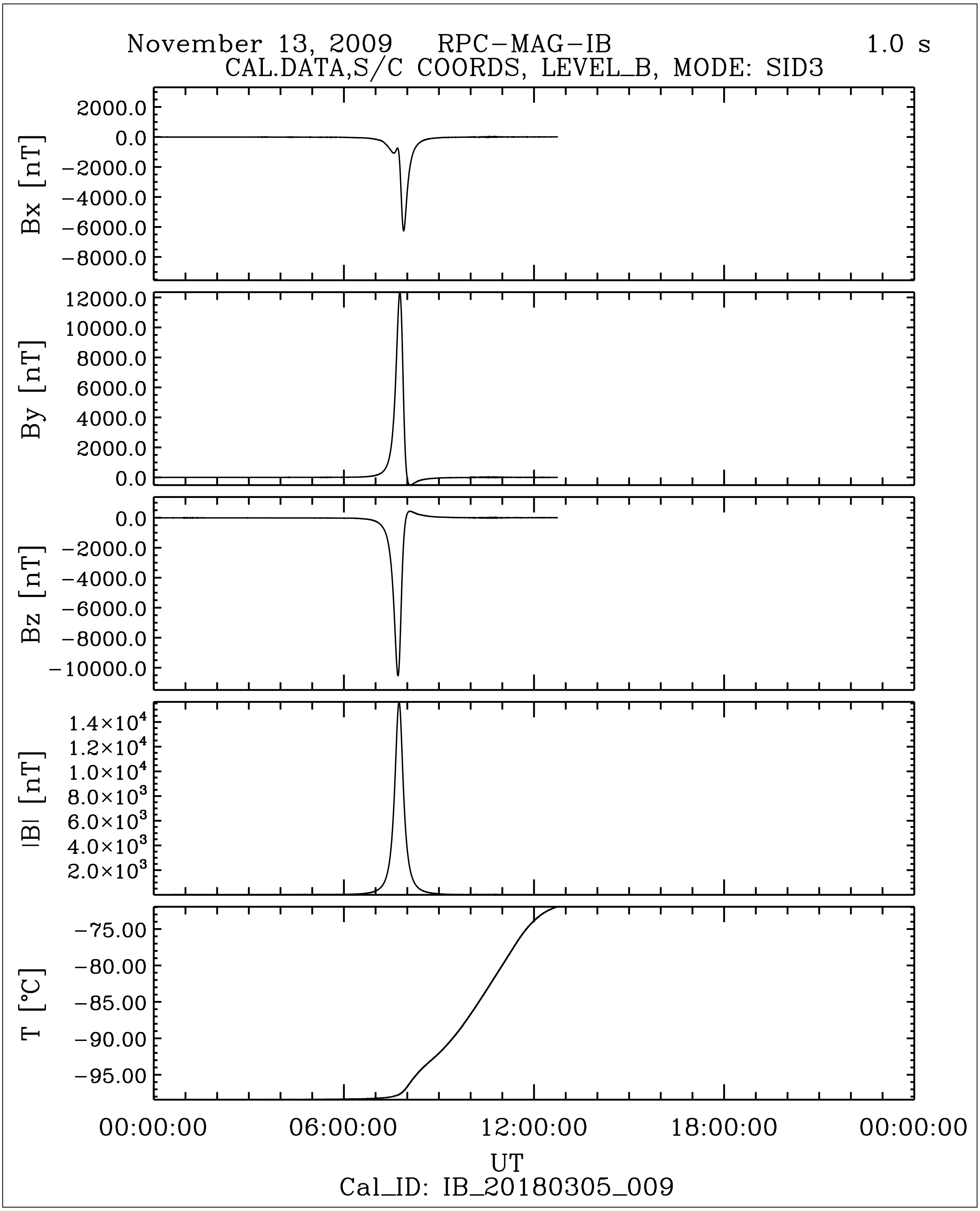

Figure 38: File: RPCMAG091113T0000_CLB_IB_M3_T0000_2400_009

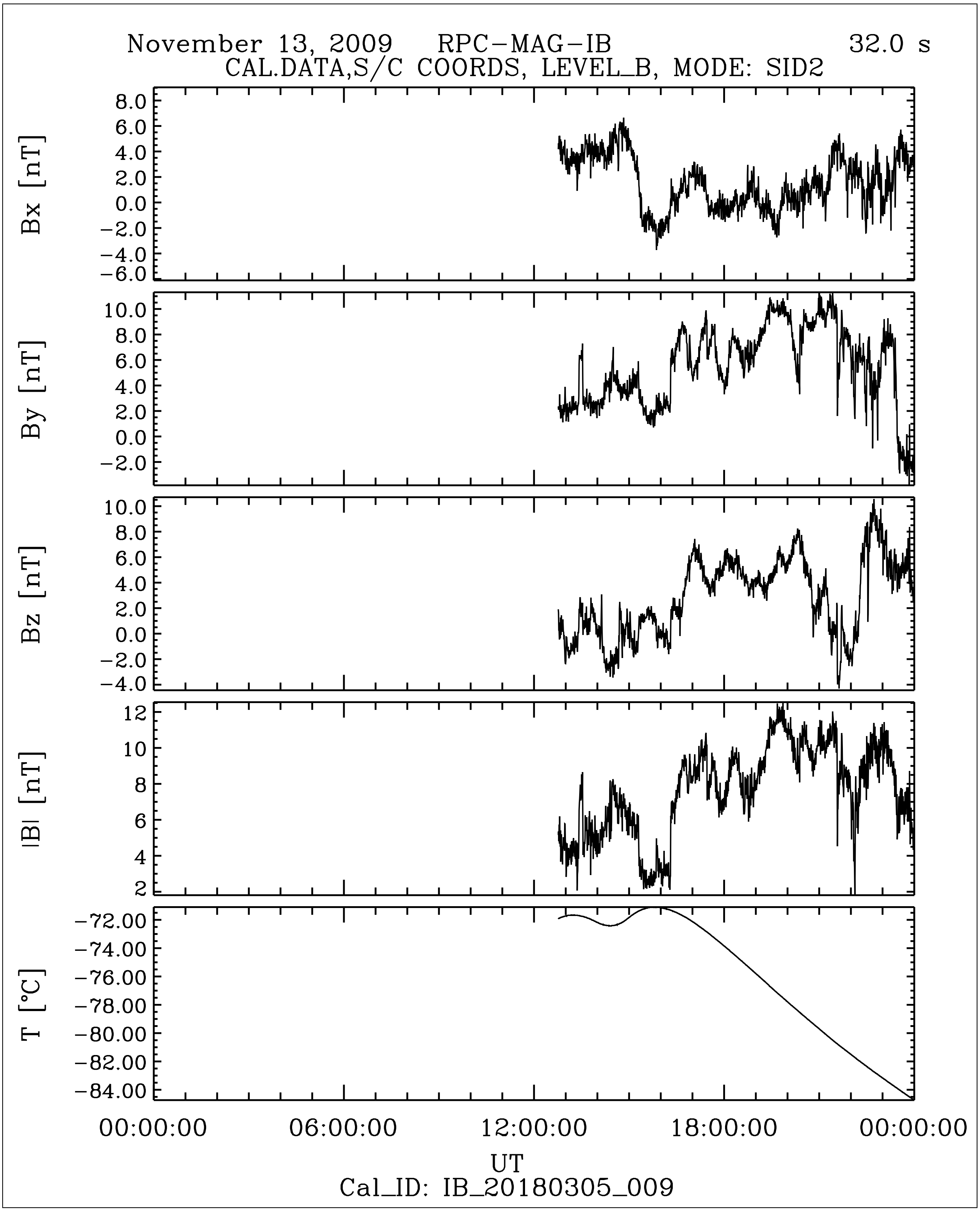

Figure 39: File: RPCMAG091113T1245_CLB_IB_M2_T0000_2400_009

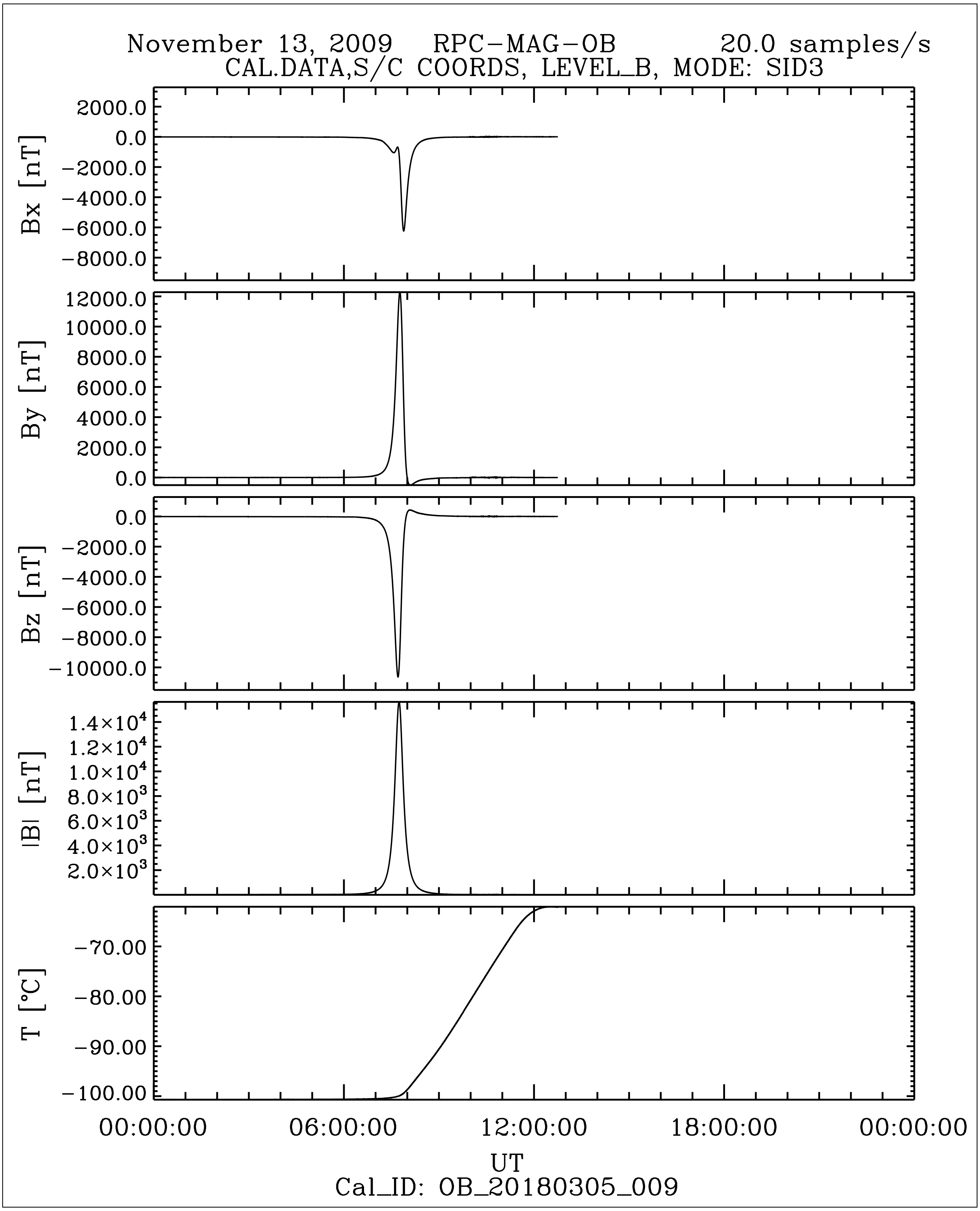

Figure 40: File: RPCMAG091113T0000_CLB_OB_M3_T0000_2400_009

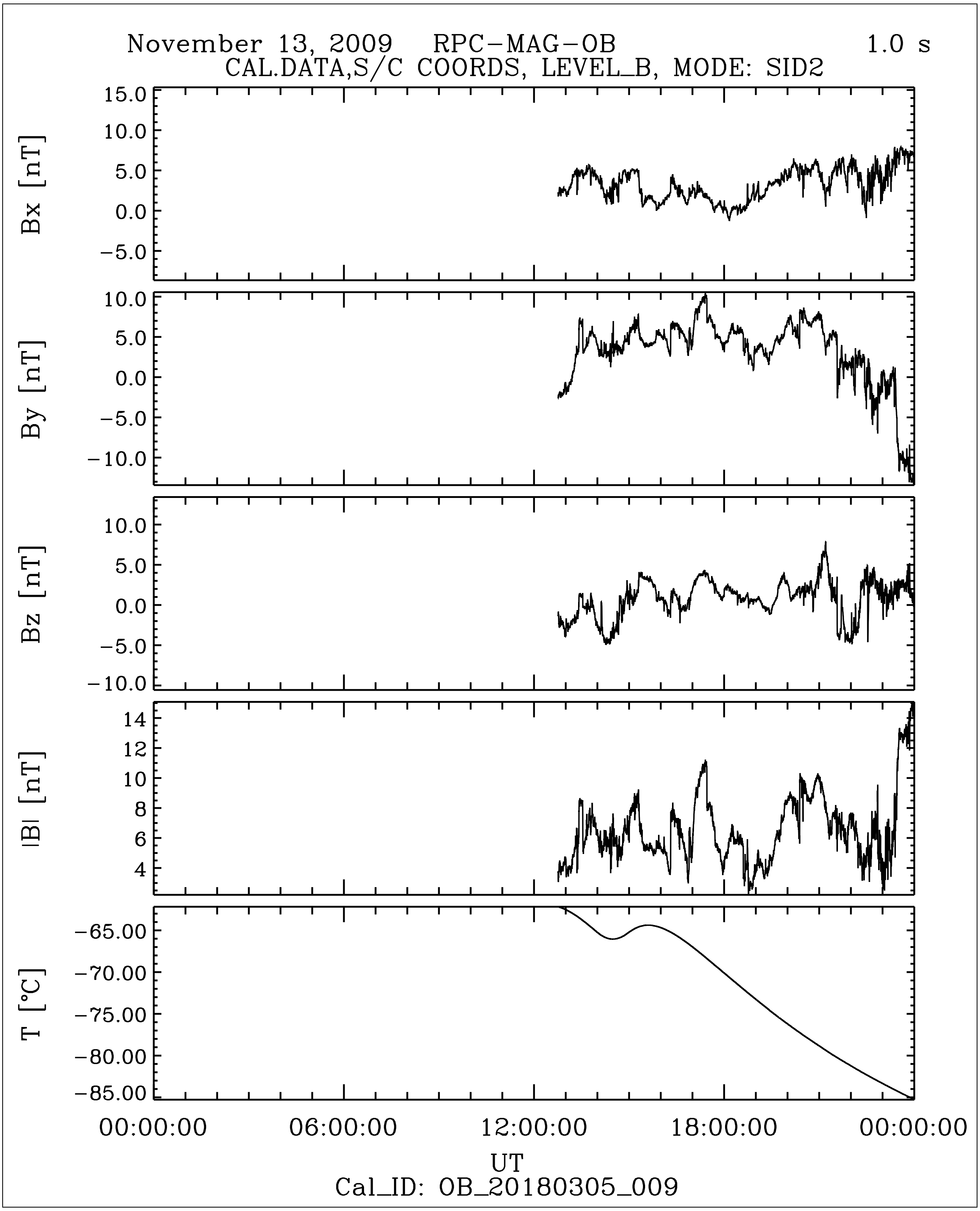

Figure 41: File: RPCMAG091113T1245_CLB_OB_M2_T0000_2400_009

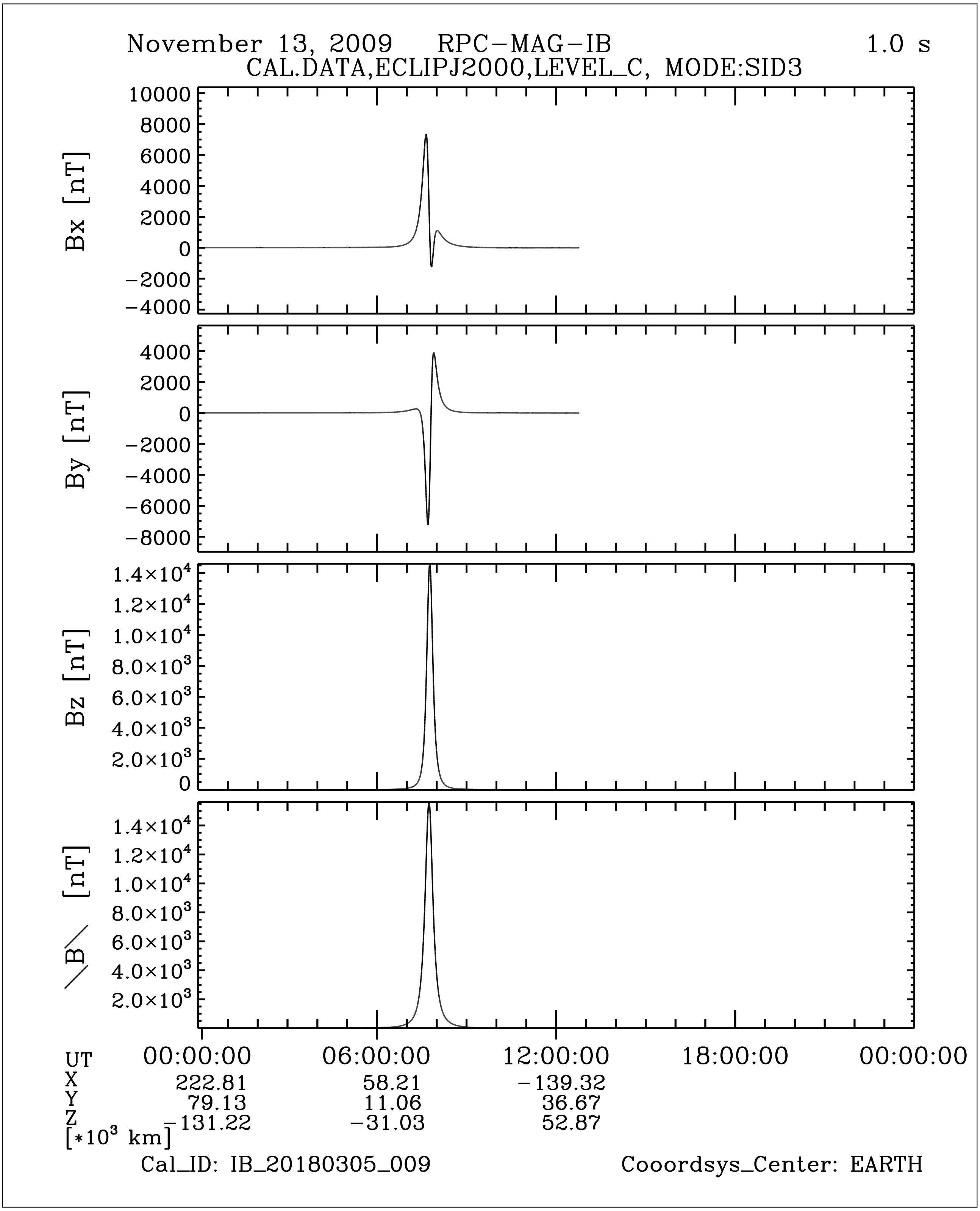

Figure 42: File: RPCMAG091113T0000_CLC_IB_M3_T0000_2400_009

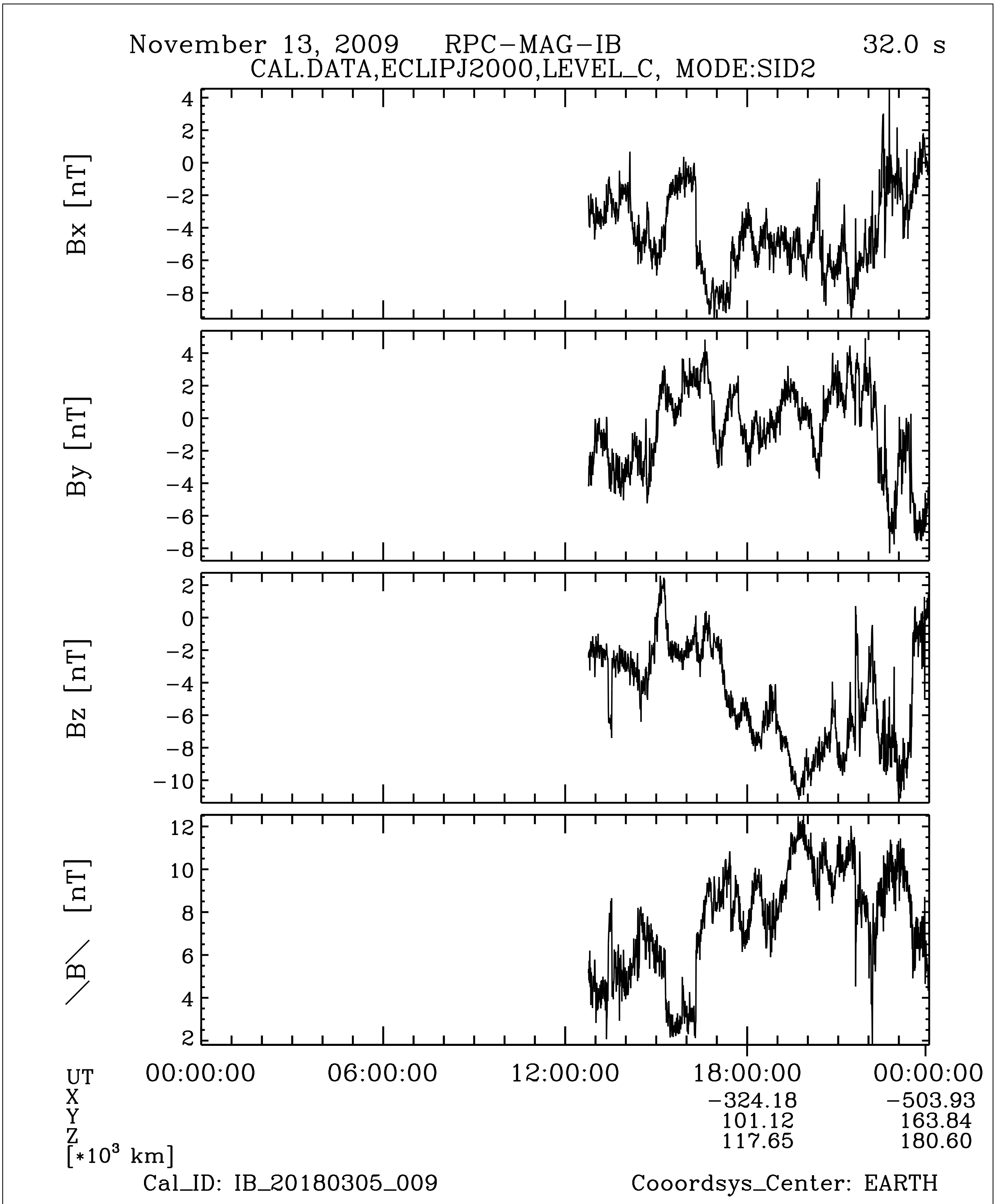

Figure 43: File: RPCMAG091113T1245_CLC_IB_M2_T0000_2400_009

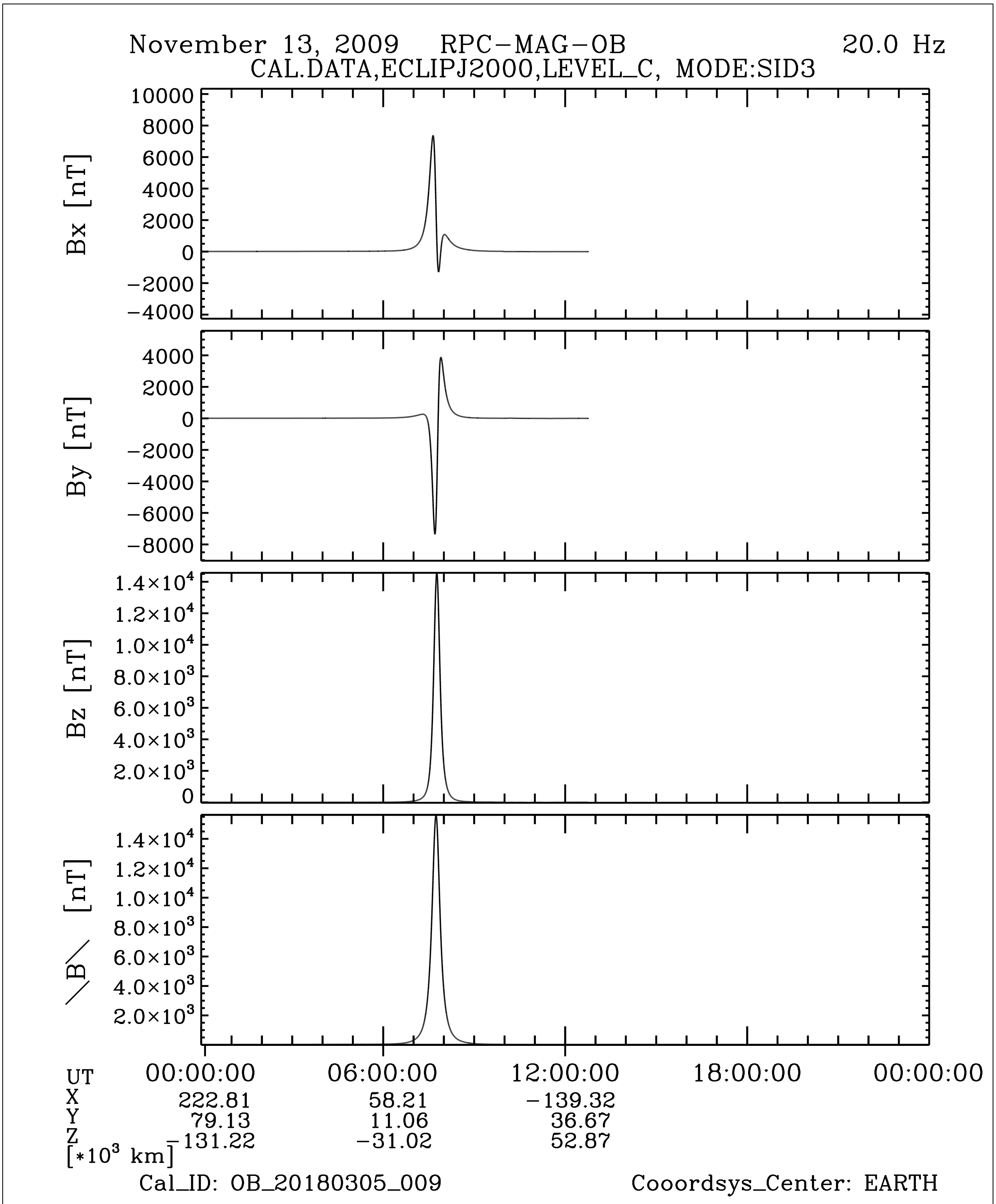

Figure 44: File: RPCMAG091113T0000_CLC_OB_M3_T0000_2400_009

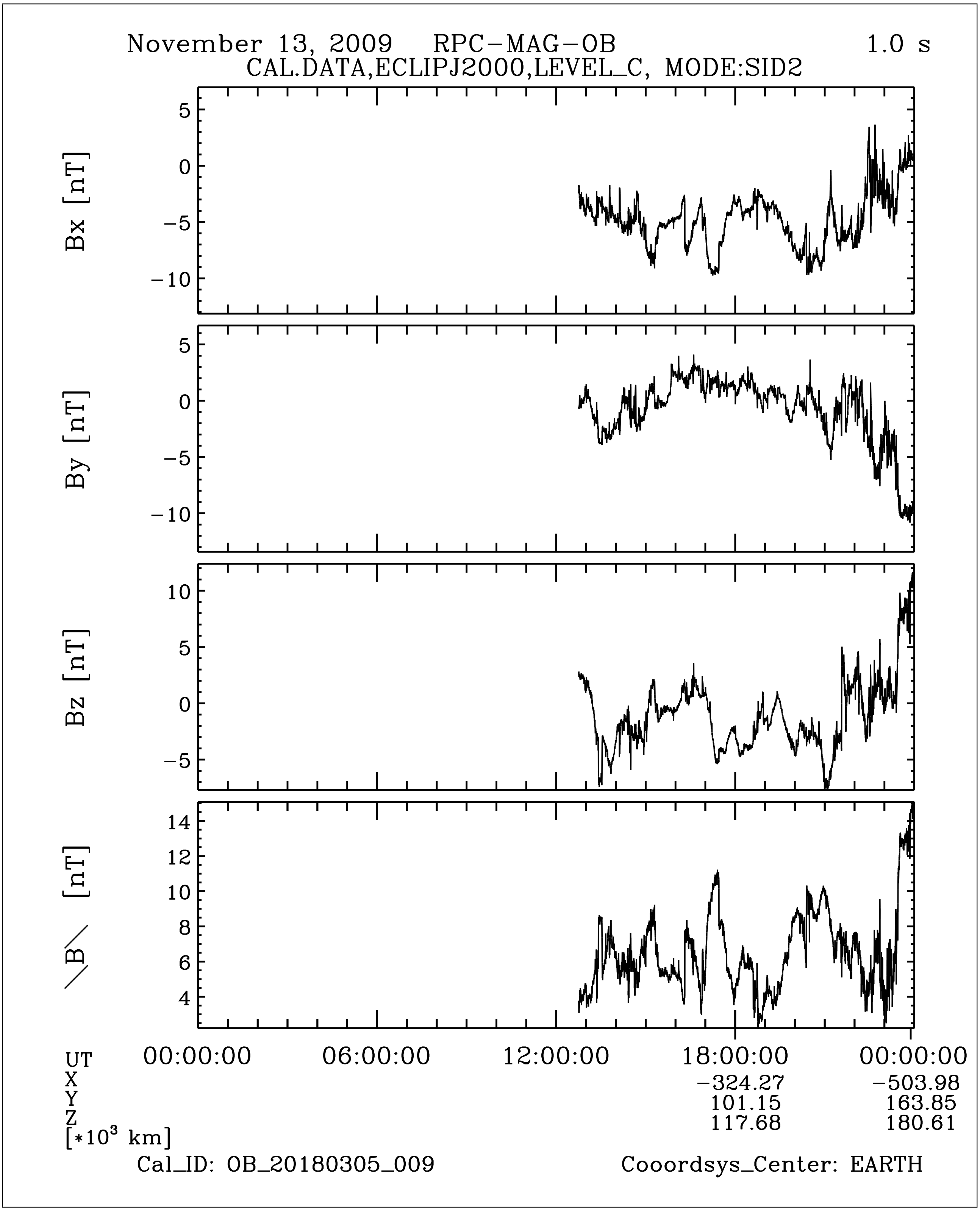

Figure 45: File: RPCMAG091113T1245_CLC_OB_M2_T0000_2400_009

3.7 November 14, 2009:

3.7.1 Actions

MAG stayed in SID 2. No problems occurred.

3.7.2 Plots of Calibrated Data

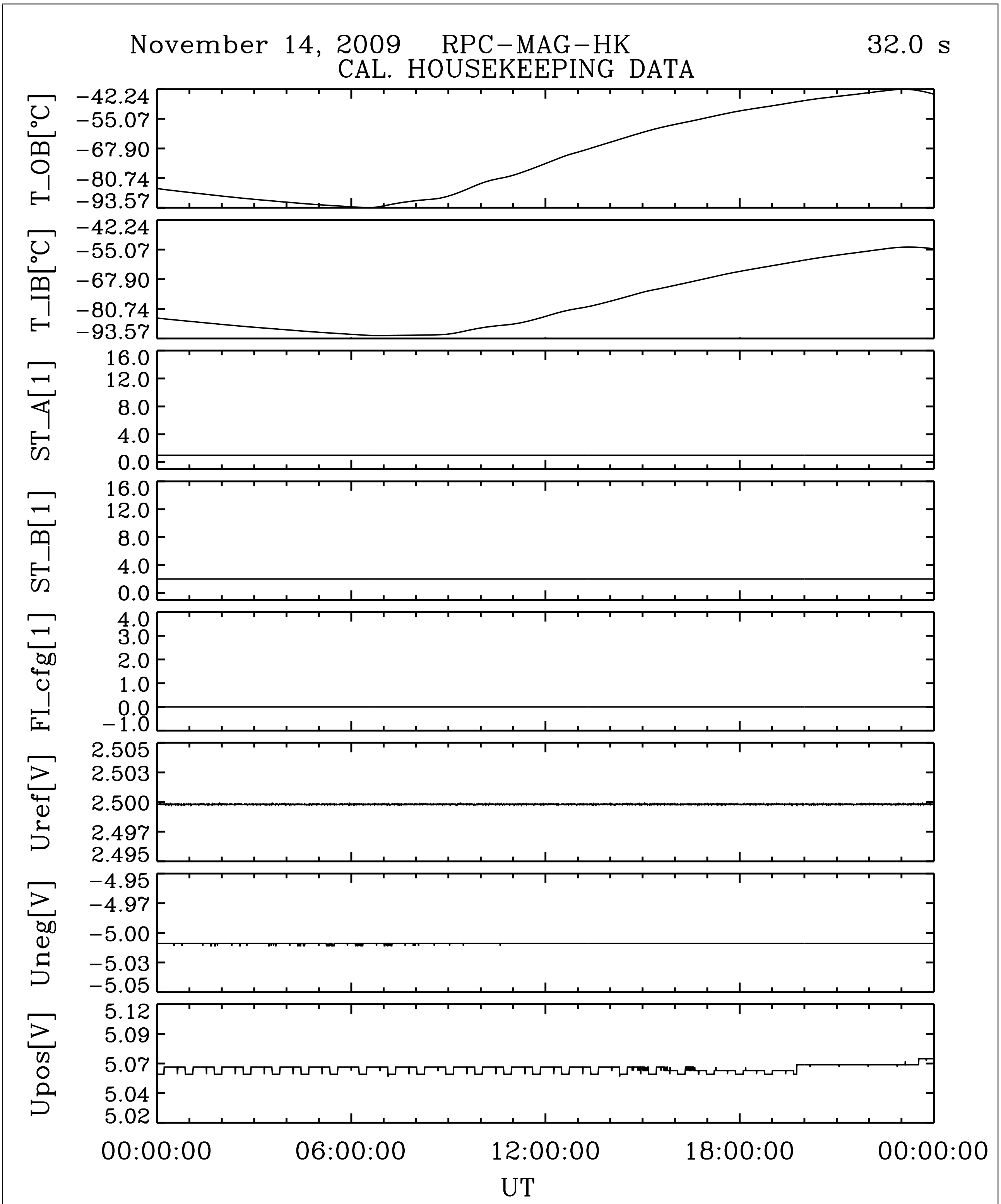

Figure 46: File: RPCMAG091114T0000_CLA_HK_P0000_2400

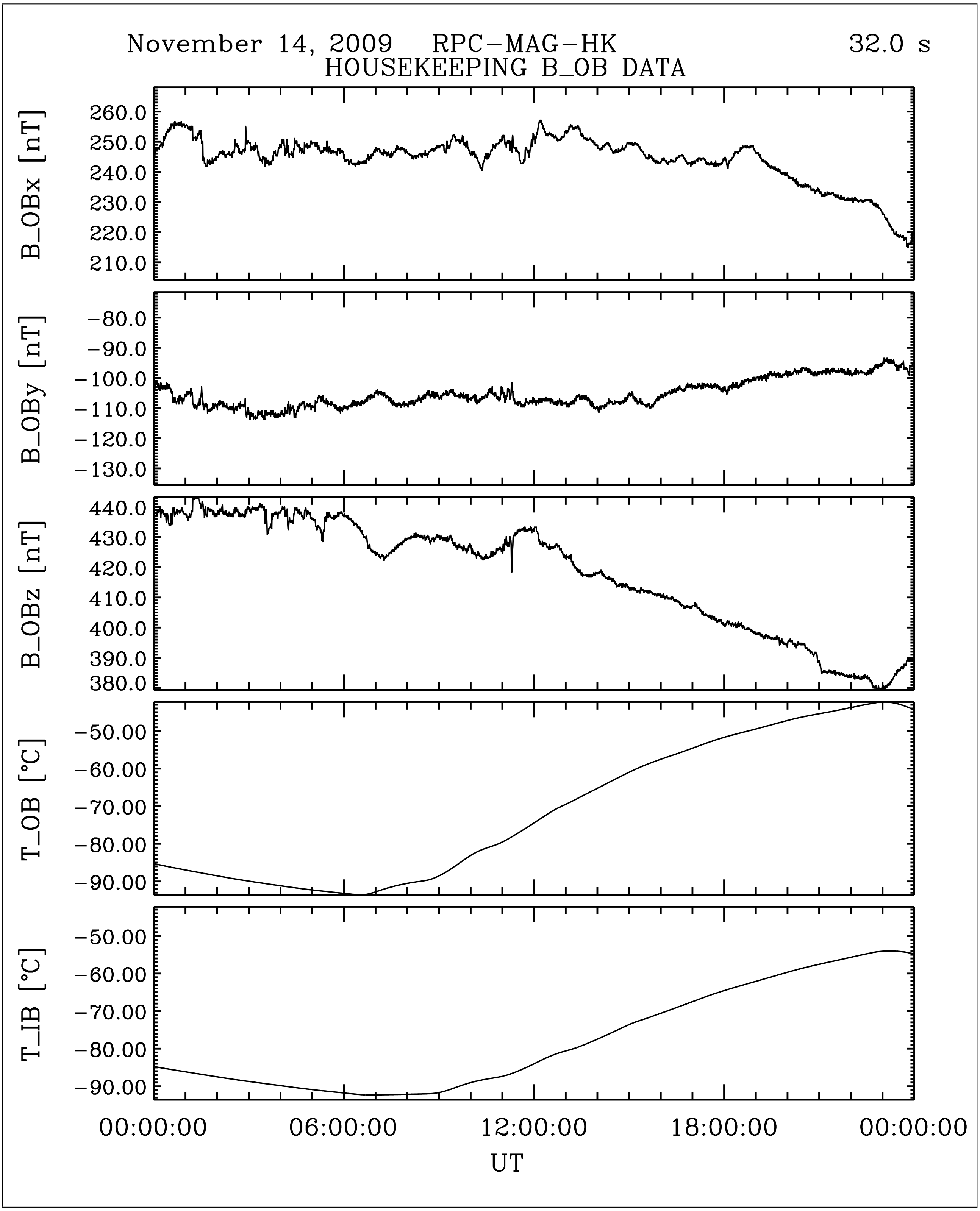

Figure 47: File: RPCMAG091114T0000_CLA_HK_B_P0000_2400

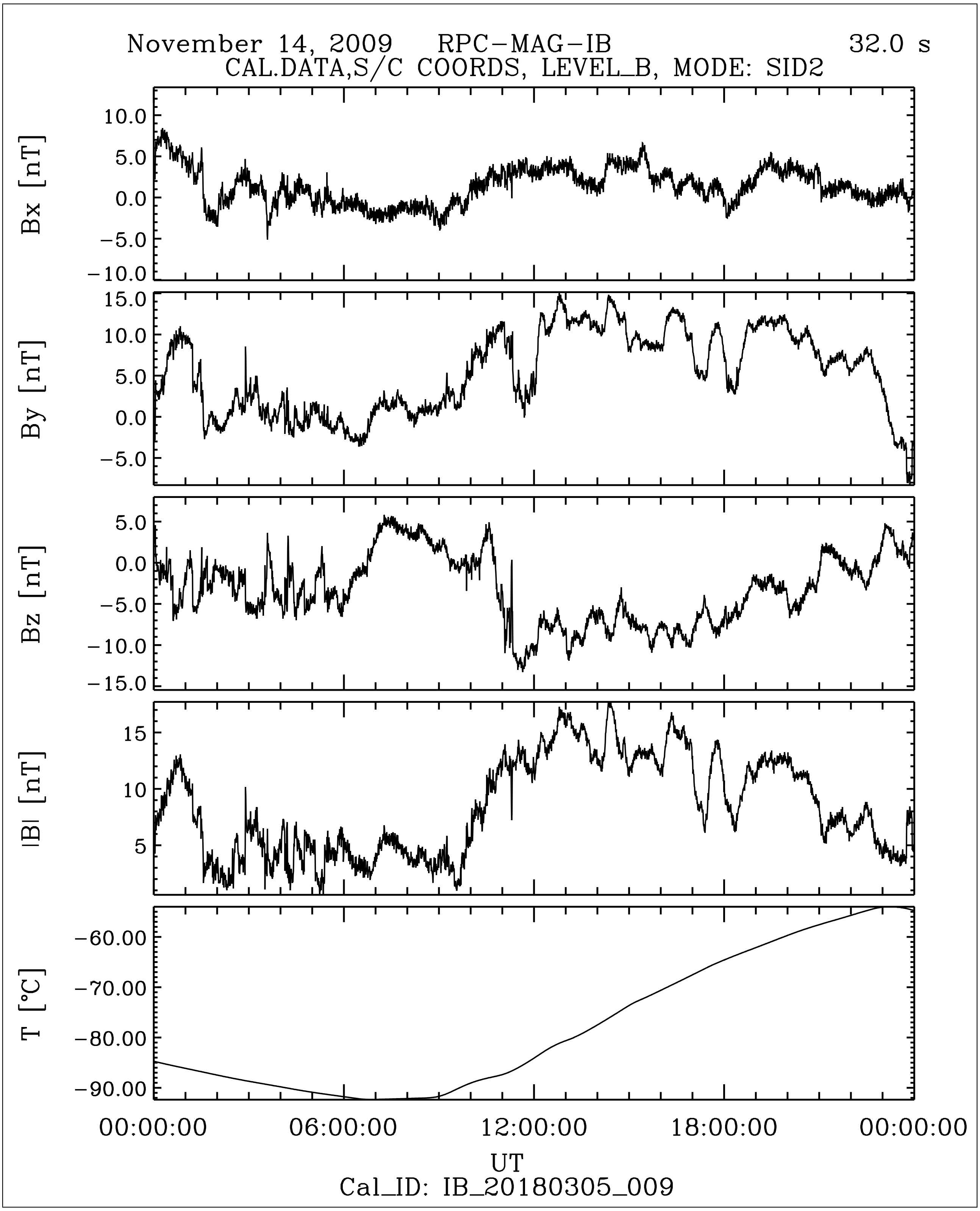

Figure 48: File: RPCMAG091114T0000_CLB_IB_M2_T0000_2400_009

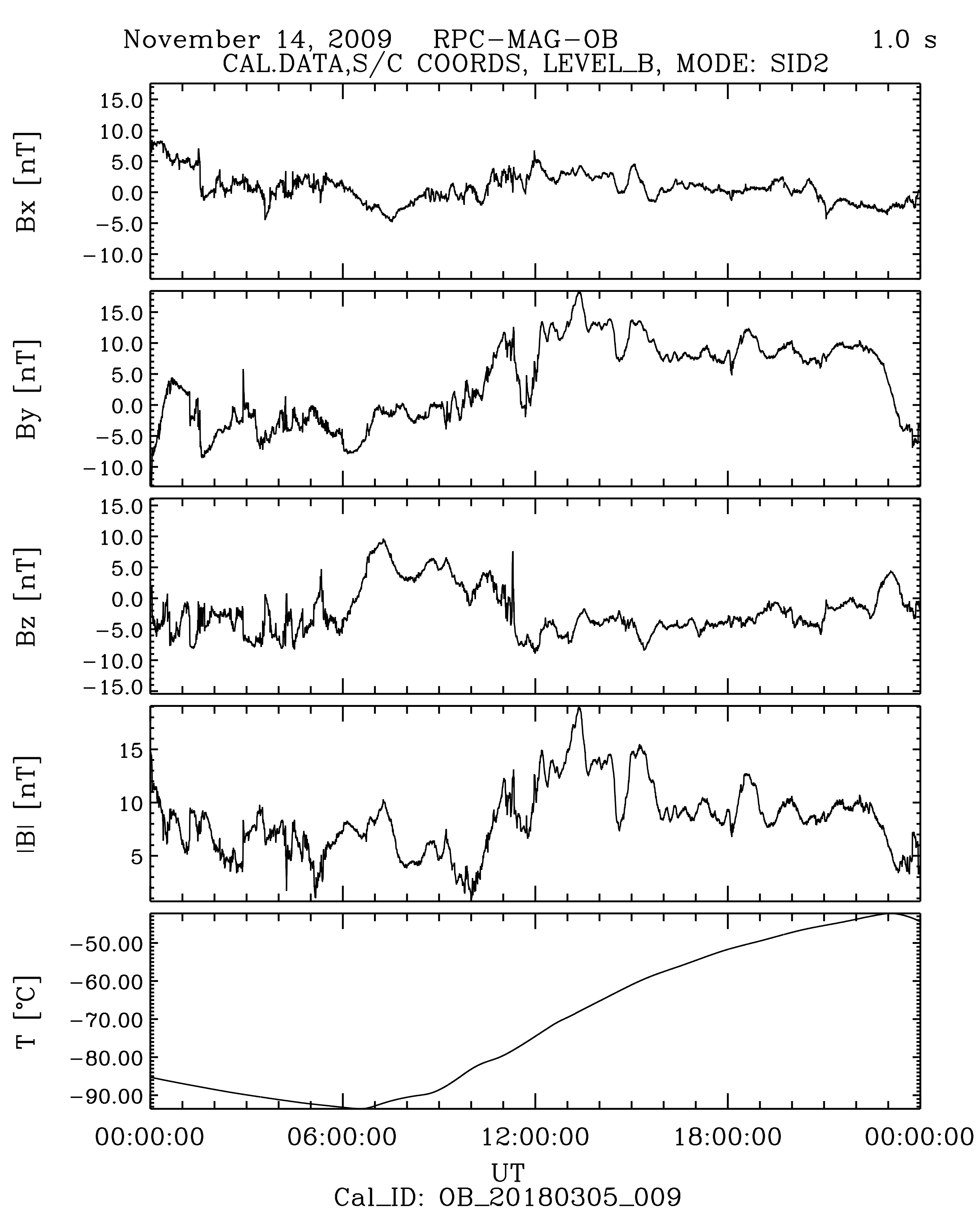

Figure 49: File: RPCMAG091114T0000_CLB_OB_M2_T0000_2400_009

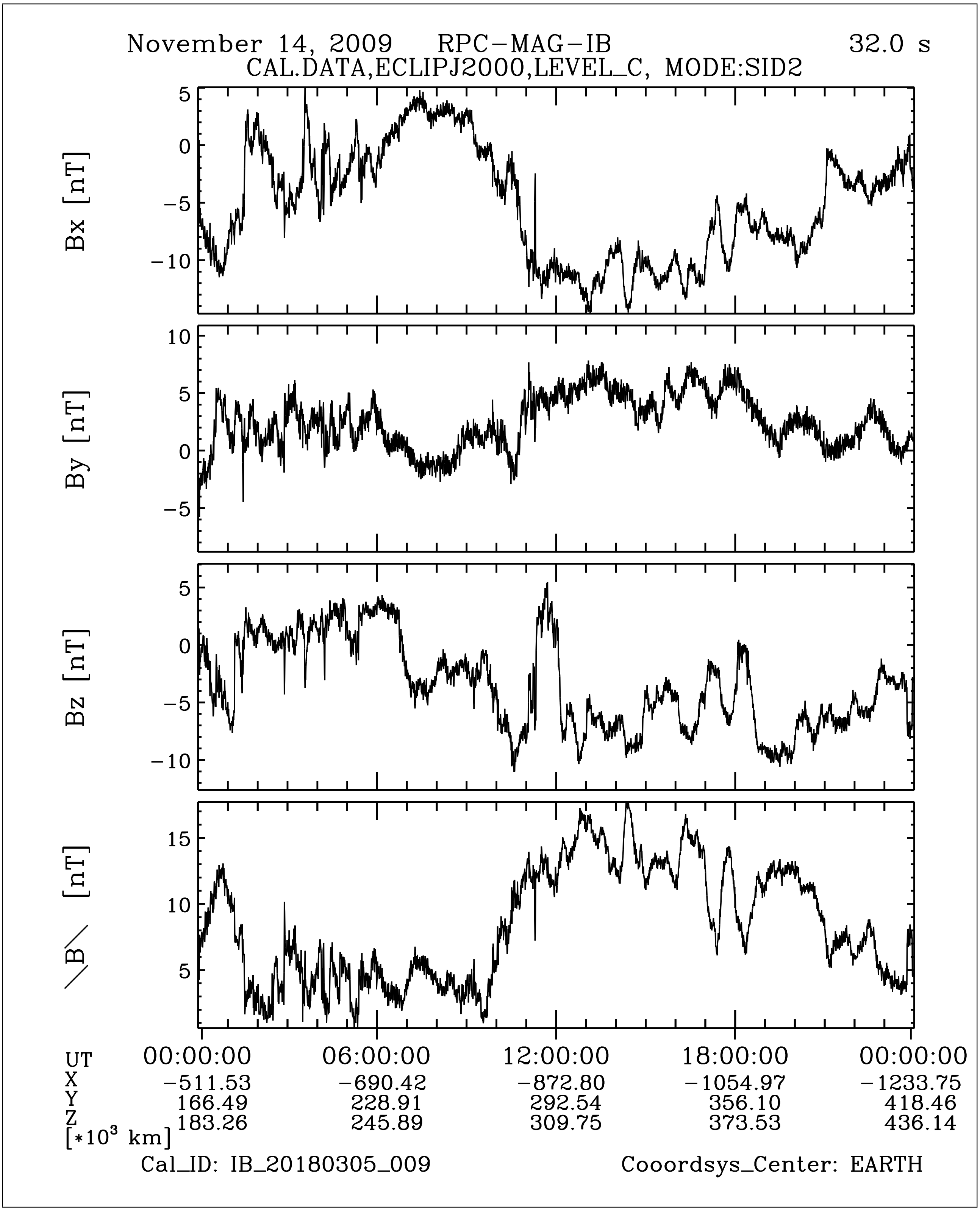

Figure 50: File: RPCMAG091114T0000_CLC_IB_M2_T0000_2400_009

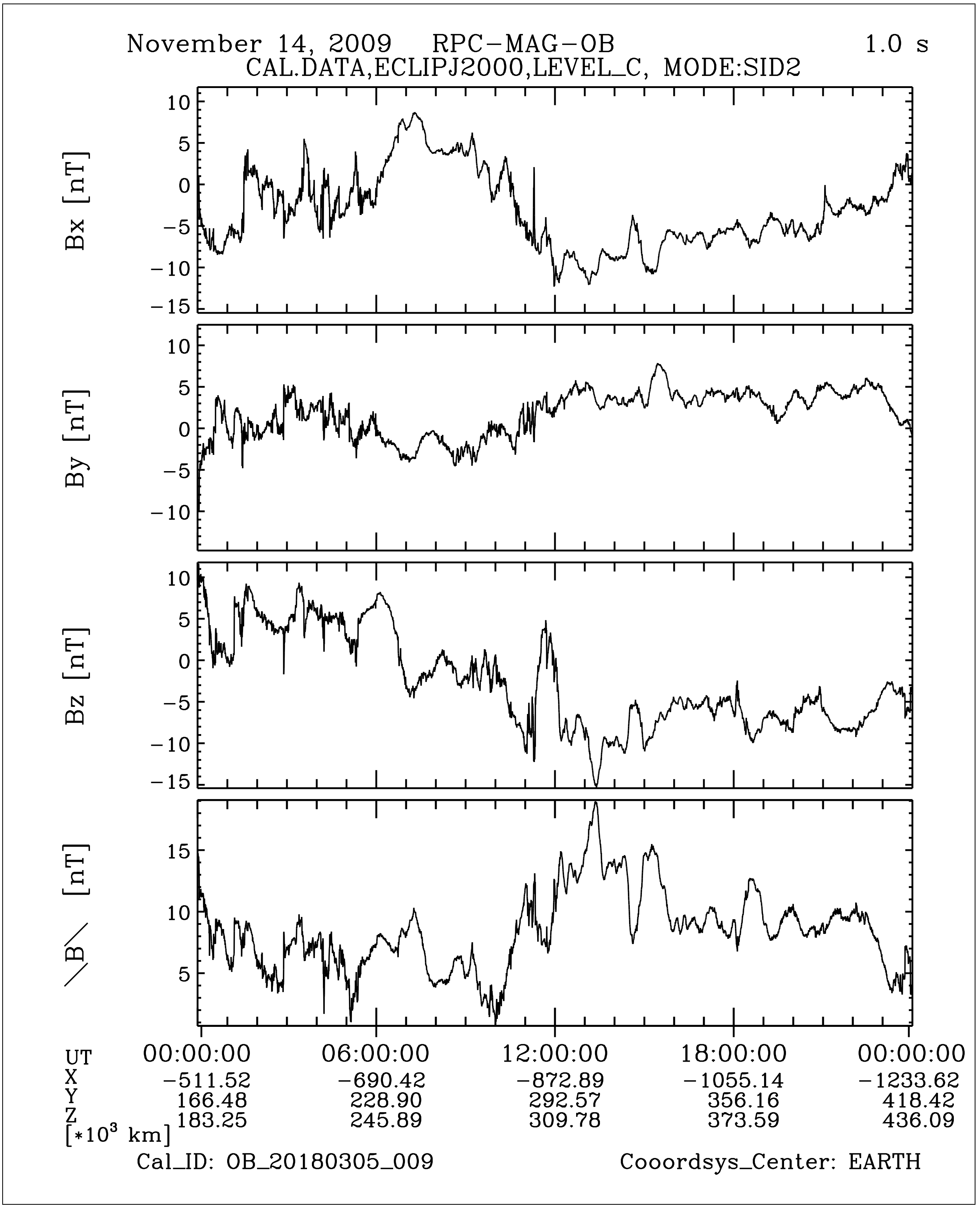

Figure 51: File: RPCMAG091114T0000_CLC_OB_M2_T0000_2400_009

3.8 November 15, 2009:

3.8.1 Actions

MAG stayed in SID 2. No problems.

3.8.2 Plots of Calibrated Data

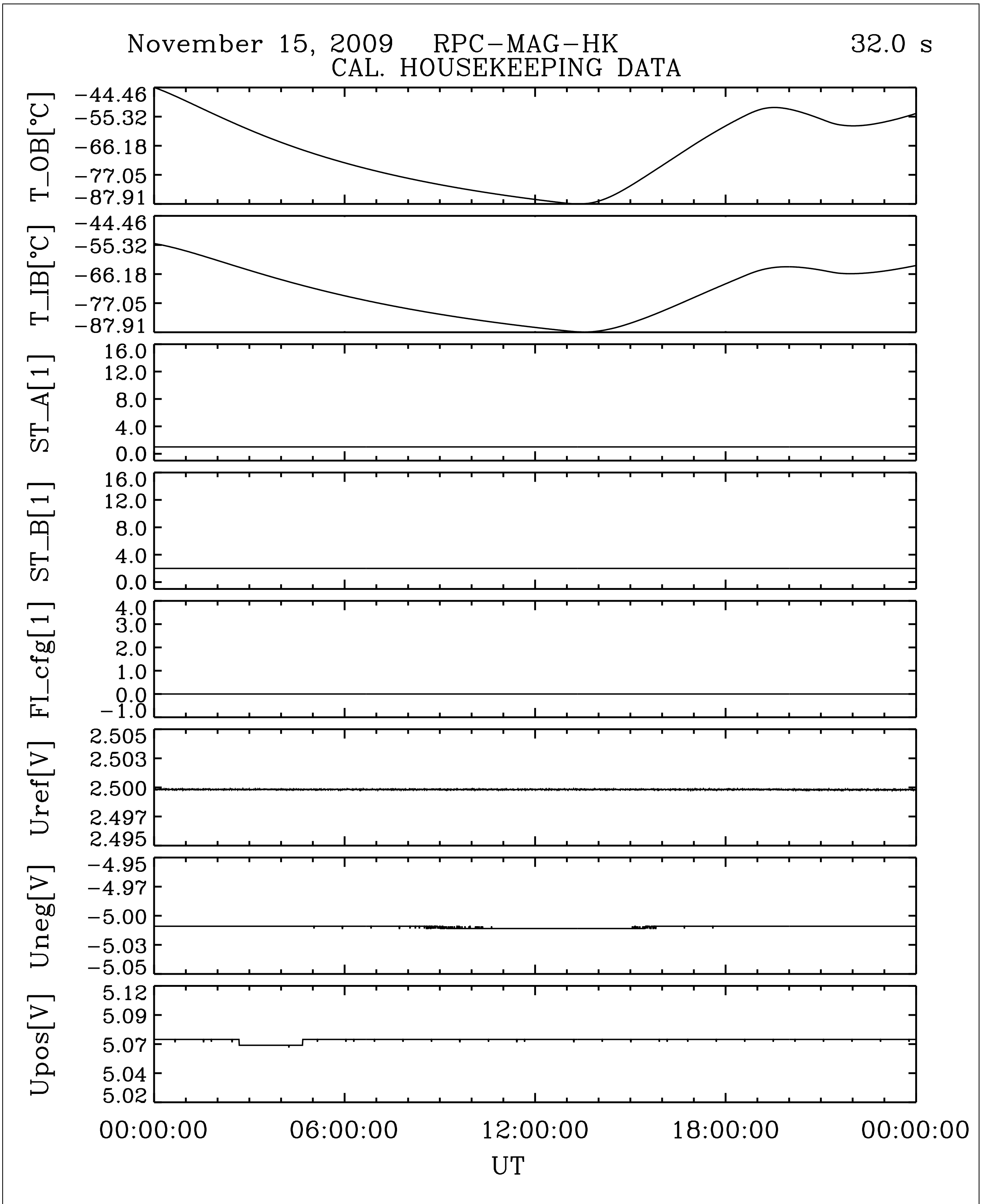

Figure 52: File: RPCMAG091115T0000_CLA_HK_P0000_2400

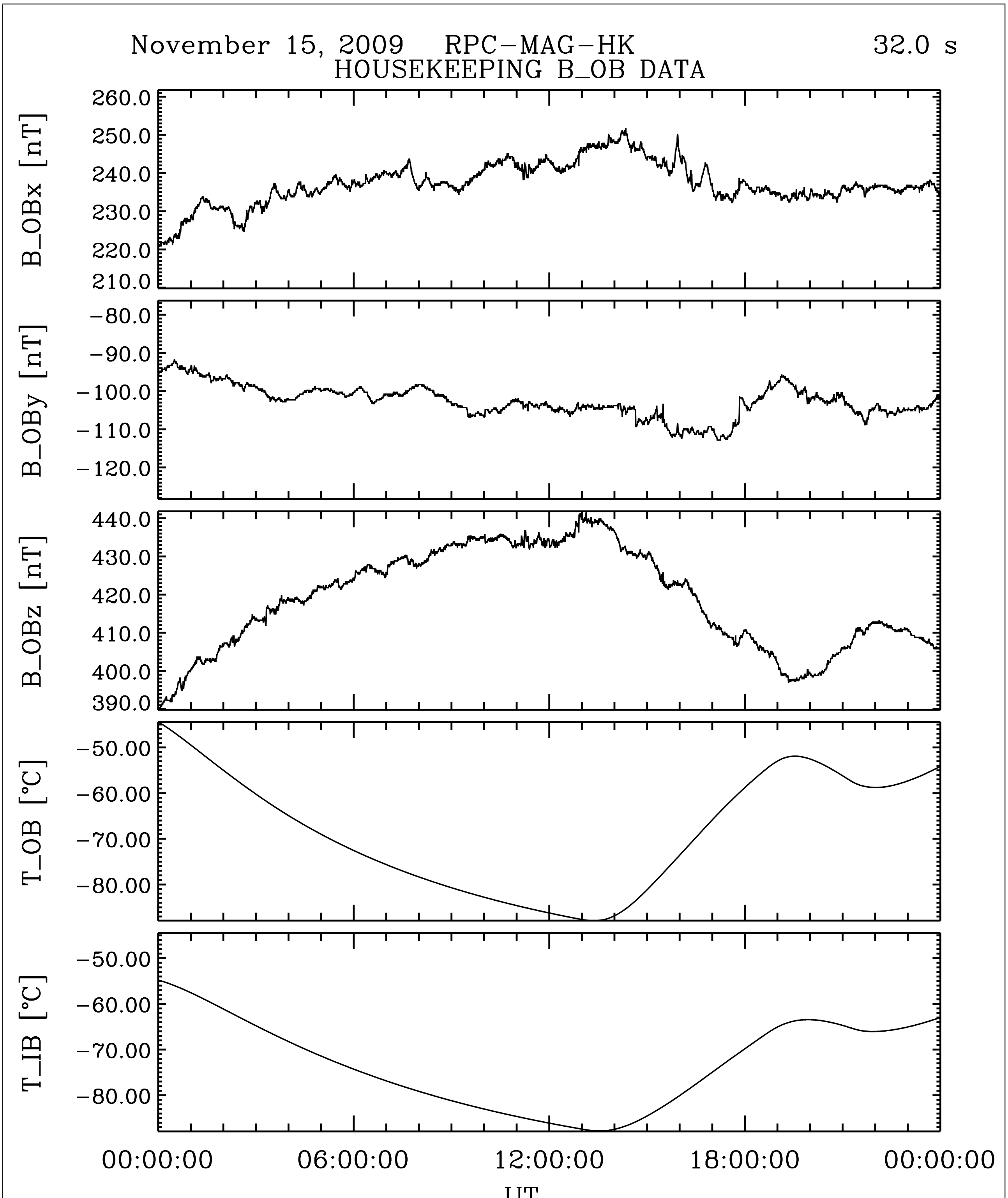

Figure 53: File: RPCMAG091115T0000_CLA_HK_B_P0000_2400

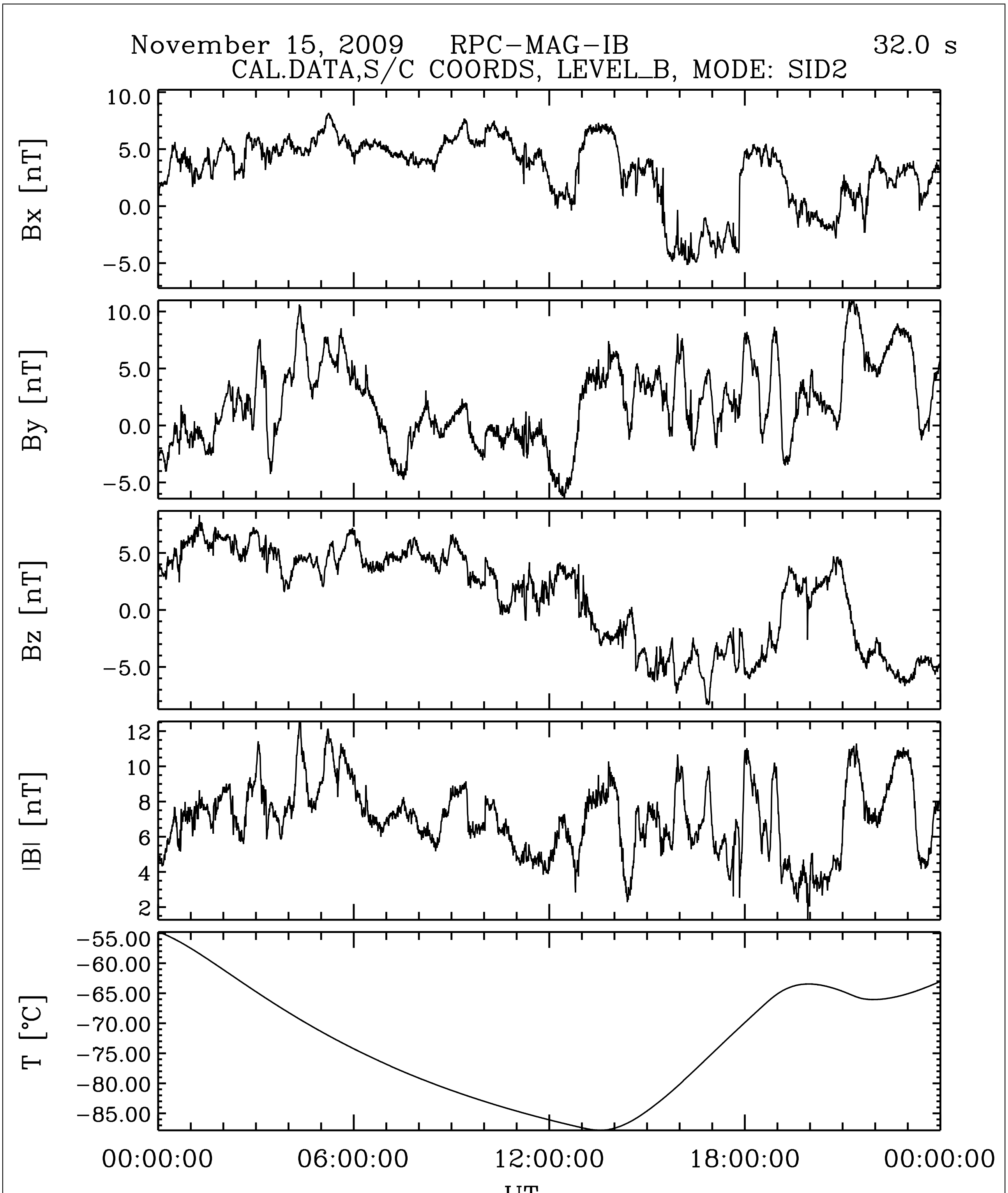

Figure 54: File: RPCMAG091115T0000_CLB_IB_M2_T0000_2400_009

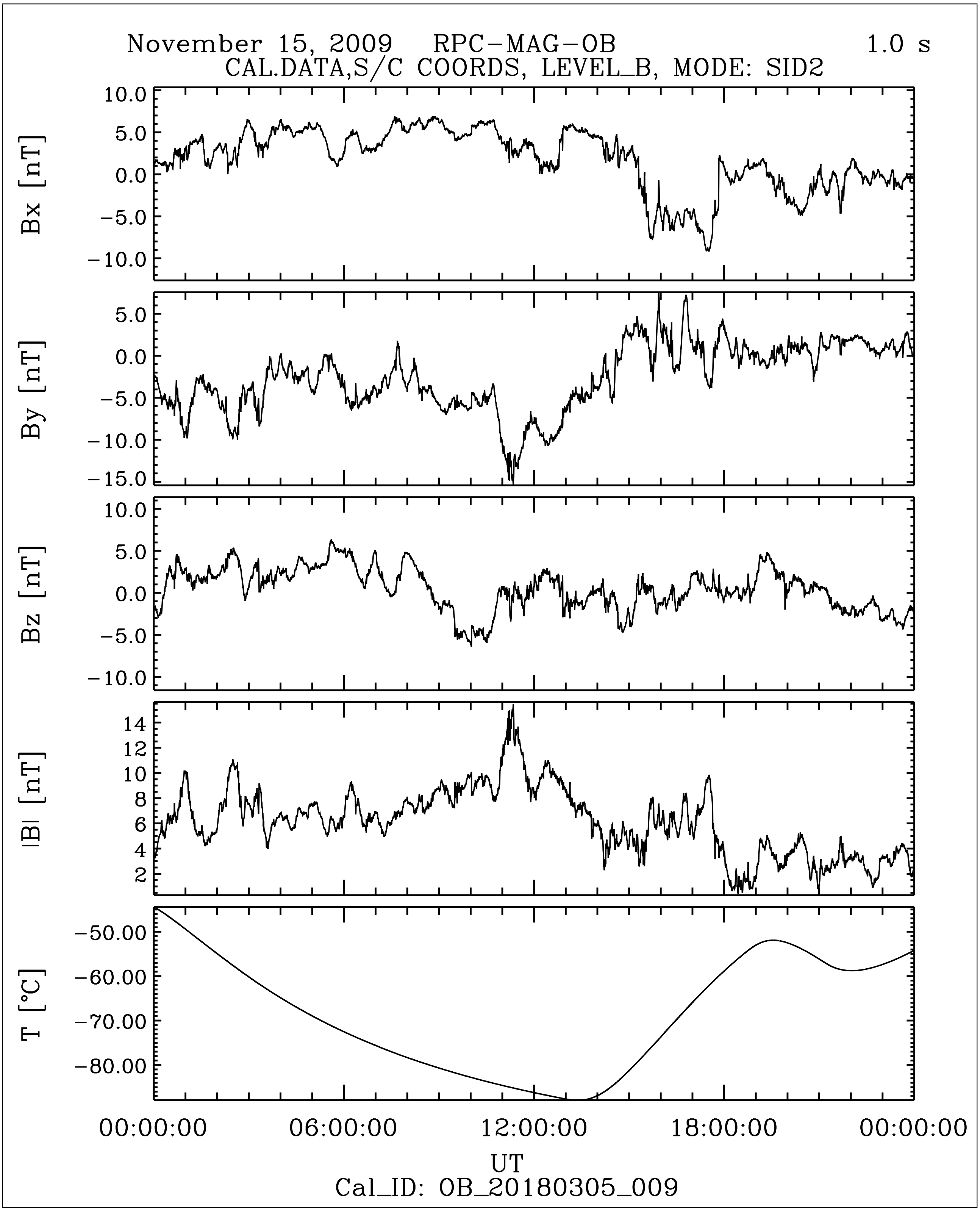

Figure 55: File: RPCMAG091115T0000_CLB_OB_M2_T0000_2400_009

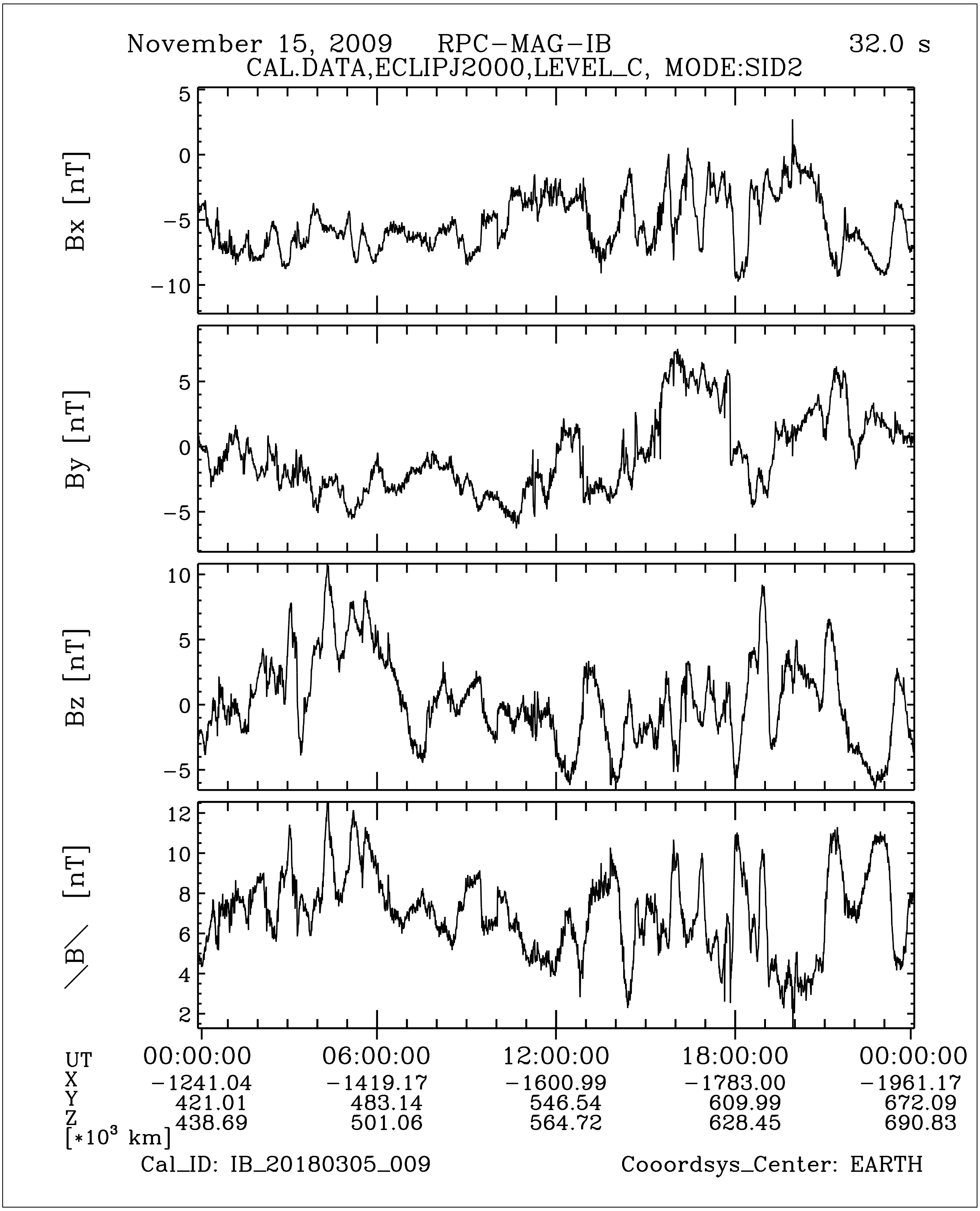

Figure 56: File: RPCMAG091115T0000_CLC_IB_M2_T0000_2400_009

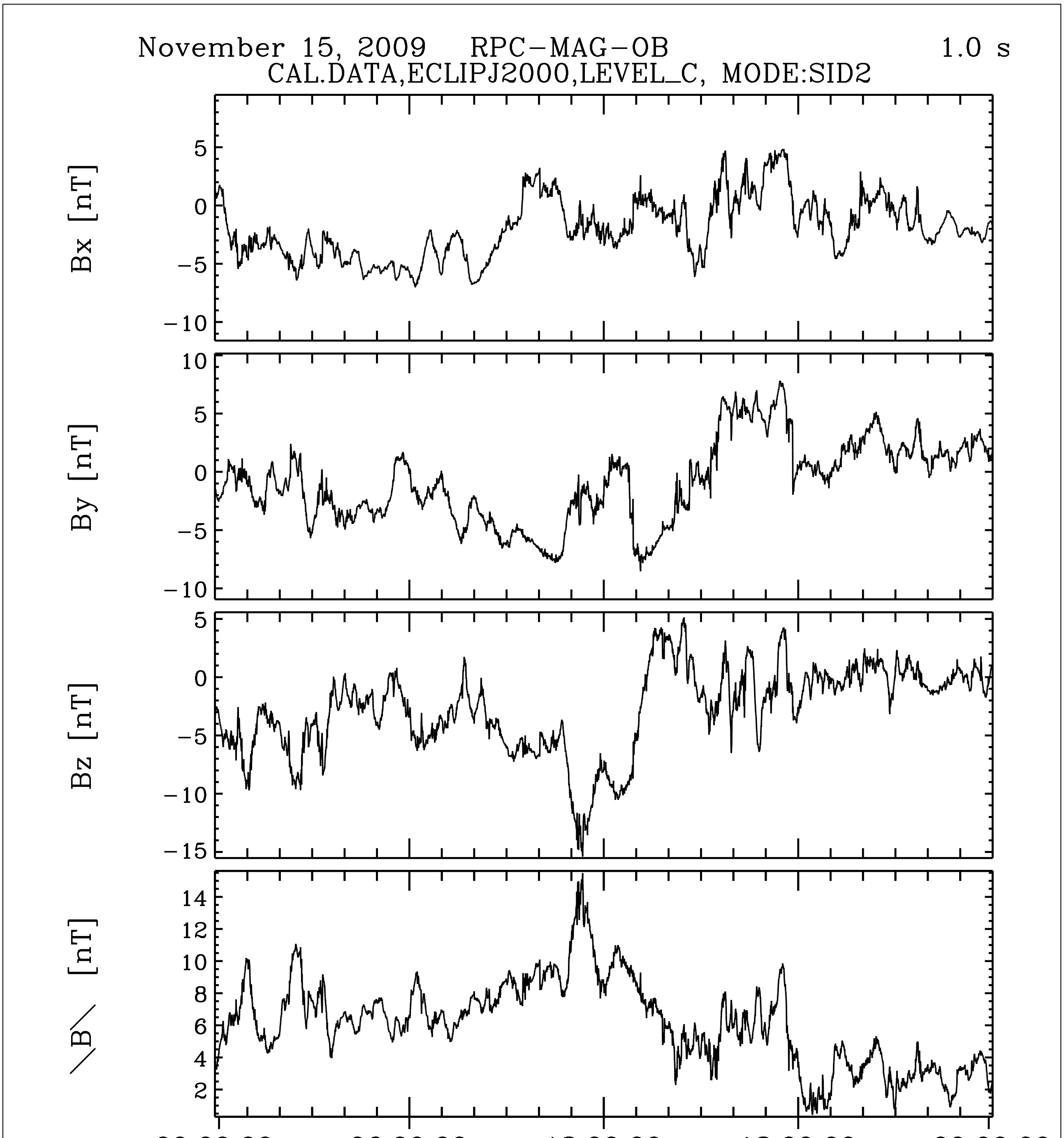

Figure 57: File: RPCMAG091115T0000_CLC_OB_M2_T0000_2400_009

3.9 November 16, 2009:

3.9.1 Actions

MAG stayed in SID 2 until 15:00. Then the LAP-MAG Interference Test started with MAG in BURST mode and OB primary. For further Details of the Interference Test refer to RO-IGEP-TR0030.

3.9.2 Plots of Calibrated Data

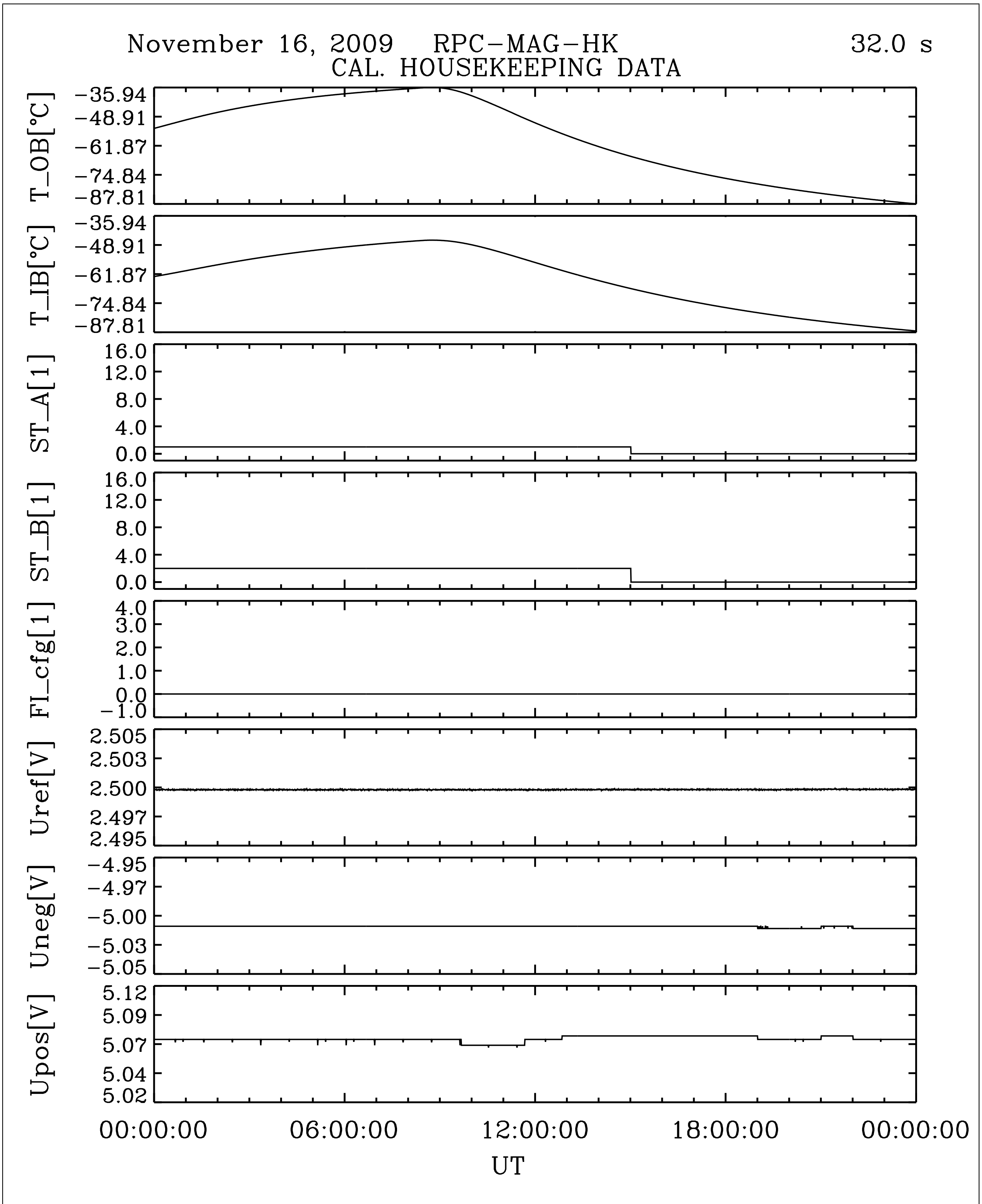

Figure 58: File: RPCMAG091116T0000_CLA_HK_P0000_2400

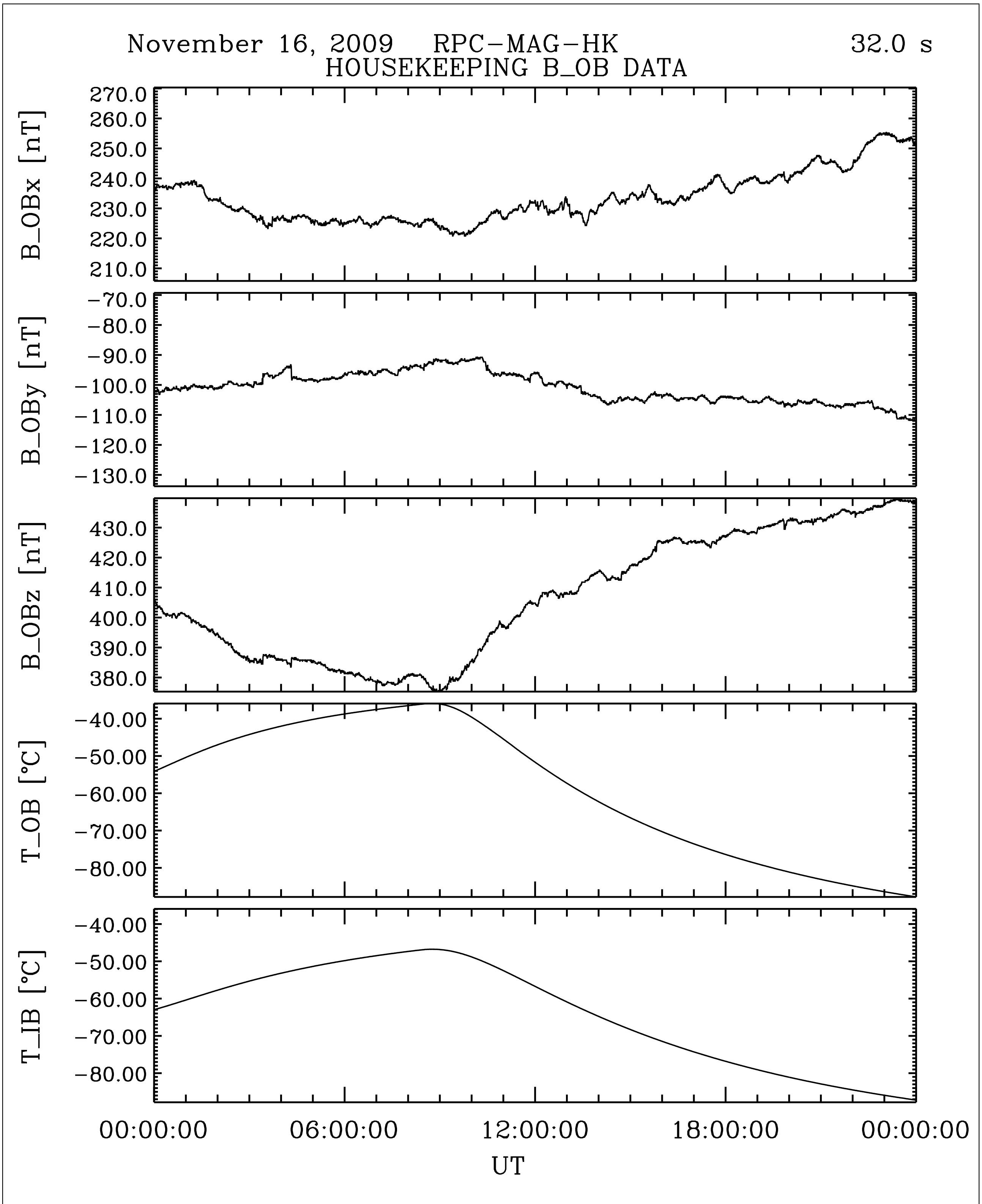

Figure 59: File: RPCMAG091116T0000_CLA_HK_B_P0000_2400

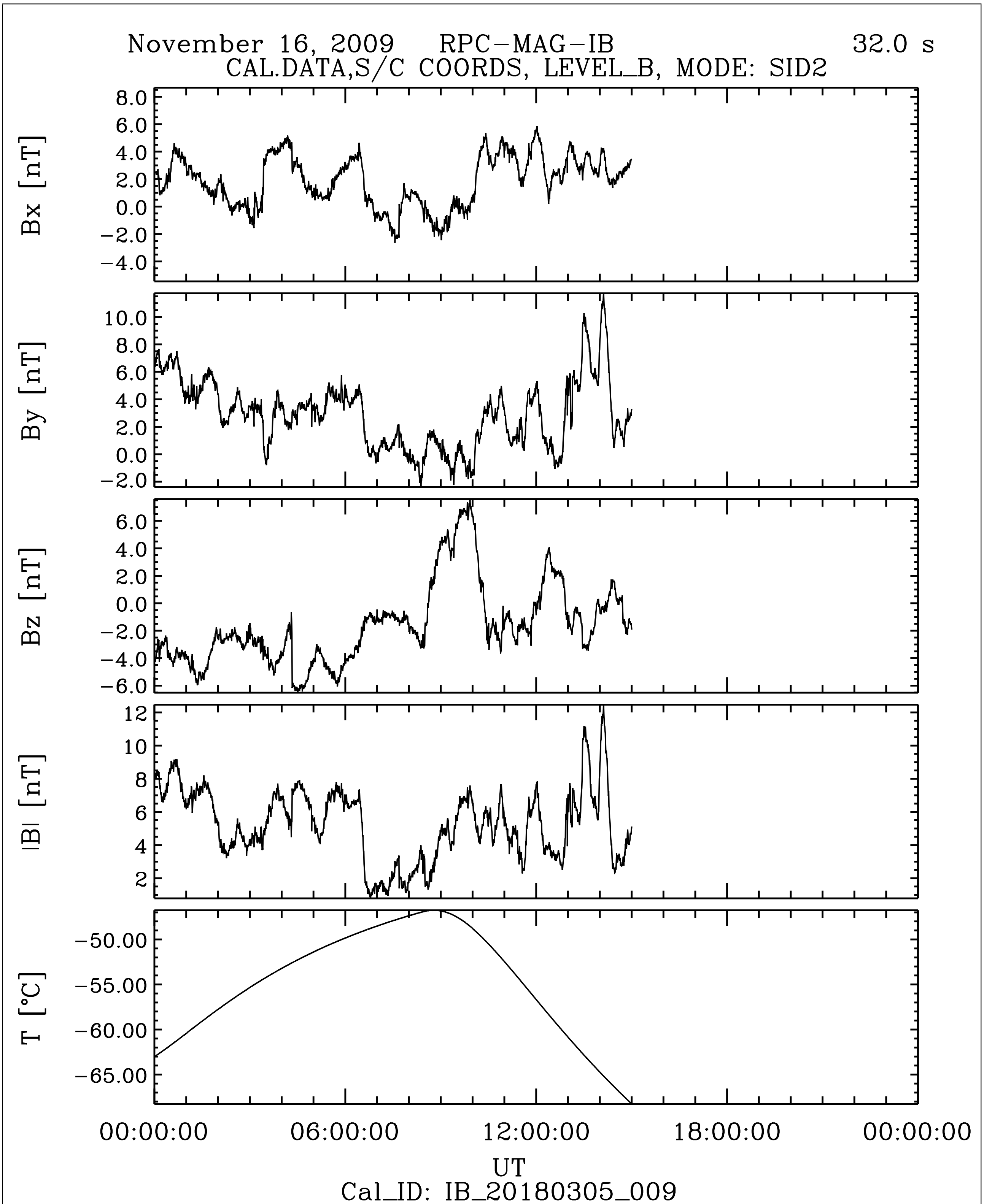

Figure 60: File: RPCMAG091116T0000_CLB_IB_M2_T0000_2400_009

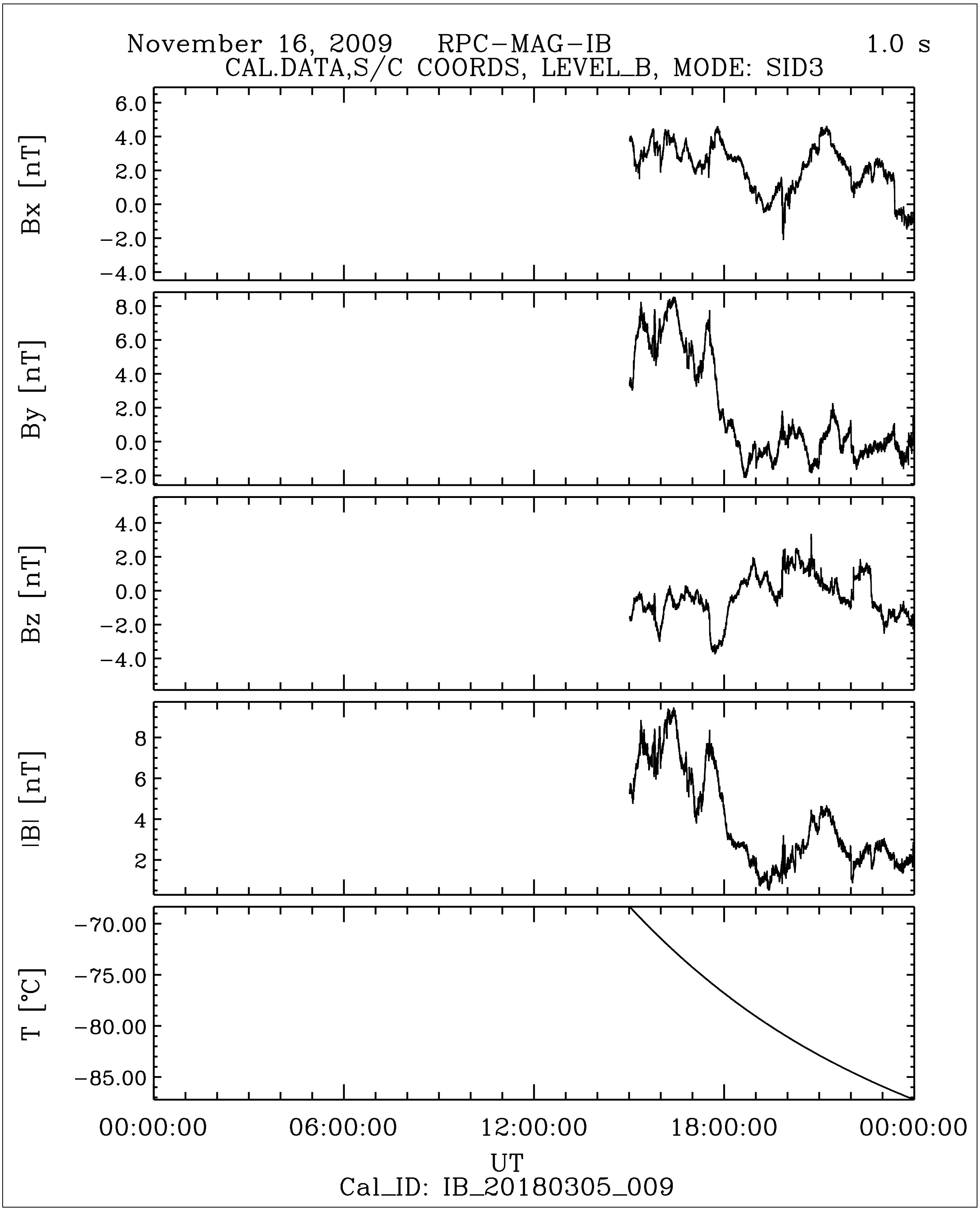

Figure 61: File: RPCMAG091116T1501_CLB_IB_M3_T0000_2400_009

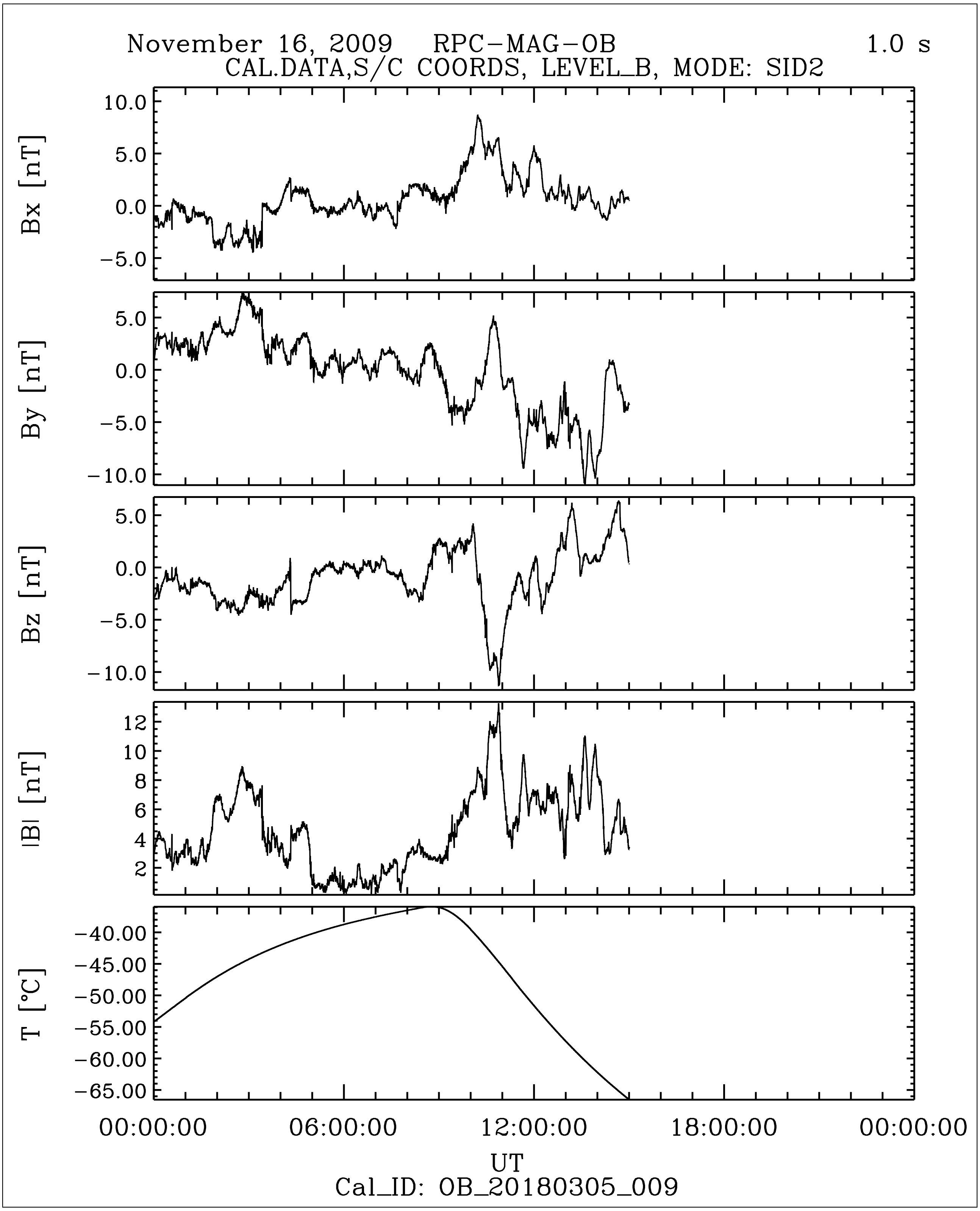

Figure 62: File: RPCMAG091116T0000_CLB_OB_M2_T0000_2400_009

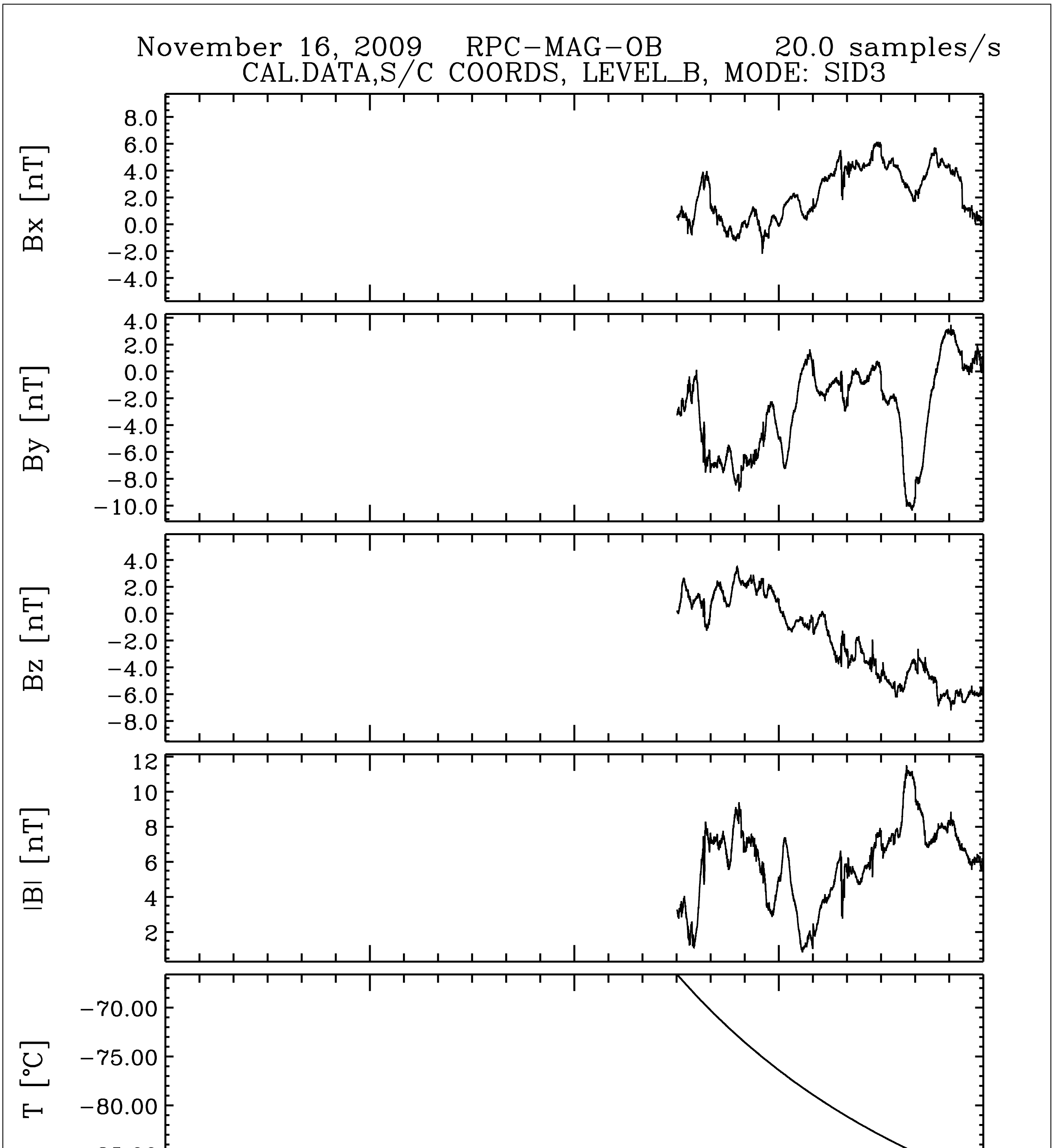

Figure 63: File: RPCMAG091116T1501_CLB_OB_M3_T0000_2400_009

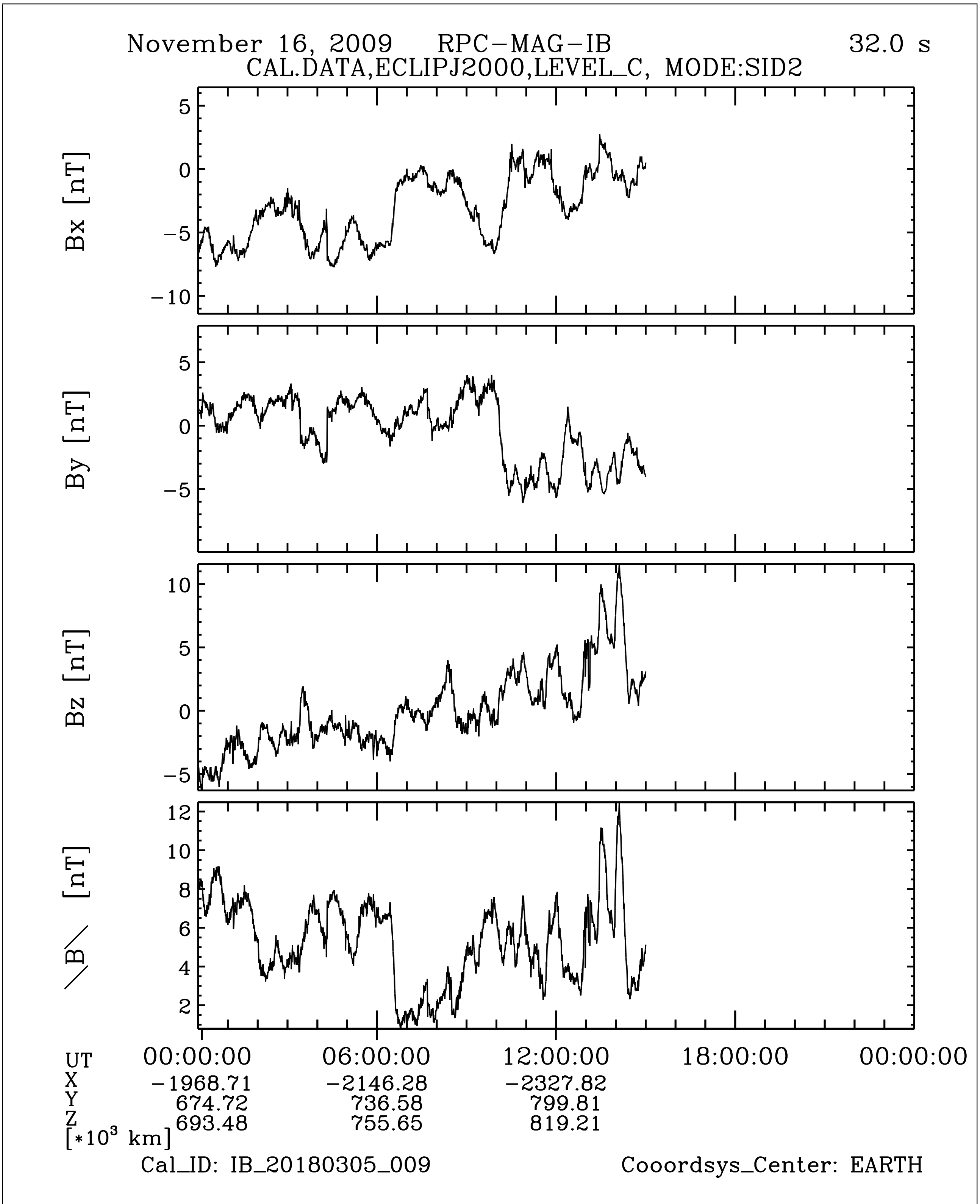

Figure 64: File: RPCMAG091116T0000_CLC_IB_M2_T0000_2400_009

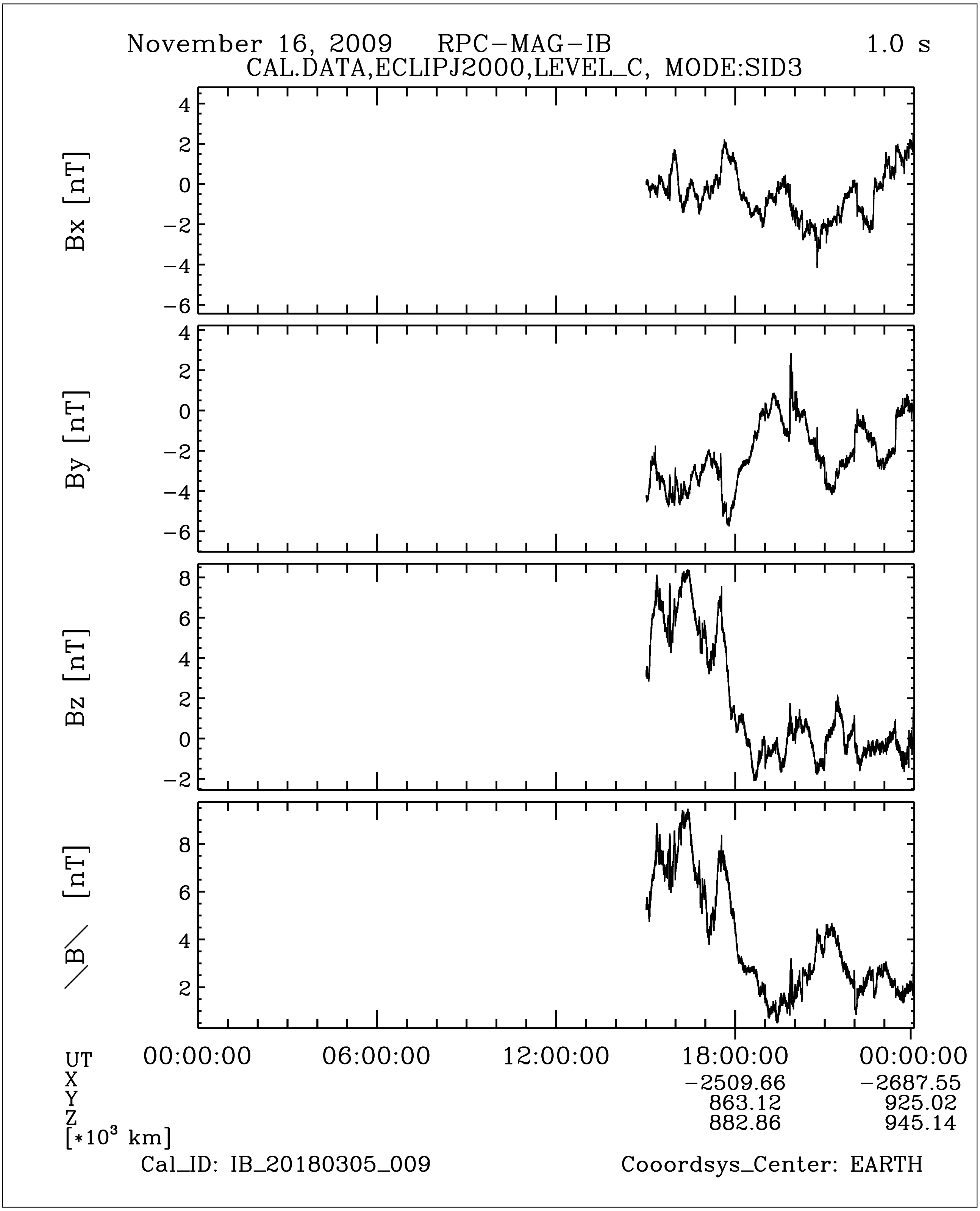

Figure 65: File: RPCMAG091116T1501_CLC_IB_M3_T0000_2400_009

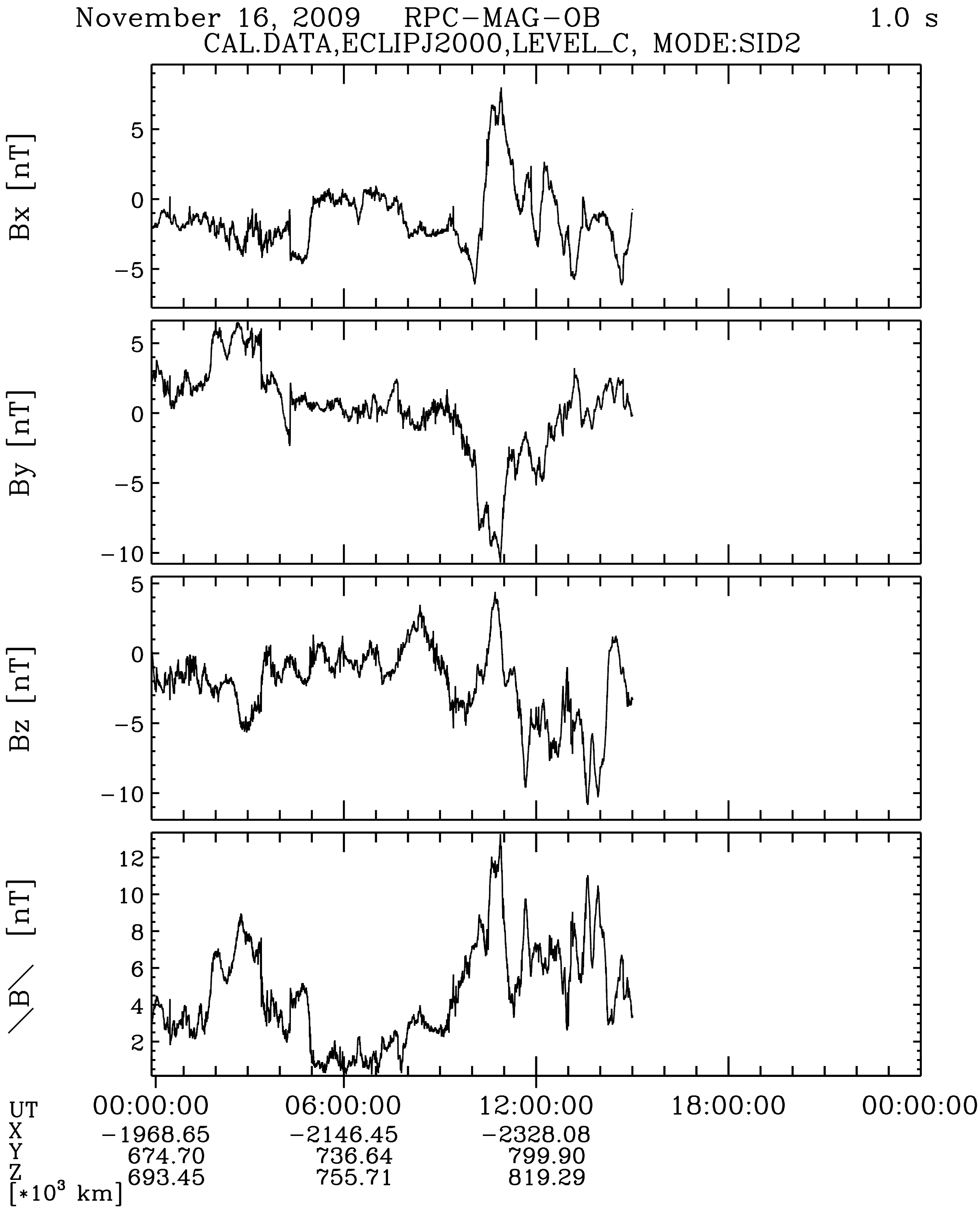

Figure 66: File: RPCMAG091116T0000_CLC_OB_M2_T0000_2400_009

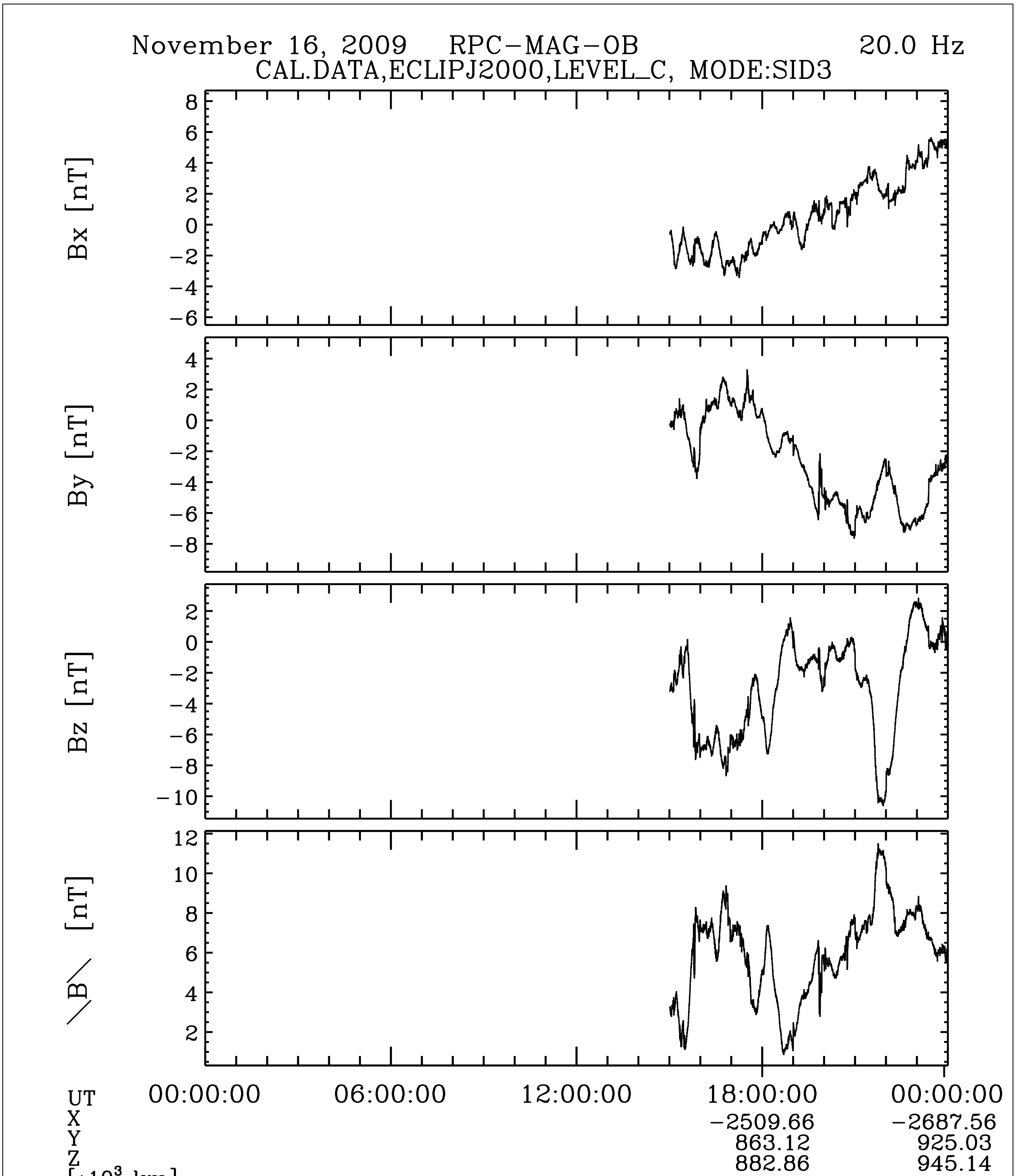

Figure 67: File: RPCMAG091116T1501_CLC_OB_M3_T0000_2400_009

3.10 November 17, 2009:

3.10.1 Actions

The LAP-MAG interference test continues. MAG stayed in SID 3 until 08:10. Then it was switched to MEDIUM mode SID4. Until 01:10 the OB sensor was the primary one, then IB became the primary sensor until 08:00. No problems occurred. The test finished at 17:00. RPC was switched off after a successful campaign at 17:15

3.10.2 Plots of Calibrated Data

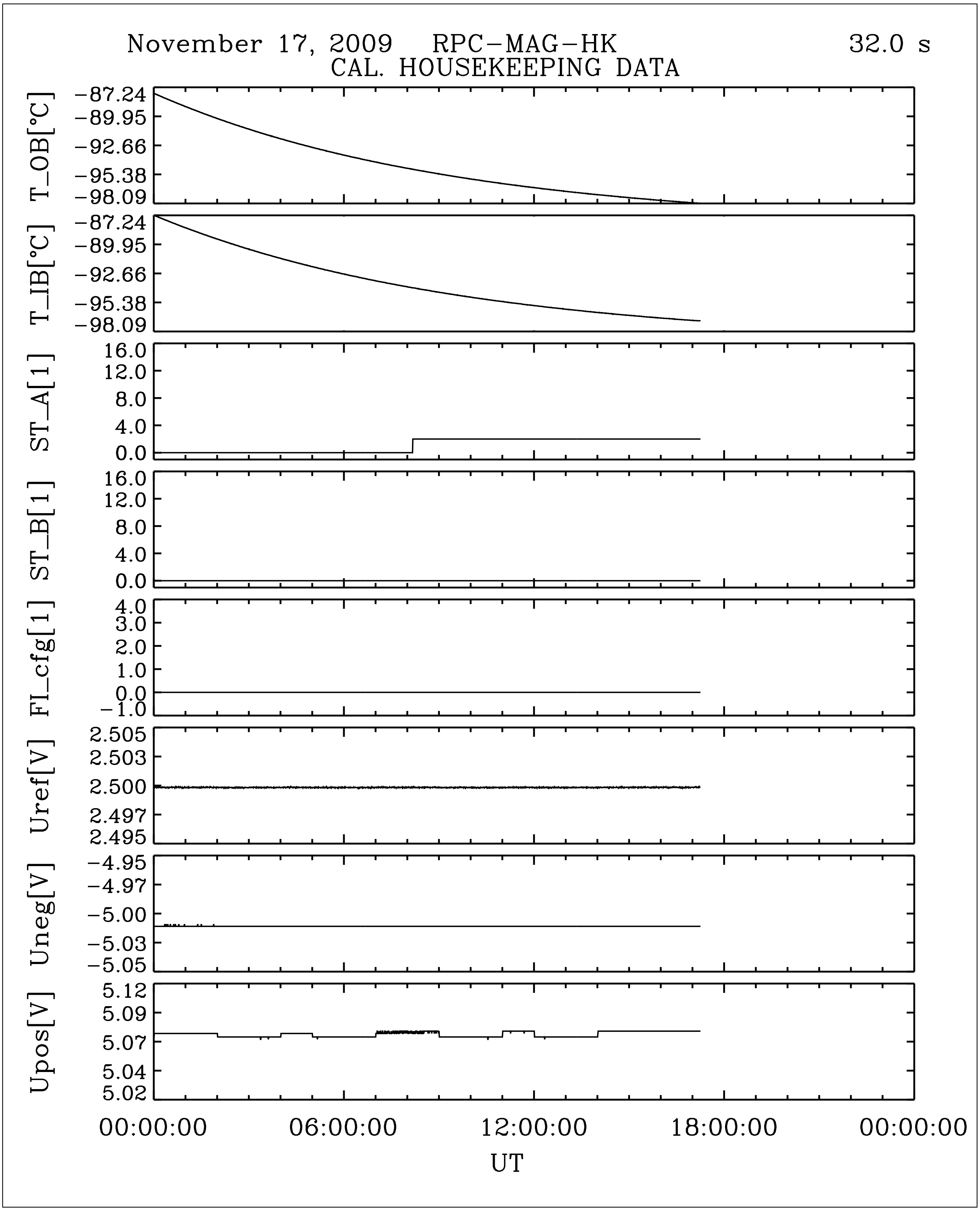

Figure 68: File: RPCMAG091117T0000_CLA_HK_P0000_2400

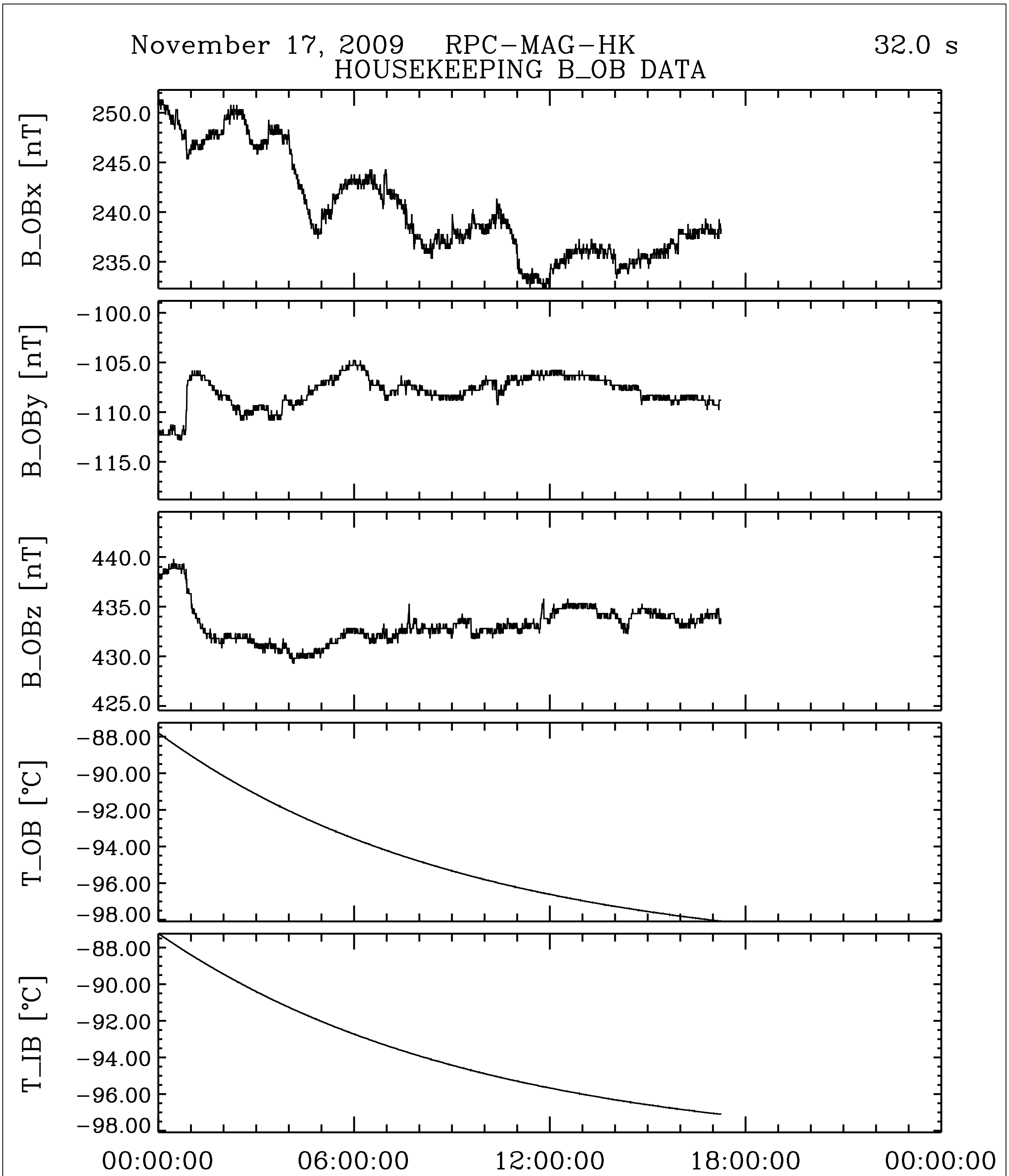

Figure 69: File: RPCMAG091117T0000_CLA_HK_B_P0000_2400

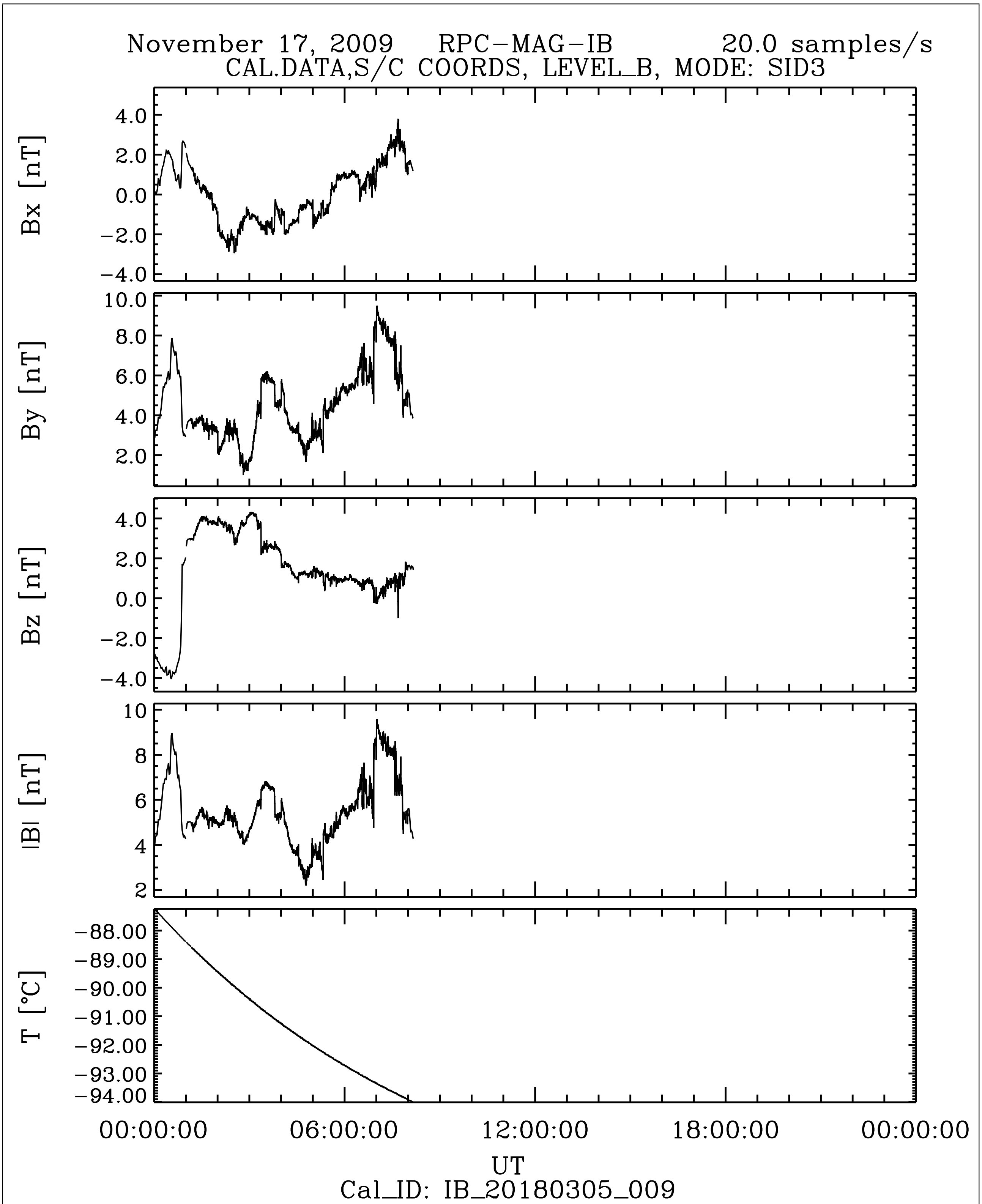

Figure 70: File: RPCMAG091117T0000_CLB_IB_M3_T0000_2400_009

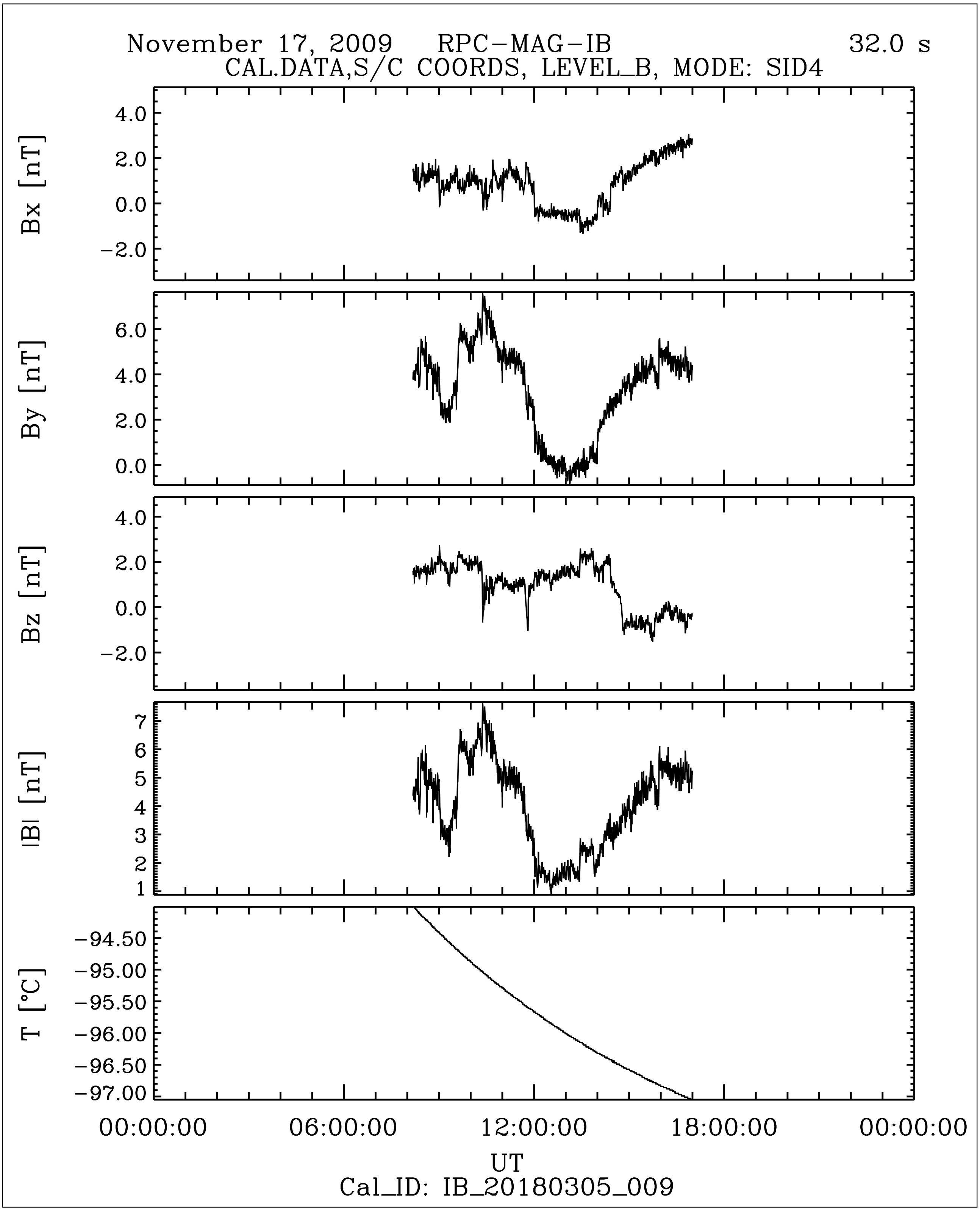

Figure 71: File: RPCMAG091117T0810_CLB_IB_M4_T0000_2400_009

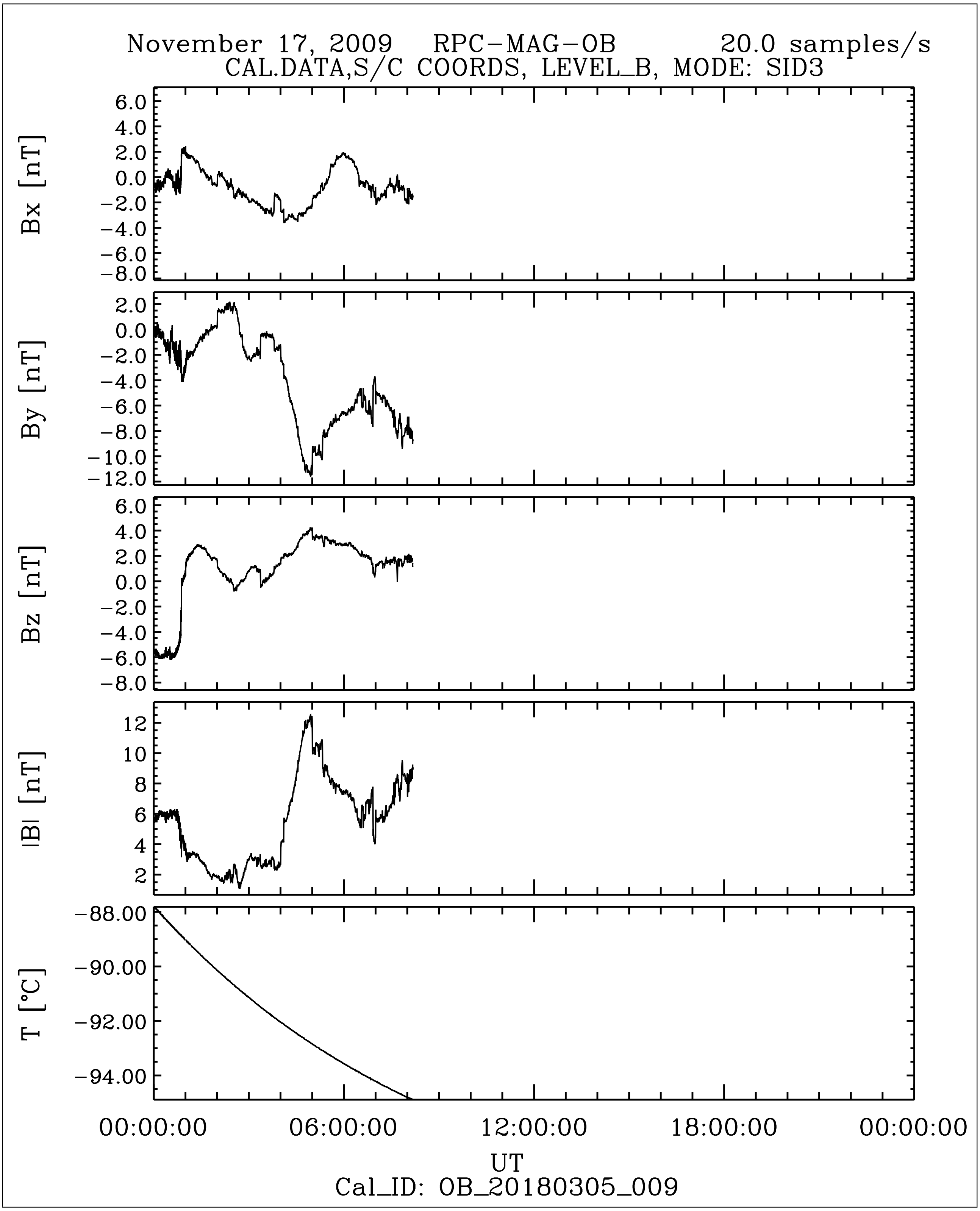

Figure 72: File: RPCMAG091117T0000_CLB_OB_M3_T0000_2400_009

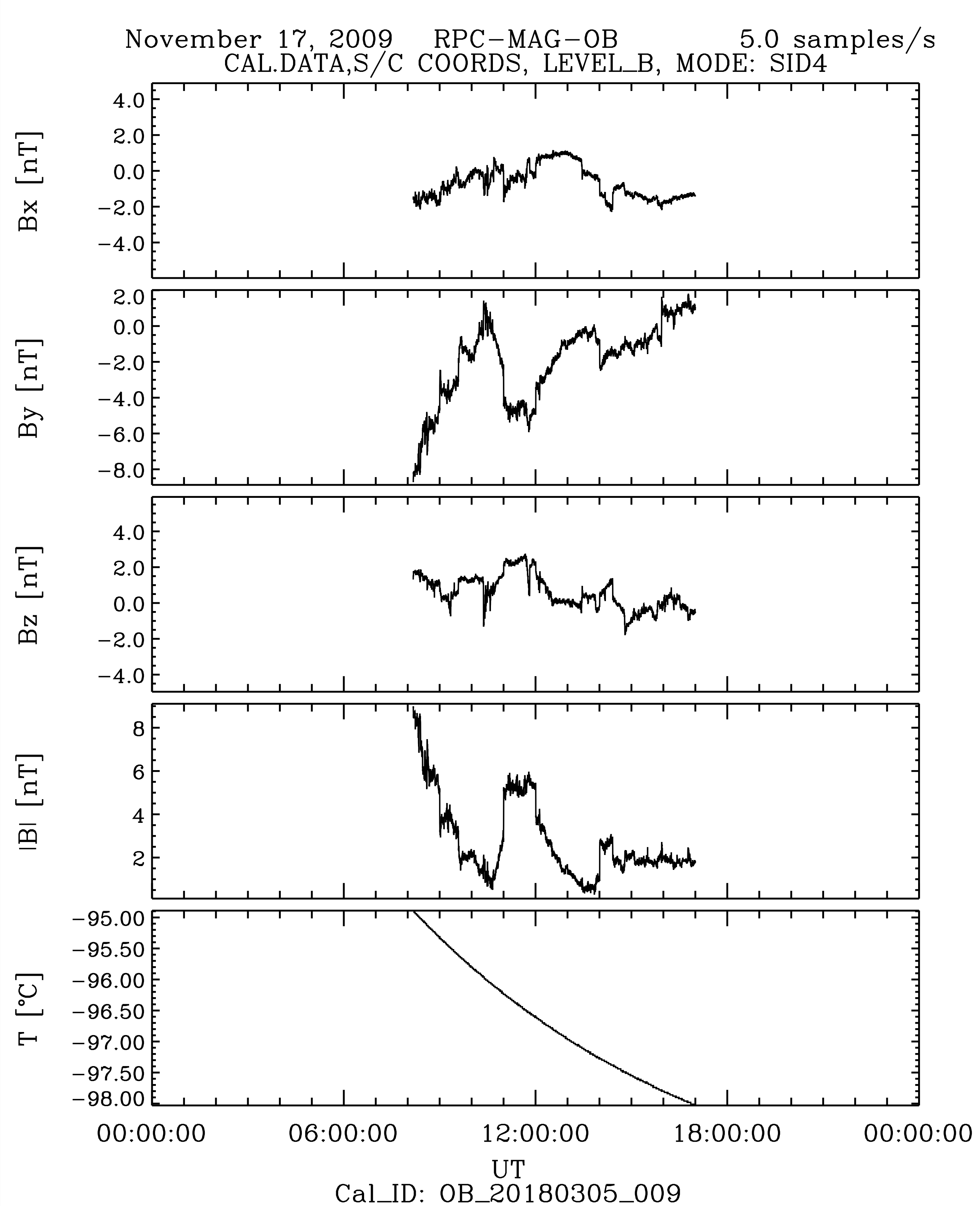

Figure 73: File: RPCMAG091117T0810_CLB_OB_M4_T0000_2400_009

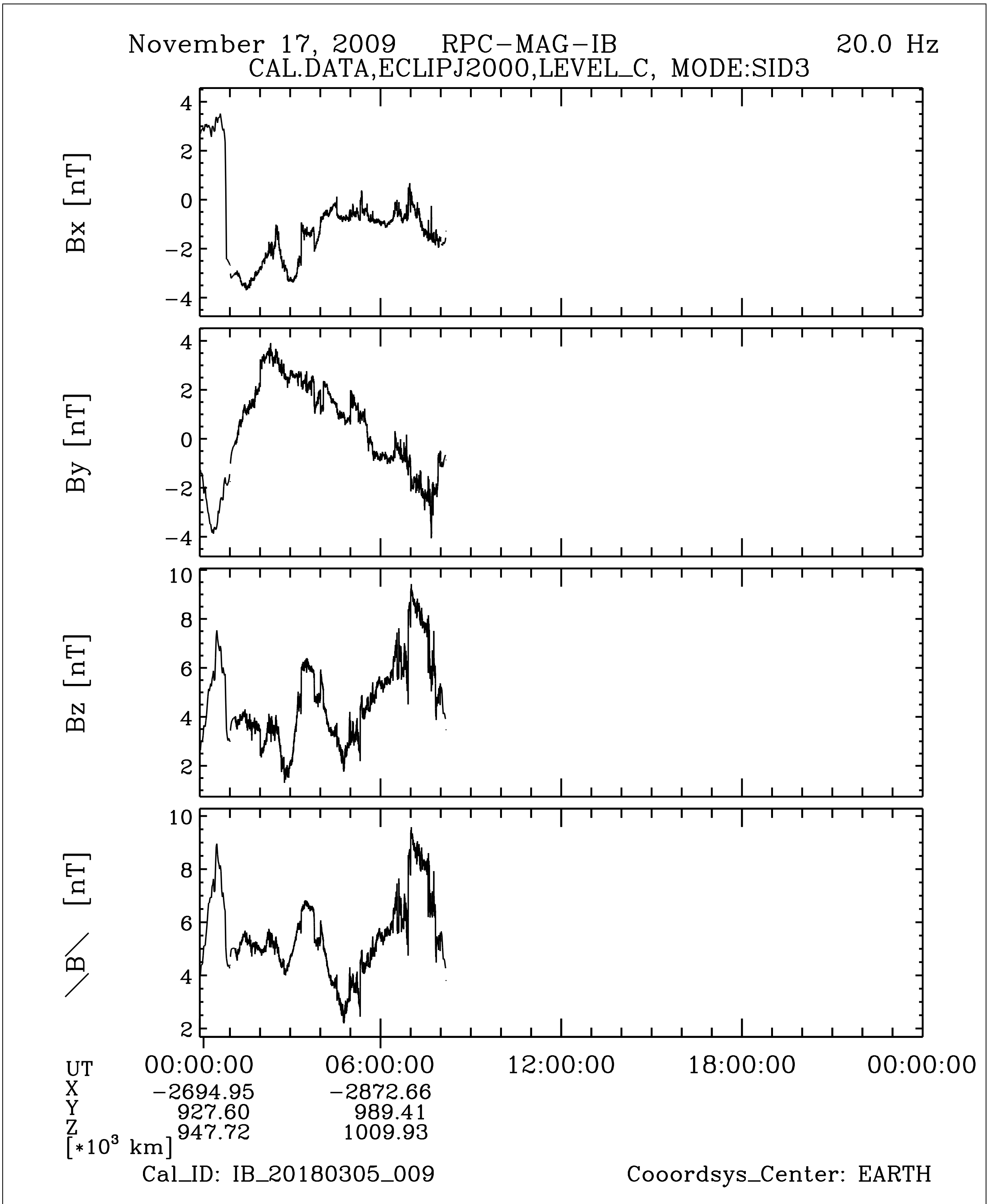

Figure 74: File: RPCMAG091117T0000_CLC_IB_M3_T0000_2400_009

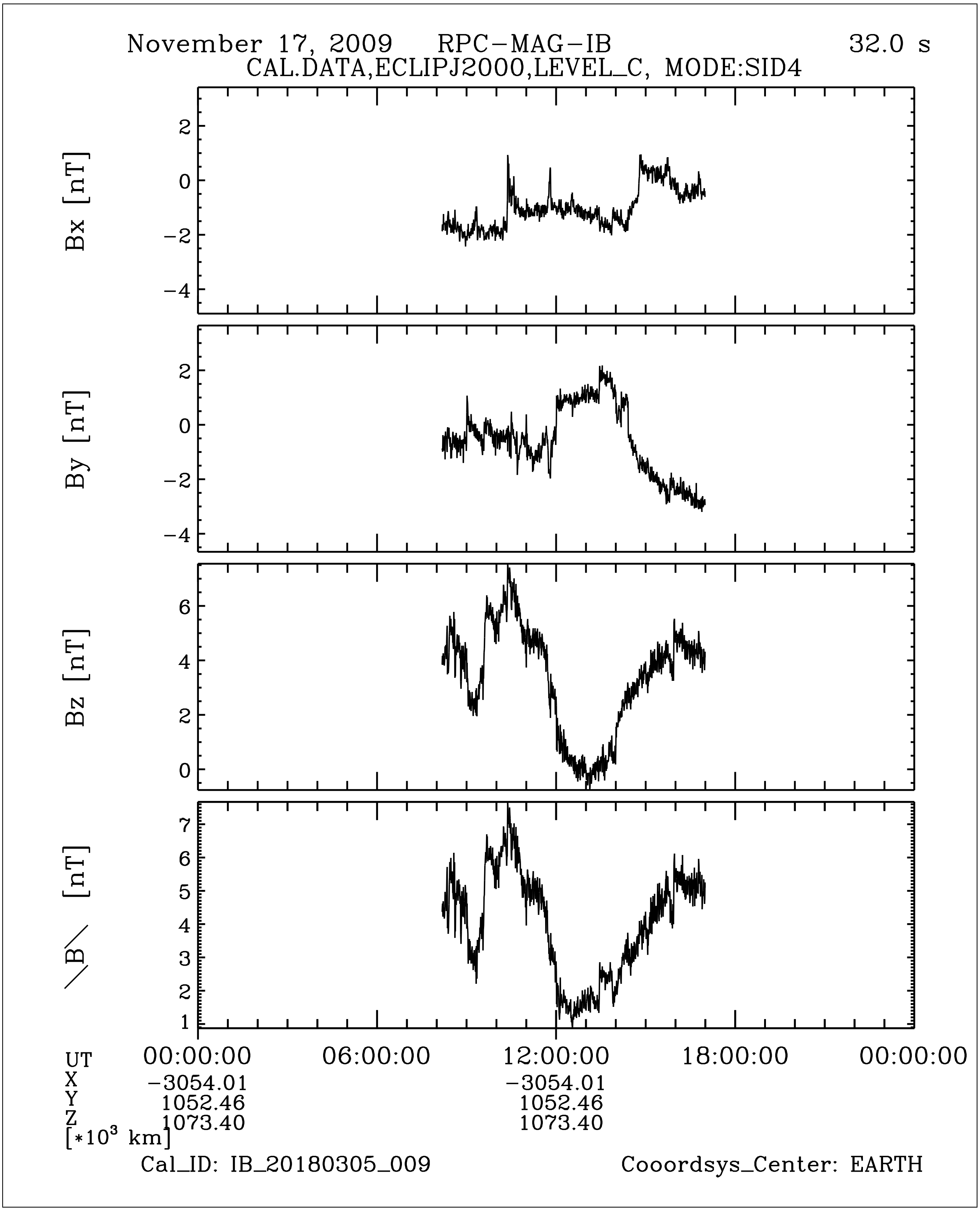

Figure 75: File: RPCMAG091117T0810_CLC_IB_M4_T0000_2400_009

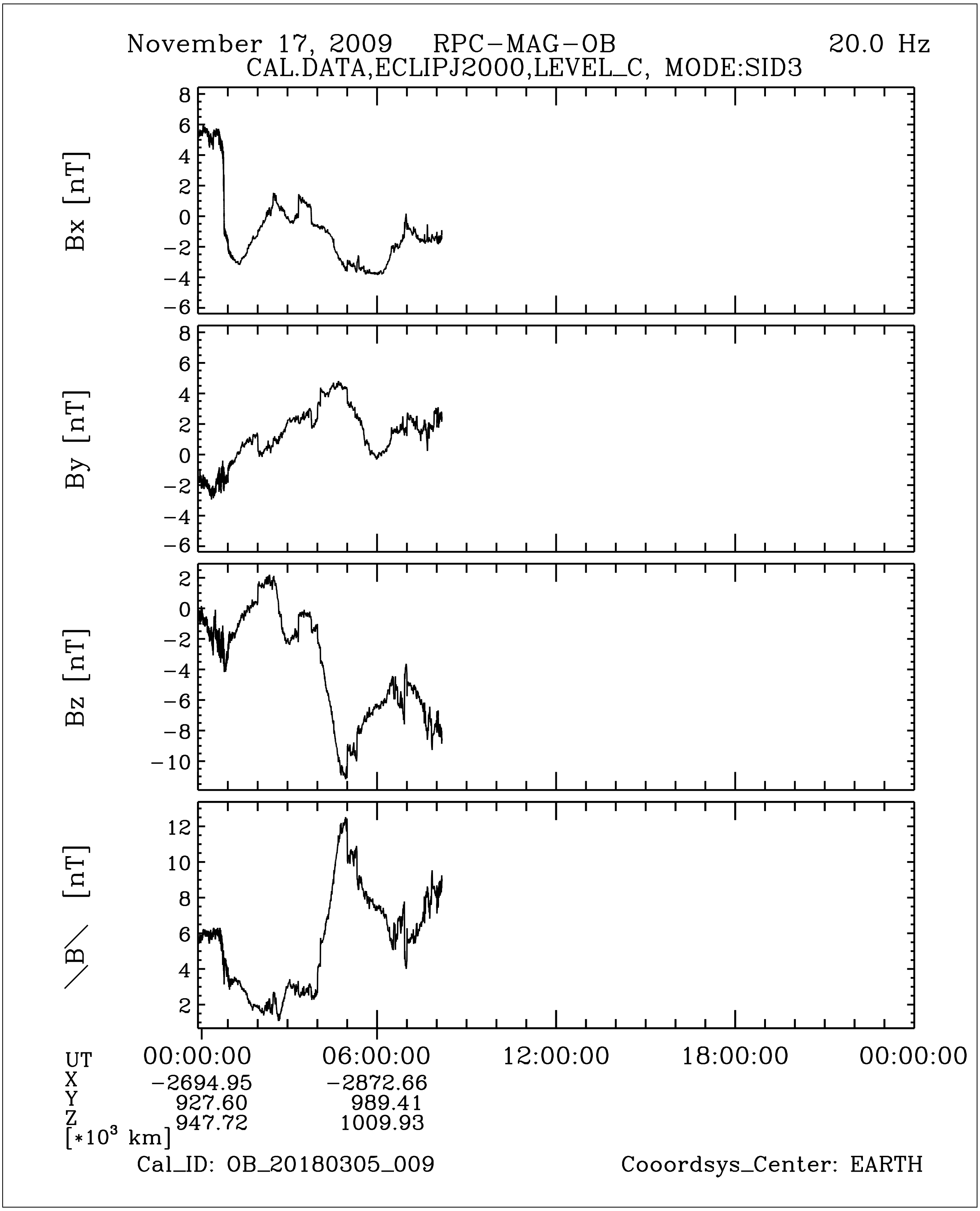

Figure 76: File: RPCMAG091117T0000_CLC_OB_M3_T0000_2400_009

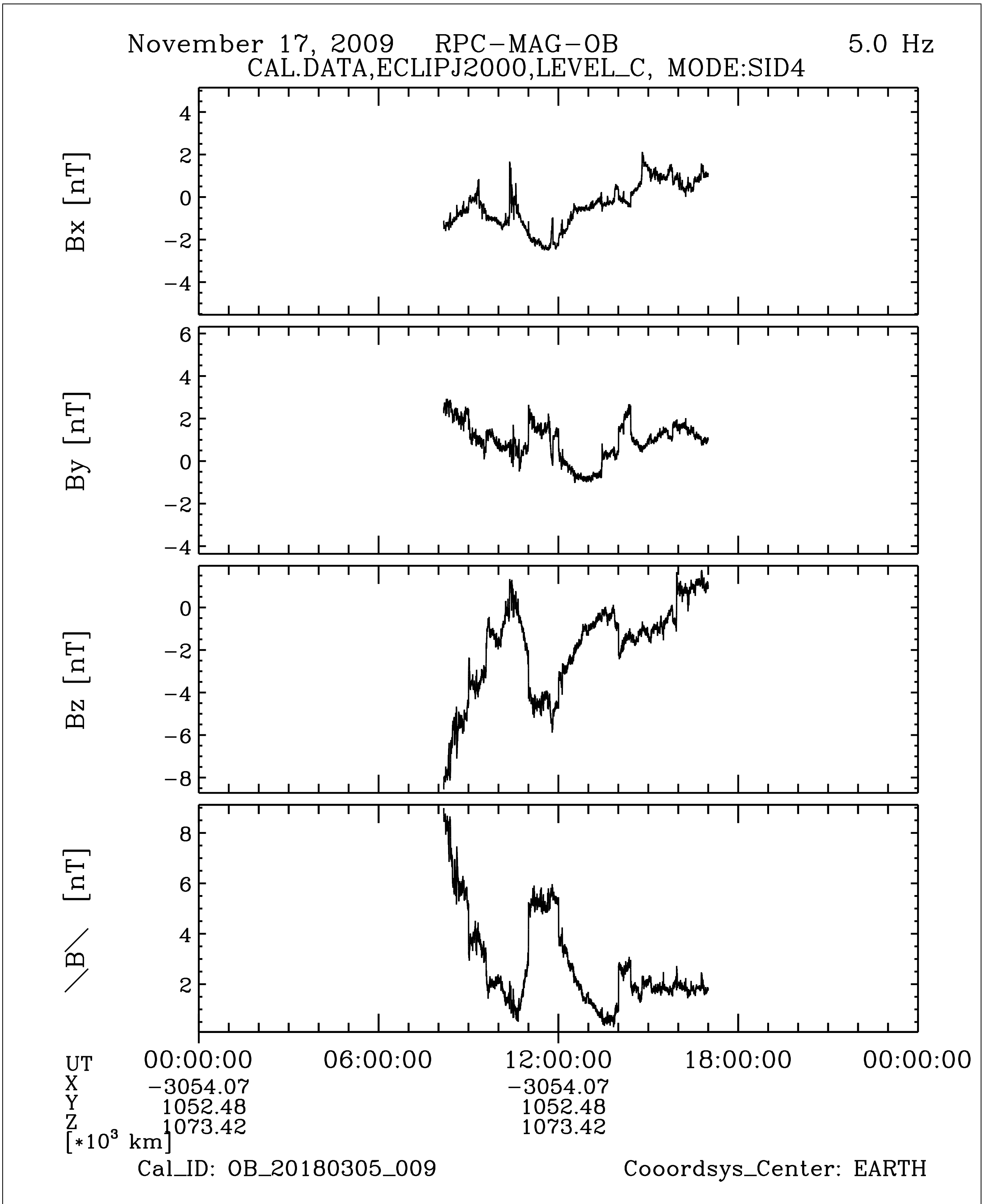

Figure 77: File: RPCMAG091117T0810_CLC_OB_M4_T0000_2400_009

4 Comparison between OB and IB: The Influence of the Sensor Temperature to the Data Quality

In this section we compare the measured data of the OB Sensor with the IB ones. The investigation is done with 1 s averaged LEVEL_F data (s/c-coordinates) for various days.

Figure 78 shows the magnetic field data of the OB and the IB sensor and the sensor temperatures of November 10. The differences of both magnetic field signals for the same day are plotted in Figure 79. The data and differences for November 12 have been plotted in Figures 80 and 81.

It's clearly to be seen, that the OB and IB data match very well at times where the both sensors feel the same temperature *variation*. When the temperature changes are different, then the magnetic field data diverge as well. We do see this effect, although the temperatute calibration model 009 has been applied. On short time scales, however, different heat capacities and micro physical hysteresis effects of the sensors core material may cause this behavior.

Besides the temperature effects also s/c generated 'noise' on different time scale diminishes the data quality significantly.

From the temperature analysis we can derive a "Data Quality Indicator" based on the temperature difference between OB and IB. The data quality is expected to be good if this difference is constant. If it varies with time, however, the data quality will most likely be poor.
For the future a more sophisticated temperature calibration and maybe a more convenient s/c attitude, with unique sun illumination to both sensors, might improve the measurements.

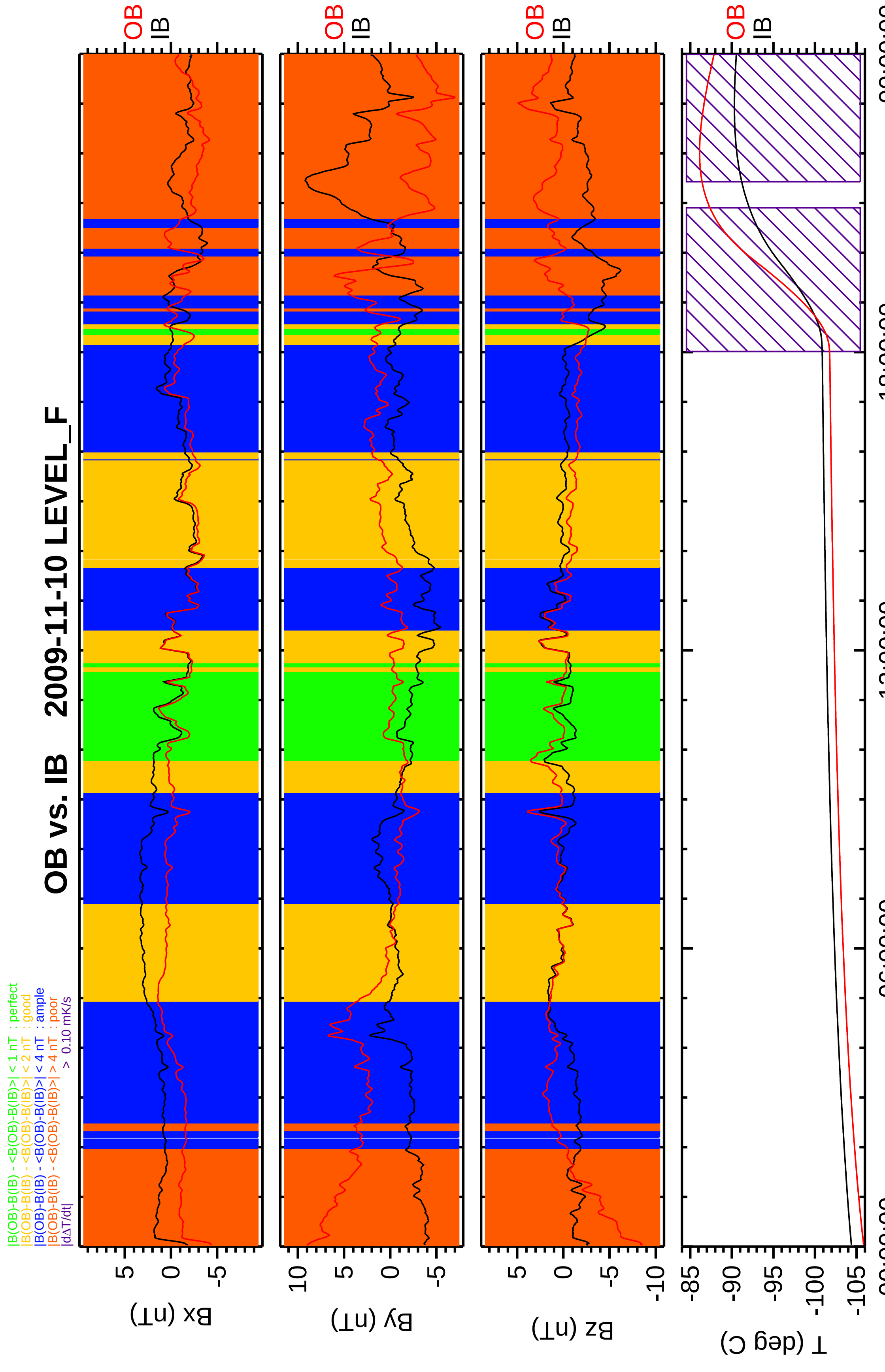

Figure 78: RPCMAG OB/IB data of November 10, 2009

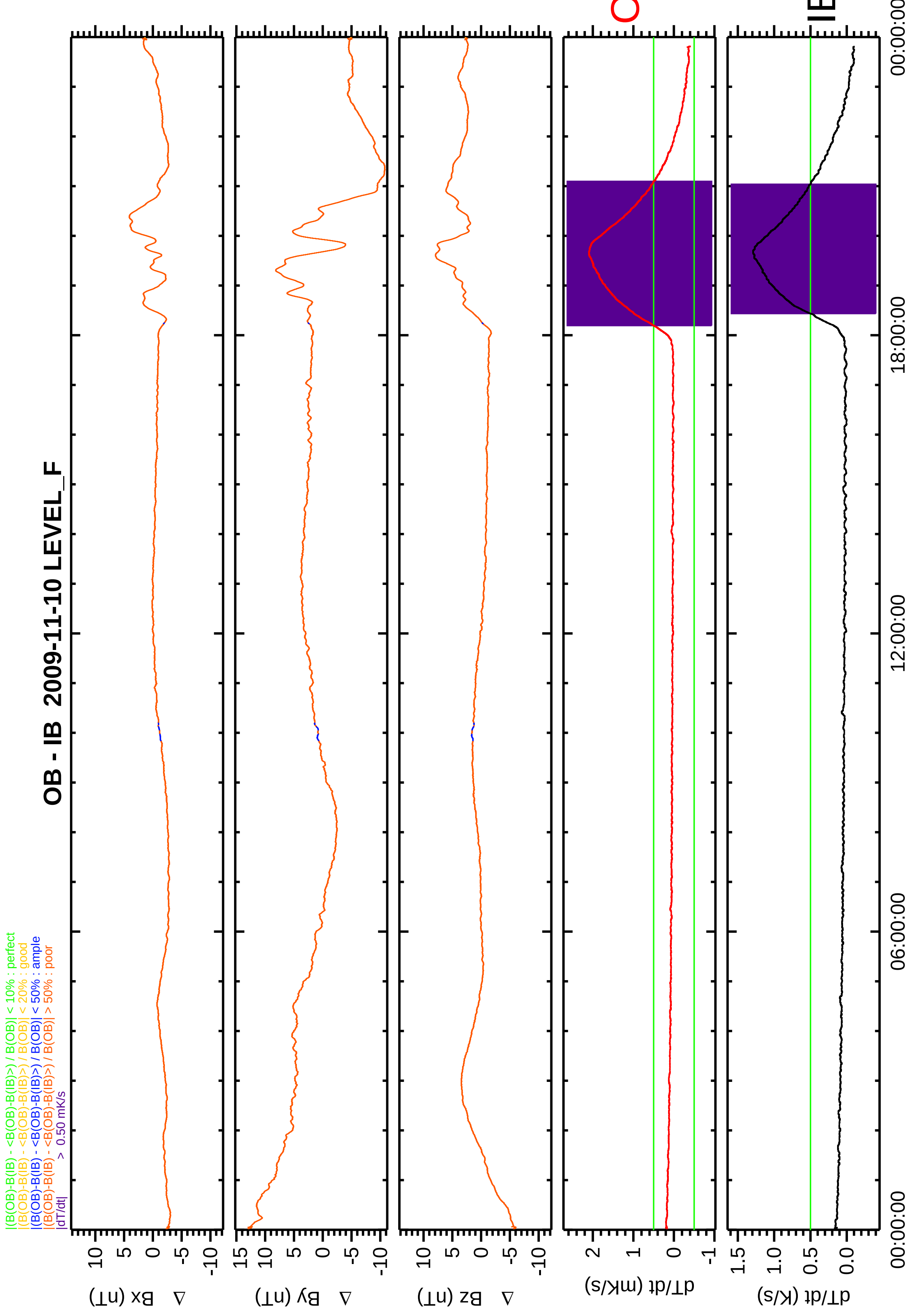

Figure 79: Differences of RPCMAG OB/IB data and Rate Temperature-Difference change of November 10, 2009

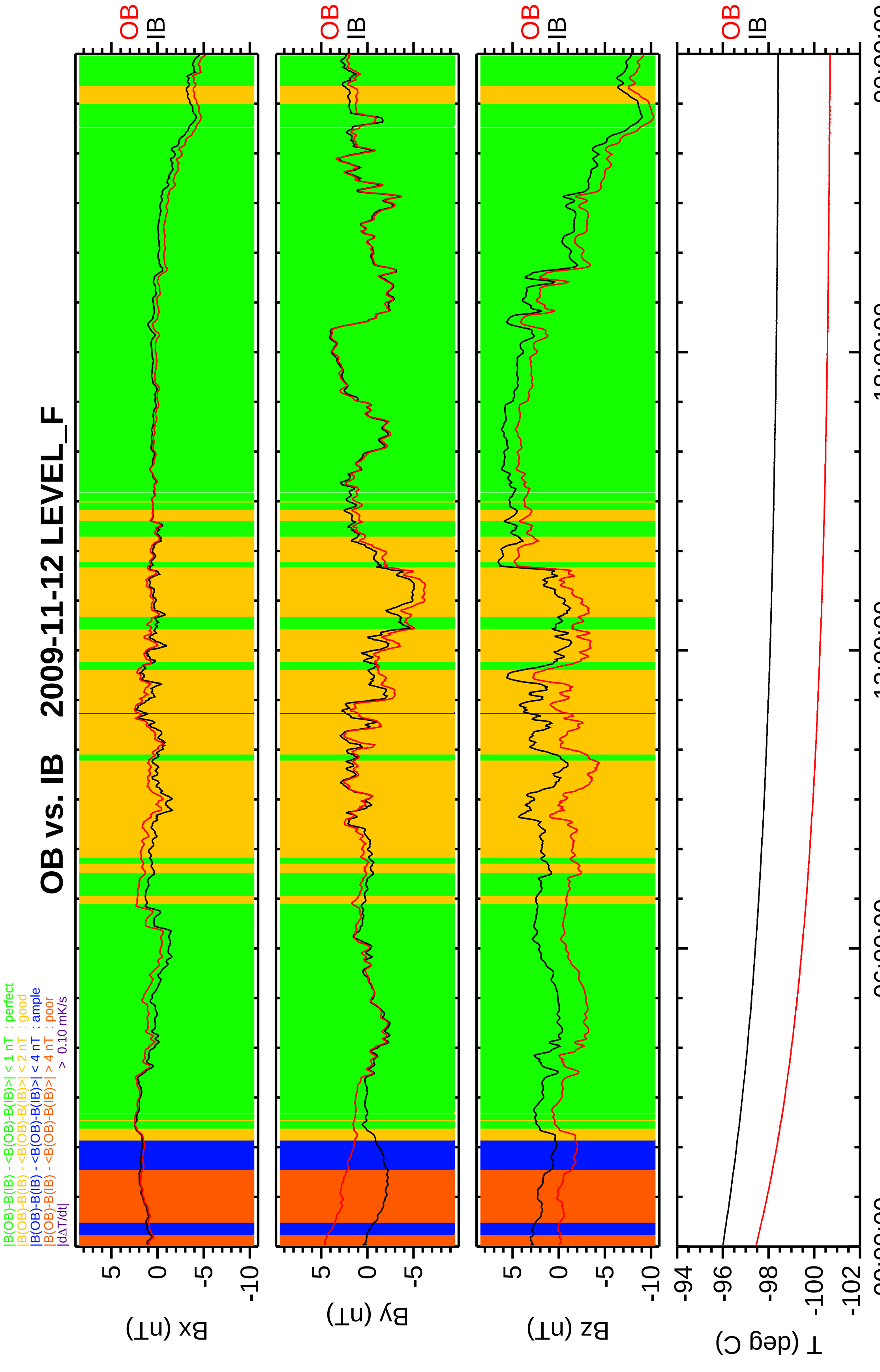

Figure 80: RPCMAG OB/IB data of November 12, 2009

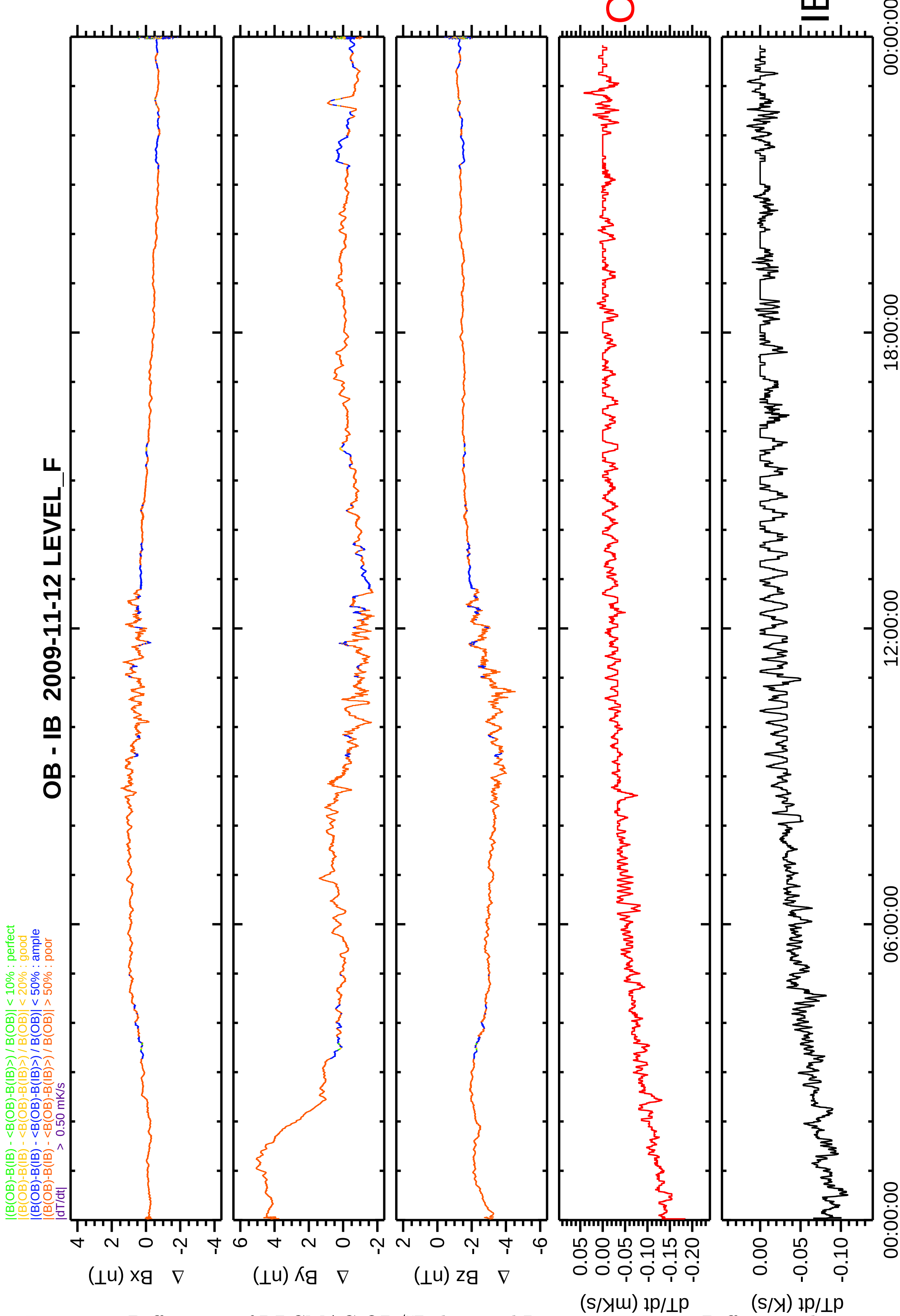

Figure 81: Differences of RPCMAG OB/IB data and Rate Temperature-Difference change of November 12, 2009

5 The RPC-MAG data in GSE-Coordinates

The following plots show RPCMAG data rotated to GSE coordinates. The first two plots show the data of the OB and the IB sensor from the complete measurement campaign. Both data sets show good accordance in the x-component. The y- and z- component are similar in the higher frequent structures but show also huge differences on the lower frequency scale. That means that fields in the vicinity of the magnetometers, i.e. on the s/c or P/L side, are generated and disturb the measurement.

Figure 84 shows the complete magnetic field during the very swing by. The field raises up to about 14000 nT (instrument maximum range is 16000 nT). The dipolar structure of the Earth's magnetic field is clearly depicted.

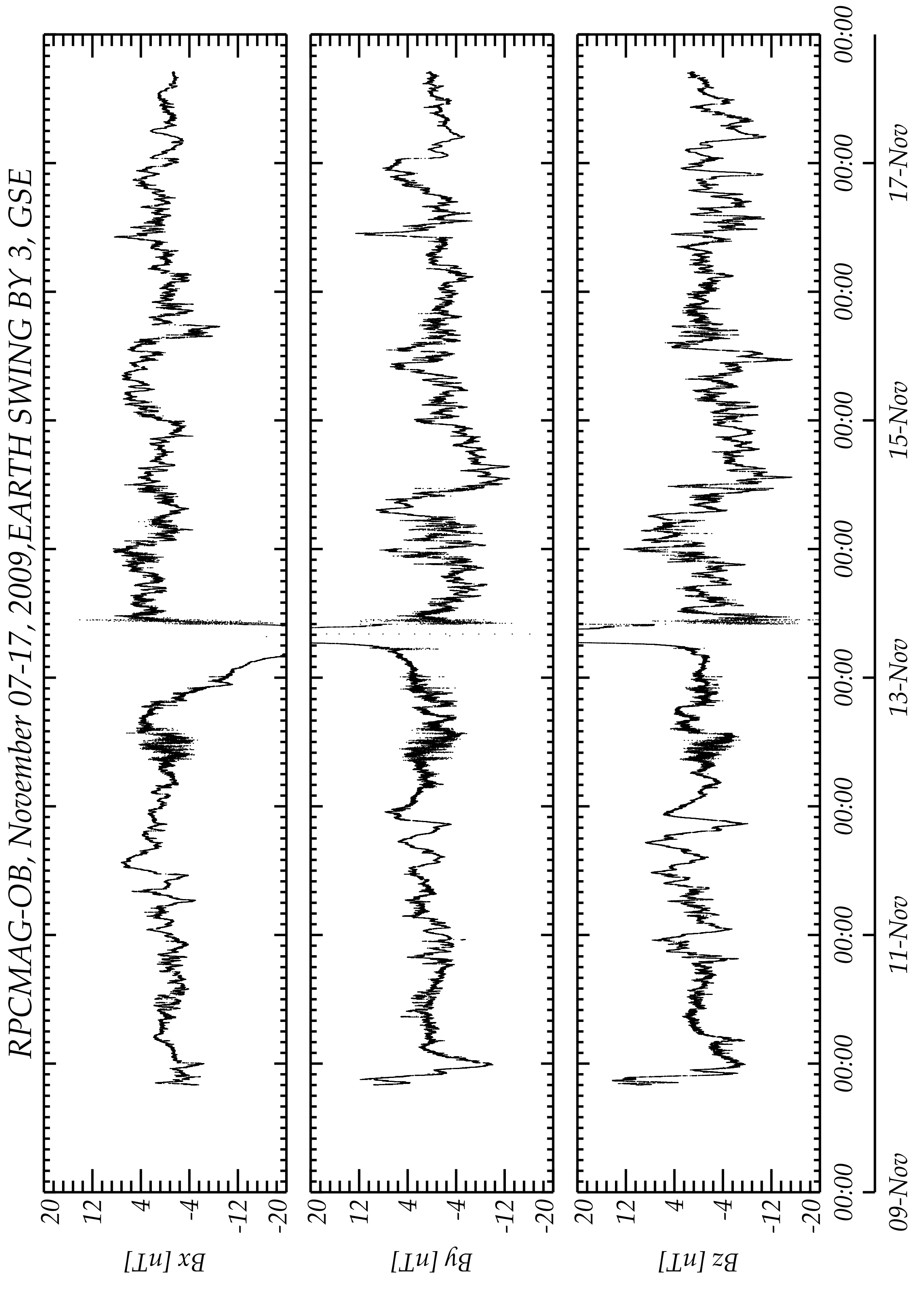

Figure 82: RPC-MAG OB data in GSE coordinates for the complete campaign

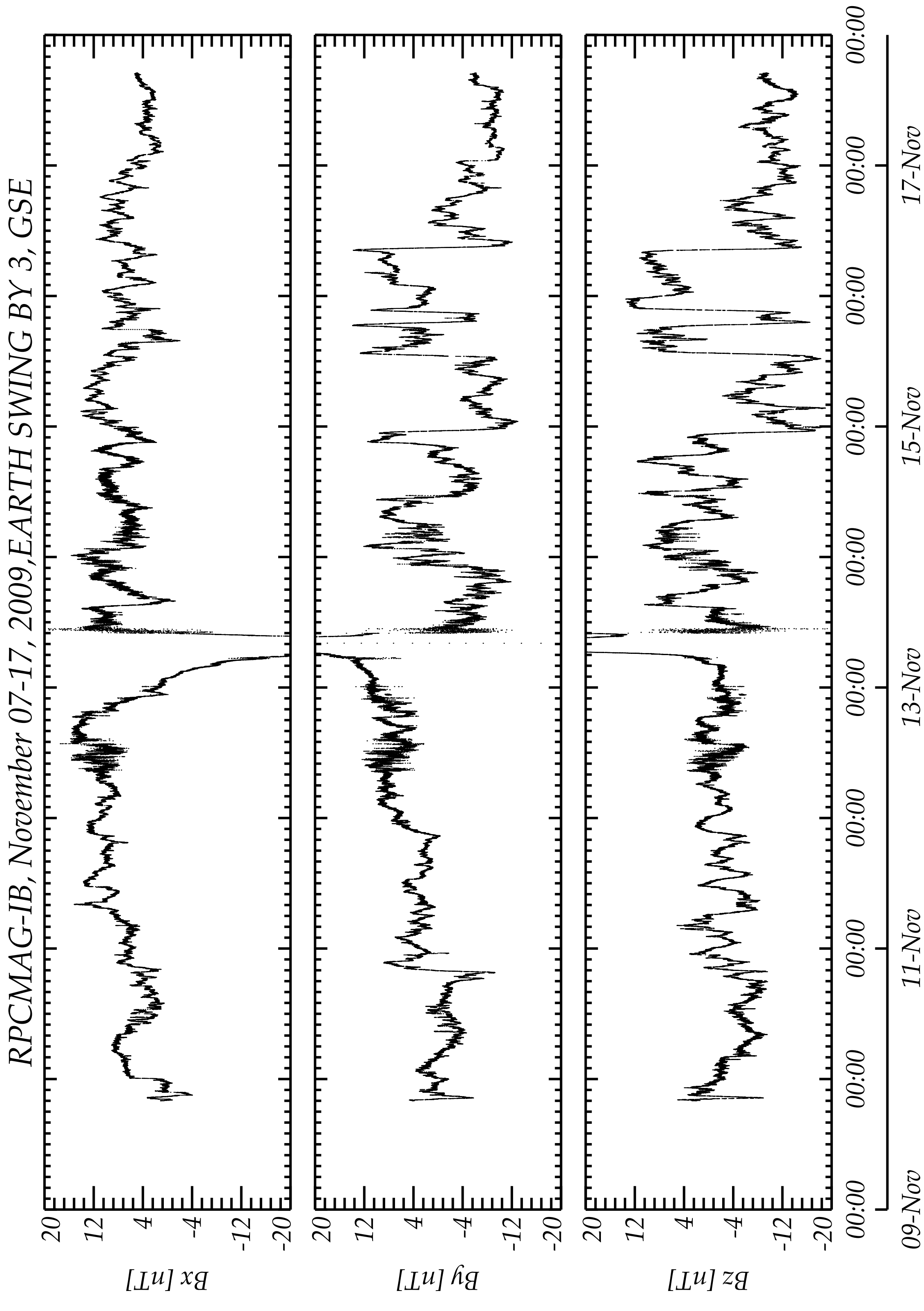

Figure 83: RPC-MAG IB data in GSE coordinates for the complete campaign

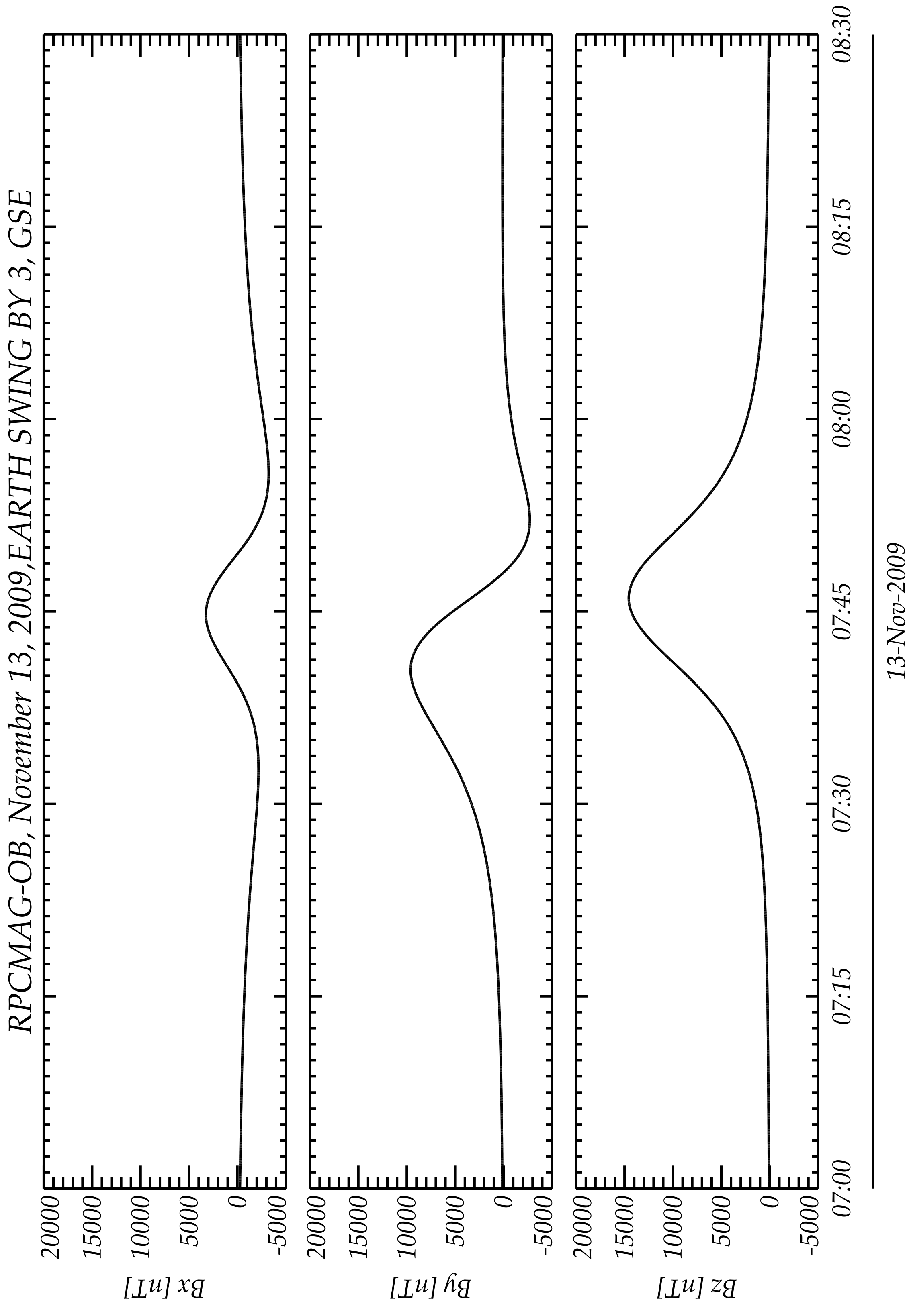

Figure 84: RPC-MAG OB data in GSE coordinates for the very Swing by

6 Identification of Magnetospheric Regions

The following figure shows a zoomed view of the magnetic field data measured around CA. Superimposed are the locations of relevant plasma boundaries and region like

- Magnetosphere
- Magnetopause (MP)
- Magnetosheath
- Bow Shock (BS)
- Solar wind region

A comparison of the predicted position of the Outbound Bow shock and the Magnetopause derived from the Tsyganenko Model (refer to Figures 3 and 4) shows a good agreement. The positions of the inbound Bow shock and the inbound Magnetopause is uncertain.

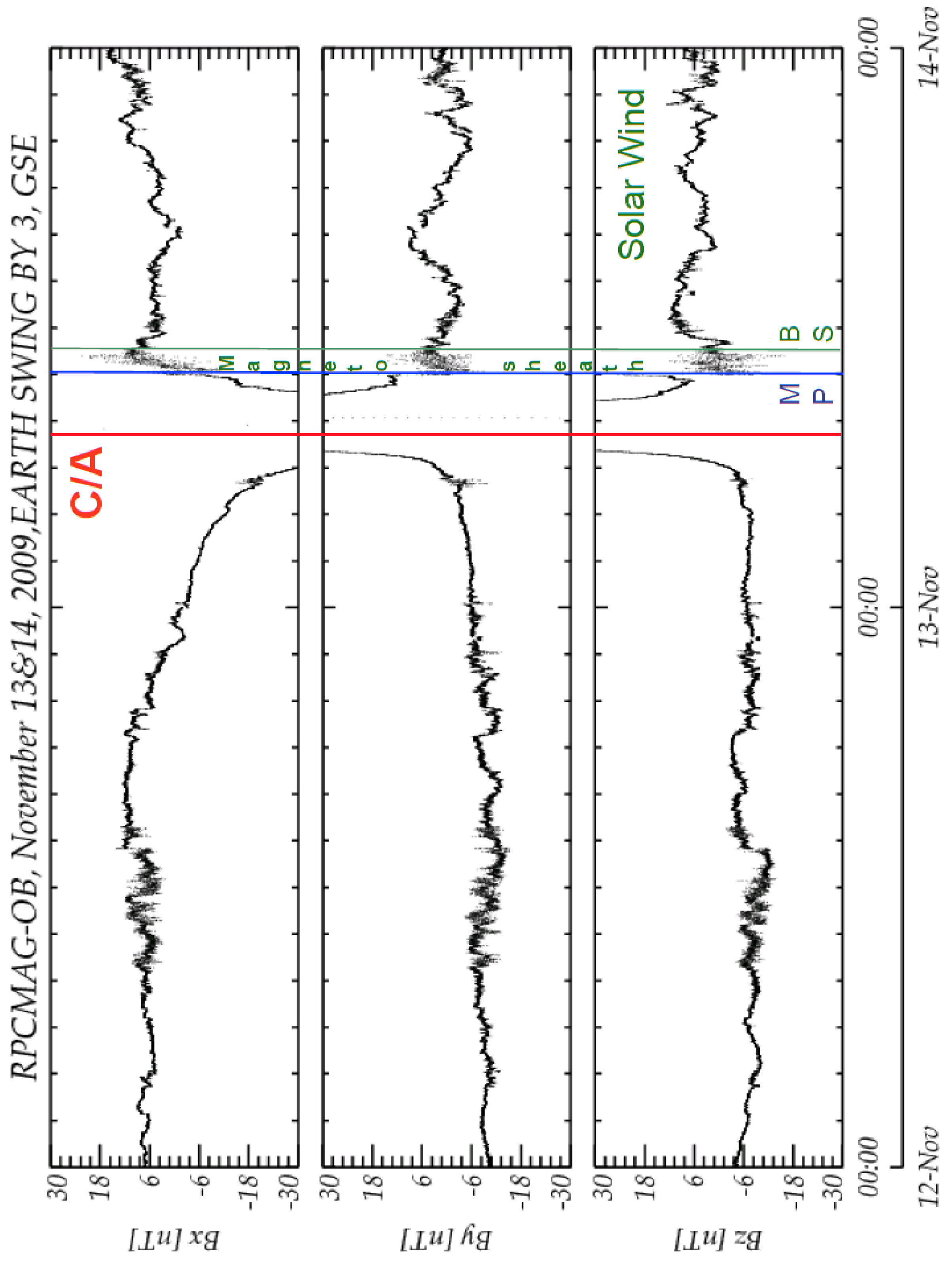

Figure 85: RPC-MAG OB data in GSE coordinates. Preliminary estimated Plasma boundaries are depicted.

7 Comparison of the MAG data with the POMME Model

In this section we compare the RPCMAG data with a theoretical Earth field model. As model the so called POMME-3-model (**Po**tsdam **M**agnetic **M**odel of the **E**arth) developed by the Geo–Forschungs–Zentrum (GFZ) Potsdam is used. This model is based on CHAMP and OERSTED data and includes the following geophysical features:

- Time varying core field
- Ring current (DST)
- Time averaged magnetospheric field
- Secular variations
- Taking into account Main field & Crust field model MF4
  (MF4 Model : crust field model, based on spherical harmonic analysis up to degree 90)
- Tsyganenko-Model

The comparison will be done for the total field and as well for the single components for a time interval of about ± 1.5 hours around Closest Approach (CA).

Figure 86 shows the modulus of the OB sensor in the most upper panel and the total field calculated by the POMME model in the second panel. On this large scale the difference are negligible. The computed difference in the bottom panel, however, reveals an maximum error of about ± 20 nT. The used POMME model contains internal and external sources and also the contribution of the Tsyganenko-Model.

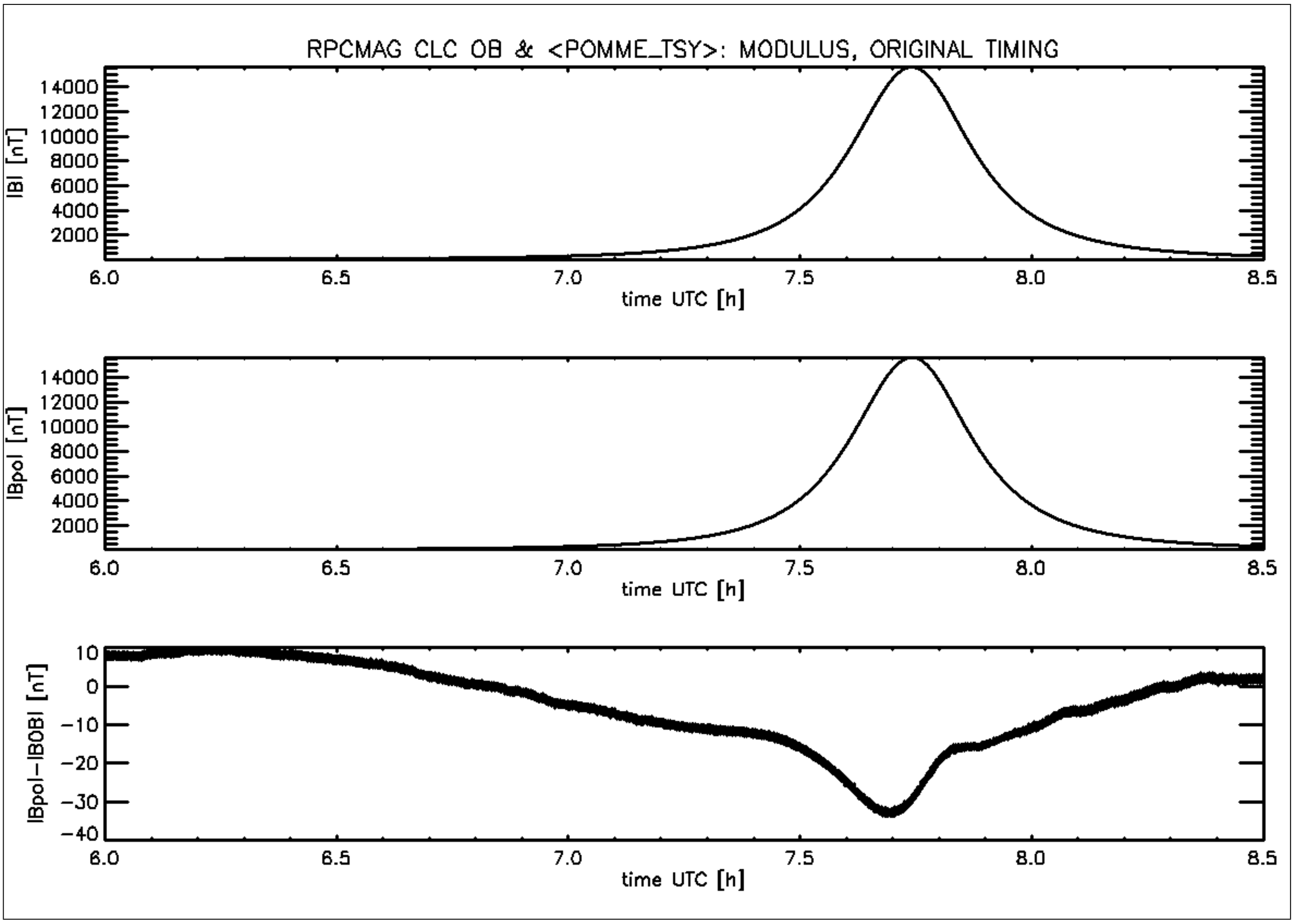

Figure 86: POMME versus OB: Total field, original timing

A comparison of the components of the OB sensor and POMME is displayed in Figure 87. At a first view of these data looks quite good as well. The differences of the model and the measurements are plotted in Figure 88.

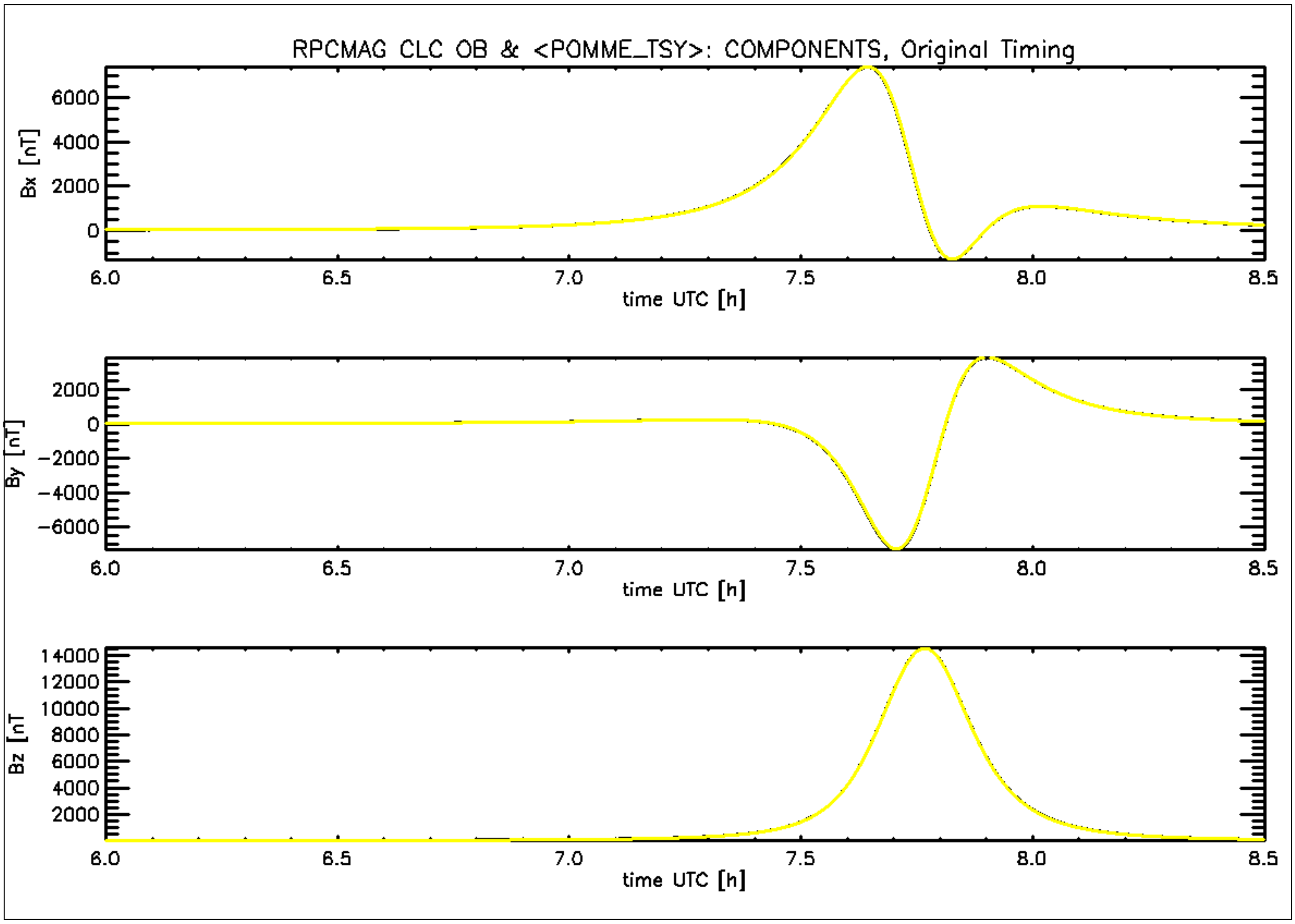

Figure 87: POMME versus OB: Components

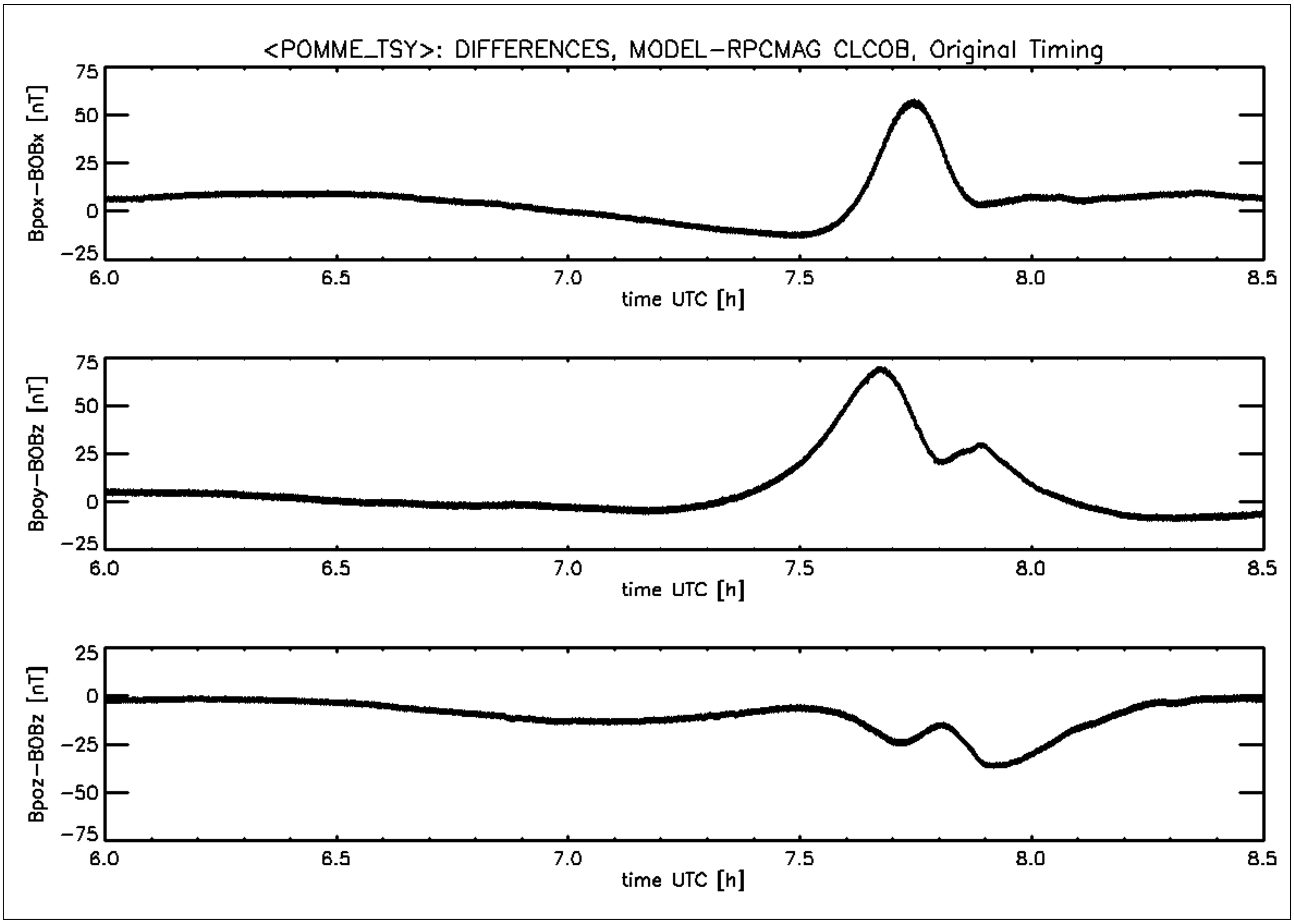

Figure 88: POMME versus OB: Differences of the Components

The result improves a little bit if the data are shifted in time. The optimum time shift seems to be -0.36 seconds. The differences of the shifted data can be seen in Figure 89.

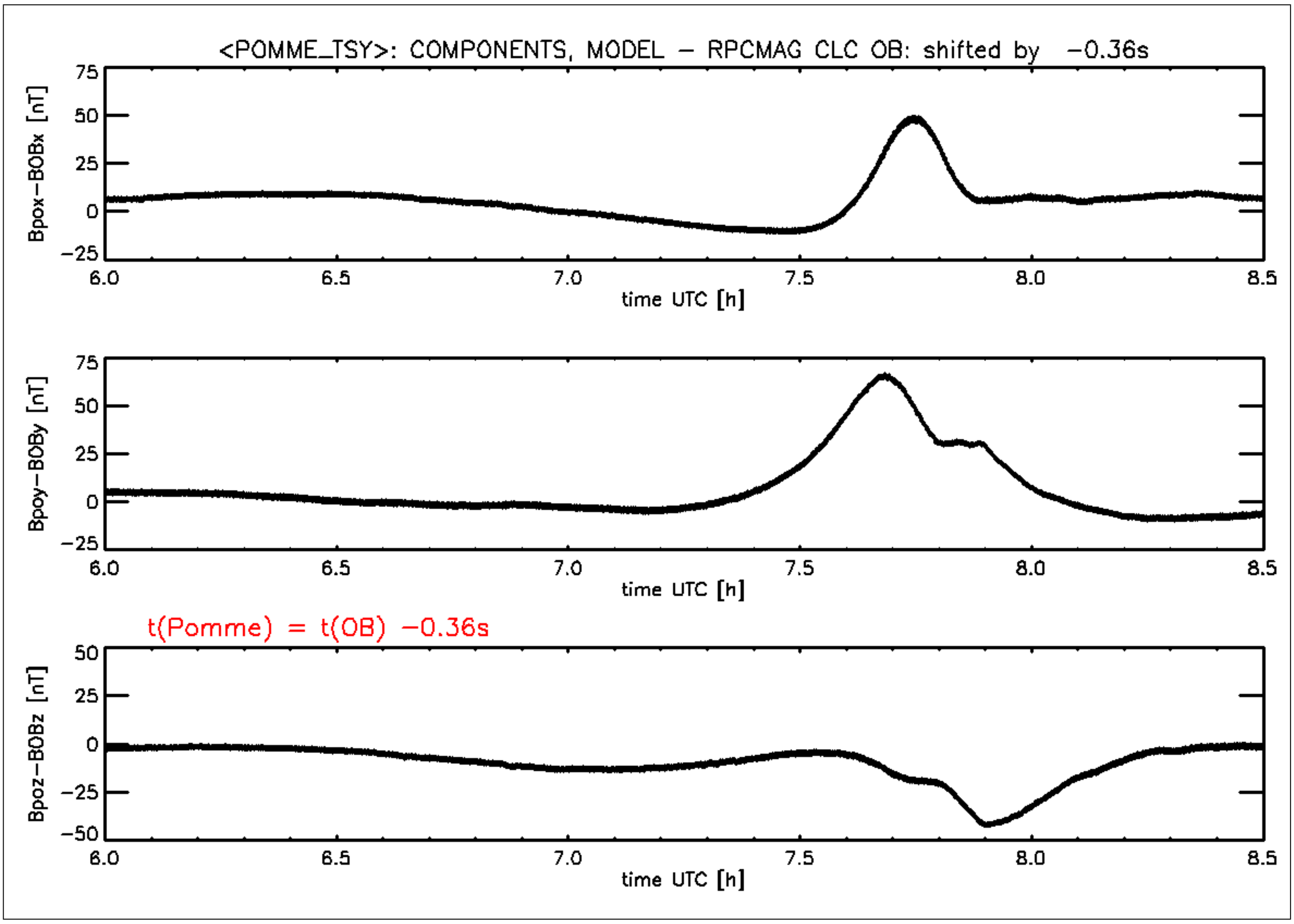

Figure 89: POMME versus OB: Differences of the Components, shifted in time.

The result improves even a little bit more if the magnetometer boom is virtually rotated by a few hundreds of a degree. A minimum fit yields

- $-0.19°$ around x
- $-0.09°$ around y
- $+0.17°$ around z

to be the optimum rotation angles. The remaining residua in the order of ± 15 nT can be seen in Figure 90.

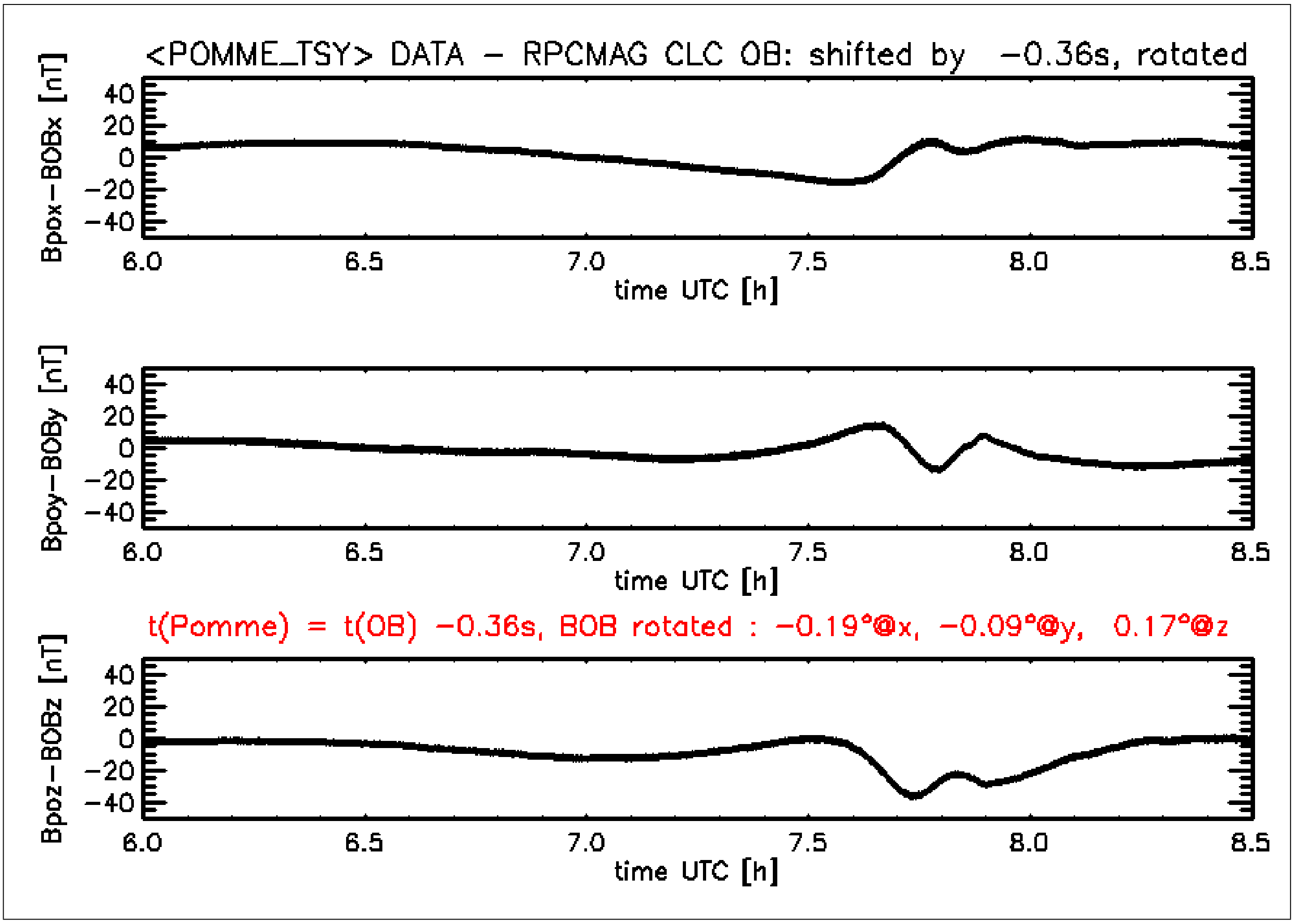

Figure 90: POMME versus OB: Differences of the Components, shifted and rotated.

The rotation and time shift of the data diminishes the difference between measured ROSETTA data and the Model data. Nevertheless a residual error remains. This is probably caused in the model parameters which might not be chosen in an optimal way for the ROSETTA swing by trajectory. In any case this discrepancy is not originated in wrong sensitivity parameters of the RPC-MAG instrument, for a test with data in original instrument coordinates could definitely exclude such a suspicion.
Although a residual error of about ± 15nT remains, the results shows good accordance of the swing by data and the theoretical expected values.

8 Comparison of the MAG with WIND and ACE data

This section shows the result of a comparison between the RPCMAG OB data and the magnetic field data measured by the WIND and the ACE satellites. Both spacecrafts are positioned near the Lagrange Point L_1 at a distance of about 1.5 Million Kilometers from the Earth. The comparison has been executed for the complete time interval where RPCMAG has been switched on.

It can be seen that there are several structures that have been observed by all instruments. Of course RPCMAG shows a complete different behavior after ROSETTA has passed the inbound bow shock and stays inside the magnetosphere. It also can be seen that a bunch of jumps exists in the RPCMAG data. These jumps have their source somewhere on the spacecraft. Obviously there was a lot of activity on the spacecraft side which caused this noise.

Although the temperature variations at the RPCMAG sensors during the 8 days of measurement were really huge (refer to chapter 11) the temperature calibration model of RPCMAG compensates the temperature drift effects so successfully, that a long scale divergency between the 3 instruments is not observable.

For a quantitative comparison between the data, an appropriate varying time shift dependent on the solar wind speed and the relative positions of the spacecrafts has to be taken into account, which has not been done here for this coarse overview.

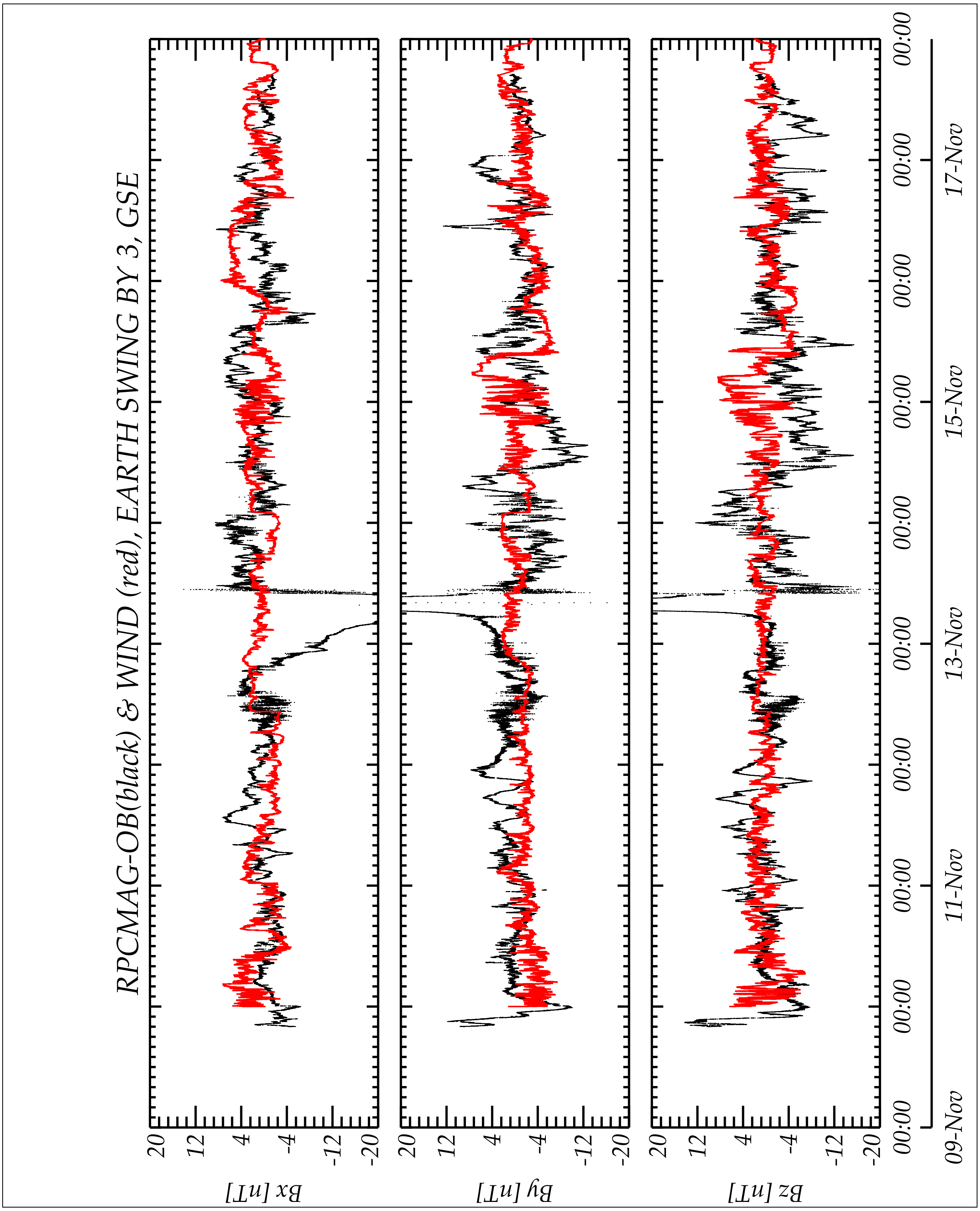

Figure 91: File: RPCMAG0911_0917_GSE_OB_WIND

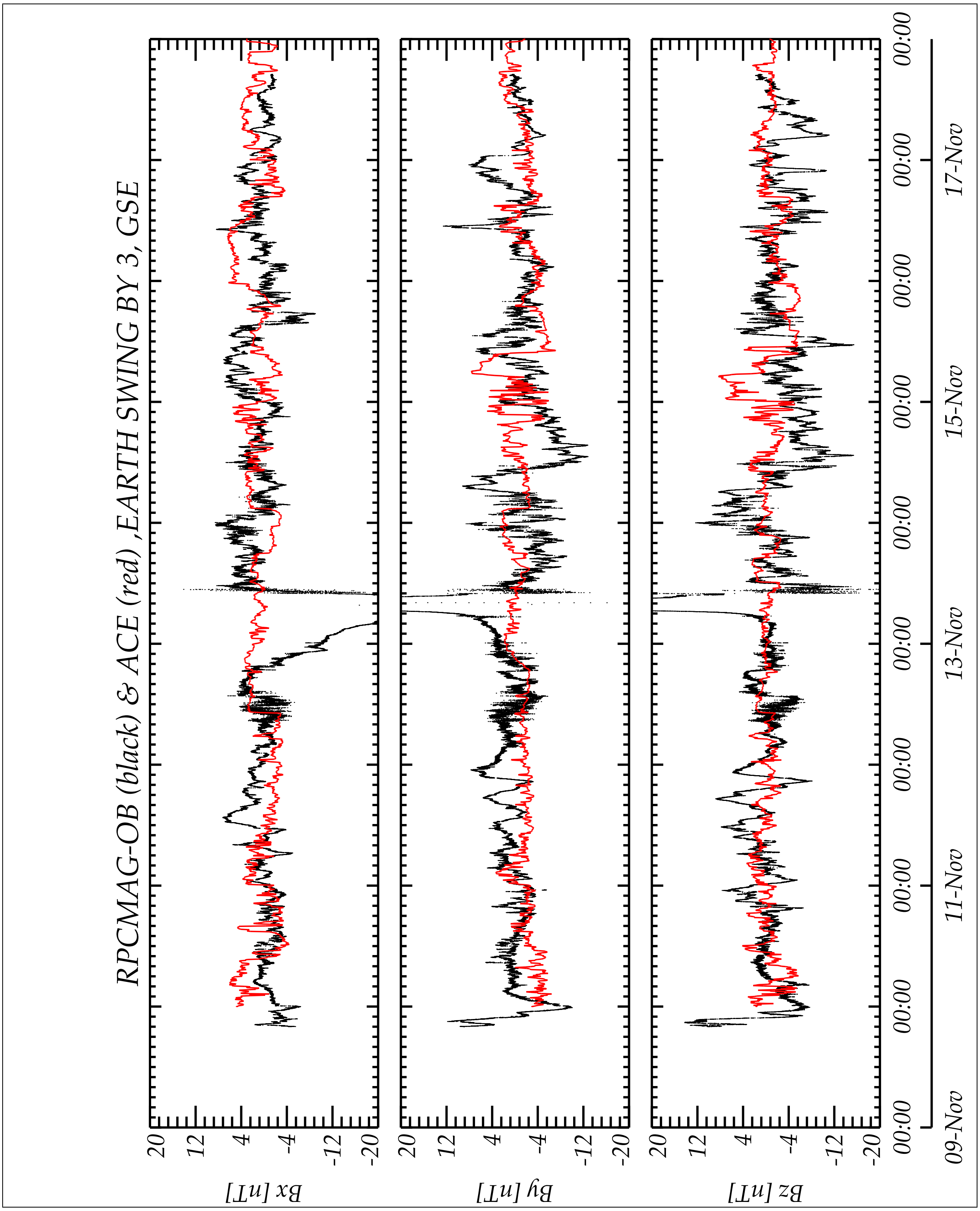

Figure 92: File: RPCMAG0911_0917_GSE_OB_ACE

9 Dynamic Spectra of the Swing by

This section shows the dynamic spectra of the OB sensor in LEVEL_C = ECLIPJ2000 coordinates. For the times were the instrument was operated in NORMAL mode, SID2, the maximum resolvable frequency is 0.5 Hz. For BURST mode it is 10 Hz.

The tilted lines are caused by ROSETTA'S reaction wheels. Refer to the next chapter for details.

The horizontal fixed frequency lines at about 3.2/3.6 Hz and multiples are caused by the LAP instrument. A detailed investigation of this interference is discussed in the report RO-IGEP-TR0030.

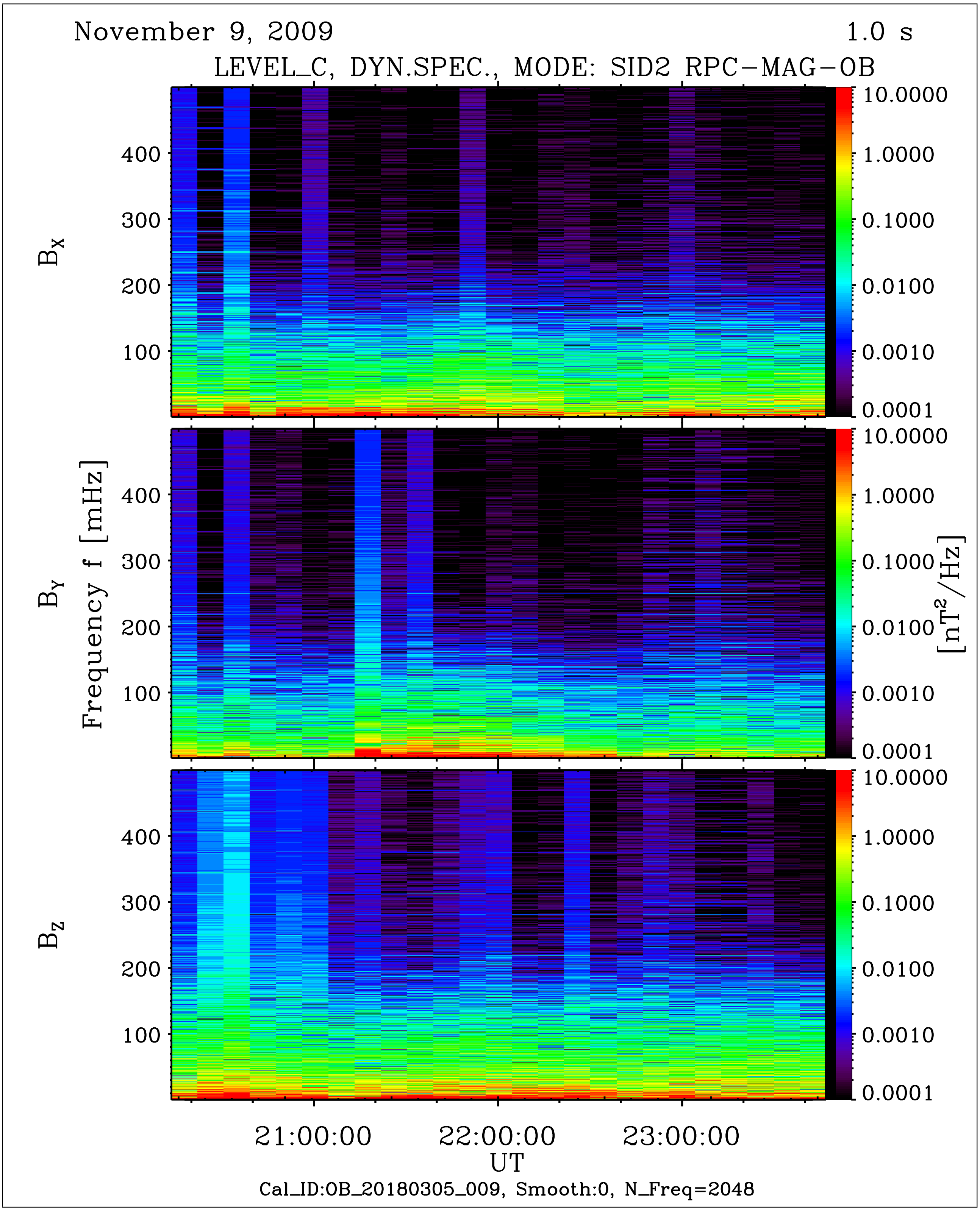

Figure 93: File: RPCMAG091109T2000_CLC_OB_M2_DS0_500_009

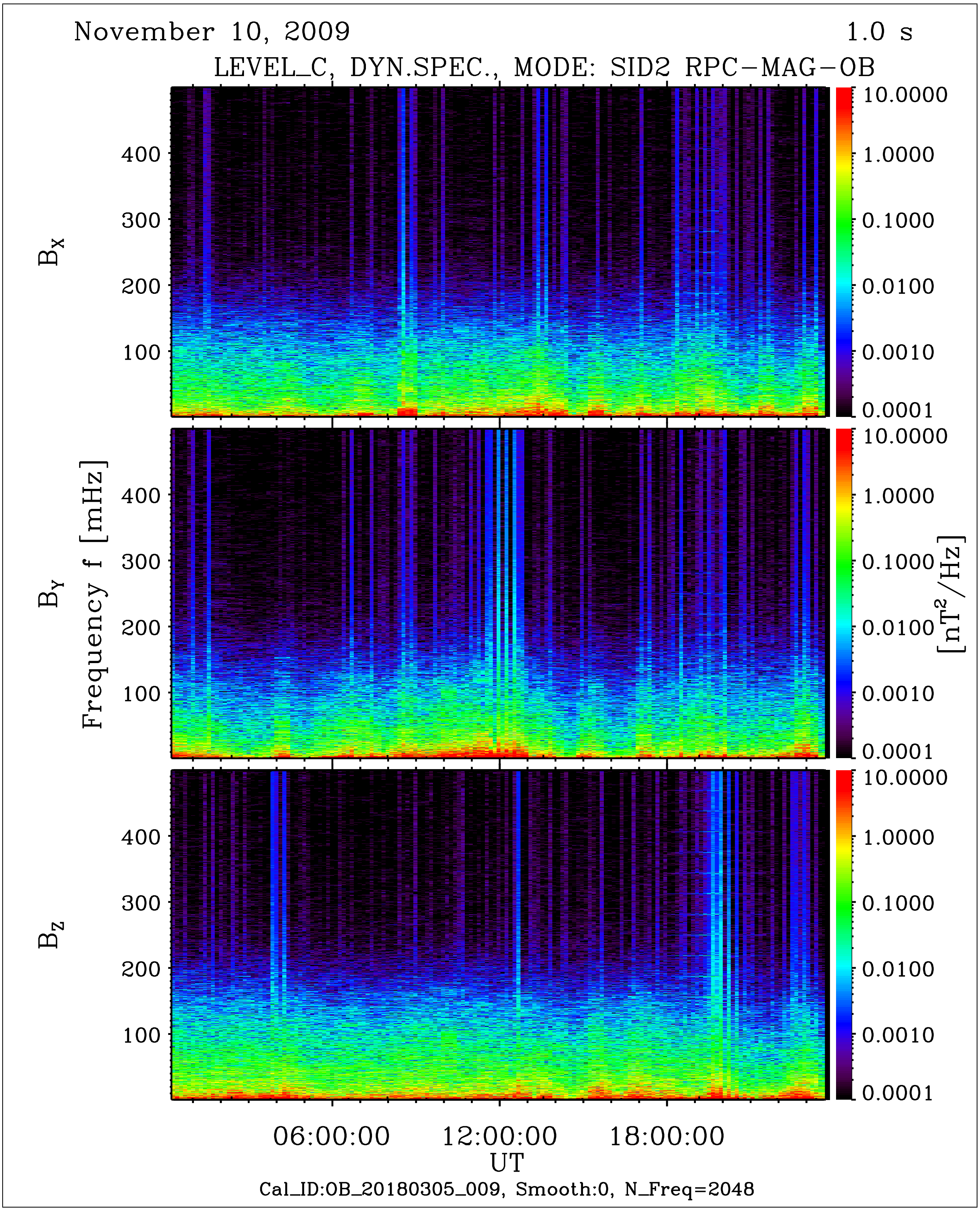

Figure 94: File: RPCMAG091110T0000_CLC_OB_M2_DS0_500_009

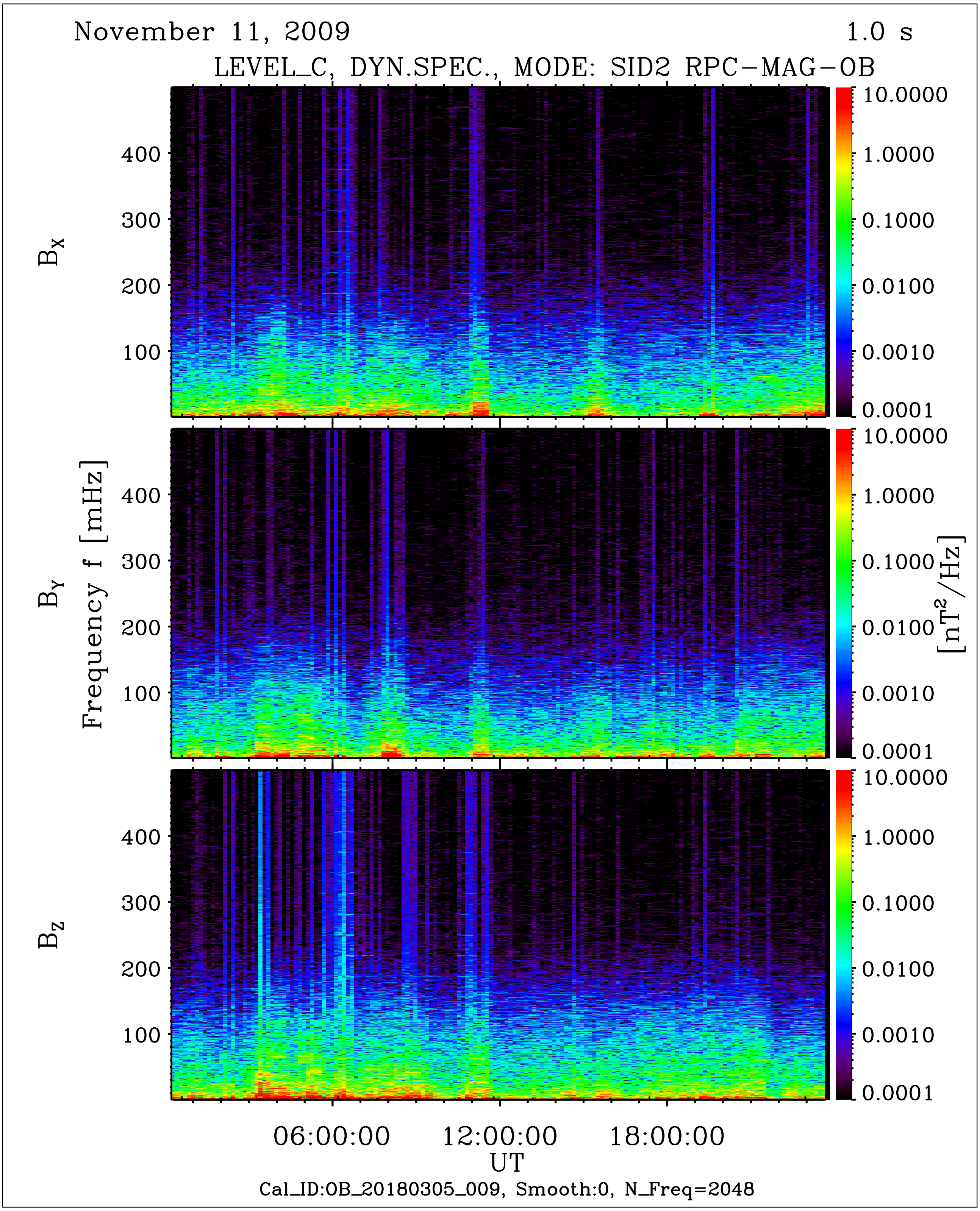

Figure 95: File: RPCMAG091111T0000_CLC_OB_M2_DS0_500_009

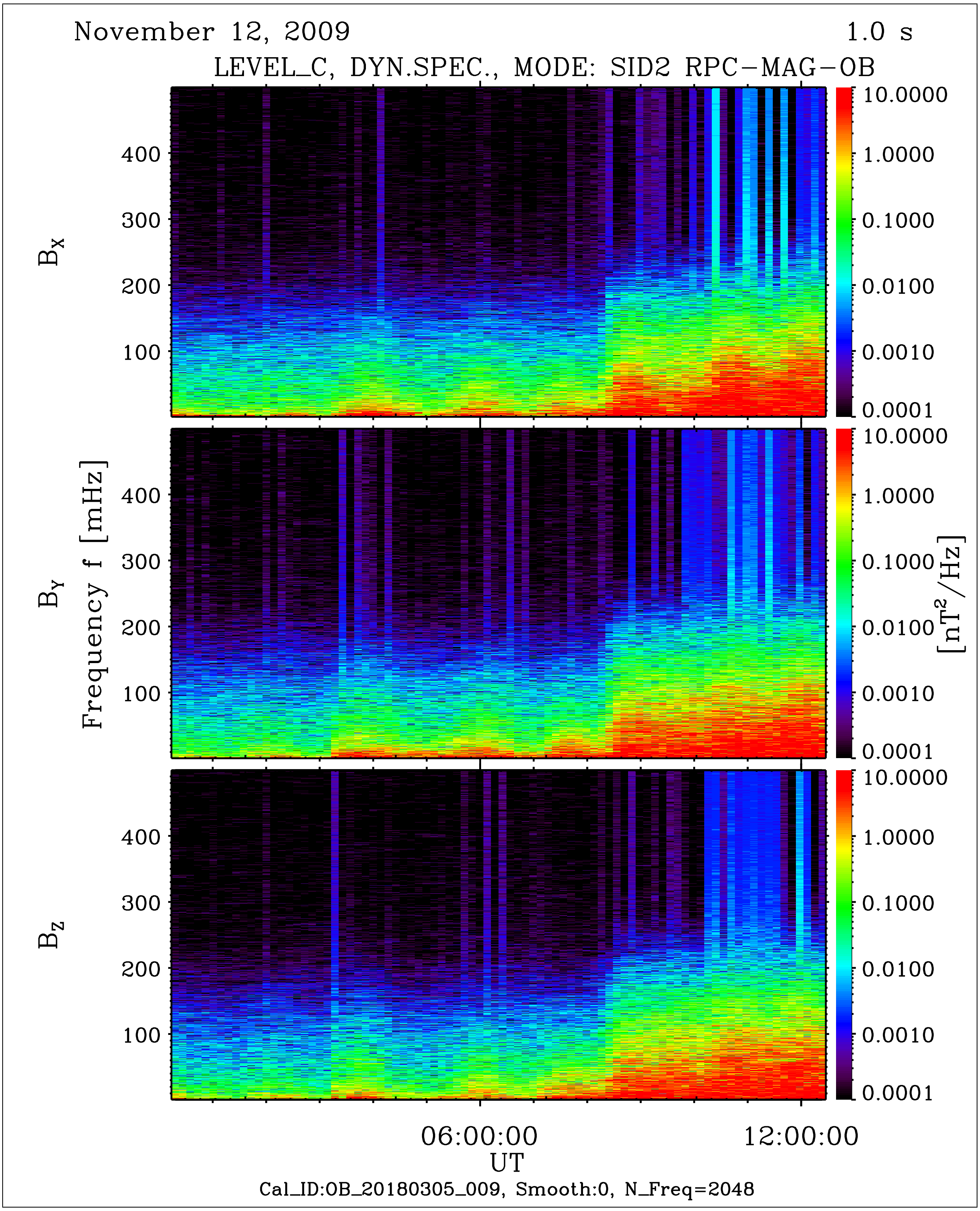

Figure 96: File: RPCMAG091112T0000_CLC_OB_M2_DS0_500_009

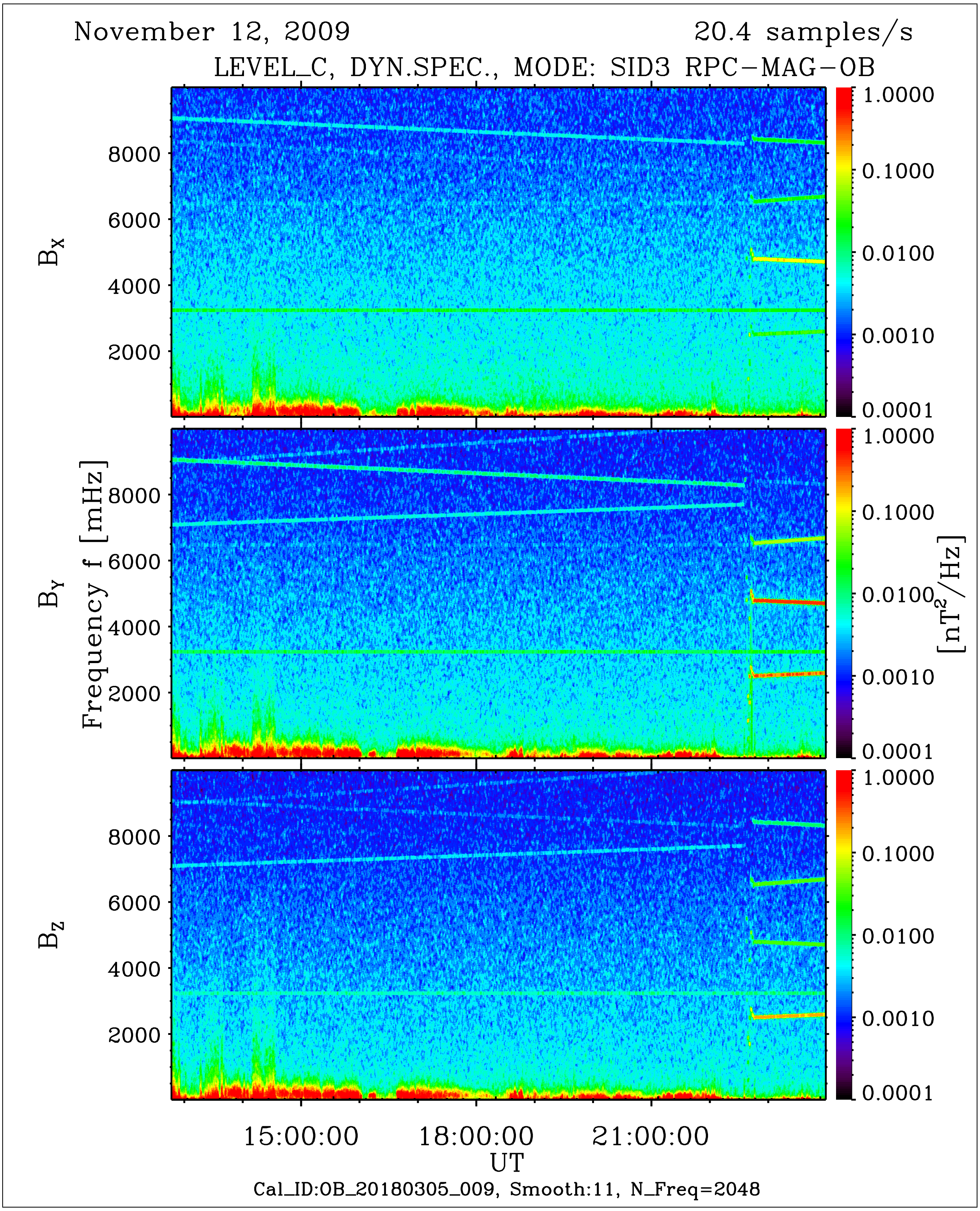

Figure 97: File: RPCMAG091112T1246_CLC_OB_M3_DS0_10000_009

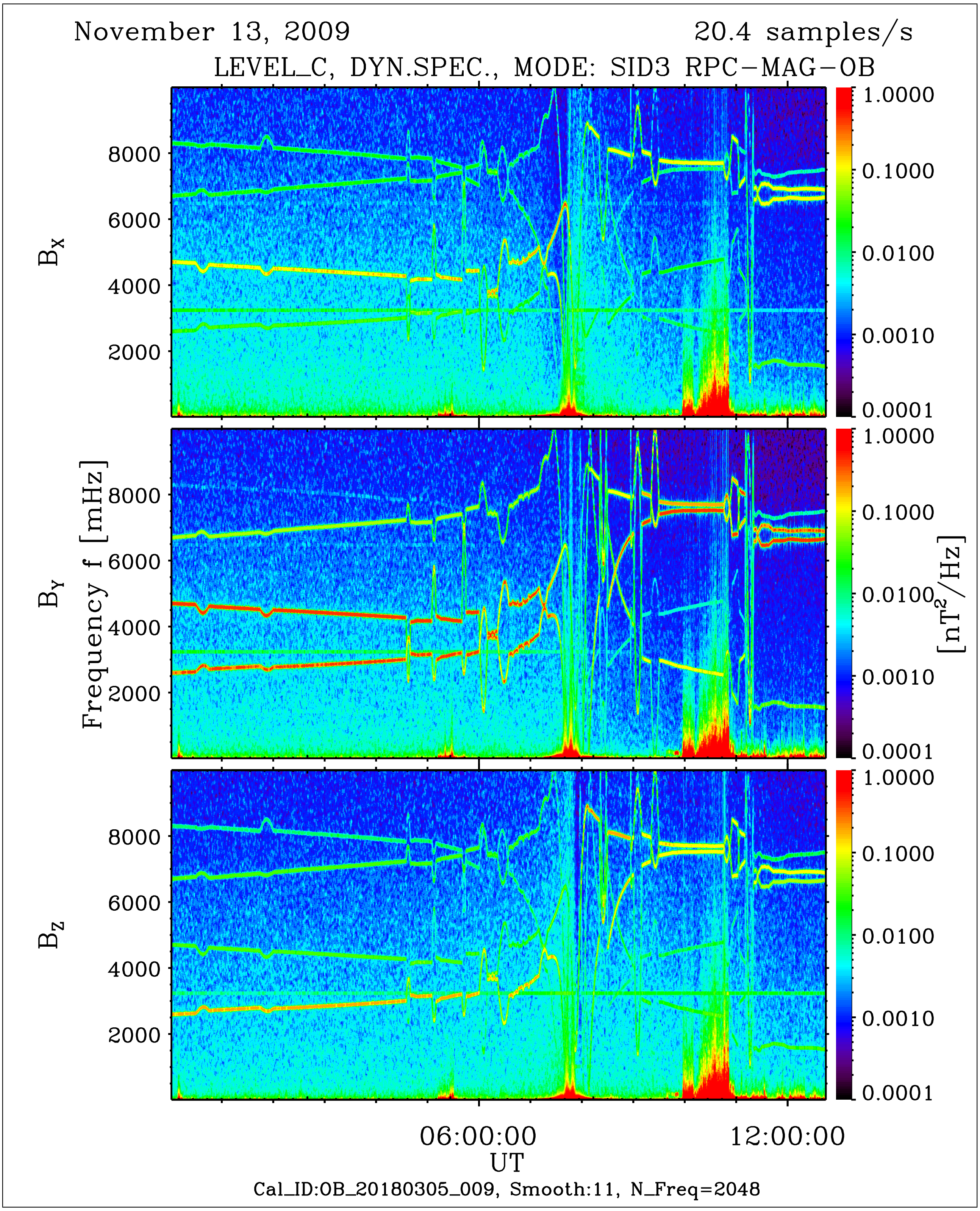

Figure 98: File: RPCMAG091113T0000_CLC_OB_M3_DS0_10000_009

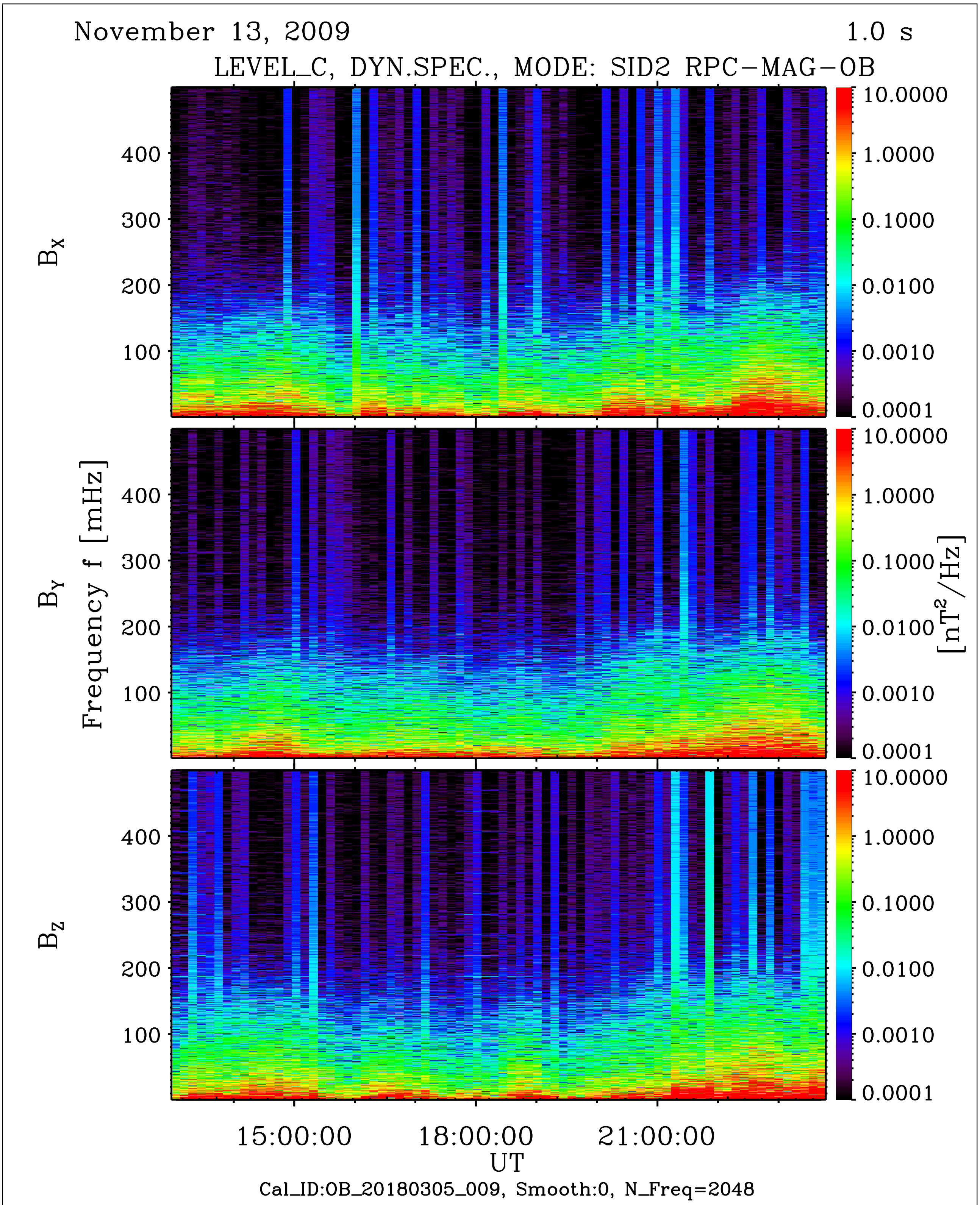

Figure 99: File: RPCMAG091113T1245_CLC_OB_M2_DS0_500_009

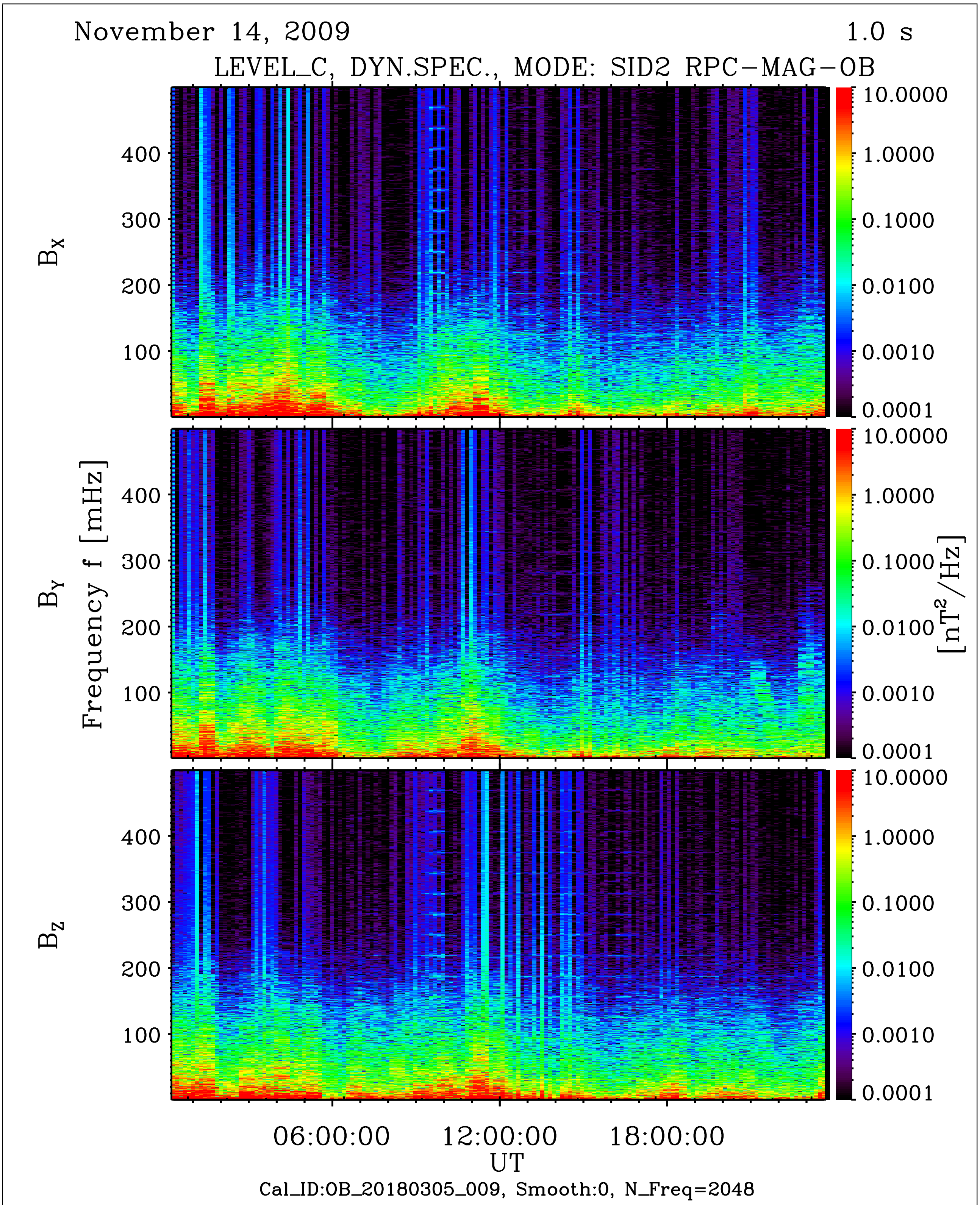

Figure 100: File: RPCMAG091114T0000_CLC_OB_M2_DS0_500_009

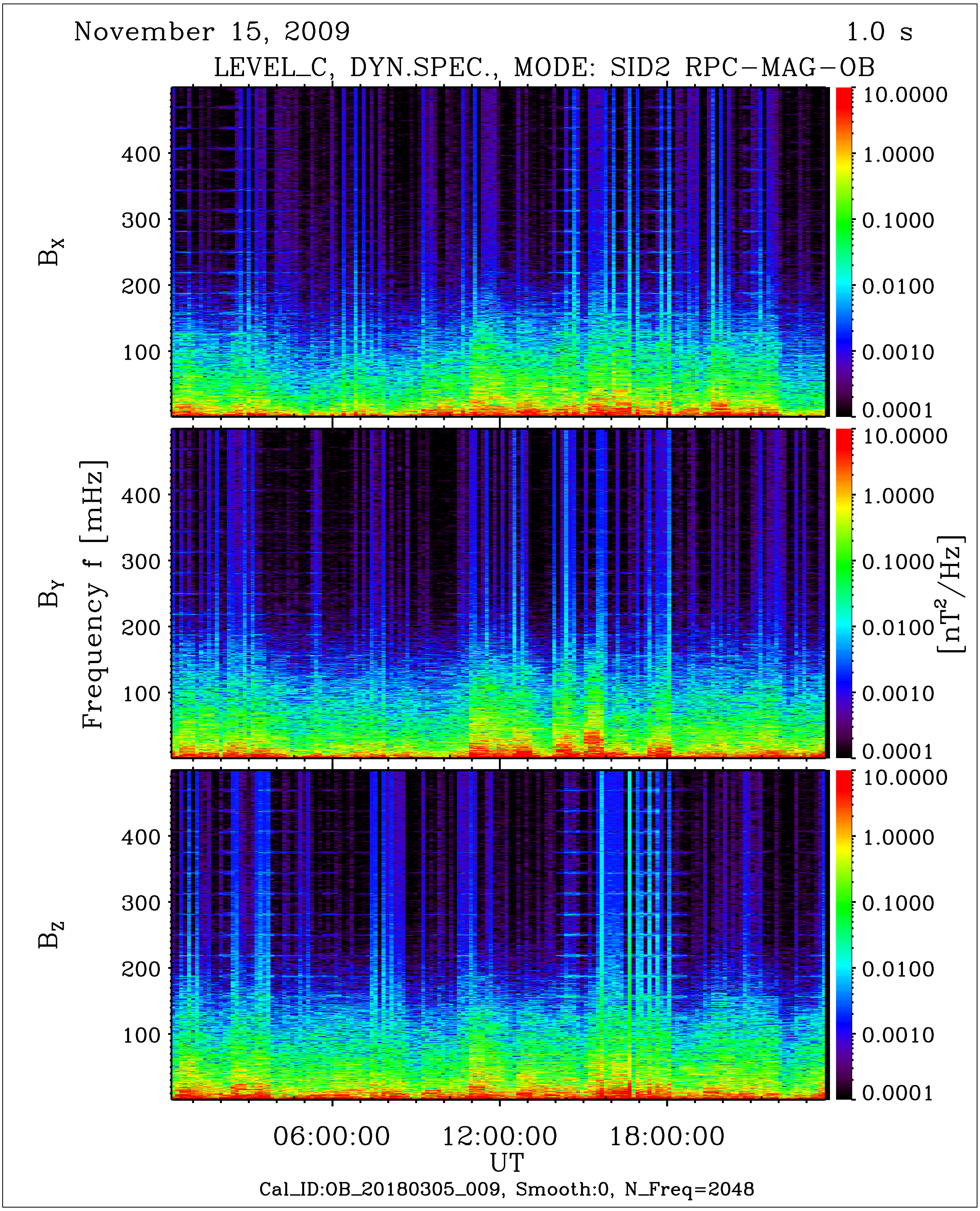

Figure 101: File: RPCMAG091115T0000_CLC_OB_M2_DS0_500_009

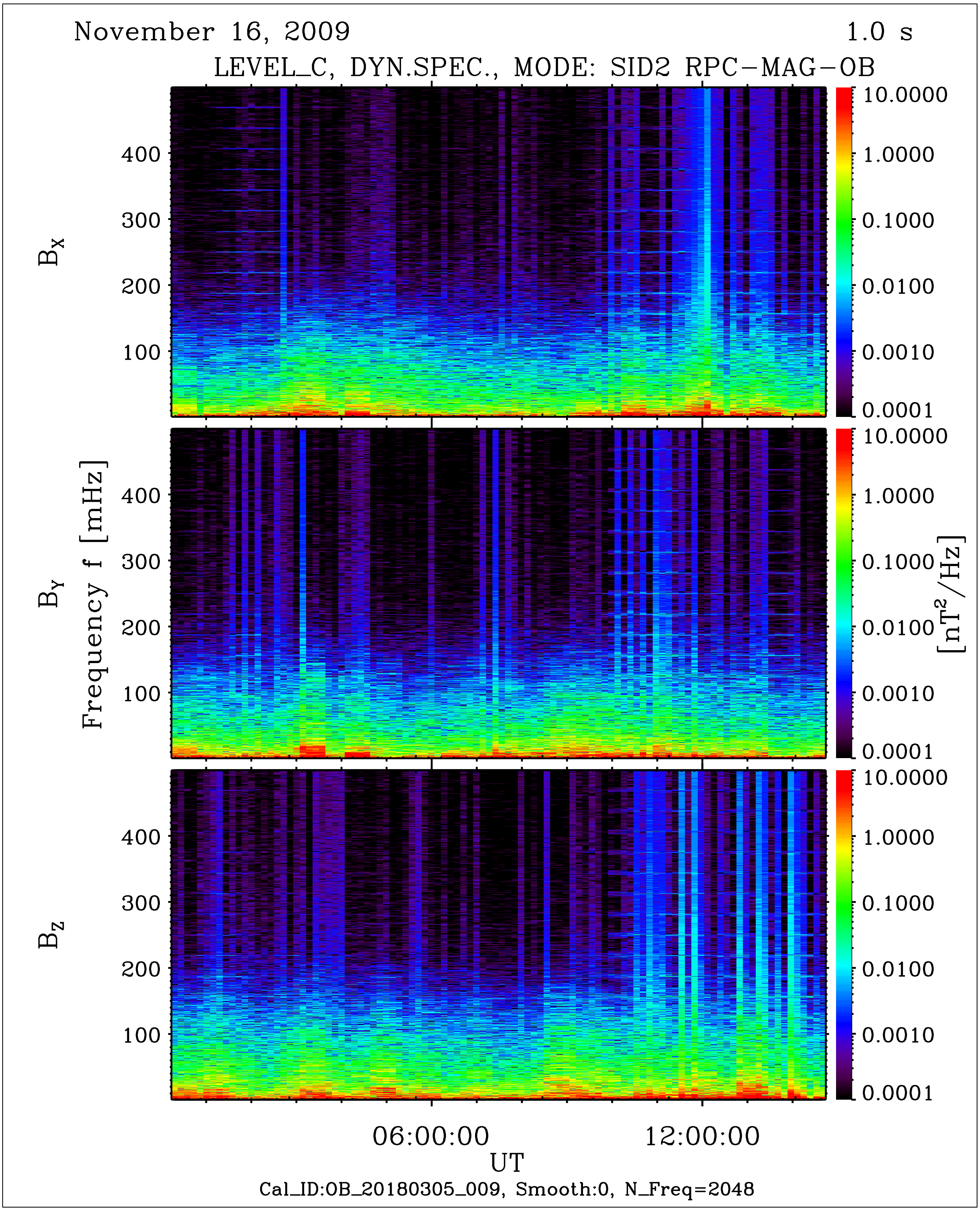

Figure 102: File: RPCMAG091116T0000_CLC_OB_M2_DS0_500_009

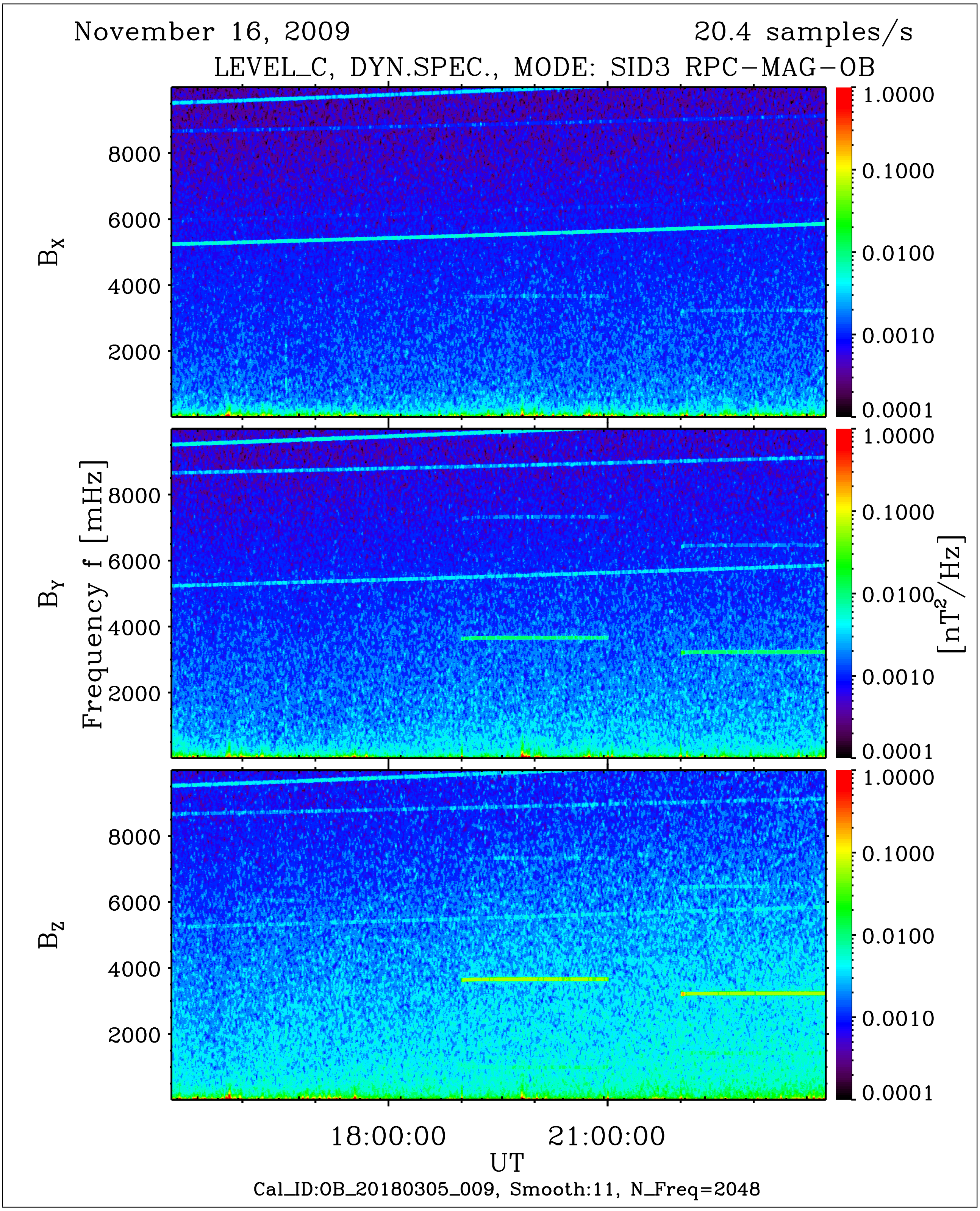

Figure 103: File: RPCMAG091116T1501_CLC_OB_M3_DS0_10000_009

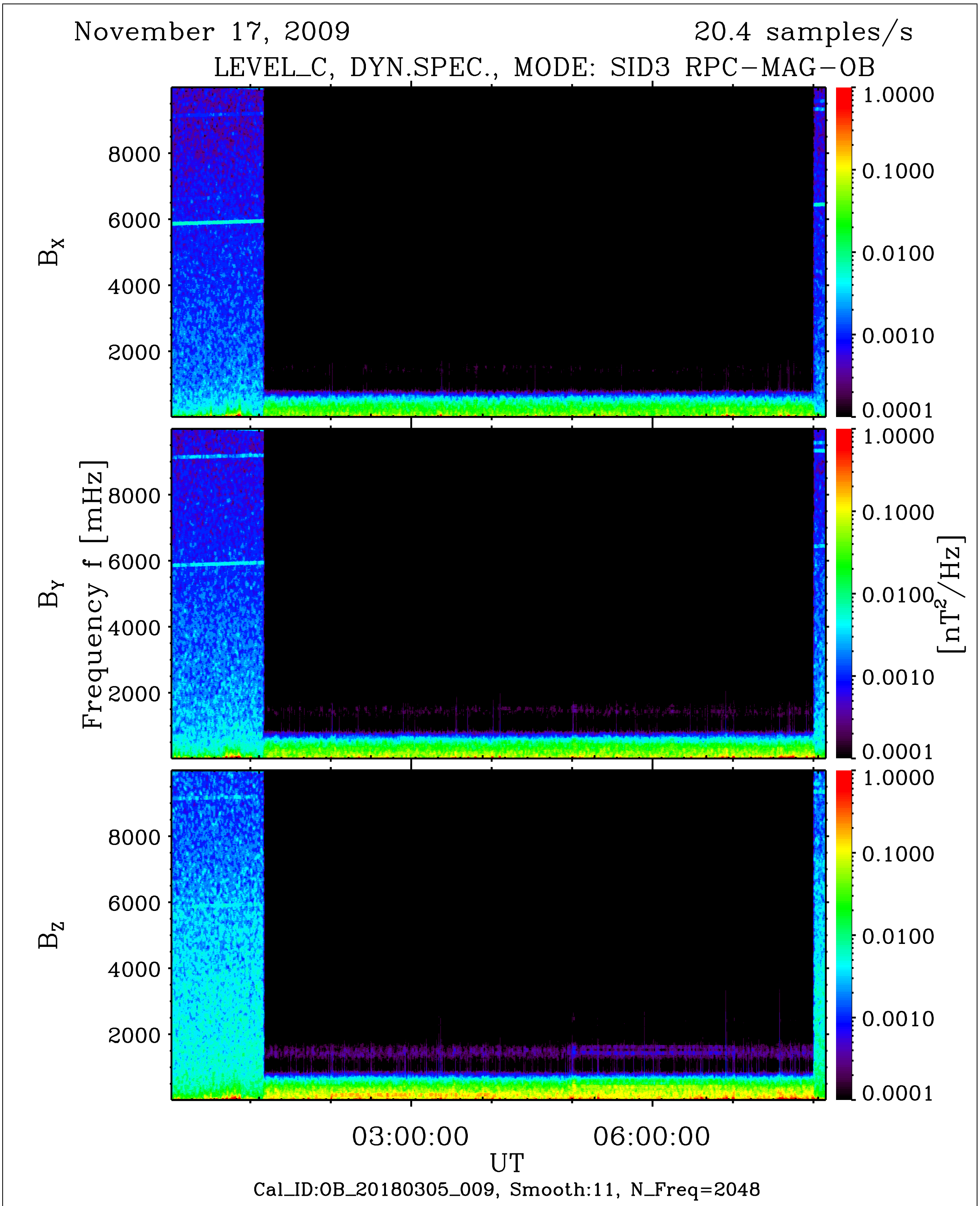

Figure 104: File: RPCMAG091117T0000_CLC_OB_M3_DS0_10000_009

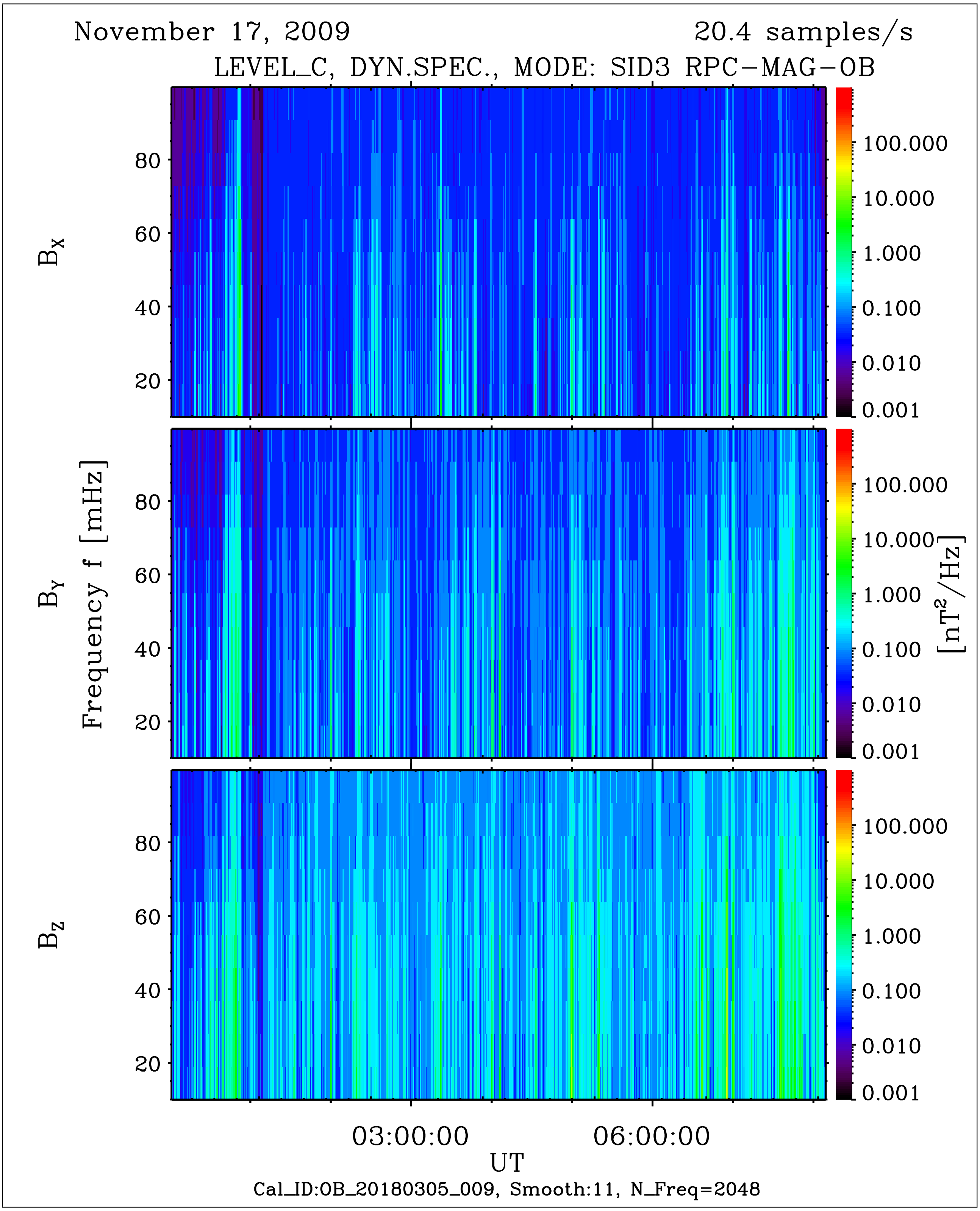

Figure 105: File: RPCMAG091117T0000_CLC_OB_M3_DS0_100_009

10 Dynamic Spectra of ROSETTAs Reaction Wheels

This section shows the spectra of ROSETTAs Reaction Wheels (RW). There are 4 different wheels rotating with different frequencies. The plots do not show the original rotation frequencies but the signatures that would be expected using an data acquisition system operating at 1 Hz and 20 Hz sampling frequency without any aliasing filter.
These signatures are expected to be seen on the actual primary sensor.

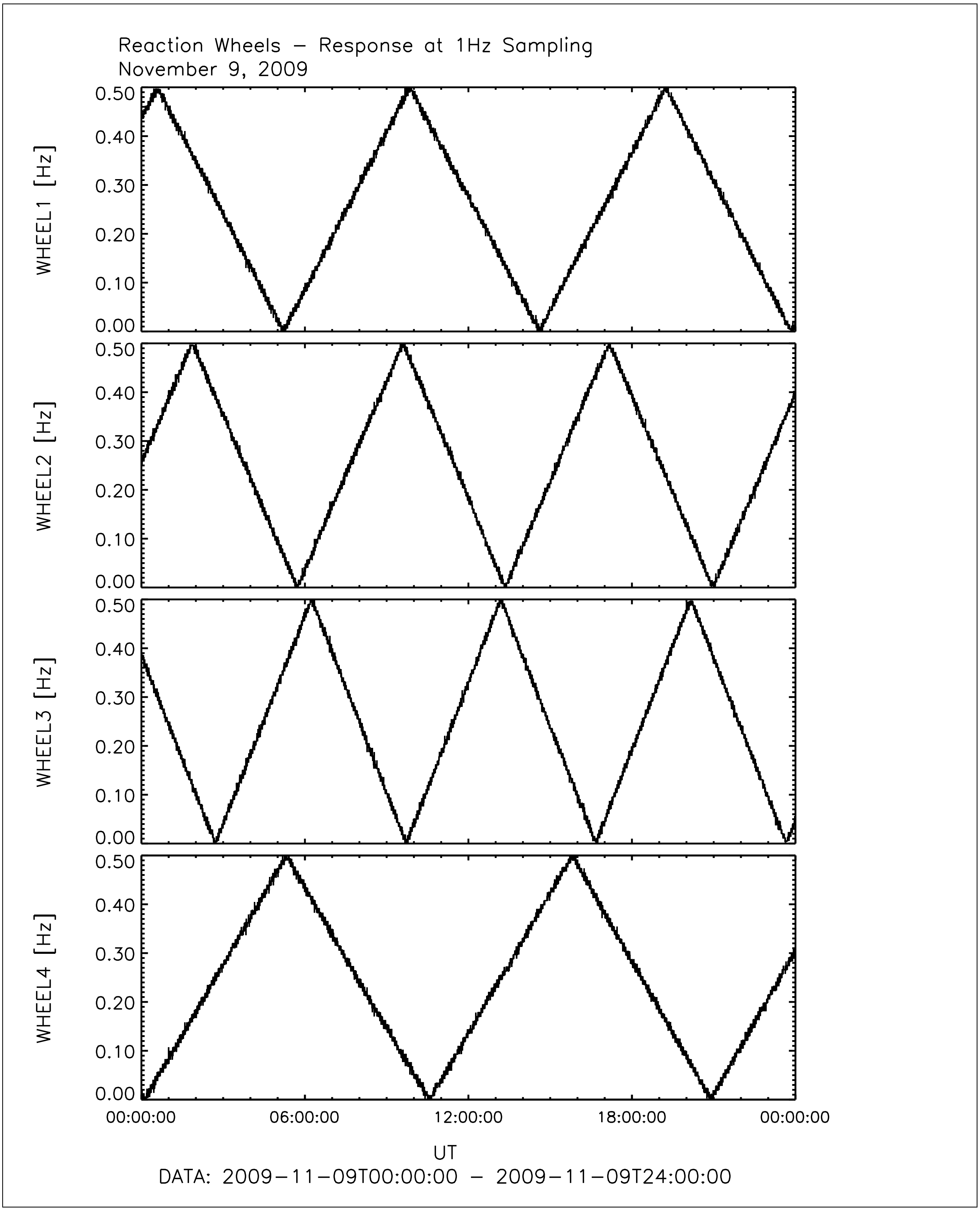

Figure 106: File: wheels_1Hz_Sampling2009-11-09T00-00

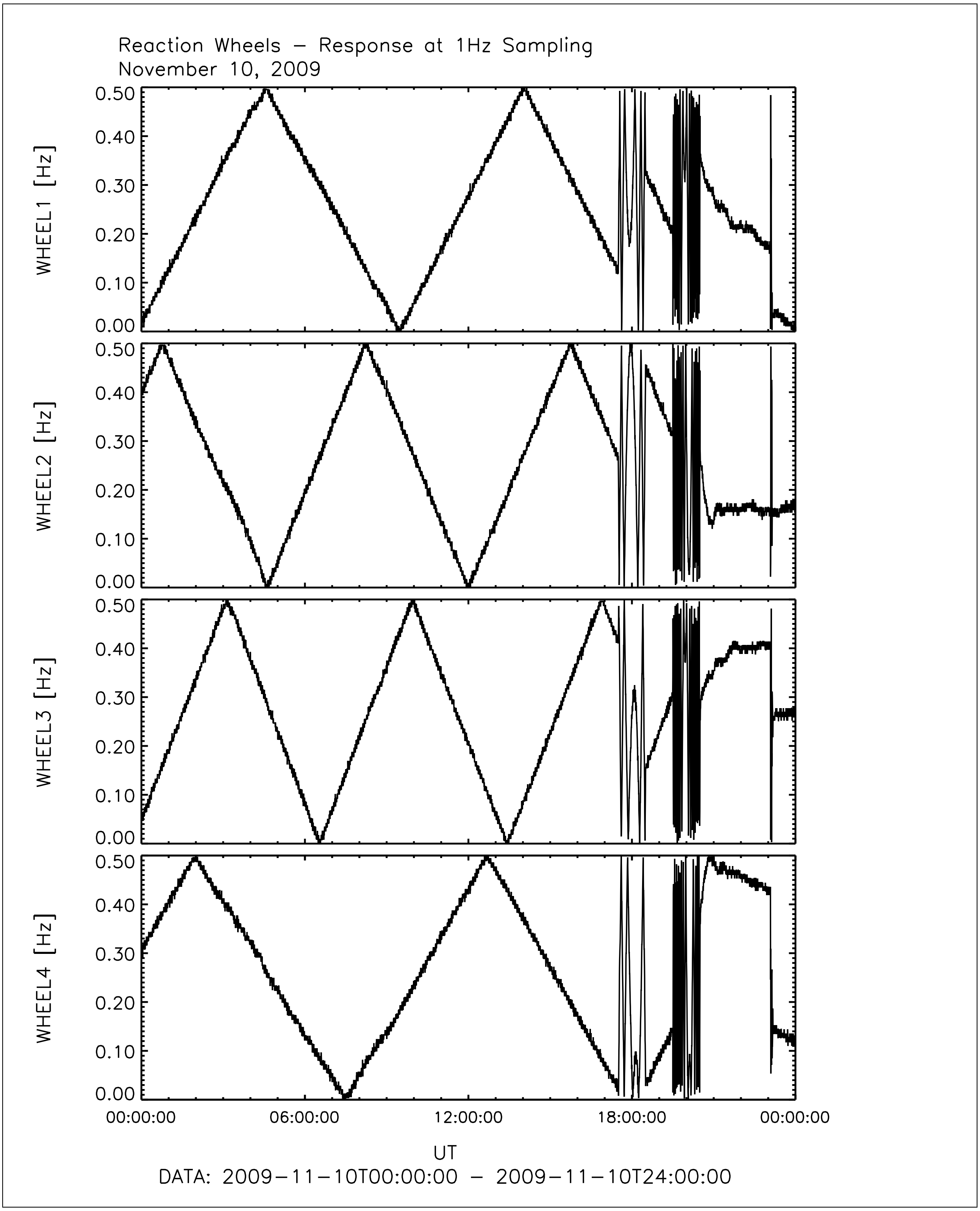

Figure 107: File: wheels_1Hz_Sampling2009-11-10T00-00

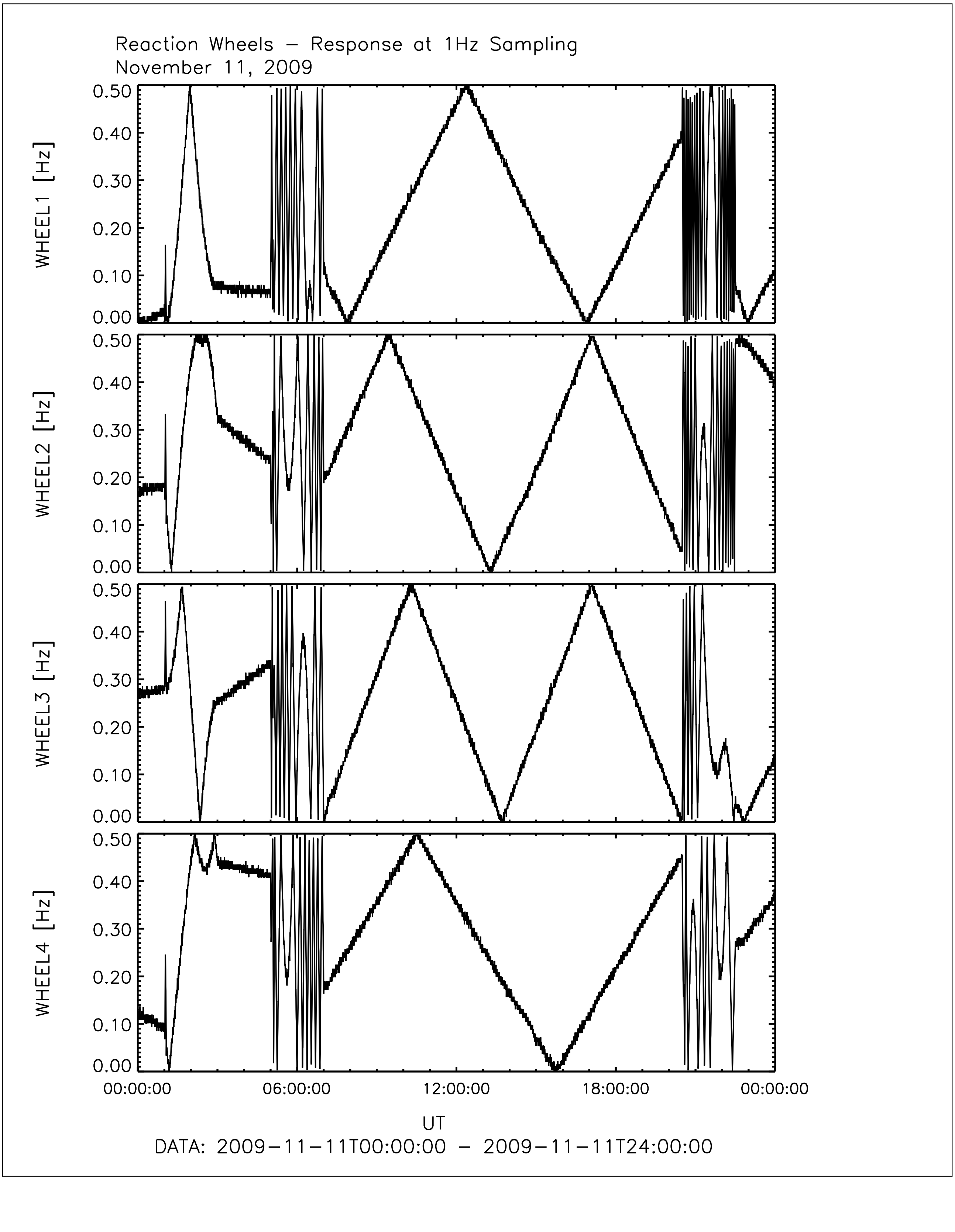

Figure 108: File: wheels_1Hz_Sampling2009-11-11T00-00

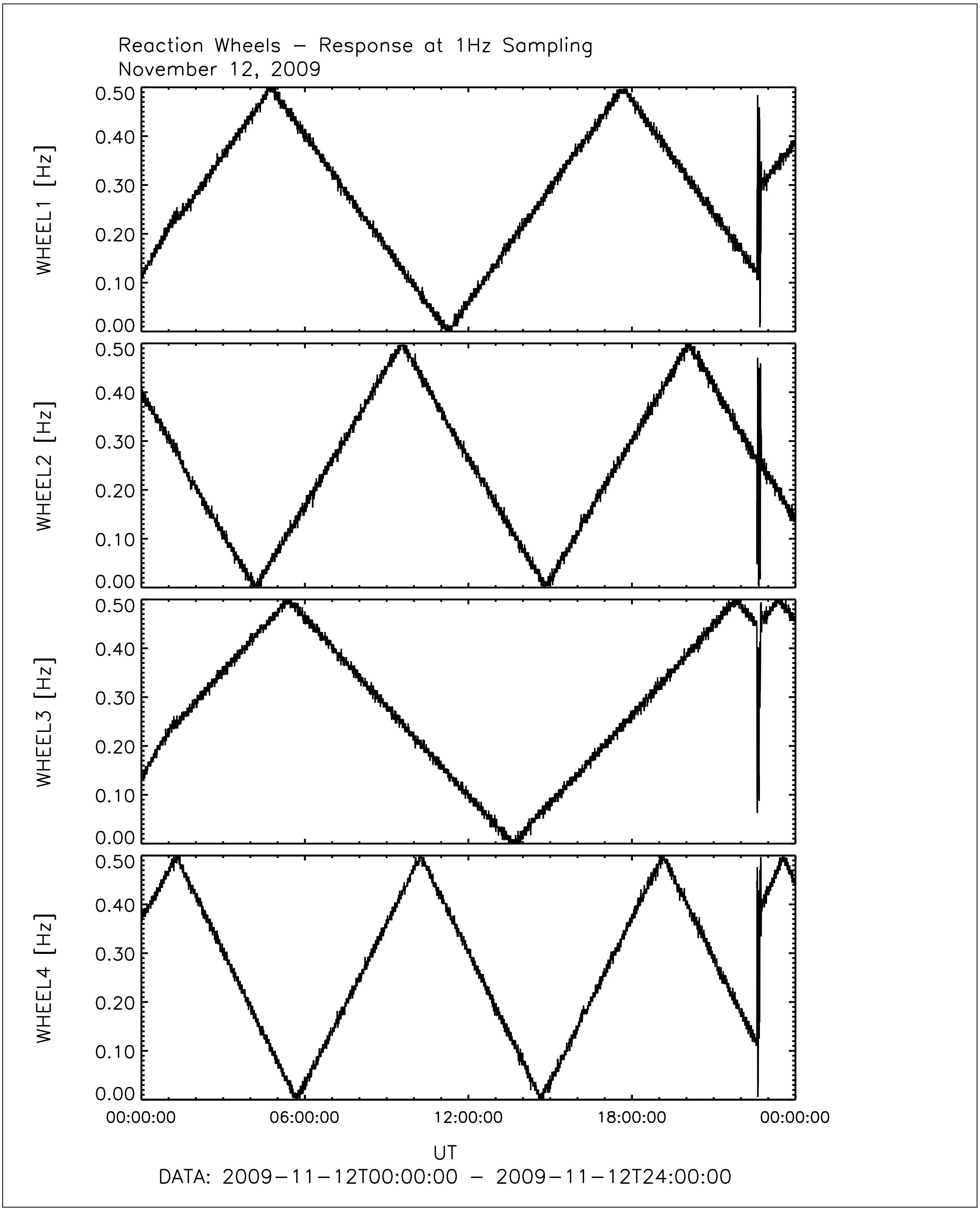

Figure 109: File: wheels_1Hz_Sampling2009-11-12T00-00

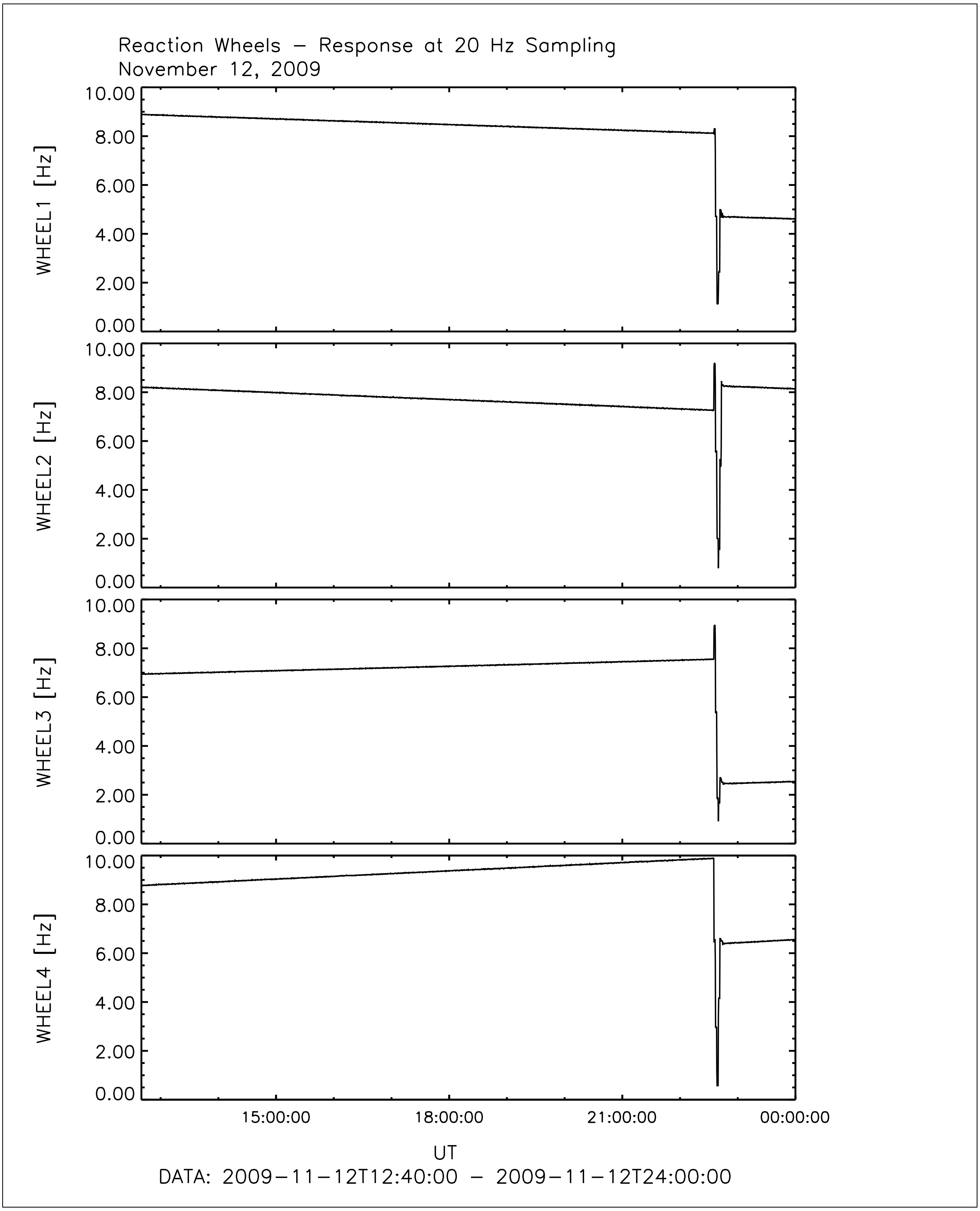

Figure 110: File: wheels_20Hz_Sampling2009-11-12T12-40

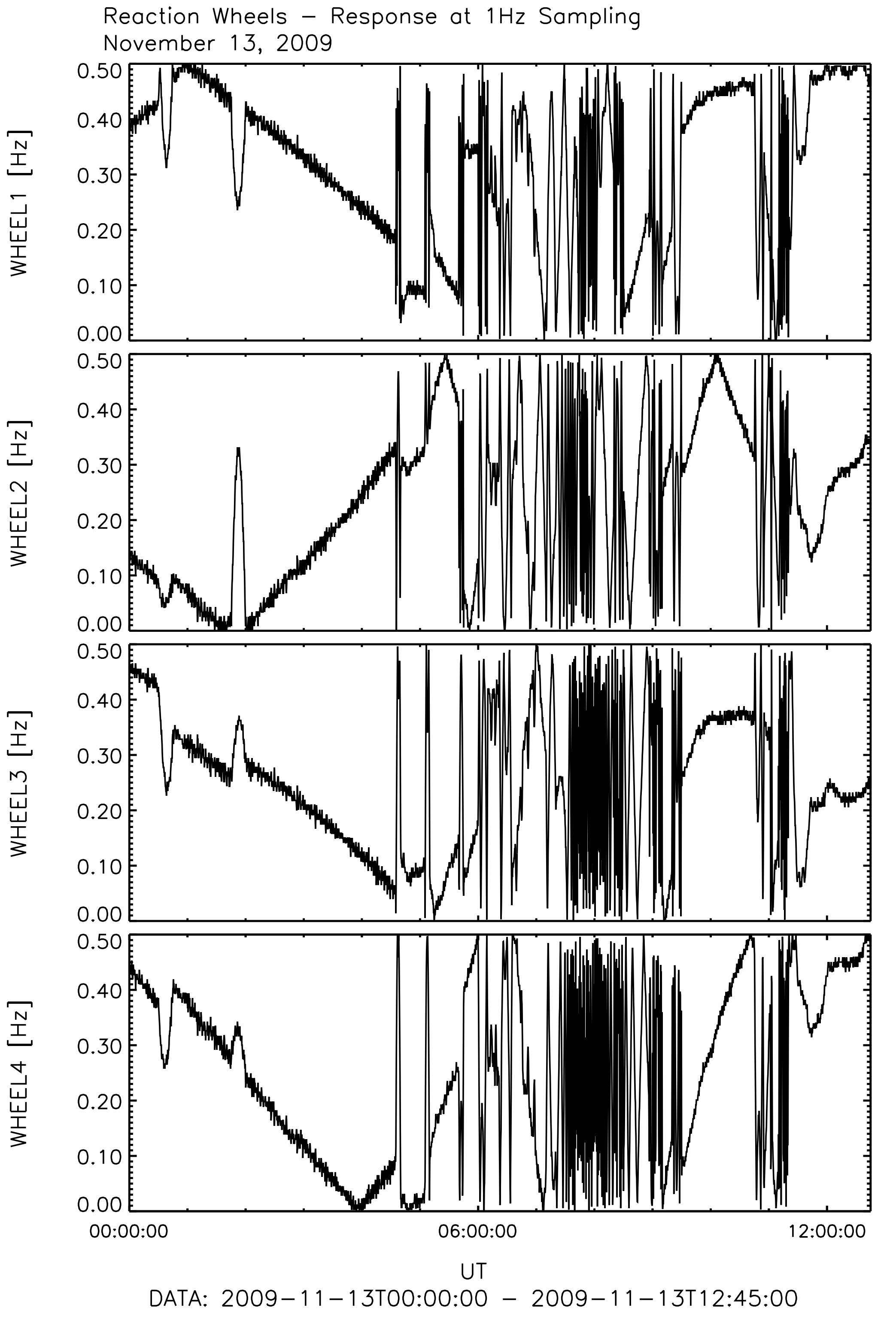

Figure 111: File: wheels_1Hz_Sampling2009-11-13T00-00

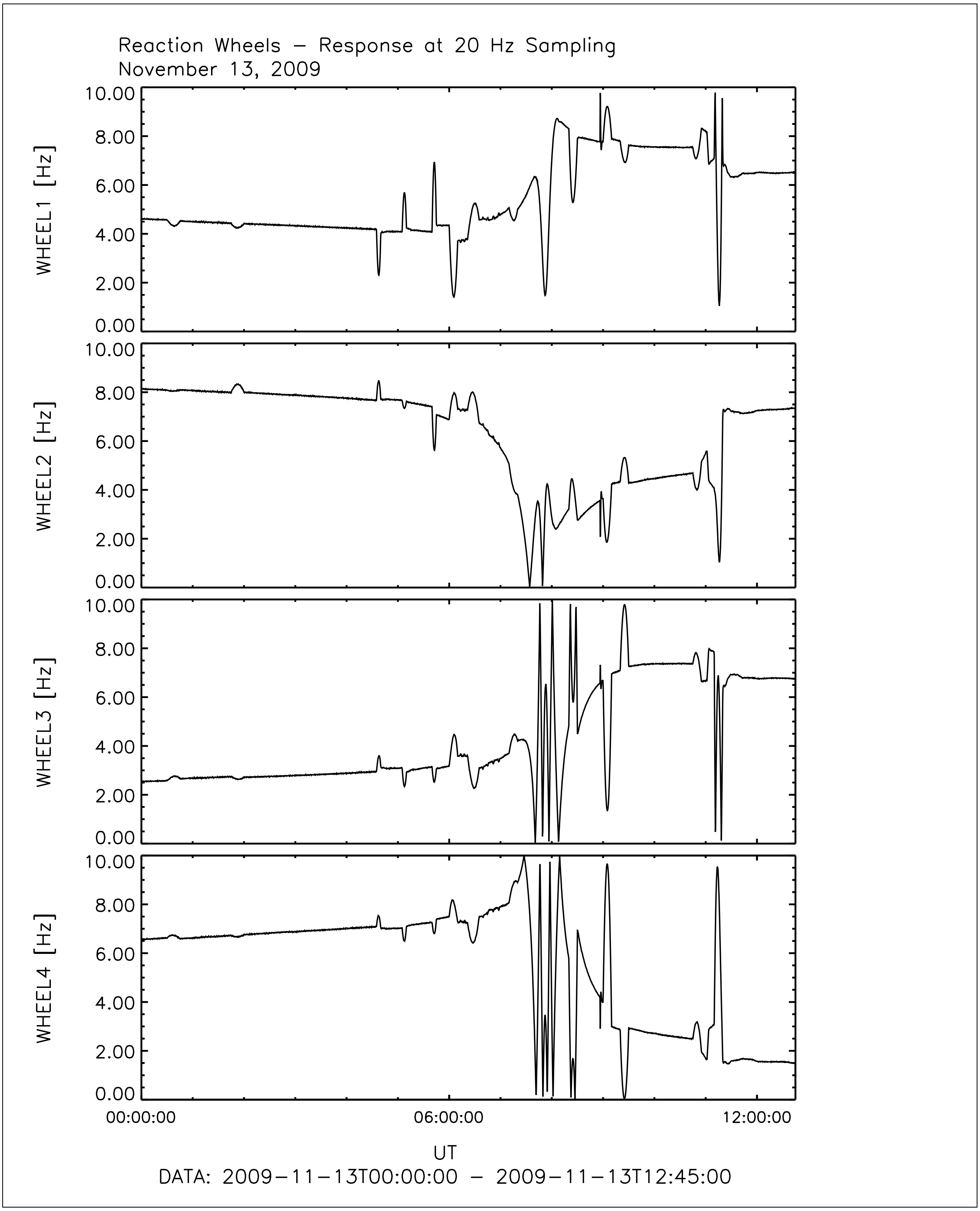

Figure 112: File: wheels_20Hz_Sampling2009-11-13T00-00

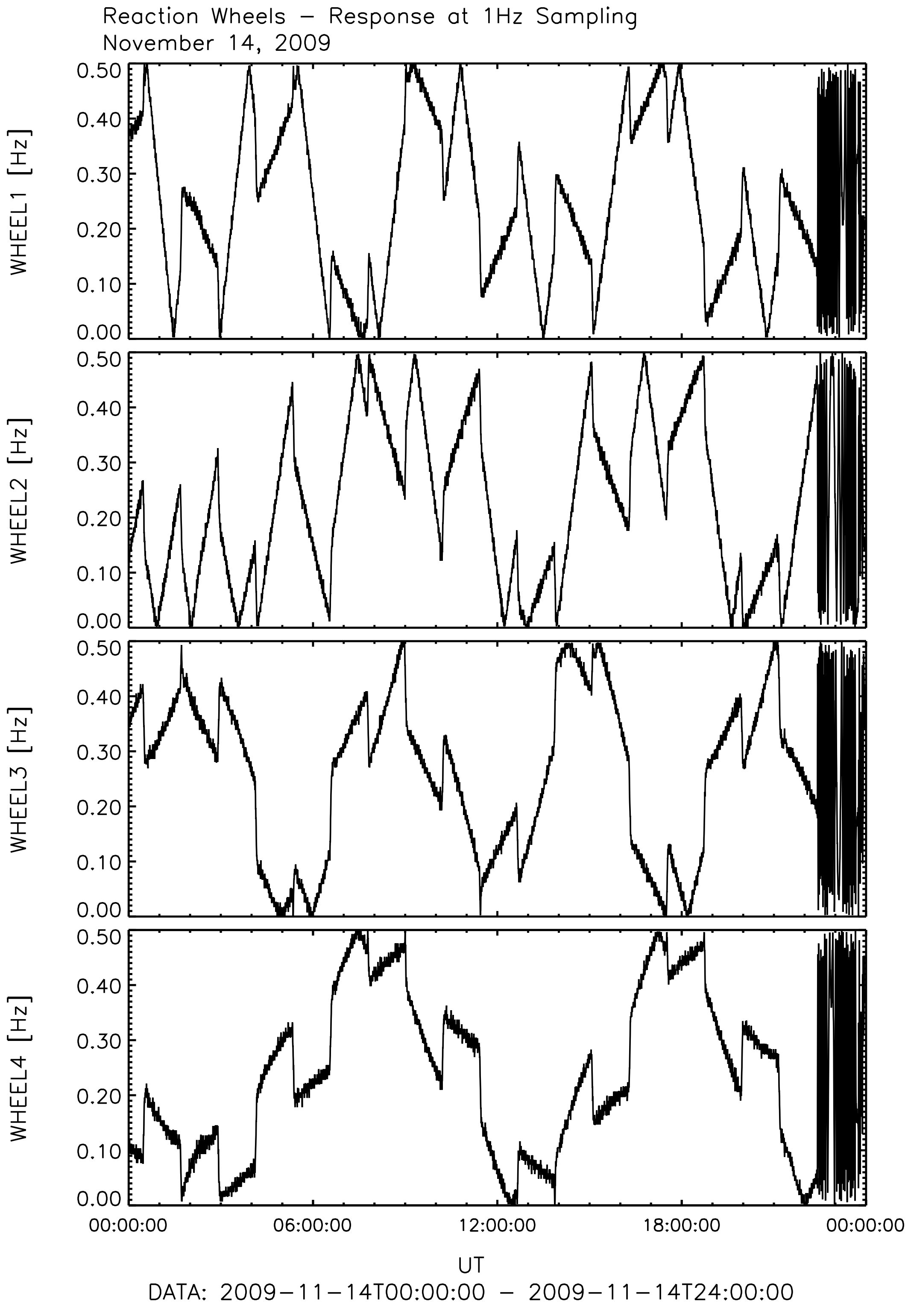

Figure 113: File: wheels_1Hz_Sampling2009-11-14T00-00

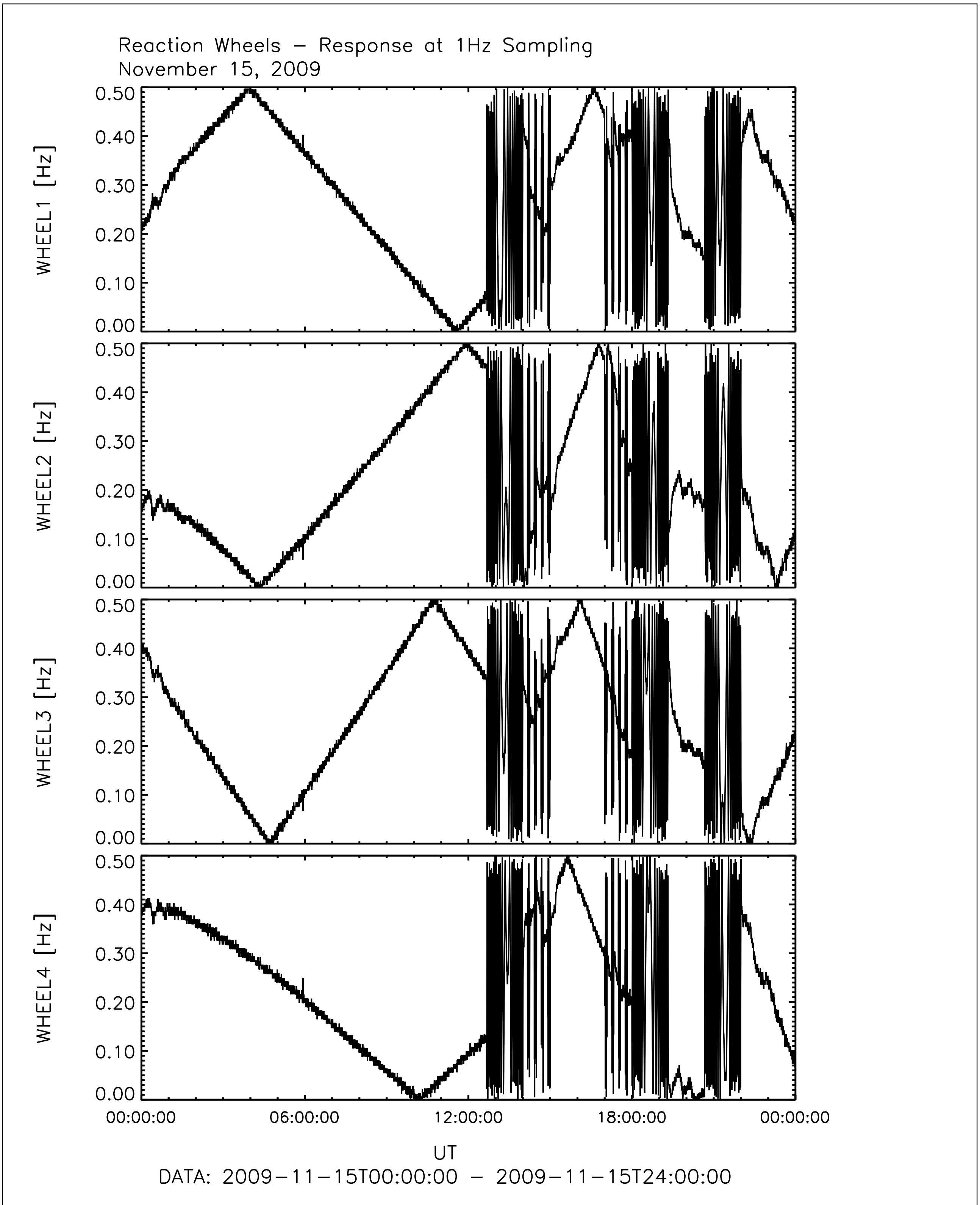

Figure 114: File: wheels_1Hz_Sampling2009-11-15T00-00

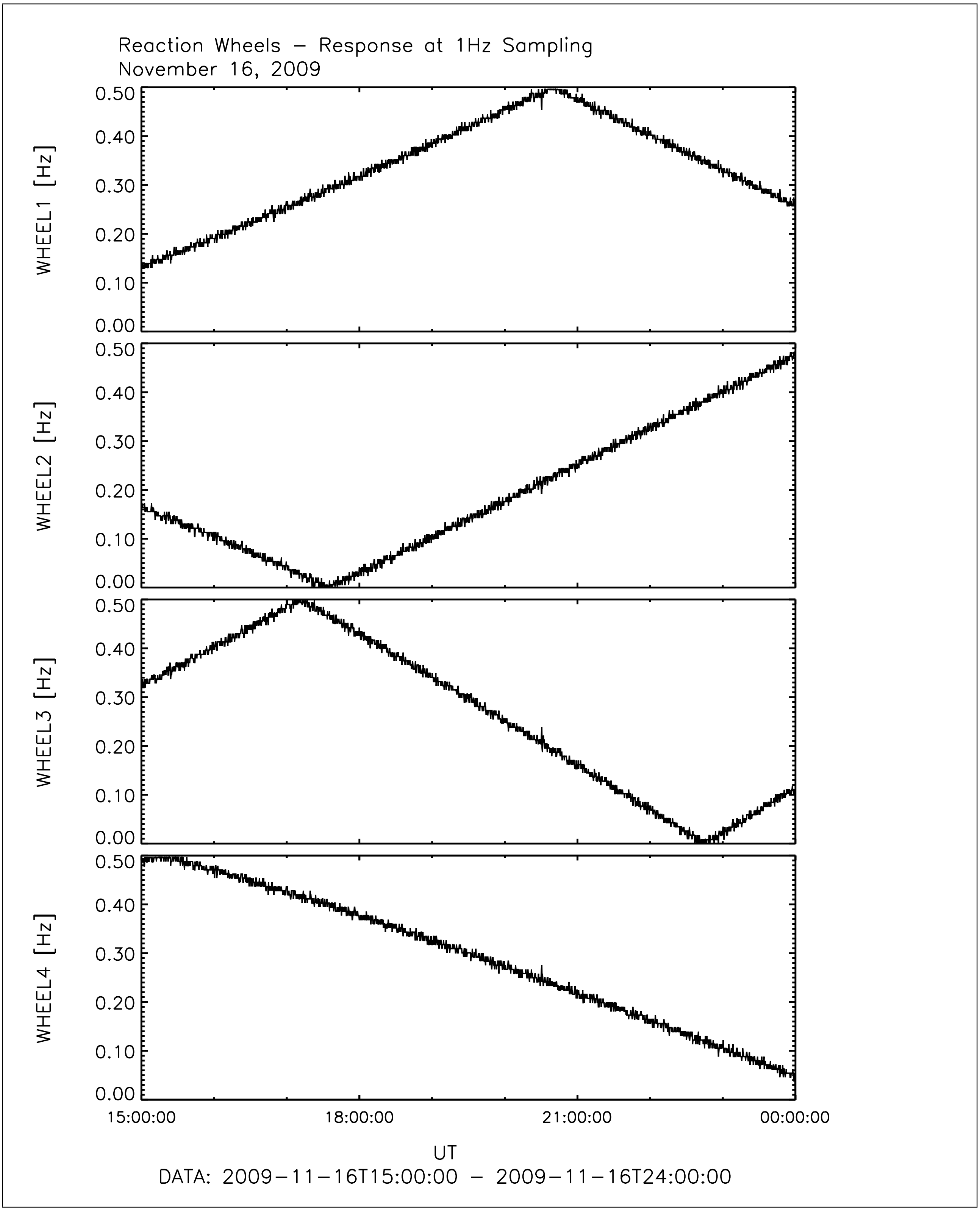

Figure 115: File: wheels_1Hz_Sampling2009-11-16T15-00

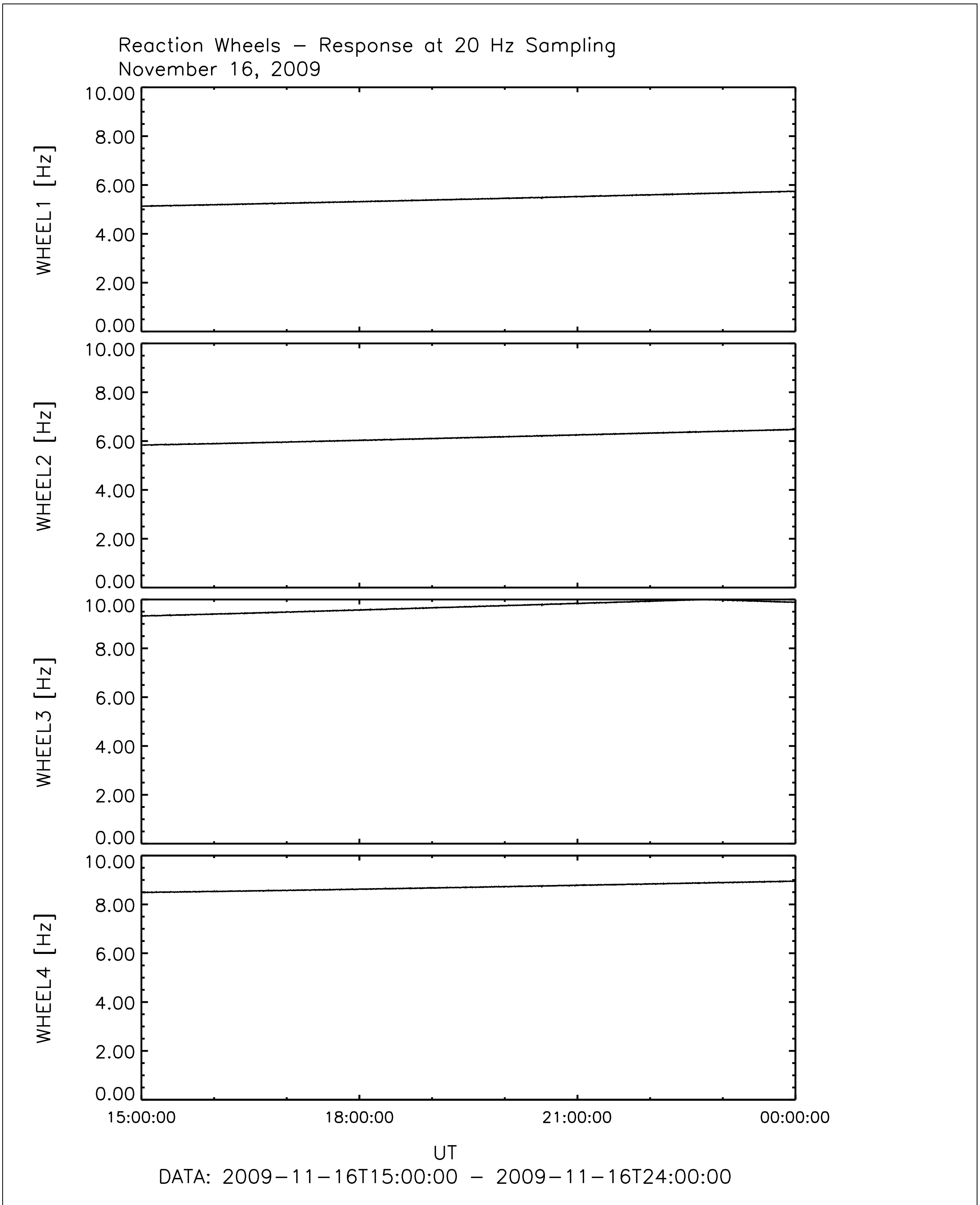

Figure 116: File: wheels_20Hz_Sampling2009-11-16T15-00

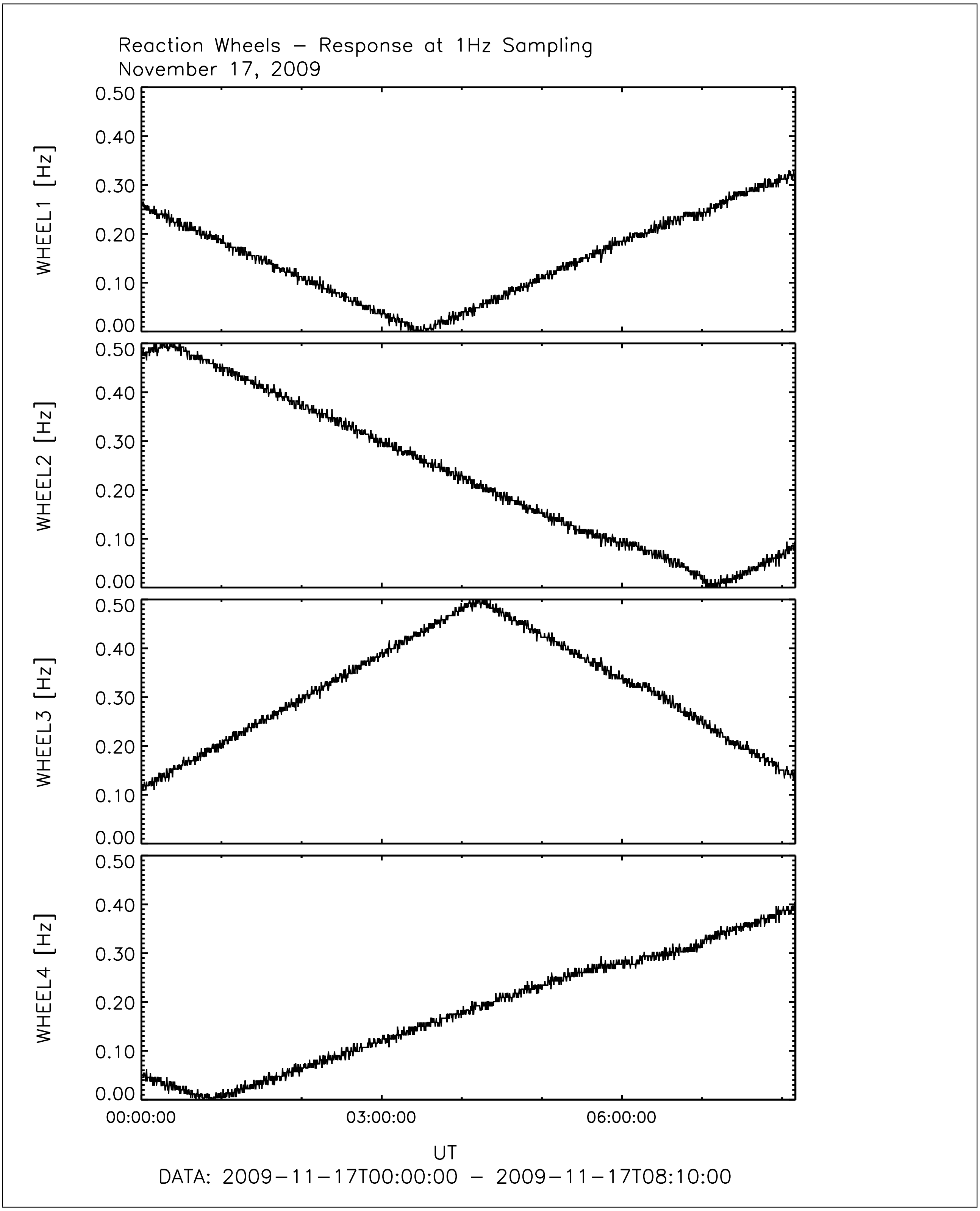

Figure 117: File: wheels_1Hz_Sampling2009-11-17T00-00

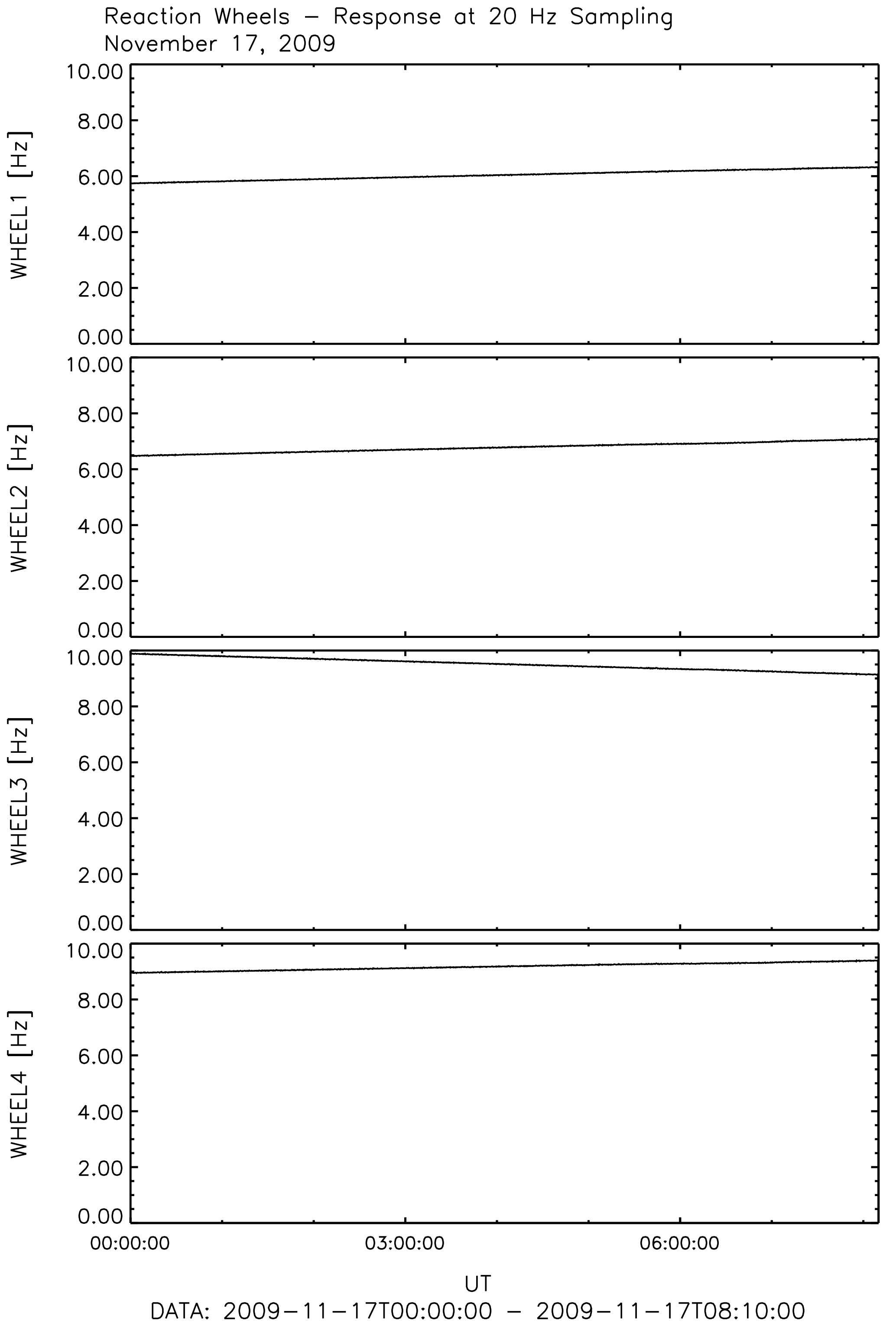

Figure 118: File: wheels_20Hz_Sampling2009-11-17T00-00

11 Temperature profile during ESB3

The following figure shows the measured temperatures of the OB and IB sensor during ESB3. The lower panels of the graph show the angles between x–, y–, and z–axis of the s/c frame and the sun direction.

The analysis of these plots shows that - as expected - most of the temperature changes are related to attitude changes.

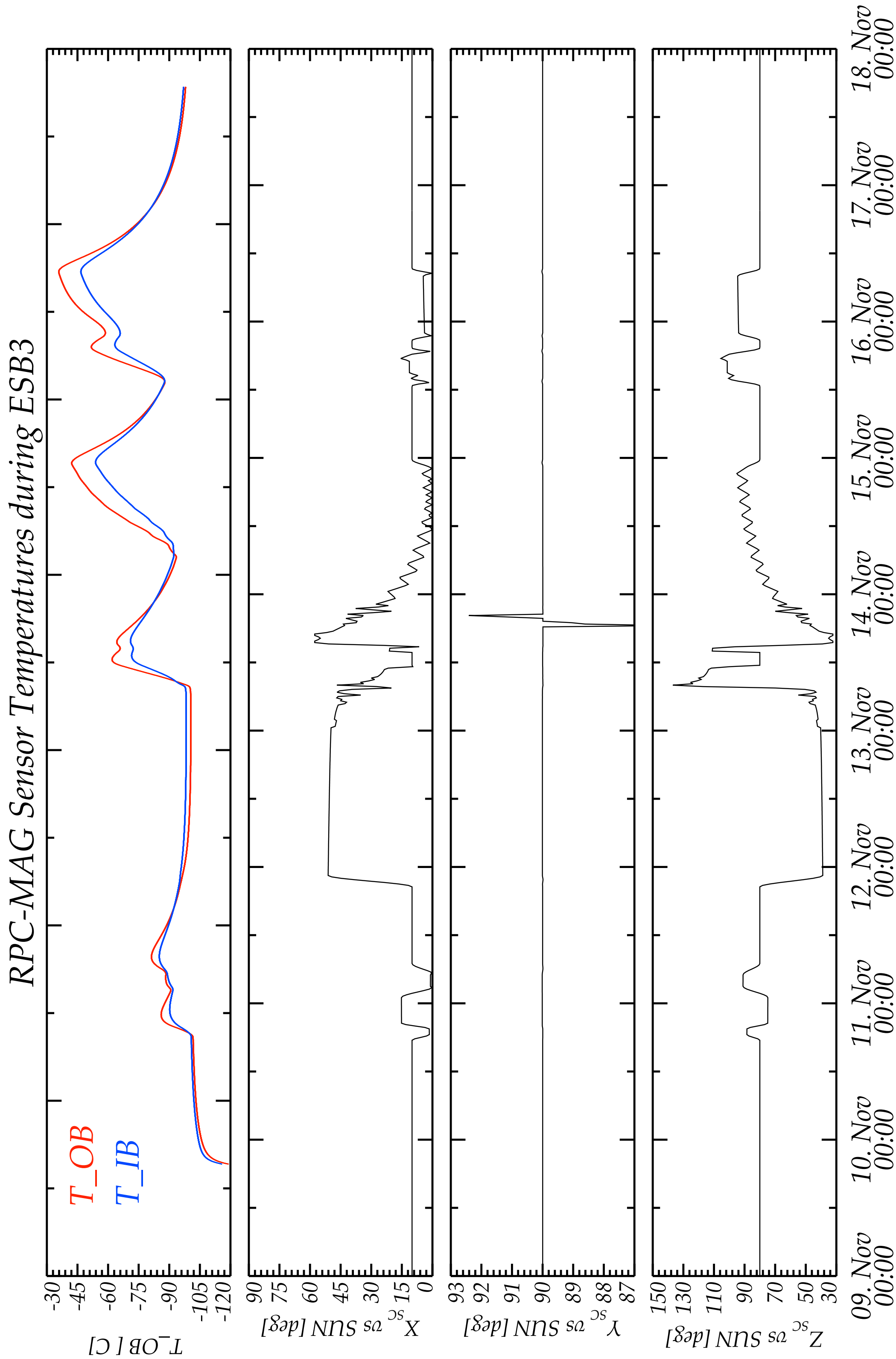

Figure 119: Measured Sensor Temperatures and attitudes during ESB3

12 Conclusions

- RPCMAG has performed amazing measurements during the 3rd Earth Swing by ESB3 and worked flawlessly during the complete operation interval from 2009-11-09 until 2009-11-17
- The structure of the Earth's magnetic field along the trajectory could be measured. Almost the full measurement range (16000 nT) of RPCMAG was needed to map the Earth's dipole.
- Plasma boundaries within the Earth's magnetosphere could be identified.
- When operated in Burstmode (SID3), the RPCMAG data were disturbed by ROSETTA's reaction wheels as usual.
- Also the LAP instrument generates disturbing frequency lines which can be seen when operated in Burst mode.
- The LAP disturbance has been investigated in detail at the remaining PC10 slot at the end of ESB3. Refer to RO-IGEP-TR0030 for details. As result of this investigation the LEVEL_H correction algorithm has been extended from the RW correction to the LAP disturbance correction as well.
- A comparison of the MAG data with the forecast of a theoretical model (POMME) of the Earth's magnetic field shows only small differences in the order of less than 15 nT even in the components. This result was obtained by shifting the data in time (a fraction of a second) and a slight rotation of the MAG URF in the order of 0.1 degrees.
  Thus, EAR 3 was a perfect opportunity to check again the actual sensor calibration.
- The comparison between IB and OB data showed that the measurements are very sensitive to specific temperature changes at the single sensors. The behavior is used as one component of a data quality indicator.
- Besides this a lot of S/C or P/L noise (i.e jumps in the magnetic field due to switch on/off processes on the s/c) was detected.
- Nevertheless the ESB3 campaign was a big success for RPCMAG.

A Operation Logbook

```
############################################################################################################
#
# FILE: D:\ROSETTA\DATA\TLM\LOGBOOK_20090920_20091117.ASC
#
# This Logbook lists all relevant activities and events regarding the ROSETTA
# Orbiter Magnetometer RPCMAG. All information in lines starting with a '@'
# as prefix has been extracted from automatically generated Telecommand (TC)
# logging files and  Event-files to be found on the ROSETTA DDS. All lines
# starting with '#' are automatically generated comments
# Lines with a preceding ';' represent manually added text for further
# information on the actual measurement phase.
#
# Each day, where RPCMAG was switched on, is listed. The days are separated
# by table headers. All commands and events are listed in chronological order.
#
#
############################################################################################################
############################################################################################################
#                                                                                                          #
#                                                                                                          #
#                                    2009-09-20                                                            #
#                                                                                                          #
#                                                                                                          #
############################################################################################################
#                                                                                                          #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                    REMARK   #
#                                                                                                          #
############################################################################################################
@ 2009-09-20T19:45:02.0                  ZSKA8091  START RPC Power On OBCP
@ 2009-09-20T19:45:02.0                  ZSKA8091  START RPC Power On OBCP
############################################################################################################
############################################################################################################
#                                                                                                          #
#                                                                                                          #
#                                    2009-09-21                                                            #
#                                                                                                          #
#                                                                                                          #
############################################################################################################
#                                                                                                          #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                    REMARK   #
#                                                                                                          #
############################################################################################################
@
@ 2009-09-21T01:35:10.0                  ZSKA8096  START RPC Mode Control 2 OBCP            ModeMAG:=  Quiet
@ 2009-09-21T01:35:10.0                  ZSKA8096  START RPC Mode Control 2 OBCP            ModeMAG:=  Quiet
@ 2009-09-21T01:50:10.0                  ZSKA8092  START RPC Power Off OBCP
@ 2009-09-21T01:50:10.0                  ZSKA8092  START RPC Power Off OBCP
@ 2009-09-21T10:35:00.0                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
@ 2009-09-21T10:35:00.0                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
############################################################################################################
############################################################################################################
#                                                                                                          #
#                                                                                                          #
#                                    2009-09-29                                                            #
#                                                                                                          #
#                                                                                                          #
############################################################################################################
#                                                                                                          #
```

```
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                        REMARK   #
#                                                                                                           #
#############################################################################################################
@ 2009-09-29T08:45:00.0                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
@ 2009-09-29T13:25:58.5                  ZSKA8091  START RPC Power On OBCP
@ 2009-09-29T13:26:41.7   Normal                   EC_PiuAlive
@ 2009-09-29T13:27:45.8   Normal                   EC_SoftReboot
@ 2009-09-29T13:27:53.7   Normal                   EC_PiuAlive
@ 2009-09-29T13:39:04.2                  ZRP19405  Set to Maintenance Mode
@ 2009-09-29T17:14:49.2                  ZRP19405  Set to Maintenance Mode
@ 2009-09-29T17:27:20.0                  ZSKA8096  START RPC Mode Control 2 OBCP           ModeMAG:=  Quiet
@ 2009-09-29T17:42:19.6                  ZSKA8092  START RPC Power Off OBCP
@ 2009-09-29T19:50:02.0                  ZSKA8091  START RPC Power On OBCP
@ 2009-09-29T19:50:41.7   Normal                   EC_PiuAlive
@ 2009-09-29T19:51:45.9   Normal                   EC_SoftReboot
@ 2009-09-29T19:51:53.7   Normal                   EC_PiuAlive
@ 2009-09-29T20:03:08.0                  ZRP19405  Set to Maintenance Mode
#############################################################################################################
#############################################################################################################
#                                                                                                           #
#                                                                                                           #
#                                    2009-09-30                                                             #
#                                                                                                           #
#                                                                                                           #
#############################################################################################################
#                                                                                                           #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                        REMARK   #
#                                                                                                           #
#############################################################################################################
@ 2009-09-30T00:00:03.0                  ZRP19405  Set to Maintenance Mode
@ 2009-09-30T17:52:02.1                  ZSKA8096  START RPC Mode Control 2 OBCP           ModeMAG:=  Quiet
@ 2009-09-30T18:07:01.9                  ZSKA8092  START RPC Power Off OBCP
@ 2009-09-30T18:12:04.1                  ZSKA8091  START RPC Power On OBCP
#############################################################################################################
#############################################################################################################
#                                                                                                           #
#                                                                                                           #
#                                    2009-10-01                                                             #
#                                                                                                           #
#                                                                                                           #
#############################################################################################################
#                                                                                                           #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                        REMARK   #
#                                                                                                           #
#############################################################################################################
@ 2009-10-01T08:20:10.0                  ZSKA8096  START RPC Mode Control 2 OBCP           ModeMAG:=  Quiet
@ 2009-10-01T08:35:10.0                  ZSKA8092  START RPC Power Off OBCP
@ 2009-10-01T09:35:00.0                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
@ 2009-10-01T20:00:02.0                  ZSKA8091  START RPC Power On OBCP
@ 2009-10-01T20:00:41.7   Normal                   EC_PiuAlive
@ 2009-10-01T20:01:45.9   Normal                   EC_SoftReboot
@ 2009-10-01T20:01:53.7   Normal                   EC_PiuAlive
@ 2009-10-01T20:10:00.0                  ZSKA8096  START RPC Mode Control 2 OBCP           ModeMAG:=  SID2
#############################################################################################################
#############################################################################################################
#                                                                                                           #
#                                                                                                           #
#                                    2009-10-02                                                             #
#                                                                                                           #
#                                                                                                           #
#############################################################################################################
#                                                                                                           #
```

```
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                          REMARK   #
#                                                                                                             #
###############################################################################################################
@ 2009-10-02T00:30:36.1   Warning                  EC_MAG_TaskFill
@ 2009-10-02T00:30:36.2   Warning                  EC_MAG_CounterUnsync
@ 2009-10-02T00:40:10.0                  ZSKA8096  START RPC Mode Control 2 OBCP             ModeMAG:=  Quiet
@ 2009-10-02T00:55:10.0                  ZSKA8092  START RPC Power Off OBCP
###############################################################################################################
###############################################################################################################
#                                                                                                             #
#                                                                                                             #
#                                     2009-11-09                                                              #
#                                                                                                             #
#                                                                                                             #
###############################################################################################################
#                                                                                                             #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                          REMARK   #
#                                                                                                             #
###############################################################################################################
@ 2009-11-09T19:40:02.0                  ZSKA8091  START RPC Power On OBCP
@ 2009-11-09T19:40:02.0                  ZSKA8091  START RPC Power On OBCP
@ 2009-11-09T19:40:42.0   Normal                   EC_PiuAlive
@ 2009-11-09T19:41:46.1   Normal                   EC_SoftReboot
@ 2009-11-09T19:41:54.0   Normal                   EC_PiuAlive
@ 2009-11-09T20:00:00.0                  ZSKA809B  MAG Mode Control                          ModeMAG:=  SID2
###############################################################################################################
###############################################################################################################
#                                                                                                             #
#                                                                                                             #
#                                     2009-11-10                                                              #
#                                                                                                             #
#                                                                                                             #
###############################################################################################################
#                                                                                                             #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                          REMARK   #
#                                                                                                             #
###############################################################################################################
@ 2009-11-10T19:42:18.3   Warning                  MAG EC_LinkRst(unit)
@ 2009-11-10T19:42:18.3   Warning                  EC_MAG_MissedSamples
@ 2009-11-10T19:42:18.3   Warning                  EC_MAG_CounterUnsync
@ 2009-11-10T19:42:18.3   Warning                  EC_MAG_MissedSamples
@ 2009-11-10T23:04:59.9                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
###############################################################################################################
###############################################################################################################
#                                                                                                             #
#                                                                                                             #
#                                     2009-11-11                                                              #
#                                                                                                             #
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###############################################################################################################
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# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                          REMARK   #
#                                                                                                             #
###############################################################################################################
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#                                                                                                             #
#                                                                                                             #
#                                     2009-11-12                                                              #
#                                                                                                             #
#                                                                                                             #
###############################################################################################################
```

```
#                                                                                                            #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                      REMARK   #
#                                                                                                            #
##############################################################################################################
@ 2009-11-12T12:45:02.0                  ZSKA809B  MAG Mode Control                           ModeMAG:=  SID3
@ 2009-11-12T19:43:22.3   Warning                  EC_MAG_MissedSamples
@ 2009-11-12T19:43:22.3   Warning                  EC_MAG_CounterUnsync
@ 2009-11-12T22:34:59.9                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
##############################################################################################################
##############################################################################################################
#                                                                                                            #
#                                                                                                            #
#                                     2009-11-13                                                             #
#                                                                                                            #
#                                                                                                            #
##############################################################################################################
#                                                                                                            #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                      REMARK   #
#                                                                                                            #
##############################################################################################################
@ 2009-11-13T12:45:02.0                  ZSKA809B  MAG Mode Control                           ModeMAG:=  SID2
##############################################################################################################
##############################################################################################################
#                                                                                                            #
#                                                                                                            #
#                                     2009-11-14                                                             #
#                                                                                                            #
#                                                                                                            #
##############################################################################################################
#                                                                                                            #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                      REMARK   #
#                                                                                                            #
##############################################################################################################
@ 2009-11-14T19:44:26.3   Warning                  EC_MAG_MissedSamples
@ 2009-11-14T19:44:26.3   Warning                  EC_MAG_CounterUnsync
@ 2009-11-14T23:44:59.9                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
##############################################################################################################
##############################################################################################################
#                                                                                                            #
#                                                                                                            #
#                                     2009-11-15                                                             #
#                                                                                                            #
#                                                                                                            #
##############################################################################################################
#                                                                                                            #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                      REMARK   #
#                                                                                                            #
##############################################################################################################
##############################################################################################################
##############################################################################################################
#                                                                                                            #
#                                                                                                            #
#                                     2009-11-16                                                             #
#                                                                                                            #
#                                                                                                            #
##############################################################################################################
#                                                                                                            #
# TIME (UTC)              EVENT          COMMAND   DESCRIPTION                                      REMARK   #
#                                                                                                            #
##############################################################################################################
@ 2009-11-16T13:04:59.9                  ZAC20188  AOCMS-WOL Swicth ON Wheel Off-Load Man
@ 2009-11-16T15:00:00.0                  ZSKA809B  MAG Mode Control                           ModeMAG:=  SID3
```

```
@ 2009-11-16T15:10:00.0                  ZRP25001  Select Outboard
############################################################################################################
############################################################################################################
#                                                                                                          #
#                                                                                                          #
#                                    2009-11-17                                                            #
#                                                                                                          #
#                                                                                                          #
############################################################################################################
#                                                                                                          #
# TIME (UTC)               EVENT          COMMAND   DESCRIPTION                                    REMARK   #
#                                                                                                          #
############################################################################################################
@
@ 2009-11-17T01:00:00.0                  ZSKA809B  MAG Mode Control                         ModeMAG:=  SID3
@ 2009-11-17T01:10:00.0                  ZRP25002  Select Inboard
@ 2009-11-17T08:00:00.0                  ZRP25001  Select Outboard
@ 2009-11-17T08:10:00.0                  ZSKA809B  MAG Mode Control                         ModeMAG:=  SID4
@ 2009-11-17T17:00:10.0                  ZSKA8096  START RPC Mode Control 2 OBCP            ModeMAG:=  Quiet
@ 2009-11-17T17:15:10.0                  ZSKA8092  START RPC Power Off OBCP
@ 2009-11-17T17:15:10.0                  ZSKA8092  START RPC Power Off OBCP
```