# R O S E T T A

# FLIGHT REPORTS
# of RPC–MAG

## RO–IGEP–TR–0023

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**January 25, 2019**

# Report of the

# Second Earth Swing By (EAR2)

# Time period: November 07 - 20, 2007

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# Contents

# 1 Introduction

ROSETTA's second Earth Swing by (EAR2) happened in the time period November 07 until November 20, 2007. RPC-MAG was switched on in the time intervals

- 2007-11-07T01:12:42 ... 2007-03-08T01:12:10.
- 2007-11-12T15:53:46 ... 2007-11-20T14:15:07.

The lack of operation between these two intervals is caused by a Single Event Upset (SEU) in the RPC-MAG instrument(for details see section 8). Besides this incident the instrument performance was excellent. There were no further problems.

This document gives a brief description of the executed activities and show 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 spectra of the magnetic field data measured by the OB sensor are plotted in section 5. As usual an influence of ROSETTAs reaction wheels (refer to section 6) can be seen in Burstmode.

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 of the earth. These investigations will be presented in chapter 4.

A temperature profile for the whole Earth Swing by is shown in section 7.

## 2 The Swing by Geometry

This section gives an overview about the trajectory during the swing by. ROSETTA approached through the tail within 7 days (November 7 until November 13), had its closest approach on November 13 at 20:57, and left through magnetopause and bow shock. The minimum distance to the surface of the Earth (closest approach, CA) was 5314 km. CA was reached south of South America at 63° 46' S, 4°35'W during daytime.

The Figures 1 and 2 show the distance of ROSETTA with respect to the Earth's surface in a long term and a zoomed view.

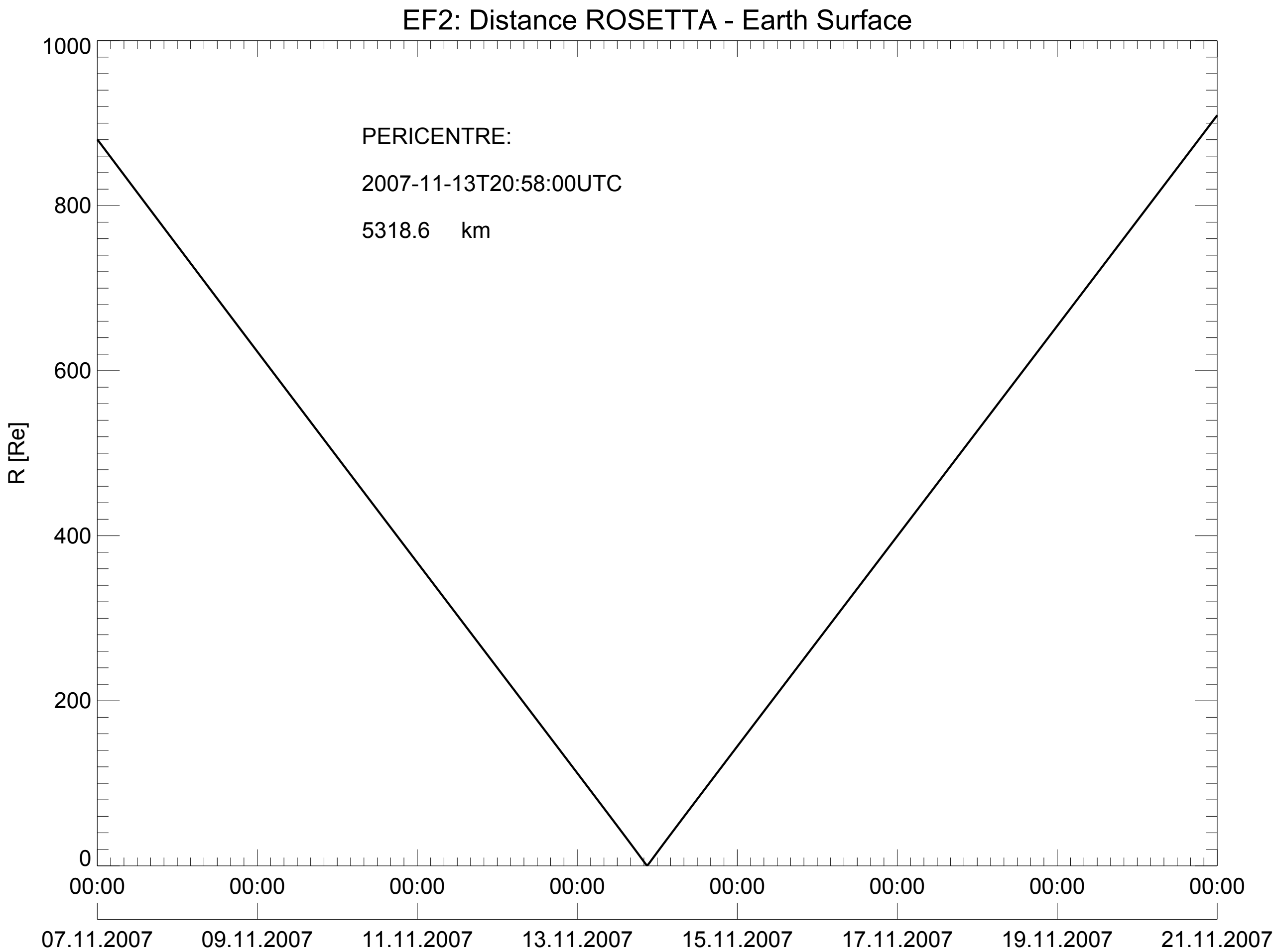


Figure 1: ROSETTA'S Distance to the EARTH'S Surface

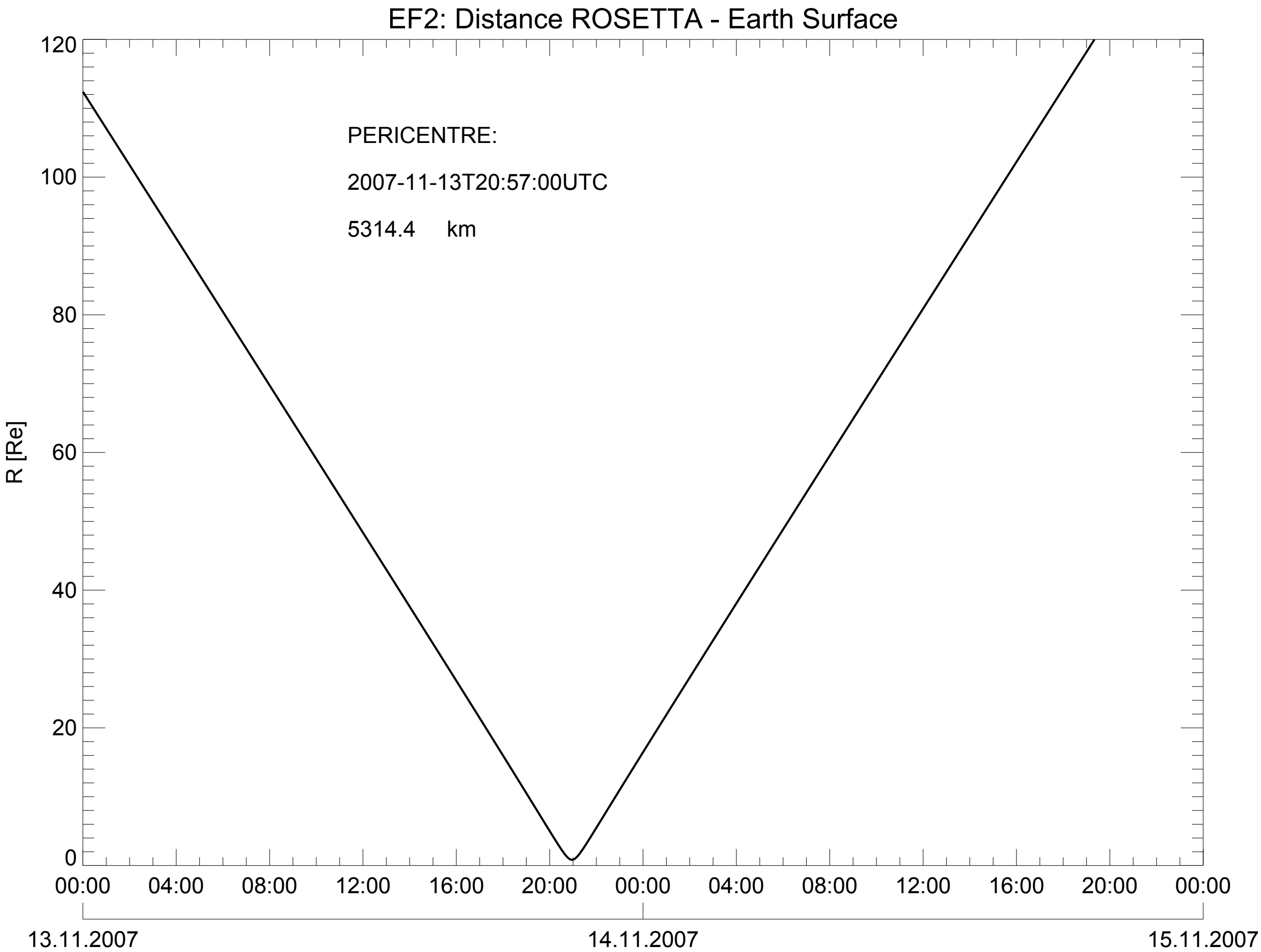


Figure 2: ROSETTA'S Distance to the EARTH'S Surface, zoomed view

The Figures 3 and 4 show the trajectory of ROSETTA in the plasma regime in the Earth's vicinity. 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 hourly spaced. The magnetopause has been modelled using a dynamic pressure of 4.4nPa, which is in full agreement with ACE and WIND measurements at that observing time. Refer to section 9 for a comparison with the measured data onboard ROSETTA.

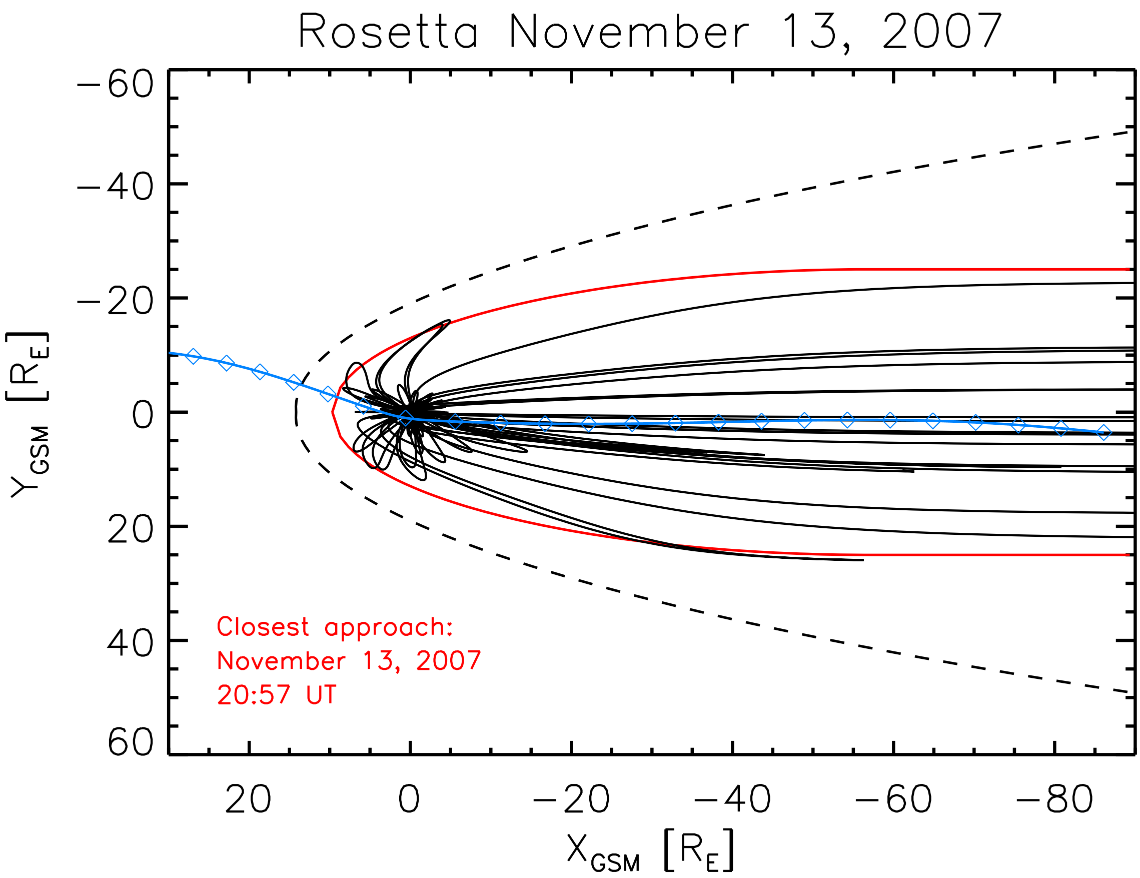


Figure 3: ROSETTA'S Swing by Trajectory in GSM coordinates: XY–Plane

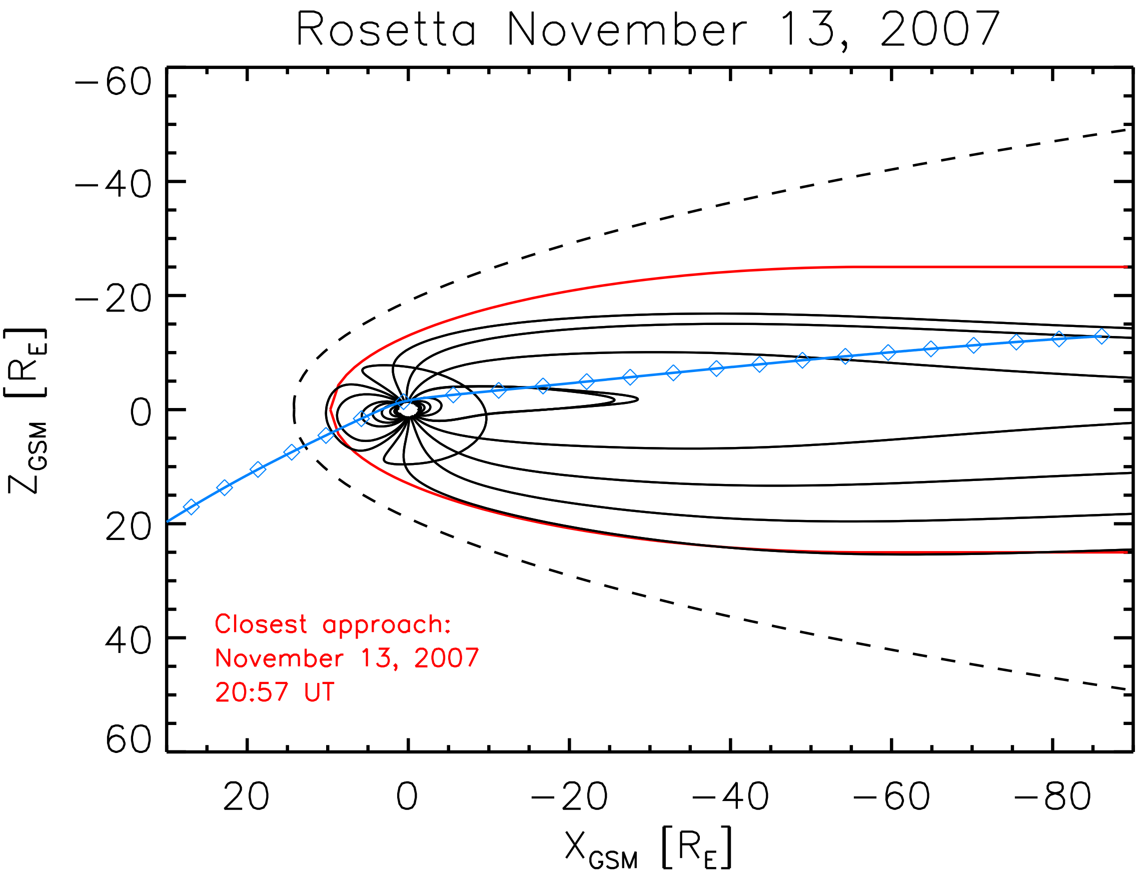


Figure 4: ROSETTA'S Swing by Trajectory in GSM coordinates: XZ–Plane

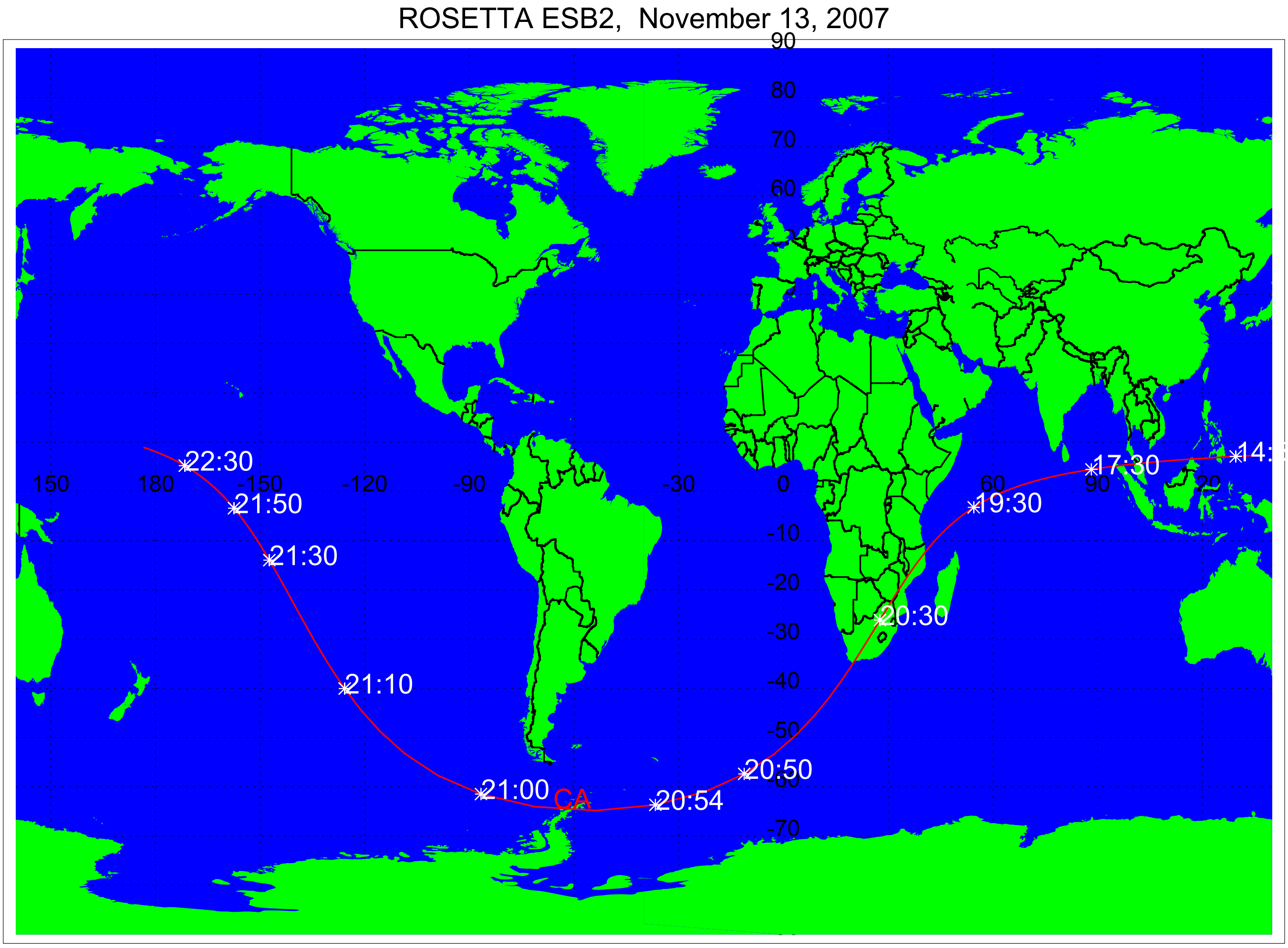


Figure 5: ROSETTA'S Ground Track during the Swing By

# 3 Activities and data plots of Earth Swingby 2

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 07, 2007:

### 3.1.1 Actions

MAG was switched on immediately after PIU and set to HK mode at 01:12. The normal mode SID 2 was set at 01:33. All commands passed smoothly and the instrument followed in the expected way.

## 3.2 Plots of Calibrated Data

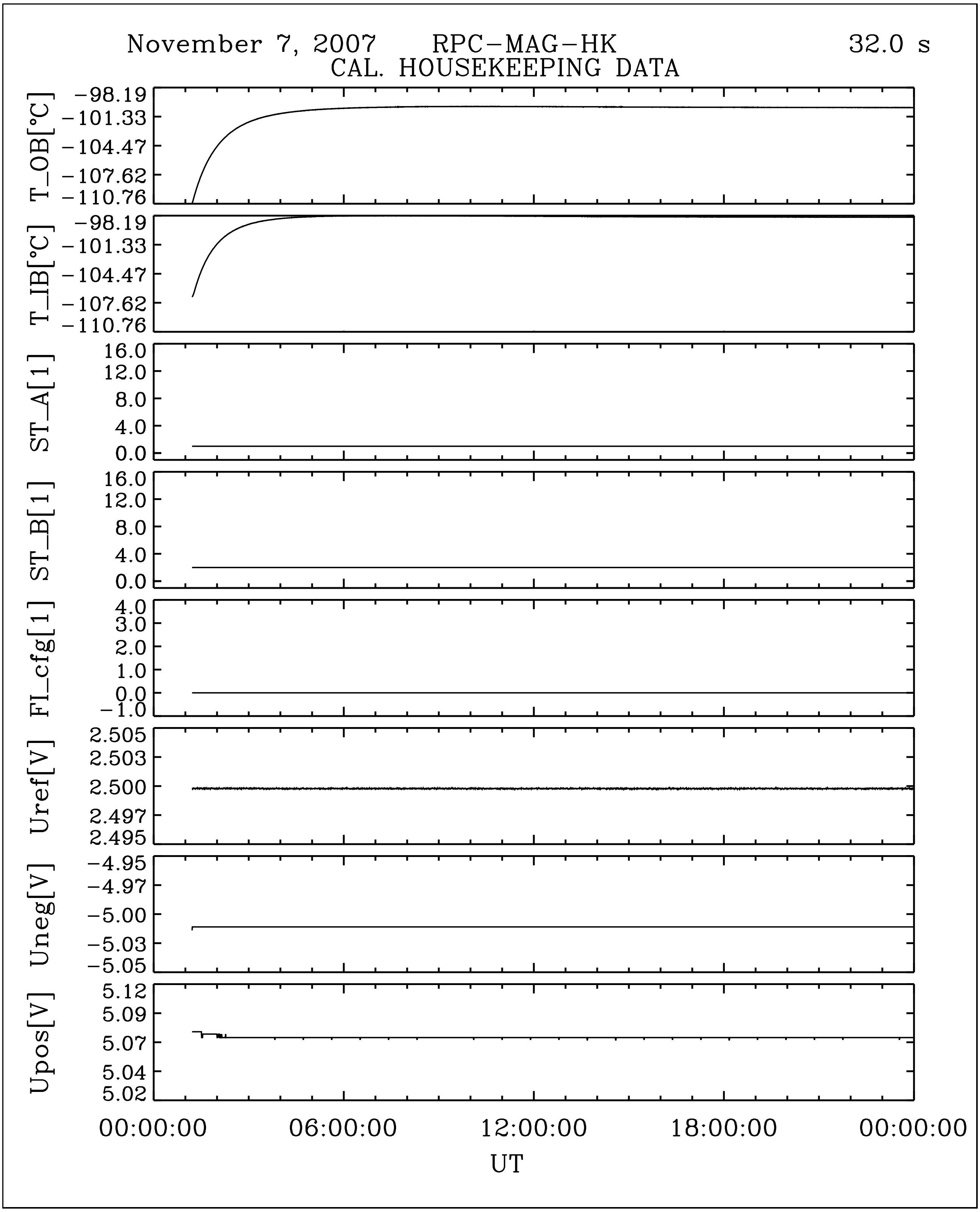


Figure 6: File: RPCMAG071107T0112_CLA_HK_P0000_2400

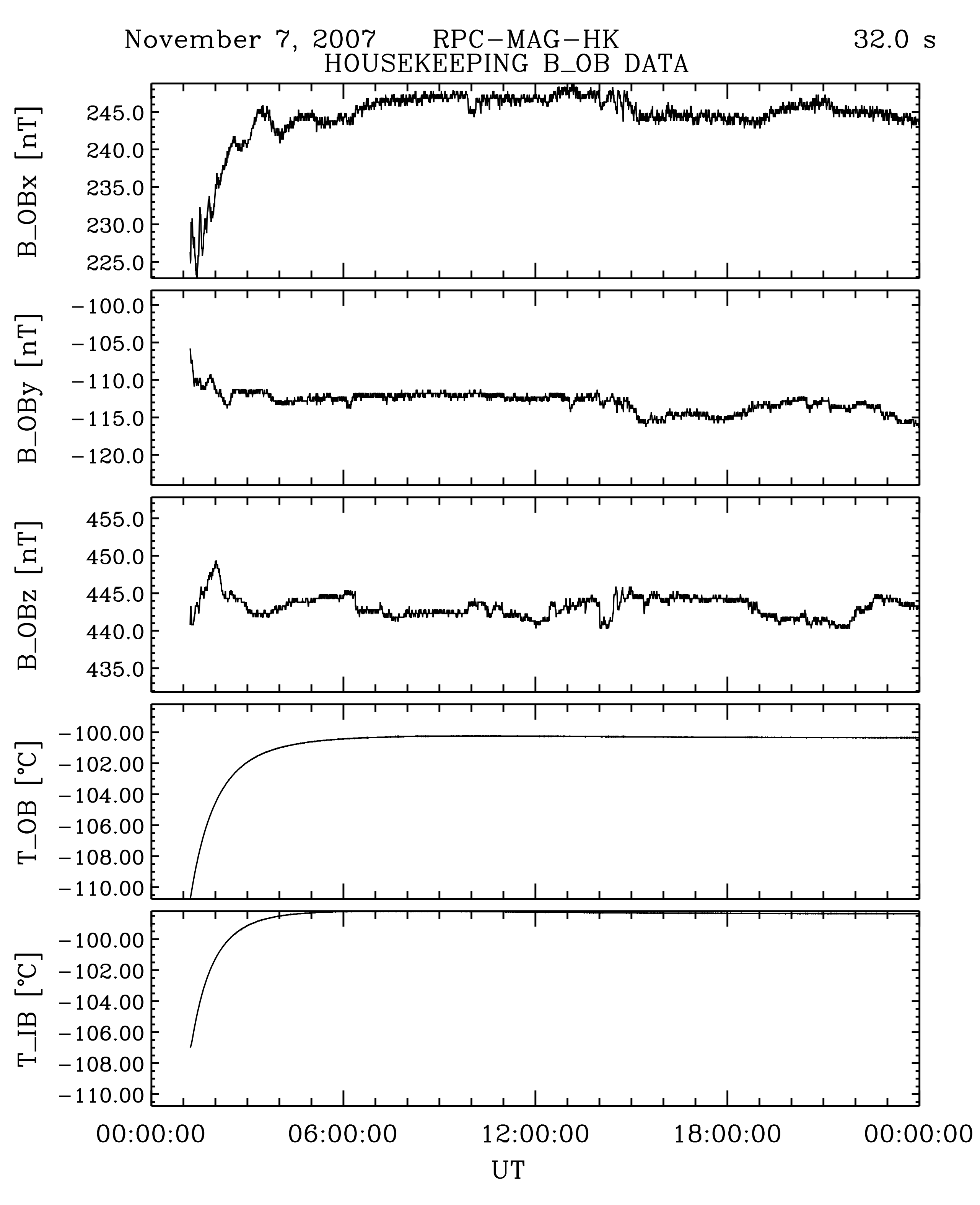


Figure 7: File: RPCMAG071107T0112_CLA_HK_B_P0000_2400

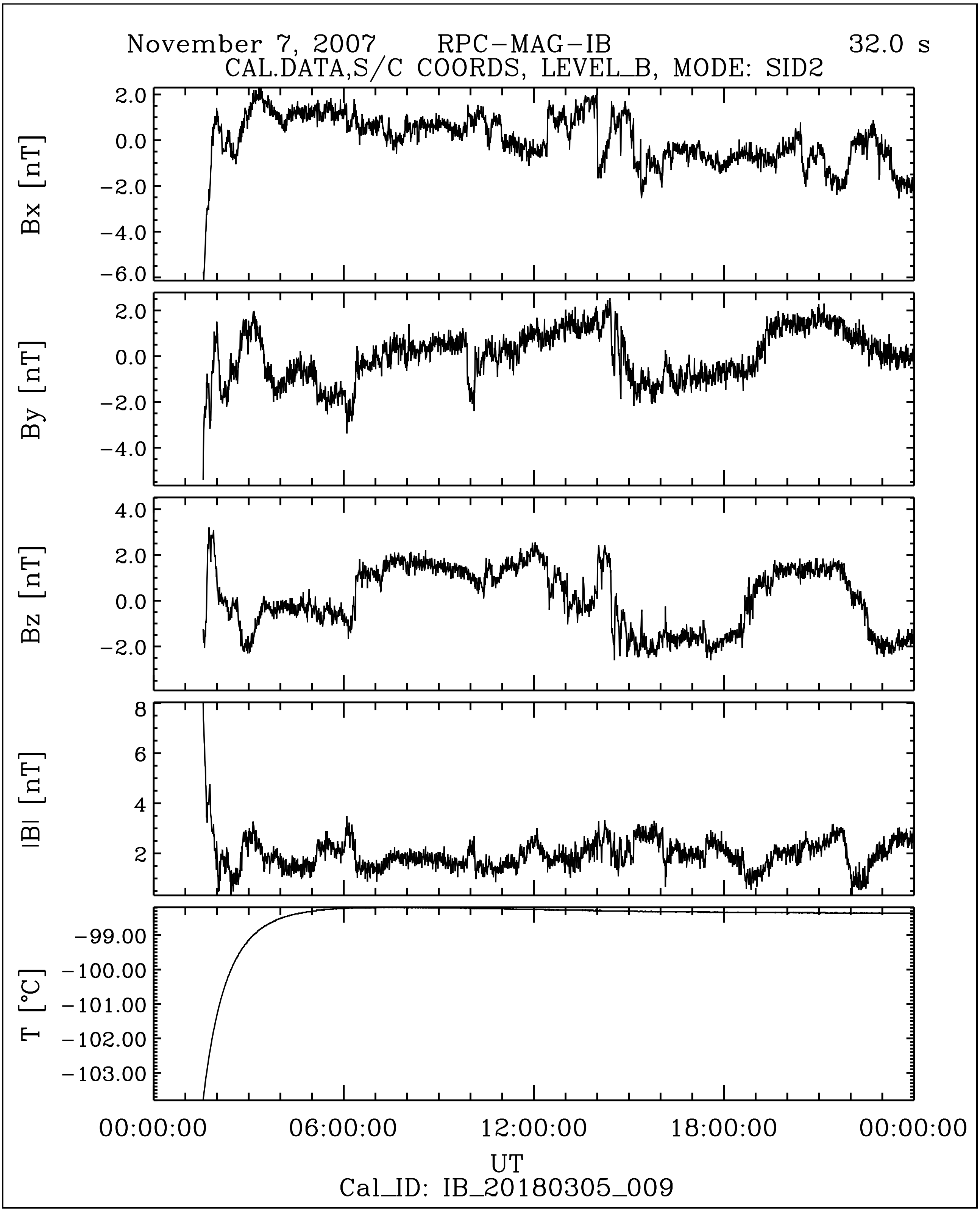


Figure 8: File: RPCMAG071107T0133_CLB_IB_M2_T0000_2400_009

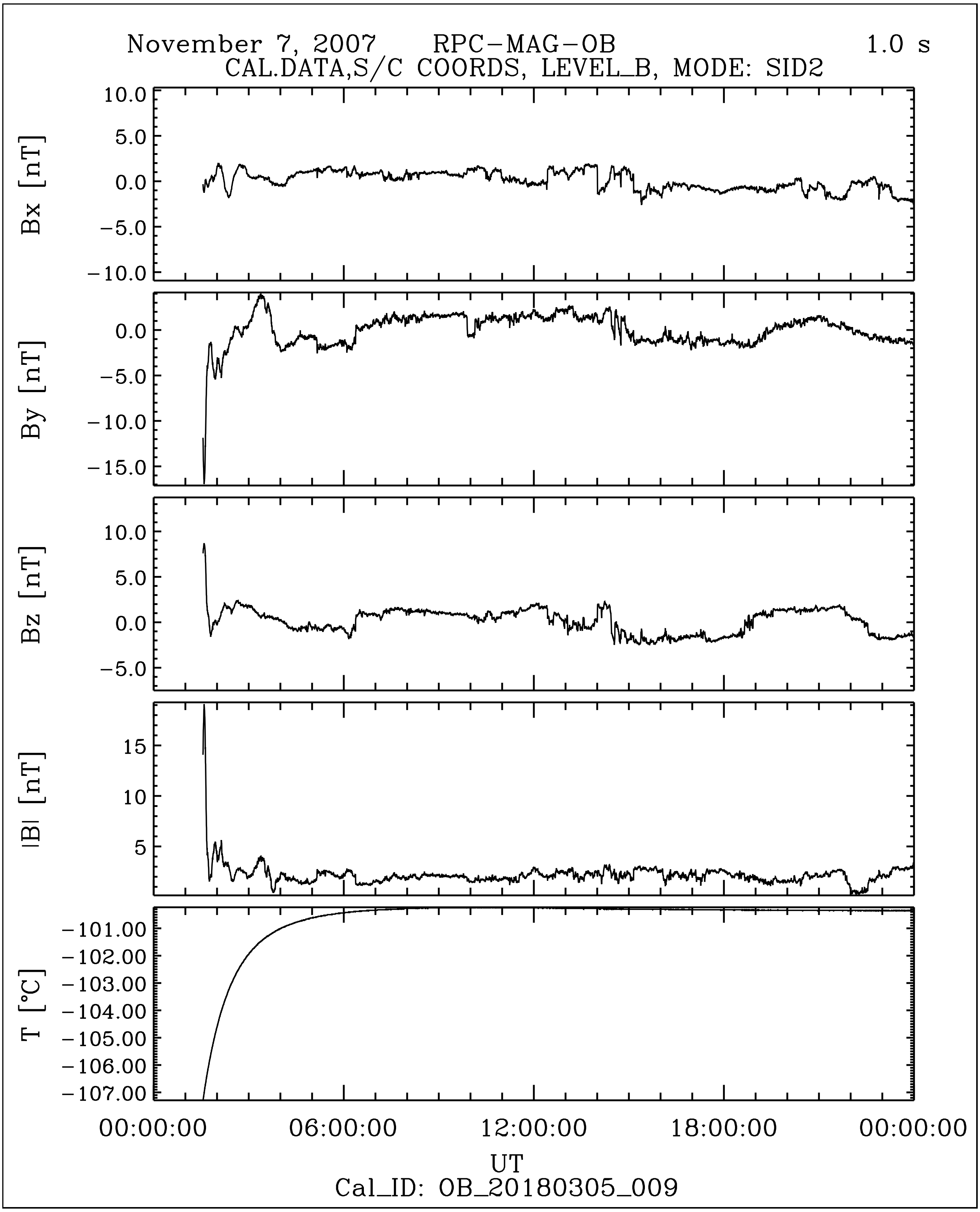


Figure 9: File: RPCMAG071107T0133_CLB_OB_M2_T0000_2400_009

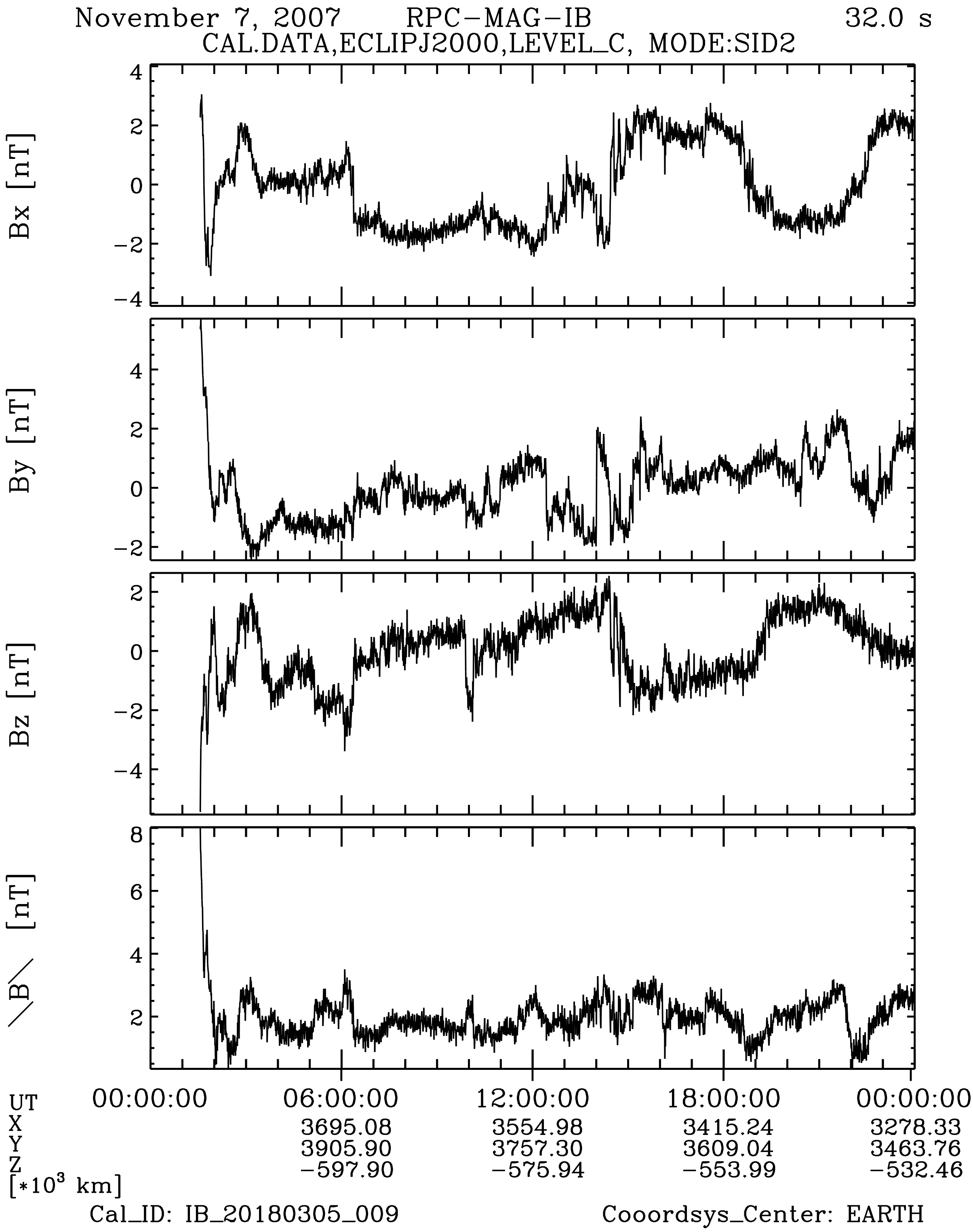


Figure 10: File: RPCMAG071107T0133_CLC_IB_M2_T0000_2400_009

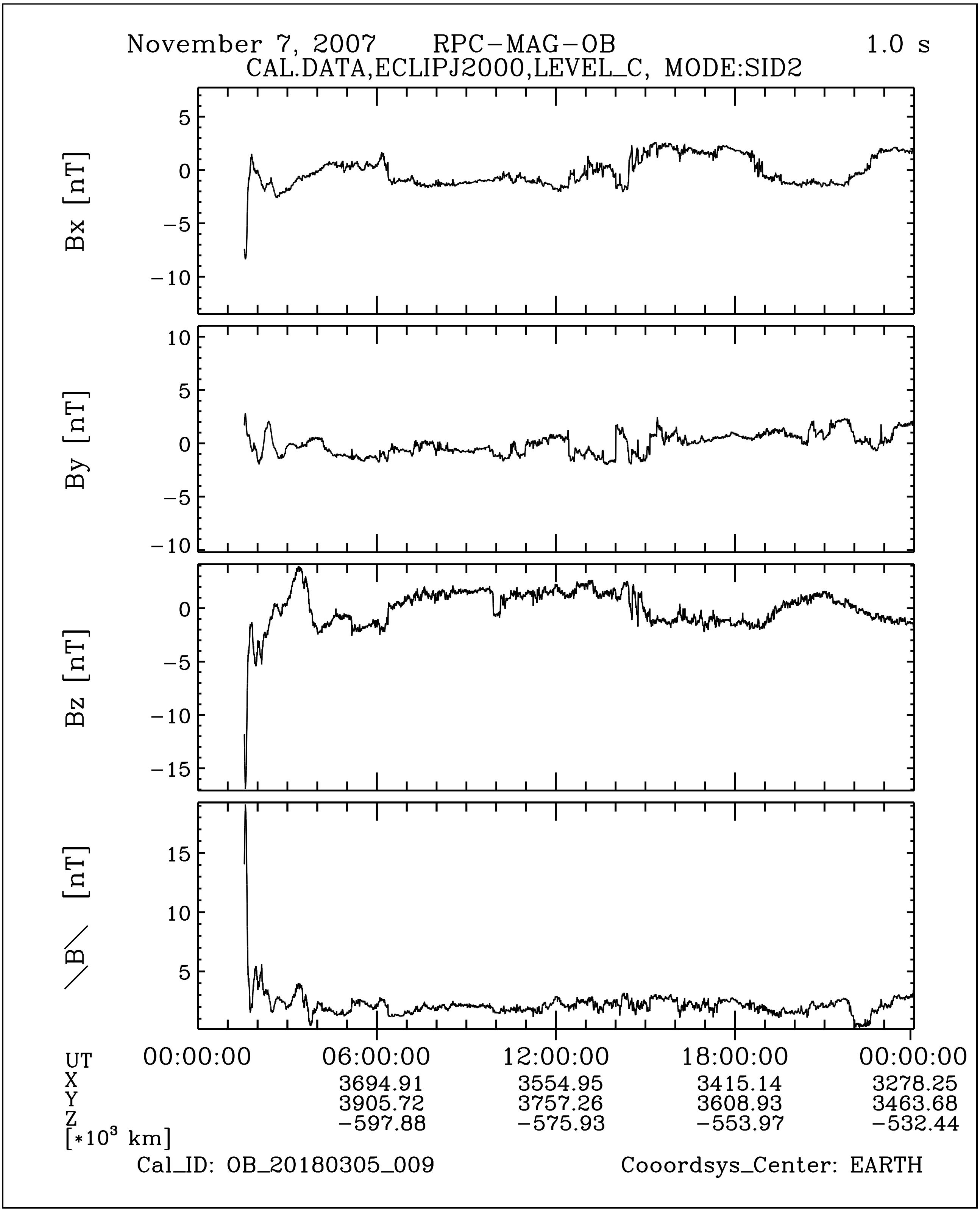


Figure 11: File: RPCMAG071107T0133_CLC_OB_M2_T0000_2400_009

### 3.3 November 8, 2007:

#### 3.3.1 Actions

MAG stayed in SID 2. At 01:12 the instrument stopped generation of science data. The HK data did not change in any bit.

#### 3.3.2 Plots of Calibrated Data

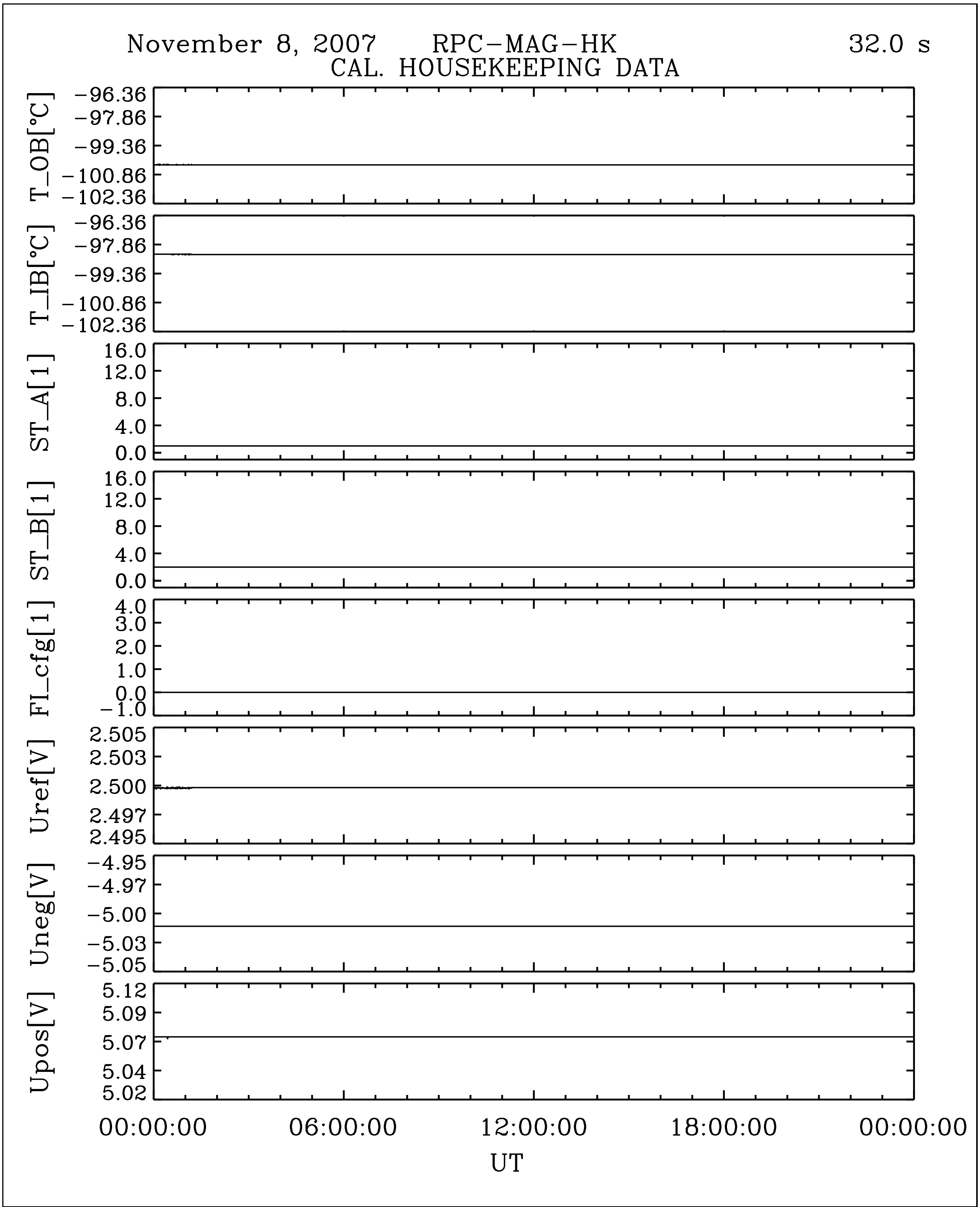


Figure 12: File: RPCMAG071108T0000_CLA_HK_P0000_2400

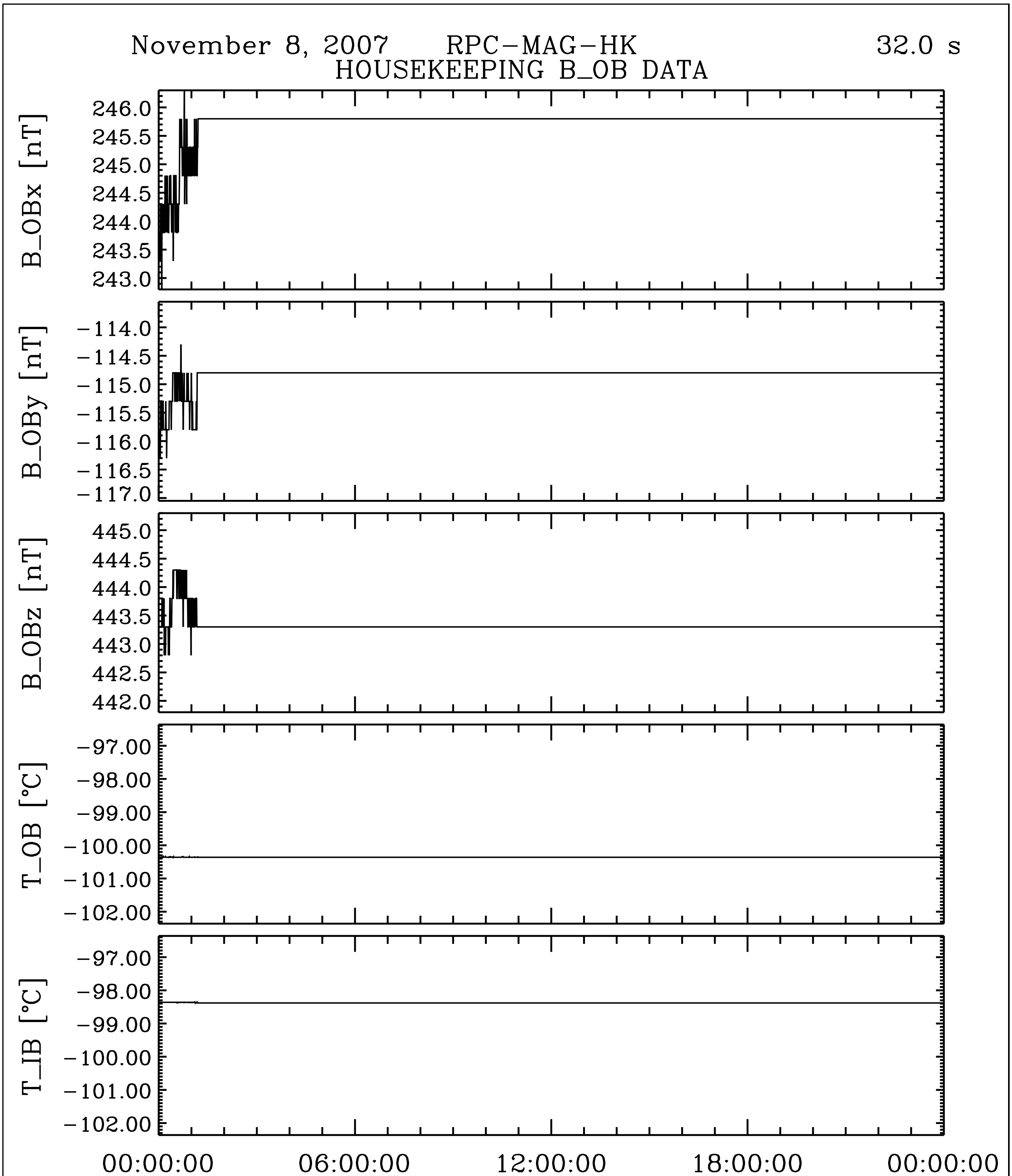


Figure 13: File: RPCMAG071108T0000_CLA_HK_B_P0000_2400

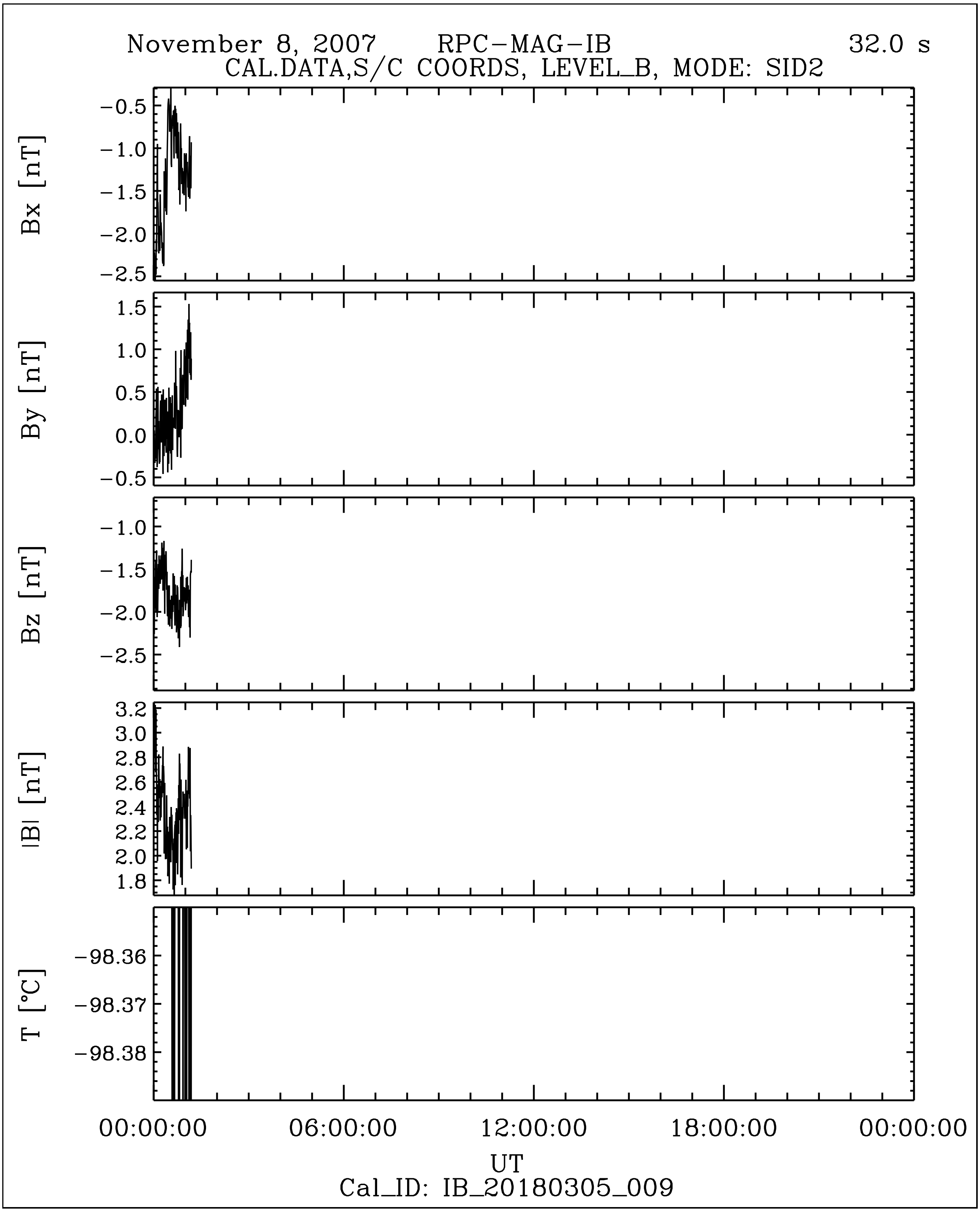


Figure 14: File: RPCMAG071108T0000_CLB_IB_M2_T0000_2400_009

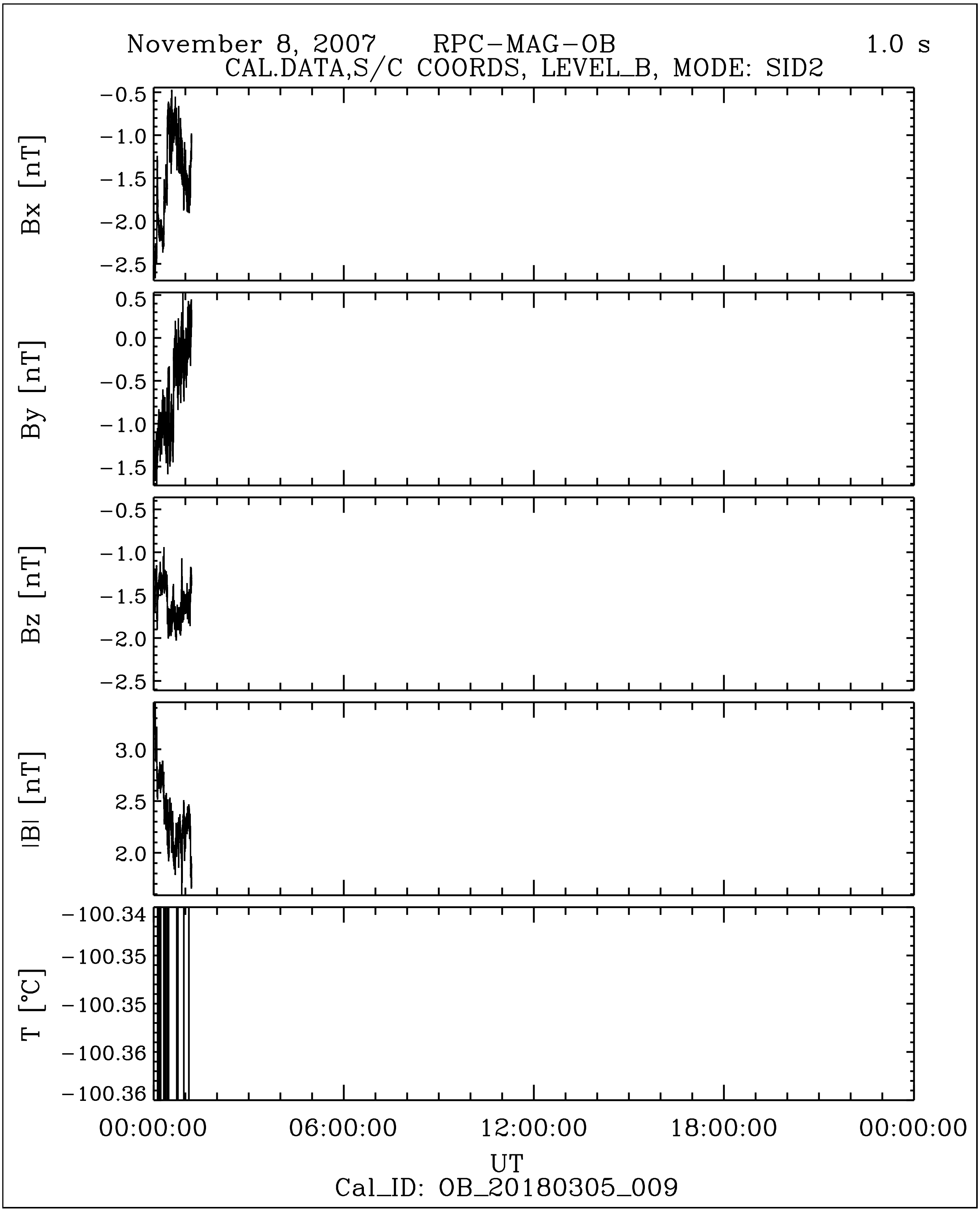


Figure 15: File: RPCMAG071108T0000_CLB_OB_M2_T0000_2400_009

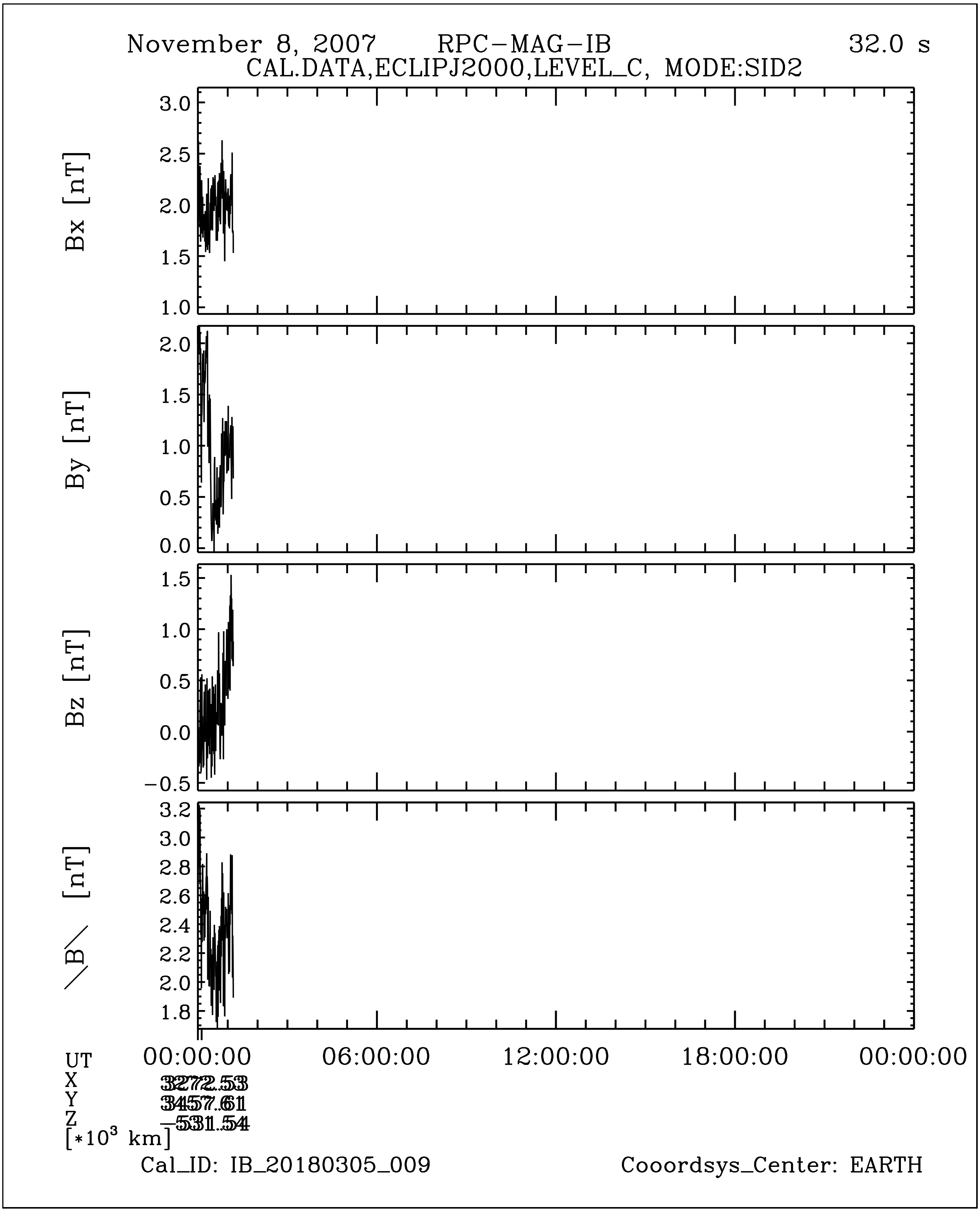


Figure 16: File: RPCMAG071108T0000_CLC_IB_M2_T0000_2400_009

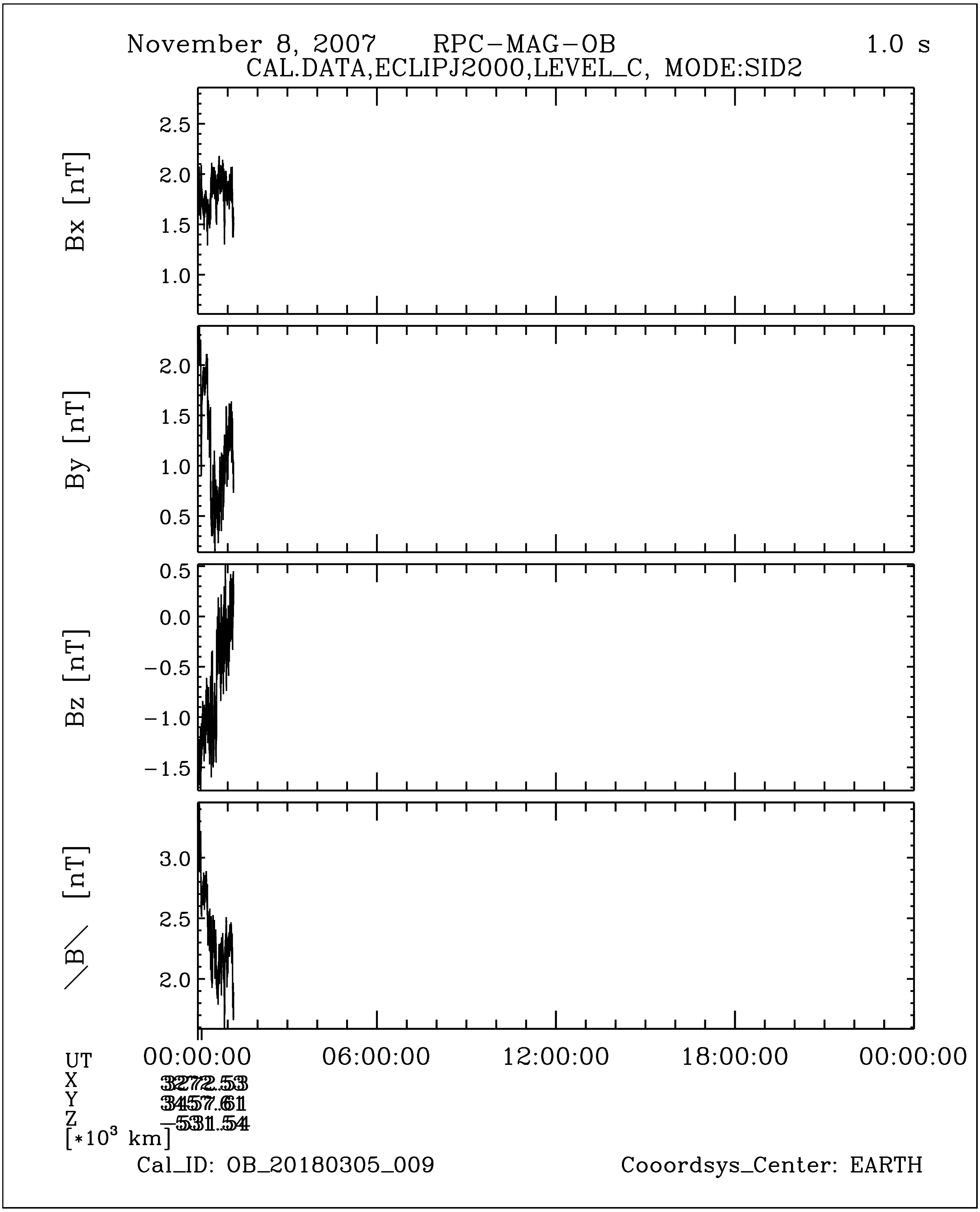


Figure 17: File: RPCMAG071108T0000_CLC_OB_M2_T0000_2400_009

## 3.4 November 12, 2007:

### 3.4.1 Actions

The recovery of the instrument was initiated and successfully executed. MAG was powered off and on again. The instrument started in normal behavior at 15:53 and transmitted data in normal mode SID2 as expected.

### 3.4.2 Plots of Calibrated Data

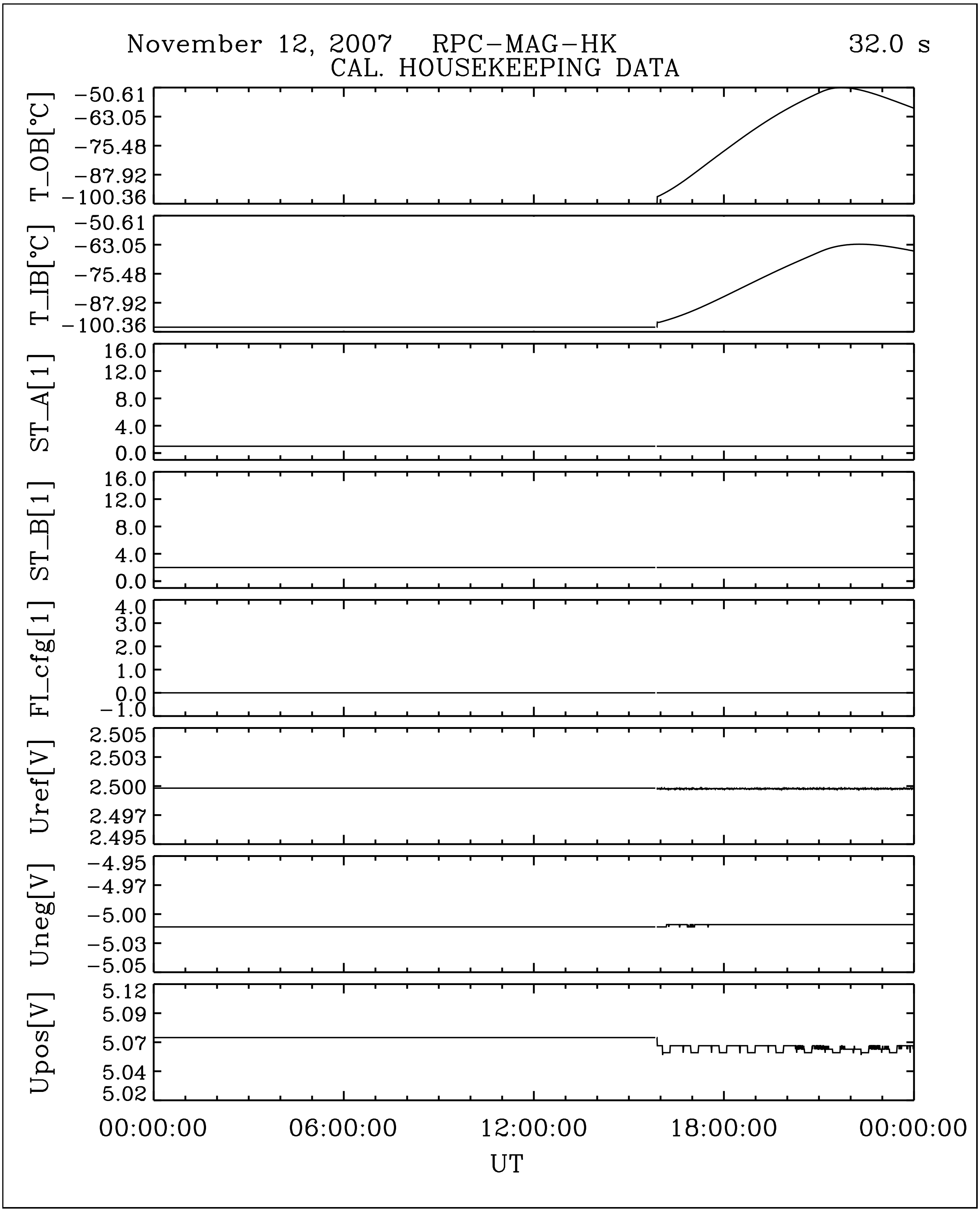


Figure 18: File: RPCMAG071112T0000_CLA_HK_P0000_2400

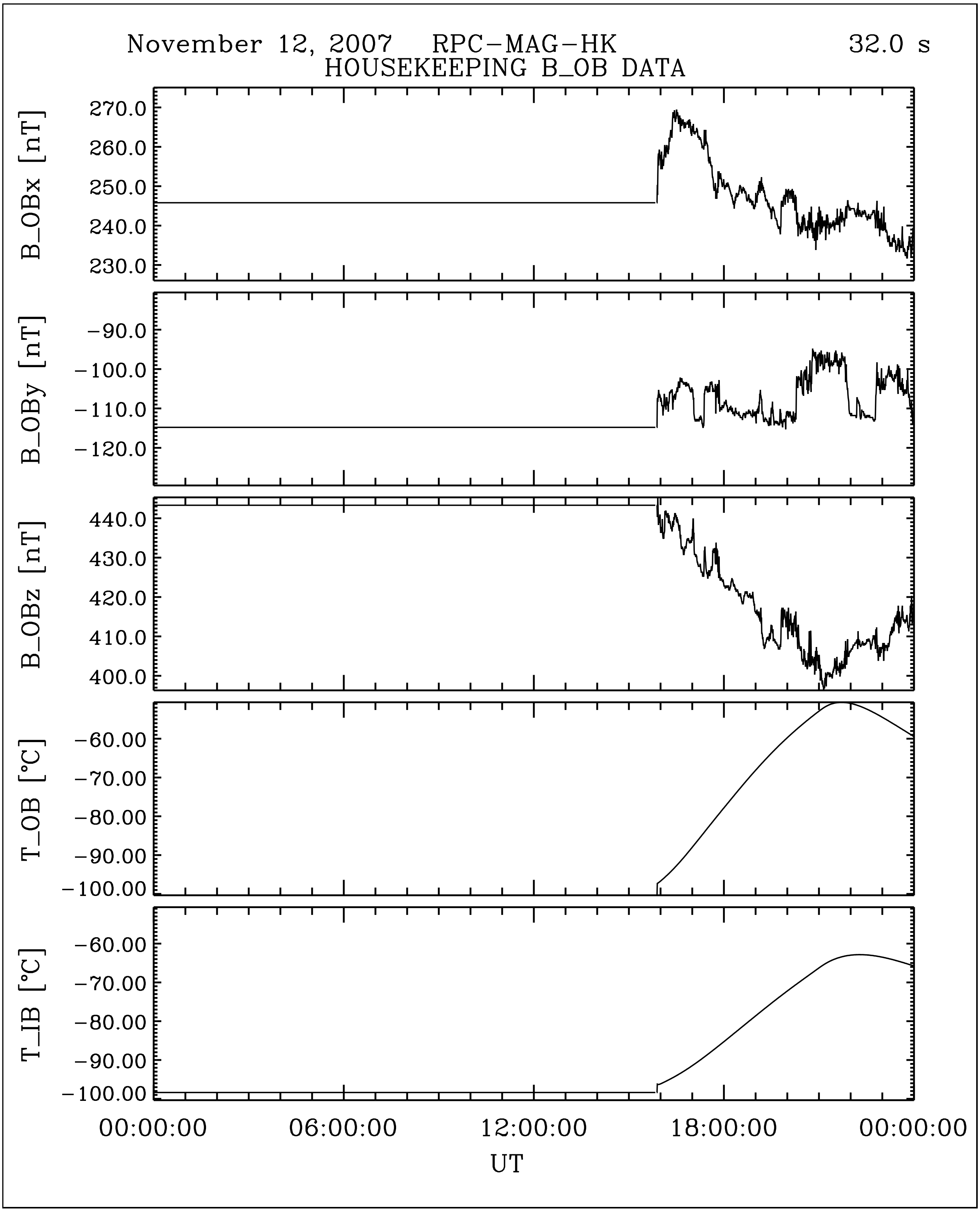


Figure 19: File: RPCMAG071112T0000_CLA_HK_B_P0000_2400

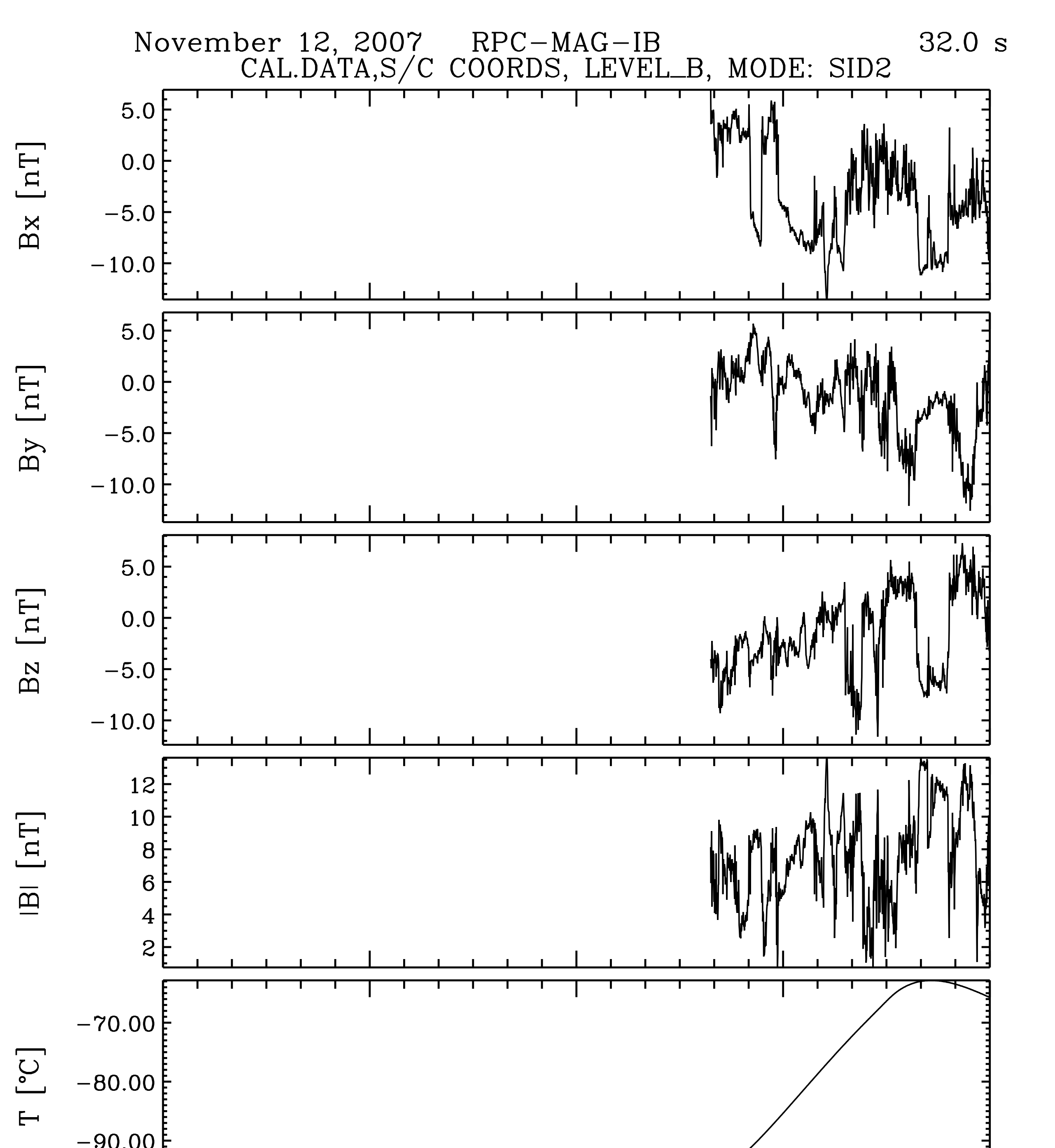


Figure 20: File: RPCMAG071112T1553_CLB_IB_M2_T0000_2400_009

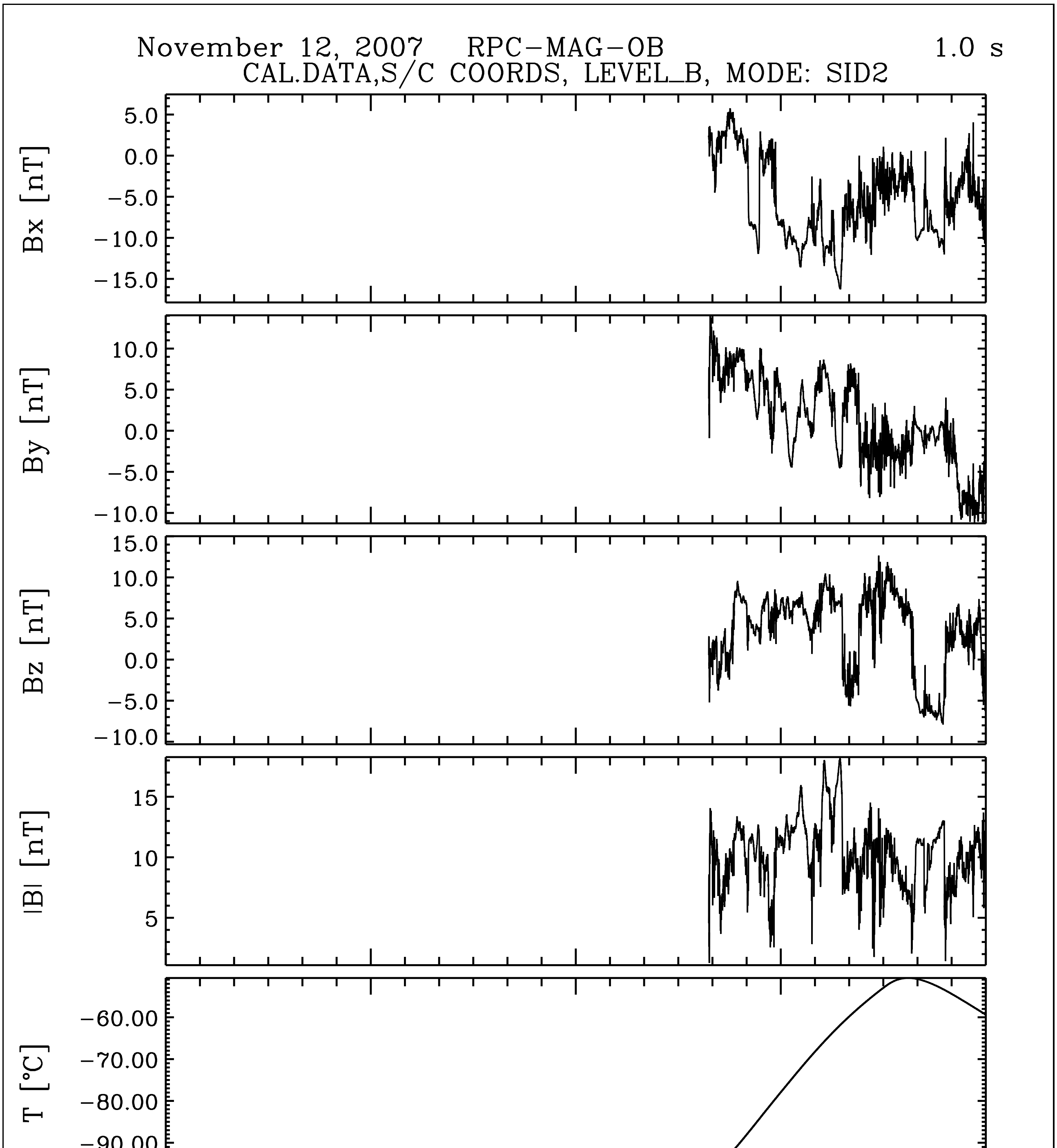


Figure 21: File: RPCMAG071112T1553_CLB_OB_M2_T0000_2400_009

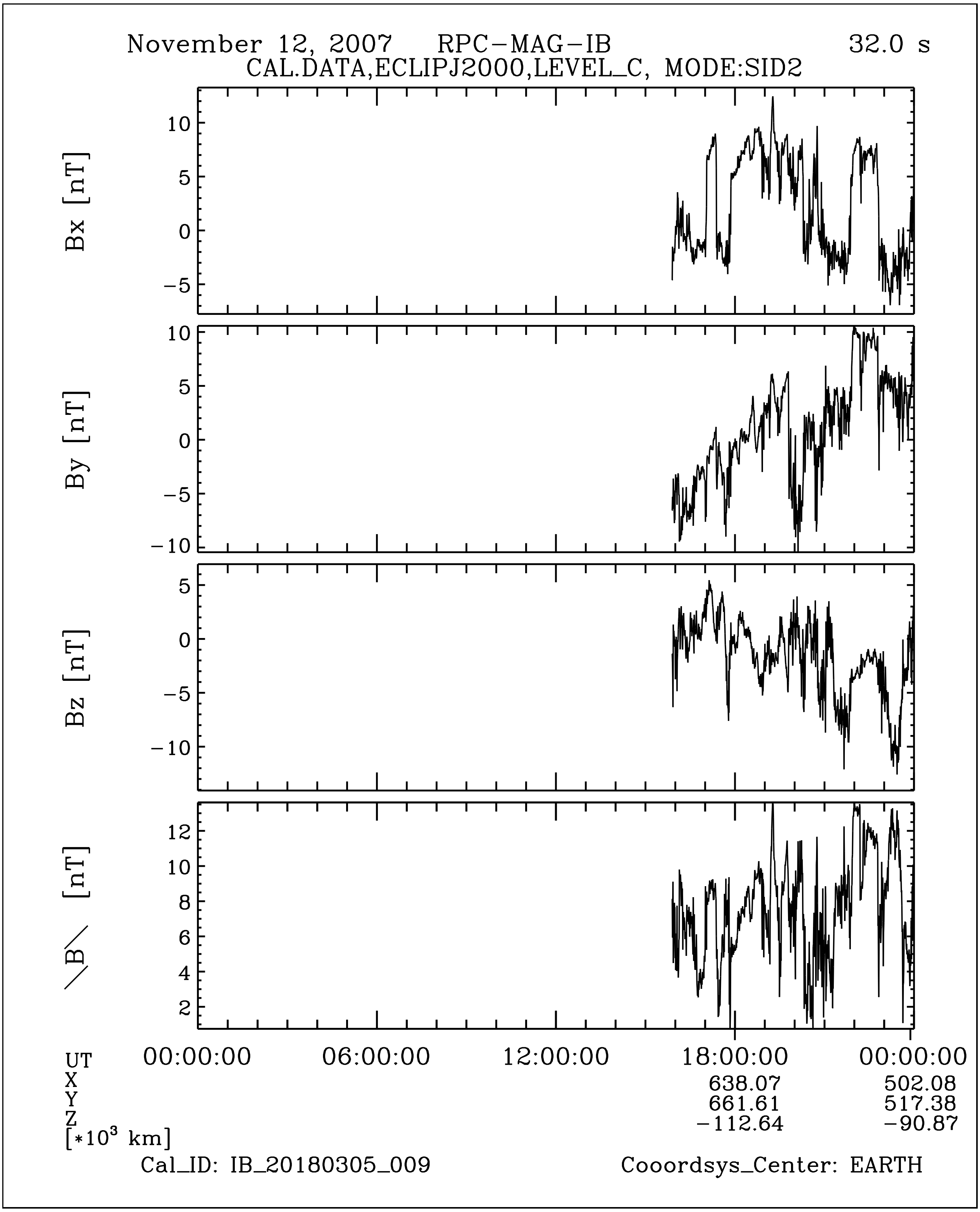


Figure 22: File: RPCMAG071112T1553_CLC_IB_M2_T0000_2400_009

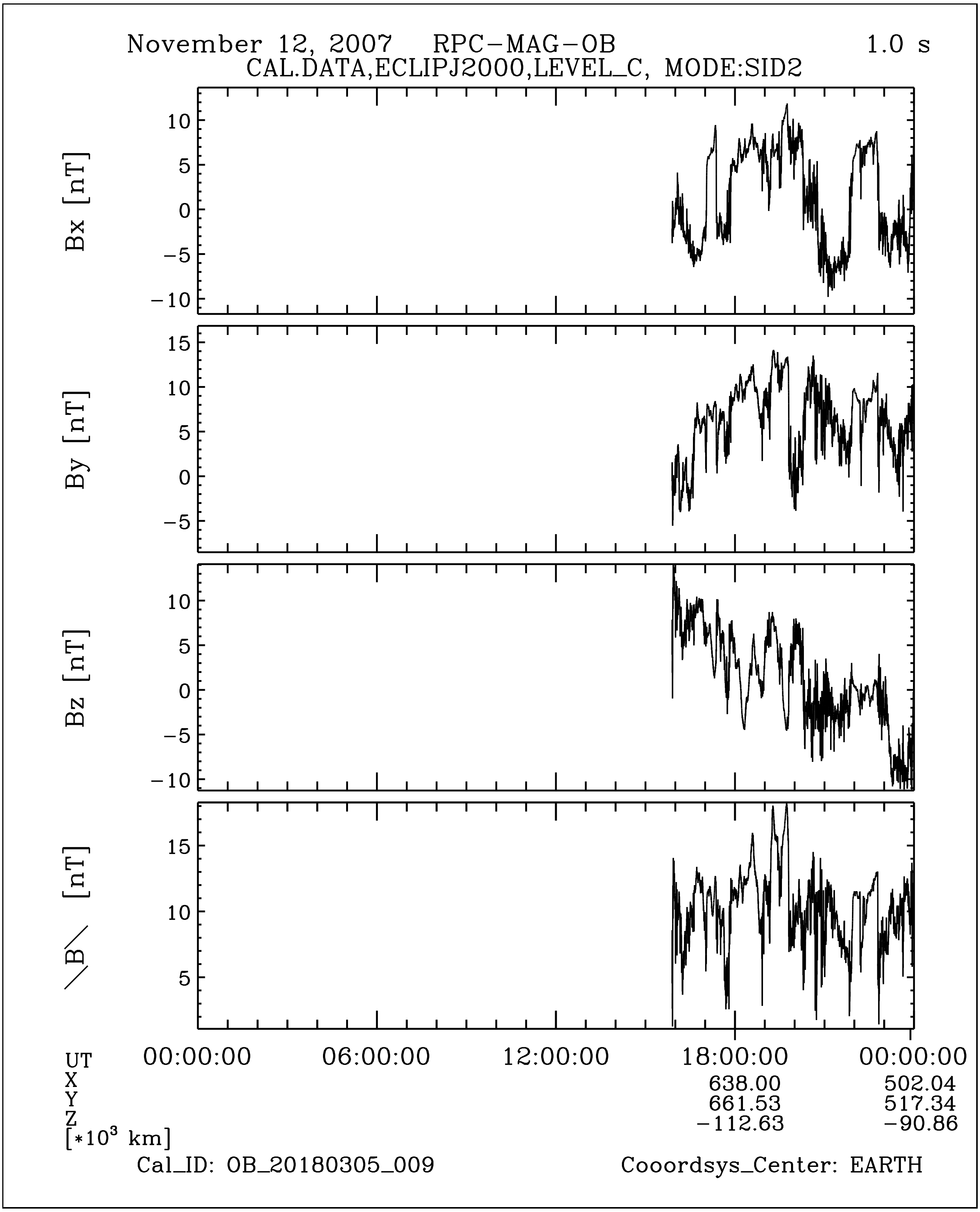


Figure 23: File: RPCMAG071112T1553_CLC_OB_M2_T0000_2400_009

### 3.5 November 13, 2007:

#### 3.5.1 Actions

MAG stayed in SID 2 until 03:03. Then we switched to BURST mode to get full resolution during the very swing by. No problems occurred. The closest approach (CA) happened at 20:57.

#### 3.5.2 Plots of Calibrated Data

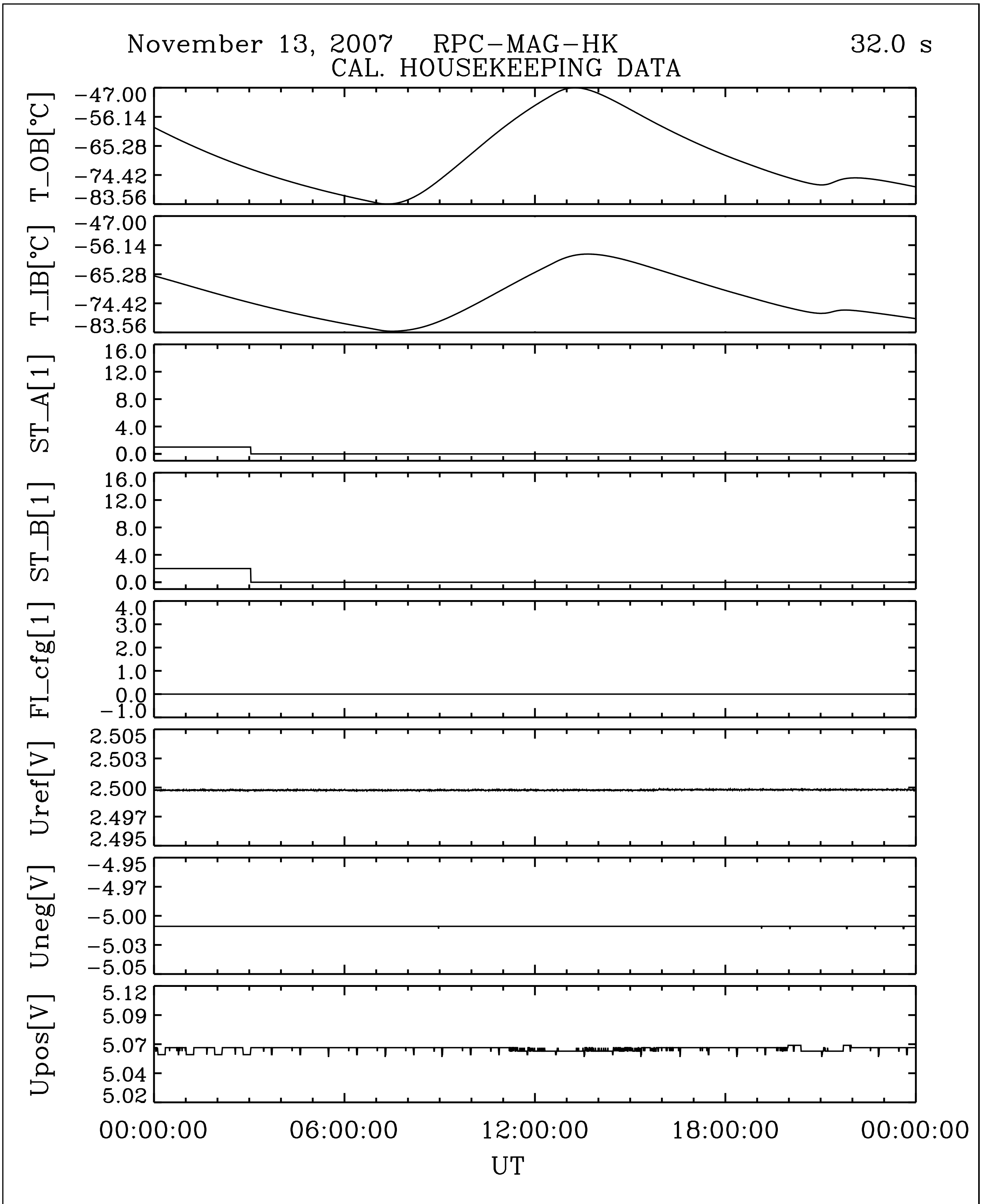


Figure 24: File: RPCMAG071113T0000_CLA_HK_P0000_2400

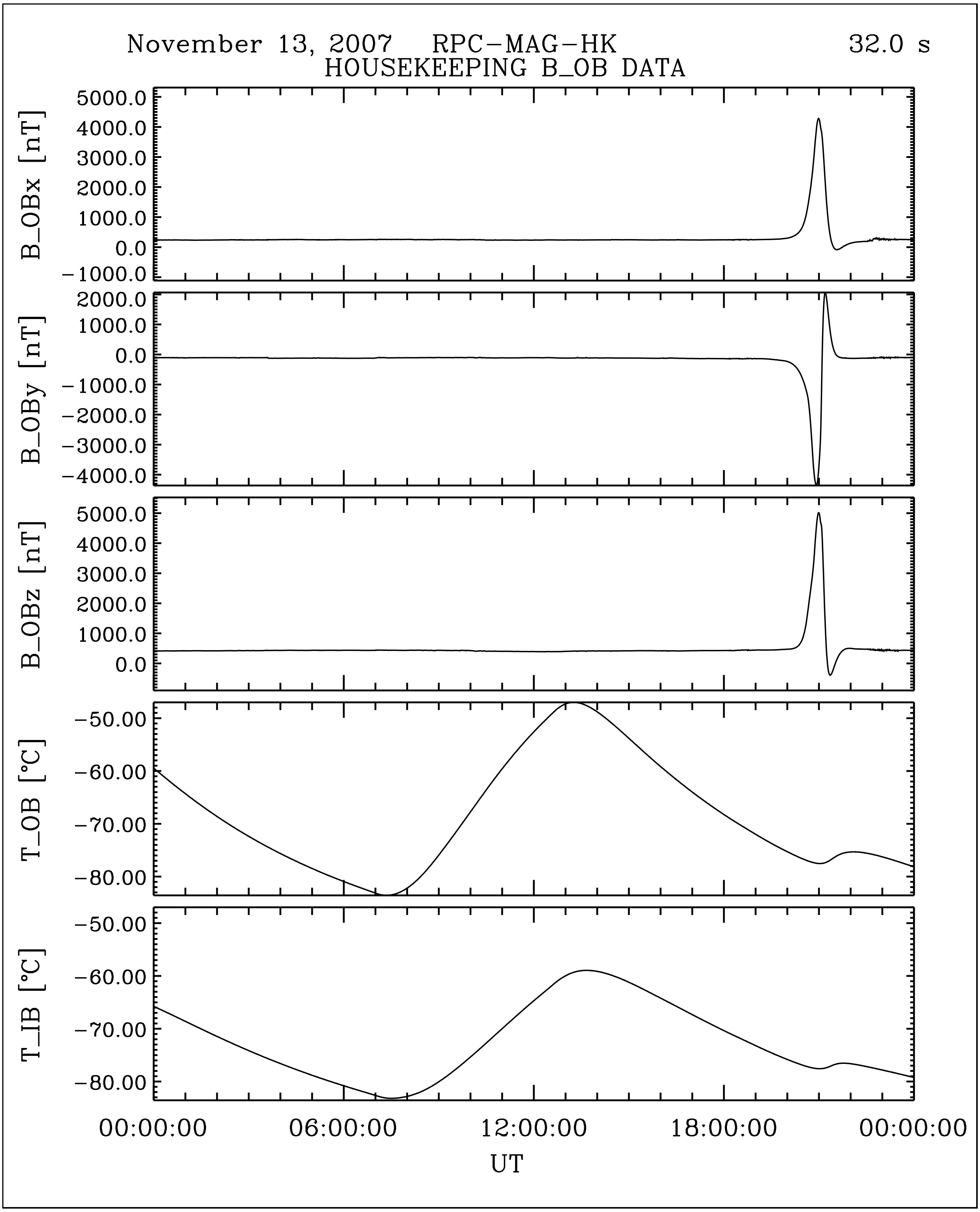


Figure 25: File: RPCMAG071113T0000_CLA_HK_B_P0000_2400

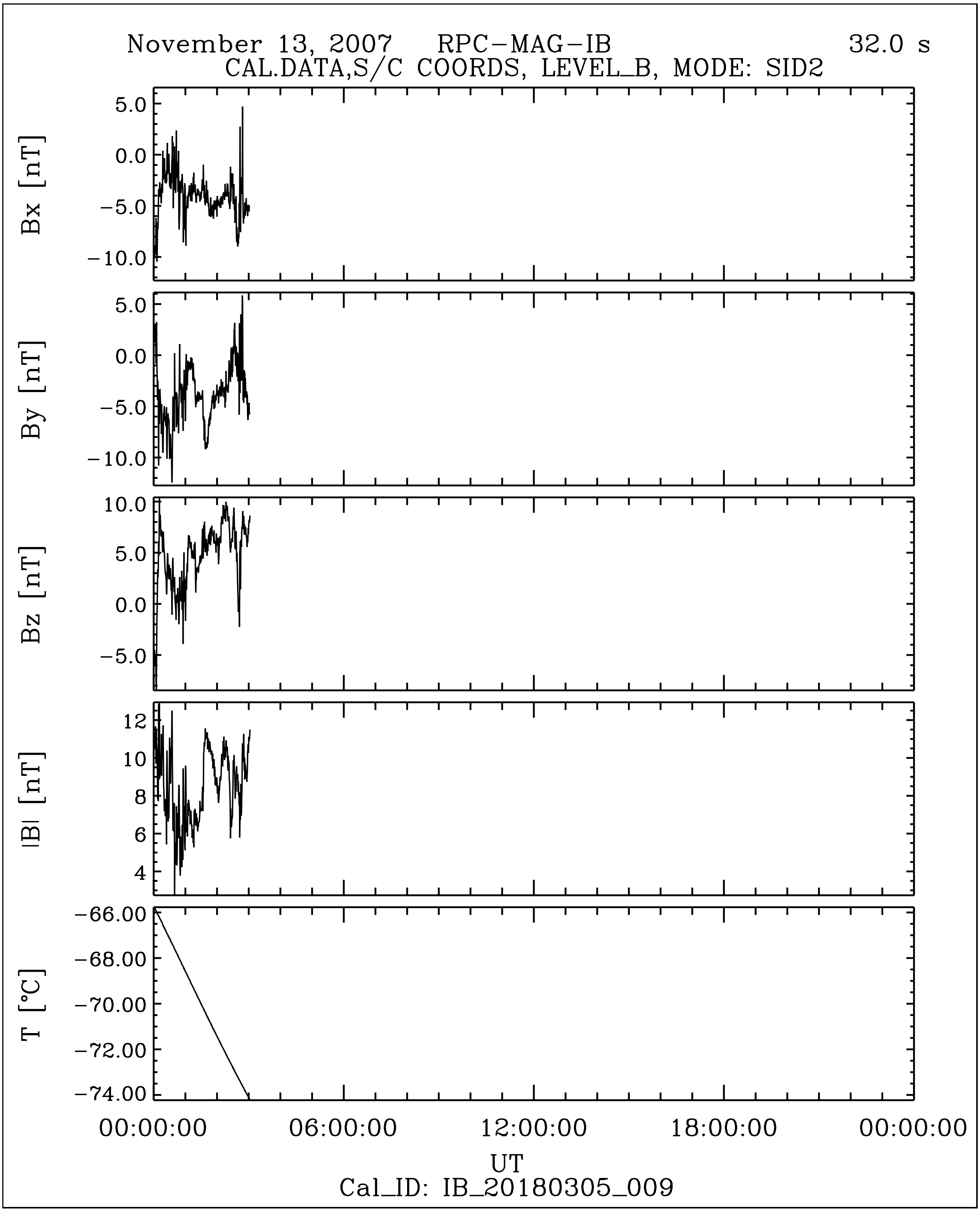


Figure 26: File: RPCMAG071113T0000_CLB_IB_M2_T0000_2400_009

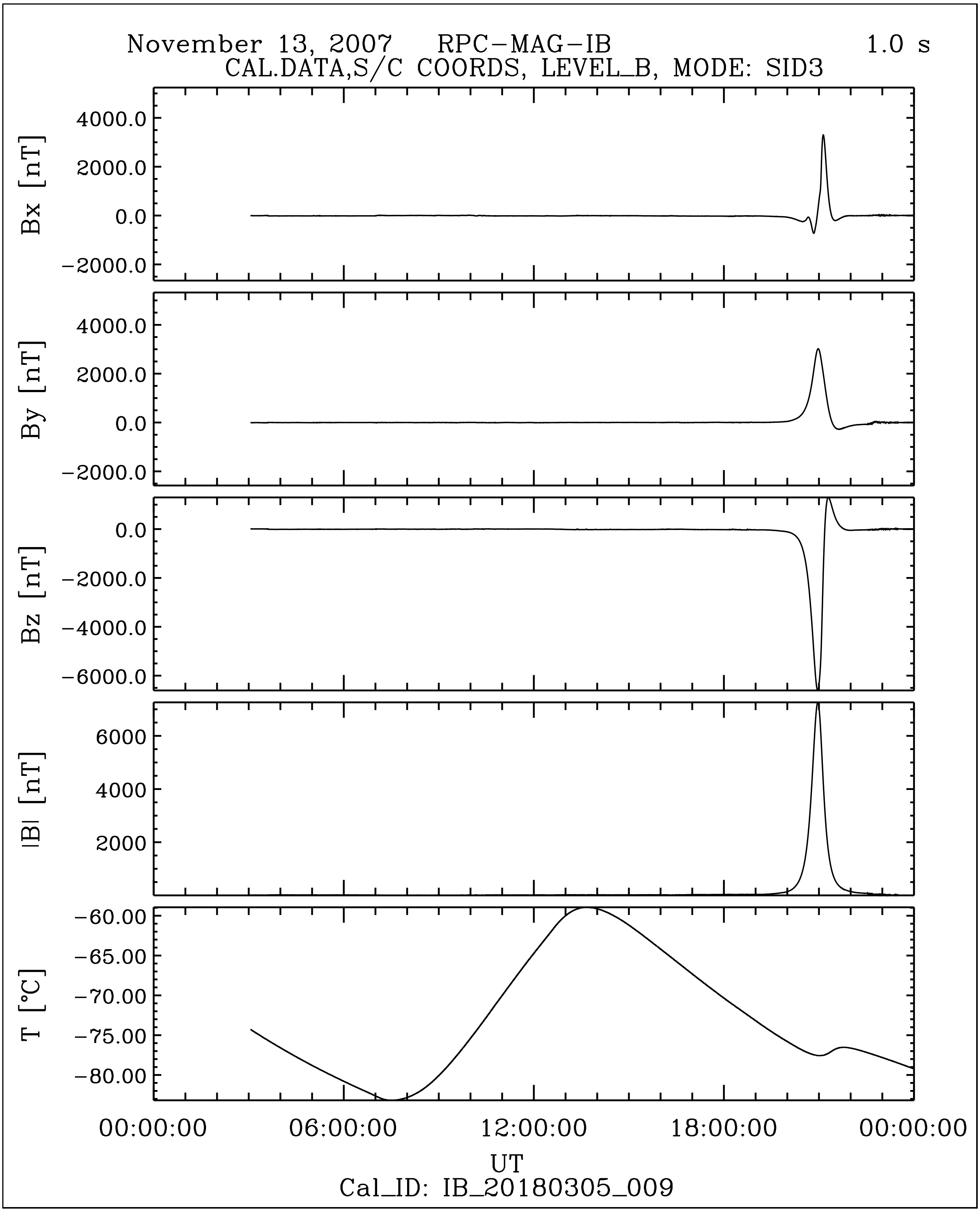


Figure 27: File: RPCMAG071113T0303_CLB_IB_M3_T0000_2400_009

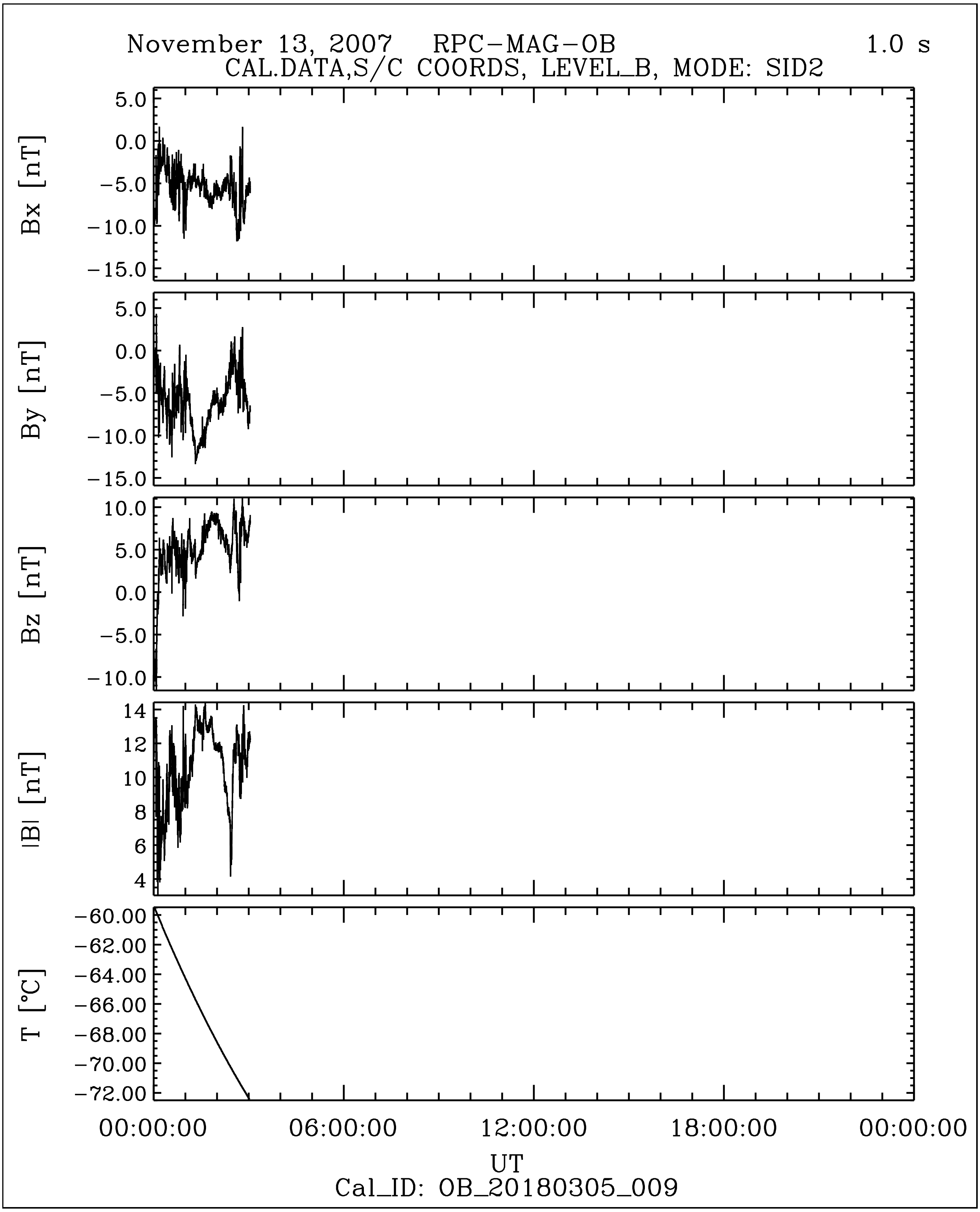


Figure 28: File: RPCMAG071113T0000_CLB_OB_M2_T0000_2400_009

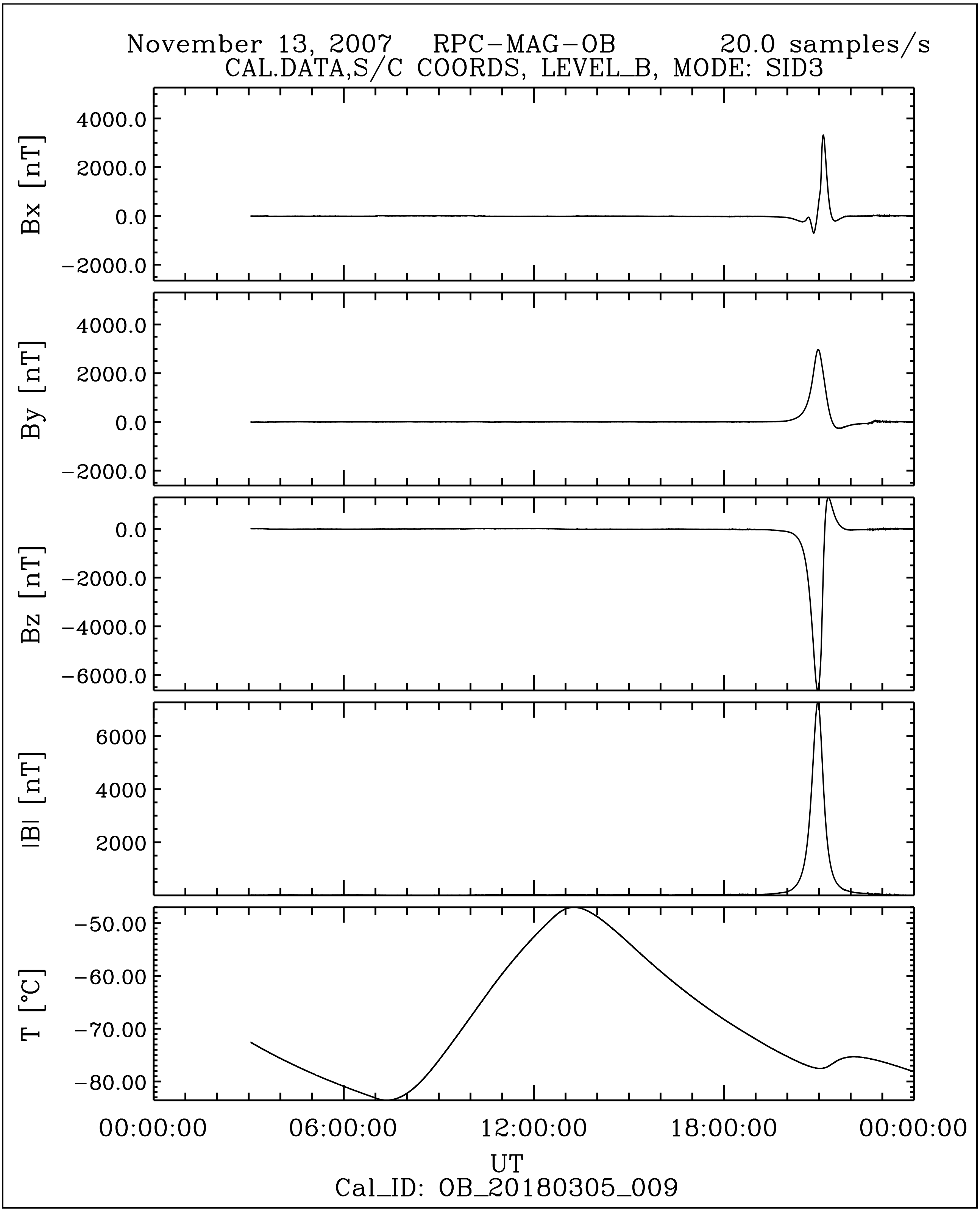


Figure 29: File: RPCMAG071113T0303_CLB_OB_M3_T0000_2400_009

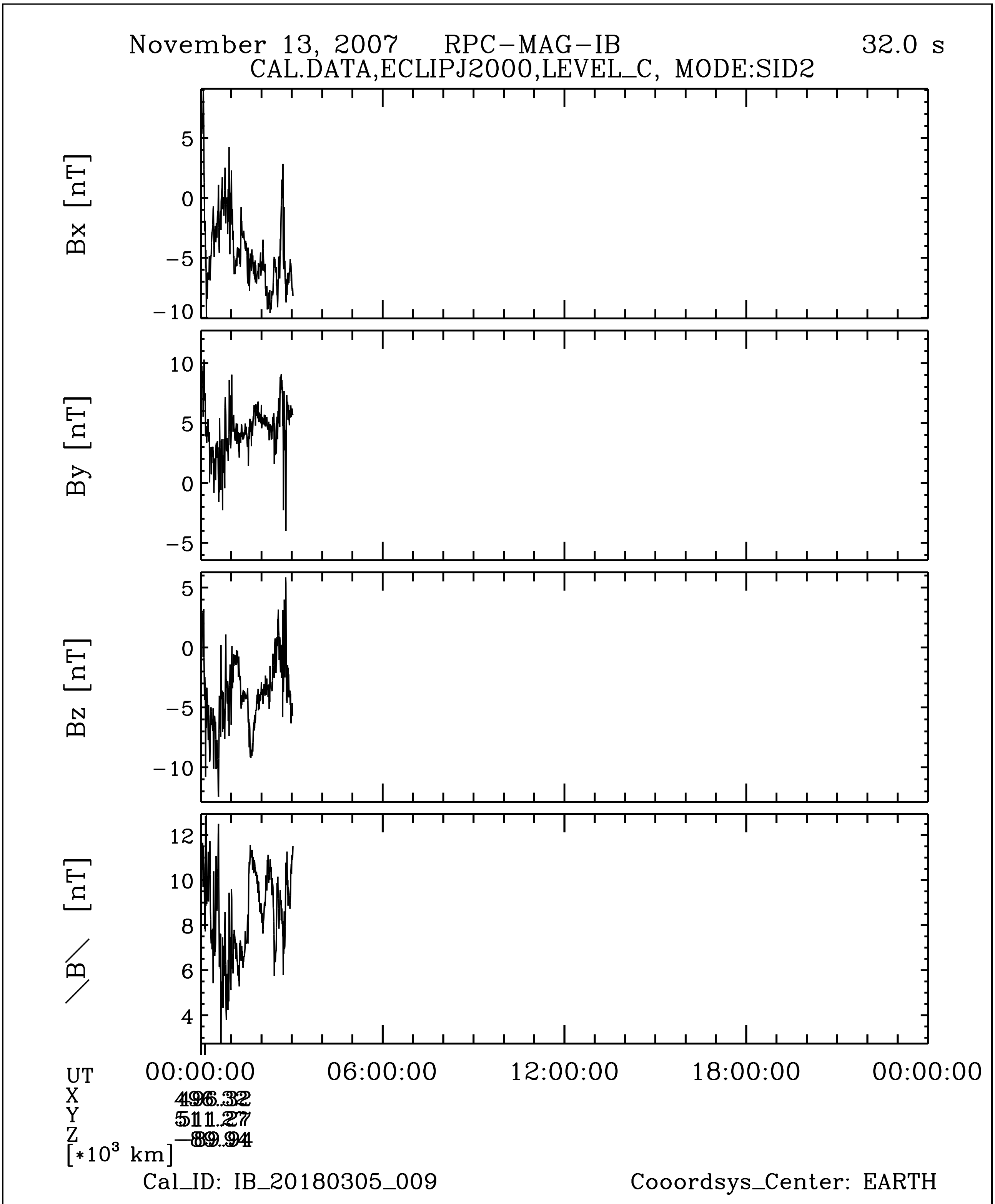


Figure 30: File: RPCMAG071113T0000_CLC_IB_M2_T0000_2400_009

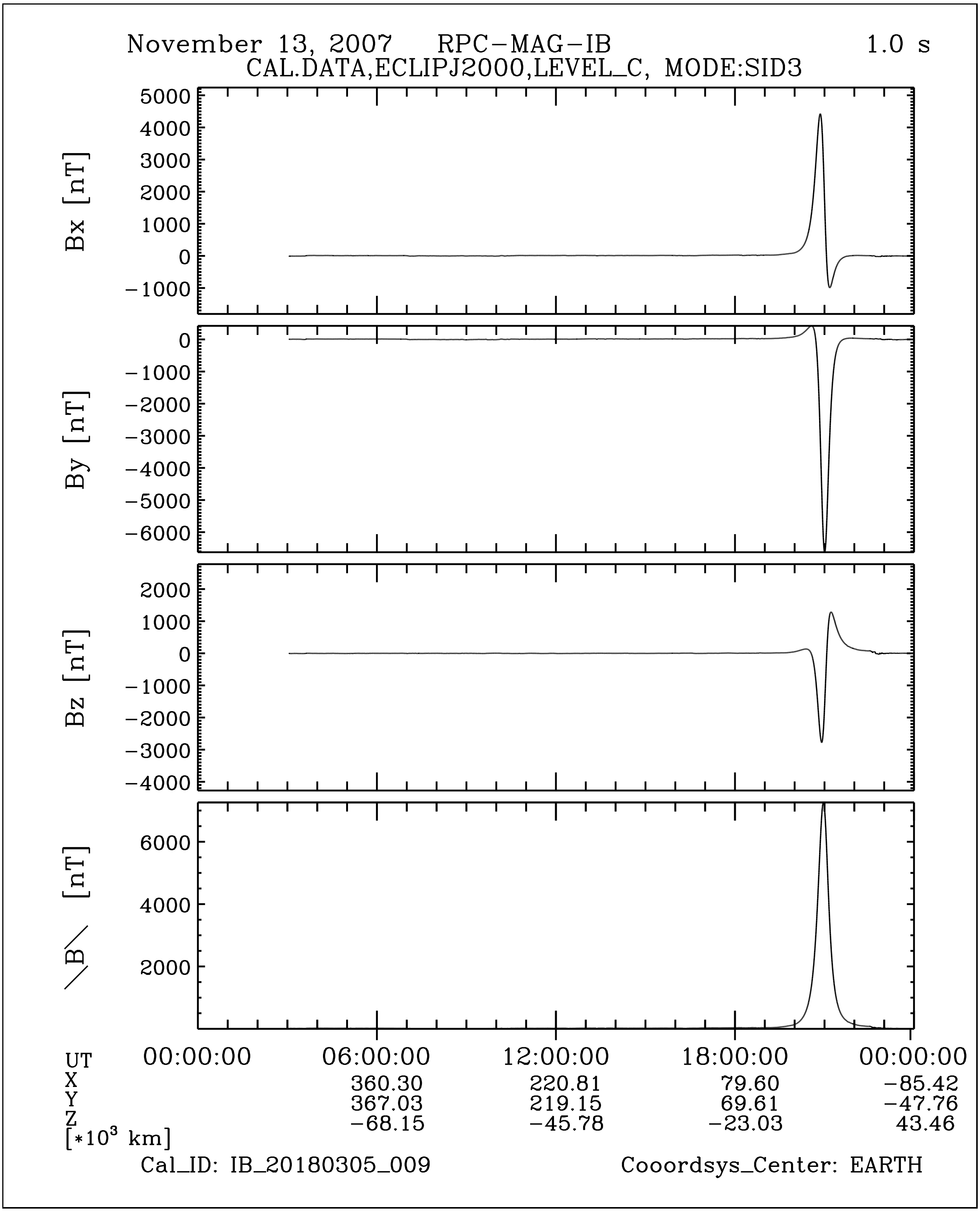


Figure 31: File: RPCMAG071113T0303_CLC_IB_M3_T0000_2400_009

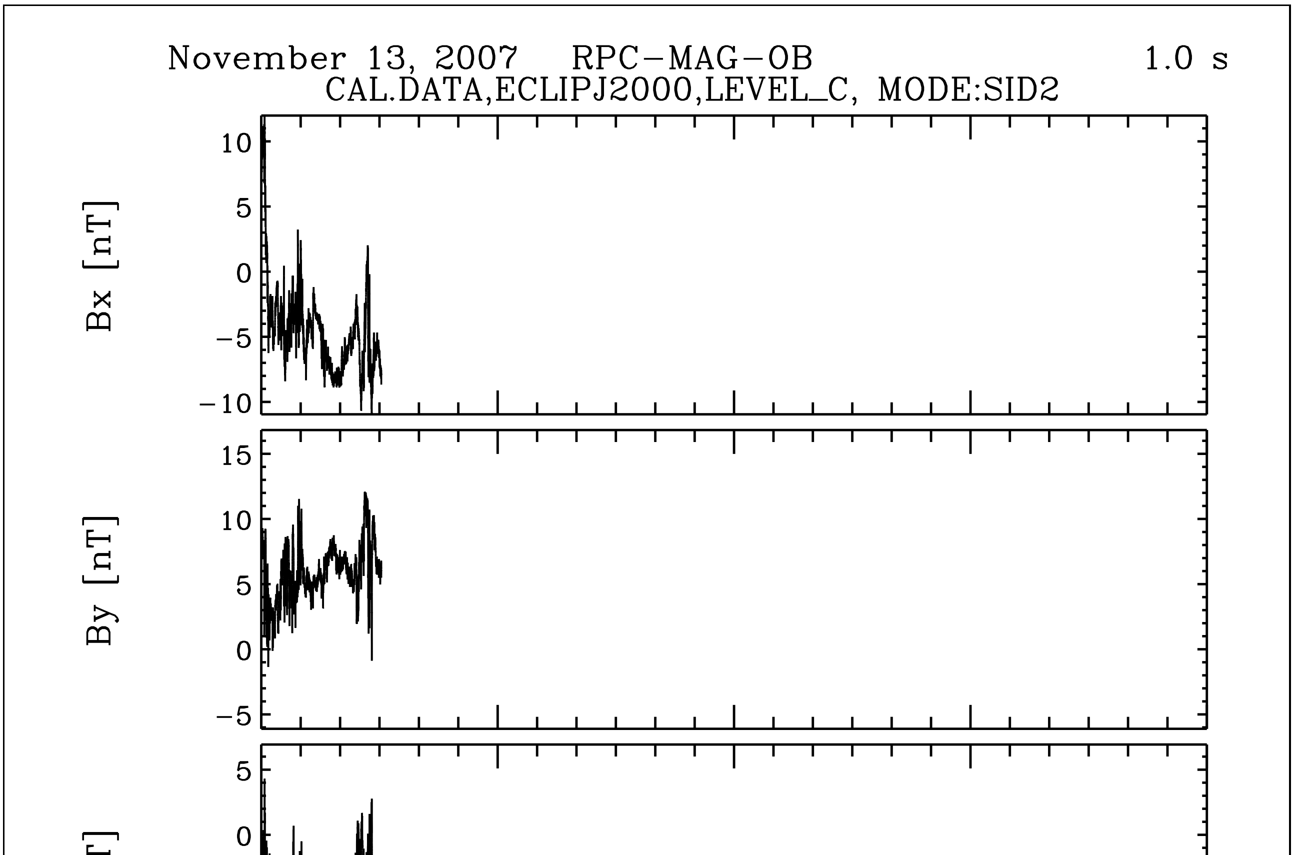


Figure 32: File: RPCMAG071113T0000_CLC_OB_M2_T0000_2400_009

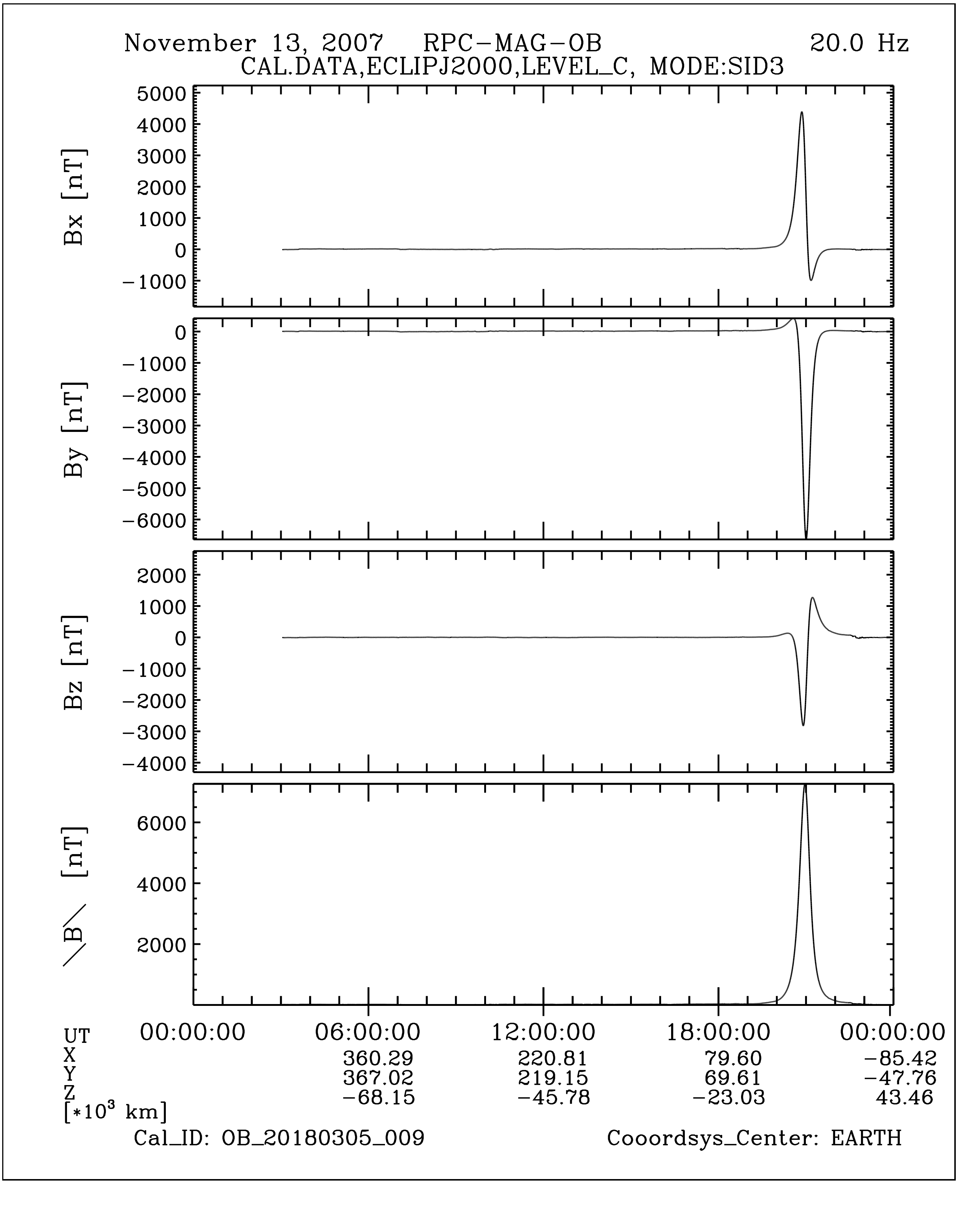


Figure 33: File: RPCMAG071113T0303_CLC_OB_M3_T0000_2400_009

## 3.6 November 14, 2007:

### 3.6.1 Actions

MAG stayed nominally in SID 3 until 03:01. The we switched back to normal mode SID2. No problems occurred.

### 3.6.2 Plots of Calibrated Data

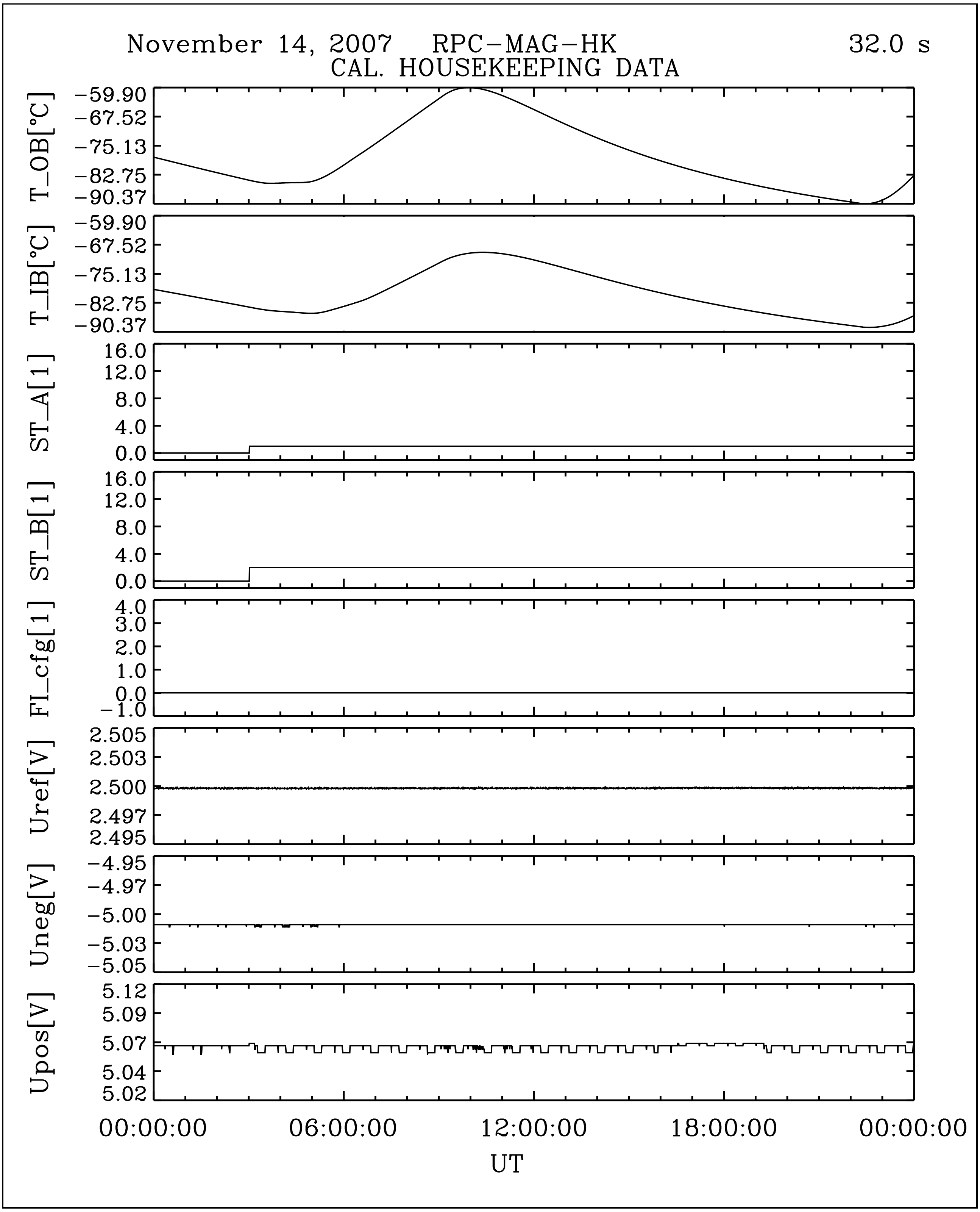


Figure 34: File: RPCMAG071114T0000_CLA_HK_P0000_2400

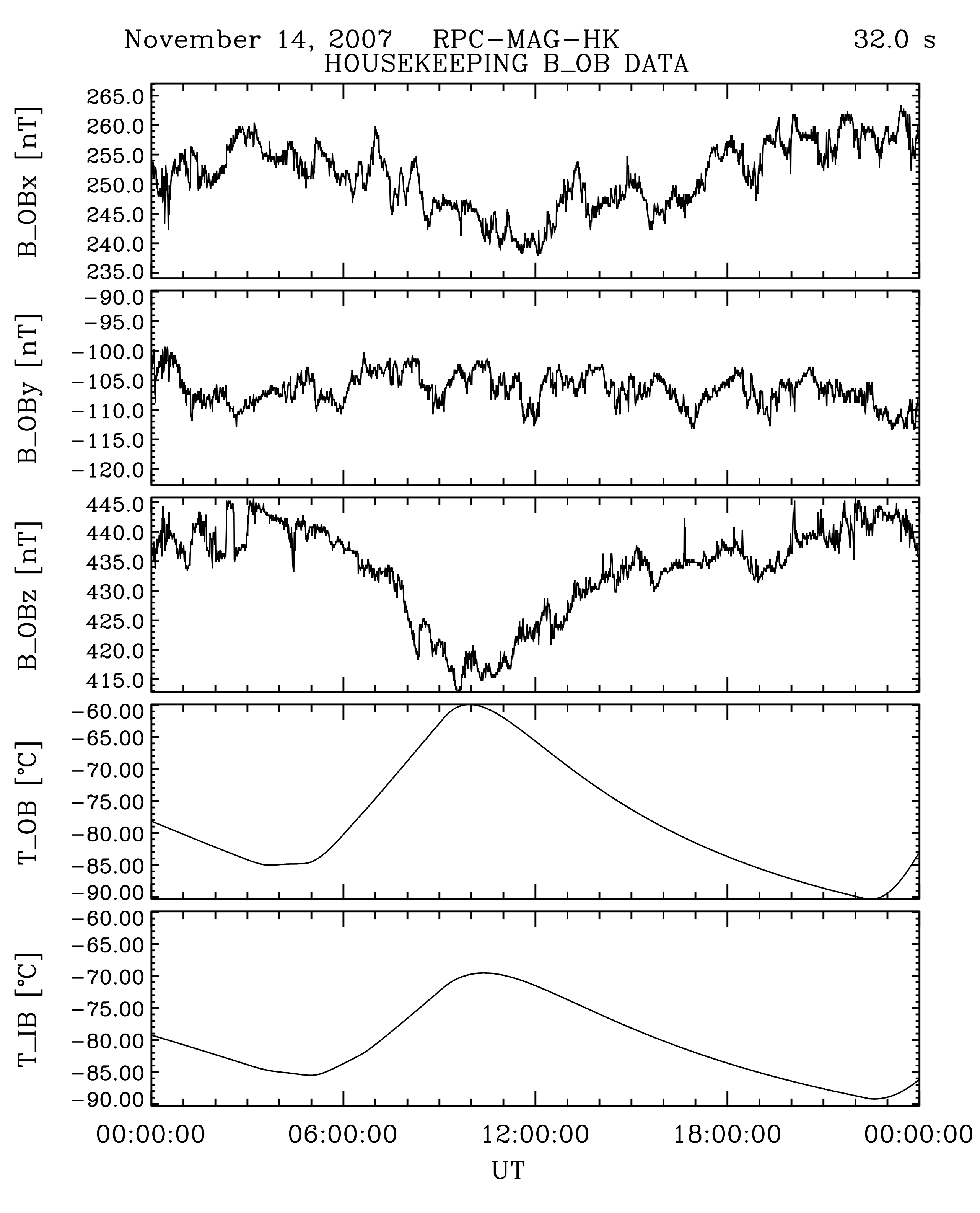


Figure 35: File: RPCMAG071114T0000_CLA_HK_B_P0000_2400

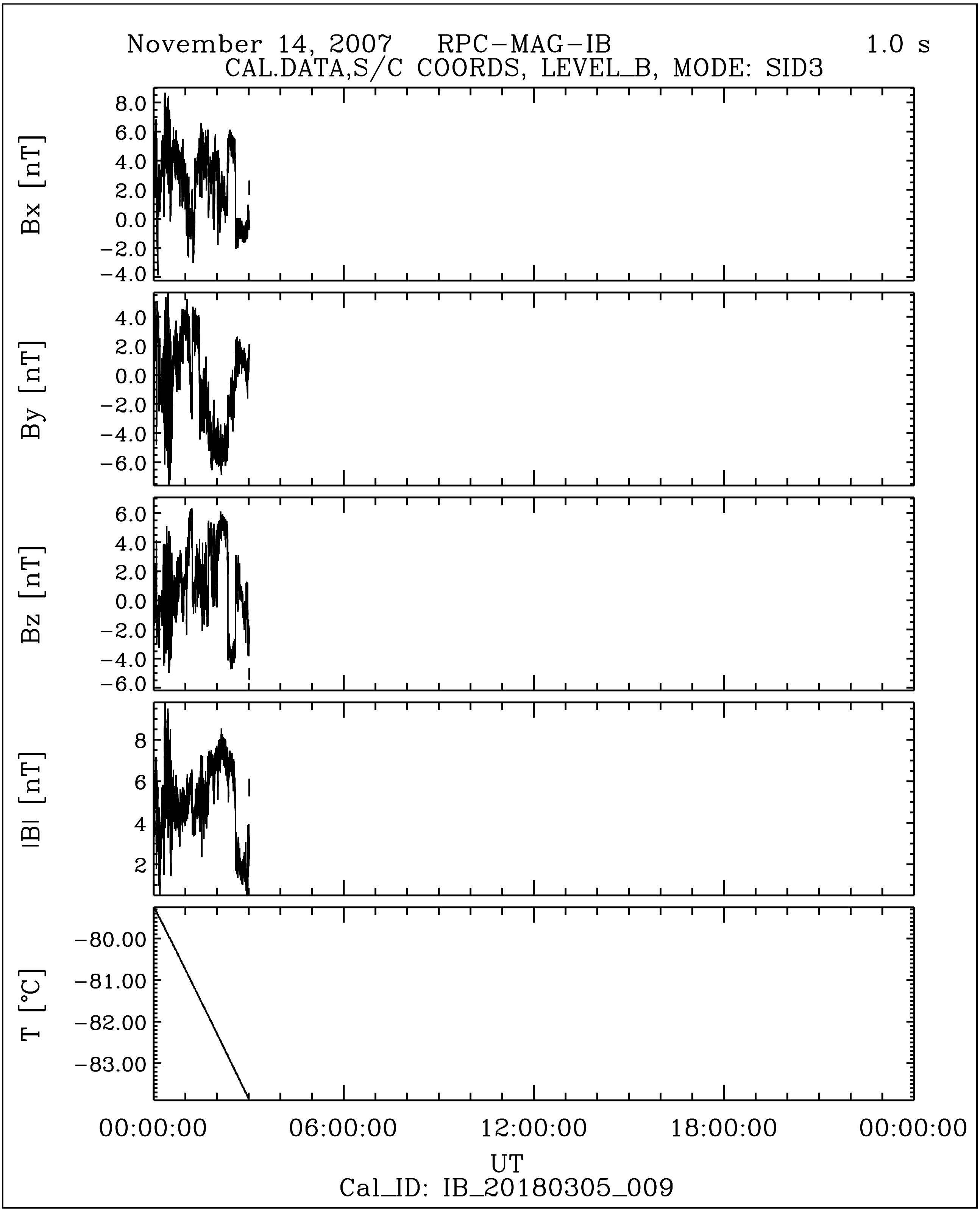


Figure 36: File: RPCMAG071114T0000_CLB_IB_M3_T0000_2400_009

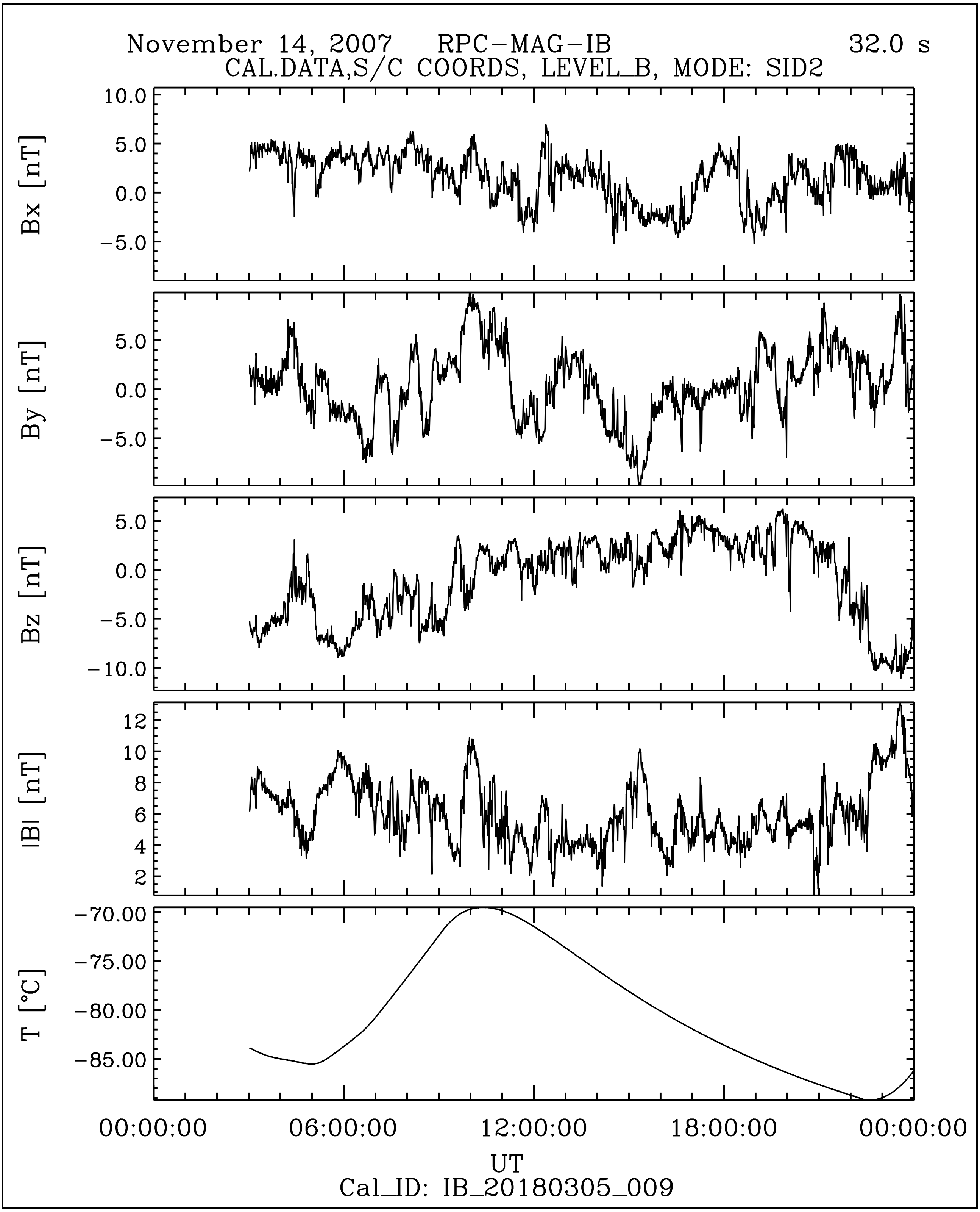


Figure 37: File: RPCMAG071114T0301_CLB_IB_M2_T0000_2400_009

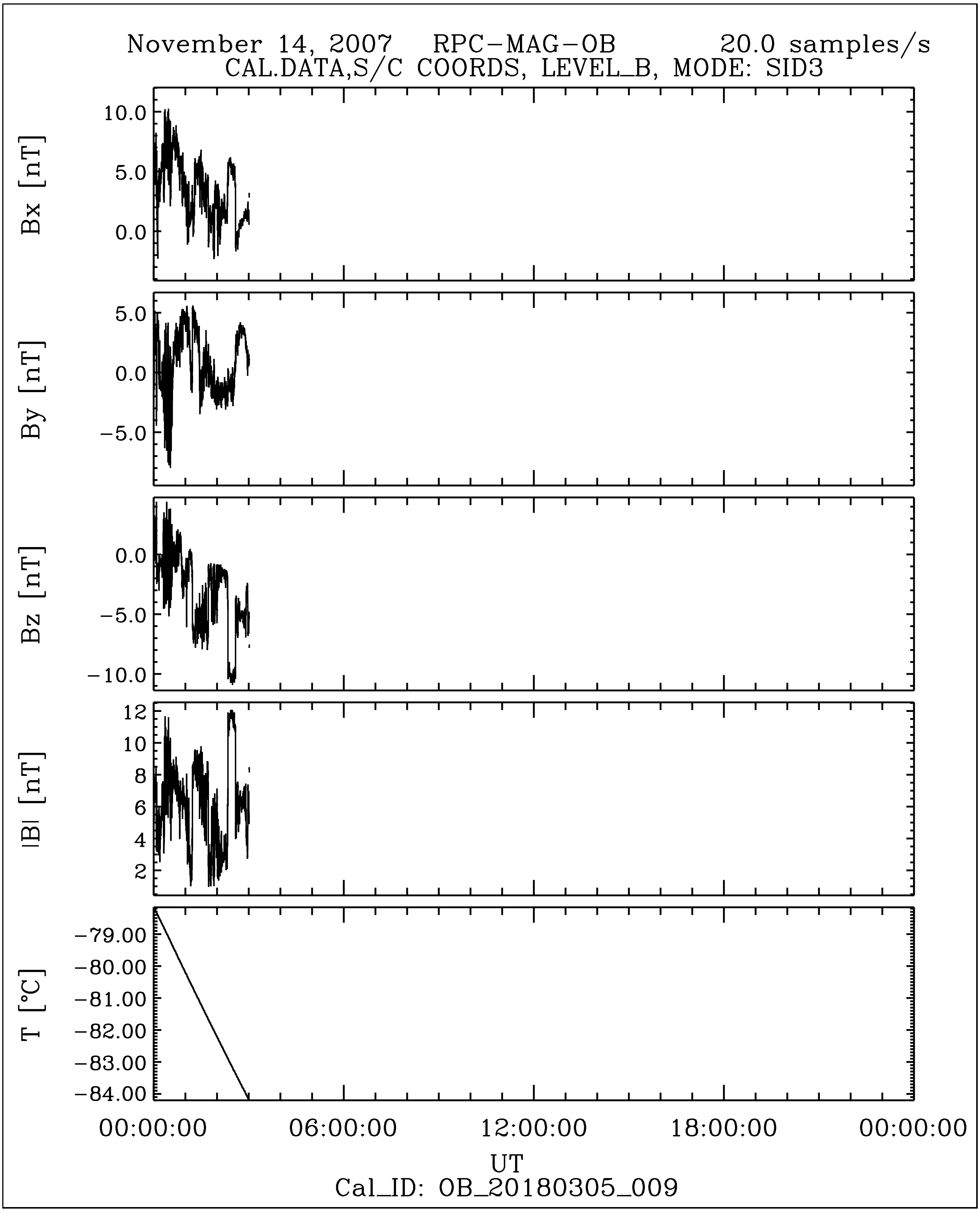


Figure 38: File: RPCMAG071114T0000_CLB_OB_M3_T0000_2400_009

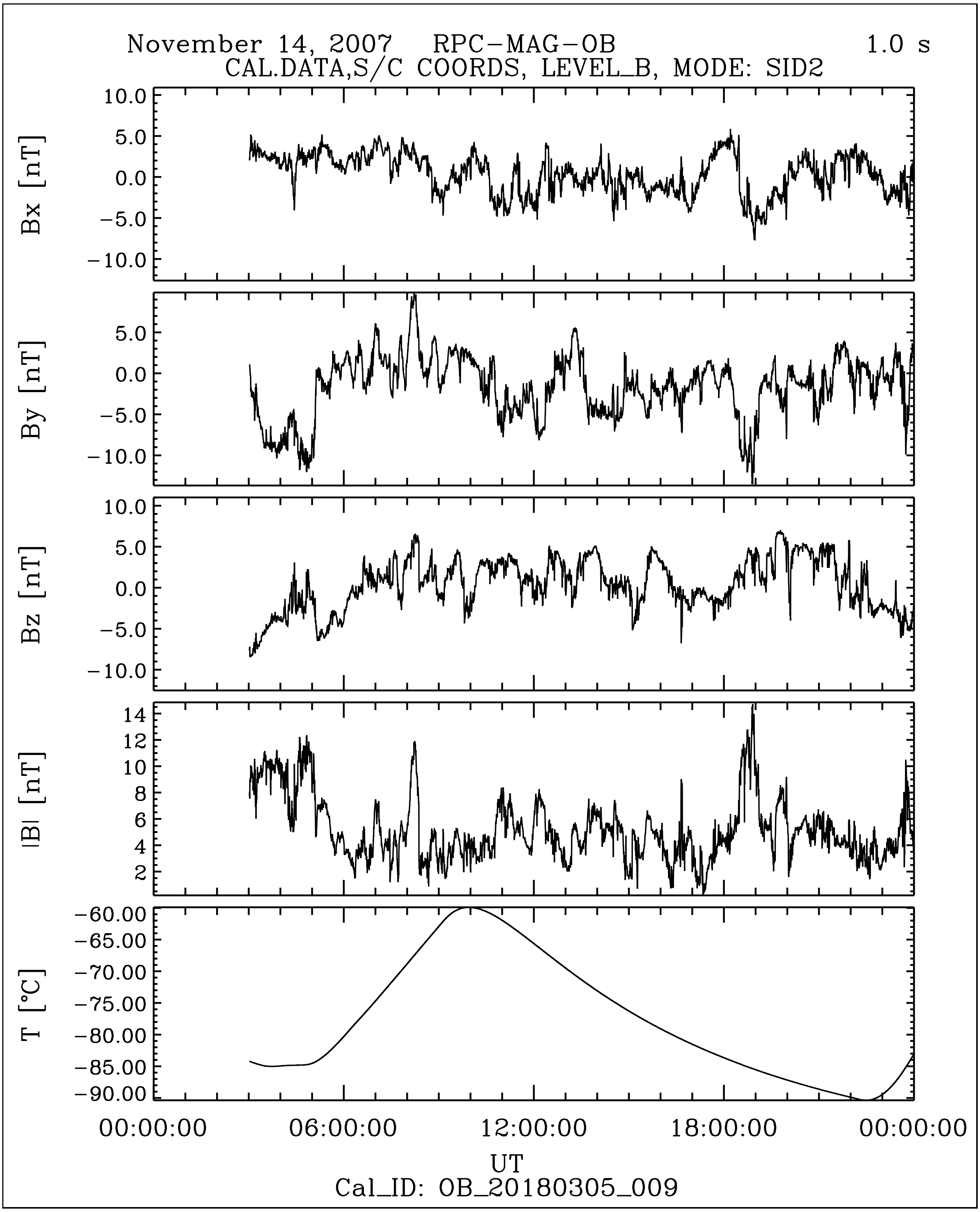


Figure 39: File: RPCMAG071114T0301_CLB_OB_M2_T0000_2400_009

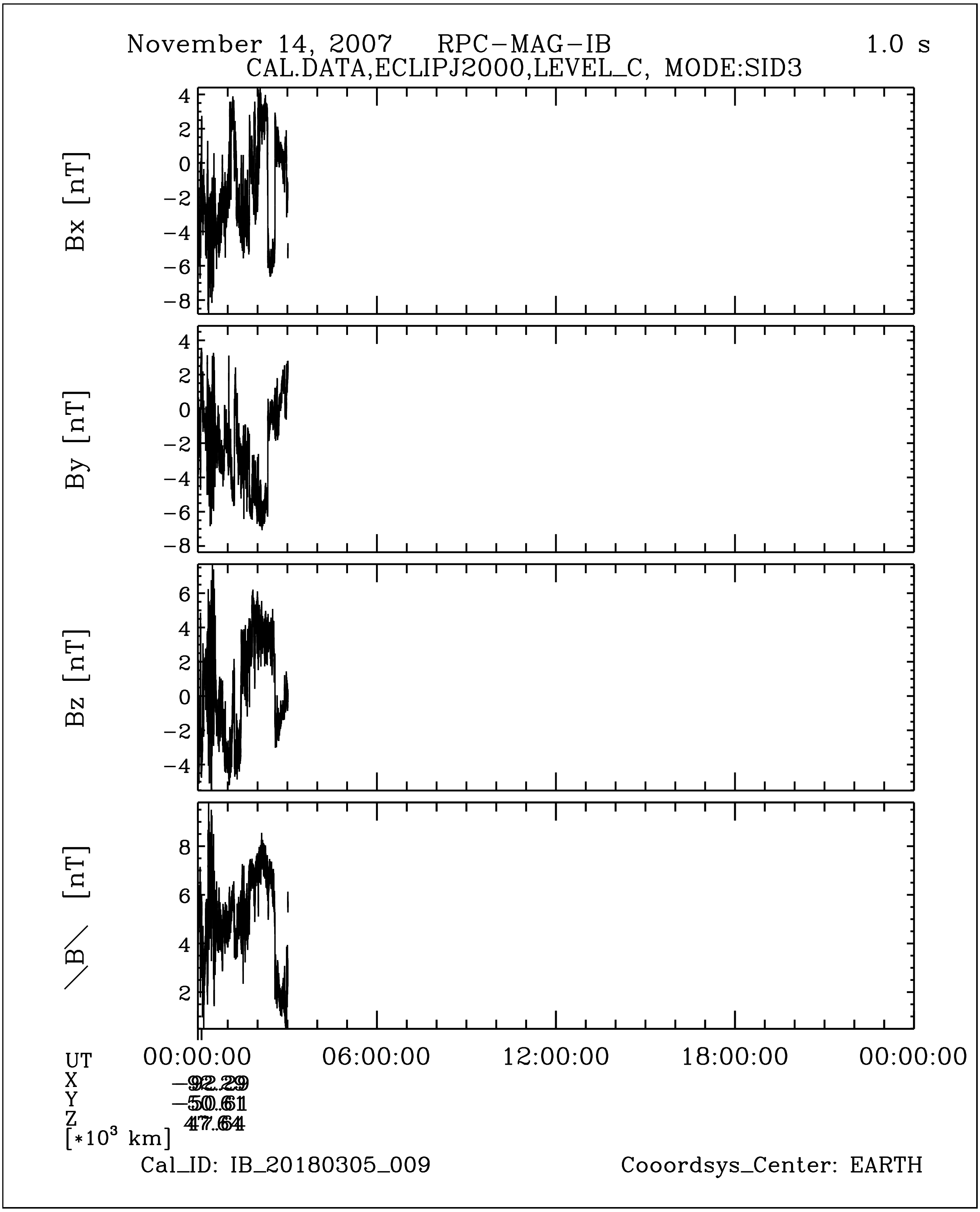


Figure 40: File: RPCMAG071114T0000_CLC_IB_M3_T0000_2400_009

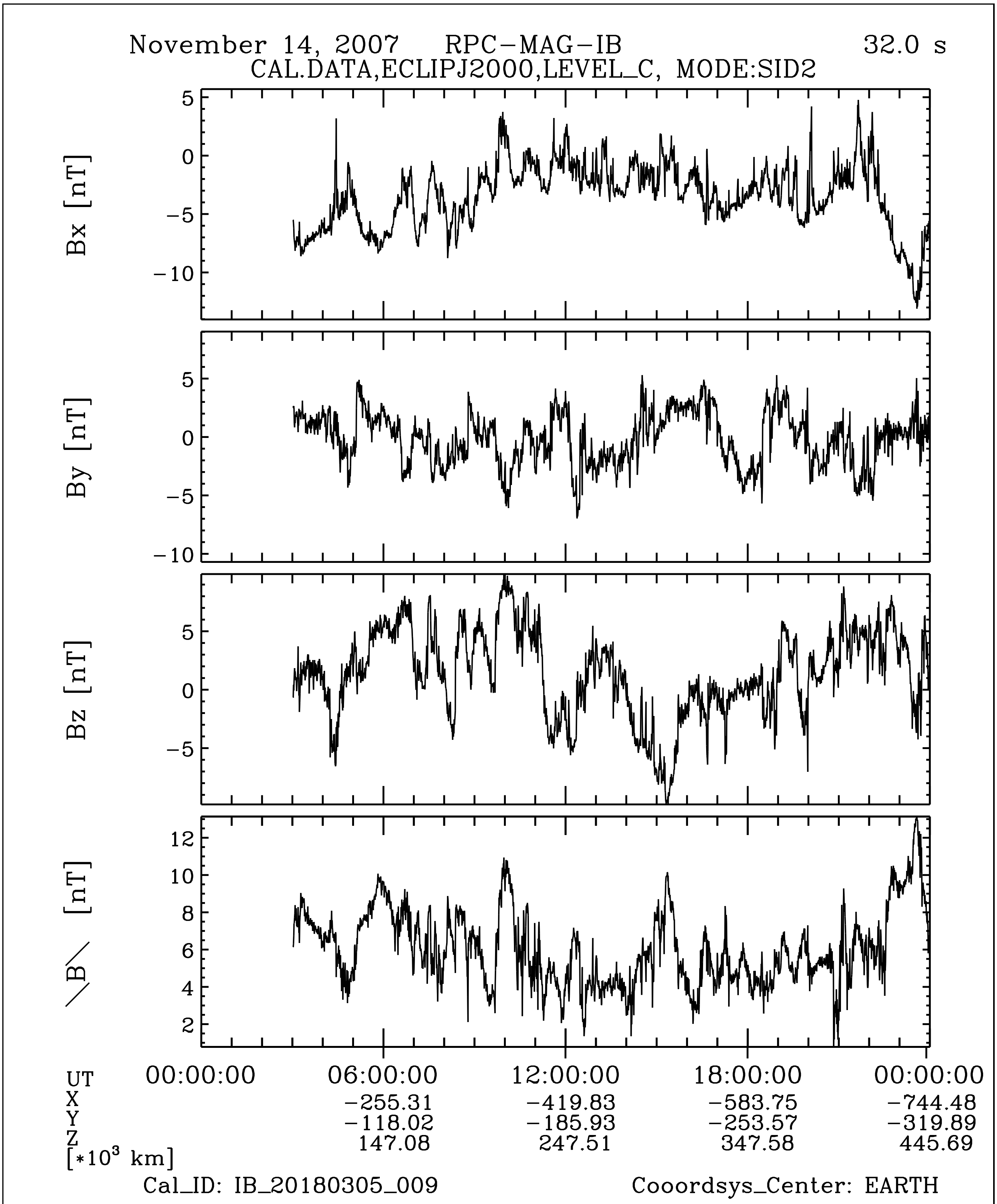


Figure 41: File: RPCMAG071114T0301_CLC_IB_M2_T0000_2400_009

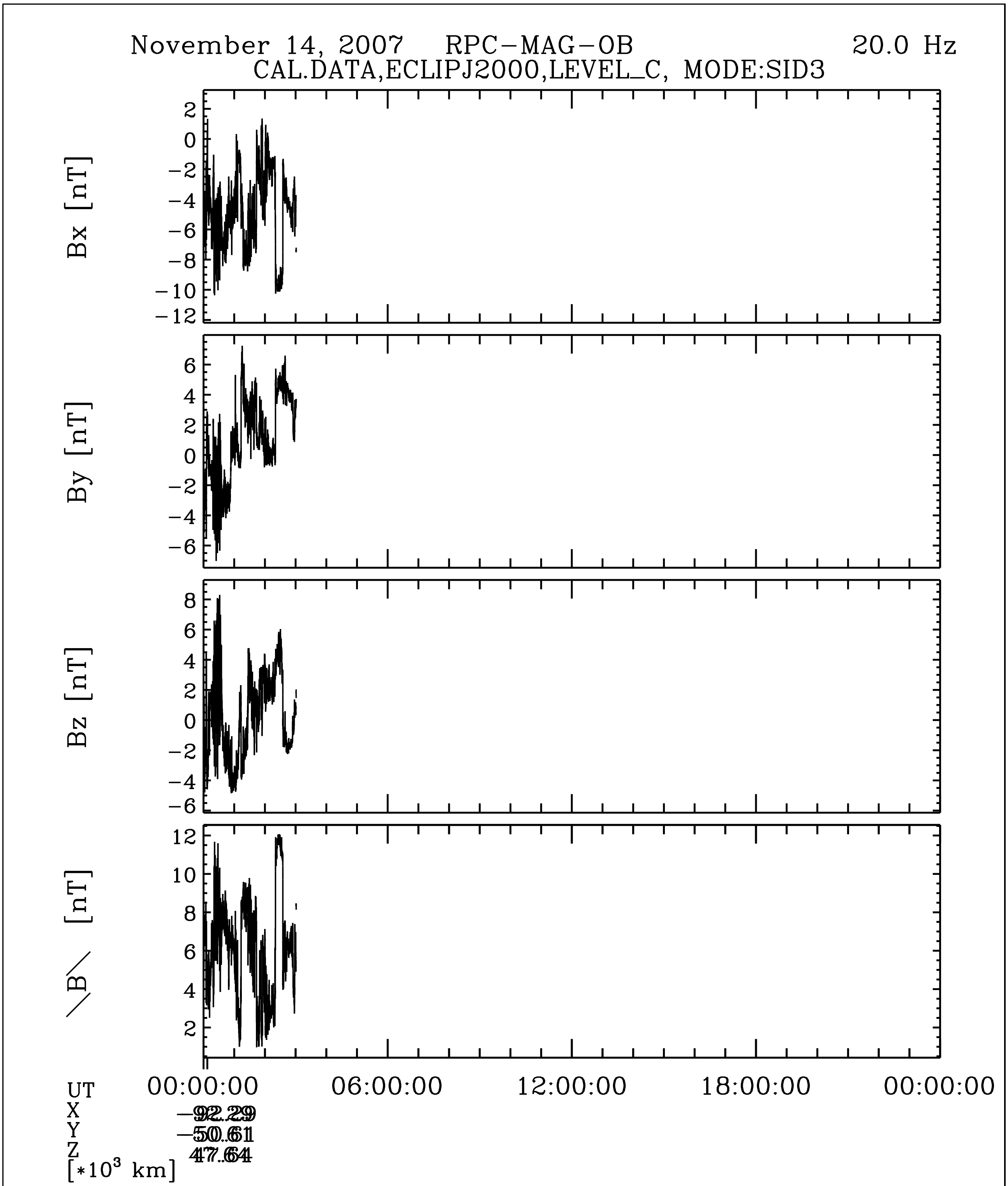


Figure 42: File: RPCMAG071114T0000_CLC_OB_M3_T0000_2400_009

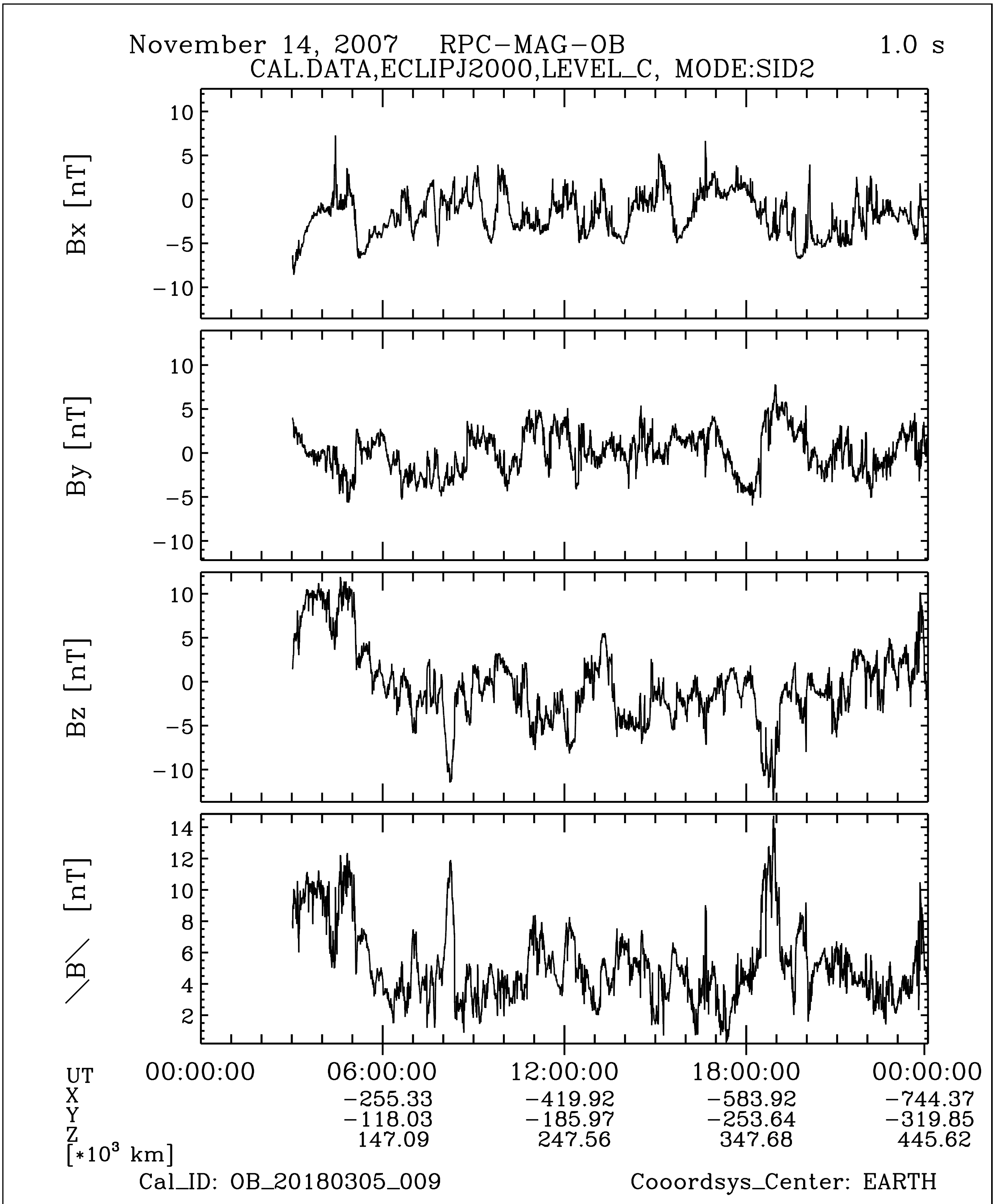


Figure 43: File: RPCMAG071114T0301_CLC_OB_M2_T0000_2400_009

## 3.7 November 15, 2007:

### 3.7.1 Actions

MAG stayed in SID 2. No problems occurred.

### 3.7.2 Plots of Calibrated Data

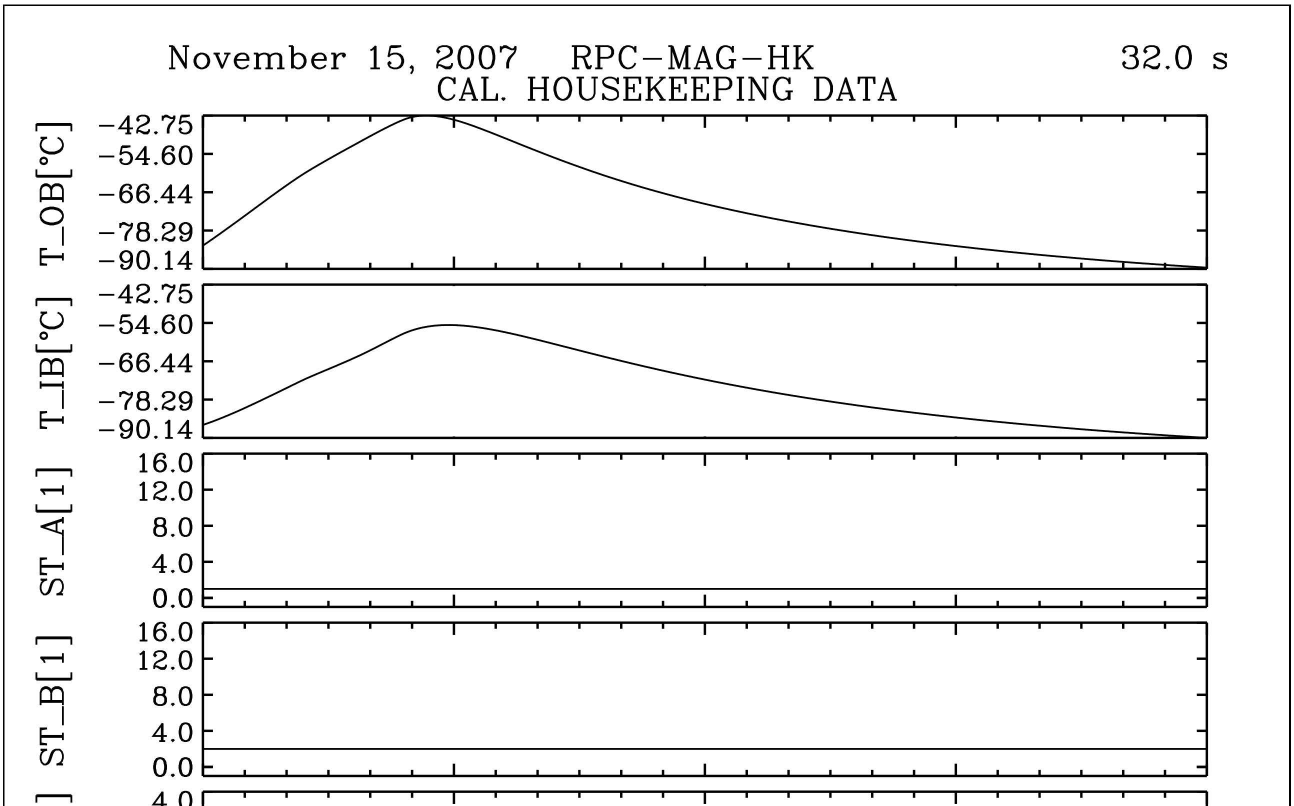


Figure 44: File: RPCMAG071115T0000_CLA_HK_P0000_2400

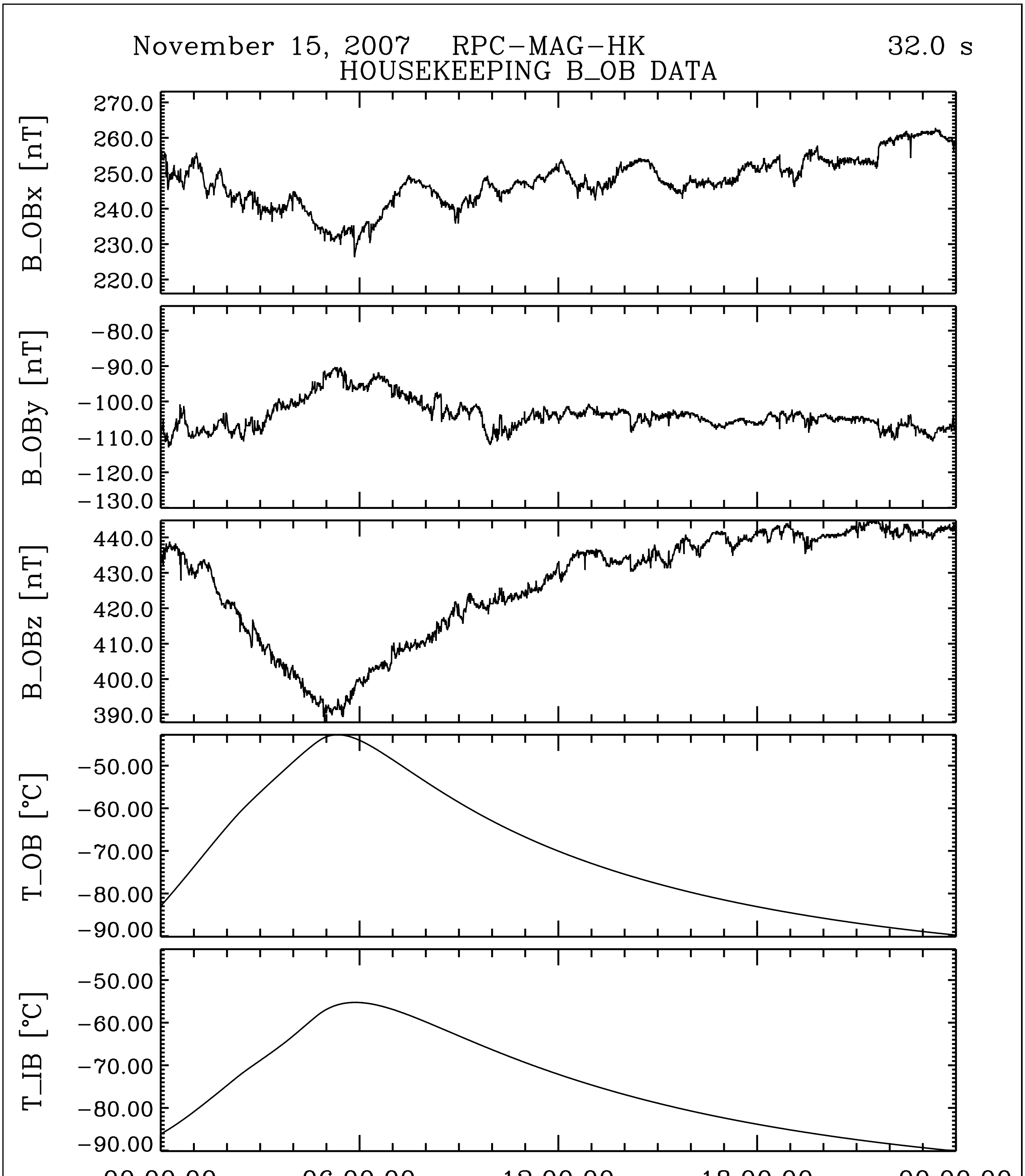


Figure 45: File: RPCMAG071115T0000_CLA_HK_B_P0000_2400

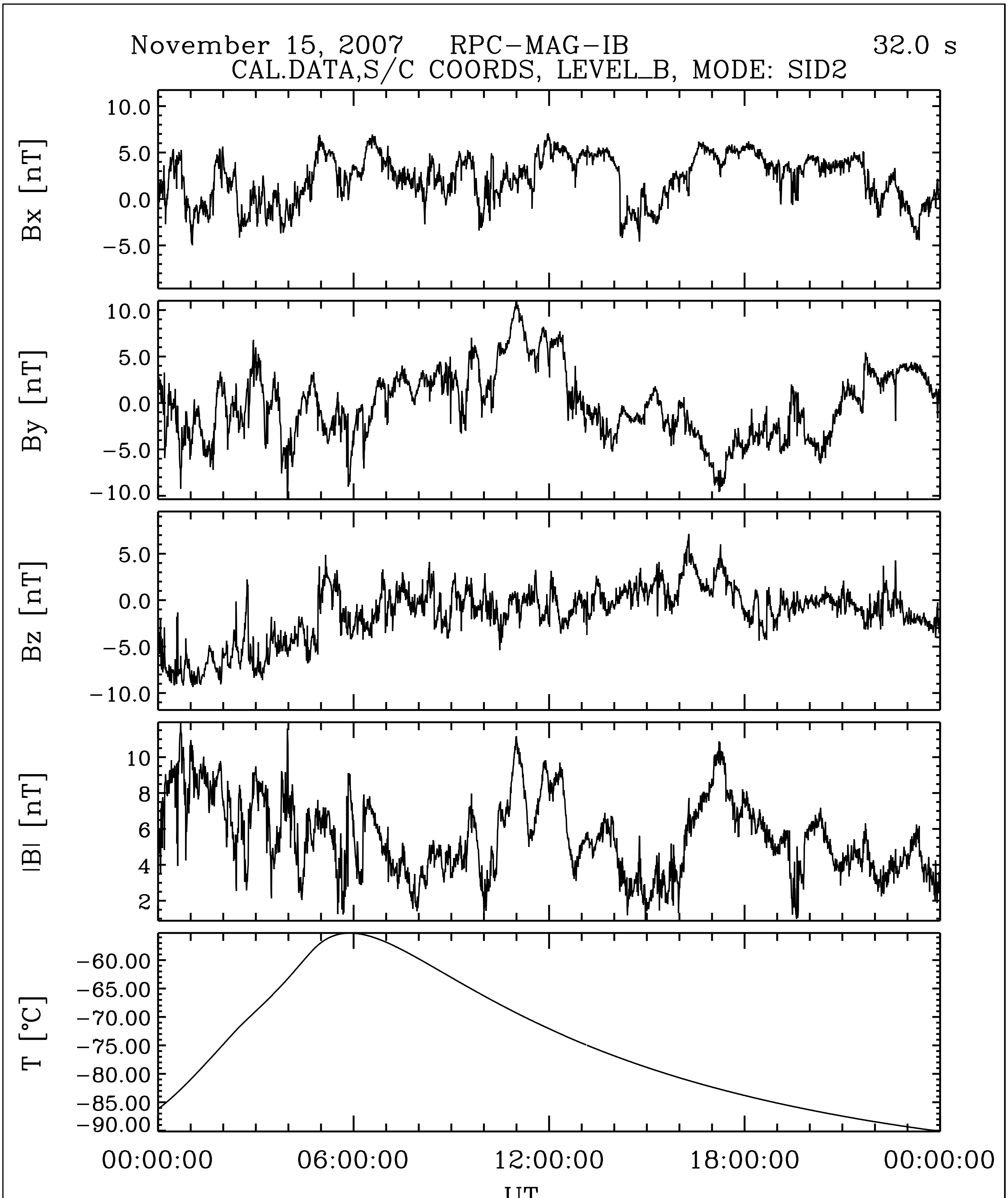


Figure 46: File: RPCMAG071115T0000_CLB_IB_M2_T0000_2400_009

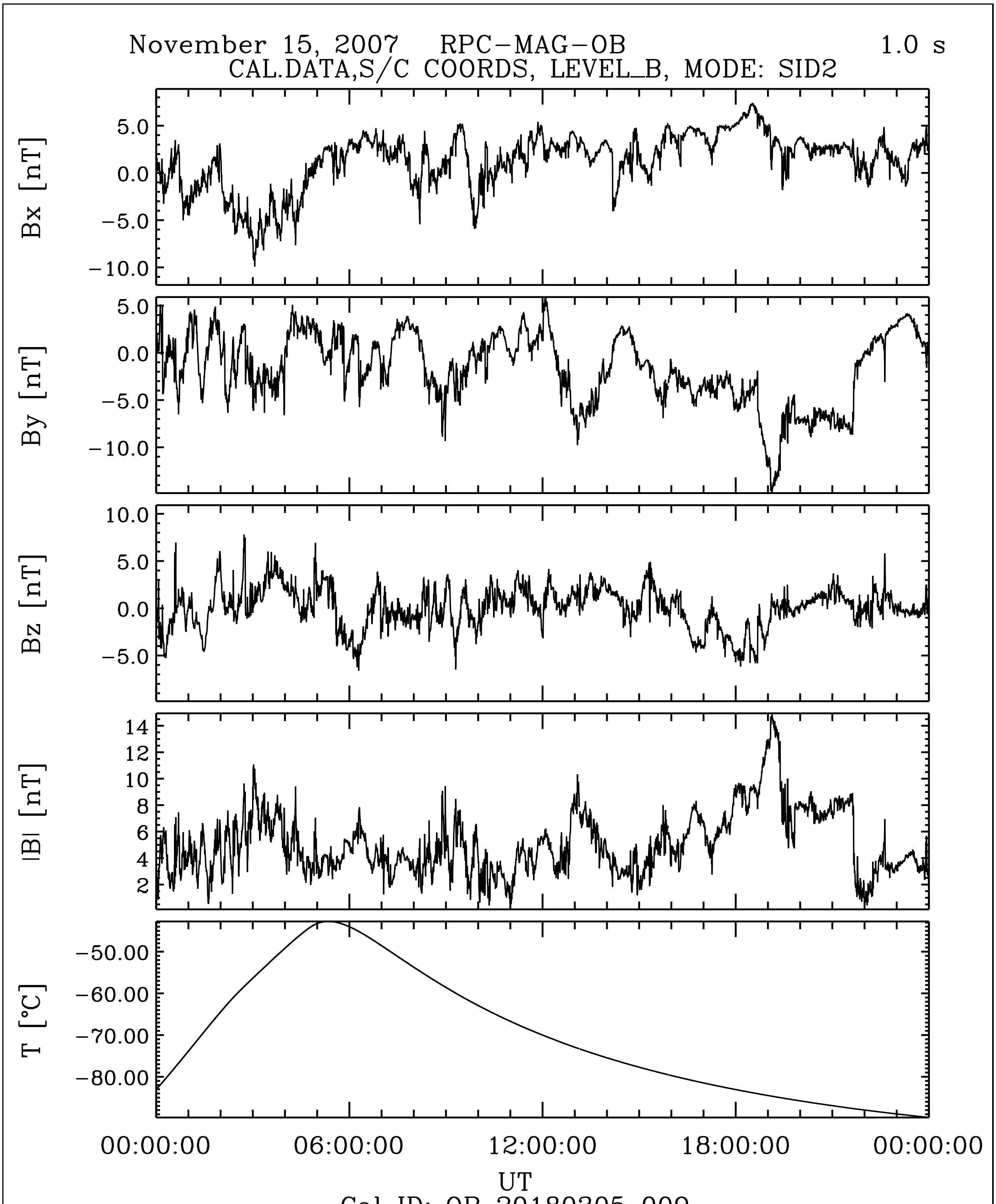


Figure 47: File: RPCMAG071115T0000_CLB_OB_M2_T0000_2400_009

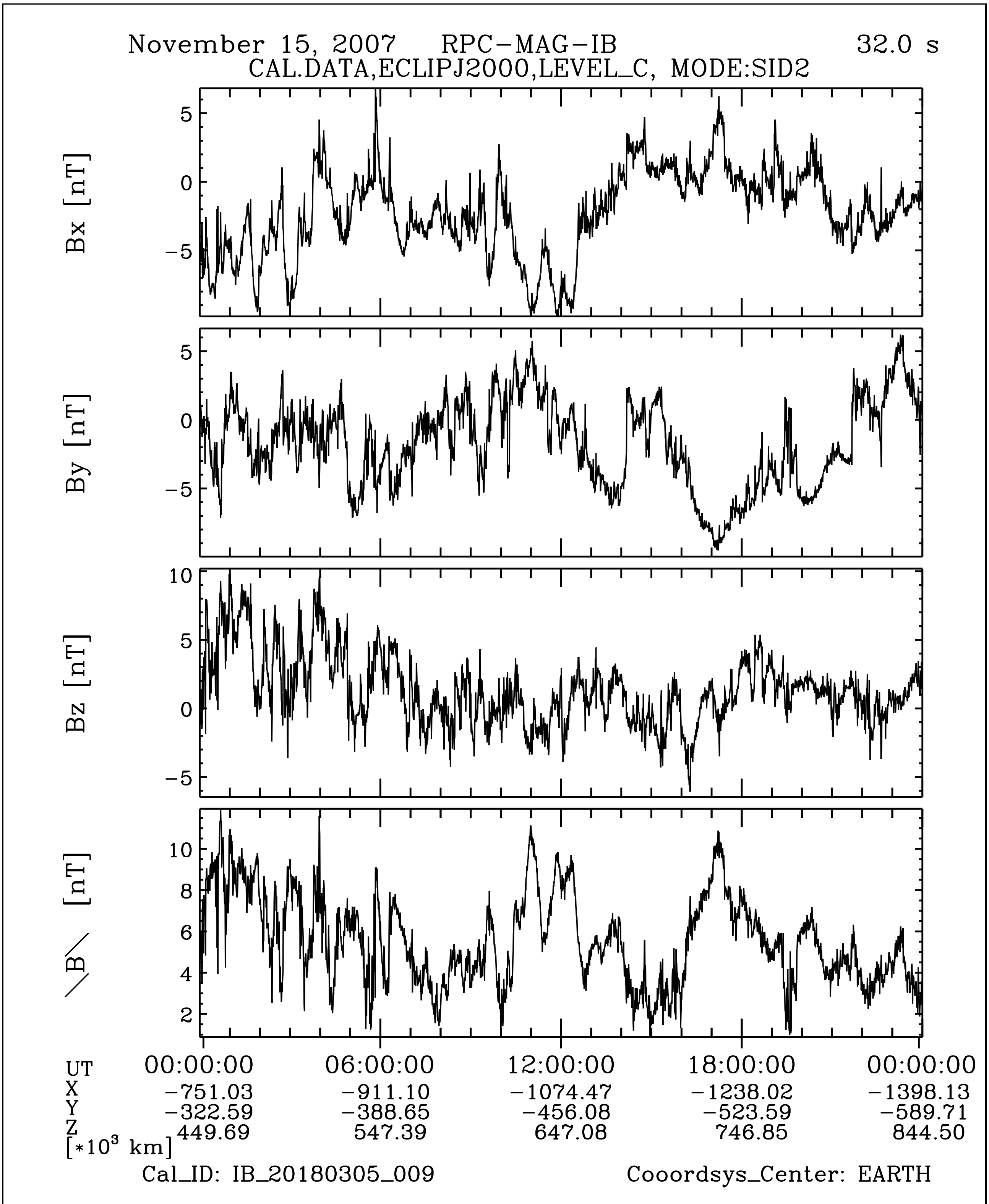


Figure 48: File: RPCMAG071115T0000_CLC_IB_M2_T0000_2400_009

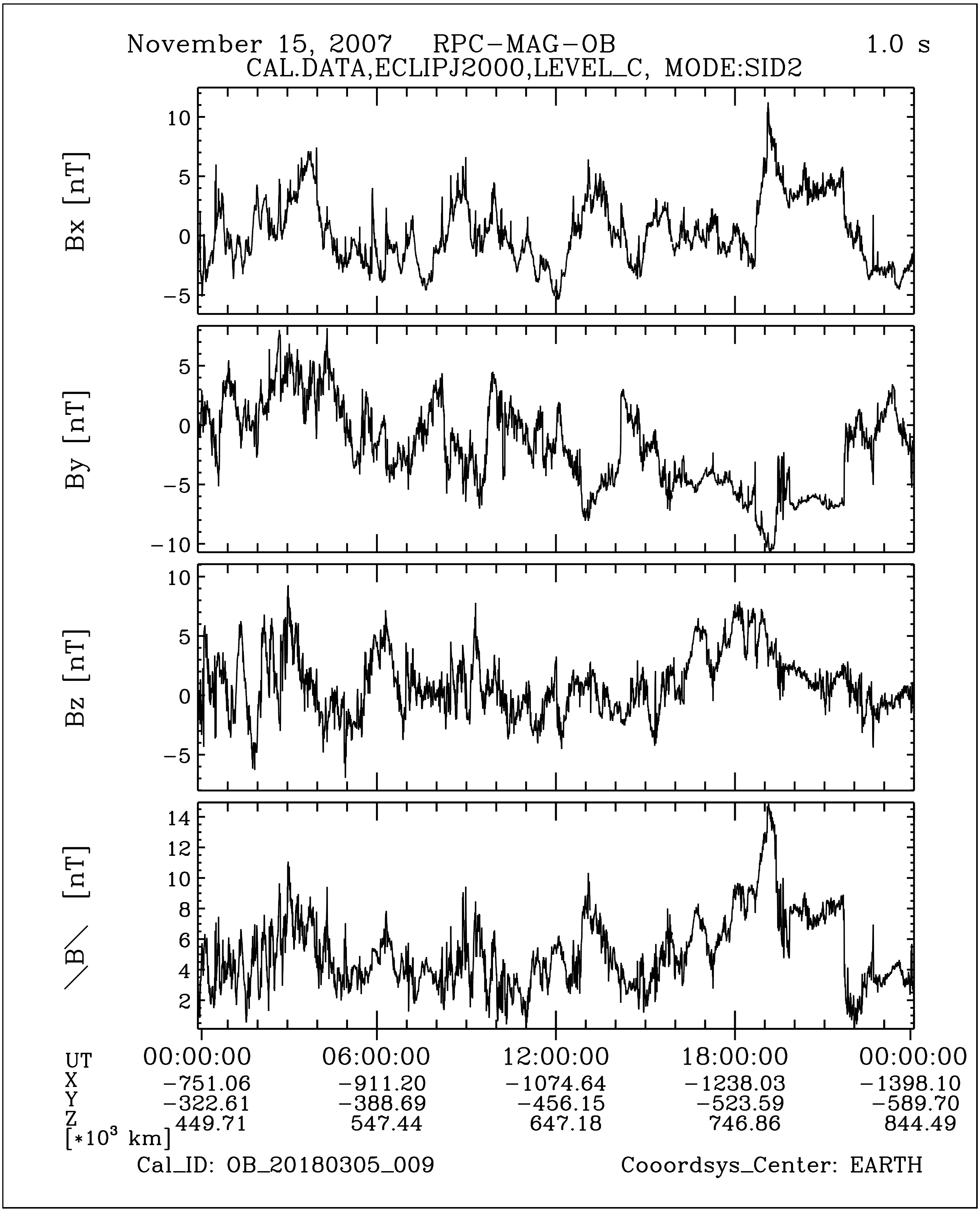


Figure 49: File: RPCMAG071115T0000_CLC_OB_M2_T0000_2400_009

## 3.8 November 16, 2007:

### 3.8.1 Actions

MAG stayed in SID 2.No problems occurred.

### 3.8.2 Plots of Calibrated Data

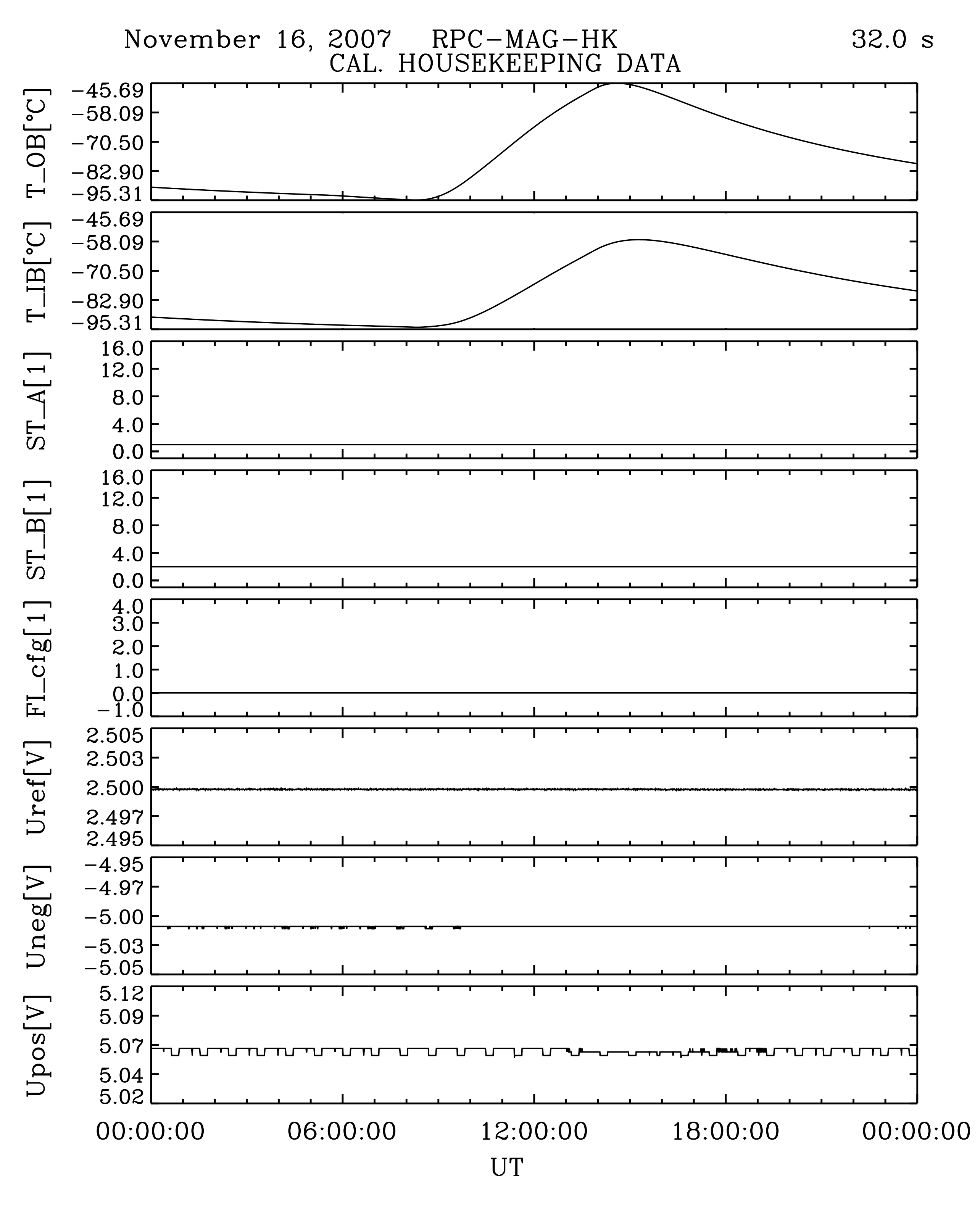


Figure 50: File: RPCMAG071116T0000_CLA_HK_P0000_2400

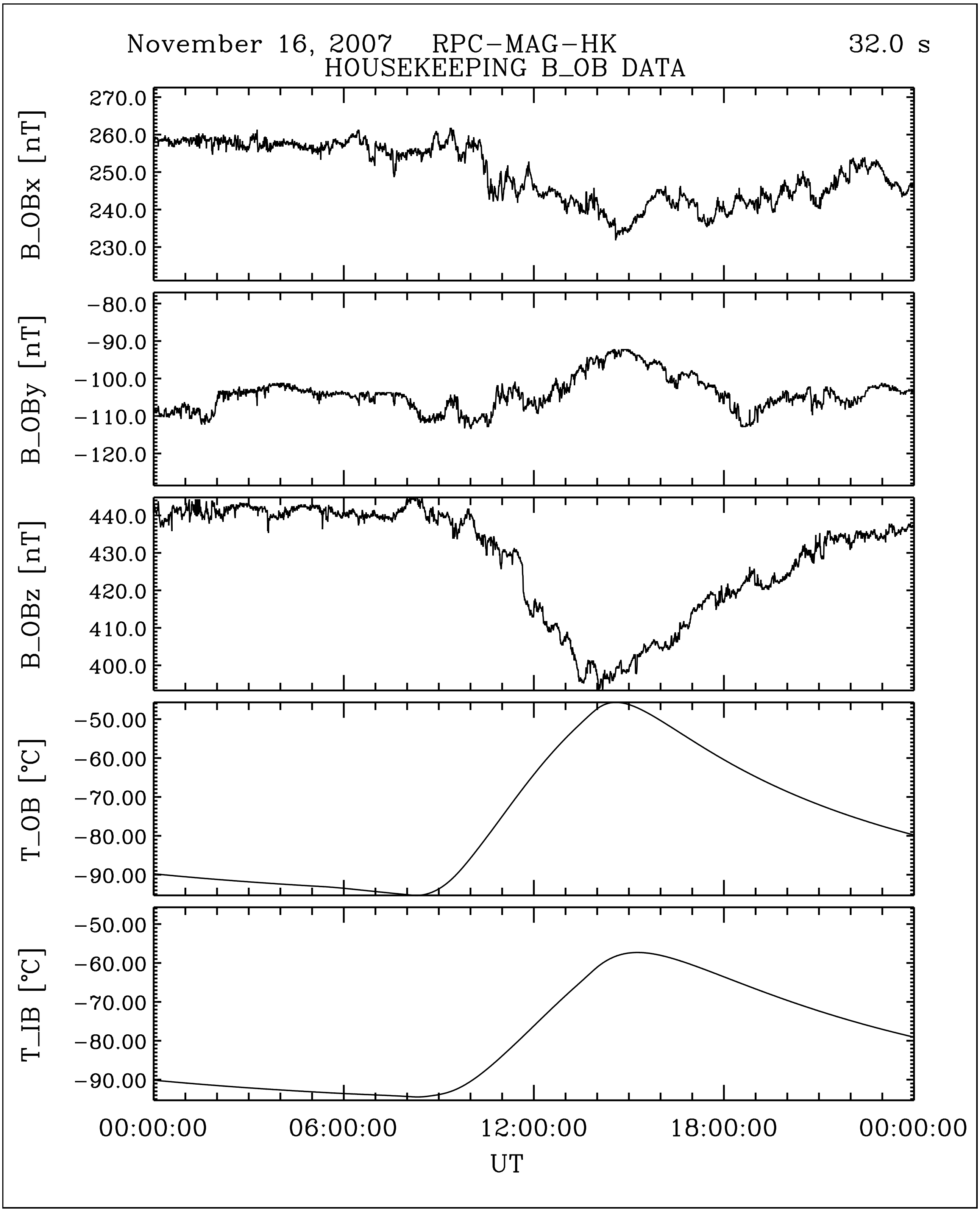


Figure 51: File: RPCMAG071116T0000_CLA_HK_B_P0000_2400

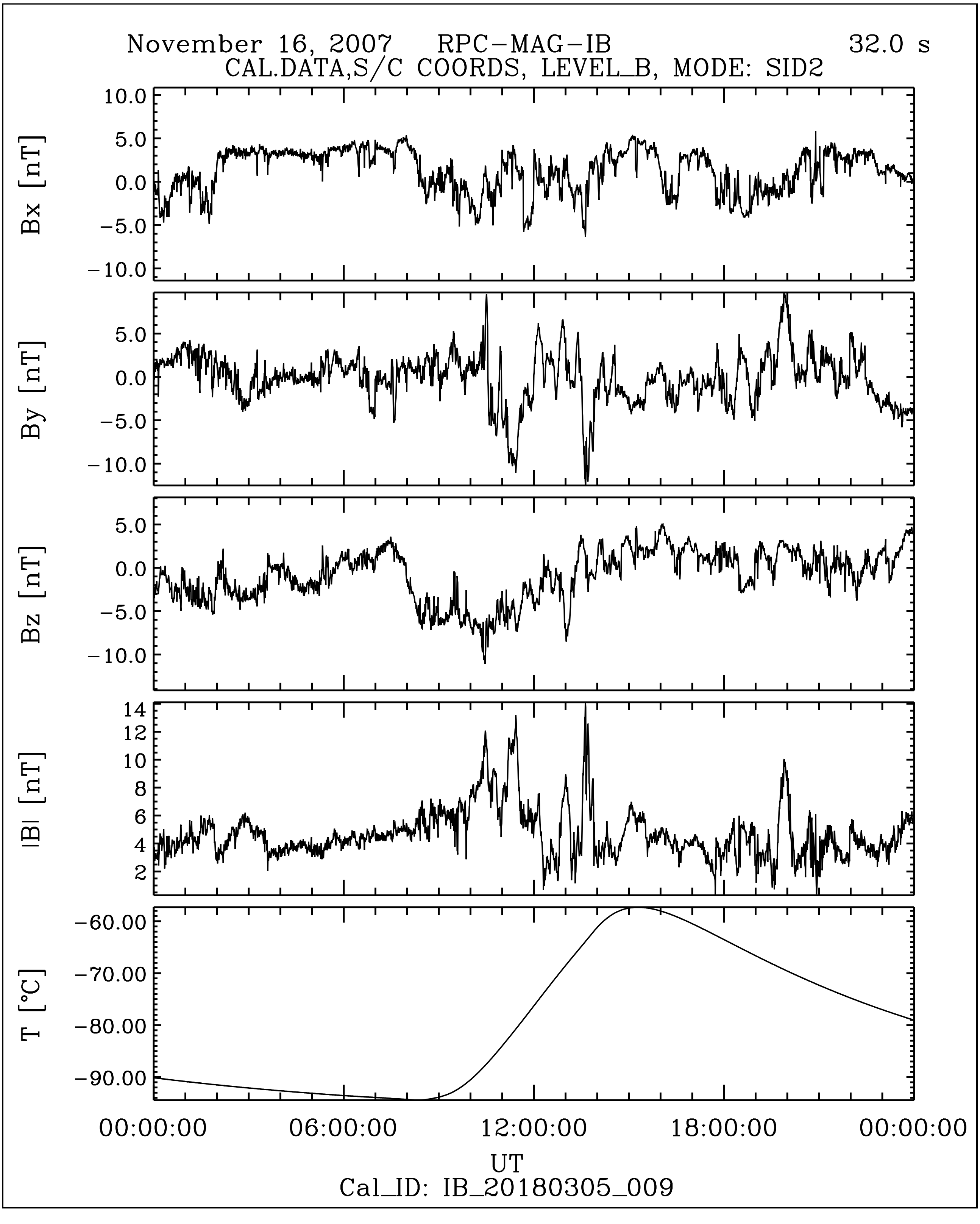


Figure 52: File: RPCMAG071116T0000_CLB_IB_M2_T0000_2400_009

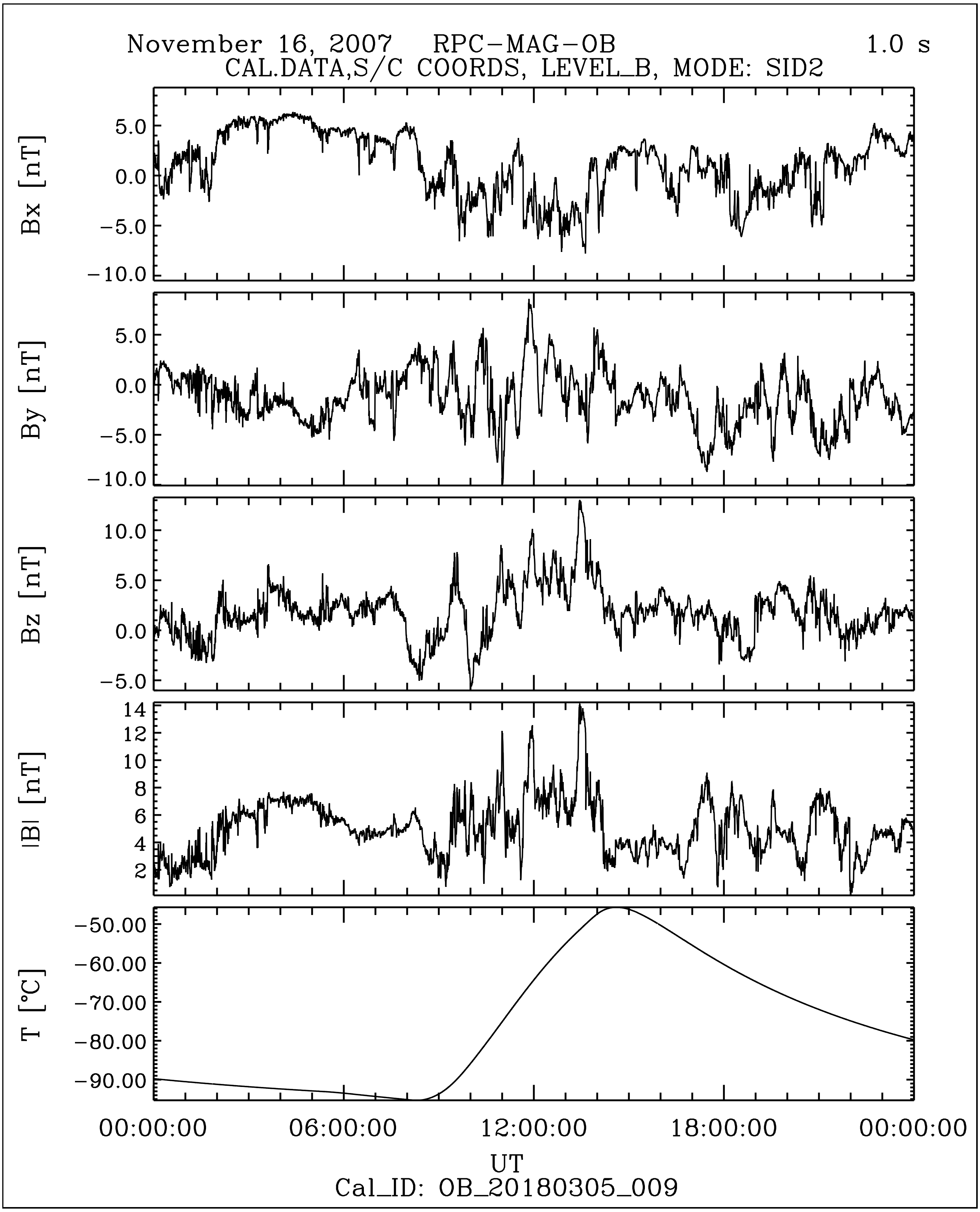


Figure 53: File: RPCMAG071116T0000_CLB_OB_M2_T0000_2400_009

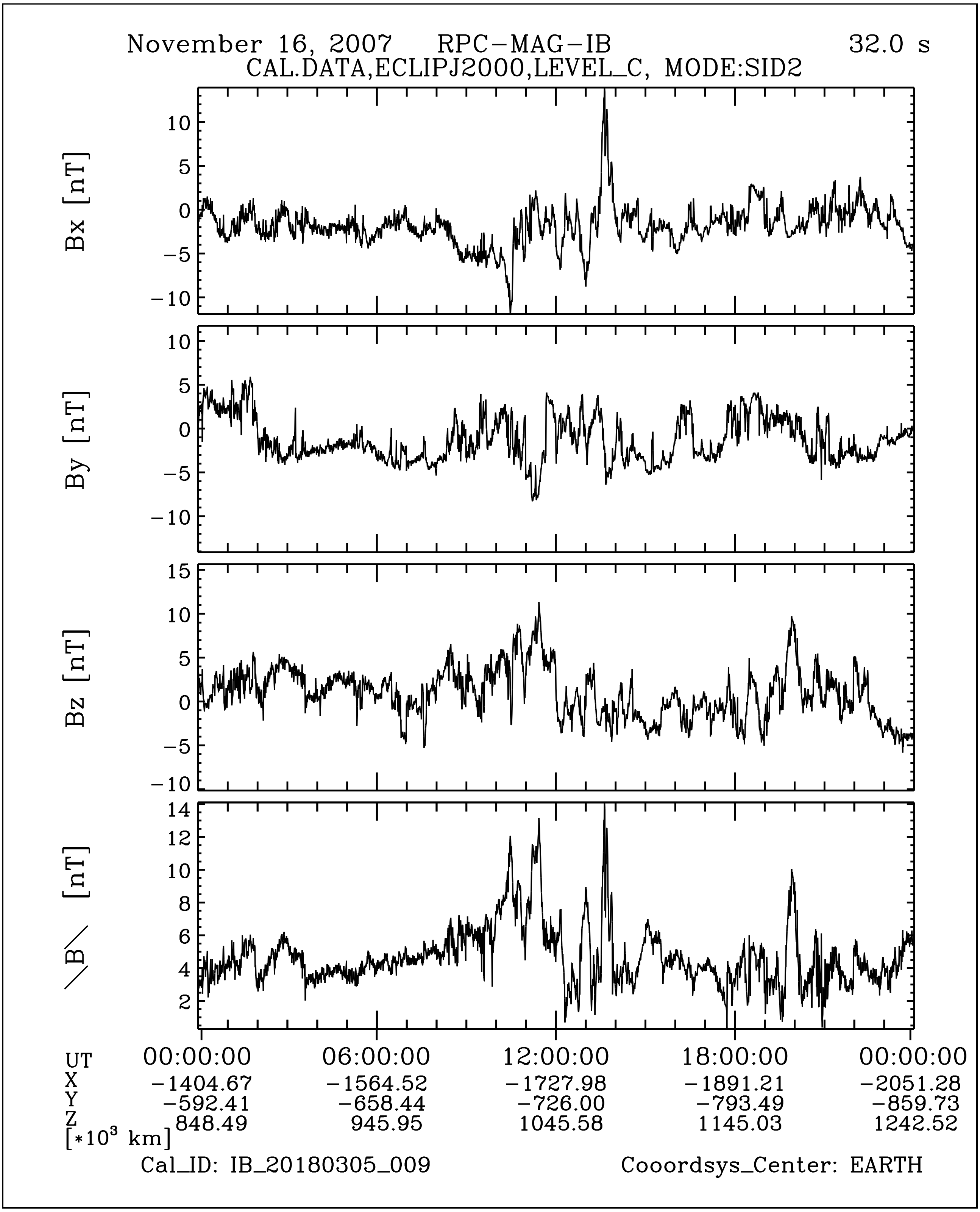


Figure 54: File: RPCMAG071116T0000_CLC_IB_M2_T0000_2400_009

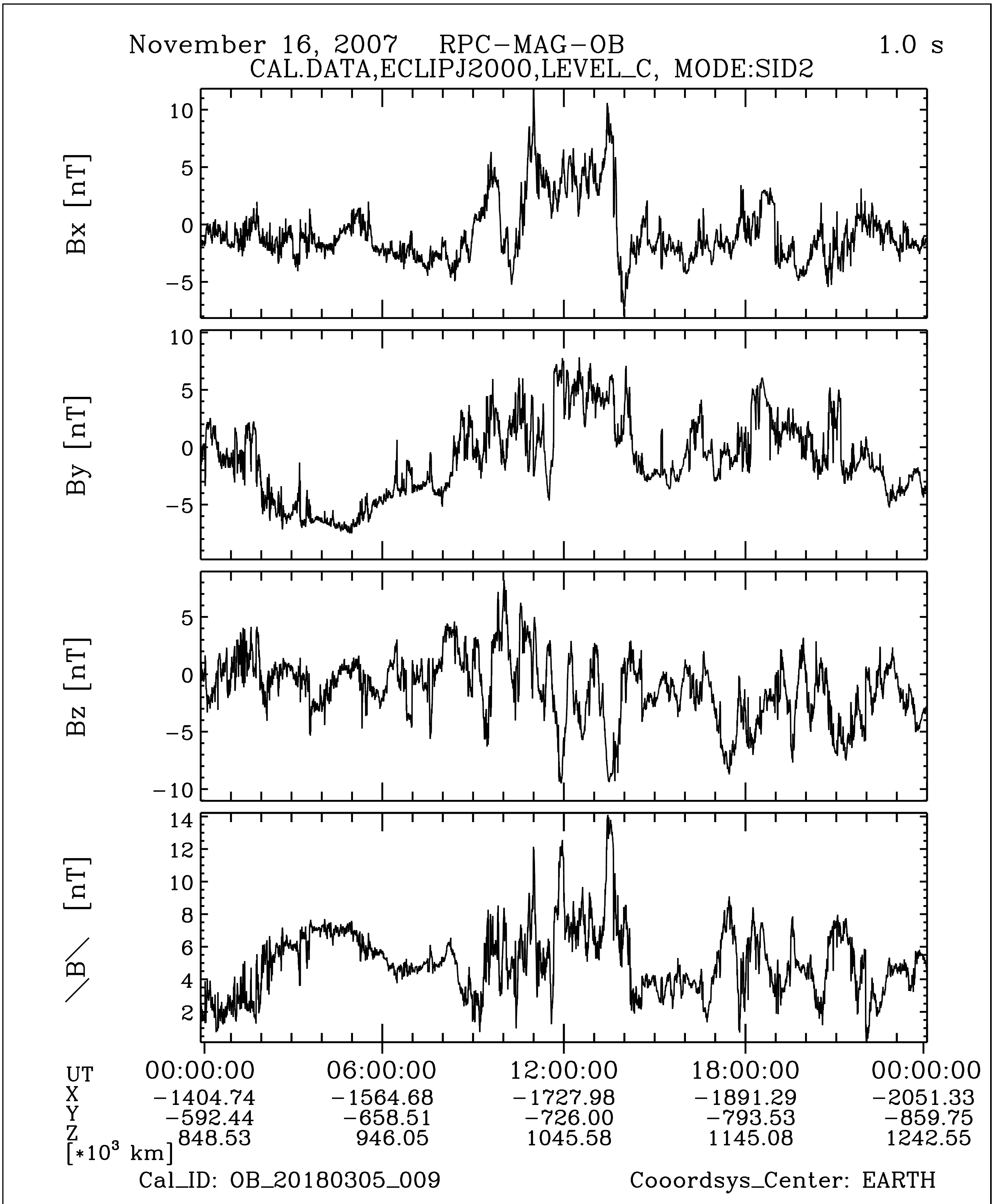


Figure 55: File: RPCMAG071116T0000_CLC_OB_M2_T0000_2400_009

## 3.9 November 17, 2007:

### 3.9.1 Actions

MAG stayed in SID 2.No problems occurred.

### 3.9.2 Plots of Calibrated Data

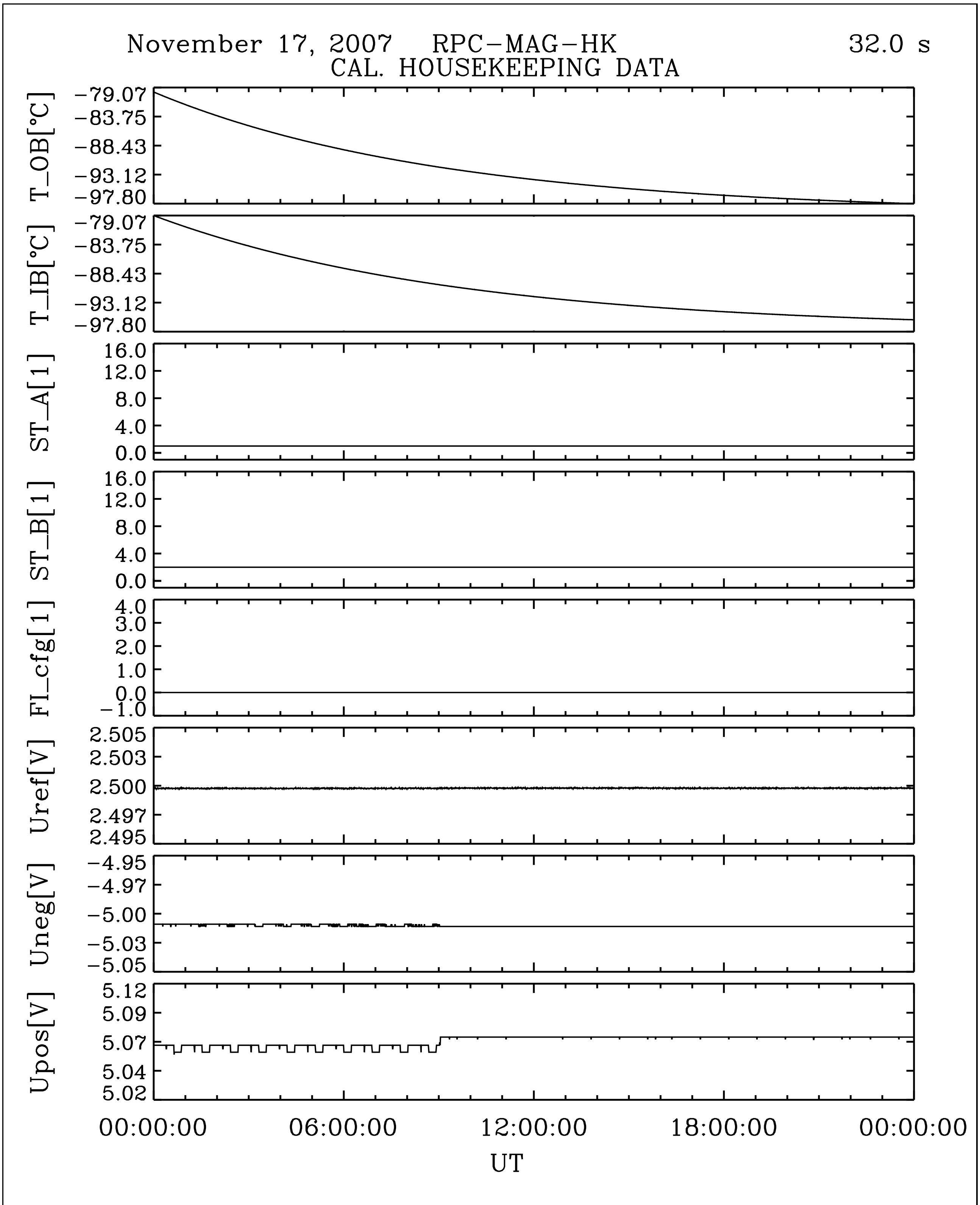


Figure 56: File: RPCMAG071117T0000_CLA_HK_P0000_2400

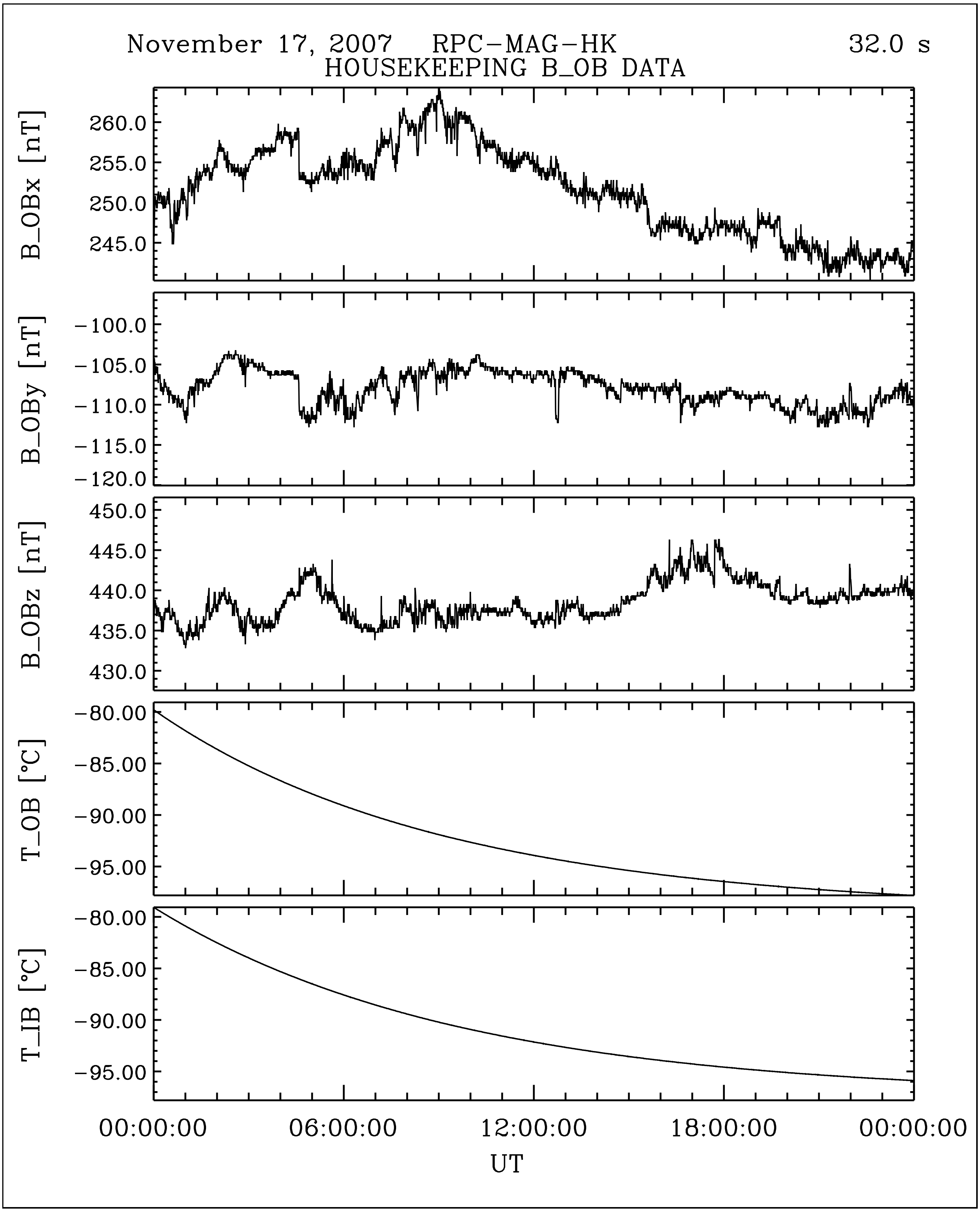


Figure 57: File: RPCMAG071117T0000_CLA_HK_B_P0000_2400

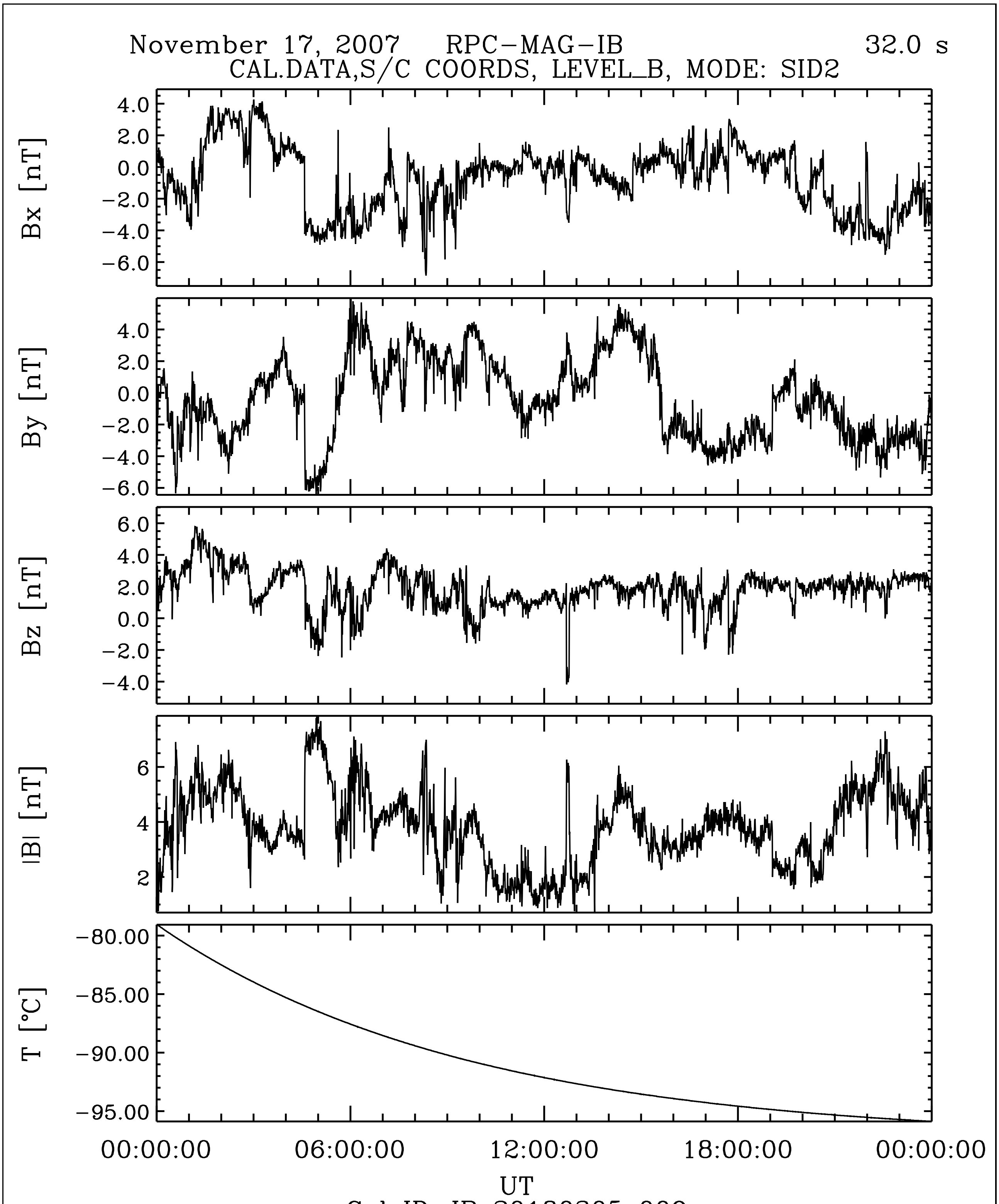


Figure 58: File: RPCMAG071117T0000_CLB_IB_M2_T0000_2400_009

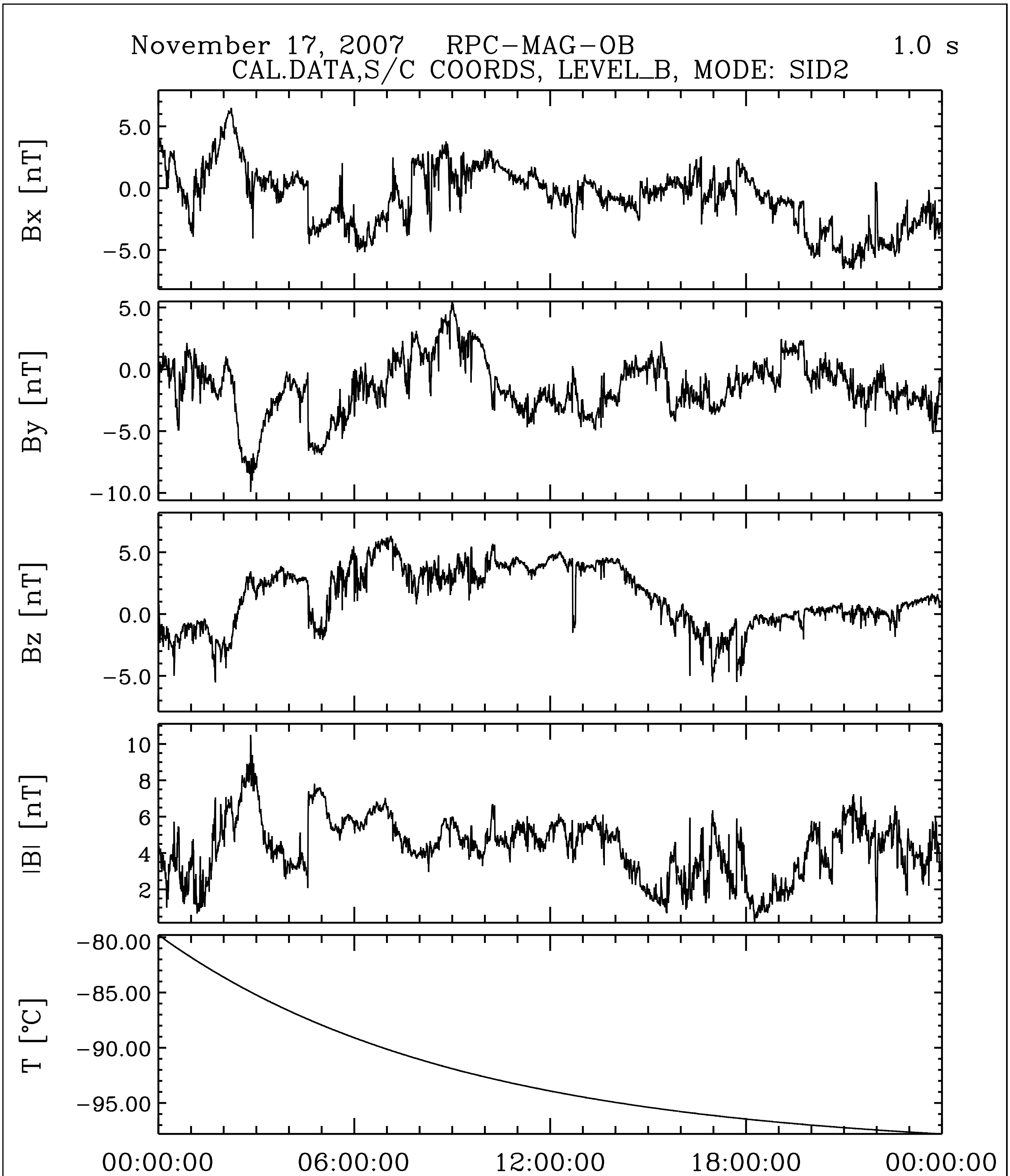


Figure 59: File: RPCMAG071117T0000_CLB_OB_M2_T0000_2400_009

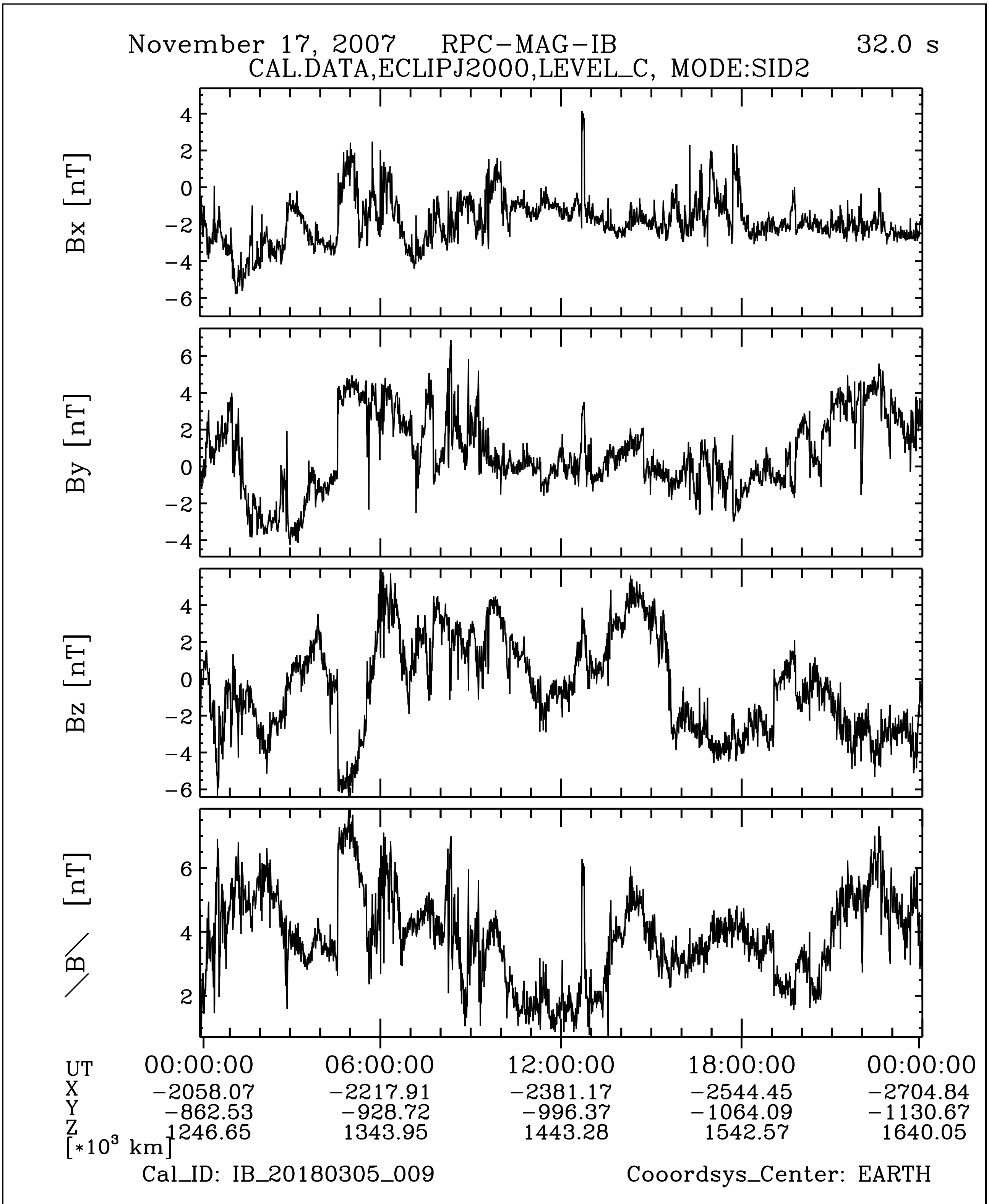


Figure 60: File: RPCMAG071117T0000_CLC_IB_M2_T0000_2400_009

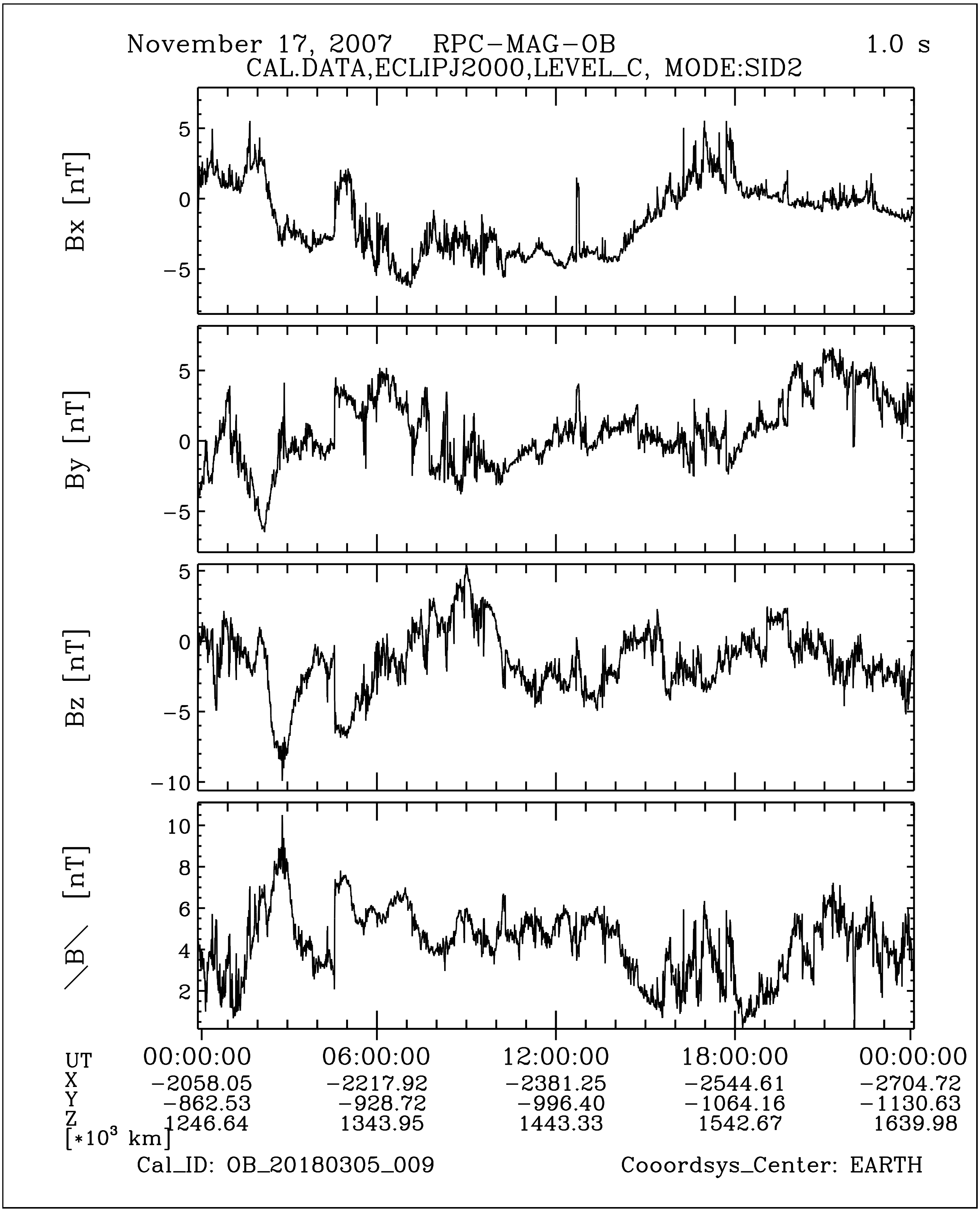


Figure 61: File: RPCMAG071117T0000_CLC_OB_M2_T0000_2400_009

## 3.10 November 18, 2007:

### 3.10.1 Actions

MAG stayed in SID 2.No problems occurred.

### 3.10.2 Plots of Calibrated Data

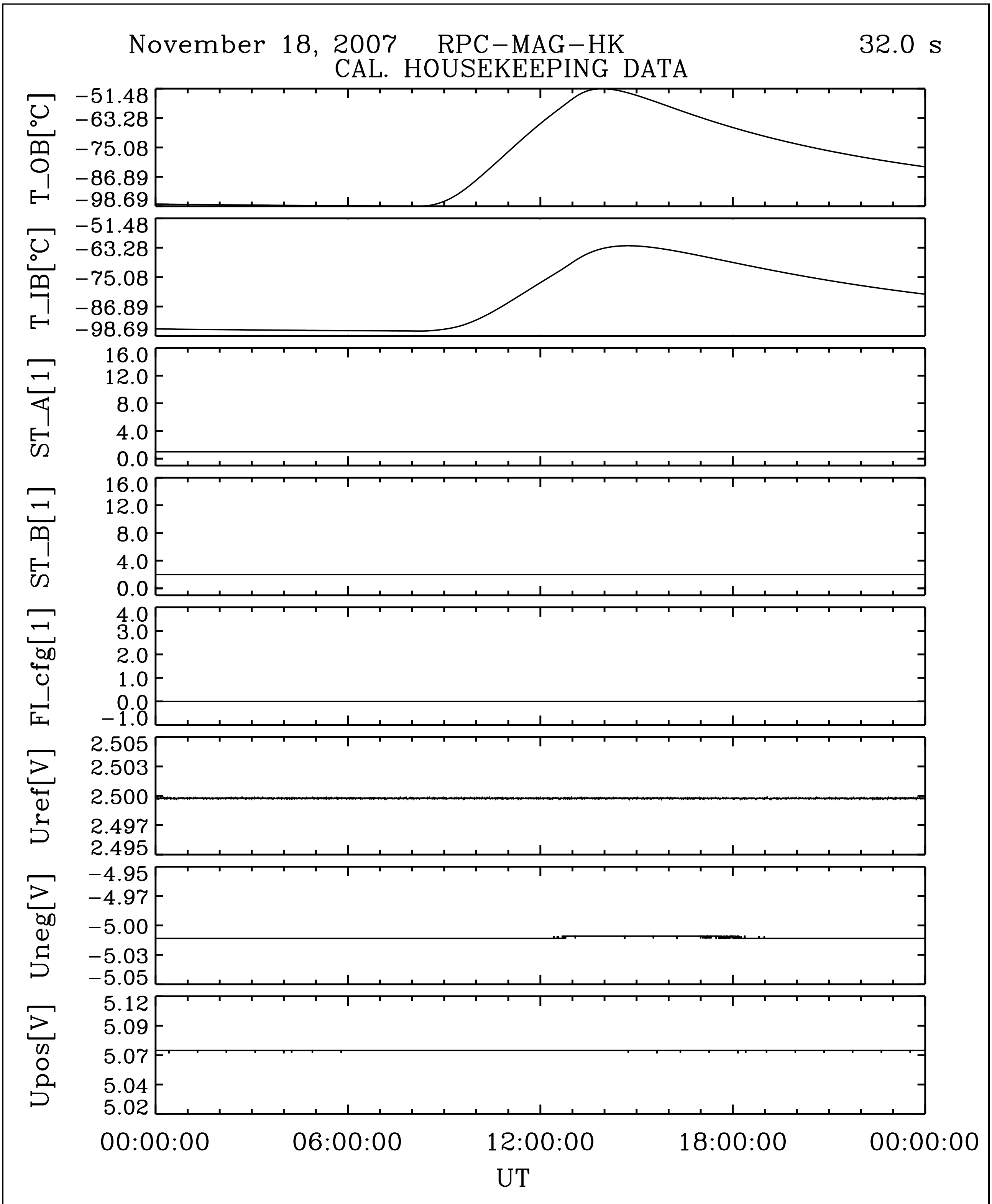


Figure 62: File: RPCMAG071118T0000_CLA_HK_P0000_2400

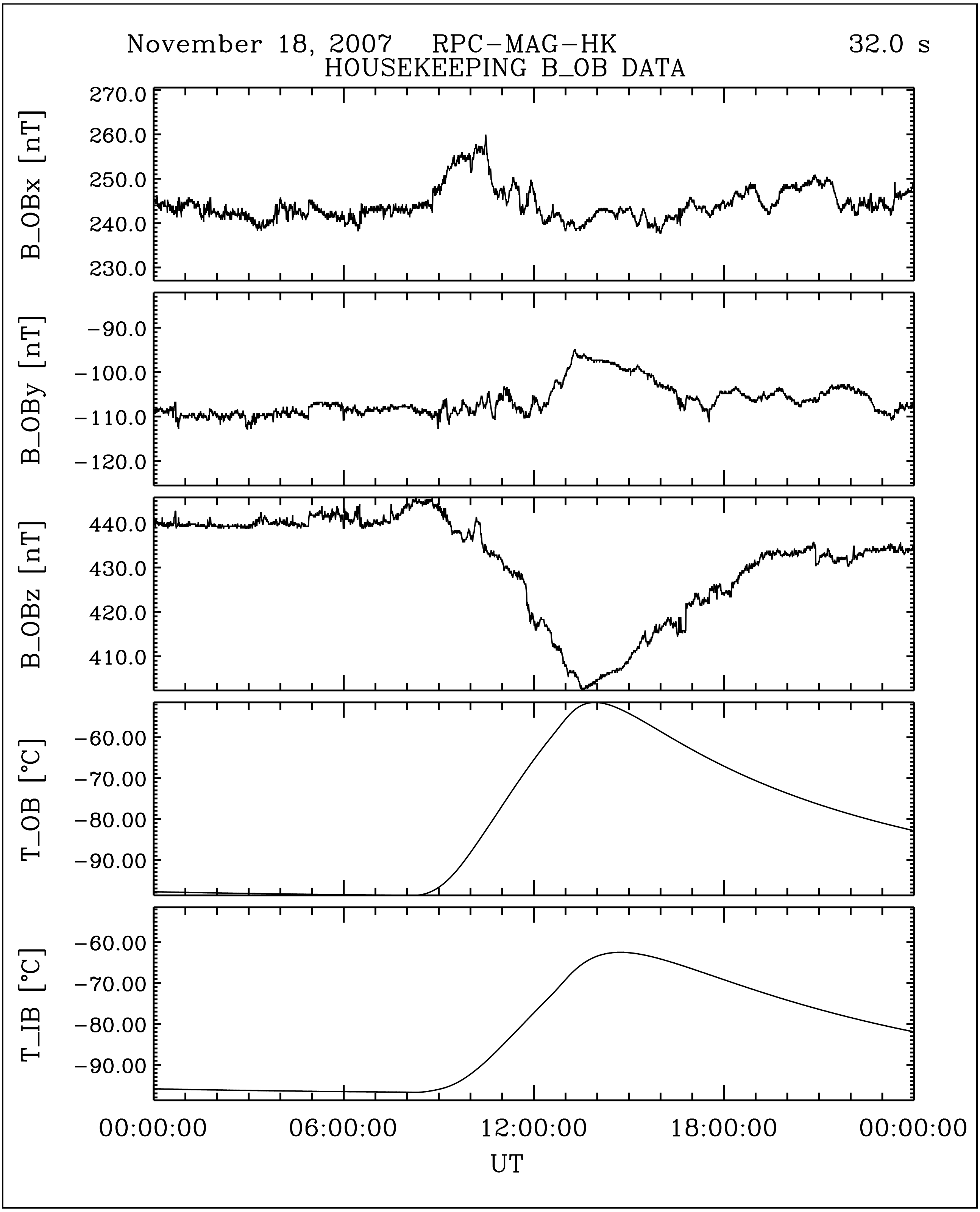


Figure 63: File: RPCMAG071118T0000_CLA_HK_B_P0000_2400

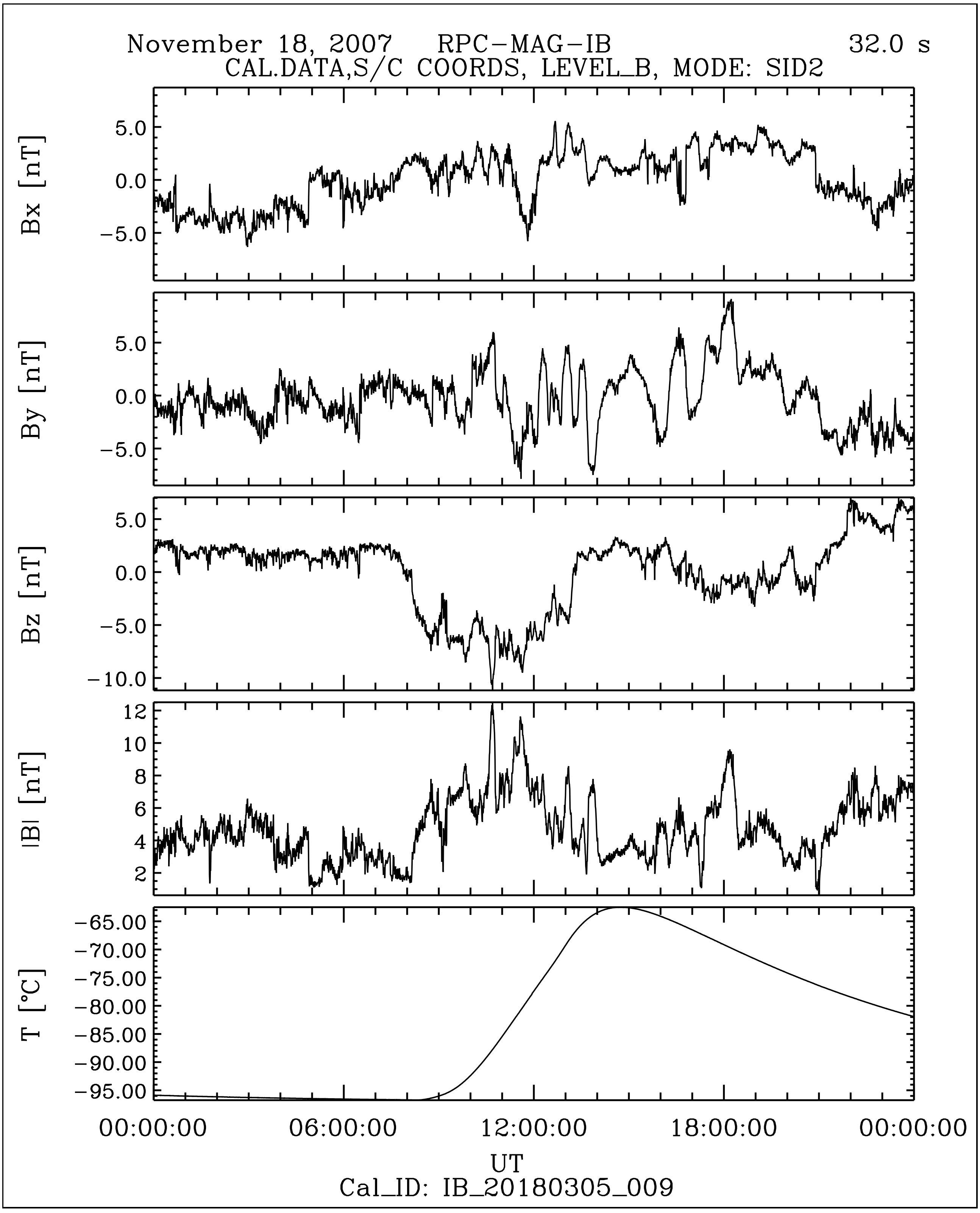


Figure 64: File: RPCMAG071118T0000_CLB_IB_M2_T0000_2400_009

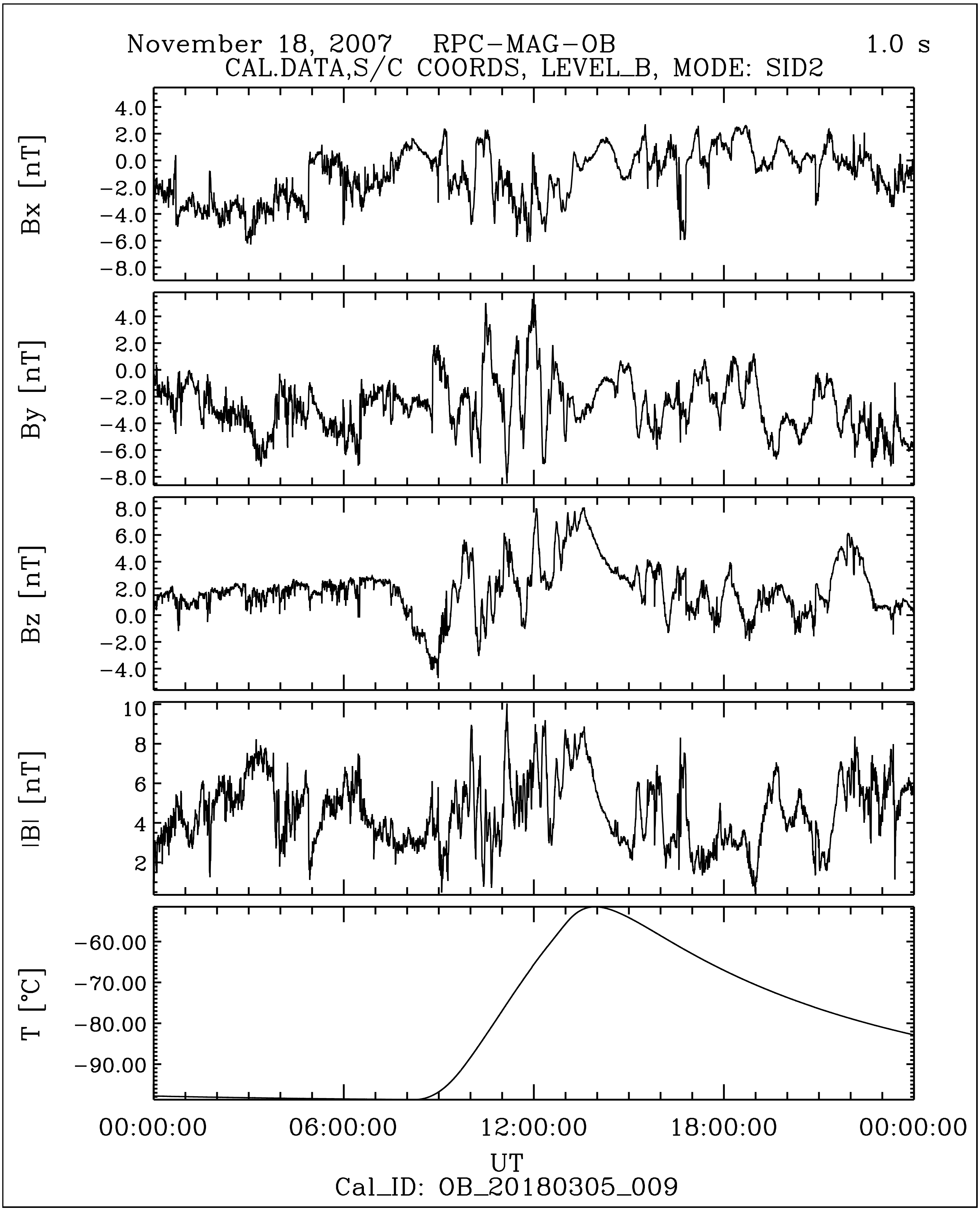


Figure 65: File: RPCMAG071118T0000_CLB_OB_M2_T0000_2400_009

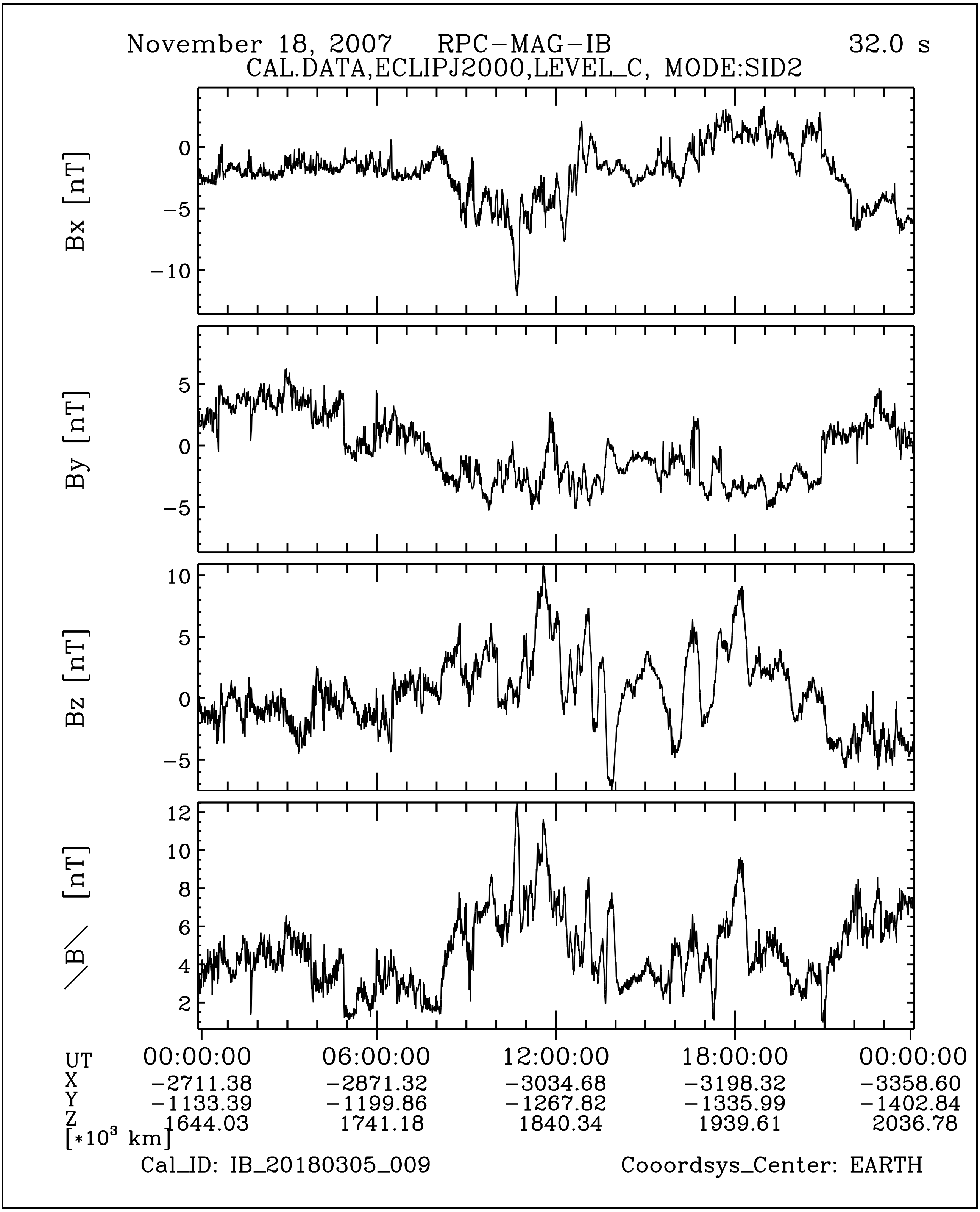


Figure 66: File: RPCMAG071118T0000_CLC_IB_M2_T0000_2400_009

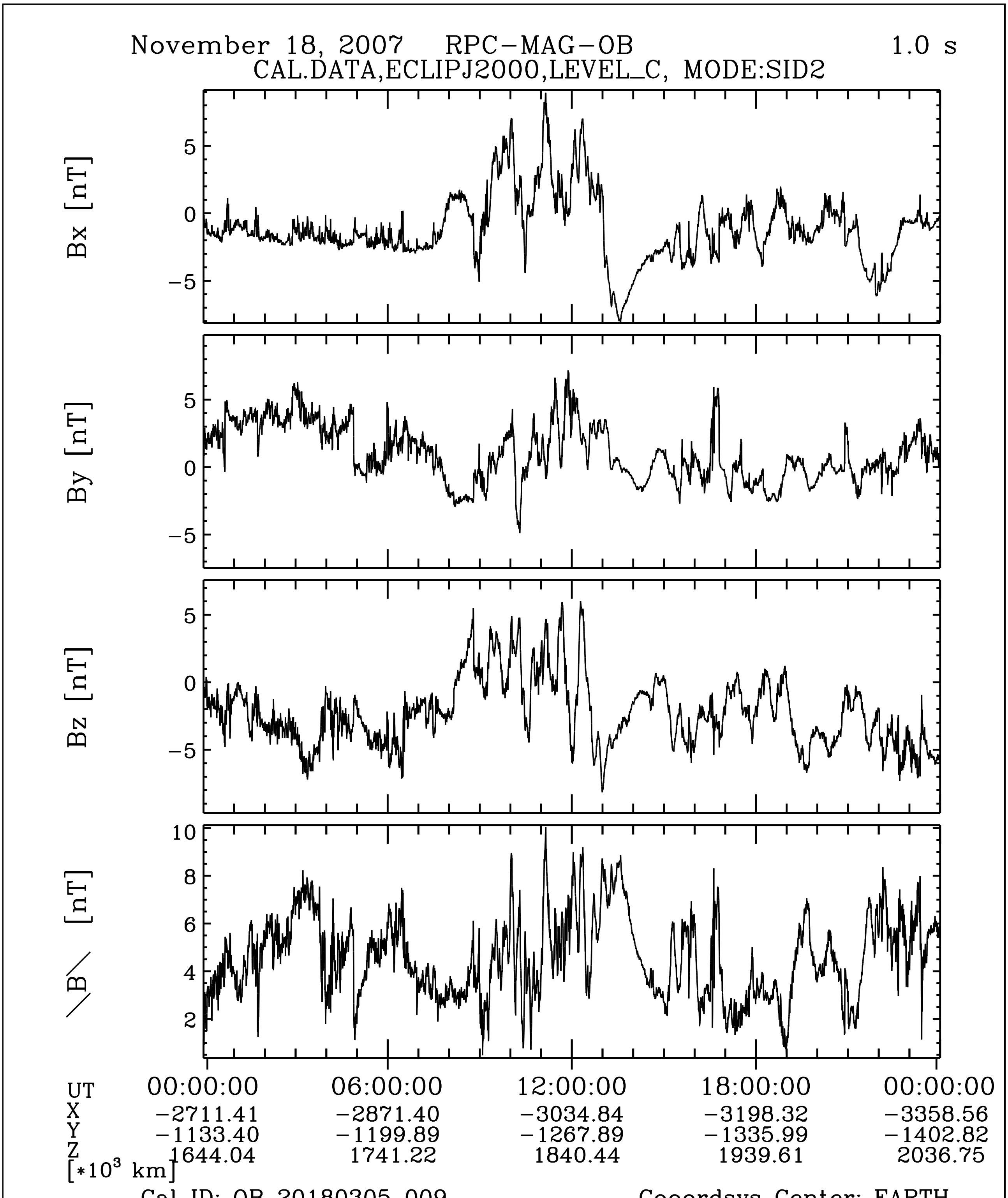


Figure 67: File: RPCMAG071118T0000_CLC_OB_M2_T0000_2400_009

## 3.11 November 19, 2007:

### 3.11.1 Actions

MAG stayed in SID 2.No problems occurred.

### 3.11.2 Plots of Calibrated Data

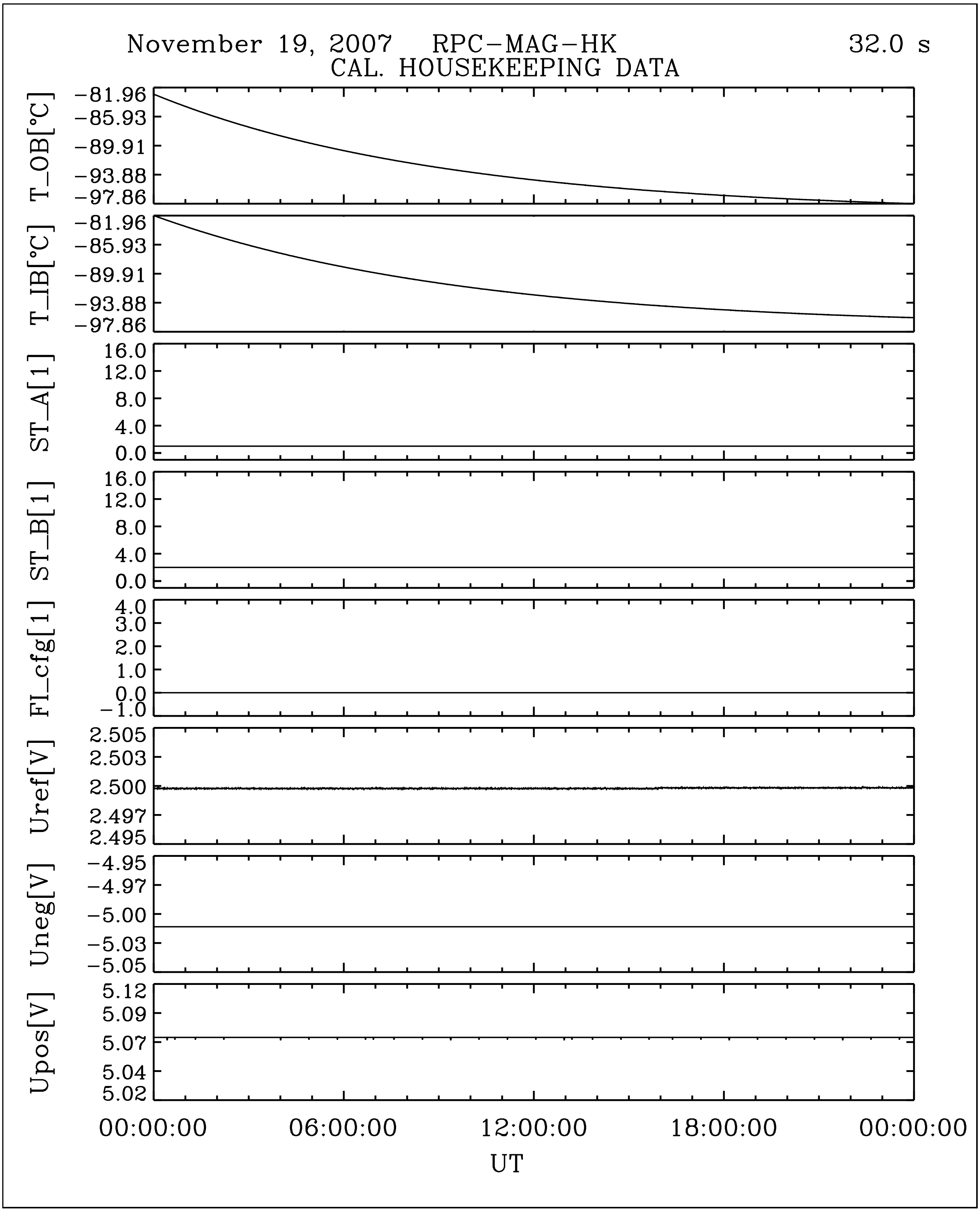


Figure 68: File: RPCMAG071119T0000_CLA_HK_P0000_2400

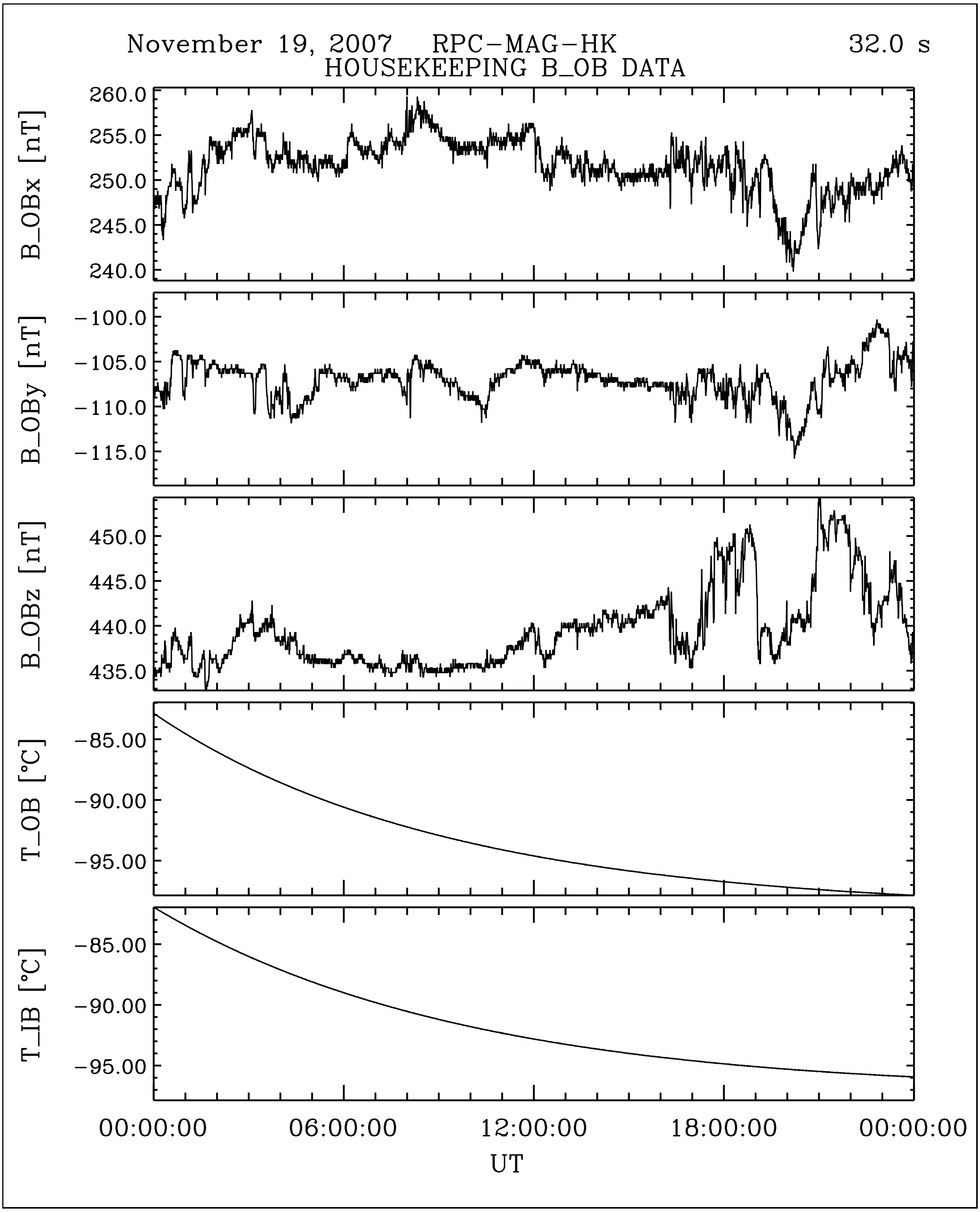


Figure 69: File: RPCMAG071119T0000_CLA_HK_B_P0000_2400

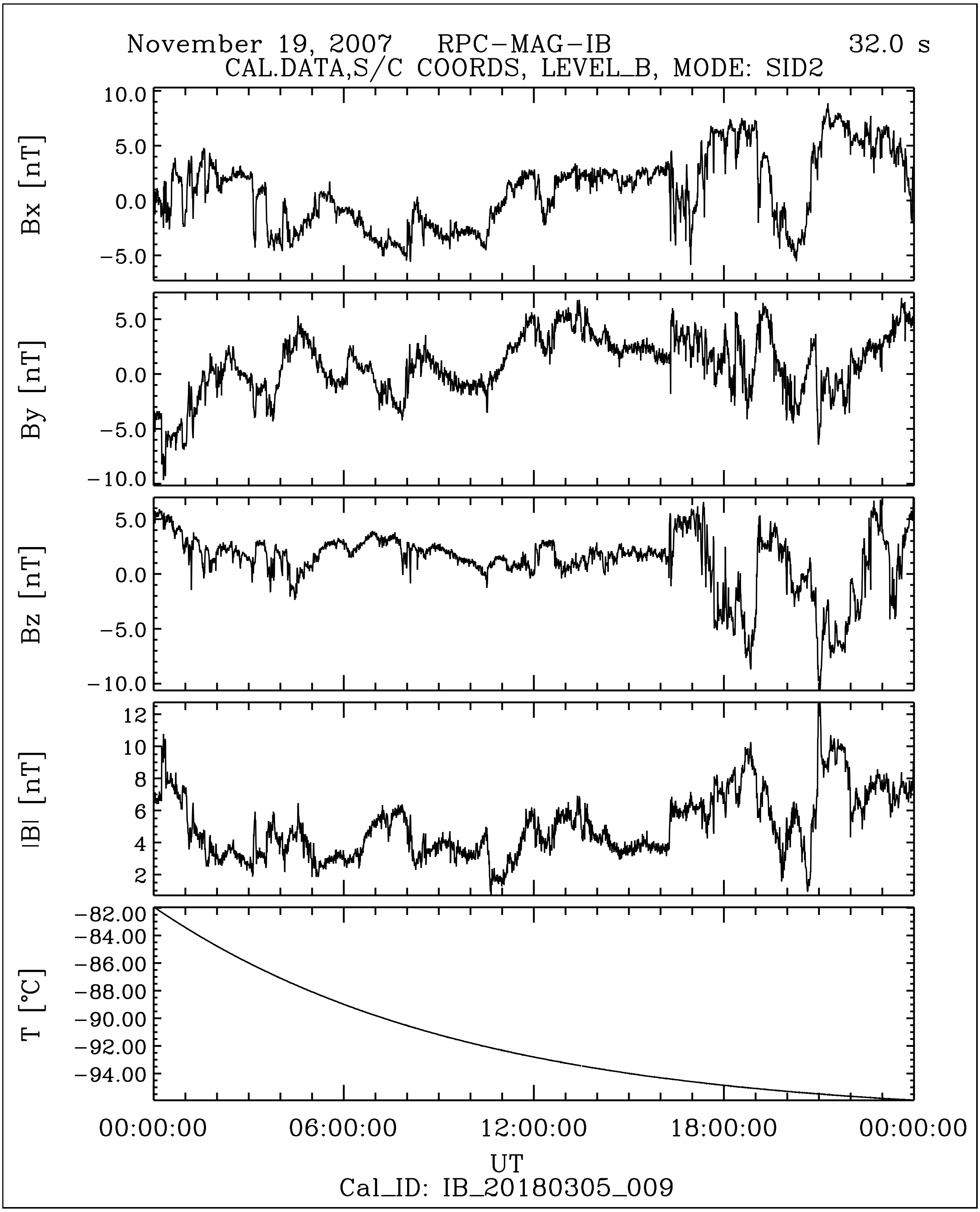


Figure 70: File: RPCMAG071119T0000_CLB_IB_M2_T0000_2400_009

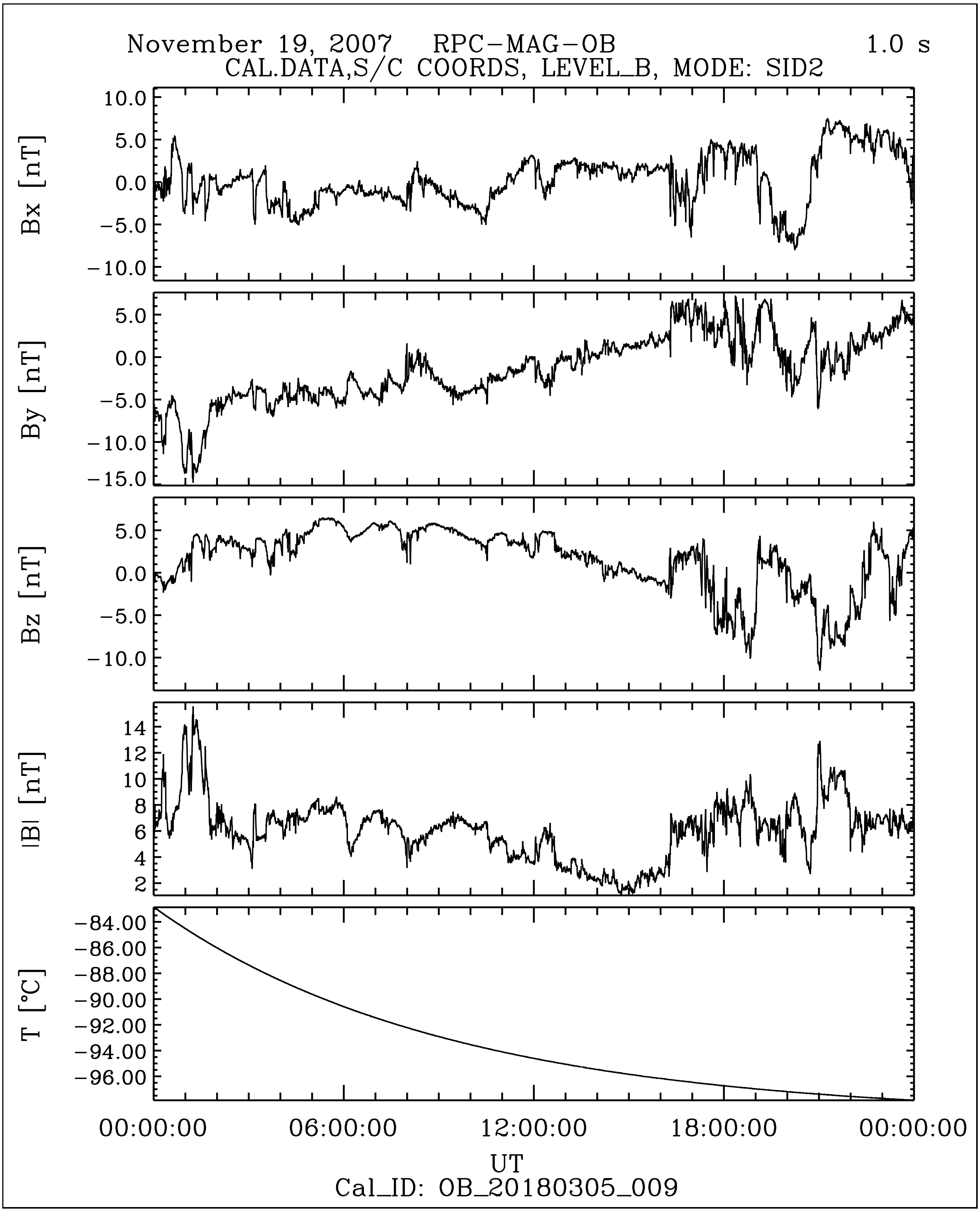


Figure 71: File: RPCMAG071119T0000_CLB_OB_M2_T0000_2400_009

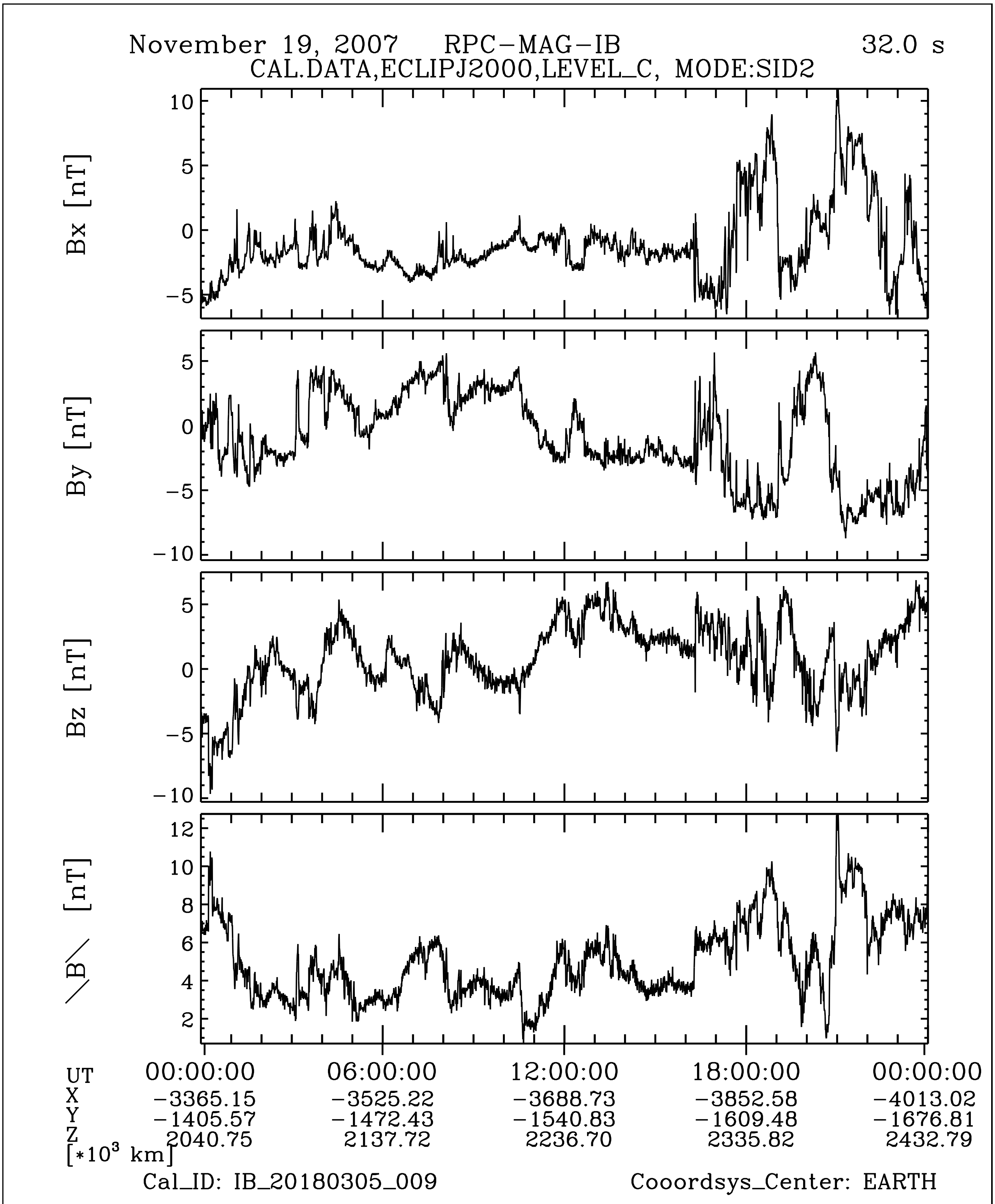


Figure 72: File: RPCMAG071119T0000_CLC_IB_M2_T0000_2400_009

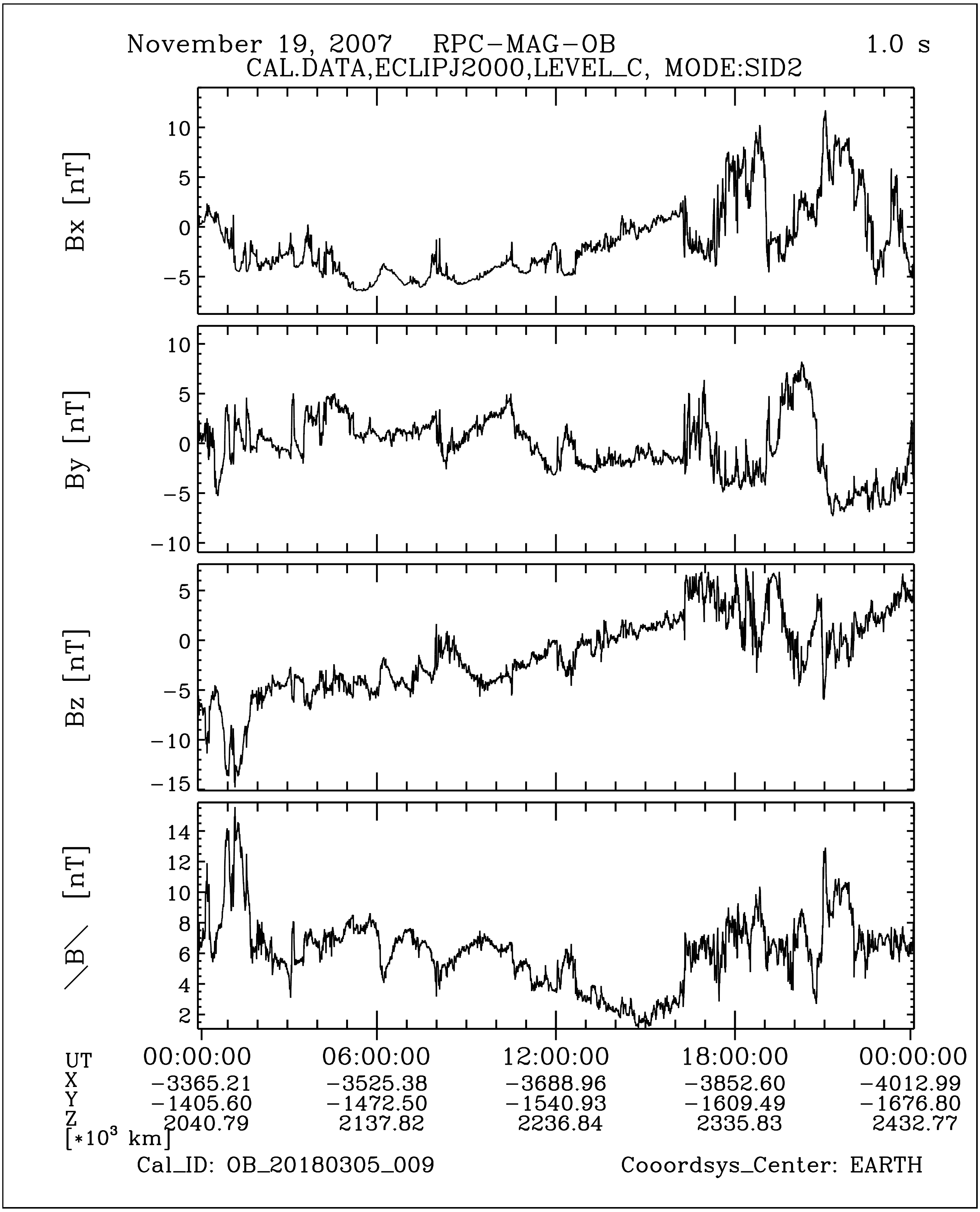


Figure 73: File: RPCMAG071119T0000_CLC_OB_M2_T0000_2400_009

## 3.12 November 20, 2007:

### 3.12.1 Actions

MAG stayed in SID 2.No problems occurred.

### 3.12.2 Plots of Calibrated Data

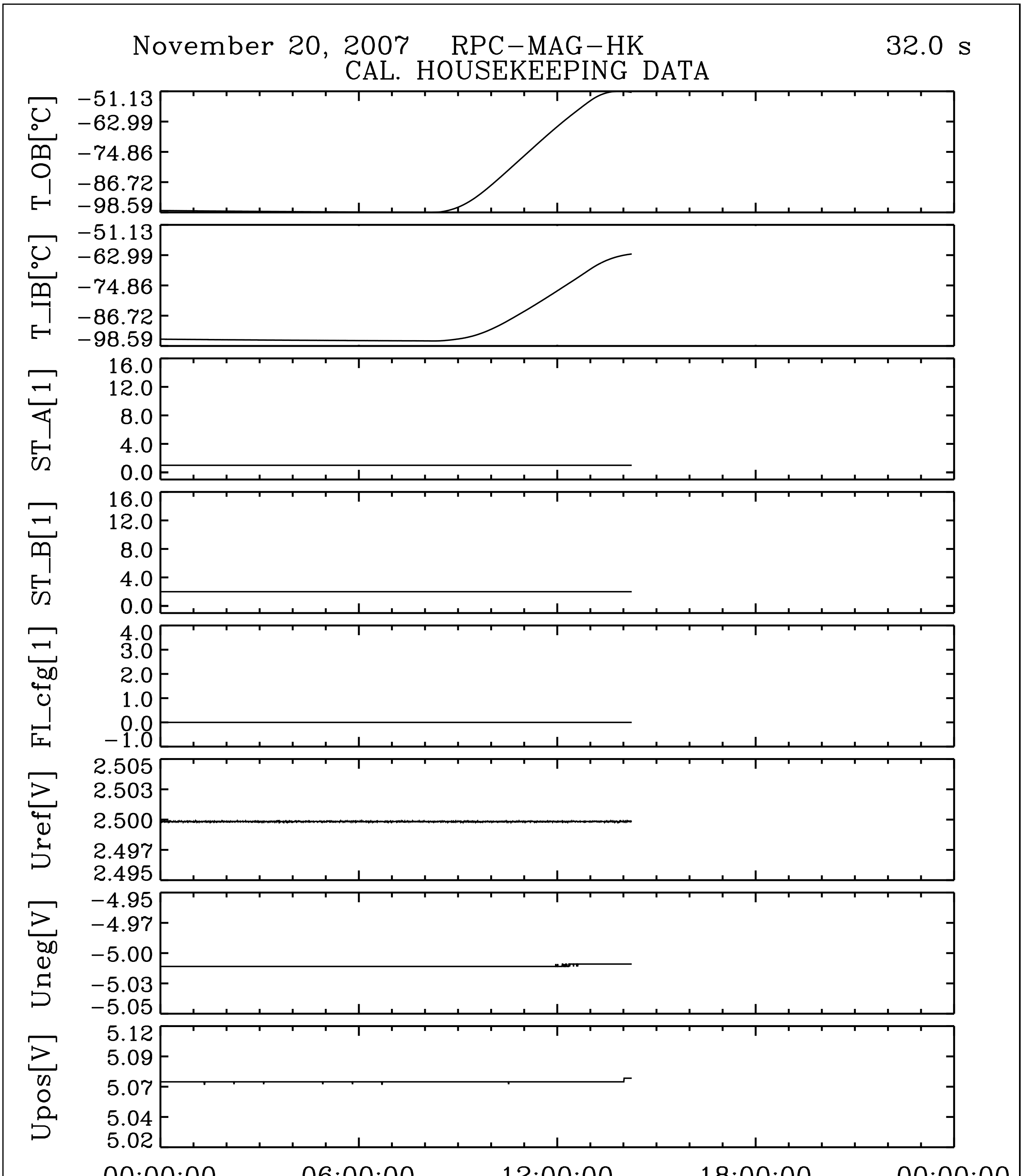


Figure 74: File: RPCMAG071120T0000_CLA_HK_P0000_2400

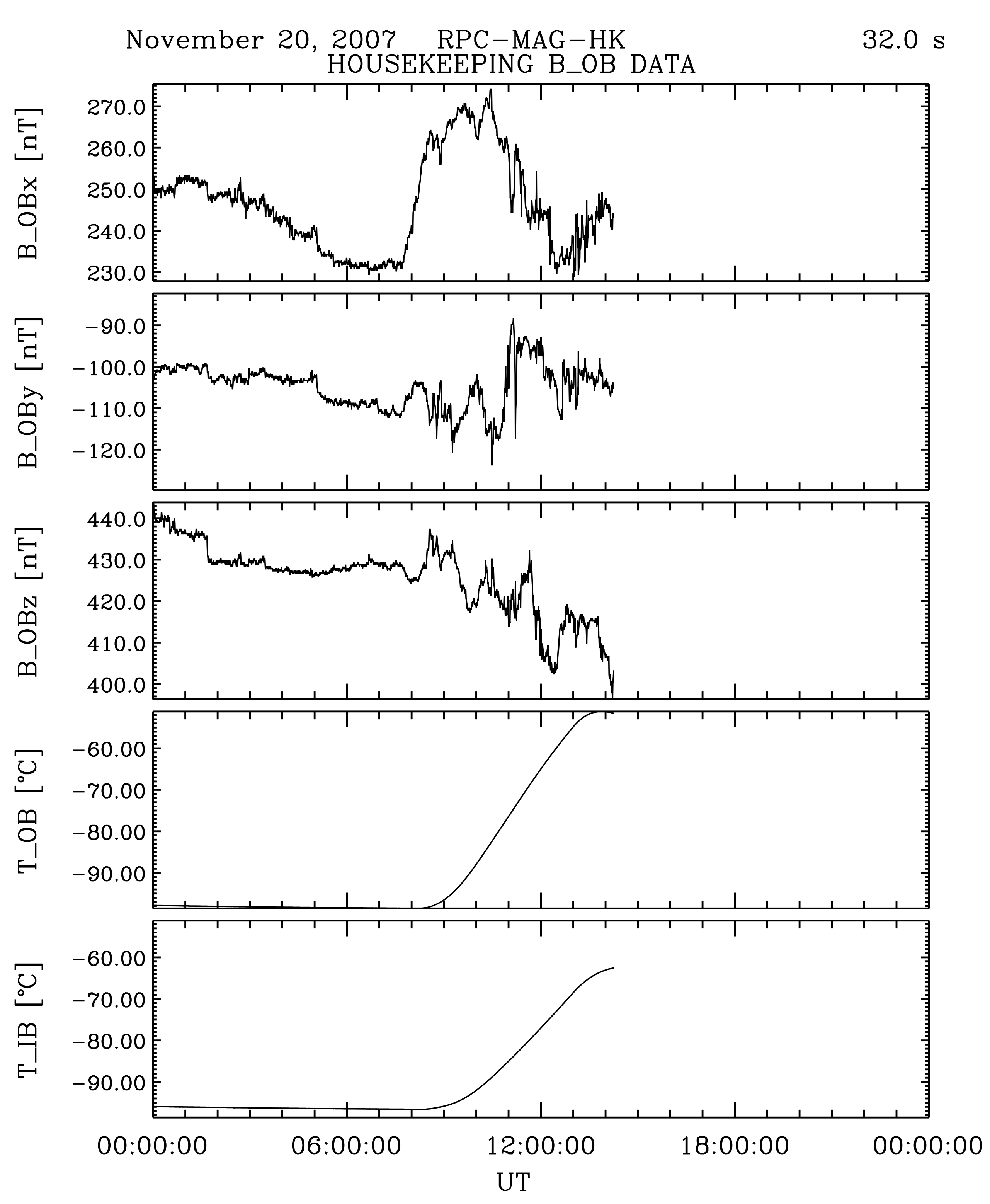


Figure 75: File: RPCMAG071120T0000_CLA_HK_B_P0000_2400

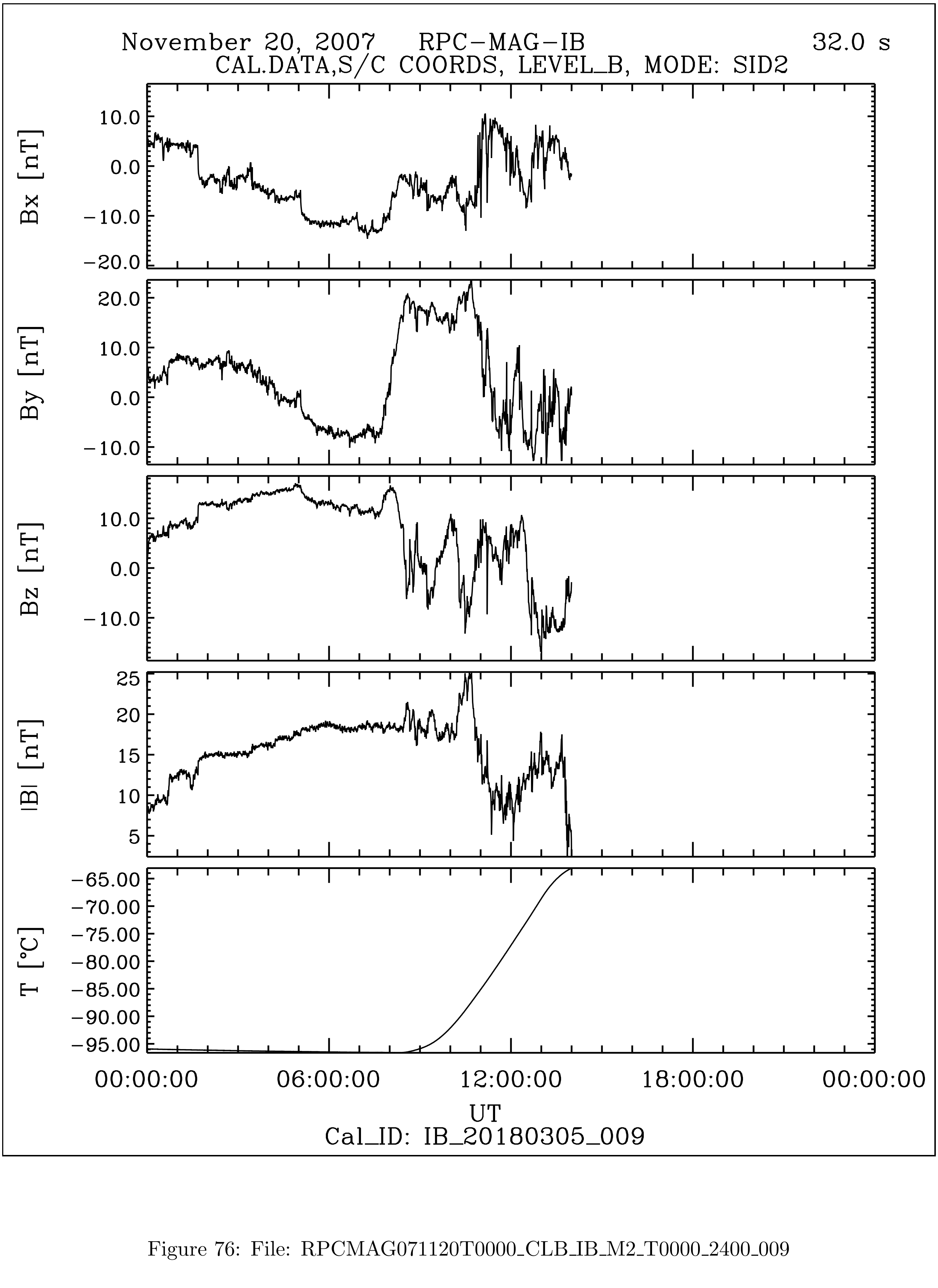


Figure 76: File: RPCMAG071120T0000_CLB_IB_M2_T0000_2400_009

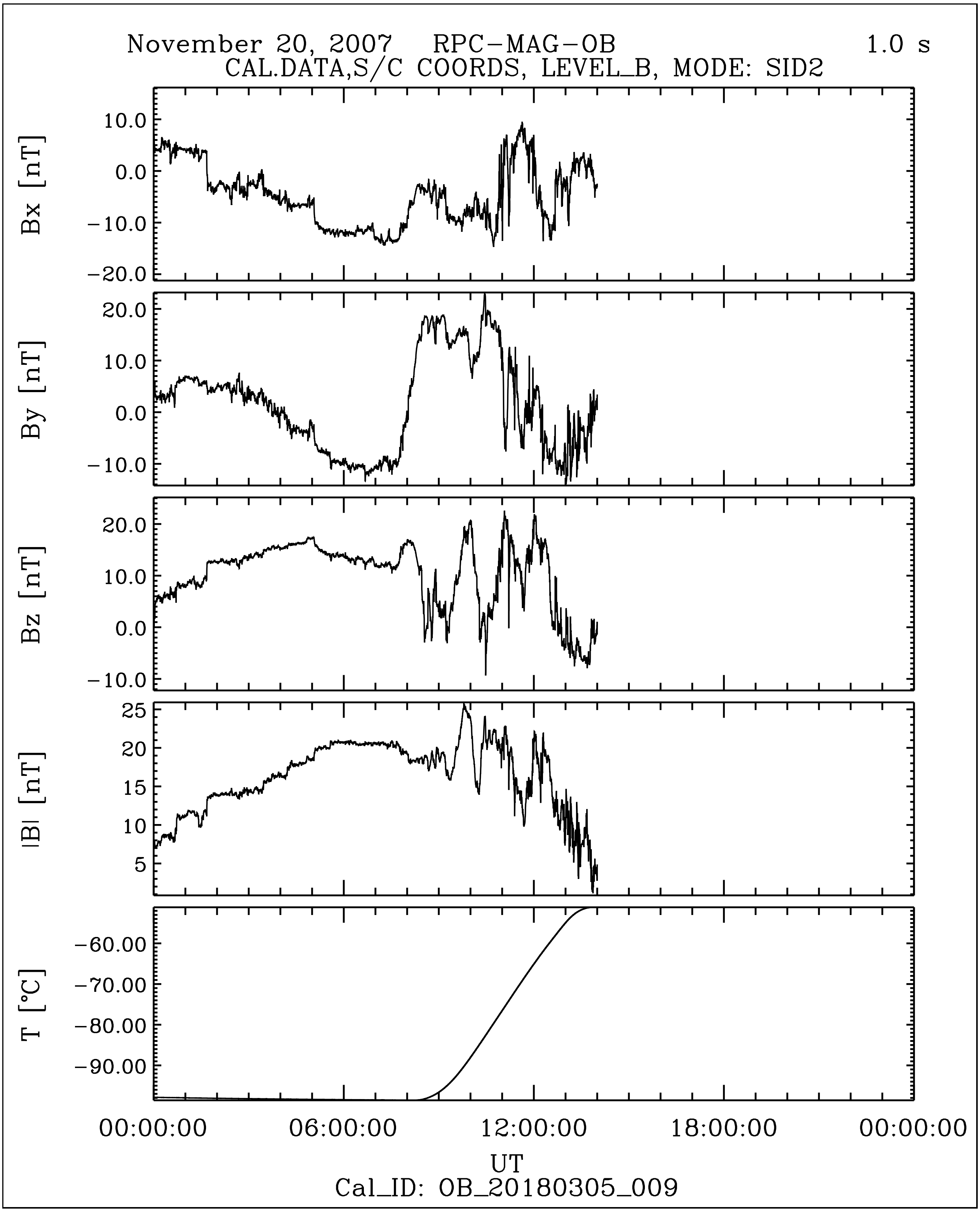


Figure 77: File: RPCMAG071120T0000_CLB_OB_M2_T0000_2400_009

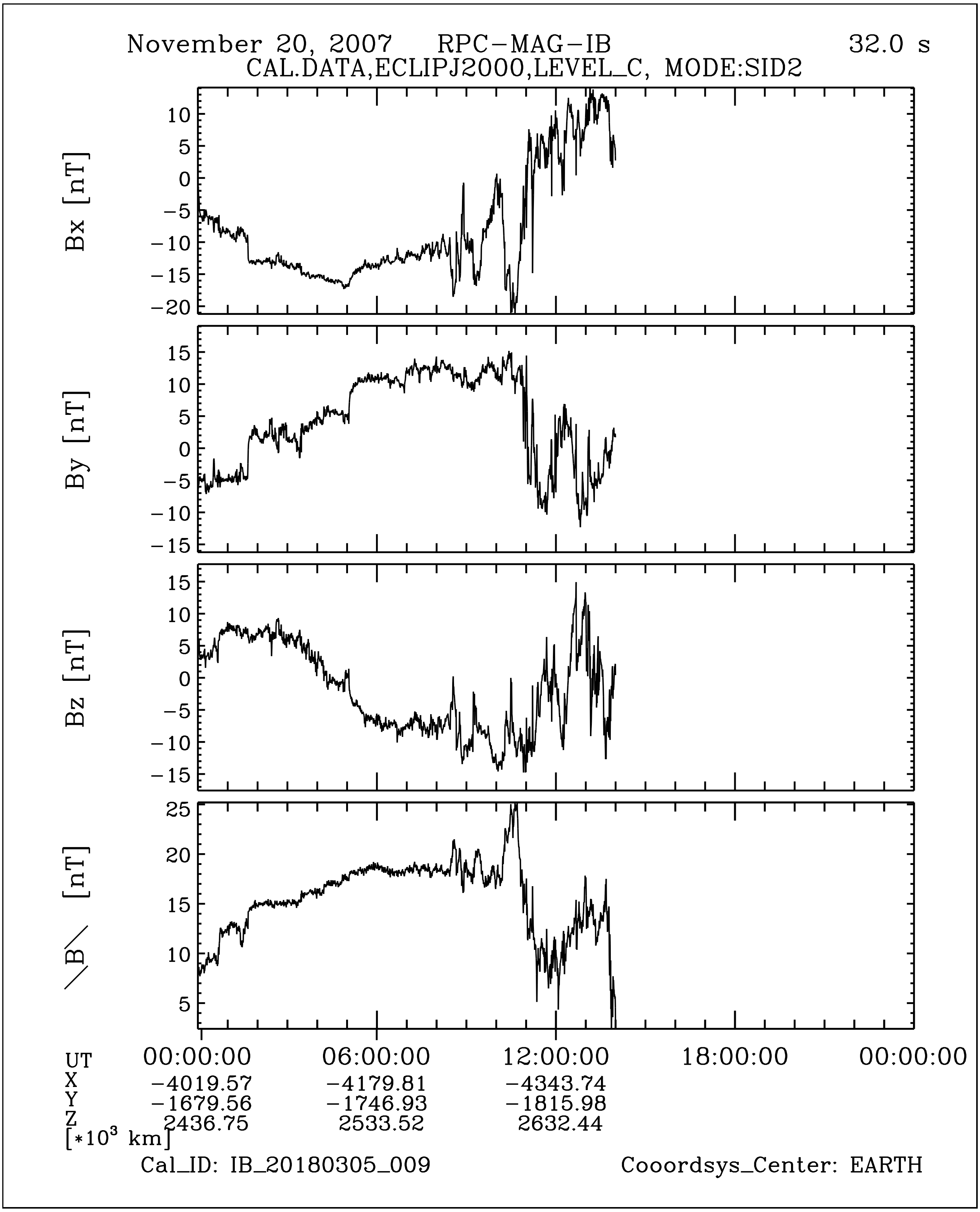


Figure 78: File: RPCMAG071120T0000_CLC_IB_M2_T0000_2400_009

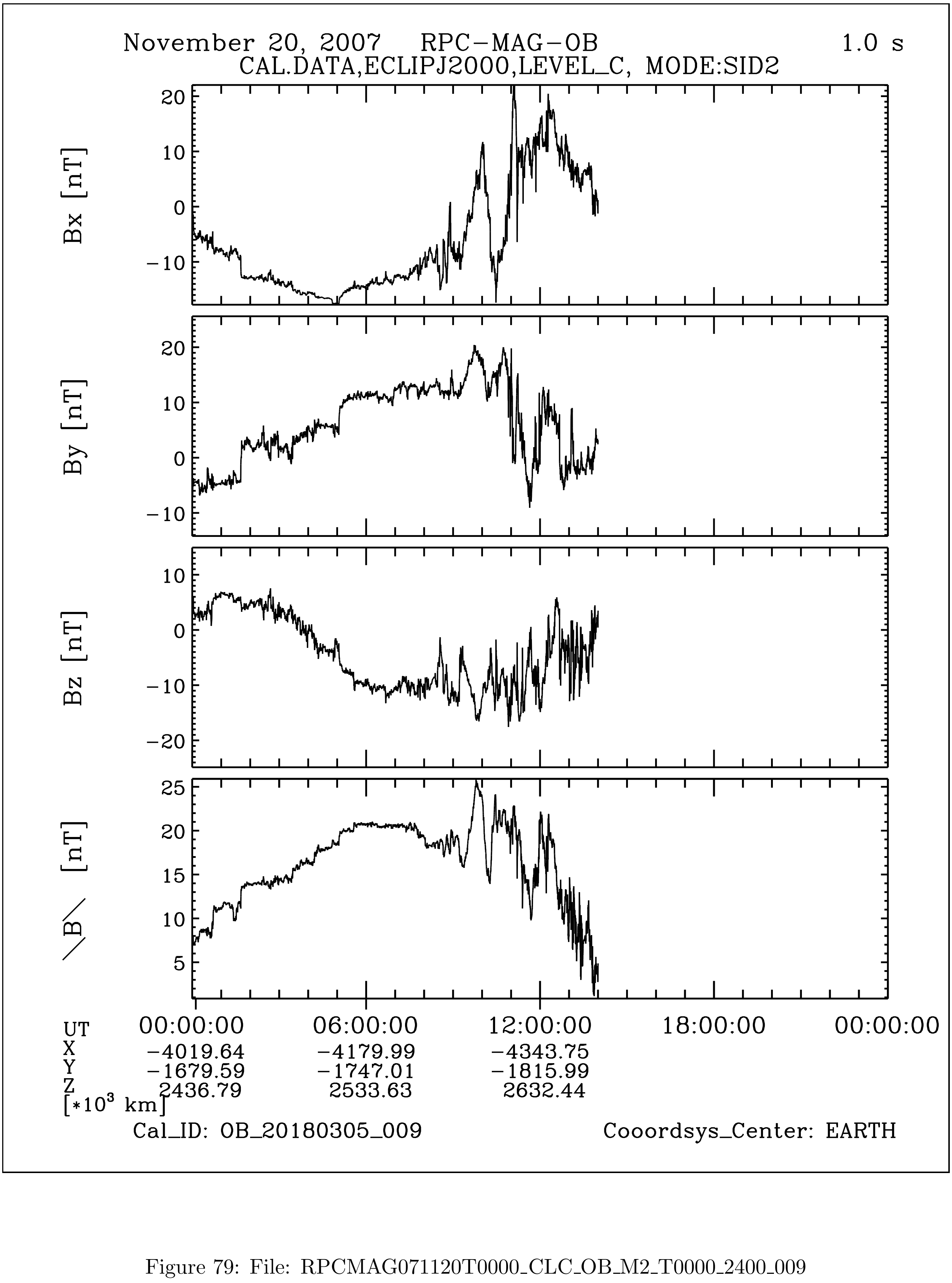


Figure 79: File: RPCMAG071120T0000_CLC_OB_M2_T0000_2400_009

# 4 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 ± 1 hour around Closest Approach (CA).

Figure 80 shows the modulus of the OB sensor in the most upper panels 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 panels, however reveals an error of about ± 15 nT for the most times. The used POMME model contains internal and external sources and also the contribution of the Tsyganenko-Model

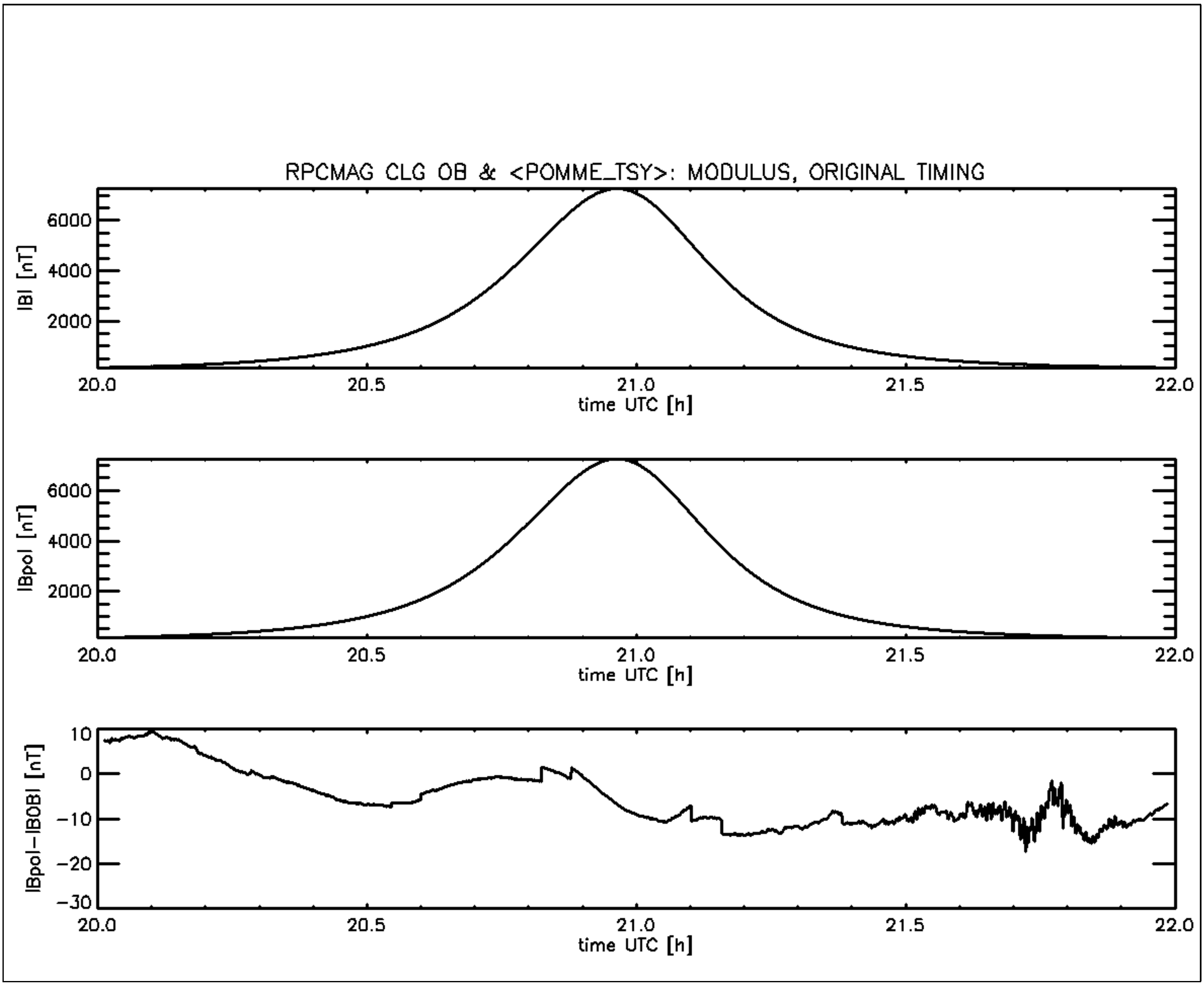


Figure 80: POMME versus OB: Total field, original timing

A comparison of the components of the OB sensor and POMME is displayed in Figure 81. At a first view of these data looks quite good as well. The differences of the model and the measurements are plotted in Figure 82.

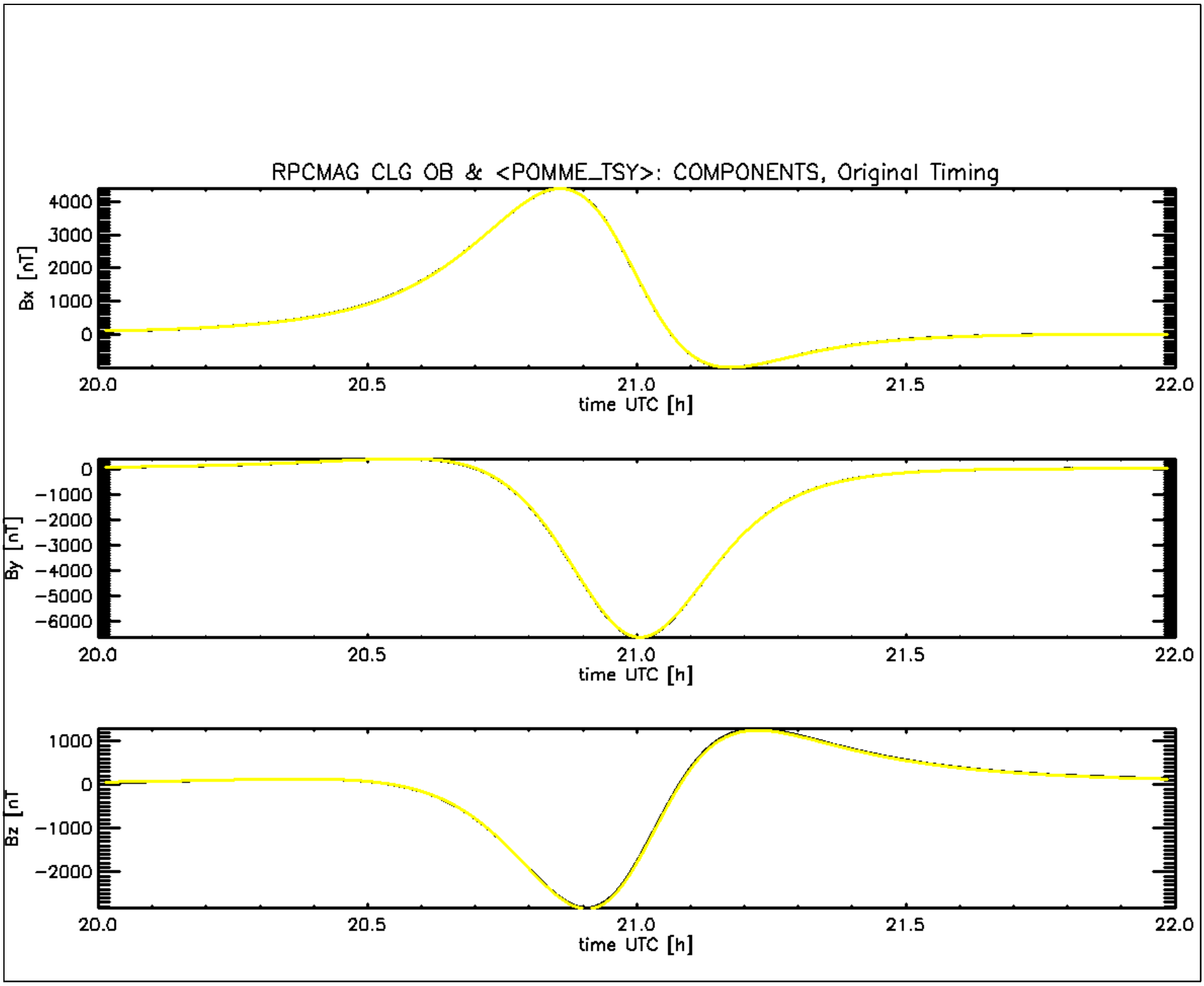


Figure 81: POMME versus OB: Components

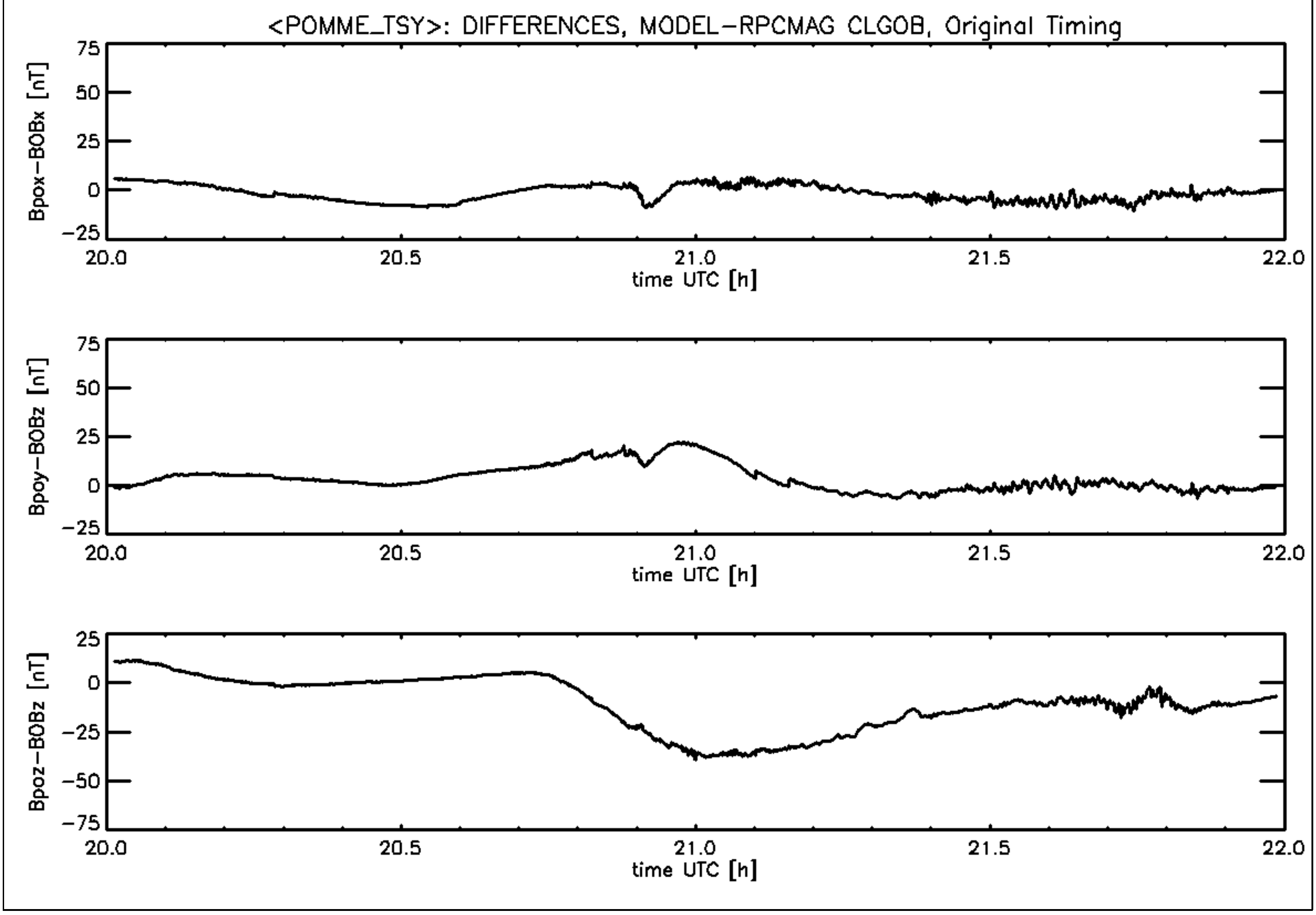


Figure 82: POMME versus OB: Differences of the Components

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

- $+0.34°$ around x
- $-0.15°$ around y
- $-0.01°$ around z

to be the optimum rotation angles. The remaining residua in the order of ± 13 nT as can be seen in Figure 83.

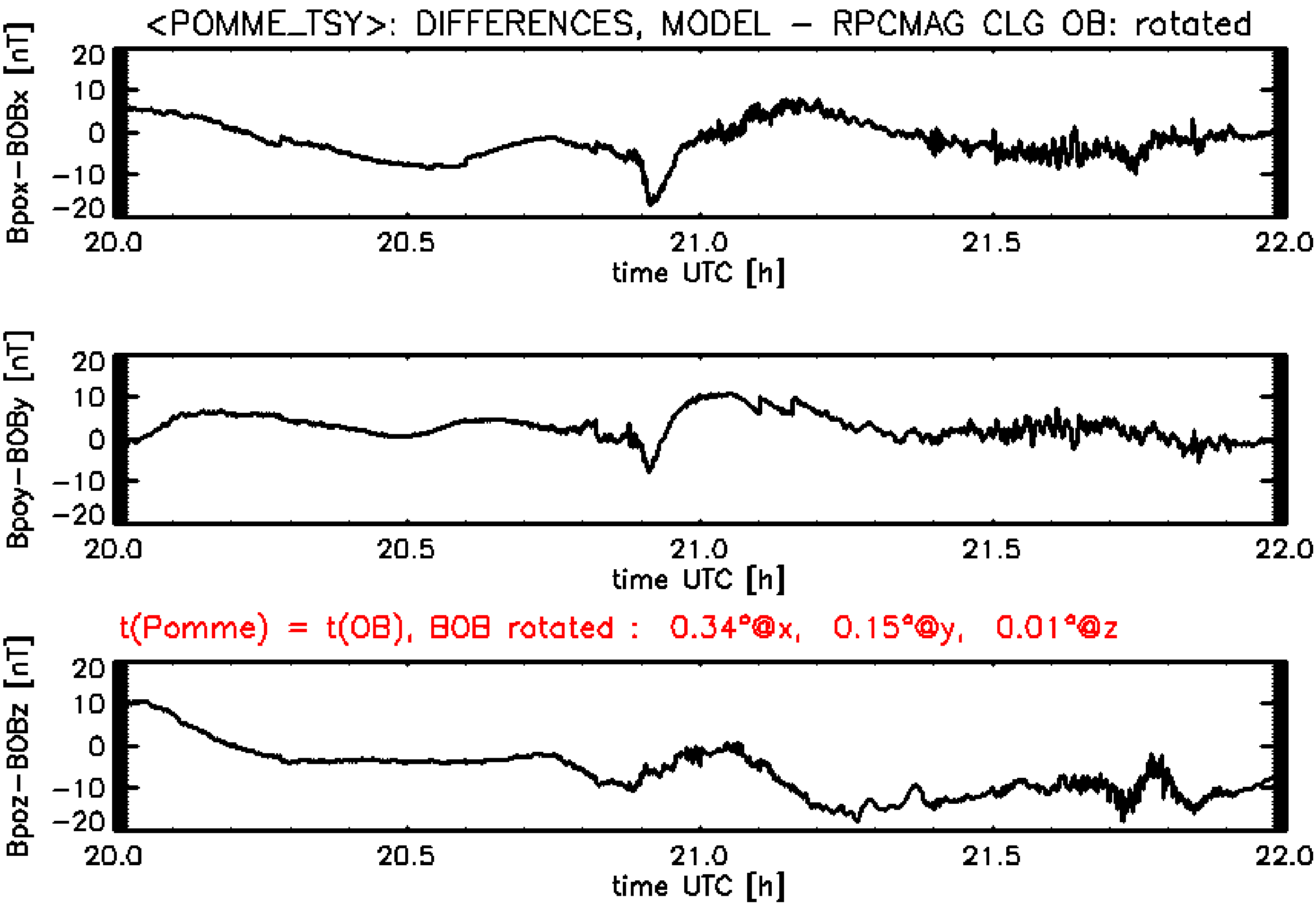


Figure 83: POMME versus OB: Differences of the Components

# 5 Dynamic Spectra of the Swing by

This section shows the dynamic spectra of the OB sensor in LEVEL_C = ECLIPJ2000 coordinates. As the sensor was operated as primary sensor in NORMAL mode, SID2, the maximum resolvable frequency is 0.5 Hz.
On November 13 and 14 MAG operations we performed in Burstmode, SID3. So here the maximum resolvable frequency is 10Hz.

From time to time there are also horizontal lines in the dynamic spectrum to be seen. These lines represent constant frequencies and are caused by the LAP instrument. This behavior was investigated and proofed during the PC10 campaign in November 2010. See RO-IGEP-TR0030 for further details.

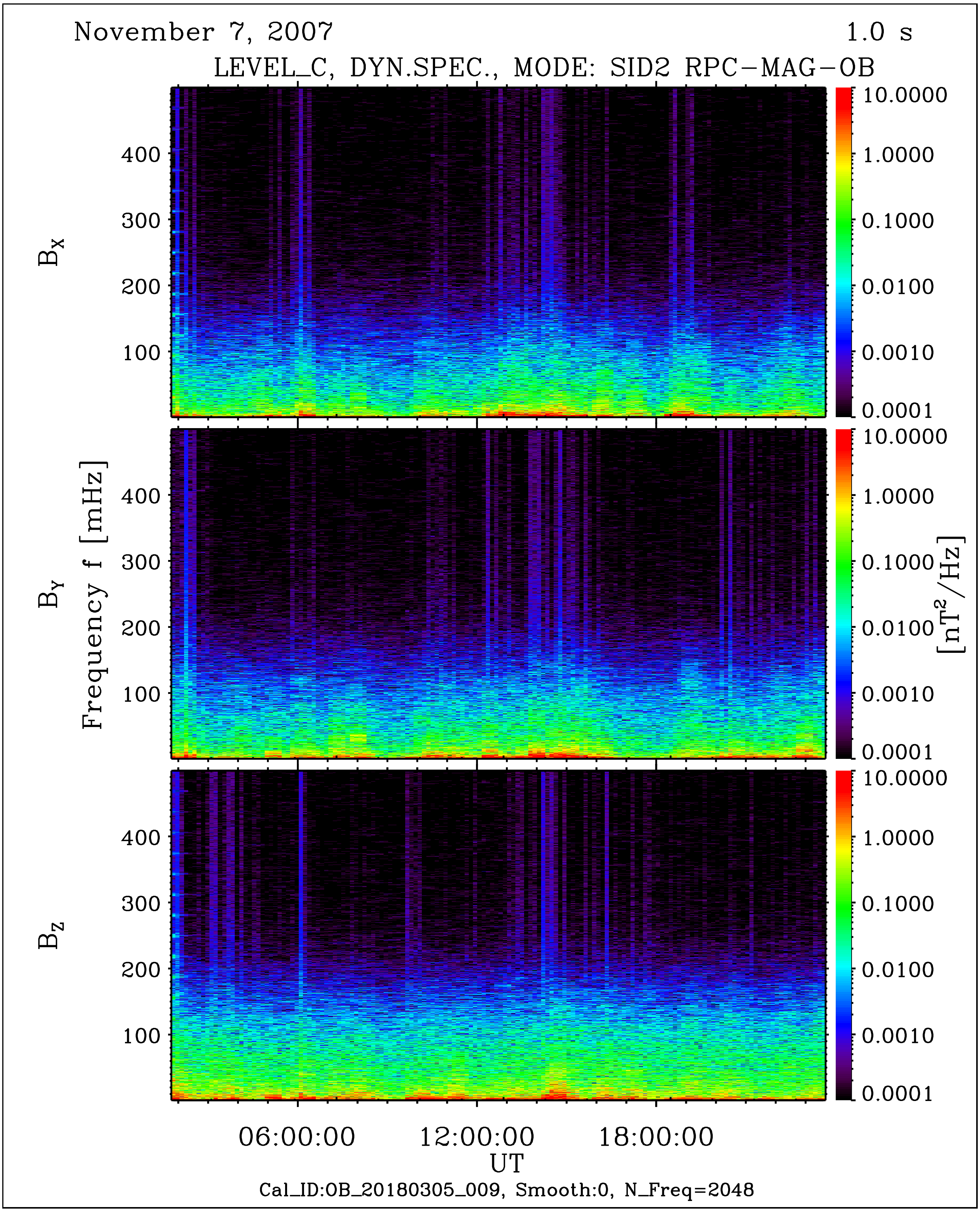


Figure 84: File: RPCMAG071107T0133_CLC_OB_M2_DS0_500_009

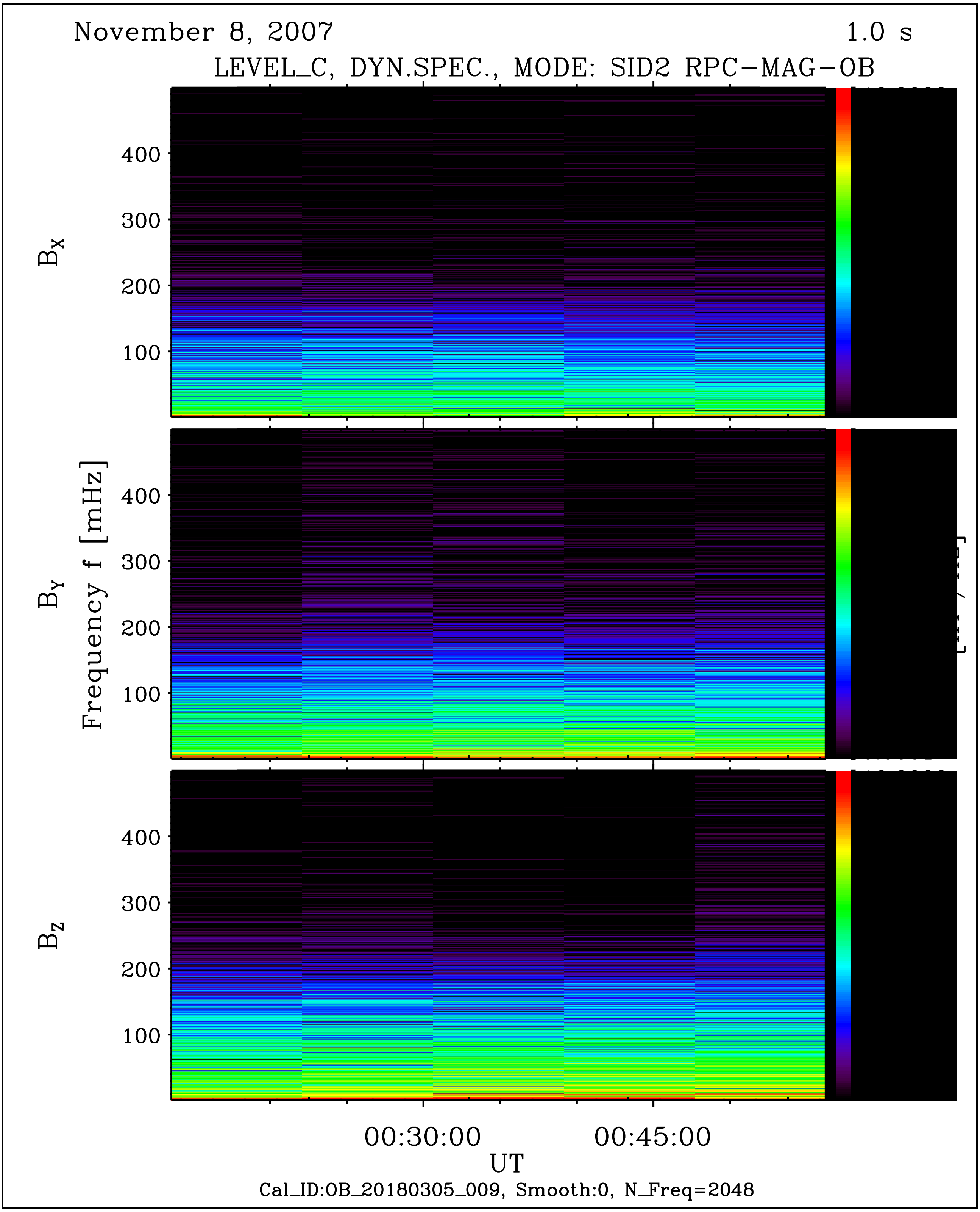


Figure 85: File: RPCMAG071108T0000_CLC_OB_M2_DS0_500_009

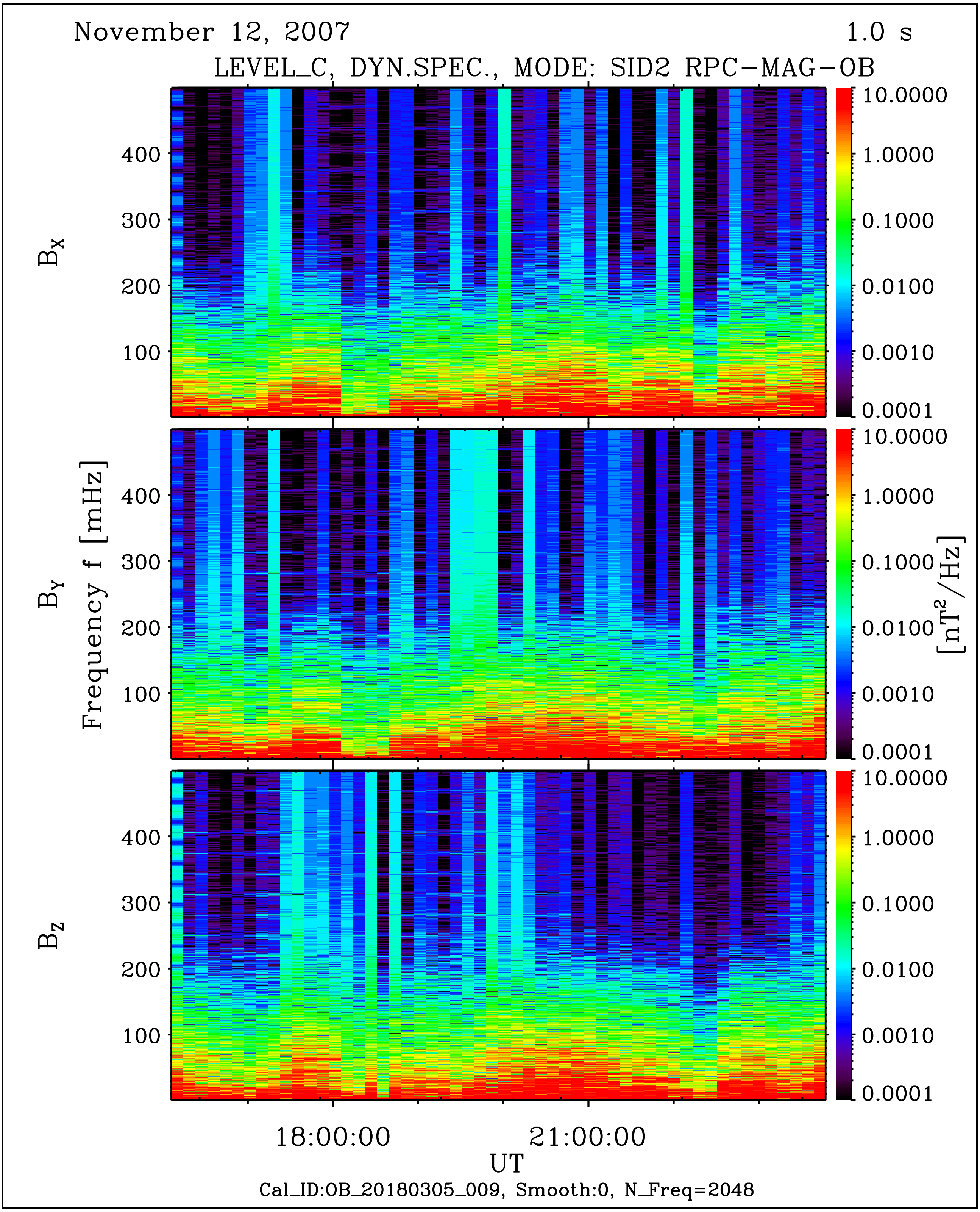


Figure 86: File: RPCMAG071112T1553_CLC_OB_M2_DS0_500_009

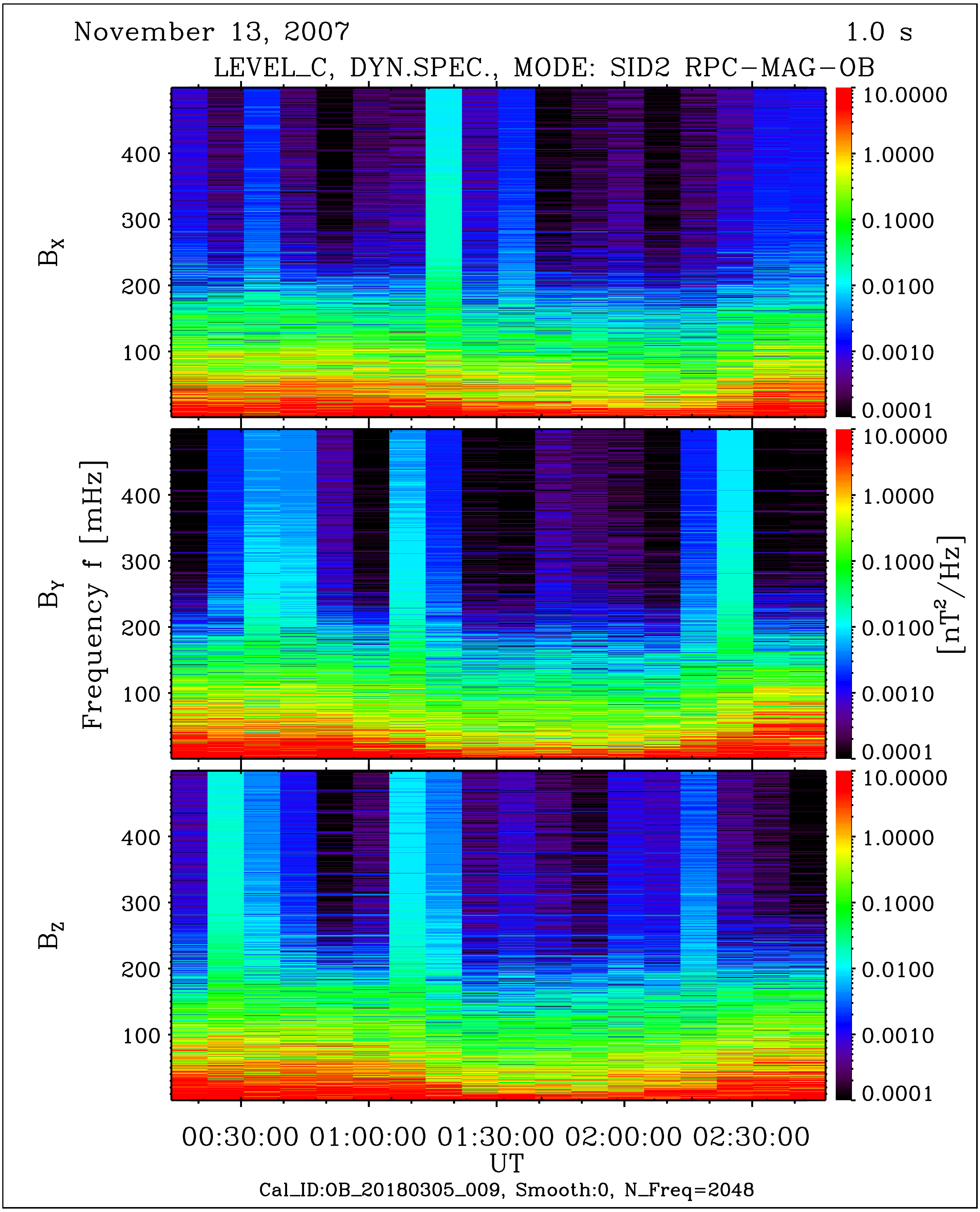


Figure 87: File: RPCMAG071113T0000_CLC_OB_M2_DS0_500_009

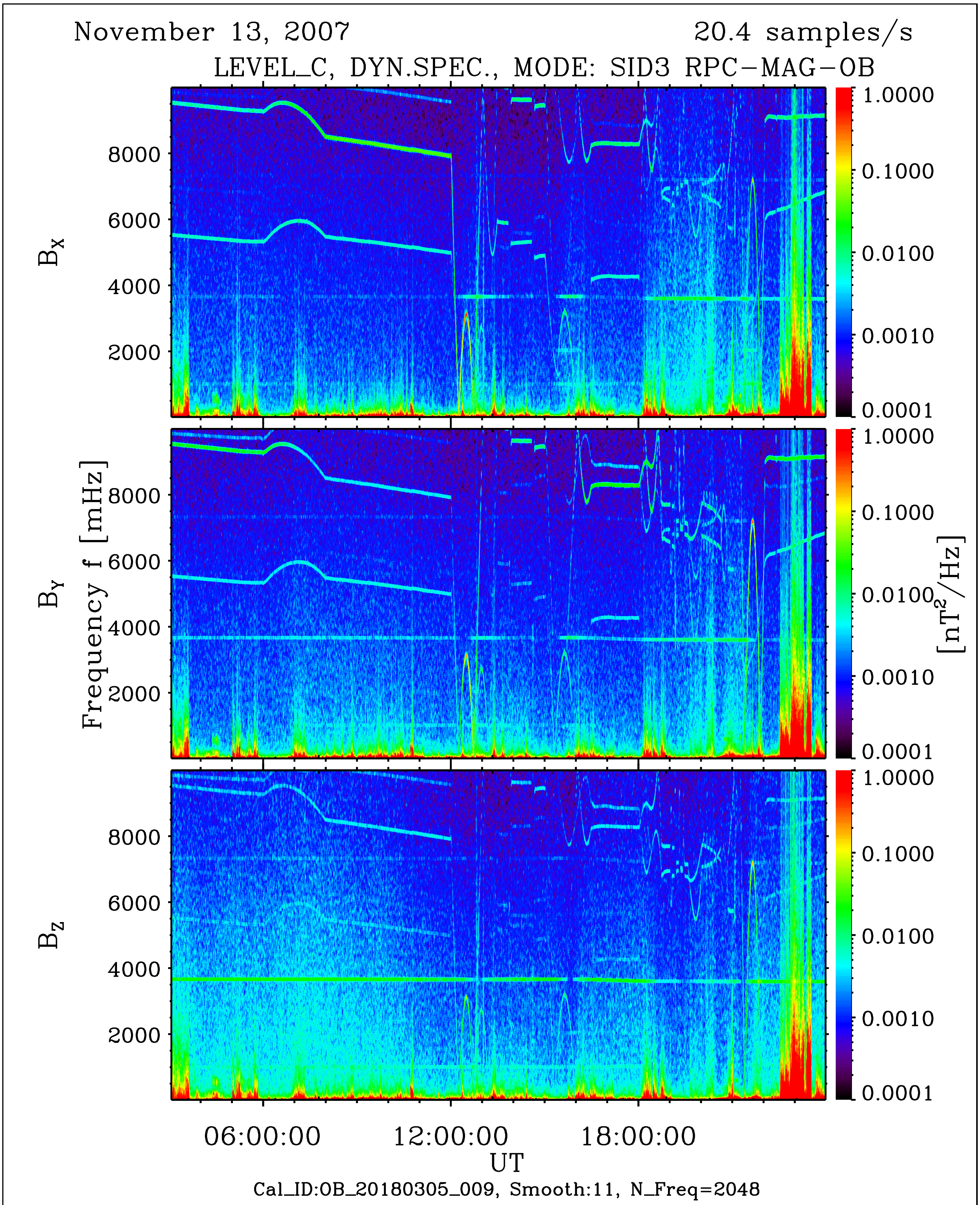


Figure 88: File: RPCMAG071113T0303_CLC_OB_M3_DS0_10000_009

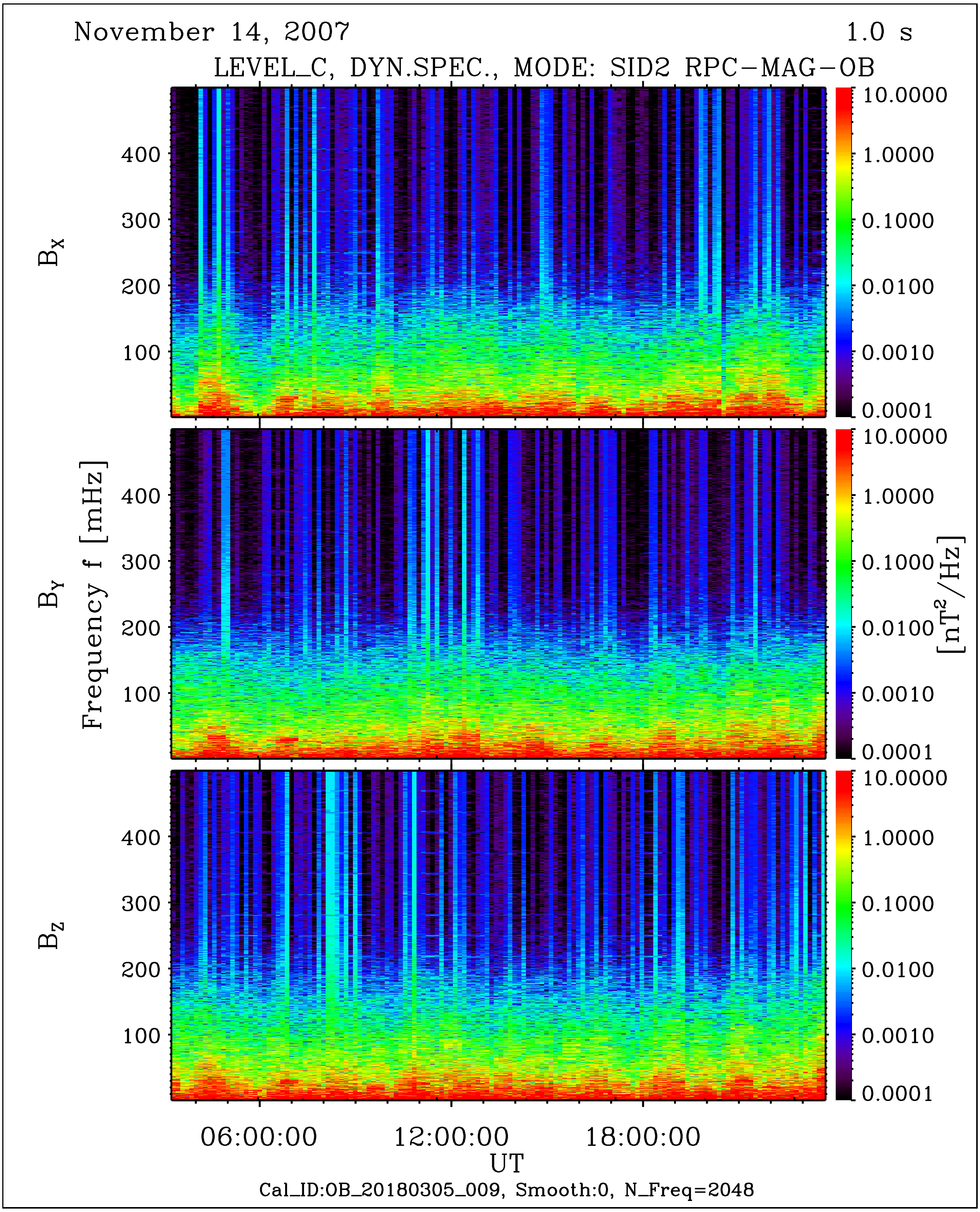


Figure 89: File: RPCMAG071114T0301_CLC_OB_M2_DS0_500_009

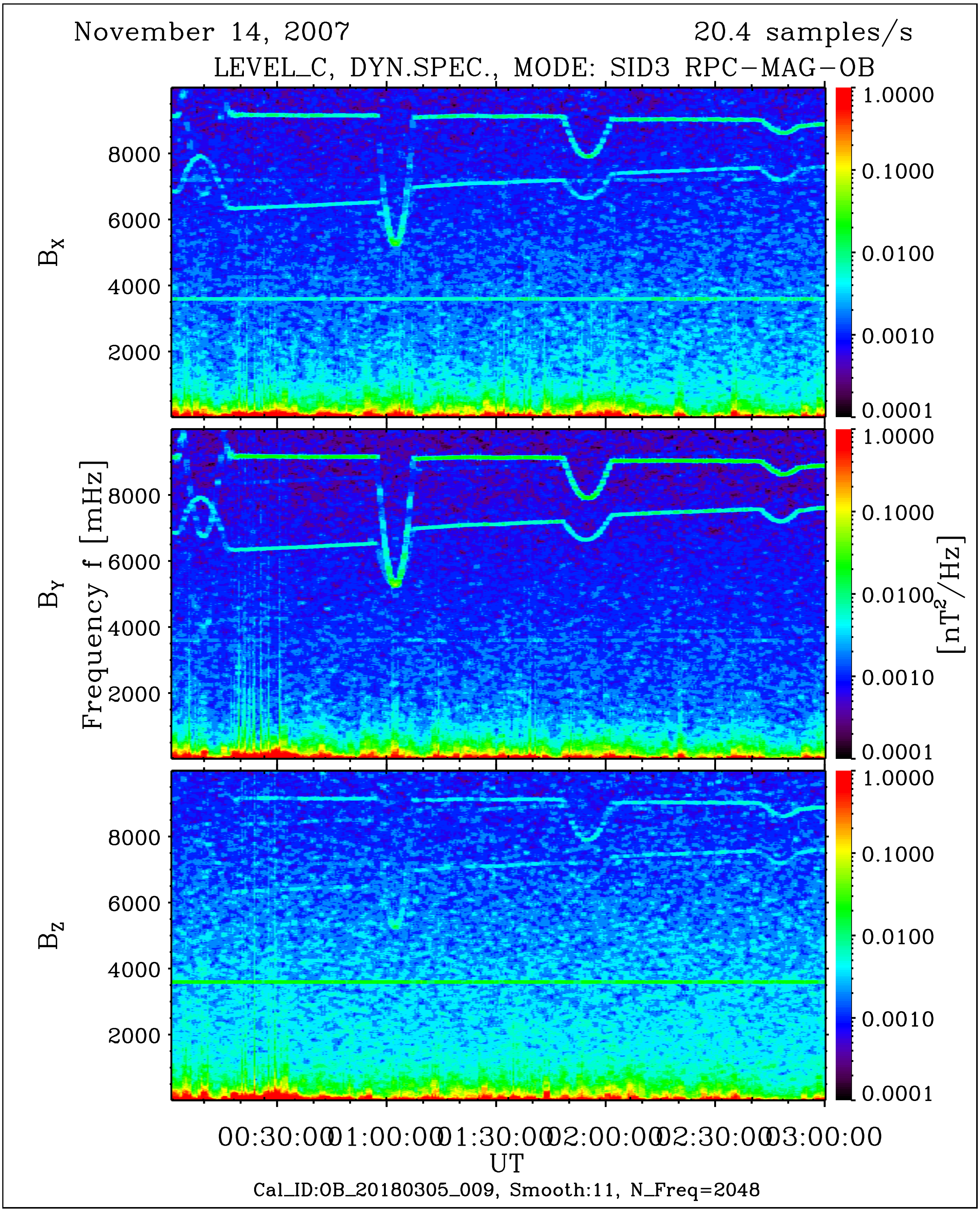


Figure 90: File: RPCMAG071114T0000_CLC_OB_M3_DS0_10000_009

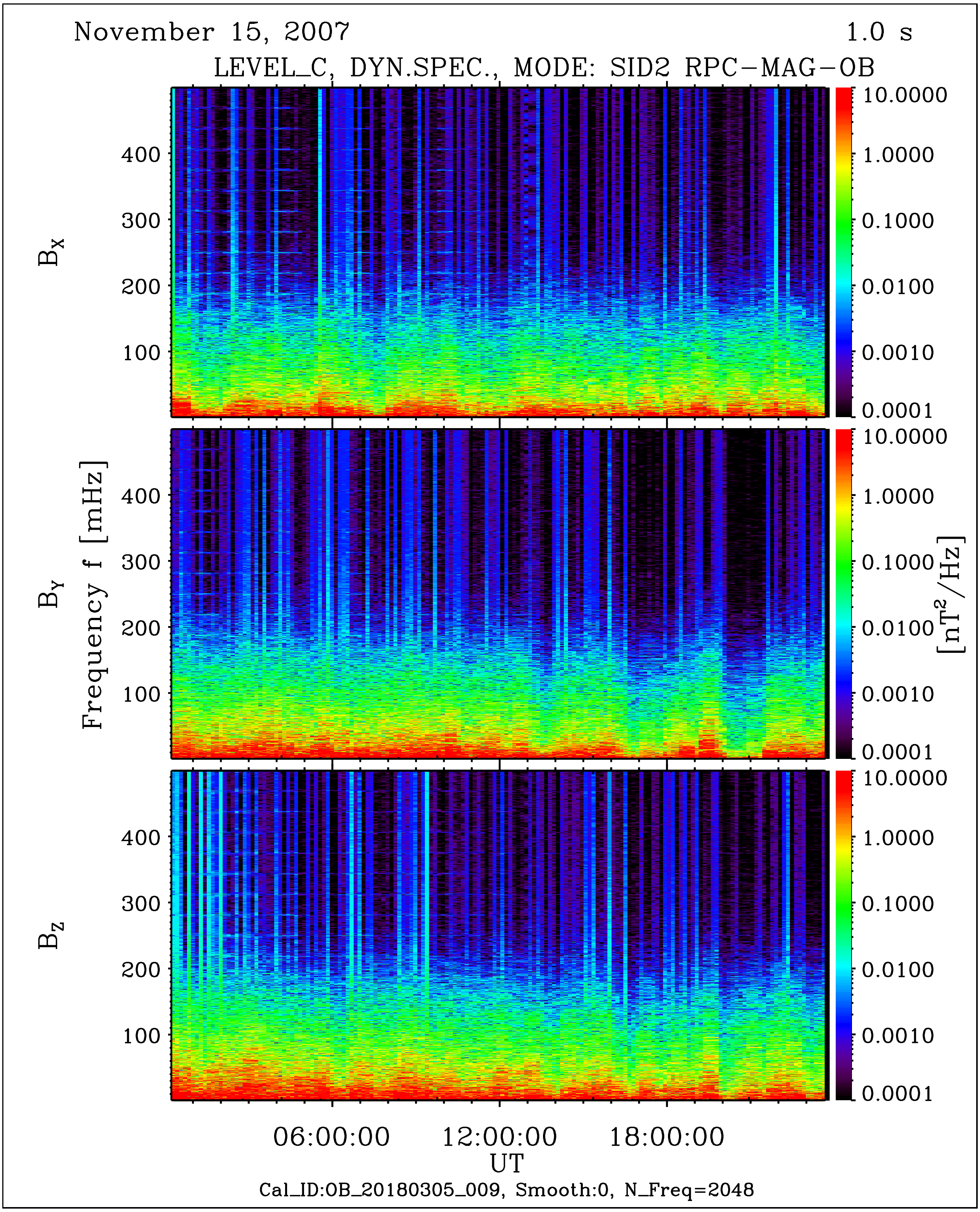


Figure 91: File: RPCMAG071115T0000_CLC_OB_M2_DS0_500_009

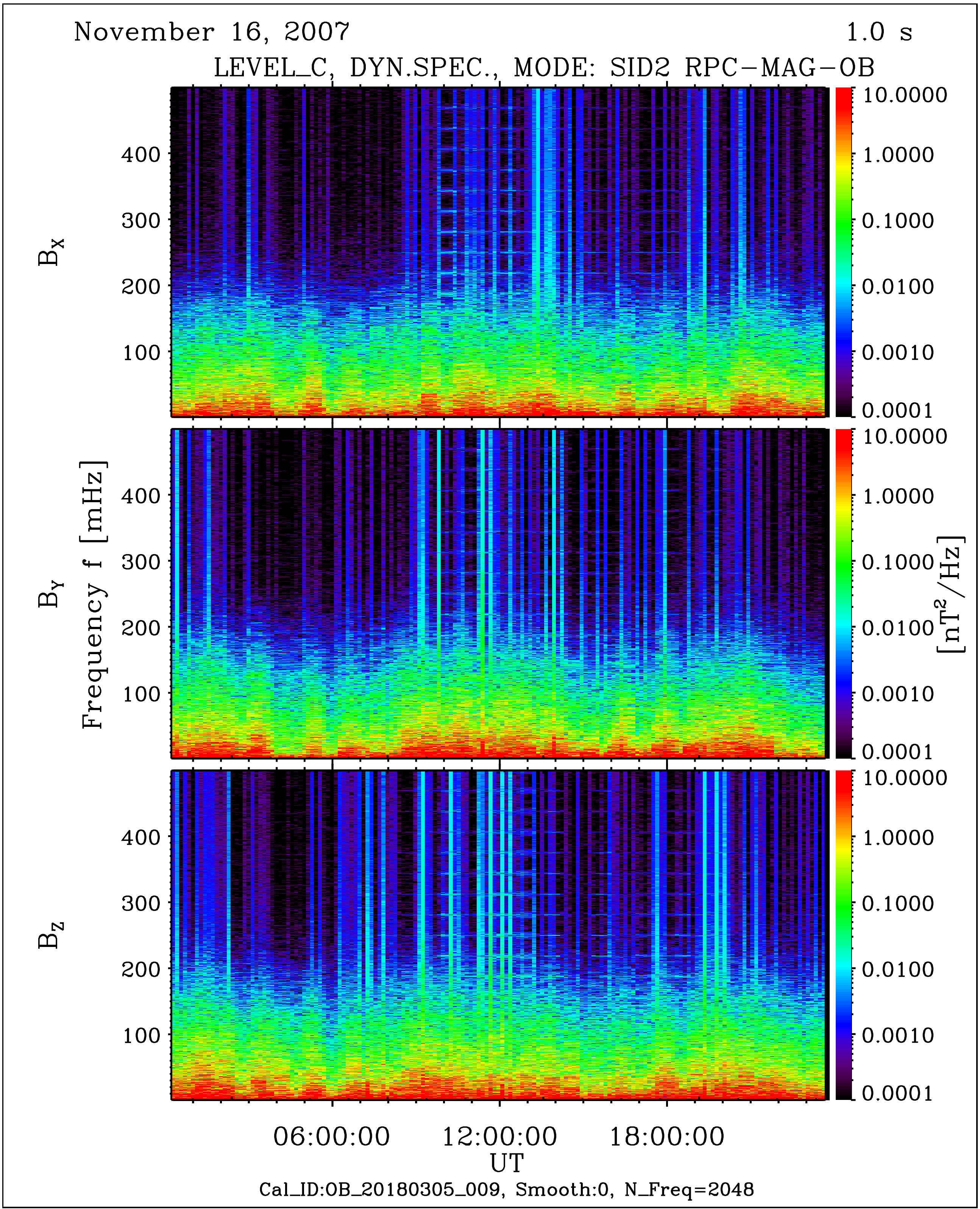


Figure 92: File: RPCMAG071116T0000_CLC_OB_M2_DS0_500_009

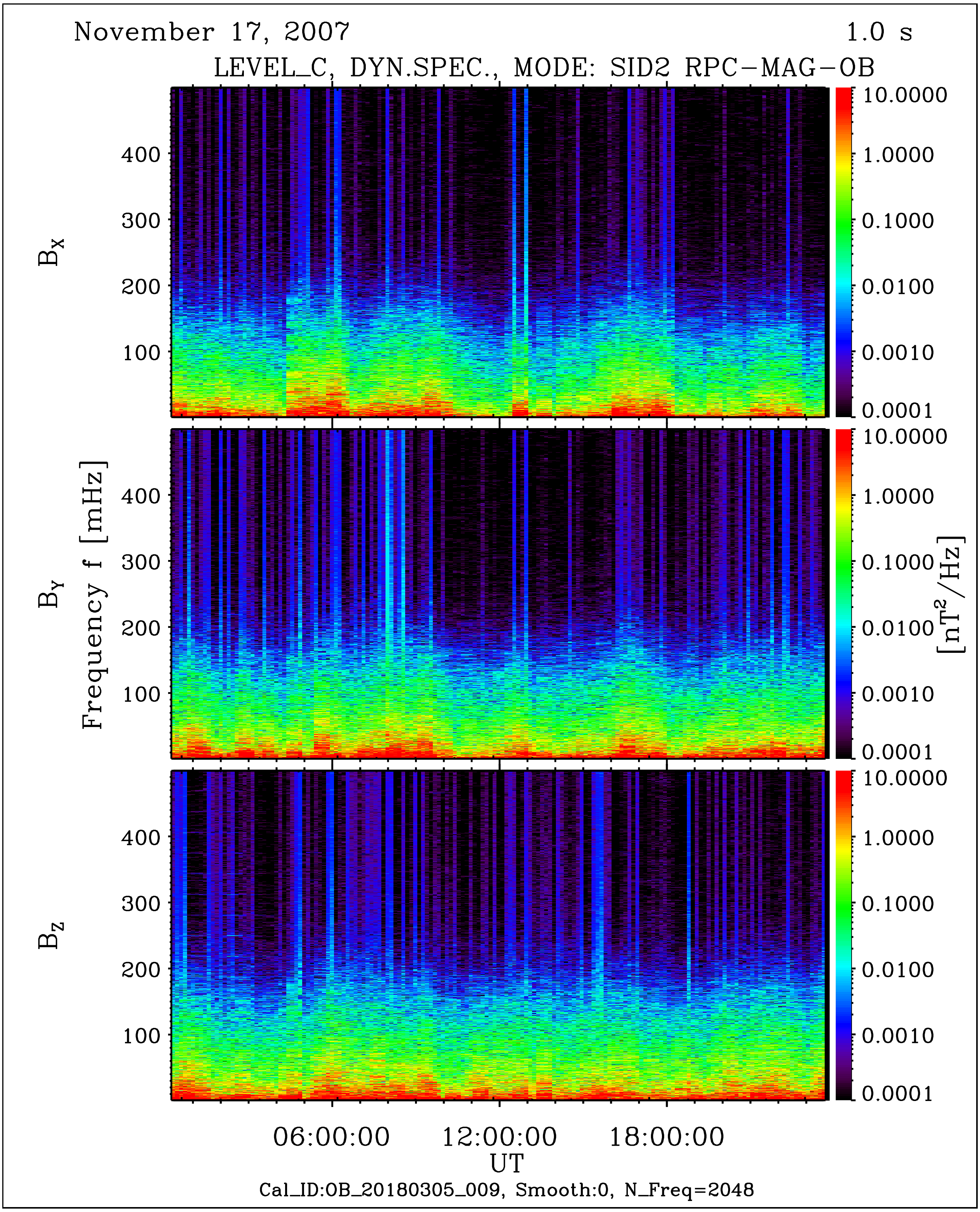


Figure 93: File: RPCMAG071117T0000_CLC_OB_M2_DS0_500_009

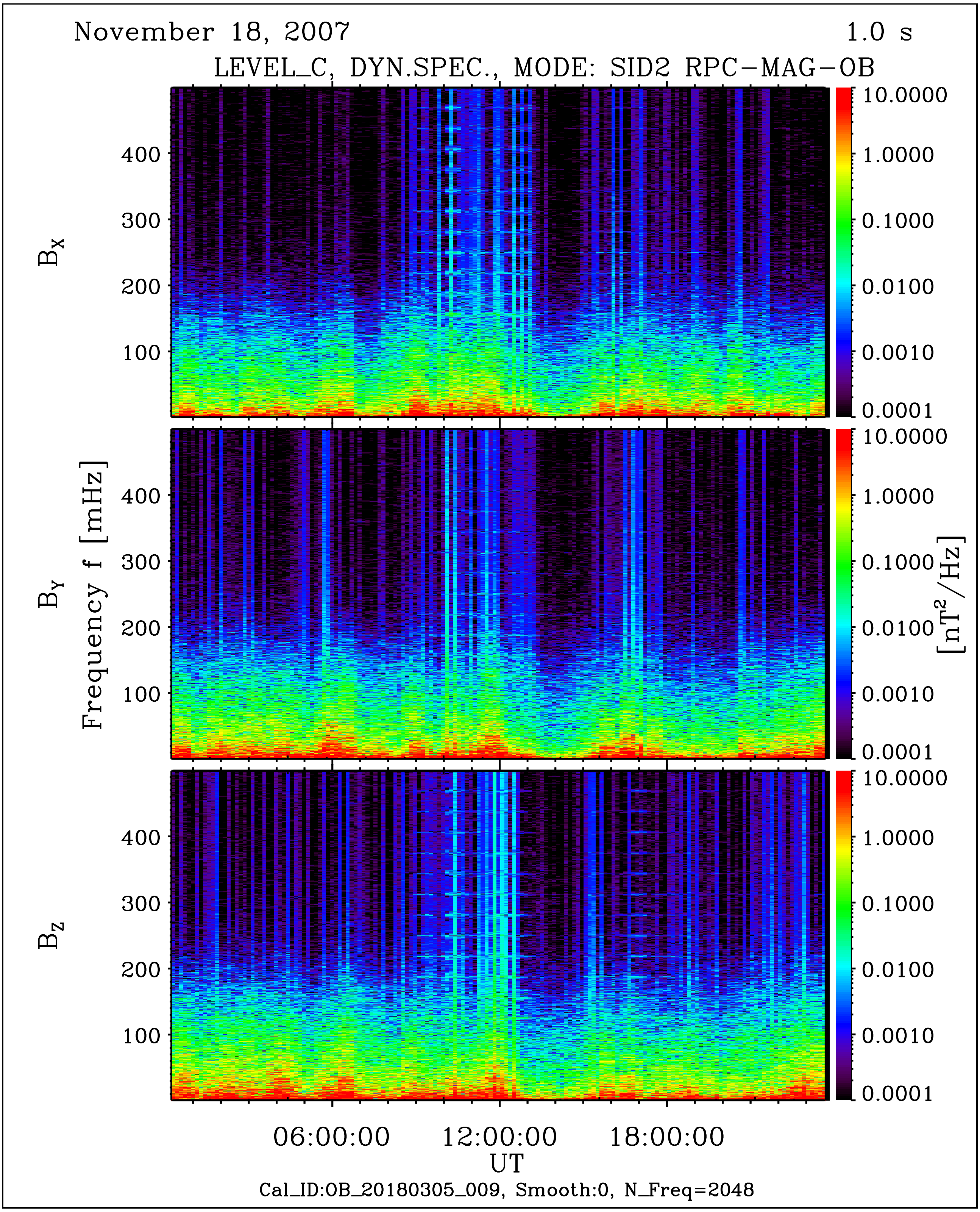


Figure 94: File: RPCMAG071118T0000_CLC_OB_M2_DS0_500_009

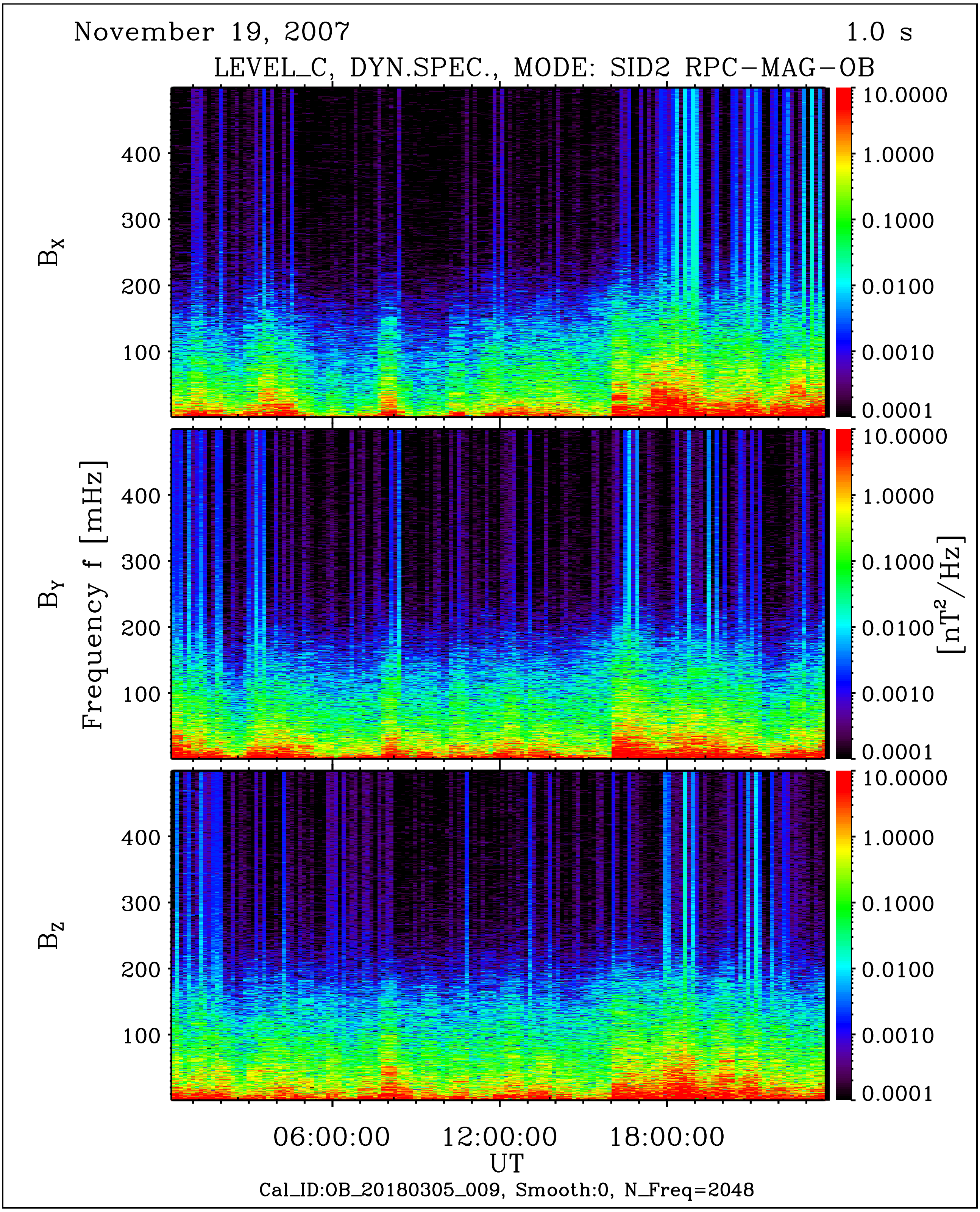


Figure 95: File: RPCMAG071119T0000_CLC_OB_M2_DS0_500_009

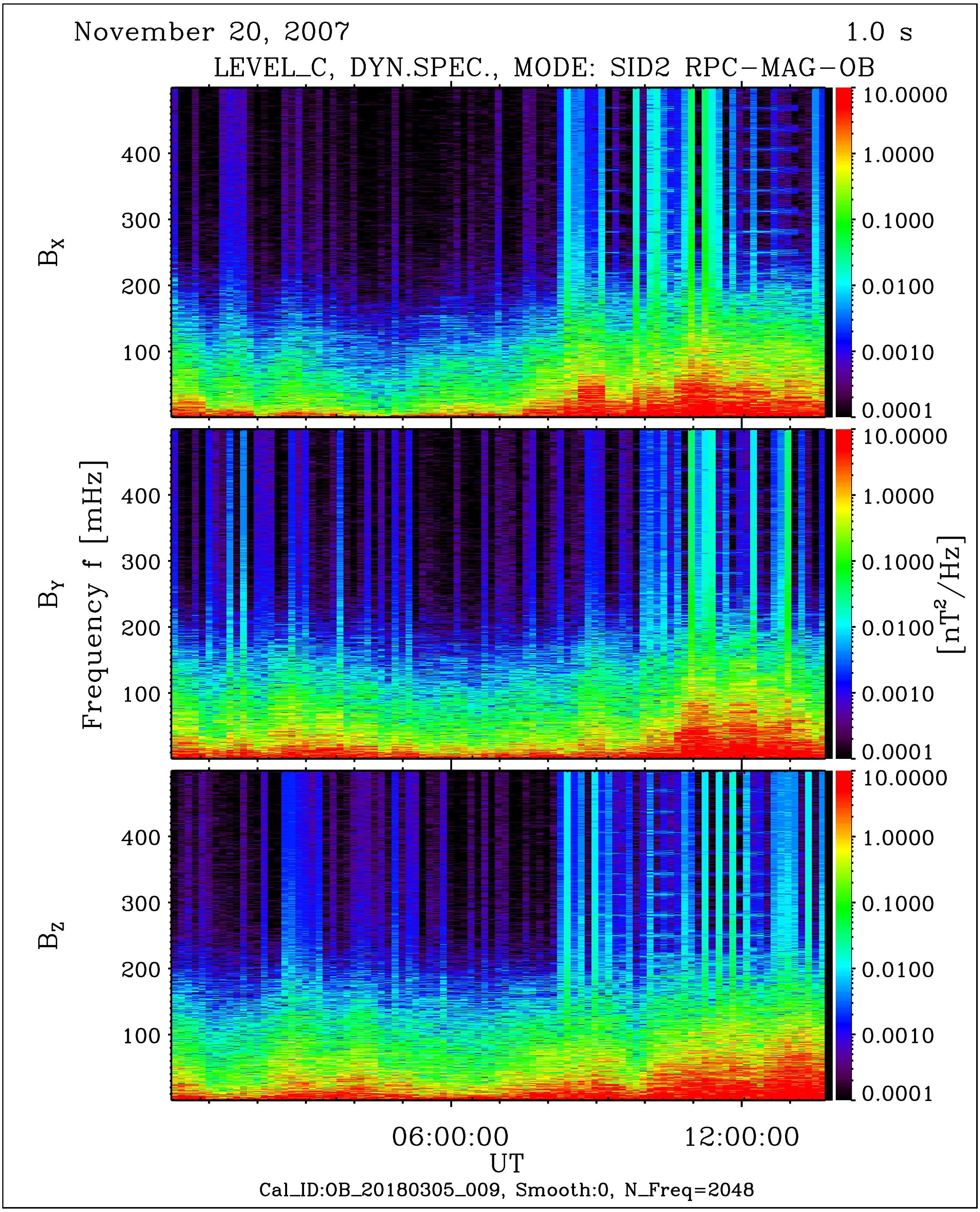


Figure 96: File: RPCMAG071120T0000_CLC_OB_M2_DS0_500_009

# 6 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 sampling frequency without any aliasing filter.
These signatures are expected to be seen on the OB sensor operated in NORMAL and BURST modes, SID2 & SID3 due to our experiences from the commissioning phase.

However, a view to the spectra of the measured magnetic field (refer to section 5) shows, that there is only an influence of the RWs in the BURST mode. The other magnetic field spectra are clean.

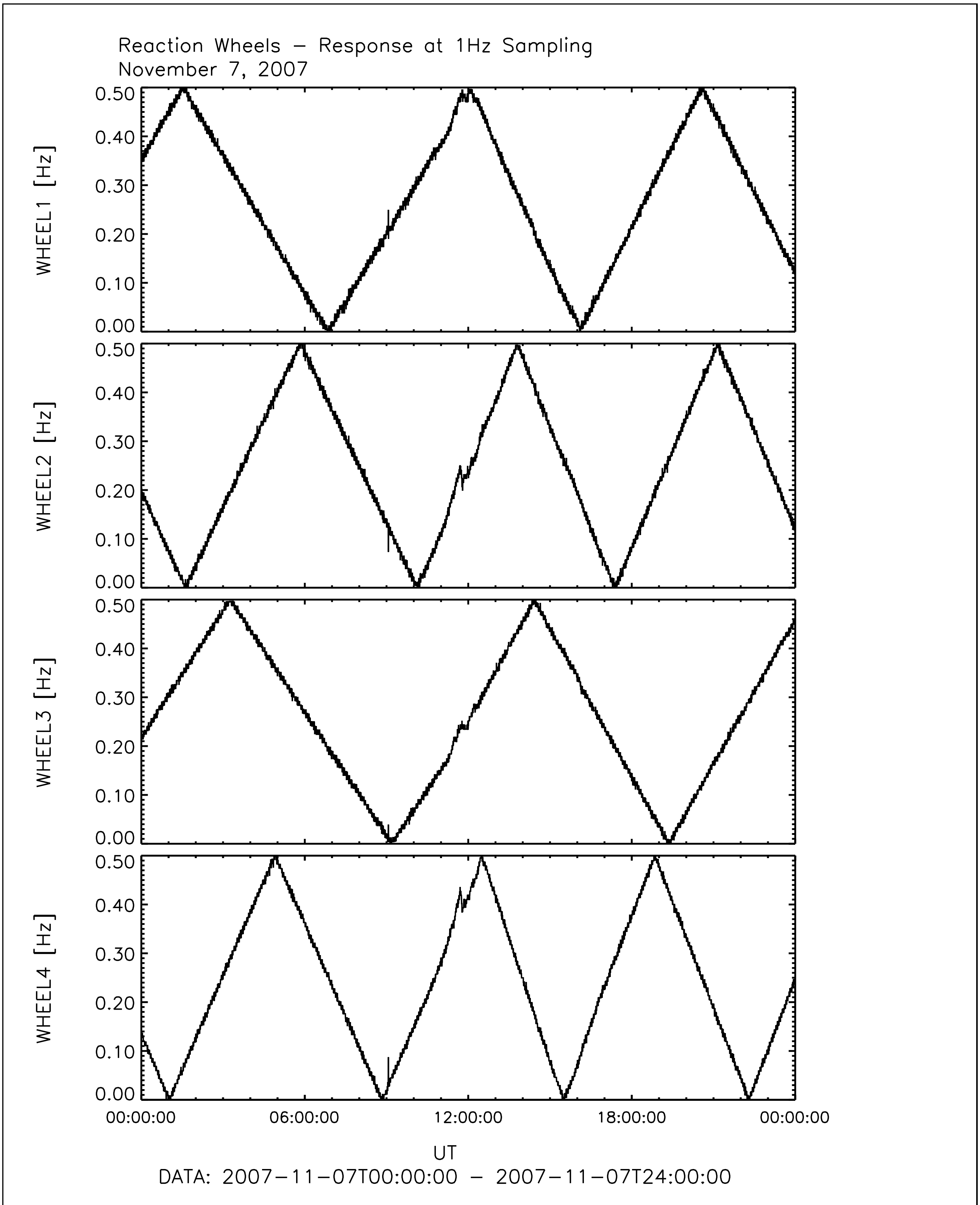


Figure 97: File: wheels_1Hz_Sampling2007-11-07T00-00

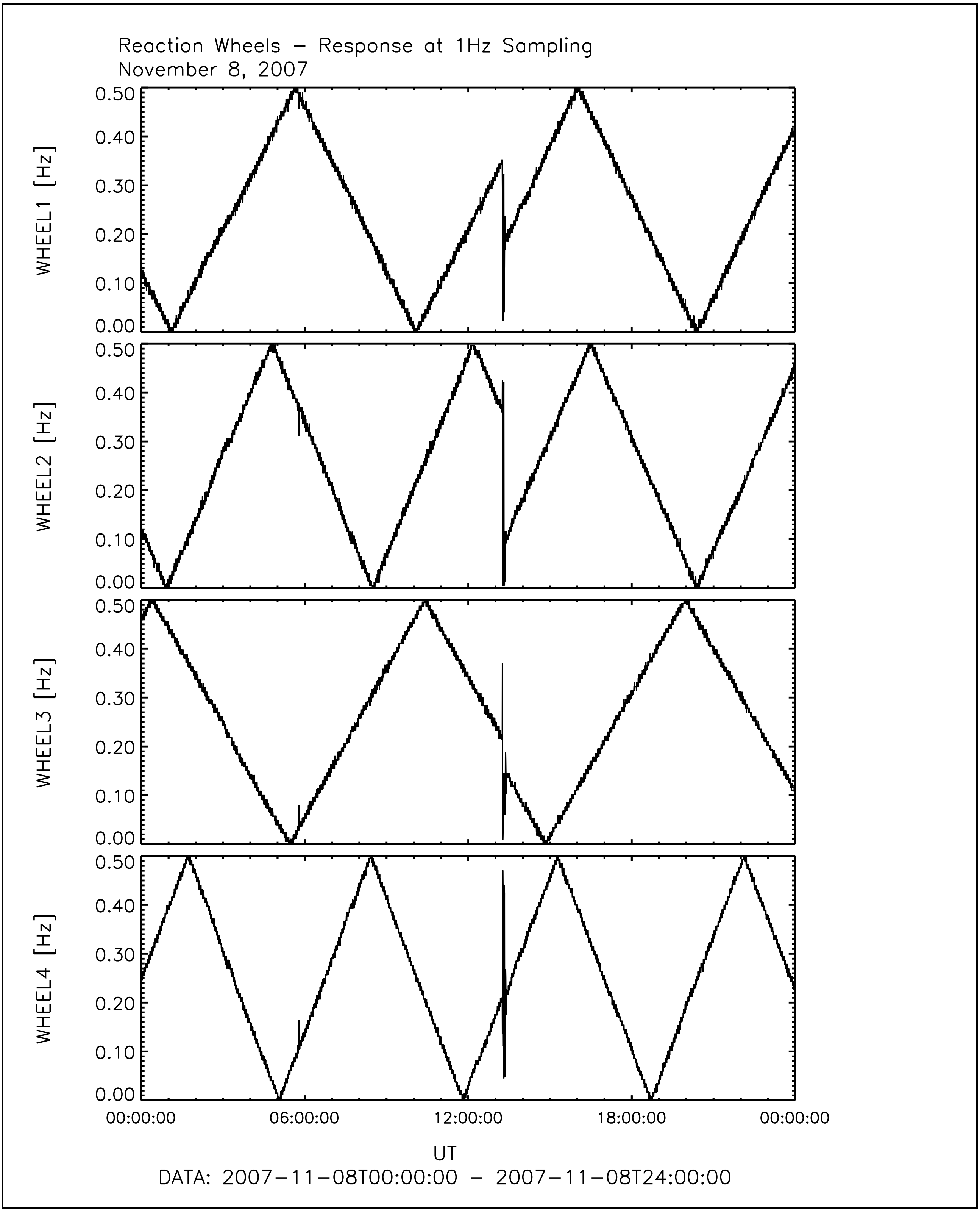


Figure 98: File: wheels_1Hz_Sampling2007-11-08T00-00

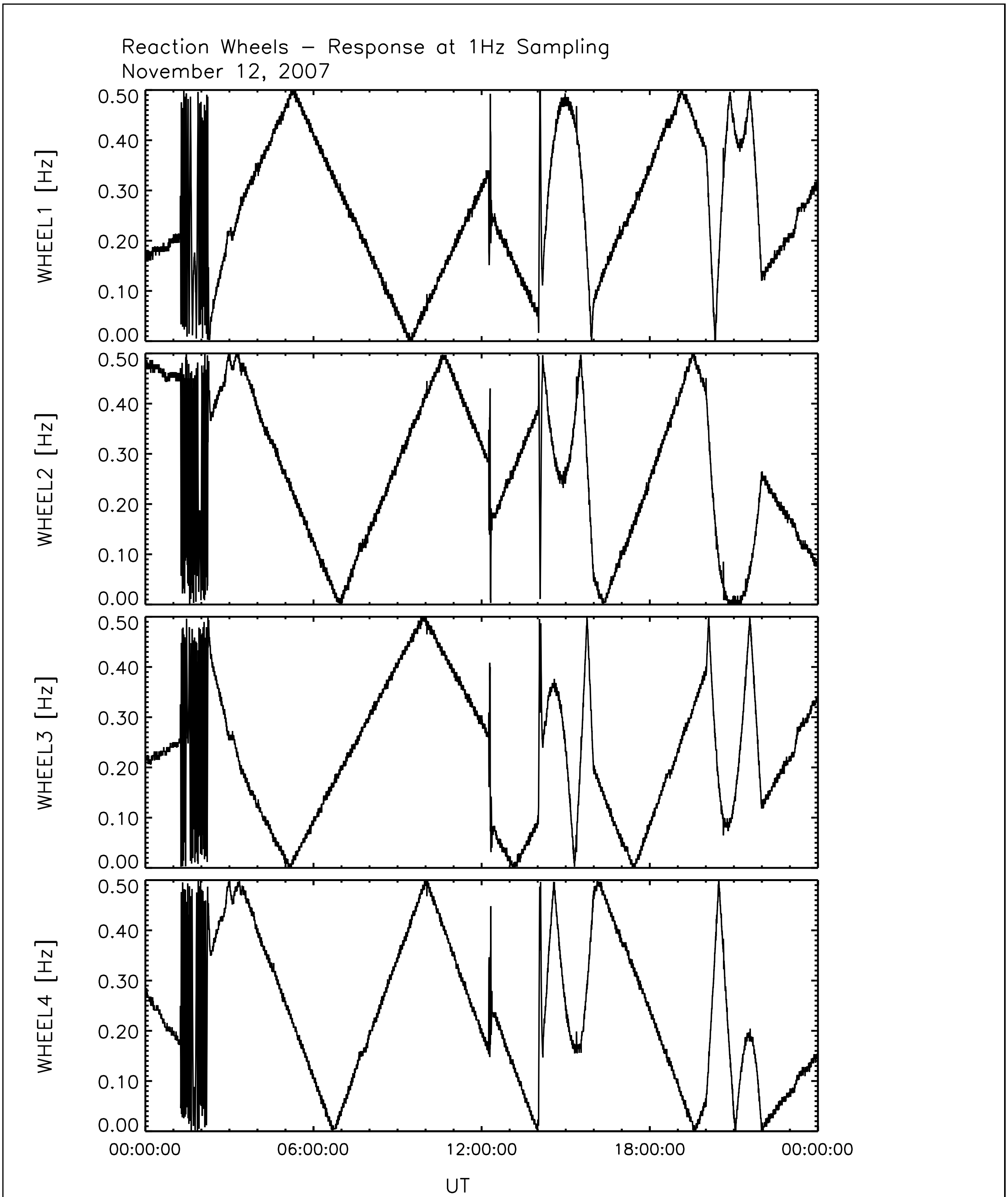


Figure 99: File: wheels_1Hz_Sampling2007-11-12T00-00

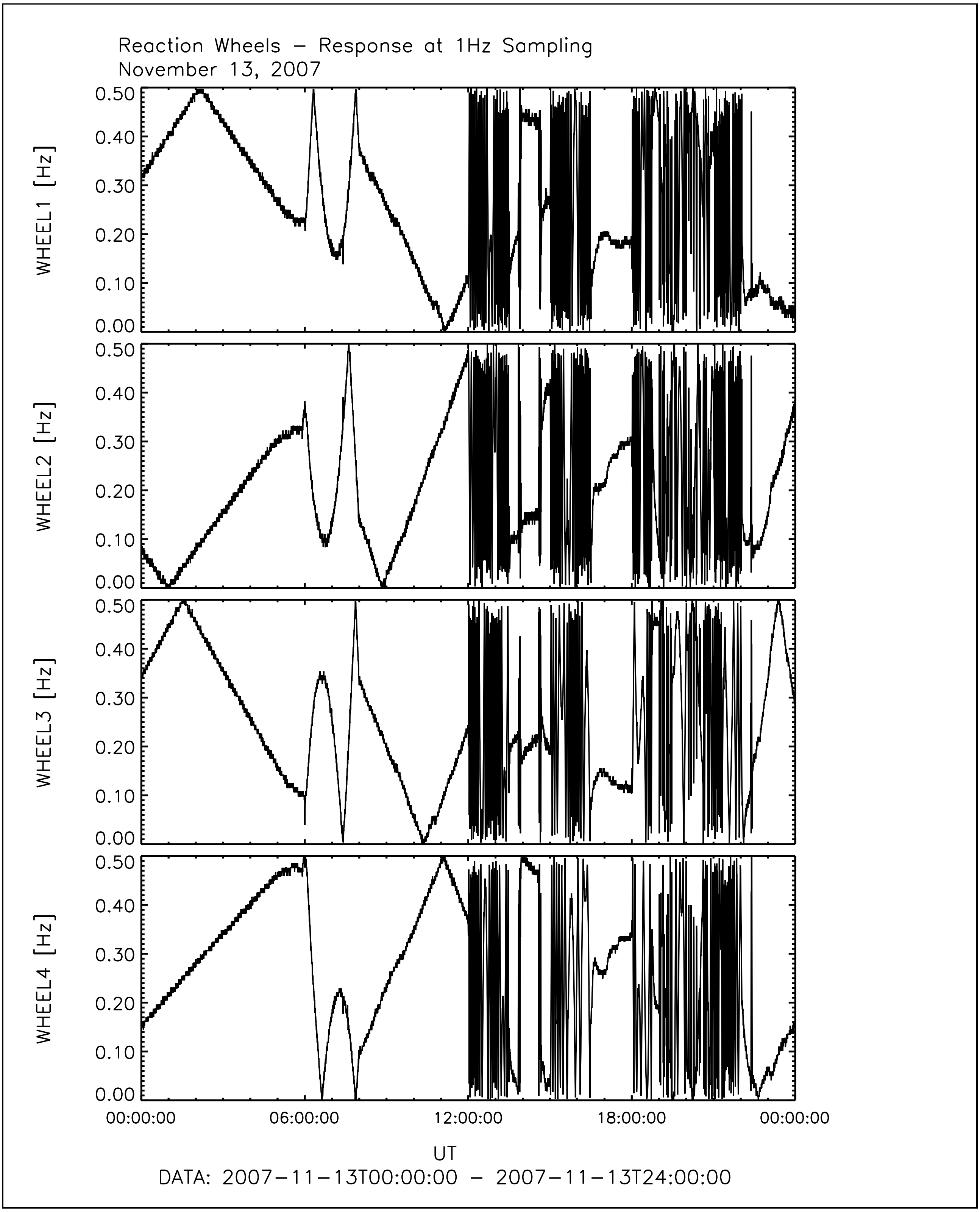


Figure 100: File: wheels_1Hz_Sampling2007-11-13T00-00

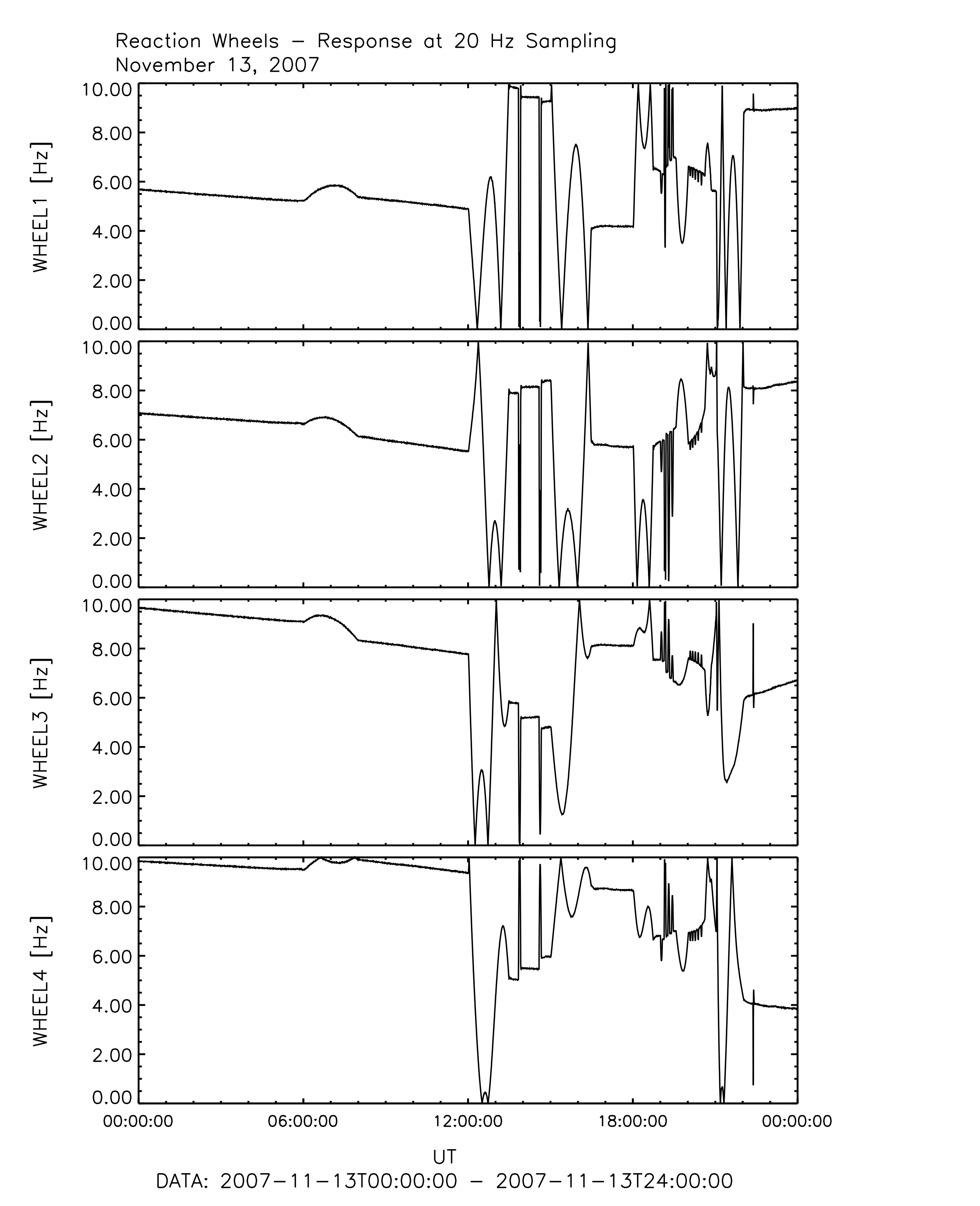


Figure 101: File: wheels_20Hz_Sampling2007-11-13T00-00

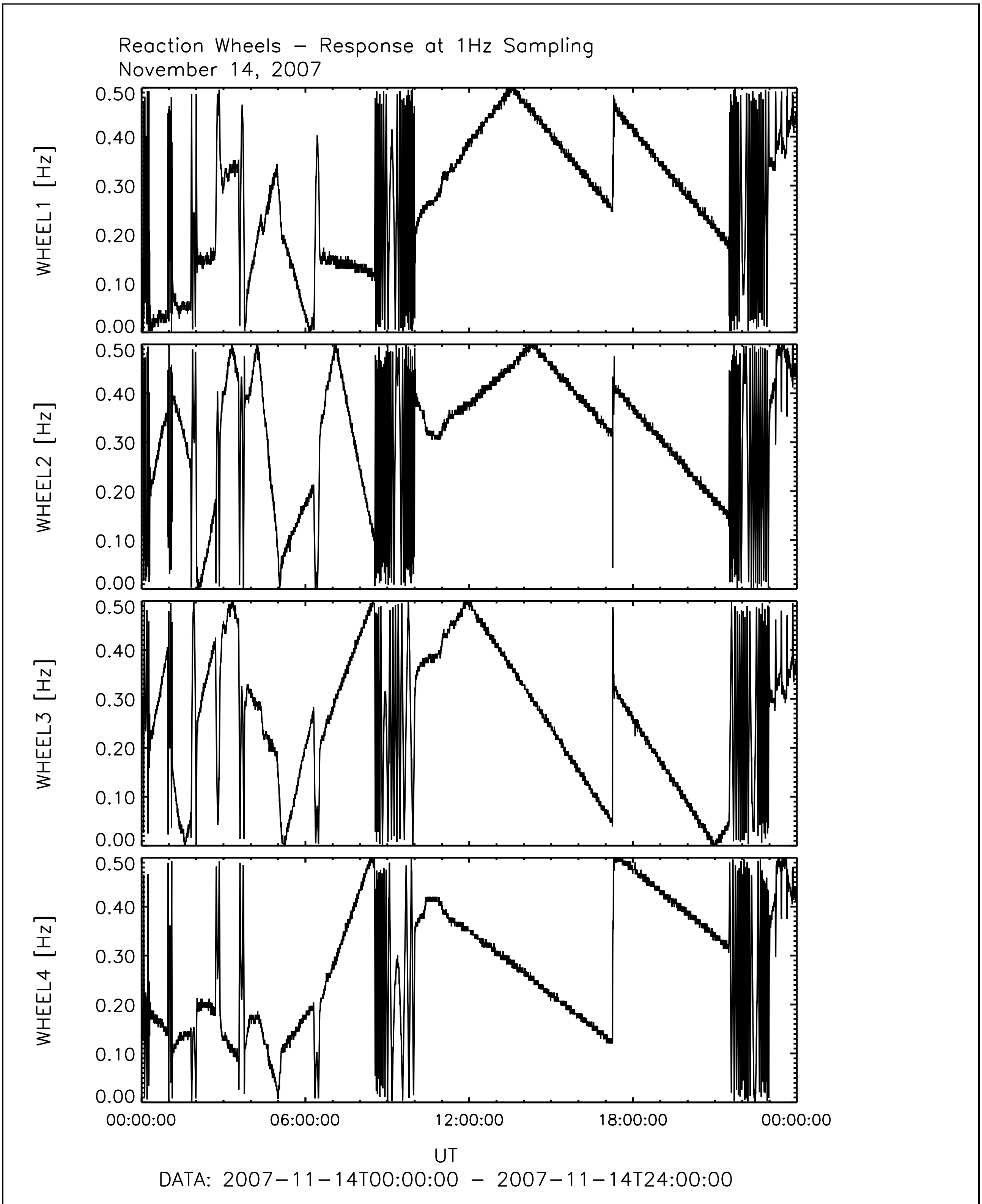


Figure 102: File: wheels_1Hz_Sampling2007-11-14T00-00

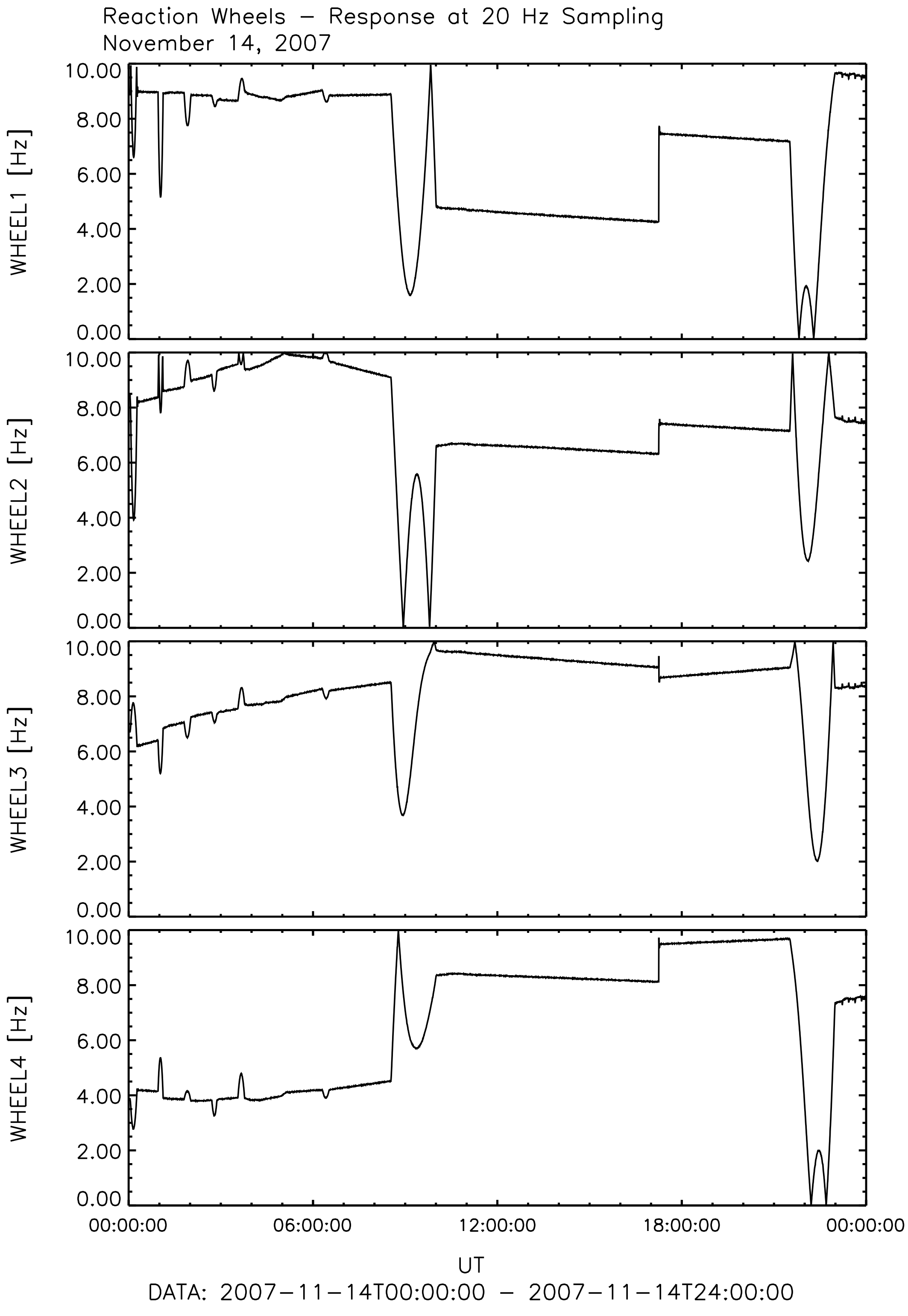


Figure 103: File: wheels_20Hz_Sampling2007-11-14T00-00

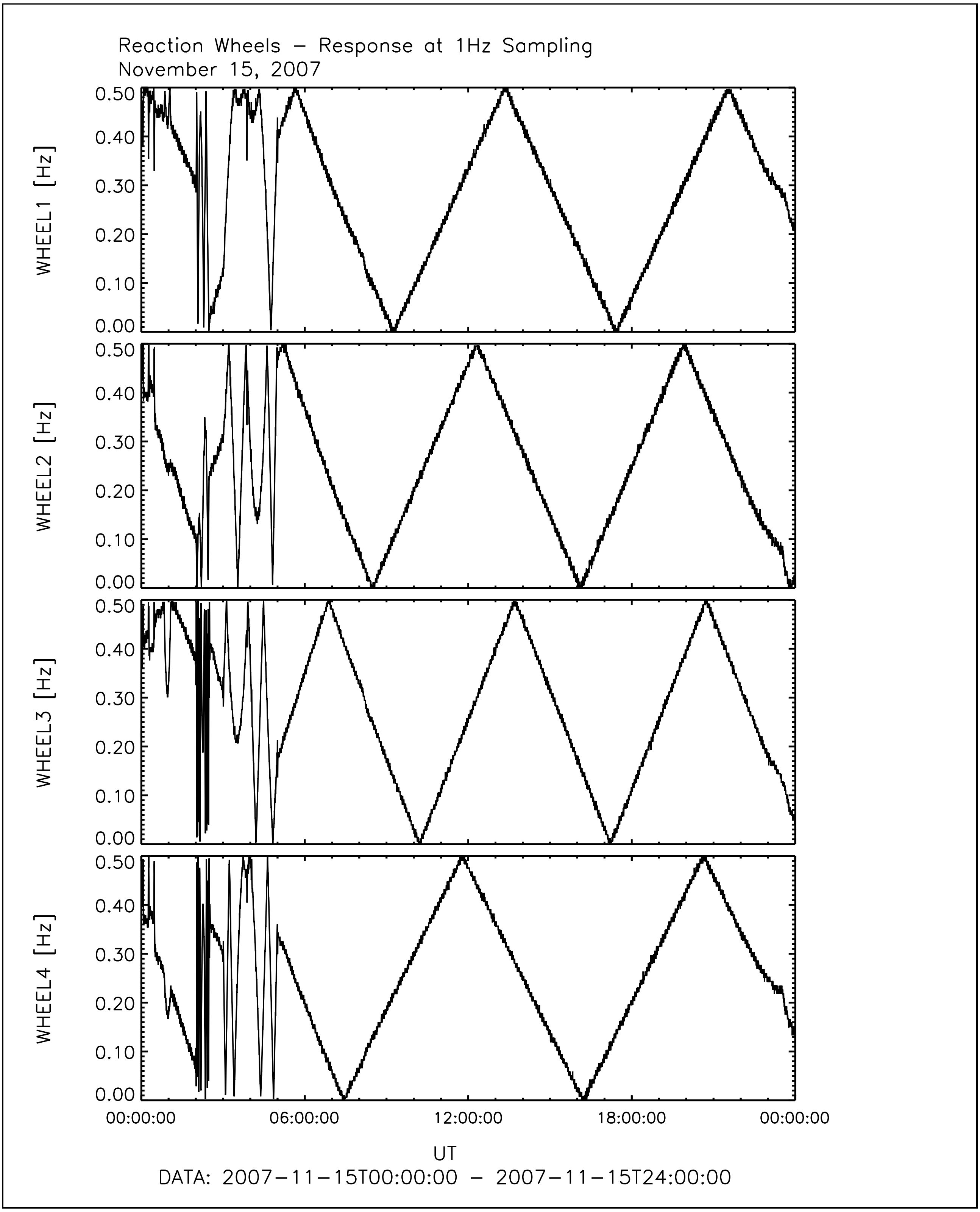


Figure 104: File: wheels_1Hz_Sampling2007-11-15T00-00

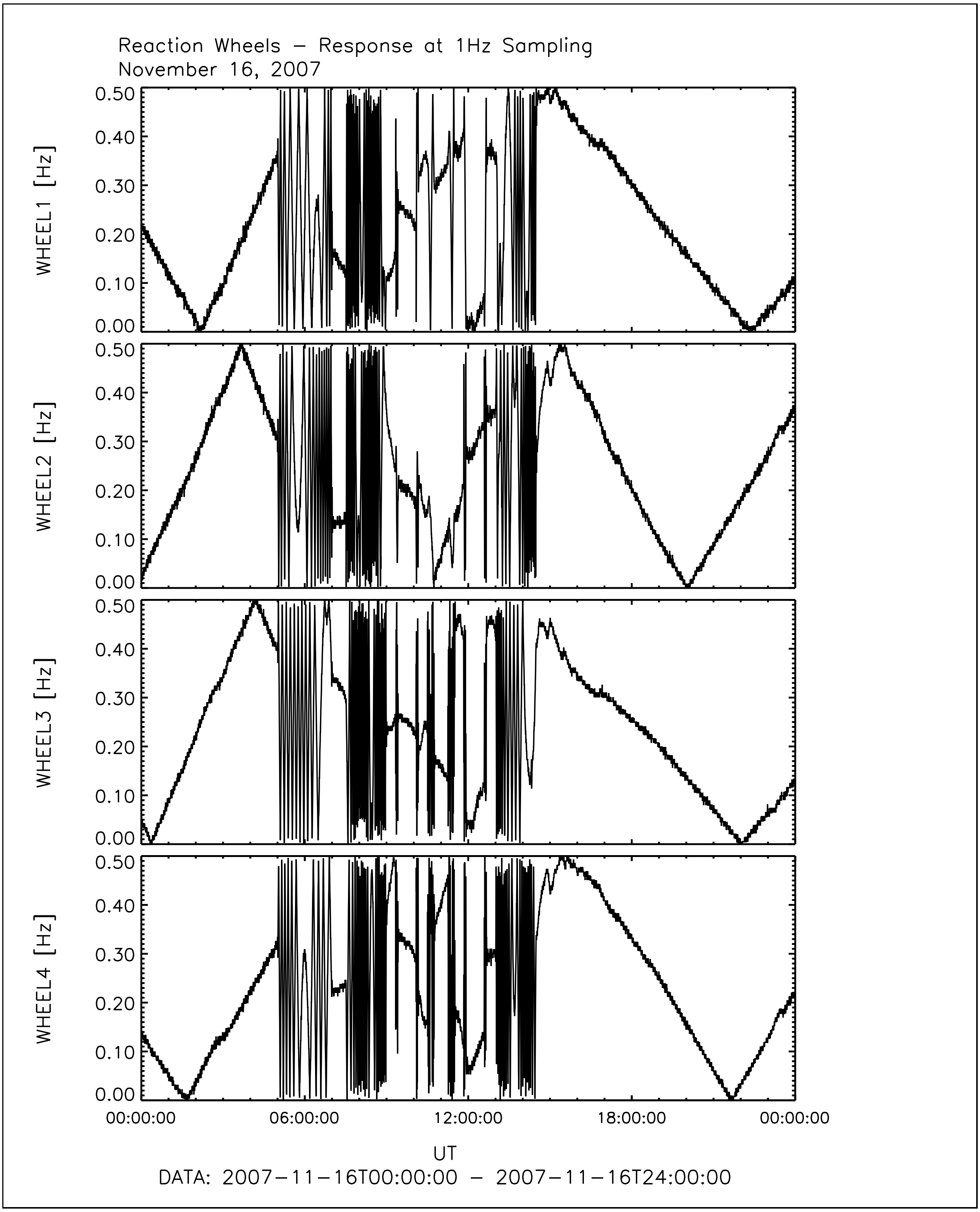


Figure 105: File: wheels_1Hz_Sampling2007-11-16T00-00

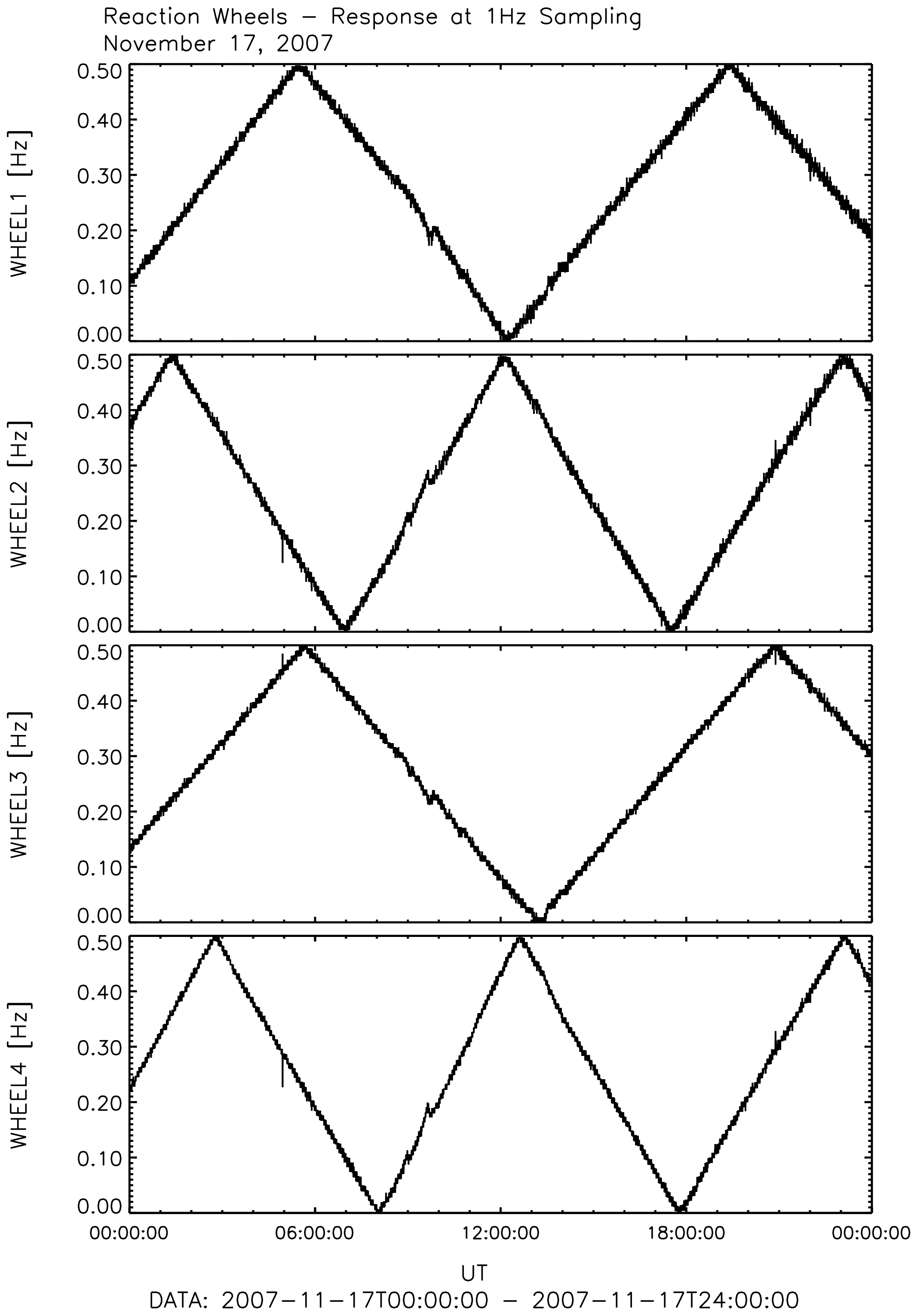


Figure 106: File: wheels_1Hz_Sampling2007-11-17T00-00

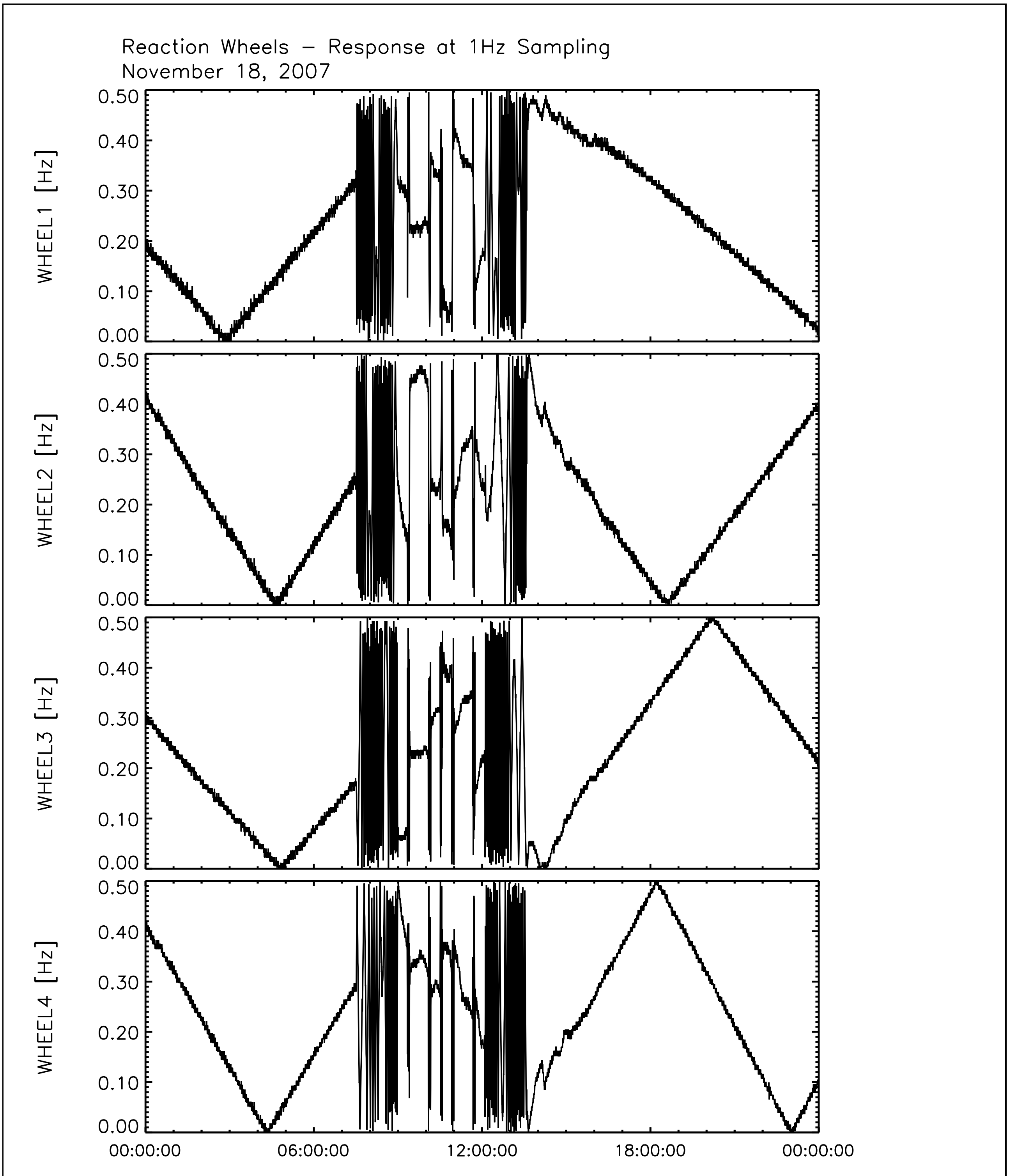


Figure 107: File: wheels_1Hz_Sampling2007-11-18T00-00

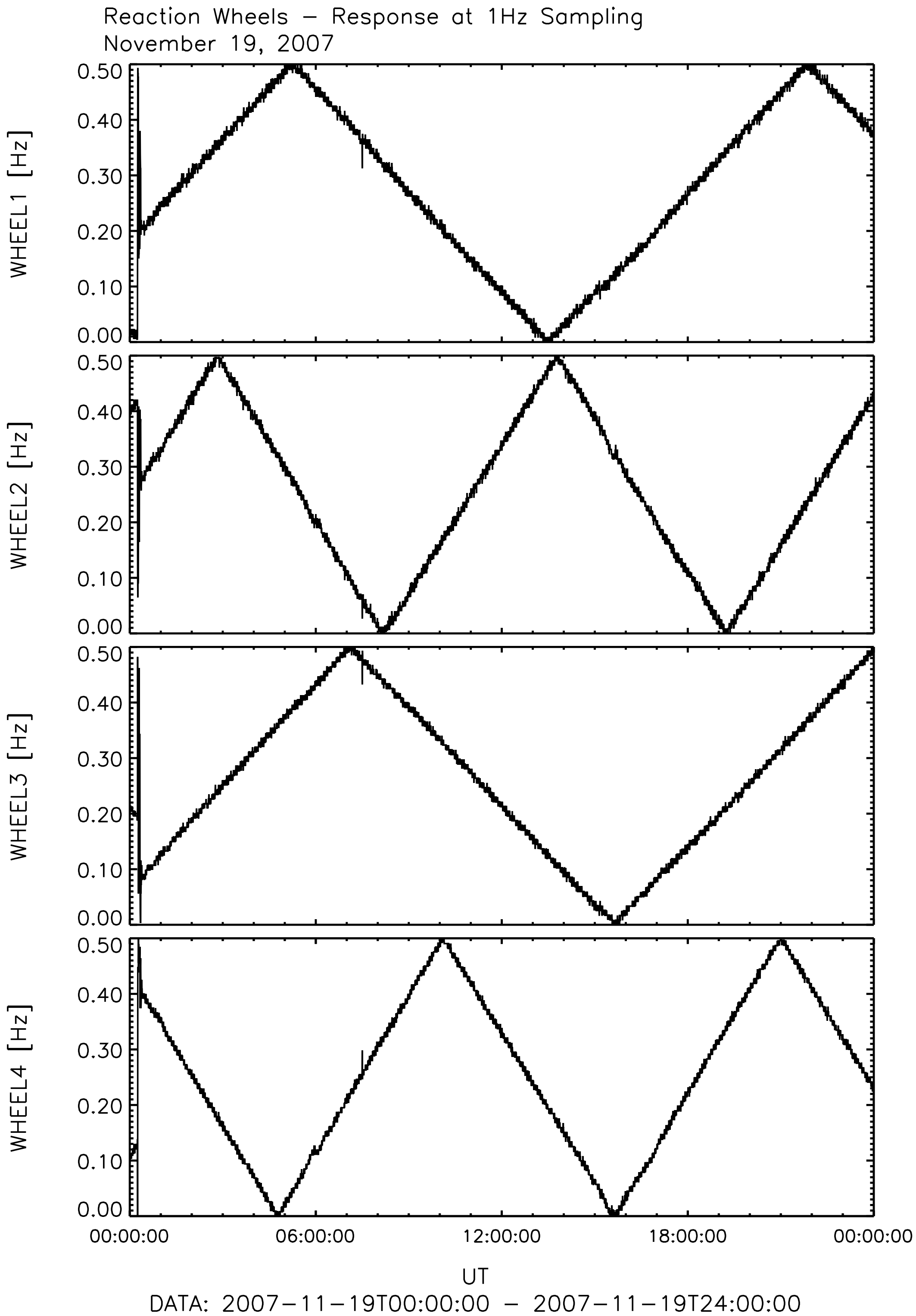


Figure 108: File: wheels_1Hz_Sampling2007-11-19T00-00

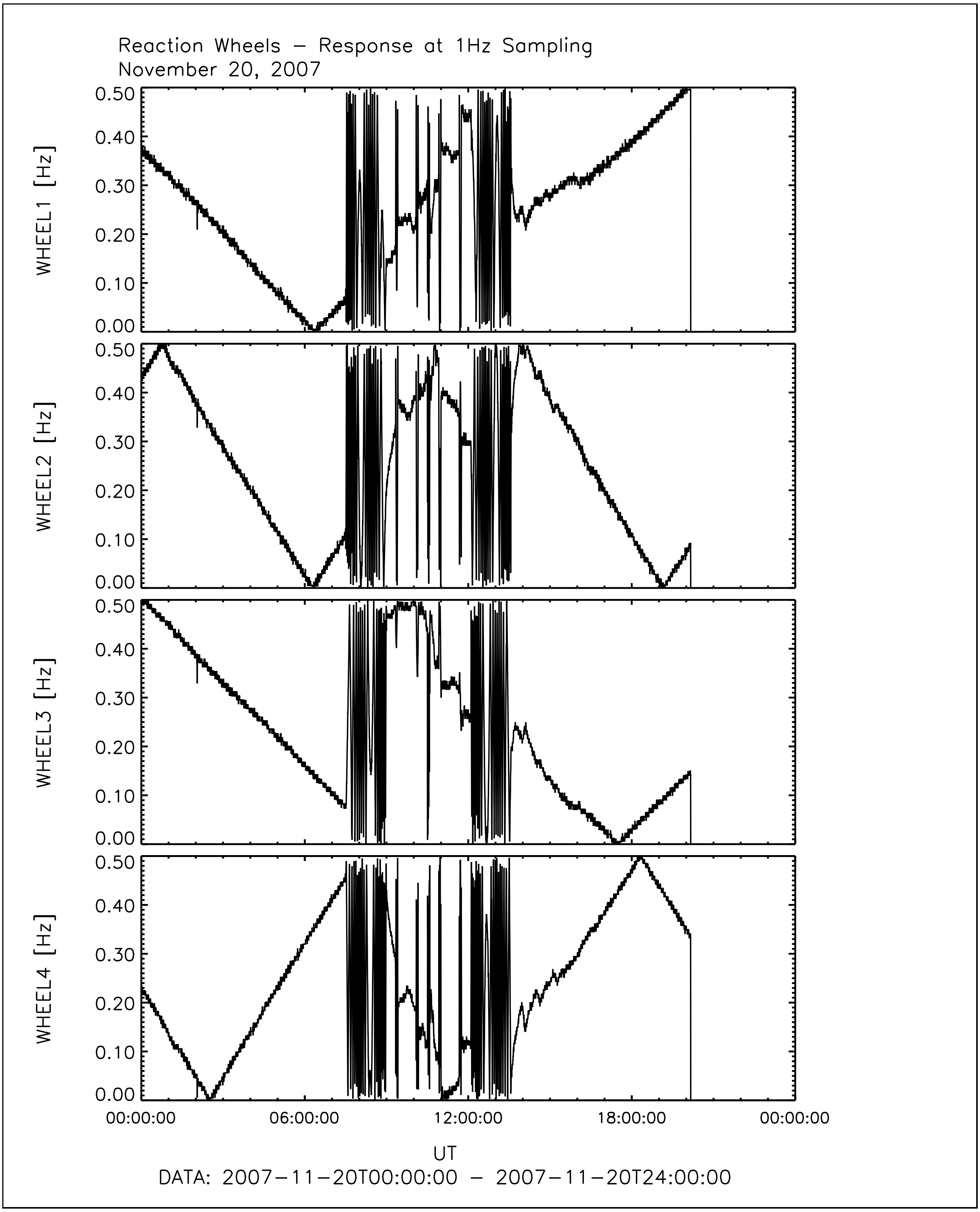


Figure 109: File: wheels_1Hz_Sampling2007-11-20T00-00

### 6.1 Plots of Reaction Wheel and LAP Disturbance corrected Data

The following plots show the dynamic spectra of the LEVEL_H data. These data have been purged from ROSETTAs reaction wheel disturbance and also from the disturbance of the LAP instrument. Plots are only shown for the primary sensor.

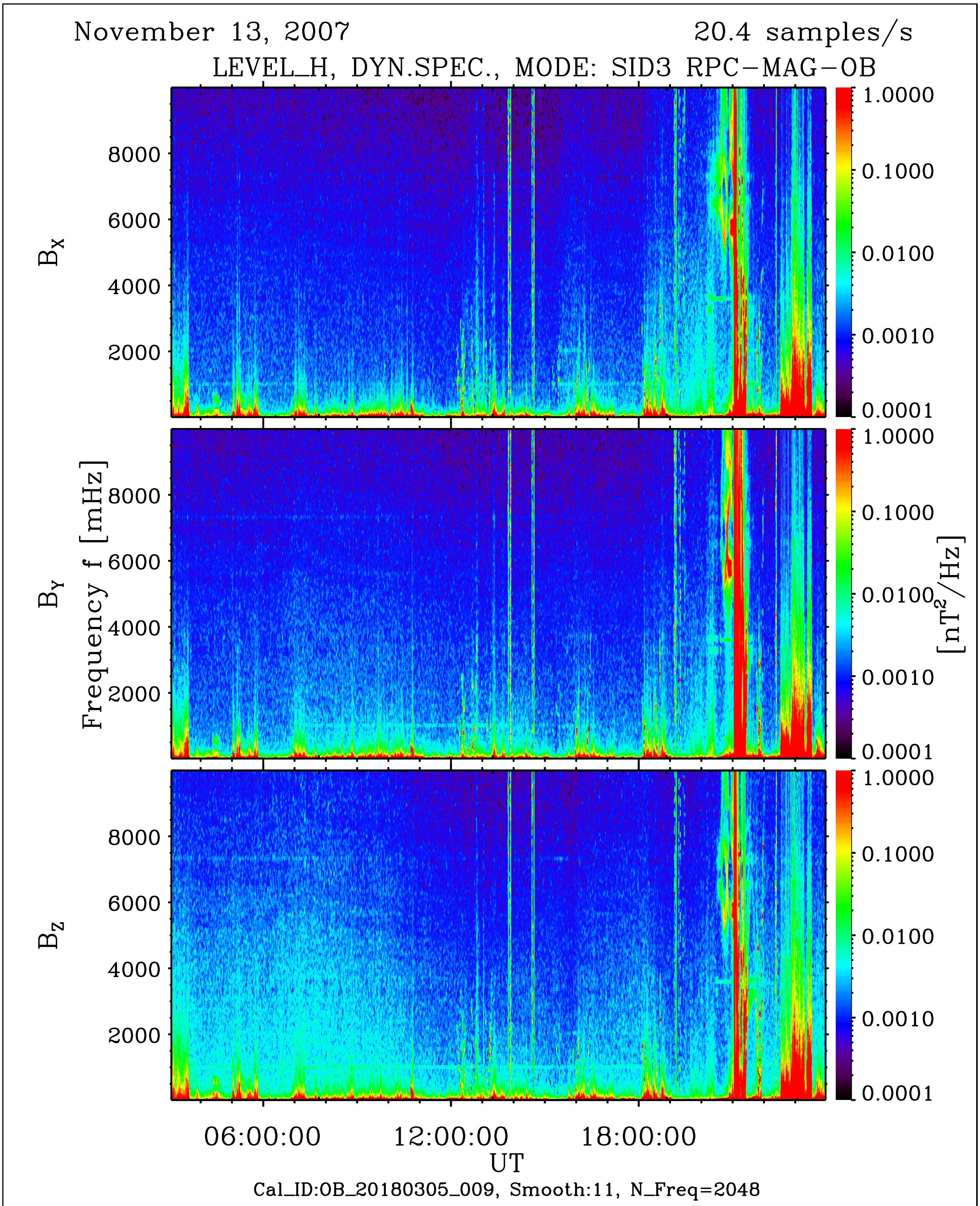


Figure 110: File: RPCMAG071113T0303_CLH_OB_M3_DS0_10000_009

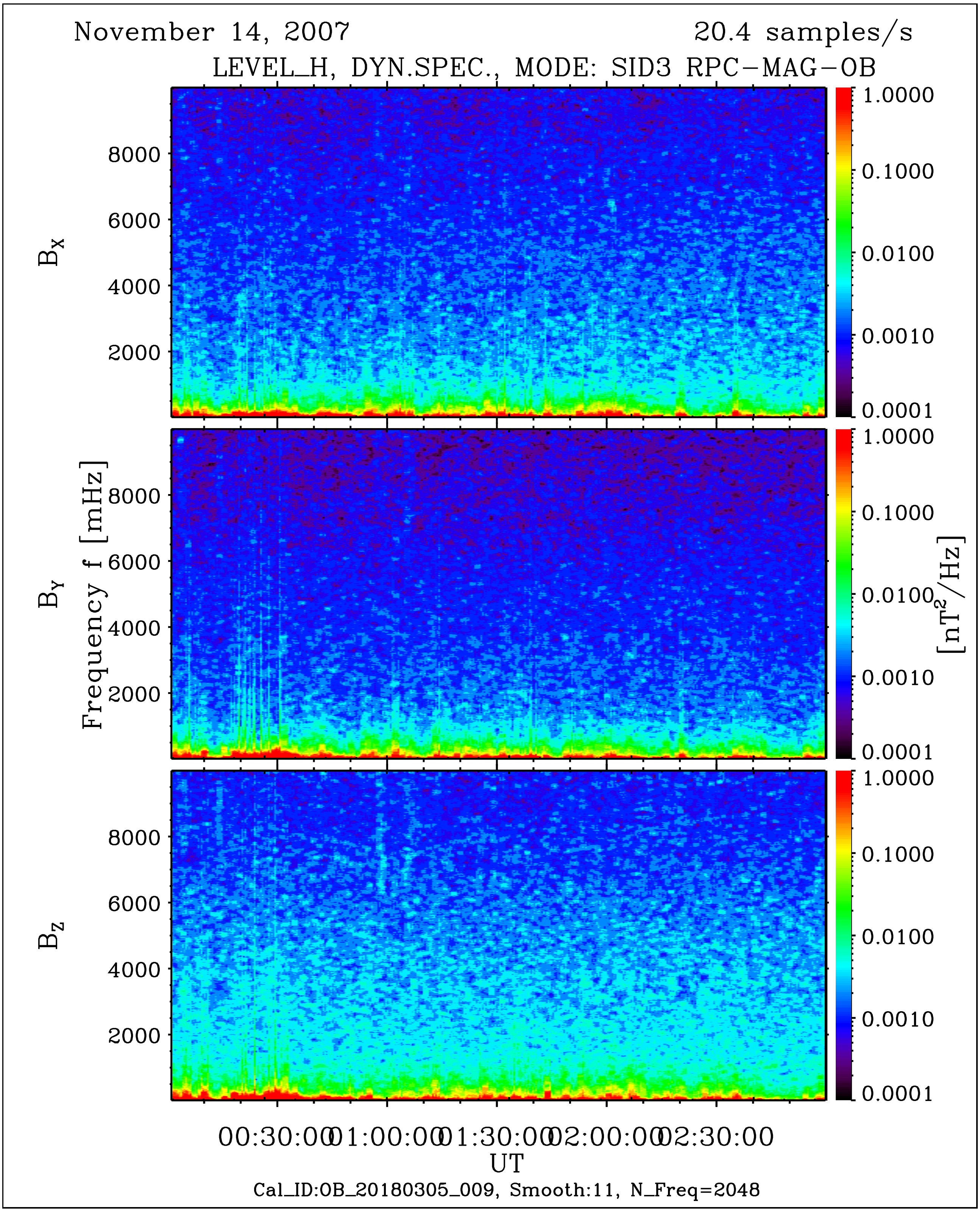


Figure 111: File: RPCMAG071114T0000_CLH_OB_M3_DS0_10000_009

# 7 Temperature profile during the EAR2

The following figure shows the measured temperatures of the OB and IB sensor during EAR2. 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.

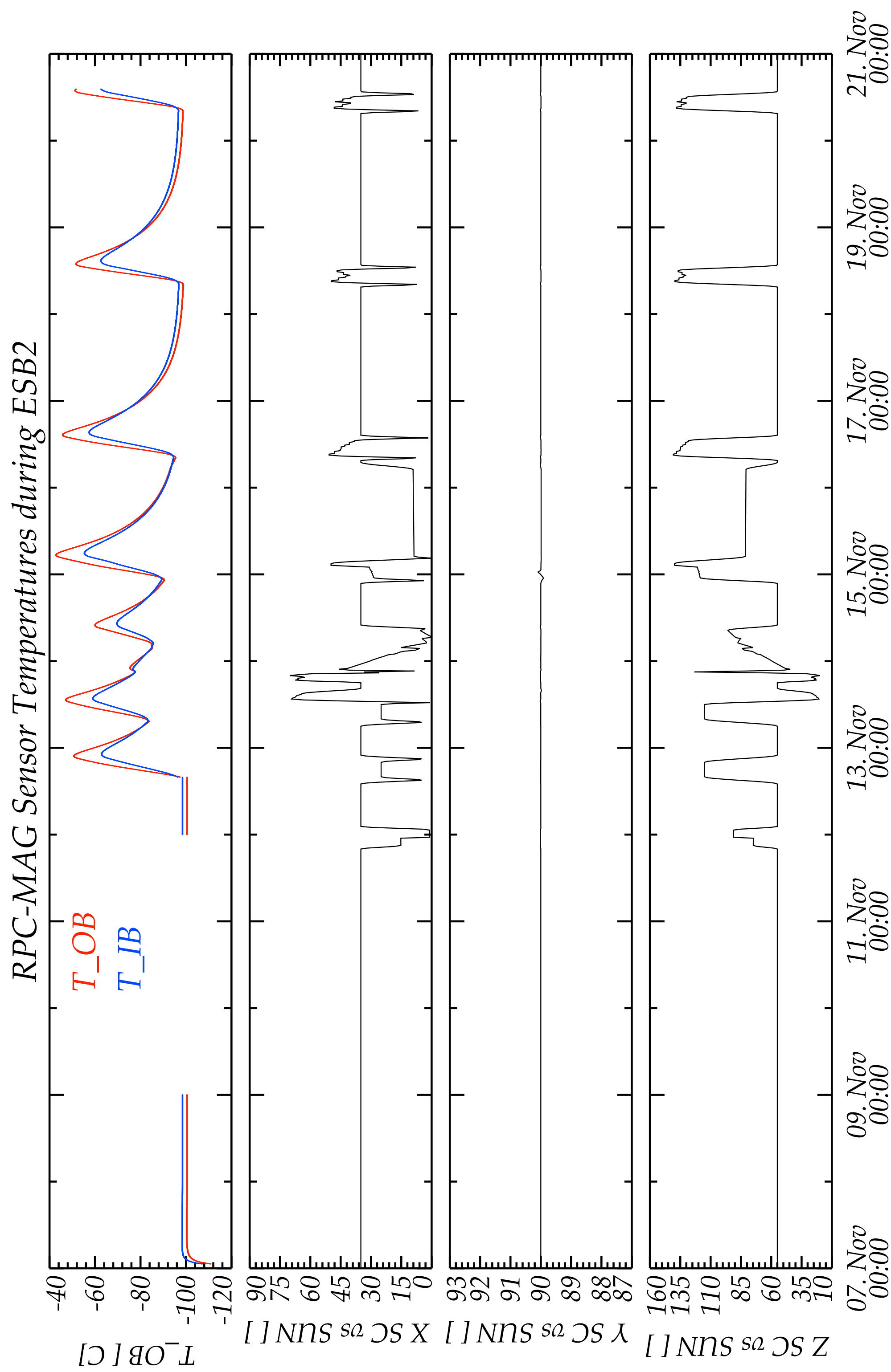


Figure 112: Measured Sensor Temperatures and attitudes during EAR2

# 8 Anomalies

As already mentioned in this report, MAG suffered an anomaly on November8, causing the instrument to stop transmitting data.
The last MAG science packet timestamp was 07.312.01.11.05.549648. There is a MAG event at 07.312.01.12.43.853392

```
"Warning    46340/0xb504  EC_MAG_TaskFill      ['0x2bf', '0xffa8']"
```

Judging by the time, this is likely to be related to MAG's loss of science packets. According to TC history, last RPC command was:

```
ZSKA8096  START RPC Mode Control 2 OBCP           ARPS804A
07.305.12.16.18  07.311.02.30.00.000 19  7   1   1   Y  Y  B E E E E MS  - 3B0 S SS  UU  SS
  FSK08096RPC Mode Control 2                      Raw      Dec 32918
  FSK02001OBCP Offset=0 (within TM)               Raw      Hex 0
  FSK02016OBCP Length of TC parameter             Raw      Dec 6
  FSK01262ModeLAP                                 Eng      SID2
  FSK01263ModeMIP                                 Eng      NoChange
  FSK01264ModeMAG                                 Eng      NoChange
  FSK01267LAPParam                                Raw      Dec 101
  FSK01268MIPParam                                Raw      Dec 255
  FSK01269EEPROM Bank                             Raw      Hex 5
```

issued at 07.311.02.30.00.00019 which did not modify MAG's status. This is to exclude any sequence miscommanding. All the other RPC instruments continued generating data.

## Anomaly Report Tracking System

| Project | Rosetta Spacecraft Anomalies | Project ID | ROS_SC | Report Type | SC |
|---|---|---|---|---|---|
| Observation | RPC-MAG stops generating science during ES2 campaign | State | Open | ID | ROS_SC-144 |

| | | | | | |
|---|---|---|---|---|---|
| **Originator** | Armelle Hubault | **Criticality** | Low | | |
| **Created** | | **Urgency** | Low | **Reproducibility** | Unknown |
| **Occurrence Date** | 2007-11-12 | **Classification** | Space Segment \| Payload \| RPC | | |

**Description**

**Description**

During N1353 pass on 12-Nov-07, E. Cupido reported in a email that the MAG instrument on RPC was not generating science anymore since DOY 312:

EC - MAG sci pkts loss - 12/11/2007 14:01

Hi Armelle,

it looks like MAG has stopped producing SCI pkts.

As far as I can tell:

- Last MAG SCI pkt timestamp was 07.312.01.11.05.549648
- There is a MAG event at 07.312.01.12.43.853392 "Warning 46340/0xb504 EC_MAG_TaskFill ['0x2bf', '0xffa8']"

Judging by the timestamps, I suspect the event is related to MAG's loss of SCI.

Has RMOC noticed any anomalous behaviour of RPC? (I shouldn't think so, otherwise you'd already have let me know), but I thought I'd ask.

Regards,

Emanuele

MOC didn't notice any anomalous behaviour from RPC, apart from the above reported event which had previously been received during the mission but only reported a glitch in MAG TM generation (no TM "stalling").

Ec also reported that although MAG was still generating housekeeping, the packet was always the same.

After discussion with the MAG team, EC requested per email (EC - RE: MAG sci pkts loss - 12/11/2007 16:35) a power cycle for the MAG instrument.

The power cycle successfully cleared the problem.

**Item Configuration**

**Environment**

**Impacted Service**

**Recommendation** RPC-MAG team to investigate on the science stalling and HK freeze.

**Affected Requirement**

**External Reference**

Figure 113: Anomaly Report AR144, Page 1

| **Processing** | |
|---|---|
| **Root Cause** | |
| **Preventive Action** | No |
| **Resolution** | |
| **Link Report** | |

| **Related Files** |
|---|
| No files are attached to this report. |

| **Actions** |
|---|
| No actions assigned to this report. |

| **Related Reports** |
|---|
| No other reports related to this report. |

Figure 114: Anomaly Report AR144, Page 2

MAG-HK packets were still transmitted but all HK values remained constant. Not any bit changed. Therefore , we assume that these values were not updated but just read out from a buffer and packetized.

After a power cycle (Switch off, switch on) of the MAG unit (only MAG, not the RPC-PIU) the instrument started transmitting science and HK data in the usual way. There was no indication of any remaining hardware problem, the actual instrument behavior is absolutely nominal.

The most likely explanation for this failure seems to be a Single Event Upset (SEU) in the MAG control Electronics, as a single power cycle of the MAG instrument alone solved the problem. The PIU side of the MAG-PIU interface was obviously not affected, therefore the failure source has to be located in the MAG unit. As there was no corruption of single components but a transmission failure of all science data, the failure has to be located in the I/F to PIU and not on the Analog side of the instrument. The control logic of MAG is located in two FPGA's on the MAG board. Our guess is that one of the flip-flops in the FPGAs changed its state by the influence of external radiation (neutron, alpha, beta,gamma). It is a known fact that such a behavior is possible and can happen any time, although its occurrence is very seldom and unlikely. There is no means to protect the against such a behavior on the hardware side.

To minimize the possible loss of data in the future we are investigating the feasibility of a more sophisticated warning/alert system in case of packet failures and will improve our contingency recovery procedures.

# 9 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
- Tail & Lobe Region

A comparison of the predicted position of the Bow shock and the Magnetopause derived from the Tsyganenko Model (refer to Figures 3 and 4 shows a good very good agreement.

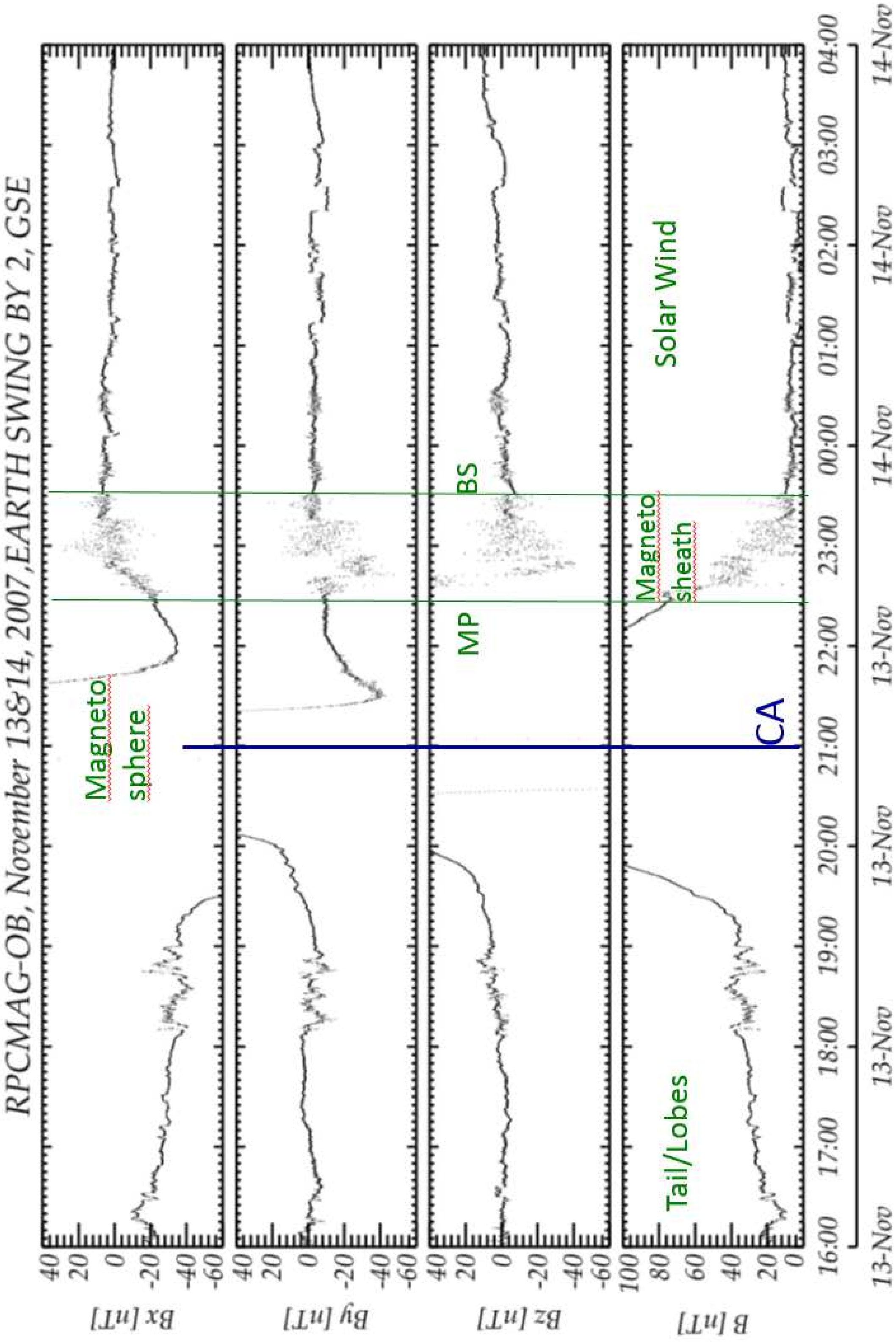


Figure 115: Identified magnetospheric regions during EAR2

# 10 Reference: WIND & ACE Data

The next plots give an overview about the plasma parameter measured onboard the WIND and ACE spacecrafts during EAR2.

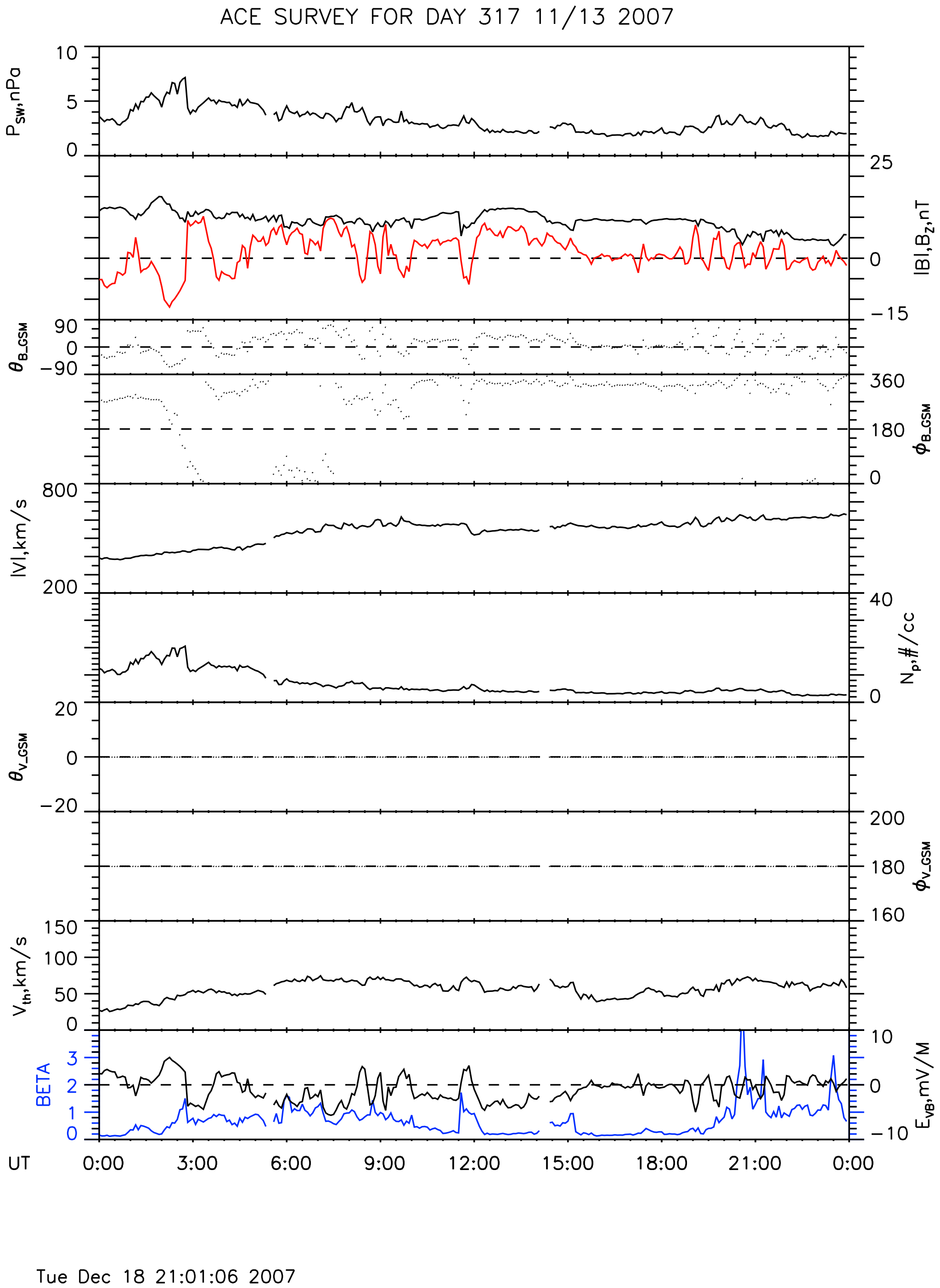


Figure 116: ACE data of November 13, 2007

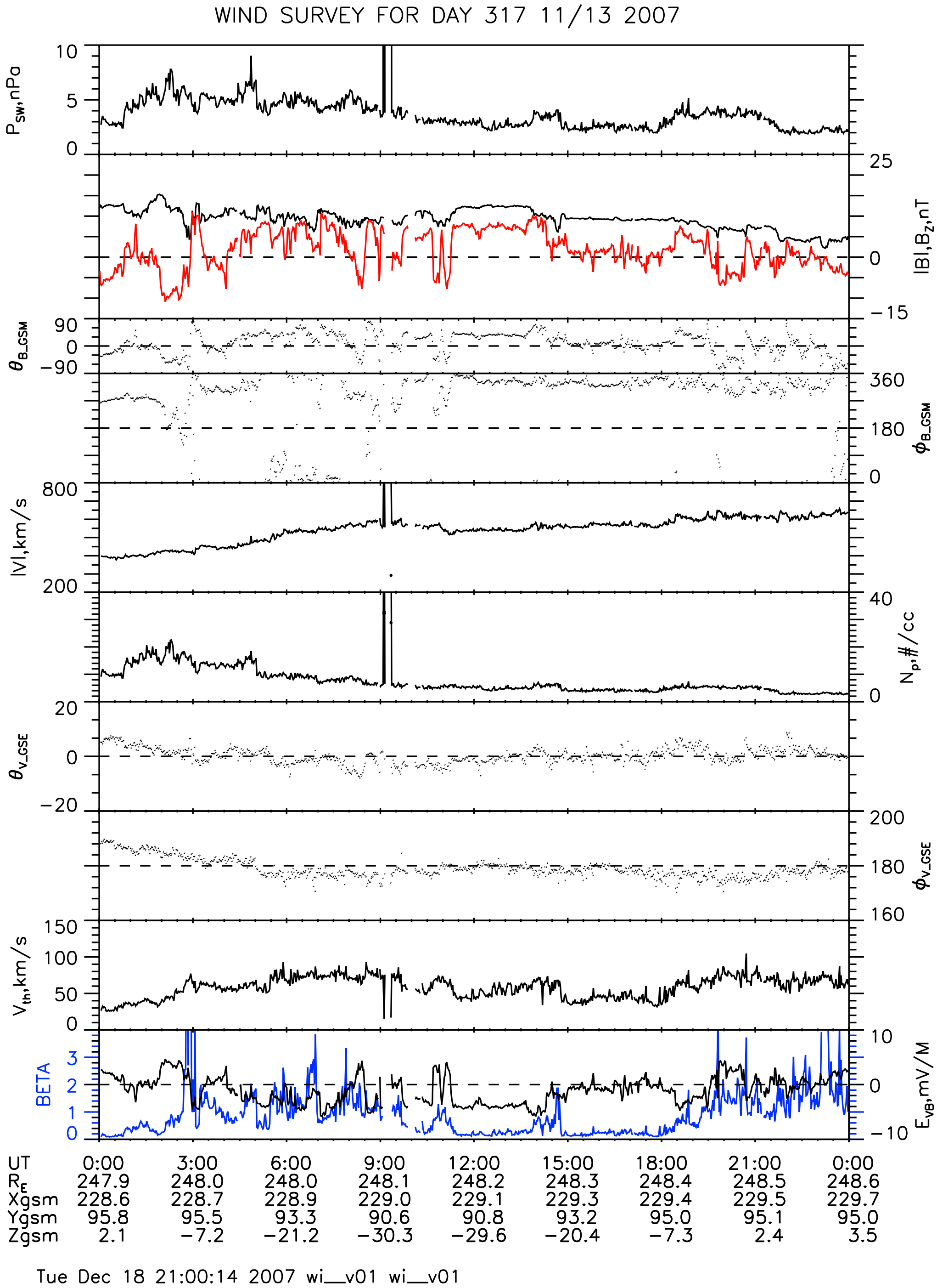


Figure 117: WIND data of November 13, 2007

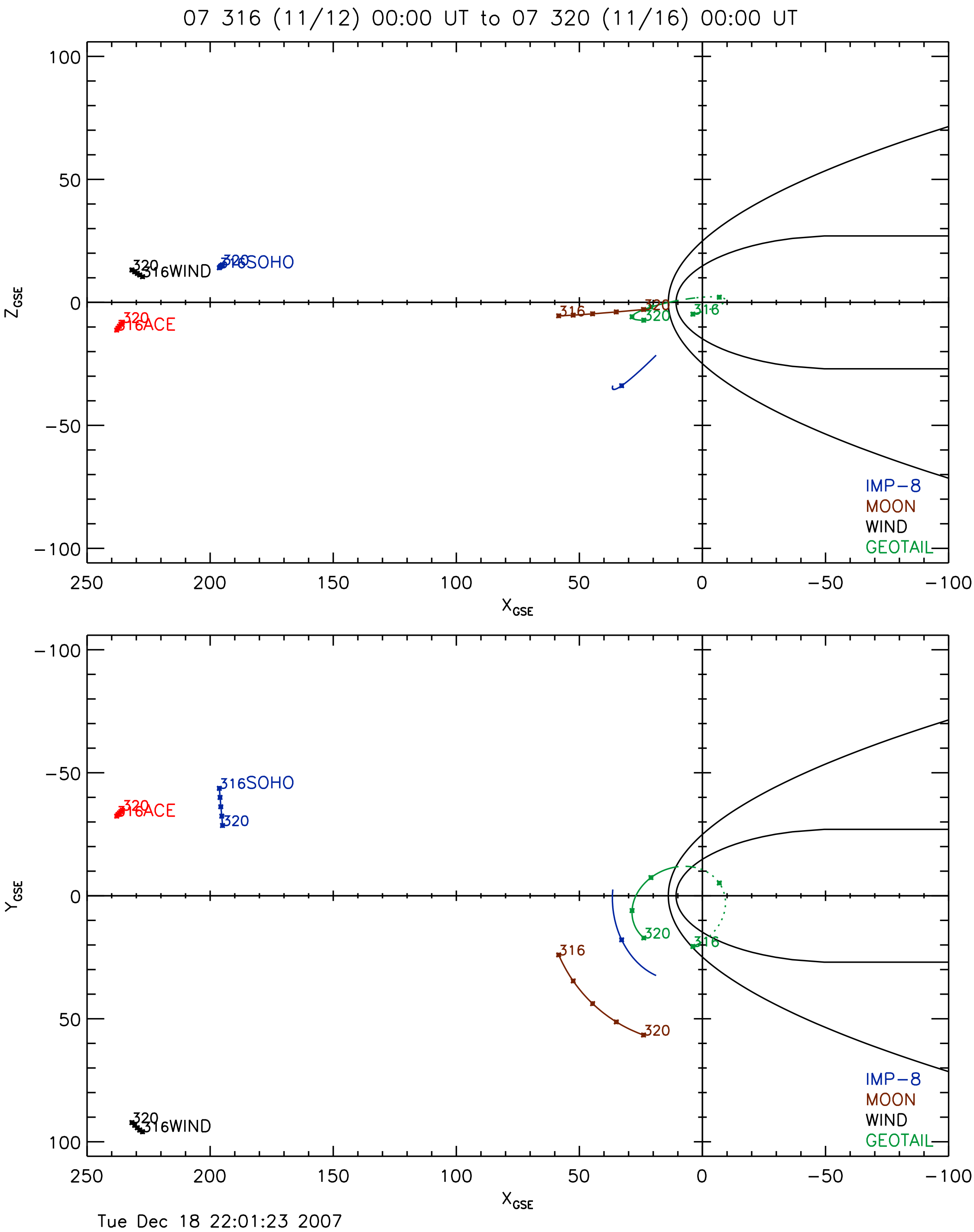


Figure 118: ACE & WIND orbits

# 11 Conclusions

- RPCMAG has performed amazing measurements during the second Earth swing by EAR2.
- 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 20 nT even in the components.
  Thus, ESB2 was a perfect opportunity to check the calibration of the instrument and the sensor assembly matrices onboard the spacecraft.
- The spectra showed the usual impact of ROSETTAs reaction wheels and LAP Disturbance whilst the instrument was operated in burst mode.
- The predicted Magnetopause and Bow Shock position derived from the Tsyganenko model using ACE/WIND dynamic solar wind parameters can be confirmed by RPCMAG measurement.