R O S E T T A

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Report of the

MARS Swing by (MSB)

Time period: February 23 - 27, 2007

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1 Introduction

ROSETTA's Mars Swing by (MSB) happened in the time period February 23 – 27, 2007. RPC-MAG was switched on in the time between 2007-02-23T00:00:54 and 2007-02-27T02:37:50. Around the closest Approach, however, all the orbiter payload was switched off due to power safety reasons. Therefore, there is a data gap for the time interval 2007-02-25T00:38:14 and 2007-02-25T02:35:42. The overall instrument performance was excellent. There were no 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, ECLIPJ2000 coordinates and in Mars Solar Orbital (MSO) coordinates for the complete overview. The data are calibrated according to the results of the ground calibration and the results of the inflight temperature model 009 using all RPCMAG data until the comet phase. 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 as well in section 6. The few measurements in BURST mode (SID3) in the hours around CA are disturbed by ROSETTAs reaction wheels (refer to section 5). This disturbance cam be eliminated d by our processing S/W.

At the end overview plots for the complete swing-by period are shown in ECLIPJ2000 and MSO coordinates.

2 The Swing-by Geometry

This section gives an overview about the trajectory during the MARS Swing-by. ROSETTA approached from the day side, had its closest approach on February 25 at 01:58, and left through tail region. The minimum distance to earth was 261 km.

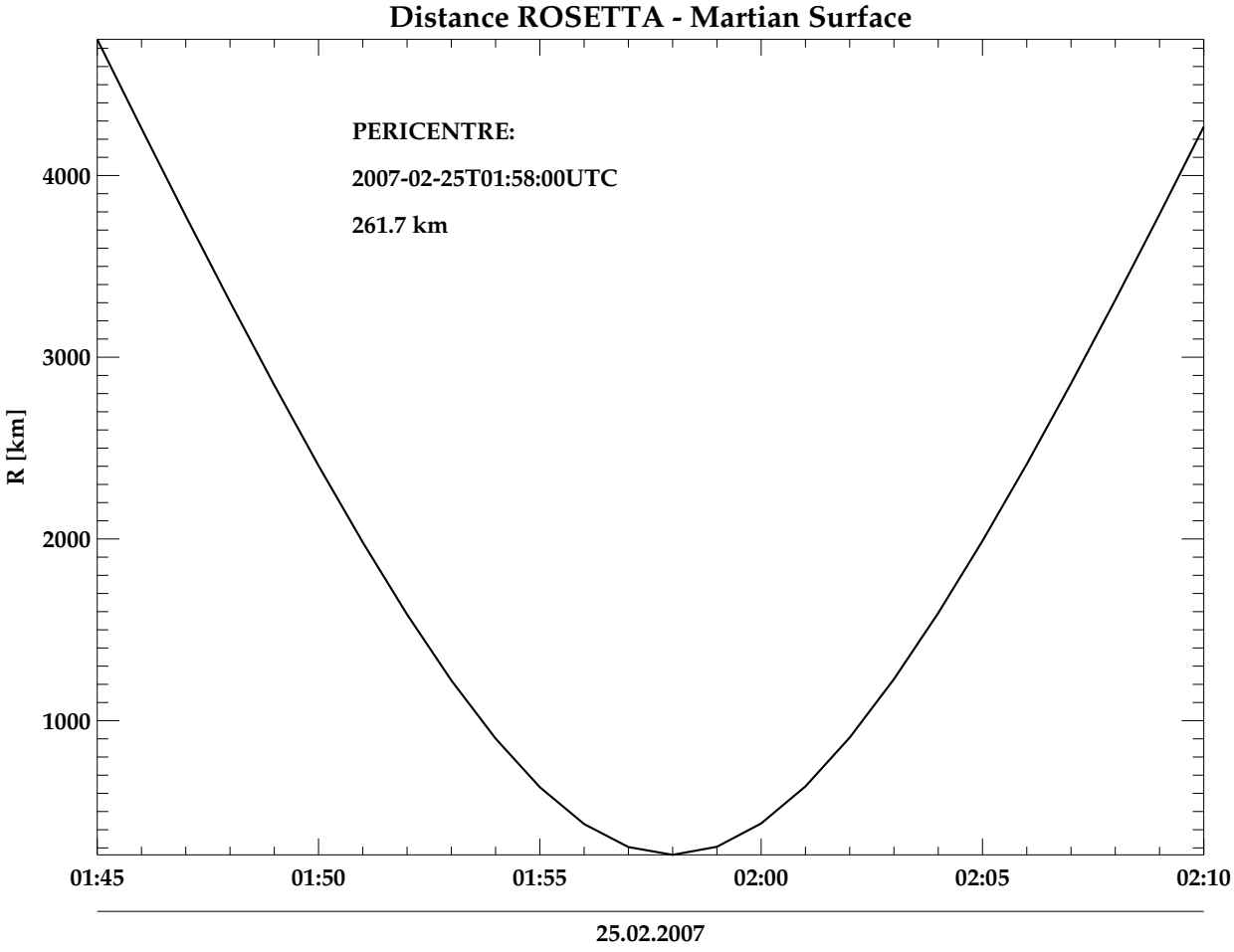

Figure 1: ROSETTA'S Distance to the Martian Surface

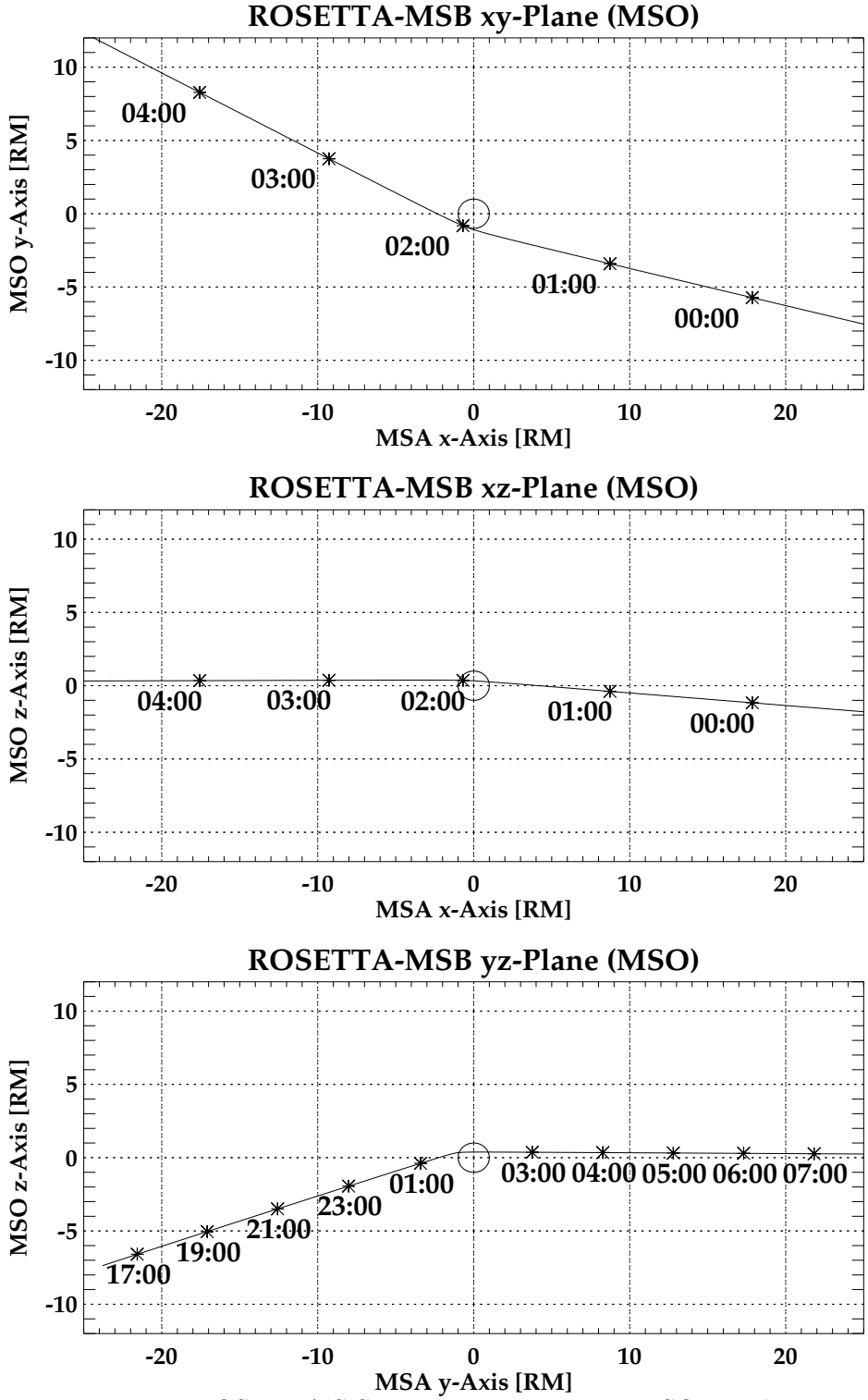

Figure 2: ROSETTA'S Swing-by Trajectory in MSO coordinates

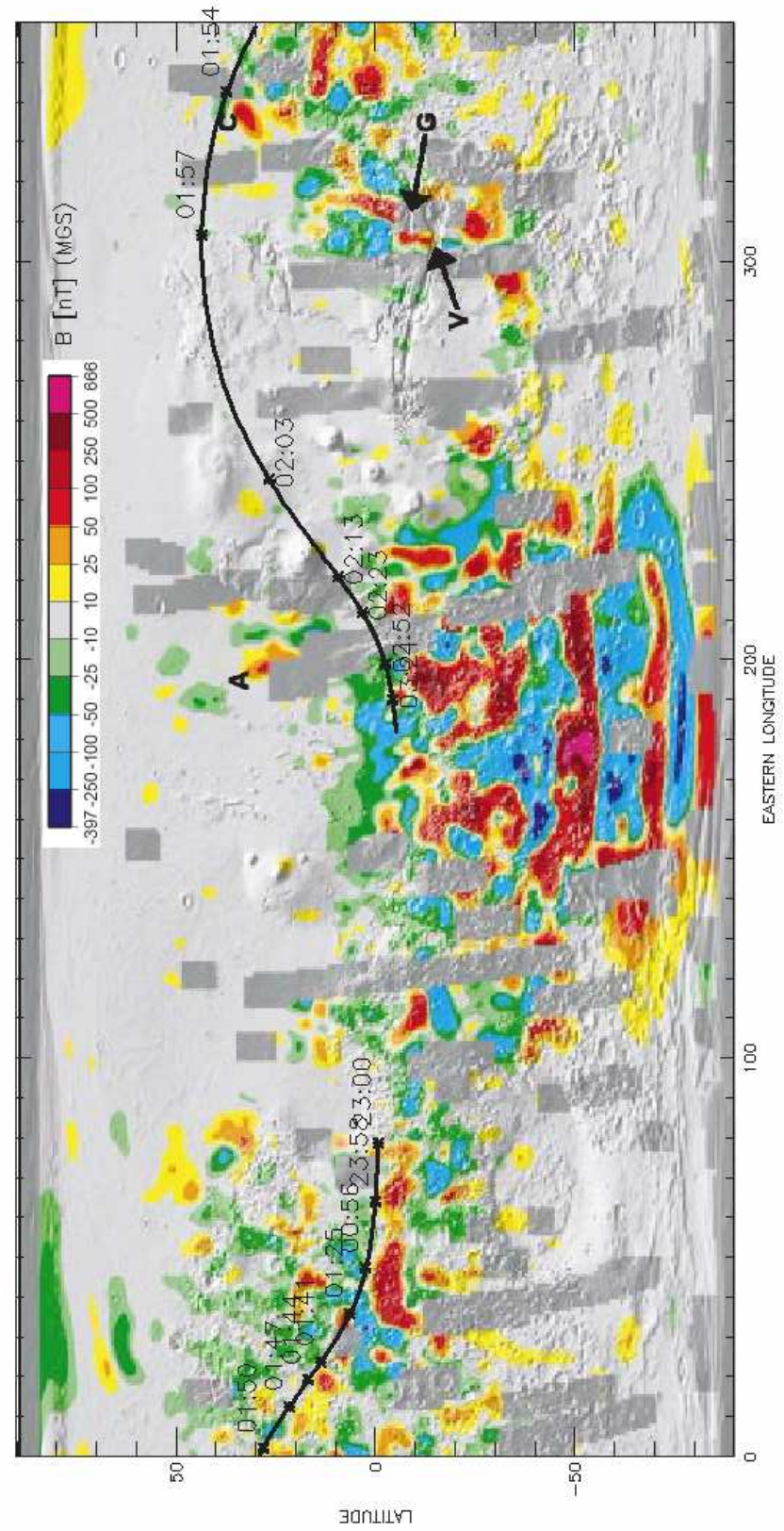

Figure 3: ROSETTA'S Swing-by ground track superimposed on MGS Magnetic Field Data

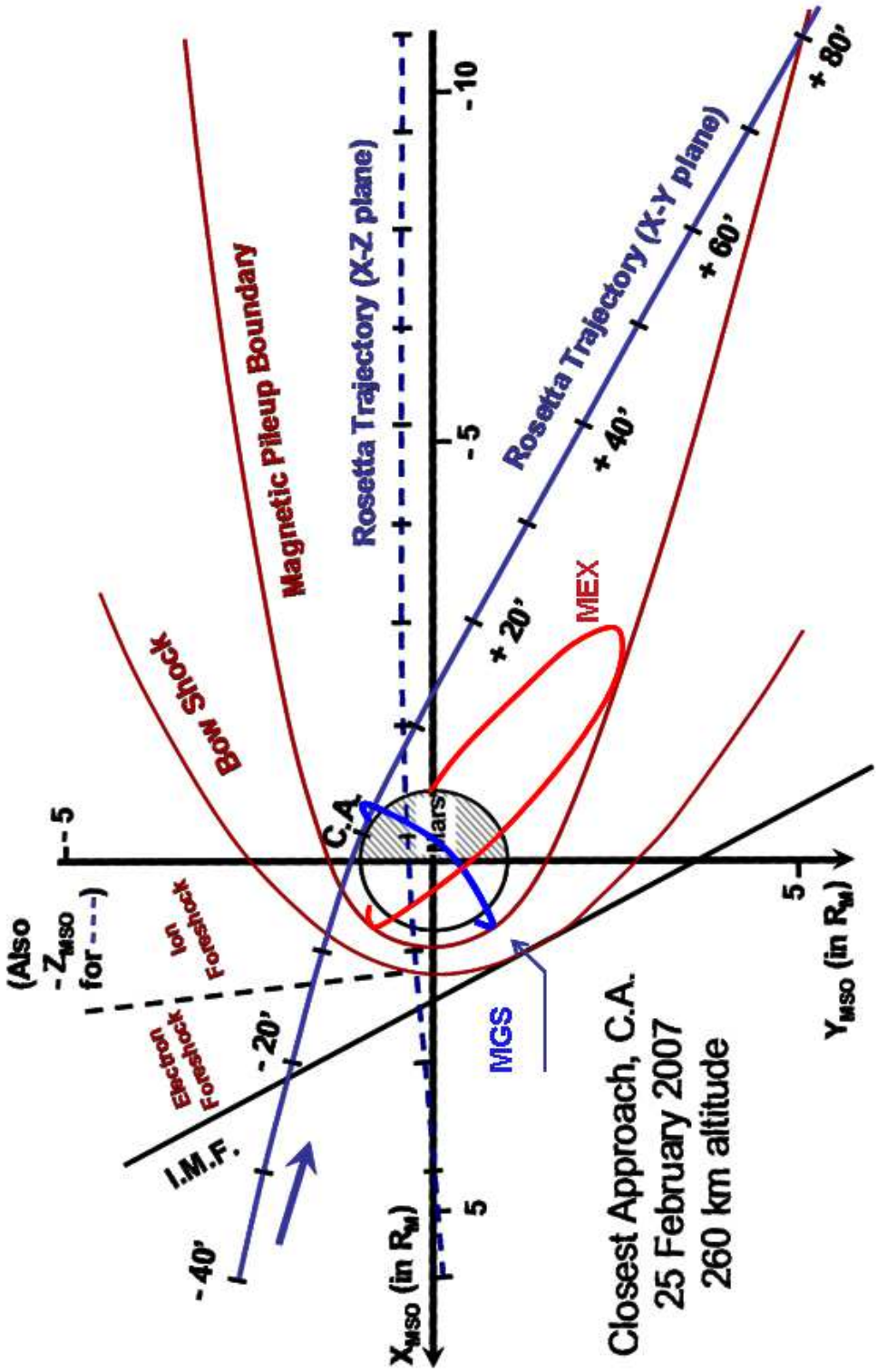

Figure 4: ROSETTA'S MARS Swingby Geometry (MSO)

3 ROSETTA'S Attitude during the Swing-by

The following plots show the attitude of the ROSETTA s/c during the swing-by campaign. The panels show the angles between the Base-axes of the s/c-coordinate system and the sun direction in degrees. On a second plot the angles between the s/c-coordinate axes and the MARS direction are displayed.

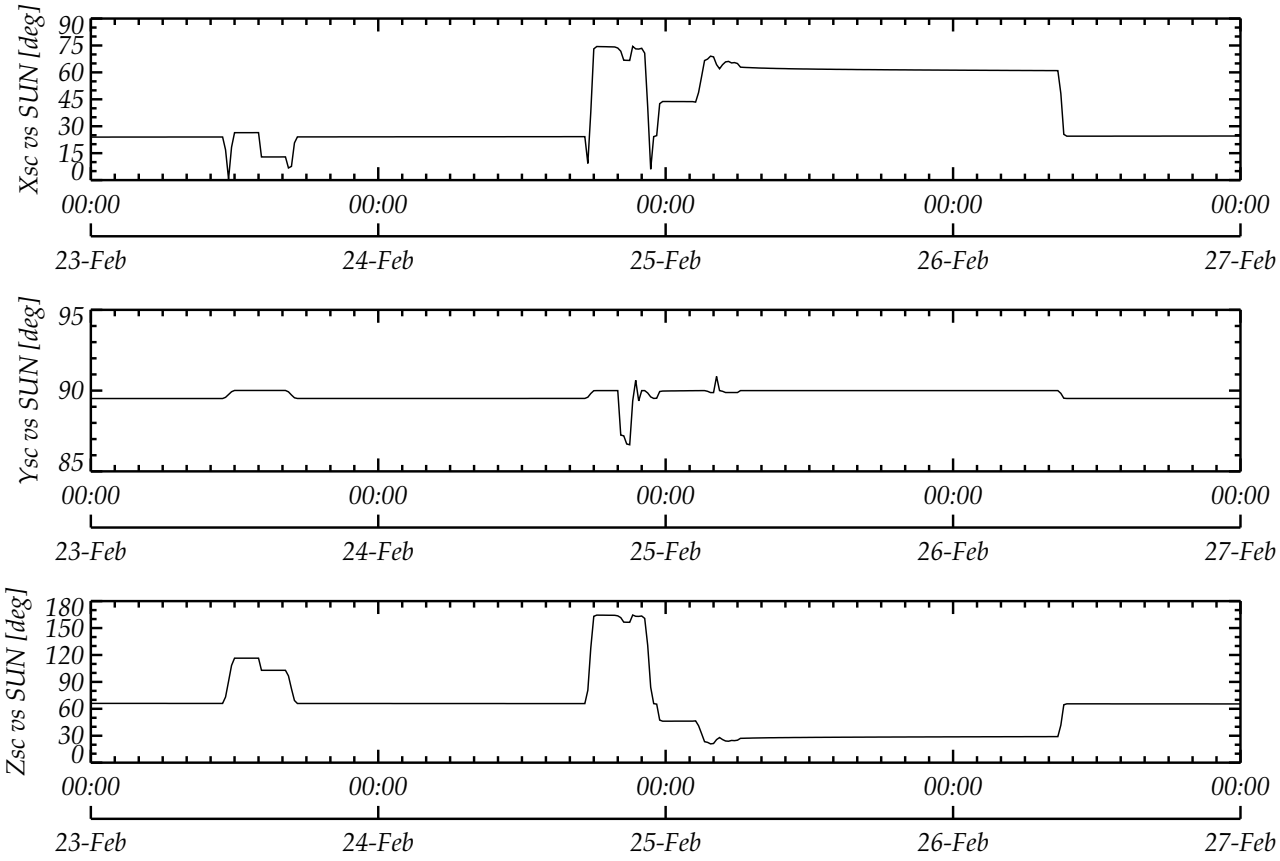

Figure 5: ROSETTA'S Attitude angles with respect to the SUN direction

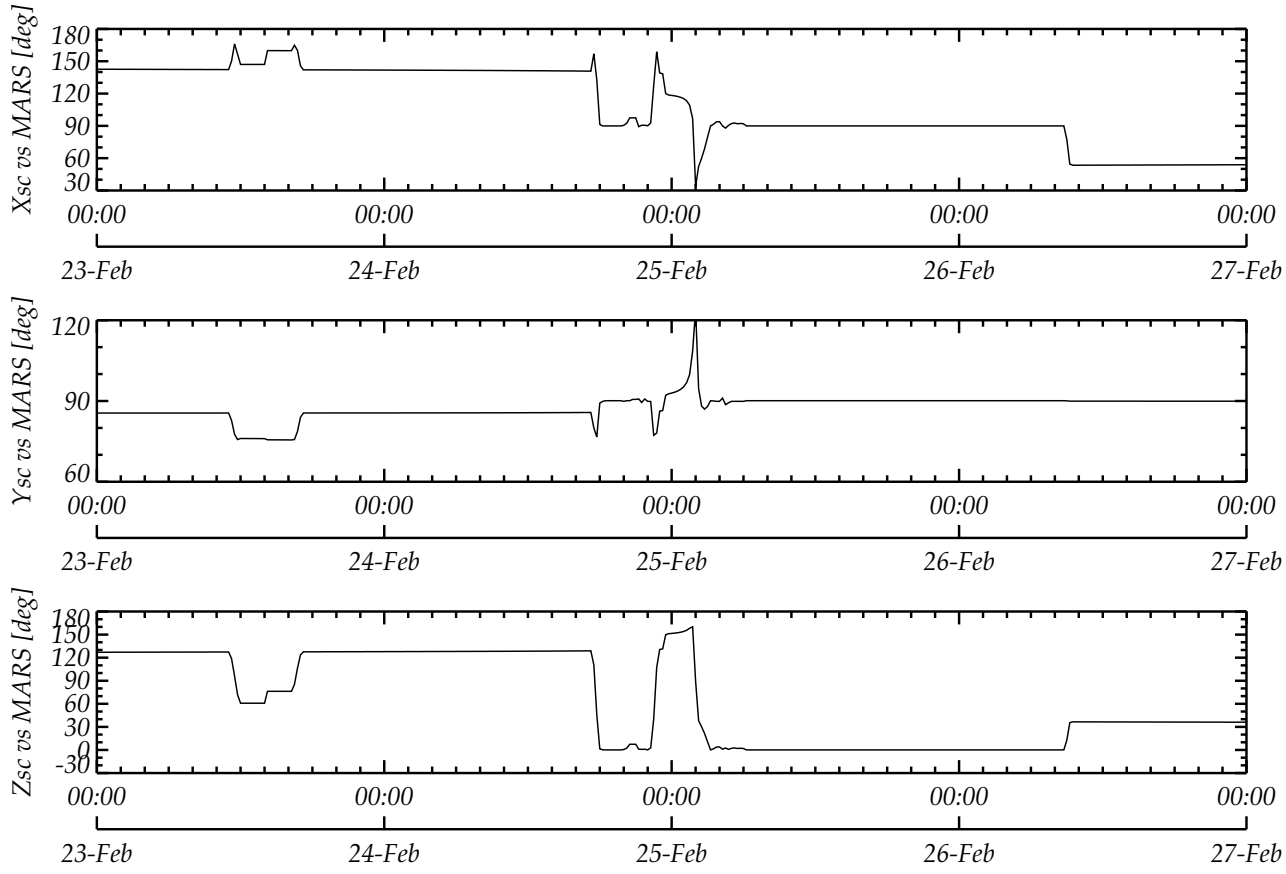

Figure 6: ROSETTA'S Attitude angles with respect to the MARS direction

4 Activities and data plots of the MARS Swing-by

This chapter presents all relevant data 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.

4.1 February 23, 2007:

4.1.1 Actions

MAG was switched on immediately after PIU and set to HK mode at 00:00:22. The normal mode SID 2 was set at 00:12. All commands passed smoothly and the instrument followed in the expected way.

4.2 Plots of Calibrated Data

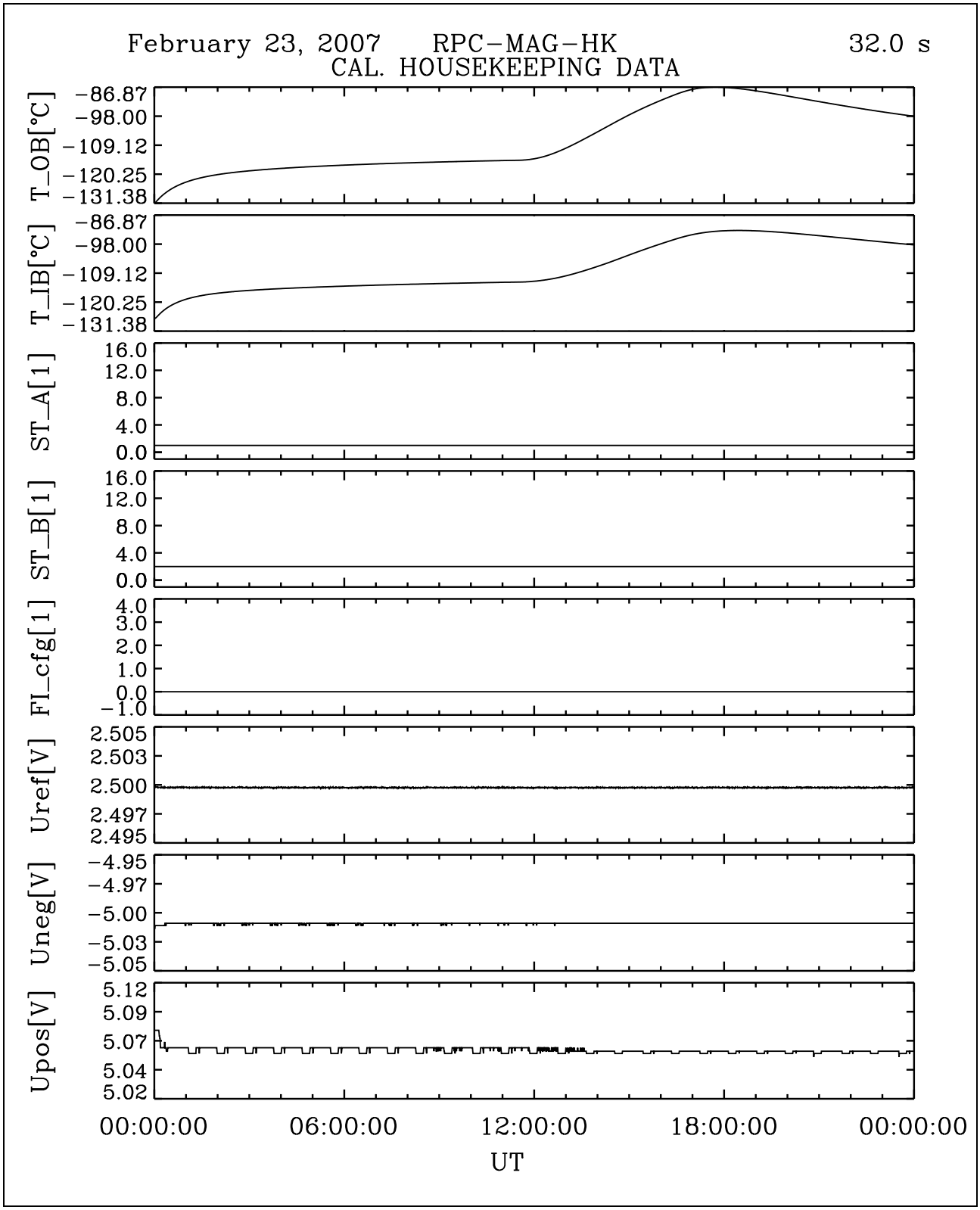

Figure 7: File: RPCMAG070223T0000_CLA_HK_P0000_2400

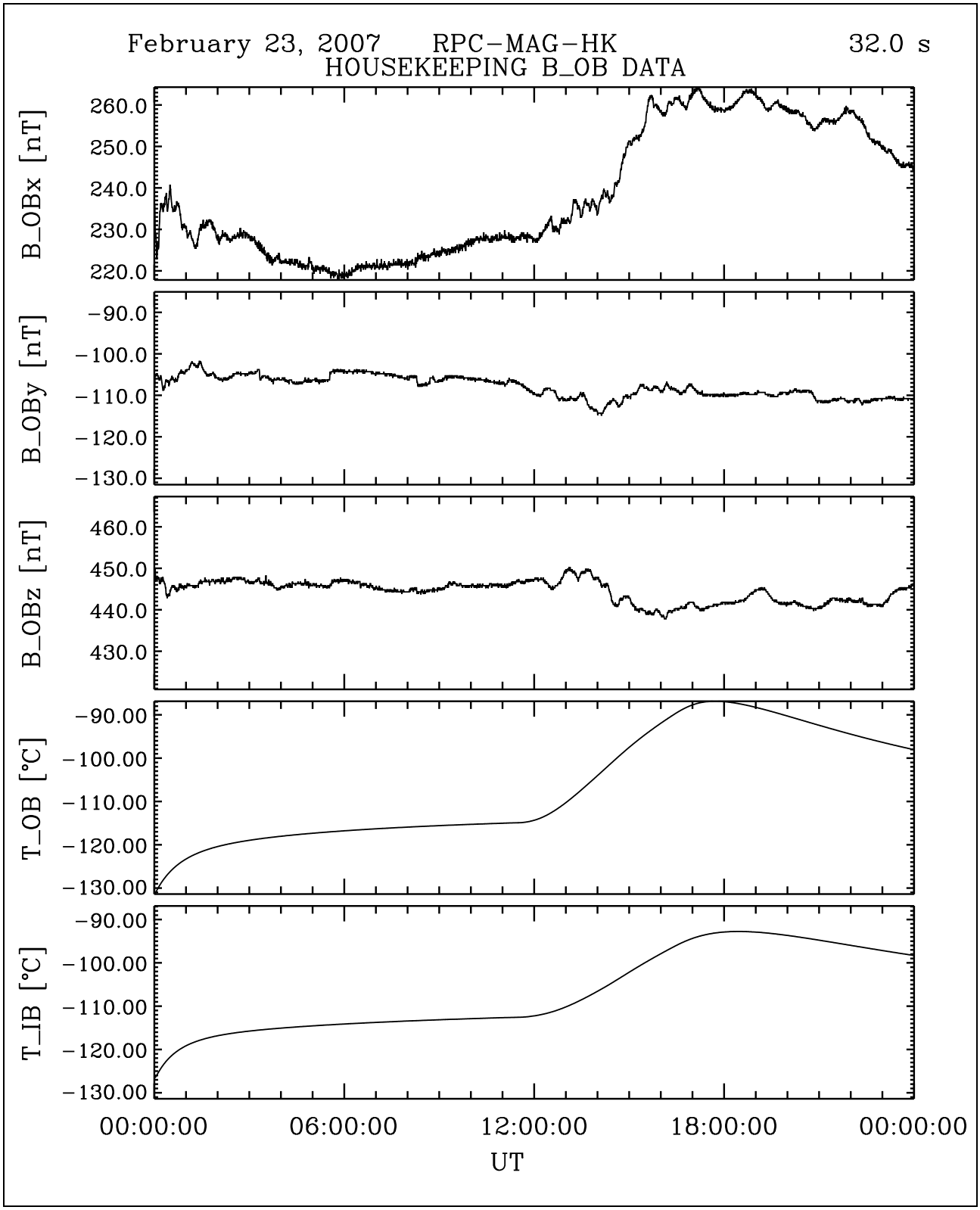

Figure 8: File: RPCMAG070223T0000_CLA_HK_B_P0000_2400

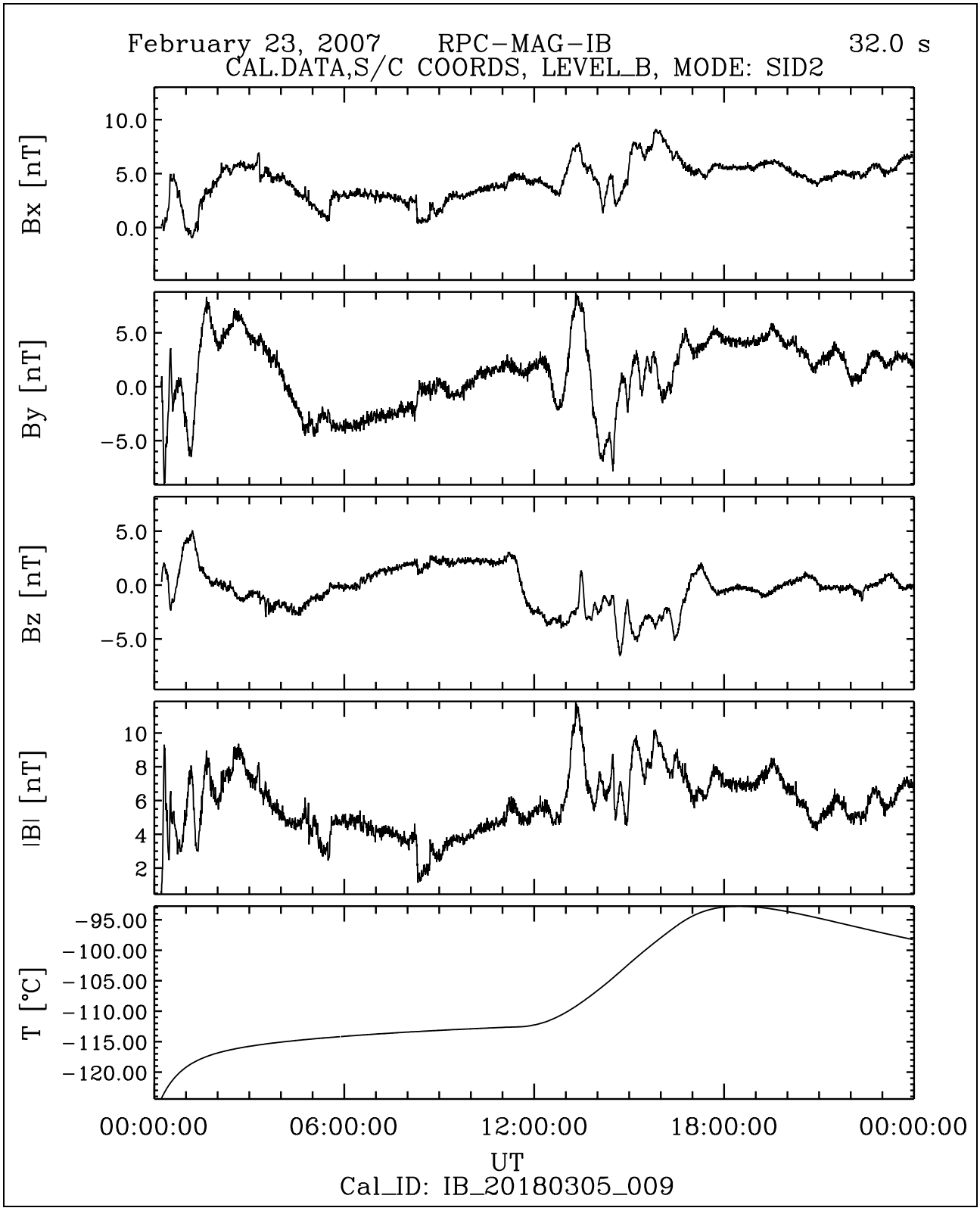

Figure 9: File: RPCMAG070223T0012_CLB_IB_M2_T0000_2400_009

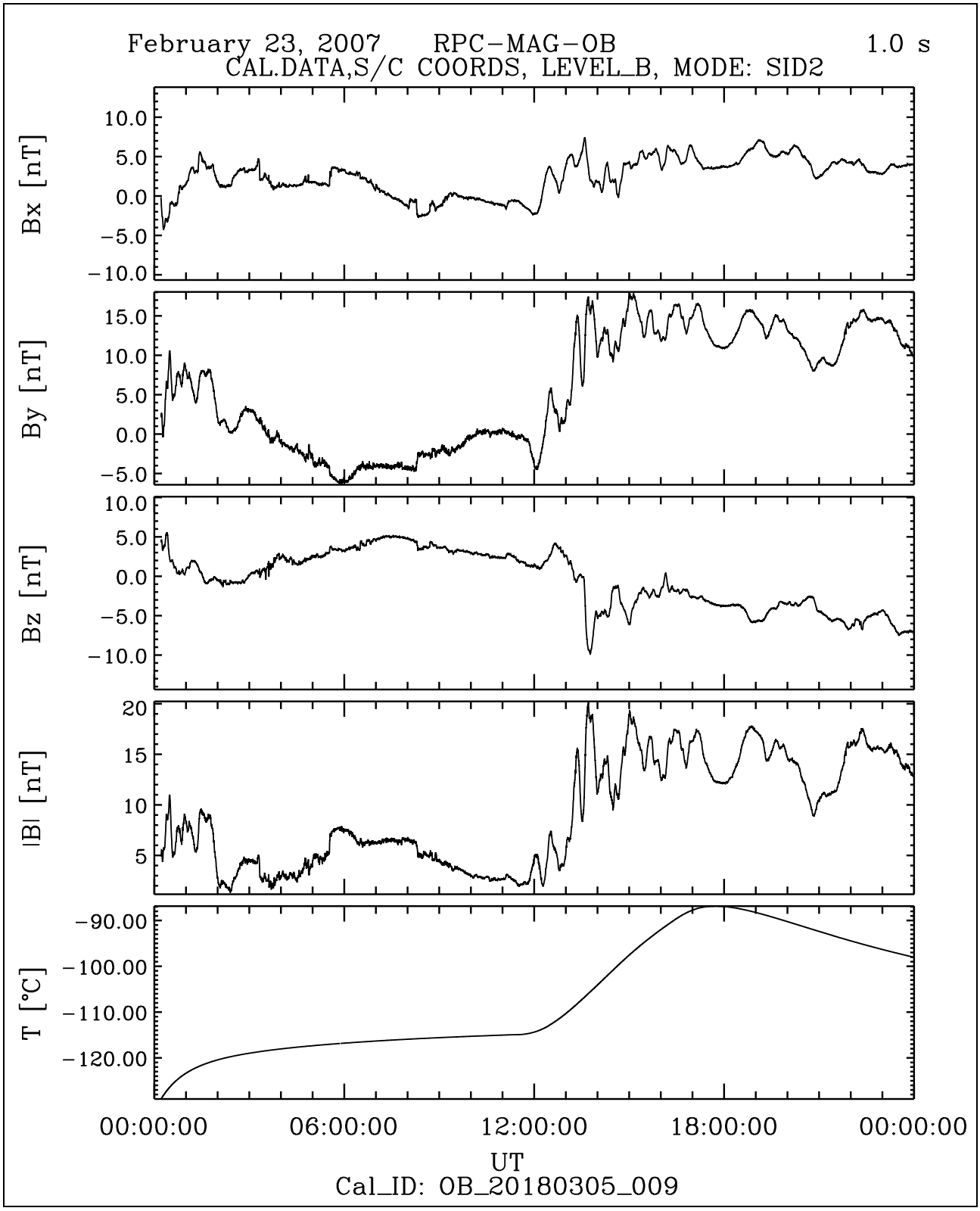

Figure 10: File: RPCMAG070223T0012_CLB_OB_M2_T0000_2400_009

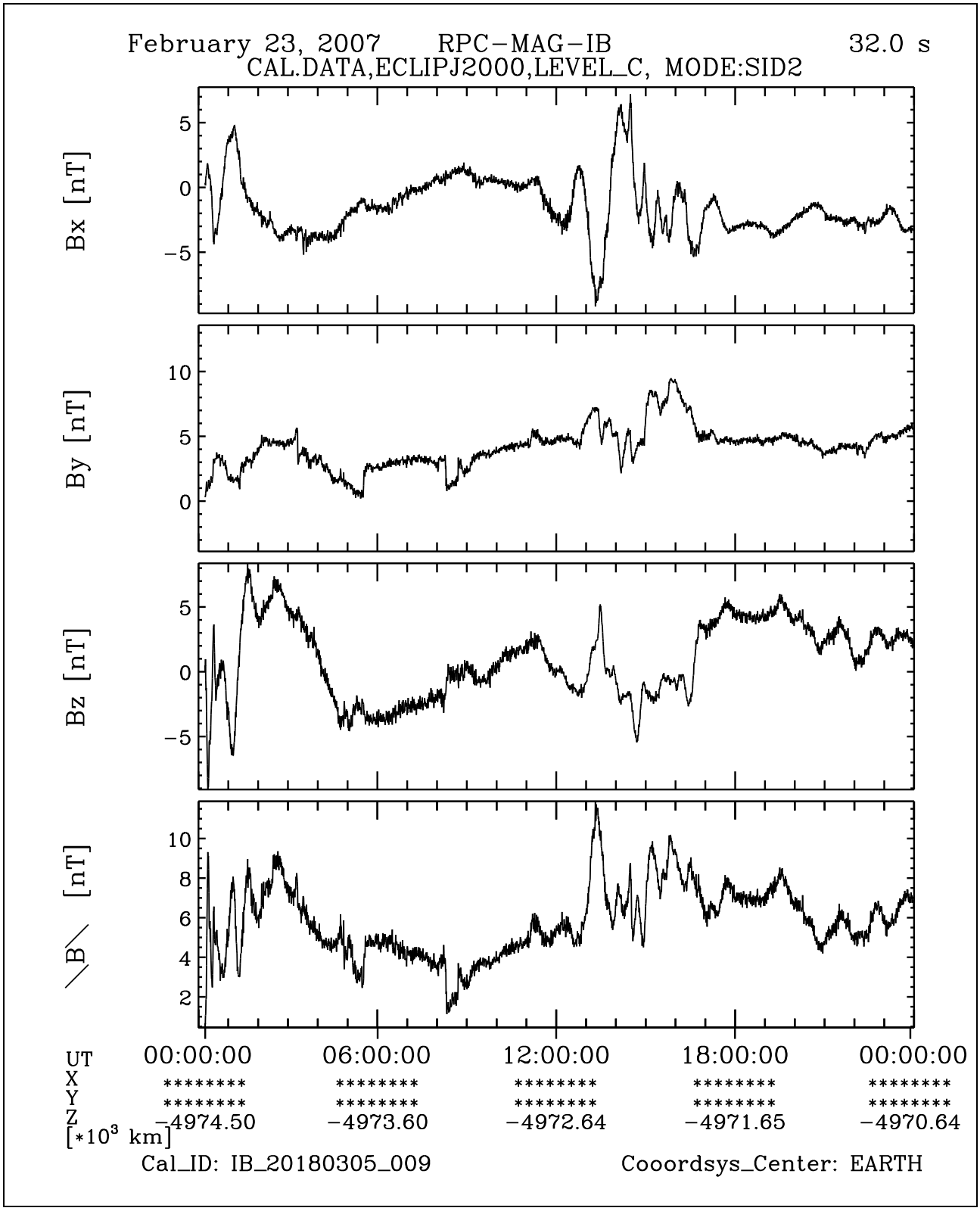

Figure 11: File: RPCMAG070223T0012_CLC_IB_M2_T0000_2400_009

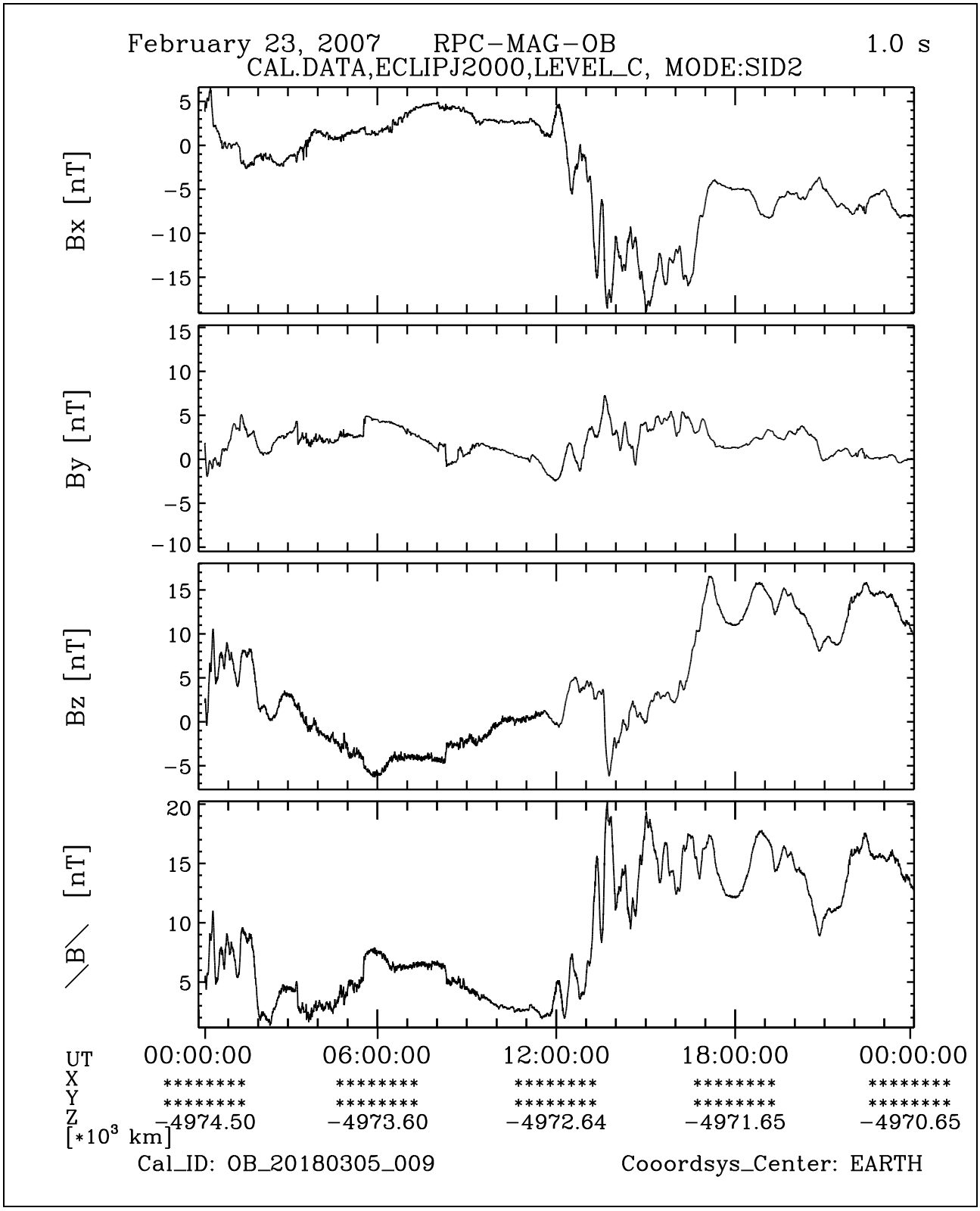

Figure 12: File: RPCMAG070223T0012_CLC_OB_M2_T0000_2400_009

4.3 February 24, 2007:

4.3.1 Actions

MAG stayed in SID2 until 20:41. Then the Burst mode SID3 was activated. All commands passed smoothly and the instrument followed in the expected way.

4.4 Plots of Calibrated Data

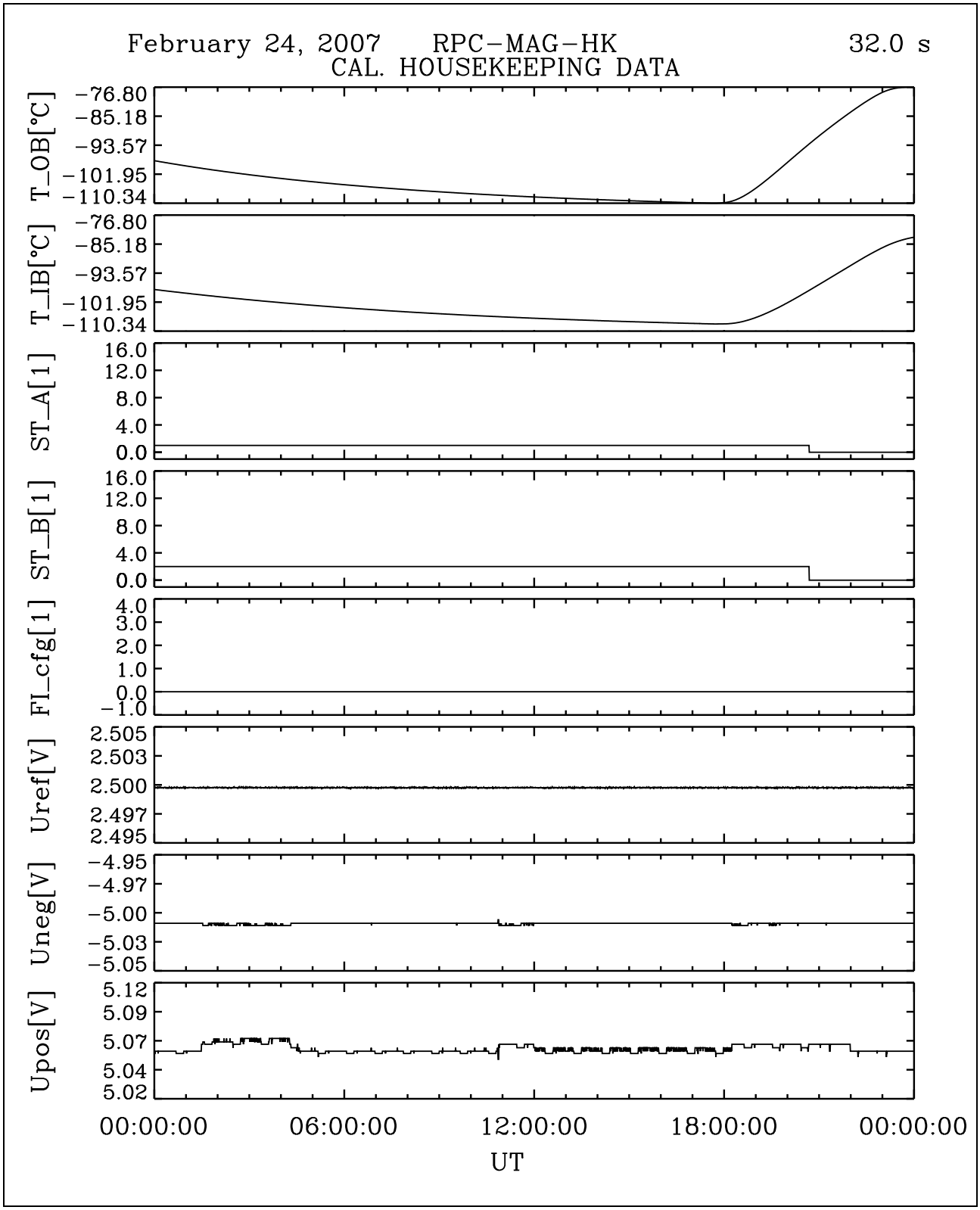

Figure 13: File: RPCMAG070224T0000_CLA_HK_P0000_2400

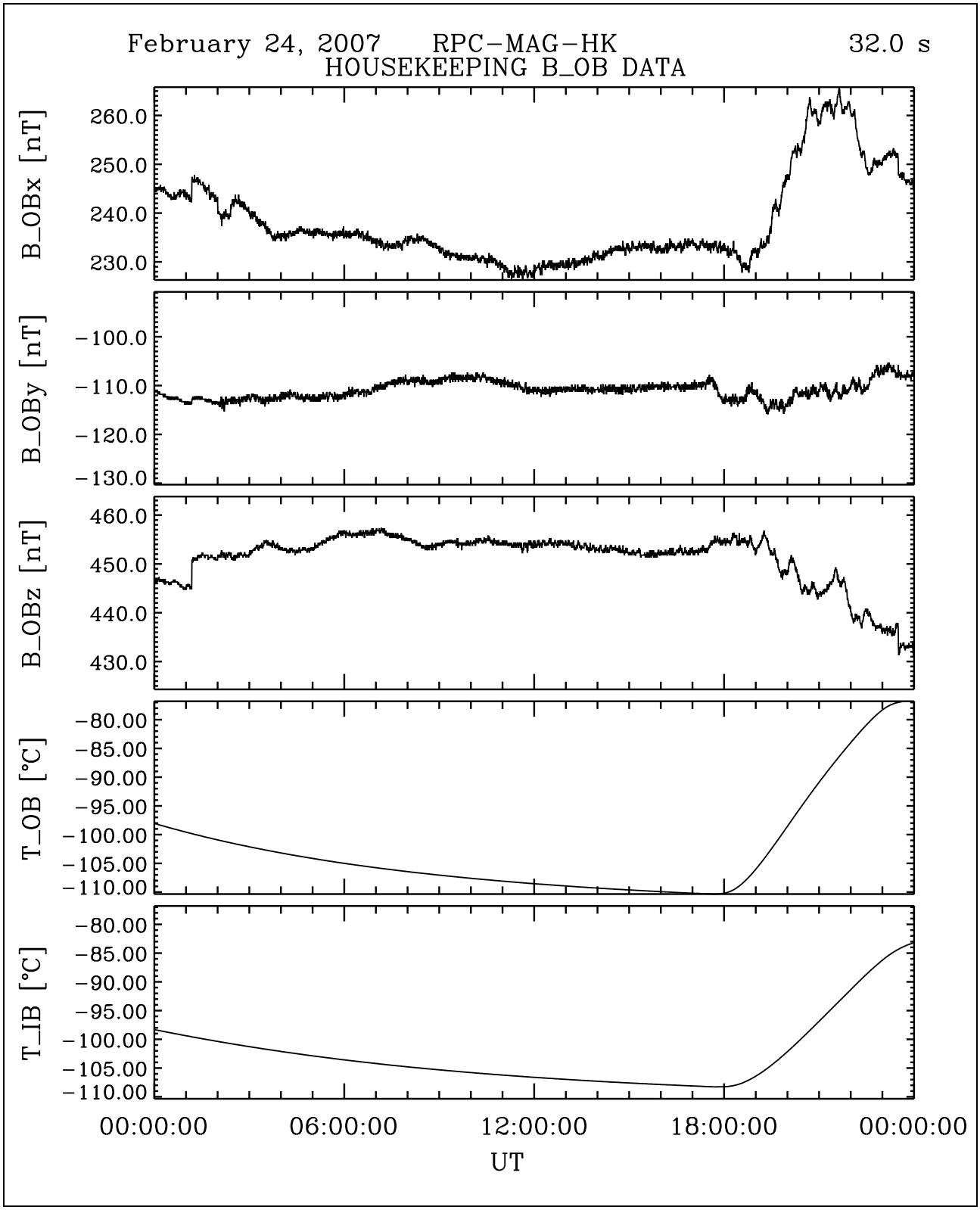

Figure 14: File: RPCMAG070224T0000_CLA_HK_B_P0000_2400

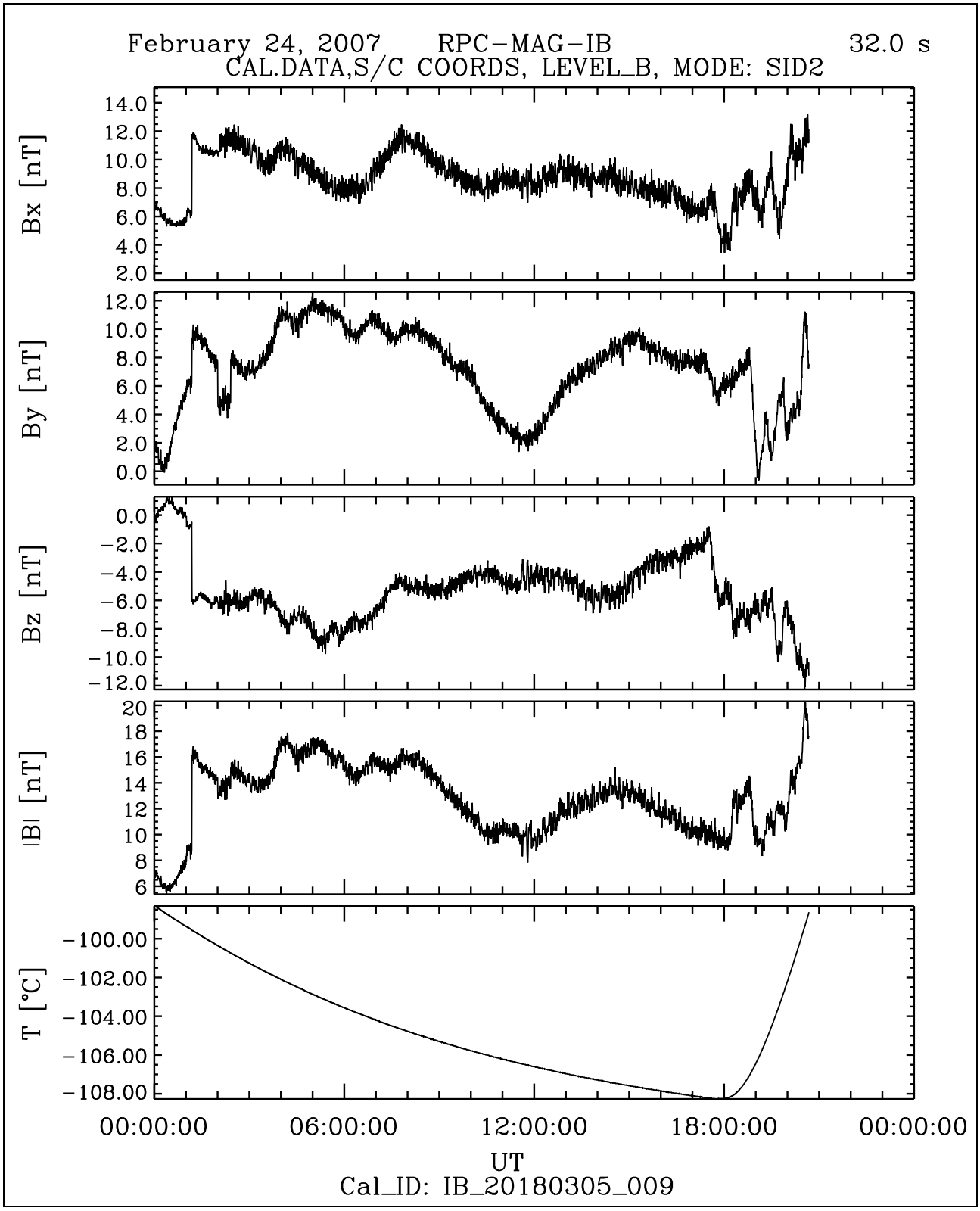

Figure 15: File: RPCMAG070224T0000_CLB_IB_M2_T0000_2400_009

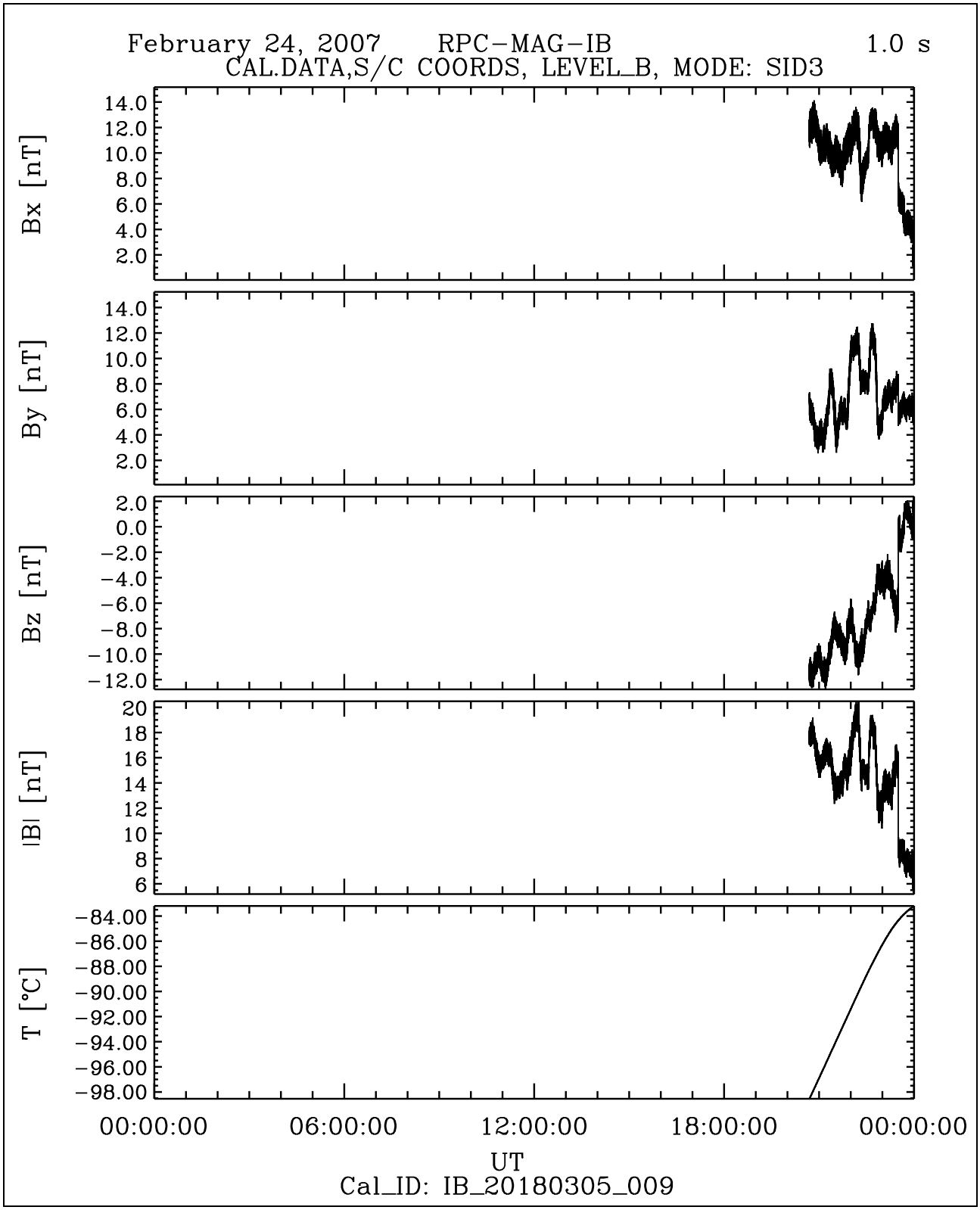

Figure 16: File: RPCMAG070224T2041_CLB_IB_M3_T0000_2400_009

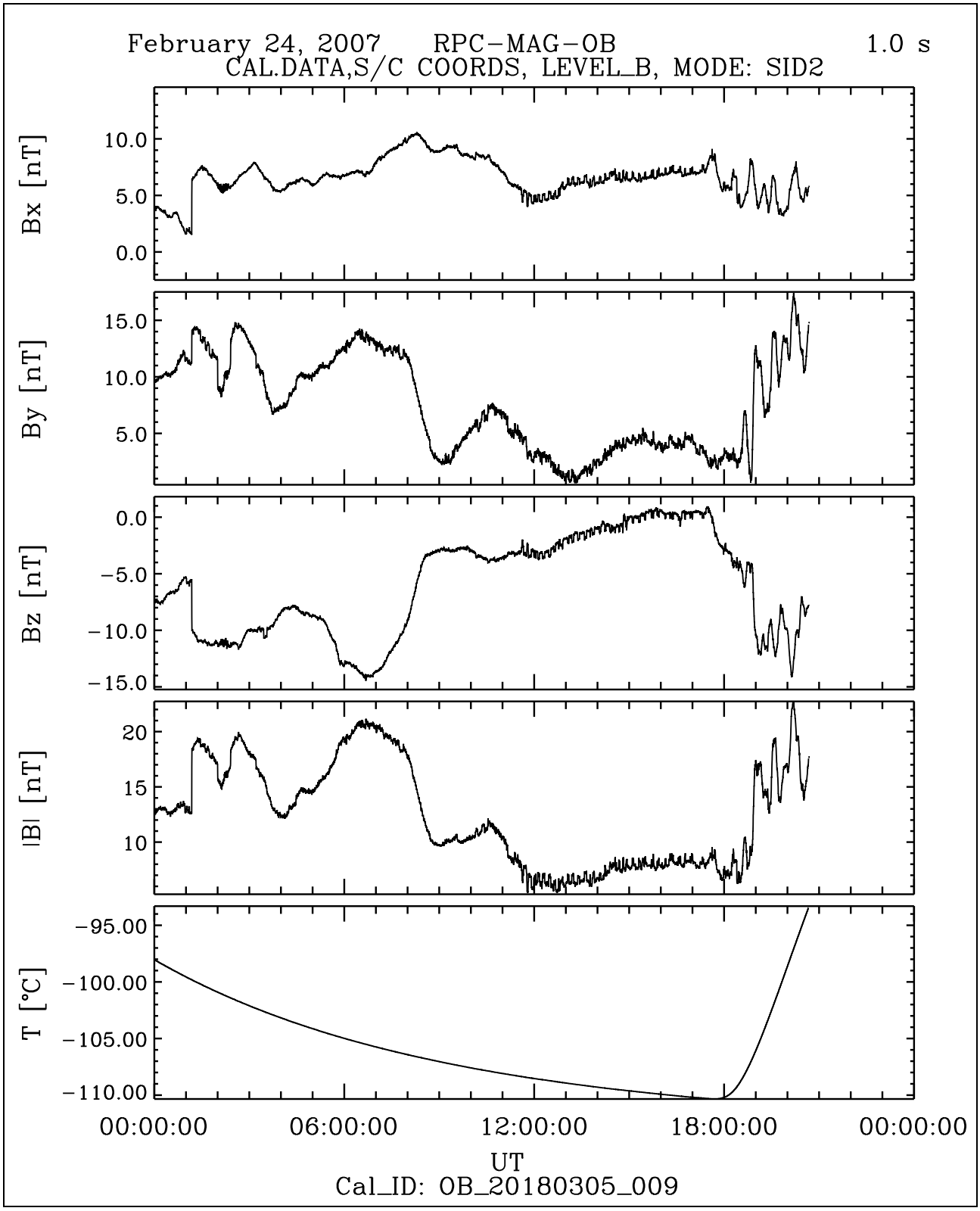

Figure 17: File: RPCMAG070224T0000_CLB_OB_M2_T0000_2400_009

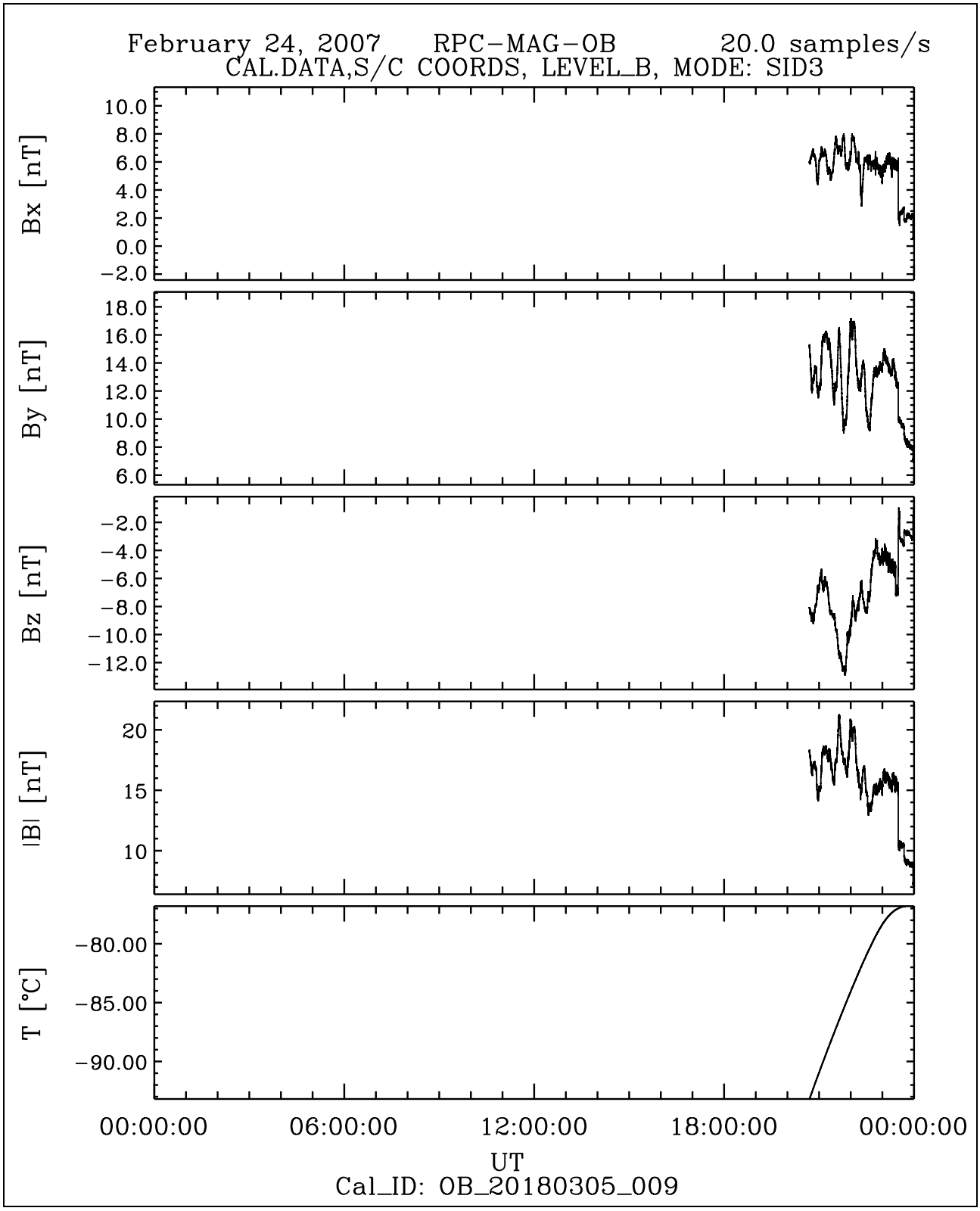

Figure 18: File: RPCMAG070224T2041_CLB_OB_M3_T0000_2400_009

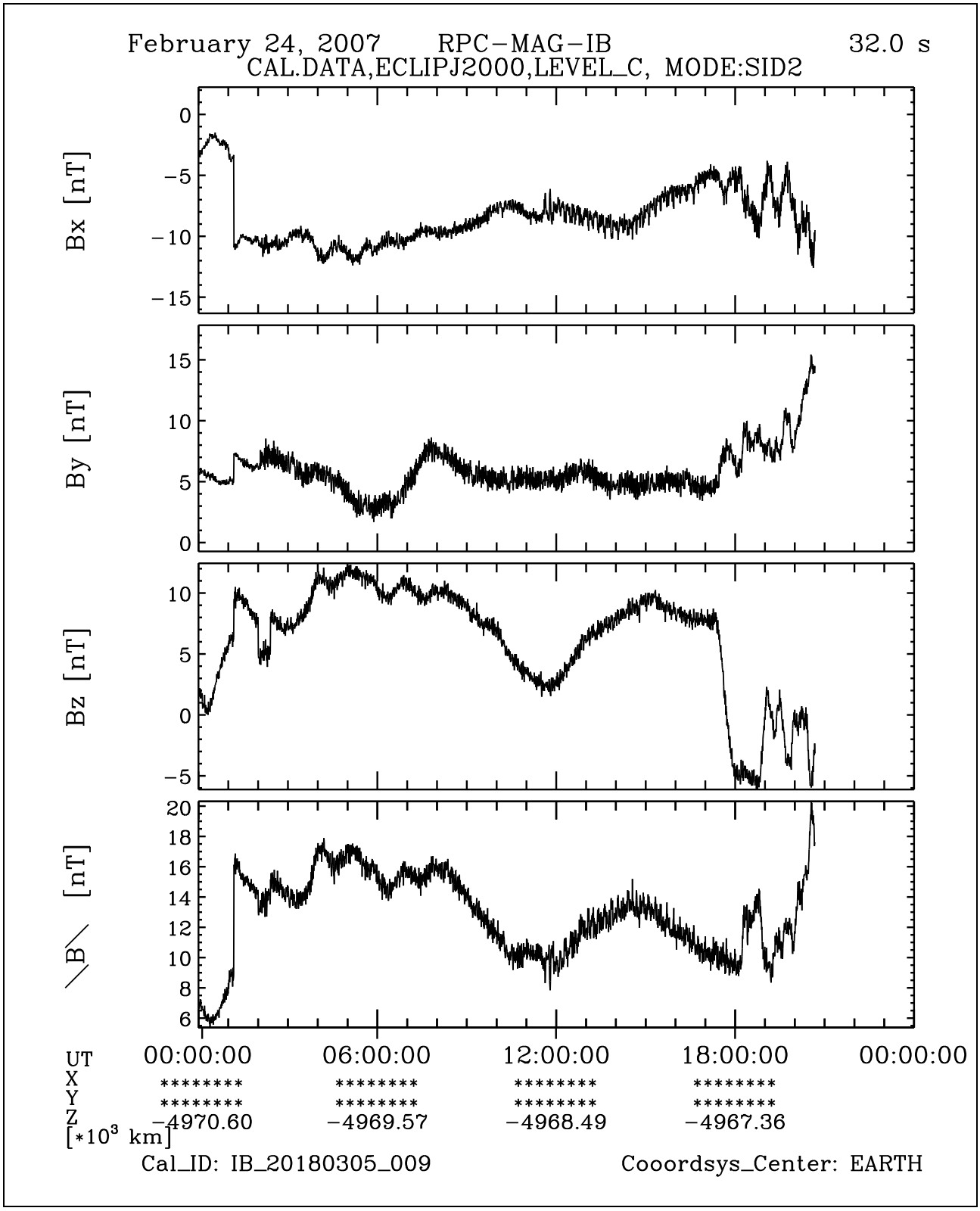

Figure 19: File: RPCMAG070224T0000_CLC_IB_M2_T0000_2400_009

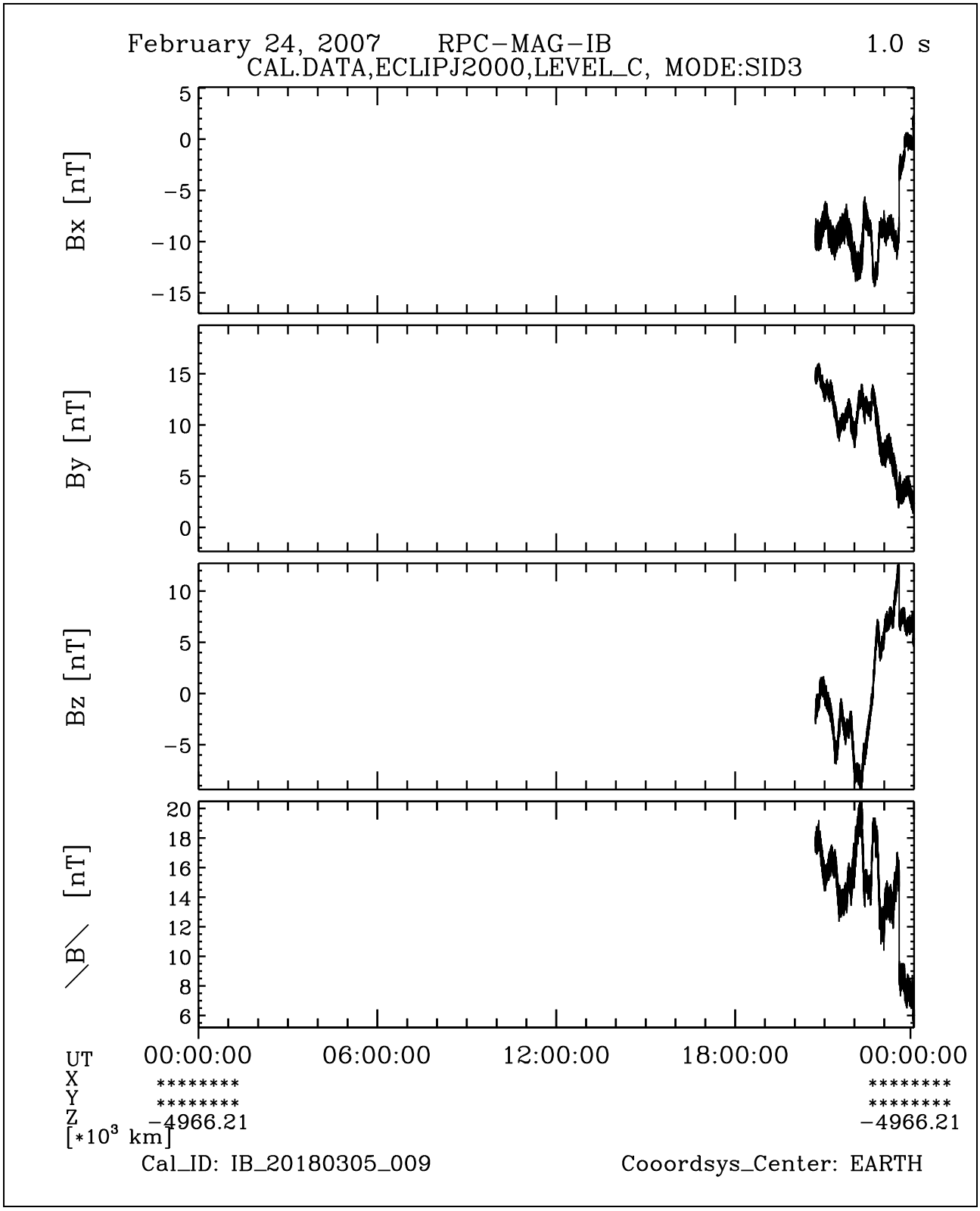

Figure 20: File: RPCMAG070224T2041_CLC_IB_M3_T0000_2400_009

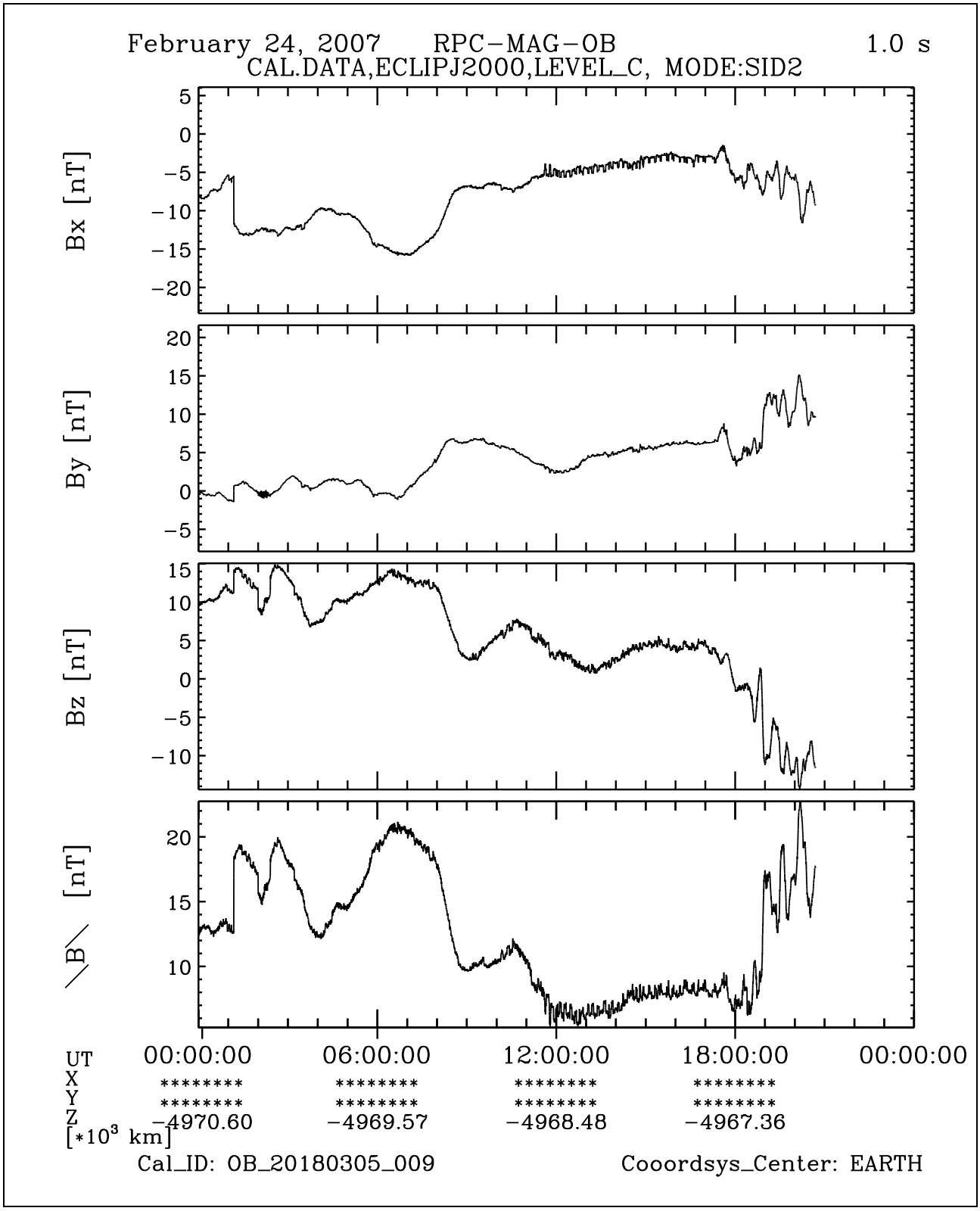

Figure 21: File: RPCMAG070224T0000_CLC_OB_M2_T0000_2400_009

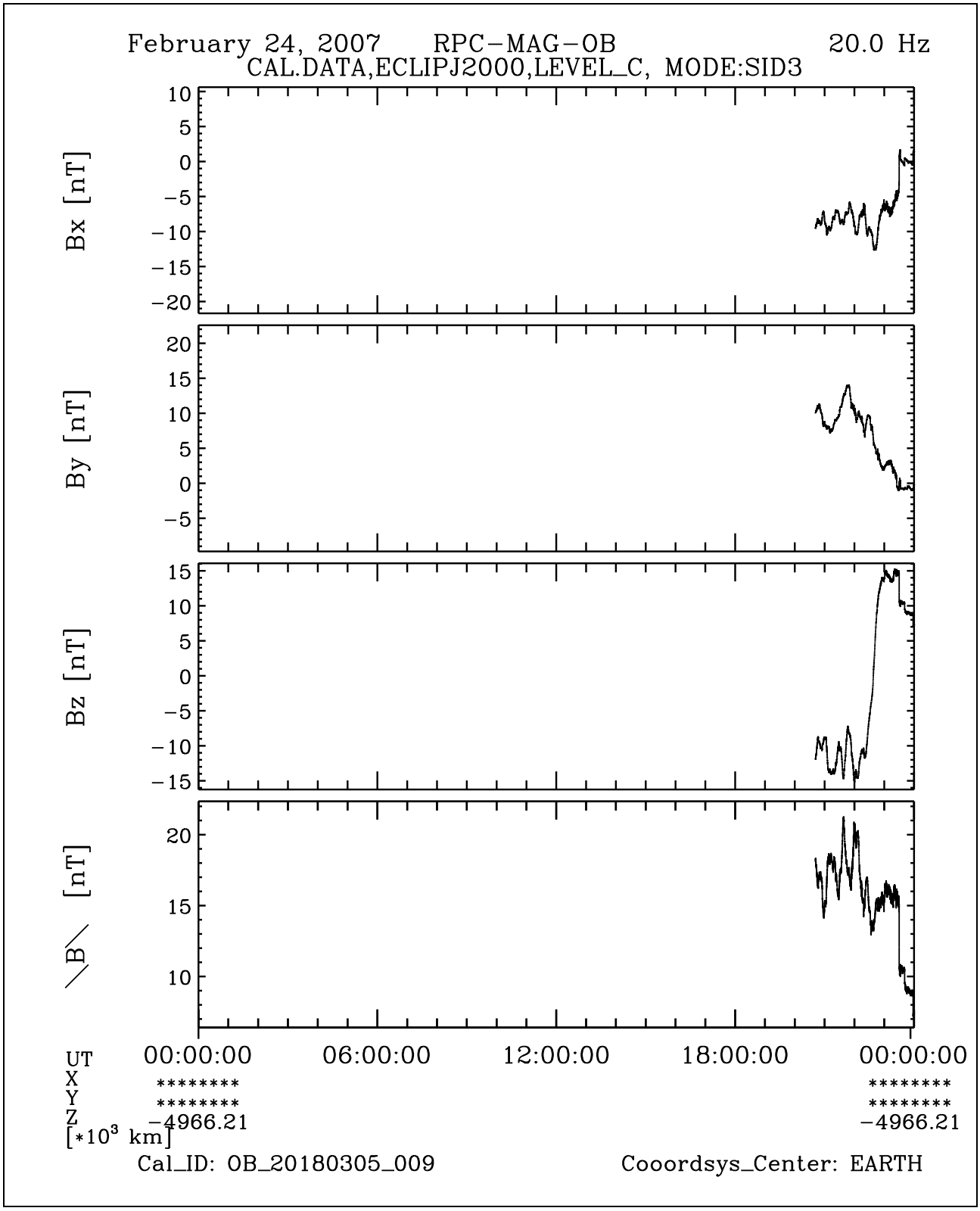

Figure 22: File: RPCMAG070224T2041_CLC_OB_M3_T0000_2400_009

4.5 February 25, 2007:

4.5.1 Actions

MAG stayed in Burst mode until 00:24. Then RPC was switched off due to power saving issues during CA. RPC was switched on again at 02:35. MAG was set to Burst mode at 02:47 and stayed in SID 3 until 04:45. Then it was set back to SID2 (Normal mode). The CA was at 01:57 All commands passed smoothly and the instrument followed in the expected way.

4.6 Plots of Calibrated Data

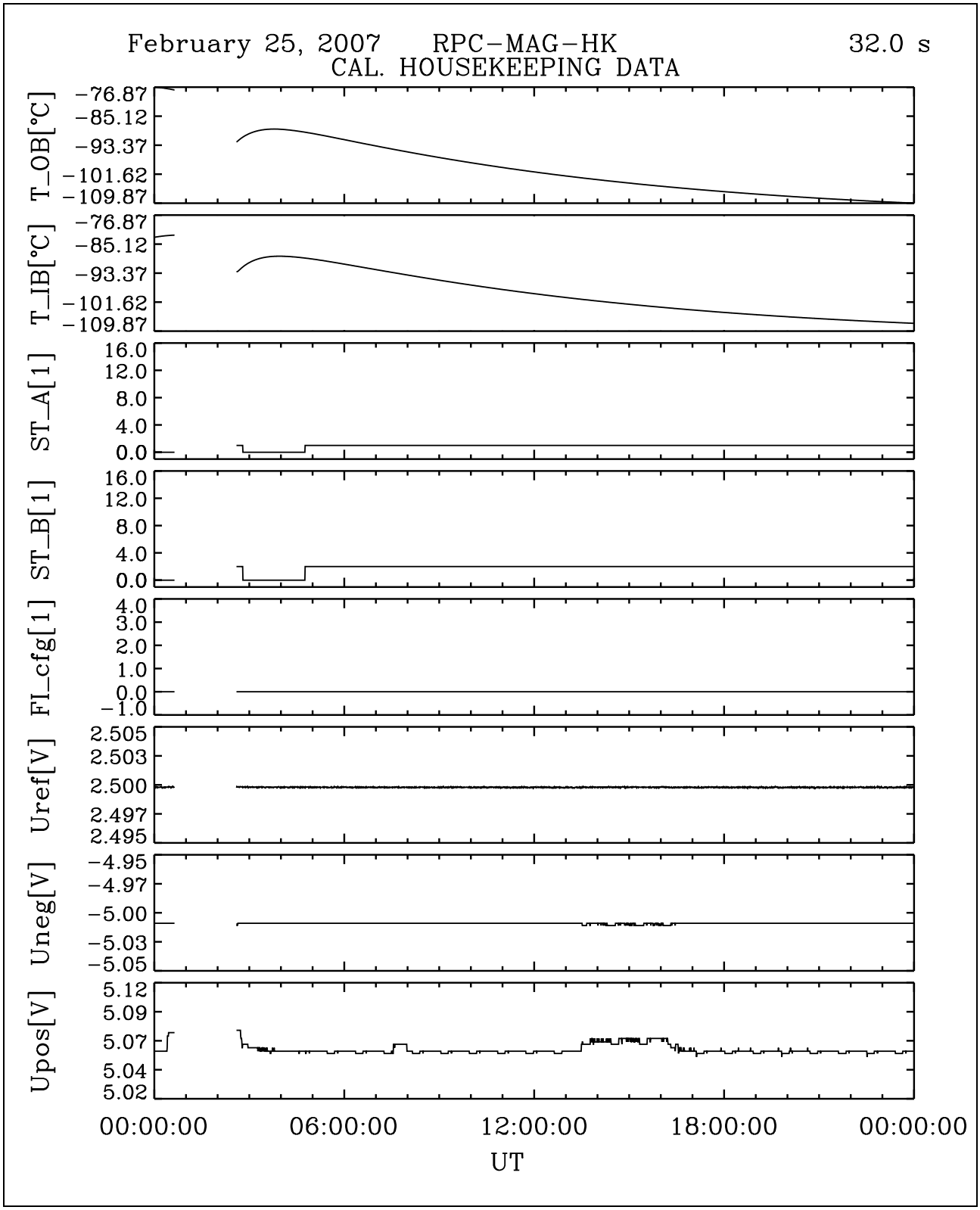

Figure 23: File: RPCMAG070225T0000_CLA_HK_P0000_2400

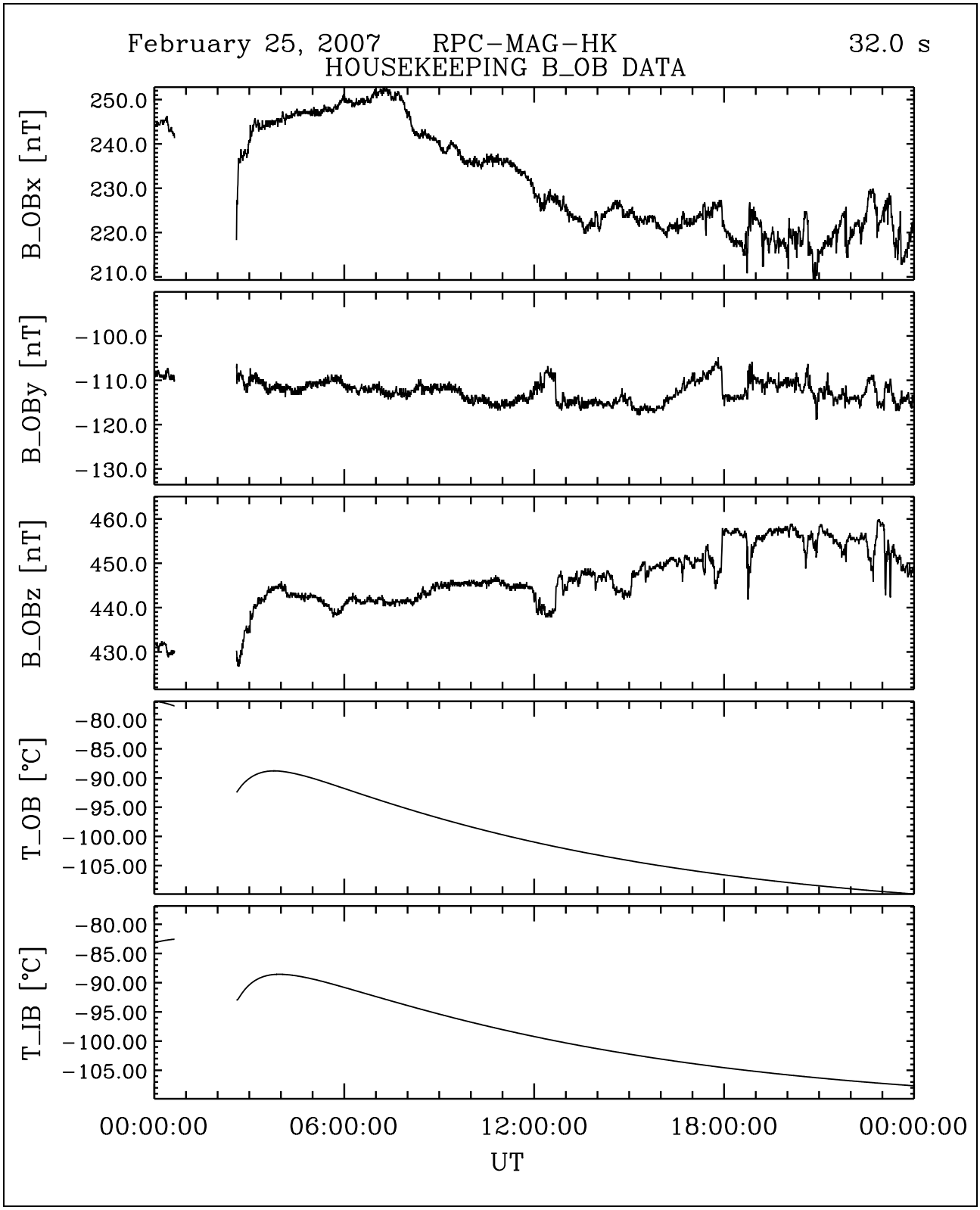

Figure 24: File: RPCMAG070225T0000_CLA_HK_B_P0000_2400

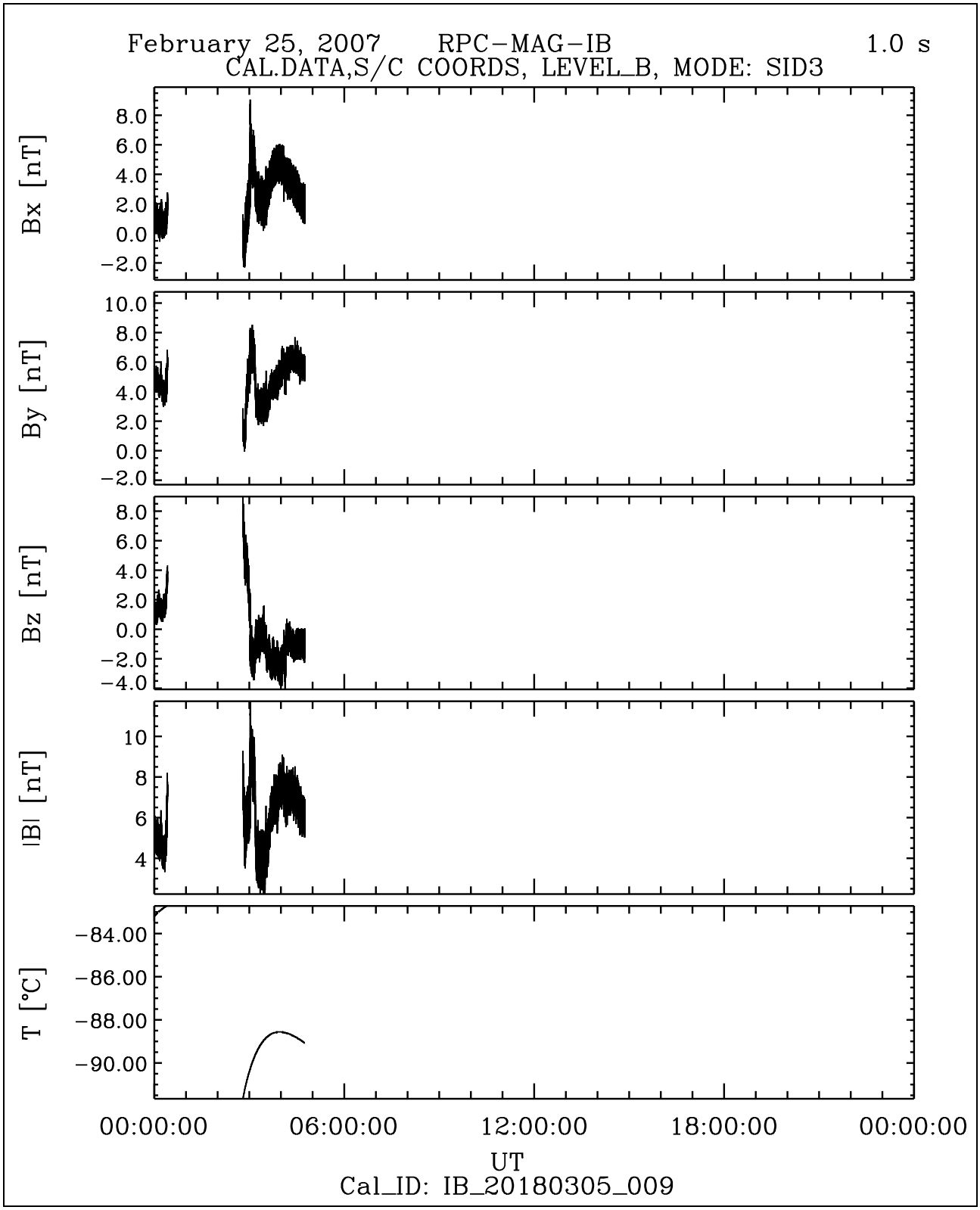

Figure 25: File: RPCMAG070225T0000_CLB_IB_M3_T0000_2400_009

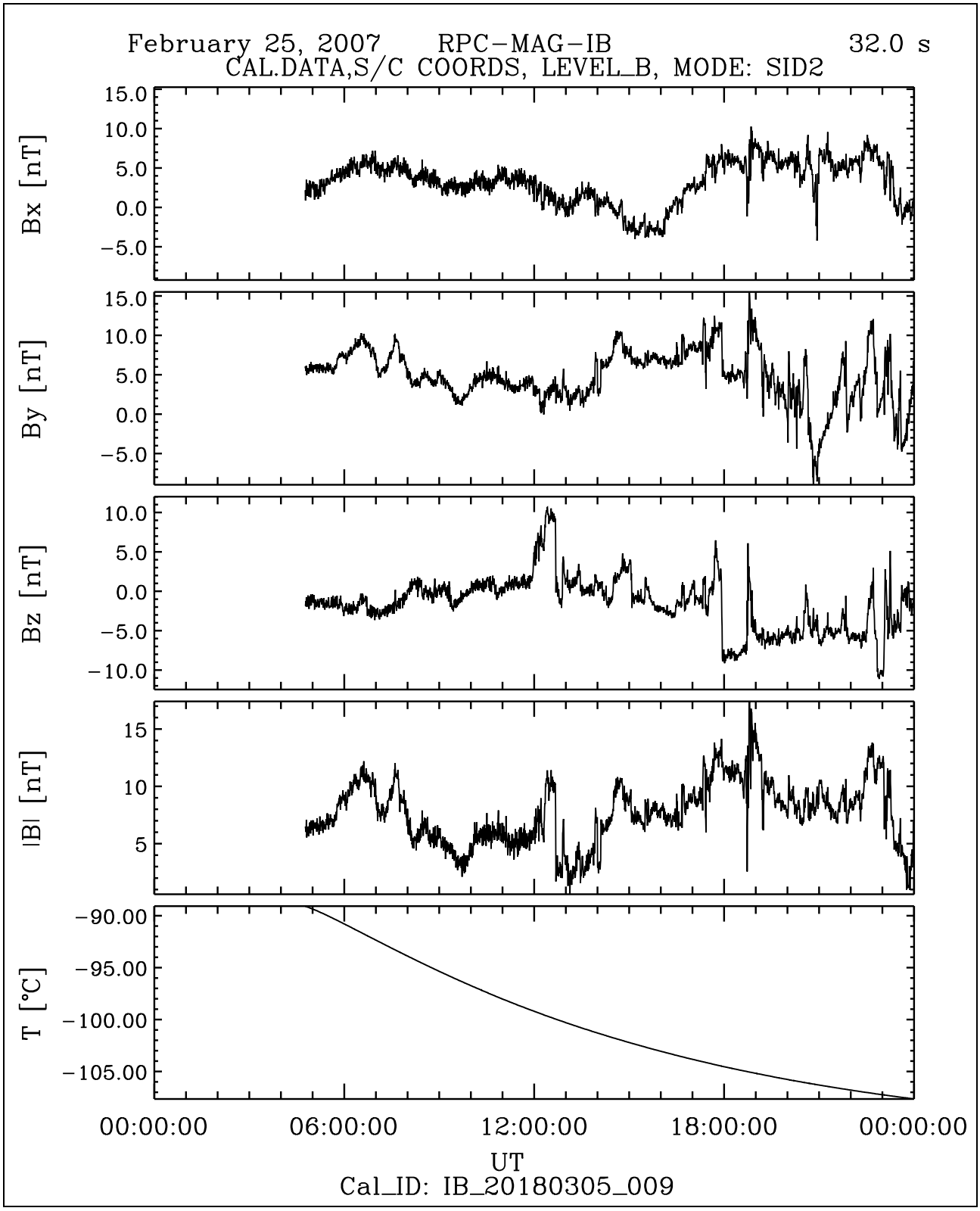

Figure 26: File: RPCMAG070225T0445_CLB_IB_M2_T0000_2400_009

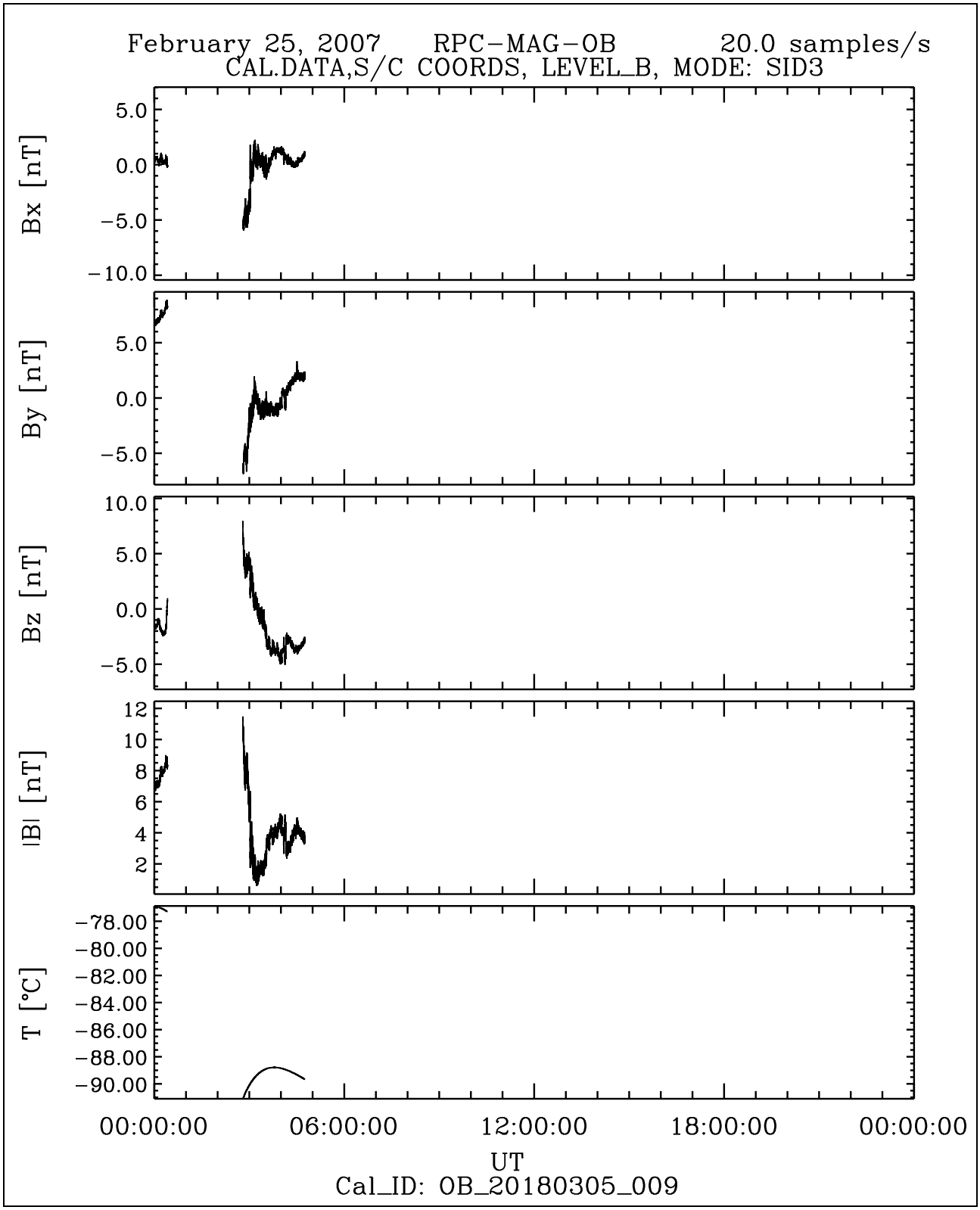

Figure 27: File: RPCMAG070225T0000_CLB_OB_M3_T0000_2400_009

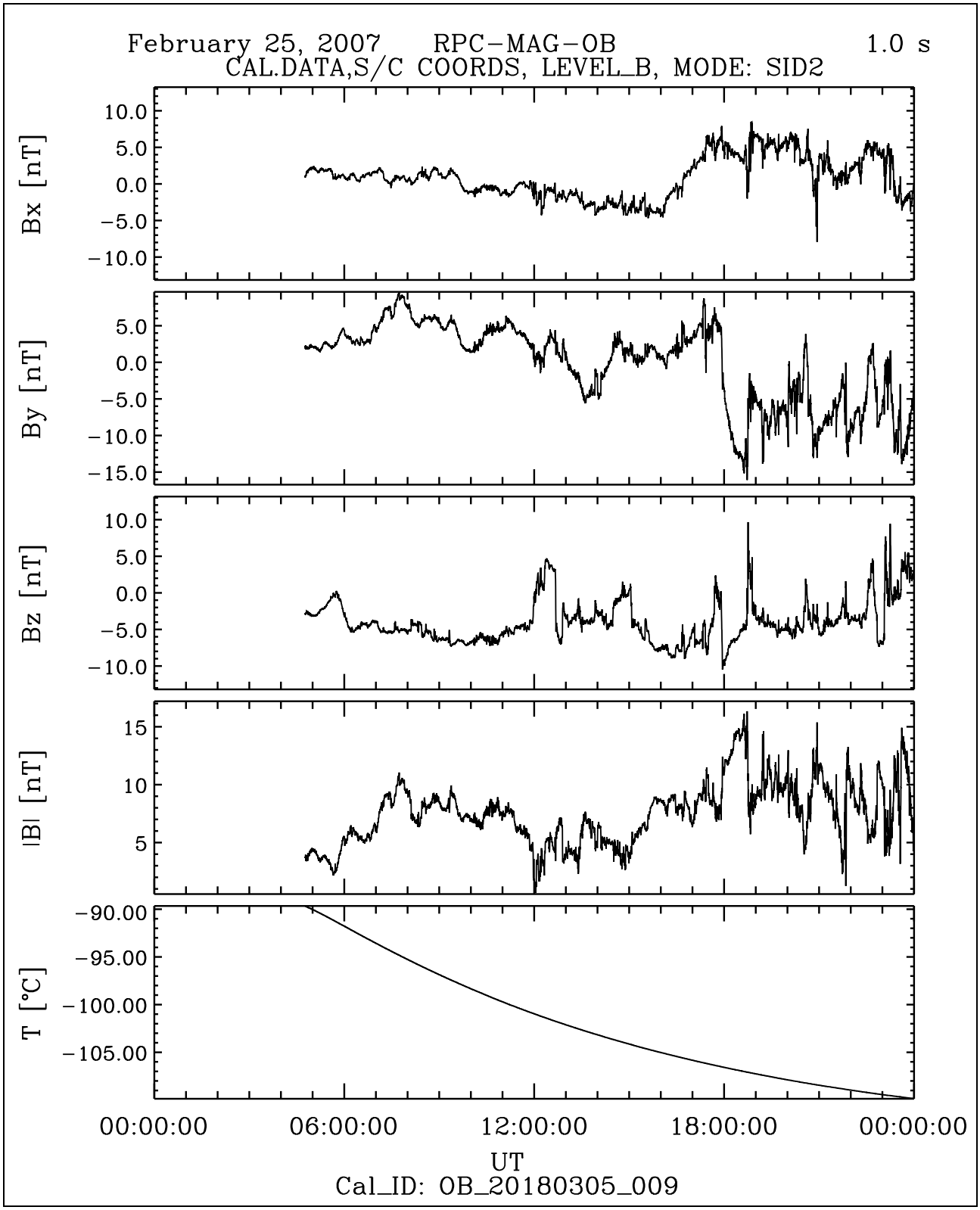

Figure 28: File: RPCMAG070225T0445_CLB_OB_M2_T0000_2400_009

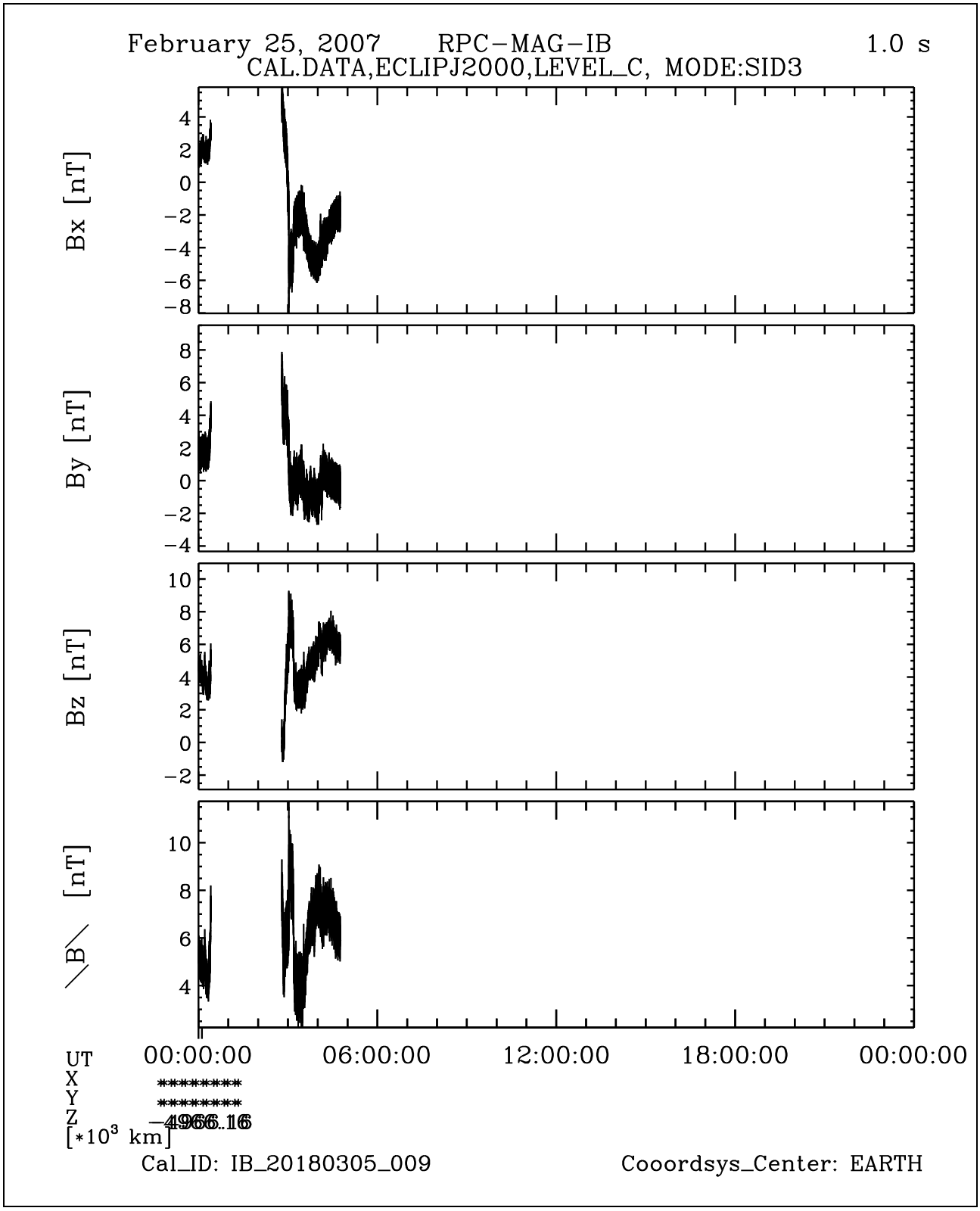

Figure 29: File: RPCMAG070225T0000_CLC_IB_M3_T0000_2400_009

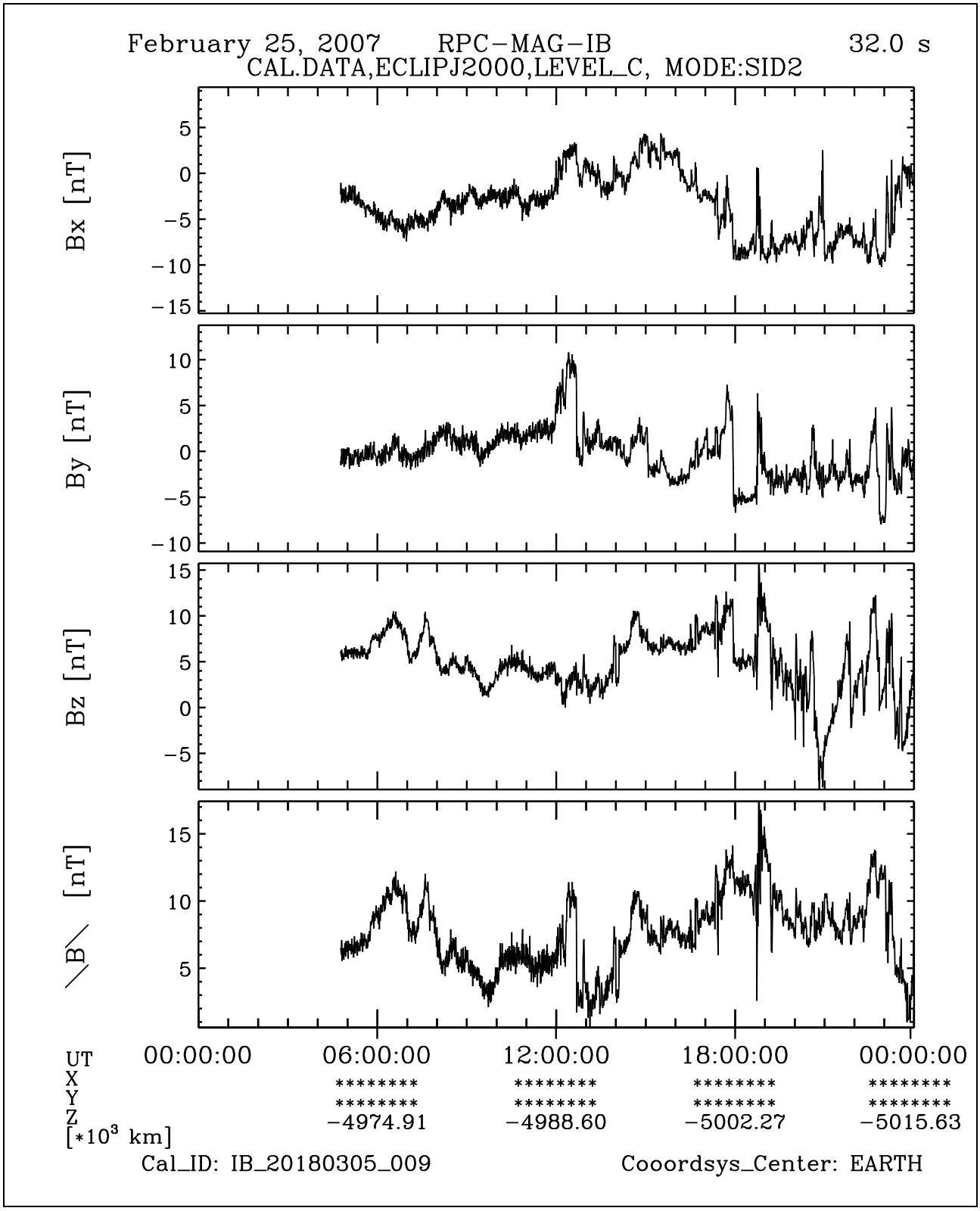

Figure 30: File: RPCMAG070225T0445_CLC_IB_M2_T0000_2400_009

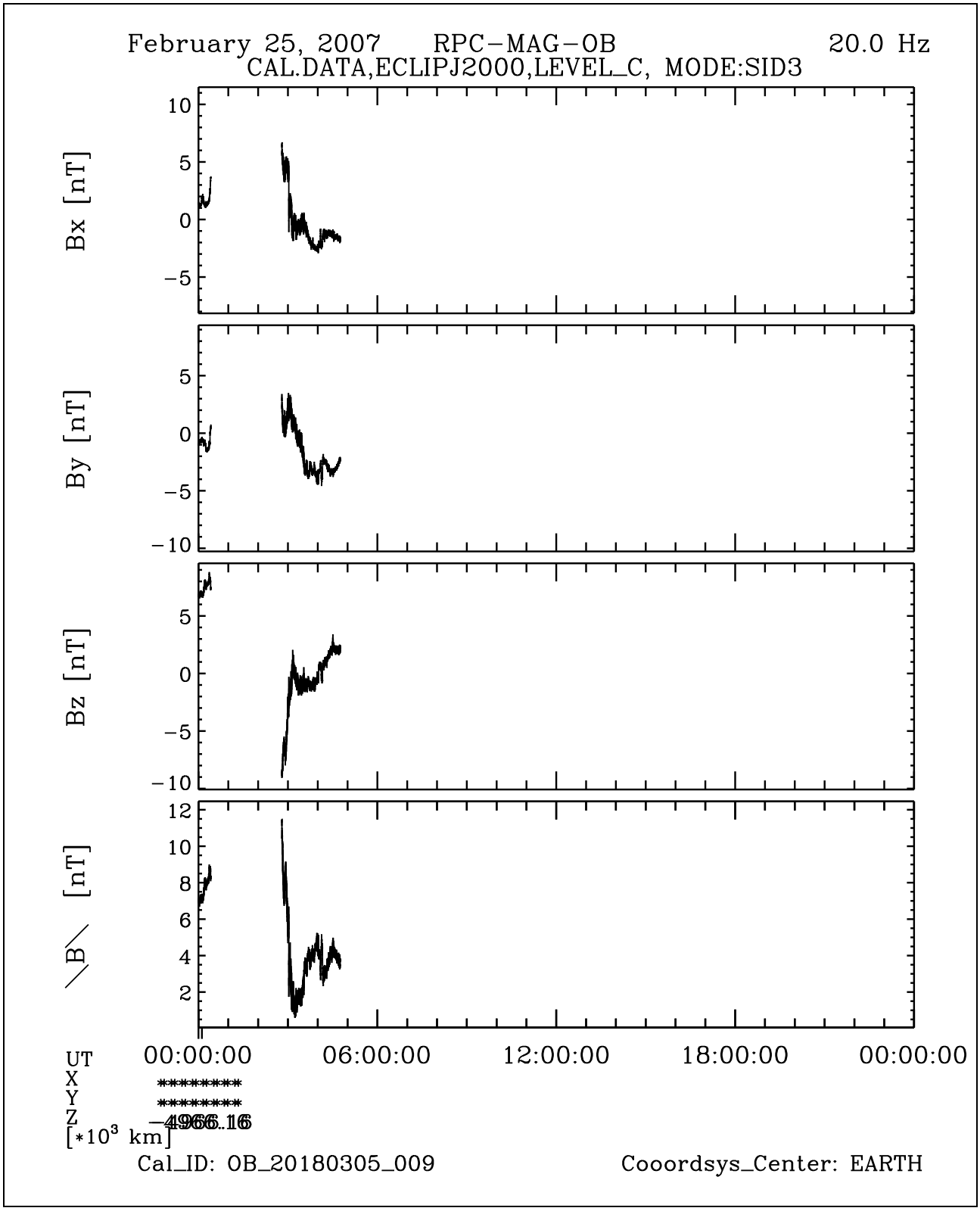

Figure 31: File: RPCMAG070225T0000_CLC_OB_M3_T0000_2400_009

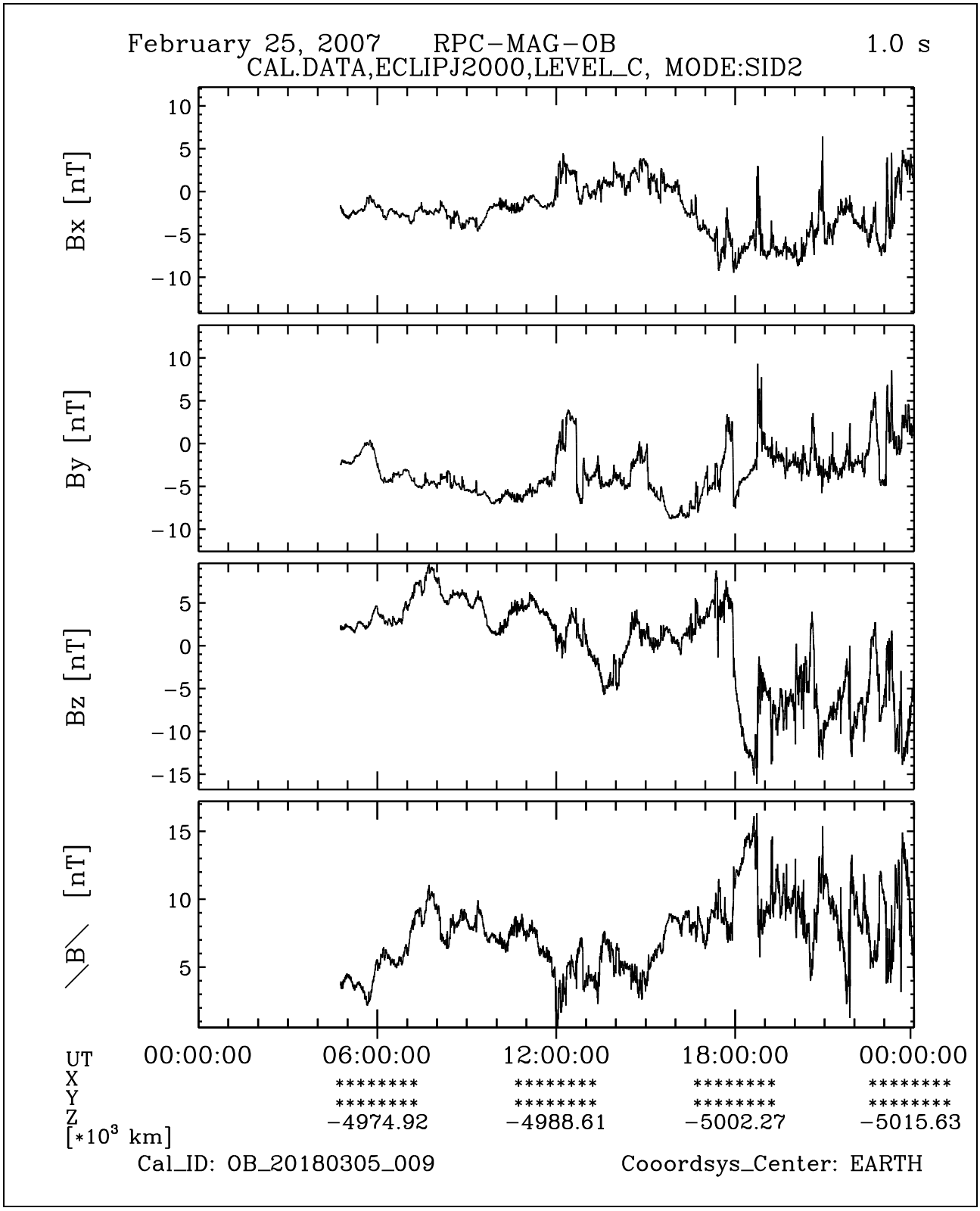

Figure 32: File: RPCMAG070225T0445_CLC_OB_M2_T0000_2400_009

4.7 February 26, 2007:

4.7.1 Actions

MAG stayed in SID2 all the day.

4.8 Plots of Calibrated Data

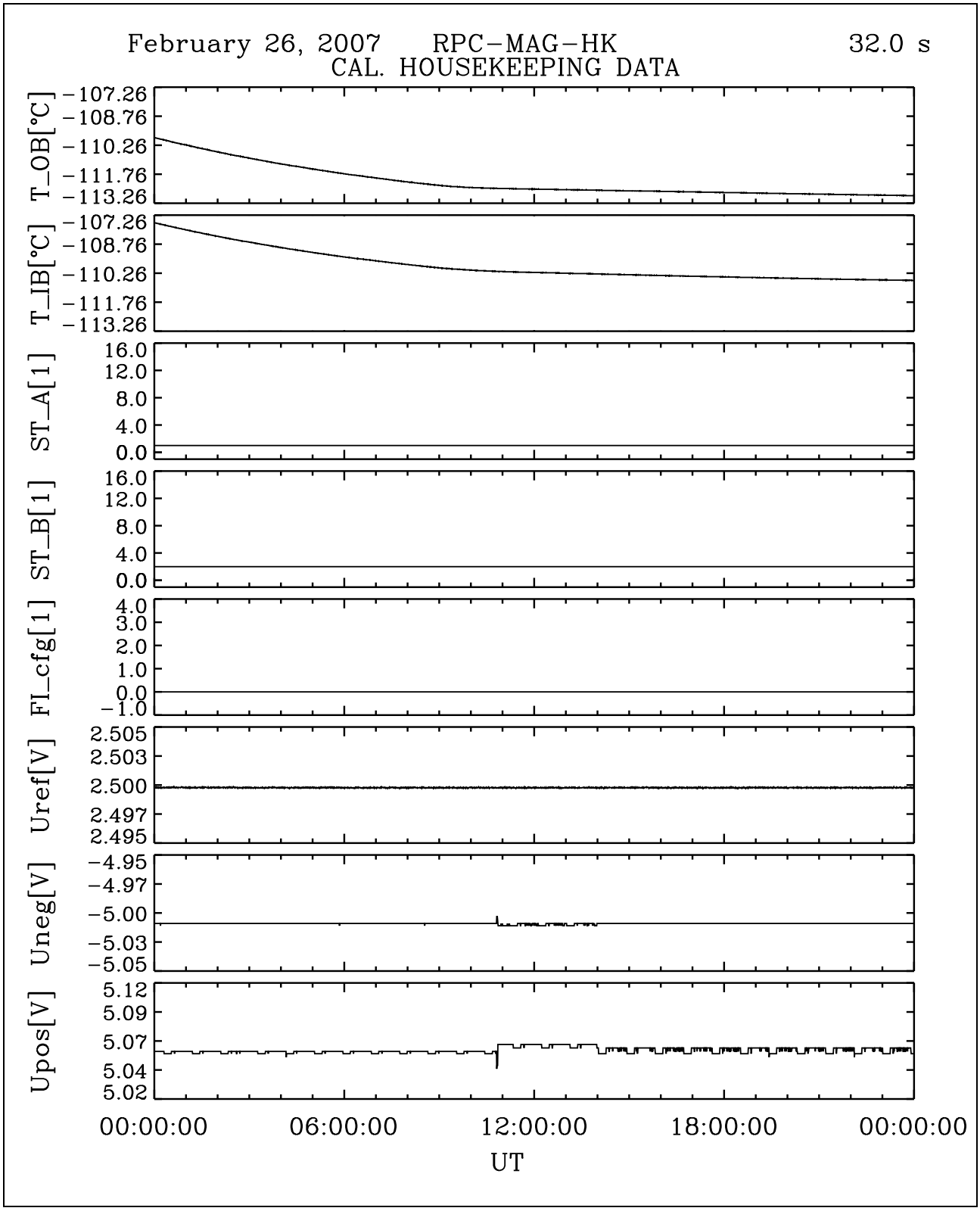

Figure 33: File: RPCMAG070226T0000_CLA_HK_P0000_2400

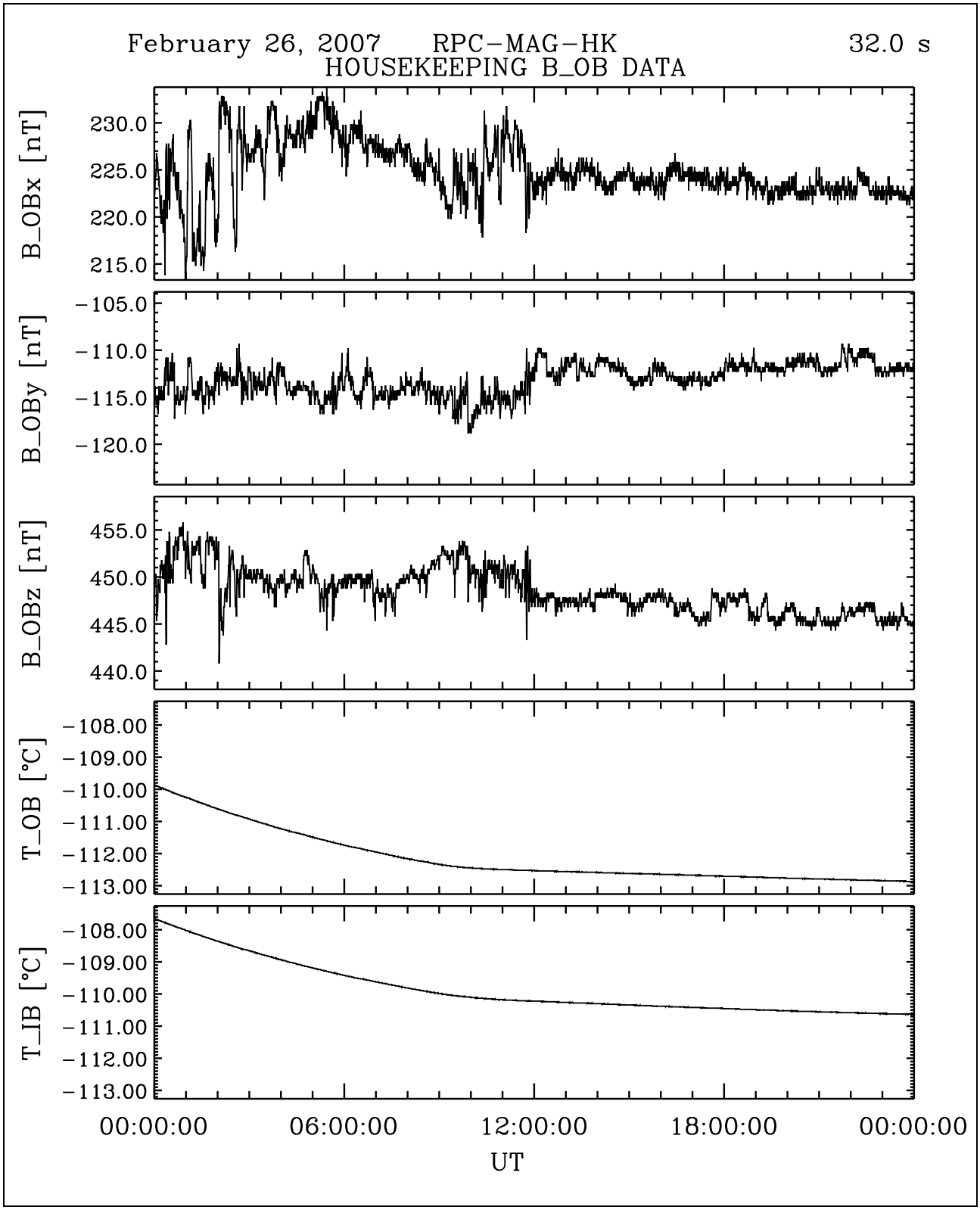

Figure 34: File: RPCMAG070226T0000_CLA_HK_B_P0000_2400

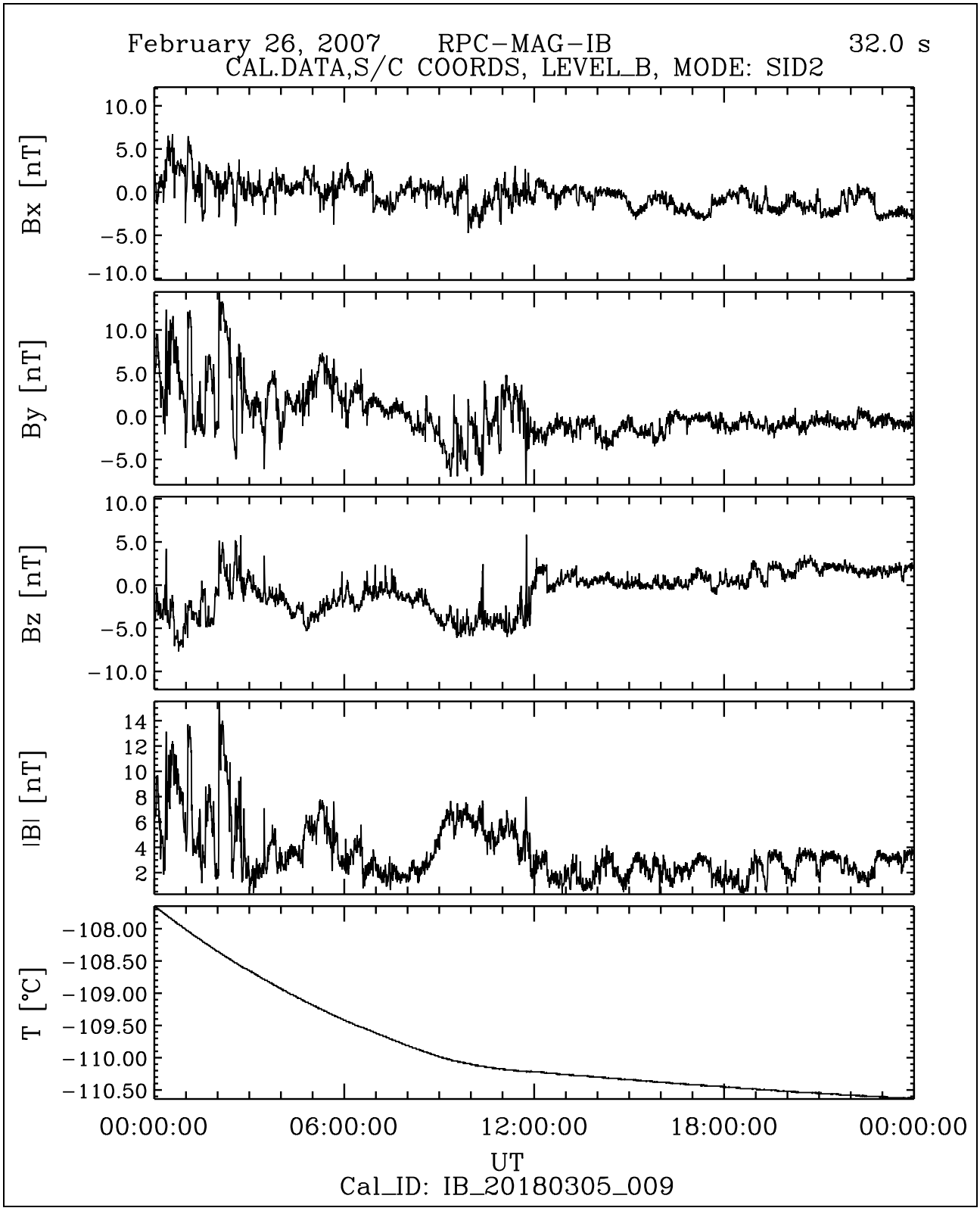

Figure 35: File: RPCMAG070226T0000_CLB_IB_M2_T0000_2400_009

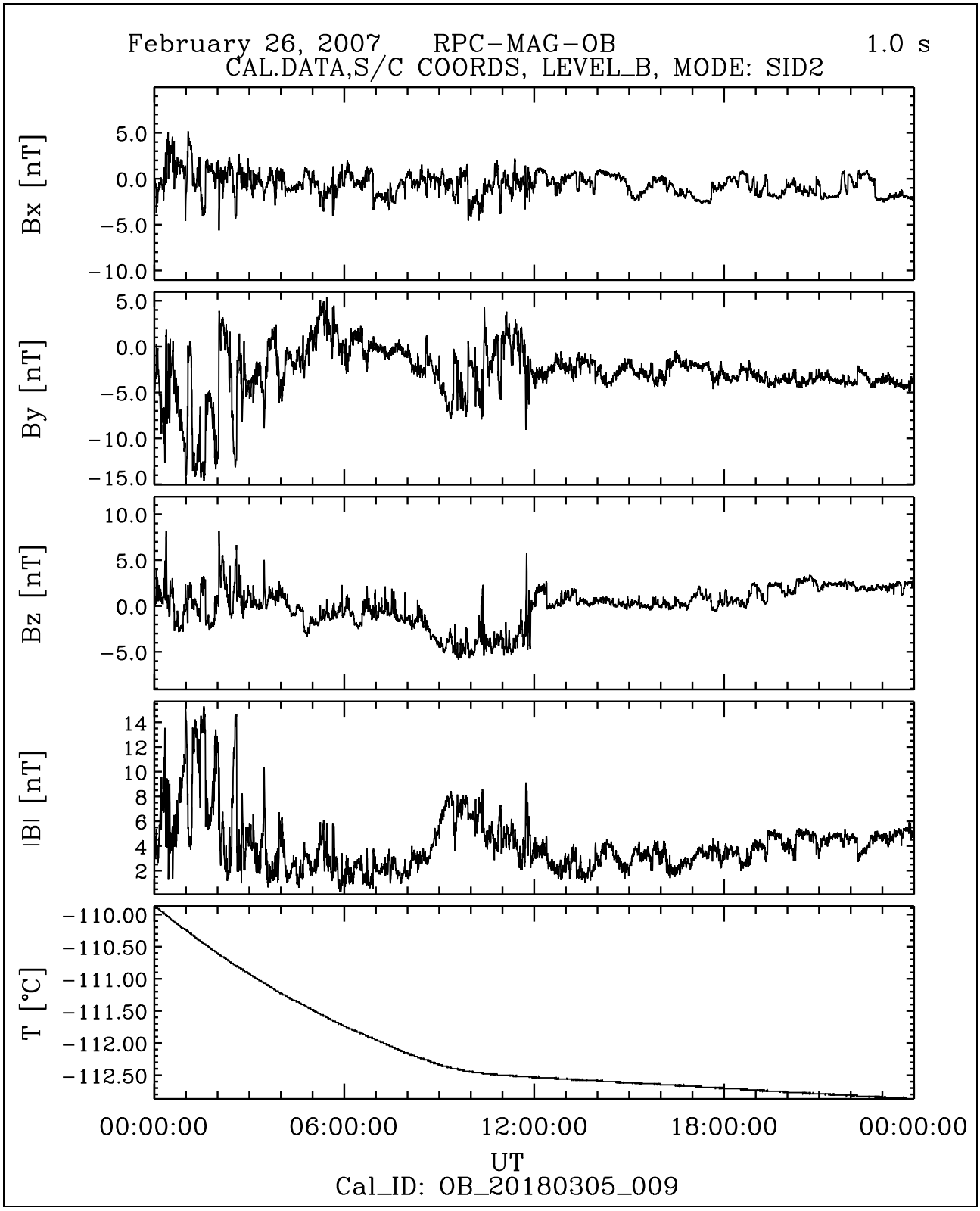

Figure 36: File: RPCMAG070226T0000_CLB_OB_M2_T0000_2400_009

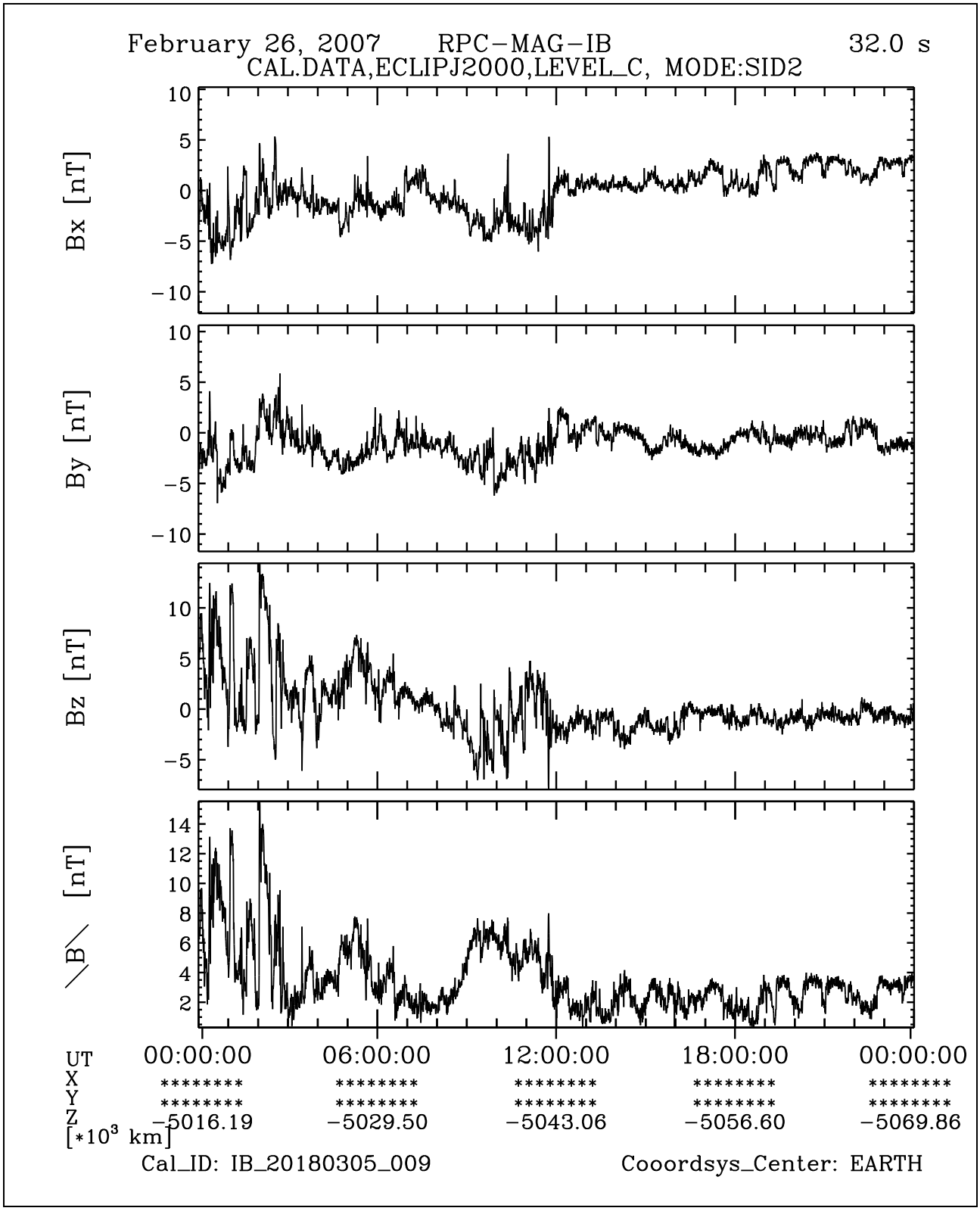

Figure 37: File: RPCMAG070226T0000_CLC_IB_M2_T0000_2400_009

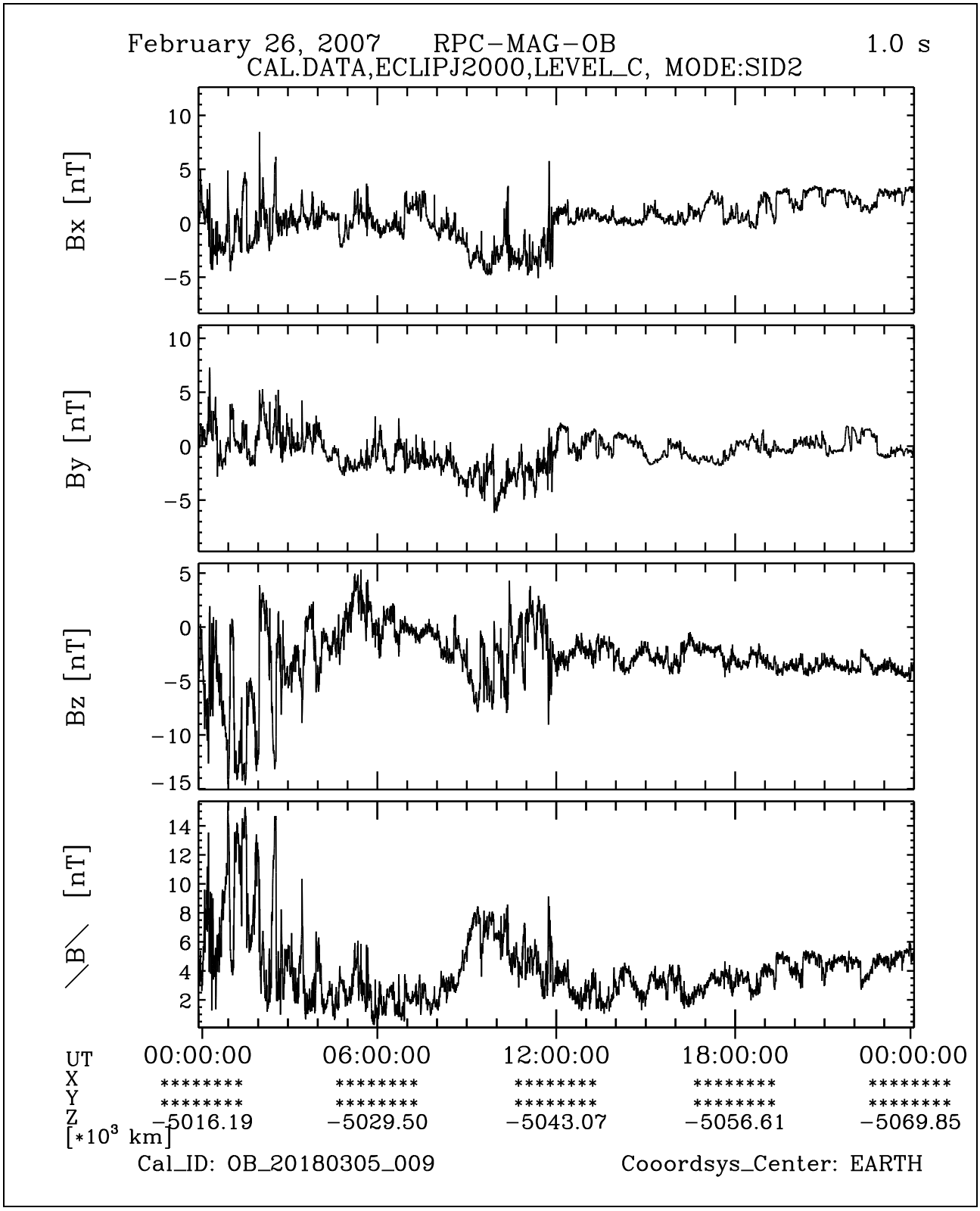

Figure 38: File: RPCMAG070226T0000_CLC_OB_M2_T0000_2400_009

4.9 February 27, 2007:

4.9.1 Actions

MAG stayed in SID2 until the RPC switch off at 02:24. All commands passed smoothly and the instrument followed in the expected way.

4.10 Plots of Calibrated Data

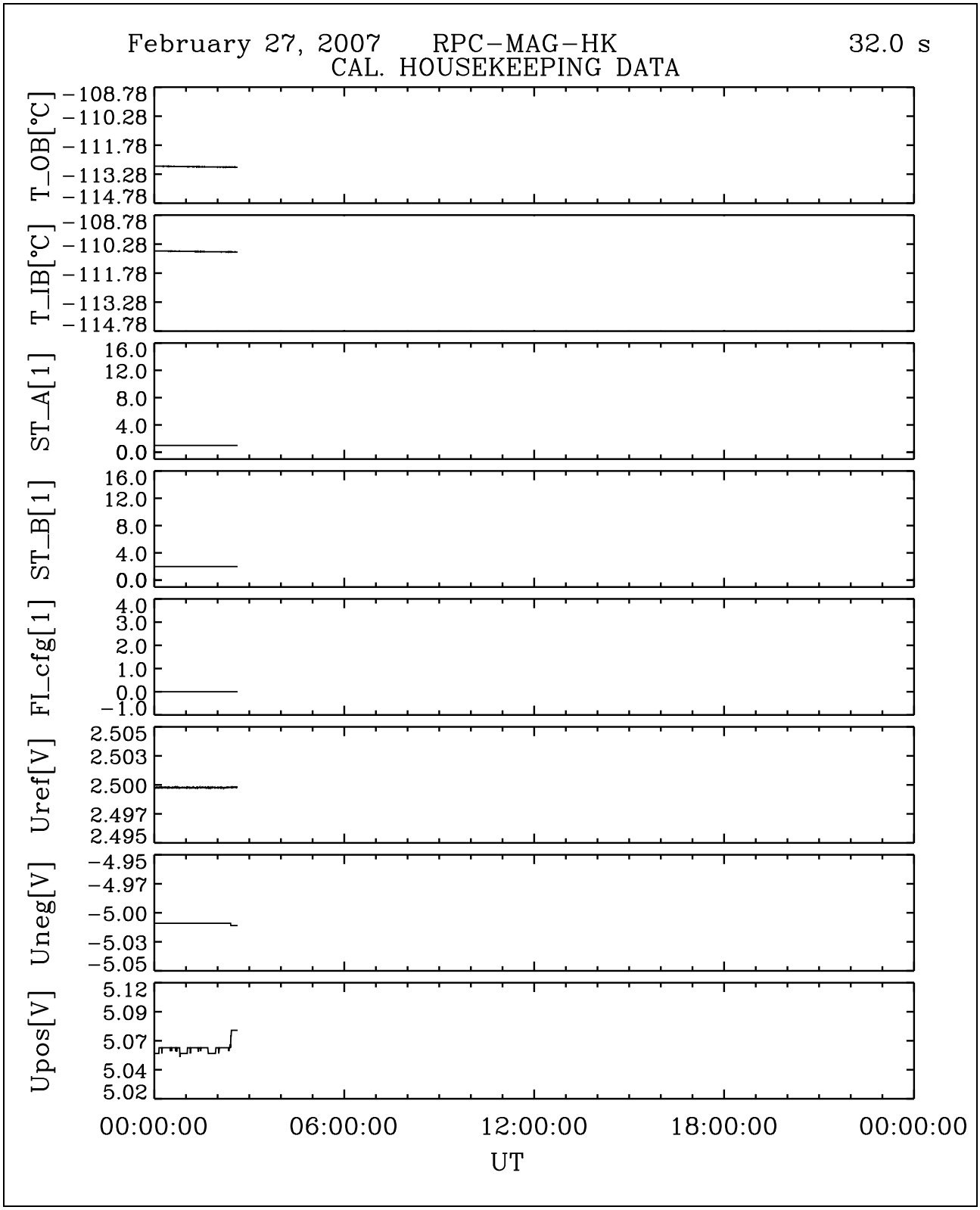

Figure 39: File: RPCMAG070227T0000_CLA_HK_P0000_2400

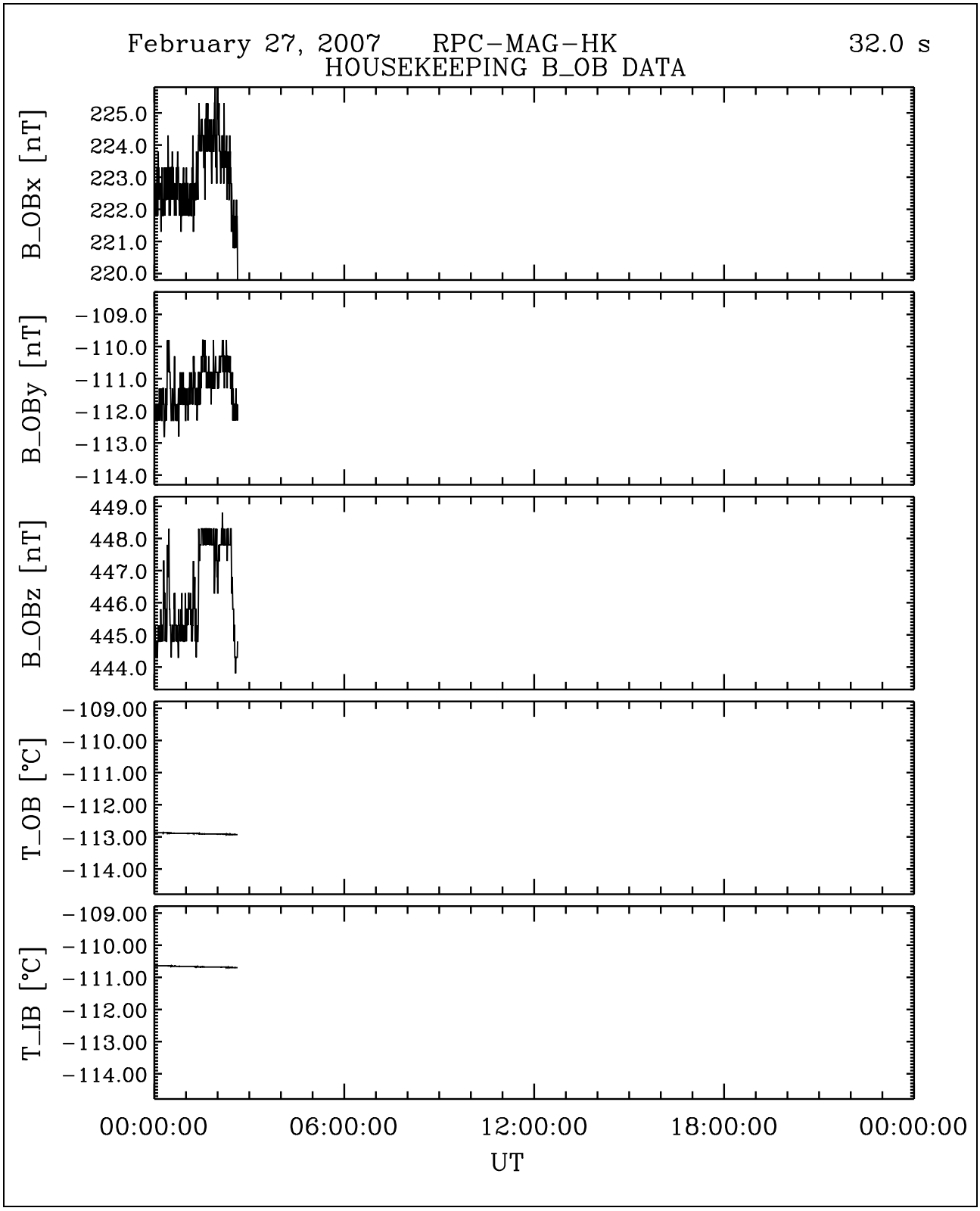

Figure 40: File: RPCMAG070227T0000_CLA_HK_B_P0000_2400

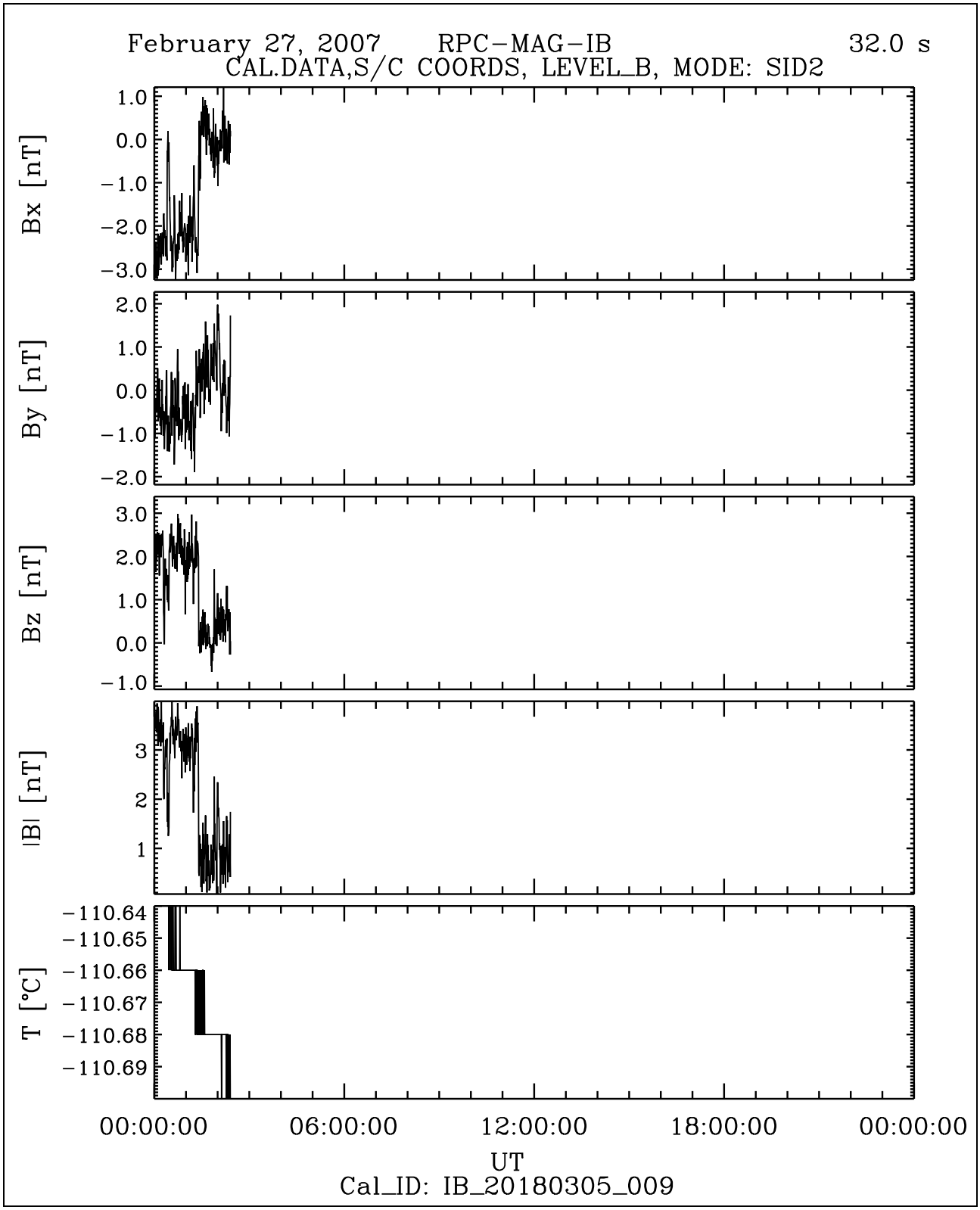

Figure 41: File: RPCMAG070227T0000_CLB_IB_M2_T0000_2400_009

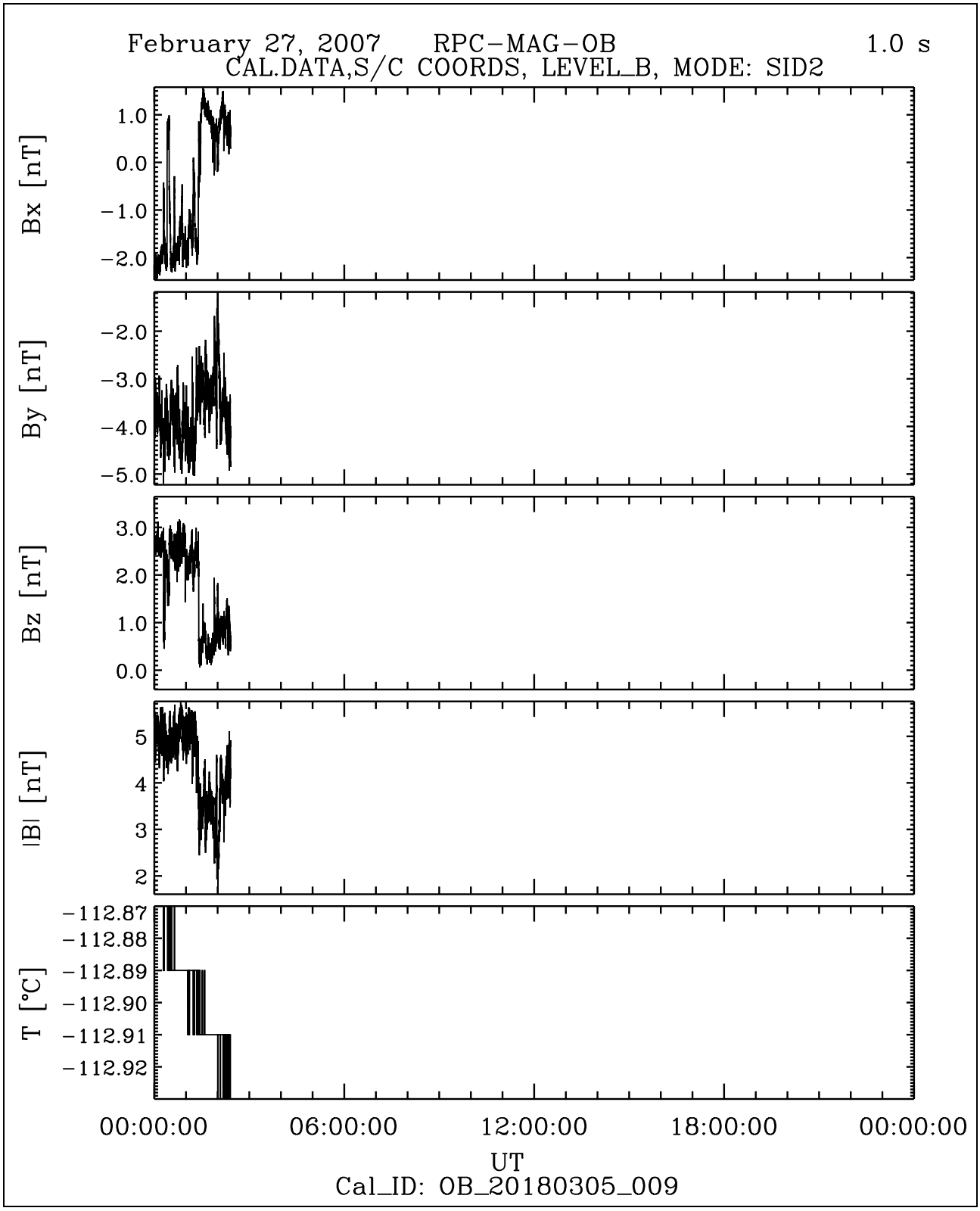

Figure 42: File: RPCMAG070227T0000_CLB_OB_M2_T0000_2400_009

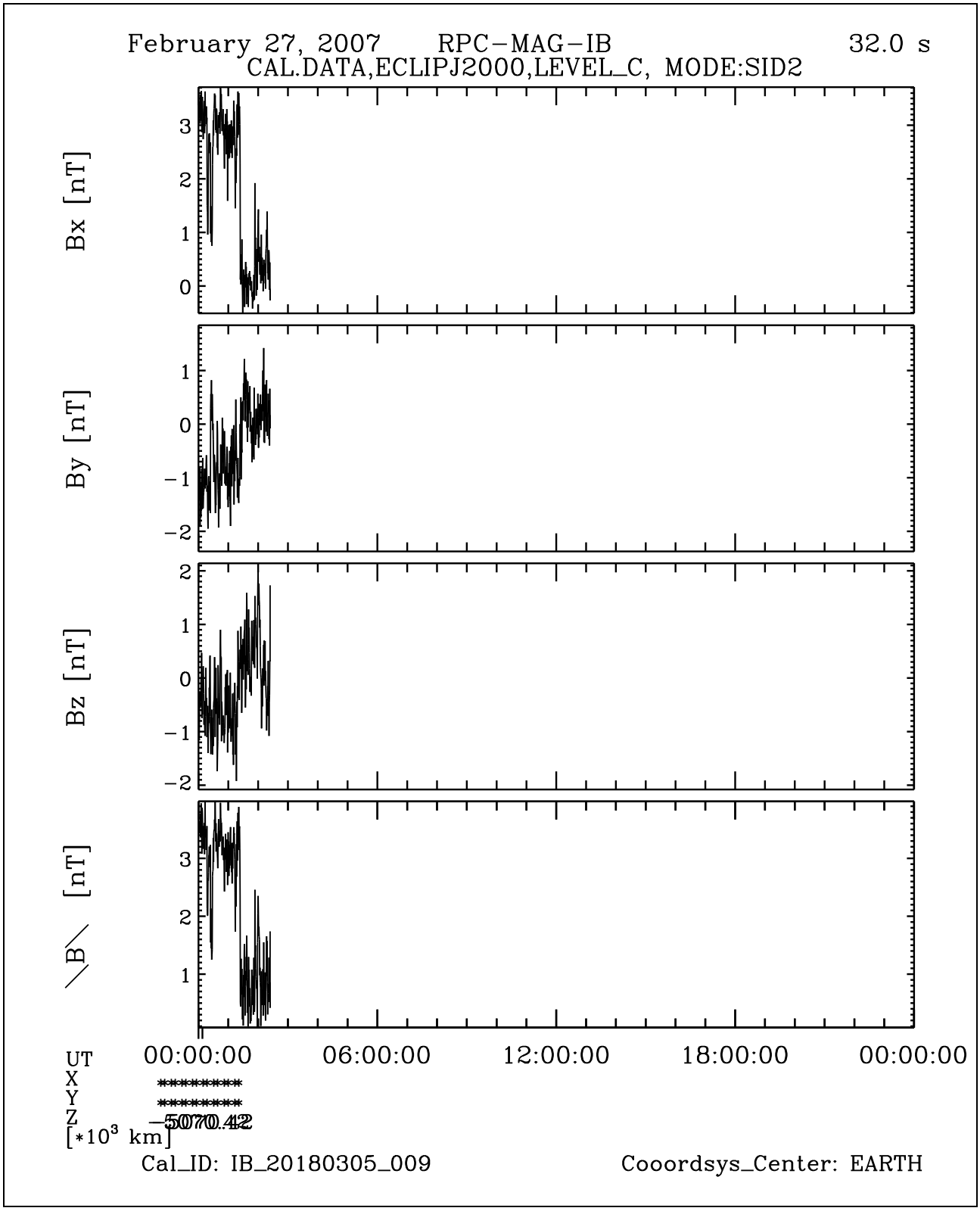

Figure 43: File: RPCMAG070227T0000_CLC_IB_M2_T0000_2400_009

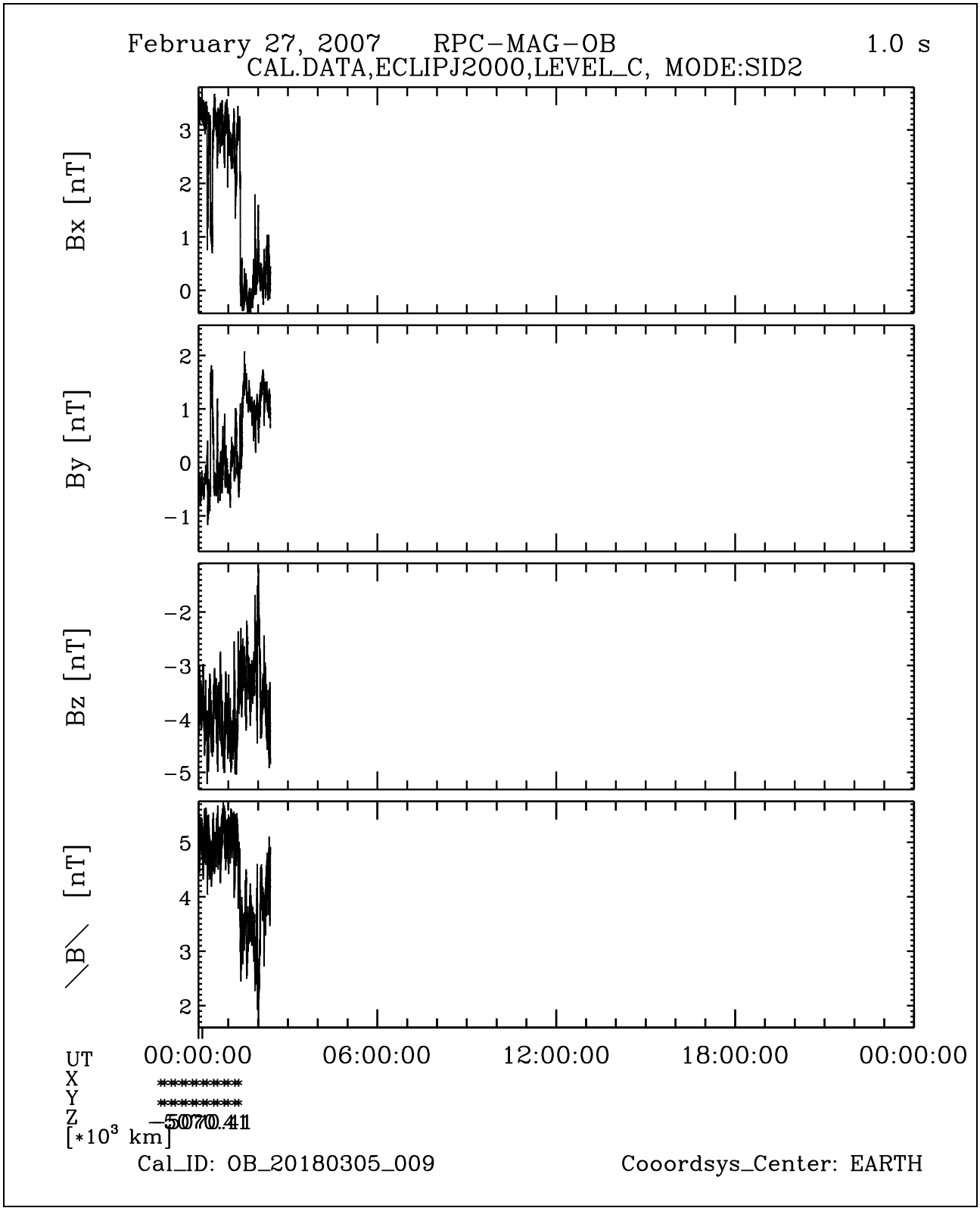

Figure 44: File: RPCMAG070227T0000_CLC_OB_M2_T0000_2400_009

5 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 due to our experiences from the commissioning phase. The analysis of Reaction Wheels influence is performed in the next section.

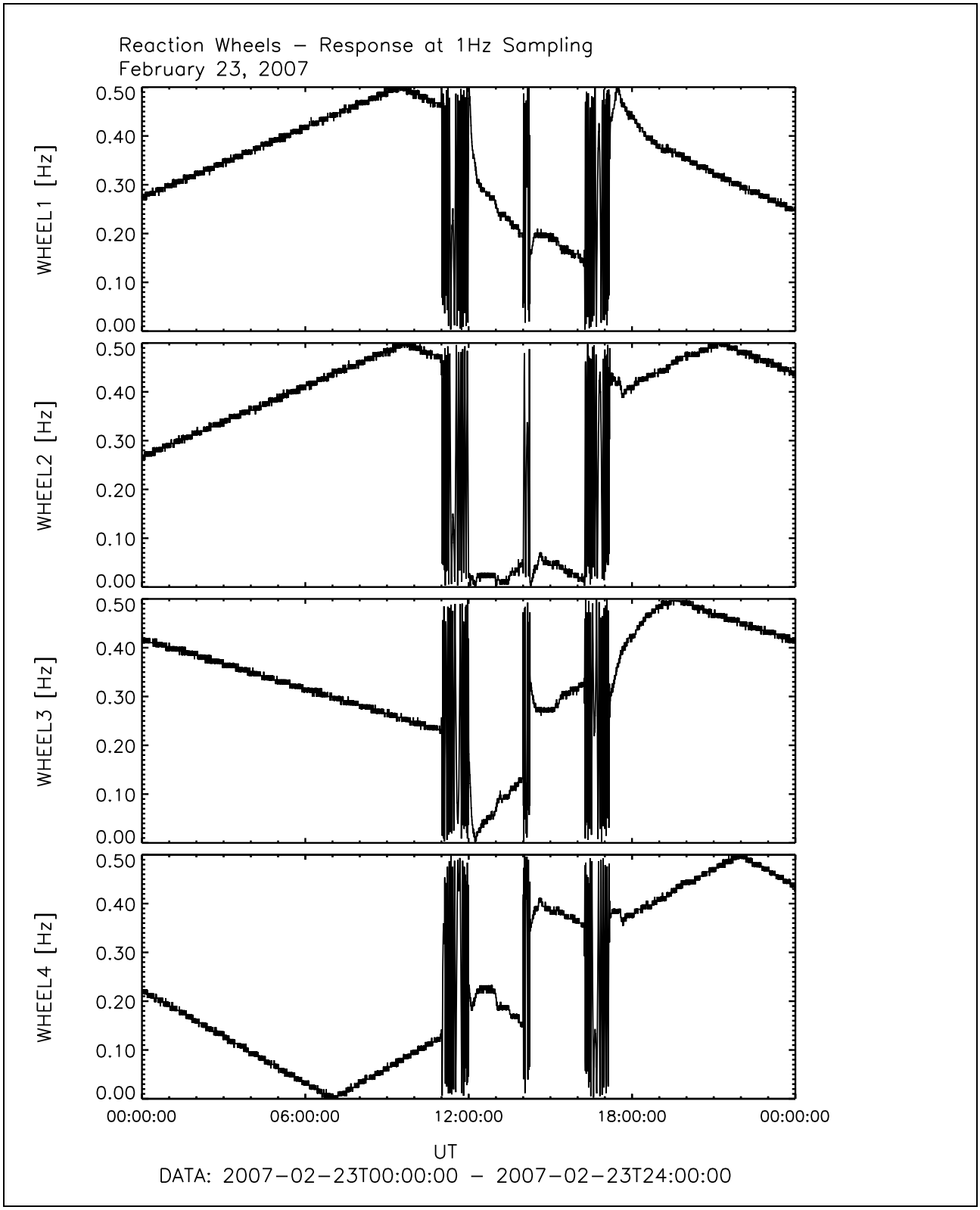

Figure 45: File: wheels_1Hz_Sampling2007-02-23T00-00

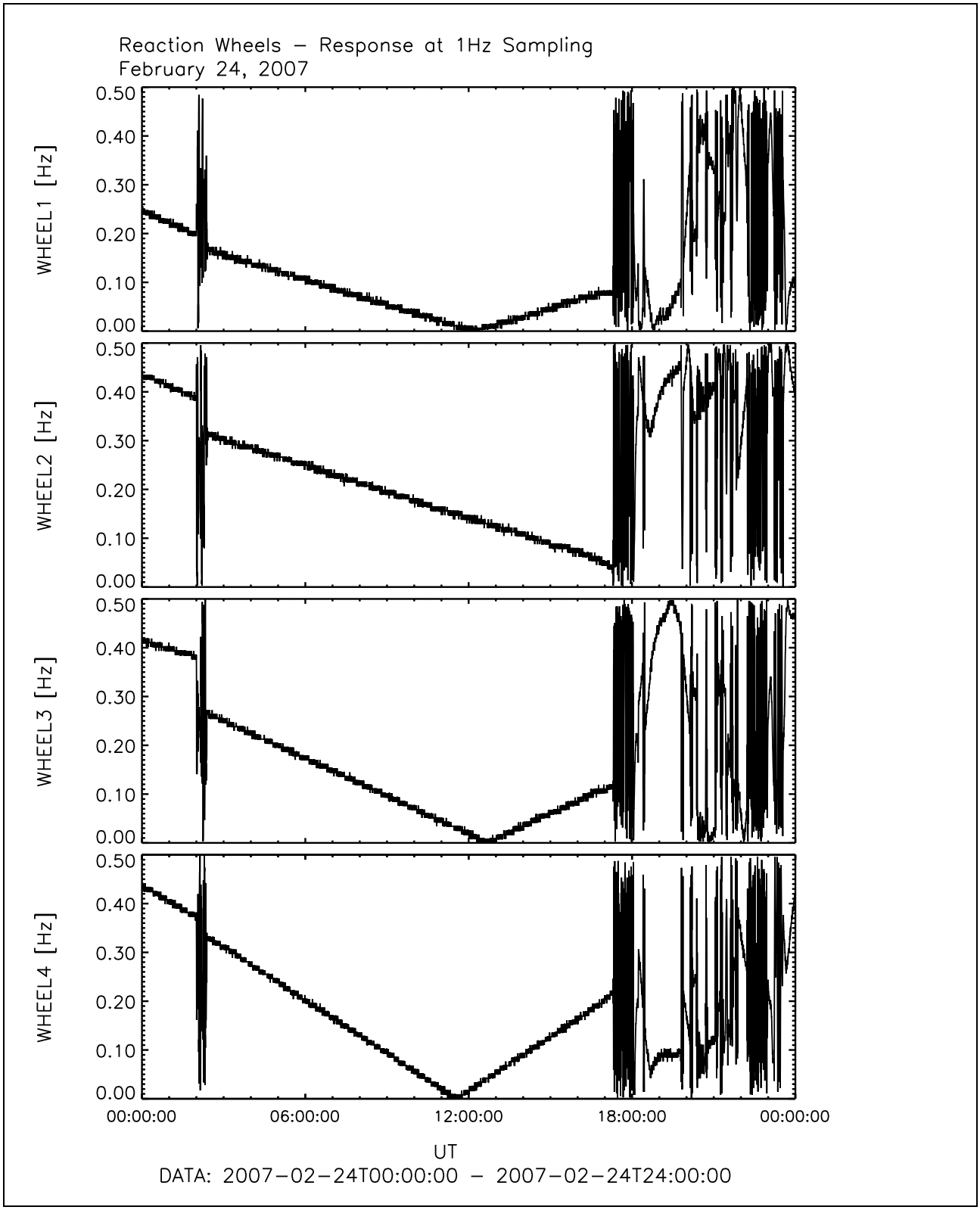

Figure 46: File: wheels_1Hz_Sampling2007-02-24T00-00

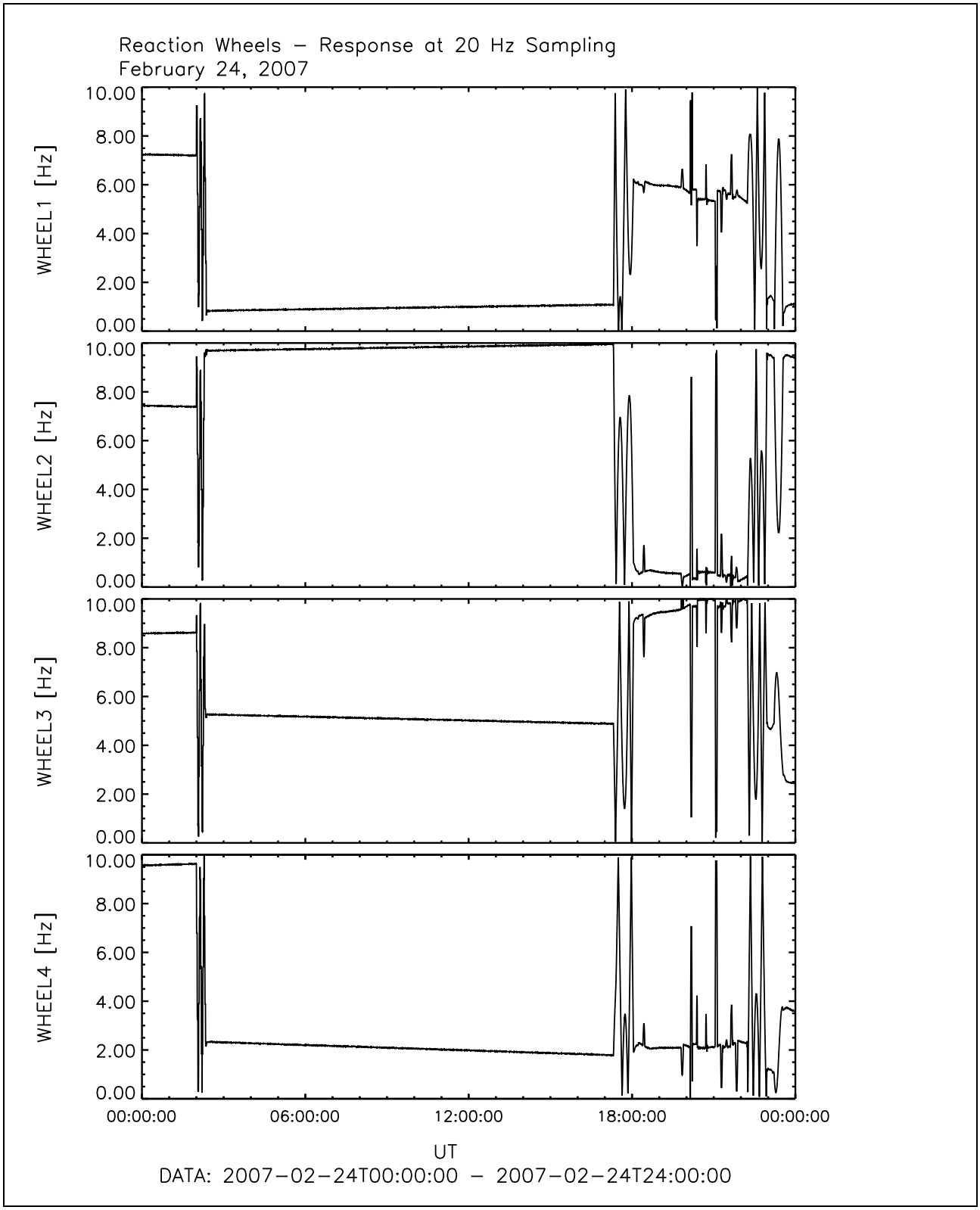

Figure 47: File: wheels_20Hz_Sampling2007-02-24T00-00

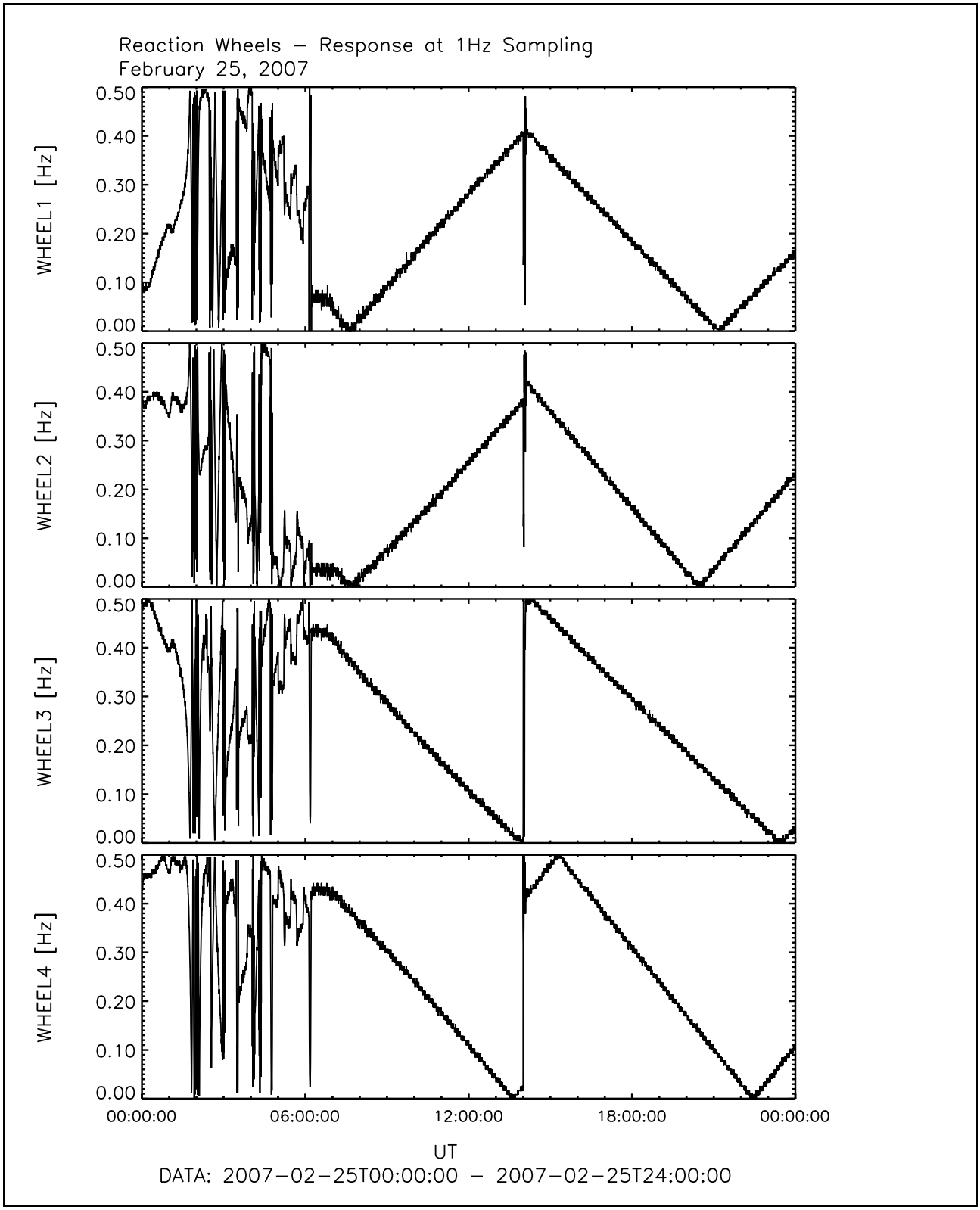

Figure 48: File: wheels_1Hz_Sampling2007-02-25T00-00

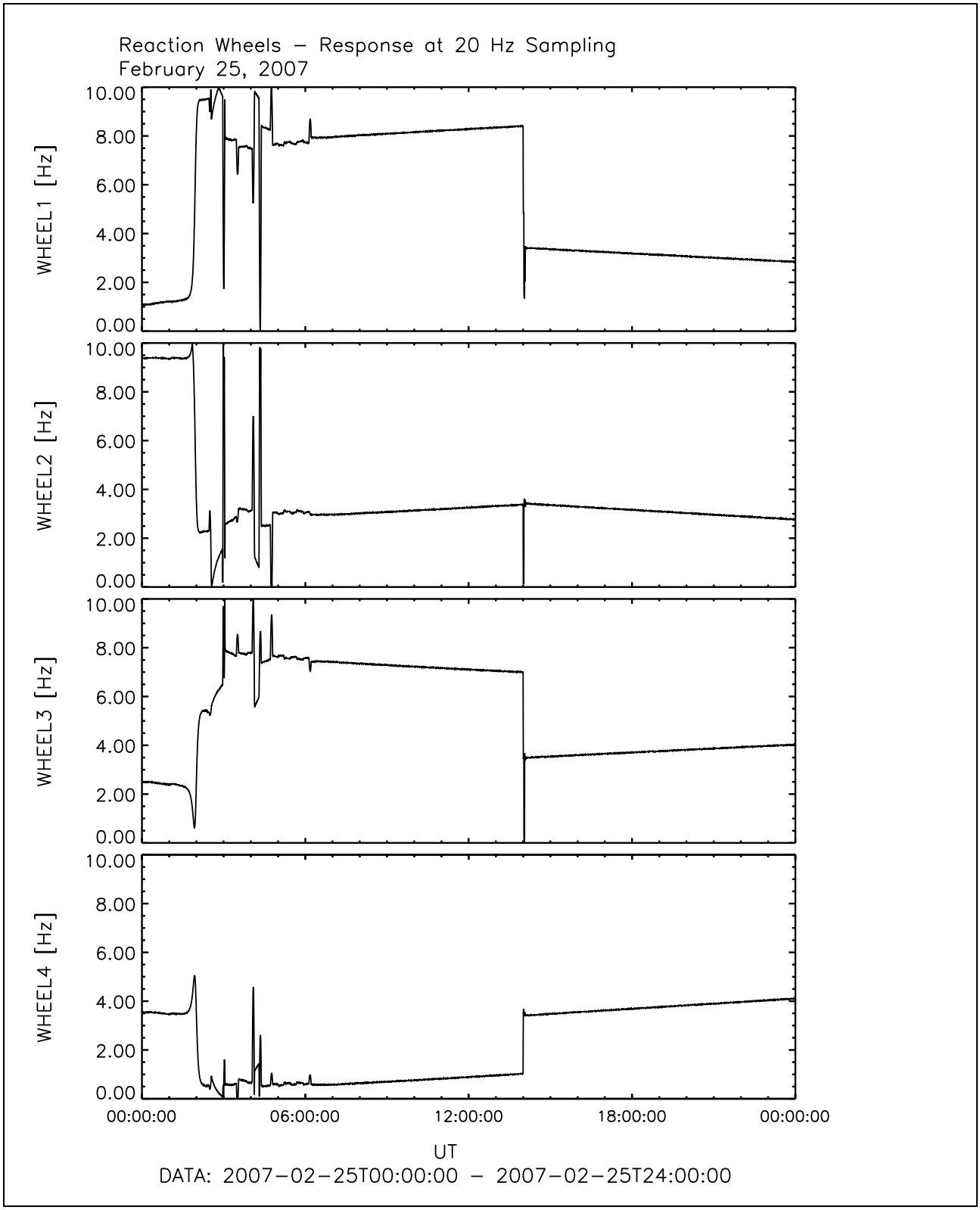

Figure 49: File: wheels_20Hz_Sampling2007-02-25T00-00

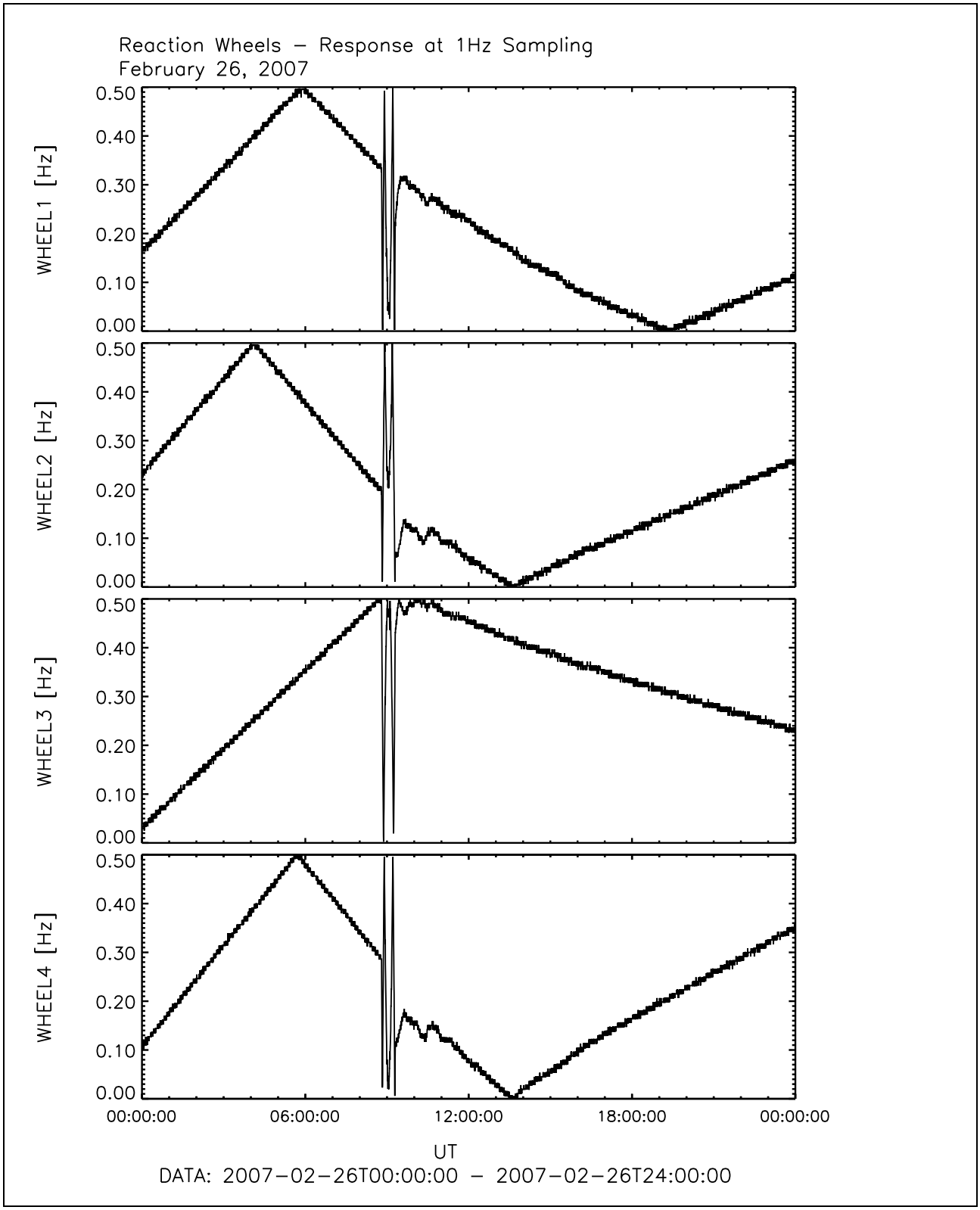

Figure 50: File: wheels_1Hz_Sampling2007-02-26T00-00

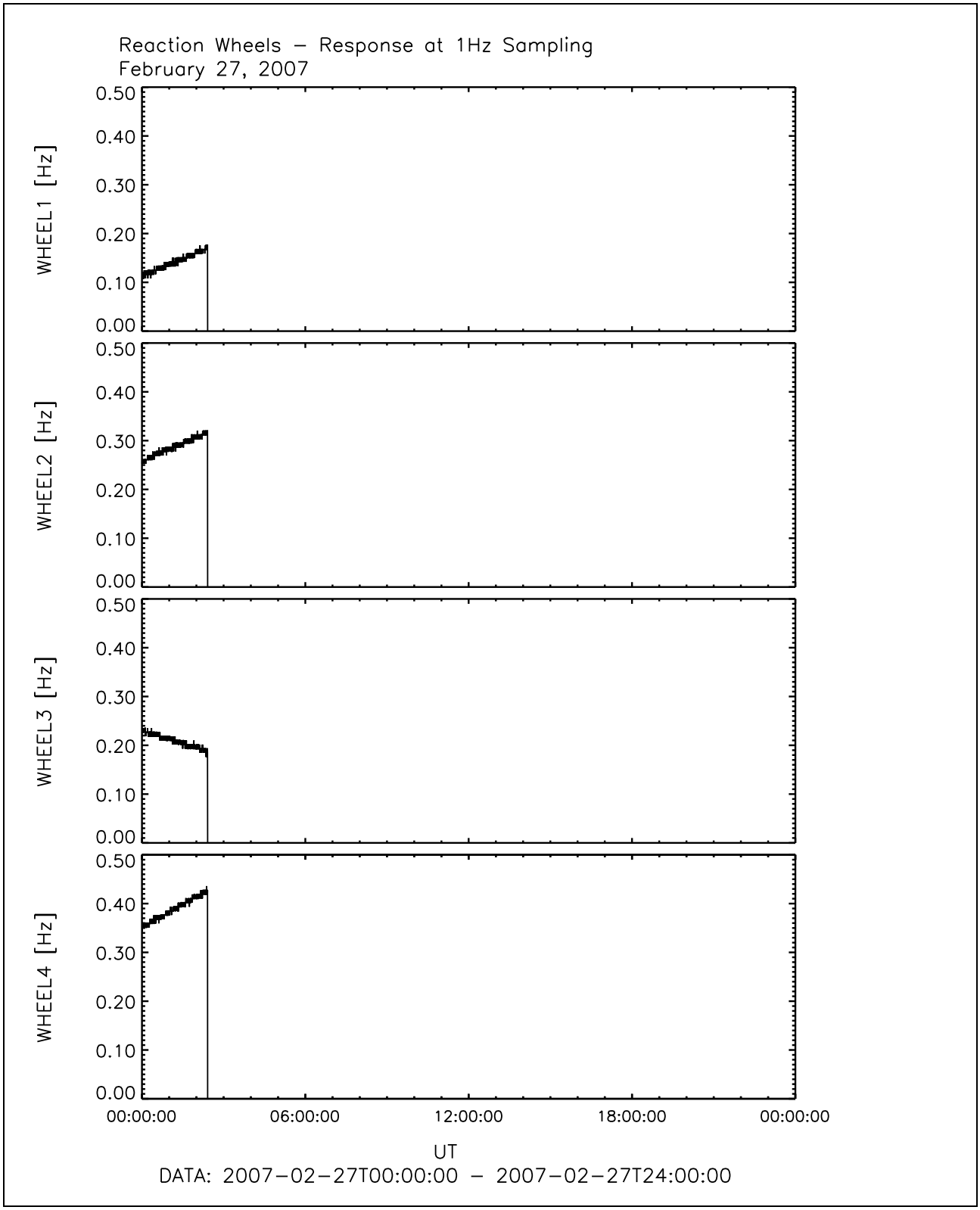

Figure 51: File: wheels_1Hz_Sampling2007-02-27T00-00

6 Dynamic Spectra of the Swing-by

This section shows the dynamic spectra of the OB sensor in LEVEL_C = ECLIPJ2000 coordinates. As the OB sensor was operated as primary sensor in NORMAL mode, SID2, the maximum resolvable frequency is 0.5 Hz. For the few hours around CA also SID3 spectra are available. Here the maximum resolvable frequency is 10Hz.

As usual the Influence of the Reaction wheels can be seen in BURST mode.

A view to the spectra of the measured magnetic field shows, that there is no influence of the RWs for SID2 operations. The Burst mode data (SID3), however, are clearly disturbed by the Reaction Wheels.

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.

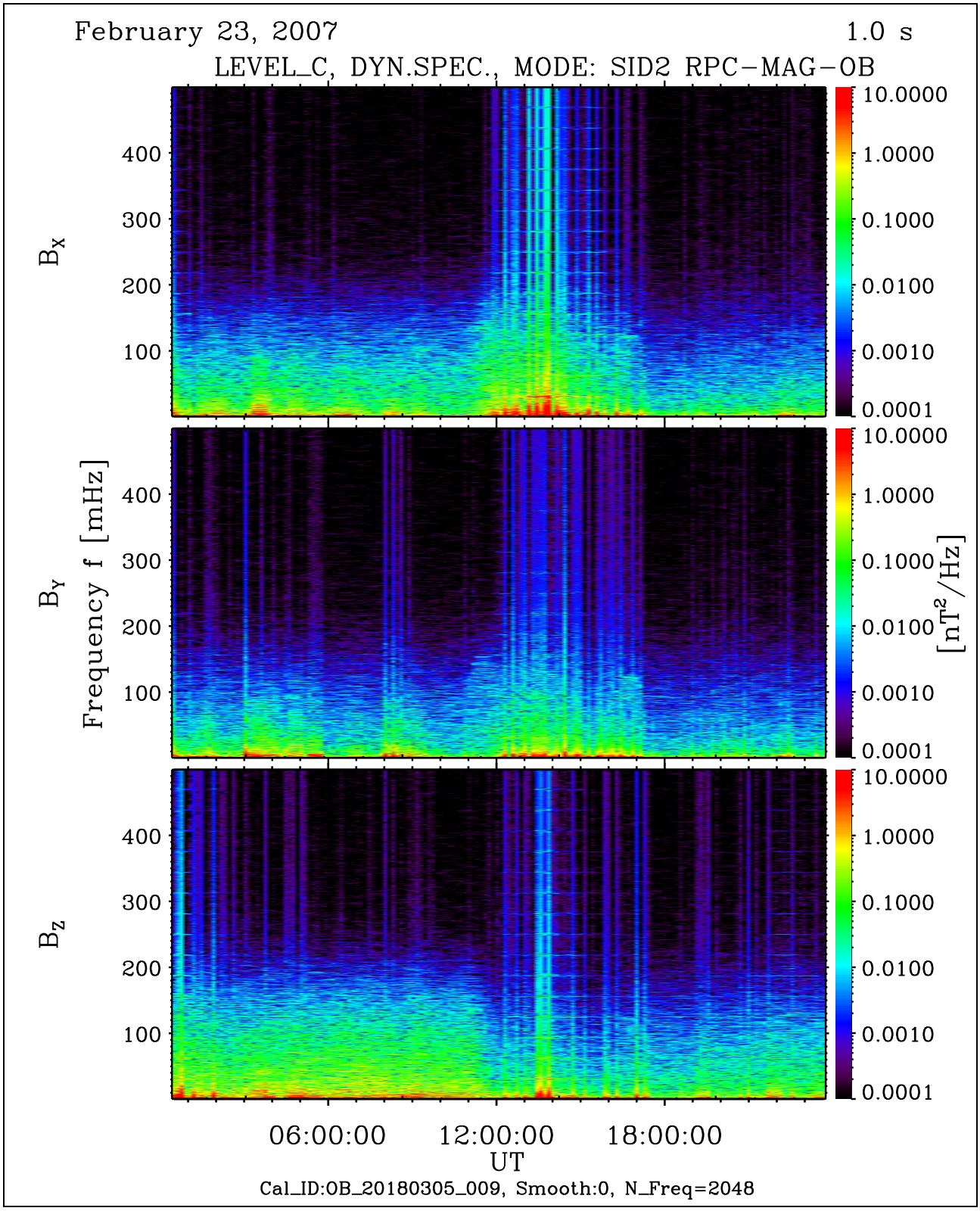

Figure 52: File: RPCMAG070223T0012_CLC_OB_M2_DS0_500_009

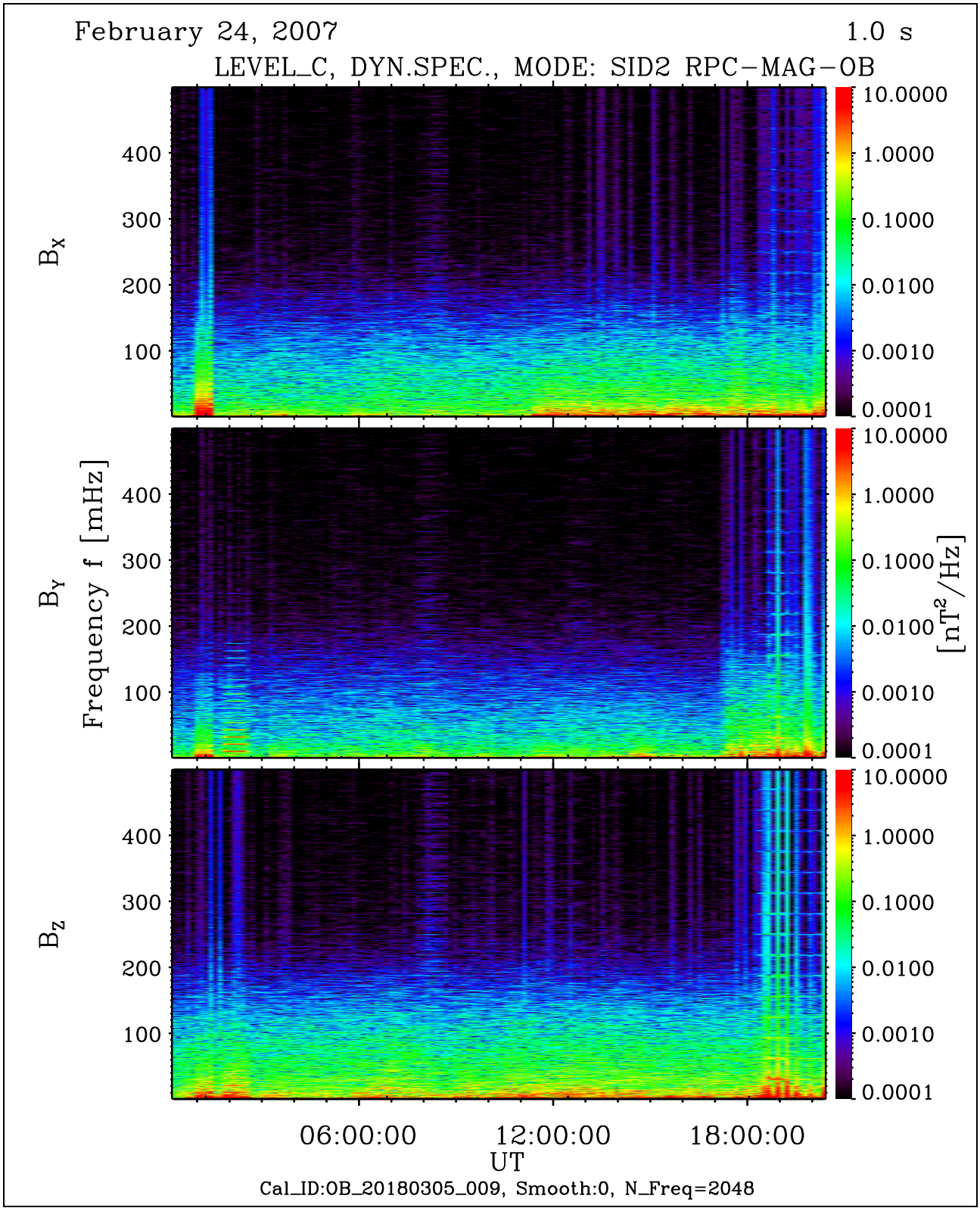

Figure 53: File: RPCMAG070224T0000_CLC_OB_M2_DS0_500_009

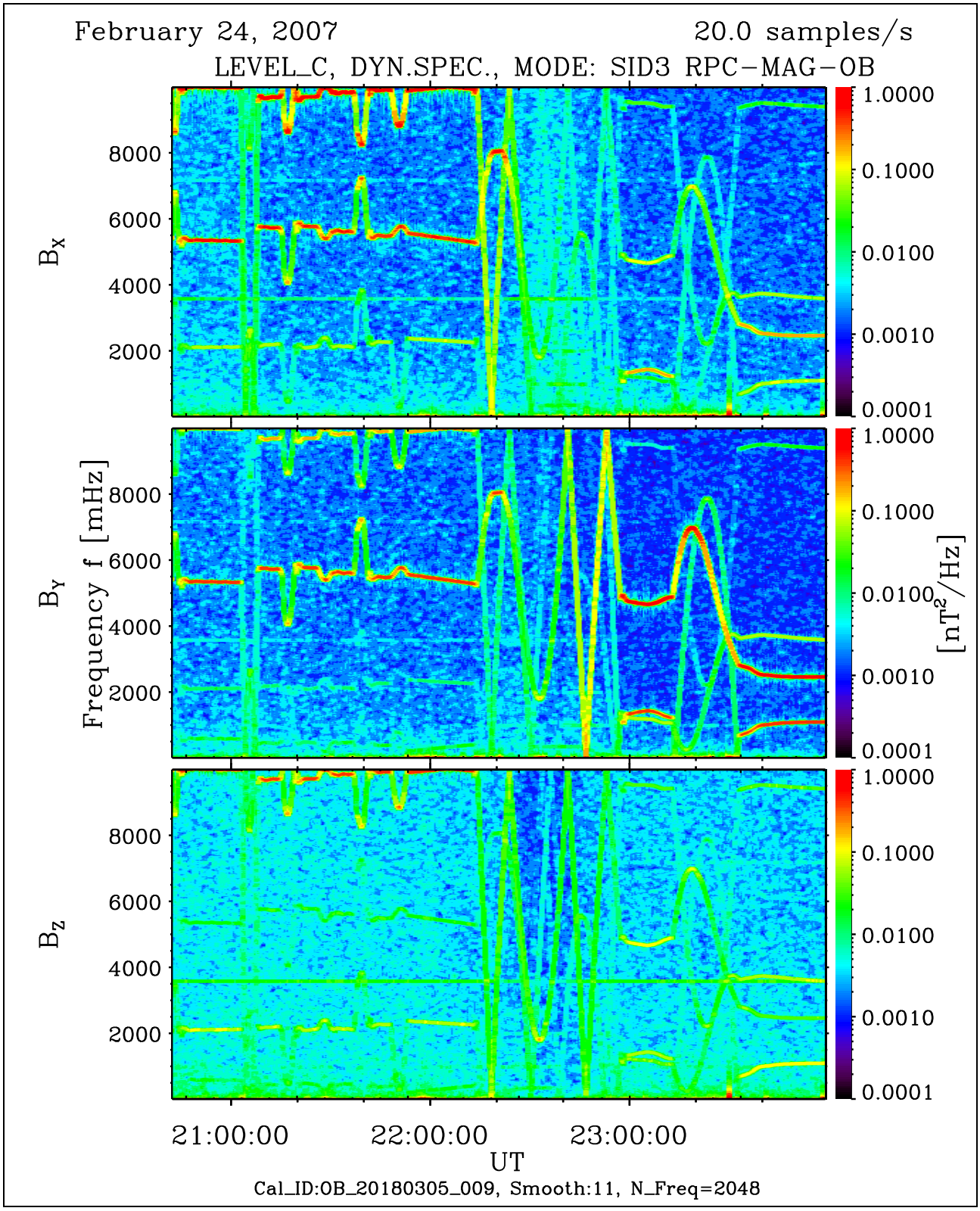

Figure 54: File: RPCMAG070224T2041_CLC_OB_M3_DS0_10000_009

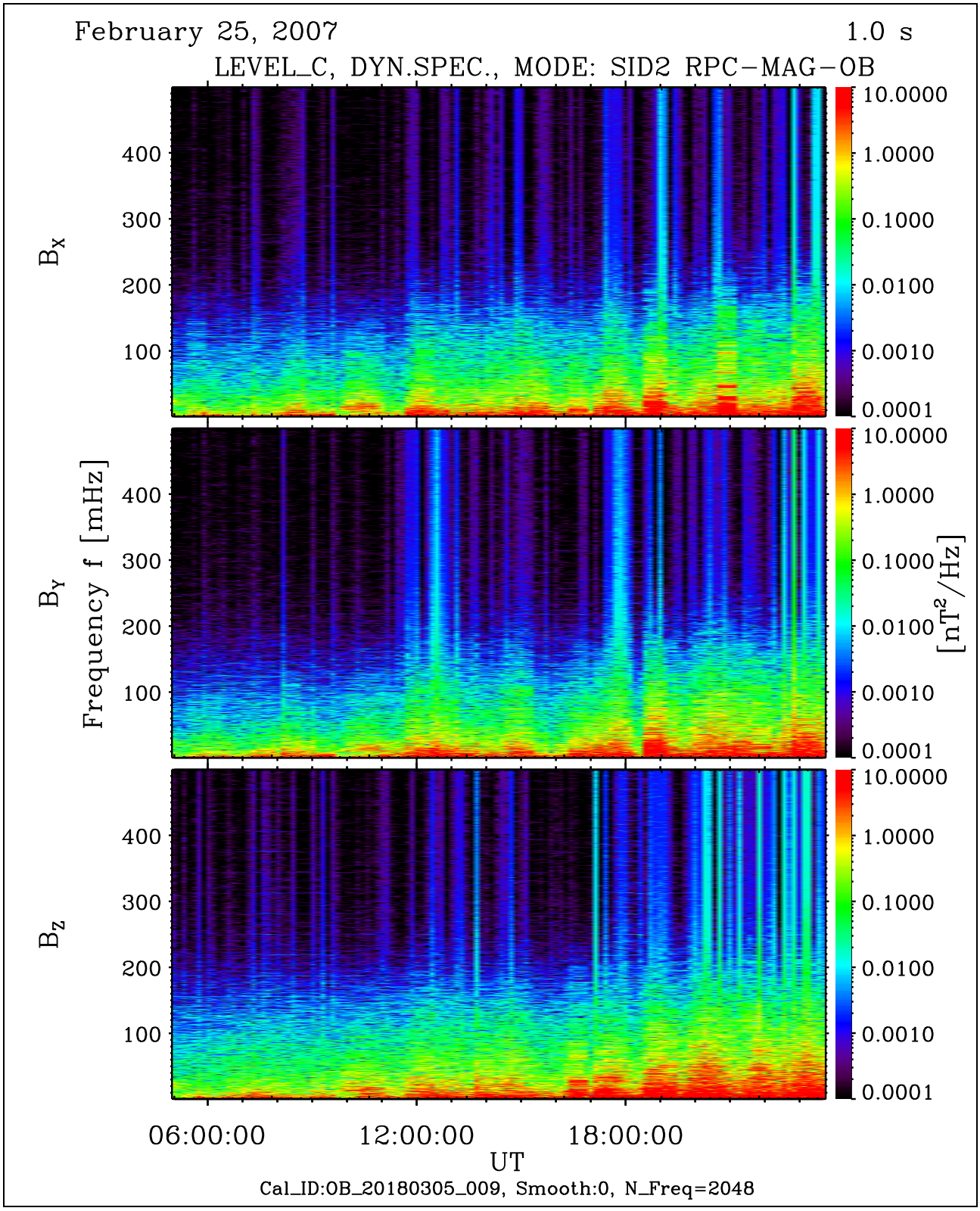

Figure 55: File: RPCMAG070225T0445_CLC_OB_M2_DS0_500_009

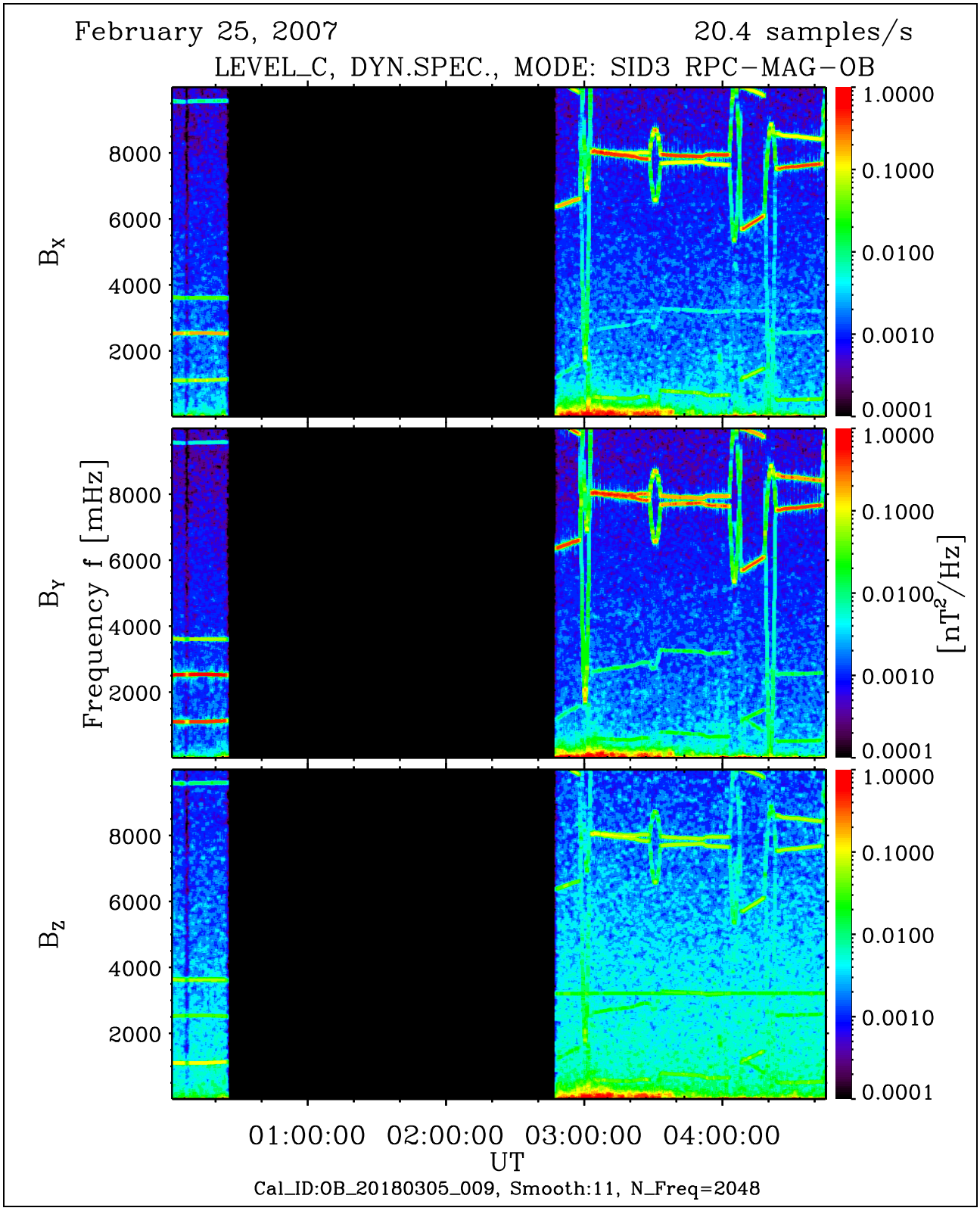

Figure 56: File: RPCMAG070225T0000_CLC_OB_M3_DS0_10000_009

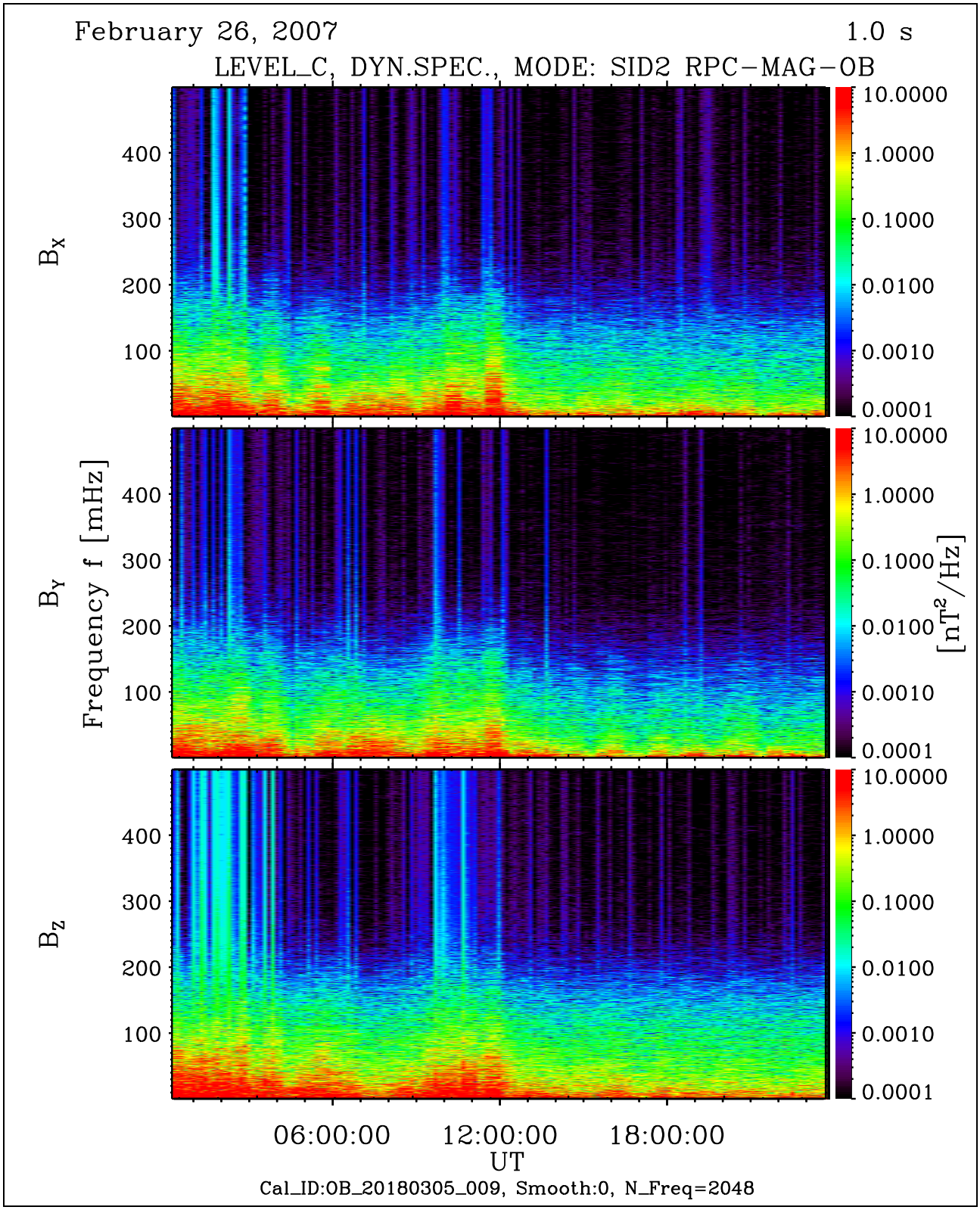

Figure 57: File: RPCMAG070226T0000_CLC_OB_M2_DS0_500_009

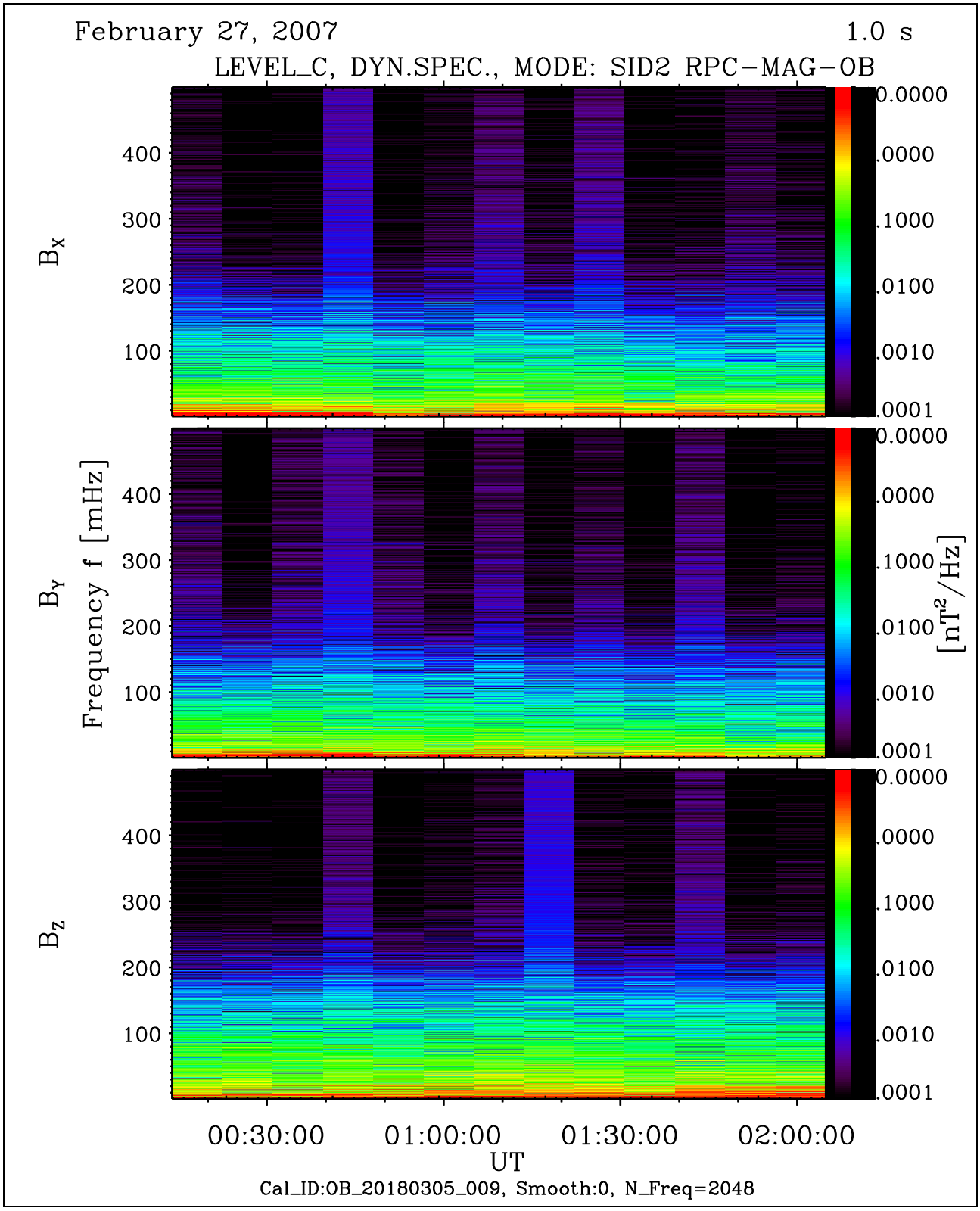

Figure 58: File: RPCMAG070227T0000_CLC_OB_M2_DS0_500_009

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.

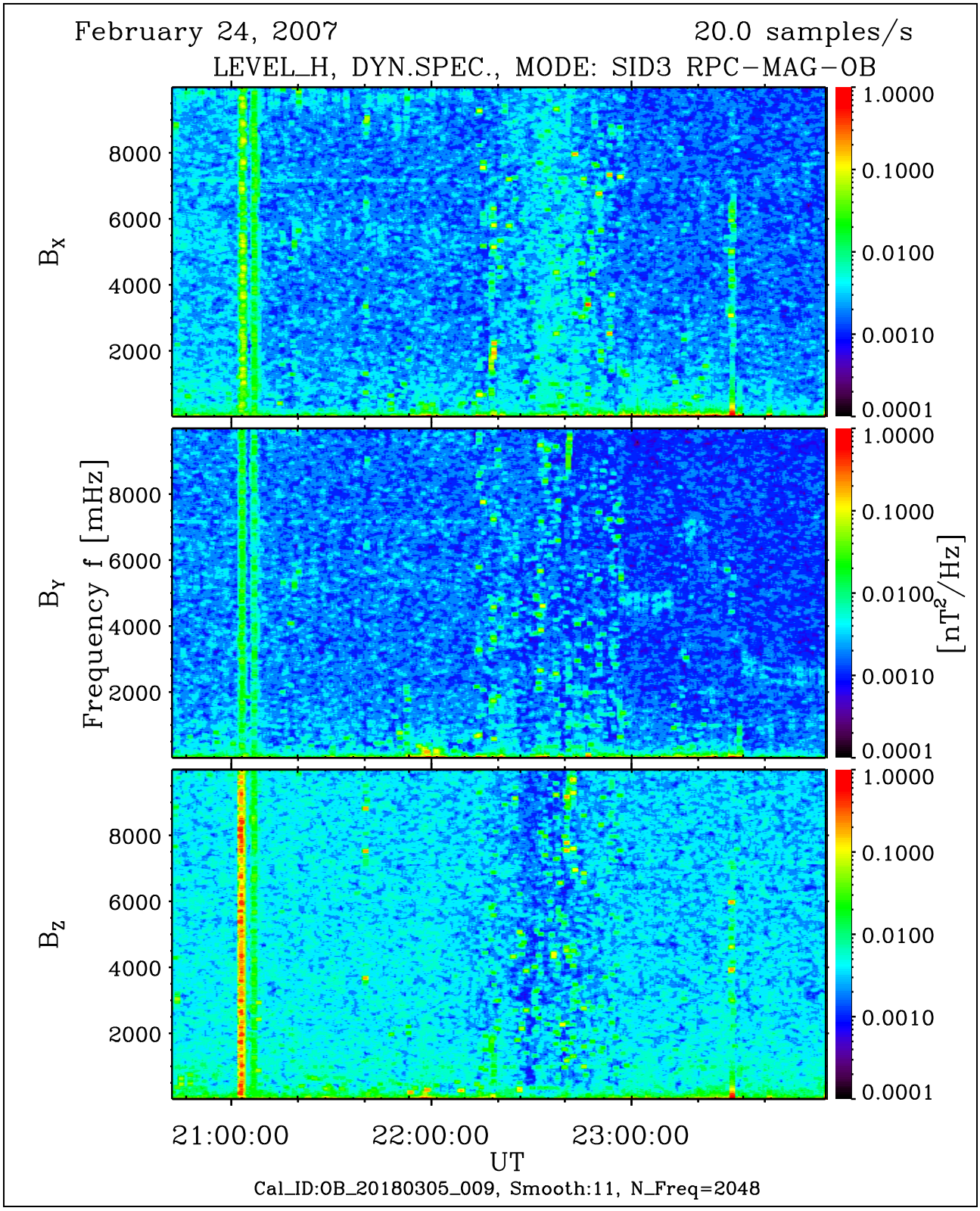

Figure 59: File: RPCMAG070224T2041_CLH_OB_M3_DS0_10000_009

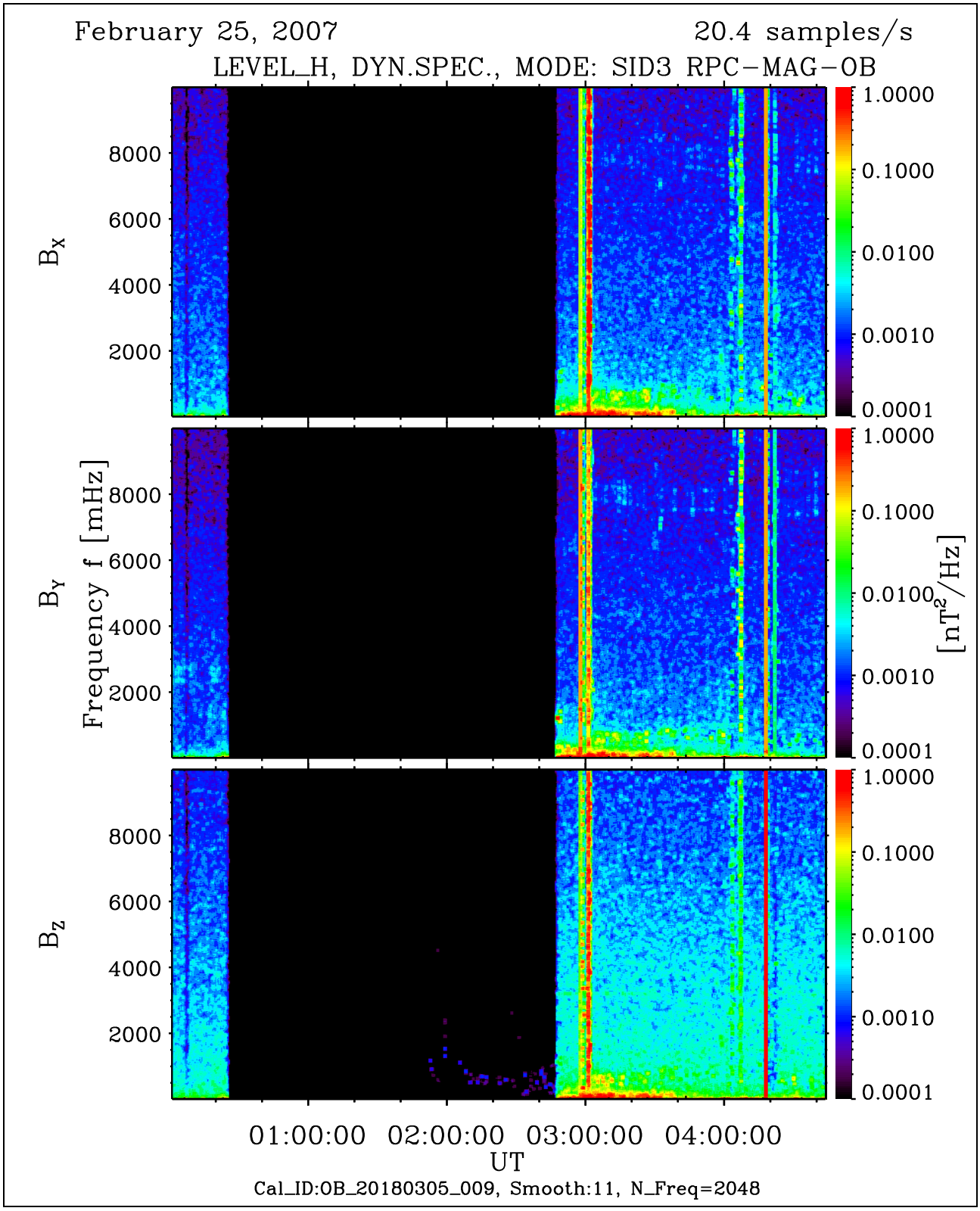

Figure 60: File: RPCMAG070225T0000_CLH_OB_M3_DS0_10000_009

7 Complete Magnetic Field data Plots in ECLIPJ2000 & MSO Frames

The following plots show the the averaged data of the OB and IB Sensors for the complete Swing-by campaign. The first two plots show the data in the usual ECLIPJ2000 frame. The latter two are dynamically rotated to the MSO frame - the Mars centered Solar Orbital coordinates. The MSO coordinates are defined as follows:

- X_{MSO}: Pointing from MARS to SUN
- Y_{MSO}: Pointing from MARS in the opposite direction of the planetary motion
- Z_{MSO}: Completes the system to be right handed

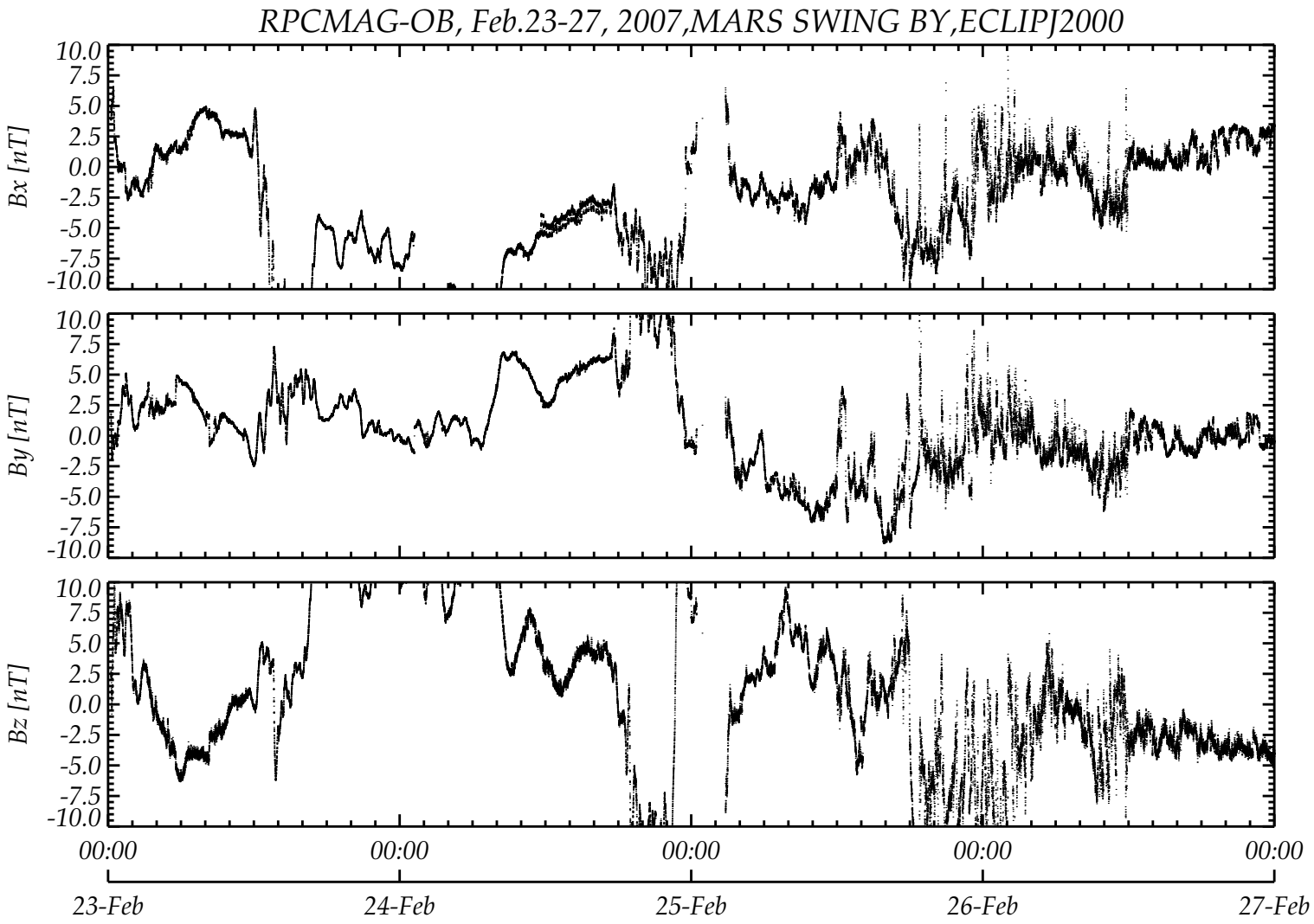

Figure 61: OB Data for the complete Swing by Period, ECLIPJ2000 Frame

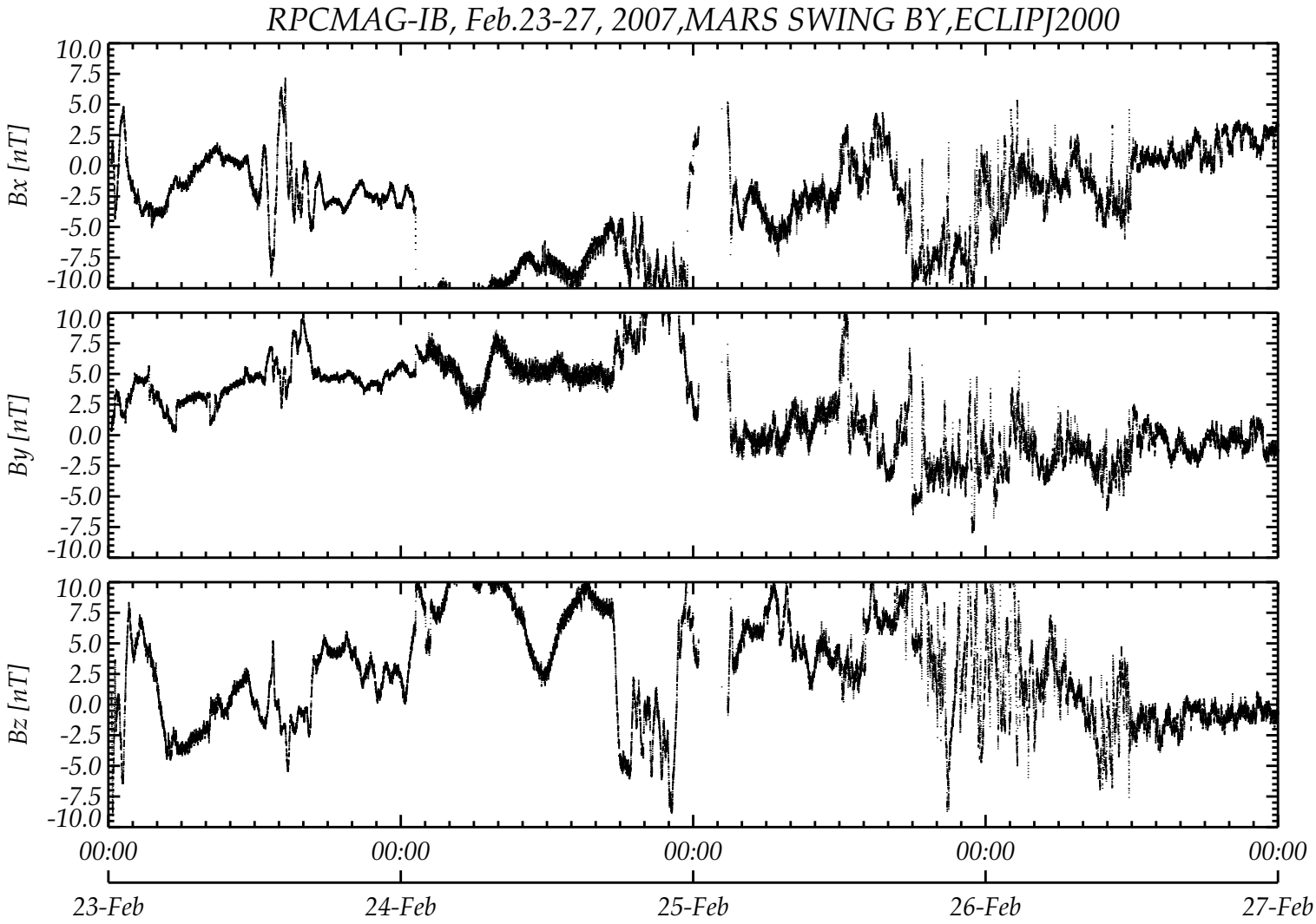

Figure 62: IB Data for the complete Swing by Period, ECLIPJ2000 Frame

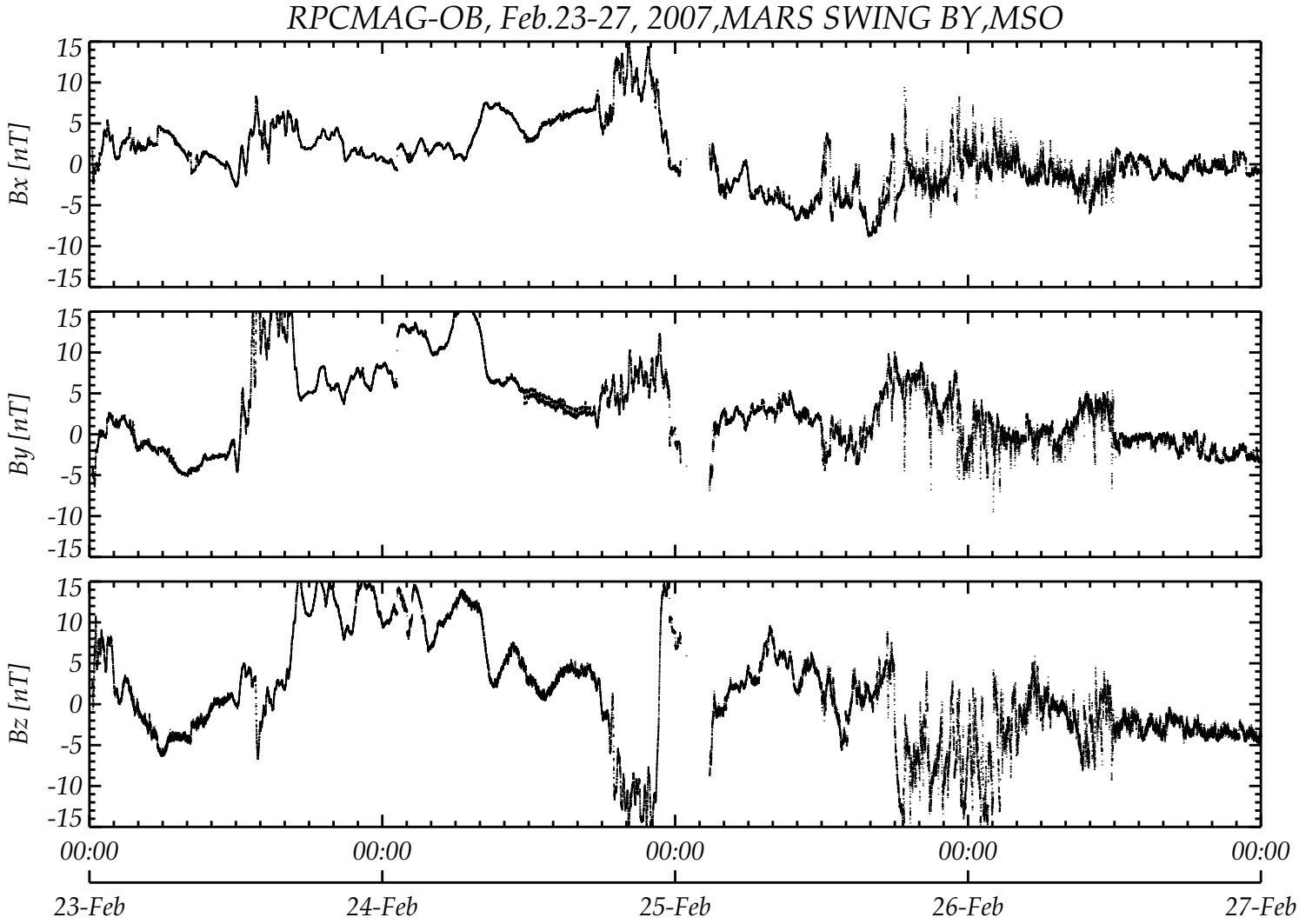

Figure 63: OB Data for the complete Swing by Period, MSO Frame

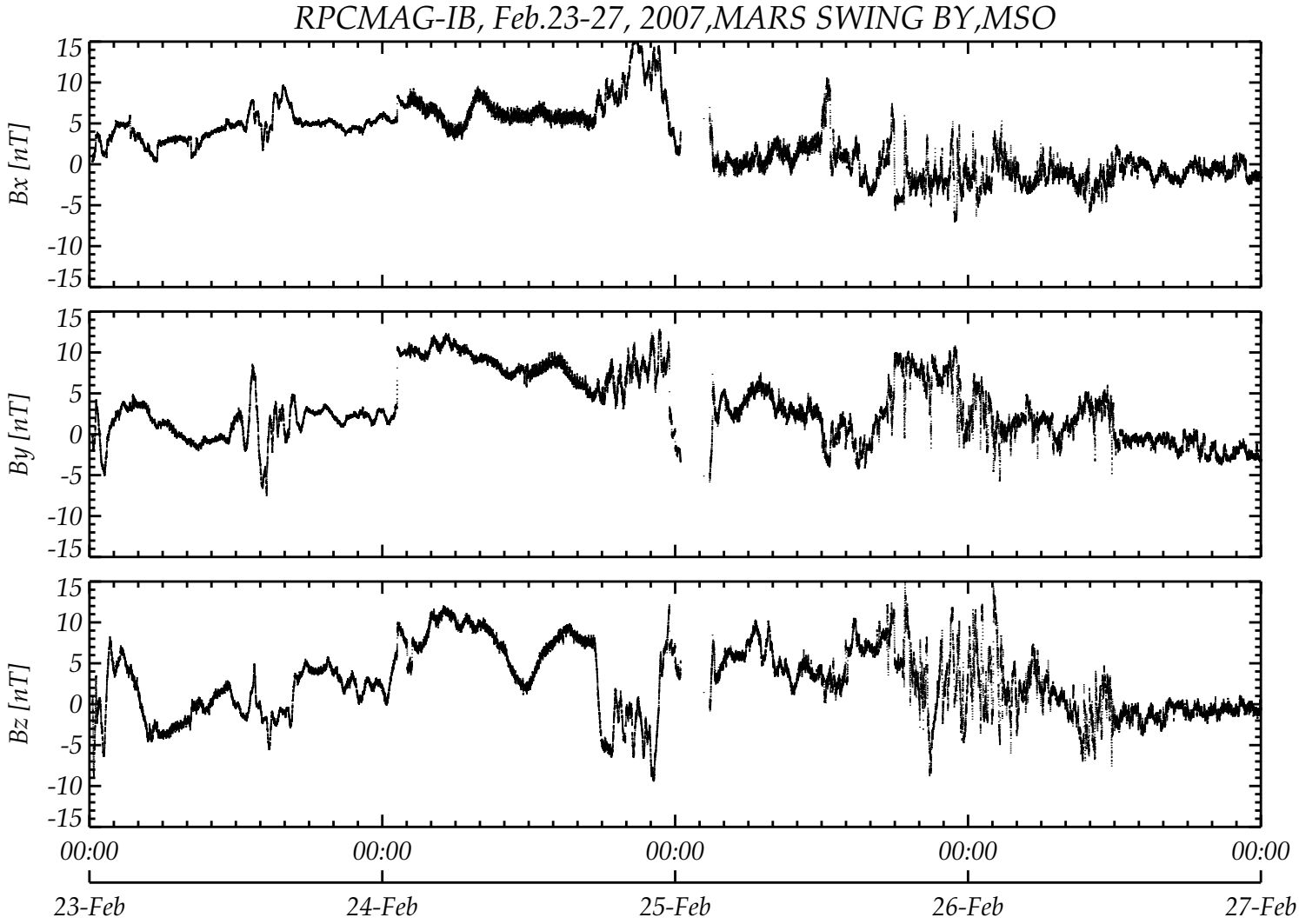

Figure 64: IB Data for the complete Swing by Period, MSO Frame

8 Temperature Variations at the OB Sensor during the Swing-By

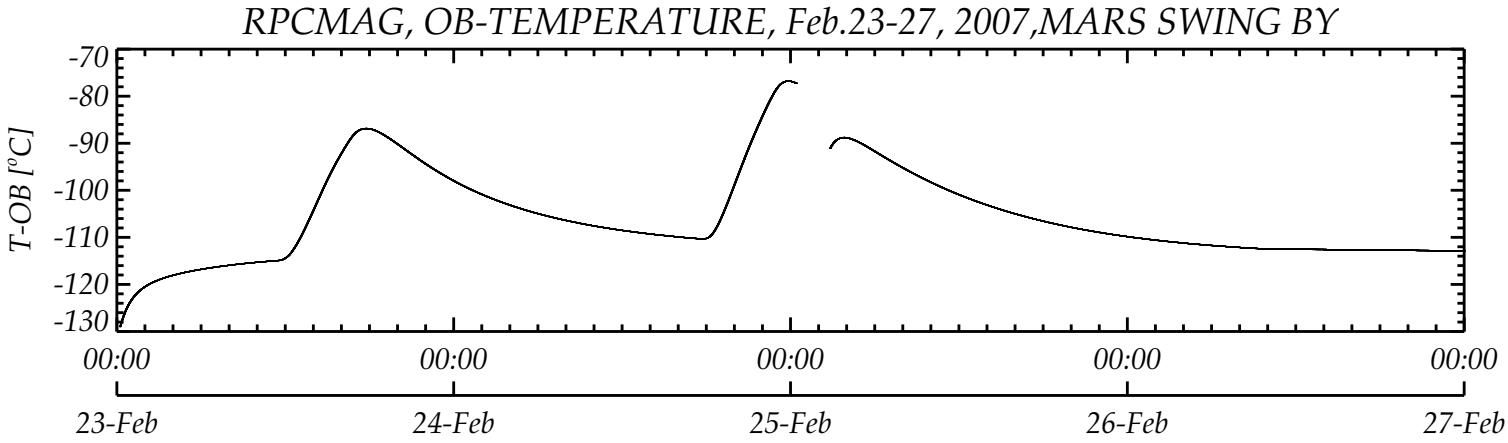

Figure 65: Temperature profile for the complete Swing by Period

9 Conclusions

- RPCMAG has performed amazing measurements during the MARS Swing-by (MSB).
- Every operation has been performed successfully.
- The scientific analysis of the data is ongoing. The lack of data during CA is painful. All the other data can be used for interesting scientific research, especially in combination with the other RPC data and also comparison with MEX data.
- The spectra do not show any impact of ROSETTAs reaction wheels whilst RPCMAG operates in NORMAL mode SID2.
- The spectra show a significant disturbance of ROSETTAs reaction wheels whilst RPCMAG operates in BURST mode SID3.
  This is a known fact since the CVP Phase.
- The comparison between IB and OB data showed that the measurements are very sensitive to specific temperature changes at the single sensors. The behavior can be used to build a data quality indicator. A new inflight calibration model concerning the sensor temperature influence has been developed and can be successfully applied.
- A constant Swing-by attitude would have been better in terms of sensor temperature variations, but of course we are aware of the circumstances which made the attitude changes necessary.