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## IDEAS+ Swarm Weekly Report 2016/2: 2016/01/11 - 2016/01/17

**Abstract** : This is the **Instrument Data Quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 11 January to 17 January 2016.

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## **AMENDMENT POLICY**

This document shall be amended by releasing a new edition of the document in its entirety. The Amendment Record Sheet below records the history and issue status of this document.

### **AMENDMENT RECORD SHEET**

<b>ISSUE</b>	<b>DATE</b>	<b>REASON</b>
1.0	27 Jan 2016	First issue



## 1. INTRODUCTION

This document refers to the activities carried out in the framework of the Sensor Performance, Products and Algorithms (SPPA) Office [RD.1], and as such, it reports on work related to:

- Algorithms and Processors Development, Maintenance and Evolution: these include all algorithm and software evolution and maintenance aspects for the different components, for both the Operational processors (OP) and Prototypes processors (PP) of L1 and L2 chains.
- Performance Assessment: these include all Quality Control activities (on-line and offline, systematic or on-demand), for the applicable product levels.
- System Calibration: these include the activities related to calibration, from sensor to system level. They also include aspects like cross calibration and handling of external calibration sources.
- Product validation: these include definition and maintenance of product validation plans.
- End-to-end Sensor Dataset Performance: these include activities related to the organisation and coordination of Quality Working Groups and all aspects of the Experimental platform. It also covers the product baseline, coordination and handling of external communities, and all aspects of ADF handling (both for the operational processors and for the prototypes).

This weekly report constitutes a work in progress throughout the mission lifetime, and new parts and complements will be added while the consolidation of knowledge on Swarm data and instruments will progress.

Section 2.1 always gives an overview of the general quality status of the mission instruments and products, while the main observations of the week are summarized in Section 2.1.

The document also includes information on data quality for the three Swarm spacecraft, inferred from automated HTML quality reports, which are produced on daily basis for each product. Please contact the IDEAS+ Swarm team if interested in accessing the reports via web or FTP (all details about interfaces and folder structure available on [RD.2]). Such quality reports represent the core of the Routine Quality Control (Chapter 3). A description of the implemented quality checks is given in [RD.3], and references therein.

Basing on specific findings of the routine quality control, or on-demand from other entities (i.e. Swarm PDGS, FOS, Mission Management, Post-Launch Support Office, Expert Support Laboratories, Quality Working Groups, and user community), anomalies can be triggered. Preliminary characterisations and investigations of such anomalies are given in Chapter 4. The anomalies documented in the Weekly Reports are tracked in the following way:

1. If triggered by ESA Eohelp or within the Service: IDEAS+ action and ticketing system (<http://requests-sppa.serco.it/RT3/index.html> ).
2. If triggered by IDEAS+ Swarm team or other entities:
  - 2a. If the observation/analysis leads to an anomaly to be addressed to the processor provider (GMV): SPR on EO ARTS (<https://arts.eo.esa.int> ), **SWL1L2DB** project;
  - 2.b. If the observation/analysis does not lead to an anomaly or the investigation shall be escalated to other entities (PLSO/industry, ESL, PDGS): Action tracked on EO ARTS, **SW-IDEAS** project, then addressed to the proper tracking system if needed (e.g. JIRA for ESLs, SW-CP-AR project on EO ARTS for PDGS).

Information on Level 1B Swarm products can be found in [RD.4].



## 1.1 Current Operational configuration of monitored data:

- Processors Version: L1BOP 3.16.p2, L2-Cat2 1.15.p4.
- L0 input products baseline: 02
- L1B baseline: MAGNET and PLASMA 04, ORBATT and ACCELE 03 (for definitions and description of the data baseline concept see <https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/swarm/data-access/product-baseline-definition>)
- Level 2 – Cat 2 baseline: EEF 01, IBI, FAC and TEC 02
- Input auxiliary files baseline: CCDB 0008 (07/12/2015), ADF 0101
- MPPF-CVQ v.2.14.01

## 1.2 Reference documents

The following is a list of documents with a direct bearing on the content of this report. Where referenced in the text, these are identified as RD.n, where 'n' is the number in the list below:

- [RD.1] Sensor Performance, Products and Algorithms (SPPA), PGSI-GSOP-EOPG-TN-05-0025. Version 2.3.
- [RD.2] Swarm PDGS External DMC Interface Control Document, SW-ID-DS-GS-0001, Issue 3.2.
- [RD.3] Swarm MPPF-CVQ Monitoring Baseline Document, ST-ESA-SWARM-MBD-0001, Issue 1.7.
- [RD.4] Swarm Level 1B Product Definition, SW-RS-DSC-SY-0007, Issue 5.13.
- [RD.5] Swarm IDEAS Configuration Management Plan, IDEAS-SER-MGT-PLN-1081 v0.14.
- [RD.6] Swarm Quality Control Project Plan, IDEAS-SER-MGT-PLN-1071
- [RD.7] SW\_L1BOP\_status\_20141124\_MoM
- [RD.8] Planned Updates for Level 1b, SW-PL-DTU-GS-008, Rev: 1dC.
- [RD.9] IDEAS+ Swarm Weekly Report: 25/08/2014 – 31/08/2014, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_20140825\_20140831.pdf (ref. for SWL1L2DB-9)
- [RD.10] IDEAS+ Swarm Weekly Report: 29/09/2014 – 05/10/2014, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_20140929\_20141005.pdf (ref. for SW-IDEAS-34)
- [RD.11] IDEAS+ Swarm Weekly Report: 06/10/2014 – 12/10/2014, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_20141006\_20141012.pdf (ref. for SW-IDEAS-36)
- [RD.12] IDEAS+ Swarm Weekly Report: 20/10/2014 – 26/10/2014, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_20141020\_20141026.pdf (ref. for SW-IDEAS-40, GPS sync loss)
- [RD.13] IDEAS+ Swarm Weekly Report: 15/09/2014 – 21/09/2014, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_20140915\_20140921.pdf (ref. for SW-IDEAS-27)
- [RD.14] Swarm L1B 03.15 Validation Report, OSMV-OPMT-SRSCO-RP-15-3385, Issue 1.3.
- [RD.15] IDEAS+ Swarm Weekly Report: 23/03/2015 – 29/03/2015, IDEAS+-SER-OQC-REP-2071\_SPPA\_SwarmWeeklyReport\_201513\_20150323\_20150329.pdf.
- [RD.16] SWARM Weekly Operations Report #76, SW-RP-ESC-FS-6172



- [RD.17] Olsen, N., H. Luhr, C.C. Finlay, T.J. Sabaka, I. Michaelis, J. Rauberg and L. Tøffner-Clausen, The CHAOS-4 geomagnetic field model, *Geophys. J. Int.* 197, 815–827, 2014
- [RD.18] IDEAS+-SER-IPF-PLN-2272, Swarm Level 1B Operational Processor Verification Plan, IDEAS+-SER-IPF-PLN-2272\_L1BOP\_316\_v1.5\_final.pdf



## 2. SUMMARY OF THE OBSERVATIONS

### 2.1 General status of Swarm instruments and Level 1B products quality

Nothing to report.

### 2.2 Plan for operational processor updates

A new delivery of the L1BOP is foreseen for end January 2016 in order to cope with the following issues:

1. RINEX correction due to a better alignment of the Instrument Measurement Time,
2. Fixing ORBATT bugs (related to Leap second handling and handling of minor SPRs)
3. Separating the time dependent calibration corrections and the external disturbance effects in the VFM data: introduction of "s\_beta" (scale factor depending on elevation angle Beta) and "s\_exp" ("aging" scale factor modelled as an exponential function) in the scale calibration.
4. Possibly, a correction in the conversion from Level 0s into Level 1B of the Langmuir Probe offset parameters.

In the meantime, a STR Inter-Boresight Angles correction model elaborated by DTU-MI, is under discussion. As soon as the goodness of this model is confirmed, the model will be implemented in the Level 1B processing.

A new delivery of the Level 2 – Cat 2 EEF processor expected by January 2016 in order to be able to produce EEF data also for Swarm C after the ASM stop.

### 2.3 Quality Working Group and Cal/Val Coordination

Following the decisions of the 5<sup>th</sup> QWG in Paris, these activities will be carried on in order to better understand the origin of the ASM-VFM residuals:

- Investigation on boom alignment error budget (from industry) that could help in developing a thermos-elastic correction approach.
- Investigation on plasma-induced stray field in order to focus on any possible current flow near the VFM (and not the ASM), because the intensity of such a current may be stronger near the VFM due to the accumulation of charged plasma particles near the STR baffles.
- Investigation of ASM-V magnetic data especially during the 4x90° yaw slew (13-14 May 2015) and 180° yaw bias (23 January 2014) manoeuvres.

IRF is about to deliver three new datasets, for the benefit of expert users (/Advanced folder):

- 16 Hz Faceplate currents and derived electron density (by beginning of February)
- Single-probe derived electron temperatures and S/C potential (by beginning of February)
- Sweep mode derived electron density and temperature and S/C potential (by mid-February).





Moreover, investigations are on-going with the help of GFZ, on the spike occurrences on the electron temperature: we have provided GFZ with HK\_BUS\_1A products in CDF, containing the solar panel currents, in order to investigate possible correlation of the spikes with solar illumination and/or currents activations.

## **2.4 Summary of observations for 2016, Week 2 (11/01 - 17/01)**

During the monitored week the following events have been found and investigated:

- **Several few seconds gaps in MAGx\_CA\_1B products** throughout the week. Some of them seem not to be associated to gaps in telemetry. Monitoring on-going.



### 3. ROUTINE QUALITY CONTROL

#### 3.1 Gaps analysis

- Several few seconds gaps in MAGx\_CA\_1B products throughout the week. Some of them seem not to be associated to gaps in telemetry. Monitoring on-going.

#### 3.2 Orbit and Attitude Products

In Table 1 are listed events that have to be reported.

**Table 1:** List of events related to attitude and orbit products to be reported in the monitoring for 2016, Week 2: 11/01 - 17/01.

Observation ID	Description	Affected parameter	Sect. of Obs. Description	Sect. of Obs. Analysis

The relevant parameters that have been monitored are:

- Position difference between calculated Medium Accuracy orbits (**MODx\_SC\_1B**) and on-board solution (**GPSxNAV\_0**). Threshold values for such differences have not been assessed yet: we have just monitored the average values and maximum variations around the week. They are reported in tables in the sections below. In addition, some example plots are given from the HTML daily reports. For the time being we evaluated an anomaly should be raised if one (or more) of the following conditions occurs:
  - The **average difference** on a given day exceeds the position accuracy requirement for the mission (1.5 m),
  - The variability around the average is quite high: **standard deviation** threshold has been arbitrarily chosen to be twice the position accuracy requirement for the mission (2-sigma = 3 m).
  - At least 4-5 spikes are observed on a given day, exceeding +/- 50 m.
- Visual inspection of Star Tracker characterisation flags (**STRxATT\_1B**)
- Deviation of the quaternion norm from unity (deviation threshold = +/- 10<sup>-9</sup>)
- Visual inspection of Euler Angles derived from quaternions.

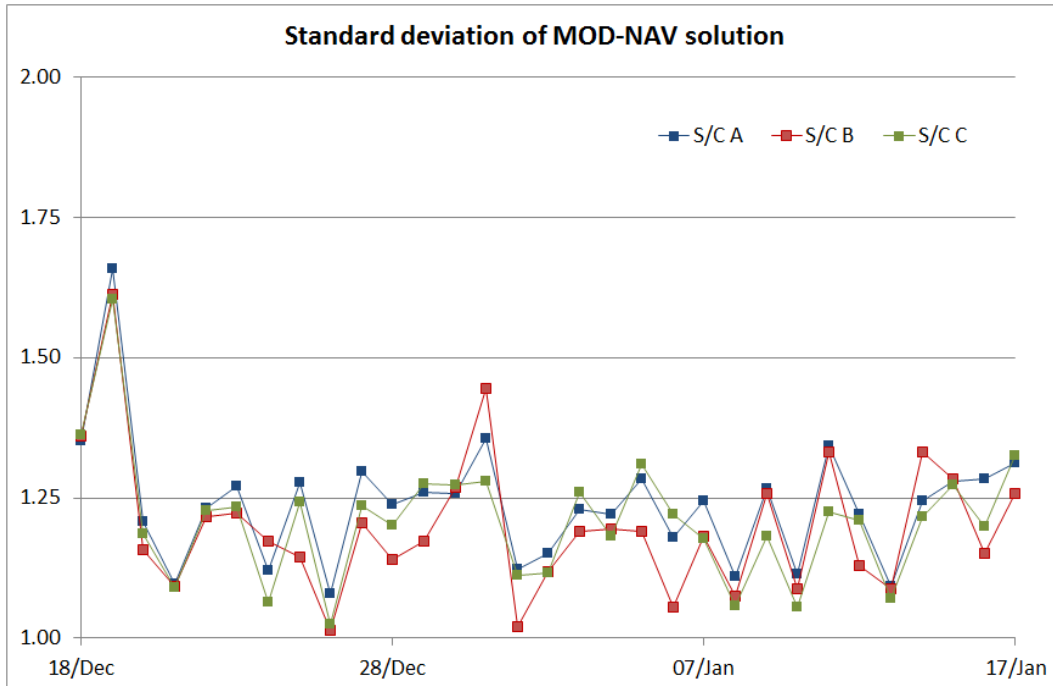
##### 3.2.1 Position Statistics

In Table 2, one can see the statistics of the differences between MOD and on-board solution positions for S/C A, B and C respectively. In the third column the maximum differences (maximum negative and maximum positive) are reported. The maximum standard deviation is in the fourth column. Maxima, minima and standard deviations usually refer to the Z component that is often the most disturbed; in case another component is most affected, it will be specified in parentheses. Figure 1 shows a cumulative trend of the maximum daily standard deviation for the past 30 days of operations of the MOD-NAV difference, while Figure 2 shows the daily maximum difference, in absolute value, of the MOD-NAV difference, always for the past 30 days of operations.

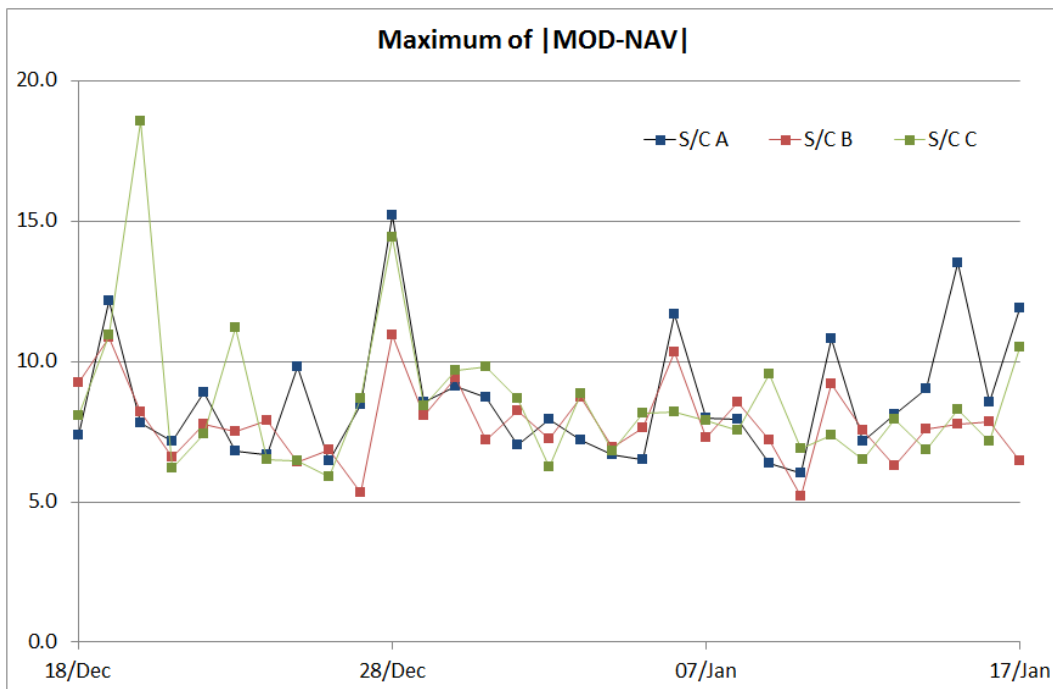


**Table 2:** Swarm A, B and C, difference between MOD and on-board solution positions. If not specified maximum difference and maximum standard deviation refers to the Z-axis.

Swarm A, 11/01 - 17/01, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
11/01	0.04	-7.2	10.8	1.34	
12/01	0.13	-7.2	5.6	1.22	
13/01	0.08	-8.1	5.4	1.09	
14/01	0.08	-9	5	1.24	
15/01	0.1	-9	13.5 (X)	1.28	
16/01	0.11	-8.6	7.6	1.28	
17/01	0.14	-11.9	6.2	1.31	
Swarm B, 11/01 - 17/01, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
11/01	0.07	-9.2	5.3 (X)	1.33	
12/01	0.1	-7.5	5.7 (Y)	1.13	
13/01	0.02	-5.4 (X)	6.3	1.09	
14/01	0.15	-7.6	6.7	1.33	
15/01	0.02	-5.8	7.8	1.28	
16/01	0.11	-7.8	5.2	1.15	
17/01	0.13	-6.4	5.9	1.26	
Swarm C, 11/01 - 17/01, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
11/01	0.08	-6.6	7.4	1.22	
12/01	0.1	-6.5	5.9	1.21	
13/01	0.08	-7.9	6.8	1.07	
14/01	0.08	-6.7	6.9	1.22	
15/01	0.04	-8.3	7.7 (Y)	1.27	
16/01	0.11	-6.5 (X)	7.1	1.2	
17/01	0.18	-10.5	7.2	1.32	



**Figure 1:** Plot of the standard deviation of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.



**Figure 2:** Plot of the maximum difference of the absolute value of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

### 3.2.1.1 Swarm A

Below is presented plot of MOD-NAV differences for S/C A, taken at the beginning of the week (11/01, Figure 3). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

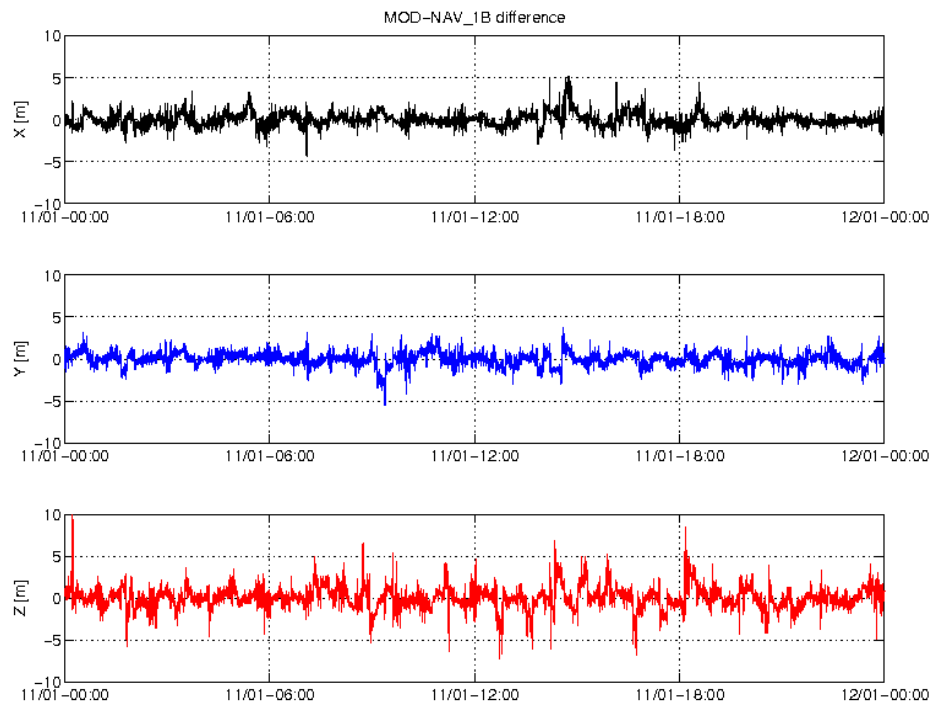


Figure 3: Difference MOD-GPSNAV, S/C A, 11/01. From top to bottom: X, Y and Z-axis

### 3.2.1.2 Swarm B

Below is presented plot of MOD-NAV differences for S/C B, taken at the beginning of the week (11/01, Figure 4). From top to bottom, the plots show of MOD-NAV differences in ITRF reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

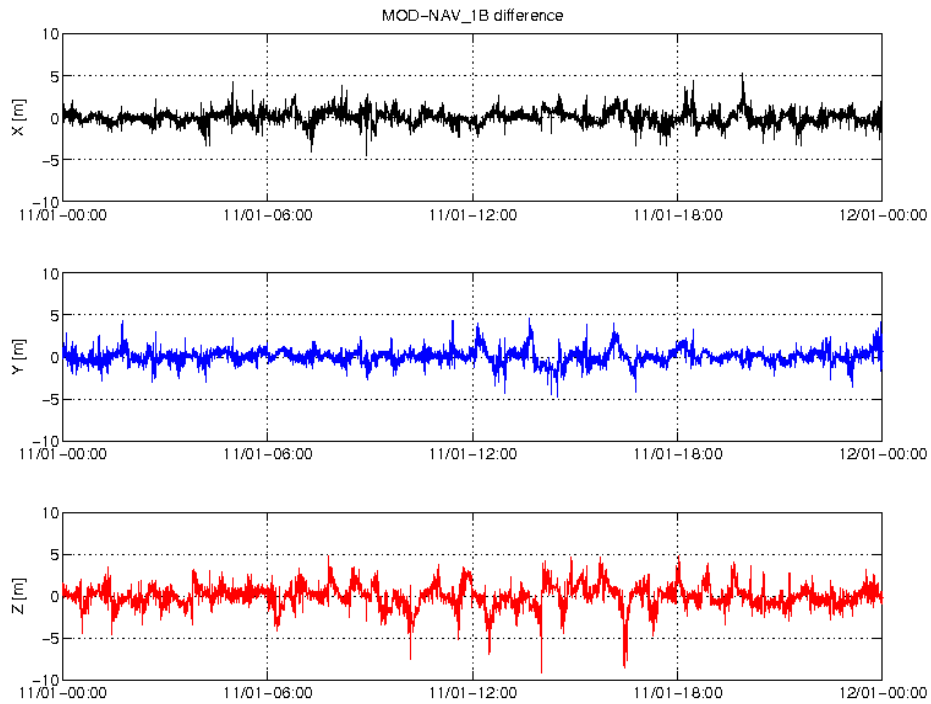


Figure 4: Difference MOD-GPSNAV, S/C B, 11/01. From top to bottom: X, Y and Z-axis

### 3.2.1.3 Swarm C

Below is presented plot of MOD-NAV differences for S/C C, taken at the beginning of the week (11/01, Figure 5). From top to bottom, the plots show of MOD-NAV differences in ITRF reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

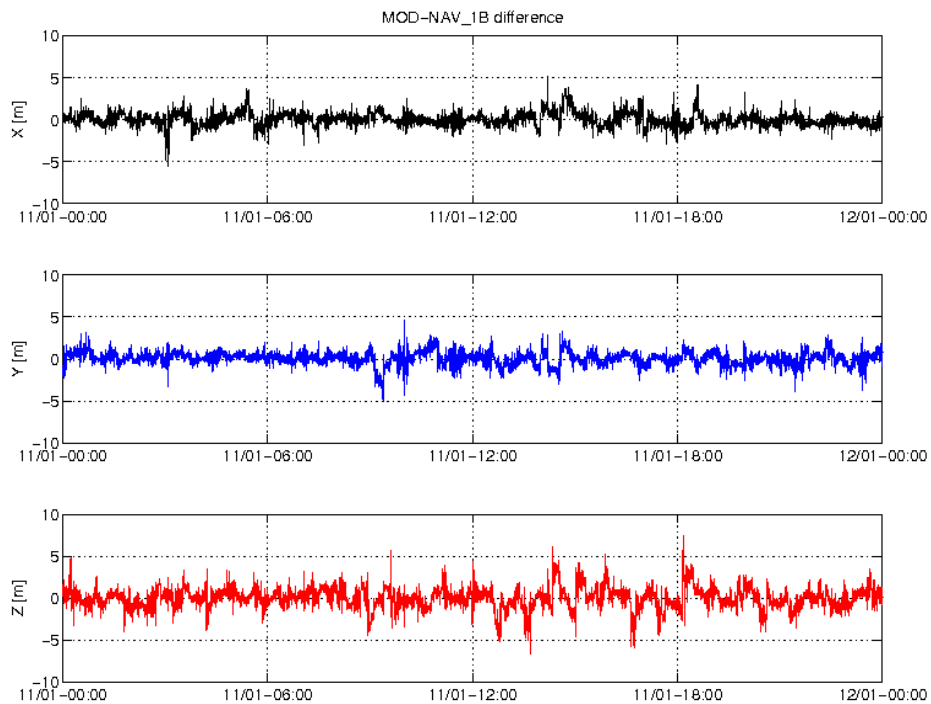


Figure 5: Difference MOD-GPSNAV, S/C C, 11/01. From top to bottom: X, Y and Z-axis

### 3.2.2 Attitude observations

#### 3.2.2.1 Swarm A

Nothing to report.

#### 3.2.2.2 Swarm B

Nothing to report.

#### 3.2.2.3 Swarm C

Nothing to report.

### 3.3 Magnetic Products

For the magnetic products, the weekly monitoring consists in:

- ASM instrument monitoring: quartz frequency and ASM temperature.
- VFM instrument monitoring: temperatures.
- Visual inspection of daily time series of magnetic field intensity  $F$ ,  $B_{NEC}$  and  $B_{VFM}$ . Looking for gaps (or zero values in case of  $MAGx\_LR\_1B$  products), out-of-threshold values (i.e. exceeding  $\pm 60000$  nT), and other strange features. Map plots of  $F$  and  $B_{NEC}$  for the whole week are then displayed.
- Monitoring of the ASM-VFM known anomaly: visual inspection of  $|B_{VFM}| - F$  taken from  $MAGx\_CA\_1B$  products and recording of daily maximum variations and standard deviations. If  $\pm 1$  nT are exceeded on a given day, an alert is raised. Map plots of the residuals are shown along with weekly time series of the residuals with and without the “dB\_Sun” correction: in fact, at least a part of the



discrepancies found in the measurements between ASM and VFM are modelled through a stray field (dB\_Sun) that is a function of the orientation of the VFM wrt Sun.

- Comparison of magnetic data ( $B_{NEC}$ ) with a model (Chaos5).

In Table 3 are listed events that have to be reported.

**Table 3:** List of events related to magnetic products to be reported in the monitoring for 2016, Week 2: 11/01 - 17/01.

Observation ID	Description	Affected parameter	Sect. of Obs. Description	Sect. of Obs. Analysis
SW-IDEAS-63	OBS_ROUTINE: MAGx_CA_1B gaps	MAGx_CA_1B	3.1	NA

### 3.3.1 VFM-ASM anomaly

#### General observation:

- SC A – violation of:
  - VFM-ASM residuals threshold on 11/01 - 14/01;
  - mean value of residuals threshold on 11/01;
- SC B - VFM-ASM residuals no threshold violation.

#### 3.3.1.1 ASM-VFM difference statistics

In Table 4, one can see the statistics of the differences between magnetic field absolute value measured by ASM and by VFM. In the second and third column are reported the maximum differences, maximum negative and maximum positive respectively. The maximum standard deviation is in the fourth column.

The ASM-VFM difference is defined as follow:

$$dF = |B_{VFM}| - F_{ASM}$$

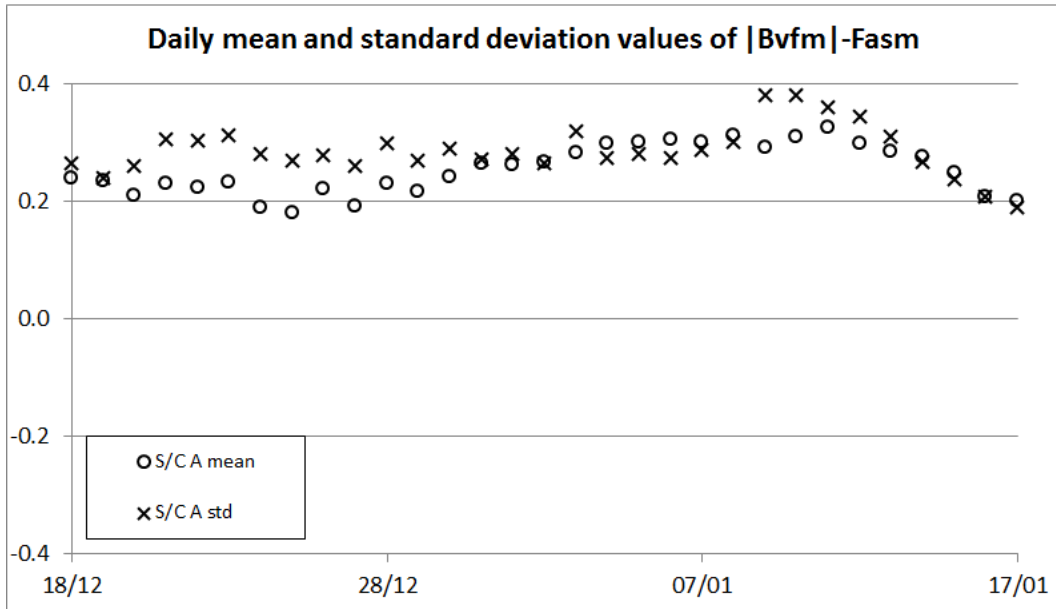
Figure 6 and Figure 7 show the daily mean (circles) and standard deviation (crosses) of dF of the last month for Swarm A and Swarm B respectively.



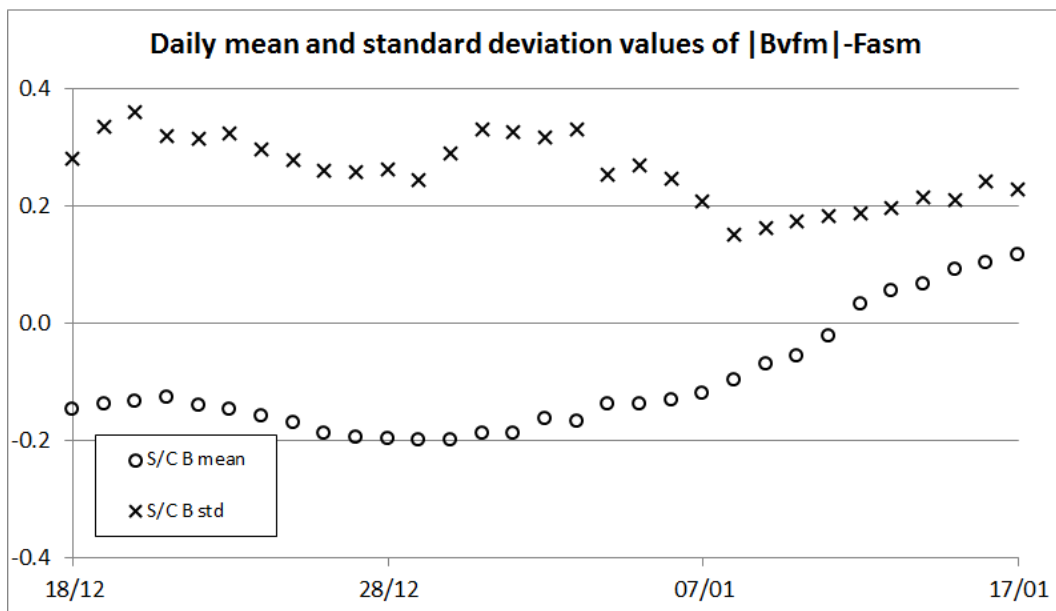


**Table 4:** Swarm A and B, difference between absolute value of magnetic field measured by ASM and by VFM.

Swarm A, 11/01 - 17/01, ASM-VFM difference					
Day	Max (nT)	Min (nT)	Standard deviation (nT)	Mean (nT)	Notes
11/01	1.22	-0.78	0.36	0.326	
12/01	1.15	-0.72	0.34	0.297	
13/01	1.24	-0.55	0.31	0.284	
14/01	1.1	-0.5	0.27	0.275	
15/01	0.88	-0.42	0.24	0.248	
16/01	0.8	-0.42	0.21	0.206	
17/01	0.73	-0.44	0.19	0.2	
Swarm B, 11/01 - 17/01, ASM-VFM difference					
Day	Max (nT)	Min (nT)	Standard deviation (nT)	Mean (nT)	Notes
11/01	0.63	-0.61	0.18	-0.023	
12/01	0.58	-0.57	0.19	0.032	
13/01	0.63	-0.55	0.2	0.054	
14/01	0.66	-0.44	0.21	0.067	
15/01	0.68	-0.42	0.21	0.091	
16/01	0.76	-0.39	0.24	0.102	
17/01	0.85	-0.39	0.23	0.116	



**Figure 6:** Daily mean and standard deviation values of ASM-VFM residuals (defined as  $dF = |B_{VFM}| - F_{ASM}$ ) for S/C A.

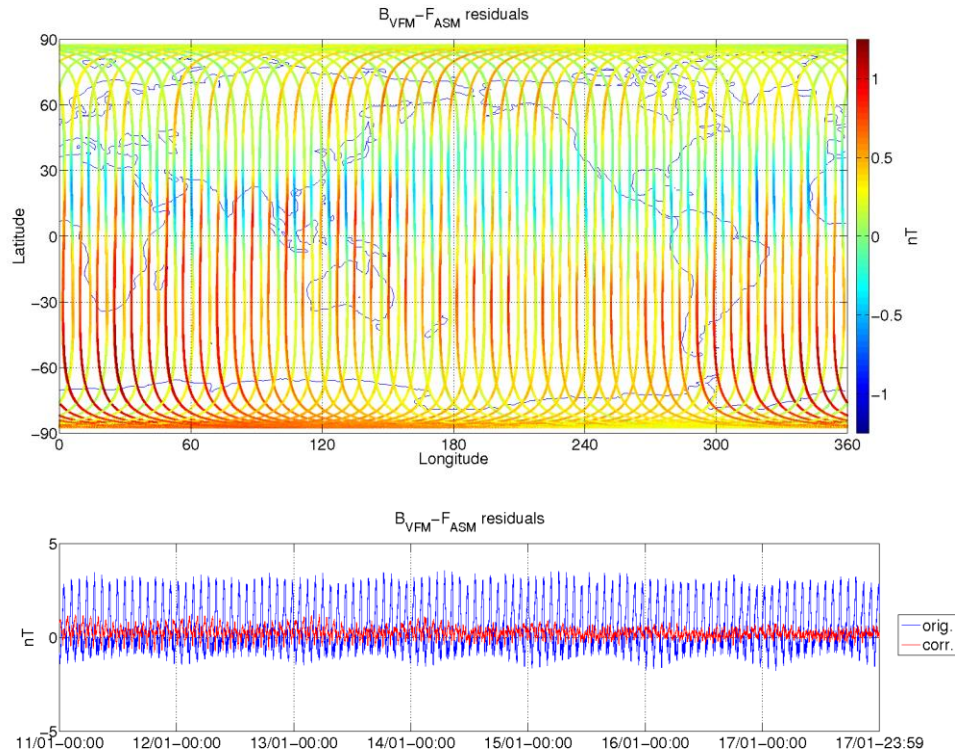


**Figure 7:** Daily mean and standard deviation values of ASM-VFM residuals (defined as  $dF = |B_{VFM}| - F_{ASM}$ ) for S/C B.



### 3.3.1.2 Swarm A

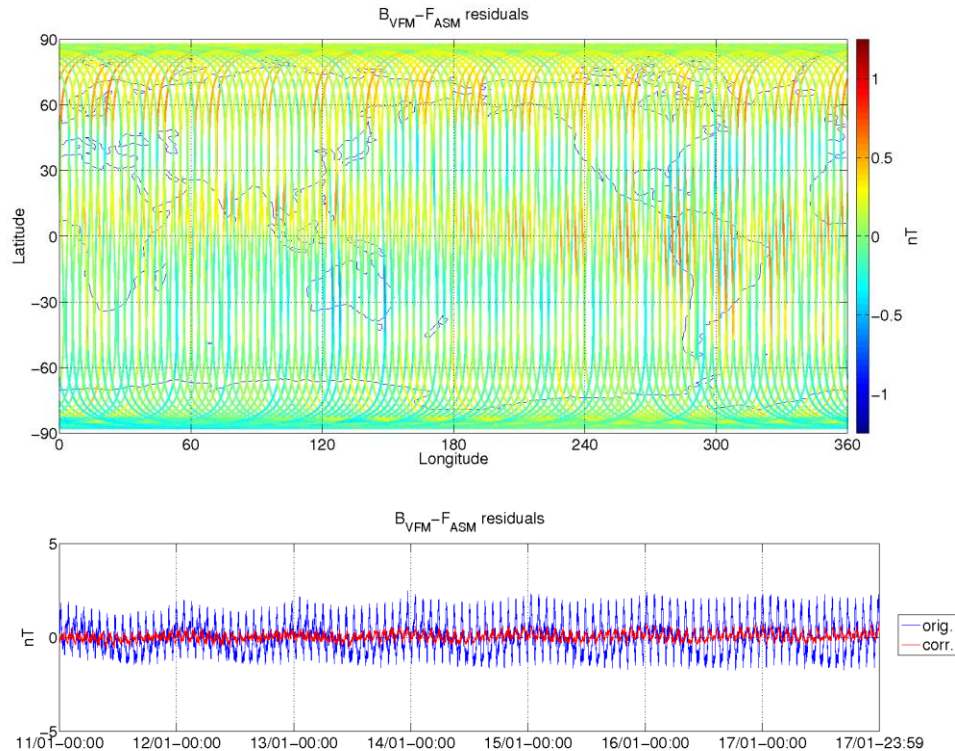
The daily peak-to-peak difference around the week stays within [-0.8, 1.2]. Below follow two plots of such differences for current week (Figure 8).



**Figure 8:** ASM-VFM residuals for S/C A, during monitoring period 11/01-17/01. In top figure residuals are presented on the world map. In bottom figure are plotted: difference between  $|B_{VFM}|$  and  $F_{ASM}$  (without  $dB_{Sun}$  correction) (blue colour), and the residuals with  $dB_{Sun}$  corrections (red colour).

### 3.3.1.3 Swarm B

The daily peak-to-peak difference around the week is, on average: [-0.6, 0.8] nT. Below follow two plots of such differences for current week (Figure 9).



**Figure 9:** ASM-VFM residuals for S/C B, during monitoring period 11/01-17/01. In top figure residuals are presented on the world map. In bottom figure are plotted: difference between  $|B_{VFM}|$  and  $F_{ASM}$  (without  $dB_{Sun}$  correction) (blue colour), and the residuals with  $dB_{Sun}$  corrections (red colour).

### 3.3.1.4 Swarm C

No data because ASM is switched off.

### 3.3.2 ASM Instrument parameters: quartz frequency and ASM temperature (ASMAVEC\_0)

For S/C A and B, the temperature and quartz frequency behaved as expected.

### 3.3.3 VFM Instrument parameters: VFM temperatures (MAG\_CA)

The VFM instrument parameters important for monitoring the instrument health are the VFM sensor temperatures:  $T_{CDC}$ ,  $T_{CSC}$  and  $T_{EU}$ .

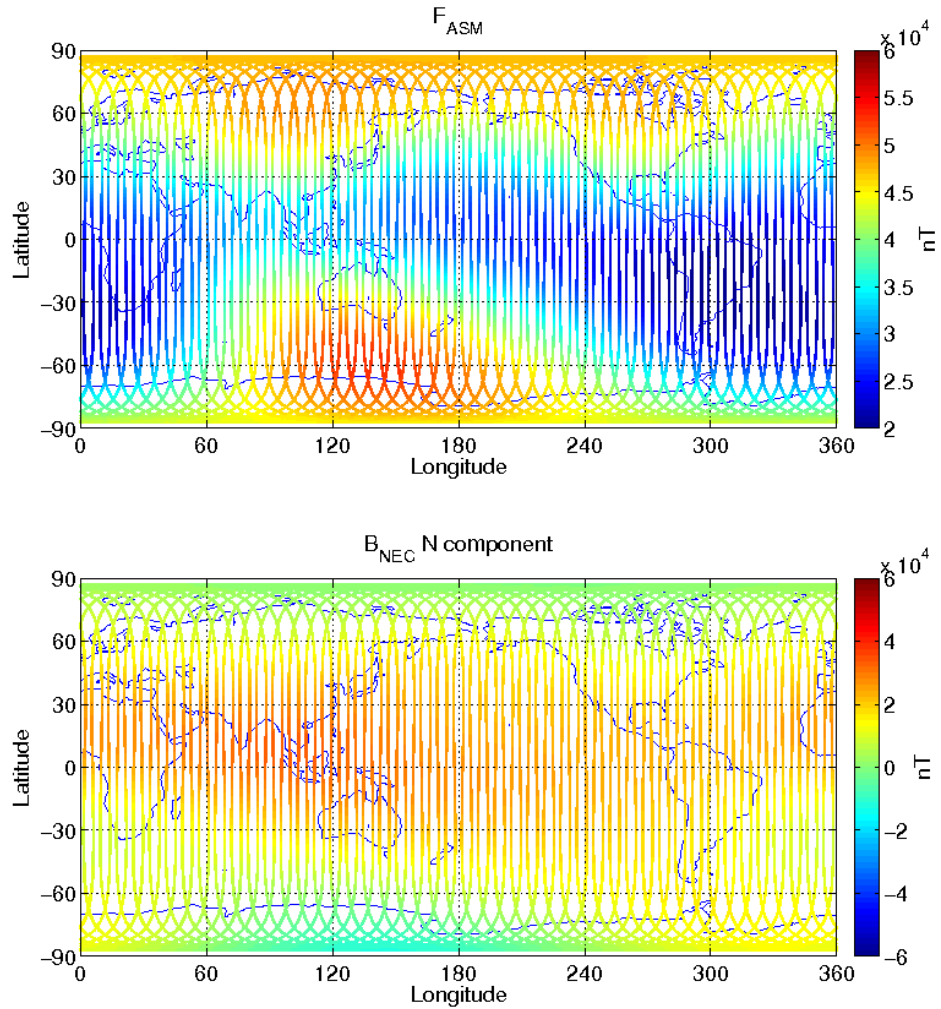
For S/C A, B and C, for reported period, the temperatures behaved as expected.

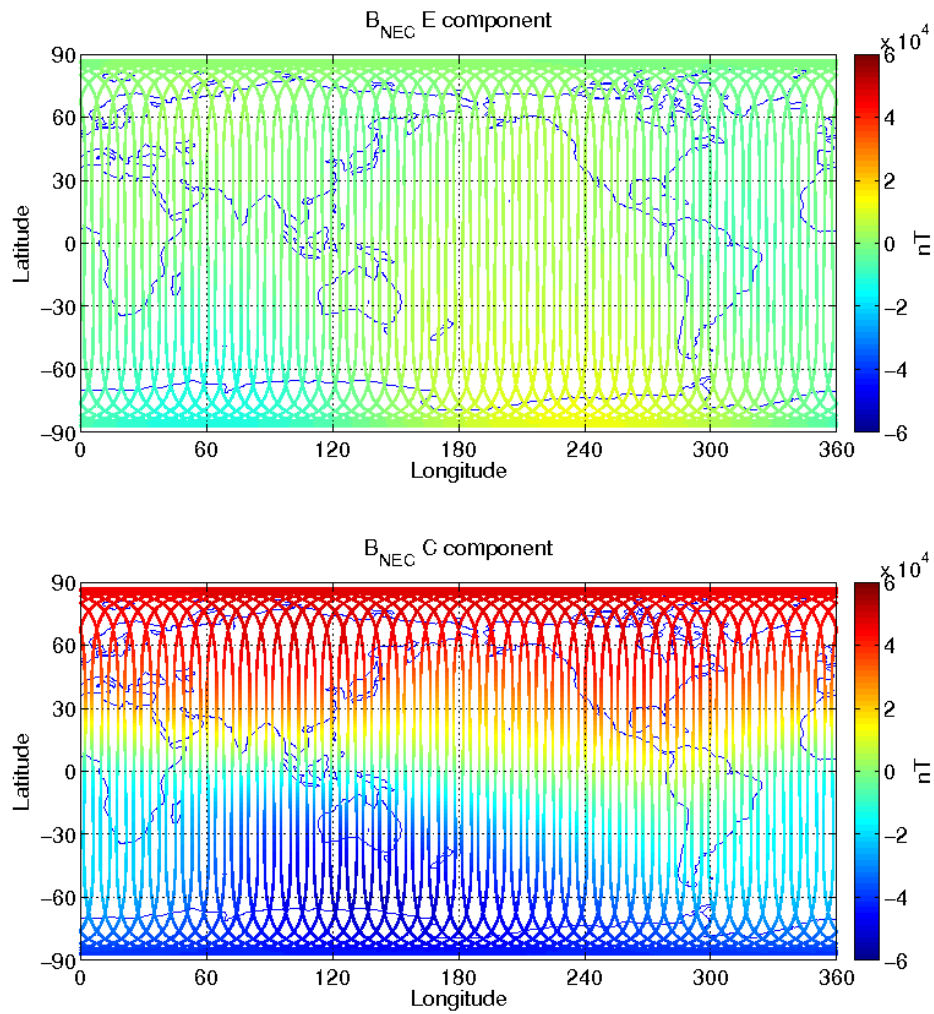


### 3.3.4 Magnetic time series visual inspection

#### 3.3.4.1 Swarm A

Map plots of magnetic field measurement for week 2 for S/C A can be seen in Figure 10 below.



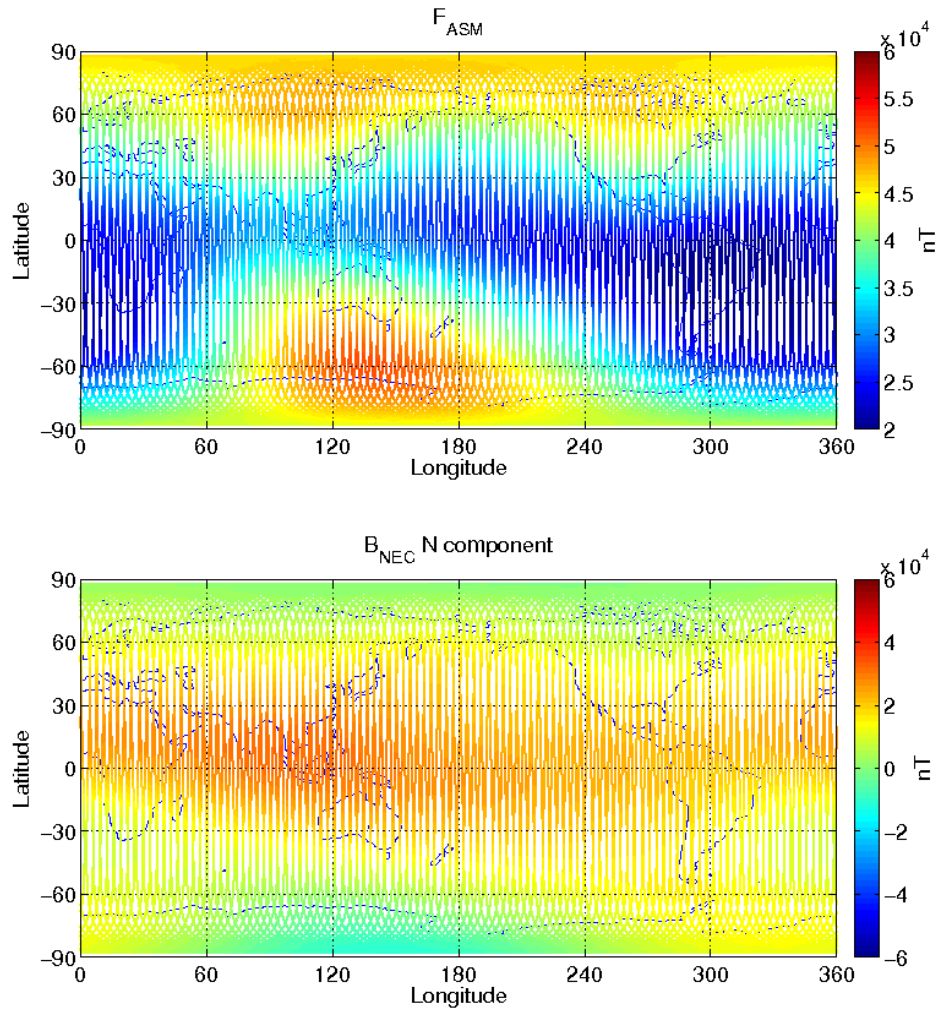


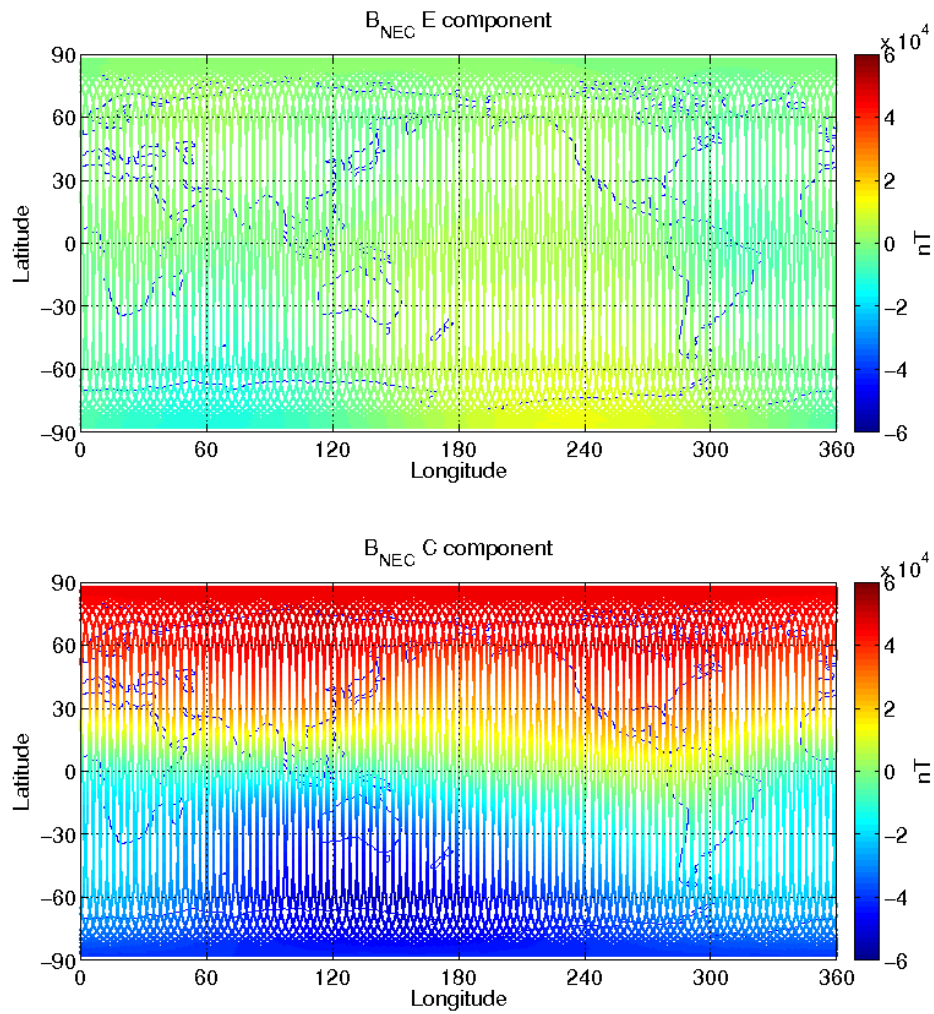
**Figure 10:** SC A, world map plots of the geomagnetic field and components measured during monitoring period 11/01-17/01. From top to bottom: F-magnetic field from ASM measurement, B<sub>NEC</sub> components (North, East, and Centre) of magnetic field from VFM measurement.



### 3.3.4.2 Swarm B

Map plots of magnetic field measurement for week 2 for S/C B can be seen in Figure 11 below.



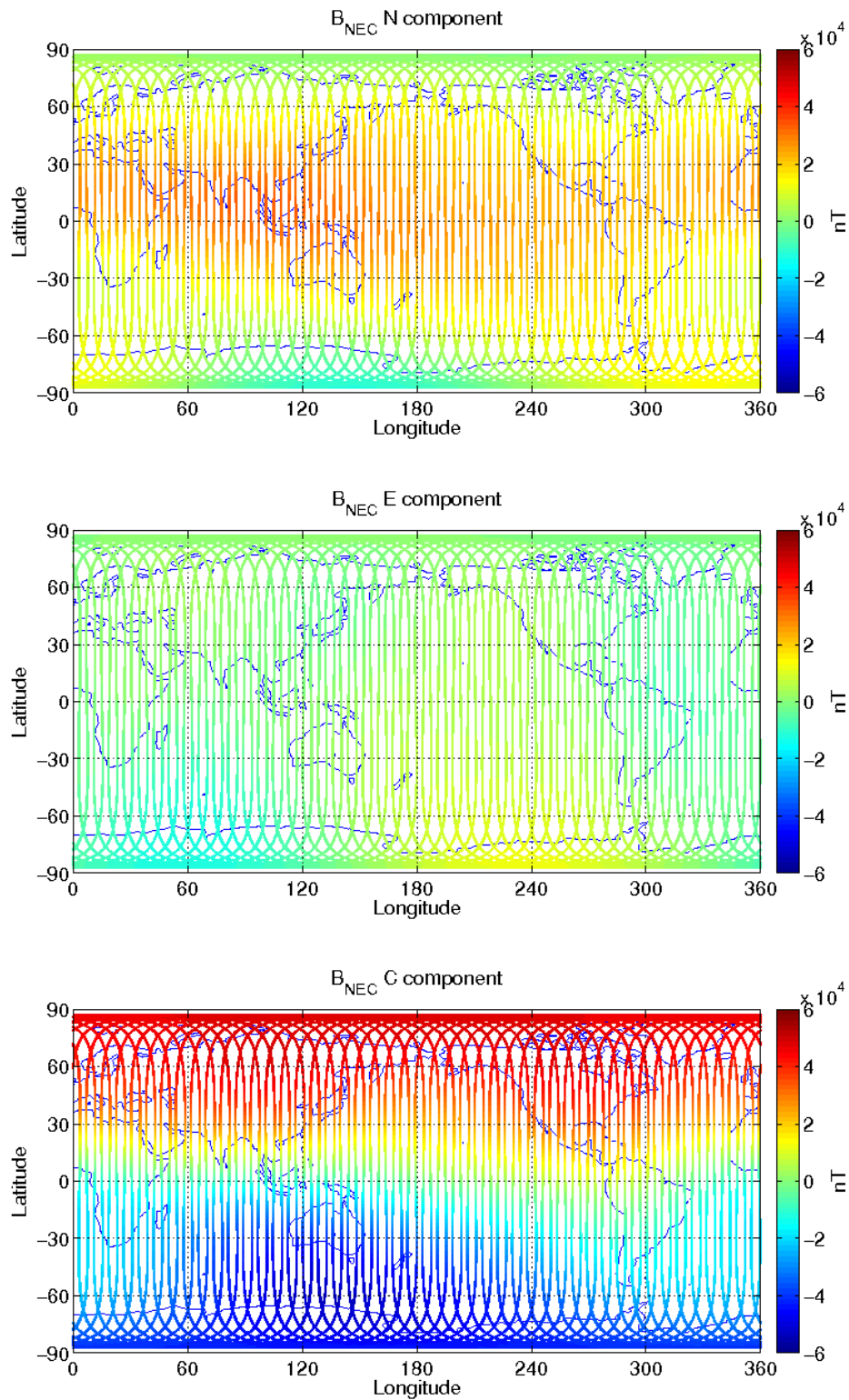


**Figure 11:** S/C B, world map plots of the geomagnetic field and components measured during monitoring period 11/01-17/01. From top to bottom: F-magnetic field from ASM measurement, B<sub>NEC</sub> components (North, East, and Centre) of magnetic field from VFM measurement.



### 3.3.4.3 Swarm C

Map plots of magnetic field measurement for week 2 for S/C C can be seen in Figure 12.



**Figure 12:** SC C, world map plots of the geomagnetic field and components measured during monitoring period 11/01-17/01. From top to bottom:  $B_{NEC}$  components (North, East, and Centre) of magnetic field from VFM measurement.

### 3.3.5 $B_{NEC}$ vs Chaos5 model residuals

The magnetic field measurement is compared to magnetic field estimation calculate from Crustal and Core contributions of model Chaos5. Currently in the monitoring routines the external contribution based on Dst index is not taken into account.

Figure 13, Figure 15 and Figure 17 show field residuals  $\Delta B = B_{NEC} - B_{Chaos}$  (all versus co-latitude in degrees), from top to bottom: 1)  $B_r$ , 2)  $B_\theta$  and 3)  $B_\phi$ .

As a general feature one can see the field residuals to be steady and usually below 50 nT at low and middle latitudes, up to  $|55| - |60|$  degrees; then the residual increases at high latitudes because the Chaos model does not take into account the contribution from the external field ([RD.17]).

Figure 14, Figure 16 and Figure 18 show, from top to bottom, the time series on 11/01 of: (1-2-3) residuals of  $B_{NEC} - B_{Chaos}$  by components, related to S/C A, B and C respectively.

The component most affected by residual spikes and variations is  $B_{\theta, NEC}$ , i.e. the component that shows the variations of the field wrt to co-latitude. At high latitudes, the order of magnitude of the variability is about  $\pm 200$  nT.

#### 3.3.5.1 Swarm A

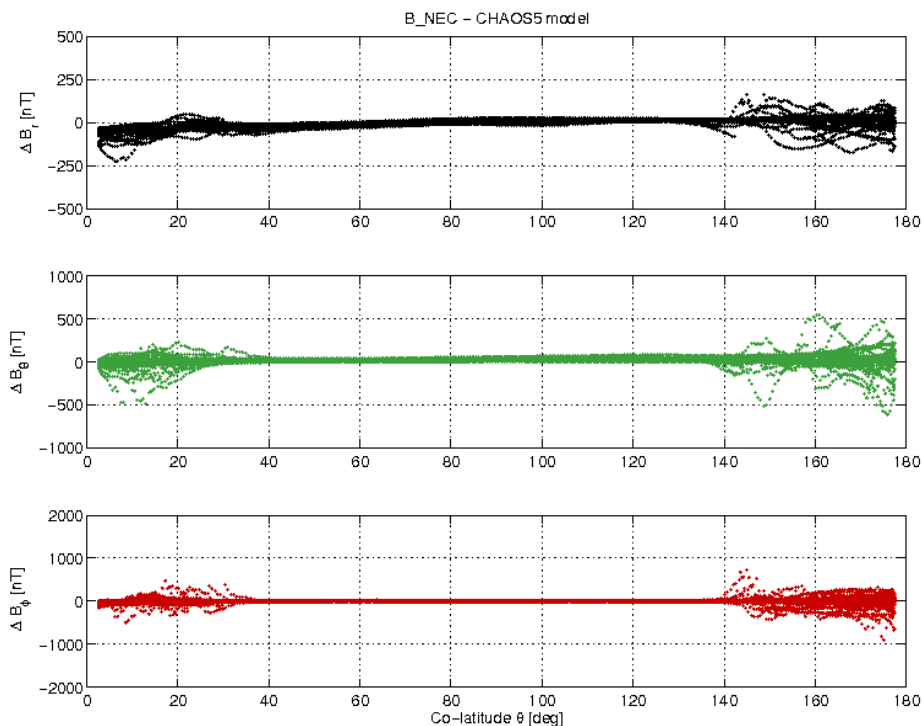


Figure 13: Swarm A day 11/01  $B_{NEC} - B_{Chaos}$  vs colatitude.

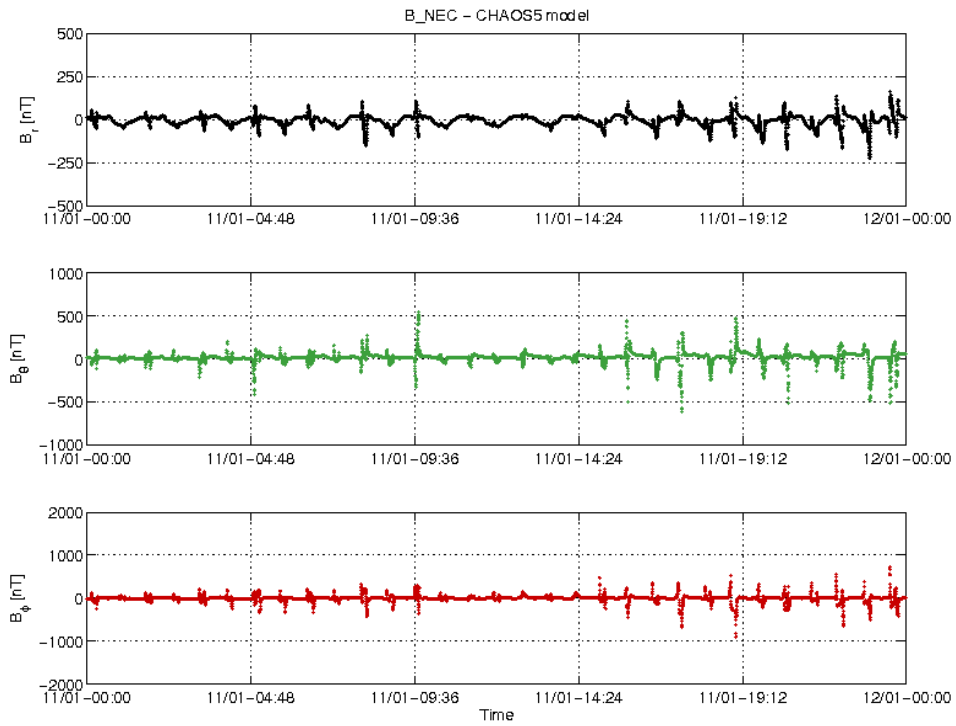


Figure 14: Swarm A day 11/01: time series of  $B_{NEC} - B_{Chaos}$  residuals.

### 3.3.5.2 Swarm B

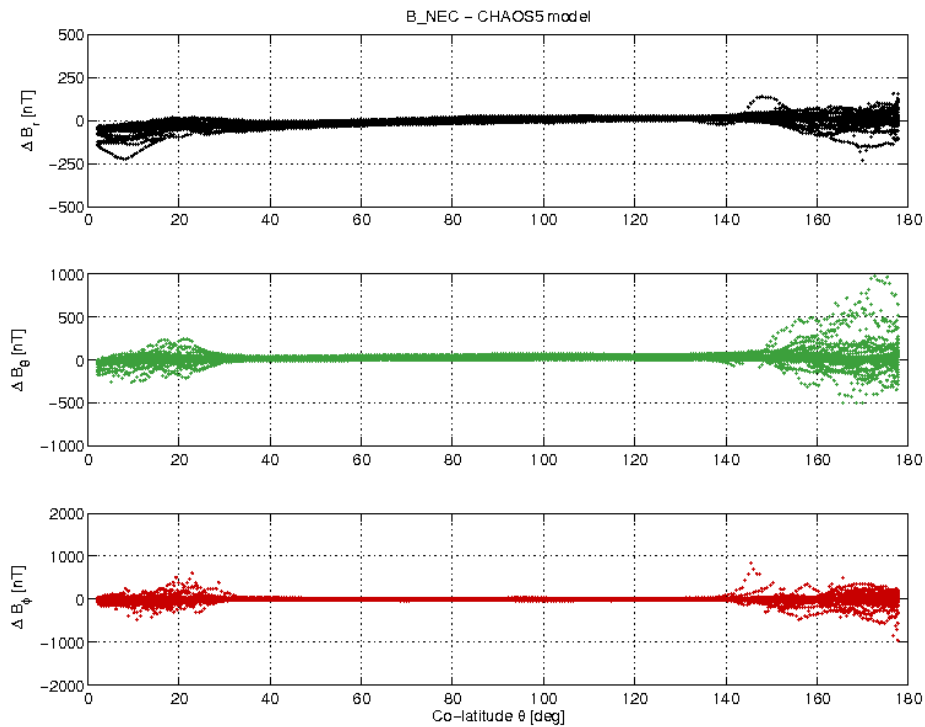


Figure 15: Swarm B day 11/01  $B_{NEC} - B_{Chaos}$  difference vs colatitude.

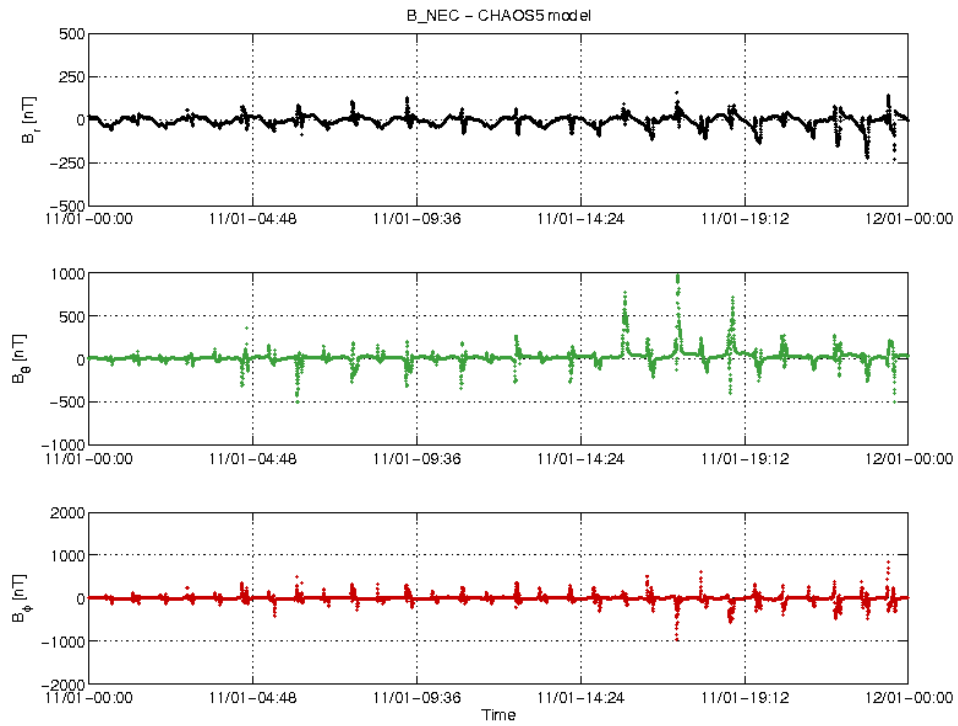


Figure 16: Swarm B day 11/01 time series of  $B_{NEC} - B_{Chaos}$  residuals.

### 3.3.5.3 Swarm C

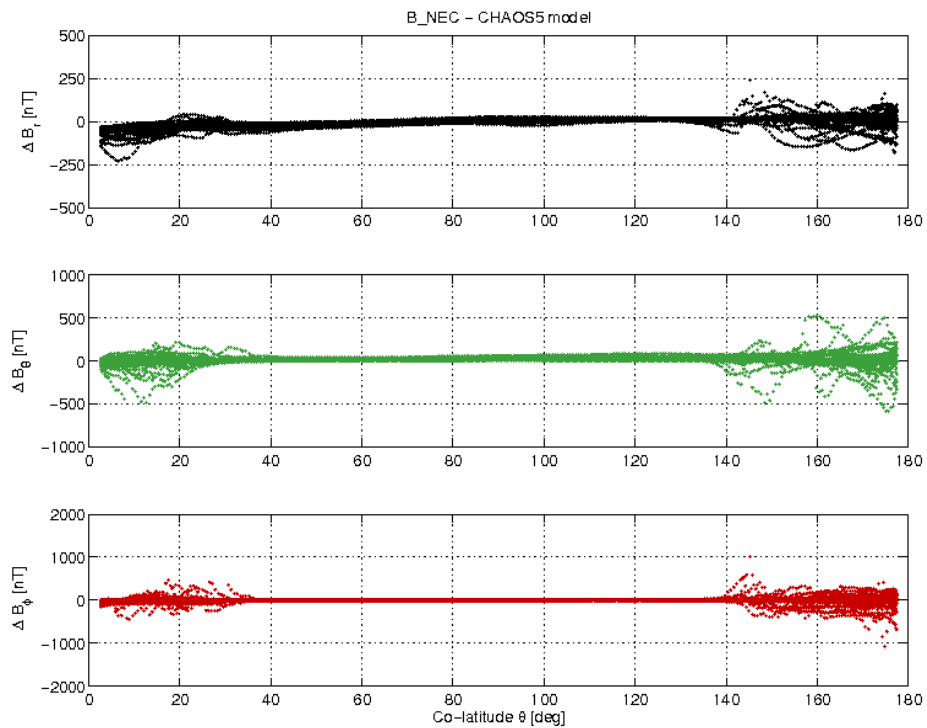


Figure 17: Swarm C day 11/01  $B_{NEC} - B_{Chaos}$  difference vs colatitude.

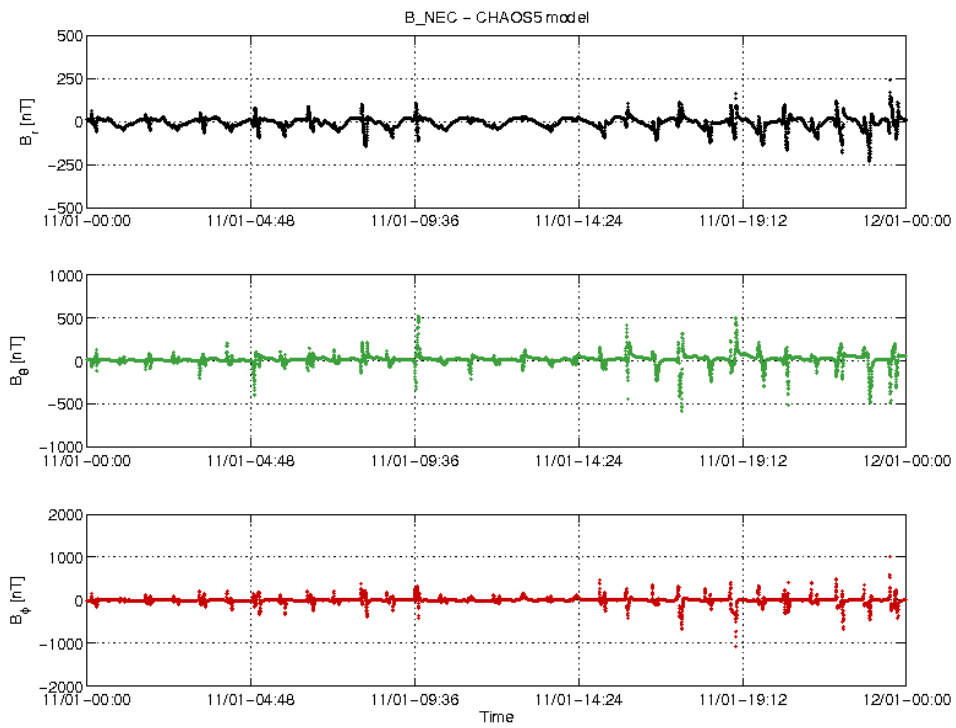


Figure 18: Swarm C day 11/01 time series of  $B_{NEC} - B_{Chaos}$  residuals.



#### **4. ON-DEMAND ANALYSIS**

Nothing to report.



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