



Customer	: ESRIN	Document Ref	: IDEAS+-SER-OQC-REP-2071
Contract No	: 4000111304/14/I-AM	Issue Date	: 21 March 2016
WP No	: 6110	Issue	: 1.0



## IDEAS+ Swarm Weekly Report 2016/09: 2016/02/29 - 2016/03/06

**Abstract** : This is the **Instrument Data Quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 29 February to 06 March 2016.

**Author** : \_\_\_\_\_ **Approval** : \_\_\_\_\_  
Iginò Coco, Jan Miedzik and Lidia Saavedra de Miguel  
Enkelejda Qamili on behalf of IDEAS+ Science and Ops.  
Swarm IDEAS+ Team Coordinator

**Distribution** : ESA/ESRIN EOP-GMQ  
ESA/ESRIN EOP-GM Swarm MM  
IDEAS+ Leadership Team  
IDEAS+ subcontractors  
ESA/ESTEC Swarm PLSO  
ESA/ESOC Swarm FOS

**Copyright © 2015 Telespazio VEGA UK Ltd**

*All rights reserved.*

*No part of this work may be disclosed to any third party translated reproduced copied or disseminated in any form or by any means except as defined in the contract or with the written permission of Telespazio Vega UK Ltd.*

**Telespazio VEGA UK Ltd**

**350 Capability Green, Luton, Bedfordshire, LU1 3LU, United Kingdom**

**Tel: +44 (0) 1582 399 000 Fax: +44 (0) 1582 728 686**

**www.telespazio-vega.com**



## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b> .....	<b>2</b>
<b>1. INTRODUCTION</b> .....	<b>5</b>
1.1 Current Operational configuration of monitored data:.....	6
1.2 Reference documents.....	6
<b>2. SUMMARY OF THE OBSERVATIONS</b> .....	<b>8</b>
2.1 General status of Swarm instruments and Level 1B products quality.....	8
2.2 Plan for operational processor updates.....	8
2.3 Quality Working Group and Cal/Val Coordination.....	8
2.4 Summary of observations for 2016, Week 9 (29/02 - 06/03).....	9
<b>3. ROUTINE QUALITY CONTROL</b> .....	<b>10</b>
3.1 Gaps analysis.....	10
3.2 Orbit and Attitude Products.....	10
3.2.1 Position Statistics.....	10
3.2.2 Attitude observations.....	15
3.3 Magnetic Products.....	15
3.3.1 VFM-ASM anomaly.....	16
3.3.2 ASM Instrument parameters: quartz frequency and ASM temperature (ASMAVEC_0).....	20
3.3.3 VFM Instrument parameters: VFM temperatures (MAG_CA).....	20
3.3.4 Magnetic time series visual inspection.....	21
3.3.5 $B_{NEC}$ vs Chaos5 model residuals.....	26
<b>4. ON-DEMAND ANALYSIS</b> .....	<b>30</b>



*This page intentionally left blank.*



## **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	21 Mar 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 0010 (04/02/2016), 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-SRCP-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
- [RD.19] Swarm Weekly Operations Report #119 SW-RP-ESC-FS-6215



## 2. SUMMARY OF THE OBSERVATIONS

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

An eccentricity control and constellation maintenance manoeuvre was successfully performed on the 03/03/2016 on Swarm Alpha. This manoeuvre has involved a 180 degree slew between 13:37:25 UTC and 14:50:56 UTC. Because of the unpredictability of the slew direction, the Electric Field Instrument was switched off during the last pass before the manoeuvre, and switched on again during the first pass following the manoeuvre.

### 2.2 Plan for operational processor updates

**L1BOP:** The L1BOP 3.17 has been released by GMV the 15<sup>th</sup> of February. The PDGS team is performing the first tests. In the coming weeks will follow the validation of all the products.

In the meantime, two changes were decided to be implemented into the MAGNET processor, i.e.:

- Change the data resampling used for the interpolation of the ASM measurements to UTC second because the present used in L1B data is removing a significant part of the high frequency content of the ASM data.
- Modification of the F\_error computation

For what concern the ORBATT processor, two changes to be implemented are under discussion.

- A STR Inter-Boresight Angles correction model
- An increase of the frequency of the STR L0 product from 1 Hz to 2 Hz

**L2 Cat-2:** Any delivery of the Level 2 – Cat 2 OP is postponed after the PDGS evolution activity (April – July 2016).

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

The former “Task Force” deputed to study the ASM-VFM residuals, has been reshaped in a Magnetic Measurements Expert Group (MMEG). The first MMEG meeting was held in Warsaw (GMV premises) on **10-11/03/2016**. During this meeting the following decisions have been taken:

ASM-VFM Scalar Residual:

- VFM calibration issue:
  - Finalize the covariance analysis between parameters in alpha/beta space
  - Further analysis directly on non-orthogonalities in-flight and on ground test data and not the computed models.
  - Scale factor  $s_{exp}$  shall be further investigated.
  - Consolidate the analysis on dependency on  $s_{\beta}$  and  $T_{EU}$ .
- Further investigation on the correlation between ASM-VFM residuals and  $T_{EU}$ .
- Continue the investigation on ASM-VFM residuals using MAGx\_HR\_1B data.
- Consolidate test proposal to use Heater activation to generate T gradient on boom during Dawn/Dusk orbit.





- Continue the investigation on ASM-VFM residuals using the ASM-V data to constrain the disturbance field.
- Further investigation on the possible impact the plasma-induced perturbations have on the VFM/ASM instrument.

STR:

- IBA correction model: to check the impact this model have on the field modelling

Euler Angles:

- Ionospheric/Magnetospheric currents was found to be responsible for the apparent change of the Euler Angles. Static Euler angles are suggested to be used in L1B processing.

Data Distribution:

- L1B data produced with corrected quaternions. A TDS to be distributed to full community in preparation of the next DQW (Sept 2016)
- Burst mode ASM data delivered by IPGP to be distributed for the day 19/01/2014
- Generate RPRO MAGx\_HR\_1B data for the day 19/01/2014.
- A complete data package containing all available data for the day 19/01/2014 will be distributed.

The “16 Hz Faceplate currents and derived electron density” dataset, delivered by IRF, has been published in the ESA ftp server (/Advanced folder). Considering the great interest expressed by the users community, this dataset will be accessible to all users since the beginning, and not to expert users only as it was originally decided.

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

- Single-probe derived electron temperatures and SC potential (by end of March)
- Sweep mode derived electron density and temperature and SC potential (by end of March).

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 9 (29/02 - 06/03)

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 9: 29/02 - 06/03.

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:
  - o The **average difference** on a given day exceeds the position accuracy requirement for the mission (1.5 m),
  - o 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).
  - o 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.

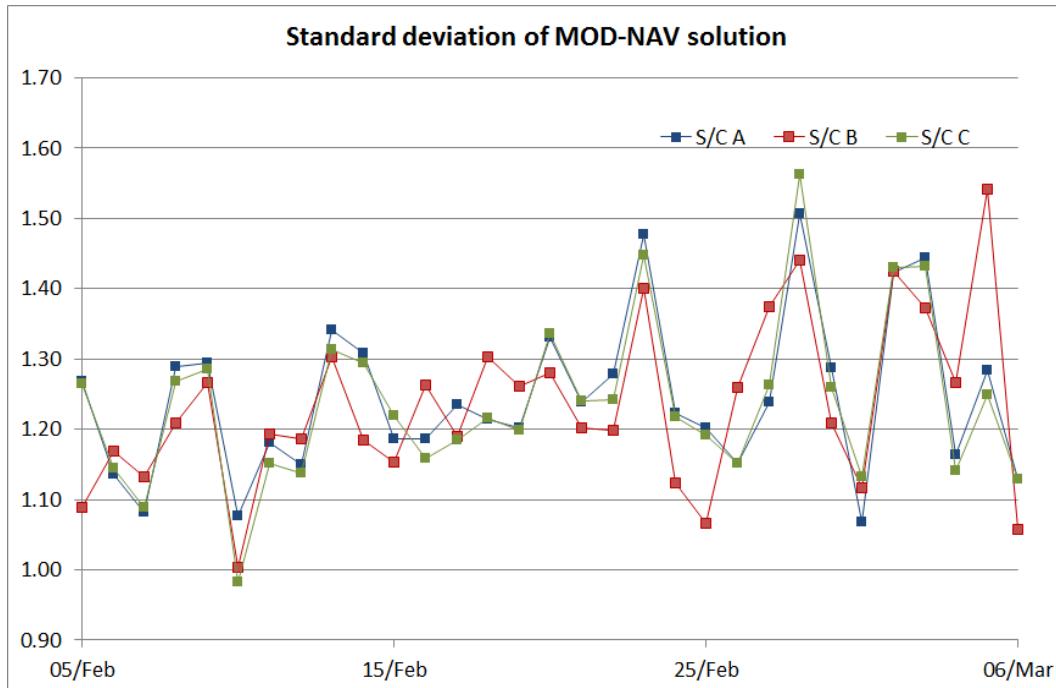
##### 3.2.1 Position Statistics

In Table 2, one can see the statistics of the differences between MOD and on-board solution positions for SC 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.

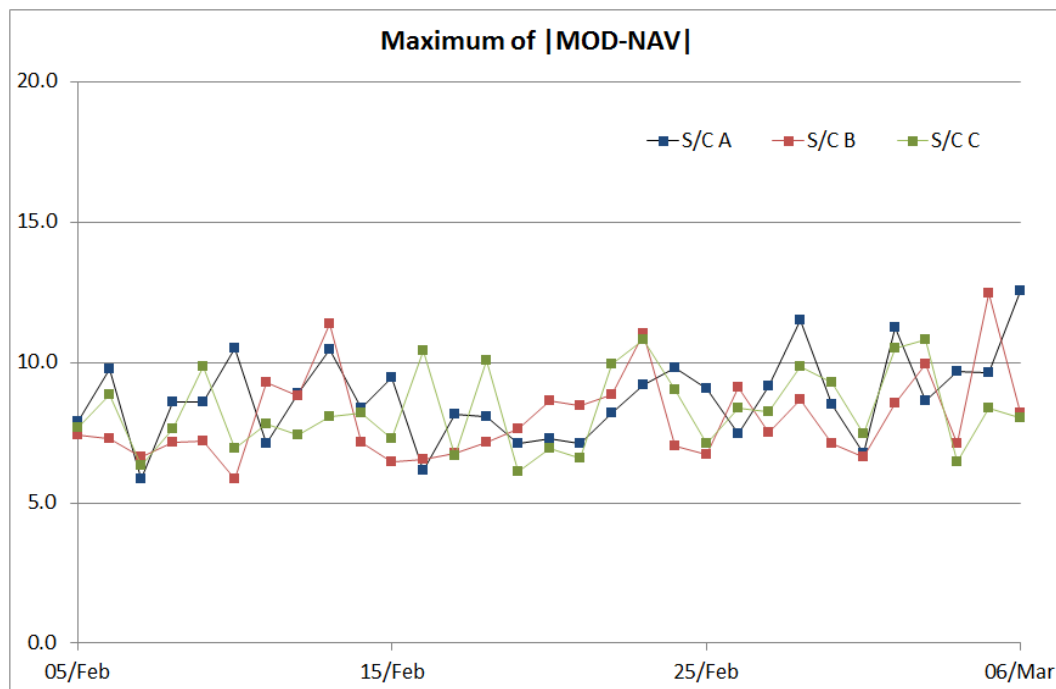


**Table 2:** Swarm A, B and C, difference between MOD and on-board solution positions. If not specified maximum difference and maximum standard deviation refers to the Z-axis.

Swarm A, 29/02 - 06/03, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
29/02	0.02	-8.5	7.5	1.29	
01/03	0.05	-6.8	6.1	1.07	
02/03	0.05	-10.3	11.2	1.42	
03/03	0.09	-8.7 (X)	8.3	1.44	
04/03	0.13	-7	9.7 (Y)	1.16	
05/03	0.1	-9.6	7.4	1.28	
06/03	0.14	-12.5	5.7	1.13	
Swarm B, 29/02 - 06/03, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
29/02	0.08	-6.4	7.1	1.21	
01/03	0.03	-5	6.6	1.12	
02/03	0.1	-8.5	6.5	1.42	
03/03	0.1	-7.3 (Y)	9.9	1.37	
04/03	0.06	-7.1	5.9	1.27	
05/03	0.06	-8	12.5	1.54	
06/03	0.1	-8	8.2	1.06	
Swarm C, 29/02 - 06/03, Position difference					
Day	Average difference (m)	Maximum difference (m)		Maximum standard deviation (m)	Notes
29/02	0.01	-9.3	8	1.26	
01/03	0.05	-7.5	5.8	1.13	
02/03	0.08	-9.4 (X)	10.5	1.43	
03/03	0.11	-7.4	10.8	1.43	
04/03	0.15	-6.5	5.3	1.14	
05/03	0.05	-8 (Y)	8.4	1.25	
06/03	0.14	-8	8	1.13	



**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 SC A, taken at the beginning of the week (29/02, Figure 3). 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].

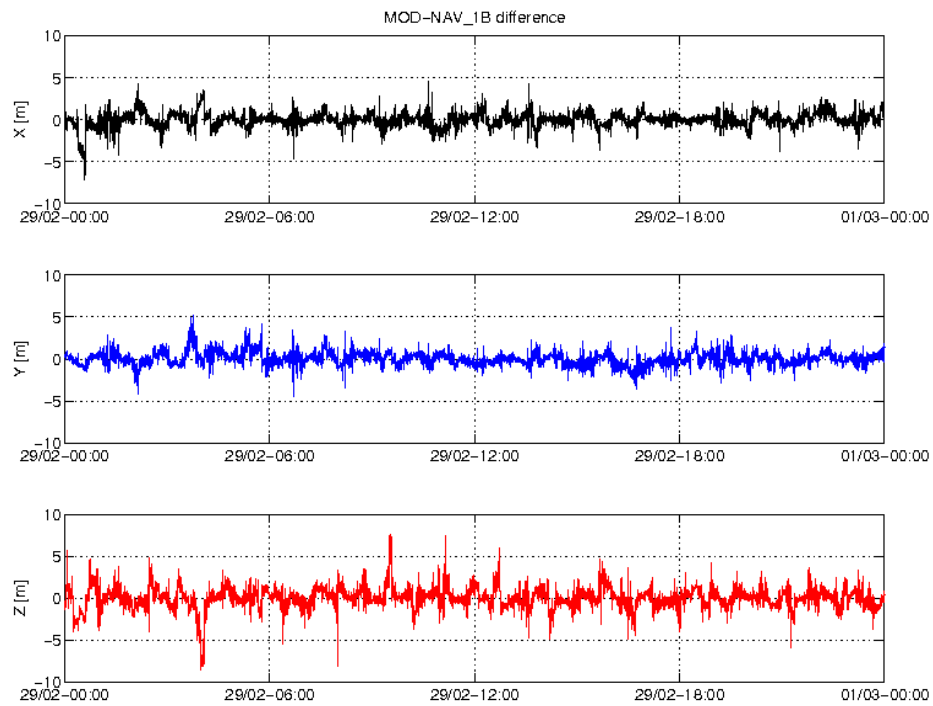


Figure 3: Difference MOD-GPSNAV, SC A, 29/02. From top to bottom: X, Y and Z-axis

### 3.2.1.2 Swarm B

Below is presented plot of MOD-NAV differences for SC B, taken at the beginning of the week (29/02, 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].

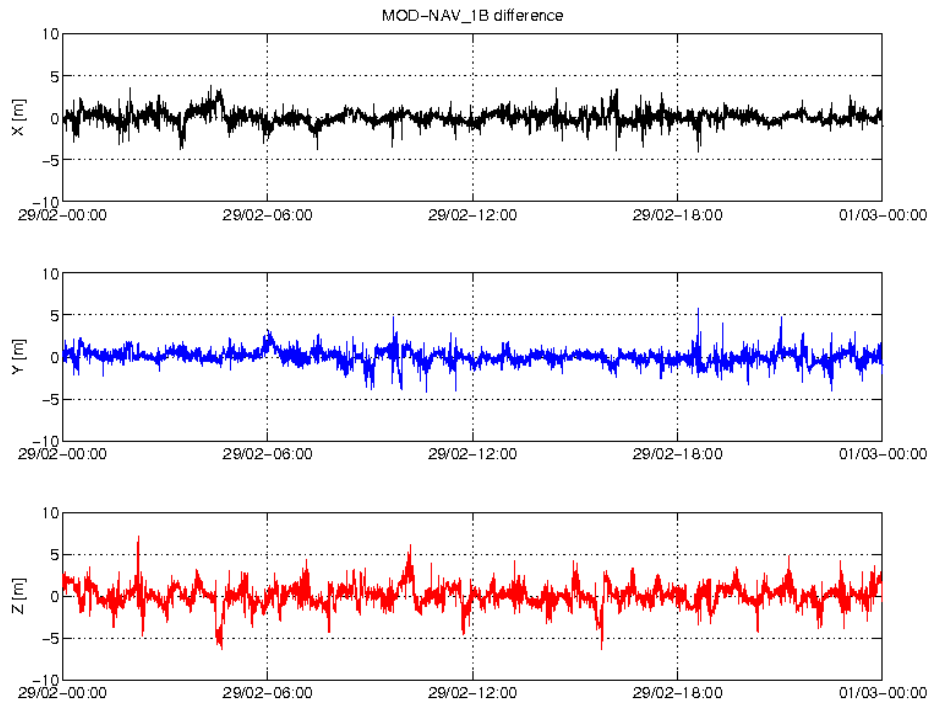


Figure 4: Difference MOD-GPSNAV, SC B, 29/02. From top to bottom: X, Y and Z-axis

### 3.2.1.3 Swarm C

Below is presented plot of MOD-NAV differences for SC C, taken at the beginning of the week (29/02, 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].

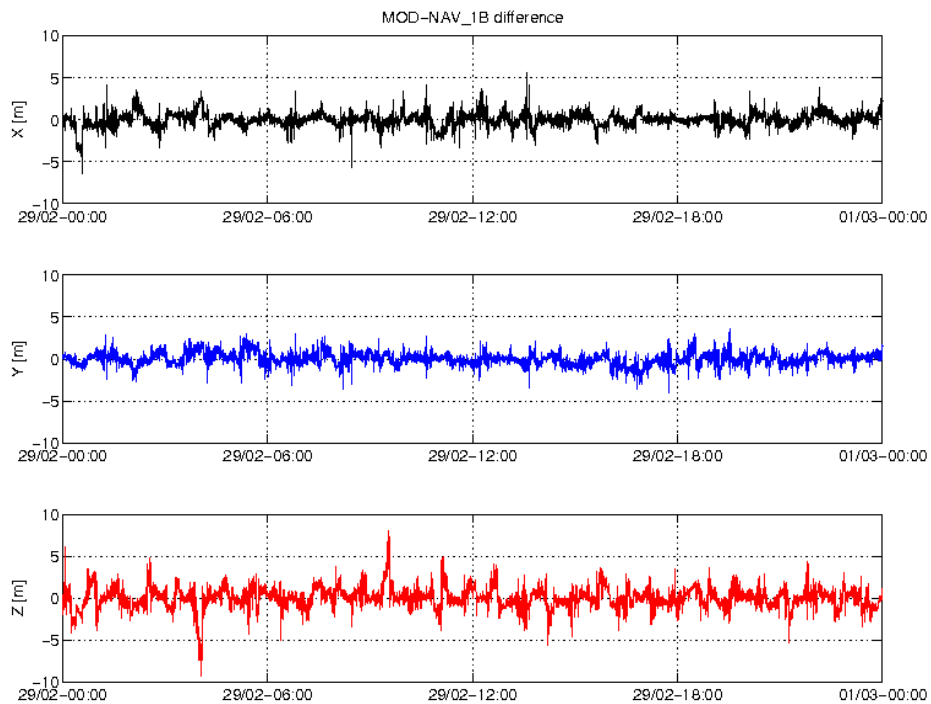


Figure 5: Difference MOD-GPSNAV, SC C, 29/02. From top to bottom: X, Y and Z-axis

### 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 9: 29/02 - 06/03.

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 03/03 due to manoeuvre (The eccentricity control and constellation maintenance manoeuvre was successfully executed on the 3<sup>rd</sup> of March on Swarm-A. There were two firings of 184 seconds at 13:37:25 and of 216 seconds at 14:23:54, for more details please see [RD.19], sections 2, 3.1.1, and 3.3.1);
- SC B – violation of:
  - VFM-ASM residuals threshold on-29/02, 02/03, 03/03;
  - standard deviation of residuals threshold 29/02 - 02/03.

#### 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:

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

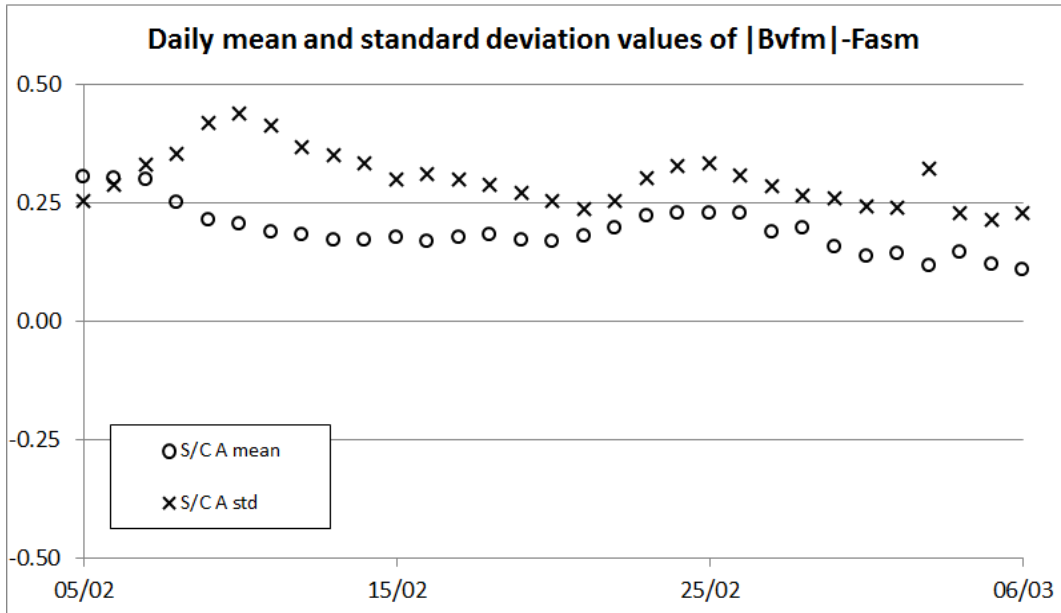
Figure 6 and Figure 7 show the daily mean (circles) and standard deviation (crosses) of dF of the last month for Swarm A and Swarm B respectively.



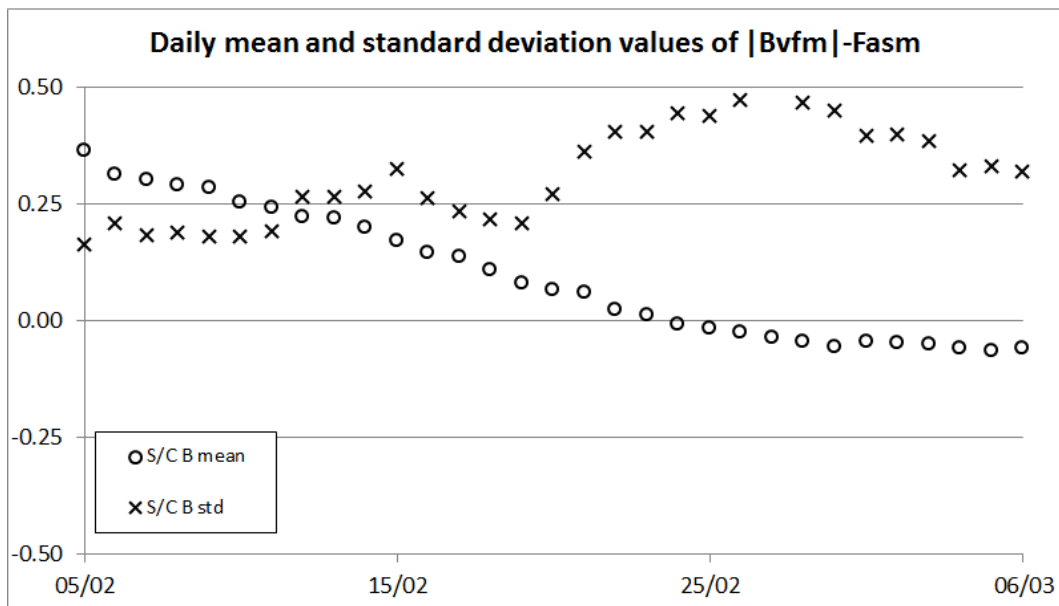


**Table 4** Swarm A and B, difference between absolute value of magnetic field measured by ASM and by VFM.

Swarm A, 29/02 - 06/03, ASM-VFM difference					
Day	Max (nT)	Min (nT)	Standard deviation (nT)	Mean (nT)	Notes
29/02	0.78	-0.55	0.26	0.156	
01/03	0.72	-0.61	0.24	0.138	
02/03	0.77	-0.63	0.24	0.141	
03/03	<b>2.83</b>	<b>-2.22</b>	0.32	0.116	See 3.3.1
04/03	0.69	-0.75	0.23	0.144	
05/03	0.65	-0.62	0.21	0.119	
06/03	0.78	-0.49	0.23	0.109	
Swarm B, 29/02 - 06/03, ASM-VFM difference					
Day	Max (nT)	Min (nT)	Standard deviation (nT)	Mean (nT)	Notes
29/02	0.75	<b>-1.07</b>	<b>0.45</b>	-0.057	
01/03	0.7	-0.97	<b>0.4</b>	-0.045	
02/03	0.74	<b>-1.02</b>	<b>0.4</b>	-0.049	
03/03	0.62	<b>-1.07</b>	0.38	-0.051	
04/03	0.53	-0.93	0.32	-0.06	
05/03	0.61	-0.93	0.33	-0.066	
06/03	0.67	-0.91	0.32	-0.058	



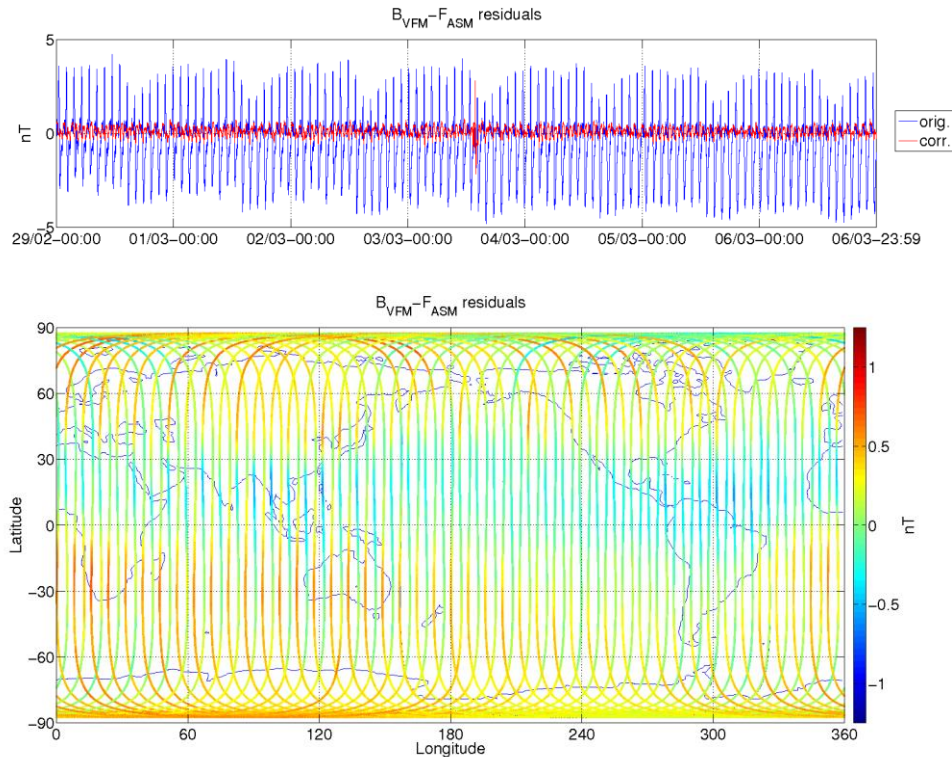
**Figure 6:** Daily mean and standard deviation values of ASM-VFM residuals (defined as  $dF=|B_{VFM}|-F_{ASM}$ ) for SC A.



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

### 3.3.1.2 Swarm A

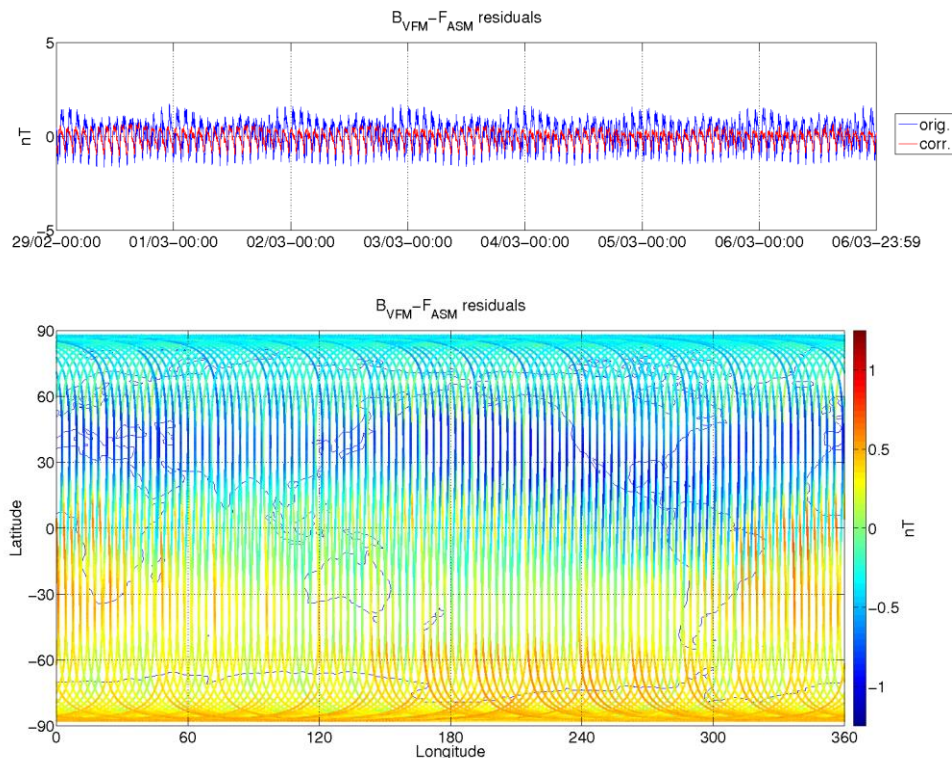
The daily peak-to-peak difference around the week stays within  $[-2.22, 2.83]$  nT. Below follow two plots of such differences for current week (Figure 8).



**Figure 8:** ASM-VFM residuals for SC A, during monitoring period 29/02-06/03. In top 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). In bottom figure residuals are presented on the world map.

### 3.3.1.3 Swarm B

The daily peak-to-peak difference around the week stays within  $[-1.07, 0.75]$  nT. Below follow two plots of such differences for current week (Figure 9).



**Figure 9:** ASM-VFM residuals for SC B, during monitoring period 29/02-06/03. In top figure are plotted: difference between  $|B_{VFM}|$  and  $F_{ASM}$  (without dB<sub>Sun</sub> correction) (blue colour), and the residuals with dB<sub>Sun</sub> corrections (red colour). In bottom figure residuals are presented on the world map.

### 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 SC 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<sub>CDC</sub>, T<sub>CSC</sub> and T<sub>EU</sub>.

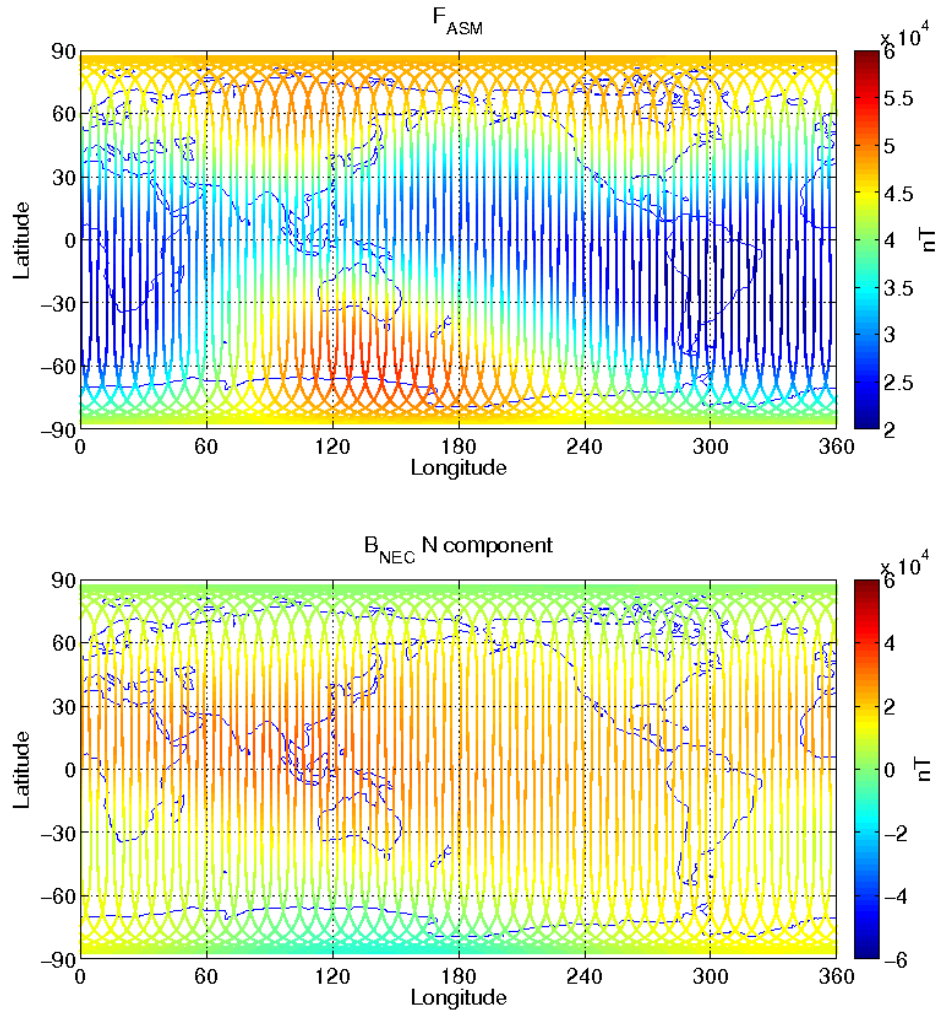
For SC A, B and C, for reported period, the temperatures behaved as expected.

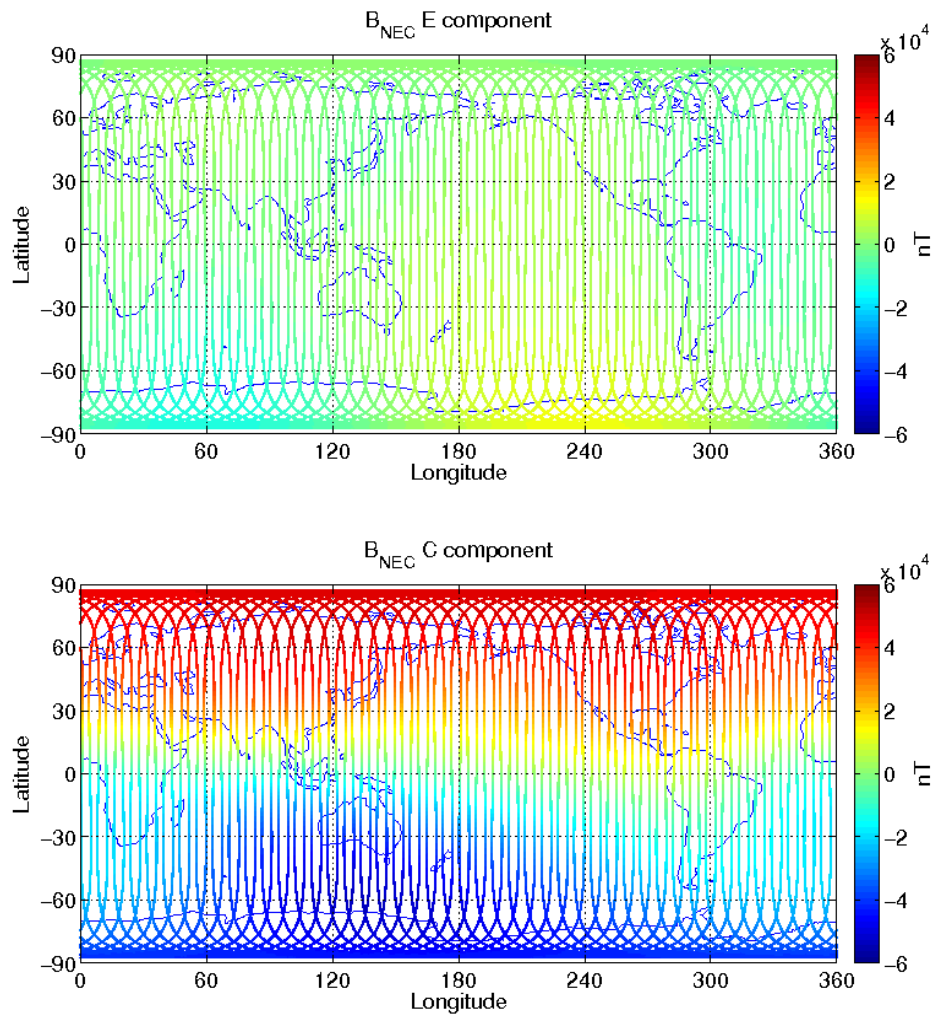


### 3.3.4 Magnetic time series visual inspection

#### 3.3.4.1 Swarm A

Map plots of magnetic field measurement for week 9 for SC A can be seen in Figure 10 below.



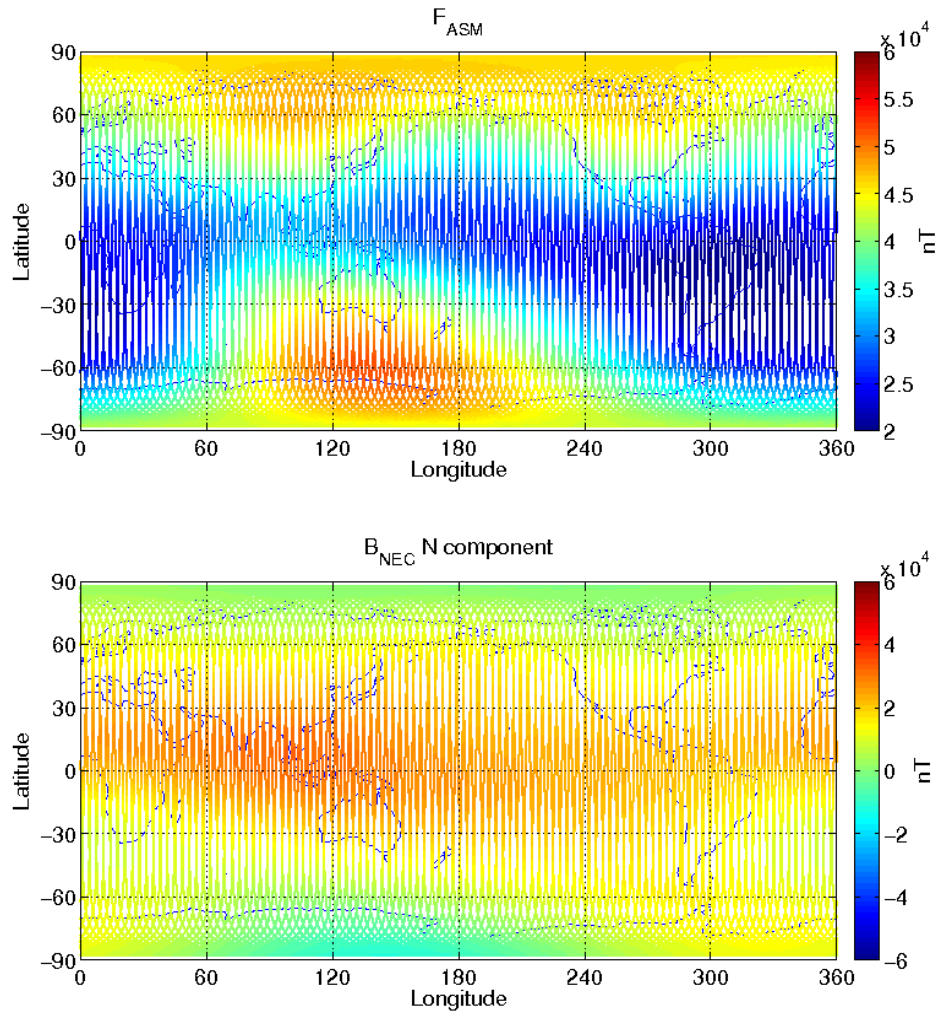


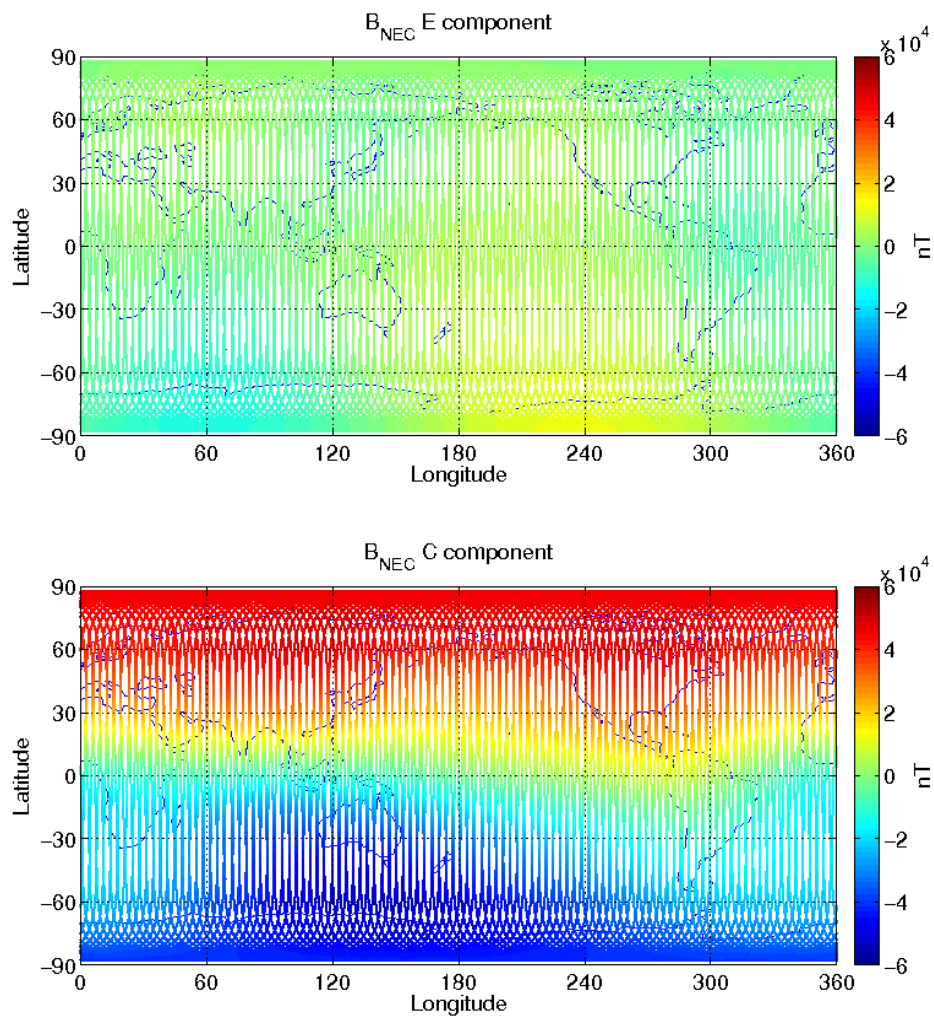
**Figure 10:** SC A, world map plots of the geomagnetic field and components measured during monitoring period 29/02-06/03. From top to bottom: F-magnetic field from ASM measurement, B<sub>NEC</sub> components (North, East, and Centre) of magnetic field from VFM measurement.



### 3.3.4.2 Swarm B

Map plots of magnetic field measurement for week 9 for SC B can be seen in Figure 11 below.



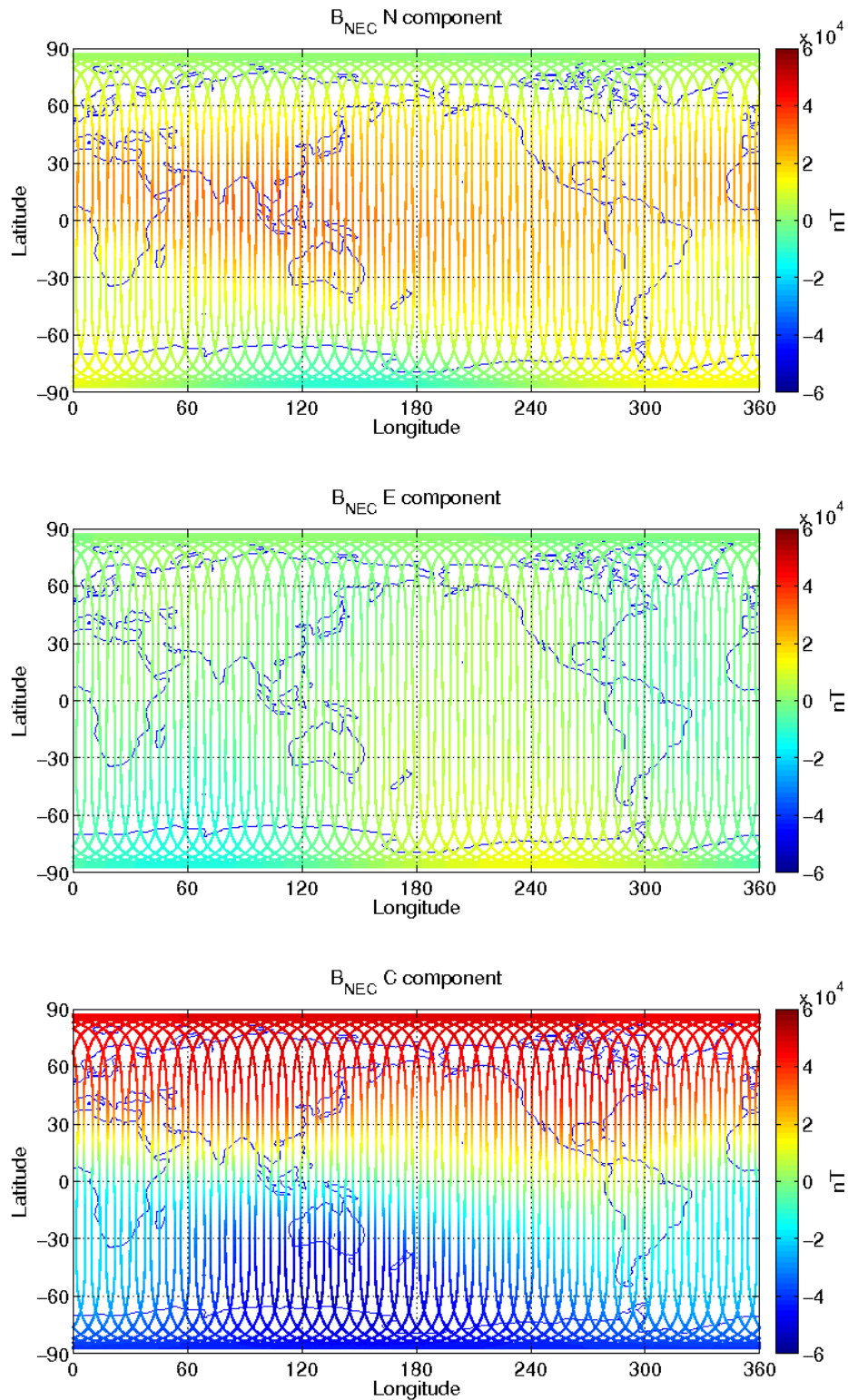


**Figure 11:** SC B, world map plots of the geomagnetic field and components measured during monitoring period 29/02-06/03. From top to bottom: F-magnetic field from ASM measurement, B<sub>NEC</sub> components (North, East, and Centre) of magnetic field from VFM measurement.



### 3.3.4.3 Swarm C

Map plots of magnetic field measurement for week 9 for SC C can be seen in Figure 12.



**Figure 12:** SC C, world map plots of the geomagnetic field and components measured during monitoring period 29/02-06/03. 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 29/02 of: (1-2-3) residuals of  $B_{NEC} - B_{Chaos}$  by components, related to SC 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

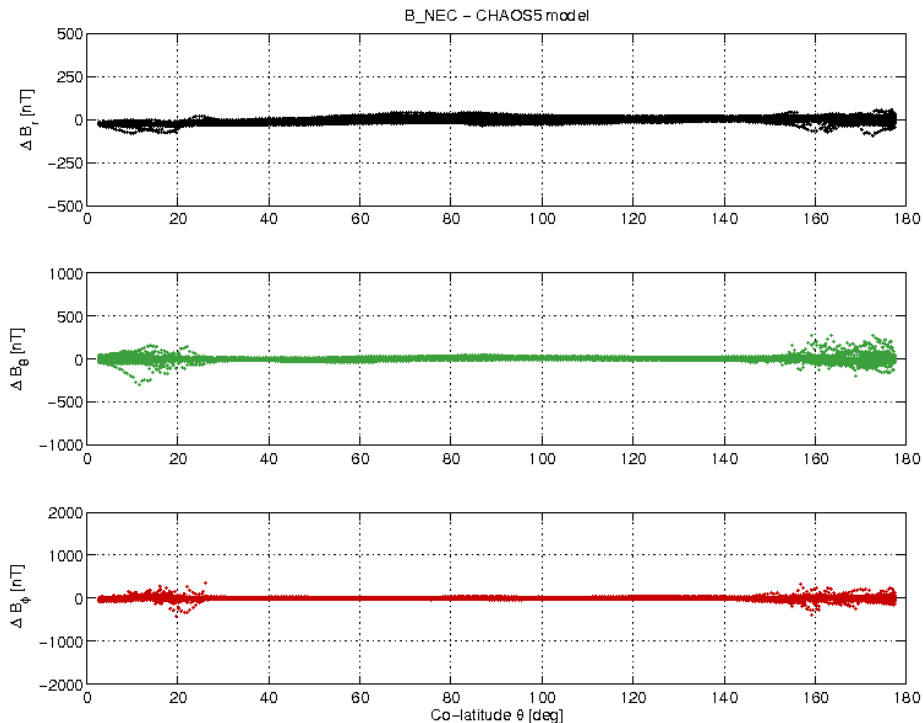


Figure 13: Swarm A day 29/02  $B_{NEC} - B_{Chaos}$  vs colatitude.

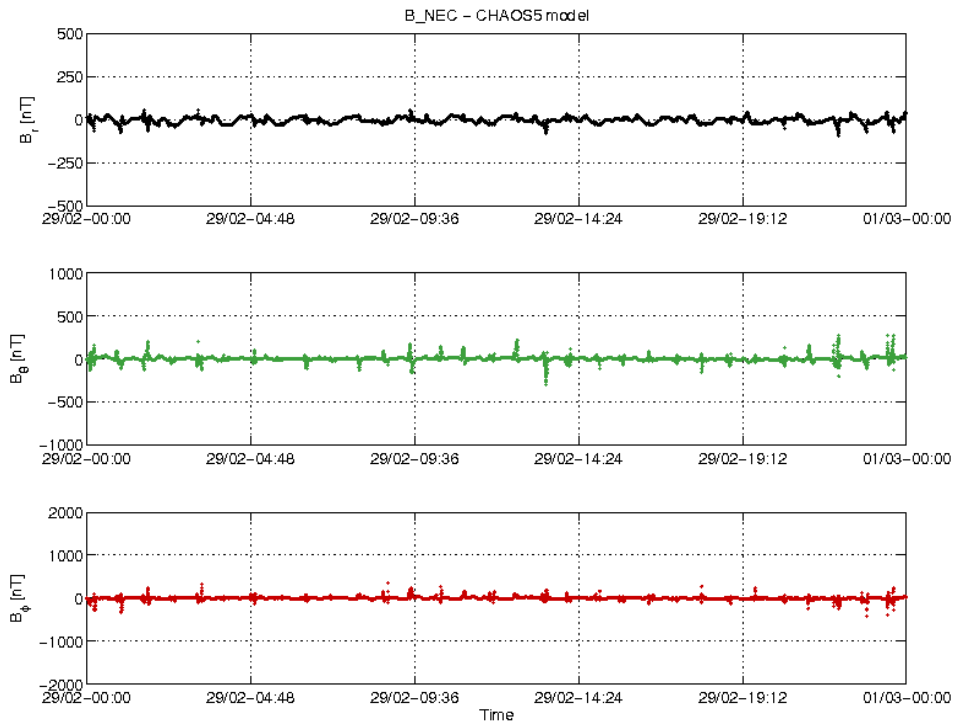


Figure 14: Swarm A day 29/02: time series of  $B_{NEC} - B_{Chaos}$  residuals.

### 3.3.5.2 Swarm B

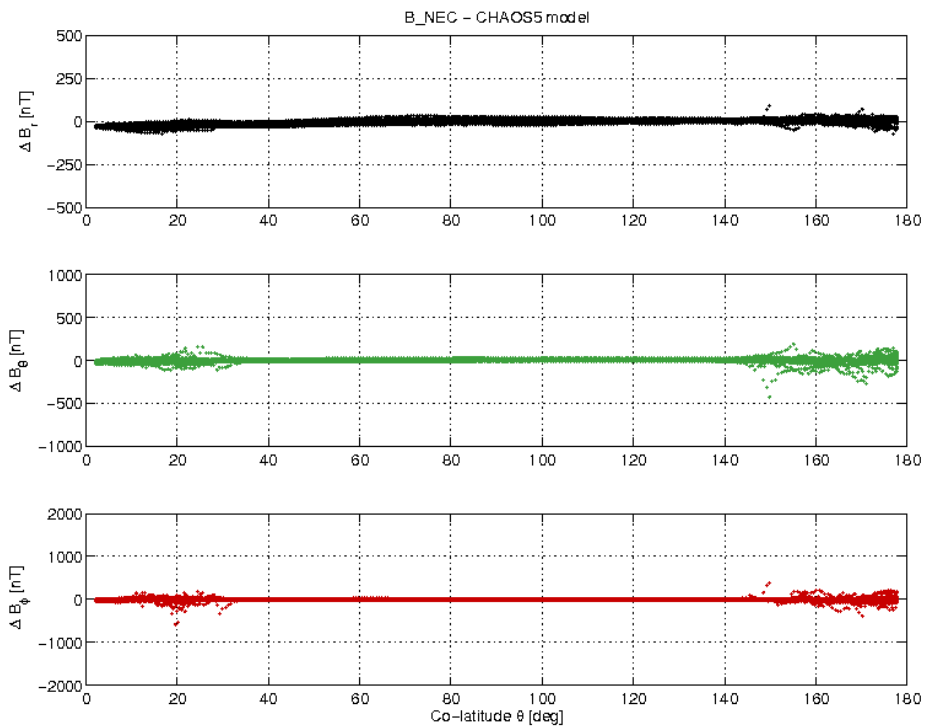


Figure 15: Swarm B day 29/02  $B_{NEC} - B_{Chaos}$  difference vs colatitude.

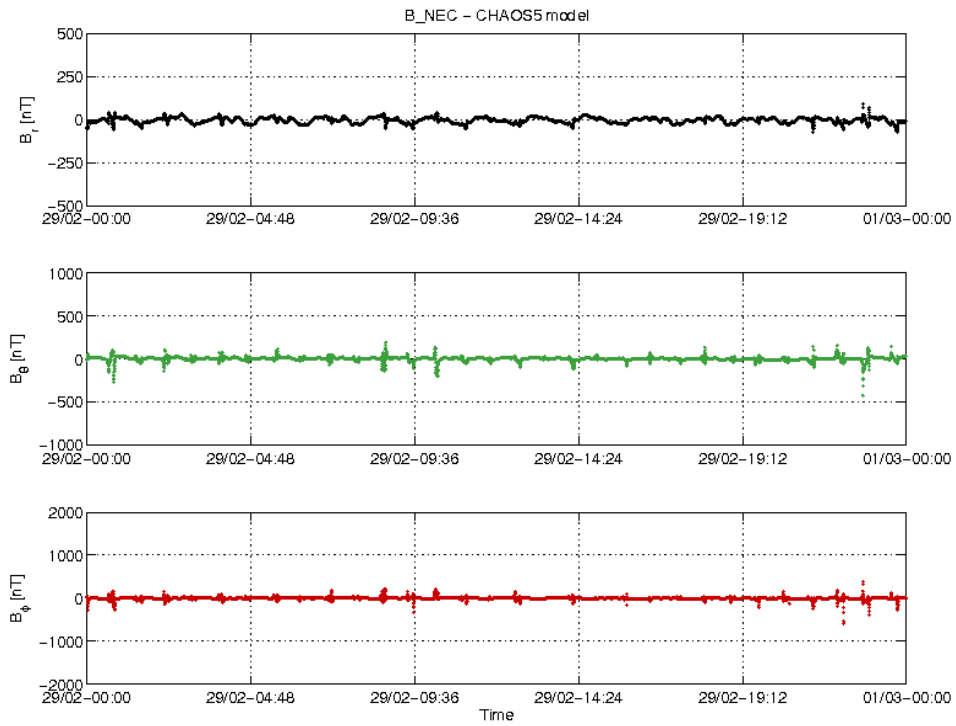


Figure 16: Swarm B day 29/02 time series of  $B_{NEC} - B_{Chaos}$  residuals.

### 3.3.5.3 Swarm C

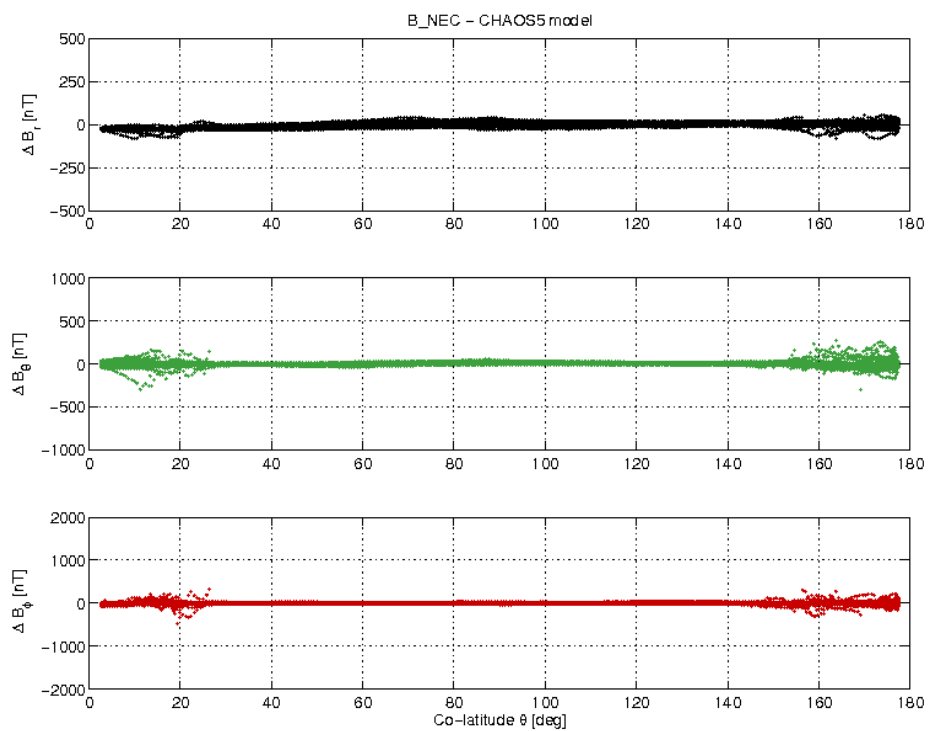


Figure 17: Swarm C day 29/02  $B_{NEC} - B_{Chaos}$  difference vs colatitude.

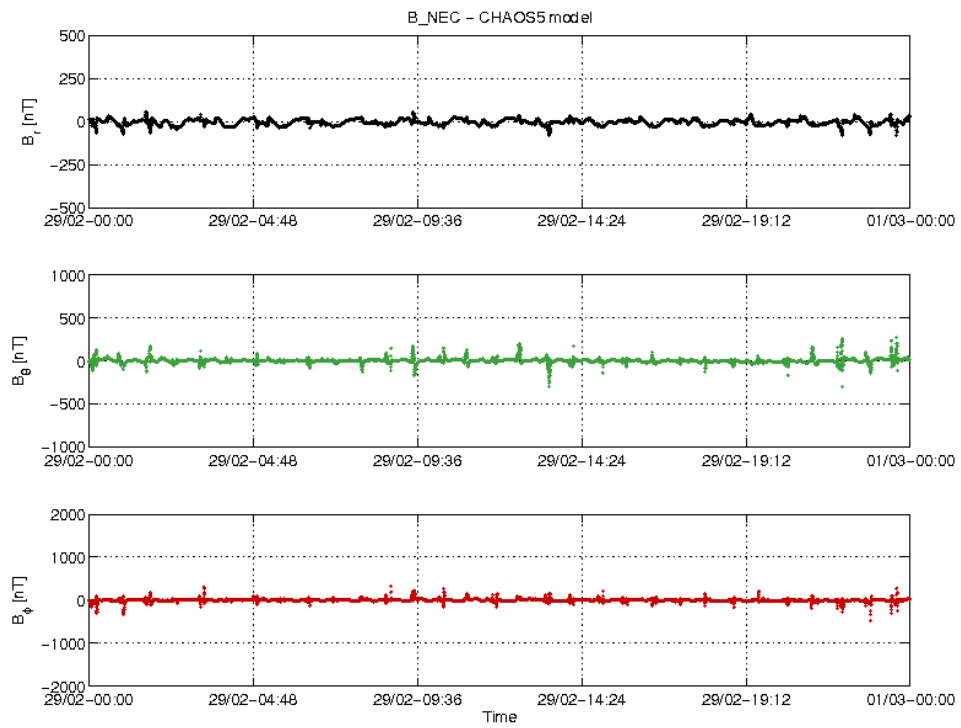


Figure 18: Swarm C day 29/02 time series of  $B_{NEC} - B_{Chaos}$  residuals.



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



**End of Document**