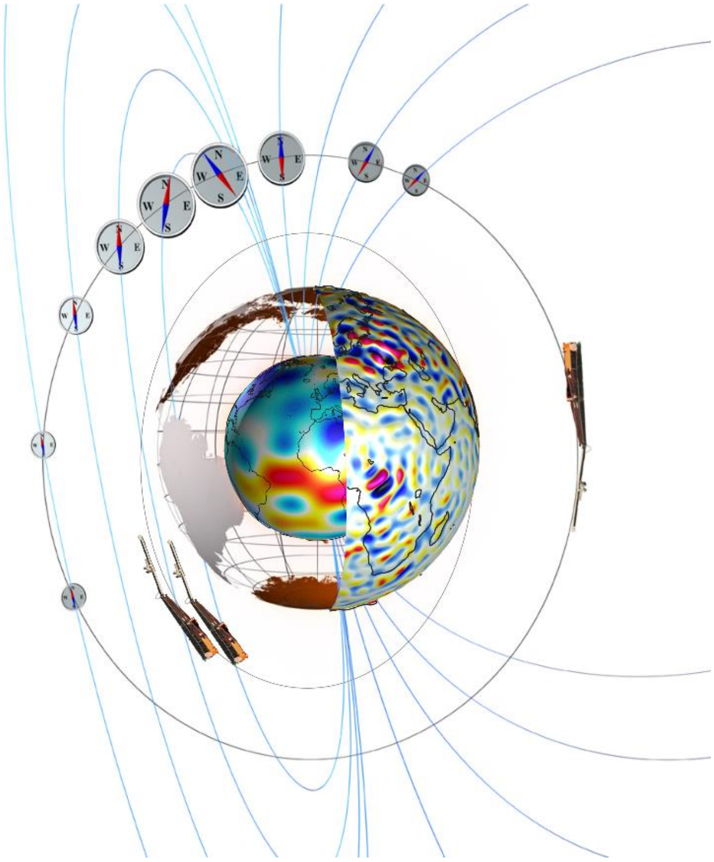
Swarm DISC Weekly Report 2018/24: 2018/06/11 - 2018/06/17



Abstract : This is the **Swarm Data Innovation and Science Cluster** (Swarm DISC) Weekly report on Swarm products quality, covering the period from 11 June to 17 June 2018.

Doc. No : SW-RP-SER-GS-010

Author : ______________________ Jan Miedzik, Enkelejda Qamili, Martyna Romanowska and Raffaella D'Amicis on behalf of Swarm DISC Team

Approval : ______________________ Jerome Bouffard ESA – EOP/GMQ

Distribution :
ESA/ESRIN EOP-GMQ
ESA/ESRIN EOP-GM Swarm MM
Swarm DISC Management Team
Swarm DISC subcontractors
ESA/ESTEC Swarm PLSO
ESA/ESOC Swarm FOS

TABLE OF CONTENTS

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

ISSUE	DATE	REASON
1.0	17 Aug 2018	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 APDF (Archive and Processing Data Facility) 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 2.2.

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 Swarm DISC 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 Payload Data Ground Segment (PDGS), Flight Operation Segment (FOS), Mission Management, Post-Launch Support Office (PLSO), Expert Support Laboratories (ESL), Quality Working Groups (QWG), 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: DISC action and ticketing system (http://requests-sppa.serco.it/RT3/index.html, for authorised personnel only).

2. If triggered by Swarm Disc 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, for authorised personnel only), SWL1L2DB project;

   2b. if the observation/analysis does not lead to an anomaly or the investigation shall be escalated to other entities (PLSO/industry, ESL, and 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 3.18p2, L2-Cat2 1.16p2.
- 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: S/C A - CCDB 0016 (01/03/2018), S/C B – CCDB 0017 (01/05/2018), S/C C – CCDB 0017 (01/03/2018), ADF 0101
- MPPF-CVQ v.03.04.01

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-SRCO-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] SW-RP-SER-GS-010_SPPA_SwarmWeeklyReport_201641_20161010_20161016.pdf

[RD.20] SW-RP-SER-GS-010_SPPA_SwarmWeeklyReport_201822_20180528_20180603.pdf

2. Summary of the observations

2.1 Changes in the general status of Swarm instruments and Level 1B products quality

Nothing to report

2.2 Plan for operational processor updates

Two different versions of L1B Operational Processor have been delivered recently, i.e., v3.19 delivered on 11/11/2017 and v3.19.1 delivered on 11/12/2017, but both these deliveries were rejected due to several issues detected. On 03/01/2018 a new version of L1BOP (v3.19.2) was delivered but is was agreed with the PDGS team not to deploy it in operation.

On 19/03/2018, the L1BOP v03.20 was delivered including the following changes:

- Increase the information contained in the logs of L1BOP processor.
- Change in ORBATT of phase observation to get full-cycle ambiguities
- Align data in RINEX files to GPS time (instead of receiver clock time)
- Plasma processor fully cross-verified.

L1B full reprocessing started on 21/05/2018 and finished on 03/06/2018 covering the time window from BOM to 30/04/2018. Data are now under assessment by quality team and expert team.

L2 Cat-2 OP v1.17 was delivered on 22/12/2017 but rejected due to several issues detected. L2 Cat-2 OP v1.18 was delivered on 16/04/2018 containing all the evolutions and fixes that impact the IBI, TEC and FAC processors. However, because of an issue encountered in the installation package, another delivery was requested and L2 Cat-2 OP v1.18.1 was received on 22/05/2018. The cross-verification of the EEF processor is on-going. Another delivery with all fixes on EEF processor is expected by the end of August.

2.3 Quality Working Group and Cal/Val Coordination

Following the decisions of the 7th QWG in Delft, the following activities will be carried on for a better understanding of some open issues:

- On the ASM-VFM Scalar Residuals further work will be done on the improvement of the correction model that consists in:
  - Short term :
    - Update of the vector data calibration and disturbance characterization currently in operation in the L1B chain
    - If needed, further adjustment of the VFM pre-flight calibration parameter
    - Investigation on the dependency of the VFM scaling with beta-angle or with T_EU
    - Separation of the pre-flight and in-flight calibration parameters with B_pre parameter in MAGx_CA_1B product as a source of “original residuals”
  - Long term :
    - Make use of the findings that came out from the thermos-electric investigations performed by DTU-MI on ground (thermoelectric currents in the pigtail wires responsible of the disturbance).
    - A preliminary thermodynamic model of the temperature of the rivets on the blanket is set up The disturbance vector varies from one spacecraft to the others. Probably caused by differences in the contact resistance of the rivets to the MLI layers.
    - Further analysis are needed to correctly model each component of the disturbance on each spacecraft.

- The effect on the ASM location has been also modelled since the beta cloth blanket around the AMS sensor has a configuration that suggest a y-axis disturbance (this could explain the discrepancy between the ASM-A and ASM-C during maneuvers).
- DTU proposed :
  - to use the models (one for ASM and one for VFM) of P. Brauer as basis-functions
  - co-estimate the scales of these basis functions together with current spherical harmonic & scaling model
  - Analyse resulting spherical harmonic models – which will contain small scale details – and iterate P. Brauer model
  - Apply $dB_{Sun,ASM}$ correction to ASM measurements and generate version 0601 L1b data for modelling and Euler angle investigations

- EFI validation and investigations:
  - Validation of LP data: electron density and temperature by inter-comparison with ground based (ISR), ionosondes and space borne (radio-occultation) measurements has been performed, with different datasets and approaches giving similar results. Also validation based on comparisons with models (e.g. IRI) and with the same parameters indirectly obtained from other Swarm datasets with some theoretical assumptions (especially electric field). In particular electron density has been compared also with faceplate measurements.
  - Validation of TII data: in particular E field data by using the method of SECS (Spherical Elementary Current System); studying plasma depletions events characterized by a correlation between E field and B; also comparison of Swarm cross-track ion drifts and SUPERDARN line-of-sight velocities.
  - Some investigations are still on-going on LP side:
    - Understanding the correlation of the electron temperature spikes and the solar illumination on the solar panels.
    - S/C potential and electron temperature hick-ups following a sweep mode activation: good progresses in modelling them, but root cause still unknown.
    - Differences between sweep mode and harmonic mode
    - Estimation of real ion mass composition since the assumption of pure O^+ ion plasma should be reconsidered.
  - The TII processing has been simplified by the Univ. of Calgary team: only the cross-track flow is determined, which is more stable and reliable. Moreover a robust flagging of data based on the raw images characteristics is in progress.
- Data Distribution:
  - ASM-V data: IPGP/LETI will deliver an updated version of the ASM vector data that will be available for all the users.
  - DTU will deliver an updated version of the MAGx_LR_1B dataset covering from BOM to end 2017 available for all the users.

2.4 Summary of observations for 2018, Week 24 (11/06 - 17/06)

During the monitored week no events have been found and investigated.

3. Routine Quality control

3.1 Gaps analysis

- A time gap in HK_CNOM product has been detected from 07:23:00 till 07:24:30 on day 15/06/2018 on S/C C, affecting MAGC_CA product.
- Several few seconds gaps in MAGx_CA_1B products throughout the week (gaps result from bug in the OP implementation, for details please see [RD.19]).

3.2 Orbit and Attitude Products

In Table 3-1 are listed events that have to be reported.

Table 3-1: List of events related to attitude and orbit products to be reported in the monitoring for 2018, Week 24: 11/06 - 17/06.

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^{-9})
- Visual inspection of Euler Angles derived from quaternions.

3.2.1 Position Statistics

In Table 3-2, 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 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 3-1 shows a cumulative trend of the maximum daily standard deviation for the past 30 days of operations of the MOD-NAV difference, while Figure 3-2 shows the daily maximum difference, in absolute value, of the MOD-NAV difference, always for the past 30 days of operations.

Table 3-2: Swarm A, B and C, difference between MOD and on-board solution positions. If not specified maximum difference and standard deviation refers to the Z-axis.

Swarm A, 11/06 - 17/06, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
11/06	0,22	-6,9 (Y)	6,6	1,3	
12/06	0,15	-7,7	7,1	1,25	
13/06	0,23	-5,5	6,4	1,16	
14/06	0,22	-6,7 (X)	7,4 (Y)	1,07	
15/06	0,11	-7,7 (Y)	7,5	1,23	
16/06	0,15	-7,1	5,6	1,19	
17/06	0,16	-7,6	6,4	1,09	
Swarm B, 11/06 - 17/06, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
11/06	0,11	-6,8	7	1,27	
12/06	0,11	-6,7	8,4	1,22	
13/06	0,08	-11,2	7,1	1,23	
14/06	0,2	-6,5	6,9	1,18	
15/06	0,12	-6,3	8,8	1,31	
16/06	0,15	-7,3	6,6	1,15	
17/06	0,21	-5,7	9,2	1,15	
Swarm C, 11/06 - 17/06, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
11/06	0,27	-8,8	7,4	1,32	
12/06	0,11	-6,4	7,5	1,23	
13/06	0,21	-8	5,4	1,2	
14/06	0,18	-5,9	5,7	1,07	
15/06	0,08	-7,7	5,1	1,22	
16/06	0,16	-6,1	6,2 (Y)	1,21	
17/06	0,16	-5,9	5,1	1,1	

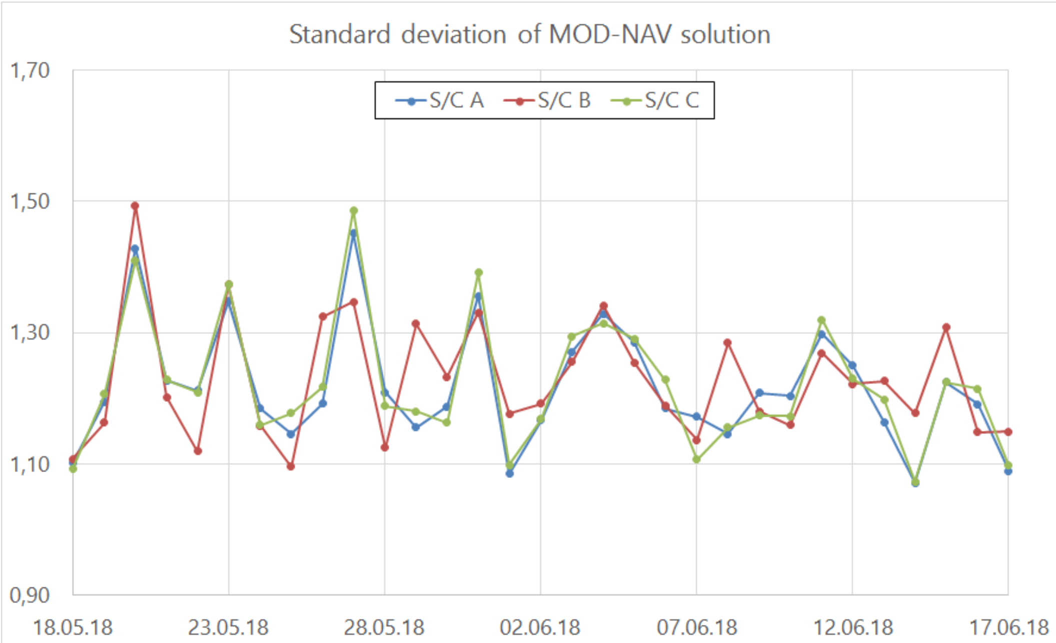


Figure 3-1: Plot of the standard deviation of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

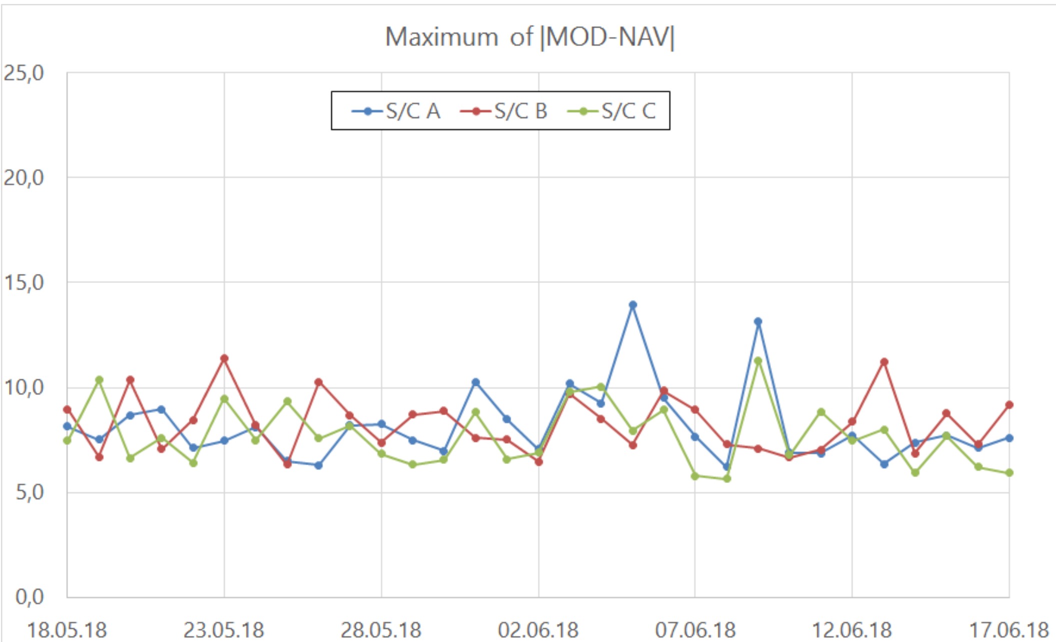


Figure 3-2: Plot of the maximum difference of the absolute value of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

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 (11.06, Figure 3-3). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively, differences are given in [m].

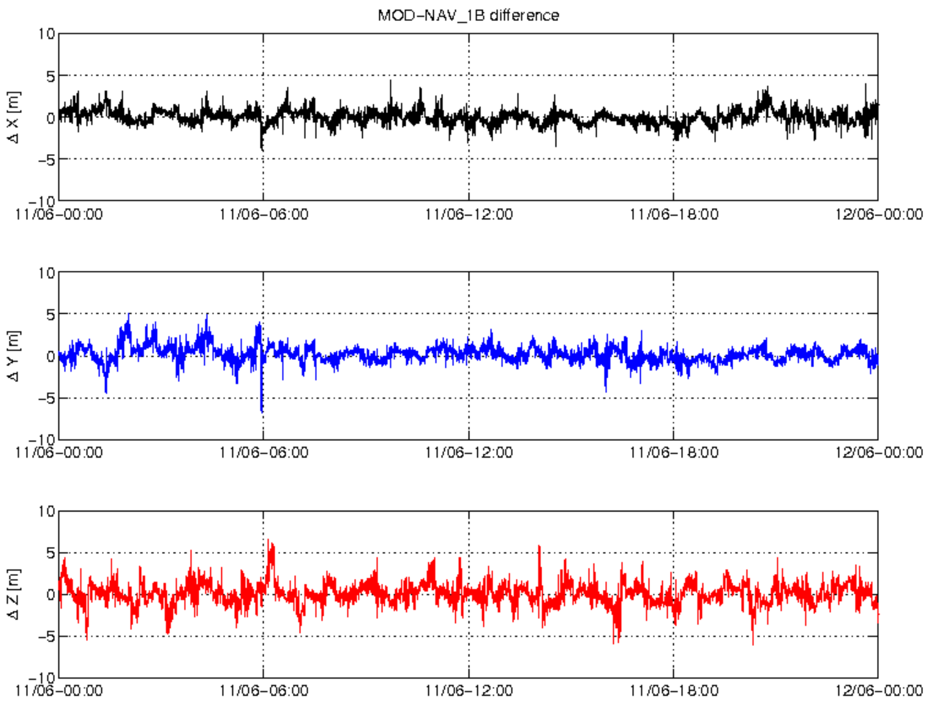


Figure 3-3: Difference MOD-GPSNAV, S/C A, 11.06. From top to bottom: X, Y and Z-axis

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 (11.06, Figure 3-4). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively, differences are given in [m].

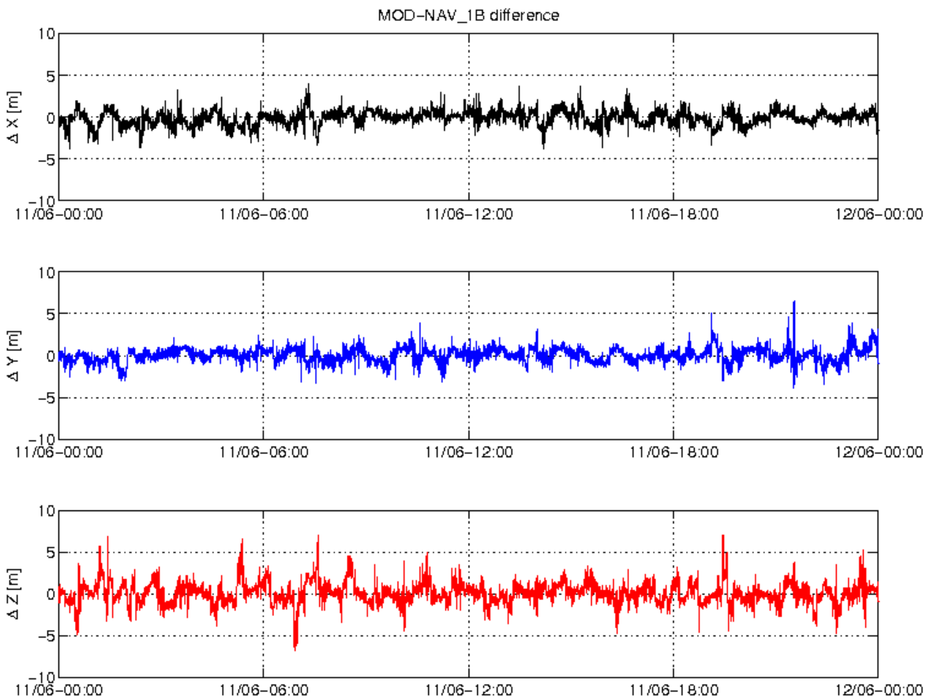


Figure 3-4: Difference MOD-GPSNAV, S/C B, 11.06. From top to bottom: X, Y and Z-axis

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 (11.06, Figure 3-5). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively, differences are given in [m].

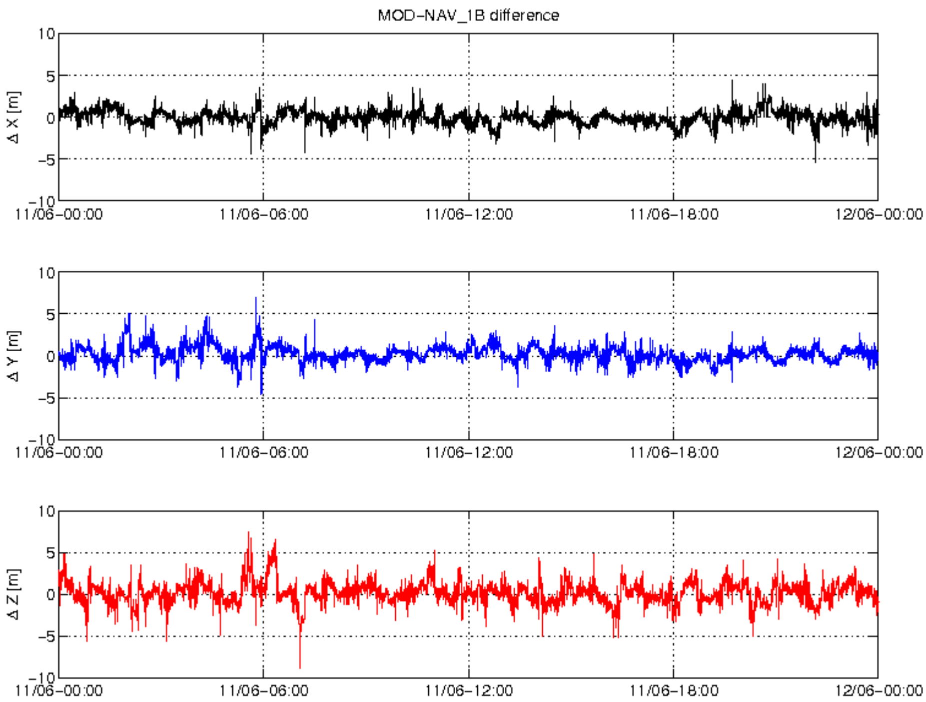


Figure 3-5: Difference MOD-GPSNAV, S/C C, 11.06. From top to bottom: X, Y and Z-axis

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 (nominal range: [2.949E7 – 2.950E7] Hz) and ASM temperature (temperature range shall be: [-30;+50] °C, Rel. Variation shall not exceed: 0.1 °C/sec).

- VFM instrument monitoring: temperatures (Rel. Variation shall not exceed: 0.1 °C/sec).
- 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 +/- 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 +/- 1 nT are exceed 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).
- Second derivative of vector field in VFM and NEC frame. Only measurement points within ±10° latitude are considered, and values above 100 nT/s2 are considered out of threshold.
- 5-min correlations between S/C A and S/C C B_{NEC} measurements.
- Differences between S/C A and C, B_{NEC} measurements. Values above 8000 nT are considered out of threshold.

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

Table 3-3: List of events related to magnetic products to be reported in the monitoring for 2018, Week 24: 11/06 - 17/06.

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

- S/C A – violation of:
  - VFM-ASM residuals threshold on 11/06, 12/06, 13/06, 14/06, 15/06, 16/06, 17/06;
  - mean value of residuals threshold on 11/06, 12/06, 13/06, 14/06, 15/06, 16/06, 17/06;
  - standard deviation of residuals threshold on 11/06, 12/06, 13/06, 14/06, 15/06, 16/06.
- S/C B – violation of:
  - VFM-ASM residuals threshold on 17/06;

3.3.1.1 ASM-VFM difference statistics

In Table 3-4, 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 standard deviation is in the fourth column.

The ASM-VFM difference is defined as follow:

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

Figure 3-6 and Figure 3-7 show the daily mean (circles) and standard deviation (crosses) of dF of the last month for Swarm A and Swarm B respectively.

Table 3-4: Swarm A and B, difference between absolute value of magnetic field measured by ASM and by VFM.

Swarm A, 11/06 - 17/06, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
11/06	**1,59**	-0,55	**0,45**	**0,491**	
12/06	**1,57**	-0,57	**0,45**	**0,489**	
13/06	**1,65**	-0,56	**0,45**	**0,508**	
14/06	**1,63**	-0,47	**0,44**	**0,521**	
15/06	**1,6**	-0,43	**0,42**	**0,511**	
16/06	**1,52**	-0,41	**0,4**	**0,533**	
17/06	**1,44**	-0,4	0,39	**0,54**	

Swarm B, 11/06 - 17/06, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
11/06	0,81	-0,76	0,36	0,151	
12/06	0,85	-0,7	0,35	0,148	
13/06	0,87	-0,71	0,34	0,143	
14/06	0,91	-0,7	0,35	0,175	
15/06	0,93	-0,67	0,36	0,167	
16/06	0,95	-0,67	0,36	0,18	
17/06	**1**	-0,64	0,36	0,2	

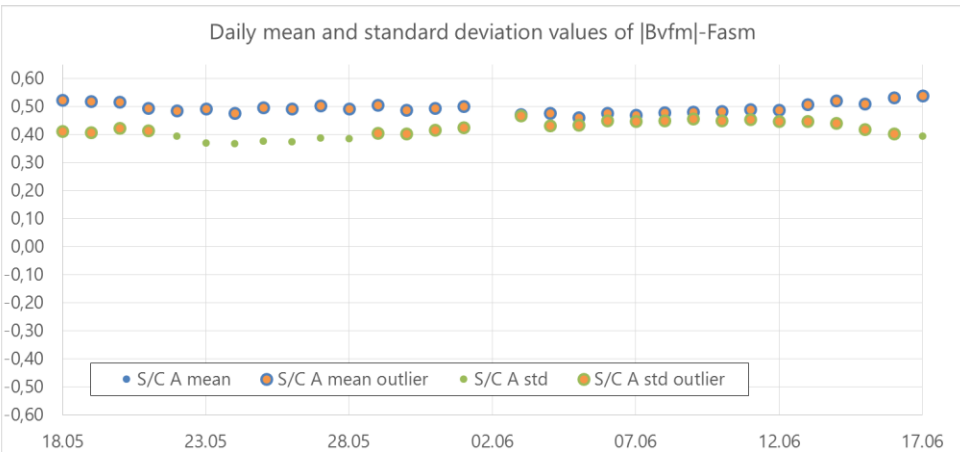


Figure 3-6: Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C A.

The gap in Figure 3-6 on day 02/06/2018 is due to the anomaly in VFM described in [RD.20].

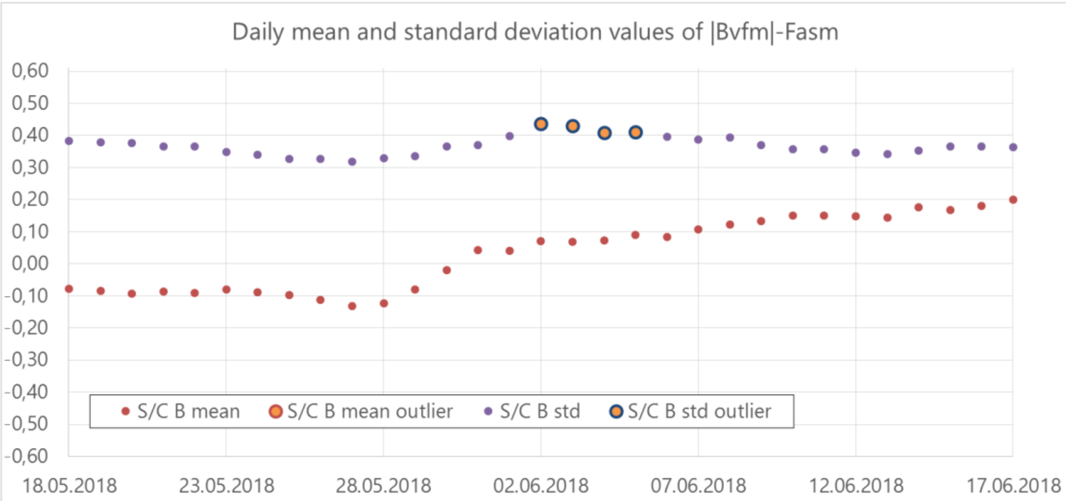


Figure 3-7: Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C B.

3.3.1.2 Swarm A

The daily peak-to-peak difference around the week stays within [-0,57 - 1,65] nT. Below follow two plots of such differences for current week (Figure 3-8).

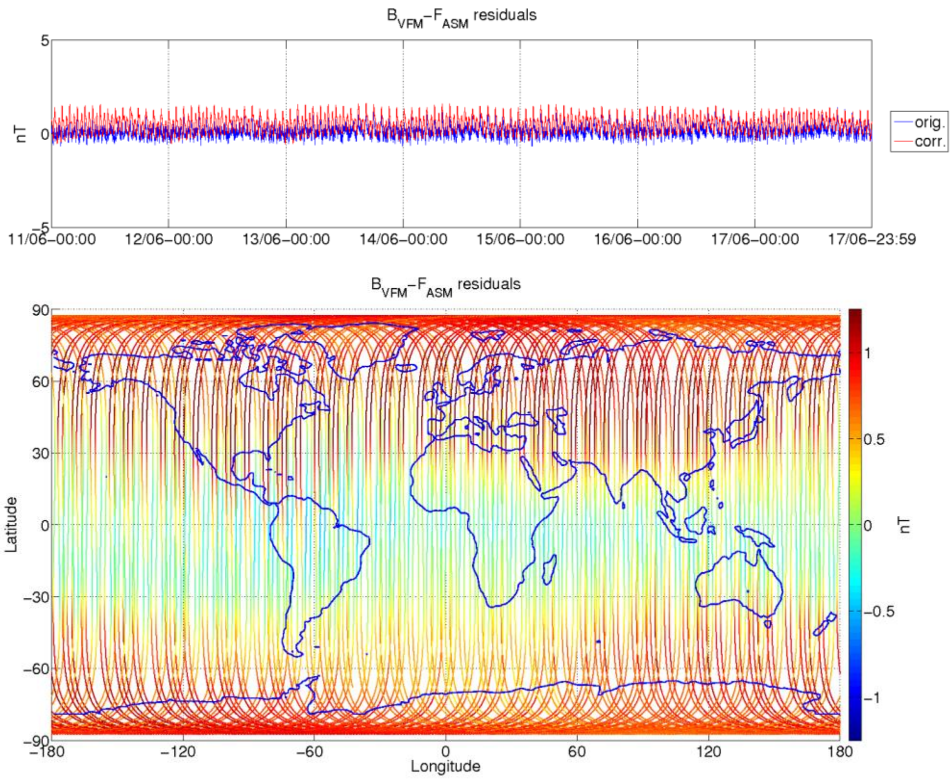


Figure 3-8: ASM-VFM residuals for S/C A, during monitoring period 11/06-17/06. In top figure are plotted: difference between |B_VFM| and F_ASM (without dB_Sun correction) (blue colour), and the residuals with dB_Sun corrections (red colour). In bottom figure residuals are presented on the world map.

3.3.1.3 Swarm B

The daily peak-to-peak difference around the week stays within [-0,76 - 1] nT. Below follow two plots of such differences for current week (Figure 3-9).

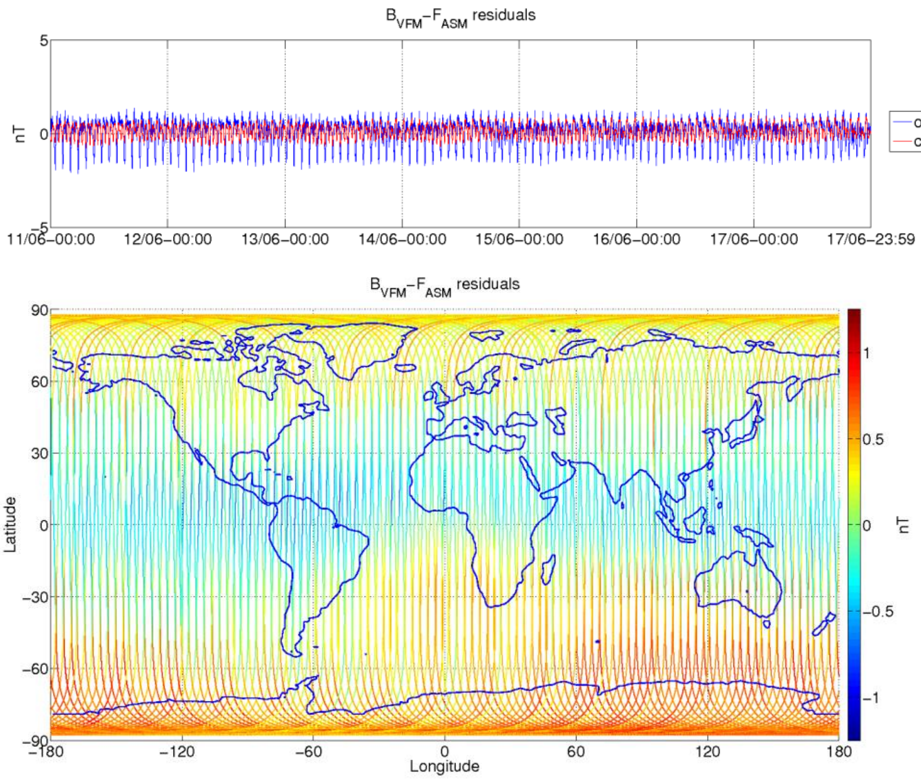


Figure 3-9: ASM-VFM residuals for S/C B, during monitoring period 11/06-17/06. In top figure are plotted: difference between |B_VFM| and F_ASM (without dB_Sun correction) (blue colour), and the residuals with dB_Sun corrections (red colour). In bottom figure residuals are presented on the world map.

3.3.1.4 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)

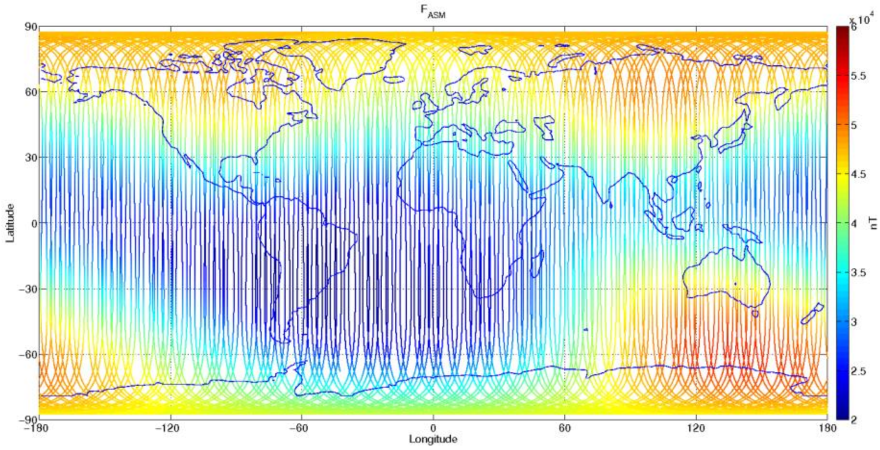
The VFM instrument parameters important for monitoring the instrument health are the VFM sensor temperatures: T_CDC, T_CSC and T_EU.

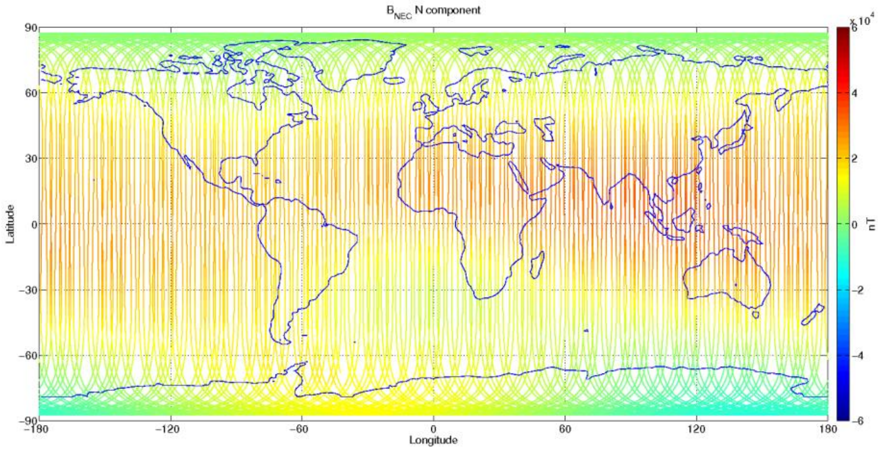
For S/C A, B and C, for reported period, the temperatures behaved as expected.

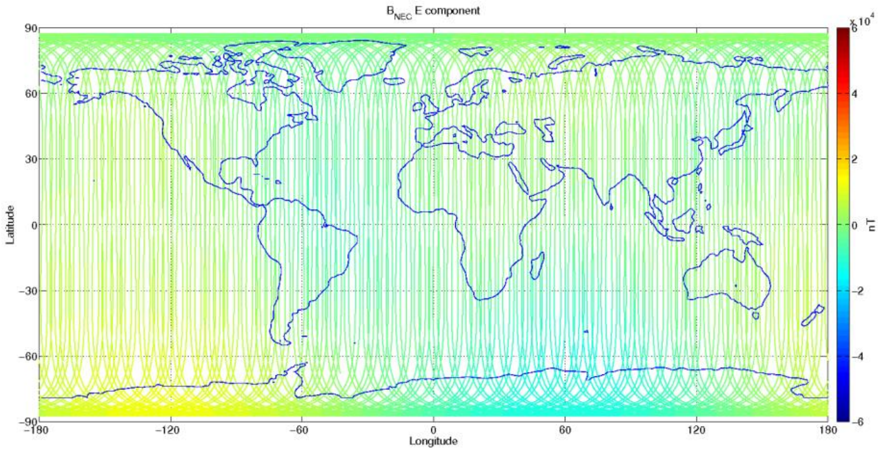
3.3.4 Magnetic time series visual inspection

3.3.4.1 Swarm A

Map plots of magnetic field measurement for week 24 for S/C A can be seen in Figure 3-10 below.







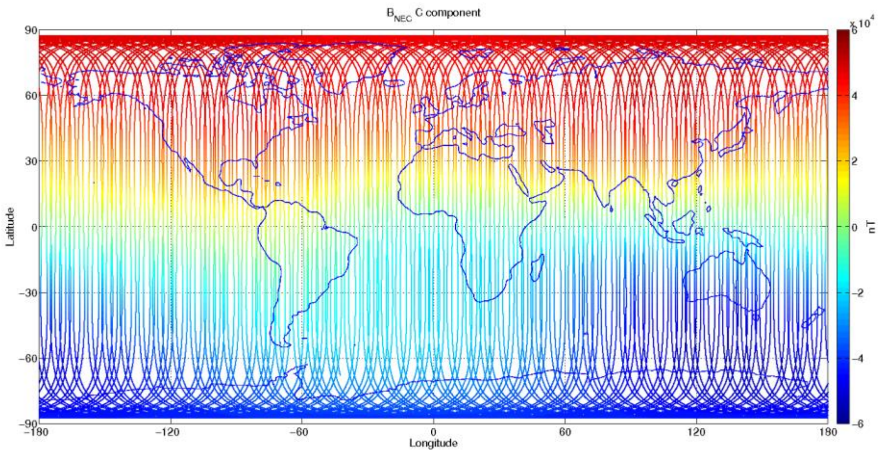
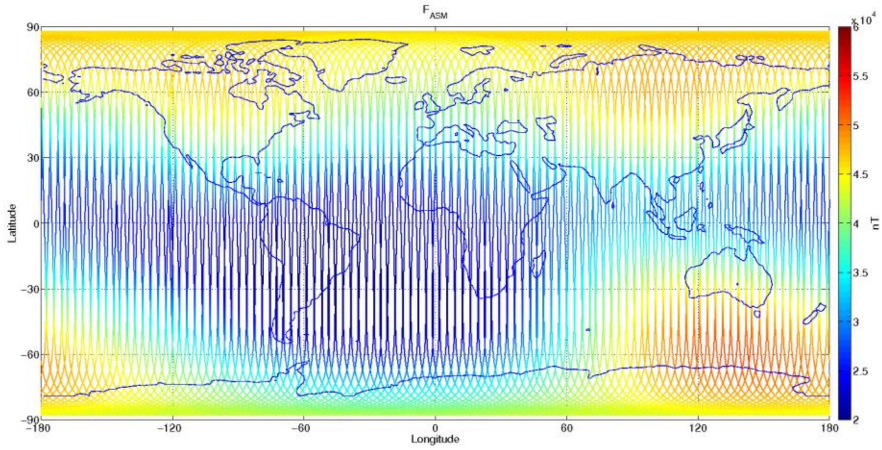
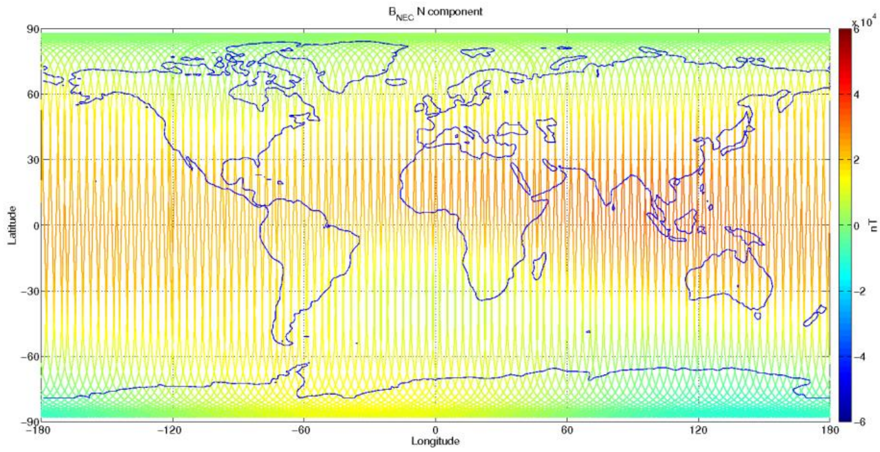


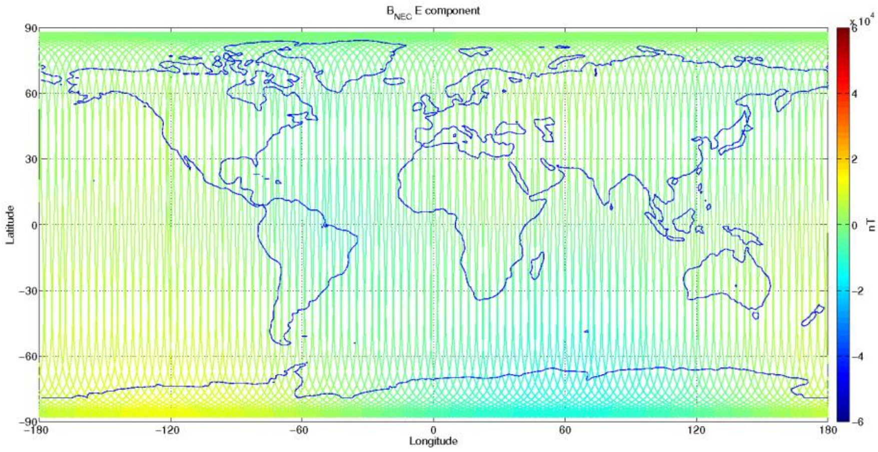
Figure 3-10: S/C A, world map plots of the geomagnetic field and components measured during monitoring period 11/06-17/06. From top to bottom: F-magnetic field from ASM measurement, B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

3.3.4.2 Swarm B

Map plots of magnetic field measurement for week 24 for S/C B can be seen in Figure 3-11 below.







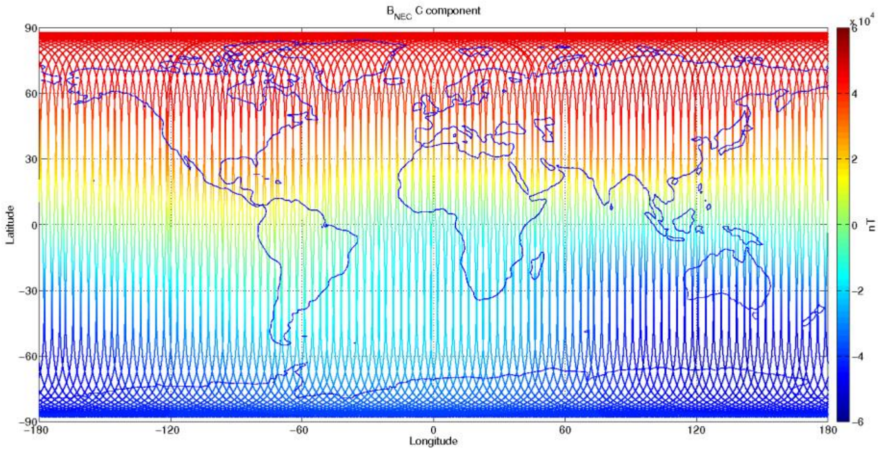
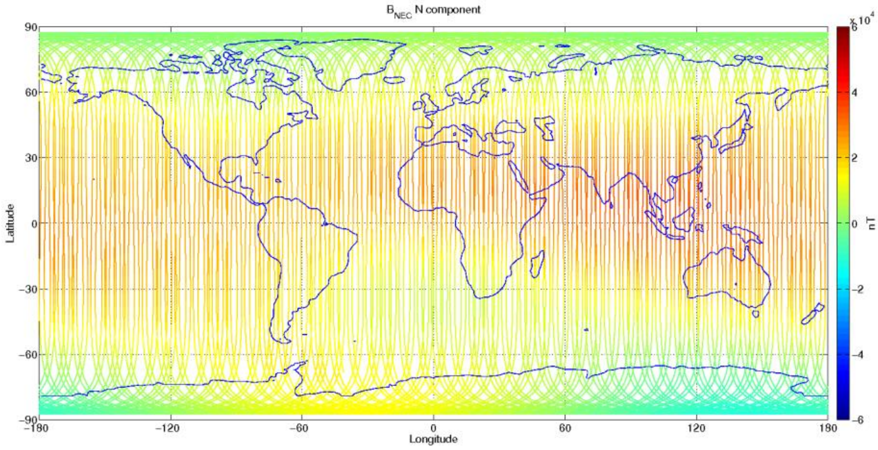
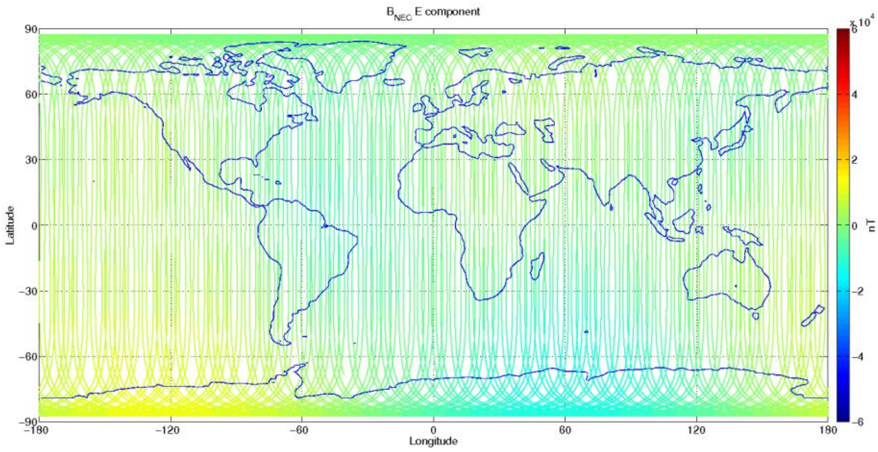


Figure 3-11: S/C B, world map plots of the geomagnetic field and components measured during monitoring period 11/06-17/06. From top to bottom: F-magnetic field from ASM measurement, B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

3.3.4.3 Swarm C

Map plots of magnetic field measurement for week 24 for S/C C can be seen in Figure 3-12.





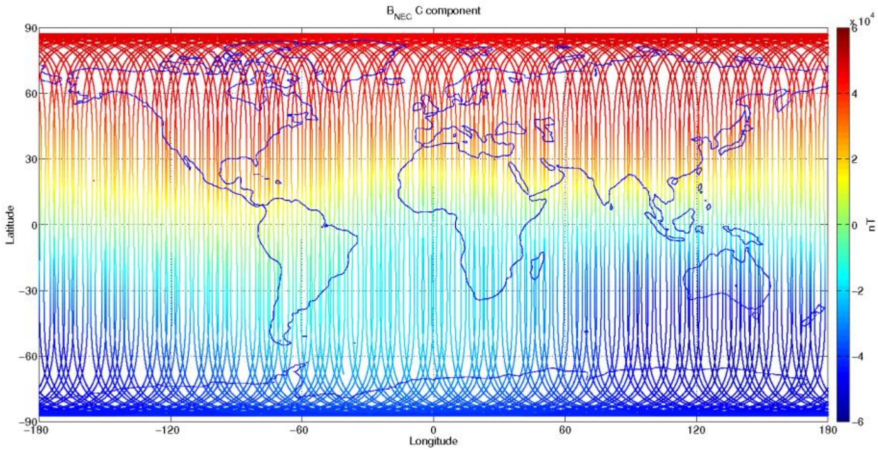


Figure 3-12: S/C C, world map plots of the geomagnetic field and components measured during monitoring period 11/06-17/06. From top to bottom: B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

3.3.5 S/C A and C magnetic correlation

In the plot below is shown the correlation in 5-minutes intervals of magnetic data between satellite A and C. B_north, B_east, and B_center are the components of the magnetic field vector in NEC frame.

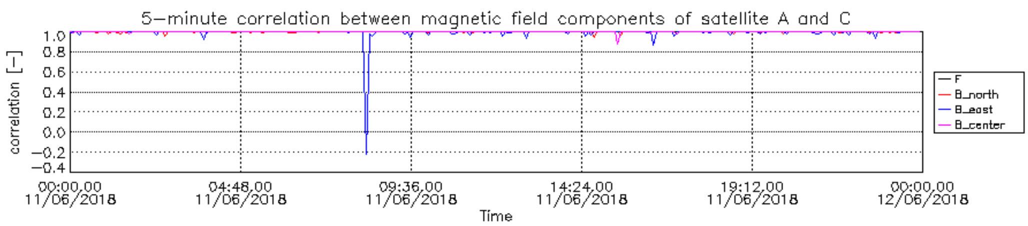


Figure 3-13: Correlation in magnetic data between satellite A and C for B_north, B_east, and B_center components of B_{NEC} are the components of the magnetic field vector in NEC frame

3.3.6 S/C A and C magnetic difference

The next three plots show the differences in magnetic data between satellite A and C. Threshold is set to 8 000 nT for each component.

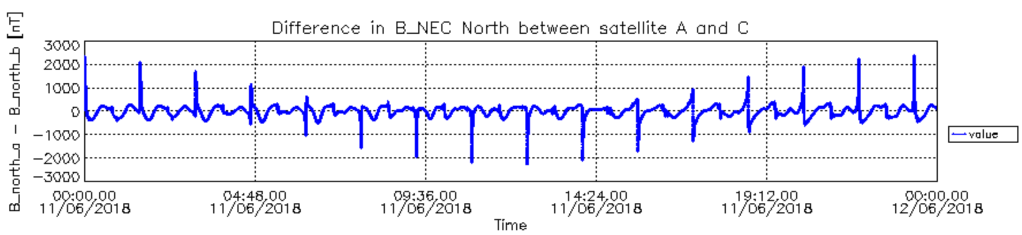


Figure 3-14: Difference in B_{NEC} North component between S/C A and S/C C.

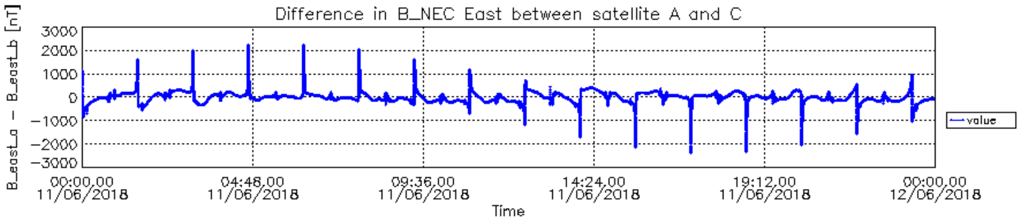


Figure 3-15: Difference in B_{NEC} East component between S/C A and S/C C.

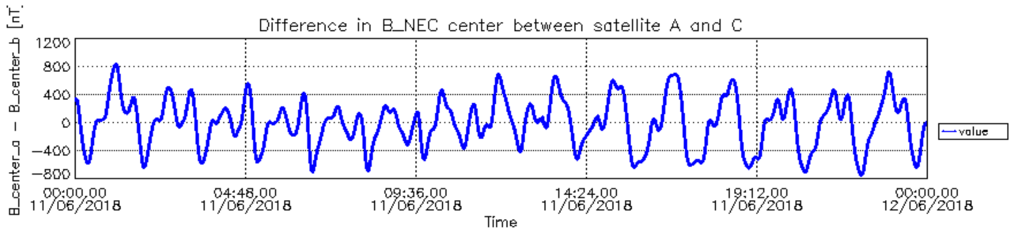


Figure 3-16: Difference in B_{NEC} Center component between S/C A and S/C C.

3.3.7 B_{NEC} vs Chaos5 model residuals

The magnetic field measurement is compared to magnetic field estimated from the Chaos5 global geomagnetic field model (only Core and Crustal contributions). Currently in the monitoring routines the external contribution based on Dst index is not taken into account.

Figure 3-17, Figure 3-19 and Figure 3-21 show field residuals $dB=B_{NEC} - B_{Chaos}$ (all versus co-latitude in degrees), from top to bottom: 1) Br, 2) Bθ and 3) Bφ.

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 3-18, Figure 3-20 and Figure 3-22 show, from top to bottom, the time series on 11/06 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 +/- 200 nT.

3.3.7.1 Swarm A

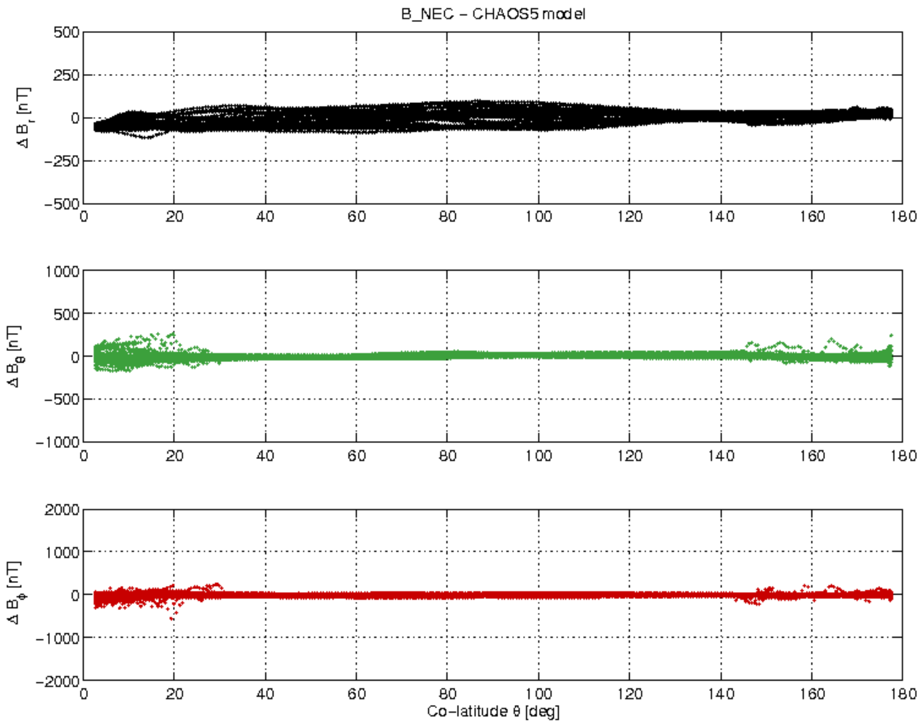


Figure 3-17: S/C A day 11.06 B_{NEC} - B_{Chaos} vs colatitude.

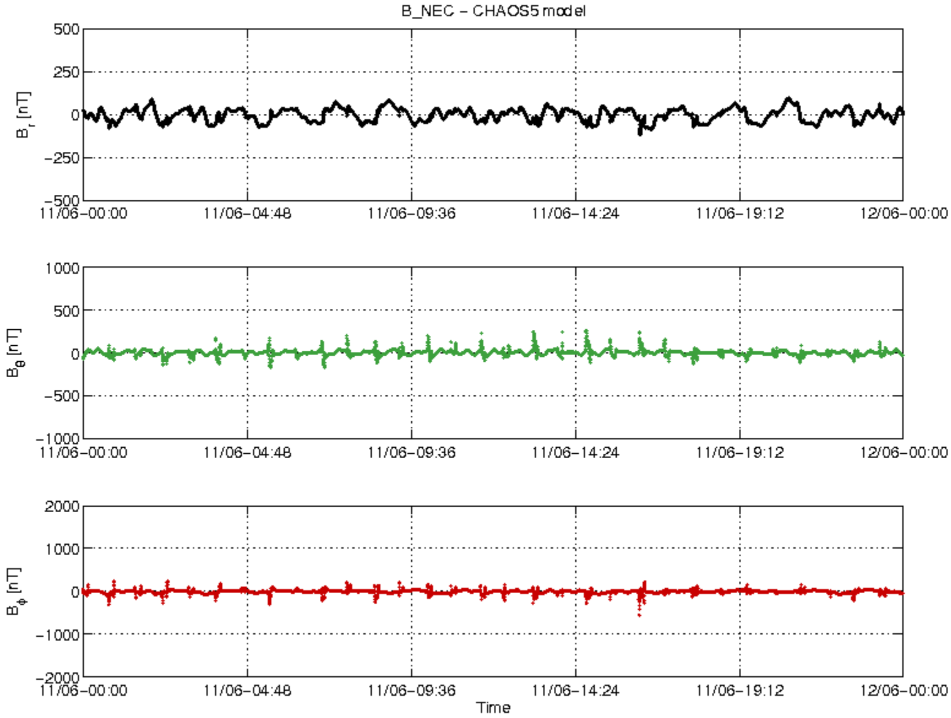


Figure 3-18: S/C A day 11.06: time series of $B_{NEC} - B_{Chaos}$ residuals.

3.3.7.2 Swarm B

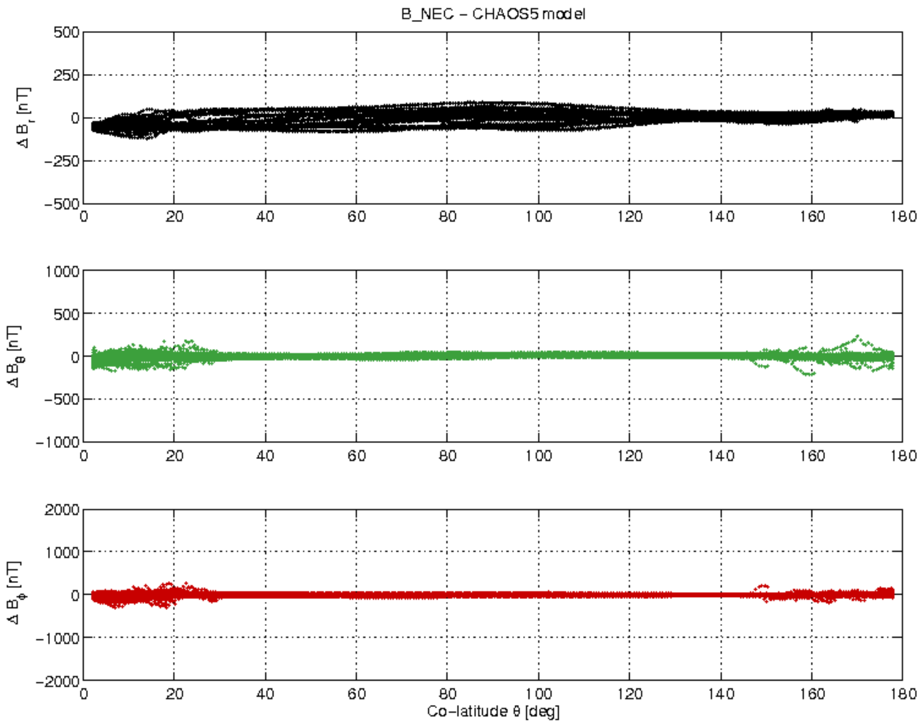


Figure 3-19: S/C B day 11.06 B_{NEC} - B_{Chaos} difference vs colatitude.

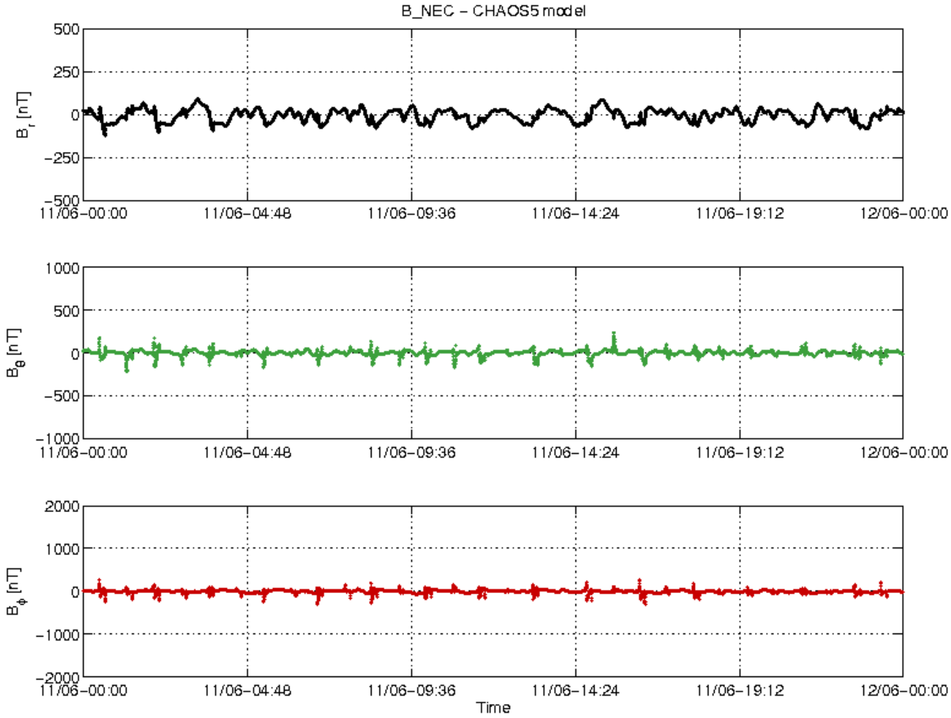


Figure 3-20: S/C B day 11.06 time series of $B_{NEC} - B_{Chaos}$ residuals.

3.3.7.3 Swarm C

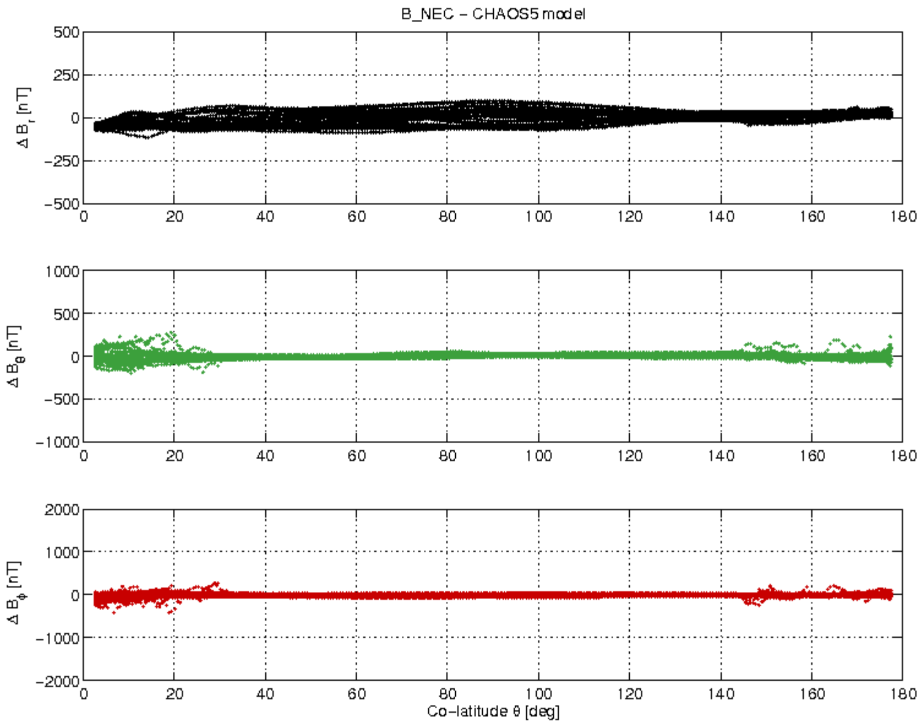


Figure 3-21: S/C C day 11.06 B_{NEC} - B_{Chaos} difference vs colatitude.

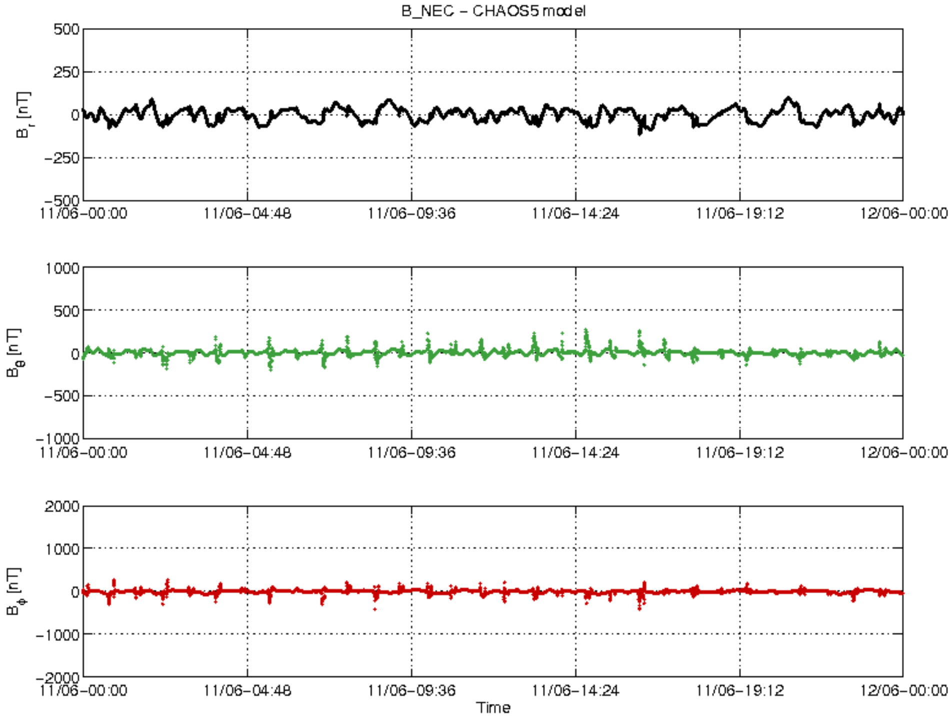


Figure 3-22: S/C C day 11.06 time series of B_{NEC} – B_{Chaos} residuals.

3.3.8 Second derivative of B_{NEC} and B_{VFM}

The second derivative of the vector magnetic field measurements in both VFM and NEC frame has been performed on 50Hz data (MAGx_HR_1B). In this analysis only measurement points within ±10° latitude have been considered. Figure 3-23, Figure 3-24 and Figure 3-25 show the daily standard deviation of the second derivative of BVFM of the last month for S/C A, B, and C respectively. Second derivative of B_{NEC} is not shown due to artificial spikes introduced during quaternions interpolation from 1Hz to 50Hz.

3.3.8.1 Swarm A

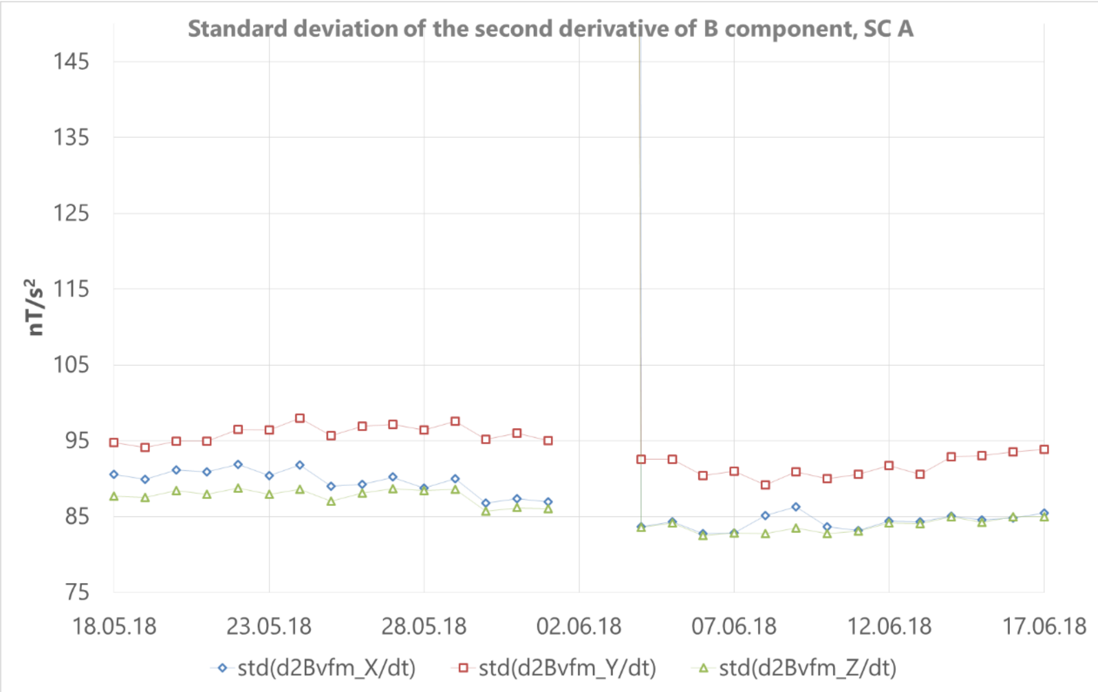


Figure 3-23: Standard deviation of the second derivative of B component

The spike observed on 3/06/2018 in the plot is caused by the bug in the script that occurs when there is a gap in the data used to calculate the standard deviation.

3.3.8.2 Swarm B

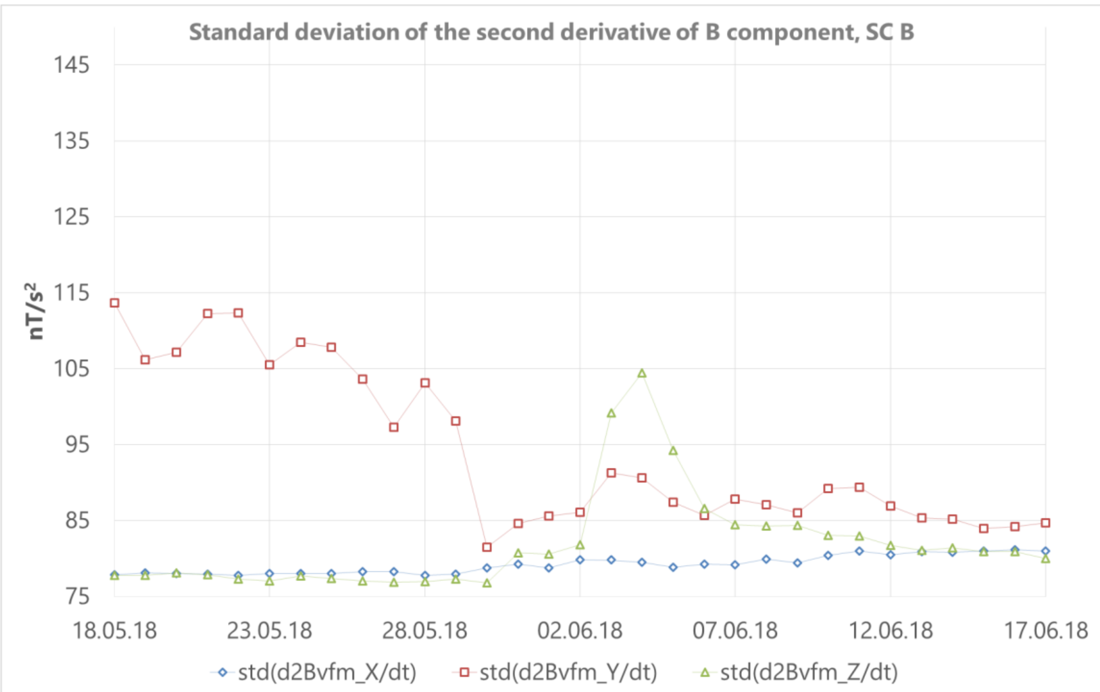


Figure 3-24: Standard deviation of the second derivative of B component

3.3.8.3 Swarm C

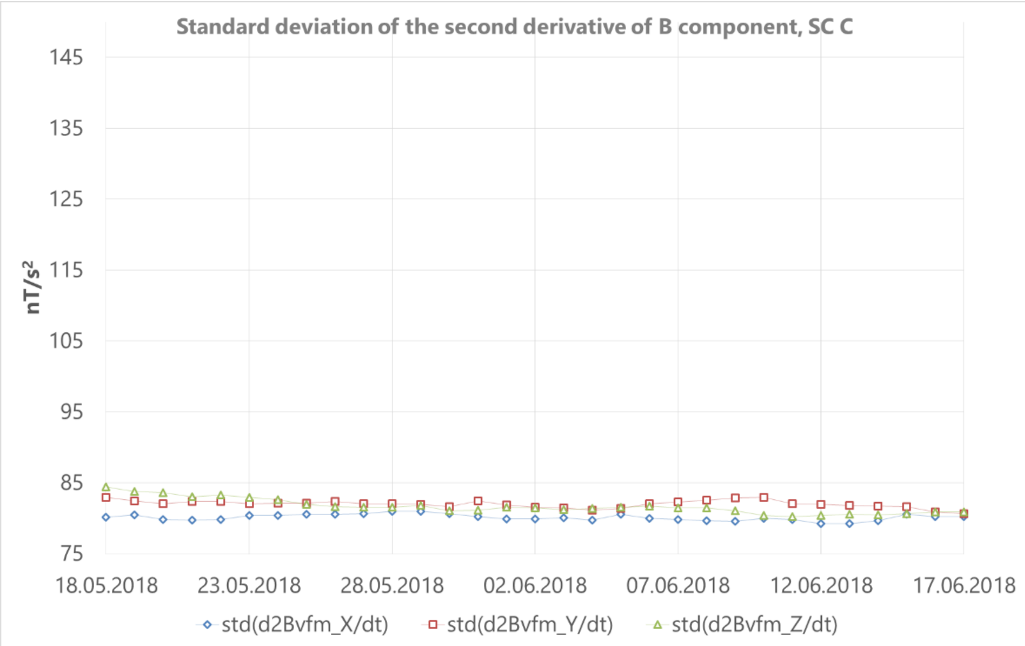


Figure 3-25: Standard deviation of the second derivative of B component

4. ON-DEMAND analysis

Nothing to report.

End of Document