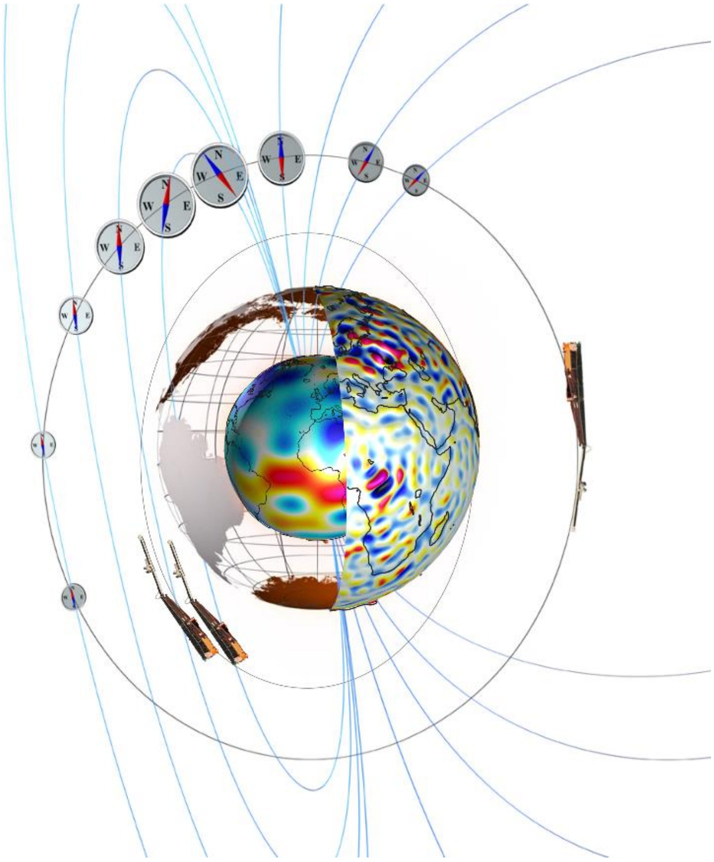
Swarm DISC Weekly Report 2018/44: 2018/10/29 - 2018/11/04



Abstract : This is the **Swarm Data Innovation and Science Cluster** (Swarm DISC) Weekly report on Swarm products quality, covering the period from 29 October to 04 November 2018.

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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

ISSUE	DATE	REASON
1.0	25 Jan 2019	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 2.4.

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 v3.20p1, L2-Cat2 v01.18p2.

- L0 input products baseline: 02
- L1B baseline: MAGNET and PLASMA 05, ORBATT and ACCELE 04 (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 03
- Input auxiliary files baseline: S/C A - CCDB 0020 (17/09/2018), S/C B – CCDB 0022 (19/10/2018), S/C C – CCDB 0021 (17/09/2018), ADF 0101
- MPPF-CVQ v.03.05

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

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

L1BOP: The next delivery of the L1BOP v03.21 (delivery date end February 2019) will contain only the porting of this processor to a more upgraded operational system, i.e., Red Hat Enterprise Linux 7.5. No evolutions of the L1B processor algorithm will be included in this delivery.

L2 Cat-2: The next delivery of the L2 Cat-2 OP v01.19 (delivery date Mid-March 2019) will contain only the porting of this processor to a more upgraded operational system, i.e., Red Hat Enterprise Linux 7.5. No evolutions of the L2 Cat-2 processor algorithms will be included in this delivery.

2.3 Quality Working Group and Cal/Val Coordination

The 8th Swarm Data Quality Workshop (DQW#8) held in ESA ESRIN from Monday 08th October (afternoon) to Friday 12th October 2018 (morning).

The main objectives of the workshop were to:

- Provide an overview of Swarm Mission status to the user Community
- Update the data quality status from Magnetic, Electric, GPSR and accelerometer measurements
- Discuss new Swarm-based Scientific results

Besides the usual Cal/Val topics, this Swarm DQW#8 has also allowed to address new technical, scientific and strategic challenges related to:

- Swarm-based Multi-disciplinary applications
- Swarm-based Data processing virtual environments
- Swarm-based Machine Learning methods
- Multi-mission synergies (e.g. with CryoSat, Goce, e-POP, CSES etc.)

The Swarm DQW#8 was an occasion to discuss potential synergetic benefits obtained through collaboration initiatives with ESA's partner agencies and other sensor systems.

A dedicated session on Swarm / Chinese CSES mission synergies were organized for the first time to further discuss and structure future joint Cal-Val activities and scientific cooperation.

All the presentations, discussions, and the summary of the recommendations based on the contributions from Swarm DQW#8 sessions can be found at (PDF version).

2.4 Summary of observations for 2018, Week 44 (29/10 - 04/11)

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

3. Routine Quality control

3.1 Gaps analysis

- Several short duration time gaps (duration from 1 to 4s) found in HK_ANOM_0_ from 07:25:36 till 07:28:18 on day 02/11/2018. It does not affect other products.
- Several short duration time gaps (duration 1 to 4s) found in HK_BNOM_0_ from 09:36:23 till 09:38:06 on day 02/11/2018. It does not affect other products.
- Time gaps found in STRC_NOM_0 from 18:00:01 till 18:00:03 on day 31/11/2018. It affects magnetic products: MAGx_LR, MAGx_HR and MAGx_CA.
- Time gaps found in HK_CNOM_0_ from 08:59:51 till 09:01:35 on day 02/11/2018. It does not affect other products.

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 44: 29/10 - 04/11.

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, 29/10 - 04/11, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
29/10	0,06	-6,6	7 (Y)	1,19	
30/10	0,15	-8,7	8,9	1,35	
31/10	0,15	-6,6	8,9	1,22	
01/11	0,08	-7,8	12	1,49	
02/11	0,15	-8,1	7,3	1,42	
03/11	0,07	-6	7,3	1,29	
04/11	0,12	-7,2	9,6	1,3	
Swarm B, 29/10 - 04/11, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
29/10	0,06	-6,6	8,1	1,04	
30/10	0,1	-6,3 (X)	11,9	1,32	
31/10	0,08	-9,2	8,5	1,21	
01/11	0,18	-10	9	1,38	
02/11	0,24	-8 (X)	5,7 (X)	1,24	
03/11	0,06	-8,7	6,9	1,18	
04/11	0,1	-7	9,1	1,12	
Swarm C, 29/10 - 04/11, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Standard deviation (m)**	**Notes**
29/10	0,06	-7,4	6,9	1,18	
30/10	0,1	-9,4 (X)	7,2 (X)	1,29	
31/10	0,15	-9,8 (X)	6,8 (Y)	1,22	
01/11	0,1	-6,8	12,3	1,5	
02/11	0,18	-8,2	8,7 (Y)	1,38	
03/11	0,03	-7,2	5,9 (X)	1,23	
04/11	0,16	-6,2	7,6	1,24	

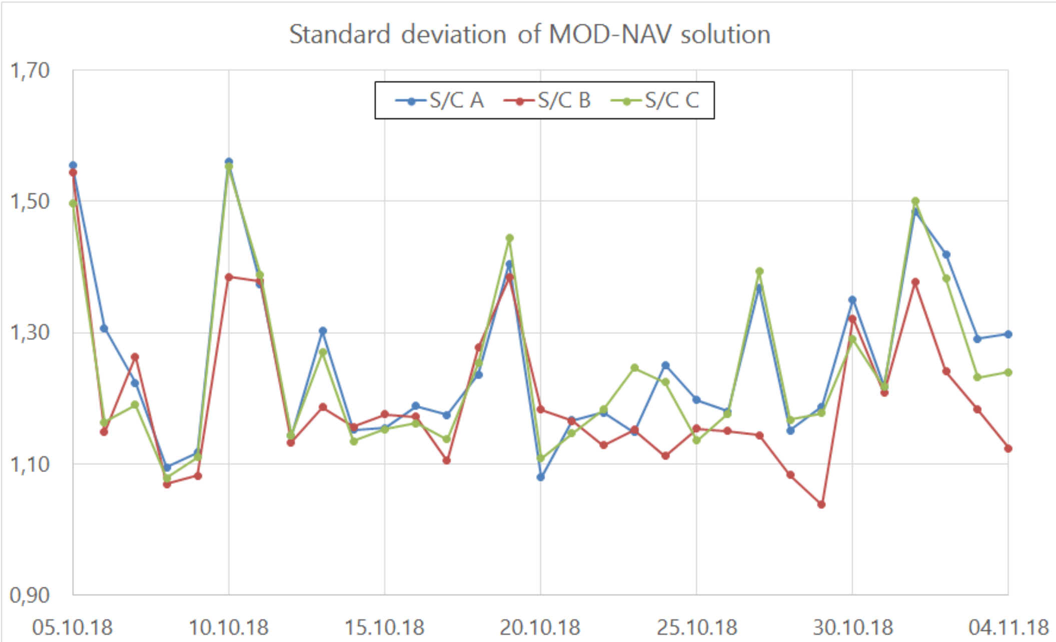


Figure 3-1: Plot of the standard deviation of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

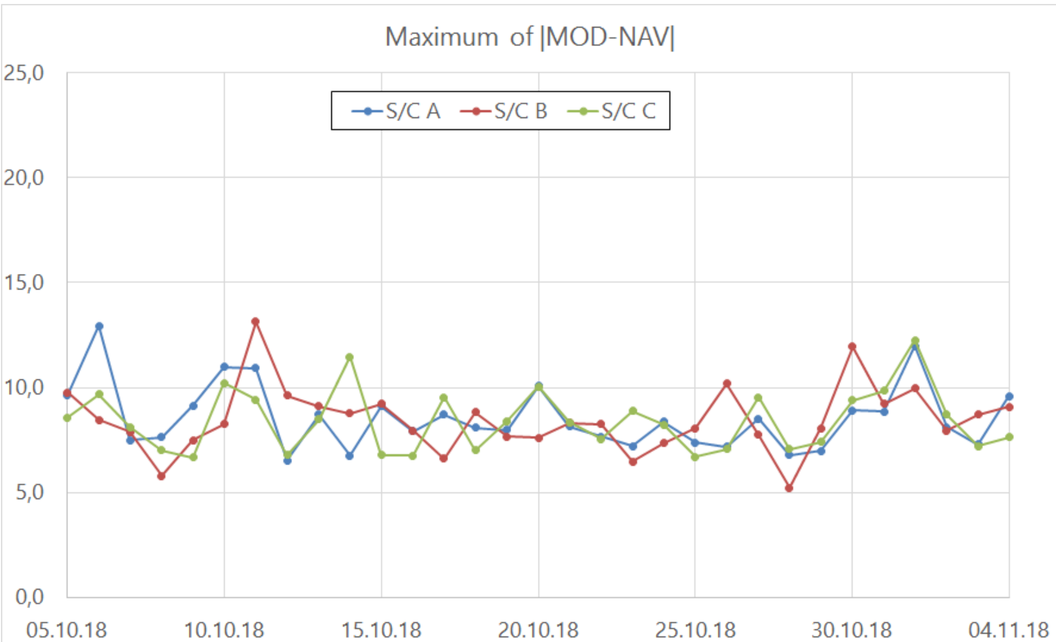


Figure 3-2: Plot of the maximum difference of the absolute value of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

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 (29.10, 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].

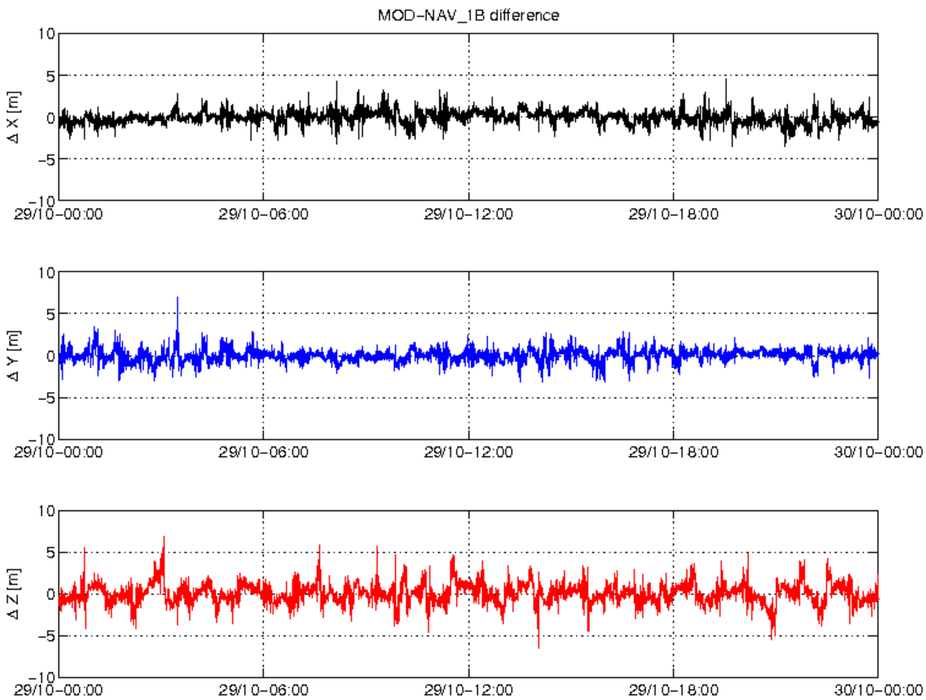


Figure 3-3: Difference MOD-GPSNAV, S/C A, 29.10. From top to bottom: X, Y and Z-axis

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 (29.10, 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].

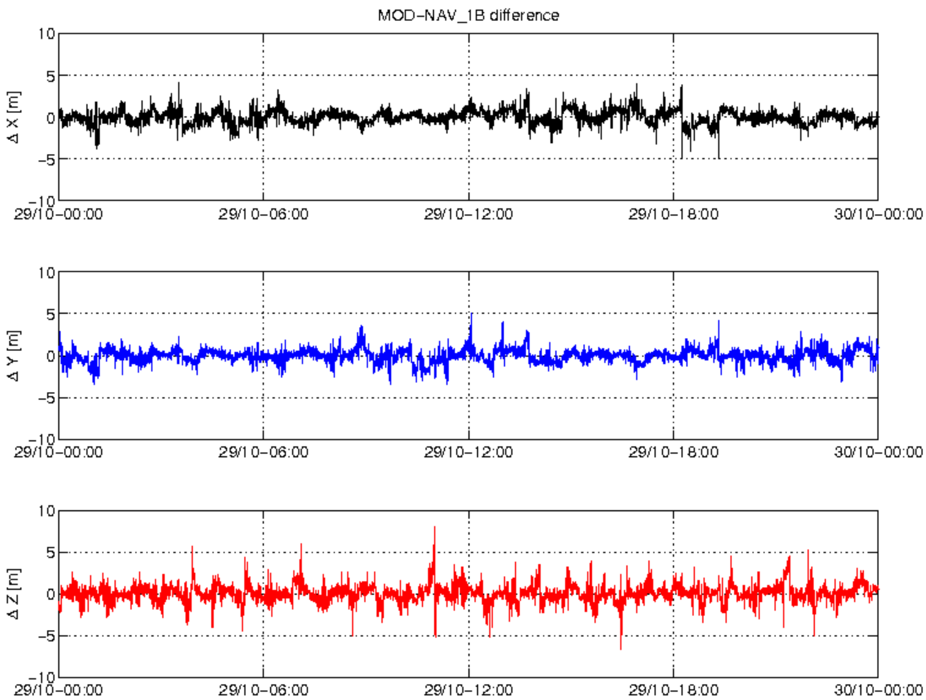


Figure 3-4: Difference MOD-GPSNAV, S/C B, 29.10. From top to bottom: X, Y and Z-axis

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 (29.10, 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].

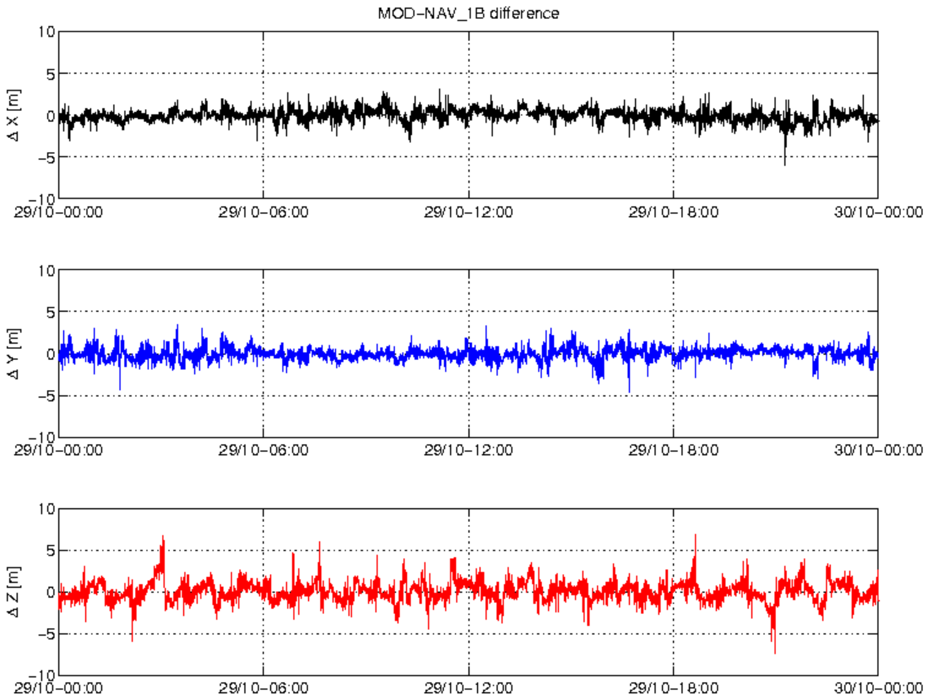


Figure 3-5: Difference MOD-GPSNAV, S/C C, 29.10. From top to bottom: X, Y and Z-axis

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 44: 29/10 - 04/11.

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

3.3.1 VFM-ASM anomaly

- S/C A – no violation.
- S/C B – no violation.

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, 29/10 - 04/11, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
29/10	0,55	-0,33	0,15	0,083	
30/10	0,67	-0,42	0,19	0,086	
31/10	0,57	-0,46	0,2	0,087	
01/11	0,57	-0,37	0,17	0,1	
02/11	0,59	-0,54	0,21	0,087	
03/11	0,67	-0,51	0,21	0,116	
04/11	0,78	-0,48	0,22	0,1	

Swarm B, 29/10 - 04/11, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
29/10	0,9	-0,47	0,36	0,067	
30/10	0,87	-0,42	0,33	0,075	
31/10	0,98	-0,45	0,38	0,079	
01/11	0,94	-0,48	0,37	0,089	
02/11	0,92	-0,39	0,34	0,102	
03/11	0,8	-0,37	0,29	0,099	
04/11	0,78	-0,37	0,23	0,103	

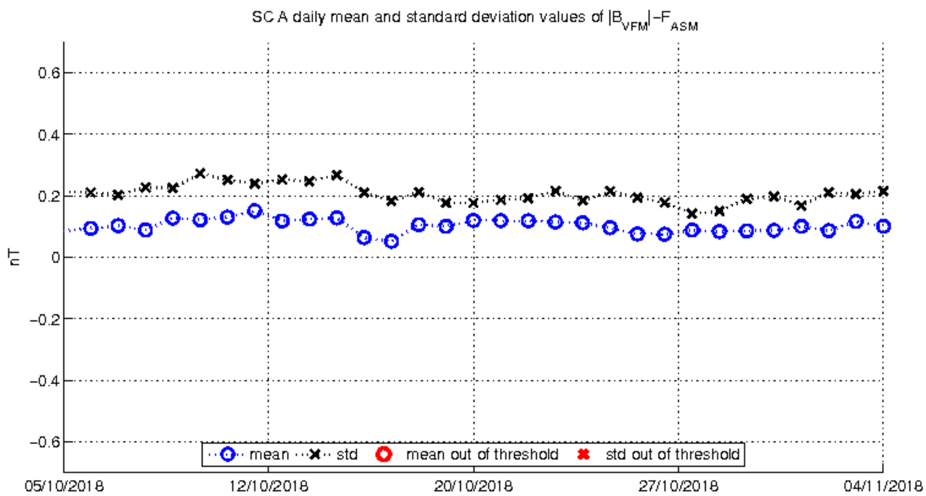


Figure 3-6: Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C A.

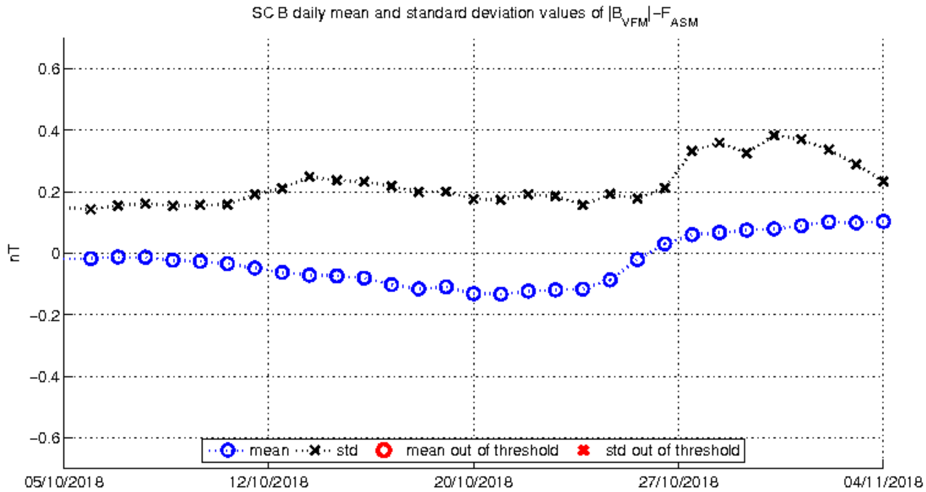


Figure 3-7: Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C B.

3.3.1.2 Swarm A

The daily peak-to-peak difference around the week stays within [-0,54 - 0,78] nT. Below follow two plots of such differences for current week (Figure 3-8).

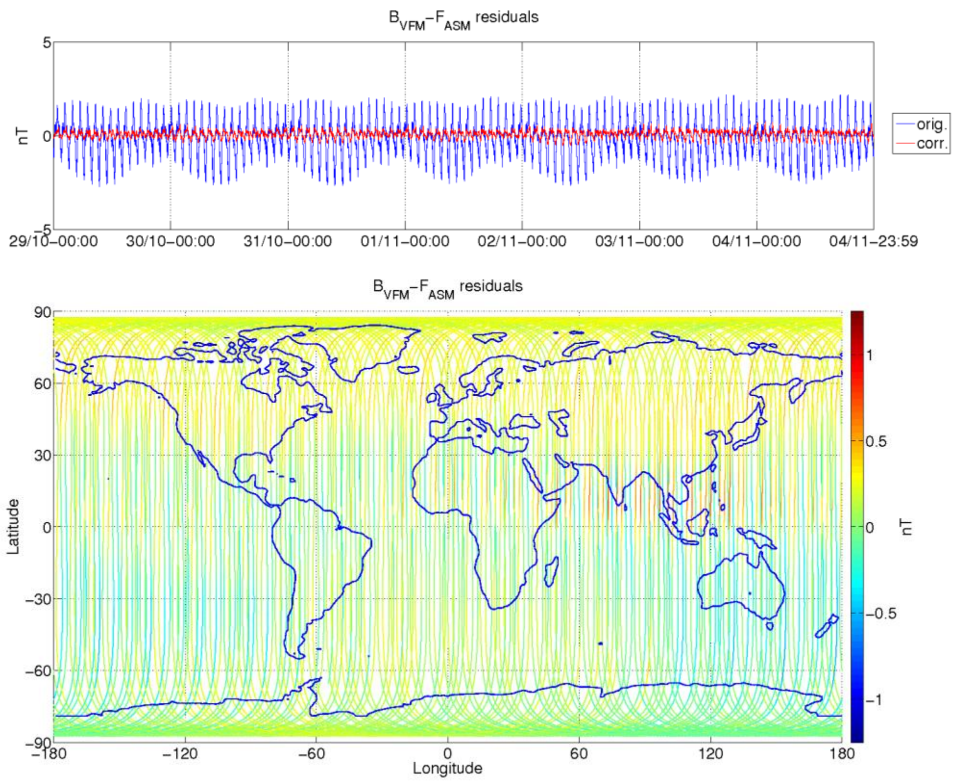


Figure 3-8: ASM-VFM residuals for S/C A, during monitoring period 29/10-04/11. In top figure are plotted: difference between |B_VFM| and F_ASM (without dB_Sun correction) (blue colour), and the residuals with dB_Sun corrections (red colour). In bottom figure residuals are presented on the world map.

3.3.1.3 Swarm B

The daily peak-to-peak difference around the week stays within [-0,48 - 0,98] nT. Below follow two plots of such differences for current week (Figure 3-9).

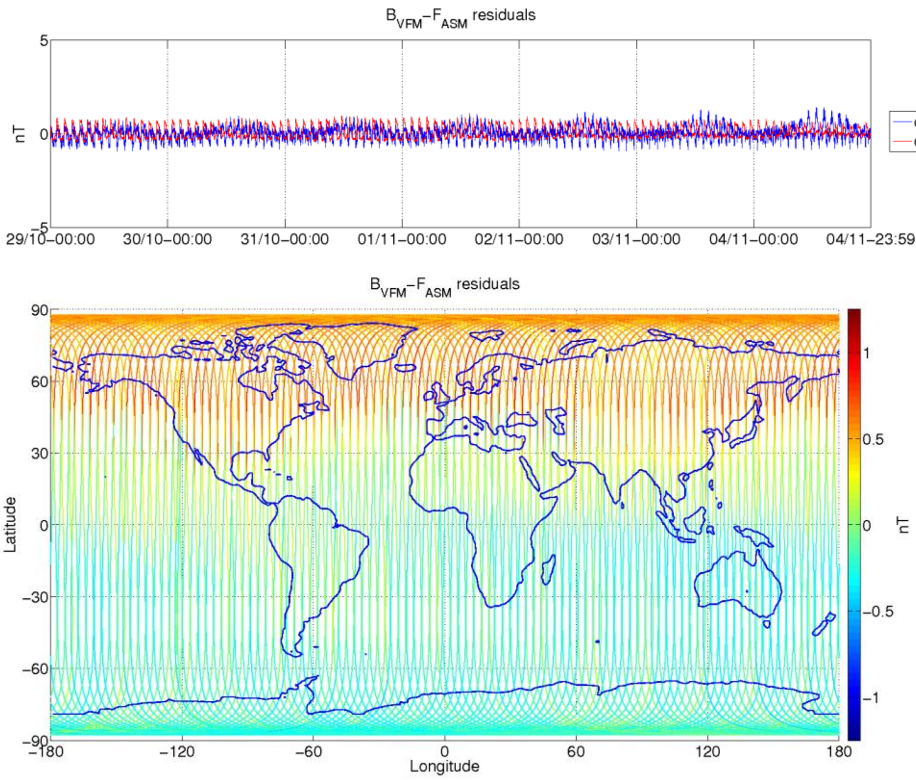


Figure 3-9: ASM-VFM residuals for S/C B, during monitoring period 29/10-04/11. In top figure are plotted: difference between |B_VFM| and F_ASM (without dB_Sun correction) (blue colour), and the residuals with dB_Sun corrections (red colour). In bottom figure residuals are presented on the world map.

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)

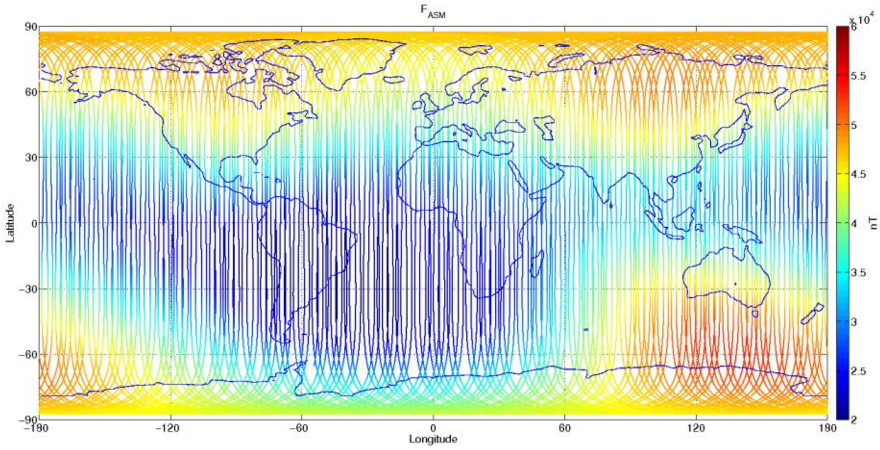
The VFM instrument parameters important for monitoring the instrument health are the VFM sensor temperatures: T_CDC, T_CSC and T_EU.

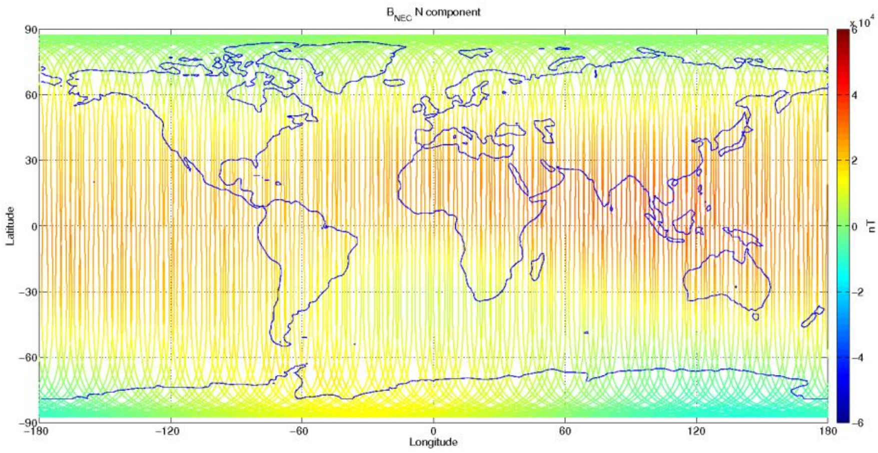
For S/C A, B and C, for reported period, the temperatures behaved as expected.

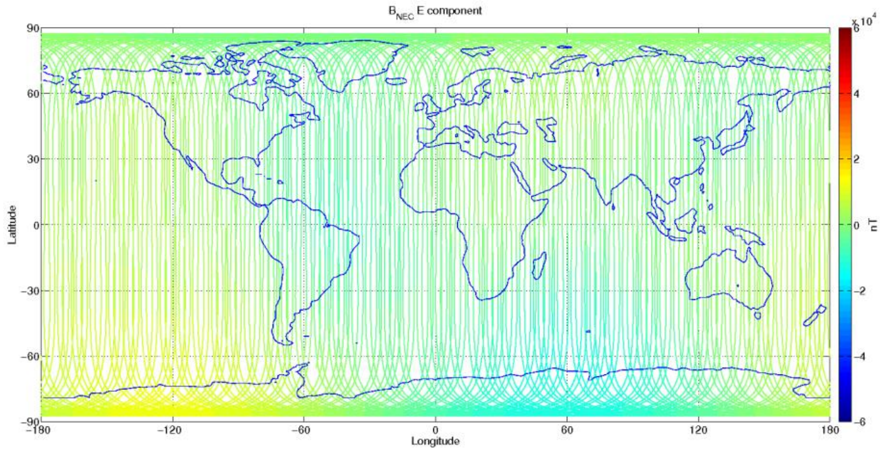
3.3.4 Magnetic time series visual inspection

3.3.4.1 Swarm A

Map plots of magnetic field measurement for week 44 for S/C A can be seen in Figure 3-10 below.







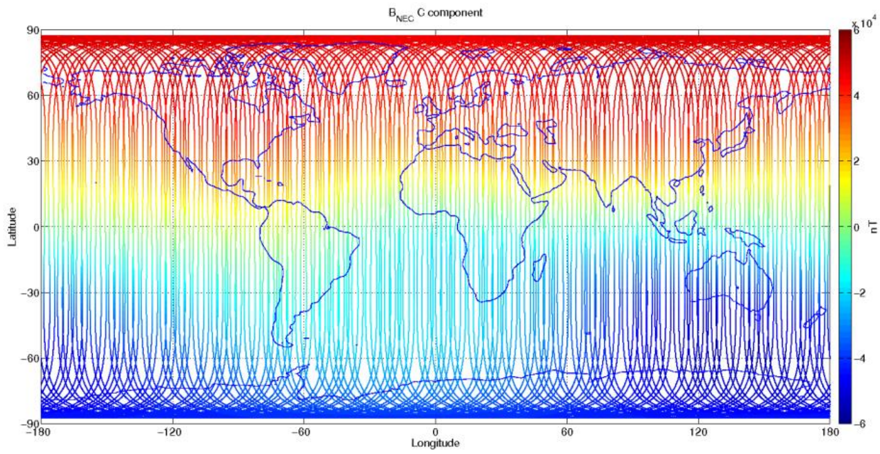
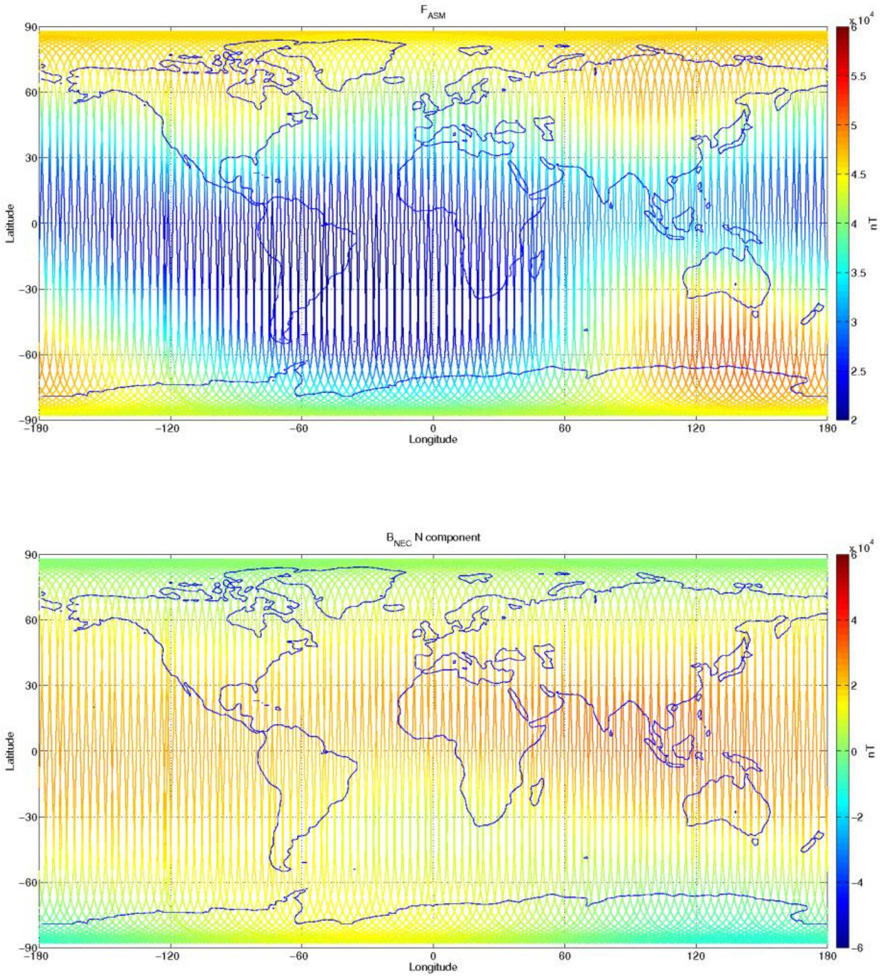
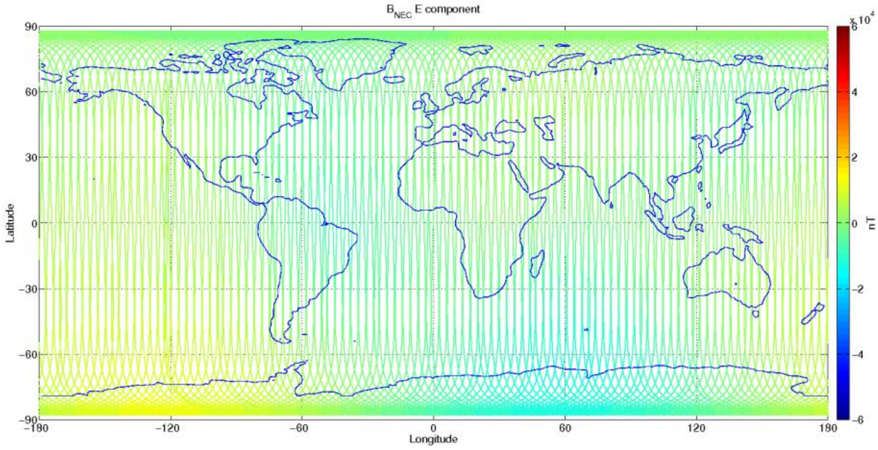


Figure 3-10: S/C A, world map plots of the geomagnetic field and components measured during monitoring period 29/10-04/11. From top to bottom: F-magnetic field from ASM measurement, B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

3.3.4.2 Swarm B

Map plots of magnetic field measurement for week 44 for S/C B can be seen in Figure 3-11 below.





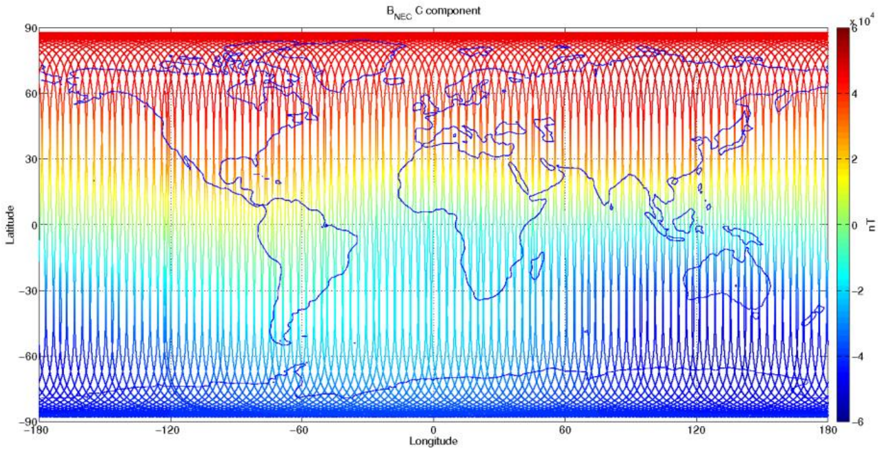
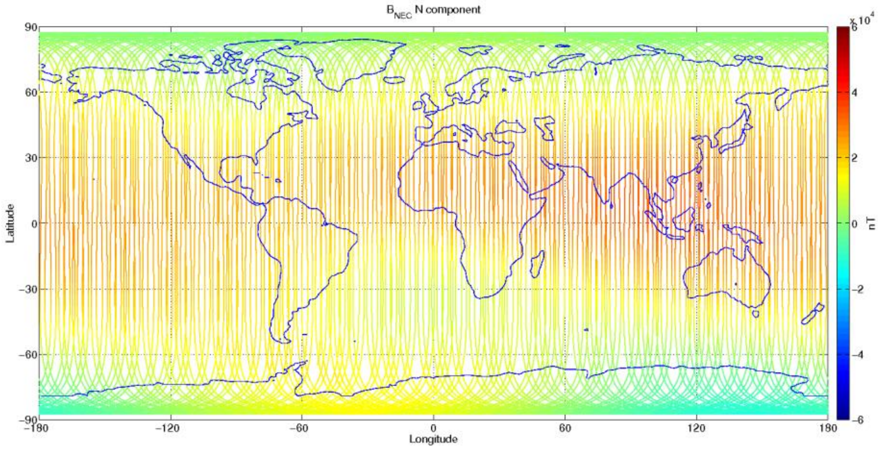
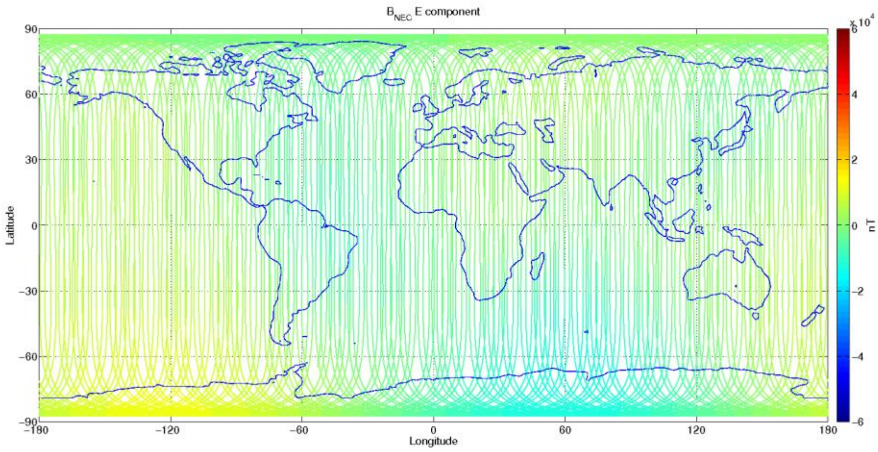


Figure 3-11: S/C B, world map plots of the geomagnetic field and components measured during monitoring period 29/10-04/11. From top to bottom: F-magnetic field from ASM measurement, B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

3.3.4.3 Swarm C

Map plots of magnetic field measurement for week 44 for S/C C can be seen in Figure 3-12.





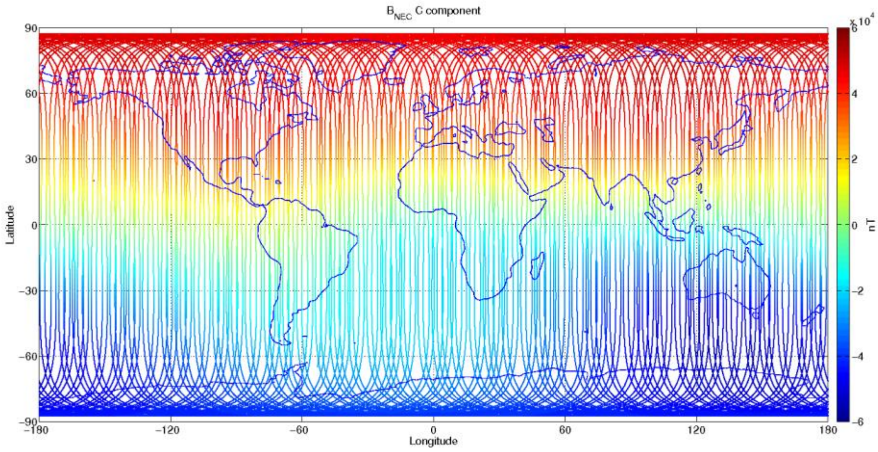


Figure 3-12: S/C C, world map plots of the geomagnetic field and components measured during monitoring period 29/10-04/11. From top to bottom: B_{NEC} components (North, East, and Centre) of magnetic field from VFM measurement.

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.

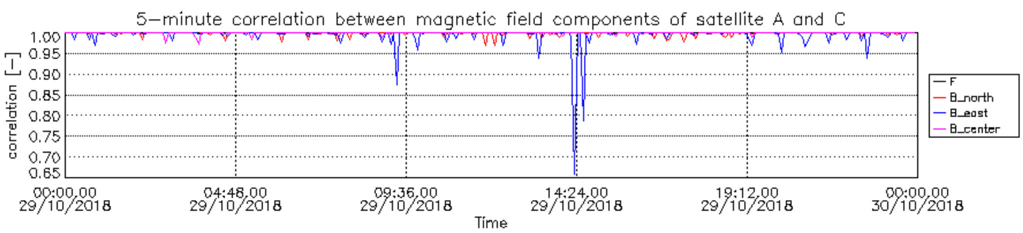


Figure 3-13: Correlation in magnetic data between satellite A and C for B_north, B_east, and B_center components of B_{NEC} are the components of the magnetic field vector in NEC frame

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.

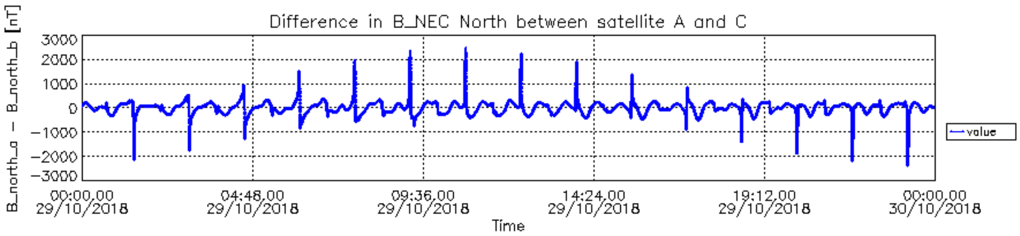


Figure 3-14: Difference in B_{NEC} North component between S/C A and S/C C.

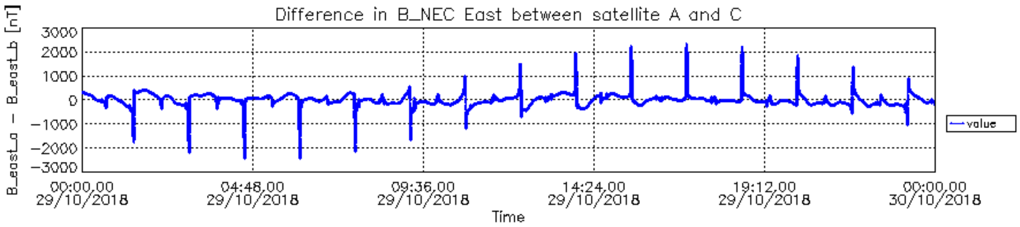


Figure 3-15: Difference in B_{NEC} East component between S/C A and S/C C.

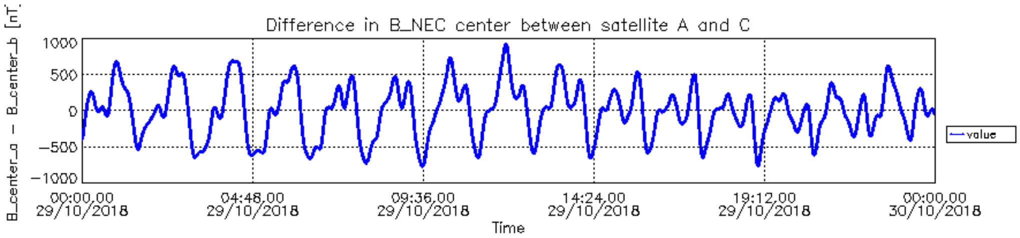


Figure 3-16: Difference in B_{NEC} Center component between S/C A and S/C C.

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 3-22show, from top to bottom, the time series on 29/10 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

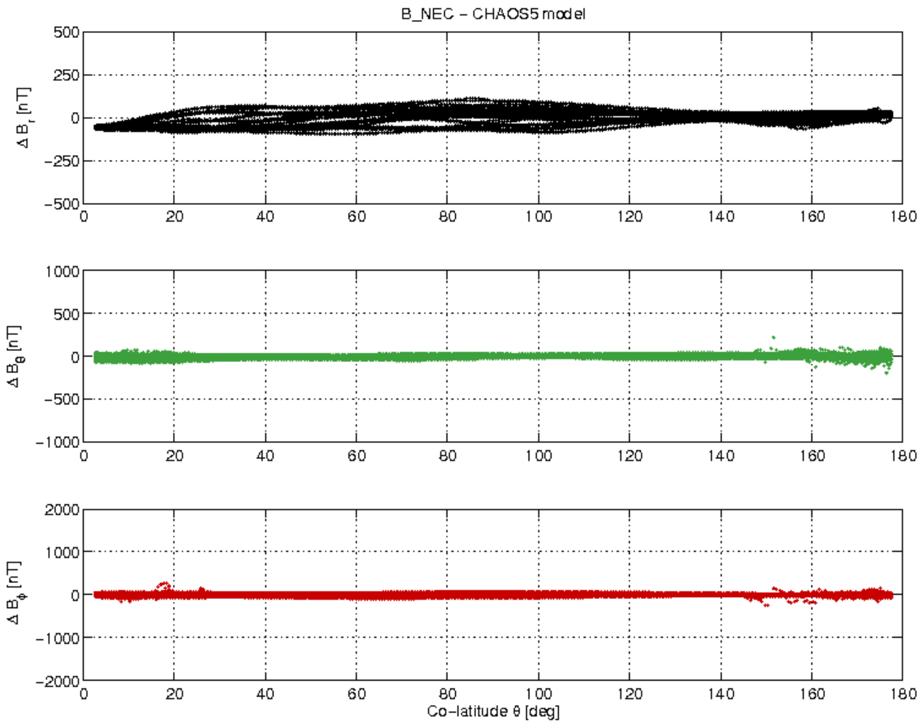


Figure 3-17: S/C A day 29.10 B_{NEC} - B_{Chaos} vs colatitude.

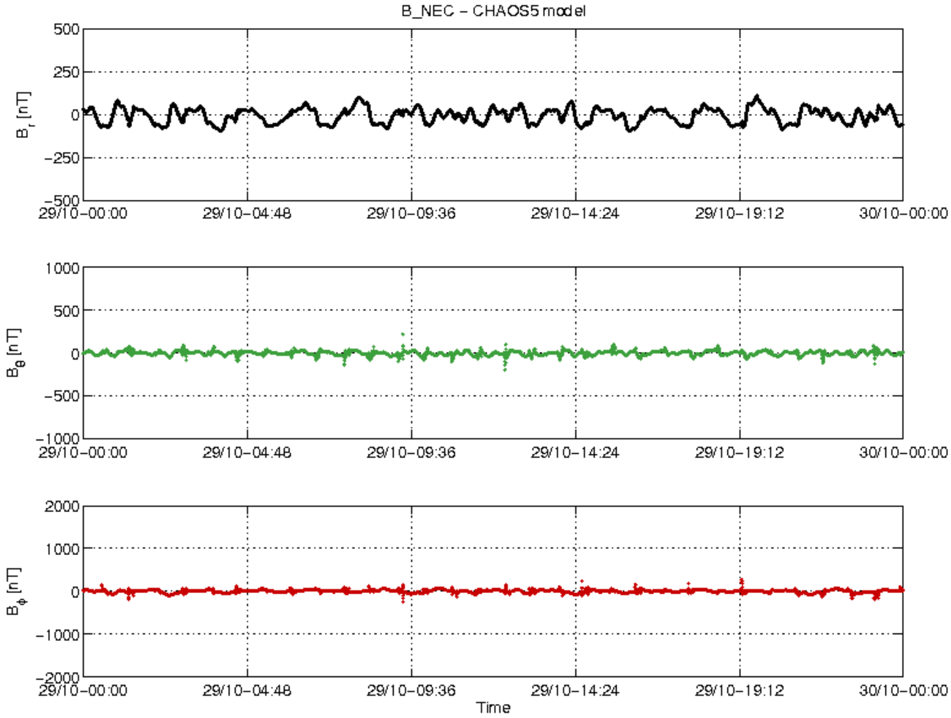


Figure 3-18: S/C A day 29.10: time series of $B_{NEC} - B_{Chaos}$ residuals.

3.3.7.2 Swarm B

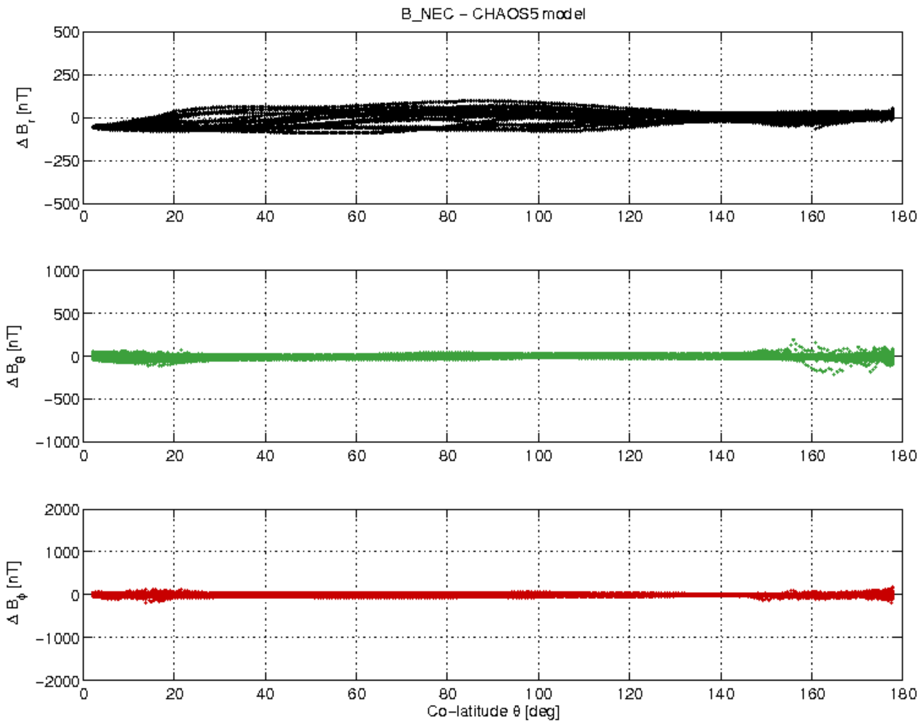


Figure 3-19: S/C B day 29.10 B_{NEC} - B_{Chaos} difference vs colatitude.

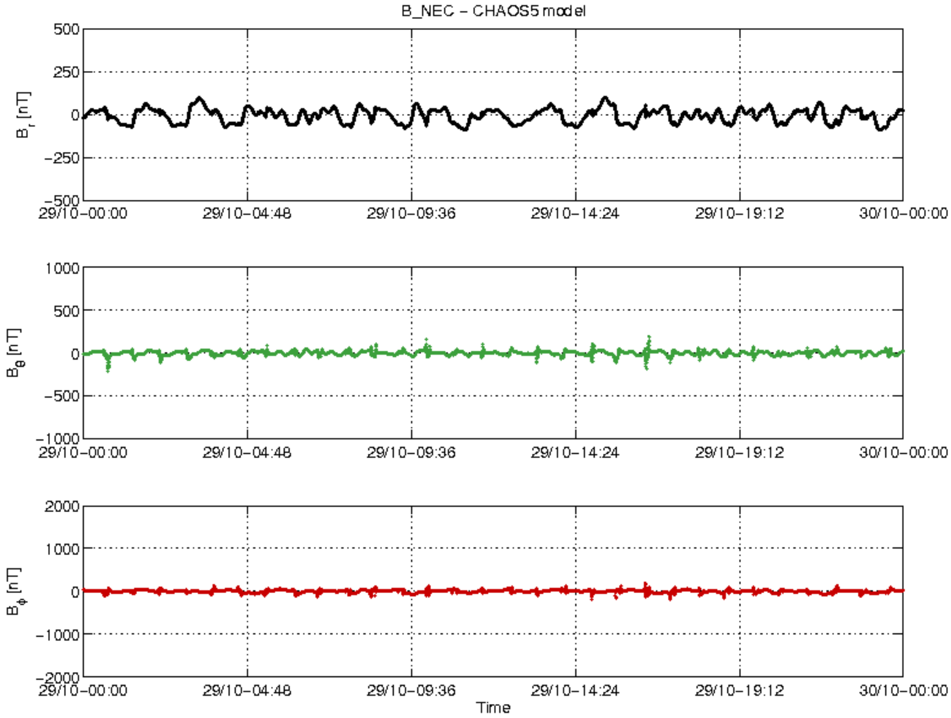


Figure 3-20: S/C B day 29.10 time series of $B_{NEC} - B_{Chaos}$ residuals.

3.3.7.3 Swarm C

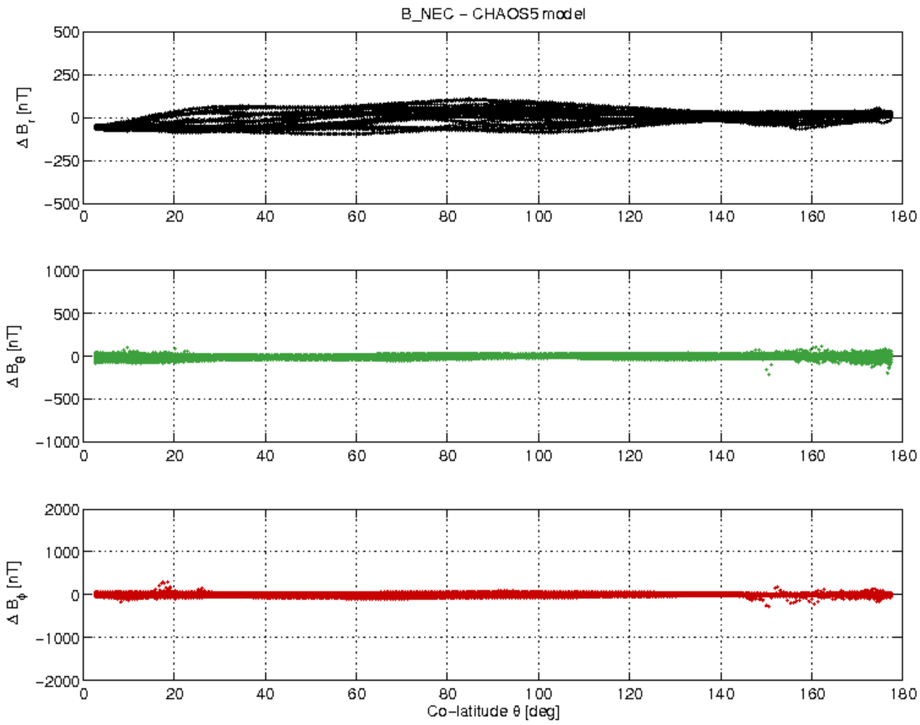


Figure 3-21: S/C C day 29.10 B_{NEC} - B_{Chaos} difference vs colatitude.

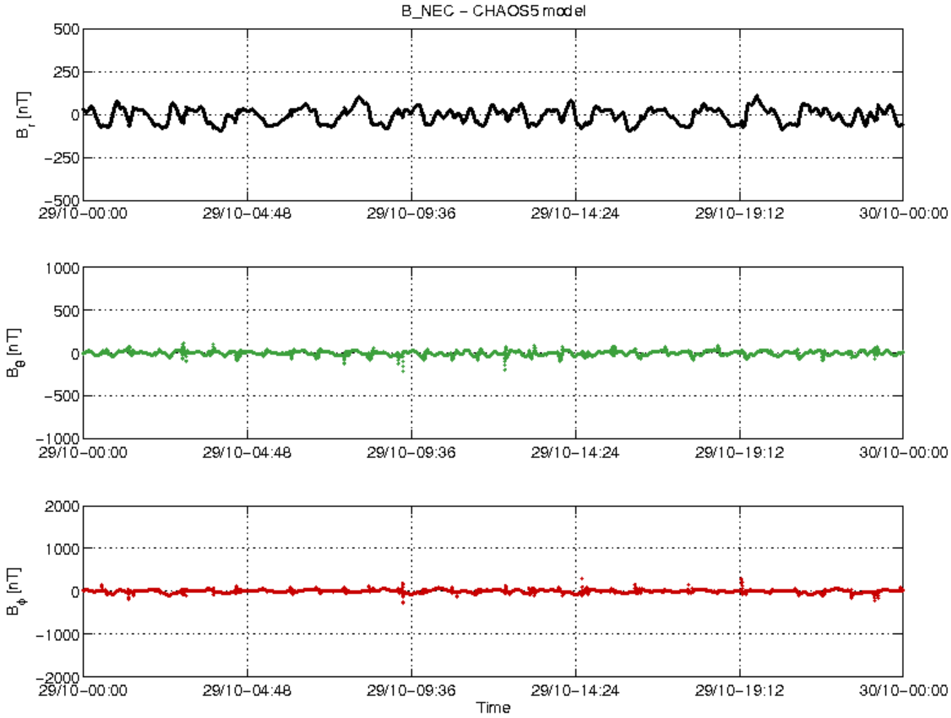


Figure 3-22: S/C C day 29.10 time series of $B_{NEC} - B_{Chaos}$ residuals.

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

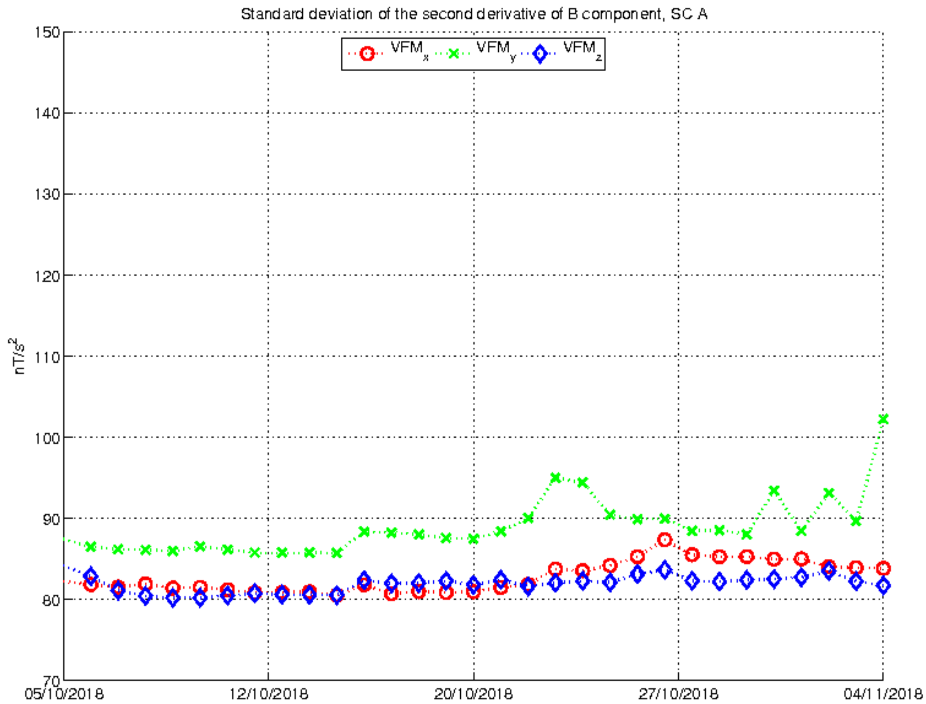


Figure 3-23: Standard deviation of the second derivative of B component

3.3.8.2 Swarm B

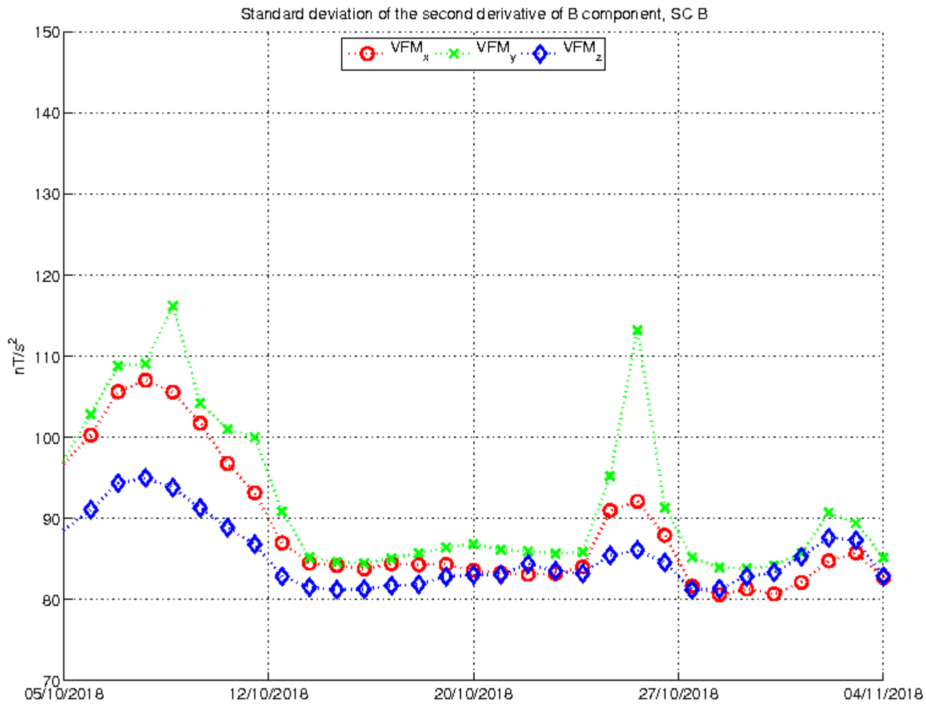


Figure 3-24: Standard deviation of the second derivative of B component

3.3.8.3 Swarm C

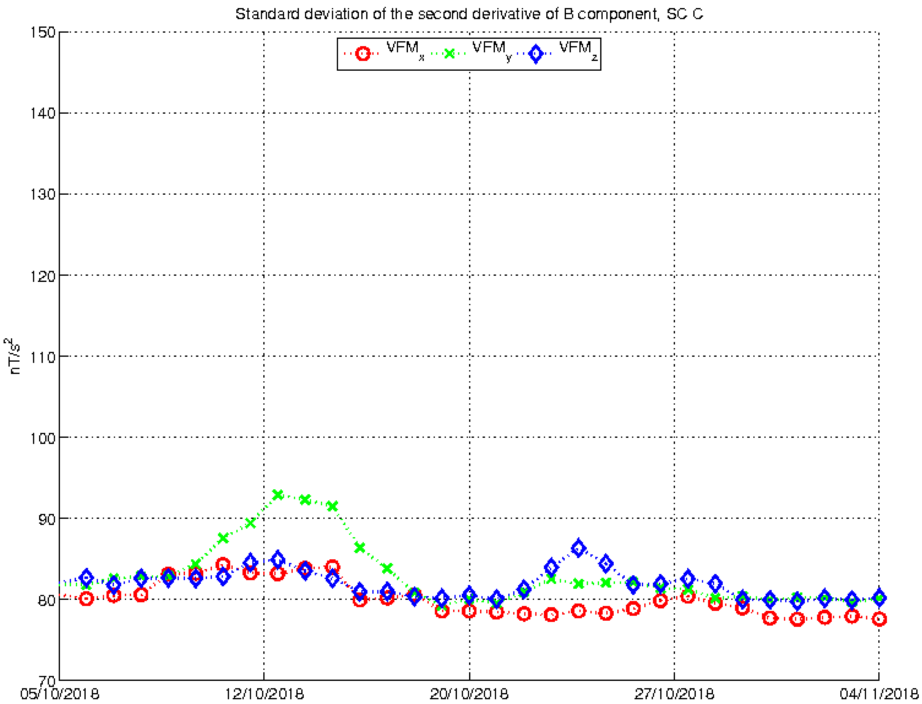


Figure 3-25: Standard deviation of the second derivative of B component

4. ON-DEMAND analysis

Nothing to report.

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