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IDEAS+ Swarm Weekly Report 2015/44: 2015/10/26 - 2015/11/01

Abstract : This is the **Instrument Data quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 26 October to 11 January 2015.

Author :
Igino Coco, Jan Miedzik and Enkelejda Qamili on behalf of Swarm IDEAS+ Team

Approval :
Lidia Saavedra de Miguel
IDEAS+ Science and Ops. 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

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

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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	10 Nov 2015	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.p1.
- 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 0005 (20/07/2015), ADF 0101
- MPPF-CVQ v.2.14.01

1.2 Reference documents

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

[RD.1] Sensor Performance, Products and Algorithms (SPPA), PGSI-GSOP-EOPG-TN-05-0025. Version 2.3.

[RD.2] Swarm PDGS External DMC Interface Control Document, SW-ID-DS-GS-0001, Issue 3.2.

[RD.3] Swarm MPPF-CVQ Monitoring Baseline Document, ST-ESA-SWARM-MBD-0001, Issue 1.7.

[RD.4] Swarm Level 1B Product Definition, SW-RS-DSC-SY-0007, Issue 5.13.

[RD.5] Swarm IDEAS Configuration Management Plan, IDEAS-SER-MGT-PLN-1081 v0.14.

[RD.6] Swarm Quality Control Project Plan, IDEAS-SER-MGT-PLN-1071

[RD.7] SW_L1BOP_status_20141124_MoM

[RD.8] Planned Updates for Level 1b, SW-PL-DTU-GS-008, Rev: 1dC.

[RD.9] IDEAS+ Swarm Weekly Report: 25/08/2014 – 31/08/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140825_20140831.pdf (ref. for SWL1L2DB-9)

[RD.10] IDEAS+ Swarm Weekly Report: 29/09/2014 – 05/10/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140929_20141005.pdf (ref. for SW-IDEAS-34)

[RD.11] IDEAS+ Swarm Weekly Report: 06/10/2014 – 12/10/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20141006_20141012.pdf (ref. for SW-IDEAS-36)

[RD.12] IDEAS+ Swarm Weekly Report: 20/10/2014 – 26/10/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20141020_20141026.pdf (ref. for SW-IDEAS-40, GPS sync loss)

[RD.13] IDEAS+ Swarm Weekly Report: 15/09/2014 – 21/09/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140915_20140921.pdf (ref. for SW-IDEAS-27)

[RD.14] Swarm L1B 03.15 Validation Report, OSMV-OPMT-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

2. SUMMARY OF THE OBSERVATIONS

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

- **Errata Corrige on EFI anomaly on Swarm B, 02/11/2015:** an attempt to uplink the updated gain map for the TII CCD caused the instrument to fail the switch-on into ready state. Fortunately, the commands were sent again the day after, ~~recovering the old gain maps~~, and the operation was successful. Now the EFI on B is up and running nominally, **with the new gain maps**.

2.2 Plan for operational processor updates

The L2Cat2 1.15 patch 3 has been deployed in operations on 09/11. FAC data of the past months are being regenerated. A gap in FAC data will still hold, from 02/06 to 15/07/2015, due to the fact that the Level 1B magnetic data needed as inputs for the FAC chain are available with baseline 04 (i.e. corrected from ASM-VFM residuals) only from 16/7/2015, when the PDGS deployed the new L1BOP 3.16 in operations. GFZ has been asked to provide the data for filling the gap.

Investigations on the FAC AC failure on day 27/10 led to the following conclusion: the problem relies on the input data, because in the MAGC_LR_1B of day 27/10, two records exist with exactly the same latitude value; The FAC AC algorithms compute record by record the distance of the S/C from the point of maximum latitude and fall therefore in a conflict. A robustness will be introduced in the FAC AC processor for handling such situations, but now the investigation has been shifted on the magnetic inputs, in order to understand why such latitude duplication occurs.

2.3 Quality Working Group and Cal/Val Coordination

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

- Investigation on boom alignment error budget (from industry) that could help in developing a thermos-elastic correction approach.

- Investigation on plasma-induced stray field in order to focus on any possible current flow near the VFM (and not the ASM), because the intensity of such a current may be stronger near the VFM due to the accumulation of charged plasma particles near the STR baffles.

In the meantime, DTU will deliver an ASM-VFM residual dataset to be distributed to all the Swarm users through the ESA FTP server (/Advanced folder).

2.4 Summary of observations for 2015, Week 44 (26/10 - 11/01)

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

- Gaps in all L0 products which resulted in L1B gaps on S/C C on 26th Oct, more details in following section.

- **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

- **Gaps in all L0 products on S/C C on 26th Oct** (see table below). Summing up all the occurrences, the total extent of the gaps barely exceeds one minute, which is well below the threshold required for triggering a data re-dump. Such telemetry losses occur at times (fortunately not very often), and depend on communication failures between the receiving ground station and the S/C S-band antennae. Nevertheless, an investigation towards FOS has been opened to clarify the cause of such gaps.

Start of time anomaly	End of time anomaly	Anomaly size [s]
26/Oct 22:15:54	26/Oct 22:15:56	2
26/Oct 22:15:59	26/Oct 22:16:01	2
26/Oct 22:16:12	26/Oct 22:16:15	3
26/Oct 22:16:17	26/Oct 22:16:19	2
26/Oct 22:16:21	26/Oct 22:16:25	4
26/Oct 22:16:25	26/Oct 22:16:31	6
26/Oct 22:16:32	26/Oct 22:16:36	4
26/Oct 22:16:36	26/Oct 22:16:40	4
26/Oct 22:16:40	26/Oct 22:17:01	21
26/Oct 22:17:02	26/Oct 22:17:12	10
26/Oct 22:17:12	26/Oct 22:17:21	9
26/Oct 22:17:21	26/Oct 22:17:25	4
26/Oct 22:17:25	26/Oct 22:17:32	7
26/Oct 22:17:33	26/Oct 22:17:38	5
26/Oct 22:17:38	26/Oct 22:17:42	4
26/Oct 22:17:42	26/Oct 22:17:44	2
26/Oct 22:17:44	26/Oct 22:17:46	2
26/Oct 22:17:47	26/Oct 22:17:51	4
26/Oct 22:17:55	26/Oct 22:17:58	3
26/Oct 22:18:05	26/Oct 22:18:07	2

- **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 2015, Week 44: 26/10 - 11/01.

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

		parameter	Description	Analysis
SW-IDEAS-63	OBS_ROUTINE: MAGx_CA_1B gaps	MAGx_CA_1B	3.1	3.1

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

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

Swarm A, 26/10 - 11/01, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Maximum standard deviation (m)**	**Notes**
26/10	0.11	-7.9	7.1 (X)	1.16	
27/10	0.14	-6.9 (Y)	9.8	1.14	
28/10	0.07	-8.8 (Y)	9.7	1.25	
29/10	0.17	-9.9	7.7	1.42	
30/10	0.04	-6.1 (X)	6.7	1.24	
31/10	0.14	-7.4	6.5	1.25	
11/01	0.13	-8.6 (X)	11.3	1.34	
Swarm B, 26/10 - 11/01, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Maximum standard deviation (m)**	**Notes**
26/10	0.15	-7.7	5.7	1.18	
27/10	0.11	-5.2	7.3	1.2	
28/10	0.1	-7	7.4	1.31	
29/10	0.13	-7.1	8.3	1.36	
30/10	0.08	-7.2 (Y)	6.6	1.27	
31/10	0.13	-6.7	6.9 (Y)	1.3	
11/01	0.15	-5.7	7.3	1.3	
Swarm C, 26/10 - 11/01, Position difference					
Day	**Average difference (m)**	**Maximum difference (m)**		**Maximum standard deviation (m)**	**Notes**
26/10	0.1	-10.2 (Y)	8.9 (X)	1.15	
27/10	0.16	-6.8	7.2	1.11	
28/10	0.07	-7.8	8.5	1.25	
29/10	0.17	-8.1	7 (X)	1.38	
30/10	0.06	-7.8 (Y)	6.2	1.21	
31/10	0.13	-8.9	7.1 (Y)	1.19	
11/01	0.08	-11.9 (Y)	8.4	1.32	

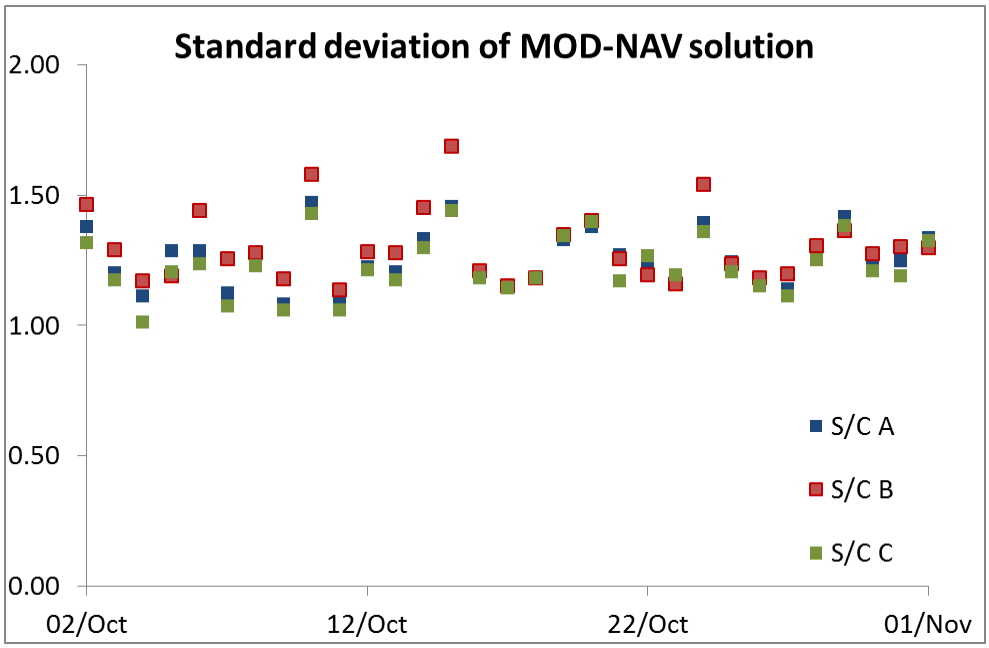

Figure 1 Plot of the standard deviation of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

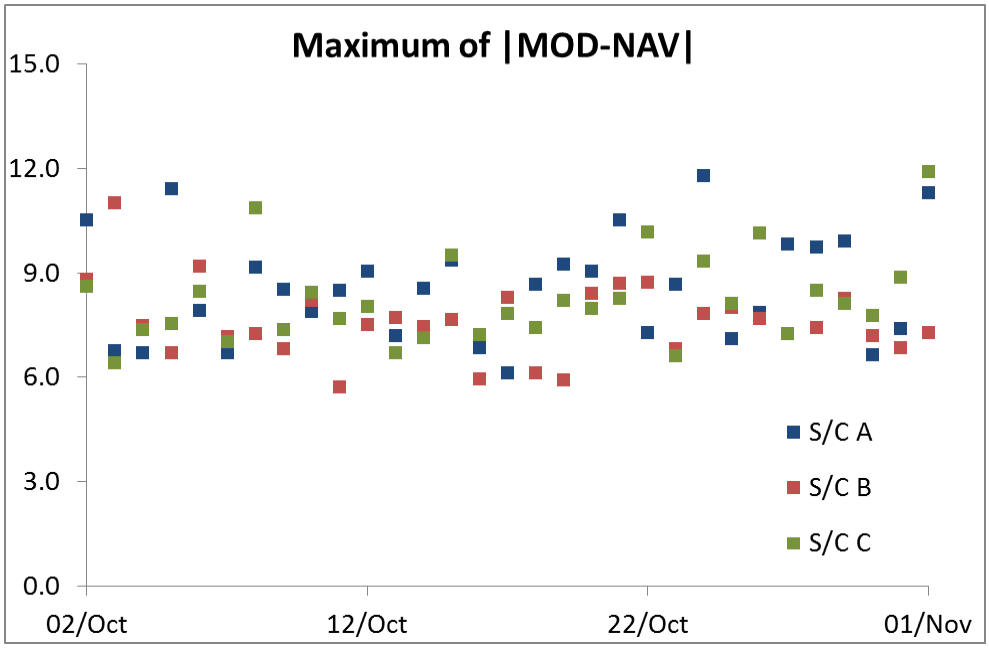

Figure 2 Plot of the maximum difference of the absolute value of the difference between MOD and NAV solutions for all satellites. Plot covers last month of operation.

3.2.1.1 Swarm A

Below some plot example follows of MOD-NAV differences, S/C A, taken at the beginning of the week (26/10, Figure 3). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

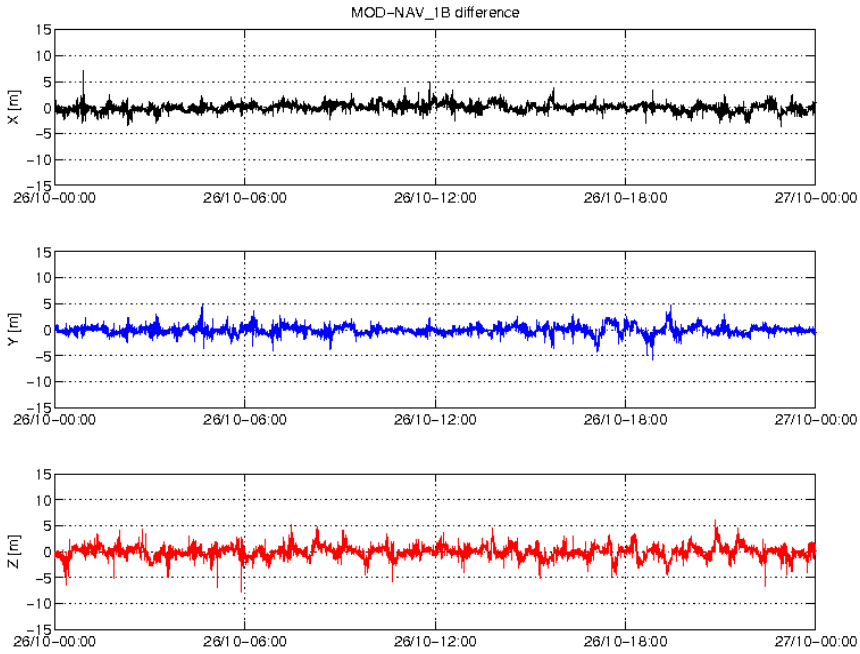

Figure 3: Difference MOD-GPSNAV, S/C A, 26/10. From top to bottom: X, Y and Z-axis

3.2.1.2 Swarm B

Below some plot example follows of MOD-NAV differences, S/C B, taken at the beginning of the week (26/10, Figure 4). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

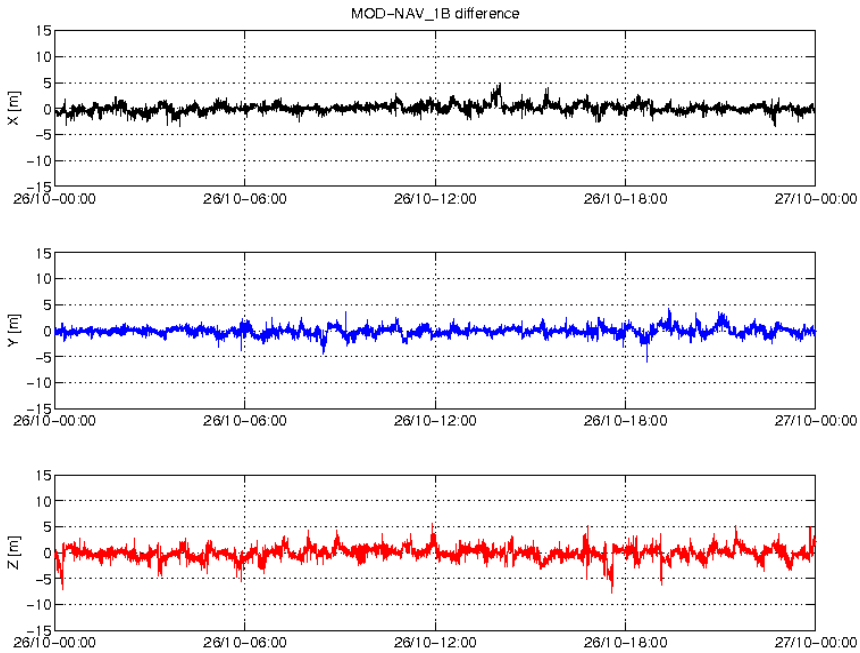

Figure 4: Difference MOD-GPSNAV, S/C B, 26/10. From top to bottom: X, Y and Z-axis

3.2.1.3 Swarm C

Below some plot example follows of MOD-NAV differences, S/C C, taken at the beginning of the week (26/10, Figure 5). From top to bottom, the plots show of MOD-NAV differences in ITFR reference frame: on X, Y and Z-axis respectively. The difference between both solutions is given in [m].

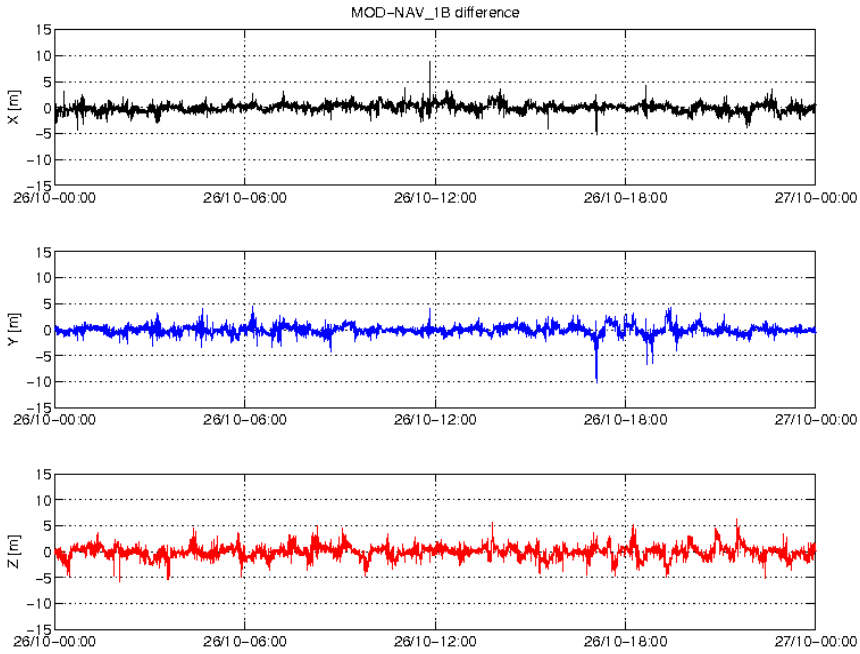

Figure 5: Difference MOD-GPSNAV, S/C C, 26/10. From top to bottom: X, Y and Z-axis

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

Multiple event of attitude rejection due to L0 gap, see section 3.1.

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 +/- 60000 nT), and other strange features.
- Monitoring of the ASM-VFM known anomaly: visual inspection of $|B_{VFM}|$ - F and recording of daily maximum variations. If +/- 2 nT are exceed on a given day, an alert is raised.
- Comparison of magnetic data (B_{NEC}) with a model (Chaos4plus)

3.3.1 VFM-ASM anomaly

General observation: on day 26/10, on Swarm C, VFM L0 gap, see section 3.1.

3.3.2 ASM-VFM difference statistics

In Table 3, 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 shows the daily mean (circles) and standard deviation (crosses) of dF from the deployment of the new L1B processor on (18/07) for Swarm A and Swarm B respectively. The only remarkable feature is a peak on the residual standard deviation for Swarm B, which reaches a 400 pT maximum around the 20 of August. The experts at DTU claim this is not a cause of concern.

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

Swarm A, 26/10 - 11/01, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
26/10	0.85	-0.92	0.28	0.07	
27/10	0.74	-1.31	0.27	0.05	
28/10	2.14	-1.06	0.27	0.03	
29/10	1.05	-0.87	0.26	0.03	
30/10	1.05	-3.59	0.27	0.04	
31/10	1.41	-1.38	0.28	0.02	
11/01	0.97	-0.8	0.26	0.03	
Swarm B, 26/10 - 11/01, ASM-VFM difference					
Day	**Max (nT)**	**Min (nT)**	**Standard deviation (nT)**	**Mean (nT)**	**Notes**
26/10	0.8	-0.69	0.22	-0.02	
27/10	1.01	-0.65	0.23	-0.04	
28/10	0.77	-1.67	0.22	-0.03	
29/10	1.51	-1.44	0.2	-0.04	
30/10	1.73	-1	0.19	-0.04	
31/10	0.86	-1.19	0.19	-0.04	
11/01	2.71	-2.22	0.19	-0.04	

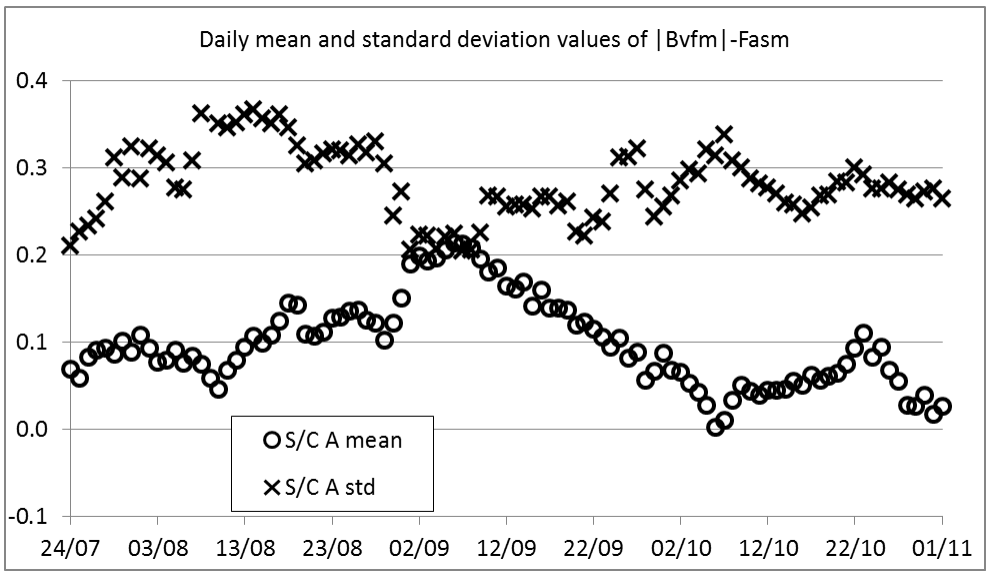

Figure 6 Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C A.

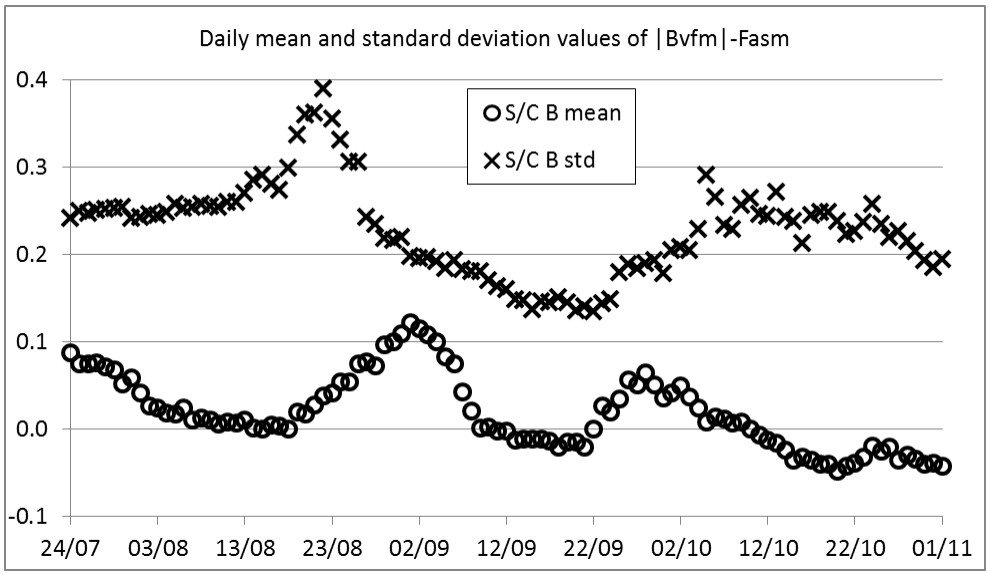

Figure 7 Daily mean and standard deviation values of ASM-VFM residuals (defined as $dF=|B_{VFM}|-F_{ASM}$) for S/C B.

3.3.2.1 Swarm A

The daily peak-to-peak difference around the week stays within [-0.8, 0.8] nT with a few spikes not exceeding 2nT and three spikes of about 3.5nT on 30/10. Below two example plots of such differences for the days: 26/10 (Figure 8), and 01/11 (Figure 9).

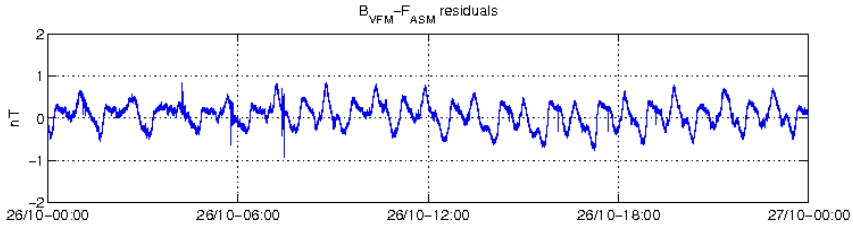

Figure 8: ASM-VFM residuals for S/C A, 26/10.

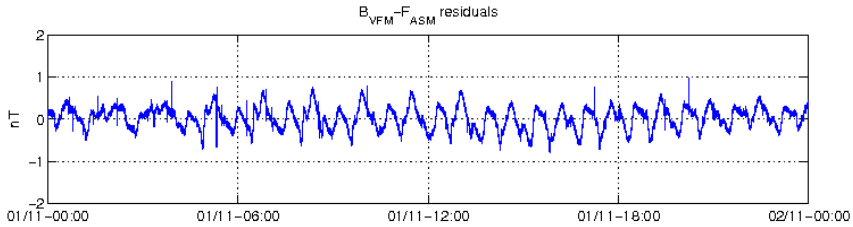

Figure 9: ASM-VFM residuals for S/C A, 01/11.

3.3.2.2 Swarm B

The daily peak-to-peak difference around the week is, on average: [-0.7,0.6] nT, with a few spikes not exceeding 3nT. Below two example plots follows of such differences: 26/10 (Figure 10), and 01/11 (Figure 11).

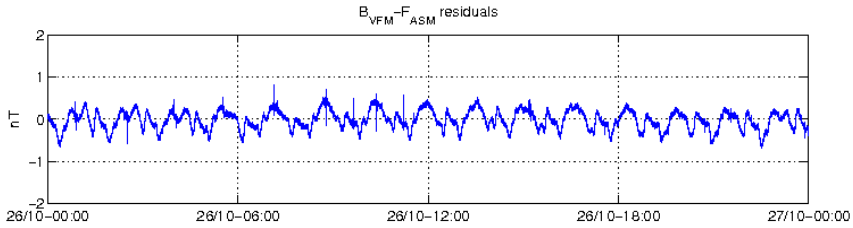

Figure 10: ASM-**VFM** residuals for S/C B, 26/10.

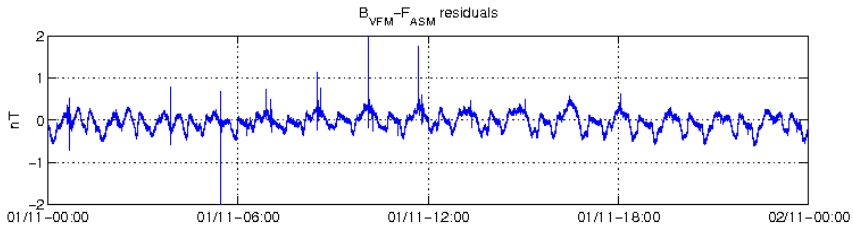

Figure 11: ASM-VFM residuals for S/C B, 01/11.

3.3.2.3 Swarm C

No data because ASM is switched off.

3.3.3 ASM Instrument parameters: quartz frequency and ASM temperature (ASMAVEC_0)

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

3.3.4 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, or reported period, the temperatures behaved as expected.

3.3.5 Magnetic time series visual inspection

3.3.5.1 Swarm A

An example of representative magnetic field time series for S/C A (11/01) can be seen in Figure 12 below.

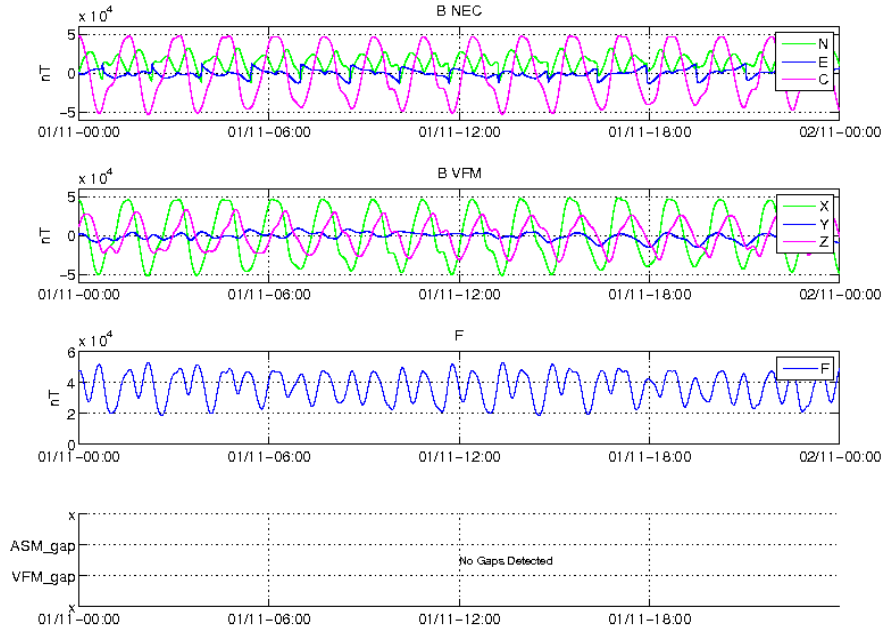

Figure 12: Time series of the geomagnetic field, for 11/01, S/C A. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.5.2 Swarm B

An example of representative magnetic field time series for S/C B (11/01) can be seen in Figure 13 below.

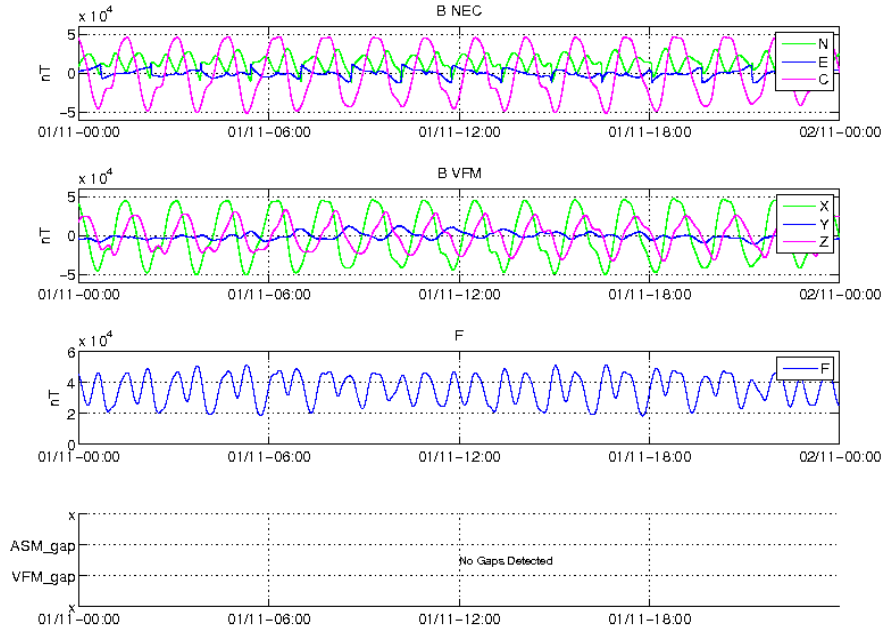

Figure 13: Time series of the geomagnetic field for 11/01, S/C B. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.5.3 Swarm C

An example of magnetic field time series for S/C C (11/01) can be seen in Figure 14.

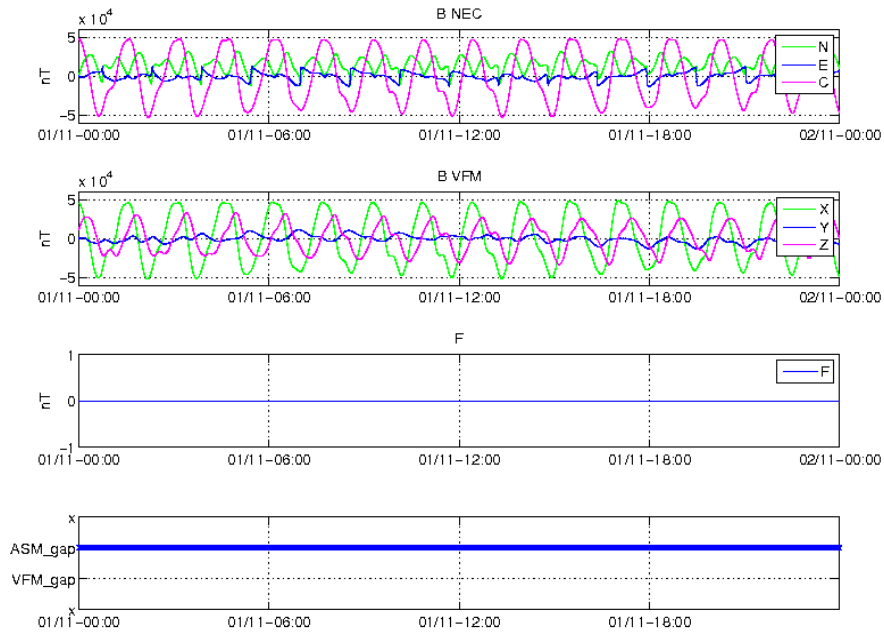

Figure 14: Time series of the geomagnetic field for 11/01, S/C C. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the

VFM reference frame, magnetic field intensity (F) from ASM (no data here because ASM it is off) and location of gaps.

3.3.6 B_{NEC} vs Chaos4plus model residuals

Figure 15, Figure 17 and Figure 19 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 16, Figure 18 and Figure 20 shows, from top to bottom, the time series on 26/10 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 Bθ_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.

3.3.6.1 Swarm A

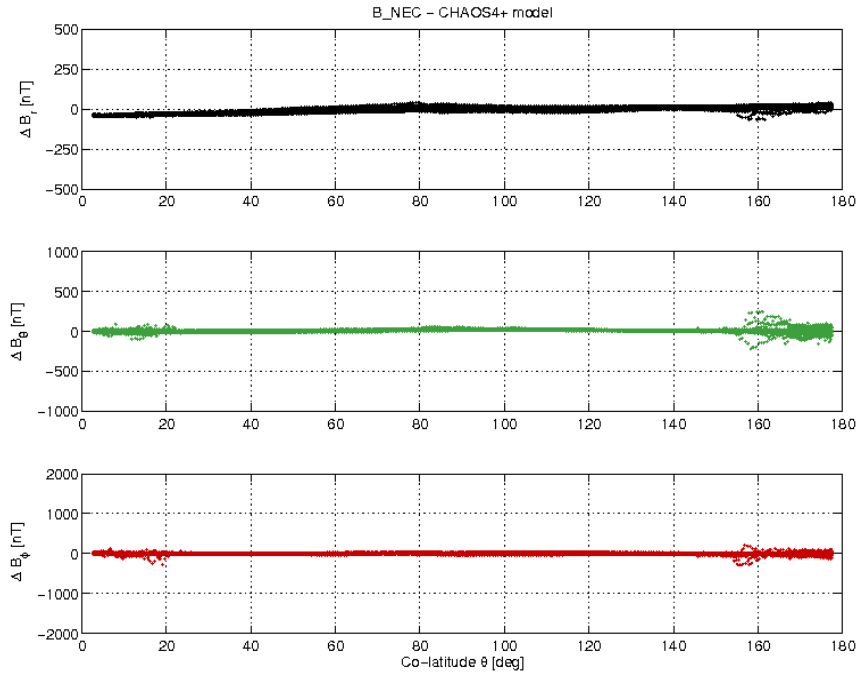

Figure 15: Swarm A day 26/10 B_NEC - B_Chaos vs colatitude.

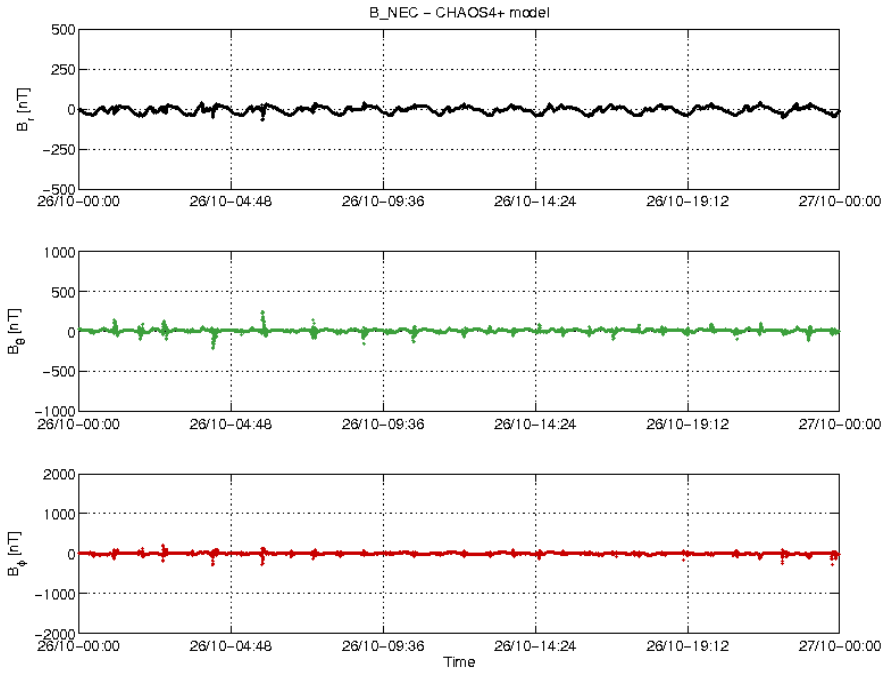

Figure 16: Swarm A day 26/10: time series of B_NEC – B_Chaos residuals.

3.3.6.2 Swarm B

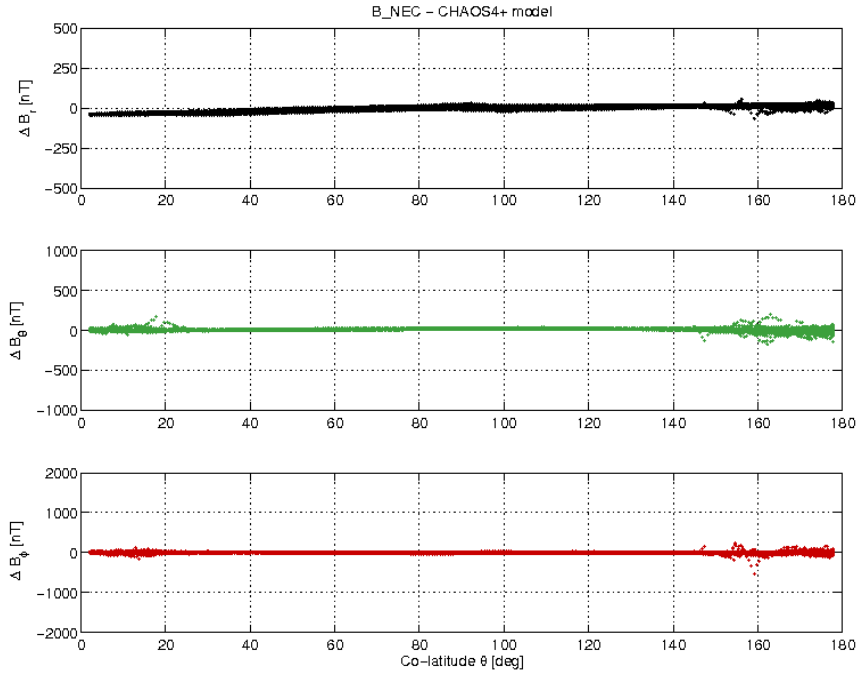

Figure 17 Swarm B day 26/10 B_NEC - B_Chaos difference vs colatitude.

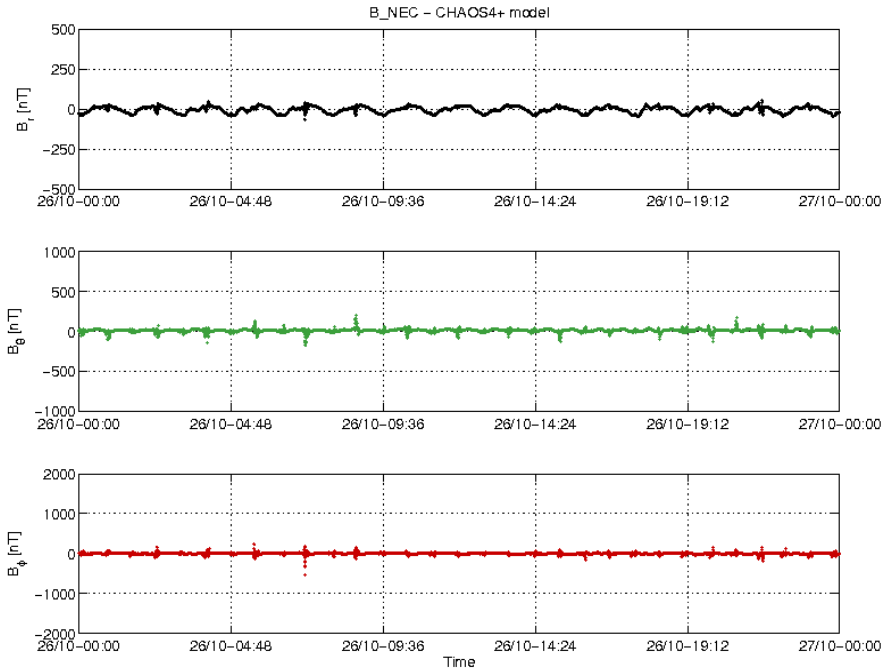

Figure 18 Swarm B day 26/10 time series of B_NEC – B_Chaos residuals.

3.3.6.3 Swarm C

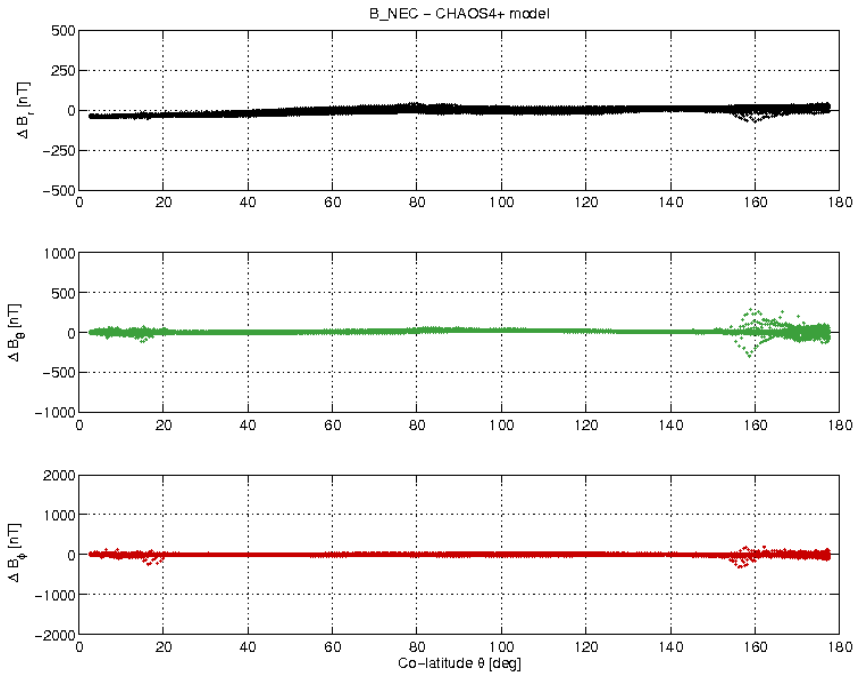

Figure 19 Swarm C day 26/10 B_NEC - B_Chaos difference vs colatitude.

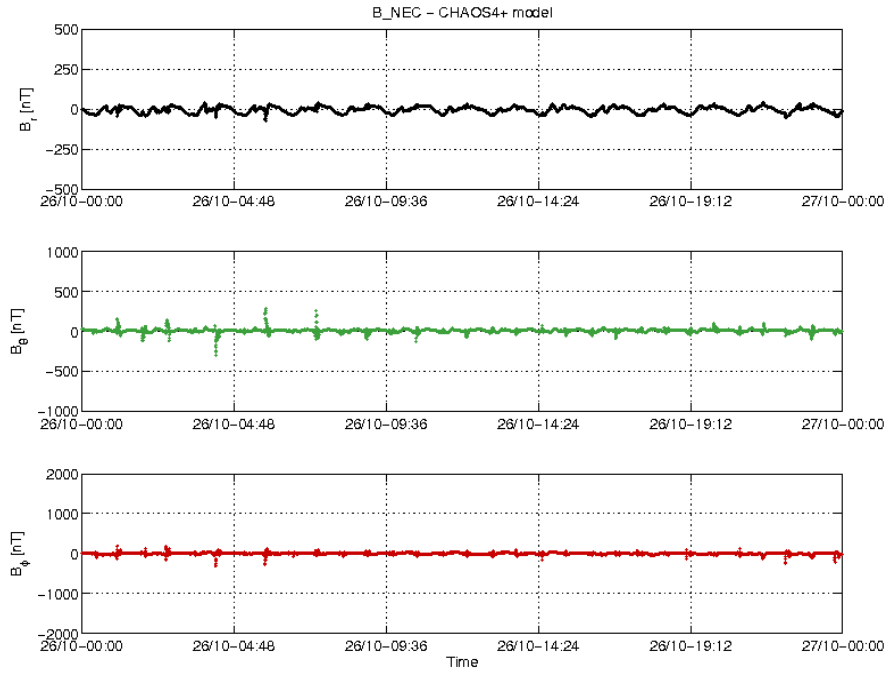

Figure 20 Swarm C day 26/10 time series of B_NEC – B_Chaos residuals.

4. ON-DEMAND ANALYSIS

4.1 $B_{NEC} - B_{chaos}$ and geomagnetic activity

Figure 21 below shows the daily standard deviations of all the components for all S/C of the $B_{NEC} - B_{chaos}$ residuals, filtered in a latitude belt of +/- 50 degrees (auroral ovals and polar areas excluded). The black dotted curve is the geomagnetic DST index (http://wdc.kugi.kyoto-u.ac.jp/dstdir/) which is a rough proxy of the geomagnetic activity, in particular is an indicator of occurrences of geomagnetic storms.

We want to show here how the $B_{NEC} - B_{chaos}$ residuals can be used as a proxy of the geomagnetic activity on one hand, and as a possible monitor of instruments issues on the other hand.

It is known that the Chaos model does not account for all the contributions of the external field, so that the difference between model and real Swarm data will exactly evidence the external field variations. On 7 October a moderate geomagnetic storm occurred, during which the DST index reached a minimum peak of -110 nT (red circled area in the figure). The residuals behaviour closely followed this trend: almost all components and S/C are affected but the main effects are observed on B_θ , i.e. the latitudinal component (along S/C track), and on S/C B the effect is greater than for the other two. Swarm B is flying about 100 km higher than the A and C and is possibly less influenced by specific ionospheric dynamics and air drag that can diminish or mask the effects of the ring current increase on the magnetic field. Later on, around 18/10, another small storm occurred, and again a small peak is observed in the residuals standard deviation.

This example is rather striking, but we have often observed close correlations between residuals increases and geomagnetic activity concentrated at high latitudes (looking at the AE index more than DST). We plan to regularly monitor and correlate the residuals standard deviation with DST and Polar Cap Index (http://pc-index.org/). This can prove very useful in case we observe anomalous increases of the residuals not associated with increases in the solar/geomagnetic activity: such situations can potentially point out to instrument anomalies.

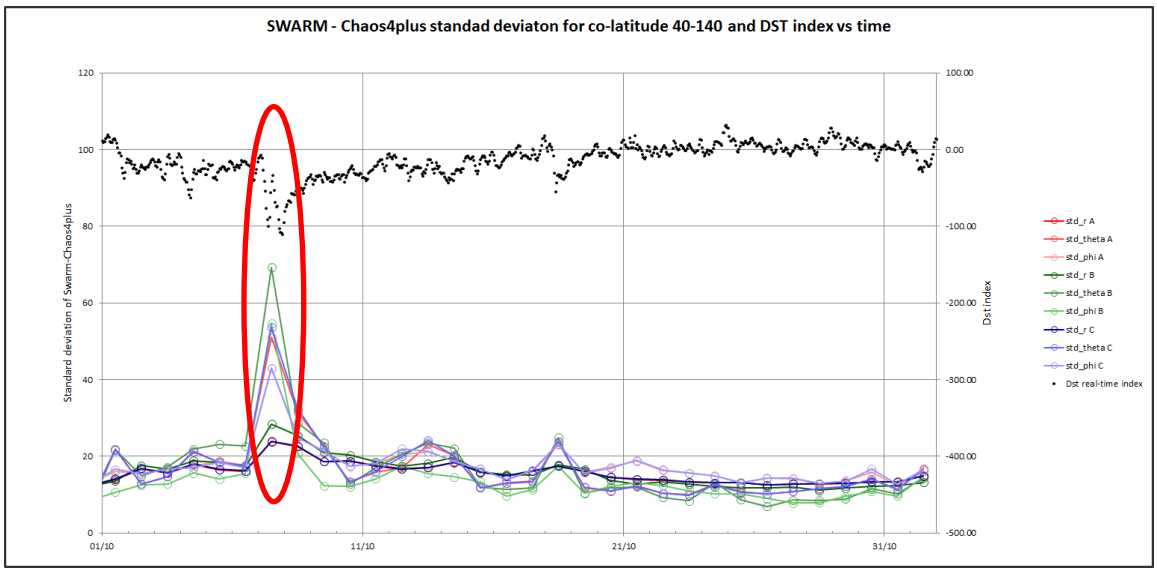

Figure 21: daily standard deviations of the B_{NEC} - B_{Chaos} residual (colour curves), and hourly DST geomagnetic index (black dotted curve) during October 2015.

End of Document