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IDEAS+ Swarm Weekly Report : 06/10/2014 – 12/10/2014

Abstract : This is the **Instrument Data quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 6 to 12 October, 2014.

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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	17 Oct 2014	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 life time, 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 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, user community), anomalies can be triggered and 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 3.11p2, L2-Cat2 1.12
- L0 input products baseline: 02
- L1B baseline: 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: 01
- Input auxiliary files baseline: CCDB 0009, ADF 0101
- MPPF-CVQ v.2.11p2

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_20141001_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

[RD.10] IDEAS+ Swarm Weekly Report: 15/09/2014 – 21/09/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140915_20140921_2.pdf

[RD.11] IDEAS+ Swarm Weekly Report: 22/09/2014 – 28/09/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140929_20141005.pdf

2. SUMMARY OF THE OBSERVATIONS

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

With respect to the previous reporting period, the following updates have to be reported:

Status of EFI – TII recent operations. On Monday 20/10 the "scrubbing" procedure will start on S/C C: both sensors will operate in cycles of 14 orbits + 2 orbits in calibration mode, with V_{phos}=1000V, V_{mcp}=-1800 and V_g sweeping between -3, -5 and -7 V at each cycle. We are still waiting for ComDev supporting material from the qualification phase, for confirming there is no risk to operate the TII with V_{phos} > 5000 V. The second part of the procedure would in fact recommend to operate for a while phosphors at a voltage about 20% higher than the normal operations, i,e, 6000 V. The aim of the procedure overall is to expel contaminants (neutral gas, ions impinging on the bottom side of the MCPs...) from both MCP and phosphors.

Plasma dataset to be prepared by EFI team. Following the EFI teleconference of 1st October, a decision has been taken to provide the Cal/Val users with a plasma dataset built by means of outcomes from the best prototype quality we are able to provide up to now. It has been pointed out that is very difficult to align the operational processor with the evolutions of the scientific algorithms, which are developed in "light" and flexible versions of the EFI prototype ("sandbox" prototypes), and the time needed to commit changes in the official EFI prototype is too much. Such dataset will be ready by early November, in reasonable advance for the Data Quality meeting in December.

Summary of the 3rd ASM-VFM task force meeting (ESTEC, 8-9/10). The main conclusion everyone seems now to accept is that a kind of disturbance is present in the proximity of the VFM instrument which is not sensed by the ASM. The corrections to thermal models provided up to now by the VFM manufacturers seem not enough to fully reproduce the observed ASM-VFM residuals behaviour, which show modulations with the orbit, and the overall geomagnetic conditions. Plasma models are more likely to be addressed too.

2.2 Plan for operational processor updates

From the last L1B coordination teleconference the following updates shall be reported:

- The GPS patch (ORBATT 3.11_p3) has been delivered the 13/10. Installation and functional tests went smoothly on the APDF reference platform. Verification tests are ongoing for cross-checking the APDF results with those from GMV TDS.

- The PLASMA cross-verification proceeds and most of the discrepancies concerning LP outputs have been fixed. The only remaining discrepancy consists in small jumps of the S/C potential observed at regular intervals which seem related to a non correct initialization of the S/C position made in the prototype. We are discussing the way forward, also considering the effort now put by the EFI team in building the dataset for the Cal/Val and the overall approach to the cross-verification is under discussion.

2.3 Quality Working Group and Cal/Val Coordination

The third QWG – Cal/Val meeting is being planned for the 2-5 December 2014 at GFZ premises in Potsdam, Germany.

A number of Task forces, each dedicated to an instrument group, continuously co-ordinates the investigation of the various anomalies.

2.4 Summary of observations for Week 41 (06-12/10/2014)

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

1. **Differences in the MOD-GPSNAV solutions reported again:** the observations are related to the already described **SWL1L2DB-9** ([RD.9]), i.e. a large departure from the MOD and NAV solution is observed starting from a given time during the day and increasing up to the end of the day.

2. **Other strange features observed in the MOD-GPSNAV solution difference:** again we often notice a marked “spiky” behaviour, with deviations from the average which are not normal spikes but lasts for several seconds if not minutes ([RD.11]); moreover, this week we also observed cases where the solution difference seems to vary systematically in a quasi-sinusoidal way: this effect seems correlated with periods when the GPS clock cannot be determined in the MOD data.

3. **A STR reboot on S/C A**, caused the loss of 11 seconds of STR data for the day 12/10.

3. ROUTINE QUALITY CONTROL

3.1 Gaps analysis

SW-IDEAS-37: OBS_ROUTINE: STR A gap on 12/10/2014.

A gap of 11 seconds is reported on the Level 0 STR data for S/C A, 12/02/2014. The gap occurs between 13:07:48 and 13:07:59:

SW_OPER_STRANOM_0__20141012T084552_20141012T**130748**_0201

SW_OPER_STRANOM_0__20141012T**130759**_20141012T133251_0201

From the weekly FOS report n. 46, page 8 (SW-RP-ESC-FS-6142_Swarm_Weekly_Operations_Report#46_06-10-2014_12-10-2014) we read:
“Re-occurrence of the "STR Autonomous reboot" anomaly for SW-A with the STRE_A reboot during SAA”.

Such gap in Level 0s is filled in Level 1B data by having quaternions=0 and flags_q=255.

3.2 Orbit and Attitude Products

The following events have to be reported:

Observation ID	Description	Affected parameter	Sect. of Obs. Description	Sect. of Obs. analysis
SW-IDEAS-34	OBS_ROUTINE: large number of spiky features observed in the NAV-MOD difference	Orbits (position and velocity)	3.2.3.1	[RD.11]
SW-IDEAS-36	OBS_ROUTINE: deviations of MOD-NAV difference and GPS clock deteriorated	Orbits (position and velocity)	4.1	4.1
SWL1L2DB-9	L1B: MOD - NAV1B discrepancies [...]	Orbits (position and velocity)	3.2.1.1	[RD.9] and [RD.11]

Table 1: list of events related to attitude and orbit products to be reported in the monitoring for Week 41: 06 - 12/10/2014

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, and reported in tables in the sections below, along with some example 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 Swarm A

3.2.1.1 Position statistics

In Table 2 one can see the statistics of the differences between MOD and on-board solution positions. In the third column the maximum differences (maximum negative and maximum positive) are reported with, in parentheses, the ITRF component affected by such difference. The maximum standard deviation is in the fourth column: it usually refers to the Z component which is always the most disturbed; in case another component is most affected, it will be specified in parentheses.

Swarm A, 06-12/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard deviation (m)**	**Notes**
06/10	0.13	-7 (Z), 9 (X)	1.5	SW-IDEAS-34 (see [RD.11])
07/10	0.13	-19, 8.4 (Z)	1.7	
08/10	0.2	-13.6 (Y), 10.5 (Z)	1.7	
09/10	0.07	-10.5 (Z), 8.2 (X)	1.5	
10/10	0.1	-12, 18.6 (Z)	1.9	SW-IDEAS-34 (see [RD.11])
11/10	0.07	-9.3 (Y), 7.4 (Z)	1.6	
12/10	0.11	-12 (X), 11.7 (Y)	1.8	

Table 2: Swarm A, difference between MOD and on-board solution positions.

Below some plot example follows of such differences taken at the beginning of the week (06/10, Figure 1), in the middle (09/10, Figure 2) and at the end (12/10, Figure 3). From top to bottom the plots show: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The values are given in Km.

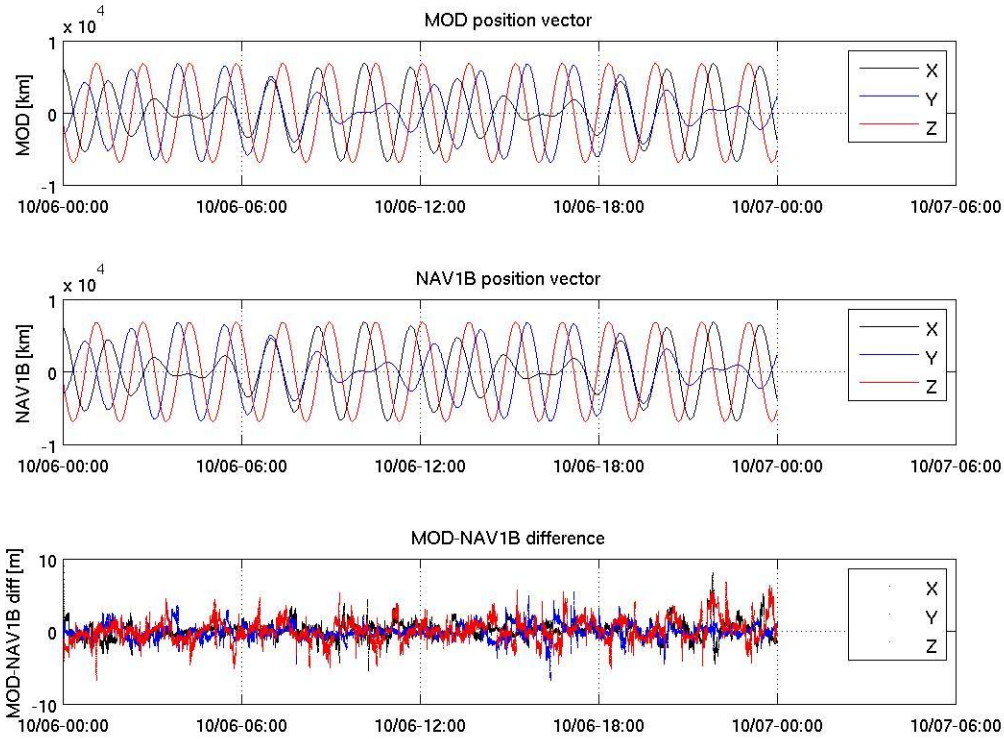

Figure 1: Difference MOD-GPSNAV, sc A, 06/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

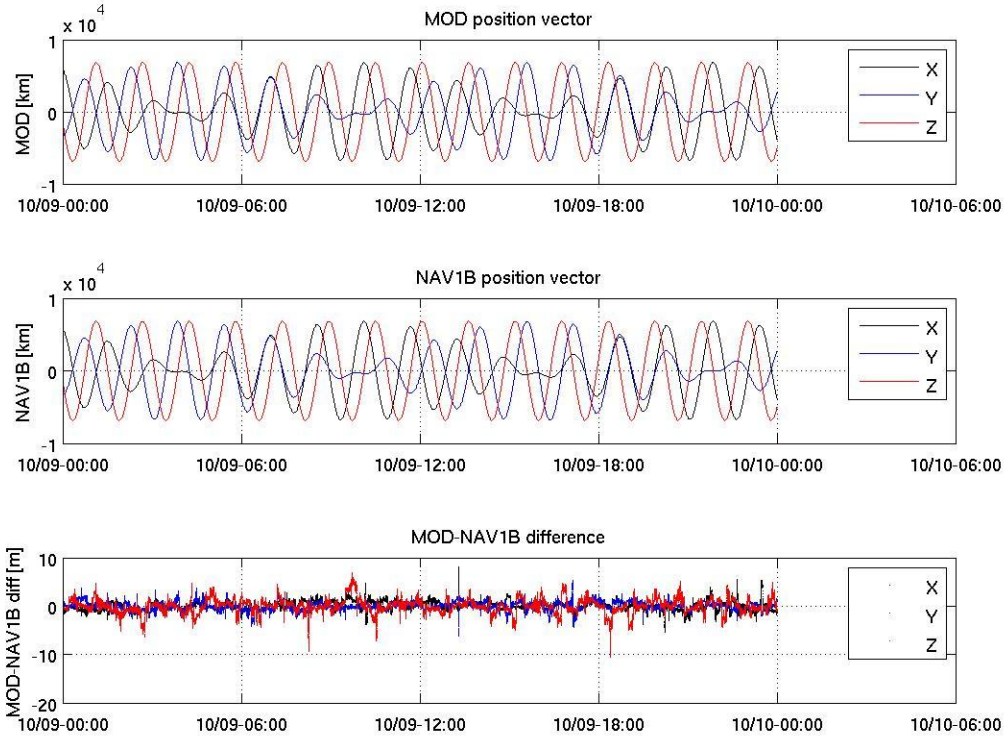

Figure 2: Difference MOD-GPSNAV, sc A, 09/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

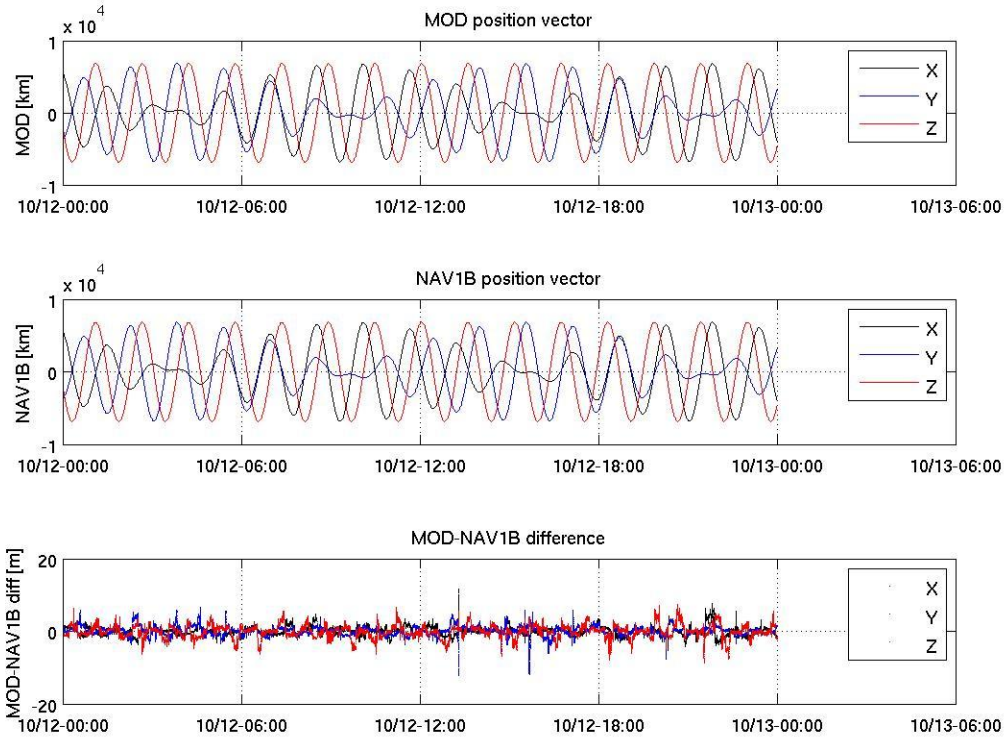

Figure 3: Difference MOD-GPSNAV, sc A, 12/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.1.2 Attitude observations

Nothing to report.

3.2.2 Swarm B

3.2.2.1 Position Statistics

In Table 3 one can see the statistics of the differences between MOD and on-board solution positions. In the third column the maximum differences (maximum negative and maximum positive) are reported with, in parentheses, the ITRF component affected by such difference. The maximum standard deviation is in the fourth column: it usually refers to the Z component which is always the most disturbed; in case another component is most affected, it will be specified in parentheses.

Swarm B, 06-12/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
06/10	**0.14**	**+/- 9 (X)**	**2.2**	**SWL1L2DB-9 (see [RD.9] and [RD.11])**
07/10	0.03	-8.4, 10.4 (Z)	1.8	
08/10	0.13	-9 (Z), 8 (X)	1.5	
09/10	0.05	-9 (Z), 11.5 (Y)	1.6	
10/10	0.23	+/-12.5 (Z)	2	SW-IDEAS-34 (see [RD.11])
11/10	0.11	-7.3, 9 (Z)	1.6	SW-IDEAS-36 (see Sect. 4.1)
12/10	0.09	-17, 12.6 (Z)	1.8	

Table 3: Swarm B, difference between MOD and on-board solution positions.

Below some plot example follows of such differences taken at the beginning of the week (06/10, Figure 4), in the middle (09/10, Figure 5), and at end of the week (12/10, Figure 6). From top to bottom the plots show: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The values are given in Km.

In Figure 4 one can observe another occurrence of the anomaly described in SPR **SWL1L2DB-9** (06/10/2014): starting from about 18 UT the navigation solution and MOD calculation start to depart each other.

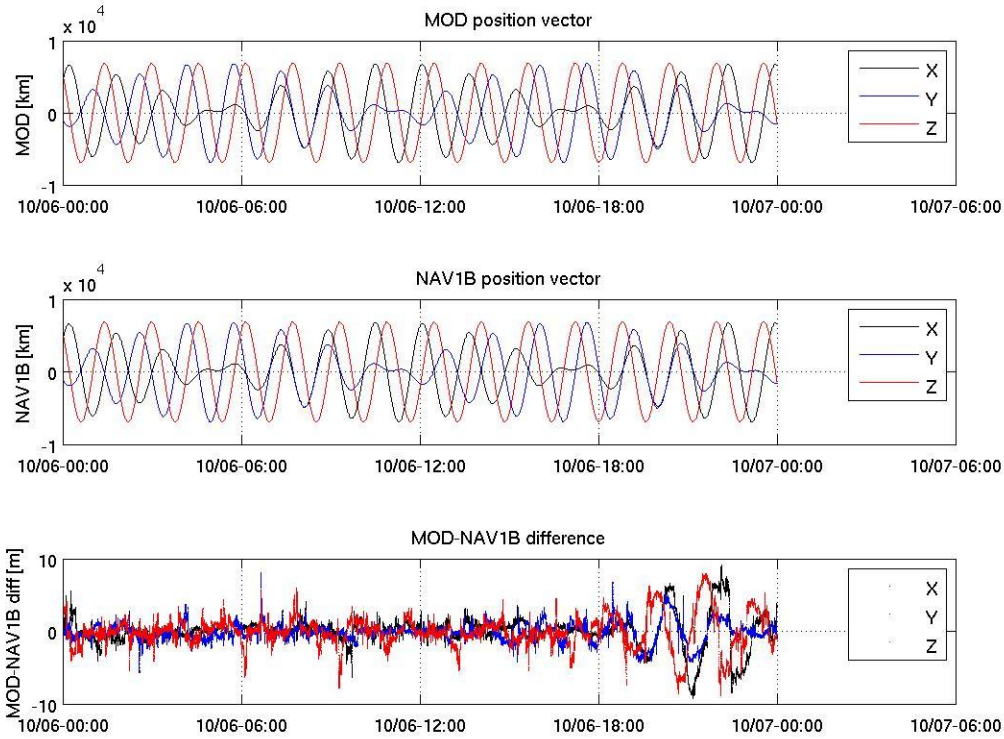

Figure 4: Difference MOD-GPSNAV, sc B, 06/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

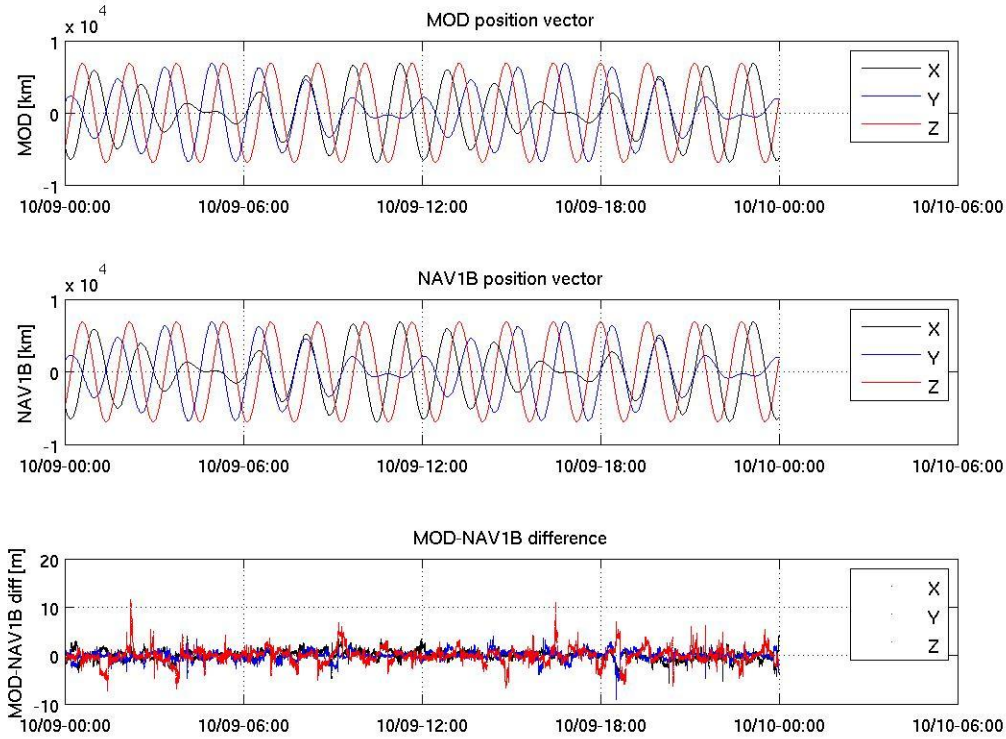

Figure 5: Difference MOD-GPSNAV, sc B, 09/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

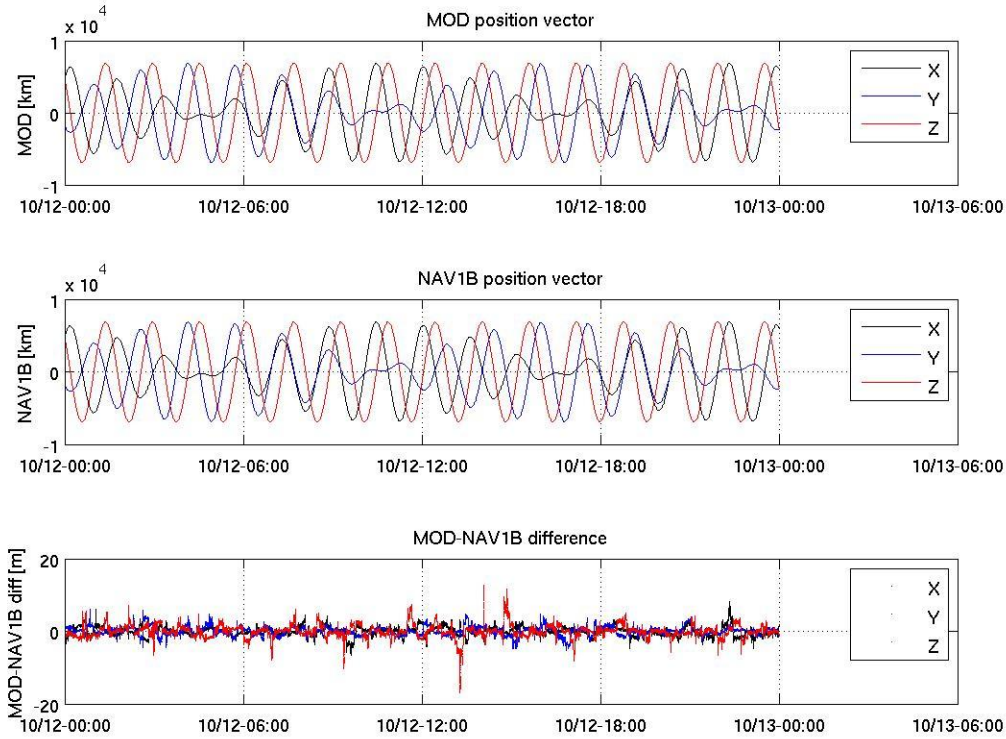

Figure 6: Difference MOD-GPSNAV, sc B, 12/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.2.2 Attitude observations

Nothing to report.

3.2.3 Swarm C

3.2.3.1 Position Statistics

In Table 4 one can see the statistics of the differences between MOD and on-board solution positions. In the third column the maximum differences (maximum negative and maximum positive) are reported with, in parentheses, the ITRF component affected by such difference. The maximum standard deviation is in the fourth column: it usually refers to the Z component which is always the most disturbed; in case another component is most affected, it will be specified in parentheses.

Swarm C, 06-12/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
06/10	0.16	-7 (Y), 13 (X)	1.4	SW-IDEAS-34 (see

Swarm C, 06-12/10/2014, Position difference				
				[RD.11])
07/10	0.08	-14.4, 9 (Z)	1.65	
08/10	0.35	-12.7, 11.7 (Z)	1.7	SW-IDEAS-34 (see [RD.11])
09/10	0.13	-8.5, 9 (Z)	1.6	
10/10	0.12	-10.8, 12.8 (Z)	1.9	SW-IDEAS-34 (see [RD.11])
11/10	0.07	-10 (Y), 8 (Z)	1.6	
12/10	0.11	-12.4 (Y), 10 (X)	1.9	SW-IDEAS-34 (see [RD.11])

Table 4: Swarm C, difference between MOD and on-board solution positions.

Below some plot example of such differences follows, taken at the beginning of the week (06/10, Figure 7), in the middle (09/10, Figure 8) and at the end (12/10, Figure 9). From top to bottom the plots show: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The values are given in Km. In all the figures the effect described in SW-IDEAS-34 ([RD.11]) can be observed: the solution difference often departs from the average and keeps higher/lower values for several seconds or even minutes (see e.g. the red circled areas in Figure 8).

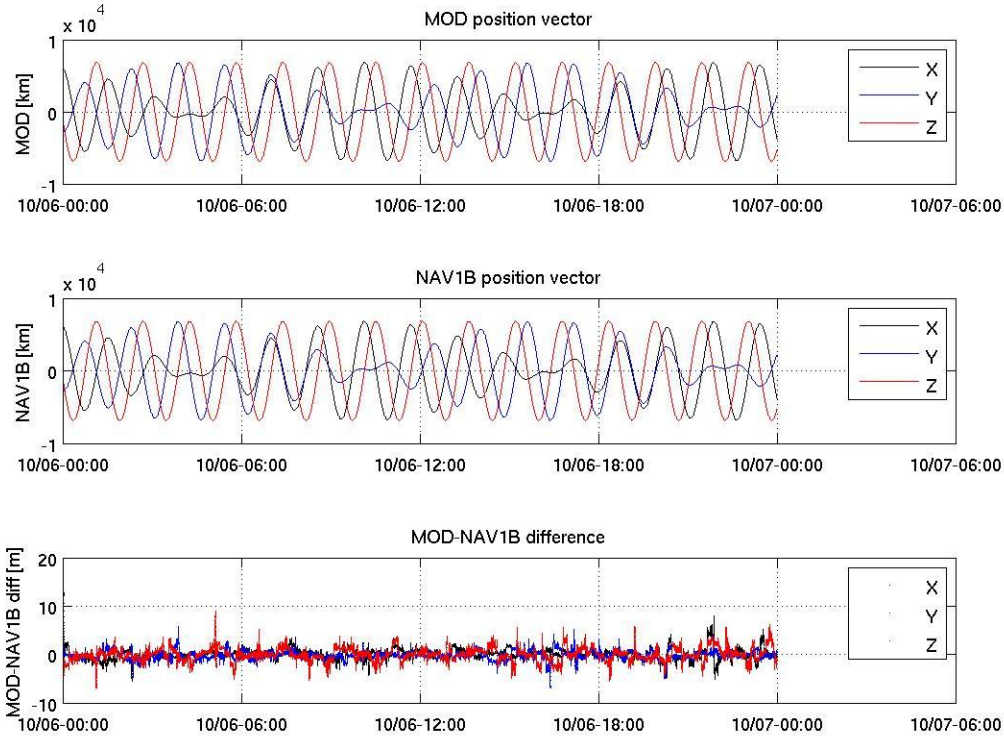

Figure 7: Difference MOD-GPSNAV, sc C, 06/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

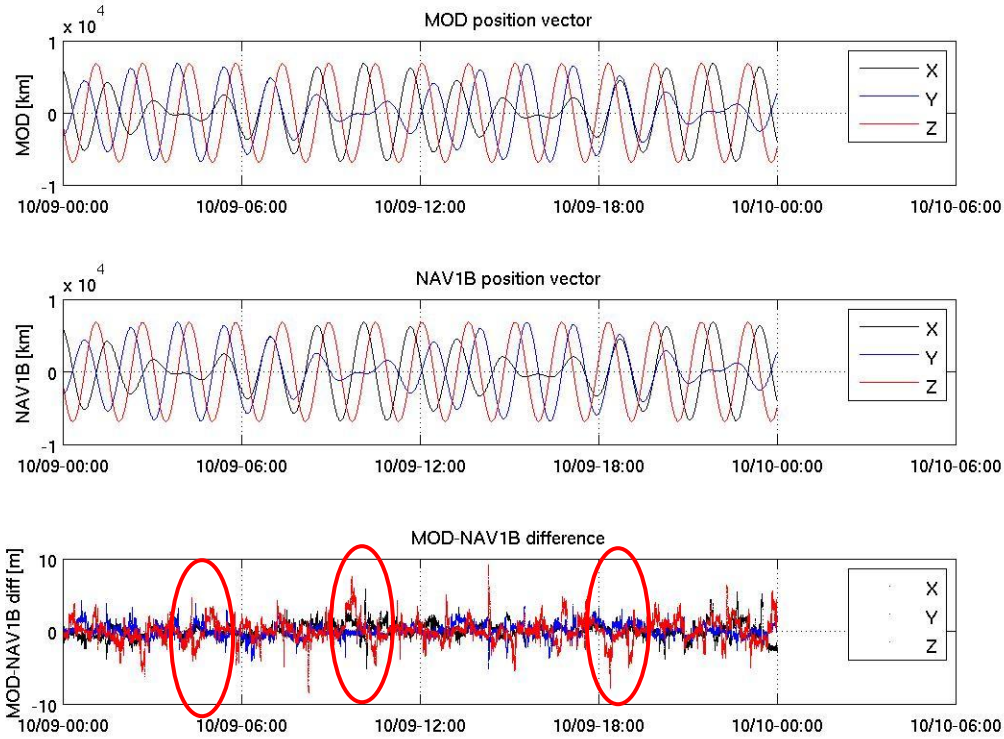

Figure 8: Difference MOD-GPSNAV, sc C, 09/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The red circled areas evidence the deviations from the average described in SW-IDEAS-34 ([RD.11]).

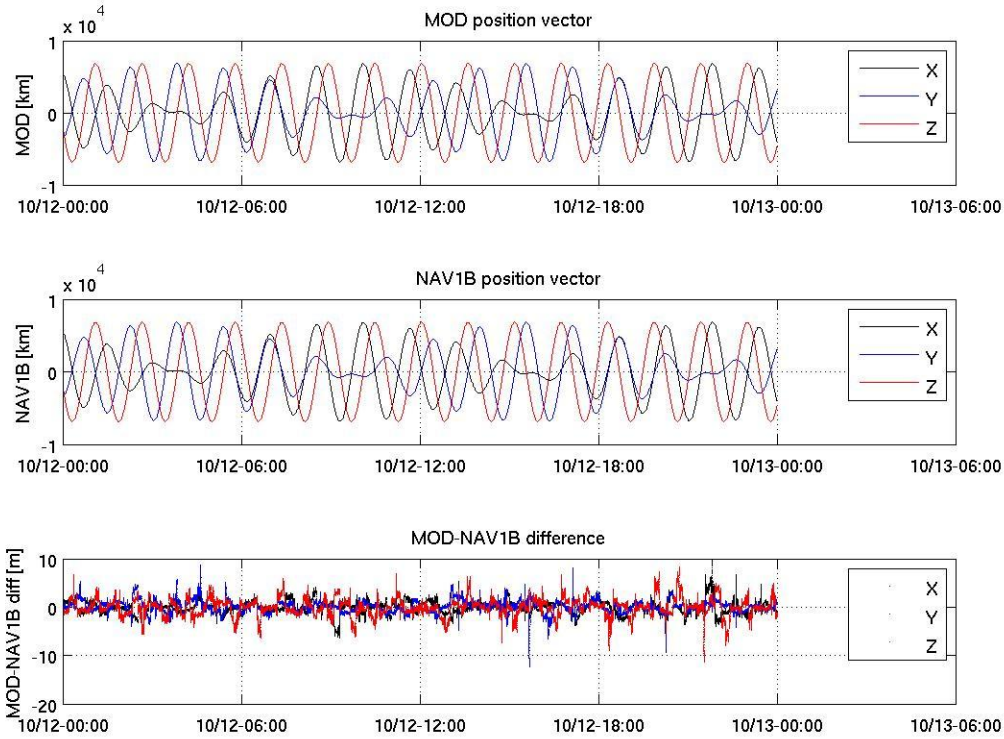

Figure 9: Difference MOD-GPSNAV, sc C, 12/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.3.2 Attitude observations

Nothing to report.

3.3 Magnetic Products

For the magnetic products the weekly monitoring consists in:

- Visual inspection of daily time series of magnetic field intensity F, $\mathbf{B_{NEC}}$ and $\mathbf{B_{VFM}}$. 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 **VFM-ASM known anomaly**: visual inspection of $|B_{NEC}|$ - F and recording of daily maximum variations. If +/- 5 nT are exceed on a given day, an alert is raised.

- TCF.VFM parameters monitoring (VFM calibration parameters): series of biases, scales, non-orthogonality factors and RMS. **This check is performed on monthly basis.**

3.3.1 Swarm A

3.3.1.1 Magnetic time series visual inspection

Nothing relevant to report. An example of representative magnetic field time series for S/C A can be seen in Figure 10 (12/10/2014):

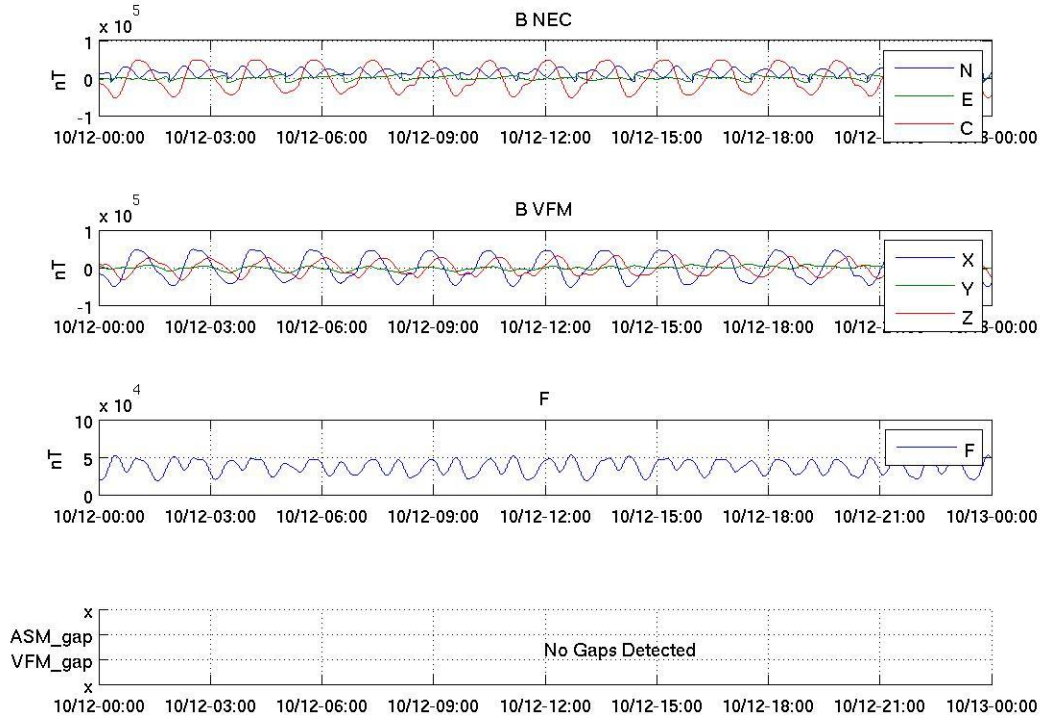

Figure 10: Time series of the geomagnetic field, for 12/10/2014, S/C A. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.1.2 VFM-ASM anomaly

- **SW-IDEAS-27 (monitoring of the anomaly):** During week 41 we do not observed serious events of noise increase in the ASM-VFM residuals. The spectrum remains rather flat in the 0.04-0.1 Hz band, except for some little increase in power towards the end of the week.

The daily peak-to-peak difference around the week is, on average: [-2, 2] nT, with some isolated spike which reaches up to 4 nT.

Below some plot example of such differences follows, taken at the beginning of the week (06/10, Figure 11) middle of week (09/10, Figure 12), and end of the week (12/10, Figure 13). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

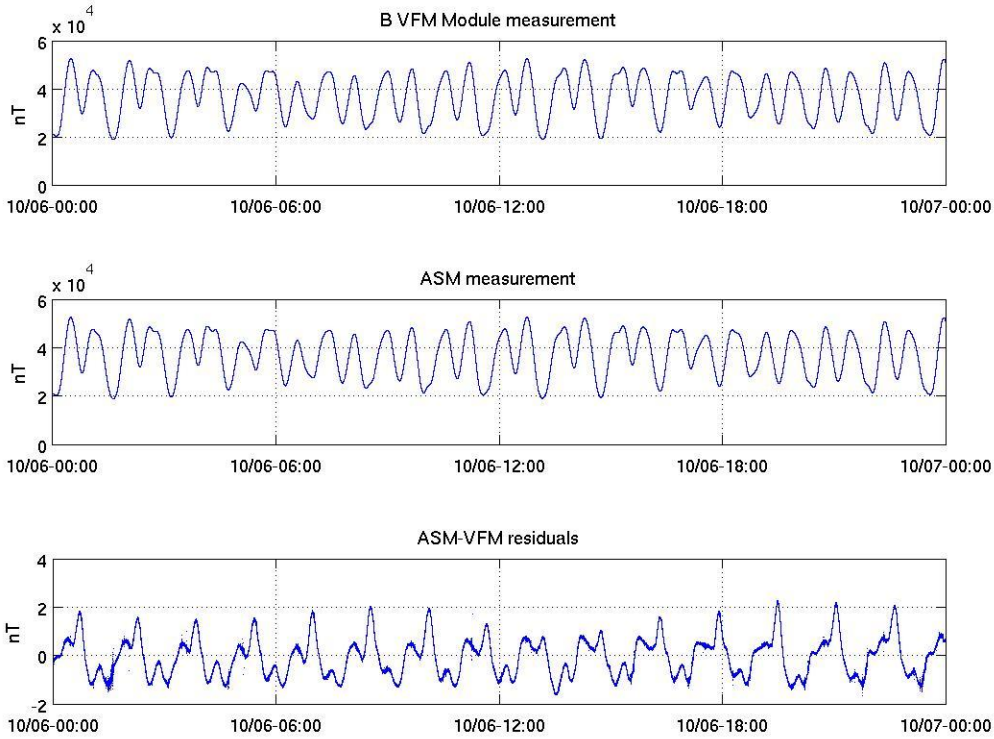

Figure 11: VFM module, ASM module and ASM-VFM residuals for S/C A, 06/10/2014.

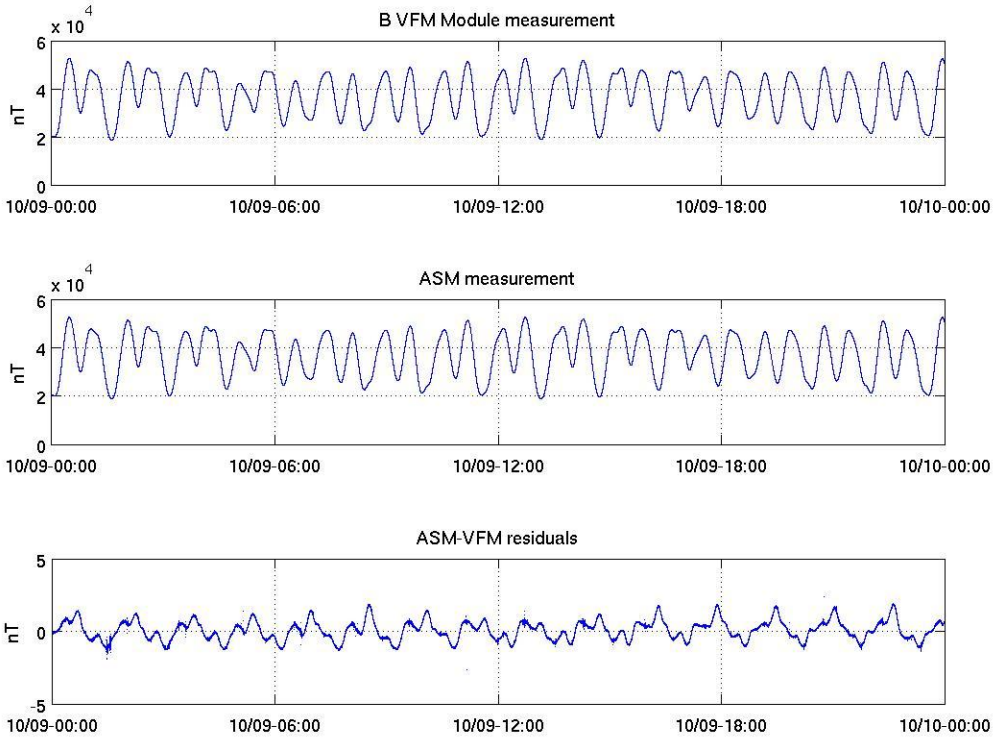

Figure 12: VFM module, ASM module and ASM-VFM residuals for S/C A, 09/10/2014.

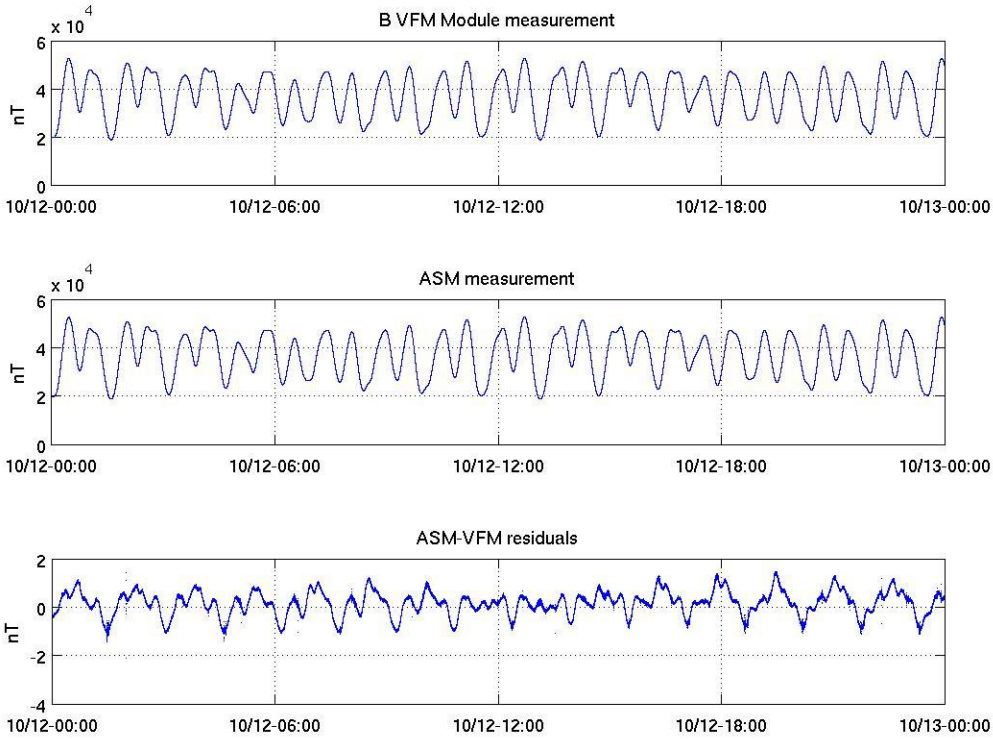

Figure 13: VFM module, ASM module and ASM-VFM residuals for S/C A, 12/10/2014.

3.3.1.3 TCF.VFM monitoring

Output will be provided in the last report of the month.

3.3.2 Swarm B

3.3.2.1 Magnetic time series visual inspection

Nothing relevant to report. An example of representative F time series for S/C B (12/10/2014) can be seen in Figure 14 below.

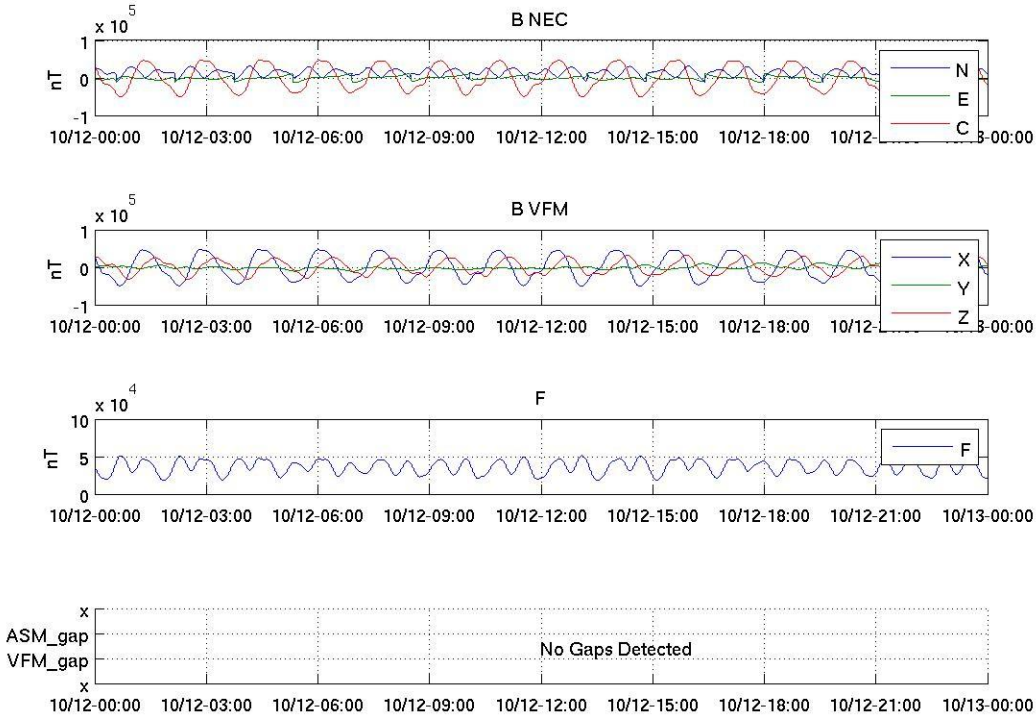

Figure 14: Time series of the geomagnetic field for 12/10/2014, S/C B. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.2.2 VFM-ASM anomaly

The daily peak-to-peak difference around the week is, on average: [-2.3, 2] nT.

Below some plot example follows of such differences taken at the beginning of the week (07/09, Figure 15), middle of the week (09/10, Figure 16) and at the end of the week (12/10, Figure 17). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

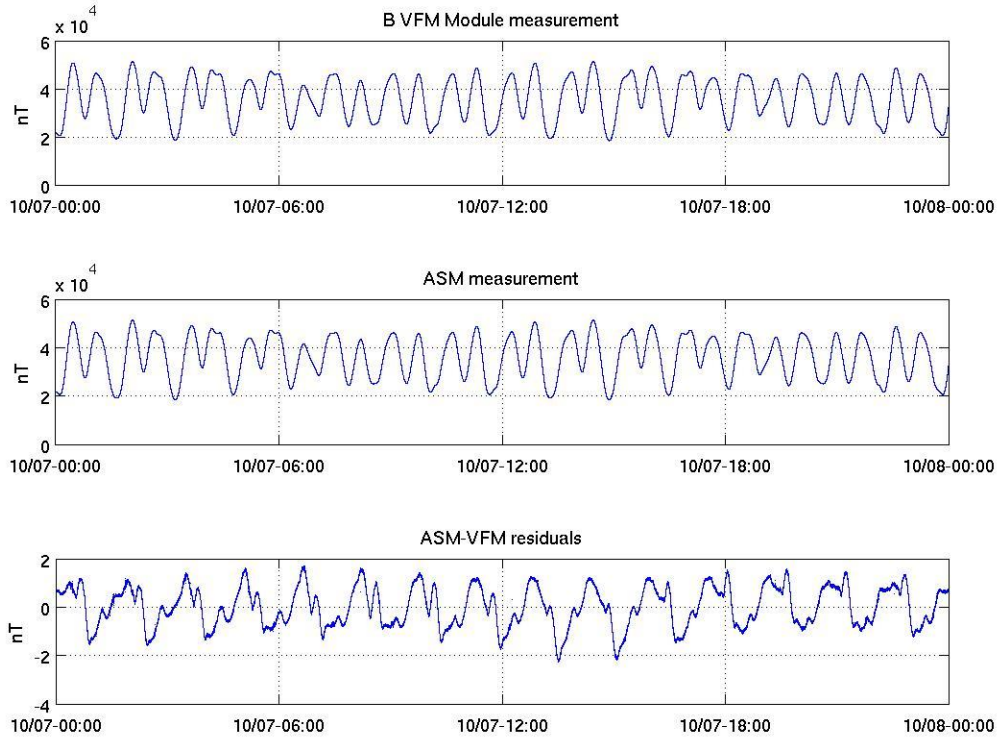

Figure 15: VFM module, ASM module and ASM-VFM residuals for S/C B, 07/09/2014

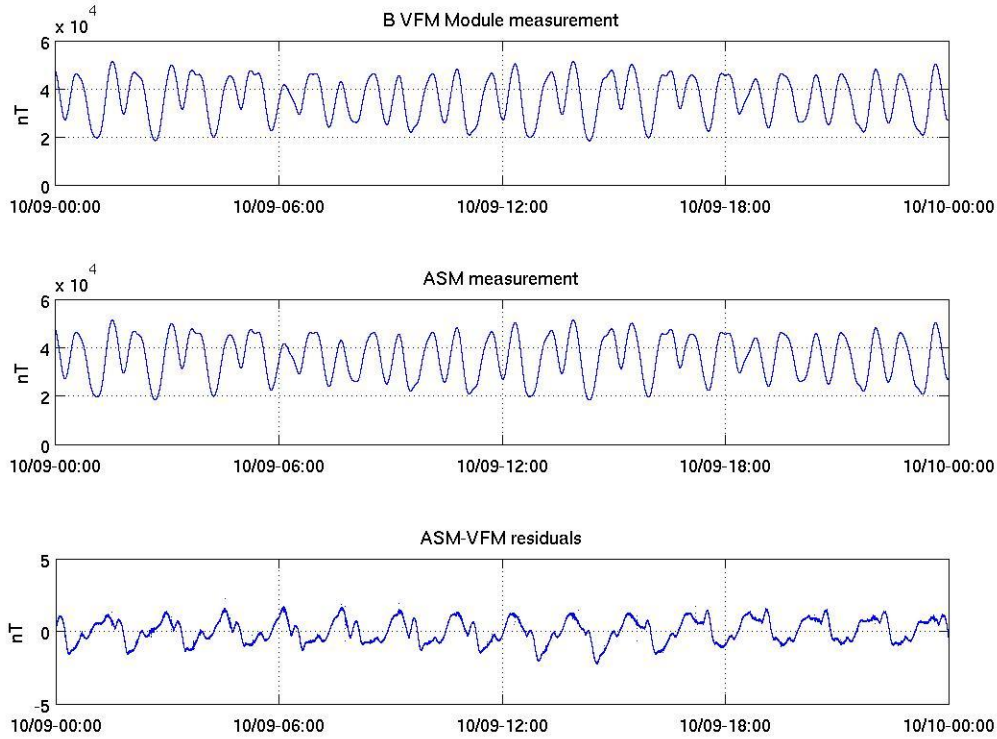

Figure 16: VFM module, ASM module and ASM-VFM residuals for S/C B, 09/10/2014.

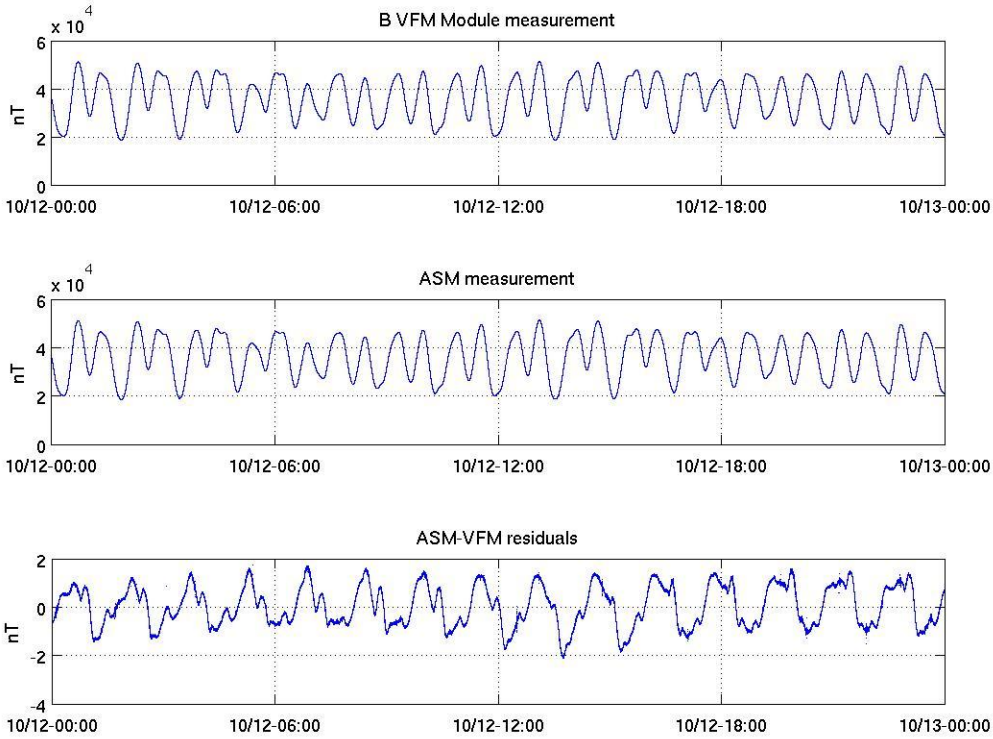

Figure 17: VFM module, ASM module and ASM-VFM residuals for S/C B, 12/10/2014.

3.3.2.3 TCF.VFM monitoring

Output will be provided in the last report of the month.

3.3.3 Swarm C

3.3.3.1 Magnetic time series visual inspection

Nothing relevant to report. An example of representative F time series for S/C C (12/10/2014) can be seen in Figure 18 below.

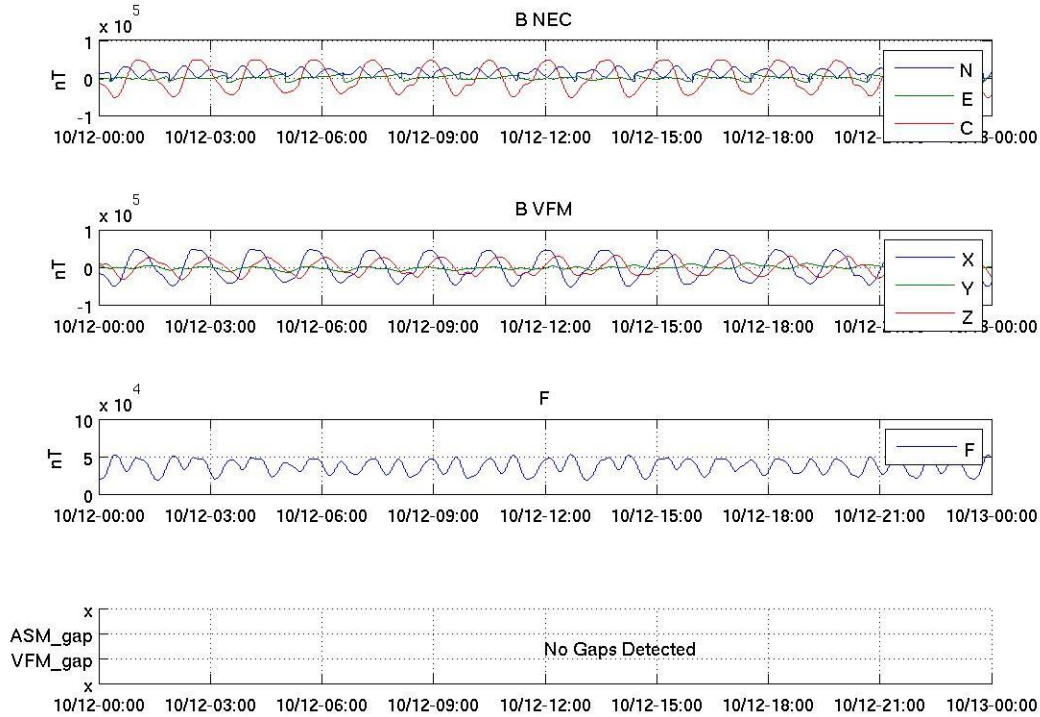

Figure 18: Time series of magnetic field intensity, F, for 12/10/2014, S/C C. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.3.2 VFM-ASM anomaly

The daily peak-to-peak difference around the week is, on average: [-1.5, 1.5] nT, with isolated spikes which reaches up to 4 nT.

Below some plot example follows of such differences taken at the beginning of the week (06/10, Figure 19), at the middle of the week (09/10, Figure 20), and at the end of the week (12/10, Figure 21). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

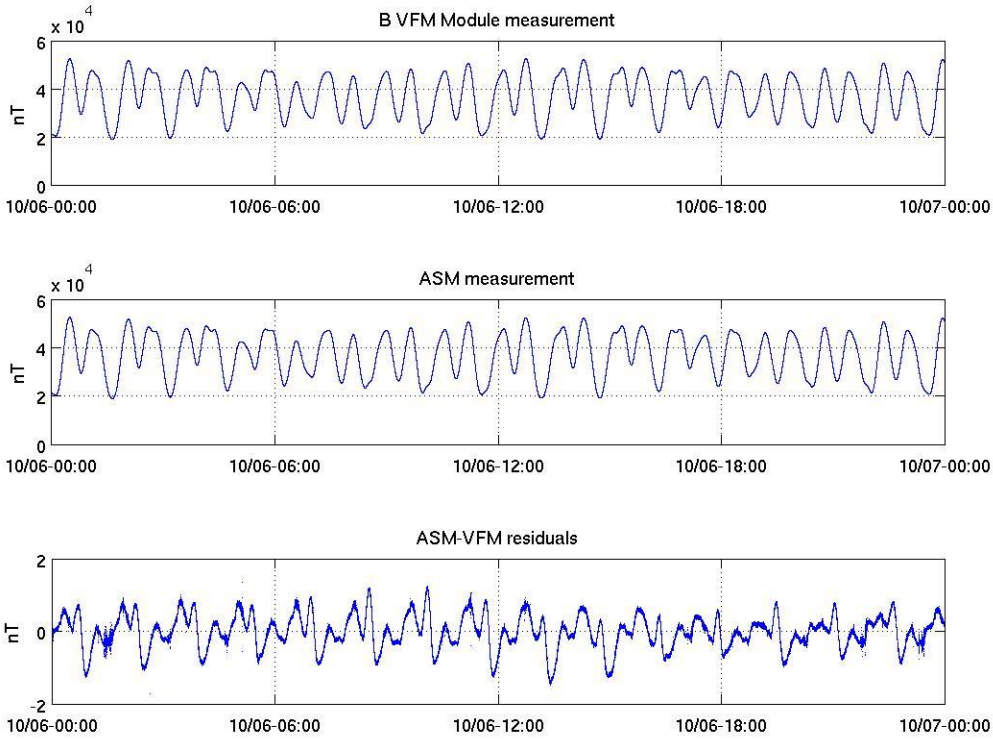

Figure 19: VFM module, ASM module and ASM-VFM residuals for S/C C, 06/10/2014.

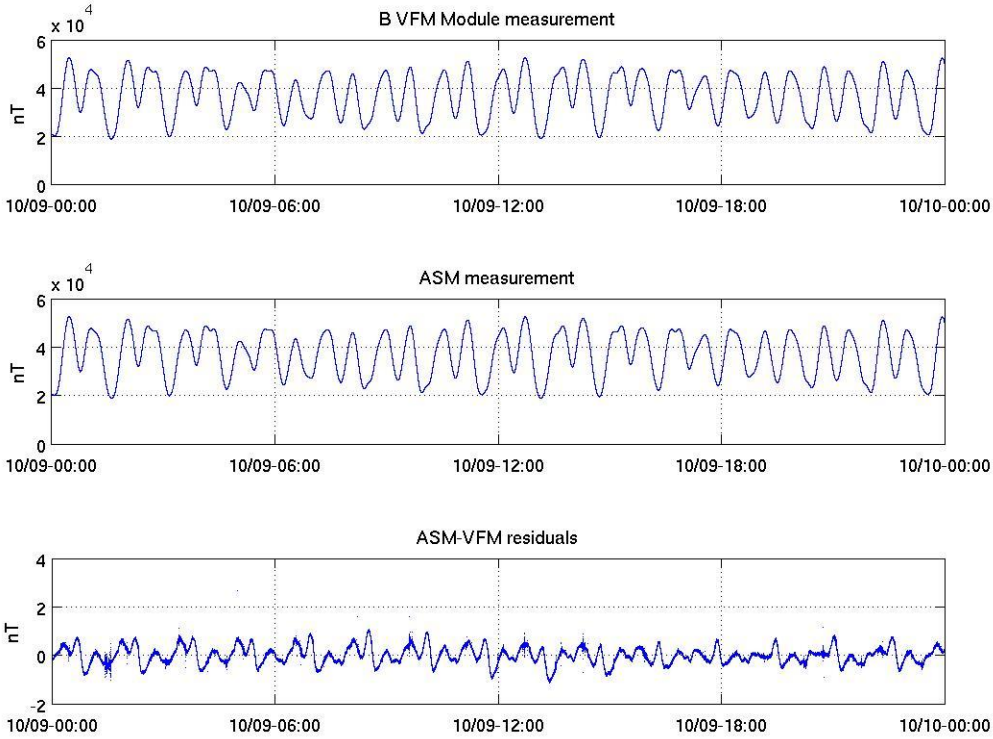

Figure 20: VFM module, ASM module and ASM-VFM residuals for S/C C, 09/10/2014.

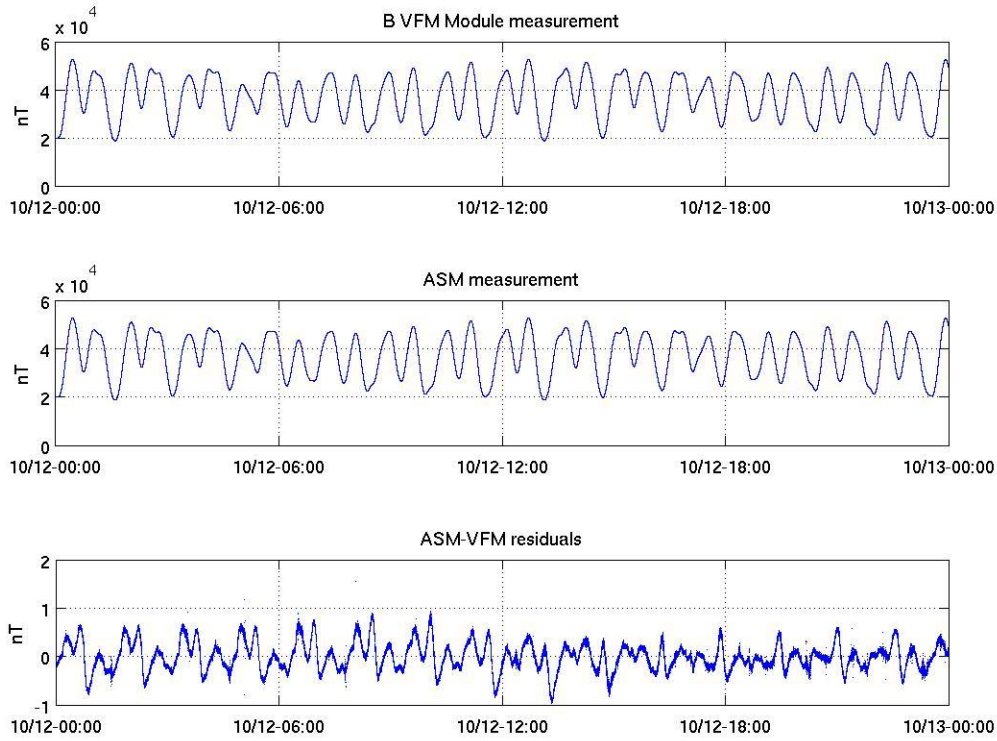

Figure 21: VFM module, ASM module and ASM-VFM residuals for S/C C, 12/10/2014.

3.3.3.3 TCF.VFM monitoring

Output will be provided in the last report of the month.

3.3.4 Summary of TCF behaviour for the three S/C

Output will be provided in the last report of the month.

4. ON-DEMAND ANALYSIS

4.1 SW-IDEAS-36: deviation of MOD-NAV solution apparently correlated with GPS clock deteriorations

In Figure 22, lower panel, one can see the time series of the MOD-NAV solutions difference for S/C B, 11/10/2014. In the second half of the day, starting roughly at about 16 UT, one can see a quasi-oscillatory behaviour (particularly in the Z component, in red), leading to think to a systematic effect of focusing/defocusing of the MOD solution with respect to the Navigation solution. The peak-to-peak excursion is not very big, keeping +/- 6 m values more or less, so that the standard deviation of the MOD-NAV difference over the day is not much affected (1.6 m).

Corresponding to the start of such effect, one can see the GPS clock calculated in the MOD product has gaps, which are linearly interpolated (Figure 22, upper panel).

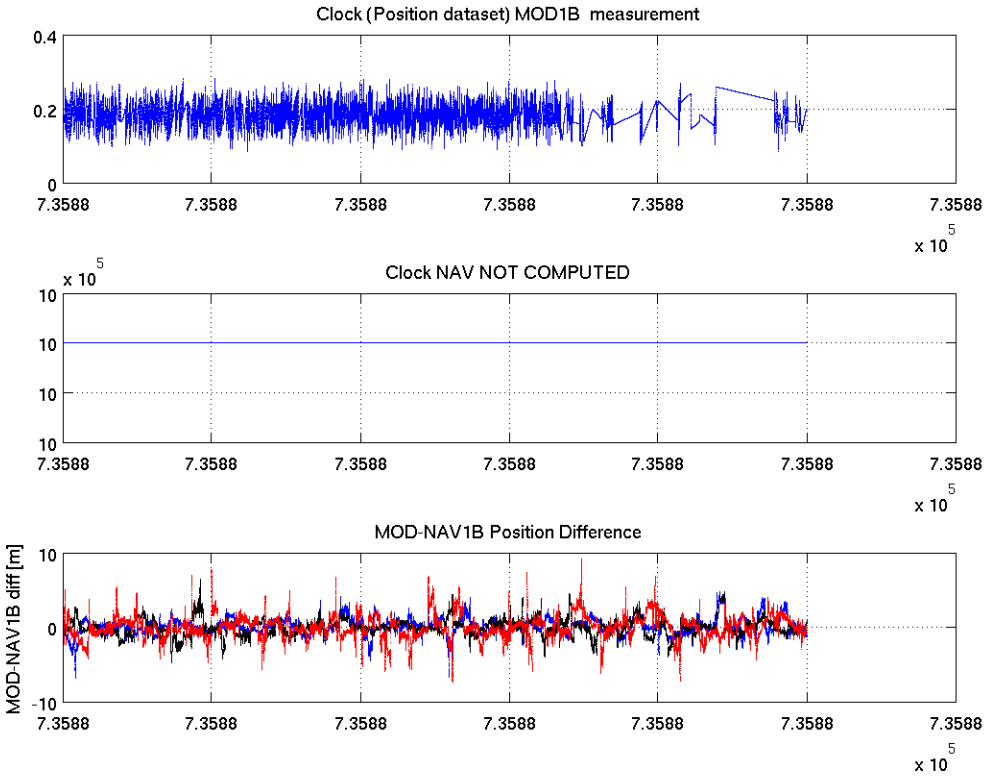

Figure 22: MOD Clock (upper panel), and MOD-NAV difference (lower panel) for S/C B, 11/10/2014.

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