Customer	**:**	**ESRIN**	**Document Ref**	**:**	**IDEAS+-SER-OQC-REP-2071**
Contract No	**:**	**4000111304/14/I-AM**	**Issue Date**	**:**	**30 October 2014**
WP No	**:**	**6110**	**Issue**	**:**	**1.0**

IDEAS+ Swarm Weekly Report : 20/10/2014 – 26/10/2014

Abstract : This is the **Instrument Data quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 20 to 26 October, 2014.

Author : Igino Coco, 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

Serco Italia Spa
Via Sciadonna 24/26, 00040, Frascati, Italy
Tel: +39 06 98354400 Fax: +39 06 9419426
www.serco.com

TABLE OF CONTENTS

Contents

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	30 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 3.11p3, 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: 29/09/2014 – 05/10/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20140929_20141005.pdf

[RD.11] IDEAS+ Swarm Weekly Report: 13/10/2014 – 19/10/2014, IDEAS+-SER-OQC-REP-2071_SPPA_SwarmWeeklyReport_20141013_20141019.pdf

[RD.12] Swarm Level 1b Processor Algorithms, SW-RS-DSC-SY-0002, Issue 6.8

[RD.13] Level 0 Data Products, SW.IF.EAD.GS.00017, Issue 13.

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. After the twofold repetition of the burn-in procedure on S/C C, we are waiting the results to be analysed and discussed in ARB #8 with Univ. of Calgary (30/10). Discussions took place with the MCP manufacturers (PHOTONIS) and no reason has been figured out for the MCP being the cause of the image degradation.

Other Plasma related issues. The dataset requested to scientists is almost ready. IRF has prepared the core work, which will be submitted to DTU for refinements and harmonisation with what will be provided by the Univ. of Calgary. A discussion has also been triggered within the ESLs on the opportunity to dismiss the EFI Matlab prototype in favour of the "sandbox" processors in use at IRF and Calgary for development.

A number of GPS out-of-sync events have been reported by FOS throughout week 34. This issue affects only S/C A and C (the low pair), and the occurrence distribution seems to peak in proximity of the South Atlantic anomaly. This leads to think to a scintillation effect that broadens the GPS signal, especially during periods of high solar activity, as it seems to be currently the case.

2.2 Plan for operational processor updates

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

- The Level 1B 3.12 delivery date is pending from a couple of remaining activities to be properly finalized: 1) resolution of a group of SPRs related to the "leap second" treatment of the STR data in ORBATT, 2) finalization of the MAGNET cross-verification about the Flags_Platform and B_errors parameters. A tentative timeline is fixed to **half November**.

- Depending on the work needed for the above mentioned activities a new analysis on the ORBATT performances after 3.11 p3 and 3.12 improvements could be or not be included in the delivery. In case the time is not enough, this activity will be postponed after the delivery.

- An activity is to be scheduled after the delivery in order to fully cross-verify the most relevant platform flags which cannot be checked due to the limitations of the cross-verification test data set.

- A dedicated teleconference on PLASMA cross-verification has been held the 27/10, between ESA, GMV, ESLs and EFI team. The LP parameters are almost aligned between PP and OP, only few spiky features are still under investigation; the TII parameters are a different story: plenty of discrepancies occur everywhere, with large amplitude and quasi-random pattern. Univ. of Calgary will cross-compare the OP results with their "sandbox" prototype, which uses fitting libraries consistent with those of the OP. The conclusion is that GMV will continue the cross-verification of PLASMA as a best effort work, trying to completely solve the LP remaining discrepancies, and only documenting the final cross-verification status in a detailed cross-verification report.

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 43 (20-26/10/2014)

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

1. **Strange features observed again 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 (**SW-IDEAS-34**, [RD.10]).

2. **One re-occurrence of SWL1L2DB-09 on S/C B ([RD.9])**: MOD and NAV solutions depart each other and the divergence increases up to end of the day.

3. **Ten cases of GPS loss of sync occurred during the week on S/C A and C:** this causes rejection of the corresponding Level 0 packets in the Level 1B processing and consequent data gaps in STR and magnetic products (**SW-IDEAS-40**, [RD.11]).

4. **ASM-VFM residuals superimposed noise** observed again (**SW-IDEAS-27**) especially in the second half of the week.

3. ROUTINE QUALITY CONTROL

3.1 Gaps analysis

SW-IDEAS-40:

The GPS sync loss already mentioned in Sect. 2.4 affects all the Level 0 products. The Sync Status is = 32 for all the intervals specified in Sect. 3.2.1.2 and 3.2.3.2, also for the ASMxVEC_0_ and VFMxNOM_0_ product types of Swarm A and C affected by such sync loss, and this causes the corresponding records to be rejected and not processed further.

In the MAGx_HR_1B product types a gap is left corresponding to the a GPS sync loss interval, while in the MAGx_LR_1B product types, in the same intervals, all the magnetic values are set to exactly zero (but properly flagged as not good).

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
SWL1L2DB-9	L1B: MOD - NAV1B discrepancies	Orbits (position and velocity)	3.2.2.1	[RD.9] and 4.2
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.10]
SW-IDEAS-40	OBS_ROUTINE: STR out of range - ANOMALOUS CASES	STRCATT_1B STRCSCI_1A	3.2.1.2 3.2.3.2	4.1

Table 1: list of events related to attitude and orbit products to be reported in the monitoring for Week 43: 20 - 26/10/2014

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, 20-26/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard deviation (m)**	**Notes**
20/10	0.07	-16.5 (Z), 12.2 (X)	1.7	SW-IDEAS-34 ([RD.10])
21/10	0.13	-12 (Y), 11.5 (Z)	1.8	
22/10	0.05	-8.3 (Z), 10.2 (X)	1.3	
23/10	0.11	-24.4 (Y), 13.3 (X)	1.4	Isolated spikes in X and Y comp. corresponding to Sync loss intervals
24/10	0.04	-17 (Z), 18 (X)	1.7	
25/10	0.06	-11.6 (Y), 28.5 (X)	1.7	Isolated spikes in X and Y comp. corresponding to Sync loss intervals
26/10	0.06	-46.5 (Y), 15.2 (Z)	1.8	Isolated spikes in Y and Z comp. corresponding to Sync loss intervals

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 (20/10, Figure 1), in the middle (23/10, Figure 2) and at the end (26/10, 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.

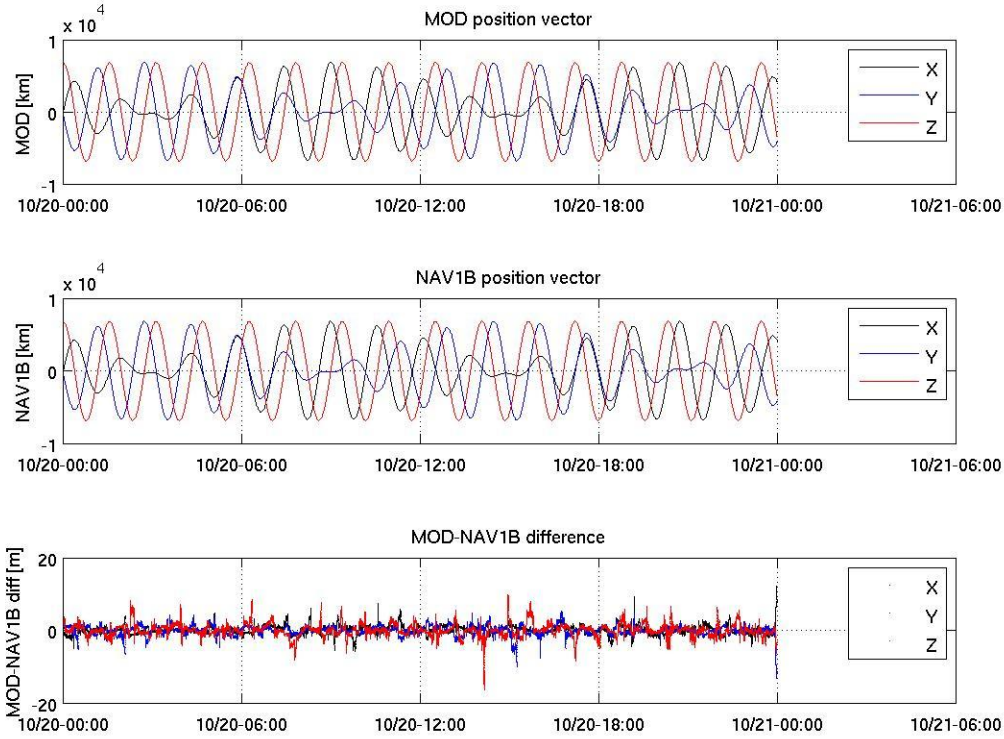

Figure 1: Difference MOD-GPSNAV, sc A, 20/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

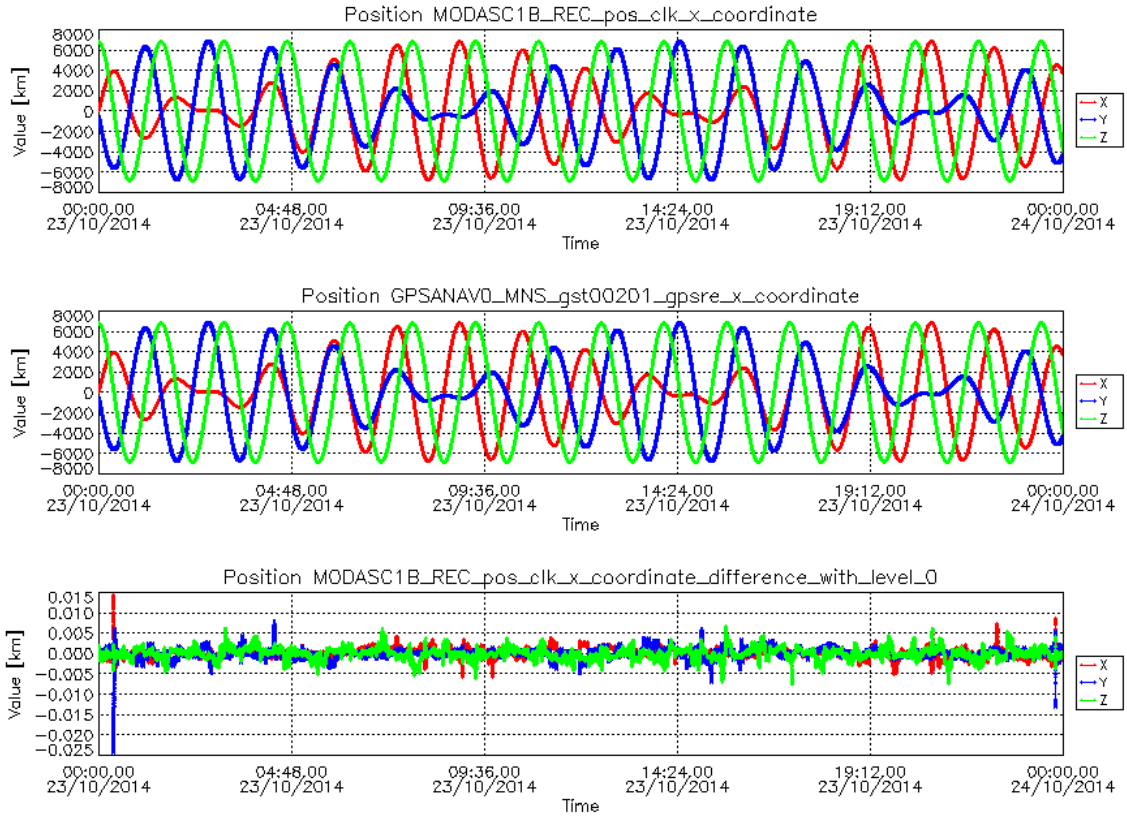

Figure 2: Difference MOD-GPSNAV, sc A, 23/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

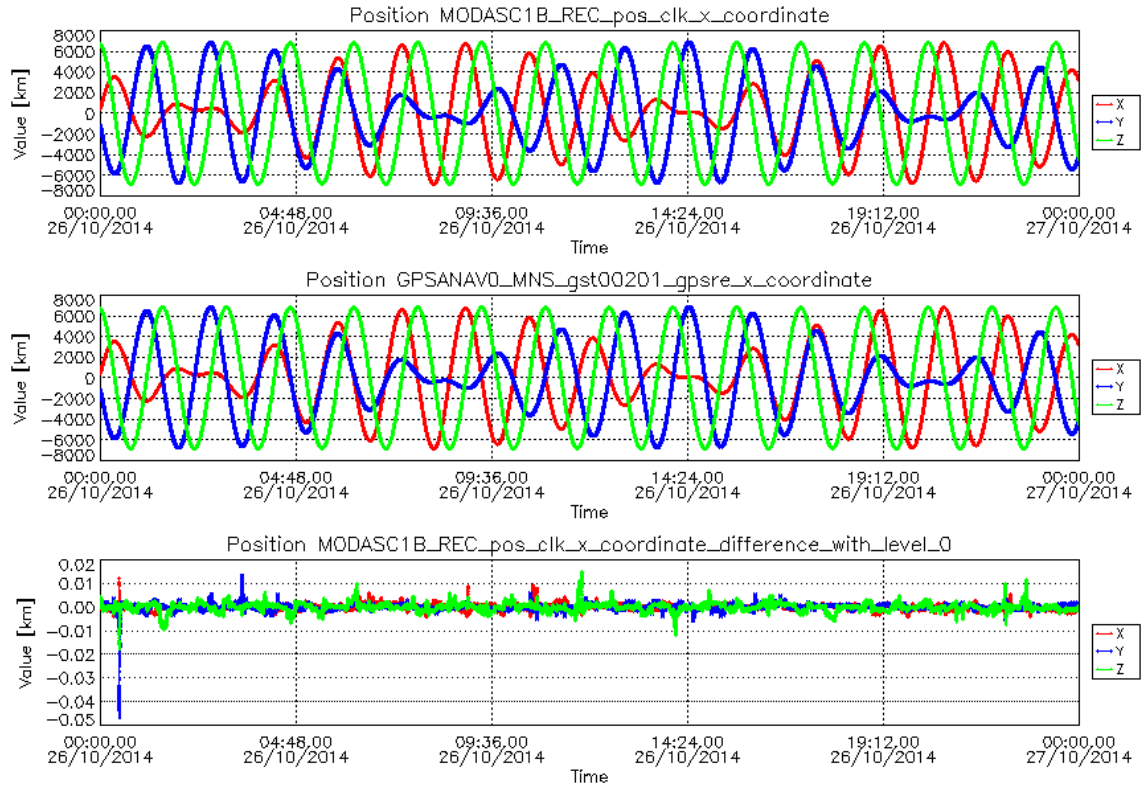

Figure 3: Difference MOD-GPSNAV, sc A, 26/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.1.2 Attitude observations

- **SW-IDEAS-40**

  1) 20/10/2014, Affected product:
  SW_OPER_STRAATT_1B_20141020T000000_20141020235959_0302

  25 seconds out of range (Flags_q=255, no attitude available).
  See Table 3 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
20OCT2014 23:58:13	20OCT2014 23:58:38	25	255

Table 3: Attitudes out-of-range, S/C A, 20/10/2014

The cause of such rejected attitudes is a time gap in the Level 1A product:

SW_OPER_STRASCI_1A_20141019T235500_20141021T000459_0302

The Level 0 source file:

SW_OPER_STRANOM_0__20141020T153652_20141021T053551_0201 seems not to have time gaps in the corresponding interval.

2) 23/10/2014, Affected product:

SW_OPER_STRAATT_1B_20141023T000000_20141023235959_0302

52 seconds out of range (Flags_q=255, no attitude available).

See Table 4 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
23OCT2014 00:20:52	23OCT2014 00:21:08	17	255
23OCT2014 23:48:04	23OCT2014 23:48:38	35	255

Table 4: Attitudes out-of-range, S/C A, 23/10/2014

The causes of such rejected attitudes are two time gaps in the Level 1A product:

SW_OPER_STRASCI_1A_20141022T235500_20141024T000459_0302,

Corresponding to the intervals specified in the table above.

The Level 0 source files:

SW_OPER_STRANOM_0__20141022T160652_20141023T091451_0201,
SW_OPER_STRANOM_0__20141023T153452_20141024T053351_0201

seem not to have time gaps in the corresponding intervals.

3) 24/10/2014, Affected product:

SW_OPER_STRAATT_1B_20141024T000000_20141024235959_0302

103 seconds out of range (Flags_q=255, no attitude available).

See Table 5 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
24OCT2014 23:15:28	24OCT2014 23:16:37	71	255
24OCT2014 23:24:37	24OCT2014 23:25:07	32	255

Table 5: Attitudes out-of-range, S/C A, 24/10/2014

The causes of such rejected attitudes are two time gaps in the Level 1A product:

SW_OPER_STRASCI_1A_20141023T235500_20141025T000459_0302,

Corresponding to the intervals specified in the table above.

The Level 0 source file:

SW_OPER_STRANOM_0__20141024T101752_20141025T080851_0201,

seems not to have time gaps in the corresponding intervals.

4) 25/10/2014, Affected product:

SW_OPER_STRAATT_1B_20141025T000000_20141025235959_0302

59 seconds out of range (Flags_q=255, no attitude available).

See Table 6 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
25OCT2014 22:43:40	25OCT2014 22:44:37	59	255

Table 6: Attitudes out-of-range, S/C A, 25/10/2014

The cause of such rejected attitudes is a time gap in the Level 1A product:

SW_OPER_STRASCI_1A_20141024T235500_20141026T000459_0302,

Corresponding to the interval specified in the table above.

The Level 0 source file:

SW_OPER_STRANOM_0__20141025T160852_20141026T073651_0201,

seems not to have time gaps in the corresponding intervals.

5) 26/10/2014, Affected product:

SW_OPER_STRAATT_1B_20141026T000000_20141026235959_0302

48 seconds out of range (Flags_q=255, no attitude available).

See Table 7 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
26OCT2014 00:27:36	26OCT2014 00:27:39	4	255
26OCT2014 22:10:54	26OCT2014 22:11:37	44	255

Table 7: Attitudes out-of-range, S/C A, 26/10/2014

The causes of such rejected attitudes are time gaps in the Level 1A product:

SW_OPER_STRASCI_1A_20141025T235500_20141027T000459_0302,

Corresponding to the intervals specified in the table above.

The Level 0 source files:

SW_OPER_STRANOM_0__20141025T160852_20141026T073651_0201,

SW_OPER_STRANOM_0__20141026T153752_20141027T053151_0201,

seem not to have time gaps in the corresponding intervals.

With respect to past week, we had a clue on such anomalous rejections. In Sect. 4.1 more details are given.

3.2.2 Swarm B

3.2.2.1 Position Statistics

In Table 8 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, 20-26/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
20/10	0.15	-13, 10 (Z)	2	SW-IDEAS-34 [RD.10]
21/10	0.5	-43 (X), 31 (Z)	6	SWL1L2DB-09 [RD.9]
22/10	0.07	-9, 15.5 (Z)	1.5	
23/10	0.03	+/- 10 (Z)	1.3	
24/10	0.08	-9.6 (X), 10.3 (Z)	1.5	
25/10	0.12	-9, 8.6 (Z)	1.7	
26/10	0.2	-8.7 (Z), 8.5 (X)	1.6	SW-IDEAS-34 [RD.10]

Table 8: 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 (21/10, Figure 4), in the middle (23/10, Figure 5), and at end of the week (26/10, 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 see a new occurrence of the issue described in [RD.9] and classified as **SWL1L2DB-9** on ARTS: the difference between the MOD and NAV solutions starts to diverge from about 22 UT. The processor manufacturer has fixed the issue in its test environment and the fix will be part of the next L1BOP delivery, more information are given in Sect. 4.2.

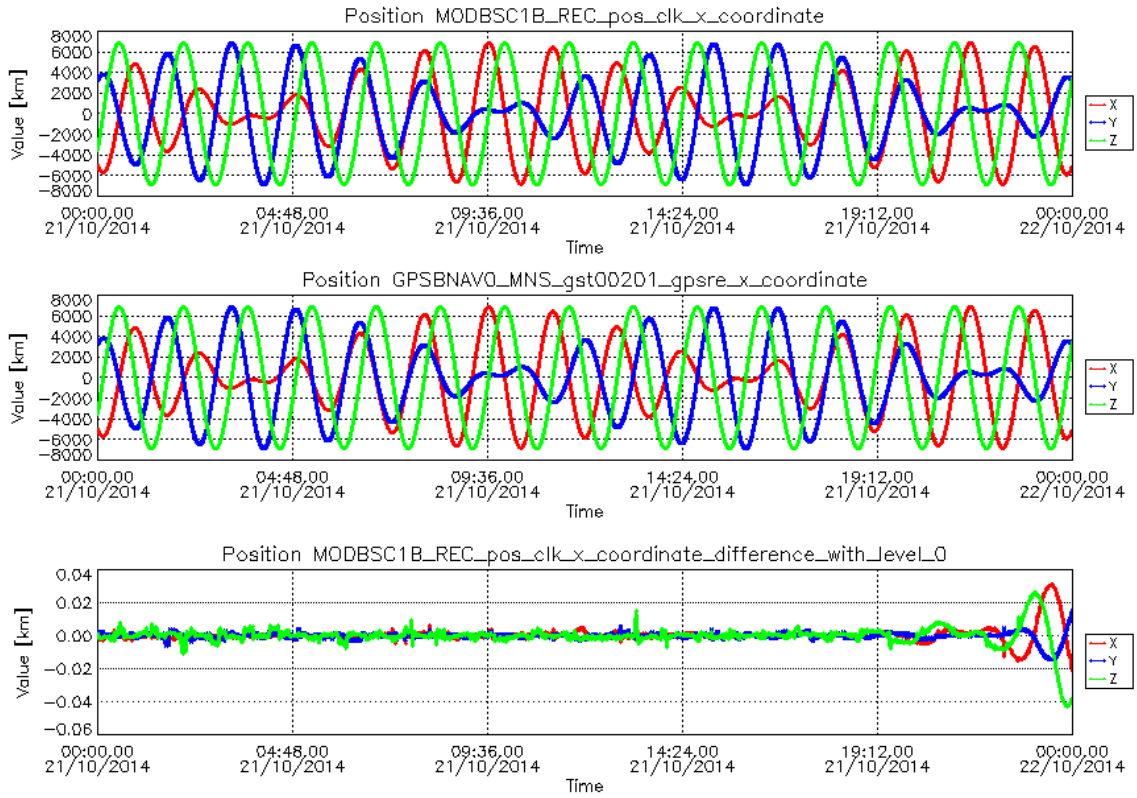

Figure 4: Difference MOD-GPSNAV, sc B, 21/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. From about 22 UT a re-occurrence of SWL1L2DB-9 can be seen.

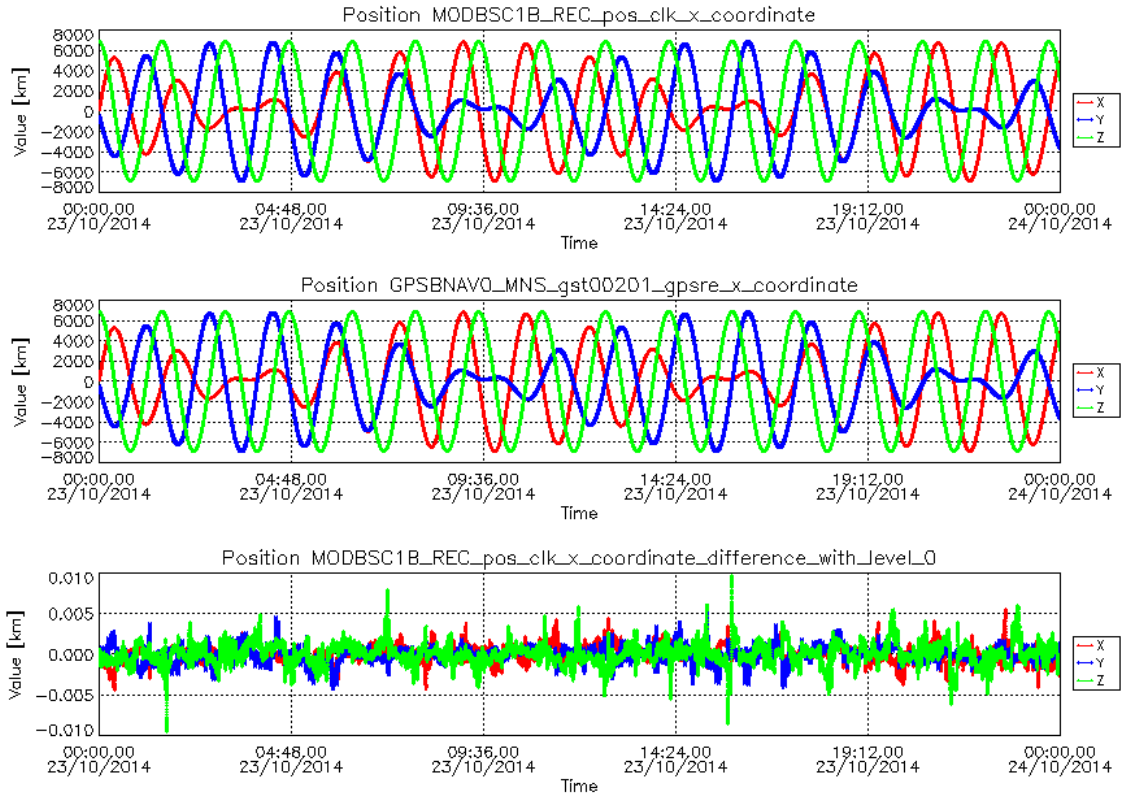

Figure 5: Difference MOD-GPSNAV, sc B, 23/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

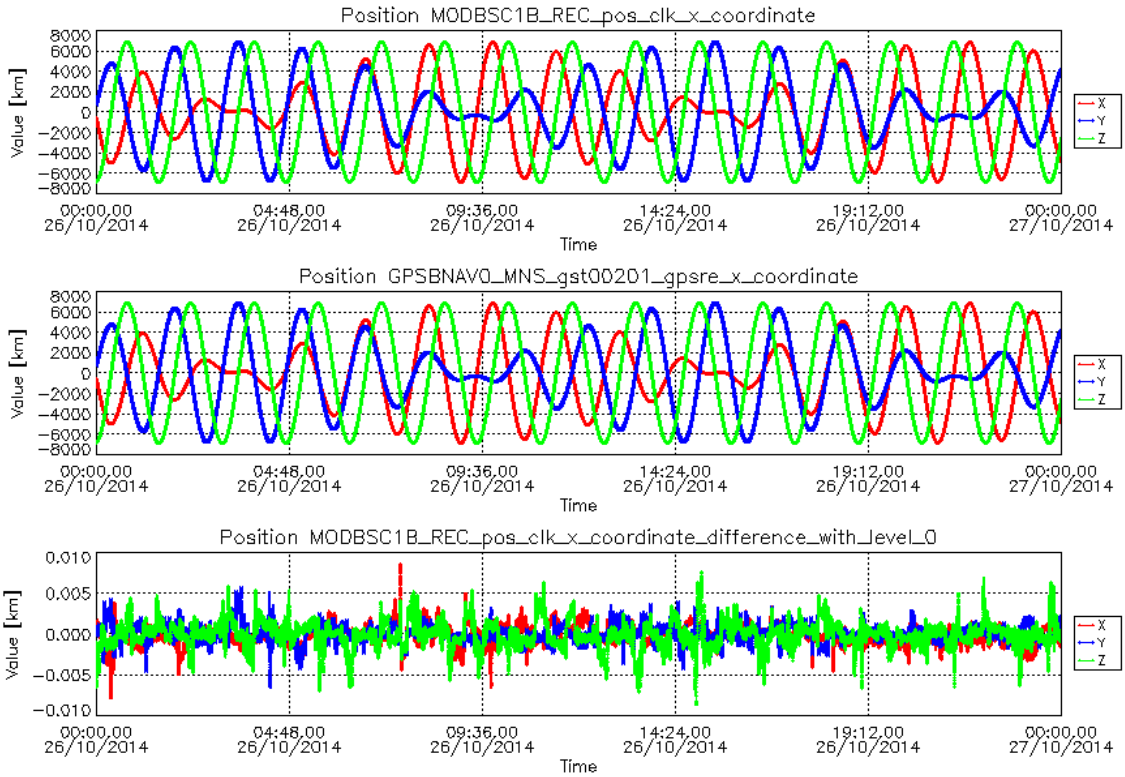

Figure 6: Difference MOD-GPSNAV, sc B, 26/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.2.2 Attitude observations

Nothing to report.

3.2.3 Swarm C

3.2.3.1 Position Statistics

In Table 9 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, 20-26/10/2014, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
20/10	0.04	-10.7 (Y), 10 (Z)	1.7	SW-IDEAS-34 [RD.10]

Swarm C, 20-26/10/2014, Position difference				
21/10	0.11	-14.5, 12 (Z)	1.8	SW-IDEAS-34 [RD.10]
22/10	0.07	-14 (X), 13.5 (Z)	1.5	
23/10	0.07	-7.6, 17 (Z)	1.5	
24/10	0.04	-15.8 (Z), 13.2 (X)	1.6	
25/10	0.04	-9, 10 (Y)	1.6	
26/10	0.18	-12 (X), 13 (Z)	1.8	Isolated spikes in X and Z comp. corresponding to Sync loss intervals

Table 9: 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 (20/10, Figure 7), in the middle (23/10, Figure 8) and at the end (26/10, 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 Figure 7 one can see examples of “spiky” features (red-circled area), of the kind described in [RD.10] for **SW-IDEAS-34**: the MOD-NAV difference steeply departs from its average and keeps a higher/lower value for several minutes.

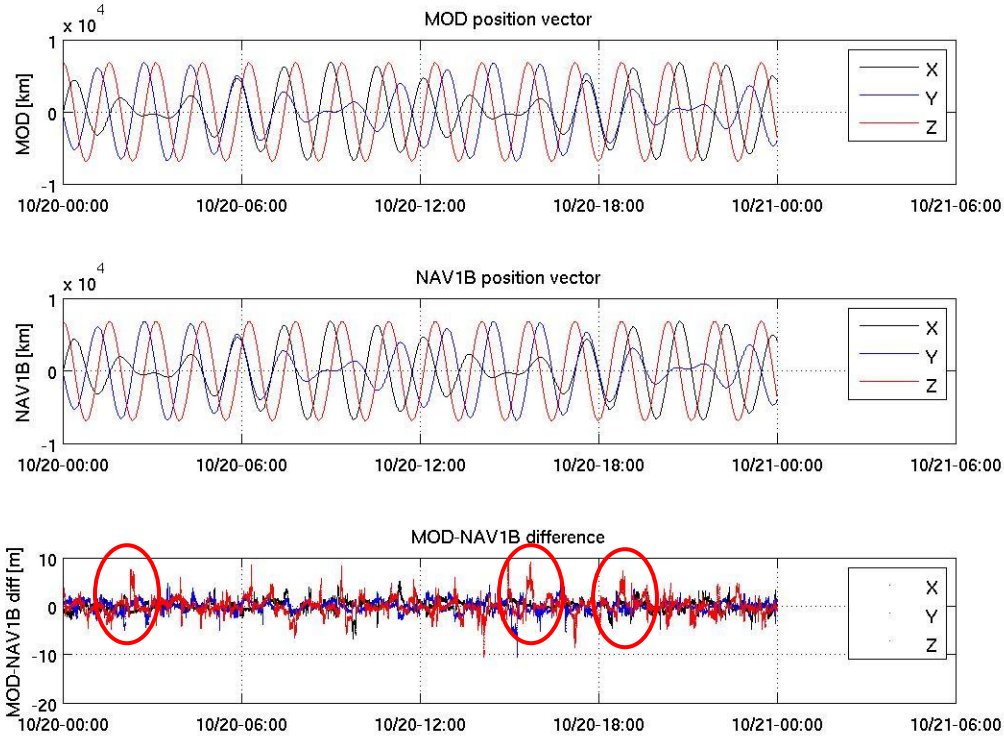

Figure 7: Difference MOD-GPSNAV, sc C, 20/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The red-circled areas highlight regions characterized by “spiky” features (SW-IDEAS-34).

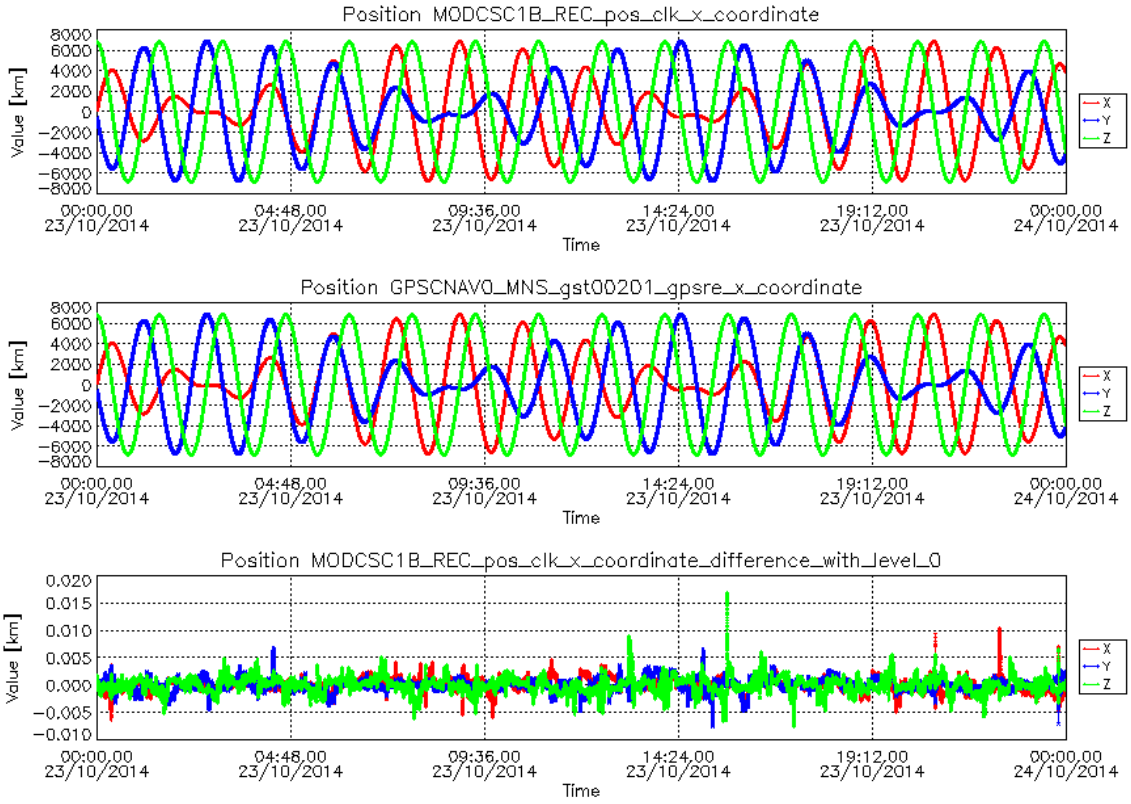

Figure 8: Difference MOD-GPSNAV, sc C, 23/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

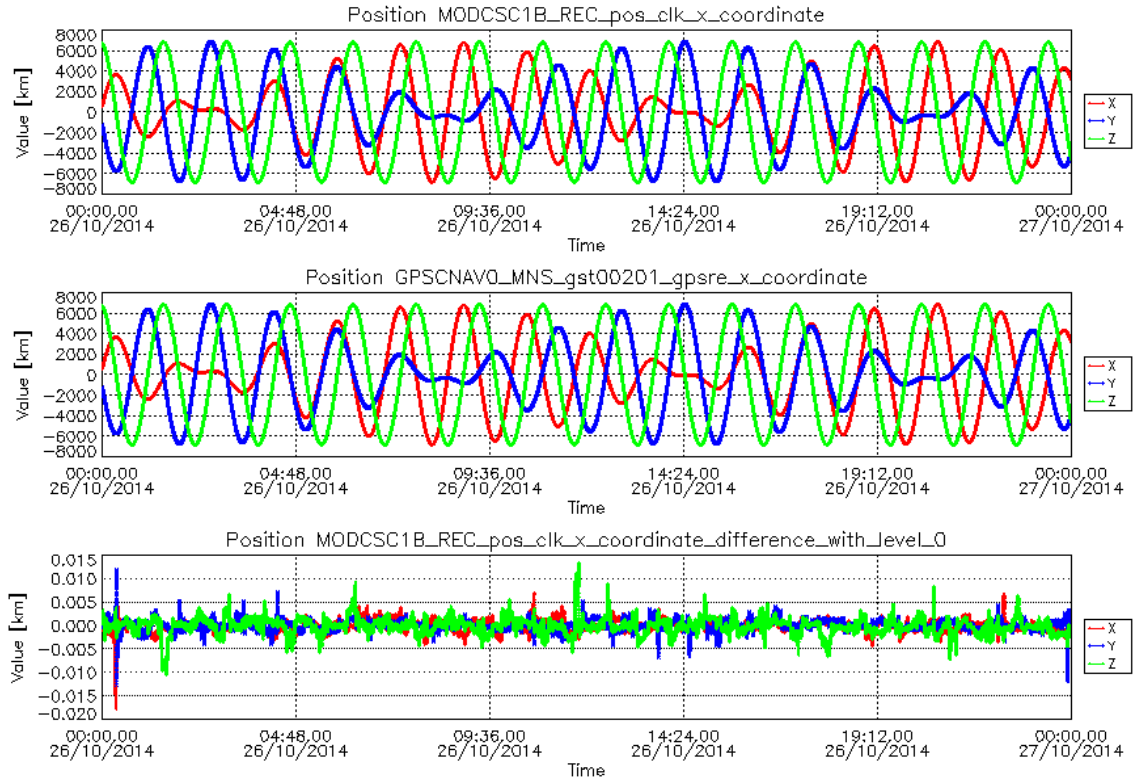

Figure 9: Difference MOD-GPSNAV, sc C, 26/10/2014. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

3.2.3.2 Attitude observations

- **SW-IDEAS-40**

1) 23/10/2014, Affected product:

SW_OPER_STRCATT_1B_20141023T000000_20141023235959_0302

25 seconds out of range (Flags_q=255, no attitude available).

See Table 10 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
23OCT2014 20:44:50	23OCT2014 20:45:08	18	255
23OCT2014 23:48:32	23OCT2014 23:48:38	7	255

Table 10: Attitudes out-of-range, S/C C, 23/10/2014

The causes of such rejected attitudes are two time gaps in the Level 1A product:

SW_OPER_STRCSCI_1A_20141022T235500_20141024T000459_0302

The Level 0 source file:

SW_OPER_STRCNOM_0__20141023T105007_20141024T070606_0201

seems not to have time gaps in the corresponding intervals.

2) 24/10/2014, Affected product:

SW_OPER_STRCATT_1B_20141024T000000_20141024235959_0302

22 seconds out of range (Flags_q=255, no attitude available).

See Table 11 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
24OCT2014 23:24:16	24OCT2014 23:24:38	22	255

Table 11: Attitudes out-of-range, S/C C, 24/10/2014

The cause of such rejected attitudes is a time gap in the Level 1A product:

SW_OPER_STRCSCI_1A_20141023T235500_20141025T000459_0302

The Level 0 source file:

SW_OPER_STRCNOM_0__20141024T115307_20141025T063506_0201 seems not to have time gaps in the corresponding interval.

3) 25/10/2014, Affected product:

SW_OPER_STRCATT_1B_20141025T000000_20141025235959_0302

18 seconds out of range (Flags_q=255, no attitude available).

See Table 12 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
25OCT2014 02:34:51	25OCT2014 02:35:07	18	255

Table 12: Attitudes out-of-range, S/C C, 25/10/2014

The cause of such rejected attitudes is a time gap in the Level 1A product:

SW_OPER_STRCSCI_1A_20141024T235500_20141026T000459_0302

The Level 0 source file:

SW_OPER_STRCNOM_0__20141024T115307_20141025T063506_0201 seems not to have time gaps in the corresponding interval.

4) 26/10/2014, Affected product:

SW_OPER_STRCATT_1B_20141026T000000_20141026235959_0302

45 seconds out of range (Flags_q=255, no attitude available).

See Table 13 for details.

Start Out-of-range	Stop Out-of-range	Duration (s)	Value
26OCT2014 00:19:53	26OCT2014 00:20:37	45	255

Table 13: Attitudes out-of-range, S/C C, 26/10/2014

The cause of such rejected attitudes is a time gap in the Level 1A product:

SW_OPER_STRCSCI_1A_20141025T235500_20141027T000459_0302

The Level 0 source file:

SW_OPER_STRCNOM_0__20141026T104807_20141027T084106_0201 seems not to have time gaps in the corresponding interval.

With respect to past week, we had a clue on such anomalous rejections. In Sect. 4.1 more details are given.

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.**

SW-IDEAS-27 (monitoring of the anomaly): During week 43 we do observe events of noise increase in the ASM-VFM residuals. After day 23/10, the geomagnetic activity increases (Kp above 5), and the noise level in the spectral region [0.03 – 0.06] Hz often exceeds the average PSD usually observed for more “quiet” days.

3.3.1 Swarm A

3.3.1.1 Magnetic time series visual inspection

An example of representative magnetic field time series for S/C A can be seen in Figure 10 (26/10/2014). In the lower plot, the two intervals characterized by GPS sync loss are evidenced as gaps in magnetic data.

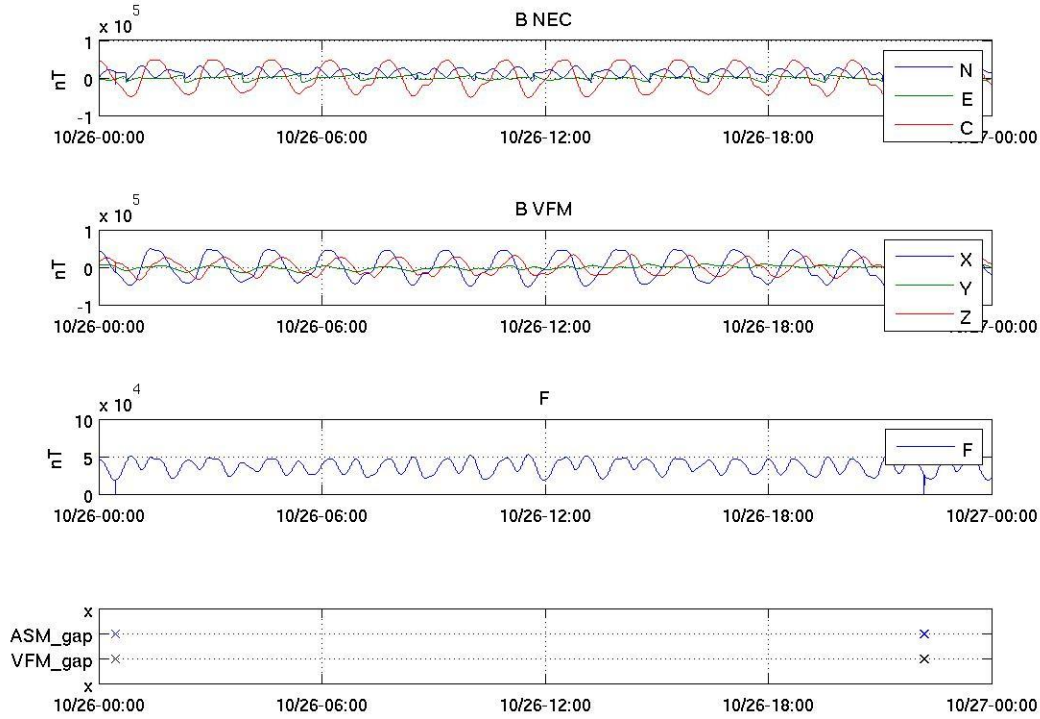

Figure 10: Time series of the geomagnetic field, for 26/10/2014, S/C A. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps.

3.3.1.2 VFM-ASM anomaly

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

Below some plot example of such differences follows, taken at the beginning of the week (21/10, Figure 11) and end of the week (26/10, Figure 12). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

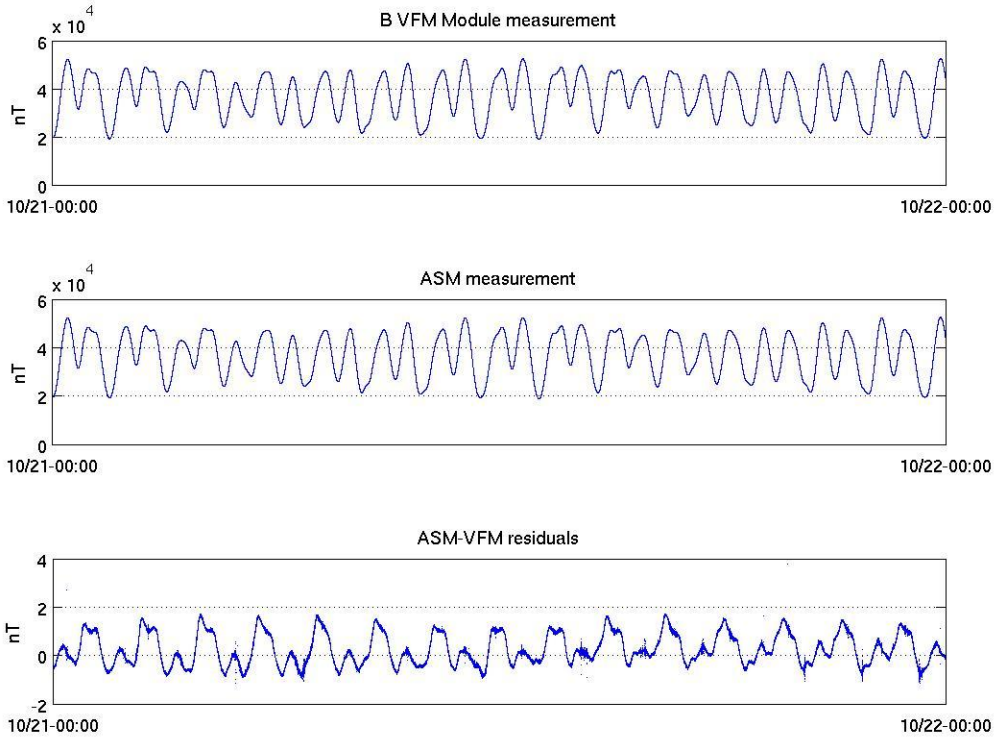

Figure 11: VFM module, ASM module and ASM-VFM residuals for S/C A, 21/10/2014.

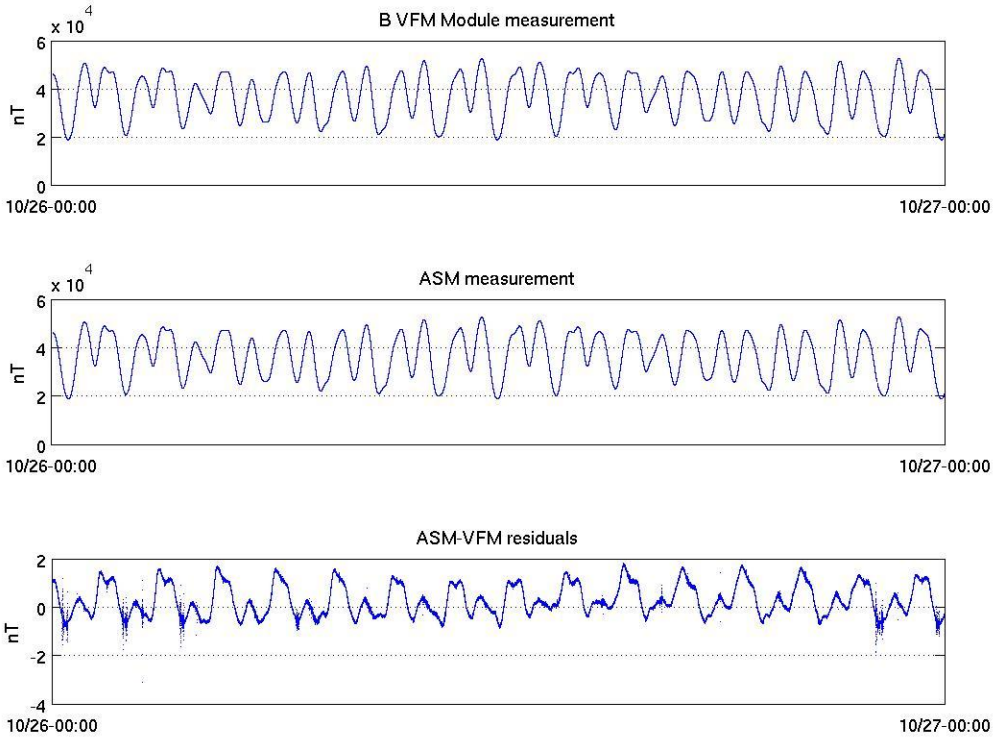

Figure 12: VFM module, ASM module and ASM-VFM residuals for S/C A, 26/10/2014.

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 (26/10/2014) can be seen in Figure 13 below.

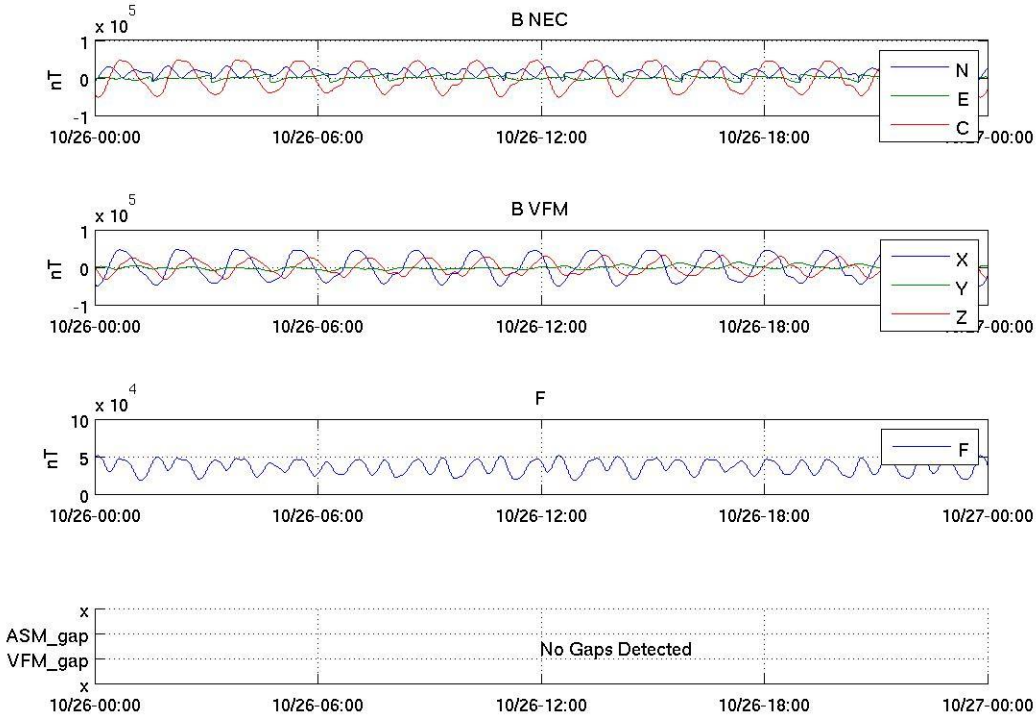

Figure 13: Time series of the geomagnetic field for 26/10/2014, S/C B. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.2.2 VFM-ASM anomaly

The daily peak-to-peak difference around the week is, on average: [-2, 2] nT, with isolated spikes (gradients) that reaches up to 6 nT.

Below some plot example follows of such differences taken at the beginning of the week (21/10, Figure 14), middle of the week (23/10, Figure 15) and at the end of the week (26/10, Figure 16). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

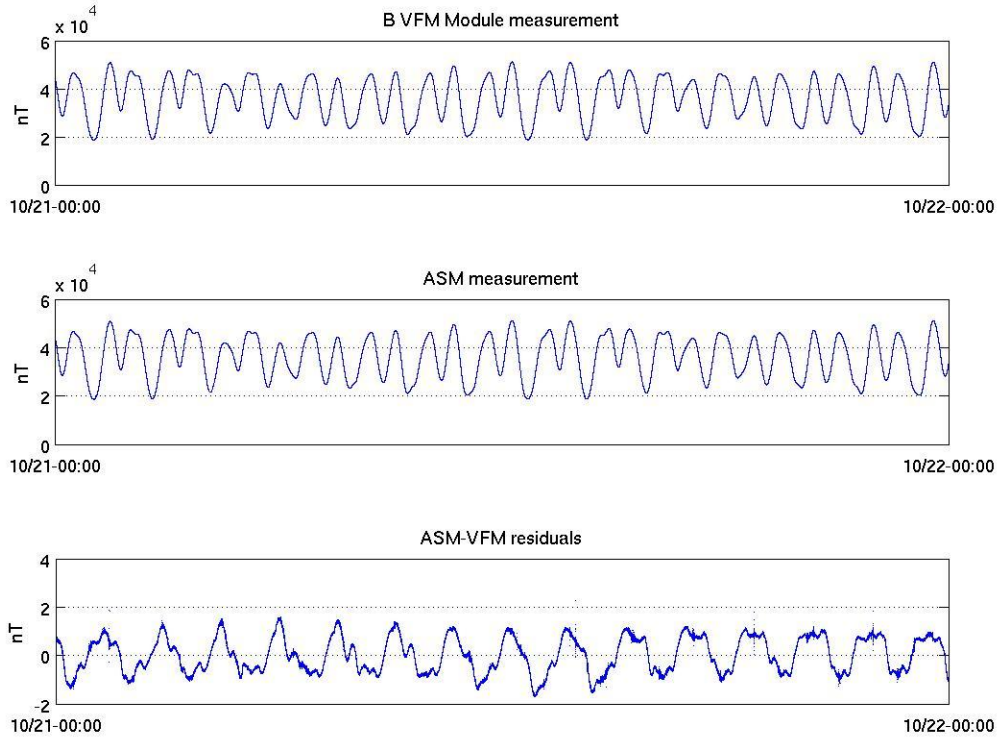

Figure 14: VFM module, ASM module and ASM-VFM residuals for S/C B, 21/10/2014

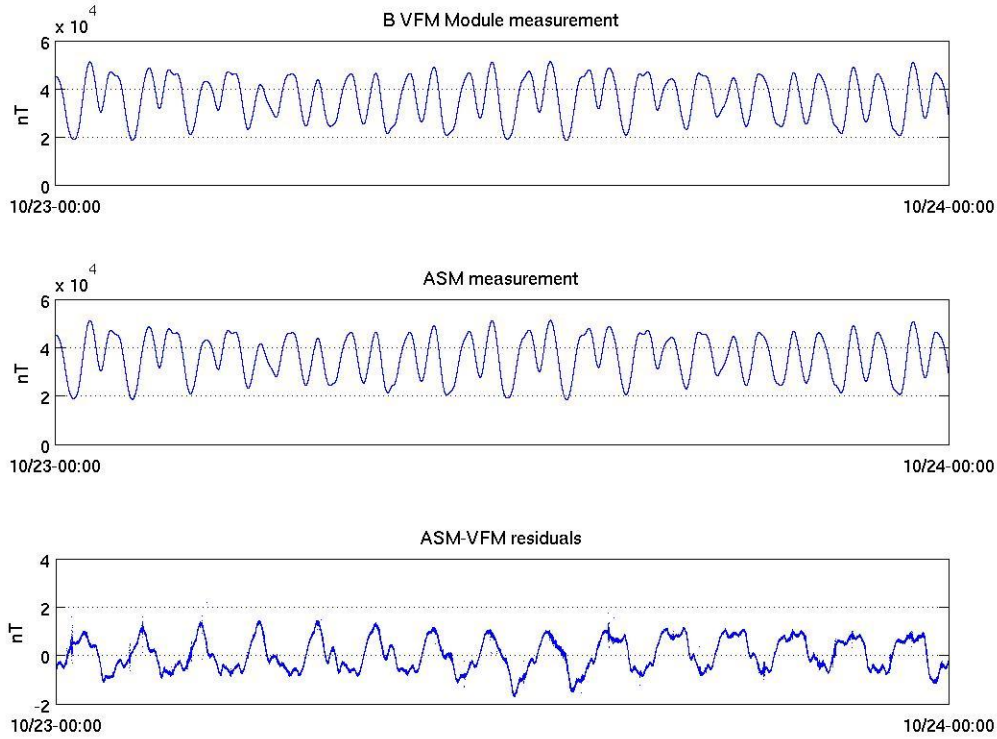

Figure 15: VFM module, ASM module and ASM-VFM residuals for S/C B, 23/10/2014.

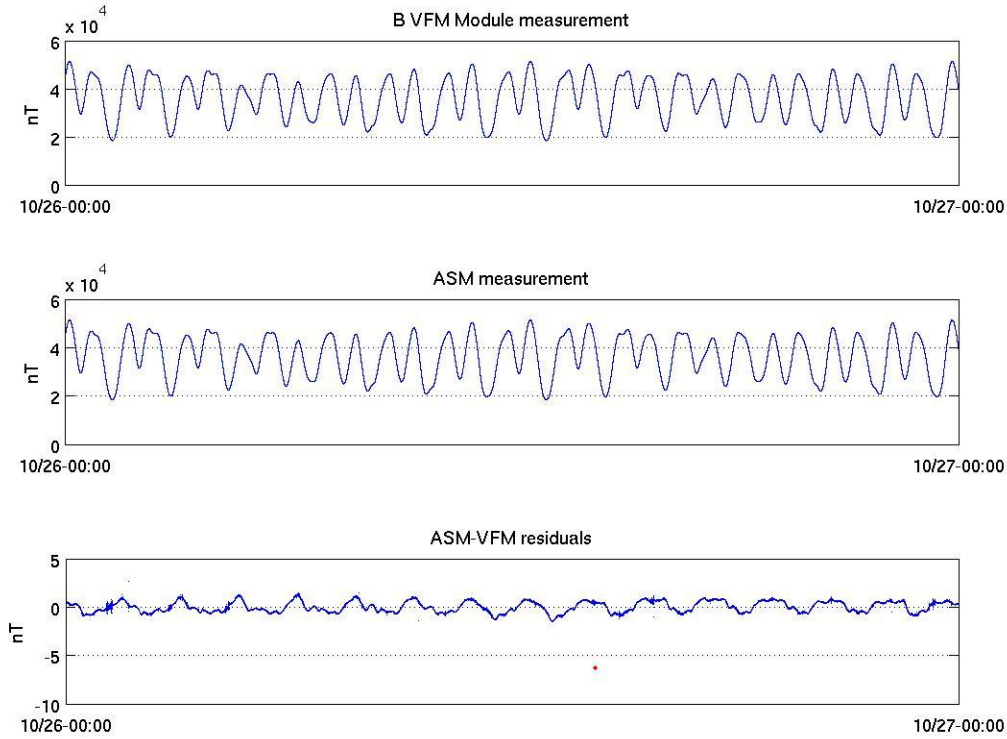

Figure 16: VFM module, ASM module and ASM-VFM residuals for S/C B, 26/10/2014.

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

An example of representative F time series for S/C C (26/10/2014) can be seen in Figure 17 below. In the lower plot, the two intervals characterized by GPS sync loss are evidenced as gaps in magnetic data.

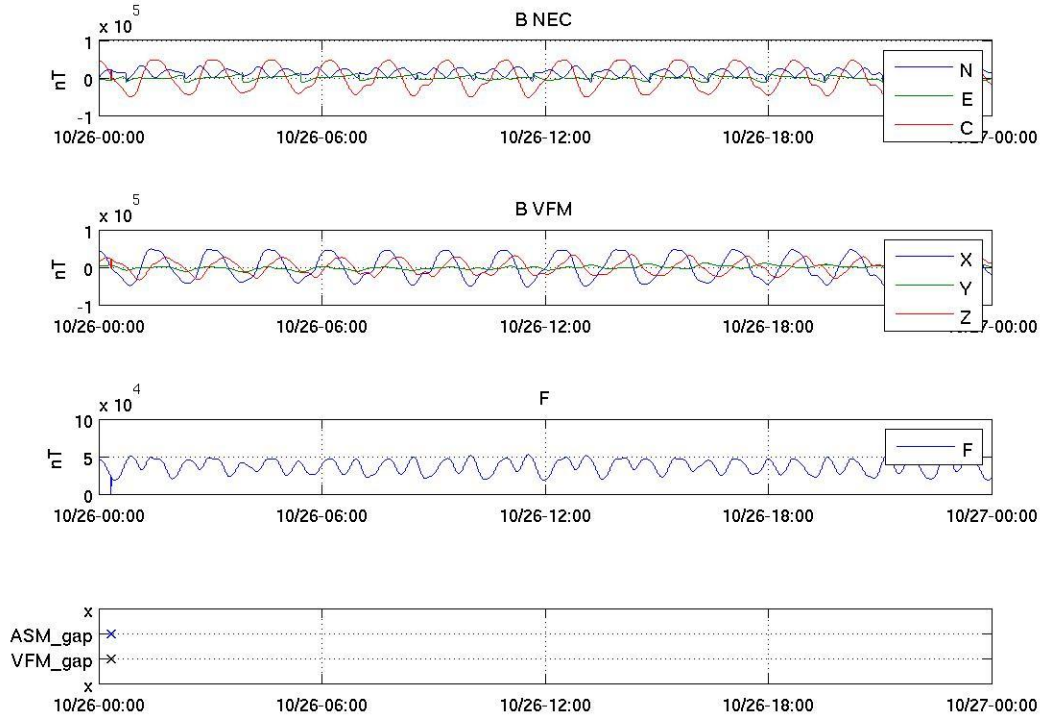

Figure 17: Time series of magnetic field intensity, F, for 26/10/2014, S/C C. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps.

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 10 nT.

Below some plot example follows of such differences taken at the beginning of the week (21/10, Figure 18), and at the end of the week (26/10, Figure 19). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

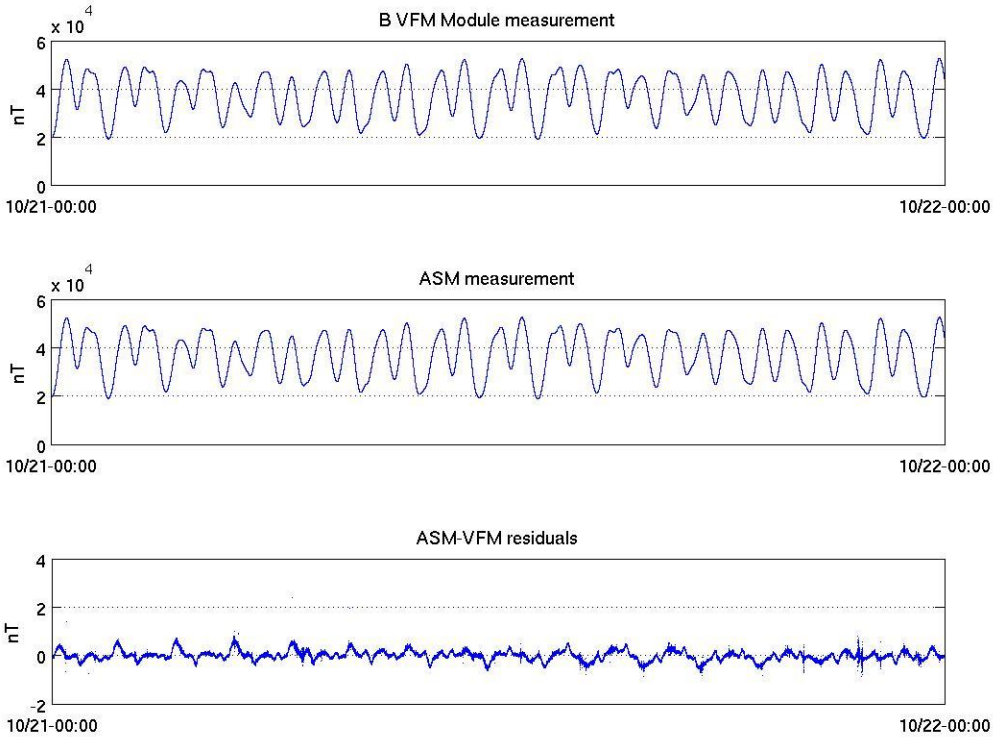

Figure 18: VFM module, ASM module and ASM-VFM residuals for S/C C, 21/10/2014.

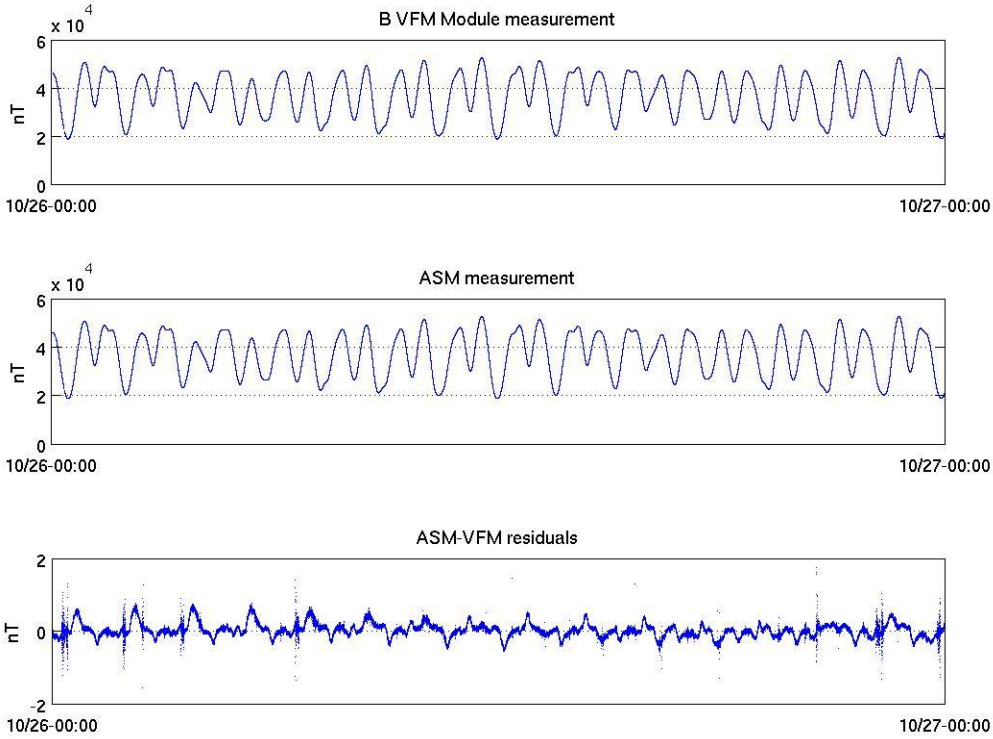

Figure 19: VFM module, ASM module and ASM-VFM residuals for S/C C, 26/10/2014.

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-40: Explanation on STR rejection anomalous cases

As listed in Sects. 3.2.1.2 and 3.2.3.2, and in [RD.11], we had up to now ten cases of attitude rejections that cannot be explained with the simultaneous occurrence of BBO, and invalid measurements. Such cases show up as time gaps in the MDRSTRSCI_1A dataset of the Level 1A products, which contain the attitude and auxiliary information for the single camera units, and are characterized by Flags_q=255 in the MDRSTRPRC_1A dataset which contains combined information for the three cameras to be transferred into the Level 1B products.

The rejections seem therefore to have place between the source Level 0 products and the Level 1A. As there are neither gaps in telemetry, nor packets corrupted, we got into [RD.12], Sect. 5.1, and [RD.13], Sect. 4.2.2. in order to understand which checks are preliminarily performed by the Level 1B OP when it reads into the Level 0s ISPs. In fact, we knew from FOS that we had some GPS sync loss in the past days, and this is one of checks done on Level 0s.

An analysis follows concerning day 19/10/2014, S/C C, described past week in Sect. 3.2.3.2 of [RD.11]. From the FOS weekly report n. 47 (day 292 corresponds to 19/10):

"[From Table 3-3: Swarm-C Daily Summary of Activities] GPS alarm 'Delta GPS Time Inconsistent' and 'GPSSyncLost' at 292.02.38.49. GPST re-synchronisation was achieved at 292.02.39.18."

In Figure 20 one can see some relevant parameters concerning the STR C 19/10/2014, attitude rejection case: in red, the Level 1A and 1B Sync Status parameter is reported, in blue the Level 1A and 1B Flags_q are shown and in green one can see the Level 0 Sync Status, already converted in decimal units. Let's define T= [2:38:49 - 2:39:07] the rejection interval.

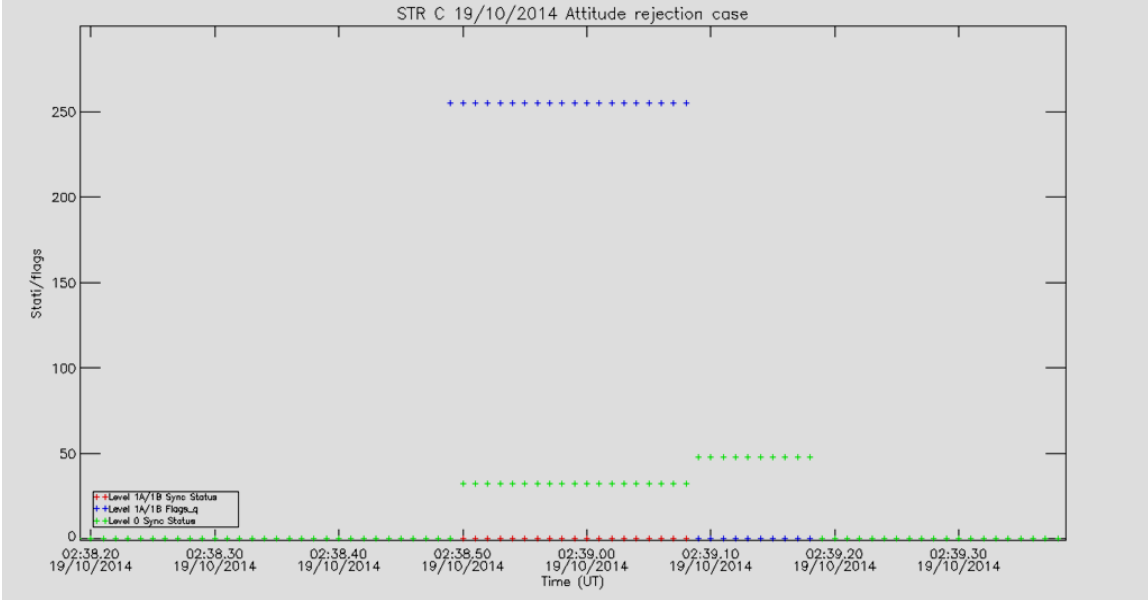

Figure 20: STR C 19/10/2014, attitude rejection case.

The following has to be noted:

1. During T, the STRNOM_0_ sync status = 32, which means Sync_source=2 and Sync_quality=0 ([RD.13], Sect. 4.2.2). A Sync source being = 2 means: *"Sync in Progress - Inaccurate PPS and OBRT used."*

2. This T is followed by a T1 = [2:39:08-2:39:18] (ten seconds) where the STRNOM_0_ sync status = 48, which means: Sync_source=3 and Sync_quality=0; A Sync source being = 3 means: *"Sync in Progress - accurate PPS and OBRT used."*

3. The Level 1A and Level 1B Flags_q = 255 during interval T and Flags_q = 0 during interval T1. Quaternions and other control parameters that should be contained in the MDRSTRSCI_1A dataset are rejected and we have a 20 second gap in such dataset, corresponding to the interval T.

4. The Level 1A and Level 1B Synchronization Status is = 0 during interval T, and = 48 during interval T1.

In [RD.12], pages 23-24 one reads:

"The ISPs shall be checked for quality and validity. This includes checks of [...]

- *PPS synchronization source.*
    - *If the source is OBC a warning flag is to be set in the Level 1a and Level 1b Products. The processing shall be done as for GPS PPS.*
    - *If the source is not GPS or OBC the packet shall be marked as invalid and shall be rejected."*

In [RD.13] page 19 one reads:

"PPS Source = 0 --> In sync with GPS PPS and UTC from the GPSR is used [i.e. source=GPS]

PPS Source = 1 --> Out of Sync; OBC PPS used and OBRT used [i.e. source=OBC]"

Which we interpret as: PPS source = 0, or 1 the packet shall be accepted (with a warning in case of OBC source), otherwise it should be discarded.

So the conclusion seems to be the 20 second interval is discarded because of a GPS Sync loss (Sync_source=2), but the Synchronization Status in the Level 1A and 1B seems not correct: in fact it should be = 32 during T, and not = 0. Moreover in the case described above, only the interval with PPS Source = 2 is discarded, while the interval T1, with PPS Source = 3 is accepted.

The behaviour described above is representative of all the cases reported in the present document. A discussion with the processor manufacturer is ongoing for understanding the L1a/L1b sync status discrepancies with respect to the L0 sync status and the reason why the packets with PPS Source = 3 are not rejected. SPR **SWL1L2DB-27** has been opened on ARTS to track the issue.

4.2 SWL1L2DB-9: updates on SPR fix.

A new version of Napeos is prepared with the following changes (only configuration changes. There are no SW changes):

- Update the position of Centre of Gravity and mass of the SWARM satellites in the NAPEOS DB.

- Substitute the dynamical model of the satellites to:

  - Do not apply an explicit drag force model.
  - Use empirical accelerations (sine, cosine and constant terms) to absorb non-conservative forces (e.g. drag). The number of empirical accelerations used is 12 per 24 hours (i.e. one every 2 hours) This modelling should account better for the low altitude satellites like SWARM´s.
  - Increase the weight sigma of the measurements from:
    - 0.8 to 1 meter for pseudo-range
    - 10 to 30 mm for carrier-phase.

    These parameters are related with the observed noise of the observations. For pseudo-range 1 meter is typically used. For carrier-phase 10 mm is possible if accurate clocks at 30 seconds rate are available. With the current set-up the noise level observed is between 20 and 30 mm. This change allows to increase the number of observations accepted in the processing.

  - Increase the number of steps in the propagation of the orbit. This is needed due to the low altitude of the satellites. The main outcome of this change is an increase in the number of observations used, reducing the rejection level from 15-20% to just 2-4%, with the subsequent improvement in the estimation of the orbit. In particular, with respect to the SPR# SWL1BL2DB-9, the reason of the large differences with respect to the navigation solution were an un-accurate estimation of the orbit due to large rejection of observations (35%). With this new set-up the rejection goes down to 2.4% and the large deviation with respect to the navigation message disappear.

End of Document