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IDEAS+ Swarm Weekly Report 2015/04 : 19/01/2015 – 25/01/2015

Abstract : This is the **Instrument Data quality Evaluation and Analysis Service Plus** (IDEAS+) Swarm Weekly report on Swarm products quality, covering the period from 19 to 25 January 2015.

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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	30 Jan 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 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.2.12p1

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)

2. SUMMARY OF THE OBSERVATIONS

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

- **EFI TII Updates.** Based on the outcomes of the EFI TII ARB-12 (20/01/2015), an updated run of the MCP & Phosphor scrubbing procedure was initiated on Swarm-B. And the EFI of Swarm-C was commanded to Ready State, pending reception of new Gain Maps, after which the high voltage will be reactivated (Active State) with these new gain maps.

- **Spikes on plasma electron temperatures.** We got the following report from S. Buchert at IRF (29/01/2015): "*There are some issues, most seriously with very high peak values of Te that occur systematically and concentrated along lines in an orbit-latitude plot. Earlier Johnathan had found pulse-like large variations of Te and Vs, possibly Matthias' and Johnathan's discoveries are the same phenomenon. We are working to find out what is going on.*"

2.2 Plan for operational processor updates

L1BOP 3.12 and L2-Cat2OP 1.13 have been delivered to PDGS the 28th of November. Verification and integration tests will take place in the next weeks, before the final deployment of the processors in operation in January.

A full L1BOP 3.13 delivery has been sent by GMV, in order to deal with anomalies found during v3.12 verification and in order to solve SPR **SWL1L2DB-40** about the increase of the magnetic residuals caused by an incorrect handling of the leap seconds. Verifications are ongoing and the deployment in operations is foreseen by the second week of February.

2.3 Quality Working Group and Cal/Val Coordination

Coordination is in place for organizing the 6th Swarm Data Quality Workshop in Paris (hosted by IPGP) in late September 2015.

Following the QWG recommendations in Potsdam and the scientists need in view of the IUGG conference in June, the preliminary plasma dataset will be released end of January 2015.

According to the last coordination meeting within the MAGNET QWG (22/01/2015) the following decisions have been taken:

- With the data provided by DTU/ESL, further analysis can be performed by industry (ADS, DTU-MI, other scientific groups (e.g. Richard Marchand and Stephan Buchert on plasma induced fields), and of course by ESA. The agreement is - as always - that results will be shared with all others on the Task Force.

- DTU/ESL will further refine the Lesur-Tøffner-Clausen model parametrisation and share a final description of the process (input data, model description, output results and tests) (by mid February).

- In parallel, GFZ will distribute the Lühr-Michaelis results, and a number of people (e.g. Malcolm Dunlop, Yulia Bogdanova, Arnaud Chulliat, Patrick Alken) will further support the analysis of these datasets. (by mid February).

- The PDGS will generate the currently VFM missing data on Charlie due to the ASM failure (by end February).

- DTU/ESL will share the final set of corrected data by early March. These corrected data will also contain the dBsun correction, providing the users the possibility to access to uncorrected data.

- The corrected data will be distributed by ESA to all Swarm users (by early April and no later than 20th April). The correction will also be implemented in the OP. Until this is fully validated, it is agreed that the operational processing will continue as nominal without the correction.

- Next Task Force meeting: **9-10 April**. The meeting will be held in ESTEC.

2.4 Summary of observations for 2015, Week 04 (19/01-25/01)

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

1. **Strange features observed at times 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. **We report about an average increase of the ASM-VFM residuals** on SC A starting from the end of December 2014 (from 4 to 8 nT peak to peak).

3. **ORBMAN files delivered by FOS with wrong creation date.** This has caused the PDGS to process at times orbits using information concerning manoeuvres that actually did not take place (See Sect. 4.2).

3. ROUTINE QUALITY CONTROL

3.1 Gaps analysis

- **Magnetic production lost on S/C C for the whole week**, because of the ASM switched off.

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)	3.2.2.1	[RD.10]

Table 1: list of events related to attitude and orbit products to be reported in the monitoring for 2015, Week 04: 19/01 - 25/01.

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, 19/01 – 25/01, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard deviation (m)**	**Notes**
19/01	0.13	-13 (Z), 6 (X)	1.6	
20/01	0.3	-13 (X), 8 (Z)	1.6	SW-IDEAS-34 [RD.10]
21/01	0.13	-11.6 (Z), 13.5 (Y)	1.6	
22/01	0.15	-9.4 (Z), 17 (X)	1.4	
23/01	0.07	-12.7, 10.2 (Z)	1.5	
24/01	0.25	-13.8, 7.4 (Z)	1.6	SW-IDEAS-34 [RD.10]
25/01	0.12	-12.6 (X), 10.8 (Z)	1.5	

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 (19/01, Figure 1), in the middle (22/01, Figure 2) and at the end (24/01, 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.

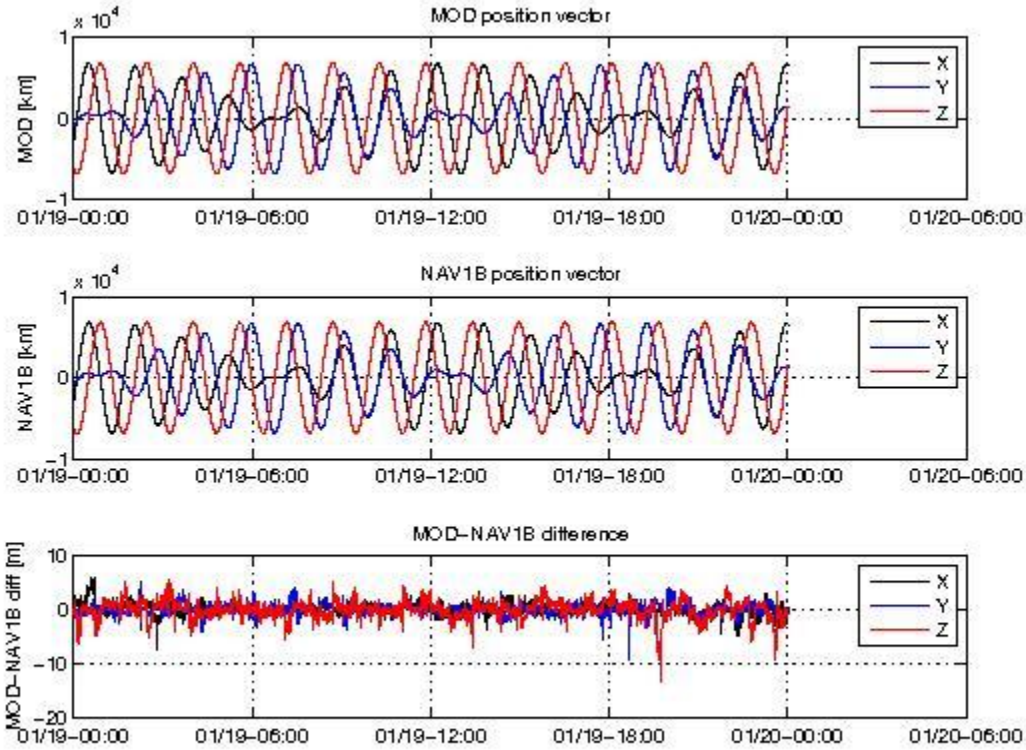

Figure 1: Difference MOD-GPSNAV, sc A, 19/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

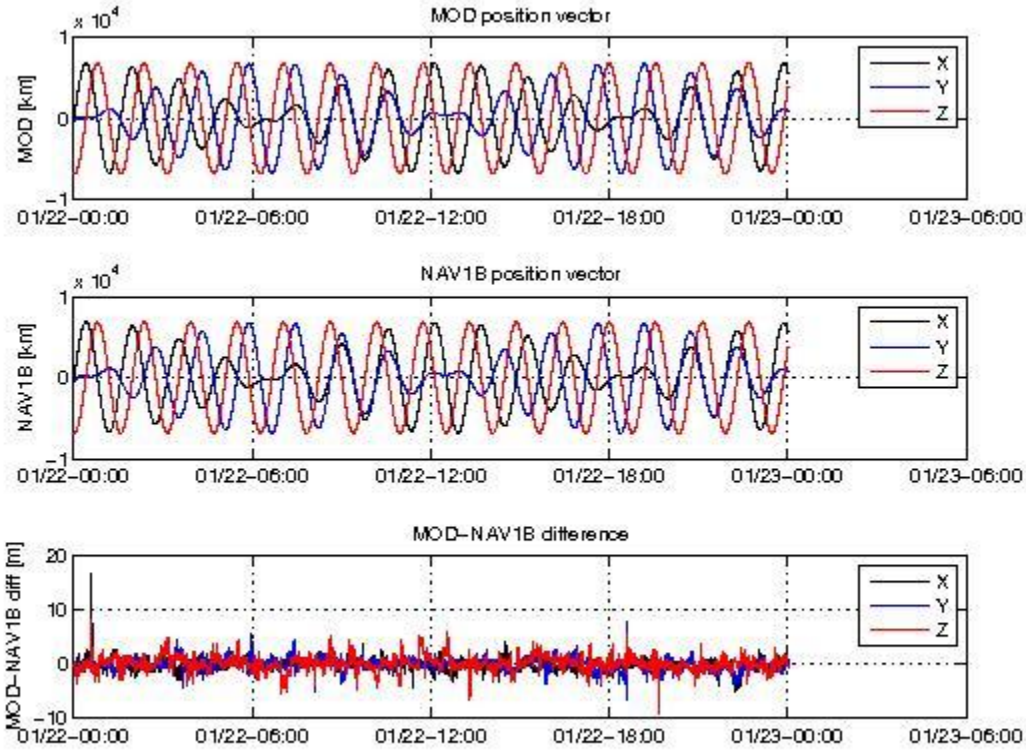

Figure 2: Difference MOD-GPSNAV, sc A, 22/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The red-circled area evidences a time interval characterized by SW-IDEAS-34 ([RD.10]) anomaly occurrence.

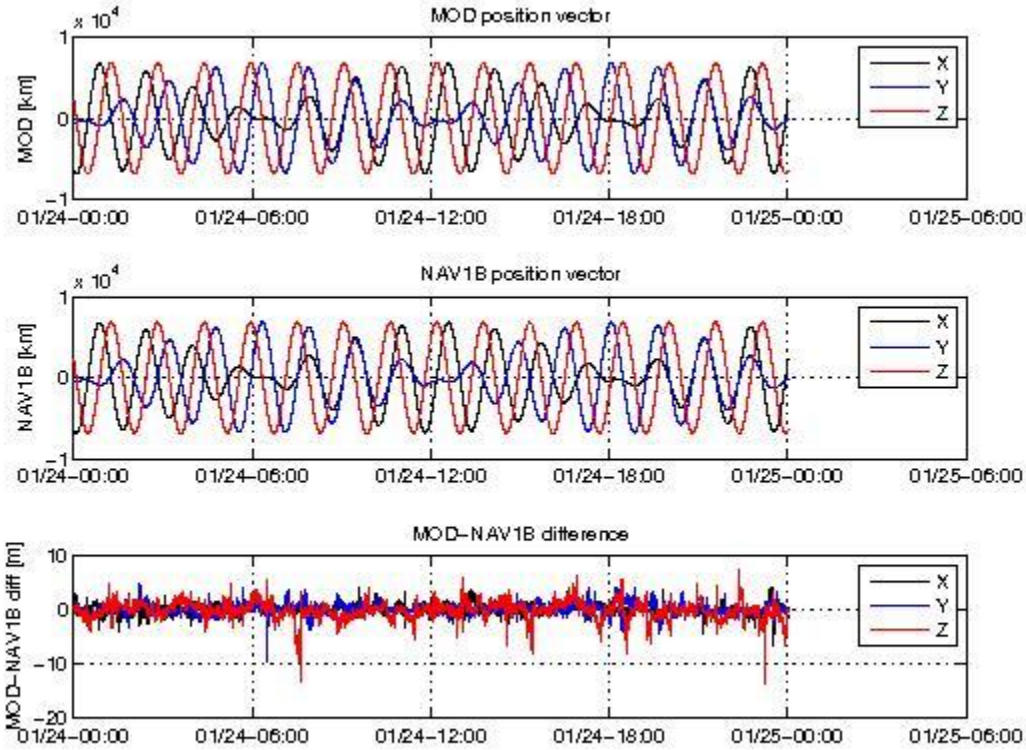

Figure 3: Difference MOD-GPSNAV, sc A, 24/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

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, 19/01 - 25/01, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
19/01	0.2	-8.4 (Z), 9.4 (Y)	1.4	SW-IDEAS-34 [RD.10]
20/01	0.25	-10.7 (X), 6.8 (Z)	1.7	SW-IDEAS-34 [RD.10]
21/01	0.04	-9, 8.5 (Z)	1.5	SW-IDEAS-34 [RD.10]
22/01	0.13	-6.7 (Z), 6.2 (X)	1.2	
23/01	0.16	-9 (Z), 8 (Y)	1.5	SW-IDEAS-34 [RD.10]
24/01	0.2	-10.7 (Z), 7.5 (X)	1.5	SW-IDEAS-34 [RD.10]
25/01	0.11	+/- 10.5 (Z)	1.5	

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 (19/01, Figure 4), in the middle (22/01, Figure 5), and at end of the week (24/01, 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 an example of SW-IDEAS-34 ([RD.10]) anomaly is shown (red-circled area): the MOD-NAV solution difference departs from the average value taking higher/lower values for several minutes.

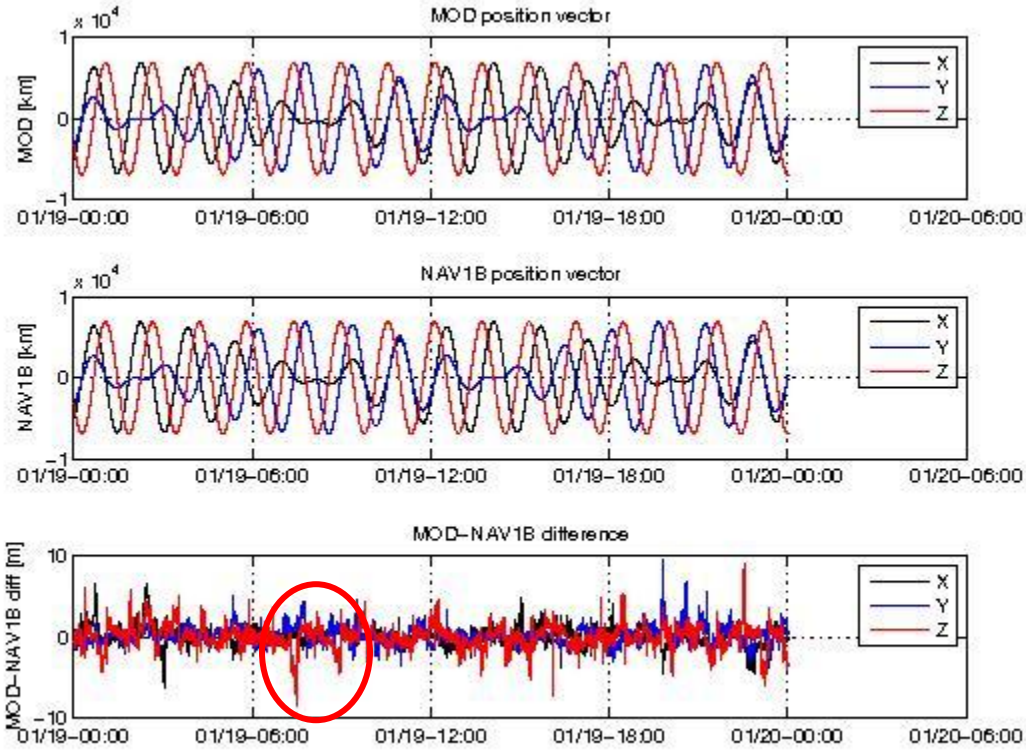

Figure 4: Difference MOD-GPSNAV, sc B, 19/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two. The red-circled area evidences a time interval characterized by SW-IDEAS-34 ([RD.10]) anomaly occurrence.

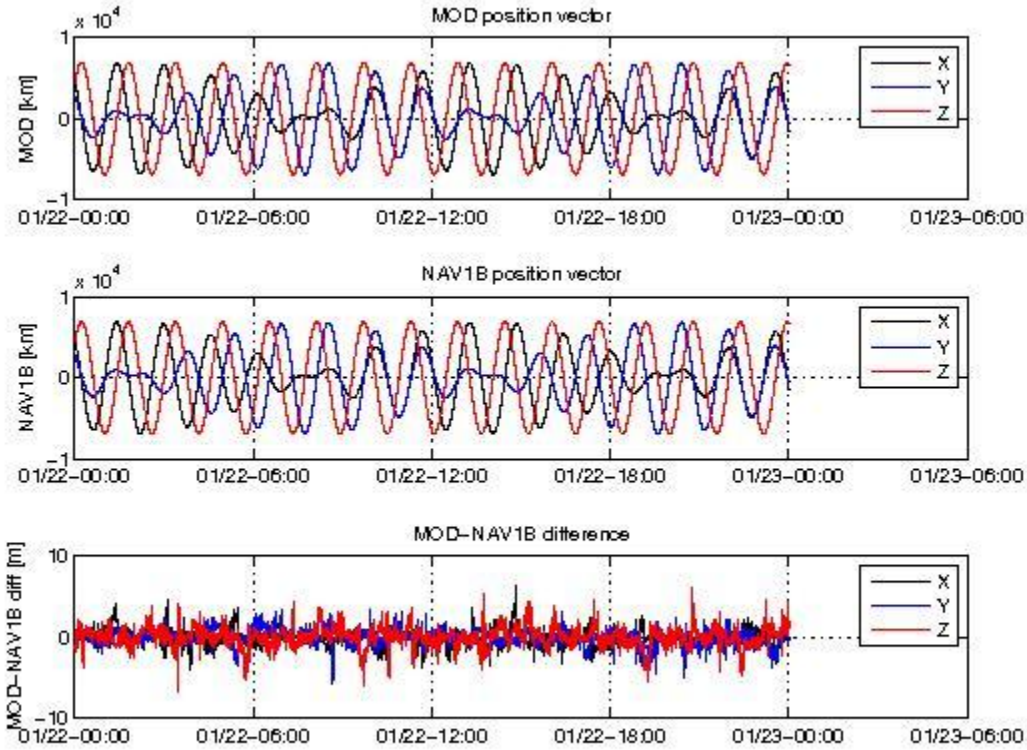

Figure 5: Difference MOD-GPSNAV, sc B, 22/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

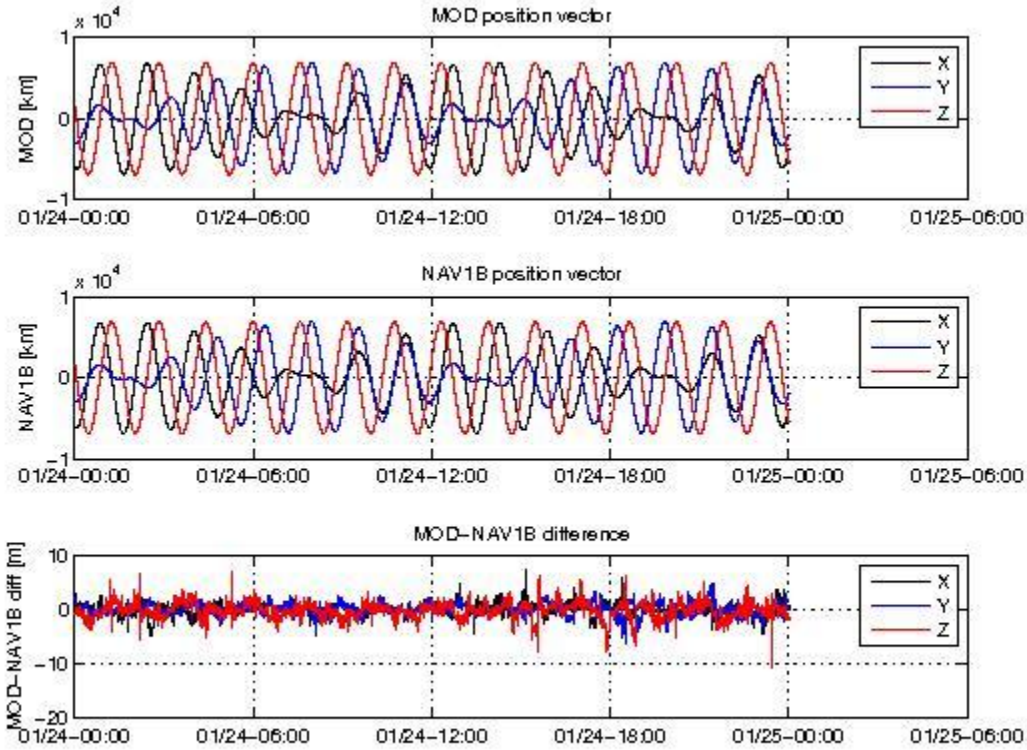

Figure 6: Difference MOD-GPSNAV, sc B, 24/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

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, 19/01 - 25/01, Position difference				
Day	**Average Difference (m)**	**Maximum difference (m)**	**Standard Deviation (m)**	**Notes**
19/01	0.16	-9, 7 (Z)	1.4	
20/01	0.18	-7.4 (X), 7 (Z)	1.4	SW-IDEAS-34 [RD.10]
21/01	0.1	+/- 12 (Z)	1.5	
22/01	0.18	+/- 6 (Z)	1.2	
23/01	0.05	-6 (X), 10 (Z)	1.3	
24/01	0.2	+/- 7 (Z)	1.3	
25/01	0.12	-10, 5.4 (Z)	1.3	

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 (19/01,

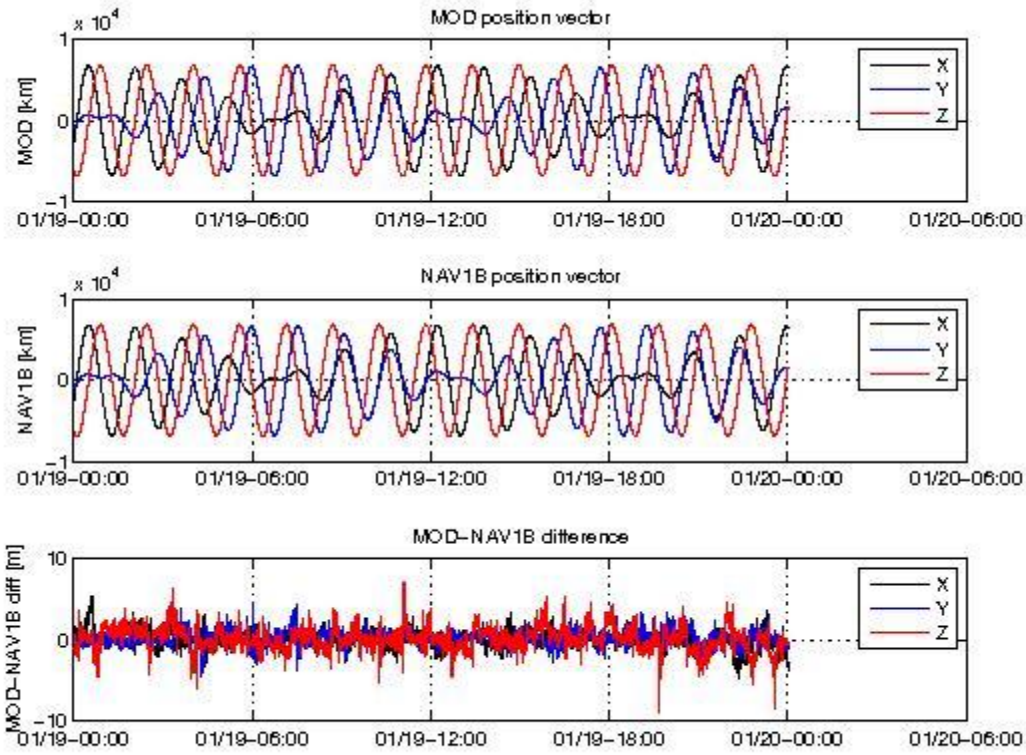

Figure 7), in the middle (22/01, Figure 8) and at the end (24/01, Figure 9). From top to bottom the plots show: the S/C position determined from the MOD calculation, the S/C

position determined on-board, the difference between the two. The values are given in Km.

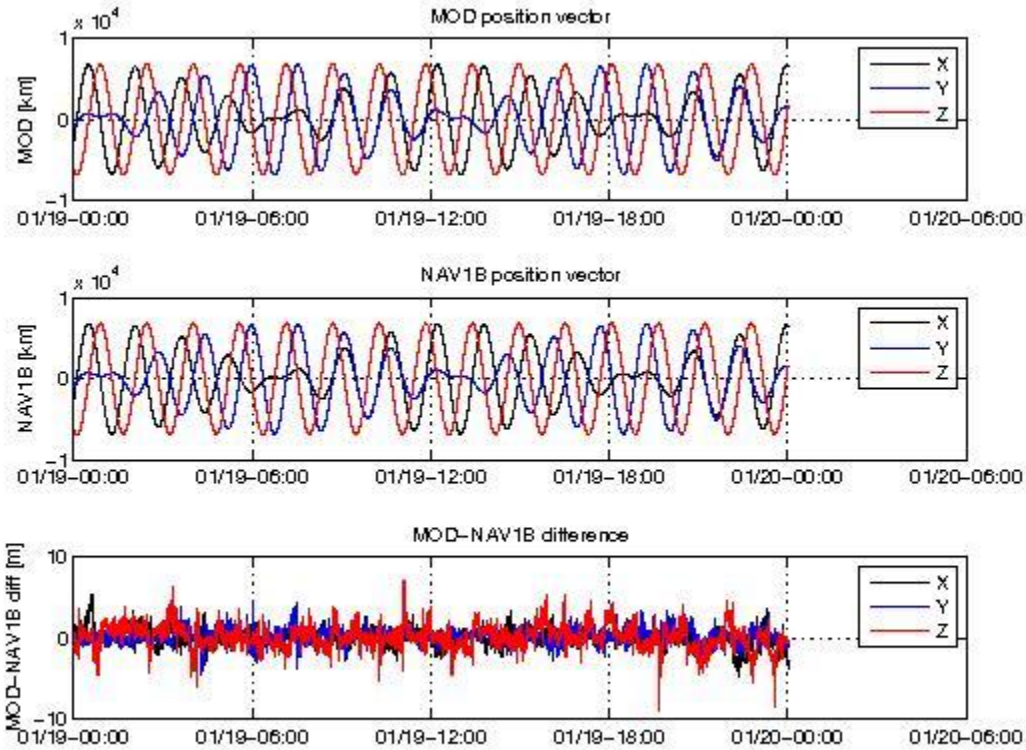

Figure 7: Difference MOD-GPSNAV, sc C, 19/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

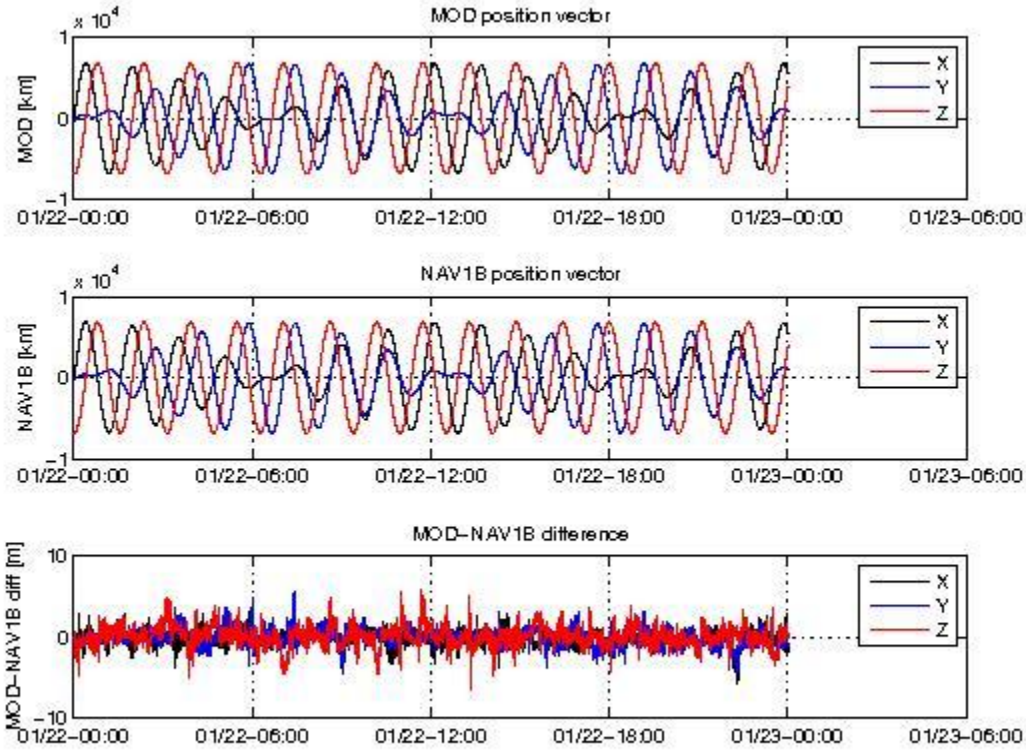

Figure 8: Difference MOD-GPSNAV, sc C, 22/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

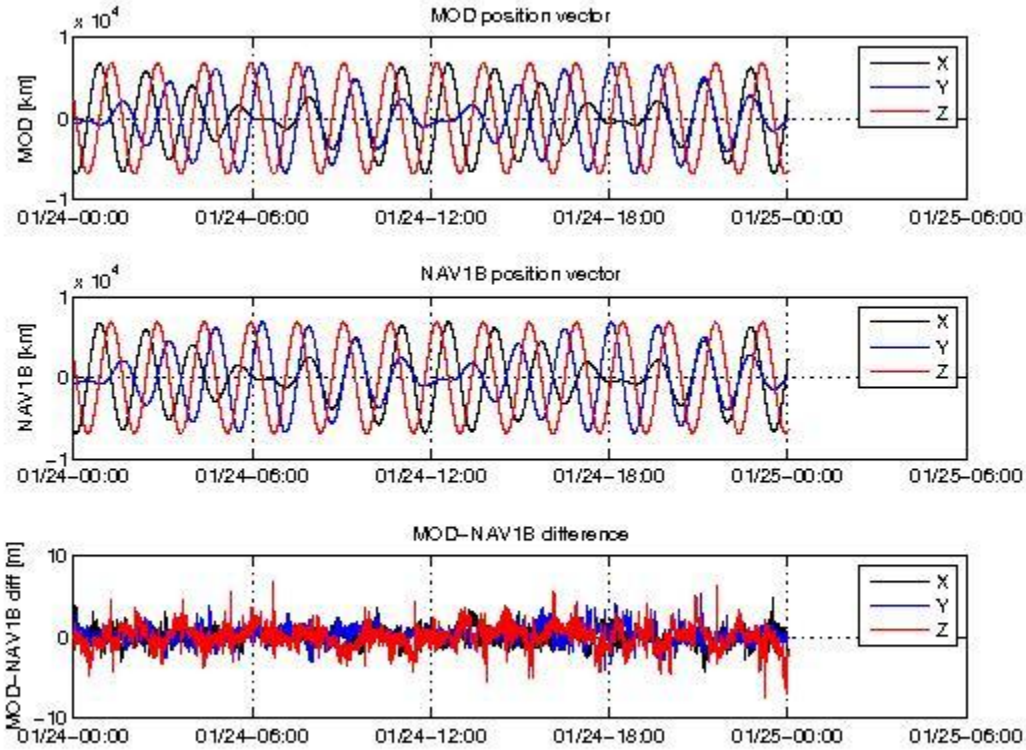

Figure 9: Difference MOD-GPSNAV, sc C, 24/01/2015. From top to bottom: the S/C position determined from the MOD calculation, the S/C position determined on-board, the difference between the two.

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.**

SW-IDEAS-27 [RD.13]: Geomagnetic activity is low throughout the week and we do not observed high level of noise in the high frequency region of the spectra.

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 (24/01/2015).

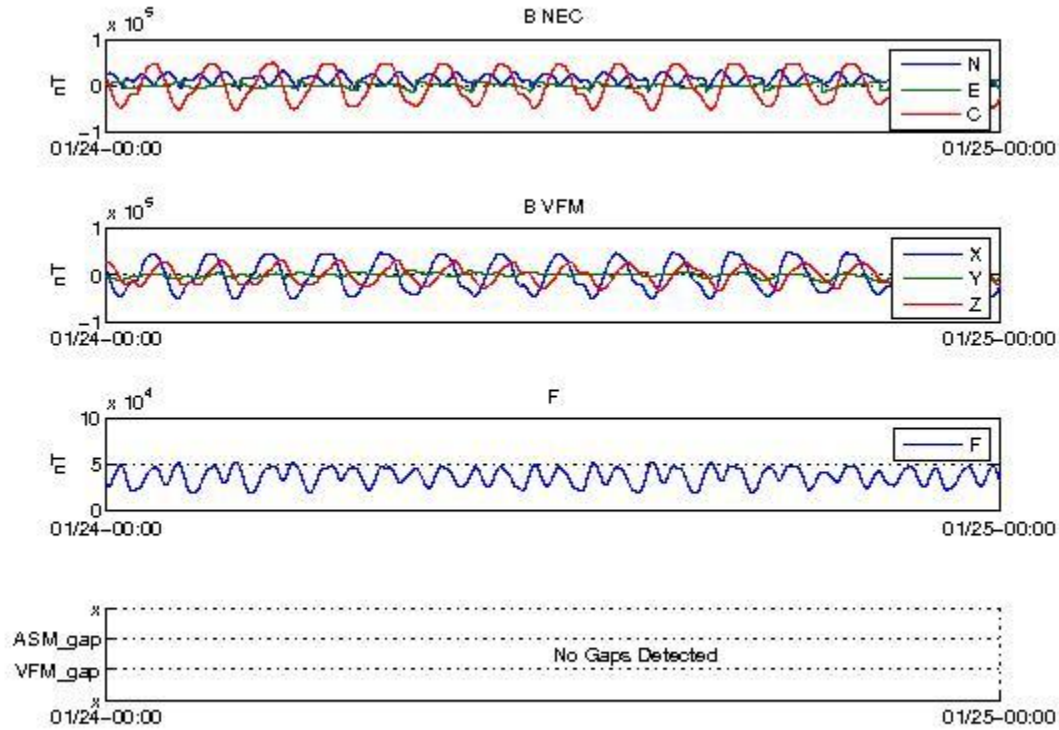

Figure 10: Time series of the geomagnetic field, for 24/01/2015, S/C A. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.1.2 VFM-ASM anomaly

The daily peak-to-peak difference around the week is, on average: [-3, 5] nT.

Below two example plots of such differences follows: taken at the beginning of the week 19/01 (Figure 11) and at the end of the week 24/01, (Figure 12). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

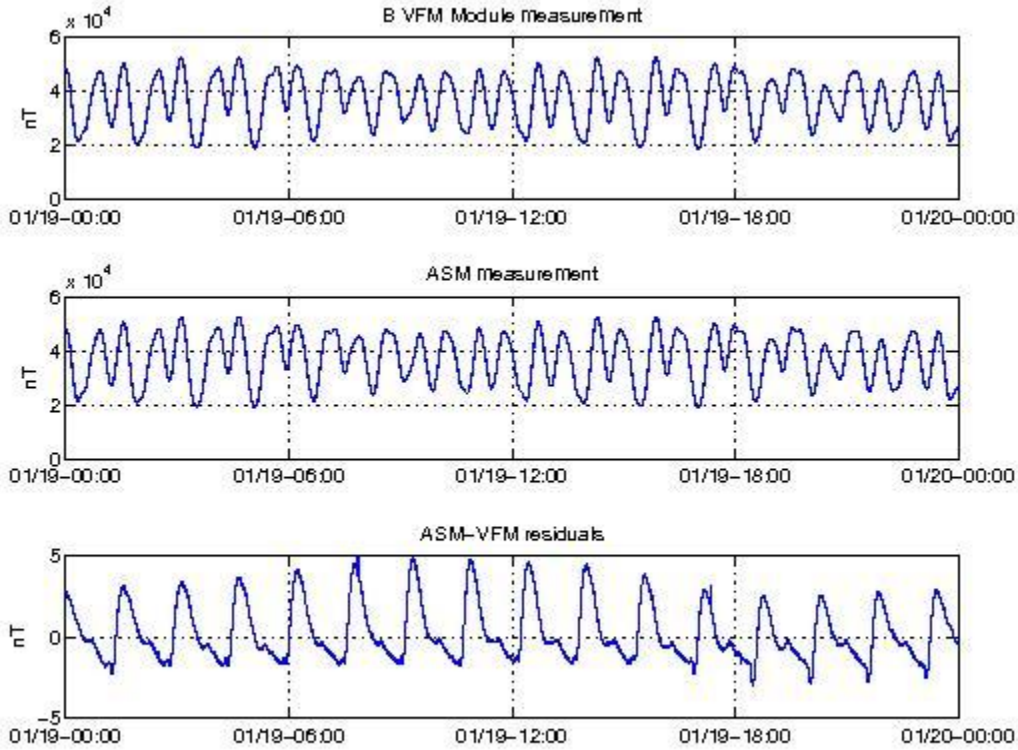

Figure 11: VFM module, ASM module and ASM-VFM residuals for S/C A, 19/01/2015.

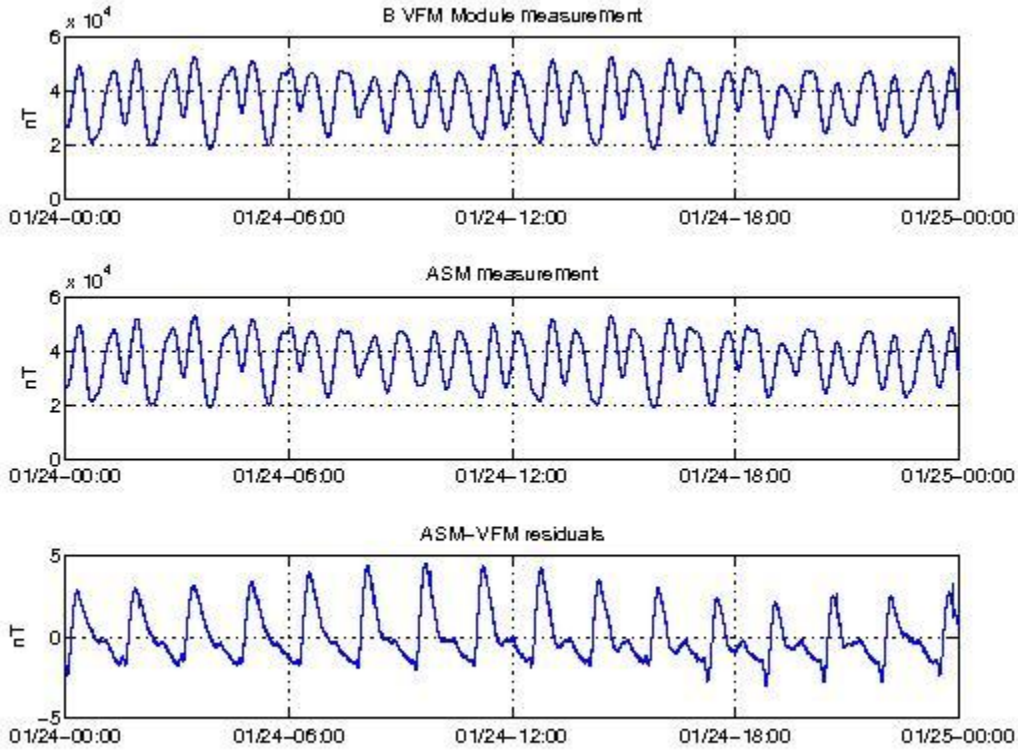

Figure 12: VFM module, ASM module and ASM-VFM residuals for S/C A, 24/01/2015.

3.3.1.3 TCF.VFM monitoring

The TCF.VFM analysis will be included in the first report of February.

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 (24/01/2015) can be seen in Figure 13 below.

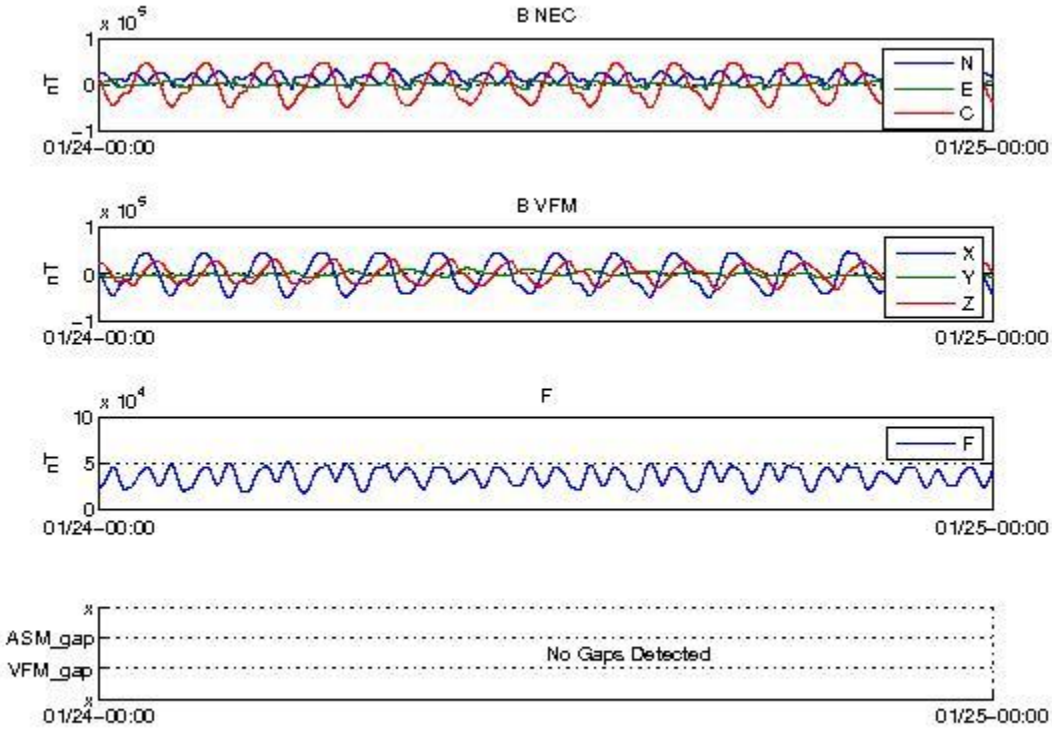

Figure 13: Time series of the geomagnetic field for 24/01/2015, S/C B. From top to bottom: magnetic field components in NEC reference frame, magnetic field components in the VFM reference frame, magnetic field intensity (F) from ASM, and location of gaps (if any).

3.3.2.2 VFM-ASM anomaly

The daily peak-to-peak difference around the week is, on average: [-1.2, 2.5] nT, with peaks of about 10 nT.

Below two example plots follows of such differences: 19/01 (Figure 14), and 24/01 (Figure 15). From top to bottom the plots show: The VFM module, the ASM module, the difference ASM-VFM.

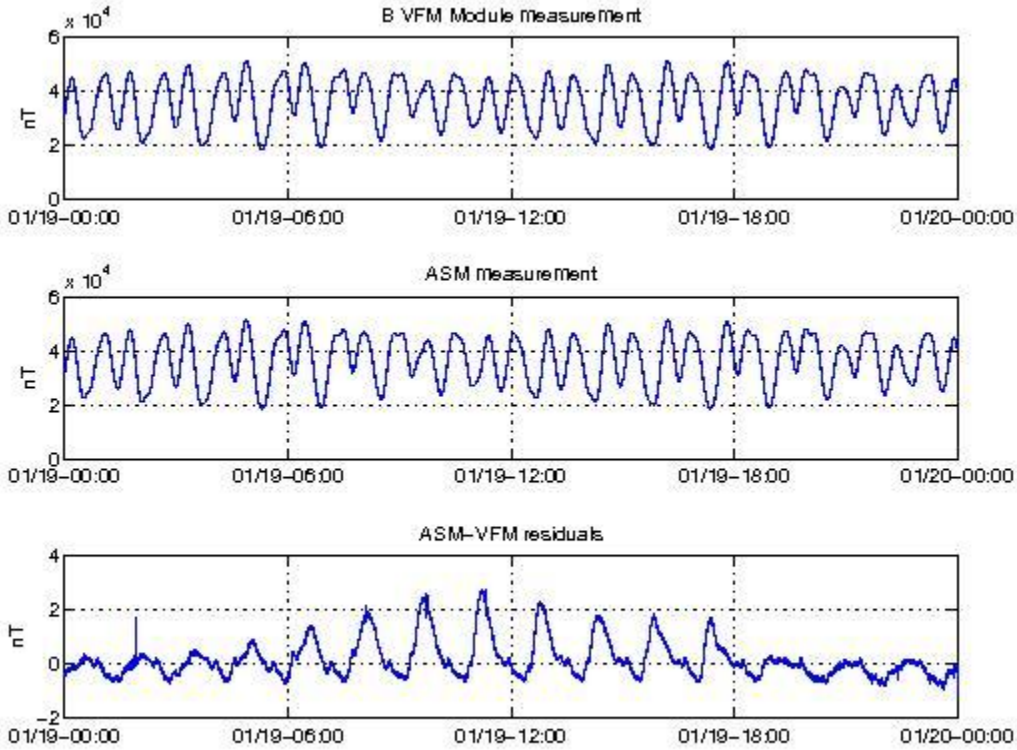

Figure 14: VFM module, ASM module and ASM-VFM residuals for S/C B, 19/01/2015

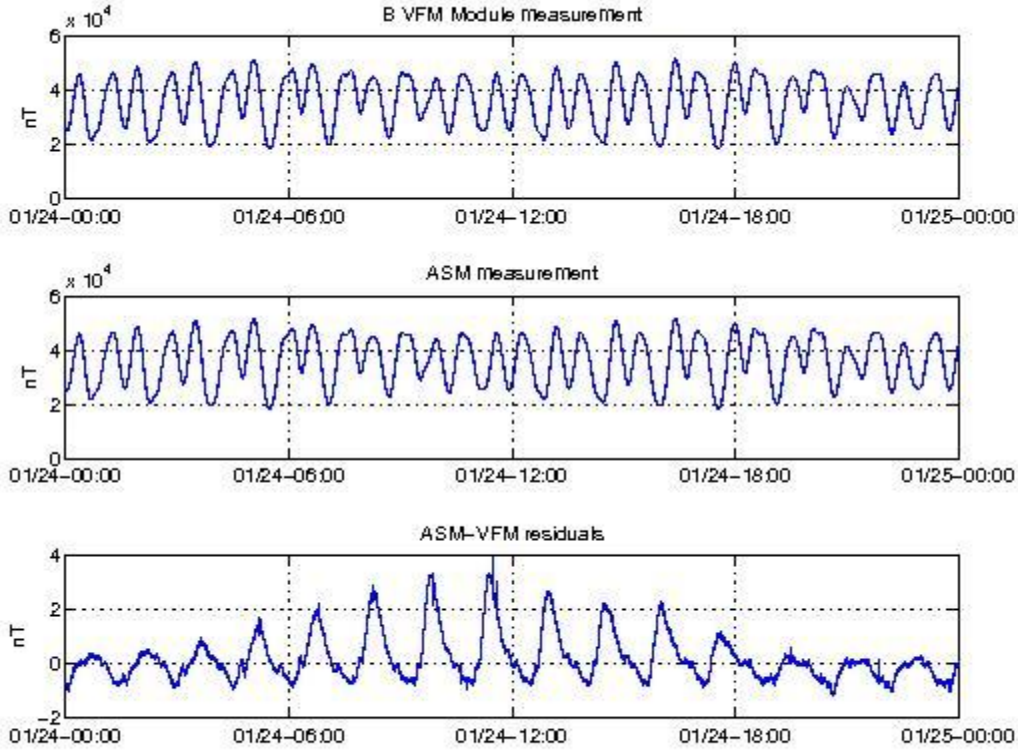

Figure 15: VFM module, ASM module and ASM-VFM residuals for S/C B, 24/01/2015.

3.3.2.3 TCF.VFM monitoring

The TCF.VFM analysis will be included in the first report of February.

3.3.3 Swarm C

3.3.3.1 Magnetic time series visual inspection

No data because ASM is still switched off

3.3.3.2 VFM-ASM anomaly

No data because ASM is still switched off

3.3.3.3 TCF.VFM monitoring

No data because ASM is still switched off

3.3.4 Summary of TCF behaviour for the three S/C

The TCF.VFM analysis will be included in the first report of February.

4. ON-DEMAND ANALYSIS

4.1 ASM-VFM residual overview of the past two months

We have performed a long term trend analysis of the difference between the F field measured by the ASM and the module of the vector field measured by the VFM, from November 1, 2014, up to January 23, 2015.

In Figure 16 such overview for SC A is given, while in results for SC B are shown.

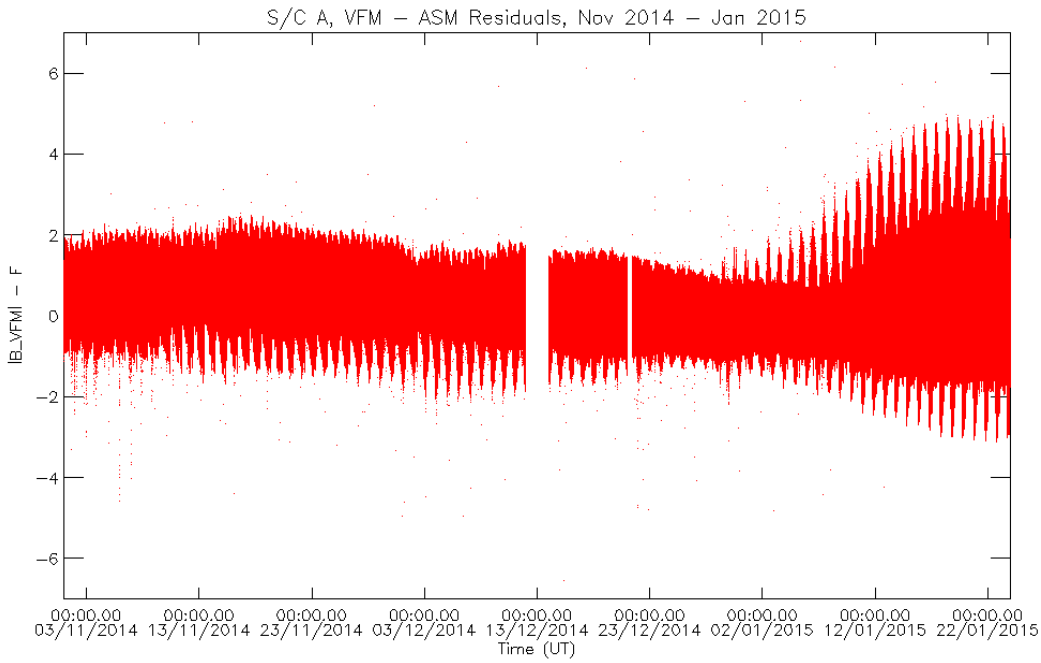

Figure 16: VFM - ASM residuals, S/C A, November 2014 - January 2015.

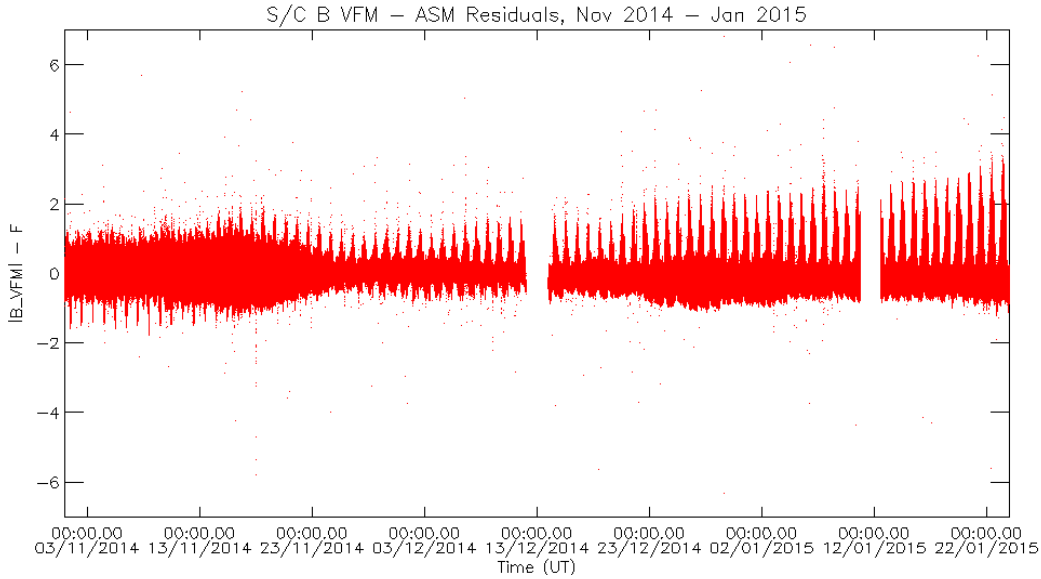

Figure 17: VFM - ASM residuals, S/C B, November 2014 - January 2015.

An increase of the average residual is clearly visible for SC A, starting from about 27-28/12/2014. Before that time, and for several months, the residuals were in the range [-2, 2] nT,

4.2 Orbit Manoeuvers History files delivered by FOS with incorrect creation date.

The xORBMAN auxiliary file contains the list of the orbital manoeuvres done on a given S/C with information on the accelerations impressed on the S/C axes and the duration of each firing. Usually such files contain also a list of the manoeuvres planned for the near future, and, each time a given manoeuvre is actually executed on a S/C, the related ORBMAN is updated and delivered again to the PDGS in due time for allowing the data processing with correct orbital information.

The file comes to PDGS in EEF, i.e. is composed by a DBL part, which contains the actual list as described above, and a HDR part, an XML “header” file containing technical information on the production of the file itself. Very important for the orchestration is the <Creation_Date> tag in such header, because the APDF makes use of the “LatestValIntersect” selection policy for such product: among all the available ORBMAN whose validity intersects the processing interval, the latest created is selected.

We realized FOS never updated this <Creation_Date> since the first ORBMAN delivered, and this caused the APDF to systematically select the wrong ORBMAN files (old versions) for long time intervals, especially for S/C B and C. At least in one case (**01/04/2014, SC C**), we processed manoeuvres which actually did not take place, becuse we did not take into account the most up-to-date ORBMAN where such manoeuvres were deleted.

In Figure 18 one can see the discrepancies observed in the difference between the navigation solution for the orbit and the calculated medium-accuracy solution (MODC_SC_1B product) for S/C, 01/04/2014: the accumulated error explodes up to few km at the end of the day.

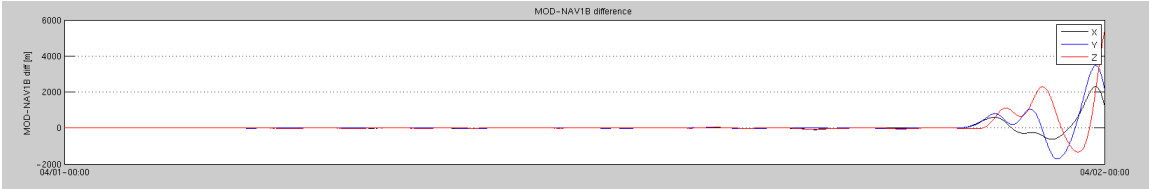

Figure 18: Difference in NAV-MOD solutions for the S/C position, 01/04/2014, S/C C.

GMV carried on some further investigation and gave an evaluation of impact of such issue. Here follows an extract of an e-mail from Jaime Sanchez Fernandez, on 26/01/2014:

“[...] *The manoeuvre information provided by FOS has to be accurate in two senses: the time of manoeuvre and the size of the manoeuvre. NAPEOS is not able to check the actual existence of the manoeuvre or the accuracy of the time of the manoeuvre. NAPEOS just “calibrate” the size of the manoeuvre provided. This means that it is able to “fine tune” the size of the manoeuvre to match the data to the maximum extent.*

However if the information provided in the manoeuvre file is not correct, this is a source of big uncertainty in the final orbital product, so large deviation can be expected.

NAPEOS uses the manoeuvre information to propagate the estimated state-vector of the satellite. Every time there is a manoeuvre, the physical propagation stop and a "jump" is included. The jump is computed based on the information provided in the manoeuvre file.

1. ***What is the impact on the final MODs of processing a manouever that actually did not take place?***

   NAPEOS is going to include that manoeuvre and to some extent decrease it actual size in order to try to match the actual data, but a manoeuvre will be included in any case and the final MOD product will be affected.

2. ***What is the impact on the final MODs of NOT processing a maneuver that actually DID take place?***

   NAPEOS is not going to detect any manoeuvre and it will estimate a very bad MOD product. It is expected big deviation with respect to the real orbit."

   Furthermore, GMV performed other runs, using the correct ORBMAN file for 01/04/2014 S/C C. In Figure 19 one can see the results of such run: the difference between Navigation and MOD solution stays in the range [+/- 10 m] as usually observed.

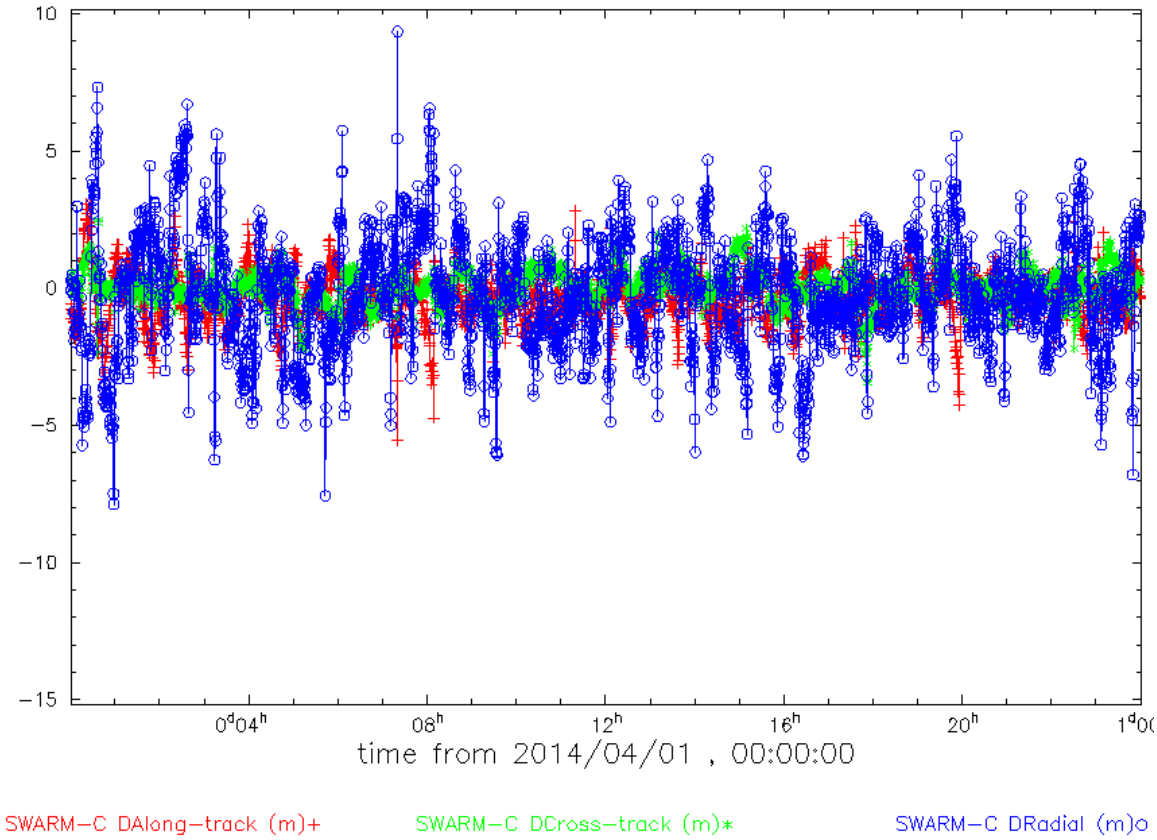

Figure 19: 01/04/2014, S/C C, NAV-MOD differences with orbital manoeuvres NOT applied (correct ORBMAN).

On 30/01/2015, FOS has delivered a new correct set of ORBMAN files, and an assessment is ongoing at the PDGS for finding all the cases when non executed manoeuvres were processed by mistake and the cases when manoeuvres actually executed were missed (not many hopefully). Then, after the installation of the new processor, such cases will be regenerated using the correct ORBMAN files.

End of Document