

# Recent updates on Swarm L1B and L2 operational processors



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**Issue/Revision**

**1.0**

**Date of Issue**

**12/02/2020**

**Status**

**Issued**

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# 1 INTRODUCTION

## 1.1 Scope

This document describes the recent modifications introduced in Swarm L1B and L2 data processing chain. First, the operational processor generating both the L1B and L2 products, has been migrated to a new operational system without any impact on the data quality. Then, an improved L1B operational processor containing algorithm evolutions is introduced in Swarm L1B processing chain. All the L1B data improvements have a negligible impact on L2 IBI, FAC and TEC products. Please note that all these changes have caused a File Counter increase for all the L1B and L2 operational products.

## 1.2 Reference documents

- [RD.1] SW-RS-DSC-SY-0002, Level 1B processor algorithm
- [RD.2] SW-RS-DSC-SY-0007, Level 1b Product Definition
- [RD.3] SW-TR-GFZ-GS-0005, Swarm L2 FAC-single Product Description
- [RD.4] SW-TR-GFZ-GS-0008, Swarm L2 FAC-dual Product Description
- [RD.5] SW-TR-GFZ-GS-0006, Swarm L2 IBI Product Description
- [RD.6] SW-TR-GFZ-GS-0007, Swarm L2 TEC Product Description

- All listed document accessible in Swarm [Key Documentation](#) page.

### 1.3 Context

This document contains a brief description of the changes introduced in L1B algorithm with respect to previous version [RD.1], together with the updates related to operational system for both the L1B and L2 processors.

It is worth to specify that the L1B processor comprises of four individual processors ([RD.2]):

The ORBATT processor, which generates the following orbit and attitude data products:

- GPSx\_RO\_1B
- GPSx\_RN\_1B
- MODx\_SC\_1B
- GPSxNAV\_1B
- STRxATT\_1B

The MAGNET processor, which generates the following magnetometer related data products:

- VFMxAUX\_1B
- ASMAUX\_1B
- MAGx\_LR\_1B
- MAGx\_HR\_1B
- MAGx\_CA\_1B

The PLASMA processor, which generates the following electric field related data products:

- EFIx\_LP\_1B
- EFIxLPI\_1B
- LP\_x\_CA\_1B

The ACCELE processor, which generates the following accelerometer related data products:

- ACCx\_PR\_1B
- SC\_xDYN\_1B

## **2 PORTING TO THE NEW OPERATIONAL SYSTEM**

Both the L1B and L2 (FAC (Field Aligned Currents) single [RD.3], FAC dual [RD.4], IBI (Ionospheric Bubble Index) [RD.5], TEC (Total Electron Content) [RD.6]) operational processors have been migrated into a machine with an updated Operational System (OS), that is CentOS 7.5. The Swarm data products, generated with the new OS and with the old OS, have been cross-compared. The results showed no discrepancies between the two products, thus the porting to the updated OS will not introduce any change in the data quality.

The migration to the updated OS is the only evolution of the L2 processors, i.e., (FAC single, FAC dual, IBI and TEC).

## **3 MAIN EVOLUTIONS OF THE L1B DATA**

In this chapter are described the main evolutions of the L1B data production. A dedicated section for each processor will describe the related data quality improvements.

### **3.1 ACCELE**

The failure of ACCELE processor is registered when level 0 (L0) ACC data are missing, meaning that both ACCx\_PR\_1B and SC\_xDYN\_1B products are not generated in that case.

The only evolution on the ACCELE processor is to disable the dependence of the SC\_xDYN\_1B data production on the ACCxNOM\_0\_L0 files. Indeed, the only files needed as inputs for the generation of the SC\_xDYN\_1B products are on the platform information contained in the HK\_xAOCS1A and HK\_xBUS\_1A files. This modification will avoid future failure of the ACCELE processor for the SC\_xDYN\_1B production, in the case of L0 ACC data missing.

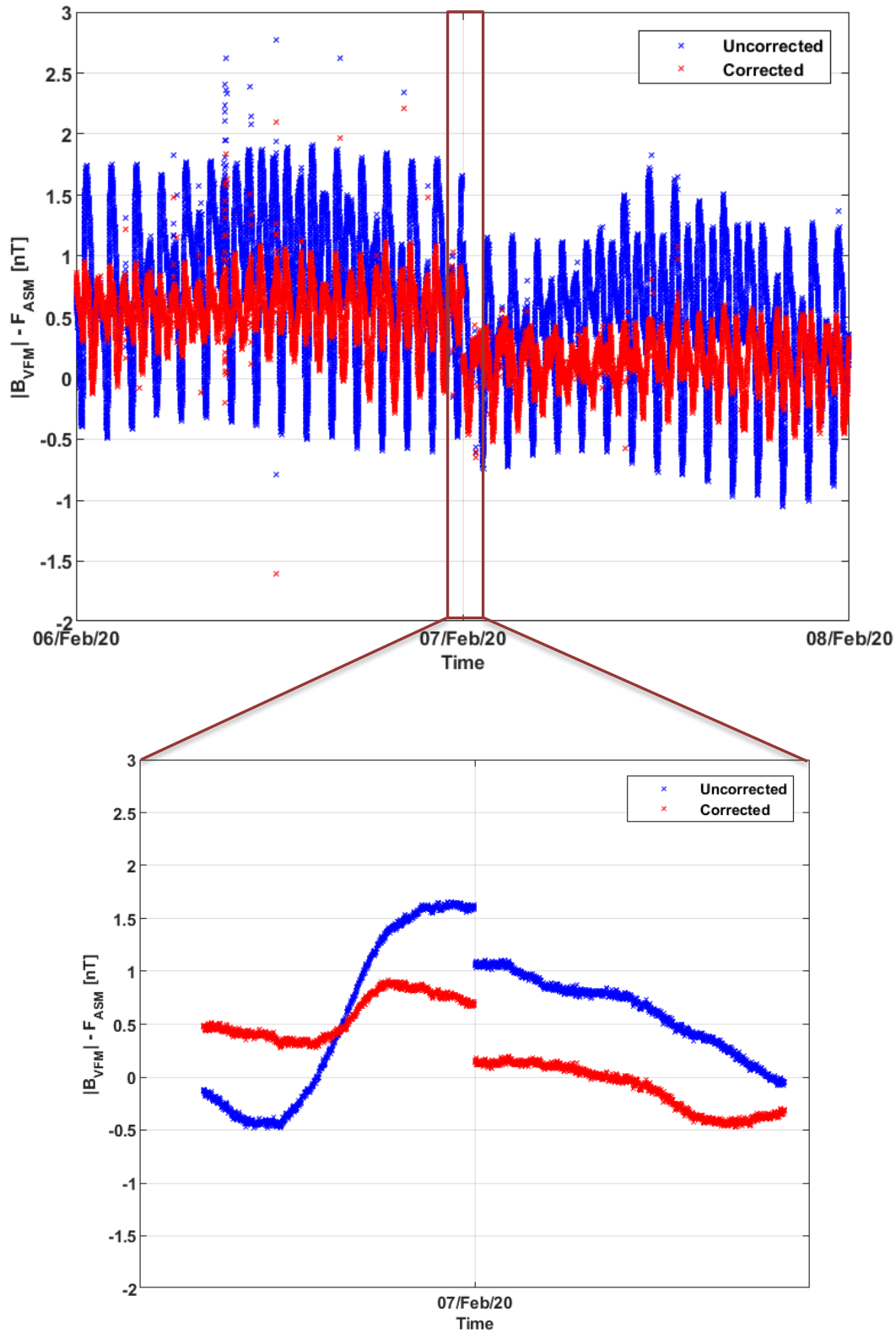
### **3.2 ORBATT**

The new version of the ORBATT processor introduces two main evolutions, that are:

- The adaptation of the processor to read only the necessary part of the L0 inputs files. This modification will introduce more flexibility for possible changes in the content of the L0 telemetry files.
- The Star Tracker (STR) is comprised of three Camera Head Units (CHUs) mounted on the innermost end of the optical bench. One Head is regularly blinded by the Sun, leaving the attitude of only two CHU. These two, are combined into one attitude of the STR Common Reference Frame. When the Moon is on the field-of-view of the STR, small deviations in the attitude data have been observed. Thus, the method that combine the STR attitude quaternions has been improved, and the Attitude error has been largely reduced.

### 3.3 MAGNET

- The ASM (Absolute Scalar Magnetometer) instrument, on board Swarm satellites, is more and more often commanded in burst mode, to measure the magnetic field intensity with a cadence of 250 Hz. With the previous version of L1B operational processor, the magnetic field intensity derived from the ASM stored in MAGx\_LR\_1B and MAGx\_CA\_1B products were set to zero during ASM Burst mode sessions. This is due to the fact that, during the burst mode sessions the L1B MAGNET processor was not able to read the new L0 input file, that is the ASMxBUR\_0\_. With this new version the MAGNET processor is able to read the L0 ASMxBUR\_0\_ file, and produce the 1Hz magnetic field intensity derived from the ASM and stored in in MAGx\_LR\_1B and MAGx\_CA\_1B. Also, the magnetic field data produced during past ASM Burst sessions will be reprocessed in order to regenerate the 1Hz magnetic field intensity derived from the ASM.
- For Swarm Alpha and Charlie only, the VFM (Vector Field Magnetometer) scaling that changes with time, i.e.,  $s_t$ , needs to be slightly adjusted starting from 2018-01-01 onward. This is done through CCDB (Characterization and Calibration Data Base) updates. Starting from the day of the new version of MAGNET processor in operation, the data will be generated by using the updated CCDB files. The differences between the VFM data produced with past CCDB files (example of day 06/02/2020) and VFM data generated with new CCDB files (example of day 07/02/2020) are visible in Figure 1 where the ASM-VFM Scalar residuals of uncorrected (blue) and corrected (red) measurements versus time are shown. Furthermore, a regeneration of MAGNET data for 2018-01-01 to 2020-02-07 will be performed.



**Figure 1: Scalar residuals of uncorrected (blue) and corrected (red) measurements versus time.**

### 3.4 PLASMA

The main evolution of the PLASMA processor is the decoupling from the MAGNET processor. In fact, the PLASMA processor were receiving as input the MAGx\_LR\_1B products to retrieve the information of the spacecraft position.

With the new version, the PLASMA processor will retrieve these information from the MODx\_SC\_1B products. The decoupling from the MAGNET processor, will avoid failure of the PLASMA processing due to partial coverage or full failure of the magnetic product generation.