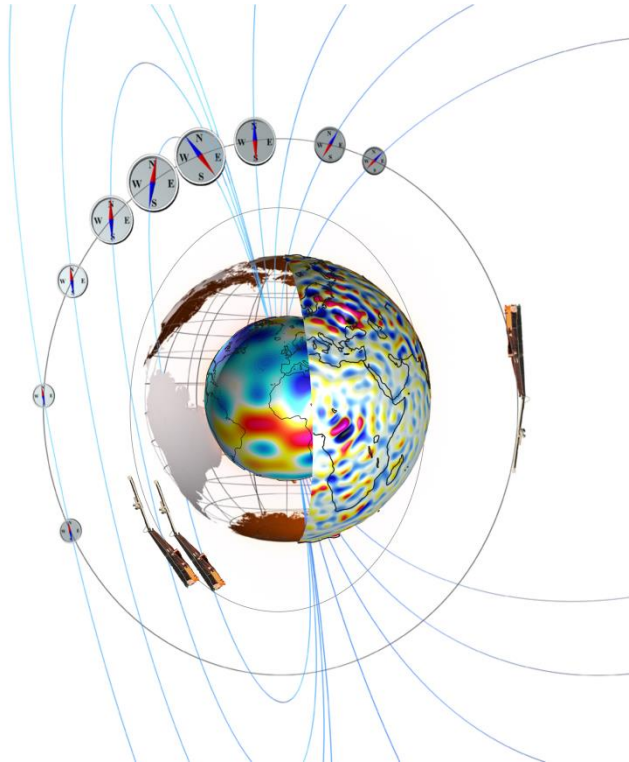




Mapping of Swarm Magnetic Field Intensity from Alpha to Charlie



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1 Introduction

1.1 Scope and applicability

This document describes the method used for mapping the magnetic field intensity measurements of the Absolute Scalar Magnetometer (ASM) on Swarm Alpha to Swarm Charlie. The background for this procedure is the failure of the ASM on Swarm Charlie occurring on 5. November 2014 which calls for alternative means to provide magnetic field intensity reference measurements for the calibration of the Vector Field Magnetometer (VFM) instrument on Swarm Charlie.

2 Applicable and Reference Documentation

2.1 Applicable Documents

[AD-1] SW-RS-DSC-SY-0002 Swarm Level 1b Processor Algorithms

2.2 Reference Documents

The following documents contain supporting and background information to be taken into account during the activities specified within this document.

[RD-1] *Recent geomagnetic secular variation from Swarm and ground observatories as estimated in the CHAOS-6 geomagnetic field model*; Finlay, Christopher C.; Olsen, Nils; Kotsiaros, Stavros; Gillet, Nicolas; Tøffner-Clausen, Lars; Earth, Planets and Space, Swarm Special Issue, 2016, in press, DOI: 10.1186/s40623-016-0486-1

[RD-2] *A model of Earth's magnetic field derived from two years of Swarm satellite constellation data*; Olsen, Nils; Finlay, Christopher C.; Kotsiaros, Stavros; Tøffner-Clausen, Lars; Earth, Planets and Space, Swarm Special Issue, 2016, in press, DOI: 10.1186/s40623-016-0488-z

2.3 Abbreviations

| Acronym or abbreviation | Description |
|------------------------------------|---|
| ASM | Absolute Scalar Magnetometer |
| CCDB | Characterisation and Calibration DataBase |
| DISC | (Swarm) Data, Science, and Innovation Cluster |
| DTU | Technical University of Denmark, DK |
| ESA | European Space Agency |
| JIRA | Atlassian JIRA internet based tool for tracking issues with server located at DTU https://jira.spacecenter.dk/ |
| L1b | Level 1b (satellite data) |
| Swarm | Constellation of 3 ESA satellites, http://www.esa.int/Our_Activities/Observing_the_Earth/Swarm/Introducing_Swarm |
| VFM | Vector Field Magnetometer |

3 Mapping of Scalar Data from Swarm Alpha to Swarm Charlie

3.1 Background

The Absolute Scalar Magnetometer (ASM) instrument on Swarm Charlie stopped providing measurements on 5th November 2014 hence the magnetic scalar reference data for the VFM calibration and disturbance model characterisation are not available from the ASM on Charlie after this date. Consequently an alternative method for generating scalar reference data for Swarm Charlie has been devised.

3.2 Mapping Method

The method for mapping the ASM scalar measurements taken on Swarm Alpha to the time and position of Swarm Charlie uses the following equation:

$$F_{A \rightarrow C \text{ map}} = F_A(t_A) - F_{\text{model}}(t_A, \mathbf{r}_A) + F_{\text{model}}(t_C, \mathbf{r}_C) \quad (\text{Eq. 1})$$

where $F_A(t_A)$ are the ASM measurements on Swarm Alpha at time t_A ; t_A , \mathbf{r}_A , t_C , and \mathbf{r}_C are times and positions of Swarm Alpha and Charlie respectively chosen such that $|t_A - t_C| < 50$ seconds and \mathbf{r}_A and \mathbf{r}_C are at the same geographical latitude. F_{model} is a field model of the Earth's core and lithosphere taken from the series of Swarm Initial Field Models ([RD-2]) and CHAOS ([RD-1])

3.3 Validation

A validation of the method is demonstrated in Figure 3-1 below, showing the difference between $F_{A \rightarrow C \text{ map}}$ and F_C , the scalar field measurements of the ASM on Swarm Charlie (' $F_{\text{ASM,C}}$ ' in the figure) for the period 1st May through 4th November 2014 plotted versus geomagnetic co-latitude. The field models used for this plot are the early SIFM+ and CHAOS-4b models. The overall rms of the differences is 835 pT with a clear separation between low latitudes (in green) and high latitudes (in blue). The recent CHAOS-6 model shows rms of the $F_{A \rightarrow C \text{ map}} - F_C$ difference down to 420 pT at non-polar latitudes ([RD-1]).

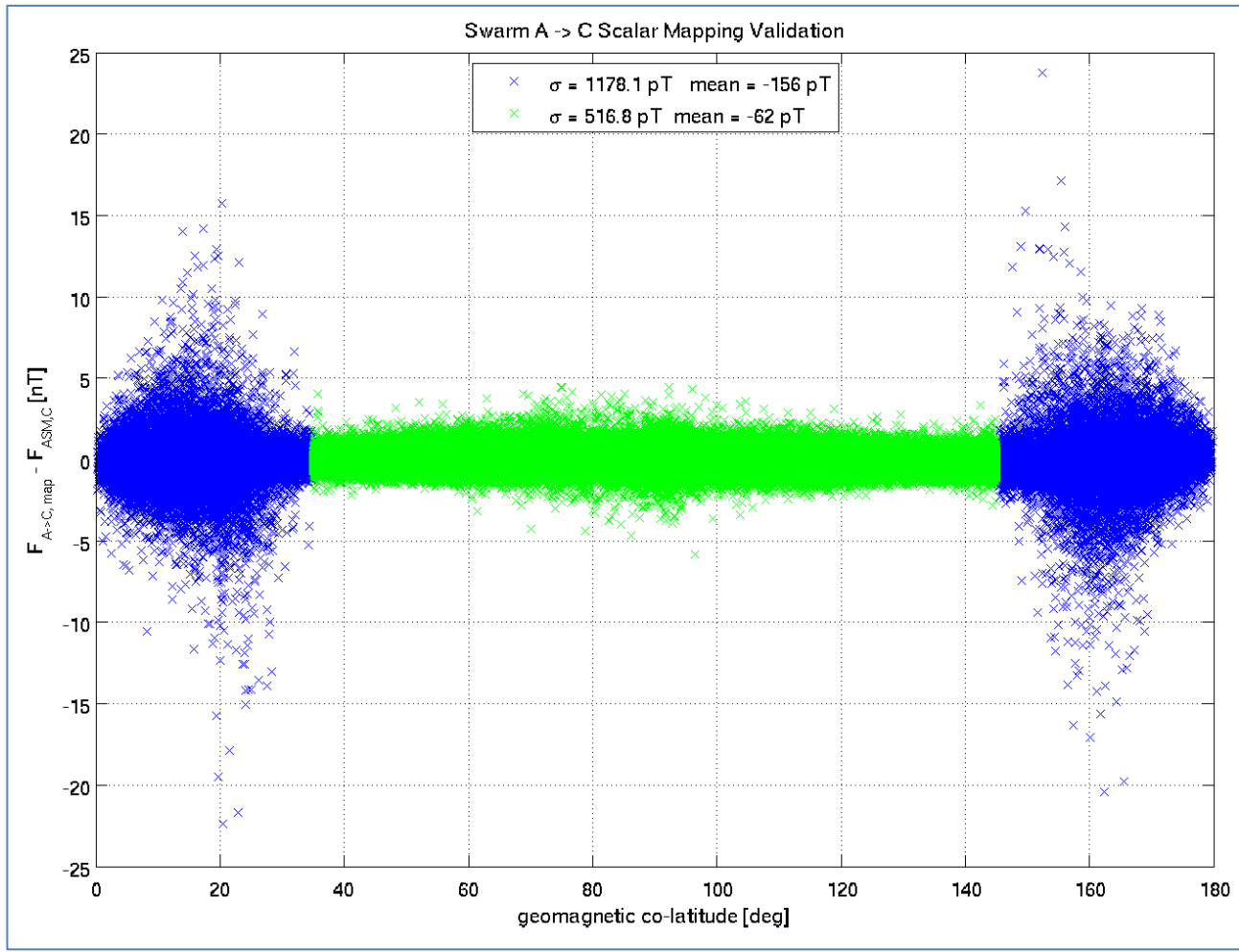


Figure 3-1: Difference between mapped data, $F_{A \rightarrow C, \text{map}}$, and the ASM measurements on Charlie, F_c (" $F_{ASM,C}$ ")