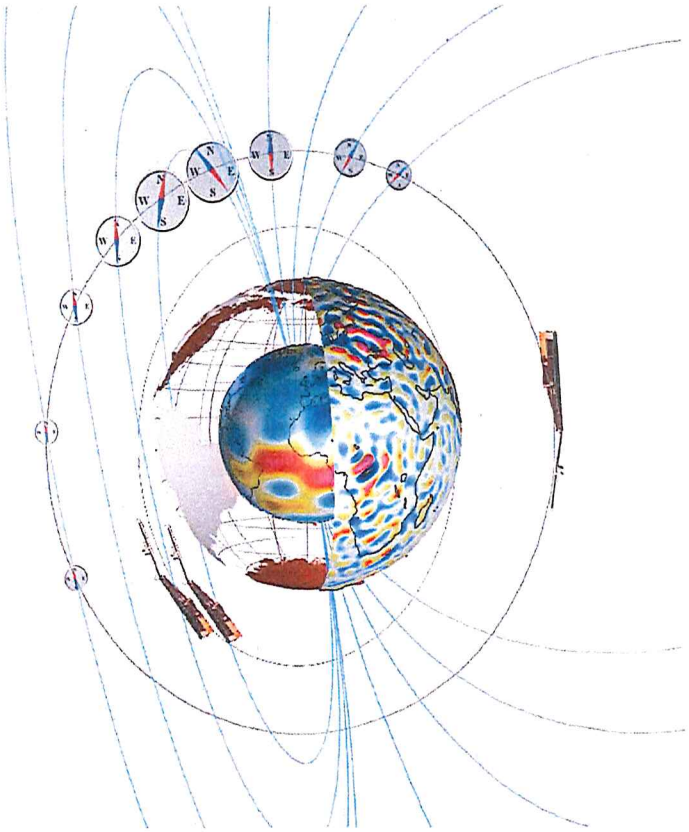
Swarm IPIR Work Plan



Doc. no: SW-TN-UiO-GS-001, Rev: 1A, 01 Sept. 2018

Prepared:

Yaqi Jin

Yaqi Jin Date 01 Sept. 2018

Scientist

Prepared:

Chao Xiong

Chao Xiong Date 01 Sept. 2018

Scientist

Approved:

Wojciech J. Miloch Date 01 Sept. 2018

Project Manager

Record of Changes

Reason	Description	Rev	Date
Initial vers.	Released	1 dA	05 Dec 2017
Updated for-matting	Released	2 dA	04 July 2018
Final version	Corrected revision number, dates, references, and headers.	1A	1 Sept 2018

Table of Contents

1 Introduction

1.1 Scope and applicability

This document is the Swarm Level 2 (L2) IPIR - Ionospheric Plasma IRregularities characterised by the Swarm satellites – Work Plan for the Swarm Data, Innovation and Science Cluster (Swarm DISC) consortium in response to the requirements of [AD-1]. PDD is to be published on the Swarm Data Handbook [AD-1]. Current or updated version of this document is available in the SVN folder: https://smart-svn.spacecenter.dk/svn/smart/SwarmDISC/DISC_Projects/ITT1_4_ionospheric_irregularities/Deliverables/.

2 Applicable and Reference Documentation

2.1 Applicable Documents

The following documents are applicable to the definitions within this document.

[AD-1] SW-SW-DTU-GS-114, rev 1 Statement of Work for Swarm DISC ITT 1.4 “Ionospheric irregularities and fluctuations based on Swarm data”

[AD-2] IPIR-Swarm-IPIR-1-2017 – Ionospheric Plasma IRregularities characterised by the Swarm satellites.

[AD-3] https://earth.esa.int/web/guest/missions/esa-eo-missions/swarm/data-handbook

2.2 Abbreviations

Acronym ***or abbreviation***	***Description***
DISC	The Data, Innovation and Science Cluster
ESA	European Space Agency
GFZ	The Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, DE
IPIR	Ionospheric Plasma IRregularities characterised by the Swarm satellites
L1b	Level 1b (satellite data)
L2	Level 2 (satellite data)
SVN	SVN Repository with server located at DTU. Presently, the following URLs apply: https://smart-svn.spacecenter.dk/svn/smart/SwarmDISC/DISC_Projects/ITT1_4_ionospheric_irregularities/Deliverables/
Swarm	Constellation of 3 ESA satellites, https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/swarm
TBD	To Be Defined
UiO	The University of Oslo, Oslo, Norway

3 Report from the initial stage of the project

For the initial stage of the project, we have chosen the following dates for the test cases that account for different solar activity levels:

Quiet day: 8 Oct., 2017, daily average Kp=0.7
Moderate day: 15 Sep. 2017, daily average Kp=4.3
Active day: 8 Sep. 2017, daily average Kp=6.0

For these dates all the datasets (magnetic field, plasma density, GPS) are available for the three Swarm satellites. In addition to the three selected dates, some other days were used for particular checks.

The results of the initial investigation of the dataset is presented in Figs. 1-4.

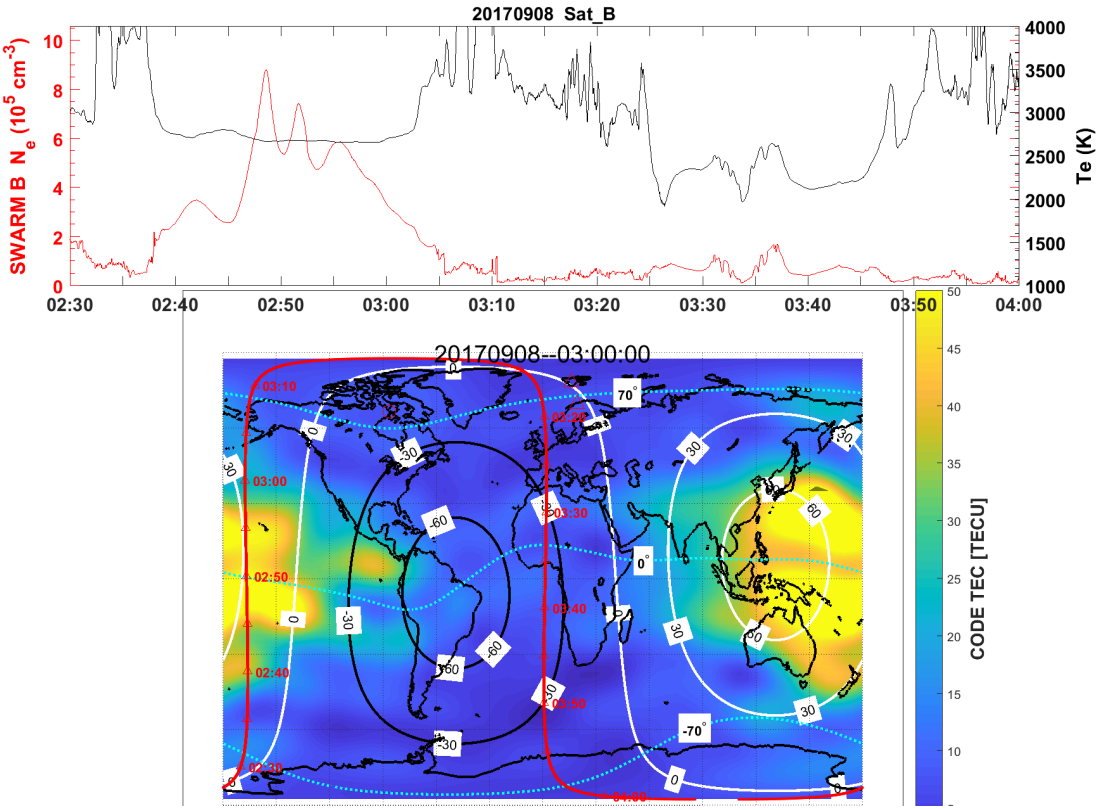


Fig. 1*: Ne, TEC and ROT for Swarm B on 08 September 2017. The upper panel is Ne and Te from EFI, while the lower panel shows a ground-based GPS TEC map (interpolated and hourly averaged). The red line shows the trajectory of the SWARM satellite. The white and black contours show the solar elevation angle. The magnetic latitudes of 0, and +/- 70 degrees are also shown.*

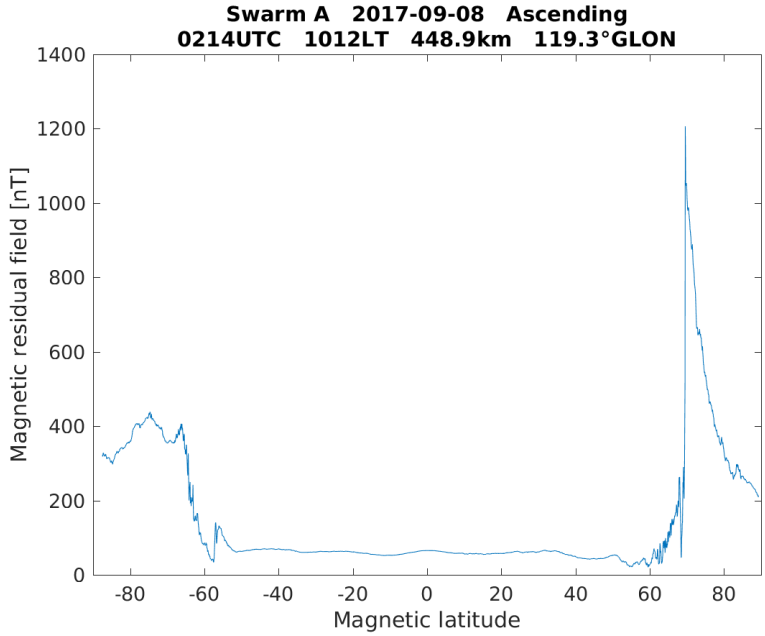


Fig. 2: *Residual magnetic field derived by subtracting the CHAOS-6 predictions (core, lithosphere and external fields all taken into account) from Swarm A for a half-orbit. It is clear that ionospheric currents dominate the magnetic signatures at high latitudes, and thus magnetic residual field cannot be used for detecting irregularities.*

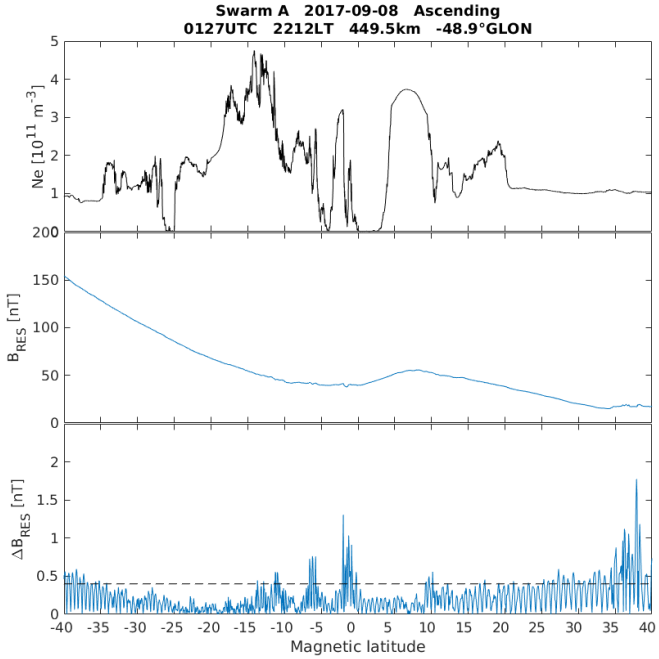


Fig. 3: *The background electron density, Ne, residual magnetic field B_RES derived by subtracting the CHAOS-6 predictions from Swarm A magnetic measurements and its spatial variation. The focus is on low geomagnetic latitudes.*

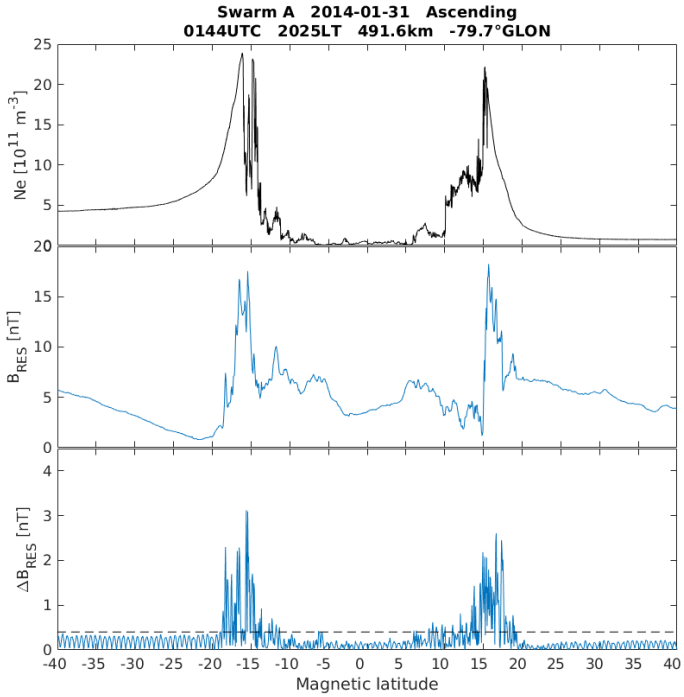


Fig. 4: *The background electron density, Ne, residual magnetic field B_RES derived by subtracting the CHAOS-6 predictions from Swarm A magnetic measurements and its spatial variation. The data is for the day with high solar activity and relatively high background density. The variations in the magnetic field correspond well to plasma irregularities in this case.*

With the results described above, and after investigating a large number of orbits, we have verified that using electron temperature data for determining if the satellite enters the auroral oval is not robust, due to varying data quality, and will not be used further. However, magnetic field data at small scales provides detection of ionospheric currents and it will be used instead for determining that the Swarm satellite enters high latitude ionosphere.

We have also concluded that the correlation of magnetic field data with ionospheric irregularities depends strongly on the solar activity and the overall level of the background plasma density. Determination of plasma irregularities by using magnetic field residuals at high latitudes is not straightforward, due to large ionospheric currents, as was also previously anticipated.

Thus, the most adequate datasets for the IPIR project to work with further are the electron density and GPS data. The team decided to identify 4 geomagnetic regions of interest: Low latitudes, Mid latitudes, Auroral region, Polar cap for detailed studies and categorisation of plasma irregularities. To identify these regions, we will use the combination of magnetic field data (determining high latitude ionosphere), density data (the mid latitude region will be determined by the relative change in the background density), and orbital data (for determining mainly the polar cap region).

The results of the preliminary study have not influenced significantly the overall work plan of the IPIR project. The preparatory phase of the project will be carried out according to the plan. The work plan for the IPIR project, with required datasets, Swarm-data and meta-data, models, and independent datasets has been outlined in the project proposal and discussed during the negotiation meeting. Below we present the table with the updated work-plan, with revised completion times.

4 Work Plan

The detailed work plan has been defined based on the results from the initial work in the project, and is given in Table 1.

Table 1: *The updated work plan of the IPIR project.*

Work phase	Event code	Description	Time
Definition	MIL-01 / ME-01	Project Kick Off, start of WP1, WP2, WP3 (Webex)	01.11.2017
Definition	MIL-02	Delivery of the work plan - end of definition phase of the project	15.12.2017
Implementation	WP4 - start	Start of WP4	01.01.2018
Implementation	ME-02a	Project status meeting with Swarm DISC project office	By 15.02.2018
Implementation	MIL-03	Delivery of the algorithm description	01.04.2018
Implementation	Mid term review	Mid term review.	01.04.2018
Implementation	ME-02b	Project status meeting with Swarm DISC project office	01.05.2018
Implementation	MIL-04	Validation report	01.06.2018
Prep. for ops.	Outreach	Submission of scientific papers	01.07.2018
Prep. for ops.	MIL-05	Delivery of first dataset to PDGS	01.07.2018
Prep. for ops.	WP5 –start	Start of WP5	01.07.2018
Prep. for ops.	VirES	Visualisation of the data with the VirES platform	01.07.2018
Prep. for ops.	ME-2c	Project status meeting with Swarm DISC project office	By the end of 08.2018
Prep. for ops.	Outreach	Acceptance of scientific papers, presentation of the work at scientific meetings	By 31.10.2018
Init. ops.	ME-03	Presentation of the final results at a scientific meeting(s) – including Swarm DQW.	By 31.10.2018
Init. ops.	MIL-06	Finalising the dataset for the all available Swarm data up to date	By 31.10.2018