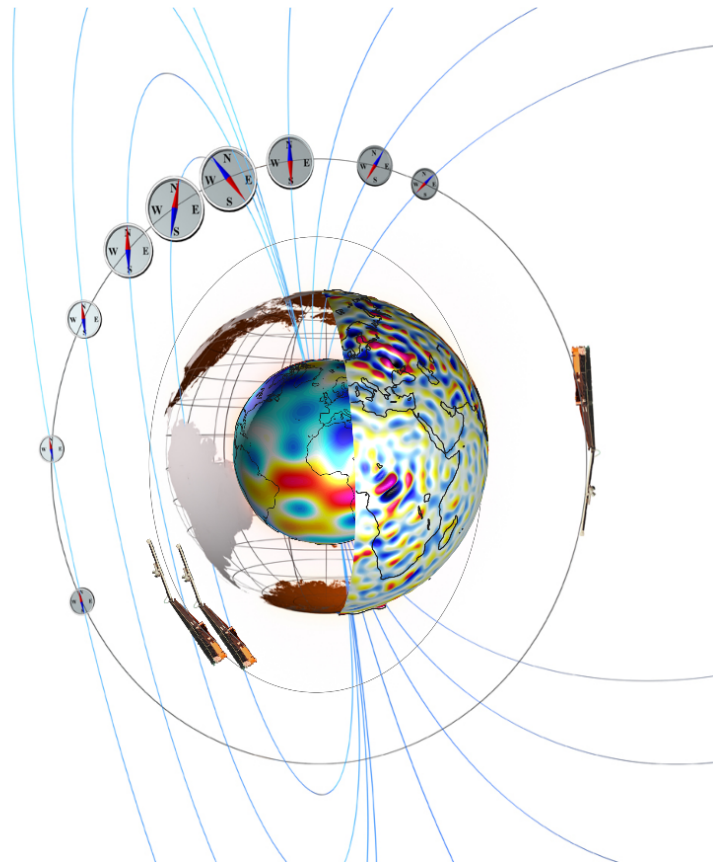




Swarm IPIR Product Definition Document



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Record of Changes

Reason	Description	Rev	Date
Initial vers.	Released	1 dA	05 May 2018

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1 Introduction

1.1 Scope and applicability

This document is the Swarm Level 2 (L2) IPIR Product Definition Document (PDD) 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-12017 – 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
GFZ	The Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, DE
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 Product identifier

The product identifier is: **L2 Cat-1: IPDxIRR_2F**

L2, Cat-1 : IPIR is the level 2 fast track product, that is processed by UiO through the DISC consortium.

IPD : stands for Ionospheric Plasma Density

x : ~~signifies that the product is derived separately for all satellites~~

IRR : stands for Irregularities in the plasma density

2F : signifies that this is a fast track product. The validation is performed by means of an internal quality check in the algorithms of the product, and the quality of the product is provided by a quality flag. It is released without a validation report.

4 Product definition

Product identifier	IPDxIRR_2F																																		
Definition	Time series of characteristics of the plasma density and plasma irregularities along the orbit from single satellite measurements. Time series of local plasma conditions, including background density and total electron content. Data related to geomagnetic regions in the ionosphere. Indication of severity of plasma irregularities for ground-based users provided.																																		
Input data	EFIx_PL_1B, Satellite positions, Time stamps (UTC), TECxTMS_2F, AOBxFAC_2F, IBIxTMS_2F, PCP - Polar Cap Products																																		
Input time span	3 days																																		
Spatial representation	Data provided along entire orbits at positions of SwA, SwB, and SwC.																																		
Time representation	1 second time series																																		
Units	See data format table																																		
Resolution	Temporal data resolution of 1 second, density variations estimated at 0.5 second resolution.																																		
Uncertainty	N/A																																		
Quality indicator	Quality flags are handed through from Level 1b and Level 2 processing which is used as input data.																																		
Data volume	15MB per day, per satellite																																		
Data format	<table border="1"> <thead> <tr> <th>Variable name</th> <th>Data Type</th> <th>Description</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>cdf_epoch</td> <td>cdf epoch</td> <td>CDF epoch of the measurement, i.e., number of milliseconds since 01.01.0000 00:00.</td> <td>milli-seconds</td> </tr> <tr> <td>Latitude</td> <td>CDF_DOUBLE</td> <td>Geographic latitude of the satellite in degrees.</td> <td>Degrees</td> </tr> <tr> <td>Longitude</td> <td>CDF_DOUBLE</td> <td>Geographic longitude of the satellite in degrees.</td> <td>Degrees</td> </tr> <tr> <td>Radius</td> <td>CDF_DOUBLE</td> <td>Geocentric altitude of the satellite in km.</td> <td>km</td> </tr> <tr> <td>Ne</td> <td>CDF_DOUBLE</td> <td>Plasma density, directly copied from the Langmuir probe files (in cm⁻³).</td> <td>cm⁻³</td> </tr> <tr> <td>background Ne</td> <td>CDF_DOUBLE</td> <td>Background density, as calculated from Ne using a percentile filter.</td> <td>cm⁻³</td> </tr> <tr> <td>foreground Ne</td> <td>CDF_DOUBLE</td> <td>Foreground density, as calculated from ndens using a percentile filter.</td> <td>cm⁻³</td> </tr> </tbody> </table>			Variable name	Data Type	Description	Unit	cdf_epoch	cdf epoch	CDF epoch of the measurement, i.e., number of milliseconds since 01.01.0000 00:00.	milli-seconds	Latitude	CDF_DOUBLE	Geographic latitude of the satellite in degrees.	Degrees	Longitude	CDF_DOUBLE	Geographic longitude of the satellite in degrees.	Degrees	Radius	CDF_DOUBLE	Geocentric altitude of the satellite in km.	km	Ne	CDF_DOUBLE	Plasma density, directly copied from the Langmuir probe files (in cm ⁻³).	cm ⁻³	background Ne	CDF_DOUBLE	Background density, as calculated from Ne using a percentile filter.	cm ⁻³	foreground Ne	CDF_DOUBLE	Foreground density, as calculated from ndens using a percentile filter.	cm ⁻³
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	Te	CDF_DOUBLE	Electron temperature, directly copied from the Langmuir probe files (in Kelvin).	K
	PCP_flag	CDF_UINT4	The polar cap patch flag: 0 if the plasma density measurement occurred OUTSIDE a polar cap patch. 1 if the plasma density measurement occurred at one of the edges of a polar cap patch (no plasma velocity measurements are available). 2 if the plasma density measurement occurred at the LEADING edge of a polar cap patch. 3 if the plasma density measurement occurred at the TRAILING edge of a polar cap patch. 4 if the plasma density measurement occurred INSIDE a polar cap patch proper. When no ion drift data is available, the leading and trailing edges cannot be distinguished. In this case the polar cap patch flag is set to 4 throughout the patch proper and to 1 throughout both edges.	no unit
	Grad_Ne@100km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 27 data points for the 2 Hz electron density data.	cm ⁻³ /km
	Grad_Ne@50km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 13 data points for the 2 Hz electron density data.	cm ⁻³ /km
	Grad_Ne@20km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 5 data points for the 2 Hz electron density data.	cm ⁻³ /km
	Grad_Ne@PCP_edge	CDF_DOUBLE	The linear electron density gradient calculated over the edges of a patch. This variable is non-zero only at the edges of polar cap patches.	cm ⁻³ /km
	ROD	CDF_DOUBLE	Rate Of change of Density	cm ⁻³ /s
	RODI10s	CDF_DOUBLE	Rate Of change of Density Index (RODI) is the standard deviation of ROD over 10 seconds.	cm ⁻³ /s

RODI20s	CDF_DOUBLE	Rate Of Density Index (RODI) is the standard deviation of ROD over 20 seconds.	cm ⁻³ /s
delta_Ne10s	CDF_DOUBLE	delta_Ne10s is derived by subtracting Ne by its median filtered value in 10 seconds. As a result, delta_Ne10s indicates the electron density fluctuations smaller than 75 km.	cm ⁻³
delta_Ne20s	CDF_DOUBLE	delta_Ne20s is derived by subtracting Ne by its median filtered value in 20 seconds. As a result, delta_Ne20s indicates the electron density fluctuations smaller than 150 km.	cm ⁻³
delta_Ne40s	CDF_DOUBLE	delta_Ne40s is derived by subtracting Ne by its median filtered value in 40 seconds. As a result, delta_Ne40s indicates the electron density fluctuations smaller than 300 km.	cm ⁻³
num_GPS_satellites	CDF_UINT4	total number of tracked GPS satellites above 20 degrees.	no unit
mVTEC	CDF_DOUBLE	Median of VTEC from all available GPS satellites above 30 degrees.	TECU
mROT	CDF_DOUBLE	median of Rate Of TEC (ROT) from all available GPS satellites above 30 degrees.	TECU/s
mROTI10s	CDF_DOUBLE	Median of Rate Of TEC Index (ROTI) from all available GPS satellites above 30 degrees. The ROTI of each satellite is the standard deviation of ROT over 10 seconds.	TECU/s
mROTI20s	CDF_DOUBLE	Median of Rate Of TEC Index (ROTI) from all available GPS satellites above 30 degrees. The ROTI of each satellite is the standard deviation of ROT over 20 seconds.	TECU/s
IBI_flag	CDF_UINT4	Plasma Bubble Index, copied from the level-2 Ionospheric Bubble Index product, IBIxTMS_2F .	no unit
Ionosphere_region_flag	CDF_UINT4	0: equator, 1: mid-latitudes; 2: auroral oval; 3: polar cap.	no unit
IPIR_index	CDF_UINT4	0-3 low, 4-7 medium, and 8-10 high probability of ionospheric scintillations.	no unit

	Ne_quality_flag	CDF_UINT4	Quality flag for the Ne data and the derived data from Ne, e.g., background density, foreground density etc.	no unit
	TEC_quality_flag	CDF_UINT4	Quality flag for the TEC data and the derived data from GPS TEC, e.g., ROT, ROTI etc.	no unit
	AOB_quality_flag	CDF_UINT4	Flags for the auroral boundary product	no unit
	IPIR_index_flag	CDF_UINT4	Flags for the IPIR index	no unit
Output data	CDF file with time series			
Output time span	1day			
Latency	10 min			
Update rate	1 per day			
Notes				

