FDR4ALT

Validation Report Document
Land-Ice TDP

CLS-ENV-NT-23-0420

Issue 4.1 – 03/07/2023

Public

AUTHORS TABLE

Object	Name
Authors	Malcolm McMillan, Jennifer Maddalena (Lancaster University), Fanny Piras (CLS)
Checked by	Gabriele Brizzi (SERCO) and Pierre Féménias (ESA)
Accepted by	Pierre Féménias (ESA)

CHRONOLOGY ISSUES

Issue	Date	Object
1.0	17/05/22	Draft version for Phase 2 PM#1
2.0	02/12/22	Intermediate version for Phase 2 PM #1 (80% completed for ENVISAT)
3.0	02/05/23	Final version for Final Review
4.0	23/05/23	Final version for Final Review with RIDs implemented
4.1	04/07/2023	Validation report has been separated into distinct reports for each product type

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

1 Introduction

This document has been written in the frame of the FDR4ALT project, ESA contract N°4000128220/19/I-BG. It is a deliverable of task 4 of the project and is identified as [D-4-02].

1.1 The FDR4ALT Project

In the framework of the European Long Term Data Preservation Program (LTDP+) which aims at generating innovative Earth system data records named Fundamental Data Records (basically level 1 altimeter and radiometer data) and Thematic Data Records (basically level 2+ geophysical products), ESA/ESRIN has launched a reprocessing activity of ERS-1, ERS-2 and ENVISAT altimeter and radiometer dataset, called the FDR4ALT project (Fundamental Data Records for Altimetry). A large consortium of thematic experts has been formed to perform these activities which are:

1) To define products including the long, harmonized record of uncertainty-quantified observations.

2) To define the most appropriate level 1 and level 2 processing.

3) To reprocess the whole times series according to the predefined processing.

4) To validate the different products and provide them to large communities of users focused on the observation of the atmosphere, ocean topography, ocean waves, coastal, hydrology, sea ice, ice sheet regions.

1.2 Purpose and scope of the validation report

After the FDR/TDP definition step and all benchmarking (Round Robin) between standard solutions addressed by each expert group, comes the production and validation step.

The objective of this document is to provide a validation report for the Land-Ice TDP, following the strategy defined in the Validation Plan Document [D-4-01]. Note that to avoid heavy documents, the validation reports have been divided: there is one validation report for the FDRs (ALT FDR and MWR FDR) and one validation for each of the six TDPs. This document therefore contains only results for the **Land-Ice TDP**.

This document describes in detail the validation that has been performed for the Land-Ice TDP to assess the performances of the FDR4ALT final products. The validation covers the full lifespan of the missions and therefore includes long-term analysis, as well as cyclic analysis or targeted analysis that are relevant for this TDP.

2 Terminology

This section aims at defining clearly the terminology used in the FDR4ALT deliverables.

- **Product** refers a specific type of file, defined and described by a dedicated handbook, and designed for a clear purpose (the FDR4ALT project, the REAPER project, …). It is a “container”. One product refers to one file. The use of plural is designed to refer to a group of files, for instance the Thematic Data Products. “FDR4ALT products” will usually refer to all TDPs and FDRs, i.e., the outputs of the whole project. Note that the word “product” does not imply any notion of start date or end date, whereas “dataset” does.
- **File** can be used to refer to one single product or any other file that is not a product.
- **Parameter or variable** refers to a product’s field, i.e., the content of the product. For instance, the sea level anomaly is a parameter of the Ocean & Coastal Thematic Data Products.

- **Dataset** can be used to refer to any group of data, not necessarily products. However, in the context of this project, it will often be used to refer to a sub-ensemble of products, on a specific period of time or a specific geographic area. For instance, the TDS (test dataset) refers to a dataset of 3 years of test products.

3 Land-Ice Thematic Data Products

3.1 Introduction

The Land Ice TDP processing chain is a L2P processing chain that ingests standard Level-2 parameters and produces enhanced, along-track L2P measurements, which are easier to use for the end user. Specifically, the Land Ice TDP chain takes ERS-1, ERS-2 and ENVISAT Level-2 parameters as input, and generates consistent, geolocated elevation measurements at fixed nodes along the reference ground track, together with associated uncertainty, plus several auxiliary fields related to waveform characteristics and surface classification. The full methodology and workflow of the TDP is described in the Detailed Processing Model [DPM CLS-ENV-NT-20-0424]. In summary, the approach ingests Level-2 data that have been produced using a bespoke ice sheet Level-2 processor, including dedicated ice sheet retracking and relocation using the method of Roemer et al. (2007). The TDP processing then migrates Level-2 data from all cycles onto common reference nodes, 380m apart, along the reference ground track, thereby mitigating the impact that orbit drift has on the variance of elevation measurements at any given location. This makes it easier for the user to isolate temporal changes in ice sheet elevation. Furthermore, additional post-processing filtering steps are applied to account for artefacts in the altimetry record that cause noise within the dataset that would be challenging for a non-altimetry expert to interpret (see DPM CLS-ENV-NT-20-0424). As such, the processing chain delivers a more consistent along-track dataset that maintains the native 20 Hz sampling of a Level-2 product but improves its ease-of-use for the end user.

This section describes the results of the Land Ice Thematic Data Product validation. The subsections firstly briefly describe the validation datasets and methodologies, and then present the validation results.

3.2 Validation Datasets

The validation datasets that are used to validate the Land Ice TDP are airborne surface elevation measurements acquired by the Airborne Topographic Mapper (ATM) flown on-board NASA's Operation IceBridge (http://nsidc.org/icebridge/portal/) and pre-IceBridge (https://nsidc.org/data/blatm2) campaigns. Although often sporadic during the ERS-1, ERS-2, and ENVISAT period, these measurements represent the most extensive reference dataset available (Figure 3-1). Further details relating to the characteristics of the validation datasets can be found within the Validation Plan document [D-4-01].

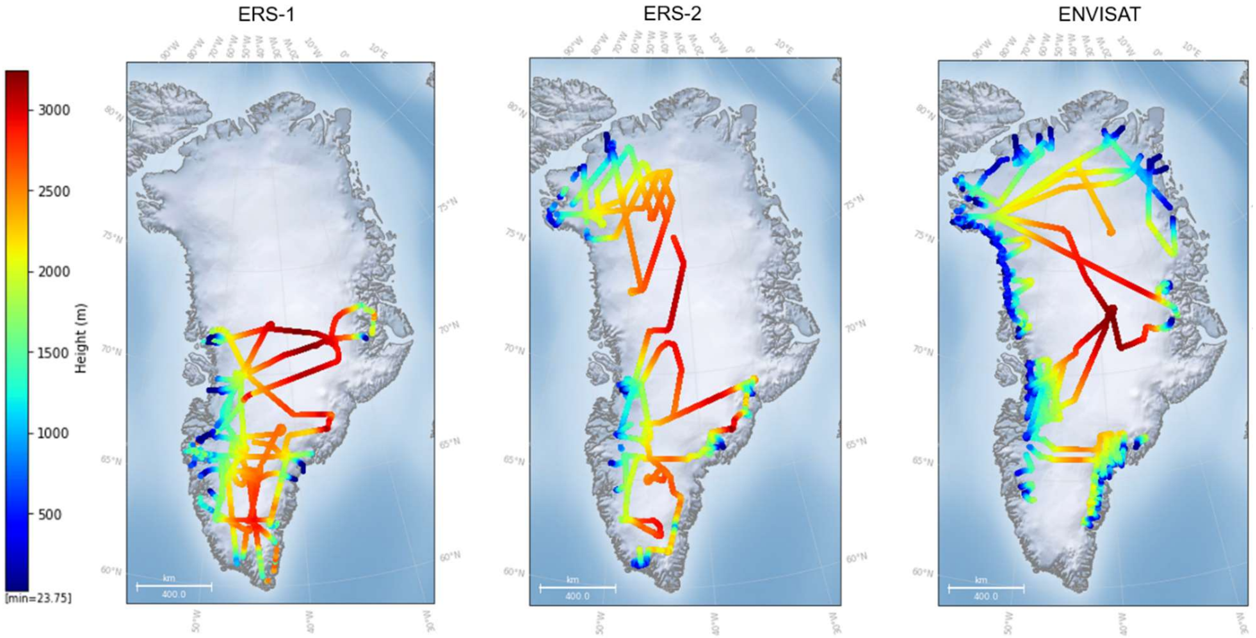

Figure 3-1 : The airborne reference data used to validate the FDR4ALT Land Ice products.

3.3 Validation Methodology

Within this validation exercise, two complimentary methodologies are employed. The first determines the absolute accuracy of the FDR4ALT datasets, which allows us to assess whether the evolutions to the Level 2 processing chain have delivered improvements in the accuracy of the land ice elevation measurements. The second validation exercise evaluates the internal stability of the TDP elevation measurements. This is critical for reliable determination of the temporal evolution of the ice sheets and therefore allows us to assess the extent to which the TDP processing chain has improved upon the existing Level-2 product in terms of delivering a more consistent – and therefore useable – dataset, particularly for the non-altimetry expert user.

Absolute accuracy is assessed by comparing the newly generated datasets to contemporaneous, co-located airborne measurements, to compute statistics with which to characterise their accuracy. Further details of the method employed are provided within the Validation Plan document. Internal stability is assessed by computing the temporal variance – across all cycles – of elevation measurements acquired at defined intervals along the satellite track. This variance arises due to the influence of (1) temporal changes in ice surface elevation (usually the desired signal to be quantified), and (2) surface topography (usually the unwanted noise). By comparing the variance of elevations from the TDP product with the equivalent measurements from the Level-2 product, we eliminate the common surface elevation change component and isolate changes in the residual topographic noise. This allows us to determine whether the TDP processing has reduced the topographic noise and therefore improved the stability of elevation measurements across all cycles.

The different dataset comparisons performed within the validation activities are designed to explore different aspects of the processors' performance, which allows us to isolate improvements arising from both the Level-2 processing and the TDP chain. First, we consider the difference between the accuracy of the new FDR4ALT L2 measurements and the existing baseline L2 products; GDRv3 for ENVISAT and REAPER for ERS-1 and ERS-2. This validation activity allows us to quantify the impact of the changes implemented within the FDR4ALT Level 2 processing chain; namely the FDR4ALT ice sheet retracker, an enhanced slope correction (Roemer et al., 2007), a dedicated ice sheet quality flag, and a refined surface-type classification for land ice.

These changes influence the absolute accuracy of the resulting L2 elevation measurements, and also enhance the quality assurance of the product. The latter step, by implication, reduces slightly the number of comparison measurements contributing to the validation activities. The second component of our validation activities is to compare the FDRALT Level-2 and TDP measurements, for the purpose of assessing the impact of the TDP processing; namely, the correction for topographic across-track drift, the production of a dataset that is sampled at regular along-track reference nodes, and the post-processing filtering. As a consequence of this TDP processing, the number of comparisons for the TDP product is reduced compared to the L2 product for a couple of reasons. First, additional filtering is applied to remove poor quality data, so as to ensure a more quality-assured product for the user (see DPM for further details). Second, due to the TDP's design to provide a consistent along-track sampling, in areas of more complex terrain, multiple satellite measurement can be migrated onto a single TDP reference node for any given cycle. This occurs because altimetry measurements cluster towards peaks in areas of undulating topography (i.e. the Point of Closest Approach within the beam footprint), and can act to reduce the number of TDP comparison points relative to the L2 counterpart.

3.4 Validation Results

3.4.1 ENVISAT

Absolute Accuracy

The absolute accuracy of the ENVISAT FDR4ALT elevation measurements was assessed through comparison to airborne reference data. The ice sheet elevation differences are shown in Figure 3-2 and Figure 3-3, and a summary of the statistics is provided in Table 1. This analysis indicates that the FDR4ALT dataset has sub-metre bias and precision, which represent a substantial improvement over GDR version 3. Improvements include an approximate 67 % reduction in the Median Absolute Deviation of the elevation differences, and a 62 % reduction in the number of gross outliers relative to GDR v3.

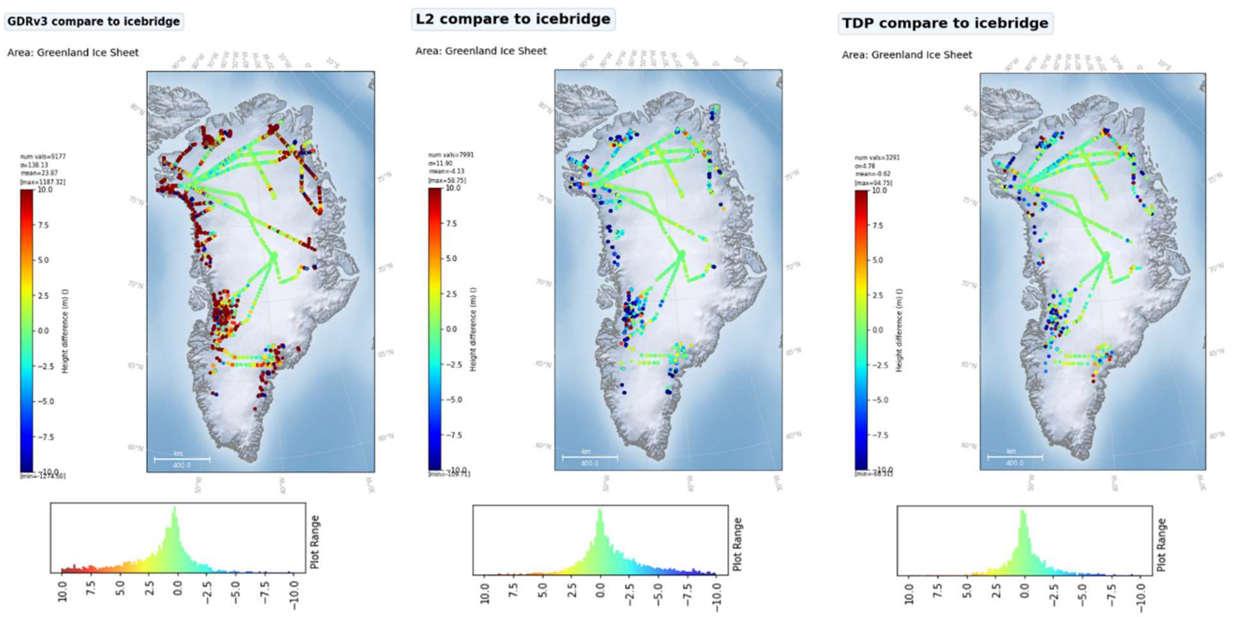

Figure 3-2 : . Comparison of elevation differences between Icebridge airborne reference data and GDR version 3 (left), equivalent FDR4ALT L2 product (middle), and FDR4ALT TDP (right).

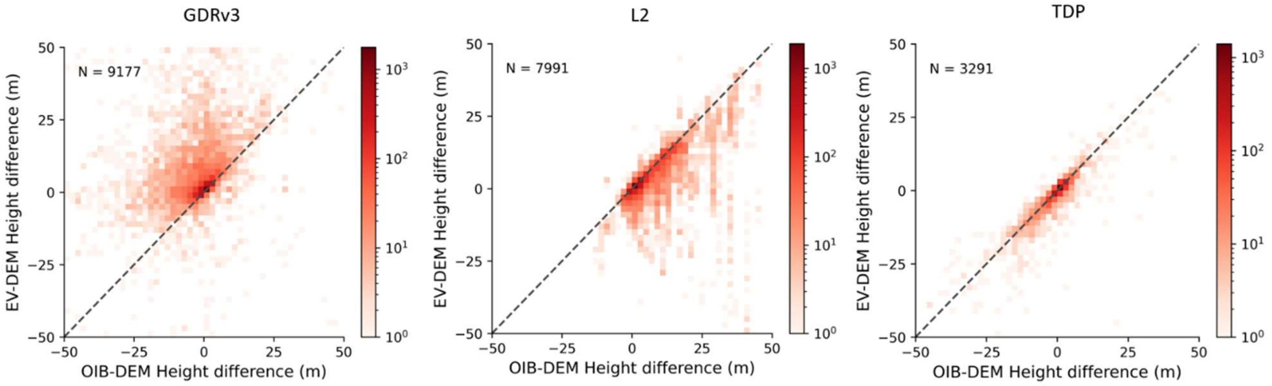

Figure 3-3 : Differences between airborne reference data and GDR version 3 (left), equivalent FDR4ALT L2 product (middle), and FDR4ALT TDP (right). In all cases, an auxiliary Digital Elevation Model has been used to remove the large-scale elevation signal.

ENVISAT				
	unit	GDRv3	L2	TDP
Mean absolute height difference	m	46.1	5.50	2.18
Mean height difference	m	23.9	-4.13	-0.62
Median of absolute deviation of height difference	m	4.38	1.83	0.90
Median height difference	m	2.89	-0.81	-0.04
Number of comparisons	-	9177	7991	3291

Table 1 : Accuracy statistics for ENVISAT based upon comparisons to co-located airborne reference data.

<u>Internal Stability</u>

The internal stability of the Land Ice TDP was assessed across all tracks intersecting the Greenland and Antarctic Ice Sheets, by computing the standard deviation of elevations across all cycles, at defined intervals along-track. Example, results along a single ground track (Figure 3-4) show the clear improvement in stability achieved by the TDP relative to the Level-2 product, due to the migration of measurements from all cycles on to common reference nodes (See Detailed Processing Model Document [D-2-01]).

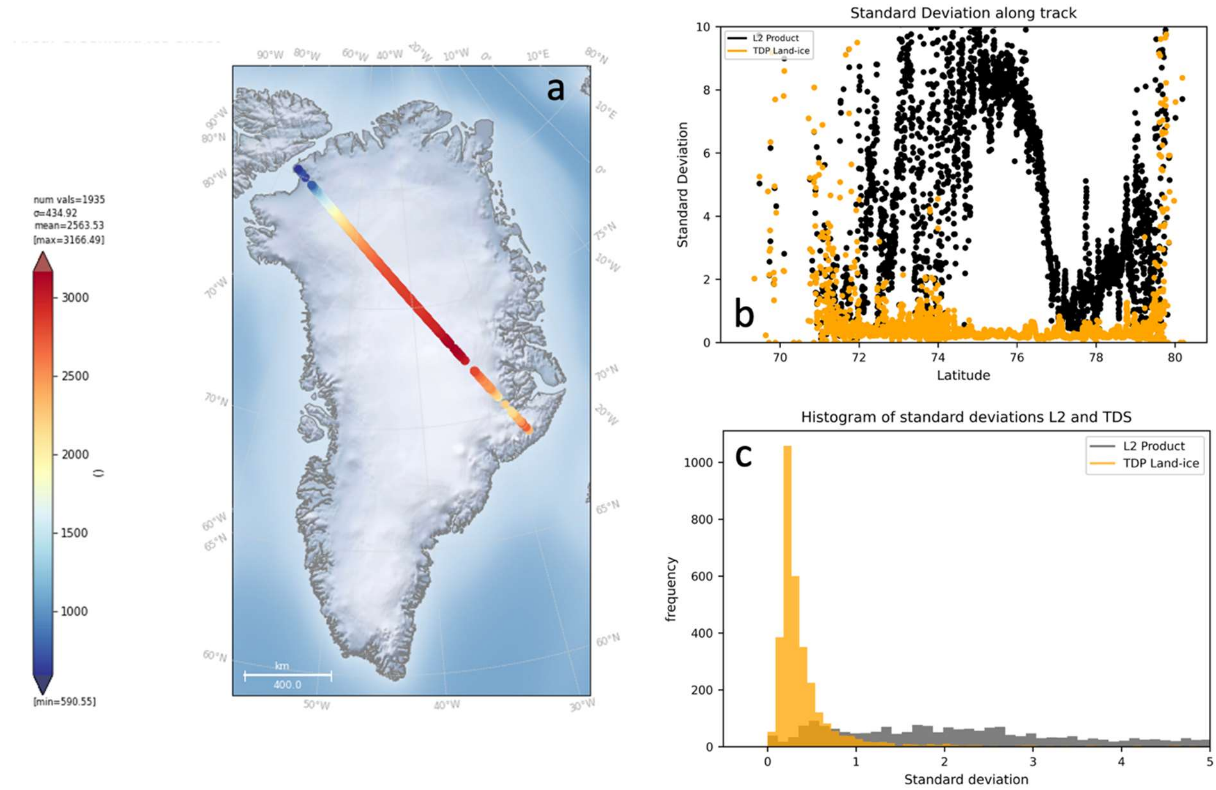

Figure 3-4: Assessment of the internal stability of the Land Ice TDP, for all cycles acquired along track 1 over the Greenland Ice Sheet. Panel a shows the location of track 1. Panel b shows the all-cycle standard deviation at defined 380m intervals from each reference node along the satellite reference track for the input Level-2 elevation (black) and the TDP elevation (orange). The TDP achieves a much lower standard deviation, indicating better stability due to the reduction in topographic noise. Panel c shows the distributions of standard deviations for the entire track for the Level-2 (grey) and the TDP (orange), again showing the improvement in standard deviation achieved by the TDP.

This assessment was performed for all tracks across both Greenland and Antarctica (Figure 3-5;Figure 3-6). This analysis demonstrates that the TDP achieves a much lower standard deviation for both Greenland and Antarctica, indicating a more stable product due to the reduction in topographic noise achieved by the TDP processing.

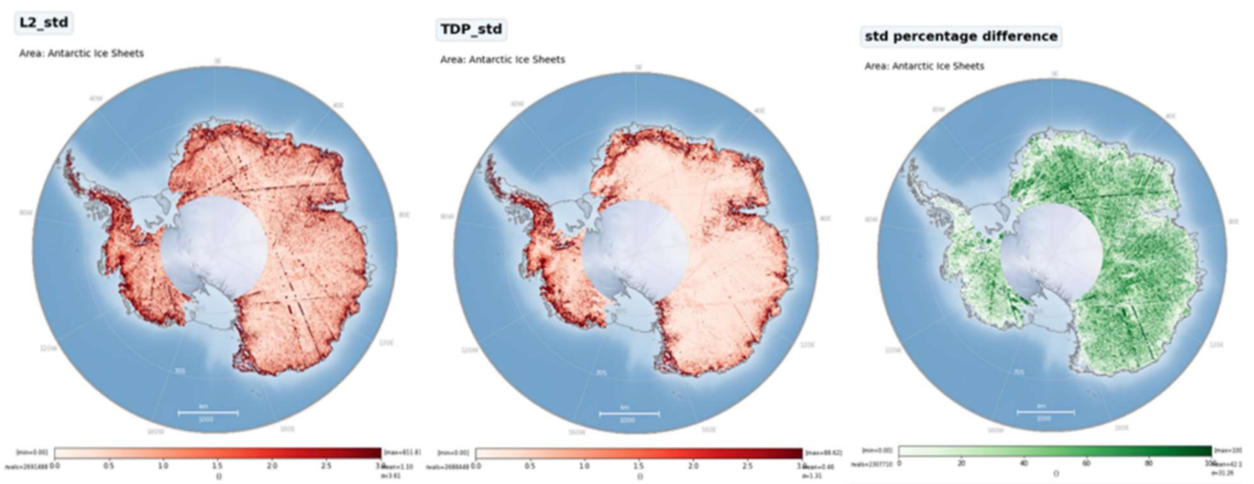

Figure 3-5 : Assessment of the internal stability of the Land Ice TDP for tracks over the Antarctic Ice Sheet showing the standard deviation for the Level-2 product (left), the TDP product (center) and the percentage improvement of standard deviation along each track (right).

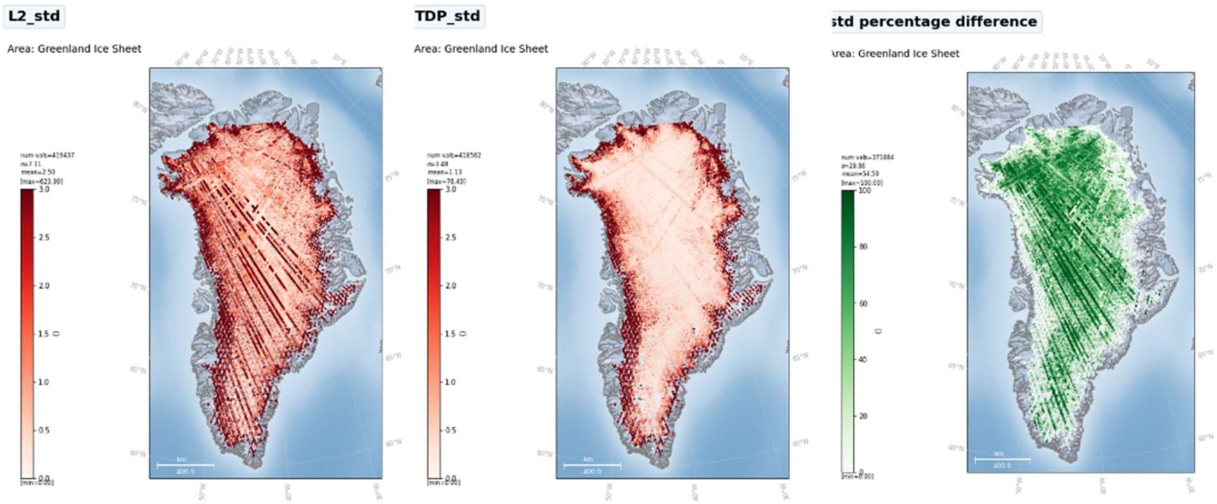

Figure 3-6 : Assessment of the internal stability of the Land Ice TDP for tracks over the Greenland Ice Sheet showing the standard deviation for the Level-2 product (Left), the TDP product (center) and the percentage improvement of standard deviation along each track (right).

Similarly, the continent-wide distributions of standard deviations shown in Figure 3-7 demonstrate a reduction in topographic noise for ENVISAT for the TDP product compared to the L2 product.

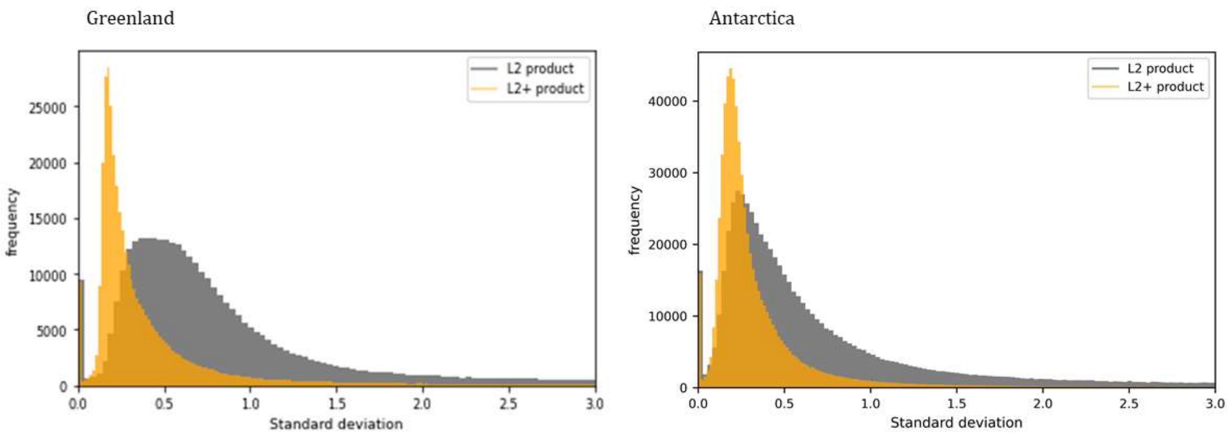

Figure 3-7 : The distribution of standard deviation for all tracks for the Level-2 product (grey) and the TDP (L2+) product (orange) for both Greenland (left) and Antarctica (right), showing the reduction in dispersion achieved by the TDP processing

3.4.2 ERS-2

Absolute Accuracy

The absolute accuracy of the ERS-2 FDR4ALT elevation measurements were assessed through comparison to pre-icebridge, airborne reference data. The ice sheet wide elevation differences are shown in Figure 3-8 and Figure 3-9, and a summary of the statistics are provided in Table 7. In comparison, to ENVISAT, the number of validation points is lower, because less airborne data is available for comparison.

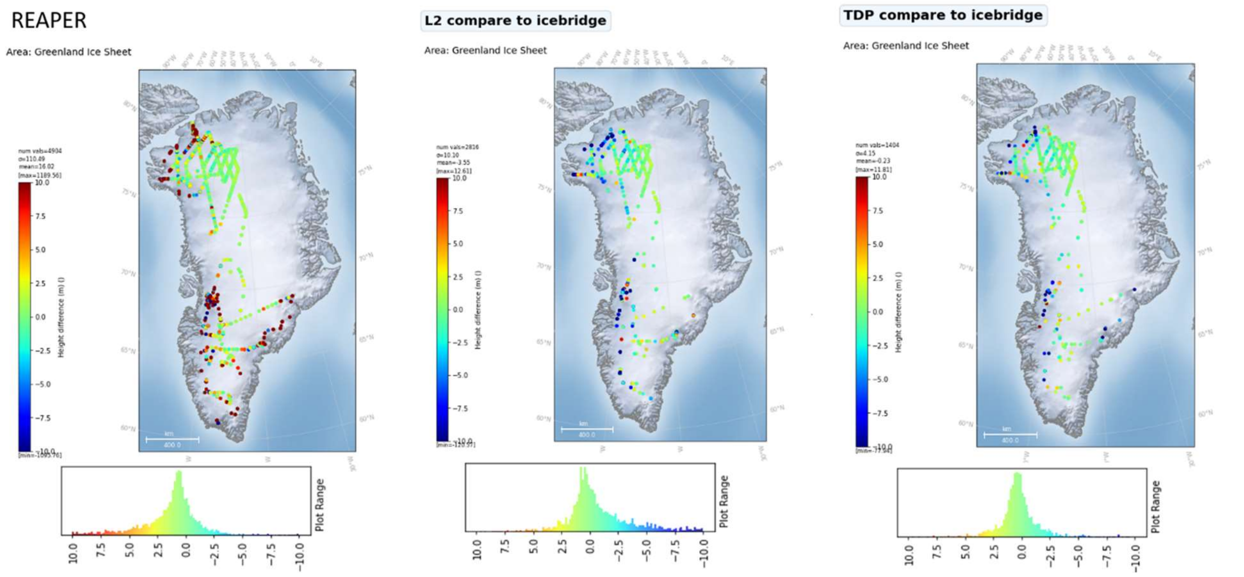

Figure 3-8 : Comparison of elevation differences relative to airborne reference data of REAPER product (left), the FDR4ALT L2 product (centre) and the FDR4ALT TDP product (right).

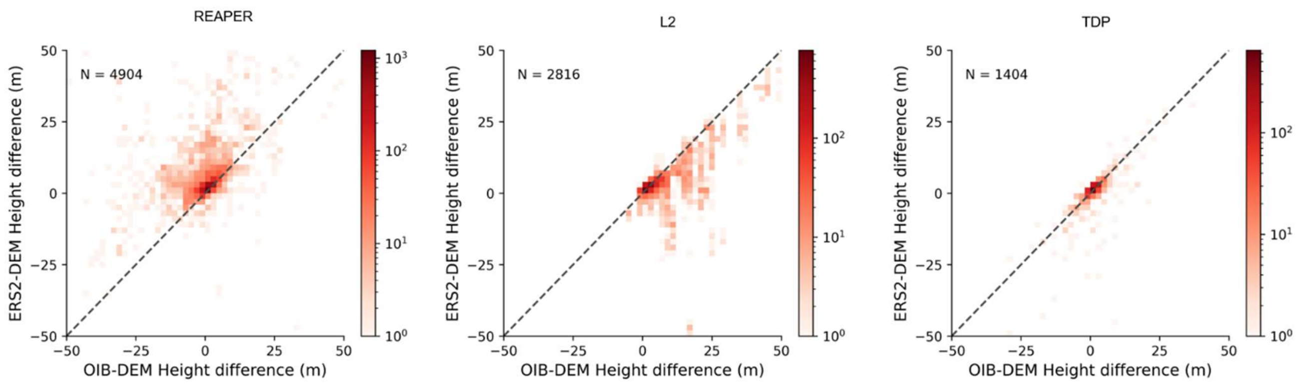

Figure 3-9: Differences relative to airborne reference data of the REAPER product (left), the FDR4ALT L2 product (centre) and the FDR4ALT TDP product (right). In all cases, an auxiliary Digital Elevation Model has been used to remove the large-scale elevation signal.

ERS-2				
	unit	REAPER	L2	TDP
Mean absolute height difference	m	20.1	4.70	1.70
Mean height difference	m	16.0	-3.55	-0.23
Median of absolute deviation of height difference	m	1.54	1.54	0.72
Median height difference	m	1.18	-0.41	0.29
Number of comparisons	-	4904	2816	1404

Table 2 : Accuracy statistics for ERS-2 based upon comparisons to co-located airborne reference data.

Internal Stability

As was done for ENVISAT, the along-track assessment of standard deviation was also performed for the ERS-2 TDP dataset; again, with, the analysis performed for all tracks across both Greenland and Antarctica (Figure 3-10 ; Figure 3-11). As was found with ENVISAT, this analysis demonstrates the TDP achieves a much lower standard deviation for both Greenland and Antarctica, indicative of a more stable product due to the reduction in topographic noise.

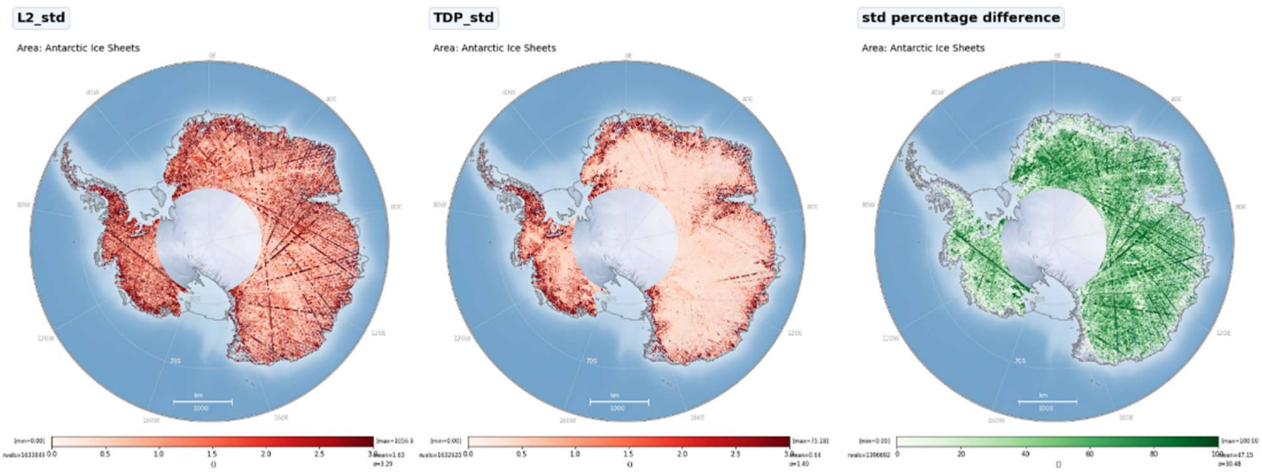

Figure 3-10: Assessment of the internal stability of the ERS-2 Land Ice TDP for tracks over the Antarctic Ice Sheet showing the standard deviation for the Level-2 product (left), the TDP product (centre) and the percentage improvement of standard deviation along each track (right).

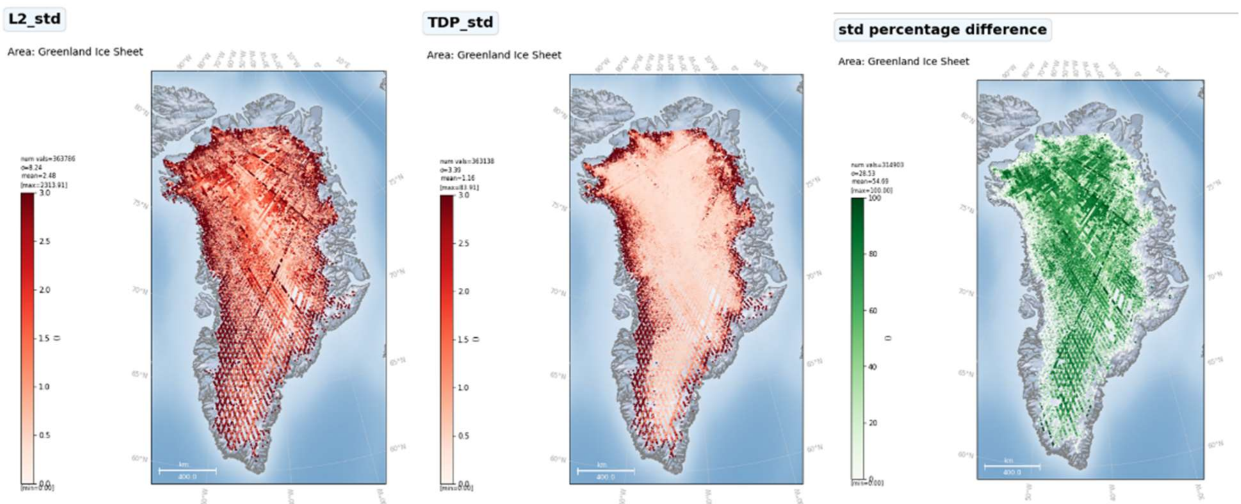

Figure 3-11: Assessment of the internal stability of the ERS-2 Land Ice TDP for tracks over the Greenland Ice Sheet showing the standard deviation for the Level-2 product (Left), the TDP product (centre) and the percentage improvement of standard deviation along each track (right).

Similarly, the continent-wide distributions of standard deviations shown in Figure 3-12 demonstrate a reduction in topographic noise for ERS-2 for the TDP product compared to the L2 product.

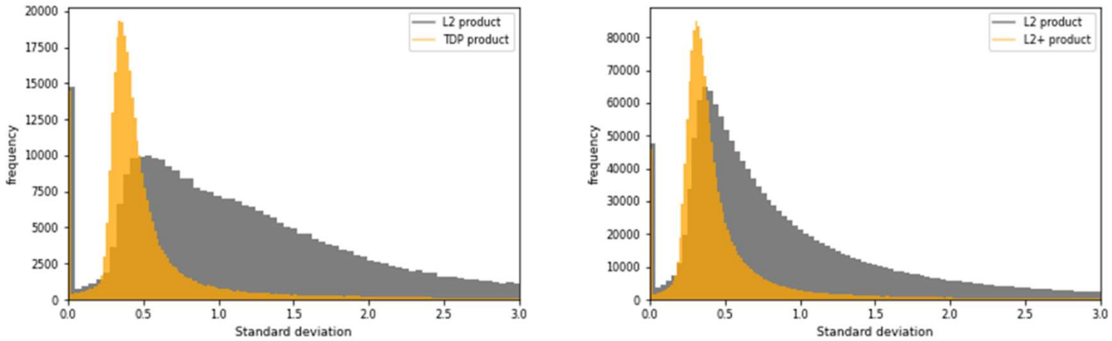

Figure 3-12: The distribution of standard deviation for all tracks for the ERS-2 Level-2 product (grey) and the TDP product (orange) for both Greenland (left) and Antarctica (right).

3.4.3 ERS-1

<u>Absolute Accuracy</u>

The absolute accuracy of the ERS-1 FDR4ALT elevation measurements were assessed through comparison to pre-IceBridge airborne reference data. The ice sheet wide elevation differences are shown in Figure 3-13 and Figure 3-14 , and a summary of the statistics are provided in Table 3. The analysis is undertaken for cycle 96 whilst ERS-1 is in a 35-day repeat orbit with ground reference tracks most similar to that of ERS-2 and ENVISAT. In comparison to ENVISAT and ERS-2, the number of validation points is lower, because less airborne data is available for comparison and these campaigns were limited to southern Greenland.

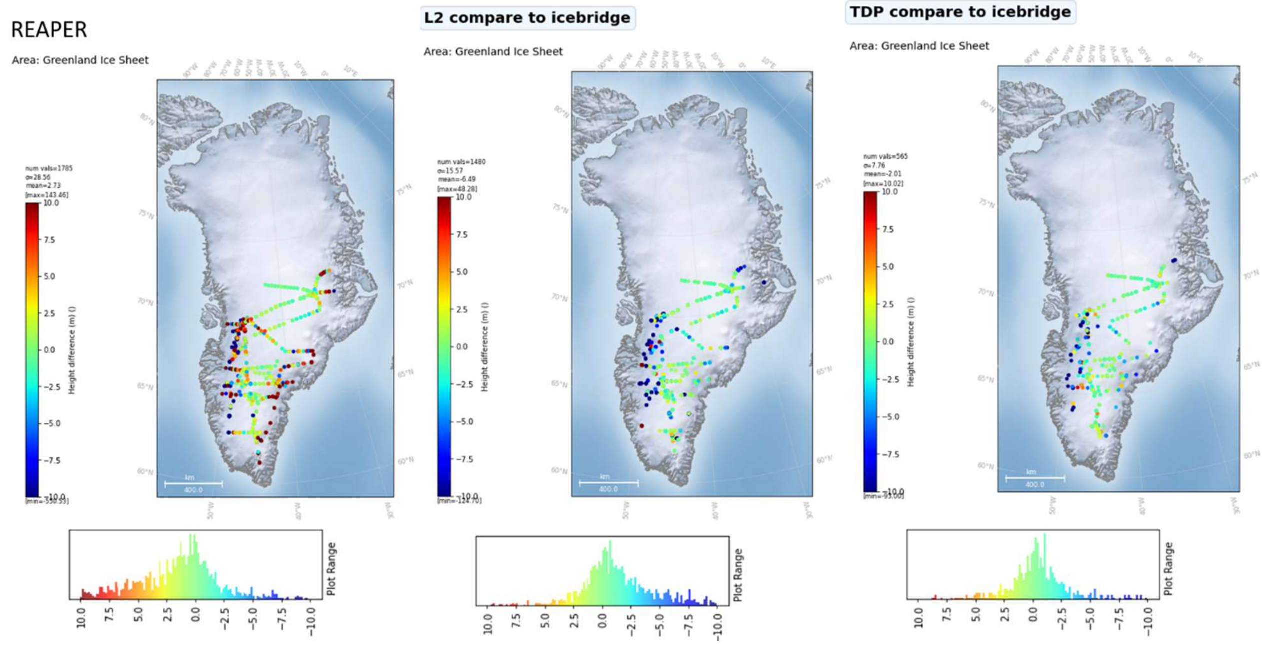

Figure 3-13 : Comparison of elevation differences relative to airborne reference data of REAPER product (left), the FDR4ALT L2 product (centre) and the FDR4ALT TDP product (right).

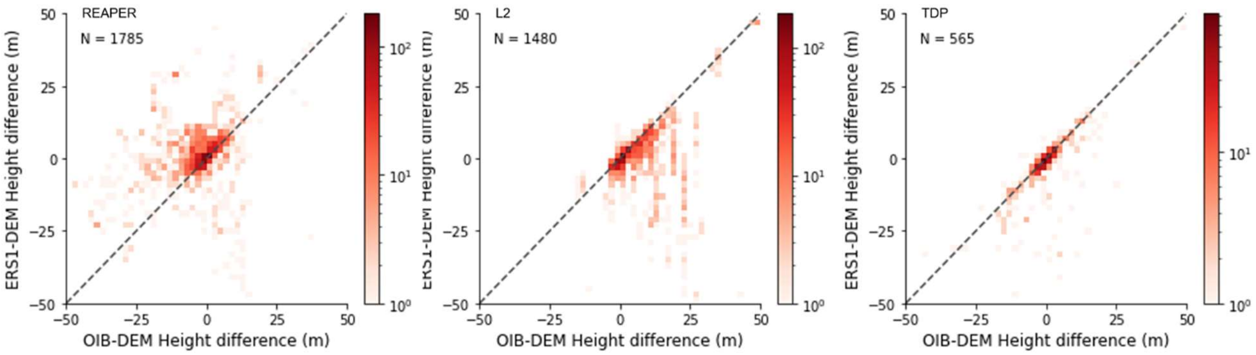

Figure 3-14: Differences relative to airborne reference data of the REAPER product (left), the FDR4ALT L2 product (centre) and the FDR4ALT TDP product (right). In all cases, an auxiliary Digital Elevation Model has been used to remove the large-scale elevation signal.

ERS-1				
	unit	GDRv3	L2	TDP
Mean absolute height difference	m	10.3	8.29	3.49
Mean height difference	m	2.72	-6.49	-2.01
Median of absolute deviation of height difference	m	3.00	2.49	1.37
Median height difference	m	1.55	-1.64	-0.43
Number of comparisons	-	1785	1480	565

Table 3 : Accuracy statistics for ERS-1 based upon comparisons to co-located airborne reference data.

Internal Stability

The along-track assessment of standard deviation was performed for the ERS-1 dataset whilst in its 35-day repeat orbit. During this orbit the reference tracks are most similar to the other Land Ice TDP datasets from ERS-2 and ENVISAT, enabling a consistent approach across the three satellite missions. Again, in comparison to the L2 product, the TDP achieves a much lower standard deviation for both Greenland and Antarctica, indicative of a more stable product due to the reduction in topographic noise.

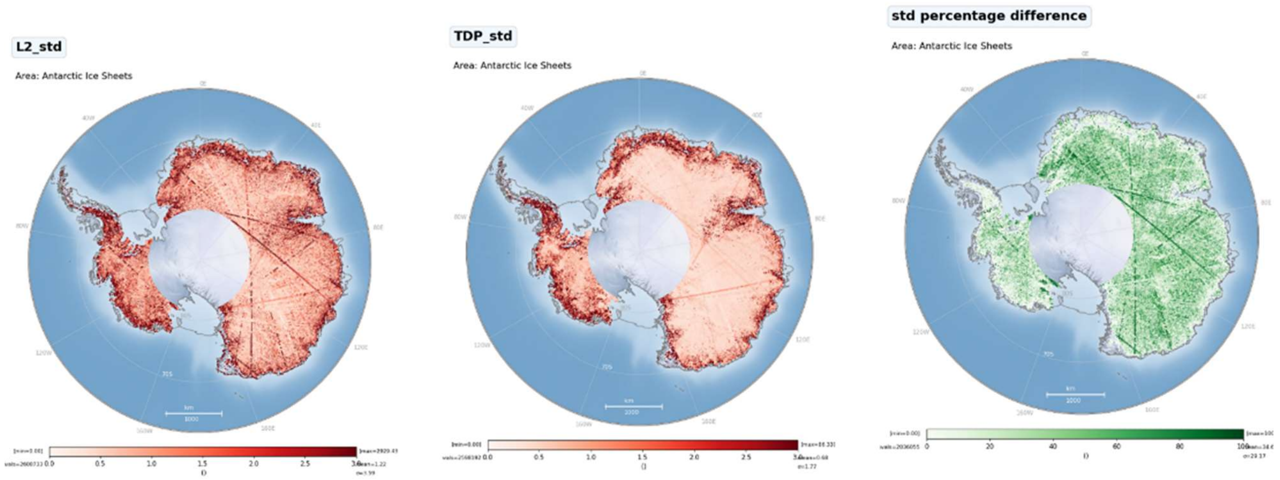

Figure 3-15: Assessment of the internal stability of the ERS-1 Land Ice TDP for tracks over the Antarctic Ice Sheet showing the standard deviation for the Level-2 product (left), the TDP product (center) and the percentage improvement of standard deviation along each track (right).

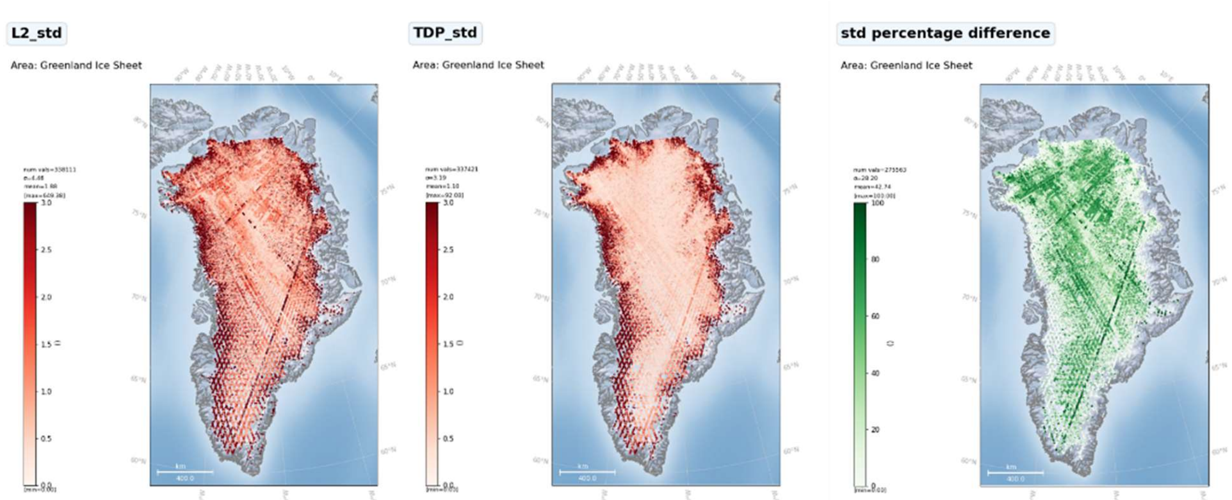

Figure 3-16: Assessment of the internal stability of the ERS-1 Land Ice TDP for tracks over the Greenland Ice Sheet showing the standard deviation for the Level-2 product (left), the TDP product (center) and the percentage improvement of standard deviation along each track (right).

Similarly, the continent-wide distributions of standard deviations shown in Figure 3-17 demonstrate a reduction in topographic noise for ERS-1 for the TDP product compared to the L2 product.

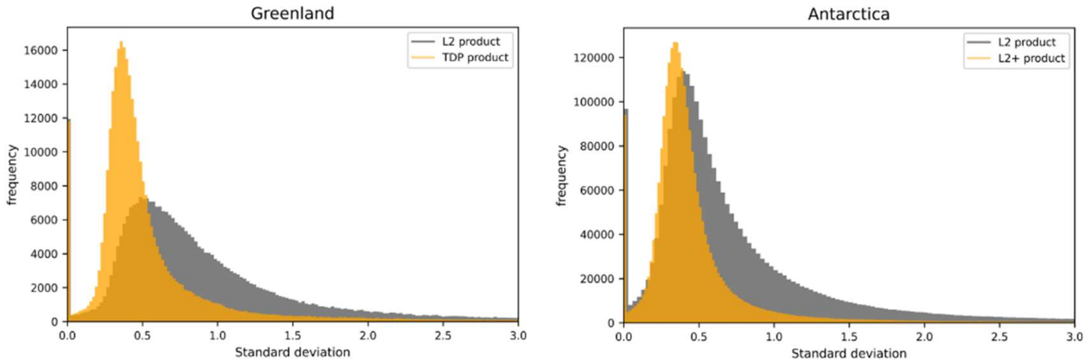

Figure 3-17: The distribution of standard deviation for all tracks for the Level-2 product (grey) and the TDP product (orange) for both Greenland (left) and Antarctica (right).

3.5 Conclusions

A comprehensive validation of both the FDR4ALT Level 2 product and the ensuing Land Ice TDP was performed, in order to assess their accuracy relative to airborne reference measurements and their stability through time. The validation undertaken on the TDP Land Ice product confirms the TDP has significantly improved both the internal stability and the absolute accuracy compared to the pre-existing and FDR4ALT L2 products. The absolute accuracy has improved for several reasons: for the evolutions in Level-2 processing, with the application of a more advanced relocation approach to correctly identify the location of the surface reflection, and for the enhanced quality control of the data, with static DEM's used to remove poor quality records from the datasets. Finally, there is also a reduction in the measurements over high sloping terrain, due to the fact that more than one L2 POCA measurement may be migrated onto a single reference node. The internal stability of the Land Ice TDP has improved by reducing the topographic noise compared to the L2 product. We see this in both the continent-wide assessment of standard deviation mapped over both ice sheets and in the corresponding histograms for all satellite missions.

Appendix A - FDR4ALT deliverables

The table below lists all FDR4ALT deliverables with their respective ID number and confidentiality level.

Document	ID	Confidentiality Level
Products Requirements & Format Specifications Document	[D-1-01] [D-2-02]	Public
Roadmap & Product Summary Document	[D-1-02]	Project Internal
Data Requirements Document	[D-1-03]	Project Internal
System Maturity Matrix	[D-1-04]	Project Internal
Examples of products	[D-1-05]	Project Internal
Review Procedure Document	[D-1-06]	Project Internal
Review Data Package	[D-1-07]	Project Internal
Phase 1 Review Report Document	[D-1-08]	Project Internal
Detailed Processing Model Document	[D-2-01]	Public
Round Robin Assessment Report Document	[D-2-03]	Public
Data Production Status Report	[D-3-01]	Project Internal
Final Output Dataset	[D-3-01]	Public
Product Validation Plan	[D-4-01]	Project Internal
Product Validation Report : FDR	[D-4-02a]	Public
Product Validation Report : Sea-Ice TDP	[D-4-02b]	Public
Product Validation Report: Land-Ice TDP	[D-4-02c]	Public
Product Validation Report : Ocean Waves TDP	[D-4-02d]	Public
Product Validation Report : Ocean & Coastal TDP	[D-4-02e]	Public
Product Validation Report: Inland Waters TDP	[D-4-02f]	Public
Product Validation Report: Atmosphere TDP	[D-4-02g]	Public
Uncertainty Characterization Definition Document	[D-5-01]	Project Internal
Uncertainty Characterization Report	[D-5-02]	Public
Product User Guide	[D-5-03]	Public
Completeness Report ALT	[D-7-01]	Public
Completeness Report MWR	[D-7-02]	Public

Table 4 : List of FDR4ALT deliverables

Appendix B - Acronyms

AATSR	Advanced Along-Track Scanning Radiometer
AEM	Airborne electromagnetic
AIR	AIRWAVES2
AVISO	Archivage, Validation et Interprétation des données des Satellites Océanographiques
AMSR-E	Advanced Microwave Scanning Radiometer - Earth Observing System sensor
AMSU-A	Advanced Microwave Sounding Unit-A
ALT	Altimetry
ASSIST	Arctic Shipborne Sea Ice Standardization Too
ATM	Airborne Topographic Mapper
BDHI	Base de datos Hidrologica integrada
BGEP	Beaufort Gyre Exploration Project
CAL	Calibration
CCI	Climate Change Initiative
CFOSAT	Chinese-French Oceanic SATellite
CDS	Copernicus Data Service
CLS	Collecte Localisation Satellite
CMEMS	Copernicus Marine Environment Monitoring Service
CMSAF	Climate Monitoring Satellite Application Facility
CNES	Centre National des Etudes Spatiales
CRREL	Cold Regions Research and Engineering Laboratory
DAHITI	Database for Hydrological Time Series of Inland Waters
DGA	Direccion General de Aguas
ENVISAT	ENVIronment SATellite
EMD	Empirical mode decomposition
EO	Earth Observation
EPS	European Polar System
ERA	ECMWF Re-Analysis
ERS	European Remote-Sensing Satellite
ESA	European Space Agency
ESTEC	European Space Research and Technology Centre
FCDR	Fundamental Climate Data Record
FDR	Fundamental Data Records
FIDUCEO	Fidelity and uncertainty in climate data records from Earth Observations
FMR	Full Mission Reprocessing
FYI	First Year Ice
GEWEX	Global Energy and Water Exchanges
GFO	Geosat Follow-On
GIEMS	Global Inundation Extent from Multi-Satellites
GMSL	Global Mean Sea Level
GNSS	Global Navigation Satellite System
GPM	Global Precipitation Measurement
GRDC	Global Runoff Data Centre
G-REALM	Global Reservoir And Lake Monitor
G-VAP	GEWEX Water Vapour Assessment
HYBAM	HYdro-géochimie du Bassin AMazonien
ICARE	

IGM	Instituto Geografico Militar
IGN	Instituto Geografico Nacional
IMB	Ice Mass Balance
INA	Instituto Nacional de Agua
ISRO	Indian Space Research Organisation
IRPI	Istituto di Ricerca per la Protezione Idrogeologia
IWMI	International Water Management Institute
LEGOS	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales
LIDAR	Ligth Detection And Ranging
LTAN	Local time of the ascending node
LWP	Liquid Water Path
MAC	Multisensor Advanced Climatology
MEAS-SIM	Measure-Simulation
MQE	Mean Quadratic Error
MSSH	Mean Sea Surface Height
MWR	Microwave Radiometer
NASA	National Aeronautics and Space Administration
NE	North East
NN	Neural Network
NPI	Norwegian Polar institute
NWP	Numerical Weather Prediction
NOAA	National Oceanic and Atmospheric Administration
OIB	Operation Ice Bridge
OLC	Open Loop Calibration
OSTST	Oceanography Surface Topography Science Team
POSTEL	Pôle d'Observation des Surfaces continentales par TELEdétection
PTR	Point Target Response
RD	Reference Document
REAPER	Reprocessing of Altimeter Products for ERS
RM	Review Meeting
RSS	Remote Sensing System
SALP	Service d'Altimétrie et de Localisation Précise
SARAL	Satellite with Argos and Altika
SLA	Sea Level Anomaly
SCICEX	Submarine Arctic Science Program
SGDR	Sensor Geophysical Data Record
SHOA	Servicio Hidrografico y Oceanografico de la Armada
SSB	Sea State Bias
SSH	Sea Surface Height
SSM/I	Special sensor microwave/imager
SST	Sea Surface Temperature
SWH	Significant Wave Height
SWIM	Surface Waves Investigation and Monitoring instrument
TAC	Thematic Assembly Center
TB	Température de Brillance (Brightness Temperature)
TDP	Thematic Data Products
TDS	Test Data Set
TFMRA	Threshold First-Maximum Retracker Algorithm
TMR	Topex Microwave Radiometer
TP	Topex/Poseidon

TCWV	Total column water vapour
VCC	Vicarious calibration
VS	Virtual Station
ULS	Upward Looking Sonar
USA	United States of America
USDA	United States Department of Agriculture
WHALES	Wave Height Adaptive Leading Edge Subwaveform
WTC	Wet Tropospheric Correction