# CryoTop Evolution: Data User Manual

## 1 Table of contents



## 2 Change log

| Version | Date | Description |
|---|---|---|
| **1.0** | 19-02-2018 | First public version |

## 3 Purpose

This document details product formats provided by the CryoTop Evolution ESA project

## 4 Swath elevations

Swath elevations are produced by applying a swath processing algorithm [RD1] to L1b CryoSat SARIn mode products available at: ftp://science-pds.cryosat.esa.int.

### 4.1 Data citations

Users of this data should cite the following in any publication that uses these data:
N. Gourmelen, M.J. Escorihuela, A. Shepherd, A. Muir, L. Foresta, M. Roca, A. Garcia, S. Baker, M.R. Drinkwater. CryoSat-2 swath interferometric altimetry for mapping ice elevation and elevation change. Advances in Space Research, https://doi.org/10.1016/j.asr.2017.11.014

## 4.2 How to get the data

The swath elevation products (are) available from the UK Polar Data Centre:

https://data.bas.ac.uk/full-record.php?id=GB/NERC/BAS/PDC/01068

### 4.2.1 The data files

The file naming convention follows ESA convention using 2S to denote L2 swath format, e.g.: CS_LTA__SIR_SIN_2S_20110102T073142_20110102T073303_C001.nc
The data are stored in a netcdf file with the following fields:

| Field Description | Netcdf field names | Units |
|---|---|---|
| **Latitude** | lat | Degrees North |
| **Longitude** | lon | Degrees East (between 0 and 360 degrees) |
| **Elevation** | elev | Meters above the reference ellipsoid |
| **Power** | powerdB | dB |
| **Coherence** | coh | |
| **Sample Number** | sampleNb | In the original CryoSat-2 waveform |
| **Waveform number** | wf_number | In the input L1b file |

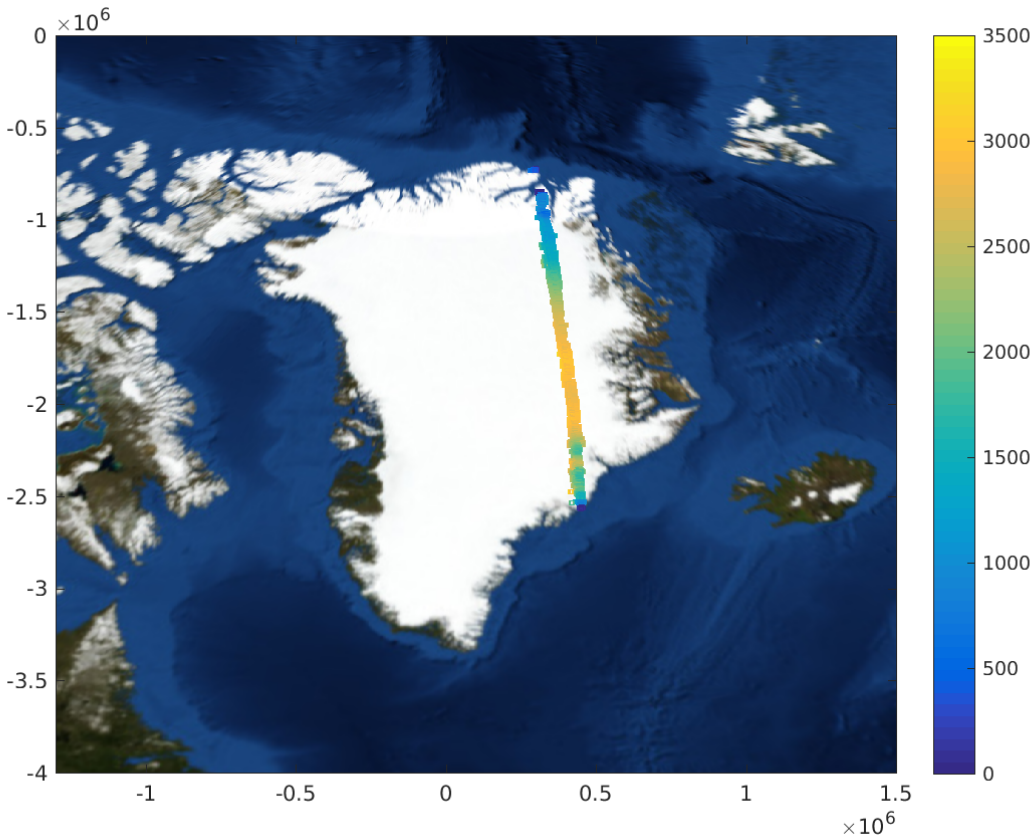


**Figure 1: Example of swath elevation (m above WGS84 ellipsoid) over the Greenland Ice Sheet. This data correspond to the file: CS_LTA__SIR_SIN_2S_20110318T033128_20110318T033631_C001.nc**

### 4.2.2 How to read the data files

Netcdf is a popular format, and examples of how to read the file with python or matlab are provided here:

- https://uk.mathworks.com/help/matlab/ref/ncread.html
- http://unidata.github.io/netcdf4-python/

### 4.2.3 Data quality

This is an experimental dataset, we attempted to provide as many data point as possible to let the user extract as much information as possible and explore the best set of quality criteria and thresholds to apply – this means that not all records provided are a good estimate of surface elevation. Record with e.g. low power and low coherence are likely to provide poor quality estimate of elevation and should be discarded (e.g. fig. 2). In this example, low power records are creating spuriously high surface elevation and should be screened out. The strategy used to create this experimental swath dataset, retains more CryoSat records than the standard swath processing, but can also lead to higher number of unwrapping errors as is usual. Using this dataset to generate precise measure of elevation and elevation change therefore requires applying careful data screening, e.g. described in Gourmelen et al., 2017. This paper also provides more extensive validation.

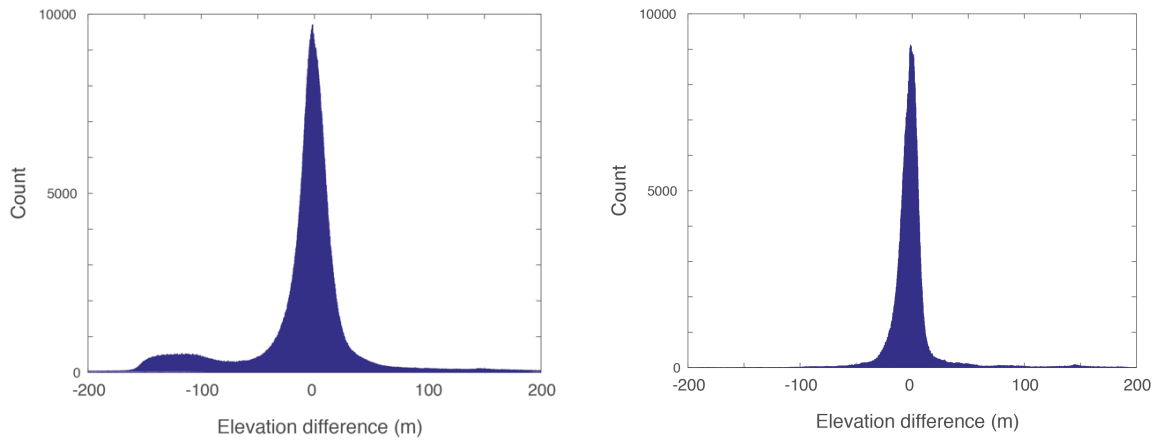


**Figure 2: Elevation difference between swath elevation and ArcticDEM v6, for (left) all the data present in file CS_LTA__SIR_SIN_2S_20110318T033128_20110318T033631_C001.nc, and (right) for data above a coherence of 0.8 and power of -150dB.**

## 5 Gridded product DEM and rate of elevation change

The gridded data are delivered in GeoTIFF format. GeoTIFF files are a TIFF raster image format with added geographic data embedded as tags, allowing precise geo-location of pixels in the image.

### 5.1 Data

Three types of gridded data product are produced:

- Digital elevation model (DEM) of the ice-sheet in m
- Rate of elevation change in $ma^{-1}$
- Error in the rates of surface elevation change in $ma^{-1}$

The methodology to derive the gridded products is described in [RD1 and RD2].

## 5.2 Data citations

When referring to use of these data in a publication or report please cite the following background reference:
N. Gourmelen, M.J. Escorihuela, A. Shepherd, A. Muir, L. Foresta, M. Roca, A. Garcia, S. Baker, M.R. Drinkwater. CryoSat-2 swath interferometric altimetry for mapping ice elevation and elevation change. Advances in Space Research, https://doi.org/10.1016/j.asr.2017.11.014

## 5.3 How to get the data

The gridded products are available from the UK Polar Data Centre:

https://data.bas.ac.uk/full-record.php?id=GB/NERC/BAS/PDC/01068

## 5.4 Projection

For Greenland, the projection is EPSG3413: https://epsg.io/3413
For Antarctica, the projection is EPSG3031: https://epsg.io/3031

## 5.5 Greenland margins

Over the SARIn geographic mask of CryoSat-2 that corresponds to the Greenland margins, the grid has a 500m spacing. The files contain 5824 rows and 7778 columns
File naming: Greenland_500_DEM.tif, Greenland_500_rate.tif and Greenland_500_error.tif and

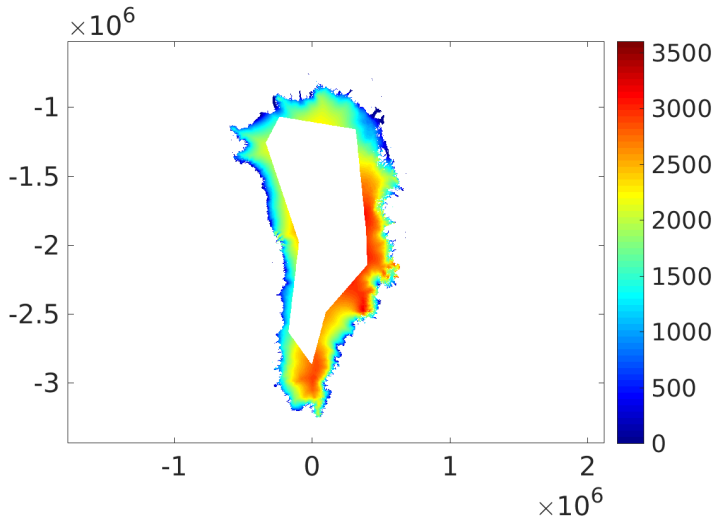


Figure 3: Greenland_500_DEM.tif (m)

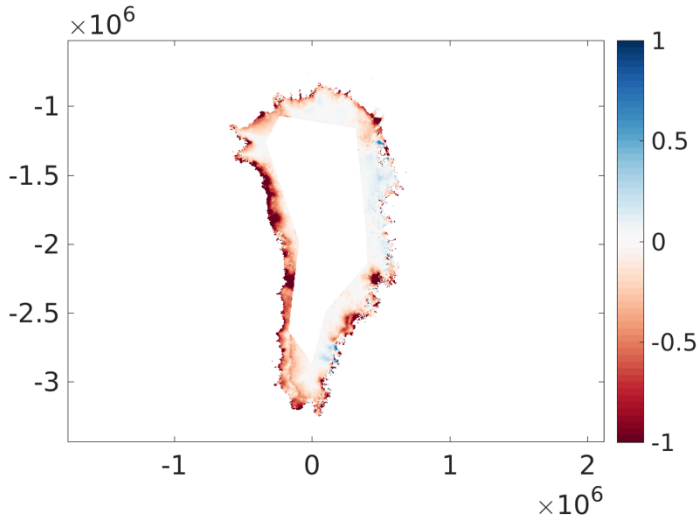


Figure 4 Greenland_500_rate.tif (ma$^{-1}$)

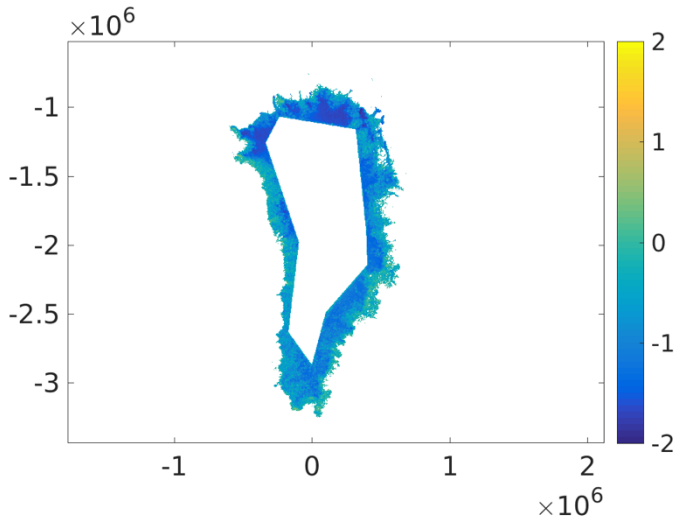


Figure 5 log10(Greenland_500_error.tif) (ma$^{-1}$)

## 5.6 The entire Greenland

The 500m-products are merged over the LRM area with the CPOM product [RD3] with a grid of 1km spacing. The files contain 2912 rows and 3889 columns.
File naming: Greenland_1000_DEM.tif, Greenland_1000_rate.tif and Greeland_1000_error.tif

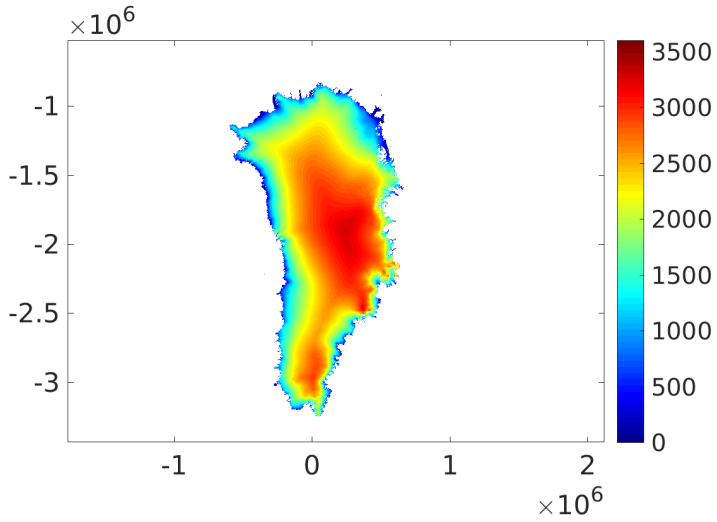


Figure 6 Greenland_1000_DEM.tif (m)

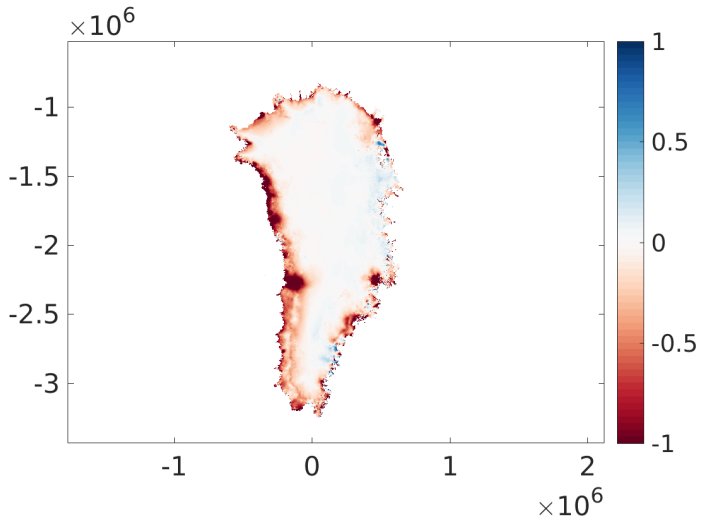


Figure 7 Greenland_1000_rate.tif ($ma^{-1}$)

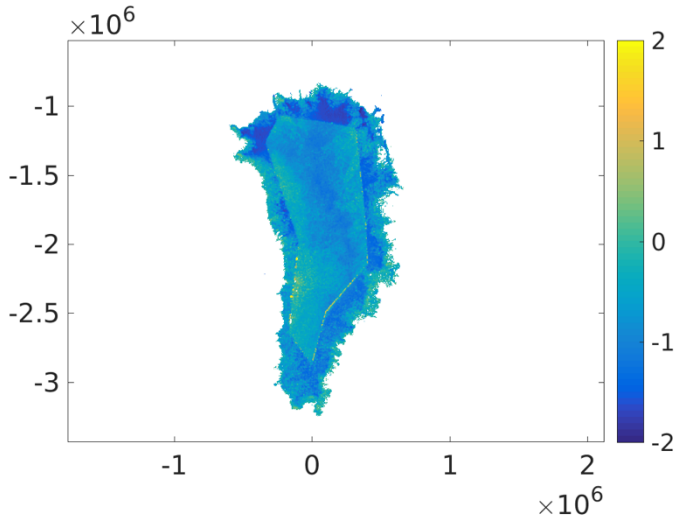


Figure 8 log10(Greenland_1000_error.tif) ($ma^{-1}$)

# 6 References

[RD1] Gourmelen, N., M.J. Escorihuela, A. Shepherd, A. Muir, L. Foresta, M. Roca, A. Garcia, S. Baker, M.R. Drinkwater. CryoSat-2 swath interferometric altimetry for mapping ice elevation and elevation change. Advances in Space Research, https://doi.org/10.1016/j.asr.2017.11.014

[RD2] Foresta, L, Gourmelen, N, Pálsson, F, Nienow, P, Björnsson, H & Shepherd, A 2016, 'Surface Elevation Change and Mass Balance of Icelandic Ice Caps Derived From Swath Mode CryoSat-2 Altimetry' Geophysical Research Letters., 10.1002/2016GL071485

[RD3] McMillan, Malcolm; Leeson, Amber; Shepherd, Andrew; Briggs, Kate; Armitage, Thomas; Hogg, Anna; Kuipers Munneke, P.; van den Broeke, M.R.; Noël, B.P.Y.; van de Berg, W.J.; Ligtenberg, S.R.M.; Horwath, M.; Groh, Andreas; Muir, A.; Gilbert, Lin (2016) Geophysical Research Letters, volume 43, pp. 7002 - 7010