STSE CryoSat+ Mountain Glaciers

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Data User Manual

(DUM)

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1 Introduction

1.1 Purpose and Scope

This document contains the Dataset User Manual (DUM) for the CryoSat+ Mountain Glaciers project (CryoSat+ MtG). The purpose of the document is to describe the datasets made publicly available on the project's website: http://www.cryosat-mtg.org

The dataset is composed of (i) individual elevation measurements of the ice surface, with a time tag, produced from swath processing of CryoSat data, and (ii) gridded products derived from (i). Swath processing is a way to extract high density measurements of elevation from CryoSat SARIn mode, therefore these products are a step further from the conventional L2 'POCA' product available from ESA.

The DUM has been written by UoE. UoE as the project lead and isardSAT as the project manager are the contact points for all communications regarding this document:

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1.2 Acronyms and Abbreviations

DEM	Digital Elevation Model
ESA	European Space Agency
STSE	Support to Science Element
UoE	University of Edinburgh

1.3 Dataset User Manual structure

The document is structured as follows:

- **Section 1** - Describes the purpose of the document
- **Section 2** - Describes the swath elevation products.
- **Section 3** - Describes the gridded products.

2 Swath elevation

The swath elevation products over the Antarctic Peninsula, Patagonia, High Mountain Asia, Russian Arctic, Svalbard, Iceland, Canadian Arctic and the Pacific Coast Range upon reasonable request. Please contact Noel Gourmelen (Science Lead) Email: noel.gourmelen@ed.ac.uk

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

The CryoSat-2 swath elevation files are supplied as binary (float), each file mirroring the content of the L1b files used as input for the swath processing.

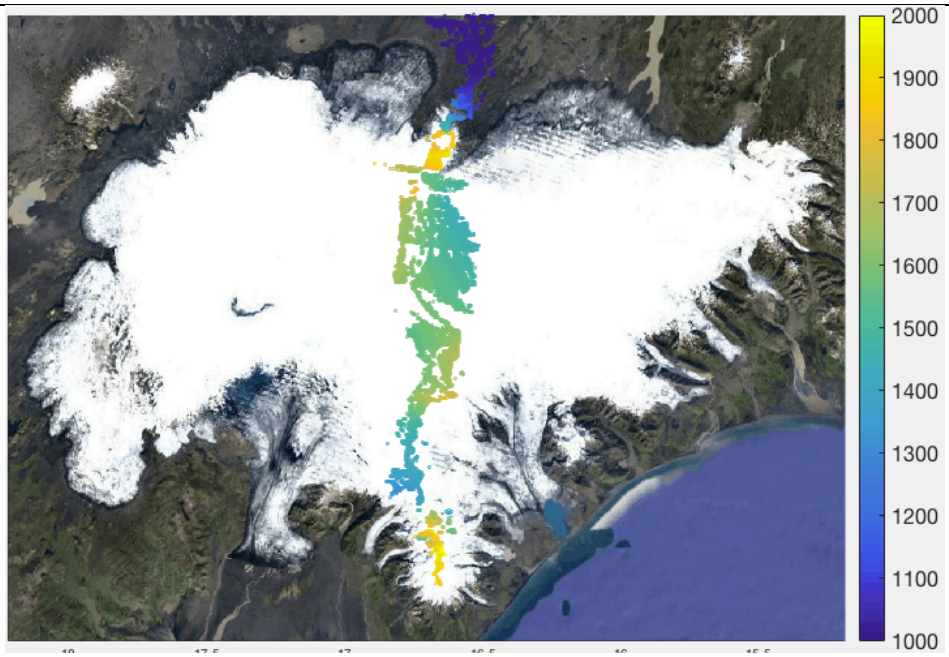

Figure 1: Example of swath elevation (m above WGS84 ellipsoid) over the Vatnajokull Ice Cap, Iceland. This figure corresponds to the file: CS_LTA__SIR_SIN_1B_20110401T013953_20110401T014039_C001.dat

Each files stores information in 7 columns corresponding to:

Column 1: Latitude of the sample on the reference ellipsoid (WGS84)

Column 2: Longitude of the sample on the reference ellipsoid

Column 3: Elevation (in meters) of the sample above the reference Ellipsoid

Column 4: Absolute elevation difference (in meters) from reference DEM

Column 5: Dispersion (Mean Absolute Deviation, in meters) of the elevation difference from reference DEM

Column 6: Sample number in the original CryoSat-2 waveform

Column 7: Waveform number on the original L1b file

An example file is displayed in Figure 1. The naming convention of the files corresponds to the naming convention of the L1b files used to generate the swath elevation. The methodology to generate the swath elevation is described in Foresta et al. (2016).

3 Gridded products

Gridded products derived from the CryoSat-2 swath elevation will be made available upon publication here: http://www.cryosat-mtg.org/datasets/

Due to differences in the methodology between regions with very complex terrain (High Mountain Asia and Pacific Coast Range) and the other regions (Patagonia, Russian Arctic, Svalbard, Iceland and Canadian Arctic) the datasets are presented in different formats.

3.1 Patagonia, Russian Arctic, Svalbard, Iceland and Canadian Arctic

The methodology to derive the gridded products for these regions is described in the publication by Foresta et al. (2016), Foresta et al. (2018) and Tepes et al. (2020).

Three gridded products are available, in geotiff format:

a. A digital elevation model:

http://www.cryosat-mtg.org/wp-content/uploads/2015/05/topo_T734412_T736238_500m__500m_.tif

This product has a 500m posting and corresponds to the surface elevation, in m above the reference Ellipsoid (WGS84), and corresponds to the elevation of the ice cap in July 2010.

b. Rates of surface elevation change:

http://www.cryosat-mtg.org/wp-content/uploads/2015/05/dhdt_T734412_T736238_500m__500m_1.tif

This product has a 500m posting and corresponds to the linear rates of surface elevation change, in m d^{-1}, between 10/2010 and 09/2015.

c. Error in the rates of surface elevation change:

http://www.cryosat-mtg.org/wp-content/uploads/2015/05/error_T734412_T736238_500m__500m_1.tif

This product has a 500m posting and corresponds to the uncertainties in the linear rate of surface elevation change, in m d^{-1}, between 10/2010 and 09/2015.

Product	Spatial resolution	Unit
Digital Elevation Model	500 m by 500 m	m
Rates of surface elevation change		m a^{-1}
Uncertainties in the Rates of surface elevation change		m a^{-1}

3.2 High Mountain Asia and Pacific Coast Range

The methodology to derive the gridded products for these regions is described in the publication by Jakob and Gourmelen (2020).

The data is provided in a different format than the other regions (vector format as opposed to raster format) since the spatial units are larger and it's not a regular grid. The products are provided in Shapefile (.shp) format (one file per region), with a spatial resolution of 100km x 100km. The point geometries in the shapefile are located in the center of the 100km x 100km grid cells.

Geographic projection:

- **High Mountain Asia:** +proj=aea +lat_1=25 +lat_2=47 +lat_0=36 +lon_0=85 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs=True +wktext=True
- **Pacific Coast Range:** +proj=stere +lat_0=90 +lat_ts=70 +lon_0=-45 +k=1 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs=True +wktext=True

Product time period:

- **High Mountain Asia:** August 2010 - April 2019

- **Pacific Coast Range:** August 2010 - April 2019

Product dataset attributes:

Column	Unit	Description
minX	Region projection	Minimum X-coordinate of the spatial unit
minY	Region projection	Minimum Y-coordinate of the spatial unit
maxX	Region projection	Maximum X-coordinate of the spatial unit
maxY	Region projection	Maximum X-coordinate of the spatial unit
area	km^2	The glacierized area within the spatial unit based on the Randolph Glacier Inventory (RGI 6.0) glacier masks
dhdt	$m\ yr^{-1}$	Rates of glacier surface elevation change
error	$m\ yr^{-1}$	Uncertainties in the rates of elevation change

4 References

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

Foresta, L, Gourmelen, N, Weissgerber, F, Nienow, P, Williams, J, Shepherd, A, Drinkwater, MR & Plummer, S 2018, 'Heterogeneous and rapid ice loss over the Patagonian Ice Fields revealed by CryoSat-2 swath radar altimetry', Remote Sensing of Environment. https://doi.org/10.1016/j.rse.2018.03.041

Tepes, Gourmelen et al., 2020, Surface and dynamic mass balance of the Arctic ice caps and glaciers, [Manuscript submitted to Remote Sensing of the Environment]

Jakob, L, Gourmelen, N, Ewart, M, Plummer, S, 2020, 'Ice loss in High Mountain Asia and the Gulf of Alaska observed by CryoSat-2 swath altimetry between 2010 and 2019', [Manuscript submitted to The Cryosphere]