



TanDEM-X PolarDEM Product Description

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DOCUMENT PREPARATION

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DOCUMENT CHANGE CONTROL

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Issue	Date	Chapter	Changes
1.3	03.07.2020	all	Initial version
1.4	30.11.2020	all	Minor updates in all chapters Change of stereographic projection for Antarctica and the Arctic to EPSG:3031 and EPSG:3413

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1 Introduction

This document describes the specifications and format of the TanDEM-X PolarDEM. The base for this product is the global TanDEM-X DEM provided by the TanDEM-X mission as described in the TanDEM-X DEM Specification document [1]. The latter represents an unedited surface model that still contains noisy, random or void DEM values and a compilation of several acquisition campaigns performed at different times. Usually, the consideration of such multiple acquisitions increases the accuracy of the resulting DEM. For polar regions the state for a single year might be of interest, too.

The TanDEM-X PolarDEM is the framework for the provision of derivatives of the global DEM of the TanDEM-X mission for polar regions. These derivatives include edited DEM products, single year coverages and penetration bias corrected DEMs. The TanDEM-X PolarDEM was generated by the German Remote Sensing Data Center at the German Aerospace Center (DLR) within the activities of the TanDEM-X mission.

2 References

	Document ID	Document Title	Issue
[1]	TD-GS-PS-0021	"TanDEM-X Ground Segment – DEM Products Specification Document", EOC, DLR, Oberpfaffenhofen, Germany, Public Document TD-GS-PS-0021, Issue 3.2, 2018. [Online]. Available: https://tandemx-science.dlr.de/	Issue 3.2, 2018
[2]	Wessel et al., 2020	Wessel, B., Huber, M., Wohlfart, C., Bertram, A., Marschalk, U., Abdullahi, S., Georg, I., Roth, A.: TanDEM-X Polar DEM 90m of Antarctica: Generation and Error Characterization of a filled and edited DEM, <i>The Cryosphere</i> , in preparation	2020
[3]	Gruber et al., 2016	Gruber, Astrid und Wessel, Birgit und Martone, Michele und Roth, Achim (2016) The TanDEM-X DEM mosaicking: Fusion of multiple acquisitions using InSAR quality parameters. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 9 (3), Seiten 1047-1057. IEEE - Institute of Electrical and Electronics Engineers. DOI: 10.1109/JSTARS.2015.2421879 ISSN 1939-1404	2016
[4]	Huber et al., 2015	Huber, M., Wessel, B., Wendleder, A., Hoffmann, J., Roth, A.: A Framework for an Automatical Editing of TanDEM-X Digital Elevation Models. Proceedings of IGARSS 2015, 26-31 July 2015, Milan, Italy, pp. 3826-3829, DOI: 10.1109/IGARSS.2015.7326658 , 2015.	2015
[5]	TDM90	https://geoservice.dlr.de/web/dataguide/tdm90/	accessed on 30.03.2020
[6]	Wessel et al., 2016	Wessel, B., Bertram, A., Gruber, A., Bemm, S., and Dech, S.: A new high-resolution elevation model of Greenland derived from TanDEM-X, ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., III-7, 9–16, https://doi.org/10.5194/isprs-annals-III-7-9-2016 , 2016.	2016
[7]	Abdulahi et al., 2019	Abdullahi, Sahra und Wessel, Birgit und Huber, Martin und Wendleder, Anna und Roth, Achim und Kuenzer, Claudia (2019) Estimating penetration-related X-band InSAR elevation bias - A study over the Greenland ice sheet. Remote Sensing, 11 (24), pp. 1-19. Multidisciplinary Digital Publishing Institute (MDPI). DOI: 10.3390/rs11242903 ISSN 2072-4292	2019
[8]	Wohlfart et al., 2018	C. Wohlfart et al., "Tandem-X DEM Derived Elevation Changes of the Greenland Ice Sheet," <i>IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium</i> , Valencia, 2018, pp. 8511-8514.	2018

4 TanDEM-X PolarDEM Products

The TanDEM-X PolarDEM products are mainly based on the global TanDEM-X DEM. The goal was to produce a gap-free version with edited water bodies for the direct use in scientific applications. To further ease applications the TanDEM-X PolarDEM 90m has a 90 m spacing in polar stereographic projections. The DEM elevation values represent the ellipsoidal heights relative to the WGS84 ellipsoid in the WGS84-G1150 datum.

The production steps comprised the following steps

- Gaps in the global TanDEM-X DEM are filled using additional TanDEM-X acquisitions where possible.
- The editing process comprises a smoothing of noisy areas, the removal of voids and a replacement of frozen and partially open sea-ice areas with geoidal undulations. A semi-automatic approach for coastline delineation was developed and applied to identify the water areas and assign homogeneous height values.
- The editing and gap filling was applied to the TanDEM-X DEM products in their original spacing in geographic coordinates. The TanDEM-X PolarDEM is finally transformed into a polar stereographic projection with a homogeneous metric spacing in northing and easting. At the same time the resolution is reduced to 90 meters.

More details of the product generation, validation and quality measures are provided in [2] and [3]. [4] describes the editing strategy.

4.1 TanDEM-X PolarDEM 90m of Antarctica

The TanDEM-X PolarDEM 90m of Antarctica comprises a DEM wherein all land masses below 60° South latitude are covered.

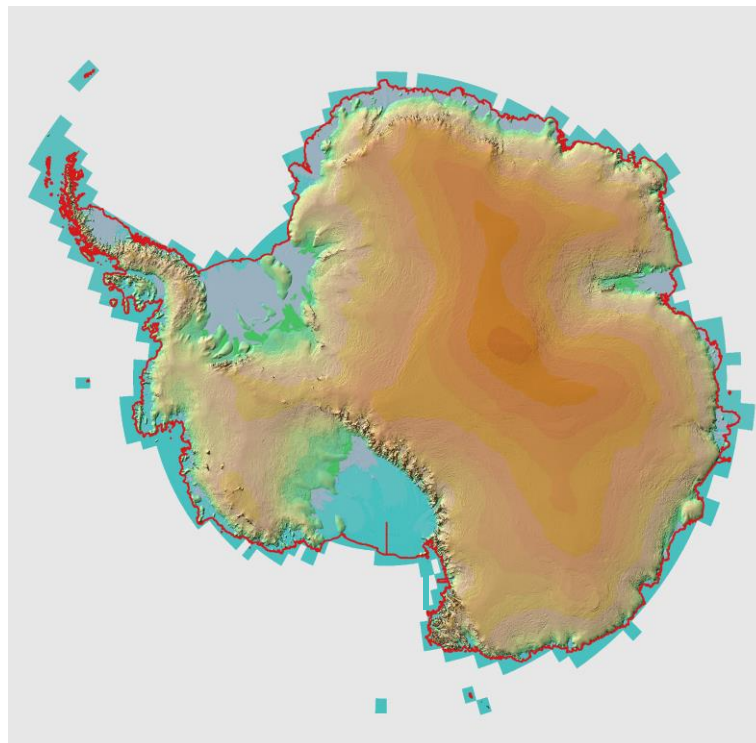


Fig. 1: Color shaded version of TanDEM-X PolarDEM 90m of Antarctica with overlaid coastline (red)

Product overview and format

The TanDEM-X PolarDEM 90m of Antarctica product comprises one layer of information:

- DEM raster layer

The product is provided in GeoTIFF format as compressed ZIP files.

File naming convention

The prefix string in the file base name has the general form:

TDM_PolarDEM_90m_Antarctica_part<n> with $n = 1,2,3,4$

The attribution of the part numbering can be seen in Figure 2.

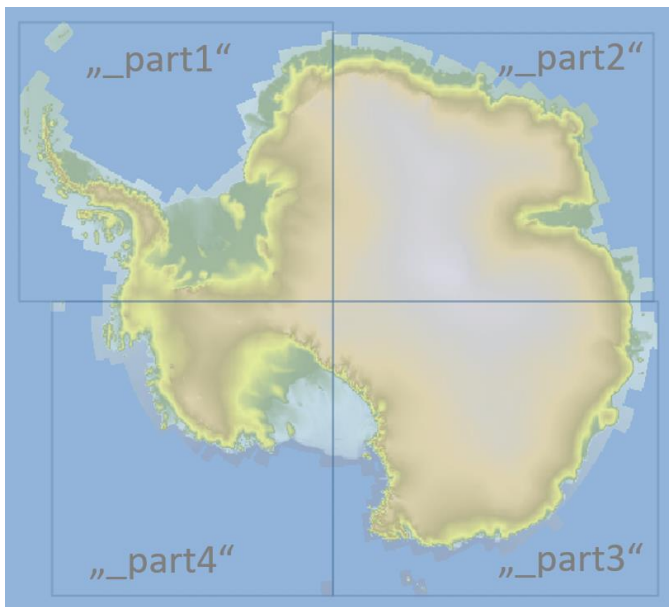


Fig. 2: TanDEM-X PolarDEM 90m of Antarctica is provided in four parts

Product extent

All land masses below 60° South latitude are covered.

Further information files

Further information like amplitude or height error raster layers, acquisition can be extracted from the TDM90 product [5].

The following product parameter are applicable:

TanDEM-X PolarDEM 90m of Antarctica	
Parameter	Value
Projection	Antarctic Polar Stereographic
EPSG	3031
Datum	WGS84-G1150
Height reference	ellipsoidal heights
Coverage	all land masses below 60° South in 4 tiles
DEM dataset size	~ 12 GB
Grid spacing	90 m
Elevation unit	meters
Acquisition dates	April 2013 to October 2014 for gap filling July 2016 to September 2017
Data format	4-byte floating point format
No data value	-32767.0
License	User License for the Utilization of the TanDEM-X PolarDEM 90m Data Products for Scientific Use
Available for download	https://download.geoservice.dlr.de/TDM_POLARDEM90/ANTARCTICA

4.2 TanDEM-X PolarDEM 90m of the Arctic

4.2.1 Greenland

The TanDEM-X PolarDEM 90m of Greenland (Fig. 3) comprises the edited and gap-filled TanDEM-X DEM in a 90 m spacing in northing and easting and is provided in Arctic Polar Stereographic projection. More details of the product generation, validation and quality measures are provided in [3] and [6]. [4] describes the editing strategy.

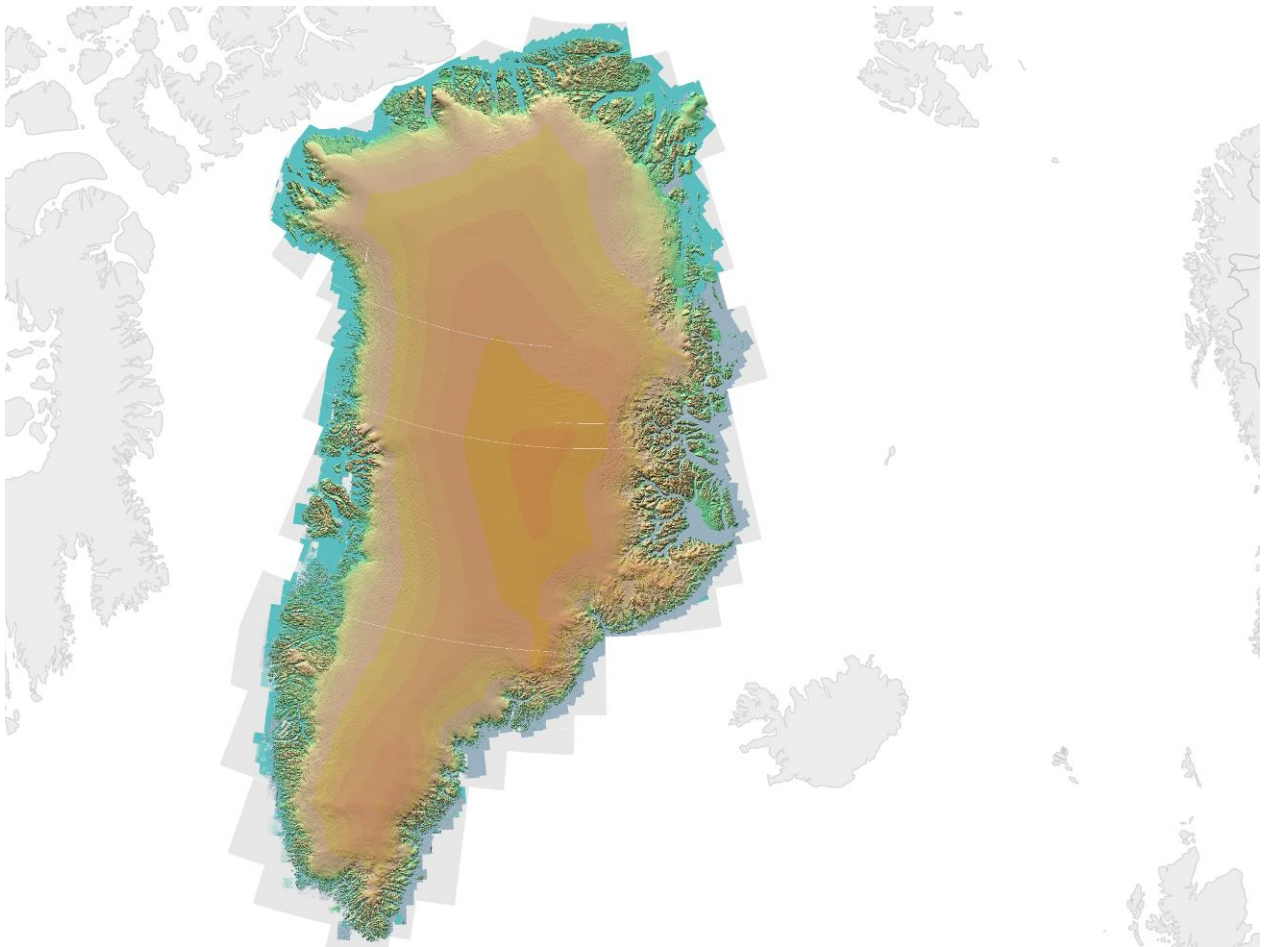


Fig. 3: Color shaded version of TanDEM-X PolarDEM 90m of Greenland

The following product parameter are applicable:

TanDEM-X PolarDEM 90m of Greenland	
Parameter	Value
Projection	Arctic Polar Stereographic
EPSG	3413
Datum	WGS84-G1150
Height reference	ellipsoidal heights
Coverage	59° to 84° North 13° to 74° West in one tile
DEM dataset size	~ 3 GB
Grid spacing	90 m
Elevation unit	meters
Period of Acquisition	December 2010 to July 2014 for gap filling October 2015 to February 2016
Data format	4-byte floating point format
No data value	-32767.0
License	User License for the Utilization of the TanDEM-X PolarDEM 90m Data Products for Scientific Use
Available for download	https://geoservice.dlr.de/web/

4.2.2 Iceland

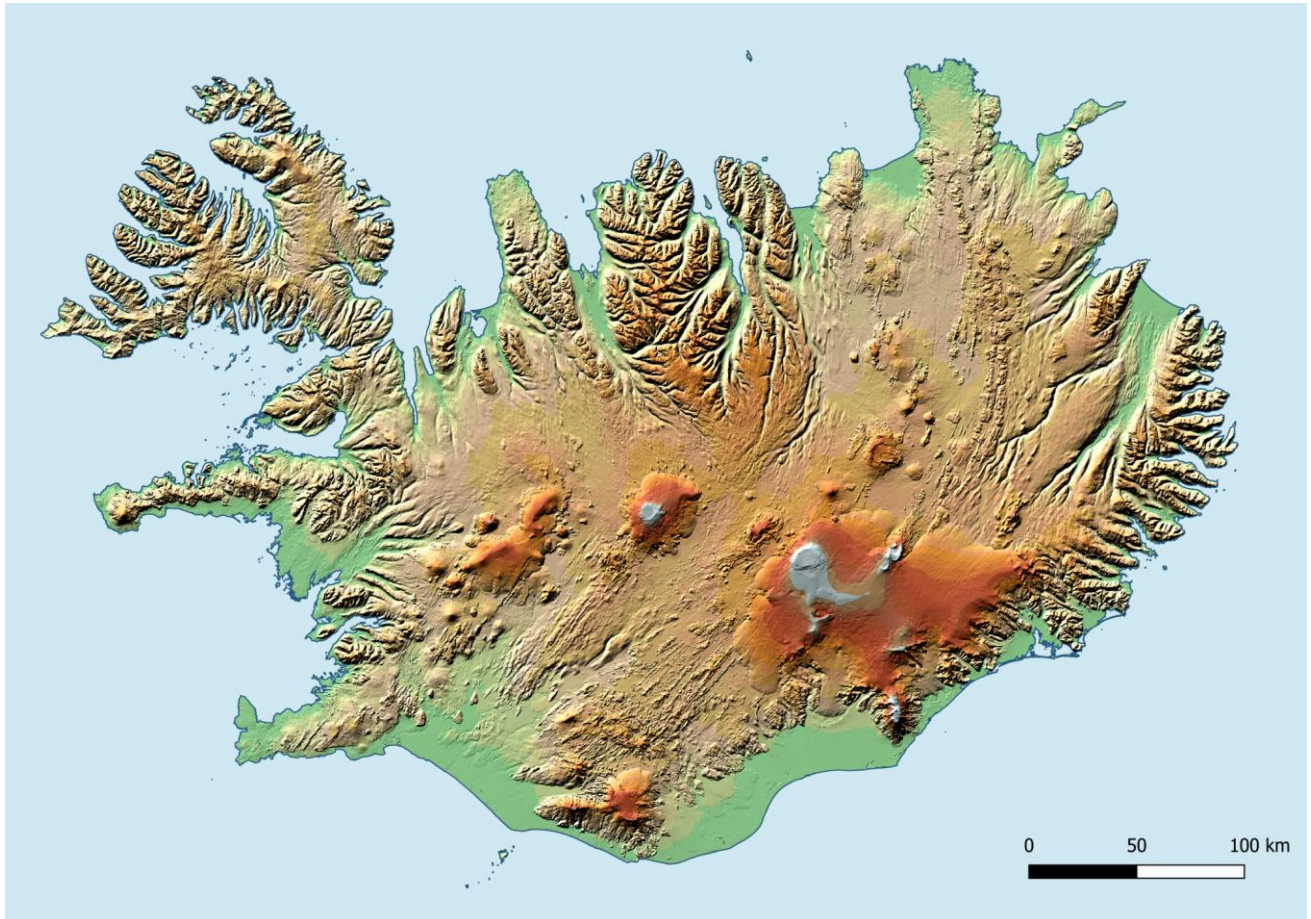


Fig. 4: Color shaded version of TanDEM-X PolarDEM 90m of Iceland

The TanDEM-X PolarDEM 90m of Iceland (Fig. 4) has a 90 m spacing in northing and easting and is provided in Arctic Polar Stereographic projection. More details of the product generation, validation and quality measures are provided in [3]. [4] describes the editing strategy.

The following product parameter are applicable:

TanDEM-X PolarDEM 90m of Iceland	
Parameter	Value
Projection	Arctic Polar Stereographic
EPSG	3413
Datum	WGS84-G1150
Height reference	ellipsoidal heights
Coverage	63° to 67° North 13° to 25° West in one tile
DEM dataset size	~ 0.25 GB
Grid spacing	90 m
DEM unit	meters
Period of Acquisition	January 2011 to March 2014
Data format	4-byte floating point format
No data value	-32767.0
License	User License for the Utilization of the TanDEM-X-PolarDEM-90m Data Products for Scientific Use
Available for download	https://geoservice.dlr.de/web/

4.3 Time-Tagged TanDEM-X PolarDEM 90m

The global DEM of the TanDEM-X mission is a compilation of several acquisition campaigns performed at different years and with different imaging conditions [4]. Usually, the consideration of such multiple acquisitions increases the accuracy of the resulting DEM. An average height resulting from different acquisitions describes well the topography in general, but does not reflect the real situation of any of the shape of a glacier or an ice shield of a specific acquisition dates. The use of such a DEM e.g. for ice mass balances is limited.

Moreover, SAR signals are usually not reflected directly on the surface of a glacier. They penetrate into the snow and ice surface which leads to a bias in the measured height. The penetration depth is dependent on the radar frequency, the imaging conditions like incidence angle and interferometric baseline length, and the physical and dielectric characteristics of the snow and ice layer [7].

4.3.1 Greenland (to be released)

Greenland was mapped in several years during the winter season. The purpose of the time-tagged TanDEM-X PolarDEM 90m of Greenland (Fig. 4) is to provide the state for a single winter season to broaden the applicability of the elevation models. The calibration and mosaicking is performed in the original product spacing in geographic coordinates. The Time Tagged TanDEM-X PolarDEM 90m is finally transformed into Arctic Polar Stereographic projection with a homogeneous metric spacing of 90 meters in northing and easting. An editing process is not applied. More details of the product generation, validation and quality measures are provided in [8].

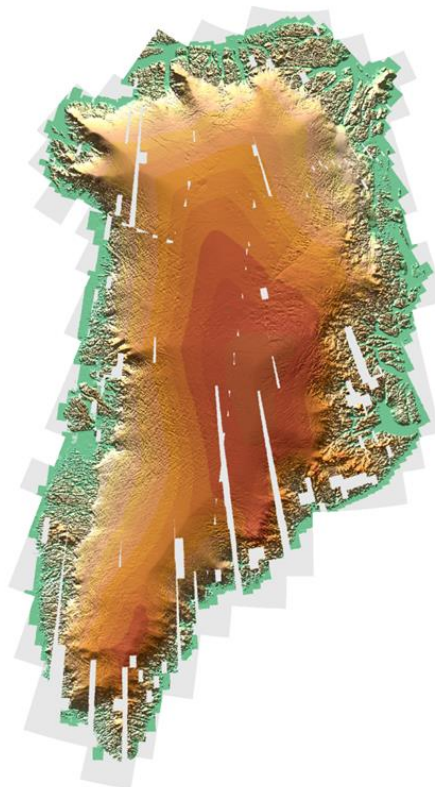


Fig. 5: Color shaded version of time-tagged TanDEM-X PolarDEM 90m of Greenland (coverage 2010/2011)

The following product parameter are applicable:

Time-Tagged TanDEM-X PolarDEM 90m of Greenland	
Parameter	Value
Projection	Arctic Polar Stereographic
EPSG	3995
Datum	WGS84-G1150
Height reference	ellipsoidal heights
Coverage	59° to 84° North 13° to 74° West in one tile
DEM dataset size	~ 3 GB
Grid spacing	90 m
Elevation unit	meters
Acquisition dates	
Winter 2010 / 2011	October 2010 to May 2011
Winter 2016 / 2017	November 2016 to May 2017
Data format	4-byte floating point format
No data value	-32767.0
License	User License for the Utilization of the TanDEM-X-PolarDEM-90m Data Products for Scientific Use
Available for download	https://geoservice.dlr.de/web/