Product documentation:
Land cover prototype II – vegetation height

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Code: DUE-GlobPermafrost
Organisation: Central Institute for Meteorology and Geodynamics
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Consortium:

Signatures

	Name	Organisation	Signature
Edited by	Annett Bartsch	ZAMG	
Contributions from	Barbara Widhalm (ZAMG), Georg Pointner (b.geos)		

Distribution

Version	People and/or Organisation	Publicly available on website
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Change Log

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1. Product overview

1.1. General

The GlobPermafrost project developed, validated and implemented Earth Observation (EO) products to support research communities and international organisations in their work on better understanding permafrost.

Land cover serves as a base dataset for upscaling of ecosystem characteristics in permafrost regions. With respect to user requirements (including permafrost modelling, hydrology, and soil carbon upscaling), targeted approaches for characterization of land cover in permafrost regions were undertaken.

All land cover prototypes are static products. The primary analyses region covers the West Siberia Lowlands. The spatial coverage of the land cover prototypes does strongly depend on acquisitions of Sentinel-2 data from summer 2016-2018 and partially Sentinel-1 (EW versus IW acquisition strategy). This area overlaps with one of the transects identified for permafrost longterm monitoring purposes (Bartsch et al. 2014). Sentinel-2 is considered where available but a complete coverage of the area was not available within the project time frame. Small areas with masked clouds are present in the dataset.

This version considers acquisitions until September 2018. Calibration has been carried out using data from Western Siberia provided by user groups (Russian Academy of Science and University of Alaska Fairbanks).

Three types of dataset have been developed

   I.   Land surface structure from Sentinel-1 HH (normalized winter backscatter)

  II.   Vegetation height from Sentinel-1 VV and Sentinel-2 (NDVI)

 III.   Traditional land cover classification based on Sentinel-1 and Sentinel-2

This product guide describes type II.

1.2. Vegetation height

Current global and circumpolar maps lack the thematic detail and/or spatial resolution to appropriately represent tundra shrubs, their types and height (Bartsch et al. 2016). The retrieval of vegetation height has been therefore tested for selected regions across the Arctic. Primary data source is Sentinel-1 (C-band Synthetic Aperture Radar) with masking based on Sentinel-2. Processing steps include border noise removal, calibration, thermal noise removal and orthorectification using the digital elevation model

(DEM) GETASSE30 (Global Earth Topography And Sea Surface Elevation at 30 arc second resolution). Sentinel-1 data have been normalized as described in Widhalm et al. (2018). The normalization approach has been adapted for VV polarization (incidence angle 30°), in order to utilize the better spatial coverage and better performance of VV compared to HH (Bartsch et al. in review). Several indices have been tested for Sentinel-2 for masking purposes. The cloud mask of the 'fmask' algorithm (Zhu et al. (2012 and 2015)) is applied as well as additional cloud detection by anomaly analyses. The latter is required as certain cloud situations are not captured in the original dataset. Water masking based on 'fmask' is applied in addition. Areas with NDVI < 0.4 are excluded for vegetation height retrieval in order to account for effects related to C-band scattering from rough and bare surfaces. Areas with VV < -15.4 dB (and NDVI > 0.4) are flagged as well as indicator for anomalous high values in vegetation related indices with at the same time low vegetation height. This occurs specifically in high Arctic wetlands (drained lakes). The remaining land area is assigned shrub heights up to 160 cm. All heights > 160 cm are excluded and labelled as a separate class.

This product has been also derived for selected sites outside the landcover prototype extent.

2. Product Specification

Table 1: Specifications of the file naming nomenclature for the landcover product based on medium resolution satellite data.

Subject	Code	Specification
Organization	ZAM	ZAMG
Product	LCP	Land cover prototype
Algorithm	LANDV	vegetation height based on S1 and S2
Satellite sensor used to create product	SEN12	Sentinel-1 and Sentinel-2
Product version	VVV	E.g. V05
Start date and time	YYYYMMDD	E.g. 20150815
End date and time	YYYYMMDD	E.g. 20180830
Region of interest	T01	Landcover prototype extent for Westsiberian transect, it includes C08 (central Yamal)
	C01	Barrow, Alaska
	C02	Toolik, Alaska
	C03	Teshekpuk, Alaska
	C04	Mackenzie Delta (Canada)
	C05	Umiuaq (Canada)
	C06	Kytalyk (Russia)
	C07	Lena Delta (Russia)
	C12	Seward peninsula, Alaska
Tile ID for T01	1	69°44′53″N – 73°42′14″ N, 65°33′16″E – 79°0′3″E
	2	66°25′26″ – 69°49′23″N, 60°24′38″E – 70°28′52″E
	3	66°06′18″N – 70°01′23″N, 70°44′01″E – 79°02′10″N
	4	63°37′55″N – 66°12′59″N, 60°50′29″E – 70°20′03″E
	5	63°16′53″N – 66°25′26″N, 70°28′52″E – 79°04′53″E
	6	60°57′07″N – 63°24′42″N, 60°57′10″E – 70°13′14″E
	7	60°32′32″N – 63°37′55″N, 70°20′02″E – 79°08′18″E
File Extension	TIF	Geotiff
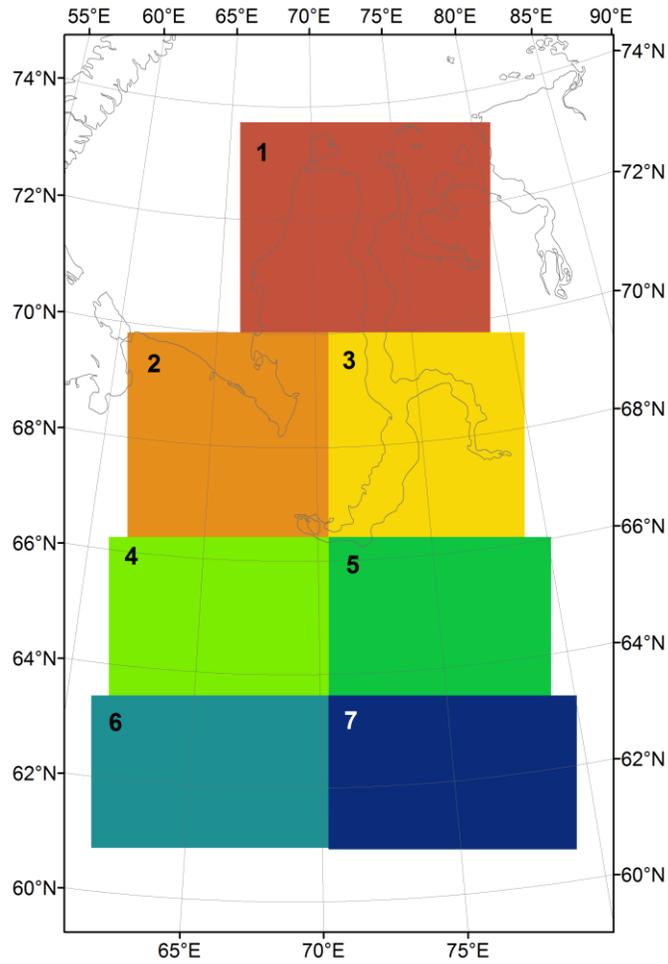
Figure 1: Numbering of vegetation height tiles for the extent of T01

Table 2: Specifications of the vegetation height product (LANDV)

Subject	Specification
Variable	Vegetation height
Units	cm
Coverage	Sentinel-2 extent by September 2018 within LC prototype extent and selected further regions, see Table 1
Time period	2015 - 2018
Temporal frequency	Static
Coordinate system	UTM, WGS84
Spatial resolution (grid spacing)	20 m
Geometric accuracy	Subpixel
Thematic accuracy	RMSE 45 cm (validation height range 0-300 cm)
Data (file) format	Geotiff
Data codes	0 – 160 … vegetation height in cm -1 … NDVI < 0.4 -2 … VV < -15.4 dB -3 … > 160 cm
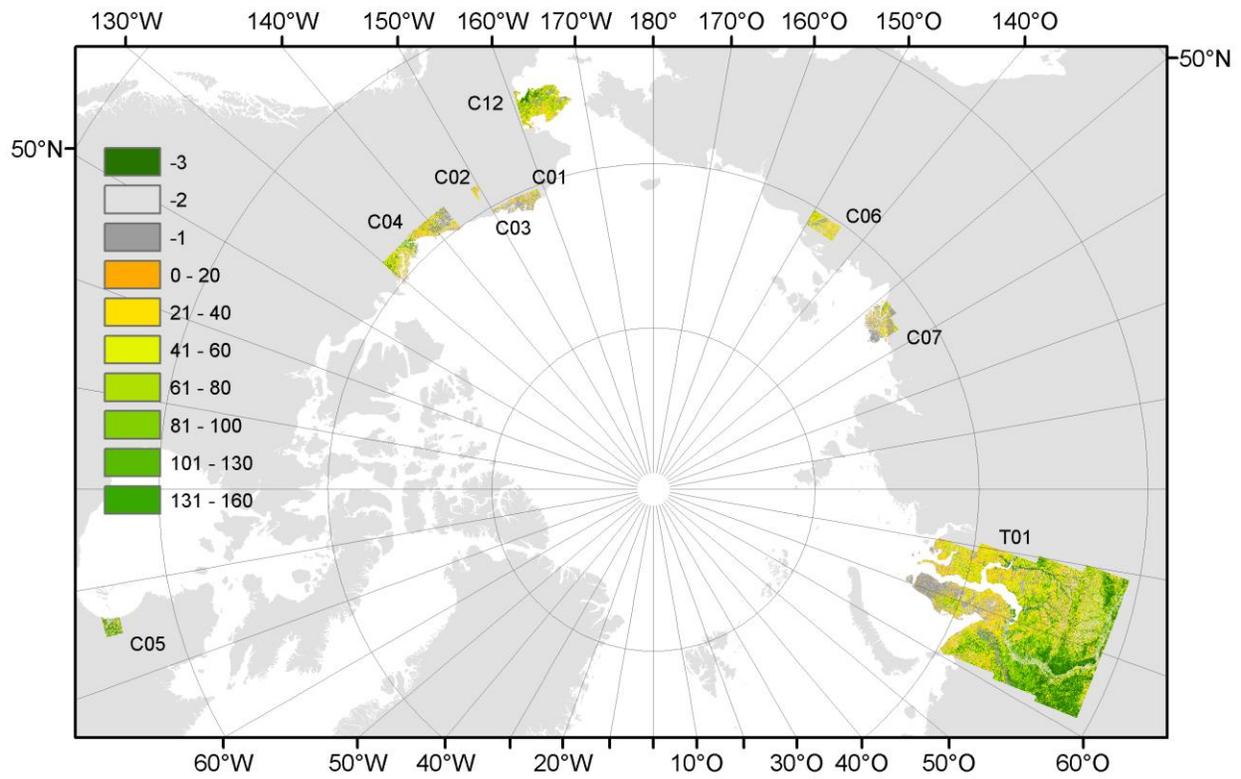
Figure 2: LANDV datasets – vegetation height from Sentinel-1 and Sentinel-2

3. Known issues

Many data gaps exist due to cloud cover in Sentinel-2 data, especially for T01. This may affect the masking of rough and barren areas (e.g. scree slopes) and thus result in an overestimation of vegetation height in such areas.

Vegetation height is overestimated in areas with very steep slopes facing the sensor due to foreshortening effects in Sentinel-1 acquisitions. This applies e.g. to N-S running cliffs in the Lena-Delta. In general, the chosen Sentinel-1 normalization approach is only applicable in flat to moderate terrain as described in Widhalm et al. (2018).

4. Data access and contact information

Data are available for download via the Permafrost Information System "PerSys". They follow the structure described in section 3.

PerSys: http://apgc.awi.de/group/about/globpermafrost

All datasets are also available on the PerSys-WebGIS for visualization and browsing.

WebGIS-Link: http://maps.awi.de/map/map.html?cu=Globpermafrost_Overview#layers

Data access and citation information on PANGAEA (https://www.pangaea.de/?q=globpermafrost)

For more information about the datasets please contact annett.bartsch@zamg.ac.at

5. References

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