permafrost
cci

CCI+ PHASE 1 – NEW ECVS
Permafrost

CCN3 Option 6
IMPROVED SOIL DESCRIPTION THROUGH A LANDCOVER MAP DEDICATED FOR THE ARCTIC

D3 Product user guide (PUG)

Version 2.5

30 November 2024

Prepared by

b·geos Stockholm University GAMMA REMOTE SENSING

Document Status Sheet

Issue	Date	Details	Authors
1.0	31.05.2023	First version	A. Bartsch, G. Hugelius, T. Strozzi
2.0	31.08.2023	Update of legend and documentation of data quality	A. Bartsch
2.1	02.10.2023	Update of file naming	A. Bartsch
2.2	20.11.2023	Update of references	A. Bartsch
2.3	10.06.2024	Update tables 1 & 2, RD-5, data access	A. Bartsch
2.4	10.07.2024	Update table 2, extension of CCI Landcover translation	A. Bartsch
2.5	30.11.2024	V2, extended coverage and reprocessing	A.Bartsch, R. Khairullin

Author team

Annett Bartsch, b.geos
Rustam, Khairullin, b.geos
Barbara Widhalm, b.geos
Helena Bergstedt, b.geos
Aleksandra Efimova, b.geos
Gustaf Hugelius, Stockholm University
Tazio Strozzi, Gamma

ESA Technical Officer:
Frank Martin Seifert

EUROPEAN SPACE AGENCY CONTRACT REPORT
The work described in this report was done under ESA contract. Responsibility for the contents resides in the authors or organizations that prepared it.

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Executive summary

Within the European Space Agency (ESA), the Climate Change Initiative (CCI) is a global monitoring program which aims to provide long-term satellite-based products to serve the climate modeling and climate user community. Permafrost has been selected as one of the Essential Climate Variables (ECVs) which are elaborated during Phase 1 of CCI+ (2018-2021).

This document is the Product User Guide (PUG) of Option 6 within CCN3 of Phase 1 of the Permafrost_cci project. It describes the landcover product targeting proxies for soil properties in tundra regions underlain by permafrost. The product specifications address the main requirements expressed by the users in the User Requirements Document (URDv1.0, [RD-3]) including those expressed by the Permafrost_cci Climate Research Group (CRG).

The PUG includes the product specifications and formats, including details of meta data.

Landcover information is provided at 10m resolution, polar stereographic projection, covering the Arctic tundra (and extensions over selected regions in version 2) and representing the status 2016-2022/24. Product level is 4. The datasets are created from the analysis of lower level data, resulting in gridded products. In addition, aggregated information (1 km) is provided for further use in the Permafrost_cci project for version 1.

Version 2 (release 11/2024) includes updates contributed by the ERC Synergy project Q-Arctic, HORIZON2020 project CHARTER and the ESA funded project AMPAC-Net. More than one third has been reprocessed and the extent enlarged by about 28%. The latter includes e.g., Northern Scandinavia, the Cherskii region in Eastern Siberia, southern Greenland and the Hudson Bay lowlands.

1 Introduction

1.1 Purpose of the document

This document describes in detail product specifications of a pan-arctic permafrost region specific landcover product that is consistent. The purpose of this document is to present the structure, syntax and file naming conventions used to describe the landcover product. It provides all the necessary data needed by users to read the products.

1.2 Structure of the document

Section 2 describes the general product properties. The remaining sections detail the thematic content and known issues.

1.3 Applicable documents

[AD-1] ESA 2017: Climate Change Initiative Extension (CCI+) Phase 1 – New Essential Climate Variables - Statement of Work. ESA-CCI-PRGM-EOPS-SW-17-0032

[AD-2] Requirements for monitoring of permafrost in polar regions - A community white paper in response to the WMO Polar Space Task Group (PSTG), Version 4, 2014-10-09. Austrian Polar Research Institute, Vienna, Austria, 20 pp

[AD-3] ECV 9 Permafrost: assessment report on available methodological standards and guides, 1 Nov 2009, GTOS-62

[AD-4] GCOS-200, the Global Observing System for Climate: Implementation Needs (2016 GCOS Implementation Plan, 2015.

1.4 Reference Documents

[RD-1] van Everdingen, Robert, ed. 1998 revised May 2005. Multi-language glossary of permafrost and related ground-ice terms. Boulder, CO: National Snow and Ice Data Center/World Data Center for Glaciology. (http://nsidc.org/fgdc/glossary/; accessed 23.09.2009)

[RD-2] Bartsch, A., Westermann, S., Heim, B., Wieczorek, M., Pellet, C., Barboux, C., Kroisleitner, C., Strozzi, T. (2019): ESA CCI+ Permafrost Data Access Requirements Document, v1.0

[RD-3] Bartsch, A., G. Hugelius, Strozzi, T.(2021): ESA CCI+ Permafrost CCN3 Option 6: improved soil description through a landcover map dedicated for the Arctic. User Requirements Document, v1.0

[RD-4] Bartsch, A., Widhalm, B., Elimova, A., G. Hugelius, Palmtag, J., Strozzi, T.(2022): ESA CCI+ Permafrost CCN3 Option 6: improved soil description through a landcover map dedicated for the Arctic. Design Engineering, v1.0

[RD-5] Bartsch, A., Efimova, A., Widhalm, B., Muri, X., von Baeckmann, C., Bergstedt, H., Ermokhina, K., Hugelius, G., Heim, B., and Leibman, M.: Circumarctic land cover diversity considering wetness gradients, Hydrol. Earth Syst. Sci., 28, 2421–2481, https://doi.org/10.5194/hess-28-2421-2024, 2024.

1.5 Bibliography

A complete bibliographic list that supports arguments or statements made within the current document is provided in Section 5.1.

1.6 Acronyms

A list of acronyms is provided in section 5.2.

1.7 Glossary

A selection of terms relevant for the parameters addressed in Permafrost_cci is provided in [RD-2].

2 General product properties

2.1 Geographical coverage

Permafrost is a phenomenon of the subsurface thermal state across vast areas. Permafrost underlies approx. 24% of the terrestrial Northern Hemisphere (Figure 1). Specifically, tundra regions are very heterogeneous regarding landcover and soil properties what is so far unaccounted for in global landcover datasets. The v1 landcover product did therefore cover all tundra area in the Arctic which is underlain by permafrost. The borders were defined based on the Circumarctic Vegetation Map (CAVM) by Raynolds et al. (2019). Sentinel-2 granules which have partial or full overlap were included in the product. Preference was given to the granule with best coverage in case of multiple granules at a certain location.

No masking of the processed granules has been applied for version 2. Further on, the processing extent (Figure 2) was extended by 27.8% and determined by user requests from Permafrost_cci, the ERC Synergy project Q-Arctic, HORIZON2020 project CHARTER and the ESA funded project AMPAC-Net.

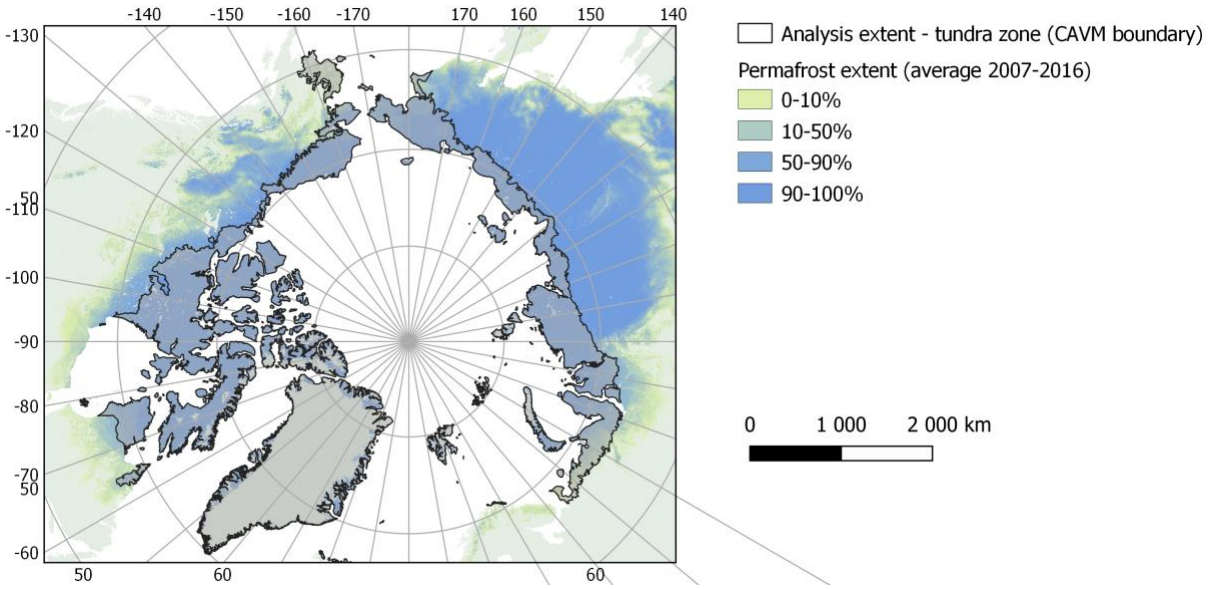

Figure 1: Analyses extent for the version 1 landcover product (Bartsch et al. 2023). Permafrost extent: CRDPv1 - Obu et al., 2020, Tundra extent: Circumarctic vegetation map (CAVM) – Raynolds et al. (2019)

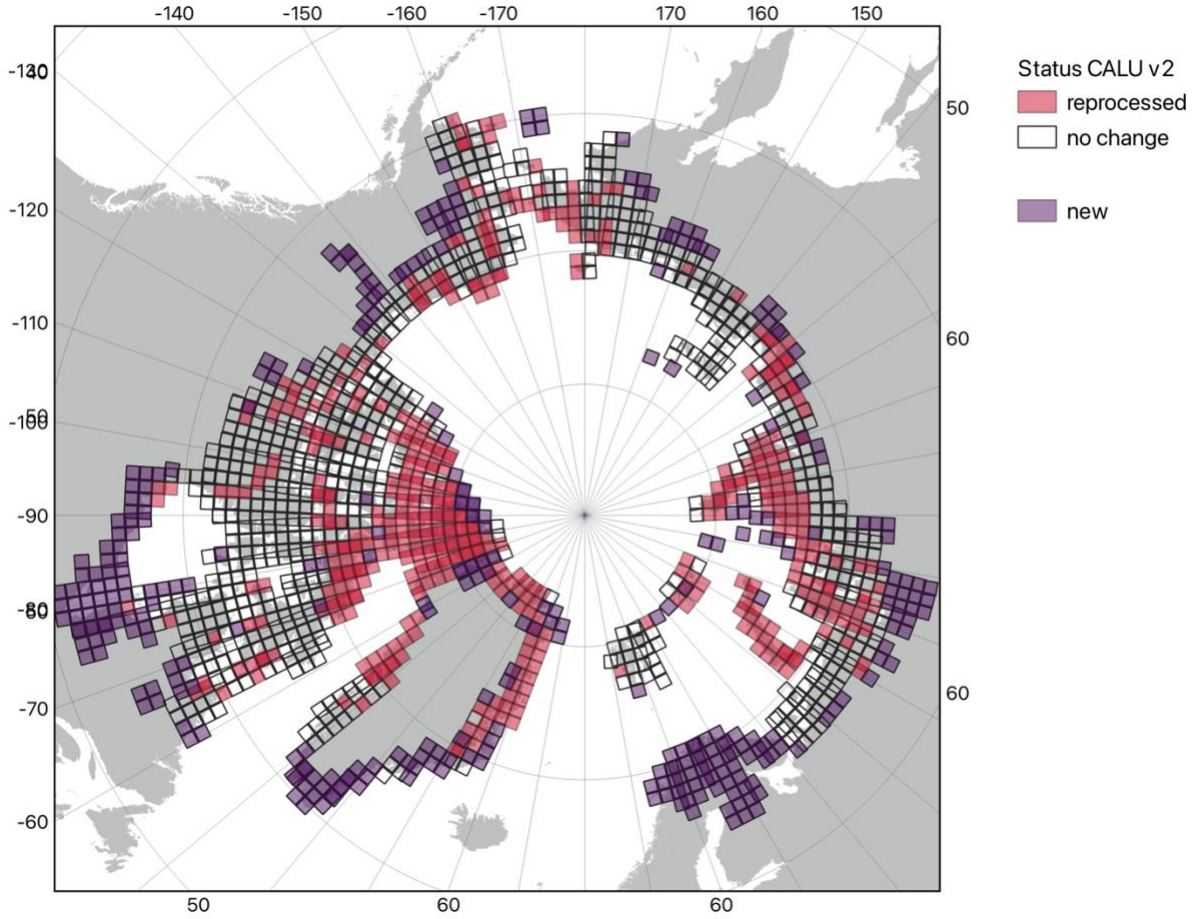

Figure 2: Analyses extent for CALU version 2 product and processing status.

2.2 Temporal compositing

The v2 product is static and is a mosaic of acquisitions from 2016 to 2024, depending on availability of cloud free Sentinel-2 data during the vegetation peak season.

2.3 Spatial resolution

The Spatial resolution of the landcover product is linked to the available resolution of the input sensors. This includes Sentinel-1 and Sentinel-2, both with 10m nominal resolution (Sentinel-2 bands partially transferred to 10m, see [RD-4]).

2.4 Product projection system

The Coordinate Reference System (CRS) used for the landcover unit dataset is Polar Stereographic projection (Arctic) based on the World Geodetic System 84 (WGS84) reference ellipsoid. The coordinates are specified in meters. Higher level products of v1 are provided in geographic coordinates at 0.01° resolution.

2.5 File formats

The product is delivered in GeoTIFF format (compressed).

2.6 Product file naming conventions

The files for each product type are named as follows:

ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]-<Start Date>-<End Date>-fv<File version>.tif

<CCI Project>
PERMAFROST for permafrost_cci

<Processing Level>
L4 for Level 4; Data sets are created from the analysis of lower level data, resulting in gridded, gap-free products.

<Data Type>
CLS – landcover unit

<Product String> : <source>_<algorithm>
SENTINEL1-2_ KMLH
<Source>

- SENTINEL1_2 - Fusion of Sentinel-1 and Sentinel-2 data.

<algorithm>

- KMLH – Two step approach of K-means and Maximum Likelihood (prototype method, Bartsch et al. 2019)

<Additional Segregator>
This should be AREA<TILE_NUMBER>_<Sentinel-2 granule ID>_<Layer type>
<TILE_NUMBER>being the tile number the Permafrost_cci subset index: 1- global, 2-North America, 3-Eurasia, 4-Northern Hemisphere, 17- Arctic tundra CAVM (north of tree line); 18 – Arctic tundra extended.

<Sentinel-2 granule ID>

- Sentinel-2 granule ID: e.g. 42WVC, following the scheme of the Copernicus service, or
- Subregion ID:
  - ALASK – Alaska,
  - CANA1 – Canada mainland (version 1), CANA2 – Canada islands UTM10- UTM16 (version 1), CANA3 - Canada islands UTM17- UTM18 (version 1), CANA4 - Canada islands UTM19 – UTM20 (version 1), CANL1 – Canada mainland west, CANL2, Canada mainland centre, CANL3 – Canada mainland east, CANI1 – Canada islands part 1, CANI2 – Canada islands part 2, , CANI3 – Canada islands part 3,

- GREEN – Greenland (version 1), GREEE – Greenland East, GREEW – Greenland West,
- SVALB – Svalbard,
- RUSS1 – Russia UTM38 – UTM50 (version 1), RUSS2 – Russia UTM51 – UTM02 (version 1), RUSL1 – Russia part 1 (Europe), RUSL2 – Russia part 2 (Western Siberia), RUSL3 – Russia part 3 (Taimyr), RUSL4 – Russia part 4 (Lena delta), RUSL5 – Russia part 5 (Cherskii), RUSL6 – Russia part 6 (east of dateline),
- SCAND – Northern Scandinavia

<Layer type>

- LCU: layer type 1, corresponding to value of the landcover unit class.

<Start Date> and <End Date>
The identifying date for this data set:
Format is YYYYMMDD, where YYYY is the four digit year, MM is the two digit month from 01 to 12 and DD is the two digit day of the month from 01 to 31.

fv<File Version>
File version number in the form n{1,}[.n{1,}] (That is 1 or more digits followed by optional . and another 1 or more digits). The most recent version is fv02.0 (released in November 2024).

Examples:
ESACCI-PERMAFROST-L4-CLS-SENTINEL1_2_KMLH-AREA17_LCU_ALASK-2016-2022-fv01.0.tif
ESACCI-PERMAFROST-L4-CLS-SENTINEL1_2_KMLH-AREA18_LCU_ALASK-2016-2024-fv02.0.tif

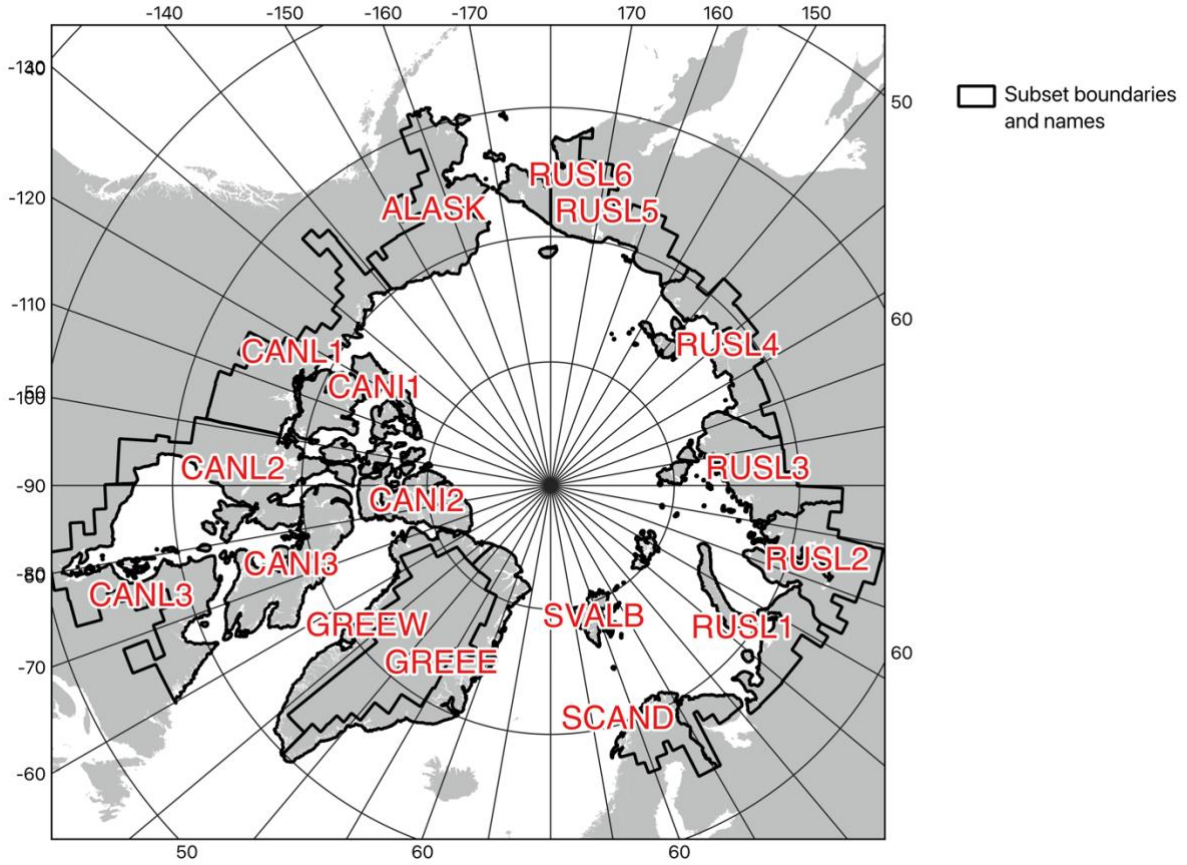

Figure 3: Analyses extent for CALU version 2 product and subregions.

2.7 Meta data

Meta data are available as an auxiliary dataset. A vector data set (geopackage) is provided which contains the extent of the used Sentinel-2 granules and as attributes acquisition dates, reprocessing status and a quality flag.

Name: Sentinel-2 granule specification
S2_date_1 to 8 Dates of used Sentinel-2 acquisitions
S1_polariz: Polarization of available Sentinel-1 data (VV or HH)
Country: Country
Admin_region: Administrative region
SACHI_v2: Availability of infrastructure classification; 1- yes (68.3%), 0 – no
Quality_v2:

(1) Good (21.3%)
(2) Medium (gaps and stripes originating from Copernicus DEM, extensive misclassification in settlement areas) (39.7%)
(3) Low (misclassification due to Sentinel1/2 data availability issues, non-peak season, clouds, high aerosol optical thickness, etc. and partially as for #2) (32.4%)
(4) Very low (gaps due to missing Sentinel-1/2, date line and partially as for #2/3) (6.0%)
(5) No Sentinel-2 data (0.6%)

Repr: Reprocessing of v1; 1- yes (38.1% of original granules)
New: Additional area compared to v1; 1- yes (27.8% more than original granules)
S2_num: Number of used Sentinel-2 acquisitions (up to 8)

File name for v2 quality layer:
ESACCI-PERMAFROST-L4-CLS-SENTINEL1_2_KMLH-AREA18_LCU_QUALI-2016-2024-fv2.0.gpkg

2.8 Higher level products

An aggregated version of the version 1 landscape units is provided for a 1 km grid (as for CCI Landsurface Temperature). It includes:

- Center coordinate of grid point
- Fraction of each landcover unit within each grid cell (one file per unit [1, … , 23])
- Landcover unit with fraction majority

File name for v1 majority layer:
ESACCI-PERMAFROST-L4-CLS-SENTINEL1_2_KMLH-AREA17_LCU_MAJORITY-2016-2022-fv01.1.csv

2.9 Product access and citation

Version 1 (beta version)
Bartsch, A., Efimova, A., Widhalm, B., Muri, X., von Baeckmann, C., Bergstedt, H., Ermokhina, K., Hugelius, G., Heim, B., Leibman, M. & Khairullin, M. (2024). Circumarctic Landcover Units (1.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.11486149

Version 2
Bartsch, A., Khairullin, R., Efimova, A., Widhalm, B., Muri, X., von Baeckmann, C., Bergstedt, H., Ermokhina, K., Hugelius, G., Heim, B., Leibman, M., Gruber, C. (2024). Circumarctic Landcover Units (2.0) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.14235736

3 Thematic content

3.1 Terminology

This product addresses tundra specific landcover units, which reflect specific soil conditions and vegetation communities. Detailed documentation is provided in the Appendix of Bartsch et al. (2024) [RD-5].

Units are assigned abundance of vegetation types including shrub growth form/height as well as moisture conditions. The following shrub types are considered (following the differentiation of the CAVM, Reynolds et al. 2019 and Walker et al. 2018):

- Prostrate dwarf shrub – approximately 5 cm, also referred to as prostrate shrub
- Erect dwarf shrub – up to 40 cm, also referred to as dwarf shrub
- Low shrub – up to 2m
- Tall shrubs – tundra biome species taller than 2m

Vegetation coverage is derived from AVA (Arctic Vegetation Archive) data for Western Siberia (Zemlianskii et al. 2023).

Figure 4: Dwarf shrubs (erect, up to 40 cm), dwarf birch (Betula Nana). Photo A. Bartsch (Northern Ural foothills, 2018)

Figure 5: Low shrubs, dwarf birch (Betula Nana). Photo A. Bartsch (Northern Ural foothills, 2018)

Figure 6: Low shrubs (stick height is 140 cm) in an incised creek channel, willow (Salix ssp). Photo A. Bartsch (Northern Ural foothills, 2018)

3.2 Abstract of data publication

Landcover units have been derived from Copernicus Sentinel-1 und Sentinel-2 data acquired between 2016 and 2024 for the Arctic tundra biome. 23 units of which 20 represent different vegetation characteristics and soil conditions are provided. The units have been identified with K-means over a representative transect and in a second step retrieved across the entire Arctic north of the treeline and selected adjacent regions. The description of the units is based on several thousand samples from vegetation surveys and soil probes.

The units are supplied at 10m resolution in 17 irregular tiles. Auxiliary data for quality information and input acquisition dates are supplied in a separate shape file.

3.3 Pixel attributes

Table 1:
Landcover unit properties (vegetation characteristics based on https://avarus.space/) and soil characteristics (source: Palmtag et al. 2022; nd – no data; (..)- low number of samples; AVA – Arctic vegetation archive); source: Bartsch et al. 2024 [RD-5].

ID	Derived description	Group	Soil wetness (AVA)	Organic layer thickness	SOC density	Mineral content
1	Water	Water	-	-	-	-
2	shallow water/abundant macrophytes	Wetland	nd	high	nd	nd
3	wetland, permanent	Wetland	aquatic	low to medium	medium	low
4	wet to aquatic tundra (seasonal), abundant moss	Wetland	wet to aquatic	low to medium	(medium)	(low)
5	Moist to wet tundra, abundant moss, prostrate shrubs	Tundra	moist to wet	low to medium	(medium)	(high)
6	dry to moist tundra, partially barren, prostrate shrubs	Tundra	dry to moist	medium	medium	high
7	dry tundra, abundant lichen, prostrate shrubs	Tundra	dry	low to medium	(medium)	(high)
8	dry to aquatic tundra, dwarf shrubs (& sparse tree cover along treeline)	Shrub tundra	dry to aquatic	medium	medium	medium
9	dry to moist tundra, prostrate to low shrubs	Shrub tundra with tussocks	dry to moist	low to medium	medium	medium
10	moist tundra, abundant moss, prostrate to low shrubs	Shrub tundra with tussocks	moist	low	high	medium
11	moist tundra, abundant moss, dwarf and low shrubs	Shrub tundra with tussocks	moist	low	high	medium
12	moist tundra, dense dwarf and low shrubs (& sparse tree cover along treeline)	Shrub tundra	moist	medium	(medium)	(low)
13	moist to wet tundra, dense dwarf and low shrubs (& sparse tree cover along treeline)	Shrub tundra	moist to wet	(low)	nd	nd
14	moist tundra, low shrubs	Shrub tundra	moist	medium	medium	medium
15	Dry to moist tundra, partially barren	Shrub tundra	dry to wet	high	(low)	(high)
16	moist tundra, abundant forbs, dwarf to tall shrubs	Shrub tundra	moist	medium	(medium)	(high)
17	recently burned or flooded, partially barren	Shrub tundra/ disturbed	nd	low to medium	nd	nd
18	forest (deciduous) with dwarf to tall shrubs	Forest	nd	nd	nd	nd
19	forest (mixed) with dwarf to tall shrubs	Forest	nd	nd	nd	nd
20	forest (needle leave) with dwarf and low shrubs	Forest	nd	nd	nd	nd
21	Partially barren	Barren	dry	(low)	(low)	(very high)
22	Snow/ice	Snow/ice	-	-	-	-
23	Other (incl. shadow)	Shadow/Other	-	-	-	-

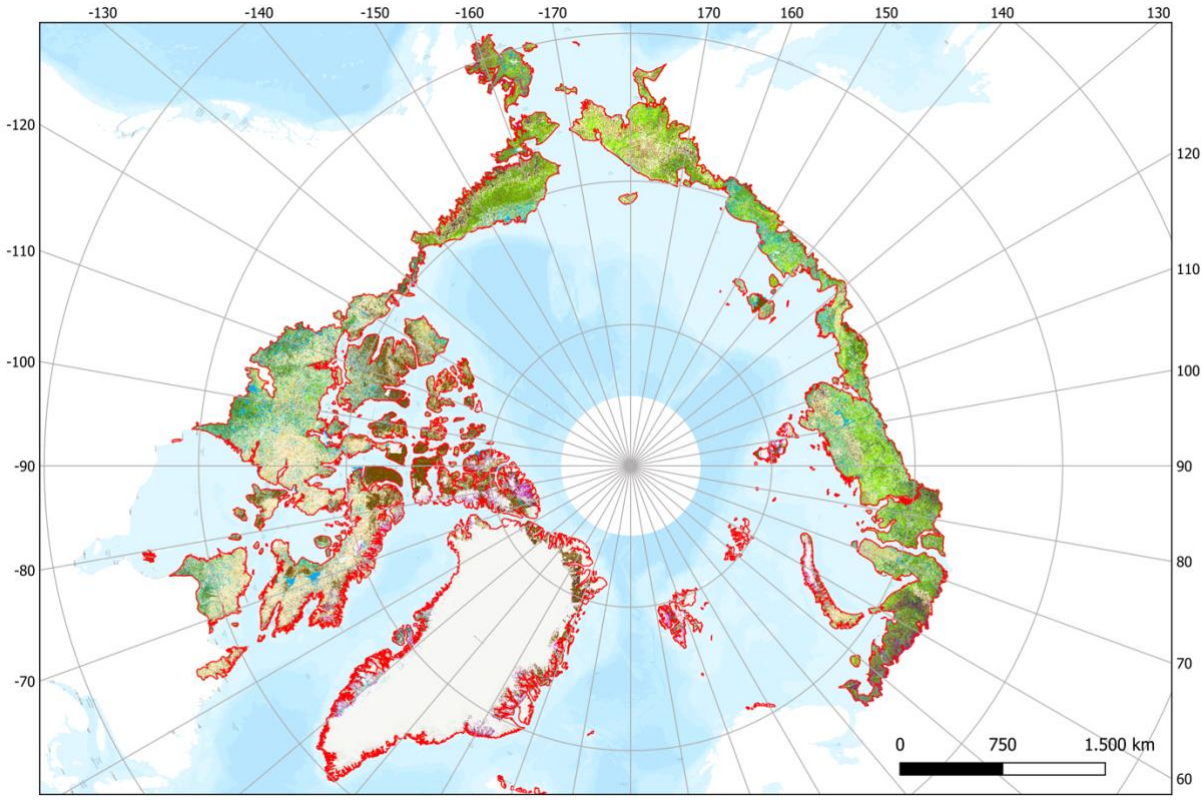

Figure 7: CALU version 1 within CAVM extent (red outline; source: Raynolds et al. 2019). For legend see Table 1.

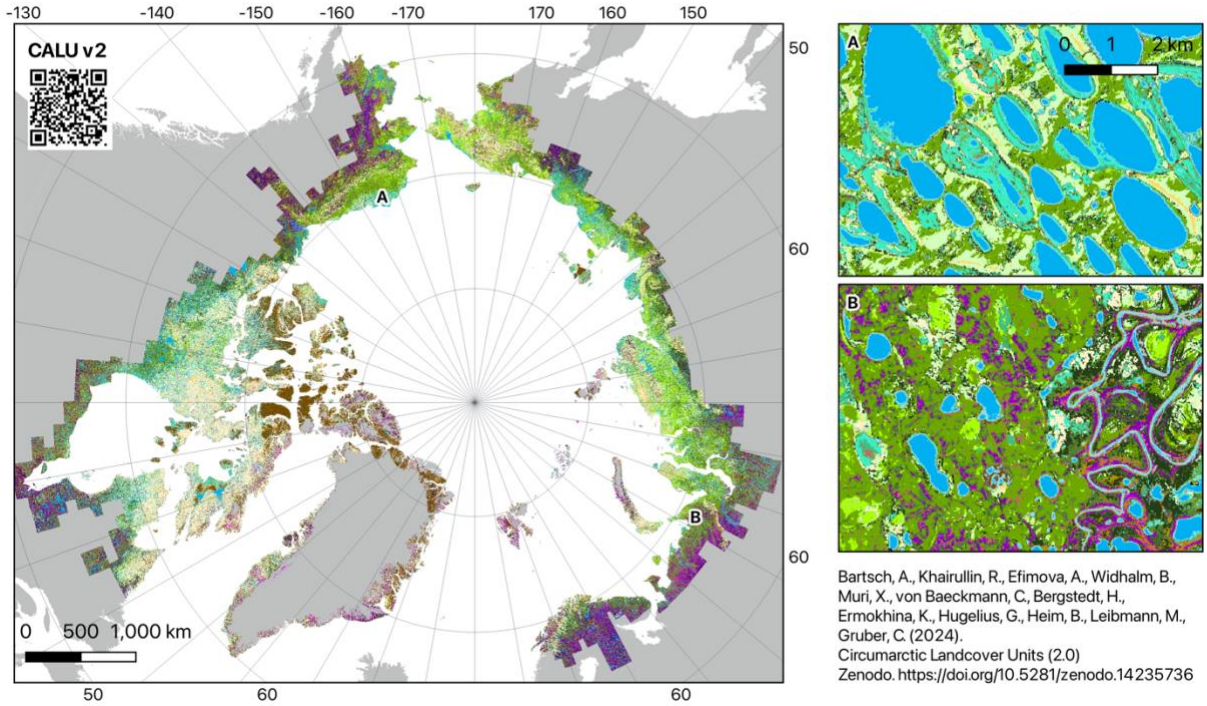

Figure 8: CALU version 2. For legend see Table 1.

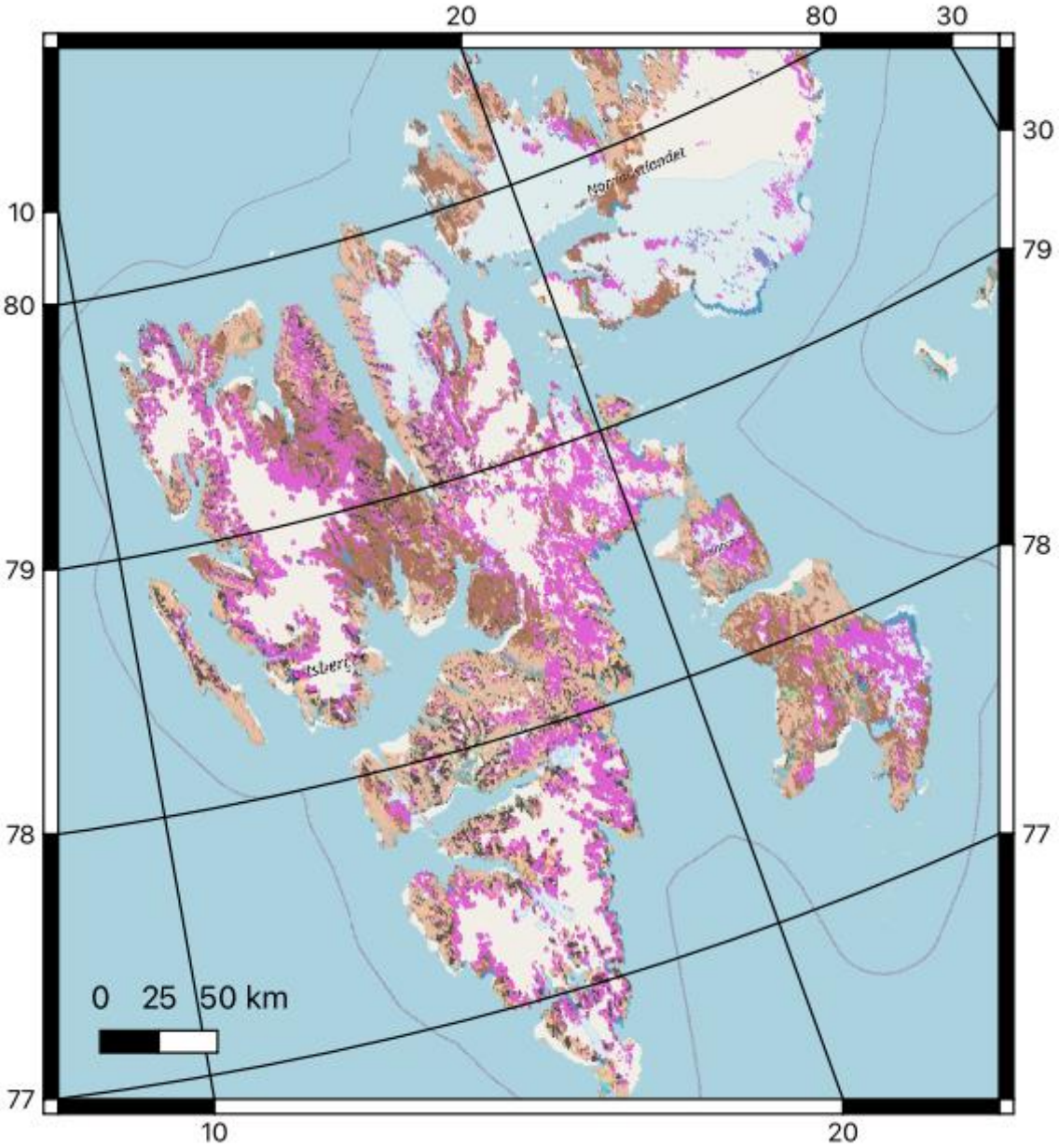

Figure 9: Example for L4 (version 1) for Svalbard – aggregated 1km gridded product. Landcover unit with majority (for legend see Table 1). Units 6 and 21 (partially barren types) are dominant in snow/ice free areas.

3.4 Compatibility with CCI Landcover

The translation scheme in Table 2 is suggested for combination with CCI Landcover (https://esa-landcover-cci.org/). Tree line uncertainties need to be addressed. The assignment to forest should be run in a first step. A threshold of 15 % of a CALU forest unit may be used to assign an area to forest. In some regions also values down to 1% could be applicable. An issue are also dense low shrubs in the proximity of the tree line (unit #12). They are classified as forest in CCI Landcover and should be therefore translated to ‘Mosaic with trees and shrubs’ (or alternatively to forest) depending on abundance.

Table 2: Suggested translation scheme of CALU classes to Landcover_cci using abundance statistics at target pixel extent (300m)

CALU ID	**Translation using fraction within 300 m x 300 m areas**	**CCI Landcover ID original**	**CCI Landcover name, original**	**CCI Landcover ID extended**	**CCI Landcover name, extended**
1	majority	210	Water		
2	majority	180	Shrub or herbaceous cover, flooded		
3	if > 10% or majority	180	Shrub or herbaceous cover, flooded		
4	majority	180	Shrub or herbaceous cover, flooded		
5	majority	140	Lichen and mosses	141	Mosses, lichen, graminoids and prostrate shrubs
6	majority	150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	142	Mosses, lichen, graminoids, prostrate shrubs and barren (<10%)
7	majority	140	Lichen and mosses	143	(abundant) lichen, mosses, graminoids and prostrate shrubs
8	majority	110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)		
9	majority	140	Lichen and mosses	144	Mosses, lichen, graminoids and shrub tundra
10	majority	140	Lichen and mosses	145	(abundant) Mosses, graminoids and shrub tundra
11	majority	120	Shrubland		
12	majority, then 100 (or 60) if > 50%, 110 if < 50%	100/110	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)		
13	majority	120	Shrubland		
14	majority	120	Shrubland		
15	majority	150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)		
16	majority, then 100 if > 50%, 110 if < 50%	100/110	Mosaic tree and shrub (>50%) / herbaceous cover (<50%) or Mosaic herbaceous cover (>50%) / tree and shrub (<50%)		
17	Majority	110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)		
18	60 if > 15% (or 1%), 120 if < 15% (or	60/120	Tree cover, broadleaved, deciduous, closed to open or shrubland		

	1%)				
19	90 if > 15% (or 1%), 100 if < 15% (or 1%)	90/100	Tree cover, mixed leave type or Mosaic tree and shrub (>50%) / herbaceous cover (<50%)		
20	70/80 if > 15% (or 1%), 100 if < 15% (or 1%)	70 (America) /80 (Siberia)/100	Tree cover, needle leaved or Mosaic tree and shrub (>50%) / herbaceous cover (<50%)		
21	majority	150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)		
22	majority	220/210	permanent snow and ice or water (misclassifications)		
23	majority	0	no data		

Figure 10: Example for CALU Class 12 'dry to moist tundra, dense dwarf and low shrubs' (foreground). Dense extensive areas of especially Betula nana are common in the proximity of the tree line and classified as forest in CCI Landcover. (Photograph A. Bartsch, 2018, Northern Ural foothills).

4 Known limitations

Cloudiness is a common issue across the Arctic and the vegetation peak season is comparably short. This is leading to data gaps in cases where no cloud free acquisition was made by Sentinel-2 since launch until Summer 2024. These granules are flagged in an auxiliary dataset (shape file of granule extent with quality flag in attributes; flag value 5). The occurrence of this issue could be reduced in version 2. Data is partially missing in several cases for either Sentinel-1, Sentinel-2 or issues occurred with the use of the Copernicus elevation model and along the date line (flag value 4).

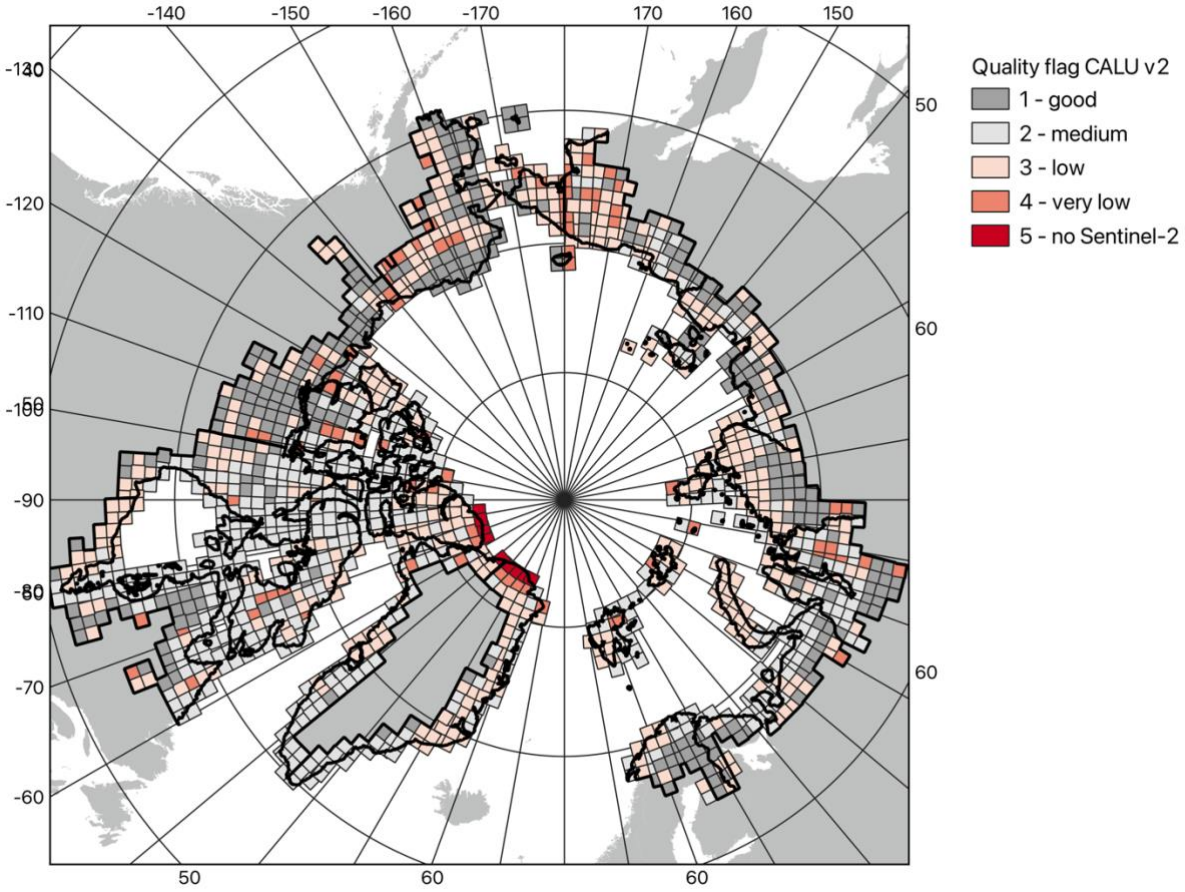

Figure 11: Extent of version 2 granules and data quality.

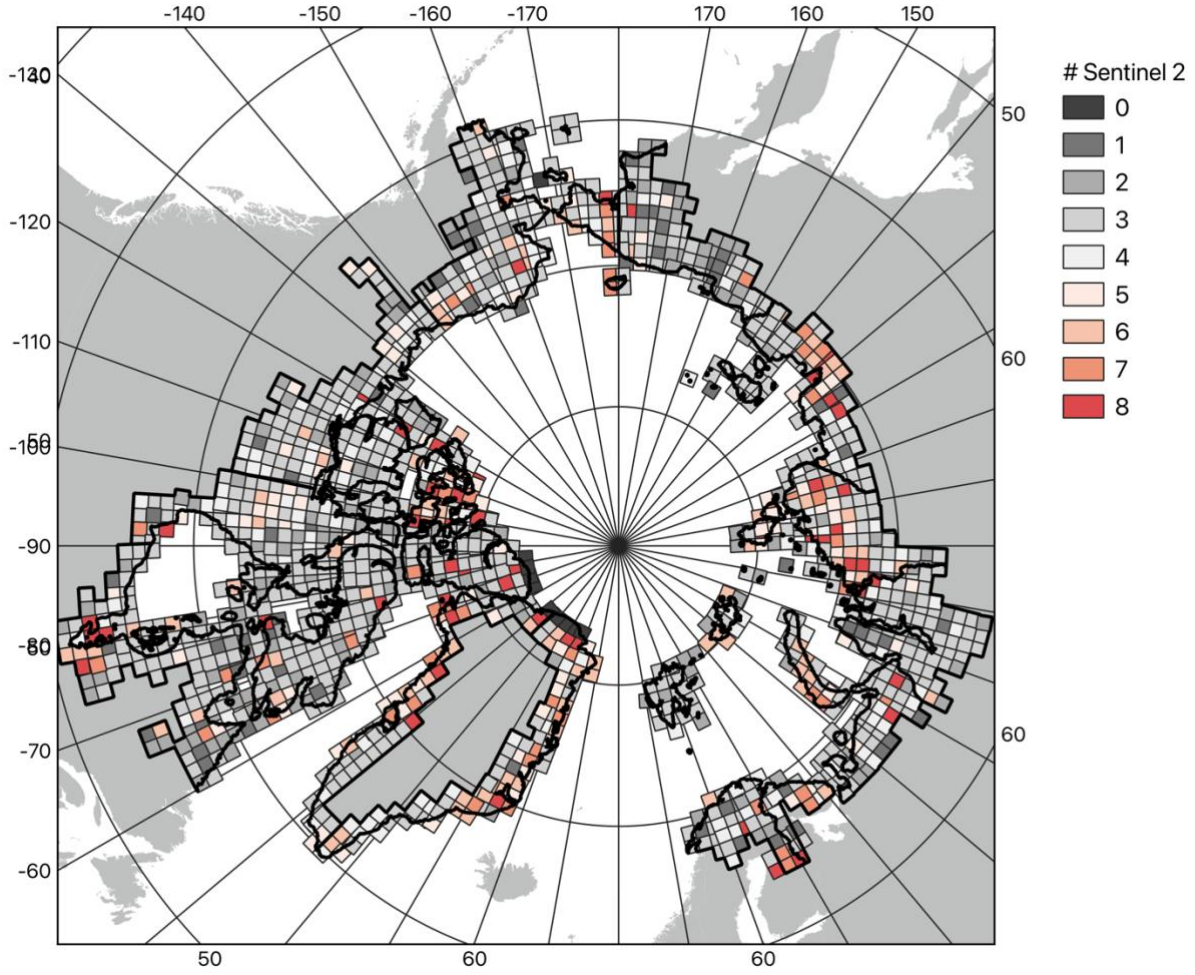

Figure 12: Extent of version 2 granules and number of used Sentinel-2 acquisitions.

The lack of data from the peak vegetation season or unusually dry or wet conditions can lead to shifts in class assignments especially among the wetland and shrub tundra classes (quality flag 3; example in Figure 16).

Water can be classified as ‘no data’ in proximity to coasts as a masking for the coastline was applied as part of the Sentinel-1 pre-processing as well as postprocessing based on the Copernicus DEM (Figure 13). In some cases, water is also included in the snow/ice class. Snow/ice miss-assignment occurs specifically for larger river courses. The occurrence of this issue reduced in version 2.

High latitude mountainous regions such as Svalbard or the Books Range in Alaska can have misclassifications due to shadows. The class ‘other’ has been assigned where steep slopes can be identified from digital elevation models (Copernicus DEM), but DEM quality is not sufficient in some cases. Stripes resulting from the use of the Copernicus elevation model occur in some mountainous regions (Figure 14).

CAL units are developed for the tundra biome. Nevertheless, three forest classes were included for the purpose of separation of non-tundra in transitions zones. No specific assignment to forest species and types should be made although a separation for deciduous, mixed and needle leave is suggested. Patches with trees with limited growth (height and/or crown diameter) along the tree line are not captured as forest since the spatial resolution is not sufficient in this case.

The current version of CALU does not consider a separate class for artificial areas. Buildings and roads are in cases misclassified as class #2. A separate dataset of human impacted areas (SACHI, Bartsch et al. 2023) has been, however, developed previously (Figure 17). It is recommended to combine both datasets where available (for 68.3%)

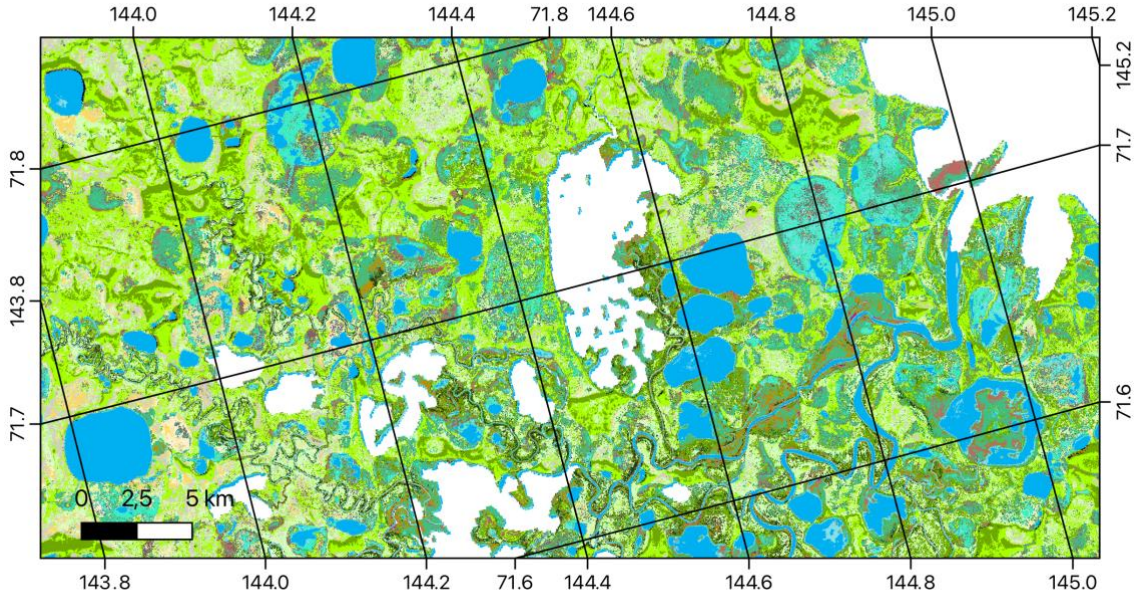

Figure 13: Example for Copernicus DEM related gaps in case of lakes located close to the ocean (tile 54WXE)

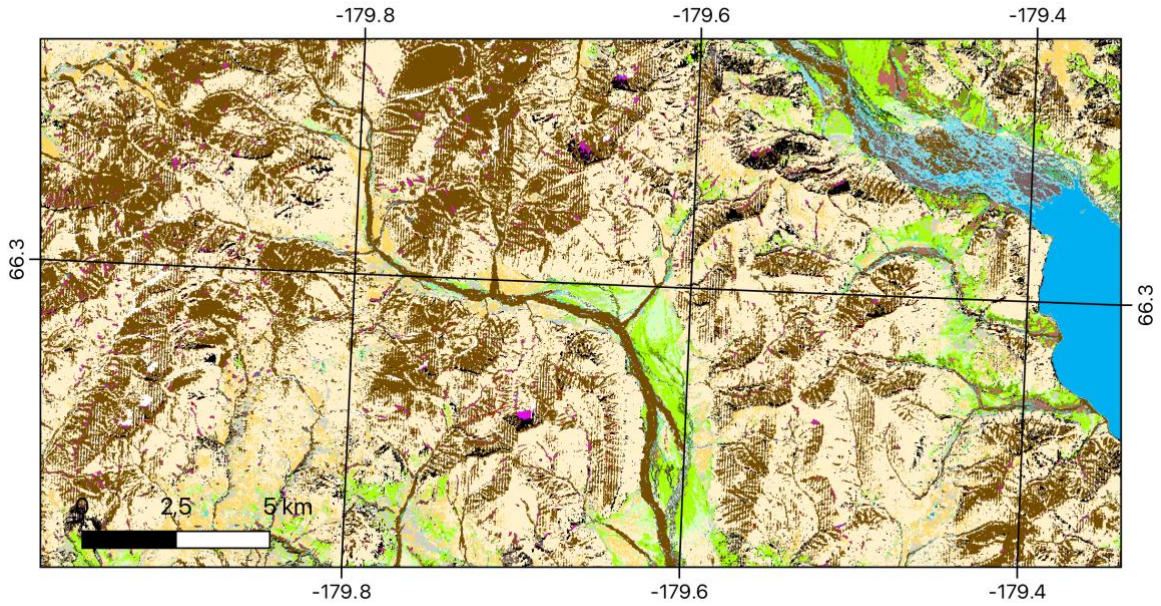

Figure 14: Example for Copernicus DEM related stripes in mountainous areas (tile 01WCP)

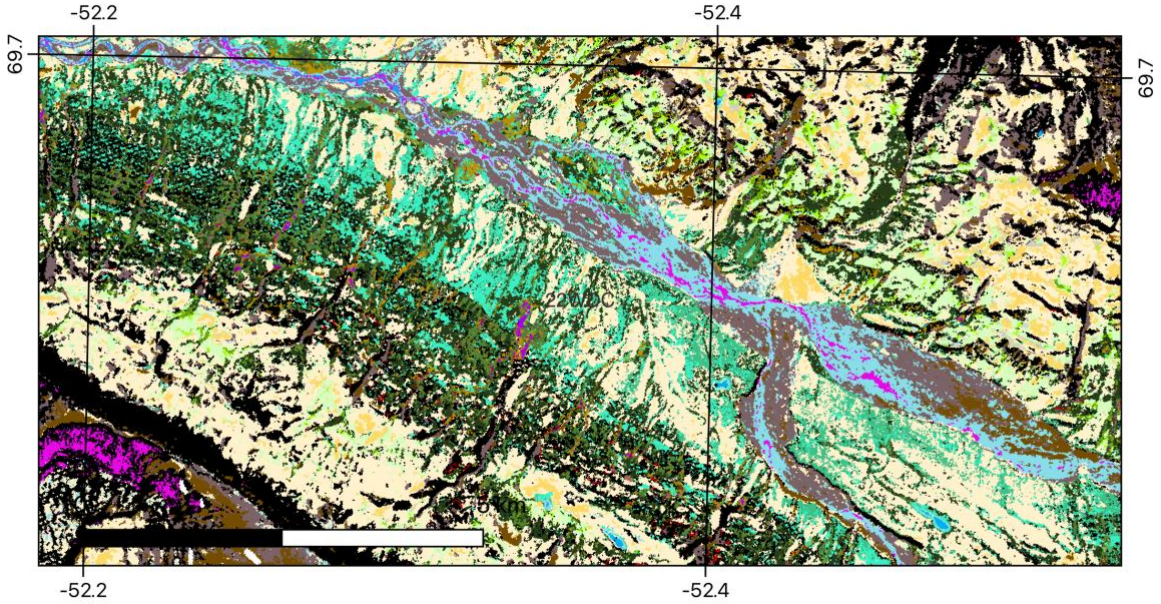

Figure 15: Example for misclassification of river courses as snow and Copernicus DEM issues in mountainous areas (tile 22WDC, Disko Island)

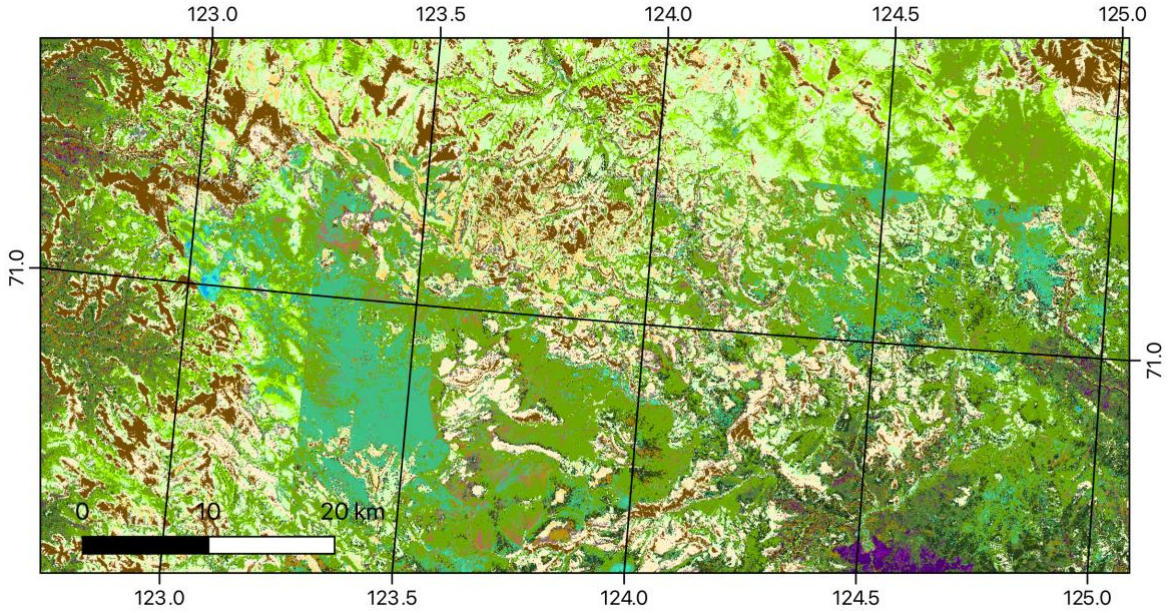

Figure 16: Example for availability of only one scene (17.08.2022) which is affected by too high aerosol optical thickness (tile 51WWU).

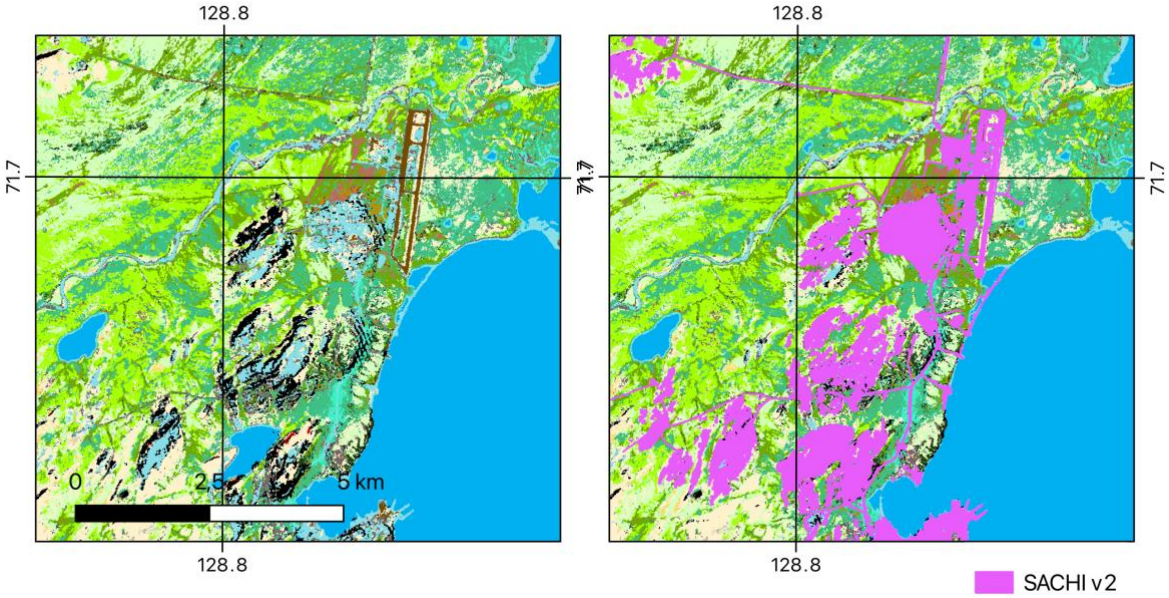

Figure 17: Example for misclassification of infrastructure as class #2 (left), and with overlay SACHI v2 (human impacted areas, Bartsch et al. 2024), (tile 51WXV, Tiksi)

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5.2 Acronyms

AD	Applicable Document
ALT	Active Layer Thickness
AWI	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
AVA	Arctic vegetation archive
B.GEOS	b.geos GmbH
CALU	Circumarctic Landcover Units
CAVM	Circumarctic Vegetation Map
CCI	Climate Change Initiative
CRDP	Climate Research Data Package
CRS	Coordinate Reference System
ECV	Essential Climate Variable
EO	Earth Observation
ESA	European Space Agency
ESA DUE	ESA Data User Element
GAMMA	Gamma Remote Sensing AG
GCOS	Global Climate Observing System
GTN-P	Global Terrestrial Network for Permafrost
IPA	International Permafrost Association
PSD	Product Specifications Document
RD	Reference Document
RMSE	Root Mean Square Error
RS	Remote Sensing
SOC	Soil organic carbon
SU	Department of Physical Geography Stockholm University
URD	Users Requirement Document
WGS 84	World Geodetic System 1984