

climate change initiative

→ PERMAFROST

ESA CCI+ Permafrost – data access and use

Annett Bartsch + ESA project teams (>50 scientists directly involved)

DUE Permafrost (2009-2012)



DUE GlobPermafrost (2016-2019)



CCI+ Permafrost:
Phase I (2018-2021)
Phase II (2022-2025)



permafrost
cci

ESA UNCLASSIFIED - For Official Use

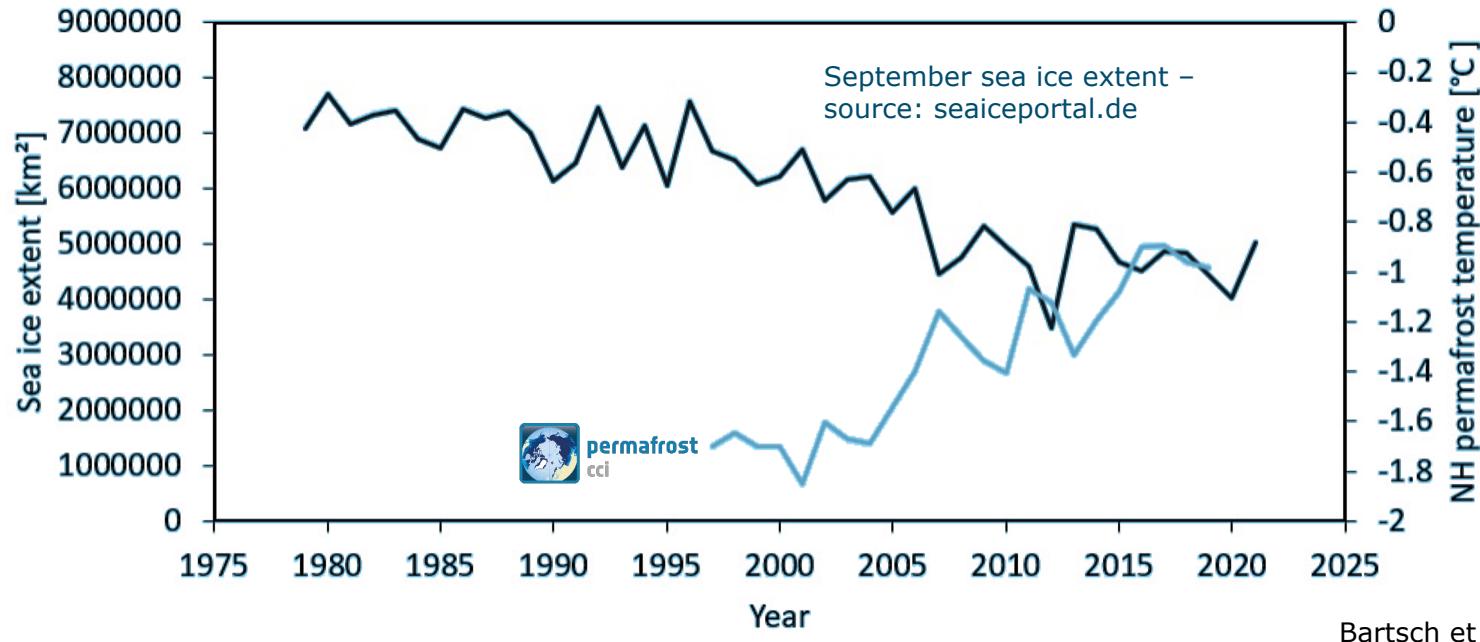




CCI+ Permafrost results



2 m depth ground temperature – derived based on Obu et al. 2021 (CEDA archive)
using Landsurface temperature + CryoGRID model



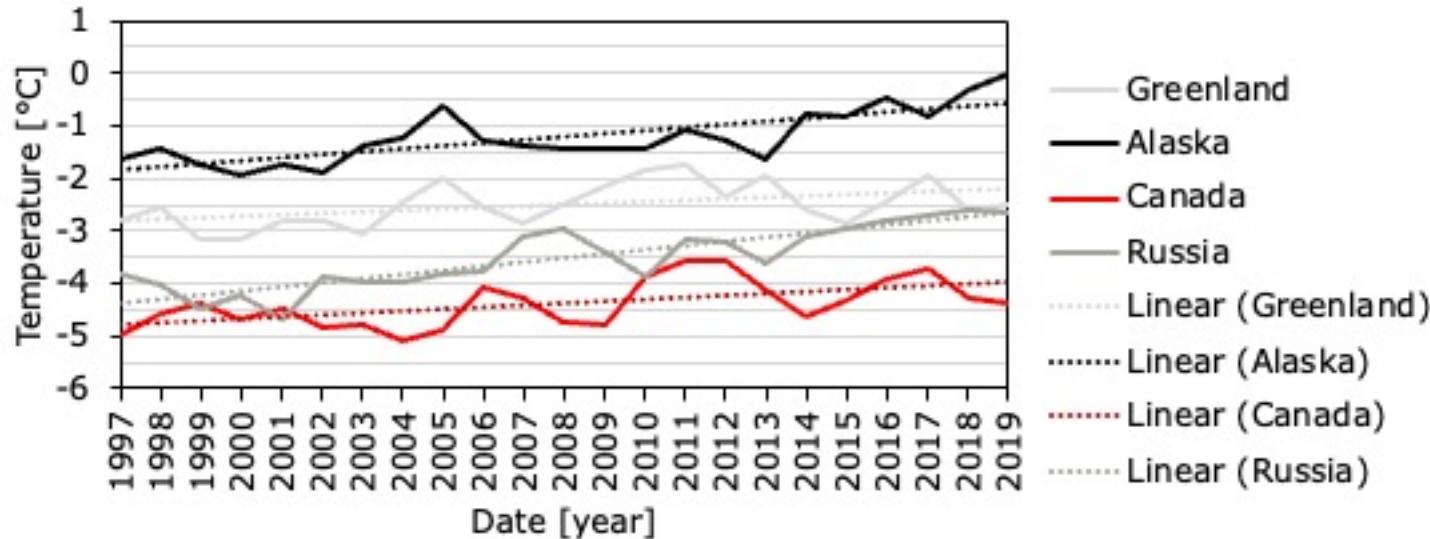
Bartsch et al. (2023)



CCI+ Permafrost results



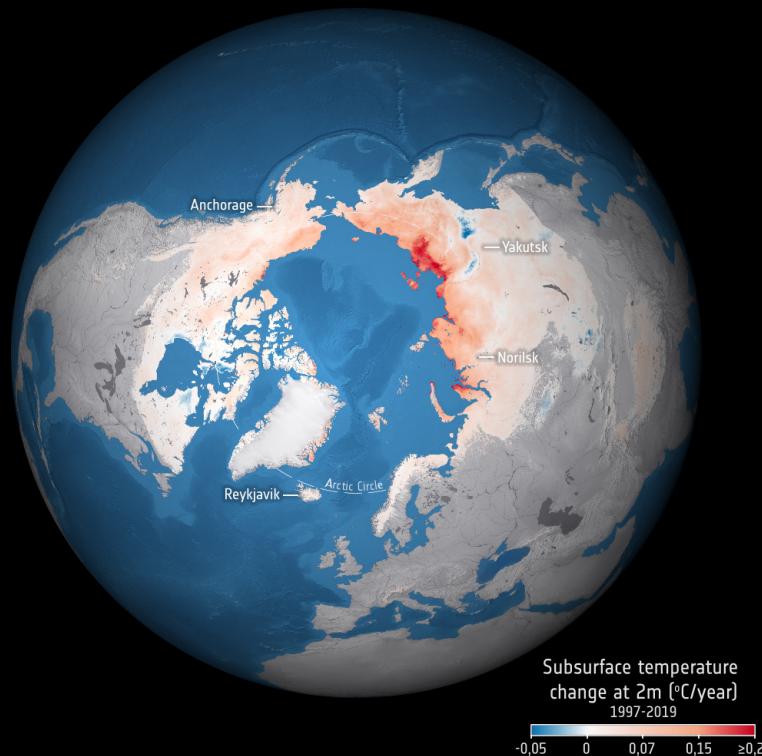
Ground temperature at 2 m depth - CRDPv2 regional average
(spatial subset < 0°C at least 1 year)





permafrost
cci

© ESA, based on Obu et al. (2020)





History & Status

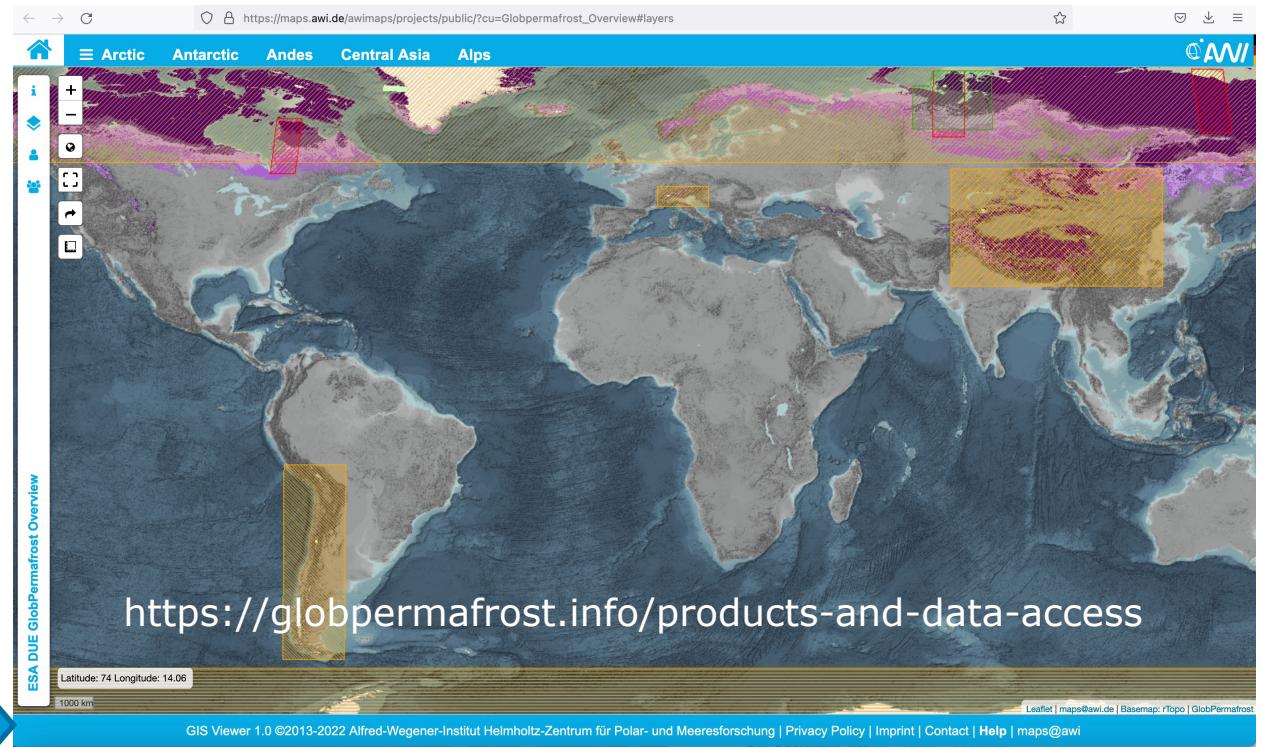


GlobPermafrost (2016-2019)

J. Obu, S. Westermann, A. Bartsch,
N. Berdnikov, H.H. Christiansen, A.
Dashtseren, R. Delaloye, B.
Elberling, B. Etzelmüller, A.
Kholodov, A. Khomutov, A. Kääb,
M.O. Leibman, A.G. Lewkowicz,
S.K. Panda, V. Romanovsky, R.G.
Way, A. Westergaard-Nielsen, T.
Wu, J. Yamkhin, D. Zou (2019).

**Northern Hemisphere
permafrost map based on TTOP
modelling for 2000-2016 at 1
km² scale.** Earth-Science Reviews,
Volume 193, Pages 299-316.

+ southern hemisphere
→ AWI WebGIS





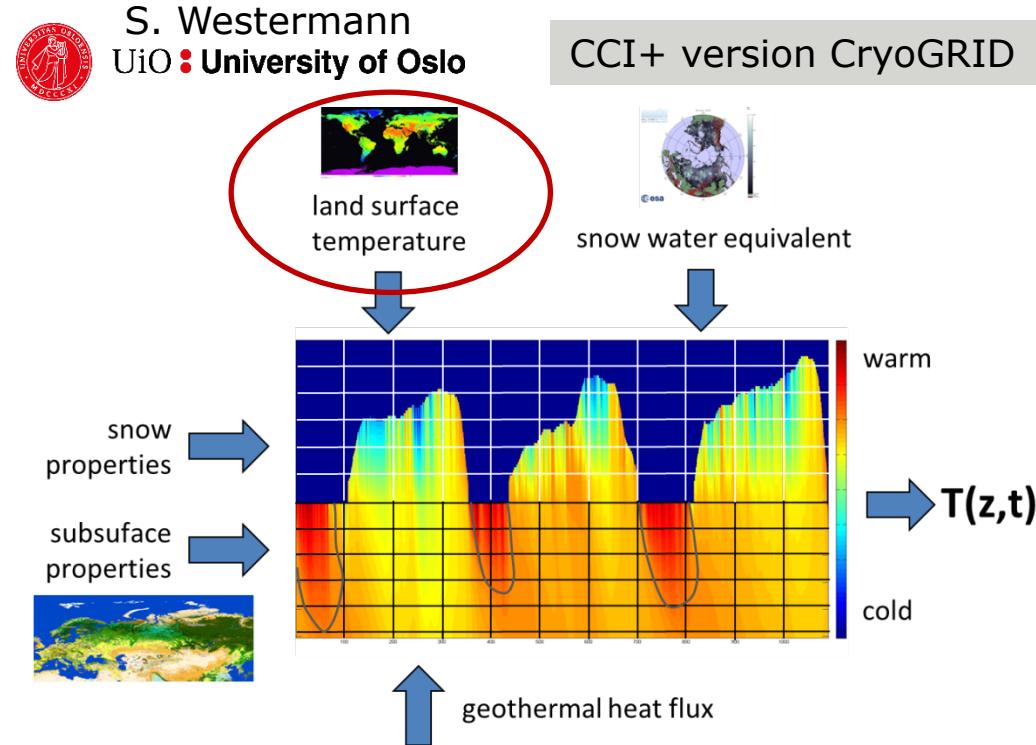
History & Status



CCI+ Permafrost Phase I
(2019-2021)

Transient modelling
is required to produce
time slices

- need of long-term records of
 - Land Surface Temperature,
 - Snow, and
 - suitable soil parameterization





Overview CCI+ Permafrost products

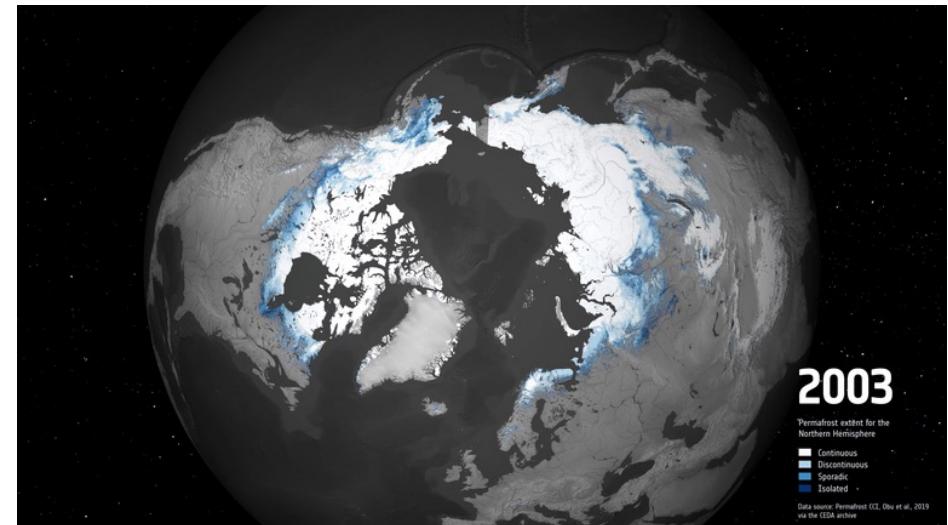


Baseline products for **northern hemisphere (1km)**:

- ❖ Permafrost Temperature
- ❖ Active Layer Thickness
- ❖ Permafrost extent

- ❖ Harmonized borehole temperature records database for calibration and validation

Current version (May 2021): 1997-2019, CRDPv2



Animation: 2003-2017, CRDPv0

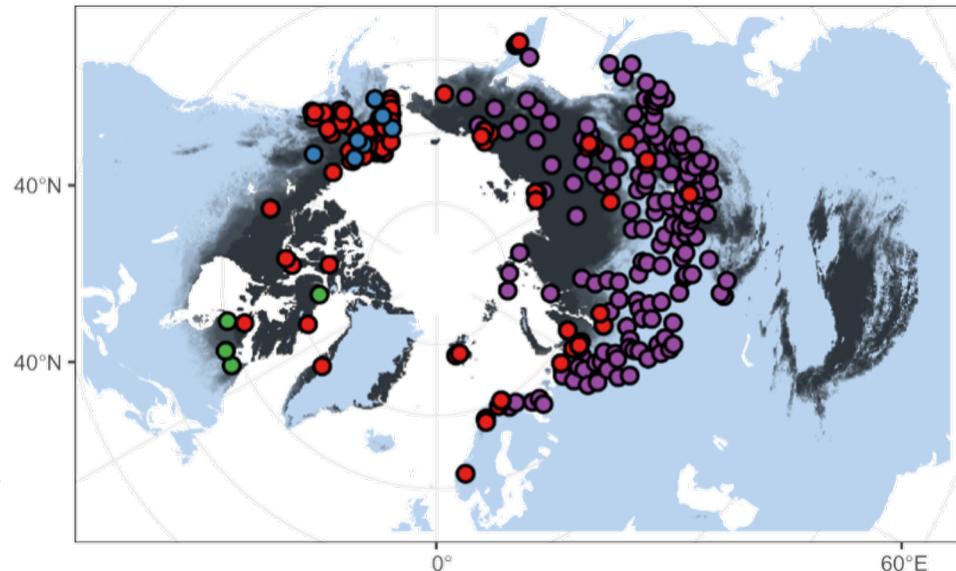


Overview CCI+ Permafrost products



Baseline products for **northern hemisphere (1km)**:

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- ❖ Harmonized borehole temperature records database for calibration and validation



Source of sites for GT Match-up

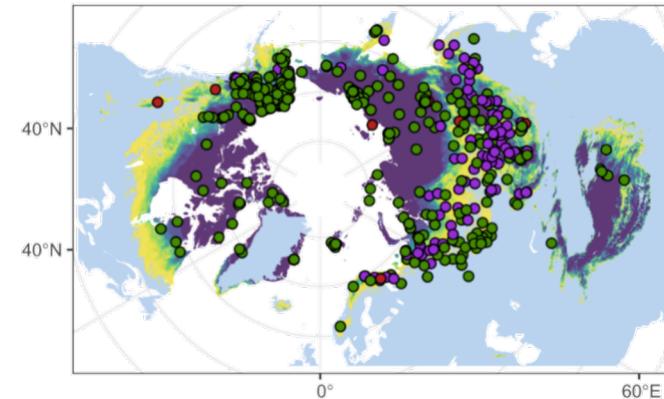
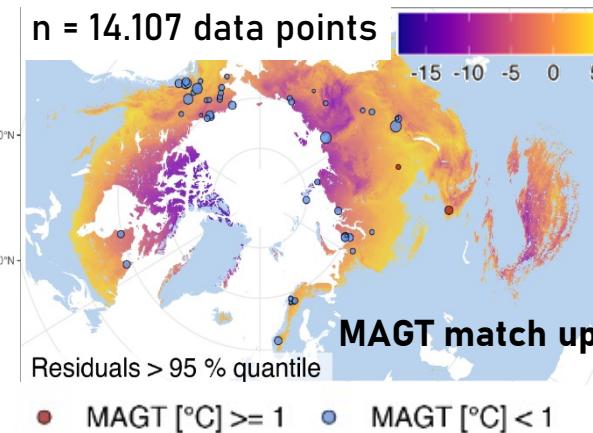
- GTN-P & USGS
- NASA ABoVe
- Nordicana-D
- RHM

In situ data publication
in preparation

MAGT 1997-2019 at depths:
0,0.25,0.5,0.75,1,1.5,2,2.5,3,3,
5,4,4.5,5,10,20 m



ESA Permafrost_cci validation



**Permafrost extent PE
match up**

Permafrost_cci MAGT $<1^{\circ}\text{C}$ good performance bias 0.2°C ($0, 1, 2, 5, 10, 20\text{m}$), stable across years.

Permafrost_cci MAGT discontinuous to non permafrost zones too cold, MAGT bias -1.47°C .

Majority of Permafrost_cci ALT trends match GTN-P ALT trends (60 %), large geographic data gaps.

Majority of Permafrost_cci PE match-up pairs in agreement (70 %), stable across years.



CCI+ Permafrost Phase I



GlobPermafrost
(2016-2019)

Obu et al. (2019)
Earth-Science Reviews

+ lake change along transects
(Nitze et al. 2018)

+ regional InSAR studies (Strozzi et al. 2018, Bartsch et al. 2019)

+ AWI WebGIS

+ several user workshops

Permafrost_cci Phase I (2018 - 2021) Extensions Phase 1 (-2023)

MODIS LST use as input for **transient** modelling

Use: Comparison to lake change, landsurface model evaluation, trend extraction

Circumpolar implementation of GlobPermafrost landcover prototype (10m, ongoing)

Comparison freeze/thaw

Homogeneous inventories of **rock glaciers, kinematics from InSAR**

Extension **of InSAR ground subsidence** for seasonal and long-term signals

Dissemination via CEDA and AWI WebGIS

Landcover data publication in preparation



CCI+ Permafrost Phase I



GlobPermafrost
(2016-2019)

Obu et al. (2019)
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+ lake change along transects
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MODIS LST use as input for **transient** modelling

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Comparison freeze/thaw

Homogeneous inventories of **rock glaciers, kinematics from InSAR**

Extension **of InSAR ground subsidence** for seasonal and long-term signals

Dissemination via CEDA and AWI WebGIS

Rock glacier inventory available (IPA action group)



Phase II



GlobPermafrost
(2016-2019)

Obu et al. (2019)
Earth-Science Reviews
+ lake change along transects
(Nitze et al. 2018)
+regional InSAR studies (Strozzi et al. 2018, Bartsch et al. 2019)
+AWI WebGIS
+several user workshops

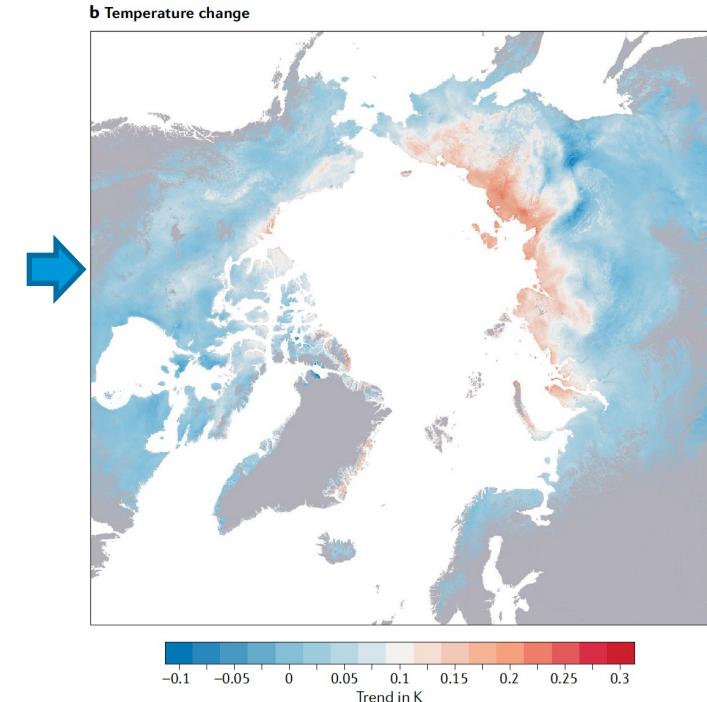
Permafrost_cci Phase I (2018 - 2021) Extensions Phase 1 (-2023)	Permafrost_cci Phase II (2022-2025)
MODIS LST use as input for transient modelling	Adjustment to LST_cci (Sentinel-3) and Snow_cci as input
Use: Comparison to lake change, landsurface model evaluation, trend extraction	Higher level products generation for enhanced user uptake
Circumpolar implementation of GlobPermafrost landcover prototype (10m, ongoing)	Use of landcover for model parameterization, in situ evaluation
Comparison freeze/thaw	
Homogeneous inventories of rock glaciers, kinematics from InSAR	updates
Extension of InSAR ground subsidence for seasonal and long-term signals	R&D for InSAR use in CryoGRID
Dissemination via CEDA and AWI WebGIS	Dissemination via CEDA and AWI WebGIS
	Dedicated user workshops, 1 st at EUCOP 2023



Information gained based on CryoGRID



- Obu (2021), GRL: 15% of NH underlain by permafrost (based on GlobPermafrost dataset)
- Miner et al. (2022), NREE: ground temperature increase pronounced along Arctic coasts
- Bartsch et al. (2023): Since 2000, NH permafrost ground temperatures (2m) have increased on average by about 1°C
- Brouillette (2021), Nature: ALT increased on average 2.5cm across NH during 2007-16 compared to the previous decade





Examples of site specific use



Bartsch et al.

SAR for Arctic Coastal Erosion

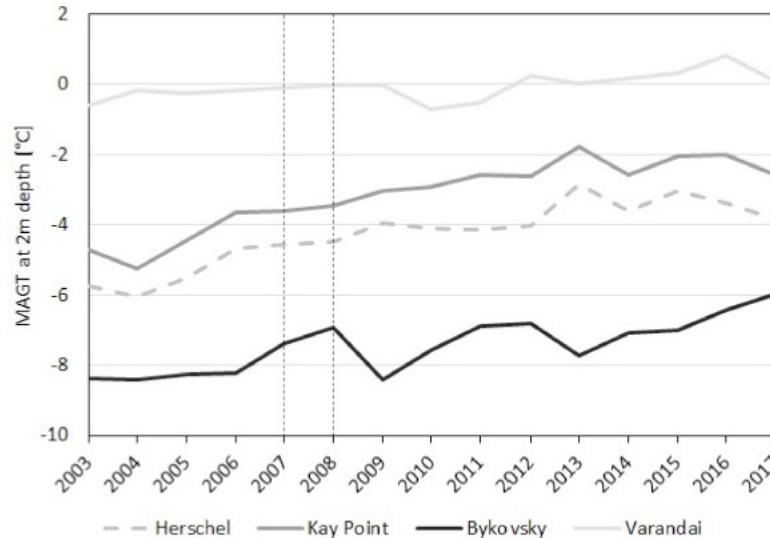


FIGURE 10 | Mean annual ground temperature (MAGT) at 2 m depth for 2003–2017 (source: Obu et al., 2019a). Vertical dashed lines indicate years with PALSAR acquisitions.

Change at sites with high coastal erosion rates

Bartsch A., Ley S., Nitze I., Pointner G., Vieira G. (2020): Feasibility Study for the Application of Synthetic Aperture Radar for Coastal Erosion Rate Quantification Across the Arctic. *Frontiers in Environmental Science* 8, 143



Examples of site specific use



IOP Publishing

Environ. Res. Lett. 16 (2021) 115013

A Bartsch *et al*

Trends versus 2019
status at locations
with infrastructure

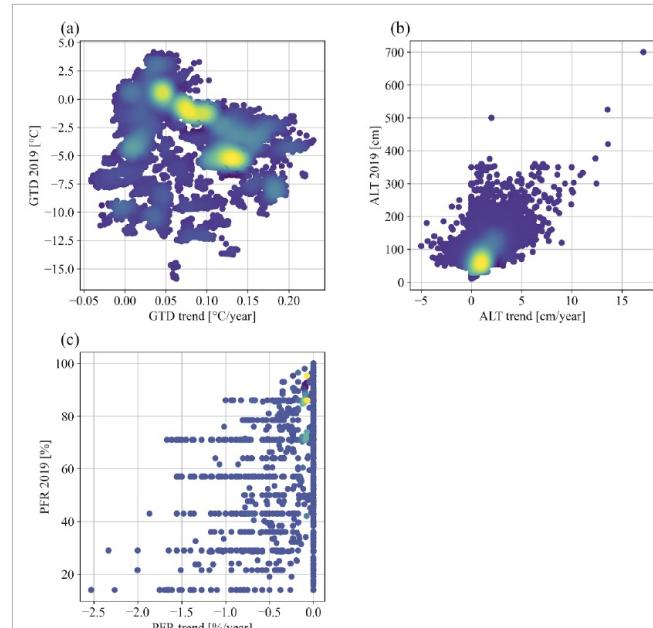


Figure 9. Scatterplots of trend versus 2019 status for (a) ground temperature at 2 m depth, (b) active layer thickness and (c) permafrost fraction. Each point represents the average for a distinct object (human impacted area) as mapped with Sentinel-1 and -2 (Bartsch *et al* 2021). Calculations are based on Obu *et al* (2021a, 2021b, 2021c) respectively.



CLIMATE CHANGE FROM SPACE

CLIMATE KIT

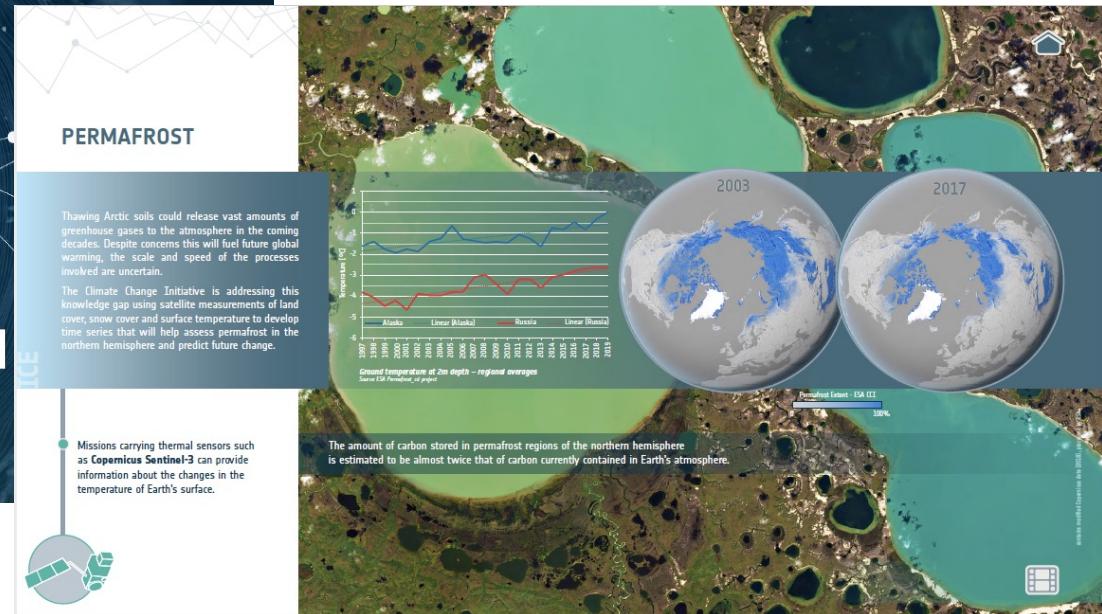
ICE

Missions carrying thermal sensors such as **Copernicus Sentinel-3** can provide information about the changes in the temperature of Earth's surface.

PERMAFROST

Thawing Arctic soils could release vast amounts of greenhouse gases to the atmosphere in the coming decades. Despite concerns this will fuel future global warming, the scale and speed of the processes involved are uncertain.

The Climate Change Initiative is addressing this knowledge gap using satellite measurements of land cover, snow cover and surface temperature to develop time series that will help assess permafrost in the northern hemisphere and predict future change.



Visualization of CRDPv0



Data access and use tutorial overview



- Focus on CryoGRID results
 - There is one data download portal (CEDA)
 - There are two visualization options (AWI WebGIS and ESA 'Climate from Space')
- Access examples:
 1. Download of annual northern hemisphere dataset and use in QGIS
 2. Extraction of ground temperature for a specific coordinate from data portal
 3. Visualization of data and manual extraction of value for a specific site through WebGIS

← Can be done with a mobile



Data access



- Search for CCI Permafrost
- <https://climate.esa.int/en/projects/permafrost/data/>

Data

[ABOUT](#)[DATA](#)[KEY DOCUMENTS](#)[TEAM](#)[PUBLICATIONS](#)[LINKS](#)[CONTACTS](#)[WORKSHOPS](#)[NEWS AND EVENTS](#)



Permafrost Year 3 Climate Research Data Package (CRDP v2) on [CEDA Archive](#) and on the [Climate Data Dashboard](#).

CRDPv2 includes:

- [Mean Annual Ground Temperature in permafrost areas for the Northern Hemisphere, v3.0, 1997-2019, 1km; 0m, 1m, 2m, 5m and 10 m depth](#) (University Oslo);
- [Permafrost extent for the Northern Hemisphere, v3.0, 1997-2019, 1km, fraction, annual](#) (University Oslo);
- [Permafrost active layer thickness for the Northern Hemisphere, v3.0, 1997-2019, 1 km, annual maximum thaw depth](#) (University Oslo).

Citation of complete dataset:

Obu, J.; Westermann, S.; Barboux, C.; Bartsch, A.; Delaloye, R.; Grosse, G.; Heim, B.; Hugelius, G.; Irrgang, A.; Kääb, A.M.; Kroisleitner, C.; Matthes, H.; Nitze, I.; Pellet, C.; Seifert, F.M.; Strozzi, T.; Wegmüller, U.; Wieczorek, M.; Wiesmann, A. (2021): ESA Permafrost Climate Change Initiative (Permafrost_cci): Permafrost version 3 data products. Centre for Environmental Data Analysis, *date of citation*. <http://catalogue.ceda.ac.uk/uuid/8239d5f6263f4551bf2bd100d3ecbead>

Alternative access via WebGIS visualization at <https://maps.awi.de>.

Additional Permafrost_cci records:

- Rock glacier inventories at [WebMAPS](#) (University Fribourg).
- Days with potential alteration of ground temperature through rain on snow: mid-winter (Nov-Feb) snow thaw and refreeze, north of 65°N, MetopASCAT + SMOS at <https://zenodo.org/record/7575927> (b.geos and FMI).

Heritage

- Global permafrost properties (probability and mean annual ground temperature) based on equilibrium modelling (TTOP, 2000-2016) from GlobPermafrost (<https://globpermafrost.info/products-and-data-access>).



Key documents

a

Permafrost_CCI baseline project Phase 1

Document name	Version	Issue date	Download
D1.1 User Requirements Document (URD)	2.0	Nov. 30, 2020	
D1.2 Product Specification Document (PSD)	3.0	Nov. 30, 2020	
D1.3 Data Access Requirements Document (DARD)	2.0	Dec. 22, 2020	
D2.1 Product Validation and Algorithm Selection Report (PVASR)	3.0	Feb. 24, 2021	
D2.2 Algorithm Theoretical Basis Document (ATBD)	3.0	Nov. 30, 2020	
D2.3 End-to-End ECV Uncertainty Budget (E3UB)	3.0	Feb. 24, 2021	
D2.4 Algorithm Development Plan (ADP)	3.0	Nov. 30, 2020	
D2.5 Product Validation Plan (PVP)	3.0	Dec. 22, 2020	
D3.1 System Requirement Document (SRD)	3.0	April 8, 2021	
D3.2 System Specification Document (SSD)	3.0	April 8, 2021	
D3.3 System Verification Report (SVR)	3.0	April 8, 2021	
D4.1 Product Validation and InterComparison Report (PVIR)	3.0	Sept. 30, 2021	
D4.2 Climate Research Data Package (CRDP) Version 2	2	Sept. 25, 2021	
D4.3 Product User Guide (PUG)	3.0	April 13, 2021	
D5.1 Climate Assessment Report (CAR)	3.1	Jan. 19, 2022	



Permafrost_CCI baseline project Phase 2

Future updates here

Document name	Version	Issue date	Download
D1.1 User Requirement Document (URD)	3.0	Feb. 15, 2023	
D1.2 Product Specification Document (PSD)	4.0	Feb. 15, 2023	



Permafrost Year 3 Climate Research Data Package (CRDP v2) on CEDA Archive and on the Climate Data Dashboard.

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ESA Climate Office

[Home](#) > [Open Data Portal](#)

Evidence | Explore | Educate | ESA & Climate

Climate Data Dashboard

of the ESA Climate Change Initiative

→ Climate Data Search interface

for the ESA Climate Change Initiative

- Aerosol
- Cloud
- Greenhouse Gases
- Ozone
- Ocean Colour
- Sea Ice
- Sea Level
- Sea State
- Sea Surface Salinity
- Sea Surface Temperature
- Water Vapour
- Antarctic Ice Sheet
- Above-Ground Biomass
- Fire
- Glaciers
- Greenland Ice Sheet
- Lakes
- Land Cover
- Land Surface Temperature
- Permafrost
- Snow
- Soil Moisture

1980 1990 2000 2010 2020

ESA Climate Office

Home > Open Data Portal

Evidence | Explore | Educate | ESA & Climate

← Climate Data Dashboard

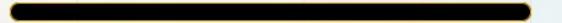
of the ESA Climate Change Initiative

Permafrost ↗

The ultimate objective of Permafrost_cci is to develop and deliver permafrost maps as ECV products primarily derived from satellite measurements. The required associated parameters by GCOS for the ECV Permafrost are 'Depth of active layer (m)' and 'Permafrost temperature (K)'.

Total catalogue size: 42.9 GB

Permafrost active layer thickness for the Northern



Permafrost Ground Temperature for the Northern Hem



Permafrost extent for the Northern Hemisphere, v3.



2000 2010 2020

This dataset contains permafrost active layer thickness data produced as part of the European Space Agency's (ESA) Climate Change Initiative (CCI) Permafrost project. It forms part of the second version of their Climate Research Data Package (CDRP v2). It is derived from a thermal model driven and constrained by satellite data. Grid products of CDRP v2 are released in annual files, covering the start to the end of the Julian year. The maximum depth of seasonal thaw is provided, which corresponds to the active layer thickness. Case A: This covers the Northern Hemisphere (north of 30°) for the period 2003-2019 based on MODIS Land Surface temperature merged with downscaled ERA5 reanalysis near-surface air temperature data. Case B: This covers the Northern Hemisphere (north of 30°) for the period 1997-2002 based on downscaled ERA5 reanalysis near-surface air temperature data which are bias-corrected with the Case A product for the overlap period 2003-2019 using a pixel-specific statistics for each day of the year.

Data have been produced by the ESA CCI Permafrost project as part of ESA's Climate Change Initiative programme

Permafrost active layer thickness
for the Northern Hemisphere, v3.0
Click here for data access ↗

Catalogue size: 6.6 GB
Number of files: 24

- ↗ Dataset Information ↗
- ↗ Product Guide ↗
- ↗ Start date: 01 Jan 1997
- ↗ End date: 31 Dec 2019
- ↗ FTP Download ↗
- ↗ Additional Download Options

Link to CEDA



CRDP – Climate research data package



CRDPv0 is dataset v1.0

CRDPv1 is dataset v2.0

...

CEDA Archive

Search Catalogue Get Data Help Tools Deposit News Sign in

Dataset

esa [View XML](#) **ESA Permafrost Climate Change Initiative (Permafrost_cci): Permafrost extent for the Northern Hemisphere, v3.0**

 [Download](#)

Update Frequency:	Not Planned
Status:	Completed
Online Status:	ONLINE
Publication State:	Citable
Publication Date:	2021-06-25
DOI Publication Date:	2021-06-28
Download Stats:	last 12 months
Dataset Size:	23 Files 3 GB

Abstract

This dataset contains permafrost extent data produced as part of the European Space Agency's (ESA) Climate Change Initiative (CCI) Permafrost project. It forms part of the second version of their Climate Research Data Package (CRDP v2). It is derived from a thermal model driven and constrained by satellite data. Grid products of CDRP v2 are released in annual files, covering the start to the end of the Julian year. This corresponds to average annual ground temperatures (at 2 m depth) which forms the basis for the retrieval of yearly fraction of permafrost-underlain and permafrost-free area within a pixel. A classification according to the IPA (International Permafrost Association) zonation delivers the well-known permafrost zones, distinguishing isolated (0-10%) sporadic (10-50%), discontinuous (50-90%) and continuous permafrost (90-100%).

Case A: This covers the Northern Hemisphere (north of 30°) for the period 2003-2019 based on MODIS Land Surface temperature merged with downscaled ERA5 reanalysis near-surface air temperature data.

Coverage

Temporal Range

Start time: 1997-01-01T00:00:00
End time: 2019-12-31T23:59:59

Geographic Extent



File naming



Level 4 - Data sets are created from the analysis of lower level data, resulting in gridded, gap-free products

Area 4 – Northern Hemisphere

One file – one year

Screenshot of the CEDA Archive website showing a list of files for the "Permafrost extent for the Northern Hemisphere, v3.0" dataset. The files are listed in a table with columns for Description, Size, and Actions. A red circle highlights the top right corner of the table header, which includes the total size ("3.4 GB | 23 files | mostly.nc") and navigation icons for shopping cart, document, and search.

Description	Size	Actions
O README_catalogue_and_licence.txt	894 bytes	
ESACCI-PERMAFROST-L4-PFR- ERA5_MODISLT_BIASCORRECTED- AREA4_PP-1997-fv03.0.nc	150.0 MB	
ESACCI-PERMAFROST-L4-PFR- ERA5_MODISLT_BIASCORRECTED- AREA4_PP-1998-fv03.0.nc	150.0 MB	
ESACCI-PERMAFROST-L4-PFR- ERA5_MODISLT_BIASCORRECTED- AREA4_PP-1999-fv03.0.nc	150.0 MB	
ESACCI-PERMAFROST-L4-PFR- ERA5_MODISLT_BIASCORRECTED- AREA4_PP-2000-fv03.0.nc	150.0 MB	
ESACCI-PERMAFROST-L4-PFR- ERA5_MODISLT_BIASCORRECTED- AREA4_PP-2001-fv03.0.nc	150.0 MB	
ESACCI-PERMAFROST-L4-PFR-		



Bulk download options



Size	Actions
894 bytes	
150.0 MB	

Manual download



Subset download
(only spatially,
bands)



Bulk Download Options

- Raw HTTP downloads: https://dap.ceda.ac.uk/neodc/esacci/permafrost/data/active_layer_thickness/L4/area4/pp/v03.0/ (Tip: If our file indexing is behind for some reason, then this service may show more recent changes that may not be displayed here)
- Wget: `wget -e robots=off --mirror --no-parent -r https://dap.ceda.ac.uk/neodc/esacci/permafrost/data/active_layer_thickness/L4/area4/pp/v03.0//` Wget is great for bulk downloading.
- FTP: ftp://ftp.ceda.ac.uk/neodc/esacci/permafrost/data/active_layer_thickness/L4/area4/pp/v03.0/ There are lots of tools that can use FTP to do bulk downloads (e.g. Filezilla)
- DAP: If you need to just get a subset of NetCDF files have a look at help page about interacting programmatically with the data
- JSON listing: Use json listing of this directory to script download.



MODISLT_CRYOGRID-AREA4_PP-2010-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2011-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2012-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2013-fv03.0.nc	150.0 MB		
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ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2015-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2016-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2017-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2018-fv03.0.nc	150.0 MB		
ESACCI-PERMAFROST-L4-PFR-MODISLT_CRYOGRID-AREA4_PP-2019-fv03.0.nc	150.0 MB		

Permafrost extent



Example 1



- Note, issue with NetCDF metadata projection information for all datasets in the current version on CEDA

- Python fix available on GitHub
 - https://github.com/bgeosgit/permafrost_cci.git
- will be solved in next upload later this year

The screenshot shows a GitHub repository page for `bgeosgit/permafrost_cci`. The repository has 49 lines of code in 39 loc, totaling 3.51 KB. The file `nc_crs_fix.py` is the main script being discussed. The code is a Python script that imports netcdf files, copies them, and writes corrected CRS information. It includes comments explaining its purpose and limitations.

```
1  """
2  # Created on Aug 8 2022
3
4  #author: Helena Bergstedt, b.geos GmbH
5  """
6
7  #####
8  # This script imports (ESA CCI Permafrost) netcdf files, copies it, writes the correct
9  # ONLY USE if you are sure about the CRS, this is not reprojecting the data, just fix
10 # This script can be used to correct the netcdf files currently available.
11
12 # This is the CRS WKT currently in the published netcdf files: 'PROJCS["WGS 84 / Arctic
13 # The CRS WKT string currently in the files is not valid, can not be read by QGIS/Arc
14 # especially when comparing this data to data from other sources.
15
16 # This is the CRS WKT that is needed: 'PROJCS["WGS 84 / Arctic Polar Stereographic",
17
```



Setting the layer coordinate system in QGIS, e.g. in version 3.12 for windows (not all versions work)

Koordinatensystem	AutoritätsID
Sphere_Stereographic	ESRI:53026
TERRE ADELIE POINTE GEOLOGIE PERROU...	IGNF:TERA50STEREO
TERRE ADELIE POINTE GEOLOGIE PERROU...	IGNF:PGP50STEREPS
WGS 84 / Antarctic Polar Stereographic	EPSG:3031
WGS 84 / Arctic Polar Stereographic	EPSG:3995
WGS 84 / Australian Antarctic Polar Stereo...	EPSG:3032



CEDA Archive

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 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2011- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2012- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2013- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2014- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2015- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2016- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2017- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2018- fv03.0.nc	1.4 GB		
 ESACCI-PERMAFROST-L4-GTD- MODISLST_CRYOGRID-AREA4_PP-2019- fv03.0.nc	1.4 GB		



Example 2



Action: [Get ASCII](#) [Get Binary](#) [Show Help](#)

Data URL: http://dap.ceda.ac.uk/thredds/dodsC/neodc/esacci/permafrost/data/ground_temperature/L1/2021-02-24/11:21:13

Global Attributes:

```
title: CCI Permafrost ground temperature
institution: University of Oslo
source: MODIS MOD11A1 and MYD11A1 level 3 Collection 6, ESA CCI Land Cover dataset v1.6.1, ERA5 Reanalysis
history: 2021-02-24 11:21:13
```

Variables:

- polar_stereographic:** 32 bit Integer
polar_stereographic =
grid_mapping_name: polar_stereographic
straight_vertical_longitude_from_pole: 0.0
false_easting: 0.0
false_northing: 0.0
latitude_of_projection_origin: 90.0
- X:** Array of 64 bit Reals [x = 0.14761]
x:
standard_name: projection_x_coordinate
long_name: x coordinate of projection
units: m
axis: X
actual_range: -6111938.535111316, 7566906.108876757
- Y:** Array of 64 bit Reals [y = 0..10352]
y:
standard_name: projection_y_coordinate
long_name: y coordinate of projection
units: m
axis: Y
actual_range: -5477994.701867972, 4115358.40741319
- time:** Array of 64 bit Reals [time = 0.0]
time:
axis: T
standard_name: time
long_name: time
calendar: standard
units: hours since 1950-01-01 00:00:00
- GST: Grid**
time: y: x:
standard_name: surface_temperature
grid_mapping: polar_stereographic



Resolution is 927m!

T2m: Grid

time: 0:1:0 y: 2282:1:2282 x: 5516:1:5516

standard_name: solid_earth_subsurface_temperature
grid_mapping: polar_stereographic
units: degrees celsius
conversion: to degrees celsius **x*0.01-273.15**
scale_factor: 0.01



X -1.000.000
Y 2.000.000

(e.g. projection number EPSG:3995 in QGIS)

Grid
X 5516
Y 2282
-> 'get ASCII'



Action: [Get ASCII](#) [Get Binary](#) [Show Help](#)

Data URL: http://dap.ceda.ac.uk/thredds/dodsC/neodc/esacci/permafrost/data/ground_temperature/L1

Global Attributes:

```
title: CCI Permafrost ground temperature
institution: University of Oslo
source: MODIS MOD11A1 and MYD11A1 level 3 Collection 6, ESA CCI Land Cover dataset v1.6.1, ERA5 Reanalysis
history: 2021-02-24 11:21:13
```

Variables:

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straight_vertical_longitude_from_pole: 0.0
false_easting: 0.0
false_northing: 0.0
latitude_of_projection_origin: 90.0
- X:** Array of 64 bit Reals [x = 0.14761]
x:
standard_name: projection_x_coordinate
long_name: x coordinate of projection
units: m
axis: X
actual_range: -6111938.535111316, 7566906.108876757
- Y:** Array of 64 bit Reals [y = 0.10352]
y:
standard_name: projection_y_coordinate
long_name: y coordinate of projection
units: m
axis: Y
actual_range: -5477994.701867972, 4115358.40741319
- time:** Array of 64 bit Reals [time = 0.0]
time:
axis: T
standard_name: time
long_name: time
calendar: standard
units: hours since 1950-01-01 00:00:00
- GST: Grid**
time: y: x:
standard_name: surface_temperature
grid_mapping: polar_stereographic



Resolution is 927m!

T2m: Grid

time: 0:1:0 y: 2282:1:2282 x: 5516:1:5516

```
standard_name: solid_earth_subsurface_temperature
grid_mapping: polar_stereographic
units: degrees celsius
conversion: to degrees celsius xx*0.01-273.15
scale_factor: 0.01
```

=-4.15° C

T2m.time[1]

604848.0

T2m.y[1]

2000335.8562749452

T2m.x[1]

-1000209.3332037004



CRDPv1 (ends 2018)

Map Content

Data Layers

- Ground temperature (surface, 1m, 2m, 5m, 10m; annual mean, overall mean, standard deviation, change)
 - Surface
 - 1 m depth
 - 2 m depth
 - 5 m depth
 - 10 m depth
- Permafrost extent (annual probability, overall probability)
- Active Layer Thickness (annual mean; overall: max, mean, min, change)

Temporal Filter

1997 Year 2016 2018

Service Name: GlobPermafrost_Groundtemperature_Timeseries
Provider Name: ESA Permafrost Climate Change Initiative (Permafrost_cci): Permafrost Climate Research Data Package
Project: Permafrost_cci
Project website: <http://ccl.esa.int/Permafrost>
Data source: <https://catalogue.ceda.ac.uk/uuid/6ebcb7315>
PI: Prof. Sebastian Westermann
CID: <https://orcid.org/0000-0003-0514-4321>
Date/time: 2016-01-01T00:00:00
Pixel Value: -5.87

e.g. via www.globpermafrost.info



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Climate Data Dashboard

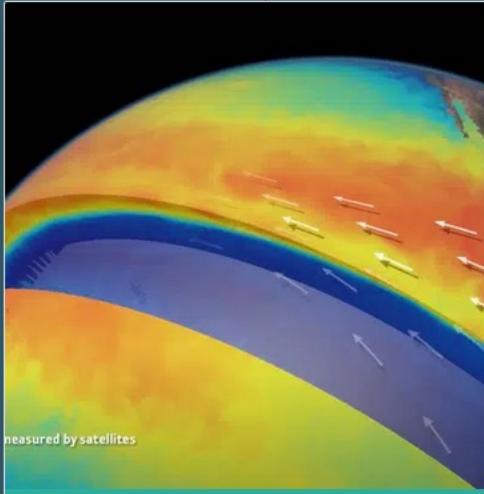
of the ESA Climate Change Initiative

→ Climate Data Search interface

for the ESA Climate Change Initiative

- Aerosol
- Cloud
- Greenhouse Gases
- Ozone
- Ocean Colour
- Sea Ice
- Sea Level
- Sea State
- Sea Surface Salinity
- Sea Surface Temperature
- Water Vapour
- Antarctic Ice Sheet
- Above-Ground Biomass
- Fire
- Glaciers
- Greenland Ice Sheet
- Lakes
- Land Cover
- Land Surface Temperature
- Permafrost
- Snow
- Soil Moisture

1980 1990 2000 2010 2020



Climate from Space - interactive application

Explore the changing climate through the eyes of satellites with this interactive app

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Explore Climate Data

Explore how our climate has evolved through 40 years of research-quality satellite data

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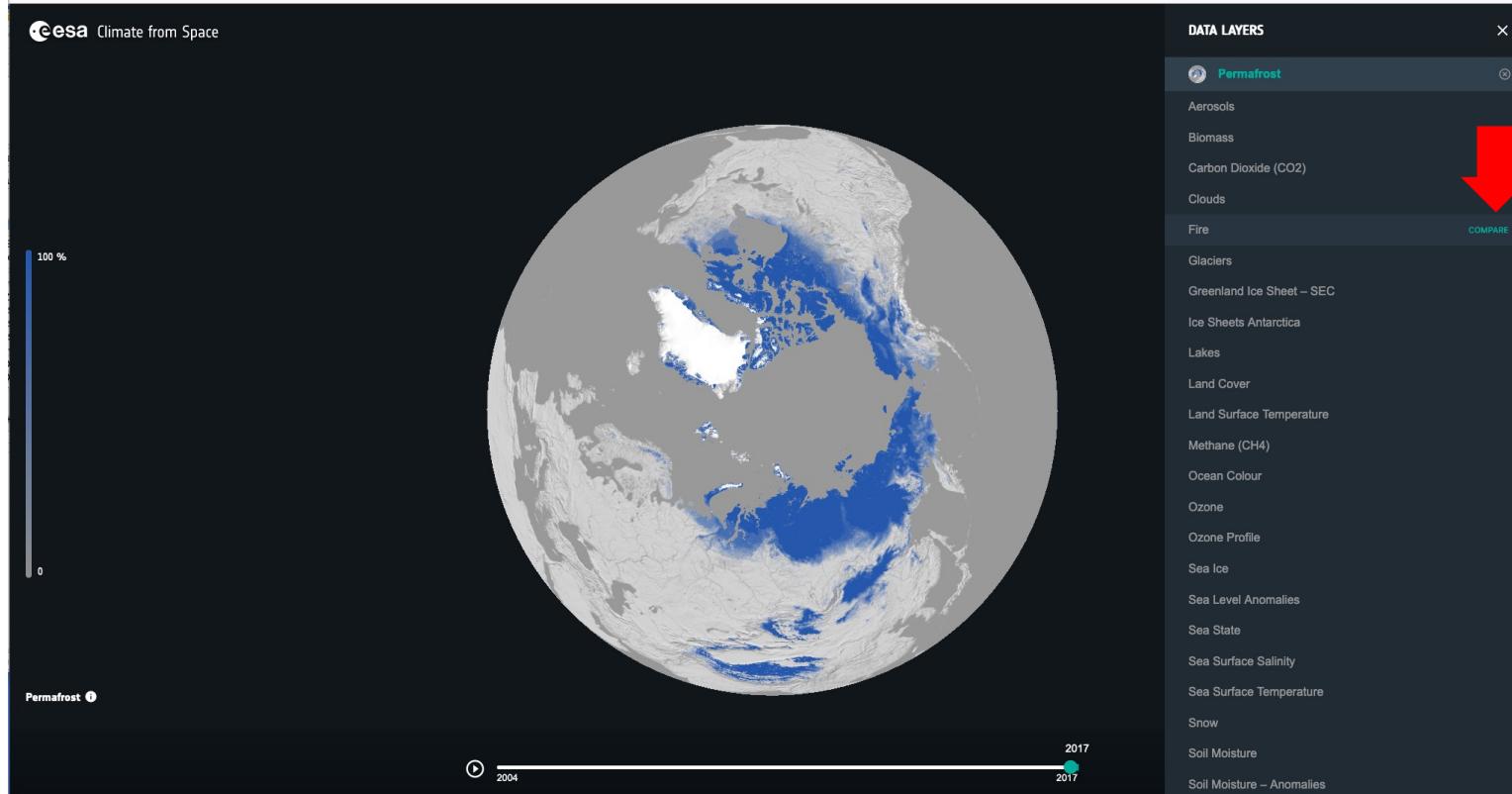
CCI Open Data Portal

Free and open access to all CCI Essential Climate Variable data products

[Learn more](#)



CCI portal – Climate from Space

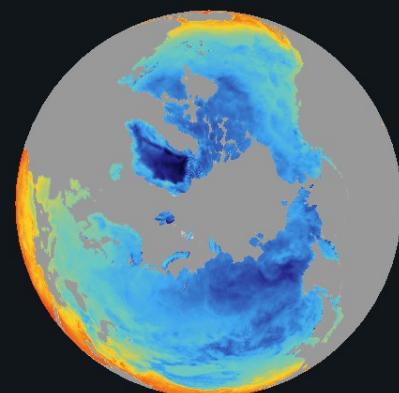
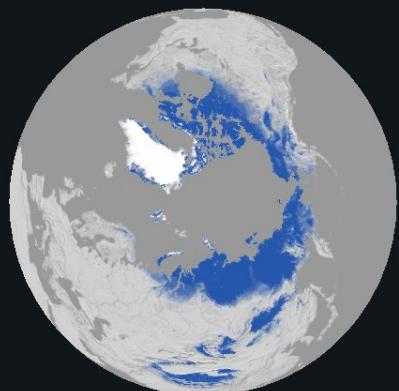


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European Space Agency



Permafrost

Land Surface Temperature



1996

2017

2020

January 2017

2D





Permafrost Year 3 Climate Research Data Package (CRDP v2) on CEDA Archive and on the Climate Data Dashboard.

CRDPv2 includes:

- Mean Annual Ground Temperature in permafrost areas for the Northern Hemisphere, v3.0, 1997-2019, 1km; 0m, 1m, 2m, 5m and 10 m depth (University Oslo);
- Permafrost extent for the Northern Hemisphere, v3.0, 1997-2019, 1km, fraction, annual (University Oslo);
- Permafrost active layer thickness for the Northern Hemisphere, v3.0, 1997-2019, 1 km, annual maximum thaw depth (University Oslo).

Citation of complete dataset:

Obu, J.; Westermann, S.; Barboux, C.; Bartsch, A.; Delaloye, R.; Grosse, G.; Heim, B.; Hugelius, G.; Irrgang, A.; Kääb, A.M.; Kroisleitner, C.; Matthes, H.; Nitze, I.; Pellet, C.; Seifert, F.M.; Strozzi, T.; Wegmüller, U.; Wieczorek, M.; Wiesmann, A. (2021): ESA Permafrost Climate Change Initiative (Permafrost_cci): Permafrost version 3 data products. Centre for Environmental Data Analysis, *date of citation*. <http://catalogue.ceda.ac.uk/uuid/8239d5f6263f4551bf2bd100d3ecbead>

Alternative access via WebGIS visualization at <https://maps.awi.de>.

Additional Permafrost_cci records:

- Rock glacier inventories at WebMAPS (University Fribourg).
- Days with potential alteration of ground temperature through rain on snow: mid-winter (Nov-Feb) snow thaw and refreeze, north of 65°N, MetopASCAT + SMOS at <https://zenodo.org/record/7575927> (b.geos and FMI).

Heritage

- Global permafrost properties (probability and mean annual ground temperature) based on equilibrium modelling (TTOP, 2000-2016) from GlobPermafrost (<https://globpermafrost.info/products-and-data-access>).