Sub-ground permafrost data management and complementation by remotely sensed data for circumpolar assessment of changing permafrost within PAGE21

Jean-Pierre Lanckman[1], Halldor Johannsson[1], Kerstin Gillen[1], Boris K. Biskaborn[2], Leena-Kaisa Vitanen[2], Hugues Lantuit[2], Annett Bartsch[3], Barbara Widhalm[3], Elin Högström[3], Catherine Ottlé[4], Cyrille André[4]

1 Arctic Portal, Akureyri, Iceland

2 Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany

3 Vienna University of Technology, Austria

4 Labotatoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette, France

13th Circumpolar Remote Sensing Symposium
Reykjavik, 09/09/2014

Overview

- Status Network
  - GTN-P Database from Page21 project
  - Integration of DUE Permafrost variables
  - Factsheet (numbers)
- New Achievements of the GTN-P System
  - Standardized Repository for *permafrost temperature* and *annual thaw depth* variables, Metadata article, New monitoring campaign assignment, Publication of global interpolated product for modelers in NetCDF
  - Degree of Convergence (DUE Permafrost)
- Towards an integrated Network
  - Quantitiave and qualitative data
  - Merge Remote Sensing products with Field Measurement Variables and knowledge products
  - Toward an Ontology for Permafrost: *PermafrostML*

GTN-P Database

- ## Central database of the Global Terrestrial Network on Permafrost (GTN-P)

The European Union project PAGE21 (Changing Permafrost in the Arctic and its Global Effects in the 21st century) created opportunities to develop this central database for permafrost monitoring parameters of GTN-P during the duration of the project and beyond.

The GTN-P database is hosted and designed at the Arctic Portal in Akureyri, Iceland. It is managed in close cooperation with the Alfred Wegener Institute for Polar and Marine Research in Potsdam, Germany, which is also coordinator of the PAGE21 project within EU 7th framework programme, main sponsor for the establishment of this database.

GTN-P was developed in the 1990s by the IPA (International Permafrost Association) under the GCOS (Global Climate Observing System) and the GTOS (Global Terrestrial Observing Network), with the long term goal of obtaining a comprehensive view of the spatial structure, trends, and variability of changes in the active layer thickness and permafrost temperature.

- ## Components:

- *Permafrost Temperatures*: Thermal state of Permafrost (TSP)
- *Annual Thaw Depths*: Circumpolar Active Layer Monitoring (CALM)
- *Surface Temperature and Surface Soil Moisture* Satellite Datasets (ESA DUE Permafrost)

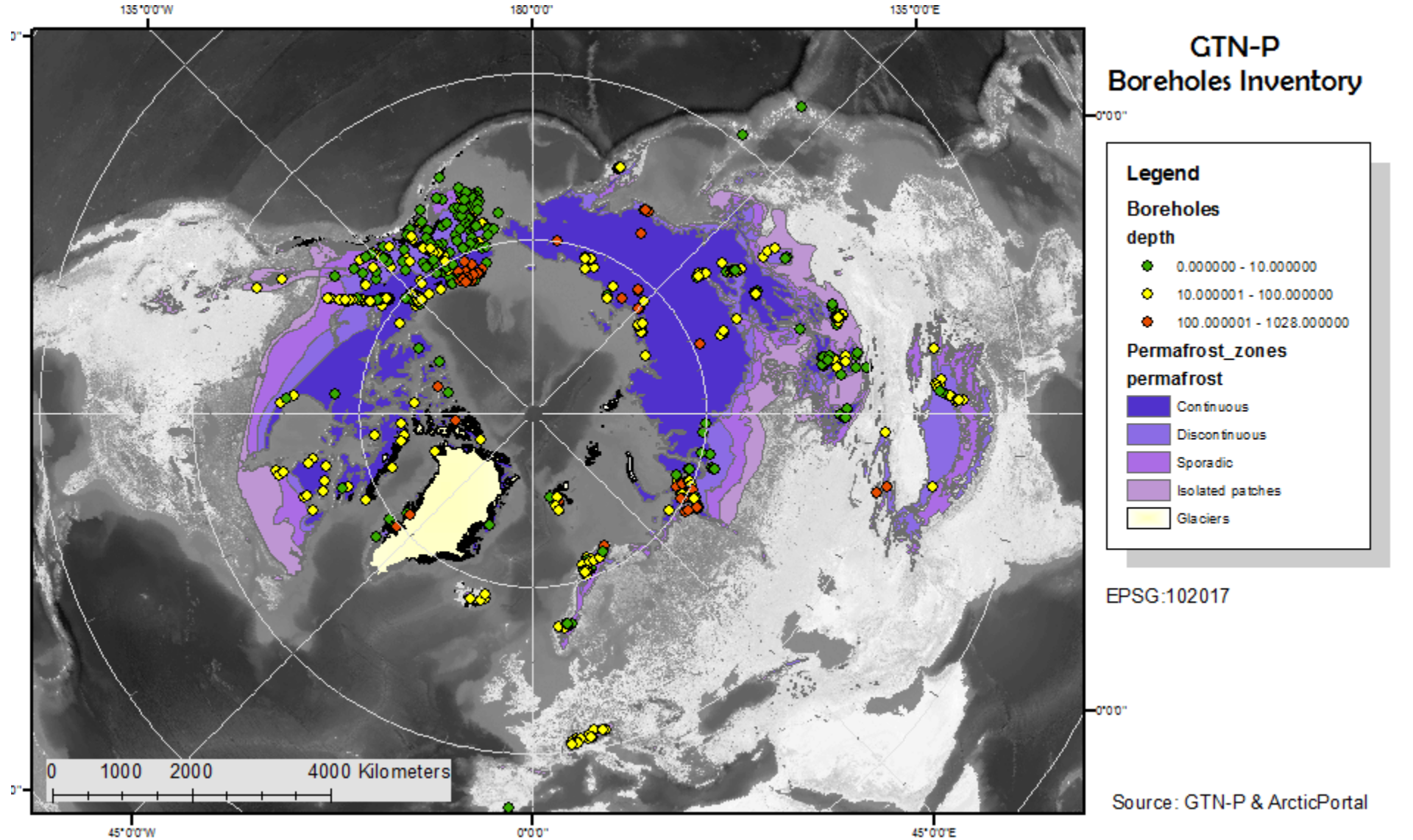
GTN-P Global Terrestrial Network for Permafrost

DUE PERMAFROST

PAGE21

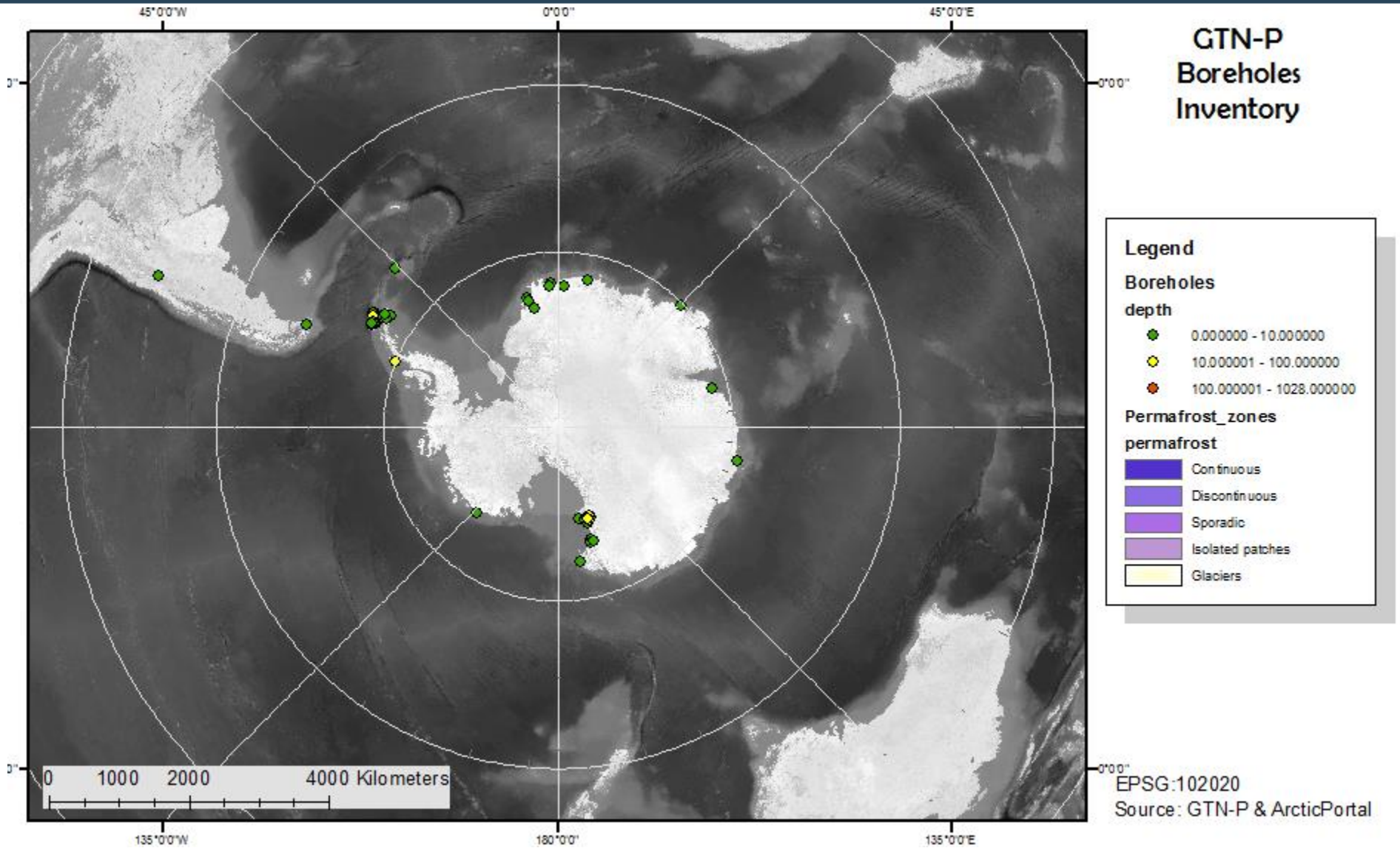
ARCTIC PORTAL

Boreholes



GTN-P Global Terrestrial Network for Permafrost
DUE PERMAFROST
PAGE21
ARCTIC PORTAL

Boreholes



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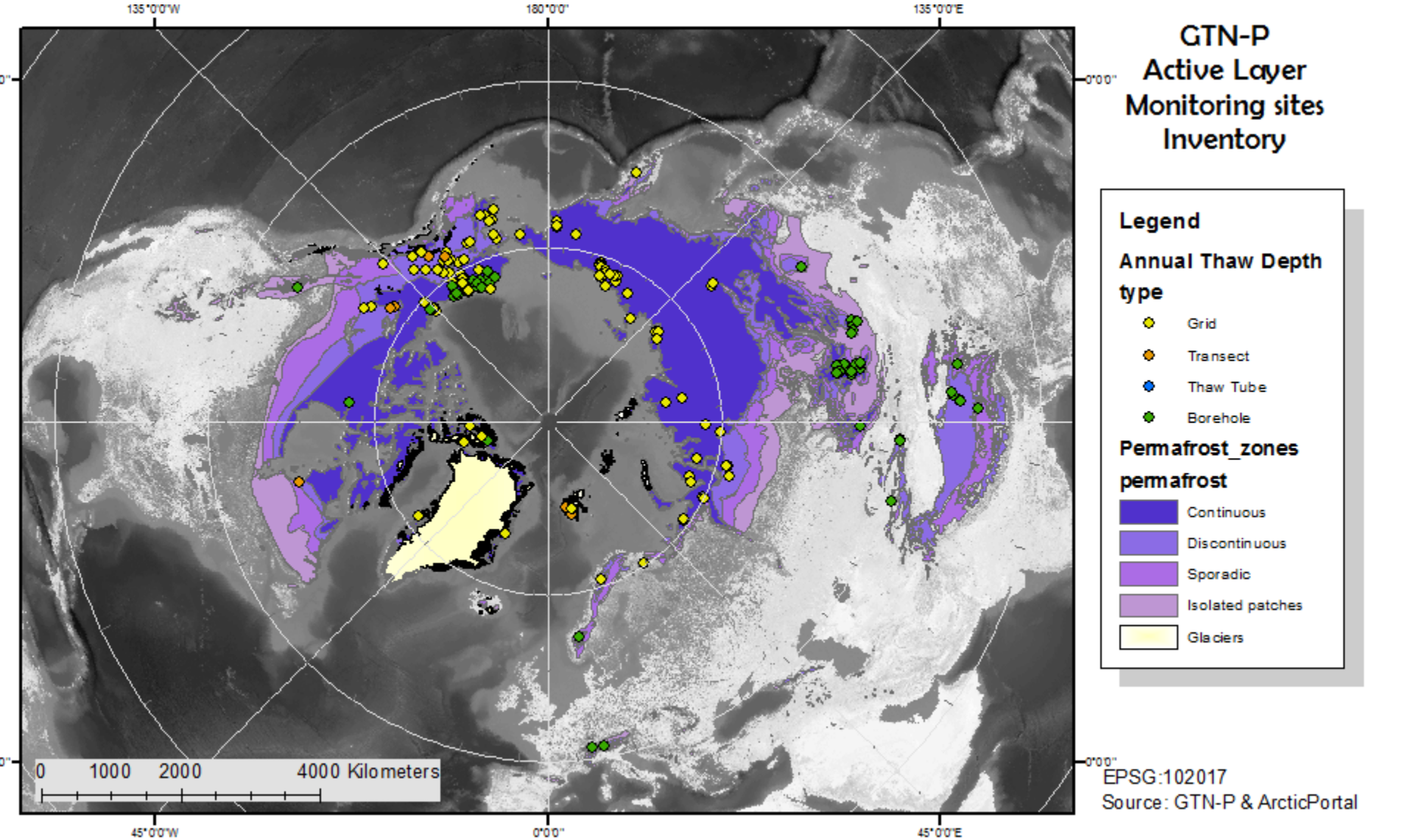
DUE PERMAFROST
PAGE21
ARCTIC PORTAL

Active layer monitoring sites



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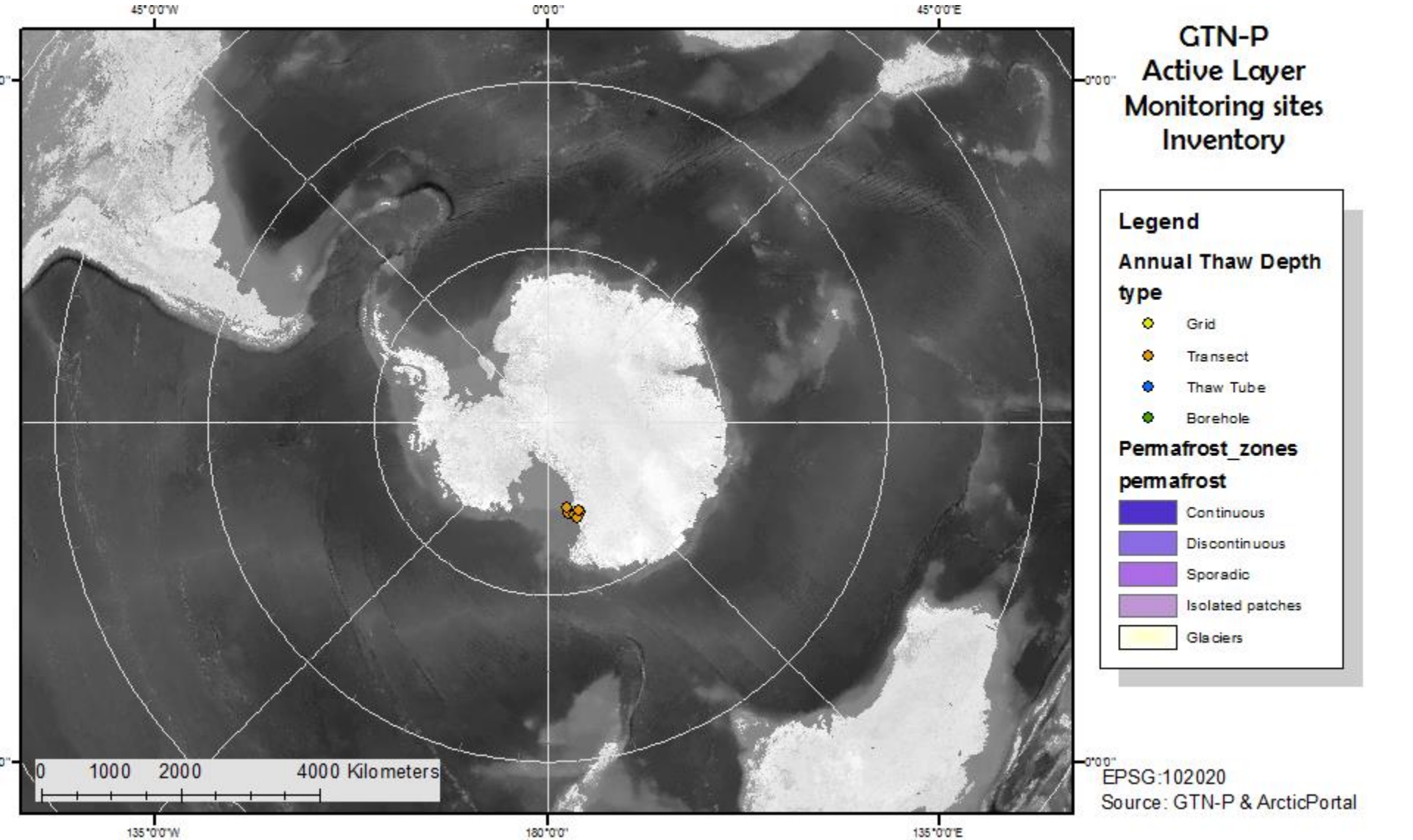
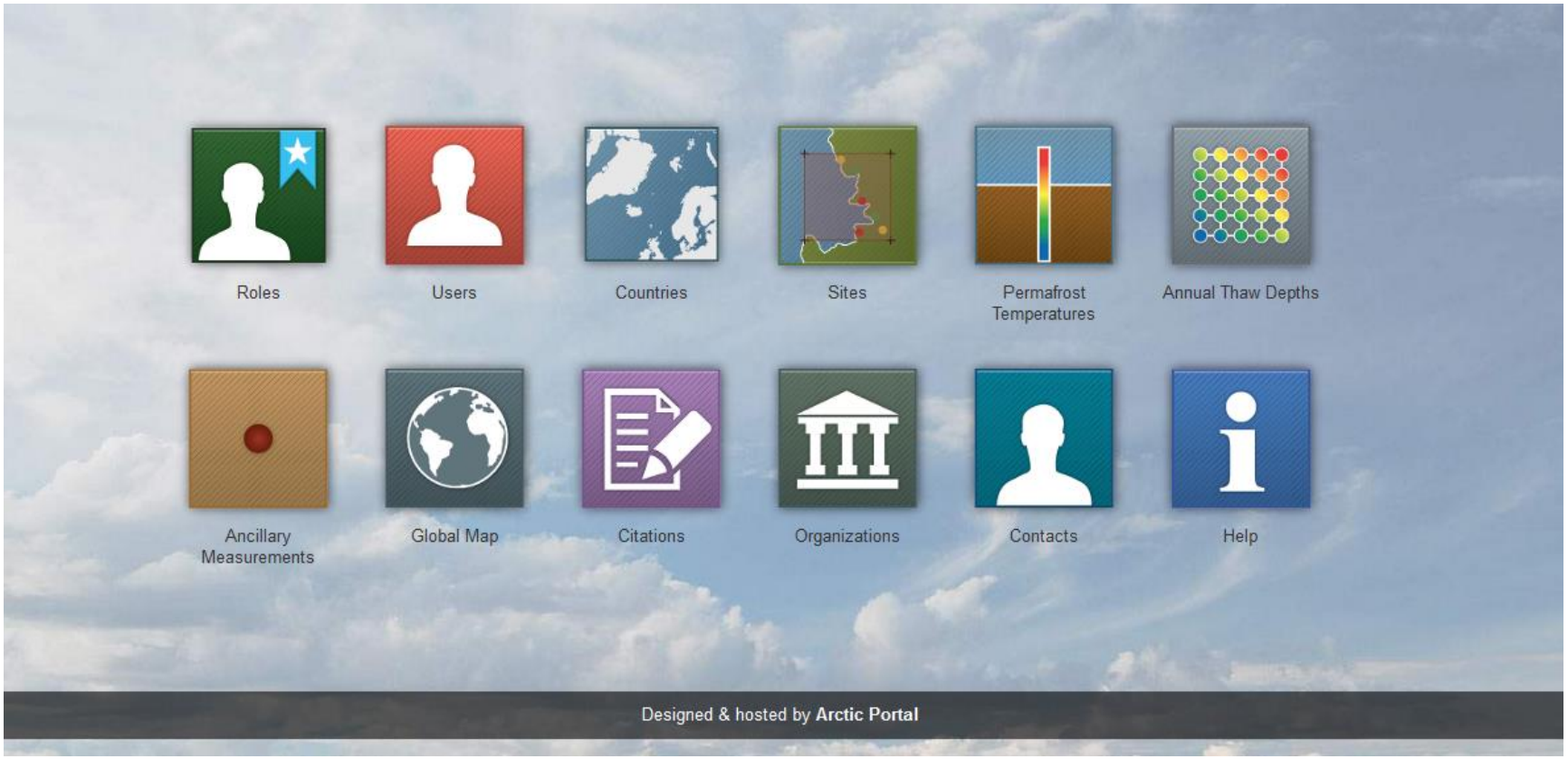
DUE PERMAFROST
PAGE21
ARCTIC PORTAL

Active layer monitoring sites



GTN-P Data Management System

gtnpdatabase.org



GTN-P Data Management System Main interface

GTN-P Global Terrestrial Network for Permafrost | DUE PERMAFROST | PAGE21 | ARCTIC PORTAL

GTN-P Data Management System

gtnpdatabase.org

Permafrost Temperatures

Custom Search

Depth in meters Minimum: Maximum:

Vegetation Zone: Grassland

Data: Yes

Search:

Name	Site	Country	GTN-P	Depth
Olkhon-Pit	Olkhon	Russia		3.65
Toolik Lake 1	Toolik Lake	United States	US 58	92
Tuymada 70	Yakutsk	Russia	RU 73 08_0002	70

Showing 1 to 3 of 3 entries (filtered from 1,073 total entries)

Map

Perform a detailed search through permafrost temperature sites

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DUE PERMAFROST

PAGE21

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GTN-P Data Management System

gtnpdatabase.org

Edit Borehole: Ahmelo lake 5_07*

General | Drilling | Measurement | Observation | Accessibility | Disturbance | SEO

General Information

Name *
Ahmelo lake 5_07*

GTN-P Code
RU 68 06_0015

Borehole Code
5_07*

Borehole Depth (m) *
15

Site *
Cherskii

Responsible Countries *
- Antarctica
- Argentina
- Austria
- Brazil
- Canada
- China
- Denmark

Timezone *
GMT +11:00 hours

Description

Source | Styles | Format

Gallery

Add new

Ahmelo lake 1 | Ahmelo lake 2

Map

Plan | Satellite

Google

Longitude
160,98841

Latitude
68,812194

Edit Add a new Monitoring Site

GTN-P Data Management System

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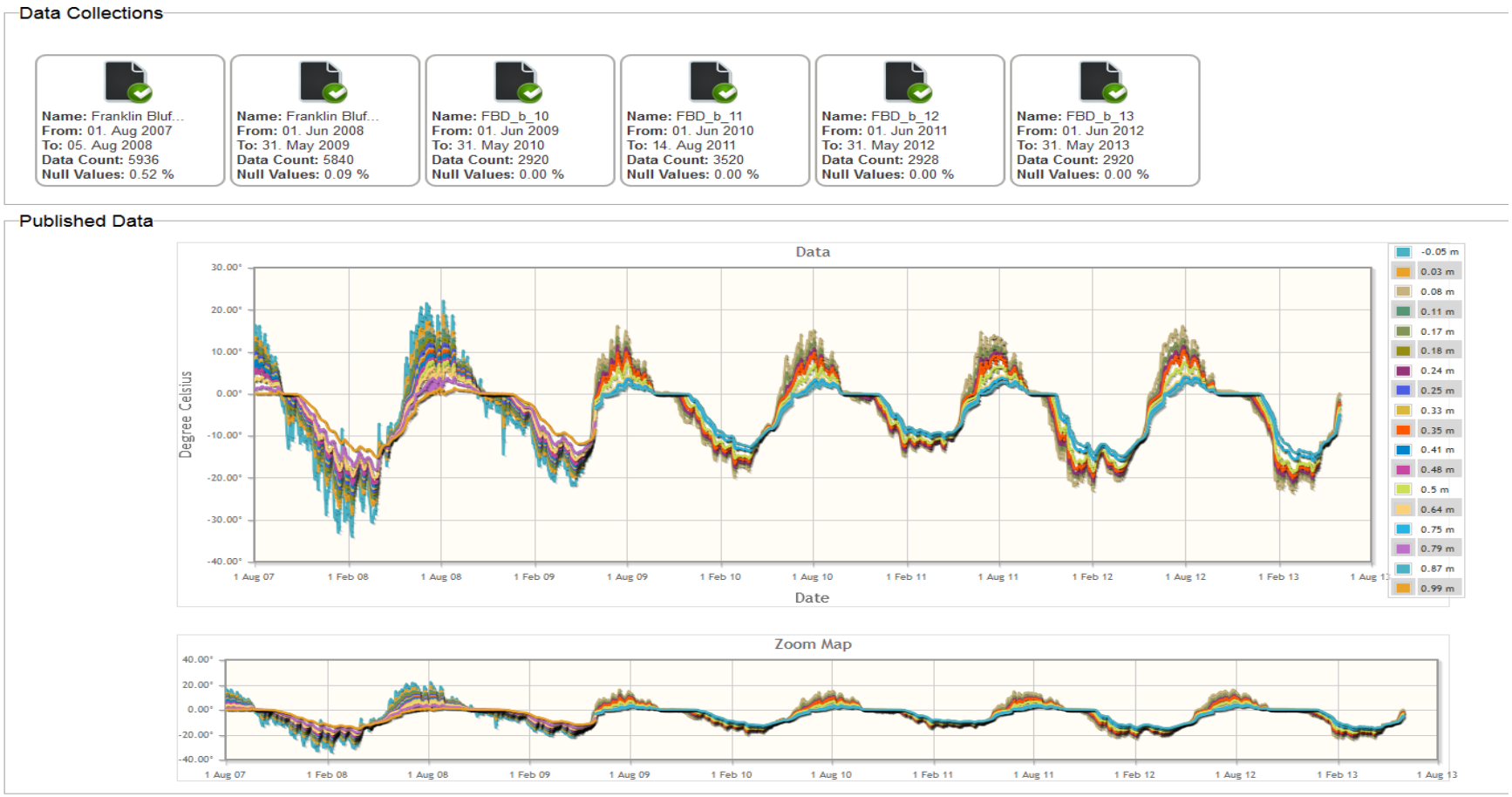


Add or Edit a new dataset

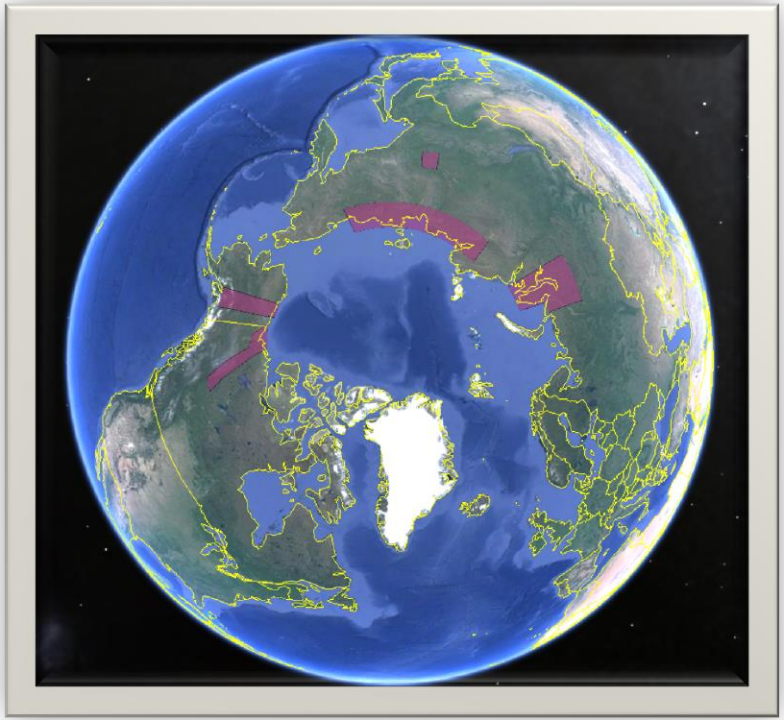
DUE Permafrost

- The main purpose of the ESA DUE Permafrost project is to define, demonstrate and validate, permafrost monitoring information service from local to large scale, mainly towards climate change studies and addressing the pan-boreal/arctic zone.

- Permafrost is a subsurface phenomenon and cannot be directly observed with satellite data. Yet, monitoring can be done based on indicators and via permafrost models.

- Products:
  - Land surface temperature
  - Snow
  - Land cover
  - Terrain
  - Landsurface hydrology

Variable	Sensor	Spatial Coverage	Temporal Coverage	Resolution	Frequency
Surface Temperature	AATSR	panarctic	2005-2009	25 km x 25 km	Monthly
	MODIS	panarctic	since 2000	25 km x 25 km	Monthly
			since 2007		Weekly
		regional[1]	since 2007	1 km x 1 km	Monthly, weekly
Surface Soil Moisture	Metop ASCAT	panarctic	since 2007	25 km x 25 km	Weekly

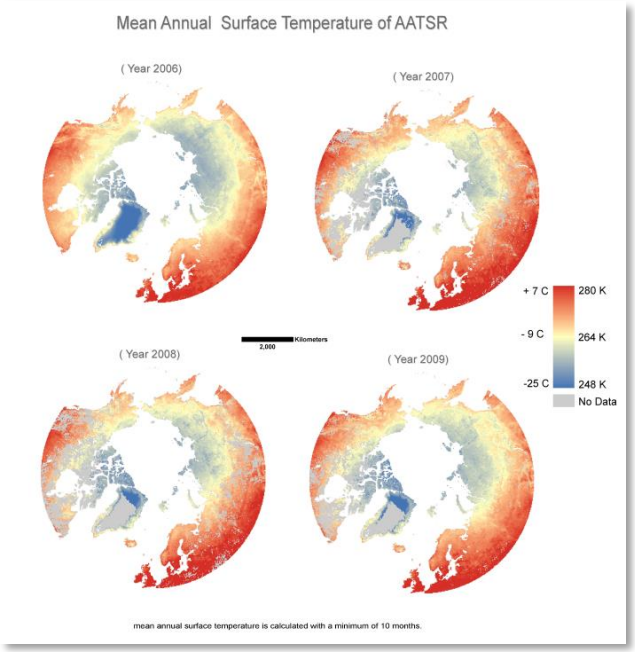


Due Permafrost project coverage regions

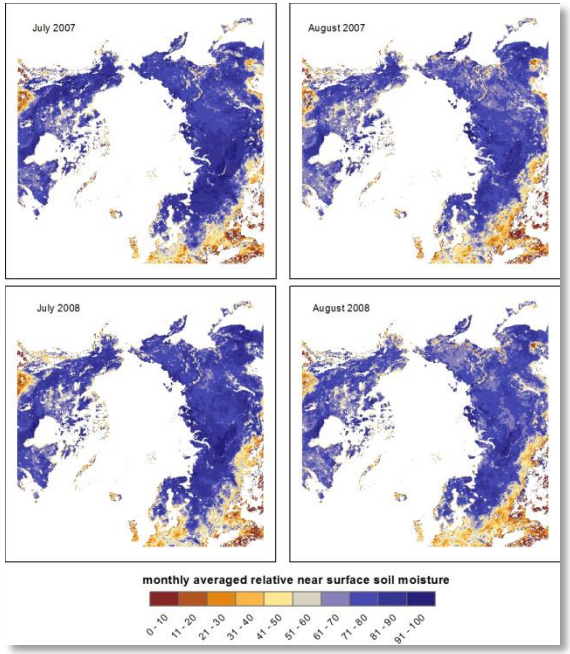
- 1 Laptev see
- 2 Ob Esturary
- 3 Alaska
- 4 Mackenzie
- 5 Central Yakutia

Integration of DUE Permafrost

- Surface temperature AASTR and MODIS



- Soil Moisture Metop ASCAT



GTN-P Global Terrestrial Network for Permafrost

DUE PERMAFROST

ARCTIC PORTAL

Integration of DUE Permafrost, example

General Information

Created: 2014-03-07 10:54:20
Modified: 2014-03-07 10:54:20

Variable:	Surface Temperature (satellite)
Unit:	Degree Kelvin
Datatype:	Average
Frequency:	Monthly
Method:	MODIS (satellite)
Medium:	Not Relevant
Resolution:	25x25 km
Policy:	Restricted
Quality Check:	Quality Controlled

Statistics

Minimum value:	236.000
Maximum value:	284.000
Average value:	260.075
Data values:	166
Null values:	0
Date start:	01. Mar 2000
Date end:	01. Dec 2013

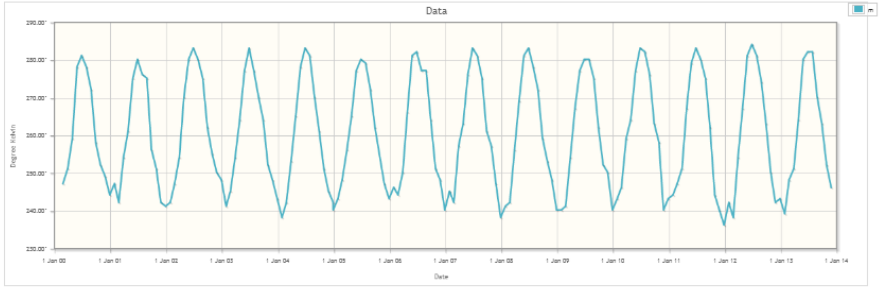
Integration of surface temperature MODIS satellite data to the GTN-P Data Management System.
On the Fly aggregations of the data are performed and compiled within the NetCDF global dataset product.

Data Collections

Name: lst_25km_mont...
From: 01. Mar 2000
To: 01. Dec 2012
Data Count: 154
Null Values: 0.00 %

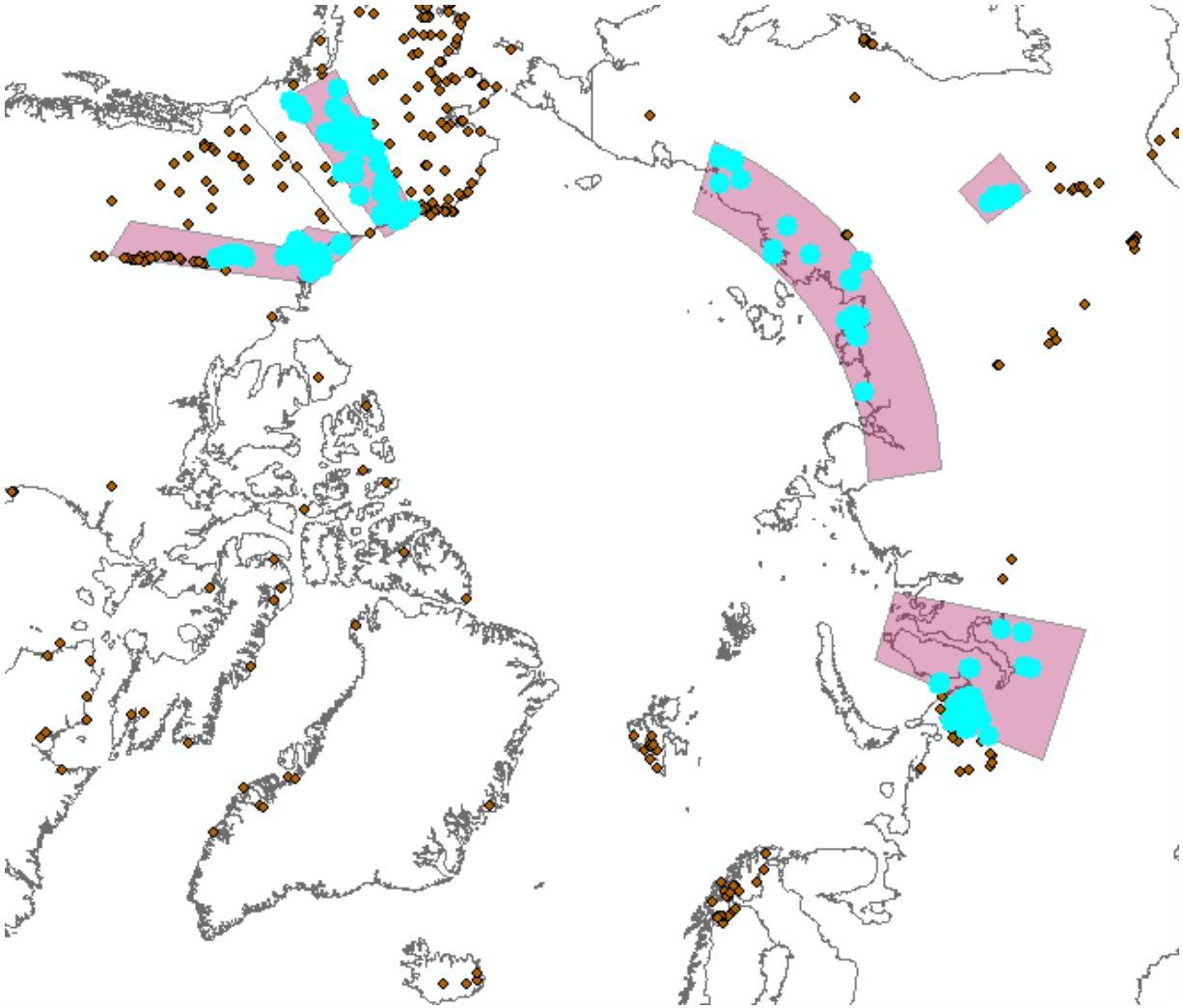
Name: lst_25km_mont...
From: 01. Jan 2013
To: 01. Dec 2013
Data Count: 12
Null Values: 0.00 %

Published Data



Online visualisation and download of the surface temperature MODIS dataset.

Degree of Convergence



TSP: 379 of 1073 (35.3%)

CALM: 91 of 242 (37.6%)

Overlapping of DUE Permafrost investigation polygons with TSP and CALM sites in the GTN-P Database

GTN-P Global Terrestrial Network for Permafrost | DUE PERMAFROST | PAGE21 | ARCTIC PORTAL

Factsheet

Update from May 2014

- Total number of data: 2 948 202
- Total number of datasets: 1 300
  - Surface Temperature (Satellite): 869, datasets from 2000-2013
  - Ground Temperature: 144, datasets from 1982-2014
  - Active Layer Thickness: 75, datasets from 1992-2012
  - Surface Soil Moisture (Satellite): 75, datasets from 1992-2012
  - Air Temperature: 30, datasets from 2001-2013
  - Surface Temperature: 24, datasets from 2001-2013
- Number of boreholes: 1 059
- Number of active layer monitoring sites: 239
- Deepest borehole: 1028 m (Marryatt K-71, Canada)
- Longest Ground Temperature Record: 30 years, 1 month, 17 days (Umabybyt 20, Russia)

New Achievements

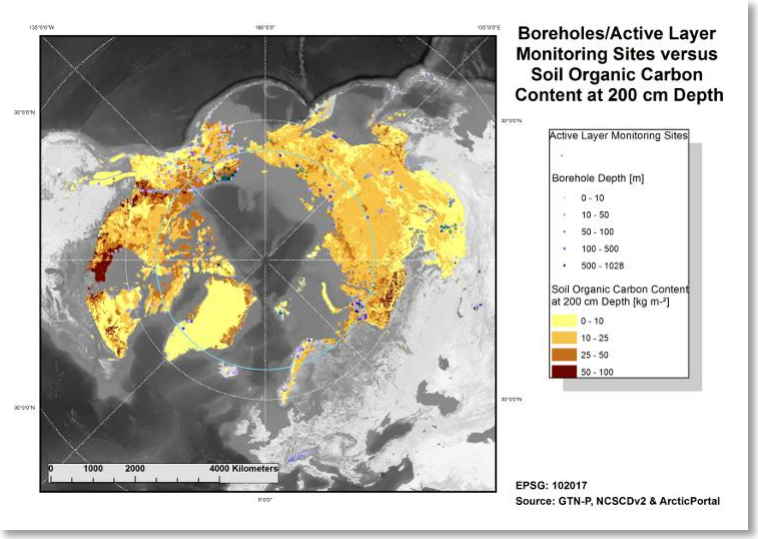
- Repository of GTN-P database sites

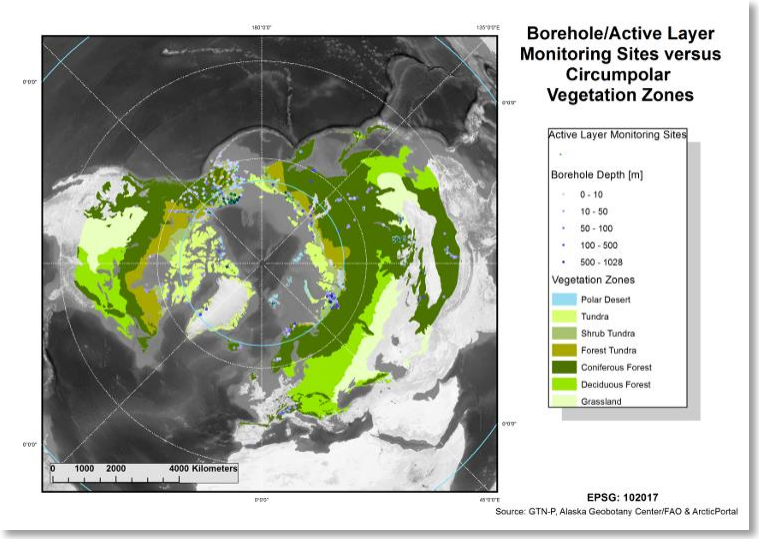
New Achievements

- Creation of the first global Netcdf Product for permafrost temperature variables and annual thaw depth.
- The NetCDF product and all spatial layers are implemented full ISO TC211 standard compliant.
- Due permafrost variables are implemented as ancillary measurements. But a one stop repository for permaforst field measurements and remote sensing should be considered.

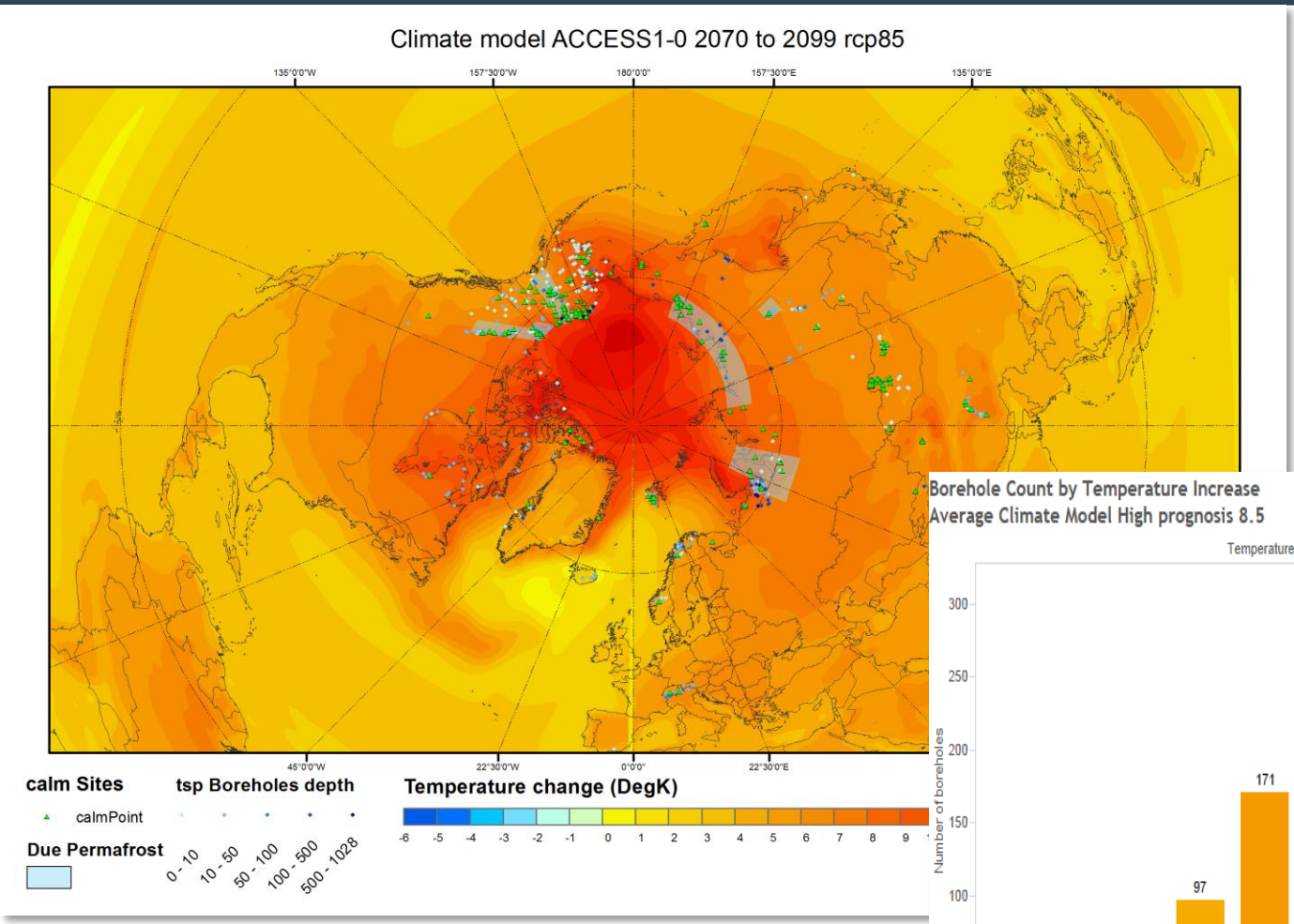
New Achievements

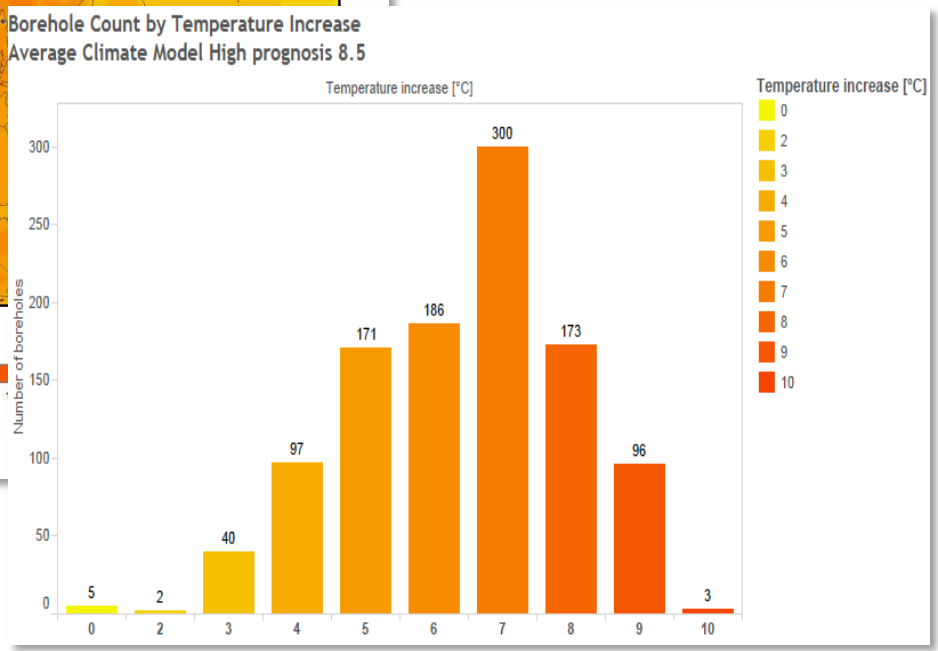
- Crossing metadata with:
  - Permafrost zones
  - Soil organic carbon zones
  - Vegetation zones



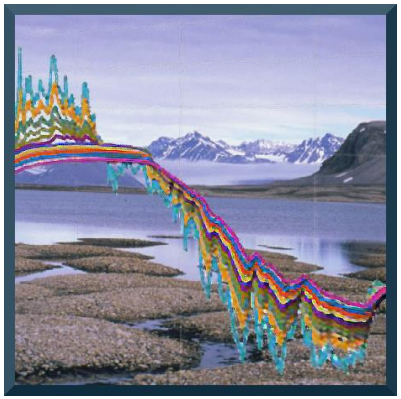


Crossing with climate change models





Quantitative and qualitative data



Quantiative data

- all data that can be measured numerically
- Raster, DEM
- in situ measurements, i.e. permafrost temperatures and active layer thickness

Qualitative data

- knowledge products
- observations not based on measurements, such as observations on soils, vegetation, relief, etc.

Permafrost Ontology

- Permafrost Ontology (PermafrostML) is an encoding standard for the representation and the exchange of Permafrost observations data, with a focus on time-series (implemented as an application schema of the Geography Markup Language), it enable interoperability between permafrost research and education community; international, national and local agencies that set standards for, distribute and use permafrost observation data.

Section	Term		Necessity (Mandatory/Optional)	Data Type[3]
General Information	Name		M	varchar(63)
	GTN-P Code		O	varchar(16)
	Borehole Code		O	varchar(16)
	Borehole Depth (m)		M	double precision
	Site		M	varchar(63)
	Responsible Countries		M	varchar(63)
	Timezone		M	UTC/GMT +01:00 hours
	Longitude		M	double precision (minimum: 4 decimals)
	Latitude		M	double precision (minimum: 4 decimals)
	Elevation		O	double precision
	Description		O	varchar(8191)
	Permafrost Thickness (m)		O	varchar(16)
	Permafrost Zone		M	varchar(127)
	Vegetation Type		M	varchar(63)
	Citation	Title	M	varchar(63)
		Responsible Country	M	varchar(63)
		Abstract	O	varchar(4095)
		Keywords	O	varchar(511)
		Language	O	varchar(63)
		Metadata Link	O	reserved to the system
		Digital Object Identifier	O	varchar(255)
		Organizations	M	varchar(511)
	Organization	Address	O	varchar(127)
		Zipcode	O	varchar(32)
		City	O	varchar(127)
		Province or State	O	varchar(127)
		Country	O	varchar(63)
		Phone	O	varchar(63)
		Fax	O	varchar(63)
		Website	O	varchar(255)
		Email	O	varchar(127)
		First Name	M	varchar(127)
		Last Name	M	varchar(127)

- PermafrostML will overcome the lack of standardized data model for permafrost variables. The GTN-P Data Management System will submit a first draft of the standard within the scope of the project.

Future developments

- Arctic Portal is developing open source portable Data Management System that can generalize and automatize the data work-flow demonstrate within the GTN-P Database.
- Web technologies are developing very fast and Arctic Portal is designing techniques and processes for data discovery, semantic search, multi step data-series, metadata harmonization, quality check, legal constraints, data analysis, data visualization and mapping tools.

Thank you!

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