Globsnow product use within the ESA DUE Permafrost project

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ESA DUE Permafrost project

- The objective is to establish a monitoring system based on mostly existing satellite data products
- DUE – Data User Elements
- Supporting
  - The GCOS implementation plan
  - National and intergovernmental bodies
  - Scientific groups involved in climate change research
- Multiscale concept
  - Pan-boreal/arctic (> 50° N)
    - Regional (1.5 mio km²)
      - Local (> 20.000 km²)

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DUE Permafrost project

- User organizations
  - Alfred-Wegener Institute of Polar and Marine Research with IPA
  - University of Alaska Fairbanks
    - Perm. Laboratory, IARC
  - Lomonossov Moscow State University, Russia
  - Permafrost Institute Yakutsk
  - State Hydrological Institute St Petersburg, Russia
  - Geological Survey of Canada
  - University of Hokkaido, Japan
  - MPI Jena, Germany
  - + currently > 10 associated users

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DUE Permafrost project

- Status
  - Phase I start in June 2009
    - User requirements Sept. 2009 ✓
    - Design engineering ☜
  - Phase II June 2010 – November 2011
    - Implementation & validation

Changing Permafrost

- Ground thermal regime changes due to
  - Changes in air temperature and/or precipitation
  - Surface disturbances
    - Clearing of vegetation
    - Removal of insulating organic layer
    - Forest fires
    - River channel migration
    - Shoreline erosion
- Response to climate change depends on variations in local seasonal factors
  - Snow cover
  - Vegetation
  - Surficial material
  - Moisture content
  - Drainage

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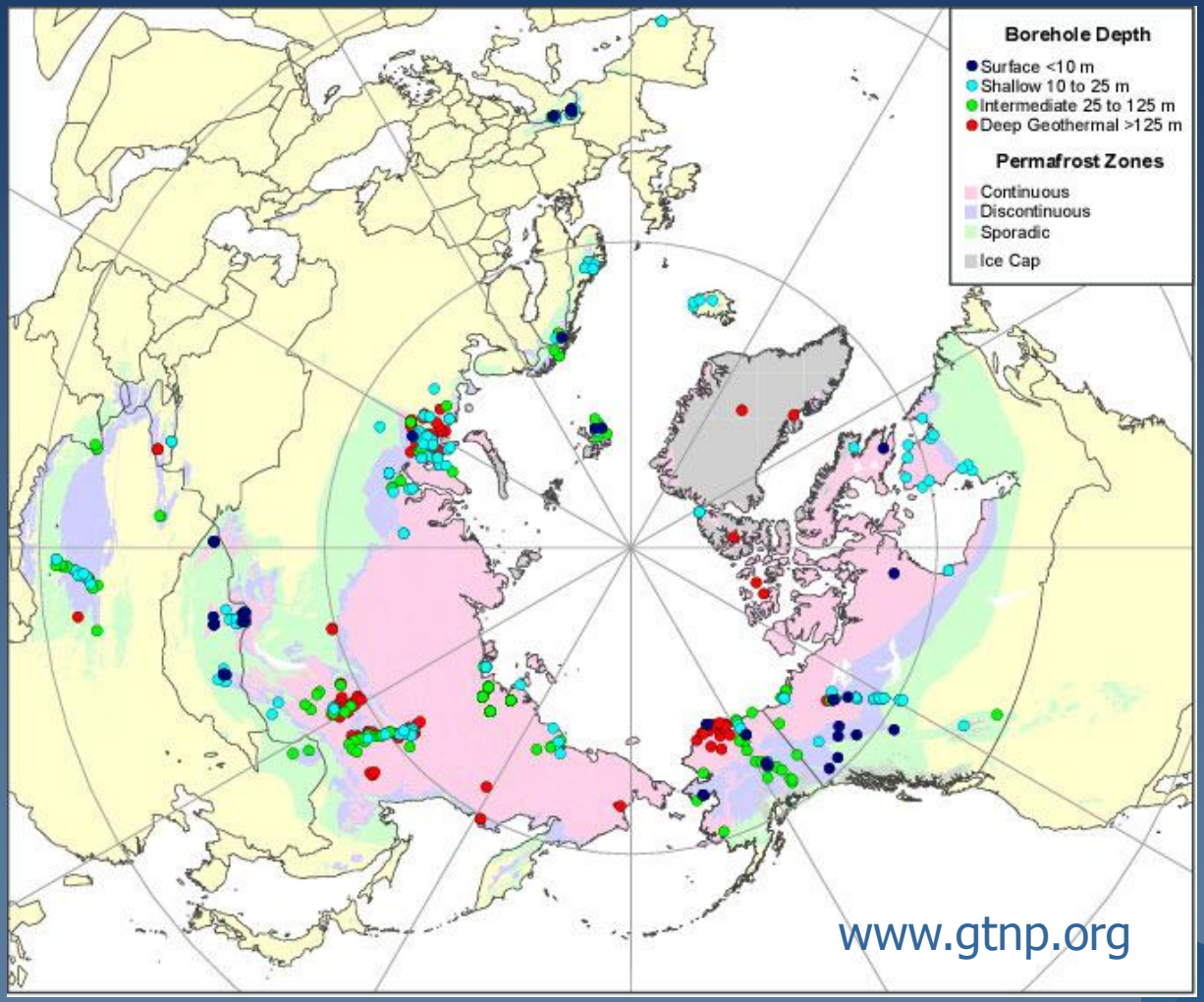
Circumpolar ground networks



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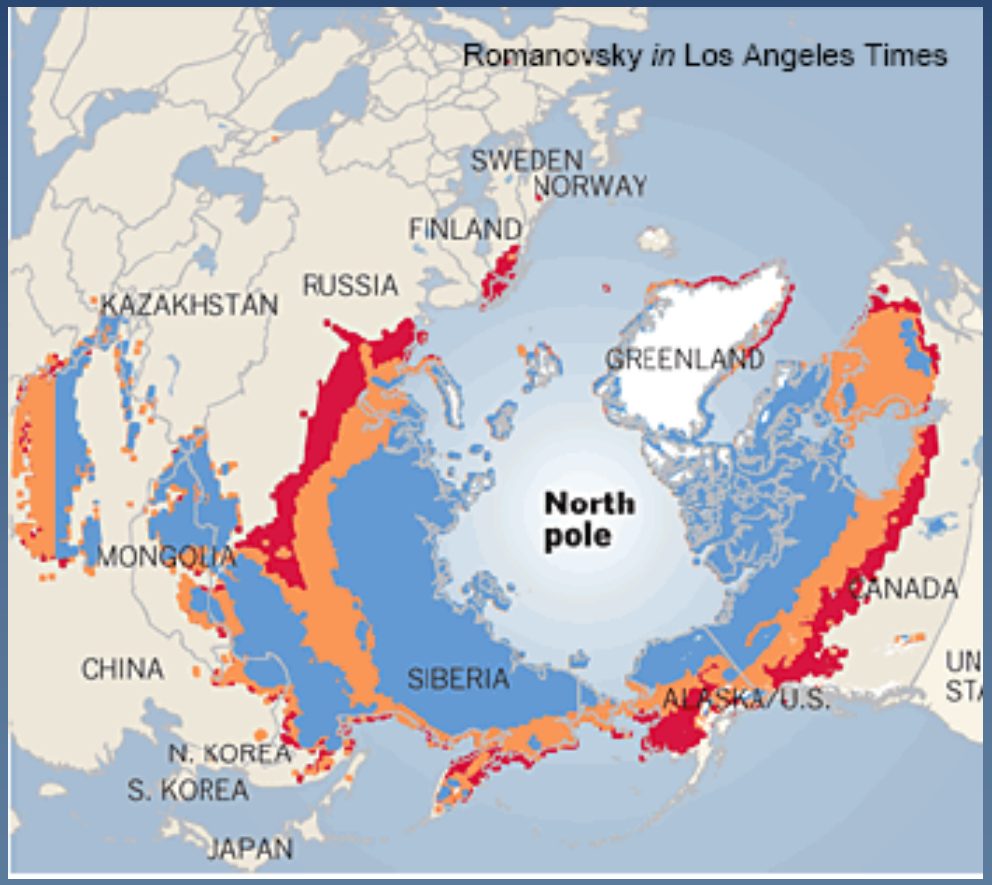
Changing Permafrost



Permafrost is one of the GCOS ECV's of the terrestrial domain

Remote Sensing

- Cannot see below the soil surface, but
  - Monitoring of indicators
  - Monitoring of parameters used in models

Permafrost Models

- GIPL (Spatially Distributed Model for High Performance Permafrost Dynamics)
- LPJ (Dynamic Global Vegetation Model)
- MATSIRO (land surface model as part of coupled atmosphere-ocean climate models - CCSR/NIES/FRCGC)
- TTOP
- Other AOGCMs

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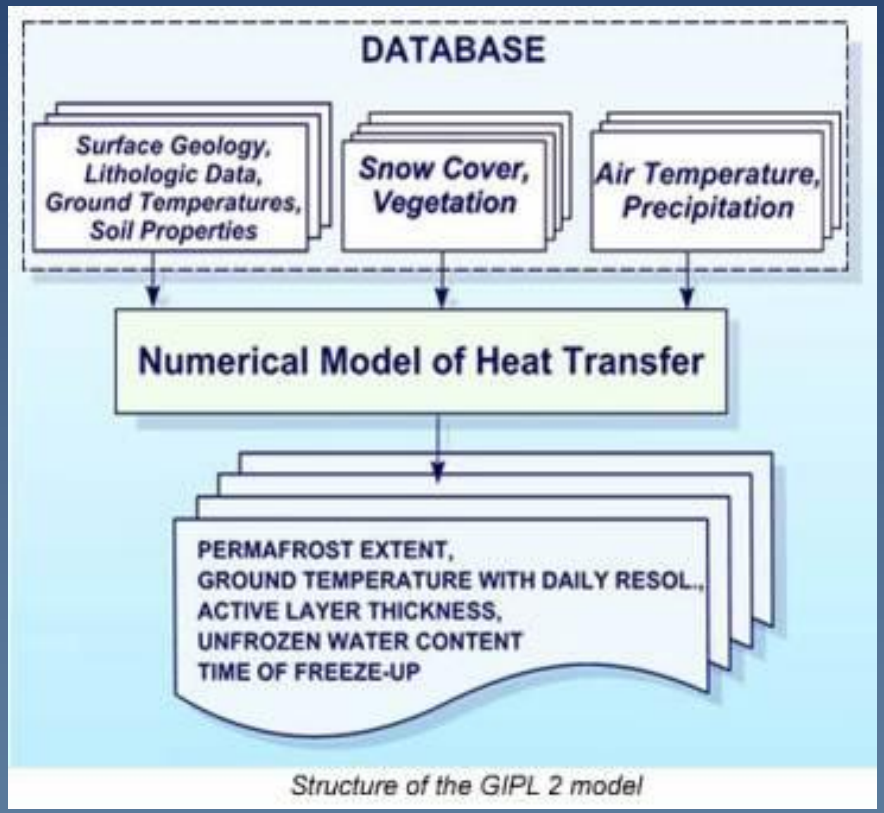
Parameters for modelling

Example: GIPL



Structure of the GIPL 2 model

Parameters for modelling from Remote Sensing – pan-boreal/arctic scale

- Land Surface Temperature
- Landcover
- Disturbances
- Snow properties
- Soil moisture
- Terrain

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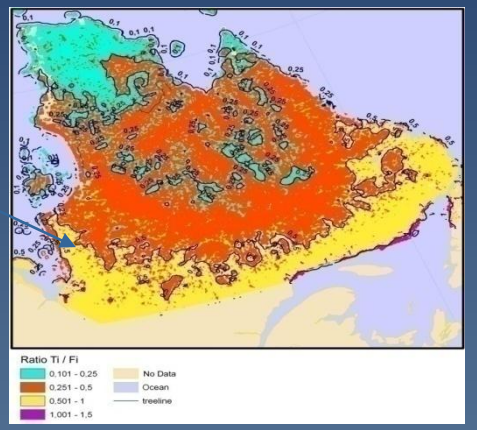
Pan-boreal/arctic scale

- Land Surface Temperature
  - Available from
    - MODIS
    - ENVISAT AATSR
    - Passive microwave
- Creation of a combined product for optimal coverage
- Application example:
  - Thaw index/freeze index

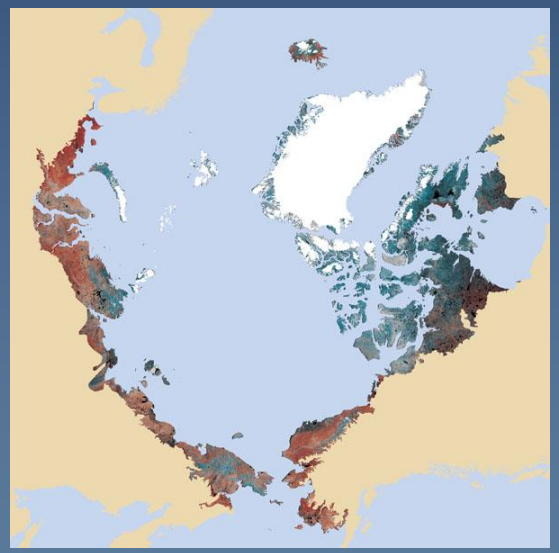
Approximate limit of sporadic permafrost



Source: Hachem 2008

Pan-boreal/arctic scale

- Landcover
  - ESA Glob-Projects
  - MODIS products
  - CAVM – Circum Arctic Vegetation Map
  - National maps



Pan-boreal/arctic scale

- Snow properties
  - From Globsnow (Snow extent & Snow Water equivalent)
  - Other products: MODIS, NSIDC
- snow depth and physical characteristics (density, snow water equivalent, albedo, structure) play an important role in the permafrost energy and water balance
- The timing of steady snow cover destruction coincides with the rise of land surface temperature above 0°C
- Required for LST and soil moisture products on pan to regional scale

GAMMA REMOTE SENSING

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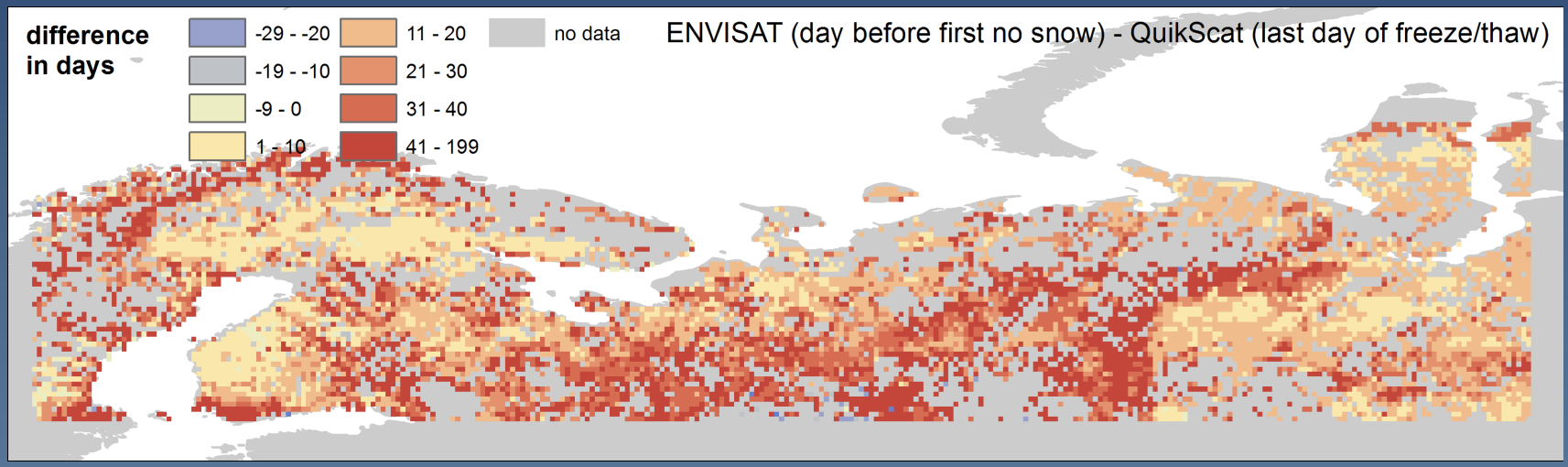
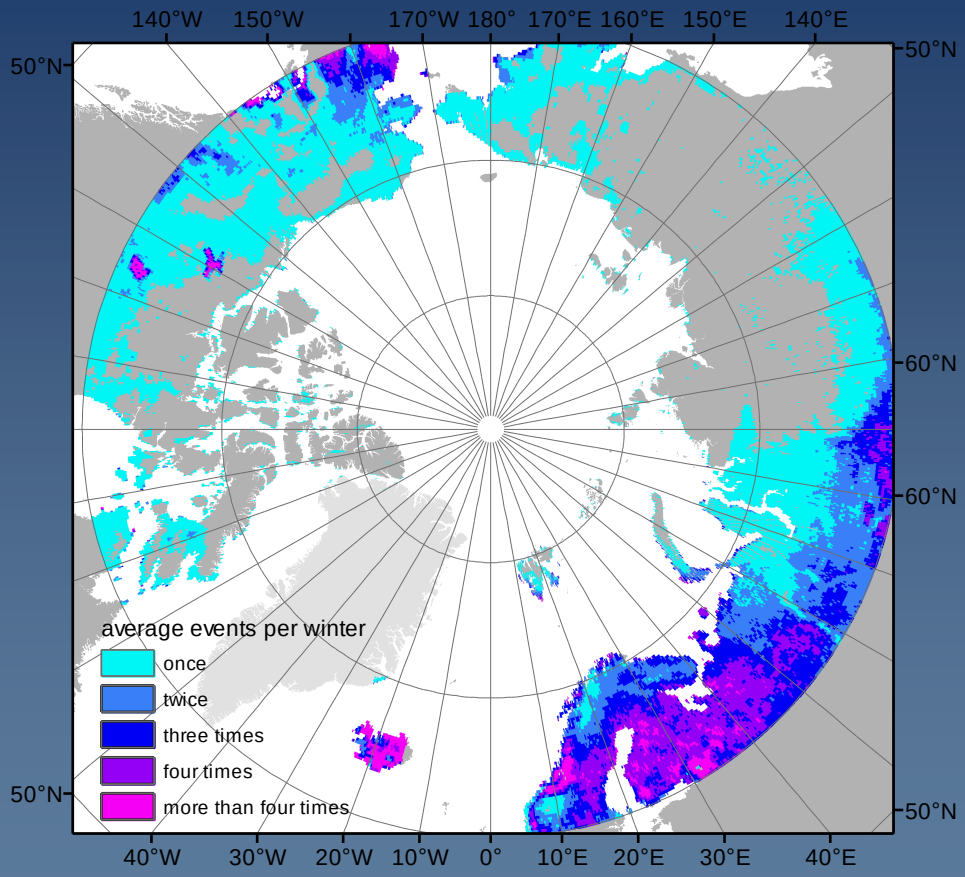
- first comparison



2003

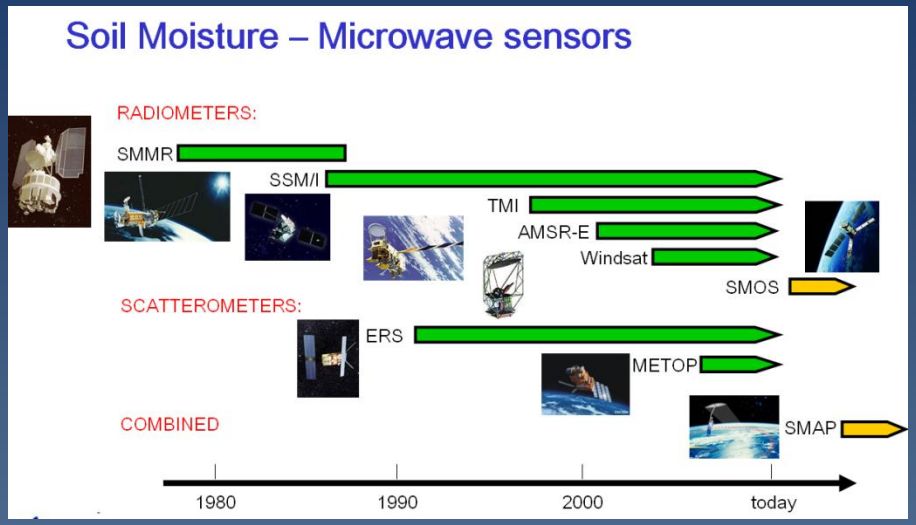
Snow structure – thaw/refreeze



Source: QuikScat (2000-2009), Bartsch et al. (in review)

Pan-boreal/arctic scale

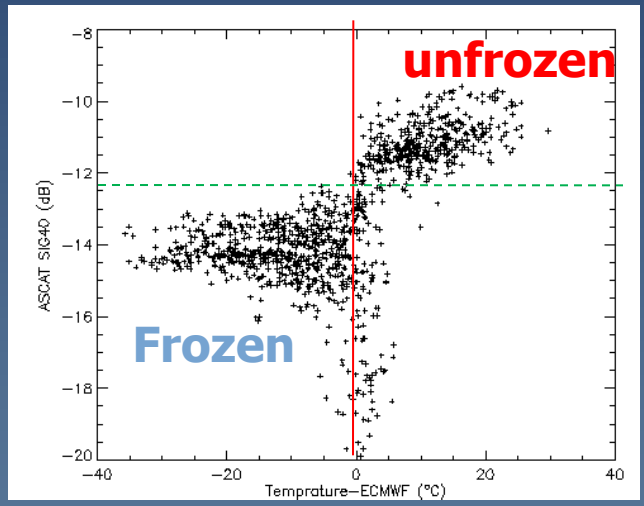
- Soil Moisture
  - From microwave sensors
  - Near surface soil moisture



- MetOp ASCAT NRT
- ESA WACMOS project
  - Combination of passive and active soil moisture products

Pan-boreal/arctic scale

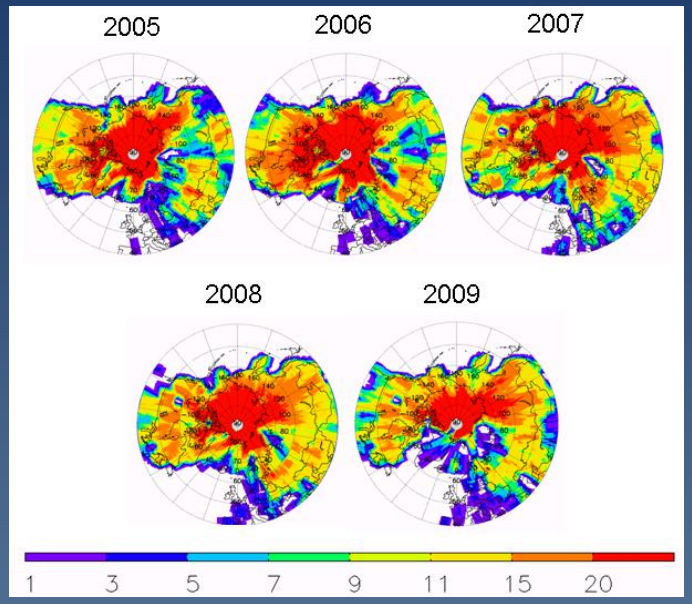
- Improvement of MetOp ASCAT soil moisture product
- Quality flags:
  - Snow cover (source Globsnow)
  - Freeze/thaw (source MetOp ASCAT (25km))



Metop ASCAT backscatter and ECMWF air temperature

Regional scale

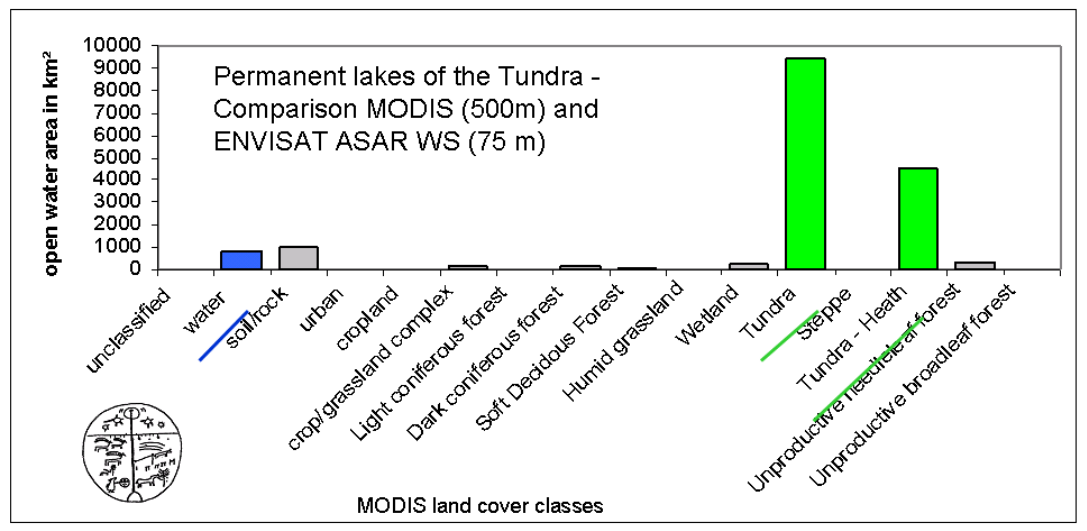
- Soil moisture (incl. Freeze/thaw) from ENVISAT ASAR GM (1km)
  - Has been already implemented within the ESA DUE Tiger project SHARE for Africa and entire Australia (www.ipf.tuwien.ac.at/radar/share)



Spatial and temporal variability in data coverage. Example: June

Regional scale

- Water bodies identification with ENVISAT ASAR WS
  - Has been developed within the FP5 Project Siberia II



Comparison of water class in MODIS land cover (500m) and ENVISAT ASAR WS (75m)
Taymir pensinsula

Bartsch et al. (2008) Hydrology Research
Bartsch et al. (2007) J. Aquatic Conservation

Local scale monitoring

- Terrain
  - Incl. Subsidence

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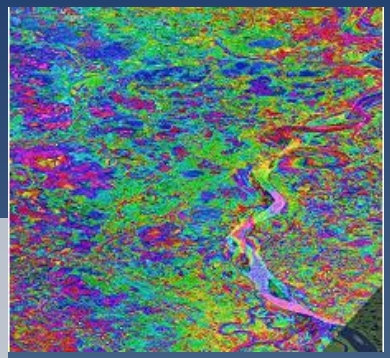
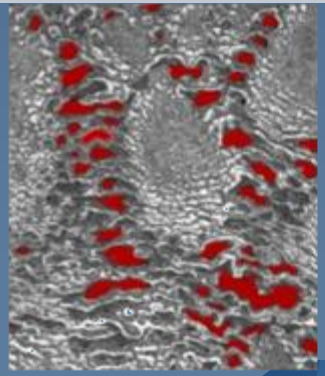


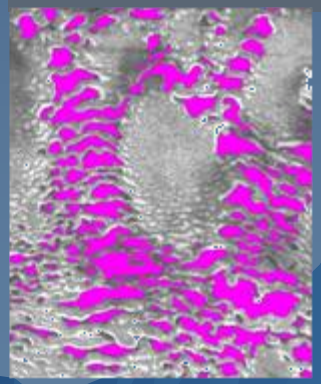
ERS2/ENVISAT interferogram (Mackenzie)

- Landcover
  - Lake dynamics
  - vegetation

Corona 1964



NIR QB 2004



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Local scale monitoring

- Scaling
  - Lakes
  - Land Surface Temperature
  - Landcover
  - Soil moisture

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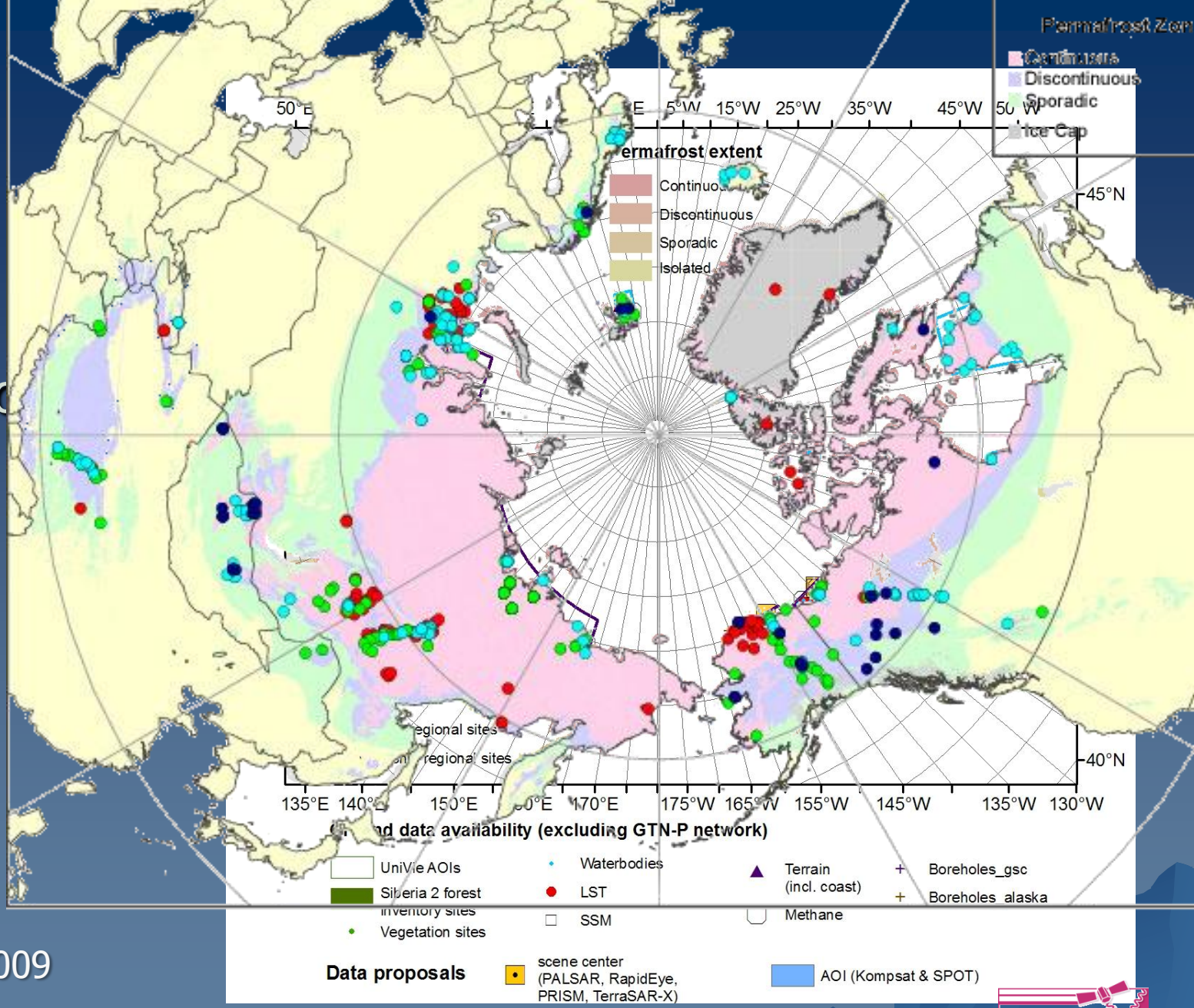
Service case regions & Validatic sites



AWI

Status Oct 2009

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Information System

MERIS
MODIS
AVHRR

ASAR
PALSAR
TerraSAR-X
PRISM
Corona
Landsat
RapdEye
…

GAMMA REMOTE SENSING

none-operational

Land cover,
Local,
scaling

Operational

LST, snow, soil moisture, water surfaces (regional)

ENVISAT AATSR
ENVISAT MERIS
ENVISAT ASAR
MODIS
MetOp ASCAT
AMSR-E

Database

Permafrost Models (external)

WebGIS

IPA Permafrost Information System

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Pan-boreal/arctic product specifications

Product	Sensor/ external source	Temporal resolution	Spatial resolution	Time span
LST	MODIS, AATSR, AMSR-E	Monthly	25 km	2002 -
Soil moisture	*WACMOS EUMETSAT* ASCAT	Weekly (daily)	25 km	1978 -
SE	*Globsnow*	Weekly (daily and weekly?)	25 km (1 km)	2002 -
SWE	*Globsnow*	Weekly (daily/weekly/ monthly)	25 km	1995 -
Landcover (incl. dist., water)	*GlobCover, GlobCarbon, CAVM, GlobSCAR*	once	300 m	

Regional product specifications

Product	Sensor/ external source	Temporal resolution	Spatial resolution	Time span
LST	MODIS, AATSR, AMSR-E	weekly	1 km	2002 -
Soil moisture	*Envisat ASAR GM*	weekly	1 km	2005 -
SE	*Globsnow*	Weekly (daily and weekly?)	1 km	2002 -
~~SWE~~	~~*Globsnow*~~	~~Weekly~~	~~25 km~~	~~1995 -~~
Water surface	ENVISAT ASAR WS	annually	150 m	2003 -

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Summary of snow product requirements

- operational but not NRT daily and weekly products
- prototype products will be made available to the Permafrost users beginning of March:
  - AOI‘s: Central Yakutia and Mackenzie Transect

Outlook

- First user workshop and presentation of monitoring service design and the permafrost information system at Vienna University of Technology on 2nd of May 2010 (EGU week)

- More information:
  - www.ipf.tuwien.ac.at/permafrost
  - annett.bartsch@ipf.tuwien.ac.at

FWF
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