Circumpolar Permafrost Monitoring – the ESA DUE Permafrost project

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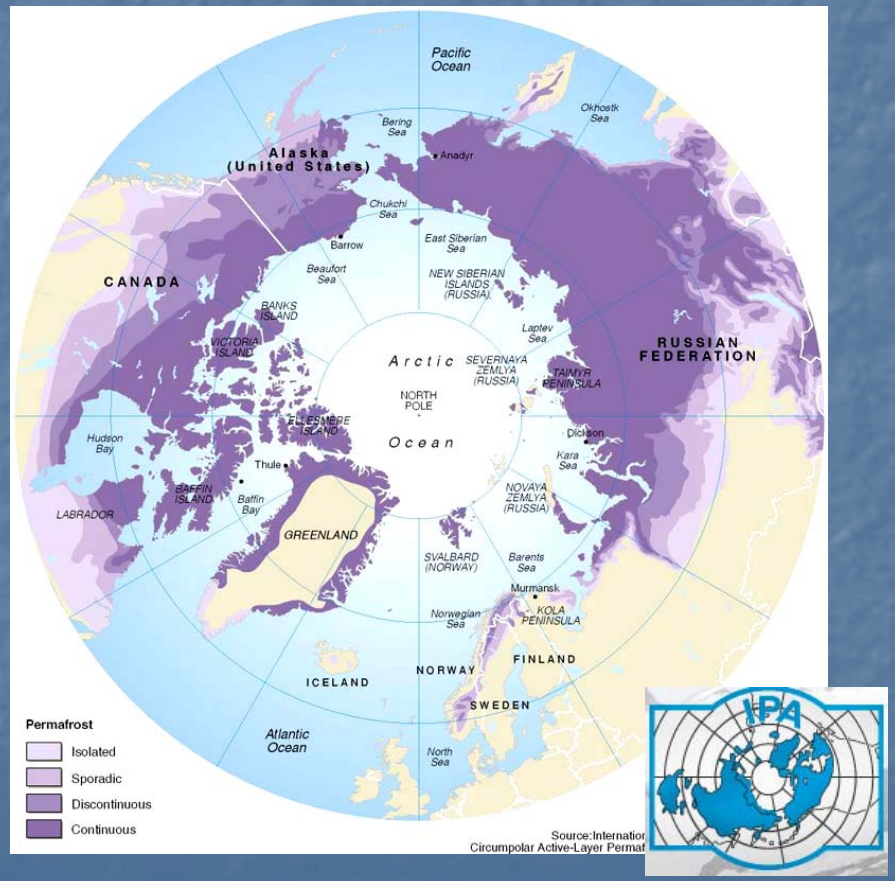
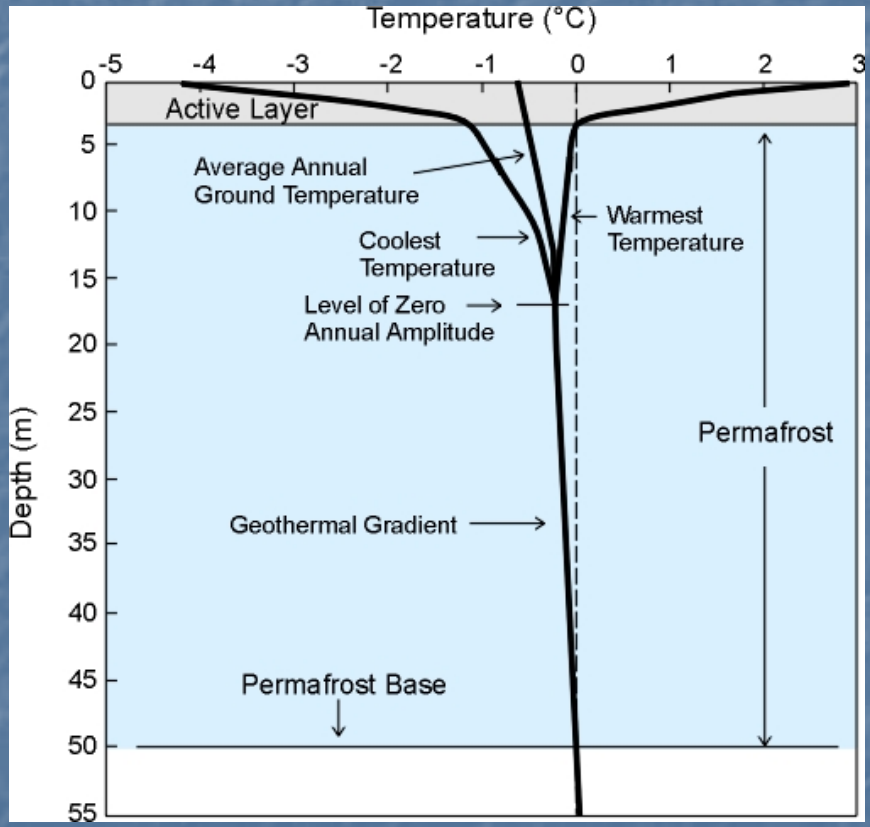
Permafrost

- Permafrost is defined as ground (soil or rock and included ice or organic material) that remains at or below 0°C for at least two consecutive years.
- Source: IPA – International permafrost association

Permafrost extent



Permafrost



Permafrost active layer

http://cgc.rncan.gc.ca/permafrost/

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

gsc.nrcan.gc.ca/permafrost

Changing permafrost

- Response to climate change depends on variations in local seasonal factors
  - Snow cover
  - Vegetation
  - Surficial material
  - Moisture content
  - Drainage
    - Burgess & Smith 2001

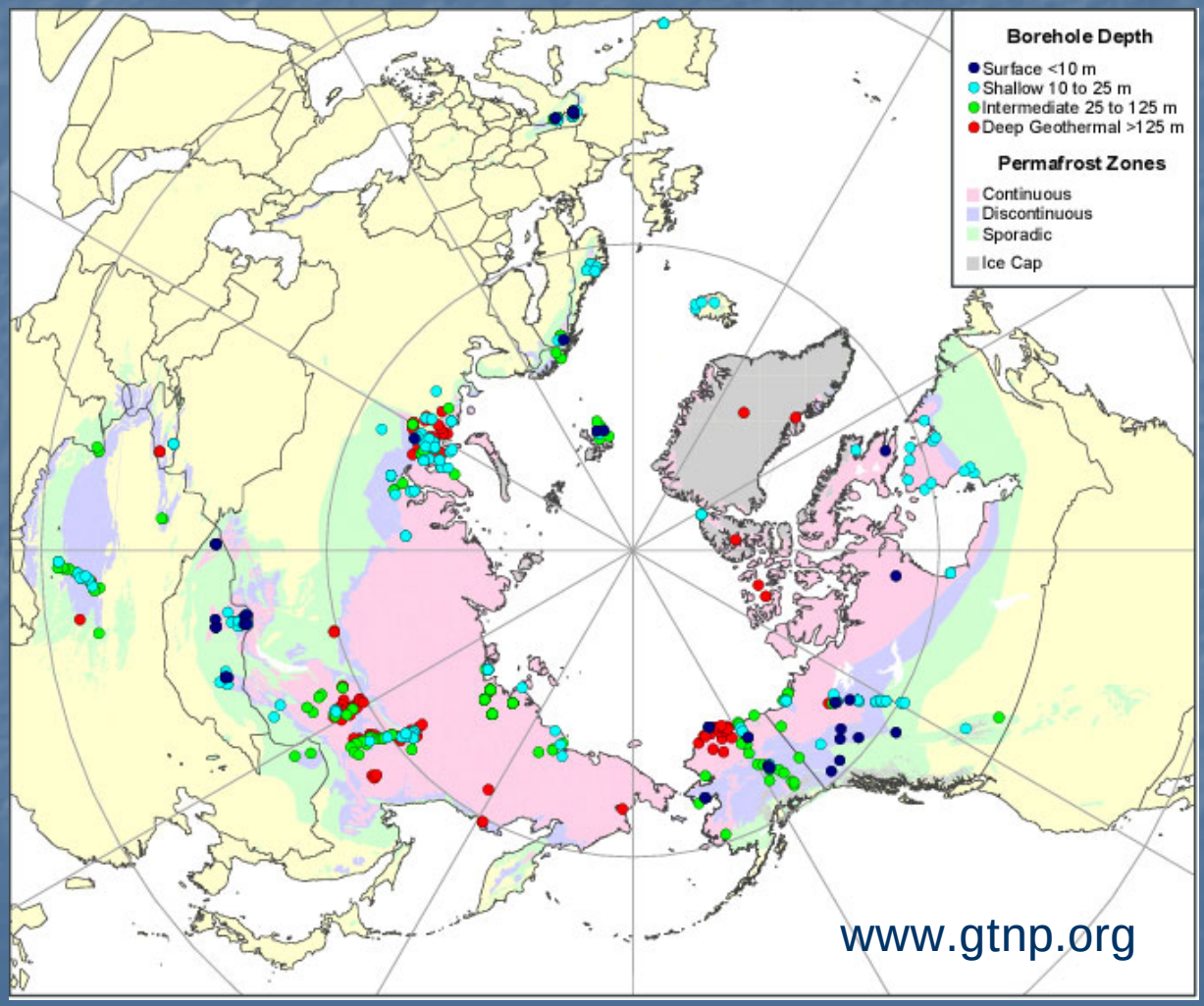
Changing Permafrost

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

Circumpolar ground networks

- GTN-P
  - Global Terrestrial network for Permafrost
  - Initiated by IPA, authorized under GCOS
  - provides information on 1) active layer and 2) permafrost thermal state
- CALM – Circumpolar Active Layer Monitoring
  - Component of GTN-P
  - Monitoring changes in active layer thickness and temperature
- PACE – Permafrost and Climate in Europe
  - European contribution to GTN-P

Circumpolar ground networks



Remote Sensing

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

- Both is pursued within the ESA DUE Permafrost project

ESA DUE Permafrost project

- DUE – Data User Elements
- The objective is to establish a monitoring system based on satellite data
- Supporting
  - The GCOS implementation plan
  - National and intergovernmental bodies
  - Scientific groups involved in climate change research
- Multiscale concept
  - Pan-boreal/arctic
    - Regional
      - local

DUE Permafrost project

- EO experts
  - Vienna University of Technology, Austria
  - University of Waterloo, Canada
  - University Jena, Germany
  - Gamma Remote Sensing, Switzerland
  - Alfred-Wegener Institute of Polar and Marine Research

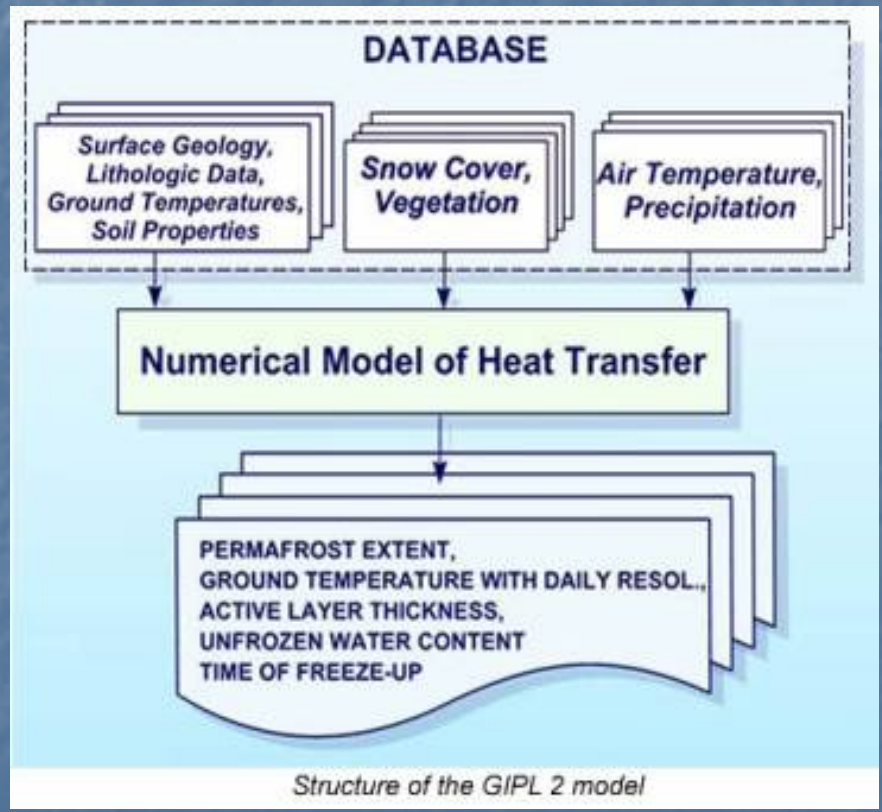
- User organizations
  - Alfred-Wegener Institute of Polar and Marine Research with IPA
  - University of Alaska Fairbanks
    - Perm. Laboratory, IARC
  - Lomonossov Moscow State University, Russia
  - Permafrost Institute Yakutsk
  - State Hydrological Institute St Petersburg, Russia
  - Geological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

DUE Permafrost project

- Status
  - Phase I start in June 2009
    - User requirements
    - Design engineering
  - Phase II June 2009 – November 2010

Parameters for modelling

Example: GIPL



Structure of the GIPL 2 model

Parameters for modelling from Remote Sensing – pan-boreal scale

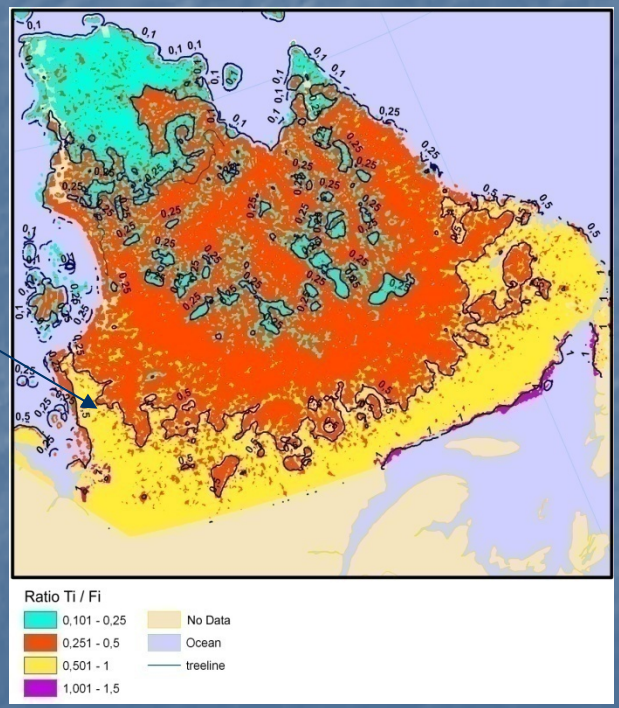
- Land Surface Temperature
- Landcover
- Disturbances
- Snow properties
- Soil moisture
- Terrain

Parameters for modelling from Remote Sensing – pan-boreal scale

- Land Surface Temperature
  - Available from
    - MODIS
    - AATSR
    - Passive microwave
- For approximation
  - Thaw index/freeze indey

Approximate limit of sporadic permafrost

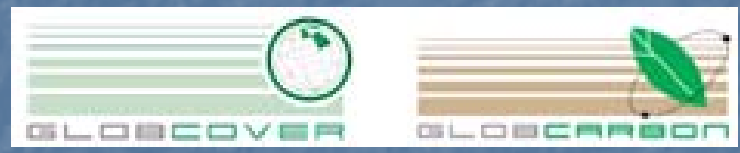
Ratio

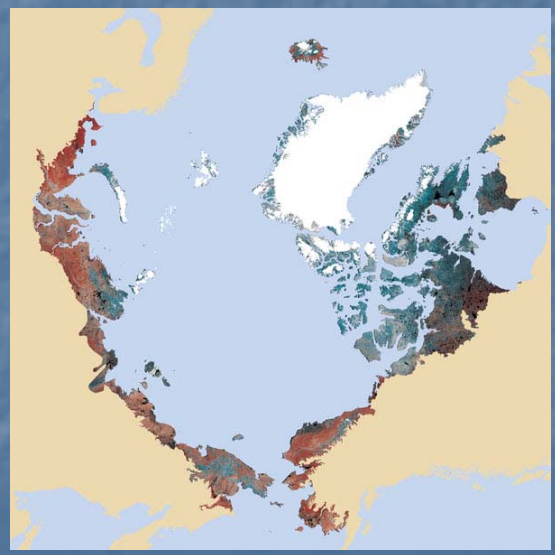


Source: Hachem 2008

Parameters for modelling from Remote Sensing – pan-boreal scale

- Landcover
  - ESA Glob-Projects
  - CAVM – Circum Arctic Vegetation Map





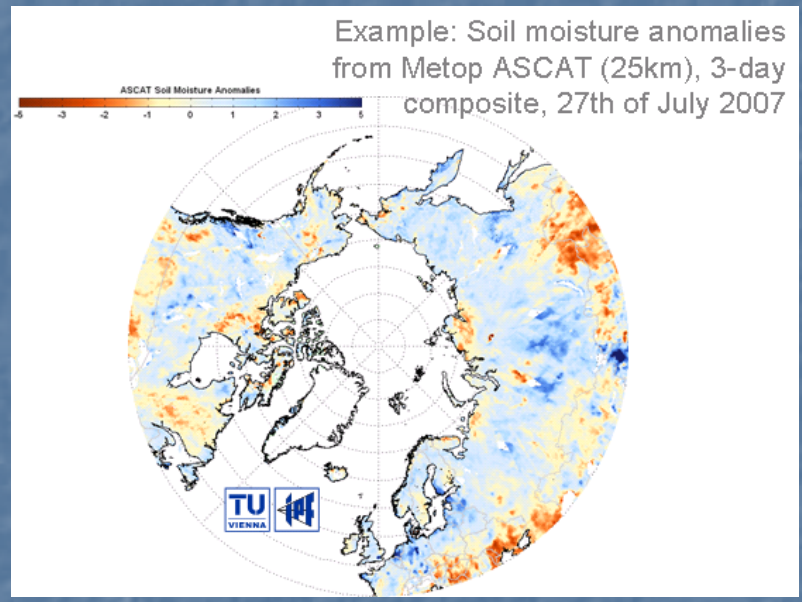
Parameters for modelling from Remote Sensing – pan-boreal scale

- Snow properties
  - Extent
  - Snow Water equivalent
  - Products available from
    - Optical sensors
    - Microwave sensors

GlobSnow Newsletter 3/2009

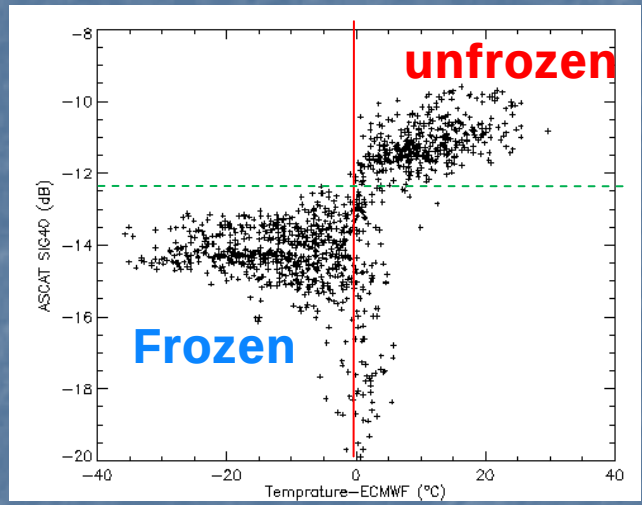
Parameters for modelling from Remote Sensing – pan-boreal scale

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



Parameters for modelling from Remote Sensing – pan scale

- Freeze/thaw
  - Product foreseen within the GCOS implementation plan
  - So far low progress (status report 2009)
- Implemented within DUE PERMAFROST based on active microwave sensors



Metop ASCAT backscatter and ECMWF air temperature

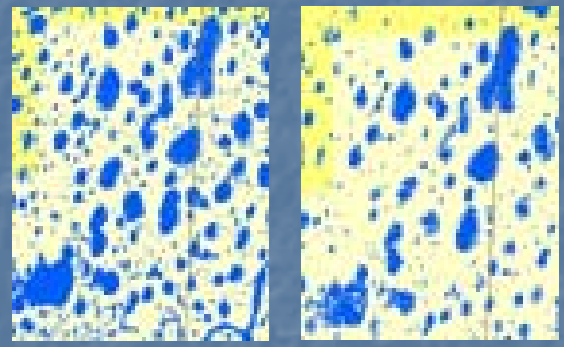
Parameters for modelling from Remote Sensing – regional scale

- Implementations within
  - Regional scale soil moisture from ENVISAT ASAR GM (1km)
    - Has been already implemented within the ESA DUE Tiger project SHARE for Africa and Australia
  - Regional scale water bodies identification with ENVISAT ASAR WS (150m)
    - Has been developed within the FP5 Project Siberia II

Permafrost local scale monitoring

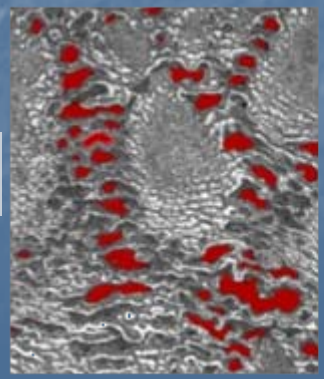
- Thermokarst
  - Lake dynamics
  - Subsidence
- Landcover change

24.06.2004 30.06.2004

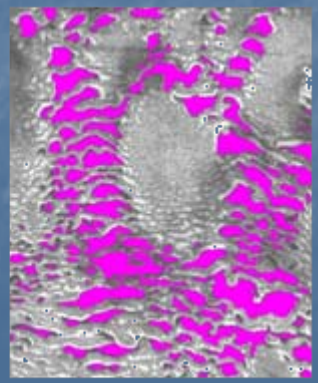


Seasonal change
(ENVISAR ASAR WS)

Corona 1964



Hese 2009



20.10.2009

Long term
changes

NIR QB 2004

DUE PERMAFROST

TU WIEN

IPF

Validation sites

relief

LST

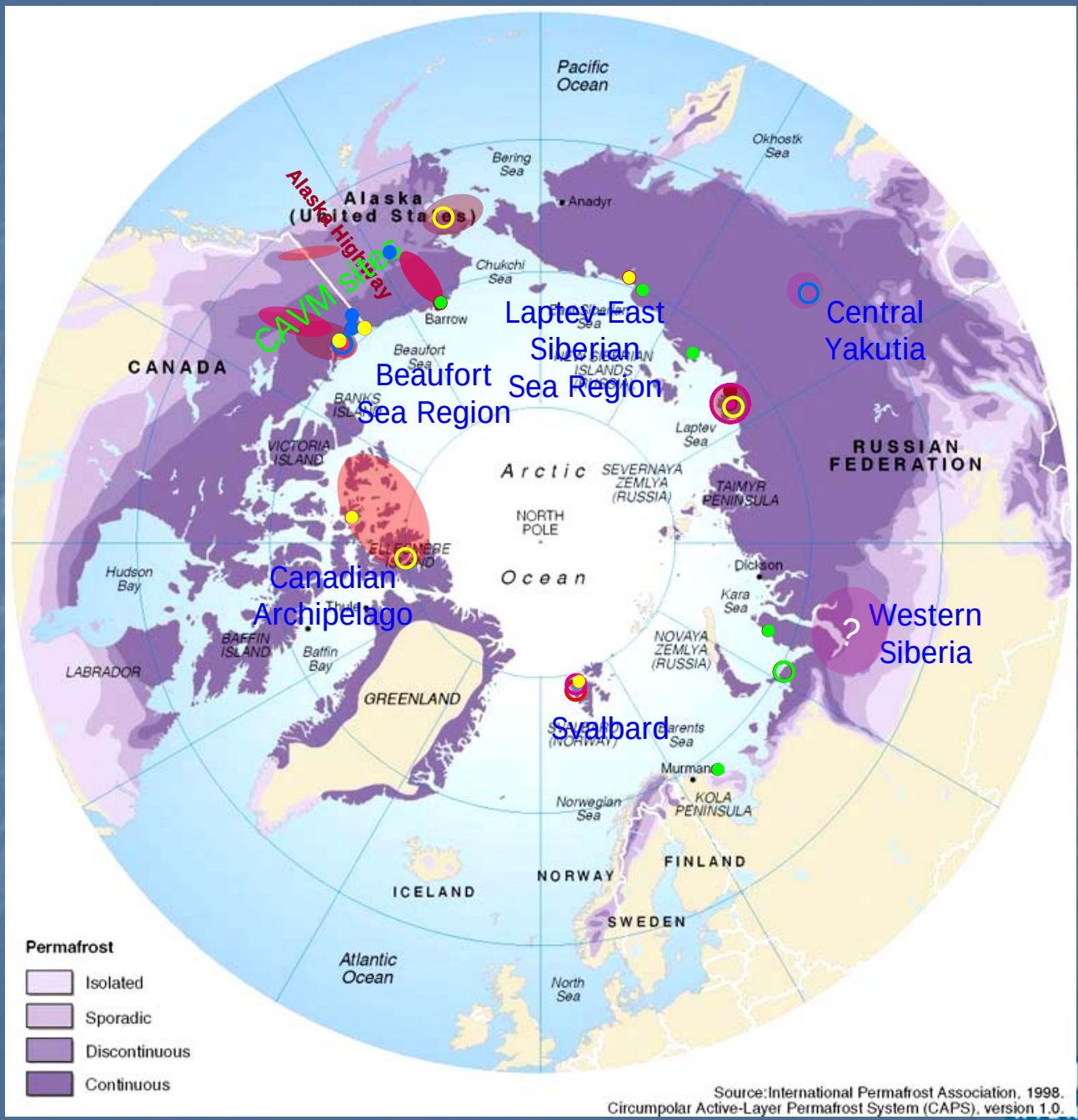
SSM

vegetation

water bodies

green house gases

Status Oct 2009



DUE PERMAFROST

EO Monitoring Summary

Pan-boreal/arctic

- Land Surface Temperature
- Soil moisture and freeze/thaw
- Landcover
- Disturbances
- Snow extent and SWE

Regional

Local

- Subsidence
- Water Surface Dynamics
- DEM

Outlook

- Next user workshop and presentation of monitoring service design and the permafrost information system in May 2010
- More information:
  - www.ipf.tuwien.ac.at/permafrost

DUE PERMAFROST