Vienna University of Technology
Institute of Photogrammetry and Remote Sensing

Arctic Monitoring
Permafrost and Land Surface Hydrology

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Elise Richter Program
Austrian Science Fund

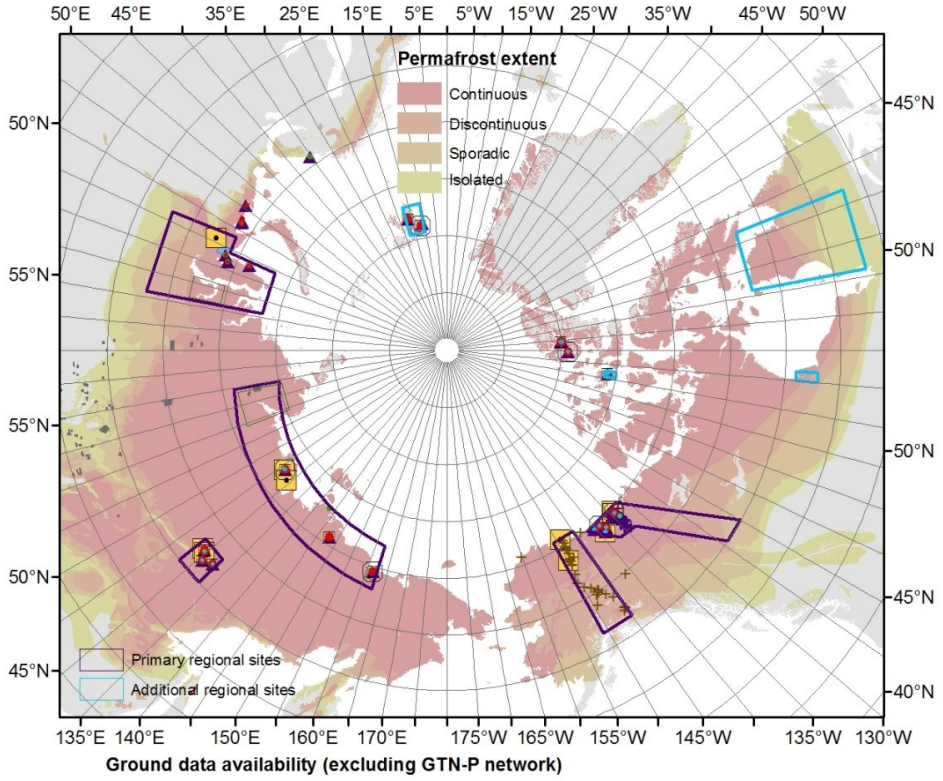
esa

DUE PERMAFROST

alanis methane
support to science element

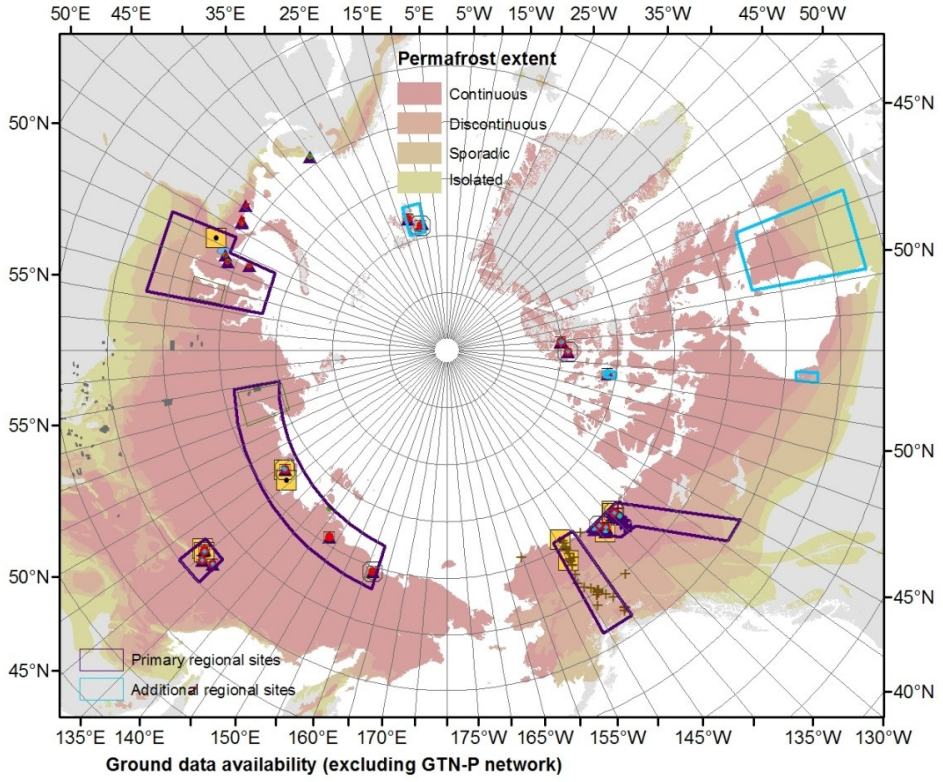
Why Permafrost in DUE?

- Permafrost is an environmental indicator on climate change
- Thawing permafrost is a carbon source
- Transport in boreal areas (roads, railways, pipelines) is affected by permafrost degradation
- Thawing of permafrost in alpine areas raises the risks of landslides
- …



DUE Permafrost

- Aim is to establish a circumpolar monitoring system **based on mostly existing satellite data products**
- Users:
  - Permafrost scientists and
  - Climate Modellers



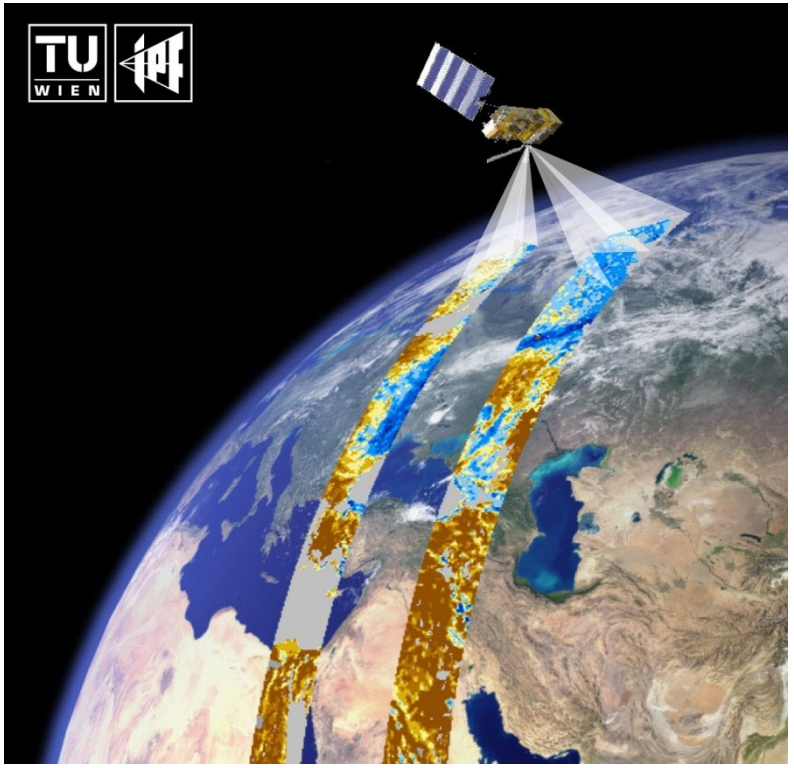
DUE Permafrost

- 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 of Permafrost to climate change depends on variations in local seasonal factors
  - Snow cover
  - Vegetation
  - Surficial material
  - Moisture content
  - Drainage

Permafrost & Remote Sensing

- Cannot directly see below the soil surface, but
  - Monitoring of indicators
    - Lake dynamics
    - Terrain changes
    - vegetation
  - Monitoring of parameters used in models
    - Land Surface Temperature
    - Landcover
    - Disturbances
    - Snow properties
    - Soil moisture
    - Terrain



User organizations

- International Permafrost Associations - IPA
- Supported by IPA Remote Sensing Task Force

- Alfred-Wegener Institute of Polar and Marine Research
- University of Alaska Fairbanks
  - Permafrost Laboratory
  - International Arctic Research Centre
- 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

User requirements survey summary

- Easy access to end-products which provide information on the current status of permafrost and add value to existing networks
- Synergy with other current international activities such as the Global Cryosphere Watch and the Sustained Arctic Observing Network (SAON)
- The joint activities shall support regular updates of permafrost extent (e.g. monthly). This can be supported by the permafrost modelling community and through the IPA (International Permafrost Association) based on a long-term sustained management strategy
- The currently feasible update intervals range between annual and weekly on regional to pan-arctic scale. The spatial scale of pan-arctic services is limited to 25km. Precise monitoring does, however, require daily time steps at minimum 1km.
- This agrees with the GCOS observation requirements for permafrost itself but not the ECVs which are model input parameters

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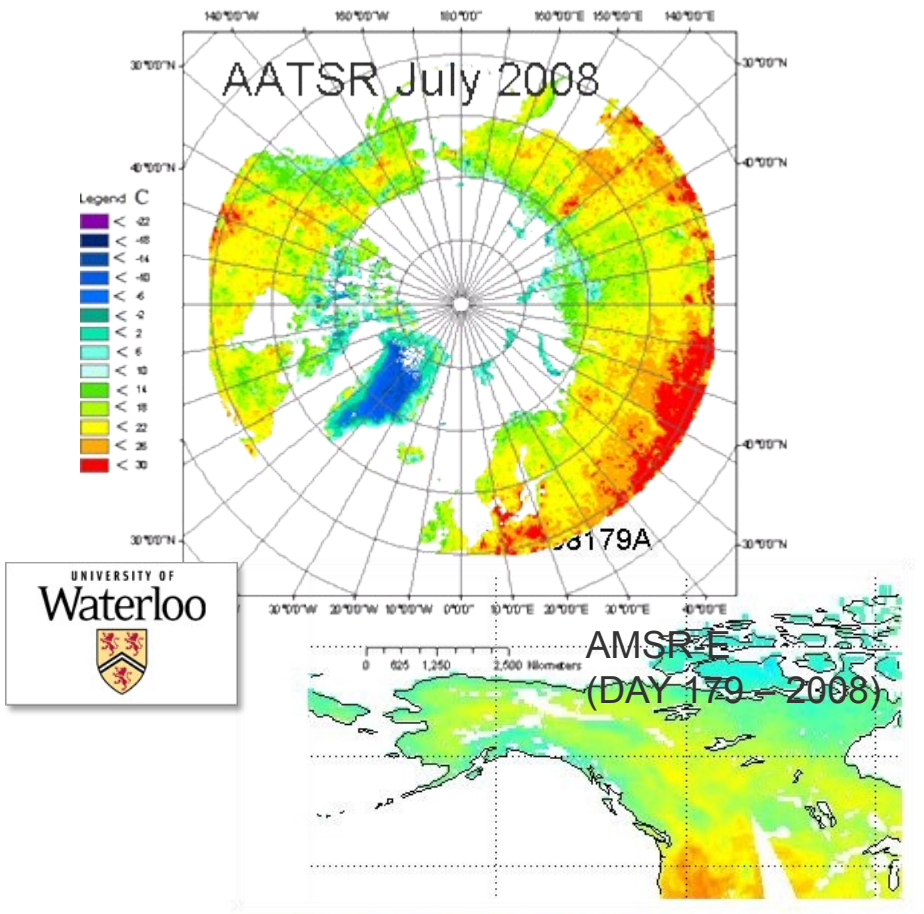
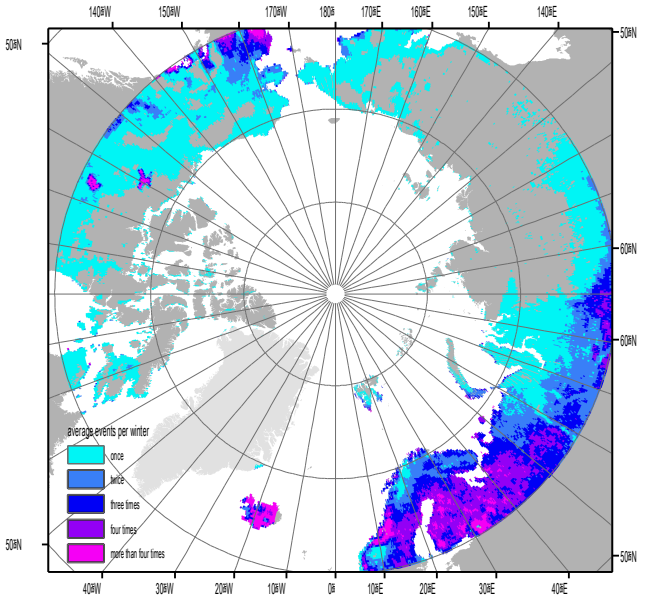
Possibilities of circumpolar monitoring - examples

- Land Surface Temperature



- Snow properties
  - Globsnow: extent, snow water equivalent
  - But also structure and grain size



Ice crust formation frequency 2000-2009
Bartsch (2010; QuikScat)

Europe's Arctic Course
Workshop on the Future of Space Cooperation in the Arctic Region
8 December 2010

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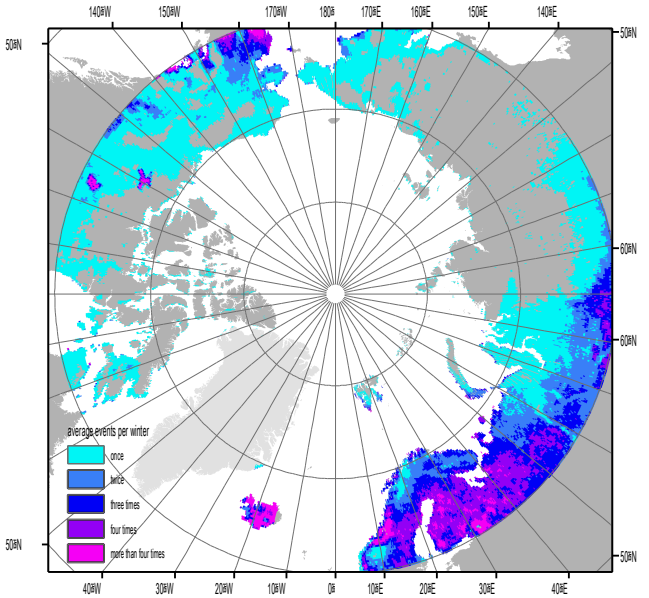

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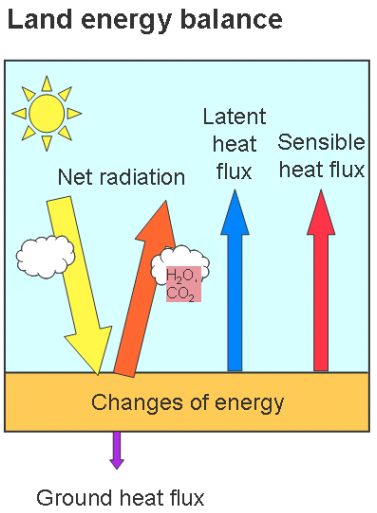
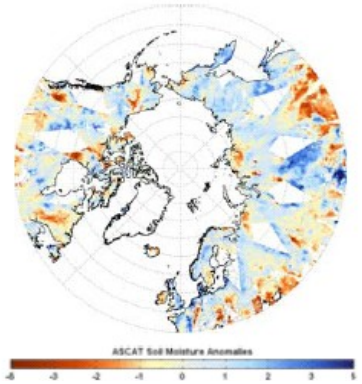
Importance of soil moisture monitoring

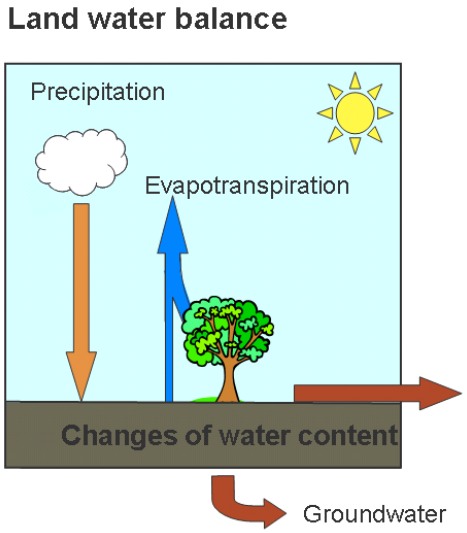
- Important component of the water cycle and land energy balance
- Influences land-atmosphere carbon exchange
- Associated with hazards





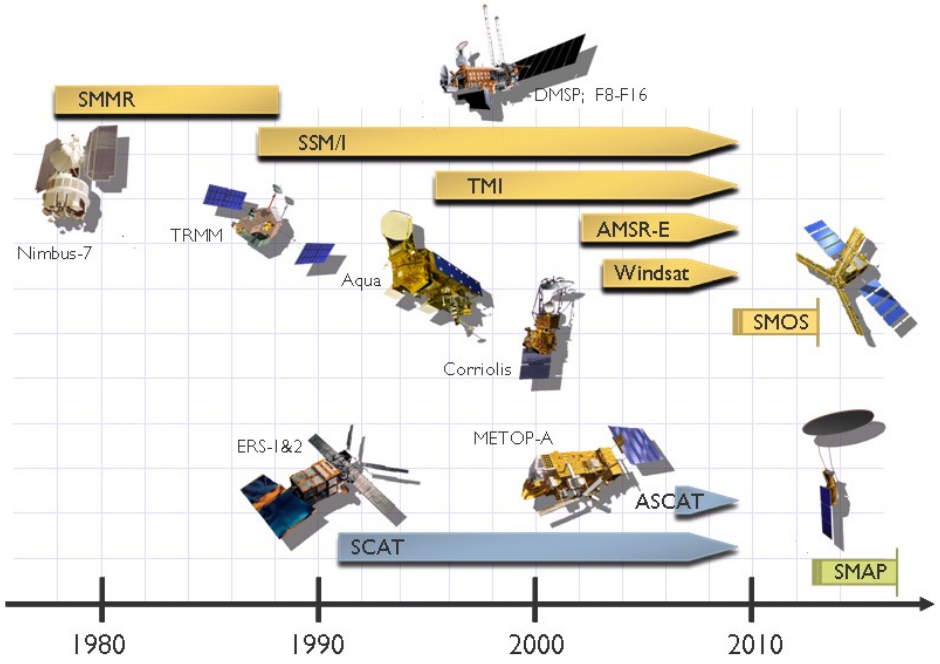
Polar view of soil moisture anomalies from METOP ASCAT data of July 2007. 1–day composite (July 30th)

Large, all summer lasting tundra fire event on the Alaskan North Slope



Possibilities of soil moisture monitoring

- Significant advances over the last few years
  - Sensor technology
    - Soil Moisture and Ocean Salinity (SMOS): launch in November 2011
    - Soil Moisture Active/Passive (SMAP): launch in 2014/15
  - Improvements in physical understanding and retrieval
- Several global soil moisture data sets derived from different sensors and algorithms have been released over the past few years
  - Multi-frequency radiometers, scatterometers, SAR
- Validation
  - Independent assessments and inter-comparisons
  - International in-situ soil moisture network
  - New methods (triple collocation, data assimilation, …)



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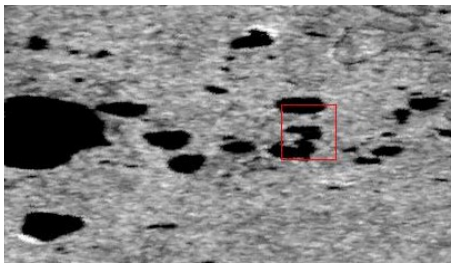
Challenges for soil moisture monitoring in the Arctic

- Landscape heterogeneity
  - current operational schemes provide 25 km resolution
  - Seasonal inundation dynamics + thermokarst
  - Regular higher spatial and temporal resolution (SAR) required
  - Future improved monitoring with Sentinel-1?

- Surface freeze/thaw
  - Current operational services have been developed with focus on regions without frozen ground conditions
  - Improved service development in progress

ENVISAT ASAR WS



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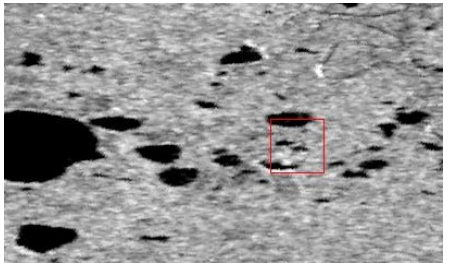

28.08.2007

5km

Thank you!

- www.ipf.tuwien.ac.at/permafrost
- www.ipf.tuwien.ac.at/radar
- www.alanis-methane.info

- Soil moisture data viewer
  - http://www.ipf.tuwien.ac.at/radar/dv/ascat/
  - http://www.ipf.tuwien.ac.at/radar/dv/smos

Photograph: Sina Muster, AWI; Lena Delta

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FWF Elise Richter Program Austrian Science Fund
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