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1 Abstracts
EnMAP Specific BRDF Measurements of Low-Growing Biomes in the Arctic Tundra

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Global warming is highest in the Arctic where the tundra regions are expected to undergo pronounced changes. Remote sensing can provide spatial and temporal data on variables linked to vegetation and ecosystem processes on global scale. Specifically, hyperspectral remote sensing data can relate to Vegetation Indices (VIs), Leaf Area Index (LAI) and the fraction of Photosynthetically active Radiation (fPAR).

Currently, spaceborne hyperspectral imaging data is provided by the CHRIS/PROBA and the Hyperion programs. The Environmental Mapping and Analysis Program (EnMAP), a German hyperspectral mission, is the next step in this line and will provide high spectral resolution observations with a ground sampling distance of 30 meter. The continuous spectral sampling provided by imaging spectroscopy offers the possibility to develop robust algorithms for vegetation indices in low-growing tundra biomes. Since the EnMAP sensor has pointing capabilities, both spectral and directional reflection characteristics need to be taken into account. In order to examine the influence of the bidirectional reflectance distribution function (BRDF) on spectral variables such as the Vegetation Indices, LAI and fPAR, we developed the EnMAP specific field spectro-goniometer, EyeSight. We took part at the summer field campaign of the Earth Cryosphere Institute (RU) in 2011 on the Yamal Peninsula, Western Siberia, Russia. Field spectroscopy, vegetation and biomass analysis, and field goniometer measurements under varying sun zenith angles and moisture conditions have been conducted.

First results show that the BRDF influence on VI’s of low-growing arctic biomes has to be taken into account for the development of Tundra adapted VI’s. The low sun zenith angles in the Arctic latitudes prevent Hotspot-Effects in EnMAP data, but BRDF normalization is still needed. The first BRDF calculations for the tundra relevé plots VD1 R25 and VD1 R28 proof the mirror asymmetry in relative azimuth with respect to the principal plane. The BRDF calculations also show the maximum scattering displaced in the backward direction, but no minimal forward scattering. Instead, the forward scattering from the moss-dominated tundra type with 10 to 15 % vascular plant cover is characterized by similar to higher reflectance values (see figure 1).

Figure 1: Forward and backwards reflectance measured at VD1, releve25, R25 (2012-08-29)
The ANIsotropy Factor ANIF is normalized to the nadir value. The 3-dimensional BRDF ANIF graphs of the red wavelength (672nm) and the Near Infrared NIR Wavelength (840nm) visualize this untypical BRDF effect (figure 2). Highest influence is viewable in the backward direction. This BRDF effect is also visible in the vegetation indices, like NDVI, calculated out of the spectro-radiometrical field data.

*Figure 2: BRF visualisation and ANIF of the red wavelength (675 nm) and the Near InfraRed NIR wavelength (840 nm) at plot VD1, relevé25, R25 (2012-08-29)*
Study in Biebrza Wetlands using optical and microwave satellite data

PECS Project:
"Study and implementation of remote sensing techniques for the assessment of carbon balances for different biomasses and soil moistures within various ecosystems"

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The project presents monitoring and mapping of various soil-vegetation variables using optical and microwave satellite data for Biebrza Wetlands situated in the Northern part of Poland. Satellite data applied for the study included: ENVISAT ASAR and MERIS, ALOS.PALSAR, NOAA.AVHRR. Optical images were used for classification of wetlands communities and calculation of vegetation indices. Heat fluxes as latent heat, sensible heat were applied for calculations of soil moisture index. Microwave images have been used for the assessment of soil moisture. For each of the classified wetlands vegetation habitats the relationship between soil moisture and backscattering coefficient has been examined, and the best combination of microwave variables (wave length, incidence angle, polarization) has been used for mapping and monitoring of soil moisture. One of the approaches that have been considered in this research was to present LAI as surface roughness indicator. For each of the wetlands vegetation classes and LAI classes, the relationship between soil moisture (SM) measured at the test site and backscattering coefficient (σ’) calculated from microwave images registered in various modes (IS2, IS4, IS6) and polarizations (VV, HV, HH) has been examined.

Results of the relationship between σ’ and SM are presented. The equations have been used for the preparation of soil moisture maps. The maps of soil moisture for May 2003 and 2008 were calculated using developed algorithms. These maps well describe the moisture conditions - values of SM are higher in May 2008. Similar maps have been produced for each of the ENVISAT.ASAR IS2 HH images.

Preliminary results of measurements of CO₂ exchange in various wetland communities were presented for the area of Biebrza National Park in north-eastern Poland. It is a part of the ongoing PECS project titled “Study and implementation of remote sensing techniques for the assessment of carbon balances for different biomasses and soil moistures within various ecosystems” realized in the Institute of Geodesy and Cartography Remote Sensing Department in Warsaw. CO₂ flux measurements were performed with a static chamber method from the end of April till September in 2010. The method is based on placing a transparent chamber over the surface vegetation and monitoring the change in CO₂ concentration and air temperature over time in the chamber headspace. Under light conditions, a measurement of NEE is obtained, and after darkening of the chamber with a cloth, ecosystem respiration is measured. More than 70 sites, revisited with varying frequency throughout the season, were included in the study. Environmental variables such as soil moisture and leaf area index (LAI) were also measured at each site, and aboveground biomass was sampled in order to calibrate data obtained from satellites. The field campaigns were organized at the same time as satellite registrations of the area. The data derived from satellites working in optical and microwave spectrum have been delivered by ESA during the carbon balance, and biophysical measurements. Spatial information concerning wetlands vegetation communities is essential in application of microwave images to calculate soil moisture. Carbon balance values were related to soil moisture and LAI assessed from optical and microwave data.

The Project was carried out in the framework of the national grant N N526 0217 33. The satellite images have been obtained for ESA projects AO ID 122 and AOALO.3742.

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A strong linear relationship exists between Special Sensor Microwave/Imager (SSM/I) microwave (19 and 37 GHz) surface emissivities at horizontal and vertical polarizations over snow- and ice-free land surfaces (Filly et al., 2003). The main factor modifying the emissivity is the Fraction of Water Surface (FWS) within a pixel.

Based on these relations, a retrieval algorithm has been developed by Filly et al. (2003). It has been used to study wetland seasonal dynamics and inter-annual variability over northern high latitudes and change in surface water over the western Siberia lowland (Mialon et al., 2005; Grippa et al., 2007).

Since 2002, ENVISAT ASAR Wide Swath data can identify open water surface areas with 150 m resolution. DUE Permafrost has just developed a SAR processing subsystem for the Water Bodies and now provides maps of summer water extent from 2007 to 2009 for regional sites (Ob Estuary, Alaska, Mackenzie, Laptev Sea Coast and Central Yakutia).

In the framework of the FP7 MONARCH-A project, FWS have recently been re-calculated from SSM/I brightness temperature over the 1989-2009 period in order to carry through variability and trend studies.

In the study presented here, DUE Permafrost Water Bodies are first used to validate FWS summer fields over the last years of the period. SSM/I-based FWS agree well with DUE Water Bodies but some differences remain, which origins are still under investigation. FWS 5-days means and monthly means are then used for yearly to multi-decadal variability analyses over the whole continents above 50°N.
Benefits of remotely sensed soil moisture data for the validation of a land-surface model

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Soil moisture is a ground characteristic of considerable interest for climate modelling, due to its key role in bioclimatic processes and land surface-atmosphere interactions. However, the ability of climate models (and within them land surface models) at representing soil moisture is difficult to assess. The extreme spatial variability of soil moisture is hard to reconcile with the scale of interest of these models. Most existing datasets are site-specific and even if they sometimes account for a certain spatial variability, they do not allow the validation of soil moisture modelling results at scales larger than a few square kilometres.

Here, the pan-Arctic ESA DUE permafrost surface soil moisture product is used to evaluate the new hydrological scheme of the land surface model ORCHIDEE, part of the state-of-the-art climate model IPSL-CM4. Specific emphasis is put on the ability of the model to reproduce the spatial and temporal variabilities inferred from satellite data, at both a large (hydrological basins of the pan-Arctic area) and a more regional (central Yakutia) scale.
Thermo-erosion of permafrost coasts in the Laptev Sea Region

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Currently observed decreases in arctic sea ice extent and changes in water and air temperatures are expected to directly influence the geomorphodynamics of permafrost-affected coasts. Thermo-abrasion and denudation are the dominant destructive processes in the context of arctic coastal erosion. They change coastline position and release clastic and organic material to the near-shore zone. The term thermo-erosion describes the entire suite of these processes. The Yedoma coasts of the Laptev Sea are the most ice-rich permafrost coastlines of the Arctic, where we expect erosion to be most sensitive to changing environmental conditions. In 2010, we studied Yedoma and permafrost-affected sites on the Buor Khaya Peninsula and focused on coastal thermo-terrace features found along the high Yedoma coastal bluffs.

Providing large areal coverage at high ground resolution, RapidEye serves as a consistent master dataset for georeferencing of historical CORONA and aerial imagery. Applying robust data fusion methods, we determined historical and contemporary coastline positions and planimetric change vectors using GIS. Annual cliff top erosion rates range from 0.4 to 3.3 m a⁻¹ and vary between sites. Through differencing multi-temporal DEMs, analysis of volumetric erosion revealed values around 42 000 and 34 000 m³ for Yedoma sites and 12 000 m³ per coastline km for alas sites. The approach of using different units of 2D and 3D change detection and relating them to each other is a promising means of analyzing thermo-erosion. The spatial pattern of erosion along this permafrost coastline is heterogeneous, because the effects of thermo-erosion are superimposed on a landscape already reworked by thermokarst processes.

This work is funded in part by the BMBF through PROGRESS: Potsdam Research Cluster for Georisk Analysis. RapidEye imagery was kindly provided by the DLR science archive.
User Interaction within ESA DUE PERMAFROST: Evaluation of circum-polar remote sensing products and their usability for models (permafrost and climate modelling)

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The ESA DUE Permafrost project (2009-2011) is developing a suite of parameters indicative of the subsurface phenomenon permafrost using satellite remote sensing: Land Surface Temperature (LST), Surface Soil Moisture (SSM), Surface Frozen and Thawed State (Freeze/Thaw), Terrain, Land Cover, and Surface Water. Snow parameters (Snow Extent and Snow Water Equivalent) are being developed through the DUE GlobSnow project, Global Snow Monitoring for Climate Research (2008-2011). The final DUE Permafrost remote sensing products cover the years 2007 to 2011 with a circumpolar coverage that will soon be released (early 2012), and then be used to analyze the temporal dynamics and map the spatial patterns of indicators. Further information is available at www.ipf.tuwien.ac.at/permafrost.

Since the beginning, scientific stakeholders and the International Permafrost Association (IPA) have been involved in the science and implementation plan. Interactive international user workshops took place in 2010 at the Technical University of Vienna, Vienna (AT), and in 2011 at the International Arctic Research Center (IARC), Fairbanks, Alaska (US). The final User workshop was held between Feb 15-17 2012 at the Alfred-Wegener-Institute for Polar and Marine Research (AWI) in Potsdam. It brought together a multidisciplinary permafrost community working on satellite-derived data and in-situ field validation. About 60 participants from Austria, Canada, Finland, France, Germany, Italy, Japan, Norway, Poland, Russia, Sweden Switzerland, UK, and USA participated and gave oral presentations and poster presentations.

The involvement of the user communities and the ongoing evaluation of the indicators derived from remote sensing for the high-latitude permafrost regions make the DUE Permafrost products trustworthy for the permafrost and the climate research community. Ground data are provided by user groups and global networks. A major part of the DUE Permafrost core user group is contributing to GTN-P, the Global Terrestrial Network of Permafrost (IPA). Its main programmes, the Circumpolar Active Layer Monitoring (CALM) and the Thermal State of Permafrost (TSP) has been extended during the last International Polar Year (2007-2008) to provide a true circumpolar network. Ground data include active layer- and snow depths, air-, ground-, and borehole temperature data as well as soil moisture measurements and the description of landform and vegetation.

The adaption of the remote sensing products for the permafrost and climate modeling is experimental and highly dependent on the users’ involvement. For a few years already, the Geophysical Institute Permafrost Laboratory (GIPL), University of Alaska Fairbanks, US (http://www.gi.alaska.edu/research/snowicepermafrost/Permafrost) has successfully demonstrated the value of using LST derived from remote sensing data for driving its permafrost models. Further experimental testing of the DUE Permafrost products for use by the modeling community (permafrost and climate) will range from (i) the evaluation of external data of the models, with modifying or providing new external data (e.g. tundra land cover, surface water ratio, soil distribution), to (ii) new drivers for regional models derived from remote sensing (e.g., LST), to (iii) the evaluation of the output data from the models (e.g. spatial patterns of moisture and temperature).
Assessment of value added applying a regional climate model for Siberia - Potential use of ESA DUE products -

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Being a region where the temperature rise has been among the most pronounced globally, Siberia is a hot spot of climate change. In order to investigate the variability and the changes of atmospheric and terrestrial variables we performed a reconstruction of the climate for the last 60 years (1948-2010) using the regional climate model COSMO-CLM (climate mode of the limited area model COSMO developed by the German weather service). This dataset provides consistent and homogeneous fields of these variables in a high temporal and spatial resolution for the whole Siberian Region.

However, the question arises whether the regional climate reconstruction provides additional information beyond the resolution of global re-analyses. Therefore, we assess the model's simulation quality in representing recent climate conditions by comparing it with reanalysis and observational reference data. Since in-situ station data is relatively sparse in that region, remote sensing products e.g. provided by ESA DUE Permafrost are an important data source for model assessment for a large spatial extent. As global forcing for the initialization and the regional boundaries we used NCEP-1 Reanalysis of the National Centers for Environmental Prediction since it has the longest temporal data coverage among the reanalysis products. Additionally, spectral nudging is applied to prevent the regional model from deviating from the prescribed large-scale state within the whole simulation domain. The area of interest covers a region in Siberia, spanning from the Laptev Sea and Kara Sea to Northern Mongolia and from the West Siberian Lowland to the border of Sea of Okhotsk. The current horizontal resolution is of about 50 km.

To assess the value added by the regional model we investigate spatial and temporal characteristics of temperature and precipitation of the model output in comparison to global reanalysis data (NCEP-1, ERA40, ERA-Interim). As reference Russian station data from the “Global Summary of the Day” data set provided by NCDC is used. Furthermore, we use monthly land surface temperature provided by ESU DUE Permafrost and snow water equivalent provided by ESA GlobSnow to examine the usability of these products for model output evaluation.
Satellite InSAR and Envisat Wide Swath backscatter time series for monitoring of periglacial landscape features on Svalbard

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Here we present the Norwegian PermaSAR research project, where synthetic aperture radar (SAR) is applied for monitoring of periglacial landform changes in areas with permafrost on Svalbard and in northern Norway. Improved understanding of the processes controlling periglacial landscape dynamics are highly relevant for climate change studies, but so far mainly based on point based field studies of individual landforms. We have been testing if the interferometric SAR (InSAR) technology would be able to provide upscaling of point based field measurements to landscape scale, and if it time series of InSAR could provide data on seasonal and interannual surface dynamics.

In high arctic Svalbard, the permafrost is continuous and thus also occurs in lowland sediment-filled valleys. Collection of in-situ field data quantifying periglacial landform processes on Svalbard is ongoing, but rather expensive and time consuming. In the PermaSAR project, the objective is to use time series of InSAR to detect, characterize, and quantify land surface changes related to activity of various periglacial landforms, which are largely controlled by permafrost on both regional and local scales. Preliminary results show that InSAR using ERS and Envisat ASAR data, with its 35 day repeat cycle, and relatively low resolution, are unable to capture the significant seasonal ground displacement happening relatively quickly mainly during spring thawing and autumn refreezing of the active layer above the permafrost. Our results show that the high spatial resolution and short revisit time of TerraSAR-X is particularly well suited for monitoring this fine-scale and highly nonlinear displacement. We have since 2009 acquired data from both ascending and descending orbits, which enable separation of vertical and horizontal east-west displacement components. This makes it possible to distinguish different movement patterns between individual periglacial landforms, from solifluction sheets and rock glaciers with a significant horizontal component to landforms characterized by vertical displacement due to frost heave, such as beach ridges.

Furthermore, we have since 2005 measured the near-daily temporal development of radar backscatter using wide swath data from the Envisat ASAR sensor. The backscatter is a proxy for the amount of liquid water in the top surface layer, which is related to freezing and thawing of the active layer above the permafrost. The time series allow studies of the spatial distribution of different periglacial landforms in Svalbard. The results are compared with in situ field measurements of soil temperature as well as other simultaneous remote sensing data (TerraSAR-X and Terra MODIS).
Mapping of permafrost features using land-based and remote-sensing data

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Permafrost mapping is traditionally based on a landscape-key method which includes landscape mapping using both field observations and remote-sensing data, then choosing the representative sites for detailed study, and finally distributing field data from the key sites to entire area having the same features. Specifically for permafrost studies, landscape mapping and the choice of the key sites follows controls affecting permafrost features on study. For active layer these are organic mat type and thickness, soil texture, drainage/moisture content. For ground temperature most important in tundra are shrub thickness and height (as a proxy for snow cover thickness), slope aspect and steepness.

Mapping was undertaken along a key 1.5 km long transect crossing main geomorphologic units of the Central Yamal. Geodetic survey within a 200 m wide stripe followed main vegetative complexes. Boreholes and pits linked to these complexes allowed characterization of the lithology, moisture content, active-layer depth and descriptive features.

Data is arranged into a database containing coordinates of the description points. In each point specified are (a) parameters of vegetation, coverage, moss thickness and shrub height, (b) sample depth, lithology and moisture content, (c) active-layer depth and ground temperature (where available), (d) description of landforms.

Some regularity was determined after preliminary processing of the database:
- Ground temperature varies from ±0°C on slopes with 60 cm and higher shrub thickets, up to -5°C on the main watersheds with dominating tundra vegetation, and as low as -6°C on the sandy hilltops where snow is blown away;
- Active layer depth change in a wide range between 40 and 148 cm. The main control is moss thickness (high negative correlation) with additional impact from surface features, such as spot-medallions, shrub height and coverage and moisture content.
- Observed is a strong negative correlation among the landforms (concave or convex), height of shrubs and moisture content (higher within concavities), and permafrost features (ground temperature as a rule and active layer depth often are higher within the concavities).

Correlations established provide an algorithm of permafrost mapping through topography, vegetation survey and permafrost monitoring at key sites.
The efforts of the European Space Agency (ESA) Data User Element (DUE) funded GlobSnow project has resulted in two new global records of snow parameters intended for climate research purposes. The datasets contain satellite-retrieved information on snow extent (SE) and snow water equivalent (SWE) extending 15 and 30 years respectively. The dataset on snow extent is based on optical data of Envisat AATSR and ERS-2 ATSR-2 sensors covering Northern Hemisphere between years 1995 to 2011. The record on snow water equivalent is based on the methodology by Pulliainen [1], utilizing satellite-based passive microwave measurements combined with ground-based weather station data, beginning from 1979 and extending to present day.

The GlobSnow SWE data record is based on the time-series of measurements by two different space-borne passive radiometers (SMMR and SSM/I) measuring in the microwave region, spanning from 1979 to present day. The utilized sensors provide data at K- and Ka-bands (19 GHz and 37 GHz respectively) at a spatial resolution of approximately 25 km. Another notable feature of the SWE product, when compared with the previously available datasets, is the inclusion of a statistically derived accuracy estimate accompanying each SWE estimate (on a pixel level). The current GlobSnow SWE data record has been released and is available through the GlobSnow web-pages (www.globsnow.info). The ESA GlobSnow project was initiated in November 2008, and is being coordinated by the Finnish Meteorological Institute (FMI). Other project partners involved are NR (Norwegian Computing Centre), ENVEO IT GmbH, GAMMA Remote Sensing AG, Finnish Environment Institute (SYKE), Environment Canada (EC) and Northern Research Institute (Norut).

The evaluation for the long-term SWE record reported in [2] assesses the GlobSnow SWE data with various ground-based reference data. Based on the evaluations, the retrieval of SWE using the GlobSnow approach, combining satellite- and ground-based data, is significantly more accurate than alternative approaches based solely on satellite data.

References:

Thermokarst lakes and alasses in ice-rich permafrost of the Lena Delta region

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In the late Pleistocene ice-rich deposits (Ice Complex) of northern Yakutia, Siberia, distinctive periglacial landscapes have been formed since the Boelling/Alleroed - early Holocene. Thermokarst lakes and thermokarst depressions (alasses) alternate with ice-rich Yedoma uplands. Recent studies on modern thermokarst activity have focused on thermokarst lakes, e.g. by using large scale change detection of thermokarst lake area, but rarely addressed alasses. However, the effect of thermokarst development on landscape changes and carbon cycling varies depending on whether it takes place on undisturbed plain surfaces or in alasses of older generation thermokarst. Newly developing thermokarst lakes on Yedoma uplands have a stronger transformative impact on permafrost sediments, landscape character, and environmental processes than thermokarst lakes in existing alasses. Taliks forming underneath thermokarst lakes on Yedoma uplands allow for the activation of physical and biochemical processes in the Ice Complex sediments altering their structure and composition that had been conserved for thousands of years. The sediments in existing alasses, however, have already been reworked during past talik formation and refreezing and do not represent the characteristics of the very ice-rich permafrost of the surrounding Yedoma uplands as they contain less ice and labile carbon.

We investigate different stages of thermokarst development in the ice-rich permafrost of the north Siberian Lena River delta regarding their morphometry and spatial distribution with respect to relief position and cryolithological context and deduce the potential extent of future thermokarst evolution in the study area.
Investigations of Snow Water Equivalent and Land-Surface Temperature across the Northern High-Latitudes of Earth

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Earth's seasonality is due to the tilt of the rotation axis relative to the ecliptic plane. This with subtle changes in the Length-of-Day and nutation modulates the incoming solar radiation affecting boreal winter snow cover and boreal summer surface temperature. Permafrost will be affected by changes of snow cover and changes of land-surface temperature. We investigate satellite-derived trends and variations of snow water equivalent and land-surface temperature for their impact on permafrost degradation and thawing. The release of CO2 and CH4 from thawing permafrost to Earth's atmosphere may represent a positive feedback affecting Earth's temperature budget.

Snow Water Equivalent

We compare in-situ snow water equivalent (SWE) with AMSR-E, GIPL model and GLOBSNOW. AMSR-E SWE underperforms relative to in-situ measurements, on average. GIPL and GLOBSNOW show the best performance relative to in-situ measurements. Complex topography and dense vegetation cover affect AMSR-E performance. A key parameter of satellite-derived SWE-retrieval algorithms is snow density taken from surveys in Canada (1946-1995) and Eurasia (1966-1996). Snow density measurement along the Alaska permafrost transect in April 2009 and 2010 show a significant gradient, low-density snow in central Alaska to higher-density snow near the Arctic coast at Prudhoe Bay.

Land-Surface Temperature

We investigate land-surface changes using the NASA Moderate Resolution Imaging Spectroradiometer. On lands 65N and above during 2000 the number of days above 0 degrees C is 97 and during 2010 is 111, an increase of 14 days in 10 years. Land-surface temperatures during 2010 show an increase of 2.1 ± 0.2 degrees C (P-value 0.01), on average from those during 2000 with a regression R-square of 0.97.

Hypothesis

Air and surface temperatures show increases in the Arctic that are greater than the global average increase. We hypothesize that a factor in the AMSR-E SWE underperformance is caused by assumption of snow densities from the 1950s to 1990s that are no longer representative of Arctic snow packs due to effects from Arctic climate change, when other factors are negligible.

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Added value assessment of the DUE Permafrost DEM

- Comparison of topographic wetness indices and wetland distribution

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The focus of the ESA STSE ALANIS methane project on the remote sensing side is the development of new and/or improved wetland maps, and snowmelt and frozen ground information. DUE Permafrost is a project to define, demonstrate and validate permafrost monitoring information services from local to large scale, mainly towards climate change studies and addressing the pan-boreal/arctic zone. The pan-arctic DEM product of DUE permafrost project [1] has been evaluated within the framework of the ALANIS methane project. The DEM was used to derive the topographic wetness index for Northern Eurasia using the same formula as used for calculation of the CTI (compound topographic wetness index [2]). The CTI is derived of HYDROk1 (GTOP0 30) with a resolution of 1 km and frequently used for climate modelling. The additionally generated Wetness Index product (RTM WI derived from RTM DEM provided by DUE Permafrost with a resolution of 100 m) was cross-compared with the existing Wetness Index product (CTI) and with the spatial distribution of the open water bodies and areas permanently saturated with water. This classification was conducted using ASAR WS time series statistics of 2007 and a decision tree method. Differences occur mainly in the Ob river floodplain and in the peat zone of the West Siberian lowland areas permanently highly saturated with water, where the CTI underestimates the wetness of the areas compared to the RTM WI. The occurrence of artifacts was lower as well.

References:
[1] ESA DUE Permafrost Pan - Arctic DEM V1 product guide 2011
http://webgis.wr.usgs.gov/globalgis/metadata_qr/metadata/hydro1k.htm (2011 - 12 - 19)
Active microwave satellite data in support of methane modelling at high latitudes

Discrimination of areas with open water surfaces and permanently high saturation

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The focus of the ALANIS methane project on the remote sensing side is the development of new and/or improved wetland maps, and snowmelt and frozen ground information. Wetland dynamics that play an important role for methane release in high latitudes are investigated on regional to local scale over Northern Eurasia for the years 2007 and 2008. Synthetic aperture radars (SARs) operating in ScanSAR mode (e.g. ENVISAT ASAR Wide Swath, 150m) have shown to be applicable for efficient and accurate water bodies mapping at high latitudes [1]. In this study the seasonal backscatter statistics of ENVISAT ASAR Wide Swath C-band data were used to discriminate areas permanently high saturated with water from open water bodies by using a decision tree classification algorithm. The statistical measures minimum and maximum were calculated of all available datasets within the time series period of May to September. The value margins for permanently saturated areas and open water bodies (maximum inundation) were defined. The classes were derived for Ob and Lena river basin and delta test regions with a spatial resolution of 150m, 75m spacing. Areas which are frozen according to TU Vienna’s Freeze /Thaw product are masked prior classification [2]. The derived classes were compared with the regional surface water product in the northern Eurasian Taiga of Ob and the transition zone of Lena region. The regional wetland product provides the areal extent of wetland for the boreal zone for one year (July 2007–June 2008), on an equal area grid of ~25 km (equal area grid of 0.25° at the equator), with a 10-day temporal sampling [3].

The comparison shows that open water surfaces are underestimated in areas with tundra ponds in the regional product. In boreal areas, the ASAR WS information on saturated and open inundated areas enables the discrimination between the different components, which contribute to the regional wetland extent.

References:
Tracing Arctic frost weathering intensity with ASCAT and borehole temperature data

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Freeze-thaw (F/T) cycling in soil is a main driver of physical weathering in the terrestrial Arctic. The higher the amount of F/T is during a season, the greater is the production of debris that will result from rock breakdown. The ASCAT sensor (Advanced SCATerometer aperture radar on board of MetOp) allows a hemispheric estimate of seasonal F/T due to a daily coverage of northern latitudes. It operates at 5.255 GHz (C-Band) and is sensitive to detect frozen and unfrozen conditions in the upper cm of soil. Whereas the spring signatures suffer from a snowmelt response that dominates much of the backscatter, the autumn signals with little to no snow cover can be validated using soil temperature data.

We use temperature time series of two sites in the Russian Arctic (1. El’gygytgyn Impact Crater, mountainous Chukotka; 2. MamontovyKlyk, northern Yakutian lowland) for comparing satellite derived F/T with ground truth derived F/T. We examine the potential to create a pan-arctic map that aids interpreting the cryogenic weathering strength in the terrestrial Arctic with continuous permafrost.
Observation of thaw and freeze processes in an arctic tundra landscape with TerraSAR-X and RADARSAT-2

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Space-borne imaging radar is a suitable tool for the detection of thaw and freeze processes, as the backscattering of radar waves is highly dependent on the dielectric properties of the surface. The backscattered intensity from frozen and unfrozen wet soils in Siberia differed by 3 to 4 dB using C-band radar. The timing of ice formation and melt on lakes and rivers has successfully been determined from space-borne SAR data.

The study site is located in the southern central part of the Lena River Delta, Northern Siberia, Russia, at 72°N, 126°E. The area is a polygonal arctic tundra landscape, located in a zone of continuous permafrost and covered by ponds, lakes (15 m² to 1.3 km²) and river arms.

A time series of twelve TerraSAR-X images (Stripmap mode) and six RADARSAT-2 (Fine quad-pol) images acquired during spring 2011 and nine RADARSAT-2 images recorded during fall 2011 were analysed for this study. The dates of snow-melt, lake- and river-ice decay and onset, and soil thaw / refreeze obtained from the SAR-based study were compared to meteorological data from Samoylov Island, located in the investigation area, and Tiksi, located about 110 km southeast of the study site.

Soil thaw and refreeze was investigated in regions with different soil properties and vegetation cover. Temporal variations of the mean backscattered radar intensity were analysed for the different land units. The results show that snowmelt events are clearly displayed in the mean backscatter values of the ROIs within the time series. The thaw of the active layer could not be observed in the X-band data, in which the mean backscatter values are mainly the same for both, the frozen and the thawed landscape. The backscatter values of the C-band data are about 3 dB higher during the thaw period than during the freezing period, and vice versa for the refreeze of the soils.

Lake- and river-ice decay and refreeze was monitored in the frame of this study as well. Ice-decay could be observed in both, the TerraSAR-X and the RADARSAT-2 data. Classification methods were applied to distinguish between ice and open water surfaces of lakes and river arms. The results show that lake-ice decay is not only dependent on lake size and location, as the timing of lake-ice decay of neighbouring lakes of the same size was different in some cases. Thus it is assumed that lake depths are different, but this needs confirmation from other data sources.

A very high spatial image resolution is useful to distinguish land surfaces and water bodies. The ice cover on lakes remains in spring several weeks after the active layer thaw has started. In fall, the ice-onset in the water bodies is later than the refreeze of the soils. As snowmelt, refreeze, thaw processes, and ice-decay on water bodies happen quite quickly, it is necessary to acquire an image series with a high temporal resolution.
Applications of near-surface permafrost modelling at regional scales

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A methodology for evaluating near-surface permafrost variability at regional scales was developed for regions of Northern Alaska and Northwest Siberia. This procedure brings together climate datasets, observational data and a physically based permafrost model parameterized in accordance with high-resolution data describing regional vegetation and soil properties. Developed model was designed to estimate the changes in active-layer thickness (ALT) and temperature of permafrost top (TTOP) under changing climatic conditions. GIS-based landscape approach was used to apply model at the regional scales. Data availability issues in two regions created region-specific approaches in evaluation of near-surface permafrost parameters. The observational data on air temperature, vegetation and soil properties available at CALM sites were used to validate the model and to produce characteristic site-specific distributions of ALT. Changes in ALT and TTOP were then computed for locations where observational data were not available. Several gridded climate datasets were used to run the model, representing different climatic conditions of Northwest Siberia and Northern Alaska. Model was further used to evaluate ground subsidence and provide engineering assessments under contemporary and projected climate. The results are presented in a series of maps of near-surface permafrost parameters for the North Slope of Alaska and North-West Siberia. Simplified parameterization was used to provide assessments of impacts of changing climate on infrastructure, transportation and energy consumption in the Russian Arctic and is presented as a set of small-scale thematic maps.
Coastal erosion at Drew Point, Alaska, from spotlight TerraSAR-X satellite data

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Analysis of a 60 km segment of the Alaskan Beaufort Sea coast using a time-series of aerial photography revealed that mean annual erosion rates increased from 6.8 m a\textsuperscript{-1} (1955 to 1979), to 8.7 m a\textsuperscript{-1} (1979 to 2002), to 13.6 m a\textsuperscript{-1} (2002 to 2007). Also spatial patterns of erosion have become more uniform across shoreline types with different degrees of ice-richness. Further, during the remainder of the 2007 ice-free season 25 m of erosion occurred locally, in the absence of a westerly storm event. Concurrent arctic changes potentially responsible for this shift in the rate and pattern of land loss include declining sea ice extent, increasing summertime sea surface temperature, rising sea level, and increases in storm power and corresponding wave action. Taken together, these factors may be leading to a new regime of ocean-land interactions that are repositioning and reshaping the Arctic coastline.

We considered use of very-high resolution TerraSAR-X data for coastal erosion at Drew Point. Very-high resolution satellite SAR remote sensing may aid detection of seasonal and interannual coastal erosion, having the advantage of penetrating clouds and darkness, both common in these northern coastal sites, especially during the stormy fall/early winter season when erosion is largest. Images were acquired on 15 June 2010, 11 September 2010 and 28 August 2011 with slant-range and azimuth resolutions of about 1 m over an area of about 12 km x 5 km. Satellite SAR images can be precisely co-register in the original radar images with an accuracy on the order of 1/10th of a pixel or better before geocoding, so that subtle changes can be observed. On the other hand, radar images are affected by speckle noise, which reduces visibility of ground features. In general, coastal erosion could be well observed between the two late summer images, with maximum erosion on the order of 20 m in one year over restricted areas. In early summer sea ice is disturbing the distinction of the coast.
Debris flows in the Brooks Range, Alaska, observed with satellite SAR interferometry

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Debris flows in the Brooks Range (Alaska) currently exceed 100 m in width, 20 m in height, and 1000 m in length. Movement indicators observed in the field include toppling trees, slumps and scarps, detachment slides, scratch marks on frozen sediment slabs, recently buried tree-size vegetation, mudflows, and large cracks in the lobe surface. The type and diversity in observed indicators as well as their seasonal variation suggests that the lobes likely consist largely of a frozen sediment debris core subject to creep and seasonally unfrozen surface sediment that is transported in warm seasons by creep, slumping, viscous flow, block fall, and leaching of fines, as well as in cold seasons by creep and sliding of frozen sediment slabs. Ground-based measurements on one frozen debris flow over three years (2008-2010) revealed average movement rates of approximately 1 cm/day, which is substantially larger than rates measured in historic aerial photography from the 1950s to 1980s and indicates that the frozen debris flows have responded to climate change by becoming increasingly active during the last 10 years. This is posing potential direct hazard to the nearby Dalton Highway and Trans Alaska Pipeline System, the main artery for transportation between Interior Alaska and the North Slope, within the next 2 decades or sooner.

We investigated the potential of satellite SAR interferometry to determine the movement of the debris flows in the Brooks Range. For that purpose a stack of ERS-1/2 SAR data, including images acquired during the Tandem phase with a 1-day acquisition time interval, and of ALOS PALSAR data were considered. Particular attention was paid to the consideration of a suitable Digital Elevation Model (DEM) to remove the topographic related phase from the interferograms. Use of the U.S. Geological Survey DEM is generally discarded because of poor quality. A better performance was observed for the ASTER GDEM, but its use had to be restricted to very short interferometric baselines (less than about 40 m for ERS and 200 m for ALOS). Best performances, with satisfactory quality for a large range of baselines (up to 200 m for ERS and 1000 m for ALOS), could be obtained with use of the airborne IFSAR and Lidar DEM's, which are nevertheless available only for limited areas.

In our talk we will first present surface displacement maps obtained with ERS-1/2 InSAR Tandem data over the debris flows in the Brooks Range that can be compared to ground based DGPS studies as well as remote sensing based studies of lateral change using high-resolution optical data. Between October 4 and 5 1995 movements larger than 1 cm/day were observed over large parts of these bodies, while between December 13 and 14 1995 the observed displacements were generally slower. In a second part of the talk, our attention will move to larger areas InSAR studies with ALOS PALSAR data, highlighting unstable slopes on many other areas.
Introduction of GRENE-Arctic:
A new Japanese arctic research project

GRENE-TEA (GRENE Terrestrial Ecosystem in Arctic)
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Since 2012, Japan has launched a new 5-year research project for arctic science, GRENE-Arctic. GRENE, abbreviation of "GReen NEtwork of Excellence", is a top-down research initiative from government to stimulate environmental science and engineering. GRENE-Arctic is one of its key topics, which aims to strengthen the arctic-related research activity, in particular, to reinforce the research infrastructure, such as observation networks and database, and to promote the collaboration between observational and modeling researchers. The Project consists of 7 working groups: Model development, Terrestrial Ecosystem, Glacier and Ice sheet, Atmosphere (2 projects), and Ocean (2 projects).

Terrestrial Ecosystem working group, formally called "Change in Terrestrial Ecosystem of Pan-Arctic and its effect on Climate", has defined our scientific goals as follows: (A) to elucidate roles of terrestrial processes in the polar amplification of global warming, (B) to investigate variations of carbon and other material cycles which potentially affects global climate, and (C) to grasp current state of circumpolar ecosystem under the rapidly-changing climate, as a base of (A) and (B). Under this framework, working group’s specific topics in observations/modellings are, 1) thermal process and hydrology of permafrost, 2) change in vegetation and biomass, 3) methane production and storage, and 4) land-atmosphere interaction in decadal scale.

Integration of the extant research activities is, especially for Observational part, a necessary step. Standardization of measuring items and systems between major observational stations are in progress. As for the modeling, improvement of land surface model with a focus on permafrost process will be carried out during this project term. Model verification with point- to plot-scale data, and related refinement of the model is the target of whole working group.

Schematic figure showing the targets of the Terrestrial Ecosystem working group (left) and the circumpolar network of observational sites. Most of observational sites are in collaboration with local counterparts.
Use of satellite-derived surface soil moisture data to compare with estimated soil moisture based on tree-ring delta-$^{13}$C and methane emission in eastern Siberia

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Ecosystems in eastern Siberia have experienced significant climate changes over the past few decades. Changes of soil moisture in this region are closely related to the variability of climate (e.g. precipitation) and permafrost conditions. Fluctuation of soil moisture affects not only the vegetation but also the stream flow characteristics when the runoff changes from the land system to a river. Therefore, it can be said that soil moisture in this region plays an important role in the hydrology of the ecosystem.

We estimated past 100 years soil moisture form tree-ring delta-$^{13}$C in Yakutsk (62°N, 129°E), central eastern Siberia. The estimated soil moisture was compared with satellite-derived surface soil moisture (ESCAT) for the period from 1991 to 2000 and we found significant positive correlation ($r=0.69$, $p<0.05$). This result provides a validation for each dataset.

Soil moisture conditions also have a large influence on methane emission, which is a strong greenhouse gas and which is controlled by changes of the vegetation pattern or the soil moisture conditions. We compared the satellite-derived surface soil moisture (ASCAT) with the methane emission observed at the taiga-tundra boundary near Chokurdakh (70°N, 148°E) in summer from 2009 to 2011 in order to clarify the controlling factors of the interannual variation in methane emission.
GIS-Integrated automated feature identification and geovisualanalytics for isolated transient landforms

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Automated feature identifications are a valuable tool in the field of geomorphology. Our work deals with an automated identification process of landforms and their attributes. The process is GIS-integrated and is carried out on the commercial platform ArcGIS. It is helpful for experts to identify many feature types over large areas. Our study case are thermokarst lakes as prime climate indicators in three different areas: North Canada, North Siberia and Alaska.

The workflow of automated feature identification has been created on a conceptual level for available and suitable data. The whole process has been effectively transposed to multispectral satellite-image data of Landsat ETM+. In order for geomorphologists and geologists to be able to take advantage of the automated feature identification process, we plan to apply this conceptual process on terrain model data. The advantage of this workflow is that its use is not limited to particular data.

Spatio-explorative analysis offers a wide range of methods and techniques for the feature identification. For the analysis of variance and correlation we have established a required significance level up to five percent. We have found correlations between the existing feature parameters and use regression analysis to optimize the identification process as well as to be able to better distinguish individual landforms from each other.

We used star charts to visualize multivariable data and to make visible how landforms attributes are relate to each other. Our goal is to provide GIS-integrated object-identification tools to identify and characterize landforms indicative of climate change, to allow extracting parameters required to assess climatic boundary conditions.
Permafrost dynamics by thermokarst due to human impacts and climate changes in Central Yakutia, Russia

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Thermokarst linked to short- and long-term permafrost dynamics is a widespread phenomenon in the sub-Arctic regions of Central Yakutia. Holocene thermokarst evolution is generally a climate-driven process. Permafrost thawing caused by increased temperatures and a rising climate in the early Holocene resulted in surface subsidence and the formation of thermokarst lakes. In addition, the landscape in Central Yakutia is subject to strong short-term modifications by intensified land use and meteorological/weather events.

However, it is not yet sufficiently clear, firstly, how and when thermokarst depressions in Central Yakutia were formed or how they have evolved since the late Pleistocene-Holocene transition and secondly, which parameters are currently influencing thermokarst depression and lake dynamics. In particular, the anthropogenic aspect is of special interest as human existence in this populated region is strongly connected to thermokarst depression and lake dynamics.

The central idea underpinning this project is to combine remote sensing and GIS techniques with cryolithological analyses. By comparing disturbed and undisturbed areas, it should be possible to distinguish between influenced and natural thermokarst evolution. The Lena-Aldan region east and north-east of Yakutsk is of special interest, as this is an area highly affected by thermokarst effects. Furthermore, the region has been investigated over the last few decades by several Russian colleagues and also as part of joint Russian-German projects, which provides an excellent basis for more comprehensive further studies.
Analyse of surface moisture and freeze/thaw dynamic within pingo (Bulgunykhs) area distribution

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Pingos are among the most widespread cryogenic processes complicating the surface. Features of pingo formation dynamics depend on different aspects such as climate, geomorphology, lithology and permafrost. The intensity of this process is restricted by the type and properties of soil and its freezing conditions. The spatial soil moisture and temperature regime irregularity due to cryogenic forms like pingos can be distributed irregularly. The thickness of the active layer is an important component in the pingo formation process influencing the process dynamics and the morphological manifestations. With increasing surface soil moisture the intensity of soil freezing is increased as well. It further increases the water migration intensity. The freezing process accompanies an additional allocation of ice formation heat. This is due to the decreasing of the freezing rate.

The urgency of current research is given by the necessity to have actual data related to changing climate conditions and the intensive construction in Yakutia. Application of ASAR remote sensing data for pingo distribution sites in Yakutia allows us to analyse the active layer and surface soil moisture dynamics. On the basis of modern data the characteristics of formation conditions and the development will be assessed.

One more important aspect of using remote sensing information on land surface temperature, frozen/thawed state and surface soil moisture is the transfer to raster format storage and to process geographical data. Analysing temporal imagery is now the most topical technology of remote sensing application. Combined analysing raster data allow us to make different kinds of calculation and create volumetric maps.
Implementation of remote sensing data in the research of coastal dynamics in the Western Russian Arctic

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The development of Western Russian Arctic coastal regions is now in progress due to significant amount of hydrocarbon deposits discovered. A prominent feature of Arctic Seas is the development of coast in permafrost conditions. Despite the long ice period coastal dynamics are very intensive (1-3 m/year and higher). Natural hazards such as coastal thermal erosion, linear thermal erosion, thermo-karst, deflation and denudation can make petroleum production and transport unprofitable. Protective measures may appear inefficient, since shore sections with active coastal erosion are subject not only to bluff retreat, but also to nearshore zone and coastal slope erosion.

For correct definition of coastal dynamics setting we use dual approach. The first part is perennial instrumental monitoring of shore morphology, relying on system of benchmarks used for repeated measures, together with in-field geomorphologic expertise. Measures include direct observations and geodetic leveling onshore and echosounding offshore. Being the most precise method, direct measurements are expensive. The other drawback is that they can’t give an overview of long-span tendencies of coastal evolution for prolonged shore sections, which is essential for shore deformation forecast complying with lifetime of structures (usually 30 to 50 years). This is where the importance of the 2nd part, analysis of the different time remote sensing data, becomes decisive.

Most important sources of remote sensing data of different times include Corona imagery, aerial photos, Landsat imagery (covering a long time span, detailed enough for preliminary analysis), Ikonos, QuickBird, and other modern high-resolution imagery. Georeferencing is taken from State topographic and bathymetric maps and high-resolution imagery (corrected by field GPS survey where possible). All data are aligned and catalogued with ArcGIS. Aerial images must be aligned thoroughly with use of high-resolution data as reference, placing control points on most stable topography (gully junctions, inter-lake channels, river heads), which are vectorized in advance. Shoreline is usually easily recognizable for both erosion and accumulation sections of the coast. Other distinct features include along-shore bars, thermokarst basins, and deflation areas.

Basing on above-mentioned analysis, coastal dynamics maps were created for time span long enough to ensure shore dynamics forecasts. Further steps include creation of shore classification and segmentation maps, which consider different features of coastal morphology, dynamics, and formation taken from both field investigations and remote sensing data analysis.
Monitoring of inter-annual water storage changes in the Lena basin, Siberia using GRACE and satellite altimetry

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The Gravity Recovery and Climate Experiment (GRACE) satellite mission has proven as valuable tool to observe hydrological mass variations, e.g., in the Amazon basin, groundwater depletion in Northwest India, inland glacier mass losses. The long time span of more than 10 years of GRACE observations now allows also the detection of smaller interannual mass variations. In our study, we address the permafrost-regime in Siberia, Russia. We use GRACE data to study water mass variations in the Lena basin between 2003 and 2011. The observed mass changes indicate long-term changes in the hydrological budget of the large Siberian watersheds. For selected lakes in the Lena basin, we employ satellite radar altimetry observations to estimate water storage changes related to lake level variations. Large parts of Siberia are covered by thousands of lakes. As consequence of a strong wetting trend in this region lake levels are rising. We compare the total mass variation derived from GRACE and the mass variations related to changes in lake level. The lake level changes can explain between 15% to 40% of the water storage changes observed by GRACE. Other potential reasons for water storage variations could be related to changes in lake surface extension, soil moisture changes, increase in sub-permafrost ground-water storage and talik formation.
Monitoring of palsas and lithalsas in Sweden using very high-resolution satellite data

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Palsas are peat hummocks, mounds or plateaus in mires with a core of permanently frozen peat and usually also mineral soil. Palsas are found in the discontinuous permafrost zone in, inter alia, Sweden. Palsa-like frost mounds in pure mineral soil, so called lithalsas, also occur in some areas.

Palsas go through a cycle of stages. They are initiated, grow through frost heave, reach a lengthy mature stage, but are often finally broken down. A complete degradation results in a water body surrounded by unfrozen palsa remnants. It becomes filled by vegetation and eventually palsa formation can start again. Swedish palsa mires could for long show palsas of all stages, but during the last 10-20 years degradation has become more and more dominant.

Palsas and lithalsas are conspicuous and sensitive expressions of permafrost, which apparently have been strongly affected by climate changes. Therefore, there is a need, from a climate change perspective, to start a monitoring program to follow their development. Furthermore, palsa mires are a key habitat according to EU’s Habitat Directive. That means that Sweden has a responsibility to keep them in a favourable conservation status, which also implies a need for a monitoring program.

We have been commissioned by the Swedish Environmental Protection Agency and the Swedish National Space Board to develop and test a methodology for palsa monitoring, mainly based on very high-resolution satellite data, and draft a monitoring program. Any such program has to use remote sensing technique because most palsas are located in wilderness areas far from roads. Furthermore, palsas and lithalsas can preferably be studied by remote sensing. They are situated in open areas and degradation, a key issue for monitoring, results in easily detectable water bodies.

Our work is carried out in Tavvavuoma and eight other areas in northern Sweden. It focuses on testing different very high-resolution satellite imageries (WorldView, QuickBird, IKONOS, etc.) as a resource for palsa monitoring. M-L classification is used as a basic tool, e.g. for comparative classification of water bodies in 1980 (aerial photographs) and 2010 (WorldView data). See below. Other key components of the work are studies on ways to identify young, growing palsas through differences in vegetation. Also laser scanning, compilation of scientific data, studies of photos from 1963 to 2011 and field studies (of permafrost distribution, geomorphology, hydrology, vegetation, etc.) are carried out.

The draft monitoring program will be presented in early 2013. Results up to now indicate that study of very high-resolution satellite imageries is a cost-effective way to carry out palsa monitoring. Palsa mires occur also in Norway, Finland, Russia, Canada and Alaska, and a method for detecting changes over these vast areas may be of interest for application by a broader community.
Data fusion of remote sensing products for operational permafrost monitoring

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The ESA DUE Permafrost project has provided a wealth of new remotely sensed (RS) data sets on various parameters relevant for permafrost. However, a RS-based scheme has not been demonstrated yet, that can deliver the physical variables characterizing the thermal state of the permafrost.

We present a data fusion approach employing MODIS land surface temperatures (LST) and GlobSnow snow water equivalent (SWE) to drive a transient permafrost model (Westermann et al. 2011a), which yields the column-resolved temperature distribution in the ground. We discuss the accuracy of the scheme with respect to soil temperatures, and present an analysis of the main sources of uncertainty. While average LST inferred from MODIS can be biased by up to 3K for prolonged periods (Langer et al. 2010, Westermann et al. 2010, Westermann et al. 2011b), the considerable uncertainty in the thermal parameters of the snow pack and the soil is the largest error source with respect to soil temperatures. Furthermore, the available time series of MODIS LST is too short to achieve a reliable initialization of soil temperatures, so that in particular deeper soil temperatures can be biased. We discuss the possibility to assimilate further RS products, such as soil moisture and snow melt information, to achieve an improved performance. Finally, the prospects of a large-scale application of an RS-based permafrost monitoring scheme are outlined.

References:
Natural regime of forest-tundra and palsa bog landscapes in the Northern part of Western Siberia from satellite and in situ observations

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We present the spatial and temporal variability of natural parameters in the Northern part of Western Siberia (Poluy, Nadym, Pur and Taz watersheds). This is a region with mostly flat relief, comprising a multitude of interconnected natural objects - large and small rivers streams, large floodplains, lakes, bogs, wetlands etc. Flooded areas and bogs also act as a buffer zone, providing a dampening "sponge" effect on the water redistribution within the river system. Northern part of the Western Siberia is located in the permafrost zone and has dynamic thermokarst processes. This zone is also influenced by human activity (construction of roads, gaz and oil pipelines etc) that affects the primary hydrological network.

We discuss differences in the environmental parameters (soil moisture, lake and wet zones extent) for the two dominant types of landscapes of the study region - forest-tundra and palsa bog landscapes - at different temporal (from multi-year to seasonal) and spatial (from local to regional) scales through a multidisciplinary approach based on in situ and remote sensing data. Active and passive microwave observations (radar altimetry and radiometry) are used in combination with the in situ observations and the recent field studies done in 2008-2011. We compare our observations with the products "SAR water bodies" from the ESA DUE Permafrost and with the "ASCAT Freeze/thaw" from the ESA STSE-Alanis methane projects.

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