# LATICE – 2017 Annual Meeting

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1. Degrading palsa mires in northern norway simulated with a regional climate model with a subgrid snow scheme

*Kjetil Aas, UiO, k.s.aas@geo.uio.no*

Aas K.S., Westermann S., Martin L. ,Berntsen T.K. (2017) Degrading palsa mires in northern norway simulated with a regional climate model with a subgrid snow scheme, LATICE annual meeting 2017.

Rapid and accelerating degradation of palsa mires and peat plateaus has been reported in northern Norway during the last decades (Borge et al. 2017), following rising air temperatures and changes in precipitation. In order to understand these changes, and predict the magnitude and timing of future permafrost degradation in this and other permafrost regions we need accurate simulations of both local climate conditions and the small-scale land surface processes.

Here we present results from regional climate simulations over northern Norway. Simulations are performed with the regional climate model WRF, covering both the recent history and the future climate scenario RCP8.5. The observed changes at these mires are evaluated in light of the simulated change in climate variables on local scale, and the simulated future changes. The effect of individual climate variables is discussed.

In a second step, we evaluate the effect of inhomogeneous snow distribution within each palsa mire. Systematic measurements of snow depths from four mires in this region shows that this can be well represented by log-normal distributions. Based on this we perform a set of offline simulations for selected mires with land surface models used in WRF (NoahMP and CLM), where snow is scaled according to the observed distributions. Accounting for small-scale snow depth variability with a set of subgrid “tiles” has already been tested online in WRF for southern Norway, resulting in improved near surface atmospheric conditions in high-mountain regions (Aas et al. 2017). Here we evaluate if this approach can also be a first step towards a better representation of small-scale permafrost processes in climate simulations. The results are compared with a large set of ground surface temperature measurements from these mires, as well as active layer thickness measurements. By testing this method in a region where temperatures are currently at the limit for sustaining permafrost, we also get a window into the likely future evolution of larger peat areas which is now located in the colder, continuous permafrost zone.

References:

Aas, K. S., et al. 2017. A Tiling Approach to Represent Subgrid Snow Variability in Coupled Land Surface–Atmosphere Models. Journal of Hydrometeorology 18(1): 49-63

Borge, A. F., et al. 2017. Strong degradation of palsas and peat plateaus in northern Norway during the last 60 years. The Cryosphere 11(1): 1-16.

2. Advancing permafrost carbon climate feedback – improvements and evaluations of the Norwegian Earth System Model with observations (FEEDBACK)

*Casper T. Christiansen, Uni Research, BCCR,* casper.christiansen@uni.no

Lee H., Christiansen C.T., Westermann S., Etzelüller B., Stordal A., Risk D. (2017) Advancing permafrost carbon climate feedback – improvements and evaluations of the Norwegian Earth System Model with observations (FEEDBACK), LATICE annual meeting 2017.

Permafrost-affected soils contain over 1600 Pg of carbon which constitutes approximately half of the total terrestrial carbon storage and double that of the atmosphere. Projected climate warming will likely thaw permafrost and accelerate the release of soil carbon to the atmosphere – but a major uncertainty relates to how this carbon is released, either as $CO_2$ or $CH_4$. The rate of carbon turnover and $CO_2$ release is generally faster under dry-mesic aerobic conditions; whereas, under wetter anaerobic conditions, soil carbon turnover is slower – but here carbon is primarily released as $CH_4$ which has a 25 times greater global warming potential relative to $CO_2$ over a 100 year time scale. Therefore, changes in hydrological conditions during permafrost thaw may have a large influence on both the total rate of soil carbon loss as well as the emitted greenhouse gases' potential to affect future climate.

Accurate climate predictions from Earth System Models (ESMs) are dependent on a sound representation of the biogeochemical processes in permafrost-affected soils. Nevertheless, limited observational data on permafrost carbon release over a range of soil hydrological environments currently restrict development of biogeochemical process-level models, and prevent robust evaluation of model simulations. As a consequence, the coupled dynamics of permafrost hydrology and biogeochemical processes that result in permafrost carbon release in the forms of $CO_2$ and $CH_4$ are generally not realistically simulated by the ESMs used in the most recent model version of the Coupled Model Inter-comparison Project (CMIP5).

The FEEDBACK project will establish long-term automated observatories for in-soil (gas and solution) $CO_2$ and $CH_4$ concentrations across a permafrost thaw gradient going from dry palsas with intact permafrost to completely degraded and inundated thaw slumps in northernmost Norway. In addition, ecosystem-atmosphere greenhouse gas exchange will be conducted at plot and landscape scales, allowing for up-scaling from soil-depth specific trace gas production to net landscape gas emissions. Last, a broad suite of meteorological and soil physical and biogeochemical parameters will be obtained and the full dataset will be used to develop necessary model parameterization and thereby improve existing parameters in the soil biogeochemistry modules of the Norwegian Earth System Model (Nor-ESM) where parameterization is currently unrealistic.

Continuous soil profile measurements of greenhouse gases under different hydrological conditions are extremely rare, making the data obtained in FEEDBACK highly novel while also providing a unique contribution to both field observational and earth system modeling research environments. Ultimately, FEEDBACK aims to improve our understanding of permafrost carbon and its feedback under future climate change scenarios – and use this knowledge to advance the capabilities of the Nor-ESM.. The two other methods simulated these processes more realistically throughout the season except that precipitation based parameterization underestimated and river channeling based parameterization overestimated the overall high latitude inundated fraction compared to satellite based estimation. Despite the large difference in inundated fraction estimation, total $CH_4$ production and oxidation simulated in the high latitude region were similar across the three different parameterization of inundated fraction.

3. Stationary Snow radar
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Eriksrød J.H.H., Lande T.S., Hamran S., Burkhart J.F., Wisland D. (2017) Stationary Snow radar, LATICE annual meeting 2017

This poster presents a prototype S/C-band, short-range, microwave sensing instrument for continuous seasonal snow stratigraphy survey and SWE measurements. The instrument is ground based and is upwards looking, i.e. an upwards looking GPR (Ground Penetrating Radar). The radar is an ultra-wide band pulsed radar that utilizes state-of-the-art miniaturized radar technology for low power consumption and low cost. The instrument generates 2D stratigraphy images using SAR (Synthetic aperture radar) imaging techniques. Moreover, the instrument is capable of measuring velocity of each layer using a bistatic-SAR concept. Thus, the instrument can measure SWE individually for each snow layer, and not just bulk SWE that is more commonly done. SAR imaging increase spatial resolution compared to multi-static radar systems, but requires movable radar units. However, only two radar systems are required. The system is semi-mobile and instrumented for remote interconnect. With suitable solar power-source, unattended, remotely controlled operation is achievable.

4. A network of instrumentation to keep track of snow distribution at Finse, NO
*Simon Filhol, UiO, simon.filhol@geo.uio.no*

Filhol S., Schuler t.V., Burkhart J.F., Hutlh J., Decker S. (2017) A network of instrumentation to keep track of snow distribution at Finse, NO, LATICE annual meeting 2017

Seasonal snow in open landscapes at high elevations and high latitudes builds into a snow cover throughout the winter season. The nature and the succession of weather events reshape the snowpack, altering successively its spatial distribution. Because snow is a source of fresh water, and also an effective insulator, gaining knowledge about the processes responsible for snow redistribution is essential for a comprehensive understanding of for instance a catchment hydrology or energy fluxes at the scale of a landscape. Complementary to the network of instruments of the LATICE project at Finse, we are developing and maintaining instruments and snow courses to monitor the seasonal and annual dynamic of the snowpack as part of the ESCYMO project. Important questions we ought to explore are 1) during a storm event can we characterize if snow is redistributed or is precipitated on the ground, 2) can we estimate how much snow has been precipitated or redistributed, and 3) can we infer how the snowpack has been reshaped in the landscape? This poster presents an overview of the network we are building at Finse to help us answering those key questions.

5. Estimation of the mean snowline elevation with MODIS data: the Norwegian case.
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Hauksson B.Þ., Rizzi J., Burkhart J.F. (2017) Estimation of the mean snowline elevation with MODIS data: the Norwegian case., LATICE annual meeting 2017

In the framework of the SWITCH-ON project, we conduct an evaluation of a simple method for calculating regional snowline elevations from MODIS data for Norwegian catchments. Proper treatment and quantification of the winter snow pack is essential for forecasting the seasonal runoff in Norway. The SWITCH-ON project has developed a method to evaluate the seasonal magnitude and interannual variability of the snow pack based on a simple method using snow-line elevations from MODIS. We are interested in evaluating if this simple method can be applied to Norwegian catchments and provides a robust predictor of spring runoff. The method identifies an elevation line where the area being explored has the least amount of pixels with snow below the elevation line and the least amount of pixels without snow above the elevation line. Since MODIS is an optical sensor and Norway is at a high latitude and in close proximity to the ocean, it has a high frequency of cloud covered pixels and little sunshine during winter, reducing the amount of usable data. To evaluate the product for the challenging Norwegian conditions, we calculated regional snowline elevations for seventy catchments in Norway using this method with both the MODIS data and from the seNorge snow cover maps, which provide an independent analysis. We present an evaluation of the differences from the results of the two independent estimations to find the melt period and duration for each catchment and we are planning further comparisons utilizing available catchment discharge series.

6. Distribution model of the selected vegetation types in the boreal arctic zone
*Peter Horvath, UiO,* peter.horvath@geo.uio.no>

Horvath P., (2017) Ecological Climatology and Distribution Modelling, LATICE annual meeting 2017

Distribution modelling is a common approach for predicting species' occurrence in unmapped areas based on presence data and environmental data. Here, we use Distribution modelling method to predict the probability of occurrence of different Vegetation Types, a much larger ecological entity than species. Our vegetation data, with both presence and absence occurrences, is based on The Norwegian area frame survey of land cover and outfield land resources (AR18x18) dataset, a 10-year sampling effort of vegetation carried out by NIBIO. In addition, we are supplying our models with high-resolution Environmental data (100 meter) covering the whole land area of the country. Using statistical method of GLM, an automatic forward model selection based on MIAmaxent R-package, and independent validation datasets, we predict selected Vegetation Types for Norway.

7. Incorporating biogeochemistry in the permafrost model Cryogrid 3
*Håvard Kristiansen, UiO,* havard.kristiansen@geo.uio.no

Kristiansen H., Elberling B., Aas K.S., Westermann S. (2017) 19. Incorporating biogeochemistry in the permafrost model Cryogrid 3, LATICE annual meeting 2017

Permafrost ground contains vast amounts of carbon (C), and there is a well-known risk that increasing air temperatures and changes in precipitation can accelerate permafrost thaw and increase the decomposition of stored C. This may lead to increasing emissions of carbon dioxide (CO2) and methane (CH4) depending on the oxygen availability. Despite ongoing research efforts, the scale of this permafrost carbon feedback remains uncertain.
In this project, we incorporate biogeochemical processes into the land-surface model Cryogrid 3, which simulates the thermal state of permafrost, based on climate forcing and initial freeze-thaw conditions in the soil (Westermann et al. 2016). Our goal is to simulate the effects of surface temperature, precipitation, net primary production, carbon allocation and sedimentation on the rates of individual subsurface processes (e.g. heterotrophic respiration, methanogenesis and methanotrophy) and the resulting surface flux of CO2 and CH4.
The new model will simulate sedimentation and decomposition of organic carbon across the Holocene, in order to improve our understanding of the balance between permafrost formation and C sequestration and on the other hand the increasing decomposition driven by climate changes.
If the model is able to successfully reproduce local and/or regional carbon stocks, the resulting estimates can in the future be used as initial conditions for a simulation of the permafrost carbon feedback, given specific climate trajectories over the next century.
Because the project is in its beginning, we present model concepts.

References:
Westermann, S., Langer, M., Boike, J., Heikenfeld, M., Peter, M., Etzelmüller, B. & Krinner, G. 2016. Simulating the thermal regime and thaw processes of ice-rich permafrost ground with the land-surface model CryoGrid 3. Geosci. Model Dev., 9, 523-546.

*8.* LATICE—Relevant research activities at NVE
*Hong Li, NVE, holi@nve.no*

Beldring S., Engeland K., Hisdal H., Lawrence D., Magnusson J., Saloranta T., Huang S., Skaugen T., Li H. (2017) LATICE—Relevant research activities at NVE, LATICE annual meeting 2017

Norwegian Water Resources and Energy Directorate (NVE) is the directorate under the Ministry of Petroleum and Energy, Norway and is responsible for the management of Norway's water and energy resources, forecast of floods, land landslides and avalanche as well as prevent damage. As a national institution for hydrology, NVE performs hydrological measurements, routine forecasting and analyses. Additionally, we participate in national and international research about energy, hydrology and climate change. NVE is a partner in the Norwegian Centre for Climate Services (NCCS) and in many projects funded by the

Norwegian research council as well as in European research projects. Finally yet importantly, we are closely cooperating with universities, lecturing and supervising master and PhD students.

This poster reviews our current research projects relevant to the Lattice project. These projects cover themes of the atmosphere, biosphere, cryosphere and hydrosphere as well as their interactions.

9. Modelling the thermal stability of peat plateaus and palsas in Northern Norway

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Martin L., Westermann S., Aas K.S., Etzelmüller B. (2017) Modelling the thermal stability of peat plateaus and palsas in Northern Norway, LATICE annual meeting 2017

Palsa and peat plateaus are geomorphological features often observed in zones of sporadic permafrost (Sollid and Sørbel, 1998). Their evolution shows a complex feedback with the climatic conditions, being both dependant on climatic parameters such as the mean annual air temperature and on local small scale evolutions of the topography and vegetation (Seppälä, 2011). As palsas characterize the warmest areas presenting permafrost, understanding their evolution is of critical importance to bring robust constraints on the permafrost-atmosphere interactions that may be expected in case of long term climate warming and large scale permafrost thawing (Koven et al., 2011).

In Northern Norway, palsas and peat plateaus have shown a clear trend of degradation over the last 60 years (Borge et al., 2016), giving the opportunity for process studies that can shed light in the evolution of vast permafrost peatlands e.g. in Siberia under a warmer climate. In 2015, around 200 loggers temperature were installed at the ground surface of four peat plateaus in Northern Norway to assess the spatial variability of the surface forcing and its driving factors. Changes in micro-topography over the investigated year were quantified using differential GPS, while thaw depth was obtained for each logger site by manual probing. Despite of recorded mean annual ground surface temperatures of up to +3 degree C, the palsas and peat plateaus were overall stable with ground subsidence restricted to localized spots.

Understanding the underlying processes and conceptualizing them in numerical frameworks is challenging, but these measurements provide an ideal benchmark dataset to guide model development. We use the permafrost model CryoGrid 3 (Westermann et al., 2016) with input climate forcing data derived from meso-scale atmospheric modelling (WRF model, 3km resolution, see Aas et al., 2015), which is a flexible scheme that can in principle be adapted to arbitrary locations. Based on 1D-realizations for different logger sites, we present a first analysis in how far the scheme is capable of reproducing the coexistence of permafrost and permafrost-free areas over distances of only a few meters. We test the importance of parameters such as the water balance, the snow cover build-up or the evolution of the micro-topography on the palsas stability. First results suggest a distinct role of the lateral fluxes in the water balance, affecting the spatial patterns of ground subsidence and thus the evolution of micro-topography.

10. Potential feedbacks between snow cover, soil moisture and surface energy fluxes in Southern Norway.

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Nilsen, I. B., Tallaksen, L. M., Stordal, F. (2017) 14. Potential feedbacks between snow cover, soil moisture and surface energy fluxes in Southern Norway, LATICE annual meeting 2017.

At high latitudes, the snow season has become shorter during the past decades because snowmelt is highly sensitive to a warmer climate. Snowmelt influences the energy balance by changing the albedo and the partitioning between latent and sensible heat fluxes. It further influences the water balance by changing the runoff and soil moisture. In a previous study, we identified southern Norway as a region where significant temperature changes in summer could potentially be explained by land-atmosphere interactions. In this study we hypothesise that changes in snow cover would influence the summer surface fluxes in the succeeding weeks or months. The exceptionally warm summer of 2014 was chosen as a test bed. In Norway, evapotranspiration is not soil moisture limited, but energy limited, under normal conditions. During warm summers, however, such as in 2014, evapotranspiration can be restricted by the available soil moisture. Using the Weather Research and Forecasting (WRF) model we replace the initial ground conditions for 2014 with conditions representative of a snow-poor spring and a snow-rich spring. WRF was coupled to Noah-MP at 3 km horizontal resolution in the inner domain, and the simulations covered mid-May through September 2014. Boundary conditions used to force WRF were taken from the Era-Interim reanalysis. Snow, runoff, soil moisture and soil temperature observational data were provided by the Norwegian Water Resources and Energy Directorate for validation. The validation shows generally good agreement with observations. Preliminary results show that the reduced snowpack, hereafter "sim1"  increased the air temperature by up to 5 K and the surface temperature by up to 10 K in areas affected by snow changes. The increased snowpack, hereafter "sim2", decreased the air and surface temperature by the same amount. These are weekly mean values for the first eight simulation weeks. Because of the higher net energy available (~ 100 Wm-2) in sim 1, both the evapotranspiration and sensible heat fluxes increased. In sim 2, they decreased because of lower net energy. The ground heat flux decreased in sim1 (and increased in sim2), also in regions with a thin snow cover (with no significant difference between simulation and the control). Large increases were seen in runoff, both surface and underground runoff, during the first weeks of sim2, but the timing of snowmelt was only slightly affected. This study contributes to a greater understanding of land-atmosphere interactions in a wet, temperate climate, in particular the role of snow cover (and snowmelt) and its feedback to the atmosphere.

11. Towards a remote-sensing based global map of permafrost
*Jaroslav Obu, UiO, jaroslav.obu@geo.uio.no*

Obu J., Westermann S., Kääb A., Batsch A. (2017) Towards a remote-sensing based global map of permafrost, LATICE annual meeting 2017

Permafrost cannot be directly detected from space, but many permafrost surface features and properties are observable with a variety of earth observation sensors. ESA's GlobPermafrost project develops, validates and implements different permafrost information products to support the research communities and related international organisations. Within GlobPermafrost project, we aim to produce a circum-polar map of permafrost extent and thermal state.
The thermal state of the ground cannot be directly inferred from spaceborne platforms with current remote sensing technologies. We overcome these limitations by combining the information content of several remote sensing products, namely time series of remotely sensed land surface temperature, snow cover and snow water equivalent. These products are employed to force ground thermal models at 1km resolution which deliver ground temperatures and probability of permafrost occurrence within a grid cell.
We ran this semi-empirical model for the land areas of Northern Hemisphere. Mean annual ground temperatures were estimated at a spatial resolution of 1 km at using MODIS land surface temperatures and ERA reanalysis products between years 2000 and 2016. The snow thickness and its variability have been estimated using GlobSnow and CCI Land cover products. Model parameters in different model realizations were set according to subcell distribution of land cover. The mean annual ground temperature (MAGT) results were compared to in-situ temperature measurements of GTN-P boreholes and showed accuracy of 2.3 °C. The number of model runs with MAGT below 0 °C indicates the probability of permafrost occurrence within a modelled cell. The permafrost zones (continuous, discontinuous and sporadic) defined from statistical modelling correspond well with known zonation on global scale.

12. A low-cost camera setup to monitor vegetation-snow interactions in a high-arctic valley on the Svalbard archipelago
*Frans-Jan Parmentier, UiT – The Arctic University of Norway Norway, frans-jan@thissideofthearctic.org*

Parmentier f.J.W., Nilsen L., Tømmervik H., Cooper E.J. (2017) A low-cost camera setup to monitor vegetation-snow interactions in a high-arctic valley on the Svalbard archipelago, LATICE annual meeting 2017

Detailed monitoring of the development of arctic plant species, and the impact of changing snow cover and increasing growing season length, can be challenging due to observational constraints and/or the high cost of the required infrastructure. Satellite platforms, for example, are useful tools to monitor vegetation indices such as NDVI at a broad range of scales, but are dependent on clear-sky conditions. Although ground-mounted NDVI sensors are more suitable to monitor specific plant communities at a high spatial and temporal resolution, these instruments are a costly investment – which limits the possibility for wide-spread deployment. In recent years, however, it has become apparent that vegetation indices comparable to NDVI can be derived from low-cost commercially available RGB cameras, and used to monitor vegetation development. This study, therefore, combines low-cost RGB methods with NDVI and PRI sensors to monitor vegetation development in relation to snow cover and growing season length. This research is part of the SnoEco project, which also includes a long-term snow manipulation experiment, and focuses on the high-arctic valley of Adventdalen on Svalbard. Throughout the valley, cameras have been set up on small rigs that take continuous photographs of vegetation during the snow-free season. From these images, green-up and senescence of the vegetation can be closely monitored and compared to integrated NDVI measurements that are obtained in parallel from a separate sensor. These rigs have small footprints, of about 2 $m^2$, but are supplemented by digital cameras placed on two mountainsides in the valley – recording both color and near-infrared photographs of an area roughly 1 to 2 $km^2$ in size. This poster will focus on the technical implementation of the experiment, as well as some preliminary results. The information on specific plant communities obtained with the smaller rigs will ultimately be combined with the mountainside cameras, and compared to remote sensing data, to estimate patterns of snow melt timing, growing season length and plant growth at the landscape scale. This project will provide a unique dataset, that will act as a valuable in-situ validation set for satellite remote sensing, and lead to new insights on snow-vegetation interactions in the fast-changing climate of the high Arctic.

13. Calculating defensible annual CO2 budgets in high Arctic tundra
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Pirk N. (2017) Calculating defensible annual $CO_2$ budgets in high Arctic tundra, LATICE annual meeting 2017

The typically small magnitudes of the land-atmosphere $CO_2$ fluxes in high Arctic tundra complicate the accurate assessment of these ecosystems’ responses to climate warming. We conducted eddy covariance and snowpack gas measurements in a permafrost-underlain wetland in Adventdalen Valley, Svalbard (78°N) to study systematic processes affecting flux measurements and their annual budgets. The analysis of spectral distributions showed that conventional eddy covariance methods do not accurately capture the turbulent $CO_2$ exchange with the surface. Non-local (low frequency) flux contributions were exceedingly pronounced during snowmelt and introduced a large bias of -46 gC $m^{-2}$ to the annual $CO_2$ budget in conventional methods (minus-sign indicates an uptake by the ecosystem). Our improved flux calculations with the ogive optimization method indicated that the site was a strong sink for $CO_2$ in 2015 (-82 gC $m^{-2}$) and due to differences in light-use efficiency, wetter areas with low-centered ice-wedge polygons sequestered 47% more $CO_2$ than drier areas with flat-centered polygons. In wintertime, the snowpack featured several ice layers, which suppressed the expected gas emissions to the atmosphere and conversely lead to snowpack gas accumulations of up to 3800 ppm $CO_2$ by late winter. These snowpack accumulations were typically released to the atmosphere during strong wind episodes. Methane to $CO_2$ concentration ratios indicated distinctly different source characteristics in the rampart of ice-wedge polygons compared to elsewhere on a measured transect, possibly due to geomorphological soil cracks. Collectively, these findings exemplify the complexity of calculating defensible annual $CO_2$ budgets and studying the climate sensitivity of high Arctic tundra.

14. Comparison of operational snow models in Norway - SnowHow

*Thomas Skaugen, NVE, ths@nve.no*

Skaugen T., Saloranta T., Müller K., Melvold K., Luijting H., Schuler D.V., Kolberg S. (2017) Comparison of operational snow models in Norway - SnowHow, LATICE annual meeting 2017

One of the objectives of the SnowHow is to develop operational, effective snowmodels for use in hydrology. Traditionally, snow models in hydrology are heavily dependent on calibrated relationships, which is not optimal for addressing the society's need for predictions in ungauged basins and assessing the effect of climate change on snow conditions. In SnowHow we run 5 different snow models of different complexity, need of forcing data and spatial scale. The models are CROCUS (energy-balance melting, 1X1 km2), DDD (degreed-day melting, catchment elevation zones), DDD_EB DDD (energy-balance melting, catchment elevation zones), GAMSNOW (energy-balance melting, 1X1 km2) and seNorge (degree-day melting with additional radiation term, 1X1 km2). The models are run on a 1hr temporal resolution for the period 1.9.2013-31.8.2016 with identical precipitation and temperature forcing and with a threshold temperature of 0.5 °C for separating between liquid and solid precipitation. CROCUS has additional forcing from HARMONIE-AROME MetCoOp (2.5 km). The following simulated snow parameters are compared; snow depth, snow water equivalent, snow coverage, snowmelt rates and energy balance elements such as short- and long wave radiation and turbulent fluxes. When possible and appropriate, the simulations results are compared against observed variables such as runoff, snow coverage and snow water equivalent. The project is ongoing but preliminary results show that at the scale of catchment elevation zones, a pure degree-day snowmelt approach is inferior to that of using the energy balance or a combination the two (inclusion of a radiation term as in seNorge). This is an important result, which demonstrates that the dependence on calibrated relationships is unnecessary and should be avoided in operational snow models in hydrology. The results also show that the modelling of energy-balance elements such as radiation, relative humidity, cloudiness, etc. on the basis of location, time of year, precipitation and temperature is feasible and is a reasonable alternative to overcome the general lack of in-situ observations of energy-balance elements in Norway.

15. The influence of nitrogen limitation on Arctic vegetation dynamics in Community Land Model (CLM) and the coupling of CLM with Weather Research and Forecasting model (WRF)
    *Hui Tang, UiO, hui.tang@geo.uio.no*

    Tang H., Stordal F., Berntsen T.K., Bryn A. (2017) The influence of nitrogen limitation on Arctic vegetation dynamics in Community Land Model (CLM) and the coupling of CLM with Weather Research and Forecasting model (WRF), LATICE annual meeting 2017

    Arctic vegetation is undergoing significant changes in response to global warming, which can exert great impact on the Arctic climate and contribute to a stronger warming in the Arctic (i.e., Arctic Amplification). Correctly modelling vegetation dynamics and its climate feedbacks in the Arctic region is therefore essential for a better projection of future Arctic climate changes. Dynamic global vegetation model (BGCDV) has been developed in community land model (CLM4.5), but the description of Arctic vegetation is quite coarse. Its ability in simulating Arctic vegetation distribution and climate feedbacks has been found in our previous study to suffer from several setbacks including seriously underestimation of the plant cover fraction of the arctic shrubs that leads to a strong cold bias in northern Eurasia and Canada due to a positive feedback between Arctic vegetation cover and temperature. To alleviate the biases of CLM4.5BGCDV in simulating Arctic vegetation and the strong cold biases in the coupled atmosphere-CLM4.5BGCDV run, several vegetation parameters have been modified for the Arctic plant functional types, including photosynthetic capacity, root distribution, light competition and nitrogen limitation. It is found that nitrogen limitation has been a major cause for the model biases in simulating the Arctic shrub cover. An improvement on the nitrogen limitation scheme in CLM4.5BGCDV is therefore proposed. In addition, we will present our preliminary work on the coupling of CLM4.5 with Weather Research and Forcasting model (WRF). The accomplishment and the remaining technical difficulties will be discussed.

16. Snow redistribution modelling using topographic parameters and a conceptual hydrological model
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    Tweldebrahn A.T., Burkhart J., Schuler T. (2017) Snow redistribution modelling using topographic parameters and a conceptual hydrological model. LATICE annual meeting 2017

    Previous studies have pointed out that snow accumulation and depletion patterns in complex terrain are highly influenced by topographic controls. In this study we extend the snow cover area (SCA) parameterization for topographic effect through parameterization of the sub-grid snow CV and explicit inter-grid snow redistribution in a conceptual rainfall-runoff model. The terrain parameters used are altitude and a wind sheltering index (sx). Although, model parameters are conditioned using only observed flow, model outputs are evaluated against both observed flow and MODIS SCA. A split sample based cross validation of model predictions has shown some improvement in simulated SCA and flow when using the terrain parameter based snow redistribution algorithm.

17. Optimizing the land cover mapping process: field inventory or 3D aerial photo interpretation?
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Ullerud H. A., Bryn A., Halvorsen R. (2017) Optimizing the land cover mapping process: field inventory or 3D aerial photo interpretation?, LATICE annual meeting 2017

Land cover maps give information about what types of nature we have and where these types are found, and can be used both as input layers and for evaluation in modelling of climate. However, low quality maps can lead to erroneous results. The quality of the land cover maps is a result of the chosen mapping method, and these vary greatly, from field survey systems to human interpretation of aerial photos. The system used for classification also affects both the chosen method and the quality. A new system for classification, Nature in Norway (NiN), has recently been introduced in Norway. No research has yet compared different mapping processes for this system.
In this study three different mapping processes (interpretation, field survey and a combination) have been used for mapping at Hvaler in south, eastern Norway. A separate dataset of points has been collected to compare the quality of the maps. The resources used for mapping, especially time spent in field, will also be considered. Results are to come shortly, and will hopefully enable us to give advice on the optimal land cover process.

18. LATICE Flux – High resolution measurement infrastructure at Finse
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Vatne A., Burkhart J.F., Decker S., Filhol S., Hulth J., Engeland K., Parmentier F.J., Schuler T.V., Stordal F., Tallaksen L.M. (2017) Optimizing the land cover mapping process: field inventory or 3D aerial photo interpretation?, LATICE annual meeting 2017

19. Forest line dynamics in Lærdal
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Volden I.G.., Bryn A., Halvorsen R., Horvath P., Pothoff K. (2017) Optimizing the land cover mapping process: field inventory or 3D aerial photo interpretation?, LATICE annual meeting 2017

Tree- and forest lines are potential bellwethers for climate change, and upwards range expansion of trees in the northern hemisphere may therefore reflect recent climate changes. To investigate this further, we will analyze the changes of tree- and forest limits in Lærdal municipality, through remapping of a similar project from 1940, executed by botanist Søren Ve. The growing conditions for each registered tree and forest have been established through the use of NiN (Natur i Norge) and a vegetation mapping system. The aim of the study is thus to improve understanding of the mechanisms behind tree- and forest line dynamics.