

Oslo, 31 December 2022

## **LATICE – Annual letter 2022**

Dear all,

2022 is coming to its end and it is time to thank you all for your contribution to making it yet another interesting and stimulating LATICE year. Our high level of activity and the many achievements are due, not only to LATICE, but also to the many projects and people that are closely associated with it.

The year started with a new lockdown due to the Omicron variant, however, its impact was short-lived and we were back to normal pre-corona work conditions before summer. This has allowed us to work towards increasing our national and international engagement and collaboration, an effort that will continue in 2023. Prof. John Burkhart, one of the founders of LATICE, resigned his position at the Department of Geosciences, University of Oslo, 1 September 2022 to work at Statkraft within the energy market. We gratefully acknowledge his contribution to the success of LATICE and wish him all the best in his new job. Norbert Pirk has taken over his role as co-coordinator of LATICE jointly with Frode Stordal.

Significant time has been devoted to three main LATICE activities, all with important contributions from associated projects (see below for further details); i) the continuing collection and analysis of data from LATICE Flux and associated sites, encompassing various infrastructure and field investigations, ii) the development of a common modelling platform for CLM/FATES, and iii) the LATICE Model Intercomparison project's two key activities (LATICE-MIP snow and evaporation). New observations are vital for improved process understanding and support novel parametrisation of high latitude processes in land surface and hydrological models.

A special highlight this year was the PhD defence of our LATICE PhD, Peter Horvath, who successfully defended his thesis "Ecological Climatology and Distribution Modelling" for the degree of Philosophiae Doctor, 18 February 2022. His thesis presents detailed predictions of vegetation-type distribution for the whole Norway; shows that large-scale landscape patterns are helpful additional information for establishing good predictions; tests ways of assembling wall-to-wall vegetation maps; and finally contributes to improvement of how vegetation is represented in climate models. Peter now works in NHM as senior engineer in the GECO group, focusing on geomatics, GIS and spatial analysis. We appreciate that he continues to contribute to LATICE.

Marius S.A. Lambert defended his thesis "Modelling the critical role of cold acclimation for vegetation survival during extreme winter weather" for the degree of Philosophiae Doctor, 20 December. Although not a LATICE funded PhD, he acknowledged in his thesis collaboration and interesting meetings provided by LATICE and CBA. Marius has recently started a one-year position at MetOs working on relevant projects.

Some further highlights and details of activities in 2022 (our eighth year) are presented below.

### **Infrastructure and Observations**

Our flux measurement sites operated well during the last year. Apart from a few days with data logging issues, most sensors at the Finse site reported useful measurements throughout 2022. We decided to

keep the mobile flux tower running at Iškoras to provide continuous baseline estimates for carbon and energy exchange, as well as for meteorological and soil conditions. The new BioGov project from CBA (see below) uses Iškoras as a key research site, for which the flux tower delivers invaluable data. At the Hedmark (Hisåsen) twin sites, one of the drained mires was restored during the autumn of 2021. The operation of the field instruments still requires much care and attention, but we are confident to be able to assess the effect of the re-wetting on the carbon, energy and water balance from our measurements. A number of related activities benefit from the data collected and experience gained through the establishment of the LATICE Flux sites. This includes Postdocs, PhD and master students, as well as interns, both from UiO and abroad. We maintained our collaboration with NIBIO (PI Holger Lange) and NMBU (PIs Mareile A. Wolff and Laura Ehrnsperger, MetNo), which are responsible for the ICOS-Norway site at Hurdal and a grassland site at Ås, respectively.

The LATICE cold climate container was in place at campus in 2021 and is now registered as its own 'leiested' at the department of Geosciences. The first simple experiments were undertaken in 2022, including providing stable winter conditions for high latitude vegetation and a cloud condensation experiment, and several new experiments on land-atmosphere interactions are planned for 2023 and 2024. Among them sublimation experiments in collaboration with the University in Oulu, Finland. The container is expected to provide novel insights into high-latitude processes.

A promising new drone-based flux mapping technique with the potential to capture spatial heterogeneity has been developed within the Research Council of Norway (RCN) Spot-On project. This novel approach combines meteorological measurements on drones with turbulence-resolving large eddy simulations using data assimilation to infer surface fluxes. A proof of concept outlining this technique was recently published in Atmospheric Measurement Techniques.

### **Land surface and Hydrological model developments**

The CLM group at GeoHyd/MetOs has maintained regular online meetings with the attendance of group members from Oslo, Bergen and Trondheim as part of the RCN project EMERALD. The group has continued operating in close contact with the CLM group at NCAR. The coordinator of the group meetings, Kjetil Aas, has left MetOs, and now works for CICERO since 1 October. Hui Tang started 1 September at the Finnish Meteorological Institute. We congratulate the two of them with permanent positions and appreciate that they are still engaging actively with the CLM group, contributing to coordination of research activities, LATICE related papers and sharing their knowledge and competence. We are happy that Yeliz Yilmaz, also in our original CLM core group, is back from parental leave, still working at GeoHyd.

A paper summarising the experience gained in the development of the land site platform, NorESM-LSP, was recently submitted. The paper presents new software that facilitates site-level simulations with an advanced Dynamic Global Vegetation Model (DGVM) coupled with the land surface model of the Norwegian Earth System model (NorESM). The first release supports customisable simulations for 20 geo-ecological observation sites in Norway, including LATICE sites. First authorship is shared between Eva Lieungh and Lasse Keetz, both UiO-PhDs (LATICE and NHM funded) and with several LATICE participants as co-authors. New developments funded by LATICE associated projects (e.g. EMERALD), include a new PFT for mosses and lichens (led by Hui Tang), a new soil organic matter decomposition scheme (Elin Aas), and a frost mortality and hardening scheme (Marius Lambert). Iris Mužić's (PhD at CICERO, previously LATICE intern) has implemented a coupled WRF-CTSM model in the Nordic region. Terje Berntsen and Yeliz Yilmaz are co-supervisors, strengthening the links between CICERO and LATICE partners.

Activities related to the two LATICE-MIP groups continue. The LATICE-MIP Snow group (led by Yeliz Yilmaz) has focused on snow cover, preparing data from satellites and drones for spatially representative validation of output from land surface model. In the ongoing initial phase, representative observational products are being prepared to serve as benchmarks for the models. These snow observations are derived from long-term satellite observations (MODIS), newer high-resolution satellite observations (Sentinel-2, Landsat 8), and reanalyses (ERA5, ERA5-Land, MERRA2) over the Scandinavian region and at some key flux observation sites (Finse, Iškoras, Bayelva, Hisåsen, and Adventdalen). Downscaled forcing fields for these sites are prepared based on the ERA5 reanalysis data using the TopoSCALE tool. The recently published Multiple Snow Data Assimilation toolbox, MuSA (co-developed by Kristoffer Aalstad), will be an integral part of the snow intercomparison effort facilitating both model comparison and within-model uncertainty quantification. The development of MuSA was completed during the visit of Esteban Alonso-González (Postdoc, CESBIO) at GeoHyd and presented at the LATICE seminar in September.

The LATICE-MIP ET group (led by Kolbjørn Engeland) focuses on evaporation (ET) as a component of the water cycle and motivated by the large uncertainties in simulated annual water balance in Norway. It involves researchers from several organisations in the Oslo region (MET, NIBIO, NVE and UiO) with expertise on different types of models. Three hydrologic models (HBV, Shyft and LisFlood) and two land surface models (CLM and SURFEX) are compared at three spatial scales: the point scale encompassing several flux sites (Finse, Hedmark, Hurdal, Iškoras and Ås), the catchment scale, and the regional scale covering all of mainland Norway. LisFlood - a spatially distributed water resources model developed by the Joint Research Centre (JRC) of the European Commission - was added in 2022 (LATICE PD Emiliano Gelati). During 2022, test simulations were performed for all sites and models and initial results presented at EGU2022. Expanding on this research aspect, a successful proposal (led by Terje Berntsen) was funded by the Faculty call for PhD within Sustainability. The project TREX-Hydro, addresses how treeline changes in Norway affect the water balance through increased evaporation and thus the hydropower potential.

LATICE collaborates with the University of Helsinki, Finland on the use of Machine Learning (ML) to improve our land surface modelling. As part of this collaboration, LATICE PhD Lasse Keetz is supervised by Indrė Žliobaitė. A joint paper, led by Rita Beigaitė (PhD student in Helsinki), was recently published on identifying climate thresholds for dominant natural vegetation types at the global scale using machine learning, considering extremes in addition to average climate.

### **New associated projects and initiatives**

SnowSub – A new project ‘Assessing impact of snow sublimation for hydropower production in Norway (SnowSub)’ was funded by RCN as a Collaborative and Knowledge-building project (starting early next year). The project is led by Olga Silantyeva (LATICE Innovation PD) and collaborates with partners from Statkraft, Skagerak Energi, MET, NVE, and Uni. of Oulu. Several LATICE members contribute. The project aims to answer an important question for hydropower production: how much snow is ‘lost’ as a result of sublimation processes?

BioGov - The project “Biogeochemical processes governing boreal C cycling (BioGov)” was funded as part of the “Fellesløftet” funding scheme of RCN and started in 2022. It is coordinated by Dag Hessen and affiliated with CBA. The primary objective of BioGov is to contribute to improved validity and accuracy of NorESM through better constrained model description of biogeochemical processes and kinetics governing boreal C cycling under climate change. This is achieved by integrating disciplinary approaches across scales in collaborative field, lab and model studies ultimately improving climate prediction. BioGov focuses on the high risk of mobilisation and loss of soil organic carbon in the boreal biome in response to a general warming, permafrost thaw, and changes in hydrological processes.

DURIN – This project is led by the University of Bergen, and also funded through “Fellesløftet.” LATICE participants (Elin Aas and Hui Tang) contribute with CLM and FATES modelling. The project studies context-dependencies in plant-mycorrhizal interaction, and ecosystem climate responses. The project will offer one of the first parameterisations and test-beds of dwarf-shrubs in large-scale earth system modelling efforts.

CN-coESM - The project, run by NTNU, aims to advance our understanding of the interactions and the feedback cycles between key Arctic-Boreal ecosystem processes and the climate system. It investigates the impacts of emissions driven climate feedbacks and physically driven feedbacks from albedo associated with abrupt permafrost thaw and wildfire. This goal will be achieved by collaboratively improve ESMs developed and maintained in China, respectively Norway. LATICE members, Kjetil Aas and Marius Lambert, contribute with CLM modelling.

CircAgriGHG – This new EU ERA-Net project led by NIBIO assesses greenhouse gas emissions from the agriculture sector and develop strategies for emission reduction. The LATICE group will contribute with gas flux measurements at three farms along a gradient from Norway, Germany, to Kenya.

### **New team members**

The LATICE group consisted in 2022 of three PhDs and one Postdocs funded by the Faculty. In addition, there are several other researchers, Postdocs and PhDs associated with the LATICE project, many of them contributing with important fieldwork at Finse and other high latitude sites in Norway.

This year we welcomed Michael Bekken, who joined LATICE as a postdoctoral fellow in August. Bekken is a Fulbright Grantee on exchange from University of Wisconsin-Madison to the University of Oslo in 2022/23 - one of five Fulbright Scholars with a stay at University of Oslo. His research activities focus on estimating the total carbon balance of the restored mire in Hisåsen in collaboration with LATICE PhD Astrid Vatne. Bekken is jointly supervised by members at GeoHyd, MetOs and NHM.

Elisabeth-Christina Wörner started autumn 2022 at UiO (MetOs) as a PhD affiliated with the BioGov project. She will continue and expand the soil carbon modelling work of Elin Aas. Wörner is supervised by Terje Berntsen.

Laura Mack started her PhD project at UiO on stochastic parametrisation of stable boundary layers in complex terrain. Laura is supervised by Nikki Vercauteren (MetOs) and will, among others, work with data from the Finse site.

We are pleased to have you all as part of the LATICE team.

### **Interdisciplinary teaching and training**

GEO9915/5915 Ecological Climatology, led by Anders Bryn and Frode Stordal, was taught for the fifth time in spring 2022. After two years with most of the teaching on zoom, it was good to return to physical attendance at Blindern, Tøyen and Drøbak. The course addresses relationships between climate and ecology, with focus on climate related feedbacks within boreal, alpine and arctic terrestrial ecosystems. This year the course gathered eight master and three PhD students. As in previous years, several members from the LATICE community contributed with lectures in their fields of specialty.

GEO3032 Climate Change and Impacts was given for the third time in spring 2022. The LATICE leadership (Tallaksen) contributed with several lectures and candidate evaluation.

## Dissemination and Communication

The group has been active in dissemination and communicating the LATICE project and our research at various international conferences, such as the EGU conference in Vienna in May, and by invited talks at more targeted national events, such as the CBA seminar series. Contributions from LATICE scientists at these events are provided at our LATICE website, including six presentations given at EGU (listed under 'News').

Six LATICE seminars were arranged in 2022 (also attendance on Zoom), providing a discussion forum for new research initiatives, funding applications, interaction with related projects, and regular updates on field and modelling activities. A complete list can be found on the LATICE website under 'Events'.

Five LATICE researchers presented their work (on Zoom) at the 2022 CESM Land Model & Biogeochemistry Working Group Meeting organised by NCAR in Boulder, early 2022. This annual meeting is regularly held to provide a venue for CLM developers and users to meet and share experiences.

The Land Surface Modelling Summit 2022 in Oxford 12-15 September, provided opportunities to have extended discussions on development priorities, challenges and how the international land modelling community can work together to build the next-generation land models needed to address the pressing scientific and societal questions of the 21st century. Kjetil Aas presented a poster "Recent high-latitude vegetation developments in CLM-FATES" with several LATICE participants as co-authors.

The 7th Conference on Modelling Hydrology, Climate and Land Surface Processes - from Earth System Modelling to Catchment Scale - to be held at Lillehammer 19-21 September 2023 is under planning. Next year's topic is 'Modelling, forecasting, communicating, and handling weather-induced natural hazards'. Lena M Tallaksen contributes as a member of the organisation committee.

The exhibition "Natur i endring" (A changing nature) remained at the Norwegian Mountain Centre in Lom throughout the year, acknowledging among others the LATICE project. Visitors learn how climate scientists measure the amount of snow and the soil temperature in alpine areas, and how studies of plant communities are executed. It is based on an exhibition originally made for the Climate House at the Natural History Museum (NHM), but largely expanded and with new activities especially aimed at a younger audience.

We have created a CRiStin project page for LATICE where all are encouraged to link their LATICE-relevant publications: <https://app.cristin.no/projects/show.jsf?id=2492739>. Check out our website for recently published highlighted articles. For example, an article on tundra isoprene emissions published in PNAS, and an article on energy budget published in Nature Communications.

Thanks to you all, we are maintaining a high level of activities both in the field, lab and within the modelling groups, endorsing LATICE's position as a natural hub for research within the field of land-atmosphere interactions at high latitudes. We look forward to continuing our joint effort in what we are sure will be another motivating LATICE year with exciting research results emerging. In particular, we aim to be active in engaging more with the international community through conferences and invitations. The friendly and open atmosphere that characterises LATICE makes it a motivating and great project to coordinate and be part of, so thanks to you all for making it so.

The LATICE 2022 annual meeting was postponed to 29-30 March 2023 for practical reasons. We are looking forward to seeing you all in Drøbak next year.

With our best wishes for the New Year - Godt Nyttår!

Lena, Frode, Norbert, Yeliz, and Emiliano

LATICE coordination team