LATICE – Land-ATmosphere Interactions in Cold Environments

The role of Atmosphere - Biosphere - Cryosphere - Hydrosphere interactions in a changing climate

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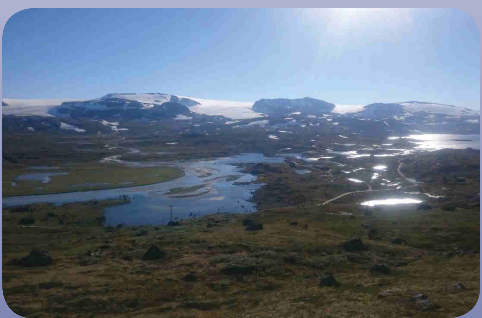
Introduction

Climate change is impacting the high latitudes more rapidly and significantly than any other region of the Earth. A warmer climate has already led to thawing of permafrost, reduced snow cover and a longer growing season; changes, which in turn influence the atmospheric circulation and the hydrological cycle.

LATICE, aims to advance the knowledge base concerning land atmosphere interactions and their role in controlling climate variability and climate change at high northern latitudes through:

- Improving parameterizations of processes in earth system models controlling the interactions and feedbacks between the land (snow, ice, permafrost, soil and vegetation) and the atmosphere at high latitudes, including the boreal, alpine and artic zone.
- Assessing the influence of climate and land cover changes on water and energy fluxes.
- Integrating remote earth observations with in-situ data and suitable models to allow studies of finer-scale processes governing land-atmosphere interactions.
- Addressing observational challenges through the development of novel observational products and networks.

LATICE is recognized as a strategic research area by the Faculty of Mathematics and Natural Sciences at the University of Oslo who has provided funding for five PhD and one Postdoc during the period 2015 - 2019.



LATICE Flux – High resolution measurement infrastructure at Finse

State-of-the art observations of fluxes of water vapor and greenhouse gases are needed in Norway (Figure 1). With the installation of a permanent micrometeorological tower with eddy covariance instrumentation (Figure 5) in the mountain environment of Finse (Figure 2, 3 and 4), LATICE aims to reduce this knowledge gap. The tower complements existing instrumentation at Finse, which includes observations of discharge and snow. Finse lies in the low alpine zone at 1200 meters a.s.l. and about 250 meters above the tree line. LATICE collaborates closely with Finse Alpine Research center, which is owned by the Faculty of Mathematics and Natural Sciences of the University of Oslo and operated jointly with the University of Bergen. In addition to the fixed flux tower at Finse (Figure 5), LATICE has a mobile flux tower. Both towers have instrumentation for observations of fluxes of H_2O and CO_2 using the eddy covariance method.

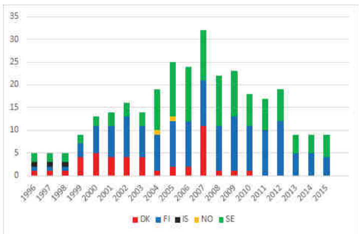


Figure 1. Number of Nordic FLUXNET sites with active data collection for each year in the period 1996 - 2015, categorized by country. Source: fluxnet.ornl.gov

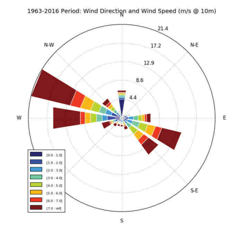


Figure 2. Wind distribution at Finse. Prevailing winds are WNW and ESE. Data avaliable at eklima.no

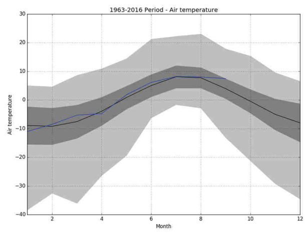


Figure 3. Air temperature. The snow-free period is normally between mid-July and October. Blue line represent data from 2016.

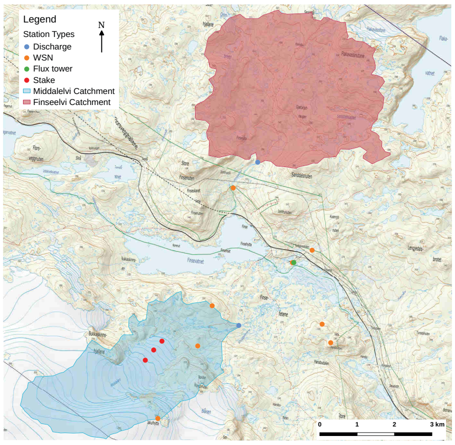


Figure 4. Map showing Finse Alpine Research center and instrumentation. Finse is situated at the Hardangervidda mountain plateau in south central Norway (60°36' N, 7°30' E).

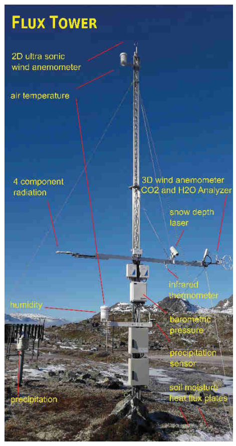


Figure 5. Micrometeorological tower with eddy covariance instrumentation installed at Finse in 2016.

Instrumentation at Finse

- **Micrometeorological tower**
  - Wind at 4,4 m (3D) and 10 m (2D)
  - H_2O/CO_2 gas analyzer
  - Air temperature at 2 m and 10 m
  - Air Humidity at 2 m
  - Snow depth sensor
  - Precipitation
  - Barometric pressure
  - 4 comp. radiation sensor
  - Soil moisture sensor
  - Heat flux plates
  - Snow drift sensor
- **Discharge stations**
- **WSN of meteorological stations**
- **Extensive snow observations**
- **Mobile Flux tower (not exclusively for use at Finse).**

Sensors - Design

Developing new techniques for measuring hydrological fluxes, such as snow water, soil moisture and water vapor, at high spatial resolution is a key part of LATICE. Building on existing technologies in our infrastructure with novel technologies, we address distinct challenges within land-surface observations.

- **Advanced sensor technologies** - Through LATICE we bring novel radar technologies to the field of geosciences. We envision developing radar arrays for snow water and soil moisture monitoring that will provide a 4-D view of the dynamics of the systems.
- **Datascapes** - As we probe with our observations at finer temporal and spatial resolution, new methodologies for model calibration and validation are required. Developing such new calibration tools and methodologies is a core activity within LATICE.

Snow - Permafrost

Snow is recognized as having a dominate role in the regulation of energy and chemical exchanges through modulation of albedo, insulating cover, and providing an exchange surface for chemistry. LATICE works towards refinement of cold region processes in land-surface models.

- **Snow hydrology** - To develop new snow parameterizations, better measurements of the evolution of snow packs, and the overall snow water equivalence are required. Through LATICE we seek novel methods for calibrating hydrologic models that treat snow equally to discharge.
- **Snow distribution and permafrost/carbon dynamics** - Through LATICE we seek to improve the characterization of snow distribution in ESMs, and to explore sensitivity of permafrost distribution to evaluate impacts to carbon turnover (GHG emissions) within the ESMs.

Vegetation - Soil

Vegetation plays an important role in the climate system in the arctic and boreal zone and LATICE seeks to improve its representation in ESMs. Exchange of energy, water and chemical compounds between the atmosphere and land surface are modelled and measured for different seasons and surface conditions.

- **Vegetation ecology modelling** - Vegetation migrates as climate change and nature-types and in LATICE their migration are mapped and monitored through field campaigns and remote sensing. Their future distributions are projected using a dynamic vegetation modelling approach.
- **Climate impacts of biogenic emissions** - Formation of aerosols and ozone from Biogenic Volatile Organic Compounents (BVOCs) and impacts on atmospheric chemistry and physics are studied, in particular cloud formation. Uptake of ozone in plants is also modelled.

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