Global and Regional Atmosphere – Land Surface Modelling at the University of Oslo: Vegetation, Permafrost and Snow Surfaces

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Land-Atmosphere Interactions in Cold Environments
The role of Atmosphere – Biosphere – Cryosphere – Hydrosphere interactions in a rapidly changing climate

LATICE

Coordinator: Lena M. Tallaksen
Co-leaders: Frode Stordal, John Burkhart
Motivation

- Global warming
- Arctic amplification
- Major impacts in cold environments
- The role of the land-surface

Sources: NASA; National Oceanic and Atmospheric Administration
Arctic amplification: Albedo feedbacks

Surface without snow or ice absorbs more heat

Surface with snow and ice reflects more heat
Arctic amplification: data from seNorge

Winter warming is accelerating

Brox-Nilsen & Tallaksen, EGU (2014)

Impacts – Cold environments

- Greening of the artic
- Reduced snow cover
- Thawing of frozen ground
- More extreme events
- New and emerging hazards
- Uncertain ecosystem changes
Is our understanding sufficient?

- Are hydropower resources secure?
- Investments in infrastructure - are they relevant tomorrow?
- How will timing of snow melt impact agriculture?
- How will vegetation respond to a changing climate?
- What will be the feedbacks from a shift in snow-rain transition?
- How will the regional climate be affected by changing land cover?
Objective
To establish an interdisciplinary team of Earth System scientists to address critical knowledge gaps in current climate assessments through:

- Improved parameterizations of processes in earth system models
- Assess **feedbacks** resulting from land surface changes through an observational-based modelling approach
- Integrate remote earth observations with in-situ data and instrument networks
- Develop novel observational products
- Bridge the scales between atmosphere and terrestrial model systems through targeted field efforts and network design
LATICE – Who are we?

GEOFAG (GEO) 
Atmosphere 
Terje Koren Berntsen 
Jón Egill Kristjánsson 
Kirstin Krüger 
Frode Stordal 

Cryosphere 
Bernd Etzelmüller 
Jon Ove Methlie Hagen 
Andreas Kääb 
Thomas V. Schuler 
Sebastian Westermann 

Hydrosphere 
John Burkhart 
Lena M. Tallaksen 
Chong-Yu Xu 
Kolbjørn Engeland (II) 

NATURHISTORISK MUSEUM (NHM) 
Biosphere 
Anders Bryn 
Rune Halvorsen 
Vegar Bakkestuen (II) 

IFI 
Environmental sensors 
Tor Sverre Lande 
Svein Erik Hamran (II) 
Dag Wisland (II)
Land-atmosphere interactions and feedbacks

- Albedo
- Surface temperature
- Soil moisture
- Permafrost
- Vegetation
The Norwegian Earth System Model (NorESM) will be used as a common tool to study interactions across processes and scales.

- WRF – regional weather and climate model
- Distributed terrestrial models
Observations

Observations are fundamental for improving Earth System Models

Colin Jones, Head UK Earth System Modeling Project

- Analyse and map recent changes
- Verify earth observations (ground truth data)
- Model development and verification
Earth observations

Satellite and LIDAR

Satellite mapped vegetation area (A. Kääb)

Lidar mapped canopy layer (biomass)
Instrument clusters

Flux tower + in-situ data + routine observations

• Data analyses
• Verification
FluxNET

a "network of regional networks," coordinates regional and global analysis of observations from micrometeorological tower sites
LATICE-Flux

Primary* & Portable Tower:
LI-7500A Open Path CO2/H2O Analyzer
Biomet System 4 – Tower (net radiation, humidity, soil heat flux, precipitation sensor, soil temperature/moisture)
4 component radiation
Sonic anemometer

Wireless Sensor Network (distributed measurements)
Snow depth
Snow/precipitation radar platform
Soil temperature/moisture
piezometers (?)
Net radiation
Temperature / Humidity
Environmental sensing

New radar sensor technology

- RADAR Sensors FFI/IFI
  - Ground Penetrating Radar (GPR)
    - Monitoring soil conditions
  - Surface sensing
    - Snow and moisture monitoring
- Stationary surface radar
- Miniaturized radar
  - Distributed systems (≈100 nodes)
  - Remote long-term operation
High resolution Earth System observations

Remote Sensing

HyCAMP 2014-2017

UAS Statkraft 2015-2017

LATICE PhD 1: Novel Sensors

LATICE PhD 2: Spatial Data

LATICE Intensive Earth System Observations

Snow / Hydrology

Novel Instrumentation
Permafrost degradation and carbon feedback

2014: Degrading permafrost mire in Finnmark, Norway
Boreal and Arctic Vegetation feedbacks

Atmosphere

Postdoc Dynamic Vegetation

PhD Vegetation feedbacks

LATICE NorESM - WRF simulations

Land

LATICE PhD 3: BVOC
PHD 5: Veg-Ecol

Photo: Anders Bryn, NHM
Two examples - ongoing PhDs

• Johanne Rydsaa
  Feedbacks to regional boreal climate due to structural vegetation changes: WRF modelling

• Kjetil S. Aas
  Simulation of surface energy balance at the Svalbard archipelago plus subgrid scale snow distribution: WRF modelling
Integration of LATICE PhD projects

• **PhD-1**: Advanced sensor technologies for eco/cryo/hydrologic studies
• **PhD-2**: Datascapes: spatial data sensitivity and representativeness in models.
• **PhD-3**: Biogenic emissions of particle and ozone precursors
• **PhD-4**: Carbon turnover sensitivities to permafrost and snow dynamics in ESMs.
• **PhD-5**: Vegetation-ecology modelling

Postdoc-1: Model sensitivity to changes in surface conditions
Poster

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Thank you for your attention!

LATICE: http://mn.uio.no/latice