UiO : Department of Geosciences
University of Oslo

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

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NHR 3rd conference on Modelling Hydrology, Climate and Land Surface Processes 7-9 September 2015, Lillehammer

UiO : Department of Geosciences
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Strategic Research Initiative 2015-2019

Land-Atmosphere Interactions in Cold Environments

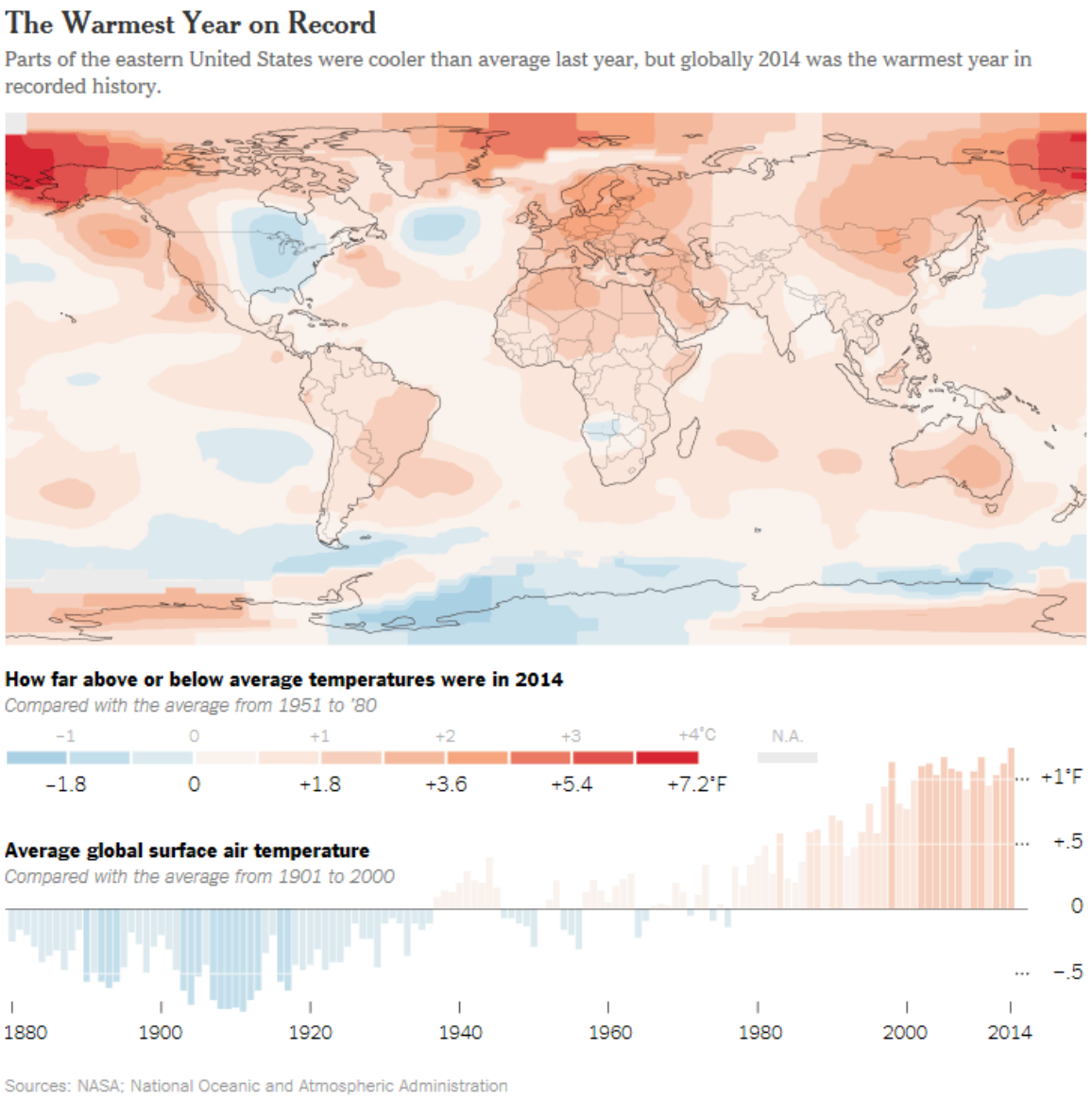
The role of Atmosphere – Biosphere – Cryosphere – Hydrosphere interactions in a rapidly changing climate

LATICE

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

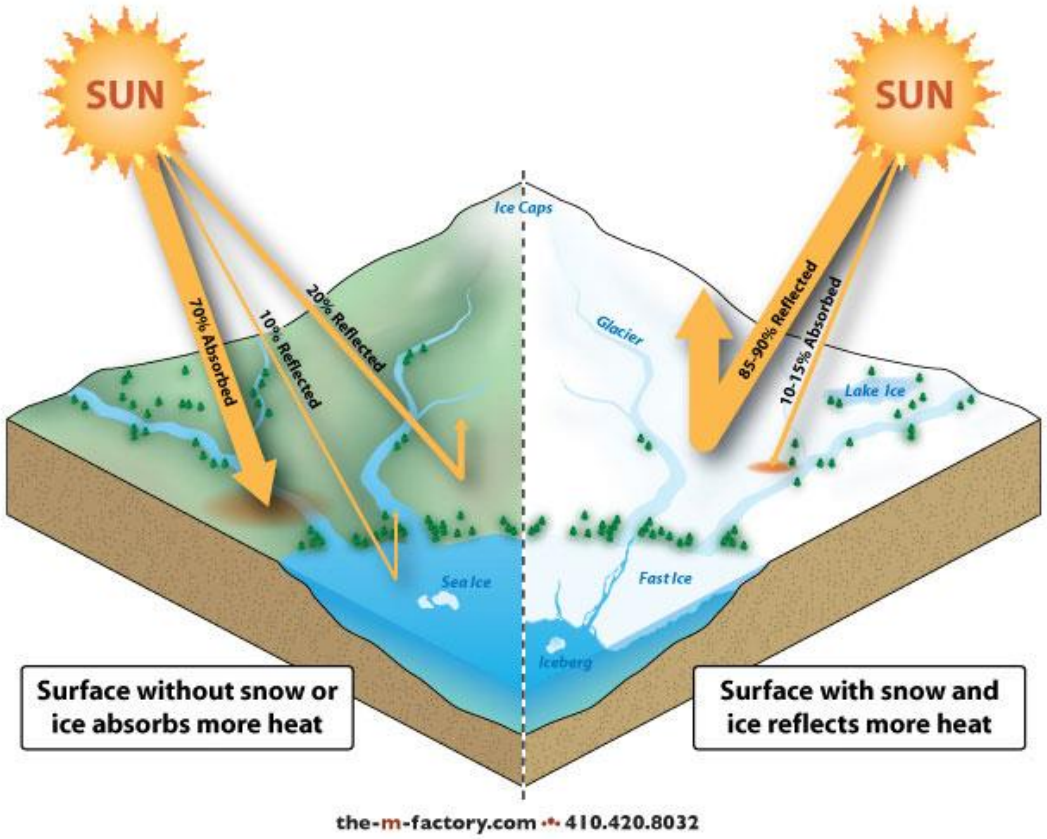
Motivation

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

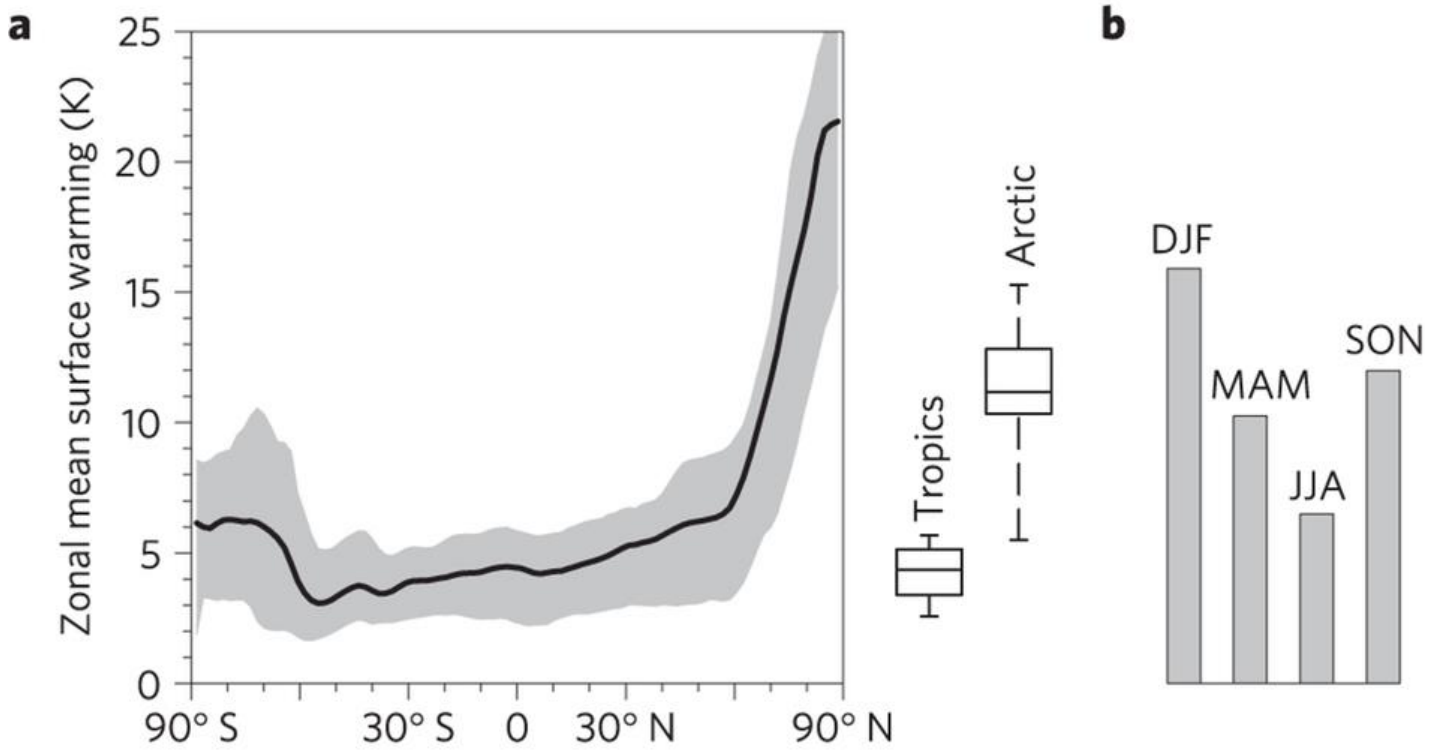


Sources: NASA; National Oceanic and Atmospheric Administration

Arctic amplification: Albedo feedbacks

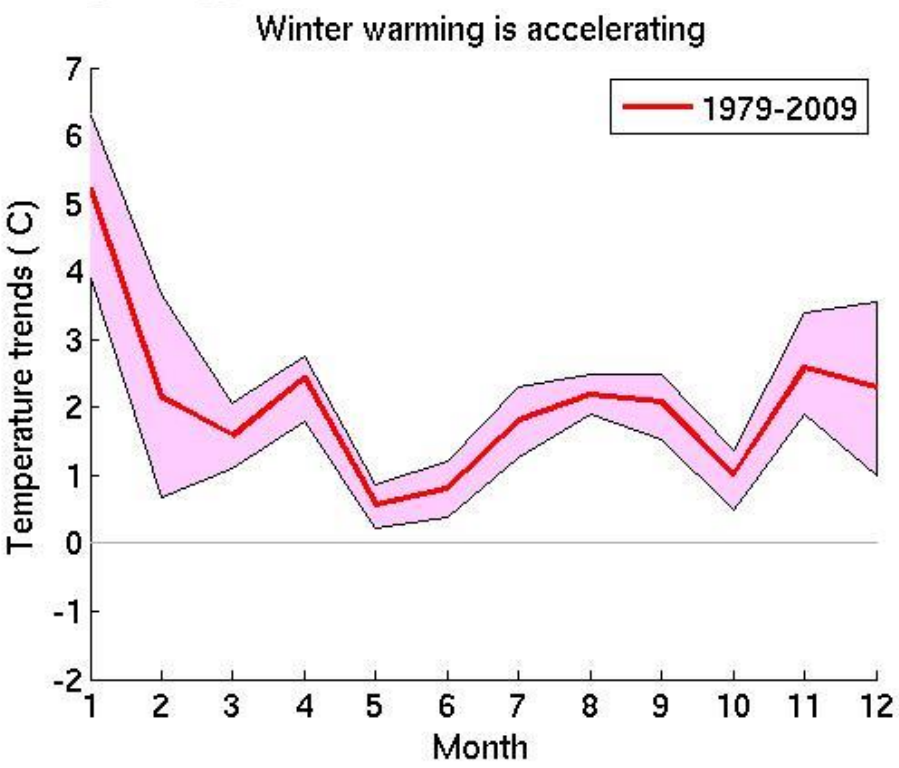


Arctic amplification: Temp. feedbacks

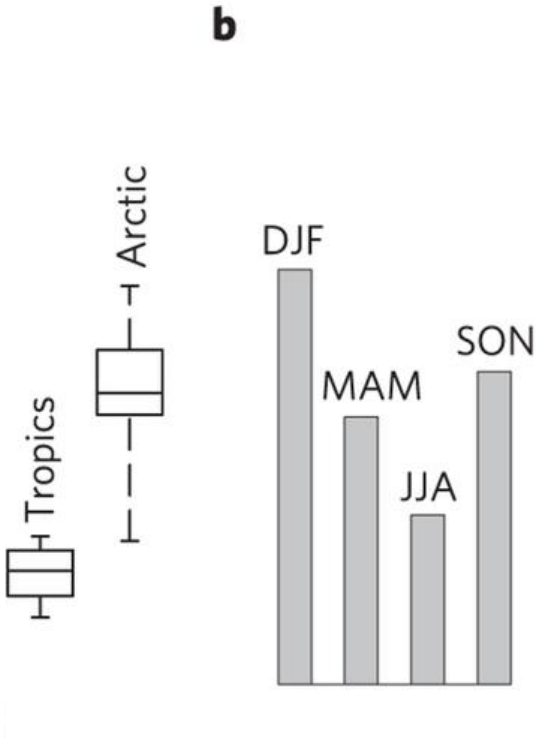


Arctic amplification dominated by temperature feedbacks in contemporary climate models. Pithan & Mauritsen, Nature Geoscience 7, 181–184 (2014)

Arctic amplification: data from seNorge



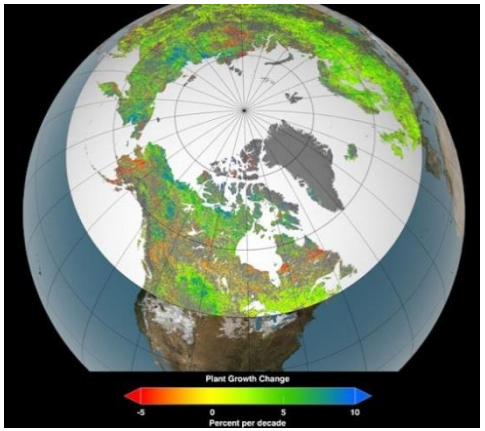
Brox-Nilsen & Tallaksen, EGU (2014)



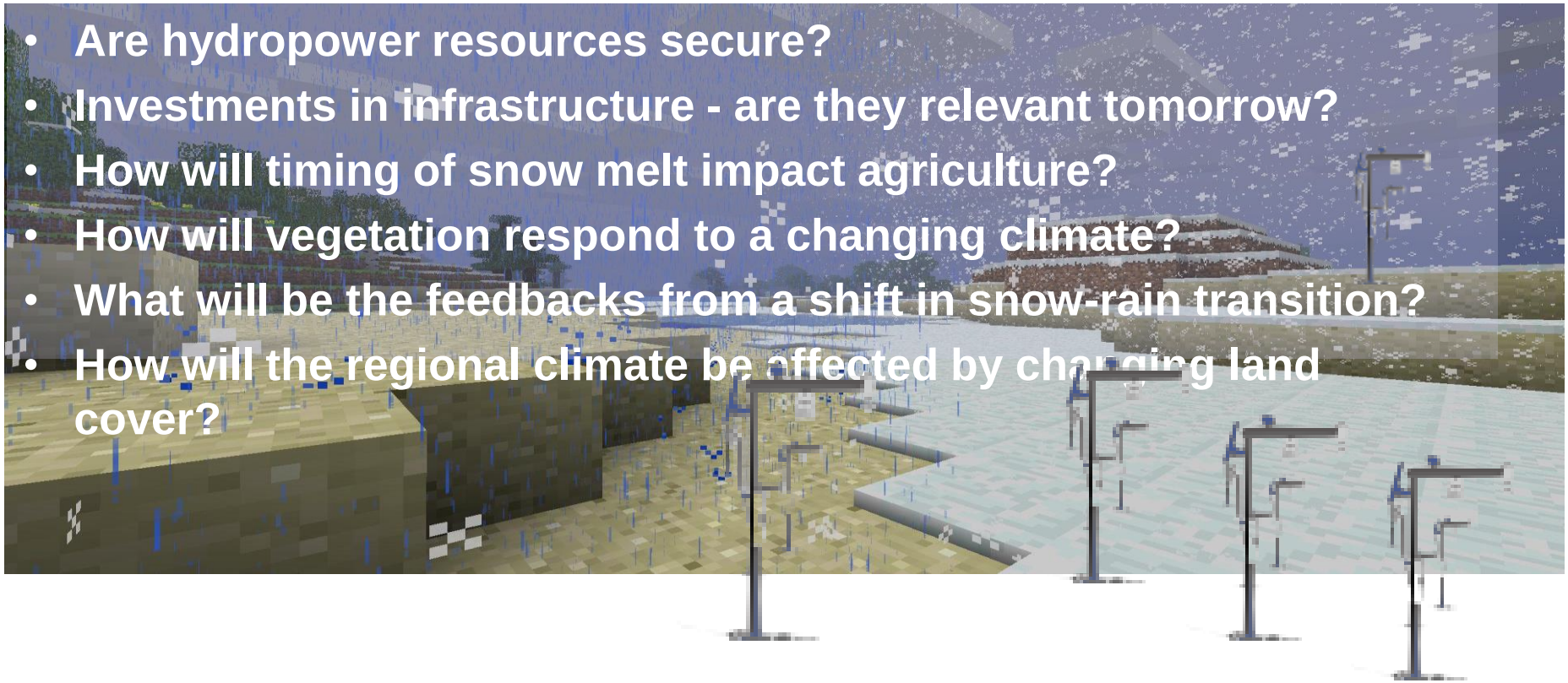
Pithan & Mauritsen, Nature Geoscience 7, 181–184 (2014)

Impacts – Cold environments

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



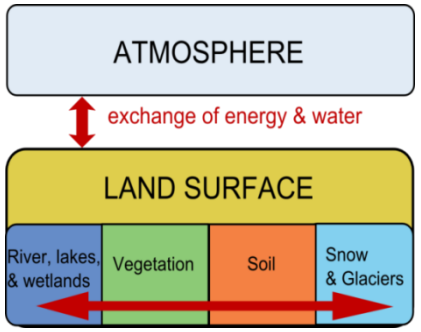
Is our understanding sufficient?



- 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)

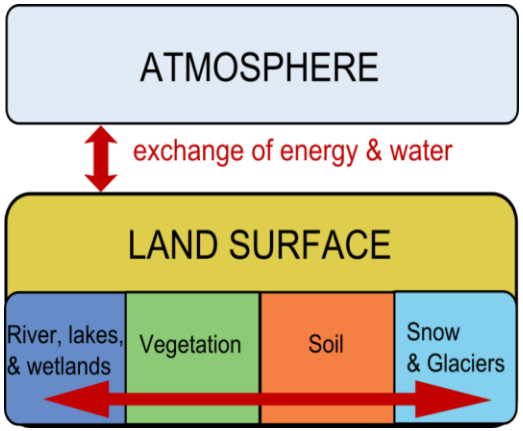
Biosphere

Anders Bryn
Rune Halvorsen
Vegar Bakkestuen (II)

IFI

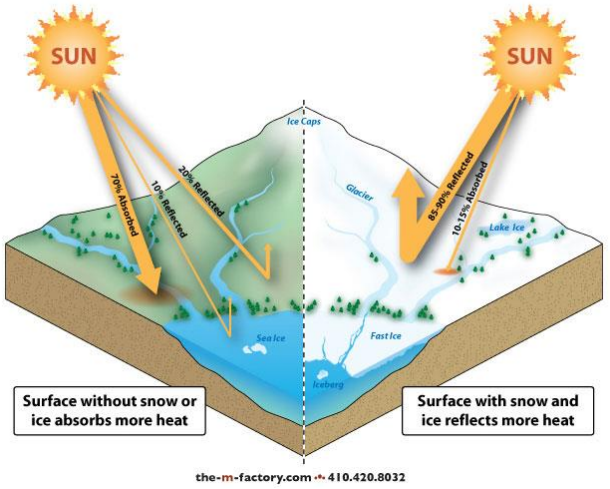
Environmental sensors

Tor Sverre Lande
Svein Erik Hamran (II)
Dag Wisland (II)



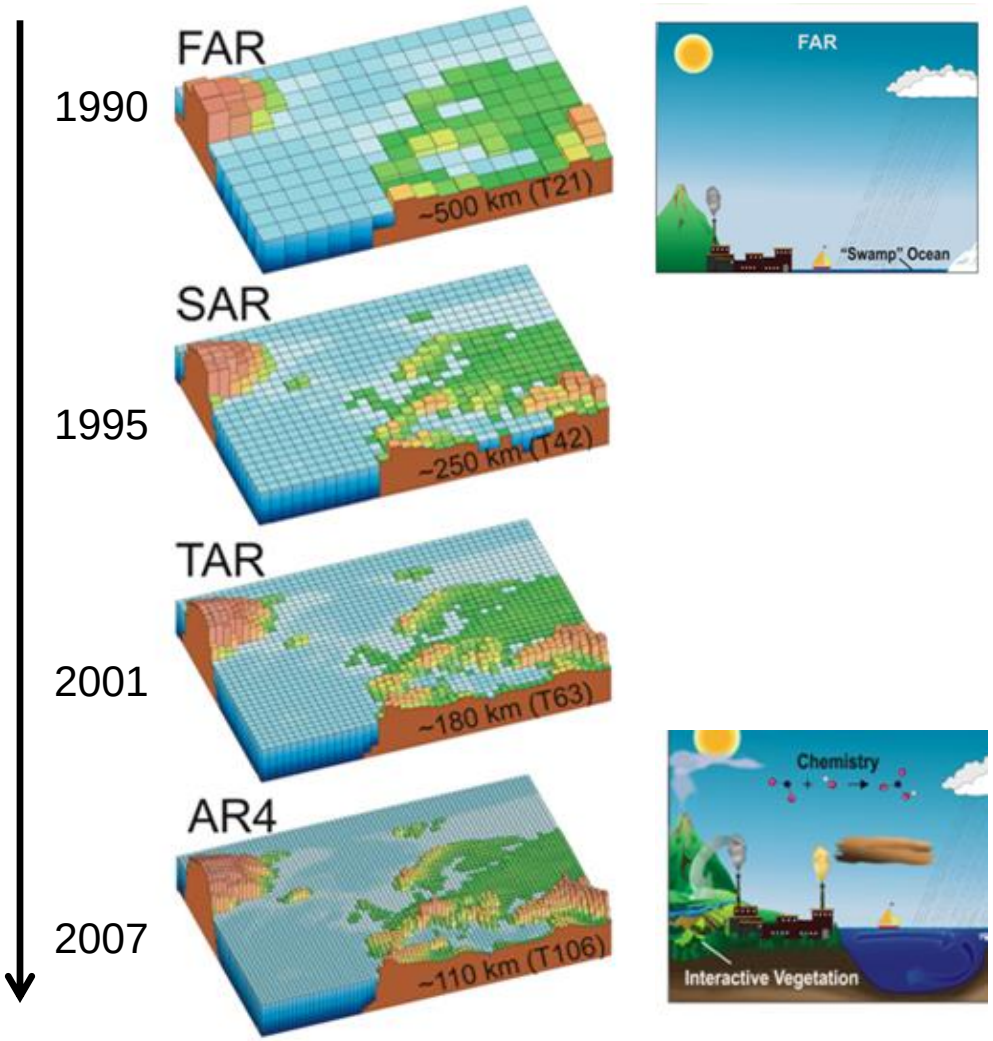
Land-atmosphere interactions and feedbacks

- Albedo
- Surface temperature



- Soil moisture
- Permafrost
- Vegetation

NorESM – An integrating tool



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

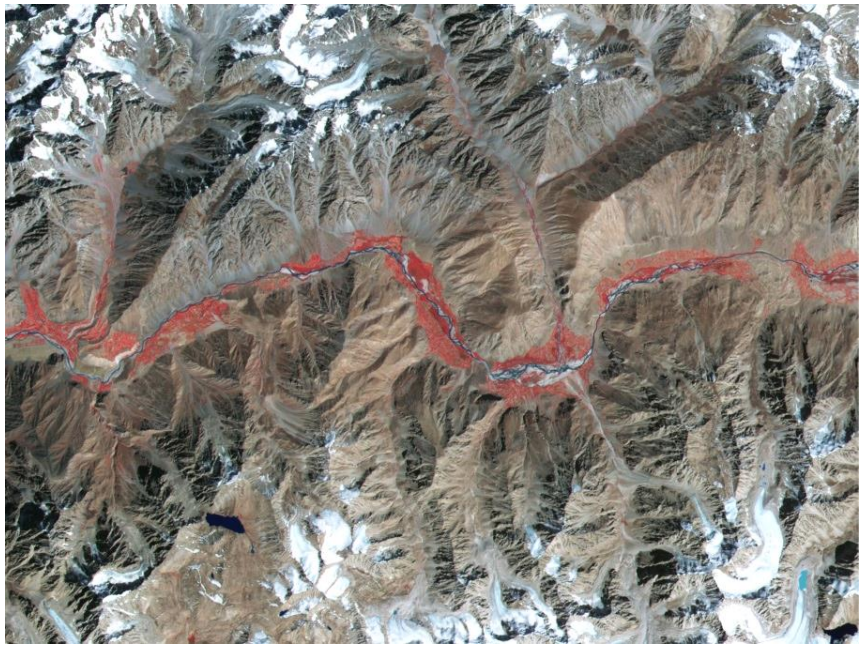
Observations are fundamental for improving Earth System Models

Colin Jones, Head UK Earth System Modeling Project

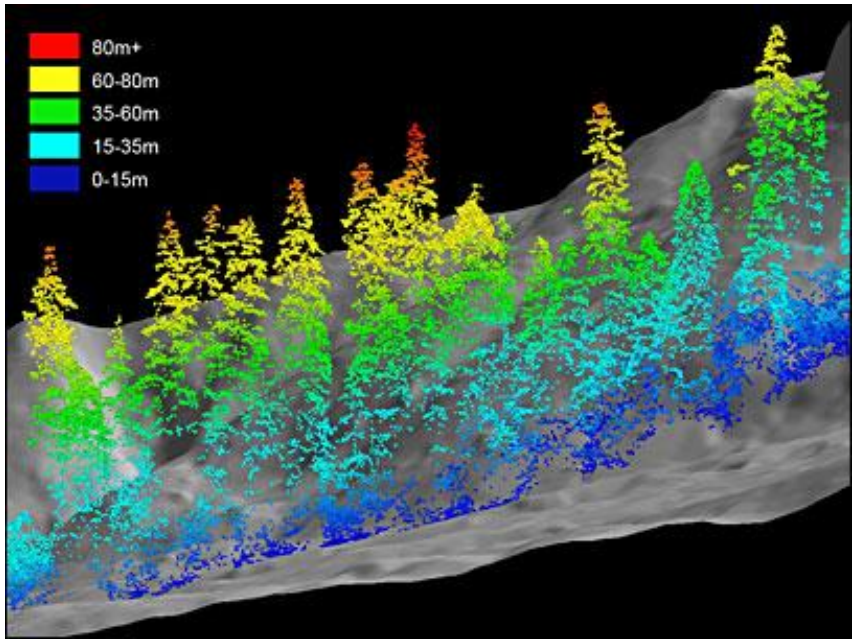
- Analyse and map recent changes
- Verify earth observations (ground truth data)
- Model development and verification

Earth observations

Satellite and LIDAR



Satellite mapped vegetation area
(A. Kääb)

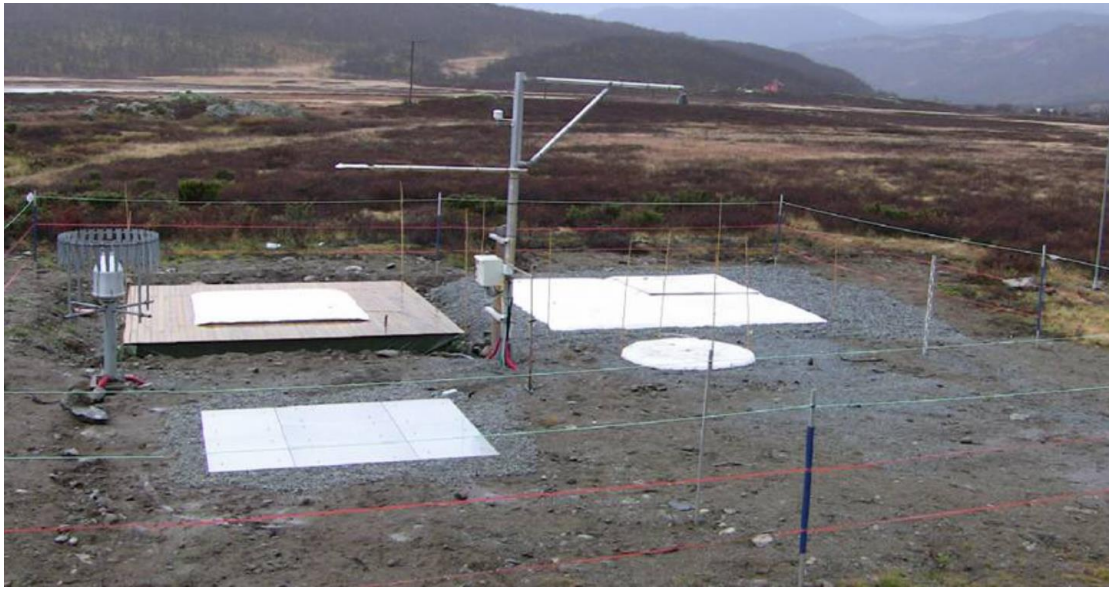


Lidar mapped canopy layer (biomass)

Instrument clusters

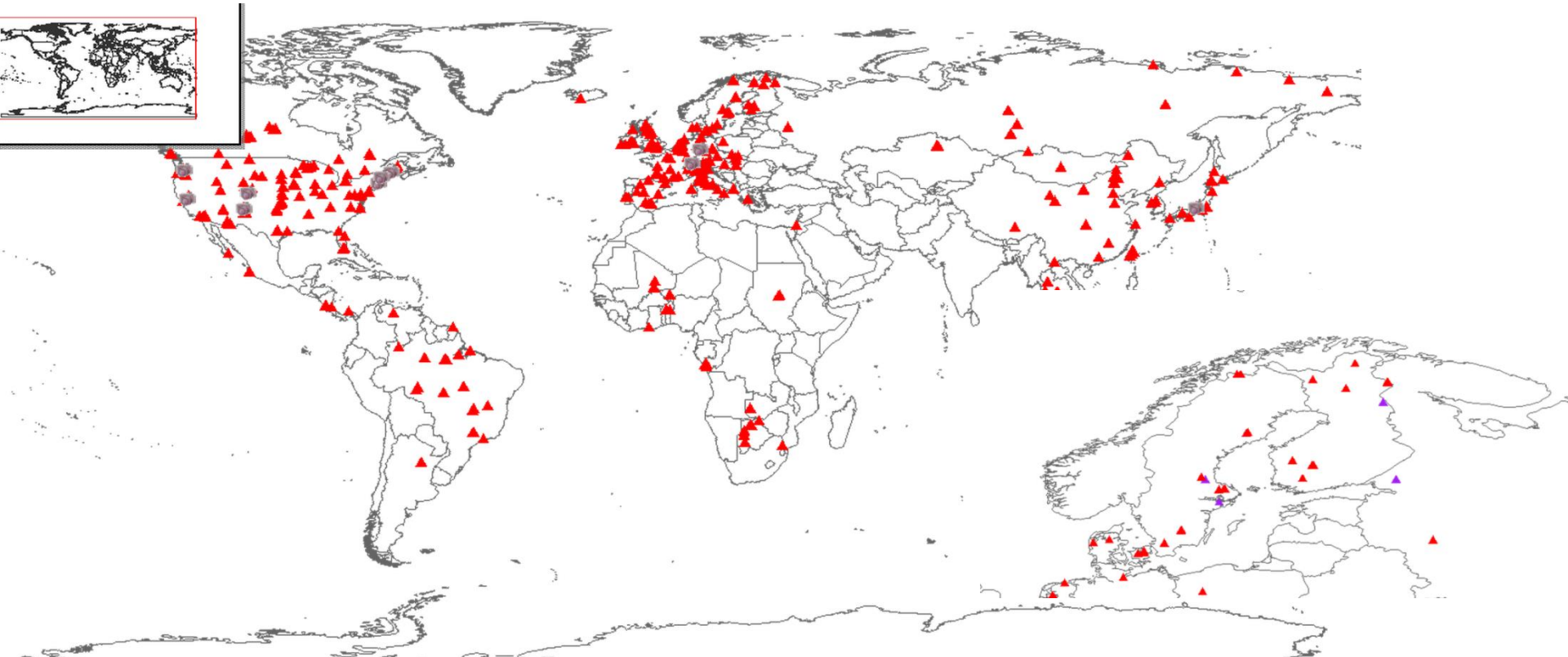
Flux tower + in-situ data + routine observations

- 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

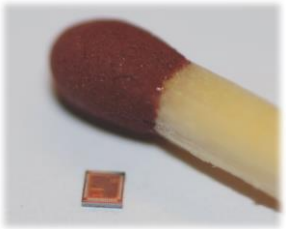
Wireless Sensor Network (distributed measurements)

Snow depth
Snow/precipitation radar platform
Soil temperature/moisture
piezometers (?)
Net radiation
Temperature / Humidity

Environmental sensing

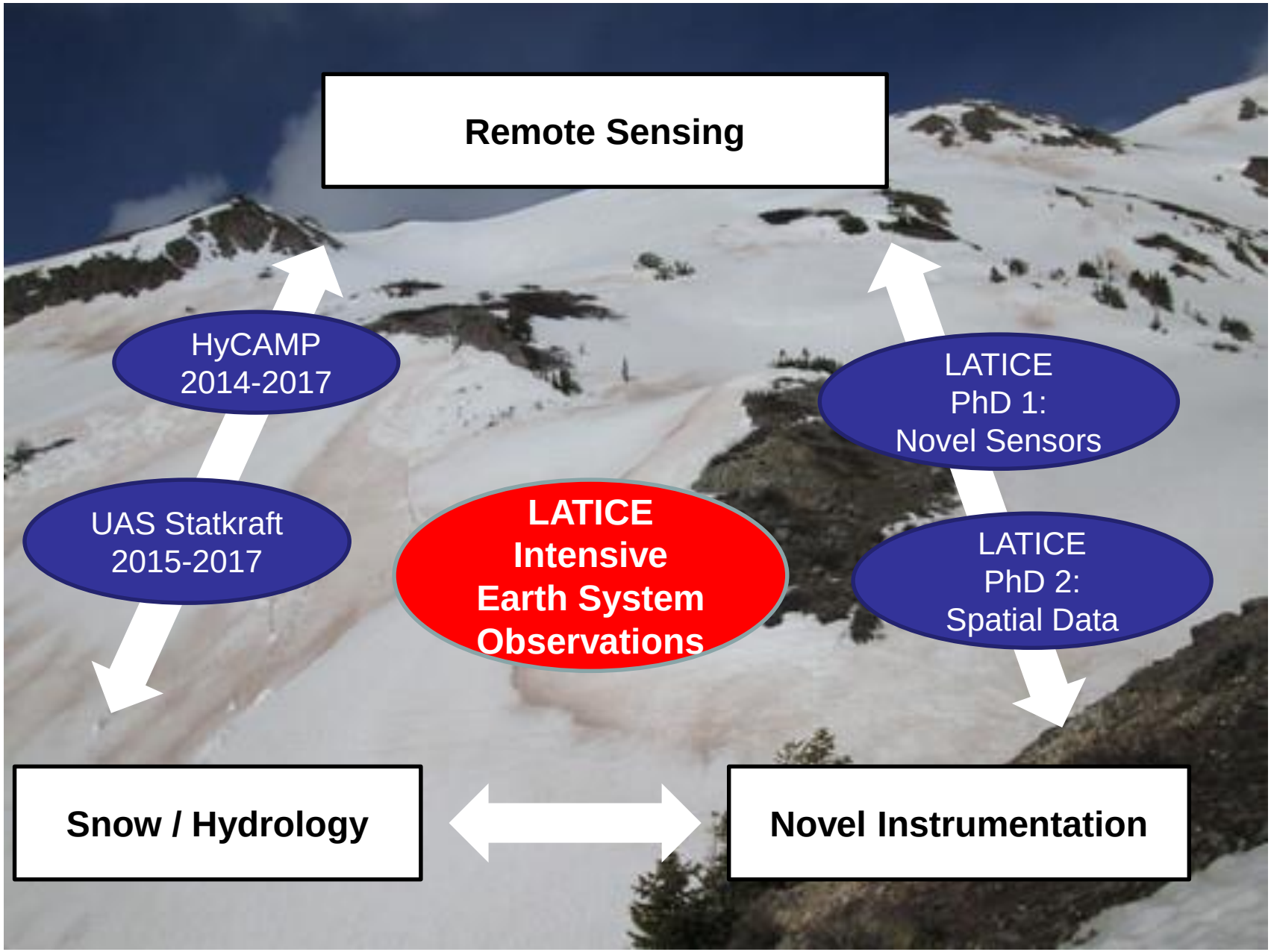
New radar sensor technology

- 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

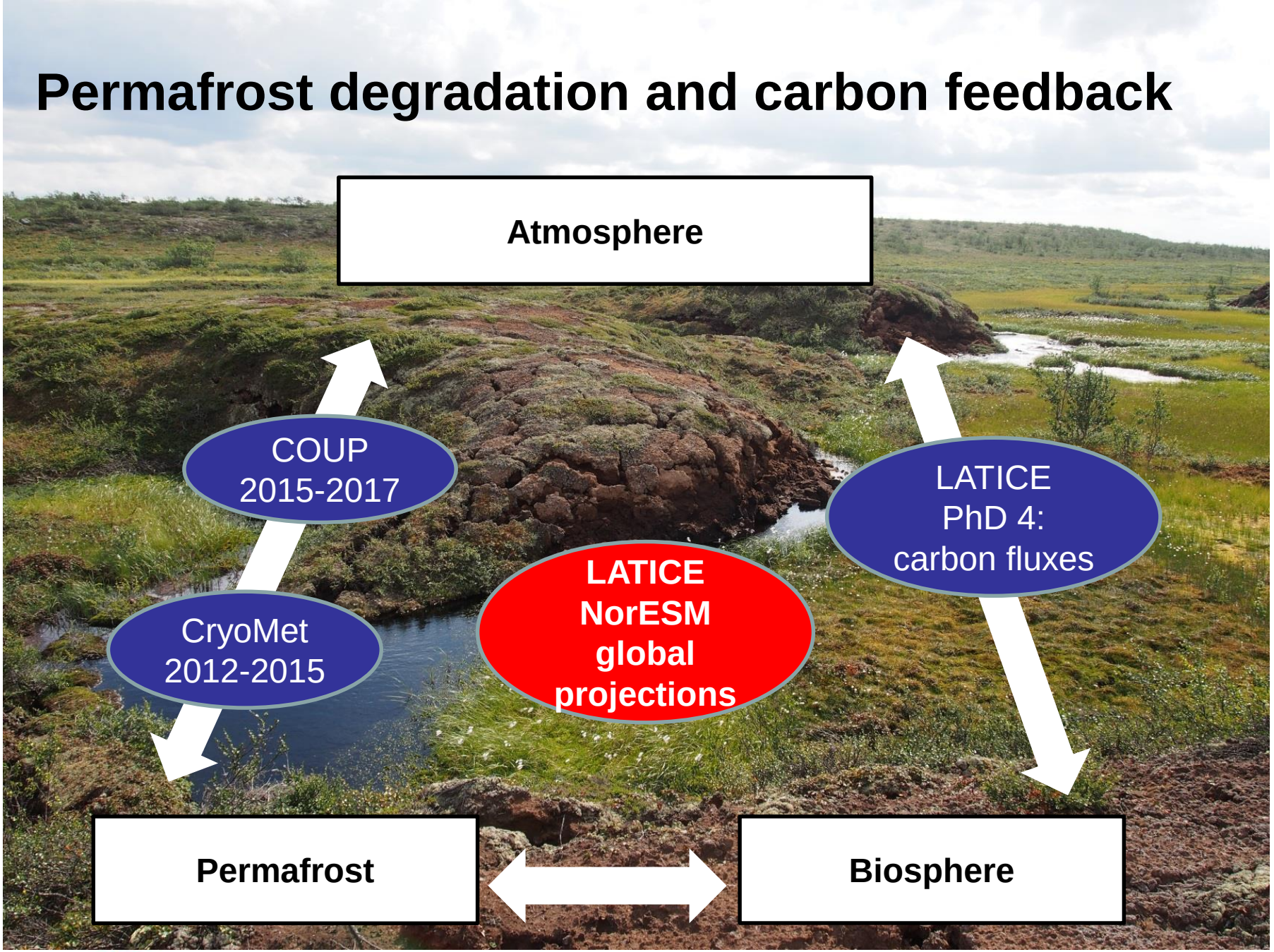


Novelda AS
single-chip radar

High resolution Earth System observations



Permafrost degradation and carbon feedback



2014: Degrading permafrost mire in Finnmark, Norway

Boreal and Artic Vegetation feedbacks

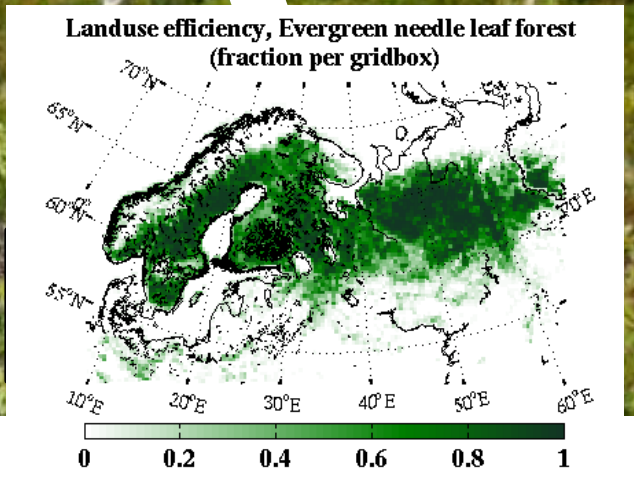
Atmosphere

Postdoc
Dynamic
Vegetation

PhD
Vegetation
feedbacks

LATICE
NorESM -
WRF
simulations

LATICE
PhD 3: BVOC
PHD 5: Veg-Ecol



Land

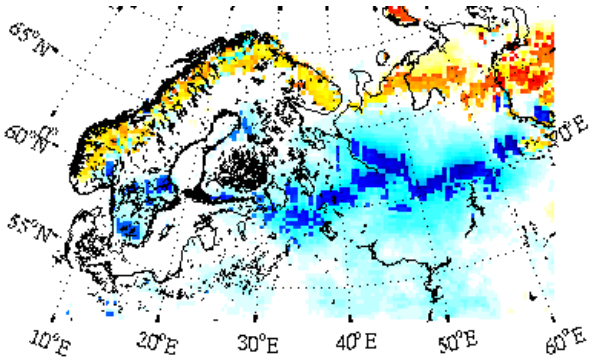
Photo: Anders Bryn, NHM

Two examples - ongoing PhDs

- *Johanne Rydsaa*

Feedbacks to regional boreal climate due to structural vegetation changes:

WRF modelling

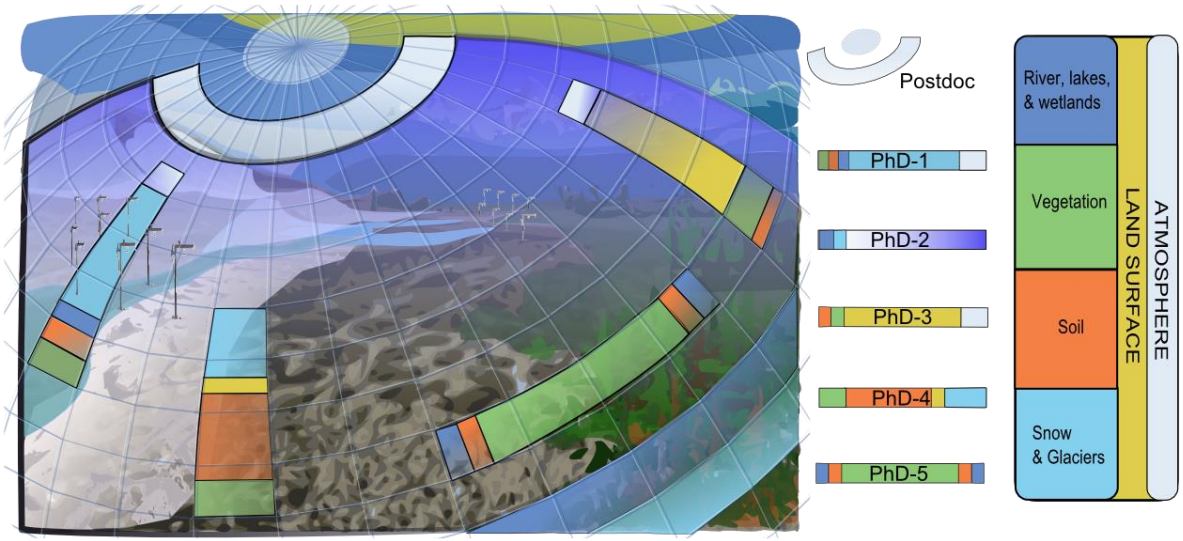


- *Kjetil S. Aas*

Simulation of surface energy balance at the Svalbard archipelago plus sub grid scale snow distribution:

WRF modelling

Integration of LATICE PhD projects



Postdoc-1: Model sensitivity to changes in surface conditions

- **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

Poster

NHR 3rd conference on Modelling Hydrology, Climate and Land Surface Processes

7-9 September 2015, Lillehammer

Thank you for your attention!

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