



# ArcticBiomass

US-Norway Network project

**Hans Tømmervik**



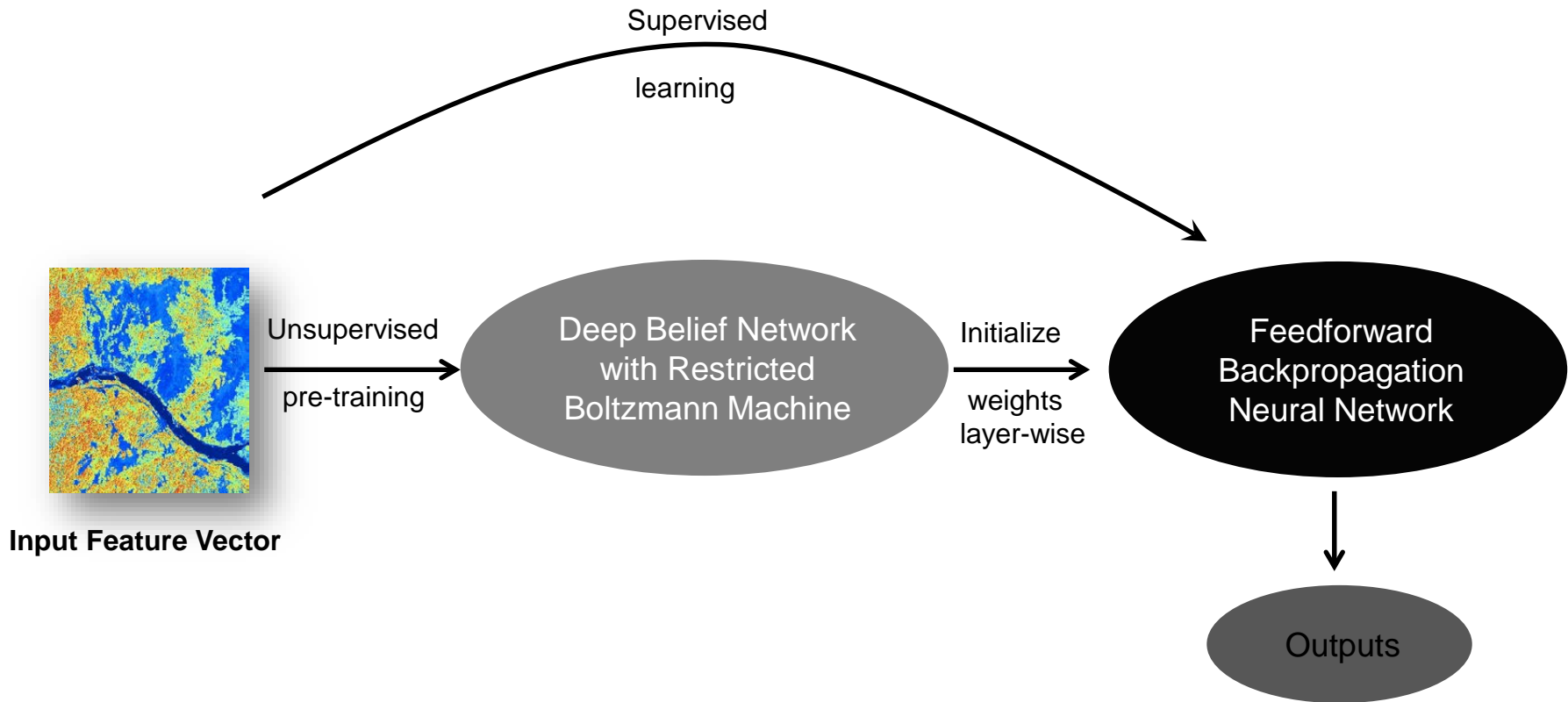
# Work packages

- The project seeks to address the following research questions and tasks:
- **WP 1:** Arrange workshops and joint field campaigns on Svalbard (Ny-Ålesund and Nordenskiöldland), and in northern Alaska for development of efficient field protocols for field measurements of biomass and productivity and in order to filling gaps in plant biomass and plant productivity data.
- **WP 2:** *Improvement of mapping methods of plant biomass and plant production in northern Alaska and on Svalbard, as well as on a circumpolar scale .*
- **WP 3:** This work-package aims to estimate, map and model the overall productivity of arctic landscape and vegetation of Svalbard/Fennoscandia and in Alaska.
- **WP 4:** Improvement of mapping methods of the growing season (phenology) .

# High to very high spatial imagery

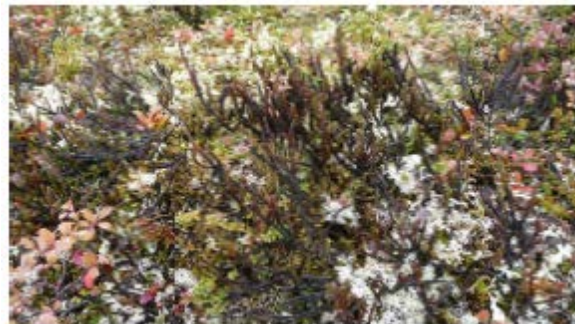
- New algorithms: **Deep belief networks/deep learning** might help us in extracting objects on the ground that can give us enhanced information about the vegetation structure/texture, status, health, phenological stage, disturbance mapping etc.

# Learning



Sangram's talk

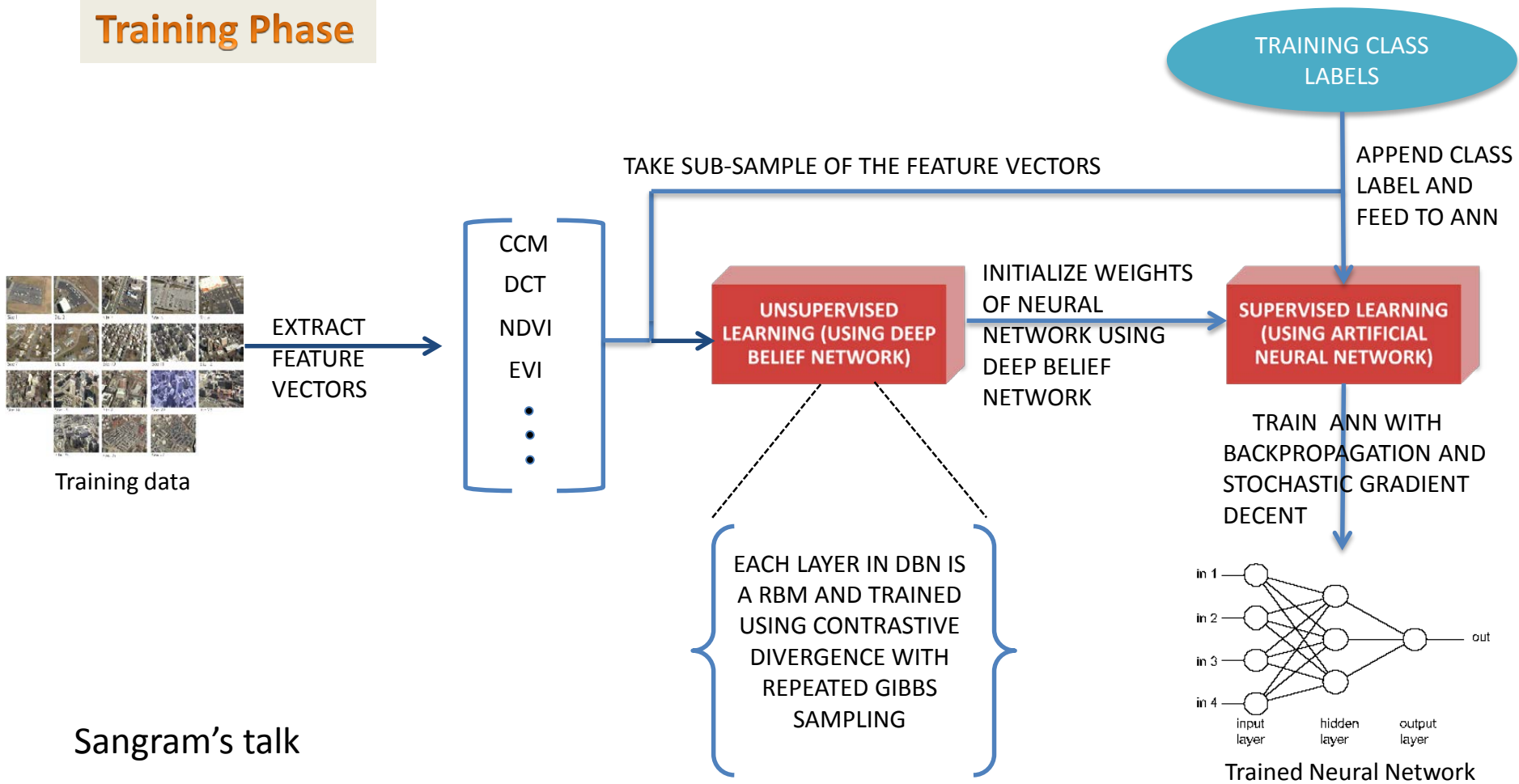
## ***Disturbance mapping***



Damage to ***Cassiope tetragona*** – Denali highway 2014

# Learning Module

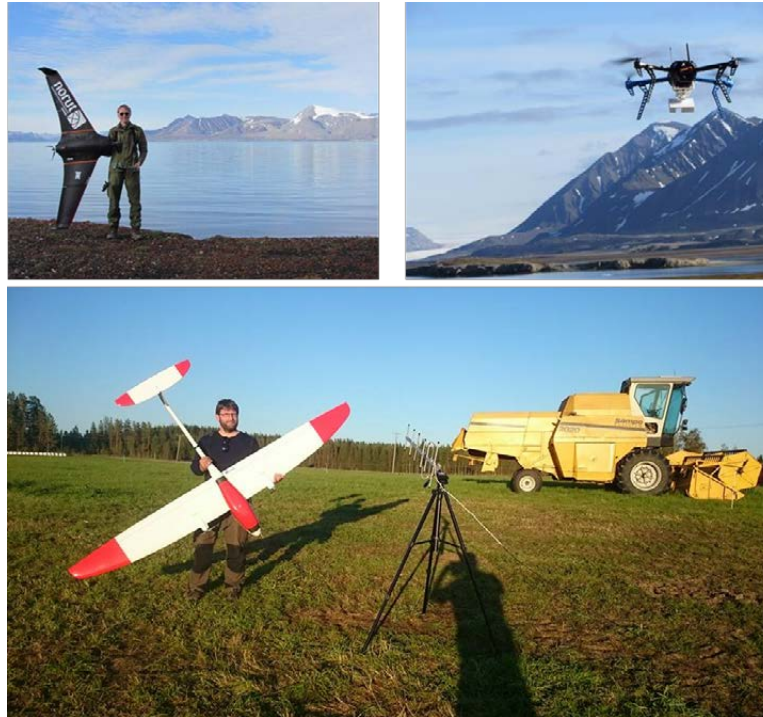
## Training Phase





# Sub pixel image classification/scaling etc

Use of RPAS/UAS to add information in scaling  
procedures from plot to satellite



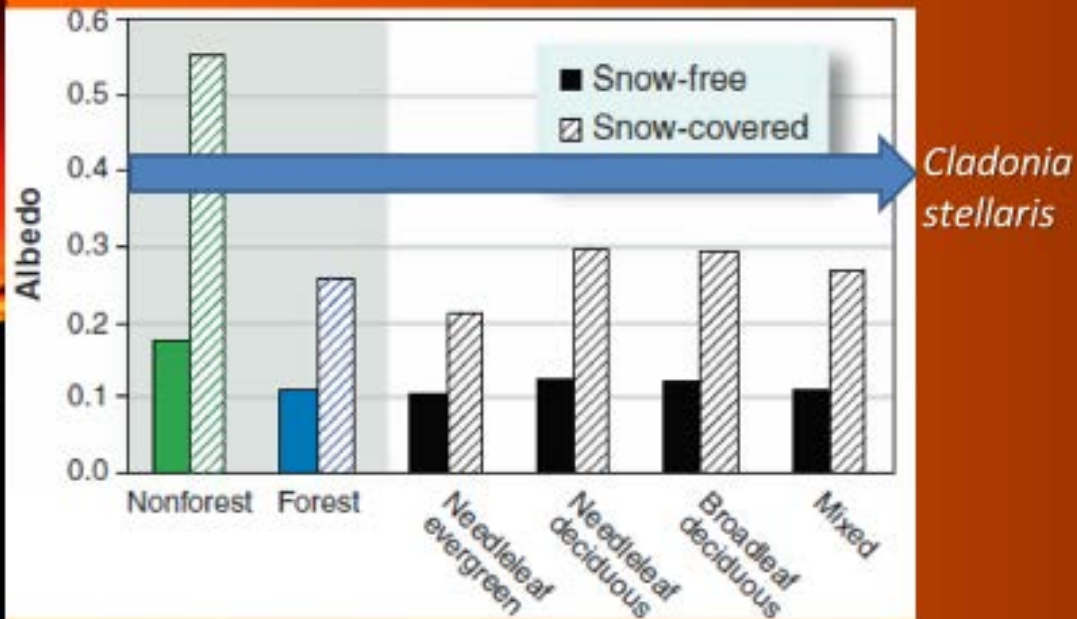
# Processing of data from Sentinel-2

Facility with super computers in order to process the large amounts of data (Longyearbyen)



# Lichens can help?

## Estimated albedo of *C. stellaris*



Graph from: Bonan 2008. Forests and climate change... *Science*.

# Lichen volume estimator

The final regression model used to predict the observed lichen volume, i.e. the Lichen Volume Estimator (LVE), is:

$$LVE(NDLI, NDMI) = a \times \exp^{-0.5 \times \left( \left( \frac{NDLI - NDLI_{mean}}{b} \right)^2 + \left( \frac{NDMI - NDMI_{mean}}{c} \right)^2 \right)}$$

where NDLI mean and NDMI mean are the NDLI and NDMI respectively, and a, b and c are the normal distribution parameters to be parameterized.

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Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: [www.elsevier.com/locate/rse](http://www.elsevier.com/locate/rse)



## Estimating lichen volume and reindeer winter pasture quality from Landsat imagery<sup>☆</sup>



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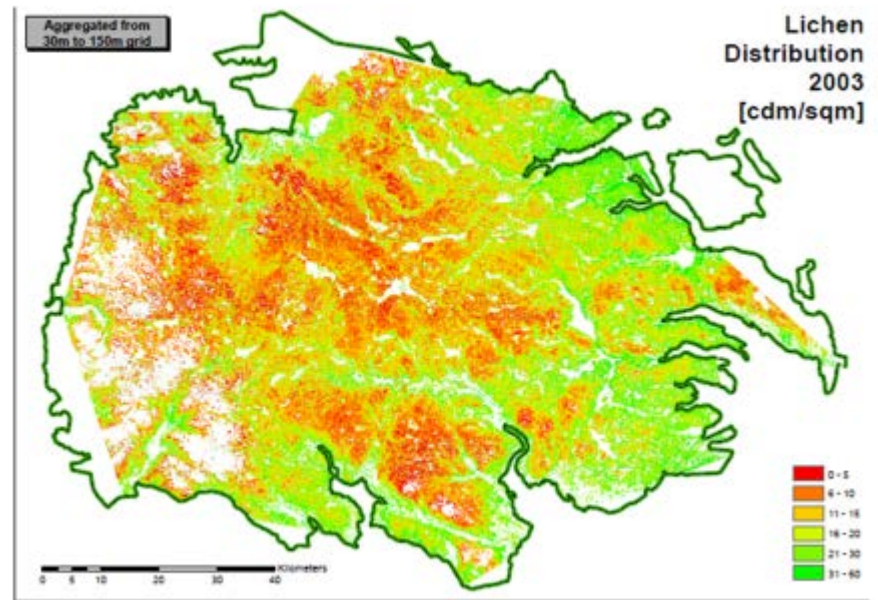
### ARTICLE INFO

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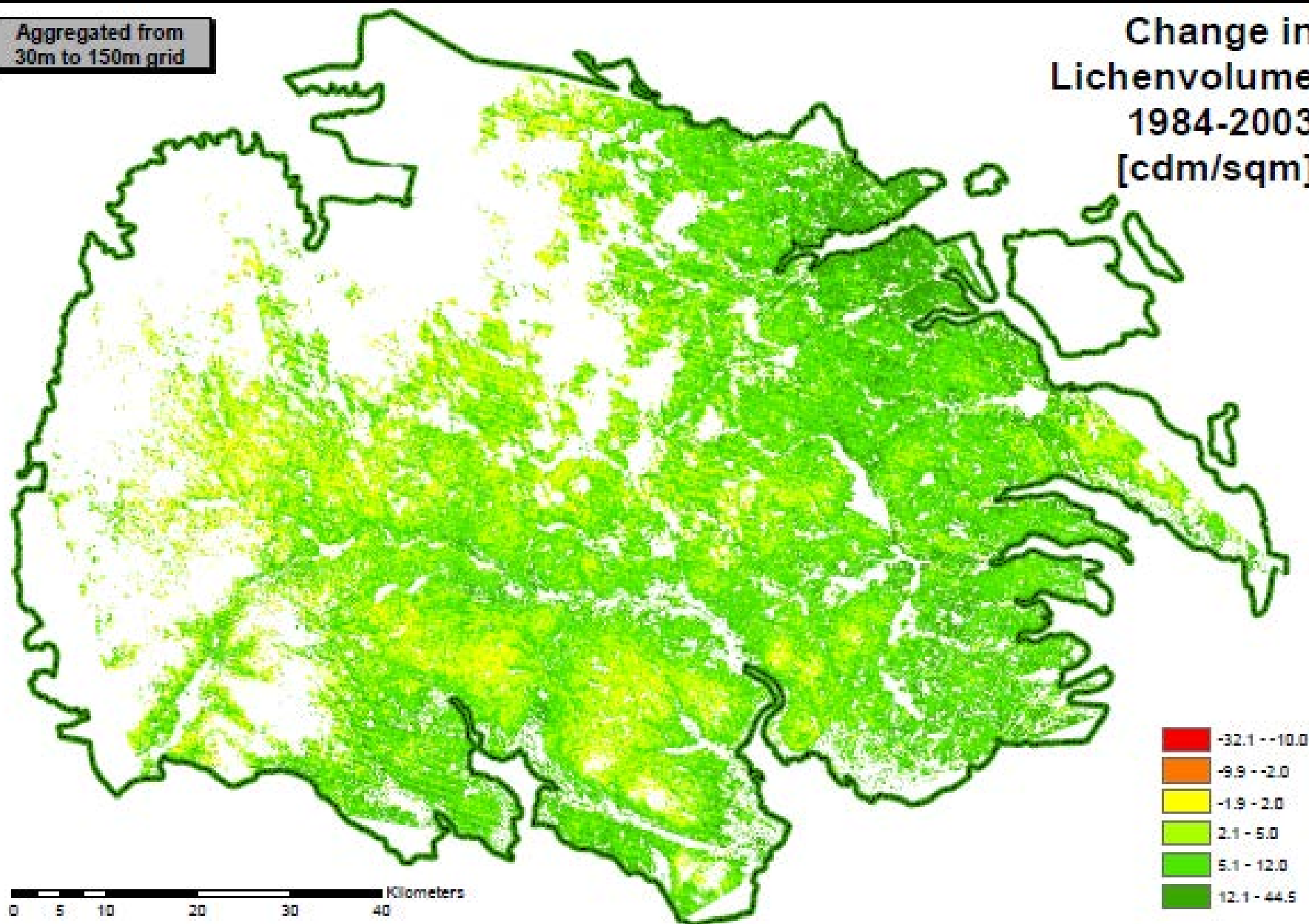
### ABSTRACT

Reindeer and caribou are keystone species in the circumpolar region, and rely on lichens as their main winter forage to survive in some of the most extreme environments on Earth. Lichen mats, however, can be heavily overgrazed at high deer densities, triggering area abandonment or population declines. Although the species' management and conservation require precise information on the quality of winter grazing areas, no reliable and cost-efficient methods are available to date to measure lichen volume across wide and remote areas. We developed a new Lichen Volume Estimator, LVE, using remote sensing and field measurements. We used a Landsat TM land cover mask to separate lichen heath communities from other vegetation types and, therein, we predicted lichen volume from a two dimensional Gaussian regression model using two indices: the Normalized Difference Lichen Index, NDLI (Band 5 – Band 4 / Band 5 + Band 4), and the Normalized Difference Moisture Index, NDMI (Band 4 – Band 5 / Band 4 + Band 5). The model was parameterized using 202 ground



Aggregated from  
30m to 150m grid

# Change in Lichenvolume 1984-2003 [cdm/sqm]



# Scientific Publications

- Høgda, K.A., Tømmervik, H. & Karlsen, S.R. 2013. Trends in the Start of the Growing Season in Fennoscandia 1982–2011. *Remote Sensing*, 2013, 5(9), 4304-4318; doi:10.3390/rs5094304.
- Karlsen, S.R., Elvebakk, A., Høgda, K.A. & Grydeland, T. 2014. Spatial and temporal variability in the onset of the growing season on svalbard, arctic Norway - Measured by MODIS-NDVI satellite data. *Remote Sensing* 2014, 6, 8088-8106, doi:10.3390/rs6098088
- Tømmervik, H., Karlsen, S.R., Nilsen, L., Johansen, B., Storbvold, R., Zmarz, A., Beck, P.S., Johansen, K.S., Høgda, K.A., Goetz, S., Park, T., Zagajewski, B., Myneni, R.B. & Bjerke, J.W. 2014. Use of unmanned aircraft systems (UAS) in a multiscale vegetation index study of Arctic plant communities in Adventdalen on Svalbard. *EARSeL eProceedings* 13 (S1), 47-52.
- Bjerke, J.W., Tømmervik, H., Zielke, M. & Jørgensen, M. 2015. Impacts of snow season on ground-ice accumulation, soil frost and primary productivity in a grassland of sub-Arctic Norway. *Environmental Research Letters* 2015, 10 (2015) 095007. doi:10.3390/rs6098088

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## Focus on Recent, Present and Future Arctic and Boreal Productivity and Biomass Changes

### Guest Editors

**Hans Tømmervik** Norwegian Institute for Nature Research

**Bruce Forbes** University of Lapland

**Donald Walker** University of Alaska Fairbanks

**Scott Goetz** Woods Hole Research Center



Credit: Bruce C Forbes, July 2014.

### Scope

This focus issue will address recent changes in phenology, biomass and productivity and the mechanisms and drivers that control such changes, along with the consequences for local, regional and global scale processes. This includes impacts on vegetation, ecosystems and effects on human communities that are dependent on the resources in Arctic and Boreal regions. Examples of research topics the focus issue will address include:

- Changes in the physical environment over high latitude regions and associated ecological changes in Arctic/Boreal vegetation, including vegetation-mediated responses and climate feedbacks.
- Changes in phenology of vegetation (longer growth season) and in vegetation biomass and productivity responses to recent climate warming.
- Actual and potential biomass change influenced by (local) climate, natural disturbances, human impacts (e.g. resource extraction) and impacts on humans (e.g. reindeer herders).
- Transformation of open tundra vegetation to a more shrub dominated landscape, due to warming and other processes, influencing local and global climate, albedo and climate feedback mechanisms.
- Integration of *in situ* observations and manipulation experiments with remote sensing and other data sources to advance methodological approaches for measuring and monitoring.

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# WEB:

<http://www.nina.no/english/Research/Projects/ArcticBiomass>

The screenshot shows a web browser window displaying the NINA website. The browser's address bar shows the URL <http://www.nina.no/english/Research/Projects/ArcticBiomass>. The website header includes the NINA logo (Norsk institutt for naturforskning) and a navigation menu with options: HOME, RESEARCH (selected), ENVIRONMENTAL MONITORING, PUBLICATIONS, NEWS, CONTACT, and ABOUT NINA. A search bar is also present. The main content area features the title "ArcticBiomass" and a sub-header "Plant biomass studies in the Arctic." Below this is a large photograph of a pine tree in a natural setting. On the left side, there is a sidebar with a "Arctic Biomass" section containing links for "Project team" and "Publications". On the right side, there is a "ArcticBiomass Contact" section listing "Hans Tømmervik" and a focus issue titled "Focus issue Environmental Research Letter - Focus on Recent, Present and Future Arctic and Boreal Productivity and Biomass Changes".

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## ArcticBiomass

Plant biomass studies in the Arctic.



ArcticBiomass  
Contact

[Hans Tømmervik](#)

Focus issue Environmental Research Letter

Focus issue Environmental Research Letter - Focus on Recent, Present and Future Arctic and Boreal Productivity and Biomass Changes