Project information

Project title
NCoE-Tundra: Moth-reindeer-birch dynamics in northernmost Fennoscandia
Year
2013/2014
Project leader
Jane Uhd Jepsen, NINA
Participants

- Project leaders: Jane U. Jepsen (Researcher, NINA), Rolf A. Ims (Prof., UiT)

Participants: Martin Biuw (postdoc, NCoE/NINA), Ole Petter L. Vindstad (PhD-student, UiT), Moritz Klinghardt (MSc-student, NINA/UiT)

In addition international collaborators within the Nordic Centre of Excellence – Tundra program at the University of Turku (Finland), the University of Oulu (Finland) and the Finnish Meteorological Institute

Flagship

Terrestrial, Theme: Vegetation state change and herbivore management

Funding Source
Fram Centre, NCoE-Tundra
Summary of Results

During the summer field season in 2013 ongoing activities at our field sites in Finnmark were continued, and initial results were analysed and prepared as a research article. Within one of the two main activities, one master's project was completed and will be defended on November 22, 2013. We will provide details about these developments under the respective activity below.

The first activity focuses on the effects of grazing by herbivores on the regeneration and successional pathways in birch forest systems heavily affected by the recent outbreak of geometrid moth in the region. The field sites established during the 2011 field season were revisited for a third time during the 2013 summer field campaign. In addition to repeating all the measurements taken during 2011 and 2012, we also recovered the first full year of data on snow accumulation and site usage by herbivores (mainly reindeer), obtained from the wildlife cameras that were deployed during the 2012 summer field campaign. To briefly recount the setup, twelve automatic wildlife cameras were deployed, each overlooking one of our exclosures to monitor snow accumulation and melt throughout the season, and twelve additional cameras were deployed overlooking the control plots to document the usage of these plots by reindeer and other herbivores. All cameras except two performed very satisfactorily throughout the entire season, and the data have provided an extremely valuable confirmation of the suspected differences in seasonal reindeer presence between the Finnish and Norwegian sides of the border. Overall, the presence of reindeer is substantially greater on the Finnish side. In addition, while reindeer potentially have year-round access to the region in Polmak where our study site is located, they appear to use this region exclusively during the snow free season (arriving in early April and leaving by mid-September). In contrast, the seasonal grazing regime implemented on the Norwegian side results in reindeer being present in the Polmak region almost exclusively during winter, and almost never during spring (See Fig 1 in Appendix). This last point is important, since it suggests that the critical spring grazing on woody plants such as mountain birch only occurs on the Finnish side. In addition to herbivore usage, we have also developed an automatic approach for extracting snow depth data from images obtained from the wildlife cameras (see Fig 2 in appendix). This automatic approach will save substantial amounts of time as each new years of data becomes available. The information on herbivore usage and duration of snow cover has now been included as supporting data to the research article describing the ecosystem-wide baseline conditions in the plots in 2011, prior to any changes occurring as a result of the experimental setup. This manuscript was submitted to the journal *Ecosystems* just prior to the 2013 summer field campaign, with post-doctoral student M. Biuw as lead author. After initial acceptance with minor revisions, the paper is now ready to be re-submitted for final acceptance. Within the framework of this manuscript, we have collaborated with international partners within our own WP4, but also WP7 (climatologists) of the NCoE-Tundra, thereby obtaining a dataset covering a range of levels, including soil condition (nutrients, bacteria and fungi), vegetation community composition, forest structure and regeneration and herbivore abundance. By combining these datasets with remote sensing data on vegetation index (NDVI) and albedo, we were also able to show that differences in long-term grazing regimes, and the resulting differences in ecosystem structure, has the potential to translate into differences in the climate feedback signals (see Figure 2 in appendix of last year's report).

The second activity aims to examine the effectiveness of logging as a management approach for stimulating rejuvenation and re-establishment of birch forests following moth outbreaks. Study plots established and inventoried during the 2011 season were re-visited for a third time during the 2013 field campaign. To re-iterate the experimental design, half of these plots were clear-cut following the 2011 field season by our collaborators at Finnmarkseiendommen and Fylkesmannen in Finnmark. We re-examined vegetation community structure, herbivore abundance and were now able to follow up on the initial estimates of short-term effects of clear-cutting in terms of early recruitment and rejuvenation of the forest which were obtained during the 2012 field campaign. This short-term effect has now been analysed by master's student Moritz Klinghardt, with thesis defense scheduled on Nov. 22. The striking short-term changes highlighted in last year's report have continued. The significantly greater increase in regeneration through basal shoots in clear-cut plots compared to control plots continues, albeit at a slightly slower pace. The results of these analyses were presented to our collaborators at Finnmarkseiendommen and Fylkesmannen i Finnmark during a recent visit to the Fram Centre, and the final thesis has been submitted to our collaborators as an initial report of the project. Discussions are now underway about the frequency with which these study plots

should be revisited. The likely outcome will be a continuation of the full scale protocol in 2014, followed by transition to a long-term protocol with reanalysis every 5-year, in order to monitor the longer-term effects of clear-cutting on the regeneration and reestablishment of mountain birch forests following geometrid moth outbreaks.

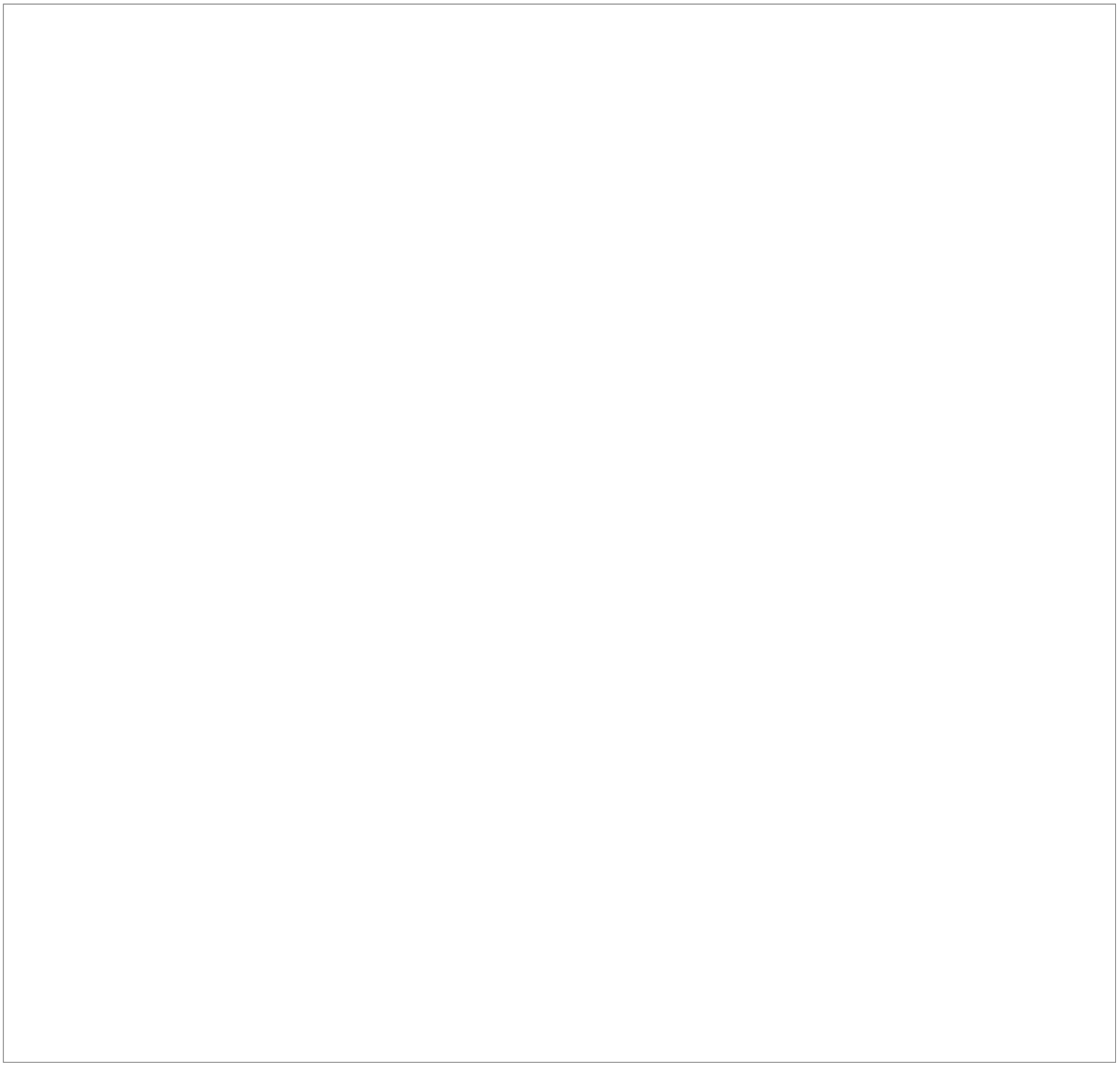


Figure 1. Histograms of the number of images in which reindeer were observed within each control plot. The lefthand column represents plots on the Finnish (Year-round grazed) side while the right-hand column represents Norwegian (Winter grazed) plots. Each bar represents one week. The vertical grey lines and horizontal arrow indicates the period of snow cover. Both these data series were obtained from the wildlife cameras deployed during the summer campaign 2012, and the figure has been included as supporting material for the research article recently accepted in *Ecosystems*.

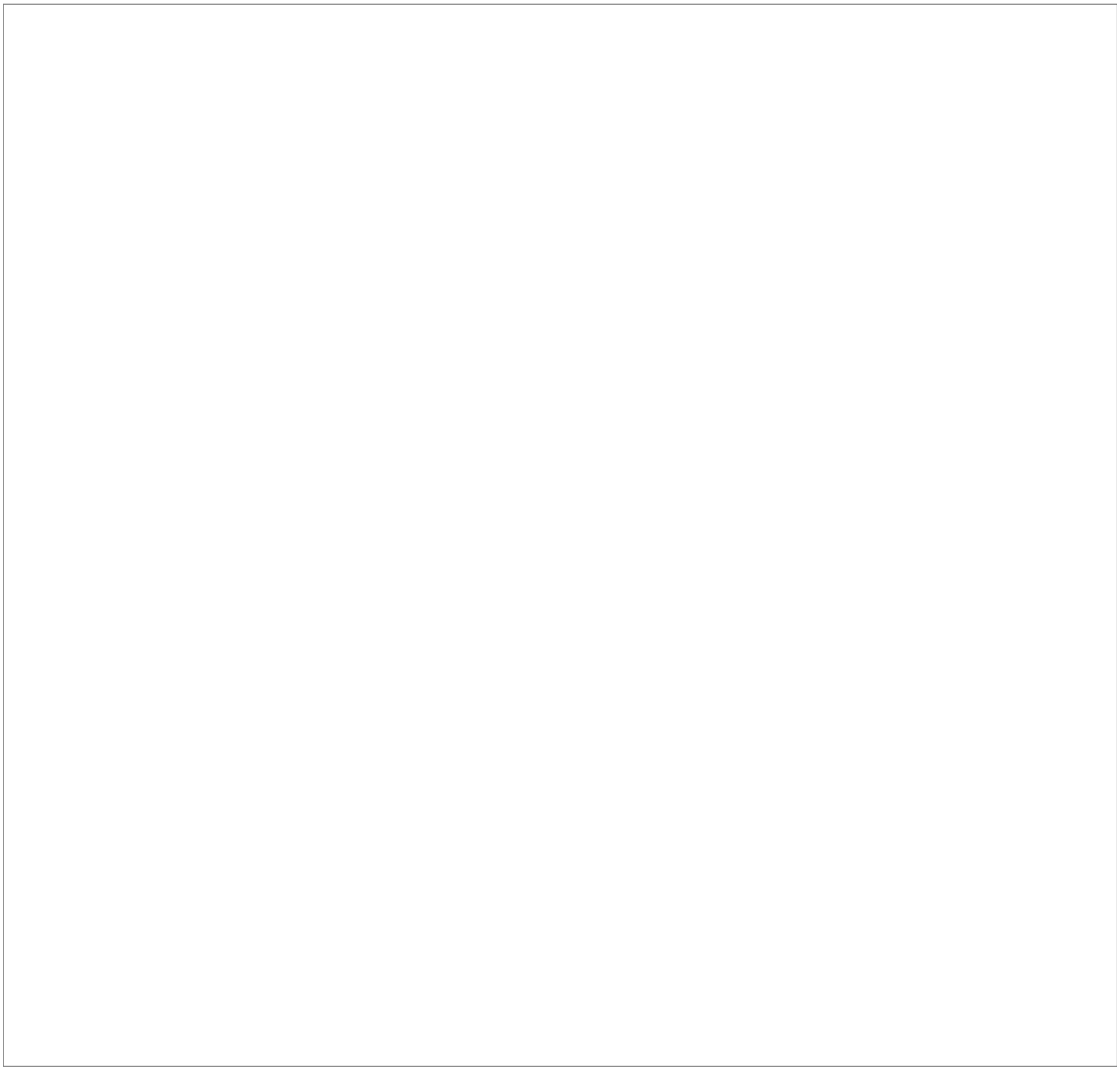
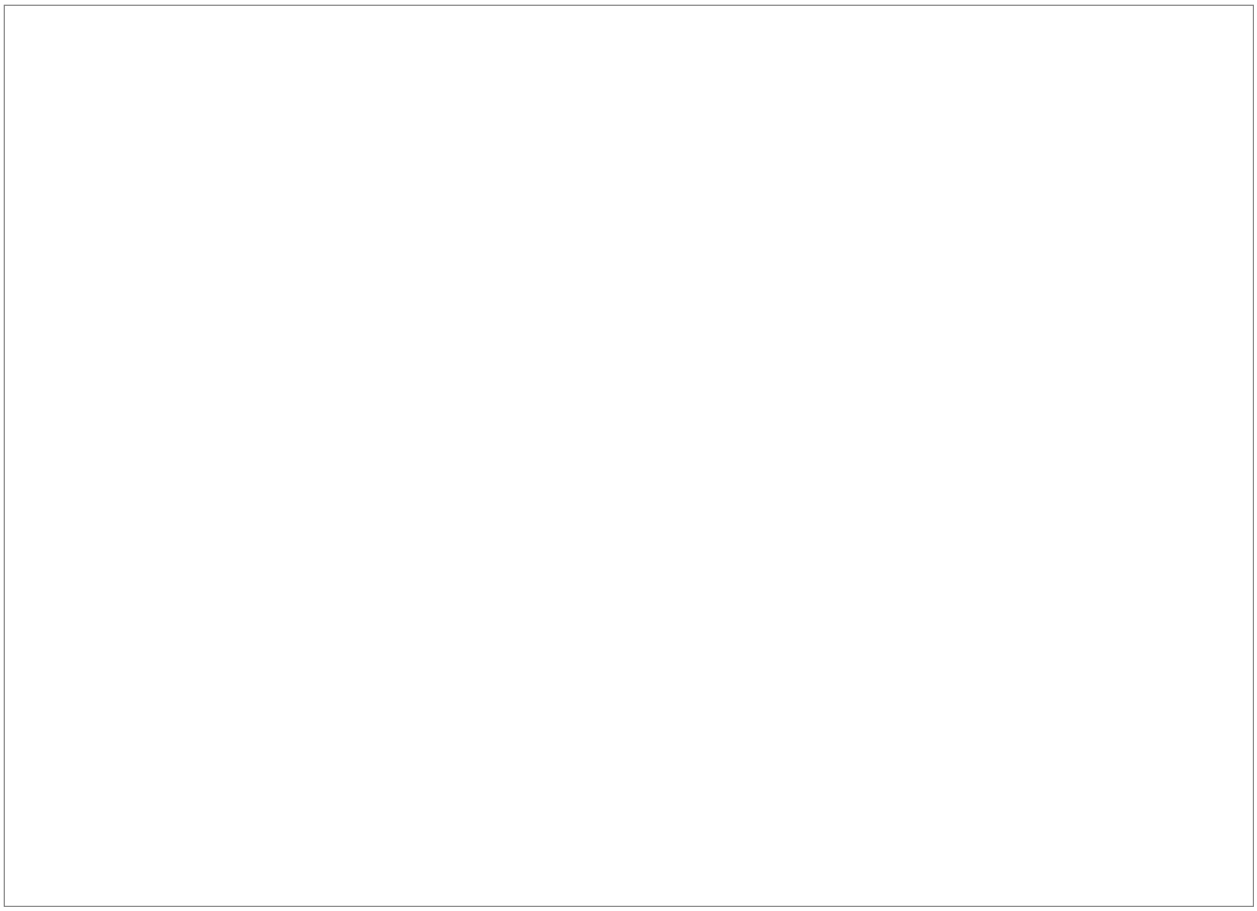


Figure 2. Example of estimated snow depth at one of our study plots. The estimation procedure is based on a four-step approach: 1) Automatic detection of snow poles in images (see example below) based on the occurrence of a maximum in the difference between the red and blue bands (V_{red}-V_{blue}) along a vertical slice through the image; 2) automatic rotation of the image to maximize the alternating minima and maxima in the V_{red}-V_{blue} signal characteristic of the alternating red and blue-grey 10-cm segments of the snow pole; 3) extracting the top and bottom positions of the visible part of the pole, convert from pixel distance to real-world distance and adjust height estimate for the rotation obtained in step 2. These three steps results in a time series of depth estimates (black and grey dots in Fig 2). To extract the representative snow depth signal from these points, the 4^{th} step consists of applying a constrained beta spline filter to the snow depth time series (green lines). This last step is necessary since the automatic approach above occasionally results in erroneous and spurious estimates.



For the Management

The results from the various work packages within the NCoE-Tundra are gradually becoming available and synthesized into a general multidisciplinary set of results. These aim to describe the potential of reindeer grazing as a climate change mitigation tool, and therefore has a very direct and explicit management implication. While our work in WP 4 focuses on the effects of grazing on the regeneration of mountain birch stands after geometrid moth outbreaks, our initial analysis of the long-standing contrast in grazing regimes between Finland and Norway provides some very crucial pieces of data showing the links between grazing, forest structure and climate feedback (albedo).

In addition, our information on the short-term effects of clear-cutting as a method for stimulating the regeneration of birch forests after moth outbreaks provides immediate input into the management strategies adopted by Finnmarkseiendommen and Fylkesmannen I Finnmark.

Published Results/Planned Publications

Karlsen, S.R., **Jepsen, J.U.,** Odland, A., Ims, R.A., Elvebakk, A. 2013. State-dependent shifts in plant communities following an insect outbreak range expansion across the birch forest-tundra ecotone in northern Fennoscandia. Oecologia, 173(3), 859-870.

Biuw, M., et al. Long-term impacts of contrasting management of large ungulates in the arctic tundra-forest ecotone: Ecosystem structure and climate feedback. – Accepted in *Ecosystems.*

Vindstad, O.P.L. et al. Numerical responses of saproxylic beetles to rapid increases in dead-wood-availability following geometrid moth outbreaks. – Submitted to PLoS One.

Communicated Results

Workshops:

- NCoE-Tundra spring meeting in Tromsø, Norway March 18-20 2013 (organizers).
- NCoE-Tundra autumn meeting in Rovaniemi, Sept 5-6 2013
- NCoE-Tundra summer meeting in Stockholm, May 23 2013
- NCoE-Tundra preparation for the Mid-term Evaluation, Stockholm, Oct 31.

Meetings with collaborators:

Meeting with collaborators in Norway (Fefo and Fylkesmannen i Finnmark), Oct 15 2013: presentation of project status 2013.

Other:

Jepsen, J.U. & Klinghardt, M. Gjenvekst av lauvmakk-skadet skog: effekt av flatehogst. Notat til skogforvaltningen i Finnmark. Okt 2013.

NINA internal seminar: (Klinghardt, Nov. 2013)

Interdisciplinary Cooperation

While the activities carried out under this specific project is purely ecological, the multidisciplinary nature of the NCoE provides a natural framework within which the results will be incorporated and made relevant in a broader societal and managerial perspective. During 2012 and 2013 we have developed a direct collaboration with climatologists involved in NCoE-Tundra WP7 to develop estimates of surface reflectance (albedo) in our field experimental areas (see Publication section above).

Budget in accordance to results

The funding obtained from the Terrestrial Flagship has allowed us to complete a full scale field season in NCoE-Tundra WP4 in 2013. Direct funding from NCoE only cover post doc salaries and some travel costs for workshops, while salaries for senior personnel and field costs are expected to be covered by other sources. During the period 2011-2013 additional support from the Terrestrial Flagship has hence been critical in order to maintain the required high level of field activity in the project.

The Fram Centre funding in 2013 has covered student salaries, field costs and researcher salary (NINA, project leader).

The approximate allocation of the funding received from the Terrestrial Flagship has been:

Indirect costs (Student salaries and field costs): 196K

Project leader salary: 204K

We refer to the budget report for the exact figures.

Could results from the project be subject for any commercial utilization

No

Conclusions

The preliminary analysis of the first data generated by the project (accepted in *Ecosystems*) have already led to the interesting finding that the long-standing (min. 50 years) difference in reindeer grazing regime across the Finnish-Norwegian border has led to systematic differences in forest structure and vegetation reflectance patterns, with Finnish plots having significantly elevated spring albedo. The implications of this will be followed up over the next few years in collaboration with climatologists from the NCoE-Tundra.

Further, the experimental setup established in NCoE-Tundra WP4 during 2011-13 will become an integral component of the Forest-Tundra module of COAT-Climate Ecological Observatory for Arctic Tundra. COAT, which is currently progressing from planning to implementation, has undergone a thorough review by an international review panel and received the highest grade possible (‘Excellence’, Nov. 2012). A revised scientific plan for COAT has recently been published (*Ims, R., Jepsen, J.U., Stien, A. & Yoccoz, N.G. (Eds) 2013. Science plan for COAT: Climate-ecological Observatory for Arctic Tundra. Fram centre Report Series No. 1. 177 pp*.).

New methods and techniques

The wildlife cameras have provided crucial information on herbivore site usage and variations in snow depth. The automatic procedure for extracting snow depth from these images could become a time saving and valuable tool to be used by this study as it becomes incorporated into the COAT system, and other COAT work packages may also benefit from these developments.