

Minutes from the ArcticBiomass Workshop in Fairbanks, Alaska and the ArcticBiomass field excursion to the Denali mountains and the Fairbanks - Circle area



The workshop in Fairbanks was arranged on September 2nd and 3rd with 21 participants. The workshop was hosted by the ArcticBiomass project and the University of Alaska - Fairbanks and included researchers from USA, Norway, Finland, UK and EU – Joint Research Centre in Italy (Figure 1). The workshop was co-arranged with NASA’s Yamal LCLUC Synthesis project “<http://lcluc.umd.edu/>” (2014-2016). The presentations covered several themes covering land- and vegetation change, climate, phenology and productivity, field sampling methods, use of UAS, upscaling and monitoring. It was decided by the project team that a special issue of Environmental Research Letters (ERL) or another peer reviewed journal should be the final result of the ArcticBiomass and a proposal for this is sent to the ERL Editorial Board for assessment and so far we have got positive response. A total of 20 papers are planned by the ArcticBiomass team members and the NASA Yamal project team.



Figure 1. Picture showing Martha Reynolds, Uma Bhatt and Skip Walker from University of Alaska – Fairbanks and Howard Epstein from University of Virginia.

The presentations from the workshop will be soon presented on a new web-page on internet, but we include abstracts from three presentations:

10:30 AM – 10:50 AM. Timo Kumpula, M. Verdonen, Marc Macias-Fauria, and Bruce Forbes: Multiscale and multispectral detection and analysis of recent landcover changes in Central Yamal peninsula Russia.

In central Yamal peninsula both natural and anthropogenic changes has occurred during the past 40 years. Mega size Bovanenkovo gas field was found in 1970's and in 2012 production began after large infrastructure construction. We have studied gas field development and natural changes like increase of shrub growth, cryogenic landslides, thawing lakes in the region. Previous multi-decadal studies across the circumpolar regions have indicated notable vegetation changes in North America, but in Eurasia observations have been somewhat ambiguous. Normalized Difference Vegetation Index (NDVI) is a widely used proxy of vegetation in global and regional remote sensing studies. A major drawback of most earlier studies has been rather coarse resolution of NDVI products (8 x 8 km grid size) that do not allow detection of land cover changes or mechanisms driving these transitions in detailed scale. Furthermore, land use changes and their effects on land cover complicate the detection of vegetation transitions signalling the impacts of warming climate. A major climate-induced vegetation change in circumpolar regions is the decrease of area of open tundra vegetation as a consequence of greening, comprised mainly of increasing density and altitudinal expansions of mountain birches and shrubs, as indicated by high NDVI. Detecting climate-induced land cover changes and separating those from short-term natural variations and land use dynamics requires combined use of various remote sensing data in different spatial and temporal scales. We study land cover changes in Yamal peninsula Russia using time series analysis of multi-source remote sensing data from the 1960's (aerial photographs, Corona, KH-9, Landsat, SPOT, ASTER Terra VNIR, Worldview-2, Terra XS DEM, Sentinel, AVHRR NDVI3g, MODIS, TerraXS) to present and upscale the results to the regional level. We are trying to estimate the accuracy of long-term NDVI (AVHRR NDVI3g, MODIS 16 day NDVI) datasets in detecting land cover and land use changes of different rates and magnitudes.

2:00 PM – 2:20 PM. Taejin Park, Jorge E. Pinzon, Compton J. Tucker, and Ranga B. Myneni: Comparative analysis of vegetation index data from AVHRR and MODIS over the boreal-Arctic regions (Figure 2)

Drastic and complex changes in the physical environment over high latitude regions have caused significant ecological impacts on Boreal/Arctic vegetation with various feedback responses. In particular, changes in vegetation phenology and productivity are the best known consequences of ecological impacts, and thus monitoring these changes may provide useful diagnostics for the impacts of climate change on terrestrial ecosystems. Here, to assess ongoing changes in vegetation phenology and productivity of the Boreal/Arctic region, we exploited the long-term AVHRR (Advanced Very High Resolution Radiometer) GIMMS (Global Inventory Modeling and Mapping Studies; 3rd generation; from 1981 to 2013) and Terra MODIS (Moderate Resolution Imaging Spectroradiometer; collection 5; from 2000 to 2013) vegetation index datasets. The robust spatiotemporal data reconstruction approach and the pheno-phase detection method were employed to accurately determine the growing season period of Boreal/Arctic vegetation using both datasets. Ultimately, we mapped circumpolar trends in a gross productivity metric of each dataset with rigorous time series analysis. Comparative analysis between the AVHRR and MODIS datasets during the years 2000 to 2013 showed the absolute and relative differences of the vegetation signal between these sensors and demonstrated which changes in the dynamics of Boreal/Arctic vegetation were consistent or inconsistent across the datasets. Additionally, we quantified and compared spatiotemporal patterns in remotely sensed vegetation phenology and productivity in the Boreal/Arctic zones of North America and Eurasia.



Figure 1. Presentation by Taejin Park, Boston University, USA.

0:10 PM – 0:40 PM. Bernt Johansen, Hans Tømmervik, Jarle Bjerke and Stein Rune Karlsen: Vegetation and ecosystem transformation due to reindeer grazing on Finnmarksvidda, Northern Norway

Reindeer herding in northern Scandinavia is associated exclusively with the Sámi people and the herding can be traced back to the historical hunting of wild reindeer. During the 15th century, entire herds were domesticated and part of the Saami people became reindeer-herding nomads. This way of life has been preserved for parts of the herding communities until today. During the past decades considerable changes have occurred in the herder's society. Since the 1960's reindeer management has been rapidly modernising followed by general socio-economical processes. The changes in the herders society is also reflected in an increased pressure on the reindeer ranges. During the past decades the lichen ground has been severely depleted. The unfortunate situation has been documented in many scientific studies. Modern technology expressed through remote sensing has made it possible to perform mapping and monitoring of the changes going on. In 2005 the authors published a survey paper describing the changes in the lichen cover for the period 1973-2000. In this

presentation the recent development of the changes will be presented. New Landsat images for the years 2006, 2009 (Landsat 5/TM) and 2013 (Landsat 8) are processed and added to the earlier presented time series. By this the oscillation of the lichen cover can be traced for a time period of forty years. Until 1980 Finnmarksvidda plateau was regarded as one of the most favourable lichen region in entire Scandinavia, where lichen communities represented more than one third of the entire landscape. In 1987 this amount was reduced to 19 percent for the winter ranges with a further decrease in 1996 (8.4 %) and 2000 (5.6 %). In 2006 a minor increase in the lichen cover (6.7 %) was recorded, with an approximate equal situation in 2009 (6.1 %). The last step of this time series shows a new degradation of the lichen cover in 2013, representing 4.0 percent of the winter region. The dramatic increase in the reindeer population, especially during the 1980's, is regarded as one of the main explanation of the problems faced today. In 1976 the reindeer number in Finnmark was estimated to 90 000 animals. In 1988 the stock of herds had increased to 210 000. During the same period the vegetation types rich in lichen were considerably reduced compared to one decade before. Damages to the vegetation surface, visible as erosion flats or erosion ridges, were reported at several localities within the spring and fall areas. Concerning current data on reindeer body-weights, reproduction rates, and mortality describes an even more discouraging picture of the today's herding. Much of a similar situation is reported from other herding areas, both in Finland and Sweden.

One of the most important presentations was held by Scott Goetz, Woods Hole Research Centre:

4:00 PM – 4:30 PM. Scott Goetz: Arctic vegetation productivity patterns & trends: How well do satellite data sets agree?

His question was: How consistent are various global satellite data NDVI patterns & trends at high northern latitudes?

The answers/conclusions were:

- The latest version of the GIMMS data set (3g) is decidedly 'greener' than the previous one (version G), especially post-1997
- SPOT and SeaWiFS products contain patterns that deviate significantly from MODIS and GIMMS data, suggesting artifacts due to sensor inconsistencies, degradation or data processing streams.
- MODIS is the "gold standard" & together with GIMMS-3g are the data sets of choice (we believe)
- Continued comparisons & assessments of NDVI data sets are needed
 - algorithm documentation needs to be easily accessible to users
 - spatio-temporal comparisons like these are somewhat limited
- Linking with scaled field observations (like biomass & productivity) is critical to more robust assessments

Martha Reynolds (University of Alaska) presented a paper concerning the strong relationship of arctic transect biomass to circumpolar NDVI, despite the many issues in sampling biomass, while Howard Epstein (Virginia University) and Skip Walker (University of Alaska) presented scaling issues and site selection. Rune Storvold (Norut) presented UAS systems while Marcel Buchorn (University of Alaska) presented methods and standards for field spectrometry in the Arctic. Jarle Bjerke presented a paper on the effects of climate change-induced plant stress on primary productivity with focus on winter warming in the Nordic

Arctic Region and in large areas the productivity was lowered in 2012. The following pages present the program and the list of participants and coauthors.

Program

ArcticBiomass Workshop, 2-3 September 2014

Venue: University of Alaska Fairbanks - Room 109 Murie Building

Workshop themes: The focus will be on biomass estimation and monitoring from plot scale to satellite. We also welcome presentations on related themes, e.g. circumpolar arctic and boreal monitoring of vegetation, UAS systems, spectrometry, etc. Each presentation: Normally 15 minutes and 5 minutes for questions but some presentations are extended.

Program

10:00 AM – 10:10 AM. Welcome to University of Alaska - Fairbanks (Martha Reynolds and Skip Walker)

10:10 AM – 10:30 AM. Hans Tømmervik, Norwegian Institute for Nature Research (NINA): Presentation of the ArcticBiomass project

Land- and vegetation change - Chair: Scott Goetz

10:30 AM – 10:50 AM. Timo Kumpula, M. Verdonen, Marc Macias-Fauria, and Bruce Forbes: Multiscale and multispectral detection and analysis of recent landcover changes in Central Yamal peninsula Russia.

Coffee 10:50 AM – 11:10 AM

Climate and productivity - Chair: Scott Goetz

11:10 AM – 11:30 AM. Colin Tucker: Projecting changes in snow, vegetation and soil processes in Arctic Alaska in response to a changing climate.

11:30 AM – 11:50 AM. Pieter Beck: Pan-Arctic climate controls on shrub growth and tundra productivity.

11:50 AM – 0:10 PM. Marc Macias-Fauria, Timo Kumpula and Bruce Forbes: Pan-Arctic quantification of the influence of sea ice on tundra productivity during the last 30 years: possible mechanisms and future prospects.

0:10 PM – 0:30 PM. Uma Bhatt: Inter- and intra-annual variability of NDVI and correlations to large-scale circulation patterns, sea ice, snow and cloud cover.

0:30 PM – 1:00 PM. Questions and comments

Lunch 1 - 2 PM

Productivity and phenology - Chair: Bruce Forbes

2:00 PM – 2:20 PM. Taejin Park, Jorge E. Pinzon, Compton J. Tucker, and Ranga B. Myneni: Comparative analysis of vegetation index data from AVHRR and MODIS over the boreal-Arctic regions

2:20 PM – 2:40 PM. Stein Rune Karlsen: MODIS and Landsat 8 based mapping of the growing season on Svalbard in relation to climate and plant production.

2:40 PM – 3:00 PM. Jarle W. Bjerke, Hans Tømmervik, Stein Rune Karlsen, Kjell Arild Høgda and Jane U. Jepsen: The effects of climate change-induced plant stress on primary productivity in the Nordic Arctic Region.

3:00 PM – 3:20 PM. Hans Tømmervik, Olav Strand, Per Fauchald, Bernt Johansen, Jarle W. Bjerke, Taejin Park, Ranga B. Myneni and Stein Rune Karlsen: Field- and satellite-based monitoring of trends in biomass of reindeer lichen heaths in Finnmarksvidda, Hardangervidda and North-America.

3:20 PM – 3:40 PM. Martha Reynolds: The strong relationship of arctic transect biomass to circumpolar NDVI, despite the many issues in sampling biomass.

Coffee 3:40 - 4:00 PM

4:00 PM – 4:30 PM. Scott Goetz: Arctic vegetation productivity patterns & trends: How well do satellite data sets agree?

4:30 PM – 4:45 PM. Hans Tømmervik: Preparation of a review paper concerning efficient biomass estimation and monitoring in the Arctic. The background is to produce a paper on improved mapping of biomass in the Arctic combining in-situ and remote sensing data. All are invited to contribute to this paper as co-authors.

4:45 PM – 5:00 PM Brief discussion.

7 PM: Dinner (all participants are invited)

Wednesday 3 September - 9 AM–1 PM: Workshop

Field sampling methods and use of UAS - Chair Rune Storvold

9:00 AM – 9:40 PM. Donald (Skip) Walker: The North America and Eurasia Arctic Transects: Overview of plot-sample methods (species-cover, environmental, soil, biomass & spectral data).

9:40 AM – 10:00 AM. Marcel Buchorn: Methods and standards for field spectrometry in the Arctic.

10:00 AM – 10:20 AM. Rune Storvold: Use of UAS in vegetation monitoring

10:20 AM- 10:40 AM: Coffee

Field sampling methods – spatial scales - monitoring - Chair: Martha Reynolds

10:40 AM – 11:10 AM. Howard Epstein: NDVI, LAI, and biomass relationships across spatial scales in arctic tundra.

11:10 AM – 11:40 AM. Eugenie Euskirchen: Measurements and modelling of leaf phenology, plant community composition, and carbon fluxes in Arctic Alaska.

11:40 AM – 00.10 AM Bruce Forbes: Ongoing reindeer herbivory and shrub growth research in northern Fennoscandia and Yamal, West Siberia

0:10 PM – 0:40 PM. Bernt Johansen, Hans Tømmervik, Jarle Bjerke and Stein Rune Karlsen: Vegetation and ecosystem transformation due to reindeer grazing on Finnmarksvidda, Northern Norway.

0:40 PM – 1:00 PM. Discussions on future work and wrapping up the workshop.

1 PM – 2 PM: Lunch

2:00 PM – 4:30 PM. Discussions on a special issue in ERL or another journal

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Field Excursion Denali – Denali Fairbanks – Circle - Yukon

A field excursion was planned to be held in the Toolik area but due to snow blizzards/storms and snow cover (depth 15 – 20 cm) on the ground we decided instead to go to the Denali mountains along the Denali Highway (Figure 3) and Denali National Parc and Preserve (3 days) and in the Fairbanks - Circle/Yukon area (2 days). During this excursion which also included people from the NASA Yamal project, methods of biomass sampling as well as up-scaling procedures from plot to satellite was discussed. On the excursion we observed similar winter wariming damage (Figures 4-6) to dwarf shrubs (*Empetrum nigrum* and *Cassiope tetragona*) as we have observed in Fennoscandia and Svalbard through the ArcticBiomass, EWWA and WiCLAP –projects.



Figure 3. From the excursion along the Denali Highway: Alaska. Bruce Forbes, Rune Storvold and Timo Kumpula.



Figure 4. Browning and damage observed on the dwarf shrub *Empetrum nigrum*. Denali Highway, Alaska.



Figure 5. Severe damage observed on the dwarf shrub Cassiope tetragona. Denali Highway, Alaska.