Adaptation to rapid land-use and climate changes on the Yamal Peninsula, Russia: Remote sensing and models for analyzing cumulative effects

2010 Annual Report to NASA

18 February 2011

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Abstract

This report summarizes the first and second year of research for the NASA-LCLUC project entitled "Adaptation to rapid land-use and climate changes on the Yamal Peninsula, Russia: Remote sensing and models for analyzing cumulative effects". The report includes summaries of field work conducted in the summers of 2009 and 2010, a project workshop in Rovaniemi, Finland in March 2010, work completed on the major components of the study, and a list of publications to date.

Study objectives and significance

Our principal goal is to develop better, more far-looking tools to predict the cumulative effects of resource development, climate-change, and traditional land use. To accomplish this we will employ a combination of analyses and models of climate/ vegetation change with social-ecological analyses.

The Yamal Peninsula in northern Russia has undergone extensive anthropogenic disturbance and transformation of vegetation cover over the past 20 years due to gas and oil development and overgrazing by the Nenets reindeer herds. It has been identified as a "hot spot" for both Arctic climate change and land-use change. The complex interactions between a rapidly changing climate, expanding resource development, and constantly evolving social, economic and political environments make it clear that more sophisticated models and approaches are needed to help in planning for the future of the Yamal. The tools developed here will also serve to examine similar changes that are occurring elsewhere in the Arctic and help the indigenous people adapt to the impending changes.

We are using remote-sensing technologies to examine how the terrain and anthropogenic factors of reindeer herding and resource development, combined with the climate variations on the Yamal Peninsula, affect the spatial and temporal patterns of vegetation change and how those changes are in turn affecting traditional herding by indigenous people of the region.

Major Accomplishments during the first two years of funding

Field work in 2009 and 2010

One of the goals of the Greening of the Arctic project is to examine the trends in vegetation, soils, permafrost characteristics and surface spectral properties along a complete Arctic transect in Russia. The transect stretches from Nadym at 65° 19' N to Krenkel Station in Franz Josef Land at 80° 38' and consists of seven study locations in all five of the Arctic bioclimate subzones and the forest-tundra transition (Fig. 1). This work is comparable to the work recently published for the North America Arctic Transect (Walker D. A. et al. 2008).

Field research was done at OstrovBelyy and Kharp in July 2009 and near the KrenkelHydro-meteorological Station in Franz Jozef Land in August 2010 (Fig. 1). Data reports from allfour NASA-GOA Russia EAT expeditions in 2008-2010 are available online at http://www.geobotany.uaf.edu/yamal/reports.

The 2010 expedition to Hayes Island in the Franz Josef Land Archipelago completed the Eurasia Arctic Transect (EAT). The 2011 Krenkel and data report presents the vegetation, remote sensing and environmental data collected in 2010 near Krenkel Station. The studies followed the same basic procedures used at the locations visited in 2007-2009. The data report includes: (1) a general description of the location and study sites with photographs, (2) maps of the study sites, study plots, and transects at each location, (3) tabular summaries of the vegetation, site factors, and soils at each relevé, (4) summaries of the Normalized Difference Vegetation Index (NDVI) and leaf area index (LAI) along each transect, (5) detailed soil descriptions and photos of the large soil pits at each study site, (6) contact information for each of the participants. The expedition also established permafrost and active-layer monitoring sites at the zonal site. The data from the permafrost studies will be presented in another report that will be included in the next annual report. The appendices to the report include: Appendix A — Names and addresses of the participants in all four expeditions; Appendix B — Plot and soil photographs from all study sites; and Appendix C —List of birds observed at Krenkel Station and along the route of the ship during 28 Jul to 2 Aug. (available at the web site: http://www.geobotany.uaf.edu/library/reports/yamal_2009_dr091212embDRAFTa.pdf. The most recent data report is attached to show the nature of these reports.

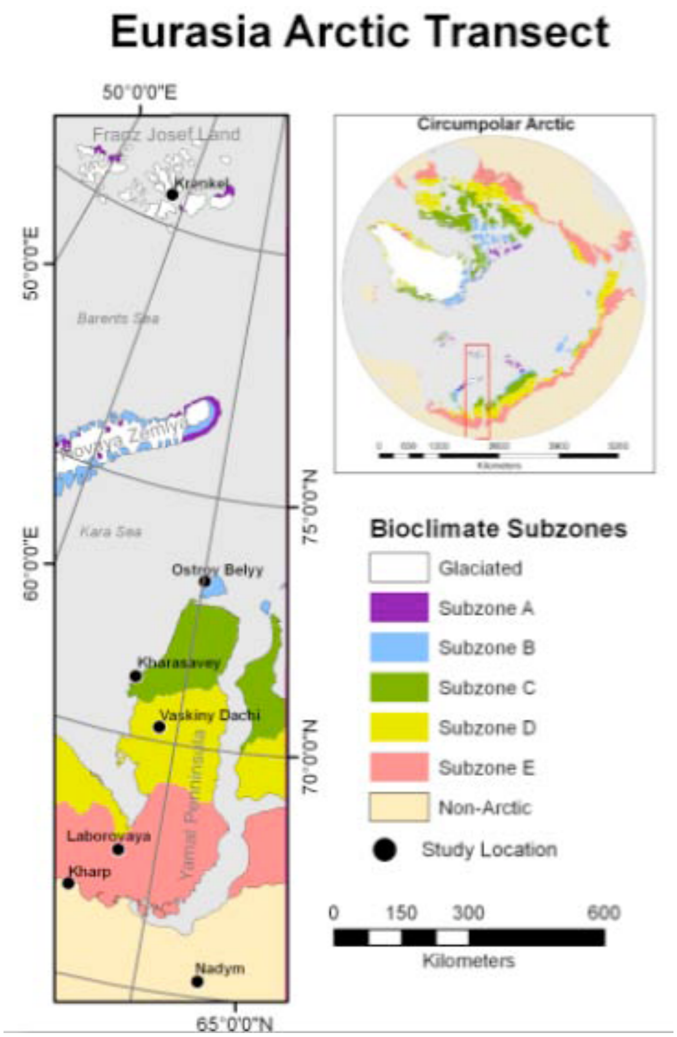

Figure 1. Eurasian Arctic Transect.Bioclimate subzones are according to CAVM Team (2003). The seven EATstudy locations are also shown.

Second Yamal Land-Cover Land-Use Change Workshop, Rovaniemi, 8-10 Mar 2010, and other conferences and workshops

The Second Yamal Land-Cover Land-Use Change Workshop was attended by 22 participantsat the Arctic Centre,Rovaniemi, Finland, 8-10 March 2010. The agenda for the meeting is on the project web site http://www.geobotany.uaf.edu/yamal/rovMtg/agenda. The overall objectives of the workshop were to (1) review the goals of the project; (2) discuss the progress of each of the individual parts of the project; (3) adjust the goals in light of new discoveries, changing funding situation, and changing personnel; (4) discuss the 2010 and 2011 summer field seasons; (5) plan new publications and research; and take advantage of the special opportunity to meet with collaborators in NASA (Joey Comiso and Jorge Pinzon). A total of 30 presentations were made at the meeting (See "Publications, Unpublished talks and posters, citations 1-30, and the Yamal LCLUC website (http://www.geobotany.uaf.edu/yamal/rovMtg/posters).

In addition, we have made presentations at several other conferences and workshops including the 2009 and 2010 LCLUC All Scientists meetings (unpublished talks and posters citations 31-43), the Fall AGU meetings in San Francisco (Dec 2009 and 2010), the State of the Arctic Meeting in Miami (Mar 2010), and the IPY Oslo Science Conference (Jun 2010).

Summaries from the each component of the project:

a. Human dimensions and analysis of shrub growth (Bruce Forbes

A major publication regarding the resilience and adaptation of the Yamal Nenets to change was published and featured on the front cover of the *Proceedings of the National Academy of Science* (Forbes et al. 2009). The Yamal peninsula encompasses a tightly integrated arctic social-ecological system (SESs). In contrast to northern Alaska and Canada, most terrestrial and aquatic components of West Siberian oil and gas fields are seasonally exploited by migratory herders, hunters, fishers, and domesticated reindeer (*Rangifer tarandus* L.). Despite anthropogenic fragmentation and transformation of a large proportion of the environment, recent socioeconomic upheaval, and pronounced climate warming, the team found the Yamal Nenets SES highly resilient according to a few key measures. The paper details the remarkable extent to which the system has successfully reorganized in response to recent shocks and evaluates the limits of the system's capacity to respond. However, expansion of infrastructure, concomitant terrestrial and freshwater ecosystem degradation, climate change, and a massive influx of workers underway present a looming threat to future resilience.

Another part of this project component examined the correspondence between the growth rings of shrub willows and the summer air temperatures in the vicinity of the Yamal Peninsula (Forbes et al. 2010). Annual ring growth of an abundant and nearly circumpolar erect willow (*Salix lanata* L.) from the coastal zone of the northwest Russian Arctic (Nenets Autonomous Okrug) were correlated with station data from numerous sites in northwestern Siberia and Europe. The resulting chronology is strongly related to summer temperature for the period 1942–2005. Remarkably high correlations occur at long distances (1600 km) across the tundra and taiga zones of West Siberia and Eastern Europe. There is a clear relationship with photosynthetic activity for upland vegetation at a regional scale for the period 1981–2005, confirming a parallel 'greening' trend reported for similarly warming North American portions of the tundra biome. The standardized growth curve suggests a significant increase in shrub willow growth over the last six decades. These findings are in line with field and remote sensing studies that have assigned a strong shrub component to the reported greening signal since the early 1980s. Furthermore, the growth trend agrees with qualitative observations by nomadic Nenets reindeer herders of recent increases in willow size in the region. The quality of the chronology as a climate proxy is exceptional. Given its wide geographic distribution and the ready preservation of wood in permafrost, *S. lanata* L. has great potential for extended temperature reconstructions in remote areas across the Arctic. These results were summarized in an invited talk at the 2010 NASA LCLUC All Scientists Meeting in Bethesda, MD (Forbes et al. 2010 unpubl.) and presented at the Fall 2010 AGU meeting in San Francisco.

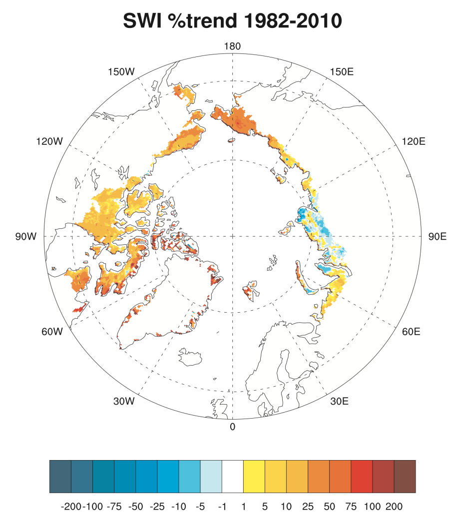

Figure 2. Percentage changes in land-surface summer warmth index (the sum of the annual mean monthly temperatures >0 ˚C (1982-2010).

b. Sea-ice, climate, land-surface temperatures, and NDVI characterization (Uma Bhatt, Skip Walker, Martha Raynolds, Jiong Jia, Howie Epstein, Jorge Pinzon, Joey Comiso).

Bhatt et al. (2010) found using satellite observations from 1982-2010 that land warming is more pronounced in North America than in Eurasia (Fig. 2) and that changes in the NDVI on land are associated with areas of greatest changes in the early-summer distribution of sea ice (Fig. 3). Changes in MaxNDVI have proceeded at a similar rate in North America and Eurasia (Fig. 4a), but there are clear differences in the rate within smaller regions. For example, MaxNDVI has increased 24% on land areas adjacent to the Beaufort Sea, but only 4% in the W. Kara Sea region (Fib. 4b).

c. Ground measurements of NDVI-LAI-Biomass (Howie Epstein, Skip Walker, G.V. Frost)

NDVI, LAI, and biomass trends have now been determined for the entire Eurasia transect. We have developed a comprehensive, synthetic dataset of field observations for vegetation and soil properties along the full bioclimate gradient in North America and Eurasia. Information from the North America transect has been accepted for publication in *Applied Vegetation Science* (Walker et al. 2011). Information from the Eurasia transect will be presented at the European Vegetation Survey Workshop in Rome, April 6-8, 2011.

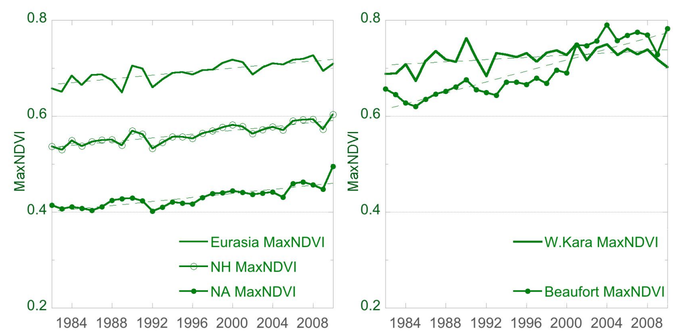

Figure 4. Percentage increases in MaxNDVI. (a for Eurasia, Northern Hemisphere and North America, and (b) land areas adjacent to the Beaufort and Kara seas (1982-2010).

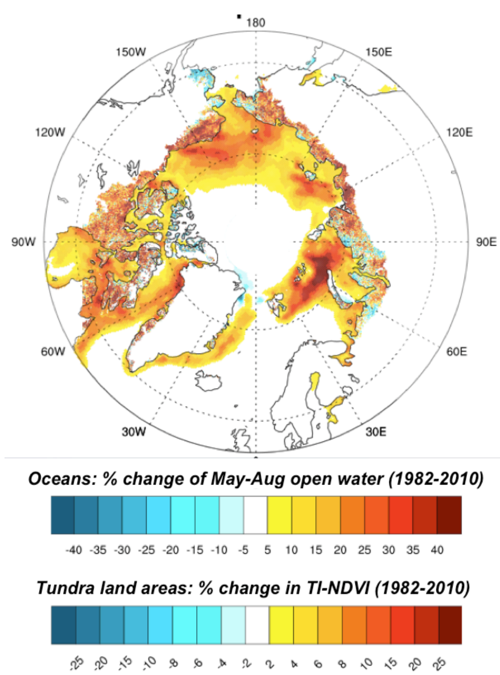

Figure 3. .Circumarctic pattern of changes in open early-summer open sea-water distribution and integrated NDVI on land portions of the Arctic (1982-210).

Among the findings is a remarkably similar relationship between zonal landscape-level aboveground biomass and AVHRR-derived NDVI along both transects (Fig. 5). However, despite the almost identical relationships between biomass and NDVI, the Eurasia transect has distinctly higher hand-held NDVI values for equivalent biomass and LAI (Fig. 6a and b). Similarly, the hand-held NDVI values are higher for equivalent AVHRR NDVI values along the EAT than along the NAAT (Fig. 6c). Most interesting is the diverging regression lines of LAI vs. biomass along the two transects, with higher LAI values along the NAAT. The differences in the trend lines are attributed to differences in plant canopy structure caused by a variety of factors including different precipitation regimes, glacial histories, soils and grazing regimes, which alter the relative proportions of different plant growth forms (Raynolds et al. 2010 in preparation,Walker et al. 2010).

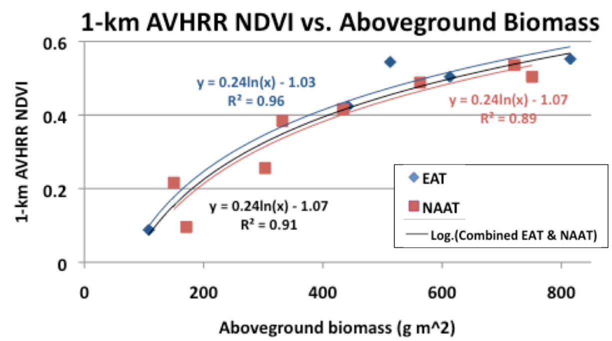

Fig. 5. Relationship between AVHRR NDVI and landscape-level zonal aboveground biomass along the North America (NAAT) and Eurasia Arctic (EAT) transects (Walker et al. 2010).

d. Modeling (Howie Epstein, Jed Kaplan, Qin Yu,)

We are using the ArcVeg arctic tundra vegetation dynamics model (Epstein et al. 2007) to simulate the combined effects of temperature increases and different grazing regimes on the tundra vegetation biomass, productivity, and species composition. In a recently published paper (Yu et al. 2009), we simulated seven sites on the Yamal Peninsula that differ in their soil organic nitrogen (SON) quantities and that are found across three different bioclimate subzones (Fig. 7). A

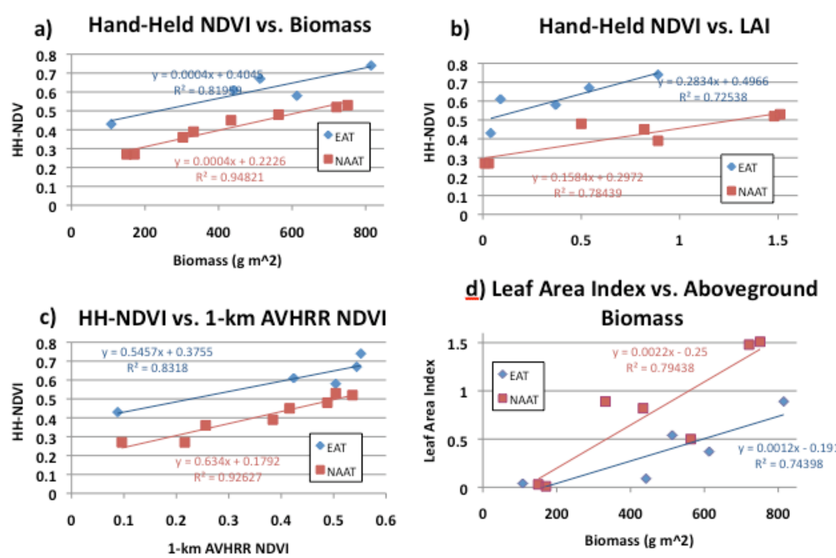

Fig. 6. Trends in ground-based meassurements of biomass and LAI vs. NDVI along the North America and Eurasia transects. (a) Hand-held (HH) NDVI vs total aboveground biomass. (b) HH NDVI vs. leaf area index. (c) HH NDVI vs. 1-km AVHRR NDVi. (d) Leaf area index vs. biomass. The distinctly different trends for the two transects reflect differences in the plant-canopy structure along the two transects.

2°C increase in temperature led to aboveground biomass increases ranging from ~150 g m^{-2} to 665 g m^{-2} depending on the subzonal climate and the SON. Increased grazing frequency from every 10 years to every 2 years, reduced the effects of climate change on tundra vegetation, yielding aboveground biomass increases ranging from ~100 g m^{-2} to ~370 g m^{-2}.

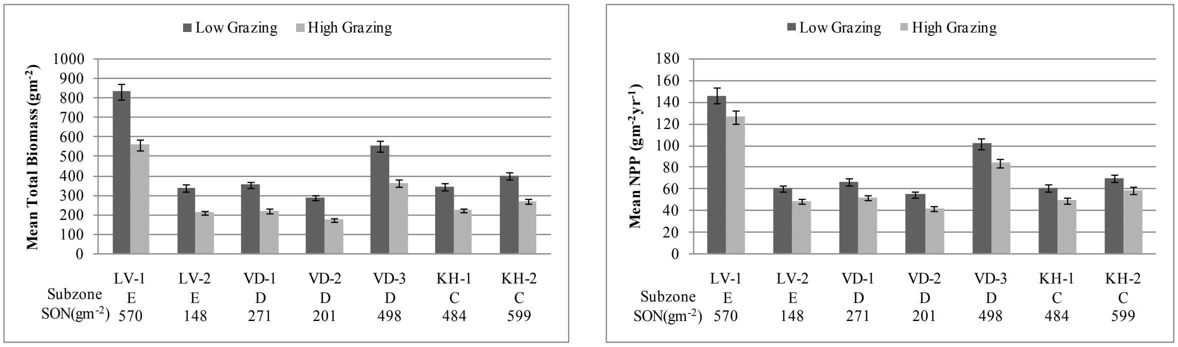

Fig. 7. Comparison of tundra biomass and net primary production (NPP) to low and high grazing regimes in three tundra subzones and different levels of soil organic nitrogen (SON). LV-1 = subzone E, loamy soil; LV-2 = subzone E, sandy soil; VD-1 = subzone D, loamy soil; VD-2, subzone D, mixed loamy and sandy soil; VD-3, subzone D, sandy soil; KH-1, subzone C, loamy soil; KH-2, subzone C, mixed loamy and sandy soil.

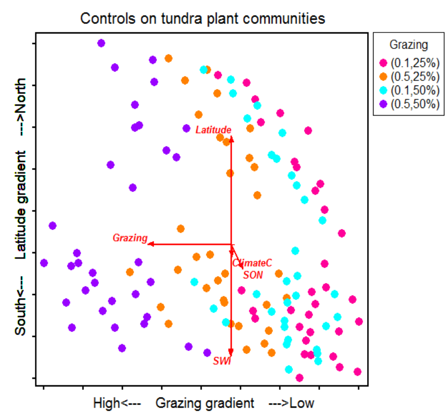

Fig. 8. NMS ordination of effects of different grazing frequency and intensity.

We have more recently used the ArcVeg model to examine in more detail the plant functional type (PFT) compositional changes in response to warming and altered grazing regimes on the Yamal Peninsula. We modified the ArcVeg model so that it was parameterized with available reindeer diet data, and grazing in the model is now a function of both foliar nitrogen concentration and plant type preferences. We simulated 11 sites on the Yamal Peninsula (subzones C-E), Belyy Ostrov (subzone B) and Hayes Island (subzone A) across a variety of SON quantities. A total of 132 simulation runs (variations of the 11 sites, three warming scenarios, and four grazing regimes) were analyzed using non-metric multi-scaling (NMS) ordination, and the results indicated that grazing can be as important as latitudinal climate gradient for controlling tundra community structure (Fig. 8). Most PFTs responded to a 2°C increase in temperature with increased biomass with a few exceptions: rushes in the High Arctic (-2%), non-vascular plants (-5%) and dwarf prostrate shrubs (-20~-10%) in the Low Arctic. (Increasing grazing frequency from every 10 years to every 2 years had a greater impact on PFT biomass than changing the annual percentage eaten from 25% to 50%, and most PFT biomass declined in response to increasing grazing intensities except for evergreen shrubs and mosses (Yu et al. in prep.).

In addition to work specific to the Yamal, we are also in the process of conducting circumpolar simulations of tundra vegetation change, using circumpolar maps of tundra subzones, soils, grazing herds, and general circulation model (GCM) output. Jed Kaplan has recently developed a module for his BIOME4 model that simulates the temporal dynamics of soil temperatures and the active layer, which we hope to link with ArcVeg (Kaplan et al. 2010). Finally, we have begun the process of developing a daily version of the ArcVeg model to simulate the effects of changing seasonality on tundra vegetation and carbon cycling. The daily version will include a daily weather generator for climates in all five subzones of both North America and Eurasia, a daily module for the mineralization of nitrogen and the growth of competing plants, empirical equations for the starts and ends of growing seasons, and seasonality of plant functional type activity as well as grazer activity.

e. Remote sensing of land use land cover change (Howie Epstein, Skip Walker, TimoKumpula, Bruce Forbes, Gerald Frost, Qin Yu, Hilmar Maier)

We have several efforts related to the remote sensing of land-use land-cover change on the Yamal Peninsula and other regions of Siberia and North America. Kumpula et al. (2011),using Quickbird, ASTER, SPOT, and Landsat imagery to examine the social and environmental impacts of development at the Bovanenkovo gas field in central Yamal on the tundra and its relation to the Nenets reindeer herders. We are continuing with this effort to use high and very high resolution satellite imagery to examine the effects of development on surface properties of the adjacent tundra, including surface temperatures, albedo, normalized difference vegetation index (NDVI) and normalized difference water index (NDWI). In addition to conducting further analyses of Bovanenkovo (Kumpula 2010, unpub.), we have expanded the scope of this effort to include gas extraction sites at Nadym and Kharasavey as well as oil development sites near Prudhoe Bay, Alaska (Yu et al. 2011 in prep., Kumpula et al. 2010unpub.; Forbes et al. 2010unpub.). We have also begun to use the Landsat Decadal Survey imagery to develop land cover change maps for the entire Yamal Peninsula, (Maier and Walker 2010a, b, unpub.).

High level pre-processing of Landsat images in the Nadym region was performed. We derived NDVI, albedo, surface temperature, NDVI for years 2007 and 1988. The composite images of differences in NDVI, albedo and either surface temperature or NDWI (Fig. 9) offer a unique approach to change evaluation and interpretation. Expanded gas facilities and new roads are detected with increased albedo. Vegetation appears to have recovered to some degree along old roads. More detailed vegetation change analysis will be based on the higher resolution image analysis.

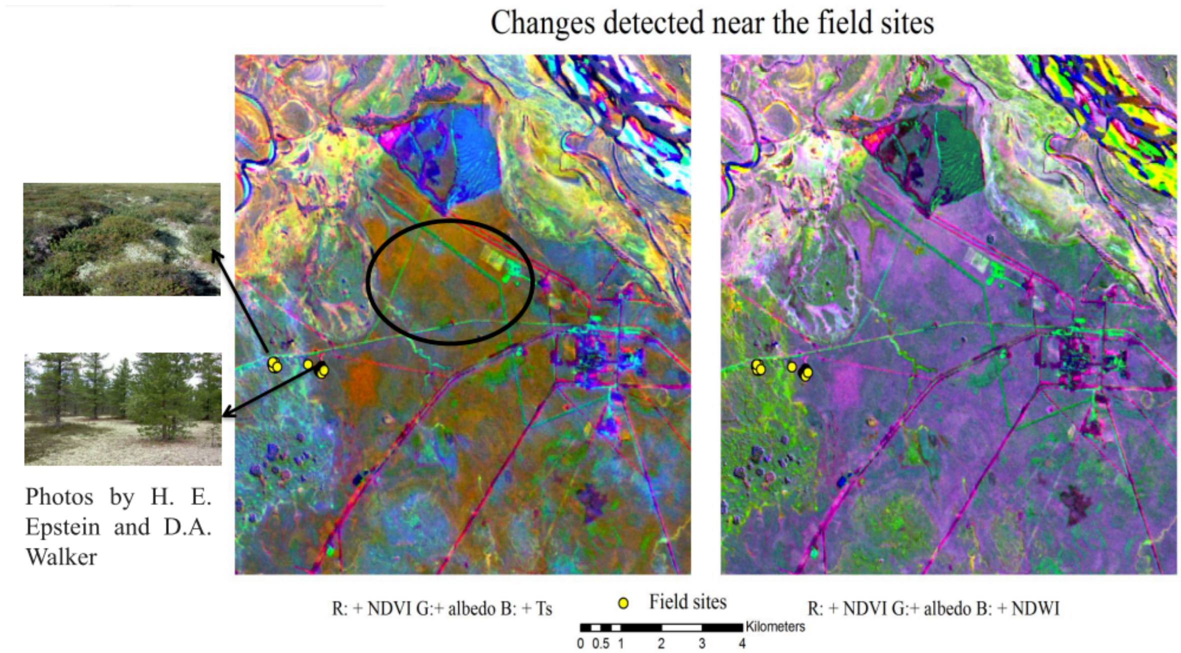

Fig. 9. Composite image of difference map based on derived NDVI, albedo, surface temperature and NDWI between year 2007 and 1988.

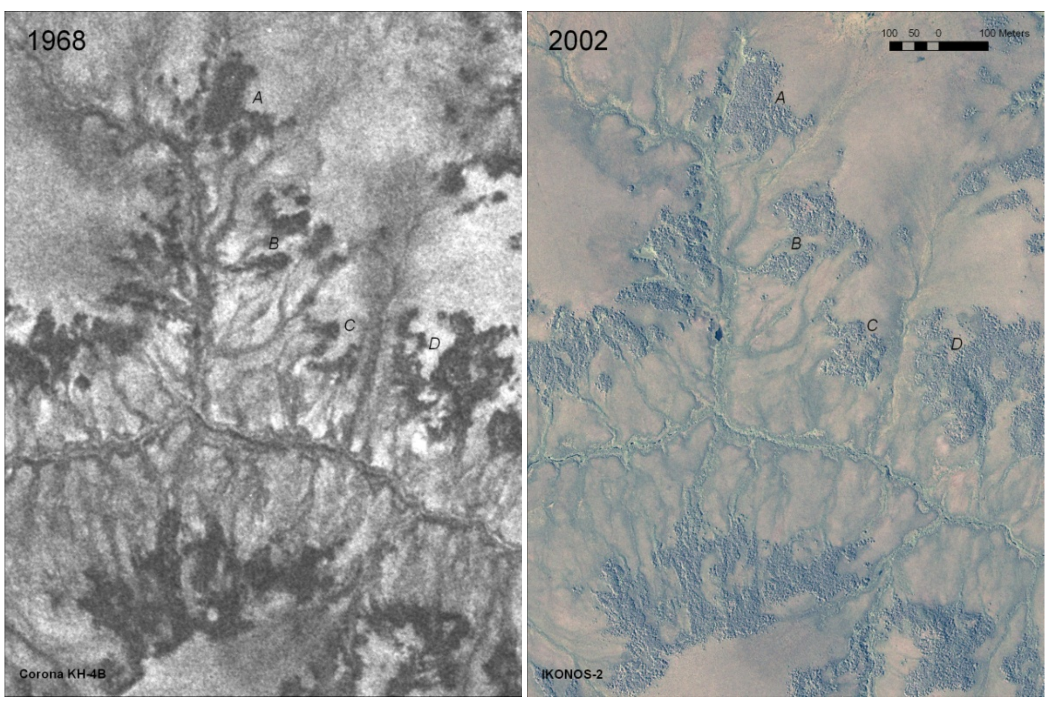

Fig. 10. Remote sensing images of the Tazovskiy Peninsula study site, ~60 km east of the southern Yamal. (Left) 1968 Corona image showing extent of alder shrublandson shallow hillslopes(most dark areas in the image). (Right) Co-registered 2002IKONOS-2 image showing infilling of alders, for examples note the areas in the vicinity of the letters A, B, C, and D.

We also are examining recent vegetation dynamics in forest-tundra ecotones across the Russian Arctic using imagery from the 1960s-era Corona high-resolution satellite missions (Frost et al.

2009, 2010). Corona images are co-registered with recent images and analyzed for changes in the extent and abundance of trees and tall shrubs. Dramatic changes in vegetation cover are evident at several sites over a ~40 year period, including two sites near the southern Yamal. On the Tazovskiy Peninsula, erosion of sandy marine deposits from shallow hillslopes has exposed clayey soils that are nutrient-rich and support highly-productive shrub vegetation (Fig. 10). The surficial geology and disturbance regime of the Tazovskiy site appears to be similar to that of the Vaskiny Dachi field site on the central Yamal, but Tazovskiy is in bioclimate subzone E and alder is a dominant shrub on landslide-affected slopes. The other site is in the foothills of the Polar Urals near the town of Kharp. We visited Kharp in summer 2009 and discovered that an old (~100 YBP), high-intensity fire probably initiated the rapid alder shrub advancement in the area. We observed that alders have established most readily on mineral soils that were exposed either by fire, or by cryogenic processes associated with small patterned-ground features (frost boils, non-sorted circles). Cryogenic disturbance is thought to lead to regularly-spaced "shrub savannas" that are common in the Low Arctic, and which up until now have not been fully explained. The fire/frost-boil/shrub savanna hypothesis is being examined in more detail by Frost as part of his Ph.D. thesis research along the Dalton Highway in Alaska, where there are extensive areas that were burned in 2007-2008, as well as at the Kharp site (planned for 2011).

In a related project looking at land cover changes in the North Slope of Alaska, we analyzed Landsat imagery over a 22-year period using the Normalized Difference Vegetation Index (NDVI) (Raynolds et al. 2010). Six Landsat scenes covering the areas of the Toolik Field Station were compared: 1985, 1989, 1995, 1999, 2004, and 2007 (TM and ETM, 30-m pixels). All scenes had minimal cloud cover and were collected during the peak of the growing season. Average NDVI of the study area increased significantly over the time period, at a rate of 0.0006 NDVI units/year, showing a 3.2% increase in NDVI over the 22 years. This was less than one-fifth the rate seen for the entire Bioclimate Subzone E on the North Slope using AVHRR data (0.0035 units/year, 1981-2001, Jia et al. 2003). This may be partly because the study area includes higher elevations and steeper slope angles in the southern portion than are characteristic of the entire Subzone E area, areas which were shown to have smaller than average increases in NDVI. Climate data during this time period (1988-2007) from within the

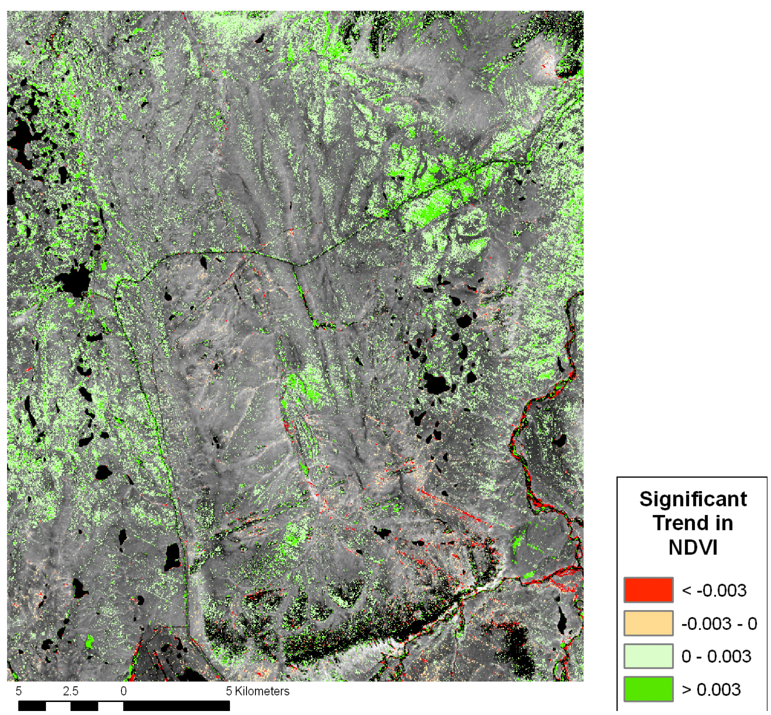

Fig. 11. Areas of significant NDVI change within the Toolik Lake Field Station region, AK (1985-2007). Most o the change has occurred on younger glacial surfaces, and in areas of disturbance, including areas with massive ground ice. Raynolds et al. 2010)

study area show no local increase in temperature, an increase in total precipitation, and increased variability between years (Wahren et al. 2005). The strongest increases in NDVI were on revegetating abandoned gravel pads and material pits, and stabilizing river terraces. The strongest decreases in NDVI were on eroding river terraces and new gravel pits. General greening occurred along the Dalton Highway. Field work is planned for 2011 to collect ground data from areas with large changes in NDVI.

Plan for 2011 field seasons

The project will complete field work along the Eurasian transect in summer 2011, with an intensive study of azonal habitats at Vaskiny Dachi in the central Yamal Peninsula. We will examine the shrub vegetation, lichen heathlands, and a wetland to help in the remote sensing interpretations of the peninsula and to examine disturbed habitats. We will also have a study in the Bovanenkovo gas field to update the extent of land-use changes during the past few years. We will also spend a week in the field at the Kharp site to elucidate the relationship between post-1968 shrub expansion and disturbance at the landscape-scale (fire) and the meter-scale (cryogenic processes).

Publications (includes publications from the first round of funding)

2011

Goetz, S.J., Epstein, H.E., Alcaraz, J.D., et al. 2011. Recent changes in Arctic vegetation: Satellite observations and simulation model predictions. *Eurasian Arctic Land Cover and Land Use in a Changing Climate*. Springer. New York.VI pp. 9-36. PDF

Khitun, O.V., Ermokhina, K.A., Leibman, M.O., Khomutov, A.V. 2011. Plant species indicating the depth of active layer on the Bely Island. *Fourth Russian Conference on Geocryology, Moscow, Russia, June 7-9*.

Leibman, M.O., Moskalenko, N.G., Orekov, P.T., et al. 2011. Interaction of cryogenic and biotic components in cryolithozone of the West Siberia along the Yamal transect. *Polar cryosphere and hydrosphere of the Land*. 3.

Walker, D.A., Forbes, B.C., Leibman, M.O., et al. 2011. Cumulative effects of rapid land-cover and land-use changes on the Yamal Peninsula, Russia. *Eurasian Arctic Land Cover and Land Use in a Changing Climate*. Springer. New York.VI pp. 206-236. PDF

2010

Alcaraz, J.D., Cabello, J., Epstein, H.E., Jia, G.J. 2010. Trends in the surface vegetation dynamics of the tundra and taiga network of protected areas in Eurasia as observed by satellite sensors. *in prep.*.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Role of atmospheric processes in trends and variability of sea-ice, land-surface temperatures, and tundra vegetation greenness in Alaska. *submitted to Atmospheric Research*.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Circumpolar Arctic tundra vegetation change is linked to sea-ice decline. *Earth Interactions*. 14:(8):1-20. PDF

Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2010. Vegetation and soil attributes along two latitudinal temperature gradients in arctic tundra. *submitted to Ecology*.

Forbes, B.C., Fauria, M.M., Zetterberg, P. 2010. Russian Arctic warming and 'greening' are closely tracked by tundra shrub willows. *Global Change Biology*. 16:1542-1554. PDF

Forbes, B.C., Fauria, M.M., Zetterberg, P., Kumpula, T. 2010. Deciduous shrub growth and the greening of the Arctic in West Siberia. Abstract GC53B-08, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

Forbes BC, Stammler F. 2009. Arctic climate change discourse: the contrasting politics of research agendas in the West and Russia. *Polar Research* 28: 28–42.

Frost, G.V., Epstein, H.E., Walker, D.A., et al. 2010. Spatio-temporal trends in vegetation structure and NDVI in Low Arctic northwest Siberia: evidence from the satellite record and ground observations. Abstract GC54A-03, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

Gould, W.A., Gonzalez, G., Walker, D.A., Ping, C.L. 2010. Commentary. Integrating research, education, and traditional knowledge in ecology: a case study of biocomplexity in Arctic ecosystems. *Arctic, Antarctic and*

Alpine Research. 42:(4):379-384. PDF
Gubarkov, A.A., Leibman, M.O. 2010. Bead-shaped channel forms as an evidence of paragenesis of cryogenic and hydrological processes in the small-river valleys of Central Yamal. *Earth Cryosphere*. 14:(1):41-49.
Kumpula, T., Forbes, B.C., Stammler, F. 2010. Remote sensing and local knowledge of hydrocarbon exploitation: the case of Bovanenkovo, Yamal Peninsula, West Siberia, Russia. *Arctic*. 63:(2):165-178.
Kumpula, T., A. Pajunen, E.M. Kaarlejärvi, B.C. Forbes, and F. Stammler (2011). Land use and land cover change in arctic Russia: ecological and social implications of a state shift from shrub- to graminoid-dominated tundra. *Global Environmental Change* doi:10.1016/j.gloenvcha.2010.12.010.
Pinzon, J.E., Raynolds, M.K., Pak, E.W., et al. 2010. NDVI3g: a consistent long term vegetation index data set optimized for polar trend analysis. *Geoscience and Remote Sensing Letters*.
Raynolds, M.K., Huettmann, F., Walker, D.A., Verbyla, D. 2010. Environmental controls of the distribution of circum-Arctic vegetation. *Ecography*.
Raynolds, M.K., Walker, D.A., Verbyla, D., Munger, C.A. 2010. Changes in tundra vegetation over 25 years as measured by Landsat NDVI in the Upper Kuparuk River Basin, North Slope Alaska, 1985-2009. Abstract GC43B-0984, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF
Talbot, S.S., Walker, D.A. 2010. Circumboreal Vegetation Mapping (CBVM) Project: Introduction and objectives. *Proceedings of the Fifth International Workshop: Conservation of Arctic Flora and Fauna (CAFF) Flora Group*. International Secretariat, CAFF Flora Expert Group (CFG). Helsinki, Finland. pp..
Walker, D.A. 2010. A Vegetation map of arctic tundra and boreal forest regions: Integrating the CAVM with the Circumboreal Vegetation Map. *Proceedings of the Fifth International Workshop: Conservation of Arctic Flora and Fauna (CAFF) Flora Group*. International Secretariat, CAFF Flora Expert Group (CFG). Helsinki, Finland. pp..
Walker, D.A. 2010. Greening of the Arctic: Spatial and temporal (1982-2009) variation of circumpolar tundra NDVI and aboveground biomass. Abstract GC53B-01, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF
Walker, D.A., Bhatt, U.S., Comiso, J.C., et al. 2010. e. Land l) Vegetation. *Special Supplement to Bulletin of the American Meteorological Society*. 91:S115-S116.
Walker, D.A., Epstein, H.E., Frost, G.V., Raynolds, M.K. 2010. Vegetation and environmental factors along a 900-km Arctic bioclimate transect on the Yamal Peninsula, Russia. *submitted to Journal of Applied Vegetation Science*.
Walker, D.A., Epstein, H.E., Kade, A.N., et al. 2010. Vegetation of zonal patterned-ground ecosystems along the North America Arctic Transect. *Applied Vegetation Science*.
Yu, Q., Epstein, H.E., Walker, D.A., Frost, G.V. 2010. Modeling dynamics of tundra plant communities on the Yamal Peninsula. Abstract GC54A-04, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

2009

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2009. Seasonality of the air-sea-ice-land environment of Arctic tundra in Northern Eurasia and North America. Abstract GC31A-0701, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0701. PDF
Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2009. Vegetation biomass, leaf area index, and NDVI patterns and relationships along two latitudinal transects in arctic tundra. Abstract GC31A-0697, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0697. PDF
Forbes, B.C., Stammler, F., Kumpula, T., et al. 2009. High resilience in the Yamal-Nenets social-ecological system, west Siberian Arctic, Russia. *Proc. Natl. Acad. Sci.*. 106:22041-22048. PDF
Frost, G.V., Epstein, H.E., Walker, D.A. 2009. Spatio-temporal trends in tree and tall shrub cover in the Eurasian Low Arctic: evidence from 1960s and contemporary satellite imagery and ground observations. Abstract GC31A-0698, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0698. PDF
Groisman, P.Y., Clark, E.A., Kattsov, V.M., et al. 2009. The Northern Eurasia Earth Science Partnership: An example of Science Applied to Societal Needs. *Bulletin of the American Meteorological Society*. 90:671-688. PDF
Jennings, M.D., Faber-Langendoen, D., Loucks, O.L., et al. 2009. Standards for associations and alliances of the U.S. National Vegetation Classification. *Ecological Monographs*. 79:173-199.
Jia, G.J., Epstein, H.E., Walker, D.A. 2009. Vegetation greening in the Canadian Arctic related to decadal warming. *Journal of Environmental Monitoring*. 11:2231-2238.
Kataoka, M. 2009. ESRI Map Book, Volume 24. *ESRI Map Book*. 24:(24):120. PDF
Kelley, A.M., Epstein, H.E. 2009. Effects of nitrogen fertilization on plant communities of nonsorted circles in

moist nonacidic tundra, Northern Alaska. *Arctic, Antarctic, and Alpine Research*. 41:(1):119-127. PDF
Khomutov, A.V., Leibman, M.O., Moskalenko, N.G., et al. 2009. Numerical characteristics of vegetation and their influence on active layer depth. *International Workshop on the results of IPY, Sochi, Krasnodar Krai, Russia, 28 September - 1 October*. 81-82.
Leibman, M.O., Khomutov, A.V. 2009. Environmental controls of the thaw depth and rate of thaw under climate fluctuations. *Association of American Geographers Annual Meeting, Las Vegas, NV, March 22-27*. PDF
Leibman, M.O., Ukraintseva, N.K. 2009. Mechanisms and geoecological consequences of cryogenic landslides in the area of marine sedimentation. Abstract EGU2009-3980, presented at *European Geosciences Union General Assembly 2009, Vienna, Austria, April 19-24*. 11:EGU2009-3980.
Raynolds, M.K., Walker, D.A. 2009. Effects of deglaciation on circumpolar distribution of arctic vegetation. *Canadian Journal of Remote Sensing*. 35:(2):118-129. PDF
Sappington, N. 2009. ESRI Map Book, Volume 20. *ESRI Map Book*. 20:(20):120. PDF
Walker, D.A., Bhatt, U.S., Epstein, H.E., et al. 2009. Circumpolar Arctic greening: Relationships to summer sea-ice concentrations, land temperatures and disturbance regimes. Abstract GC43B-08, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC43B-08. PDF
Walker, D.A., Bhatt, U.S., Epstein, H.E., et al. 2009. Circumpolar Arctic greening: Relationships to summer sea-ice concentrations, land temperatures and disturbance regimes. Abstract GC43B-08, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC43B-08. PDF
Walker, D.A., Bhatt, U.S., Raynolds, M.K., et al. 2009. Vegetation. *Arctic Report Card 2008*. 3. PDF
Walker, D.A., Bhatt, U.S., Raynolds, M.K., et al. 2009. The Arctic: Land: Vegetation. *State of the Climate in 2008*. 90 pp. S104-S105.
Walker, D.A., Hamilton, T.D., Ping, C.-L., et al. 2009. Dalton Highway Field Trip Guide for the Ninth International Conference on Permafrost. *Division of Geological and Geophysical Surveys. Fairbanks, AK. 9: pp: 117*. PDF
Walker, D.A., Leibman, M.O., Epstein, H.E., et al. 2009. Spatial and temporal patterns of greenness on the Yamal Peninsula, Russia: interactions of ecological and social factors affecting the Arctic normalized difference vegetation index. *Environmental Research Letters*. 4:16. PDF
Walker, D.A., Raynolds, M.K., Maier, H.A., et al. 2009. Circumpolar geobotanical mapping: a web-based plant-to-planet approach for vegetation-change analysis in the Arctic. *Mapping and Monitoring of Nordic Vegetation and Landscapes, Hveragerði, Iceland, 16-18 September*. 4. PDF
Yu, Q., Epstein, H.E., Walker, D.A. 2009. Simulating soil organic nitrogen and grazing effects on arctic vegetation dynamics on the Yamal Peninsula, Russia. *Environmental Research Letters*. 4:(4). PDF
Yu, Q., Epstein, H.E., Walker, D.A. 2009. Simulating soil organic nitrogen and grazing effects on arctic tundra vegetation dynamics on the Yamal Peninsula, Russia. Abstract GC31A-0693, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0693.

2008

Bhatt, U.S., Walker, D.A., Raynolds, M., Comiso, J. 2008. Examining relationships between sea ice and Arctic vegetation on the Pan-Arctic, regional and site scales. Abstract EGU2008-A-11271, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, 13 -18 April*. 10:EGU2008-A-11271.
Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2008. Application of Space-based Technologies and Models to Address Land-cover/Land-use Change Problems on the Yamal Peninsula, Russia: Circumpolar and regional analysis of the relationship between sea-ice variability, summer land-surface temperatures, Arctic t. *NASA Carbon Cycle and Ecosystems Joint Science Workshop, Adelphi, MD, April 28 - May 2*. PDF
Brown, J., Romanovsky, V.E. 2008. Report from the International Permafrost Association: State of Permafrost in the First Decade of the 21st Century, Permafrost and Periglacial Processes. *Permafrost and Periglacial Processes*. 19:(2):255-260.
Comiso, J.C., Nishio, F. 2008. Trends in the sea ice cover using enhanced and compatible AMSR-E,SSM/I, and SMMR data. *Journal of Geophysical Research*. 113:C02S07. PDF
Comiso, J.C., Parkinson, C.L., Gersten, R., Stock, L. 2008. Accelerated decline in the Arctic sea ice cover. *Geophysical Research Letters*. 35:L01703. PDF
Cook, B., Bonan, G., Levis, S., Epstein, H. 2008. Rapid vegetation responses and feedbacks amplify climate model response to snow cover changes. *Climate Dynamics*. 30:(4):391-406. PDF
Cook, B.I., Bonan, G.B., Levis, S., Epstein, H.E. 2008. The thermoinsulation effect of snow cover within a climate model. *Climate Dynamics*. 31:(1):107-124. PDF
Epstein, H.E., Walker, D.A., Kuss, P., Karlejaärvi, E. 2008. Tundra vegetation properties along a latitudinal gradient of the Yamal Region of Russia. *NASA Carbon Cycle and Ecosystems Joint Science Workshop, Adelphi, MD, April 28 - May 2*.

Epstein, H.E., Walker, D.A., Kuss, P., et al. 2008. Ecosystem Properties along a Latitudinal Gradient of the Yamal Region, Russia. Abstract EGU2008-A-04406, presented at *European Geosciences Union General Assembly, Vienna, Austria, 13 - 18 April*. 10:EGU2008-A-04406. PDF

Forbes, B.C. 2008. Equity, vulnerability and resilience in social-ecological systems: a contemporary example from the Russian Arctic. *Research in Social Problems and Public Policy*. 15:203-236.

Gubarkov, A.A., Leibman, M.O. 2008. Interrelation of Cryogenic and Hydrologic Processes on Small Streams and Catchments of Central Yamal. *Ninth International Conference on Permafrost, Fairbanks, AK, June 29 - July 3*.

Gubarkov, A.A., Leibman, M.O. 2008. Influence of cryogenic landforms on the types of runoff within the Central Yamal river basins (VaskinyDachi research polygon). *Cryogenic resources of the Polar and Mountainous regions: State and prospects of engineering geocryology, Tyumen, Russia, April 21-24*.

Jia, G.J., Epstein, H.E., Walker, D.A., Wang, H. 2008. Decadal changes of phenological patterns over arctic tundra biome. Abstract C21C-0559, presented at *AGU Fall Meeting, San Francisco, CA, Dec. 15-19*. 89:C21C-0559. PDF

Leibman, M.O., Epstein, H.E., Khomutov, A.V., et al. 2008. Relation of active layer depth to vegetation on the central Yamal Peninsula, Russia. *Ninth International Conference on Permafrost, Fairbanks, AK, June 29-July 3*. Extended Abstracts:177-178. PDF

Raynolds, M.K., Comiso, J.C., Walker, D.A., Verbyla, D. 2008. Relationship between satellite-derived land surface temperatures, arctic vegetation types, and NDVI. *Remote Sensing of Environment*. 112:(4):1884-1894. PDF

Raynolds, M.K., Walker, D.A. 2008. Circumpolar relationships between permafrost characteristics, NDVI, and arctic vegetation types. *Ninth International Conference on Permafrost, Fairbanks, AK, June 29-July 3*. 2:1469-1474. PDF

Romanovsky, V.E., Kholodov, A.L., Marchenko, S.S., et al. 2008. Thermal state and fate of permafrost in Russia: First results of IPY. *Ninth International Conference on Permafrost, Fairbanks, AK, June 28-July3*. 2:1511-1518. PDF

Vasiliev, A.A., Leibman, M.O., Moskalenko, N.G. 2008. Active Layer Monitoring in West Siberia under the CALM II Program // Permafrost. *Ninth International Conference on Permafrost, Fairbanks, AK, June 29-July 3*. 2:1815-1820.

Walker, D.A., Bhatt, U.S., Epstein, H.E. 2008. Greening of the Arctic: an IPY Initiative. Abstract U23F-05 INVITED, presented at *AGU Fall Meeting, San Francisco, CA, December 12-15*. 89:1. PDF

Walker, D.A., Bhatt, U.S., Romanovsky, V.E., et al. 2008. Application of space-based technologies and models to address land-cover/land-use change problems on the Yamal Peninsula, Russia. Abstract EGU2008-A-05697, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, April 13-18*. 10:EGU2008-A-05697. PDF

Walker, D.A., Leibman, M.O., Forbes, B.C., Epstein, H.E. 2008. Cumulative effects of rapid climate and land-use changes on the Yamal Peninsula, Russia. Abstract GC52A-07, presented at *AGU Fall Meeting, San Francisco, CA, December 15-19*. 89:GC52A-07. PDF

Yu, Q., Epstein, H.E. 2008. Evaluating Arctic tundra system resilience to grazing disturbances: A modeling approach. Abstract EGU2008-A-12154, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, 13 - 18 April*. 10:EGU2008-A-12154. PDF

2007

Alcaraz, D., Chuvieco, E., Epstein, H. 2007. Temporal trends in post-fire regeneration patterns of boreal forests using 1km AVHRR NDVI. Abstract B11D-0777, presented at *AGU Fall Meeting, San Francisco, CA, December 10-14*. 88:5.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2007. The relationship between sea ice variability and arctic tundra on the pan-Arctic, regional, and site scales. Abstract U42C-0612, presented at *AGU Fall Meeting, San Francisco, CA, December 10*. 88:5.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2007. Influence of Regional Sea Ice Variability on Arctic Tundra. *Seventh International Conference on Global Change: Connection to the Arctic, Fairbanks, Alaska, February 19-20*. 76-78. PDF

Cook, B.I., Bonan, G.B., Levis, S., Epstein, H.E. 2007. Dynamic vegetation amplifies climate model response to snow cover changes. *Climate Dynamics* .

Epstein, H.E., Yu, Q., Kaplan, J.O., Lischke, H. 2007. Simulating future changes in arctic and subarctic vegetation. *Computing in Science and Engineering*. 9:(4):12-23. PDF

Jia, G.J., Epstein, H.E., Walker, D.A. 2007. Trends of Vegetation Greenness in the Arctic from 1982-2005. Abstract B21A-0041, presented at *AGU Fall Meeting, San Francisco, CA, December 10-14*. 88:5. PDF

Stammler, F., Forbes, B.C. 2007. Declaration on coexistence of oil & gas activities and indigenous communities on

Nenets and other territories in the Russian North. *Symposium on Oil and Gas Development in NAO and YNAO, Rovaniemi, Finland, 10-11 December*. PDF

Ukraintseva, N.G., Leibman, M.O. 2007. The effect of cryogenic landslides (active-layer detachments) on fertility of tundra soils on Yamal peninsula, Russia. *1st North American Landslide Conference, Vail, CO, June 3-8*. 1605-1615. PDF

Walker, D.A. 2007. The Circumpolar Arctic Vegetation Map, the Alaska Arctic Tundra Vegetation Map, and the Arctic Geobotanical Atlas. *Proceedings of the Fourth International CAFF Flora Group Workshop, Tórshavn, Faroe Islands, May 5-17*. 60-62. PDF

vanBogaert, R., Walker, D.A., Jia, G.J., et al. 2007. Recent changes in vegetation. *Arctic Report Card 2007*. 8. PDF

2006

Comiso, J.C. 2006. Arctic warming signals from satellite observations. *Weather*. 61:(3):70-76. PDF

Cook, B.I., Bonan, G.B., Levis, S., et al. 2006. Amplification of climate model response to snow cover fraction parameterization through dynamic vegetation. Abstract C21C-1181, presented at *AGU Fall Meeting, San Francisco, CA, December 11-15*. 87:C21C-1181.

Jia, G.J., Epstein, H.E., Walker, D.A. 2006. Spatial heterogeneity of tundra vegetation response to recent temperature changes. *Global Change Biology*. 12:42-55. PDF

Jia, G.J., Epstein, H.E., Walker, D.A. 2006. Decadal changes of vegetation greenness in the Canadian Arctic.Abstract C51A-0383, presented at *AGU Fall Meeting, San Francisco, CA, December 11-15*. 87:C51A-0383.

Kumpula, T., Forbes, B.C., Stammler, F. 2006. Combining data from satellite images and reindeer herders in arctic petroleum development: the case of Yamal, West Siberia. *Nordia Geographical Publications*. 35:(2):17-30. PDF

Raynolds, M.K., Walker, D.A. 2006. Satellite land surface temperatures and tundra vegetation. *Arctic Science Conference, Fairbanks, AK, October 2-4*. 55.

Raynolds, M.K., Walker, D.A., Kade, A.N., et al. 2006. Aboveground Phytomass of Vegetation Communities Along an Arctic Climate Gradient. Abstract C51A-0385, presented at *AGU Fall Meeting, San Francisco, CA, December 11-15*. 87:C51A-0385.

Raynolds, M.K., Walker, D.A., Maier, H.A. 2006. NDVI patterns and phytomass distribution in the circumpolar Arctic. *Remote Sensing of Environment*. 102:271-281. PDF

Talks (without published abstracts):

2010

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Climatology and Seasonality of the ice-ocean-atmosphere-terrestrial system on the Yamal. *Presented at: Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Circumpolar arctic tundra vegetation change is linked to sea-ice decline. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March-2 April*.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Circumpolar Arctic tundra vegetation change is linked to sea-ice decline. *Presented at: State of the Arctic Meeting Miami, Fl March 16-19*. PDF

Comiso, J.C. 2010. State of the Cryosphere in the Arctic. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Drozdov, D.S., Grechichshev, S.E., Malkova, G.V., Korostelev, Y.V. 2010. Yamal Peninsula maps and GIS information. Update on ECI activities and permafrost research on the Yamal. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland 8-10 March 2010*. PDF

Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2010. Vegetation biomass, leaf area index, and NDVI patterns and relationships along two latitudinal transects in Arctic tundra. *Presented at: State of the Arctic Miami, FL 16-19 March*. PDF

Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2010. Vegetation biomass, leaf area index, and NDVI patterns and relationships along two latitudinal transects in arctic tundra. *Presented at: IPY Oslo Science Conference Oslo, Norway 8-12 Jun*.

Forbes, B.C., Fauria, M.M., Zetterberg, P., Kumpula, T. 2010. Deciduous shrub growth and the greening of the Arctic in West Siberia. Abstract GC53B-08, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

Forbes, B.C., Murray, M.S., Walker, D.A. 2010. Human dimensions of land-cover and land-use change in the Arctic with a focus on the Yamal Peninsula, Russia. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD April 20-22*. PDF

Forbes, B.C., Stammler, F., Kumpula, T., et al. 2010. High resilience in the Yamal-Nenets social-ecological System, west Siberian Arctic, Russia. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Frost, G.V., Epstein, H.E., Walker, D.A. 2010. Summary of 2009 field observations and proposed 2010 study plan for Kharp study site, northwest Siberia. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Frost, G.V., Epstein, H.E., Walker, D.A., et al. 2010. Spatio-temporal trends in vegetation structure and NDVI in Low Arctic northwest Siberia: evidence from the satellite record and ground observations. Abstract GC54A-03, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

Gubarkov, A. 2010. Issues of Yamal Peninsula gas fields development. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Heim, B., Bartsch, A., Boike, J., Hubberten, H.-W. 2010. DUE Permafrost: a spaceborne permafrost monitoring and information system. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Jia, G.J., Hu, Y., Wang, H., et al. 2010. Greening and Seasonality: Multi-scale Approaches. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland 8-10 March 2010*. PDF

Kaplan, J.O., Melton, J.R., Pfeiffer, M., Collins, P.M. 2010. Large-scale dynamic modeling of soil-vegetation interactions. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*.

Khitun, O.V., Moskalenko, N.G. 2010. Summary of Yamal vegetation and flora. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Khomutov, A.V., Leibman, M.O. 2010. Landscape pattern and cryogenic landsliding hazard analysis at VaskinyDachi, Central Yamal. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*.

Khomutov, A.V., Leibman, M.O., Epstein, H.E. 2010. Relation between active-layer depth, NDVI and LAI along the Yamal Transect. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Kumpula, T., Forbes, B.C., Stammler, F. 2010. Land-use and land-cover changes in Yamal peninsula. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Leibman, M.O., Gubarkov, A.A., Khumotov, A.V., et al. 2010. Geocryological Map of the USSR, 1:2,500,000, 1991. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Orekhov, P., Leibman, M.O. 2010. Yamal Peninsula, climate, zonation, physiography, geology, permafrost. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Pinzon, J.E., Tucker, C.J. 2010. GIMMS 3g NDVI set and global NDVI trends. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Raynolds, M.K., Walker, D.A., Bhatt, U.S., et al. 2010. NDVI trends 1981-2008 in the circumpolar Arctic and Yamal. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Stammler, F. 2010. Humans and animals on northern Yamal: uncovering unknown patterns of movement and settlement..*Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Streletskiy, D.A., Nelson, F.E., Shiklomanov, N.I. 2010. Spatial and temporal variability of active-layer thickness under changing climatic conditions in Northwest Siberia. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Ukraintseva, N.K. 2010. High Willow Shrubs in Yamal: Reasons of Their Wide Expansion and Methods of Biomass Assessment. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Walker, D.A. 2010. Welcome, goals of the workshop, and overview of the project. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Walker, D.A., Epstein, H.E., Bhatt, U.S., et al. 2010. Greening of the Arctic: A planet-to-plant analysis of tundra vegetation change. *Presented at: State of the Arctic Meeting Miami, Fl 16-19 March*. PDF

Walker, D.A., Epstein, H.E., Bhatt, U.S., et al. 2010. Greening of the Arctic: A planet-to-plant analysis of Arctic vegetation change. *Presented at: IPY Oslo Science Conference Oslo, Norway 8-12 June*. PDF

Walker, D.A., Epstein, H.E., Maier, H.A., et al. 2010. The Yamal Transect: Vegetation Analysis and Mapping (a plant to planet approach). *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Yu, Q., Epstein, H.E., Walker, D.A. 2010. Controls on arctic tundra vegetation dynamics on the Yamal Peninsula, Russia - an integrative study using ArcVeg and multi-temporal Landsat imagery. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland 8-10 March*. PDF

Yu, Q., Epstein, H.E., Walker, D.A., Frost, G.V. 2010. Modeling dynamics of tundra plant communities on the Yamal Peninsula. Abstract GC54A-04, presented at *Fall Meeting, AGU, San Francisco, CA, 13-17 December*. PDF

2009

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2009. Panarctic linkages between greening of Arctic tundra, sea ice decline, and summer land temperatures. *Presented at: NEESPI Workshop CITIES-2009 Krasnoyarsk, Russia July 14*. PDF

2008

Anon. 2008. Agenda and Abstracts. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Bhatt, U.S., Walker, D.A., Raynolds, M., Comiso, J. 2008. Examining relationships between sea ice and Arctic vegetation on the Pan-Arctic, regional and site scales. Abstract EGU2008-A-11271, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, 13 -18 April*. 10:EGU2008-A-11271.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2008. Pan-Arctic climate dynamics in relationship to sea ice, land-surface temperatures and NDVI: focus Yamal region & comparison with North America. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Comiso, J.C. 2008. Decadal Changes in the Arctic Sea Ice Cover and Surface Temperature with especial focus on Yamal, Alaska and the Canadian Peninsula. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Drozdov, D.S. 2008. Mapping and remote sensing of natural and technogenicgeosystems in West Siberia. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Epstein, H.E. 2008. Field and Modeling Analyses of Tundra Vegetation Communities Along Latitudinal Temperature Gradients. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Epstein, H.E., Walker, D.A., Kuss, P., Karlejaärvi, E. 2008. (1)LAI, NDVI, and vegetation biomass for Low Arctic sites in the Yamal region of Russia (2)An overview of modeling vegetation and ecosytem dynamics in arctic tundra. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia 28-30 January*.

Forbes, B.C., colleagues, w.m.d. 2008. Effects of petroleum development on reindeer herding in Northwest Siberia: Combining scientific and traditional knowledge. *Presented at: 2008 Yamal Land Cover and Land Use Workshop Moscow, Russia January 28-30*. PDF

Gubarkov, A.A. 2008. Overview of gas and oil development on the Yamal Peninsula. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia 28-30 January*. PDF

Jia, G.J., Wang, H., Epstein, H.E., Walker, D.A. 2008. Greening of Arctic: Knowledge and Uncertainties. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Kaplan, J.O., Lischke, H., Melton, J.R. 2008. Dynamic Modeling of Global Arctic and Subarctic Vegetation. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Khomutov, A.V., Leibman, M.O. 2008. Landscape structure in natural and disturbed conditions of Yamal Peninsula, field results and local GIS. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Kumpula, T. 2008. Remote sensing of land-use/land-cover change in the Bovanenkovo gas field on the Yamal Peninsula. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia 28-30 January*. PDF

Kuss, P., Karlejaärvi, E., Moskalenko, N., et al. 2008. Plant communities at Nadym, Laborovaya, and VaskinyDachi. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia 28-30 January*. PDF

Leibman, M.O. 2008. Welcome. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30, 2008*. PDF

Leibman, M.O., Malkova , G., Khomutov, A., Gubarkov , A. 2008. Overview of Yamal Peninsula with focus on Laborovaya and VaskinyDachi: Climate, zonation, physiography, geology, permafrost. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF

Matyshak, G.V. 2008. Soils at Nadym and Yamal area. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28*. PDF

Melnikov, V.P., Drozdov, D.S., Malkova, G.V. 2008. Permafrost: contemporary state, stability and dynamics. Technogenic influence. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia*

January 28-30. PDF
Moskalenko, N.G. 2008. Overview of vegetation dynamics, disturbance and recovery studies in Nadym and Yamal areas. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Orekhov, P.T. 2008. Lake ecosystems in different landscapes in the Nadym region. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Ponomareva, O.E. 2008. Overview of Nadym Region: Climate, Zonation, Physiography, Geology, Permafrost. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Raynolds, M.K., D.A. Walker, and J.C. Comiso 2008. Spatial patterns of land surface temperature and NDVI and their relation to vegetation distribution on the Yamal Peninsula. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Raynolds, M.K., Walker, D.A. 2008. Circumpolar relationships between permafrost characteristics, NDVI, and arctic vegetation types. *Ninth International Conference on Permafrost, Fairbanks, AK, June 29-July 3*. 2:1469-1474. PDF
Raynolds, M.K., Walker, D.A., Comiso, J.C. 2008. Circumpolar AVHRR Surface Temperature and its Relationship to Bioclimate Zones and NDVI. *Presented at: Komarov Botanical Institute St. Petersburg, Russia February 5*.
Romanovsky, V., Kholodov, A., Marchenko, S. 2008. Pan-Arctic permafrost thermal conditions: Where does the Yamal Peninsula fit?.*Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Stammler, F. 2008. A century of nomadic land use. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Walker, D.A. 2008. Overview of the Yamal LCLUC Project and Objectives of the Meeting. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*. PDF
Walker, D.A. 2008. Application of space-based technologies and models to address land-cover/land-use change problems on the Yamal Peninsula, Russia. *Presented at: 2008 NASA Carbon Cycle and Ecosystems Joint Science Workshop Adelphi, MD April 28 - May 2*. PDF
Walker, D.A., Bhatt, U.S., Epstein, H.E. 2008. Greening of the Arctic: an IPY Initiative. Abstract U23F-05 INVITED, presented at *AGU Fall Meeting, San Francisco, CA, December 12-15*. 89:1. PDF
Walker, D.A., Bhatt, U.S., Romanovsky, V.E., et al. 2008. Application of space-based technologies and models to address land-cover/land-use change problems on the Yamal Peninsula, Russia. Abstract EGU2008-A-05697, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, April 13-18*. 10:EGU2008-A-05697. PDF
Walker, D.A., Epstein, H.E., Karlejaärvi, E., et al. 2008. 2007 Expedition to Yamal Peninsula Region, Russia. *Presented at: Yamal Land-Cover Land-Use Change Workshop Abstracts Moscow, Russia January 28-30*. PDF
Walker, D.A., Leibman, M.O., Forbes, B.C., Epstein, H.E. 2008. Cumulative effects of rapid climate and land-use changes on the Yamal Peninsula, Russia. Abstract GC52A-07, presented at *AGU Fall Meeting, San Francisco, CA, December 15-19*. 89:GC52A-07. PDF
Yu, Q., Epstein , H. 2008. Modeling Arctic Tundra Vegetation Dynamics in North America and the Yamal Region of Russia. *Presented at: Yamal Land-Cover Land-Use Change Workshop Moscow, Russia January 28-30*.

2007

Alcaraz, D., Chuvieco, E., Epstein, H. 2007. Temporal trends in post-fire regeneration patterns of boreal forests using 1km AVHRR NDVI. Abstract B11D-0777, presented at *AGU Fall Meeting, San Francisco, CA, December 10-14*. 88:5.

2006

Cook, B.I., Bonan, G.B., Levis, S., et al. 2006. Amplification of climate model response to snow cover fraction parameterization through dynamic vegetation. Abstract C21C-1181, presented at *AGU Fall Meeting, San Francisco, CA, December 11-15*. 87:C21C-1181.
Epstein, H.E. 2006. Greening of the Arctic: Assessing tundra dynamics with remote sensing and modeling. *Presented at: Earth System Science Partnership Open Science Conference Beijing, China November 9-12*.
Forbes, B. 2006. Effects of petroleum development on reindeer herding in Northwest Siberia: Combining scientific and traditional knowledge. *Presented at: Earth System Science Partnership Beijing, China November 9-12*.
Raynolds, M.K., Comiso, J.C., Walker, D.A. 2006. Comparison of arctic tundra bioclimate subzones and AVHRR surface temperature, and relationship to NDVI. *Presented at: 9th Bi-Annual Circumpolar Remote Sensing Symposium Seward, Alaska May 16-19*. PDF
Romanovsky, V., Marchenko, S., Brown, J. 2006. Thermal State of Permafrost (TSP): The US Contribution to the International Network of Permafrost Observatories. *Presented at: NEESPI Focus Center Workshop Fairbanks, AK April 6-8*.

Romanovsky, V., Marchenko, S., Duguay, C.R., Walsh, J. 2006. Permafrost dynamics within the Northern Eurasia region and related impacts on surface and sub-surface hydrology. *Presented at: NEESPI Focus Center Workshop Fairbanks, AK April 6-8*.

Romanovsky, V.E., Marchenko, S.S., Grosse, G., et al. 2006. Monitoring and Modeling of the Northern Eurasia Permafrost Dynamics. Abstract GC21B-04 INVITED, presented at *AGU Fall Meeting, San Francisco, CA, December 11-15*. 87:52.

Walker, D.A. 2006. Greening of the Arctic: an IPY initiative. *Presented at: Arctic Science Conference, Arctic AAAS Division Meeting Fairbanks, AK October 2-4*.

Walker, D.A. 2006. Application of space-based technologies and models to address landcover/land-use change problems on the Yamal Peninsula, Russia. *Presented at: NEESPI-CLAC meeting Fairbanks, AK April 6-8*.

Walker, D.A., Daanen, R., Kade, A.N., et al. 2006. Interactions of physical and biological processes in the formation of small patterned-ground features across the arctic climate gradient. *Presented at: Arctic Science Conference, Arctic AAAS Division Meeting Fairbanks, AK October 2-4*.

Posters

2010

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Seasonality of the atmosphere-ocean-ice-terrestrial environment of Arctic tundra. *Presented at: State of the Arctic Conference Miami, FL March 16-19*. PDF

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Climatology and variability of the ice-ocean-atmosphere-terrestrial system on the Yamal. *Presented at: NASA Land-Cover and Land-Use Change Science Team Meeting Bethesda, MD April 20-22*. PDF

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2010. Circumpolar arctic tundra vegetation change is linked to sea-ice decline. *Presented at: Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2010. Vegetation biomass, leaf area index, and NDVI patterns and relationships along two latitudinal transects in arctic tundra. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 20-22 April*. PDF

Forbes, B.C., Fauria, M.M., Zetterberg, P. 2010. Russian Arctic Warming and 'Greening' are Closely Tracked by Tundra Shrub Willows. *Presented at: State of the Arctic Conference Miami, FL March 16-19*. PDF

Frost, G.V., Epstein, H.E., Walker, D.A. 2010. Spatio-temporal trends in tree and shrub cover in the circumpolar Low Arctic: Evidence from 1960s satellite photography and ground observations. *Presented at: State of the Arctic Meeting Miami, FL March 16-19*.

Frost, G.V., Epstein, H.E., Walker, D.A. 2010. Spatio-temporal dynamics in tree and tall shrub cover near Kharp, northwest Siberia: 2009 field observations and proposed 2010 study plan. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Frost, G.V., Epstein, H.E., Walker, D.A. 2010. Spatio-temporal dynamics in tree and tall shrub cover near Kharp, northwest Siberia. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD April 20-22*. PDF

Frost, G.V., Walker, D.A., Raynolds, M.K., Epstein, H.E. 2010. Ordination and gradient analysis of Yamal Peninsula releve data. *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland March 8-10*. PDF

Jia, G.J., Epstein, H.E., Walker, D.A., et al. 2010. Satellite view of changing phenological patterns over Arctic tundra biome. *Presented at: State of the Arctic Meeting Miami, FL March 16-19*.

Khitun, O., Rebristaya, O. 2010. Concrete Flora Concept as a Base for Floristic Investigations in the Russian Arctic. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Maier, H.A., Walker, D.A. 2010. Yamal Peninsula, Russia: Landsat TM Mosaic Image (1:1M scale), Land-Cover Maps and NDVI Maps of the LCLUC Study Areas (1:250K-1:300K scales). *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Maier, H.A., Walker, D.A. 2010. OstrovBelyy (White Island), Yamal Peninsula region, Russia: Landsat ETM+ false color image, land-cover map, and NDVI map (1:200K scale). *Presented at: Second Yamal Land-Cover Land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Maier, H.A., Walker, D.A. 2010. Application of Global Land Survey data to land-cover mapping: Yamal Peninsula, Russia. *Presented at: NASA Land-Cover and Land-Use Change Science Team Meeting Bethesda, MD April 20-22*. PDF

Moskalenko, N.G. 2010. Vegetation Dynamics at the Nadym and Kharasavei sites in the West Siberia North. *Presented at: Yamal Land-Cover land-Use Change Workshop Rovaniemi, Finland March 08-10*. PDF

Walker, D.A., Epstein, H.E., Maier, H.A., et al. 2010. The Yamal LCLUC Study: Vegetation analysis and mapping along a 900-km Arctic transect. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 20-22 April*. PDF

Yu, Q., Epstein, H.E., Walker, D.A. 2010. Land surface dynamics on the Yamal Peninsula based on multi-temporal imagery. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD April 20-22*.

2009

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2009. Seasonality of the air-sea-ice-land environment of Arctic tundra in Northern Eurasia and North America. Abstract GC31A-0701, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0701. PDF

Bhatt, U.S., Walker, D.A., Raynolds, M.K., et al. 2009. Greening of Arctic tundra is linked to warming summer land temperatures and sea-ice declines. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March - 2 April*. PDF

Epstein, H.E., Walker, D.A., Karlejaärvi, E., et al. 2009. Biomass-NDVI-LAI patterns and relationships on the Yamal Peninsula, Russia. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 Mar-2 Apr*. PDF

Epstein, H.E., Walker, D.A., Raynolds, M.K., et al. 2009. Vegetation biomass, leaf area index, and NDVI patterns and relationships along two latitudinal transects in arctic tundra. Abstract GC31A-0697, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0697. PDF

Frost, G.V., Epstein, H.E., Jorgenson, M.T. 2009. Spatio-temporal trends in tree and tall shrub cover in the circumpolar Arctic: evidence from repeat ground photographs and 1960s satellite imagery. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March - 2 April*. PDF

Frost, G.V., Epstein, H.E., Walker, D.A. 2009. Spatio-temporal trends in tree and tall shrub cover in the Eurasian Low Arctic: evidence from 1960s and contemporary satellite imagery and ground observations. Abstract GC31A-0698, presented at *AGU Fall Meeting, San Francisco, CA, December 14-18*. 90:GC31A-0698. PDF

Jia, G.J., Epstein, H.E., Walker, D.A., et al. 2009. Decadal changes of phenological patterns over Arctic tundra biome. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March-2 April*. PDF

Raynolds, M.K., Walker, D.A., Verbyla, D., Huetmann, F. 2009. Modeling the distribution of circumpolar arctic vegetation. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, Maryland 31 March-2 April*. PDF

Walker, D.A., Leibman, M.O., Epstein, H.E., et al. 2009. Vegetation greenness on the Yamal Peninsula, Russia: Disturbance-climate-change interactions. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March-2 April*. PDF

Yu, Q., Epstein, H.E., Walker, D.A. 2009. Simulating soil organic nitrogen and grazing effects on arctic tundra vegetation dynamics on the Yamal Peninsula, Russia. *Presented at: Land Cover, Land Use Change Spring Science Team Meeting Bethesda, MD 31 March-2 April*. PDF

Yu, Q., Epstein, H.E., Walker, D.A. 2009. Evaluating Environmental Controls on Arctic Tundra Vegetation Dynamics on Yamal Peninsula, Russia. *Presented at: EnviroDay University of Virginia, VA January 12*. PDF

2008

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2008. Application of Space-based Technologies and Models to Address Land-cover/Land-use Change Problems on the Yamal Peninsula, Russia: Circumpolar and regional analysis of the relationship between sea-ice variability, summer land-surface temperatures, Arctic t. *NASA Carbon Cycle and Ecosystems Joint Science Workshop, Adelphi, MD, April 28 - May 2*. PDF

Epstein, H.E., Walker, D.A., Kuss, P., et al. 2008. Ecosystem Properties along a Latitudinal Gradient of the Yamal Region, Russia. Abstract EGU2008-A-04406, presented at *European Geosciences Union General Assembly, Vienna, Austria, 13 - 18 April*. 10:EGU2008-A-04406. PDF

Forbes, B.C., Stammler, F., Pajunen, A., Karlejaärvi, E. 2008. Cumulative Effects of Industrial Development, Reindeer Herding, and Climate Change on the Yamal Peninsula, Russia. *Presented at: 2008 NASA Carbon Cycle and Ecosystems Joint Science Workshop Adelphi, MD April 28 - May2*. PDF

Kumpula, T., Forbes, B.C., Stammler, F. 2008. Landscape Change in the Russian Arctic: Ecological Implications of the Petroleum Industry to the Nenets Reindeer Herding in Yamal Peninsula. *Presented at: 2008 Annual Meeting and Arctic Forum Washington, D.C. 13 - 15 May 2008*. PDF

Raynolds, M.K., Walker, D.A., Comiso, J.C. 2008. Spatial Patterns of Land Surface Temperature and NDVI on the Yamal Peninsula, Russia. *Presented at: NASA Carbon Cycle and Ecosystems Joint Science Workshop Adelphi, MD April 28 - May 2*. PDF

Walker, D.A., Epstein, H.E., Karlejaärvi, E., et al. 2008. Application of space-based technologies and models to

address land-cover/land-use change problems on the Yamal Peninsula, Russia: 2007 field studies along the bioclimate gradient. *Presented at: 2008 NASA Carbon Cycle and Ecosystems Joint Science Workshop Adelphi, MD April 28 - May 2*. PDF

Walker, D.A., Forbes, B.C., Stammler, F., et al. 2008. Cumulative impacts analysis on the Yamal Peninsula, Russia: A blueprint for a comparative study in Northern Alaska?.*Presented at: 2008 Annual Meeting and Arctic Forum Washington, D.C. 13-15 May* .PDF

Yu, Q., Epstein, H.E. 2008. Evaluating Arctic tundra system resilience to grazing disturbances: A modeling approach. Abstract EGU2008-A-12154, presented at *European Geosciences Union General Assembly 2008, Vienna, Austria, 13 - 18 April*. 10:EGU2008-A-12154. PDF

Yu, Q., Epstein, H.E. 2008. Evaluating arctic tundra system resilience to grazing disturbances: a modeling approach. *Presented at: NASA Carbon Cycle and Ecosystems Joint Science Workshop Adelphi, Maryland April 28-May 2*. PDF

2007

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2007. The relationship between sea ice variability and arctic tundra on the pan-Arctic, regional, and site scales. Abstract U42C-0612, presented at *AGU Fall Meeting, San Francisco, CA, December 10*. 88:5.

Bhatt, U.S., Walker, D.A., Raynolds, M.K., Comiso, J.C. 2007. Influence of Regional Sea Ice Variability on Arctic Tundra. *Seventh International Conference on Global Change: Connection to the Arctic, Fairbanks, Alaska, February 19-20*. 76-78. PDF

Jia, G.J., Epstein, H.E., Walker, D.A. 2007. Trends of Vegetation Greenness in the Arctic from 1982-2005. Abstract B21A-0041, presented at *AGU Fall Meeting, San Francisco, CA, December 10-14*. 88:5. PDF

Raynolds, M.K. 2007. The relationship between permafrost characteristics and the distribution of arctic vegetation types. *Presented at: Arctic Science Conference, Arctic AAAS Division Meeting Anchorage, AK 24-26 September*. PDF

2006

Walker, D.A., Bhatt, U.S., Comiso, J.C., et al. 2006. Application of Space-based Technologies and Models to Address Land-cover/Land-use Change Problems on the Yamal Peninsula, Russia. *Presented at: NASA Land-Cover Land-Use Change College Park, MD October 10-12*.

2005

Walker, D.A., Epstein, H.E., Jia, G.J., et al. 2005. Greening of the Arctic: an IPY initiative. *Presented at: ICARP II Copenhagen, Denmark November 10-12*. PDF