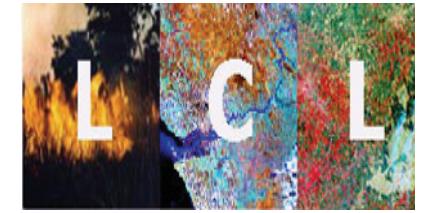




Biomass-NDVI-LAI Patterns and Relationships on the Yamal Peninsula, Russia

H.E. Epstein¹, D.A. Walker, P. Kuss, E. Kaarlejärvi, N.G. Moskalenko, P.T. Orekhov, A.A. Gubarkov, A.V. Khomutov, M.O. Leibman, and G.V. Matyshak

¹Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22904-4123



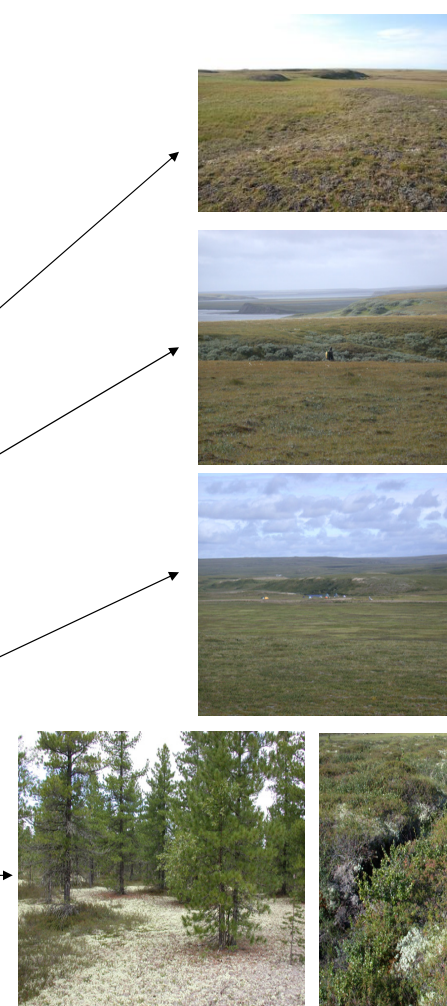
INTRODUCTION

The spatial distribution of vegetation and soil properties along regional-scale, climatic gradients provides important baseline information on the environmental controls of ecosystem structure and function. To date, only one complete regional transect along the full temperature gradient of the arctic tundra has been sampled and analyzed – the North American Arctic Transect (Walker et al. 2008). For the Siberian arctic tundra, this baseline information on vegetation and soils in a regional spatial context does not exist in any systematic fashion. As part of a U.S.-Russia collaborative project within the NASA/NEESPI Land Cover Land Use Change program, we analyzed in detail the vegetation and soil properties of four tundra locations along a latitudinal gradient across forest-tundra and arctic tundra in the Yamal Region of Siberia east of the Ural Mountains.

METHODS

Our locations were situated near Nadym (65° 18' N), Laborovaya (67° 41' N), Bovanenkova (Vaskiny Dachi – 70° 17' N), and Kharasavey (71° 11' N). At a minimum of two sites per location, using 50m x 50m grids, we systematically sampled leaf area index (LAI), Normalized Difference Vegetation Index (NDVI), species composition, vegetation biomass, and soil characteristics.

Sites for the Summer 2007 and 2008 field expeditions



Subzone C

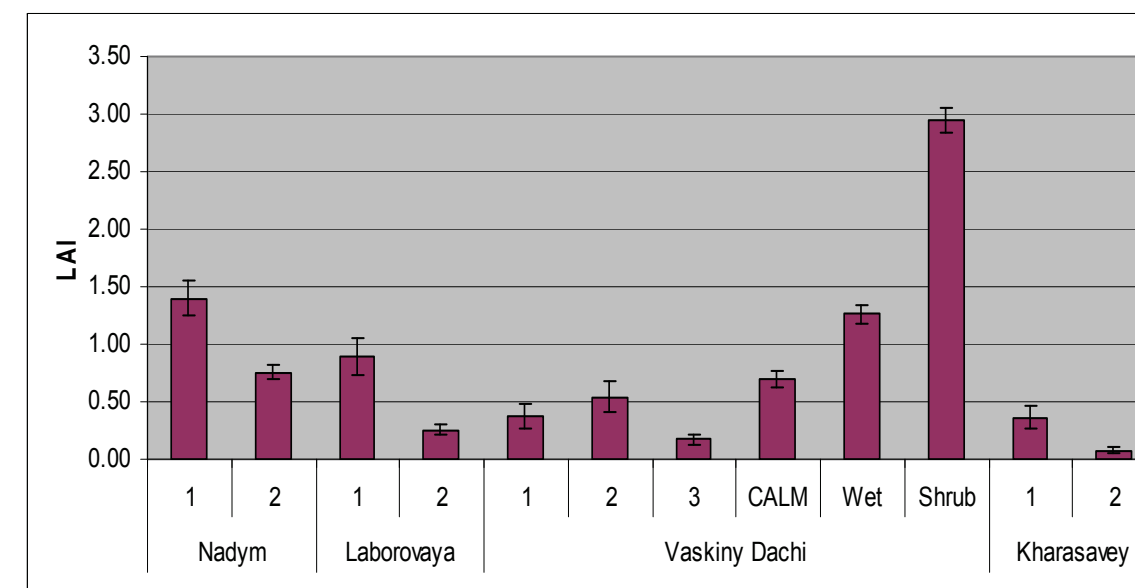
Subzone D

Subzone E

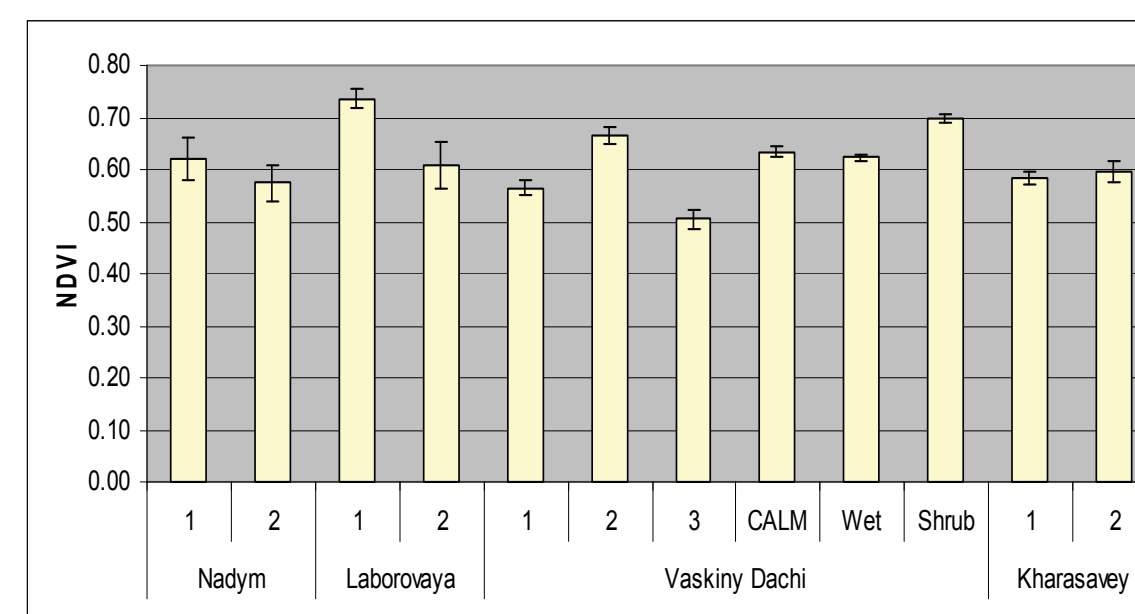
Forest-Tundra (N)

Photos by H.E. Epstein and D.A. Walker

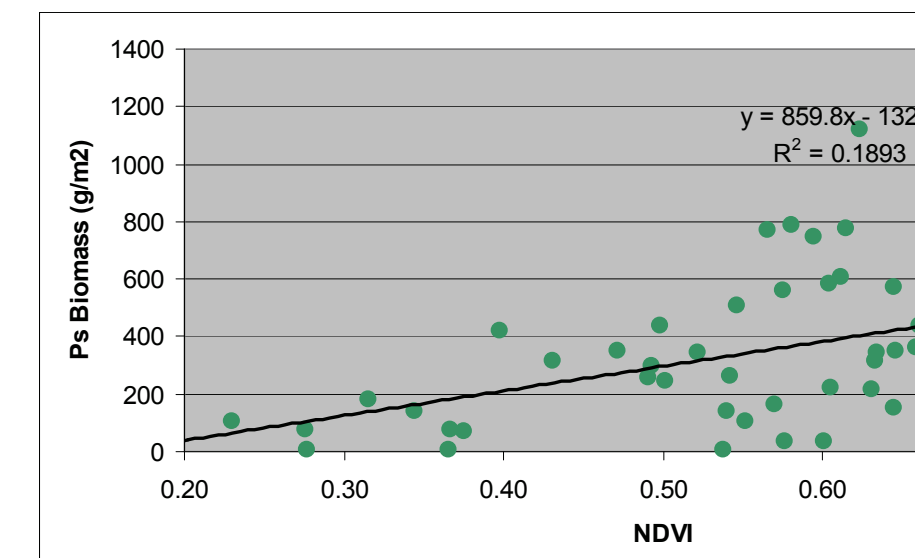
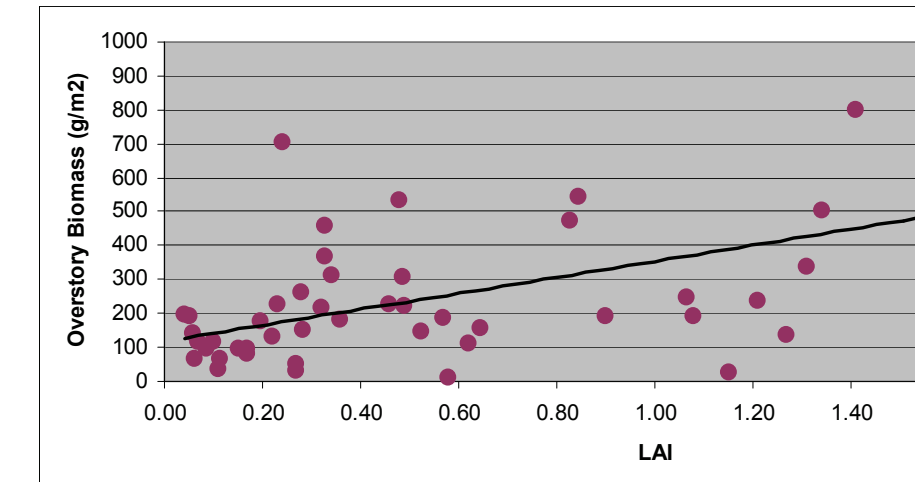
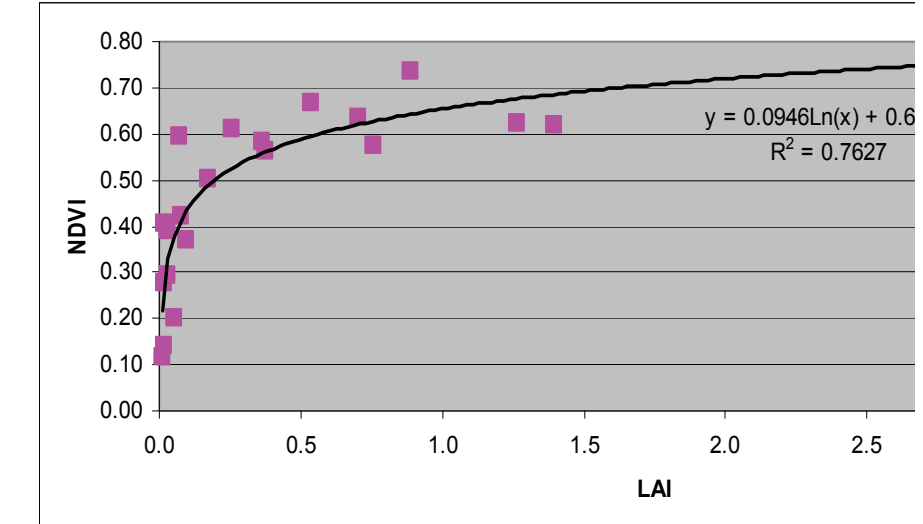
RESULTS – Vegetation Indices



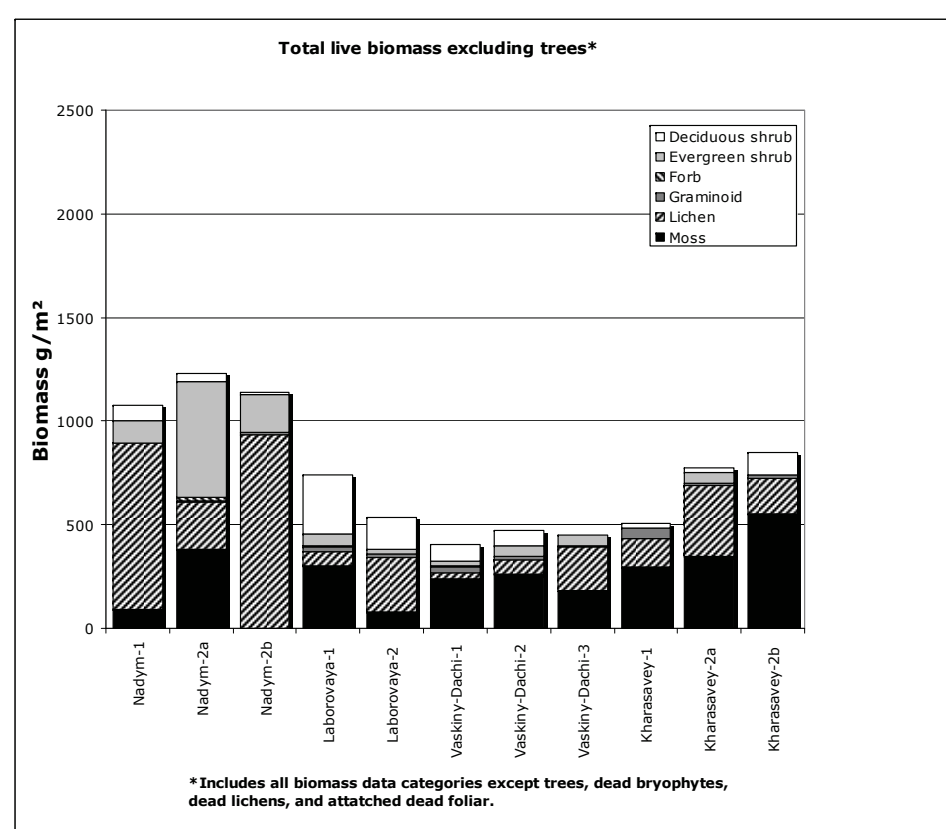
LAI generally declines with latitude, but there is high local spatial heterogeneity



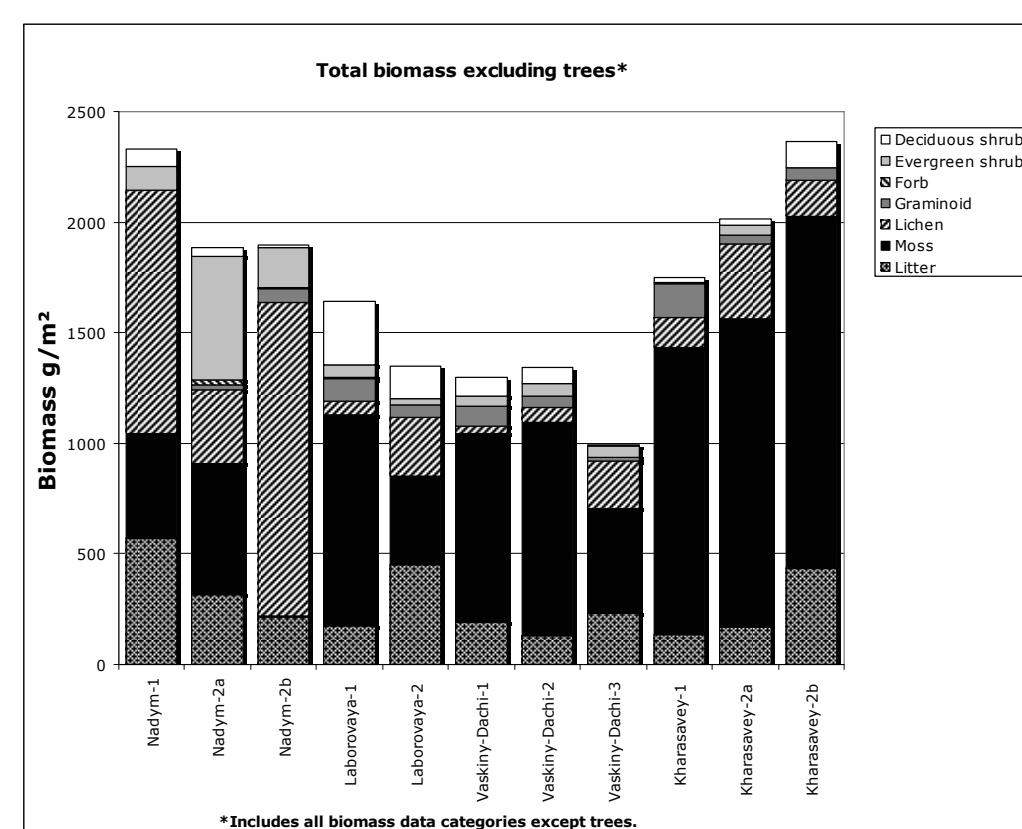
NDVI is relatively constant with latitude, with less spatial variance than LAI



RESULTS – Plant Community Composition and Biomass



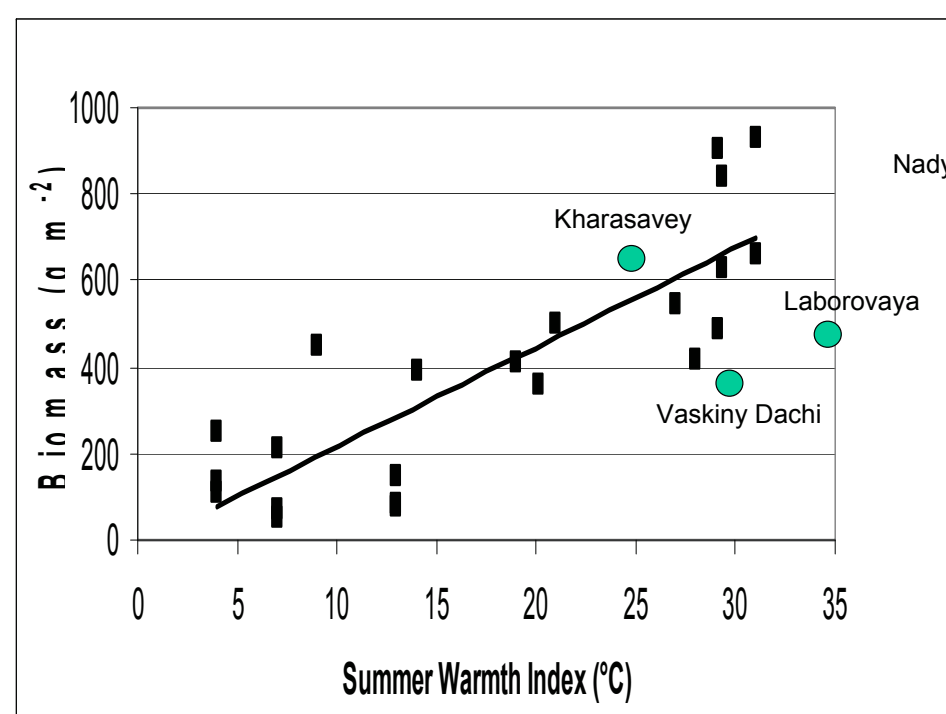
*Includes all biomass data categories except trees, dead bryophytes, dead lichens, and attached dead foliar.



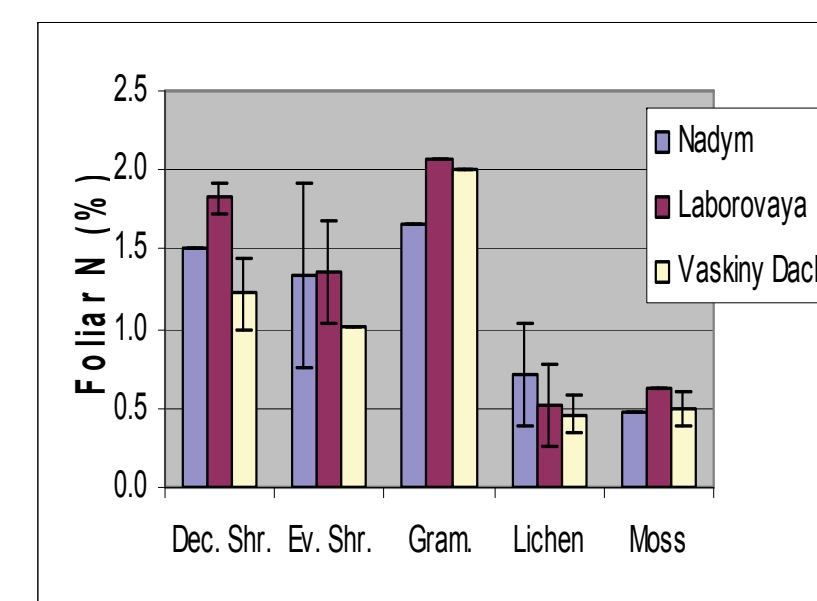
*Includes all biomass data categories except trees.

Biomass generally declines with latitude from Nadym to Vaskiny Dachi, however Kharasavey has unexpectedly high biomass, particularly for a Subzone C site; this is largely due to very high observed moss biomass. There is also high within site spatial heterogeneity.

Black squares and line are the relationship between Summer Warmth Index (sum of mean monthly temperatures > 0) and Aboveground live plant biomass across the North American Arctic Transect. Yamal sites (green ovals) have greater Summer Warmth Indices (estimates from AVHRR Land Surface Temperatures) and lower biomass than comparable North American sites, with the exception of Kharasavey.



RESULTS – Plant and Soil Nutrients



| | %Sand | %Clay | %C | %N |
|----------------------|-------|-------|------|------|
| Nadym-Forest | 48.8 | 10.88 | 3.39 | 0.09 |
| Nadym-Tundra | 90.4 | 2.80 | 0.56 | 0.01 |
| Laborovaya-Loam | 18.0 | 22.68 | 1.72 | 0.06 |
| Laborovaya-Sand | 93.6 | 2.80 | 0.59 | 0.01 |
| Vaskiny Dachi - Loam | 33.3 | 8.52 | 1.83 | 0.06 |
| Vaskiny Dachi - Sand | 92.8 | 2.56 | 1.31 | 0.04 |
| Kharasavey - Loam | 22.7 | 23.40 | 1.97 | 0.13 |
| Kharasavey - Sand | 72.1 | 5.80 | 3.12 | 0.17 |

CONCLUSIONS

Vegetation biomass declined with latitude, with the exception of Kharasavey, which had exceptionally high biomass for a Subzone C site. The LAI of vascular plants declined from an average of 1.08 m² m⁻² at Nadym to 0.22 at Kharasavey along the 6° latitudinal transect. Average NDVI values of the tundra vegetation did not decline with latitude and were 0.60 for Laborovaya, 0.58 for Vaskiny Dachi, and 0.59 for Kharasavey. This is likely due to the contribution of non-vascular, understory vegetation to the NDVI signal. Related, average foliar nitrogen concentrations were greatest at Laborovaya, the site with the highest NDVI. Soil nutrient concentrations were greater in loamy compared to sandy soils, with the exception of the Kharasavey site. A key result is that, even along this transect of approximately 600 km, the heterogeneity of vegetation properties within a location can be greater than that over the entire transect. This heterogeneity needs to be considered in estimations of ecosystem function and nutrient cycling in the Yamal region. Our research plan is to sample Belyy Ostrov in summer 2009 to encompass an even broader Yamal Arctic Transect.

LITERATURE

Walker, D.A., H.E. Epstein, V.E. Romanovsky, C.L. Ping, G.J. Michaelson, R.P. Danaan, Y. Shur, R.A. Peterson, W.B. Krantz, M.K. Reynolds, W.A. Gould, G. Gonzalez, D.J. Nicolsky, C.M. Vonlanthen, A.N. Kade, P. Kuss, A.M. Kelley, C.A. Munger, C.T. Tarnocai, N.V. Matveyeva, and F.J.A. Daniels. 2008. Arctic patterned-ground ecosystem: A synthesis of field studies and models along a North American Arctic Transect. *Journal of Geophysical Research* Vol. 113, G03S01, doi:10.1029/2007/JG000504

ACKNOWLEDGEMENTS – Support came from NASA Land Use Land Cover Change Program / NEESPI Grant No. NNG6GE00A and NSF Synthesis of Arctic System Science Grant No. ARC-0531180.