

**Application of space-based technologies and models  
to address land-cover/land-use change problems on  
the Yamal Peninsula, Russia**

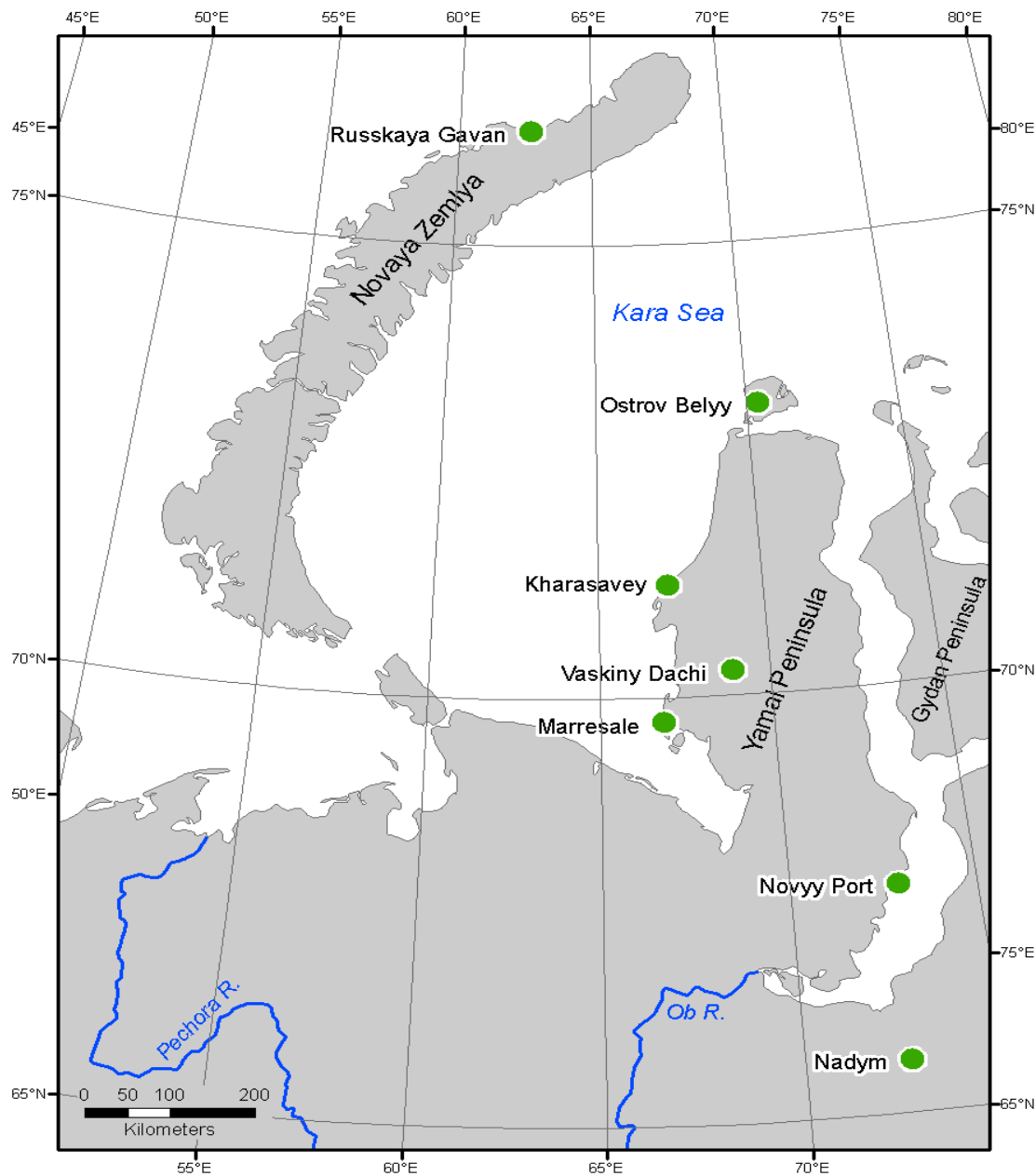
**Skip Walker, University of Alaska-Fairbanks**



## **Central land-cover/land-use change questions in Northwest Siberia**

- What will happen to the tundra regions as the global climate warms?
- What will happen as rapid industrial development and land-use changes related to the indigenous peoples proceed?

The Yamal region in northwest Siberia is a “hot spot” for both of these forces of change . Large-scale oil and gas development is interacting with a sensitive landscape and nomadic reindeer herds to produce extensive land-cover changes.



# Yamal Transect

Hilmar Maeir, Alaska  
Geobotanical Center

# NEESPI-related questions being addressed

- (1) What has been the integrated role of anthropogenic impacts, including those related to climate change and land-use changes, on producing the current status of ecosystems on the Yamal Peninsula?

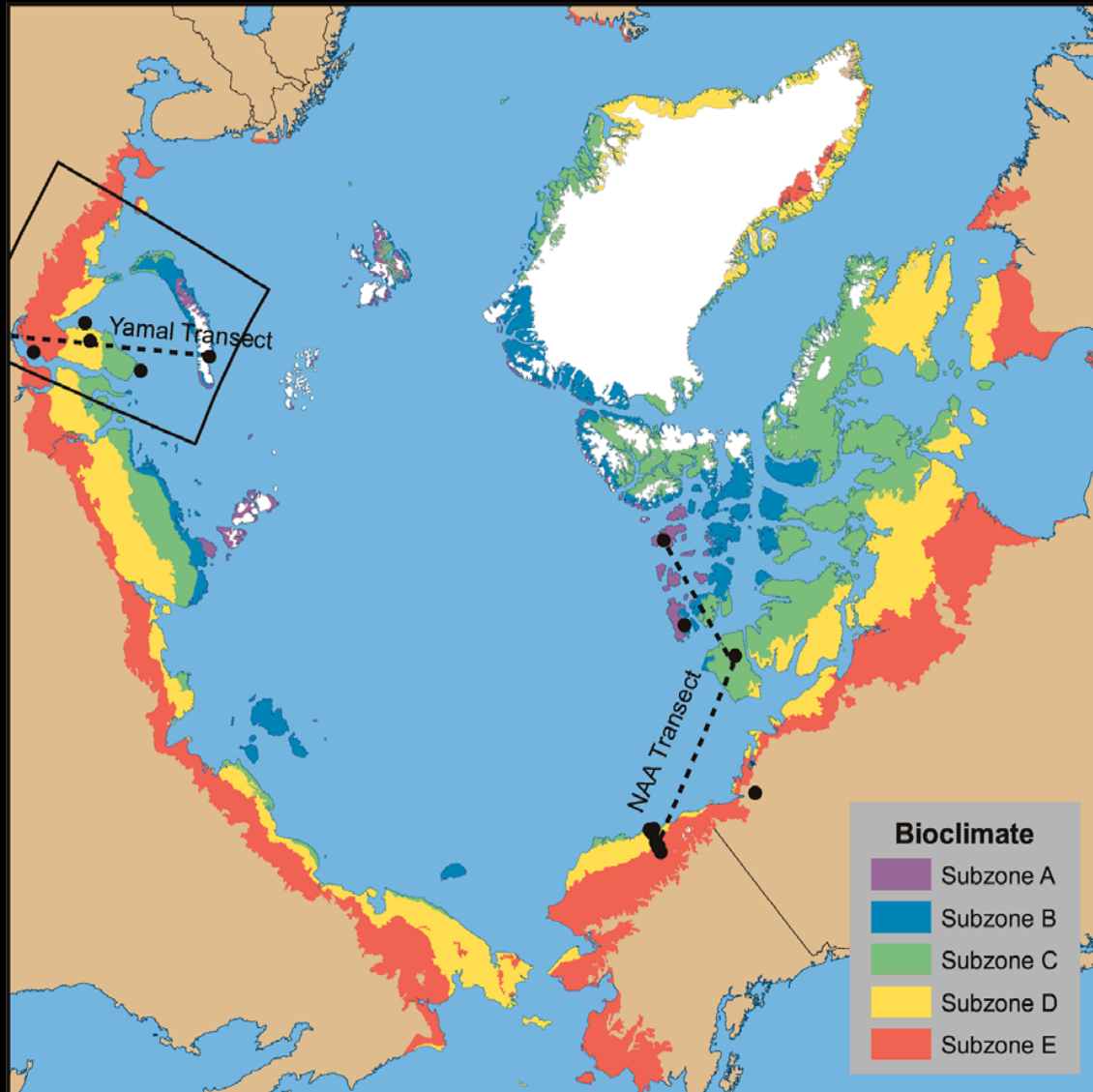
APPROACH: Analysis of historical remote sensing data in combination with grazing exclosures.

- (2) What will be the consequences of regional and global changes for the Yamal environment, the economy, and the quality of life for the Nenets people?

APPROACH: Surveys and traveling with the Nenets during their migrations.

- How will anticipated vegetation changes affect the Yamal ecosystems?  
APPROACH: BIOME4 and ArcVeg models to project future ecosystems and dynamics.

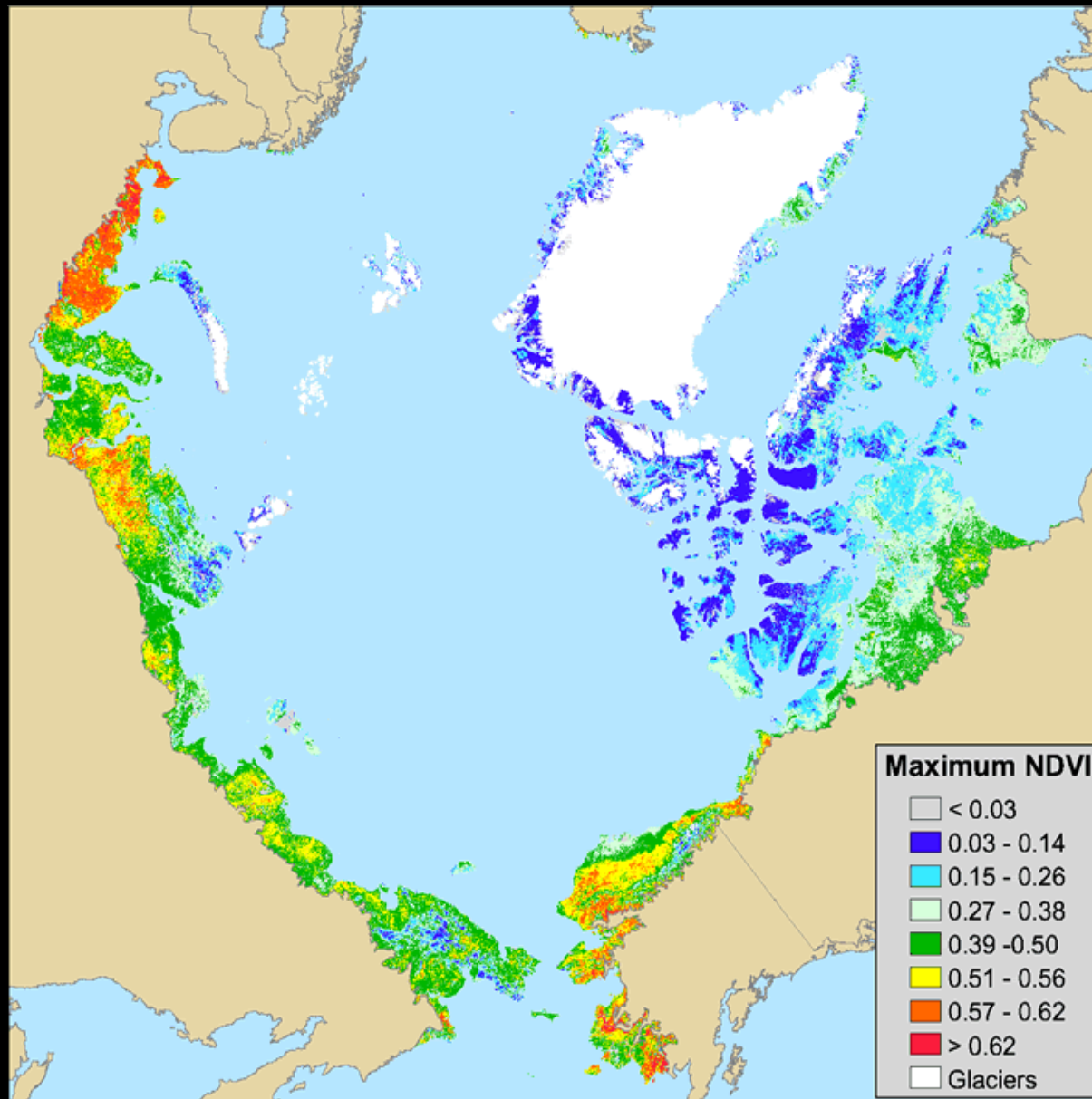
# How is climate change affecting vegetation along the complete Arctic bioclimate gradient?



- Yamal and North American Arctic Transects are being used to address the issue of how climate change is affecting the Greening of the Arctic.
- Both transects traverse the complete Arctic bioclimate gradient.

Base Map: CAVM Team 2003. Hilmar Maeir, Alaska Geobotanical Center

# Circumpolar NDVI patterns



- Spatial and historical differences in greenness patterns (as represented by the NDVI) are being analyzed with respect to changes in sea-ice, land-surface temperature, and a host of variables in a circumpolar geobotanical data base.

Base Map: CAVM Team 2003.  
Alaska Geobotanical Center

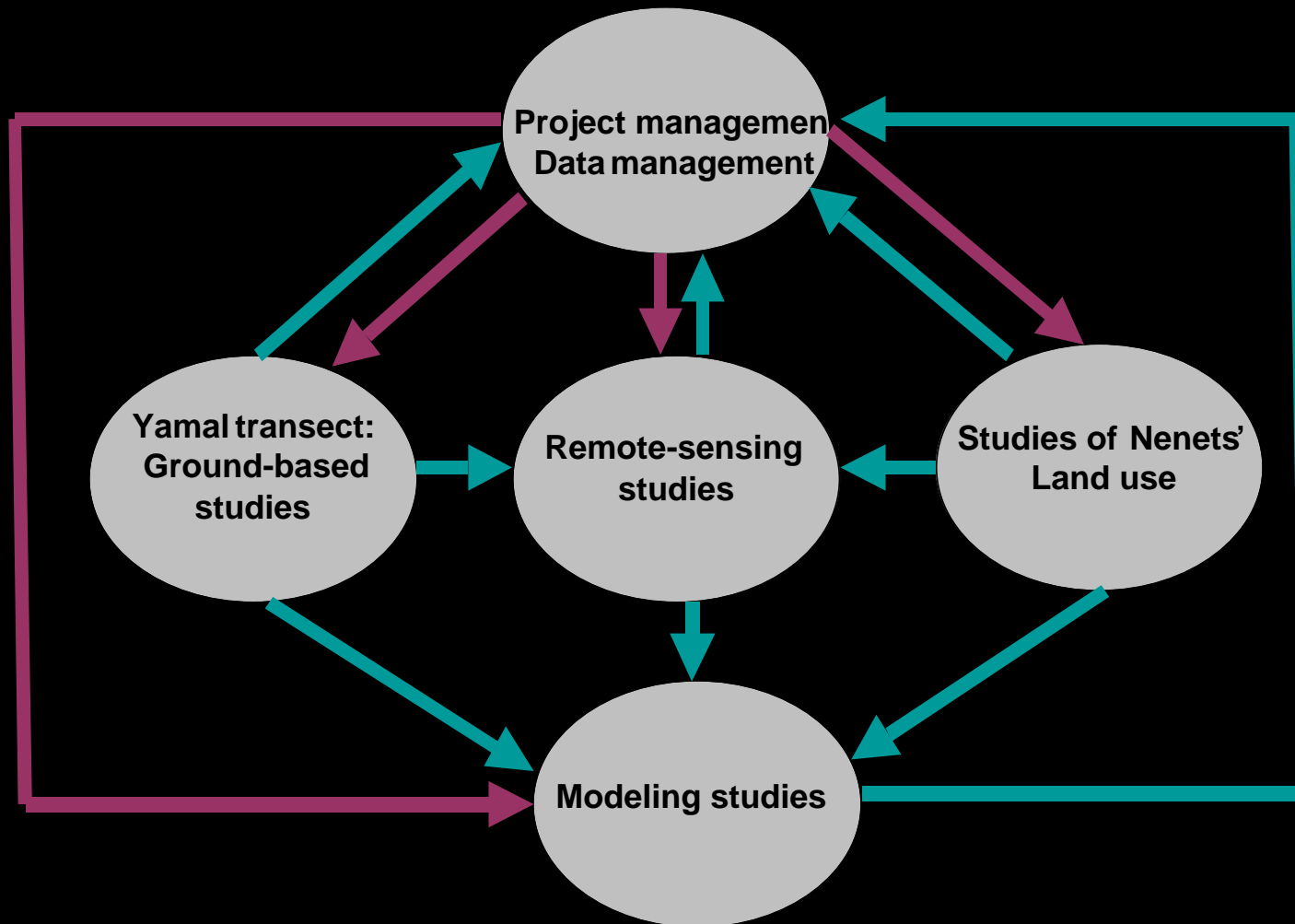
# Geobotanical variation across the Yamal transect

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.



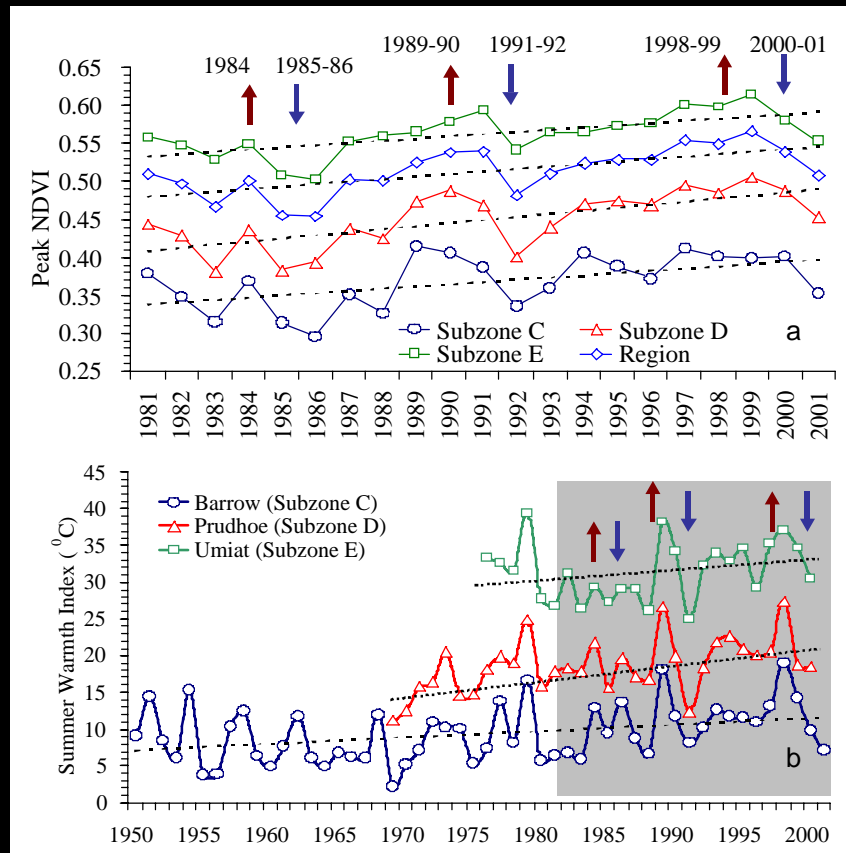
# Five project components

Coordination (red arrows) and data flow (blue arrows)



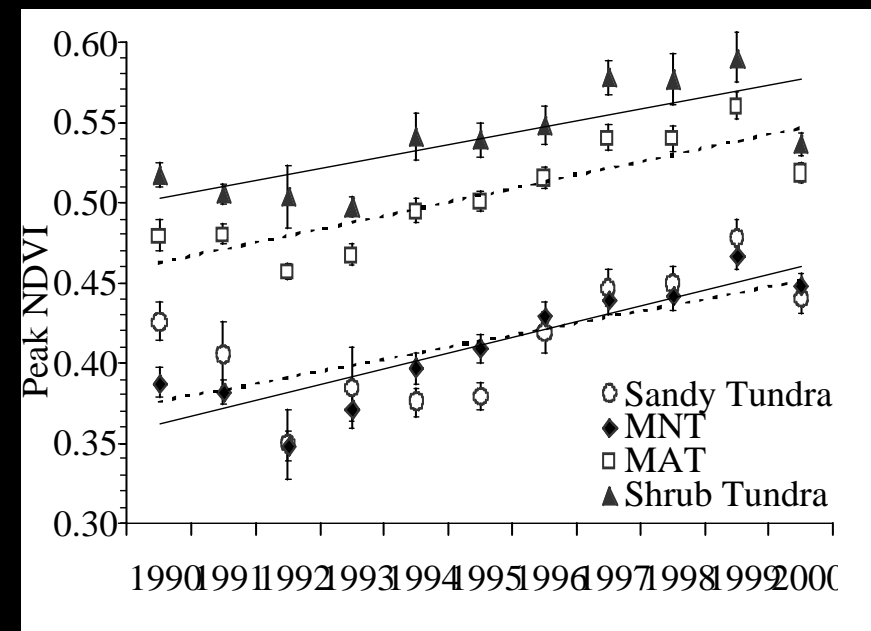


# Greening in northern Alaska



- in relationship to air temperature changes

- in relationship to substrate differences



Jiong et al. 2003. *Geophys. Res. Letters*

# Shrubification and the Nenets people



Courtesy of Sven Haakanson



## The Nenets and vegetation change

“The average brigadier is in his 50's and has lived his whole life on the tundra... they collect shrubs (mainly *Salix*)...all along the migration route for firewood. Of course, *Salix* is also one of the most important fodder species for the reindeer. so for these reasons they pay pretty close attention to the ecology of this particular genus in the landscape. In more southerly areas, they have noticed that some stands of *Salix* have gotten so big that the reindeer can now disappear into them. this is not good because if they lose sight of the animals during the migration when they are moving quickly, breaking camp once every 24 hours, the animals can get left behind. So, they have begun to make efforts to steer around the growing *Salix* patches to avoid losing animals. We would like to get a better idea of specific sites where *Salix* growth has been observed by herders. we would then try to quantify the changes in growth using western science methods - repeat air photography and/or dendrochronology - on the very same sites. the region is too large and varied to just go out and randomly try to document recent changes. Besides shrubs, we will also be asking herders about general trends in vegetation cover, e.g. grassification, sandy erosion, etc. as with shrub growth, these things are relevant to any overall 'greening' signal and so of direct interest to GOA.”

--Bruce Forbes



# Using high-resolution satellite images during interviews with Nenets herders

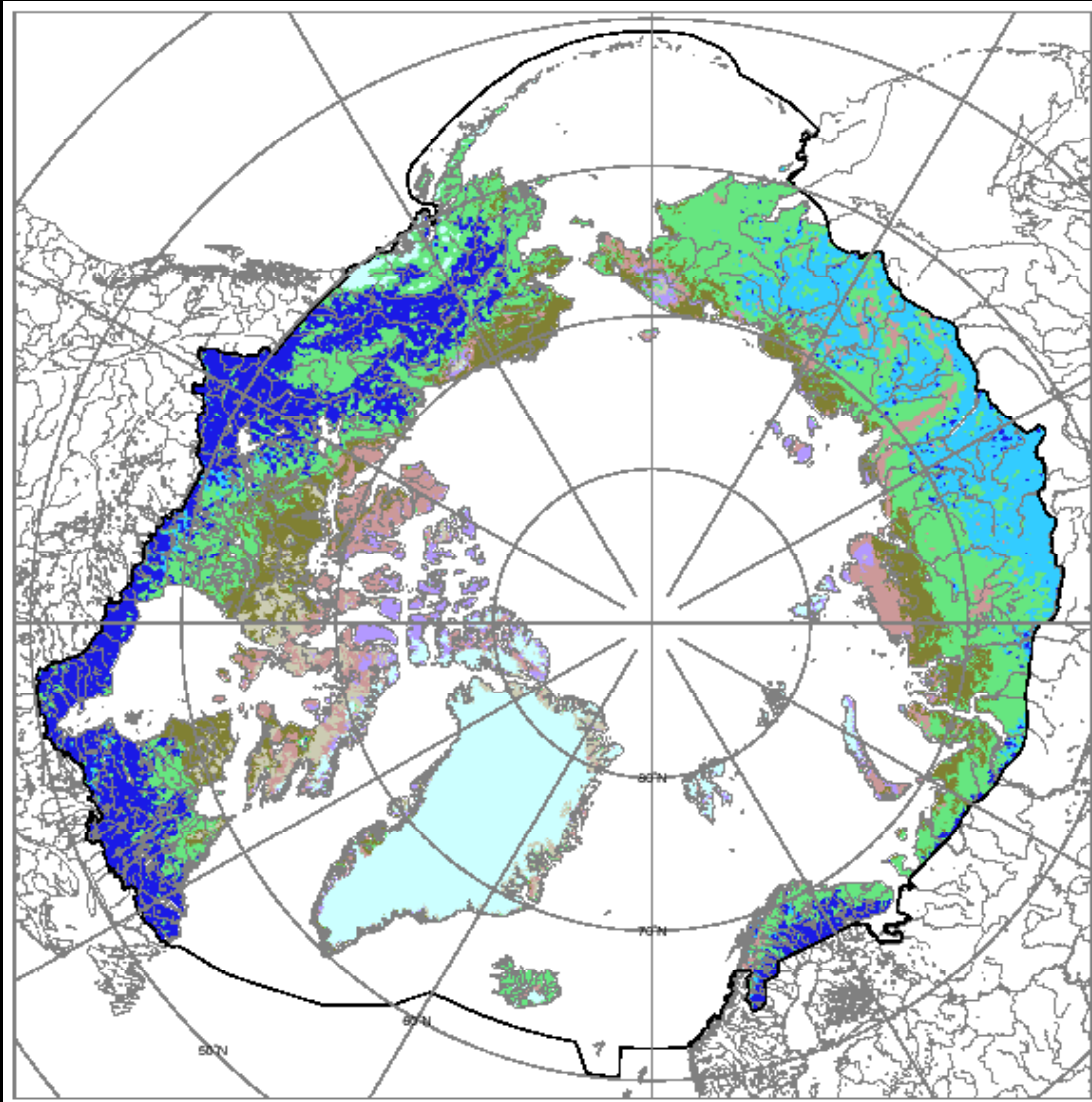


“...in addition to taking part in daily life and seeing with our own eyes exactly how the animals are managed we ... do more formal semi-structured interviews. some of these are recorded on either digital tape or film, or both. in these cases we have medium or very high resolution satellite imagery of the areas we are discussing to focus on specific places and features that the herders can recognize easily.”

Courtesy of Bruce Forbes

--Bruce Forbes

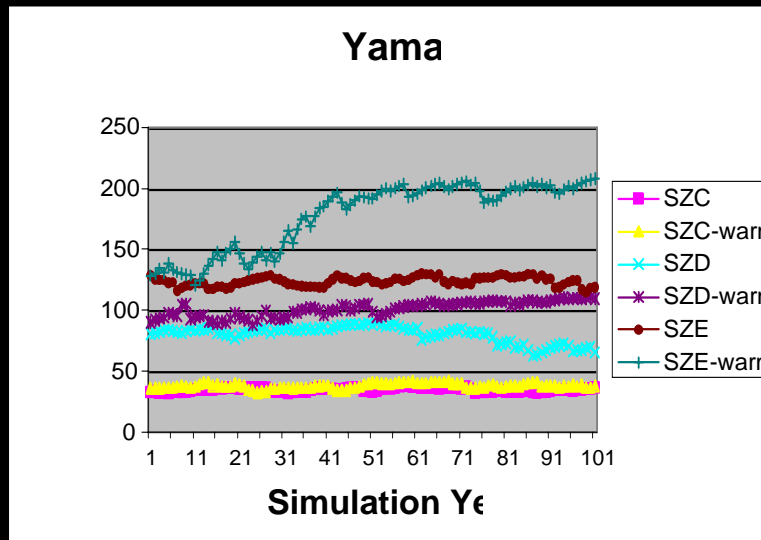
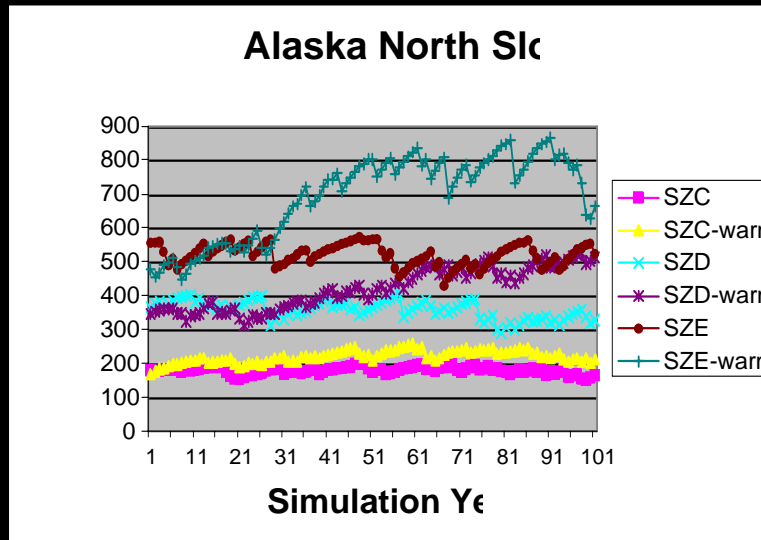
# Modeling future vegetation patterns



- BIOIME4 model of future vegetation patterns (Prentice et al. 1992, Kaplan et al. 2003).
- Coupled carbon and water-flux model that predicts steady-state vegetation distribution, structure and biogeochemistry.
- Will focus on the NAAT and Yamal transects, and use information from the study and a variety of other new circumpolar databases to improve parameterization in the model.

Courtesy of Jed Kaplan

# Modeling transient dynamics of the vegetation

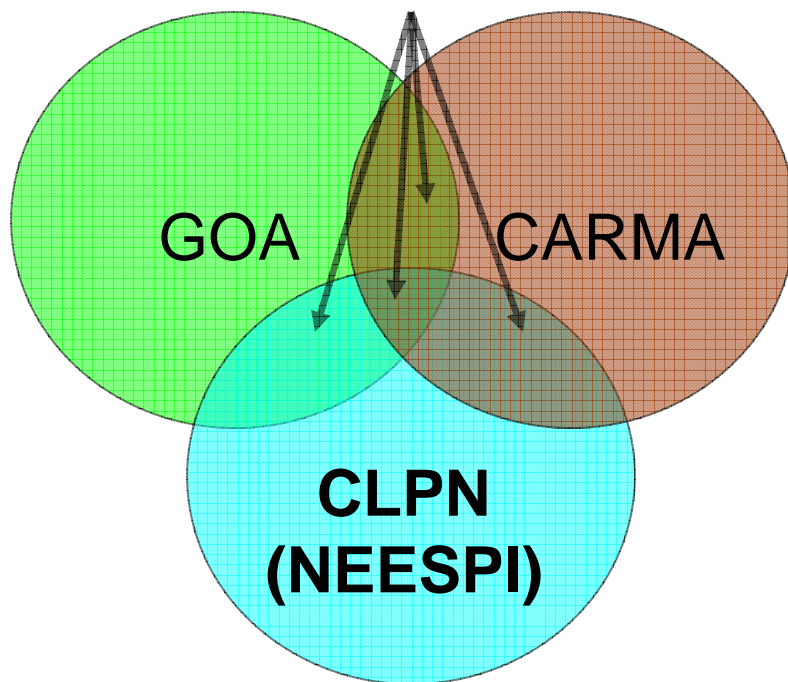


- ArcVeg model (Epstein et al. 2001, 2004) examines soil nutrient effects on interannual changes in tundra.
- Simulates changes to plant functional types, with nitrogen being the key limiting nutrient, the availability of which is driven by climate.
- Preliminary simulation shows the differences in production expected on the nutrient-rich soils of the Alaskan North Slope, vs the nutrient-poor soils of the Yamal.

Courtesy of Howie Epstein

# How this project is related to NEESPI and key International Polar Year (IPY) initiatives

## The Yamal LCLUC project



### *Intersection of 3 IPY initiatives:*

1. **GOA** - Greening of the Arctic (NSF, IPY)
2. **CARMA** - Circumpolar Arctic *Rangifer* Monitoring Assessment (NSF, IPY)
3. **CLPN** - Cold Land Processes in NEESPI

**LCLUC** - Land-cover/Land-use Change  
**NEESPI** - Northern Eurasia Earth Science Initiative