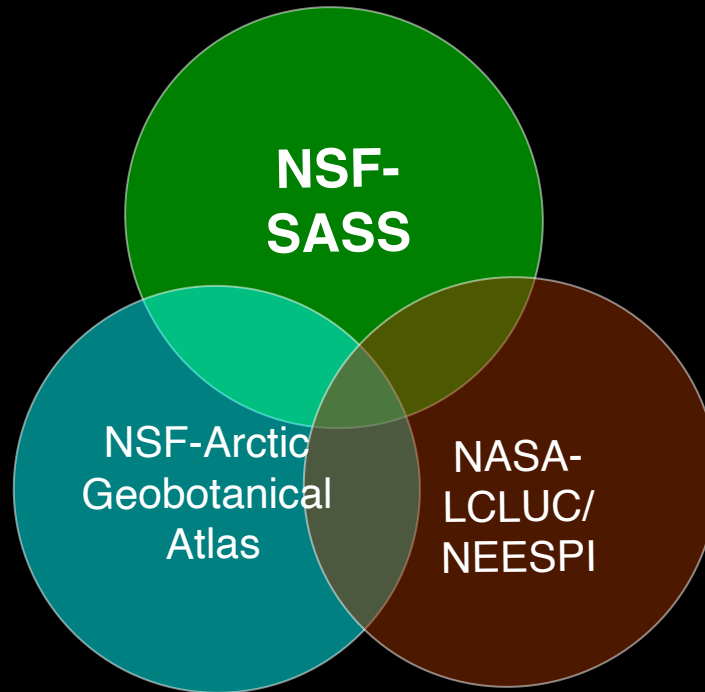


# Greening of the Arctic: Synthesis and models to examine pan-Arctic vegetation change

PIs --Skip Walker, Howie Epstein, Uma Bhatt

Photo: Shrub tundra, Yamal Peninsula by D.A. Walker

# Three Components of the GOA Project



**SASS-Synthesis of Arctic System Science**

**LCLUC-Land Cover/Land-Use Change**

**NEESPI/CLPN = Cold Land Processes in NEESPI (Northern Eurasia  
Earth Science Partnership Initiative)**

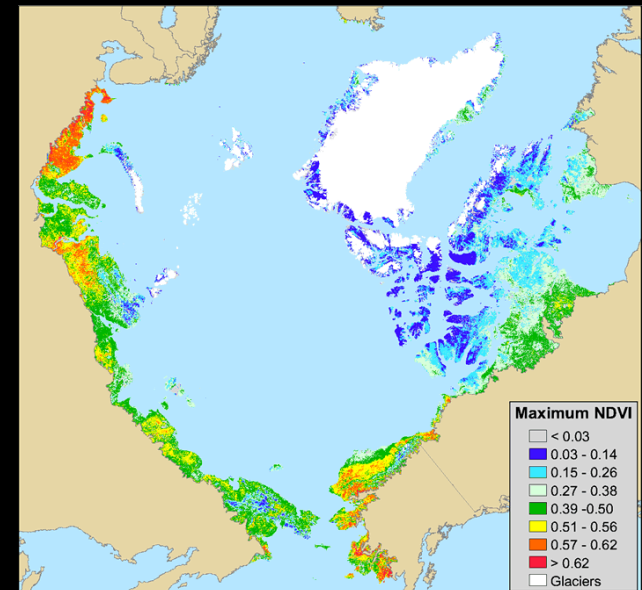
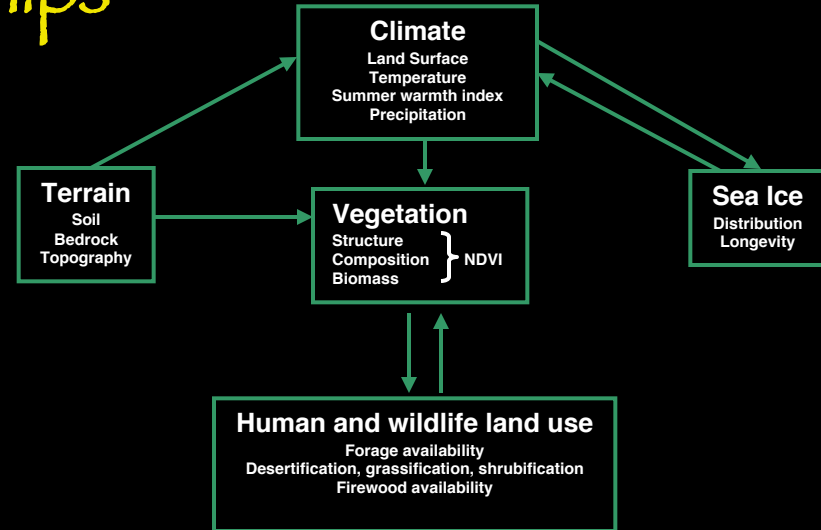
# Participants in the GOA project (all three components)

- *Uma Bhatt (UAF)*: Climate dynamics
- *Joey Comiso (NASA Goddard)*: Circumpolar sea-ice and land-surface temperatures
- *Howie Epstein, Qin Yu (U Va)*: NDVI, LAI, ArcVeg Model
- *Jiong Jia (Institute of Atmospheric Physics, Chinese Academy of Sciences)*  
Temporal analysis of circumpolar NDVI
- *Jed Kaplan, Heinke Lieschke (Swiss Federal Institute for Forest, Snow, and Landscape Research)*: BIOME4 modeling, Treeline modeling
- *Gary Kofinas (UAF) and Bruce Forbes (Arctic Centre, Finland)*: Human dimensions of Yamal transect
- *Marina Liebman and Natalia Moskalenko (Earth Cryosphere Institute, Moscow)*: Russian Yamal transect
- *Hilmar Maier, Edie Barbour*: Arctic Geobotanical Atlas web-site development
- *Corinne Munger*: Meso-scale analysis of NDVI patterns at Toolik Lake
- *Chein-Lu Ping and Gary Michaelson (UAF)*: Circumpolar soils
- *Martha Raynolds (UAF)*: Spatial analysis of circumpolar NDVI
- *Vlad Romanovsky (UAF)*: Permafrost and climate
- *Skip Walker (UAF), Patrick Kuss (U. Bern)*: Vegetation



# Unifying theme of GOA projects: Sea Ice – Land-surface-temperature – Greening – Human relationships

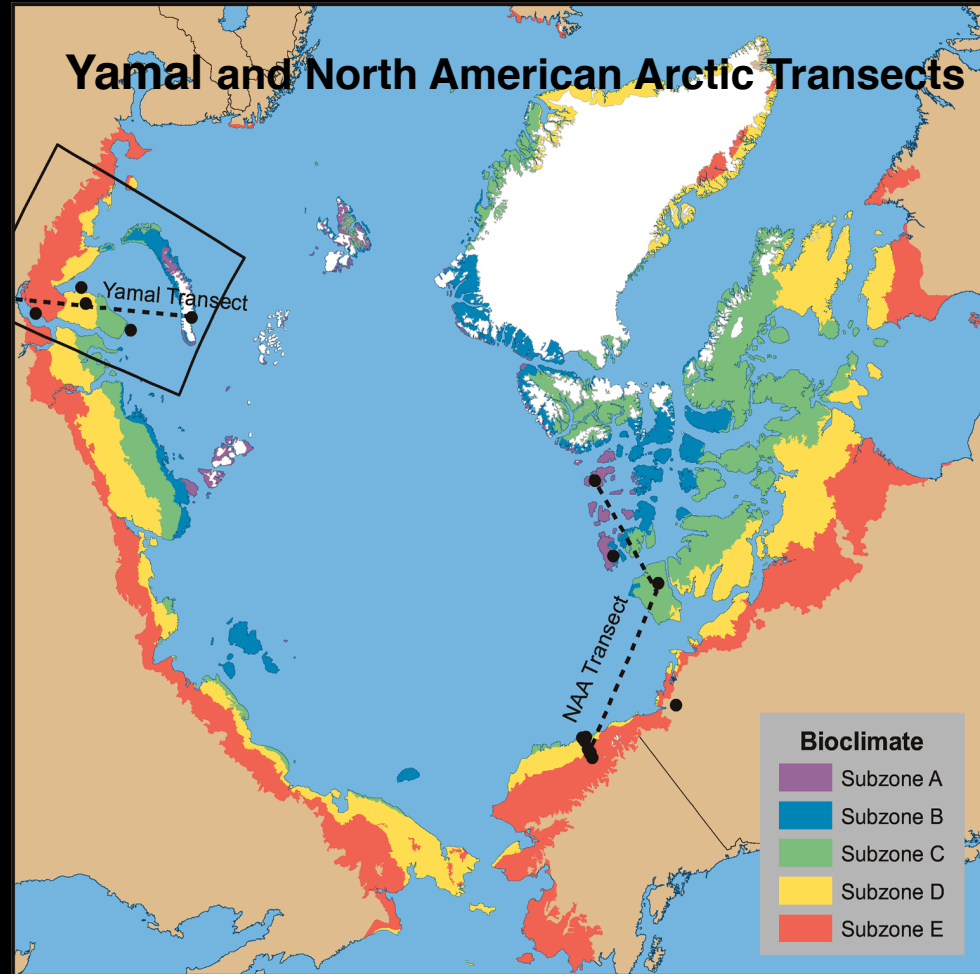
- Detailed examination of the 25-year record of greenness across the circumpolar Arctic as measured by the normalized difference vegetation index (NDVI) using satellite imagery.
- Modeling studies to predict future distribution of arctic vegetation.
- In Russia we are examining human/reindeer interactions with greening.





# GOA studies are focused along two Arctic transects.

- North America
- Eurasia
- through all five Arctic bioclimate subzones



# GOA transect on the Yamal Peninsula, Russia (Funded by NASA)

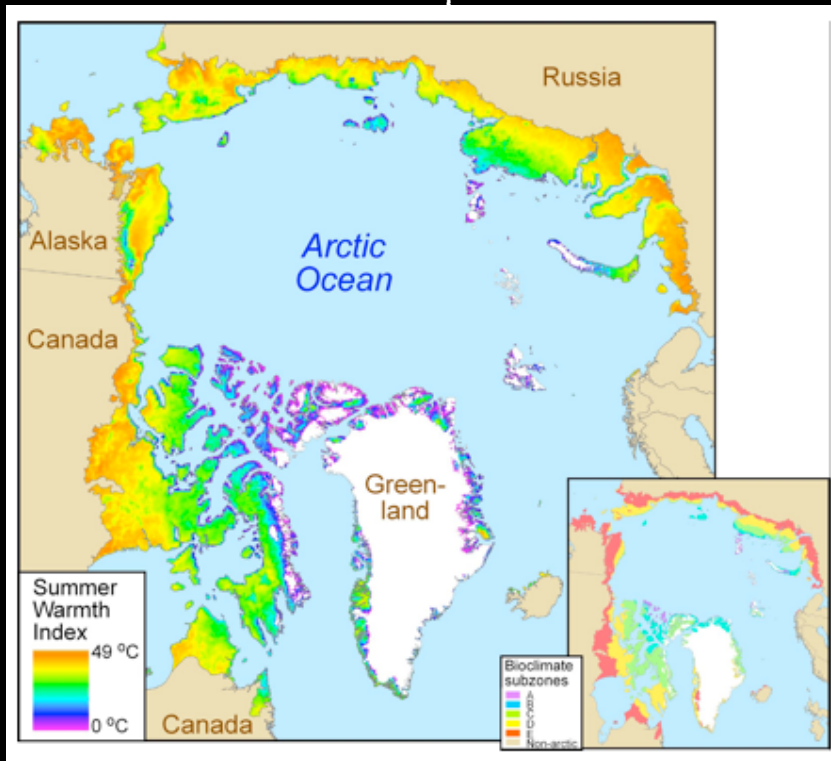


- Examines the linkages between greening trends, the range and forage for the reindeer of the Nenets people, and the regional sea-ice conditions.
- Linked to the Circumpolar Arctic *Rangifer* Monitoring and Assessment (CARMA) project, and the Cold Land Process in NEESPI (CLPN). NEESPI = Northern Eurasia Earth Science Partnership Initiative.

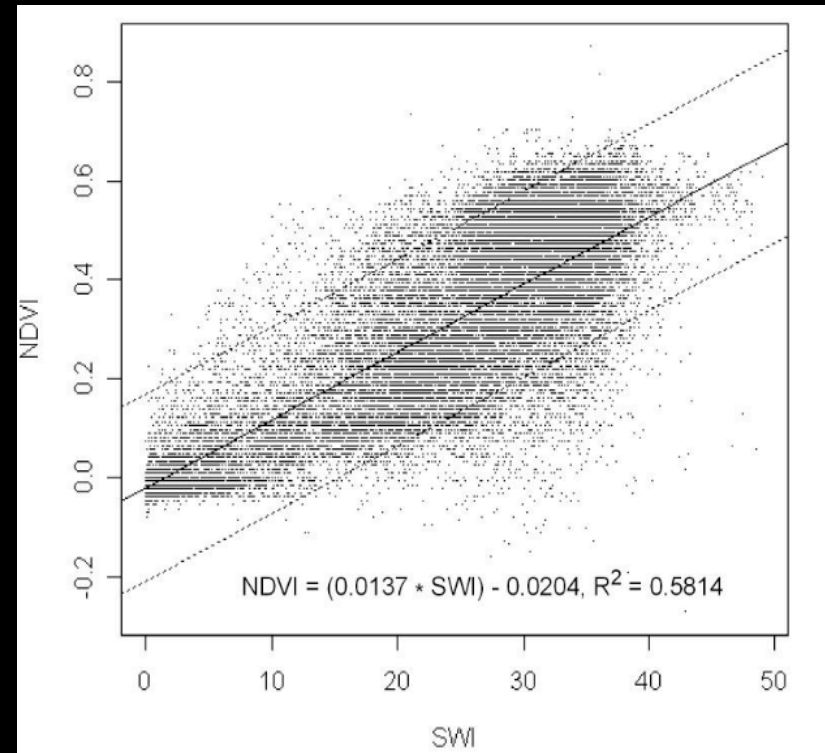


# Products: Spatial analyses of NDVI and Land surface properties

Land surface temperatures (LST)



NDVI vs. LST

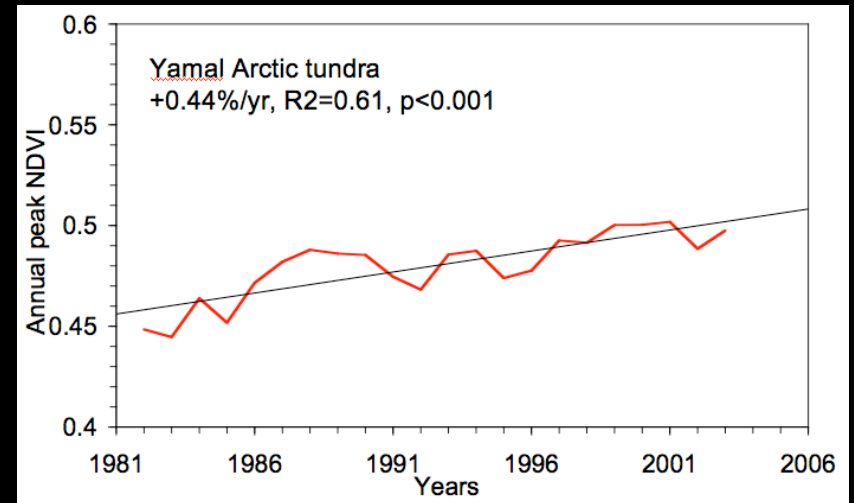
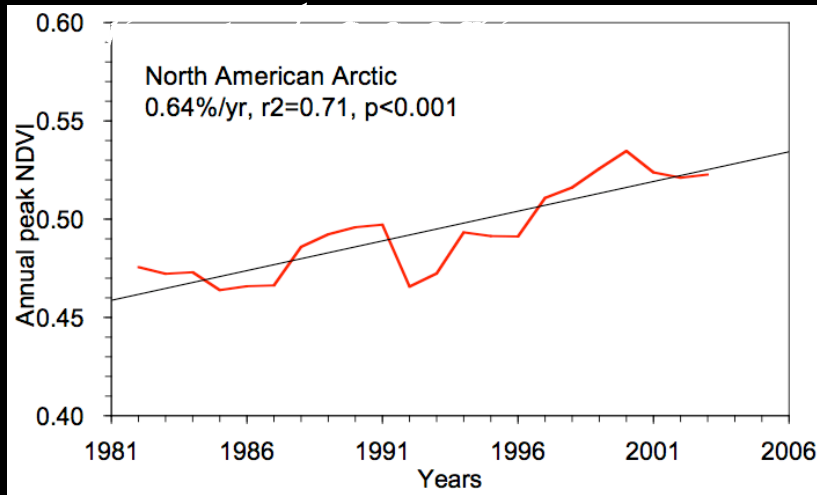


Raynolds et al. in press, *Remote sensing of the Environment*



# NDVI Temporal analyses

Transect analyses:



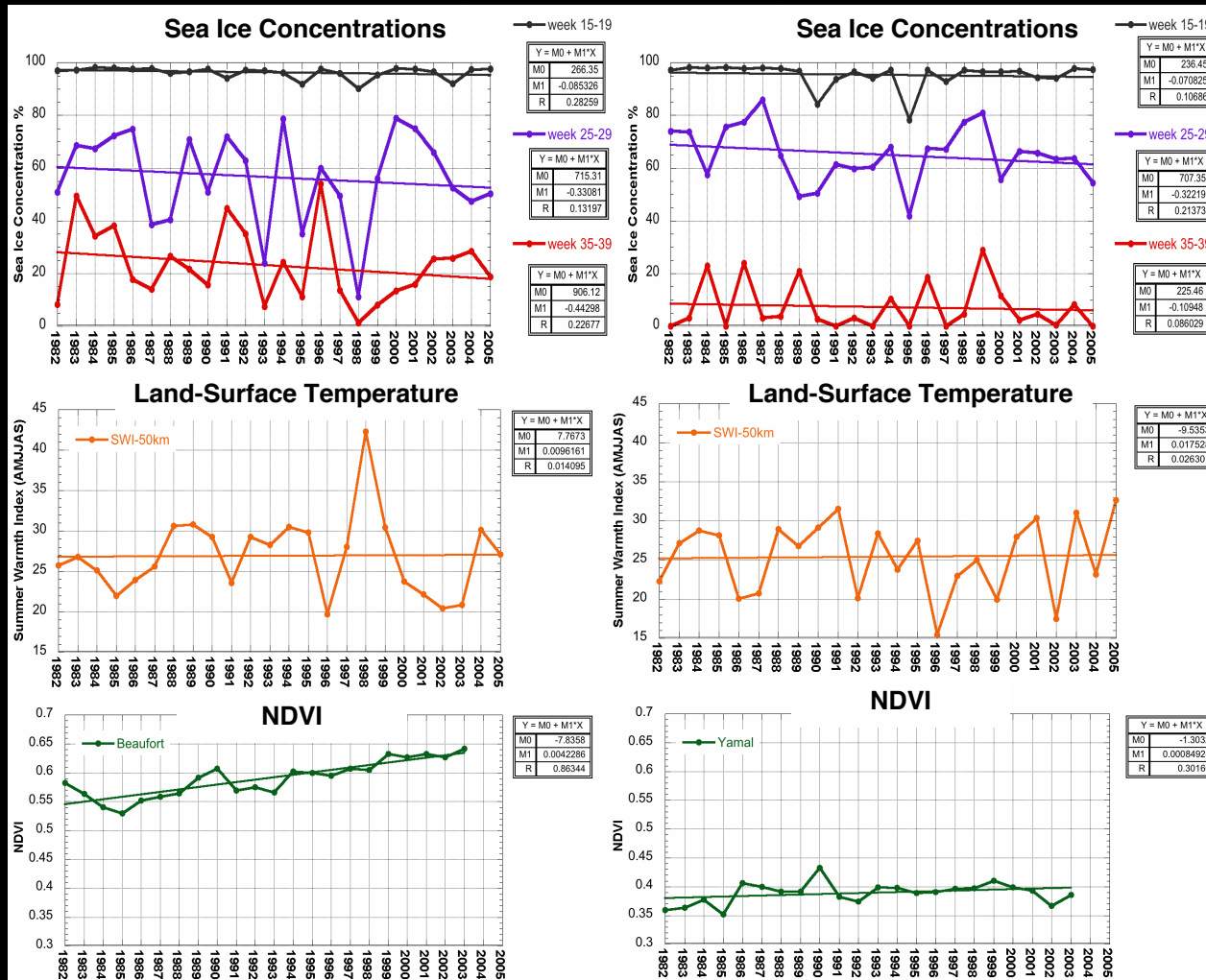
Jia et al. 2007 in press NOAA State of the Arctic Report

Pan Arctic Analysis in progress

# Time series sea-ice concentration, LST, and NDVI within 50 km of coast

## Beaufort Sea

## Kara Sea/Yamal



# Linkages between climate indices, sea-ice, LST, and NDVI

## Beaufort Sea

DJFM indices	Sea ice Week 25-29 avg	LST	NDVI
NAO	-----	<b>0.43</b> (95%)	-----
NAM	-----	0.30	0.30
NPI	-----	-----	0.12
ENSO	<b>-0.51</b> (99%)	0.37	-0.12
Siberian High	0.23	-0.27	<b>-0.43</b> (95%)
PDO	-0.26	-----	-0.33

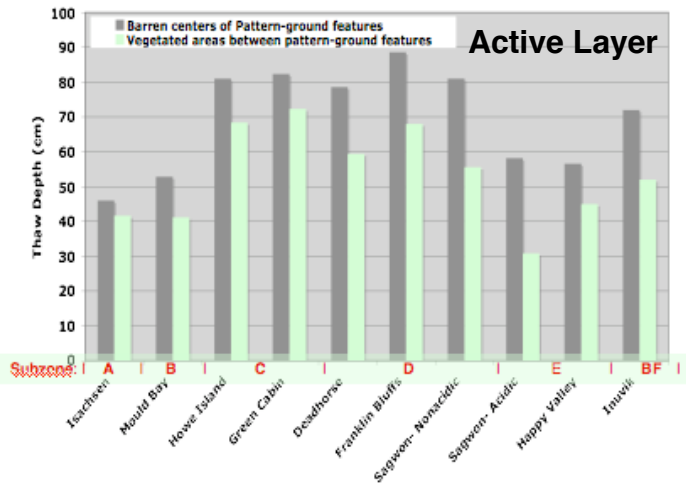
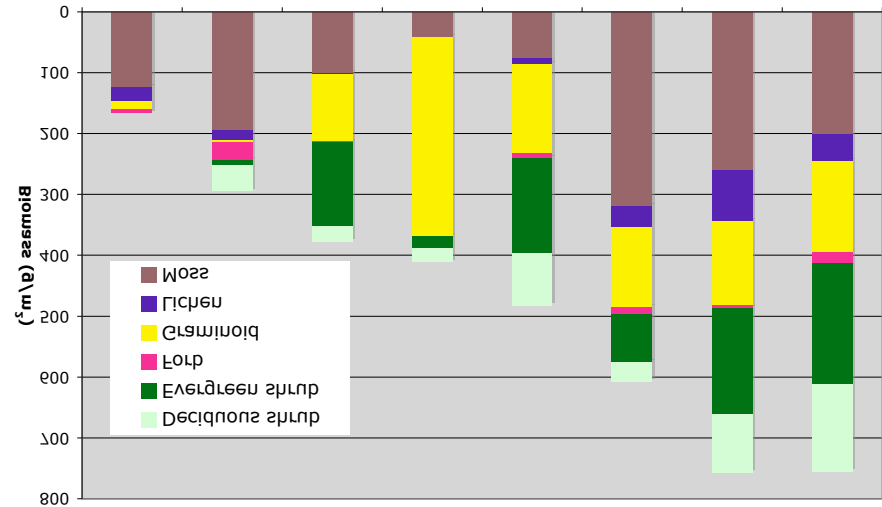
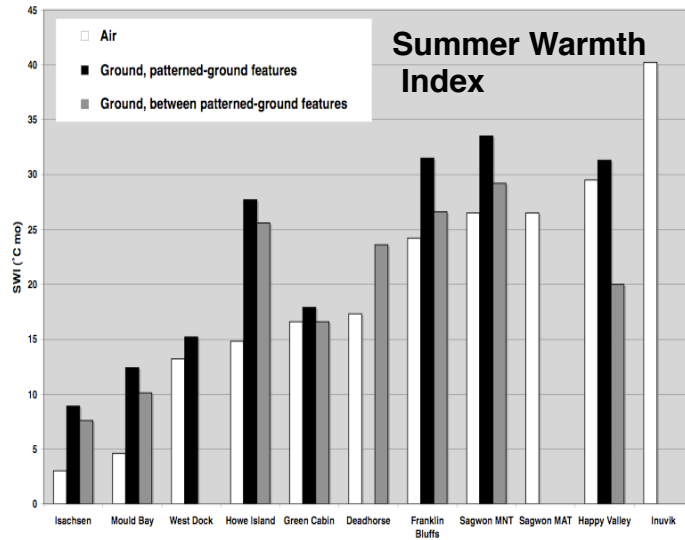
## Kara Sea/Yamal

DJFM indices	Sea ice Week 25-29 avg	LST	NDVI
NAO	<b>-0.50</b> (99%)	0.25	0.15
NAM	<b>-0.56</b> (99%)	-----	0.23
NPI	-0.35	-----	-----
ENSO	0.13	-----	-0.16
Siberian High	-----	0.15	-0.24
PDO	<b>0.48</b> (99%)?	-----	-0.12

Uma Bhatt, in progress



# Ground-observation trends along the NAAT and Yamal transects



## Soil Carbon



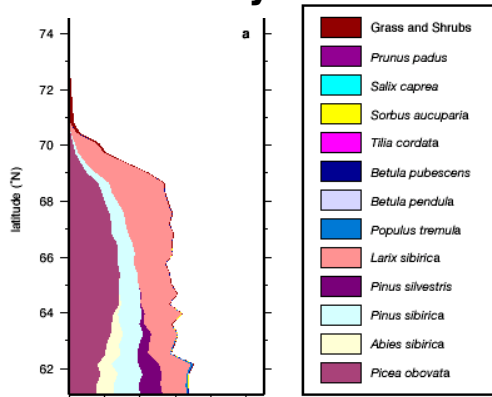
# Three modeling approaches: (1) Modeling transient dynamics of the plant species and plot level on the NAAT and Yamal transects using the ArcVeg model



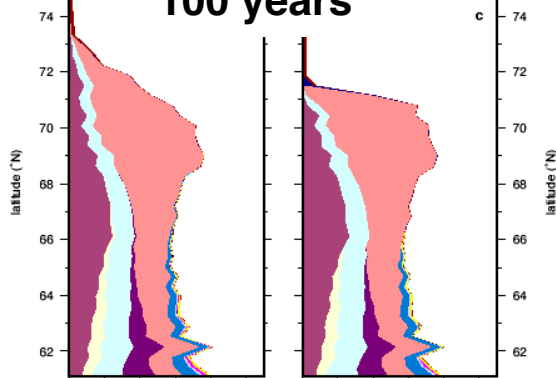
Models species response to changes in temperature and nutrients.

Epstein et al. 2007,  
*Computing in Sci. and Eng.*

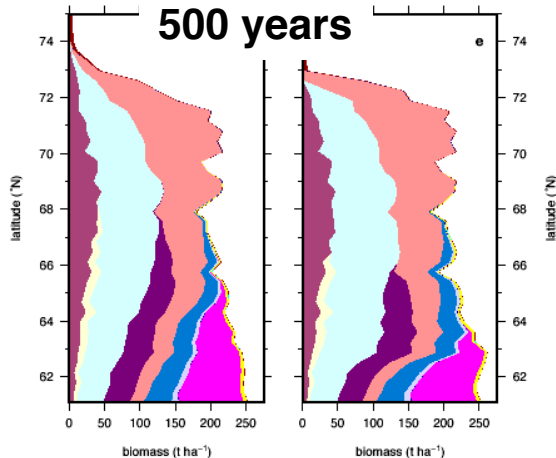
## Present day



100 years



500 years



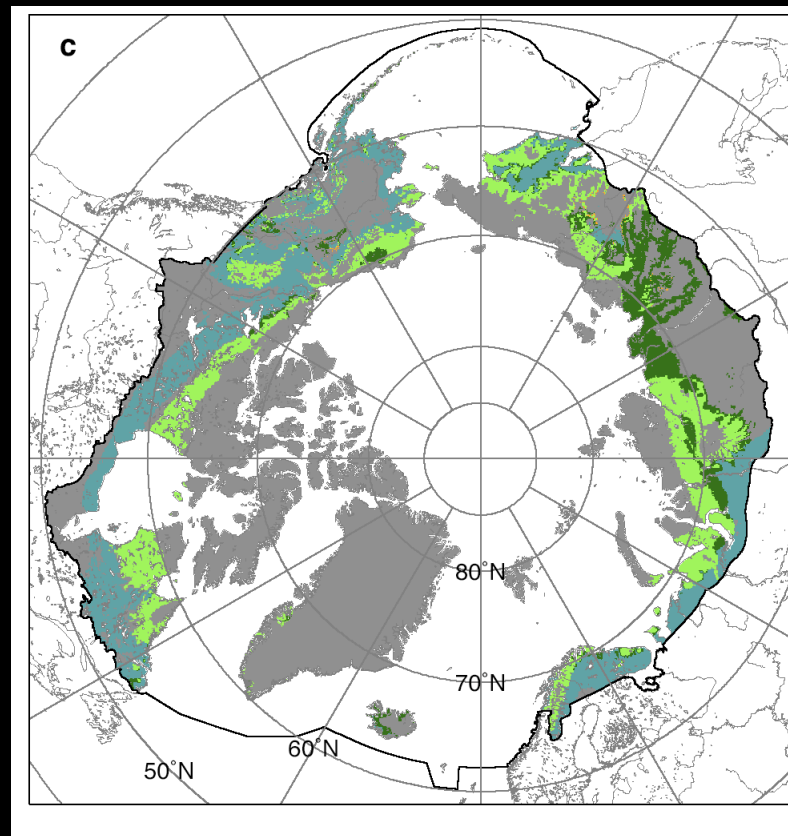
## (2) Changes in forest species composition along Siberian transect using TreeMig model

Models succession combined with dispersal and species migration rates

Lischke, H., T. J. Löffler, P. E. Thornton, and N. E. Zimmermann. 2007. Upscaling of biological properties and models to the landscape level, in *A changing world: challenges for landscape research*, edited by F. Kienast, et al., pp. 259-282, Kluwer, Dordrecht.



# Three modeling approaches: (3) BIOME4 simulation of vegetation change with change in global temperature



Models changes in global plant communities based on physiological response of plants.

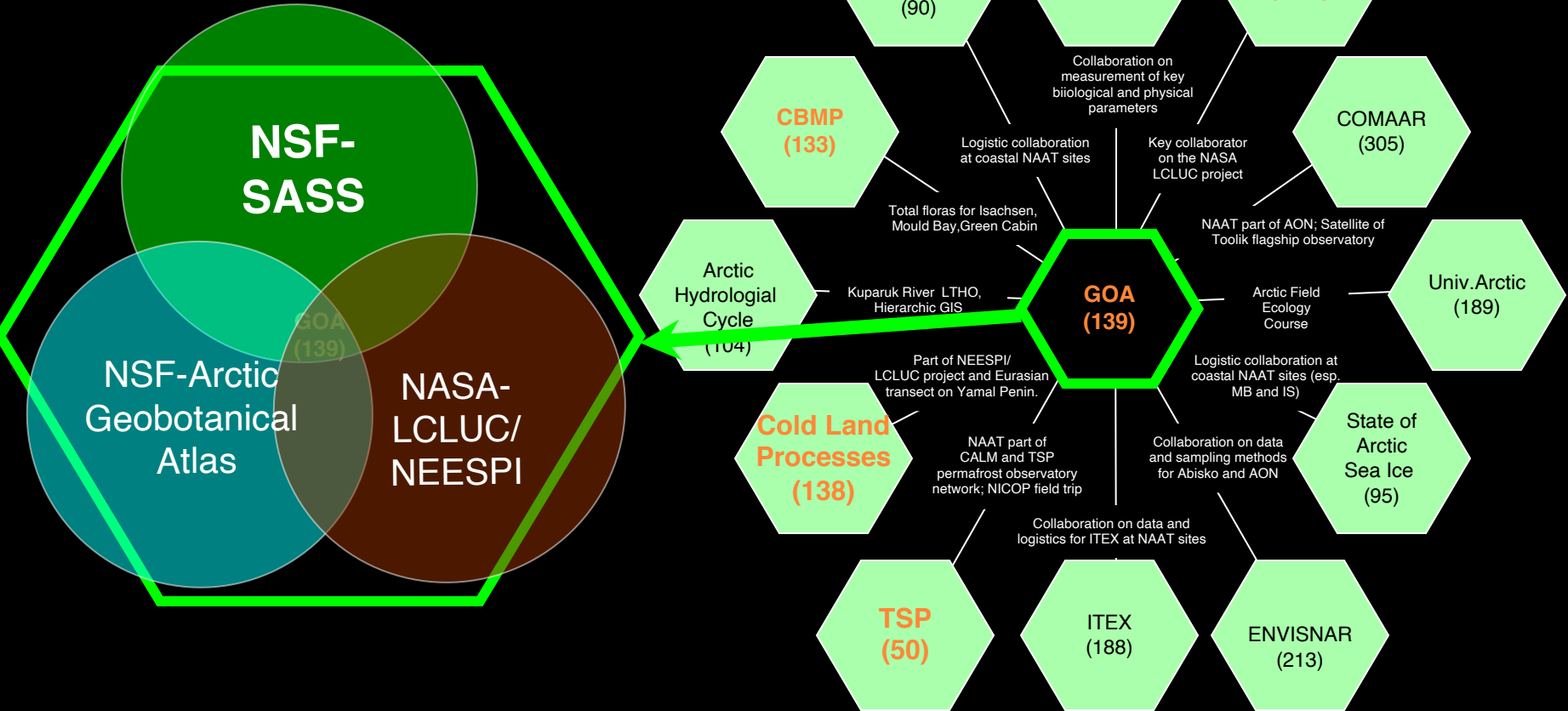
- Non-forest to parkland
- Parkland to forest
- Non-forest to forest
- Reduction of forest cover
- No change

Jed Kaplan in Epstein et al. 2007, *Computing in Sci. and Eng.*

# Integration:

## With other International IPY Initiatives

### Within GOA

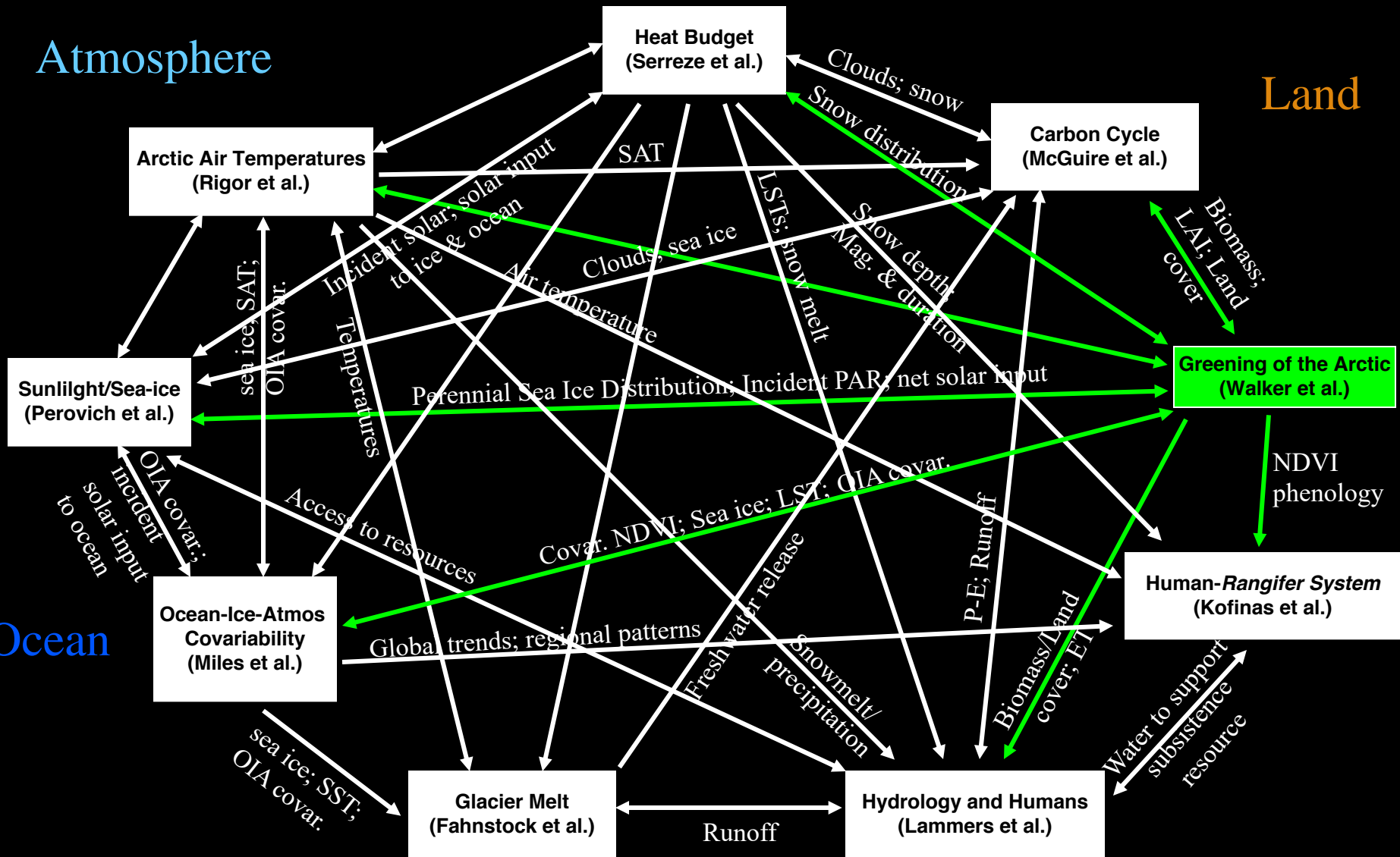


Numbers are IPY project ID numbers

# Within SASS Network

Atmosphere

Land



Ocean

Cryosphere

Humans

## *Approach to Synthesis*



- *Arctic Geobotanical Atlas* web site: <http://www.arcticatlas.org/>
- Hard copy and digital data reports from both NAAT and Yamal transects.
- Synthesis papers from the NAAT in progress for *JGR* special issue.
- Other synthesis papers from the NAAT
  - Kuss et al. Vegetation of the NAAT. *J. of Veg. Sci.*
  - Several papers and Field Trip Guide Book at the 9th International Conference on Permafrost
  - LCLUC book chapter
- Yamal Land Cover/Land-Use Change workshop, Moscow, Jan 2008