



# Patterns of NDVI in Arctic Tundra from Local to Circumpolar Scales



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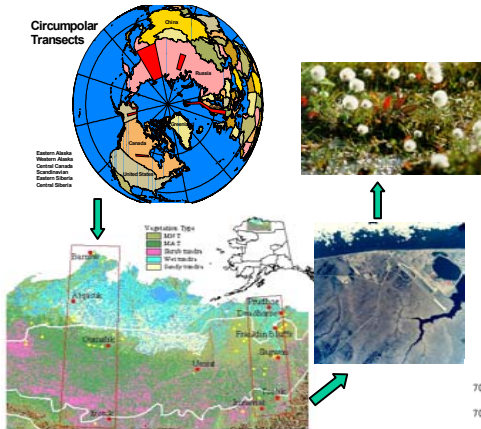
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## Introduction

Normalized difference vegetation index (NDVI) is considered to be a major indicator of vegetation features such as LAI and biomass. The features of daily repeating and large spatial coverage make the NDVI derived from NOAA-AVHRR sensors a useful source for monitoring spatial gradients and temporal changes of vegetation for large and remote regions like the circumpolar Arctic.

In this study, we examined the spatial and temporal patterns of NDVI in the Arctic at different spatial scales from field sample site (Ivotuk and Toolik), to regions (northern Alaska) to circumpolar, using AVHRR-NDVI that was derived from a one-year monthly time series for circumpolar and a 10-year biweekly time series of AVHRR data for Alaska.

## Circumpolar Transsects



## Method and Analysis

### 1) Local scale:

**NDVI:** measurements in 100x100-m grids or 2 50-m transects using hand-held radiometers.

**Biomass:** clip harvest of 6-10 20x50-cm plots at each study site.

**LAI:** Licor LAI-2000, mean value of 100 measurements along 2 50-m transects or 80 points within 100x100-m grids.

**Regression:** NDVI vs. phytomass, NDVI vs. LAI

### 2) Regional scale (North Slope):

Calculating Time-Integrated NDVI (TI-NDVI) and Annual-Peak NDVI from 1991-1999

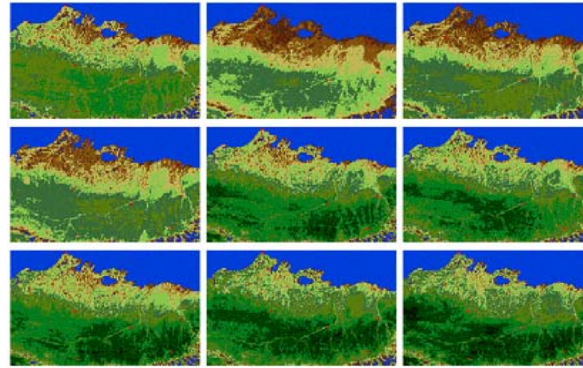
Peak-NDVI with 0.1 degree latitude interval for the two Alaskan transects in last decade: gradients of NDVI and its variance. Peak NDVI: mean value 1990-1999; variance: temporal variation 1990-1999.

### 3) Circumpolar:

Stratify circumpolar NDVI map according to bioclimate subzones.

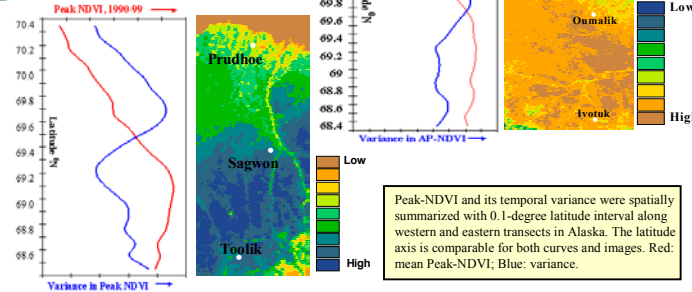
Use regression of NDVI vs. phytomass from Alaska to extrapolate to the circumpolar arctic.

## Regional – North Slope



TI-NDVI, 1991 - 1999

Time-Integrated NDVI (TI-NDVI), an integrated index of annual NDVI, calculated by sum of growing season NDVI within a year. From upper left to lower right: 1991 - 1999



Peak-NDVI and its temporal variance were spatially summarized with 0.1-degree latitude interval along western and eastern transects in Alaska. The latitude axis is comparable for both curves and images. Red: mean Peak-NDVI; Blue: variance.

## Results

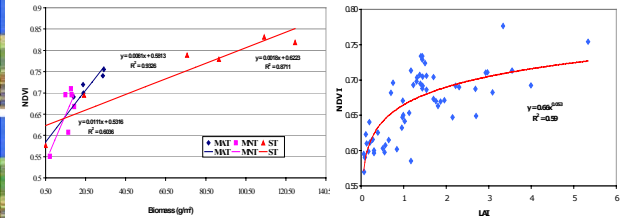
NDVI is positively correlated with plant biomass and LAI in northern Alaska, and all three variables on nonacidic substrates (MNT) are lower than on acidic substrates (MAT).

There are slightly but constant increase of peak NDVI and Time Integrated NDVI from 1992-1999 in most of the region and at selected sites. From 1990-91 to 1998-99, both Peak-NDVI and TI-NDVI increased in the region; though TI-NDVI has greater increase (up to 57% vs 31%). Both indices increase greater in Foothills than in Coastal Plain.

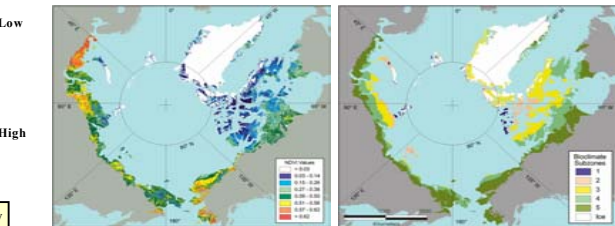
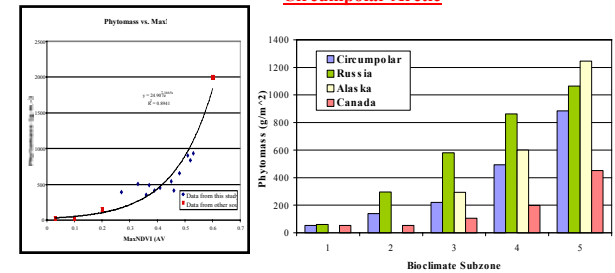
Spatial patterns of annual Peak NDVI: lower and slight increase in the Coastal Plain, steep increase in transitional zone, a higher value in Foothills and slightly drop towards Brooks Range; higher variations in Peak-NDVI found near the coast and at the transitional zone.

Circumpolar extrapolations of NDVI from regressions developed in Alaska offer reasonable estimates of phytomass and phytomass density within each of the arctic bioclimate subzones.

## Local – Ivotuk, AK



## Circumpolar Arctic



## Ongoing Activities:

Analyzing NDVI, phytomass and LAI data from 2001 fieldwork and literature to continue to improve our models of NDVI vs. phytomass and NDVI vs. LAI;

Calculating decadal changes (1991-1999) of NDVI in northern Alaska in correspondence to ecoregions and tundra types;

Investigating spatial patterns of TI-NDVI and Peak-NDVI for high latitude transitional zones (tree line, MNT-MAT, high-low Arctic, etc.) and extrapolating phytomass data along the transects.

## Literature Cited:

Jia, G. J., H. E. Epstein, and D. Walker, 2001. Spatial characteristics of AVHRR-NDVI along latitudinal transects in northern Alaska. *Journal of Vegetation Science* (Accepted)  
Muller, S. V., A. E. Racoviteanu and D. A. Walker, 1999. Landsat MSS-derived land-cover map of northern Alaska: extrapolation methods and a comparison with photo-interpreted and AVHRR-derived maps. *International Journal of Remote Sensing* 20 (15 & 16): 2921 - 2946  
Walker, D. A., H. E. Epstein, G. J. Jia, A. Balsar, C. Copass, E. J. Edwards, W. A. Gould, J. Hollingsworth, J. Knudson, H. Meier, A. Moody, and M. K. Reynolds, 2002. Phytomass, LAI, and NDVI in northern Alaska: relationships to summer warmth, soil pH, plant functional types and extrapolation to the circumpolar Arctic. *Journal of Geophysical Research* (In press)