CIRCUMPOLAR ARCTIC VEGETATION AND GREENNESS: A SPATIAL ANALYSIS OF THE DISTRIBUTION PATTERNS AND THE EFFECTS OF CLIMATE AND SUBSTRATE

A DISSERTATION

Presented to the Faculty
of the University of Alaska Fairbanks

in Partial Fulfillment of the Requirements
for the Degree of

DOCTOR OF PHILOSOPHY

By

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Fairbanks, Alaska

August 2009
Abstract

This objective of the research presented in this dissertation was to better understand the factors controlling the distribution of arctic vegetation, and their effects on present and potential future spatial distribution of that vegetation. The research uses the Circumpolar Arctic Vegetation Map (CAVM) and other recently available circumpolar data sets. I used geographical information system (GIS) software to overlay the CAVM with a satellite greenness index (normalized difference vegetation index, NDVI) and environmental factors that are most important in controlling the distribution of arctic vegetation, including summer temperature, landscape age, precipitation, snow cover, substrate chemistry (pH and salinity), landscape type, elevation, permafrost characteristics, distance to sea. I also used boosted regression tree modeling techniques to understand the relative importance of different environmental characteristics for different vegetation types and for different regions.

Some of the most valuable results of this research are the maps, charts and tables that summarize and display the spatial characteristics of arctic vegetation. The data for arctic land surface temperature and landscape age are important new resources for researchers. These results are available electronically, not only providing summary data, but also GIS data with a spatial context (www.arcticatlas.org). The results emphasize the value and reliability of NDVI for studying arctic vegetation. The spatial analysis corroborated the relationship between increases in NDVI and temperature seen over the
satellite record. Summaries of arctic biomass based on NDVI match those based on extrapolation from ground samples. The modeling confirmed the importance of summer temperatures in controlling arctic vegetation. It also demonstrated the importance of the age of landscapes in understanding the spatial distribution of arctic vegetation, and the importance of the interactions between vegetation and soils in modifying the soil and permafrost characteristics and thus changing the environment for plants.

As the world continues to focus on the Arctic as an area undergoing accelerated warming due to global climate change, this study’s documentation of existing vegetation types and their relationship to the factors most important in controlling their distribution will become more and more valuable.
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