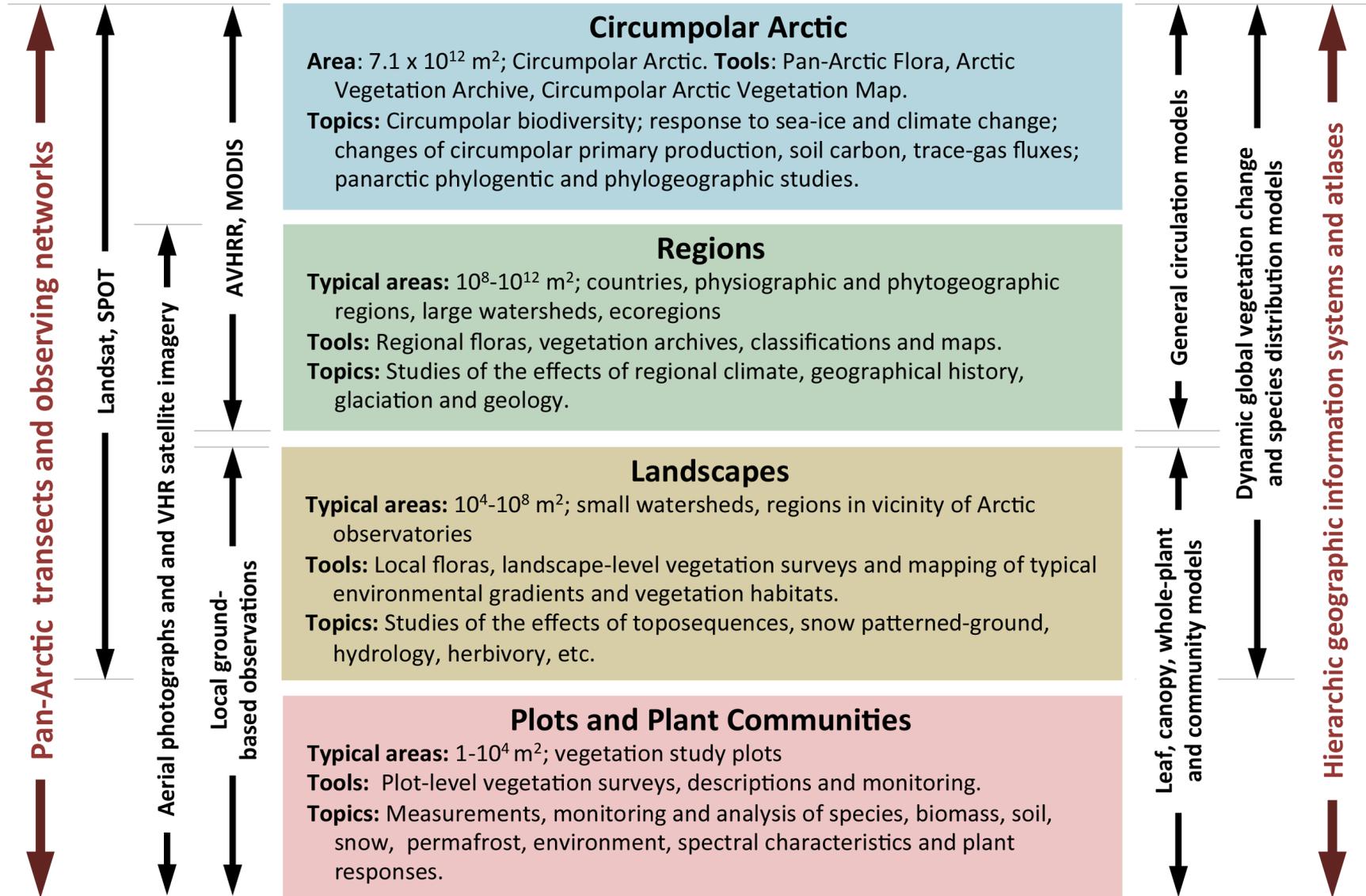


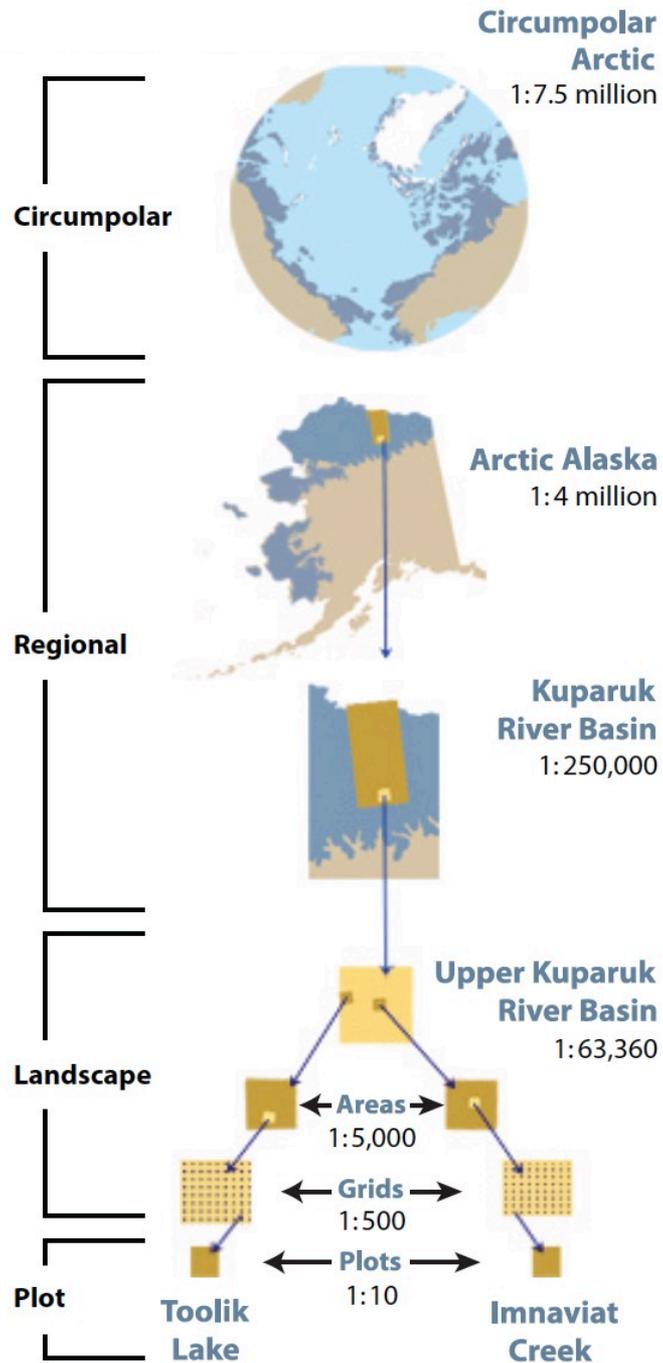
# A hierarchic framework for studying Arctic vegetation

Remote sensing  
and ground-based  
monitoring tools

Scales, size of areas, typical topics, other resources

Integration and  
modeling tools





# Hierarchy of mapping scales and relevant vegetation and productivity topics for northern Alaska

## Circumpolar:

- Circumpolar biodiversity and productivity variation due to global climate, land temperatures, sea-ice distribution.

## Regional:

- Variation due to geology, macro-topography, climate, glacial and marine history, parent material, large-scale disturbance regimes.

## Landscape:

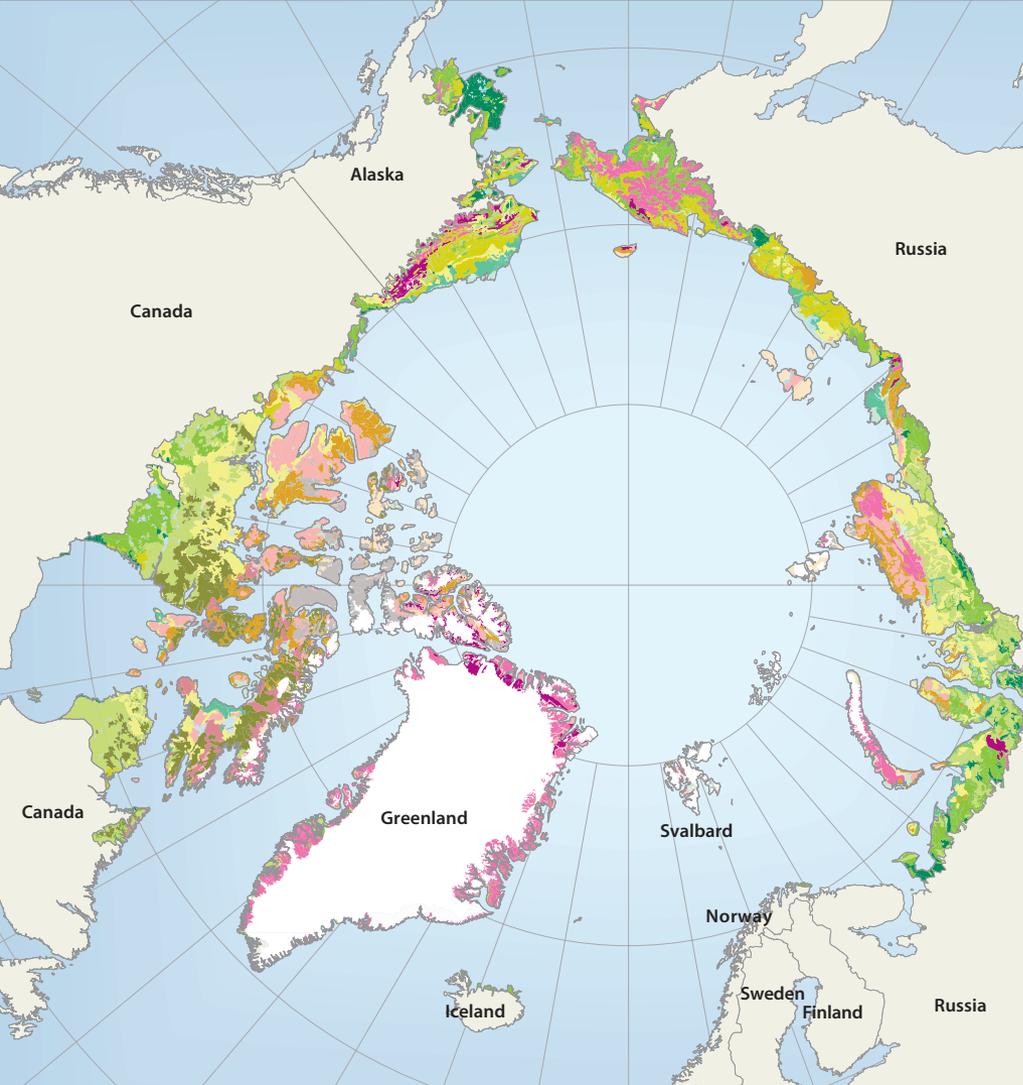
- Variation due meso-topography, landscape water and snow distribution.

## Plot:

- Variation due to patterned ground, micro-topographic variations, small scale disturbances.

# The Circumpolar Arctic Vegetation Map

- Provides a consistent pan-Arctic framework for studying and monitoring change of Arctic Vegetation.



## Barrens

- B1 - Cryptogam-herb barren
- B2 - Cryptogam-barren complex (bedrock)
- B3 - Non-carbonate mountain complex
- B4 - Carbonate mountain complex

## Graminoid tundras

- G1 - Rush/grass, forb, cryptogam tundra
- G2 - Graminoid, prostrate dwarf-shrub, forb tundra
- G3 - Non-tussock sedge, dwarf-shrub, moss tundra
- G4 - Tussock sedge, dwarf-shrub, moss tundra

## Prostrate dwarf shrubs

- P1 - Prostrate dwarf-shrub, herb tundra
- P2 - Prostrate/hemi-prostrate dwarf-shrub tundra

## Erect dwarf shrubs

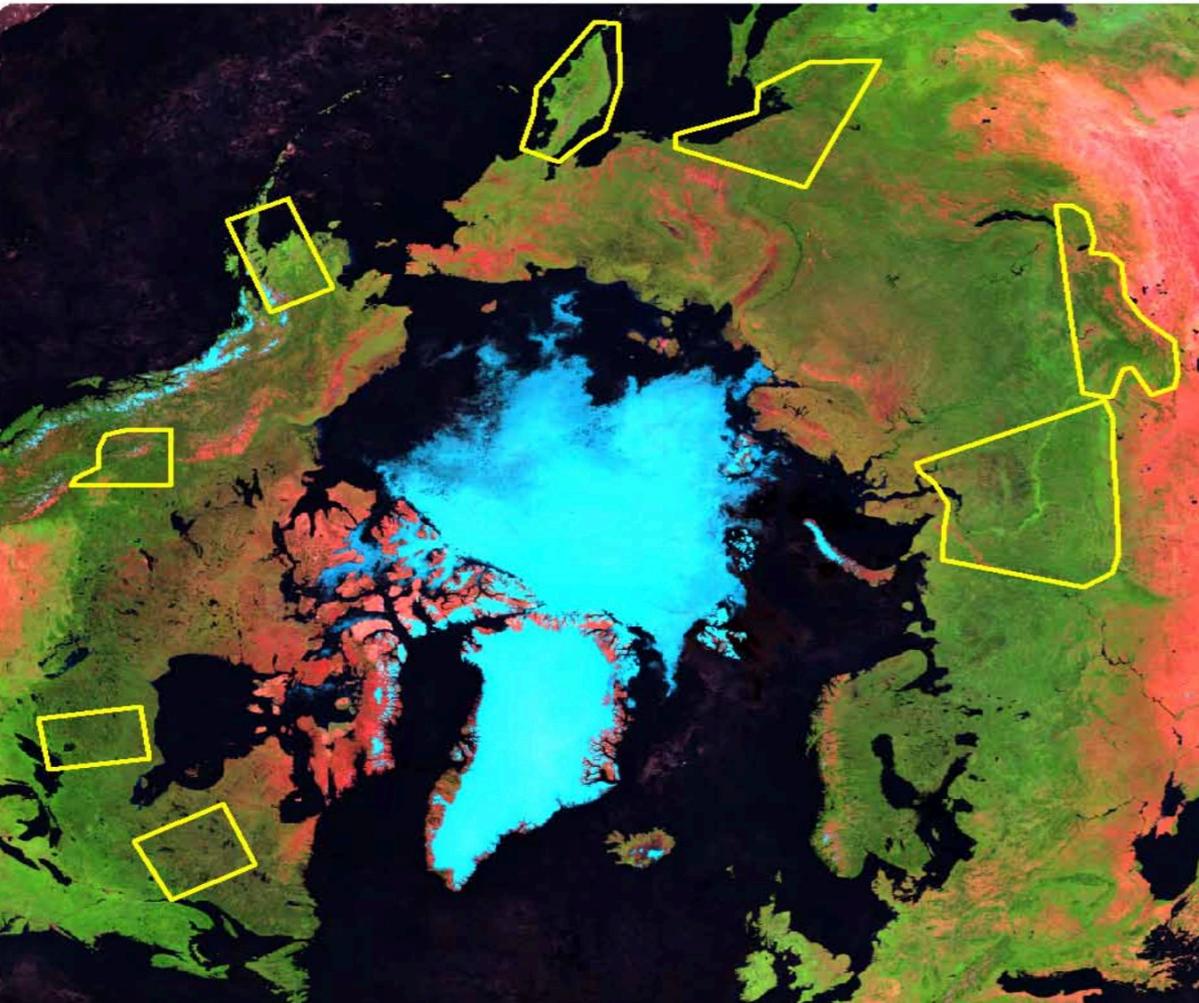
- S1 - Erect dwarf-shrub tundra
- S2 - Low-shrub tundra

## Wetlands

- W1 - Sedge/grass, moss wetland
- W2 - Sedge, moss, dwarf-shrub wetland
- W3 - Sedge, moss, low-shrub wetland

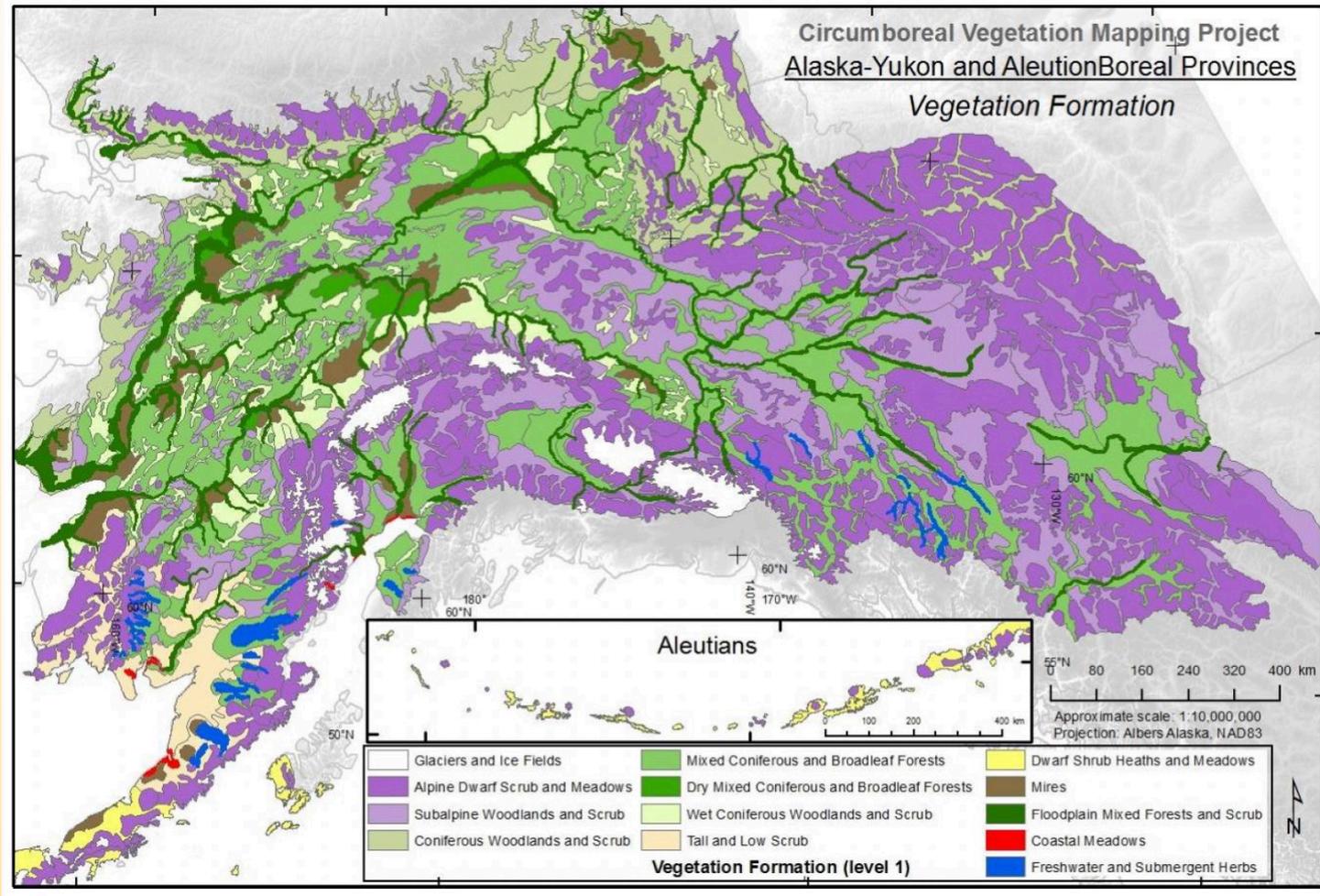
## Circumboreal Vegetation Map (CBVM) *Mapping the Green Halo* CONCEPT PAPER

# Circumboreal Vegetation Map (CBVM)

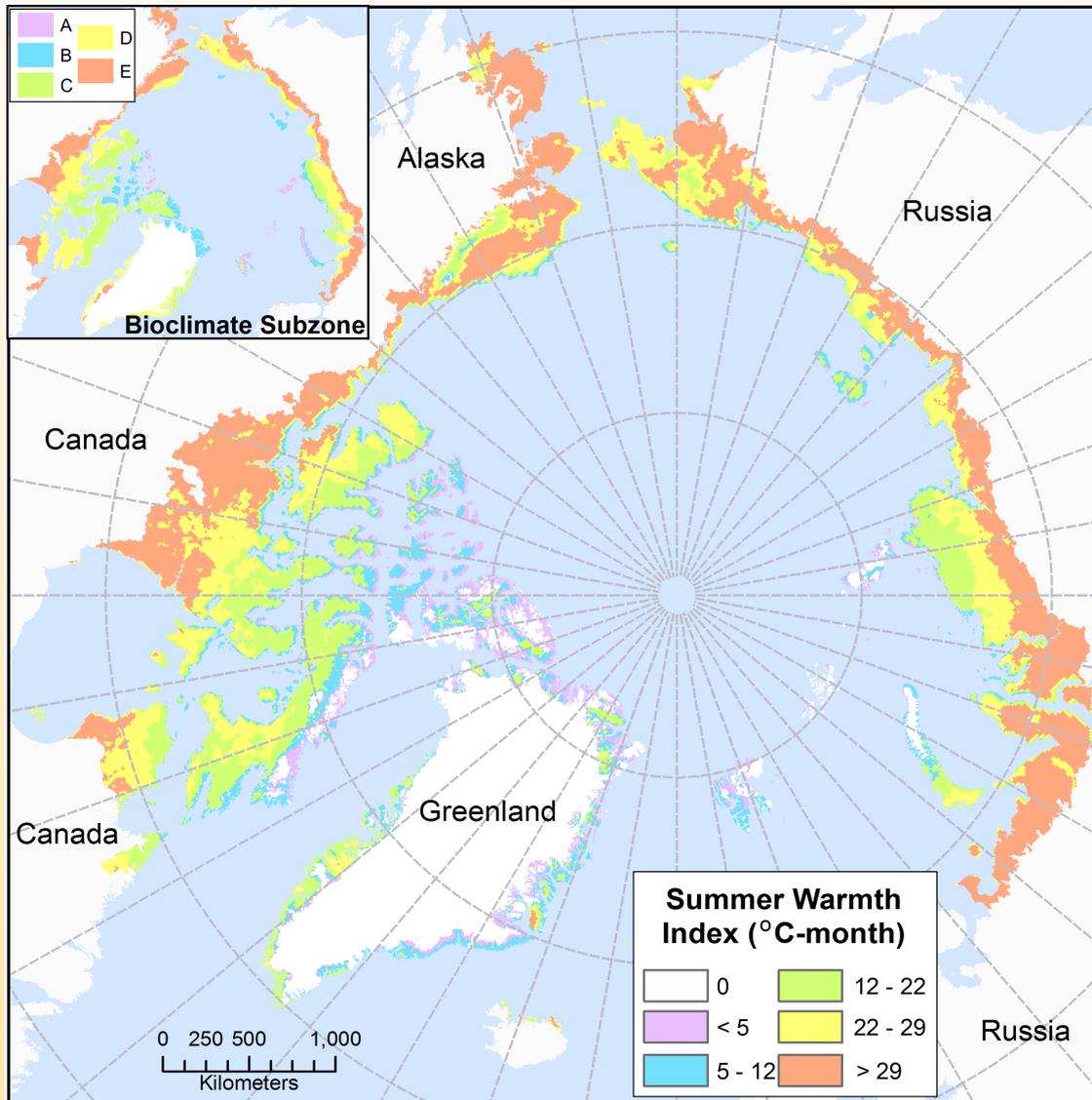


- MODIS base
- Becci Anderson:  
USGS
- Plan to link map  
and legends with  
CAVM.

# Jorgenson Boreal Alaska-Yukon-Aleutian Map



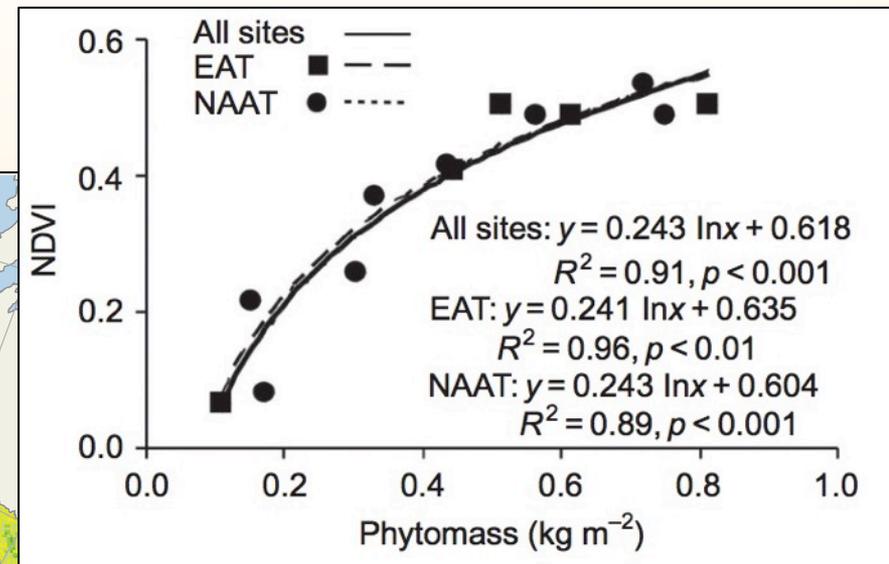
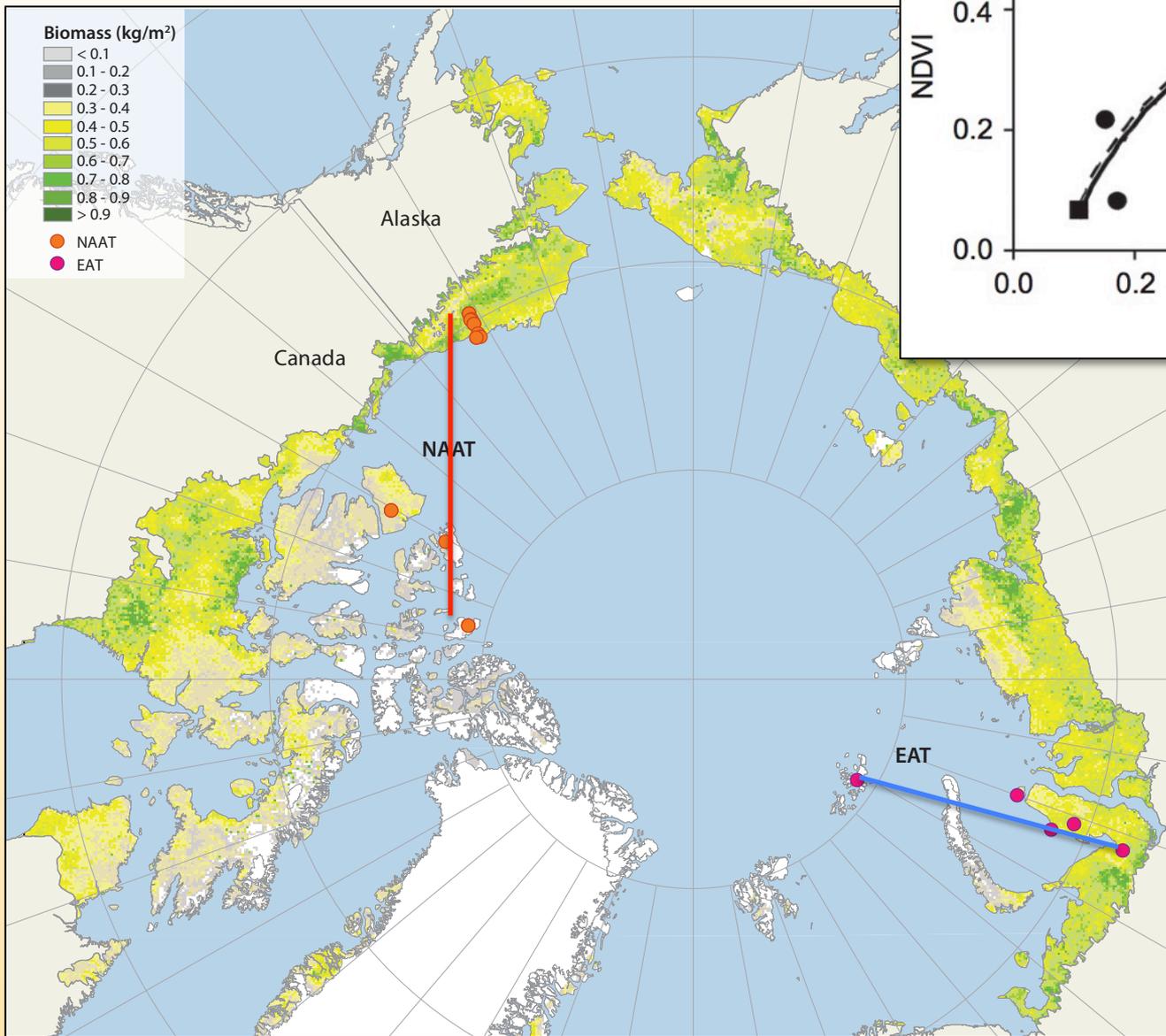
# Correspondence between CAVM subzones and AVHRR- derived total summer warmth at the ground surface



**Inset map:** CAVM bioclimate subzones.

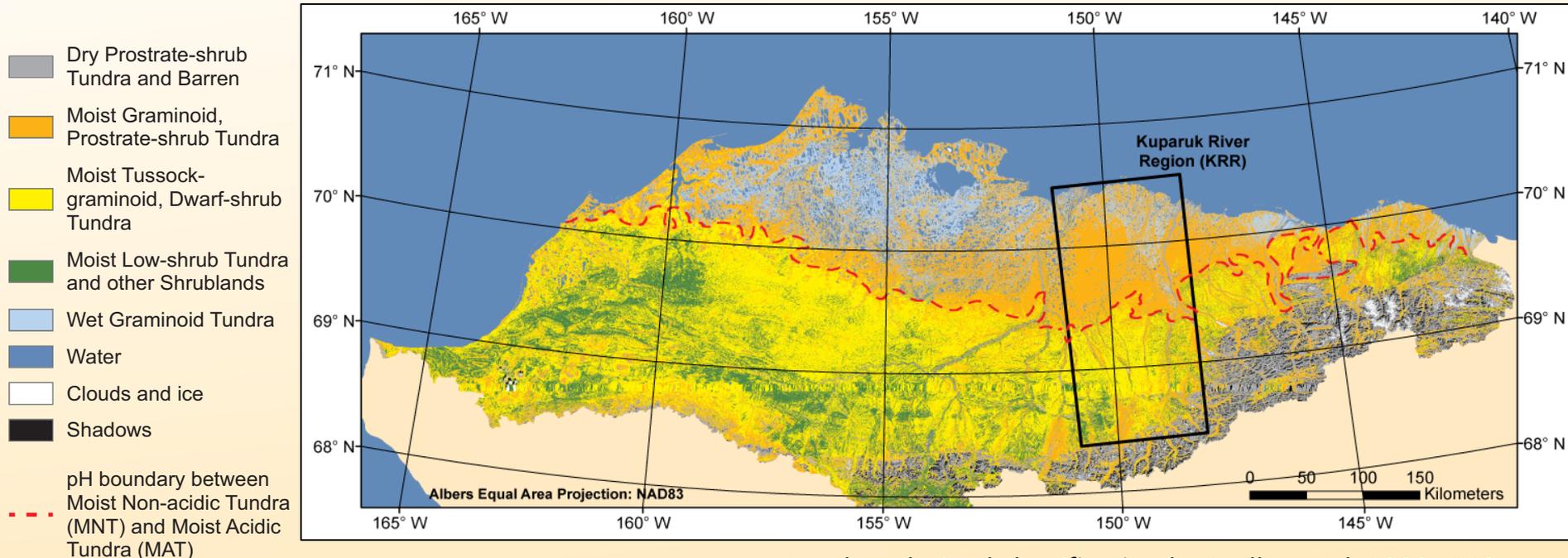
**Main map:** Zonation derived from AVHRR-derived ground surface temperatures.

- Summer warmth index (SWI) is the sum of mean monthly temperatures above 0°C (1982-2003) (Raynolds et al. 2008).
- **Strong general correspondence between the two maps.**



**NDVI vs. total aboveground phytomass relationship is nearly the same along both transects.**

# Regional scale, North Slope, Alaska



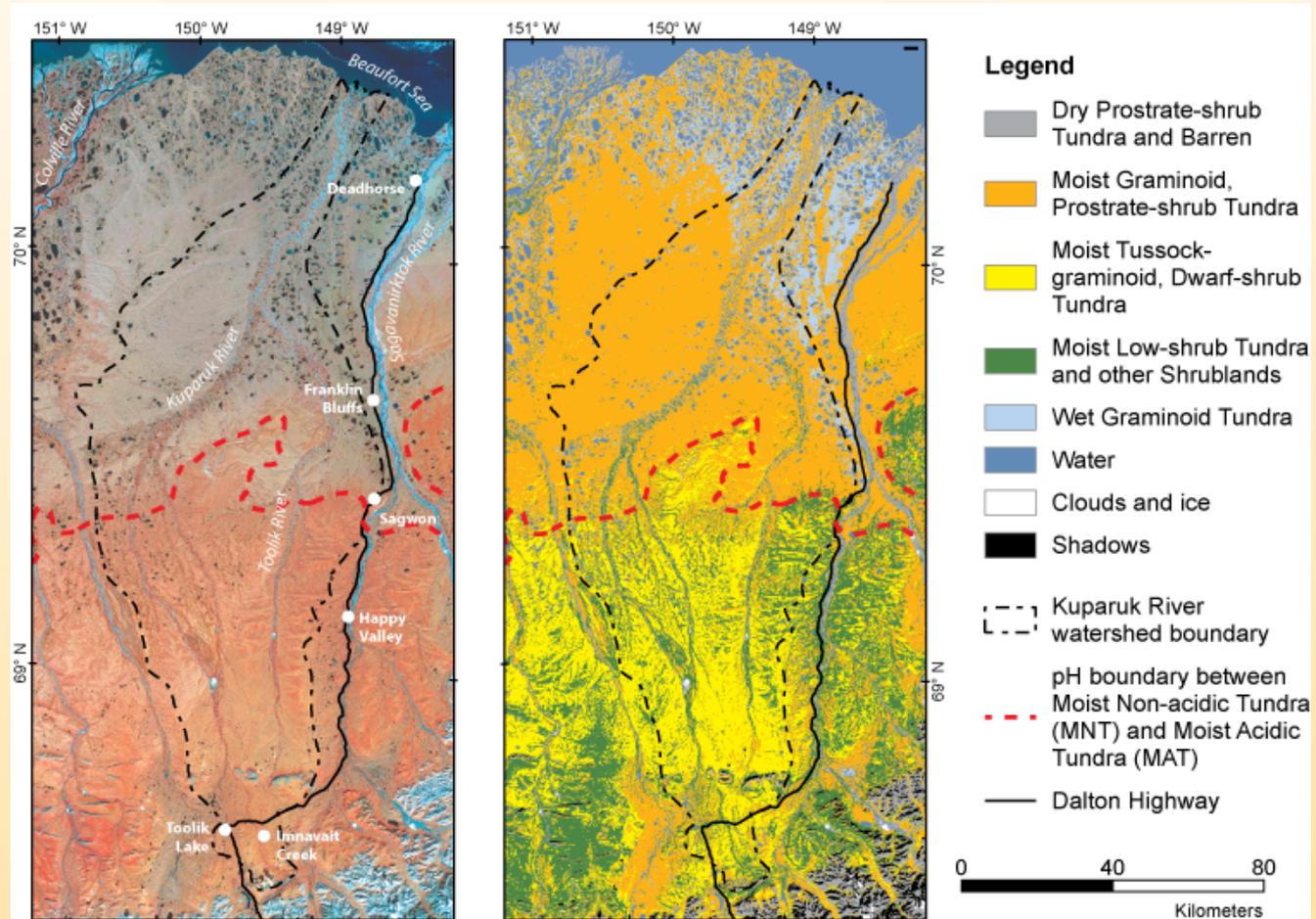
Landsat-derived classification by Muller et al. 1999. *IIRS*.

- Boundary between graminoid, prostrate-dwarf-shrub dominated tundra and graminoid erect-dwarf-shrub tundra is striking.
- Corresponds to a climatic boundary (subzone D and E) and pH boundary (nonacidic and acidic).

# Kuparuk River region and Dalton Hiway Transect

LANDSAT  
False-color infrared

Vegetation

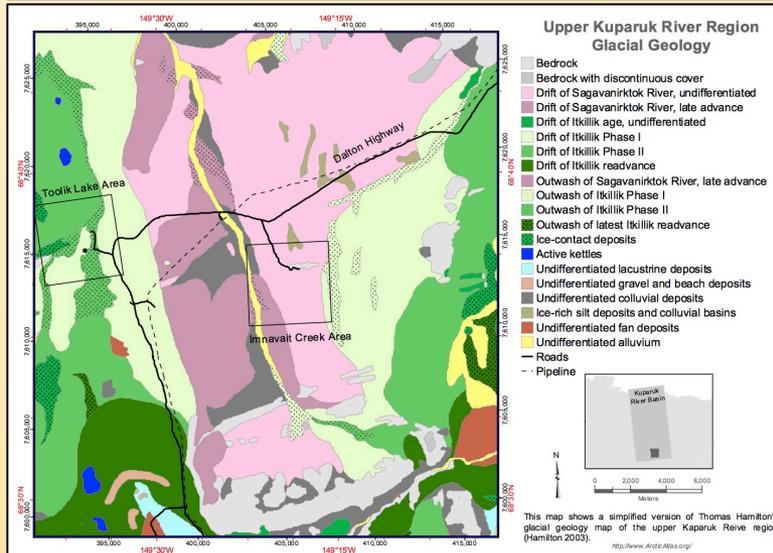
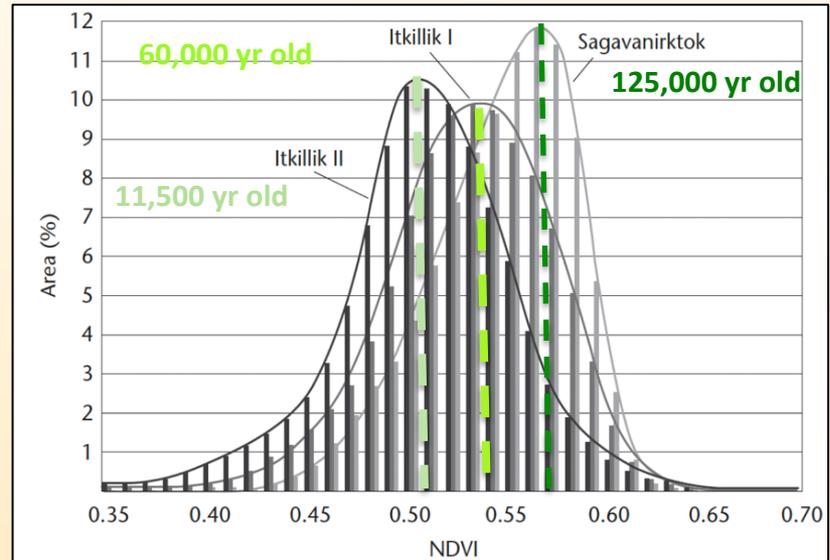
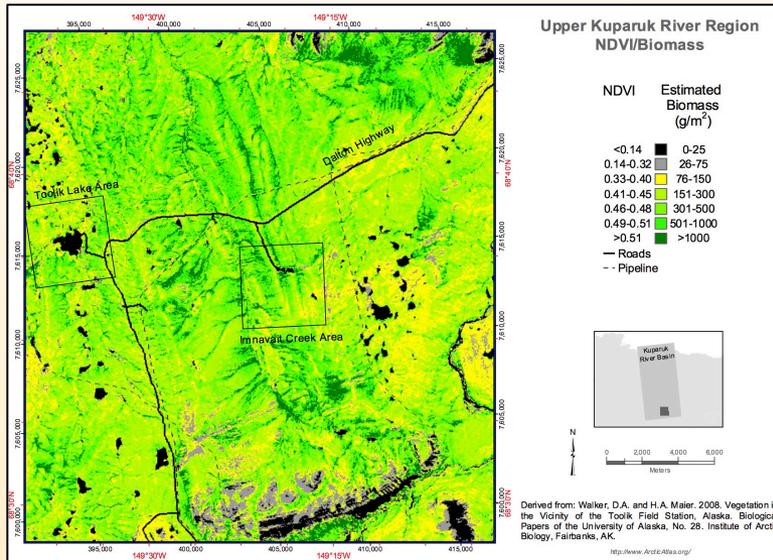


**North of the pH boundary:** Abundant bare soil (frost boils) and dead sedge vegetation, few erect shrubs, low NIR reflectance.

**South of the pH boundary:** Abundant erect shrubs, high NIR reflectance.

# Landscape-level

## Glacial chronosequence & SPOT-derived NDVI relationships in the Upper Kuparuk River region



→  
**Younger to older surfaces  
spanning about 125,000 years**

**General increase in NDVI and total  
landscape biomass/unit area with  
landscape age.**

Walker et al. 1995, Polar Record

# Plot-level observations

*The ideal, using **Braun-Blanquet approach**:*

- **Homogenous cover.**
- **Minimal sample area:** sufficient to contain >95% of species in the association.
- **Replicated:** in plant associations that repeat themselves in the landscape.
- **Plant species-cover estimates:** all species (vascular plants, lichens, mosses).
- **Canopy structure:** height and horizontal cover of vegetation layers, cover of plant functional types.
- **Site description:** coordinates, elevation, photos, slope, aspect, soil moisture regime, snow regime, pH, landform, parent material, geology, surface geomorphology, ALT, disturbance types and degree, stability.
- **Permanently marked corners.**
- **Clip harvest for biomass.**
- **Soils:** profile description, collection of top mineral horizon for physical and chemical analyses.
- **Spectral properties:** hand-held LAI, spectroscopy.

# Plot and Map Data portal

## Alaska Arctic Geoecological Atlas data portal

- Housed at the Geographic Information Network of Alaska (GINA), UAF.
- Includes the AK-AVA (plot archive) and AK-AMA (map archive).
- Web Link:  
<http://alaska.gina.alaska.edu/>

Map and Plot Data for **ABOVE**  
**Alaska Arctic Geoecological Atlas**

Home ABOVE Map Archive Plot Archive Data Catalog About Us Contact Us

### Alaska Arctic Map Archive

Map products from satellite data and elevation models of arctic Alaska. Available map themes include vegetation, topographic, and hydrologic data.

### Welcome to the Alaska Arctic Geoecological Atlas

Abundant ground-based information will be necessary to inform the planned Arctic-Boreal Vulnerability Experiment (ABOVE) activities. The Atlas is comprised of archives of maps and plot-based vegetation data, and associated information. The Map Archive contains map products at several scales and numerous themes. The maps range from detailed geoecological maps, which are polygon-based integrated terrain maps at relatively fine scales, to raster-based map products derived from satellite data and digital elevation models. The Vegetation Plot Archive contains vegetation-plot data, associated environmental data, and other related information from over 3,000 plots in Arctic Alaska.

### Relevant Publications

**MOLECULAR ECOLOGY**  
Molecular Ecology, 23: 3258-3272  
Rich and cold: Diversity, distribution and drivers of fungal communities in patterned-ground ecosystems of the North American Arctic  
Timing, L. et al. 2014

**PLANT ECOLOGY AND EVOLUTION IN HARSH ENVIRONMENTS**  
In N. Rajakaruna, R. Boyd and T. B. Harris (Eds.), Plant Ecology and Evolution in Harsh Environment (pp. 149-177)  
Ecology and evolution of plants in arctic and alpine environments  
Breen, A.L., et al. Hauppauge, New York: Nova Science Publishers, 2014

### News & Events

**Earth to Sky Climate Change Science and Communication: A Regional Approach**  
October 14-16, 2015 in Anchorage  
**No Tuition!**  
**Applications due August 15, 2015**

**Target Audience:** Federal, State, Municipal agency, as well as non-profit and private organization science communicators, interpreters, environmental educators and education specialists. Participants should have some experience with communication principles and techniques. Knowledge of climate science is not required. Partners and collaborators are especially encouraged.

Participants will meet with world-class scientists and communicators to discuss their best practices and the latest insights about understanding and responding to changing climate. They will hear about the latest research in vulnerability and resilience of ecosystems and society to the changing environment of Alaska; learn the latest about NASA's 9-year ABOVE campaign from the scientists themselves.

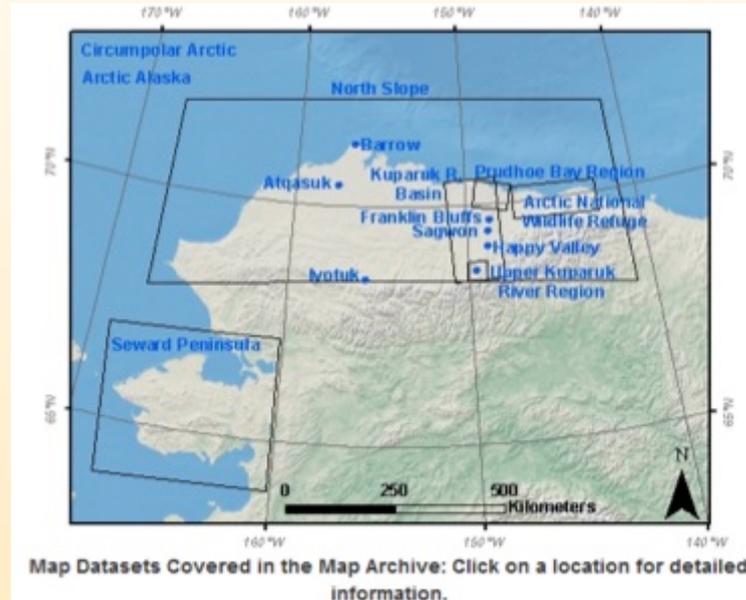
For more info, see the...  
[Full Course Announcement and Application](#)

# Three major components of the geocological atlas

## Plot Archive



## Map Archive



## Data Portal

**Alaska Arctic Geocological Atlas**

Welcome to the Alaska Arctic Geocological Atlas

Abundant ground-based information will be necessary to inform the planned Arctic-Boreal Observatory (ABO) activities. The Atlas is comprised of archives of maps and plot-based vegetation data, and associated information. The Map Archive contains map products at several scales and numerous themes. The maps range from detailed geocological maps, which are polygon-based integrated terrain maps at relatively fine scales, to region-based map products derived from satellite data and digital elevation models. The Vegetation Plot Archive contains vegetation plot data, associated environmental data, and other related information from over 3,000 plots in Arctic Alaska.

**Relevant Publications**

- Wetland Biology (2018) 2018
- Fish and cold: Diversity, distribution and drivers of target communities in northern ground ecosystems of the North American Arctic (2018)
- PLANT ECOLOGY AND CULTURE IN THE ARCTIC (2018)
- Ecology and evolution of plants in arctic and alpine environments (2018)
- in: Arctic, A. Bond and T. B. Smith (Eds.) Plant Ecology and Evolution in the Arctic (2018)

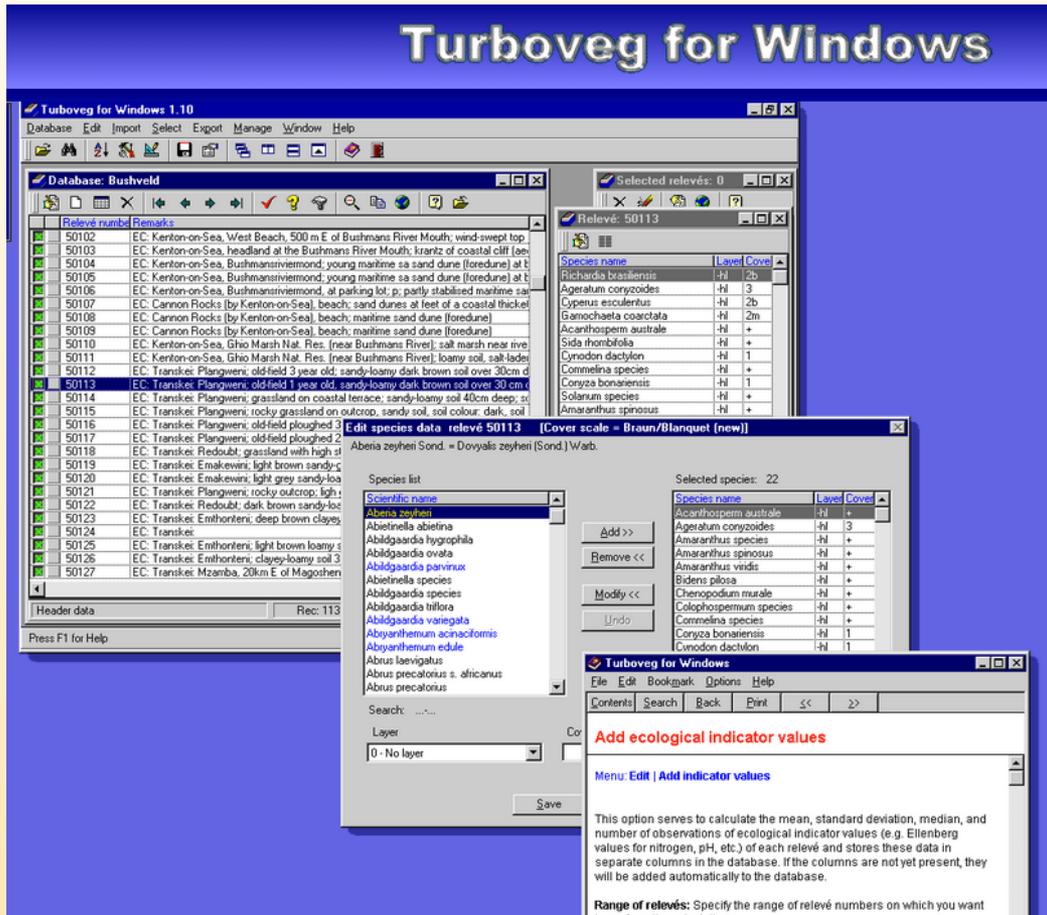
For more info, see the...  
Full Course Announcement and Application

**A synthesis of data from Arctic Alaska vegetation plot studies + remote sensing and map products derived from these studies.**

**Plot archive currently has over 3000 plots from 25 datasets.**

# Species data and a select set of environmental header data are in a single Turboveg database and separate .csv files for each dataset

## Turboveg for Windows



## Turboveg

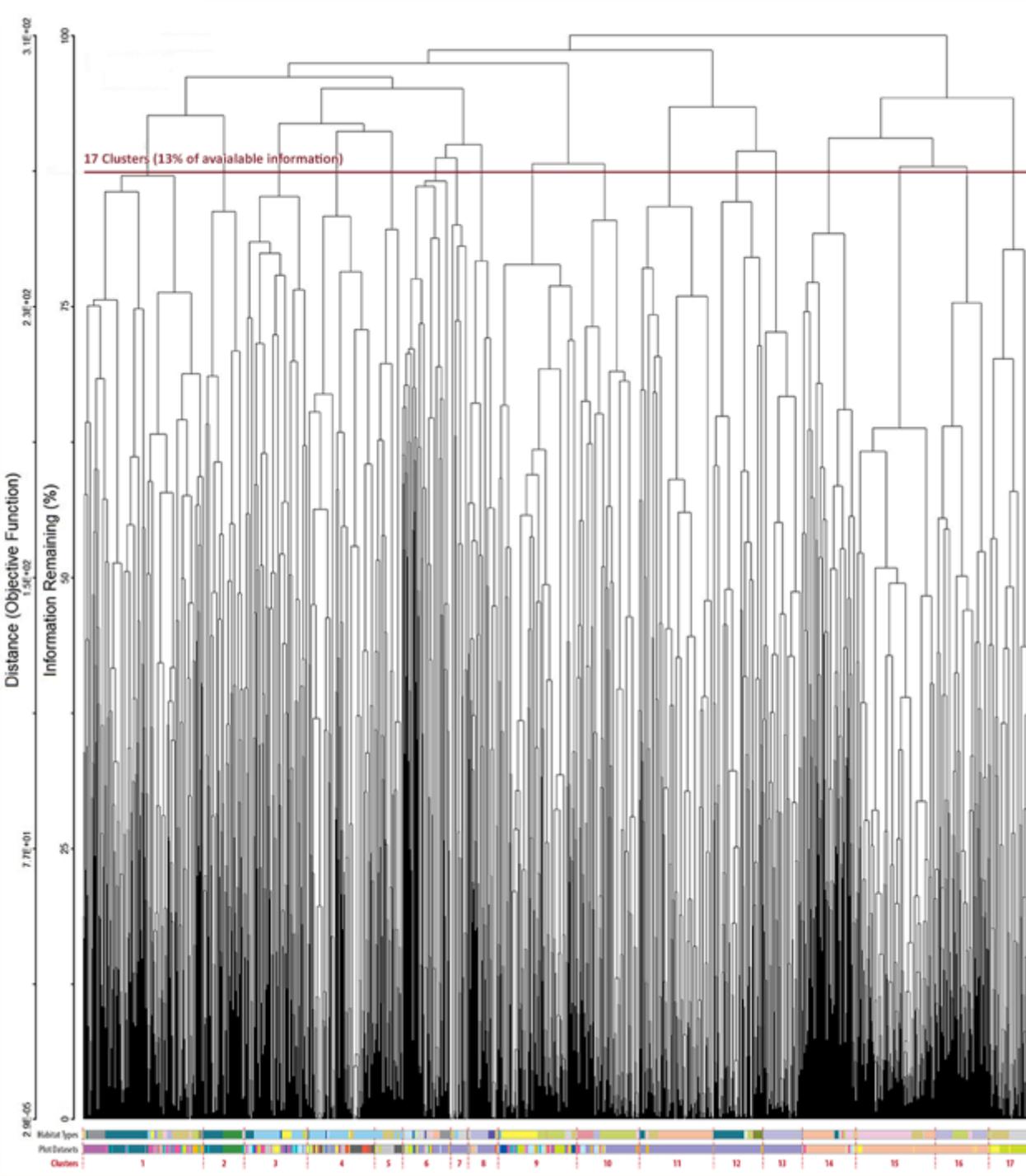
Database management system for the storage, selection, and export of vegetation data (relevés).

✓ Free for:

- private use
- students
- institutes or universities which don't have sufficient resources to buy the software.

✓ Easy import into vegetation analysis programs (e.g., JUICE, Twinspan, Canoco, Excel, Mulva).

Hennekens, S. M., & Schaminée, J. H. J. (2001). TURBOVEG, a comprehensive data base management system for vegetation data. *Journal of Vegetation Science*, 12, 589–591.



# Preliminary cluster analysis of AK-AVA data

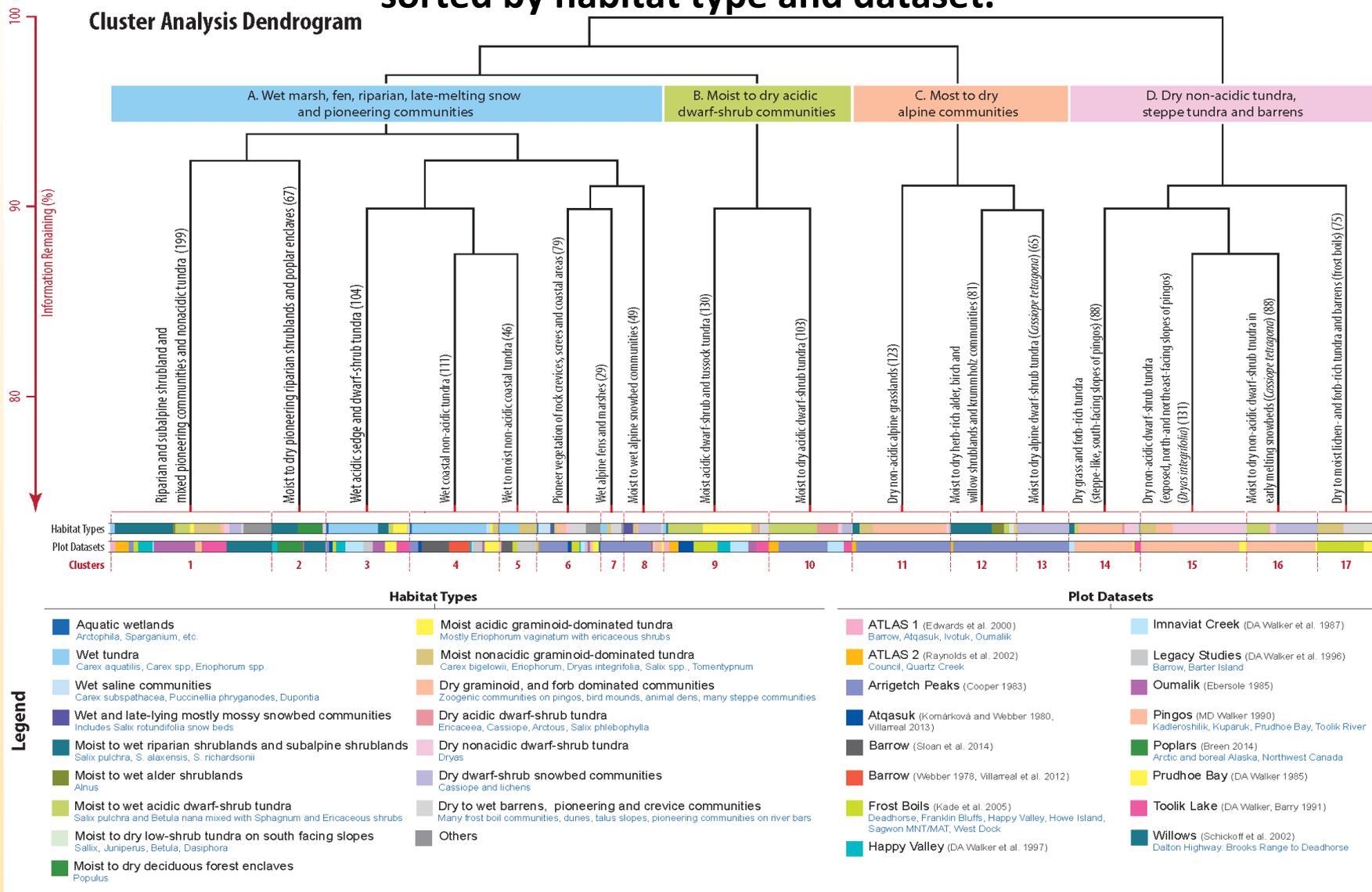
Full dendrogram showing all relevés

- 1603 plots analyzed according similarity.
- 17 high-level clusters (above the red line) show the highest “separation power” (next slide).
- The two bottom color bars show the habitat type and datasets of the plots.



# Preliminary cluster analysis of AK-AVA data: Top 4 clusters and 17 subclusters:

## sorted by habitat type and dataset.



**Cluster A:** Wet tundra, wet snowbeds, riparian shrublands, poplar groves, azonal and pioneering communities: 684 plots.

**Cluster B:** Acidic tundra types including tussock tundra, dry dwarf-shrub heaths: 233 plots.

**Cluster C:** Most alpine plant communities with high cover of forbs and grasses: 269 plots.

**Cluster D:** Dry non-acidic tundra and steppe tundra vegetation: 382 plots.

Sibik et al. 2015 in prep.

# Three suggested airborne transects to capture the major bioclimatic and regional environmental gradients

## 1. Elliott-Dalton-Hiway Transect

- Major N-S Bioclimate gradient
- Boreal Forest-Treeline-Tundra
- Acidic-Nonacidic transition
- Logistically easy to study
- Rich historical well-studied datasets along the entire route:
  - Burn studies
  - 21 mapped sites
  - Atigun Pass alpine
  - Toolik-Lake
  - Imnavait Creek
  - Happy Valley
  - Sagwon
  - Franklin Bluffs
  - Deadhorse
- Captures many disturbance gradients, including fire, infrastructure, thermokarst Prudhoe Bay.
- Two LTER sites.



# Suggested airborne transects to capture the major bioclimatic and regional environmental gradients

## 2. Western-Alaska Transect

- Maritime-continental contrast with Dalton transect
- Captures the preexisting DOE ATLAS transect + Y-K Delta
  - Barrow
  - Atqasuk
  - Oumalik
  - Ivotuk
  - Council, Quartz Creek (Seward Peninsula)
  - Frost Y-K site
- Western treeline transitions (Noatak R., Seward Peninsula)
- Important sand region in NPR-A
- Strong shrub gradient in foothills
- DOE-NGEE, NOAA collaborations



# Three suggested airborne transects to capture the major AK bioclimatic and regional environmental gradients

## 3. Central Boreal Transect:

- Focus on fire, interior thermokarst
  - Bonanza Creek
  - Caribou-Poker Creek
  - Many fire sites and forest study sites
- East west interior bioclimate gradient



# Recommendations for future plot-based studies

1. **Use the Arctic Observatories:** Take advantage of established plots in full range of habitat types and landscape-level maps based on the plot information.
1. **Link information to maps** using International standards for vegetation classification and mapping.
2. **Coordinated observations by other specialists** on the same plots (e.g., soil scientists, permafrost scientists, remote-sensing specialists, and animal ecologists).
3. **Special attention needs to be devoted to protecting the plots from trampling and changes in site factors.** Use adjacent homogeneous areas for sampling.
4. **New permanent plots should use consistent criteria, including:**
  - Methods for choosing and marking plots.
  - Methods for surveying species composition, structure, soils, and the environment, phytomass, and ground-based spectral data.