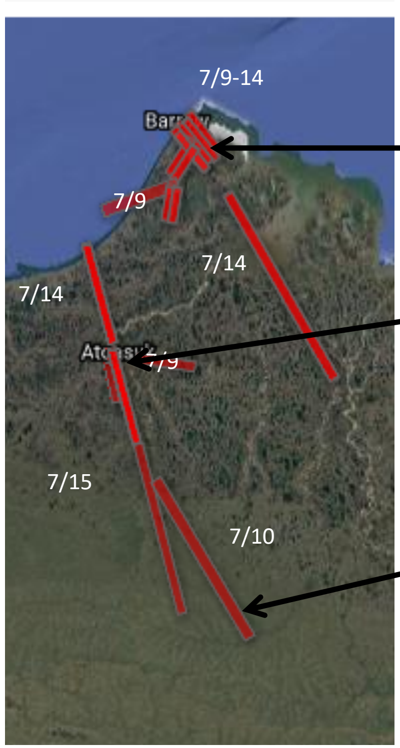
Alaska North Slope Transect

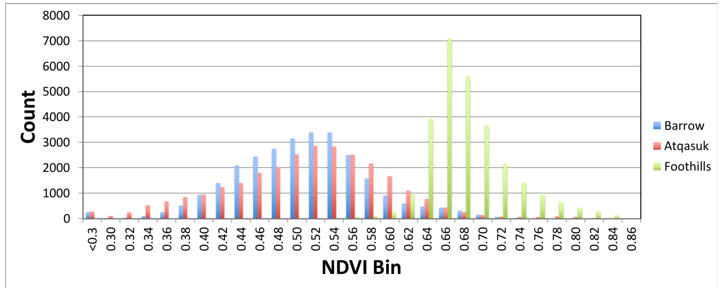
Using AVIRIS NG data from 2017 ABoVE flight campaign to describe North-South variations in tundra vegetation

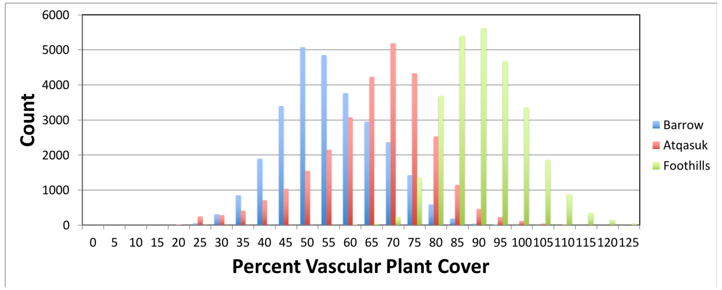


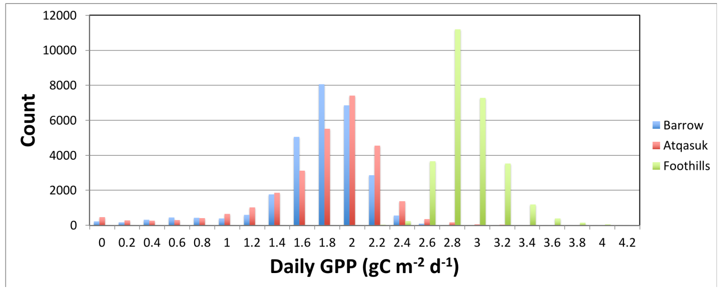
Barrow

Atqasuk

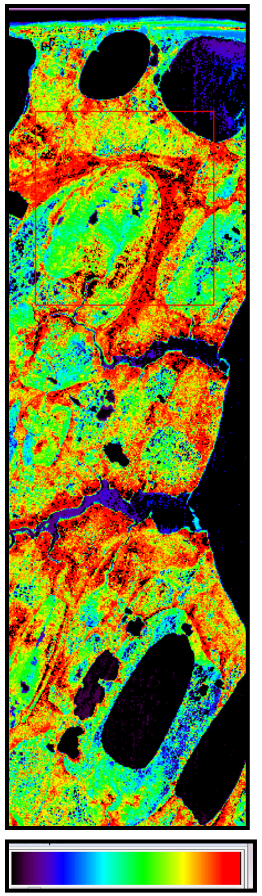
Foothills







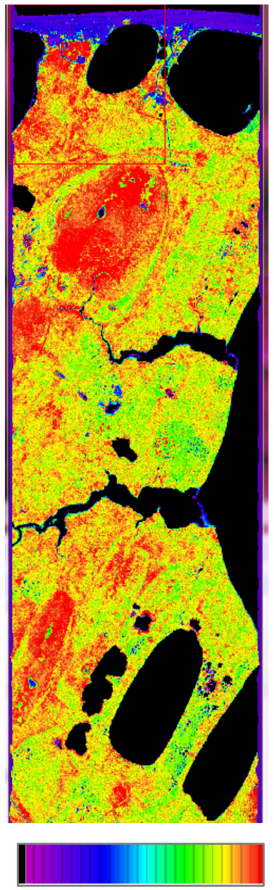
GPP



0 40

GPP

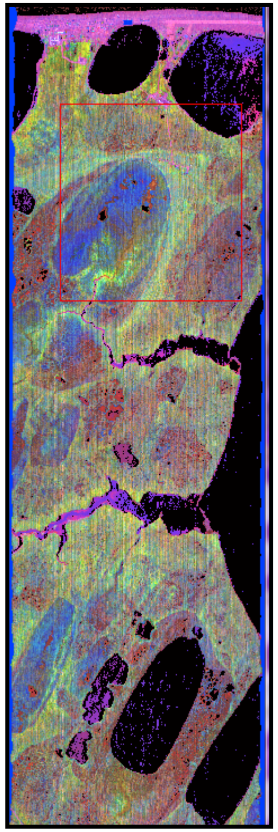
NDVI



0 1

NDVI

Functional Types



R – NonGreen

G – Vascular plant

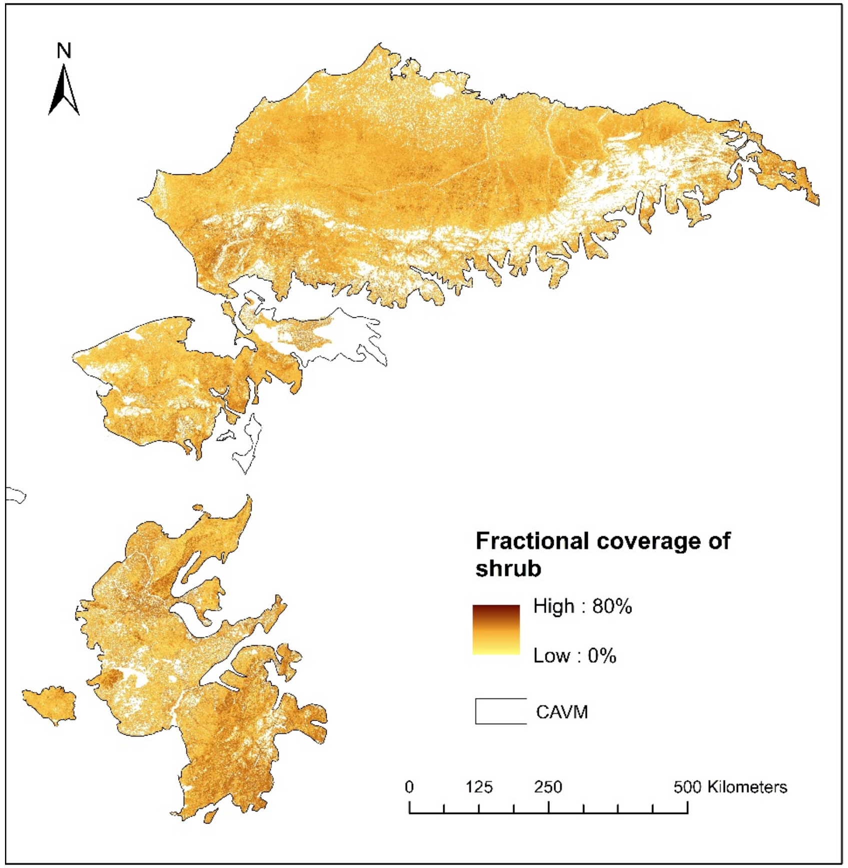
B – Lichen & Moss

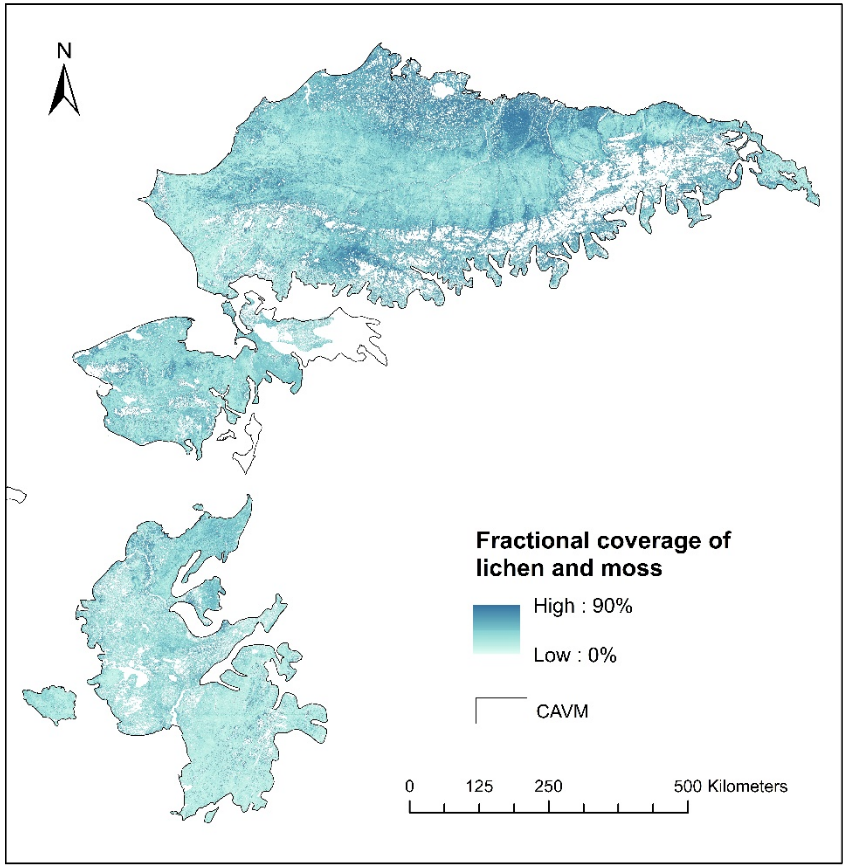
At each site 27,803 5x5 m pixels were extracted (~70 ha). Vascular plant cover and GPP were calculated from AVIRIS NG spectral reflectances using coefficients derived from Partial Least Squares Regressions on ground measured training data collected in Utqiaġvik and Atqasuk.

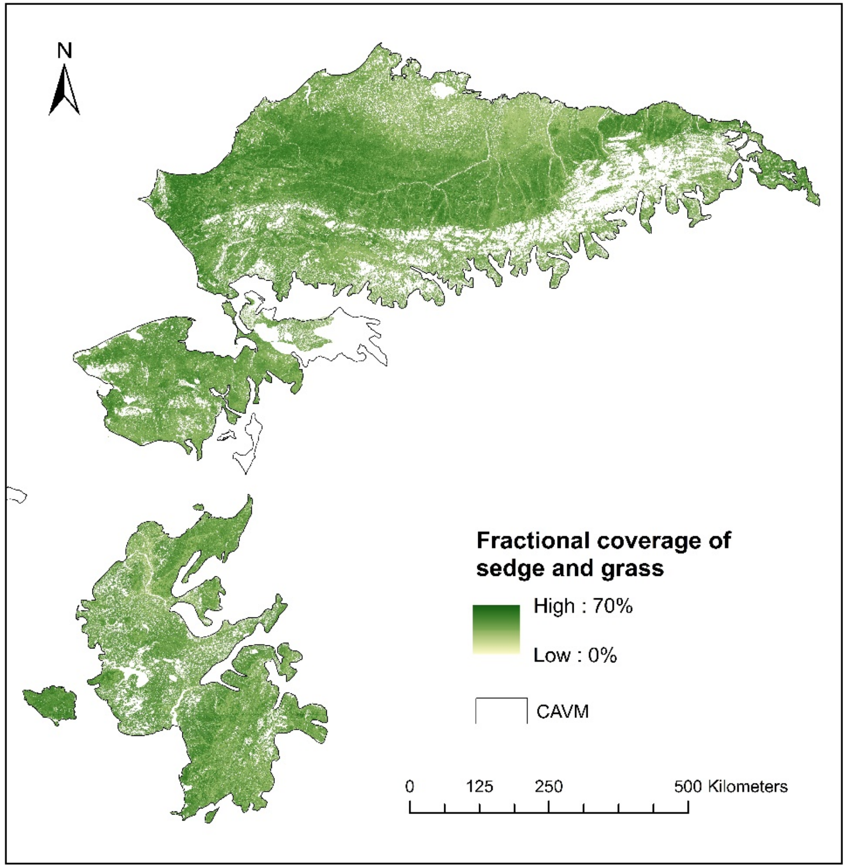
__K.F. Huemmrich karl.f.huemmrich @ nasa.gov, S.A. Vargas Z., C. Tweedie, P.K. Campbell, E. Middleton__; NNX17AC58A Causes and Consequences of Arctic Greening: The Importance of Plant Functional Types

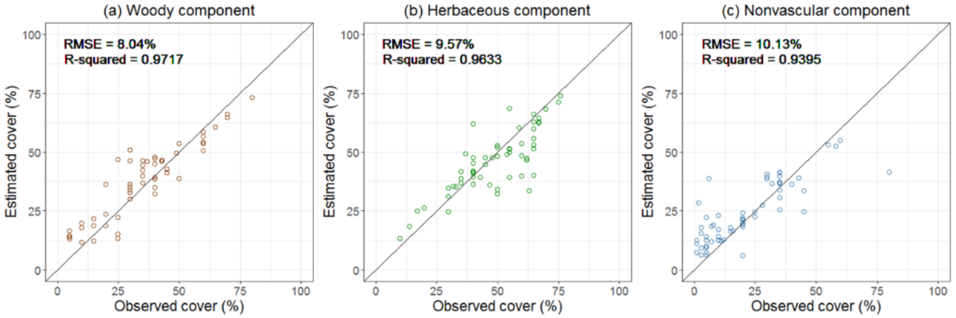
Loboda, Jenkins, Chen, He (TE 2014). *Quantifying long-term impacts of single and repeated wildfire burning in North American tundra on organic soil carbon stocks and ecosystem functioning.* (ABoVE Phase 1 project)

Fractional cover of woody, herbaceous, and non-vascular vegetation in AK tundra circa 2015







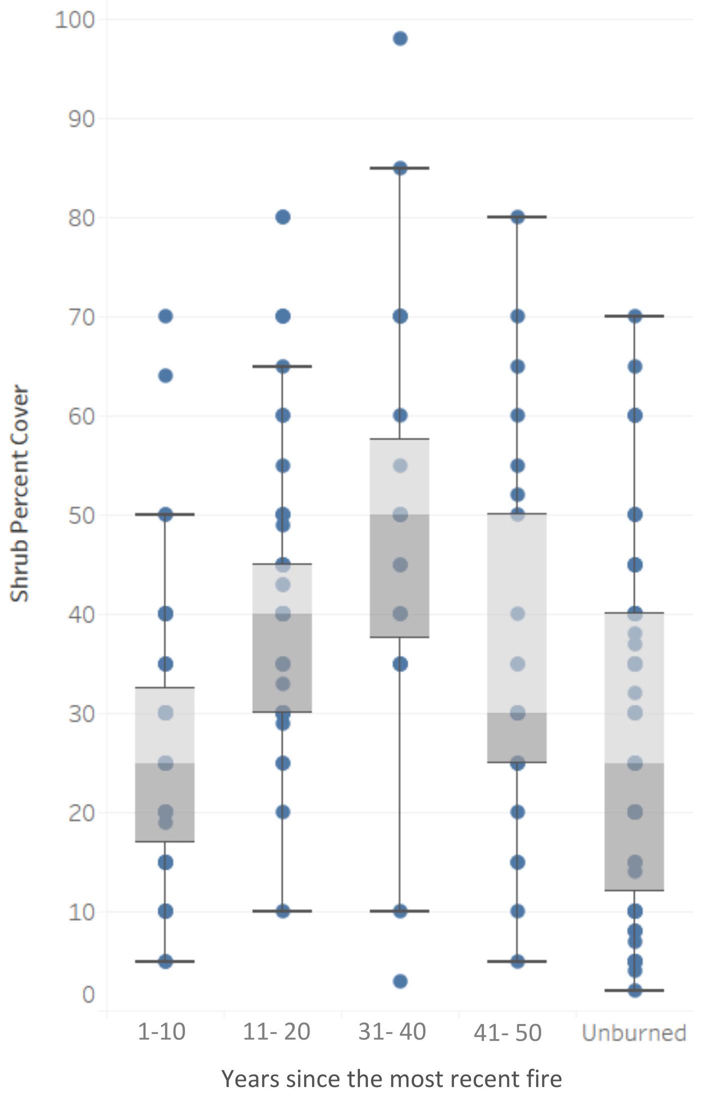


Landsat-based algorithm for fractional mapping of major vegetation components in Alaskan tussock and low shrub tundra (30m resolution) based on ocular assessments of vegetative cover collected during ABoVE Phase 1 study. (He et al. (revised) Mapping fractional cover of major fuel type components across Alaskan tundra. *RSE*)

Loboda, Jenkins, Chen, He (TE 2014). *Quantifying long-term impacts of single and repeated wildfire burning in North American tundra on organic soil carbon stocks and ecosystem functioning.* (ABoVE Phase 1 project)

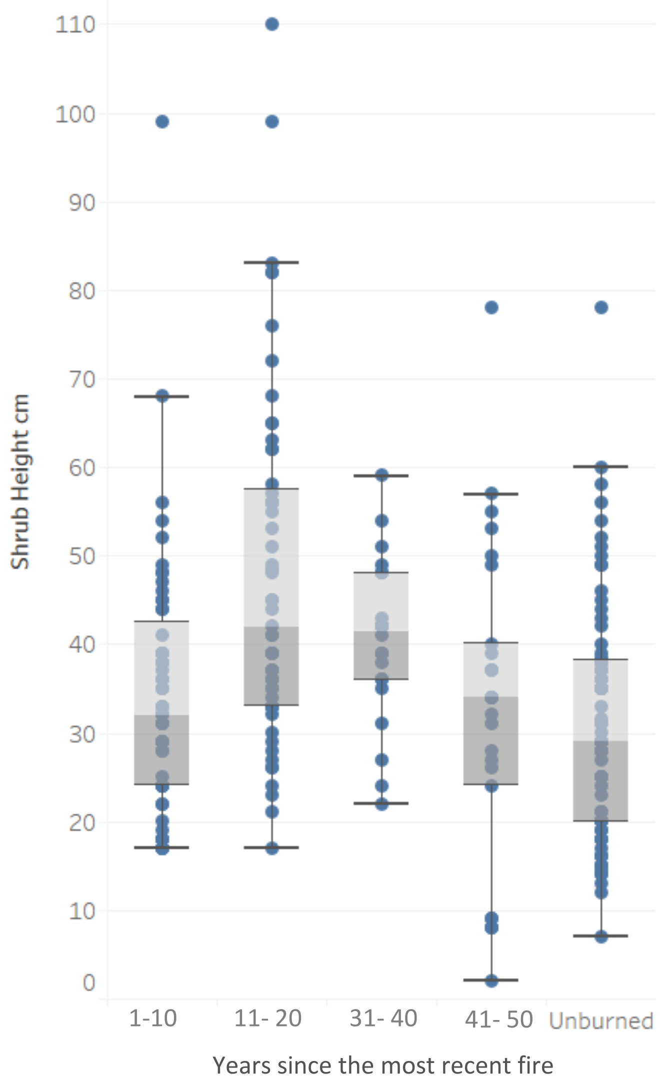
Impact of fire occurrence on shrub cover

Fractional shrub cover within 10 X 10 m plots



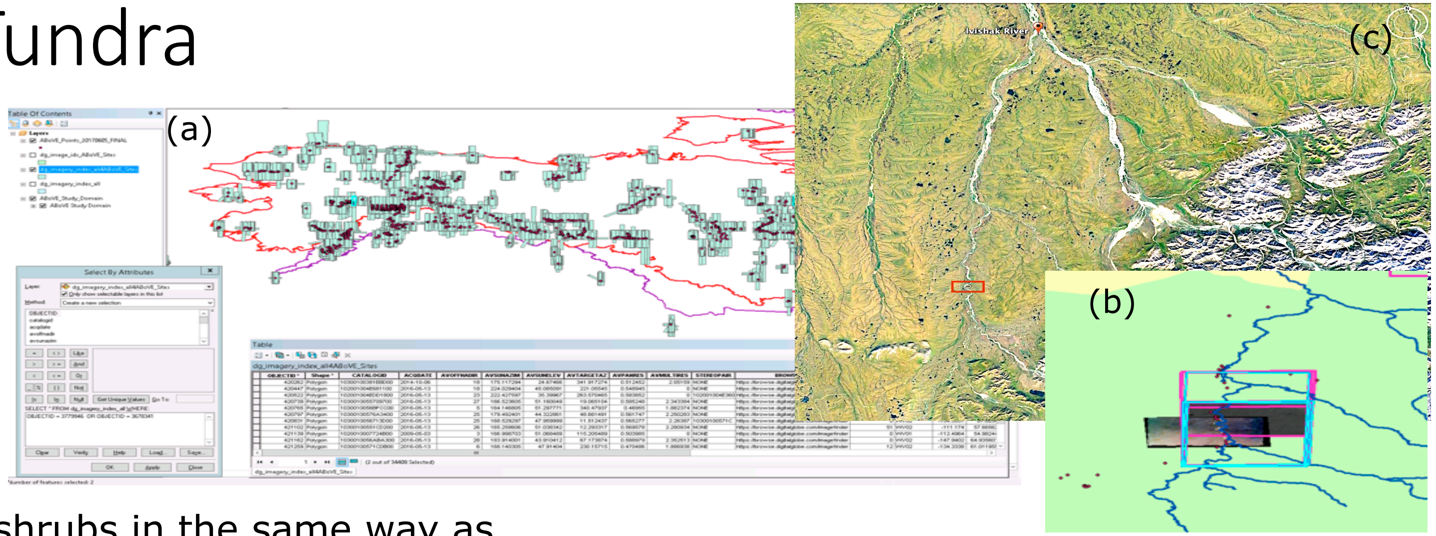
- Complex fire history of the Alaskan tundra may be contributing to documented “greening” effect / shrub encroachment
- Fractional shrub cover increases rapidly over the first 40 years since fire (left) with a substantial increase in shrub height (right)
- Values within specific plots are influenced by frequency of reburn, fire return interval, burn severity, and drainage conditions

Mean shrub height within 10 X 10 m plots



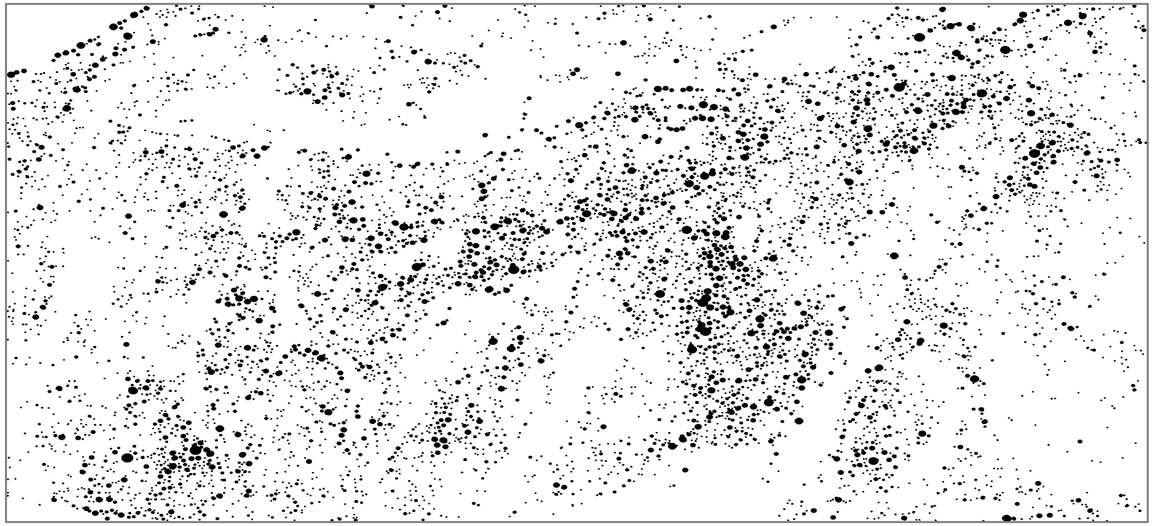
Tall Shrub Mapping in Arctic Tundra

(a) Selection of intersecting early/late NGA imagery pairs over ABoVE field sites, using the the ABoVE Science Cloud's ArcGIS database: **over 500 image pairs** (b) Selected results (c) Google Earth true color overview of the selected area.



The **CANopy Analysis with Panchromatic And Multispectral Imagery, (CANAPAMI)** code identifies candidate tall shrubs in the same way as CANAPI (by locating crescent-shaped areas of bright panchromatic image pixels arising from shrub crown illumination); collects mean crown multispectral band pixels values for all candidate shrub crowns; then rejects those that are outside the mean ± N standard deviations.

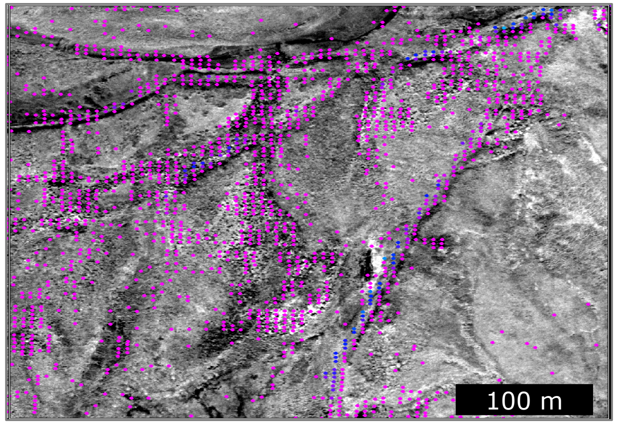
Google Earth true color image



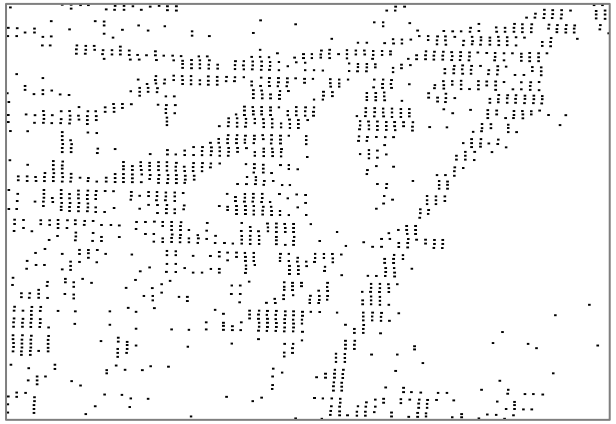
CANAMAPI_LLS Shrub Mapping

ABoVE Project Chopping-03: Changes in Shrub Abundance in Arctic Tundra from the Satellite High Resolution Record for the Arctic-Boreal Vulnerability Experiment and Impacts on Albedo

Tall Shrub Mapping in Arctic Tundra



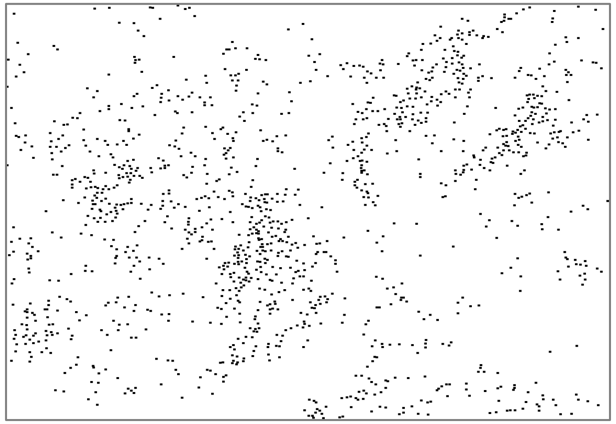
LVIS RH100/WV02 pan



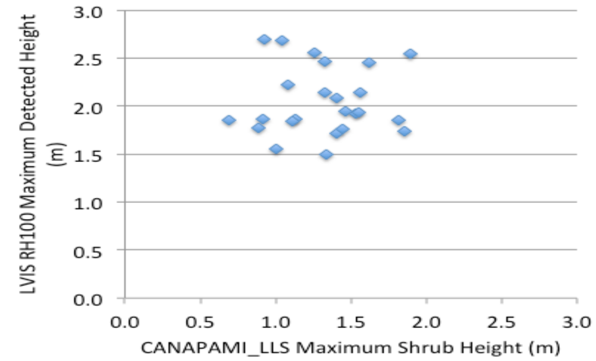
LVIS RH100 Tall Shrubs

Shrub Distribution (Visual)

Google Earth
true color



CANAMAPI_LLS Shrubs

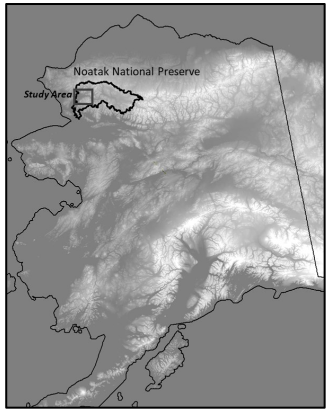


CANAMAPI_LLS
Heights vs LVIS RH100 (90 x 90 window)

ABoVE Project Chopping-03: Changes in Shrub Abundance in Arctic Tundra from the Satellite High Resolution Record for the Arctic-Boreal Vulnerability Experiment and Impacts on Albedo

Vegetation Cover Change Mapped by Combined Analysis of Airborne Visible Infrared Imaging Spectrometer (AVIRIS) and MODIS NDVI Time Series – Noatak National Preserve

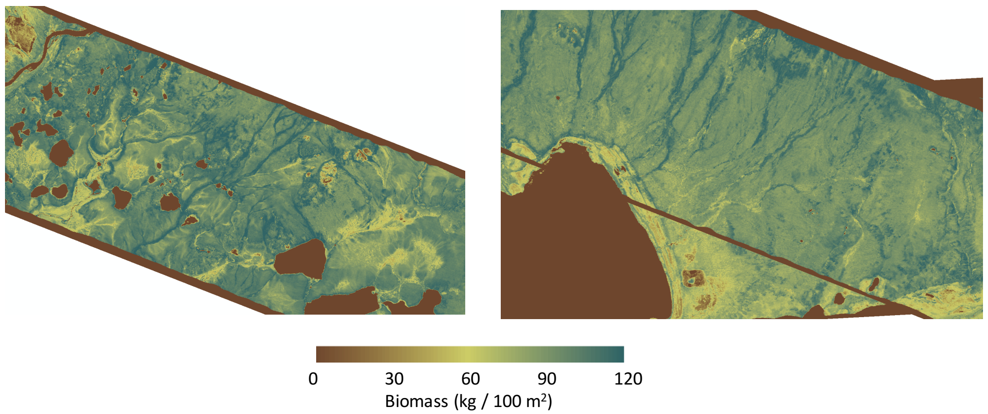
Author and Contact: Christopher Potter, NASA Ames Research Center, chris.potter@nasa.gov



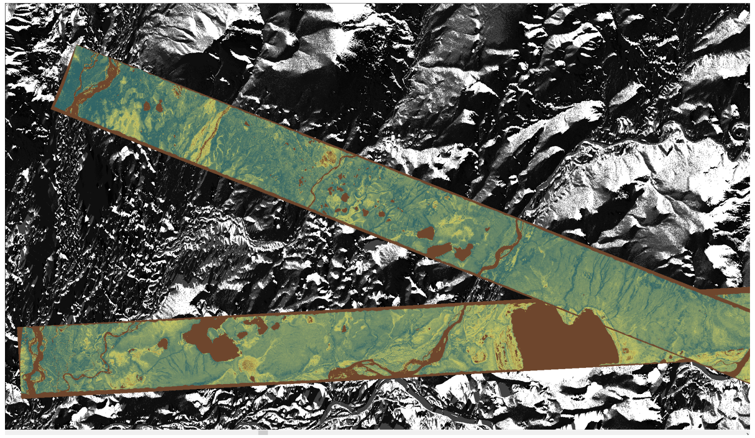
Details of vegetation biomass mapped from 2017 AVIRIS imagery

Avgun River 68.0514, -161.9427 (dd)

Lake Narvakrak 68.0209, -161.6406 (dd)

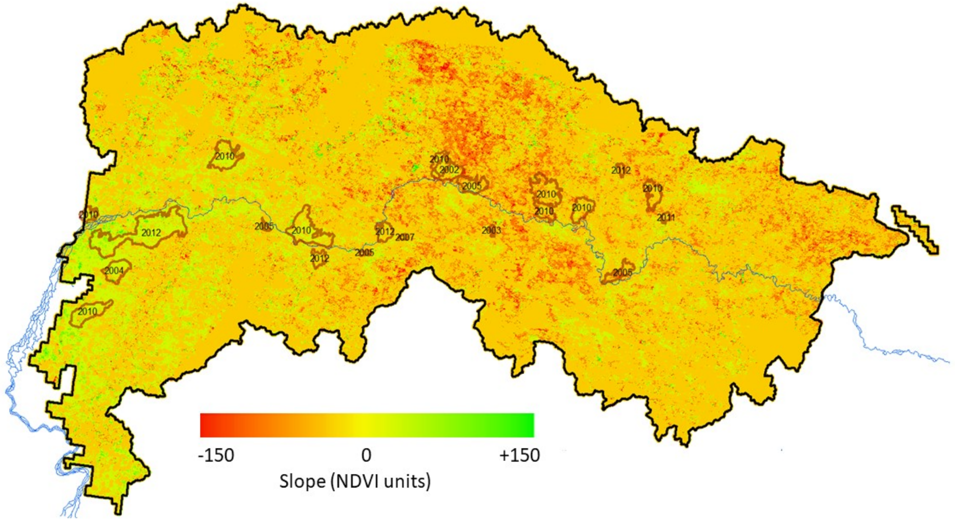


Overlay of AVIRIS vegetation biomass on hydrologic flow pathways



- **Low-to-high vegetation biomass gradients from AVIRIS followed upper-to-lower hydrologic elevation drainage pathways, respectively. The margins of low-elevation lakes and ponds commonly showed relatively low biomass cover.**

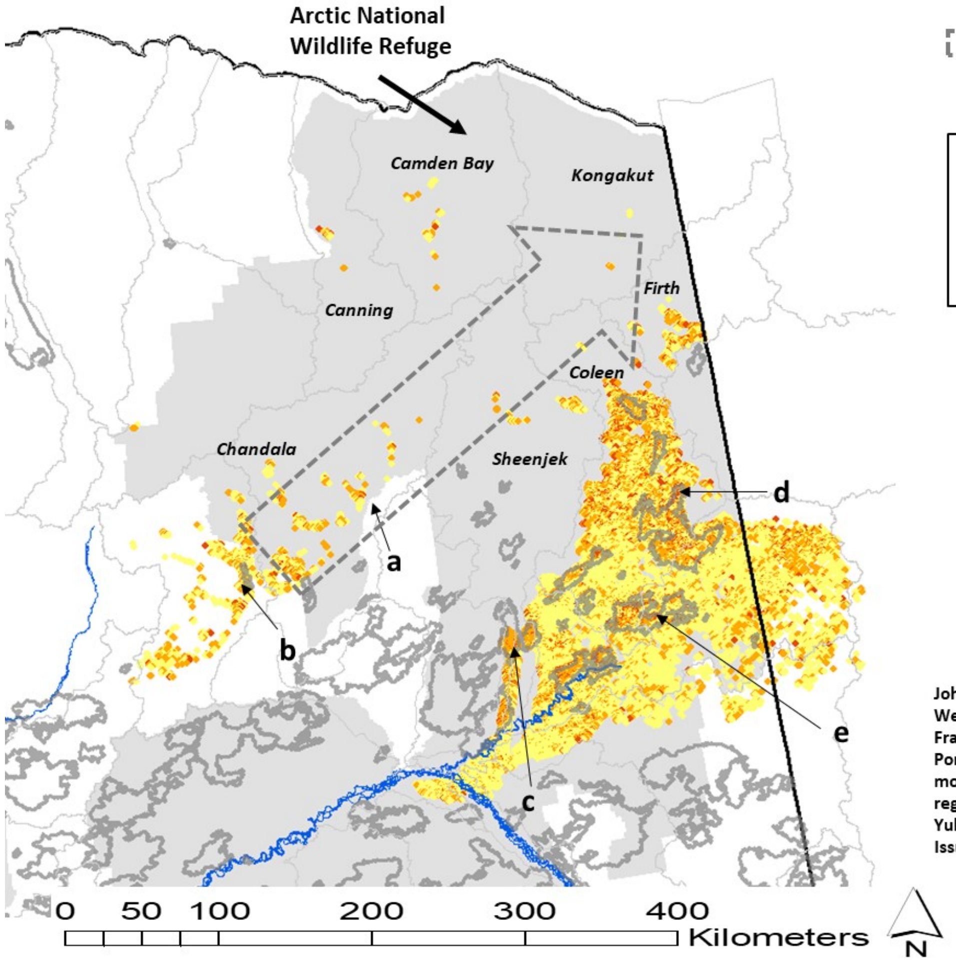
Map of MODIS NDVI deseasonalized slope from 2000 to 2018



- **MODIS NDVI time series analysis detected numerous negative breakpoints (abrupt disturbance changes) within the western sub-basins of the Lower Noatak River clustered most tightly within the boundaries of large wildfires of 2004, 2005, 2010, and 2012.**

Changes in Vegetation Cover of the Arctic National Wildlife Refuge Estimated from MODIS Greenness Trends, 2000 - 2018

Author and Contact: Christopher Potter, NASA Ames Research Center, chris.potter@nasa.gov



Spring Migration Route (after Ryder et al., 2007)

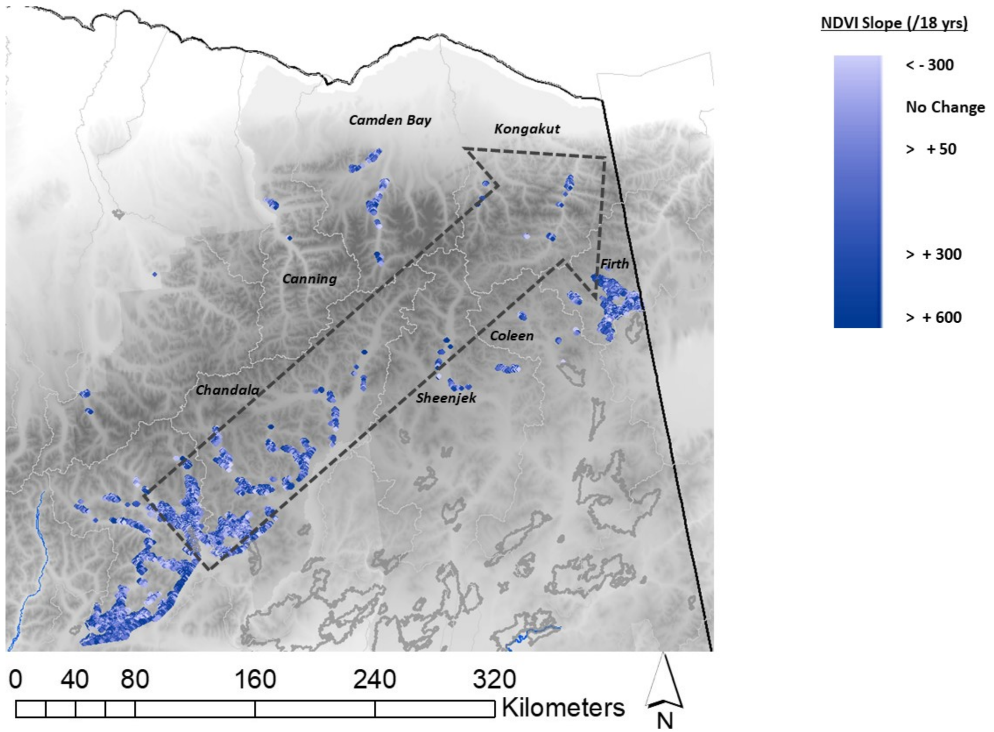
River basin names

Place Names
a. Arctic Village
b. Stringo Lake Fire (2002)
c. Sheenjek Fire (2009)
d. Rabbit Mountan Fire (2005)
e. Rock Slough Fire (2009)

Number of Breakpoints

- 0
- 1
- 2

John L. Ryder, Philippa McNeil, Jeff Hamm, Wendy A. Nixon, Don Russell, and Shawn R. Francis, 2007, An integrated assessment of Porcupine caribou seasonal distribution, movements, and habitat preferences for regional land use planning in northern Yukon Territory, Canada, *Rangifer*, Special Issue No. 17, 259-270.

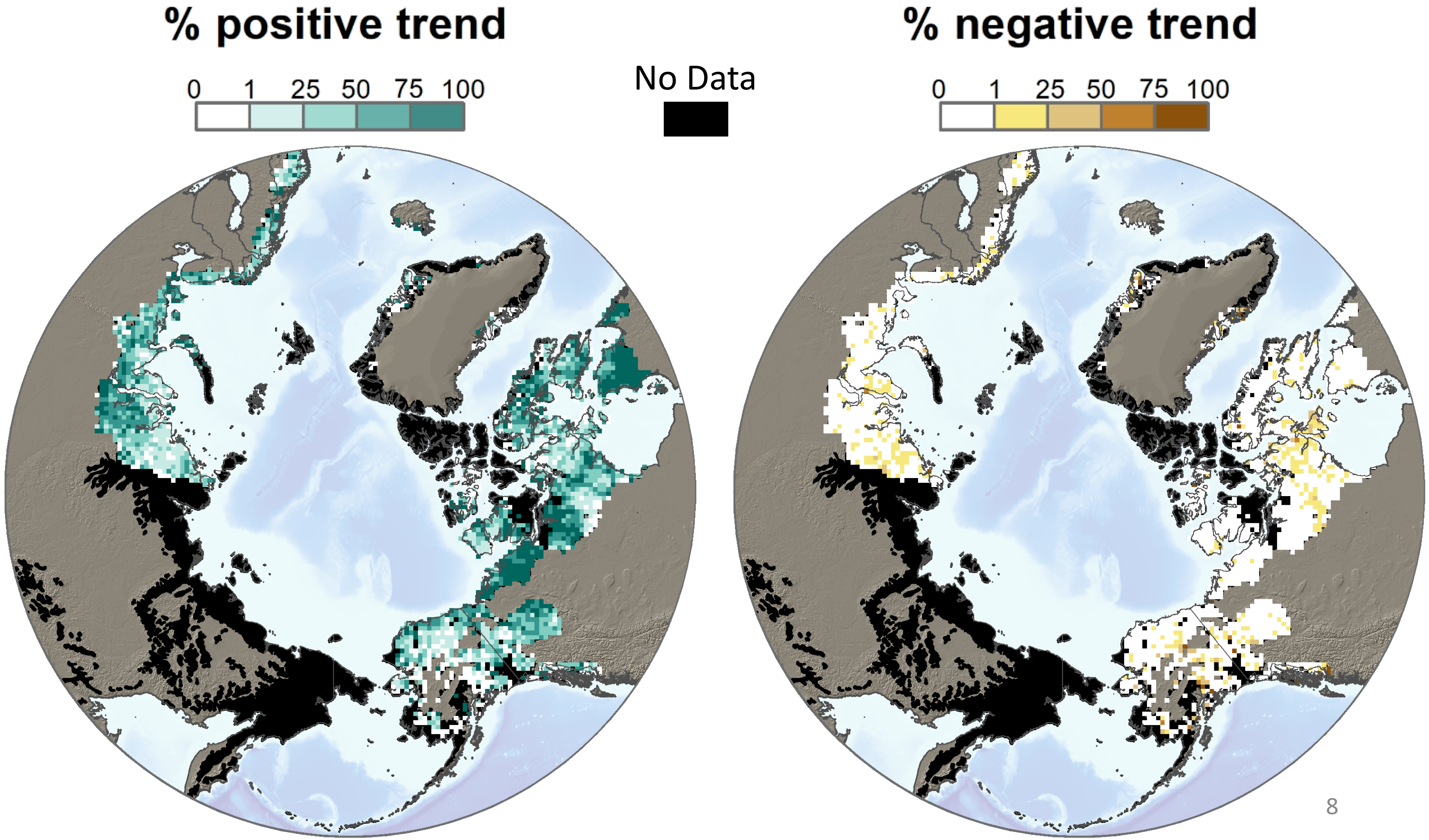


- **Structural change analysis indicated that NDVI breakpoints and negative 18-yr trends in vegetation greenness over the years since 2000 could be explained in large part by the impacts of severe wildfires. At least one NDVI breakpoint was detected in around 20% of the MODIS pixels within both the Porcupine River and Coleen River basins of the study area.**

- **The vast majority of vegetation cover in the ANWR Brooks Range and coastal plain ecoregions was detected with no (positive or negative) growing-season NDVI trends since the year 2000.**

Landsat $NDVI_{max}$ trends from 1985 - 2016

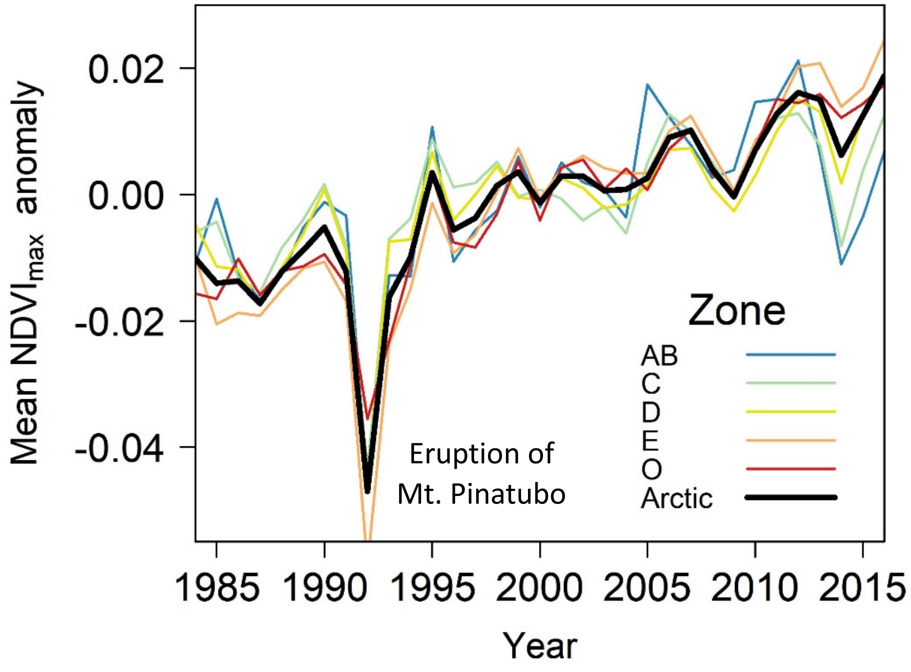
Pervasive *greening* of the tundra, with limited *browning*



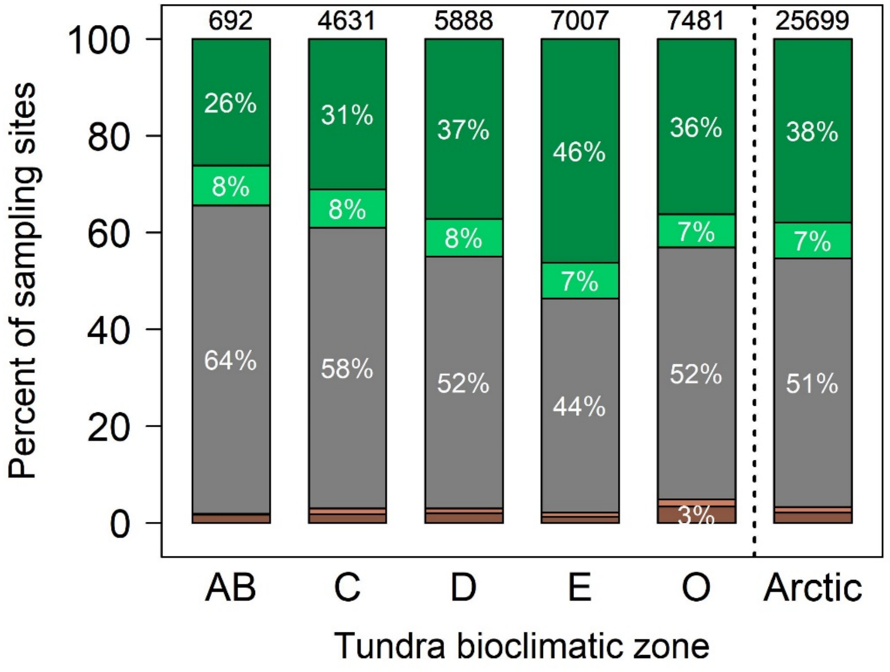
Berner et al. (forthcoming) Goetz-01 Project

Landsat $NDVI_{max}$ trends by bioclimatic zone

Significant *greening* of biome and each bioclimatic zone from 1985 - 2016



NDVI stable at half of sites, with *greening* most common in southern bioclimatic zones.



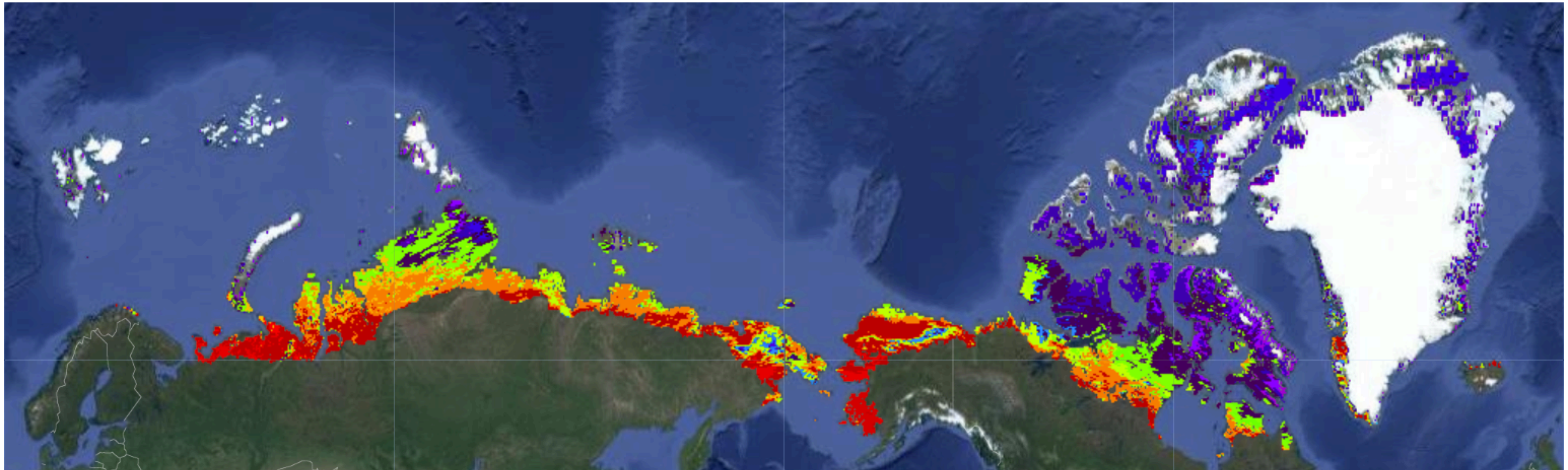
Berner et al. (forthcoming) Goetz-01 Project

Project
ROSES 2016 A.50 GEO
PI: Howard Epstein
University of Virginia

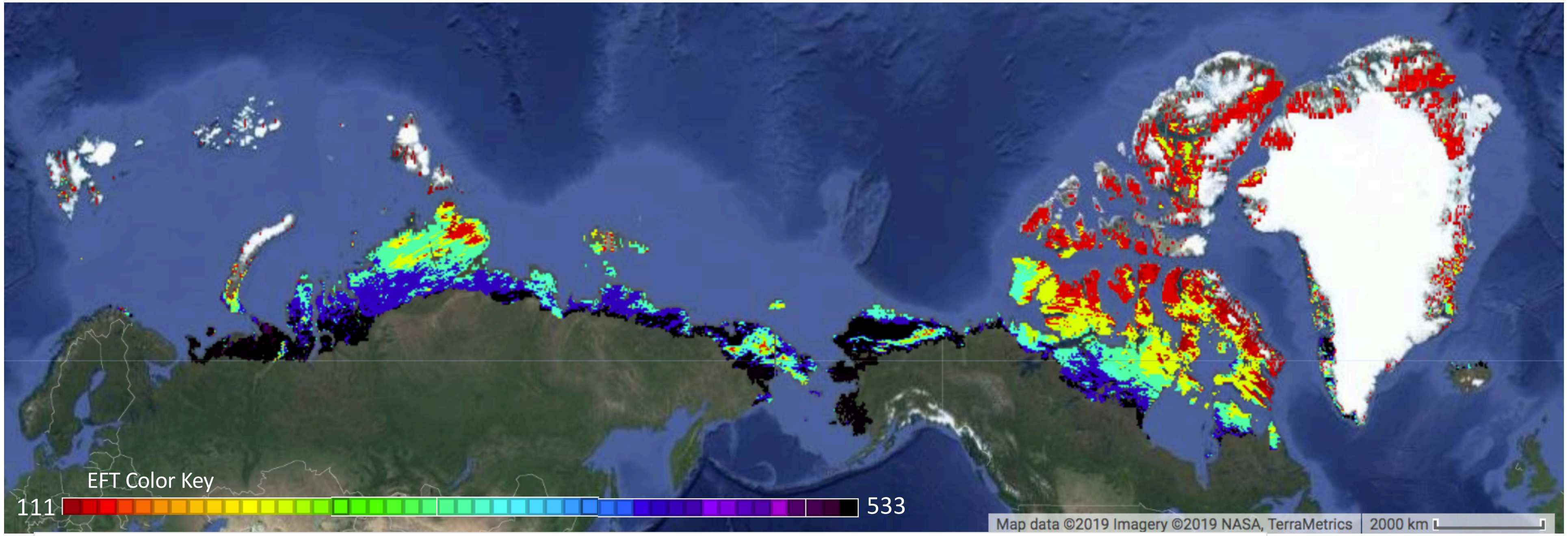
Ecosystem Functional Diversity of the Circumpolar Arctic Tundra

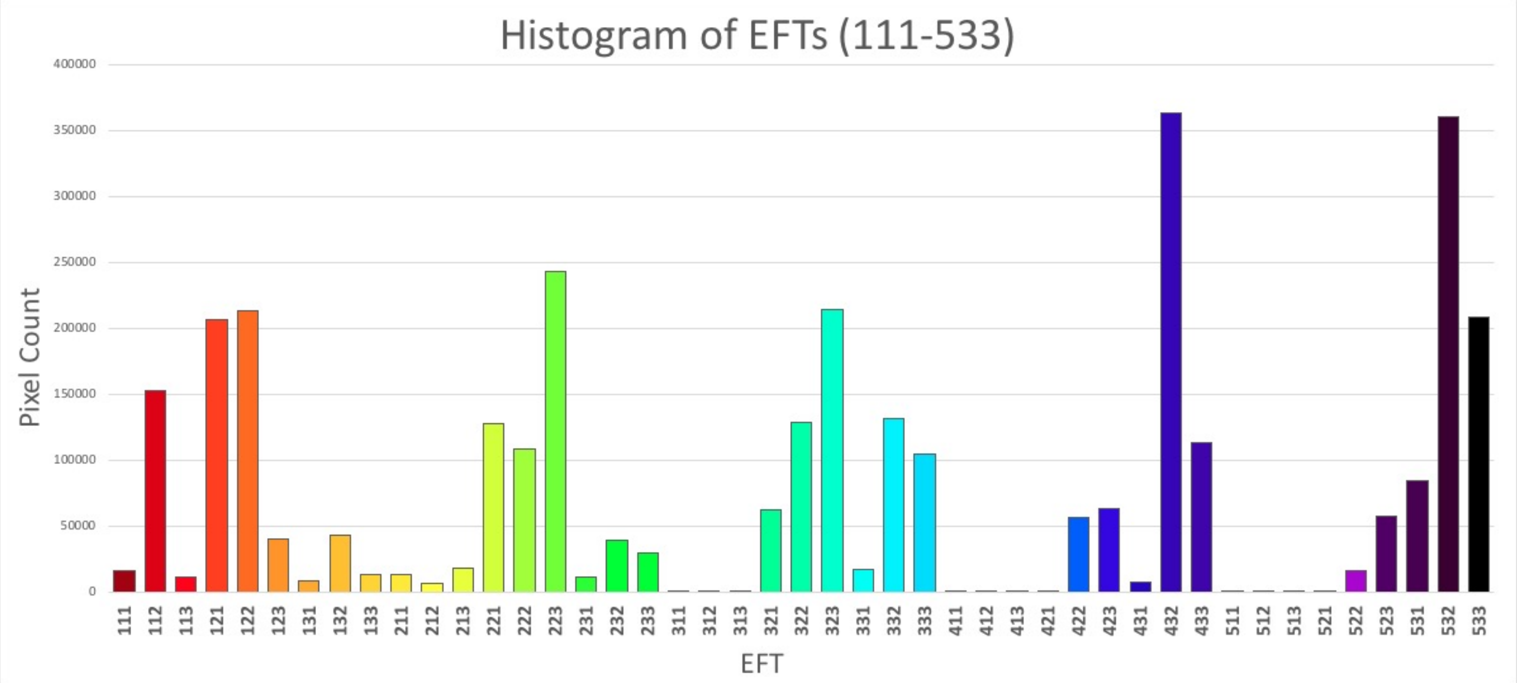
H. Epstein[1], **A. Armstrong[1]**, D. Alcaraz-Segura[2], B. Cazorla[3], A. Castro[3], M. Raynolds[4], Q. Yu[5]

1 University of Virginia, 2 University of Granada, 3 University of Almeria, 4 University of Alaska Fairbanks, 5 George Washington University



Circumpolar Arctic Tundra Ecosystem Functional Types

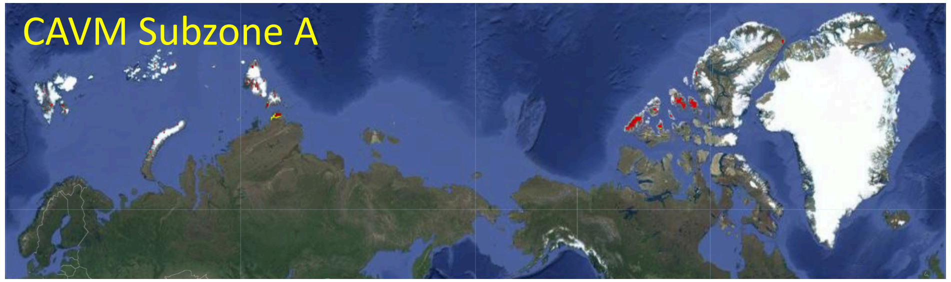


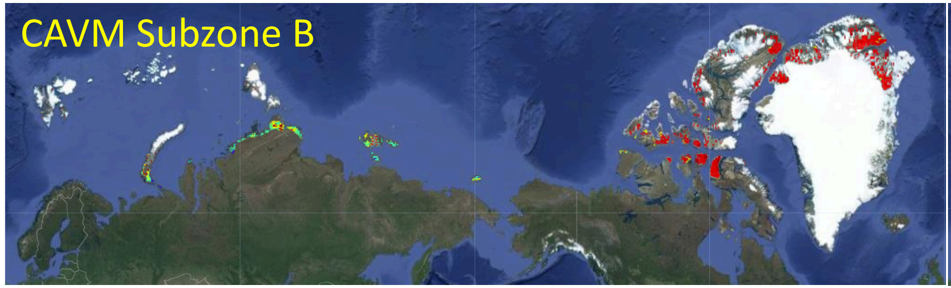


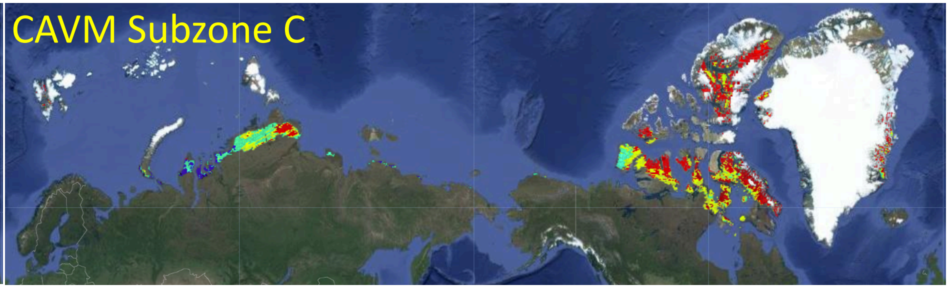
Key

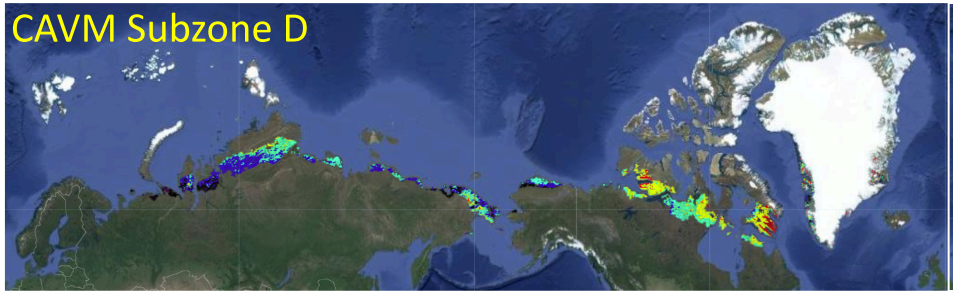
NDVI	
100	low
200	mid-low
300	mid
400	mid-high
500	high
Greening	
30	Early
20	Mid
10	Late
Browning	
1	Early
2	Mid
3	Late

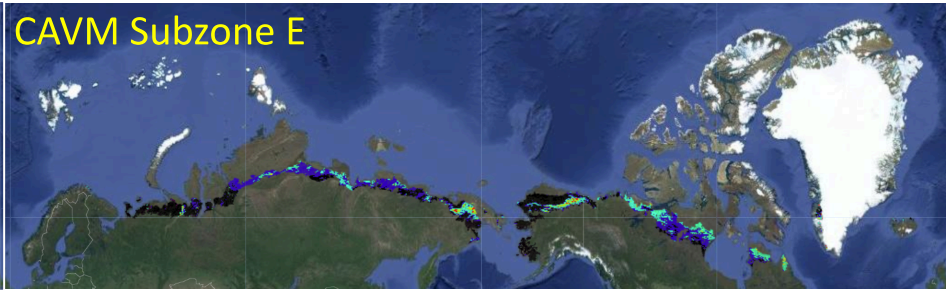
Circumpolar Arctic Tundra Ecosystem Functional Types by CAVM Vegetation Subzones



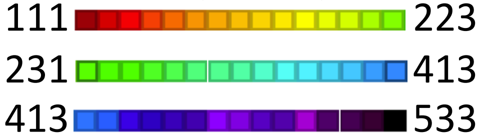






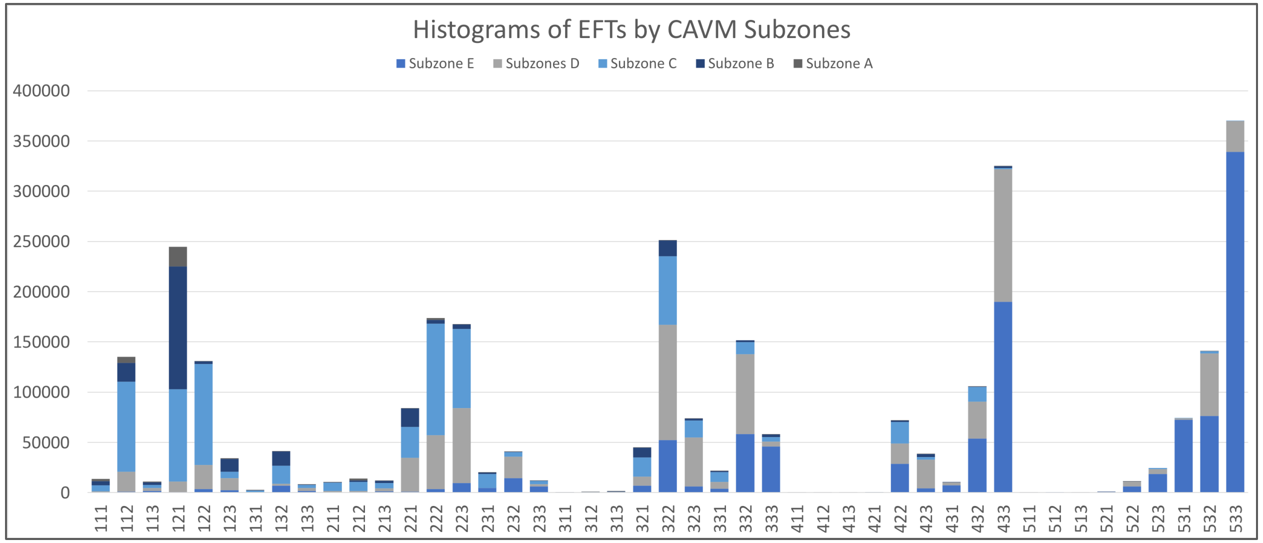


Map Color Key

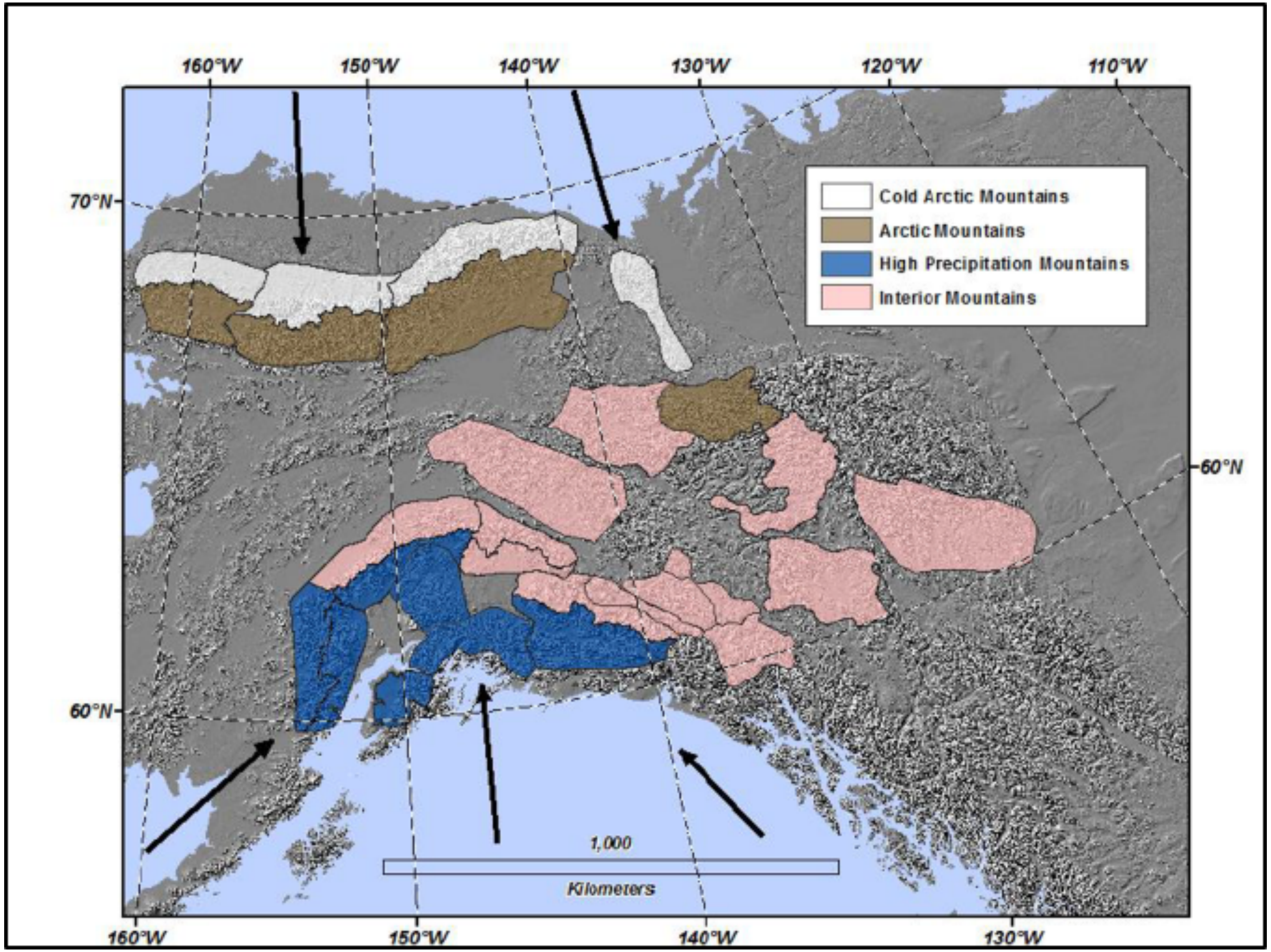


EFT Number Key

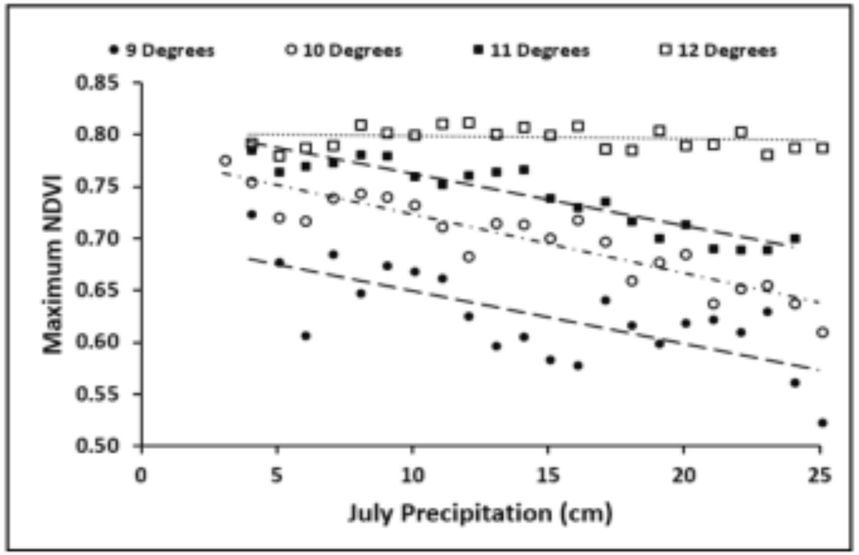
NDVI		Greening		Browning	
100	low	30	Early	1	Early
200	mid-low	20	Mid	2	Mid
300	mid	10	Late	3	Late
400	mid-high				
500	high				

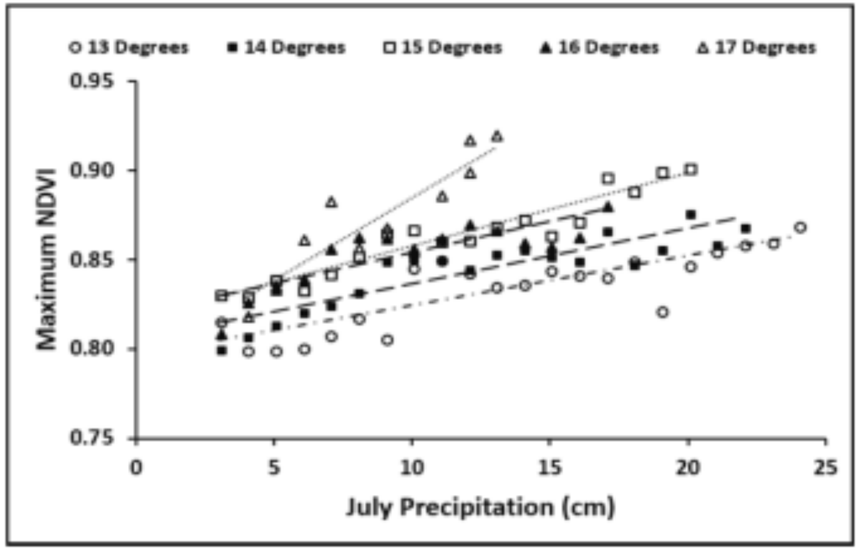


Verbyla, Prugh et al. – Alpine ecosystem vulnerability and Dall sheep



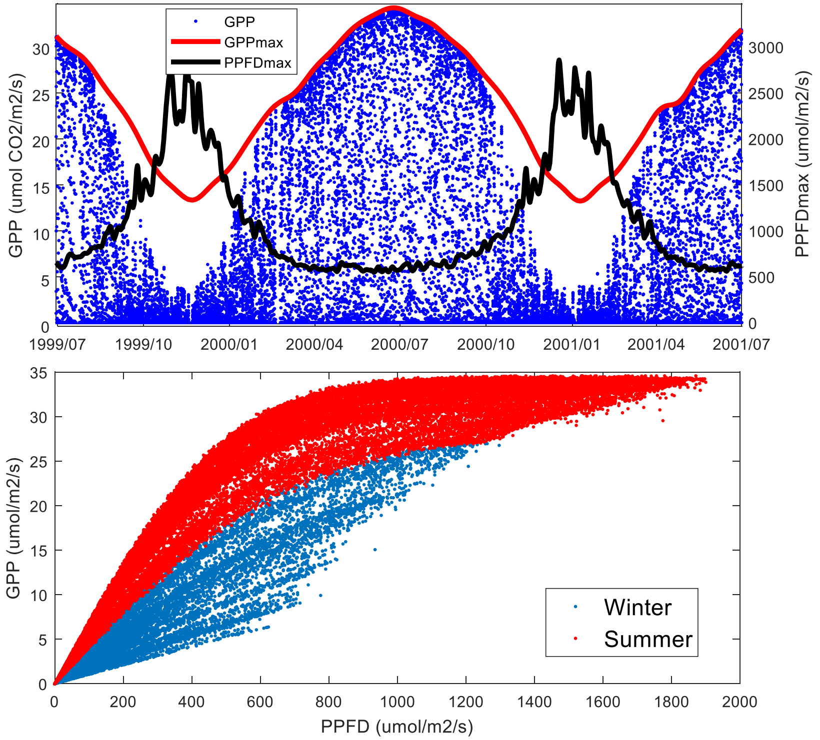
- High latitude alpine areas vary in climate from extremely cold and dry to relatively warm and wet.
- How might potential vegetation productivity change with a warming climate in these alpine areas?
- We use the long term (16-years) maximum NDVI as a proxy for maximum potential productivity under natural conditions.





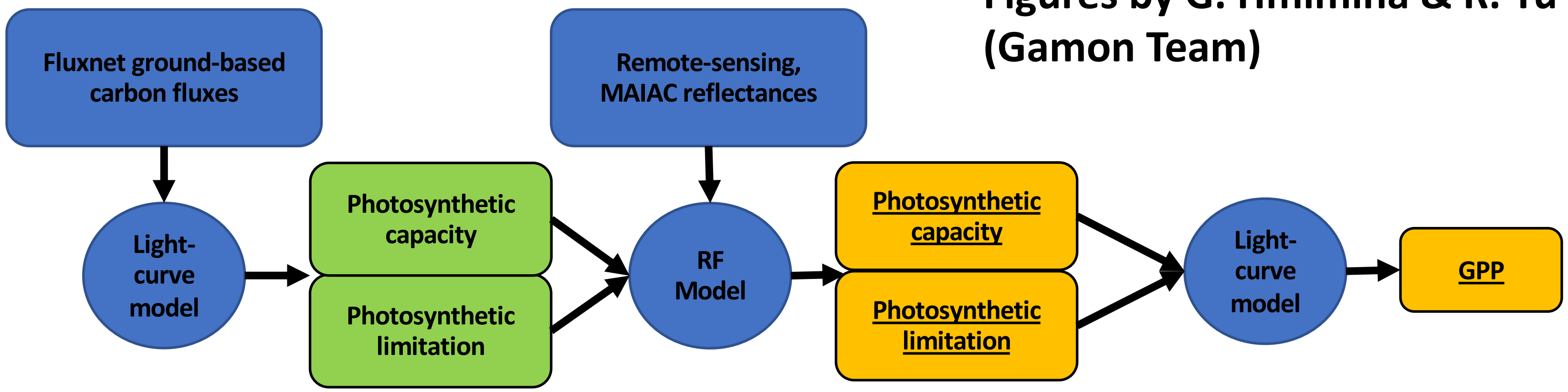
- **Upper panel:** Negative relationship between mean long-term (2002-2017) maximum NDVI by precipitation for cooler temperature classes from all mountain pixels.
- **Lower panel**: Positive relationship between mean maximum long-term NDVI by precipitation for warmer temperature classes from all mountain pixels.
- All linear trends were significant ($p < 0.01$) except for the 12-degree trend line.

Methods used in remote-sensing derived estimation of arctic and boreal ecosystems productivity



- A light-curve model was fitted on flux-tower NEE data
- Two parameters (maximum GPP and saturating PPFD) were predicted using remote-sensing data, then used to compute potential GPP ($R^2 = 0.85$)
- Inter-annual variations in predicted GPP were traced back to light curve parameters, and related to soil temperature and water content (ERA re-analysis data – see next slide)

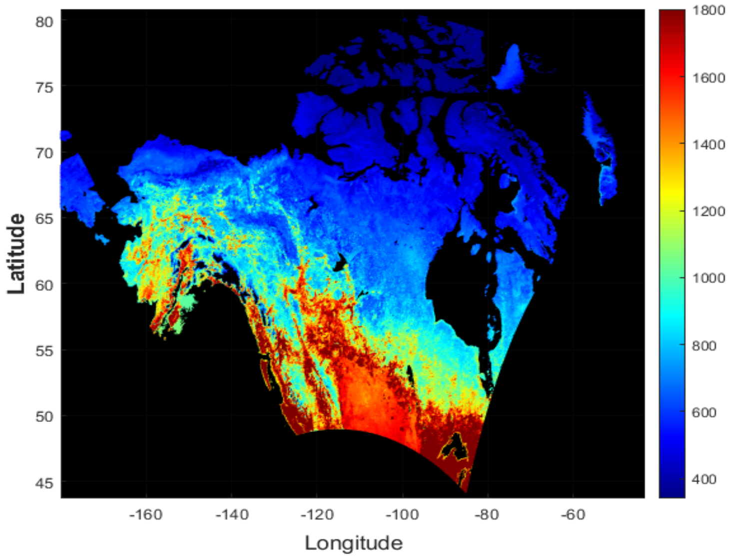
Figures by G. Hmimina & R. Yu (Gamon Team)



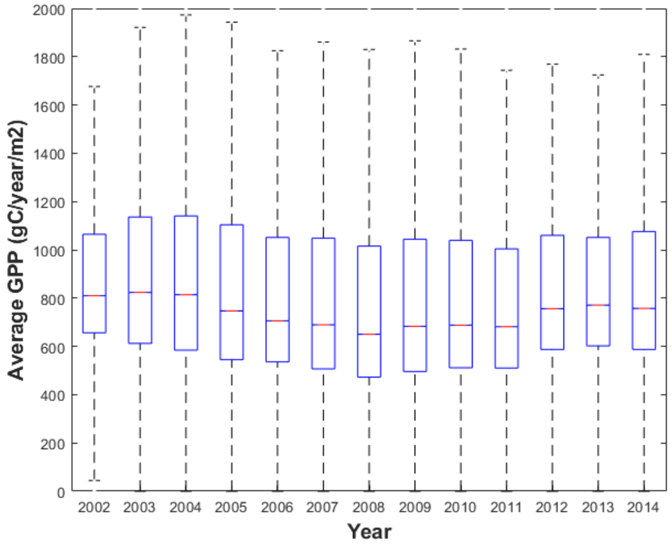
Flowchart of the developed framework. In Green, flux-tower scale products. In orange : 1 km resolution large scale product.

Remote-sensing derived estimation of arctic and boreal ecosystem productivity

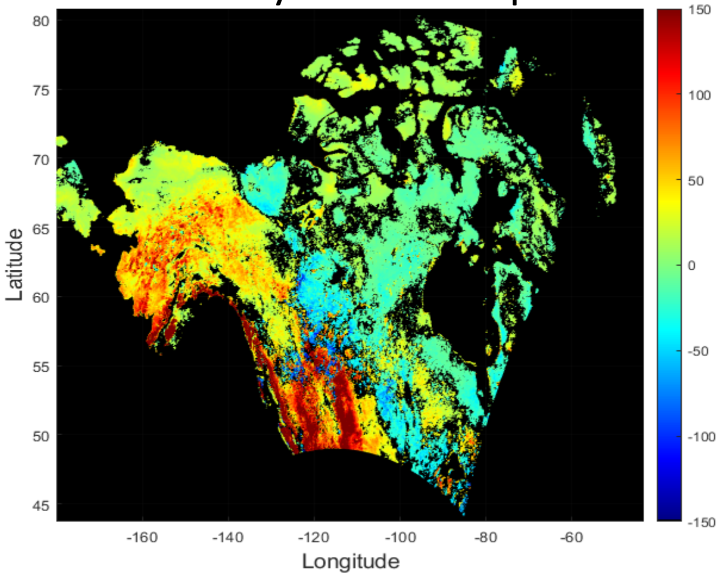
Average GPP (gC m^{-2} $year^{-1}$, 2002-2014)



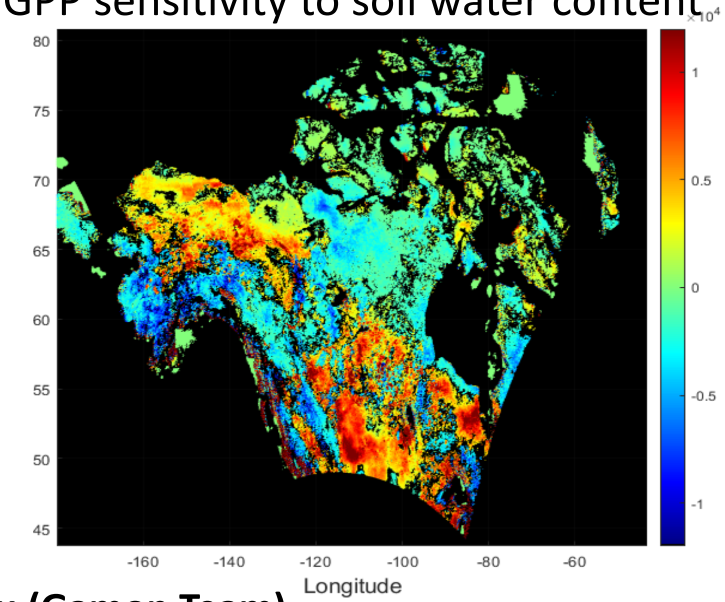
Temporal trend in GPP - ABoVE Domain



GPP sensitivity to soil temperature



GPP sensitivity to soil water content



Figs by G. Hmimina & R. Yu (Gamon Team)