John
Gamon

Evaluating growing season length and productivity across the ABoVE Domain

Main co-investigators
Dave Billesbach (U. Nebraska-Lincoln)
Fred Huemmrich (U. Maryland, NASA GSFC)
Christian Frankenberg (Cal Tech)
(20 collaborators)

Collaborations

Investigator	Role	Institution	Responsibility
John Gamon	PI	U. Nebraska & U. Alberta	Project coordination, modeling
David Billesbach	Co-I	University of Nebraksa	Field data analysis & modeling
Fred Huemmrich	Co-I	U. Maryland, Baltimore Cty	MODIS products & modeling
Christian Frankenberg	Co-I	Cal Tech	SIF products & modeling
Jahan Kariyeva	Collaborator	U. Alberta	Boreal validation & outreach
Steve Running	Collaborator	U. Montana	MOD17 GPP modeling
Andy Black	Collaborator	U. British Coumbia	Flux data
Warren Helgason	Collaborator	U. Saskatchewan	Flux data
Larry Flanagan	Collaborator	U. Lethbridge	Flux & optical data
Oliver Sonnentag	Collaborator	U. Montreal	Flux & optical data
Peter LaFleur	Collaborator	Trent University	Flux & optical data
Elyn Humphreys	Collaborator	Carlton University	Flux & optical data
Eugenie Euskirchen	Collaborator	U. Alaska, Fairbanks	Flux & optical data
Mario Tenuta	Collaborator	U. Manitoba	Flux & optical data
Altaf Arain	Collaborator	McMaster University	Flux data
Ingo Ensminger	Collaborator	U. Toronto	Optical data & physiology
Craig Tweedie	Collaborator	U. Texas, El Paso	Arctic Field Validation
Nicholas Coops	Collaborator	U. British Coumbia	Optical data
Thomas Hilker	Collaborator	Oregon State University	Optical data & LUE modeling
Phil Marsh	Collaborator	Wilfrid Laurier University	Hydrological data
Postdoc(s) - TBD	Postdoc	U. Nebraska	Modeling
Student(s) - TBD	Student	U. Nebraska	Data processing & analysis

And… but… therefore

Northern growing seasons are lengthening, leading to *increased* productivity,…

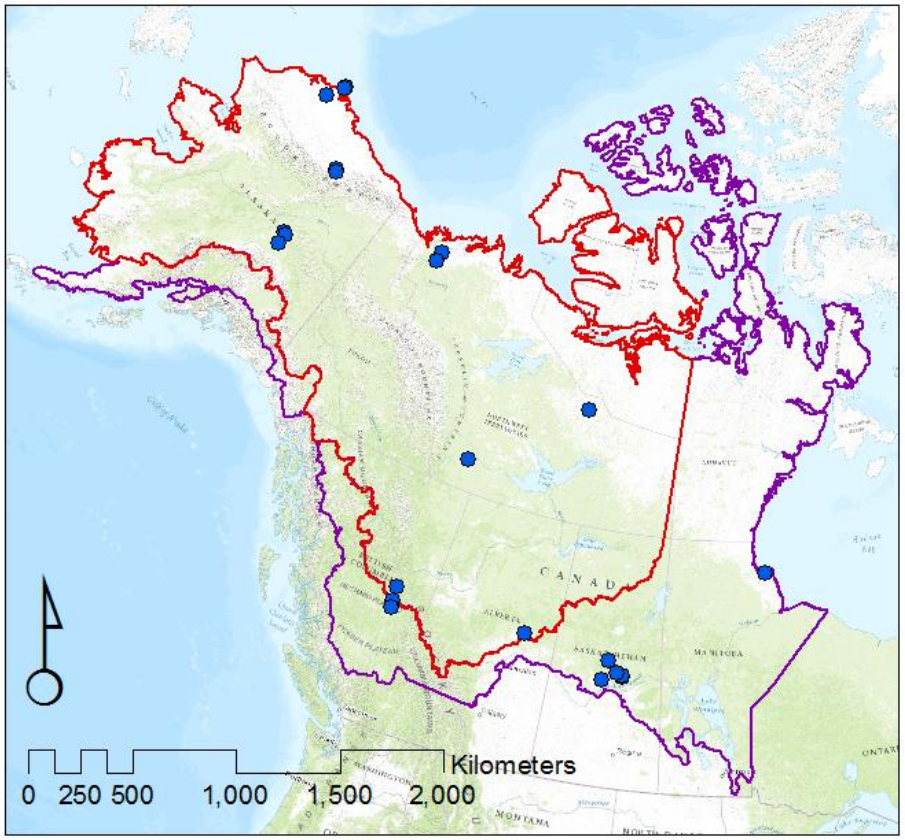
or is that *decreased* productivity?

(*disturbance* and *hydrological limitations* are wild cards affecting productivity)

Central Questions & Objectives

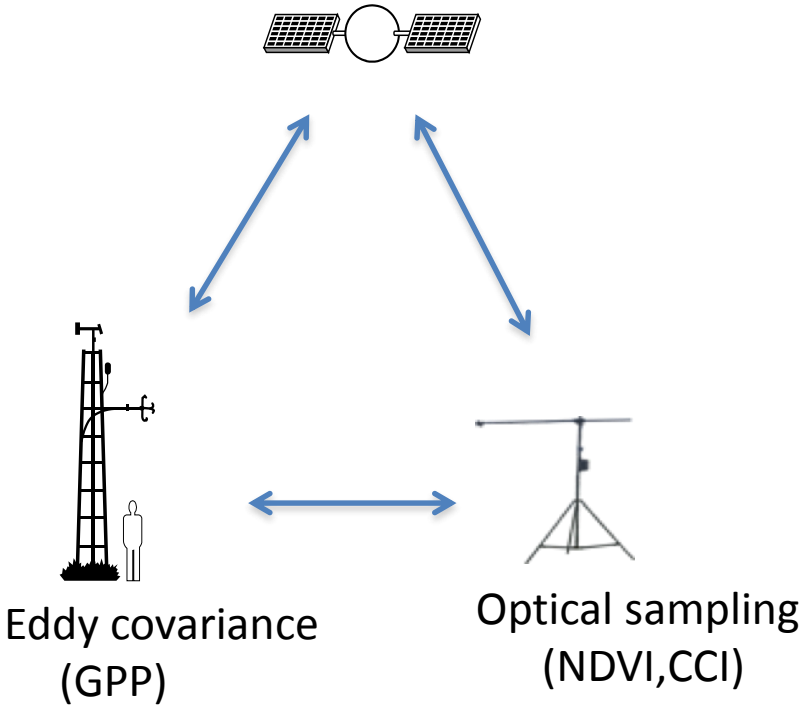
- What is the link between *growing season length* and *productivity* across the ABoVE Domain?
- How is it affected by *disturbance*? (Question 3.2)
- How is this relationship affected by changing *hydrology*? (Question 3.4)
- How can we best interpret the "browning" and "greening" observed from satellite? (Science Objective 5)

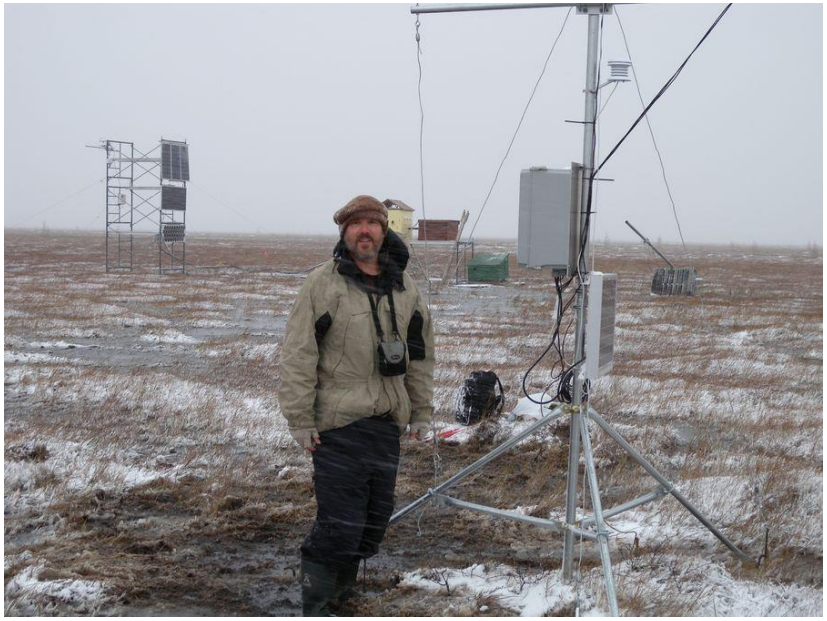
Field Sites

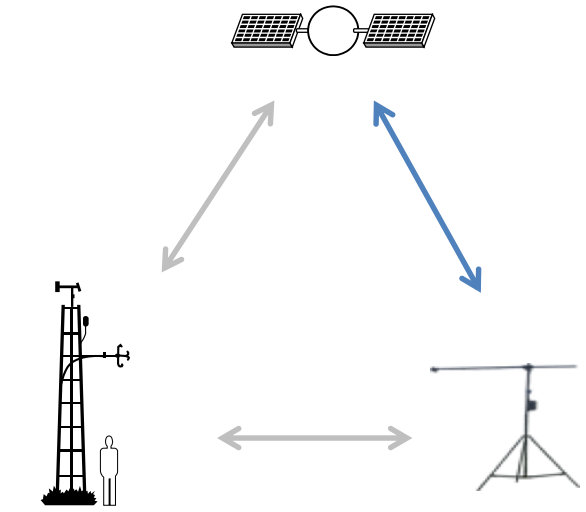


Blue dots indicate eddy covariance field sites, several also conducting ground optical sampling.

Methods

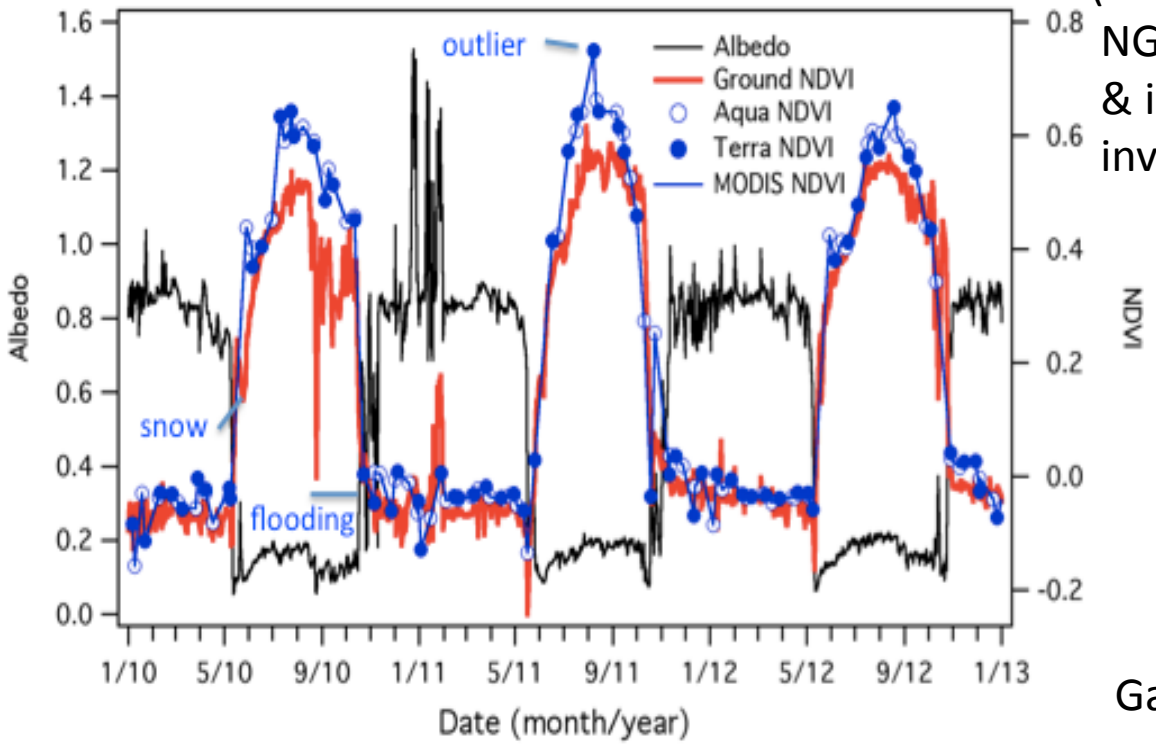






Eddy covariance (AmeriFlux, FluxNet, NGEE, ARM, & individual investigators)

Optical sampling (SpecNet & individual investigators)



Gamon et al. (in prep)

The problem of evergreen ecosystems

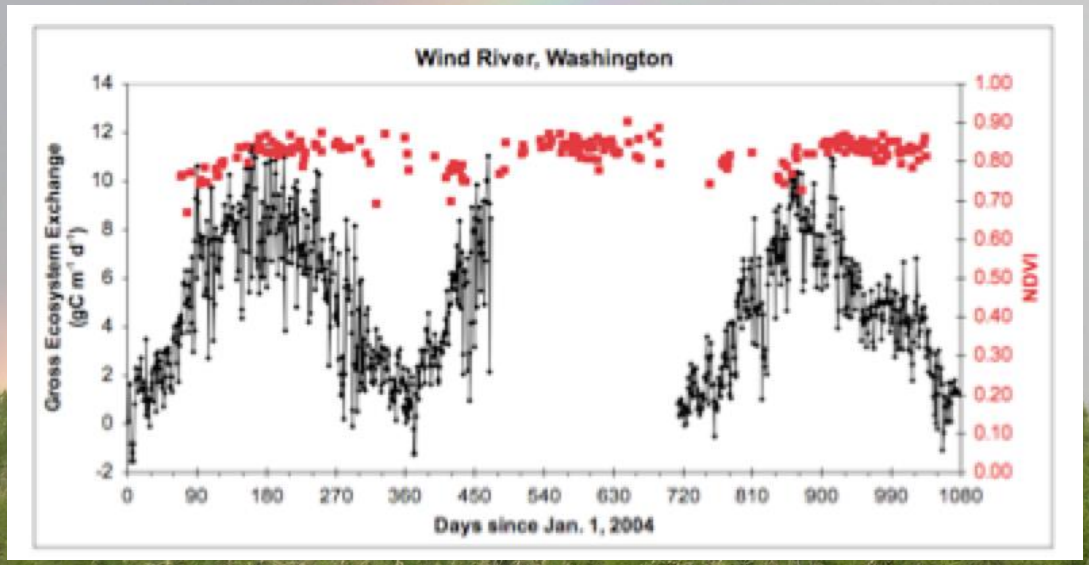
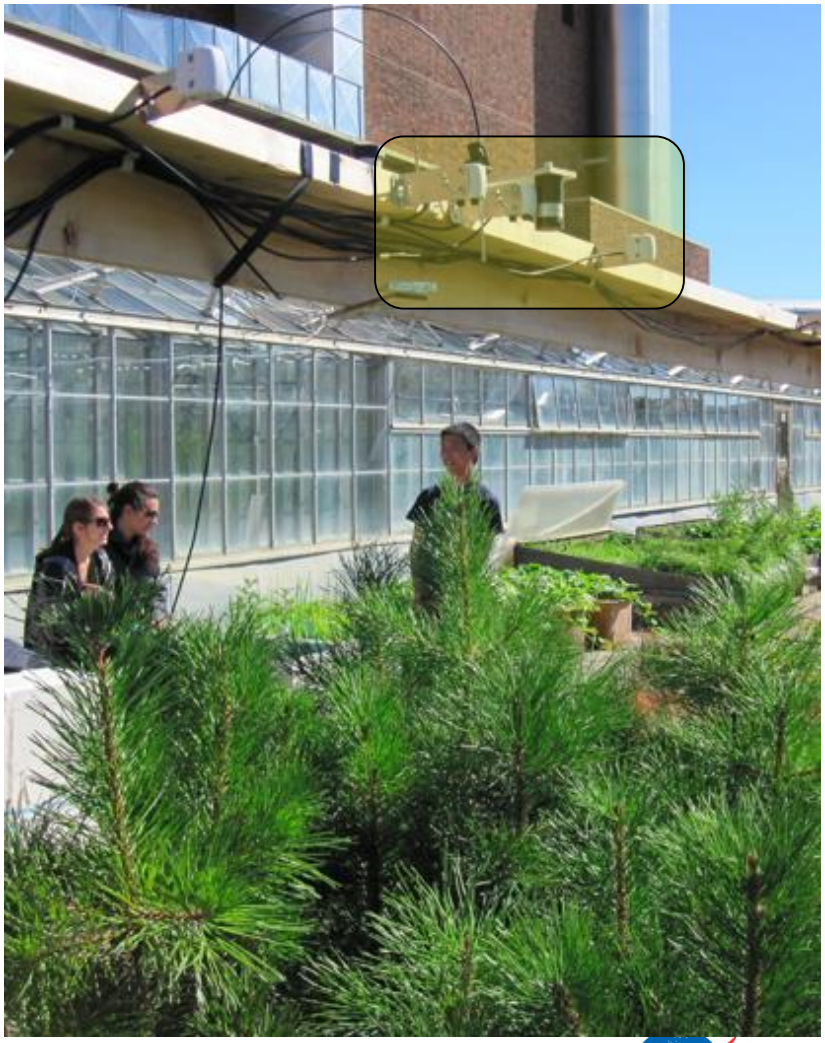


Fig. courtesy Fred Huemmrich

Leaf & Canopy Reflectance (Pine)

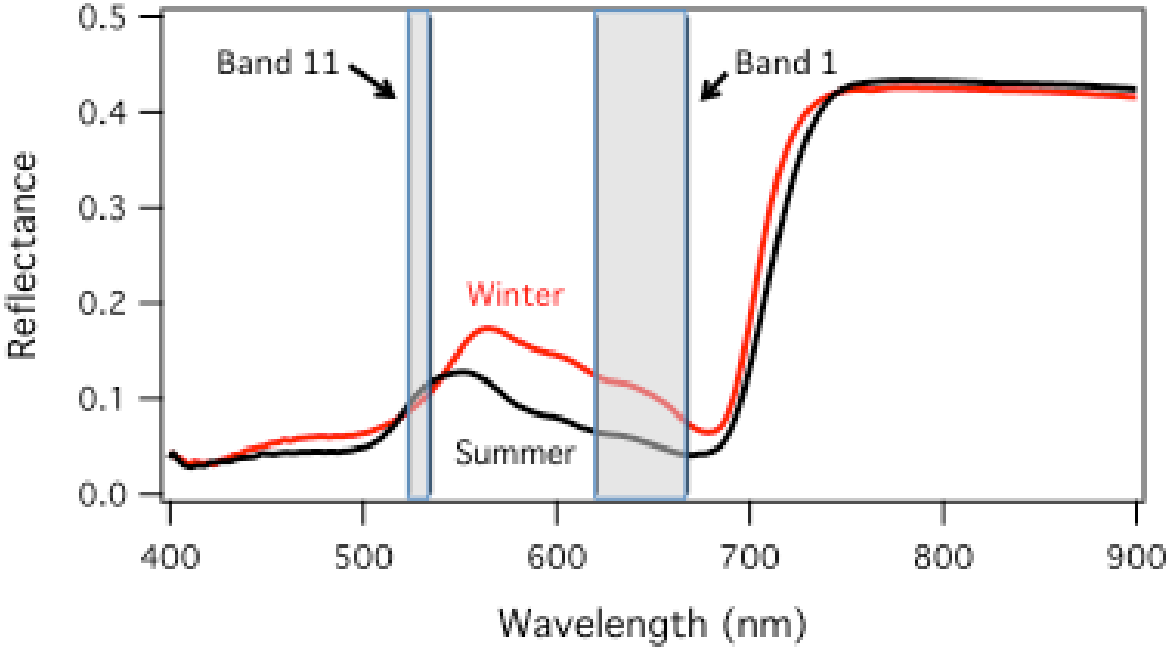
Leaf reflectance sampling



Canopy reflectance

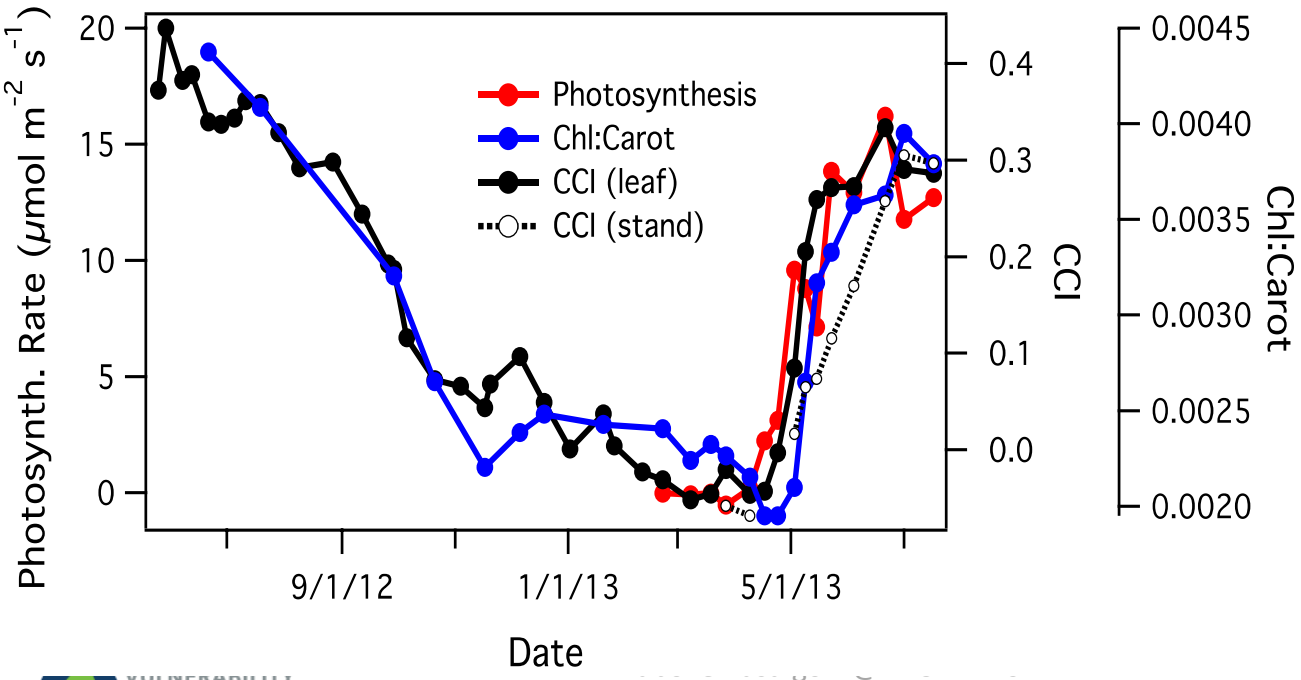
Chlorophyll:Carotenoid Index (CCI) Lodgepole pine

(combines MODIS ocean and land bands)



Gamon, Huemmrich, et al. (in prep)

Seasonal course of photosynthesis, CCI, & pigments



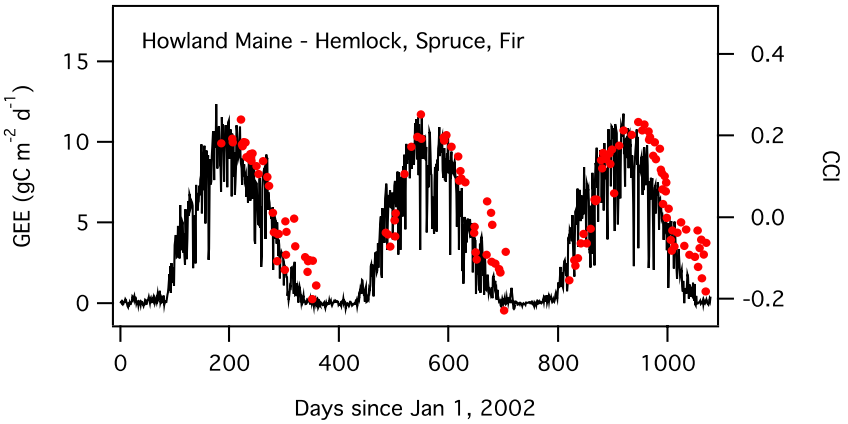
Gamon, Huemmrich, et al. (in prep)

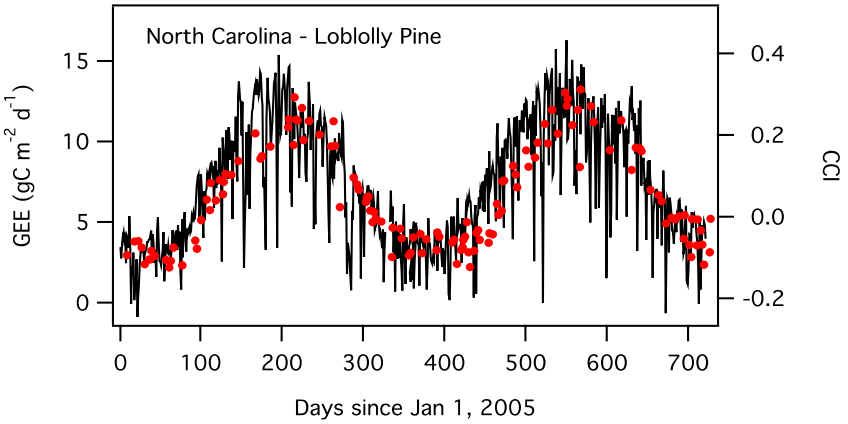
Spaceborne Resources:

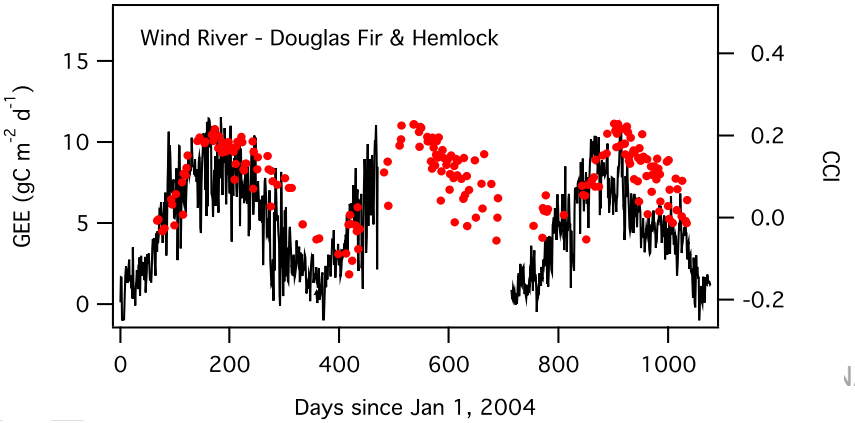
MODIS Collection 6 – Can it provide a useful photosynthetic phenology for evergreen stands?

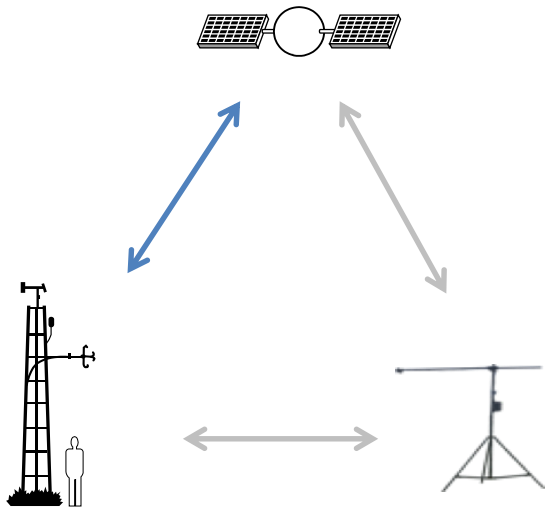
High Resolution Imagery – resolving disturbance and hydrological change.

GEP & CCI Trends – 3 Evergreen Sites







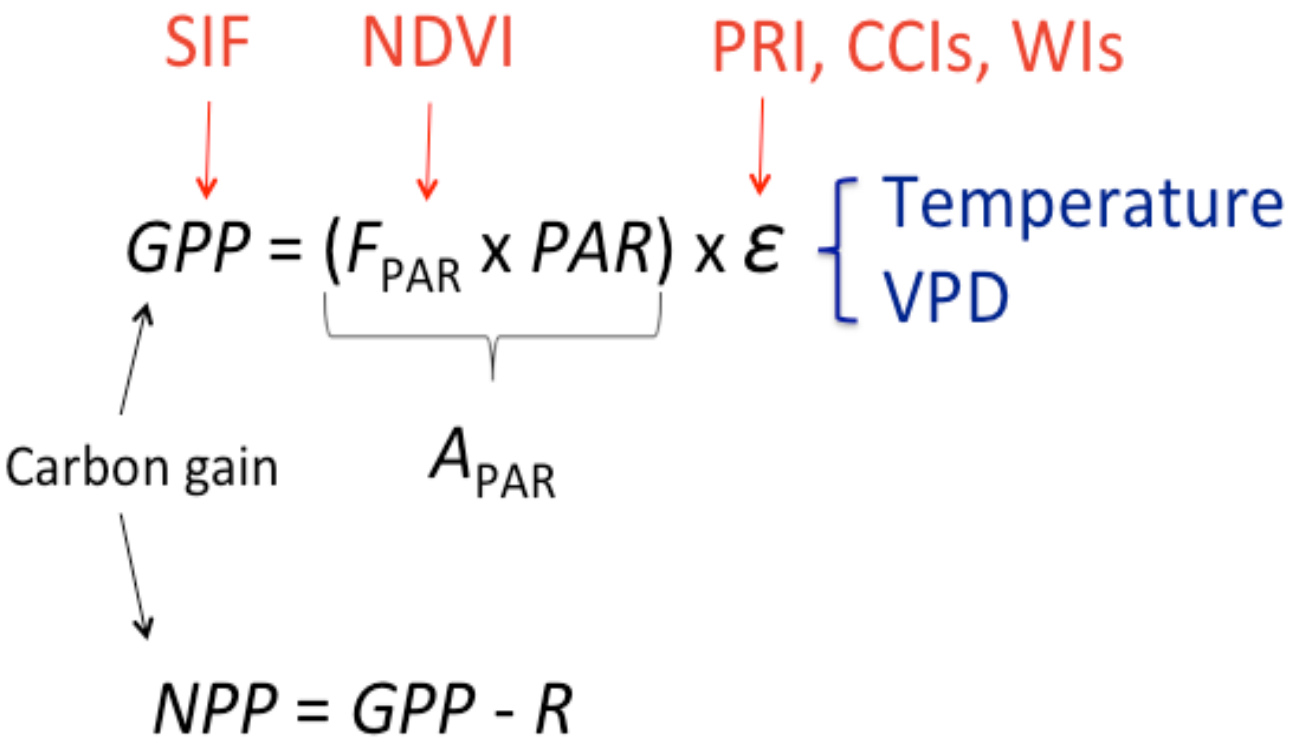


Eddy covariance (AmeriFlux, FluxNet, NGEE, ARM & individual investigators)

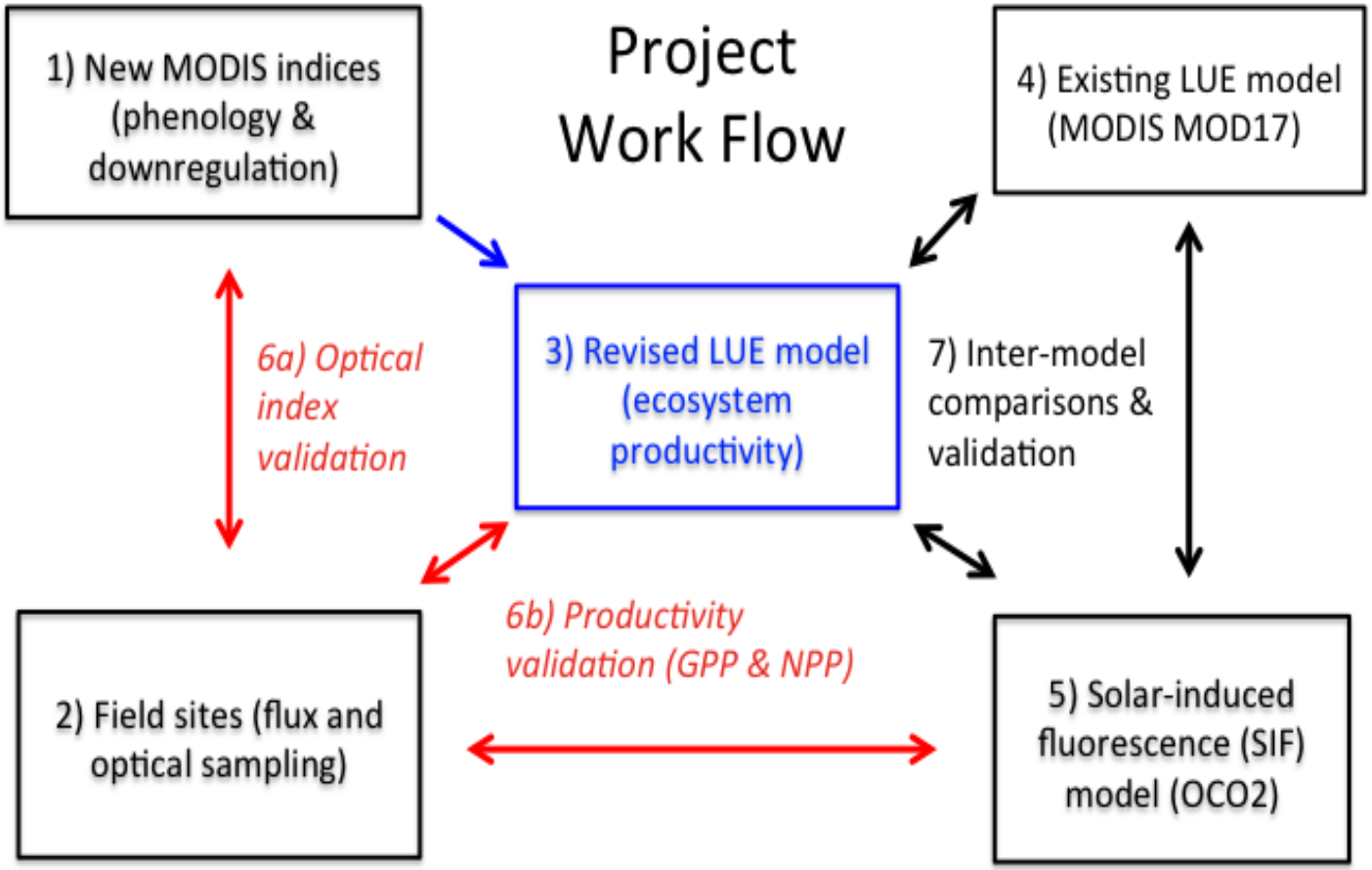
Optical sampling (SpecNet & individual investigators)

Gamon, Huemmrich et al. (in prep)

Model Approach
(Light Use Efficiency Model)



After Gamon et al. 2015


Project Work Flow
1) New MODIS indices (phenology & downregulation)
4) Existing LUE model (MODIS MOD17)
6a) Optical index validation
3) Revised LUE model (ecosystem productivity)
7) Inter-model comparisons & validation
6b) Productivity validation (GPP & NPP)
2) Field sites (flux and optical sampling)
5) Solar-induced fluorescence (SIF) model (OCO2)

Expected Data Products:

1) Sample data - Flux & optical data from core sites

2) Maps (MODIS, OCO-2):

-Vegetation type (evergreen, deciduous…).

-Photosynthetic productivity

-Season length

Temporal range: 2000-2015

Spatial Extent: ABoVE Domain

Format???

Other expected products / outcomes

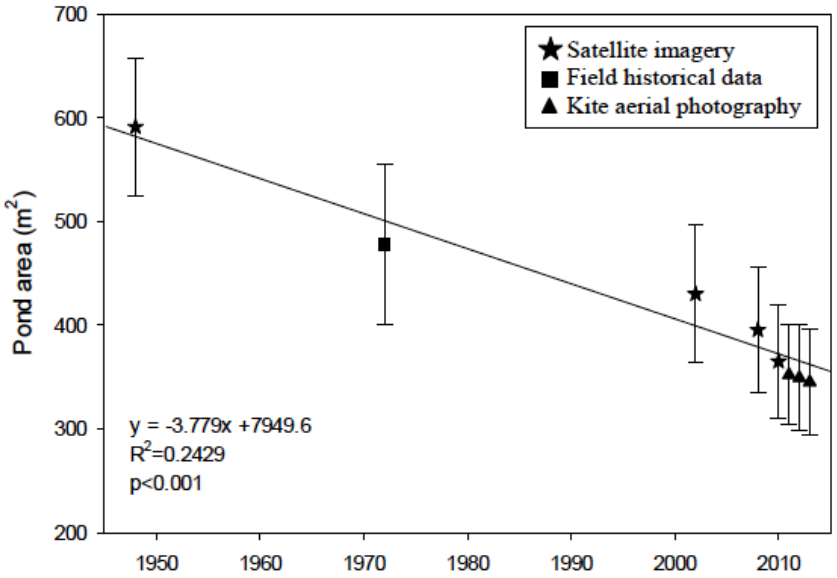
- Detailed analysis of changing hydrology, disturbance.

(What is the role of changing hydrology & disturbance in the browning & greening?)

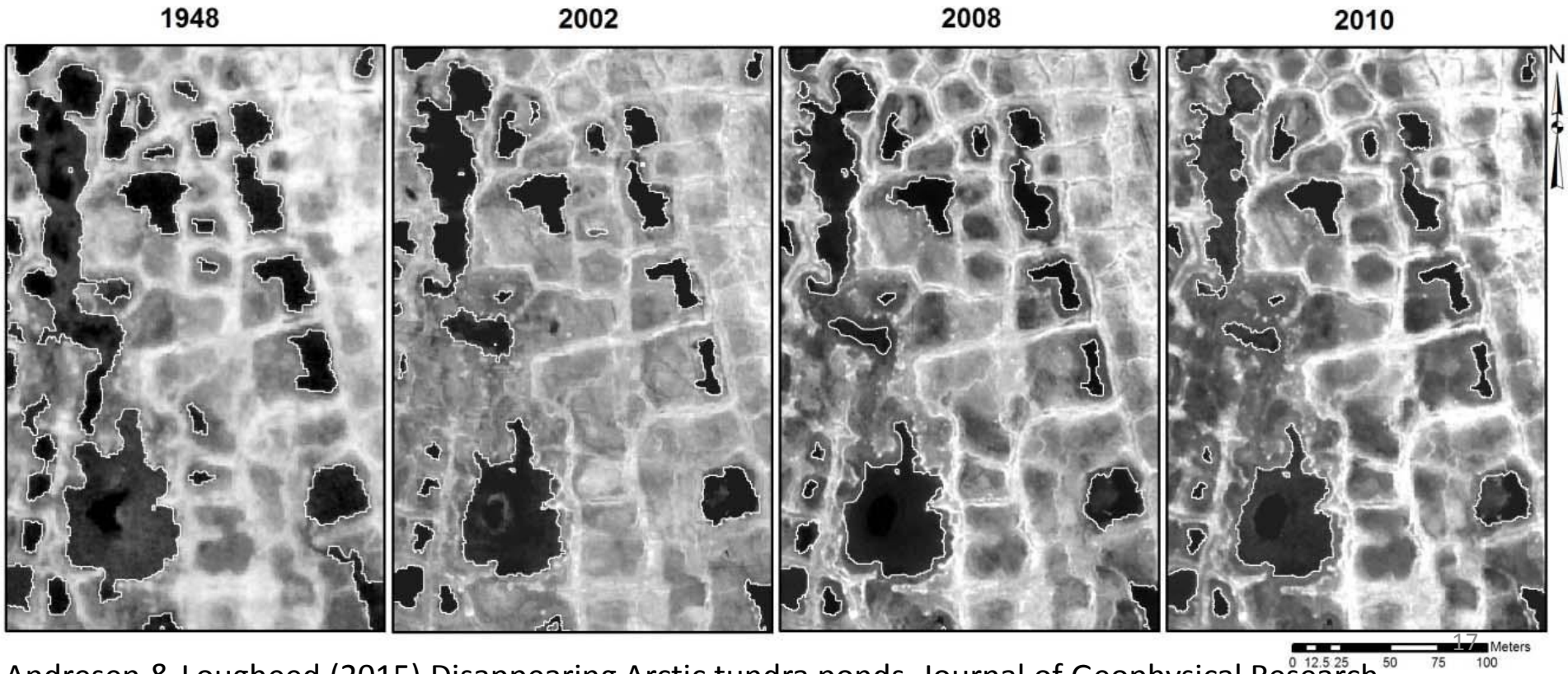
- Community Outreach
- Independent Validation (MOD17, SIF)

Tundra surface drying

(1948 - present)



Note: Surface drying also increases NDVI!

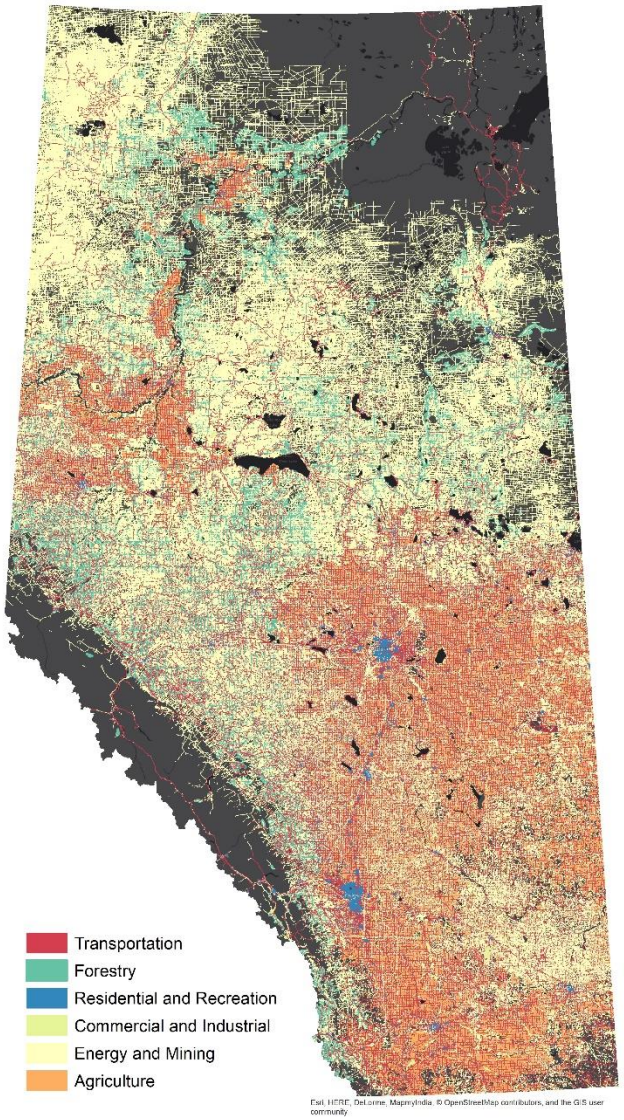


Andresen & Lougheed (2015) Disappearing Arctic tundra ponds, Journal of Geophysical Research

Disturbance – human footprint (J. Kariyeva, ABMI)

Alberta (Wall to wall) Human Footprint (HF)

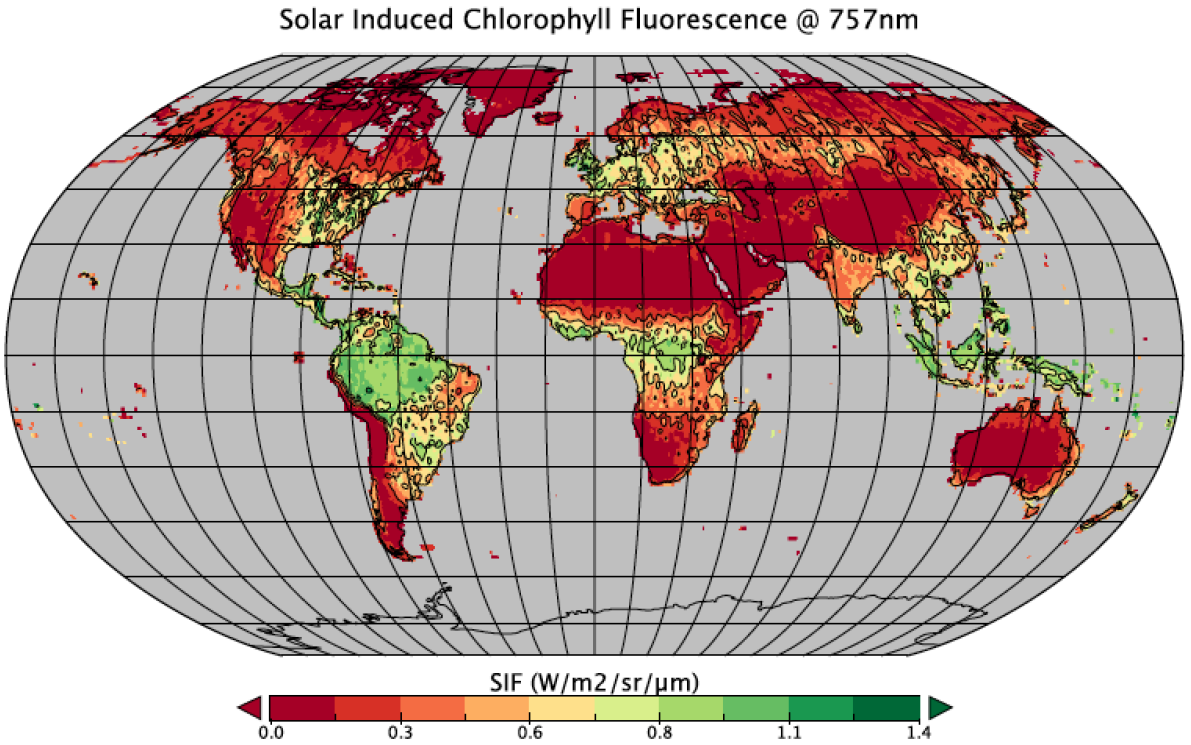
- ***2007, 2010, 2012 (V.3: June of 2015)***
- ***HF covers approximately 30% of AB***
- ***HF dataset contains over four million features***
- ***HF dataset contains more than 80 types of HF***



Slide courtesy Jahan Kariyeva (ABMI)

Independent validation with SIF (C. Frankenberg)

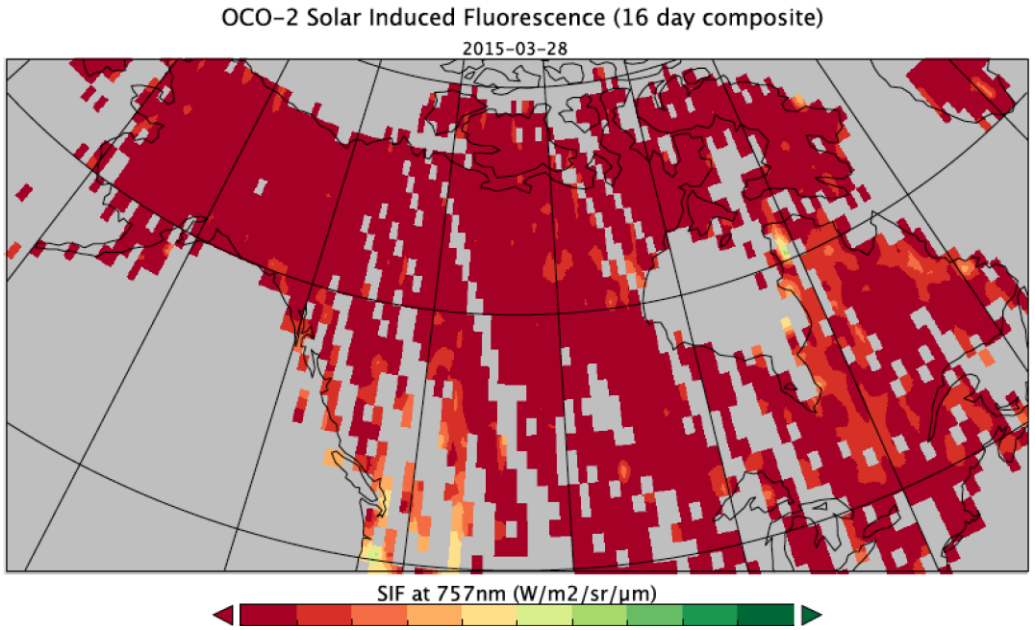
SIF @ 757nm, all OCO-2 data averaged



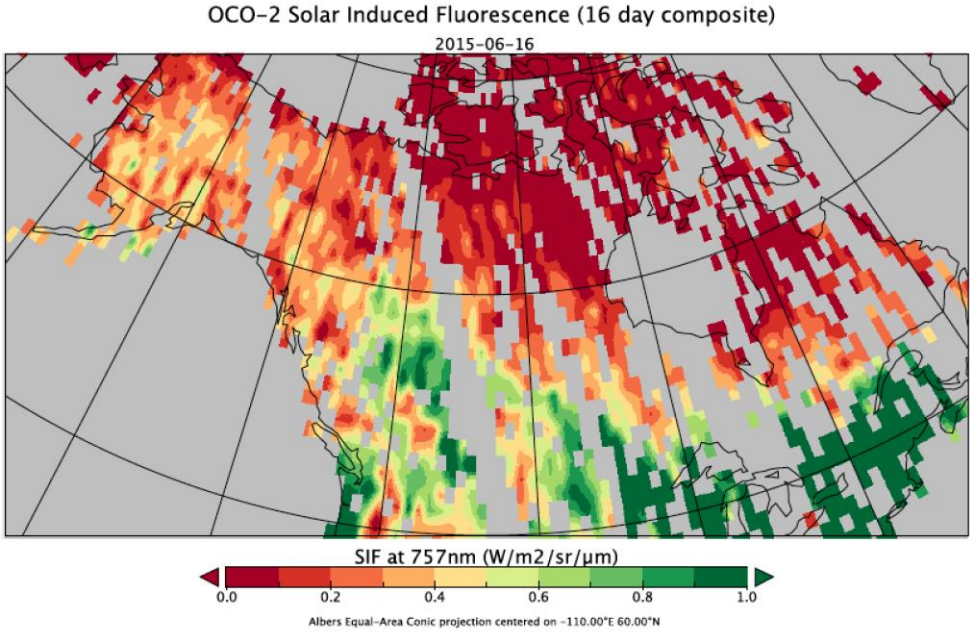
Slide courtesy Christian Frankenberg

Solar-induced Fluorescence (SIF)

March 28, 2015



June 15, 2015



Slide courtesy C. Frankenberg

ARCTIC BOREAL VULNERABILITY EXPERIMENT

Airborne Remote Sensing

- Existing airborne remote assets to be used
  - Imaging spectrometry & LiDAR
- Potential uses for new airborne data
  - Characterizing flux tower sites:
    - Vegetation type
    - Disturbance/succession
    - Basis for “upscaling”