Vegetation Dynamics and Distribution

Brendan Rogers

Mark Chopping, Jan Eitel, Josh Fisher, Mark Friedl, John Gamon, Mike Goulden, Heather Greaves, Tedd Hogg, Fred Huemmrich, Kelseyann Kremers, Douglas Morton, Jon Ranson, Adrian Rocha, Brendan Rogers, Scott Goetz, Hank Shugart, Jacquelyn Shuman, Damien Sulla-Menashe, Sander Veraverbeke, David Verbyla, Lee Vierling, Donald (Skip) Walker, Curtis Woodcock

Established Institutional Collaborations

- USDA Forest Service
- US Geologic Survey
- Bureau of Land Management
- National Park Service
- US Fish & Wildlife Service
- Alaska Fire Science Consortium
- Northwest Boreal Landscape Conservation Cooperative
- Army Corps of Engineers
- UA Fairbanks Extension
- Yukon Wildland Fire Management
- Northwest Territories Environment and Natural Resources
- Polar Knowledge Canada
- Canadian Forest Service

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Science Questions

Vegetation Dynamics WG themes

1) Mechanistic controls on vegetation: physiology, stress, biogeochemistry, phenology (**5**, **6**)

2) Mapping vegetation distributions (**2**, **5**)

3) Patterns/dynamics of vegetation structure, particularly at the forest-tundra ecotone (**5**, **6**)

4) Effects of disturbance frequency/intensity on vegetation recovery (**1**, **2**, **5**, **6**)

5) Shifting patterns of tundra vegetation, emphasis on greening/shrub encroachment (**1**, **5**)

6) Shifting patterns of boreal forest vegetation, emphasis on treeline, browning, dieback (**5**, **6**)

ABoVE Tier 2 Science Questions

1) How are environmental changes affecting critical ecosystem services…climate regulation...

2) What processes are contributing to changes in disturbance regimes and what are the impacts of these changes?

5) How are flora and fauna responding to changes in biotic and abiotic conditions, and what are the impacts on ecosystem structure and function

6) How are the magnitudes, fates, and land-atmosphere exchanges of carbon pools responding to environmental change, and what are the biogeochemical mechanisms driving these changes?

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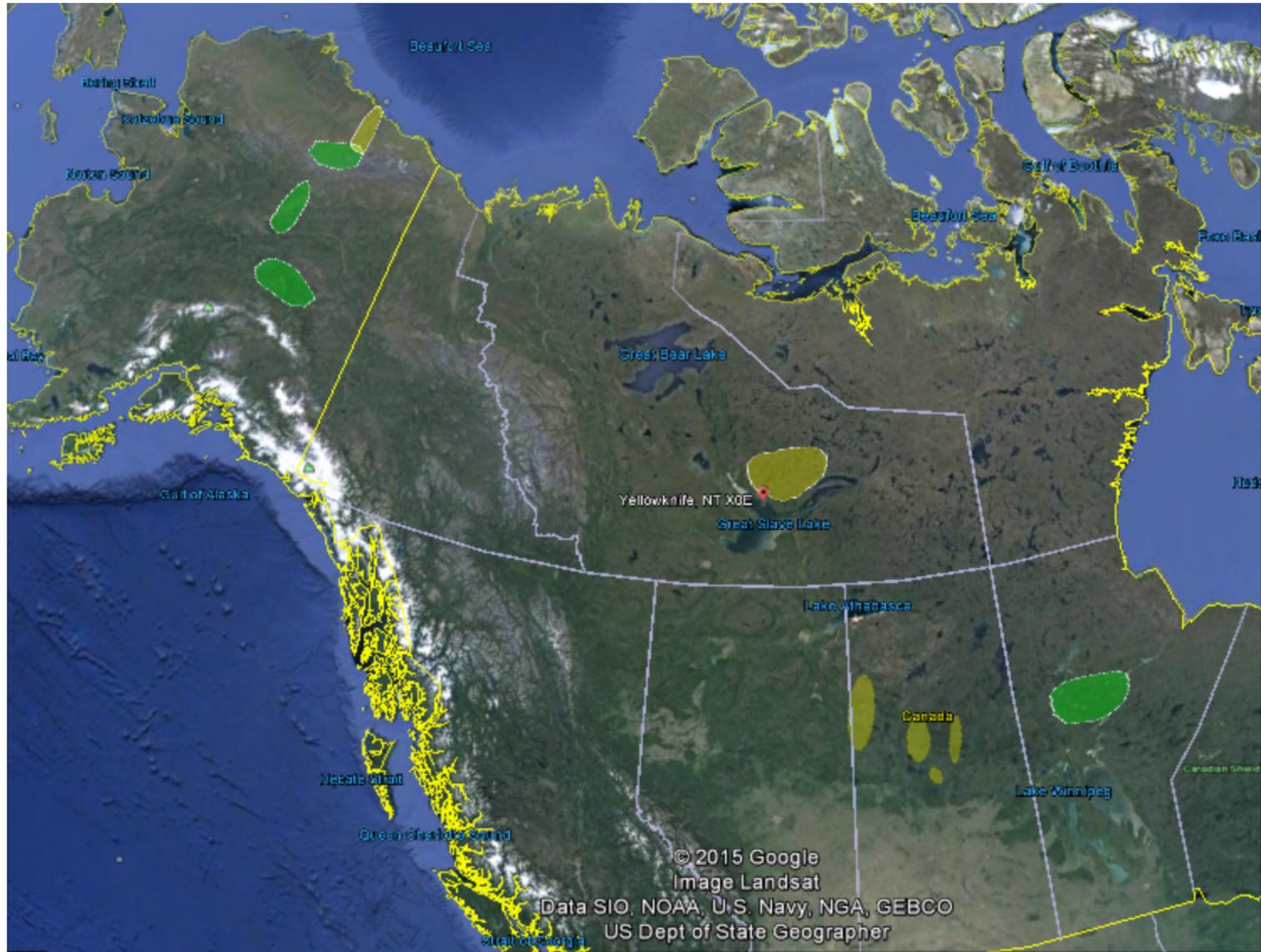
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Science Objectives

Vegetation Dynamics WG themes

1) Mechanistic controls on vegetation: physiology, stress, biogeochemistry, phenology (SO-ED **6**)

2) Mapping vegetation distributions (SO-ED **3**, **5**)

3) Patterns/dynamics of vegetation structure, particularly at the forest-tundra ecotone (SO-ED **3**, **5**, **6**)

4) Effects of disturbance frequency/intensity on vegetation recovery (SO-ED **3**, **6**; SO-ES **5**)

5) Shifting patterns of tundra vegetation, emphasis on greening/shrub encroachment (SO-ED **5**; SO-ES **5**)

6) Shifting patterns of boreal forest vegetation, emphasis on treeline, browning, dieback (SO-ED **3**, **5**, **6**)

ABoVE Tier 2 Science Objectives

SO-ED 3) Understand how vegetation attributes…respond and feedback to disturbance

SO-ED 5) Determine the causes of greening and browning trends and their impacts on ecosystem form and function

SO-ED 6) Elucidate how climate change and disturbances interact…to alter carbon biogeochemistry, including release to the atmosphere

SO-ES 5) Determine the sources and variations in climate feedbacks from Arctic and boreal ecosystems and assess the potential future changes to climate regulating services

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Field Studies – Map

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Field Studies – Ground Measurements

Can be organized by (i) instruments/methodologies, (ii) types of measurements, (iii) sampling design, (iv) locations.

Types of measurements:

- Plant physiology (micromet gas exchange, fluorescence)
- Plant community composition and demographics (recruitment, mortality)
- Vegetation structure (height, biomass, LAI)
- Biogeochemistry (C pools and fluxes)
- Ecological history (tree rings, PSPs, fire/C pool ages)
- Meteorology, hydrology, snow and permafrost

Instruments/methodologies:

- Allometry, biomass, tree rings, soil cores, forest inventory, flux towers, ground-based sensing like LiDAR, spectral, optical phenology, photography

Sampling design:

- Critical gradients: climate, drainage, species, and fire
- Key locations (e.g., ecotones)
- Key periods (e.g., immediately after a fire)
- Places of recent change (e.g., browning, greening/shrub encroachment)
- Systematic wall-to-wall or large transects (mostly RS/modeling)
- Multi-scale approaches using intensive + extensive sites

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Spaceborne Remote Sensing

Central to almost all projects in the Vegetation Dynamics Working Group

Considerable effort on spatial scaling

Major themes:

- Understanding how plant physiological signals (e.g., properties related to productivity) can be detected, what ecosystem dynamics they're related to (e.g., shrub encroachment, mortality), how they have been changing (e.g., greening/browning), and how they can be scaled in space and time.

- Understanding fine-scale vegetation structure and composition (e.g, individual shrubs/ trees), how structure is related to functional (e.g., productivity) and biogeophysical properties (e.g., carbon stocks, radiative transfer), how has this been changing, and how to scale in space and time.

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Spaceborne Remote Sensing

<u>Primary types of satellite data (passive):</u>

- Coarse-scale MODIS (250m – 1000m) and other (e.g., MISR, VIIRS, AVHRR) vis-IR. Useful for scaling, temporal frequency and trends, diversity of products: reflectance/ albedo, LST, active fires, vegetation indices, land/tree cover, snow.

- Moderate-resolution Landsat (30m) and other (e.g., Sentinel-2) data/products, mostly visible-NIR-SWIR. Useful for landscape-scale mapping/analysis, spatial scaling, temporal trends, becoming more and more accessible.

- High-resolution (~1m) commercial panchromatic, mono/stereo, multispectral, SWIR. Useful for understanding fine-scale heterogeneity and structure, spatial scaling, linking directly w/field measurements. Valuable resource through ABoVE.

Airborne Remote Sensing

Fair amount of existing airborne RS being used

Examples:

- G-LiHT: LiDAR, hyperspectral, thermal. 350m wide swaths, long flightlines, existing data for AK (Tanana valley). Being used to characterize forest structure, fire severity.
- Other airborne lidar (e.g., Alaskan Dalton, Wulder)
- Historical aerial photos: critical for change detection at fine scales (e.g., AHAP)

Upcoming campaign:

- Very interested, particularly in packages that contain LiDAR, (hyper)spectral, and NIR/SWIR.
- Very enthusiastic about contributing to experimental design.

Modeling Efforts

- Many different kinds of models being used by the Vegetation Dynamics WG

- Focused on both episodic (e.g., disturbances) and continuous (e.g., phenology, decadal trends)

- Aspire to close coordination w/the Modeling WG to develop synergies (e.g., including/focusing on the most uncertain processes/parameters, developing useful benchmarks)

- 3 major axes:

    1) Spatial modeling/scaling from local/landscape to regional/domain-wide

    2) Temporal modeling/scaling from short, intensively measured periods (~minutes – weeks) to longer (~seasons – decades)

    3) Ecophysiological modeling, sub-cellular – stand level

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Modeling Efforts

Types of models:

- Statistical: simple regression, parameterizing mechanistic algorithms (e.g., GPP), understanding ecophysiological relationships (e.g., SEMs), interpreting remote sensing data (e.g., LiDAR backscatter), spatial scaling (e.g., machine learning, classification algorithms)

- Mechanistic: radiative transfer, ecophysiological, dynamic vegetation (e.g., gap), land surface/TBMs (e.g., CLM)

- Maps

Geospatial Data Products

- A variety of products of potential interest to stakeholders

- Most products are maps; 30m or finer, some 500m MODIS

- Most defined by some region, although some are domain-wide

<u>Major themes:</u>

- Vegetation characteristics. Focus on tundra and shrubs, drilling down to stature and species. 30m and finer. Mostly newly-developed layers, some new databases of existing maps

- Carbon fluxes: NPP, GPP

- NDVI trends

- Phenology (growing season length)

- Landscape characteristics (land cover/change, tree cover, tree line) and disturbance

- Field data: new collections and databases of existing

- Climate forcings: albedo time series, fire-related (GHGs, albedo, aerosols)

- Forest C stocks, species, canopy height

THANKYOU