Arctic-Boreal Vulnerability Experiment (ABoVE)

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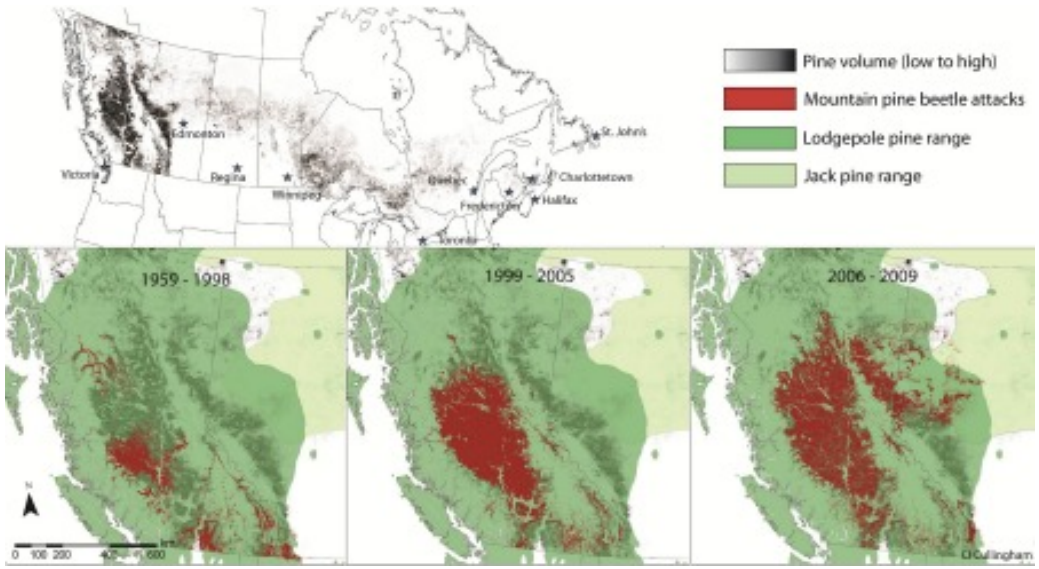
Why ABoVE? (Motivation)

The Changing Arctic-Boreal Region

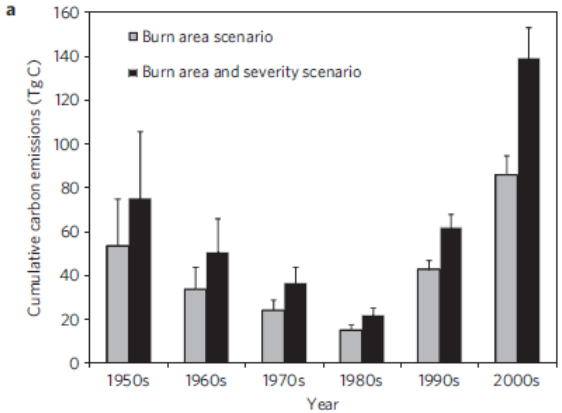
- Climate change in the Arctic and Boreal Region (ABR) is unfolding faster than anywhere else on Earth, causing warming and thawing of permafrost, increases in the frequency and severity of disturbances, and widespread changes to surface water and vegetation.
- Environmental change in this region is increasingly affecting society in a variety of ways, including impacts on forests from insects and fires, erosion of Arctic coastlines, and changes to wildlife habitat and ecosystems that affect subsistence and economic uses.
- To more fully understand the evolving ABR environment and provide the information required to develop options for societal responses to the impacts of climate change, the Arctic-Boreal Vulnerability Experiment (ABoVE) has been proposed as a NASA-sponsored field campaign.

Recent changes in climate are causing significant and novel changes to arctic/boreal ecosystems over large areas



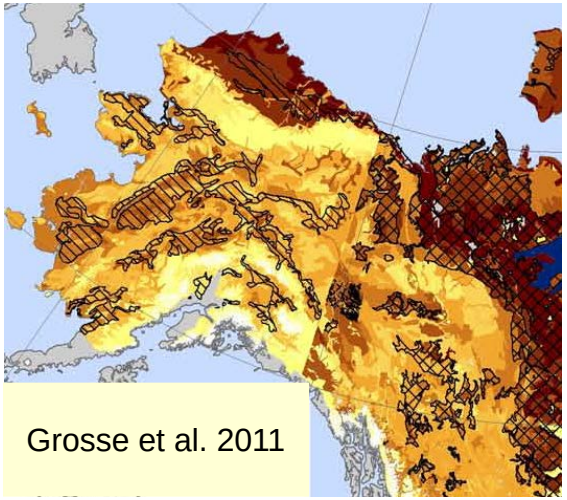
Mountain pine beetle outbreaks have accelerated and are spreading (Source: Univ. of Alberta)

Permafrost thaw is leading to shrinkage of lakes and mobilizing frozen carbon (Photo: G. Grosse)

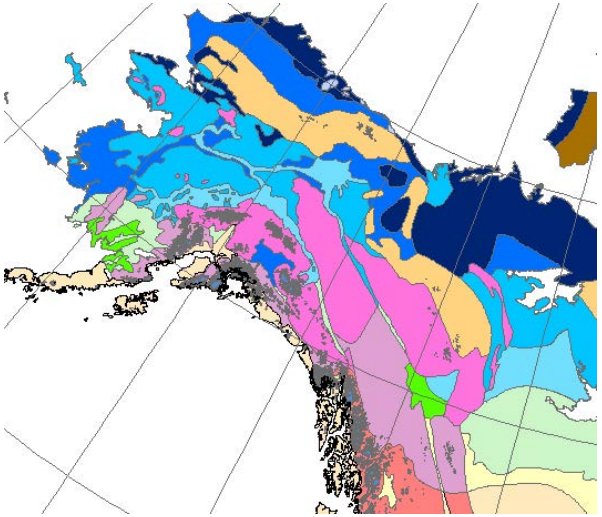


Increased fires in arctic/boreal ecosystems are accelerating soil carbon losses (from Turetsky et al., *Nature Geoscience*, 2011)

Complex interactions are the norm, with many critical feedbacks to regional and global climate



Large stocks of soil carbon



Widespread permafrost

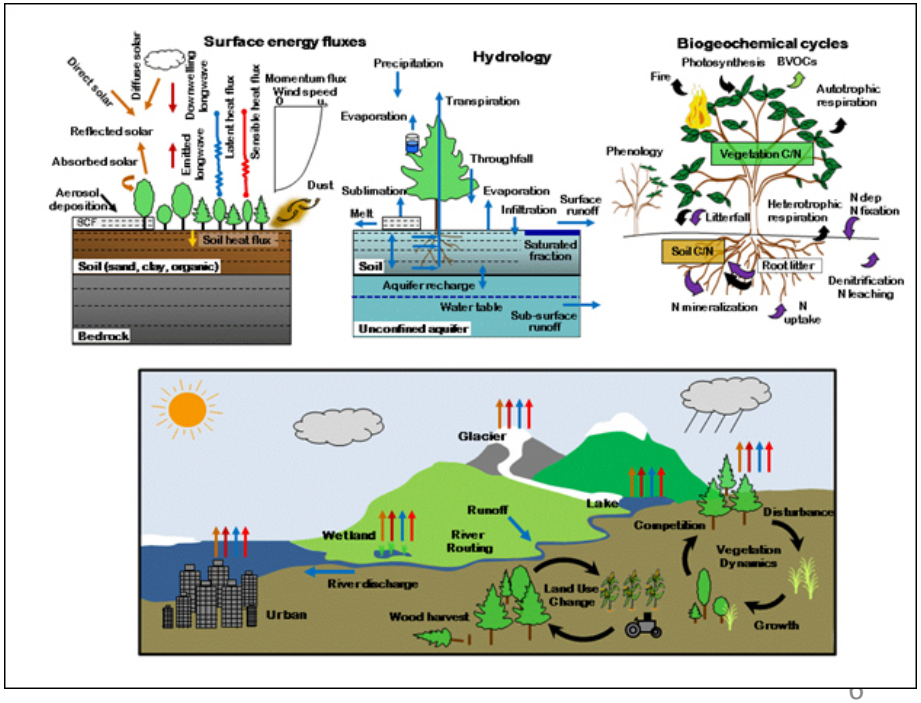
- *How rapidly will permafrost warm?*
- *What are the impacts of permafrost warming?*
- *Is there a methane tipping point?*
- *What controls burning of organic soils in tundra, forests & peatlands?*

Models of key arctic/boreal processes do not adequately explain current impacts nor can they project future impacts

- Additional research is needed to
  - Address known areas of uncertainty (the known unknowns; e.g. ground-layer processes)
  - Identify novel and new patterns of landscape change and ecosystem reorganization (the unknown unknowns; e.g. tipping points)

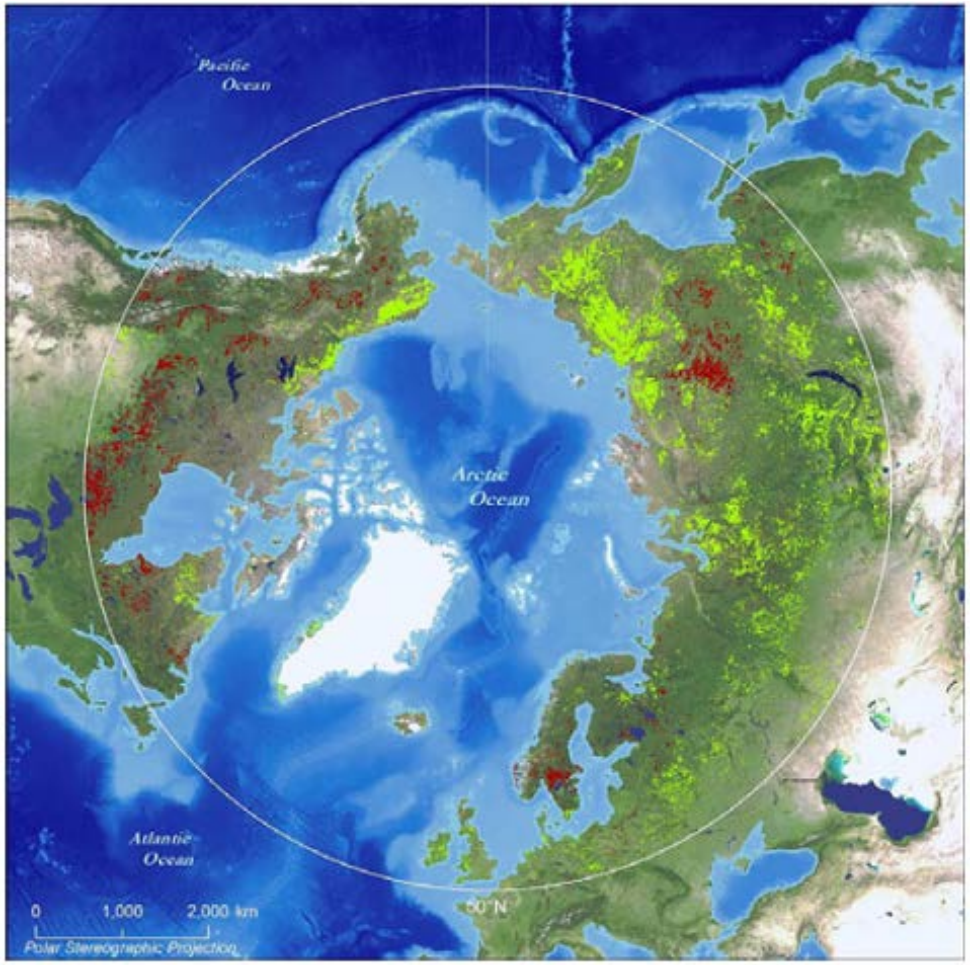
- Crucial data sets are needed to drive and independently to assess models

- An integrated modeling approach is needed (e.g., the Community Land Model [left])



source: http://www.cesm.ucar.edu/models/clm/

Remote sensing data are essential for regional context, to address uncertainties, and to inform and assess models

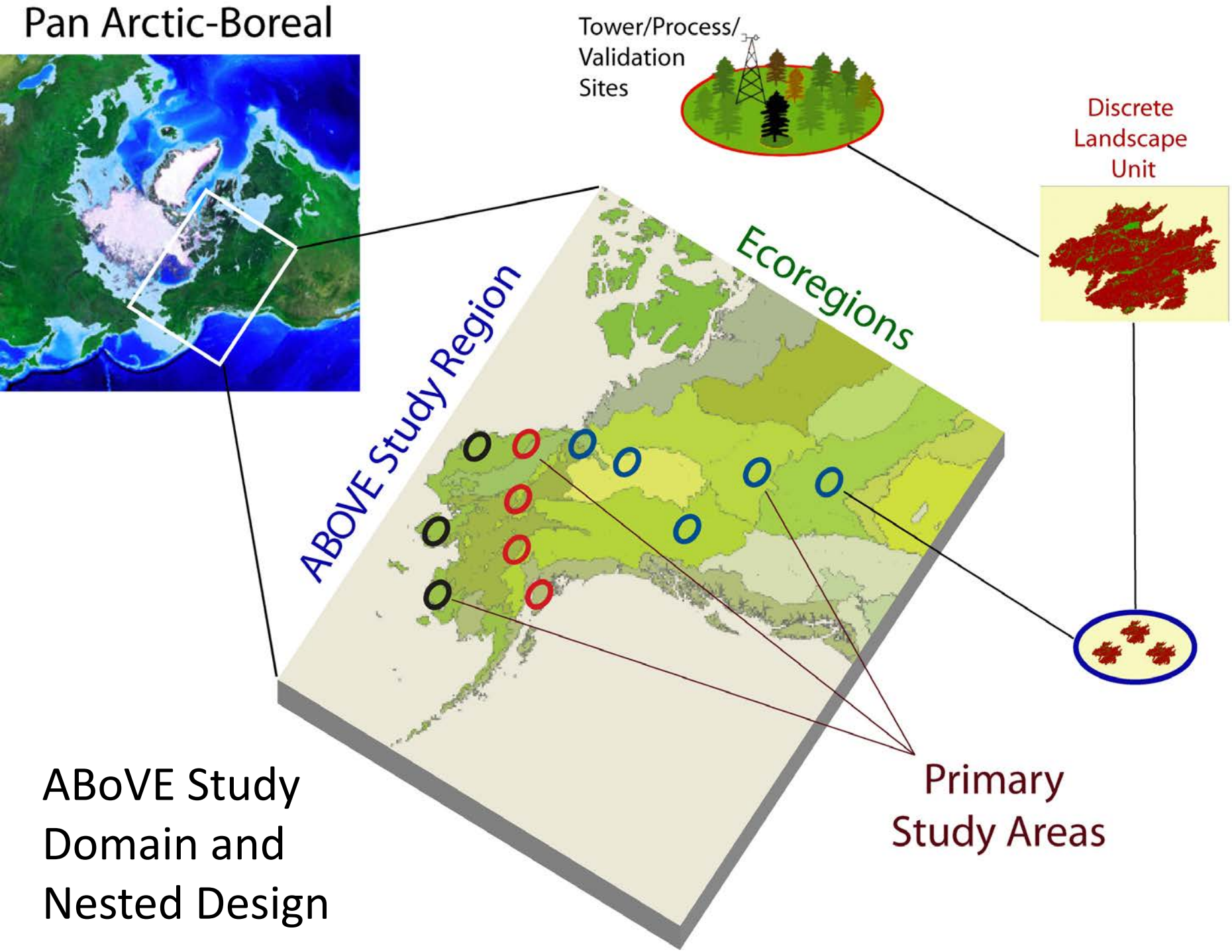


- A key component of ABoVE would be the use of spatial-temporal information products derived from remotely-sensed data.
- Remotely-sensed information products would provide improved maps of key characteristics of the land, ocean and atmosphere in the ABR and provide a means to monitor variations over time.

What is ABoVE? (Proposed Concept)

ABoVE Science Questions

- ***What processes, interactions, and feedbacks control the vulnerability of Arctic and boreal ecosystems and landscapes to structural and functional changes in a changing Earth system?***
- ***How are people at local, regional, national, and global scales being affected by and responding to these changes?***
- ***How do changes to terrestrial processes in the Arctic-Boreal region alter processes in the adjacent coastal ocean?***
- ***How do changes to terrestrial processes in the Arctic-Boreal region provide feedbacks to regional and global climate through exchanges of energy, water, gases, and particulate matter between the land surface and troposphere?***

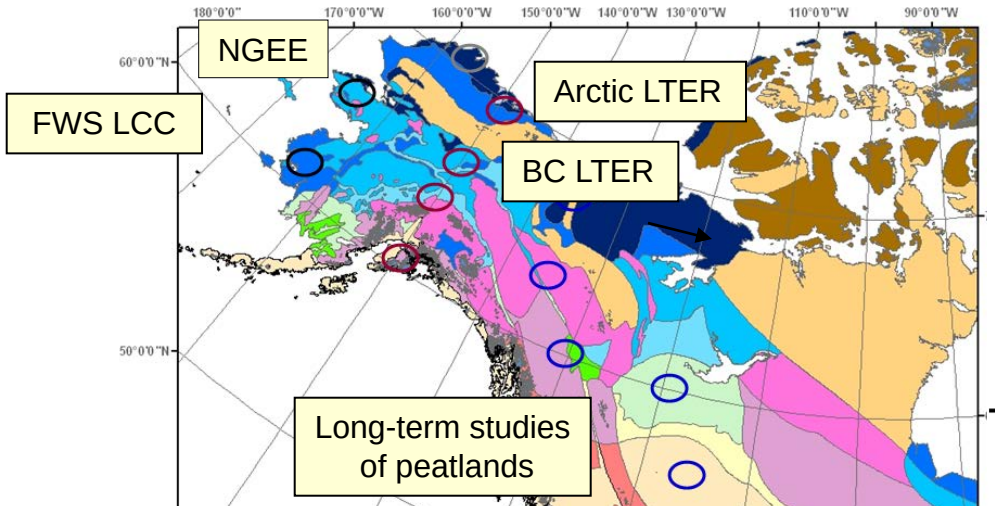


ABoVE Study Domain and Nested Design

Cooperative Interdisciplinary Research

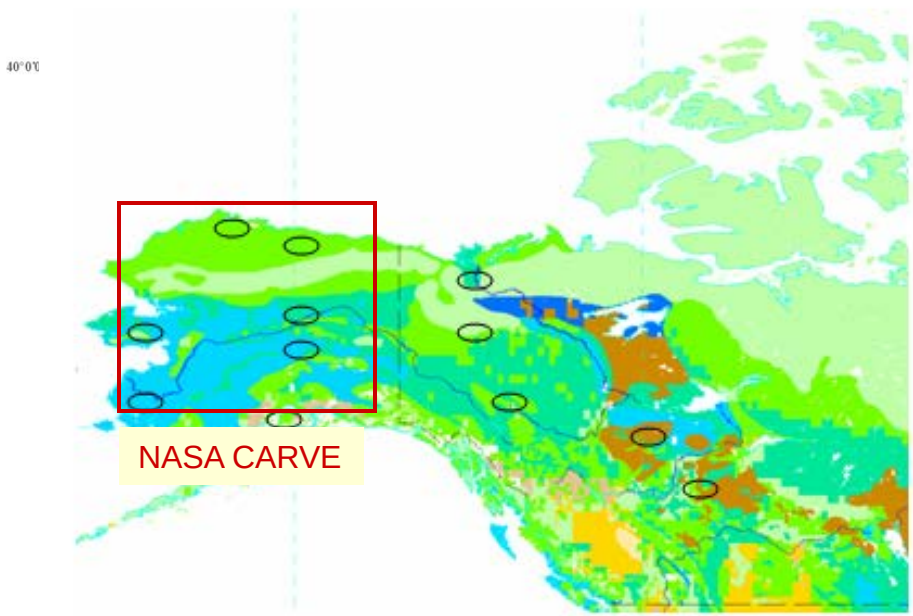
- A successful ABoVE field campaign will need to build partnerships with other programs, agencies, and nations conducting research in the Arctic-Boreal region.
- NASA will need to leverage, coordinate with, and/or build upon recent and ongoing projects being sponsored by research and resource management agencies in other nations, especially Japan and Canada, as well as those in agencies in the U.S., both at the state and federal levels, and with non-governmental organizations.
- Within these organizations, there is a substantial amount of ongoing and planned research, monitoring, and assessment activities that focus on the questions and issues being addressed by ABoVE.

Potential interactions with ongoing/planned programs



Permafrost Extent (percent of area)	Ground Ice Content (visible ice in the upper 10-20 m of the ground; percent by volume				
	Lowlands, highlands, and intra-and intermontane depressions characterized by thick overburden cover (>5-10m)			Mountains, highlands, ridges, and plateaus characterized by thin overburden cover (<5-10m) and exposed bedrock)	
	High (>20%)	Medium (10-20%)	Low (0-10%)	High to medium (>10%)	Low (0-10%)
Continuous (90-100%)					
Discontinuous (50-90%)					
Sporadic (10-50%)					
Isolated Patches (0-10%)					

Ice caps and glaciers Land



Soil Organic Carbon ($kg\ m^{-2}$)

- < 2
- 2 - 4
- 4 -8
- 8 - 12
- 12 - 16
- 16 - 20
- 20 - 40
- 40 - 80
- 80 - 120

How Can ABoVE Add Value to What is Already Being Done in the Region?

- By providing an integrated regional analysis through effective use of NASA remote sensing and geospatial data analysis tools, in combination with a well-designed field program and remote sensing-driven models.
- By designing its field program to integrate, leverage, and/or fill gaps in existing field infrastructure and process studies
- By collaborating effectively with programs planning new work in the region, e.g., NGEE and NEON
- By fostering synthesis and integration studies focused on critically important questions that bring together data, process understanding, and modeling capabilities from all sources

How Did ABoVE Come to Be & What is Going On?

ABoVE Scoping Study

Over the years the NASA Terrestrial Ecology Program (TE) has sponsored major field campaigns focused on addressing significant science questions through the application of remote sensing-oriented measurement and modeling approaches (e.g., FIFE, BOREAS, LBA).

In ROSES-2009, NASA TE solicited proposals for scoping studies to develop scientific concepts and explore feasibility for a next NASA TE-sponsored field campaign.

Two proposals were selected:

- Challenges and Opportunities in Remote Sensing of Global Savannas: A Scoping Study for a New TE Field Campaign (Hanan)
- Vulnerability and Resiliency of Arctic and Sub-Arctic Landscapes (VuRSAL) - The Role of Interactions between Climate, Permafrost, Hydrology, and Disturbance in Driving Ecosystem Processes (Kasischke); name later changed to **Arctic-Boreal Vulnerability Experiment (ABoVE)**

Review of ABoVE Scoping Study Report

The NASA Terrestrial Ecology Program (TE) requested community input on the Arctic-Boreal Vulnerability Experiment (ABoVE) plan.

Comments were sought from the research community (via community-wide email request and TE Web site request) regarding:

1) **The scientific value, importance and priority of the research questions**
2) **The appropriateness of the scientific implementation approach and methods**

The TE Field Campaign Working Group provided an integrated evaluation of the merits of the ABoVE concept, making specific recommendations for next steps.

Recommendations

OVERALL FINDING: This study is of high merit, but requires a modest amount of further study/planning before being ready for partnership discussions and more detailed planning of the study design.

Recommendations:

- **NASA should move ahead with this field campaign concept, but consider broadening its scientific scope to allow for a more whole-system (land-ocean-atmosphere-humans), integrative study of change in the Northern High Latitudes (NHL).**
- **A single, compelling overarching goal statement that makes clearer the societal relevance of the study is needed.**

→For these reasons, a bit more study and planning are needed.

Follow-Up on Recommendations

- NASA's Carbon Cycle and Ecosystems (CC&E) Office and ABoVE scoping study report authors met to draft a revised Executive Summary and plan a workshop to review the revised plan (now scheduled for June 13-15, 2012, in Boulder, CO)
- NASA began informally discussing the possibility of an interdisciplinary, regional (Alaska, western Canada, and adjacent oceans) study with potential partners
  - Preliminary discussions with other NASA Earth science programs, DOE's Next-Generation Ecosystem Experiment (NGEE), and representatives of USGS, NEON, NSF's SEARCH, and several state of Alaska programs
  - Preliminary discussions with Canadian colleagues in the CarboNA program
- Parallel NASA-sponsored workshop to explore needs/weaknesses of current Earth System Models for the Arctic-Boreal region (now planned for mid-May at NASA GSFC)

Next Steps

- NASA's TE will use June workshop to validate continuing scientific priority and feasibility of the revised ABoVE concept
  - Workshop report and revised Executive Summary will serve as the basis for selecting a science working group to develop a "concise experiment plan" – detailed study design
  - One or more community workshops likely in next year to help in the development of the concise experiment plan
- In parallel, NASA TE will be seeking partnerships (may be of differing types) to broaden (or deepen) the scope of science issues to be addressed
- NASA will use the concise experiment plan as the basis for a solicitation for an ABoVE Science Team to carry out the first phase of research (~1-1 ½ years from now) – solicitation could be joint with some partners (TBD)

Why am I Here Today?

IARPC and ABoVE: Why I am Here Today

- Providing information about ABoVE and NASA's plans
- Seeking interest in collaboration/coordination with existing U.S programs conducting and/or planning related research activities
- Wondering if IARPC is an appropriate forum for NASA TE to engage in coordinating ABoVE with other U.S. activities
- Interested in receiving suggestions regarding coordination: mechanisms, people/programs to engage, other opportunities or challenges to address. . .

Cooperative Interdisciplinary Research

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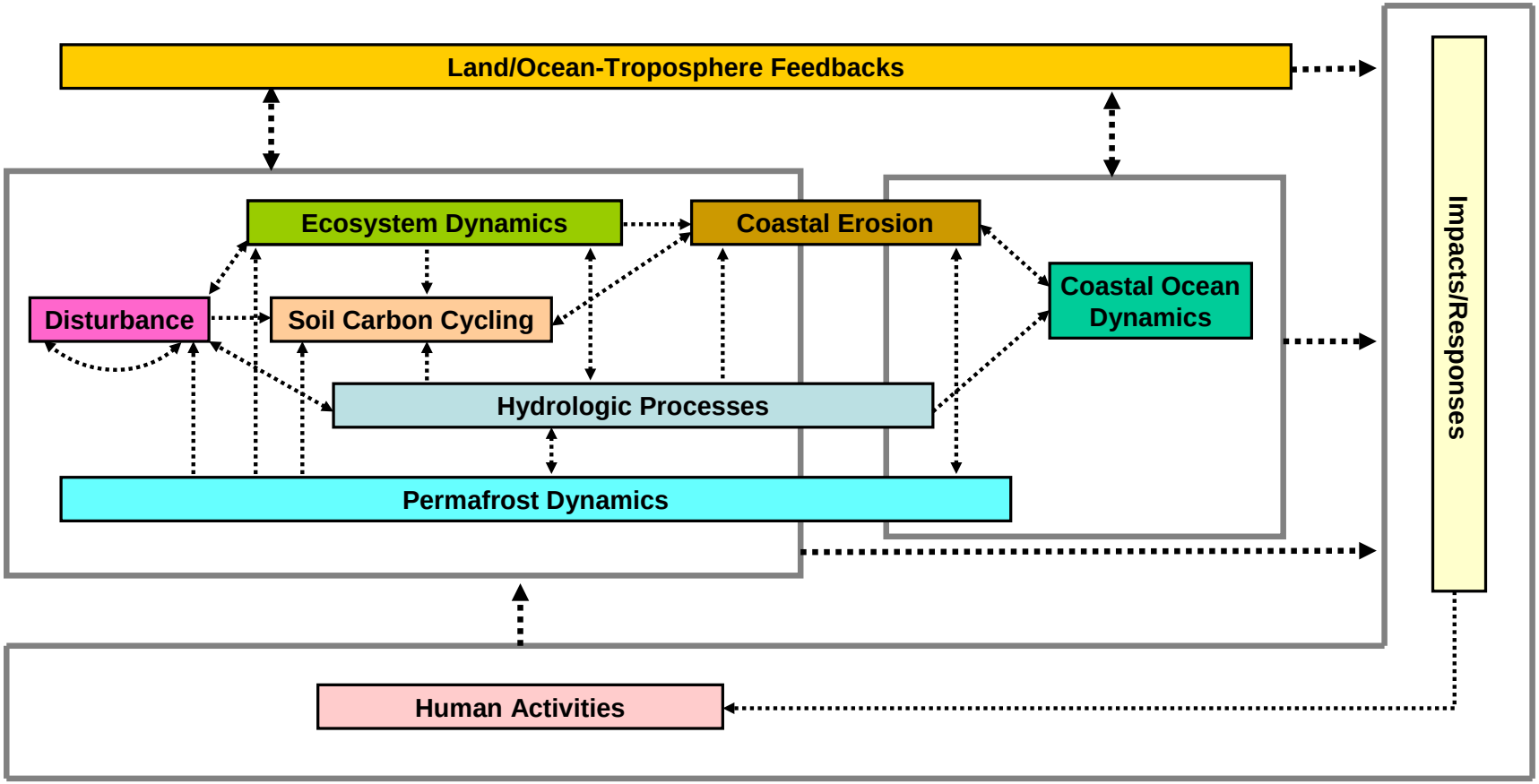
Thank you!

Back Up

Key Processes in the Arctic-Boreal Region that Provide the Focus for ABoVE Research