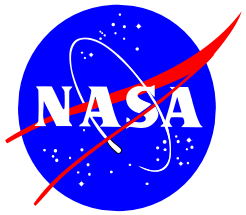
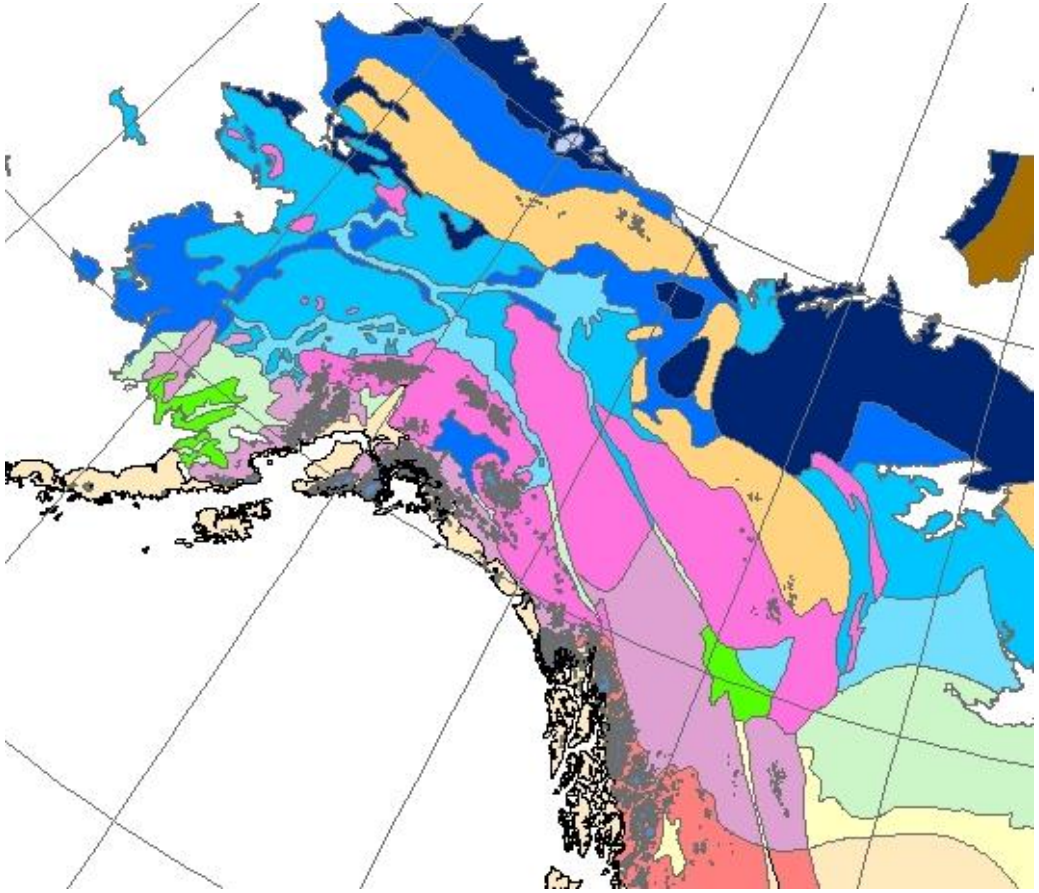
Arctic-Boreal Vulnerability Experiment (ABoVE)

The next field campaign of the NASA Terrestrial Ecology Program



ABOVE Arctic-Boreal Vulnerability Experiment



Welcome!

The Changing Arctic-Boreal Region

The Arctic and Boreal Region (ABR) is experiencing the fastest climate change on Earth, which has resulted in:

- Warming and thawing of permafrost
- Increases in the frequency and severity of disturbances
- Widespread changes to surface water, vegetation, and soil carbon stocks

These ecosystem changes alter society's exposure to a variety of risks, challenging their resilience and adaptive capacity:

- Modified access to natural resources for economic uses
- Increased risk of impacts from disturbances, including damage to infrastructure and altered disease exposure
- Inability to practice traditional cultural activities, including subsistence
- Impacts on habitat for fish and wildlife

How ABoVE Got to this Point

NASA TE solicited proposals for scoping studies to develop scientific concepts and explore feasibility for a next NASA TE-sponsored field campaign and selected two studies, one of which was ABoVE

NASA requested community input on the Scoping Study report.

- **Comments were sought from the research community regarding the scientific value, importance and priority of the research questions and 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 and made recommendations for next steps**

NASA TE decided to further plan, develop and implement a study based on the ABoVE Scoping Study concept.

The Executive Summary was revised and a final workshop was held to seek community input.

NASA requested applications for a Science Definition team for ABoVE

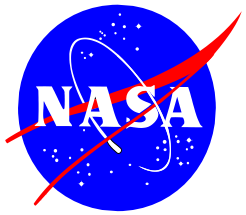
Next Steps for ABoVE

The Science Definition Team (SDT) selected in February 2013 is responsible for developing a *Concise Experiment Plan* for ABoVE, which will:

- Refine the science questions to be addressed
- Provide a compelling rationale for the scientific and societal importance of the study
- Define the research approach/strategy
- Provide a reasonably detailed study design and description of required field and remote sensing observations, field infrastructure, logistics, and data management capabilities

NASA will explore partnerships and collaborations with other programs and agencies and seek appropriate agreements

Charge to the SDT



Charge to the SDT: From the Dear Colleague Letter

Design a regional, Arctic-boreal terrestrial ecosystem research project to be conducted in western North America, including Alaska, that is faithful to the scope and primary objectives described in the Revised Executive Summary for ABoVE.

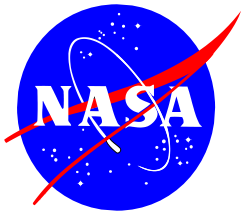
Charge to the SDT: From the Dear Colleague Letter

The ABoVE Scoping Study Report included details regarding study design and management as a proof-of-concept demonstration of feasibility.

The SDT will be free to adopt those recommendations or further consider, refine, and/or alter the study design to best address ABoVE's goals and objectives.

Charge to the SDT: From the Dear Colleague Letter

Identify the particular societal issues that will be studied in ABoVE, with the understanding that these will likely require the incorporation of complementary social and natural science perspectives and methods.



Charge to the SDT: From the Dear Colleague Letter

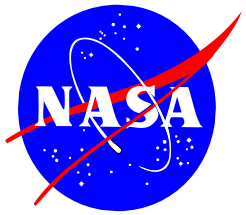
Design a study that leverages, complements, and is compatible with ongoing Arctic-boreal research projects and field observations of national and international organizations working in the region.

The NASA field campaign can then focus on filling gaps in scientific or geographic coverage and providing integrated regional analyses through effective use of satellite and airborne remote sensing, geospatial data analysis tools, and integrative data synthesis and modeling studies.

Charge to the SDT: From the Dear Colleague Letter

- **The ABoVE Science Definition Team (SDT) members will spend approximately twelve to fifteen months refining the science questions and issues to be addressed and developing a detailed study design for the ABoVE field campaign.**
- **The SDT will be supported in its efforts by the Terrestrial Ecology Program at NASA Headquarters and the ABoVE support team within the Carbon Cycle and Ecosystems (CC&E) Office at NASA Goddard Space Flight Center.**
- **The work of the SDT will culminate in a report that will serve as the *Concise Experiment Plan* NASA will use to guide its implementation of the field campaign**

A Few Guideposts



ABoVE Planning Has Already Advanced

The ABoVE SDT is not starting from scratch.

- **We are now in the middle of a planning process.**
- **We will be working in a region where there is already pertinent research underway**
- **The ABoVE Office has already assembled information about work/sites in the region**
- **NASA has already started supporting data set development for ABoVE (ROSES-2012 selections)**

Some Things Have Already Been Decided

ABoVE is a regional study -- Arctic-boreal region of Western North America, including Alaska

Its focus is on ecosystem vulnerability to change – strong interest in climate change, but not in isolation of other changes simultaneously occurring in the region

The Study Design Should Take into Account

The ABoVE field campaign will need to build partnerships with other programs, agencies, and nations conducting research in the Arctic-boreal region.

- **NASA and DOE have already agreed that NGEE and ABoVE will plan to work together**
- **The Canadian representatives in CarboNA have expressed strong interest in collaboration**
- **ABoVE science leaders have had preliminary discussions with state and local organizations in Alaska**

ABoVE will need to leverage, coordinate with, and/or build upon recent and ongoing projects being sponsored by research and resource management agencies in the U.S. and other nations, especially Canada (both at the state (province) and federal levels, and with non-governmental organizations).

Known Constraints

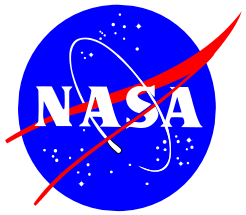
Resources will be limited – how limited depends on the how many and what types of partnerships

- **NASA TE can provide ~$8M/yr peak funding (this would likely ramp up and down, with the possibility of a one-time supplement for peak airborne activities)**
- **Up to half of those resources may go for infrastructure and logistical support to the researchers**

Time will be limited. While a 10-year duration has been proposed, that is very long for NASA. It includes ramp up, preparatory work and ramp down synthesis and integration research.

NASA aircraft an sensors may are in high demand and their availability may be limited.

NASA and Field Campaigns



NASA's Unique Role

Satellite and airborne remote sensing

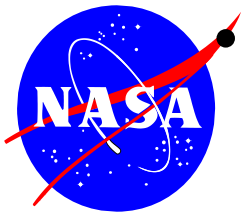
- regional and global observations
- scaling up from site-level

Capability to work a problem end-to-end (basic to applied, observations to prediction, in situ to space . . .)

Regional to global-scale context

Building and sustaining a team of researchers working on a common issue or set of questions

- training the next generation of scientists
- building new partnerships and collaborations



What NASA Wants

Answers to Big Science Questions – to make a major contribution

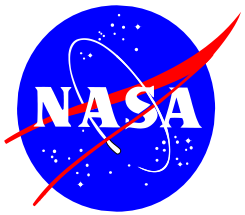
Demonstrations of the value of remote sensing data

Legacy data sets that continue to be used and useful

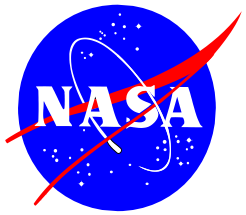
Opportunities to apply /evaluate / demonstrate new remote sensing technologies and methodologies (but not too new!)

Opportunities for synergistic calibration/validation of satellite data and data products

Good PR and visibility for NASA



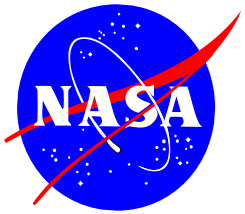
A Concise Experimental Plan



Concise Experimental Plan

This plan will include:

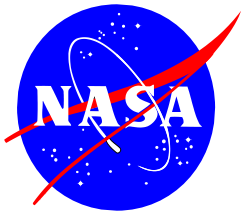
- **the science questions to be addressed**
- **a compelling rationale explaining the scientific and societal importance of the study**
- **the research approach/strategy**
- **a reasonably detailed study design and description of**
  - **required field and remote sensing observations,**
  - **required field infrastructure, logistics, and data management capabilities**



Concise Experimental Plan: How is it used?

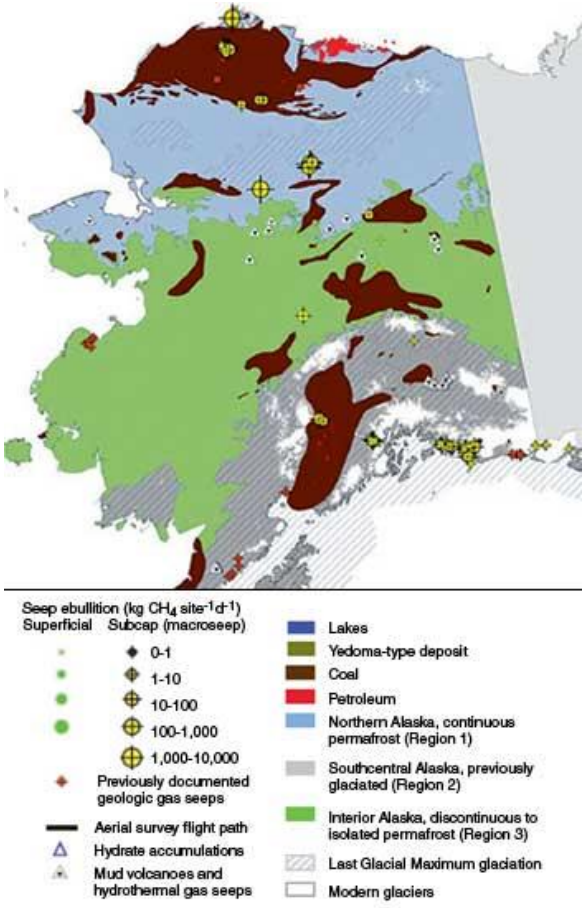
To communicate what the field campaign is about, why it is important, what research activities will be needed, and how it all will be conducted.

- **To ensure ABoVE is mature and ready to implement**
- **So that scientists can plan the individual research tasks they wish to propose**
- **For NASA to draw upon in writing its call for proposals for the Science Team to conduct the study**
- **To share with the broader scientific community, government managers, and others**



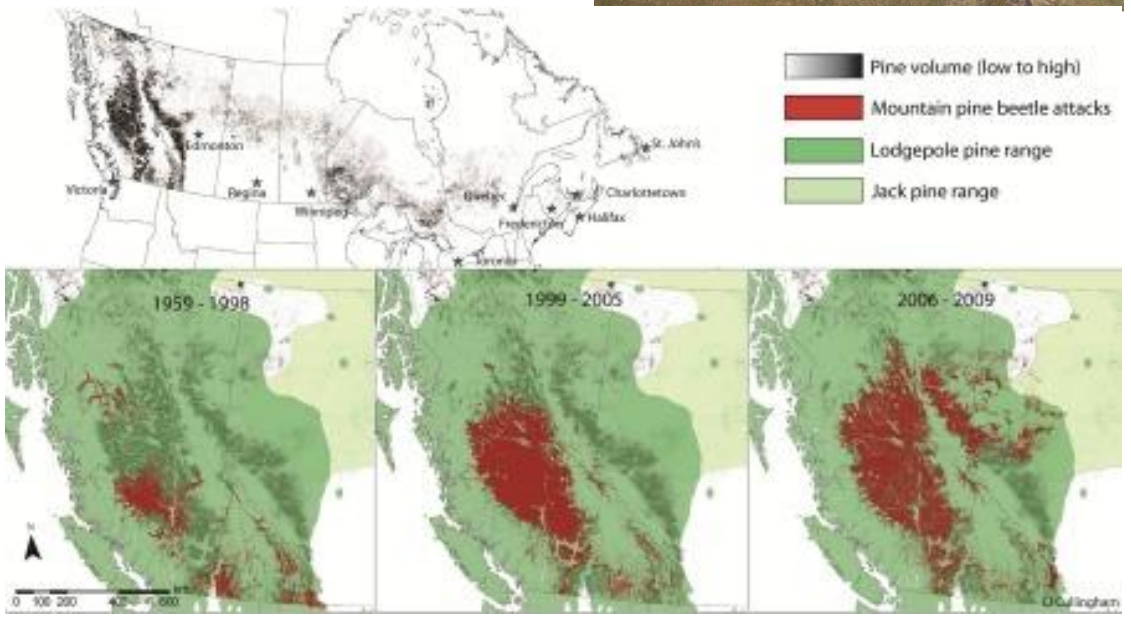
Backup

Significant and novel changes to Arctic and boreal ecosystems



Methane is being released from soils and lakes (Source: Walter et al. 2012 *Nature Geoscience* doi:10.1038/Ngeo1480)

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



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

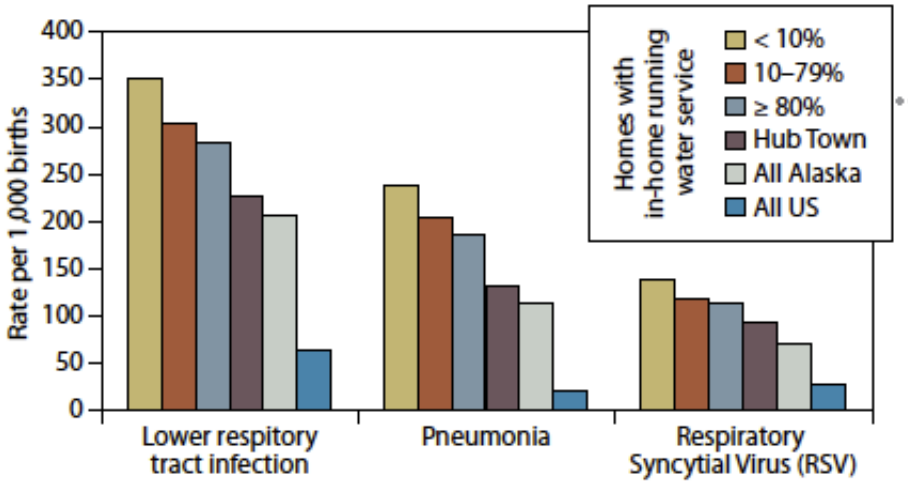
Impacts and feedbacks to local and regional communities

Shishmaref storm and erosion. (Source: Tony Weyiouanna, Shishmaref Relocation Coalition)

Table 1 Summary of climate and climate change related risks facing key regions of the Canadian mining sector (based on Pearce et al. 2009)

	Vulnerabilities and opportunities
Base metal mining in north-eastern Ontario	• Extreme precipitation and snow melting events cause flooding, erosion, and failure of impoundment structures (with the possible release of contaminants) and transportation infrastructure • Dry conditions reduce water intake capacity and exposure of tailings to sub-aerial weathering
NWT diamond mines	• Warming will make it difficult to maintain sufficient ice thicknesses to support heavy traffic flows on ice roads • Frozen core water and tailings retention structures could lose their structural integrity with warming • Extreme weather increases susceptibility of infrastructure to damage • Buildings erected on thaw-sensitive land could see foundations settle and shift as permafrost melts • Infrastructure built on or near steep slopes could be susceptible to more active slope processes • Drainage and hydrologic regimes could be affected. Flooding and erosion could result

Climate change risks to Canadian mining operations (abbreviated table. Source: Ford et al. 2011 *Climatic Change* DOI 10.1007/s10584-011-0029-5)

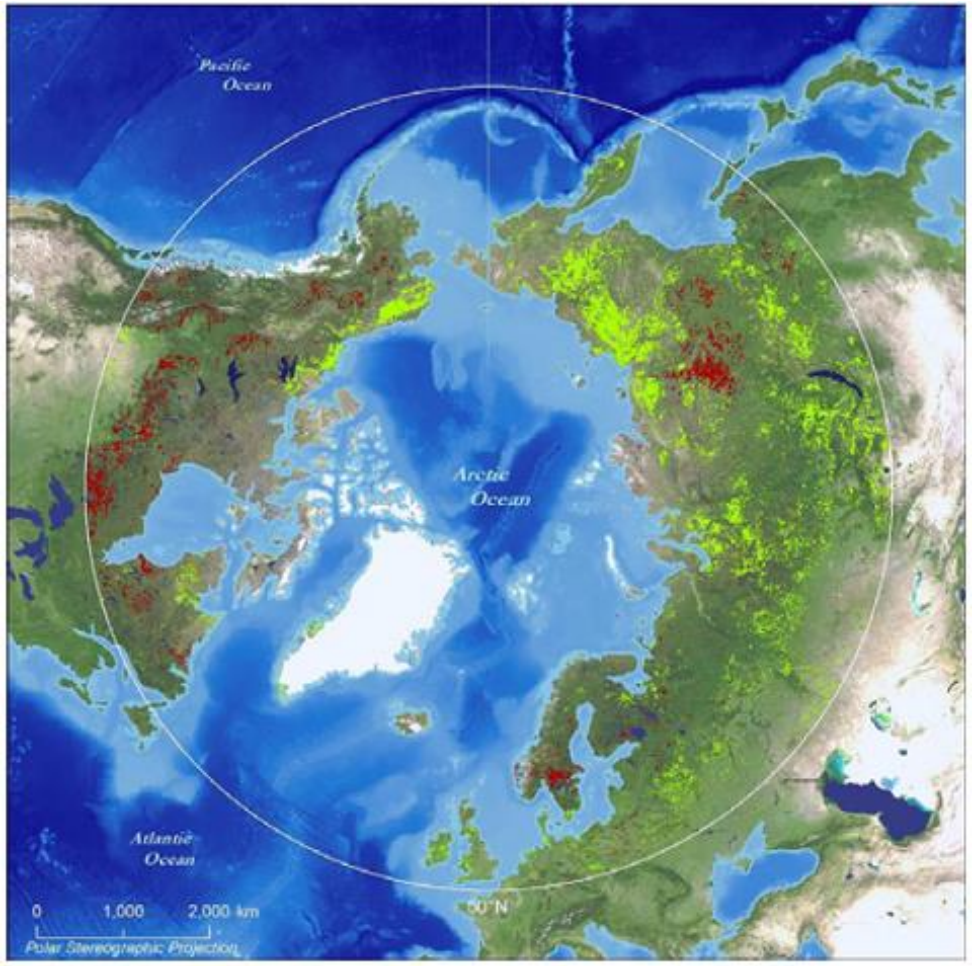


1999–2004 hospitalization rates for Alaska Native infants according to the percent of homes with in-home running water service. *Centers for Disease Control and Prevention, 2010*

ABoVE Science Questions

1. 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?
2. How are people at local, regional, national, and global scales being affected by and responding to these changes?
3. How do changes to terrestrial processes in the ABR alter inputs to adjacent oceans?
4. How do changes to terrestrial processes in the Arctic-boreal region alter climate through exchanges of energy, water, gases, and particulate matter between the land surface and troposphere?

Remote sensing data are essential



A key component of ABoVE will be the use of spatial-temporal information products derived from remotely-sensed data.

- **Improved maps of key characteristics of the land, ocean and atmosphere**
- **Providing a means to monitor and analyze variations over time**
- **Tools for spatial extrapolation and scaling**

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 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.

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