23 September 2013

Memo to: ABoVE Science Definition Team

From: Eric Kasischke, Dan Hayes, Libby Larson, and Peter Griffith

Subject: Report on Tour of Northwest Territories, Yukon, and visit with researchers in Edmonton

Between 30 August and 10 September 2013, a tour of the Northwest Territories, Yukon, and Edmonton was organized and carried out to: (a) provide information on ABoVE; (b) learn more about ongoing research in this region; and (c) listen to researchers, land managers, and decision-makers to learn more on the need for information on the impacts of climate and environmental change in order to determine how information generated through ABoVE and other research activities would be used.

Members of the ABoVE delegation included the SDT Co-Chairs (Eric Kasischke and Dan Hayes), Peter Griffith, Libby Larson and Dan Hodkinson and Leanne Kendig (who will provide logistical support to ABoVE through the Carbon Cycle and Ecosystems Office). During this tour, we met and talked with well over 100 researchers, decision makers, and members of local communities (see attached list of contacts).

Our overall impressions and conclusions from this tour include:

- One of the things we learned is how the local people refer to the place they live. The Northwest Territories is truly a group of distinct sub-territories or regions, each with their own local culture and identity. However, people in the Yukon Territory prefer the name Yukon.

- Native peoples in Yukon and NWT have autonomy, including the right to form governing bodies that are equal in stature with Territorial and National governments. However, achieving this status requires signing of agreements between all parties, with some agreements still being negotiated. In Yukon, there are 14 First Nations Tribes/Bands (11 have signed agreements), while in the NWT, there are 13 First Nations Tribes/Bands (10 have signed agreements).

- There is substantial ongoing research on the impacts of climate change and resource development being carried out by researchers in academia, government (at all levels),

and NGOs across the region. This research includes a number of long-term studies landscapes unique to Yukon, the NWT, and northern Alberta and British Columbia.

- Canada has no federal requirement for data documentation and archiving, so despite the long history of research in the region, and extensive bibliographies of published papers, too few of the actual data are available outside the projects of the individual scientists who collected them. Increasing territorial government efforts and good will of those involved may improve this situation in coming years. ABoVE could contribute additional motivation and expertise.

- Research stations exist that can provide logistical support in a number of unique landscapes and settings. Managers of the stations we visited all expressed a high level of interest in ABoVE. These managers can provide an excellent connection to researchers working out of their individual units. Nearly all stations managers mentioned decreasing federal support for science, the newly-elevated status of the Canadian High Arctic Research Station (CHARS- managed by Donald McLennan), and the evolving situation regarding funding of station operations.

- Governance in Yukon, the Northwest Territories, and the First Nations is in the process of evolving and maturing. The territorial governments are going to achieve full autonomy from the federal government in 2014, assuming many responsibilities formerly handled by the federal government, with hopes greater priority for managing resources according to the interests of the territories and First Nations.

- Within local governments there is a dynamic tension among the need for further infrastructure development (e.g., roads, improvements to buildings, etc.), the economic imperative for oil, gas, and mineral development for the creation of jobs and tax revenue, and the importance of the integrity of the environment, especially water quantity and quality, sustainable populations of fish and wildlife, and forest resources. We repeatedly heard about the rapid expansion of seismic exploration and development of hydraulic fracturing, while at the same time there are too little baseline data on seismic lines, methane emissions and water quality, all needed to monitor the situation as fraking moves forward.

- The need for reliable scientific knowledge on the impacts of climate change as well as resource development and extraction on the environment for sound decision-making is recognized by local governments.

- Local governments have important but overburdened environment and natural resources departments with the responsibility of providing the knowledge required for sound management decisions. While there are local government scientists carrying out substantial and important research, in Yukon and the NWT there are not enough of these researchers to provide the needed information (because of low populations in the region). Because of this, local government in these regions is establishing cooperative research and monitoring projects with academia, federal agencies, NGOs, and private industry.

- Non-profit conservation organizations are very active in the ABoVE study region. In addition to carrying out substantial research and monitoring, these organizations have excellent contacts with private industry and foundations that support their activities. NGOs also have extensive outreach into local communities (including Native villages) as well as to their constituencies at regional and national scales. NGOs are involved in collaborations with the Landscape Conservation Cooperatives.

- Arctic and Northwest Boreal Landscape Conservation Cooperatives (LCCs). In addition, we also learned that several federal agencies (CFS, Canadian Wildlife Service) have signed on to participate in the LCCs, and have provided funding to support modest levels of activities by their researchers in the LCCs. Given the LCCs expressed desire to develop a strong collaboration with NASA for ABoVE research, the LCCs seem to be an ideal avenue that is already in place to coordinate activities over a substantial area.

- As noted by other SDT members as well, a key challenge for ABoVE will be to establish meaningful interactions with researchers from a variety of organizations. While some interactions can be fostered through formal agreements with specific organizations (e.g., DOE-NGEE, DOI-LCCS, CFS, governments of Yukon and the NWT), it will not be possible to create formal agreements to cover all possible interactions, especially research in Canadian academic institutes funded through grants to individuals or small groups of researchers.

- There were questions on the exact geographic extent of ABoVE. In particular, Canadian Forest Service researchers asked how far south into the boreal forest will ABoVE extend? There are arguments to include the northern regions of Alberta and British Columbia in the geographic area covered by ABoVE, including: (a) not only does this region includes vast areas of peatlands, activities associated with oil development have had significant impacts on the hydrology of the peatlands in many areas; (b) given the importance of commercial forestry in this region, understanding processes that impact

the forest resources is of high interest to federal and provincial governments (thus increasing the likelihood of their participation in ABoVE); (c) it is a region where insect outbreaks are important forest disturbance, and where the outbreak of mountain pine beetle is extending northward and eastward; (d) it is a region where significant forest dieback is occurring, especially at the southern edge of the boreal forest; and (e) including this region could increase interest in participation by other parts of NASA that are involved in NACP/CarboNA, and the Carbon Monitoring System. There were also questions as to the eastern extent of the ABoVE domain. Landscapes and ecosystems are highly variable over this region and may represent distinct attributes. In all cases, questioners were told that the ABoVE SDT will take up the issue soon.

A detailed summary of our activities and the interests and research activities of the people we met are summarized below:

Our tour began in Yellowknife, NWT on 30 August 2013.

30 August 2013: E. Kasischke was interviewed on the Canadian Broadcasting Corporation radio program "The Trailbreaker" in the morning by Loren McGinnis. This interview was arranged by Judy McLinton, the Manager of Public Affairs for the Department of the Environment and Natural Resources (ENR) of the Government of the Northwest Territories (GNWT). The interview focused on ABoVE and NASA's role in conducting research on the impacts of climate change in the NWT and northwestern North America. The entire group then met with Bob Reid of the Water Resources group of Aboriginal Affairs and Northern Development Canada (AANDC). The AADNC focuses on issues affecting Native Peoples, including environmental issues. Bob led us on a tour of several research sites to the north of Yellowknife. These sites included the watershed (Baker Creek[1]) that flows through an area with a large gold mine (now closed), which contains extensive underground stores of arsenic contaminated wastewater. In the past, this wastewater has contaminated Baker Creek (which flows into the Great Slave Lake), but most of this waste is now stored underground in frozen ground (permafrost). The

[1] Baker Creek is one of the sites that we visited that are part of the NSERC Changing Cold Regions Network (CCRN) project, which will run from 2013 to 2018 (we have a copy of the CCRN proposal). CCRN investigators have expressed a strong interest in collaborating in research that would be funded through ABoVE. Other CCRN sites that we visited during this tour include: Scotty Creek (south of Fort Simpson, NWT; (b) Havipak Creek (south of Inuvik, NWT); and (c) Wolf Creek (east of Whitehorse, Yukon. Research at all the CCRN site focuses on understanding factors controlling permafrost degradation, and thus include long-term (15 to > 20 years) measurements of ground temperature and active layer depth and met data (e.g., incoming/outgoing radiation, temperature, precipitation, snow depth). Several sites have CO2/CH4 flux towers (Baker Creek, Scotty Creek, Havikpak Creek), as well as towers measuring water fluxes. All sites but Havikpak Creek are collecting data to measure hydrologic flows through watersheds.

concerns are that warming permafrost will release this contaminated water. Baker Creek and the area to the northeast of Yellowknife are on the Canadian Shield. Thus, the soils in this region are very shallow and dominated by mineral and organic soils in low areas between rocky outcrops. The long-term research at Baker Creek has been used to improve understanding of hyrodrologic flows in this distinct landscape, which contains permafrost.

31 August 2013: We were met by Jennifer Baltzer (Professor of Ecology at Wilfred Laurier University – WLU) in the morning, who led the group on a road trip from Yellowknife to Fort Providence.[2] During our trip to Fort Simpson, we transitioned off the Canadian Shield into landscapes with more developed soils. The area just to the west of the Great Slave Lake to Fort Providence is dominated by upland forests, interspersed with bogs, wetlands and small lakes. The area to the west/northwest of Fort Providence is again dominated by upland forests (including jack pine) as well as bogs and small lakes. This area has extensive areas burned during previous fires and the road transected a large fire that occurred during 2013. The region is home to a woodlands bison herd.

1 September 2013: From Fort Simpson, we flew 50 km south via floatplanes to WLU's Scotty Creek Camp. This research site is located in an extensive peatland/wetland area, where permafrost plateaus (underlain by ice) are covered by black spruce forests. For nearly 20 years, Bill Quinton (WLU Professor) has led research on the processes controlling the rapid degradation that is occurring to these permafrost plateaus and the black spruce forests covering them from the warming of permafrost, as well as the impacts of this rapid degradation. Some, (but not all) research at Scotty Creek includes:

- Studies of the rates of changes in the areas of permafrost plateaus, black spruce, forests, and wetlands based on surface observations of degradation and analyses of time series aerial photographs (Figure 2).
- Measurements of meteorological, snow depth, and permafrost temperature data needed to understand controls on permafrost degradation (Figure 3).

[2] WLU has a formal agreement with the Government of the NWT (GNWT), where the GNWT supports research by WLU researchers in areas of interest to GNWT. The GNWT is very interested in understanding how climate change and human activities are affecting the environment, in particular water quantity and quality, wildlife, and infrastructure. While various departments of the GNWT have staff that conduct environmental monitoring, the small population of the NWT (40,000 people) makes it difficult for them to hire the staff to meet all their information needs with respect to environmental monitoring. Thus, the GNWT is pursuing opportunities to establish collaborations with academia to support research in order to gain access to the expertise and research results needed to address their own needs. Their formal agreement with WLU is part of this effort.

- Measurements of water quality and changes in plant distribution associated with permafrost plateau degradation as well as transitions from bogs to fens and vice versa that are caused by permafrost loss.
- Installation of a new flux tower to measure exchanges of CO2 and CH4 by Oliver Sonnentag of the University of Montreal.
- Collection of tree-ring data to study processes controlling tree growth and productivity.

2 September 2013: A cold front moved through the area during the night, resulting in temperatures low enough to turn the rain that started early in the evening into snow. The camp received 10 cm of snow overnight, reminding the team that we are working in a far-north study site. This day was devoted to flying back to Fort Simpson and then driving back to Yellowknife.

3 September 2013: An overview briefing was presented to an audience of 45 people in the morning, which included representatives from the federal and provincial government, as well as other interested parties from Yellowknife and Wilfred Laurier University (see attached attendance list). This overview was followed by a question and answer session as well as an introduction of attendees with an overview of their research/areas of responsibility.

We then had lunch with the Minister (Michael Miltenberger) and Assistant Deputy Minister (Ernie Campbell) of the Environment and Natural Resources for the GNWT. This lunch was hosted by WLU. Both expressed a strong interest in ABoVE, and explained the GNWT's dependence on sound scientific findings to develop policies for resource development and management of natural resources. They also discussed their desire to develop strong collaborations with as well as support others who are carrying out research in the NWT. They also discussed about the installation of a fiber optics cable to Inuvik, which is part of plans to establish a number of receiving antennas in Inuvik to download satellite remote sensing data. Inuvik is presently the site of a receiving station for Radarsat Data, and DLR is planning to install a receiving station for their satellite remote sensing data. Other European space agencies are planning to follow suit, and the GNWT expects to have 6 antennas in Inuvik in the near future. The GNWT hopes this initiative will foster the development of in-house capabilities for processing and analyses of remotely-sensed data to support management of natural resources

In the afternoon, we met with various groups from the GNWT, including representatives from their wildlife, geomatics, and forestry groups. We first met with a group of Department Environment and Natural Resources scientists involved with management of wildlife, including Karin Clark, Jan Adamczewsta, Lynda Yonge, Andrea Pantenaude, Robert Gua, and Suzanne Carriere. This group is primarily involved in management of mammal game species and "non-federal" (e.g., those not falling under the jurisdiction of federal law) birds. They are interested

in developing range management maps, and stressed the need for an improved vegetation classification map for the NWT. They are particularly interested how human activities impact wildlife, as well as how climate change and disturbance influence wildlife habitat. This group issues an annual state of biodiversity report. The wildlife group manages the Tundra Ecosystem Research Station located 300 km north of Yellowknife on Daring Lake, which is located on the Canadian Shield and is "further north" ecologically and climatologically than Inuvik. This station has been in operation since 1994, and can host up to 30 scientists (http://www.enr.gov.nt.ca/_live/pages/wpPages/Tundra_Ecosystem_Research_Station.aspx). It is in an area of active diamond mining.

We met with Kristen Cameron (Manager) and Steve Schwarz of the NWT Centre for Geomatics. This group has 8 employees and is involved in a number of mapping projects that involve the use of remote sensing and GIS. Current projects include a boreal caribou recovery project, an inventory of landscape change for the AANDC Cumulative Impacts Monitoring Program (CIMP), and a human disturbance project being carried out with the German Space Agency (DLR) using Terra SAR-X data. They maintain a Northwest Discovery Portal which provides access to their database and products, but noted that they face challenges in coordinating a high demand for information as well as managing data. They also noted that they know of numerous projects that may have similar interests but may not know of each other's work. They don't know how to encourage coordination among them (their office likely does not have the capacity to do so).

We met with Tom Lakusta, who is the Manager of the Forest Resources group of DENR, and is based in Hay River, NWT. This group is interested in the monitoring the impacts of insects and disease, especially spruce budworm, forest-tent caterpillar, and mountain pine beetle, which has recently spread into the southwest portion of the NWT. It is also responsible for carrying out forest inventories, which includes (a) forest inventory maps generated by contractors who develop products based on the interpretation of aerial photographs; and (b) a set of forest inventory (~200) that are distributed across the Taiga Plains ecoregion. They are working with Ron Hall of the Canadian Forest Service to produce an improved map of forest resources based on integration of aerial photograph-based forest inventories, Landsat TM/ETM+ and IceSAT data. They are involved in mapping of forest disturbances using Landsat data. They are involved with an ecological mapping project to provide a baseline for future assessments. Lakusta described national concerns about mountain pine beetle coming through Alberta and BC and fears that if it gets into the boreal Jack Pine it will spread across Canada to access Ontario or Quebec forests.

In the evening, we participated in an expert panel discussion on the impacts of climate change in the NWT. This panel discussion was organized by David Livingstone, a private consultant with

extensive contacts throughout the NWT. Members of the panel included E. Kasischke, Fred Sangris (former Chief of the Ndilo First Nation), and Steve Kokelj (a permafrost scientist who works for GNWT, but previously worked for AANDC, where he conducted extensive research on the impacts of permafrost warming, especially the formation of thaw slumps in upland areas of the western NWT). Some 60 people from Yellowknife attended this expert panel discussion.

4 September 2013: We flew from Yellowknife to Inuvik, where we visited the Aurora Research Institute (ARI) of Aurora College, and met with Doug Robertson (acting Director of the ARI), Aurora Research Institute, Jonathon Michel (Manager, Scientific Services, ARI), and Jolie Gareis (Mgr, Western Arctic Research Centre –WARC, ARI: http://www.nwtresearch.com). The Aurora Research Institute has two other centers (Fort Smith and Yellowknife). Aurora College serves as a community college, as well as provides educational outreach to a number of NWT Native Communities. In addition, ARI licenses all scientific research in the NWT (responsibility of J. Michel) and provides logistical support to ongoing research (coordinated by J. Gareis). J. Michel provided an overview of the licensing procedure that ABoVE will have to follow. J. Gareis provided an overview of the WARC and the services it can provide. [Griffith by chance encountered Matthew Dares, the ARI programmer and web developer, on the flight from Edmonton to Toronto and had a long discussion about their plans for improved web access to permitting and data products.] The WARC provides space for receipt, storage, and staging of equipment, has meeting space, lab space, and office space for researchers, and provides low-cost housing for researchers. Most of these services (except housing) are providing in a recently constructed and very modern facility. WARC also can provide access to boats, ATVs, and snow machines. Trucks and cars vehicles can be rented locally. We learned that a road is being built between Inuvik and Tukeuyuktuk NWT (scheduled completion in 2017) which will provide all-season access to tundra areas to the north of Inuvik, which now can only be accessed via helicopter. This road may provide easier access to the Trail Valley Creek research site located in tundra north of Inuvik.

5 September 2013: In the morning, we visited the Havikpak Creek research site, a site maintained by the Hydrologic Research Centre of Environment Canada, located to the south of Inuvik, just north of the airport. We were given this tour by Mark Russell of Environment Canada. Over the long-term, the research at this site has been coordinated by Phil Marsh, who in the fall of 2013 left Environment Canada to accept a Canadian Research Chair at Wilfred Laurier University. The longer-term research at this site has included: (a) measures of ground temperature; (b) measures of met snow depth, precipitation, and temperature, and (c) eddy covariance measures of carbon dioxide and methane. This research site is located less than 1 km from an Environment Canada met station. M. Russell has idiosyncratically-documented long-term data on his own computer system for this and other site; he hopes the new

collaboration with O. Sonnentag and the installation of a flux tower will provide expertise and impetus to adapting these data to modern community standards.

At the Inuvik Airport, we encountered two Japanese Researchers conducting research on tree rings across the NWT: Yojiro Matsuura and Akira Osawa (Forestry and Forest Products Research Institute (FFPRI) and Kyoto University, respectively). They outlined the research that they are carrying out, and explained they were on their way to Hay River to collect data from forests in the southern NWT. They also told that they were quite familiar with ABoVE and Matsuura planned to participate in the telecom that has been organized between ABoVE representatives and Japanese researchers on 17 September.

We flew from Inuvik to Whitehorse, Yukon, arriving in mid-afternoon. We were met by Rick Janowicz of the Yukon Government (Water Resources), who gave as a brief tour of the Wolf Creek Watershed (WCW). The WCW (approximately 180 square km) is the site of a long-term (going back to the early 1990s) study of processes controlling water discharge as a function of permafrost warming and changes in climate. It includes three vegetation types (alpine tundra, open taiga forest dominated by black spruce and closed forest dominated by white spruce). All three vegetation types are underlain by permafrost. A wide range of research has taken place as part of this long-term study. He noted that there has been shrub expansion in the alpine tundra regions of the watershed. He also noted that the Yukon Government maintains a Yukon Water Portal that provides access to all hydrologic data collected in Yukon.

6 September 2013: We provided a briefing on the ABoVE to a range of interested parties at the Yukon Government building. This briefing was coordinated by Aynslie Ogden, who is the Senior Science Advisor to the Executive Council Office, Yukon Government (see attached list). Dr. Ogden provides integration and coordination for research and monitoring for the Yukon Government, with the goal building scientific collaborations. She helped develop the science strategy and research agenda for Yukon. The goals of the Executive Council Office include supporting decision making, building science capacity, improve data collection and management, and promoting information sharing. She noted that Geomatics Yukon (http://www.geomaticsyukon.ca/) is the clearing house for geographic data for Yukon, and is also involved in generating data products.

Following the briefing and a question and answer period, we discussed the interests and activities of different participants. A summary of these interests are as follows:

Katie Aitken (Yukon College): Coordinates Undergrad conservation degree program (degree conferred by the University of Alberta), her own research focuses on the impacts of disturbances on avian community dynamics.

Don Reid (Wildlife Conservation Society of Canada (WCS-C)): WCS-C is carrying out a variety of research projects focused on the impacts of vegetation change on vertebrate populations. They also have a program that funds graduate students. He is on the science steering committee for the Northwest Boreal LCC.

Eric Schroff (Yukon Department of the Environment) – He is the Co-Chair of the Northwest Boreal LCC. His interests include integration of datasets, access to data and information sharing, and model validation.

Mike Gill (Canadian Wildlife Service (CWS), Environment Canada). He is participating in the Arctic LCC, but as there is no listing of Canadian participants on the Arctic LCC webpage, the exact nature of his relationship is not clear. His research focuses on the impacts of extreme events, such as mid-winter thaw-freeze, on wildlife. He also participates in CWS project on biodiversity monitoring. CWS has lots of data on boreal and arctic wildlife species, with data from the Arctic being online. He is involved in the NASA Biodiversity monitoring project, as well as CARMA (reindeer monitoring program); and is on the Group on Earth Observations.

Wendy Nixon (Canadian Wildlife Service): CWS also has a wetlands and waterfowl monitoring program, where they have documented draining of wetlands. They are participating in the boreal avian monitoring network. They maintain a large database from bird surveys. They are also involved in exploring ways to use traditional knowledge (from Natives) in wildlife management.

Sian Williams (Manager, Kluane Lake Research Station – KLRS): KLRS has been in operation since 1961 and supports researchers carrying out a wide range of activities (see 7 September report below).

Panya Lipovsky (Yukon Geological Survey - YGS): Involved in producing updated surficial geology maps, as well as natural hazards maps, including a landslide database. YGS has a permafrost monitoring network, is involved with community-based active layer monitoring, and has worked with the University of Ottawa (Antoni Lewkowicz) on developing a permafrost probability map. YGS has an outreach geologist who is connected to schools and local communities.

Kirk Price (Operations Manager) and Rob Legare (Forest Management Branch, Yukon Government): Currently developing a forest management plan. As Yukon has experienced extensive outbreaks of spruce beetle and the fact that mountain pine beetle has appeared in the southern part of the territory, they are very interested in monitoring forest health. They also are interested in aspen dieback. At this time, forest health monitoring depends on collaborations with CFS. They have initiated a forest inventory project, that has 200 to 250 permanent sample plots in southern Yukon. They also have some monitoring plots in forests impacted by spruce beetle. They are developing collaborations for information sharing with local communities, both Native and non-native.

Michelle Kolla (Yukon First Nations Council - YFNC): Recommends that representatives from ABoVE interaction with the YFNC directly.

Jamie Kenyon (Ducks Unlimited, Canada – DUC) DUC is just becoming involved in Yukon, but is a participant in the NW Boreal LCC, where they are producing a human-impact map for this activity. He noted that the Sacramento Office of DU is generating wetland maps for Alaska.

Fiona Schmiegelow (Professor, Department of Renewable Resources, Univ. of Alberta, Director of Northern Environmental and Conservation Sciences degree in collaboration with Yukon College): the focus of her research is on conservation and biodiversity issues in boreal forests. Involved in BEACONS project (Boreal Ecosystems Analysis for Conservation Networks). Yukon College wants to create new opportunities for students to work with researchers.

Bronwyn Benkert (Research Coordinator, Yukon Research Center - YRC, Yukon College): YRC is involved in a number of projects and maintains EnviroData, a meta-database. Projects they are involved in include one that is involves community climate change assessments, adaptations, and mitigations, impacts of melting glaciers and snow in the headwaters of the Yukon River, a permafrost vulnerability study on impacts on roads and infrastructure, and a project to integrate climate change data into decision making. They are also involved with the University of Alaska SNAP program in developing climate change scenarios for the Yukon.

7 September 2013 - We travelled to Kluane Lake Research Center (KLRC), where we were hosted by Sian Williams, manager of this station. On the way, we visited study sites established by Ted Hogg (CFS) in the 1958 Takhini burn in 2002 (see Hogg and Wein 2005). This site was covered by mature white spruce prior to the fire, with much of the area being underlain by permafrost (Burn 1998). Upon arrival, we met with S. Williams and researchers based at KLRC. KLRC is located in a region which provides the opportunity to study transitions from boreal forest into alpine tundra. It is also in an area where the white spruce forests underwent severe

disturbance by spruce bark beetles in the early 2000s. This outbreak was mapped by CFS scientists and studied by other researchers at KLRC. Researchers we met included:

- Scott Williamson (a PhD student of the Univ. of Alberta, Dave Hik advisor) who is conducting remotely-sensed based research on effects of transitions in vegetation on snow albedo. They are working with researchers at NASA GSFC using MODIS and Hyperion Data (with Petya Campbell and Betsy Middleton), and working with UAF (Scott Rupp/SNAP). They are conducting field-based albedo measurements.
- Charles Krebs, Alice Kenney, and Jeff Werner who are studying population dynamics of small mammals (arctic ground squirrels, red squirrels, and snowshoe hares). Data go back to the 1970s.
- Alexander Bevington (MS Student - University of Ottawa), and Max Duguay and Tyler de Jong (assistants), who are conducting electronic ground conductance studies along the Alaskan Highway as well as re-measuring borehole temperatures that were first measured in the 1970's as part of a pipeline siting study. This effort is part of larger permafrost monitoring and modeling study in Yukon being headed by Antoni Lewkowicz at the University of Ottawa. Bevington is collecting data from boreholes along the Alcan between Haines Junction and Beaver Creek, as well as 400-m long resistivity measures to map permafrost depth on a transect that crosses a pipeline corridor. The University of Ottawa also has borehole data along with met data from a network across Yukon.

S. Williams also arranged for us to meet the elected chief of the Kluane First Nation, Math'ieya Alatini, who is the elected Chief of the local Kluane First Nations tribe and sits on the Council of Chiefs for Yukon. She is very interested in helping develop connections between ABoVE and the First Nations in terms of developing relevant research questions, use of results from scientific research and also in using Traditional Knowledge as a basis for scientific research. She provided several contacts for NASA/ABoVE, including:

- Norma Kassi (Vuntut Gwitchin First Nation Tribe), Director of Indigenous Collaboration, Arctic Institute of Community-Based Research (*norm*a@aicbr.ca)

- Ruth Massie, Grand Chief – Council of Yukon First Nations (ruth.massie@cyfn.net)

- Cindy Dickson, Executive Director – Canada, Arctic Athabaskan Council – Note: The AAC received a 1.3 million dollar grant from the Council for Environmental Cooperation for development of research on caribou, climate change and traditional knowledge in communities (cdickson@me.com).

8/9 September 2013: We travelled from Whitehorse to Edmonton, Alberta on 8 September and met with researchers in this area on 9 September. We presented a briefing to 17 researchers at the CFS Northern Forestry Centre on 9 September. Juha Metsaranta coordinated this meeting. Researchers from CFS, the University of Alberta, and Ducks Unlimited attended the ABoVE Briefing. Following this briefing we had discussions (some including presentations) with a number of meeting attendees.

Overall, CFS researchers are conducting a number of programs focused on forests in the managed forest zone of Canada, specifically research on processes that impact forest resources, both positive and negative. Because of this emphasis, they conduct extensive research in the southern boreal forests located in British Columbia, Alberta, and Manitoba. Their research focuses on forest dieback, changes in productivity, forest growth, and the impacts of fire, insects, and pathogens. If ABoVE decides to include the southern boreal forest in its study domain, CFS researchers recommend making contacts with representatives of provincial governments as well as Parks Canada, who have a history of providing logistical support to researchers.

Ron Hall of CFS is carrying out a number of projects involving the use of remotely sensed data, including a forest inventory project with T. Lakusta in the NWT. As part of this project, they have established a set of ground validation plots (20 by 20 m) where they have also collected tree ring data (2000 tree cores). He is also involved with development of a burned area composite (NBAC) for 2003 to present that involves processing and analysis of Landsat TM/ETM+ and SPOT VGT data.

From 2007 to 2011, Jag Bhatti of CFS conducted research on the impacts of climate change on forests and peatlands in the Mackenzie River basin, in particular the impacts on carbon source/sink relationships. A number of study sites were located across a latitudinal gradient between 61 and 70 degrees N. They measured total carbon stocks, carbon flux via eddy covariance, and analyzed productivity from tree ring data.

Dan Thompson of CFS conducts field-based studies on the impacts of fires on forests and peatlands. He also operates a burn lab where samples of biomass are combusted under controlled conditions in order to measure gas and particulate emissions. He suggested we also contact Viktor Kafka, with Parks Canada in Ottawa.

John Gammon (Univ of Alberta) is conducting research on how variations in surface properties influences land/atmosphere energy exchanges. He uses field-based

spectrometer measurements to link the surface observations to satellite remote sensing data.

Kevin Smith is the Director of Boreal Programs for Ducks Unlimited, Canada (DUC). DUC carries out field-based monitoring of migratory waterfowl, mapping of waterfowl habitat and changes to habitat. DUC works with a variety of organizations across all governmental levels. While funding comes from membership dues, DUC also obtains funding from foundations to carry out research and monitoring. DUC has a strong interest in developing improved maps of waterfowl habitat using remotely-sensed data and participating in research on the impacts of climate change on waterfowl and waterfowl habitat. DUC is willing to work with partners in obtaining resources (funds) to meet its mission.

Robert Grant (Univ. of Alberta): Discussed the Arctic Development and Adaptation to Permafrost in Transition (ADAPT), an NSERC Discovery Frontiers grant involving 15 laboratories. ADAPT focused on Arctic regions (including the high arctic), and does overlap with the ABoVE study domain. ADAPT is in its final stages, but the data and research from this program could provide a foundation for research that could be continued during ABoVE.