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PI/PD Name: Donald A Walker

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Race:
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- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
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- ☐ Mobility/Orthopedic Impairment
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Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Linda Brubaker, lbru@u.washington.edu
Jim Bockheim, bockheim@facstaff.wisc.edu
Greg Henry, University of British Columbia, ghenry@geog.ubc.ca
Torre Jorgensen, tjorgenson@abrinc.com
Wyatt Oswald, woswald@u.washington.edu
Jim Overland, James.E.Overland@noaa.gov
Craig Tweedie, ctweedie@utep.edu

REVIEWERS NOT TO INCLUDE:

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PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 08-1

NSF 08-579 **09/30/08**

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0010637000

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Adm Svcs Ctr Rm 109
3295 College Road
Fairbanks, AK 99709-3705

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

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☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Remote Very High Arctic Terrestrial Observatory Stations: A reconnaissance expedition to Isachsen, Mould Bay and Green Cabin**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 198,526	24 months	06/01/09	

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☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
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☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
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☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
CA GM
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT

Institute of Arctic Biology

PI/PD FAX NUMBER

907-474-6967

PI/PD POSTAL ADDRESS

Institute of Arctic Biology
University of Alaska Fairbanks
Fairbanks, AK 997757000
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Donald A Walker	Ph.D.	1981	907-474-2460	ffdaw@uaf.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 08-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

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Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

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Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Andrew M Parkerson-Gray**	**Electronic Signature**	**Sep 30 2008 6:29PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
907-474-6000	**fyosp@uaf.edu**	**907-474-5444**

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PROJECT SUMMARY

Intellectual merit: High Arctic Bioclimate subzone A will likely vanish if temperatures rise as predicted in global climate models. This coldest portion of the Arctic, where mean July temperatures presently do not exceed 2-3 ˚C, is entirely located in remote parts of the Arctic where there currently are no permanent terrestrial-ecology observatories. This subzone has an extremely small flora, with no woody species, no sedges, no *Sphagnum,* a lack of peat development and unique faunal assemblages. The resulting ecosystems are found nowhere else on Earth and are presently poorly studied. Following the astonishingly rapid reduction of the extent of perennial Arctic sea ice in 2005 and 2007, it became clear that baseline observations of several critical physical and biological variables are needed as soon as possible before the changes accelerate. Observations are also needed in subzones B and C to provide a continuum of observations along the complete Arctic bioclimate gradient. Once these baselines are established, several possibilities exist for future monitoring strategies in this remote region. ***Proposed activities:*** We propose a joint US-Canadian reconnaissance expedition to Isachsen (Ellef Ringnes Island), Mould Bay (Prince Patrick Island), and Green Cabin (Banks Island) to determine what would be required to establish terrestrial observatories at these High Arctic sites. The focus of the expedition would be to evaluate the feasibility of upgrading the established facilities at these sites to provide logistic centers for small expeditions into all three High Arctic bioclimate subzones (A, B, and C). We are also proposing to make several quick, easy-to-conduct observations during the 1-week expedition ranging from downloading climate, soil, and permafrost temperature data to obtaining samples for determination of soil fungal diversity. A white paper would present the recommendations of the reconnaissance team to the Committee on Designing an Arctic Observatory Network. ***Transformative research:*** The proposed observatories are much needed in this region because: (1) the region is especially poorly studied; (2) it represents the cold extreme endpoint of terrestrial life in the North America Arctic; (3) it is in close proximity to the rapidly melting perennial ice in the Beaufort Sea and could experience some of the greatest temperature changes and biological changes of any area in the Arctic. Research in bioclimate subzone A will lead to fundamental understandings of how Arctic terrestrial systems at this cold extreme will respond to climate change. ***Broader impacts:*** This proposal is a component of the Greening of the Arctic (GOA) IPY initiative, which is investigating changes in plant biomass, NDVI, and other site variables along the Arctic bioclimate gradient. The proposed sites could be readily integrated into the network of pan-Arctic observatories and provide a model for interdisciplinary collaboration at remote extensive sites in the network. The fieldwork would involve several other IPY projects that are currently funded, including the Circumpolar Biodiversity Monitoring Programme (CBMP), International Tundra Experiment (ITEX), the circumpolar Active Layer Monitoring (CALM) project, the Thermal State of Permafrost (TSP), and fungal genomic dynamics at extreme cold temperatures. The ultimate goal is to establish well-coordinated interdisciplinary studies at these sites to monitor a suite of interrelated terrestrial processes that are undergoing change.
Educational/outreach components: The project will apply for a PolarTREC teacher. If a teacher were placed on the project, he/she would use the PolarTREC infrastructure for an extraordinary opportunity to participate in research along the complete Arctic climate gradient. We will also produce a web site for the expedition and a virtual tour of the NAAT transect as part of the Arctic Geobotanical Atlas.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

PROJECT DESCRIPTION

INTRODUCTION

The extreme High Arctic of Canada will likely see some of the largest terrestrial changes during the next few decades if the summer sea ice vanishes, as suggested by several recent papers (Nghiem et al. 2007, Serreze et al. 2007, Lawrence et al. 2008, Stroeve et al. 2008). *This region, defined by Arctic Bioclimate subzone A in Fig. 1, is not considered in the current configuration of the pan-Arctic observing network of the U.S. (Jeffries et al. 2007) or Canada.* The likely reason for this is the remoteness of the region and the current lack of facilities to support observations. Both the U.S. and Canadian plans for terrestrial observatories, however, recognize the need for more extensive observation coverage in critical parts of the Arctic. The current NSF AON solicitation (NSF 08-579) specifically invites projects "that address the environmental observing system coverage, design and optimization".

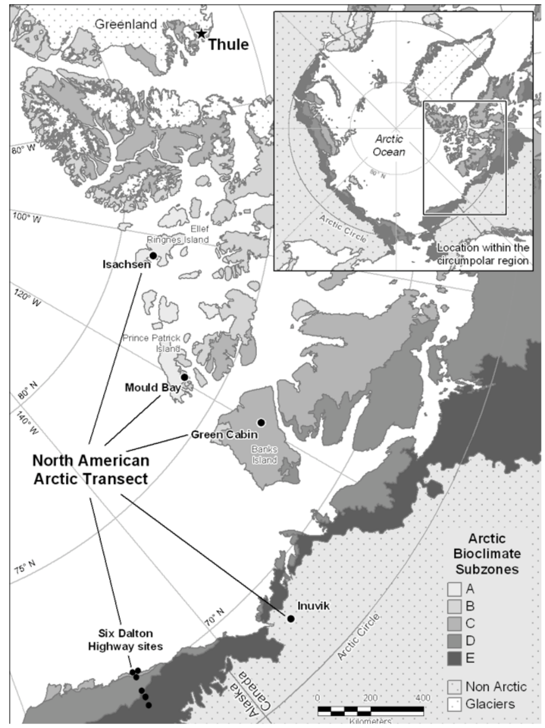

Fig. 1. *The North American Arctic Transect within the five Arctic bioclimate subzones of the Circumpolar Arctic Vegetation Map (CAVM Team 2003). The mean July temperatures in each subzone are roughly as follows: A: <3˚C; B: 3-5˚C; C: 5-7˚C; D: 7-9˚C; and E: 9-12˚C.*

In 2003-2006 NSF supported several expeditions to this region through the Biocomplexity in the Environment program and the Arctic System Sceince Program (ARCSS). These expeditions established an initial set of observations along a North American Arctic Transect (NAAT, Fig. 1) that included Isachsen in subzone A and Mould Bay in subzone B and demonstrated the feasibility of at least periodic observations in this critical area of the Arctic (Walker et al. 2008a). Here we propose a joint U.S.-Canada reconnaissance expedition to determine the wisdom, feasibility, and scope of establishing long-term arctic observatories in the extreme High Arctic. *This proposal draws on the experience from the previous NAAT expeditions. It outlines an expedition whereby members of the U.S. and Canadian Arctic observatory communities will visit the three High Arctic sites on the NAAT and develop a feasible cost-effective approach to make key observations in this remote but critical area of the Arctic and continue monitoring into the future.*

Evidence for terrestrial change in the High Arctic

The dramatic decrease in the extent of perennial Arctic sea ice in 2007 has caused worldwide concern regarding the consequences of sea-ice changes to the climate, permafrost and vegetation of Arctic terrestrial areas. Coupled climate models suggest that land warming trends during the next few decades could be 3.5 times greater than the 21st century climate change trends and that the ocean-induced terrestrial warming could extend as much as 1500 km inland (Lawrence et al. 2008). So far, the greatest warming in the Arctic has occurred in the winter as a result of an extension in the period of open Arctic Ocean water (Comiso 2003, Serreze et al. 2007). Warmer winter temperatures could have a major influence on permafrost temperatures (Lawrence et al.

2008), and enhanced snow cover could also affect key winter below-ground processes such as mineralization and soil respiration rates (Schimel et al. 2004, Sturm et al. 2005). Warmer summers have also occurred. The summer warmth index (SWI, the sum of the monthly mean temperatures above 0 ˚C) has increased at the rate of 1.5 ˚C / decade in the 50-km wide coastal band of the northern Hemisphere (Bhatt et al. 2008, in prep.) Warmer summer temperatures would most likely have the largest effect on plant production and biodiversity, and would create complex responses in the soil, permafrost, and to the entire arctic ecosystem. Evidence for this comes from the very strong correlations between summer temperatures and whole host of ecosystem properties along the Arctic bioclimate gradient, including plant production, NDVI and biodiversity (Young 1971, Rannie 1986, Chernov and Matveyeva 1997, Jia et al. 2006, Walker et al. 2008a, Jia 2008 submitted).

Most of the evidence of broad-scale changes in vegetation comes from satellite data. The record from the Advanced Very High Resolution Radiometer (AVHRR) aboard NOAA satellites now spans 25 years. The NDVI (Normalized Difference Vegetation Index) is considered an index of land-surface greenness (Tucker and Sellers 1986). Several studies have shown a general increase in NDVI within the Arctic during the past 20-25 years (Jia et al. 2003, Goetz et al. 2005, Bunn et al. 2007). These changes have been attributed primarily to changes in abundance of shrubs (Sturm et al. 2001, Tape et al. 2006). Terrestrial areas bordering the Beaufort Sea have shown some of the most noticeable changes (Table 1). From 1982 to 2007 during the Jul 2-22 period (time when the sea-ice concentration in the 50-km seaward strip along the Beaufort coast is typically 50%) sea ice declined by 15 % (29% reduction from the 1982 level); the SWI index on the corresponding 50-km landward strip increased 4.08 ˚C mo (16% increase between 1982 and 2007), and the maximum NDVI increased 0.127 (24% increase) (Bhatt et al. 2007, 2008a, b). These are astounding changes; the major question is “are the trends real?” The sea ice and SWI trends in the Beaufort are high but are not significant because of the high variability in both numbers (although trends in other areas of the Arctic are significant). The NDVI trend is significant at the p = 0.05 level, but there are no ground data to demonstrate a corresponding trend in plant biomass. Similar analyses for all the Arctic sea areas show that there is a consistent pattern of decreased summer sea-ice concentrations, and warmer summer temperatures across the Arctic, but the trend in the NDVI is more variable. The NDVI in the region from the East Siberian Sea eastward to the Canadian Archipelago (the northern Beringia region) has increased while much of the northern Russian coastline west of the East Siberian Sea has shown a slight decrease (Bhatt et al. 2007, 2008a, b). The Beaufort Sea region shows the greatest increase in NDVI — corresponding to the large summer sea-ice retreat and strong land-surface warming that occurred in the same region.

Table 1. *Change along trend lines of sea-ice concentration, summer land-surface temperatures (SWI), and maximum and integrated NDVI for 1982 to 2007 (sea ice and SWI) and to 2006 (for NDVI) for the 50-km coastal strip seaward (for sea ice) and 50-km strip inland (for SWI and NDVI) along the Beaufort Sea coast. * = significant trend at p = 0.05. From Bhatt et al. (in prep. 2008).*

Variable	Magnitude	Pct. Change
Sea ice cover (% cover, Jul 2-22):	-15.2	-29%
Summer warmth (SWI, ˚C mo):	+4.08	+16%
Maximum NDVI:	+0.125	+24%*
Integrated NDVI:	+0.625	+19%*

If we look at the complete Arctic bioclimate gradient in Canada, there was an overall 16.9% increase in NDVI within the five Arctic bioclimate subzones in northern Canada during 1982-

2003 (Jia 2008 submitted) (Fig. 2). Considering just the High Arctic part, subzones A-C, we did not expect to detect major changes of vegetation greenness in these systems because of the generally very sparse vegetation and short growing season; however, peak annual NDVI increased 0.49-0.74%/yr, comparable to the 0.46-0.67%/yr observed over the Low Arctic (subzones D and E) (Jia et al. 2008 submitted). We found a surprising approximately 0.5%/yr increase of peak greenness in Subzone A (12.5% increase over the length of the record). Two factors may have contributed to a greening: (1) an increase of plant height and coverage due to warming (Robinson et al. 1998) and (2) possibly a faster and earlier growth of tundra plants, as indicated by the earlier peak greenness (vertical solid lines in Fig. 2). Mosses and lichens are often dominant in these harsh environments and may respond to environmental changes more rapidly than vascular plants, and therefore enhance their photosynthesis even during a very short, favorable period. The satellite-derived trends are consistent with a variety of long-term warming experiments (Havström et al. 1993, Chapin et al. 1995, Hobbie and Chapin 1998, Arft et al. 1999, Jonasson et al. 1999, Walker et al. 2006), observations from other satellite sensors (Silapaswan et al. 2001), and repeat aerial photographs (Sturm et al. 2001, Tape et al. 2006), but most of these observations are from much warmer parts of the Arctic. We cannot rule out the possibilities that the satellite-derived trends could be influenced by changes in the atmosphere or changes in the orbits of the satellites (Stow et al. 2004). Most of these concerns have been addressed in the global data sets, but there are special problems at extreme northern latitudes including very low sun angles, and incomplete coverage in some areas of the published data sets There also is uncertainty regarding how much of the change is related to ongoing long-term recovery that followed the Little Ice Age in the 13th to late 19th centuries (Oswald et al. 2003). A basic question remains: *"How do the greening changes detected from space relate to biomass changes on the ground?" To answer this question, it will be necessary to establish biomass-monitoring sites on the ground in the High Arctic and compare long-term ground-derived data with the satellite-derived observations.*

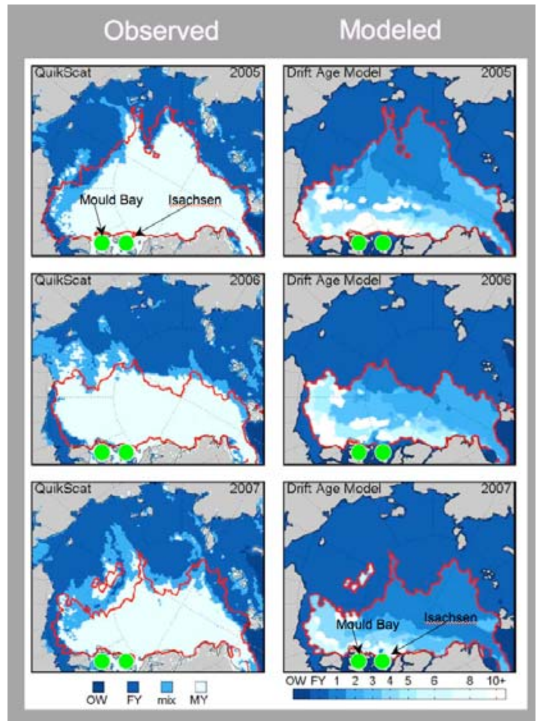

Fig. 4. *Modeled and observed sea ice in 2005-2007 (Nghiem et al. 2007).* ***Left column of maps*** *shows the observed minimum extent of sea ice each year. The red boundary conforms to the minimum sea ice extent of the drift age model of Ngheim et al. 2007. OW = open water, FY = first year ice, MY = multi-year ice.* ***Right column of maps*** *shows more detail regarding the age of ice within the multi-year ice of the model, with the oldest ice along the western boundary of the Canadian Archipelago. Green dots show the proximity of Mould Bay and Isachsen to the heavy multi-year ice.*

North American Arctic Transect (NAAT)

The NAAT was established during a project funded by the National Science Foundation entitled 'Biocomplexity of Patterned-Ground Ecosystems' (Walker et al. 2008b). The transect is approximately 1800 km long. The purpose of the transect was to observe tundra processes on zonal sites in all five bioclimate subzones of the Circumpolar Arctic (Fig. 1). The transect includes ten locations: six along the Dalton Highway in northern Alaska (Happy Valley, Sagwon, Franklin Bluffs, Deadhorse, West Dock, and Howe Island) and four in Canada (Inuvik, Green Cabin, Mould Bay, and Isachsen). The locations were selected using the following criteria: (1) They have representative zonal vegetation on fine grained soils (avoiding rocky soils for active layer measurements and sandy leached situations) and were mostly unglaciated during the last glacial maximum so that zonal vegetation and soils have had time to develop; (2) they have long-term climate records; and (3) they have good landing strips for aircraft that permit year-round access. Most of the subzones have at least two study locations, but there is only one location in subzones A and B (Isachsen and Mould Bay respectively). These were the only sites in these subzones within North America that satisfied the other criteria.

At each location, a suite of baseline climate, permafrost, soil, vegetation, and other site observations were collected. During the project, it was clear that these data would be most useful if they were collected using standardized protocols that could be applied at many sites around the circumpolar Arctic and which could be repeated in future years. Such protocols existed for describing the vegetation and soils (Dierschke 1994, Soil Survey Staff 1999); however, other variables such as species diversity and plant biomass, had no internationally accepted standards existed.

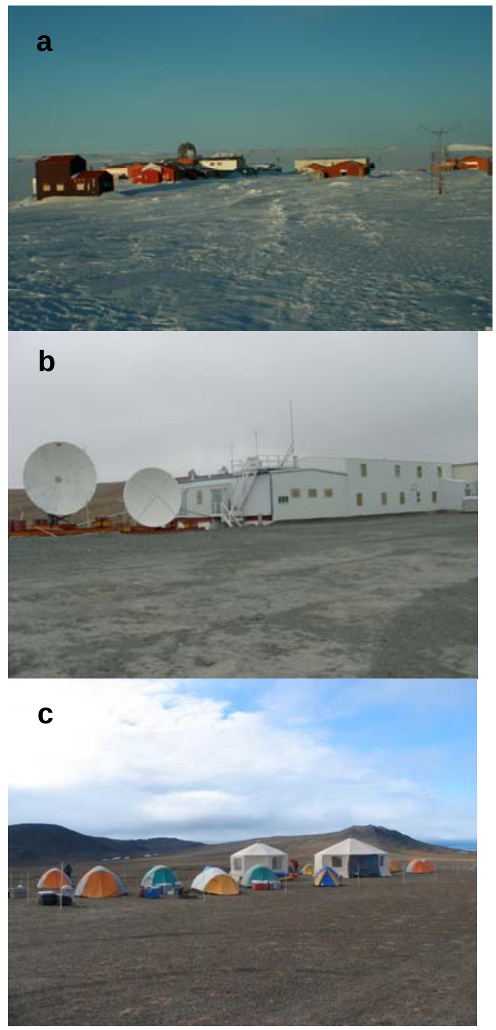

Fig. 5. (a) *Esisting camp at Isachsen in spring 2006.* ***(b)*** *Mould Bay in 2003.* ***(c)*** *Tent camp used for the Biocomplexity of Patterned Ground Ecosystems project at Isachsen in summer 2005.*

Special significance of Isachsen

Isachsen is a particularly important location on the arctic transect. It has the coldest summer climate of any weather station in Arctic North America (mean July temperature: 2 ˚C) and a small total flora (about 50 vascular-plant species). Ellef Ringnes Island is exceptionally cold in summer because it is in the region of perennial sea ice with strong summer winds that blow off the ice-pack and is consequently in Subzone A of the CAVM. At this cold extreme very small changes in summer temperature result in major system changes. For example, Mould Bay is only slightly warmer (mean July temperture: 3.1 ˚C), but it is outside Subzone A as evidenced by the much larger total flora (over 100 species) (Young 1971, Rannie 1986), and abundant prostrate shrubs and peat. There is no other terrestrial research site in the North American Arctic in this subzone, except for Alert, which is on a rocky non-zonal site and has restricted access for military reasons. Recent computer simulations suggest that the corner of the Arctic along the northwestern part of the Canadian Archipelago may become the last refuge for perennial sea-ice in the Arctic (Fig. 4), and it is important that we obtain baseline observations in this area before the sea-ice is eliminated.

PROPOSED ACTIVITIES

Component 1. Reconnaissance expedition

We propose a joint U.S.-Canada reconnaissance expedition to Isachsen (Ellef Ringnes Island, subzone A), Mould Bay (Prince Patrick Island, subzone B), and Green Cabin (Banks Island, subzone C) in 2009 or 2010. These three sites are the High Arctic section of a North American Arctic transect (NAAT) (Fig. 3). The focus of the expedition will be an evaluation of the existing facilities at Mould Bay and Isachsen (Fig. 5). Mould Bay could provide an operations center for expeditions into all three High Arctic bioclimate subzones (A, B, and C) in the western Canadian High Arctic. The Green Cabin site would also be visited because it is the key subzone C location along the NAAT. This site is in Aulavik National Park, and Parks Canada has shown interest in helping to maintain the continuity of the Biocomplexity monitoring observations there.

The Mould Bay and Isachsen facilities were established in April 1948 as part of a network of joint Canada-U.S. weather stations in the High Arctic. The U.S. withdrew support from the operations in 1971, and the Isachsen weather station was totally decommissioned in 1978. An automatic weather station was installed adjacent to the Isachsen runway in 1989. The weather-station camp at Isachsen (Fig. 5a) has totally deteriorated and is unusable for any kind of operations. There is also an abandoned mobile geophysical camp parked adjacent to the runway about 1 km north of the Isachsen weather station that has marginally useable kitchen facilities and bunk space, but the camp would need to be cleaned up and refurbished to be useable as a science facility. The runway at Isachsen is useable in winter, but summer use can be a problematic if the runway is wet — planes can get stuck in the mud.

The facilities at Mould Bay continued operation until 1997, when the main camp was decommissioned and an automatic weather station was installed adjacent to the runway. The runway at Mould Bay is still useable by C-130 Hercules aircraft. Fuel is regularly cached here for operations in the region. The main Mould Bay camp was more carefully mothballed than the Isachsen camp, and could conceivably be refurbished for science operations (Fig. 5b). Green Cabin is located in Aulavik National Park and is regularly visited by Twin Otter aircraft all summer by tourists and researchers. A small cabin is usable as a shelter and for cooking, and Parks Canada has maintained a climate station there since 1996, and permafrost temperatures have been monitored since 2000.

We are proposing to establish temporary tent camps at each of the locations similar to that shown in Fig. 5c. The proposed expedition will be 6-8 days total. Two Twin Otters will be chartered to bring a team of 10-12 U.S. and Canadian scientists and logistic experts to each location to evaluate the desirability and feasibility of establishing High Arctic observatories for long-term monitoring of a variety of terrestrial parameters. CH2M Hill Polar Services (CPS) will handle the logistics for the camps and has provided an estimate of the cost of supporting this project (see attached letter). We have been advised that fieldwork is not being funded through CPS in the first year of new projects, but it would be highly desirable to do this reconnaissance as soon as possible (i.e. in late summer 2009) because of the rapidly deteriorating sea-ice conditions and the already significant changes in summer land temperatures.

The proposed schedule for the reconnaissance is as follows: Day 1-2: Inuvik - Green Cabin, with a refuel stop at Sachs Harbor; overnight at Green Cabin. Day 3: Green Cabin - Mould Bay. Day 4: Fuel plane goes to Isachsen to check runway and weather and set up temporary camp at Geophysical Camp. Other plane stays at Mould Bay with main group for continuation of monitoring and camp observations. Day 5-6: Main group goes to Isachsen and spends two nights. Day 7: Return to Inuvik, possibly with fly over of northern part of Ellef Ringnes Island.

The proposed participants in the expedition are as follows: (1) Donald (Skip) Walker (UAF): Expedition leader, Greening of the Arctic (GOA) IPY project, and biodiversity of vascular plants monitoring; (2) Vladimir Romanovsky (UAF): Thermal State of Permafrost (TSP) IPY project, permafrost boreholes and climate monitoring; (3) Howard Epstein (U. Virginia): Soil CO_2 efflux; (4) Fritz Nelson (U. Delaware): Circumpolar Active Layer Monitoring (CALM) Project; (5) Lee Taylor (UAF): Genomic studies of fungal diversity and adaptations to cold; (6) Syndonia Bret-Harte (UAF): Toolik Lake Science Director, Arctic Observatory Network, Long-Term Ecological Research, pan-Arctic observatory network of international studies of carbon and energy balances in arctic terrestrial systems; (7) Mike Gill: Circumpolar Biodiversity Monitoring (CBMP) project, International Tundra Experiment (ITEX); (8) Marty Bergman (Canada Polar Continental Shelf Program): Logistics coordination; (9) Fred Daniëls (U. Muenster, PI MAVC IPY project, biodiversity of mosses and lichens); (10) Eddy Carmack (Institute of Ocean Sciences, Sidney, British Columbia): Climate research oceanography; (11) David Hik (University of Alberta): Executive Director, Canada IPY Secretariat; (12) PolarTREC teacher to be named; (13) William Gould, Institute of Field Education; ITEX; (14) Martha Raynolds (UAF): Logistics coordinator and data manager; (15) CPS cook, (16) Inupiat bear hunter for camp bear protection.

Component 2. Field observations during the expedition

The call for proposals states that *proposals for research will not be considered*, but that monitoring activities and field support for these are permitted. A variety of already-funded projects have shown strong interest in taking advantage of the expedition and will collaborate in obtaining a variety of quick-to-measure field observations. We will help coordinate the field activities and monitoring efforts of an integrated suite of observations related to climate, sea ice, permafrost, active layer, cold adaptations in fungi, soils, and vegetation at the three High Arctic locations. These observations will have to satisfy four requirements: (1) be useful and essential as a baseline for monitoring system change, (2) quick (requiring less than 2 field days at each location), (3) require minimal personnel, and (4) require only light-weight, non-bulky equipment.

As background for the trip, baseline data of environmental information were collected at each location along the NAAT during the Biocomplexity of Patterned Ground Ecosystems project in 2003-2006 (Walker et al. 2008a). Literature reviews of each site and data collected to date are in four data reports (Munger et al. 2004b, Munger et al. 2005, Barreda et al. 2006, Vonlanthen et al. 2006). The latitudinal trends of temperature, snow cover, active layer, frost heave, soil carbon, biomass, NDVI, patterned-ground morphology, plant diversity, and plant communities are summarized in several papers of a special section of the *Journal of Geophysical Research - Biogeosciences* devoted to Arctic Tundra Biocomplexity (Epstein et al. 2008, Michaelson et al. 2008, Ping et al. 2008, Raynolds et al. 2008c, Walker et al. 2008a, Walker et al. 2008b) and other recent publications (Kade et al. 2005, 2006, Kade and Walker 2008, Vonlanthen, 2008 (in press), Romanovsky et al. 2008; Daanen et al. 2008a, Kuss et al. 2008 in prep., Kelley et al., 2004}.

Thermal state of permafrost: Vlad Romanovsky

One of the more influential system parameters on the biotic systems is the thermal condition at the ground surface. Climate data are available at each site from automatic weather stations operated by Environment Canada. We also established climate stations at each of the 10 x 10-m grids (Romanovsky et al. 2008). The installations are part of the Permafrost Observatory Network (Osterkamp 2003, Romanovsky et al. 2003). Air and ground temperatures and snow depths are monitored at each site using Campbell data loggers. The High Arctic stations were last visited in 2006 and need to be revisited by 2009 or 2010 to obtain continuous records.

Monitoring the temperature of the permafrost will be very important for determining long-term trends in the climate at these sites. We will also bring a coring device to establish shallow (up to 5 m depth) permafrost boreholes at each location. Permafrost temperature data are very scant from the extreme High Arctic (only from Alert) and completely missing from the Western Canadian High Arctic.

Active layer: Fritz Nelson

A representative of the CALM program will visit these sites to examine the monitoring protocols and make suggestions regarding incorporation of the sites into the existing CALM network. Several 10 x 10-m grids with 1-m grid-point spacing were established on zonal sites at each location as part of the Biocomplexity studies. This scale of monitoring is currently not part of the Circumpolar Active Layer Monitoring (CALM) program [Brown et al., 2000] but is valuable for monitoring changes associated with small patterned-ground features such as non-sorted circles, and polygons. These features would likely change their character if the vegetation patterns changes because the vegetation is the key factor controlling the flux of heat into the soils. The active-layer was measured at the end of August in 2006. We will repeat these measurements during this reconnaissance trip. The active layer will be measured using a metal rod inserted into the soil until it encounters the permafrost table. Measurements will be verified using a thermal probe (Brown et al., 2000, Figure 3). Precise elevations for a subset of the probed points will be established to +/-1 cm using differential GPS technology to establish baseline data for future studies of frost heave and subsidence (Little et al. 2003).

Plant diversity on zonal sites: Skip Walker and Fred Daniëls

The plant diversity of arctic sites is strongly linked to summer air temperatures and could be one of the more sensitive variables to change. Photo points will be established at each of the 124 already-established permanent vegetation plots surveyed in 2003-2005, (McKendrick 1976, 2002). Aluminum disks with id numbers stamped into the disk will be mounted on sharpened rebar stakes and inserted into the soil in the center of a marked 1-m square plot. Vertical photos will be taken of the area centered on the photo point. Changes in the zonal plant communities are of primary concern. Complete lists of vascular plant plants will be made on the eight 10 x 10-m grids on zonal sites at Green Cabin, Mould Bay, and Isachsen that were surveyed during the Biocomplexity studies (Vonlanthen et al. 2008 (in press)). Smaller 1 x 1 m-grids will be established within each of the larger grids to monitor moss and lichen diversity.

Fungal biodiversity: Lee Taylor

Fungi play dominant roles in decomposition and plant growth, and are therefore critical biotic components of changing High Arctic ecosystems. Soil cores were collected from vegetated and non-vegetated zonal sites along the NAAT in the course of the Biocomplexity project and have been utilized for thorough molecular characterization of fungal community composition via recent OPP funding. However, only a limited range of habitats were sampled in each subzone. Furthermore, only DNA analyses, which reveal both active (e.g. growing mycelium) and inactive (e.g. spores) community members, could be conducted on the prior samples. We propose here to expand the baseline community information from DNA analyses to additional habitats, and to add a novel RNA-based approach, which reveals the identities of metabolically active members of the fungal community. Such a comparison of active versus inactive taxa is a key to elucidating functional changes in these ecosystems, but requires extremely careful soil preservation. During the proposed reconnaissance trips, soil cores can be collected rapidly on site and preserved immediately in a liquid nitrogen dry shipper for subsequent DNA and RNA analyses.

Soil CO_2 Efflux Measurements: Howard Epstein

An understanding of the controls on CO_2 efflux and the spatial-temporal dynamics of the process is crucial for assessing changes in the Arctic carbon cycle. Soil CO_2 efflux is sensitive to both soil temperature and moisture, and will therefore likely change as Arctic climate changes. Measurement of soil CO_2 fluxes is a relatively fast and easy procedure and measurements from the High Arctic and across heterogeneous soils are presently limited. The equipment is light and does not need to be purchased. CO_2 efflux and ancillary data will be collected at each location visited for the duration of the stay. The sampling would focus on zonal sites with samples on and between patterned ground features (PGF), with three replicate on/between PGF pairs (if they exist), for a maximum total of 6 sampling sites per location. Measurements of soil CO_2 efflux will be taken using a PP Systems EGM-4 infrared gas analyzer (IRGA), rotating among the 6 sampling sites for as long as possible. At each sampling site, an organic "plug" (circular) will be cut to the size of the CO_2 chamber attached to the IRGA (if an organic layer exists) down to the top of the mineral soil. Live vegetation will be removed from each sampling site to avoid aboveground plant respiration. Soil CO_2 efflux measurements will be taken both at the top of the mineral soil (with organic "plug" removed), and at the top of the organic layer (with "plug" in place) to estimate the CO_2 flux from each of the two distinct soil layers. Various ancillary data will be collected to examine as controlling variables. At the time each CO_2 measurement is taken, integrated soil moisture at 0-12-cm depth in the mineral soil will be measured using a Campbell Scientific Hydrosense. Soil temperature at 6-cm depth in the mineral soil will also be taken. The depth of the organic layer will be measured for each sample site, as will the depth of the active layer. Prior to leaving each location, the organic "plugs" will be collected for analysis of bulk density, and carbon and nitrogen content. A 0-12-cm depth soil core will be taken from the mineral soil of each sampling site for analysis of bulk density,

Pan-Arctic observatory network of international studies of carbon and energy balances in arctic terrestrial systems: Donie Bret-Harte

Donie Bret-Harte will help assess the sites at Isaachsen and Mould Bay for inclusion into existing arctic U.S. observing networks, including the AON pan-Arctic network of landscape-scale observations of carbon, water and energy flux at flagship observatories, and for synergies with activities at the core NEON and LTER sites at the Toolik Field Station. One of the key pieces of information needed from these locations is long-term plant biomass information to help confirm the NDVI trends. Biomass data will be collected from each location to conform with methods used along a similar transect in Russia. A plan will be developed for a coordinated and standardized approach to biomass collection across the Arctic Observatory Network. This will be presented at one of the planned workshops for the Circumpolar Biodiversity Monitoring Program.

Linkages to marine and sea-ice systems: Eddy Carmack

One participant in the project would evaluate the possibilities for linking the transect with a planned long-term marine transect spanning the Canadian Arctic Archipelago from South to North. It is speculated that opening of the sea ice in the higher latitudes will lead to greater ocean productivity, more use by marine mammals and birds, and more trophic interaction between the sea and the land. Discussions are currently underway in Canada to make use of science-capable Canadian Coast Guard icebreakers to carry out annual sea and land surveys extending from Coronation Gulf in the South (~67 deg-N) to the outer boundary of the Queen Elizabeth Islands in the North (~82 deg-N), thus spanning 15 degrees latitude. This will establish current conditions to document anticipated changes in water properties and circulation, ice cover (thickness, extent and duration) and biota (plankton, fish, marine mammals and birds). Ship-based oceanographic observations will include standard physical (temperature and salinity), texture, pH, and carbon and nitrogen content, geochemistry (nutrients, dissolved oxygen, oxygen isotopes) and biological (chlorophyll and zooplankton) measurements. It would be highly desirable to link terrestrial observations to those of the ocean and sea ice.

Circumpolar Biodiversity Monitoring Program and the International Tundra experiment: Mike Gill

The Circumpolar Biodiversity Monitoring Program (CBMP) goals of monitoring Arctic biodiversity and conservation of Arctic species and their habitats are being met by collaboration and involvement of numerous projects. The North America Arctic Transect offers a perfect opportunity to monitor terrestrial biodiversity and changes in plant phenology along the complete Arctic climate gradient. It is important to initiate monitoring of several key species groups including plants, insects and sea-bird populations that may begin colonizing these areas as the ocean becomes ice free in summer. Similarly, increases in summer warmth are very likely to affect the seasonality (phenology) of plants and their functional response. The International Tundra Experiment (ITEX) (Henry, 1997) in Canada is interested in establishing research sites at this northern extreme of the climate gradient. A representative of the Circumpolar Biodiversity Monitoring Program (CBMP) and the International Tundra Experiment (ITEX) would be invited to evaluate the sites for inclusion in the monitoring program of these two major circumpolar projects.

Canadian Arctic observatory network: Marty Bergmann and David Hik

At present there is no Canadian terrestrial research being conducted at Mould Bay or Isachsen, but several Canadian researchers have expressed interest in doing so, and it likely that a proposal will be submitted to the Polar Continental Shelf Program (PCSP) this fall that requests funds for monitoring research at these sites. This would trigger the involvement of PCSP in promoting the efforts described here. Representatives from the Canadian IPY effort and the Polar Continental Shelf Program will be invited on this reconnaissance expedition to provide expert advice on logistical operations in Canada and how the proposed sites would fit into the Arctic Research plans for Canada.

Component 3. Coordination and data management

A post-doctoral student, tentatively identified as Martha Raynolds, will be hired to act as the science and logistic coordinator and data manager. The coordinator will work with CH2M Hill Polar Services (CPS) to ensure that the camp runs smoothly, that all necessary permits are obtained, that everyone going to the camp has all necessary equipment and paper work completed. The post-doc would also participate in the plant diversity observations. The data obtained during the reconnaissance will be archived through the Cooperative Arctic Data and Information Service (CADIS) according to procedures recommended by the emerging new ARCSS data management system http://www.arcus.org/arcss/message_112006.html. Data will be also archived at the Geographic Information Network of Alaska (GINA) and at the Alaska Geobotany Center at UAF. We will also be disseminating data through links to the Circum-Arctic Environmental Observatory Network (CEON) and COMAAR and the Circumpolar Biodiversity Monitoring Program.

Component 3. Education/Outreach

A solid education component would be a necessary part of any observatory-station activities. Bill Gould has conducted several unique and highly regarded student expeditions into the High Arctic as part of the Biocomplexity Project (2003-2005) and as part of the 1999 CAVM

Expedition (Gould et al. 2003). He will participate to help develop the education component of the white paper. We will also work with NSF and ARCUS to bring a PolarTREC teacher on the expedition to also help with the developing a component that could be used in public-school classrooms in conjunction with the other outreach tools that will be developed, including an expedition web site and virtual tour of the North American Arctic Transect.

The expedition will also have a web site at the Alaska Geobotany Center, and a virtual tour of the NAAT transect as part of the Arctic Geobotanical Atlas.

Component 4. Follow-up meeting and white paper

The expedition would examine these locations to determine the wisdom, feasibility, and scope of continuing studies along the transect, and to make recommendations regarding possible options for doing this. A white paper would present the recommendations of the reconnaissance team to the Committee on Designing an Arctic Observatory Network. We are proposing one meeting in the fall following the expedition in Vancouver where the white paper would be written.

CONCLUSION

Because of the rapid sea-ice retreat in the nearby Beaufort Sea, and the especially sensitive nature of subzone A to rapid change, numerous arctic researchers have recognized the need to establish a terrestrial monitoring capability in this region to document the changes that are bound to occur. A cost-effective plan for U.S. involvement in working in this region will require collaboration with the Canadian Polar Continental Shelf project and other Canadian groups that are also interested in working in the region. Although the proposed areas of research are entirely in Canada, it is appropriate that the U.S. be involved because, for one, the locations proposed here constitute the High Arctic portion of the North American Arctic Transect, which traverses both the U.S. and Canadian Arctic. NSF funded the NAAT as part of the Biocomplexity in the Environment (BE) program, and the Arctic System Science Program funded the logistics. The data collected during the Biocomplexity project constitute a legacy of baseline terrestrial information along a transect that traverses all the bioclimate subzones in the Arctic. There is no other comparable transect anywhere else in the Arctic. It is logical to build on this heritage of research and integrate this transect into the AON as part of a network of extensive observatories. Since the NAAT lies in both countries, it also logical that the U.S. and Canada share in the responsibility for developing a feasible and cost-effective plan for monitoring changes along the transect and ensure that the activities are well integrated and coordinated with other U.S. and Canadian Arctic observation networks. Developing a feasible approach for monitoring the terrestrial changes in this especially sensitive region is the primary goal of this proposal.

The most critical need is to establish a set of baseline observations, against which future changes can be made. A relatively small team of researchers could reasonably achieve this within 1-2 field seasons. Once these baselines have been established, several possibilities exist for future monitoring strategies in this remote region, ranging from temporary camps at all three stations that would only be visited every 3-5 years for monitoring a key set of variables to something more permanent, particularly at Mould Bay, that could be used for a wider range of observations and experiments in the terrestrial, shoreline and marine systems, and also as logistic centers for accessing other areas in the western Canadian High Arctic.

RESULTS OF PRIOR NSF SUPPORT

1. Biocomplexity associated with biogeochemical cycles in frost boil ecosystems. OPP-0120736, $2,750,421, 10/1/01-9/30/07, D.A. Walker, PI, H.E. Epstein, W.A. Gould, W.B. Krantz, R. Peterson, C.L. Ping, V.E. Romanovsky, Co-PIs. *This study is relevant to the proposed* *work because the North American Arctic Transect was established during this project, and a great deal of baseline climate, soil, vegetation, and geomorphological information were collected. Furthermore, the logistics for the transect were worked out during the Biocomplexity project, so we know the transect is feasible.* An interdisciplinary team of vegetation and ecosystems scientists, climate and permafrost specialists, soil scientists, and modelers examined the climate, permafrost, geomorphology, soils, vegetation, and invertebrates associated with patterned ground features. Publications to date have included an overview of the project and a conceptual model of how vegetation affects the morphology of patterned ground forms with results from the Low Arctic portion of the gradient (Walker et al. 2003, Walker et al. 2004) descriptions of the differential frost heave model, a physically based model of self-organization of frost boils and earth mounds (Peterson and Krantz 2003, Peterson et al. 2003), characterization of the vegetation and its effect on the thermal properties of the soil (Kade et al. 2005, Kade 2006, Kade et al. 2006, Kade and Walker 2008), descriptions of the soil processes in frost boils (Michaelson et al. 2002, Ping et al. 2005), the active layer (Kelley et al. 2004), the hydrological system (Daanen et al. 2007), and the educational component of the project (Gould et al. 2003). A synthesis of the project has been published in a special section of *Journal of Geophysical Research*; including nine papers describing the vegetation, soils, biomass, spectral properties, and the models used along the North American Arctic Transect (Daanen et al. 2008b, Epstein et al. 2008, Michaelson et al. 2008, Nicolsky et al. 2008a, Peterson and Krantz 2008, Ping et al. 2008, Raynolds et al. 2008c, Walker et al. 2008a, Walker et al. 2008b). Additional papers published elsewhere or in preparation further describe the models (Daanen et al. 2008a, Nicolsky et al. 2008b, Peterson 2008), measurements of frost heave (Daanen et al. 2007, Romanovsky et al. 2008); the special characteristics of bioclimate subzone A (Walker et al. 2008d), vegetation in the High Arctic (Vonlanthen et al. 2008 (in press)), carbon sequestration (Ping et al. 2008 in press), and a synthesis of the zonal vegetation along the transect (Kuss et al. 2008 in prep.). Several hard-copy data reports are also available on line at http://www.geobotany.uaf.edu/library/reports/#bc_reports (Raynolds and Walker 2003, Munger et al. 2004a, Raynolds et al. 2004, Raynolds 2005, Barreda et al. 2006, Vonlanthen et al. 2006).

2. Towards an arctic geographic information network: a web-based plant-to-planet-scale geobotanical atlas centered on the Toolik Lake Field Station, Alaska. ARC-0425517, $819,460, 12/15/04-11/30/08. D.A. Walker, PI. The Circumpolar Arctic Geobotanical Atlas (AGA) is a web-based multi-scale collection of geobotanical maps and related material. It includes maps at eight different scales, from 1-m² plots to the entire Arctic. The AGA focuses on research sites at the Toolik Field Station and Imnavait Creek, Alaska, but also covers the Kuparuk River Basin, northern Alaska, Arctic Alaska, and the Circumpolar Arctic. Diverse geobotanical themes include geology, topography, landforms, surficial geomorphology, soils, and vegetation. The maps and web site are being developed at the Alaska Geobotany Center in collaboration with several other groups at the University of Alaska Fairbanks. *The databases form a legacy GIS database for the Toolik Field Station. The AGA is relevant to the proposed project because our intent is to include the spatial databases from the North American Arctic Transect in the atlas, in particular the maps of the vegetation, biomass, snow depth, and active layer thickness on each of the 21 10 x 10-m grids along the transect, including 8 maps at Green Cabin, Mould Bay, and Isachsen* (Raynolds et al. 2008c). The publications to date have focused on the master's thesis work of Corinne Munger (Munger 2007, Munger et al. 2008), analysis of the circumpolar arctic vegetation map (Raynolds et al. 2006, Raynolds et al. 2008b); publication and analysis of the vegetation map of Arctic Alaska (Raynolds et al. 2005a, Raynolds et al.

2005b) and the publication of a hierarchy of maps of the Toolik Lake region (Walker et al. 2008c, Walker and Maier 2008 in press). The core of the project is the web site that presents the hierarchy of maps, supporting information, photos of the plants and plant communities, and the key publications: http://www.arcticatlas.org/.

3. Greening of the Arctic: Synthesis and models to examine the effects of climate, sea-ice, and terrain on circumpolar vegetation change. NSF ARC-0531180, $481,765 to UAF and $406,603 to University of Virginia, 2005-2007. 1/1/06-12/31/08. D.A. Walker and H.E. Epstein, Co-PIs. The Greening of the Arctic initiative examines the sea-ice, climate and vegetation interrelationships and the relevance to people living in the Arctic. *This project is very relevant to the work proposed here because of its focus on the inter-relationships between sea-ice, land-surface temperatures, and vegetation greenness.* Since 1975, perennial sea ice in the Arctic has declined 8.6 ± 2.6% per decade for September sea-ice extent, with a total reduction of 21%. Forty percent of the models predict complete loss of Arctic sea ice in September by 2100. One of the major questions facing Arctic terrestrial ecologists at the moment is, "What will happen to the tundra regions if the Arctic Ocean becomes seasonally ice free as indicated by current trends in sea ice?" Linkages between sea ice and terrestrial vegetation are indirect – through albedo/climate feedbacks to the atmosphere. Changes to the vegetation will have major implications for the permafrost, snow, hydrology, soils, wildlife, and people who live in the Arctic. They also have global implications because of albedo and trace-gas feedbacks to the climate system.

The results of this project and several other new studies offer a fresh perspective to view and study changes to the vegetation of the whole Arctic. One often overlooked feature of the Arctic tundra is its intimate relationship with the Arctic Ocean and sea ice. Eighty percent of the Arctic tundra (3.2 million km^2) is within 100 km of at least seasonally frozen seawaters that provide the cool summer temperatures necessary for tundra's presence. Changes to the boundary of the perennial ice in the Arctic will likely cause a wide variety of other changes to the Arctic System including northward migration of extratropical cyclones, general warming of the land surfaces, and reduction in the extent of the tundra biome. Before future states of tundra ecosystems can be modeled, it is first necessary to better characterize how the current distribution of pan-Arctic plant communities and tundra production patterns are related to existing climate, sea ice, and terrain variables. New circumpolar maps and remote sensing data provide tools to examine the underlying causes of pan-Arctic vegetation change. A synthesis of these circumpolar data sets is especially appropriate now during the International Polar Year.

We are examining how the vegetation of the circumpolar Arctic is responding to recent changes in climate and sea ice, and how these changes are modified by terrain variables, such as soils, topography, and bedrock. We are using observed information from GIS and remote-sensing data sources to help predict future response of arctic vegetation. Traditionally, the Arctic system has been studied by separate groups of scientists studying the ocean, atmosphere, land, and ice components of the system. Our team consists of experts in geobotany, sea ice, climatology, soils, permafrost, remote sensing, and vegetation modeling, who address the central question of how pan-Arctic vegetation has responded to climate change and how it will change in the future. The project also has strong linkages to projects studying other components of the total Arctic System including the geophysical environment, carbon budgets, wildlife, and humans. Our project is divided into four main research components and a management component: Component I: Climate, sea-ice, land-surface temperatures: trends and interrelationships (Bhatt, Comiso, Jia, Raynolds); Component II: Spatial patterns of circumpolar vegetation and NDVI (Jia, Raynolds, Walker); Component III: Temporal patterns of circumpolar NDVI (Jia, Bhatt, Comiso, Markon, Epstein); Component IV: Simulation Modeling (Epstein, Kaplan, Lischke); Component V: Project management (Walker, Raynolds, Maier). Publications to date have focused on a summary of the modeling results (Epstein et al. 2007) (Epstein et al. 2007), summaries of the NDVI relationships in Canada (Jia 2008 submitted), relationships of circumpolar NDVI to patterns of biomass (Raynolds et al. 2006), land surface temperatures (Raynolds et al. 2008a), glacial geology (Raynolds and Walker 2008 in press), and permafrost (Raynolds and Walker 2008); and the influence of sea ice on land-surface temperatures, and NDVI (Bhatt et al. 2007, Bhatt et al. 2008, Bhatt et al. 2008 in prep.).

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Yurtsev, B. A. 1994. Floristic division of the Arctic. Journal of Vegetation Science 5:765-776.

BIOGRAPHICAL SKETCH

DONALD A. (SKIP) WALKER

Professional Preparation:

U.S. Air Force Academy	Mechanical Engineering, Astronautics, 1964-1967	
University of Colorado, Boulder	Environmental Biology,	B.A.1972
University of Colorado, Boulder	Environmental Biology,	M.A.1977
University of Colorado, Boulder	Environmental Biology,	Ph.D.1981

Appointments:

1999-present	Professor, Dept. of Biology and Wildlife, University of Alaska Fairbanks
1999-present	Director, Alaska Geobotany Center
1986-1999	Fellow, Institute of Arctic and Alpine Research, University of Colorado
1986-1999	Co-Director, Tundra Ecosystem Analysis and Mapping Laboratory
1986-1999	Dept. of Environmental Population and Organismic Biology, Univ. of Colorado (1998-99) Professor Attendant-Rank (1994-98) Associate Professor Attendant-Rank (1986-94) Assistant Professor Attendant-Rank

Publications, five most relevant:

Walker, D. A., H. E. Epstein, V. E. Romanovsky, C. L. Ping, G. J. Michaelson, R. P. Daanen, Y. Shur, R. A. Peterson, W. B. Krantz, M. K. Raynolds, W. A. Gould, G. Gonzalez, D. J. Nicolsky, C. M. Vonlanthen, A. N. Kade, P. Kuss, A. M. Kelley, C. A. Munger, C. T. Tarnocai, N. V. Matveyeva, and F. J. A. Daniëls (2008), Arctic patterned-ground ecosystems: A synthesis of field studies and models along a North American Arctic Transect, *J. Geophys. Res*., 113, G03S01, doi:10.1029/2007JG000504.

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Five other significant publications:

Ping, C.L., G.J. Michaelson, J.M Kimble, V.E. Romanovsky, Y.L. Shur, D.K. Swanson, and **D.A. Walker** (2008), Cryogenesis and soil formation along a bioclimate gradient in Arctic North America, *J. Geophys. Res*., doi:10.1029/2008JG000744.

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Jia, G. J., H. E. Epstein, and **D. A. Walker**. 2006. Spatial heterogeneity of tundra vegetation

response to recent temperature changes. *Global Change Biology* 12:42-55.
Walker, D.A., Auerbach, N.A., Bockheim, J.G., Chapin, F.S.I., Eugster, W., King, J.Y., McFadden, J.P., Michaelson, G.J., Nelson, F.E., Oechel, W.C., Ping, C.L., Reeburg, W.S., Regli, S., Shiklomanov, N.I. & Vourlitis, G.L. 1998. Energy and trace-gas fluxes across a soil pH boundary in the Arctic. Nature 394: 469-472.

Synergistic activities:

This proposal is part of a synergistic group of activities funded by several proposals under the IPY initiative called "Greening of the Artic" (GOA) that include:

- development of a web-based arctic geographic-information atlas for the Arctic observatory at Toolik Lake, Alaska
- synthesis and models to examine the effects of climate, sea-ice, and terrain along the North American Arctic Transect
- the application of space-based technologies and models to address land-cover/land-use problems along a bioclimate gradient on the Yamal Peninsula Russia

Major collaborators and affiliations:

Nancy Bigelow, UAF; Terry Chapin, UAF, Berkeley; Fred Daniëls, Institute of Plant Ecology, University of Muenster; Arve Elvebakk, University of Tromso, Norway; Howard E. Epstein, University of Virginia; William A. Gould, International Institute of Tropical Forestry USDA, San Juan, PR; Larry Hinzman, UAF; Allan Hope, San Diego State University; Jiong Jia, University of Virginia; Jed Kaplan, Max Plank Institute for Biogeochemisty, Jena, Germany; Alexia M. Kelley, Ph.D. student, University of Virginia; Julie Knudson, Colorado State University; William B. Krantz, University of Cincinnati; Carl Markon, USGS, Anchorage, AK; Nadya Matveyeva, Komarov Botanical Institute, St. Petersburg, Russia; Gary Michaelson, Palmer Research Center, UAF; Natalia Moskalenko, Earth Cryosphere Institute, Moscow, Russia; Fritz Nelson, New York University, Albany; Rorik Peterson, UAF, Chien-Lu Ping, Palmer Research Center, UAF; Martha Raynolds, UAF; Valodya Razzhivin, Komarov Botanical Institute, St. Petersburg, Russia; Buck Sharpton, UAF; Yuri Shur, UAF; Stephen Talbot, USFWS, Anchorage, AK.

Graduate and Post doctoral advisors:

Dr. Patrick Webber, Michigan State University, M.A. and Ph.D. advisor

Graduate students (10) and post docs (1):

Andrew Borner, UAF, MS committee member
Amy Carroll, UAF, Ph.D. committee member
Anja N. Kade, UAF, Ph.D. major advisor (graduated 2006)
Patrick Kuss, UAF, Post-doc
Carl Markon UAA MS committee member
Corrine Munger, UAF, MS, major advisor (graduated 2008)
Martha K. Raynolds, UAF, Ph.D. co-major advisor (in progress)
Ina Timling UAF, Ph.D. co-major advisor (in progress)
Corinne Vonlanthan, UAF, Post-doc
Jim Walton UAF, Ph.D. committee member
Martin Wilmking, UAF, Ph.D. committee member

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Alaska Fairbanks Campus

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Donald A Walker

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Donald A Walker - PI	1.00	0.00	0.00	$ 10,512	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	0.00	10,512	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	3.00	0.00	0.00	12,222	
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	1.00	0.00	0.00	3,855	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				26,589	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				9,779	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				36,368	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				3,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				500	
TOTAL OTHER DIRECT COSTS				3,500	
H. TOTAL DIRECT COSTS (A THROUGH G)				39,868	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Modified total direct costs (Rate: 45.1000, Base: 39868)					
TOTAL INDIRECT COSTS (F&A)				17,980	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				57,848	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 57,848	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Donald A Walker

ORG. REP. NAME*
Andrew Parkerson-Gray

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION: University of Alaska Fairbanks Campus	FOR NSF USE ONLY — PROPOSAL NO. / DURATION (months): Proposed, Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: Donald A Walker	AWARD NO.

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Donald A Walker - PI	1.00	0.00	0.00	$ 10,985	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	0.00	10,985	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	3.00	0.00	0.00	12,772	
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	1.00	0.00	0.00	3,971	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				27,728	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				10,184	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				37,912	

	Funds Requested By proposer	Funds granted by NSF (if different)
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)		
TOTAL EQUIPMENT	0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)	0	
2. FOREIGN	39,000	
F. PARTICIPANT SUPPORT COSTS		
1. STIPENDS $ 0		
2. TRAVEL 24,000		
3. SUBSISTENCE 0		
4. OTHER 0		
TOTAL NUMBER OF PARTICIPANTS (8) TOTAL PARTICIPANT COSTS	24,000	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION	3,000	
3. CONSULTANT SERVICES	0	
4. COMPUTER SERVICES	0	
5. SUBAWARDS	0	
6. OTHER	500	
TOTAL OTHER DIRECT COSTS	3,500	
H. TOTAL DIRECT COSTS (A THROUGH G)	104,412	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Modified total direct costs (Rate: 45.1000, Base: 80412)		
TOTAL INDIRECT COSTS (F&A)	36,266	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	140,678	
K. RESIDUAL FUNDS	0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	$ 140,678	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME: Donald A Walker	FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION
ORG. REP. NAME*: Andrew Parkerson-Gray	Date Checked / Date Of Rate Sheet / Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION: University of Alaska Fairbanks Campus				FOR NSF USE ONLY	
				PROPOSAL NO.	DURATION (months): Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: Donald A Walker				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Donald A Walker - PI	2.00	0.00	0.00	$ 21,497	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	21,497	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (2) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	24,994	
2. (2) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	2.00	0.00	0.00	7,826	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				54,317	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				19,963	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				74,280	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				39,000	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 24,000					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (8) TOTAL PARTICIPANT COSTS				24,000	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				3,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				3,000	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				1,000	
TOTAL OTHER DIRECT COSTS				7,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				144,280	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				54,246	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				198,526	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 198,526	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME: Donald A Walker	FOR NSF USE ONLY		
	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: Andrew Parkerson-Gray	Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

This is a two year budget.

Salaries and benefits:

The project PI, Dr. D.A. Walker, will lead the project. He has 37 years of experience in the Arctic, including research in geobotanical mapping, remote sensing, and arctic plant ecology, has led five expeditions to the Canadian High Arctic, and coordinated several international efforts including the Circumpolar Arctic Vegetation Map, the Biocomplexity of Patterned Ground project, and the Greening of the Arctic IPY initiative. He is on a 75% FTE. He is requesting 1 mo summer salary support for Year 1 and 2.

The project will have one post-doc, Martha Raynolds. She has organized all the previous expeditions of the Alaska Geobotany Center to the Canadian High Arctic. She has over 26 years of Arctic experience in Alaska, Canada and Russia. She will coordinate and organize the expedition and act as data manager for the data collected. Her academic year salary is covered by a UAF Fellowships through 2008. She is requesting 3 mo salary in Years 1 and 2.

The technical staff at UAF includes Edie Barbour who will develop the web-site for the project. We are requesting 1 mo support for Edie Barbour in Years 1 and 2.

Salaries have an annual inflation rate of 4.5% for senior personnel and 3% for staff.

Permanent equipment: None

Travel: Travel funds are requested for the two UAF personnel to travel to Inuvik in 2010 to begin the expedition. Two round trips to Inuvik are requested @ $3000 each to include air fare and 2 days per diem and hotels in Inuvik. We also request funds to get 10 non-UAF participants in the High Arctic observatory expedition to Inuvik. 10 round trip trips to Inuvik are budgeted @ $3000 each to include air fare and 2 days per diem and hotels in Inuvik. Funds are budgeted for Walker to travel to the Vancouver workshop. One round trip to Vancouver is budgeted @ $3000 to include airfare and four days per diem and lodging.

Participant support costs:

Participant support is requested to support 8 non-UAF international participants at an Extreme High Arctic Observatory Workshop in Vancouver, Canada. Eight round trips to Vancouver are budgeted at an average cost of $3000/RT including 4 days per diem.

Contractual services:

Printing. $3000 is budgeted in Year 2 for reproduction of the white paper.

Publications and communications. $500 is budgeted in Year 1 and 2 for communication related to the expedition including permitting paper work and copies related to production of the white paper.

Commodities:

Project supplies. $3000 is budgeted for miscellaneous items including camping gear and supplies for the expedition.

Indirect costs. Facilities and Administrative (F&A) Costs are negotiated with the Office of Naval Research. The predetermined rate for sponsored research is 45.1% of the Modified Total Direct Costs (MTDC). MTDC includes Total Direct Costs minus tuition, scholarships, subaward amounts over $25,000, and equipment.

CH2MHill Polar Services (CPS): The cost of supporting the High Arctic field camps at Green Cabin, Mould Bay, and Isachsen are included in an attached letter and budget from CPS with a preliminary estimate of $75,499. This covers the cost of establishing a 20-person camp Green

Cabin, Mould Bay, and Isachsen for 6 days plus one day of contingency weather support. The cost includes 2 Twin Otter Inuvik-Isachsen RT flights and 7 days of rental for the aircraft. The cost includes camp support (satellite phone, kerosene heater, tables, water filter, and field toilet), and food for 20 people for 7 days. We have contacted the Canadian Polar Shelf Program and they have shown considerable interest in helping to support this project, but cannot commit funds prior to the U.S. doing so. Marty Bergman in an email dated 15 Sep said, "It is entirely possible that a research project is submitted to PCSP this fall that requests such support and from my perspective that would be the official trigger for me to get involved. I certainly encourage Canadian scientists to also submit a proposal to PCSP that complements the work you propose here." If this proposal is funded we will work with CPSP to encourage Canada to support half the aircraft and fuel costs for this expedition.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Donald Walker

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Application of space-based technologies and models to address land-cover/land-use change problems on the Yamal Peninsula, Russia

Source of Support: NASA

Total Award Amount: $ 755,534 Total Award Period Covered: 06/01/06 - 05/31/09

Location of Project:

Person-Months Per Year Committed to the Project. Cal: 0.50 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Towards an arctic geographic network: a web based plant-to-planet scale geobotanical atlas centered on the Toolik Lake Field Station, Alaska

Source of Support: NSF

Total Award Amount: $ 819,460 Total Award Period Covered: 12/15/04 - 11/30/08

Location of Project: Alaska

Person-Months Per Year Committed to the Project. Cal: 3.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Adaptation to rapid land-use and climate changes on the Yamal Peninsula, Russia: Remote sensing and models for analyzing cumulative effects

Source of Support: NASA

Total Award Amount: $ 1,107,845 Total Award Period Covered: 06/01/09 - 05/31/13

Location of Project: Russia

Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Remote Very High Arctic Terrestrial Observatory Stations: A Reconnaissance Expedition to Isachsen, Mould Bay and Green Cabin

Source of Support: NSF - This Proposal

Total Award Amount: $ 198,526 Total Award Period Covered: 06/01/09 - 05/31/11

Location of Project:

Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

UAF Facilities, Equipment and Other Resources

The Institute of Arctic Biology and UAF

IAB and the University of Alaska have an extensive collection of high latitude climate library resources. Some of the arctic specific information is available nowhere else. Additionally, what is not available locally, such as more exotic interdisciplinary materials, can be obtained efficiently using the electronic document delivery services covering both stocked and unstocked journals. The supercomputer facility is already used extensively by other people in the GOA project doing data analysis and can provide resource to facilitate the use of high-resolution remote sensing data. A high-end visualization facility (including a CAVE) is available to the group at ARSC.

Alaska Geobotany Center

The mission of AGC is to explore and understand global tundra ecosystems and to foster responsible land use and conservation of these systems. The Center is dedicated to excellence in field research, teaching and making our teaching and research relevant to societal issues and concerns. Interdisciplinary geobotanical research involves the cooperation among vegetation scientists, soil scientists, hydrologists, geologists, geographers, permafrost specialists, and other involved in Earth system research. Our primary areas of interest are climate change, paleoecology, vegetation classification and analysis, geobotanical mapping, snow ecology, and disturbance ecology in northern regions. AGC is located in the Institute of Arctic Biology (IAB) at the University of Alaska Fairbanks. The facilities of the Institute include a well-staffed administrative office, and a library specializing in northern topics.

AGC's lab facilities include equipment to support vegetation and soil field research and computer equipment to support GIS and remote-sensing work. AGC's current computing resources include a total of 14 GIS workstations, personal workstations, portable notebook computers, file servers and web servers. The AGC maintains a full complement of high-end software and peripheral devices to support our GIS and remote-sensing environment, allowing us to perform advanced GIS analysis, image processing and graphic layout on the Unix, Macintosh and Intel platforms. The major software packages currently used at AGC include ARC/Info Workstation, ArcView and ArcGIS (Environmental Research Systems, Inc.) for geographic information system analysis and cartographic design, ENVI (Research Systems, Inc.) and Land Analysis System (USGS) for manipulation and analysis of multi-spectral remote sensing data, Photoshop (Adobe Systems, Inc.) for editing graphic images and Studio MX (Macromedia, Inc.) for website development and graphic production.

Fisheries and Oceans

Pêches et Océans

Pacific Region

September 21, 2008
Dear Professor Walker:

Subject: ***Proposed Arctic terrestrial observatory in the cold extreme corner of Arctic North America (Canadian Arctic Archipelago)***

I strongly (!) support your proposal to establish an Arctic terrestrial observatory based on cross-gradient sites (Isachsen, Mould Bay and Green Cabin. The Arctic has undergone and is facing extraordinary change associated with climate variability, yet even our baseline knowledge of this large and sensitive domain is so scant as to hamper if not prohibit accurate evaluation of neither rates of change not key processes involved in change. Clearly, this work is urgently needed.

I am not a terrestrial ecologist, so I will not dwell further on this topic (I will assume that experts in the field will make this case undeniably clear). Instead, let me stress that for well over a decade I have been proposing – year after year – a mirror effort in the Canadian Arctic Archipelago. It is absolutely critical that we understand the impact of climate forcing on the waters, ice and biota of this complex seaway. It is only due to the funding from International Polar Year that we have been able to establish an oceanographic transect linking the eastern and western Arctic via the 'practical' Northwest Passage (see attached). But we have not yet been able to fully establish the latitudinal (South to North) component, and this is arguably the critical missing piece. I thus see clear and important synergy between your efforts and ours; together we would have a terrestrial/marine transect that would allow us to ask an even bigger question: "*How will terrestrial systems (soil, vegetation, birds) respond to more and more open water and coupling to the land/sea ecosystems?"*

I also think, that marine support by icebreakers, combined with the proven facilities of the Polar Continental Shelf Project, will allow you to make substantial savings in logistics. Especially today, any collaboration that cut fuel and travel costs, while expanding the scientific value of the work, cannot be over-stressed.

I close by saying that (again) I am not a terrestrial ecologist, but I have heard many complementary things about you from your peers, based on your long years of work, and have found my conversations with you most stimulating. I have no doubts of your ability to plan and lead this critically needed effort.

Sincerely yours,

Eddy Carmack
Senior Scientist
Institute Of Ocean Sciences
Fisheries and Oceans Canada
Eddy.Carmack@dfo-mpo.gc.ca

WESTFÄLISCHE
WILHELMS-UNIVERSITÄT

Institut für Ökologie der Pflanzen
Prof. Dr. F.J.A. Daniëls

Institut für Ökologie der Pflanzen Hindenburgplatz 55 D-48143 Münster

Prof. Dr. D.A. Walker
Alaska Geobotany Center
PO Box 757000
Fairbanks
Alaska 99775-7000
United States of America

Münster, 12-09-2008

Dear Skip,

This letter intends to express my enthusiasm and support for your NSF Arctic Observatory Network proposal (AON) and I am very eager to participate in the project by conducting the suggested observations and writing the white paper at the end of the expedition. The polar desert subzone and its adjacent subzones are still poorly investigated albeit probably they represent the most vulnerable ecosystems in regards to global warming. The importance of the proposed project is such evident that it does not need further argumentation.
I am looking forward to continue our pleasant and successful long-term collaboration in the project.

With very best wishes

Fred J.A. Daniëls
Tel.: ++49 251 8323835 /30 Telefax: ++49 251 8321705 e-mail: Daniels@uni-muenster.de

UNIVERSITY OF ALASKA FAIRBANKS
INSTITUTE OF ARCTIC BIOLOGY
P.O. Box 757000
Fairbanks, Alaska 99775-7000 U.S.A.

907 474-7640
FAX 907 474-6967

September 18, 2008

Dr. Skip Walker
Institute of Arctic Biology
University of Alaska Fairbanks
Fairbanks, AK 99775

Dear Skip:

Thank you for inviting me to participate in your trip to the Canadian Arctic to examine the feasibility of sites at Isaachsen and Mould Bay as components of a North American Arctic Transect (NAAT) and a pan-Arctic observing network. I will be happy to join you on this expedition. I support this research, because satellite observatories will be an important complement to the main group of Flagship Observatories with whom I am working through my current NSF Arctic Observatory Network grant. The Toolik Field Station agrees to act as the southern anchor point for the NAAT to help with logistics and science where needed. This would be a synergistic activity because the NAAT will enhance the Toolik Lake research capabilities. Researchers from Toolik would be encouraged to take advantage of the climate, permafrost, active layer, soil, invertebrate, and vegetation information that you are collecting from the NAAT sites and to participate in field research at these sites. The transect will also offer a variety of educational opportunities that could be centered at Toolik. We can accommodate your needs for lab space and facilities at Toolik for your measurements, if this proposal is funded.

Your plan to focus on the spatial and temporal variation in circumpolar biomass will enhance efforts to synthesize and scale the observations of carbon, water, and energy fluxes that we are making as part of our network of flagship observatories in Alaska, Russia, Sweden, and Greenland to the pan-Arctic scale, and will complement our on-going studies of vegetation and C flux. The vegetation measurements will also complement and add to the baseline environmental data that we are collecting for the Toolik region.

Your proposed measurements are also complementary to my on-going process-level studies of shrub dynamics in northern Alaska. My mechanistic studies of the role of snow in shrub expansion will provide data that may help you interpret your broader scale patterns, and I am happy to discuss our findings with you and make data available when that is useful. I am also interested in the biomass protocol workshop you have proposed and would like to participate in this effort, and I look forward to participating in the expedition and in clip harvests.

Sincerely,
Dr. M. Syndonia Bret-Harte
Associate Science Director, Toolik Field Station
Research Assistant Professor
Institute of Arctic Biology
University of Alaska
Fairbanks, AK 99775

UNIVERSITY of VIRGINIA

ENVIRONMENTAL SCIENCES

To advance understanding of the environment through interdiscipl scientific research and education.

September 12, 2008

Dear Dr. Walker (Skip),

I am extremely pleased to collaborate on your proposal to the National Science Foundation for a reconnaissance of potential High Arctic sites for the Arctic Observatory Network (AON). I am in strong support of the inclusion of High Arctic and polar desert locations within the proposed AON. I have been to Isachsen once and to Mould Bay twice, and they both have excellent potential for becoming long-term monitoring locations. I'm in favor of examining the infrastructure that already exists at each of these sites to determine their utility. Isachsen and Mould Bay represent Subzone A and Subzone B tundra, respectively; they are very different ecosystems in terms of their plant community composition (Isachsen is absent of woody plants, for example) and in terms of their land surface features. The examination of both locations is a worthwhile endeavor.

I plan on participating in the reconnaissance and will also take a comprehensive set of soil carbon dioxide efflux measurements during our stay at the sites. These are measurements that I would like to have taken on my prior visits to these sites, but did not have the equipment at the time. These measurements could easily be repeated during subsequent site visits and would provide us with a picture of High Arctic soil respiration, a rather important component of the arctic carbon budget.

Again, you have my full support for this project and good luck with the proposal.

Sincerely,

Howard E. Epstein
Associate Professor
Department of Environmental Sciences
University of Virginia
Charlottesville, VA 22904-4123
434-924-4308

Clark Hall • 291 McCormick Road
P.O. Box 400123 • Charlottesville, VA 22904-4123
434-924-7761 • Fax: 434-982-2137

September 8, 2008

Donald A. Walker, Ph.D, Professor
Department of Biology and Wildlife
Director, Alaska Geobotany Center, http://www.geobotany.uaf.edu/
Institute of Arctic Biology, University of Alaska Fairbanks
PO Box 757000
Fairbanks, Alaska 99775-7000

Dear Skip,

In my capacity as Chair of the Circumpolar Biodiversity Monitoring Program (CBMP), I am writing to you to express my strong support and willingness to participate in the work outlined in your NSF proposal entitled: **Remote Very High Arctic Terrestrial Observatory Stations: A reconnaissance expedition to Isachsen, Mould Bay and Green Cabin.**

With over 60 global partners to date, the CBMP is an international network of scientists and conservation experts working together to harmonize and enhance monitoring efforts across the Arctic in order to improve our ability to detect, understand and report on significant trends and pressures. Much of the CBMP's work involves developing integrated, long-term pan-Arctic monitoring plans involving the development of optimal sampling schemes and standardized sampling methods. The proposed project will provide a fundamentally important contribution to the CBMP's work as it will not only establish a much needed monitoring program in an imperiled region of the Arctic, but will serve as a standardized monitoring model for adoption throughout the Arctic.

Arctic Terrestrial vegetation monitoring of this nature has been repeatedly identified as a priority activity at a number of CBMP Expert Monitoring Group workshops (e.g. Anchorage – November 2006; Washington, DC – March 2008). The proposed project will fill a critical need officially identified in the CBMP Five Year Implementation Plan which was endorsed by all Arctic Council Senior Arctic Officials. The CBMP's work will be advanced and directly benefit from the results of this project.

The CBMP will be directly involved and contribute to this project as it will be a member on the reconnaissance expedition exploring opportunities for linkages between this program and broader North American and pan-Arctic monitoring initiatives. I will also as a member of the International Tundra Experiment determine how ITEX could be effectively integrated into future monitoring efforts.

Please accept this letter as confirmation of the Circumpolar Biodiversity Monitoring Program's strong support for and direct involvement in your proposal.

Sincerely,

Mike Gill
Chair, Circumpolar Biodiversity Monitoring Program
Environment Canada
91780 Alaska Highway, Whitehorse, Yukon, Canada Y1A 5B7

UNIVERSITY OF DELAWARE

DEPARTMENT OF GEOGRAPHY

University of Delaware
Newark, Delaware, 19716-2541
Ph: 302/831-2294/2295
Fax: 302/831-6654

September 18, 2008

Dr. Donald A. Walker
Director, Alaska Geobotany Center
Institute of Arctic Biology
University of Alaska
Fairbanks, AK 99775-7000

Dear Skip:

I write to express my enthusiastic support for your proposed Arctic Observatory Network project entitled *Remote Very High Arctic Terrestrial Observatory Stations: A reconnaissance expedition to Isachsen, Mould Bay and Green Cabin*. I would be very pleased to participate in the fieldwork you propose for 2009 or 2010, and to contribute to the white paper you anticipate coming out of these activities.

As your proposal states, the area to be visited is highly unusual. It is also vulnerable to profound environmental change, owing to the rapid retreat of formerly proximal sea ice in the Arctic Ocean. Moreover, the region is understudied with respect to most permafrost-related parameters, particularly the dynamics of the active layer.

Your proposal addresses a geographical gap in the Circumpolar Active Layer Monitoring (CALM) program. Your proposed activities would provide a much-needed opportunity to create a baseline data set, collected according to a modified form of the established CALM protocol. This is an effective path, and will provide documentation of changes as we enter what appears to be a period of rapid change.

On behalf of CALM, I wish you every success with your proposed research.

Yours sincerely,

Frederick E. Nelson
Professor

September 23, 2008

Dr. Donald A. Walker,
Professor, Institute of Arctic Biology
University of Alaska Fairbanks
Fairbanks, Alaska 99775-7000

Dear Skip:

The Thermal State of Permafrost Project (IPY #50,and EoI 1004. VER) strongly endorses and agrees to collaborate with your IPY proposal entitled **"Remote Very High Arctic Terrestrial Observatory Stations: A reconnaissance expedition to Isachsen, Mould Bay and Green Cabin"** . Your proposed reconnaissance is directed at revitalizing the stations in the western part of the Canadian High Arctic, which is a critical gap in the network of TSP observatories. The proposal also aims at collaborative interdisciplinary research and a unified scientific basis for evaluating changes at these sites over a long period. Its international character, use of standardized methods, and geographic scope are in the spirit of the International Polar Year and guarantee the project's success and influence. Your proposal will provide additional sites for the permafrost observatory network that includes active layer measurements (CALM) and permafrost temperatures (TSP); including the High Arctic sites at Isachsen, Mould Bay, and Green Cabin. The data will help explain recent change in active layer thickness and permafrost temperatures for Northwestern North America and serve as a long-term baseline against which to interpret future changes.

TSP activities collectively involve well over instrumented 500 sites with participants from over 20 countries in both Hemispheres. Your high-latitude North American transect and circumpolar approach will contribute sites and data sets to the International Network of Permafrost Observatories (INPO). The GOA is included in the IPY-IPA coordinated program as a cooperating project. In addition, many aspects of the proposal directly compliment and supplement the objectives of the three Northern Hemisphere permafrost programs approved by the IPY Joint Committee: (Thermal –TSP #50; Coastal-ACCO-Net #90; Carbon CAPP #373).

It is particularly noteworthy that our permafrost project (VER) will have access to the sites at Isachsen and Mould Bay for the installation of temperature cables in boreholes at the northern end of the Arctic climate gradient. Your planned approach involving the Canadian IPY projects and PCSP will help to insure continuity of measurements after the conclusion of your project.

I extend my best wishes to you for this important project. Please let us know how TSP-INPO can assist with its development.

Yours sincerely,

V. Romanovsky

Vladimir E. Romanovsky, Professor
Principal Investigator, TSP
University of Alaska

NCAR

National Center for
Atmospheric Research

Earth Observing Laboratory (EOL)

PO Box 3000, Boulder, CO 80307 USA
Phone: 303 497.8853 Fax: 303 497.8770
www.eol.ucar.edu

September 22, 2008

Donald A. Walker, Ph.D. Professor
Department of Biology and Wildlife
Institute of Arctic Biology, University of Alaska Fairbanks
PO Box 757000
Fairbanks, Alaska 99775-7000

Dear Skip:

The purpose of this letter is to confirm the willingness of the Cooperative Arctic Data and Information System (CADIS) to support your proposal related to High Arctic Observing Stations as part of the Arctic Observing Network. The Arctic Observing Network Solicitation #NSF08-579 notes a requirement for PIs to provide a letter from the data repository describing the commitment to receive, archive, and distribute data as part of AON.

CADIS is supported by NSF to develop a data management system for AON. NSIDC and NCAR and UCAR are collaborating on building CADIS to serve AON investigators and data users. We would be most interested in assisting with the cataloging, archival and distribution of your AON related field observations data using tools and techniques now available through CADIS and in coordination with other archive centers such as Geographic Information Network of Alaska (GINA).

Please understand that you will be required to prepare and submit a metadata profile in the CADIS system as a first step in integrating your data into CADIS. You can find additional details at the CADIS website at the following url:
http://www.eol.ucar.edu/projects/aon-cadis/

I wish you the best of luck in obtaining support from the National Science Foundation for your work in AON and we look forward to working with you.

Sincerely,

[signature]

James Moore
CADIS Project Principal Investigator
NCAR Earth Observing Laboratory

EOL Deployment Development Data Services

EOL provides state of the art Deployment, Development and Data Services to the earth and atmospheric research communities.

The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation

PFS is a member of the
CH2M HILL Polar Services (CPS) team

Thursday, September 25, 2008

Dr. Donald Walker
Institute of Arctic Biology
University of Alaska, Fairbanks

Dear Skip -

Thanks for contacting us for a budget estimate and scope for CPS (formerly VPR) support of your proposal submission to the Arctic Observing Network solicitation (08-579). Based on the field plan you have provided us, we believe your project is logistically supportable within the caveats of the attached order of magnitude estimate.

If your proposal is awarded and we are asked to support you, we looking forward to working with you and NSF to refine your field plan and the attached estimate.

Best of luck in your proposal process,

Diana Garcia-Lavigne

Diana Garcia-Lavigne
CPS Science Planning Manager
Polar Field Services, Inc.
720.320.6156

8110 Shaffer Parkway, Suite 150
Littleton, CO 80127

Budget Estimate
CPS Price

CH2MHILL Polar Services

Project: Walker AON 08-579

Scope of planned work and logistics support summary :

The PIs plan a reconnaissance trip to Mould Bay and Isachsen to study the most extreme Arctic vegetation areas. This joint US - Canadian trip will visit sites established from 2003-2005 [North American Arctic transect (NAAT)] to determine the wisdom and feasibility of continuing studies along the transect, and to make recommendations regarding possible options for doing this.

A team of 14 researchers would use chartered twin otters in an approx.1 week campaign to access sites at Green Cabin, Mould Bay, and Isachsen. Overnights are planned at each location, with a CPS-staffed main camp basing at Mould Bay for the duration.

CPS support would include coordination of fixed wing charters, hiring a cook, and provision of camping gear, safety gear, and consumables for a team of 20.

Assumptions, risks, constraints, and other factors contributing to the budget estimate:

- The proposed research team includes several Canadian participants. The investigators are seeking joint funding of the expedition but details have not been confirmed. All costs for the field expedition are therefore included in the below CPS estimate and in Dr. Walker's direct to grant budget.
-The proposed research occurs in the final year of the NSF's fixed wing agreement with Ken Borek Air. This estimate is based on these rates, plus a possible fuel surcharge and GST (tax). Flight costs based on 5 flight days and 2 down days + one Twin Otter fueling flight to Mould Bay. KBA costs are included here to provide an overall picture of the project's cost. In reality, these costs are paid directly by NSF.
- The researchers will budget directly for all Inuvik costs including lodging and the purchase of camp fuel.
- Researchers are responsible for all customs clearance issues and permits to operate in Canada and within national park areas.
- Costs based on 20 participants - 14 research, 1 bear guide/support, 1 cook, 4 pilot/copilot.

Budget Estimate:

The below is an estimate of the CPS price for support of this project. The numbers include all indirect costs.

CPS 2010 Budget - 2/1/10 to 1/31/11

Canada	air support, fixed wing	KBA: days	14	days	$3,099	$43,386
Canada	air support, fixed wing	KBA: fuel surcharge / GST	1	lot	$6,000	$6,000
Canada	air support, fixed wing	KBA: hours	56	hours	$290	$16,240
Canada	equipment, camping	2 ea large western shelters, mtn tents, camp gear	1	lot	$0	$0
Canada	labor, field (RTX)		1	lot	$6,572	$6,572
Canada	safety gear	remote med kist/service, sat phones, bear fence	1	lot	$0	$0
Canada	subsistence	20 people for 1 week	140	days	$24	$3,301
			Subtotal:			**$75,499**
			Overall Total:			**$75,499**