NASA Science Mission Directorate
Research Opportunities in Space and Earth Sciences – 2012
NNH12ZDA001N
A.4 Terrestrial Ecology

The National Aeronautics and Space Administration (NASA) solicited proposals for Terrestrial Ecology investigations within the NASA Earth Science Program. The following types of research investigations were requested:

- Data set development in support of arctic-boreal ecosystem vulnerability research to be conducted in a future Terrestrial Ecology Program-sponsored field campaign.
- Data set development to meet five top-priority needs of the NASA terrestrial ecological community.
- Successor studies in the areas of remote sensing science and remote sensing methods development that offer to significantly advance the results of prior NASA Terrestrial Ecology research.

A total of 87 Step-1 proposals was received, and 29 proposals were encouraged for a Step-2 proposal submission. A total of 30 Step-2 proposals was received and 12 have been selected for funding. The total funding to be provided for these investigations is approximately $5.2 million over three years. The investigations selected are listed below. The Principal Investigator, institution, investigation title, and a project summary are provided. Co-investigators are not listed here.

Mark Carroll/Goddard Space Flight Center
Determining the Extent and Dynamics of Surface Water for the ABoVE Field Campaign

The proposed Arctic and Boreal Vulnerability Experiment (ABoVE) will conduct multi-disciplinary studies to explore and quantify the linkages between all of the individual components of the ecosystem. One common thread identified in the final report for the scoping study for ABoVE is the need for maps of the location, extent and dynamics of surface water to connect the different disciplines. Water represents a transport vehicle for nutrients and other solutes, provides habitat for flora and fauna, and has a controlling effect on surface energy exchange yet it remains one of the least characterized features of the study region.

Key questions identified in the scoping study for the campaign require knowledge of the surface and sub-surface hydrology. Changes in permafrost can both contribute to and be affected by changes in surface hydrology. Small, shallow lakes and ponds provide habitat for migratory animals. At the landscape scale the multitude of small lakes together represent a significant variable in the energy balance of the region that is largely unaccounted for.

We propose to utilize a time series of Landsat data to produce maps of surface water extent covering the entire Boreal and Tundra regions of North America for three epochs 1991, 2001, 2011 at 30m spatial resolution. Each of the maps will be generated with at

least 3 years of ice free data and will enable future work for the ABoVE campaign in determining the dynamic changes in small water bodies that dominate the region. Data will be provided in vector format with attributes to include: minimum, maximum and average size; date of last detected ice; and number of ice free days. For the 2001 and 2011 epochs MODIS data will be used to clarify the ice free period where appropriate. This is a data generation project in support of ABoVE and can be completed in 2 years.

Louise Chini/University of Maryland, College Park
Using NASA Remote Sensing Data to Reduce Uncertainty of Land-Use Transitions in Global Carbon-Climate Models

In preparation for the 5th IPCC Assessment almost all Earth System Models (ESMs) have recently incorporated new gridded products of land-use and land-use change that have been harmonized to ensure a continuous transition from the historical to the future data in a consistent format for all models. These Land-Use Harmonization (LUH) data products have now been widely adopted by the ESM community. However, the LUH land-use transitions are estimates, constrained with data where available, and with modeling assumptions, and the remaining challenge is to quantify, and reduce, the uncertainty in these products. At the same time, satellite remote sensing of the terrestrial biosphere has also evolved. Global-scale land cover extent and change monitoring is now possible given systematically acquired earth observation data sets, advanced characterization algorithms and data intensive computing capabilities. With the availability of these products, and our team's prior experience generating land-use transitions for global climate modeling, we have a unique opportunity to address the following key science questions: (1) How can satellite remote sensing products be used to generate new gridded maps of land-use transitions for use in coupled carbon-climate simulations? (2) How can satellite remote sensing products be used to characterize uncertainty in these new maps of global land-use transitions? We will address these questions via two main objectives: (1) We will use NASA remote sensing data to generate maps of global forest extent and change (GFEC) which we will then use as an additional constraint in our LUH process to produce an entirely new generation of land-use transitions that are organized in a format that has been widely adopted by climate models. (2) We will characterize the inherent uncertainty in the remote-sensing-based maps of GFEC from Objective 1 and then propagate this uncertainty through our LUH process via a large ensemble of simulations that will enable us to characterize, for the first time, the uncertainty in the LUH land-use transitions themselves. This proposal is responsive to the NASA Terrestrial Ecology request for "data set development to meet priority needs of the NASA terrestrial ecological community", particularly the request for "global gridded data on land-cover, land-use, land-use transitions, and land-cover changes (past, present, future)". The wide-spread adoption of our current LUH datasets by the climate modeling community will ensure that these new land-use transition datasets are rapidly employed in a new generation of ESM simulations that are based on, and consistent with, observations of actual forest cover change.

Niall Hanan/South Dakota State University
Partitioning Savanna Tree and Grass LAI and fPAR from MODIS and VIIRS Aggregates: Methods, Validation and Applications

Mixed tree-grass and shrub-grass vegetation associations are one of the most spatially extensive and widely distributed forms of terrestrial vegetation on earth. They constitute significant fractions of all continents, except Antarctica, in tropical, subtropical and temperate bioclimatic regions. While global tree-grass systems are diverse in their phylogeny, physiology and plant morphology, they share the key structural characteristic of woody plants distributed in the landscape at densities low enough to allow significant growth of herbaceous plants (mostly grasses) underneath and between them.

Despite the importance of tree-grass systems in earth system processes and human well-being, they are not well represented in our remote sensing and modeling capabilities. Ecosystems characterized by horizontally and vertically complex tree-grass mixtures are inherently difficult to measure with remote sensing and difficult to represent in ecosystem and earth system models. We contend in this proposal, however, that emerging data on slowly varying canopy structure (tree cover) provides us with a key constraint in the estimation of rapidly (i.e. seasonally) varying tree and grass leaf area index (LAI) and fractional PAR interception (fPAR). This tree-grass separation in remote sensing data has not, to our knowledge, been attempted before at regional and continental scales using MODIS data.

We propose to capitalize on prior TE-sponsored research to develop and test a tree-grass separation methodology, validated using field data, and applied for Africa during the MODIS (2002-2012) era. We anticipate that the methodology thus developed will later be used to also partition VIIRS LAI and fPAR aggregates. These tree and grass biophysical parameters will be of direct use as a validation and data-assimilation stream for our savanna dynamic vegetation model (the Tree-Grass Vegetation Model, TGVM). TGVM models explicitly the growth and demographics of trees and grasses in response to climate, disturbance and management. The new tree-grass biophysical datasets will advance the testing and application of TGVM in both diagnostic and prognostic modes to explore how tree-grass systems are responding to human management and climate change.

This project will (i) refine methodologies for separation of tree and grass LAI and fPAR biophysical parameters using MODIS products for all Africa, (ii) validate results using field measurements from our own and collaborator field sites across Africa, (iii) generate and distribute Africa-wide tree-grass component biophysical parameters for 2002-2012, at 8-day and 1 km resolutions, (iv) analyze and synthesize the new LAI and fPAR products for publication, and (v) use the tree-grass data with our tree-grass vegetation model (TGVM) to transform our understanding of, and ability to simulate, the future provision of ecosystem goods and services in tree-grass systems.

Over the past two decades NASA has made considerable investment in development and deployment of the MODIS platform and MODIS data products. This â"successor"

proposal seeks to leverage that investment using the LAI-fPAR product to diagnose and better understand the separate and distinct role of woody and herbaceous components in mixed tree-grass ecosystems.

Marco Lavalle/Jet Propulsion Laboratory
Extracting Structural and Temporal Parameters of Forests from Repeat-Pass Pol-InSAR Data

The overall goal of this proposal is to establish a standard method for extracting canopy height and structure from remote sensing data collected by forthcoming radar missions, including ALOS-2 and DESDynI. We aim at providing the ecosystem science community with a robust algorithm that helps to monitor ecosystems and ecosystem changes at regional and global scales using radar technology. To meet this goal, we propose to further test and improve an already-demonstrated remote sensing technique, namely repeat-pass polarimetric interferometric SAR (Pol-InSAR).

The success of Pol-InSAR in monitoring forests using repeat-pass radar data is predicated on understanding temporal decorrelation and having robust algorithms that compensate for its effects. Our key idea is to incorporate a physical model of temporal decorrelation into models of volumetric decorrelation in order to correctly compensate for dynamic changes that occur in forest canopies when forest parameters are estimated. We have already developed a novel method based on this idea and published results of height inversion using JPL/UAVSAR radar data.

Here, we propose to (1) test our method on tropical forests and mountainous terrain with UAVSAR and PALSAR-2 data; (2) extend the method and the model to temporal decorrelation caused by dielectric variations; and (3) quantify the error on the estimated canopy height and canopy structure associated with the violation of the underlying model assumptions and with the limitations of the inversion algorithm.

This proposal directly addresses the Terrestrial Ecology element of the ROSES 2012 NRA. The outcome of our research is of major relevance to terrestrial ecology applications using remote sensing. The tasks that we propose will help to quantify vegetation biomass and its variations over time, monitor the temporal perturbation of forested landscapes on short and long temporal scales and, ultimately, understand the global carbon budget and climate change.

Tatiana Loboda/University of Maryland, College Park
Long-Term Multi-Sensor Record of Fire Disturbances in High Northern Latitudes

The greatest rise in global temperature is occurring in High Northern Latitudes (HNL) above 60Â°N and this recent warming trend is projected to continue. Wildfire is the main disturbance agent in this ecosystem and a major emerging issue identified by the North Slope Science Initiative. Although much research has been done in the forested areas of HNL in the recent decade, little is still known about fire patterns in transitional forest/tundra ecotone and tundra ecosystems.

The proposed project falls under all three types of proposals solicited under the current Terrestrial Ecology (TE) call. First and foremost, the proposed work will develop a consistent data set in support of the planned NASA arctic-boreal ecosystems vulnerability experiment (ABOVE) field campaign. Within this project we will develop and implement a new approach to produce moderate resolution (30m) records of fire disturbances guided by coarse resolution datasets. We will use active fire detections and burned area products from a succession of coarse resolution sensors, including Advanced Very High Resolution Radiometer (AVHRR), Moderate Resolution Imaging Spectroradiometer (MODIS), and Visible Infrared Imager Radiometer Suite (VIIRS), to guide the selection and archival of clear surface Landsat images in order to produce moderate resolution fire perimeter and fire impact characterization maps across HNL. Within this project we will provide the first formal assessment of VIIRS and the Landsat Data Continuity Mission (LDCM) capabilities for fire detection and mapping burned areas in HNL thus establishing the continuation of fire mapping in HNL using a consistent algorithm into the future.

The proposed project will also take advantage of the opportunities offered by Synthetic Aperture Radar (SAR) sensors to characterize burns in HNL. Past research in boreal forests and current evaluation in Alaskan tundra shows that SAR data can be used successfully to map burned area perimeters and distinguish burned and unburned areas within the perimeter over a longer period of time than optical sensors. However, it is presently unclear whether SAR data can provide complimentary burn severity information to the metrics extracted from optical and thermal data. We will use our field-collected observations of burn severity in tundra fires, obtained under the previously funded NASA TE project, to compare the capabilities offered by SAR (ERS, Envisat and Radarsat-2) and optical data (Landsat) in characterizing burn severity.

The proposed project will also be a successor study in the areas of remote sensing science solicited as the third type of proposal under the current call. This project will present a continuation of the currently funded NASA TE project #NNX10AF41G (PI - French) aimed at investigating fire impacts on North American tundra. We will build on our previous findings and developed methods for coarse resolution burned area mapping in HNL by extending them to include both a consistent moderate resolution data record and burn severity characterization. Moreover, we will continue the development of remotely-sensed metrics for fire impact characterization using the field data we collected under the currently funded project.

Finally, the resultant dataset and associated in situ data will present a reference/validation dataset for use in evaluation of coarse resolution Essential Climate Variables (specifically fire disturbances) included under the second type of projects solicited within this TE call.

We will develop and test the algorithm over North American HNL during year 1. In year 2 we will finalize the algorithm and implement it over North American HNL between 1984 and 2015 and scope out the feasibility of extending the mapping method to complete the circumpolar coverage into Northern Eurasia. In year 3 we will extend the mapping activity to cover Northern Eurasia.

J William Munger/Harvard University

Development of a Data-Assimilation Framework for Integrating 25 Years of Surface and Airborne observations to asses patterns of net CO2 Exchange from Arctic Ecosystems

Arctic ecosystems store a large mass of organic carbon that could be released to the atmosphere as CO2 or CH4 if warming temperatures degrade the permafrost and drain the wetlands that have kept this carbon stable. The Arctic is too large and too variable for a network of individual site observations to define indication of regional environmental change. In order to detect region-wide changes in arctic ecosystems that could indicate destabilization of the accumulated carbon, an observational framework is needed that combines remote sensing measurements that detect vegetation and land surface changes, an ecosystem modeling framework for biogenic greenhouse gases, and atmospheric CO2 and CH4 concentration measurements that integrate the atmosphere-biosphere exchange of these gases across the region.

We propose to develop this data integration framework and test it using existing data sets that have been acquired over the past 25 years. We will evaluate the accuracy of individual elements in the framework, assess uncertainties in the outputs, and provide a foundation for developing future observational strategies. Key elements of the work are collation and harmonization of existing data, development of a modeling framework to assimilate multiple data streams, testing the ability to determine regional CO2 and CH4 fluxes and to evaluate uncertainties. Key outcomes include assessment of our ability to change detect changes of CO2 and CH4 regional fluxes in the past 25 years, and a framework for early detection of carbon destabilization in the future.

The proposed work is directly relevant to the goals in NNH12ZDA001N by demonstrating a dataâ€”model framework that integrates and synthesizes geospatial observations from airborne and orbiting sensors with information obtained from in situ atmospheric measurements and ecological field studies. Our proposed work adds value to previous NASA-supported field campaigns by re-evaluating previous data with new analytical tools and harmonizing data collected over the past 25 years to look for evidence of change in ecosystem functioning.

The data sets we will use include:

long-term measurements at ground stations of meteorology, environmental parameters (sunlight, aerosols), atmospheric trace gases, and ecosystem fluxes (NOAA; LTER, AmeriFlux)

long term data for ground temperatures and active layer depths (CALM network, borehole network [http://www.gwu.edu/~calm/])

land surface remote sensing data from LandSat using the new Google Earth Engine and the Global Land Cover Facility (www.landcover.org, "GLCF"), MODIS, and other compiled data versions

atmospheric concentration surveys from aircraft (ABLE3A, 1988; CARVE, 2011-2014; ARCTAS 2008; NOAA vertical profiles)

Jon Pelletier/University of Arizona
Development of a High-Resolution Global Soil Depth Dataset

Soil depth information is crucial for quantifying the soil moisture dynamics that strongly affect terrestrial ecosystems and carbon/water/energy cycles, but such information is not available globally at present. Regional modeling has shown the climate system behavior to be sensitive to soil depth, hence in order for Earth System Models to properly model subsurface water storage and ecosystem functioning, improved estimates of the depth of soil above bedrock globally are needed. We propose to combine global 30 m topography data with geomorphic models, calibrated with available high-resolution soil-depth datasets for the United States and validated against available high-resolution soil depth datasets for Europe, to develop a high-resolution (30 arc-second/pixel, i.e. approximately 1 km/pixel) soil depth dataset for the world. We will also evaluate the impact of the soil depth data on the land model simulation of carbon, water, and energy fluxes at various flux tower sites over the tropics, mid- and high-latitudes in comparison with observations. The data uncertainty will be addressed from four different perspectives. This project is innovative, fusing theoretical models, remote sensing data, and field measurements, yet it is also based on techniques that have proved successful at predicting soil depth at watershed scales. As such, the project is highly likely to lead to an improved global soil depth dataset at the end of the two-year project period. This project is designed to meet one of the five top-priority goals for Terrestrial Ecology dataset development as identified by the NASA Terrestrial Ecology Program's Data Working Group and Modeling Working Group. It will use NASA satellite data in combination with available field measurements. It will help address the science-area objective "Quantify and predict changes in global land cover, biological productivity, ecosystems, and the carbon cycle" of the NASA Earth Science. We will closely coordinate our proposed data development with land modelers (including dynamic vegetation and carbon cycle), other data developers, observationalists (e.g., in flux tower measurements), and data centers (e.g., ORNL and EROS data centers) through several mechanisms. A detailed data management plan has also been developed.

Paul Siqueira/University of Massachusetts Amherst
Modeling and Evaluation of Polarimetric SAR and InSAR for Forest Structure Estimation

To date, many of the relationships between remote sensing observations and forest biophysical parameters are determined through empirical relationships. The functional forms of these relationships are created through a basic physical modeling of the remote sensing signal's interaction with the vegetated target and a comparison with measured ground validation. In this scenario, model coefficients are adjusted to better fit remote sensing observations to ground validation data with the resulting model applied to the wider area of data collected by the remote sensing instrument.
While there has been a considerable degree of success in using these approaches, a limit is now being reached where such approaches are difficult to extend beyond the region where the empirical relationships were immediately formed. As a result, the global

application of such techniques is limited and difficult to perform error analyses necessary for the formulation of spaceborne missions.
The missing component in the application of remote sensing for the characterization of vegetation structure is a frame of reference of these estimates based on physical and environmental constraints (e.g. water resources, light availability and soil type) that are inherent to ecosystems. Models that take these types of constraints into account do exist, ranging from regional, climate-type models to individual tree-based models, known as IBM's.
What has not been accomplished thus far, to a high degree of resolution, is the use of remote sensing and IBM's in a combined probabilistic model. Such a model would simulate possible trajectories of the forest environment, and, using an electromagnetic interaction model to simulate remote sensing observations. The actual remote sensing observations are then used to determine which trajectory of the ecosystem was most likely for a particular region. Once accomplished, forest properties of interest (biomass, vertical structure, species diversity, etc.) are calculated from the IBM and ecologically consistent estimates of these properties produced. By taking into account uncertainties in the IBM and observational models, with the use of Bayes' theorem, the probability density functions (pdf's) of these desired quantities can be determined, and metrics such as mean, mode and variance determined in a statistically and environmentally meaningful way. By varying the configuration of the simulation input, the model will also be used for determining the sensitivity of remote sensing observations to those parameters, and thereby serve as a method for testing observing strategies that can be used by NASA's DESDynI-R satellite mission.

Peter Thornton/Oak Ridge National Laboratory
Surface Weather Data with Uncertainty Quantification for Terrestrial Ecosystem Process Models

We propose to extend and improve an existing surface weather data product, providing essential land-atmosphere boundary conditions to terrestrial ecosystem process models. Our approach delivers a rigorous quantification of data product uncertainty that can be directly incorporated in modeling analyses. Our team recently released a first-ever surface weather dataset with 1-kilometer spatial resolution and daily temporal resolution over the conterminous United States, Mexico, and southern Canada, for a 32-year period of record (1980-2011) (http://daymet.ornl.gov). This dataset, referred to as Daymet, was originally designed to provide forcing data for land process models and continues to serve that community, particularly in support of the demanding requirements for regional and continental-scale high-resolution ecosystem simulation. In the process of generating this data product, we have identified a number of targeted extensions and improvements that would significantly advance its utility in meeting the research goals of the terrestrial ecosystem modeling community. We have identified four areas where rapid progress can be made to address specific needs for surface weather products in the land process modeling community: 1) application of current Daymet algorithms to regions in Europe, Asia, and Australia supported by existing compilations of station data; 2) targeted augmentation of current surface observation synthesis products by merging multiple existing datasets under a consistent format; 3) modification of current Daymet algorithms

to enable application in regions with low density of surface observations; and 4) expansion of existing Daymet algorithms to provide longwave radiation and sub-daily temporal resolution. The surface weather variables targeted in this proposal are precipitation (rain and snow), temperature, shortwave radiation, longwave radiation, and humidity. The current Daymet approach does not provide longwave radiation or surface winds. We propose to extend the approach to make estimations of longwave radiation, but estimations of high-resolution surface winds will remain beyond the scope of this effort. Detailed uncertainty quantification metrics are generated for the current Daymet products, and we propose to extend these metrics to include new regions, and to take advantage of new independent observational data sources. Our fundamental uncertainty quantification method uses cross-validation to estimate spatial and temporal variation in estimation bias and prediction error for precipitation, temperature, humidity, and radiation. Data service, management, and usability have been constantly in focus for the Daymet effort from its outset, and we will continue this emphasis in the proposed work. Our team has forged strong ties with the NASA-sponsored Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) for Biogeochemistry Dynamics. Our efforts will follow the best practices identified by the ORNL DAAC for data and metadata formats, dissemination and data sharing. Current Daymet products are currently indexed by the ORNL DAAC and are slated for integration with DAAC data delivery tools over the coming year. We intend to provide new Daymet data products emerging from the proposed activity as additional data resources indexed and potentially served by the DAAC.

Philip Townsend/University of Wisconsin-Madison
Ecological Spectral Information System (ESIS): Integration of Spectral Data with Measurements of Vegetation Functional Traits

Spectroscopy allows indirect measurement of vegetation physical and chemical properties, assessment of plant functional types and biodiversity, and quantification of biosphere-atmosphere gas and energy exchange. While extensive spectral libraries exist, diverse collection procedures, storage formats, and limited metadata have prevented or complicated their use in comparative studies, meta-analyses, and global-scale ecosystem models. We propose a framework to bring together pre-existing spectral libraries, build new datasets and enable more effective and wider use of spectral data. We will create an Ecological Spectral Information System (ESIS). ESIS will: (1) Augment and expand current datasets through community-provided spectral data and allow identification of critical gaps in current spectroscopic holdings and applications; (2) Establish spectral data collection standards and best practices in concert with the international community and NEON; (3) Establish metadata standards and best practices consistent with ISO 19115 and other standards accepted by the remote sensing, ecology, modeling and climate change communities; (4) Develop queryable spectral databases to hold collected spectral datasets (housed on JPL servers), available via the web, and openly accessible to the community at-large; (5) Develop linked databases of associated vegetation properties, used to interpret spectra and to scale biological, chemical and physical measurements; (6) Create accessible, open-source tools from existing source-code for users to visualize and analyze spectral data and ancillary measurements including implementation of

application programming interfaces (APIs), with rigorous QAQC and error reporting; and (7) Evaluate approaches for data inter-comparison. The ultimate objectives of ESIS are to facilitate question-based ecological and remote sensing research, and to provide the foundation for long-term, community-driven collaboration. ESIS will aid NASA in meeting key objectives by archiving, curating, and enabling effective access to data obtained through NASA funded activities (e.g. in support of AVIRIS and HyspIRI activities) and contribute to broader efforts such as NEON.

Skip Walker/University of Alaska Fairbanks
Recovery and Archiving of Key Arctic Alaska Vegetation Map and Plot Data for Long-Term Vegetation Analyses

Our long-term scientific goal is to examine the causes of this heterogeneity in more detail and model the dynamics of tundra plant communities and vegetation productivity. Towards this end, we propose to collaborate with NASA and other groups working in Arctic Alaska to assemble a coherent and consistent database that contains as much of the existing tundra vegetation information as possible for the upcoming Arctic-Boreal Vulnerability Experiment (ABoVE) (Kasischke et al. 2010). Our main contribution would be to the Arctic portion of ABoVE. We would develop ready access to the many vegetation plot and map data sets that we and others have produced for the tundra regions of northern Alaska, Canada, and Russia during the last 45 years, and to provide some guidance in the selection of research sites that would best take advantage of this heritage of research. We would, furthermore, eventually use these data and research sites to continue our arctic vegetation analyses and modeling efforts.

Tingjun Zhang/University of Colorado, Boulder
Remotely-Sensed Active Layer Thickness (ReSALT) Product Derived from InSAR Data Over North American Arctic Regions

Project Summary
Study of the active layer and permafrost is one of the four science themes of the planned NASA-sponsored field campaign of the Arctic-Boreal Vulnerability Experiment (ABoVE). Data and information on the active layer and near-surface permafrost conditions are crucial for better understanding of the terrestrial ecosystem dynamics, surface hydrologic and landscape processes, and human infrastructure in the Arctic. The International Permafrost Association's Circumarctic Active Layer Monitoring (CALM) program has conducted site-specific and grid (1 km by 1 km) measurements over the past two decades and have produced valuable data and information. However, the existing CALM network is still under-populated and does not represent the full range of climatic and physiographic variability, making them poorly suited for the planning the NASA ABoVE project. Satellite remote sensing using the Interferometric Synthetic Aperture Radar (InSAR) technique can provide data and information on regional-scale active layer thickness and permafrost ground-ice conditions across a broad climatic and physiographic spectrum. The goal of this project is to expand the Remotely-Sensed Active Layer Thickness (ReSALT) dataset from a small region near Prudhoe Bay, Alaska, to the entire North American Arctic regions across the proposed ABoVE domain.

The ReSALT data over the Prudhoe Bay, Alaska, agree well with CALM measurements with an uncertainty level of 10 cm. Specifically, we will (a) optimize the InSAR Frozen Ground Algorithm (InSAR FGA) for speed and accuracy, (b) generate ReSALT products derived from the InSAR FGA from circa 1991-2014 across the proposed study areas. The expected data products are: (a) multi-year average ReSALT, (b) time series of active layer thickness (ALT) change; and (c) ground-ice addition or melting in the top layers of permafrost. The generated ReSALT data products will essentially cover the majority of the continuous permafrost regions in North America and have a spatial resolution varying from tens of meters to hundreds of meters. Radar data will be obtained from different satellites over different periods: ERS-1/2 data for 1991-2000; Envisat data for 2002-2010; ALOS data for 2006-2011, and the Sentinel-1 data for 2013-2014. The Sentinel-1 mission is scheduled to launch in 2013. Thus, we will be able to provide ReSALT data over two decades across the study area. The ReSALT products obtained from this project will, in effect, expand the CALM network from individual sites to the regional scale. The high resolution ReSALT product can serve as validation data set for models attempting to simulate active layer and permafrost dynamics and their impacts on terrestrial ecosystems within the ABoVE domain. A ReSALT dataset would serve as an invaluable planning tool by identifying the areas with the large changes in ALT and significant losses or gains of ground ice. This would help identify the best sites to study thermokarst development, surface hydrological processes, and terrestrial ecosystem dynamics within the proposed ABoVE domain. These sites could be the focus of the proposed in situ observations, aircraft measurements, and satellite remote sensing studies. The ReSALT products meet the requirements of the NASA Terrestrial Ecology program: (a) Data set development in support of ABoVE research to be conducted in a future Terrestrial Ecology Program-sponsored field campaign, (b) Data set development to meet priority needs for the NASA terrestrial ecological community. All data products generated from this study will be achieved at the NASA National Snow and Ice Data Center DAAC and available to the Arctic research community.