Summary of Tier 2 Questions and Objectives

Question	Objectives
1. How are environmental changes in the ABR affecting natural and cultural resources, human health, and infrastructure and how are human societies responding?	(a) Correlate remote sensing data with *in situ* observations to validate the use of RS for monitoring changes in important ecosystem services. (b) Identify ecosystem services individually—are some being impacted more than others? Are some more resilient that others? Rank in order of level of impact? Are there enough data to do this? (c) Evaluate tradeoffs between ecosystem services: the changing environment, coupled with altered human activity may result in the increase in availability of some ecosystem services, while others decrease. (d) Develop and validate a regional-scale coupled model of ecosystem and social processes that can be used to assess future scenarios of change, to help inform response options, and to illustrate how different responses to change might play out over 10-30 years.
2. What are the changes in the distribution and properties of permafrost in the ABR and what is controlling those changes?	(a) Understand how landscape-scale variations in air temperature, snow cover, disturbance, surface hydrology, organic layer depth, and vegetation cover interact to control the distribution of permafrost and permafrost degradation (b) Develop a model framework that accurately projects distributions of permafrost and permafrost degradation on landscape to regional scales (c) Quantify feedbacks of observed and projected permafrost changes to local to global systems
3. How are disturbance regimes in ABR changing and what processes are controlling those changes?	(a) Quantify the spatial and temporal patterns of the primary natural disturbances in Arctic and boreal regions (fire, insects/disease, and rapid permafrost thaw); (b) Determine the most important factors controlling disturbance regimes; and (c) Understand the consequences of variations in disturbance regimes for ecosystems and landscapes.
4. How are ABR flora and fauna responding to changes in biotic and abiotic conditions, and what are the impacts on ecosystem structure and function?	(a) Identify and understand the combination of factors driving longer-term temporal and spatial changes in vegetation characteristics, including habitat quality, productivity and extent, as observed in the satellite data record. (b) Determine to what degree variations in ABR disturbance regimes are driving direct and indirect changes at both the ecosystem and landscape-scale, including successional rates and pathways within ecosystems, the age and compositional structure, and plant-animal interactions. (c) Document how changes in vegetation characteristics, surface water extent, and/or changes in faunal communities influence ecosystem processes and services, in particular net feedbacks to climate.

5. How is the magnitude and fate of soil organic carbon pools in the ABR changing, and what are the processes controlling the rates of those changes?	(a) Quantify destabilization rates of slow- to fast-turnover SOC pools in permafrost and non-permafrost profiles of the ABR, and couple these rates with mechanistically linked biogeochemical and ecological data from spatially disparate scales; (b) Assess contributions of changes in above ground biomass, microbial activity, permafrost and hydrology to SOC in a diversity of soil profiles in the ABR to aid in understanding how SOC stabilization may function in a future climate, and link these data to biogeochemical fluxes and land cover at disparate scales; and (c) Integrate empirical approaches with theoretical and process modeling efforts to improve accuracy of SOC destabilization predictions and scalability.
6. What are the changes in the distribution of surface and subsurface water storages and the amount and timing of water discharge in the ABR, what is controlling those changes, and how are they affecting ecosystem structure and function and materials export in the ABR?	(a) Quantify the storage and export of water across the ABR, investigate the processes and factors controlling the spatial and temporal patterns of surface and subsurface storage and export, understand the ramifications of the spatial temporal patterns of storage and phase (liquid/solid), and improve understanding the nature of recent changes (i.e. permafrost degradation, disturbances due to fire and land use change). (b) Quantify the impact of changes in hydrologic connectivity on ecosystem structure (i.e.species composition?) and function and dissolved and particulate materials export in the ABR.
7. How do complex interactions affect the trajectory of ecosystem structure and function in the ABR and what will be the consequences for human societies within and beyond the region?	(a) Provide opportunities for research teams to articulate the design of frameworks capable of integrating and synthesizing information on complex interactions among the dynamics of permafrost, hydrology, disturbance regimes, and ecosystem processes from ABoVE and other programs with the purposes of representing (a) how specific ecosystem services are influenced by the trajectory of ecosystem structure and function in the ABR and (b) the consequences for human societies. (b). Fund a subset of what are deemed compelling designs of conceptual frameworks that span a spectrum of ecosystem services that are considered important and feasible to address within the time span of ABoVE.