**Climate change effects on ecosystems at high latitudes and altitudes:**

**The power of experiments along natural gradients**

Climate change is rapidly altering community and ecosystem dynamics, particularly at high latitudes and altitudes such as the alpine and the arctic tundra. Many mountain and arctic areas are undergoing ‘greening’, driven by increased plant biomass and productivity. This greening trend is tied to plant community changes such as an increase in the establishment of trees and the abundance of shrubs in the tundra. Because of traits specific to many of these shrubs and trees, for instance their ability to grow taller than surrounding vegetation, the type of mycorrhizal fungi they associate with, as well as the quality of their litters, there is an increased concern that these plant community changes will dramatically alter ecosystem processes and functions. Therefore, there is also an urgent need for information about the mechanisms that govern tundra plant community responses to climate change, and for robust predictions of how this change may affect ecosystem processes and services.

In this lecture, I will first present a brief history and practice of two distinct, widespread and complementary approaches to understanding ecological responses to climate change in these ecosystems – experimental manipulation and natural gradient studies. This includes experiments that manipulate air temperature to study how community and ecosystem processes respond to global warming. Because many of these experiments have been replicated across a range of sites, and have used a similar sampling protocol, they have provided strong evidence for the role of temperature in driving the vegetation changes that are occurring across high latitudes and altitudes. Further, natural climatic gradients, such as latitudinal or elevational gradients have been used to assess how organisms, communities and ecosystem processes vary with climate. This includes research showing how temperature is an important limiting factor for tree growth at high altitudes and latitudes, and that plant community changes along climatic gradients related to elevation are tied to changes in soil microbial and nutrient patterns. I will then describe the power of using experiments along natural gradients to explore underlying mechanisms driving a pattern or a process under a range of environmental conditions.

I will present some of my research findings when using experiments along natural environmental gradients to study how communities and ecosystems are responding to climatic changes. These include findings showing (i) nutrient limitation as an important driver of plant community change along a climatic gradient in a northern Swedish mountain; (ii) the importance of biotic interactions for determining community and ecosystem properties along climate gradients, and; (iii) that reindeer grazing act in the opposite direction of climate by reducing vegetation greening and the abundance of shrubs. Finally, I will discuss what I believe are important focus areas for generating better predictions on high latitude and altitude ecosystem responses to future climatic changes. This includes improved understanding of how climate and nutrient limitation interacts with specific species and organism groups for determining plant community and ecosystem functions.