2010 AGU Fall Meeting
December 13-17, 2010
San Francisco, California USA

Session C34: The Legacy and Fate of Permafrost, Geochemical, Geophysical, and Geomorphic aspects

Deployment of an Ecosystem Warming Prototype at the Fairbanks Permafrost Experiment Station

Anna M. Wagner, Jon E. Zufelt, and Stan D. Wullschleger

Controlled experiments in terrestrial ecosystems are necessary to understand how changes in climate may affect the interactions among physical, chemical, and biological parameters. Advanced approaches to above and below ground warming will improve our understanding of the biotic and abiotic processes that govern plant and soil response to climatic change in terrestrial ecosystems. A prototype concept for raising soil temperatures in field plots has been developed at Oak Ridge National Laboratory. The performance of this design has been tested in 3-m diameter plots in a deciduous forest and also numerically simulated for plots ranging from 3 to 20 m in diameter. The goal of the present study is to determine if the prototype can be used to increase the temperature of permafrost soils in arctic and sub-arctic climates. Two sites in Alaska have been selected (Fairbanks and Barrow) for installation and evaluation of 20-meter plots in 2010. Fairbanks has a continental climate, with a mean annual air temperature of -3.3^{o}C, mean annual precipitation of 287 mm, and relatively warm (-1 to -2 ^{o}C) permafrost temperatures. Barrow is located within the Alaskan Arctic coastal plain and has a mean annual air temperature of -12.6^{o}C, mean annual precipitation of 124 mm, and colder (-8 to -12 ^{o}C) permafrost temperatures. This presentation focuses on the study site located at the U.S. Army Cold Regions Research and Engineering Laboratory Permafrost Experiment Station, Fairbanks.

The experiment station was established in 1945 and consists of 135 acres of ice-rich permafrost soils generally present to a depth of 60 m with an active layer that varies from 55 to 85 cm in undisturbed areas. Soils consist of tan silt and wind blown loess near the surface and grey silt at depths below 1.4 m. Permafrost moisture contents range from 26 to 41 percent by mass for the frozen silts. Vegetation is typical of the Alaskan Interior-subarctic taiga forest with white spruce (*Picea glauca* [Moench] Voss), and black spruce (*P. mariana* [Mill] B.S.P) interspersed with lowbush cranberry (*Vaccinium oxycoccos* L.) and Labrador tea (*Ledum groenlandicum* Oeder). Feather moss and sphagnum moss are present in the understory. The experimental plot is a hexagonal shaped area where vegetation had been removed but has since regrown over the last 40-50 years. Soil warming is accomplished by low-energy heating elements installed vertically at spacing of 2.4 m and to a depth of 4 m. Only the lower 1-m is heated to a set point 4^{o}C above ambient. The heated area includes a buffer zone resulting in a test area with a diameter of 20 m. This proof-of-concept study will result in improvements to experimental design and thermal modeling ground-truth data as the scientific community plans for possible next-generation climate change experiments in terrestrial permafrost ecosystems.

Contact: Anna Wagner (Anna.M.Wagner@usace.army.mil)