

THE SPRUCE EXPERIMENT

at the Marcell Experimental Forest

<http://www.mnspruce.ornl.gov/>

S*pruce and*
P*eatland*
R*esponses*
U*nder*
C*limatic and*
E*nvironmental change*



WHAT IS SPRUCE?

A multi-year cooperative among scientists of the Oak Ridge National Laboratory operated by UT-Battelle, LLC and the USDA Forest Service Northern Research Station at the Marcell Experimental Forest in northern Minnesota

- An experiment **to assess the response of northern peatland ecosystems to increases in temperature and exposures to elevated atmospheric CO₂ concentrations.**
- Sponsored by the Office of Biological and Environmental Research within the US Dept. of Energy's Office of Science.



MEASURING EFFECTS OF CLIMATE CHANGE ON PEATLANDS

Study responses within a peatland to multiple levels of warming at ambient and elevated CO₂ levels, in a replicated design:

- Warming levels from ambient to +9 C (above and below ground) inside large, open-top chambers.
- Elevated CO₂ in the range of 800 to 900 ppm for the ambient and +9 C warming treatments.



SCIENCE QUESTIONS

microbial
processes /
plant species

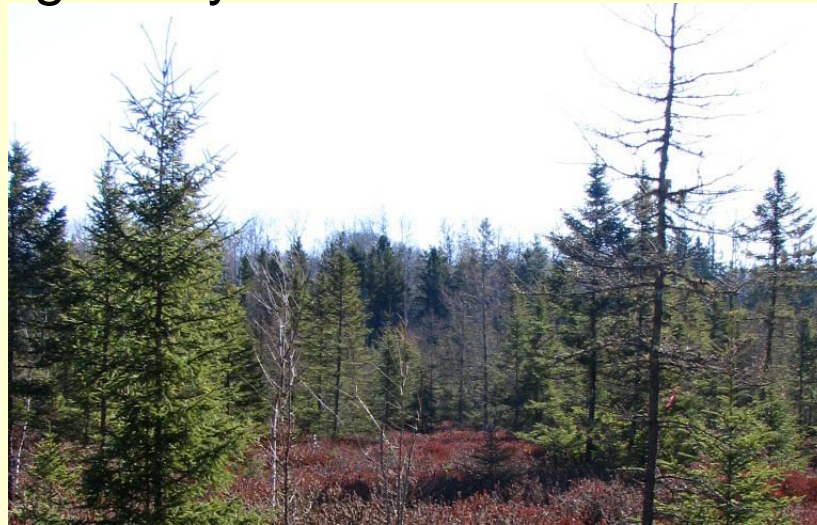


entire
peatland
ecosystems

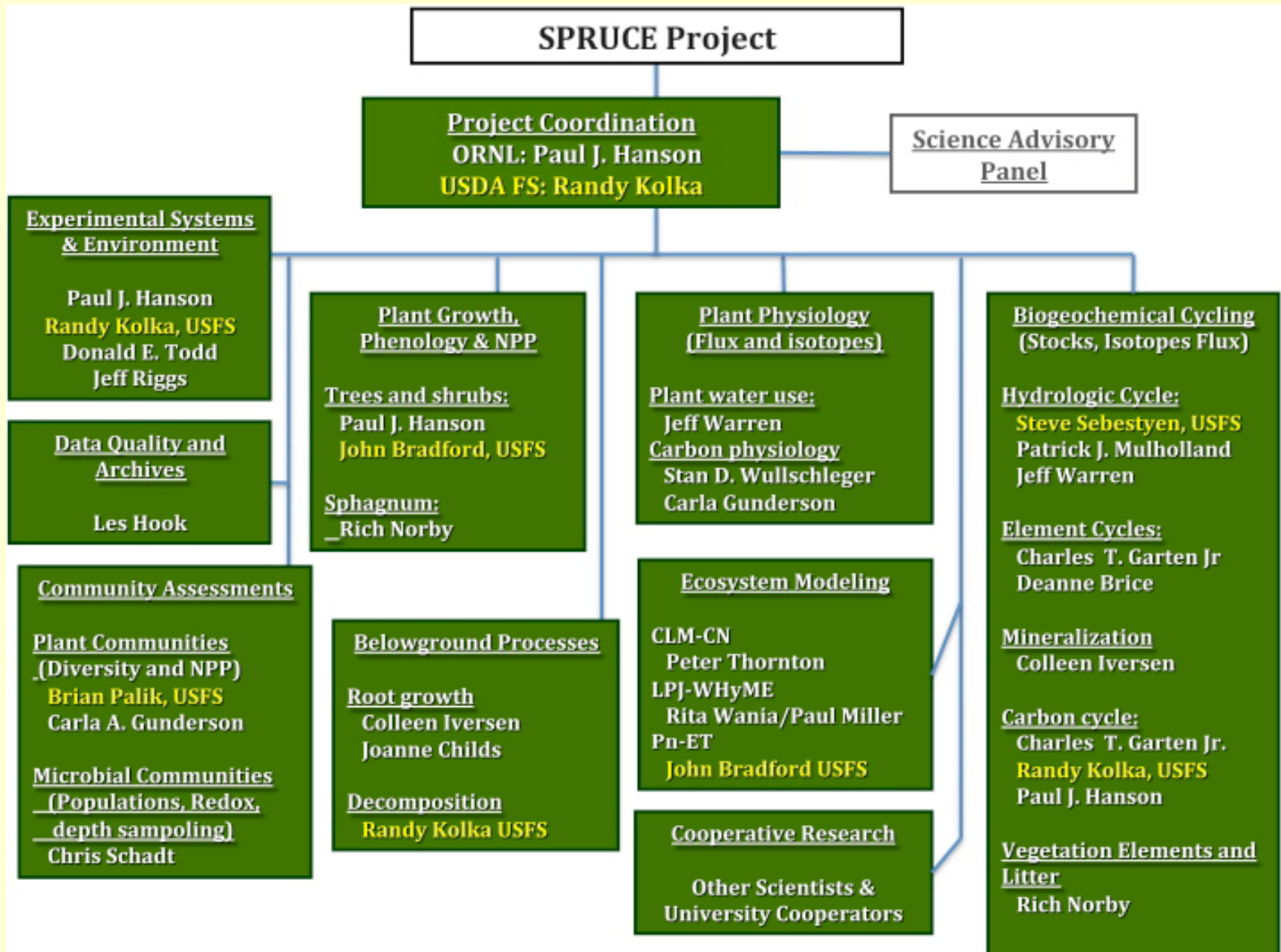
- How vulnerable are peatland ecosystems and their **component organisms** to atmospheric and climatic change?
 - Can we quantify the potential for shifts in local **species dominance and regeneration** success to assist projections of future biome changes over decades to centuries?
 - Will **species assemblages** or **loss of species** have unanticipated impacts on ecosystem processes?
 - Do changes in ecosystem services precipitate a change in state (e.g., loss of a dominant plant functional type)?
- To what degree will changes in **plant physiology** under elevated CO₂ impact a species' sensitivity to climate or **competitive capacity** within the community?
- Will full belowground warming release unexpected amounts of greenhouse gases and solutes from high-C-content northern forests?
 - How will decomposition, nutrient cycling, and feedbacks on solute availability affect ecosystem **productivity, solute efflux, and trace gas emissions**?
- What are the critical air and soil temperature **response functions** for ecosystem processes and their constituent organisms?
 - Do those response functions for ecosystem processes depend on shifts in species interactions and composition?
- Will **ecosystem services** (e.g., biogeochemical, hydrological, or societal) be compromised or enhanced by atmospheric and climatic change?

A RESEARCH PLATFORM FOR THE CLIMATE CHANGE COMMUNITY

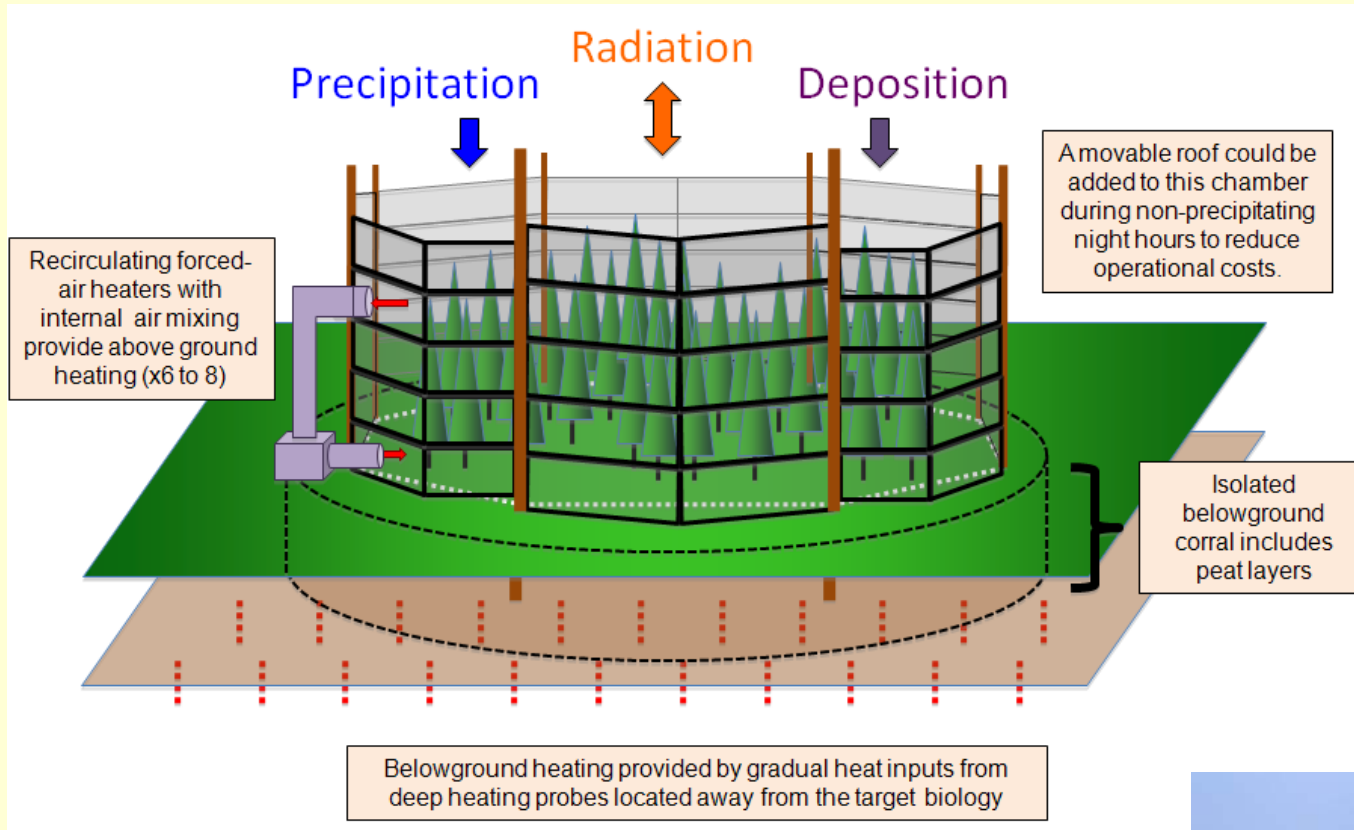
- A core suite of research will be funded and pursued by scientists at ORNL and the Forest Service in Grand Rapids.
 - With outside collaborations sought by specific research groups to fill perceived science gaps.
- Via external funding, we intend to facilitate collaborations that are consistent with the design, science mission, spatial constraints of the chambers, and integrity of the experiment on the sensitive bog ecosystem.



PROJECT FRAMEWORK



HEATED CHAMBERS



- 12 m diameter internal study area.
- 8 m tall aboveground chamber.
- Heating to 2 to 3 meter within peat. Belowground environment enclosed in a subsurface chamber.



PROJECT SETTING

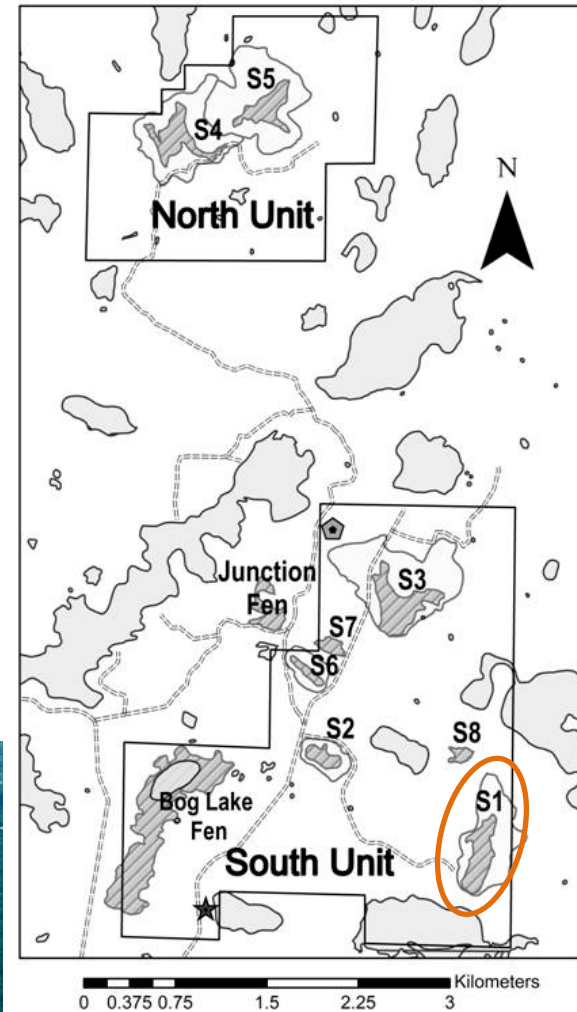
The **S1 bog watershed** at the **Marcell Experimental Forest** of the **Northern Research Station** of the **USDA Forest Service**.

North of Grand Rapids in Itasca County, MN
Deer River Ranger District
Chippewa National Forest

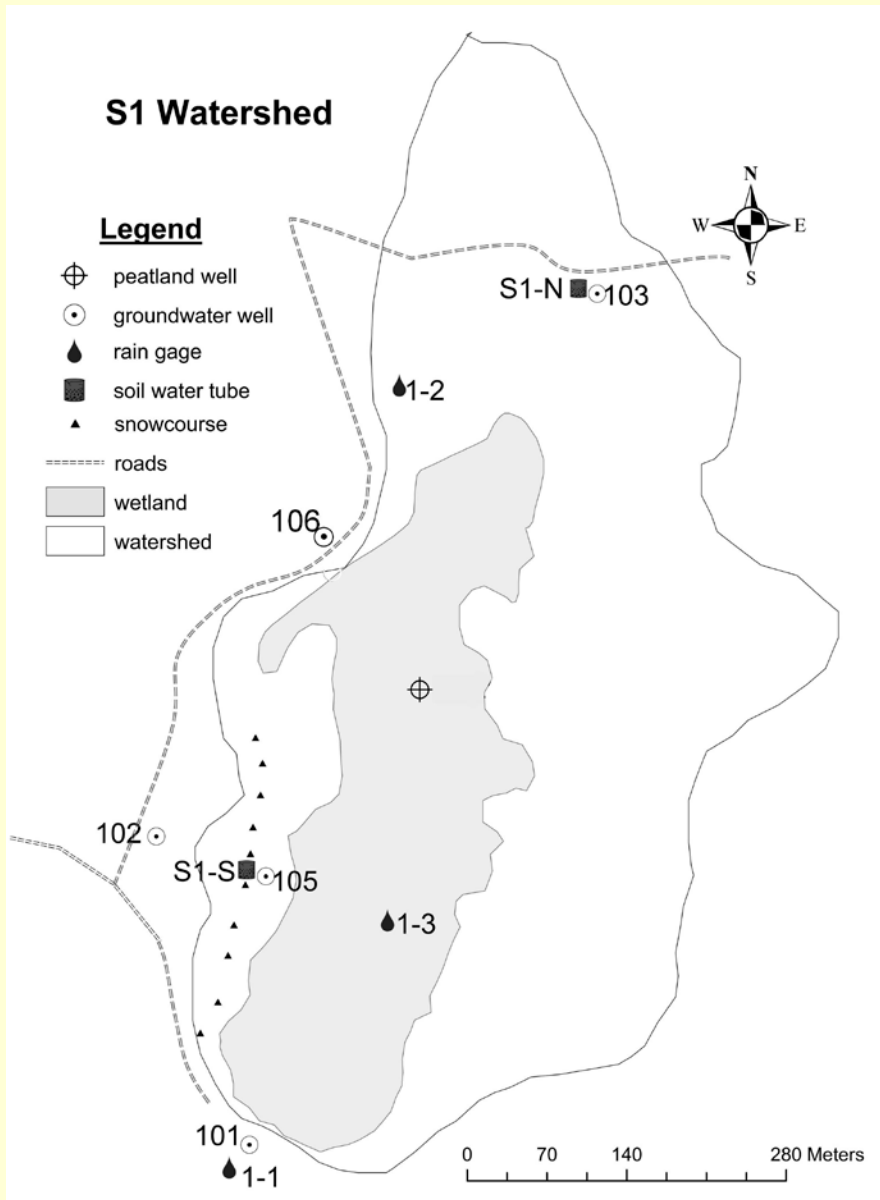
A mix of uplands, bogs, fens, lakes, and streams in the Marcell hills moraine.



Marcell Experimental Forest

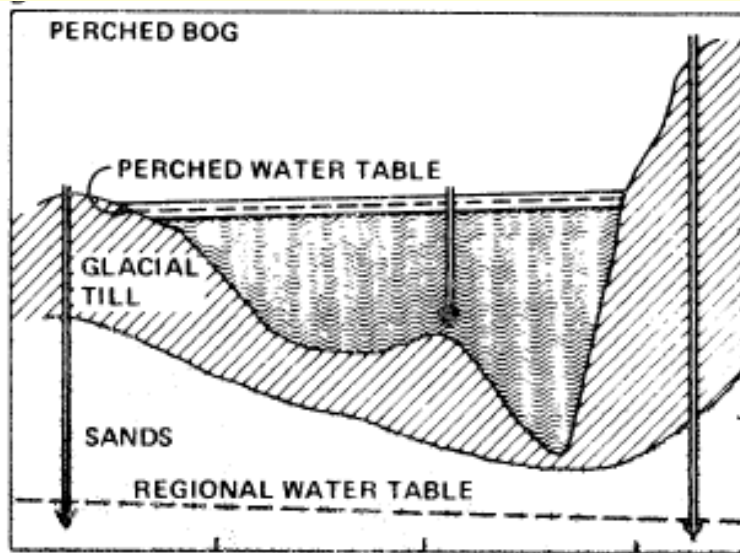


SUPPORTING LONG-TERM DATA DOCUMENTING BASELINE CONDITIONS AND TRENDS

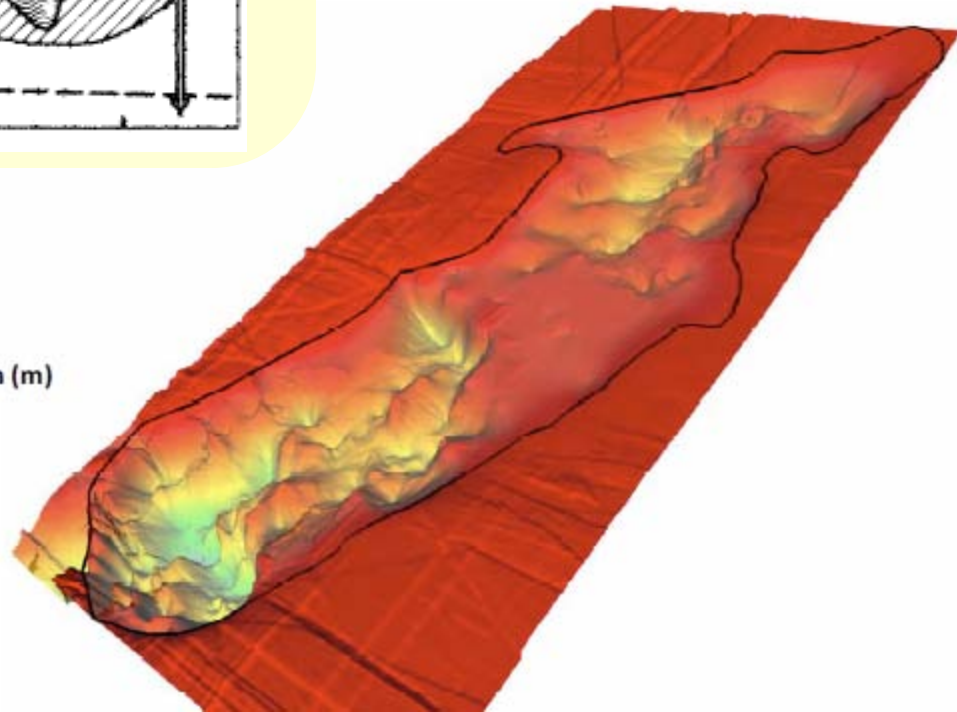
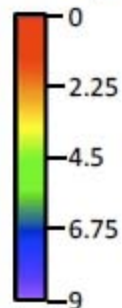


- Precipitation amount.
- Snow depth and water equivalents.
- Air temperature.
- Regional groundwater levels.
- Peatland water table levels.
- Soil moisture.
- Tree and shrub biomass.
- Stream water chemistry.
- Precipitation chemistry.
- High-resolution surface topography mapping (LIDAR).
- Peat physical properties.
- C pools and fluxes.

WELL-STUDIED HYDROLOGICAL AND ECOLOGICAL SETTINGS



Peat depth (m)



STEMMING FROM A PAST EXPERIMENT...

1968



1969



1974

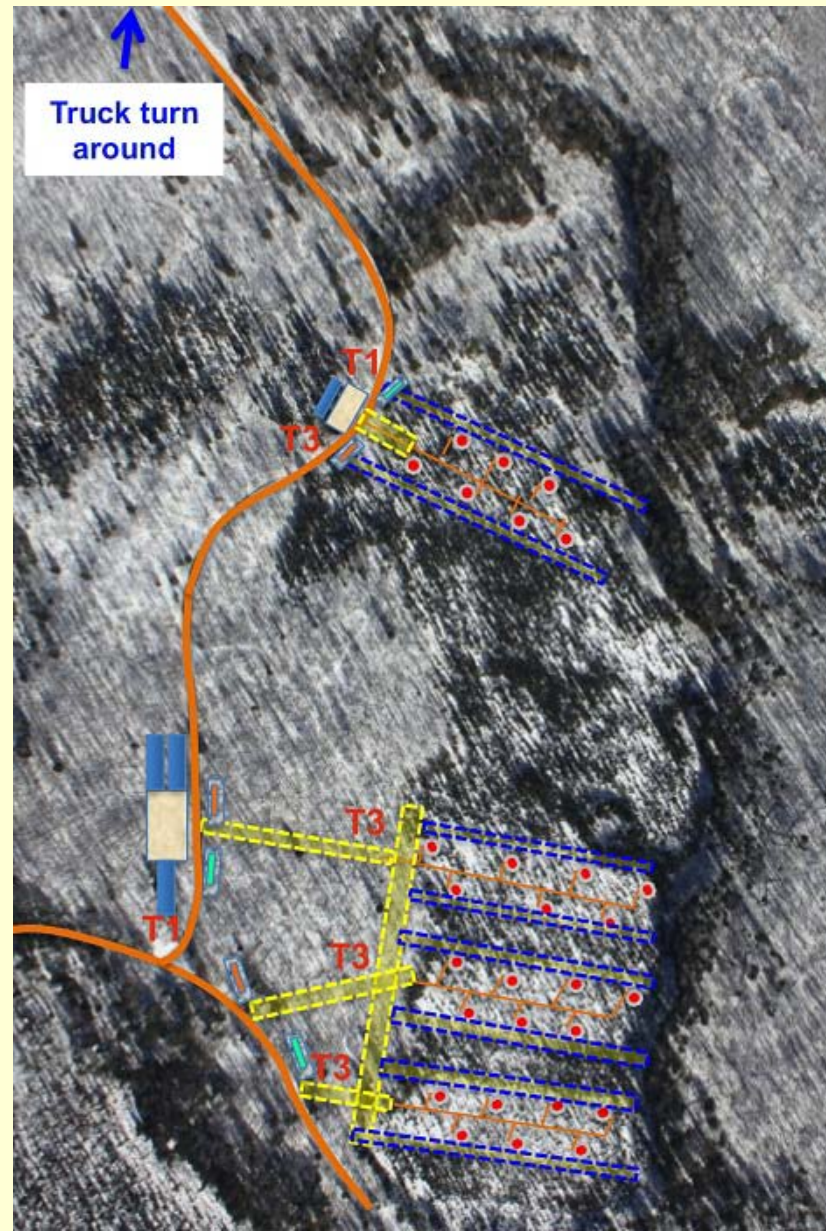


TODAY

Short-stature, accruing black spruce forest in a northern peatland.



POTENTIAL PLOT LOCATIONS



EA FOR NEPA APPROVAL MOVES FORWARD

Joint NEPA planning between FS and ORNL/DOE.

- Targeted submission in September with finalization during December 2010.
- With NEPA approval, a subsurface barrier and prototype chamber will be constructed to prove / improve the engineering concepts.
- Upon successful trial of the prototype, buildup of infrastructure is planned through 2013.
- Full-scale experiment for up to 10 years.



QUESTIONS ???

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