Informing Carbon in Arctic Reservoirs Vulnerability Experiment Flight Schedule based upon Soil and Vegetation Freeze and Thaw Event Variation along the Alaska Ecological Transect

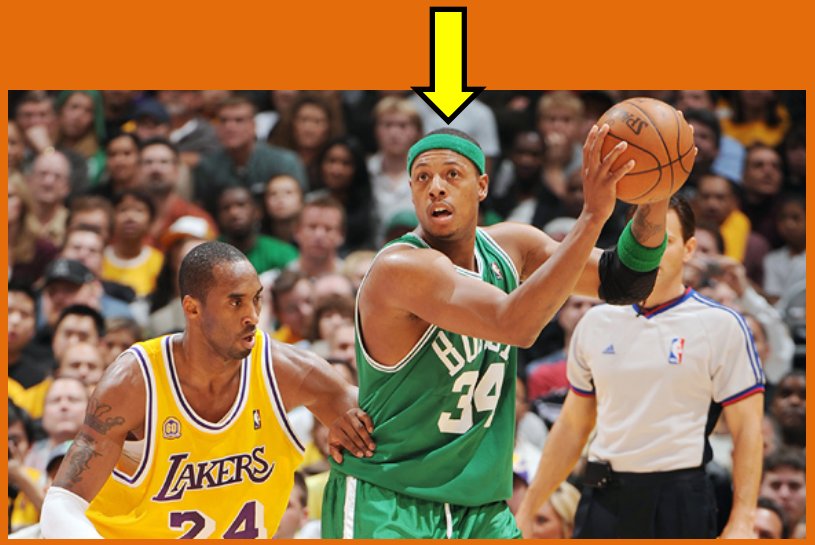
By Jessica Potter

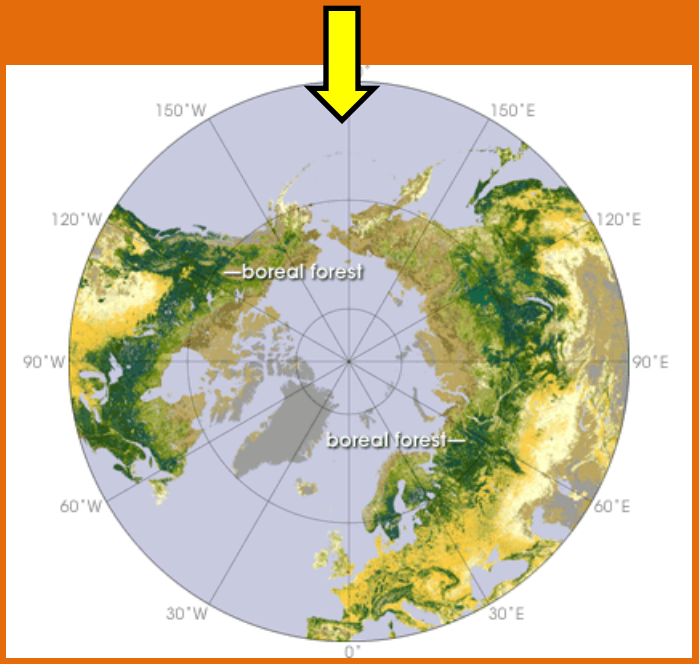
Mentors Kyle McDonald & Erika Podest

CSU STAR

Why Study Alaska?

- Boreal Forest: The Green Head Band of the Earth





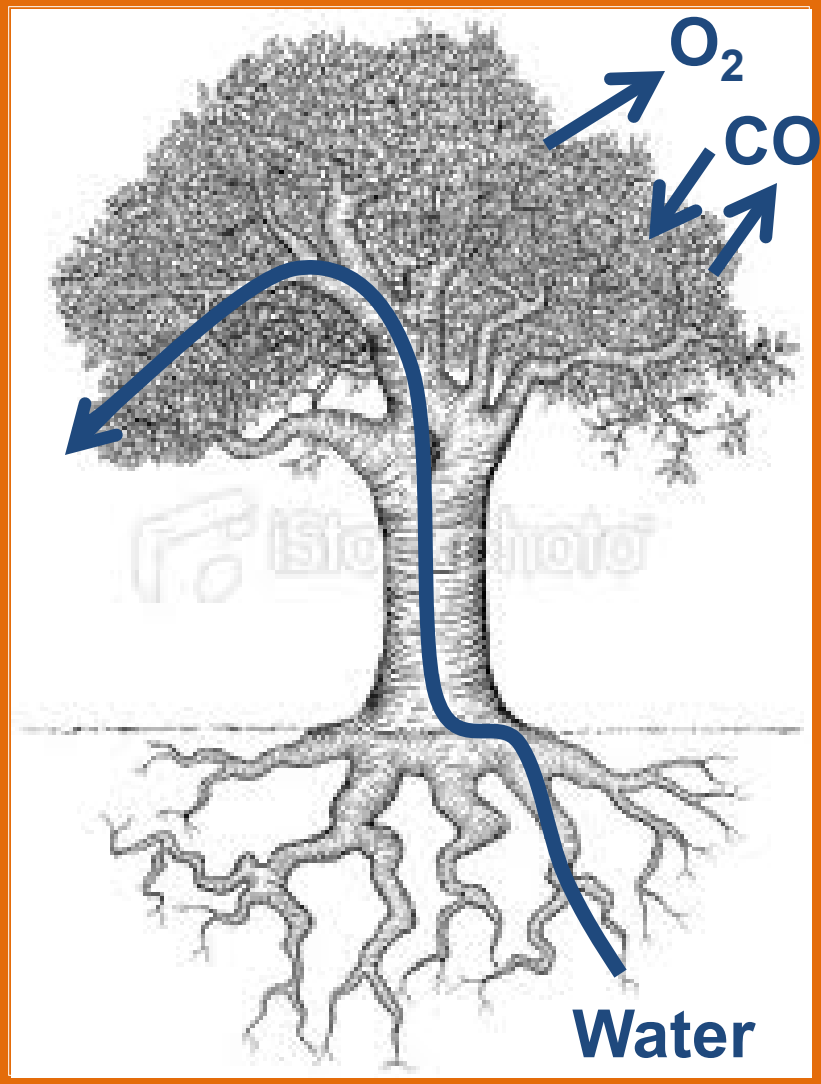
- Largest terrestrial ecosystem on Earth
- Covers 11% of land area on the planet
- Dominated by conifer trees

Why Study Alaska?

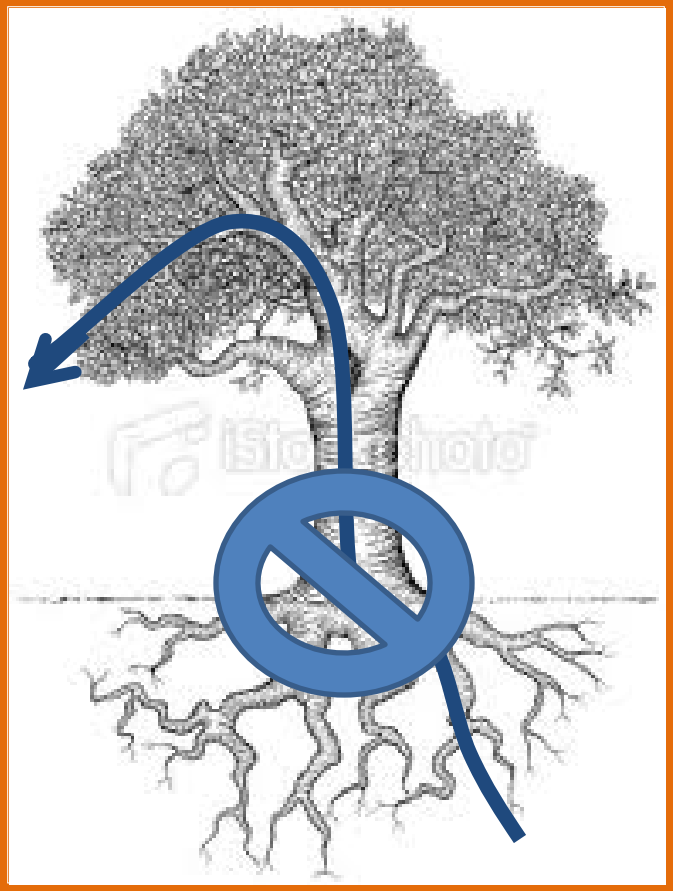
Boreal Forest in Alaska is found in the interior, between the **Brooks Range** in the north and the **Alaska Range** in the south

Tundra surrounds the Boreal Forest

Carbon Cycle

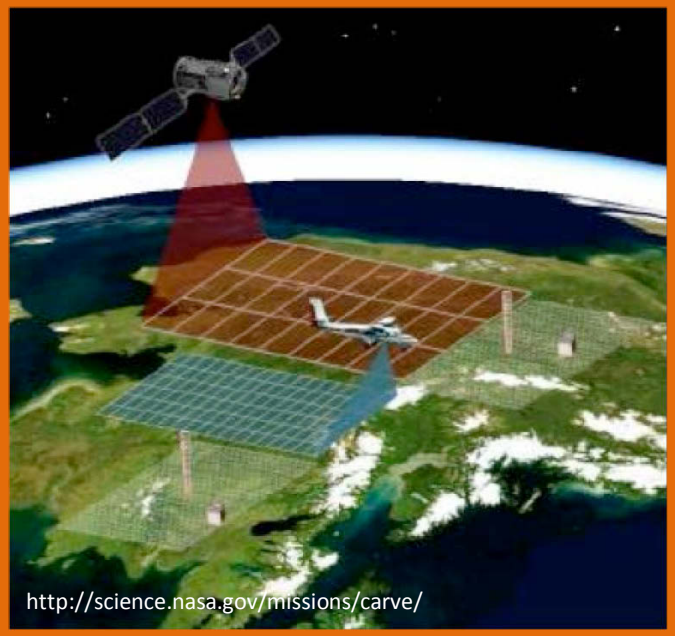


Carbon Cycle



CARVE

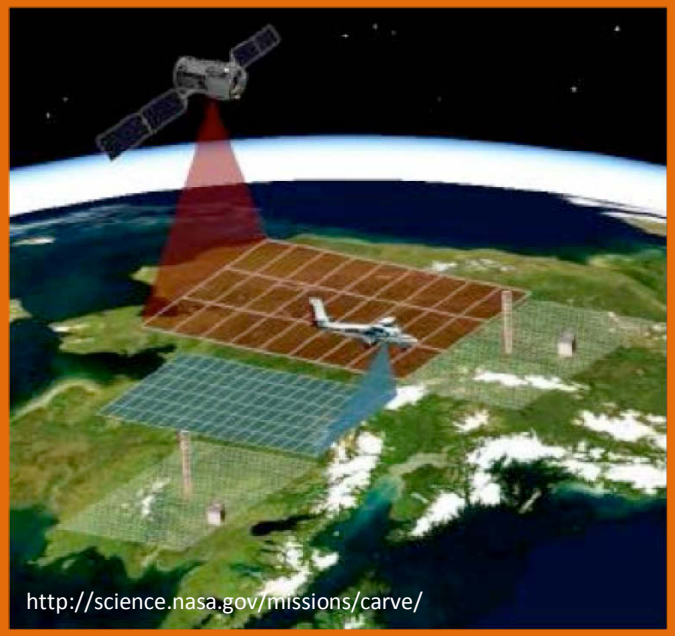
Carbon in Arctic Reservoirs Vulnerability Experiment



- De Havilland DHC-6 Twin Otter Aircraft
- Remote sensing technology used to monitor:
  - Soil Moisture
  - Freeze/Thaw State
  - Surface Temperatures
  - Total atmospheric columns of carbon dioxide, methane, and carbon monoxide

CARVE

Carbon in Arctic Reservoirs Vulnerability Experiment

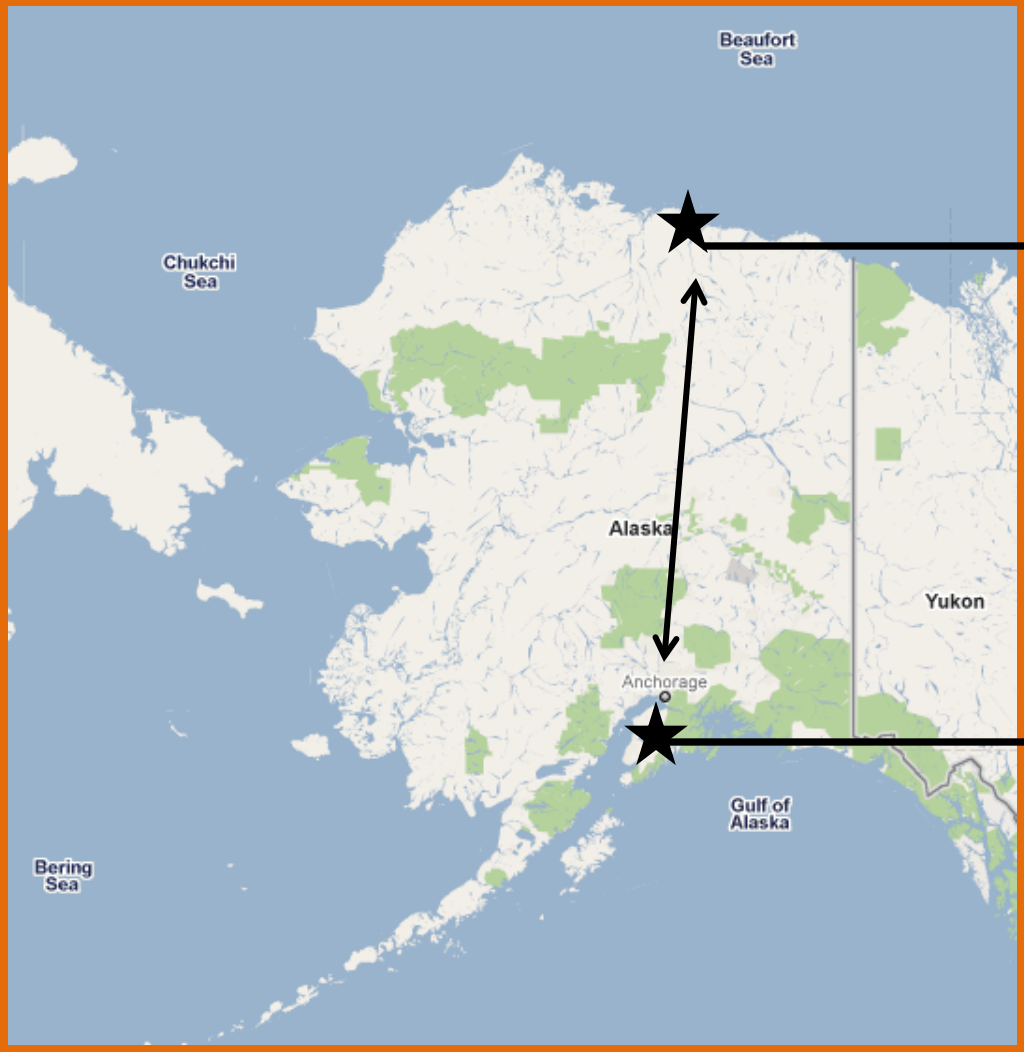


Goal: "CARVE will provide an integrated set of data that will provide unprecedented experimental insights into Arctic carbon cycling."

http://science.nasa.gov/missions/carve/

Deployments: Spring, Summer, and Fall
Starting March 2012

ALECTRA: Alaska Ecological Transect



Courtesy of Google Maps

Monitoring Equipment

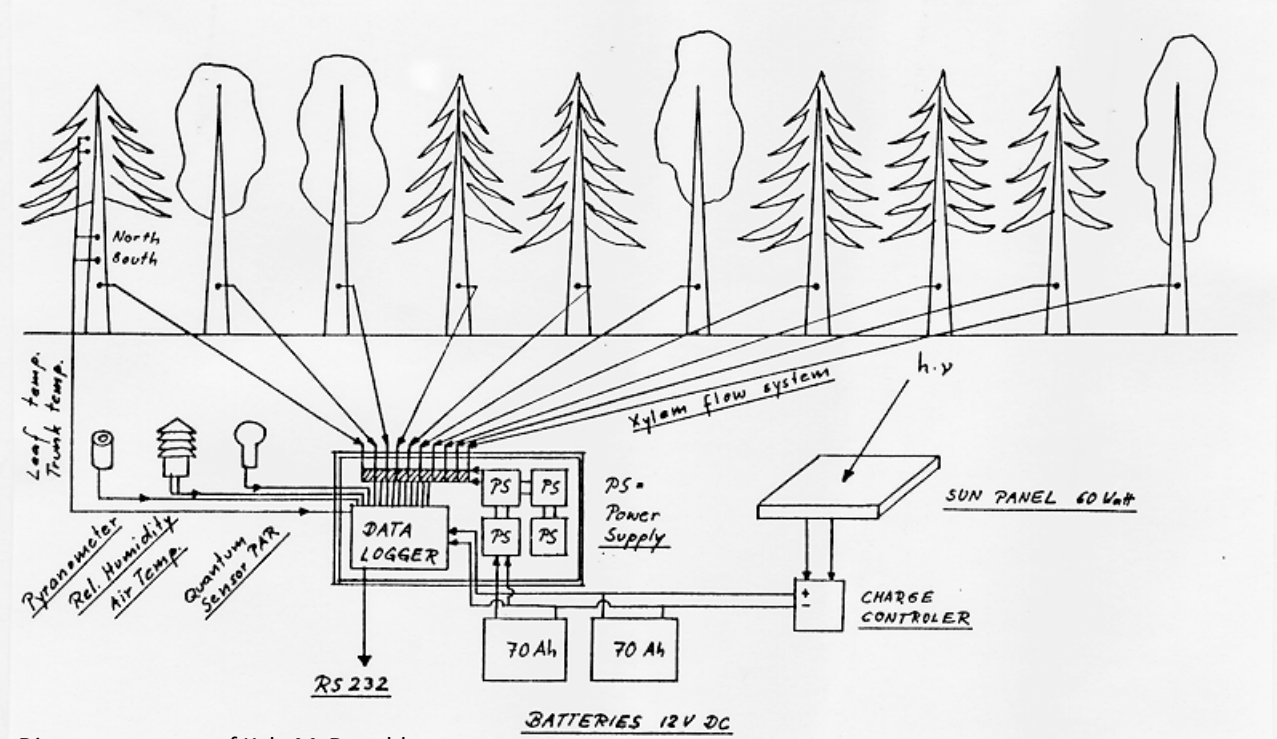
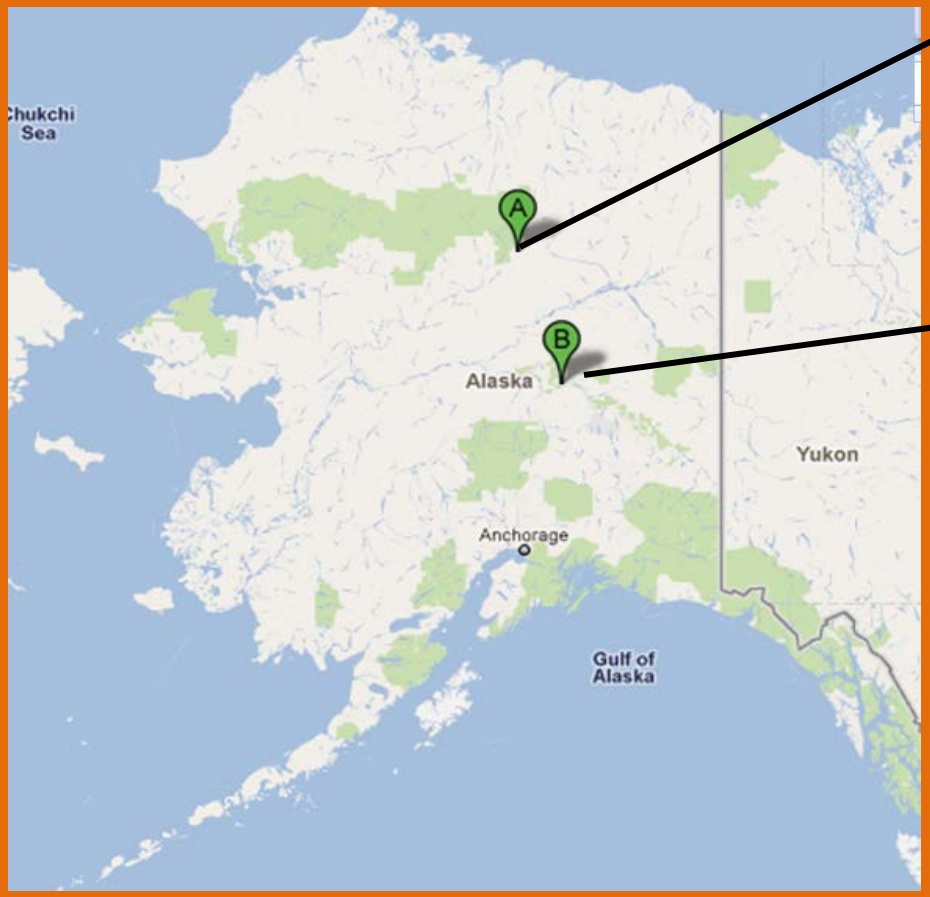


Diagram courtesy of Kyle McDonald

ALECTRA Study Sites

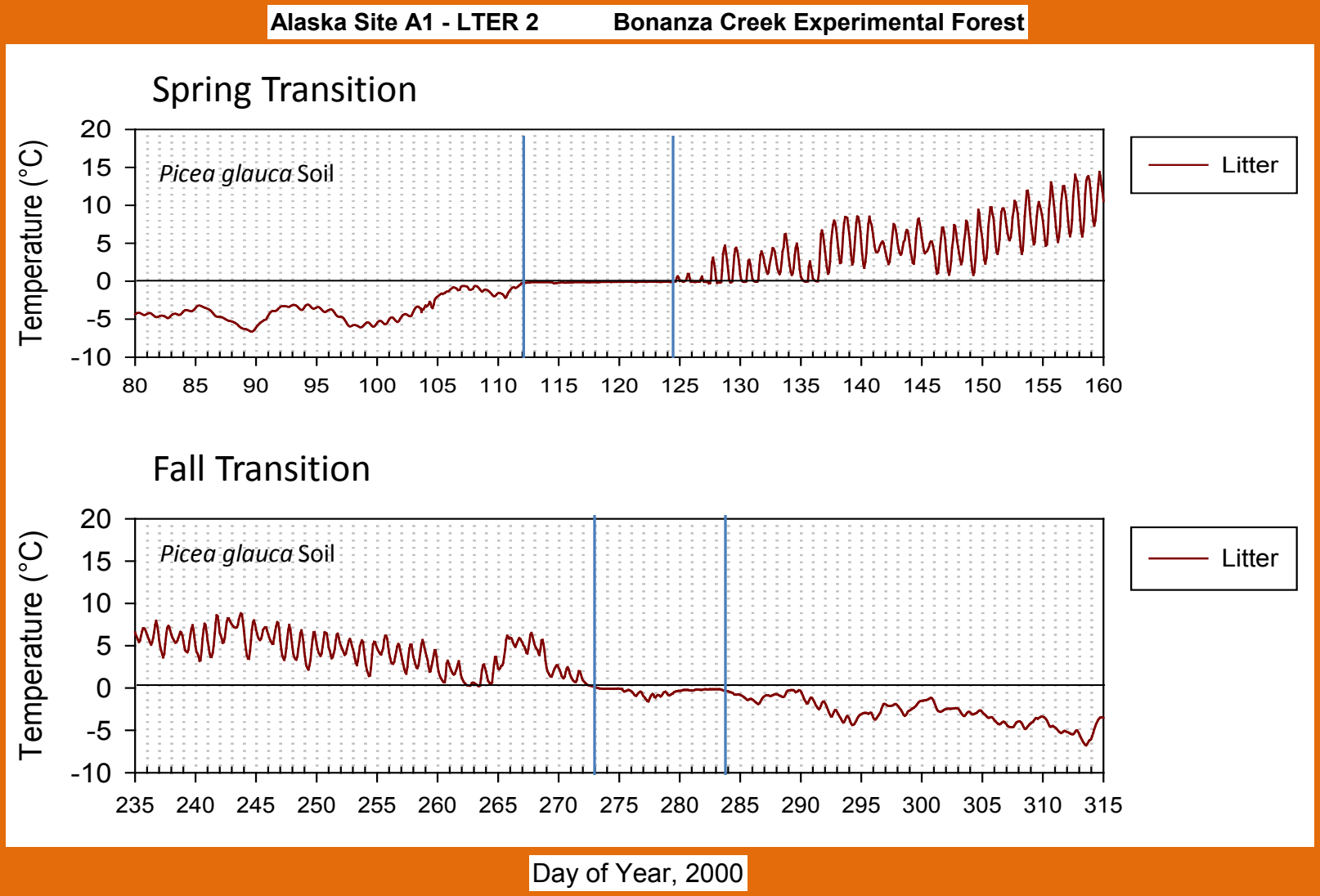


Dietrich Valley
(1) Coldfoot
(2) Treeline

Bonanza Creek

Courtesy of Google Maps

Freeze and Thaw Transitions



Methods for Statistical Analysis

Analysis of Variance (R)

Two-Way: Year & Location

Testing for differences in Freeze and Thaw Events over time and space

Regression Analysis (R)

Testing for relationships between Freeze and Thaw Events and Year

Results: Soil Thaw Events

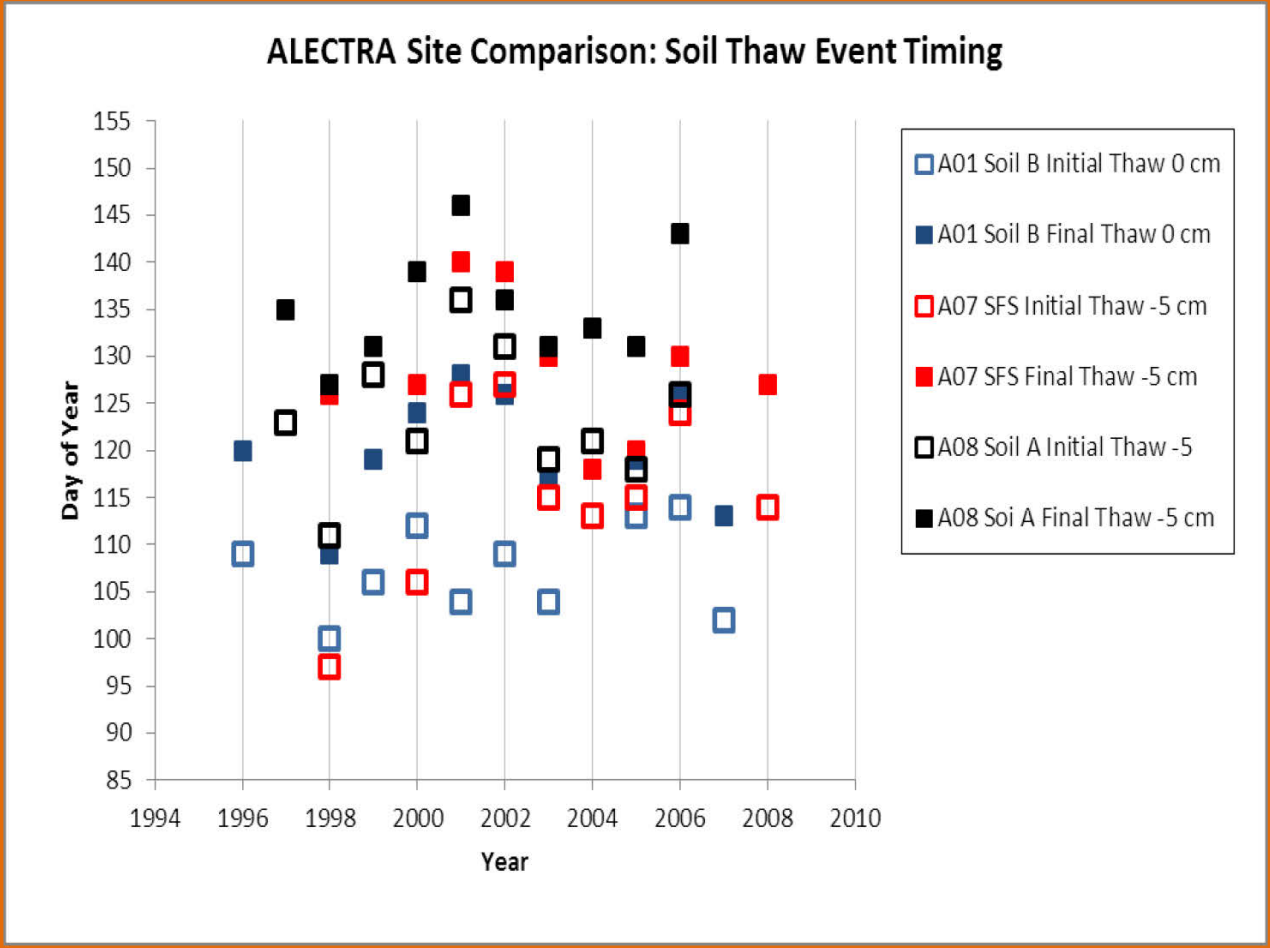


Figure 1. Soil thaw began an average of eight days earlier in Bonanza Creek (A01) compared to Coldfoot (A07), and 16 days earlier compared to Dietrich Valley Treeline (A08).

Soil thaw ended an average of nine days earlier in Bonanza Creek (A01) compared to Coldfoot (A07), and 15 days earlier compared to Dietrich Valley Treeline (A08).

Results: Vegetation Thaw Events

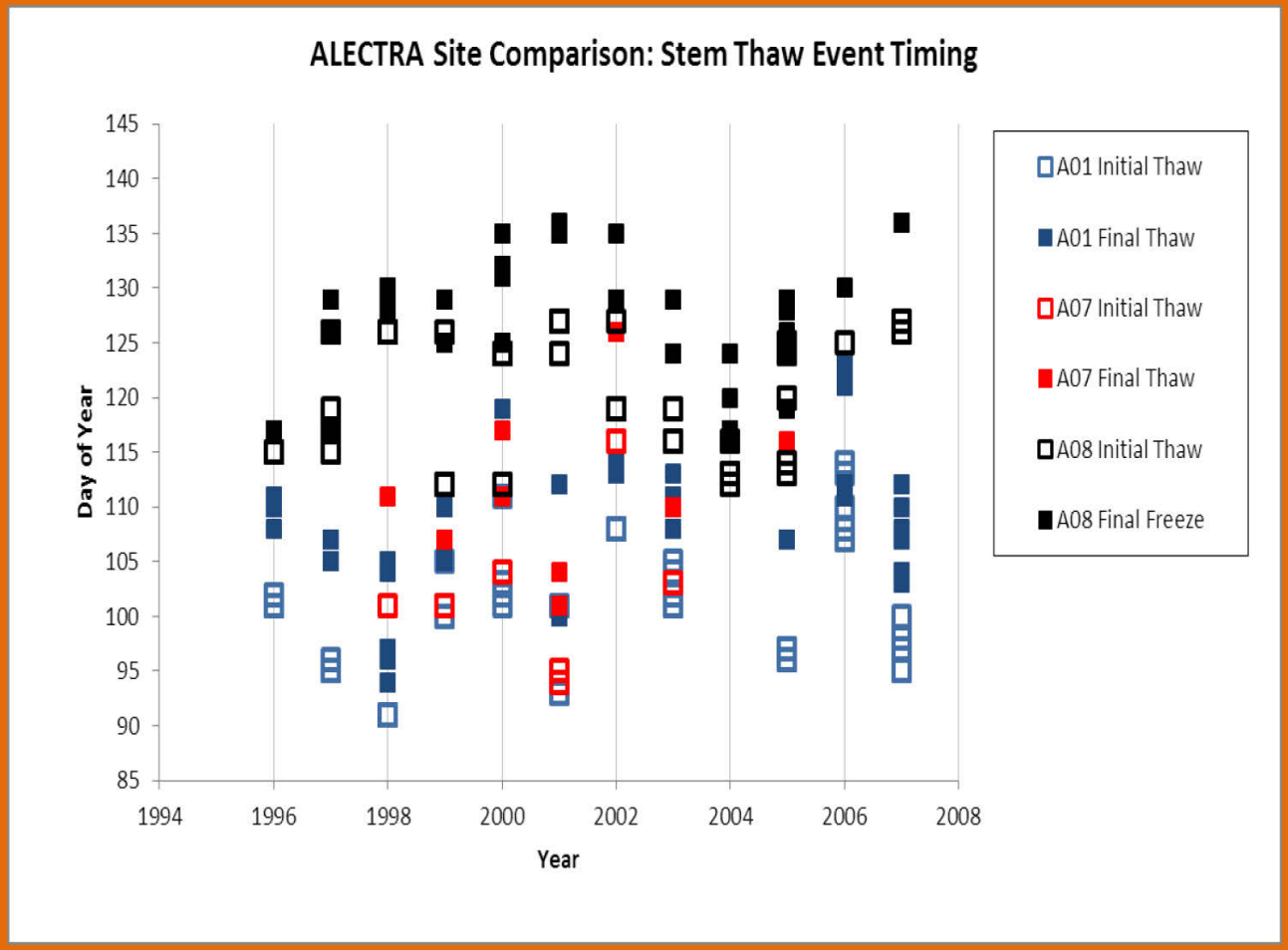


Figure 2. Vegetation tissue thaw began an average of six days earlier at Bonanza Creek compared to Coldfoot and 20 days earlier compared to Dietrich Valley Treeline.

Vegetation tissue thaw ended an average of five days earlier at Bonanza Creek compared to Coldfoot and 19 days earlier compared to Dietrich Valley Treeline.

*Data fails to meet the assumptions of normality and equal variance.

Results: Soil Freeze Events

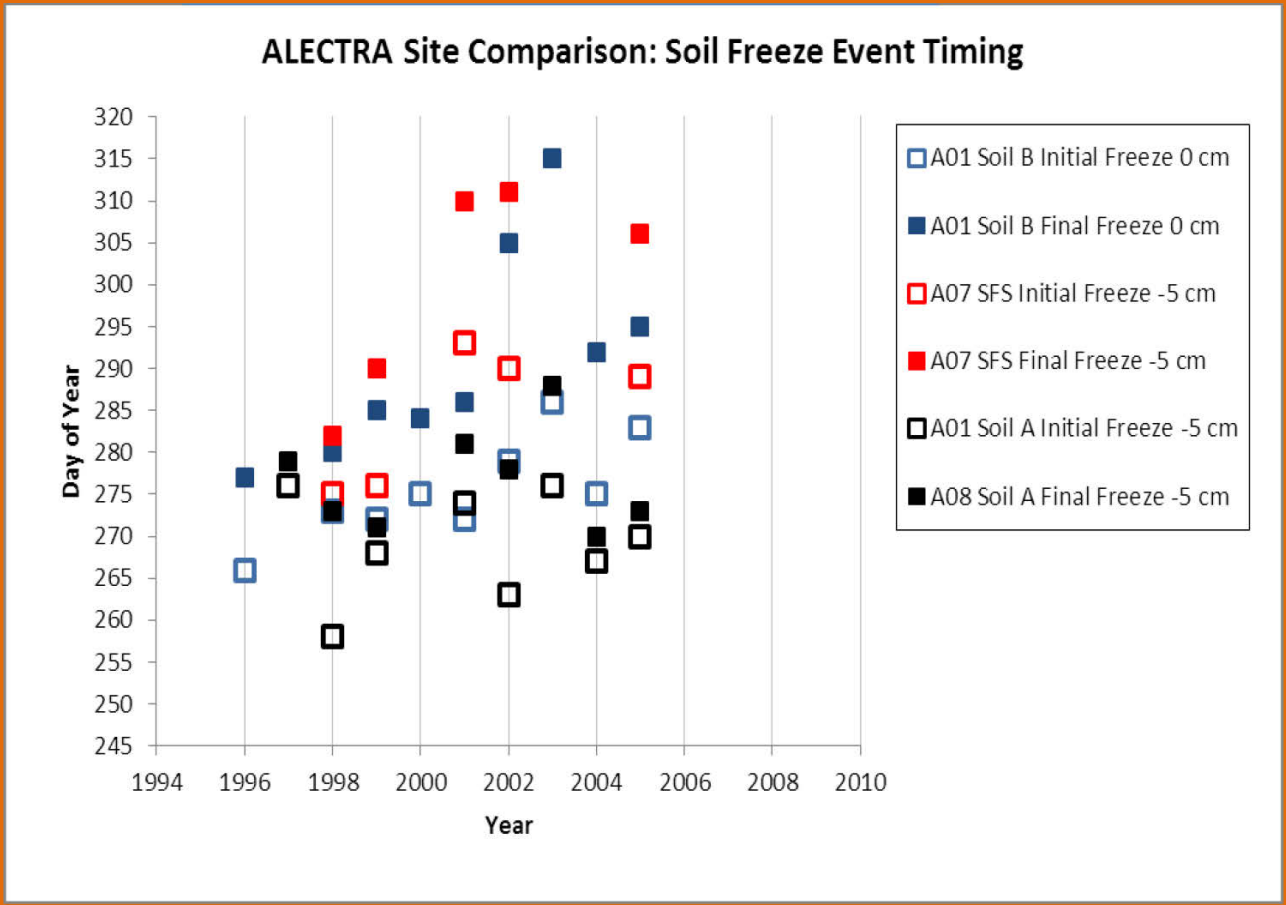
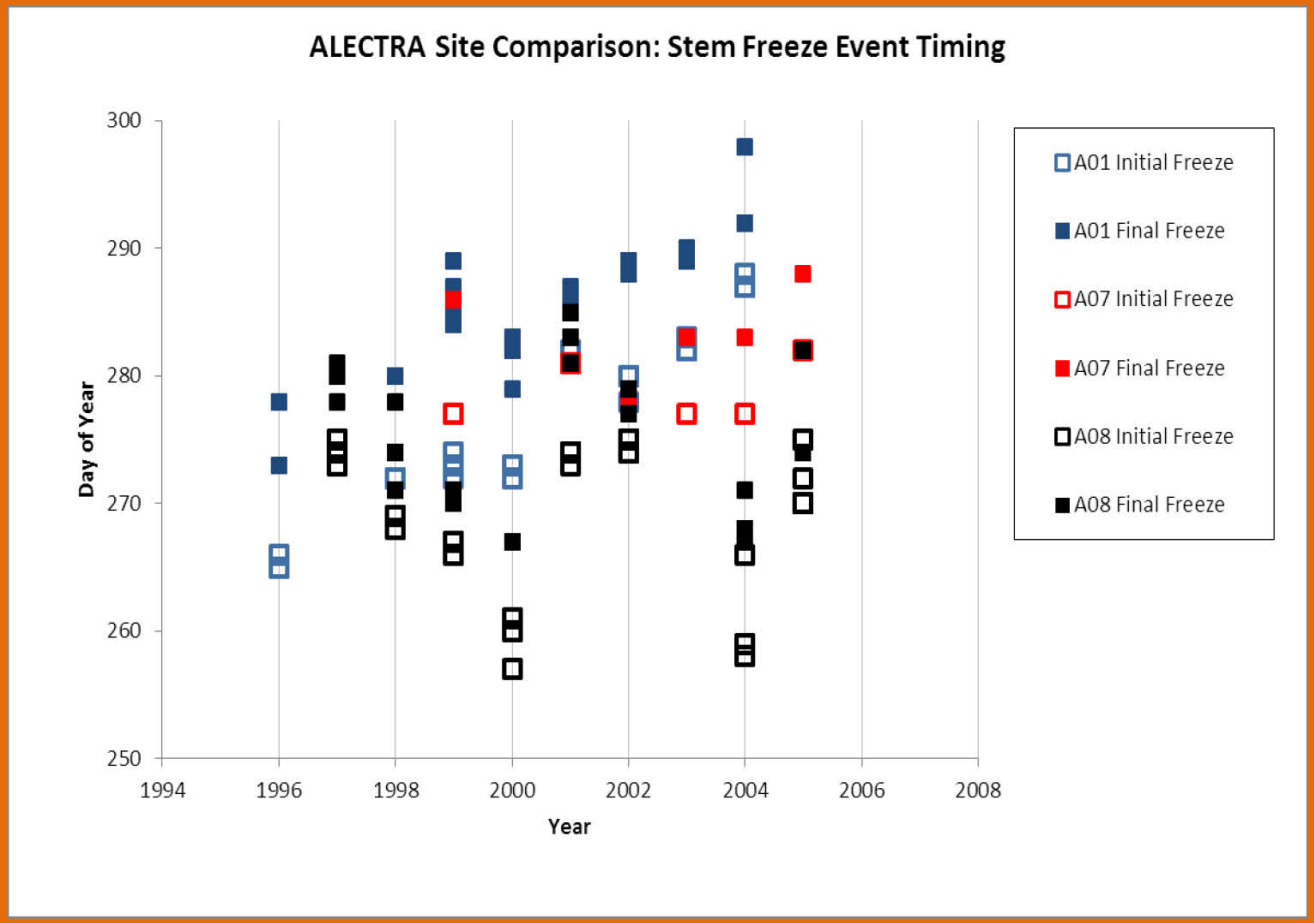


Figure 3. Soil freeze began on average, seven days earlier at Dietrich Valley Treeline compared to Bonanza Creek and 16 days earlier compared to Coldfoot.

Soil freeze ended, on average, fourteen days earlier at Dietrich Valley Treeline compared to Bonanza Creek and 23 days earlier compared to Coldfoot.

Results: Vegetation Freeze Events

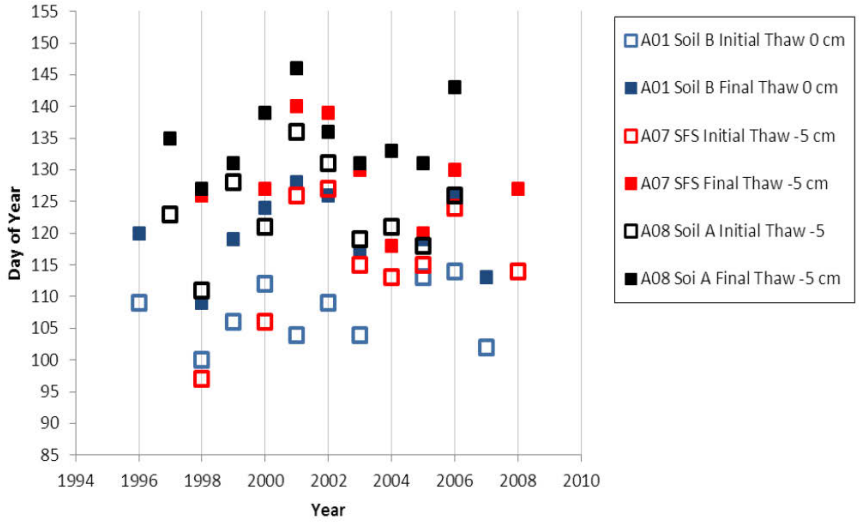


*Data fails to meet the assumptions of normality and equal variance.

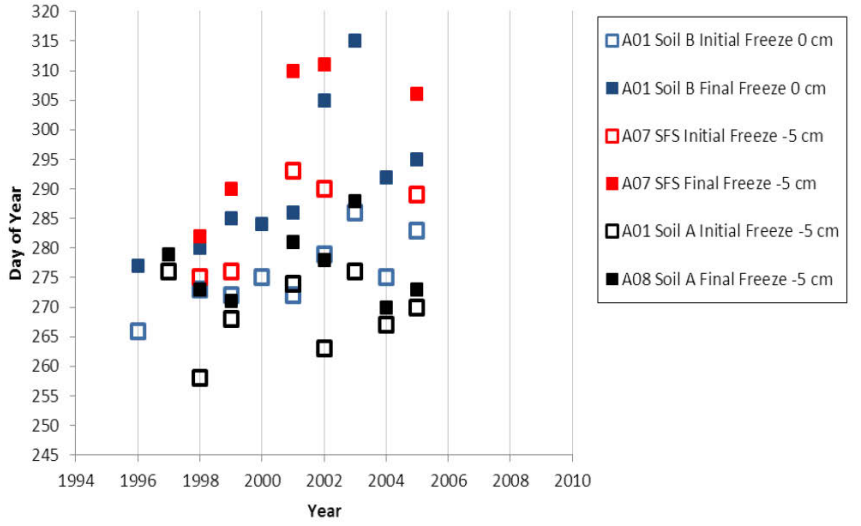
Figure 4. Vegetation tissue freeze began, on average, eight days earlier at Dietrich Valley Treeline (A08) compared to Bonanza Creek (A01) and nine days earlier compared to Coldfoot (A07).

Vegetation tissue freeze ended, on average, nine days earlier at Dietrich Valley Treeline (A08) compared to Coldfoot (07) and 10 days earlier compared to Bonanza Creek (A01).

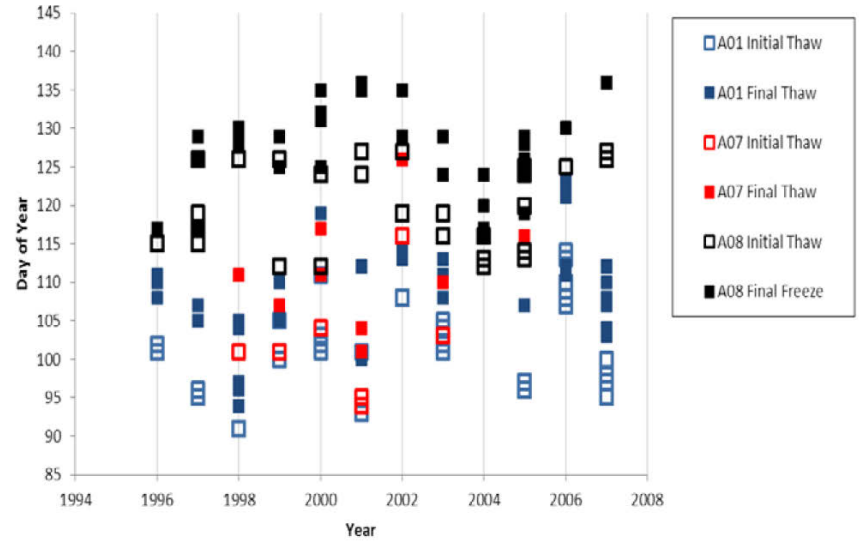
ALECTRA Site Comparison: Soil Thaw Event Timing



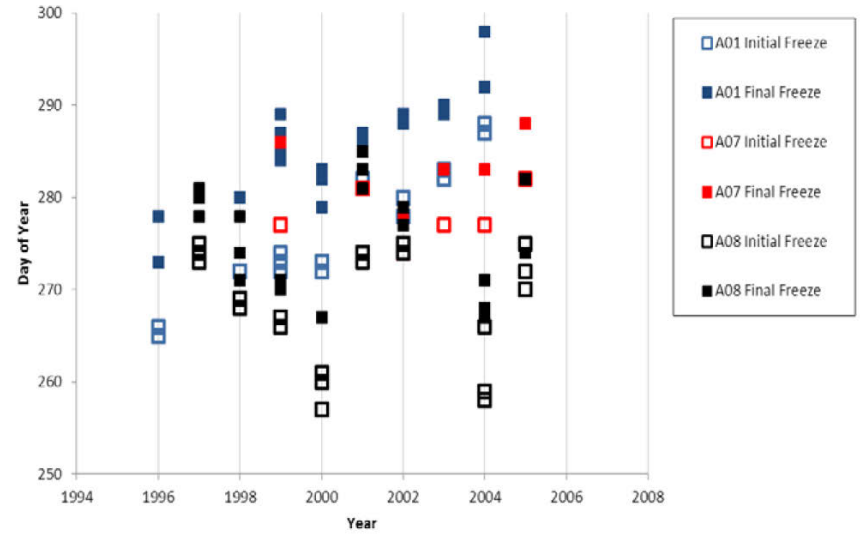
ALECTRA Site Comparison: Soil Freeze Event Timing



ALECTRA Site Comparison: Stem Thaw Event Timing

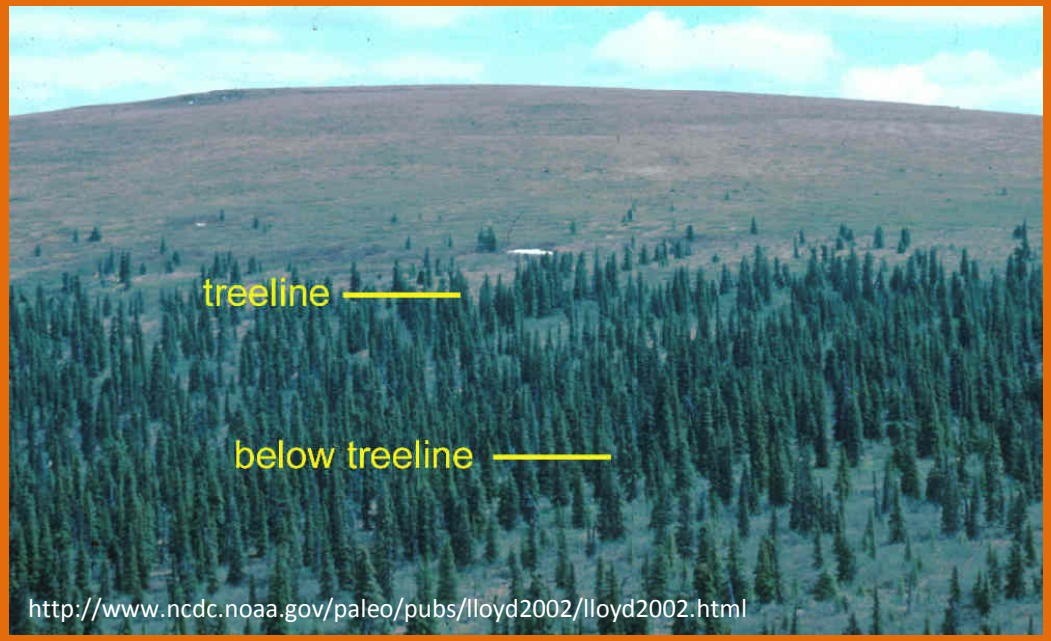


ALECTRA Site Comparison: Stem Freeze Event Timing



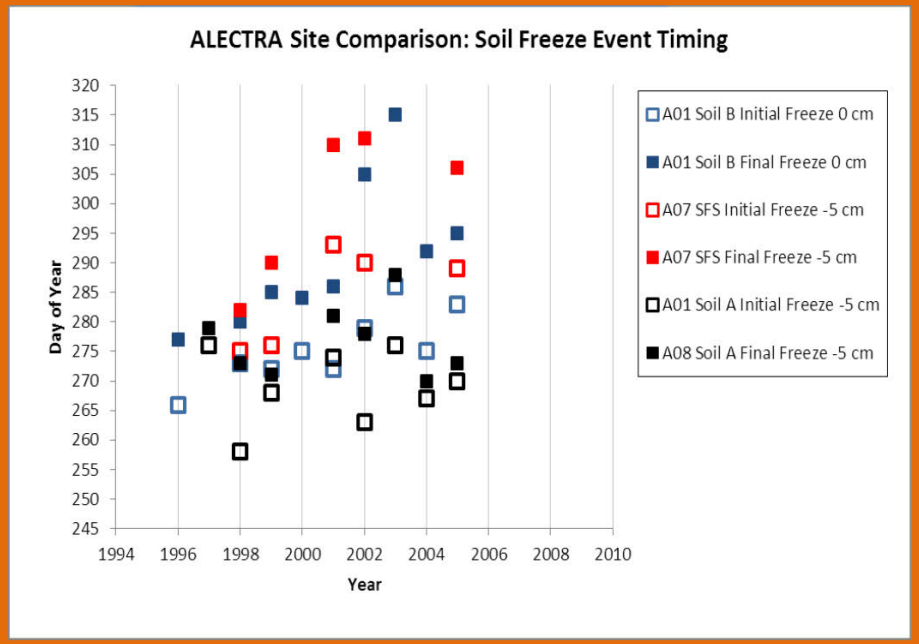
Results

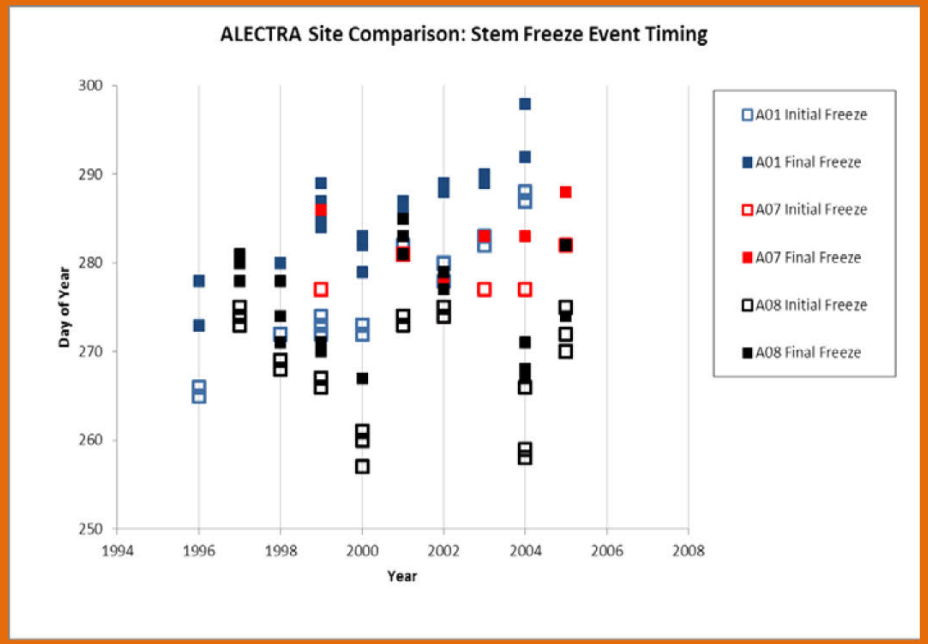
- Soil and vegetation freeze sooner and thaw later in the year at Dietrich Valley Treeline compared to Coldfoot and Bonanza Creek



Results

There is evidence to suggest freeze events occurred later each year between 1996 and 2008





Conclusions

Under the assumption that A01 Bonanza Creek is of priority due to its location in a long term experimental forest , recommended spring and fall flight dates are as follows:

Spring Flight:

April 20 (Day 110) to May 10 (Day 130)

Fall Flight:

October 2 (Day 275) to Oct 22 (Day 295)

Conclusions: Spring Flight Dates

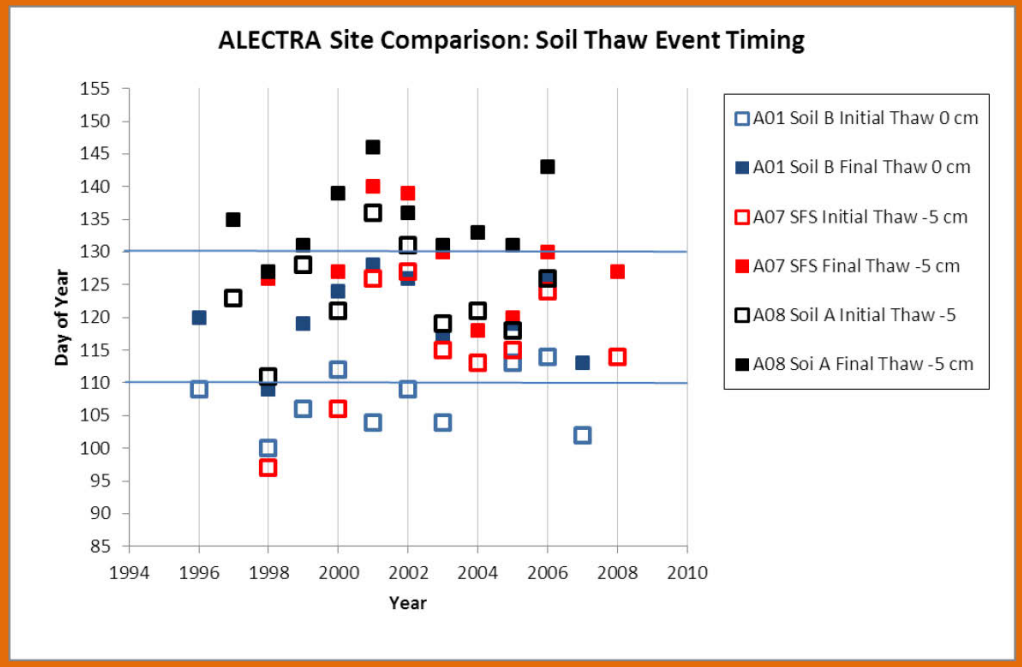


Figure 5. Blue bars indicate dates ensuring CARVE's observation of a nearly complete transition at Bonanza Creek, beginning 3 days after the average initiation of the thaw, a complete transition at Coldfoot, and observations would end 5 days earlier than the average end of the transition at Dietrich Valley Treeline

Conclusions: Fall Flight Dates

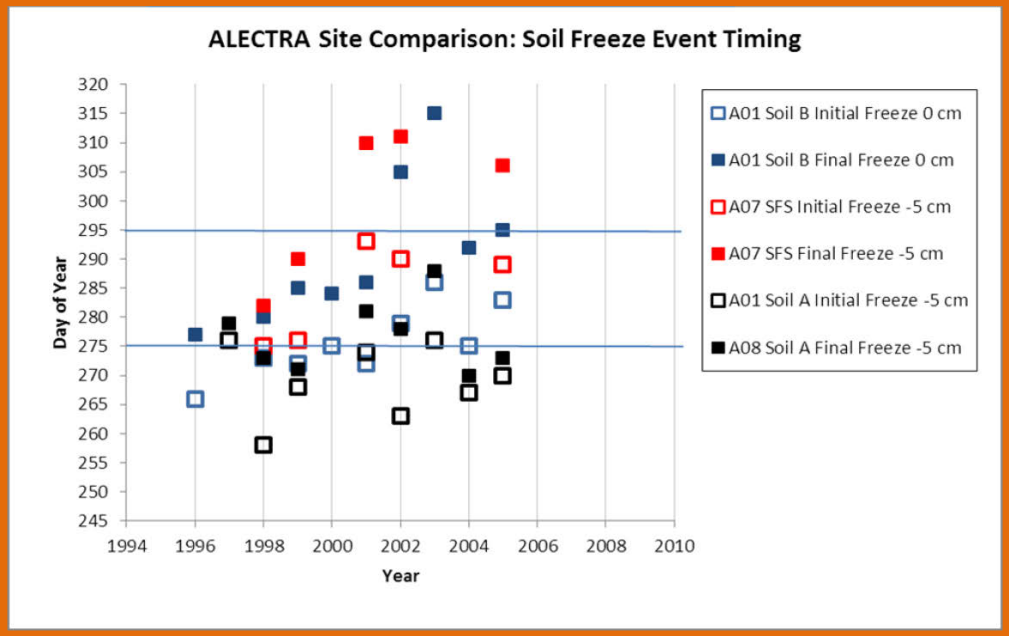
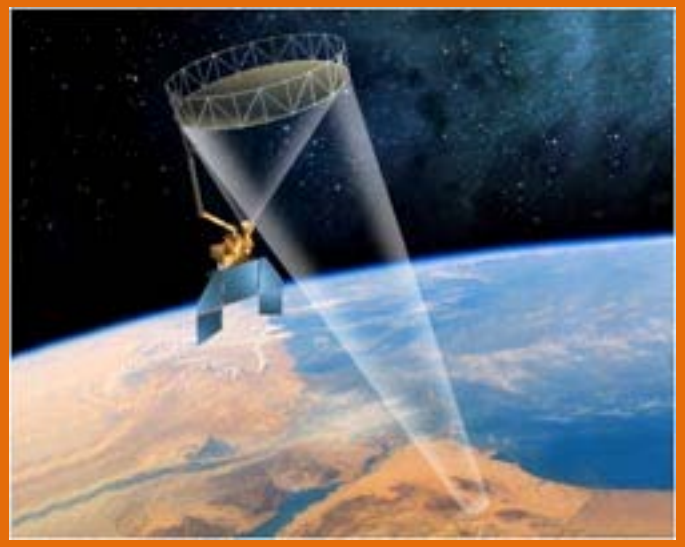


Figure 10. Blue bars indicate dates ensuring CARVE's observation of a complete transition at Bonanza Creek, and nearly complete observations of Coldfoot and Dietrich Valley Treeline, finishing observations 5 days before the former's mean date of final soil freeze and starting observations 6 days after the latter's mean date of initial soil freeze

Further Research

- Further ALECTRA Analysis
- SMAP



Acknowledgements

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- Martin Mathews, Gerry Simila, and Petra Kneissl-Milanian