

Arctic Plants & Climate Change

Robert Slider



Arctic Circle 66°30' N

COLD!

**24 Daylight
in Summer**

**24 Night in
the Winter**



The Tundra

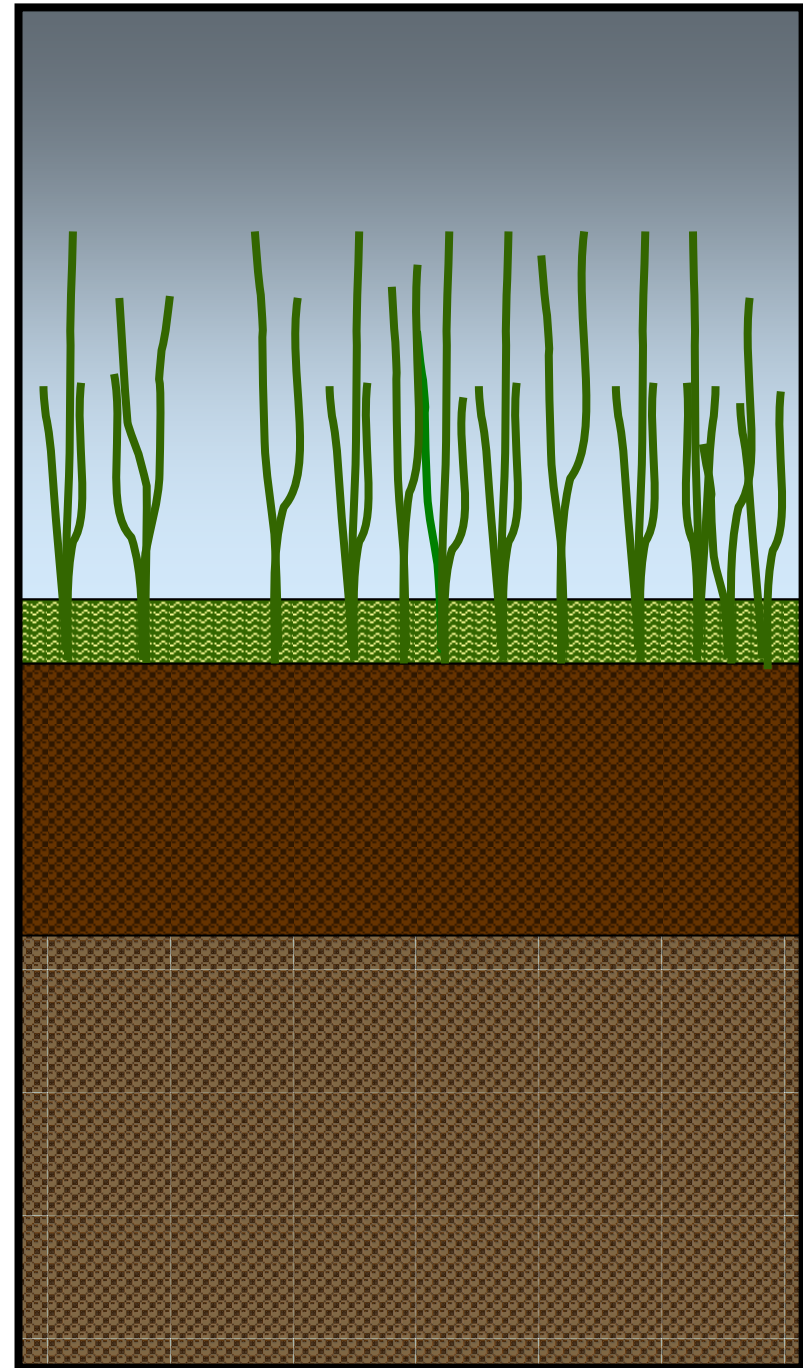


Tundra Cross Section

Vegetation Layer
(Mosses, Grasses, and
Other Plants)

Active Layer
(Thawed soil)

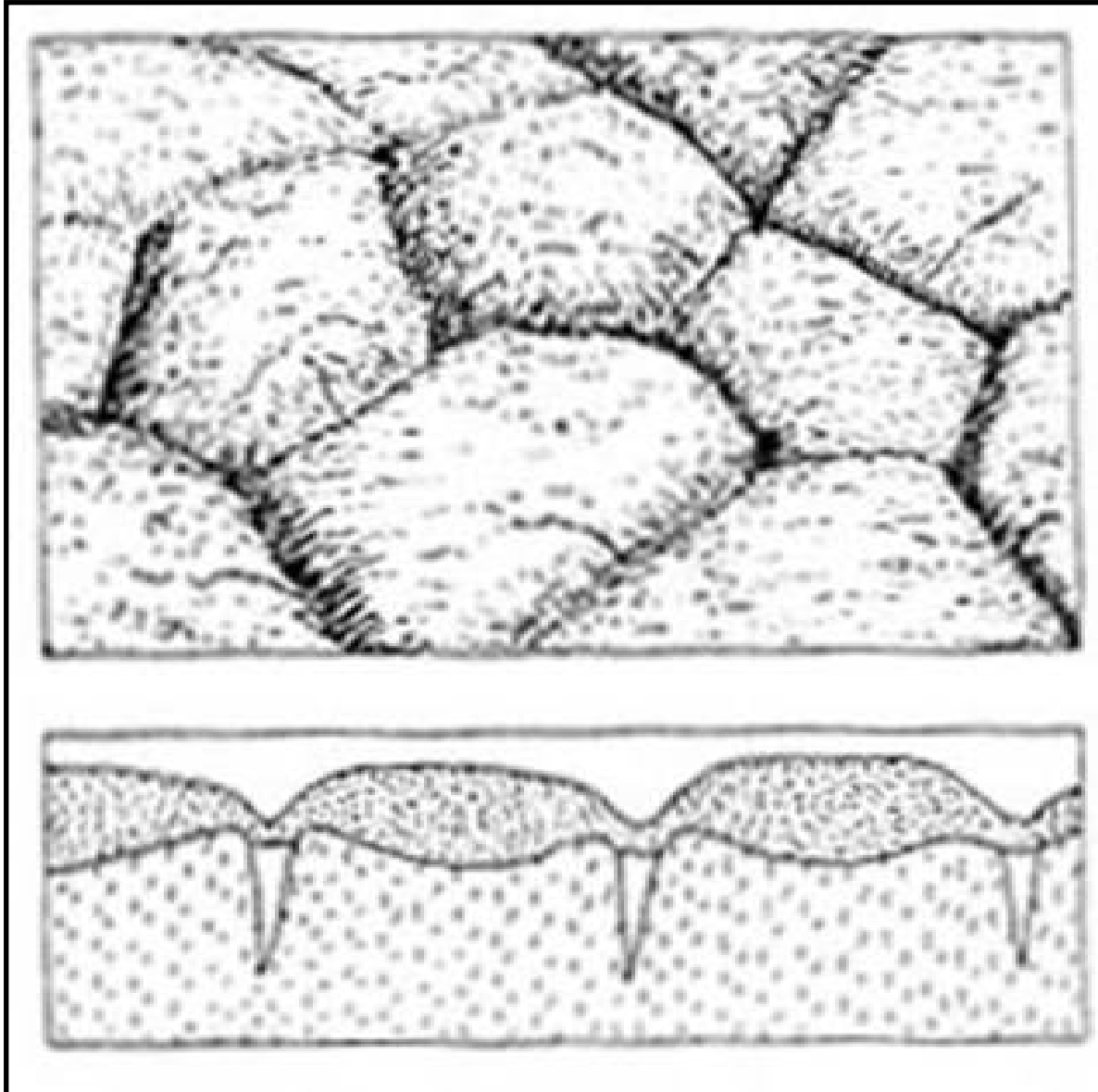
Permafrost
(Permanently frozen soil)



Ice Wedge



Tundra Polygons





Pingo



Cold-Hardy Plants & Animals

Caribou



Arctic Grass (*Poa arctica*)



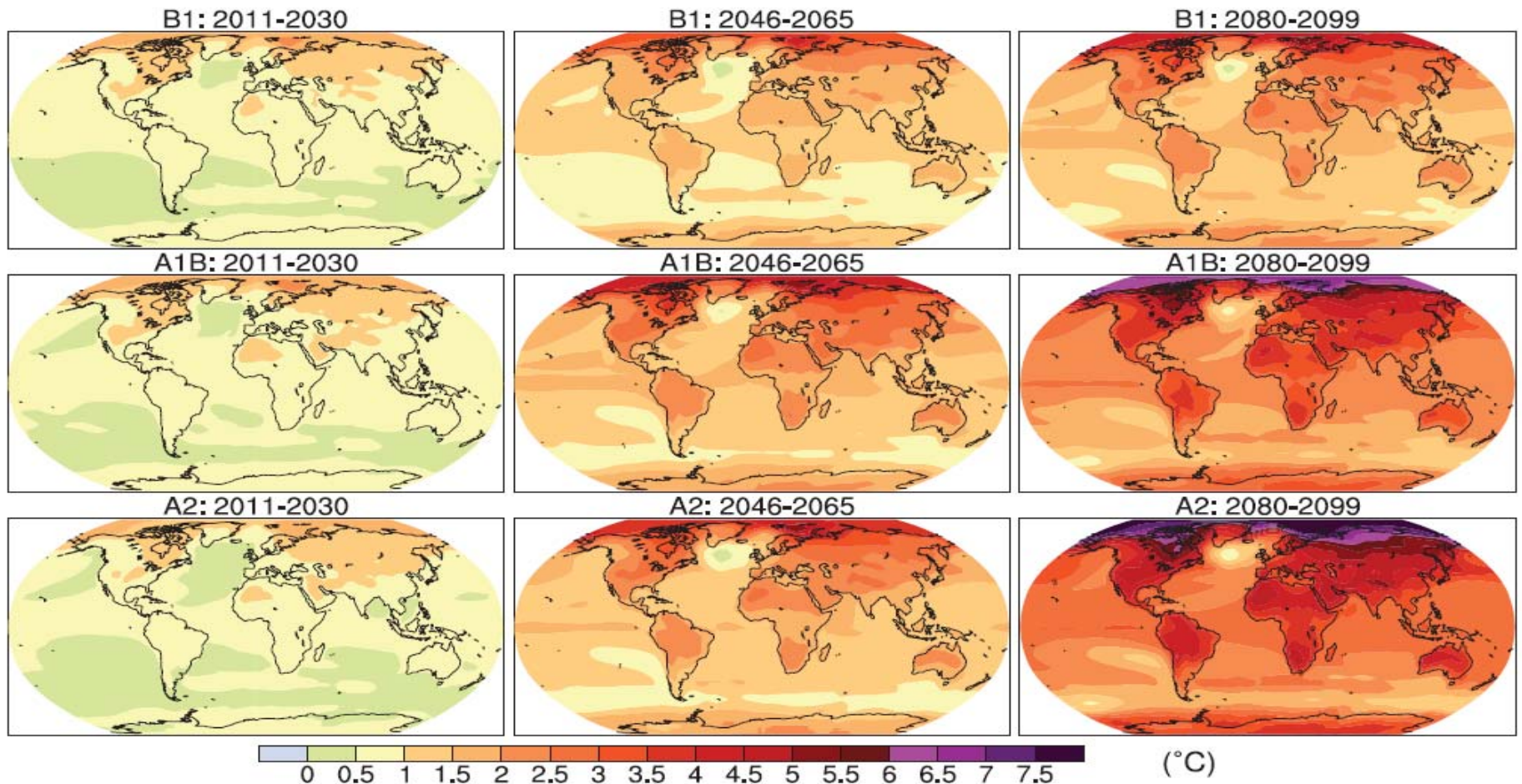
Climate Change

Predicted Impacts

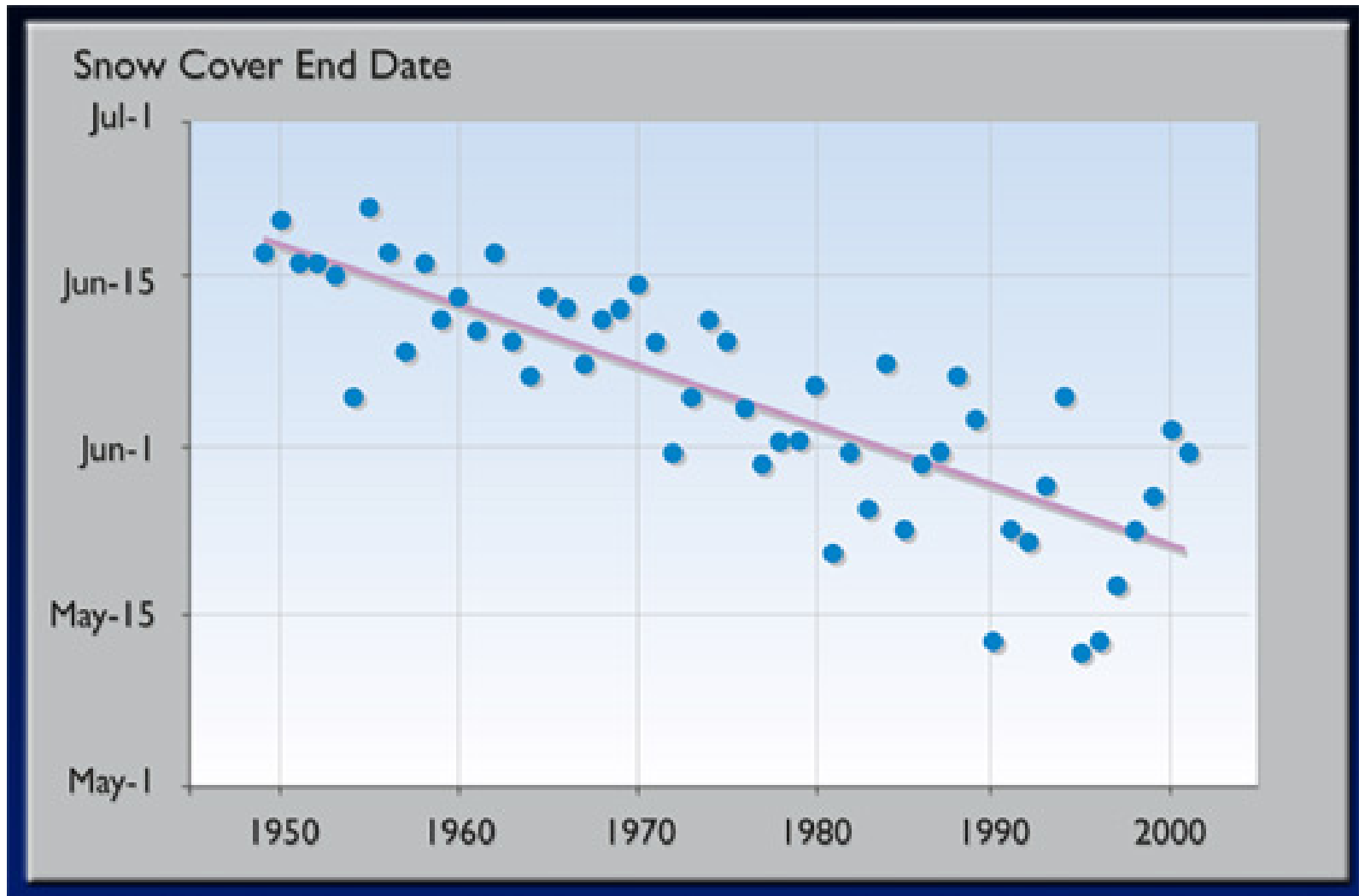
Temperature

Increase 4 - 8°C in the next 100 years

(Meehl et al. 2007)



Observed Snow Cover Change Barrow, Alaska



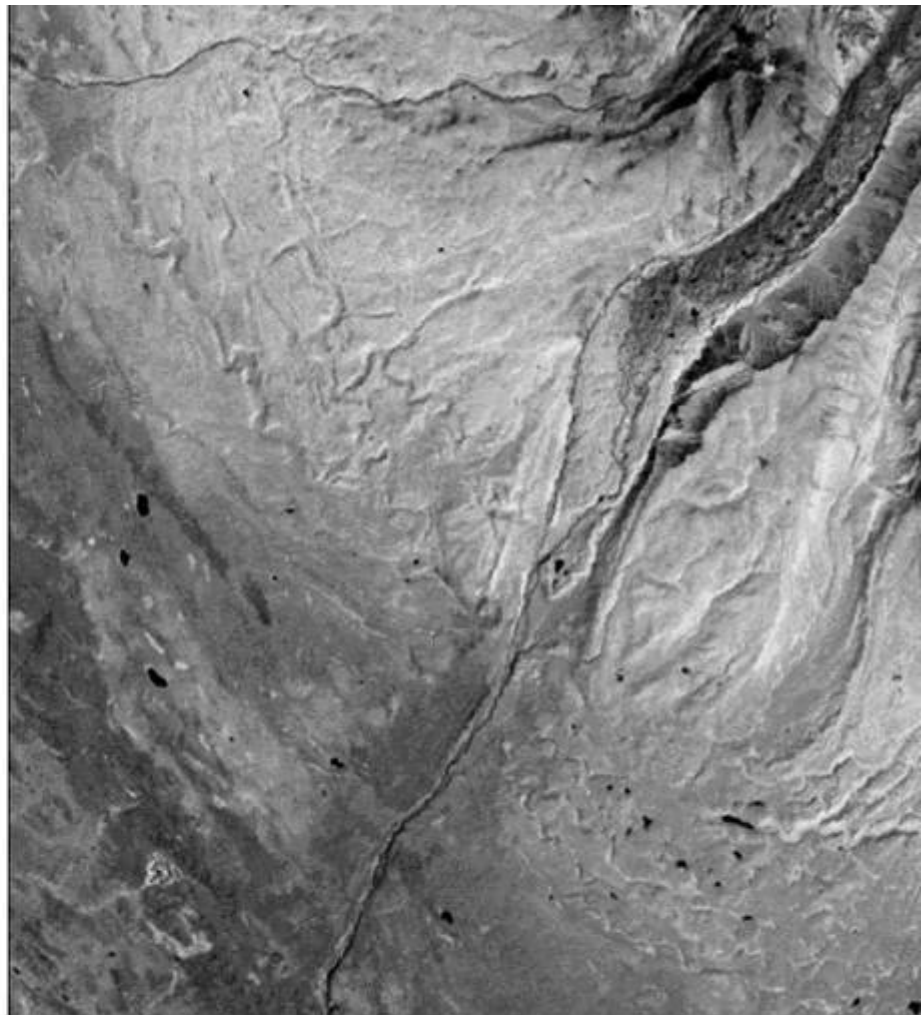
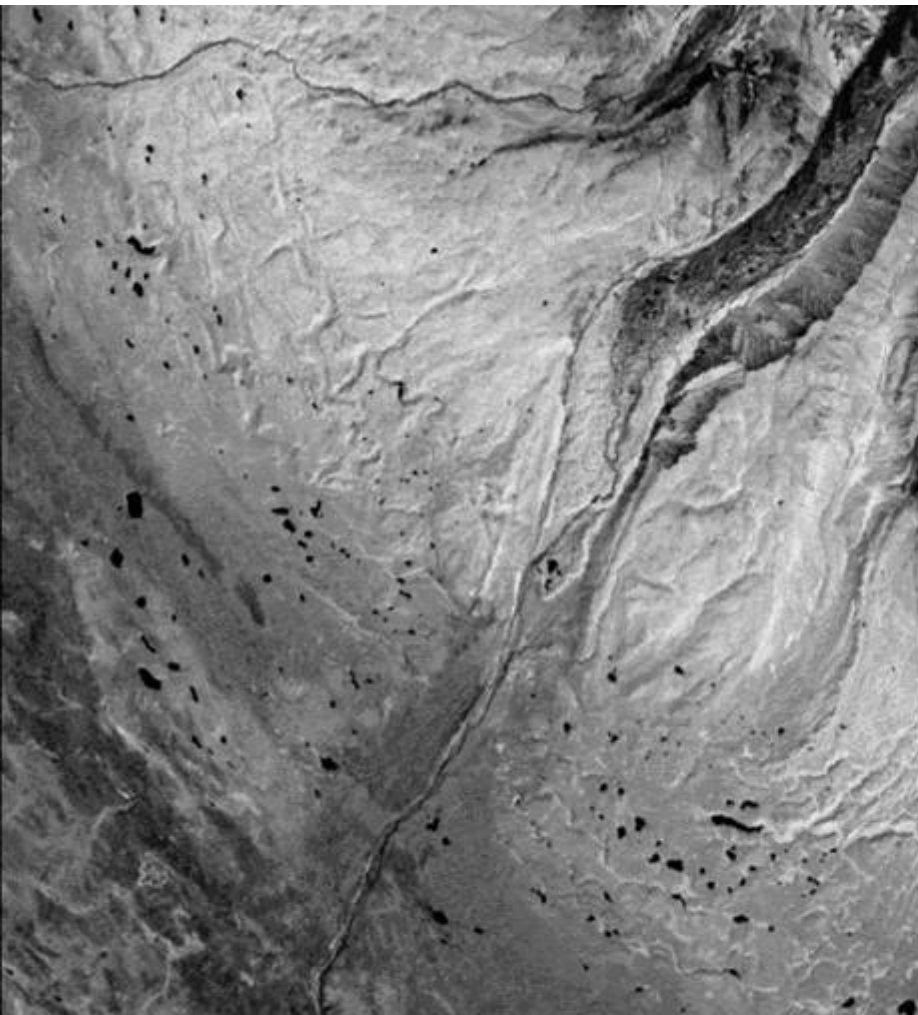
(Meehl et al. 2007)

Drunken Forest



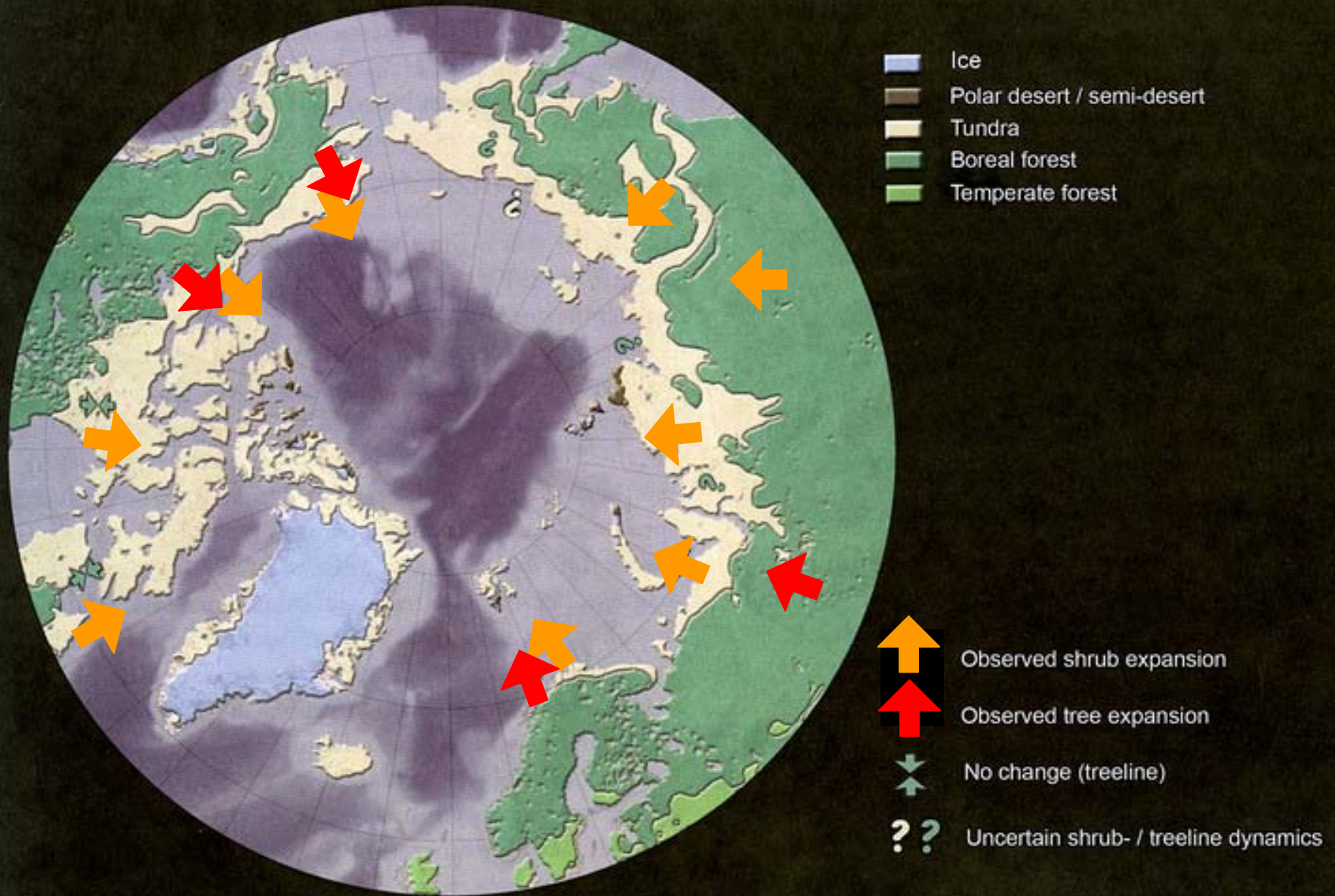
Melting Permafrost





Draining Thaw Lakes in Alaska (Meehl 2007)

Summary of Observed **Tree** and **Shrub** Expansion



Forest growth in northern Sweden



1906



1986

temperature has
increased but land use
has also changed



Shrub expansion
Alaska 1949 – 2001



Our Lab's Main Question

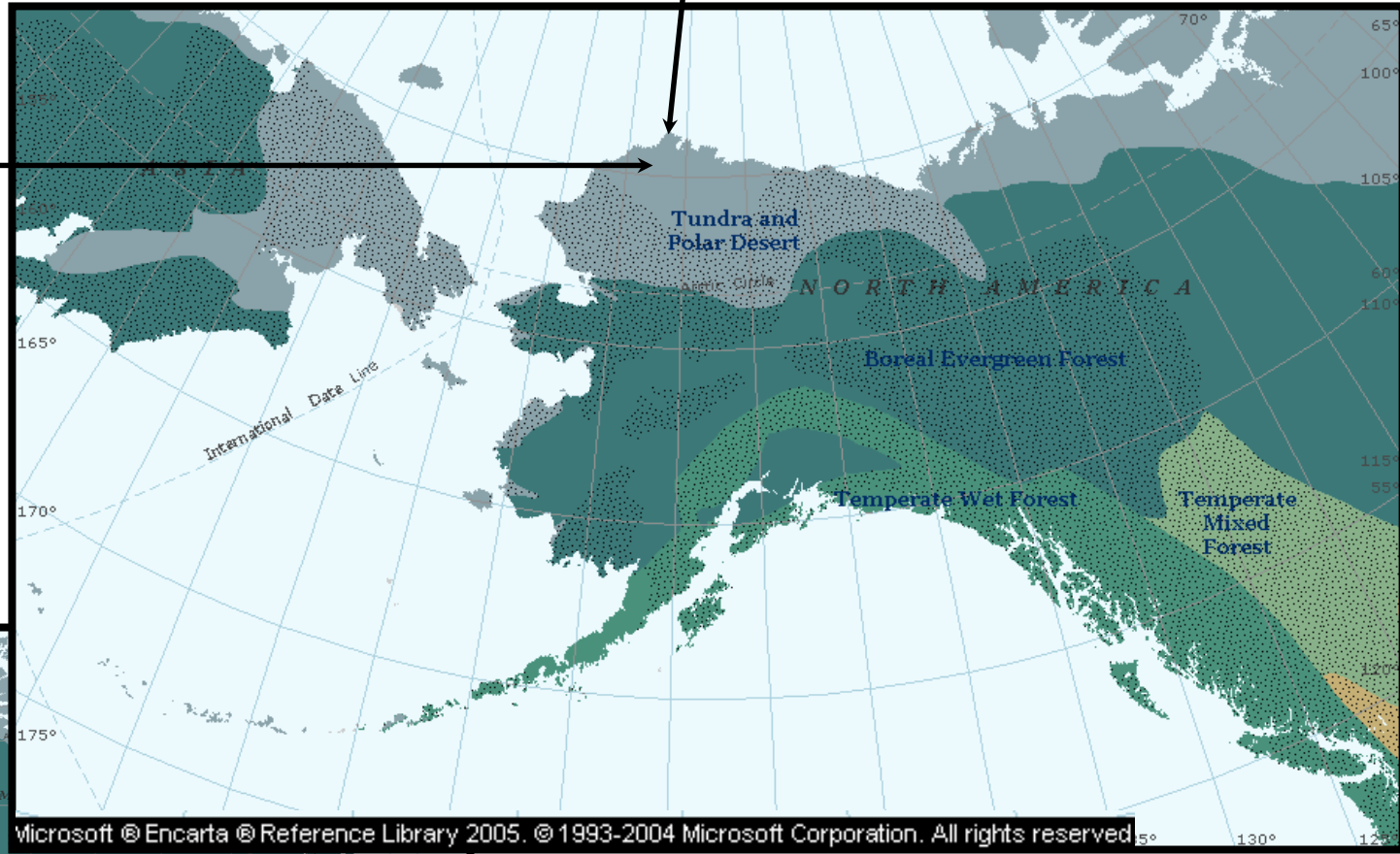
How will Arctic plants be effected by Climate Change?



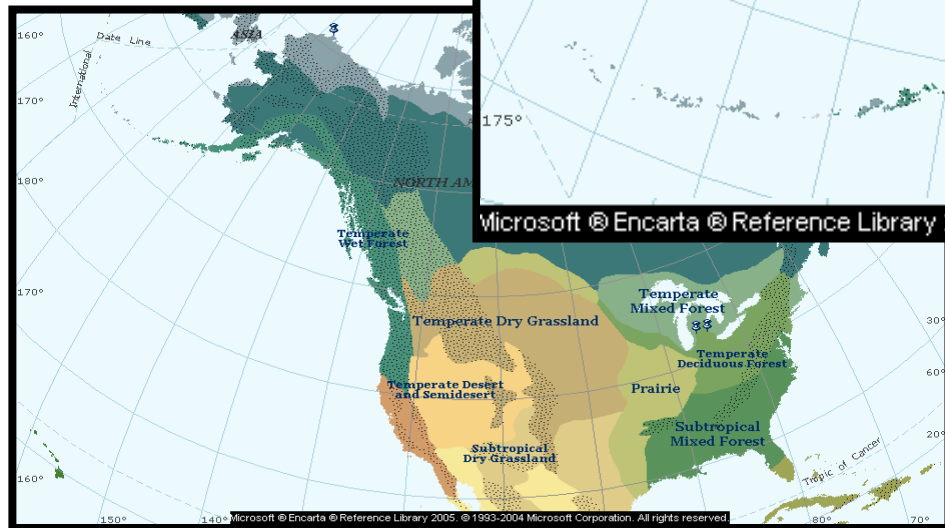
Study Sites

**Barrow 71°18'N
156°40'W**

**Atqasuk
70°29'N
157°25'W**

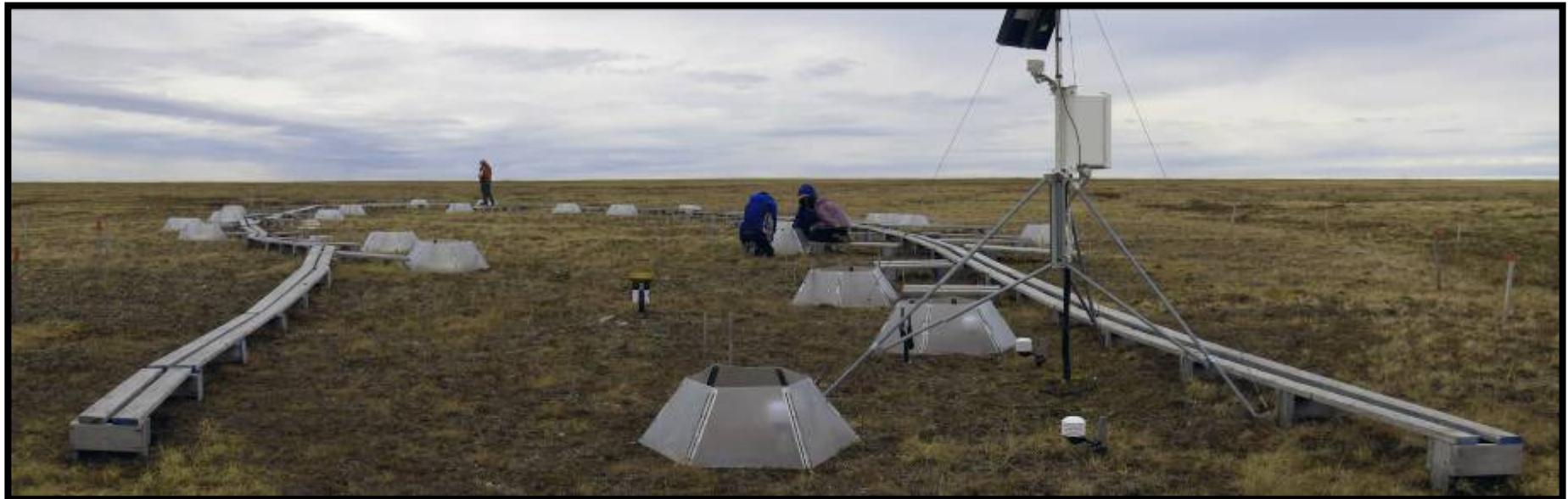
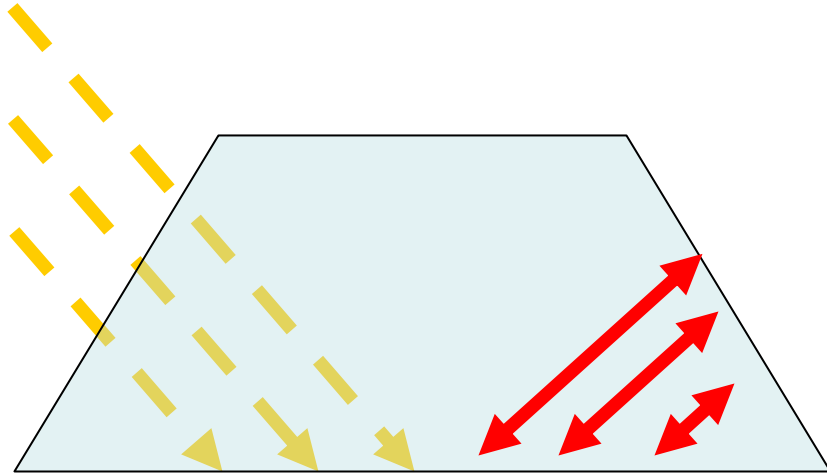


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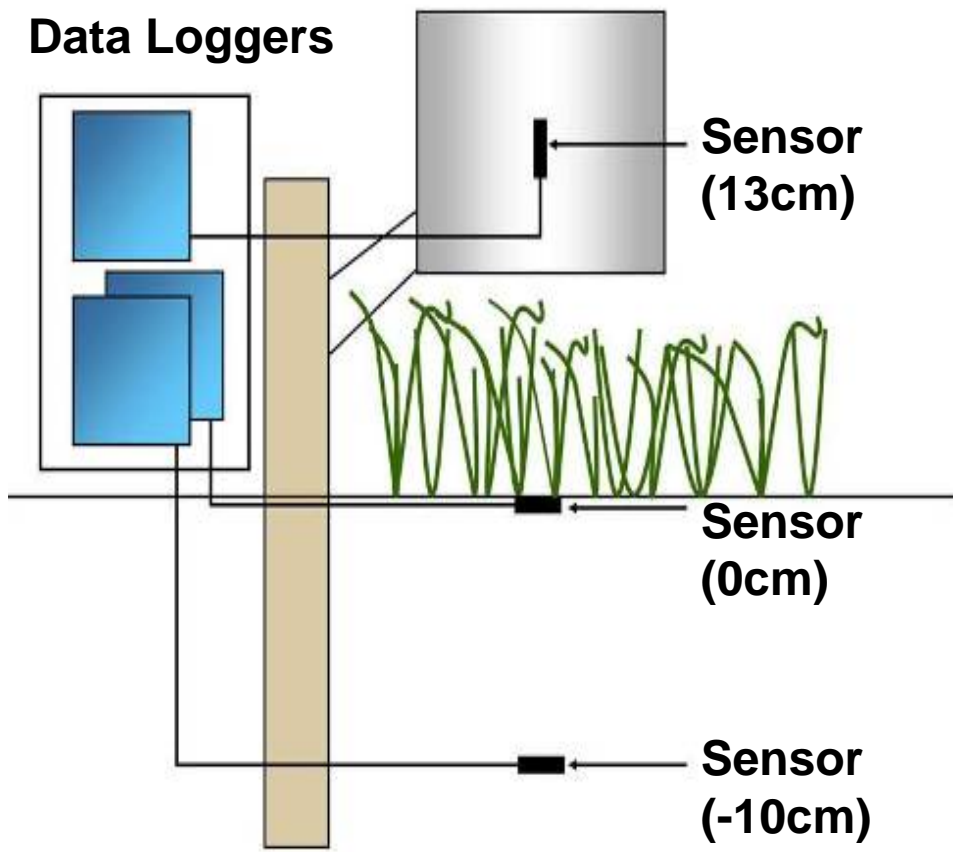


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Open Top Chambers



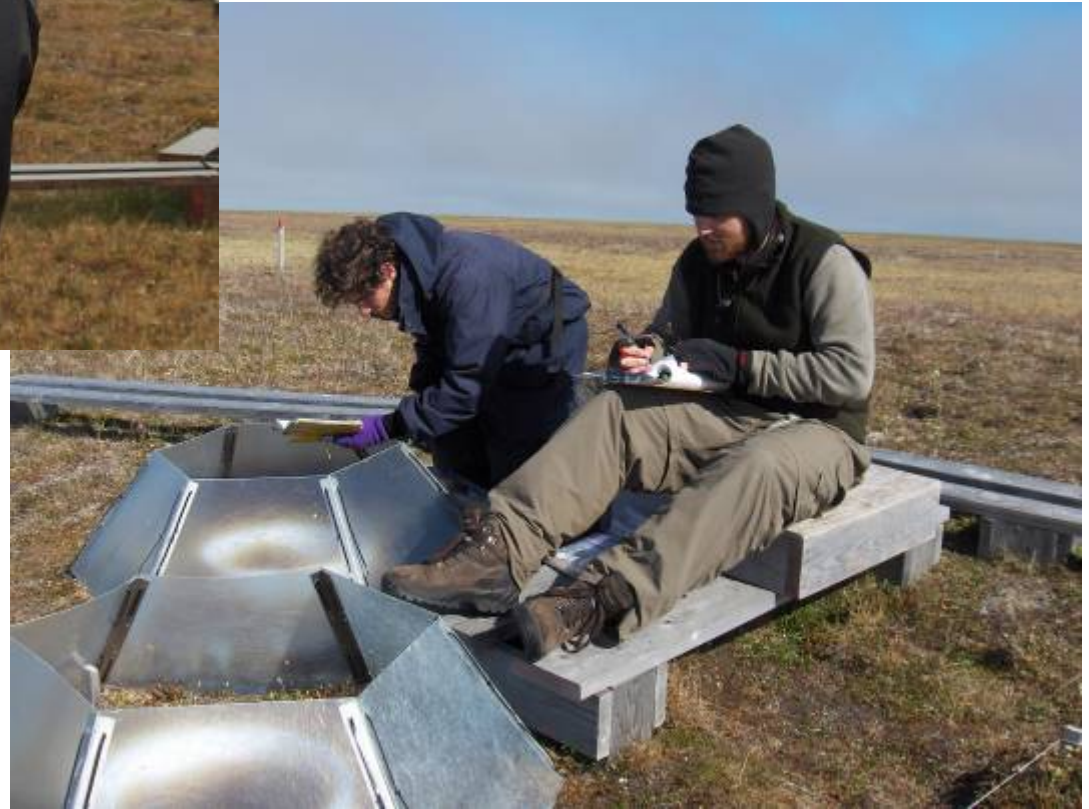
Data Loggers





My Job

Gather & Analyze Data
Present Findings



Phenology

- Observe progression of life cycle through time



Growth Measures

- Track heights of leaves
- Track heights of flowers



Flower Counts

- Count number of flowers in each plot



Species:

Cassiope tetragona

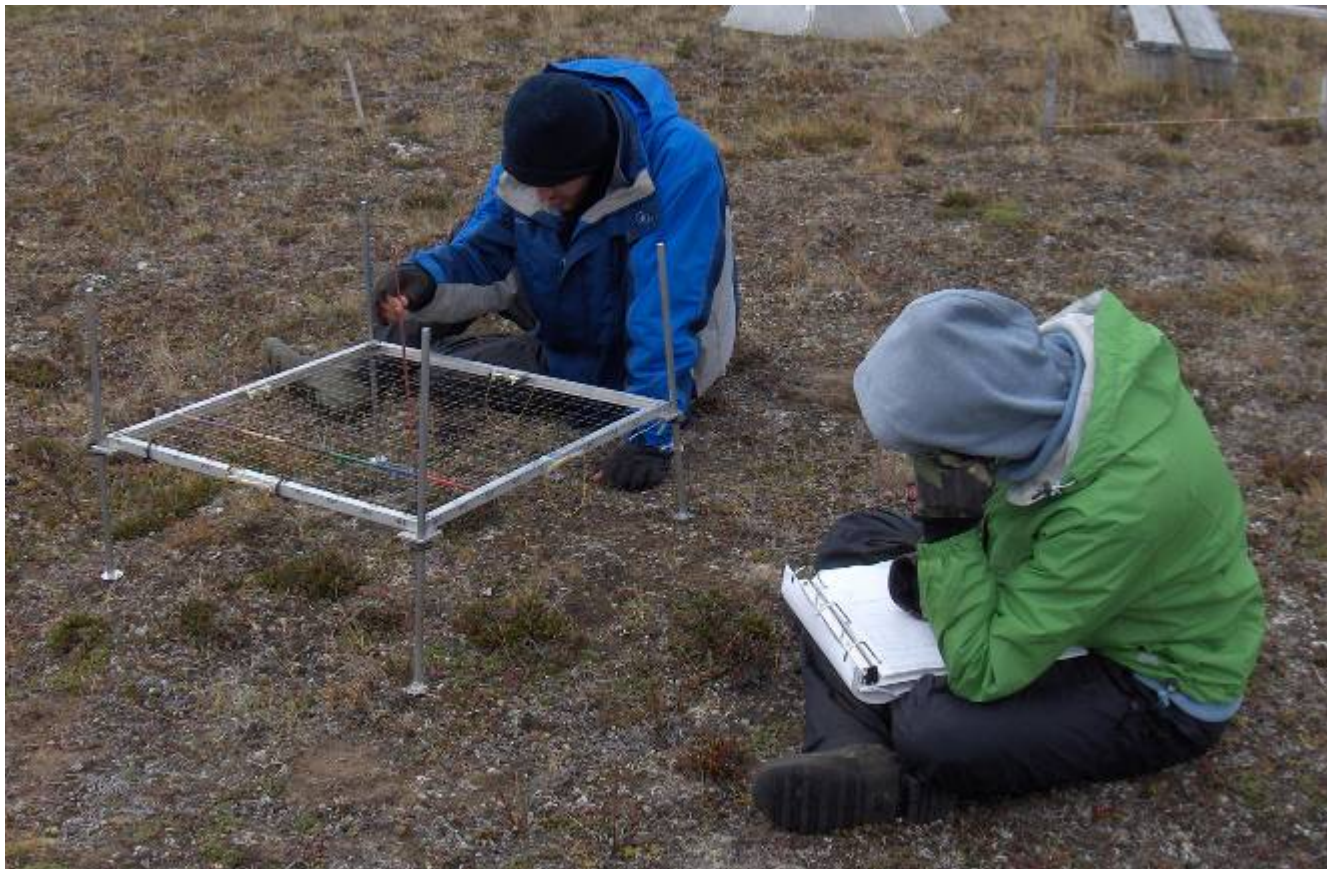
Record Count:

856 flowers in one plot.

Set by Jeremy May on
Julian Day 196 of 2008

Point Framing

- Use 100-point grid to catalogue the species “hit” by a ruler on its way to the ground

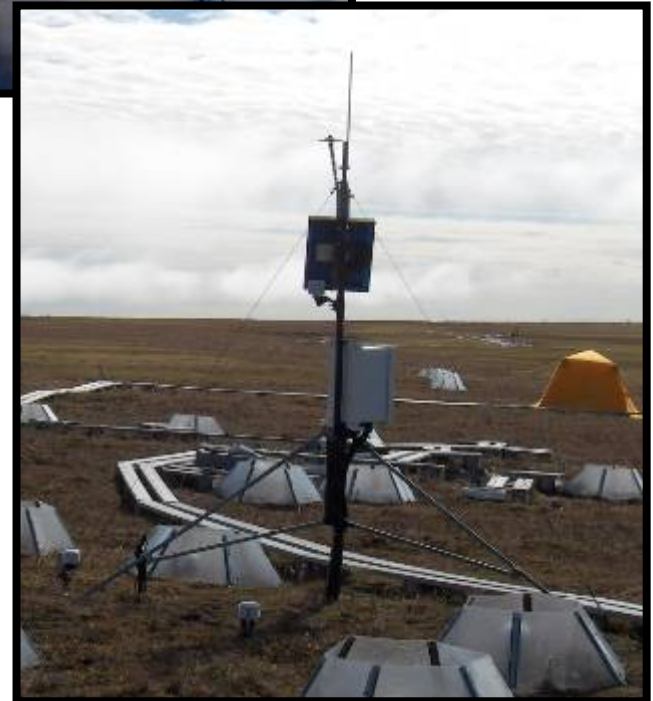


Measurements

- Thaw Depth
(Poke the ground with a stick until you hit hard stuff—that's the permafrost)



- Air and Soil Temperatures
(Store with Data Loggers)



Making Science

Gather Data in Field



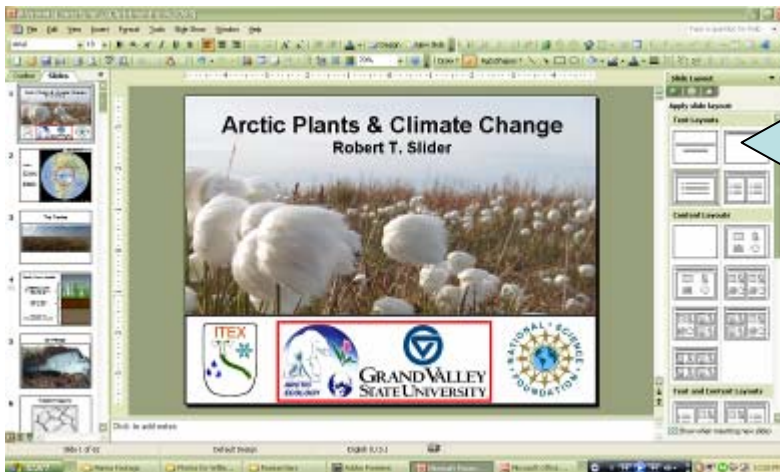
Enter in Databases

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
3	SHRE1	Cardamine pratensis	CRPABTFF	Flor	0	0	0	0	0	0	0	0	0	0	0	0
4	SHRE1	Cardamine pratensis	CRPABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
5	SHRE1	Cardamine pratensis	CRPABTFF	Solan	0	0	0	0	0	0	0	0	0	0	0	0
6	SHRE1	Cardamine pratensis	CRPABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
7	SHRE1	Carex squarrosiflora	CSQABTFF	Flor	0	0	0	0	0	0	0	0	0	0	0	0
8	SHRE1	Carex squarrosiflora	CSQABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
9	SHRE1	Carex squarrosiflora	CSQABTFF	Solan	0	0	0	0	0	0	0	0	0	0	0	0
10	SHRE1	Carex squarrosiflora	CSQABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
11	SHRE1	Carex squarrosiflora	CSQABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
12	SHRE1	Dryopteris Filiformis	DRYABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
13	SHRE1	Dryopteris Filiformis	DRYABTFF	Flor	0	0	0	0	0	0	0	0	0	0	0	0
14	SHRE1	Dryopteris Filiformis	DRYABTFF	Solan	0	0	0	0	0	0	0	0	0	0	0	0
15	SHRE1	Dryopteris Filiformis	DRYABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
16	SHRE1	Erigeron phillyriae	ERPHABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
17	SHRE1	Erigeron phillyriae	ERPHABTFF	Flor	0	0	0	0	0	0	0	0	0	0	0	0
18	SHRE1	Erigeron phillyriae	ERPHABTFF	Solan	0	0	0	0	0	0	0	0	0	0	0	0
19	SHRE1	Erigeron phillyriae	ERPHABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
20	SHRE1	Erigeron phillyriae	ERPHABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
21	SHRE1	Erigeron phillyriae	ERPHABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
22	SHRE1	Erigeron phillyriae	ERPHABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
23	SHRE1	Erigeron phillyriae	ERPHABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
24	SHRE1	Erigeron phillyriae	ERPHABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
25	SHRE1	Erigeron phillyriae	ERPHABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
26	SHRE1	Erigeron phillyriae	ERPHABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
27	SHRE1	Erigeron phillyriae	ERPHABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0
28	SHRE1	Hieracium pilosella	HPIABTFF	Frut	0	0	0	0	0	0	0	0	0	0	0	0
29	SHRE1	Hieracium pilosella	HPIABTFF	Flor	0	0	0	0	0	0	0	0	0	0	0	0
30	SHRE1	Hieracium pilosella	HPIABTFF	Solan	0	0	0	0	0	0	0	0	0	0	0	0
31	SHRE1	Hieracium pilosella	HPIABTFF	Total	0	0	0	0	0	0	0	0	0	0	0	0

Check for Errors



Present Findings!



Questions?



Why be a Researcher?



Nice Landscapes



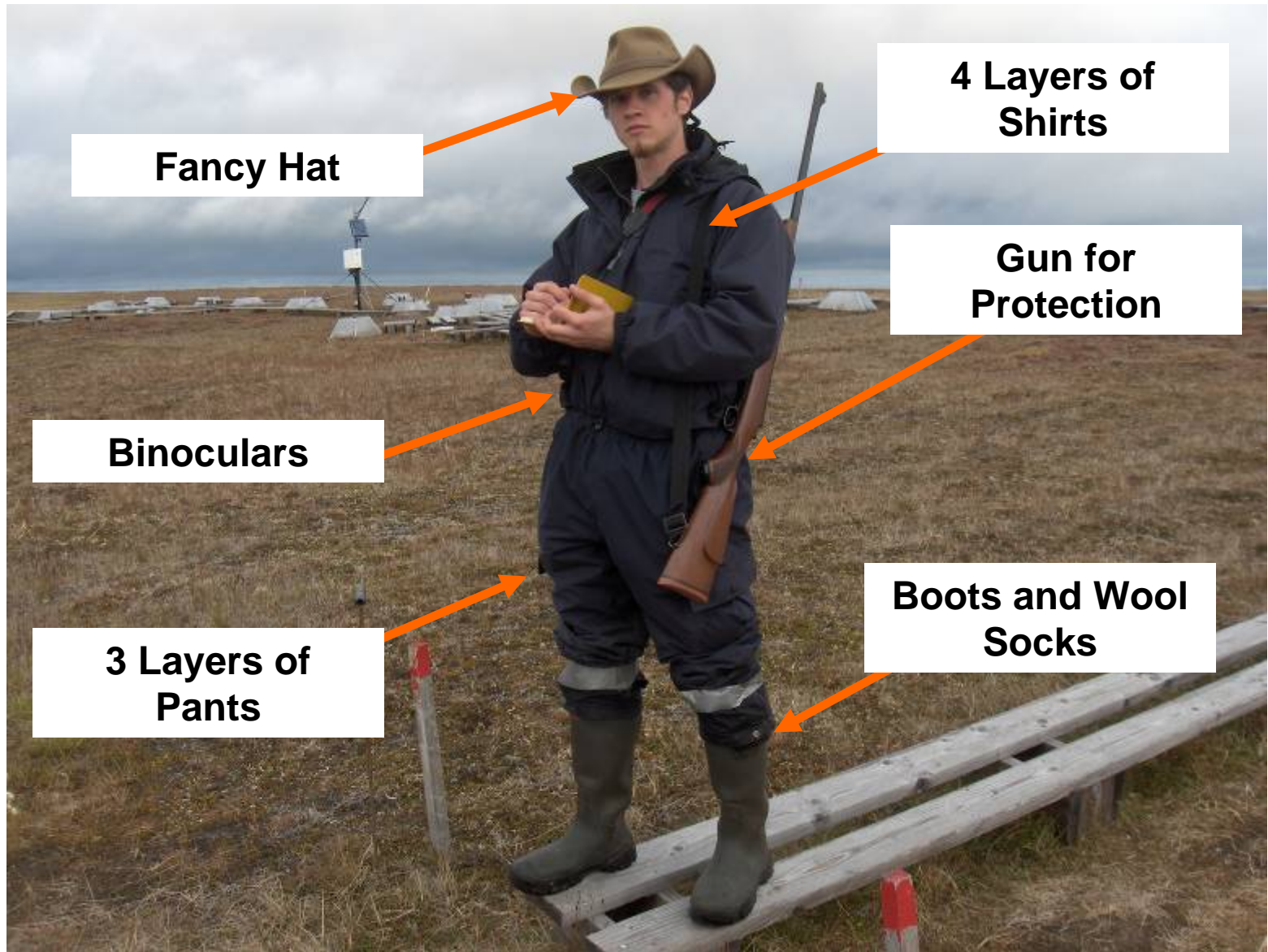
Fun Transportation



Lots of Time Outside



Spiffy Outfits



Fancy Hat

4 Layers of Shirts

Gun for Protection

Binoculars

Boots and Wool Socks

3 Layers of Pants

And of Course...

Lots of Cool Plants and Animals



Jaeger



Willow Bush

(*Salix rotundifolia*)



Ermine



Spiderplant

(*Saxifraga flagellaris*)



Gray Whale



Bowhead Whale



Woolly Lousewort

(*Pedicularis kanei*)



Woolly Lousewort

(*Pedicularis kanei*)



Ground Squirrel



Snowy Owl



Saxifrage

(*Saxifraga cernua*)



Brown Lemming



Ptarmigan



Water Sedge

(*Carex stans*)



Caribou



???

(*Luzula arctica*)



Polar Bear



Questions?





Adaptations

Growth

Adaptations Growth

Enzymes

High metabolic

High photosynthetic

Perform at low temp

(Chapin and Shaver 1985)

Preform Buds

Overwinter & Early Start

(Billings 1974)



Adaptations Growth

Increased root affinity for P
(Savile 1972)

Mycorrhiza fix N
(Kohn and Statovski 1990)



Adaptations Growth

Evergreen

- Photosynthesize under snow
 - "Longer season"
 - Slower growth
- (Savile 1972, Starr and Oberbauer 1993)

Wintergreen

- Leaves re-green
 - Early start
- (Savile 1972)



Adaptations

Reproduction

Adaptations Reproduction

Stolons & Runners

- Asexual
 - High success rate
 - Colony formation
- (Billings 1974, Savile 1972)

Selfing

- Asexual
 - High success rate
- (Savile 1972)



Adaptations Reproduction

Bulbils

- Asexual
 - High success rate
 - Spread farther
- (Billings 1974, Savile 1972)

Pseudo-vivipary

- Asexual
 - High success rate
 - Spread farther
- (Elmqvist 1996)



Adaptations Reproduction

Flowers

-Attract flies & bees
(Savile 1972)



Wind Pollination

-Many don't depend on
pollinators
(Savile 1972)



Adaptations Reproduction

Heliotropism

- Attract insect pollinators
 - Speed Development
- (Kevan 1975, Savile 1972)



Adaptations

Temperature Regulation

Pubescence

Alpine Origins (Savile 1972)

Trap warm air & accelerate
development

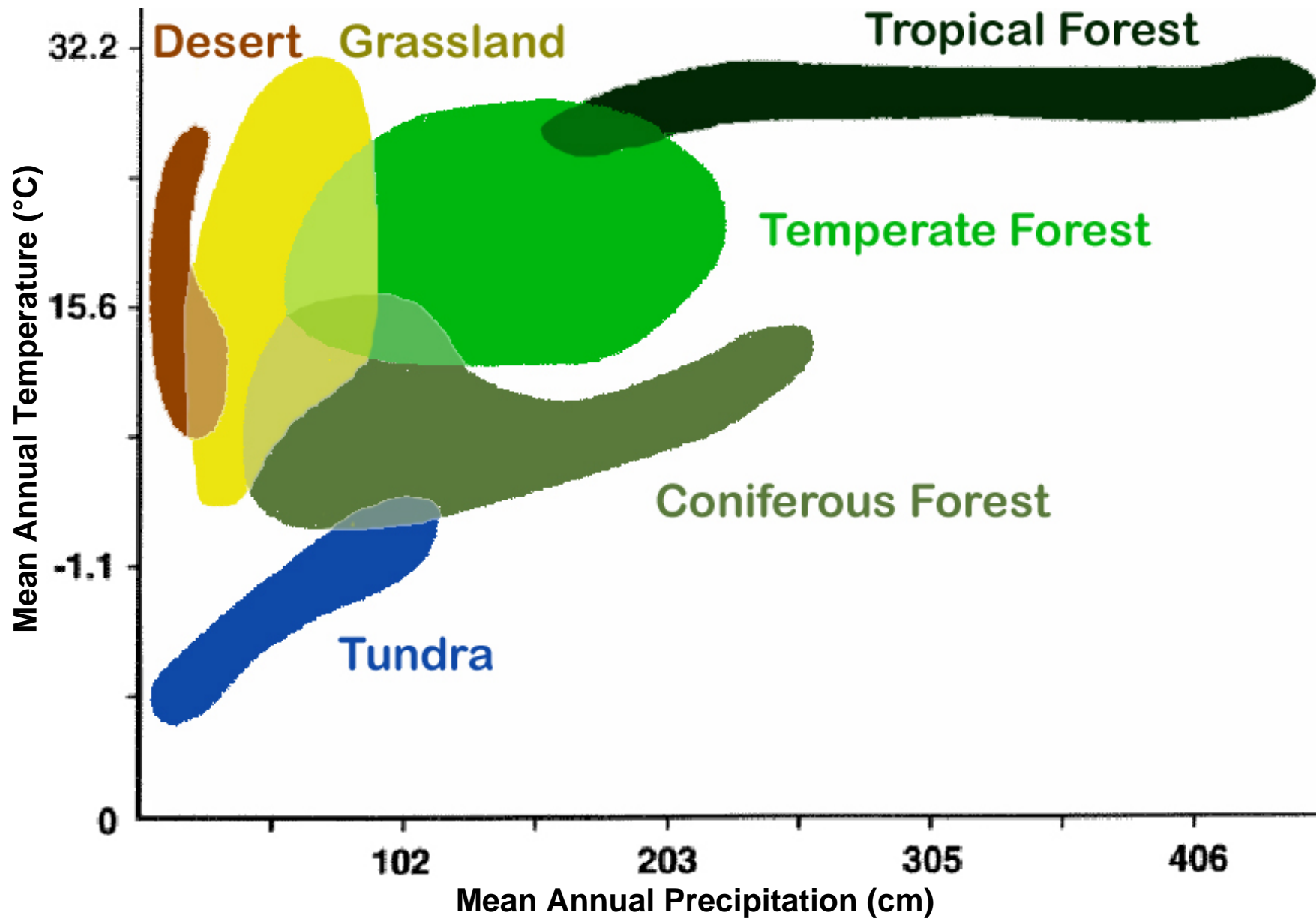
(Savile 1972, Tsukaya 2001)





Vegetation Layer
(Mosses, Grasses, and
Other Plants)

Active Layer
(Thawed soil)



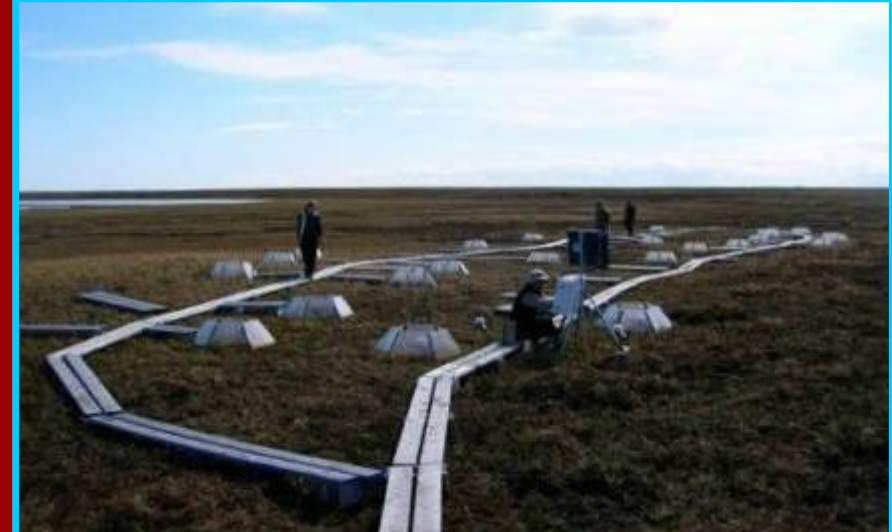
Barrow



DRY

Atqasuk

WET

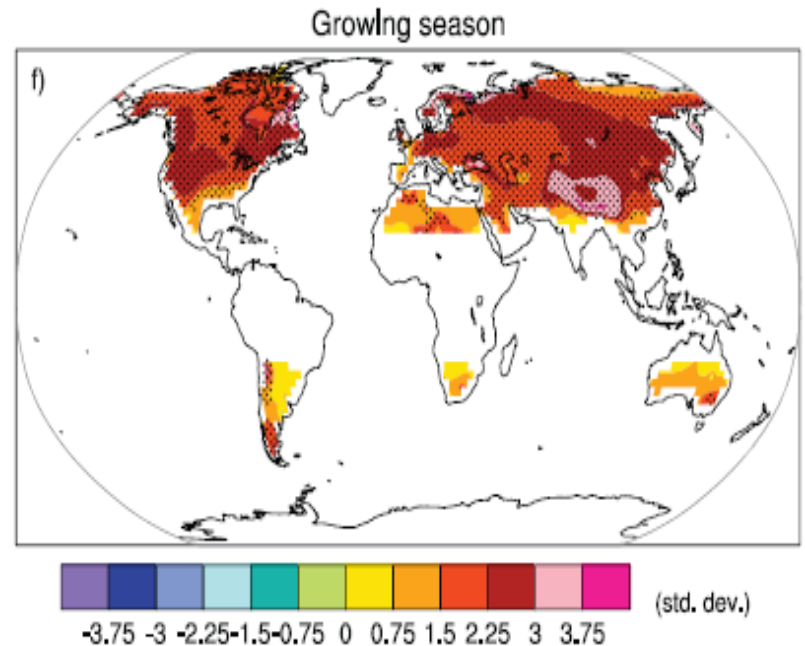


Climate Change

Snow

-Likely to see earlier snow melt
(Asimov et al. 2007, Meehl et al. 2007)

-Snow depth & melt time significantly effects phenology and performance of plant species
(Borner et al 2008)

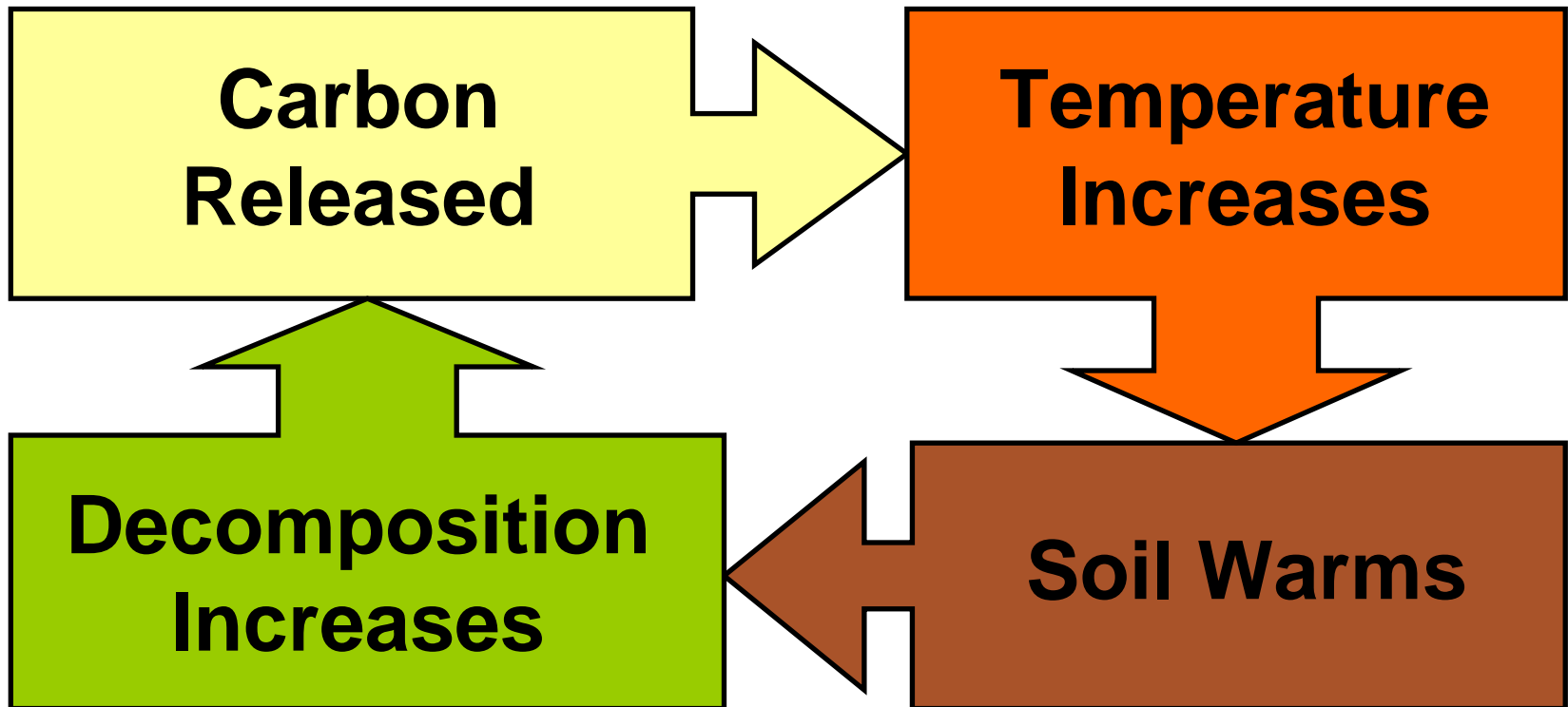


**100 year predictions for Growing Season
(Meehl et al. 2007)**

Implications of Change

Melting of Permafrost and Increase in Active Layer Depth

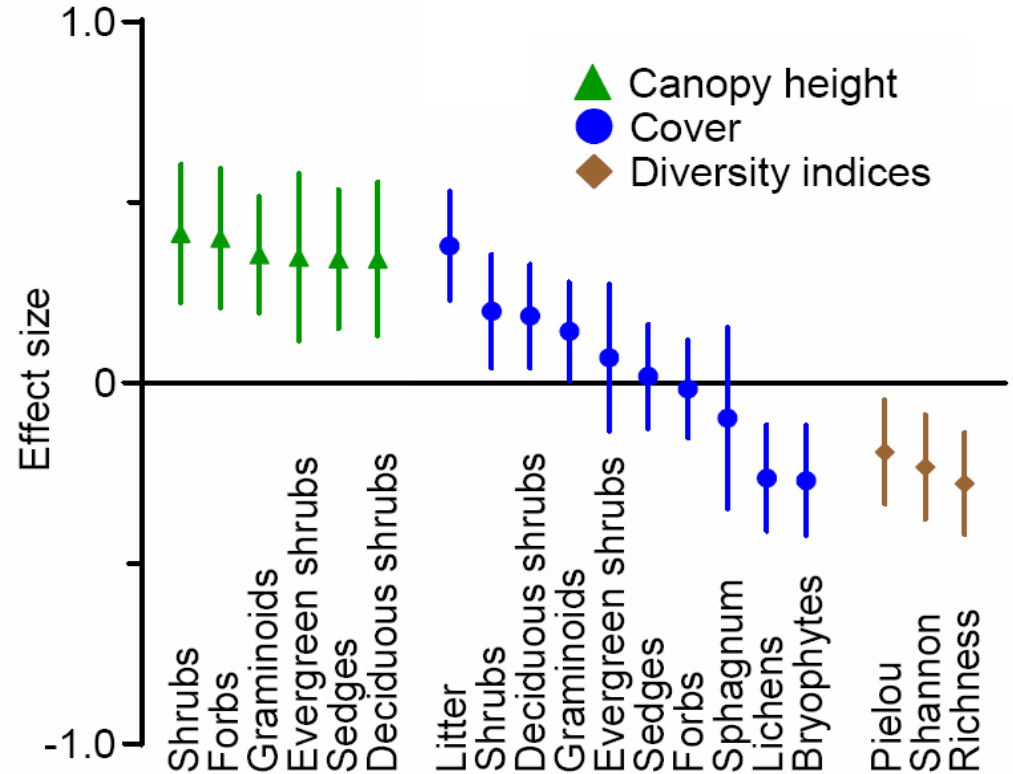
Generation of a Positive Feedback System



Climate Change

Temp. on Plants

-Effect timing, growth, reproductive effort, community composition (Arft et al. 1999, Hollister et al 2005, Walker et al 2006)



ITEX results as shown in Response of Tundra Vegetation to Temperature (Hollister & Webber 2005)

Light Exposure

Active Layer Depth



Arctic Plant

Limitations



Temperature

Nutrient Availability

Adaptations

Temperature Regulation

Dense Foliage

Form Rosettes & Colonies

Trap warm air & protect
meristems

(Savile 1972)



Adaptations

Temperature Regulation

Dead Tissues

Trap warm air & protect meristem

(Billings 1974, Savile 1972)

