

Planning for torpor at the first ITEX site

Alexandra Fiord, Ellesmere Island

Greg Henry (& many others)
University of British Columbia
2018 ITEX Meeting Stirling



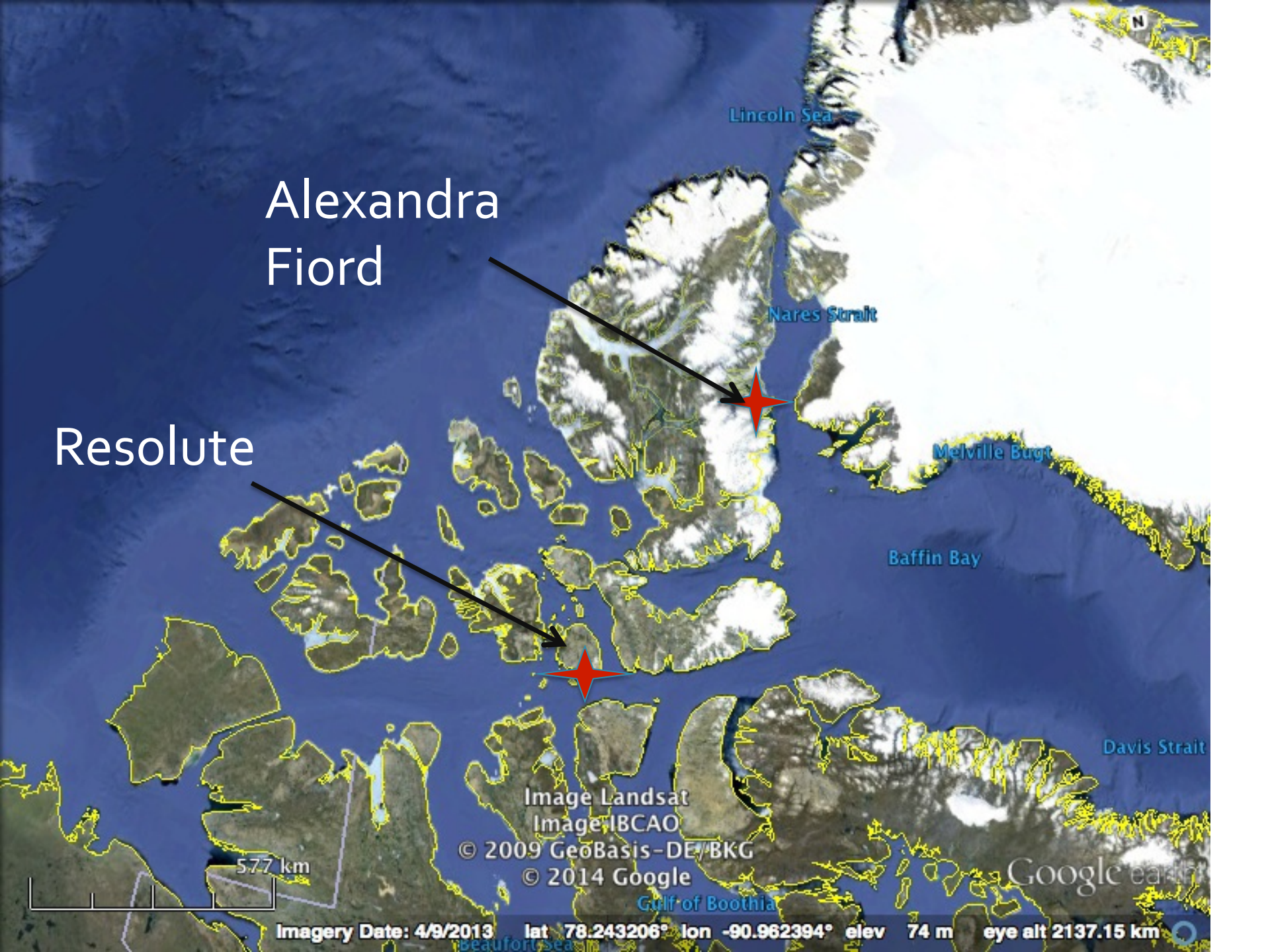
N

1541 km

Image Landsat
Image IBCAO
US Dept of State Geographer
© 2014 Google

Google earth

Imagery Date: 4/9/2013 lat 68.915085° lon -102.063773° elev 39 m eye alt 4136.33 km



Alexandra
Fiord

Resolute

Lincoln Sea

Nares Strait

Melville Bay

Baffin Bay

Davis Strait

Image Landsat
Image IBCAO

© 2009 GeoBasis-DE/BKG

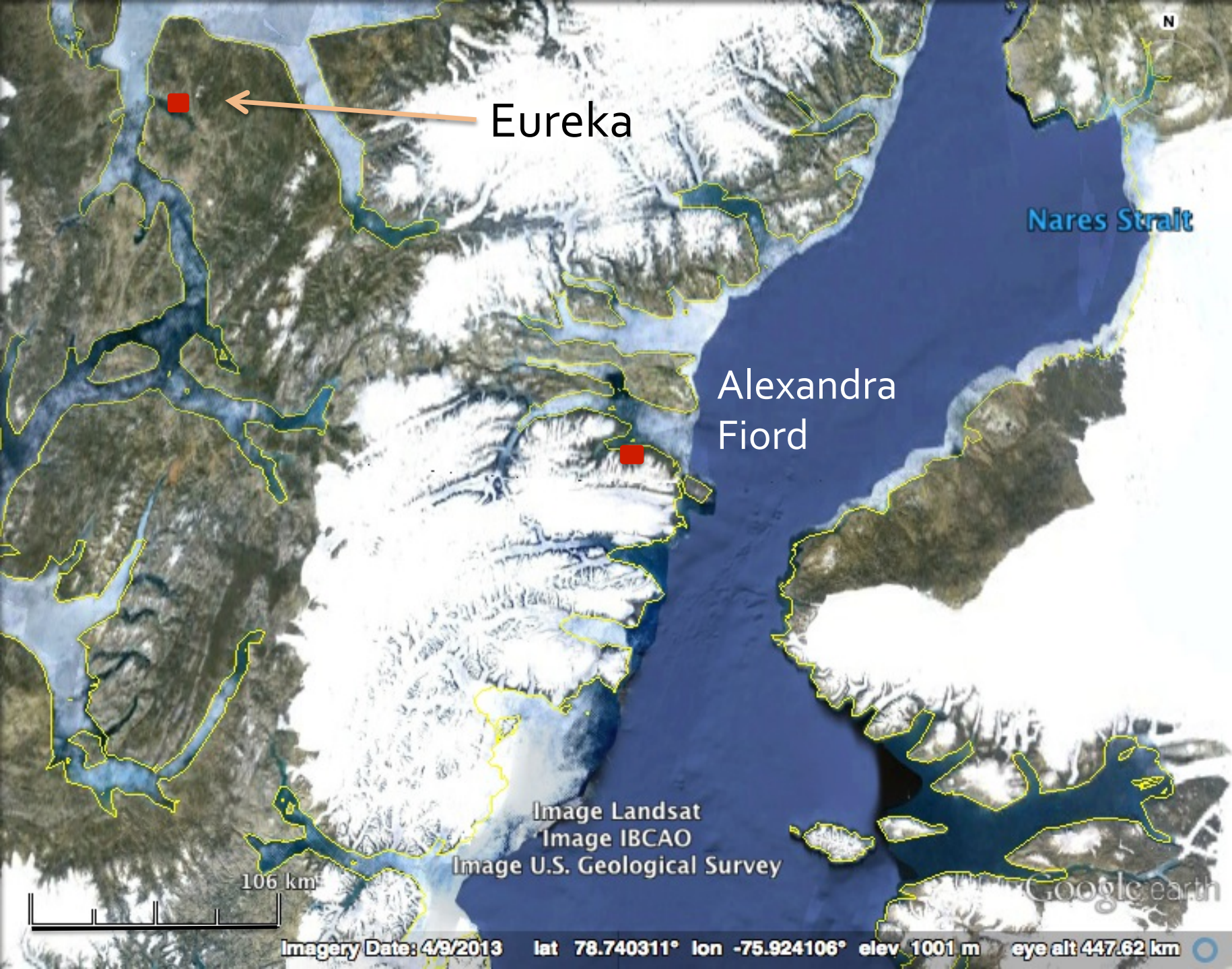
© 2014 Google

Google earth

577 km

Imagery Date: 4/9/2013

lat 78.243206° lon -90.962394° elev 74 m eye alt 2137.15 km



Eureka

Nares Strait

Alexandra
Fiord

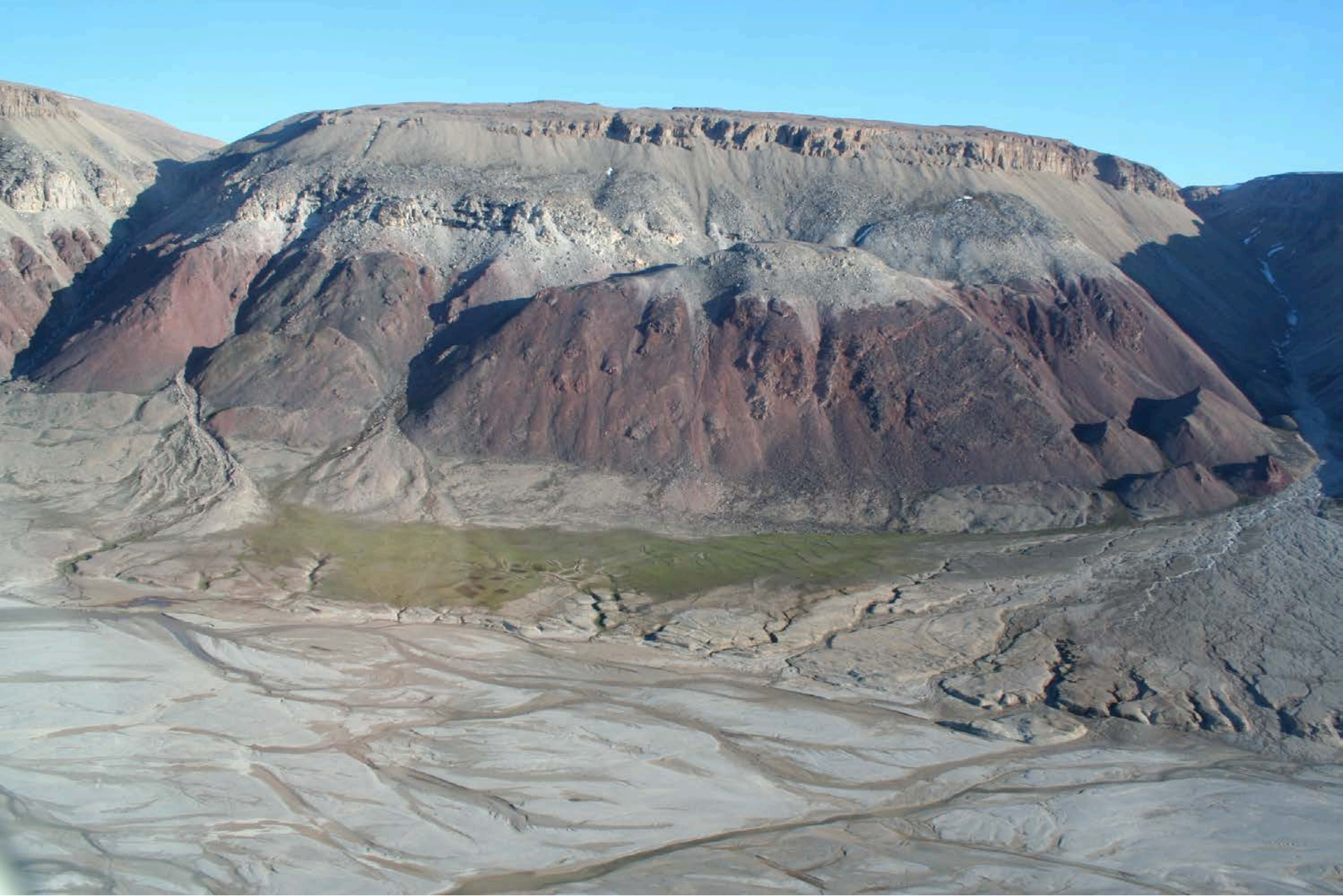
Image Landsat
Image IBCAO
Image U.S. Geological Survey

106 km

Google earth

Imagery Date: 4/9/2013 lat 78.740311° lon -75.924106° elev 1001 m eye alt 447.62 km













ECOLOGY OF A POLAR OASIS



ALEXANDRA FIORD

ELLESMERE ISLAND

CANADA

EDITED BY

JOSEF SVOBODA

AND

BILL FREEDMAN

CAPTUS UNIVERSITY PUBLICATIONS

Scientific history @ Alexandra Fiord

- 1980-1985: Alexandra Fiord project
 - General tundra ecology: climate, vegetation, soils
 - Glacial retreat and succession
 - Testing northern crops
- 1985 – Present: Multiple projects
 - Grazing experiments, site comparison
 - Succession, plant competition, insect studies
- 1992 – present: ITEX – related research
 - Warming, nutrient addition, snow experiments
 - Plant and microbial diversity, GHG flux, NDVI
 - Common garden studies, epigenetics



Position of the Twin
Glaciers in 1959

Advance during LIA

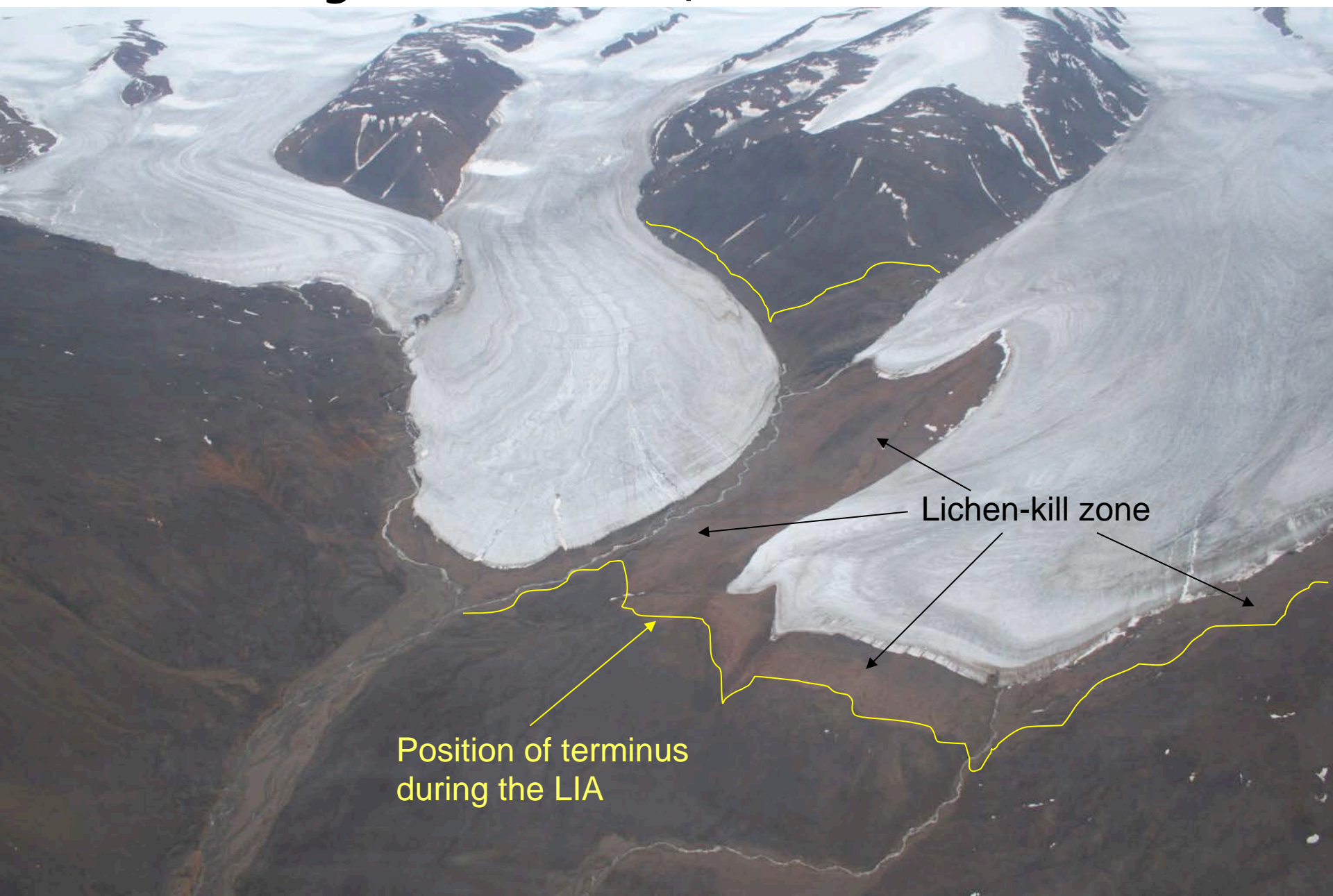


A

B

A-16612-28

Position of glaciers in 2004

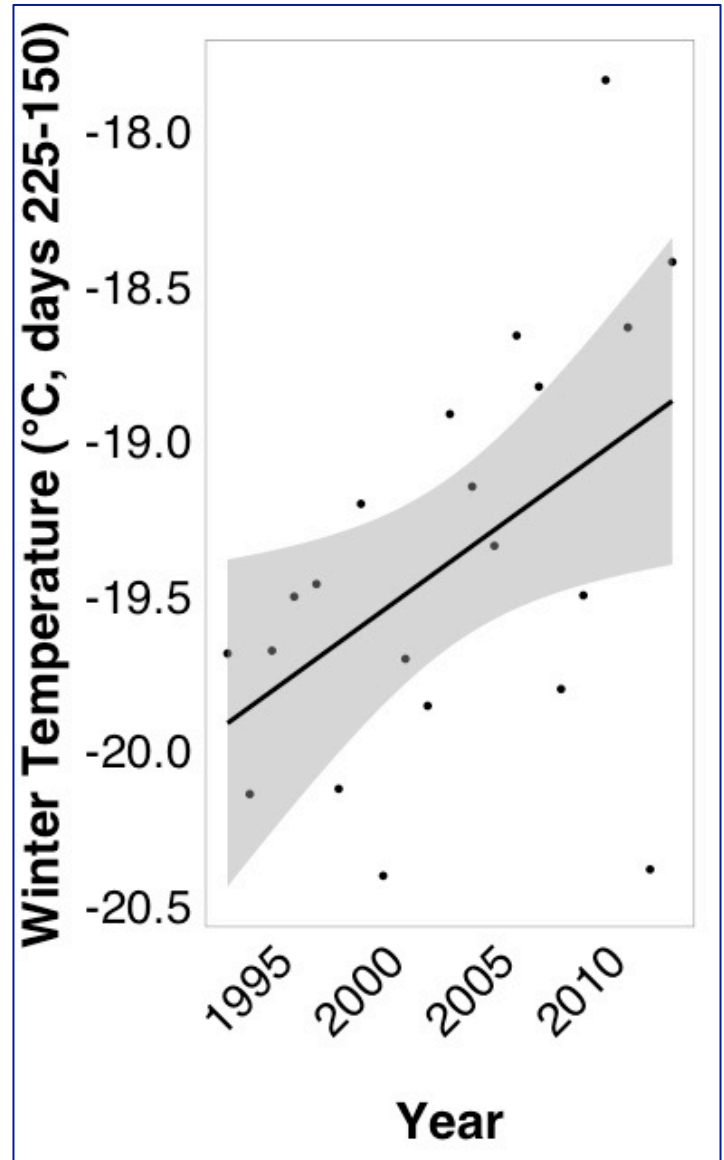
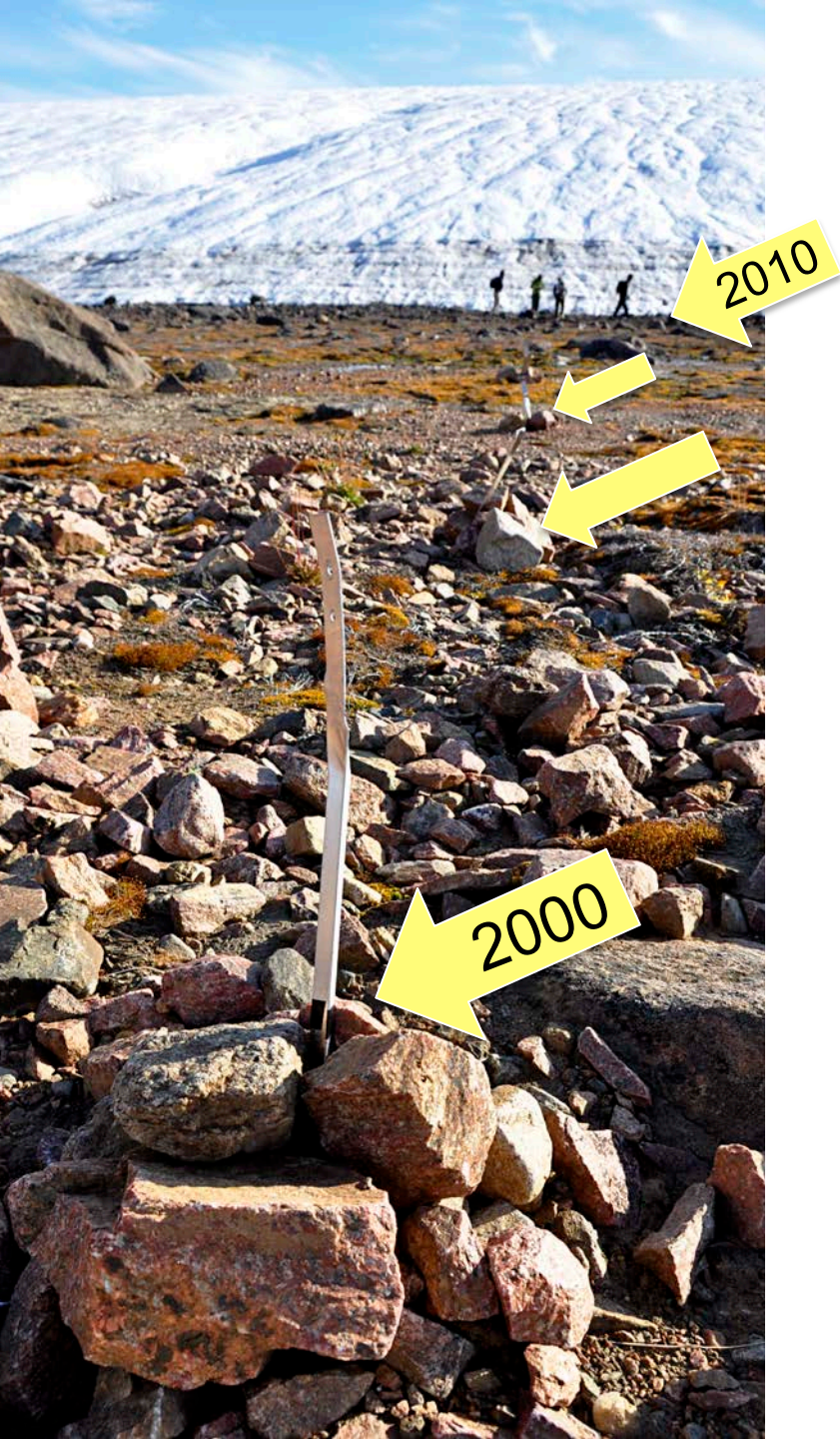


Lichen-kill zone

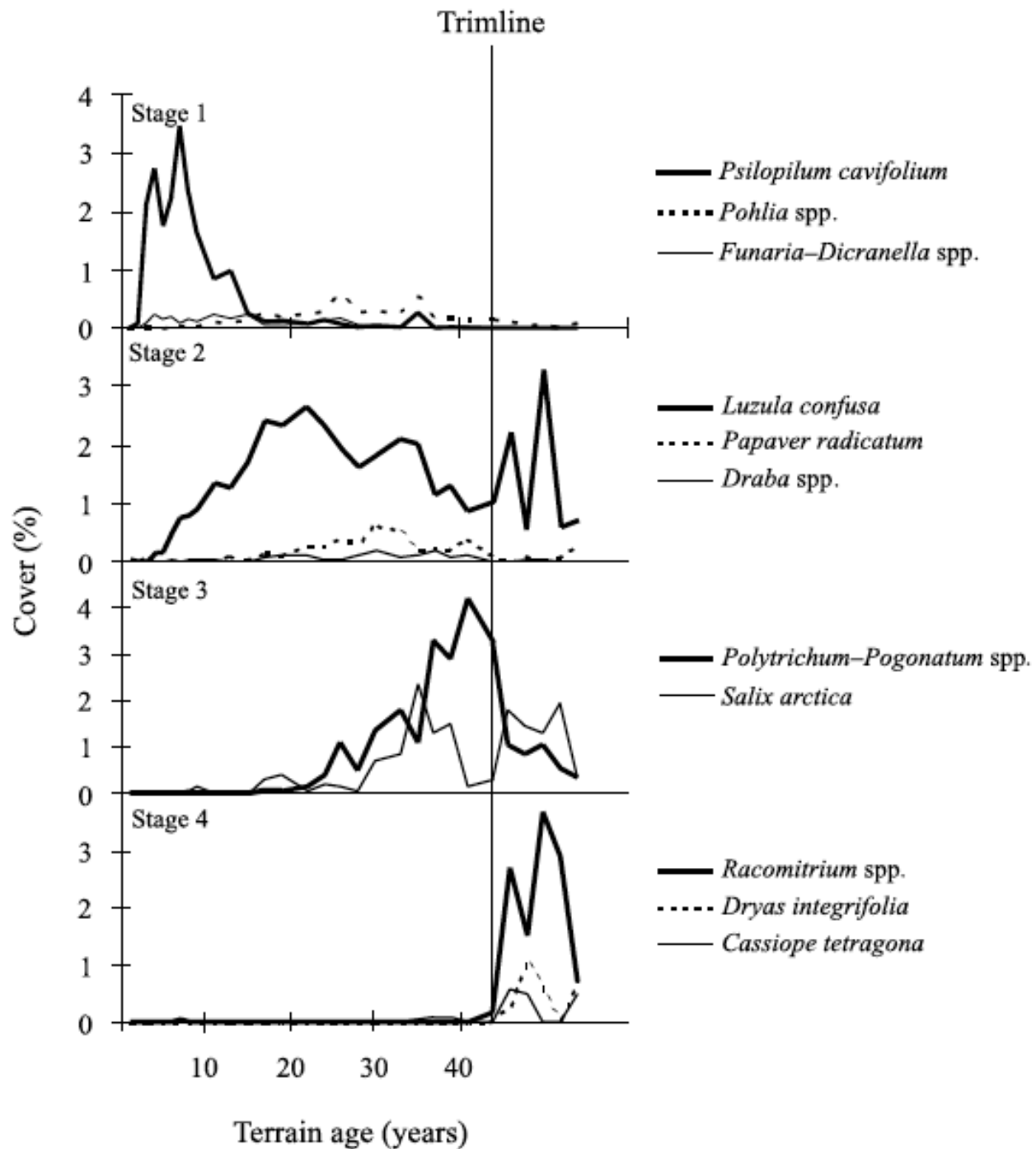
Position of terminus
during the LIA



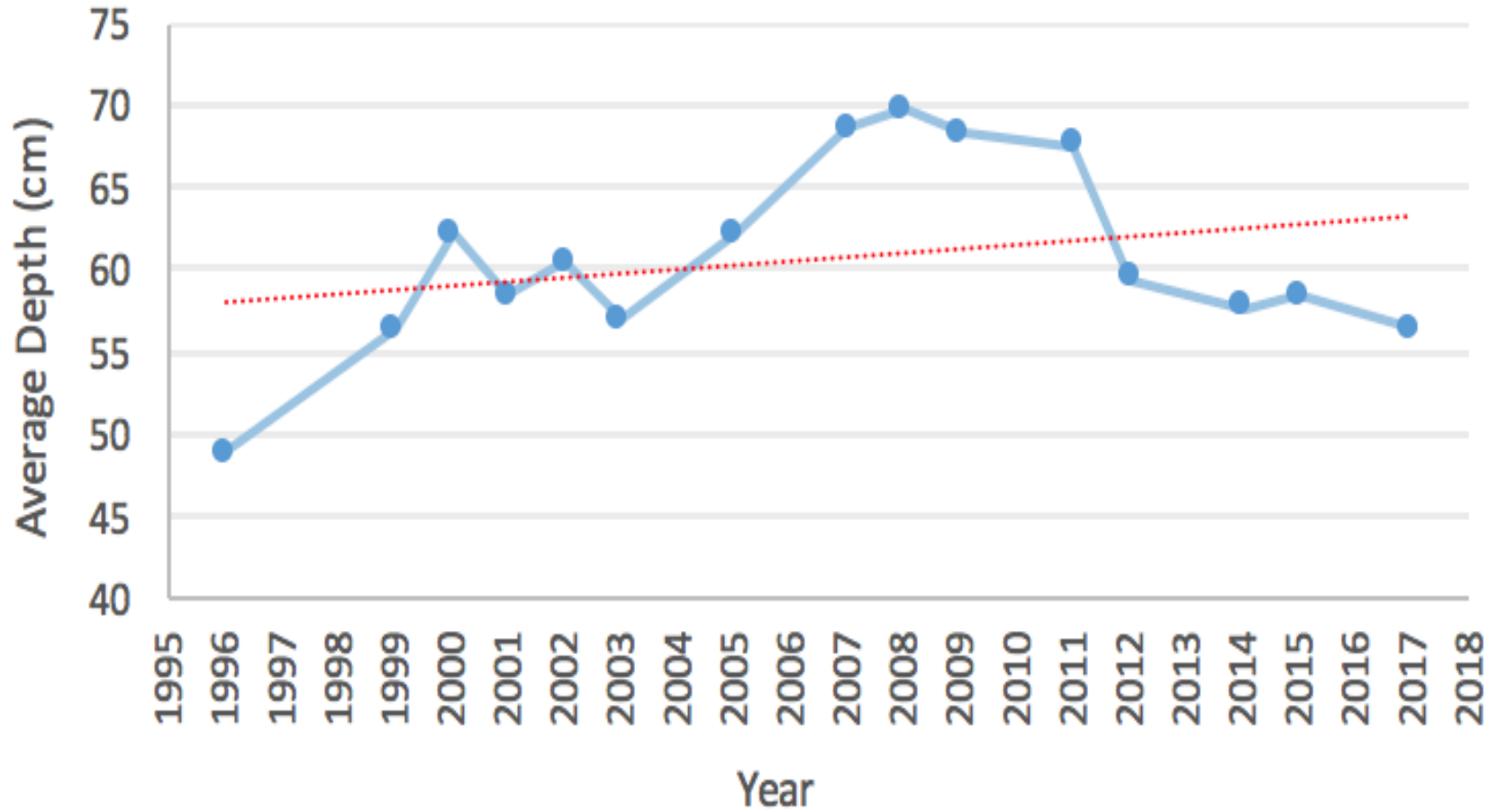
ALEXANDRA FIORD



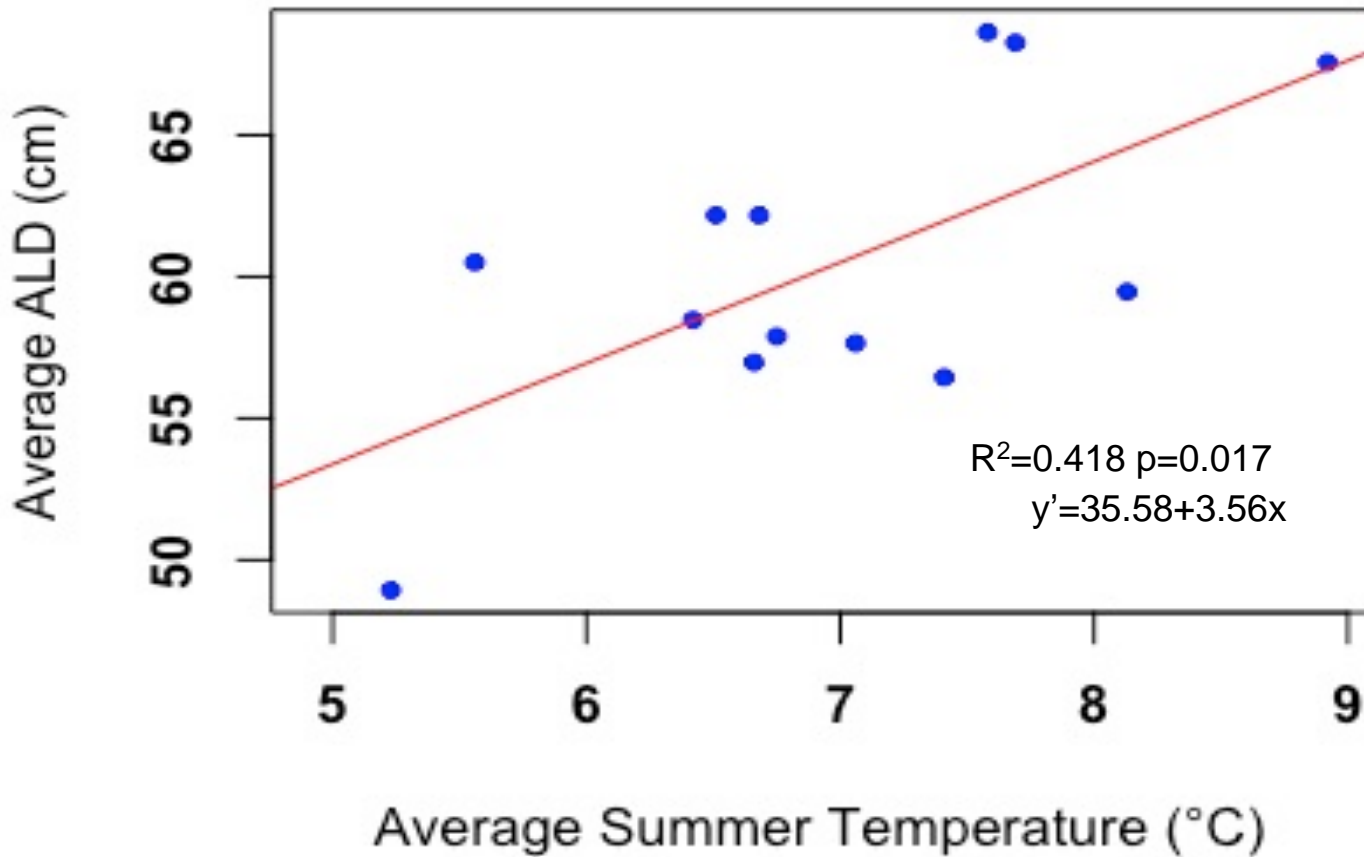


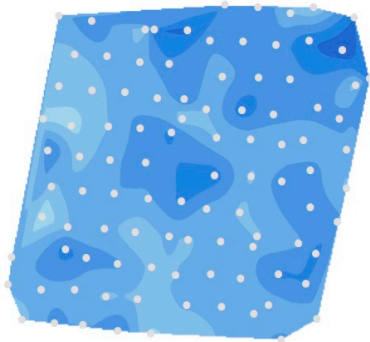


Max Active Layer Depth in CALM grid (1 ha)

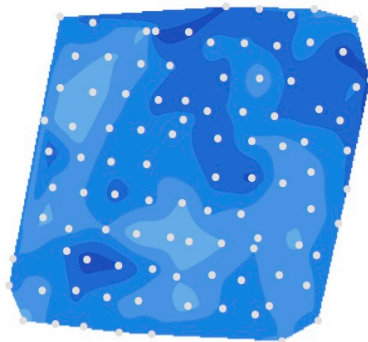


Active layer depth increases with warmer temperatures

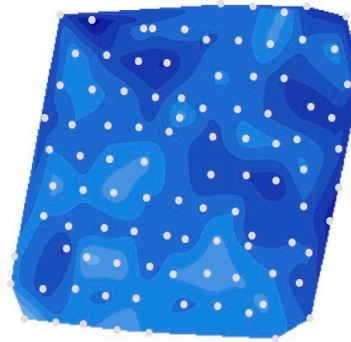




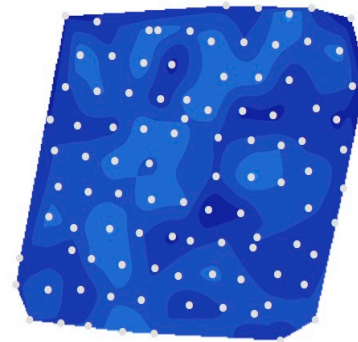
1996
49cm



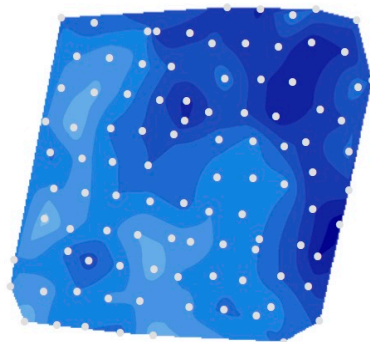
1999
56.5cm



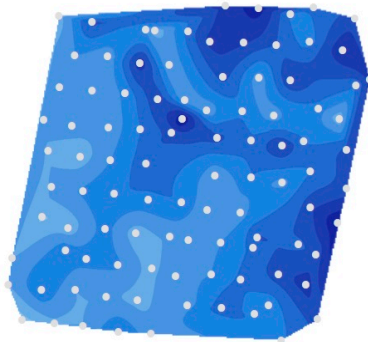
2005
62cm



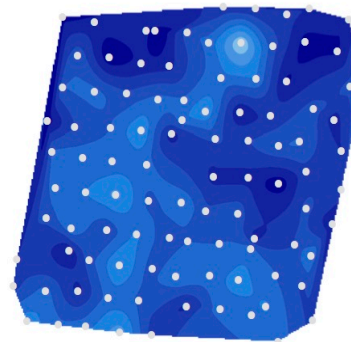
2007
68.5cm



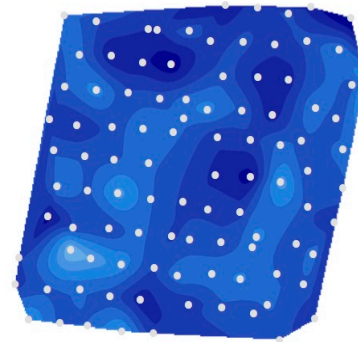
2000
62cm



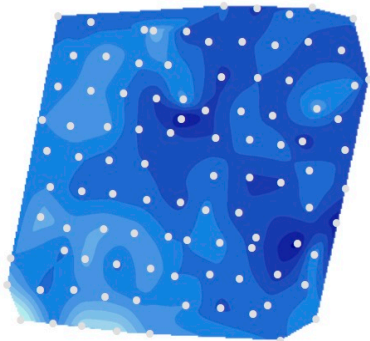
2001
58.5cm



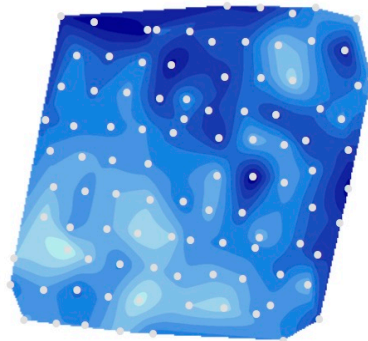
2009
68cm



2011
67.5cm



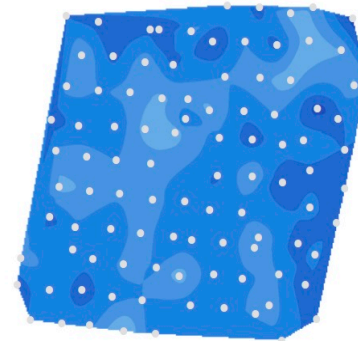
2002
60.5cm



2003
57cm

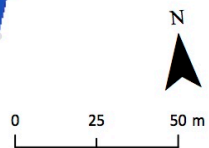
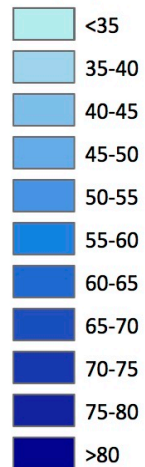


2014
57.5cm



2017
56.5cm

ALD (cm)



Alexandra Fiord: the first ITEX site

Open-top warming chambers (OTCs)

- established in 1992
- seven different habitat/community types
- phenology, climate, and snow melt recorded annually
- biodiversity, leaf traits, GHG flux, NDVI/GEI, soil variables
- common garden studies: local adaptation, migration
- genetic studies linked to long-term warming



Mosaic of habitat types and plant communities

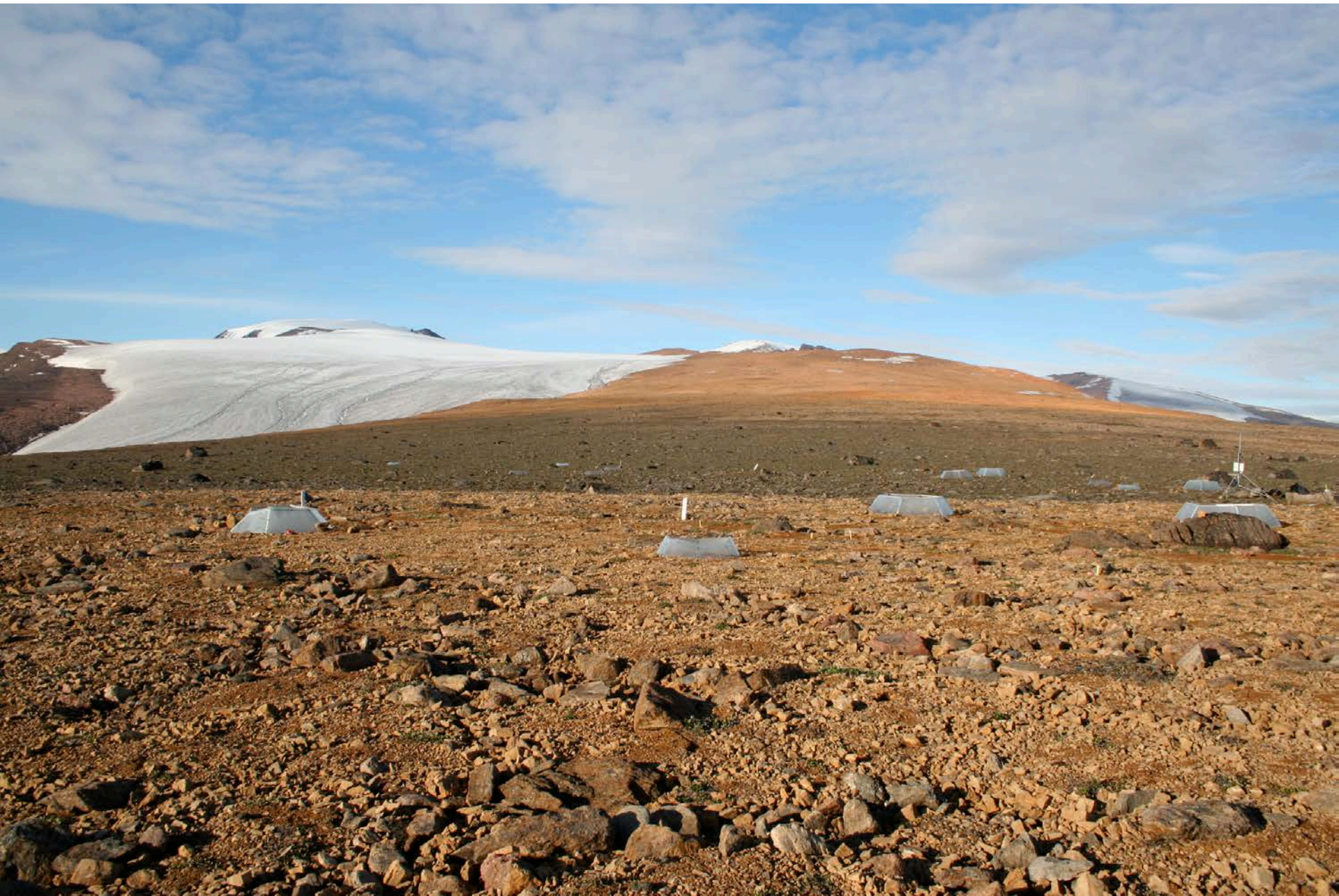
An aerial photograph of a tundra landscape. A winding stream flows through the center of the image. The landscape is divided into several distinct zones of different colors and textures, representing different plant communities. In the upper part, there is a darker, more uniform area. Below that, a lighter, more textured area contains several small, white, dome-shaped structures. Further down, a darker, more textured area is visible. At the bottom, there is a lighter, more uniform area. The stream flows from the top right towards the bottom left.

**MESIC
HEATH**

**DRY SALIX -
GRAMINOID**

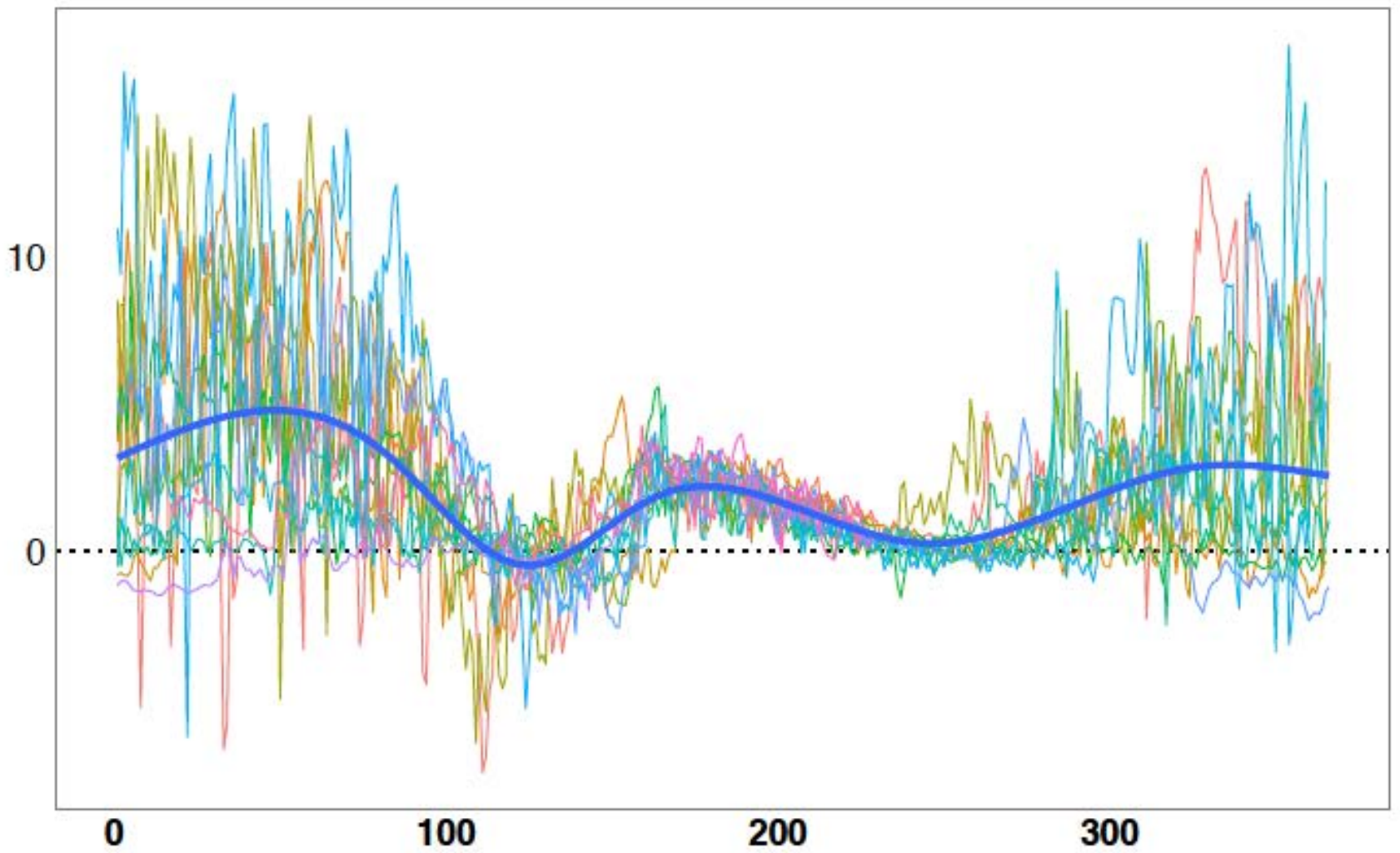
**WET SEDGE
TUNDRA**

Polar desert ITEX site: Dome



YEAR 1994 1996 1998 2000 2002 2004 2008 2011
1995 1997 1999 2001 2003 2005 2010

**Difference between Warm and Control Mean Temp
at the dry site (W-C, °C)**



DAY OF THE YEAR



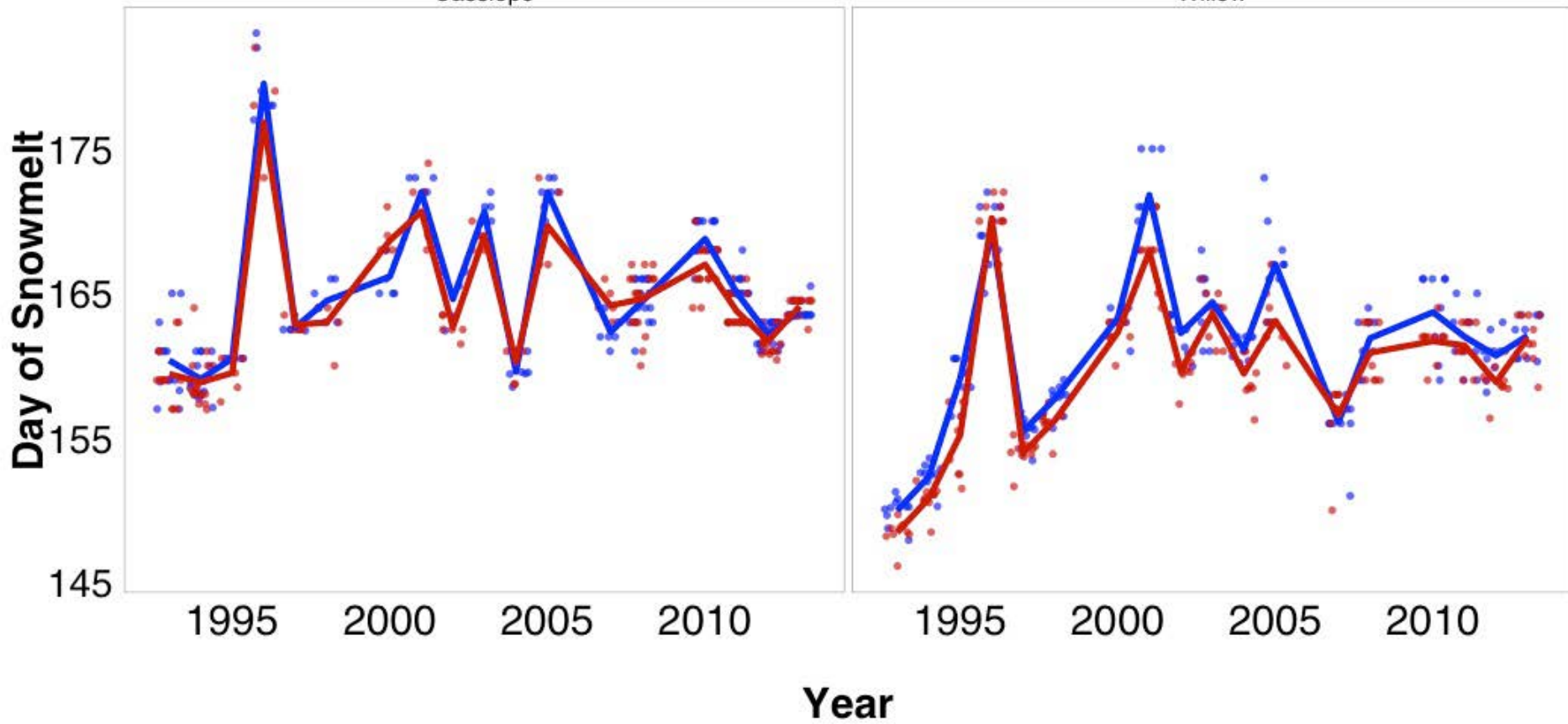
Snow depth measured automatically throughout the year at two sites (OTCs & CTL) and two climate stations

(also plant height)

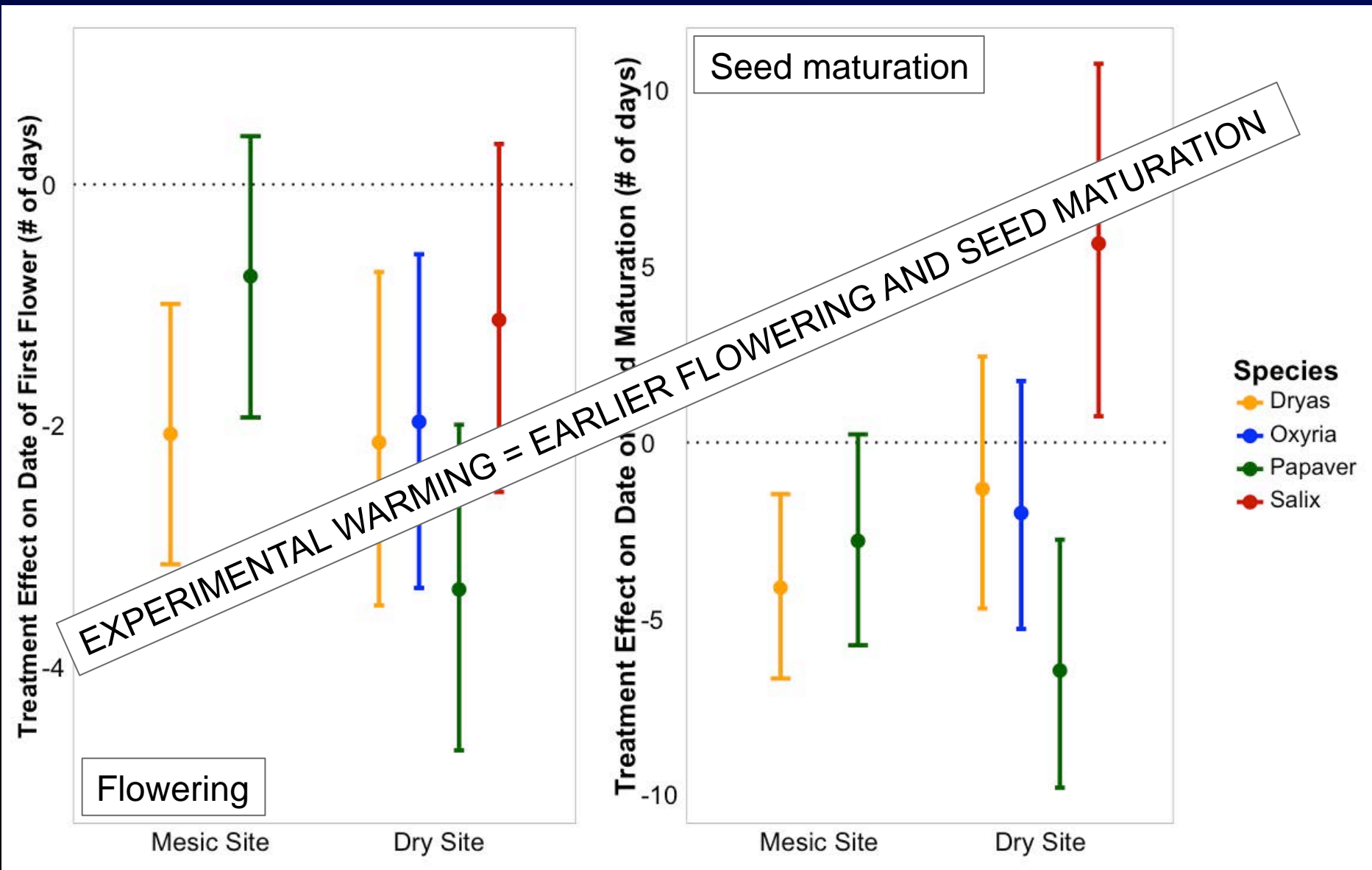
TREATMENT **Control** **Warm**

Cassiope

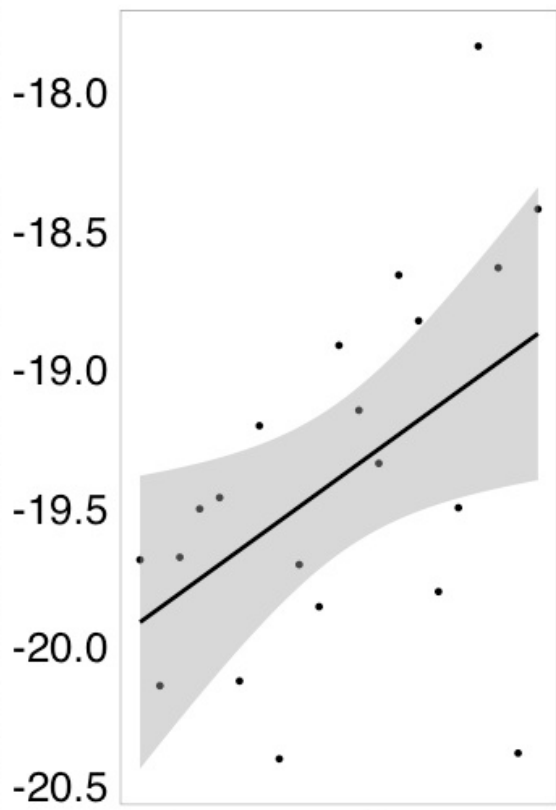
Willow



RESULTS: Treatment Effect on Phenology

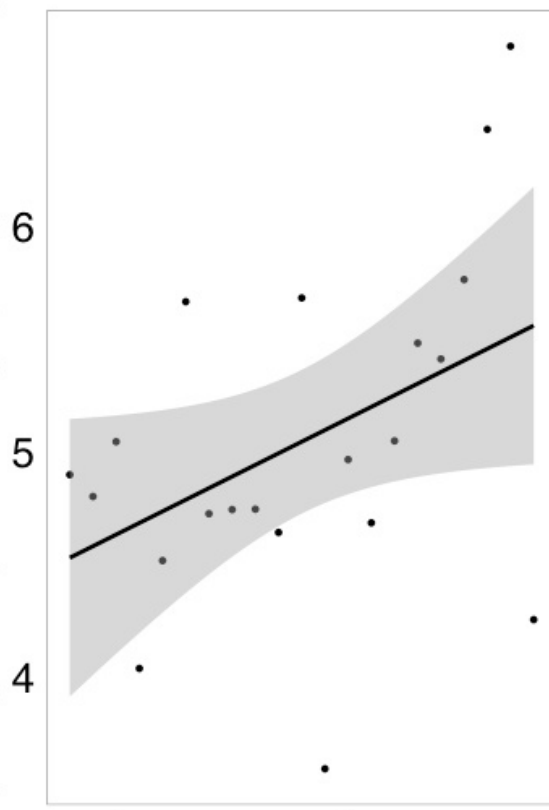


Winter Temperature (°C, days 225-150)

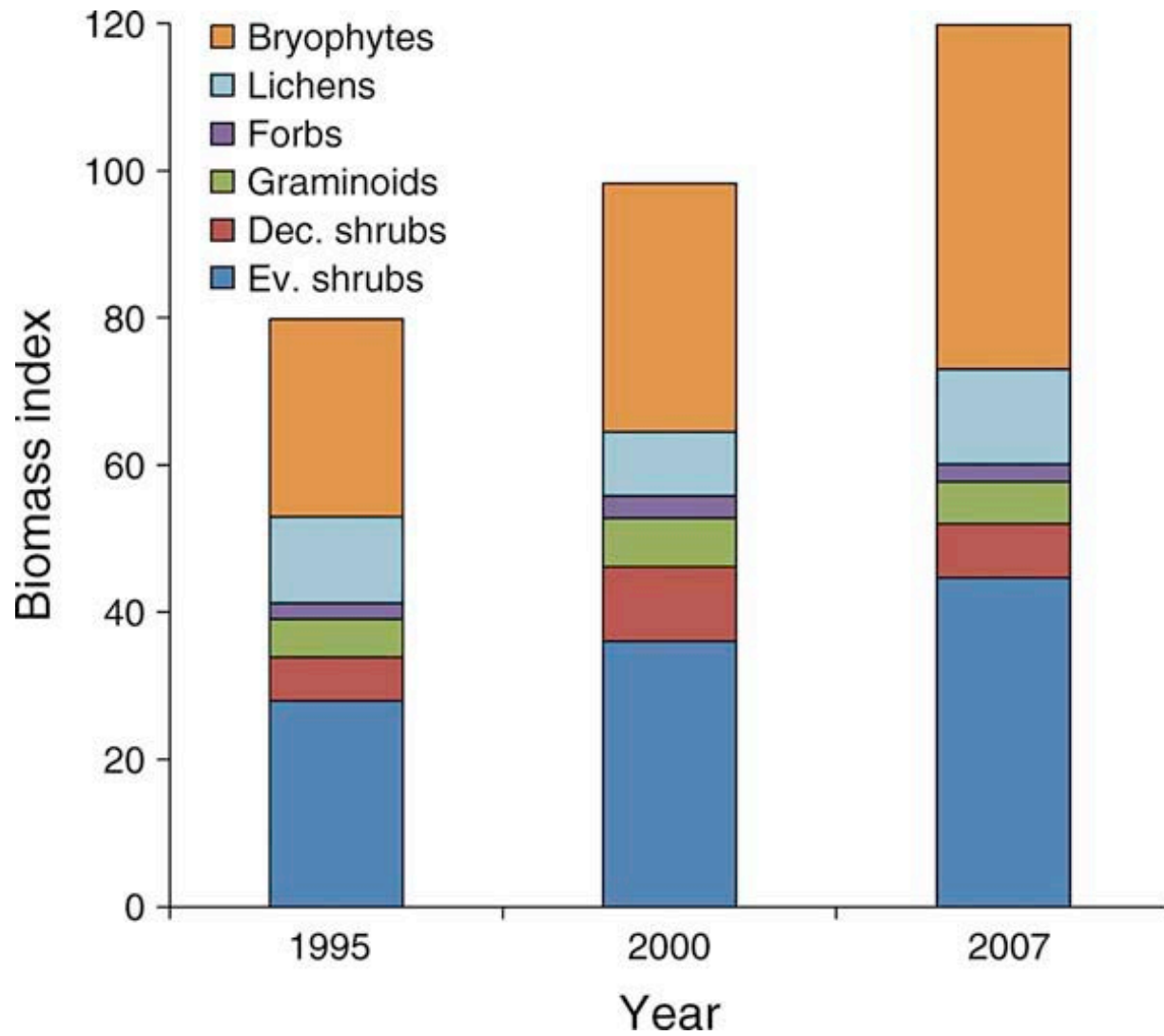


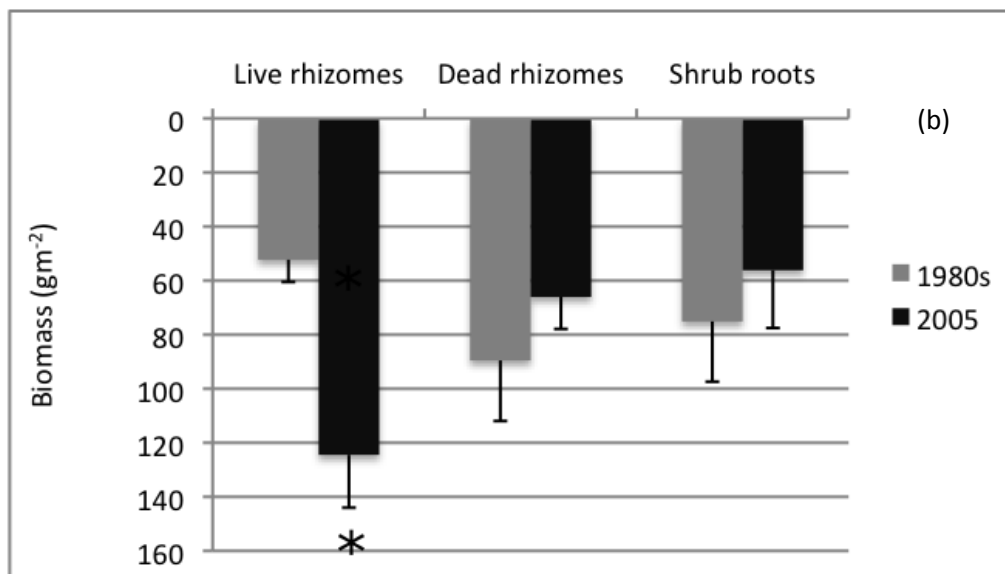
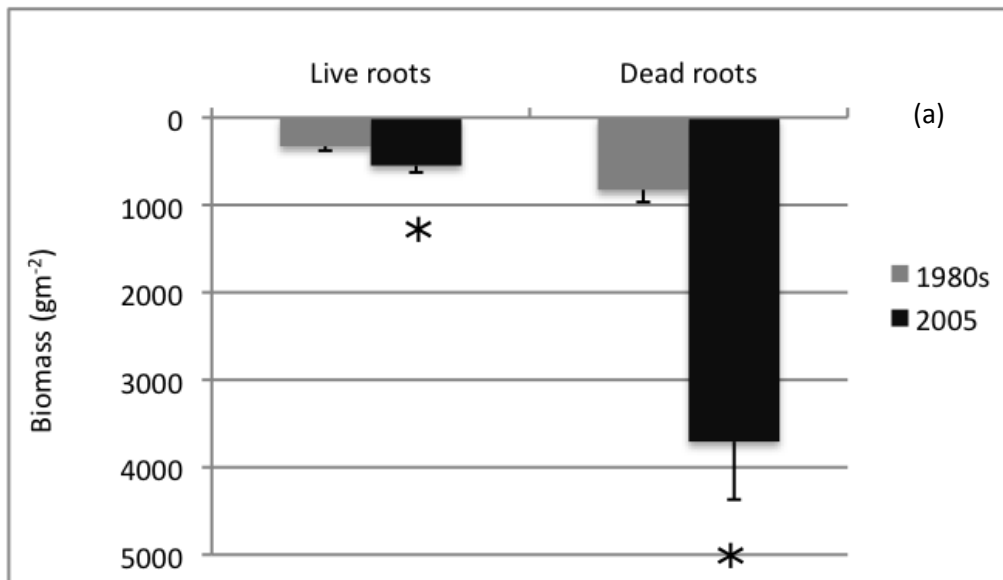
Year

Spring Temperature (°C, days 150-200)

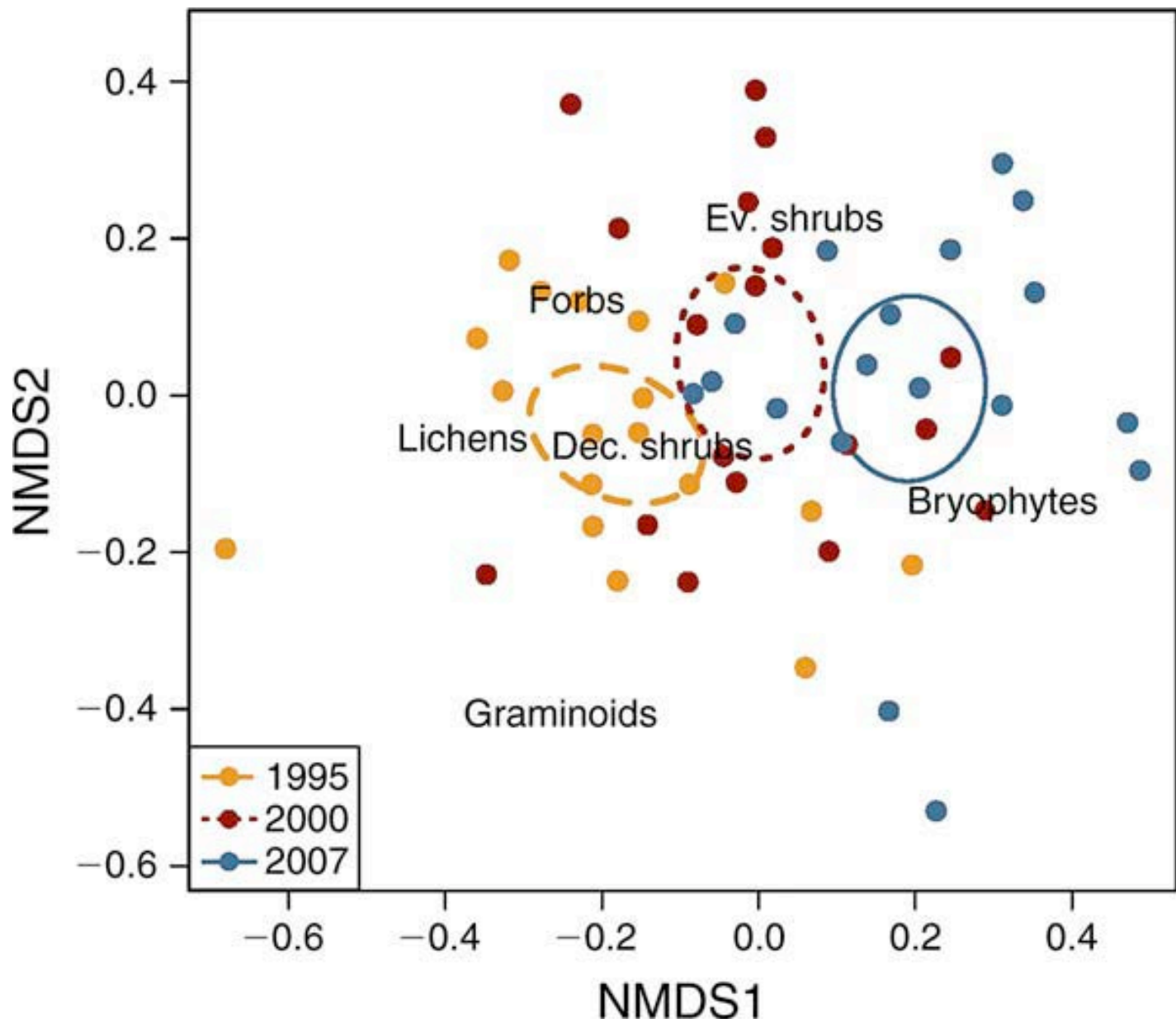


Year

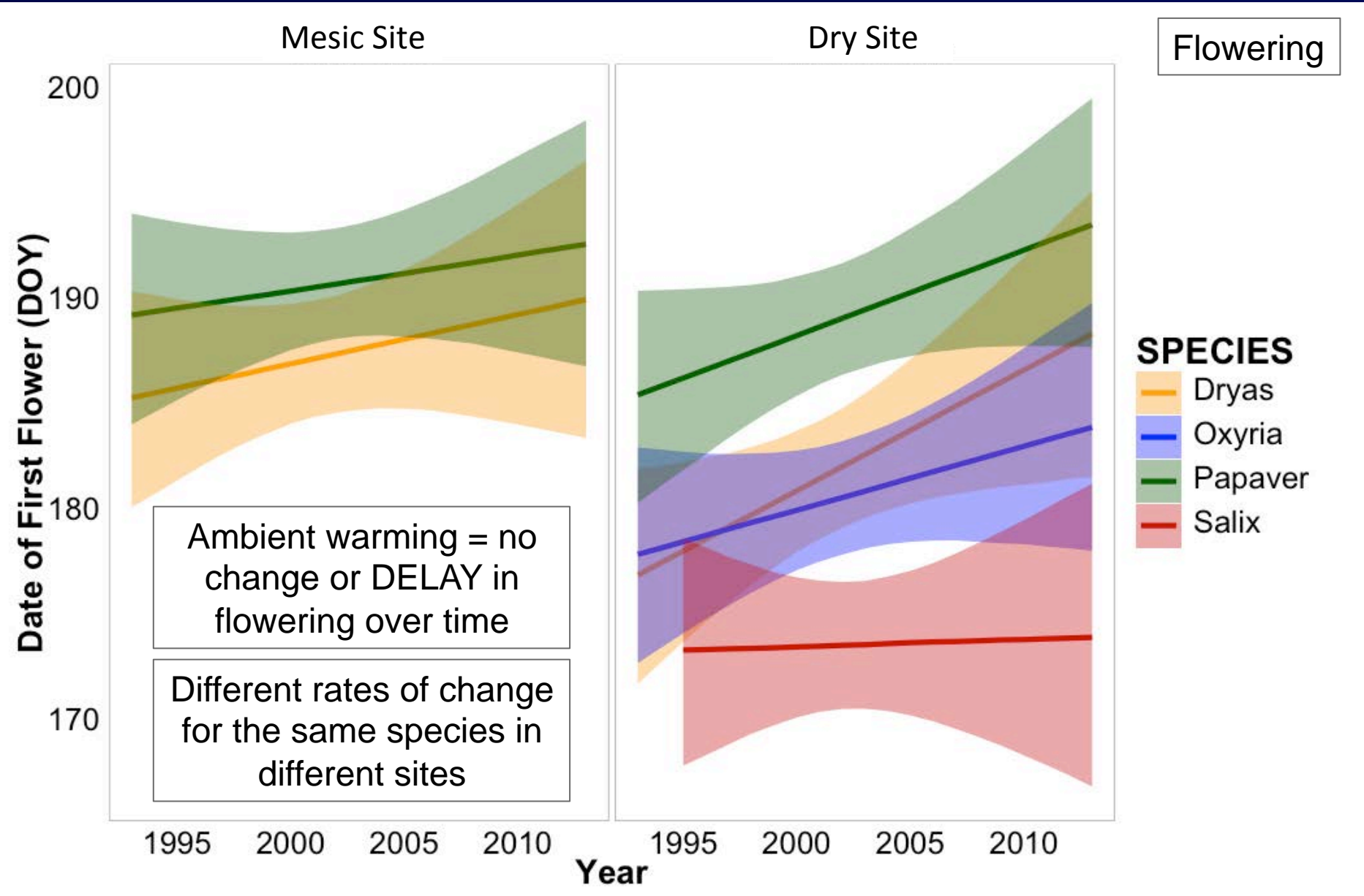




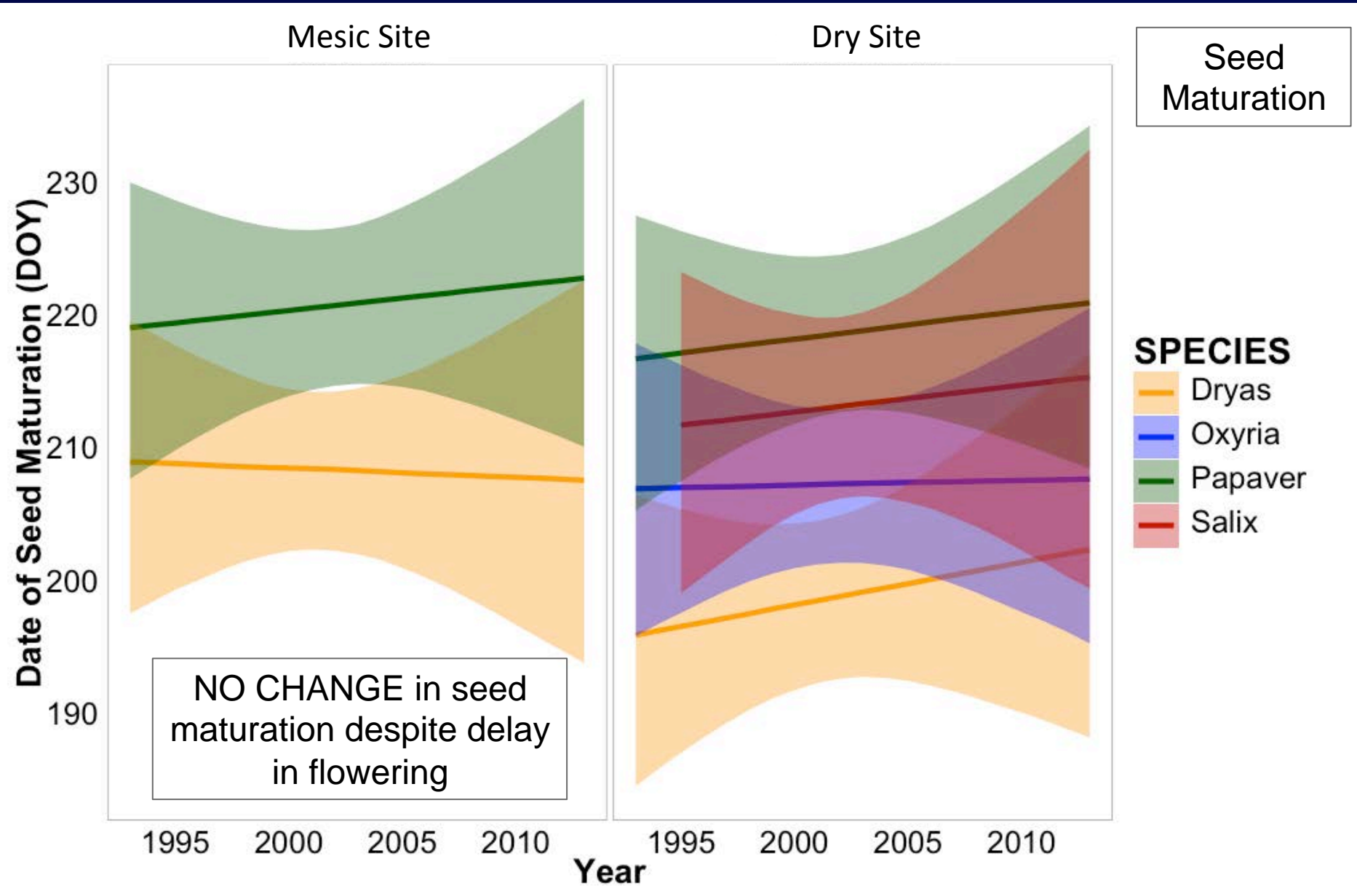
Change in belowground biomass at a wet sedge site at Alexandra Fiord: 1980s - 2005



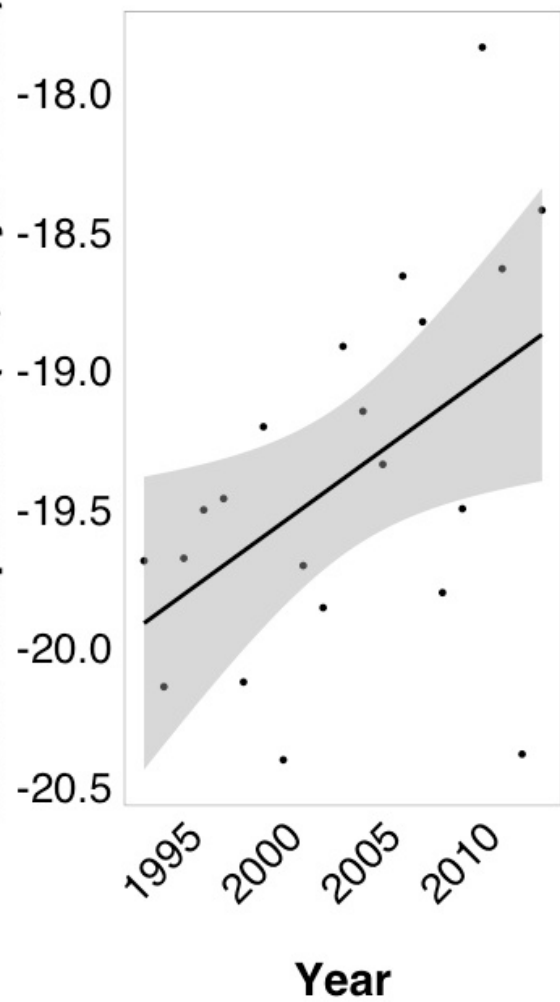
RESULTS: Phenology over time



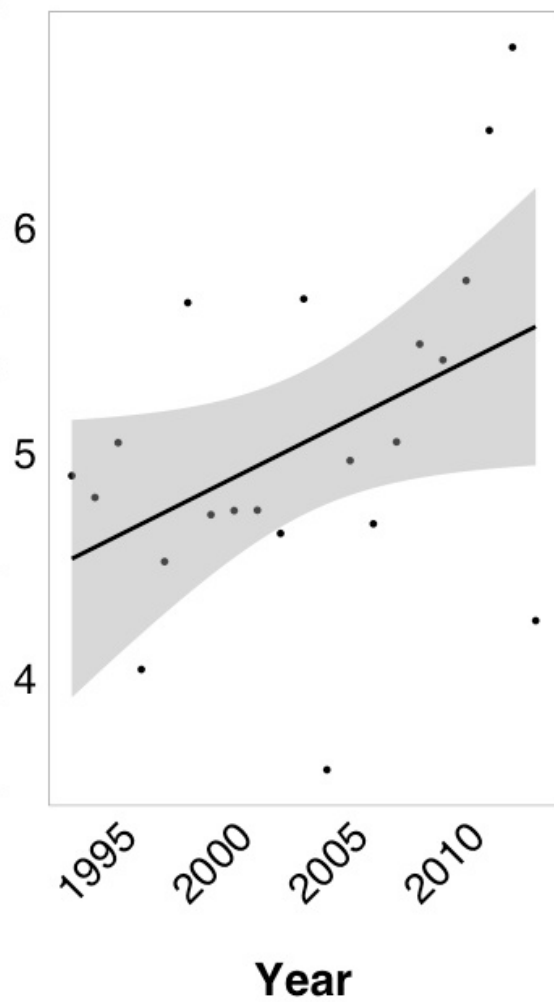
RESULTS: Phenology over time



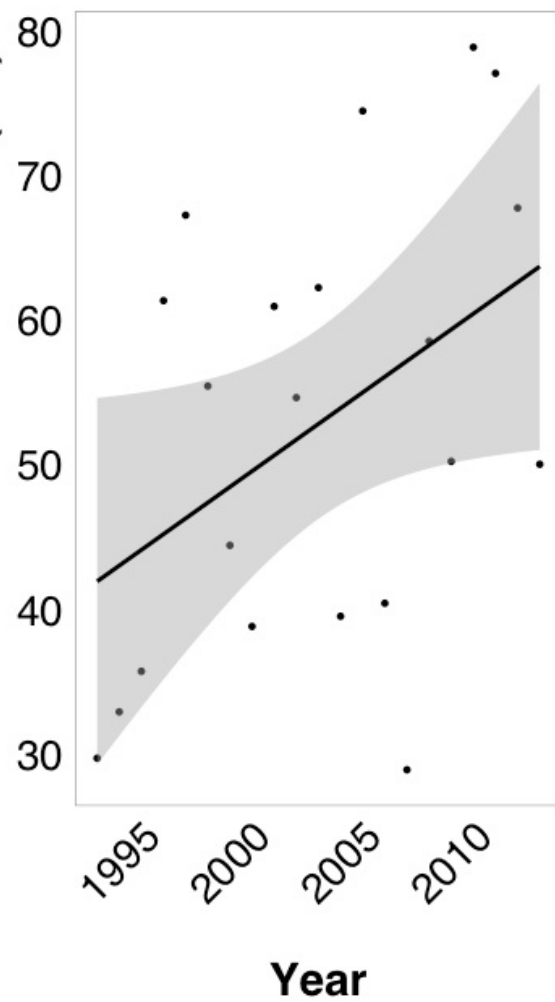
Winter Temperature (°C, days 225-150)



Spring Temperature (°C, days 150-200)



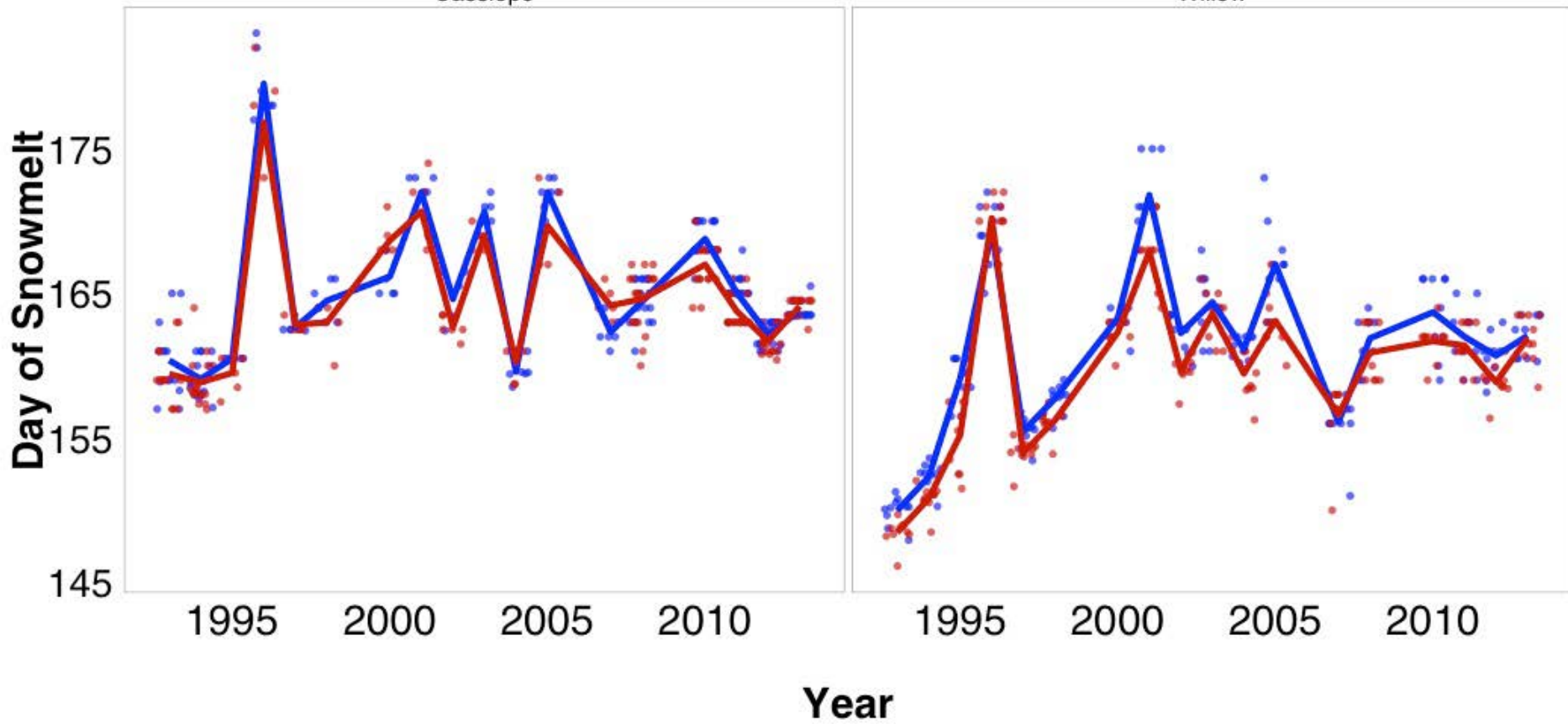
Total Winter Snow at Eureka (cm)

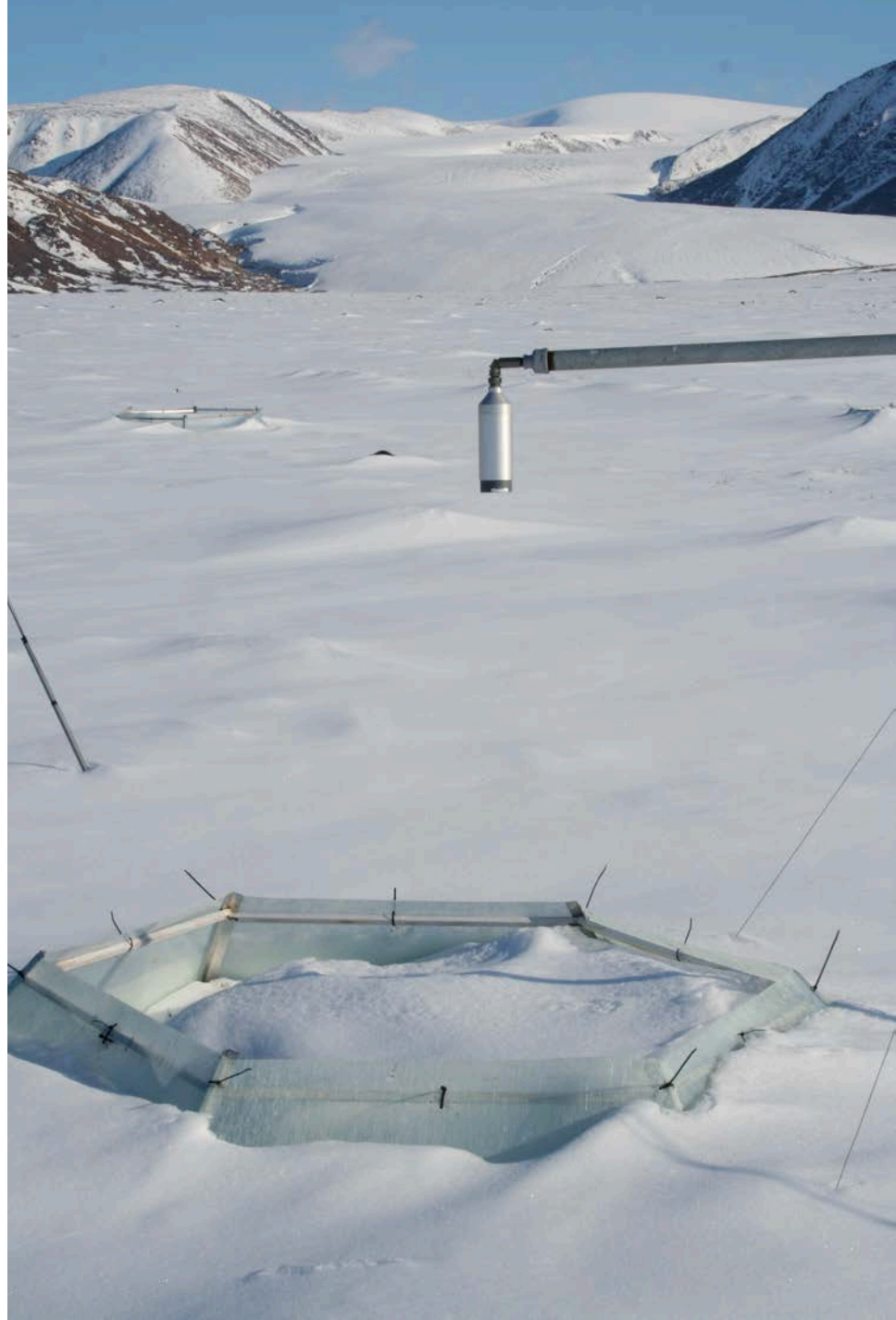
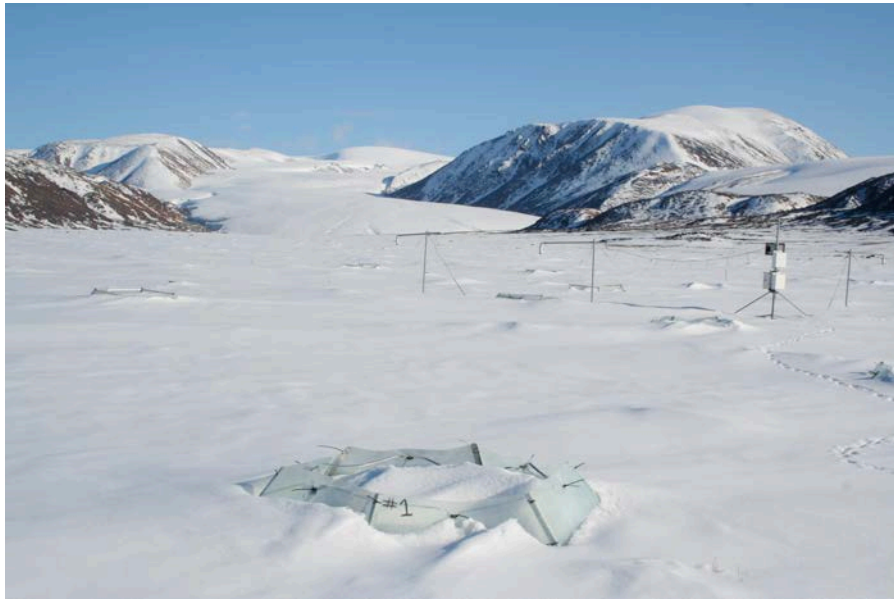


TREATMENT ■ Control ■ Warm

Cassiope

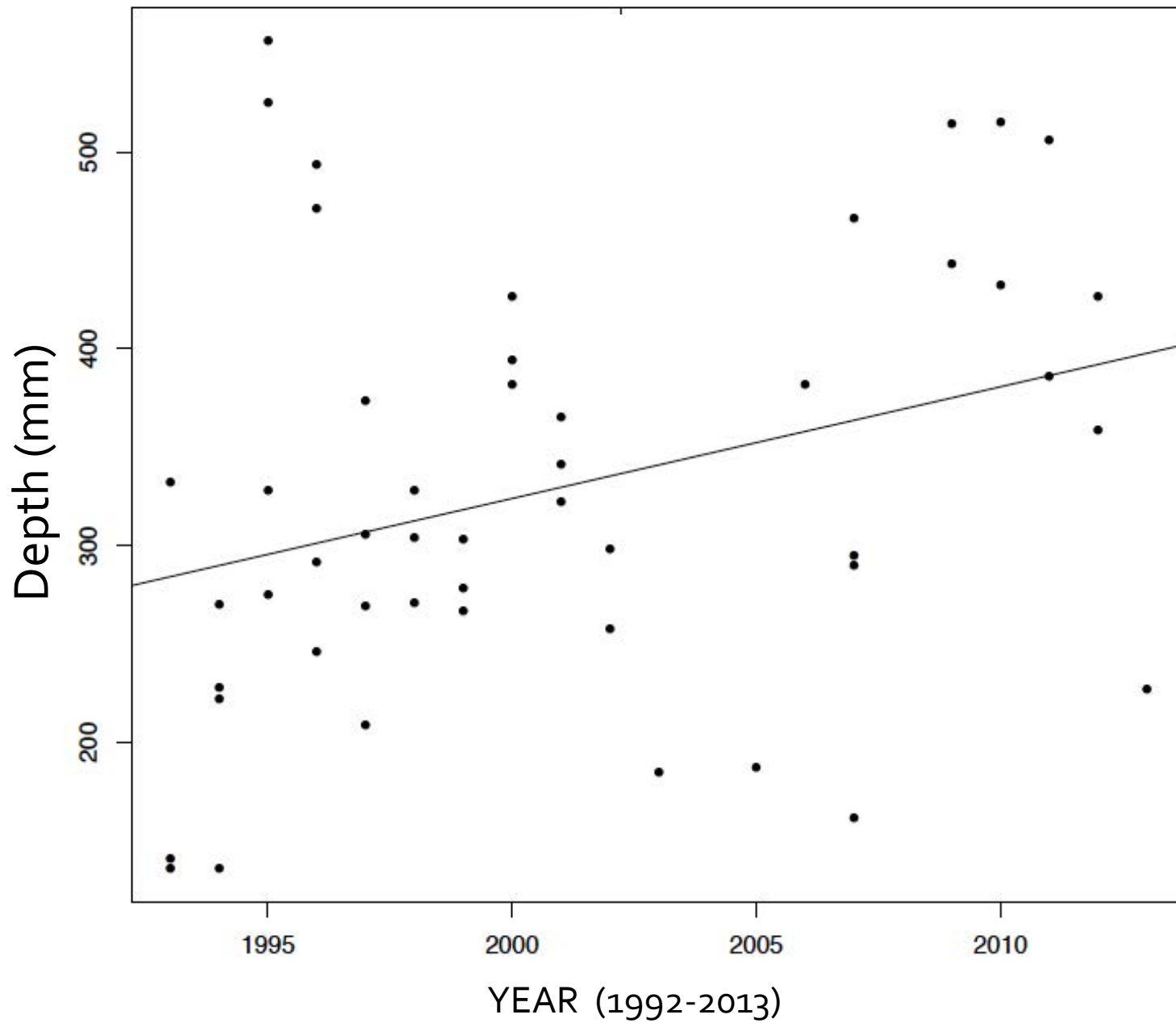
Willow



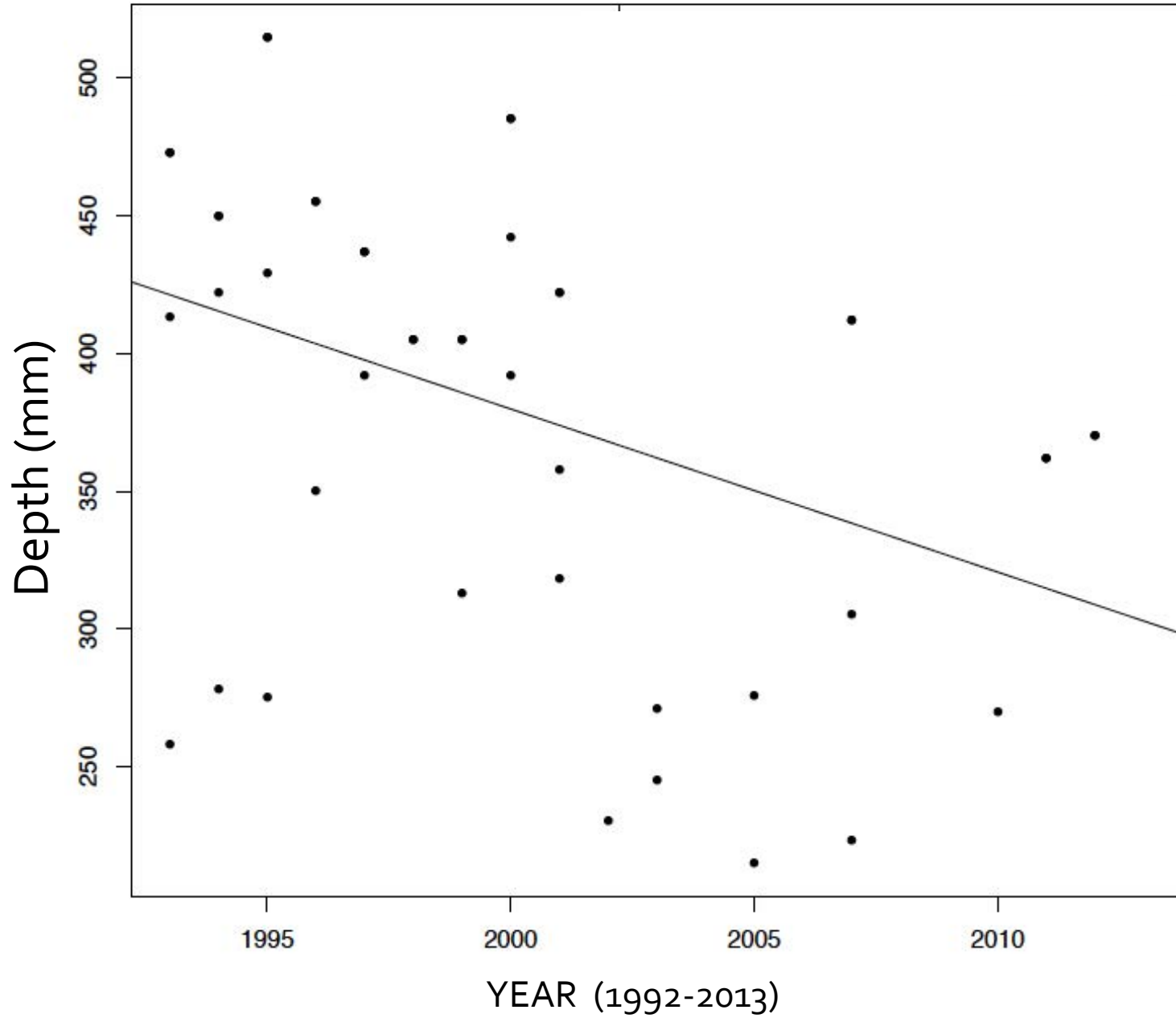


Snow depth and
snow melt dates
recorded for
experimental plots

Annual maximum snow depth (CTL)



Annual maximum snow depth (OTCs)



OVERALL CONCLUSIONS: common garden studies

Substantial phenotypic plasticity in Arctic plant species

→ 3-4 °C of warming (natural + experimental) resulted in no immediately observable detrimental effects

Local adaptation appears common in Arctic plant species, even over short physical distances

→ within-population genetic variation could facilitate adaptation to future environmental change

Evolutionary adaptation, either of resident populations to warmer temperatures or of immigrants to novel environmental conditions, will likely play an important future role.

Succession (torpor) planning – research hibernation @ Alexandra Fiord



How many ITEX sites have been “lost”

- All research comes to an end: funding, interest, ageing of researchers
- Where are the data from those sites in permanent torpor?
- Perhaps a general protocol is needed to put these sites to sleep.

Barriers to long-term research @ AF

- Logistical support and expense
 - Flights, air freight, research assistants/students
- Equipment and maintenance
 - OTC replacement, climate sensors, experimental monitoring
- Succession of researchers...
 - No lack of interest in the site; but too expensive
- Plan now to end annual research in 5 years.
 - Legacy planning: data and sites accessible for future researchers



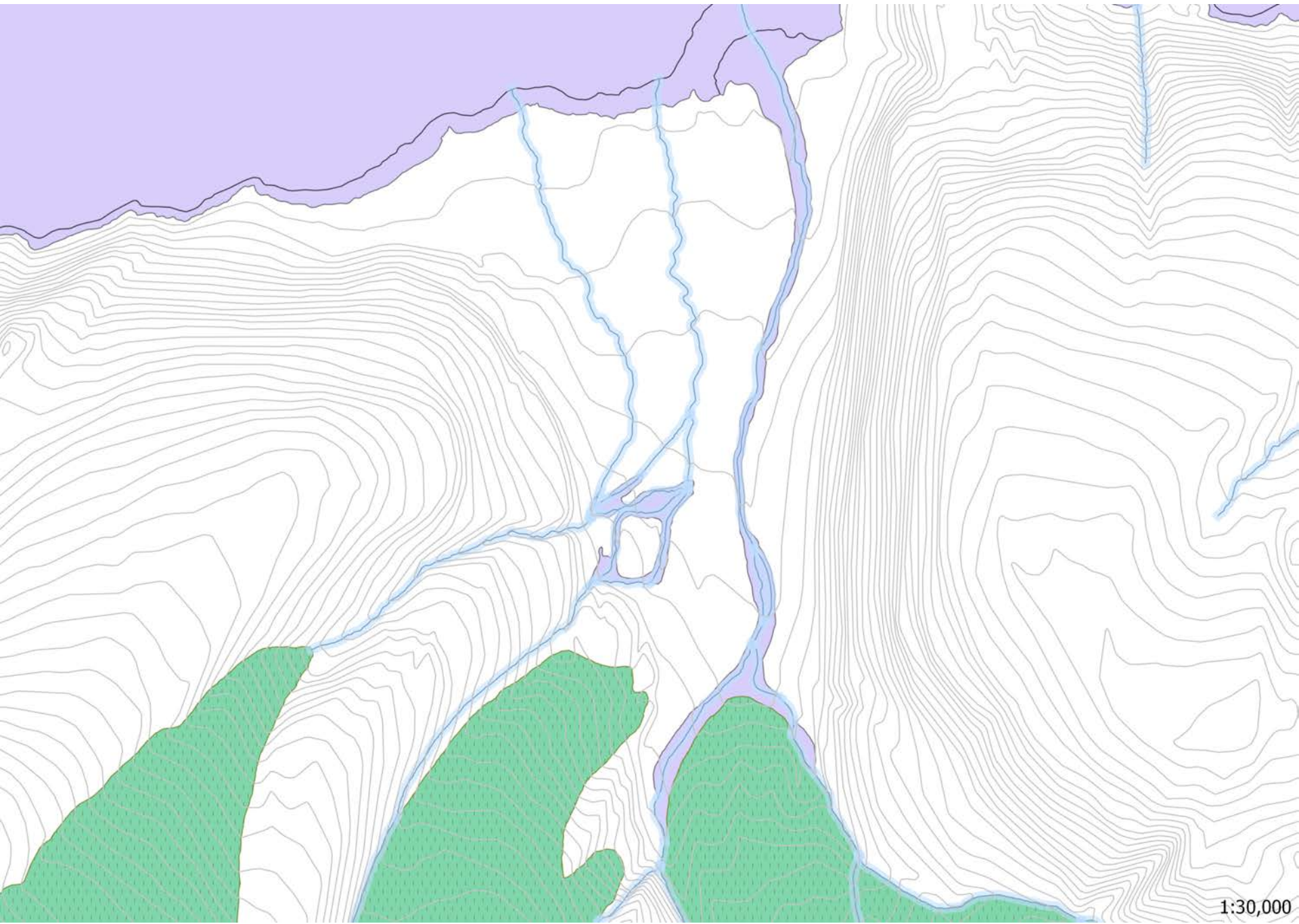
Alexandra Fiord

Image Landsat
© 2014 Google

1687 m

Google earth

2011 Imagery Date: 4/9/2013 lat 78.874177° lon -75.787164° elev 28 m eye alt 8.51 km



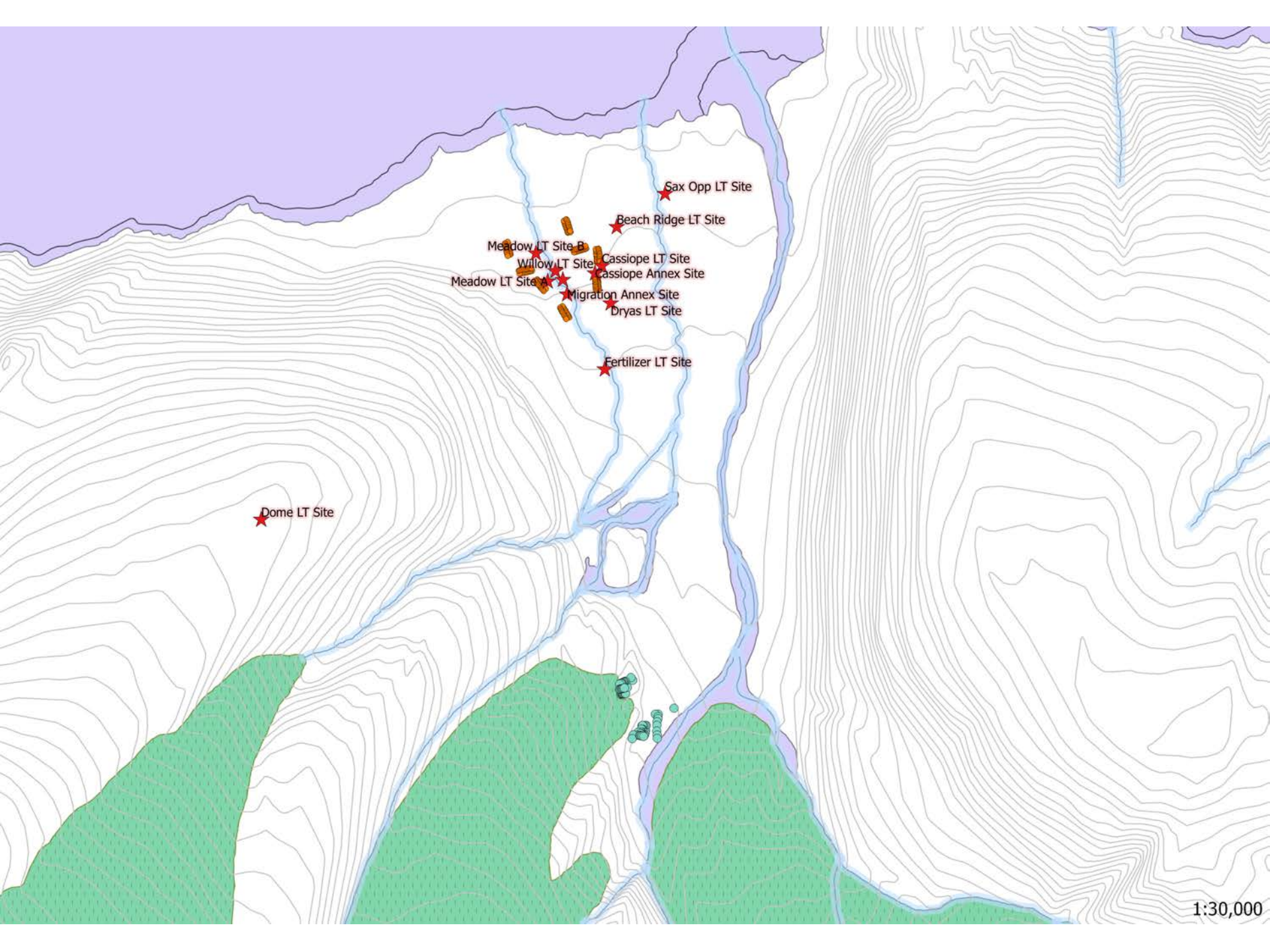
ALEXANDRA FIORD plant communities

100 m

Al_dtls.dxf

Alexpoly.shp

- herb
- lichen, cushion plant, dwarf shrub
- sedge, cushion plant, dwarf shrub
- dwarf shrub, cushion plant
- deciduous dwarf shrub, graminoid
- salt marsh
- other



★ Dome LT Site

★ Sax Opp LT Site
★ Beach Ridge LT Site
Meadow LT Site B
Willow LT Site
★ Meadow LT Site A
★ Cassiope LT Site
★ Cassiope Annex Site
★ Migration Annex Site
★ Dryas LT Site
★ Fertilizer LT Site

ITEX Sites

- Sax Opp LT Site
- Beach Ridge LT Site
- Meadow LT Site B
- Willow LT Site
- Willow Annex Site
- Meadow LT Site A
- Migration Annex Site
- Cassiope LT Site
- Cassiope Annex Site
- Dryas LT Site
- Fertilizer LT Site

Site layer

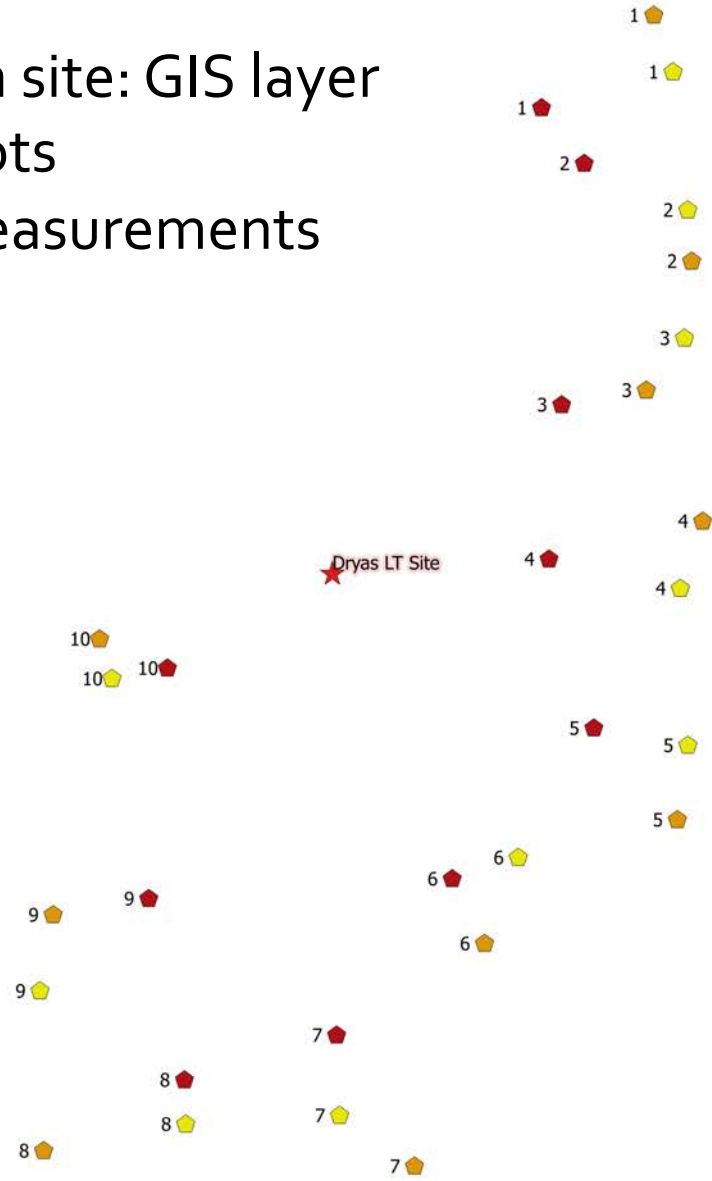


Mesic Dryas Heath site: GIS layer

Locations of all plots

Metadata of all measurements

All raw data



Planning for torpor

- Photographic records – all plots at least 1x/y
- Data availability in repositories: PolarData
- Updating plot data in the future?

- Potential links and intermittent visits by researchers at CHARs – part of Canadian network of Arctic research sites

Not the end...

- Plan for the transition
- Ensure that researchers can continue to use the site in the future
- Leave a useful legacy
- Suggestions welcomed!





Cheers!

