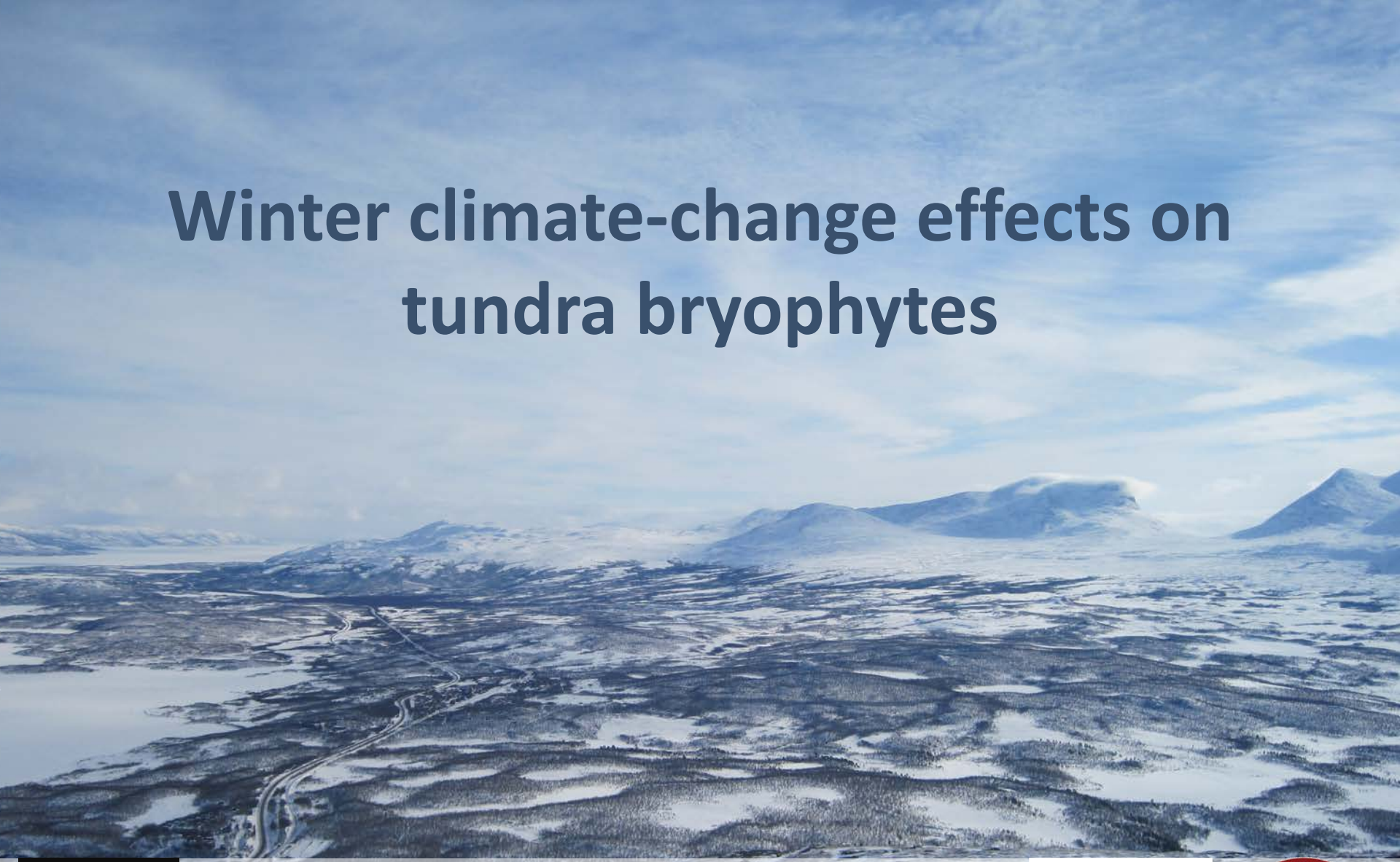
Winter climate-change effects on tundra bryophytes



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Winter climate (change)

- Temperature and precipitation
  - Stronger increase in winter than summer

- Variable effects on snow
  - Likely increase in snow water equivalent ('thickness') in colder areas
  - Likely decrease in global snow cover extent (area) and snow cover duration
  - High variation in landscape (wind, microtopography)

IPCC 2013

Snow as thermal insulator

Tundra bryophytes

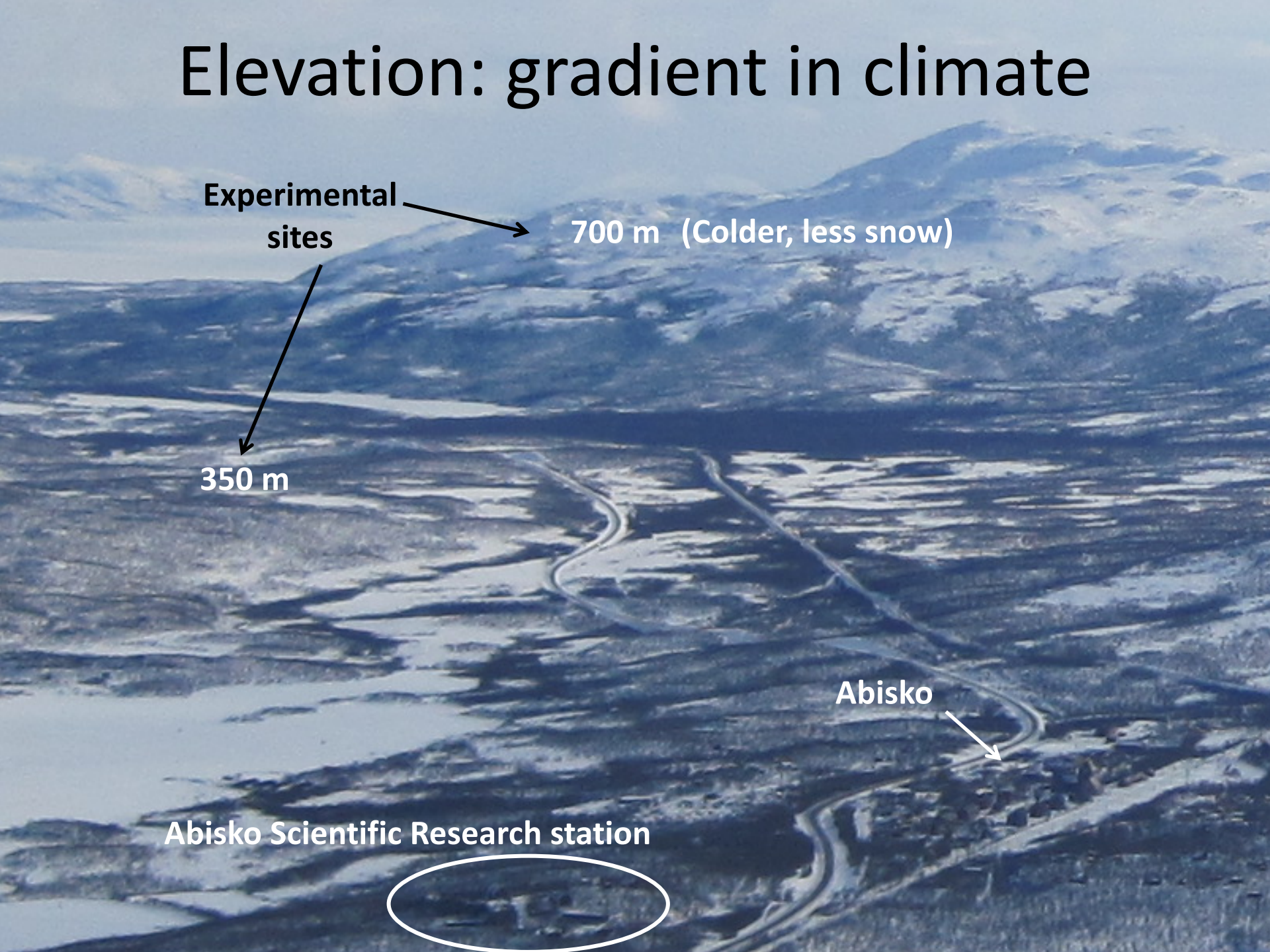
- Importance:
  - Carbon balance
  - Moisture balance
  - Energy balance
- Potentially active during winter:
  - Bottom of vegetation
  - Evergreen

  ⟶ Frost sensitive?
- Poikilohydric

  ⟶ Frost protection?

⇒ *How will winter climate-change (temperature, snow) affect frost damage of tundra bryophyte species?*

Elevation: gradient in climate



Sites

- 700 m
- 350 m

Snow treatments

- Addition
- Control
- Reduction

Insulating fleece + snow fence

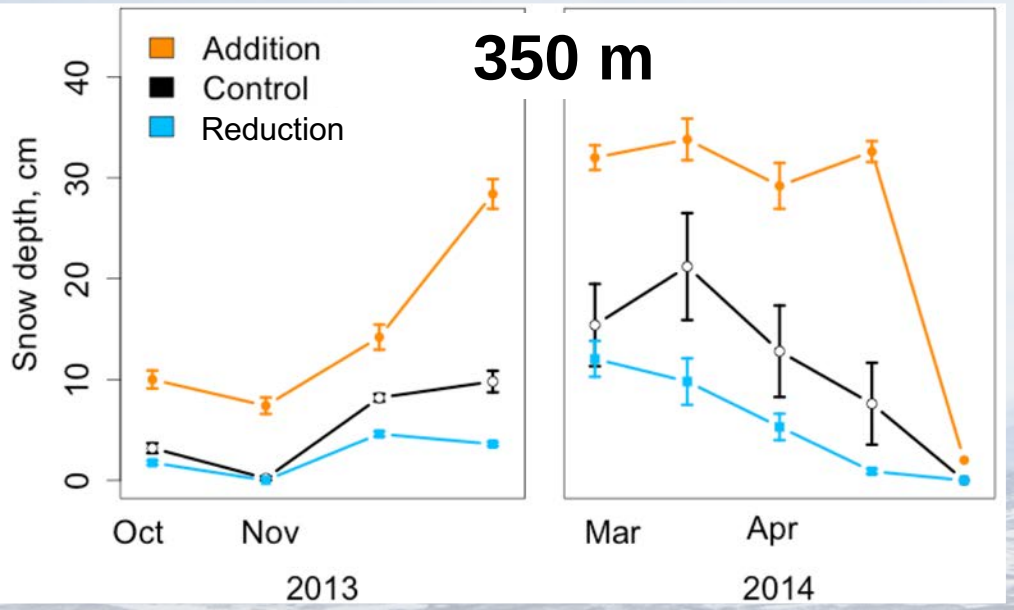
Snow addition

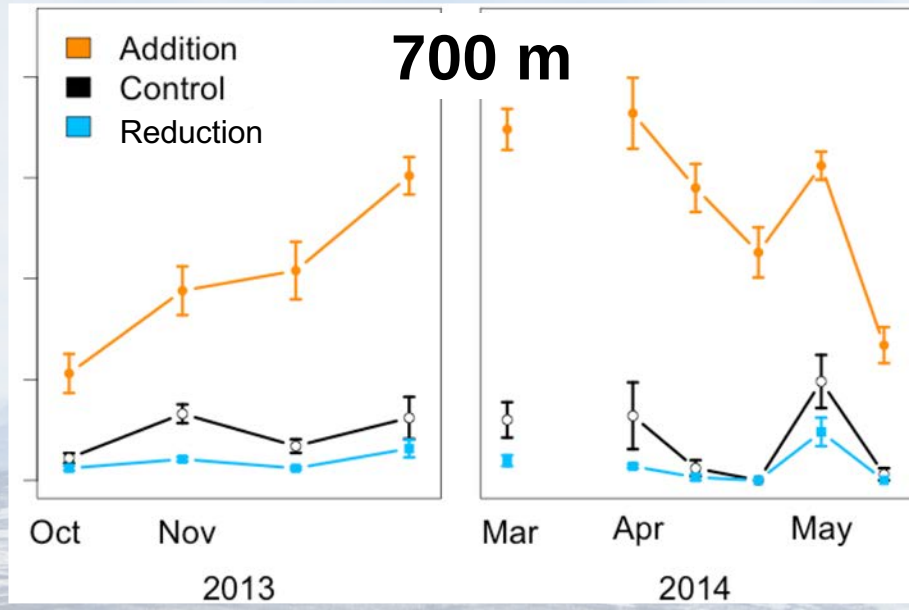
Control

Snow shoveling/brushing
(4 wks autumn, 5 wks spring)

Snow reduction

Snow depth manipulation





Lett et al 2018

H1: Frost damage high site > low site

H2: Reduction > control > addition plots, especially at high site

Sites

- 700 m
- 350 m

x 5

x 5

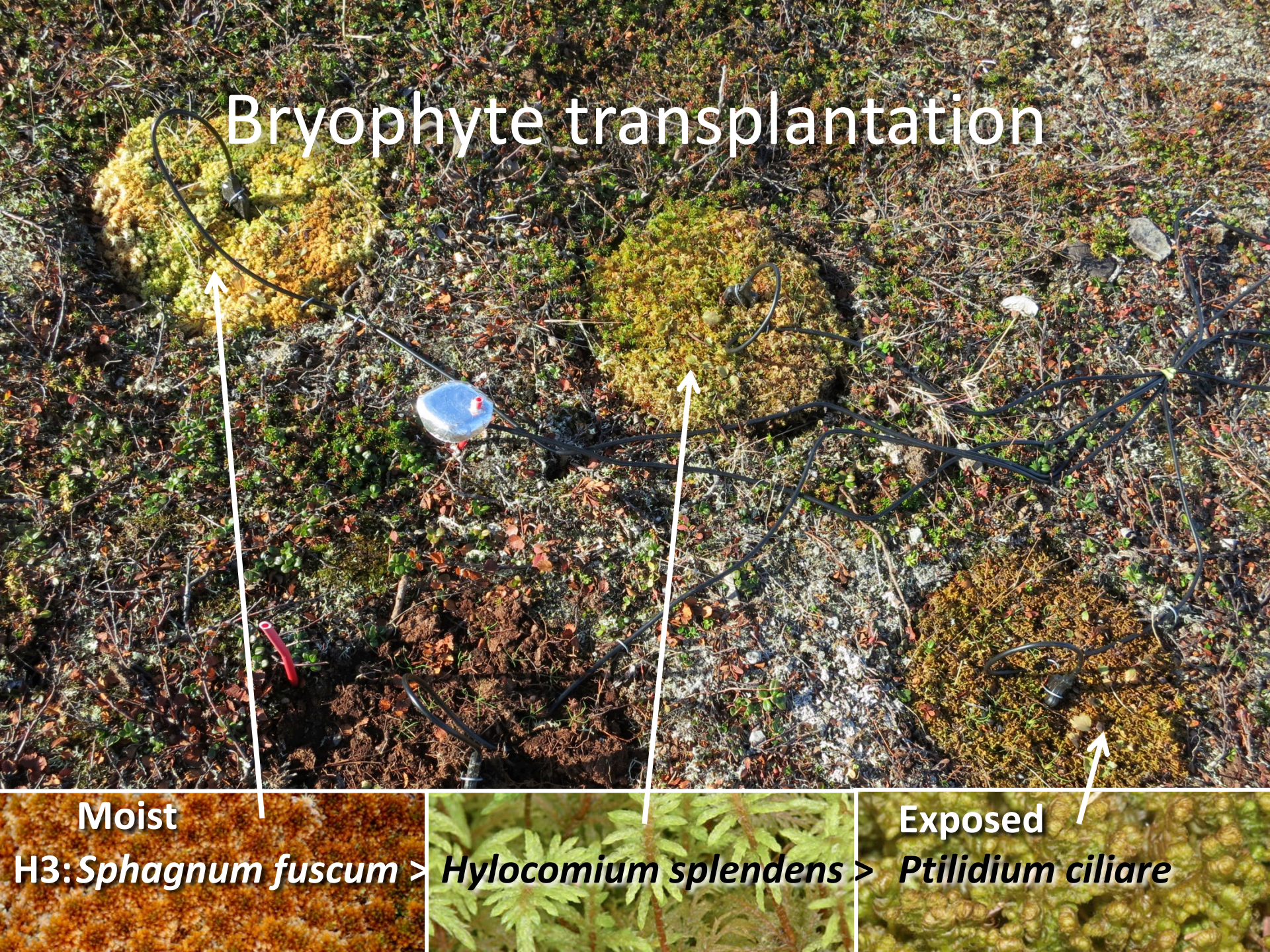
soil

Snow treatments

- Addition
- Control
- Reduction

Bryophyte species

- *Sphagnum 'fuscum'*
- *Hylocomium splendens*
- *Ptilidium ciliare*

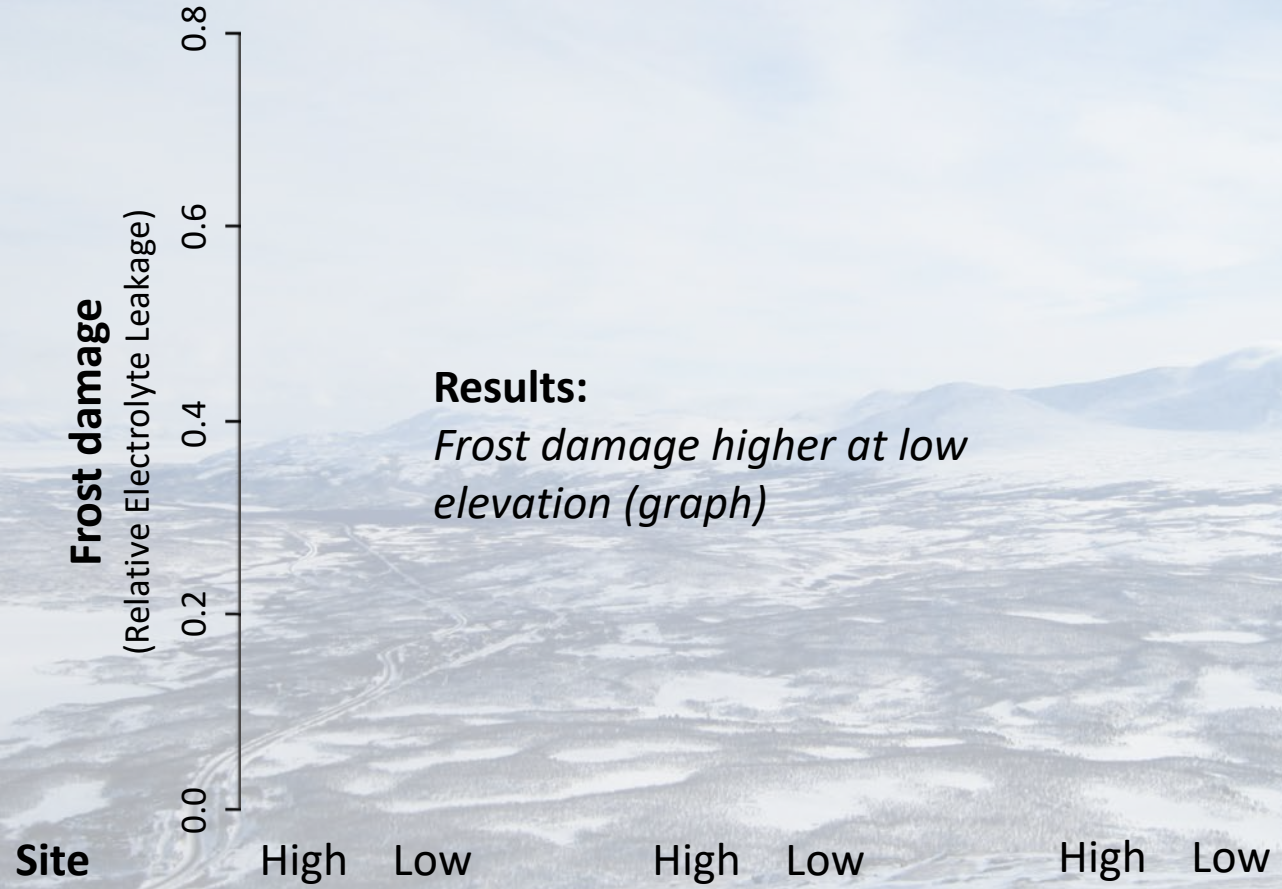

Bryophyte transplantation
Moist
H3:*Sphagnum fuscum* >
Hylocomium splendens >
Exposed
Ptilidium ciliare

Frost damage

Lab:
Electrolyte leakage higher after 1 or 6 freeze-thaw cycles (graph)

Field:
2015: 2 times after snow melt (early + late May)
2016: 5 times after snow melt (late April – early June)

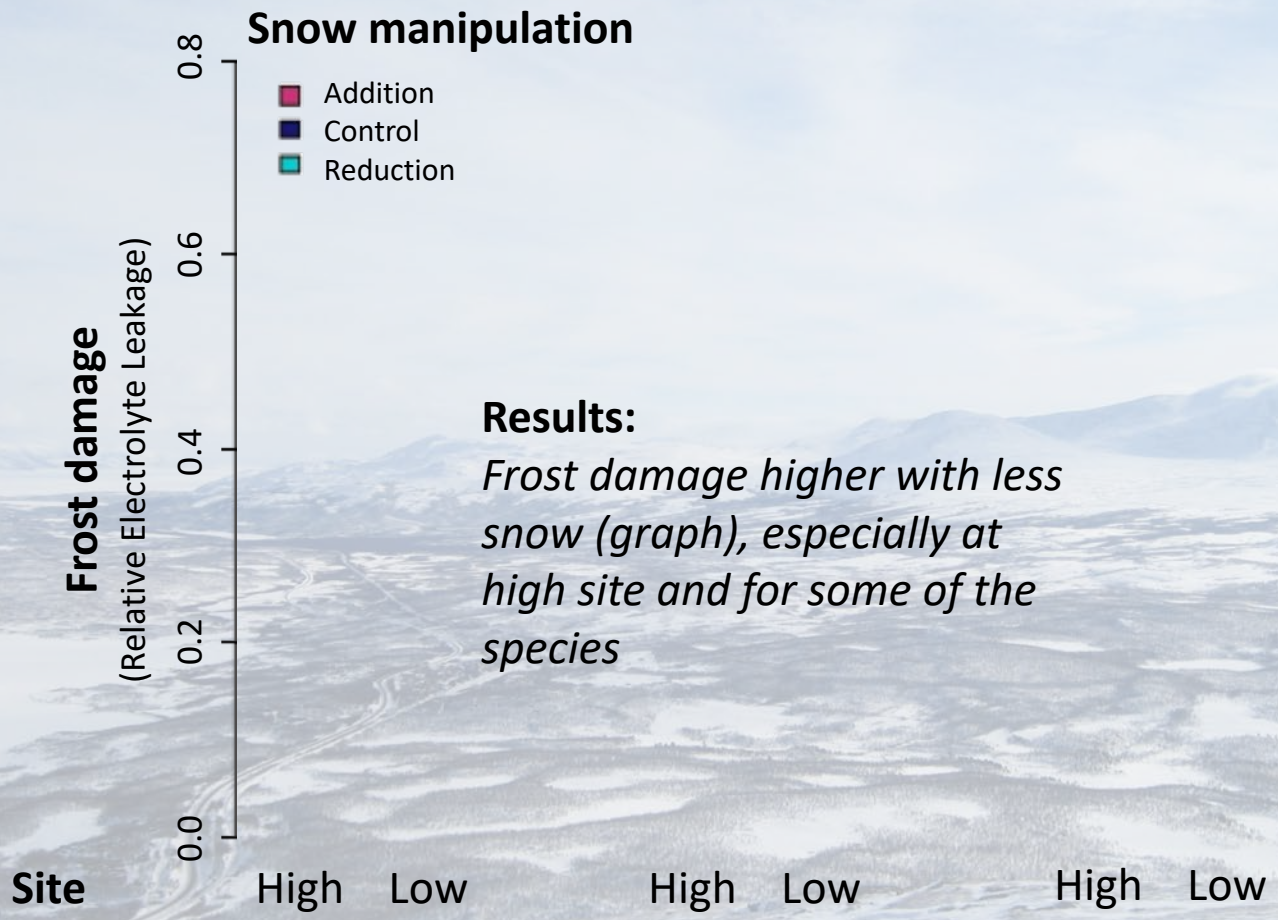
Hypothesis 1



Results:

Frost damage higher at low elevation (graph)

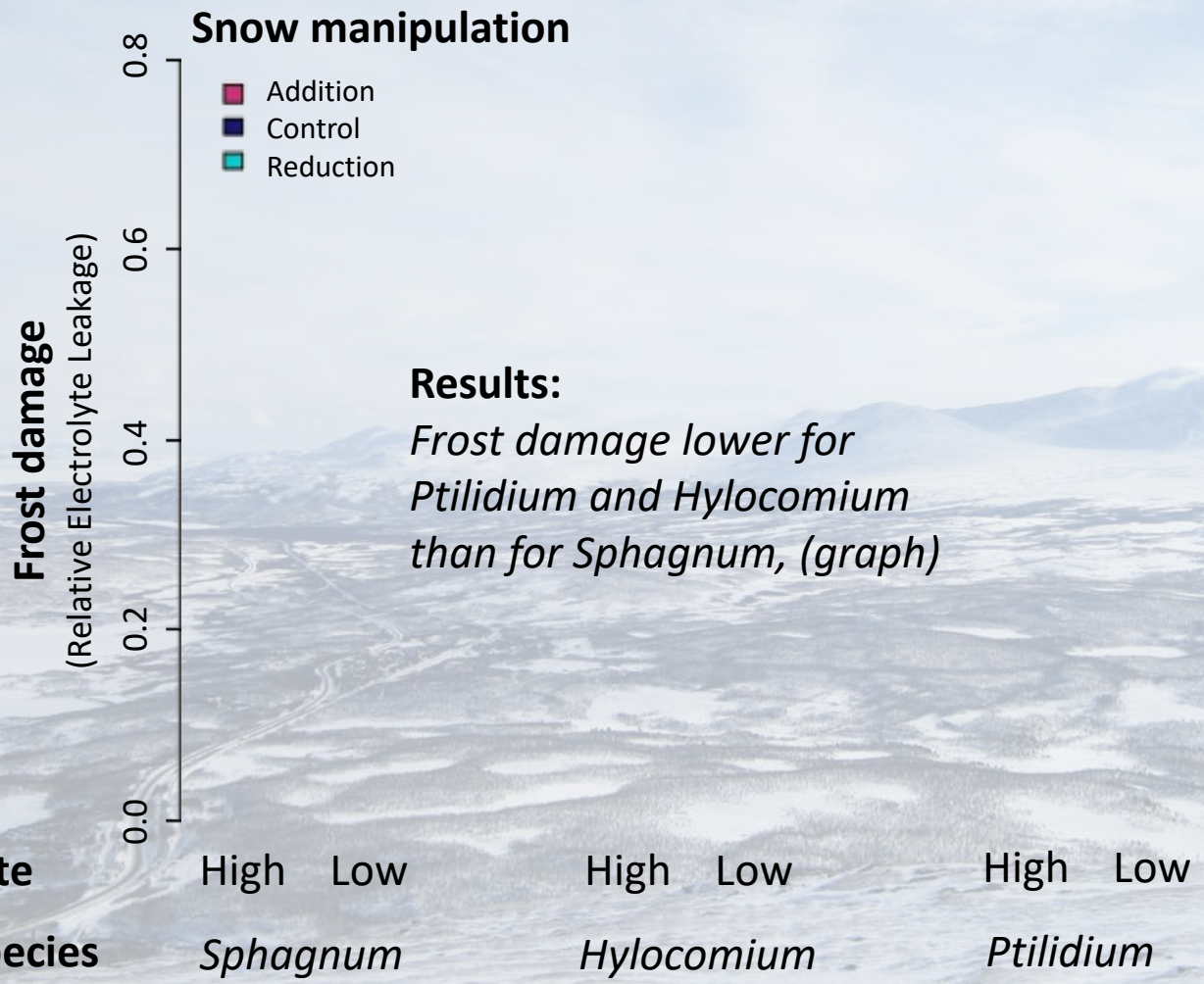
Hypothesis 2



Results:

Frost damage higher with less snow (graph), especially at high site and for some of the species

Hypothesis 3



Results:

Frost damage lower for Ptilidium and Hylocomium than for Sphagnum, (graph)

Conclusions

- Frost damage not lower in a ‘warmer’ climate (lower elevation)
  - Higher mean, min. and max. winter temperature
  - Caused by higher winter freeze-thaw frequency?
- Frost damage (weakly) lower under thicker/longer snow cover
  - Under harsh (windy?) climate (high elevation)
  - For ‘sensitive’ bryophyte species (moist, sheltered)

Thanks!

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