

Ecosystem warming may increase or decrease probability of low- temperature damage depending on tree species

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SPRUCE All-hands meeting

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Winter physiology

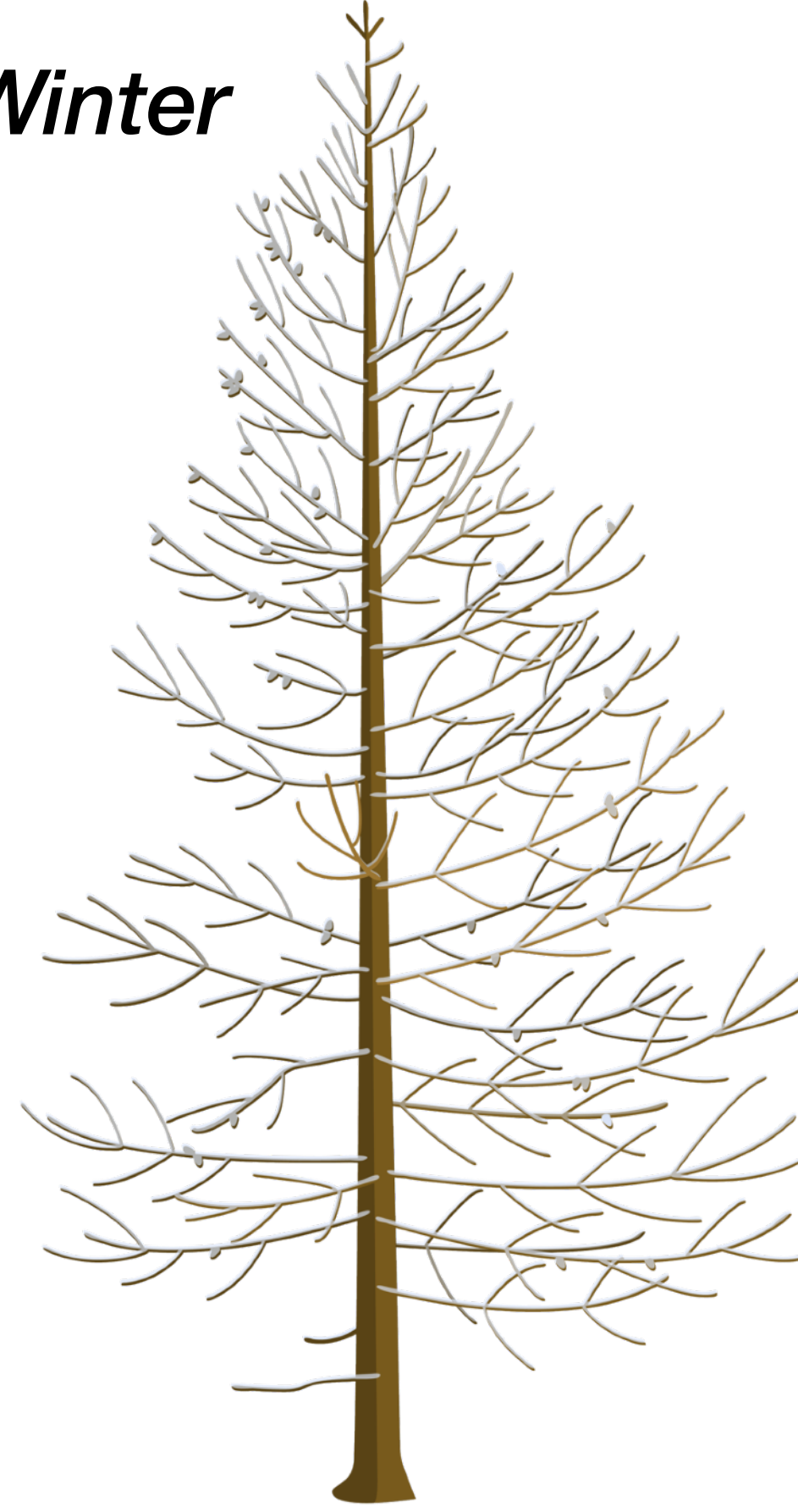
Summer



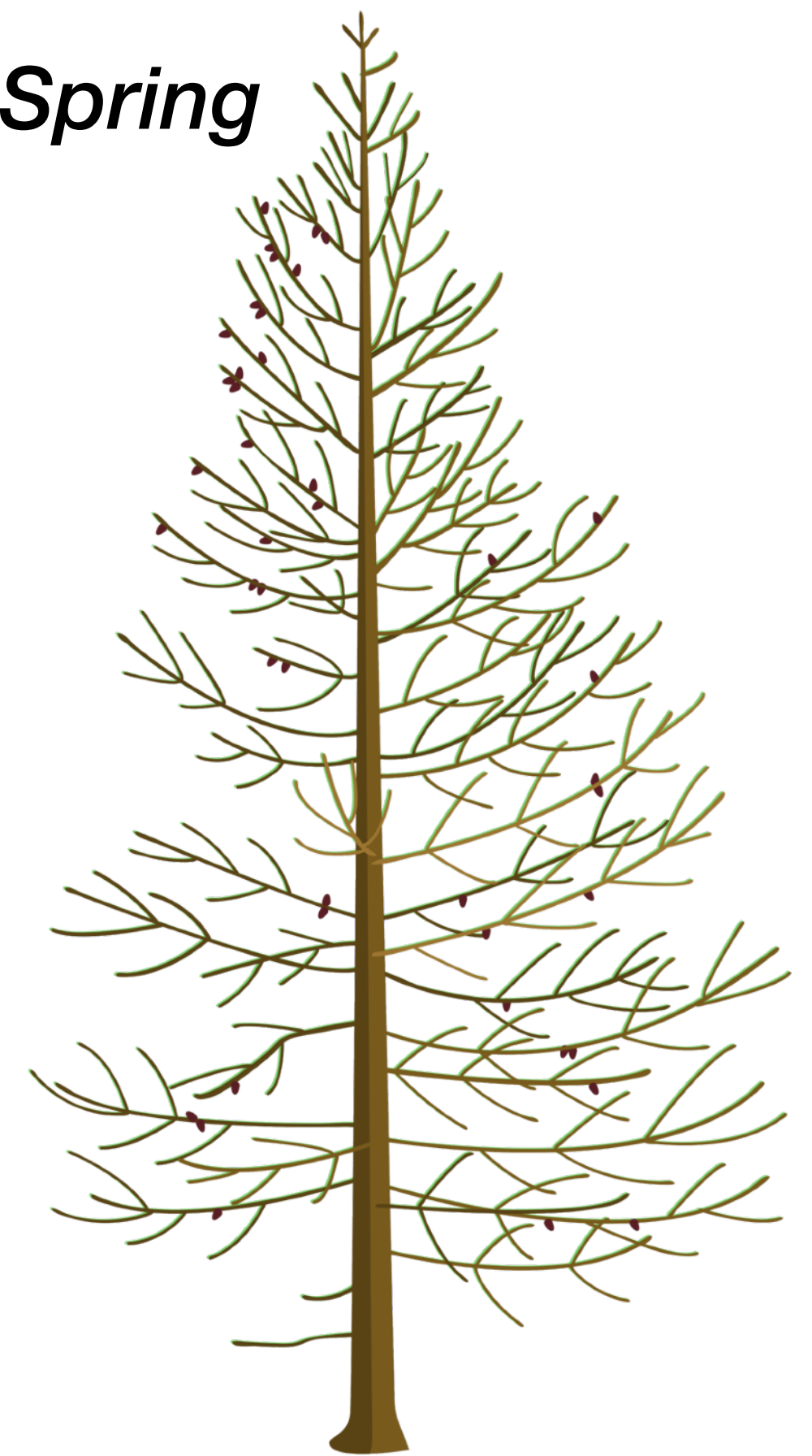
Fall



Winter



Spring



Bud set

Dormancy

Budbreak

Acclimation

Cold Hardiness

Deacclimation

Winter physiology

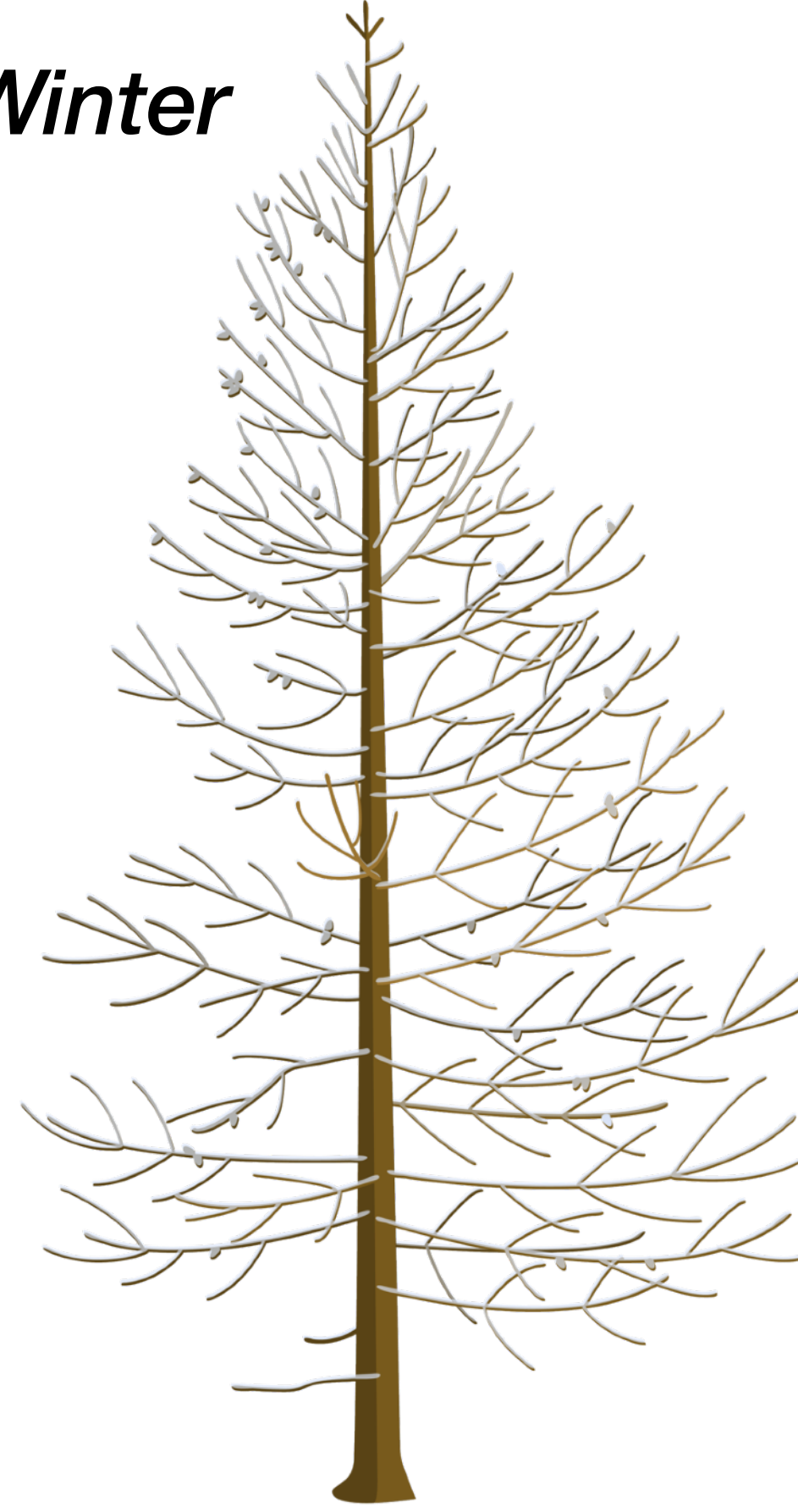
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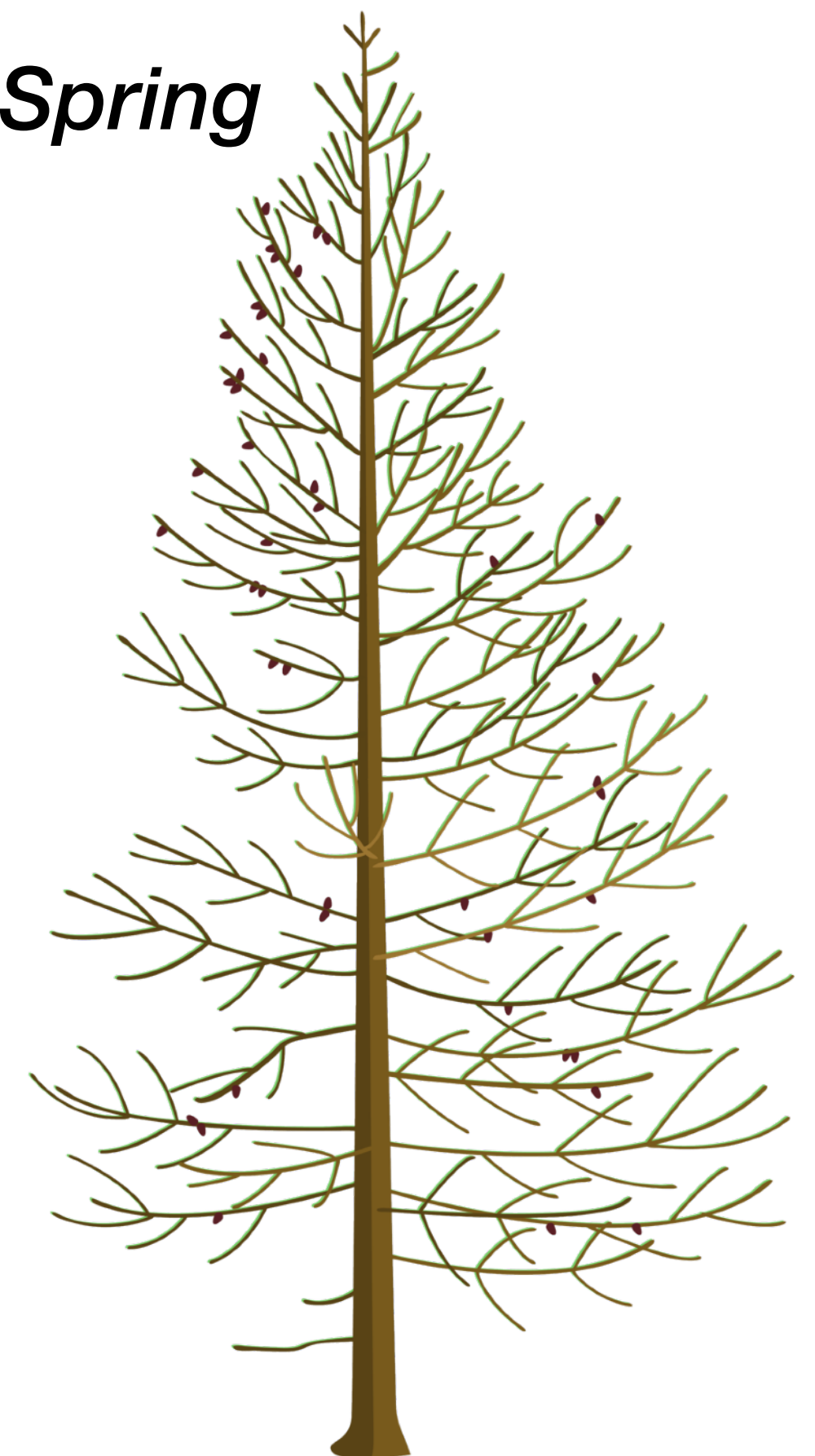
Fall



Winter



Spring



Bud set

Dormancy

Budbreak

Acclimation

Cold Hardiness

Deacclimation



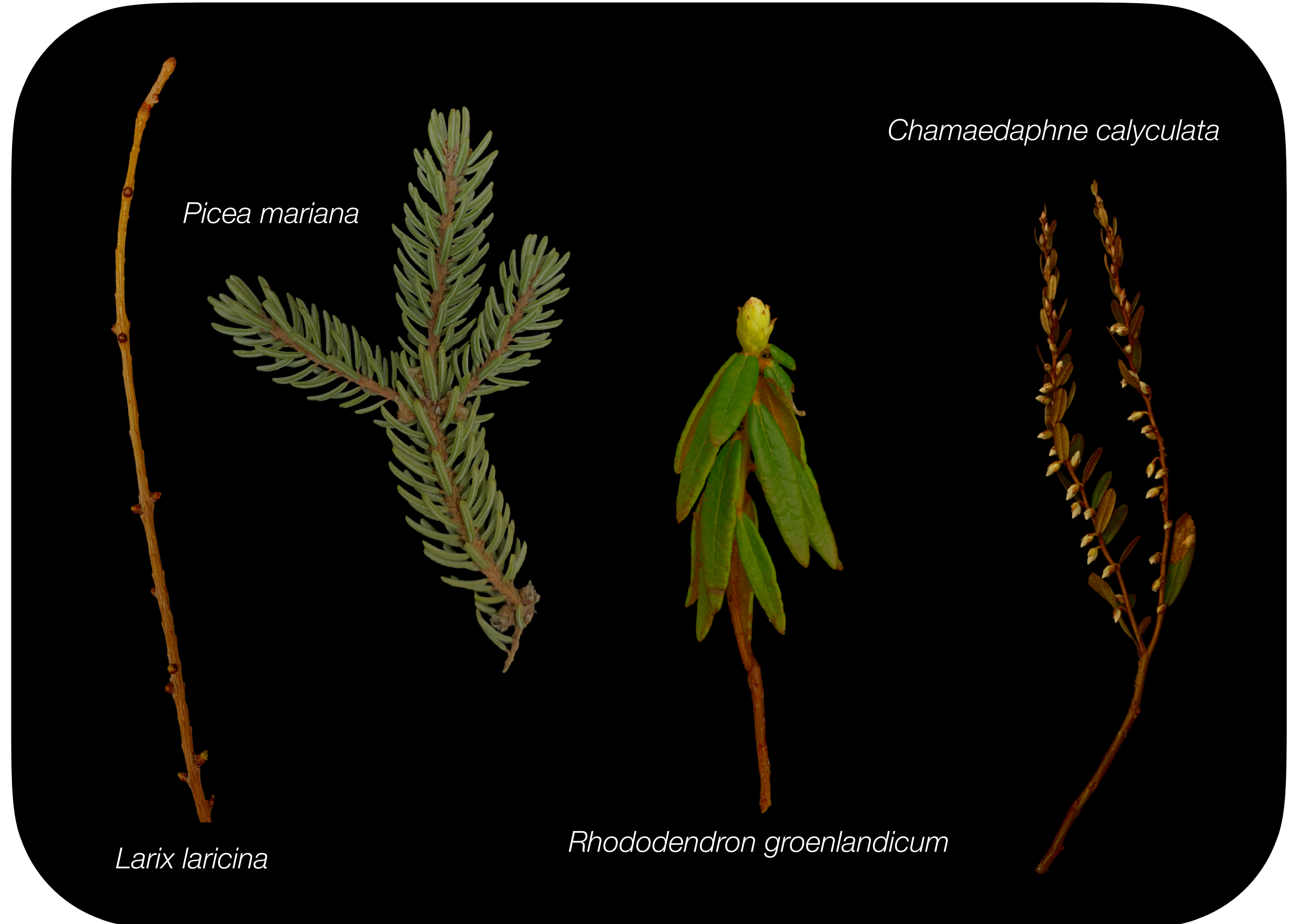
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Sampling



Dr. North

Dr. Kovaleski



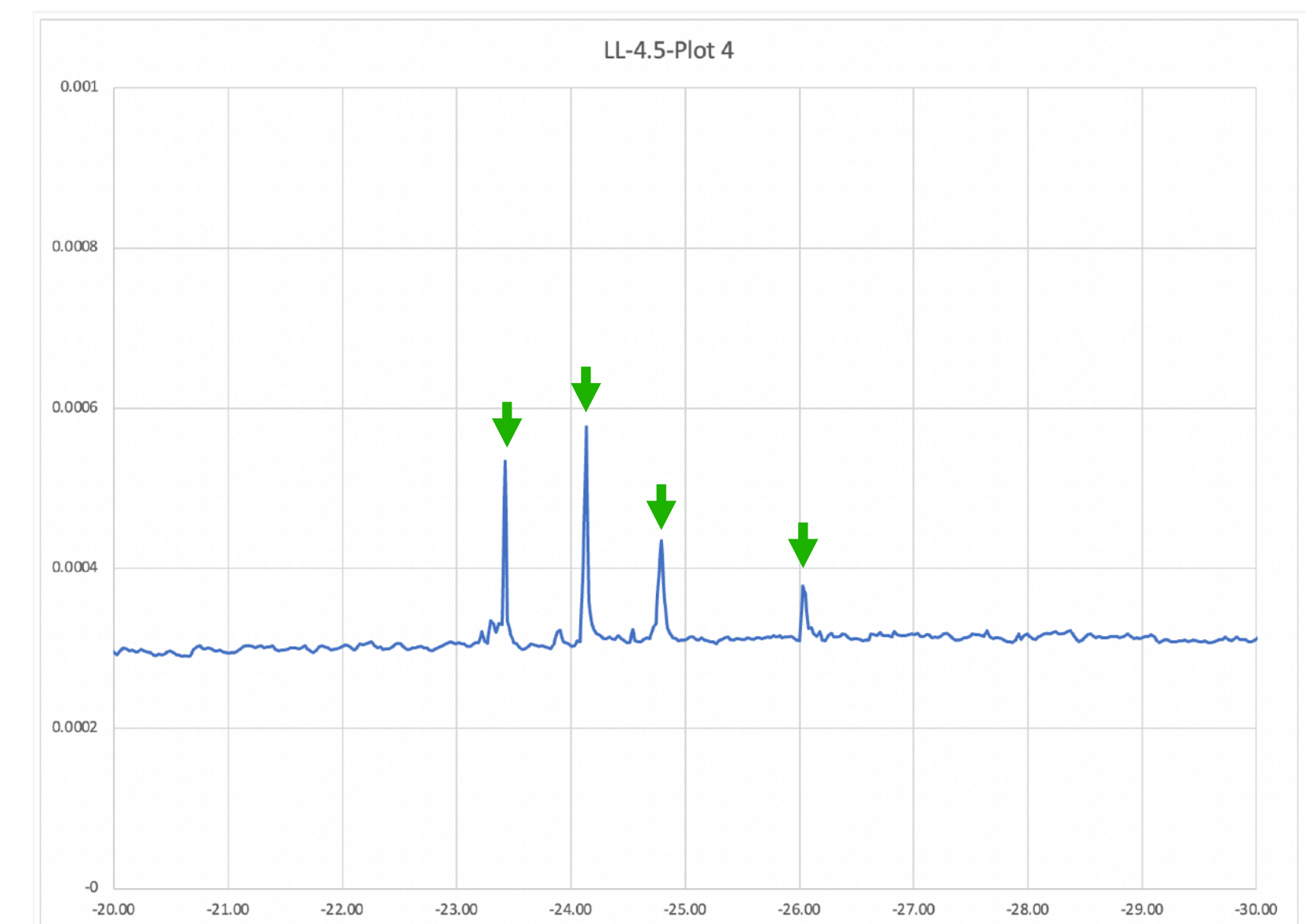
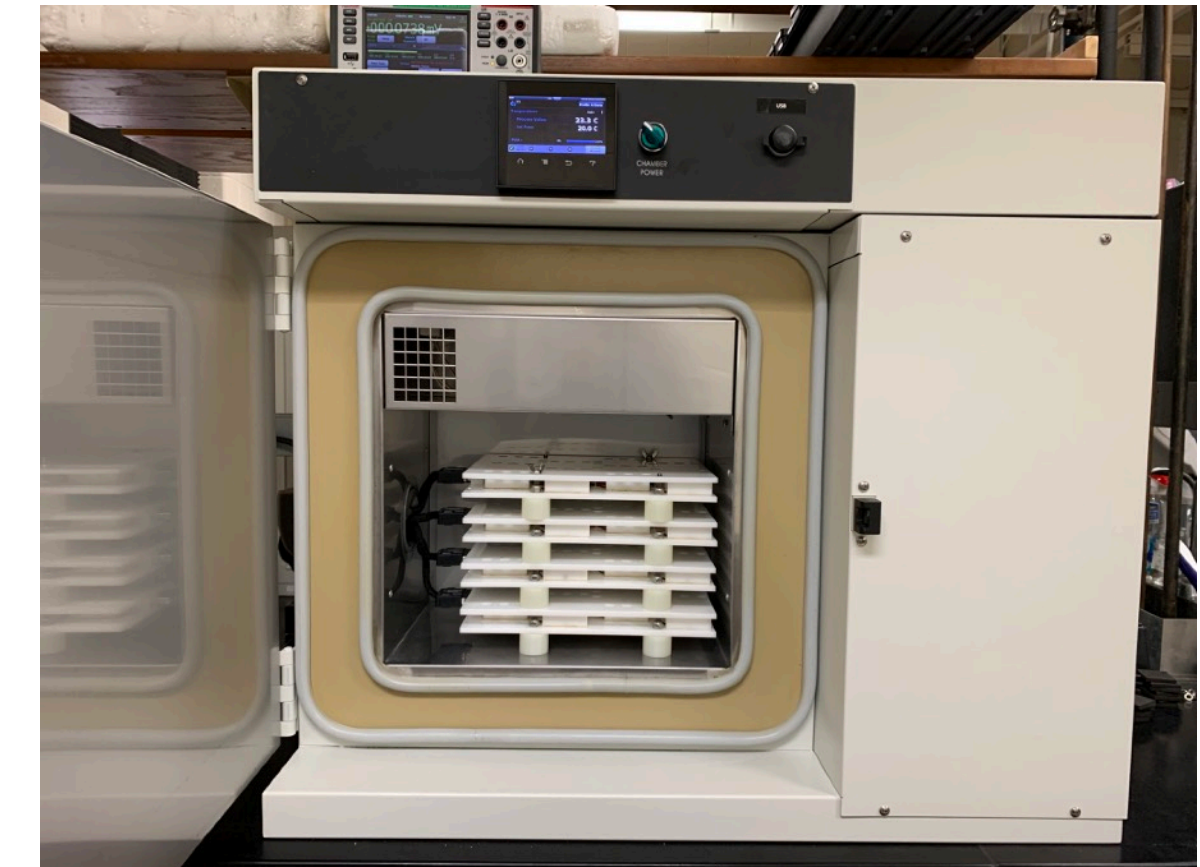
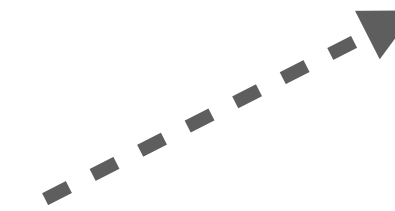
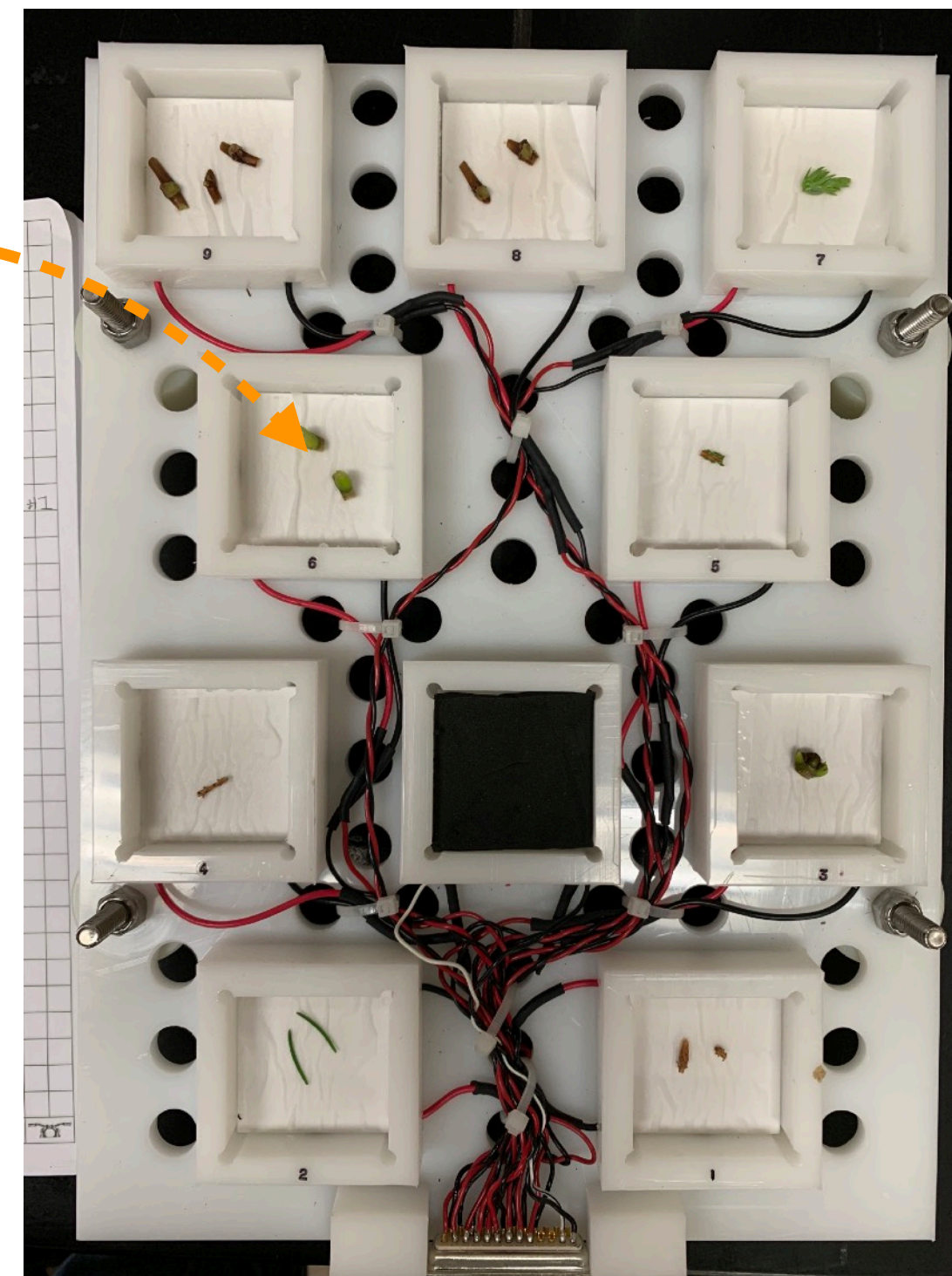
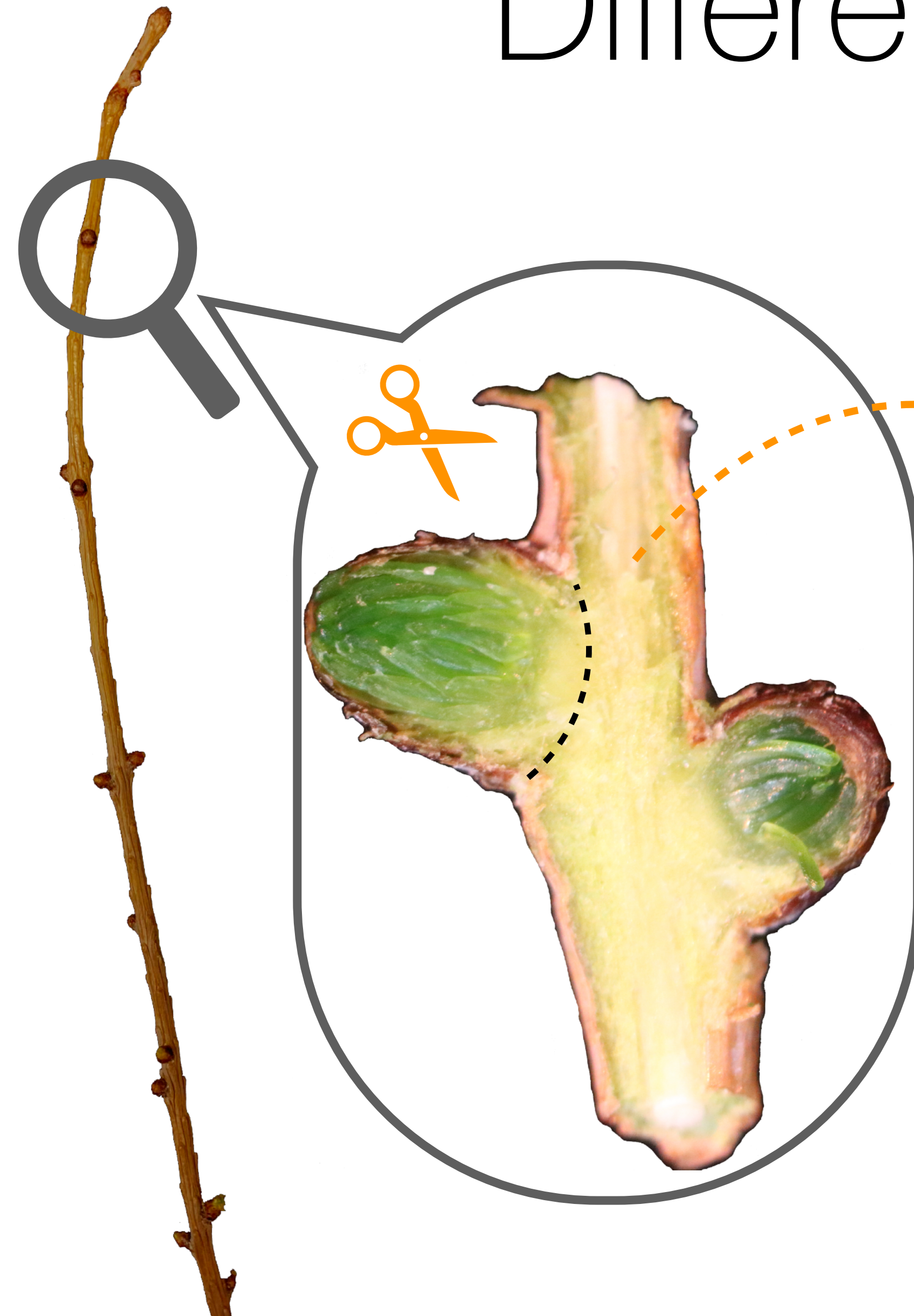
Picea mariana

Chamaedaphne calyculata

Larix laricina

Rhododendron groenlandicum

Differential thermal analysis

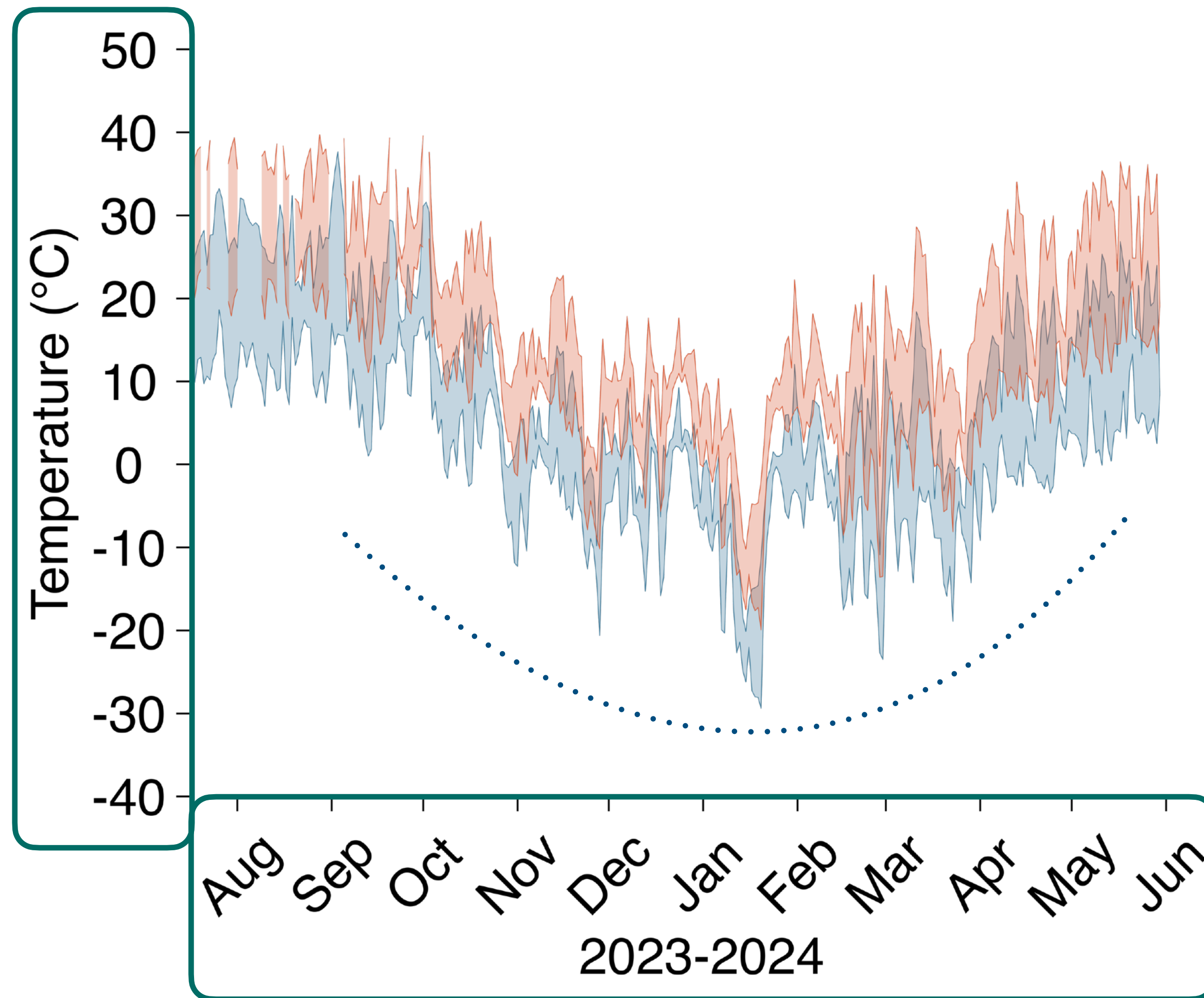


Budbreak assays

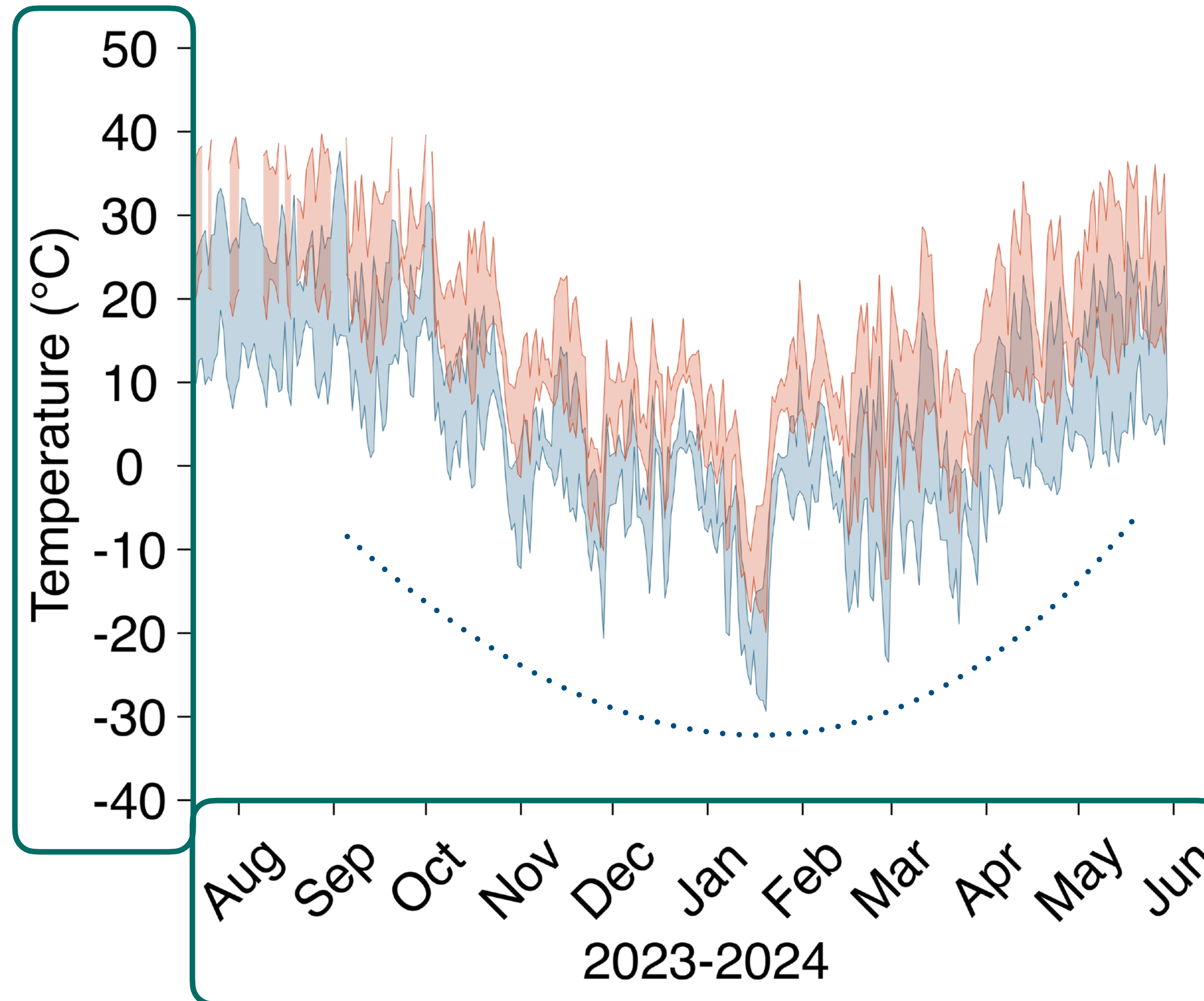


Results

How to read the results?



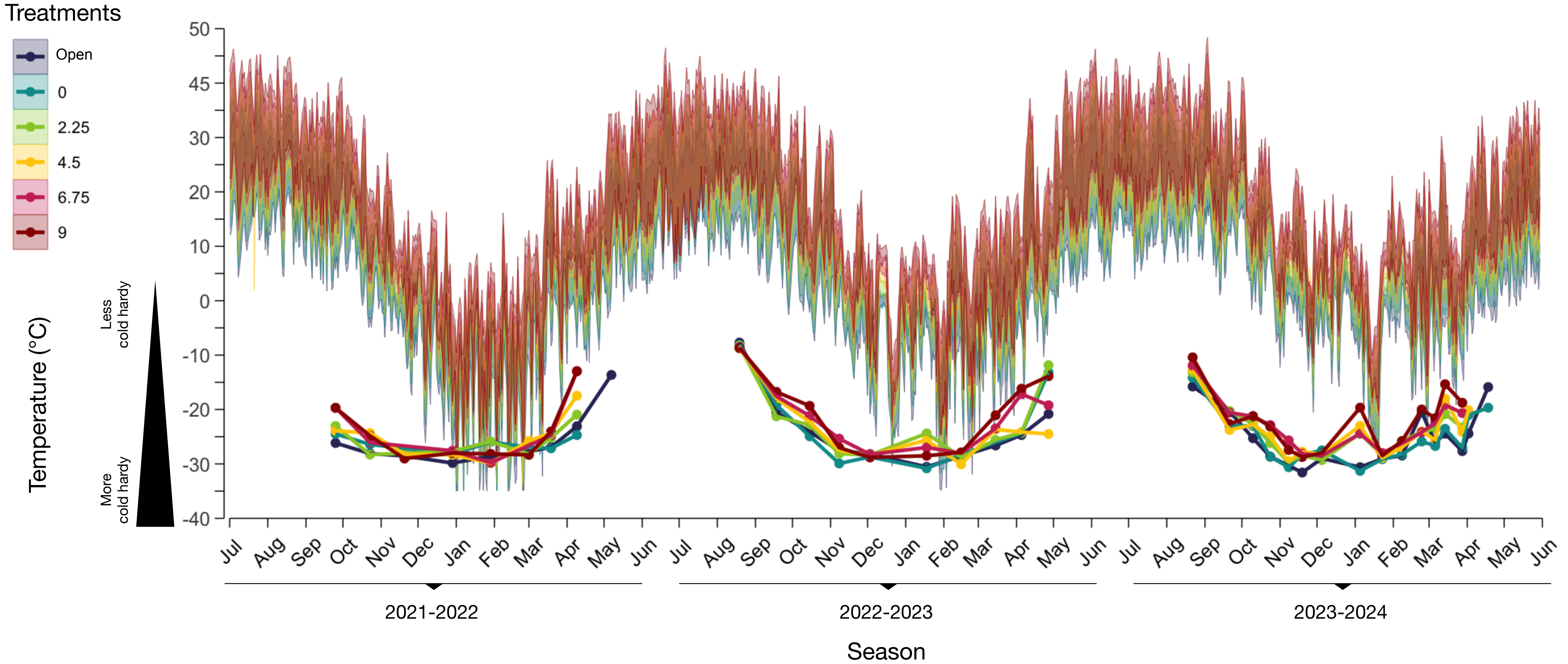
How to read the results?



Trees

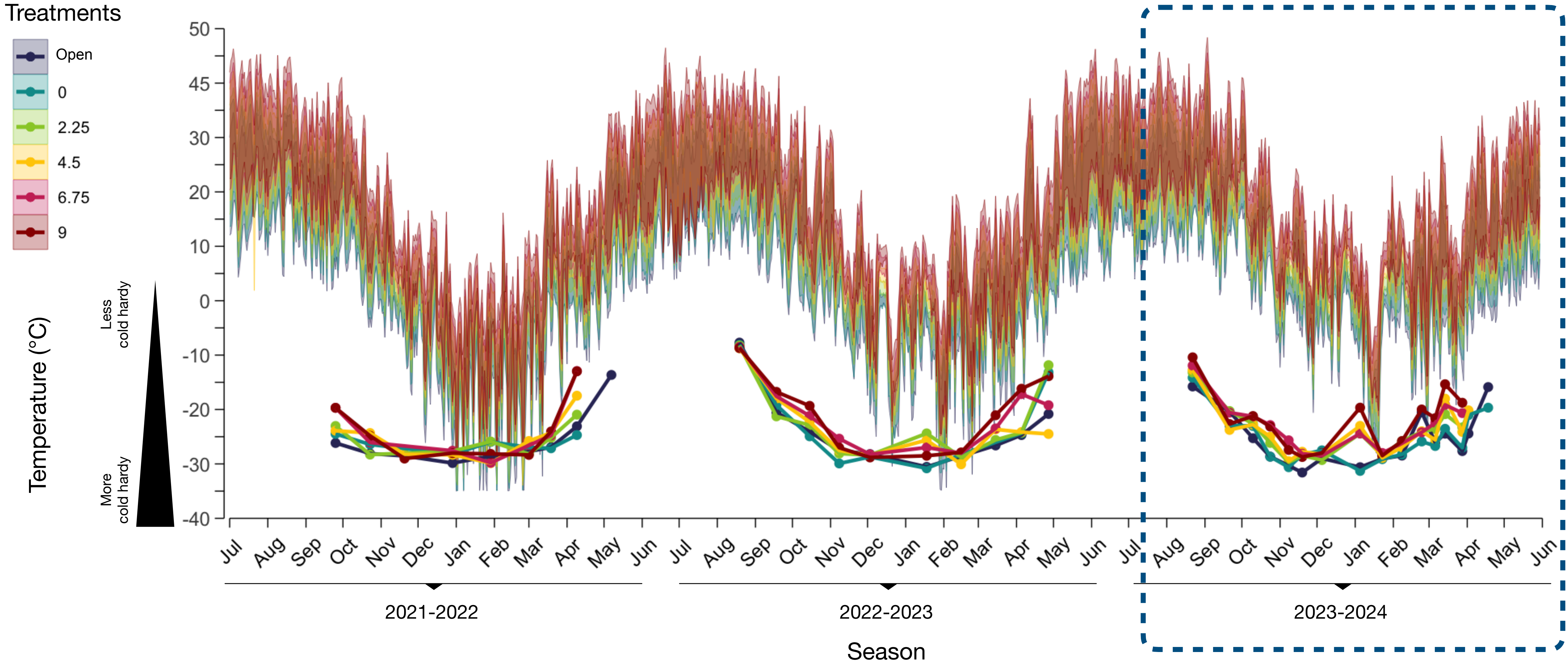
Larix laricina

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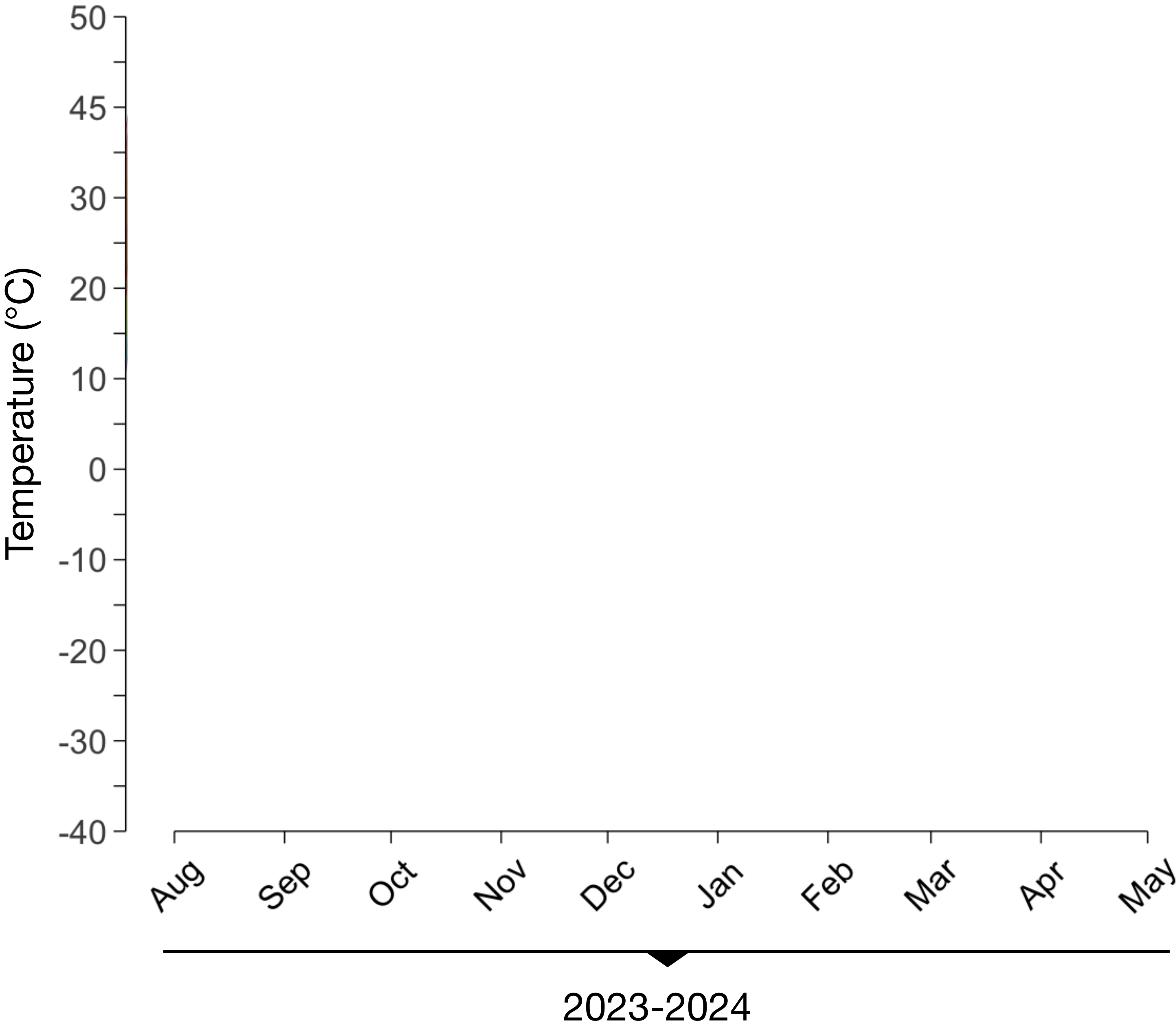
Larix laricina

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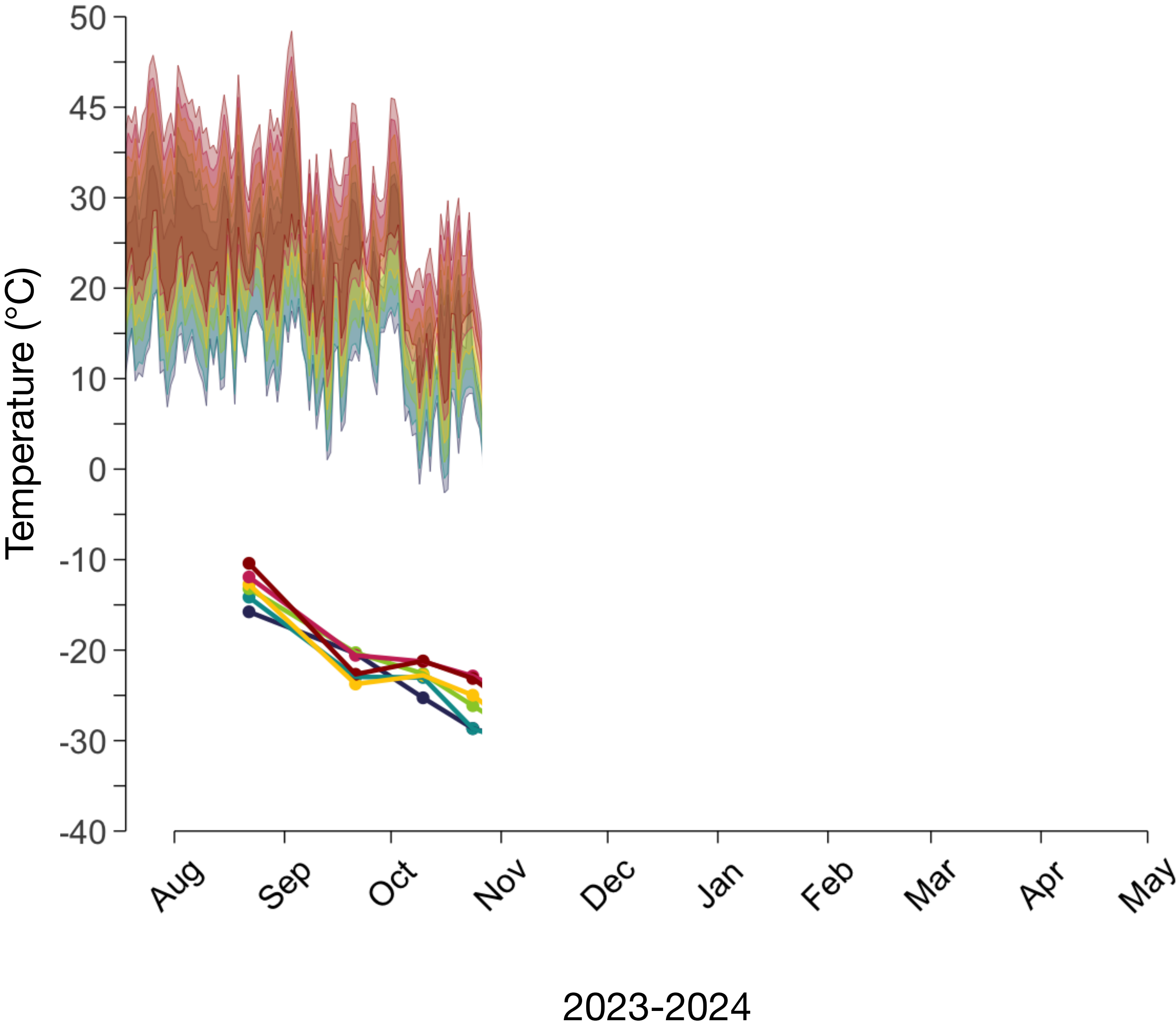
Larix laricina

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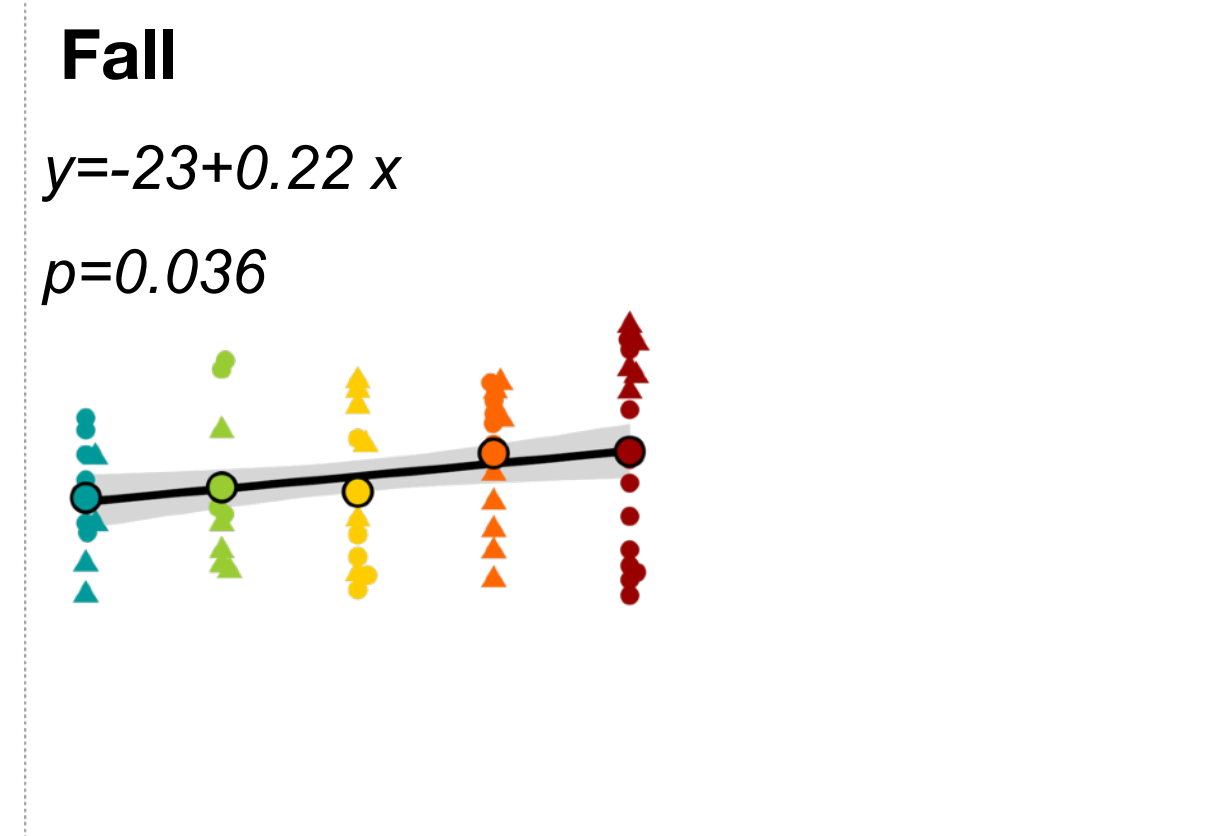
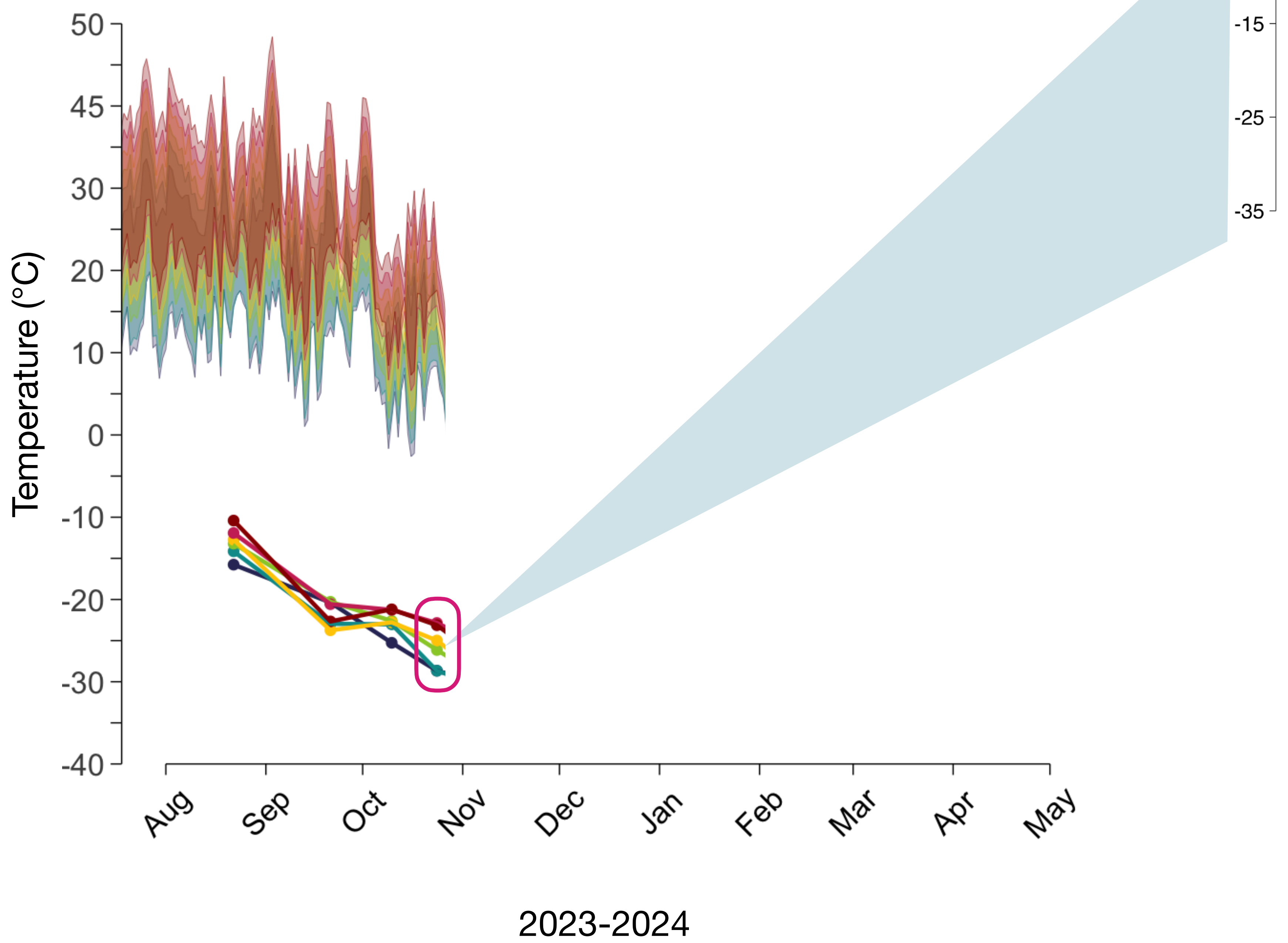
Larix laricina

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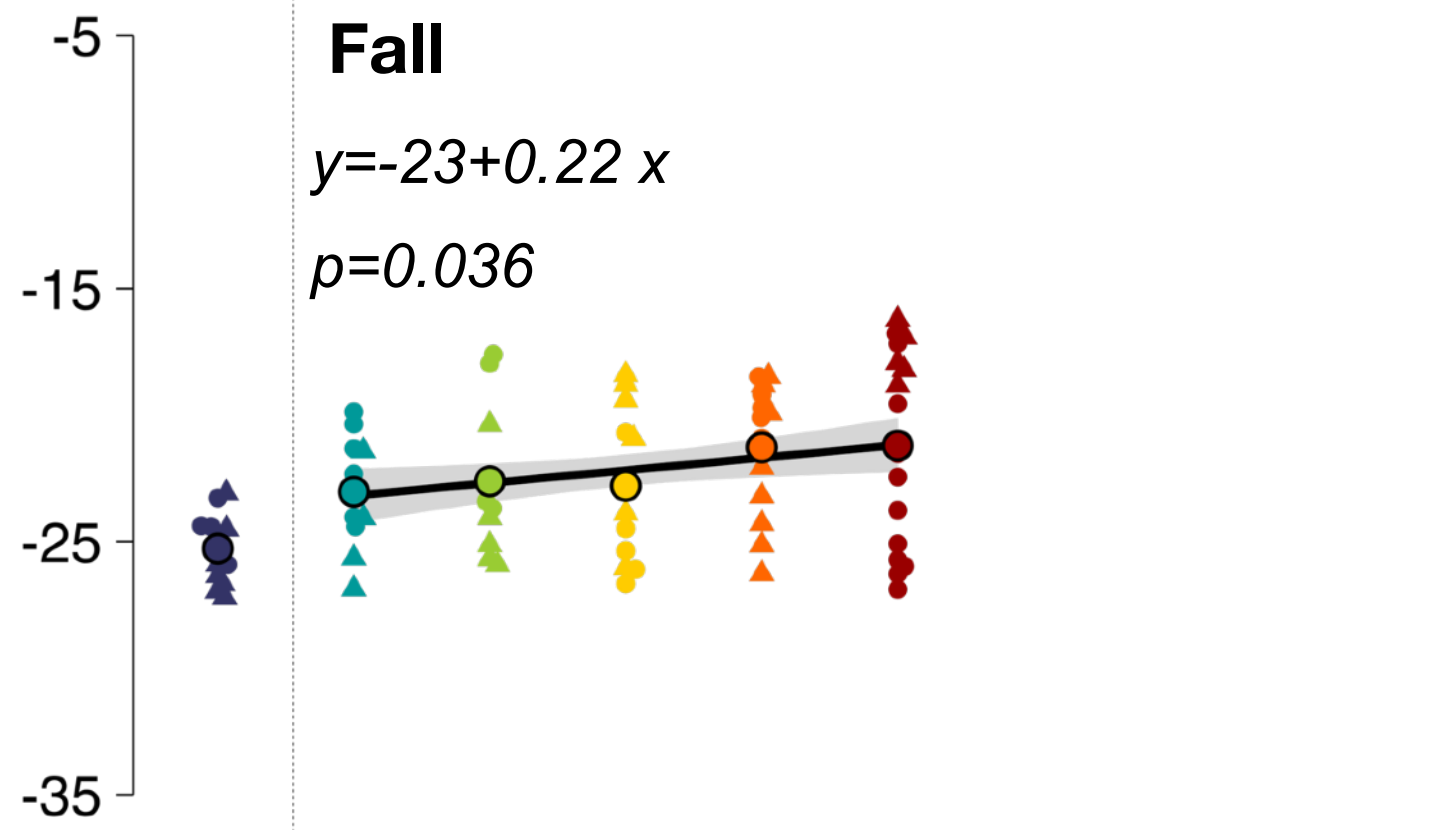
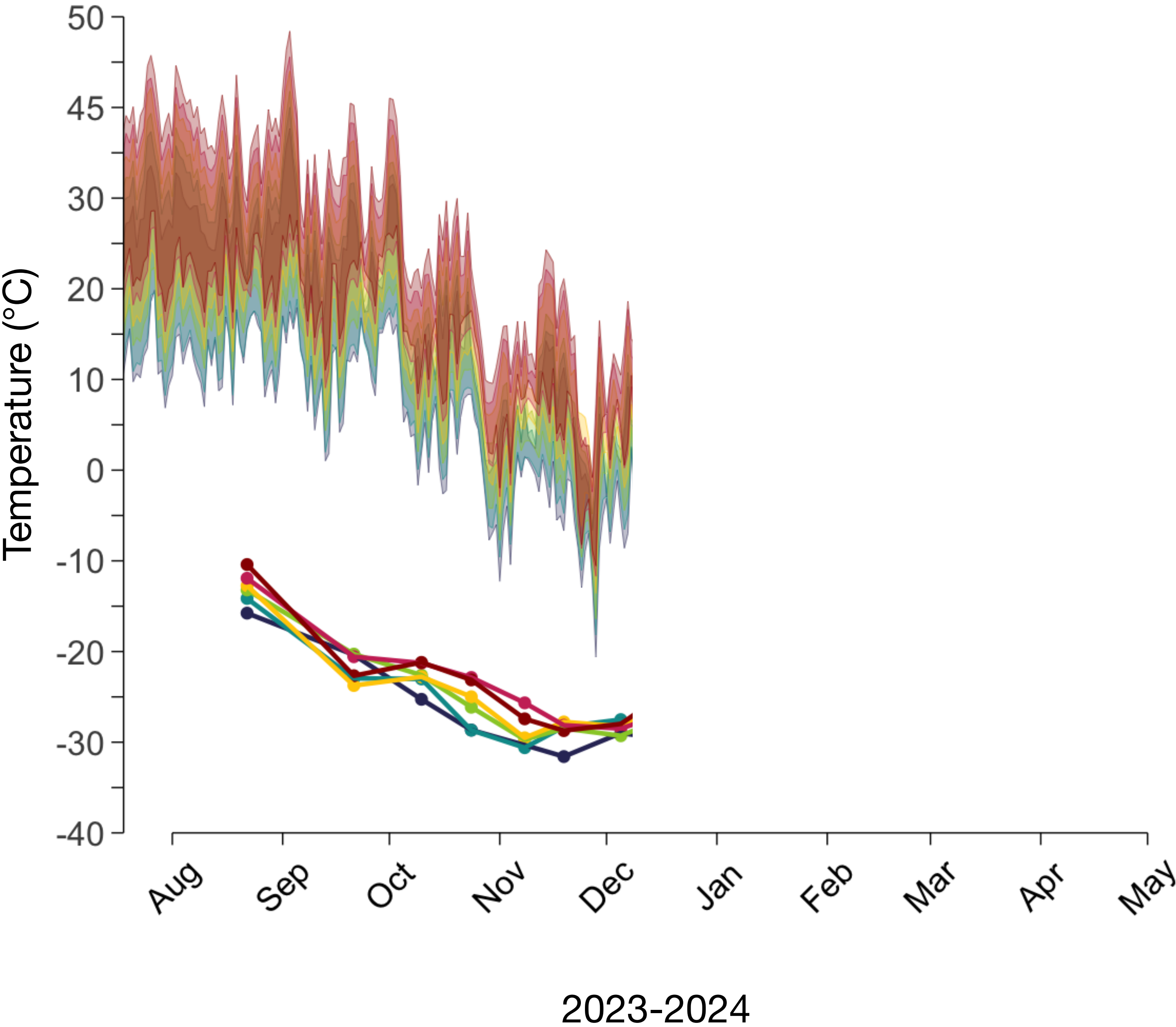
Larix laricina

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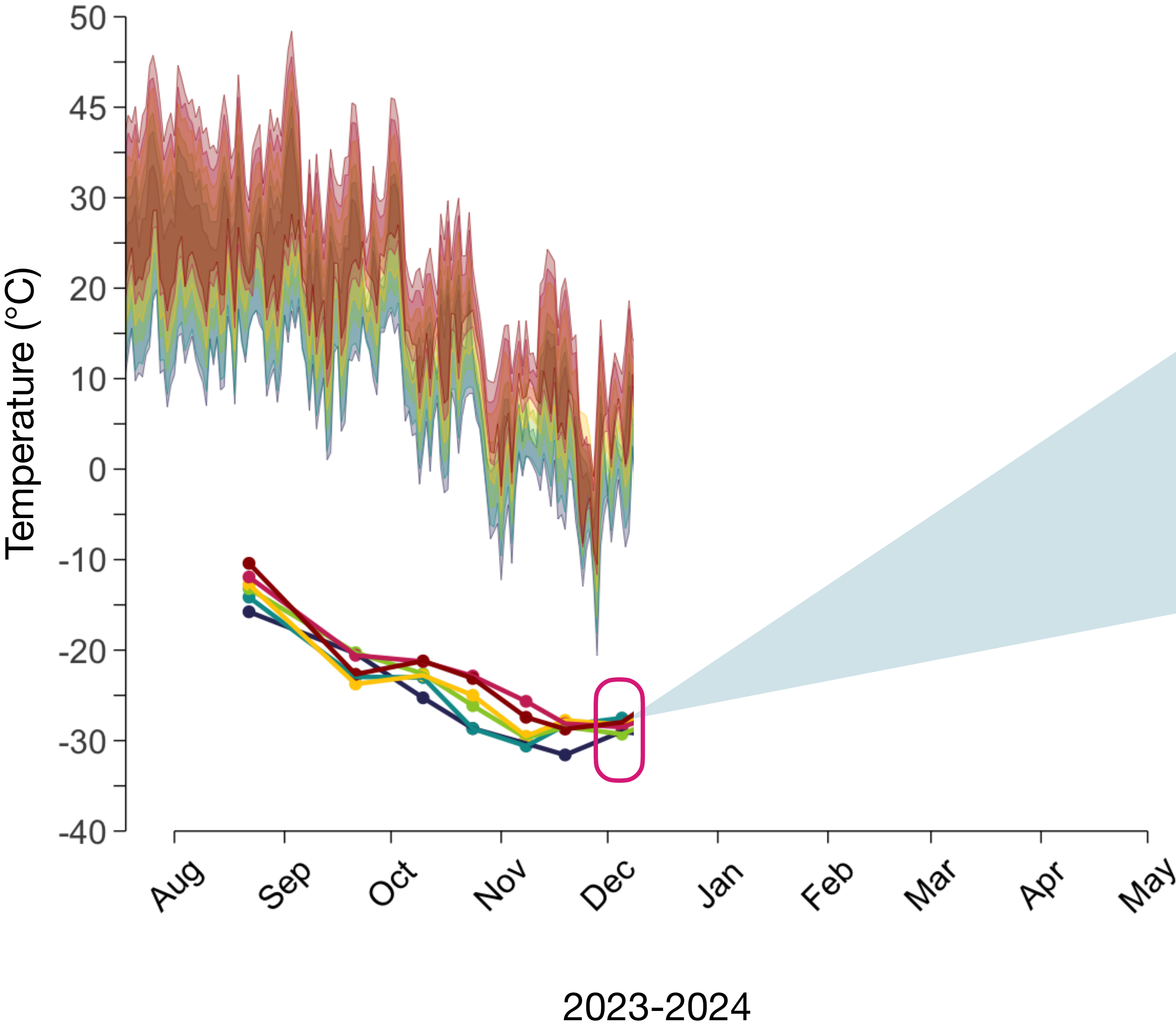
Larix laricina

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Larix laricina

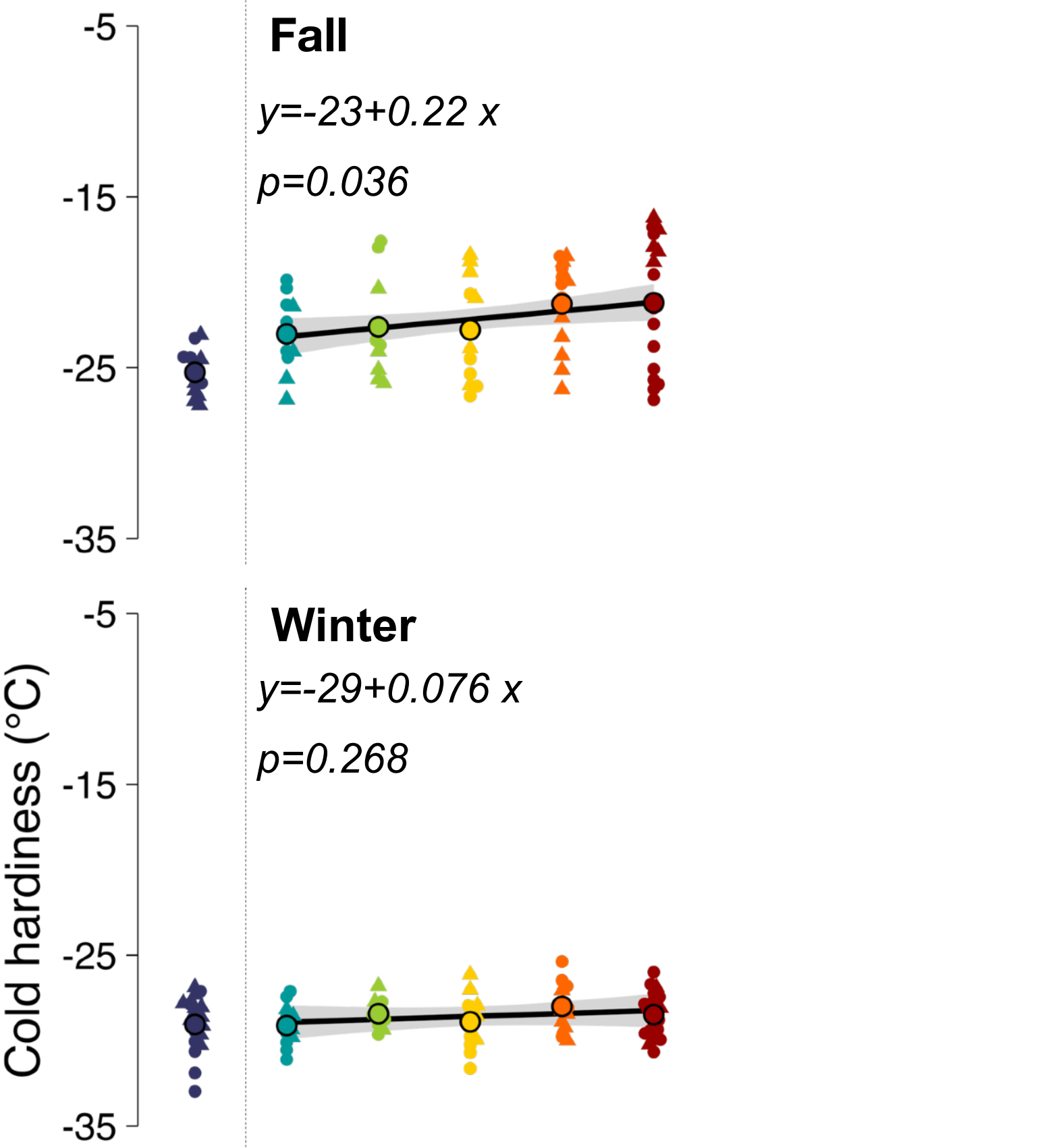
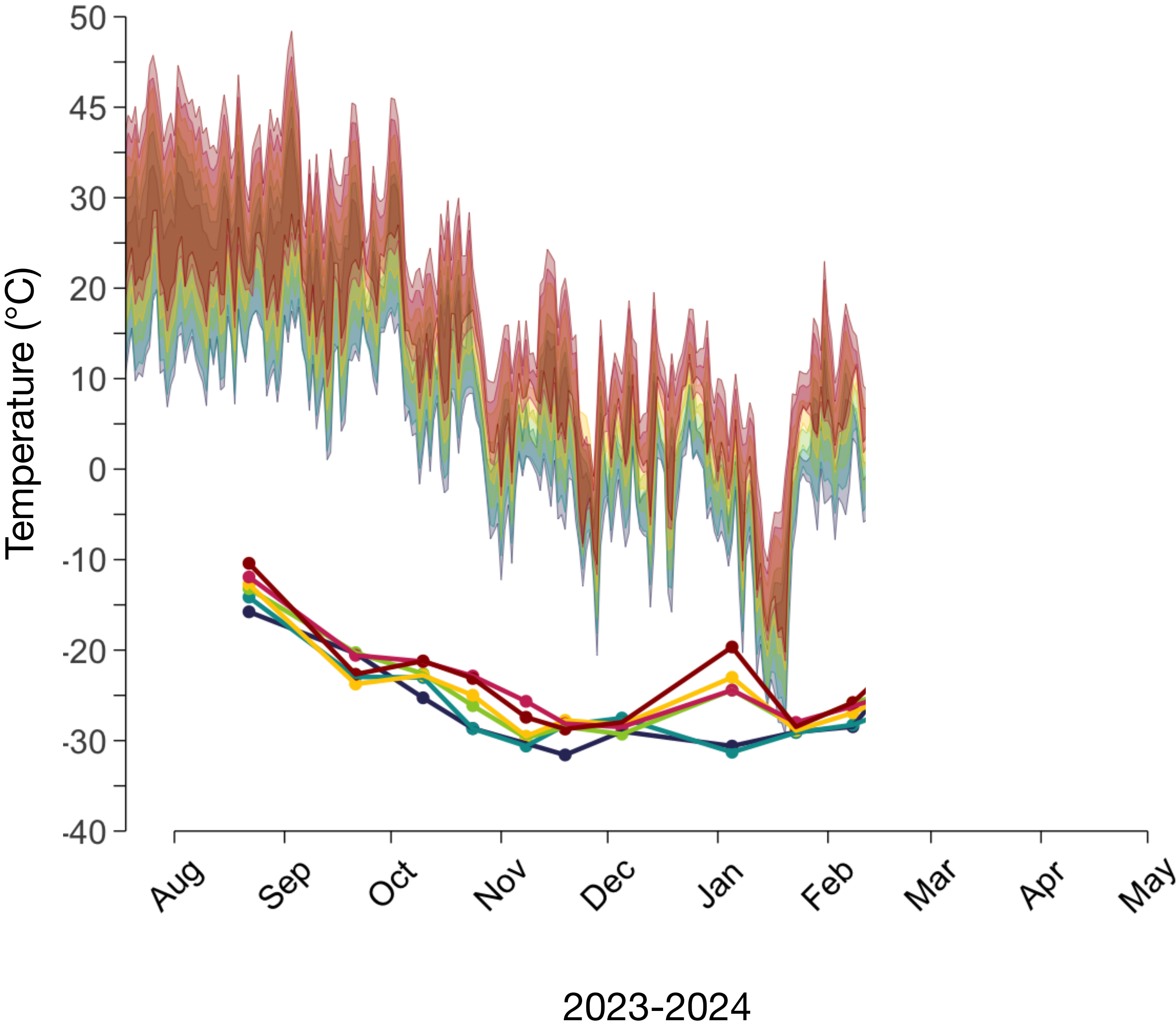
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Cold hardiness (°C)

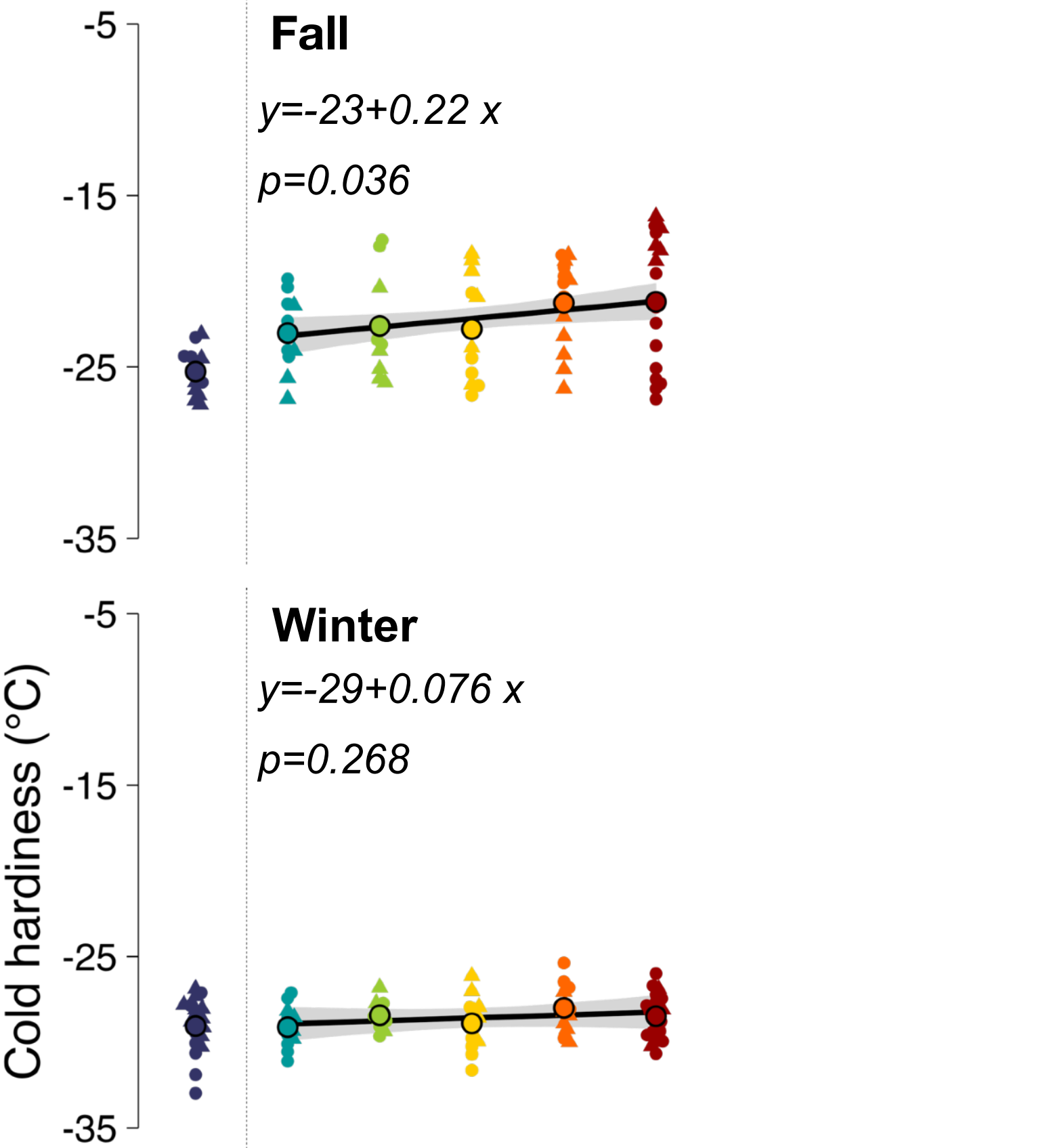
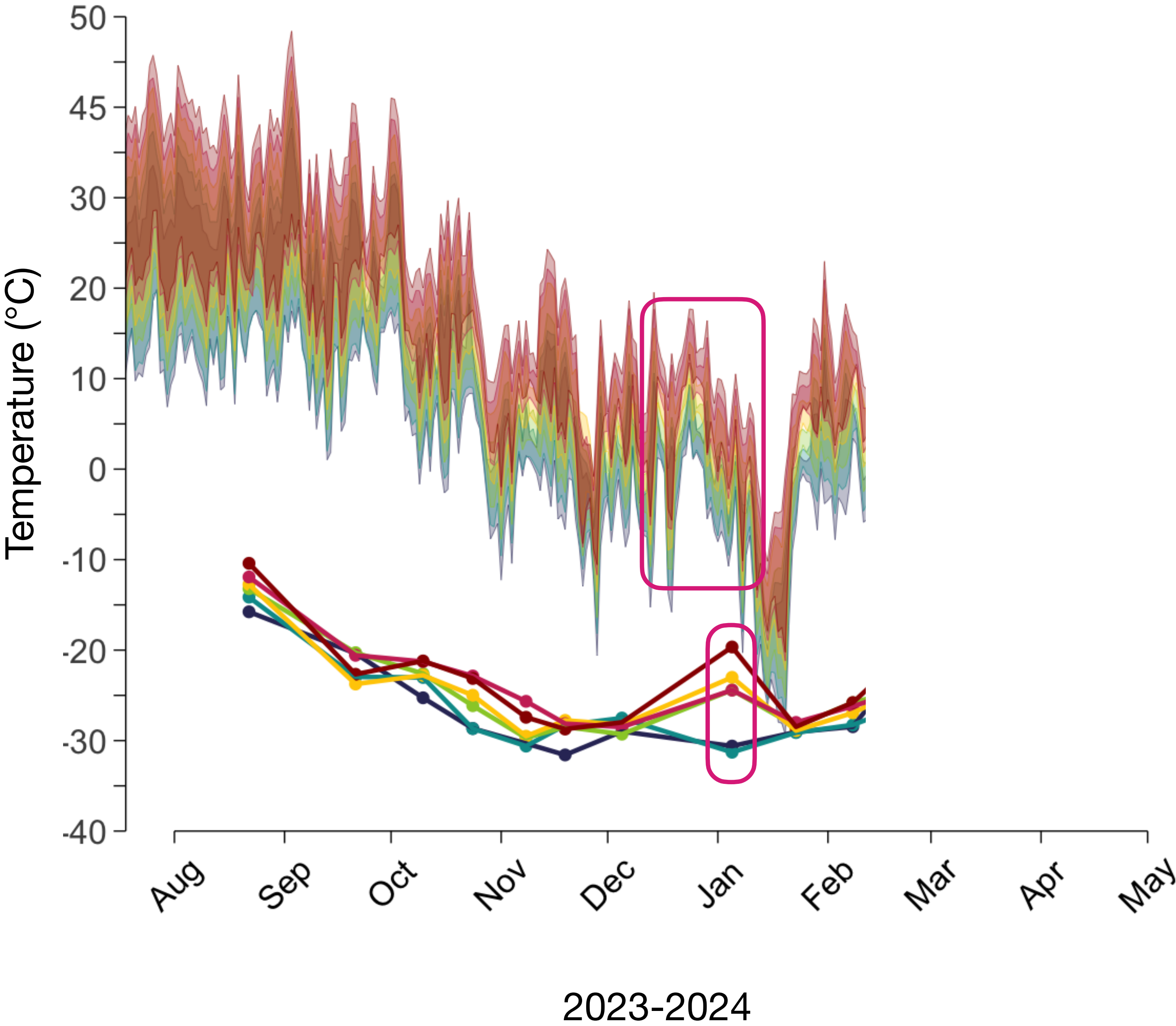
Fall
 $y = -23 + 0.22x$
 $p = 0.036$

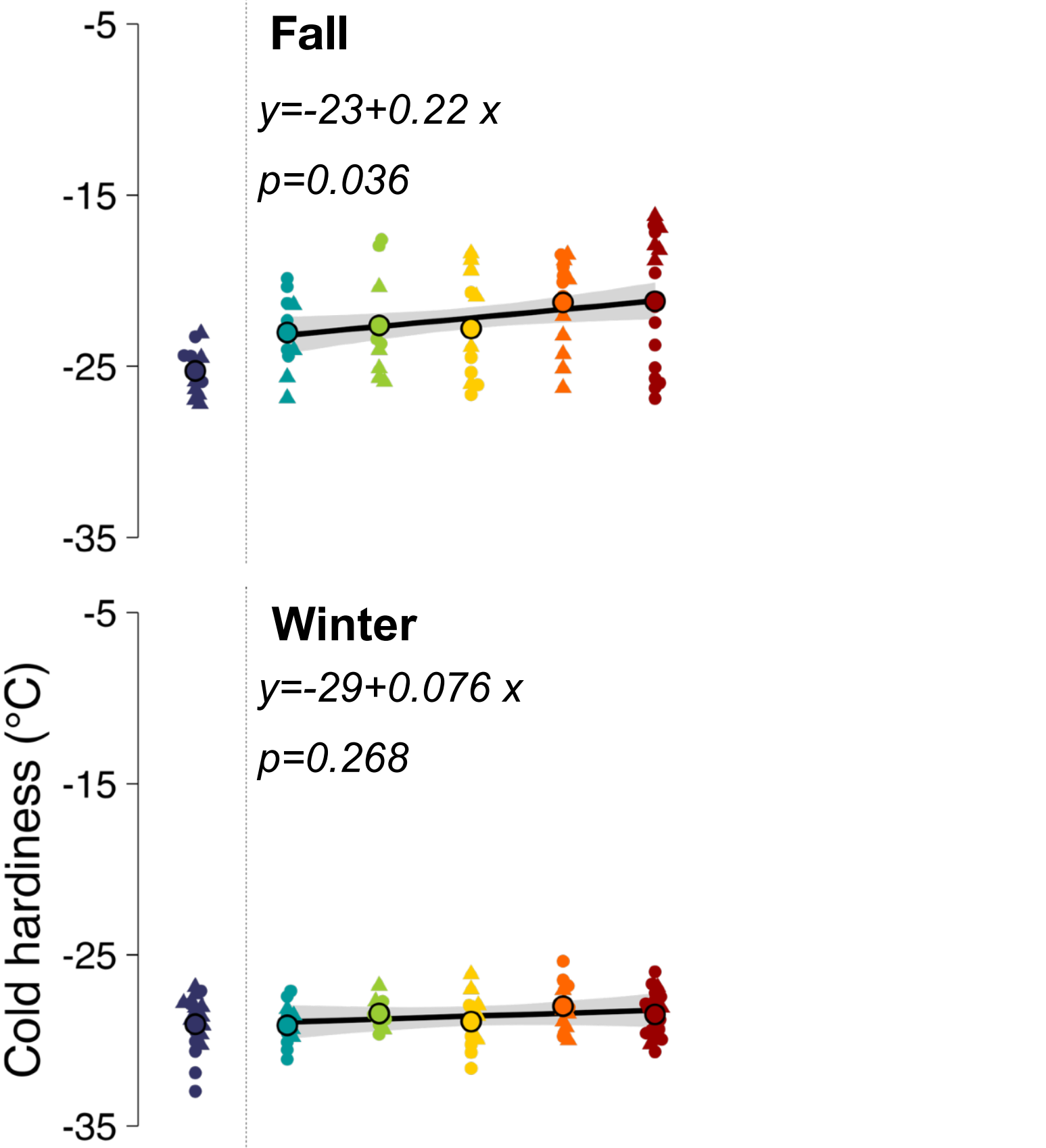
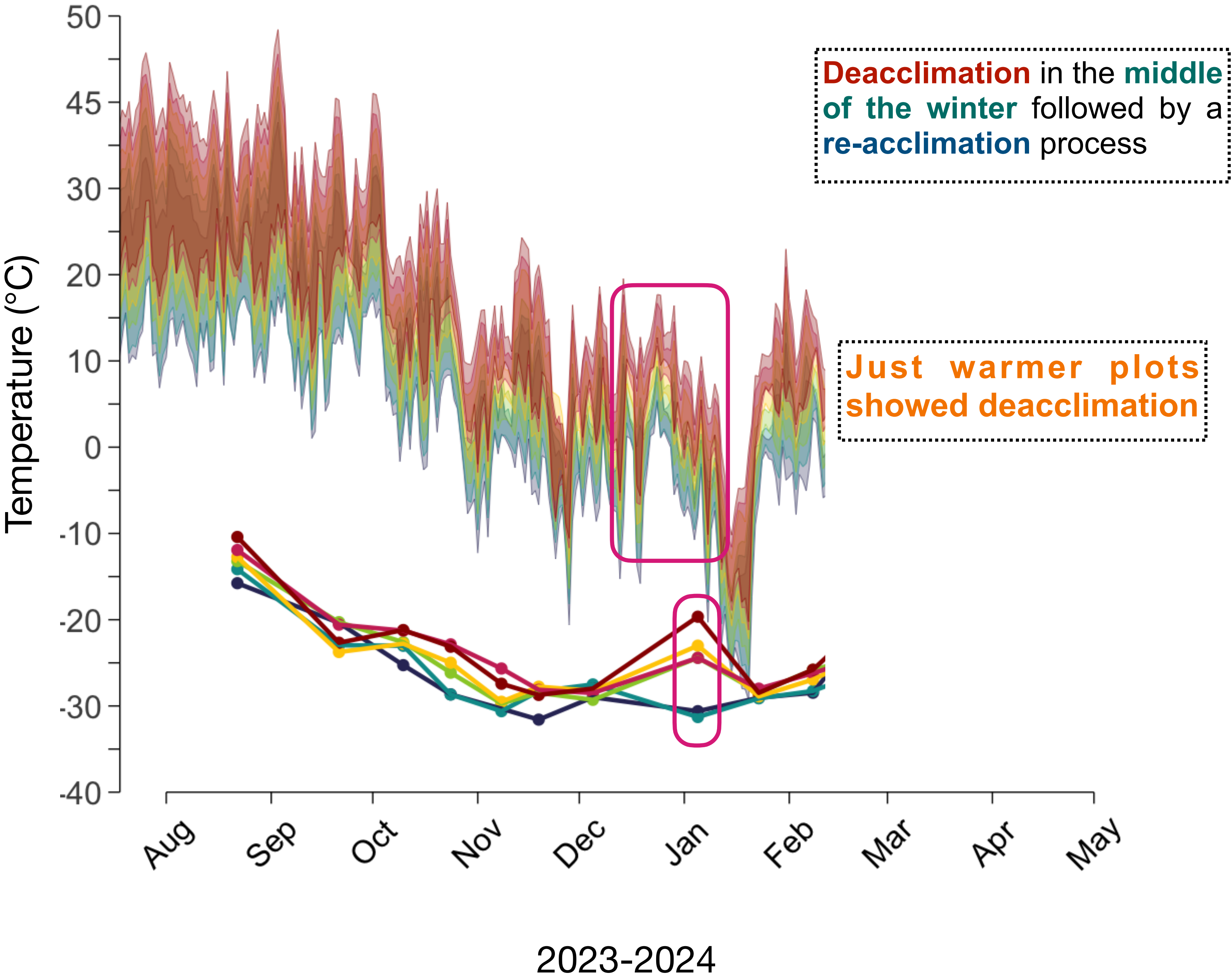
Winter
 $y = -29 + 0.076x$
 $p = 0.268$



Larix laricina

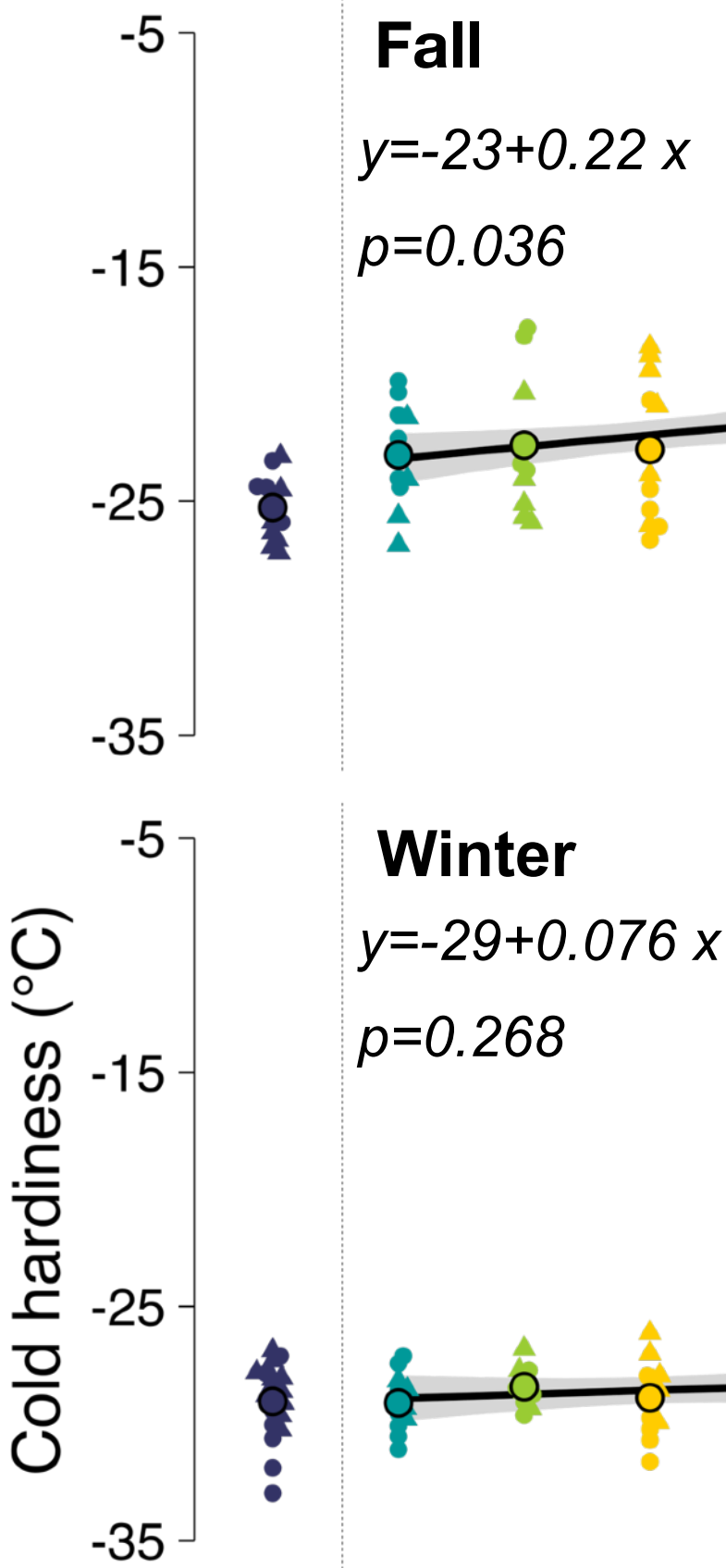
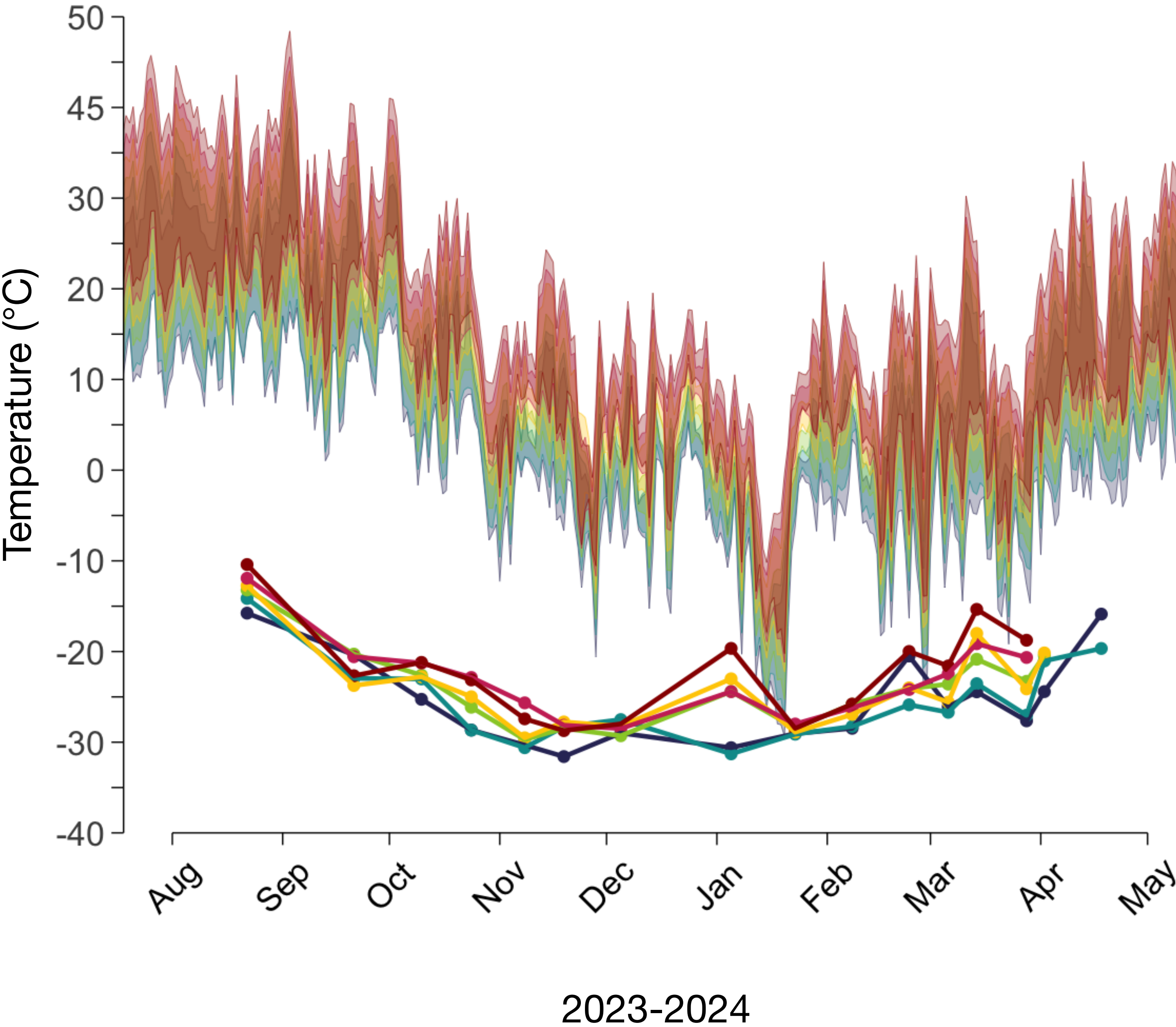
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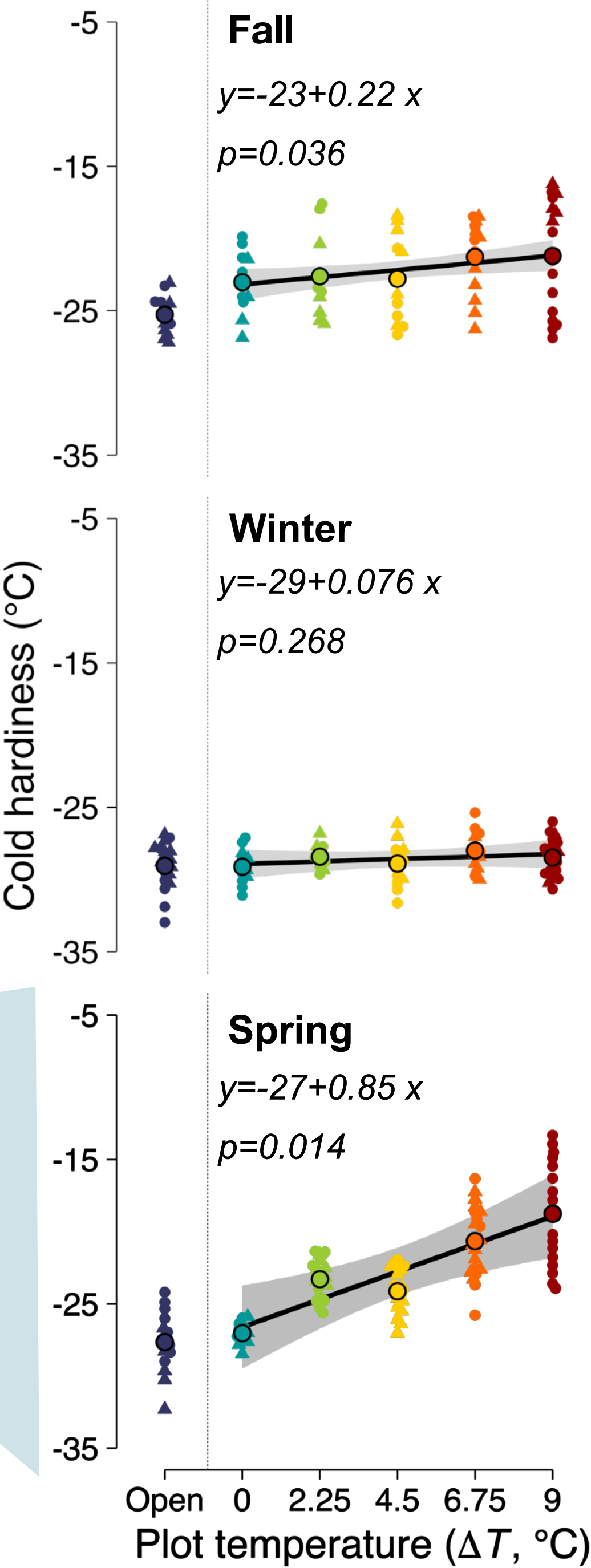
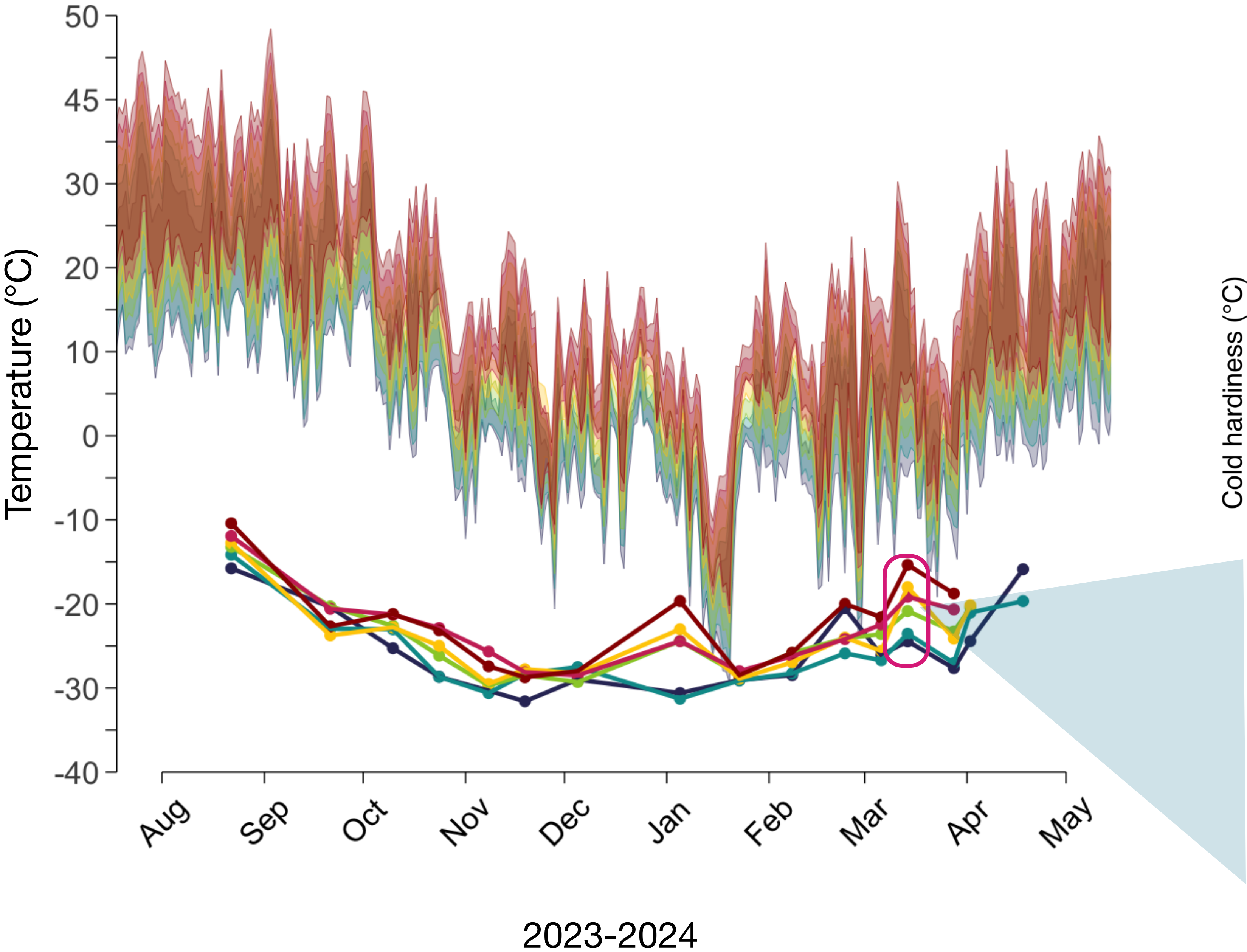
Larix laricina

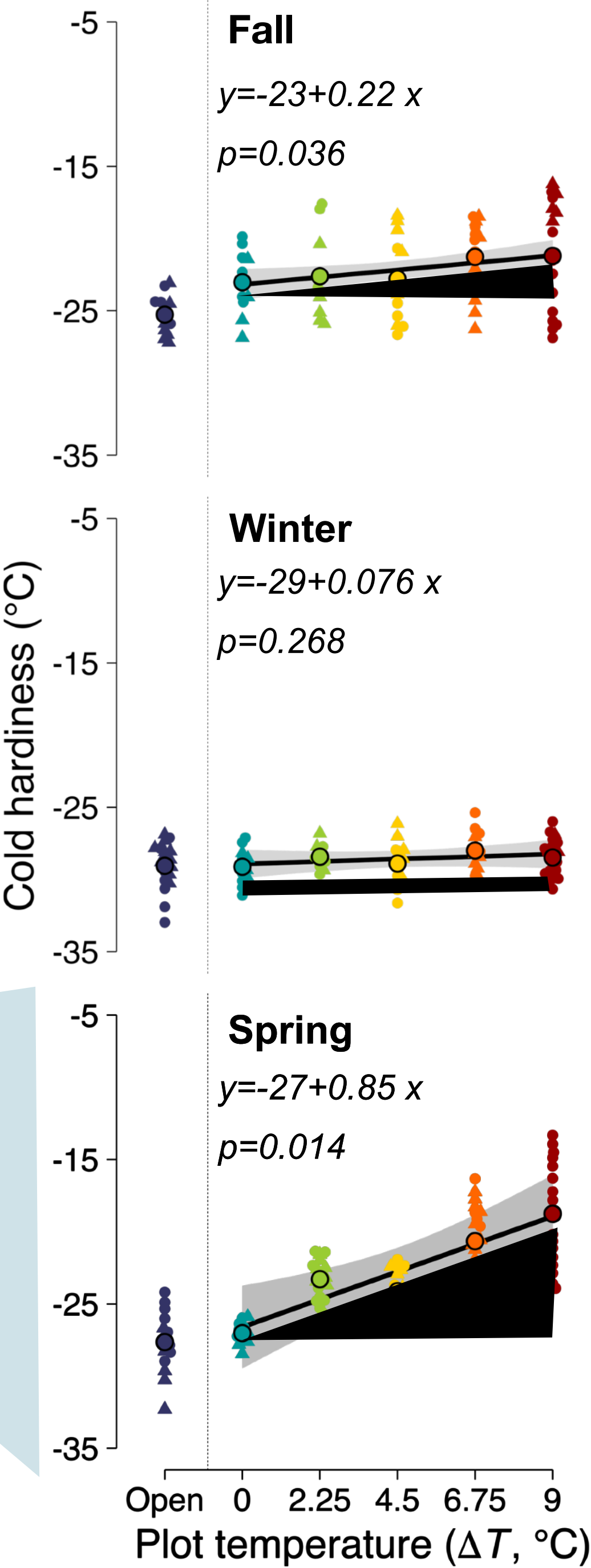
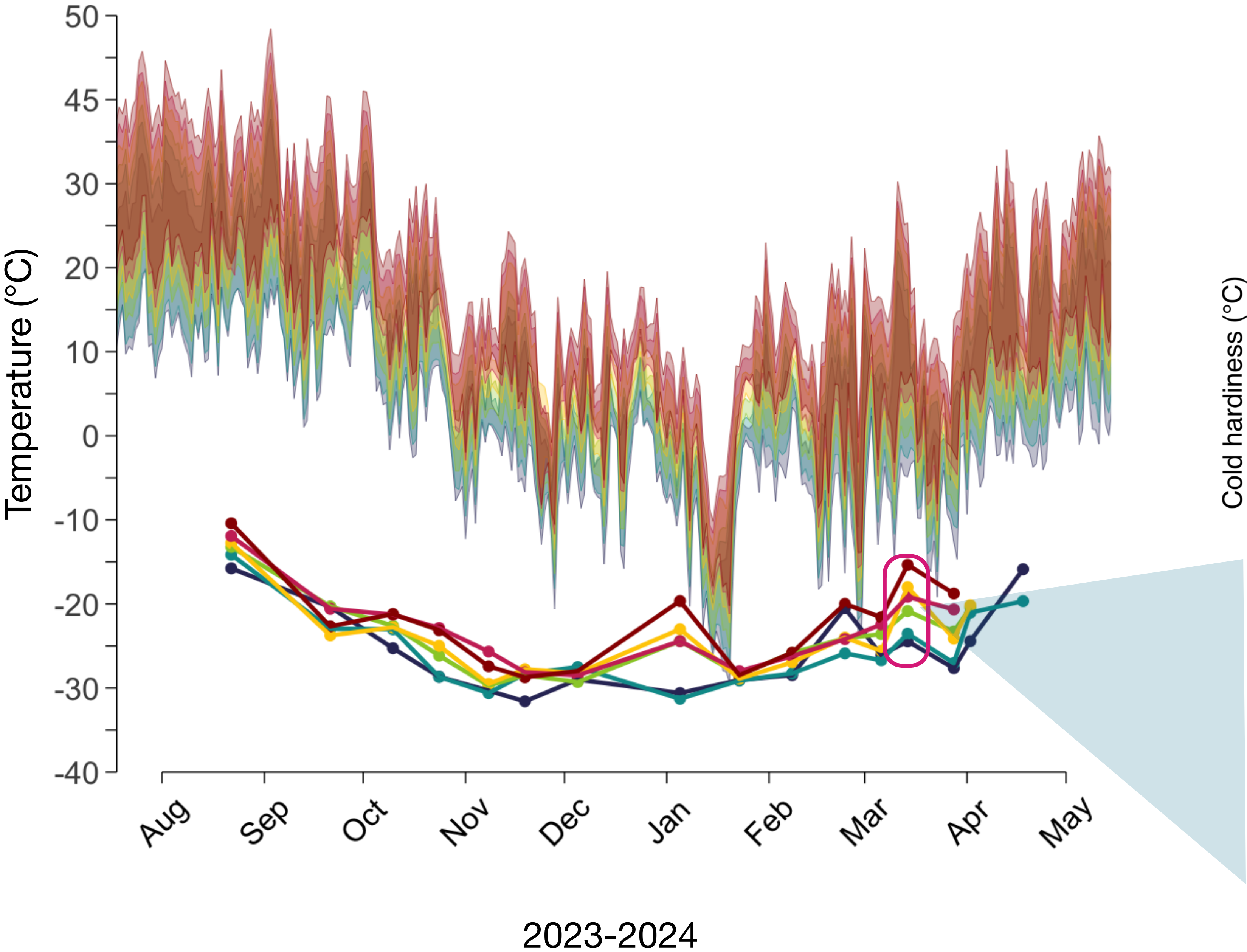
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Larix laricina

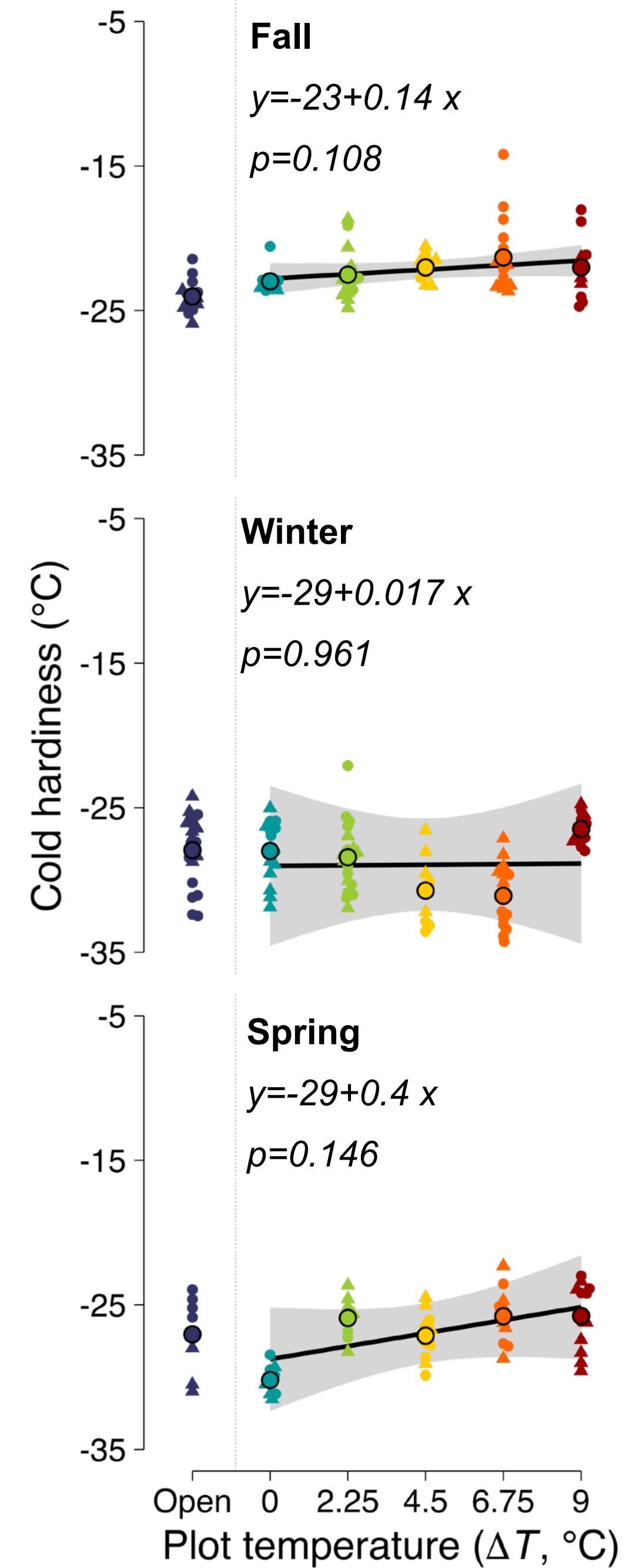
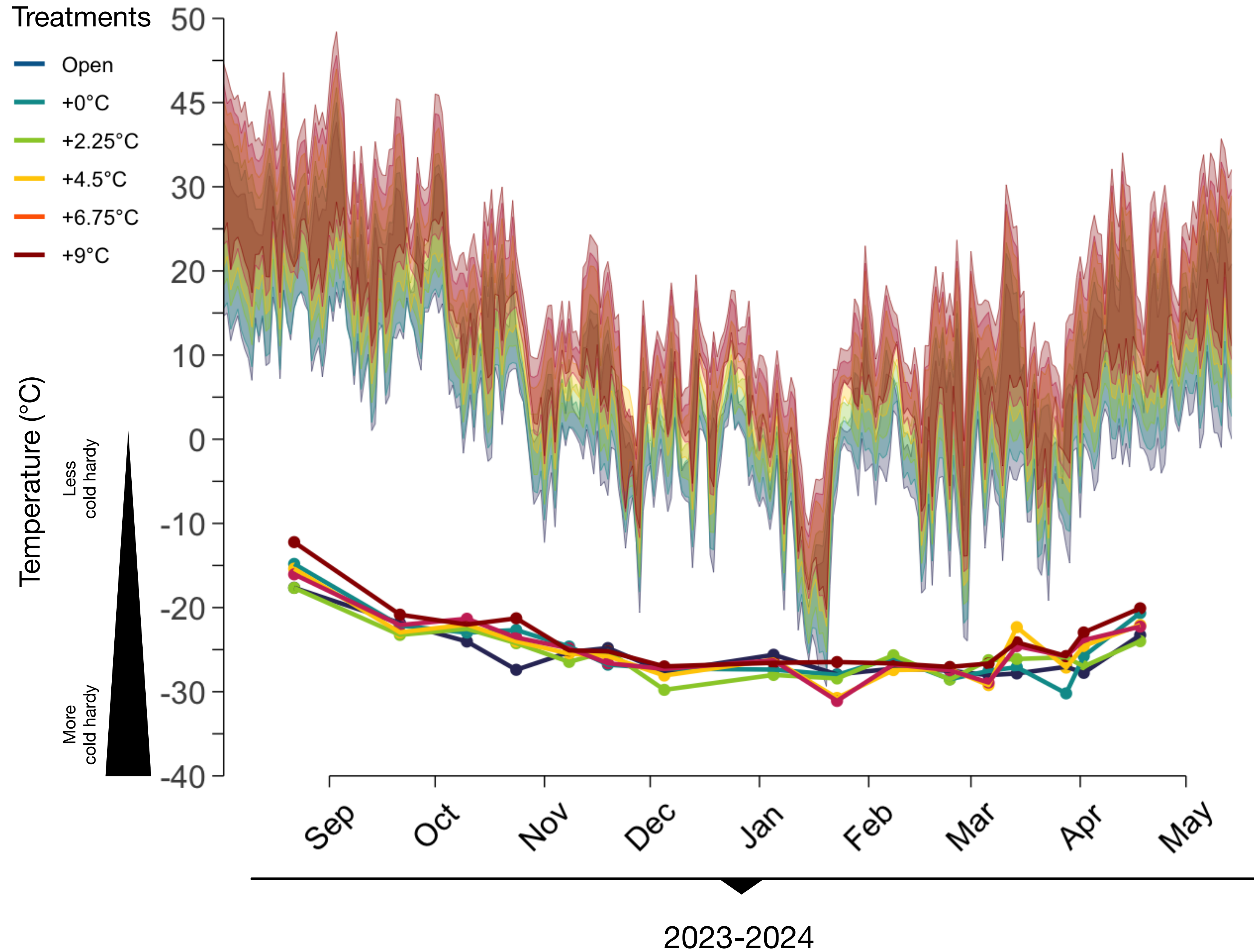
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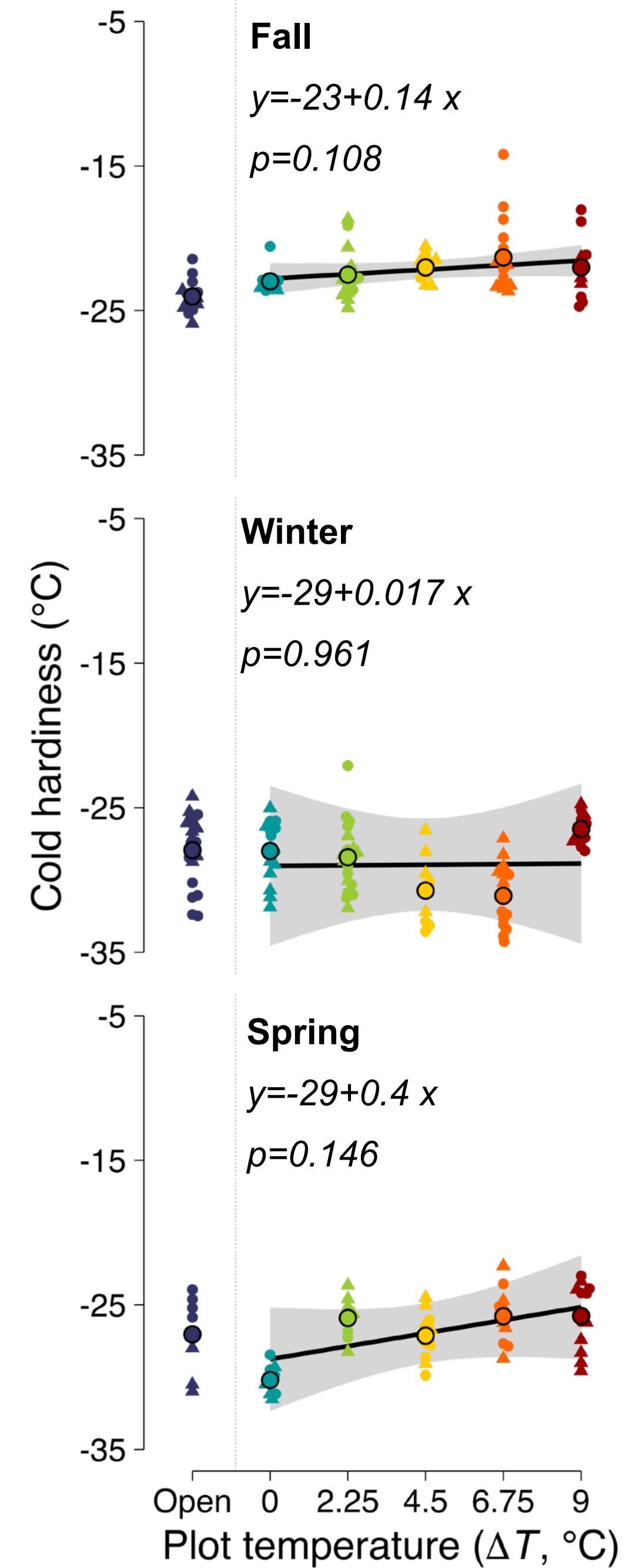
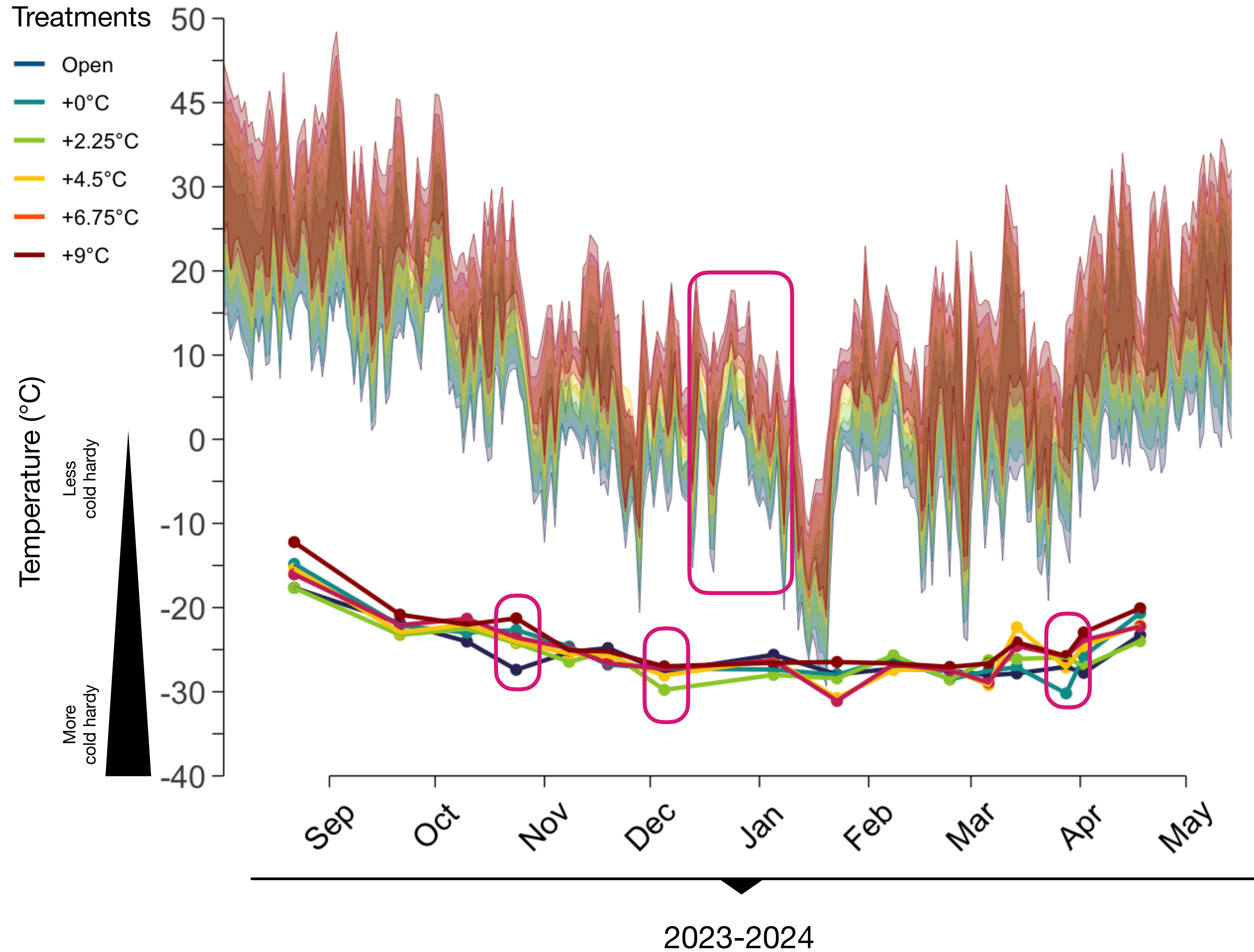
Picea mariana

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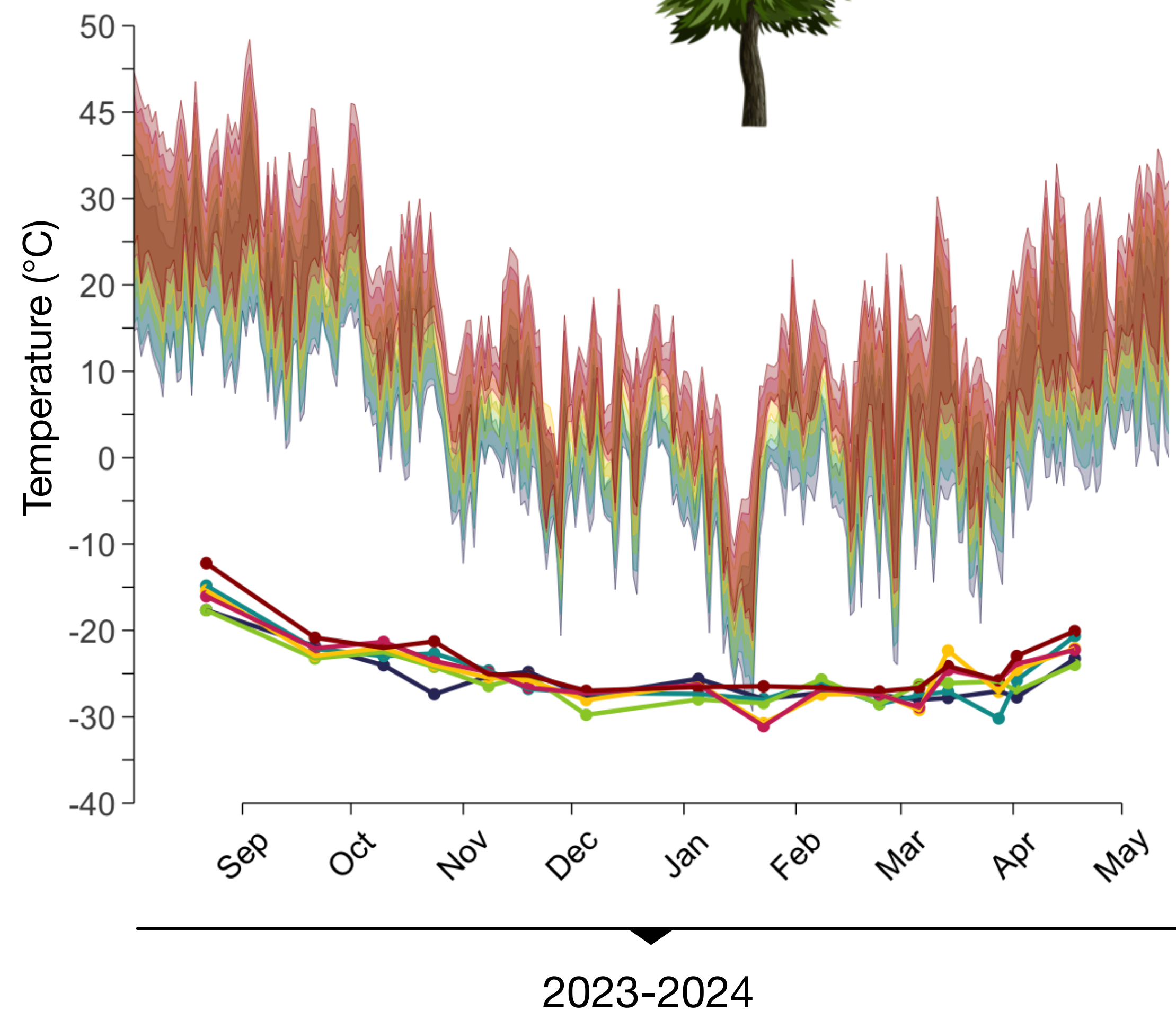
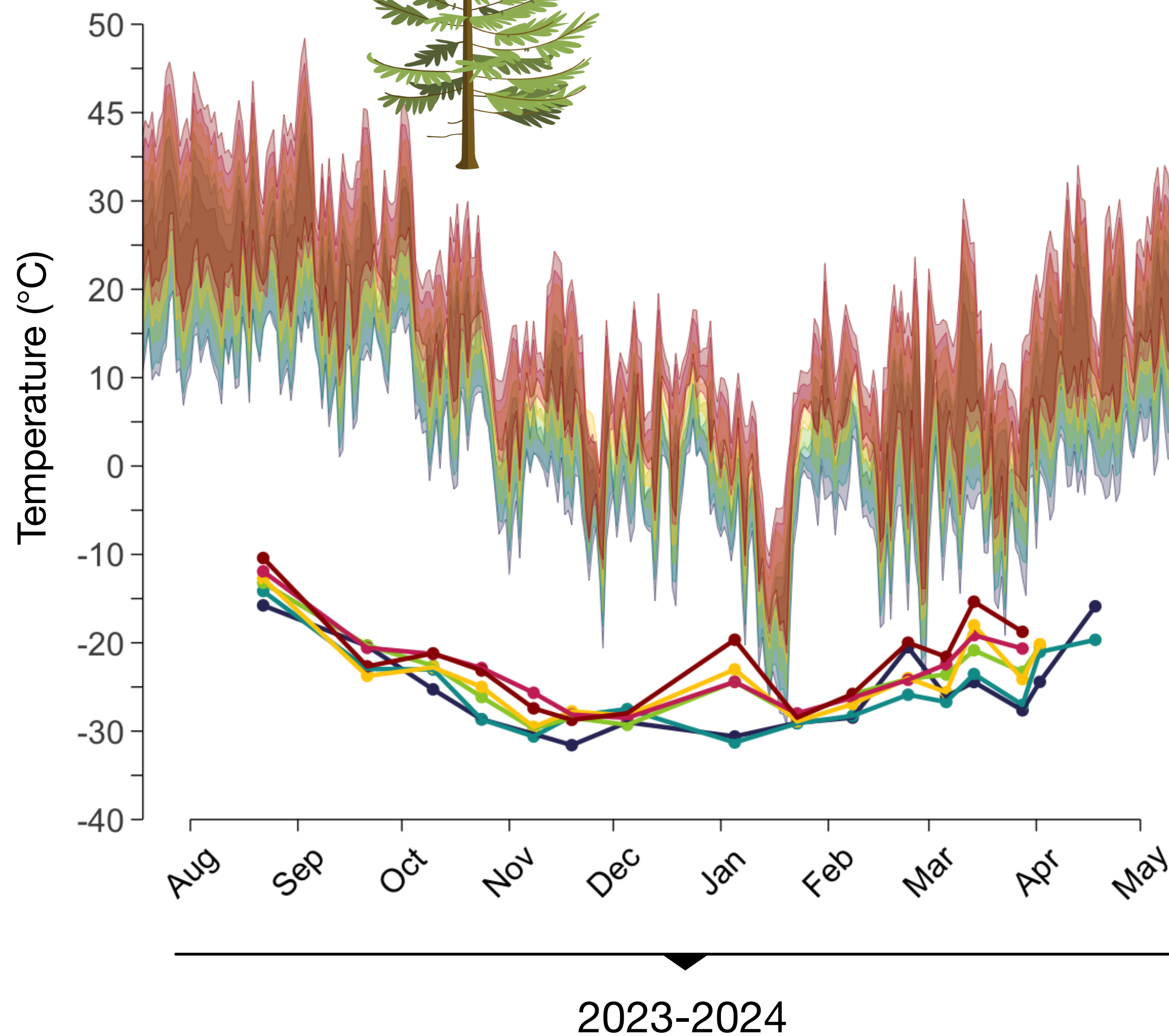


Picea mariana

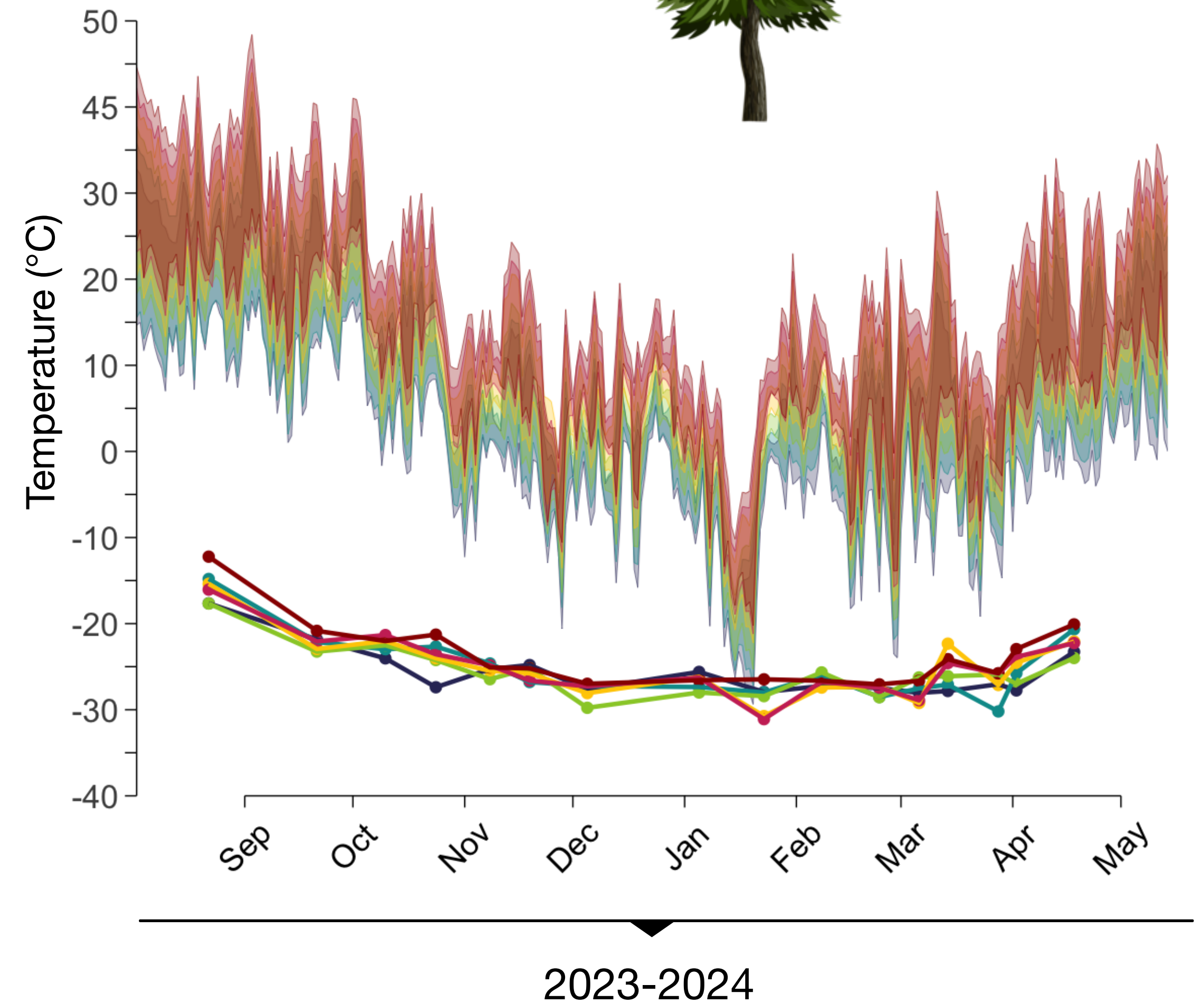
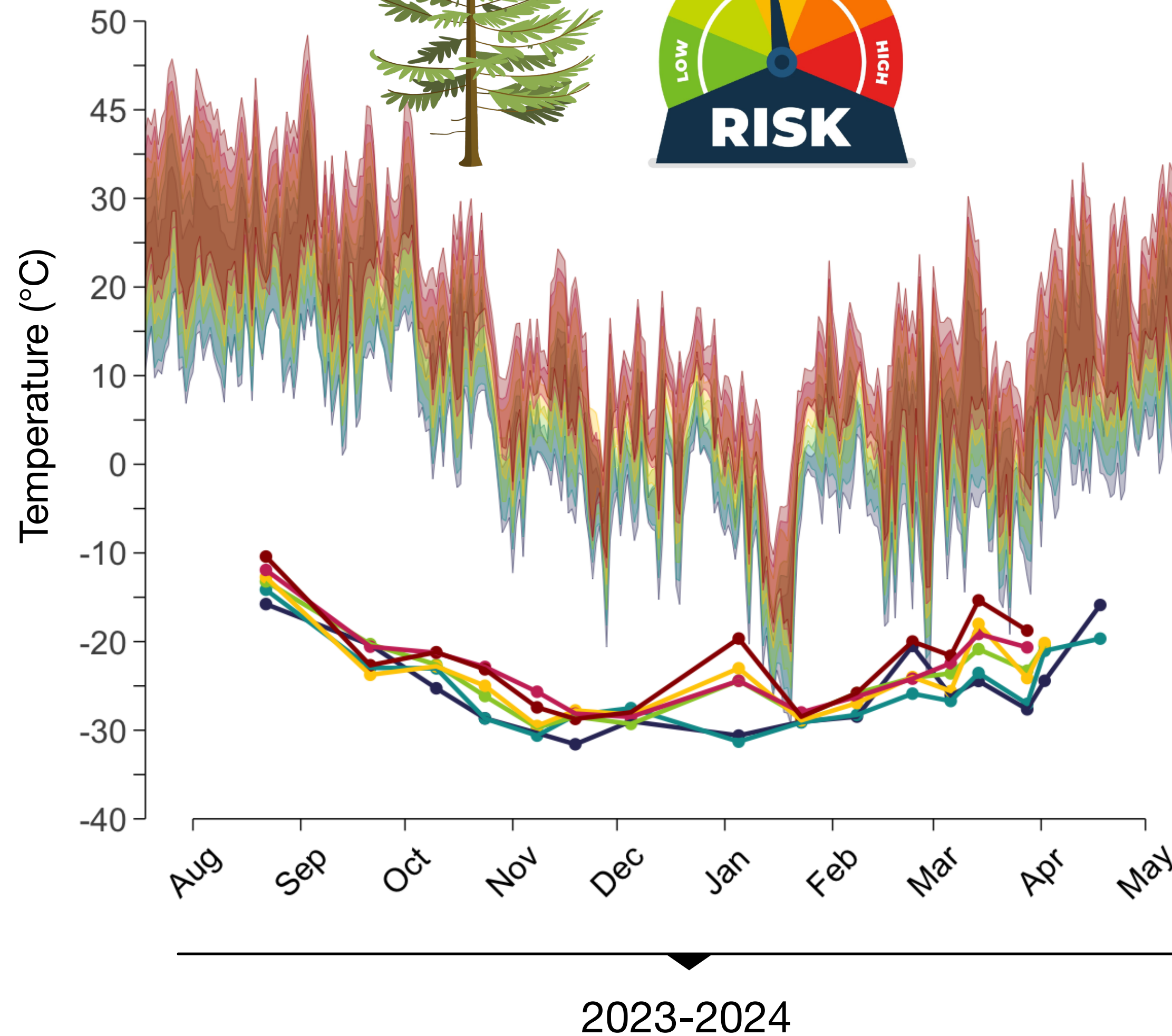
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Cold hardiness patterns: *Larix laricina* & *Picea mariana*

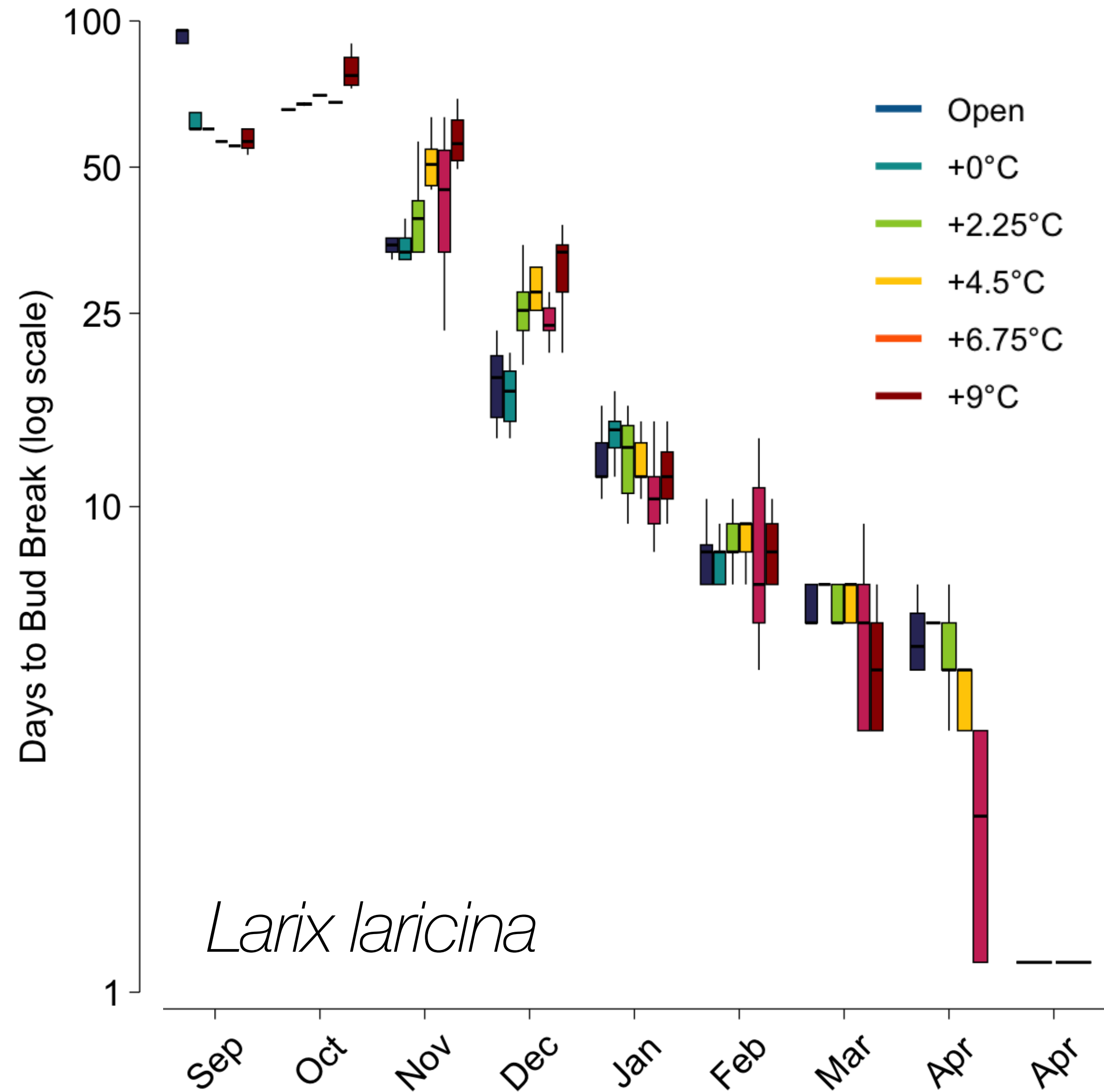


Cold hardiness patterns: *Larix laricina* & *Picea mariana*



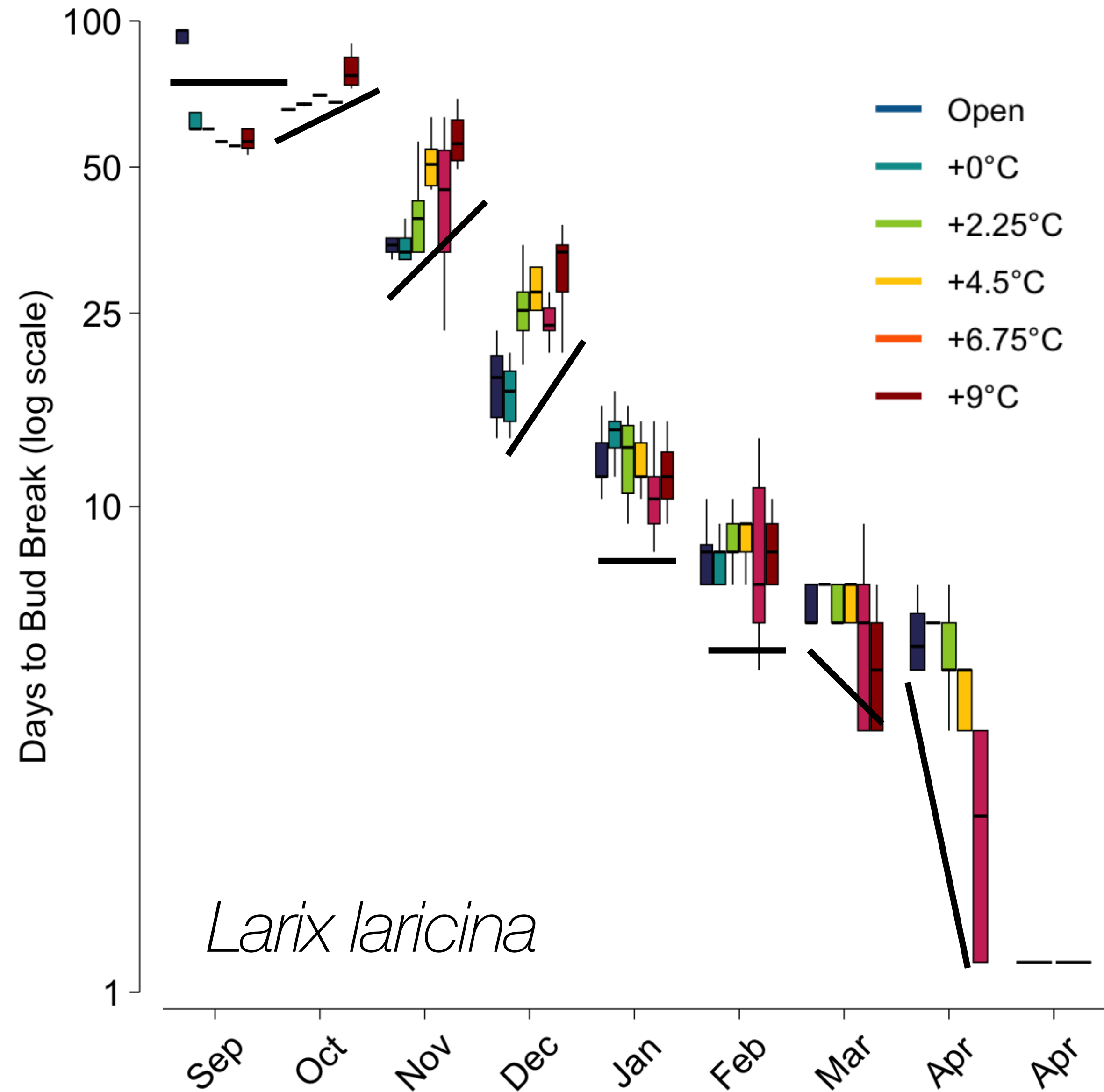
Budbreak data

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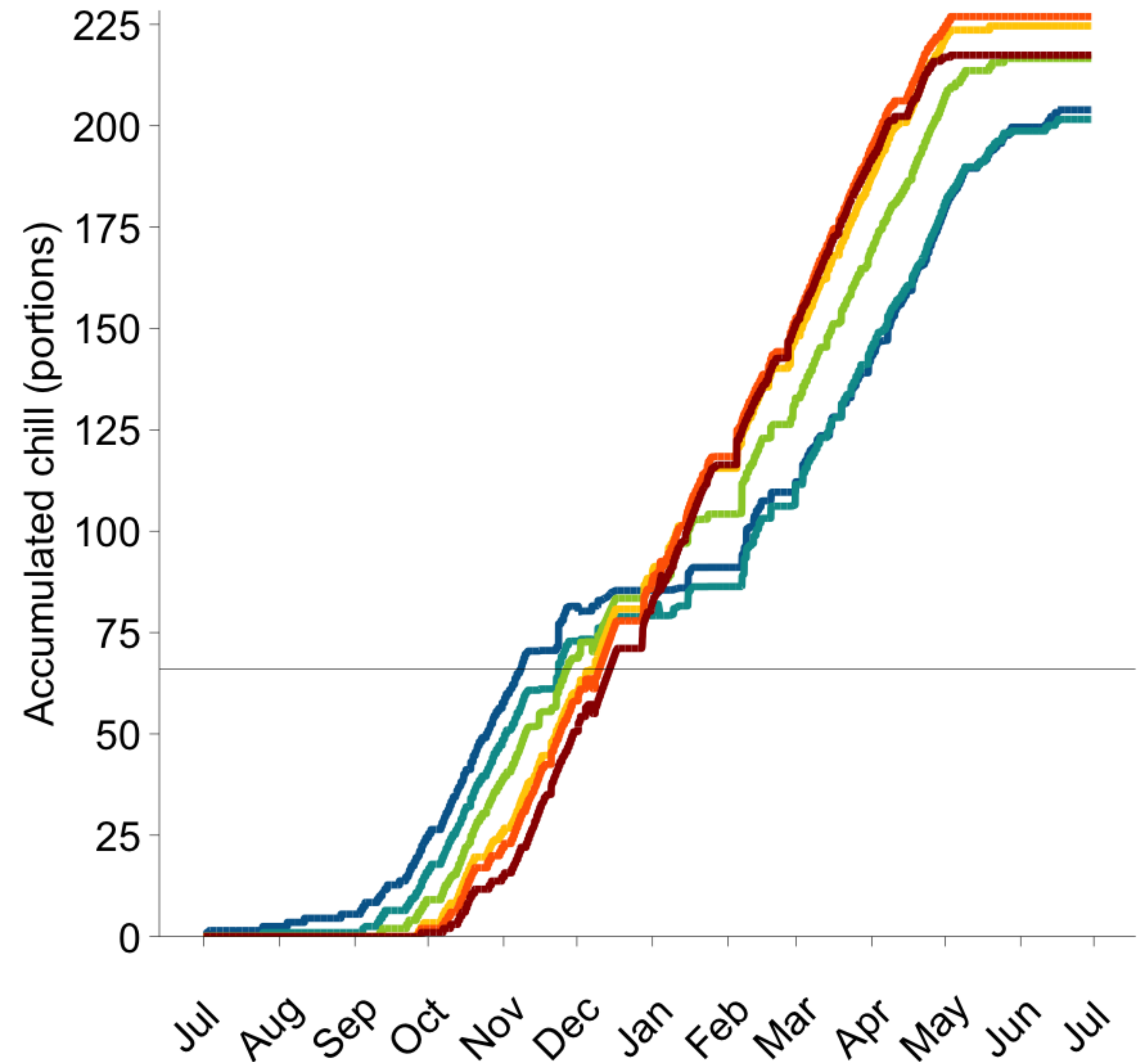
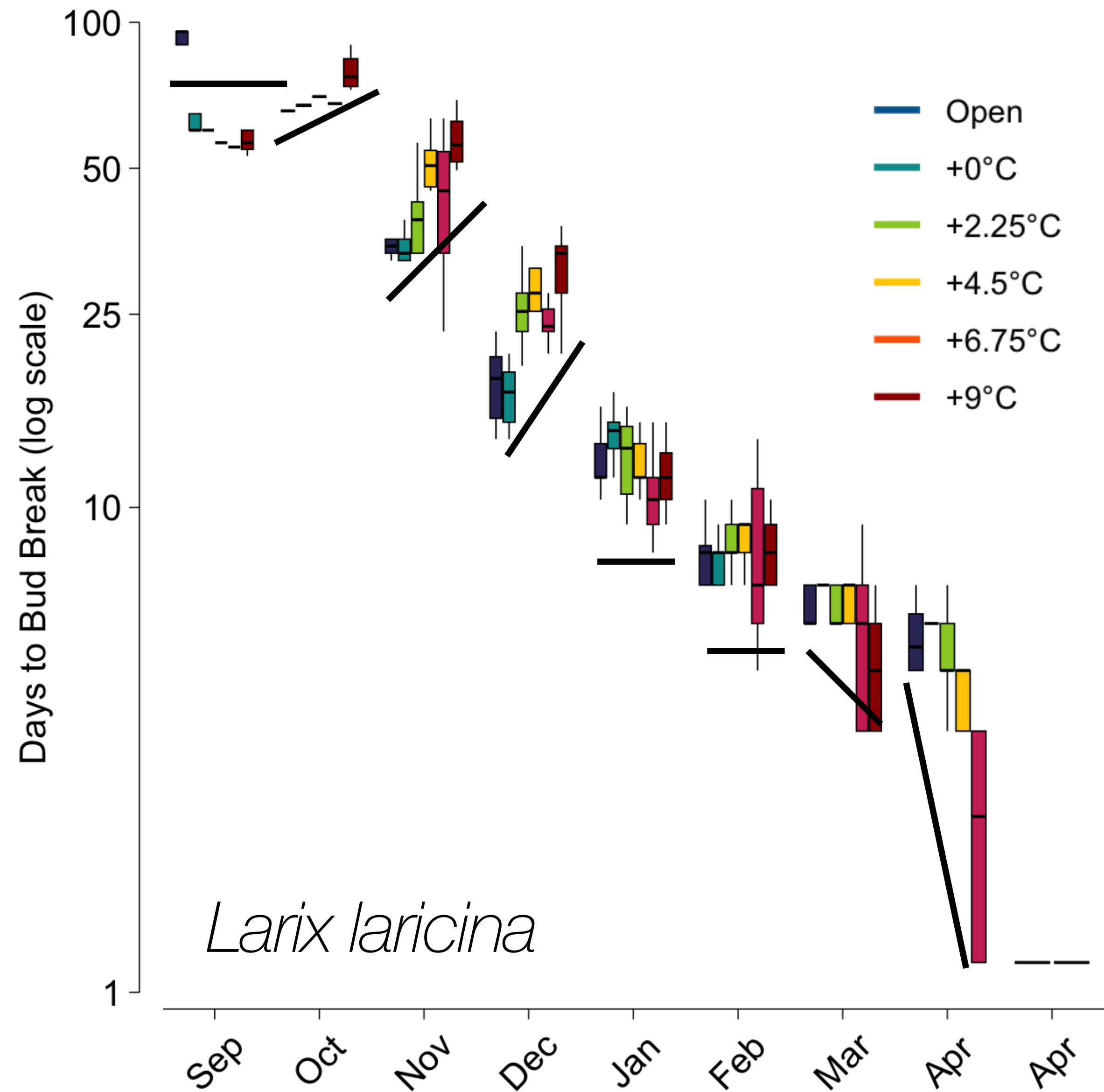
Budbreak data

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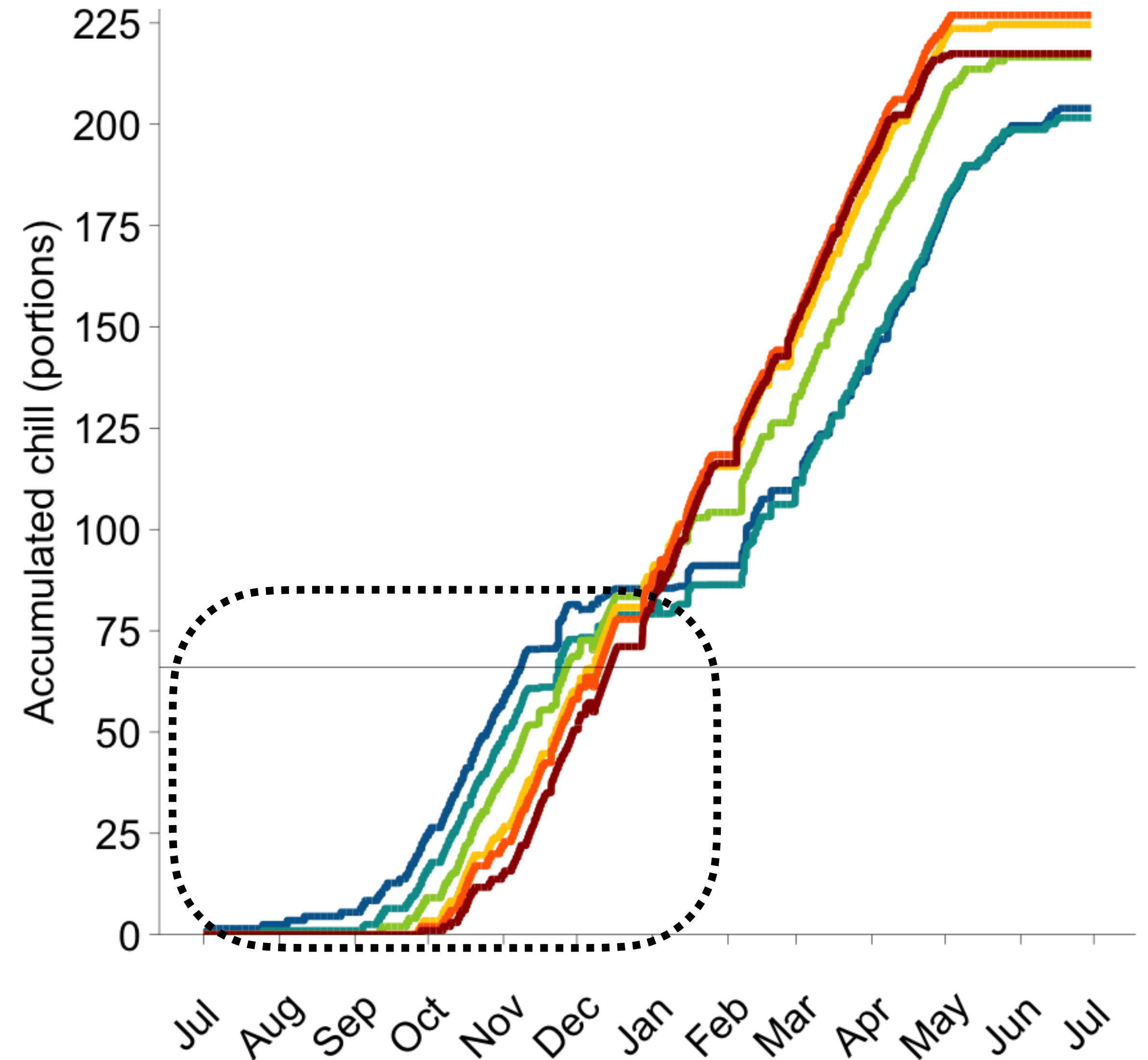
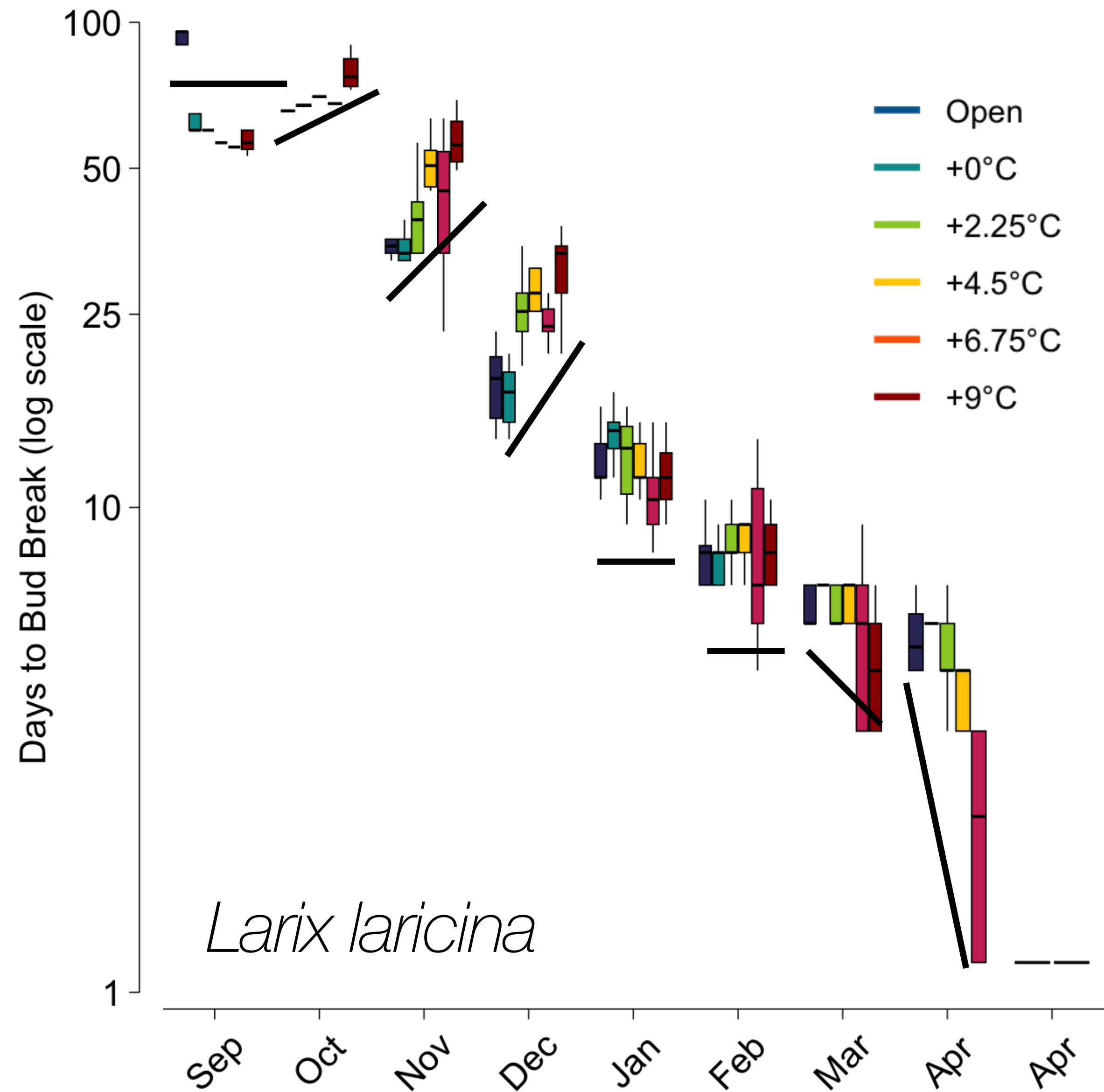
Budbreak data

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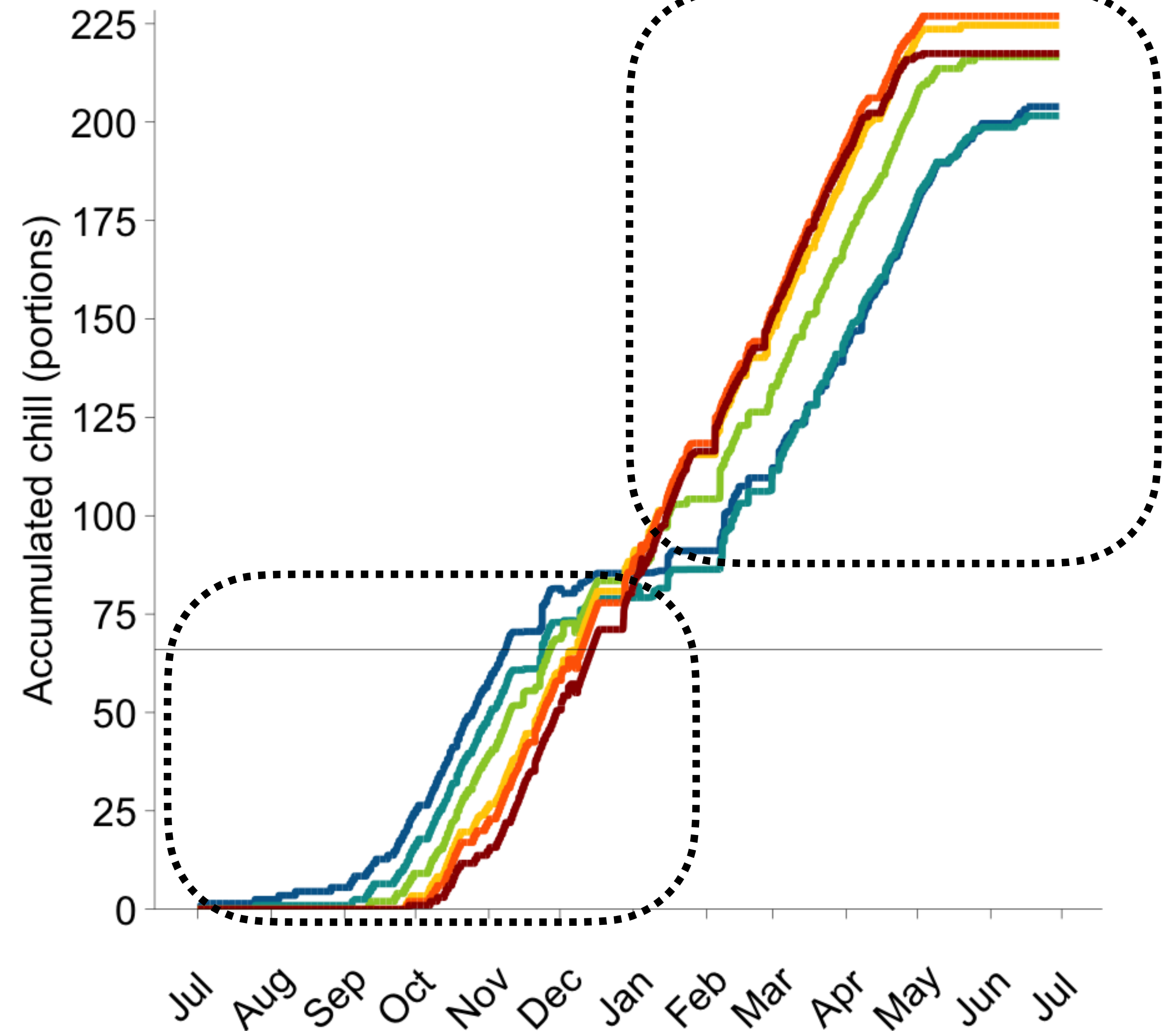
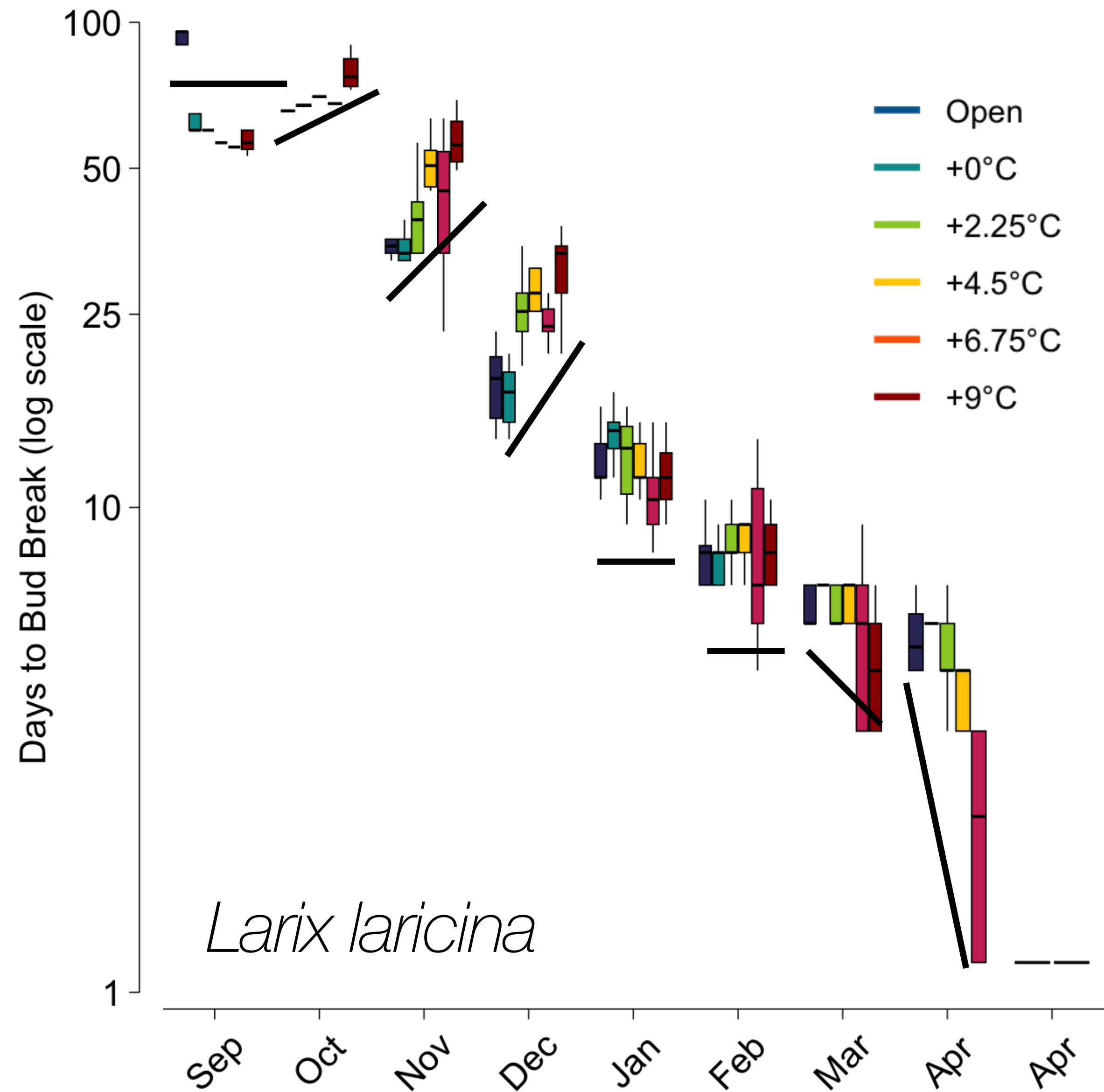
Budbreak data

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Budbreak data

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Understory

Snow cover



Open



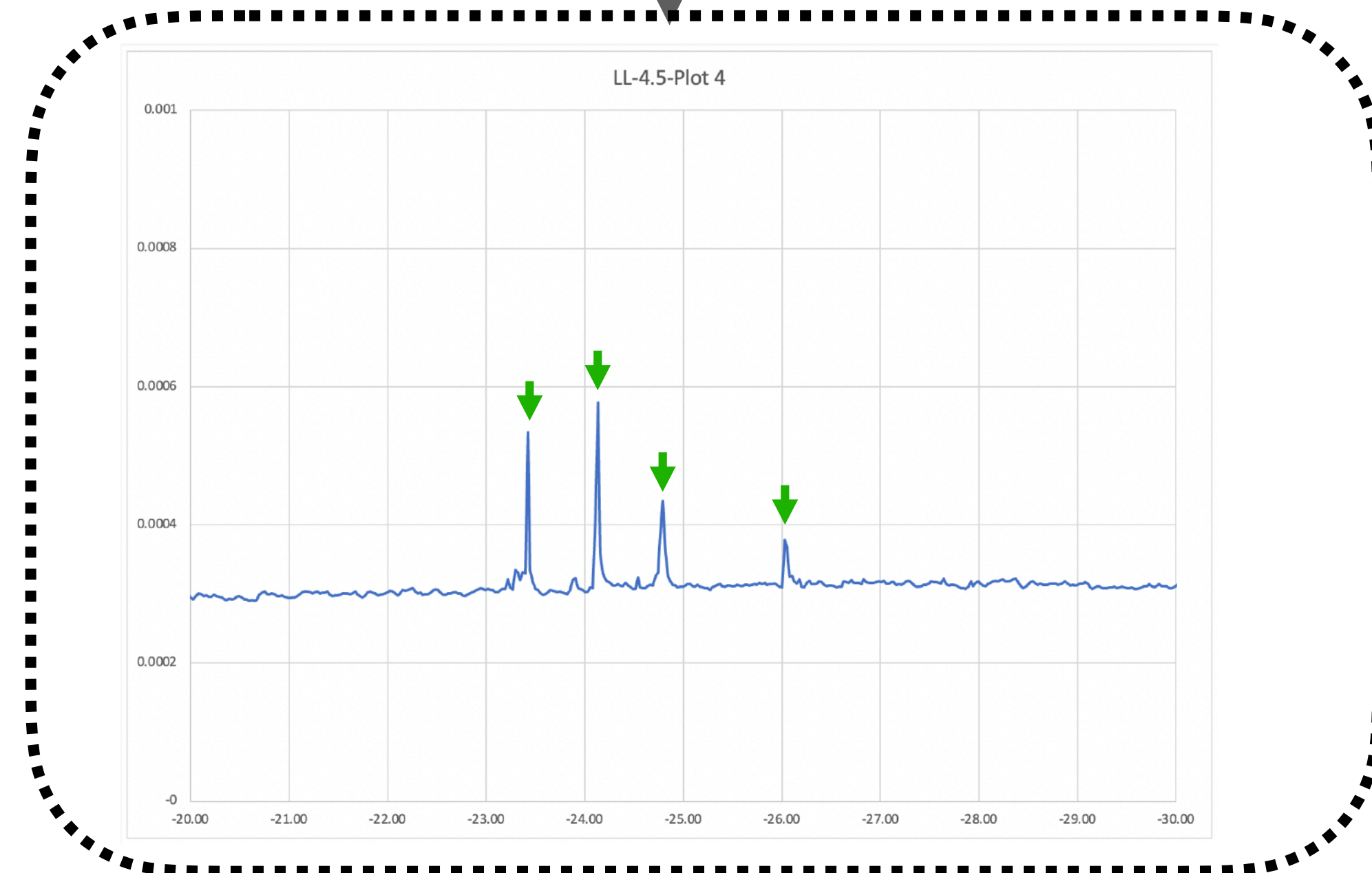
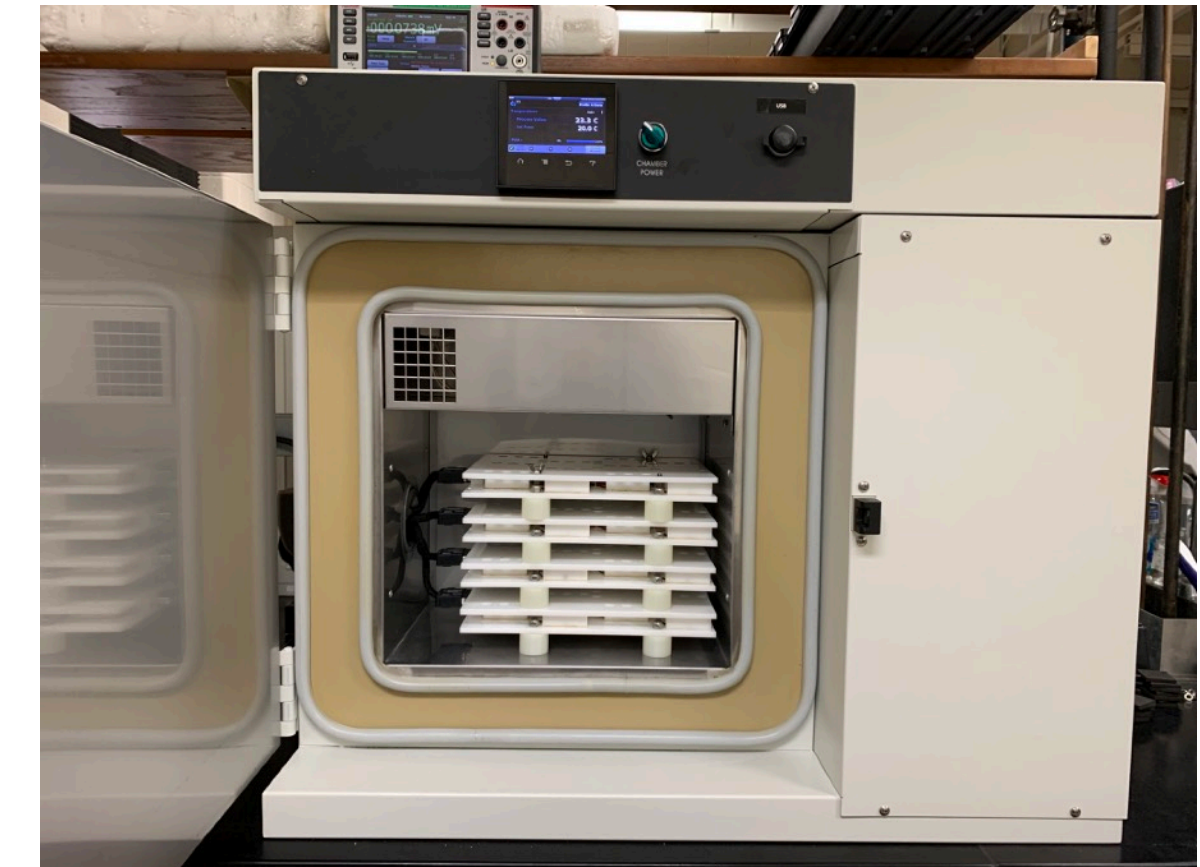
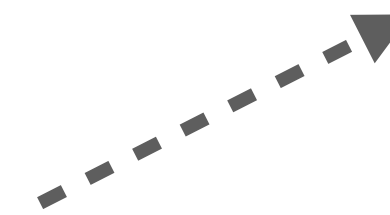
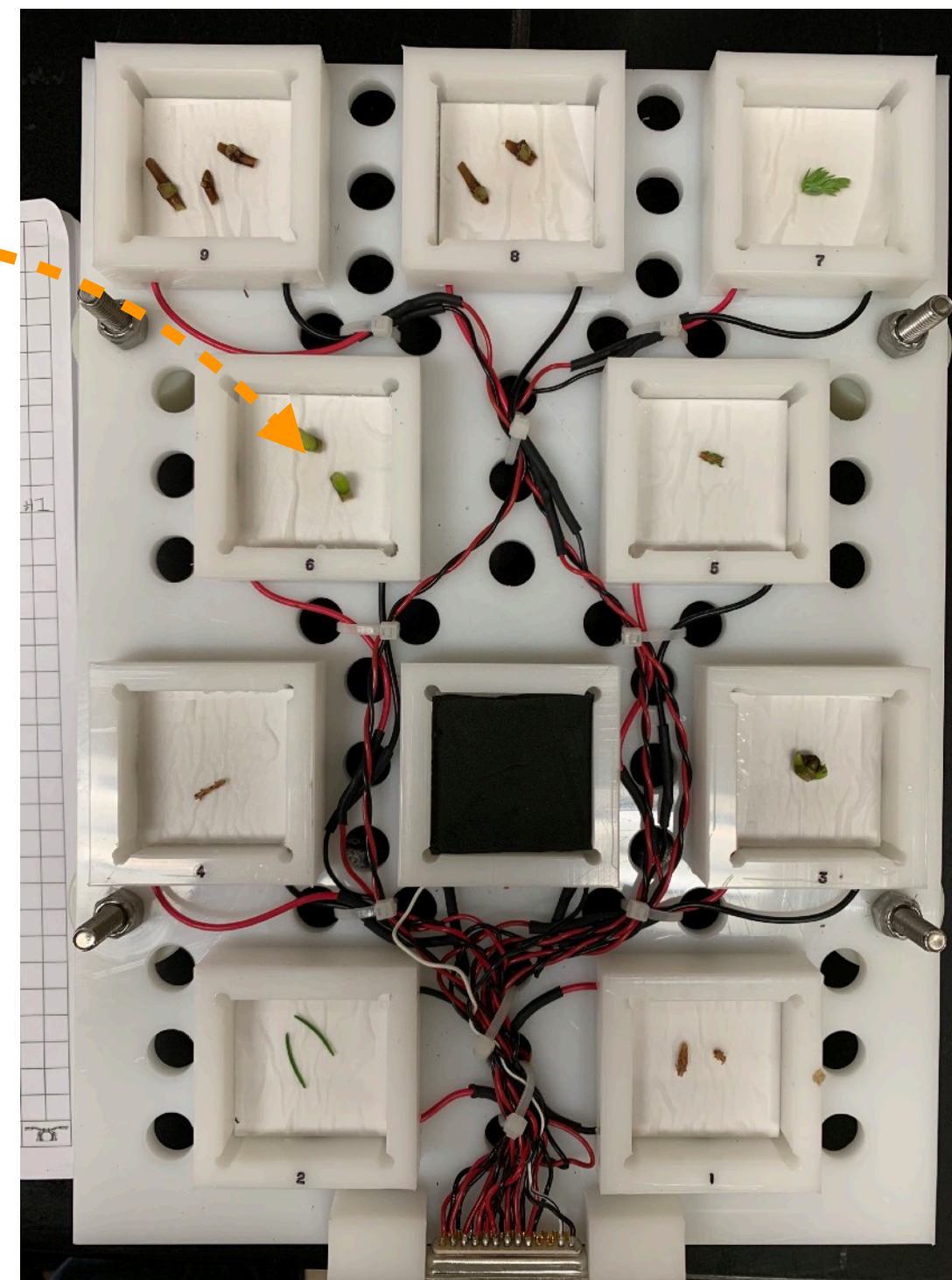
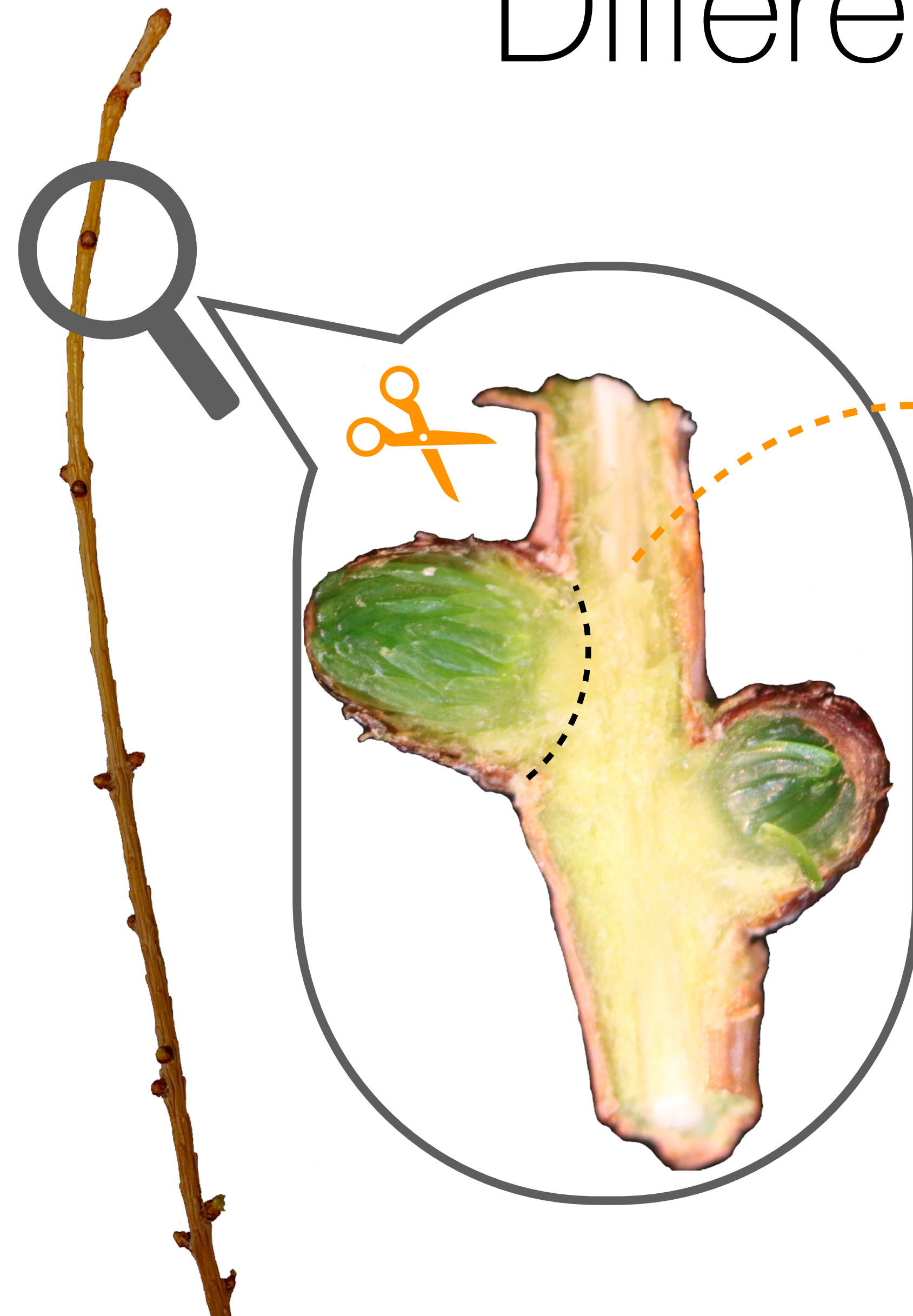
+0°C



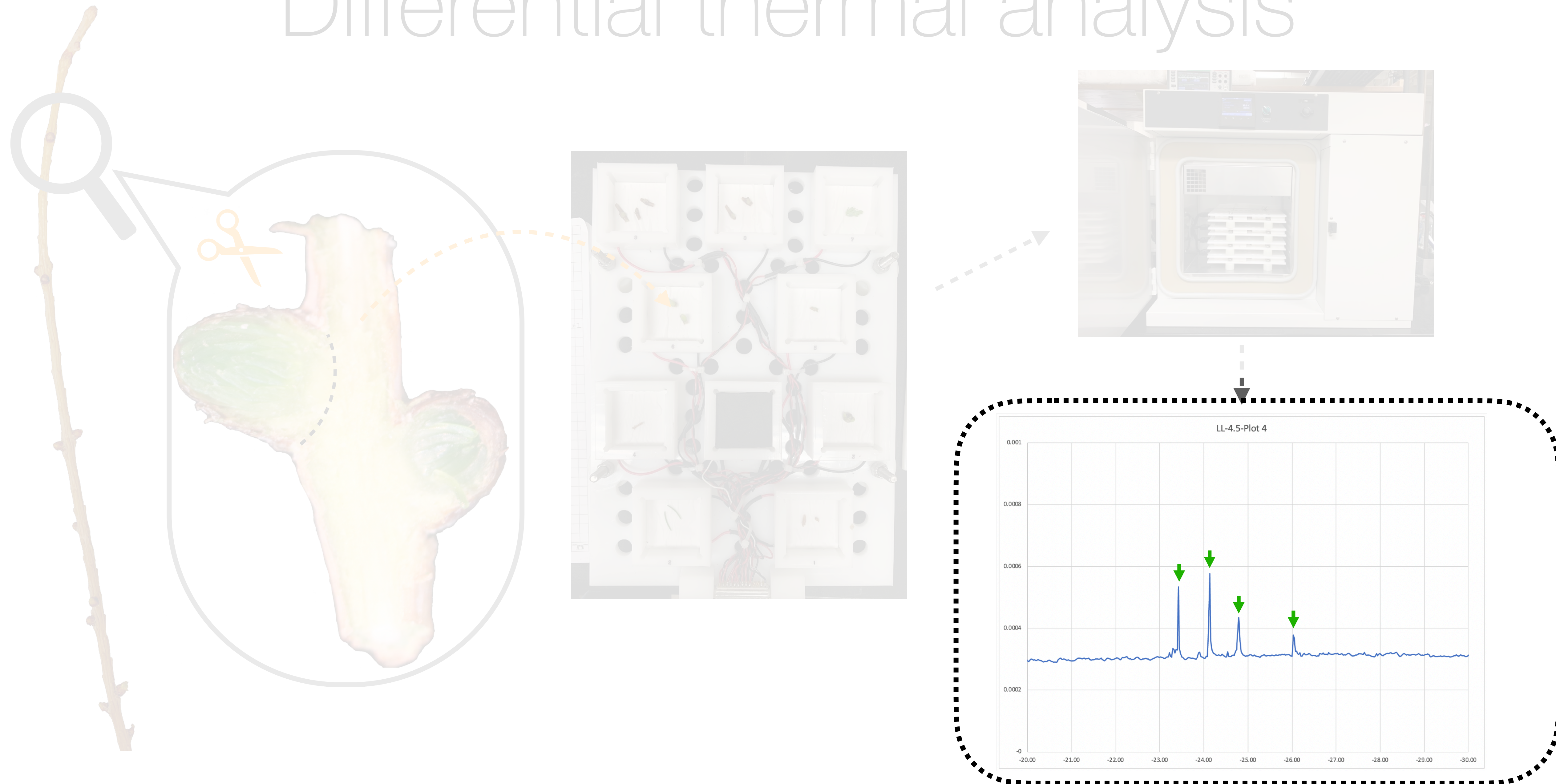
+6.75°C

Photos taken same day Feb 2022

Differential thermal analysis

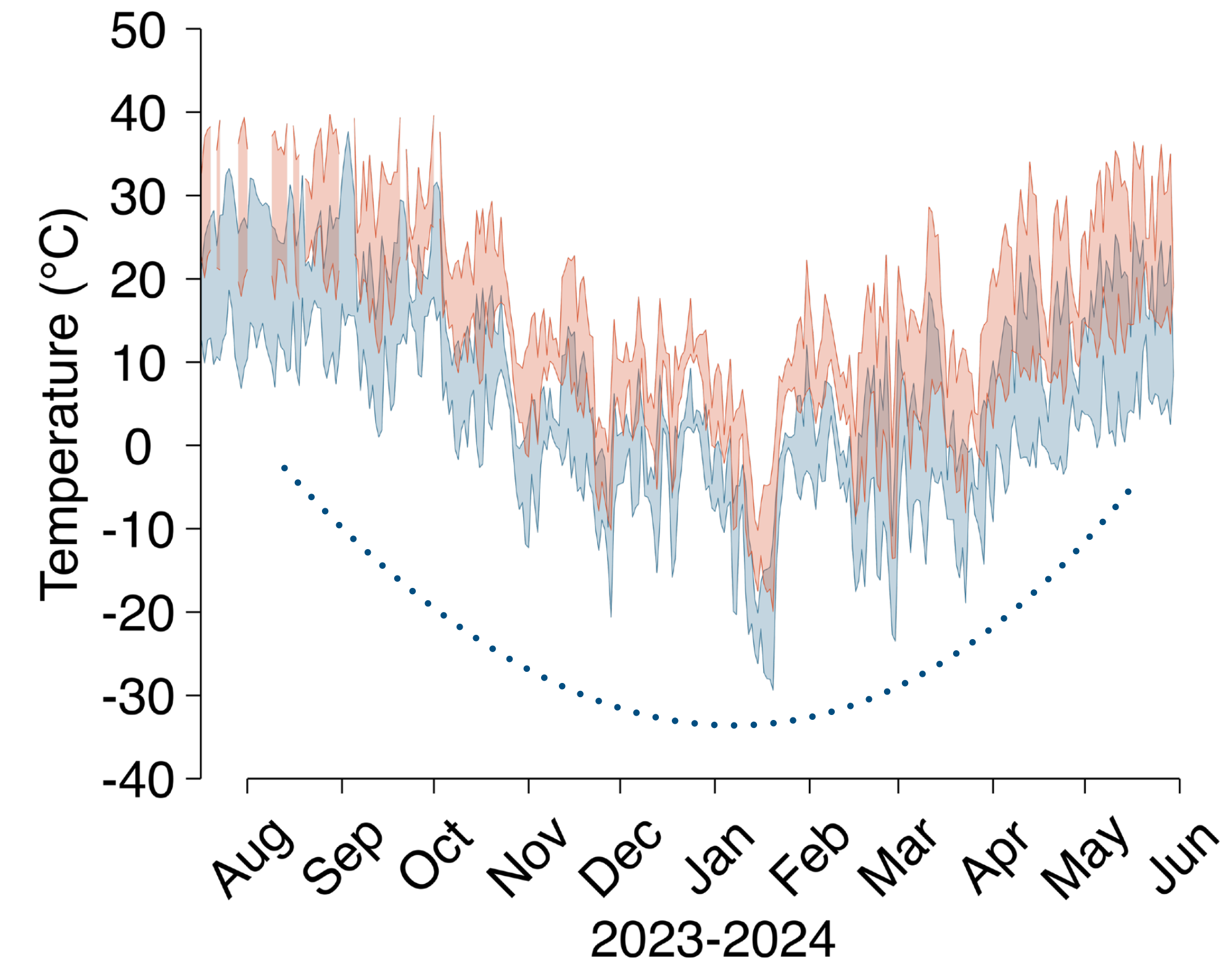


Differential thermal analysis



DTA responses

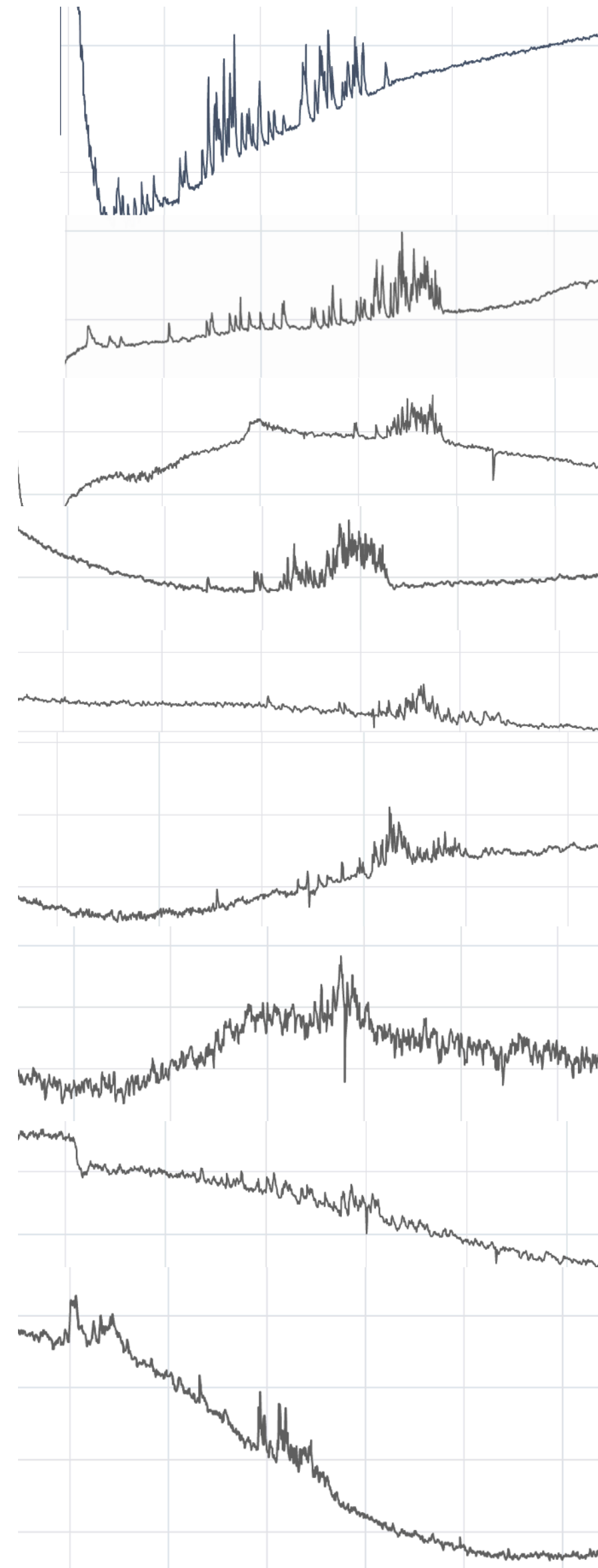
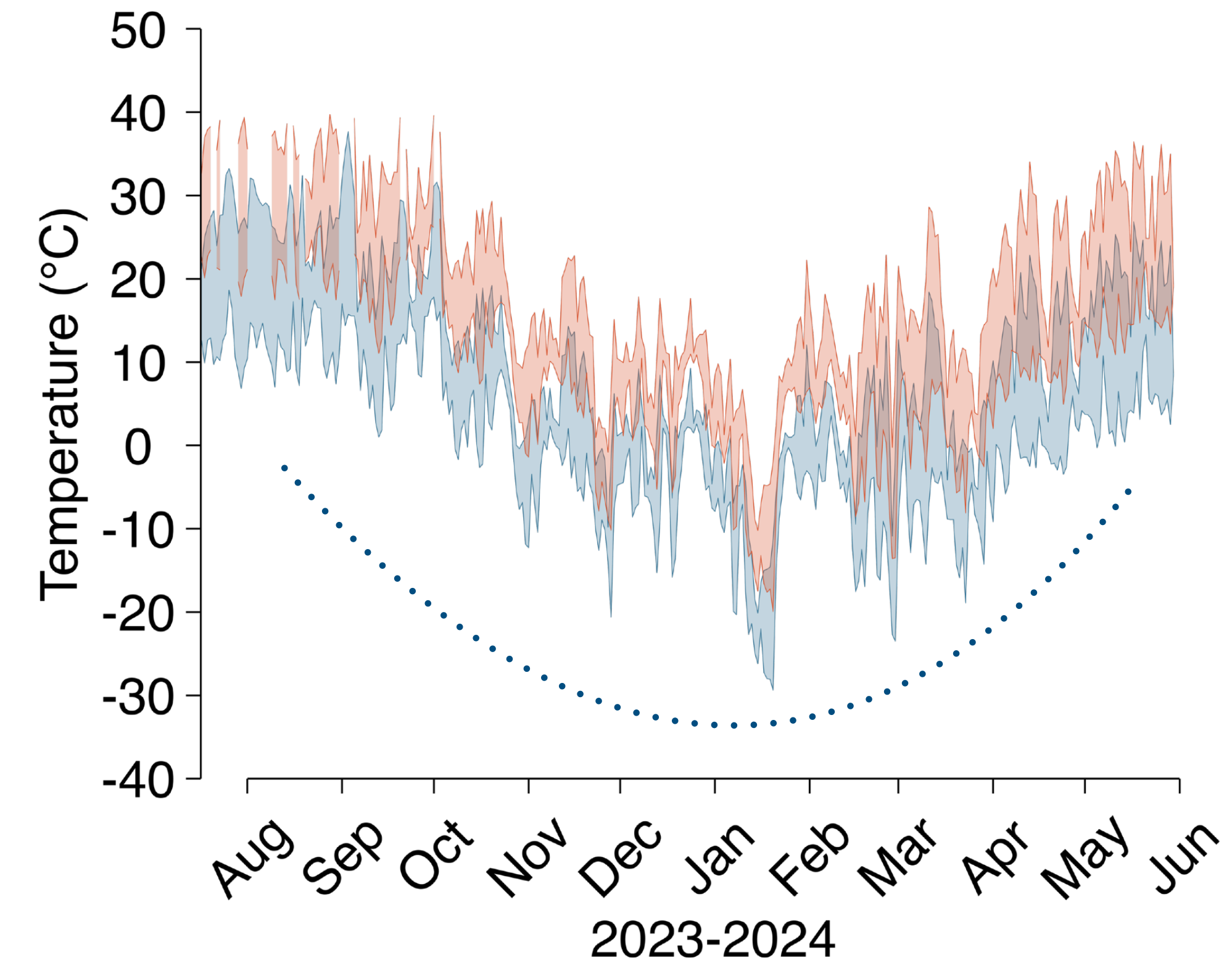
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DTA responses

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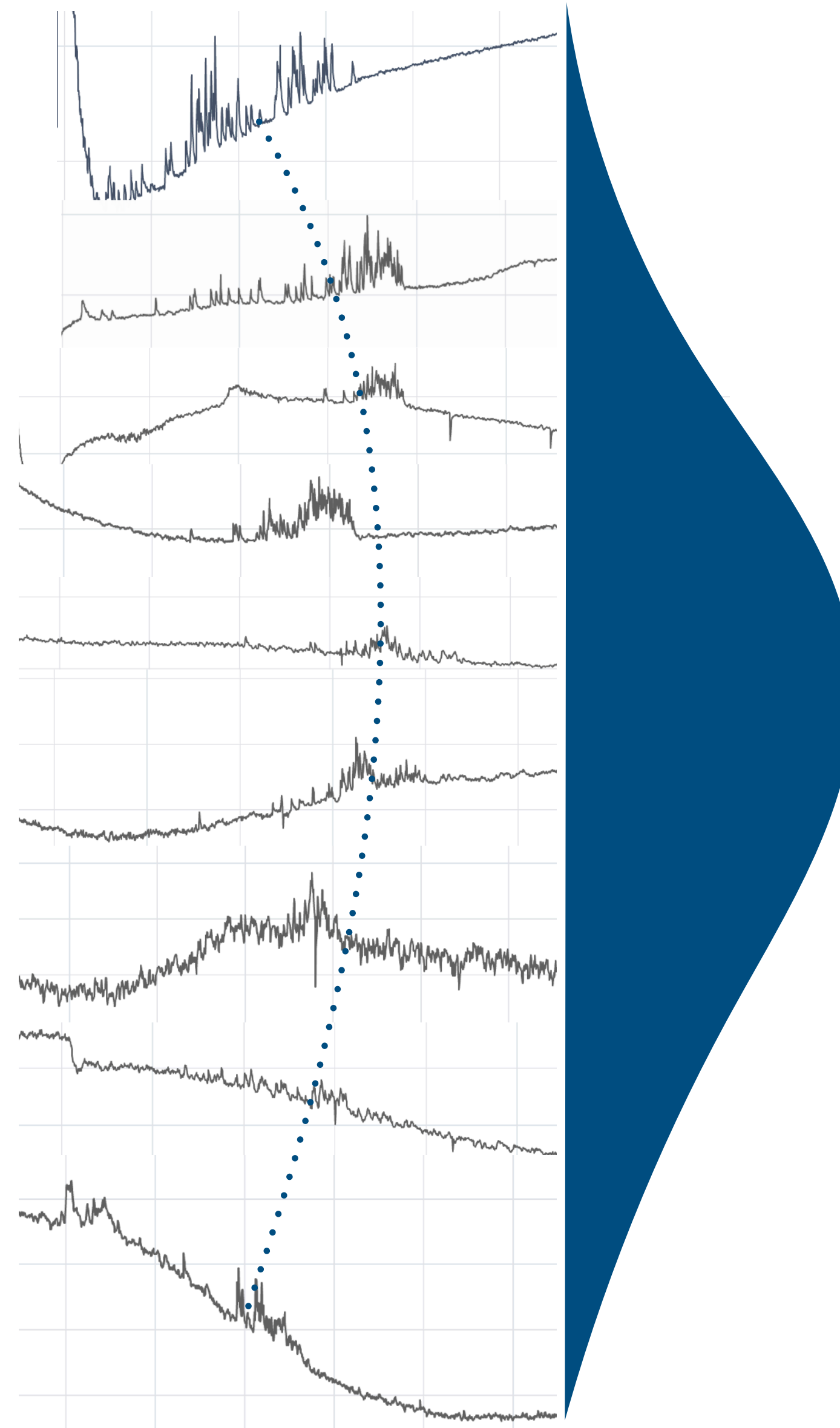
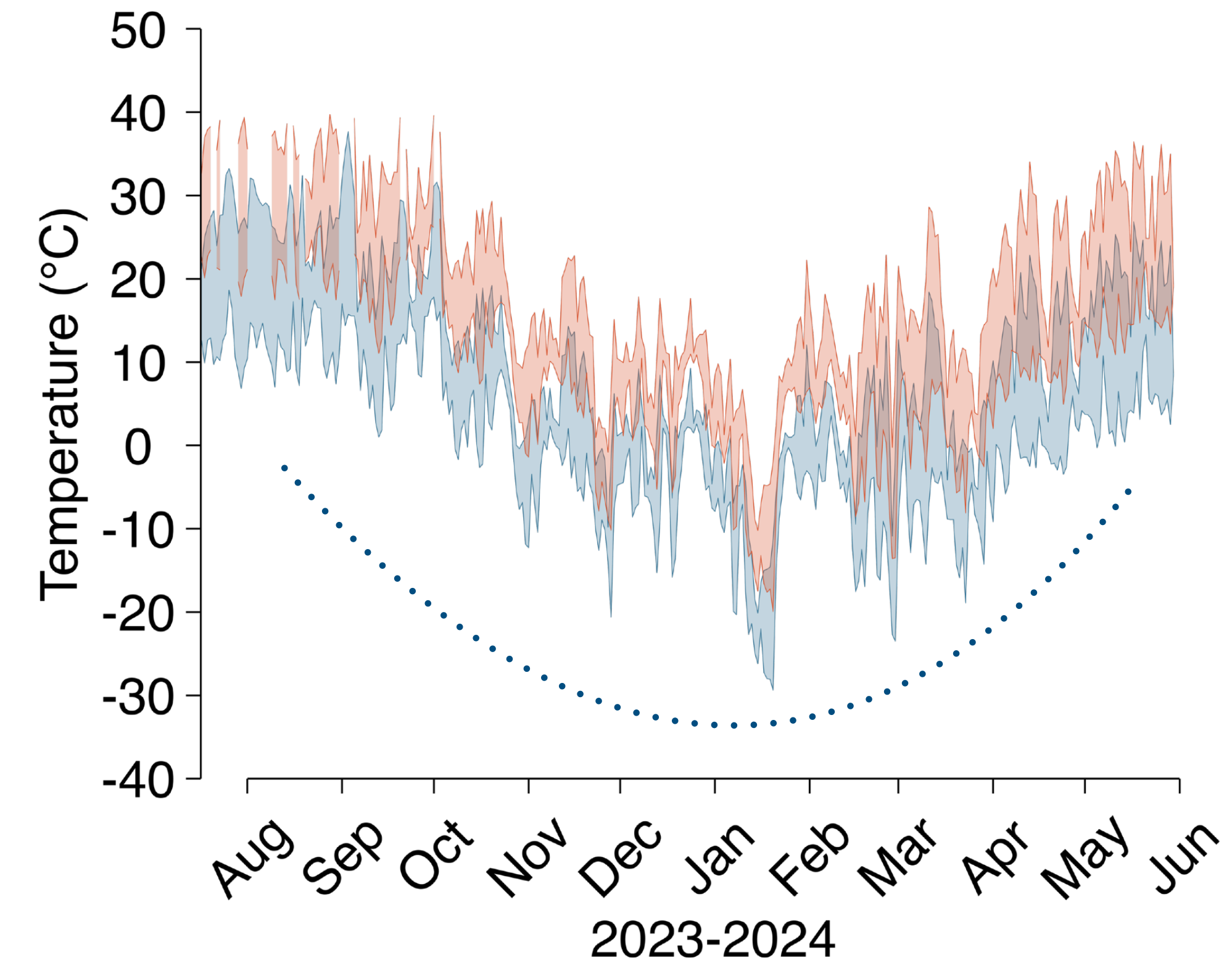
Open



DTA responses

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Open

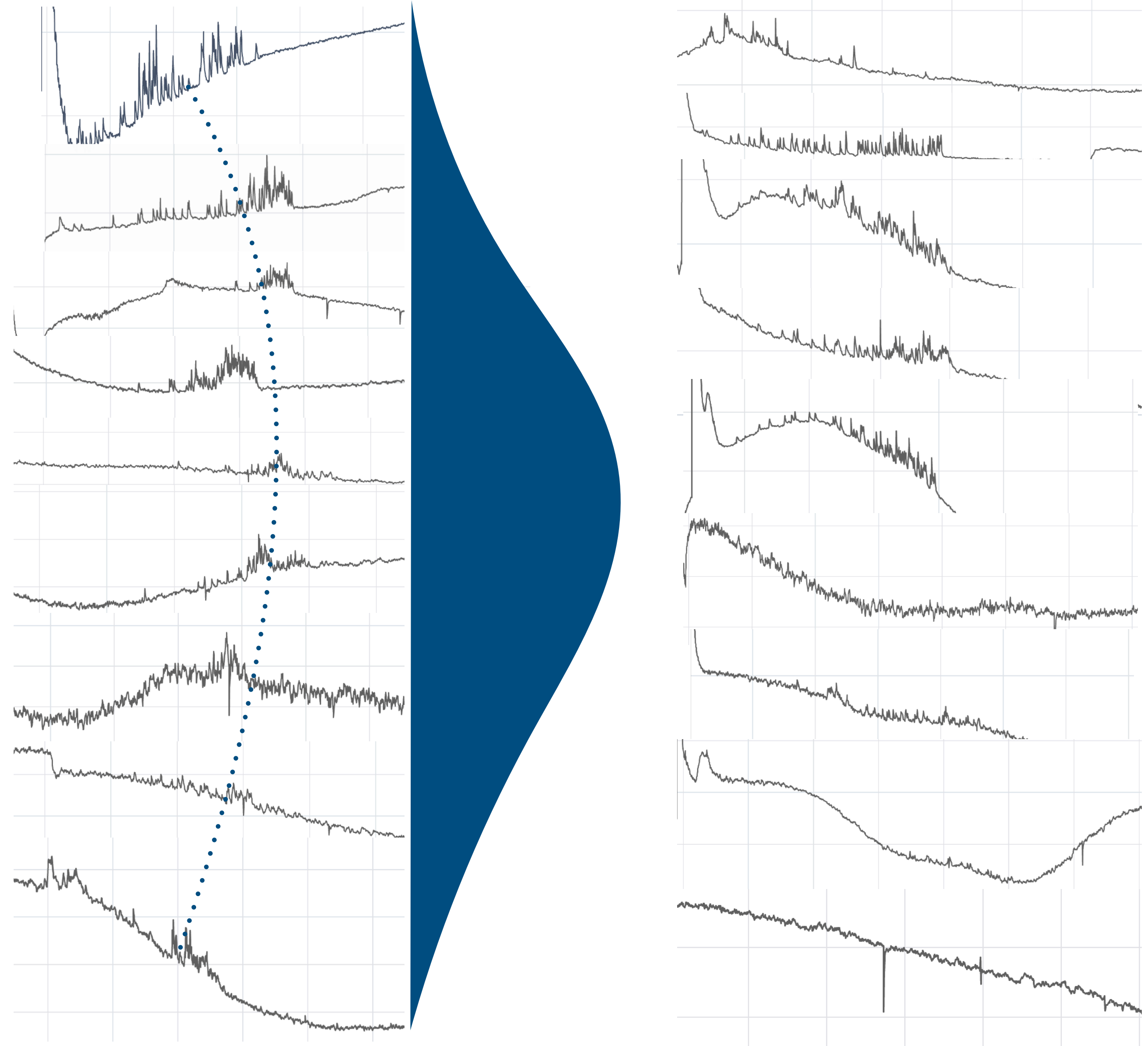
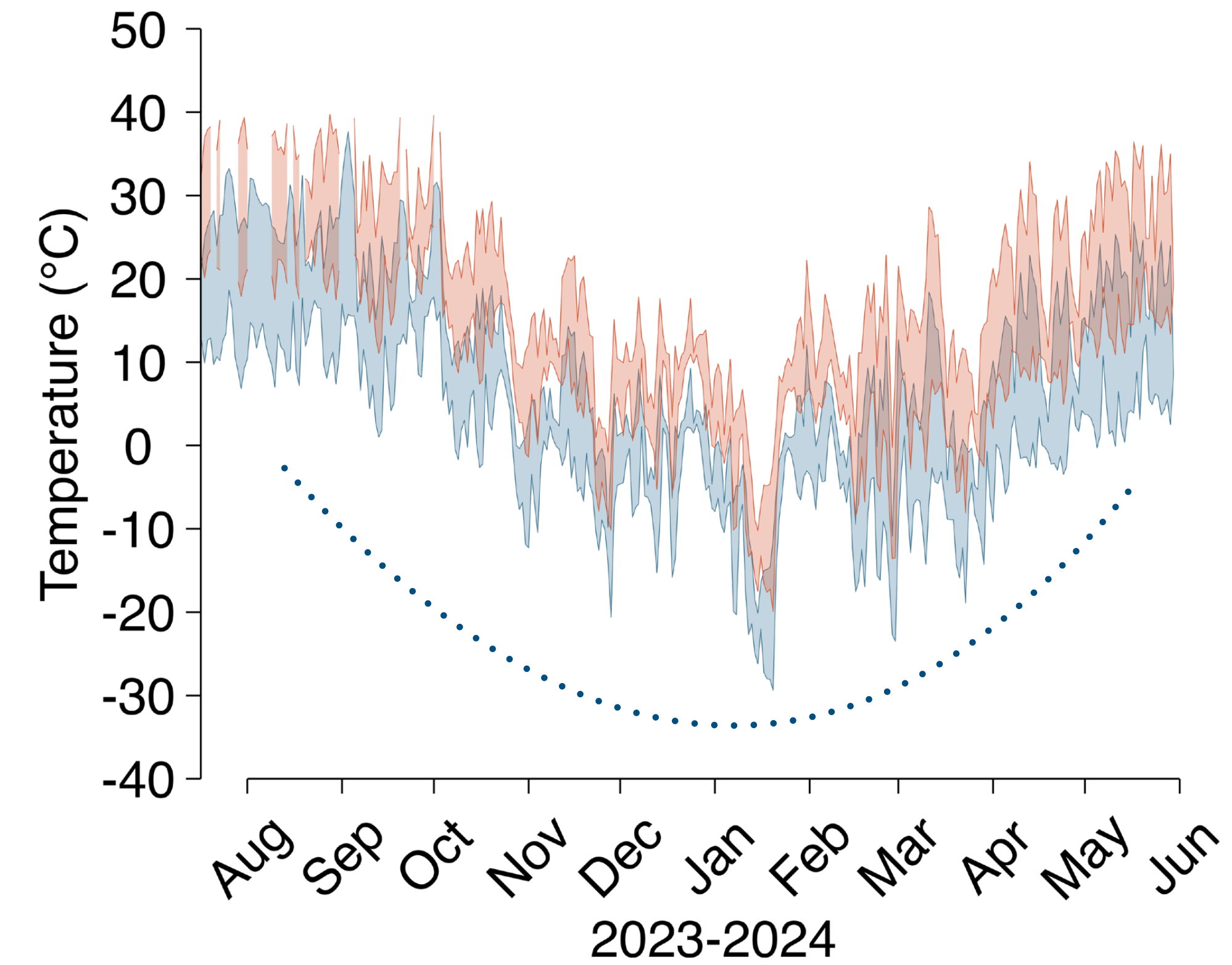


DTA responses

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Open

+9°C

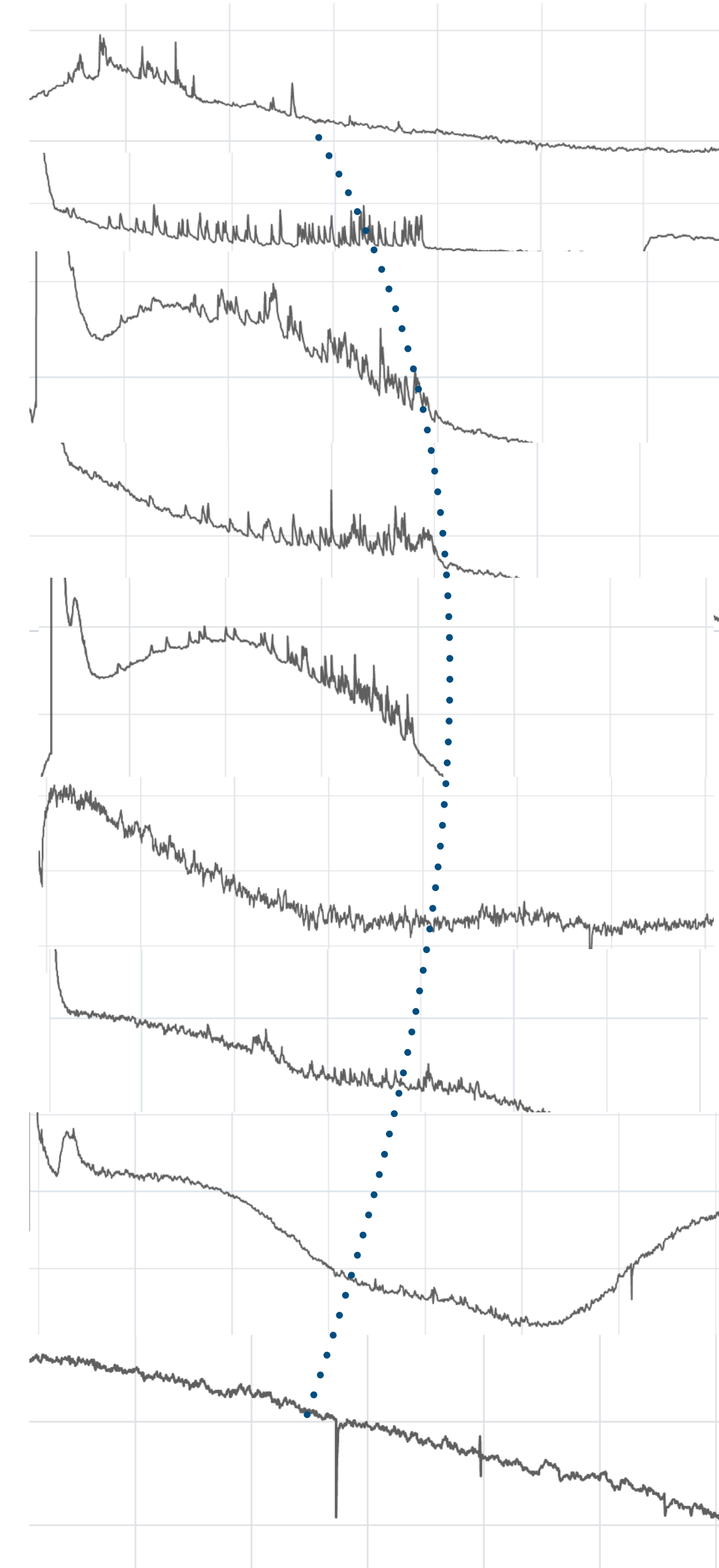
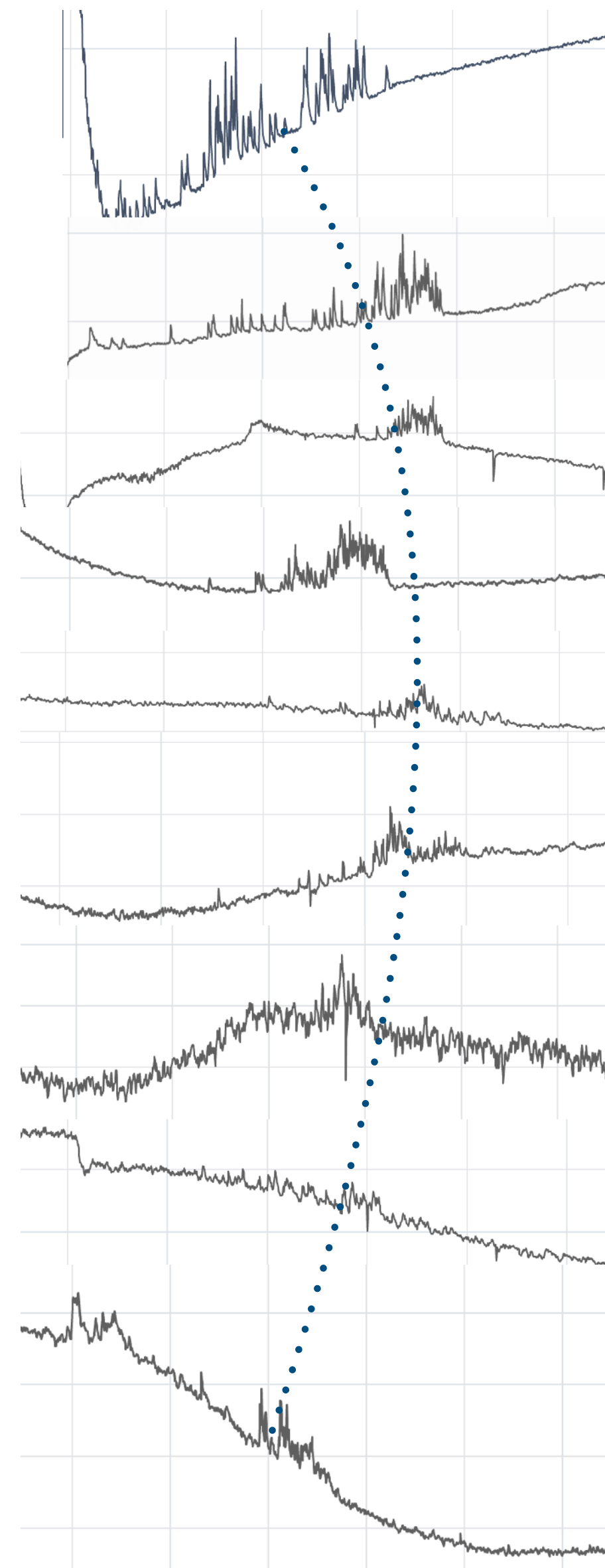
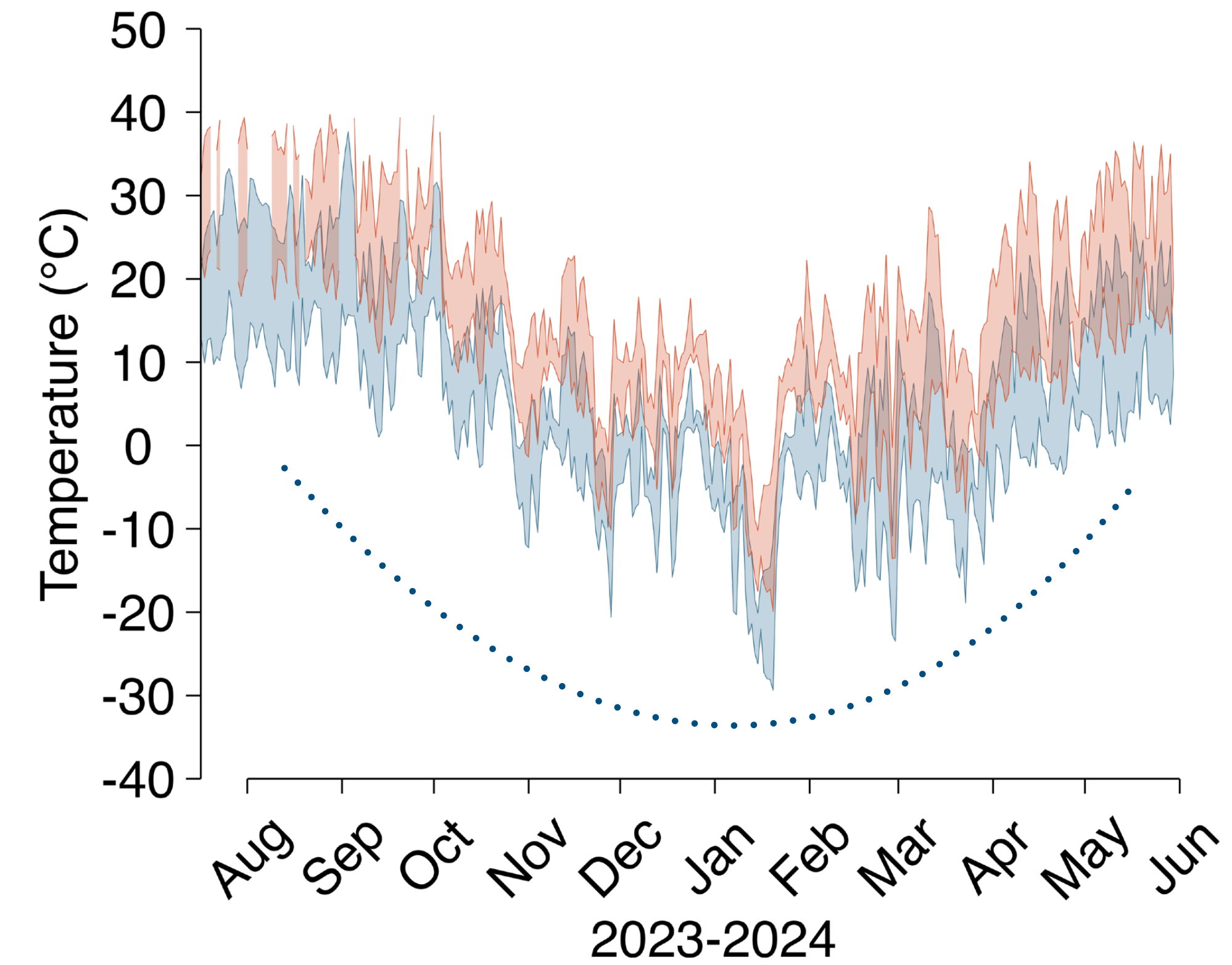


DTA responses

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Open

+9°C

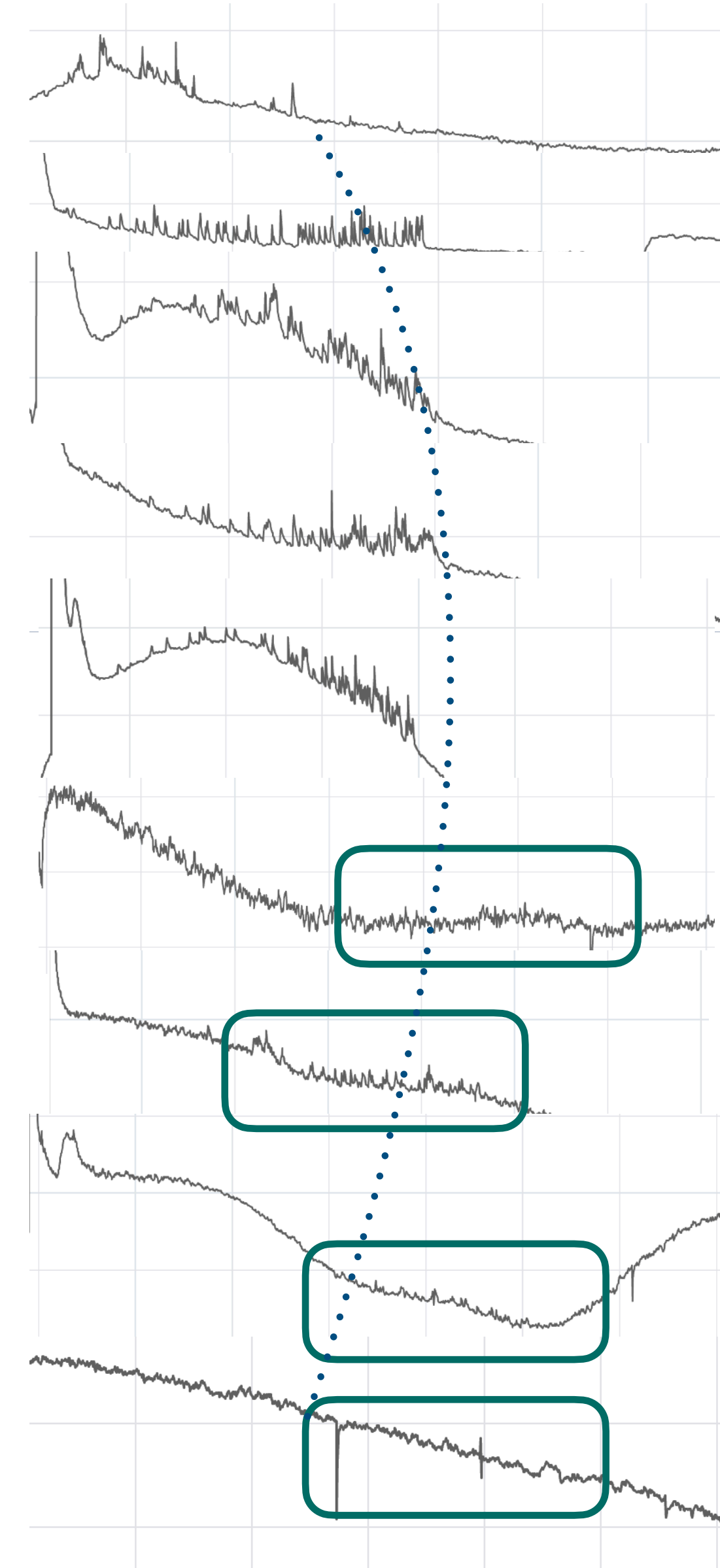
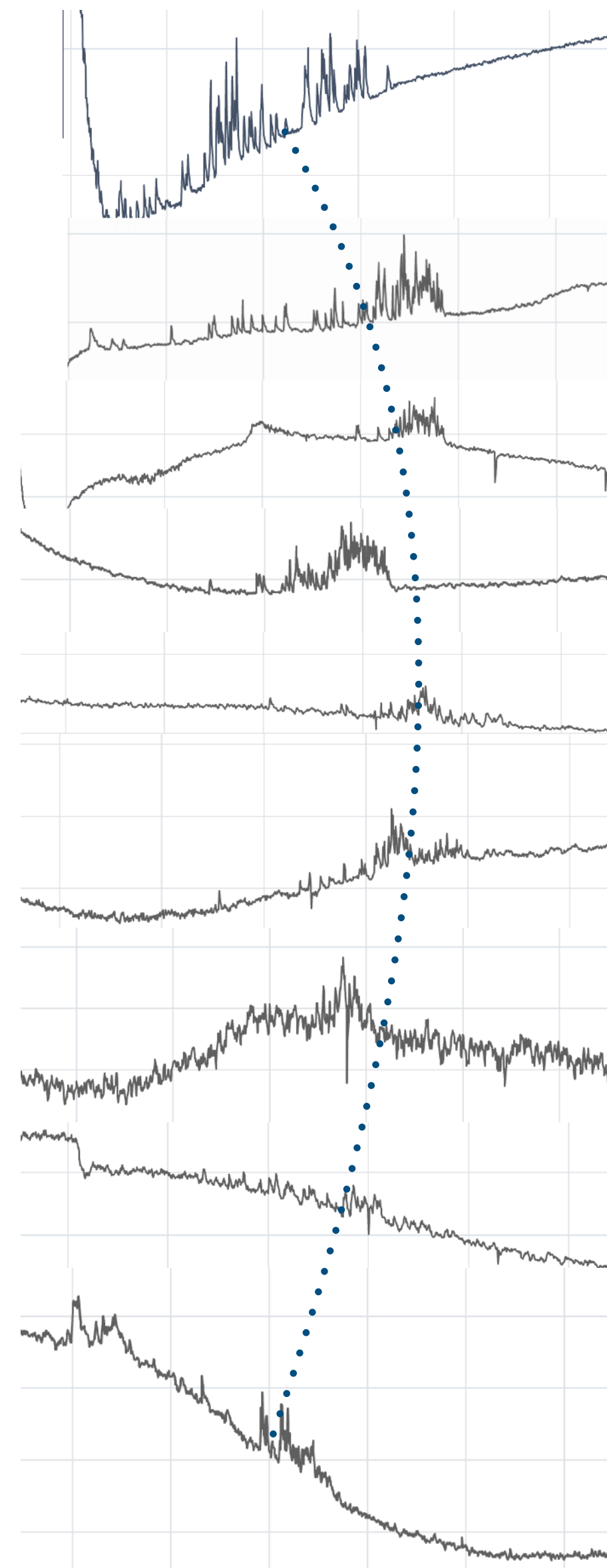
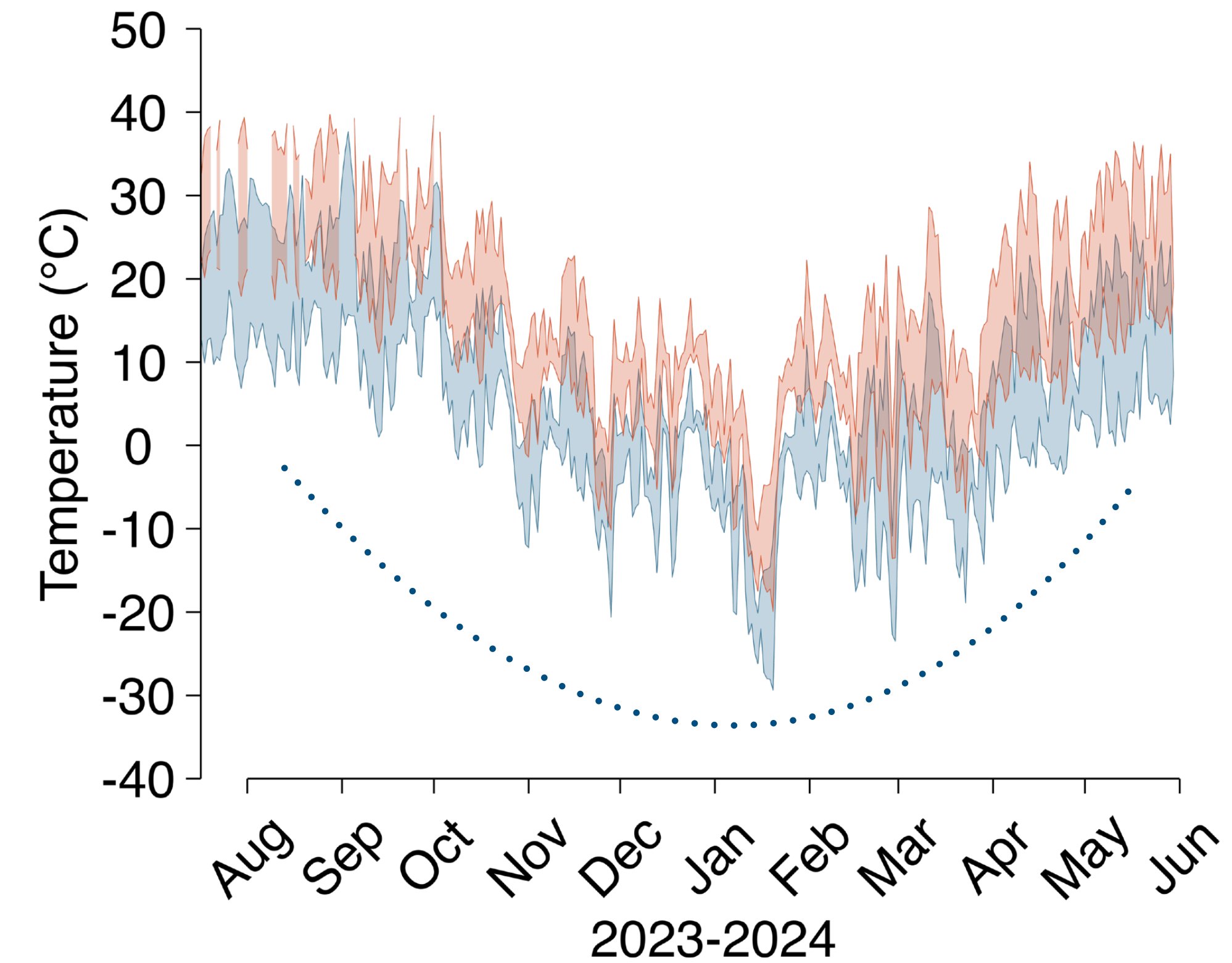


DTA responses

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Open

+9°C



Labrador tea (*Rhododendron groenlandicum*)

Open



Leatherleaf (*Chamaedaphne calyculata*)

Open

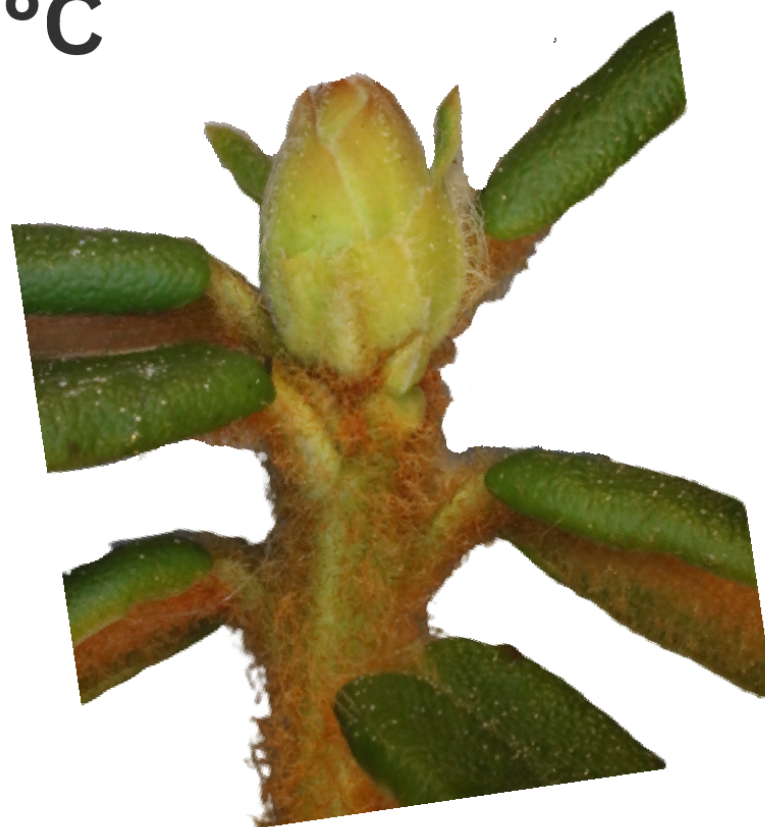


Labrador tea (*Rhododendron groenlandicum*)

Open



+9 °C



Leatherleaf (*Chamaedaphne calyculata*)

Open



Labrador tea (*Rhododendron groenlandicum*)

Open



+9 °C



Leatherleaf (*Chamaedaphne calyculata*)

Open



Labrador tea (*Rhododendron groenlandicum*)

Open



+9 °C



Leatherleaf (*Chamaedaphne calyculata*)

Open



+6.75 °C



Key findings

- Warming lead to delayed gains in cold hardiness in the fall and early loss of cold hardiness in the spring.
- A +9°C increase in temperature did not alter the cold hardiness of plants in mid-winter.
- Species have different sensitivity patterns to warm temperatures:
 - Larch deacclimated with mid-winter warm temperatures.
 - Spruce did not experience deacclimation during the same temperature exposure.
 - Rhododendron and Chamaedaphne were probably affected by an interaction of water content, dessication and snow cover.

As climate warming alters species distribution, understanding the patterns and differing responses between deciduous and evergreen species can provide valuable insights into cold hardiness patterns and dormancy progression under warming scenarios.

Ongoing/Future work

- Analyze 2024-2025 data.
- Revise the cold hardiness patterns and the effect of warming in the four species.
- Analyze deacclimation rates and deacclimation potential of the species.
- Calculate chill accumulation and do model verification [(development?) As we hypothesized that lower temperatures than the ones currently used in chill models contribute to chill accumulation].
- Test cold hardiness data and deacclimation data in budbreak predicting models.

References

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Thank you for your attention



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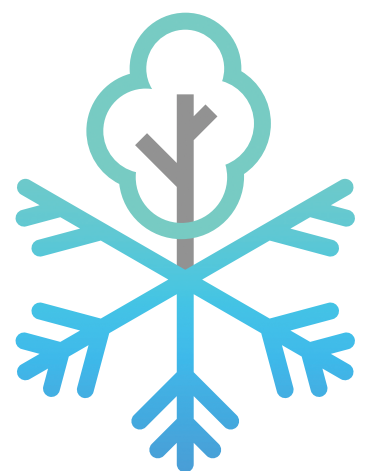
Contact info

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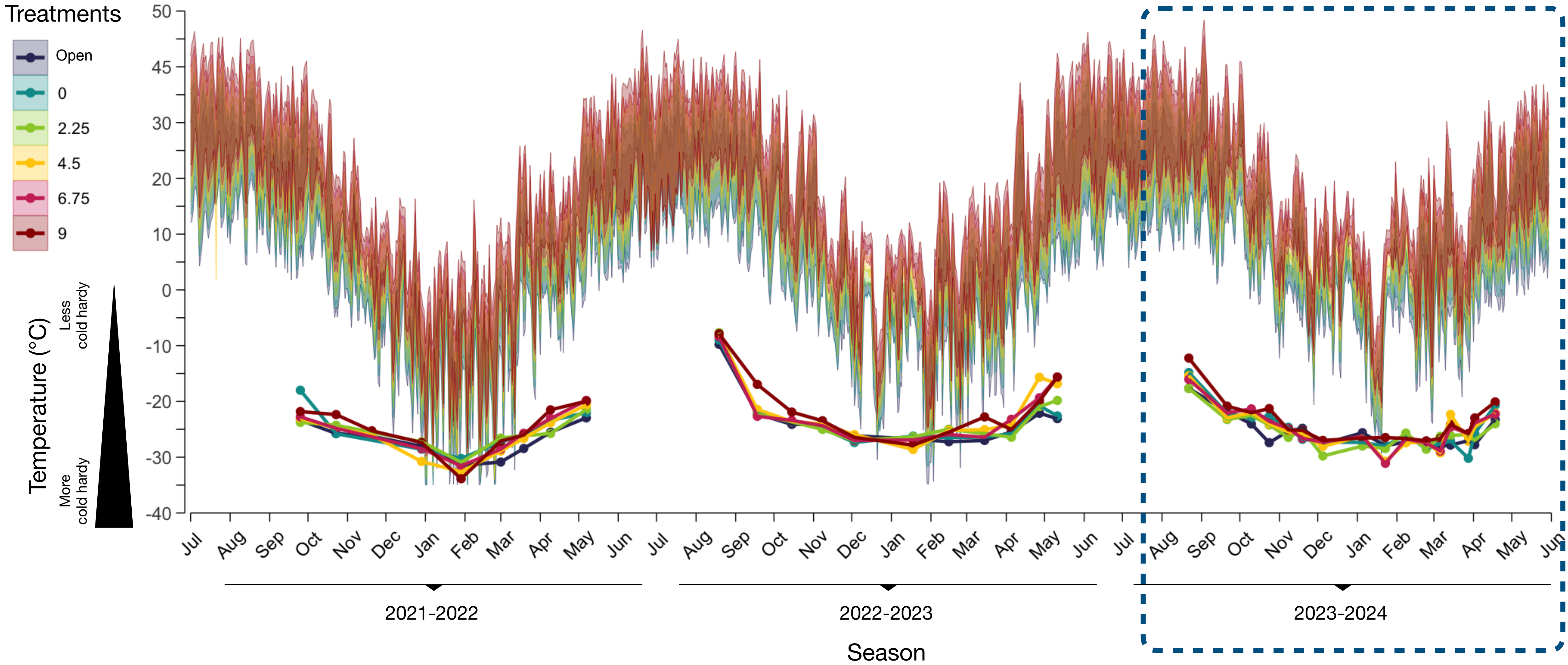
Plant
Resilience
Lab



Supplementary information

Picea mariana

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Larix laricina

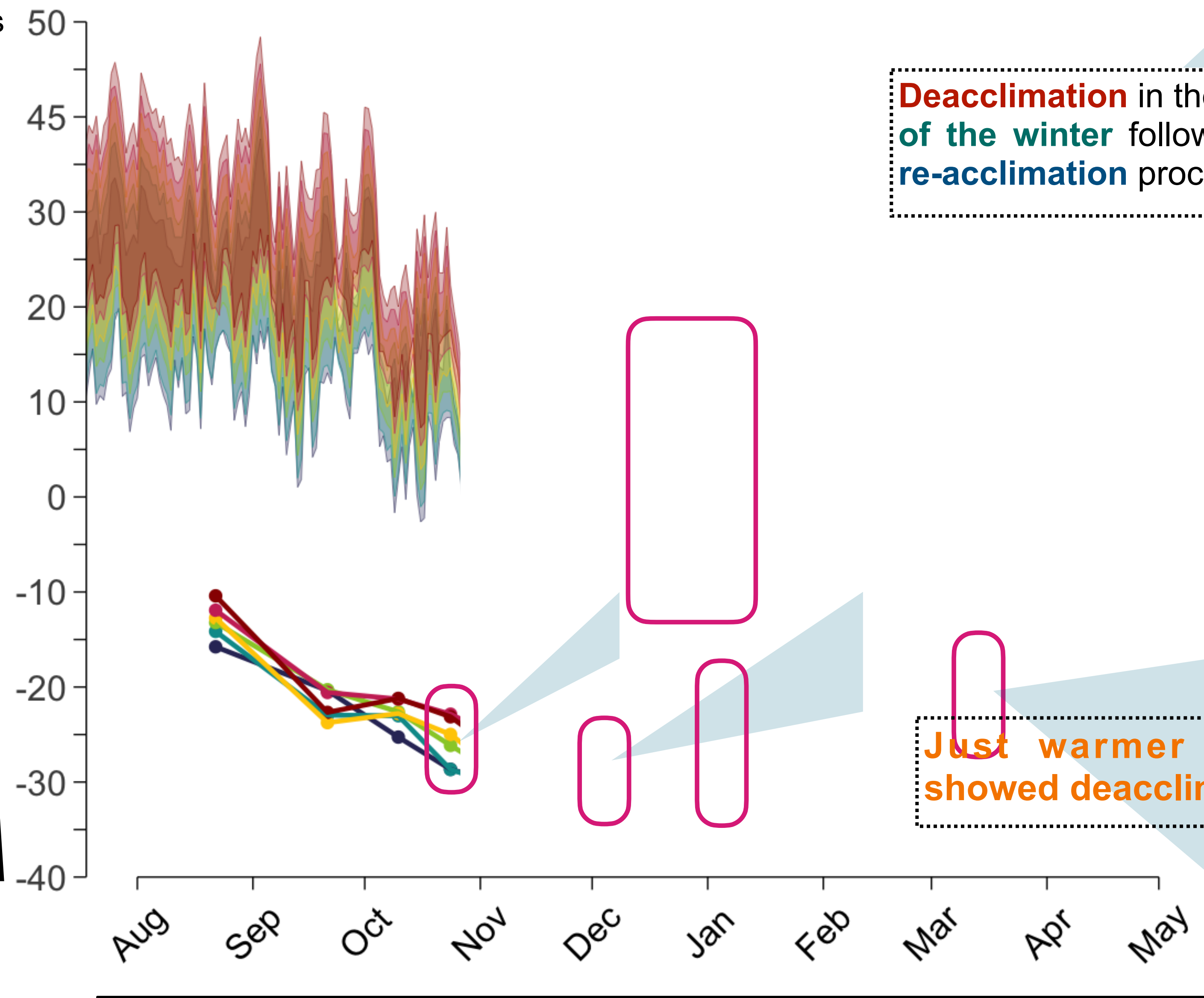
2025 SPRUCE All-hands meeting

Treatments

- Open
- +0°C
- +2.25°C
- +4.5°C
- +6.75°C
- +9°C

Temperature (°C)

Less cold hardy
More cold hardy



2023-2024

Deacclimation in the middle of the winter followed by a re-acclimation process

Just warmer plots showed deacclimation

Fall

$y = -23 + 0.22x$
 $p = 0.036$

Winter

$y = -29 + 0.076x$
 $p = 0.268$

Spring

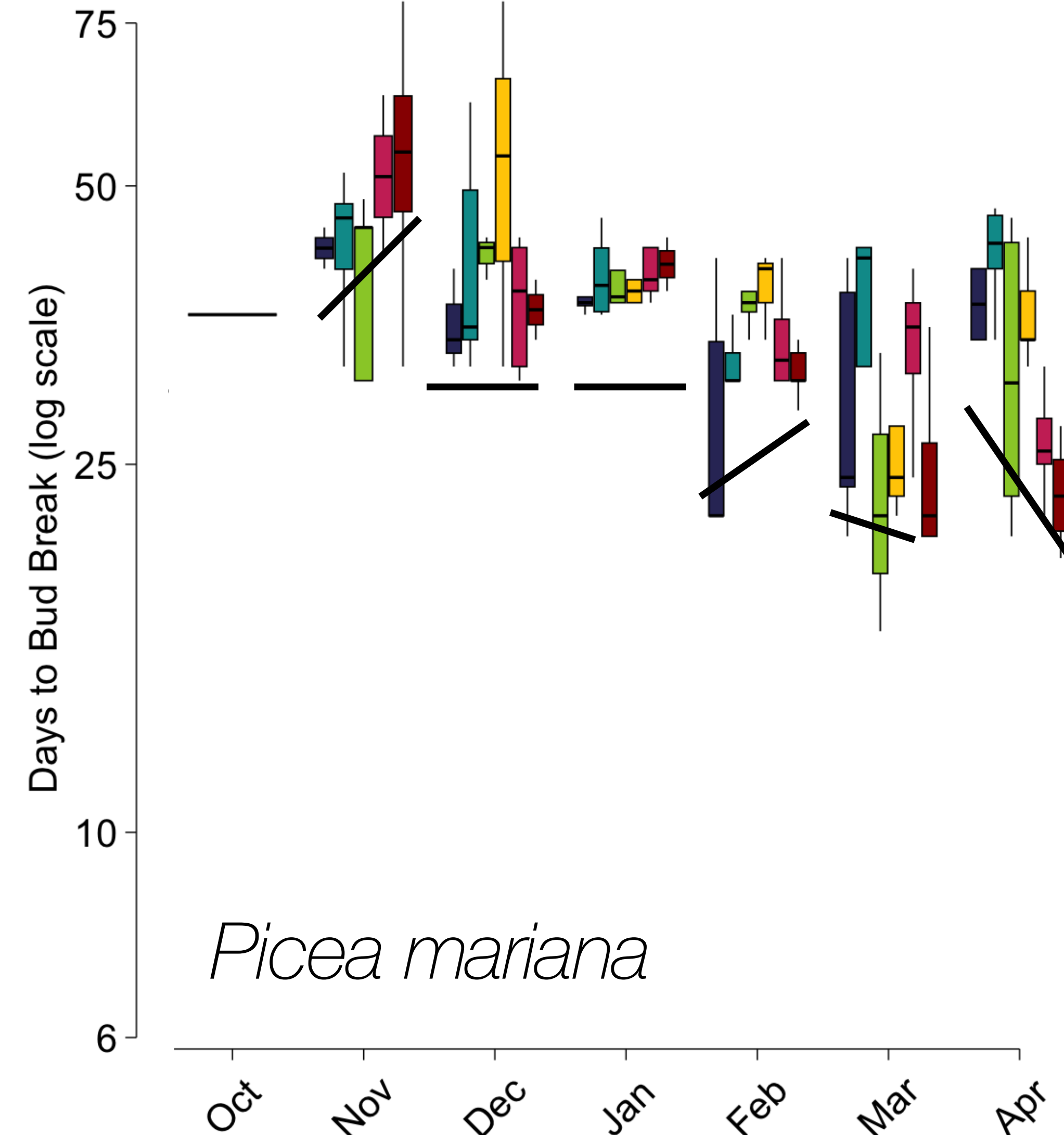
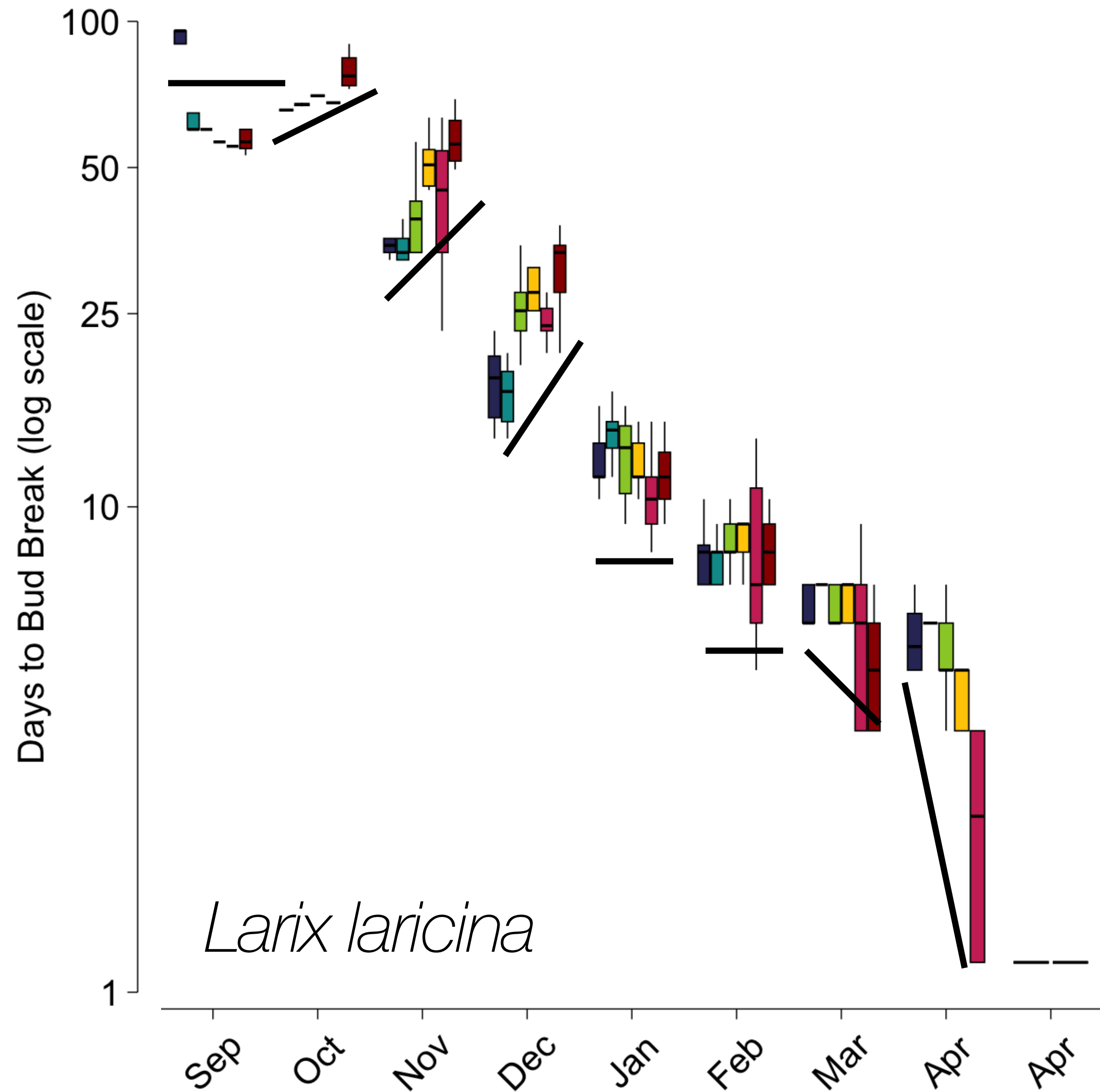
$y = -27 + 0.85x$
 $p = 0.014$

Cold hardness (°C)

Open 0 2.25 4.5 6.75 9
Plot temperature (ΔT , °C)

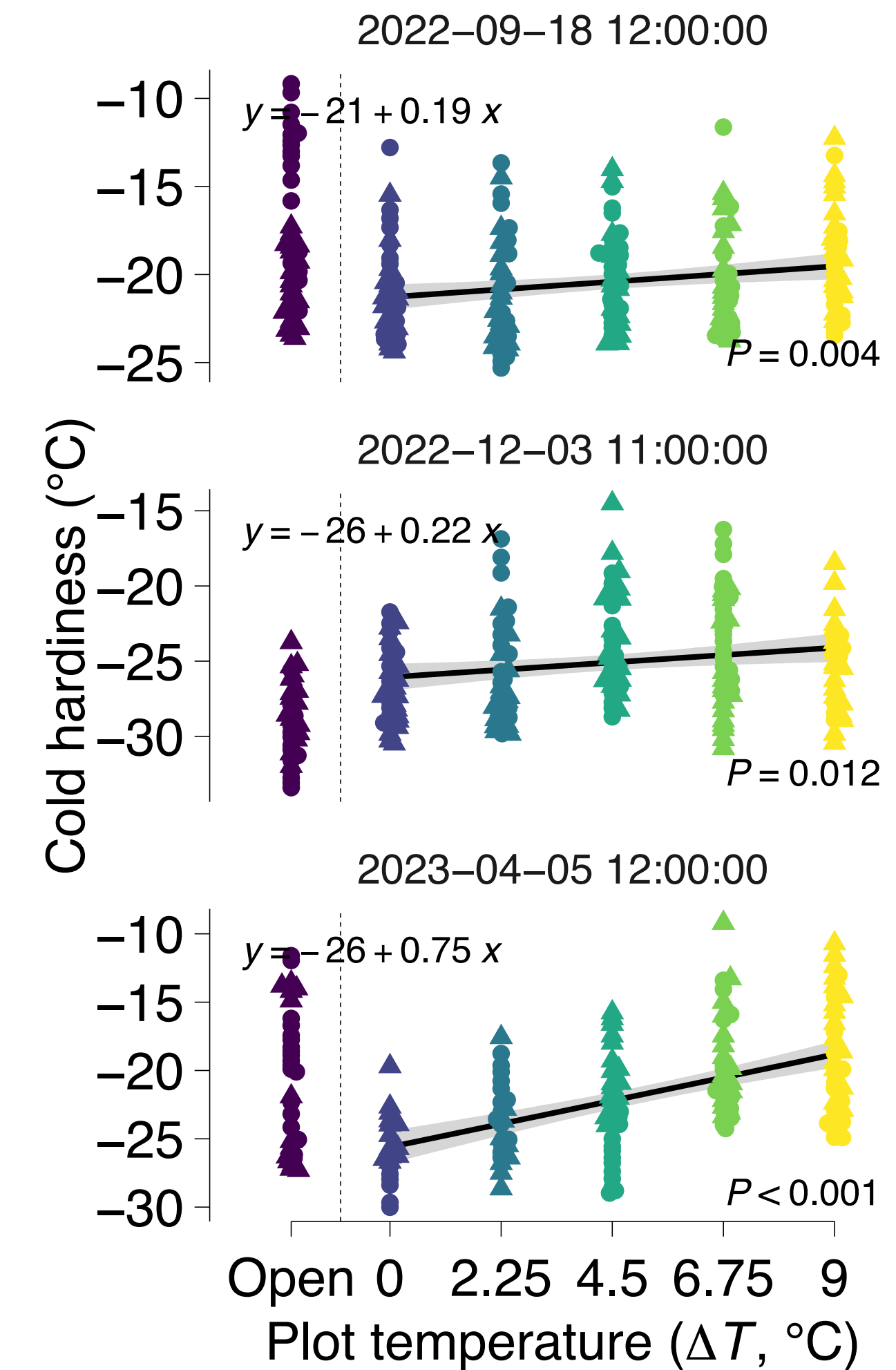
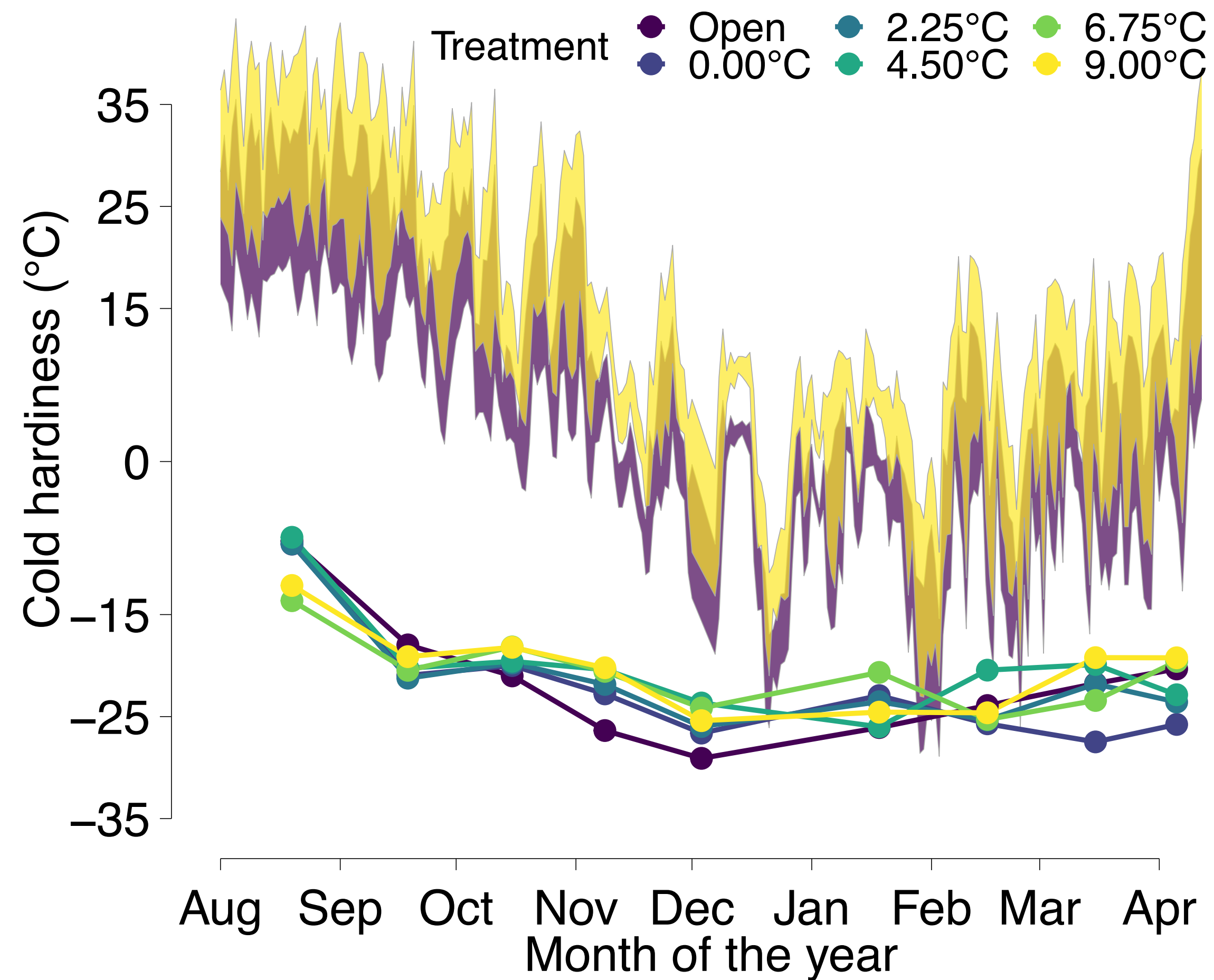
Budbreak data

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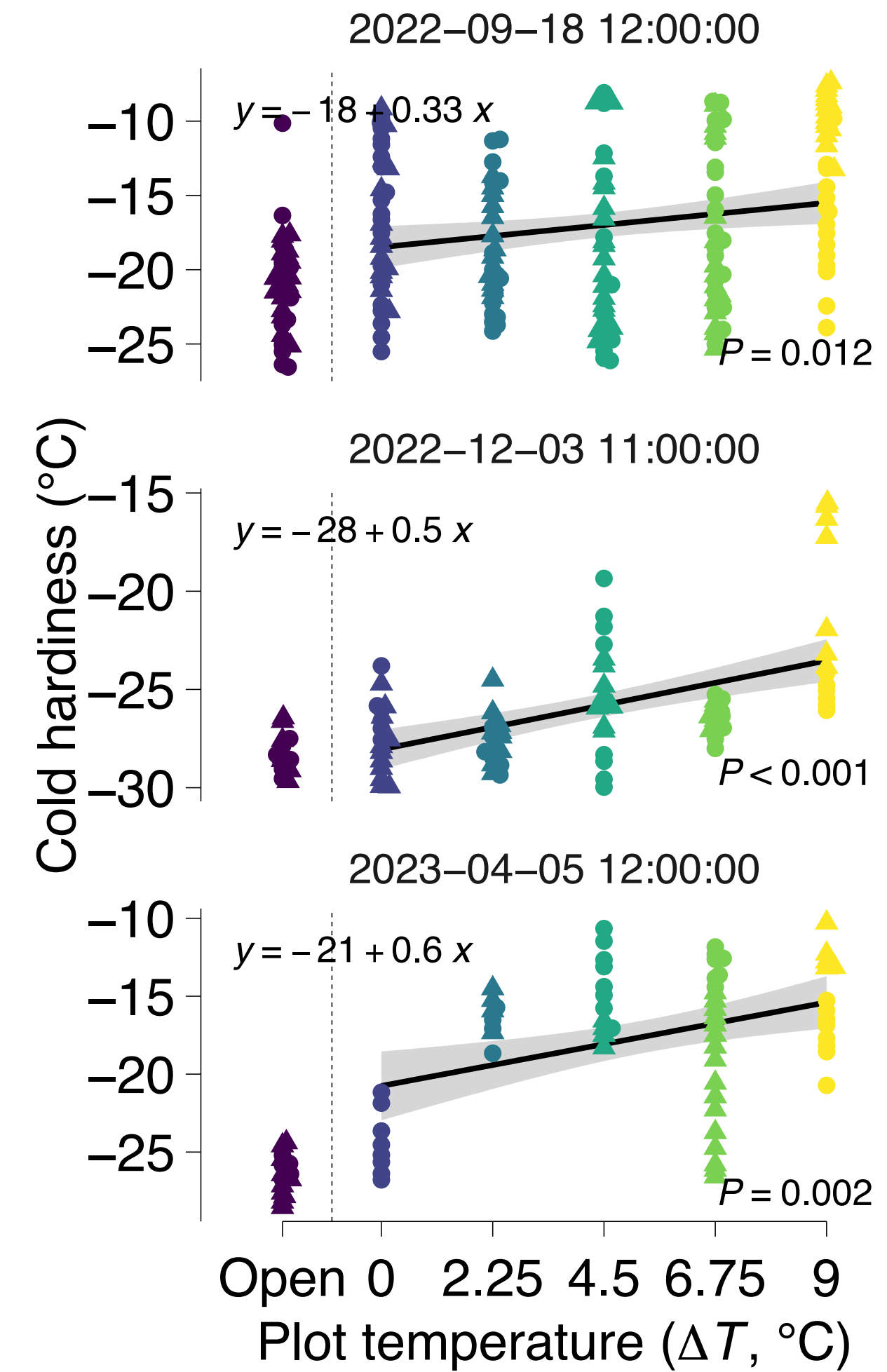
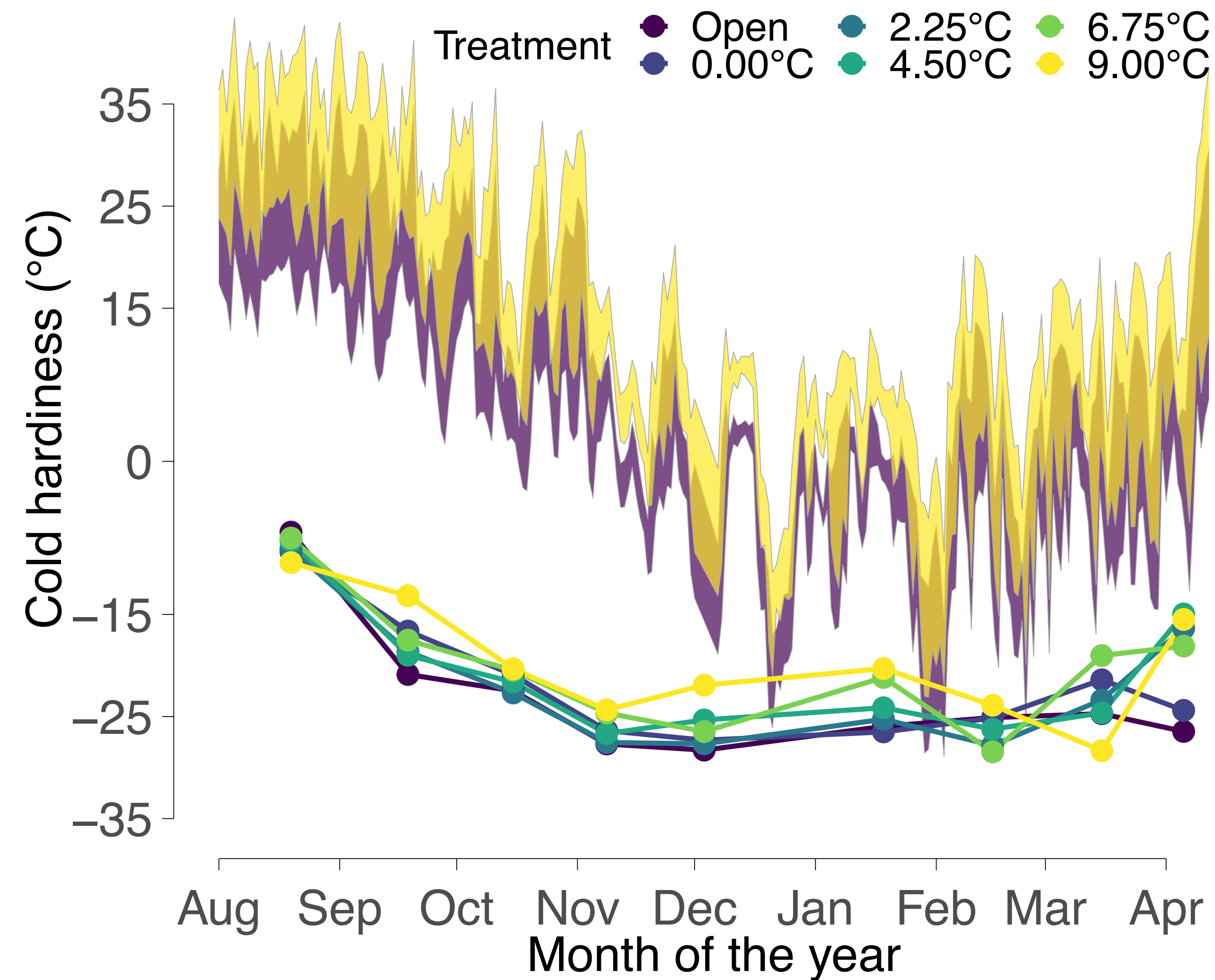
Rhododendron groenlandicum

2022–2023



Camaedaphne calyculata

2022–2023





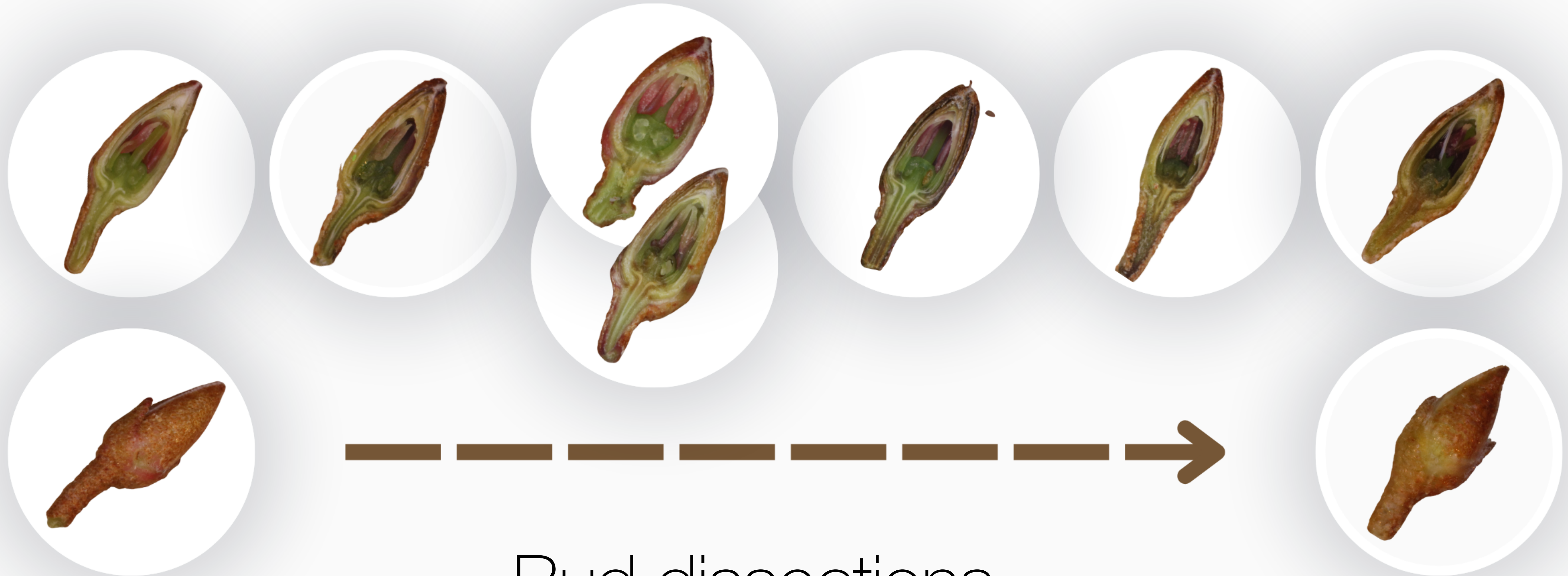
Bud dissections

Open

Rhododendron groenlandicum

+9 °C





Open

Bud dissections

Chamaedaphne calyculata

+9 °C

