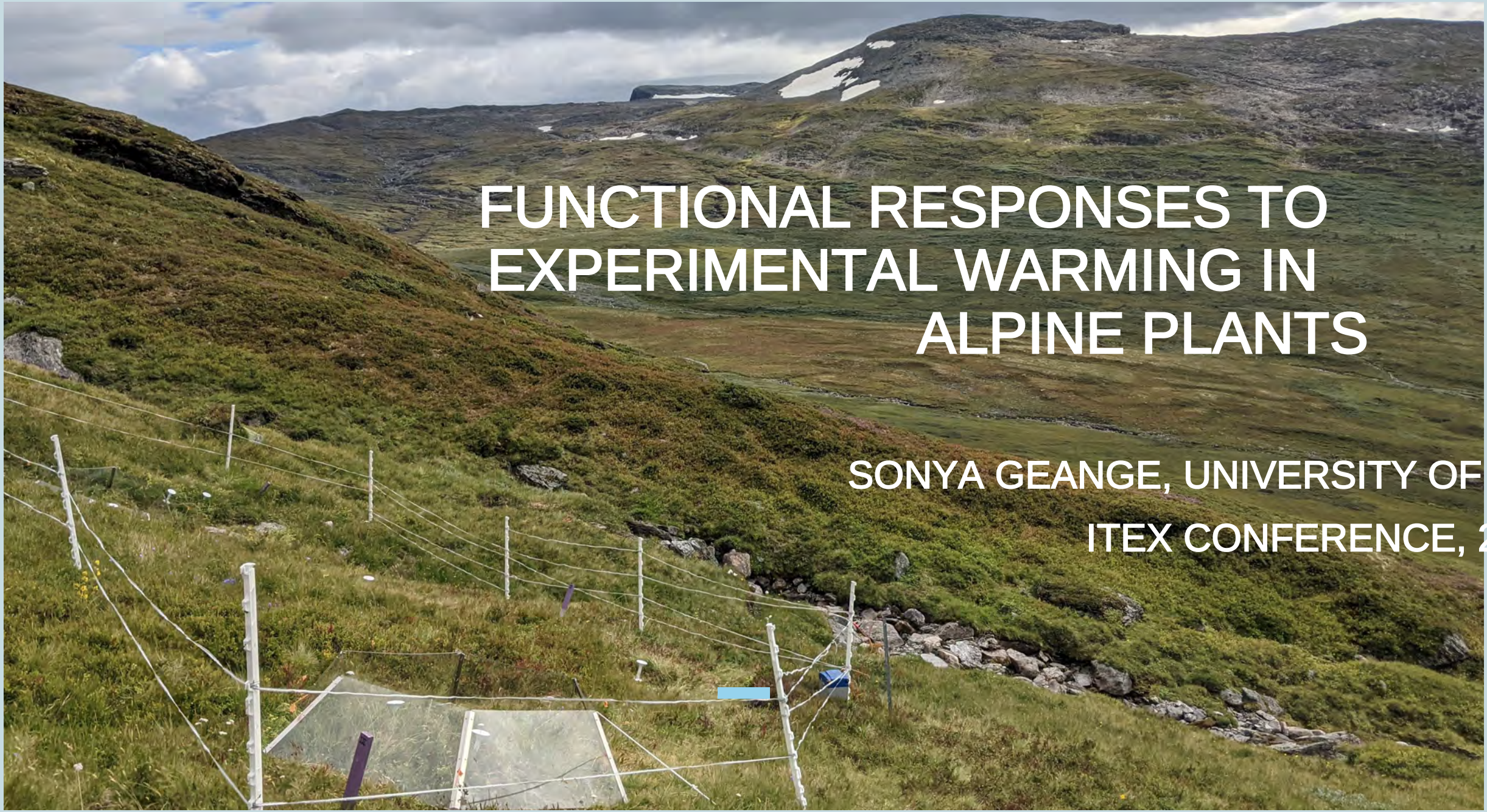
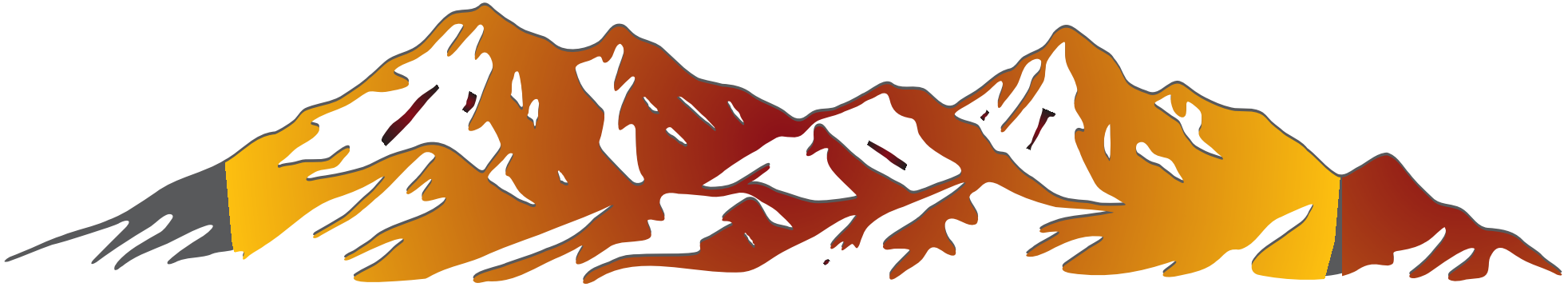


FUNCTIONAL RESPONSES TO EXPERIMENTAL WARMING IN ALPINE PLANTS

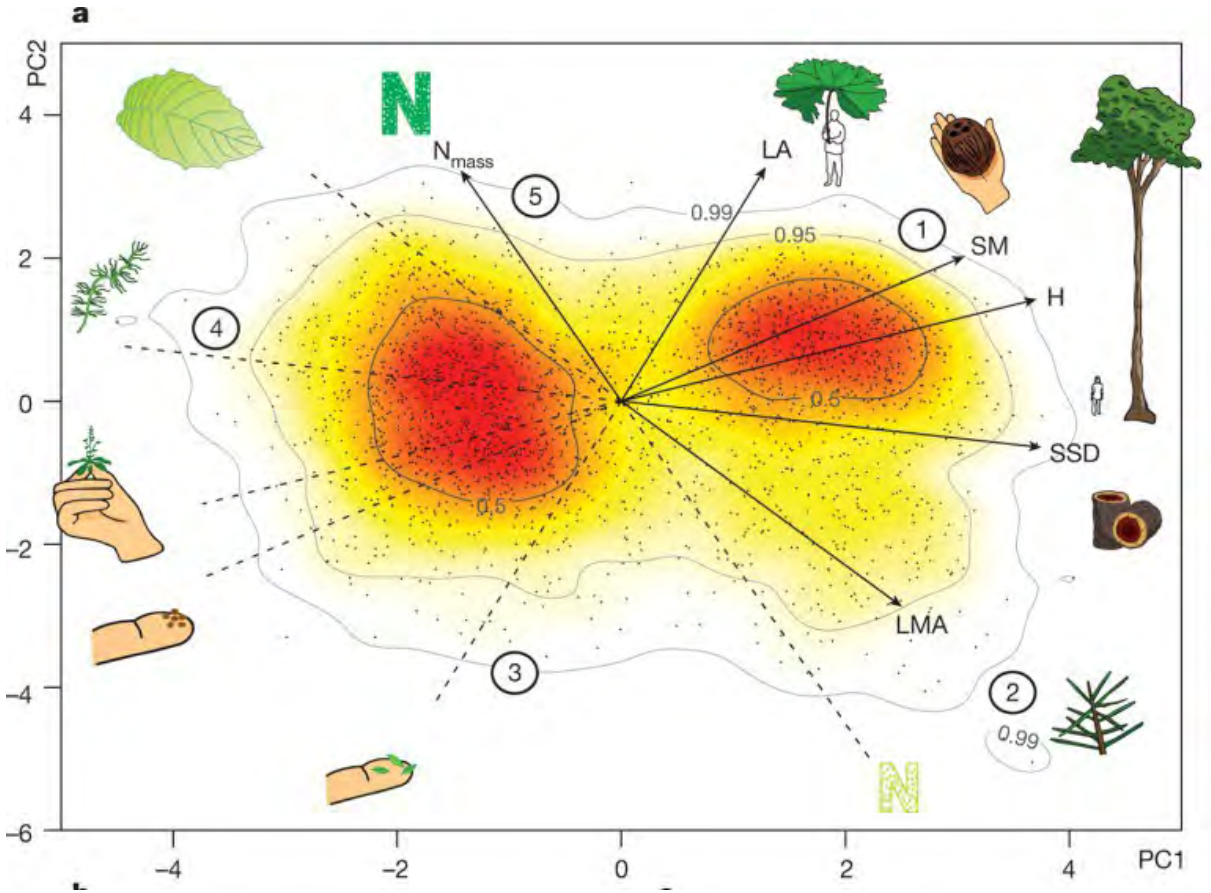
SONYA GEANGE, UNIVERSITY OF B

ITEX CONFERENCE, 20

CLIMATE CHANGE IMPACTS IN ALPINE REGIONS



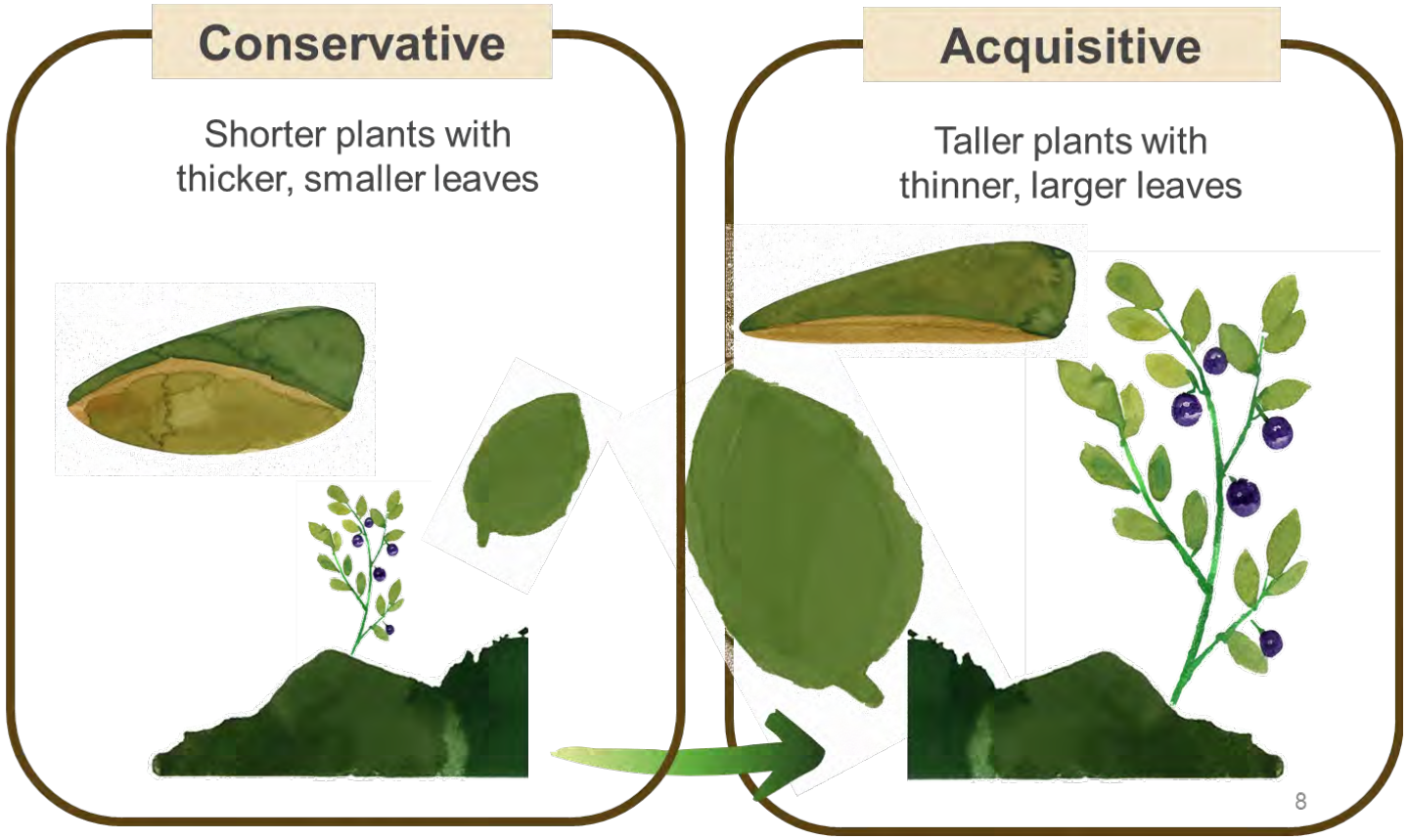
WARMING IMPACTS ON ALPINE VEGETATION



Diaz et al. 2016

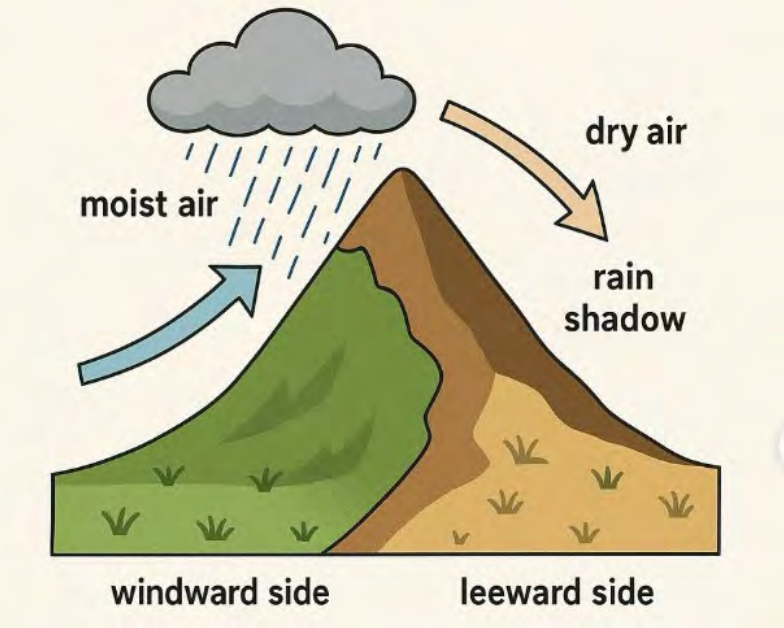
PLANT FUNCTIONAL TRAITS

Morpho, physio and phenological plant characteristics affecting overall plan
fitness through their influence on survival, growth, and reproduction



LEAF-RELATED TRAITS

Morpho, physio, and phenological plant characteristics affecting overall plan
fitness through their influence on survival, growth, and reproduction



Environmental Gradients

Growth Forms

EFFECTS MAY NOT BE UNIFORM

Biotic interactions and abiotic contexts, modulate trait responses

Necessitates a move beyond single-site, and single-species experiments

RESEARCH QUESTIONS:

Q1) To what extent does experimental warming cause intraspecific trait shifts in alpine species?

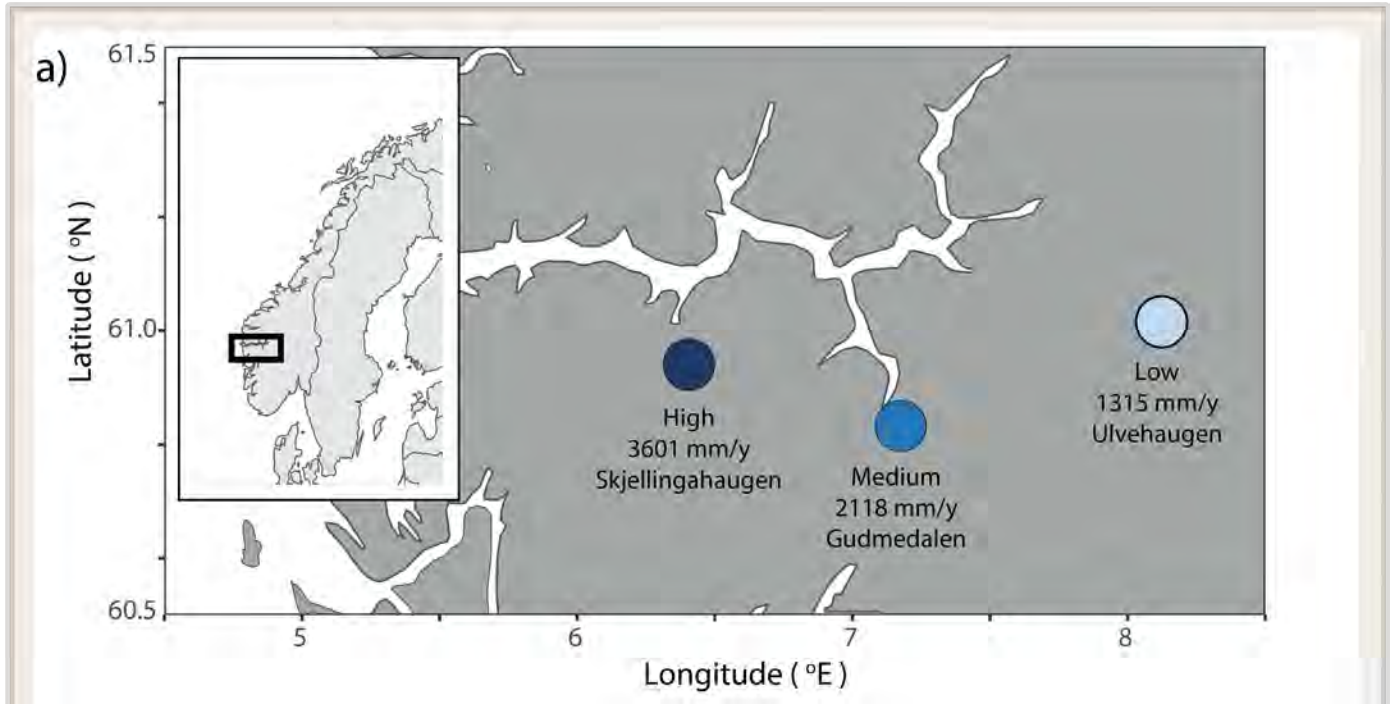
Q2) Do these intraspecific trait shifts vary across a precipitation gradient

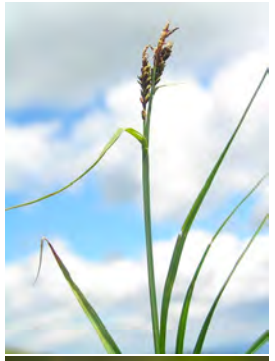
Q3) Do trait responses vary between forbs and graminoids?

EXPERIMENT DESIGN:

THE INCLINE PROJECT

South Western Norway





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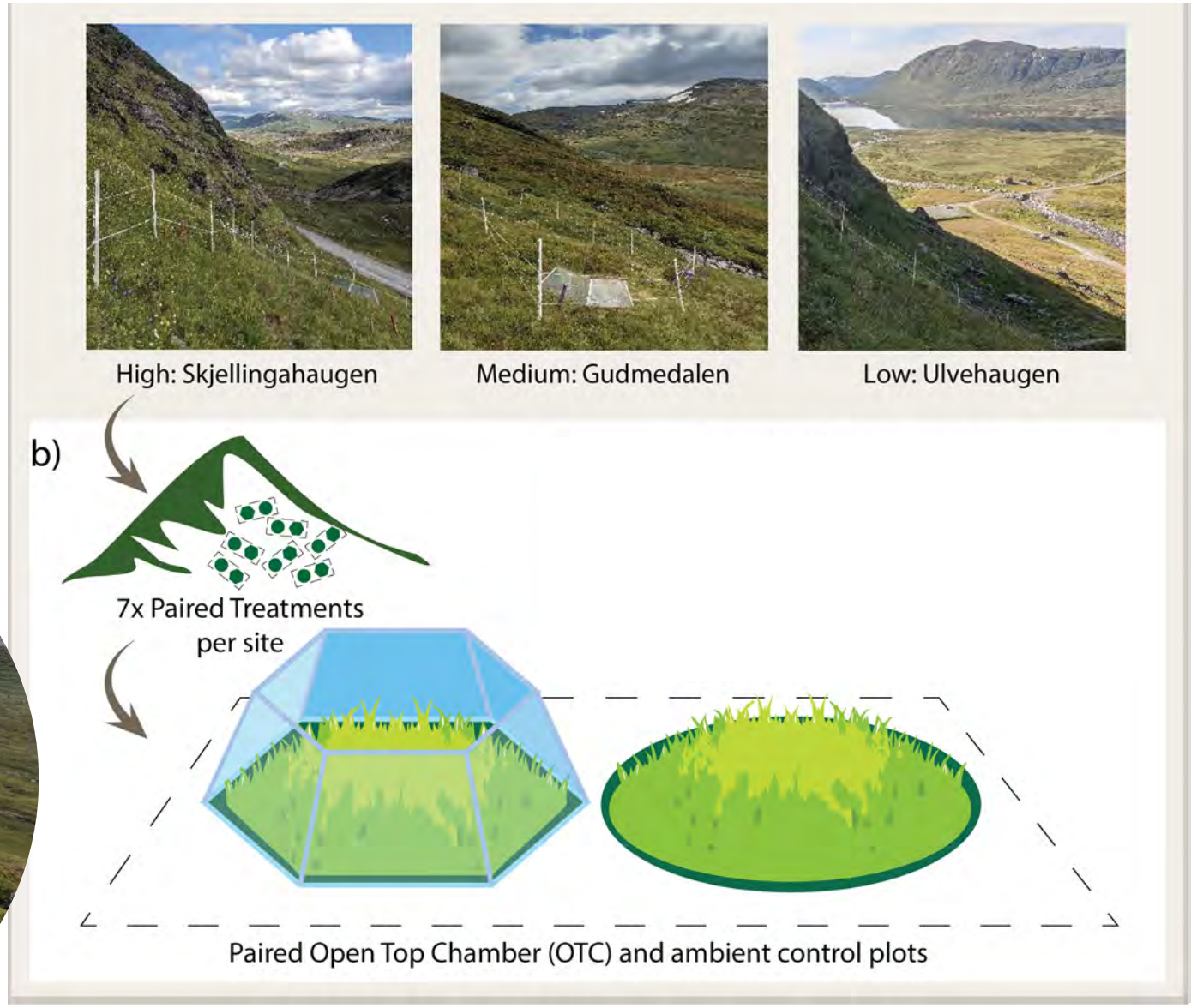

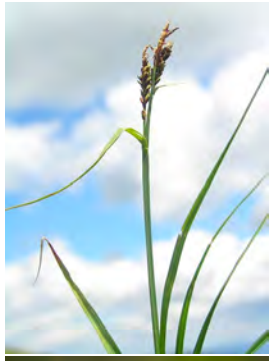

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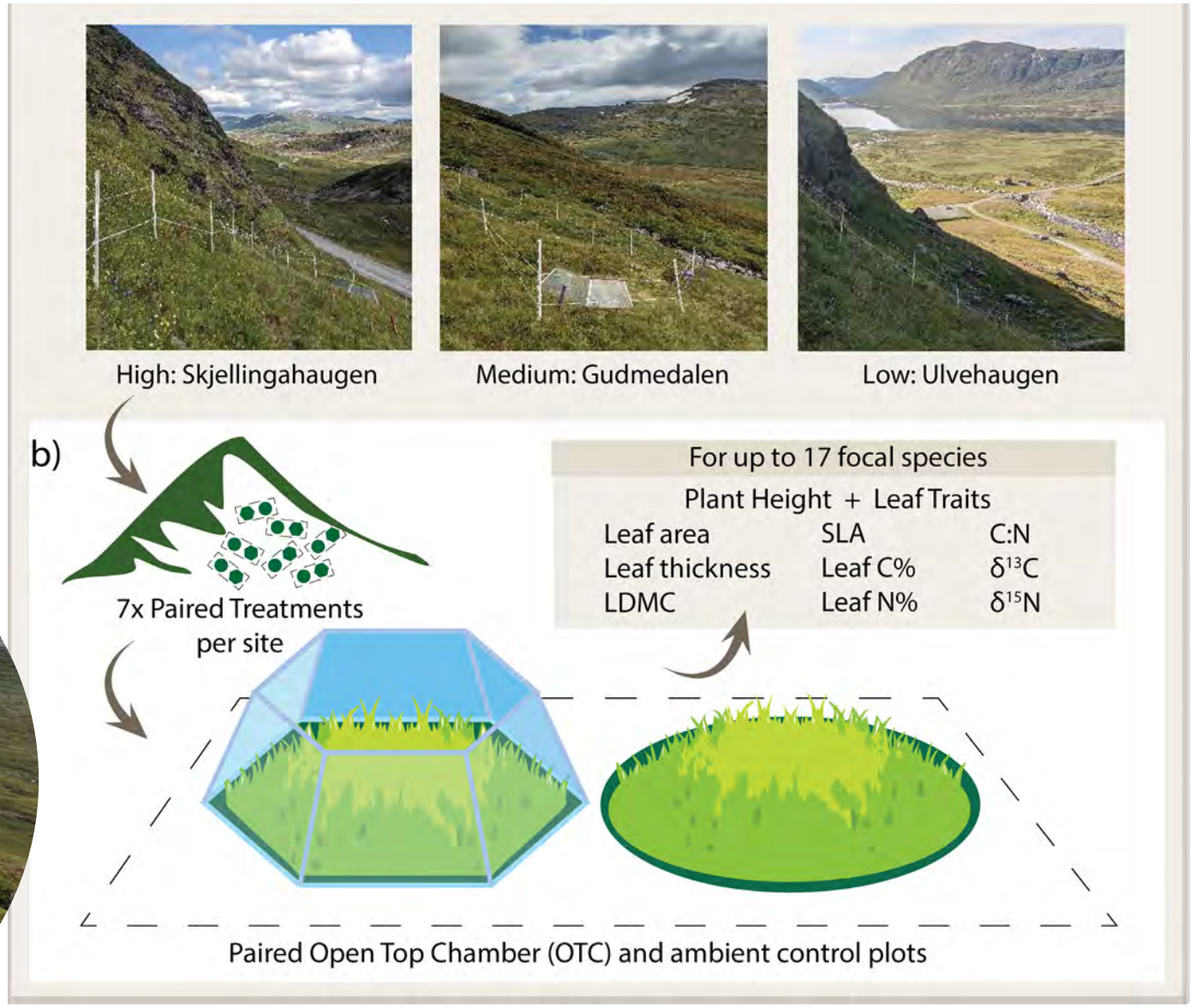
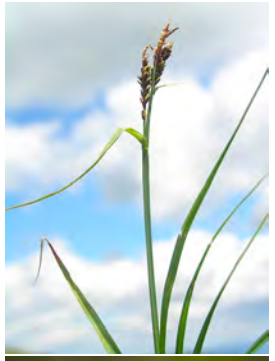




EXPERIMENT DESIGN :

THE INCLINE PROJECT

South Western Norway

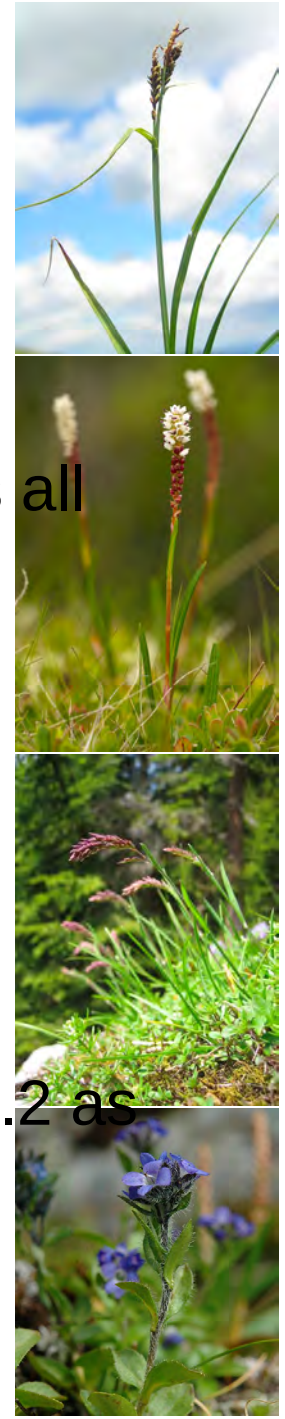
$$Cohen's\ d = \frac{mean(C) - mean(OTC)}{pooled\ sd(C,OTC)}$$

We pooled the samples of each species across all plots within each site…

For effect sizes, relative to the control mean

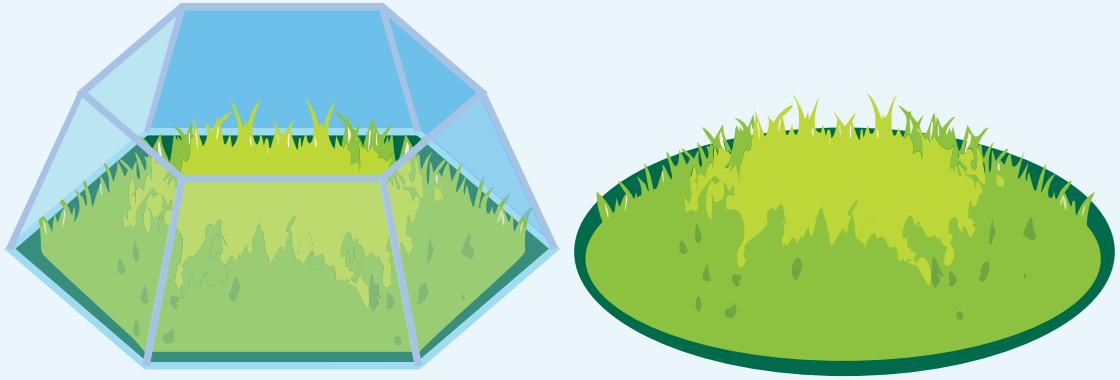
- 1 indicates a 1 SD increase under OTC
- -1 indicates a 1 SD decrease under OTC
- 0 indicates no (net) change

- We considered standardized effect sizes of 0.2 as small, 0.5 as medium and 0.8 as large



Q1: OVERALL RESPONSES TO WARMING

Trait	d_{mean}	d_{var}	n_{paired}
Plant height (H)	0.21	0.30 *	47
Leaf area (LA)	0.13	0.41	46
Leaf thickness (LTH)	-0.04	0.31 *	46
Leaf dry matter content (LDMC)	0.08	0.64	46
Specific leaf area (SLA)	0.01	0.52	46
Leaf carbon content (LCC)	-0.09	0.71	38
Leaf nitrogen content (LNC)	-0.15	0.47	38
Carbon to nitrogen ratio (C:N)	0.09	0.46	40
Leaf carbon^{13} isotope ratio ($\delta^{13}C$)	0.10	0.49	27
Leaf nitrogen^{15} isotope ratio ($\delta^{15}N$)	0.09	0.76 *	40



Increase in plant height and leaf area

Decrease in leaf nitrogen content

For many traits, there is a lack of directionality across species and sites

Q2: SHIFTS ACROSS THE PRECIPITATION GRADIENT

High: Skjellingahaugen

Medium: Gudmedalen

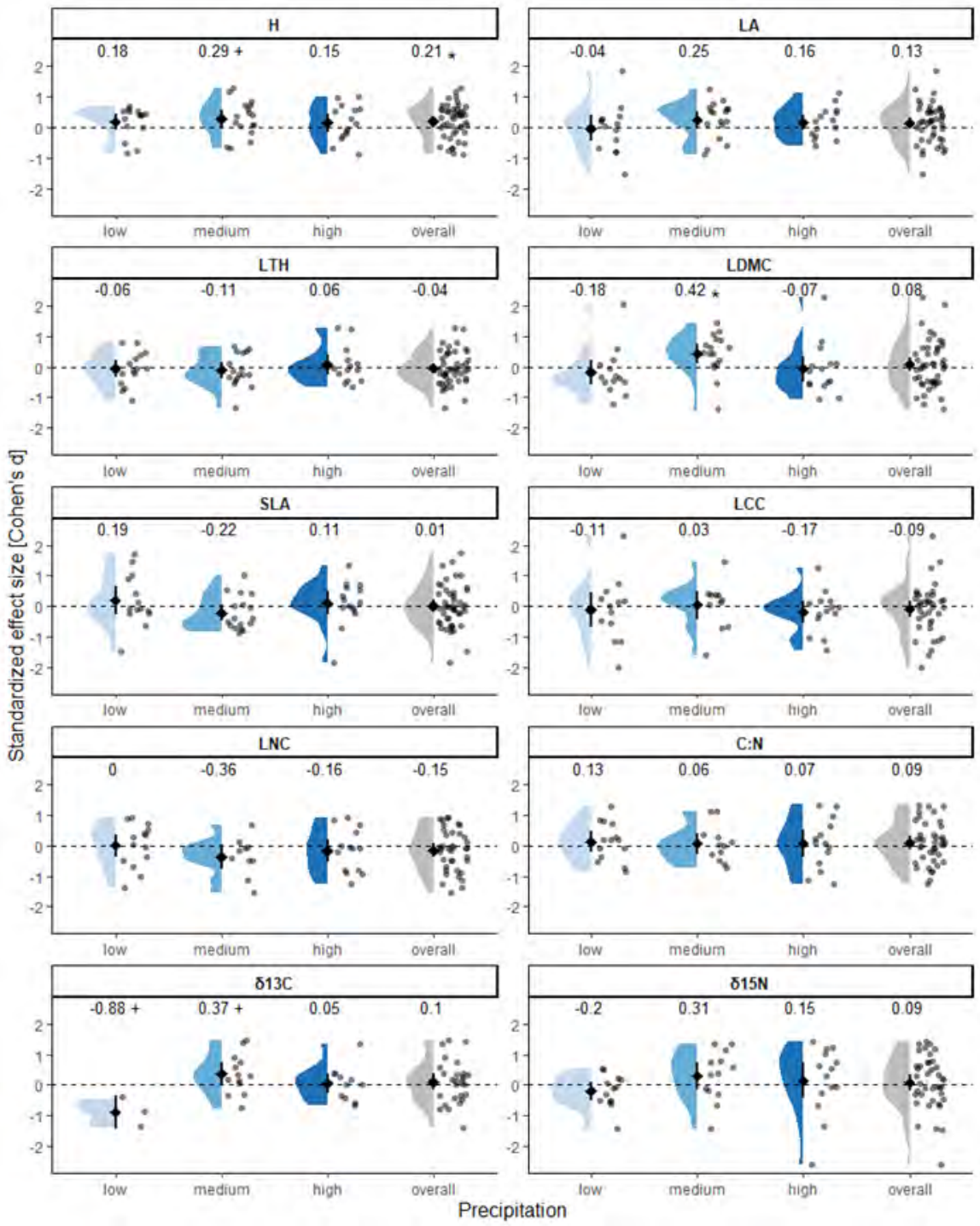
Low: Ulvehaugen

Precipitation Level	d_{mean}	d_{var}
Low (1315 mm)	0.122	0.539
Medium (2128 mm)	0.242	0.424
High (3601 mm)	0.115	0.542
Overall	0.1	0.505

Across all traits, the medium precipitation site showed the stronge intraspecific trait shifts in response to warming

The trait responses in the high and low precipitations were half as strong

The medium precipitation site had th least variance in trait responses



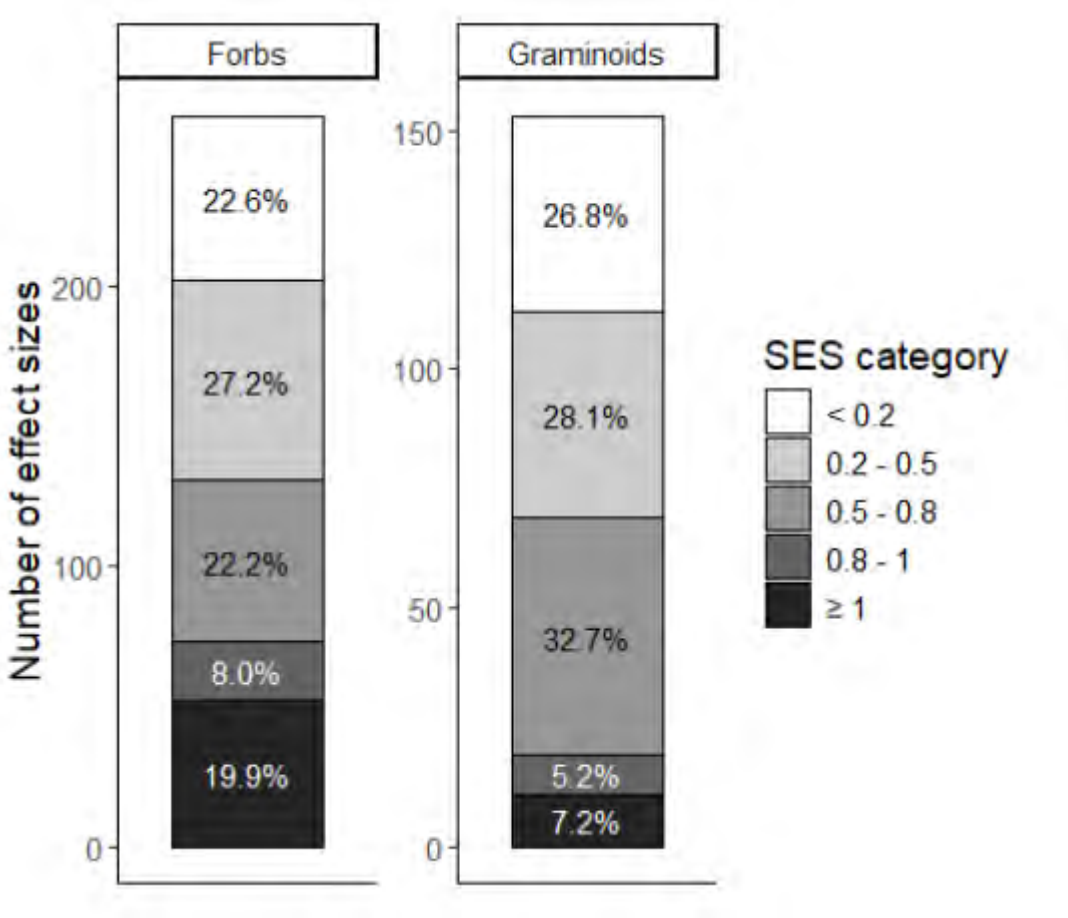
Q2: AT THE MEDIUM PRECIPITATION SITE, PLANTS GROWN UNDER OTC'S…

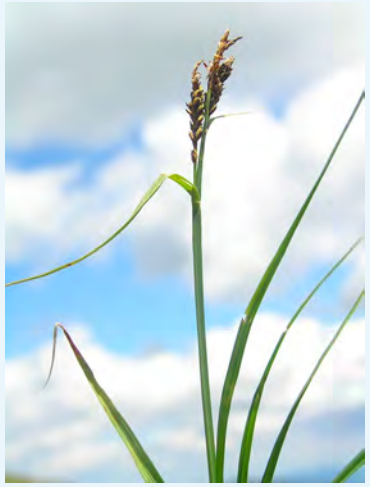
While plants were taller, shifts towards resources conservative leaf strategies to warming were common

- Lower specific leaf area (SLA)
- Lower leaf nitrogen content (LNC)
- Higher leaf dry matter content (LDMC)

Warming may have restricted the developme of resource acquisitive leaves through droug stress, in comparison to other precipitation sites

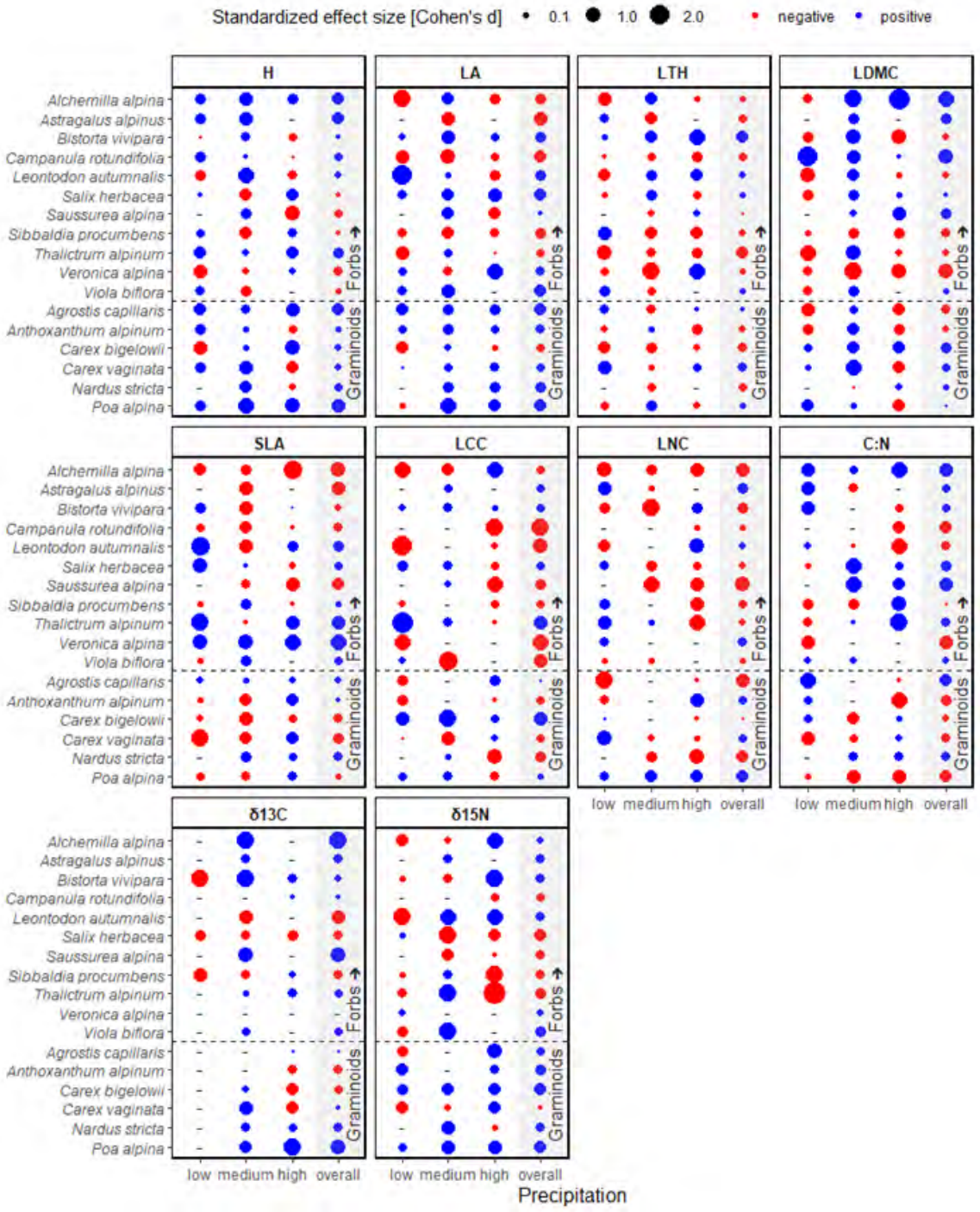
Q3: DIFFERENCES BETWEEN GROWTH FORMS





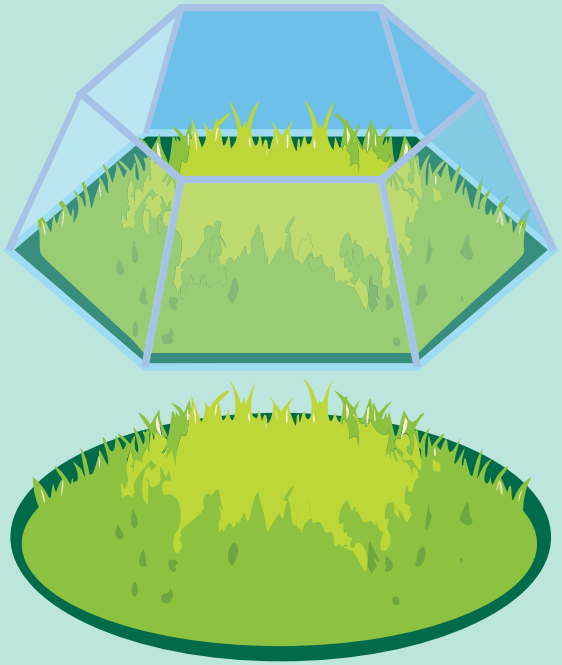
Forbs generally exhibited stronger b
more variable responses to warming
than graminoids

The greater variability in responses
across forbs may also reflect greater
phylogenetic diversity (9 families vs



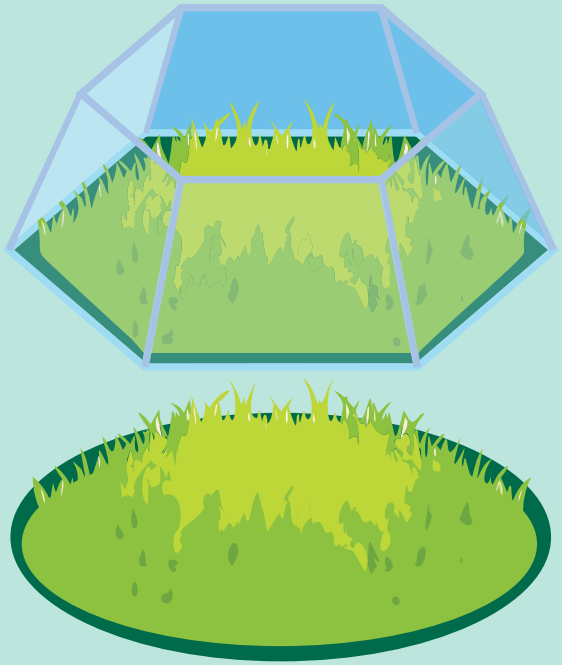
OVERALL:
RESPONSES WERE HIGHLY VARIABLE BETWEEN SPECIES, SITES AND GROWTH FORMS

THINGS TO CONSIDER



Shifts in plant height may be determined by community dominant species

THINGS TO CONSIDER



Shifts in plant height may be determined by community dominant species

High cloud coverage within our mountain systems may reduce the warming impact of the OTCs, and likelihood of strong, predictable trait shifts

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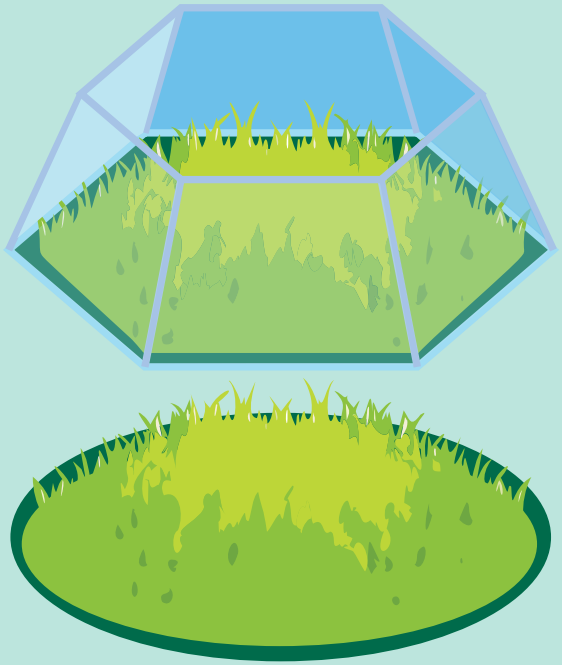
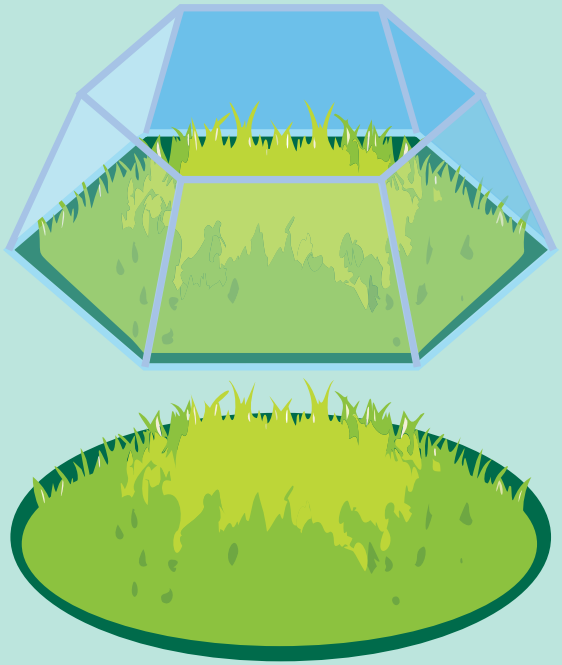


Shifts in plant height may be determined by community dominant species

High cloud coverage within our mountain systems may reduce the warming impact of the OTCs, and likelihood of strong, predictable trait shifts

Graminoid dominances under warming may be enhanced in resource rich environments

THINGS TO CONSIDER



- Shifts in plant height may be determined by community dominant species
- High cloud coverage within our mountain systems may reduce the warming impact of the OTCs, and likelihood of strong, predictable trait shifts
- Graminoid dominances under warming may be enhanced in resource rich environments
- Understanding belowground patterns of trait expression, and extended to assessing fitness (or fitness proxies) would provide more accurate community-level forecasts of the impact of warming


WARMING INDUCES TRAIT SHIFTS IN ALPINE SPECIES, BUT RESPONSES DEPEND ON LOCAL CONDITIONS AND GROWTH FORM

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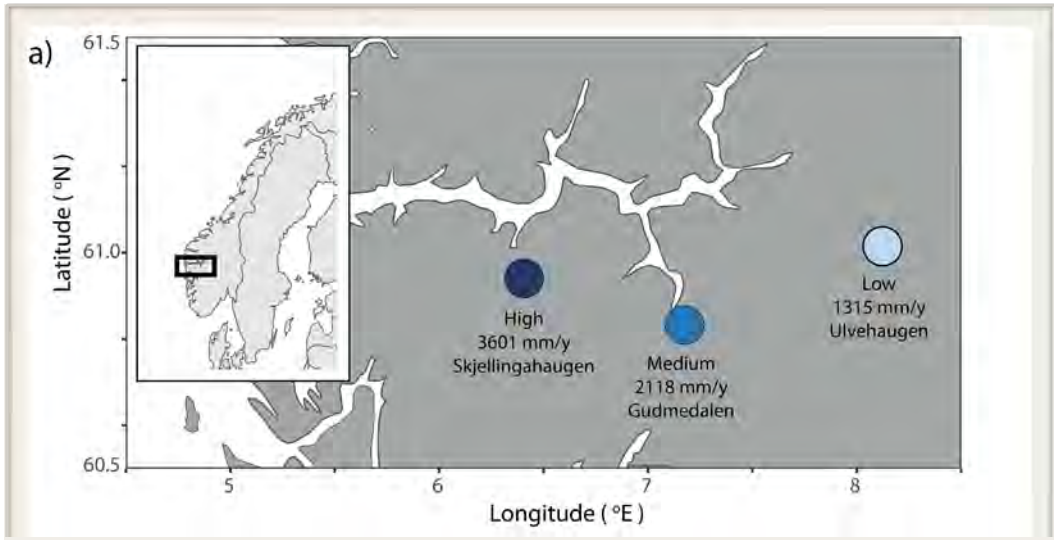
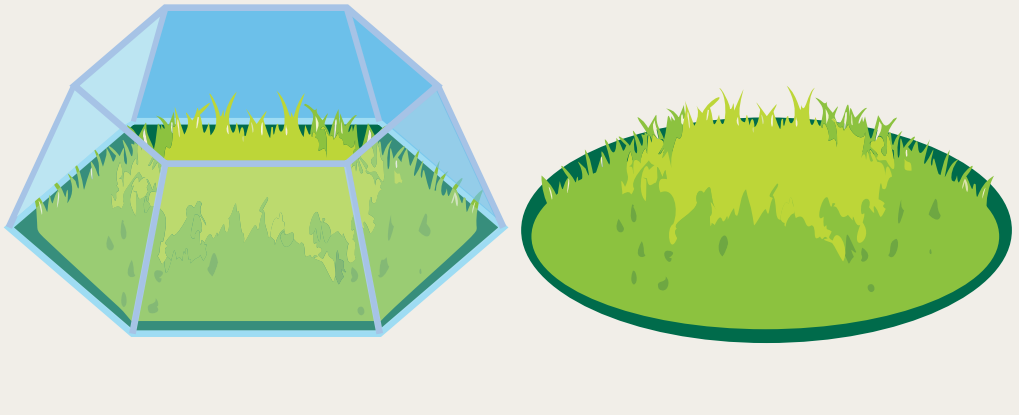
+ thanks to the broader PFTC6 participants

THE INCLINE PROJECT





The team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Kari Klanderud

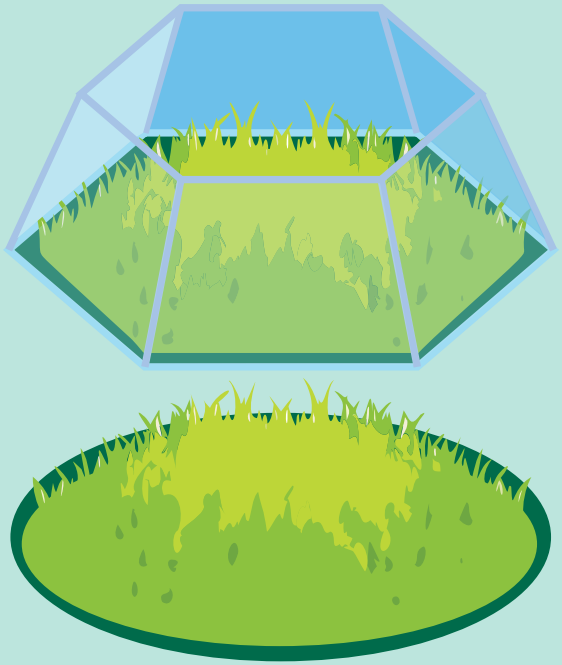

Mikel Moriana Armendariz

Other Project Components:

- Transplant of lowland species into alpine communities
- Plant community composition
- Population dynamics of focal species
- Ecosystem carbon fluxes and biomass remo
- Germination, seedbank and flowering dynan
- *Proposed*: Thermal tolerance under OTC's


ANY QUESTIONS?

RESULTS SUMMARY



We found experimental warming consistently increased plant height

In contrast, the strength and direction of responses for leaf economic traits were variable across species and sites

The strongest responses to warming were at the intermediate site, with taller plants also shifted towards more resource conservative traits

Stronger, though less consistent, responses to warming were observed in forbs compared to graminoids