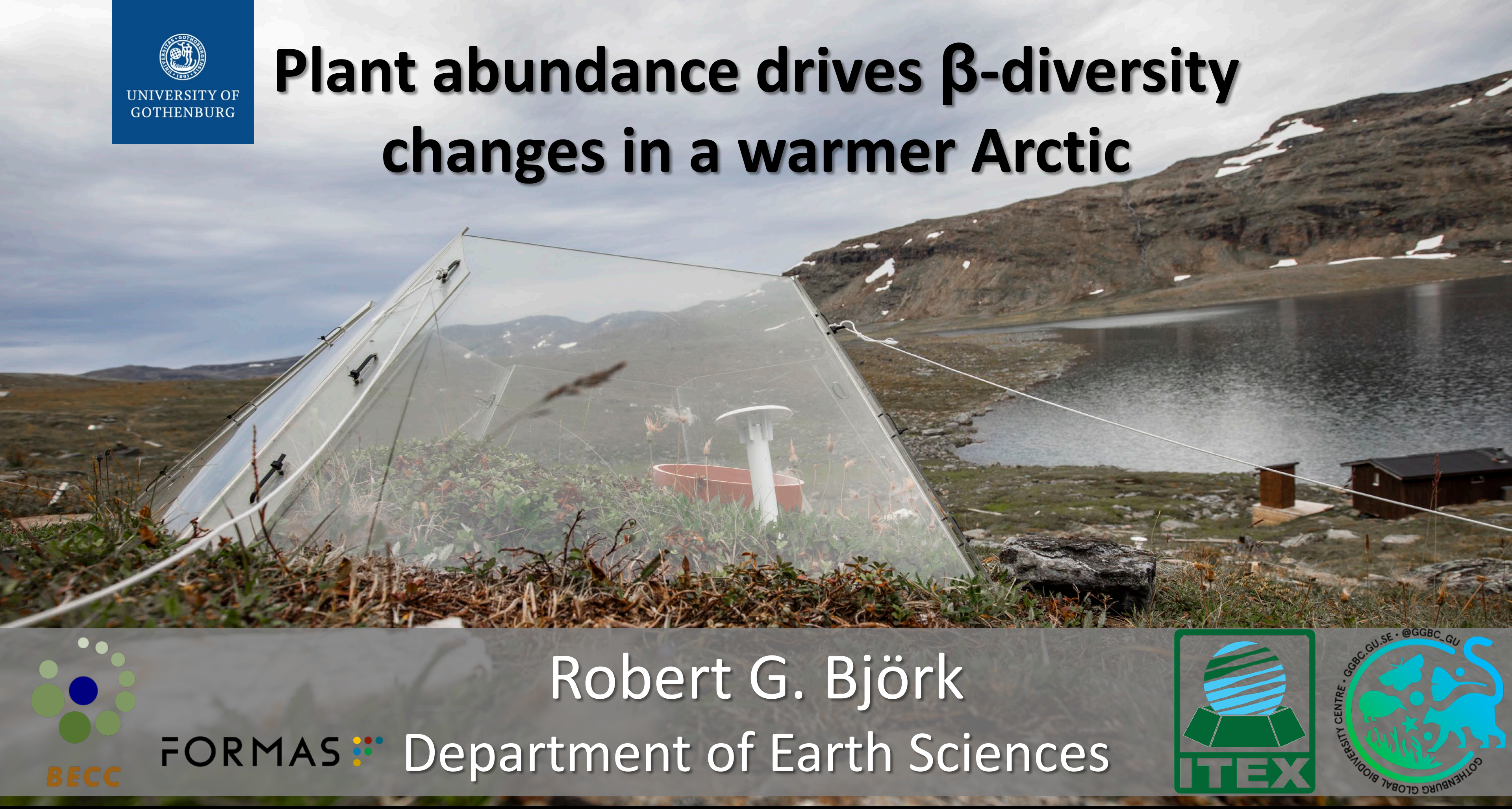
UNIVERSITY OF GOTHENBURG

Plant abundance drives β-diversity changes in a warmer Arctic



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BECC FORMAS ITEX

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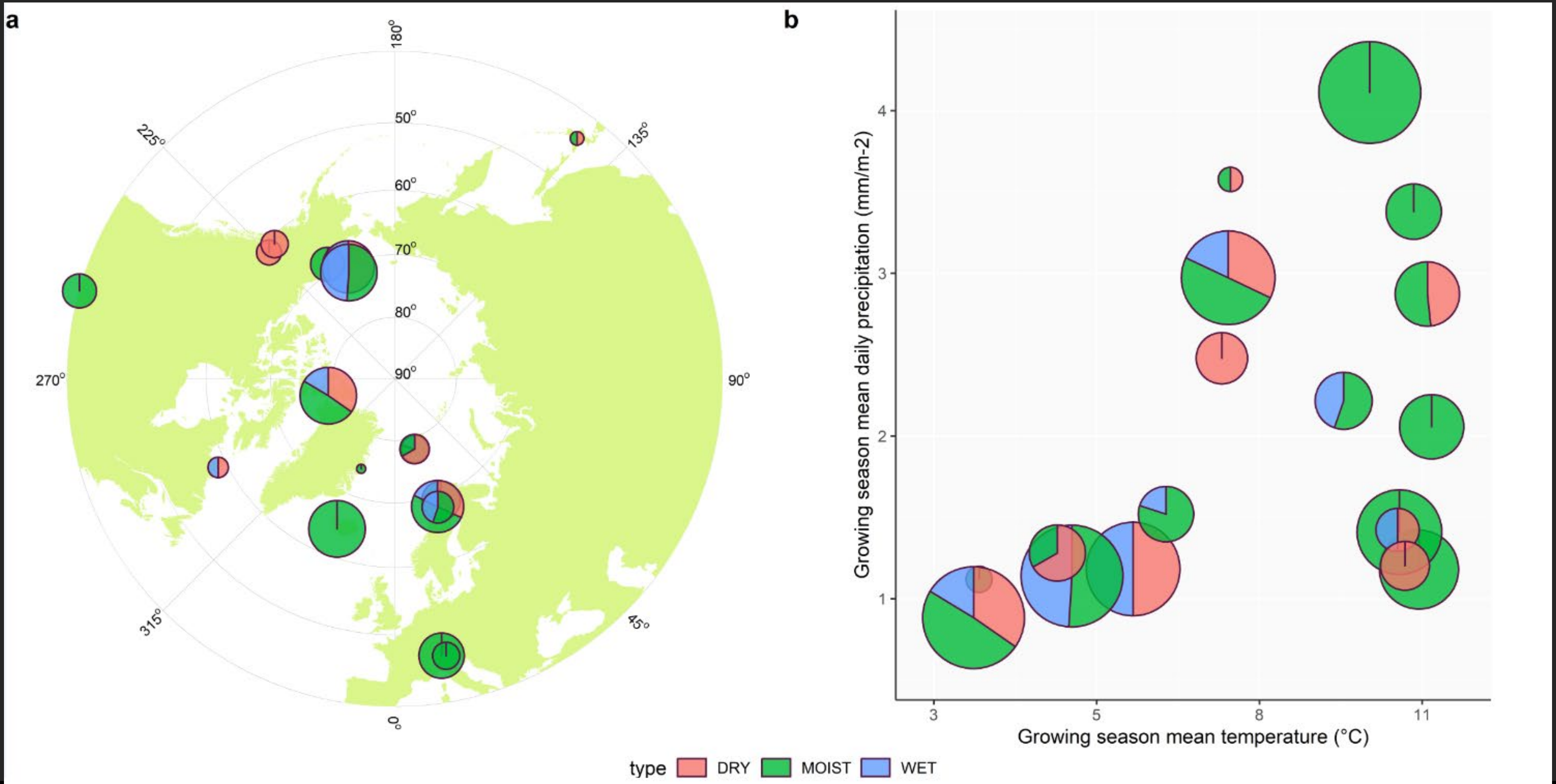
Photo: Jonas Stenström

The dataset includes 47 in-situ warmed plant communities within 18 sites



Objectives

to investigate:

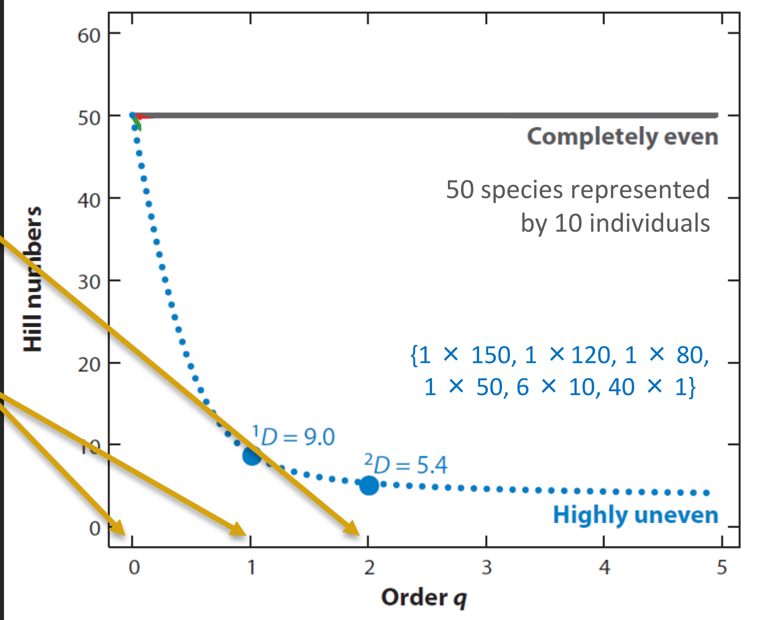
1) the sensitivity of the responsiveness of tundra plant diversity is to experimental warming over the full Arctic growing season temperature gradient **(1.64℃-12.2℃)**, experimental duration **(3-25 years)**, and inherent soil moisture status **(dry, moist and wet)**; and

2) what aspects of arctic plant diversity (taxonomic identity, abundance, functional and phylogenetic relations) are most affected by warming in

3) α-diversity as well as β-diversity.

Hill numbers (Hill, 1973)

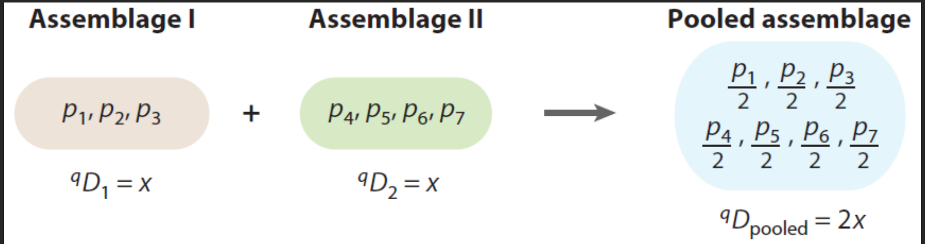
Hill (1973) integrated *species richness* and the converted *Shannon D (exp D)* and *Simpson H (1/(1-H))* measures into the class of diversity measures (called Hill numbers) of order *q*.



For $q = 1$, $^1D = 9$ implies that the Shannon diversity of the assemblage is the same as that of an assemblage with 9 equally abundant species.

Hill numbers offer six distinct advantages over other diversity indexes

1. Hill numbers of a given order *q* obey an intuitive replication principle or doubling property implicit in biologists' concept of diversity:



Thus, changes in their magnitude have simple interpretations, and the ratio of alpha diversity to gamma diversity accurately reflects the compositional similarity of the assemblages.

2. All Hill numbers are expressed in intuitive units of effective numbers of species. Therefore, they can be directly compared across orders *q* to extract information about dominance and other assemblage characteristics

Hill numbers offer six distinct advantages over other diversity indexes

3. Key diversity indexes proposed in the literature, including the widely used Shannon and the Simpson index, can be converted to Hill numbers by simple algebraic transformations.
4. They can be easily partitioned into independent within- and between-group components
5. In comparisons of multiple assemblages, there is a direct link between Hill numbers and species compositional similarity (or differentiation) among assemblages.
6. Hill numbers and their partitioning can be generalized to taxonomic, phylogenetic, and functional diversities, so they provide a unified framework for measuring biodiversity.

The ITEX phylogeny

- Taxon sampling is based on species occurrence in 22 ITEX sites during 2016.
- In total 360 unique samples were collected.
- In total 86 chloroplast genes were identified.
- The phylogenetic attribute value we use is evolutionary time in MYrs

Functional diversity

- Instead of species, we are measuring the effective sum of functional distances between two species.
- For example, a species-pair with distance of 5 units is counted as 5 “species” (i.e., 5 functional entities).
- The weight for each entity is determined by the relative abundances of the two species involved.
- Traits used for calculating the functional distances: LDMC, SLA, Leaf N, Leaf P, Plant height, and Seed mass

Diversity metrics to remember

Taxonomic diversity = effective number of species
Functional diversity = effective sum of species pairwise distances
Phylogenetic diversity = effective total branch-length

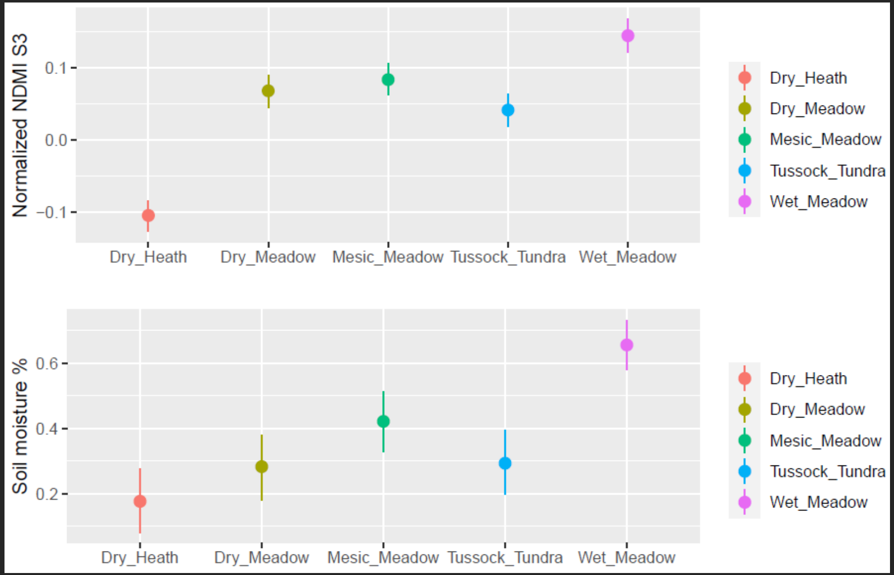
q0 = Species richness
q1 = Shannon's D (-like)
q2 = Simpsons H (-like)

α-diversity = Standing diversity, changes of the slopes (within site over time) over temperature within each moisture category, e.g., subsite level response over temperature

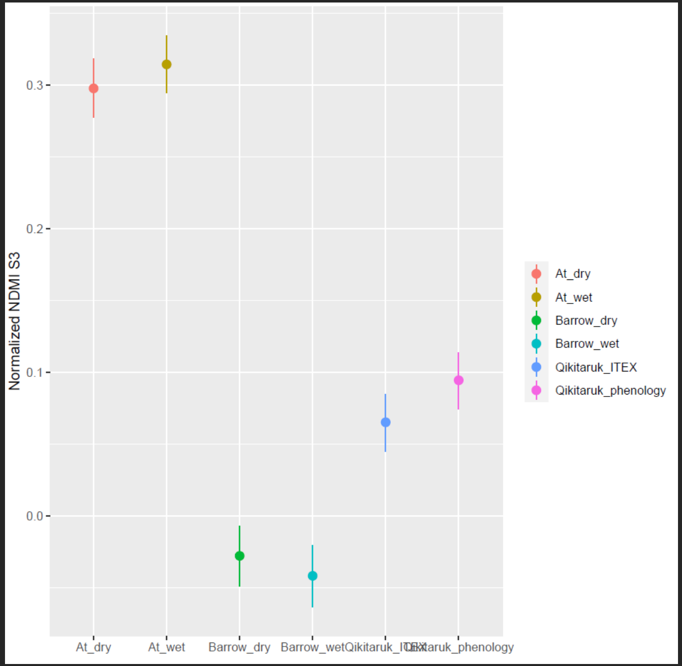
β-diversity = Dissimilarity (+ more dissimilar; - more similar) changes of the slopes (difference between OTC-Control over time) over temperature within each moisture category

Analysis that didn’t turn out as we hoped

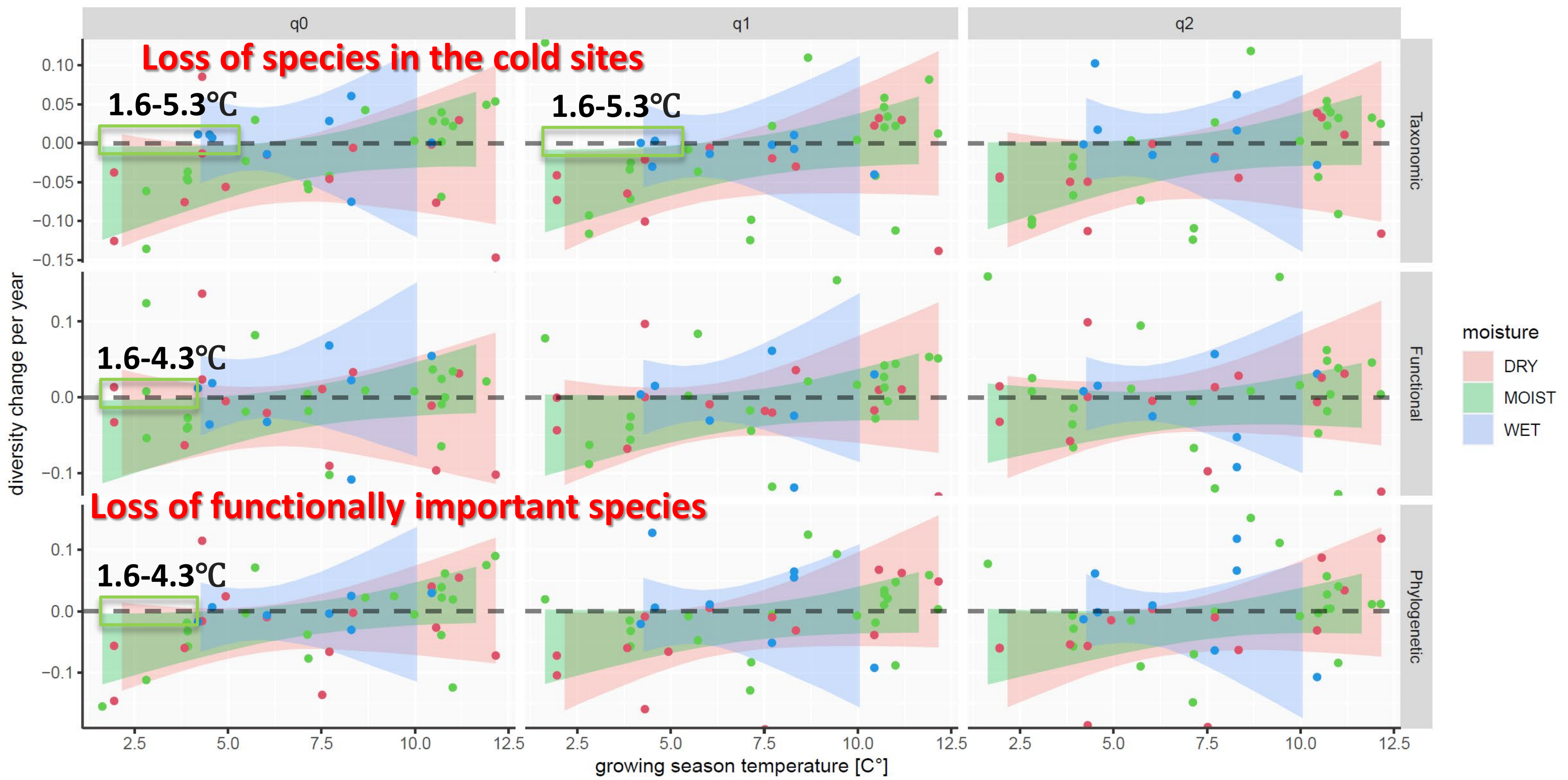
Using satellite wetness indices to quantify community soil moisture



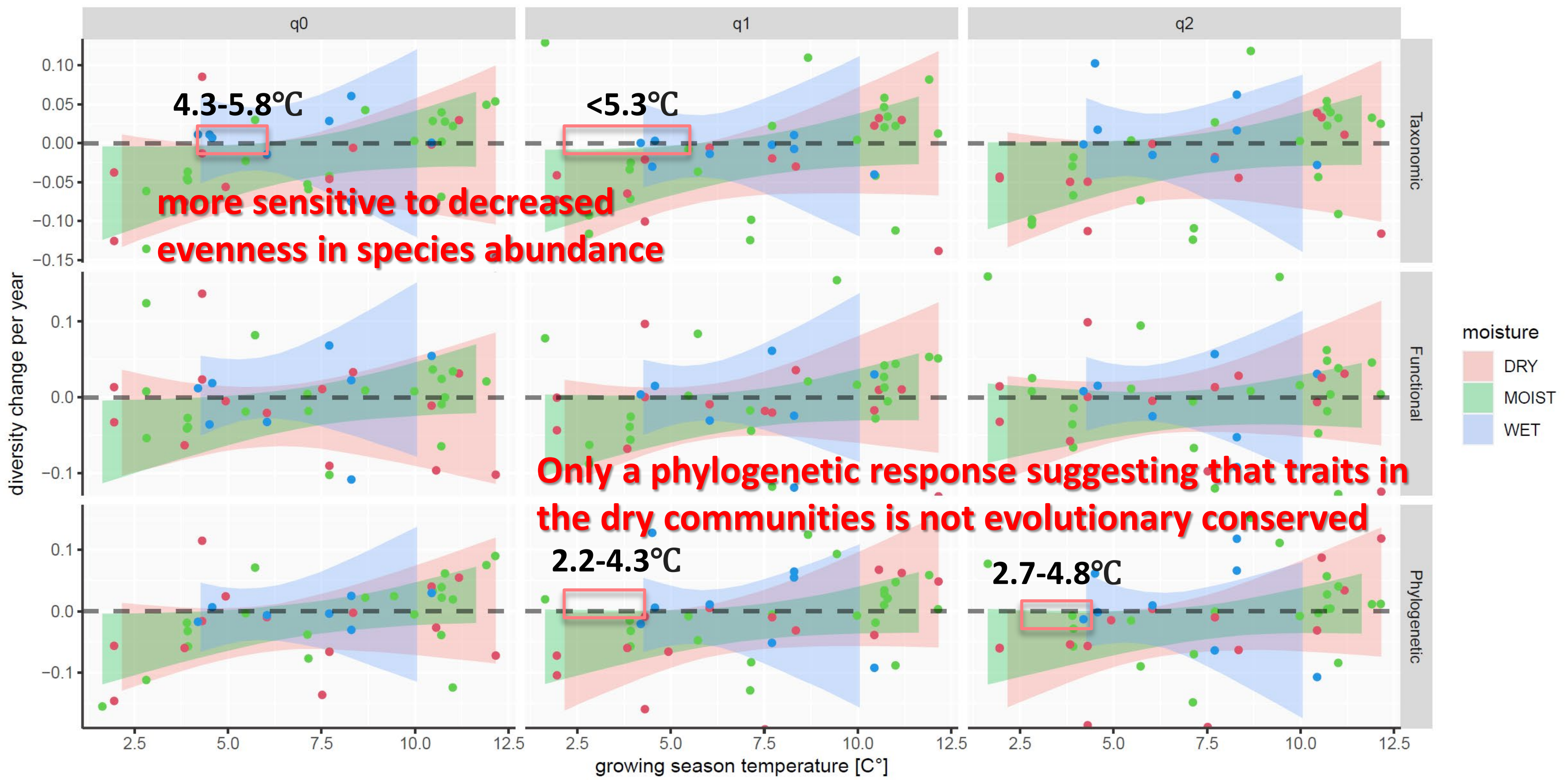
… but expanding it seems to be mainly driven by site, rather than moisture categorization



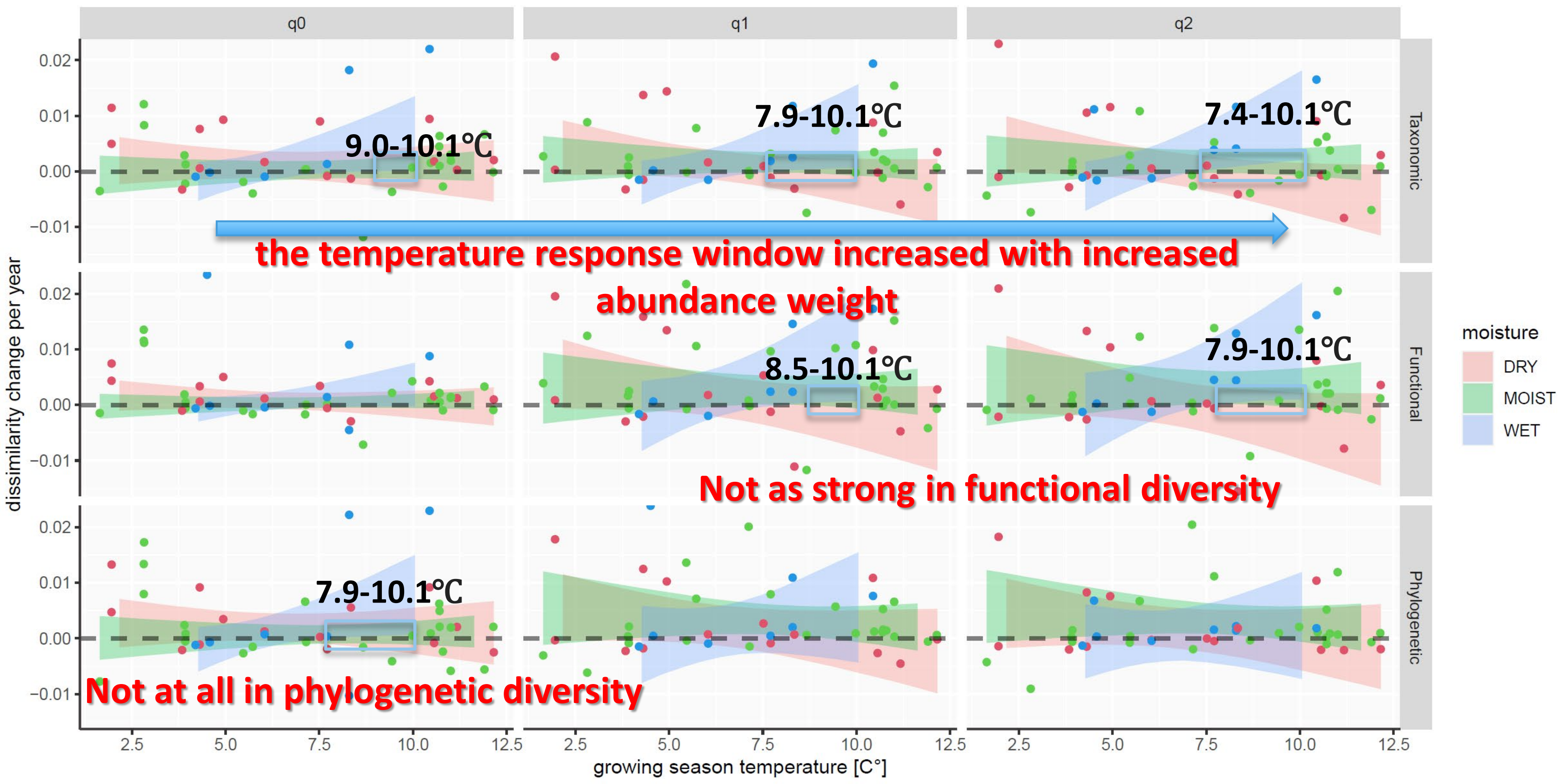
α-diversity response in moist communities



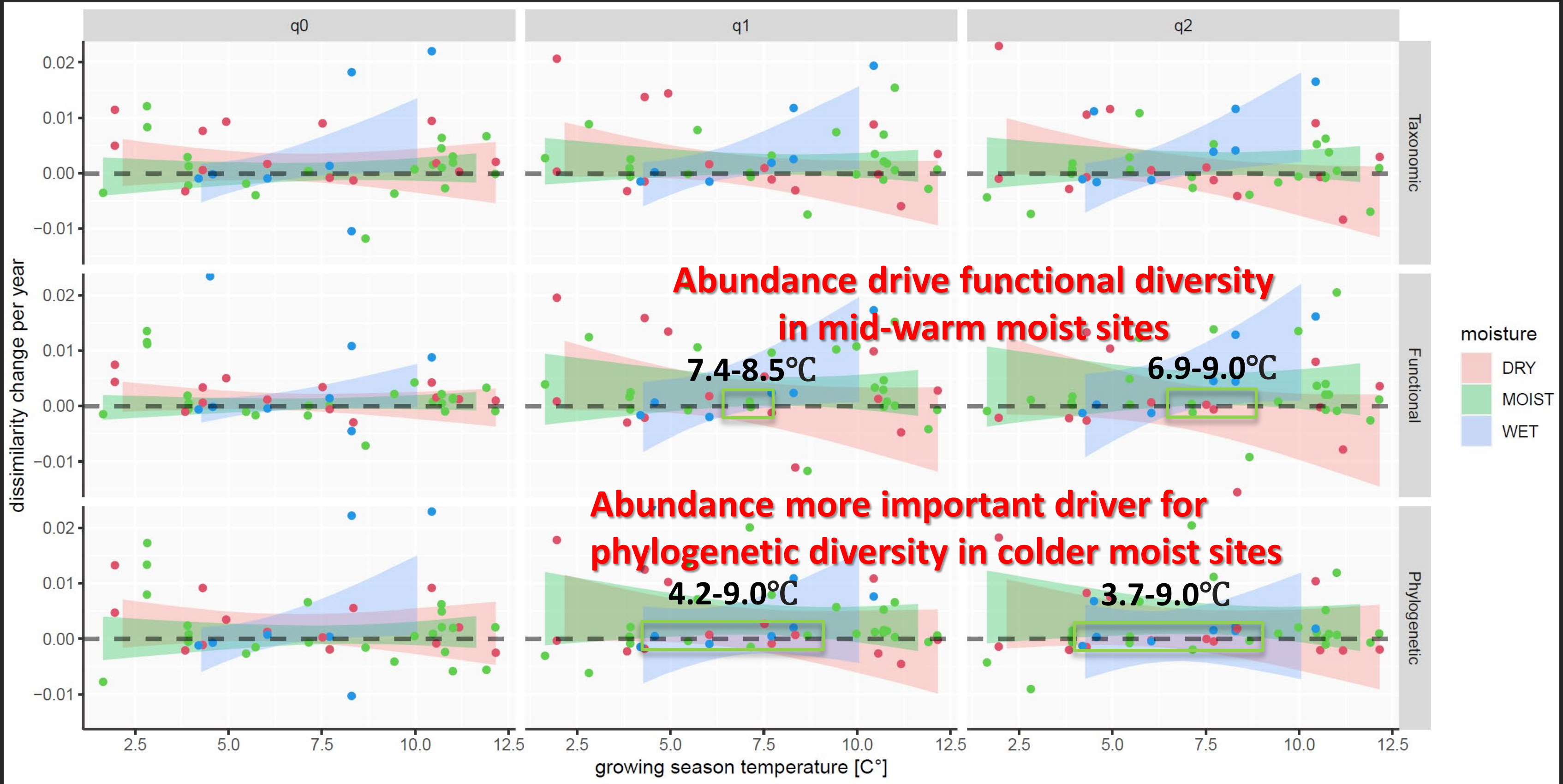
α-diversity responses in dry communities



Higher sensitivity to warming in β-diversity for the warmest wet communities



Weaker sensitivity to warming in β-diversity for the moist communities



Take-home messages

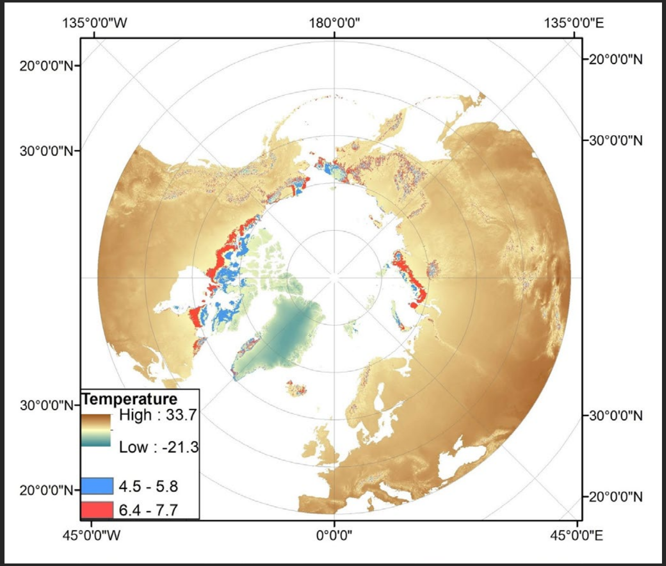
- Contrasting responses in dry and wet communities across the Arctic…
  - …with warming making the warmest wet communities more dissimilar to ambient communities, and the temperature window increases and moves towards mid-warm sites with more abundance weight. This fits with shrubification, species + functional response but the lack of responses in phylogenetic diversity, may results from the species being closely related to the ones they are replacing (e.g. small vs big *Salix*).
  - …with warming decreasing α-diversity in coldest dry communities. the alpha pattern suggests that the cold communities stay the same, but plots become less diverse. Thus, species are disappearing from plots but not necessarily from the community.

Take-home messages, cont

- Moist sites lost functionally important species in the cold sites and became more dissimilar in mid-warm sites as a result of warming.
  - The between functional and phylogenetic responses match which is interesting. A pure species response, so species that are changing are not closely related. Could this reflect turnover among existing communities like we observed at Latnjajaure? Or is it just reflecting that we have more data in that range as well increasing confidence.
- Species richness is the main driver of the patterns observed in the α-diversity, besides for phylogenetic diversity
- In general, β-diversity responses occur at higher temperatures and are not seen in the α-diversity, which suggests that diversity levels remain the same at warm sites, but there is a degree of species/functional/phylogenetic turnover (with the opposite occurring α-diversity).

Coming up

- Manuscript almost there…
- Scaling of potential areas that show high sensitivity of biodiversity change to warming




Thank you for your attention!