Initial results from BioSCape leaf-level spectral libraries

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Dimensions of Biodiversity

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Using field data to gain insights for future trait modeling

Question 1: How well do spectra collected in the Cape Floristic Region predict traits from existing models?

Question 2: How do spectra vary with plant traits and environment?

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Links to the broader questions

Question 1: How well do spectra collected in the Cape Floristic Region predict traits from existing models?

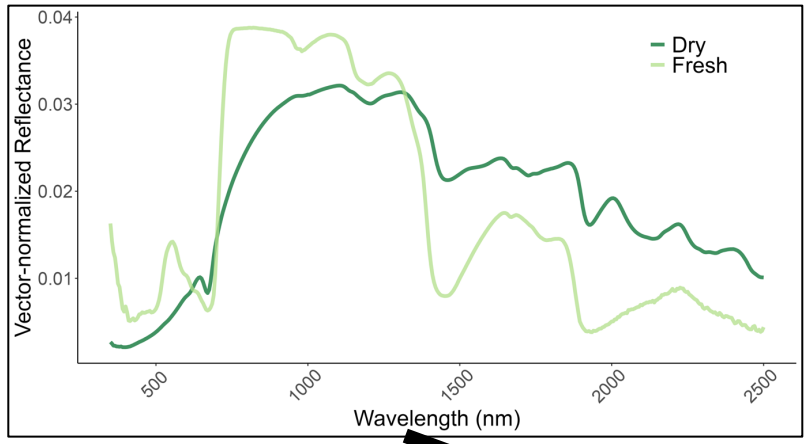
Questions of generality of algorithms within/among biomes

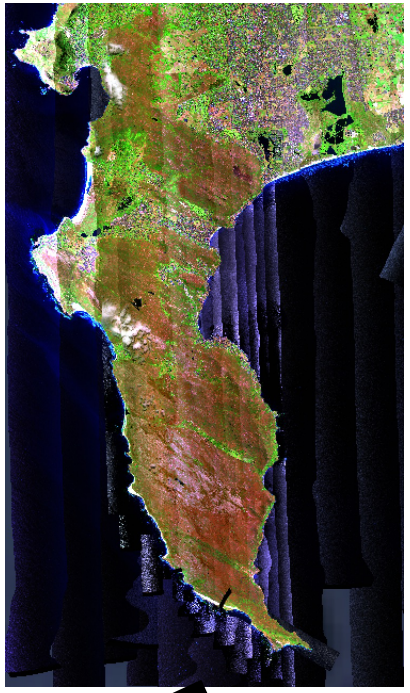
Question 2: How do spectra vary with plant traits and environment?

Understand patterns of foliar trait variation in the BioSCape

Why leaf-level spectral libraries

- It’s the foundation for we train models to predict traits in AVIRIS imagery
- It gives us insight on how spectra vary without the influence of canopy structure and substrate





Trait maps

Fresh and dry spectral libraries

- **Fresh spectral** library from BioSCape collected in 2023
  - **7885** measurements
  - **~600** spp. from **60+** plant families
  - Measured with Spectral Evolution PSR+ using leaf clip and custom contact probe

- **Dry spectral** library from Dimensions of Biodiversity (2010-2015)
  - **1915** measurements
  - **676** spp. from **72** plant families
  - Measured with ASD FieldSpec

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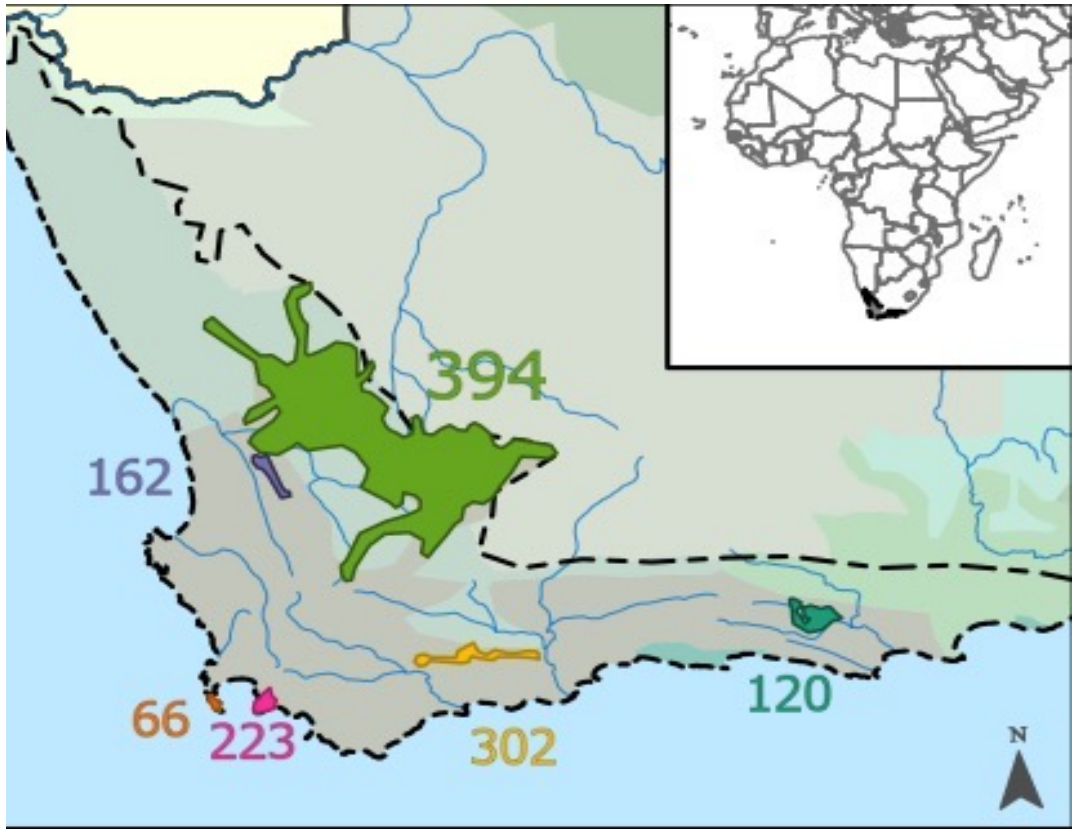
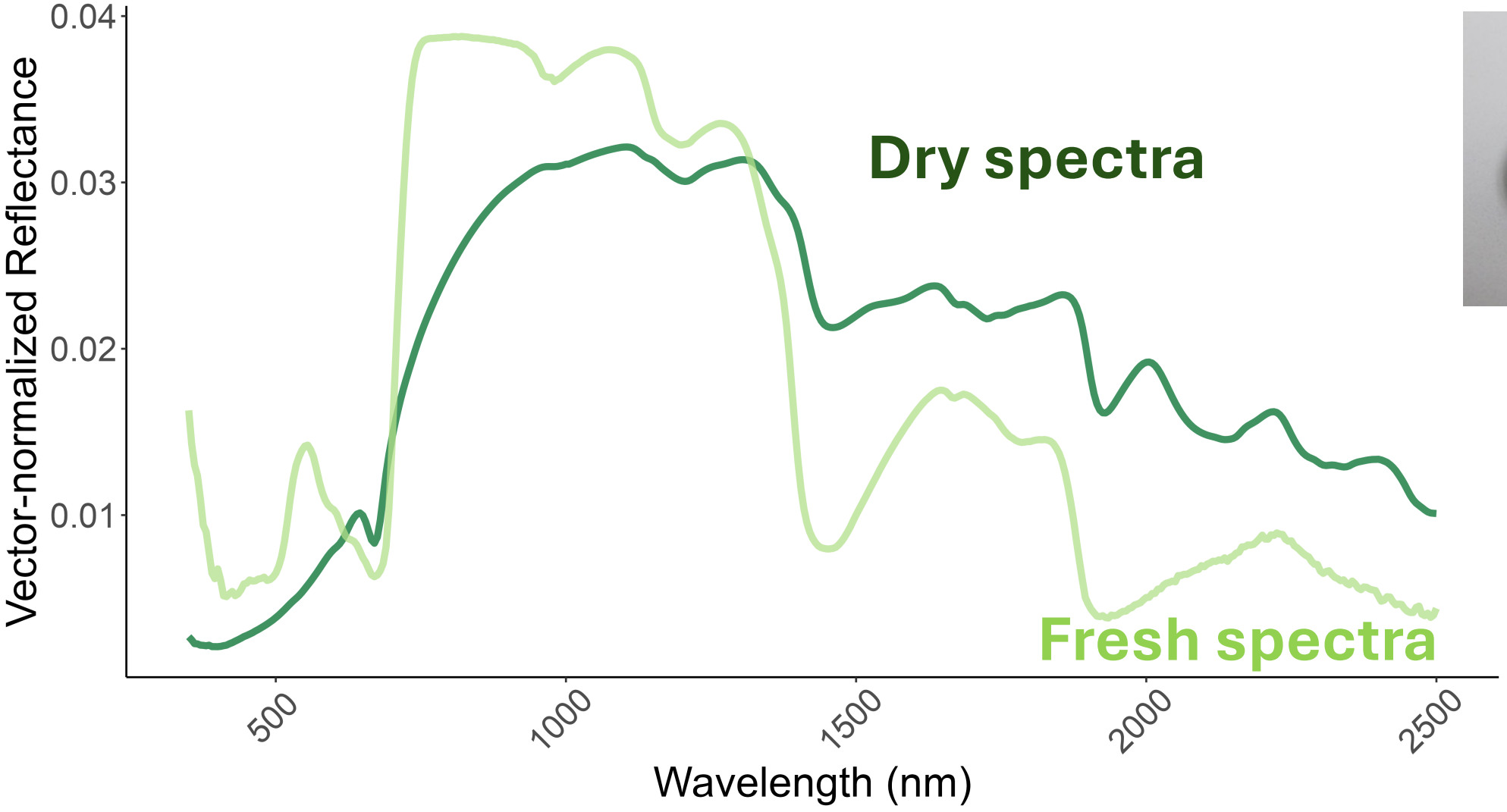


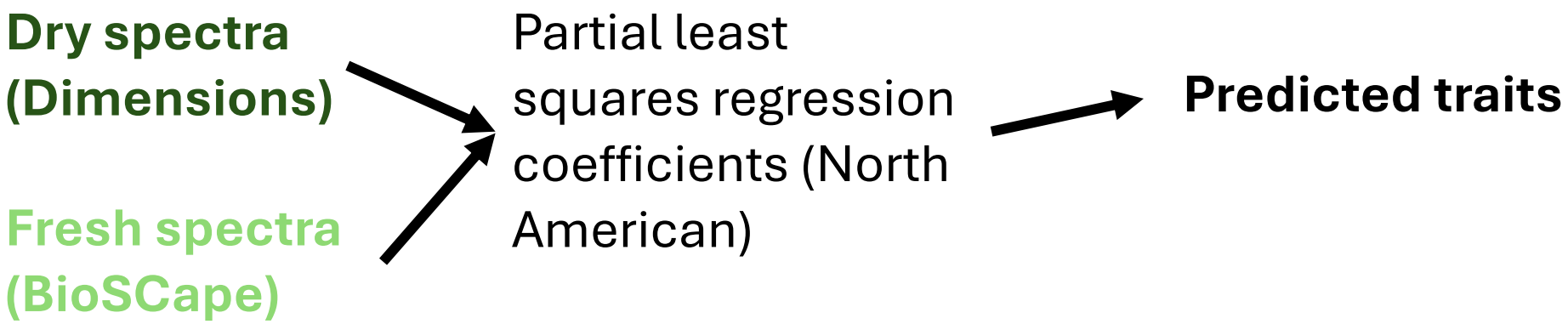
Dry vs. fresh spectra (*Protea repens*)



Using field data to gain insights for future trait modeling

Question 1: How well do spectra collected in the Cape Floristic Region predict traits from existing models?

Approach:



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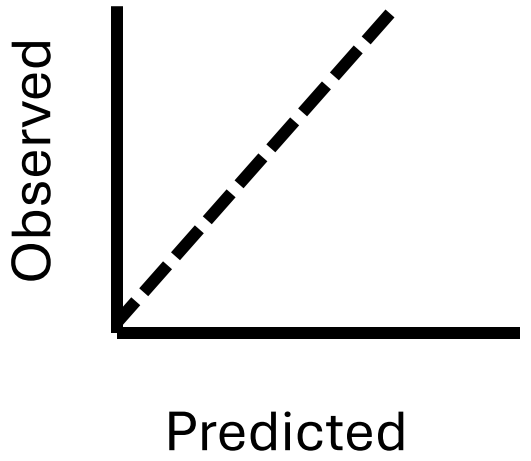
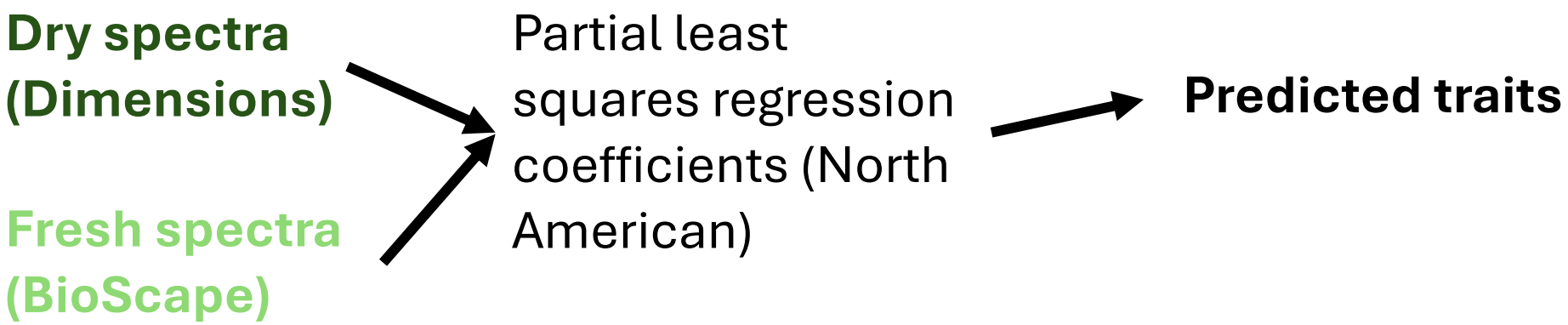


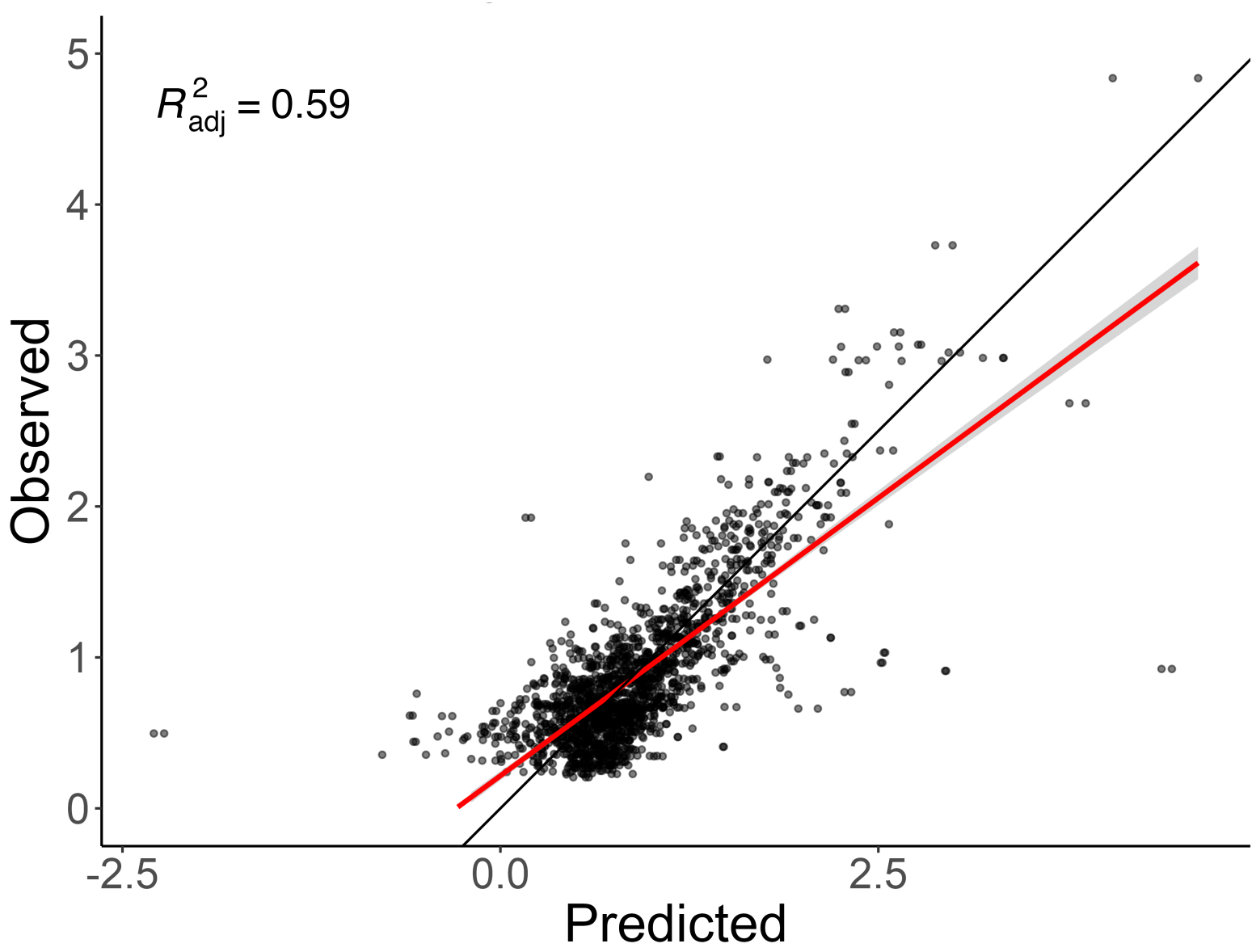
Approach:



Dry model results (Dimensions)

Leaf % Nitrogen

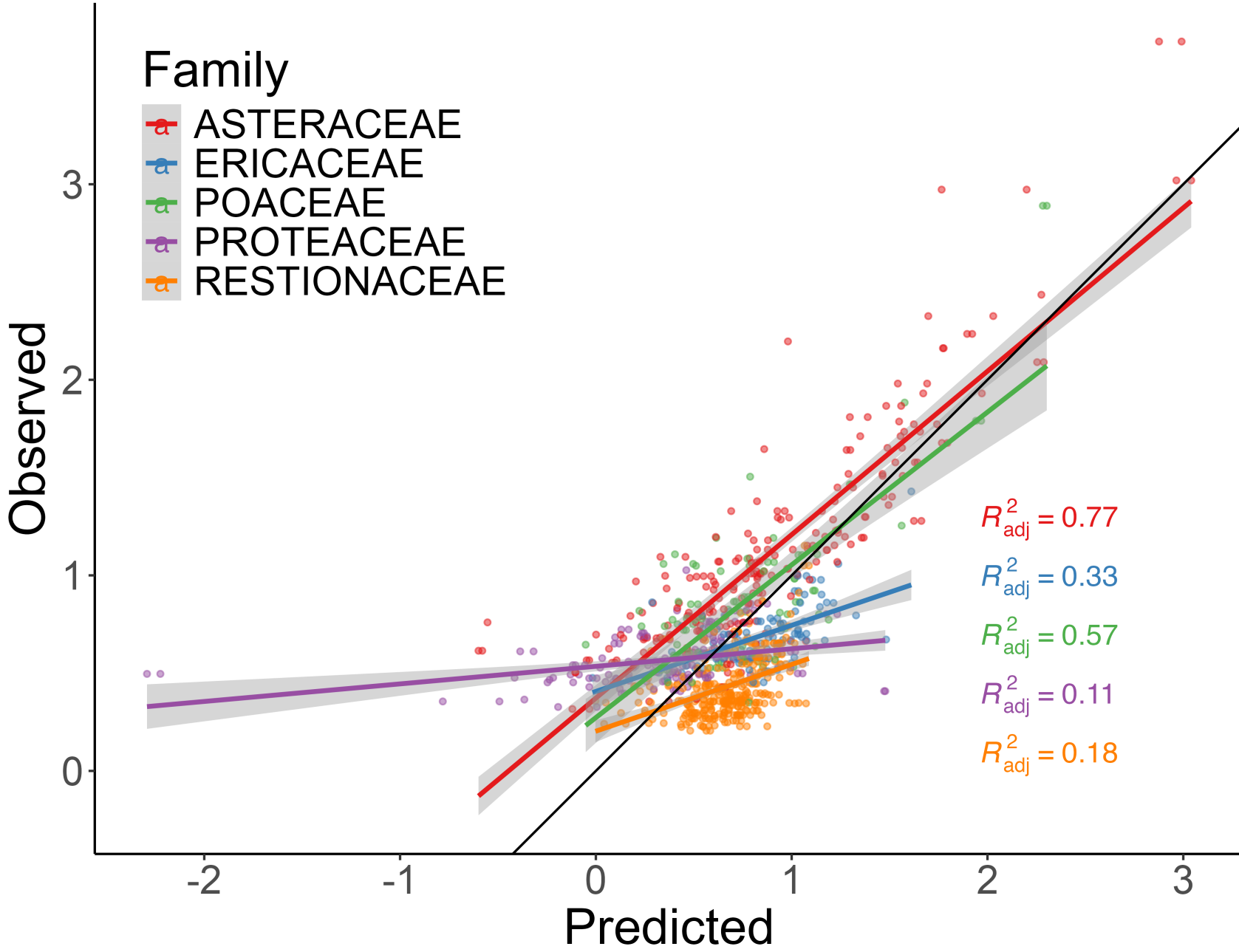
Model **<u>performs reasonably well</u>** compared for extrapolated data (similar studies tend to find R^2 values in the .8 to .9 range)



Dry model results (Dimensions)

Leaf % Nitrogen

When split by major families, **families that comprises major South African radiations perform much worse**.

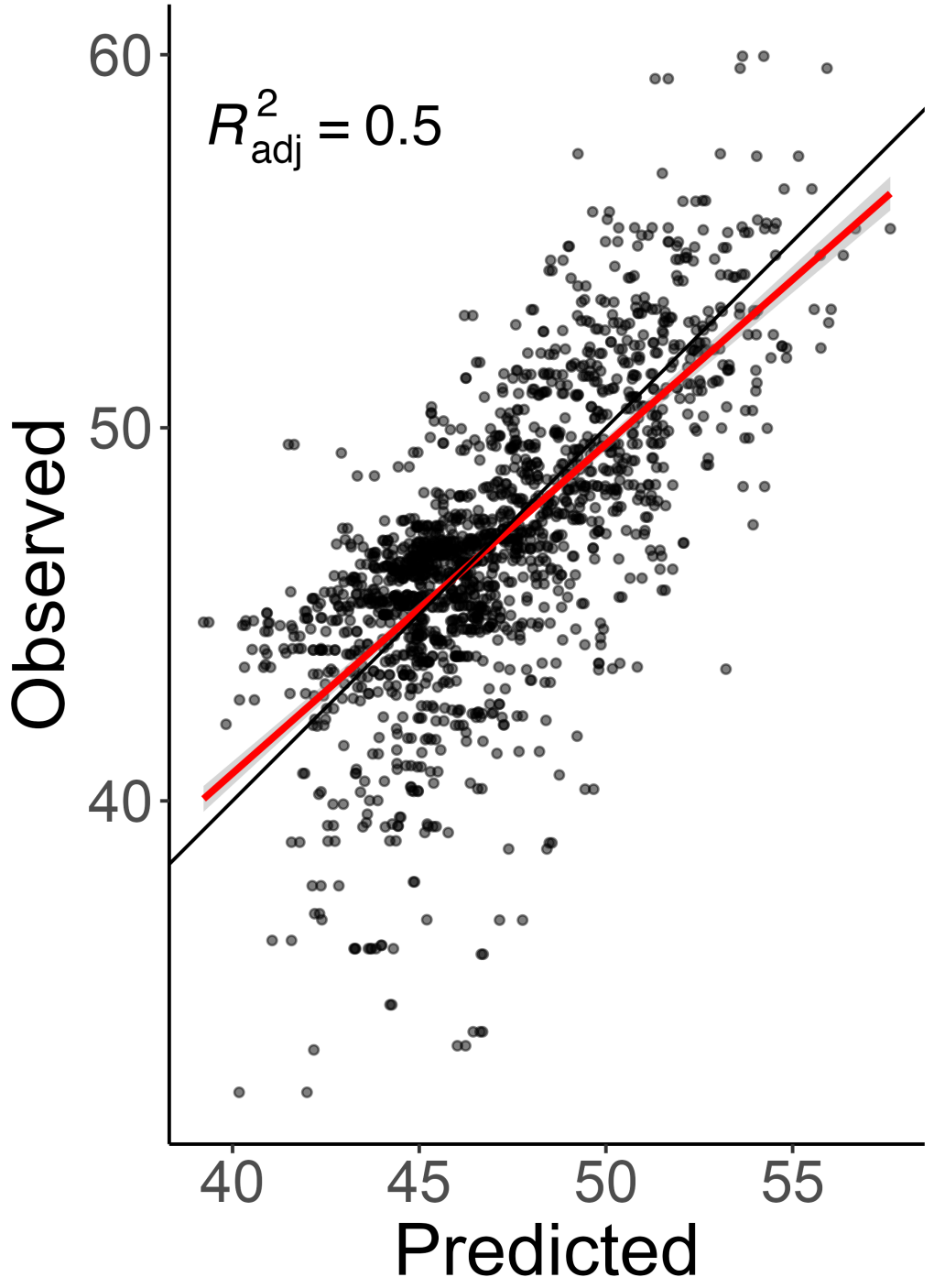


Dry model results (Dimensions)

Leaf % Carbon

Again, reasonable performance for extrapolated data.

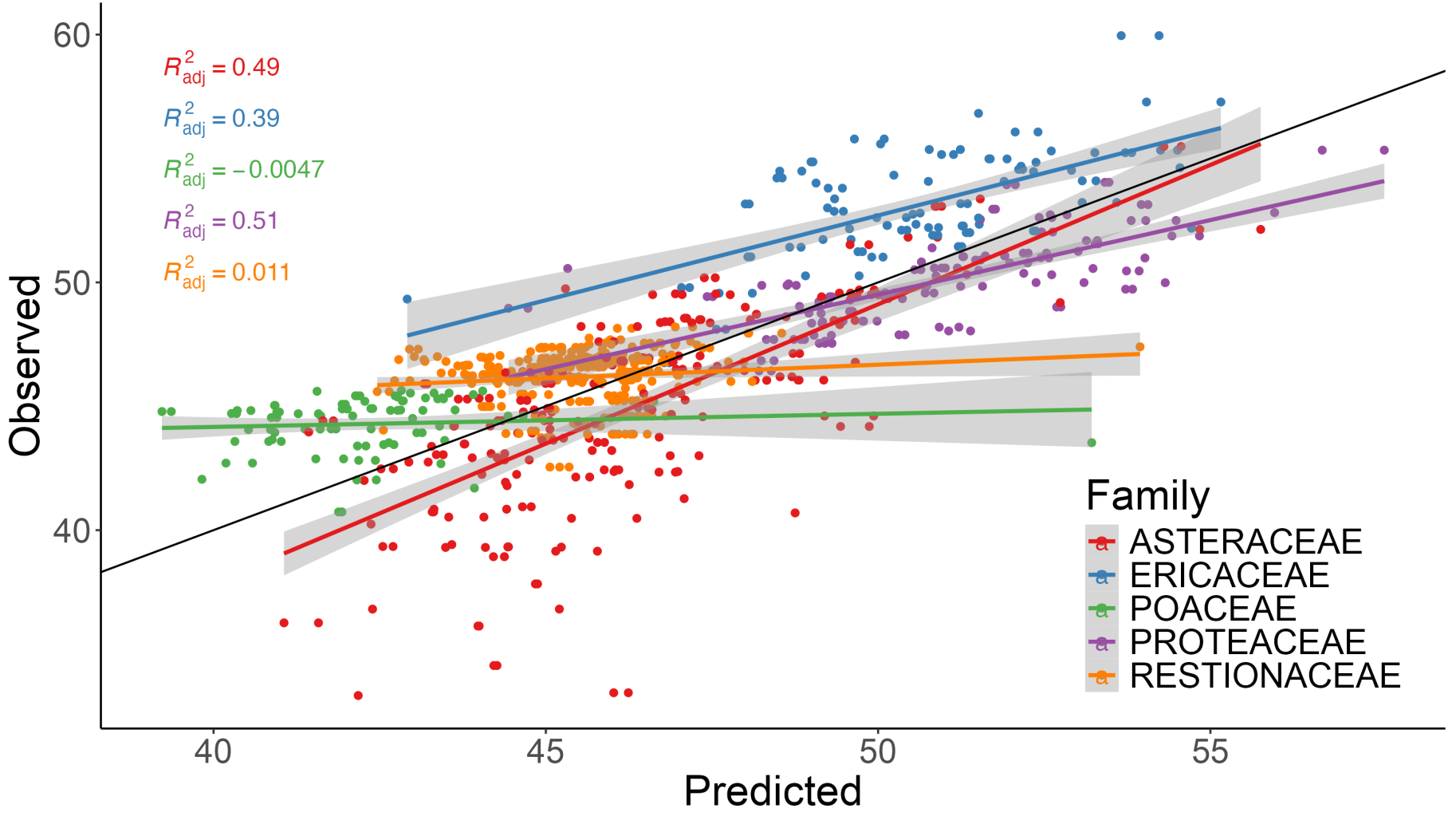
Similar studies tend to find R^2 values in the .7 to .8 range.



Dry model results (Dimensions)

Leaf % Carbon

Lowest performance associated with graminoid families (Restionaceae and Poaceae)

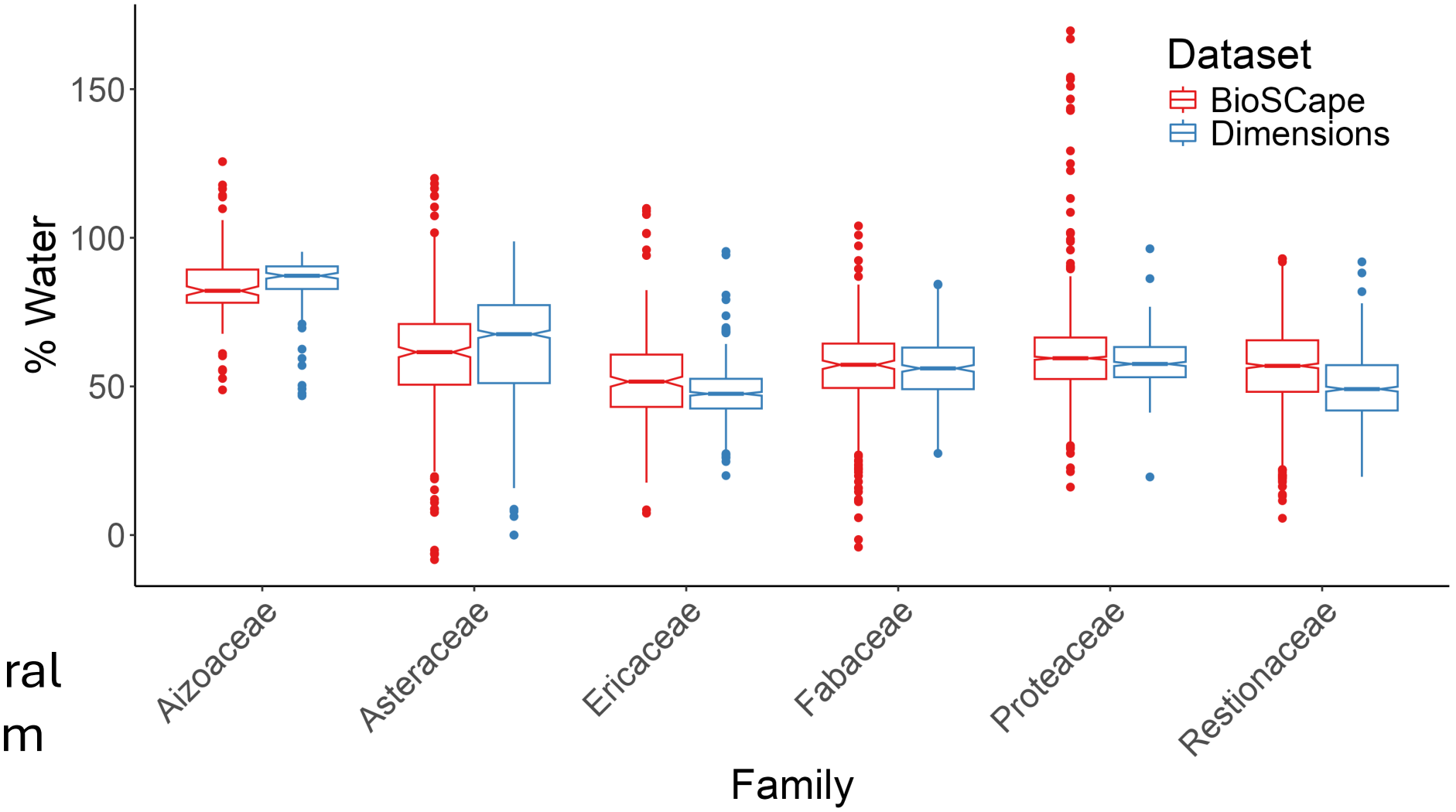


Fresh model results (BioSCape)

Leaf % water

Still processing trait data for BioSCape

Predicted BioSCape traits do match general trends measured from Dimensions



Leaf-level trait model takeaways

- **Takeaway 1:** Based on dry results, models are influenced by what families and growth forms they are predicting
  - Need to train models on endemic CFR lineages and certain growth forms, e.g. graminoids.

- **Takeaway 2:** Some traits like water content may be more generalizable than others

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Question 2: How do spectra vary with plant traits and environment?

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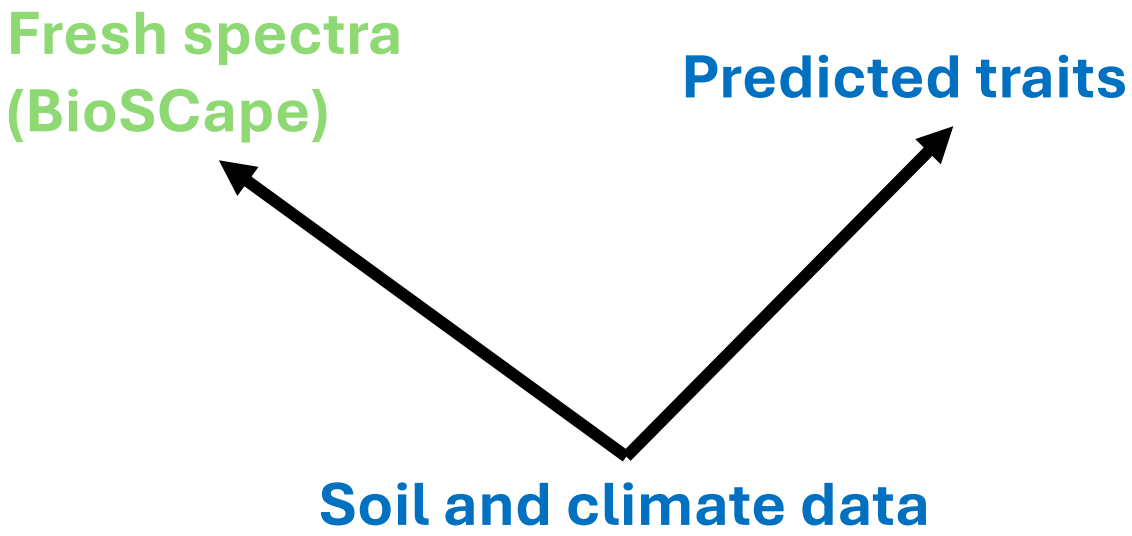
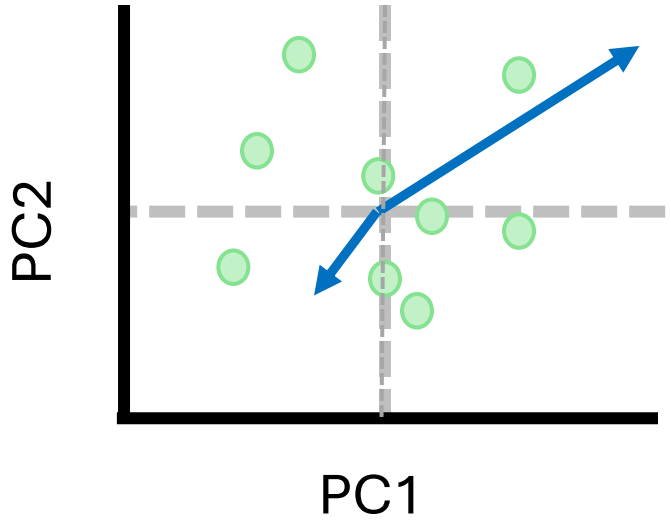
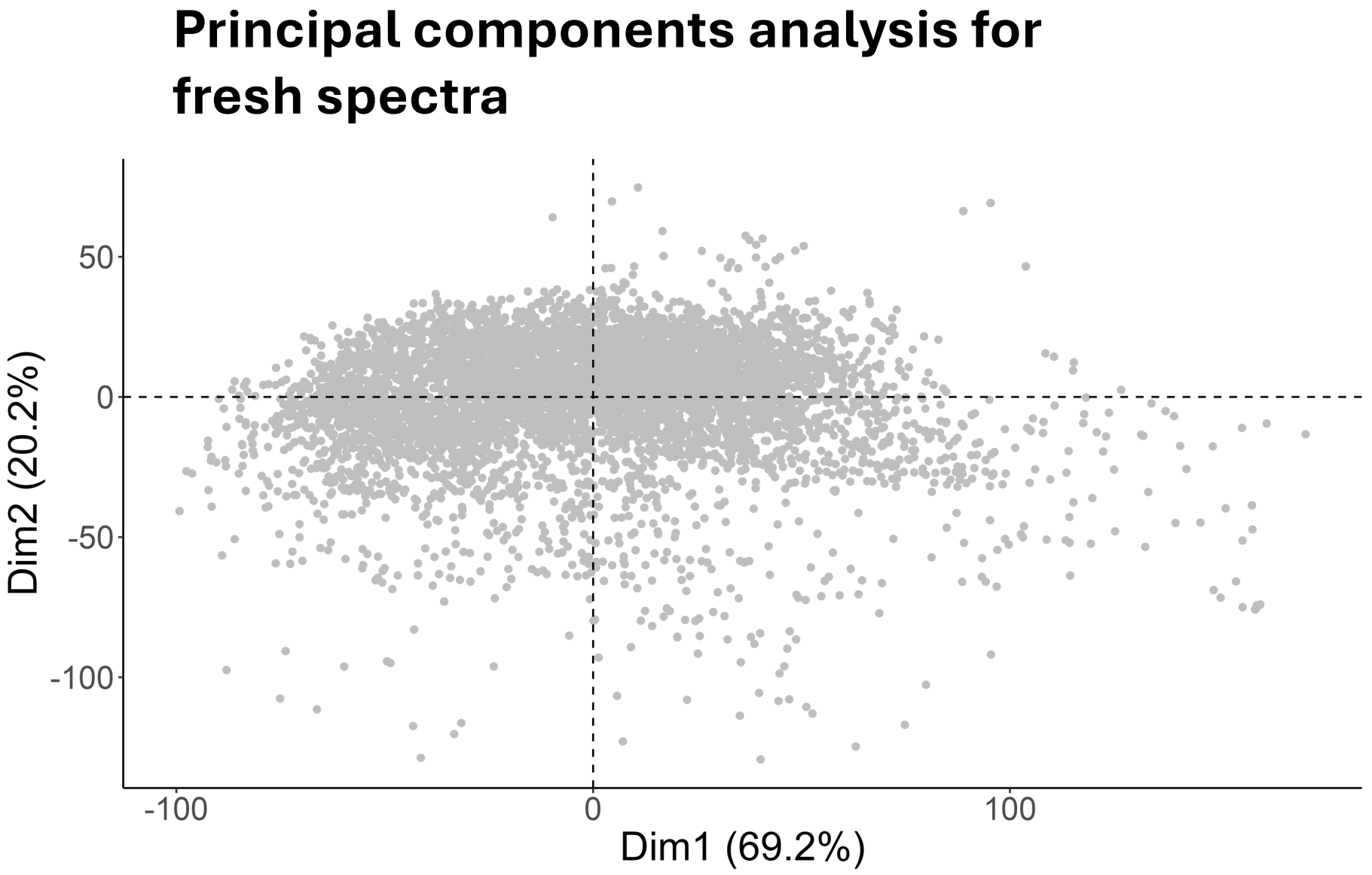


PCA of spectral library



Fresh model variation (BioSCape)

A large portion of spectral variation explained by two principal component axes

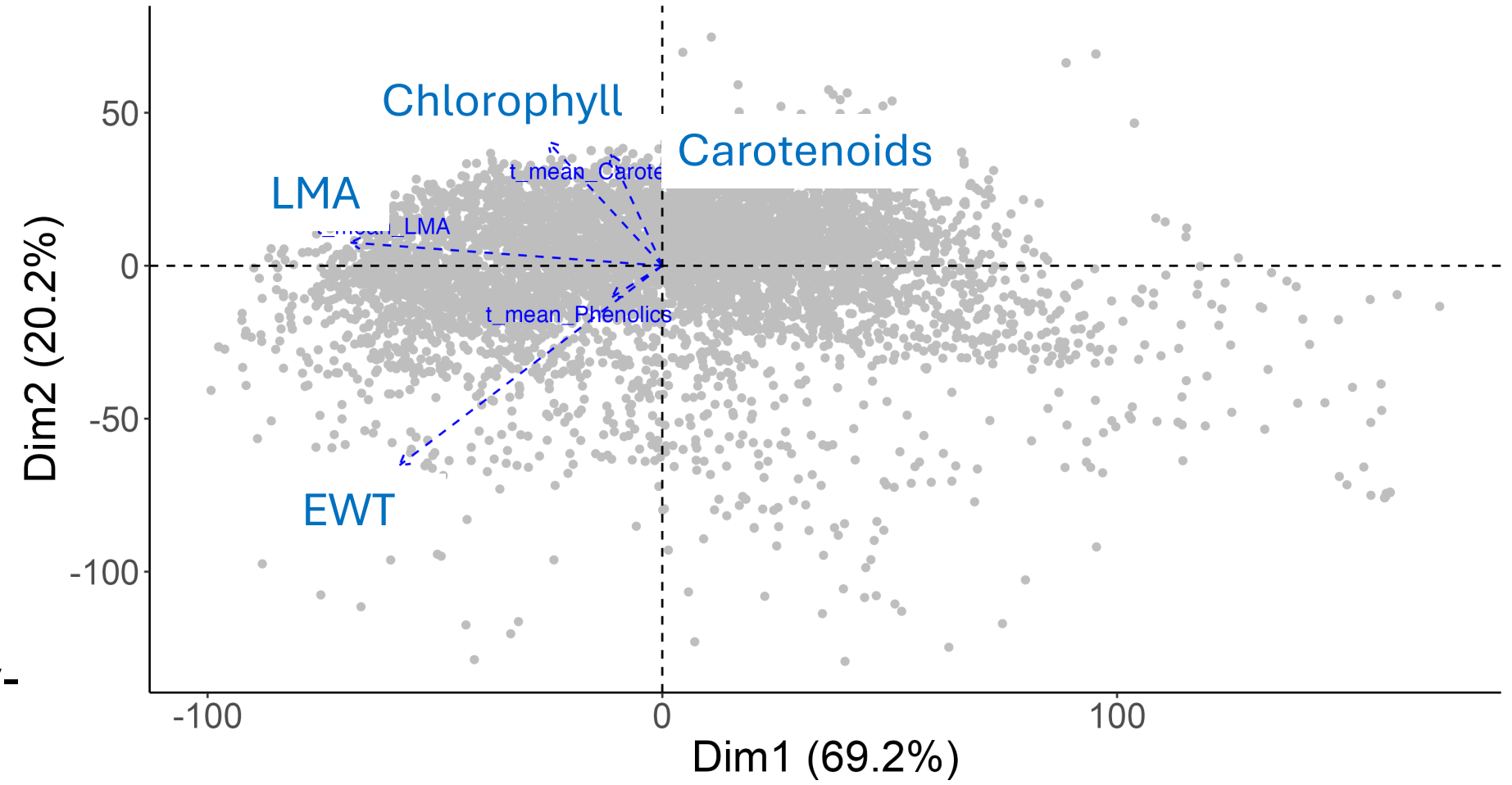


Fresh model variation (BioSCape)

The two large axes likely explained by:

Water conservation traits (x-axis)

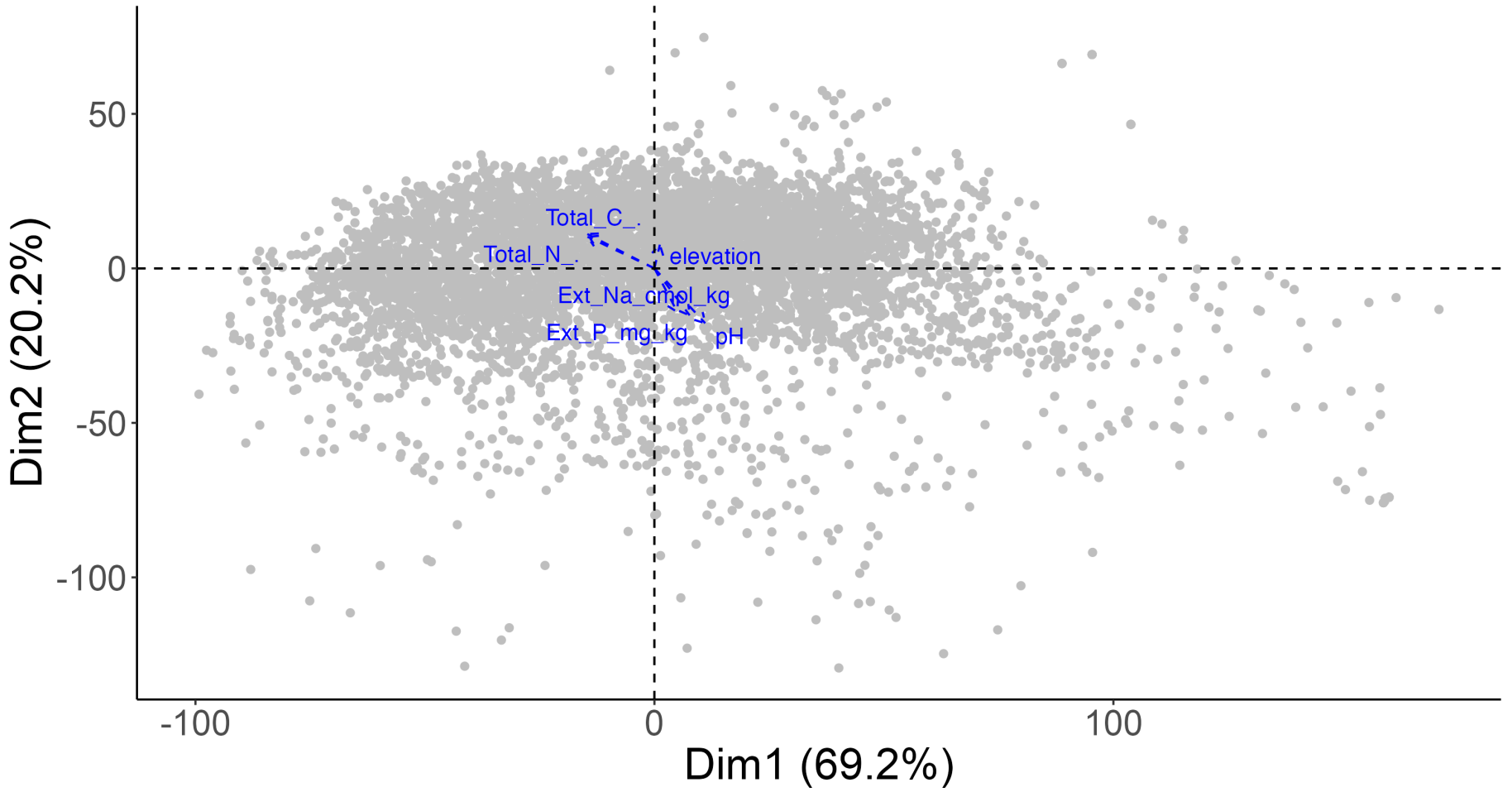
Nutrient availability (y-axis)



Fresh model variation (BioSCape)

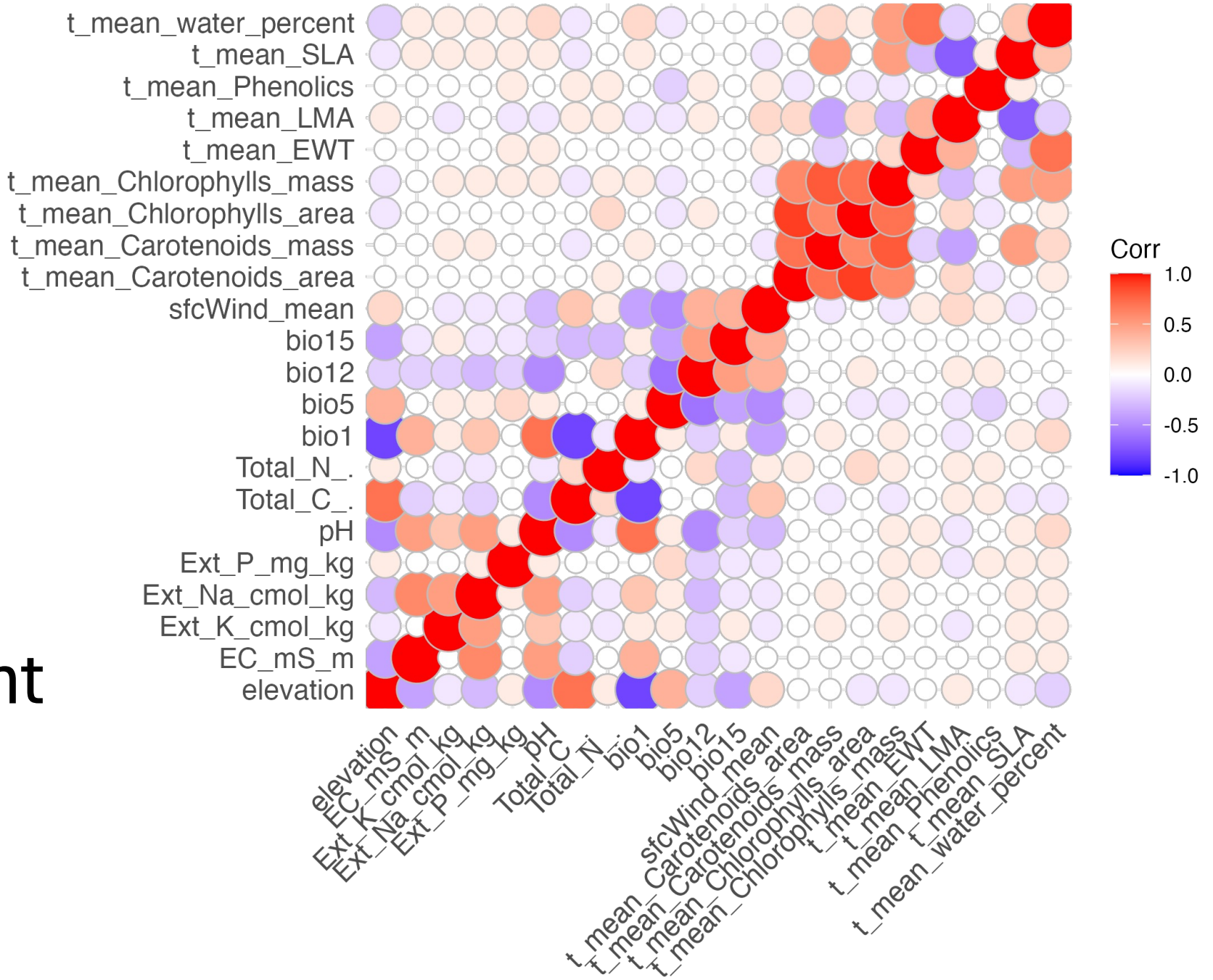
Soil data weakly associated with spectral variation in leaves

Not shown: Climate variables are even weaker



Soil data from Cramer et al., 2019 *Diversity and Distributions*

Weak correlations between spectrally predicted traits and environment

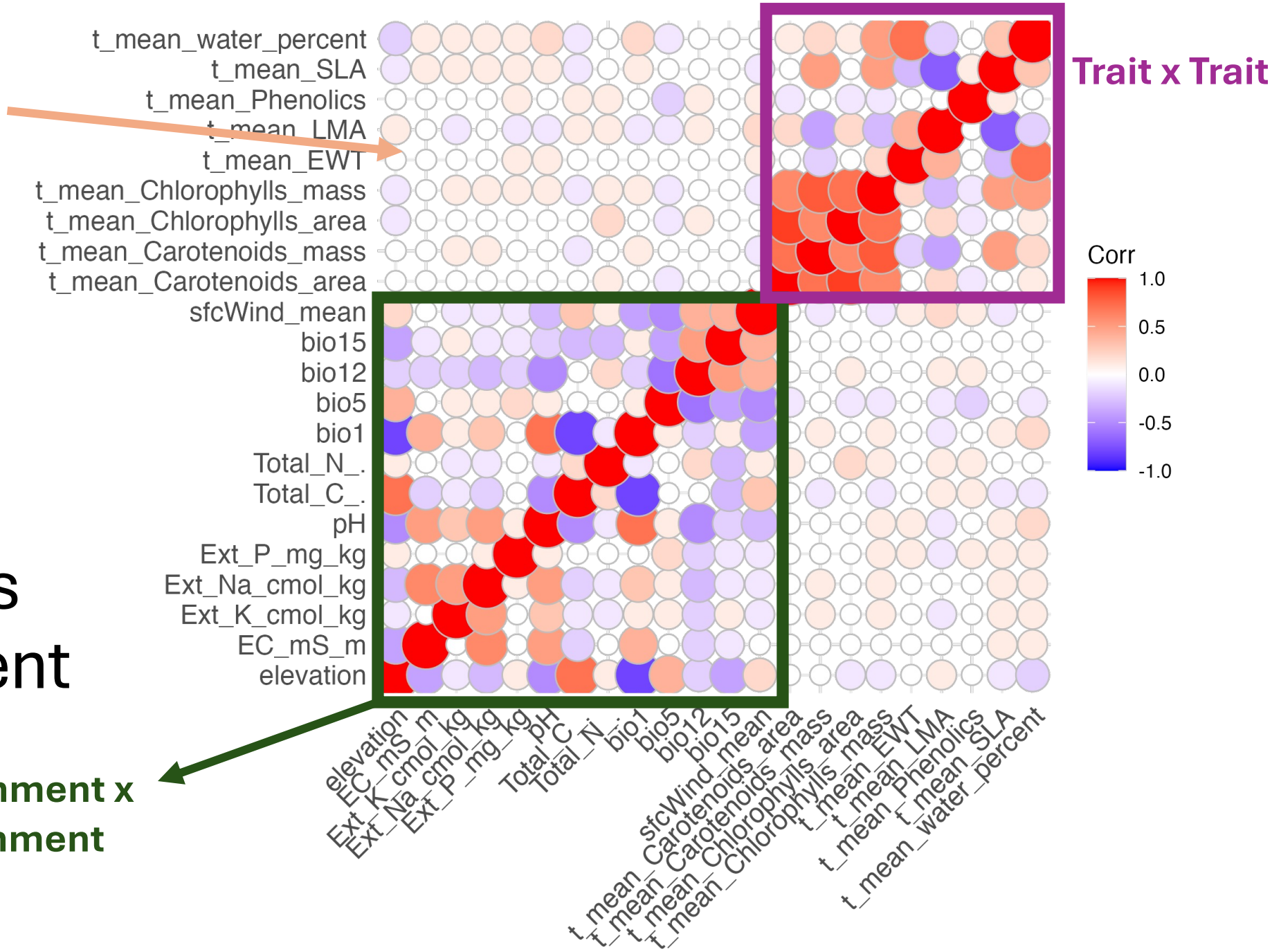


Trait x Environment

Trait x Trait

Environment x environment

Weak correlations between spectrally predicted traits and environment



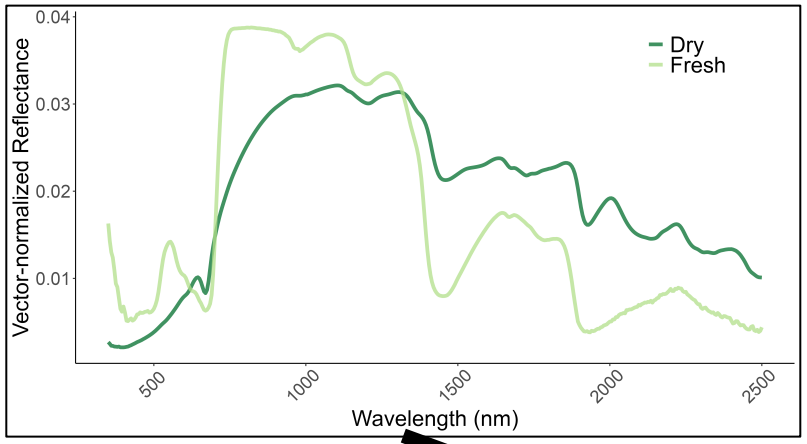
Fresh spectral variation takeaways

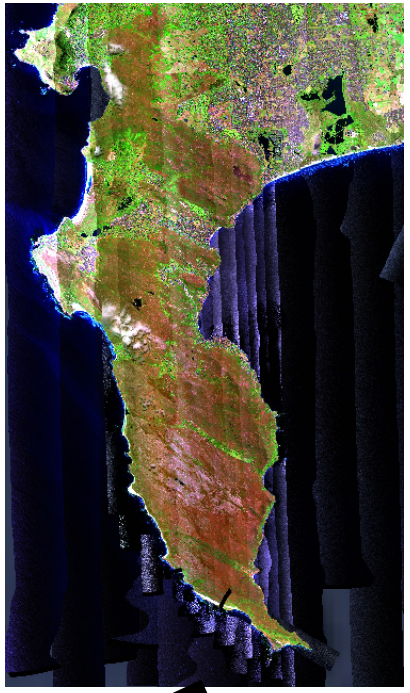
- **Takeaway 1:** A large portion of spectral variation is likely due to trade-offs in structural investments and nutrient availability.
  - Note that the lower axes of variation are still important

- **Takeaway 2:** Based on leaf level results, we can make some hypotheses for trends we may observes in trait maps:
  - Weak associations with predicted traits and environment. Variation in soil will likely be stronger than climatic variables

Next directions

- Measuring traits and dry spectroscopy for BioSCape
- Processing AVIRIS-NG imagery
- Trait map production





Trait maps


Questions?
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