

# Changes in functional trait diversity over space and time

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# Diversity and traits

- Traits interact with and respond to the environment
- Mechanistic hypotheses testing about geographic distribution of biodiversity should consider traits.
- Now technology can allow us to address this question across spatial scales

# Changes in trait diversity over space and time

- Continental level

- Swenson *et al.* 2012 GEB
- Stevens *et al.* 2006 Oikos

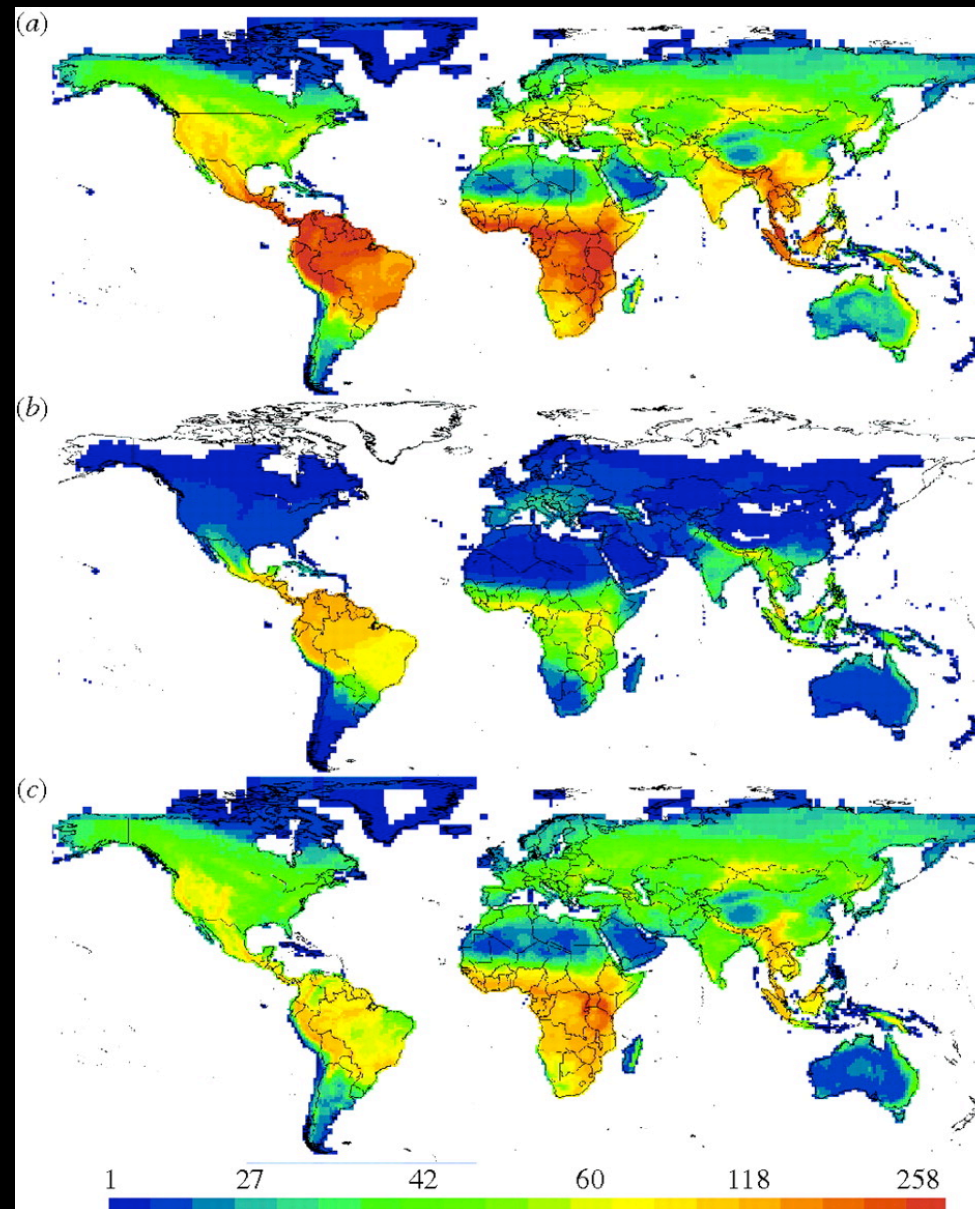
- Community level

- Swenson *et al.* 2012 Ecology
- Ding *et al.* 2011 Oikos

Species richness maps for (a) all the species, (b) bats only and (c) all species other than bats, showing how bats influence the overall latitudinal diversity gradient.

Can you just replace  
species with traits?

Can functional trait  
ecology teach us  
something NEW about  
latitudinal diversity  
gradients?



# Stevens *et. al* 2006

## Changes in phenetic diversity of bats with latitude and species richness

Methods- measured 7 morphological features in 32 bat communities in the new world. Decomposed into PCA and then measured “functional diversity” metrics then regressed these metrics with latitude and species richness.

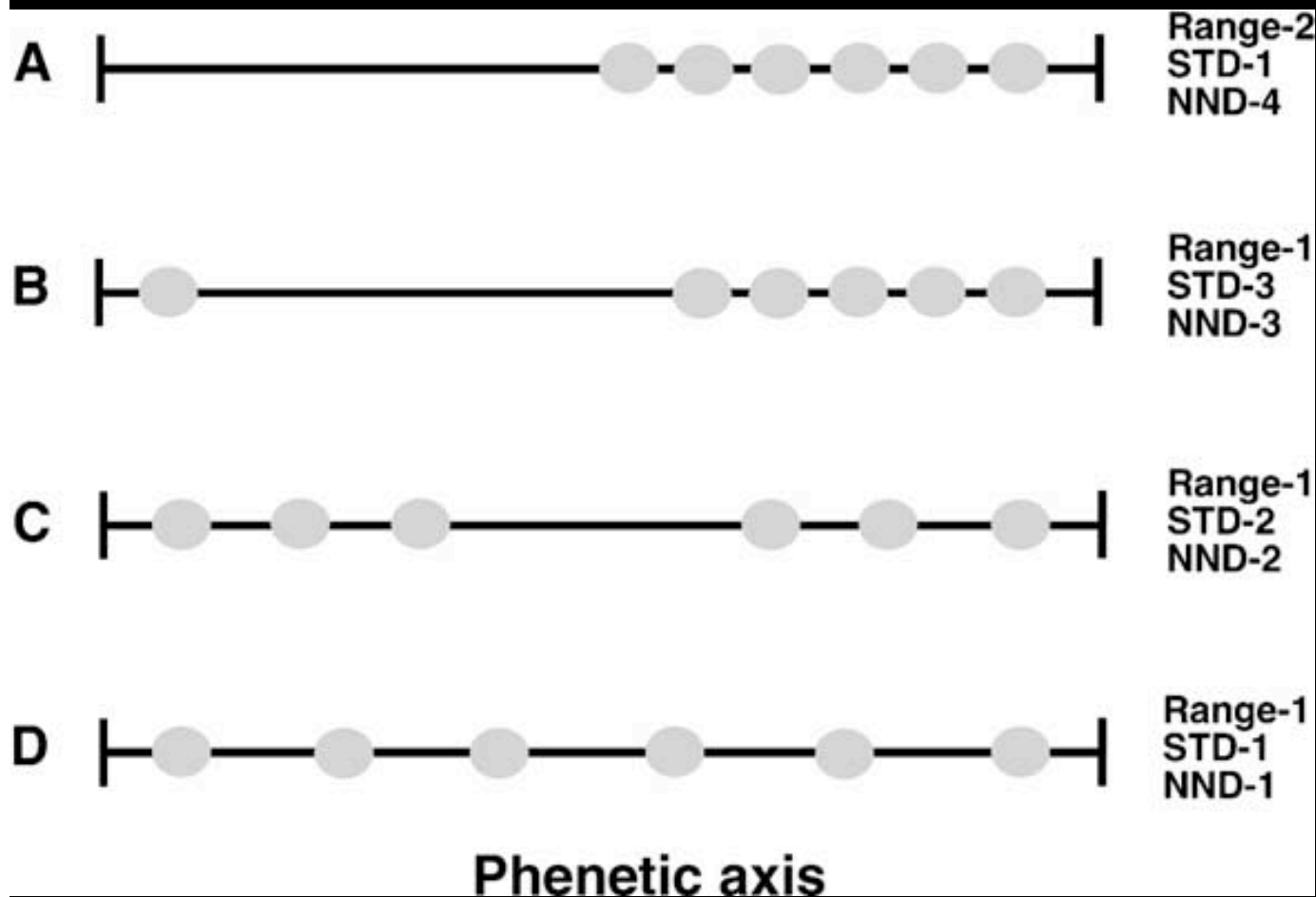
Stevens et. al 2006

# Functional Diversity Metrics

**Range** – the amount of phenetic variation in a community

**STD** – uniformity of species

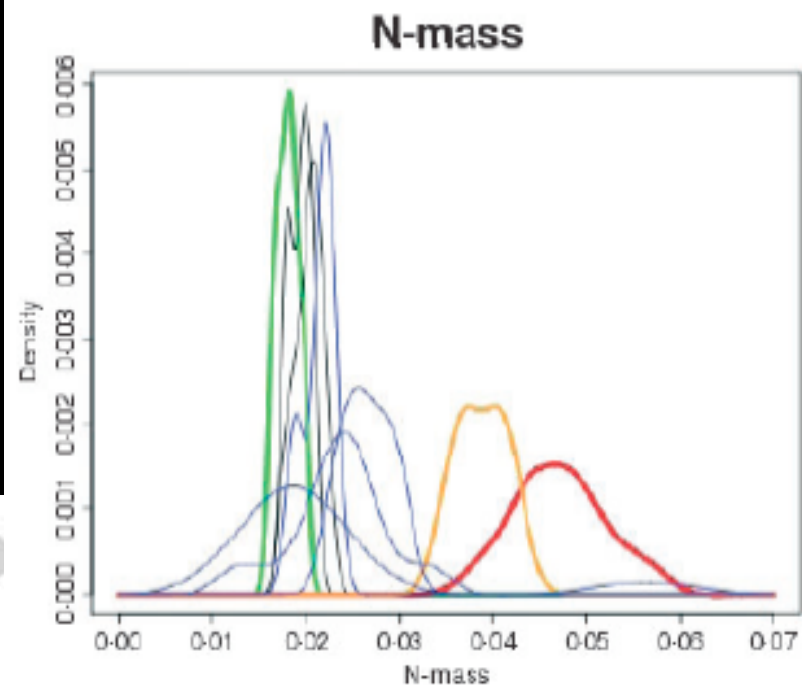
**NND** – local packing



Stevens et. al 2006



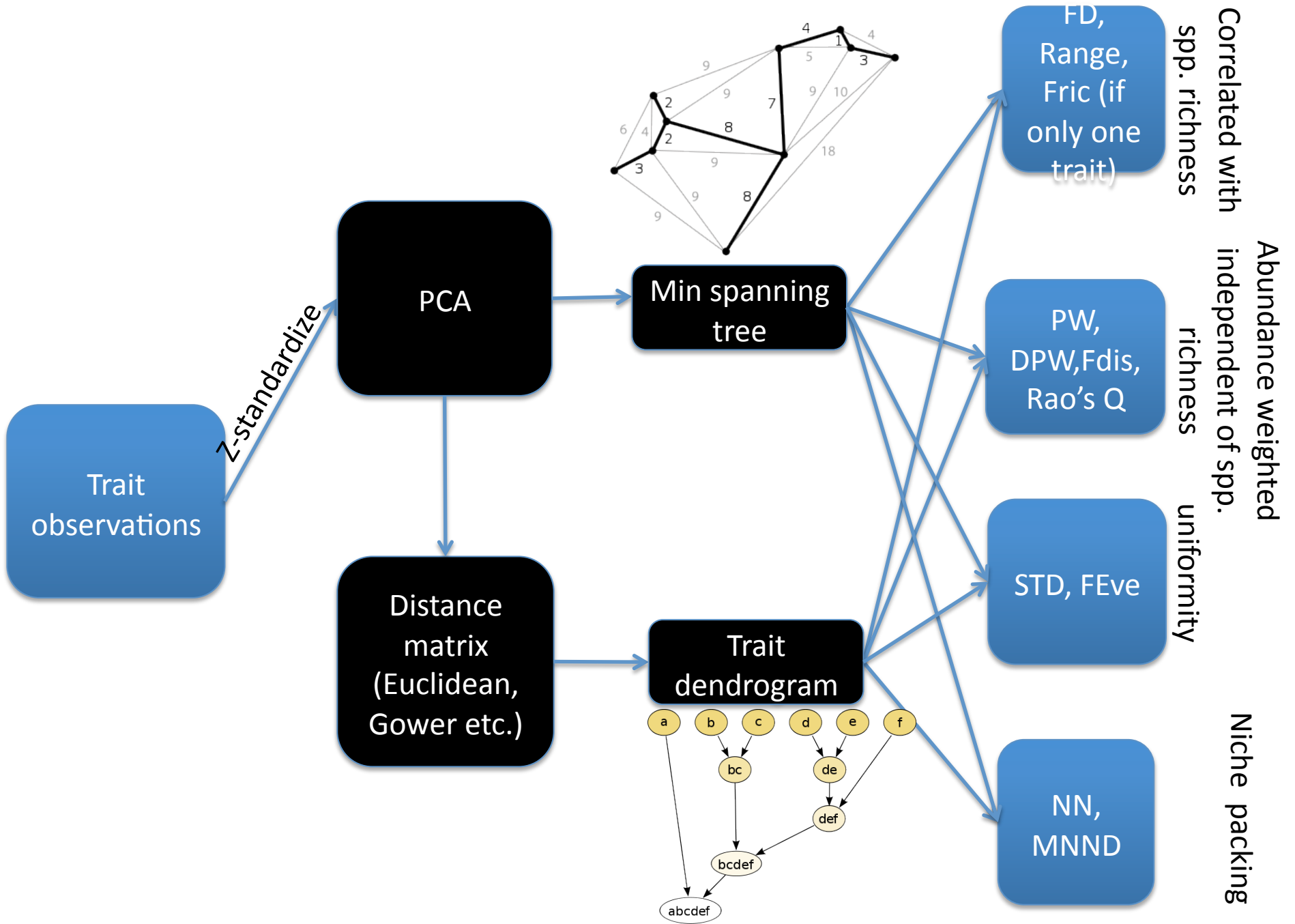
Phenetic axis



Range-1  
STD-3  
NND-3

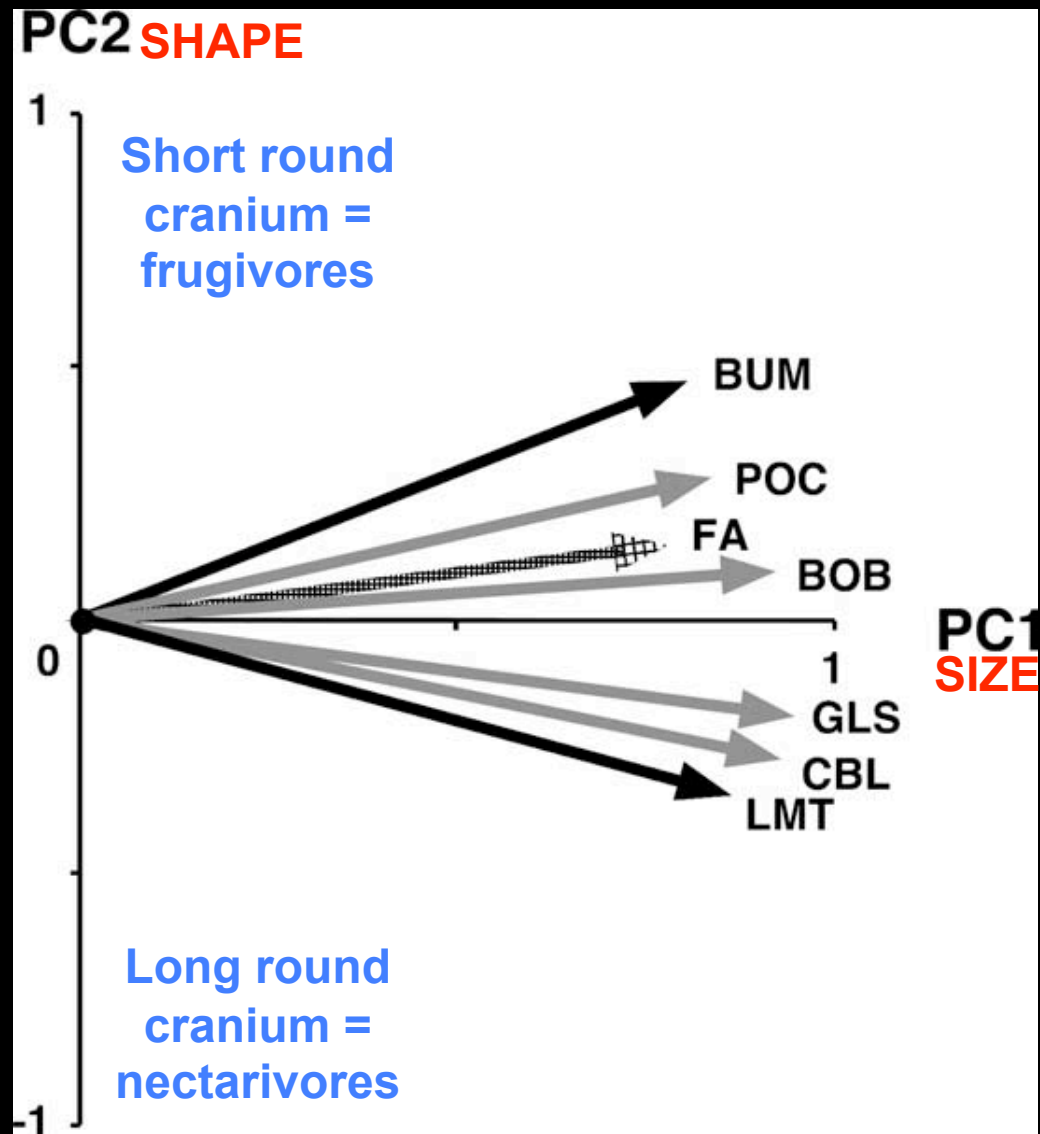
Range-1  
STD-2  
NND-2

Range-1  
STD-1  
NND-1





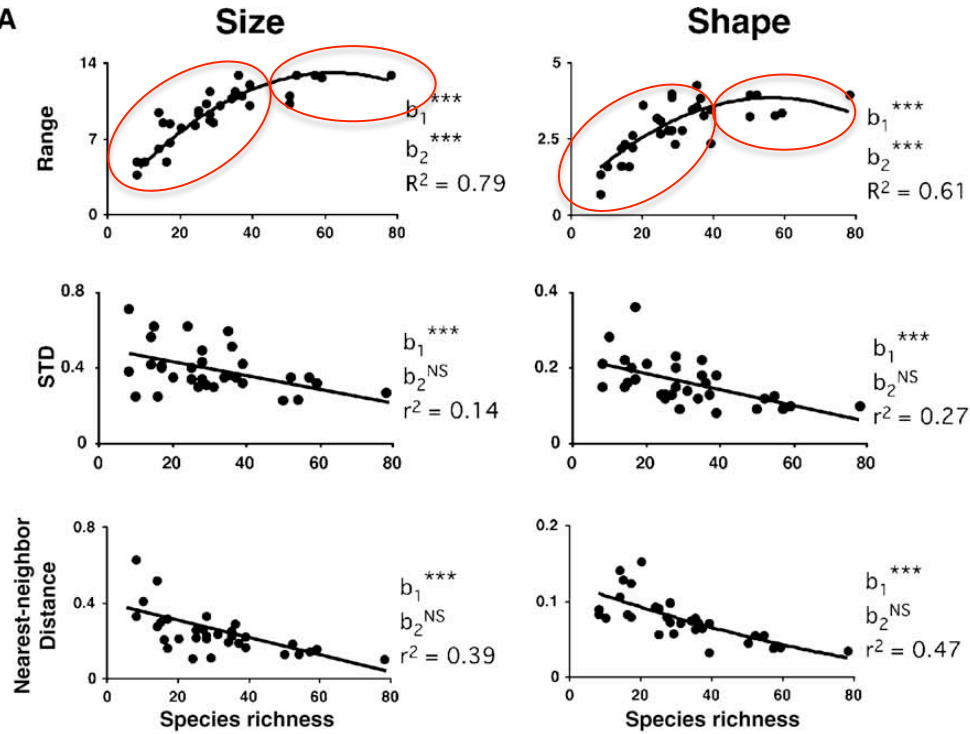
# PCA



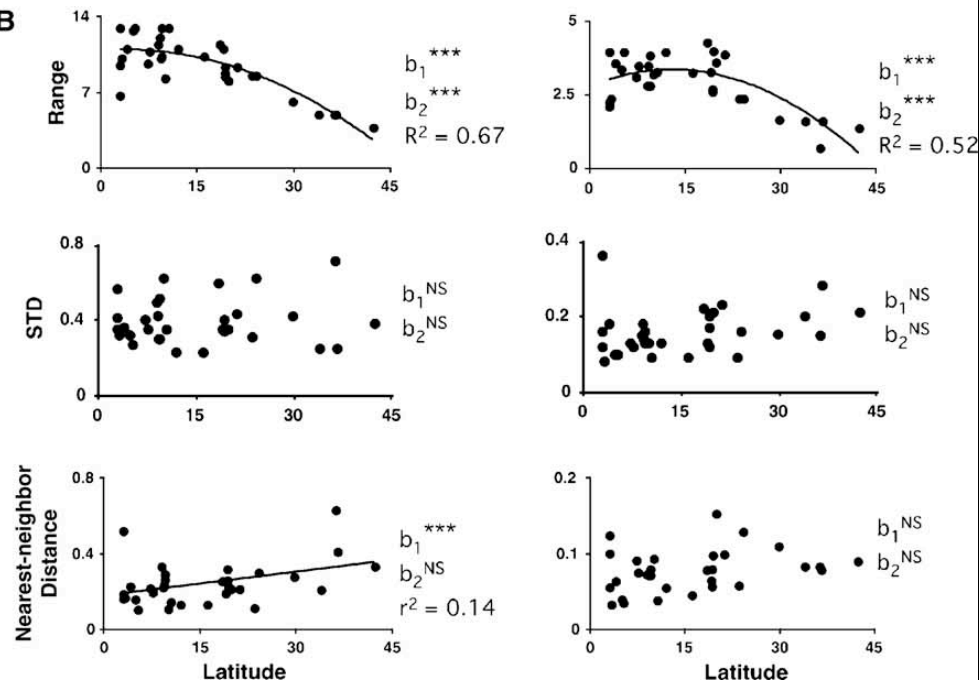
Stevens et. al 2006

Species richness

A



B



# Swenson *et. al* 2012 GEB

**Favorability hypothesis:** in climatically difficult regions abiotic filtering should produce a regional assemblage that is less functionally diverse than expected given the species richness and the global pool of traits.

- Abiotic filtering – Environmental filtering is expected to constrain the overall distribution of function observed within assemblages with the greatest amount of filtering occurring in the least favorable locations along local-scale gradients.
- Biotic filtering - Biotic interactions become more important in more favorable abiotic conditions, thereby giving rise to a reduction in functional similarity between species within a local assemblage

# Swenson *et. al* 2012 GEB

**Favorability hypothesis:** in climatically difficult regions abiotic filtering should produce a regional assemblage that is less functionally diverse than expected given the species richness and the global pool of traits.

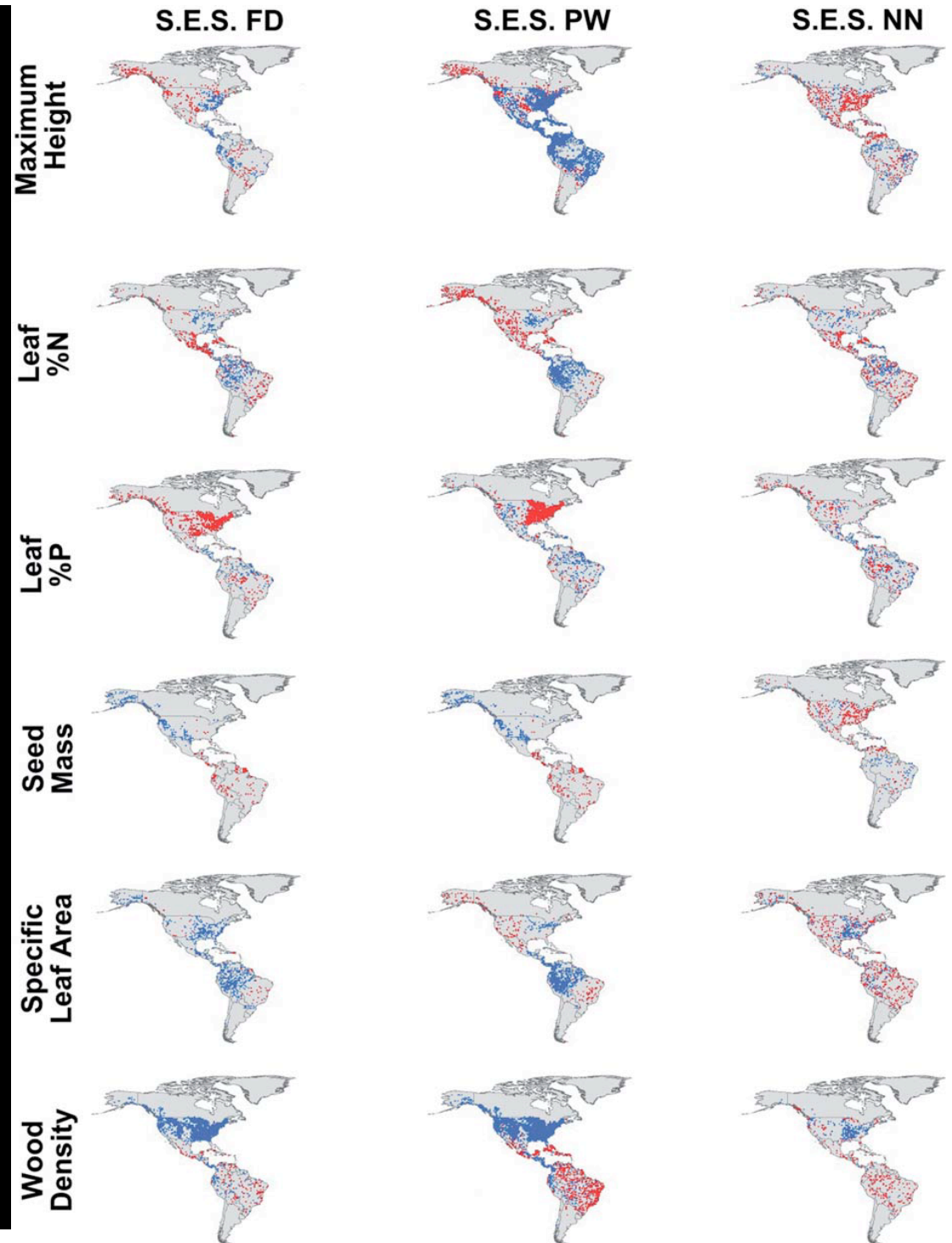
- 1) How functional traits vary across environmental gradients
- 2) Functional over and under trait dispersion at large geographic scales

# Swenson *et. al* 2012 GEB

- **FD** – functional diversity
- **PW** – mean pair-wise functional trait distance
- **NN** – mean nearest neighbor distance
- **Traits used**: Foliar %N and %P and SLA, max height, wood density
- **Methods**: Matched species occurrences with mean trait values in one degree grid cells. Used trait dendrograms to calculate FD, PW, and NN. Compares to null distribution to calculates SES.

Swenson *et. al* 2012 GEB

# Trait dispersion



# Conclusion

- Functional trait diversity in the tropics is higher than expected given the global pool of traits and observed species richness. This supports the **favorability hypothesis**

- EXTRA SLIDES:



# Climate correlations

Trait	Metric	Latitude	Altitude	MAT	TS	TR	AP	PS
Maximum height	SES FD	-0.132	-0.153	0.249	-0.189	-0.202	0.273	-0.099
	SES PW	-0.127	-0.152	0.242	-0.181	-0.194	0.273	-0.113
	SES NN	0.133	-0.018	0.094	-0.163	-0.172	0.125	0.114
Leaf % N	SES FD	0.107	-0.160	0.062	0.011	-0.006	0.213	0.242
	SES PW	-0.431	-0.271	0.463	-0.417	-0.437	0.572	0.106
	SES NN	0.062	-0.016	-0.103	0.124	0.123	0.001	0.124
Leaf % P	SES FD	0.428	-0.039	-0.398	-0.465	-0.462	0.322	0.238
	SES PW	0.347	0.045	-0.313	-0.422	-0.404	0.230	0.295
	SES NN	0.097	-0.035	-0.103	-0.075	-0.079	0.044	0.046
Seed mass	SES FD	-0.350	-0.131	0.342	-0.310	-0.311	0.254	0.049
	SES PW	-0.366	-0.125	0.344	-0.246	-0.274	0.221	0.010
	SES NN	0.131	-0.002	0.089	-0.153	-0.160	0.114	0.092
Specific leaf area	SES FD	-0.121	-0.149	0.107	-0.052	-0.083	0.236	0.232
	SES PW	-0.262	-0.166	0.362	-0.336	-0.353	0.499	0.174
	SES NN	-0.154	-0.043	-0.121	0.178	0.164	-0.088	0.118
Wood density	SES FD	-0.543	-0.112	0.546	-0.619	-0.602	0.274	0.438
	SES PW	-0.565	-0.135	0.587	-0.629	-0.612	0.288	0.418
	SES NN	-0.374	-0.071	0.367	-0.413	-0.400	0.214	0.187

# Compare terms

Stevens	Swenson
Phenetic	Functional
Range	FD
<b>STD</b>	<b>PW</b>
NND	NN
?	SES
Minimum spanning tree (using WHAT distance metric?)	Trait dendrogram (hierarchical clustering using WHAT distance metric)

Swenson *et. al* 2012 GEB

