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

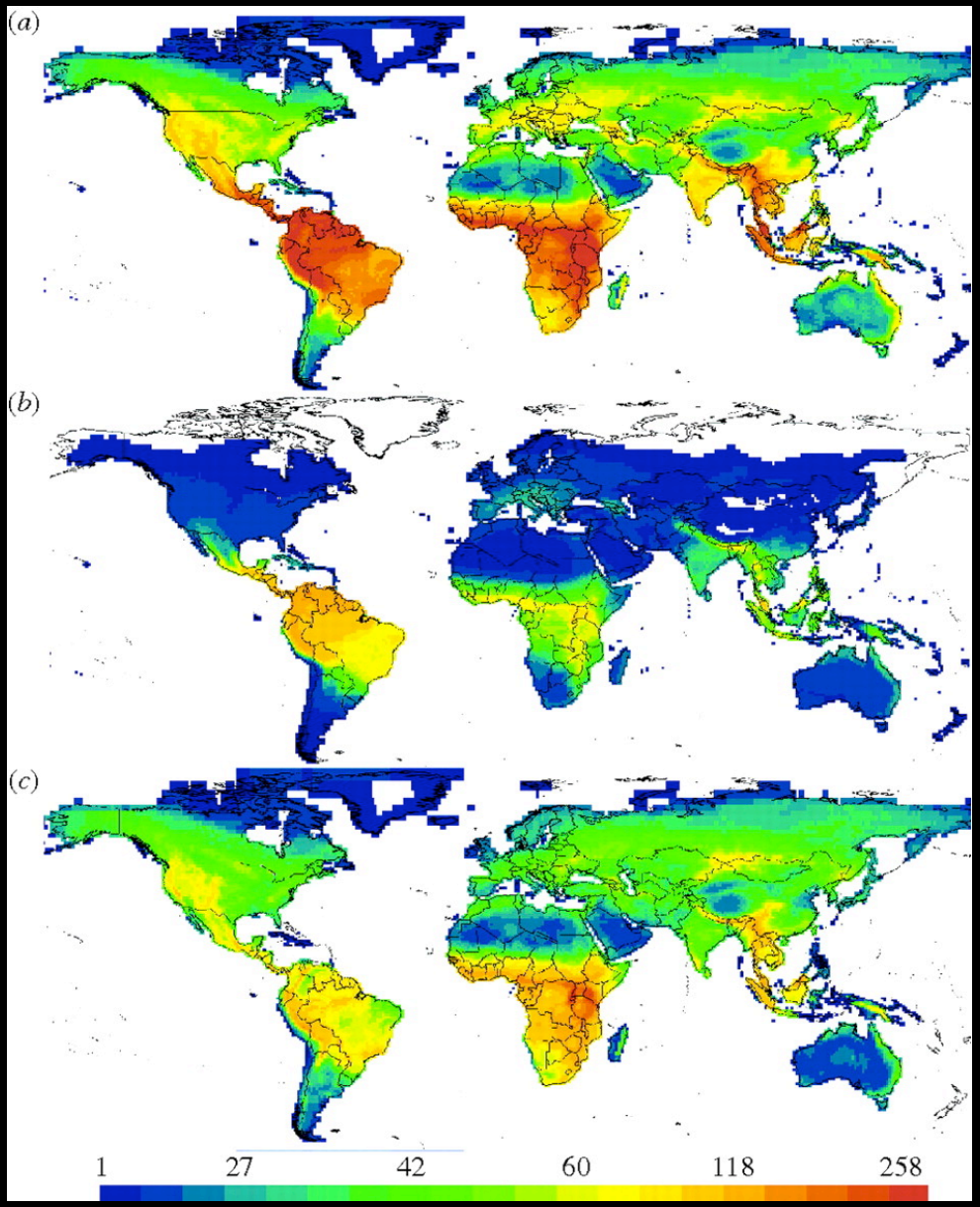
Changes in trait diversity over space and time

- Continental level
  - Swenson *et al*. 2012 GEB
  - Stevens *et al*. 2006 Oikos
- Community level
  - Swenson *et al*. 2012 Ecology
  - Ding *et a*l. 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?



Buckley L B et al. Proc. R. Soc. B doi:10.1098/rspb.2010.0179

PROCEEDINGS OF THE ROYAL SOCIETY B

Stevens *et. al* 2006

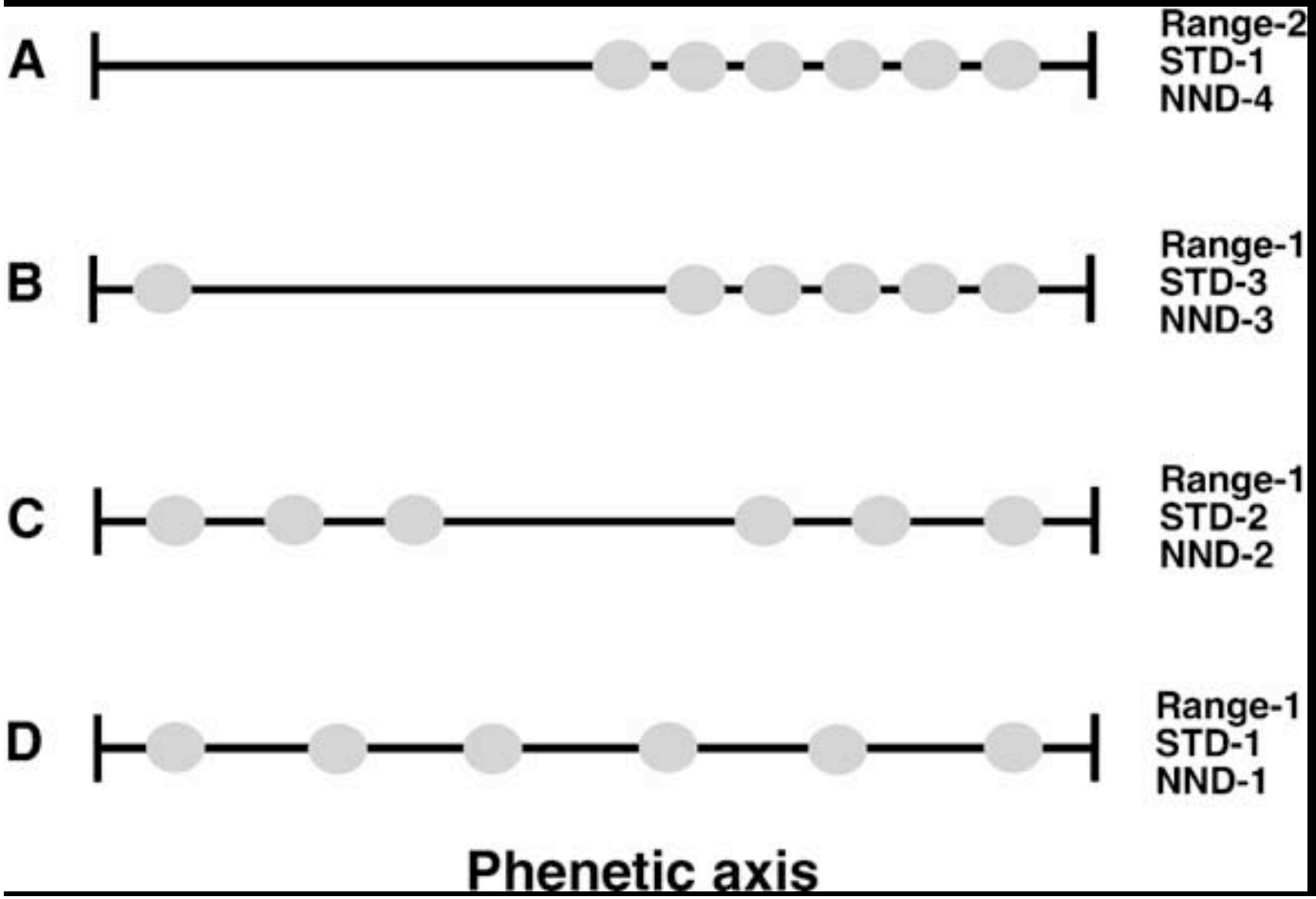
Changes in phenetic diversity of bats with latitude and species richness

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.

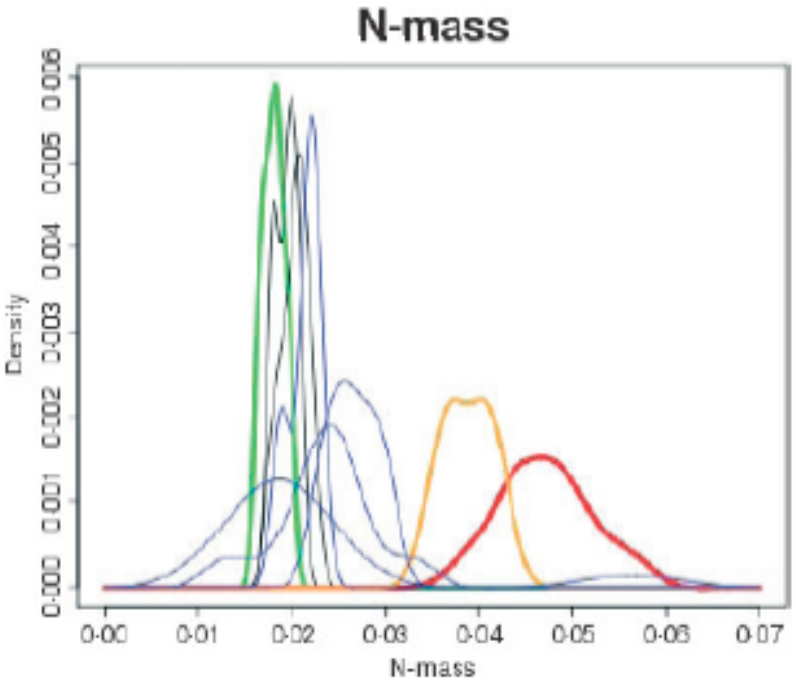
Stevens et. al 2006

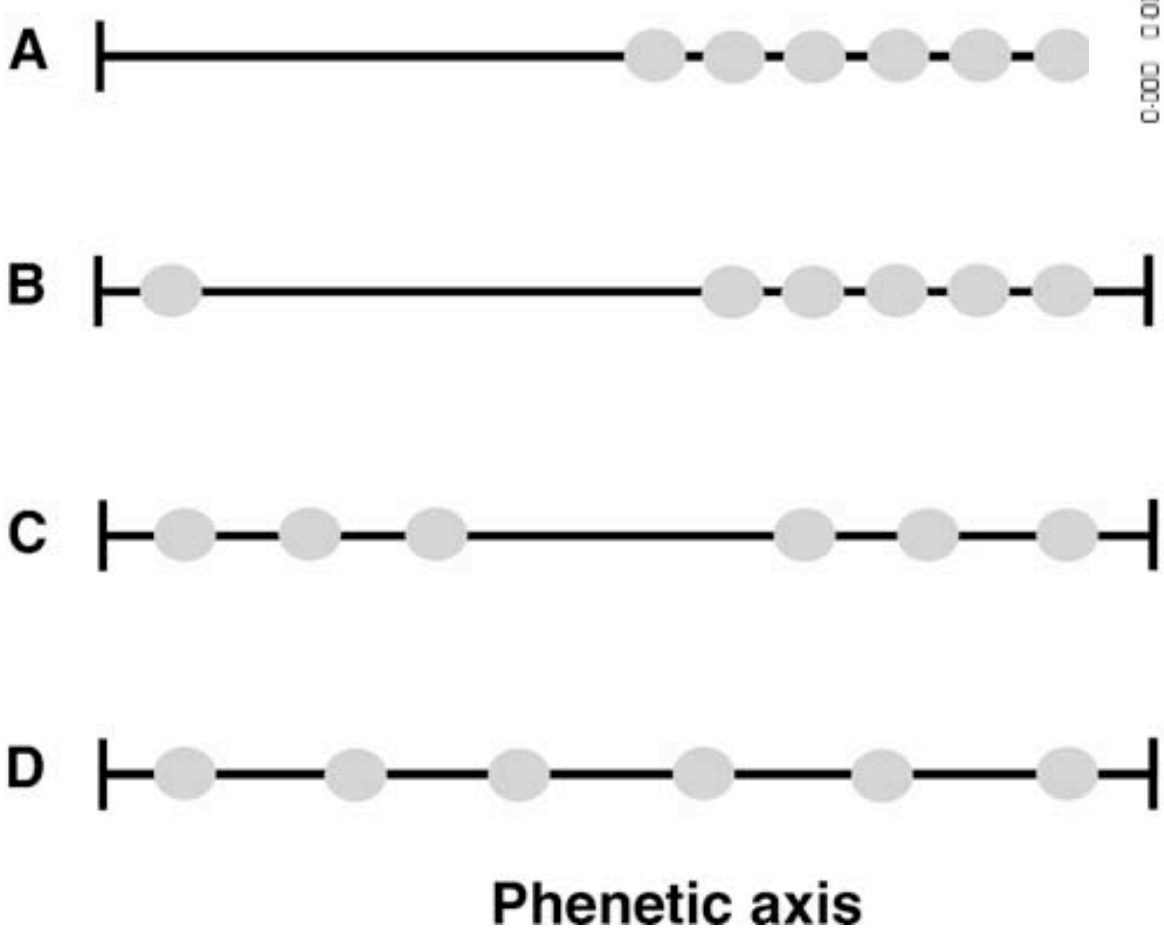
Functional Diversity Metrics

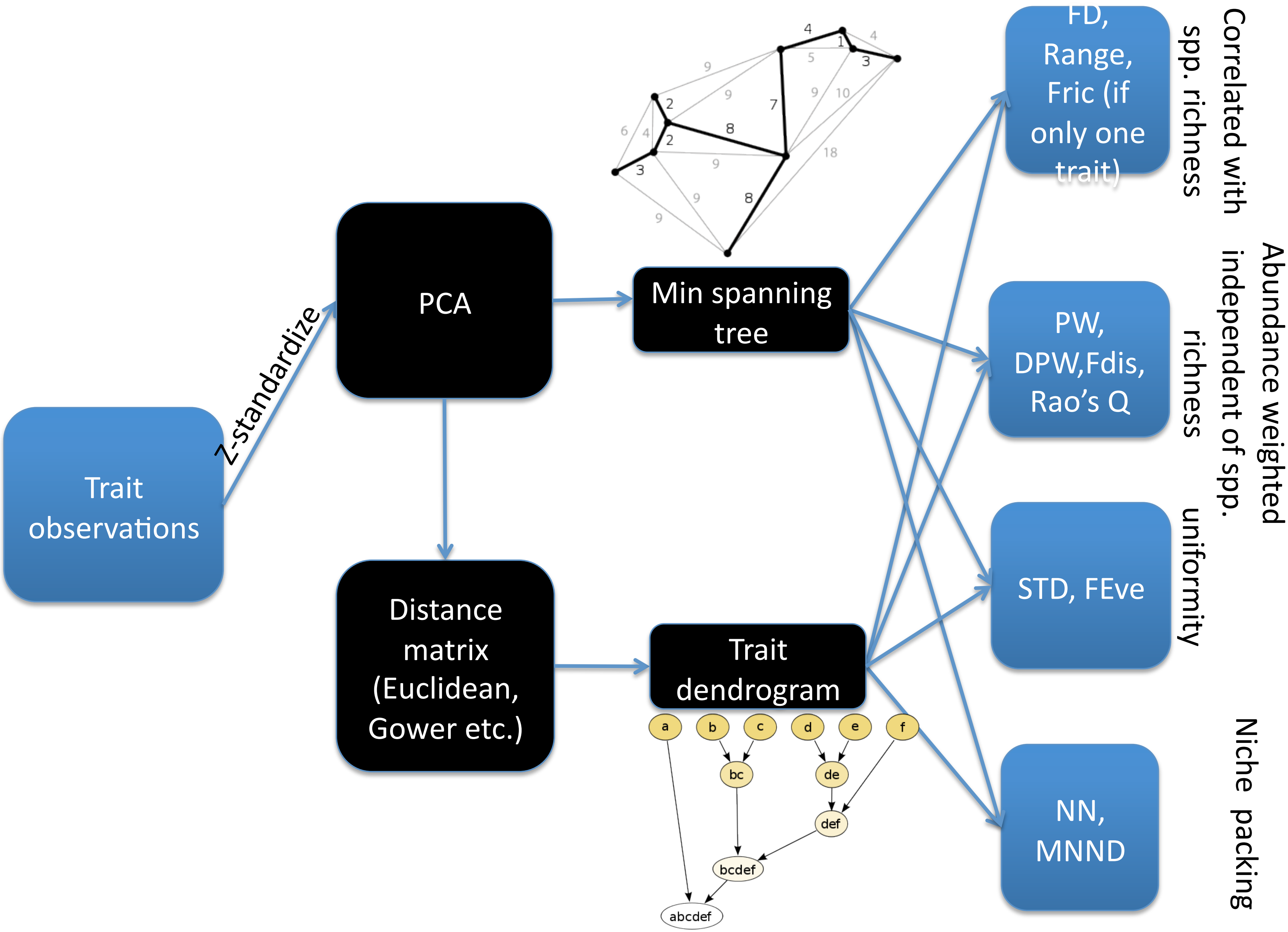
Range – the amount of phenetic variation in a community
STD – uniformity of species
NND – local packing



Stevens et. al 2006

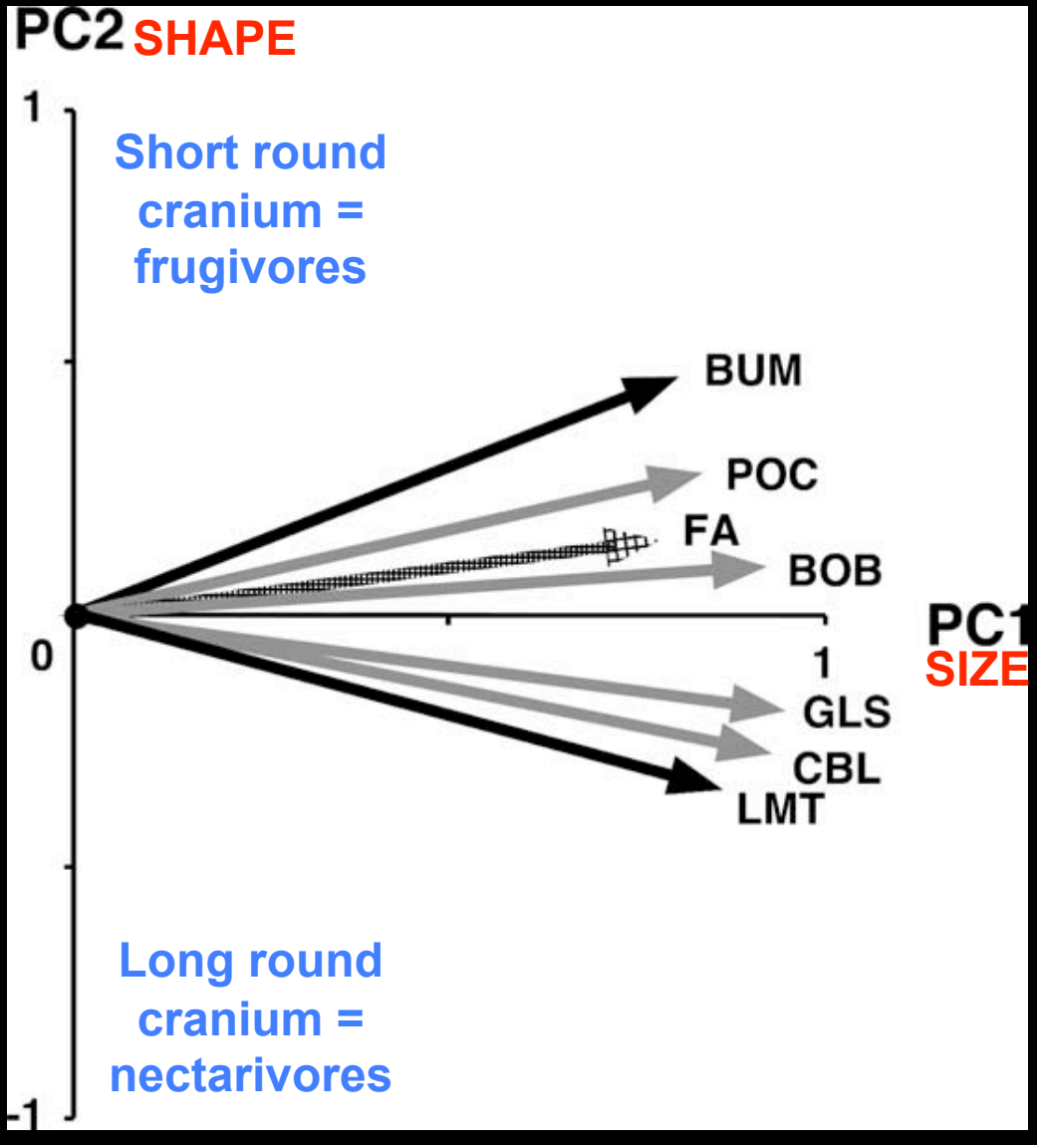





Trait observations
Z-standardize
PCA
Min spanning tree
Distance matrix (Euclidean, Gower etc.)
Trait dendrogram
a
b
c
d
e
f
bc
de
def
bcdef
abcdef
FD, Range, Fric (if only one trait)
PW, DPW,Fdis, Rao's Q
STD, FEve
NN, MNND
Correlated with spp. richness
Abundance weighted independent of spp. richness
uniformity
Niche packing

Stevens et. al 2006

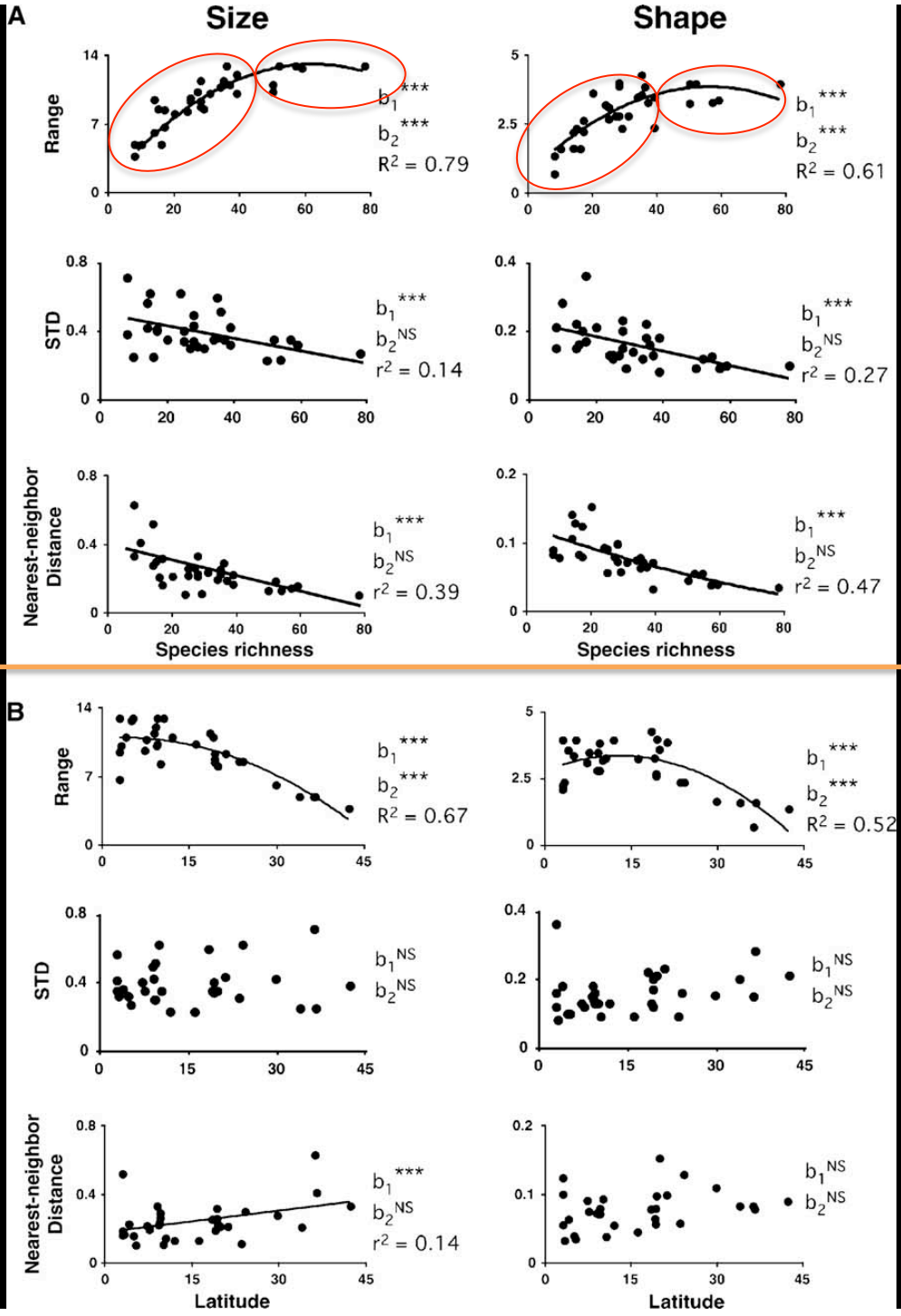
PCA



Stevens et. al 2006

Species richness

Latitude



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

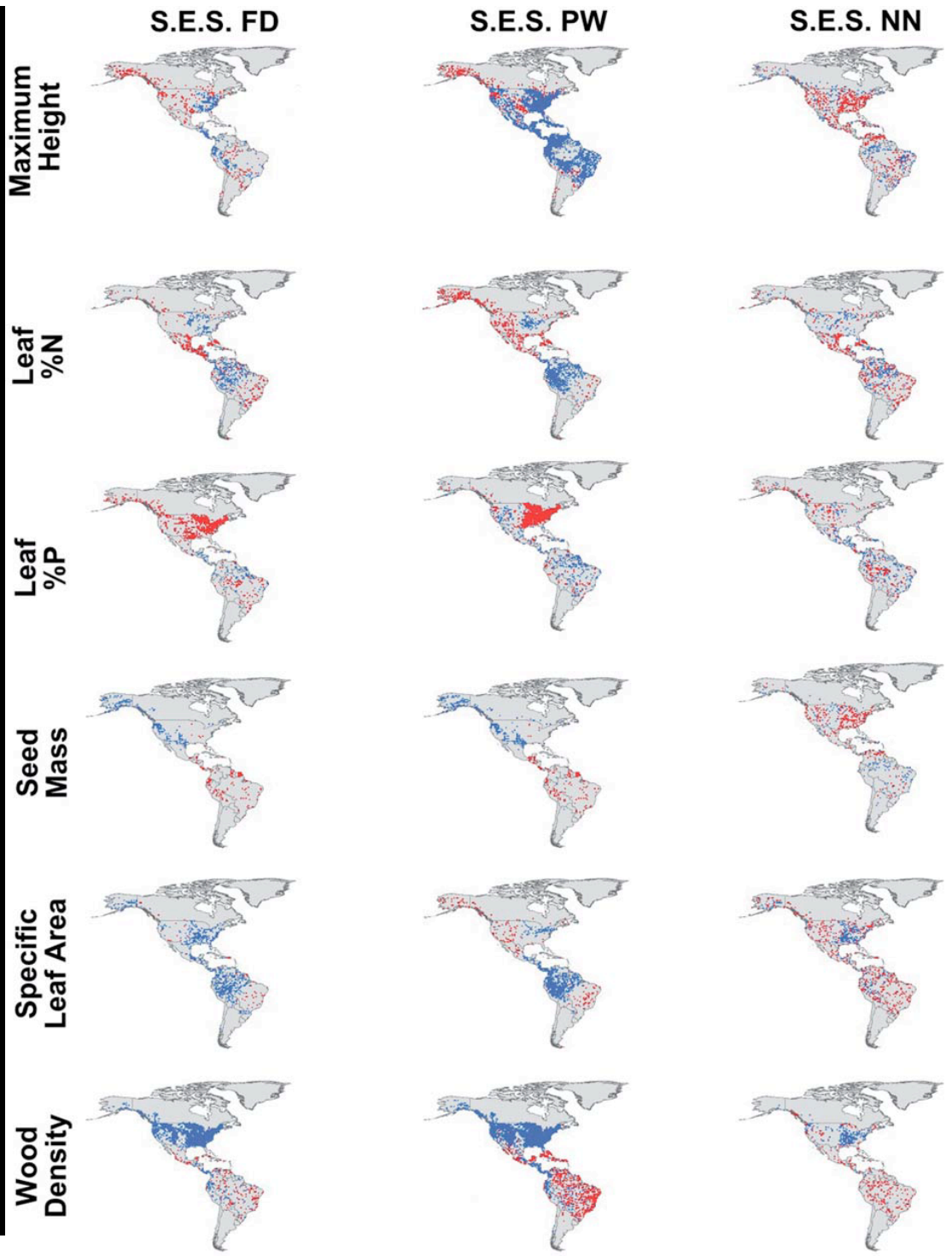
Swenson *et. al* 2012 GEB

- 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:

Swenson *et. al* 2012 GEB

Climate correlations

Trait	Metric	Latitude	Altitude	MAT	TS	TR	AP	PS
	SES FD	**−0.132**	**−0.153**	**0.249**	**−0.189**	**−0.202**	**0.273**	**−0.099**
Maximum height	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**
	SES FD	**0.107**	**−0.160**	**0.062**	**0.011**	−0.006	**0.213**	**0.242**
Leaf % N	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**
	SES FD	**0.428**	−0.039	**−0.398**	**−0.465**	**−0.462**	**0.322**	**0.238**
Leaf % P	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**
	SES FD	**−0.350**	**−0.131**	**0.342**	**−0.310**	**−0.311**	**0.254**	**0.049**
Seed mass	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**
	SES FD	**−0.121**	**−0.149**	**0.107**	**−0.052**	**−0.083**	**0.236**	**0.232**
Specific leaf area	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**
	SES FD	**−0.543**	**−0.112**	**0.546**	**−0.619**	**−0.602**	**0.274**	**0.438**
Wood density	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
STD	**PW**
NND	NN
?	SES
Minimum spanning tree (using WHAT distance metric?)	Trait dendrogram (hierarchical clustering using WHAT distance metric)

Swenson *et. al* 2012 GEB