The Impact of Cenozoic Cooling on the Diversity of Planktonic Foraminifera

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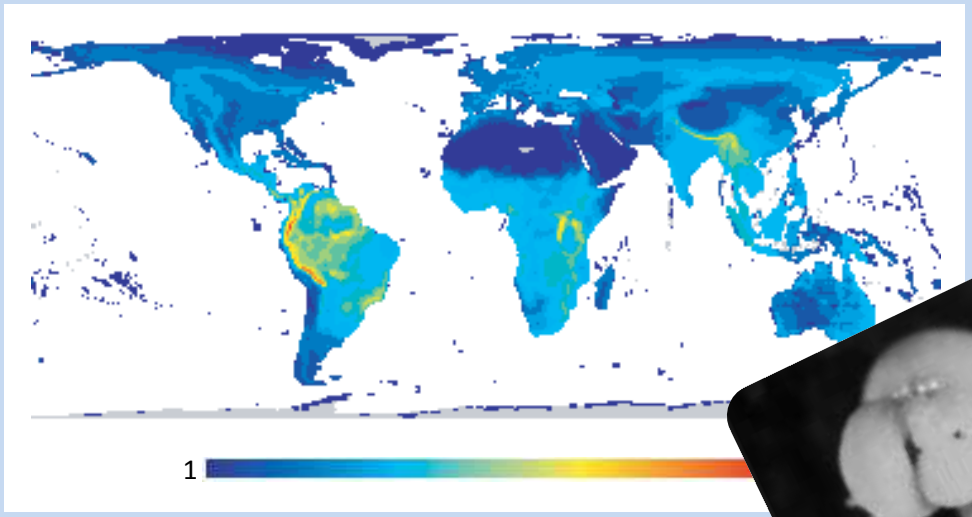
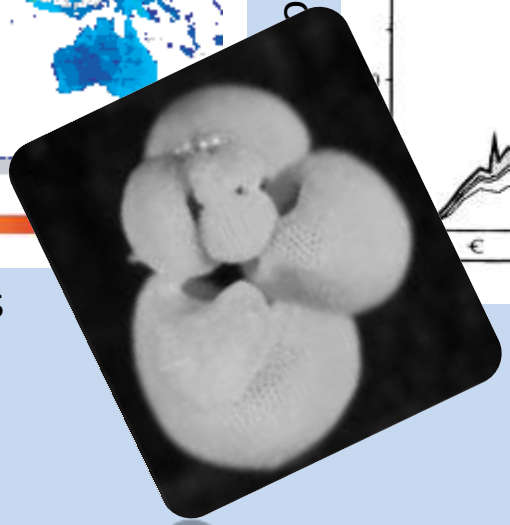
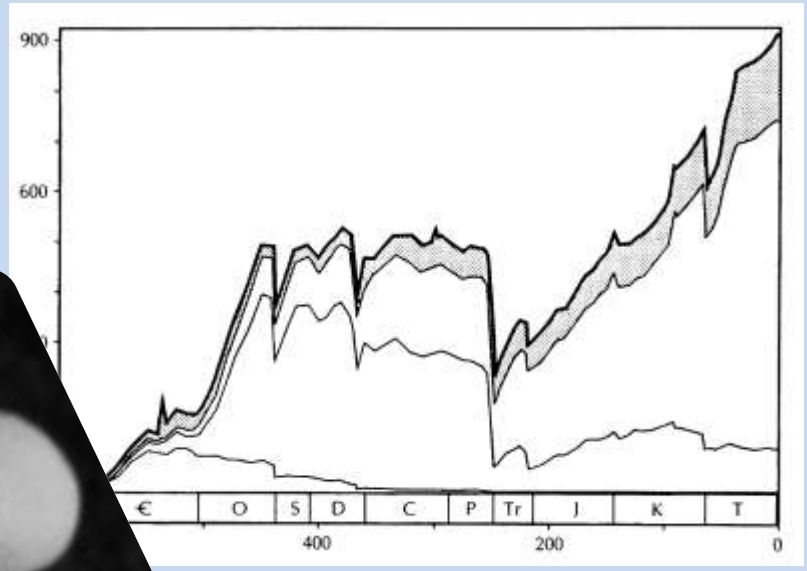
Studying Diversity in Space and Time



Species richness of birds



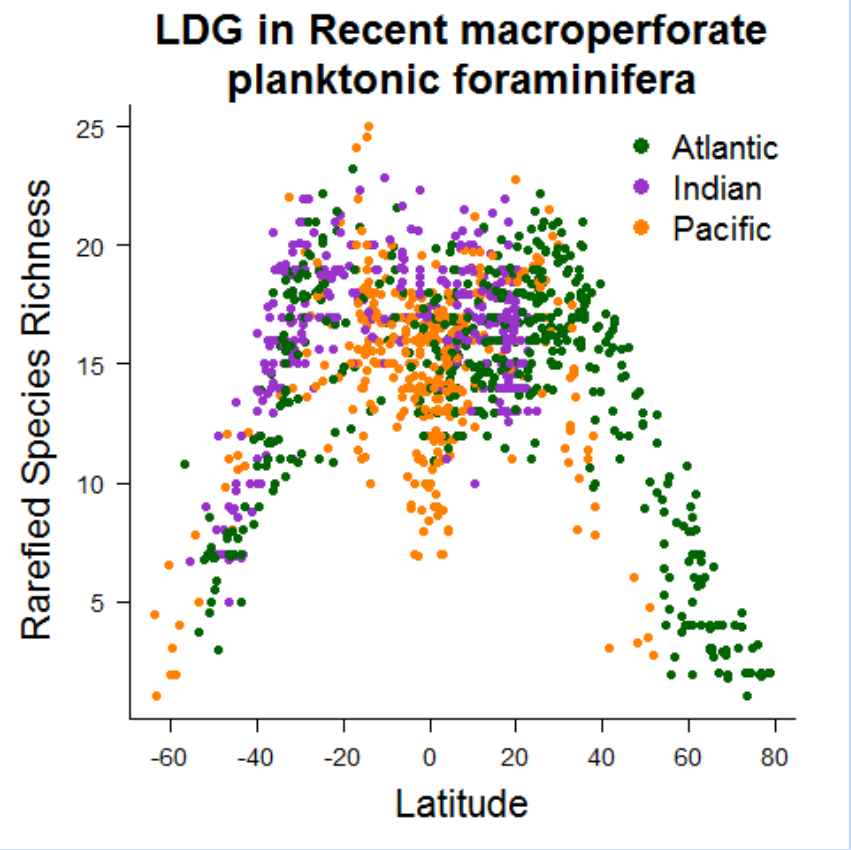


Time / Mya

Orme et al (2005) *Nature*
Sepkoski (1984) *Paleobiology*

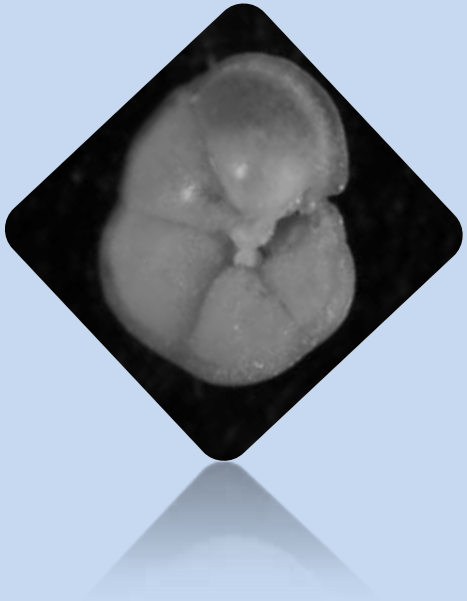
What is the Latitudinal Diversity Gradient?

- The LDG is found in many taxa, both marine and terrestrial
- Species richness is higher near the equator
- Many explanations, no clear consensus as to the cause

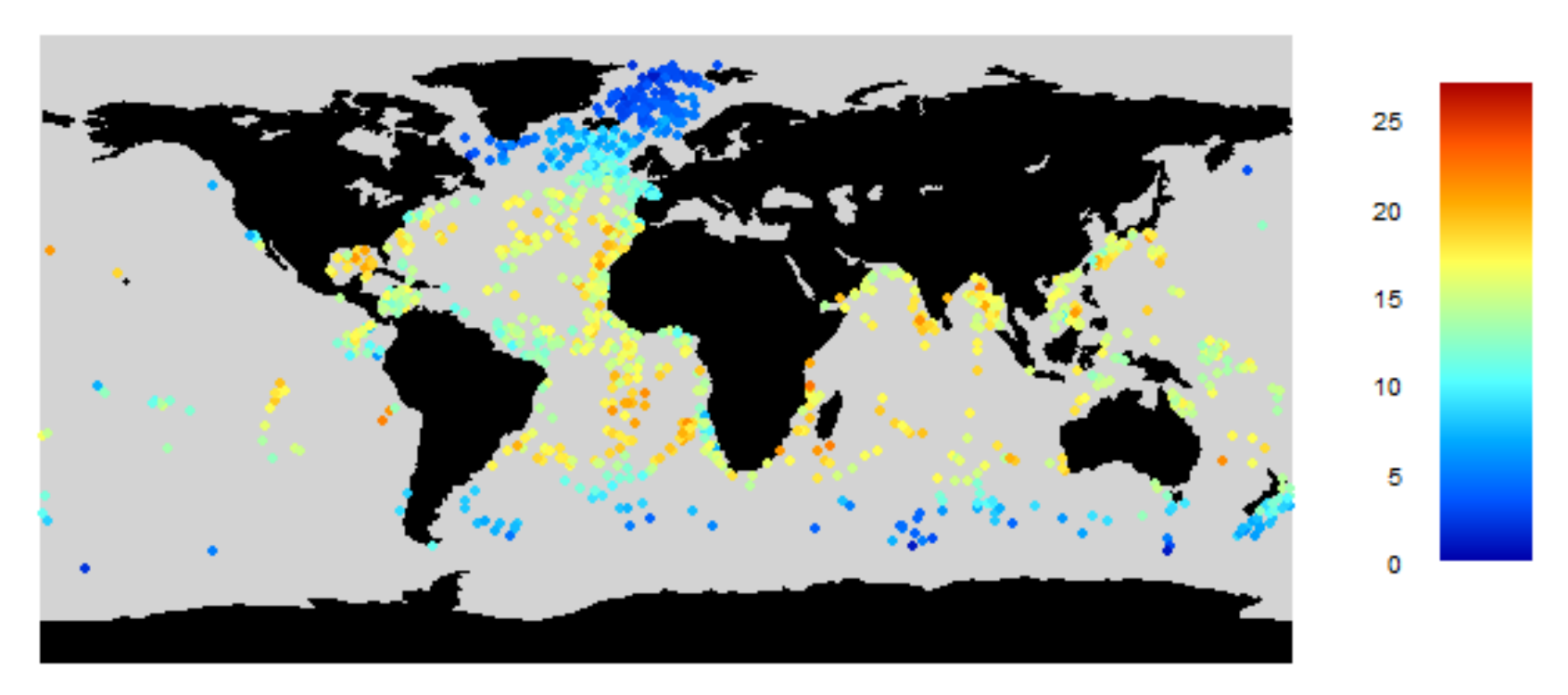


Aims

1. What drives the species richness of ocean plankton today?
2. Have those drivers remained constant through time?



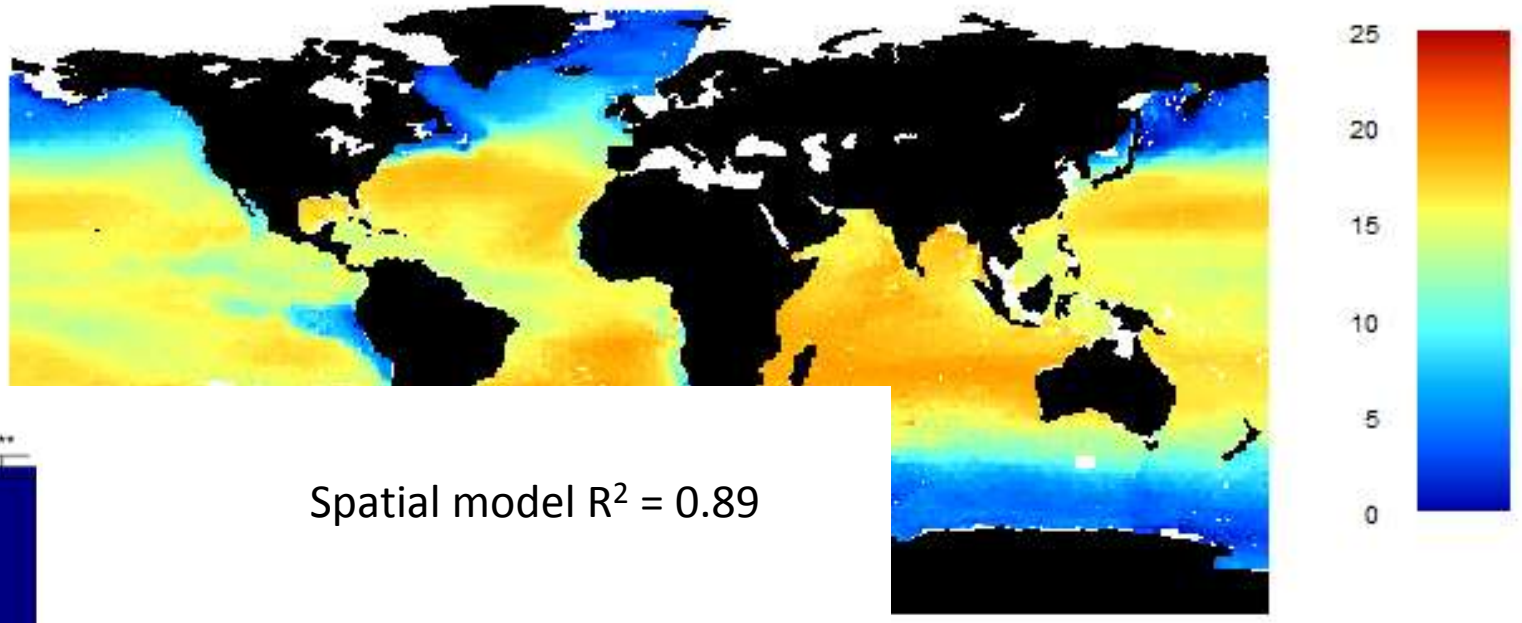
Observed Recent Richness

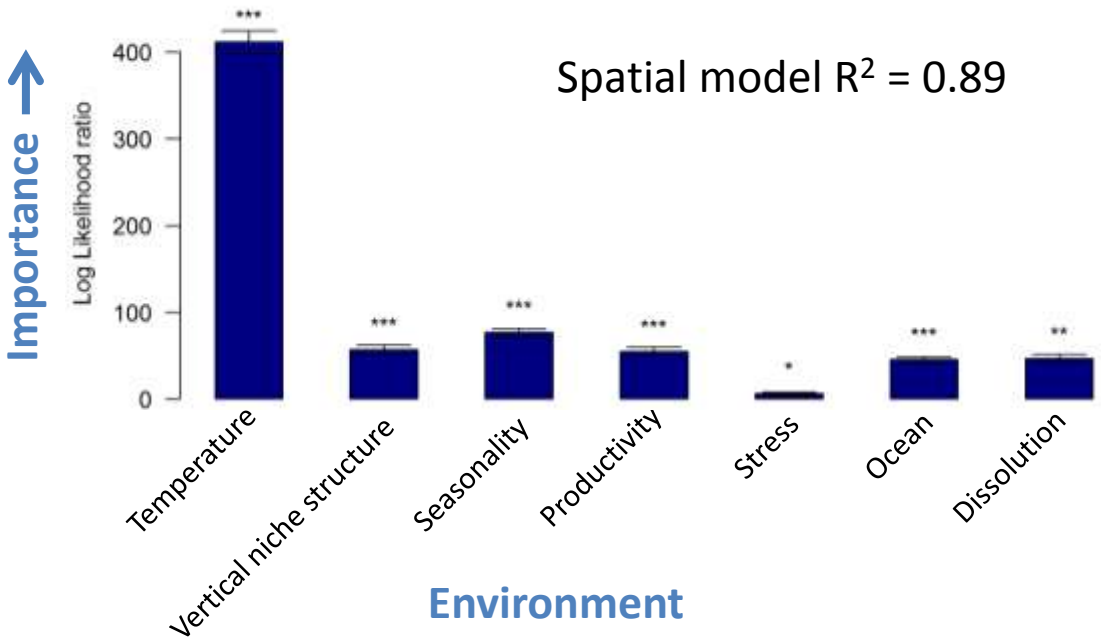


Fenton et al (2016) *PLOS One*

Predicted Recent Richness

(Spatial autoregressive models; SST a third-order polynomial; first order interactions)





Spatial model $R^2 = 0.89$

Fenton et al (in review) *PLoS One*

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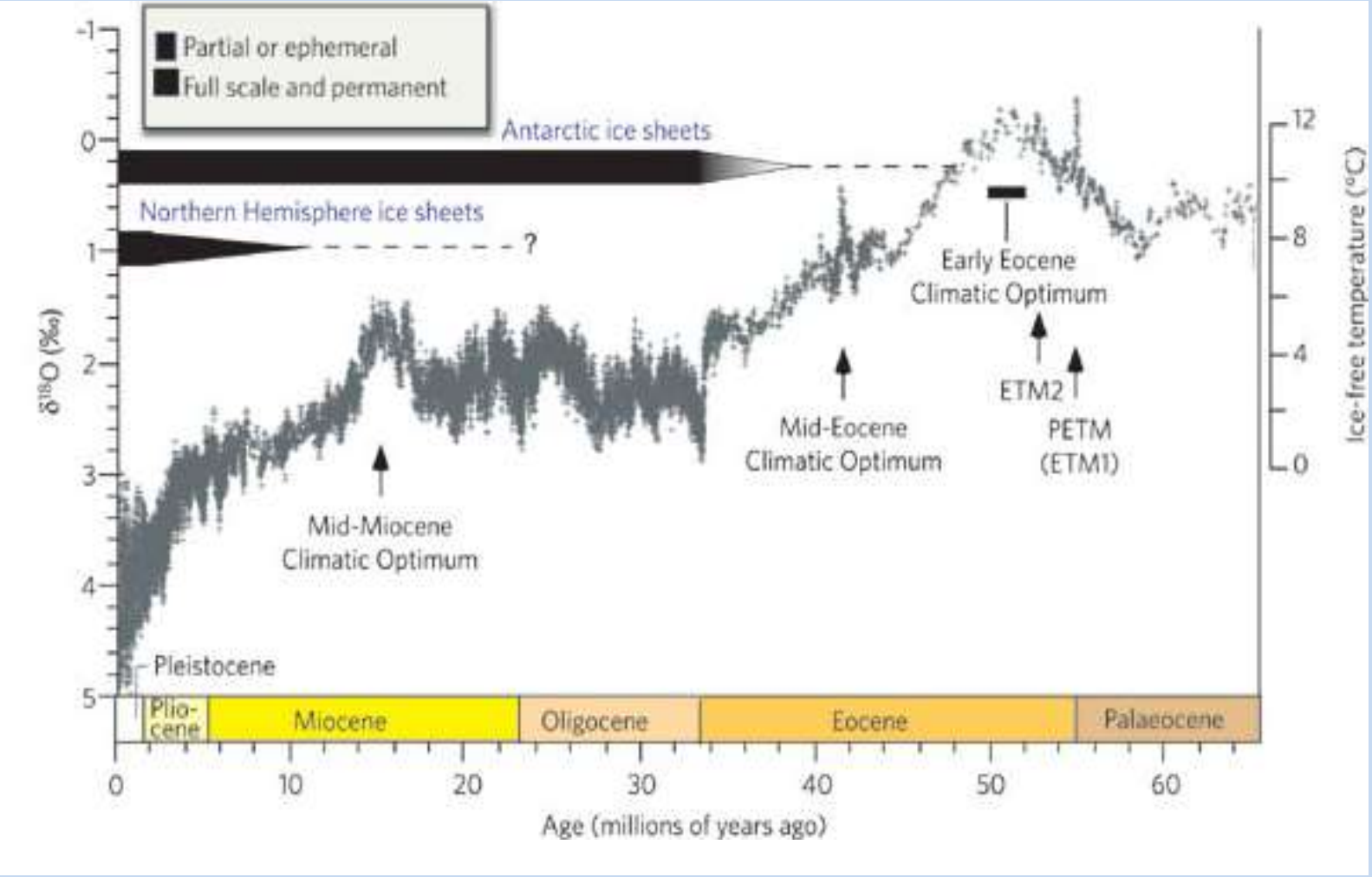
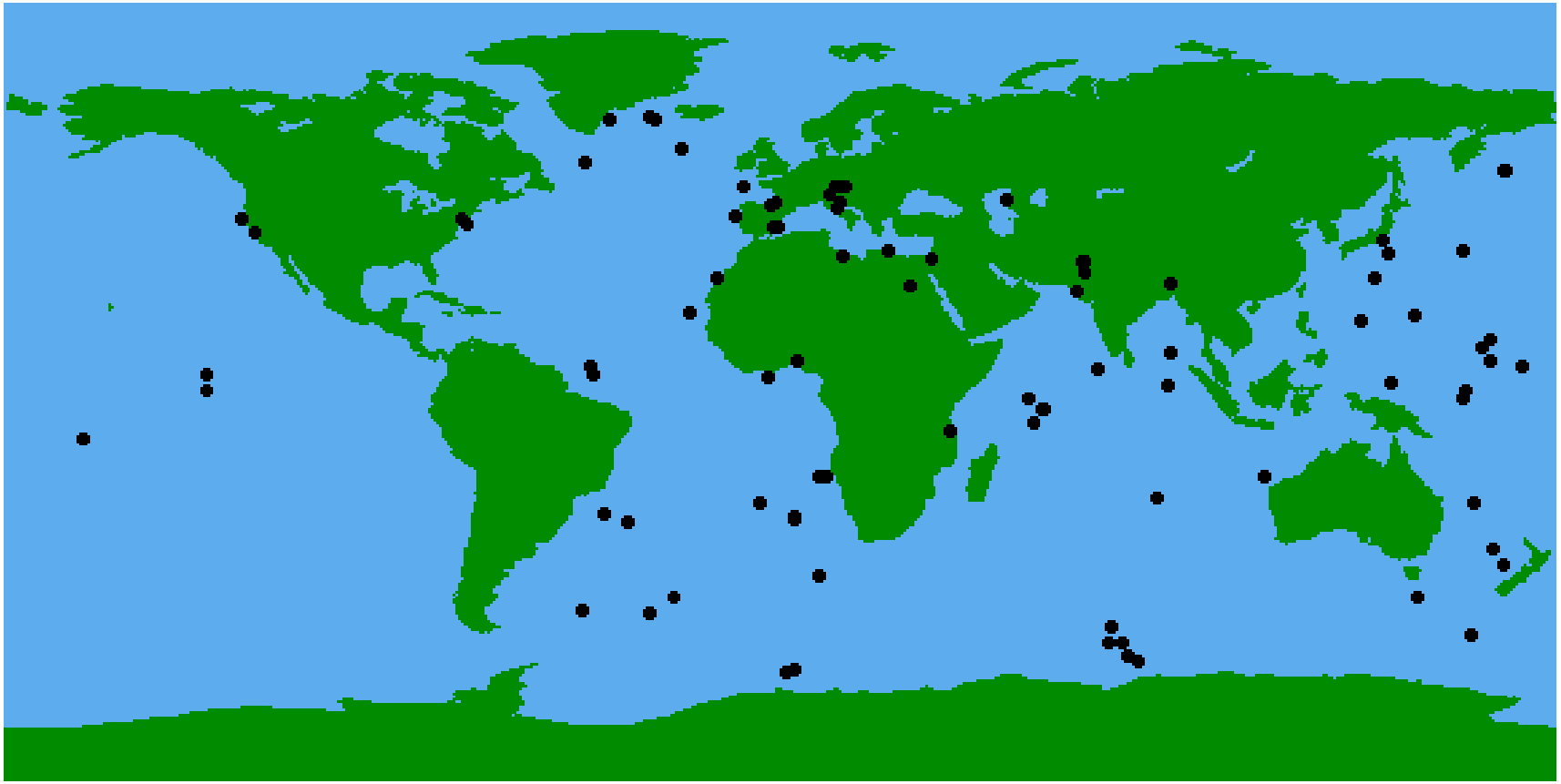
Eocene Environment



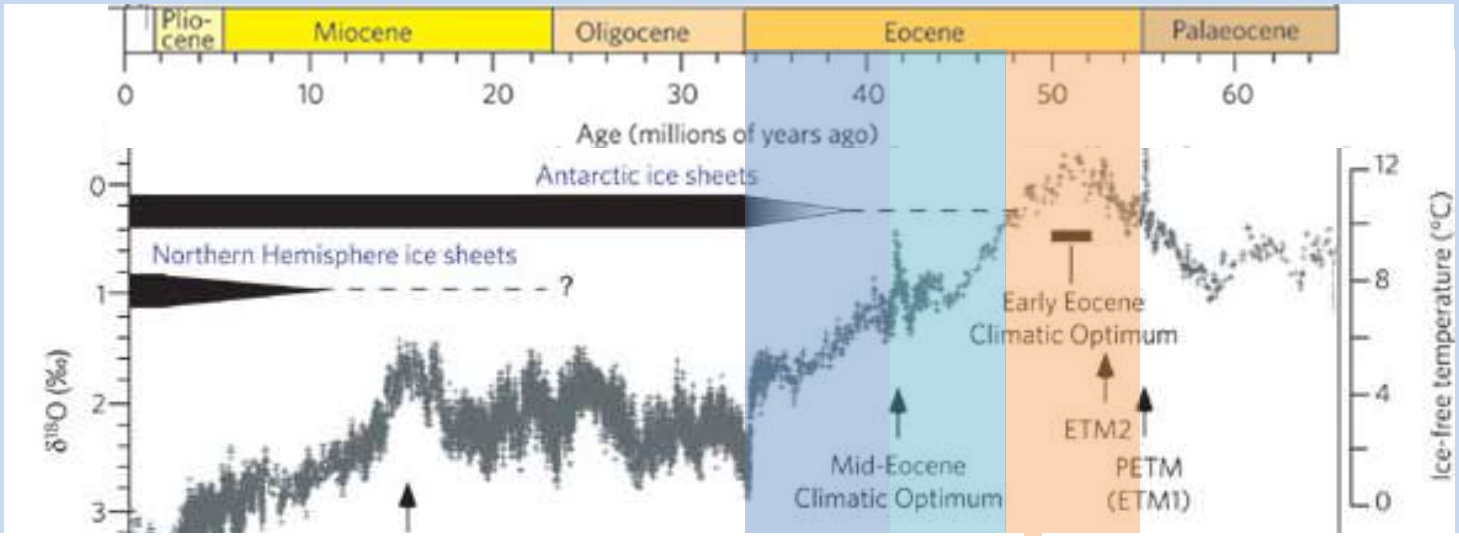
Zachos et al (2008) *Nature*

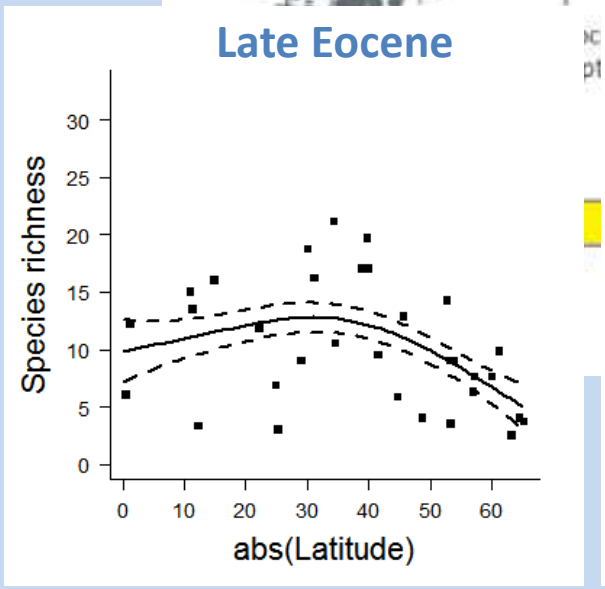
Eocene Sites

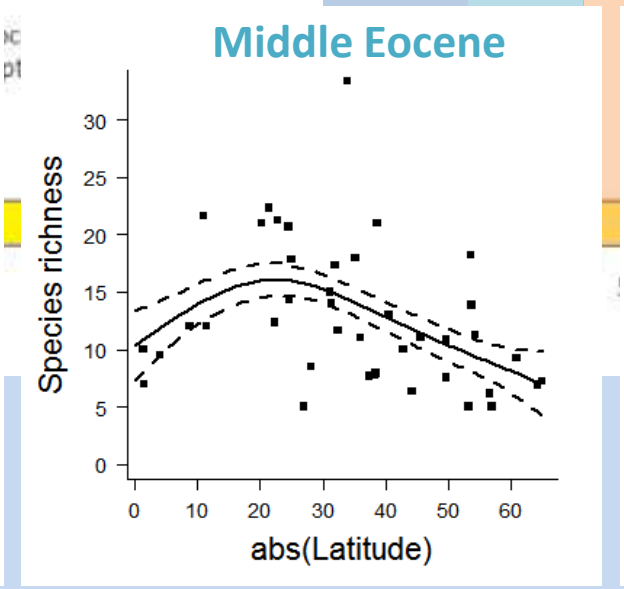


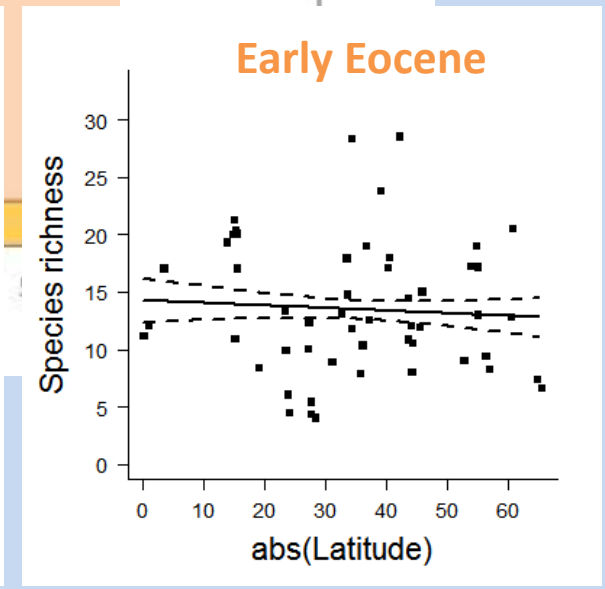
Fenton et al (2016) *PhilTransB*

Observed Eocene Richness



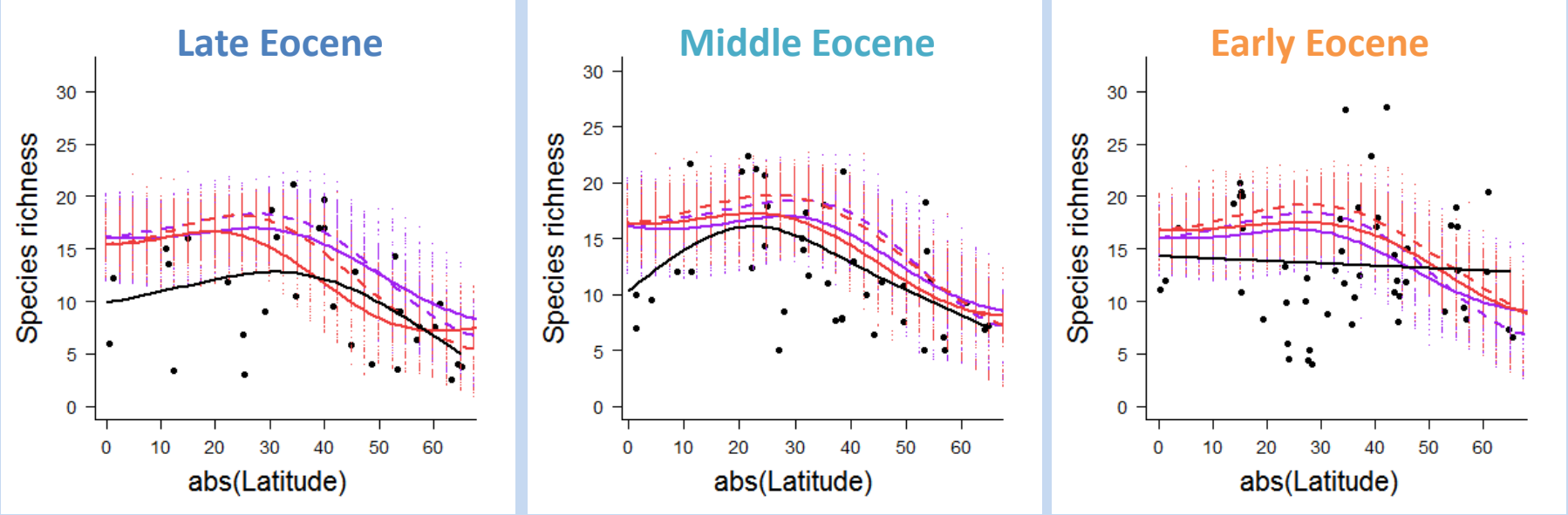






Fenton et al (2016) *PhilTransB*

Comparison of Predicted and Observed Diversity



Predicted data

Tectonics GCM

CO_2 GCM

Northern hemisphere

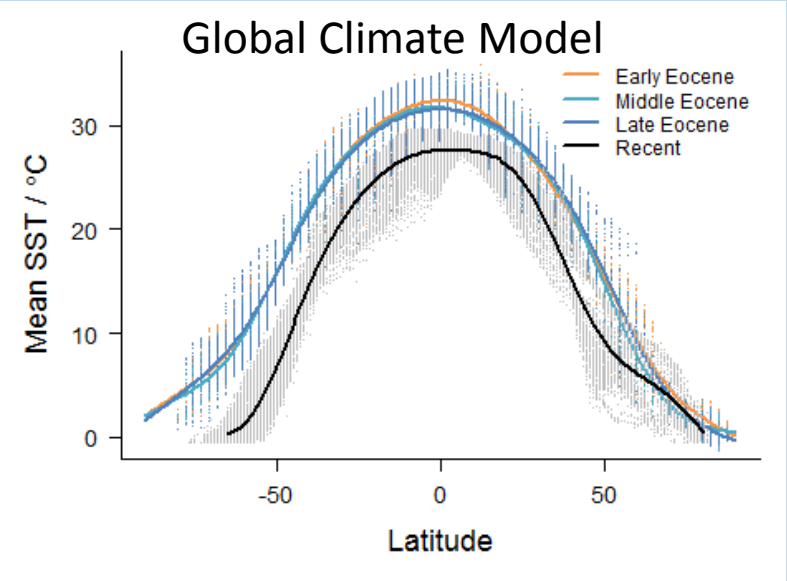
Southern hemisphere

Fenton et al (2016) *PhilTransB*

Discrepancies

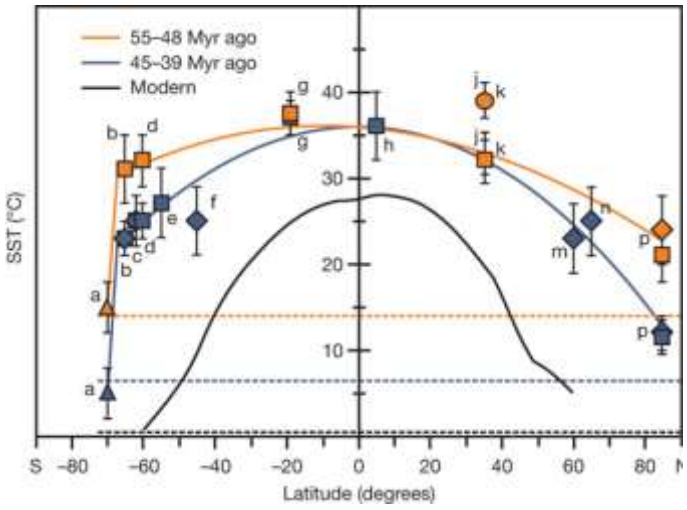
Possible explanations:

- Model missing a relevant variable
- The relationship between diversity and environment has changed
- GCM early Eocene temperature estimates are inaccurate



Inglis et al (2015) *Paleoceanography*
Lunt et al (2010) *Geology*

Proxy estimates



Bijl et al (2009) *Nature*

Conclusions

- Present day diversity of PFs is mainly driven by temperature, although other variables also contribute
- By the end of the Eocene, a latitudinal diversity gradient had developed
- Mismatch between predicted and observed diversity in early Eocene
  - Proxy records suggest these GCMs produce poor environment estimates

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NATURAL HISTORY MUSEUM

Modelling

- Using Spatial Autoregressive Models to account for spatial autocorrelation
- SST modelled as a third order polynomial (complexity level suggested by GAMs)
- First order interactions between all variables
- Exclude points with delta carbonate ion <-10.9 to reduce effect of dissolution