

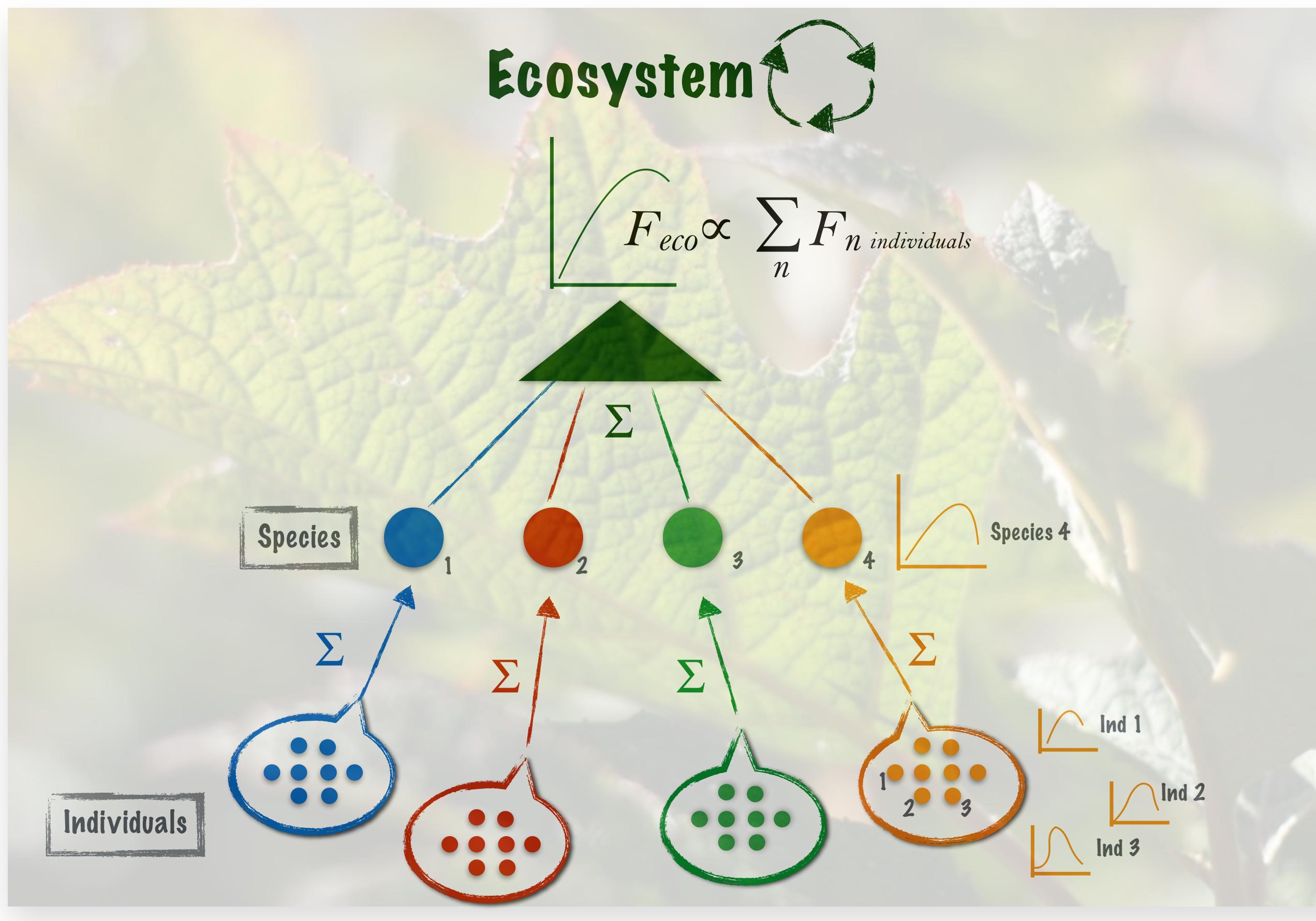
# SCALING UP INDIVIDUAL METABOLISM TO ECOSYSTEM FLUXES

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## Do species-level thermal performance curves (TPCs) scale up to ecosystem fluxes?



### Data

We combine new theory and data on the temperature dependence of key metabolic traits (photosynthesis and respiration rates) at both:

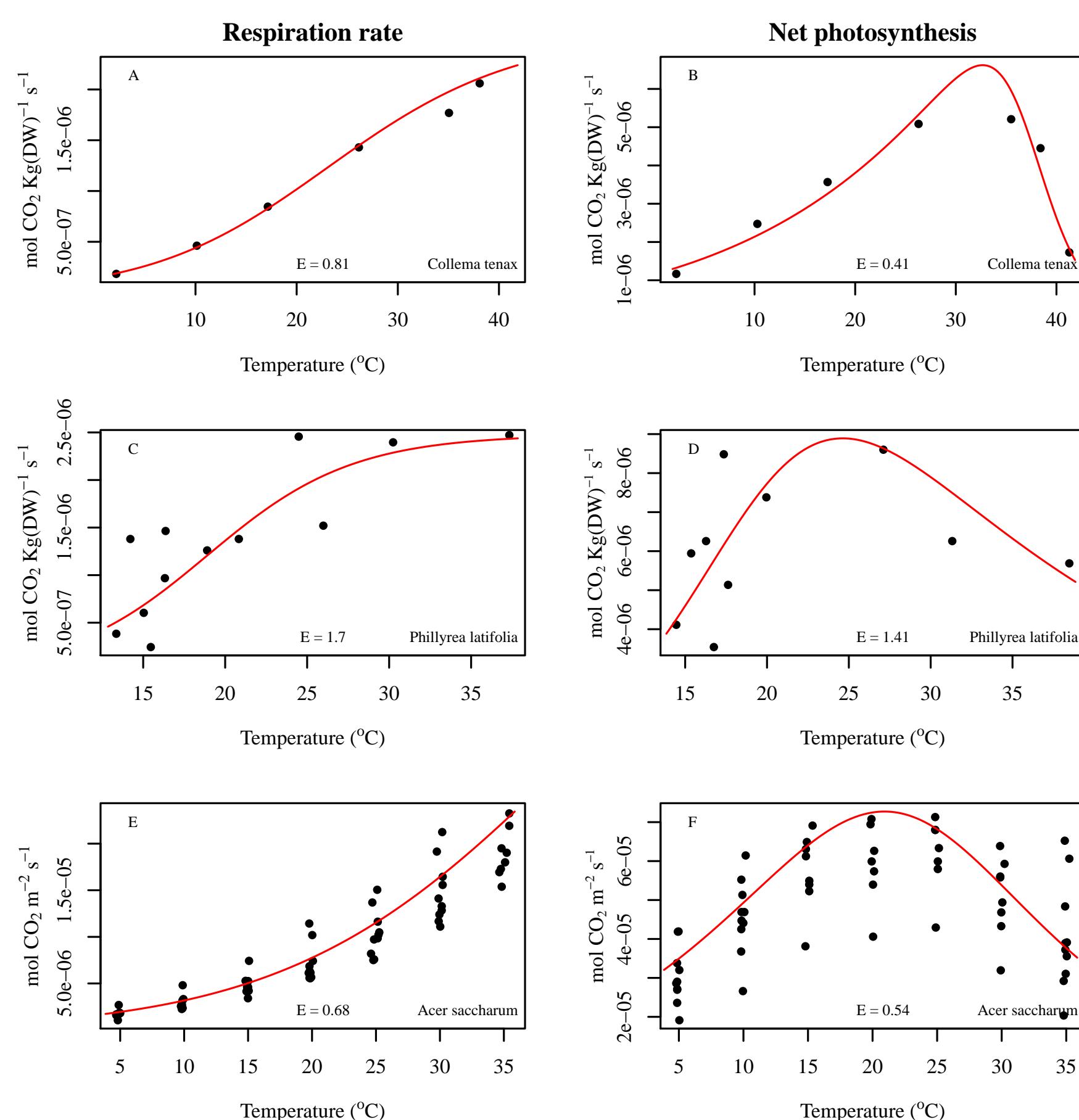
- Species level: more than 300 different species of terrestrial plants (*Biotraits Database*)
- Ecosystem level: 118 local terrestrial ecosystems across the world (*Fluxnet Database*)

We've performed a preliminary analysis of the data, to get the patterns necessary for parameterizing the model, and also validating it.

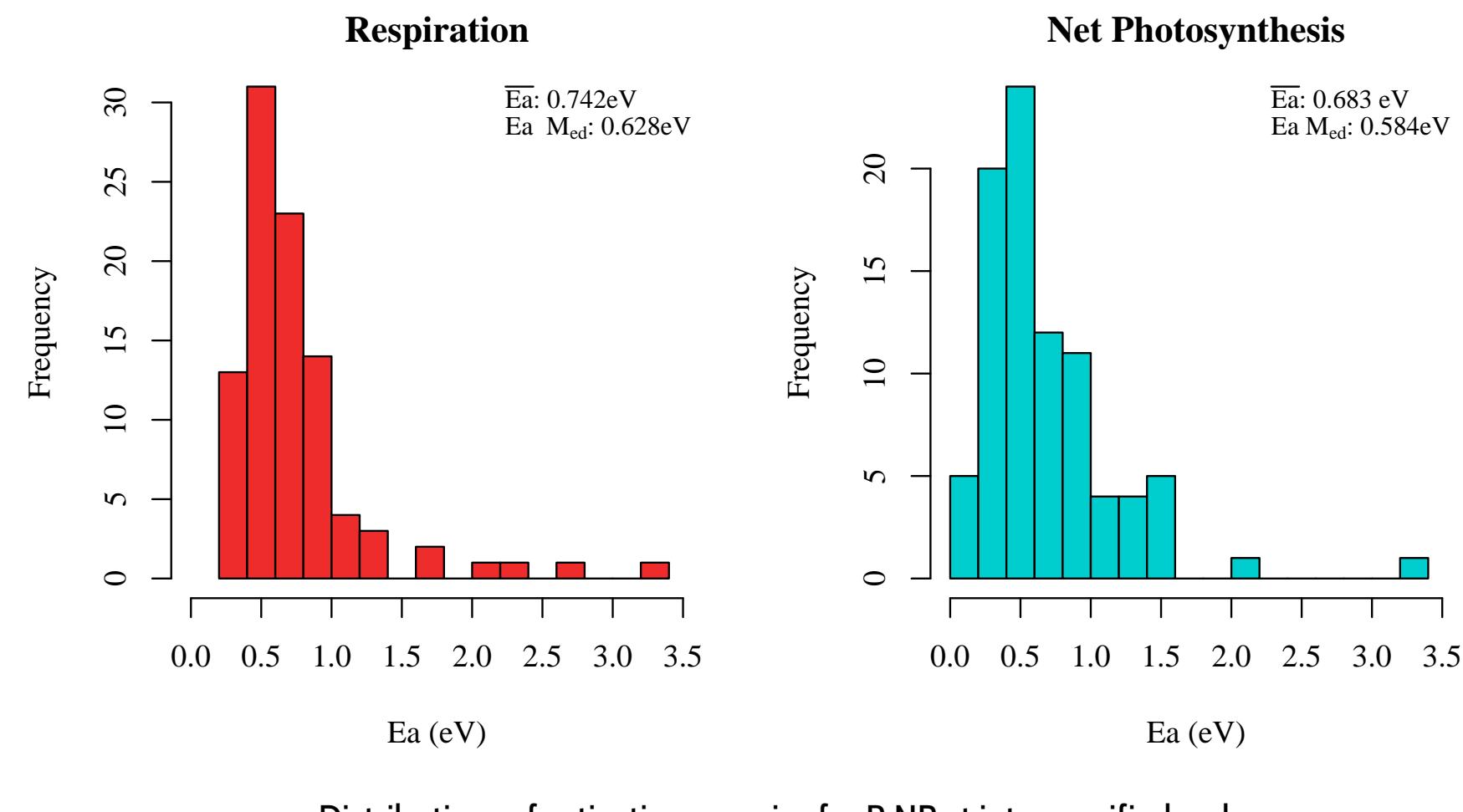
### We ask...

- Are differences in species-level temperature-dependence of photosynthesis and respiration reflected in the ecosystem thermal response?
- Does the full unimodal thermal responses of metabolic rates matter for mapping individual TPCs to ecosystem-level fluxes?
- Is simple scaling from species-level thermal responses sufficient to predict ecosystem-level responses?

### Parametrization



Representative set of individual-level plot pairs for R (left) and NP (right). Each pair of R-NP corresponds to the same experiment and species. These species are associated to temperate regions.



Distributions of activation energies for R NP at intraspecific-level.

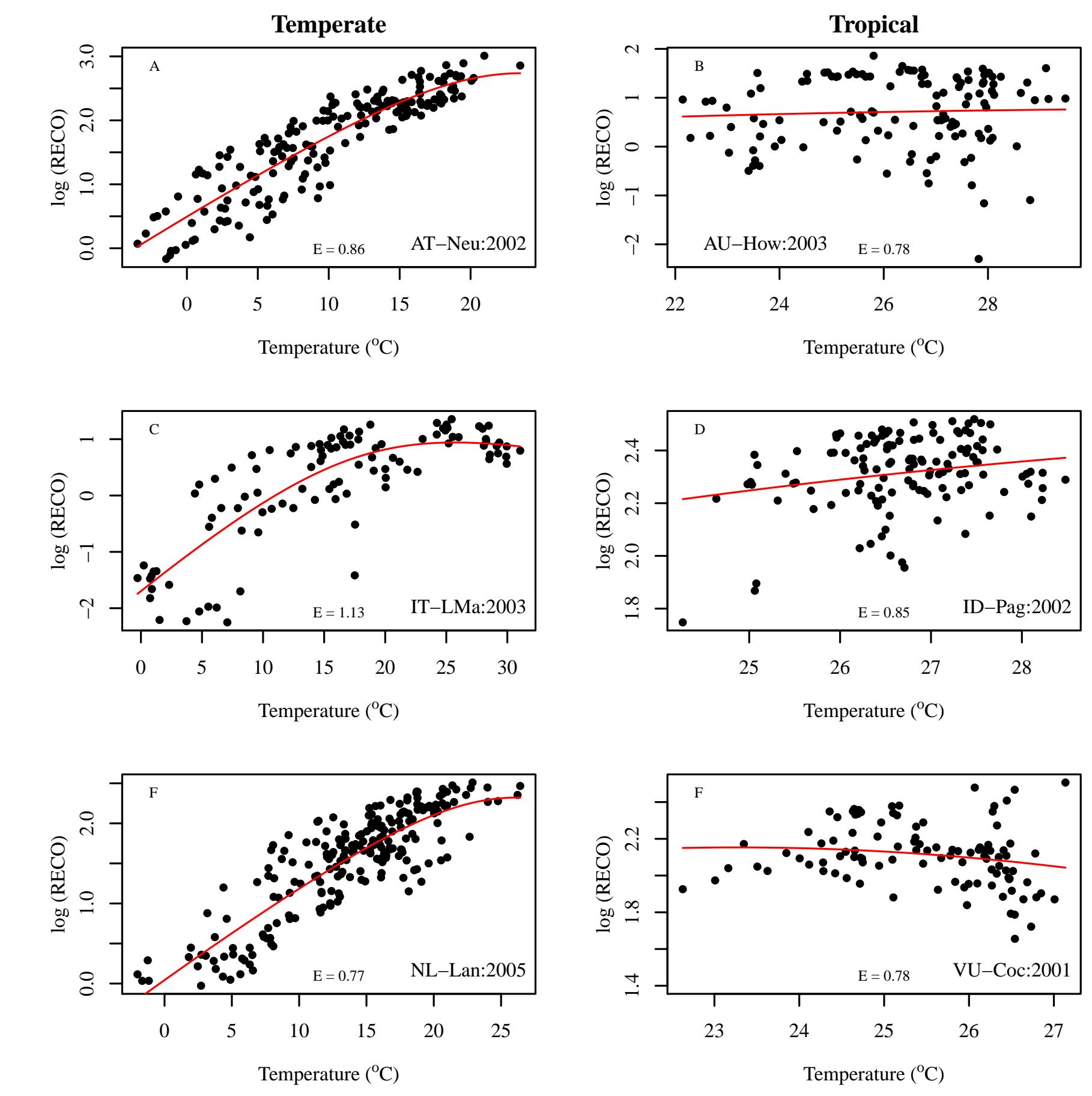
### Model

As ecosystem flux is essentially dependent upon the difference in biomass production ( $P$ ) and loss ( $R$ ) of individuals, a simple equation to map individual metabolism to ecosystem flux would be:

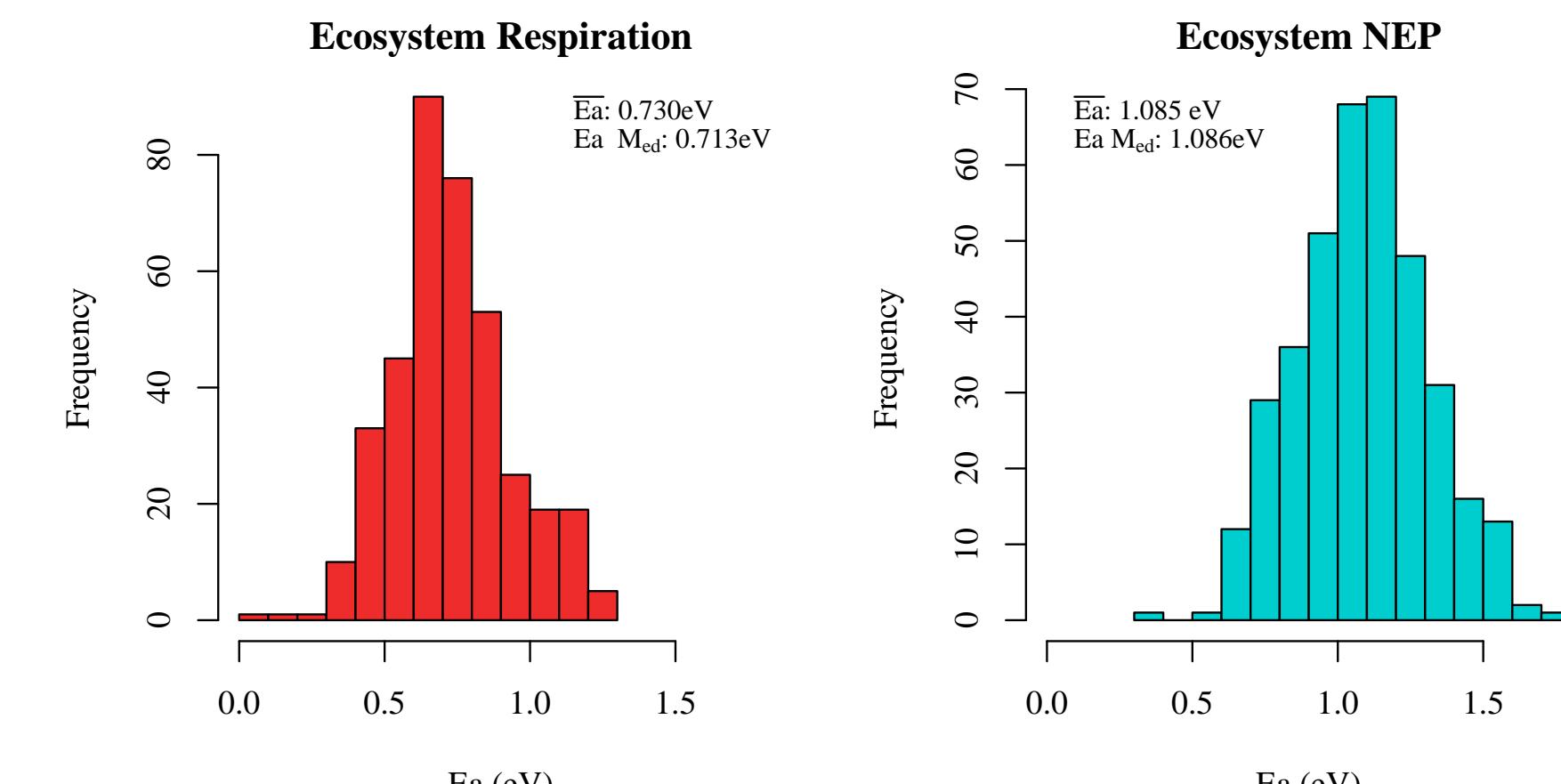
$$F = F_0 \sum_{i=1}^k x_i (f_P(m_i)g_P(T) - f_R(m_i)g_R(T))$$

- $\sum_{i=1}^k x_i$  is the total biomass of the ecosystem
- $(m_i)$  species' size
- $g(T)$  function of the contribution of temperature ( $T$ ) dependence
- $F_0$  constant that captures sources of variation in ecosystem fluxes that cannot be attributed to either body masses or TPCs

### Validation



Representative set of ecosystem flux responses to temperature for different sites from tropical and temperate regions. Y axis show respiration in log scale.



Distributions of activation energies for Reco NEP at ecosystem level.

### Summary

- At the intra-specific level,  $Ea$  and  $T_{peak}$  for  $R$  are usually higher than for  $P$ .
- $T_{peak}$ 's are usually much higher than the "characteristic" adaptive environment of the organism, so the full unimodal thermal responses of metabolic rates matter for mapping individual TPCs to ecosystem-level fluxes.
- A simple mapping seems to predict most of the ecosystem-level responses, however deviations could be expected for at least two reasons:
  - Acclimation of intraspecific TPCs might play on the ecosystem response
  - Non-linear interactions between species (e.g., competition and predation)

Further work needs to be done around these two facts.

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