Exploring the effects of biodiversity and elemental stoichiometry on terrestrial carbon balance?

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Known drivers of terrestrial C balance

- Climate, management, atmospheric deposition, land-use change…

![Diagram showing relationships between N Deposition, MAT, AET, GPP, Re, NEP, and their effects on each other.]

**Total standardised effects**

<table>
<thead>
<tr>
<th></th>
<th>N dep</th>
<th>AET</th>
<th>MAT</th>
<th>GPP</th>
<th>Re</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPP</td>
<td></td>
<td>0.60 ± 0.09</td>
<td>0.29 ± 0.09</td>
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<tr>
<td>Re</td>
<td>-0.14 ± 0.05</td>
<td>0.55 ± 0.08</td>
<td>0.27 ± 0.08</td>
<td>0.93 ± 0.03</td>
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<tr>
<td>NEP</td>
<td>0.37 ± 0.14</td>
<td>0.16 ± 0.31</td>
<td>0.01 ± 0.30</td>
<td>0.26 ± 0.11</td>
<td>-2.55 ± 0.05</td>
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</tbody>
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Modified from Fernández-Martínez et al., 2014 – Trees
Known drivers of terrestrial C balance

- *Nutrient availability* ~ altered atmospheric deposition and CO$_2$

Graph not shown due to copyright,
See de Vries et al., 2014 – *Nature Climate Change*
The role of biodiversity on ecosystem functioning

- **Biodiversity increases** productivity and stability in terrestrial and aquatic ecosystems (biomass production, decomposition)

- Shown to be **as important as other drivers of global change** (nutrients, drought)

- But it’s role on C balance is unknown!
Altered biogeochemical cycles and biodiversity

- Altered biogeochemical cycles and climate
  change C:N:P stoichiometry and reduce biodiversity

Graph not shown due to copyright,
see Steffen et al., 2015 - Science
Objectives:

Effects of foliar N and P and biodiversity on C balance

• Local scale:

  ~ 62 Fluxnet sites (GPP, Re and NEP) including:
  Forests (41), savannas, shrublands and grasslands (21)
  C flux means and their interannual variability (1/stability)
  Climate means, climate variability
  Site species abundance (species and phylogenetic diversity)
  Foliar N & P concentration (community weighted means)
Climate, nutrients and biotic factors drive C fluxes (all sites)

a) Annual sums and Interannual variability

Variance explained ($R^2$, %)

GPP

Re

NEP

b) Annual sums and Interannual variability

Species diversity weakly increases Re
Phylogenetic diversity stabilises NEP in non-forest ecosystems

a) 

<table>
<thead>
<tr>
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<th>Interannual variability</th>
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<tbody>
<tr>
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<td>Climate</td>
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<td>GPP</td>
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<td>A</td>
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<td>NEP</td>
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Variance explained ($R^2$, %)

b) 

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<tr>
<td>Diversity_{phylo}</td>
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<tr>
<td>N</td>
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<td>P</td>
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Foliar stoichiometry affects C fluxes
The magnitude of the flux controls its temporal variability

(a) GPP

$\beta = -0.68 \pm 0.09$
$P = 0.001$
$R^2 = 48.2\%$

(b) Re

$\beta = -0.40 \pm 0.13$
$P = 0.004$
$R^2 = 15.2\%$

(c) NEP

$\beta = -0.50 \pm 0.09$
$P < 0.001$
$R^2 = 27.5\%$

(d) Leaf N (% DW)

$\beta = 0.24 \pm 0.09$
$P = 0.009$
$R^2 = 8.3\%$

(e) MAP (mm y$^{-1}$)

MAT × MAP:

$\beta = -0.67 \pm 0.27$
$P = 0.018$
$R^2 = 23.1\%$

(f) MAT (°C)

$\beta = 0.22 \pm 0.09$
$P = 0.022$
$R^2 = 6.5\%$
Take-home messages

• Larger C fluxes tend to be more stable over time

• **Foliar N:P stoichiometry** affects GPP, Re and NEP. Changes are expected if stoichiometry and/or species change

• Better **biodiversity assessments are needed** to understand the role of biodiversity on C balance
Thanks for your attention!