Climate change and forest understory dynamics

Rodriguez-Sanchez *et al* 2012 *Nature Climate Change*

De Frenne, Rodriguez-Sanchez *et al* 2013 *PNAS*

De Frenne, Rodriguez-Sanchez *et al* 2015 *Nature Plants*

De Frenne *et al* 2019 *Nature Ecol & Evol*

Pieter De Frenne

E Badley

Are communities tracking warming fast enough?

LETTER

doi:10.1038/nature10548

Changes in plant community composition lag behind climate warming in lowland forests

PROCEEDINGS OF THE ROYAL SOCIETY B

Proc. R. Soc. B (2008) 275, 2743–2748
doi:10.1098/rspb.2008.0878
Published online 19 August 2008

Birds are tracking climate warming, but not fast enough

nature climate change

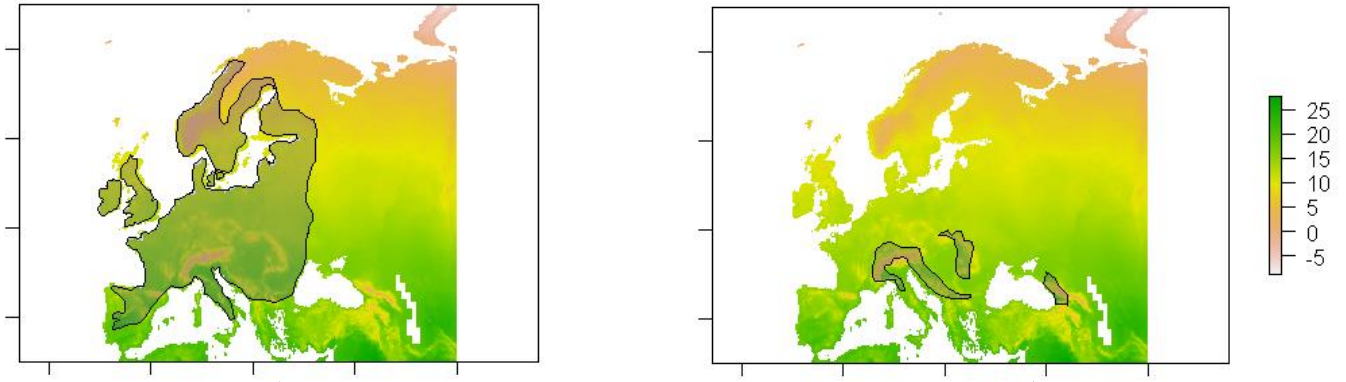
LETTERS

PUBLISHED ONLINE: 10 JANUARY 2012 | DOI: 10.1038/NCLIMATE1347

Differences in the climatic debts of birds and butterflies at a continental scale

Measuring communities' response to warming

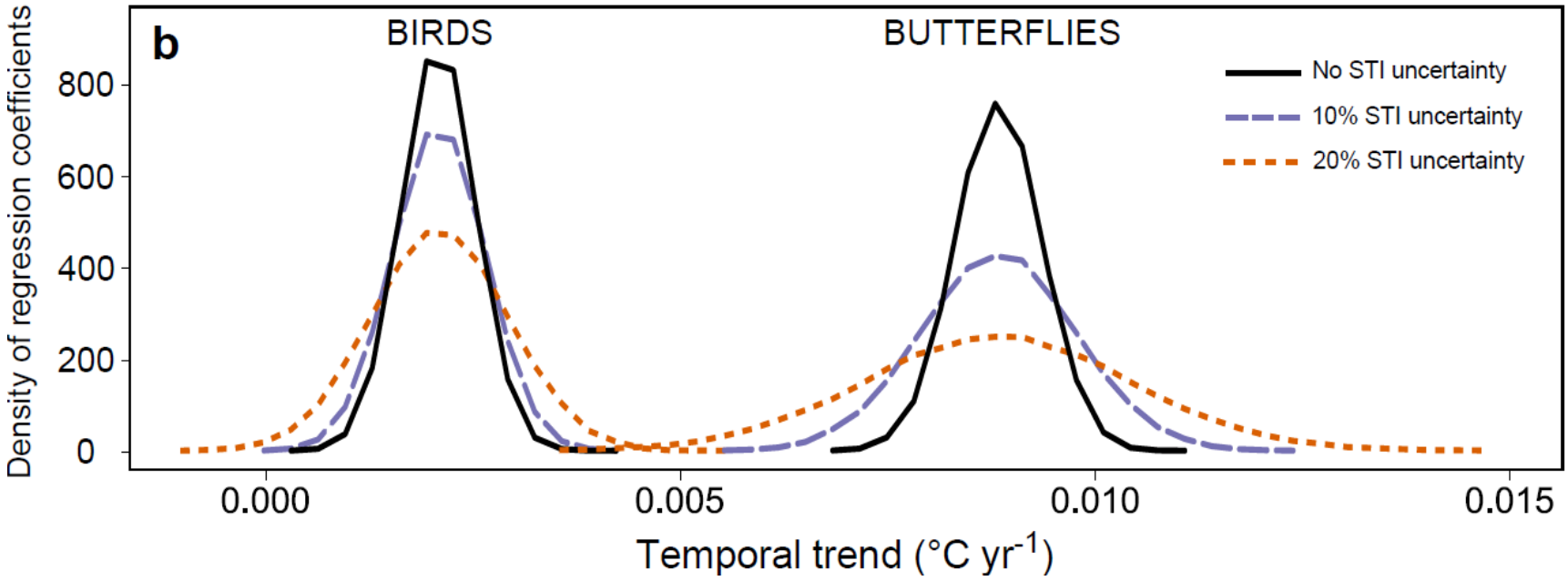
Species Thermal Index (STI)



Community Temperature Index (CTI)

$$\mathbf{CTI} = STI_1 * RelAbund_1 + STI_2 * RelAbund_2$$

Considering uncertainty and variation in species' thermal tolerances is critical



Uncertainty in thermal tolerances and climatic debt

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Pieter De Frenne[1,2] and Arndt Hampe[3,4]

NATURE CLIMATE CHANGE | VOL 2 | SEPTEMBER 2012

How are forest understoreys responding to climate change?

- >1400 plots

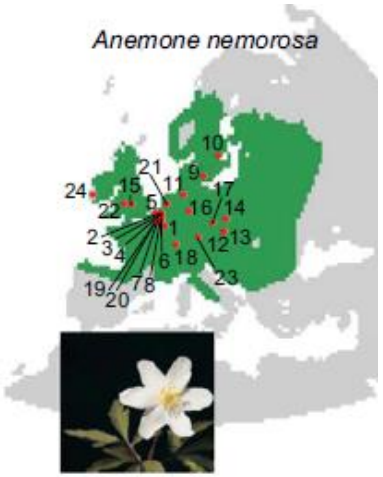
  resurveyed c. 35 years apart (range: 12 – 67 years)

- 29 regions

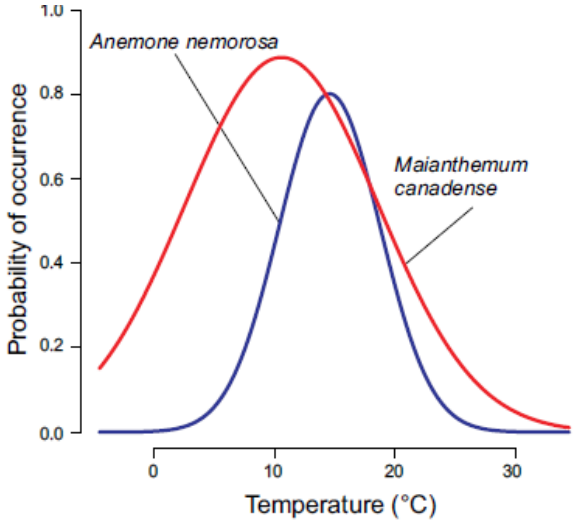
- 1032 species

From species' thermal tolerances to community thermophilization

Range maps

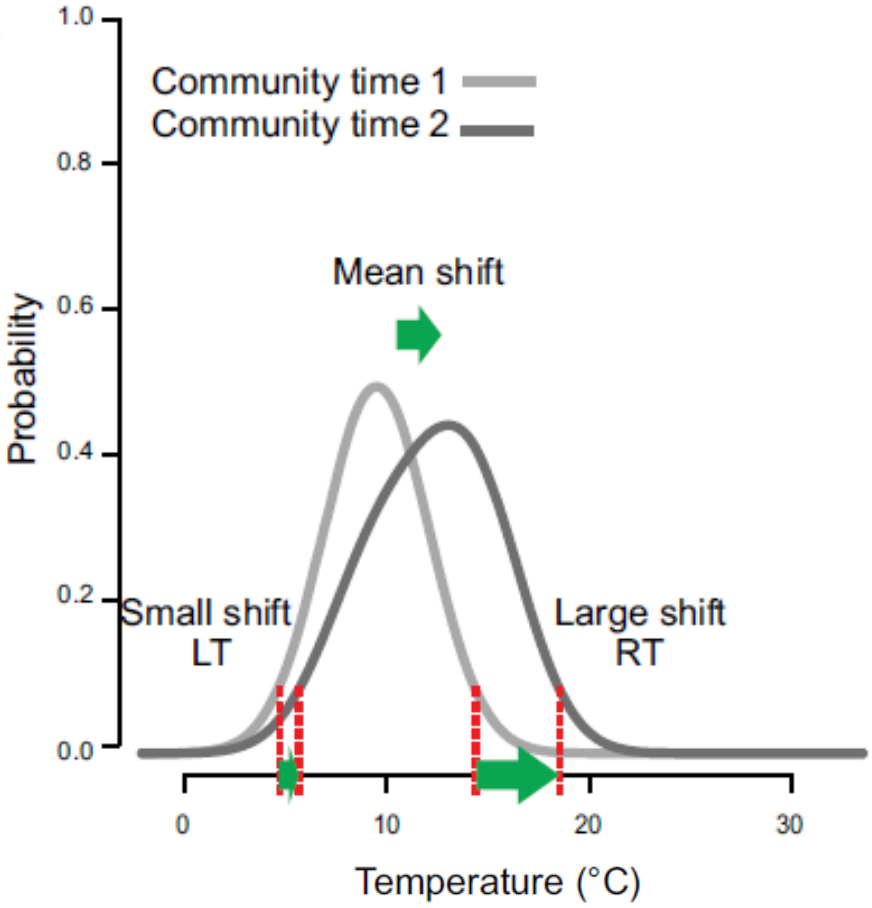


Species' thermal tolerances

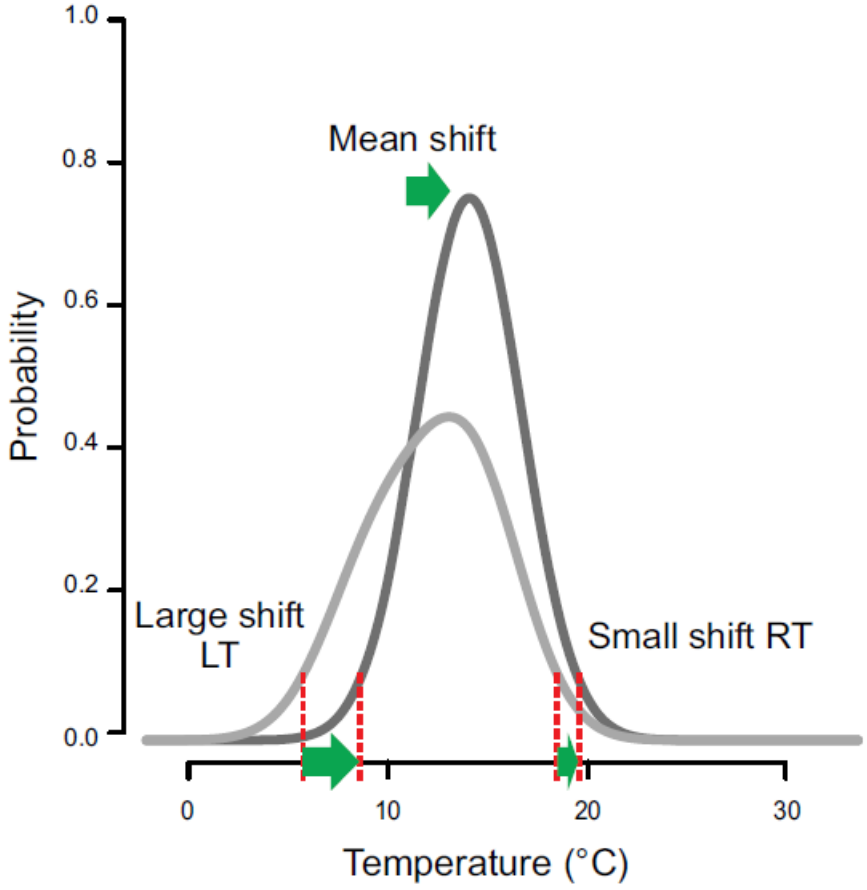


Detecting changes in cold-tolerant vs warm-dwelling species

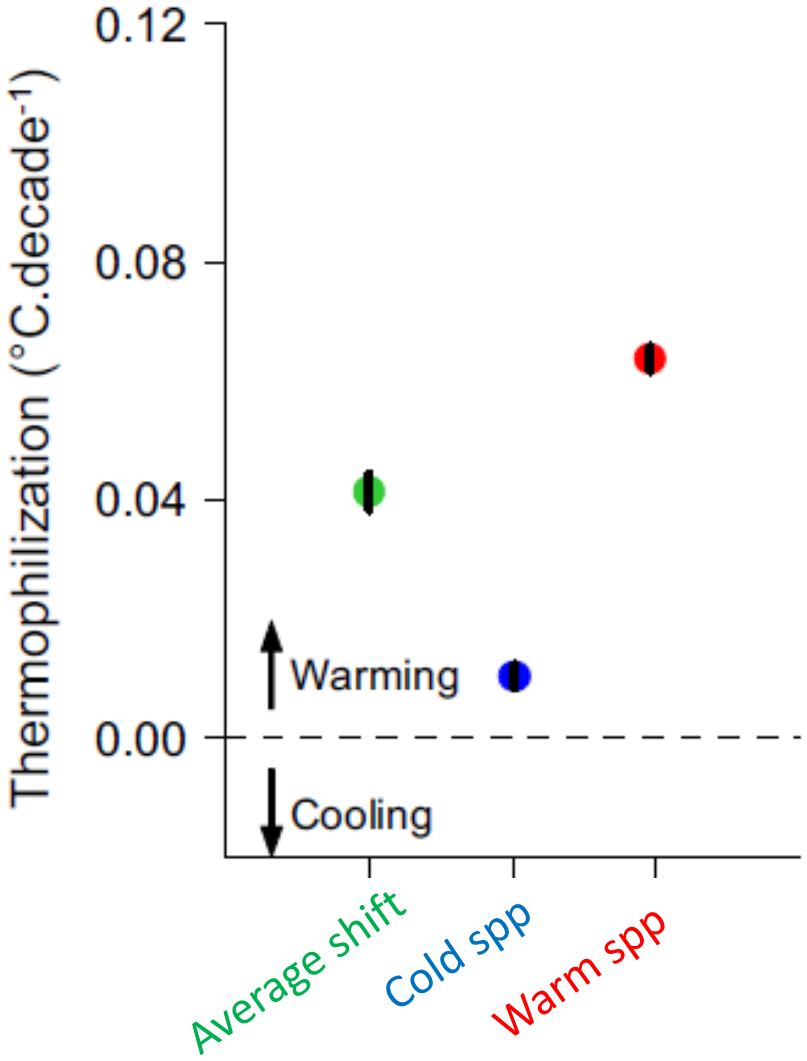
Increase of warm-adapted species

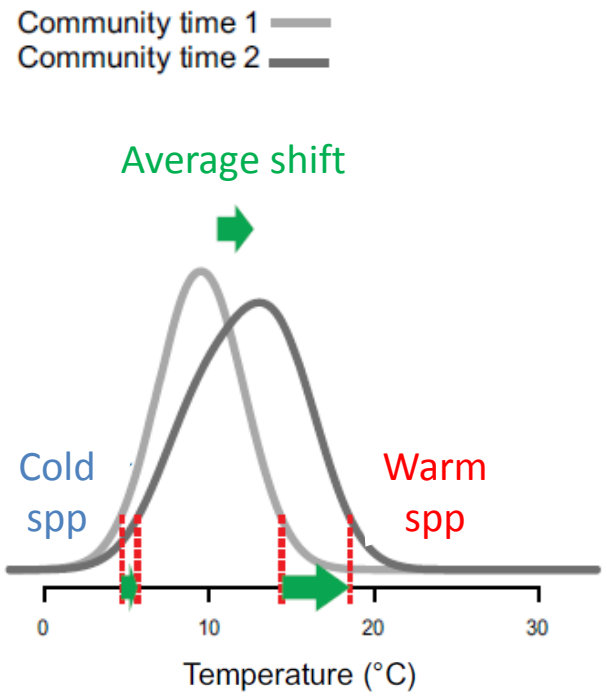


Loss of cold-adapted species

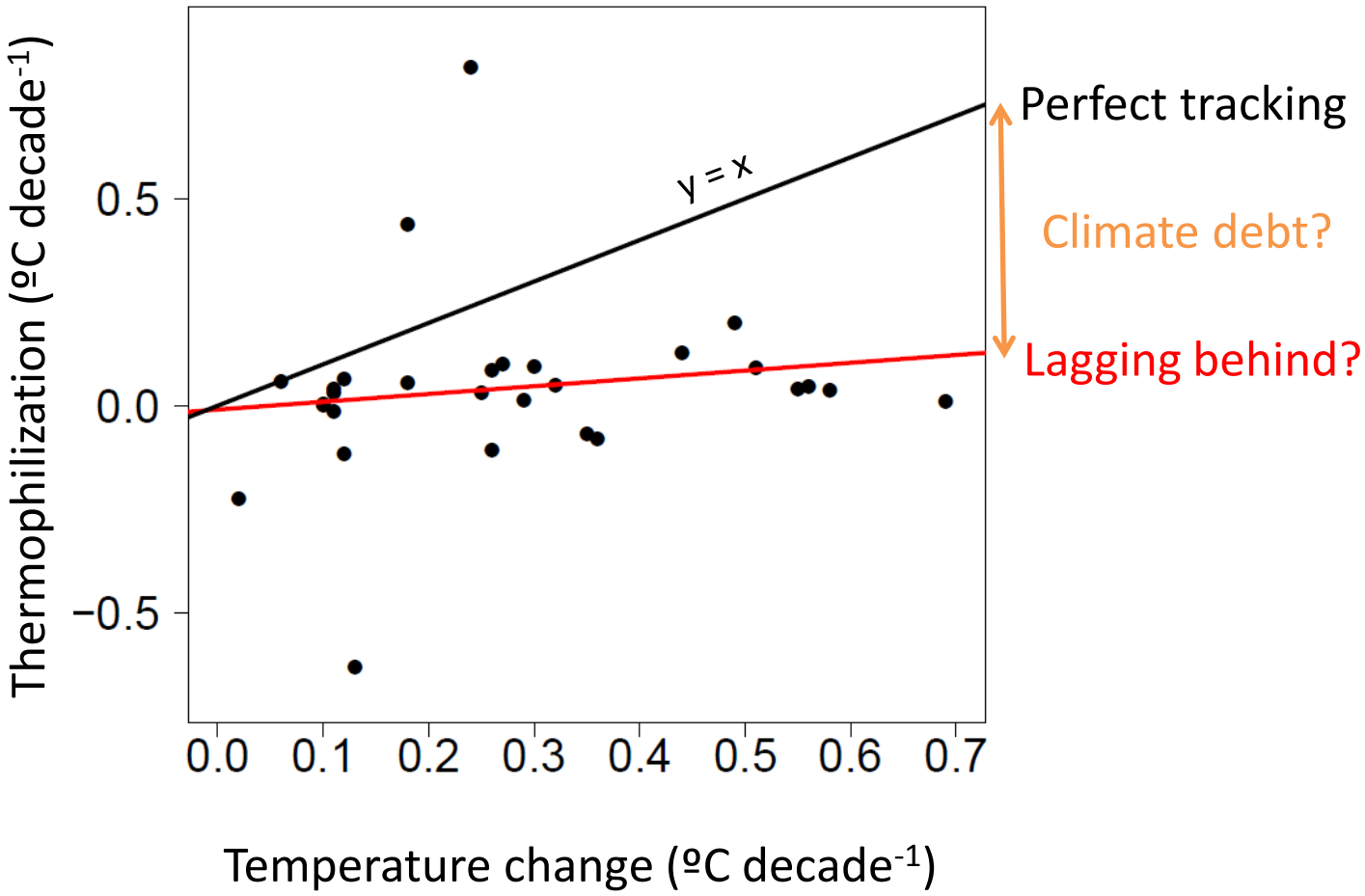


Most communities are thermophilizing



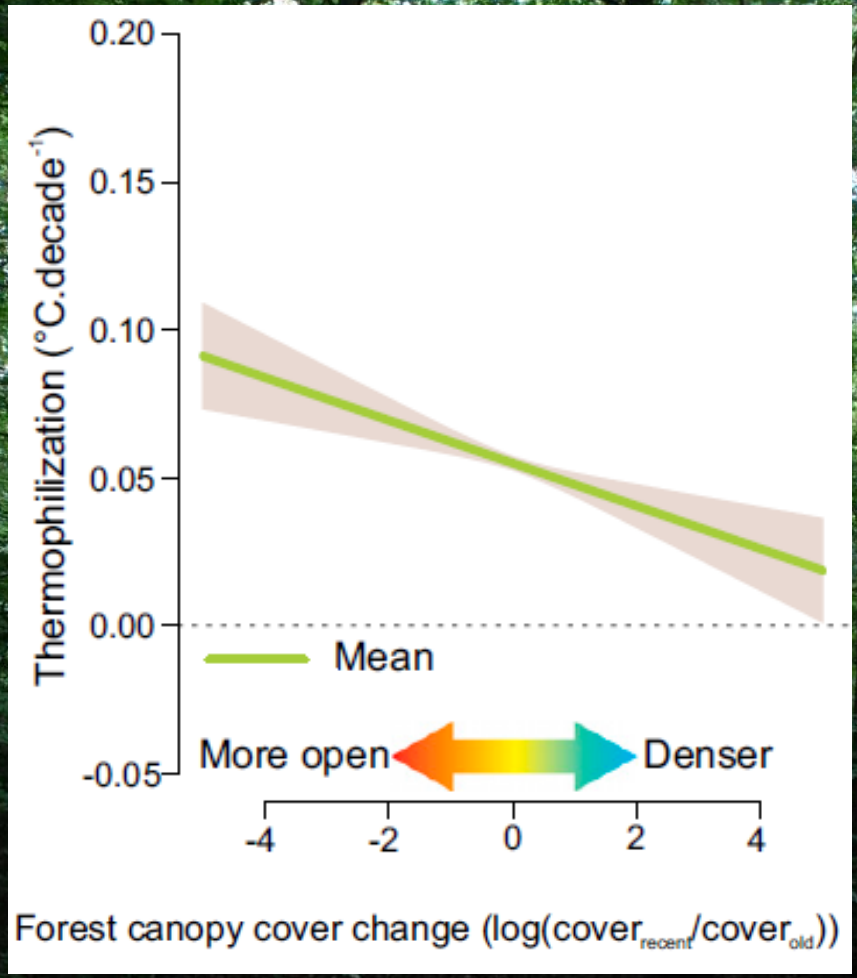


Thermophilization much lower than warming rate



Forest expansion buffers macroclimate warming

Forest expansion lowers thermophilization



Microclimate moderates plant responses to macroclimate warming

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How much do forests cool temperatures?

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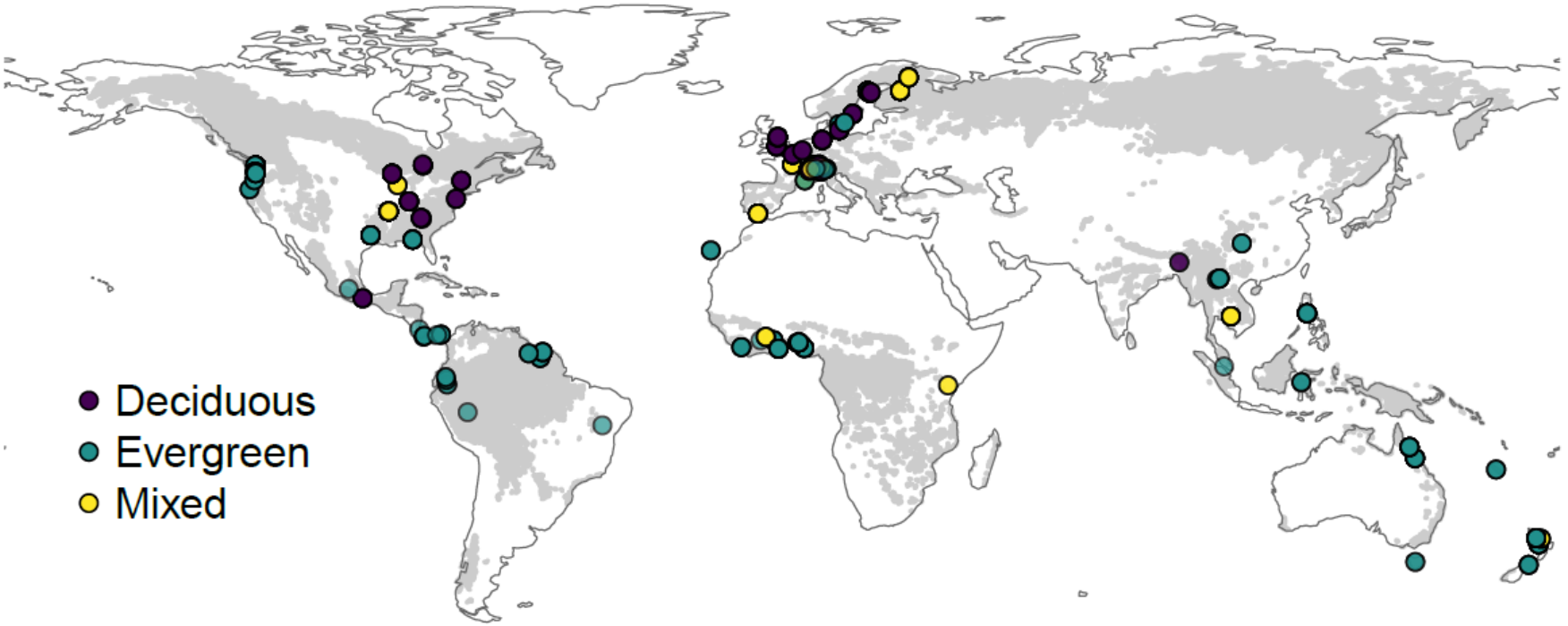
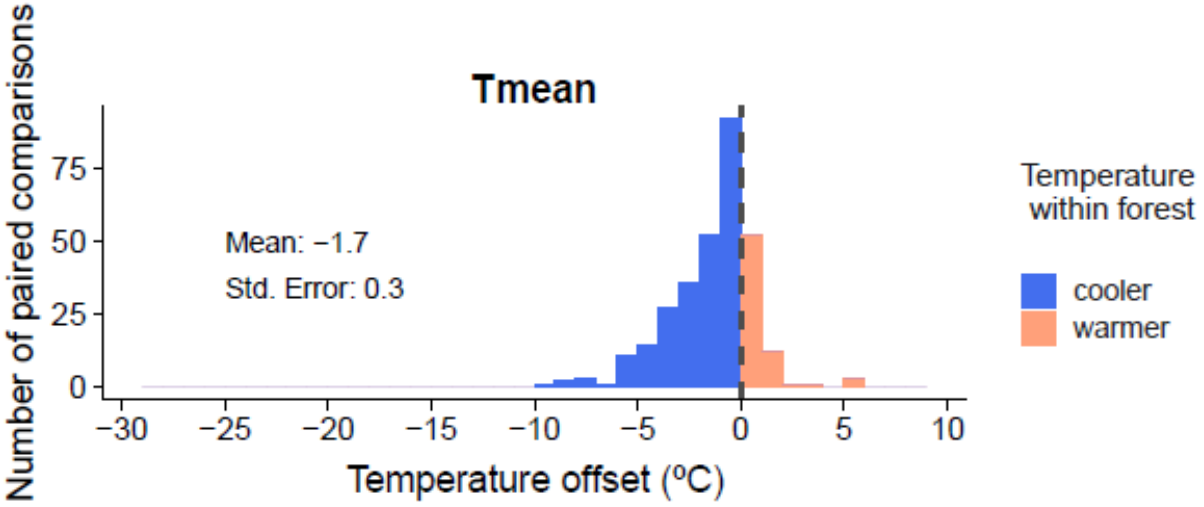


98 sites

714 paired measurements

How much do forests cool temperatures?



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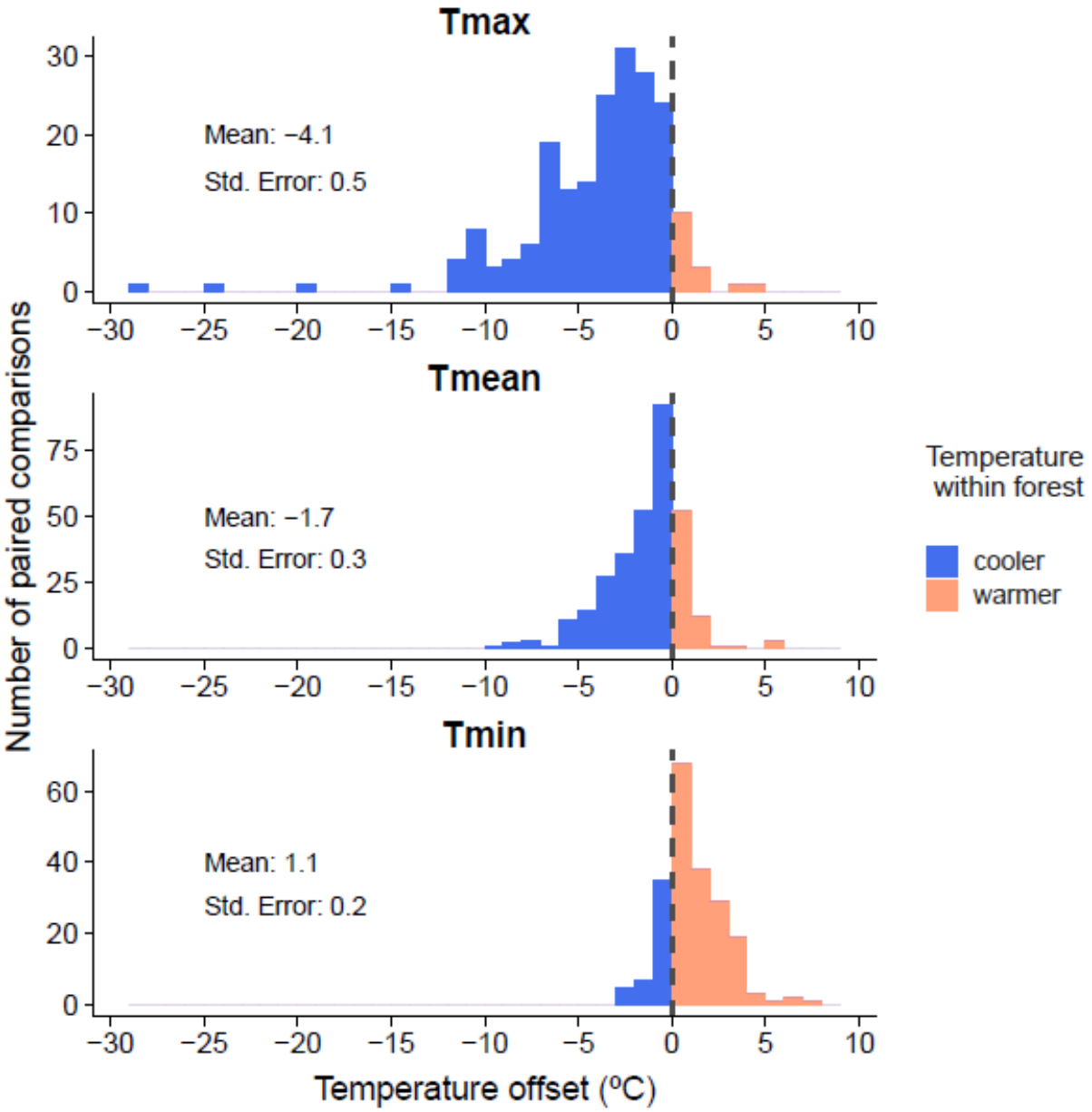
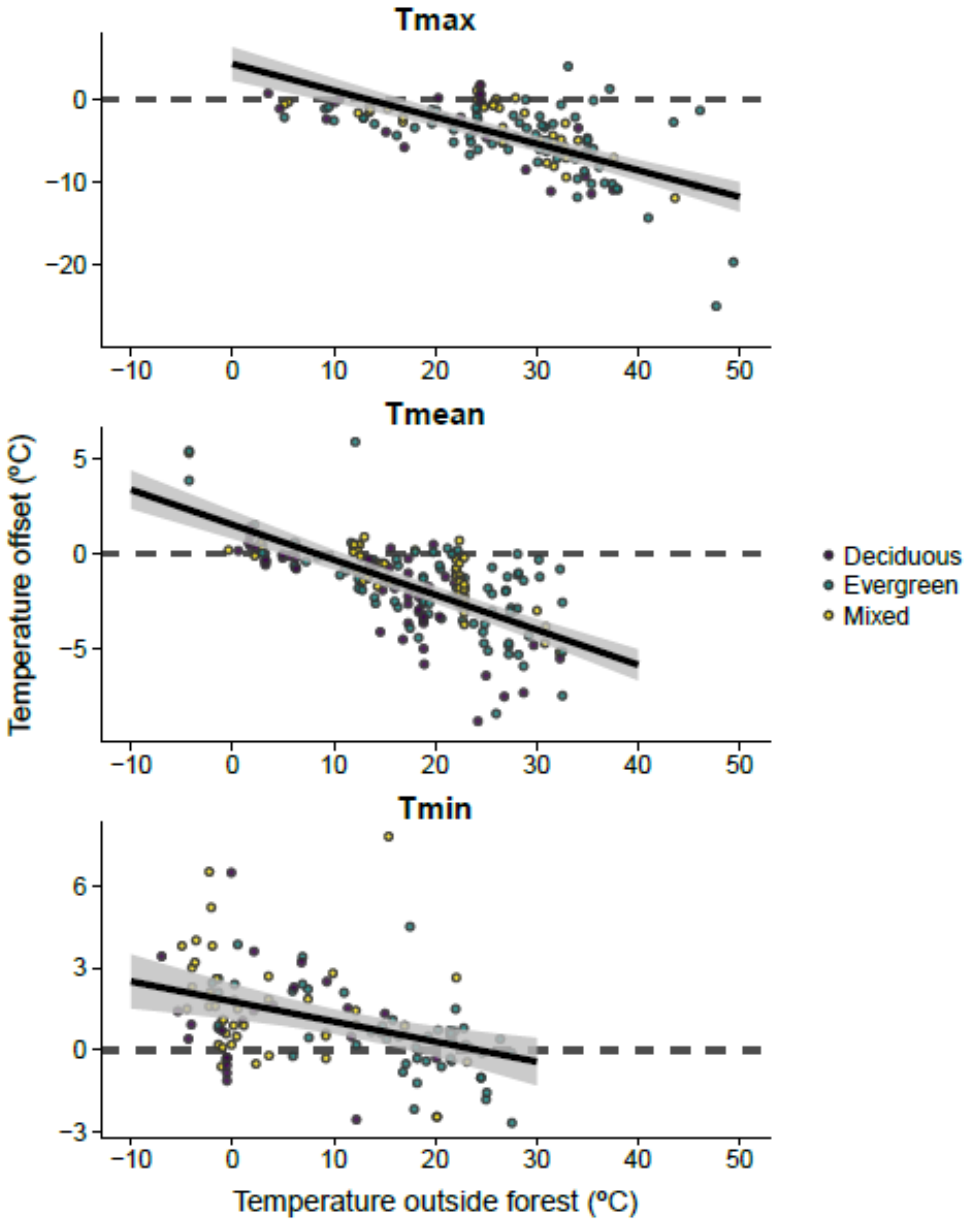


How much do forests cool temperatures?



BRIEF COMMUNICATION
https://doi.org/10.1038/s41559-019-0842-1
nature ecology & evolution

Global buffering of temperatures under forest canopies

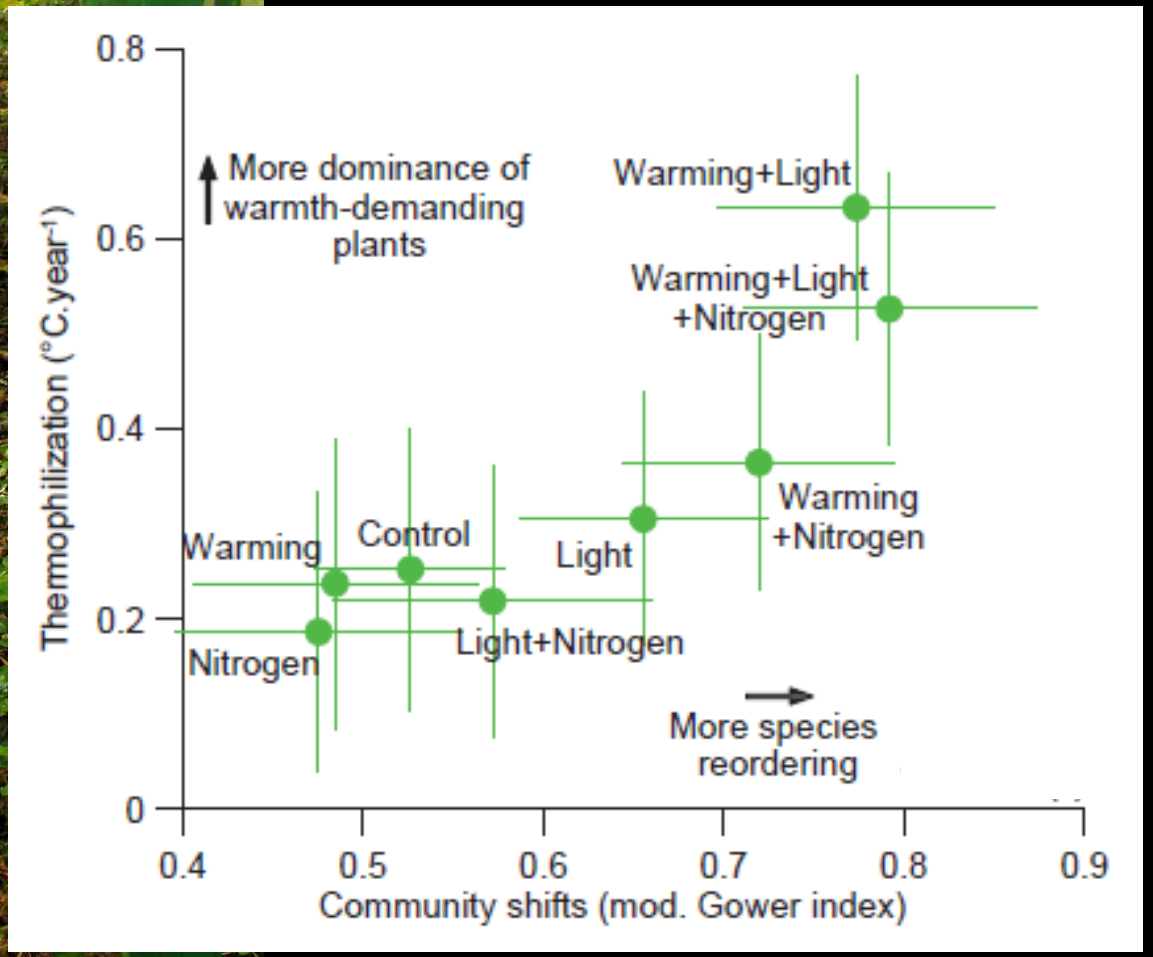
"Forests function as a **thermal insulator**, cooling the understory when ambient temperatures are hot and warming the understory when ambient temperatures are cold"

"The magnitude of this effect is larger than land warming over the past century"

Not only warming…

Multiple drivers of community dynamics

Tree shade hinders understory change due to warming



De Frenne, Rodriguez-Sanchez et al (2015) *Nature Plants*

- Nature is complex
- Forests cool macroclimate
- Tree canopies buffer temperature changes
- Shelter for millions of species