Climate change impacts on plant carbon metabolism in boreal and tropical tree species in Canada and Rwanda

Eric M. Dusenge

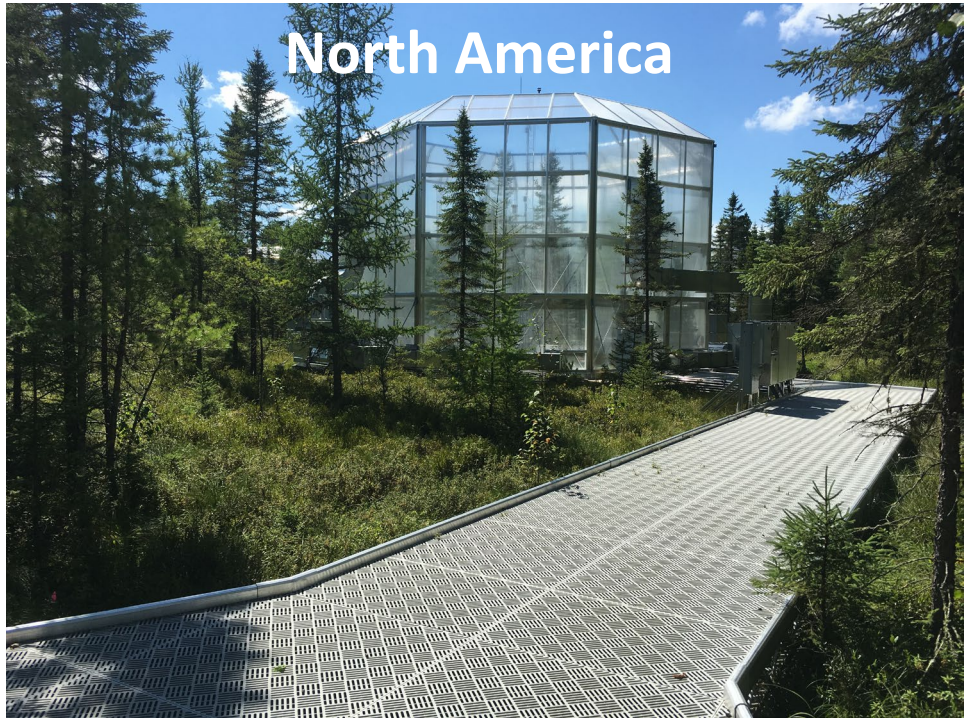
ARC DECRA Fellow,

Research School of Biology

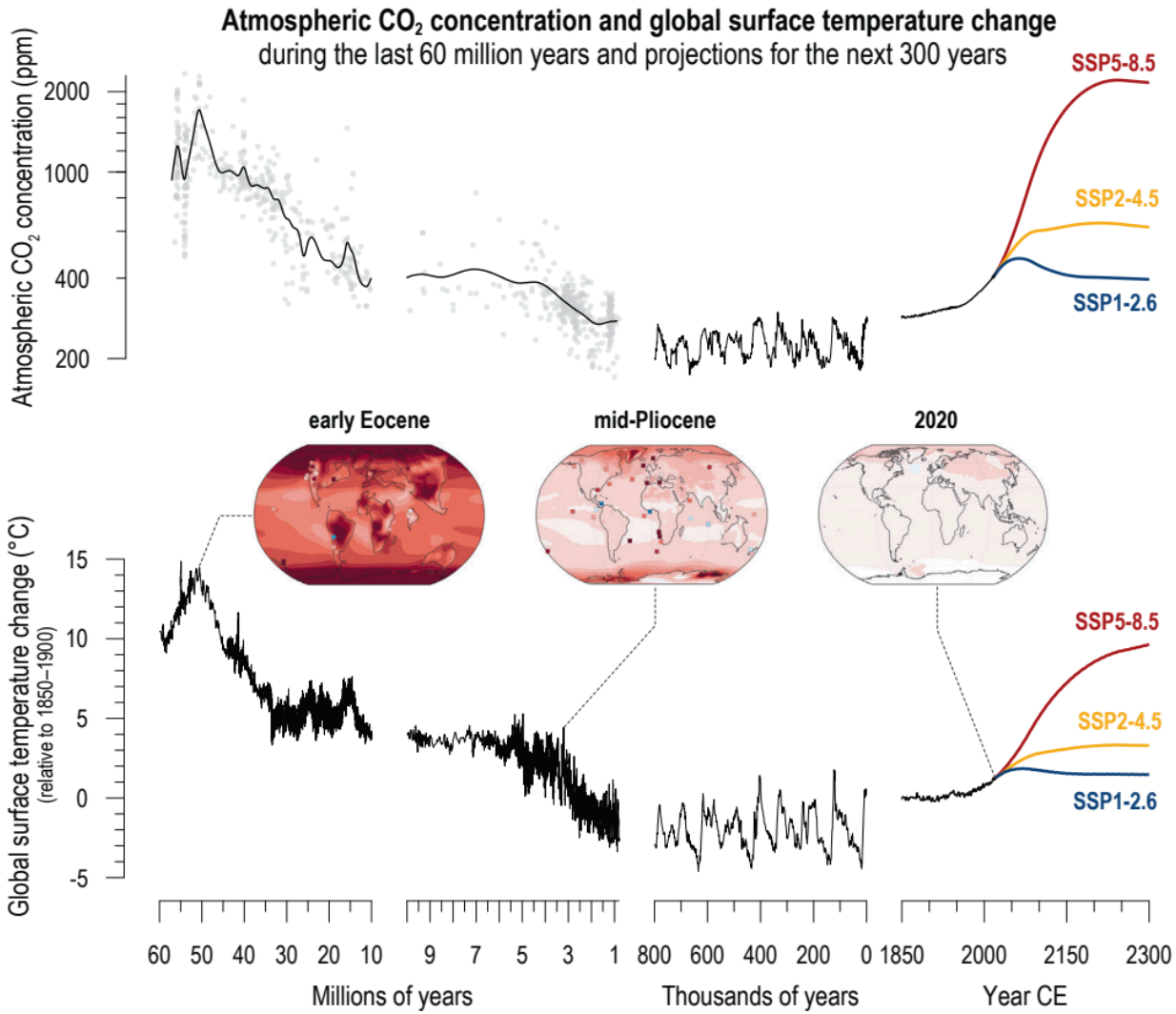
Australian National University

WeCLISH and PARTAKE Africa's

Climate Café on Zoom, February 28, 2025



Carbon dioxide (CO_2) – the largest contributor to climate change



IPCC 2021

Climate change – a global crisis

"Climate Change and loss of biodiversity is seen as the most pressing challenge over the next decade" (UNESCO 2021)

Wildfires

Drought and Heat

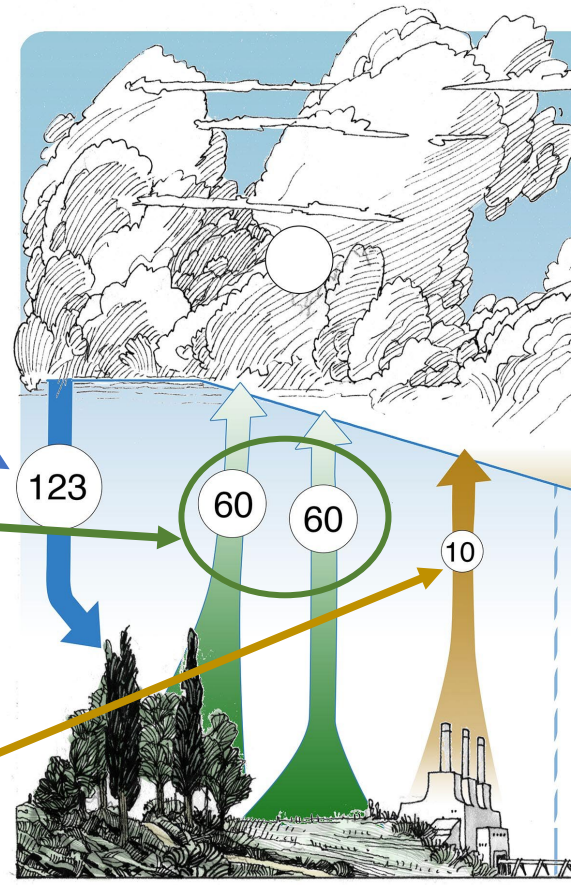
Heat stress

Importance of **plant carbon metabolism** to the global carbon cycle

Photosynthesis – Net CO_2 **uptake** by plants

Respiration – CO_2 **loss** by plants & soils

Human CO_2 emissions



~ 12 times bigger

Dusenge, Duarte & Way 2019. New Phytologist *Tansley Review* 221: 32 – 49
Friedlingstein et al. 2020. Earth Syst Sci Data 12: 3269 - 3340

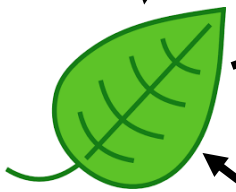
Photosynthesis

PSII

PSI

NADPH

ATP



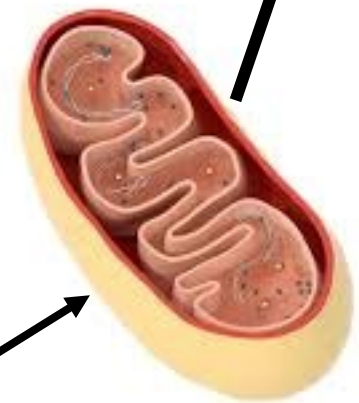
Rubisco

CO_2

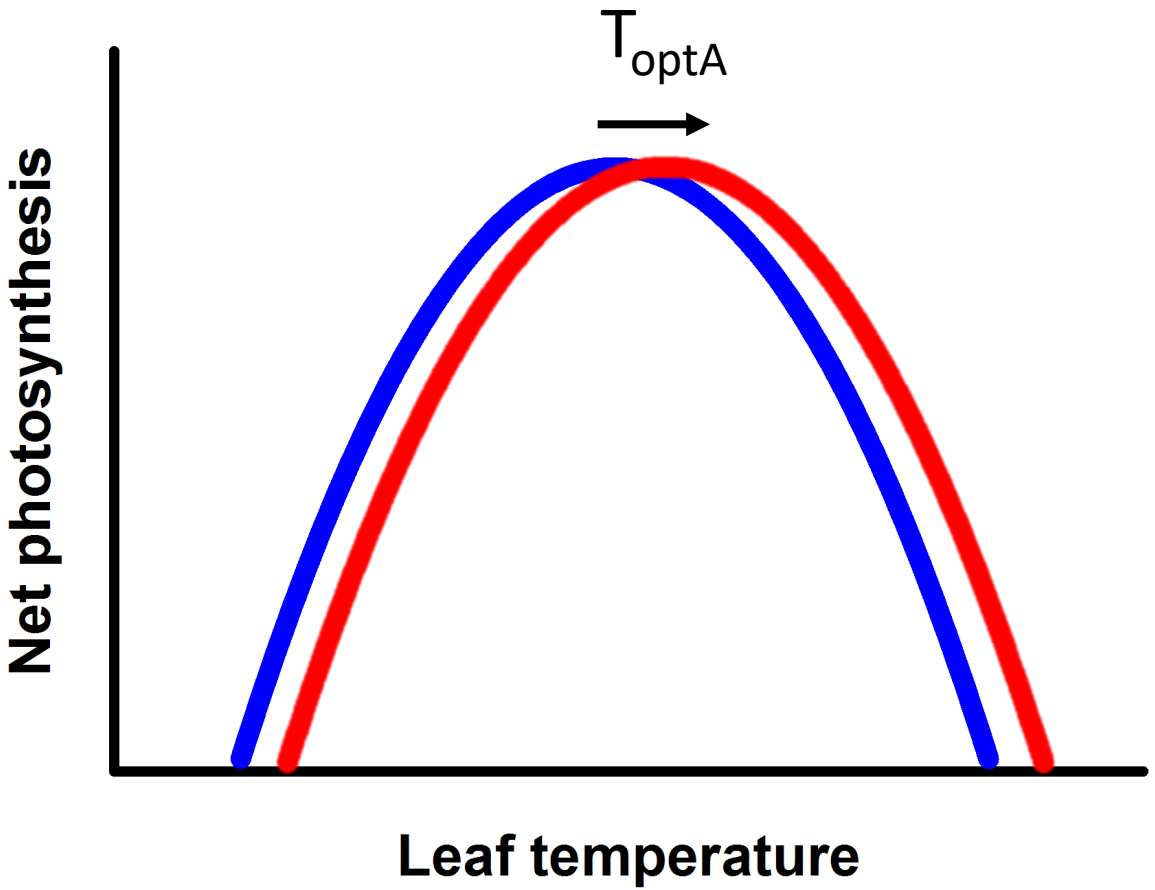
Calvin cycle

Sugars

Respiration



Responses of photosynthesis to temperature

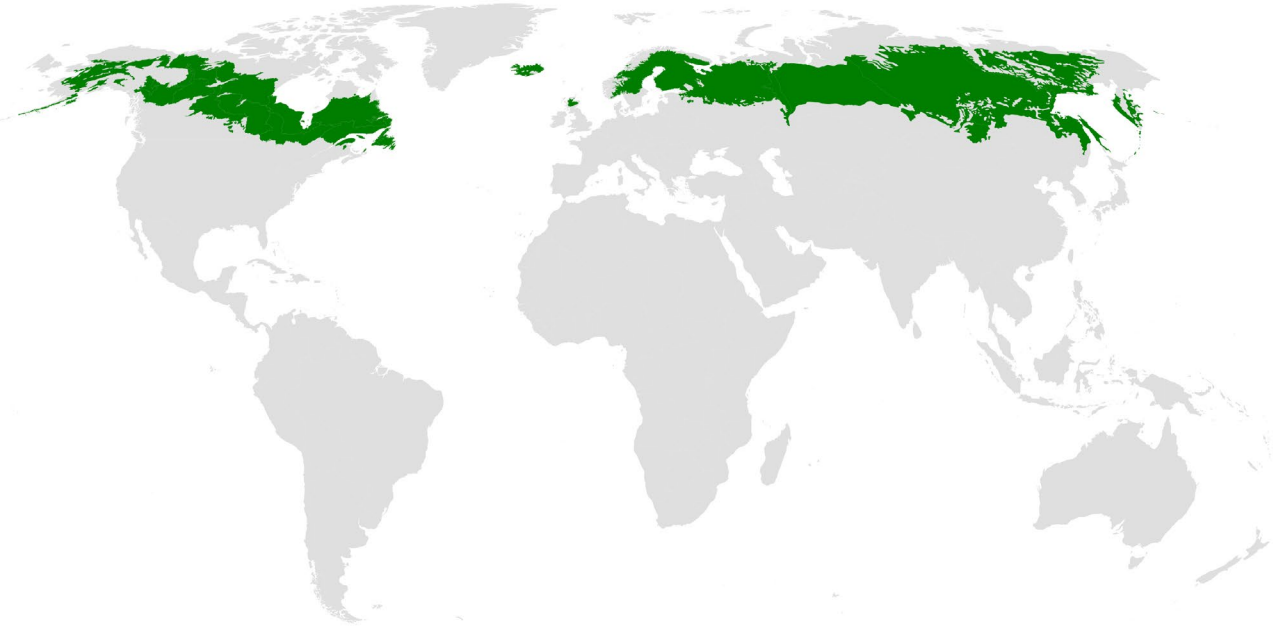


T_{optA} globally varies between 20 – 30 °C

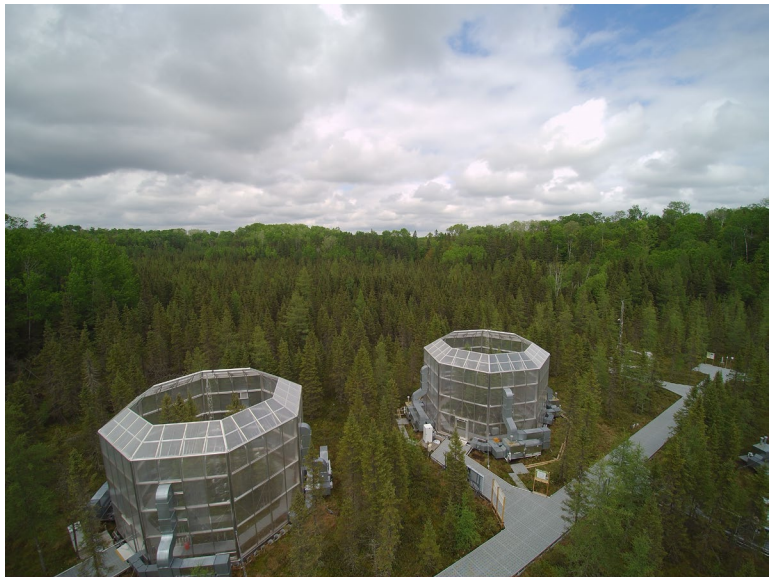
Yamori, Hikosaka, & Way 2014 Photosynthesis Research 119: 101 – 117
Kumarathunge et al. 2019. New Phytologist 222: 768 - 784

Boreal biome

Boreal forest productivity is often assumed to be temperature-limited, and moderate warming is predicted to stimulate boreal productivity

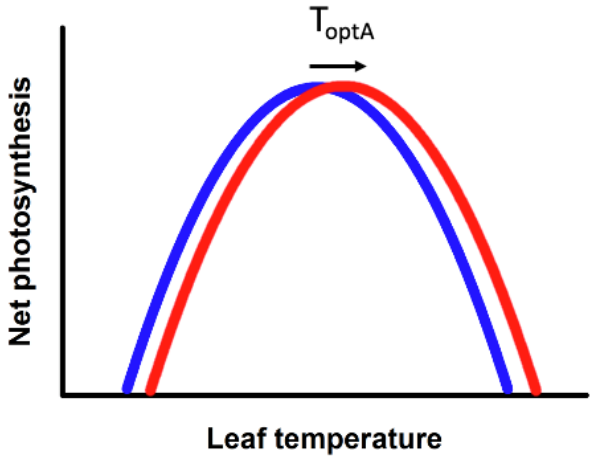


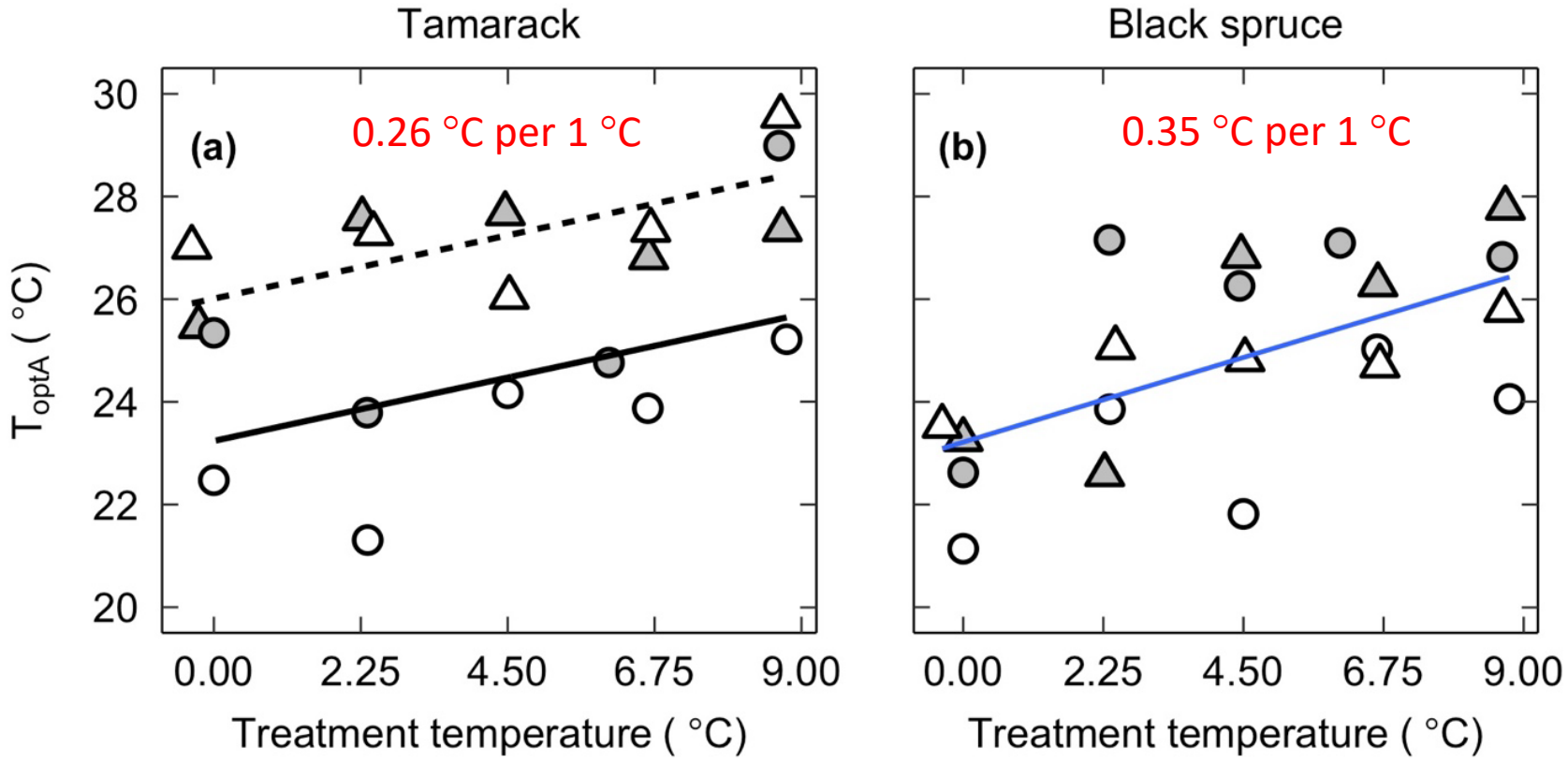
Spruce and Peatland Responses Under Changing Environments



aCO_2	+0	+2.25	+4.5	+6.75	+9
eCO_2 + 500 ppm	+0	+2.25	+4.5	+6.75	+9

T_{optA} positively shifted with warming in both species, and was higher in eCO_2 – grown tamarack likely as a response of suppression of photorespiration



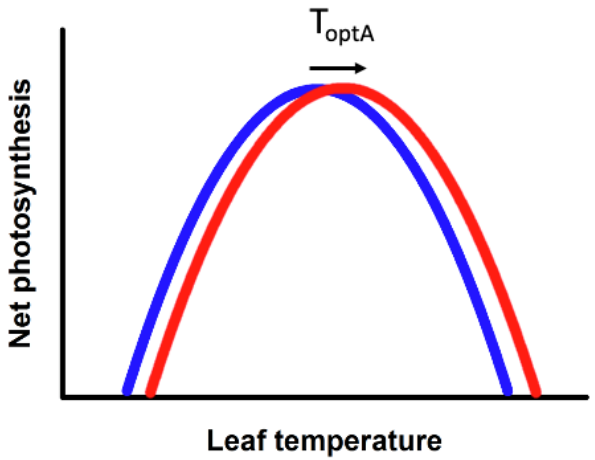


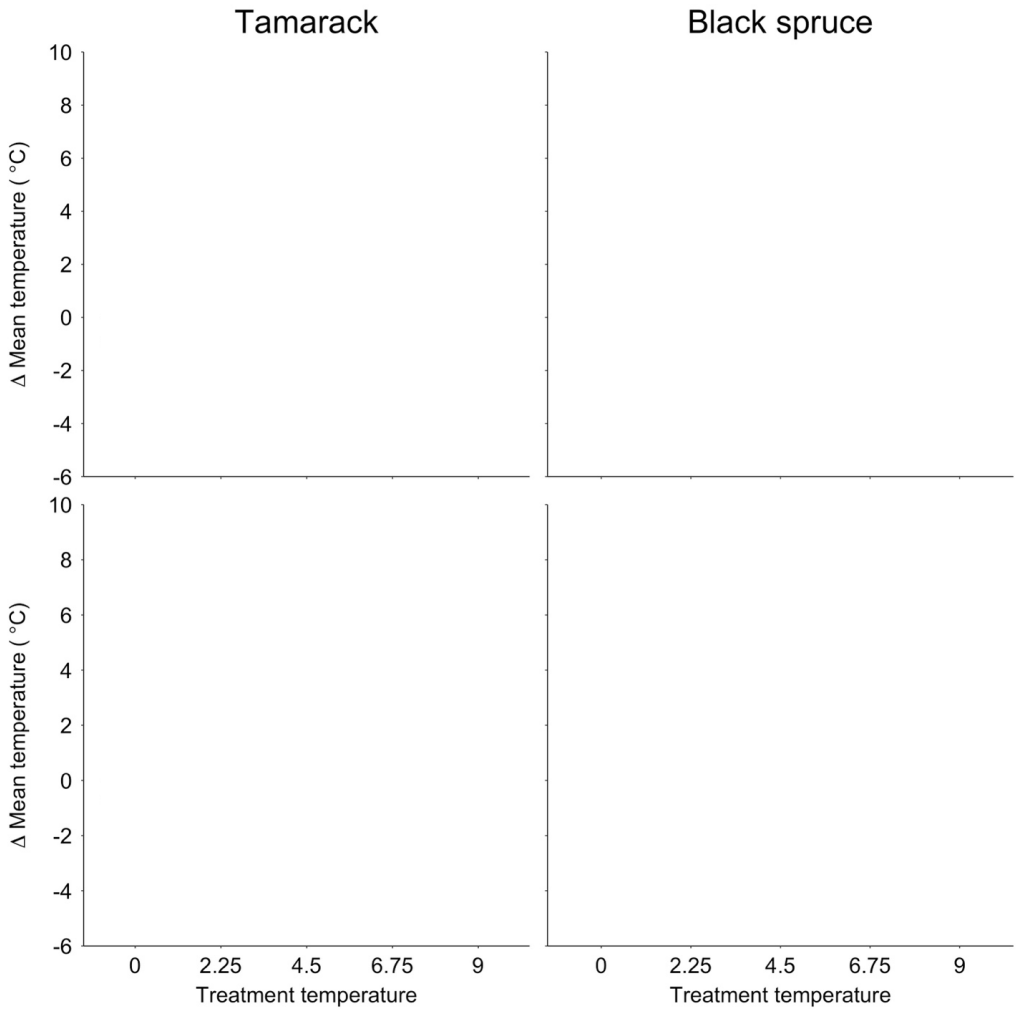
Dusenge et al. 2023. Nature Communications 14: 4667

Increases in T_{optA} did not keep pace with warming

0.26 – 0.35 °C per 1 °C

Δ Mean = Daytime Temperature - T_{optA}



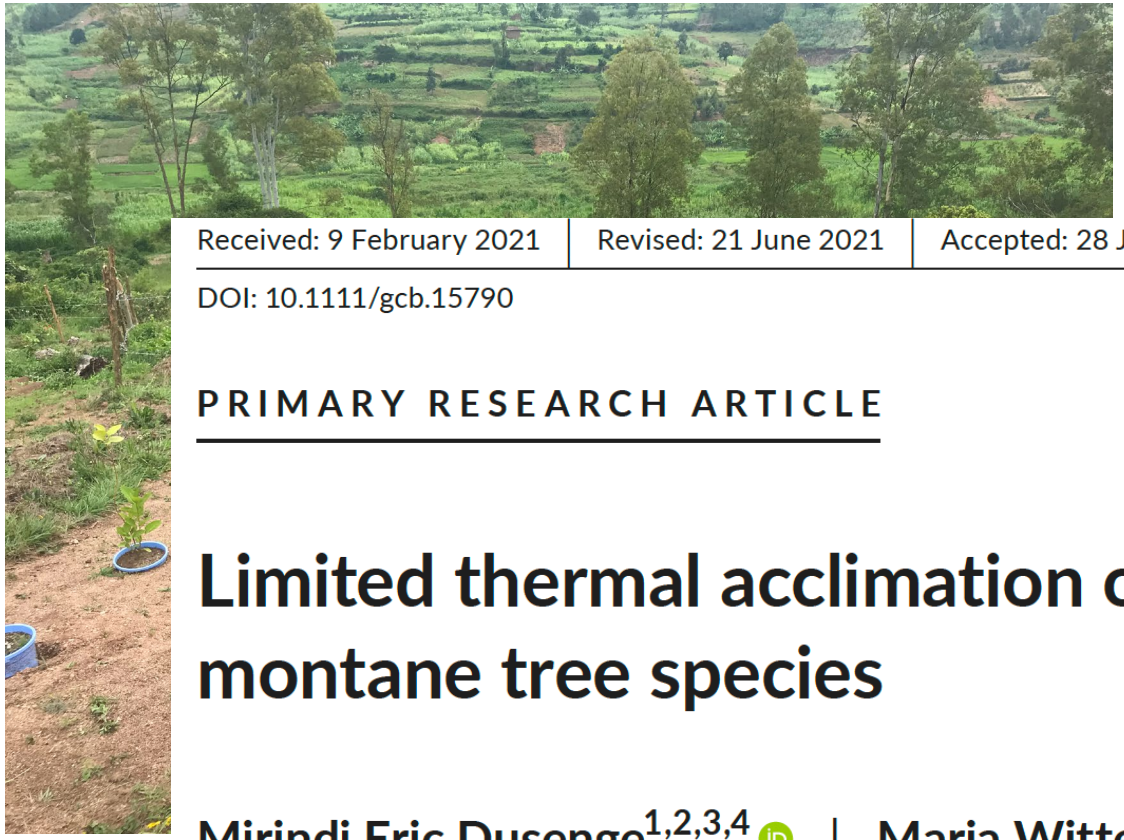


Dusenge et al. 2023. Nature Communications 14: 4667

Tropical biome

- It has been hypothesized that tropical tree species will respond negatively to warming

Africa - Rwanda



Sigira/Nyamagabe
S 2° 30’ 54”; E 29° 23’ 44”
Montane rain forest
2400 m. a. s. l.
14.6 °C, 1750 mm

Rubona/Huye
S 2° 28’ 30”; E 29° 46’ 49”

a/Kirehe
30°51'16"E
l semi-evergreen
thicket
.
nm

Received: 9 February 2021 | Revised: 21 June 2021 | Accepted: 28 June 2021

DOI: 10.1111/gcb.15790

Global Change Biology | WILEY

PRIMARY RESEARCH ARTICLE

Limited thermal acclimation of photosynthesis in tropical montane tree species

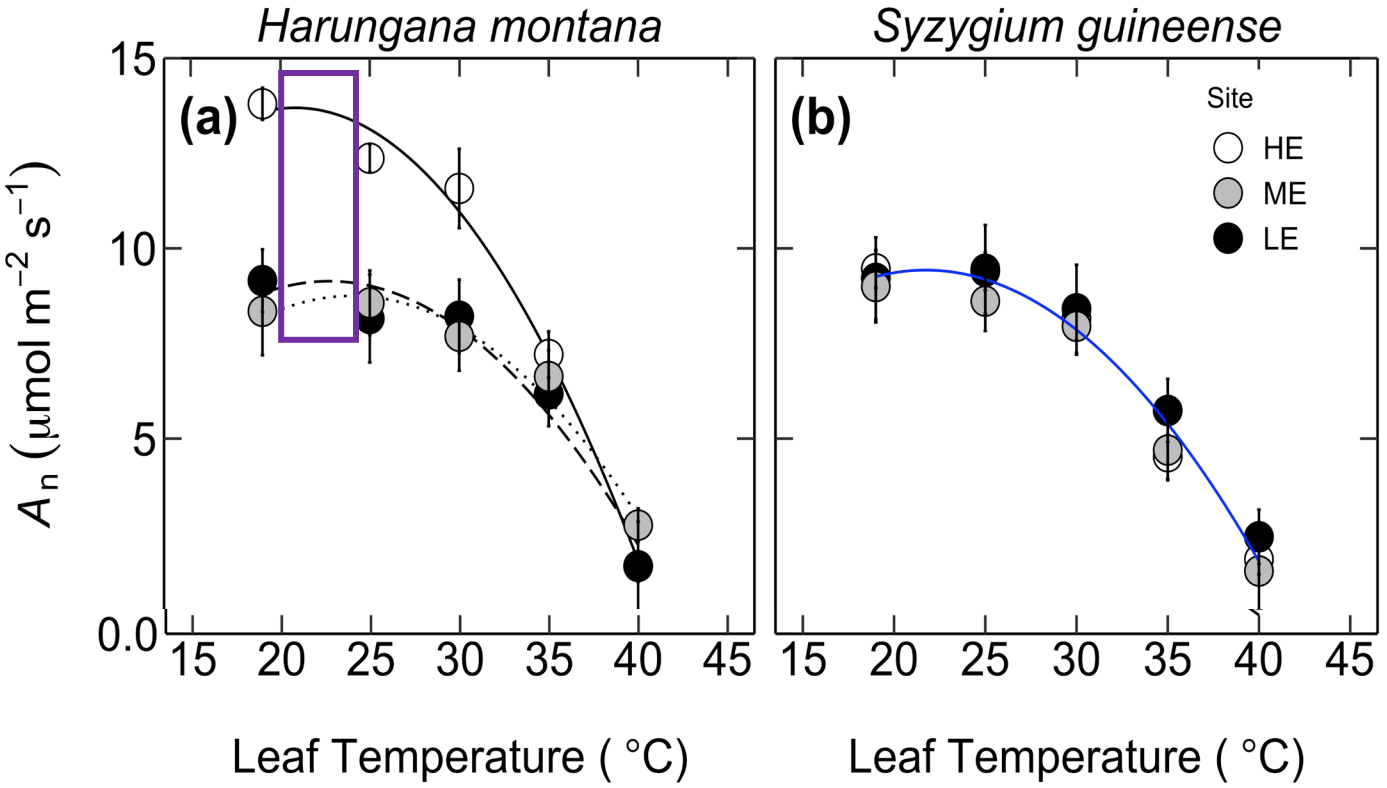
Mirindi Eric Dusenge[1,2,3,4] | Maria Wittemann[1,4,5] | Myriam Mujawamariya[1,5] | Elisée B. Ntawuhiganayo[5,6] | Etienne Zibera[2] | Bonaventure Ntirugulirwa[1,5,7] | Danielle A. Way[3,8,9,10] | Donat Nsabimana[2] | Johan Uddling[1,4] | Göran Wallin[1]

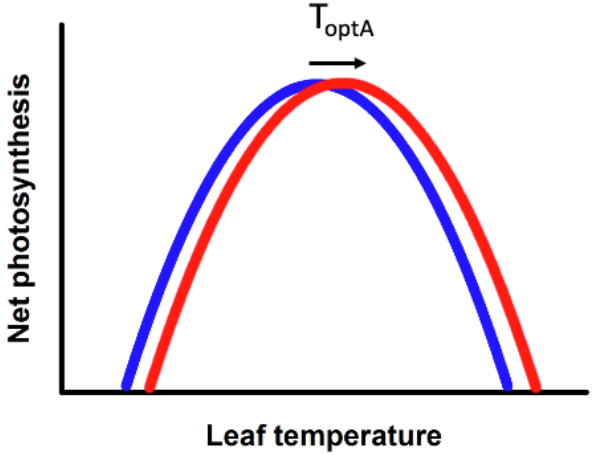
ion nm	Control
ion nm il.	Fertilizer

V LW

RWANDA TREE

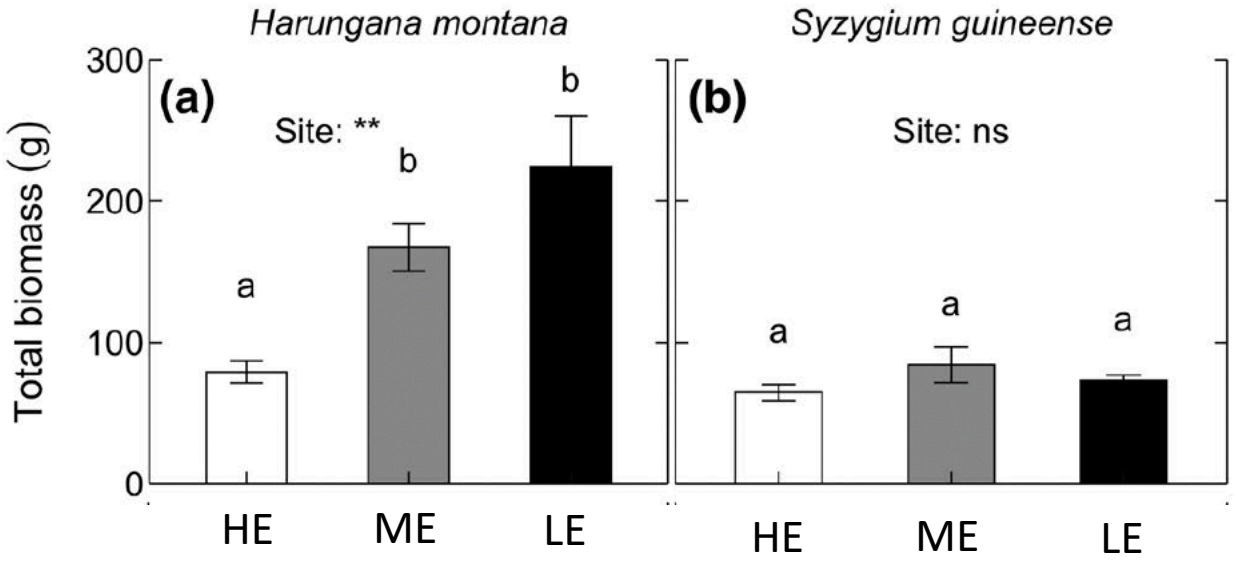
No significant shift in T_{optA} observed in both species





Dusenge et al. 2021. Global Change Biology 27: 4860 - 4878

Growth was not negatively affected despite decreases in net CO_2 assimilation with warming



Dusenge et al. 2021. Global Change Biology 27: 4860 - 4878

New Phytologist

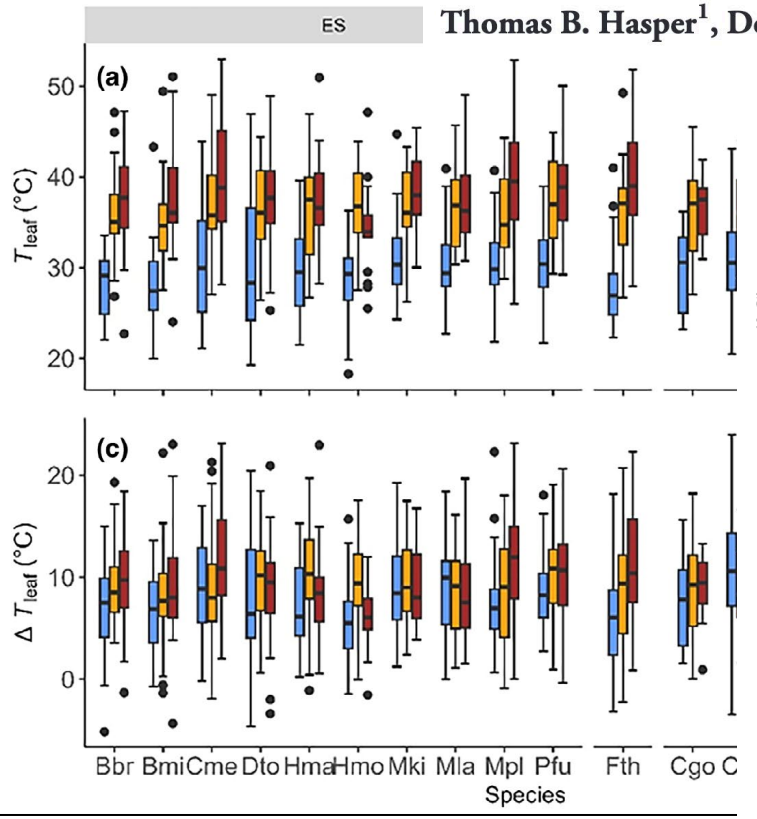
New Phytologist

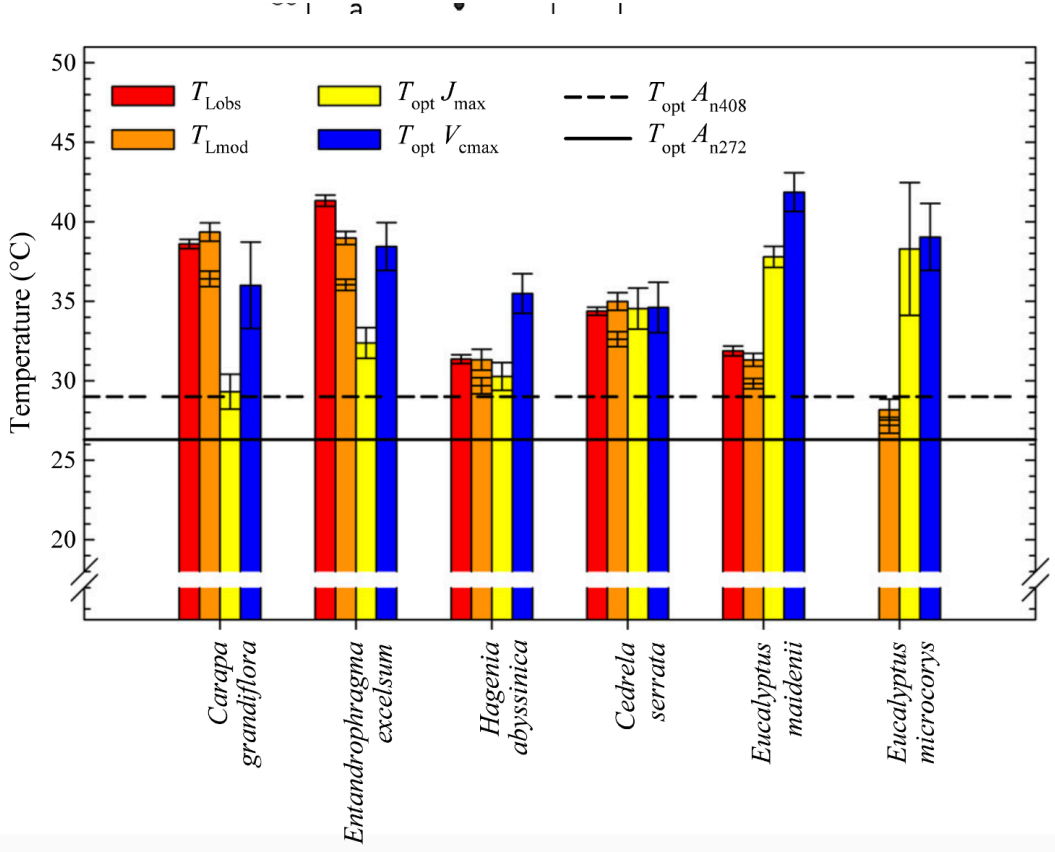
Canopy temperat
margins of tropica

Olivier Jean Leonce Manzi[1,2]
Aloysie Manishimwe[1,4], Myr
Lasse Tarvainen[1], Donat Ns

Photosynthetic temperature responses of tree species in Rwanda: evidence of pronounced negative effects of high temperature in montane rainforest climax species

Angelica Vårhammar[1], Göran Wallin[1], Christopher M. McLean[2], Mirindi Eric Dusenge[1,3], Belinda E. Medlyn[4], Thomas B. Hasper[1], Donat Nsabimana[3] and Johan Uddling[1]





Acknoweldgement

Funding

European Commission

VR

FORMAS

BECC

INNOVATION.CA
CANADA FOUNDATION FOR INNOVATION | FONDATION CANADIENNE POUR L'INNOVATION

Ontario
MINISTRY OF RESEARCH AND INNOVATION
MINISTÈRE DE LA RECHERCHE ET DE L'INNOVATION

NSERC CRSNG

U.S. DEPARTMENT OF ENERGY | Office of Science

THANK YOU 🙏🏾