Table 1. Summary of observed variation in thermally-relevant leaf traits with canopy height and/or between sun and shade leaves

trait	symbol	units	response	forest type(s)	reference(s)
Leaf anatomy and morphological traits					
leaf mass per area (or inverse of specific leaf area)	LMA (or $1/SLA$)	$g \cdot cm^{-2}$	increases with height	temperate, tropical	Mau et al. 2018, Coble et al. 2017
			sun>shade	global	Hernandez et al. 2019, Mastubara et al. 2009, Martin et. al 2020, Coble et al. 2017, Slot et al. 2019
leaf area	LA	mm^2	decreases with height	temperate, tropical	Beaumont and Burns 2009, Kafuti et al. 2020
			sun<shade	tropical	Slot et al. 2019, Sack et al. 2006
stomatal density	$D_{stomata}$	mm^{-2}	increases with height	tropical	Kafuti et al. 2020
			sun>shade	global	Valladares and Niinemets, 2008
leaf thickness	$LeaThi$	μm	increases with height	global, temperate	Poorter et al. 2019, Van Wittenberghe et al. 2012
			sun>shade	global	Poorter et al. 2019
Leaf biochemical and physiological traits					
Nitrogen per leaf area	N_a	$g \cdot m^{-2}$	increased with height	tropical, temperate	Coble and Cavaleri 2014, Scartazza et al. 2016, Hernandez et al. 2019
			sun>shade	tropical, global	Martin et al. 2020, Hernandez et al. 2020, Poorter et al. 2019, Harley et al. 1996
Nitrogen per leaf mass	N_m	$mg \cdot g^{-1}$	no significant difference	tropical, temperate	Hernandez et al. 2020, Scartazza et al. 2016
			sun $\approx$ shade	temperate broadleaf	Harley et al. 1996, Bolstad et al. 1999
xanthophyll cycle pigments	VAZ	μ mol m^{-2}	increases with height	temperate	Scartazza et al. 2016, Niinemets et al. 1998
			sun>shade	tropical, global	Mastubara et al. 2009, Valladares and Niinemets, 2008
carbon isotope composition	$\delta^{13}C$	(permille sign)	increases with height	conifer, temperatre	Duursma and Marshall, 2006, Coble et al. 2017
			sun>shade	conifer	Duursma and Marshall, 2006
chlorophyll a/b ratio	$chla/b$	mol mol^{-1}	increases with height	tropical	Poorter et al. 1995
			sun>shade	tropical, global	Matsubara et al. 2009, Niinemets et al. 1998, Valladares and Niinemets, 2008

Table 2. Summary of observed variation in leaf metabolism and thermal responses across the vertical gradient and/or between sun and shade leaves

trait	symbol	units	response	forest type(s)	reference(s)
Stomatal conductance					
stomatal conductance	gs_{max}	$mmol^{-2}s^{-1}$	increases with height	tropical, temperate	Kafuti et al. 2020, Van Wittenberghe et al. 2012, Roberts et al. 1990
			decreases with height	temperate	Coble and Cavaleri 2015; Ishii et al. 2008
			sun>shade	global, tropical	Valladares and Niinemets, 2008, Hernandez et al. 2019
stomatal conductance	g_s		sun > shade	tropical	Slot et al. 2019
optimum temperature of g_s	T_{opt} of g_s	°C	sun ≈ shade	tropical	Slot et al. 2019
frequency of stomatal closure			increases with height	tropical	Roberts et al. 1990
Photosynthesis					
photosynthetic capacity	A_A	$\mu mol \cdot m^{-2} \cdot s^{-1}$	increases with height	temperate, tropical	Niinemets et al. 2015, Mau et al. 2018
			sun>shade	temperate	Coble et al. 2017, Hikosaka and Terashima 1995, Evans 1989
light-saturated net photosynthesis	A_{sat}		sun > shade	tropical	Slot et al. 2019
optimum temperature of A_{sat}	T_{opt} of A_{sat}	°C	sun ≥ shade	tropical	Slot et al. 2019
light compensation point	LCP		sun > shade	tropical	Slot et al. 2019
maximal carboxylation rate	V_{cmax}	$\mu molm^{-2}s{-}1$	increases with height	temperate	Scartazza et al. 2016
			sun>shade	global	Valladares and Niinemets, 2008
V_{cmax} at optimal temperatue	V_{cmax} at T_{opt}	$\mu molm^{-2}s{-}1$	sun≈shade	tropical	Hernandez et al. 2020
electron transport rate	J_{max}	$\mu molm^{-2}s{-}1$	increases with height	temperate	Scartazza et al. 2016
			sun>shade	global	Valladares and Niinemets, 2008
J_{max} at optimal temperature	J_{max} at T_{opt}	$\mu molm^{-2}s{-}1$	sun≈shade	tropical	Hernandez et al. 2020
thermal damage threshold	T_{50}	°C	sun ≥ shade	tropical	Slot et al. 2019
			decreases with height*	savanna	Curtis et. al, 2018
Respiration					
dark respiration at reference T	$R_{dark}(T_{ref})$, R_d	$\mu molm^{-2}s{-}1$	increases with height	temperate	Scartazza et al. 2016
			sun > shade	tropical	Slot et al. 2019
		μmol (kg leaf)$^{-1}s^{-1}$	sun > shade	temperate	Bolstad et al. 1999
		μmol (m leaf)$^{-2}s^{-1}$	sun > shade	temperate	Bolstad et al. 1999
		μmol (kg N)$^{-1}s^{-1}$	sun > shade	temperate	Bolstad et al. 1999
temperature sensitivity of R_{dark}	Q_{10}	° C^{-1}	sun ≤ shade	temperate	Bolstad et al. 1999
VOC production					
isoprene emission rate (in emitting species)	I	nmol m$^{-2}s^{-1}$	increases with height	temperate	Harley et al. 1996, Harley et al. 1997
			sun>shade	temperate	Niinemets and Sun, 2014, Harley et al. 1996, Sharkey and Monson, 2014

*composite climatic stress variable from canopy temperature, vapour pressure deficit, and relative humidity is higher in lower canopy