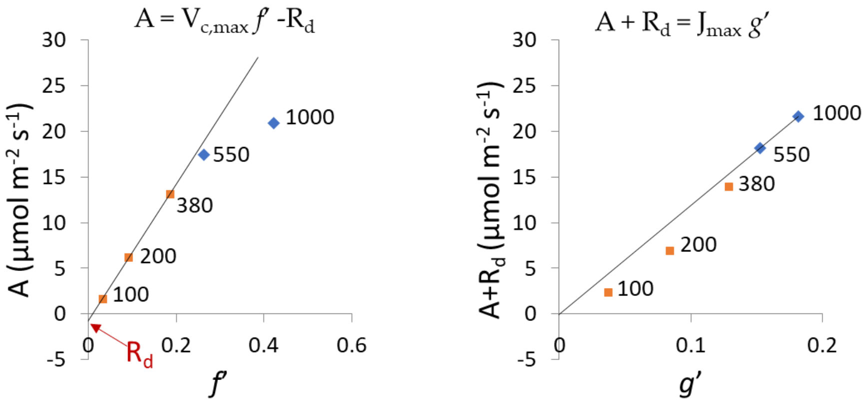
Supplemental material



$$f' = \frac{C_i - \Gamma^*}{C_i + K_c(1 + \frac{O}{K_O})}$$

$$g' = \frac{C_i - \Gamma^*}{4.5\ C_i + 10.5\ \Gamma^*}$$

Figure S1. Light-saturated net photosynthetic rate (A) as a function of *f′* (left panel), and A+R_d as a function of *g′* (right panel) in a leaf of Japanese white birch. Slopes correspond to $V_{c,max}$ and J_{max}, respectively.

Measurements of electron transport rate

Electron transport rate (ETR) was calculated as ETR = PFD x ABS x Φ_{PSII} x 0.5, where PFD is photon flux density, ABS is leaf absorptance, and Φ_{PSII} is quantum yield of photosystem (PS) II photochemistry [1]. Φ_{PSII} was measured using a portable photosynthesis system (LI-6400, Li-Cor, Lincoln, NE, USA) with a leaf chamber fluorometer (LI-6400-40, Li-Cor). Measurements were done under two levels of incident light intensities (PFD: 200 and 1500 µmol m^{-2} s^{-1}), under a block temperature of 27 °C, and respective growth CO_2 concentrations (360 or 550 µmol mol^{-1}). We measured the steady state fluorescence (F_s), and the maximal fluorescence for the light-adapted state (F'_m) with a saturating flush (8000 µmol m^{-2} s^{-1}, 1s). Based on F'_m, and F_s, we calculated Φ_{PSII} ($\Phi_{PSII} = (F'_m - F_s)/F'_m$) [2]. ABS was estimated from SPAD reading, an index of leaf chlorophyll content, which was determined by a SPAD meter (SPAD-502, Minolta, Osaka, Japan), as ABS = 0.2302 ln(SPAD reading) + 0.0158 [3].

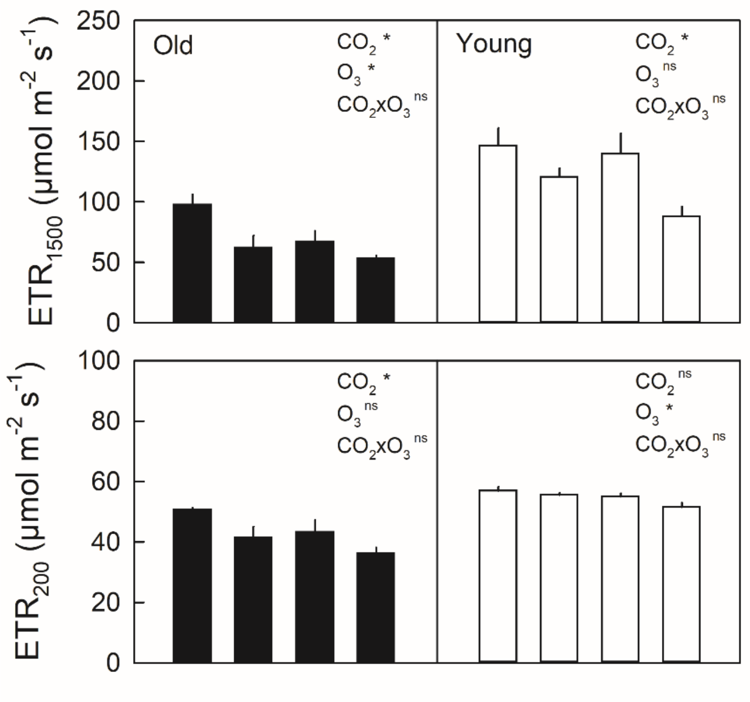


Figure S2. Electron transport rate under saturating (upper panel) or limiting light intensity (lower panel) in old (closed bars) and young leaves (open bars) of Japanese white birch seedlings grown under CO_2 and O_3 treatment combinations. Control: ambient air, eCO_2: elevated CO_2, eO_3: elevated O_3, and eCO_2+eO_3: elevated CO_2 and O_3. Young leaves were ca. 30 days old, and old leaves were ca. 60 days old. Measurements were conducted under the respective growth CO_2 concentrations, where a CO_2 concentration of 380 µmol mol^{-1} was applied for control and eO_3 plants, and 550 µmol mol^{-1} was applied for eCO_2 and eCO_2+eO_3 plants. Significant effects of CO_2 treatments, O_3 treatments, and their interaction are indicated in the panel by * $P \leq 0.05$. ns indicates non-significant. Values are mean + SE (n = 3).

Table S1. *F* values of two-factorial ANOVA to test the effects of CO_2, O_3, and their interaction on ETR_{1500}, and ETR_{200}. Significant effects are indicated in the table by *: $P \leq 0.05$.

	Effect	**ETR_{1500}**	**ETR_{200}**
Old leaves	CO_2 ($F_{1,8}$)	9.83*	7.86*
	O_3 ($F_{1,8}$)	6.23*	4.77
	$CO_2 \times O_3$ ($F_{1,8}$)	1.85	0.14
Young leaves	CO_2 ($F_{1,8}$)	9.60*	3.94
	O_3 ($F_{1,8}$)	2.53	5.99*
	$CO_2 \times O_3$ ($F_{1,8}$)	1.05	0.77

References

1. Long, S.P.; Bernacchi, C.J. Gas exchange measurements, what can they tell us about the underlying limitations to photosynthesis? Procedures and sources of error. *J. Exp. Bot.* **2003**, *54*, 2393–2401.
2. Genty, B.; Briantais, J.-M.M.; Baker, N.R. The relationship between the quantum yield of photosynthetic electron transport and quenching of chlorophyll fluorescence. *Biochim. Biophys. Acta - Gen. Subj.* **1989**, *990*, 87–92.
3. Kitao, M.; Lei, T.T.; Koike, T.; Kayama, M.; Tobita, H.; Maruyama, Y. Interaction of drought and elevated CO_2 concentration on photosynthetic down-regulation and susceptibility to photoinhibition in Japanese white birch seedlings grown with limited N availability. *Tree Physiol.* **2007**, *27*, 727–735.