Supporting Information

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SI Methods

Measurements of Intact Materials. ***With an air-temperature controller.*** We applied the following method to monitor six trees of *Larix gmelinii* (Rupr.) Rupr. in Tura, Russia (Fig. 1*A* and Fig. S2).

Whole-plant chamber. A standing sample tree was enclosed in a cylindrical whole-plant dark chamber; the chamber diameter was 1.2 m and the height could be altered from 4 to 9 m. A wooden tower ≈10 m high was constructed in which to hang the chamber. The chamber was composed of three kinds of films: a 0.2-mm-thick polyvinyl chloride transparent film on the inside to maintain CO_2 impermeability, a 0.03-mm-thick polyvinyl chloride black film to achieve total darkness, and double-layered 0.015-mm-thick aluminum-coated films to reflect radiation. The chamber was held in a cylindrical shape using flexible fiberglass rings so that the volume of the chamber could be easily calculated. After measuring the larger trees, we cut out and removed the bottom of the long chamber to enclose smaller trees. The system volume ranged from 4.3 to 8 m^3.

Closed air-circulation system. Closed air circulation was achieved by connecting the whole-plant chamber to a heat exchanger with air ducts that were 20 cm in diameter, as shown in Fig. S2. After a sample plant was enclosed, the air in the chamber was circulated using an electric fan in the upper part of the heat exchanger. As shown in Fig. S2, the air traveled up the duct to the top of the chamber. The air duct had small holes in the sidewall to avoid heterogeneous CO_2 distributions within the chamber. We created a bypass to the closed air-circulation system that acted as a transient CO_2 scrubber. We kept the connection to the stem system airtight by packing the chamber with clay that does not absorb CO_2. A leak test demonstrated that there was no decrease in CO_2 concentrations over time.

CO_2 scrubber. The scrubber consisted of an air filter filled with soda-lime granules to absorb CO_2. Before measurements, the CO_2 concentration was reduced within the system to field level to avoid CO_2 leakage from the closed system (Fig. S2). According to recent reports (Figs. S1 and S2), high CO_2 partial pressure does not disturb respiration. Accordingly, we concluded that we did not need to eliminate the high CO_2 partial pressure in the closed system.

Temperature control. To control the air temperature within the chamber, we used natural heat energy generated from wood fires and permafrost. Two steel water tanks, each with a volume of ≈40 L, were used to capture this energy. The tank for cooling was buried in the ground so as to be in direct contact with the permafrost. The hot water tank was heated by a wood fire. Hot and cool water were circulated from the tanks to a heat exchanger through water pipes as shown in Fig. S2. The hot water flow was continuously regulated by two electric water valves, and the cool water flow was regulated by turning the water pump on and off through a PID-controlled algorithm programmed into a PC. Air was circulated ≈50 times/hour through the largest chamber, and this rate was sufficient to maintain a constant CO_2 environment within the chamber. The heating and cooling abilities of the heat exchanger (Dalton Co.) were 1 kW h^{-1} and 0.6 kW h^{-1}, respectively, when the air temperature and relative humidity within the chamber were 20 °C and 60%, respectively. The system was operated using two engine generators of about 5 kg in weight and 352 W power output (KH350HA; Kokusan Electric Co.).

We increased the air temperature within the chamber using step sequence control. The PID algorithm minimized any potential overshoot of the desired air temperature to measure the whole-plant respiration at a stable air temperature. The temperature within the 8-m^3 chamber for the largest tree was efficiently kept at 10 °C higher than the ambient air temperature. The system could be readily adjusted to a target temperature to evaluate whole-plant respiration under ambient temperature conditions.

Without an air-temperature controller. We applied the following method for 17 trees of *Larix gmelinii* (Rupr.) Rupr. in Tura, Russia (Fig. 1*B*), and for 17 trees in Ishioka, Japan. A standing sample plant was enclosed in a whole-plant dark chamber of appropriate size; the chamber volume ranged from 0.08 to 785 L. An electric fan was incorporated to circulate the air and ensure an average standard airflow rate of just over 0.1 m s^{-1}. After the samples were enclosed in the chamber, we incubated them for durations of ≈30–900 s.

Measurements of Excised Above-Ground Parts and Excavated Roots. This method was used to monitor as many sample plants as possible (Fig. 1 *C*–*E*). Unlike the previously described method, which incorporated an air temperature controller, this allowed us to quickly measure respiration rates in the field.

Sampling. A black mesh sheet was used to cover the plant materials immediately after excision and root excavation (Fig. 1*F*), to maintain dark and cool conditions and to avoid loss of moisture by transpiration. For sample excisions, we used chainsaws, pruning saws, and shears to cut the sample plants down to sizes that were sufficiently small to fit in our chambers.

Whole-plant chambers. Excised aboveground parts or excavated roots were enclosed in box-shaped chambers of various volumes, according to the sizes of the sampled plants. Electric fans with cylindrical air ducts were included to circulate the air and ensure an average standard airflow rate of just over 0.1 m s^{-1}, as measured at various points within the chamber by an anemometer. After the samples were placed into the chamber, we enclosed and incubated them for ≈30–900 s. The seedlings were enclosed within a modified chamber that featured a CO_2 probe (GMP343; Vaisala) and a small electric fan, as shown in Fig. 1*E*. The chambers using this design were not equipped with the air-temperature control system described previously for measuring intact materials.

Calculation of Whole-Plant Respiration. Relevant respiration rates, as measured by the two methods described previously, were calculated as follows. During the incubation period, which ranged from ≈30 to 900 s, CO_2 concentrations were measured within the closed air-circulation system every 2 or 5 s by infrared CO_2 analyzer (GMP343; Vaisala, or LI-6200; LI-COR), as shown in Fig. S3. The whole-plant respiration metric R (μmol s^{-1}) was defined as follows:

$$R = V(273.2/(273.2+\theta))(10^3/22.4)\frac{dC}{dt},$$

where V = the total volume of the system (m^3), dC/dt = the mean CO_2 increment (μmol mol^{-1} s^{-1}), and θ = the temperature (°C).

Whole-plant respiration statistics were measured under standard barometric pressure, and the volume of the system was calculated consistent with the volume of the chamber and the mass of plant materials.

1. Bouma TJ, Nielsen KL, Eissenstat DM, Lynch JP (1997) Soil CO_2 concentration does not affect growth or root respiration in Citrus or bean. *Plant Cell Environ* 20:1495–1505.

2. Burton AJ, Pregitzer KS (2002) Measurement carbon dioxide concentration does not affect root respiration of nine tree species in the field. *Tree Physiol* 22:67–72.

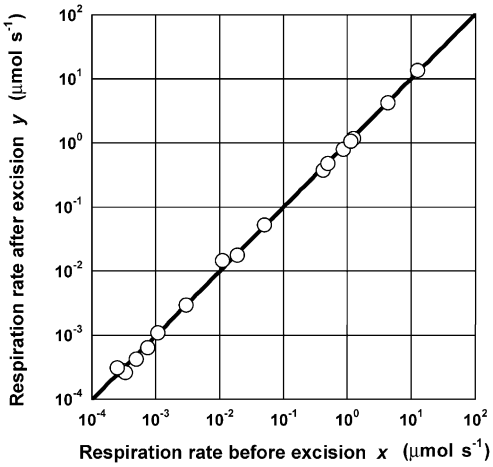

Fig. S1. The relationship between respiration rates in plants before and after excision of aboveground parts from Ishioka, Japan (n = 17, $y = 1.00\ x^{1.00}$, r^2 = 1.00; y, respiration rates after excision; x, respiration rates before excision). There were no statistical differences in the slope (95% CI = 0.978–1.015, P = 0.964) or elevation (95% CI = −0.0984–0.0942, P = 0.687) in terms of respiration rates before and after excision. The measured respiration rate was calibrated at 20 °C under the assumption that respiratory metabolism is controlled by a standard dependency on temperature, Q_{10} = 2.

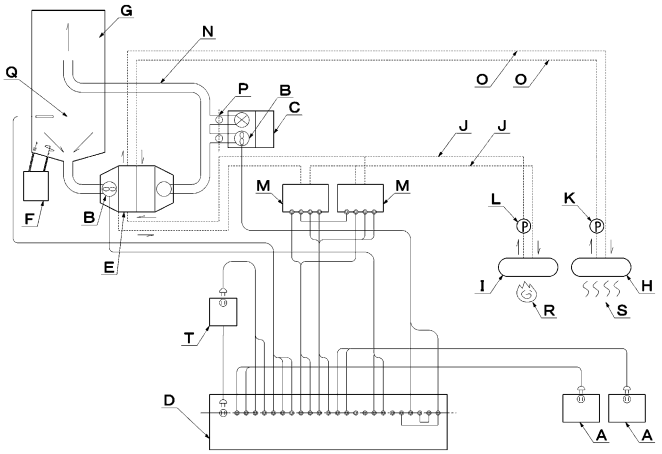

Fig. S2. A schematic representation of the measurement system. (*A*) Engine generator, (*B*) fan, (*C*) CO_2 scrubber, (*D*) system controller, (*E*) heat exchanger, (*F*) infrared CO_2 analyzer, (*G*) whole-plant chamber, (*H*) cool water tank, (*I*) hot water tank, (*J*) hot water pipe, (*K*) cool-water pump, (*L*) hot-water pump, (*M*) electric valve, (*N*) air duct, (*O*) cool-water pipe, (*P*) air valve, (*Q*) temperature sensor, (*R*) wood fire, (*S*) permafrost, and (*T*) automatic voltage regulator.

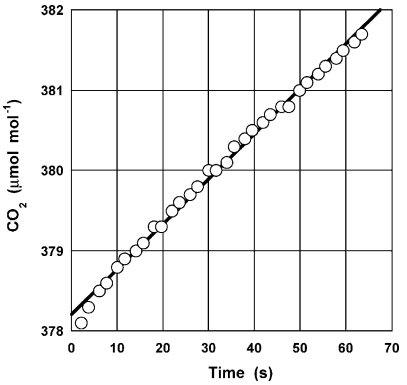

Fig. S3. An example of CO_2 increments dC/dt (μmol mol^{-1} s^{-1}) as measured within the chamber. The relation was fitted by the equation $C = 0.0562\ t + 378.2$, r^2 = 1.00.