incubation-derived indices of Cs decomposition rates will probably differ from those developed in the field, relative differences among sites are presumably real<sup>17,18,21,2</sup>

We used single-pool exponential decay models to estimate Cs turnover time in method 1 and method 2 studies. Single-pool models are widely used to describe Cs turnover, but they may over-estimate rates because the approach assumes that all Cs will behave as did the Cs released during the study<sup>30</sup>. It is unlikely, however, that our single-pool approach masked a relationship between the turnover of a large, temperature-sensitive Cs pool and temperature. In method 1 studies, we would suspect masking if Cs mass loss per year increased with temperature early in the decomposition sequence. However, for sites with <11 yr since conversion, Cs mass loss per year was higher for cool sites (9.5% yr<sup>-1</sup>) than for warm (4.5% yr<sup>-1</sup>) climate soils (P < 0.01). In method 2 studies, we would suspect masking if the total quantity of Cs released per gram of soil increased with temperature because the release of this Cs is independent of total Cs pool size. However, Cs released per kilogram of soil in one year declined with increasing incubation temperature ( $R^2$  = 0.11, P = 0.04). Further, for masking to have occurred, the proportion of total C<sub>s</sub> that is temperature sensitive or fast-cycling must decline steeply with increasing temperature. Using the best techniques available, Trumbore et al.2 found no relationship between the proportion of fast-cycling  $C_{s}$  (from 50% to 80% of total  $C_{s})$  and MAT. Nonetheless, we tested the potential for masking by assuming that all Cs released in method 2 studies was fast cycling and that 50%, 65% and 80% of total C, in tropical, temperate and subalpine soils, respectively, was fast cycling. We then recalculated turnover times for fast-cycling Cs alone. Overall, patterns of Cs decomposition were unchanged.

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## **Respiration as the main determinant** of carbon balance in European forests

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Carbon exchange between the terrestrial biosphere and the atmosphere is one of the key processes that need to be assessed in the context of the Kyoto Protocol<sup>1</sup>. Several studies suggest that the terrestrial biosphere is gaining carbon<sup>2-8</sup>, but these estimates are obtained primarily by indirect methods, and the factors that control terrestrial carbon exchange, its magnitude and primary locations, are under debate. Here we present data of net ecosystem carbon exchange, collected between 1996 and 1998 from 15 European forests, which confirm that many European forest ecosystems act as carbon sinks. The annual carbon balances range from an uptake of 6.6 tonnes of carbon per hectare per year to a release of nearly 1 t C ha<sup>-1</sup> yr<sup>-1</sup>, with a large variability between forests. The data show a significant increase of carbon uptake with decreasing latitude, whereas the gross primary production seems to be largely independent of latitude. Our observations indicate that, in general, ecosystem respiration determines net ecosystem carbon exchange. Also, for an accurate assessment of the carbon balance in a particular forest ecosystem, remote sensing of the normalized difference vegetation index or estimates based on forest inventories may not be sufficient.

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The terrestrial sink for carbon is estimated to be of the order of 2  $\pm$  1 Gt C yr<sup>-1</sup> (ref. 1). In the Northern Hemisphere, the terrestrial biosphere is currently absorbing carbon according to several studies<sup>2-8</sup>. These studies use different techniques dependent on indirect estimates of the carbon fluxes, like isotopic analysis and inversion methods from CO<sub>2</sub> concentration measurements<sup>5-7</sup>, remote sensing<sup>8</sup>, growth trend analysis<sup>2-4</sup> and modelling. All these methods provide the necessary global and continental scale perspective for carbon balance calculations. However, these studies suffer from uncertainties in the assumptions used. For instance, in the inverse modelling studies the anthropogenic sources and sinks are frequently prescribed a priori and they lack adequate representation of the carbon balance at local scales. Their use in addressing small temporal and spatial changes in the carbon balance is therefore rather limited.

The net carbon exchange of terrestrial ecosystems is the result of a delicate balance between uptake (photosynthesis) and loss (respiration), and shows a strong diurnal, seasonal and annual variability. Under favourable conditions, the net ecosystem flux is dominated by photosynthesis during daytime, and by respiration at night and for deciduous ecosystems in leafless periods. The influence of climate and growing-season length can in some cases shift a terrestrial ecosystem from a sink to a source of carbon<sup>9-11</sup>.

Global- and continental-scale techniques are of limited use in

addressing one of the key questions raised by the Kyoto Protocol, namely how to calculate the changes in "carbon stocks" associated with land use changes and forestry activities during the commitment period. Indeed, one of the major effects of land-use changes, including the afforestation, reforestation and deforestation of land, is to change soil organic matter (SOM), by both build up and decomposition<sup>12</sup>. For most ecosystems, the changes in stocks of soil carbon in a 4-5 year period are unfortunately within the errors of the survey techniques used. Remote sensing approaches also appear inadequate for such purposes, because they have limited capability for estimating below canopy processes such as soil respiration.

In this context, the direct, long-term measurement of carbon fluxes by the eddy covariance technique<sup>13</sup> offers the possibility of assessing on a local scale the carbon sequestration rates of forests and of different land-uses. The technique can also provide a better understanding of the vulnerability of the carbon balance of ecosystems to climate variability, and can be used to validate ecosystem models and to provide data for land surface exchange schemes in global models<sup>14</sup>

Automated eddy covariance measurements of CO<sub>2</sub> fluxes have been made routinely over 15 forests in Europe since 1996 within the EUROFLUX network<sup>15</sup>. In 1998, the network approach was expanded in the US (AMERIFLUX) and plans exist to implement similar networks in Brazil (the Large Scale Biosphere Atmosphere

Site*	Latitude	Species†	Ecosystem type‡	Elevation (m.a.s.l.)	T (°C)	P (mm)	Age (yr)	LAI§ (m <sup>2</sup> m <sup>-2</sup> )	Period of observation	NEE¶ $(t C ha^{-1} yr^{-1})$	RE# (t C ha <sup>-1</sup> yr <sup>-1</sup> )
1 Italy 2	41° 45′	M, BE	N	3	15.3	770	50	3.5	1997	-6.6	
2 Italy 1	41° 52′	BD	NM	1,560	6.2	1,180	105	5.5	28/06/96–27/06/97	-6.6	6.4
3 France 2	44° 05′	С	PNM	60	13.7	936	29	2.8	13/07/96–12/07/97	-4.3	8.0
4 Italy ext.	46° 18′	M, C	NM	1,720	4.1	1,010	80	4	1998	-4.5	4.45
5 France 1 6	48° 40'	BD	NM	300	8.5 9.8	672 871	30	5.7 5.6	01/05/96–30/04/97 1997	-2.2 -2.6	7.9 9.9
7 Germany 1	50° 09'	С	NM	780	5.8	885	45	6.7	01/05/97-30/04/98	-0.77	13
8 Belgium 1	50° 18′	M, BD+C	PNM	450	7.5	792	75	5.1	Aug 96–Jul 97	-4.3	10.1
9 Germany 2 10 11	50° 58′	С	NM	380	8.3	724	105	4.8	1996 1997 1998	-3.3 -4.8 -5.4	8.3 9.5 9.7
12 Belgium 2	51° 18′	M, C+BD	PNM	10	10.4	662	70	3	1997	-1.57	
13 Germany ext. 14	51°46′	С	PNM	505	6.6	1,045	110	7	1996 1997	-3.1 -4.9	8.3 9.6
15 Netherland 1	52° 10′	С	PNM	25	9.8	786	80	3	1997	-2.1	13.4
16 Denmark 1 17 18	55° 29'	BD	NM	40	8.5 7.5 8.8	510 441 621	80	4.7	1997 01/06/96–31/05/97 01/06/97–31/05/98	-0.9 -1.7 -1.3	10.6 9.7 11.1
19 Unit. King. 1 20	56° 37′	С	IMP	340	7.9 7.8	1,200 1,100	17 18	7.0 7.5	1997 1998	-6.7 -5.7	13.2 13.5
21 22 23	60° 05′	M, C	PNM	45	6.8 6.1 6.9	437 393 580	80	4	1995 1996 1997	0.9 -0.05 0.8	13.4 12.4 14
24 Finland 1	61°51′	С	PNM	170	4.2	669	30	4	1997	-2.45	7.6
25 Iceland 1	63° 50′	BD	IMP	78	4.6	1,168	7	2	1997	-1	6.1
26 Sweden 2	64°07′	С	PNM	225	4.4	480	37	2.4	1997	-1.9	10.65
2a Italy 1	41°52′	BD	PNM	1560	6.2	1,180	100	4.5	1993–94	-4.7	5.4

\* The site number refers to the data labels in figures. Sites are nominated as in the EUROFLUX project.

† M, mixed; BE, broad-leaved evergreen; BD, broad-leaved deciduous; C, coniferous. ‡ NM, natural origin and managed; PNM, planted stand with traditional forest management; IMP, intensively managed plantation

Leaf area index, projected basis Period for the flux data presented; all the sites are currently measuring fluxes

¶ Net ecosystem exchange (see Methods)

# Total ecosystem respiration (see Methods)

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Figure 1 Net ecosystem exchange (NEE) of the EUROFLUX sites plotted against latitude. Closed symbols, forest of natural origin and planted stands with traditional forest management; open symbols, intensively managed plantations. According to the eddy covariance theory, a negative sign indicates that carbon is absorbed by the forest, while a positive sign indicates that carbon is released by the forest to the atmosphere.

Experiment in Amazonia), South East Asia (the GEWEX Asian Monsoon Experiment) and Siberia. These tower sites are now forming a global network, FLUXNET<sup>16</sup>, with standard measurement protocols, data quality control and storage systems<sup>15</sup>. The flux stations measure the net flux of carbon entering or leaving the ecosystem. This is the flux which provides a measure of net ecosystem exchange (NEE), and, if summed annually, provides a direct estimate of the annual ecosystem carbon balance (excluding disturbances by harvest and fire which give rise to net biome productivity)<sup>17</sup>. In several studies the accuracy of annual sums has been estimated to be about 5%, or typically 0.3 t C ha<sup>-1</sup> yr<sup>-1</sup> (refs 18, 19), with the error influence decreasing with increasing size of the flux data set<sup>20</sup>.

To reduce the uncertainty associated with site-to-site variation in flux measurement methods and calculations and to make comparisons between sites, the EUROFLUX network was designed with the same hardware and software specifications at all sites<sup>15</sup>. The EURO-FLUX results for 1996–98 show a sink strength of up to 6.6-6.7 t C ha<sup>-1</sup> yr<sup>-1</sup> for two forests in Southern Europe and for a Sitka spruce plantation in Scotland, and indicate that European old boreal forests are close to equilibrium and may switch from being a carbon source one year to a carbon sink the next (Table 1). Within the same biome, younger stands still gain carbon, although at a lower rate than temperate forests, Mediterranean forests or fastgrowing plantations. Despite the wide range of species composition, stand structure, soils, tree age, site disturbance history and yearto-year variability, a consistent latitudinal trend in NEE is found (Fig. 1). Indeed a multivariate statistical analysis on the effect of the single factors (latitude, precipitation, ecosystem type, elevation, mean annual temperature, age, management type, leaf area index) on NEE, showed that latitude is the most significant single variable model ( $r^2 = 0.55$ , P < 0.001). Latitude is not a phenomenological driving variable *per se*, however it is a good proxy for the actions of a multiplicity of factors (for example, radiation balance, length of growing season, frost events, disturbance regime).

The trend indicates that high-latitude forests generally show lower and more variable carbon sequestration rates than lowlatitude forests. The several forests growing within  $50^\circ$  and  $52^\circ$  N show a pronounced variability, with NEE ranging from an uptake of less than 1 t C ha<sup>-1</sup> yr<sup>-1</sup> (site Germany 1, point 7) to 5.4 t C ha<sup>-1</sup> yr<sup>-1</sup> (site Germany 2, point 11). In this latitudinal band, the variability can be related to stand, soil and climate characteristics, ranging from continental to maritime. With its maritime proximity, the intensively managed and fertilized fast-growing spruce plantation (site United Kingdom 1, points 19, 20) falls off the latitudinal trend, with a higher uptake of carbon than more continental stands located at similar latitude. Despite the large variation of NEE, gross primary production (GPP) is rather conservative across sites and latitude, indicating that other components of the carbon balance are responsible for the observed variation in NEE (Fig. 2). It is noteworthy that the young spruce plantation has the largest values of GPP, indicating strong stimulation of photosynthesis, while the young poplar plantation (point 25) growing in a cold climate at 64° N shows the smallest GPP.







Figure 3 The ratio of net ecosystem exchange (NEE) and total ecosystem respiration (RE) plotted against latitude. Closed symbols, forest of natural origin and planted stands with traditional forest management; open symbols, intensively managed plantations.

## letters to nature

The observed variation in NEE across sites can be explained by the relative importance of ecosystem respiration (RE) in relation to NEE. The ratio NEE/RE increases with latitude (Fig. 3) indicating that RE becomes more important for northern sites and can explain the decrease of NEE previously shown. Generally, while GPP tends to be constant across sites, annual ecosystem respiration increases with latitude, despite the general decrease of mean annual air temperature (Table 1). It is well known that temperature has a strong effect on soil and plant respiration. For single sites our data also show a significant relationship between temperature and ecosystem respiration for both short and annual timescales. However, when a plot of RE versus temperature is drawn across all sites the relationship is not significant, indicating that mean annual air temperature may not be an important contributing factor to forest ecosystem respiration on a broader scale.

In forests, total ecosystem respiration tends to be dominated by root and microbial soil respiration. Boreal soils contain a larger amount than temperate soils of soil organic matter (SOM) in a labile form<sup>12,21–23</sup> that is prone to rapid decomposition<sup>21,22</sup>. The effective temperature sensitivity ( $Q_{10}$ ) of SOM decomposition is much higher in colder than in warmer climates and temperature increases in cold regions are likely to affect decomposition rates more than net primary productivity<sup>23</sup>. There is also evidence that northern latitudes have warmed by more than 4 °C, while southern latitudes have warmed less<sup>24</sup>. This may have resulted in non-steady state conditions for SOM which could explain relative enhancement of respiration in the north compared to the south.

In this respect, land-use change and site history could also be important. For example, site Sweden 1 (points 21-23) is losing carbon as a result of past soil drainage, while the high respiration rates of the maritime spruce plantation may be linked to preparation of the site by ploughing, the favourable maritime climate and fertilization. Furthermore the relatively low rates of respiration of the southern sites may be the result of drought limitations to soil respiration<sup>25-27</sup>.

The carbon balance is ultimately a delicate equilibrium between the two large fluxes of photosynthesis and respiration, and this appears to be particularly true for boreal European ecosystems, making them very vulnerable to disturbances in climate. Indeed, annual variability for these high latitude sites is very pronounced, as shown by the remarkable variation in NEE from year to year: warm winters tend to switch old boreal stands from a sink to a source of carbon by increasing the annual amount of respiration<sup>9</sup> (site Sweden 1; Table 1). In other boreal ecosystems, year-to-year changes in timing of the thawing of the soil in the spring are important for the carbon balance<sup>10</sup>.

The direct flux estimates of carbon exchange provide a useful tool for understanding the overall carbon balance processes of terrestrial ecosystems. Indeed, partial accounting of carbon dynamics can easily lead to erroneous conclusions. For example, plant biomass is currently increasing in all the EUROFLUX sites, even though some of these sites have a carbon budget close to neutral and one is losing carbon on a yearly basis. Similarly, the increases in plant growth at northern latitudes estimated by remote sensing of the normalized difference vegetation index (NDVI) must be examined critically in the light of these results, confirming the need to consider ecosystem respiration<sup>8</sup>. Also forest inventory-based carbon balance estimates should be carefully examined in relation to comprehensive carbon budget accounting. Furthermore, flux tower networks can provide at local scale realistic constraints on the global carbon balance estimates. 

#### the same $CO_2$ standard (NOAA Climatic Monitoring and Diagnostics Laboratory, Boulder, Colorado). The software for eddy covariance data acquisition and calculation have been extensively tested and compared against reference data sets, resulting in a maximum variation of calculated fluxes of less than 1% (ref. 15).

#### Data treatment

The collected data are quality controlled, corrected for frequency losses and sensor separation and, when needed, corrected for night-time fluxes under stable conditions with low wind speed or friction velocity typically less than  $0.2 \text{ ms}^{-1}$  (refs 14, 15).

NEE values for the entire year are obtained by summation of fluxes measured on a 30min time step. The average coverage of directly measured data for all of the sites was more than 70% of the annual half-hour periods (60–95%). Fluxes in stable conditions and data gaps have been filled through site-based functional relationships using meteorological variables, such as radiation during the day and temperature during the night. Small gaps (a few half-hours) during single days were filled by simple interpolation. For data gap filling procedure see Supplementary Information.

GPP values have been obtained by summing annual NEE and ecosystem respiration (RE). RE comes from the summation of night-time fluxes (all sites), whole-day fluxes for leafless periods (deciduous forests) and of the day-time respiration.

Night-time and leafless-period fluxes are obtained by summation of the fluxes measured by eddy covariance on a 30-min time step, including the  $CO_2$  storage component. Daytime respiration has been obtained by extrapolating the night-time fluxes to the rest of the day, using functional relationships with soil or air temperature.

A multivariate statistical analysis, based on different procedures, namely the forward and stepwise selections and the maximum R-square improvement, was used to test the controlling factors on NEE<sup>28</sup>.

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#### Methods

#### Instruments

In the EUROFLUX network, the same  $\rm CO_2/H_2O$  infrared gas analyser (LI-6262, Licor Inc.) and sonic anemometer (Solent, Gill Inst.) are used. All the analysers are calibrated against

28. SAS/STAT® User's Guide Version 6, 4th edn, Vol. 2, (SAS Institute Inc., Cary, North Carolina, 1989).

Supplementary information is available on *Nature's* World-Wide Web site (http:// www.nature.com) or as paper copy from the London editorial office of *Nature*.

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# Determination of relative growth rates of natural quartz crystals

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Although the theory describing crystal growth in the geological environment is well established<sup>1-3</sup>, there are few quantitative studies that delimit the absolute time involved in the growth of natural crystals<sup>4-6</sup>. The actual mechanisms responsible for the variation in size and shape of individual crystal faces are, in fact, not well understood. Here we describe a micro-infrared spectroscopic study of a single, gem-quality quartz crystal that allows us to measure the size, shape and relative growth rate of each of the crystal faces that are active throughout its growth history. We demonstrate that the abundances of hydrogen-bearing impurities can serve as 'speedometers' to monitor the growth rate of advancing crystal faces. Our technique can be applied to crystals from a variety of geological environments to determine their growth histories. Within the electronics industry, the technique might facilitate the production of defect-free synthetic crystals required for high-quality resonators and, ultimately, might allow determination of the absolute time involved in geological processes such as the crystallization of magmas, fluid flow in metamorphism and the sealing of open cracks in earthquake rupture zones.

Euhedral quartz crystals grown in hydrothermal metamorphic environments reveal classic trigonal structural form<sup>7</sup>. Crystals grow into fluid-filled cavities typically with six well-defined {1010} 'm' prism faces, three prominent {0111} 'r' faces, and three {1011} 'z' faces (Fig. 1). Despite the limited number of observable active growth faces, every natural hydrothermal quartz crystal has a unique crystal morphology, analogous to human fingerprints and snowflakes. Unfortunately, the final morphology of the crystal cannot be inverted uniquely to determine the relative growth rates of each face during growth. If a priori knowledge of the sizes of individual growth faces throughout the crystal's growth history are known, relative growth rates of faces within single crystals can be constrained<sup>8</sup>. Such knowledge has been ascertained by examining 'ghost' features of transparent crystals and by cathodoluminescence analyses<sup>9,10</sup>. However, neither inter-crystalline comparisons nor quantitative constraints of absolute growth rates of common metamorphic minerals are, as yet, available.

Although quartz is one of the purest minerals known, no crystal is pure  $SiO_2$ . Conventional infrared studies have shown that many of the impurities in quartz crystals are hydrogen-bearing species that

## letters to nature

form point defects in the crystal lattice<sup>11,12</sup>. Individual cations bond to the oxygen atom of the hydroxyl group with variable strength, and the O-H stretching motion absorbs energy at wavelengths characteristic of the individual species resulting in a sharp absorbance peak in the region between 3,600 and 1,000  $\text{cm}^{-1}$  (ref. 13). Three hydrous species are especially common in natural quartz crystals: (1) AlOH species that absorb energy at  $3,380 \text{ cm}^{-1}$ ; (2) LiOH species that absorb energy at 3,480 cm<sup>-1</sup>; and (3) HOH species that absorb a relatively broad band of energy centred at 3,400 cm<sup>-1</sup>. Spectroscopic studies have demonstrated that AlOH defects are oriented in the crystal structure such that O-H bonds extend nearly horizontally into channels that run parallel to the caxis<sup>11,14</sup>. Al<sup>3+</sup> replaces Si<sup>4+</sup> in the rigid silicate lattice, and the H<sup>+</sup> serves to charge-balance the substitution. In contrast, HOH and LiOH species are incorporated as neutrally charged molecules and are not integral to the crystal lattice. The HOH species probably exist as isolated molecules (but may exist within minute clusters that are too small to allow formation of an ice phase)<sup>11,12,14</sup>. The broad absorbance spectrum indicates that these species are hydrogen-bonded to varying degrees within the crystalline structure<sup>13</sup>. Because H-bearing defects are believed to alter strongly the rheological properties of nominally anhydrous minerals and thereby affect the rheology of the upper mantle and the lower crust, much experimental and theoretical work has investigated the nature of Huptake in major anhydrous phases<sup>15-19</sup>. In addition, H-bearing impurities are known to affect crystal quality relevant to the development of high-frequency devices used in the electronics industry<sup>20,21</sup>. Although these studies have broadened our understanding of the crystallography associated with the uptake of Hbearing defects, none have accounted for the large range in impurity concentrations observed in single natural crystals or in crystals across the spectrum of geological environments.

The results of our spectroscopic measurements for each of the traverses taken across levels 3, 7 and 8 of the crystal are illustrated in maps A, B and C in Fig. 2a. Map A in Fig. 2a illustrates the variation



**Figure 1** Photographs of the Brazilian quartz specimen analysed in this study, showing the specimen before sectioning. Diagrams next to the photographs show the three prominent 'z' and the three subordinate 'r' rhombohedral growth faces at the tip of the crystal, as well as the well-defined six 'm' prism faces. Scale bar, 1 cm.

#### **Supplementary Informations**

Data gaps have been filled through site-based functional relationships using meteorological variables, such as solar or photosynthetically active radiation and temperature, mean daily courses of previous periods or interpolation (see table). Small gaps (a few half-hours) during single days were filled by simple interpolation.

In order to evaluate the possible effects of different gap filling schemes on the overall carbon fluxes, 11 different procedures were tested on nine sites of the network. , The procedures, ranging from mean daily courses of previous periods to semi-empirical functions based on temperature and radiation, resulted in an overall standard error of annual NEE estimates of less than 10% (E. Falge pers. comm.).

Day-time respiration has been obtained by extrapolating the night-time fluxes to the rest of the day, using functional relationships with soil or air temperature (usually an exponential function of temperature - see table).

The measurement of ecosystem fluxes by eddy covariance does not allow the separation between autotrophic and heterotrophic respiration. Site by site, a unique temperature function which pools both the components was used for overall ecosystem respiration. The respiration-temperature functions are site-specific, making any effects attributable to age or any other site specific factor to be scaled consistently. As a physiological process, the only respiration component that can change appreciably between day and night is leaf respiration, which has been reported to be strongly reduced in light with respect to the dark rate at the same temperature<sup>1</sup>. However in closed forest canopies, leaf respiration, compared to woody biomass and soil respiration, is usually a less important component<sup>2</sup>.

Legend for the table:

u\*: friction velocity

Photosynthetic periods: MM: Michaelis-Menten type response curve,  $NEE = Rd - \frac{a \cdot R}{b + R}$ ,

RH: hyperbolic regression,  $\underline{NEE = Rd - \frac{\alpha \cdot R \cdot a}{\alpha \cdot R + a}}$ , where R: radiation (either global or

photosynthetic active radiation) and a, b,  $\alpha$  and Rd are parameters. MR: multiple regression with climatic data.

Respiration: Q10 or exponential regression are basically the same (the Q10 is an exponential

regression). They are in the form  $\underline{R_E = a \cdot Q10^{\left(\frac{T-Ta}{10}\right)}}$  and  $\underline{R_E = a \cdot \exp^{\left(b \cdot Ts\right)}}$ . One site used the function presented in reference 3.

a: site France 1: the total flux, resulting from the sum of the measured flux and the canopy  $CO_2$  storage component, proved to be constant with changing friction velocities (hence there were no flux losses). Site Belgium 2: no temperature dependence could be identified by applying various levels of the threshold.

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2 Law B.E., Ryan M.G. & Anthoni P.M. Seasonal and annual respiration of a ponderosa pine ecosystem. *Global Change Biology* **5**, 169-182 (1999).

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	Dataset	Threshold for correction during	Photosynthesis	Respiration	Data
Site	ID#	atmospheric stability.	function types	function types	coverage
		u*, m s <sup>-1</sup>			%
Italy 2	1	0.2	MM, RH	Not calculated	85
Italy 1)	2, 2a	0.17	MM, RH	Q10	65, 70
France 2	3	none	MR	Extrapolation	80
Italy ext.	4	0.2	Interpolation	Extrapolation	65
France 1	5	<b>0</b> <sup>a</sup>	MR	Exponential	65, 88
Germany 1	7	0.2	RH	Exponential	70
Belgium 1	8	0.4	RH	Lloyd and Taylor	85
Germany 2	9-11	0.3	RH	Exponential, Tsoil (night), Rd	50, 80, 80
				term of the light curve (day)	
Belgium 2	12	0 <sup>a</sup>	RH	Not calculated	60
Germany ext	13-14	0.4	RH	Exponential	
Netherland 1	15	0.25	MM	Exponential	81
Denmark 1	16-18	0.17	Interpolation	Q10	80, 85, 93
Unit.King. 1	19-20	0.2	MM	Exponential	75, 80
Sweden 1	21-23	0.4	Neural networks	Exponential	90-98
Finland 1	24	0.3	RH	Exponential	80.2-85.5
Iceland 1	25	0.2	RH	Exponential, Tair	
Sweden 2	26	0.4	Modelling	Exponential	75