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# Synthesis and analysis of biomass and net primary productivity in Chinese forests

Jian Ni<sup>a,b,\*</sup>, Xin-Shi Zhang<sup>a</sup> and Jonathan M.O. Scurlock<sup>c</sup>

<sup>a</sup>Laboratory of Quantitative Vegetation Ecology, Institute of Botany, Chinese Academy of Sciences, Xiangshan Nanxincun 20, 100093 Beijing, P. R. China

<sup>b</sup>Department of Ecology, Plant Ecology, Lund University, Sölvegatan 37, 22362 Lund, Sweden

<sup>c</sup>Environmental Sciences Division, Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, TN 37831-6407, USA

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**Abstract** – An extant dataset is presented on biomass and net primary productivity (NPP) of 6 forest biomes, including 690 stands from 17 forest types of China. Data on latitude, longitude, elevation, field measurements of stand age, leaf area index (LAI) and total biomass were collected for 29 provinces from forestry inventory data of the Forestry Ministry of China, as well as a wide range of published literature. The individual site-based NPP was estimated from field biomass measurements based on a common methodology. The range of measured LAI, biomass and estimated NPP is from 0.17 to 41.78 m<sup>2</sup> m<sup>-2</sup> (mean = 8.94), from 31.14 to 1569.85 t ha<sup>-1</sup> (means = 185.41), and from 2.41 to 40.27 t ha<sup>-1</sup> yr<sup>-1</sup> (mean = 14.4), respectively. Analyses and synthesis between NPP and environmental factors showed that, in eastern China, NPP of forests increases from north to south, whereas NPP of major forests in southern China decreases in relation to longitude from east to west. In mountainous areas, the distribution of NPP is related to elevation. On a regional basis, the NPP of Chinese forests is highly correlated with annual mean temperature and rainfall, as well as the annual potential evapotranspiration, especially on the basis of site-based comparison. Strong positive correlation also existed between NPP and growing degree-days on a 0 °C base and on a 5 °C base. These all indicated that temperature and moisture are the dominant factors controlling the spatial distribution of NPP in China. A site-based comparison between estimated NPP and NPP modelled by the BIOME3 model showed a fair agreement with a linear regression. A higher correlation occurred in the forest-based comparison between estimated and modelled NPP, whereas the highest correlation was found in the plant functional type (PFT)-based comparison. However, there are many limitations in the current data set and methodologies, such as the lack of some components of biomass and NPP, especially with respect to root production. More detailed field measurements and methodologies covering all components of NPP should be addressed in China in the future.

**biomass measurement / Chinese forests / environmental factors / estimate and comparison of net primary productivity / spatial patterns**

**Résumé** – Analyses et synthèse relatives à la biomasse et à la productivité nette primaire dans des forêts chinoises. Ce travail présente un ensemble de données relatives à la productivité nette primaire (NPP) et à la biomasse incluant des mesures pour 690 stations réparties dans 17 types de forêts en Chine. Six biomes forestiers sont représentés. Les données de latitude, longitude, altitude ainsi que les mesures de terrain sur l'âge des peuplements, l'indice de surface foliaire (LAI) et la biomasse totale ont été rassemblées pour 29 provinces à partir de ce qui est disponible dans l'Inventaire forestier du ministère des Forêts chinois et de données contenues dans un grand nombre de publications. La productivité nette primaire (NPP) pour chaque site a été estimée à partir de mesures de terrain sur la biomasse basées sur une méthodologie identique. Les valeurs minimales et maximales sont, respectivement, pour l'indice de surface foliaire

\* Correspondence and reprints

Tel. +49 3641 64 3787, Fax. +49 3641 64 3775, e-mail: jni@bgc-jena.mpg.de

Present address: Global Ecology Group, Max Planck Institute for Biogeochemistry, PO Box 10 01 64, 07701 Jena, Germany.

(LAI) : 0,17 et 41,78  $\text{m}^2 \text{m}^{-2}$  (moyenne = 8,94), pour la biomasse : 31,14 et 1569,85  $\text{t ha}^{-1}$  (moyenne = 185,410) et pour la productivité (NPP) : 2,41 et 40,27  $\text{t ha}^{-1} \text{an}^{-1}$  (moyenne = 14,4). Les analyses sur le rapport entre productivité nette primaire (NPP) et facteurs environnementaux ont montré que, dans l'est de la Chine, la productivité (NPP) augmente du nord au sud alors que pour la plupart des forêts de Chine du Sud, la productivité (NPP) décroît selon un gradient longitudinal, d'est en ouest. Pour les régions de montagne, une relation entre productivité (NPP) et altitude a pu être établie. À l'échelle régionale, la productivité (NPP) des forêts chinoises ici étudiées est fortement corrélée avec la température et les précipitations moyennes annuelles ainsi qu'avec l'évapotranspiration potentielle. Une forte corrélation positive existe également entre la productivité (NPP) et les sommes de température journalières (GDD) aussi bien à partir de 0 °C que de 5 °C. L'ensemble des analyses montre que la température et l'humidité sont les facteurs majeurs qui contrôlent la répartition spatiale de productivité (NPP) en Chine. La comparaison entre la productivité (NPP) estimée et la productivité modélisée (utilisation du modèle BIOME 3) en chaque site est satisfaisante (bonne corrélation linéaire). Une corrélation plus marquée existe quand on compare la productivité (NPP) estimée et la productivité modélisée en se situant non plus au niveau stationnel mais au niveau des massifs forestiers. La corrélation la plus élevée a été trouvée dans le cas d'une comparaison basée sur des types fonctionnels (PFT). Cependant les données actuelles et les méthodologies utilisées comportent de nombreuses limitations comme l'absence de certains composants relatifs à la productivité (NPP) et à la biomasse, notamment les éléments concernant la production racinaire. Dans le cadre d'études ultérieures en Chine, il sera nécessaire d'envisager des mesures de terrain plus détaillées et des méthodologies de mesure couvrant tous les composants de la productivité (NPP).

### **mesures de biomasse / forêts chinoises / facteurs environnementaux / évaluation et comparaison de la productivité nette primaire (NPP) / répartitions spatiales**

## **1. INTRODUCTION**

Net primary productivity (NPP) is a key ecosystem variable and an important component of the global carbon cycle. It plays a key role in our understanding of carbon exchange between biota and atmosphere, both currently and under climate change conditions caused by the human-induced increase in atmospheric  $\text{CO}_2$  concentration [26, 29, 39]. However, progress in estimating or modelling the global carbon cycle is seriously inhibited by the lack of adequate observational data or by significant uncertainties in model parameterisation and validation, such as NPP from field measurements [8, 9, 36]. The challenge is to take extensive but incomplete data sets and make them usable for analyses and models by estimating total NPP in a consistent manner, but there are many cited difficulties in comparing model predictions with the limited number of worldwide NPP estimates currently available [4, 30, 31, 32, 35, 36, 38].

Forest ecosystems play a very important role in the global carbon cycle and consequently in global climatic change. Forest biomass data used in earlier studies were mainly selected from the set of direct field measurements on small plots obtained by IBP, the International Biological Program [10]. Recent studies have estimated forest biomass at regional and national levels based on forest inventory data [e.g. 1, 2, 3, 16, 37]. Many studies have also simulated forest NPP at regional or global scale driven by different models [e.g. 11, 21, 22, 24, 25, 33, 34, 39]. In the Global Primary Production Data Initiative (GPPDI), NPP field measurements and associated environmental data in boreal and tropical forests of the world

were identified for extrapolation to various spatial scales [7, 19]. Selection of appropriate methodology is central in the calculation of accurate results for biomass and NPP estimations at different scales, i.e., regional, national and global scales.

Chinese forests, which cover about half of the total area of China, contain perhaps the widest range of types in the world, ranging from boreal forest and mixed coniferous broad-leaved forest in the north, temperate deciduous broad-leaved forest and coniferous forest in the central region, to subtropical evergreen broad-leaved forest, warm temperate coniferous forest, tropical rain forest and seasonal forest in the south [13]. They are thought to have a significant influence on the carbon budget both regionally and globally [15, 16]. Several methods such as biomass-volume relationships, mean biomass density and mean ratio of biomass to stem volume have been used to estimate biomass and NPP of Chinese forests based on forest inventory data sets [14, 16, 17], but they probably over- or under-estimated the forest biomass of China to different degrees [16]. Data- and model-based estimates of Chinese forest NPP, moreover, have not been compared. Developing a better understanding and accurate characterisation of NPP, especially in Chinese forests which lack more basic information, will be fundamental for realistic regional and global carbon budgets, for projecting how these will be affected by changing global climate and atmospheric composition, and for validating and calibrating global biogeochemical models.

This paper presents an extant dataset on biomass and NPP of 6 biomes, including 17 major forest types of

China, and their analyses and synthesis. First, we introduce the existing methodologies for field measurements of biomass and for estimates of total forest NPP, and then we comment on these methodologies and validation of data. Finally, we analyse the spatial changes of forest NPP associated with environmental factors, and compare estimated NPP with the output of the model BIOME3 [20]. The objective of this paper is to investigate the large spatial patterns of NPP in Chinese forests, their relationships with climate and the comparisons with model-based simulations rather than the individual site-based estimates.

## 2. MATERIALS AND METHODS

### 2.1. The dataset

The data on biomass and NPP of major Chinese forest types were originally extracted from the Ph. D. dissertation of Luo [23]. Most of these data came from the inventories of the Forestry Ministry of China between 1989 and 1993 [18, 23]. Additional data were obtained from published forest reports [12], as well as over 60 Chinese journals (*Acta Botanica Sinica*, *Acta Phytocologica Sinica*, *Acta Ecologica Sinica*, *Chinese Journal of Ecology*, *Forestry Science of China*, etc.), and some unpublished literature up to 1994.

The dataset includes for each record the site name, latitude, longitude, elevation, stand age, measured total LAI, total biomass, and estimated NPP (see Appendix), and all of the available information including the components of biomass and NPP [23]. These data are distributed between 6 forest biomes, including 17 major forest types of China (*table 1*).

### 2.2. Measurement of biomass

Aboveground biomass of trees was measured by destructive harvesting and weighing within a given area. The size of this sample area varies with stand condition, different forest type and the aims of the observer. In general, the area of sample plots is 100–400 m<sup>2</sup> for boreal and temperate forests, 400–1 000 m<sup>2</sup> for subtropical forests, and 1 000–2 000 m<sup>2</sup> for tropical forests. The majority of the measurements for tree biomass commonly followed one of three methods:

i) All of the trees within a sample plot were cut down and weighed for various component tissues (stem,

bark, branch, leaf, flower and fruit etc.). Total biomass was then calculated based upon the area of the sample plot.

ii) Several “standard” trees within a plot were selected for felling and weighing of component parts. The number of trees selected depended upon species, forest type and density. Total biomass was then calculated based on total tree numbers.

iii) “Standard” trees within a plot are felled and weighed as in ii) above, then regression functions were established, relating biomass of various tissues to certain tree size indices, such as diameter at breast height (DBH – 1.3 m) and/or tree height (H). Total aboveground biomass was then estimated for individual trees using one of the following equations:

$$BM_{\text{tree}} = a \times \text{DBH}^b$$

$$BM_{\text{tree}} = a \times (\text{DBH}^2 \times H)^b$$

where,  $BM_{\text{tree}}$  is total biomass of the tree, DBH is diameter at breast height, H is tree height, and  $a$  and  $b$  are constants.

Belowground biomass of trees was measured by one of two methods: (i) all roots of 6–8 standard sample trees by different diameter classes were excavated after measurement of aboveground biomass. Total belowground biomass was calculated based on measurements of standard trees; (ii) 4–6 soil pits were excavated within the central area of root distribution and the surroundings throughout the tree stand. The area of the soil pit was commonly 2 500 cm<sup>2</sup> associated with sufficient depth to sample the majority (75–90%) of the root profile. Roots were partitioned into different diameter classes, i.e., coarse roots, medium-sized roots and fine roots, for estimation of total belowground biomass.

Shrub and herb above- and belowground biomass were measured by the harvest method within the larger tree samples – typically, 10–30 smaller plots were set up inside a single tree plot, with areas of 16–25 m<sup>2</sup> for shrub plots and 1–4 m<sup>2</sup> for herb plots. Aboveground tissues were clipped and belowground roots collected for different diameter classes. From the dry weight of these tissues, the total biomass was calculated based on plot area.

Litterfall was estimated by monthly collection from 10–20 square litter traps, 1 × 1 × 0.25 m, laid out within the tree plots. Litterfall components, such as leaf, branch, flower and fruit, were dried and weighed separately, and summed to determine total litterfall.

**Table I.** Ecological characteristics of Chinese forests (from Editorial Committee for Vegetation of China, 1980). T is annual mean temperature (°C). T<sub>cm</sub> is mean temperature of the coldest month (°C). T<sub>wm</sub> is mean temperature of the warmest month (°C). P is annual precipitation (mm).

Forest type	Latitude (°)	Longitude (°)	Elevation (m)	Dominants	T (°C)	T <sub>cm</sub> (°C)	T <sub>wm</sub> (°C)	P (mm)
1. Boreal forest								
Boreal <i>Larix</i> forest	>26 (mainly 54–42.5)		<1500 2100–4000 1400–2600	<i>Larix gmelinii</i> , <i>L. sibirica</i> , <i>L. principis-rupprechtii</i>	–2 to –5	–28 to –38	16–20	350–550 600–1000
Boreal and subalpine <i>Abies-Picea</i> forest	54–22.5		1100–4300	<i>Abies georgei</i> , <i>Picea wilsonii</i>	0–8	–8 to 0	10–16	(300)600–1000
Boreal <i>Pinus sylvestris</i> var. <i>mongolica</i> forest	54–46.67	112–125	300–900	<i>Pinus sylvestris</i> var. <i>mongolica</i>	0 to –5	–25 to –35	15–20	400–550
Cold-temperate mixed coniferous broad-leaved deciduous forest	50.3–40.75	134–124.75	300–1300	<i>Pinus koraiensis</i> , <i>Tilia</i> , <i>Betula</i> , <i>Acer</i>	2–8	–25 to –10	20–24	500–800(1100)
2. Temperate deciduous broad-leaved forest								
Typical temperate deciduous broad-leaved Forest	34–42		<1500	<i>Quercus</i> , <i>Tilia</i> , <i>Carpinus</i> , <i>Alnus</i> , <i>Ulmus</i> , <i>Acer</i>	9–14	–2 to –14	24–28	500–900
Montane <i>Populus-Betula</i> forest	>35			<i>Populus</i> , <i>Betula</i>	<8			400–800
Temperate Tugai forest	30–50		500–900	<i>Populus enphratica</i> , <i>P. pruinosa</i>	8–14			30–60, 200–300
3. Subtropical evergreen broad-leaved forest								
Typical subtropical evergreen broad-leaved forest	23.67–32	99–123	200–2800	<i>Cyclobalanopsis</i> , <i>Lithocarpus</i> , <i>Castanopsis</i> , <i>Machilus</i> , <i>Schima</i>	16–18	3–8	28–30	1400–2100
Subtropical mixed evergreen-deciduous broad-leaved forest	34–23		<1800	<i>Quercus</i> , <i>Castanopsis</i> , <i>Cyclobalanopsis</i>	14–22	2–13	28–29	800–3000
Subtropical sclerophyllous evergreen broad-leaved forest	26–32	90–103	2600–4000	<i>Quercus</i>	<10			600–900

Table I (continued).

Forest type	Latitude (°)	Longitude (°)	Elevation (m)	Dominants	T (°C)	T <sub>cm</sub> (°C)	T <sub>wm</sub> (°C)	P (mm)
4. Tropical rain forest & monsoon forest								
Tropical rain forest & monsoon forest	18–23		<500–1000 <500–600	<i>Vatica</i> , <i>Hopea</i> , <i>Parashorea</i>	22–26 20–25	18 10–13		2000–3000(5000) 1000–1800(3000)
5. Temperate coniferous forest								
<i>Pinus tabulaeformis</i> forest	31–43.55	103.3–124.8	1200–1800	<i>Pinus tabulaeformis</i>	<14			<900
6. Subtropical coniferous forest								
<i>Pinus armandii</i> , <i>P. taiwanensis</i> and <i>P. densata</i> forest	28–33	93–104	1000–3000 700–1750 2000–4000	<i>Pinus armandii</i> , <i>P. taiwanensis</i> , <i>P. densata</i>	14–18	0–8	26–28	>900
<i>Cunninghamia lanceolata</i> forest	23–34	98–120	<800–2000	<i>C. lanceolata</i>	17–20	7–10	27–28	1400–1800
<i>Pinus massoniana</i> forest	20–34	100–124	<1000	<i>Pinus massoniana</i>	14–21			800–1800
<i>Pinus yunnanensis</i> and <i>P. khasya</i> forest	23–29 23–25	93.5–106.5 100–102	1500–2800 1000–1900	<i>Pinus yunnanensis</i> , <i>P. khasya</i>	17			1300–1600
<i>Cupressus</i> forest	26–30	105–120	300–3000	<i>Cupressus funebris</i> , <i>C. duclouxan</i> , <i>C. didantea</i>	>16			>1000

### 2.3. Estimate of NPP

Total forest NPP was estimated by the following equation:

$$\text{NPP} = P_s + P_b + P_l + P_r + P_u$$

where, NPP is net primary productivity of a forest,  $P_s$ ,  $P_b$ ,  $P_l$  and  $P_r$  are annual net increments of tree stem, branch, leaf and root, respectively, and  $P_u$  is annual net increment of shrub and herb.

In order to estimate annual net increment, growth rate of trees within a recent 3–5 year period was calculated using a biomass-volume growth rate model for different geographical regions and various tree species [23]. The annual net increments of stem, branch and root were obtained by multiplication of the proportion of tree biomass represented by the tissue and their growth rate, respectively, based on an assumption of allocation among different tissue types. The total annual net increment of stem, branch and root in a forest was summed based on that of all trees. The annual net increment of leaves was derived from leaf biomass by dividing by leaf age (residence time) of different trees. Annual net increments of all leaves were summed for the different tree types in a forest. The leaf residence time of deciduous coniferous and deciduous broad-leaved trees was estimated at 1 year, and 1.5 years for the evergreen broad-leaved trees, 5 years for *Picea* spp. and *Abies* spp., 4 years for *Pinus koraiensis* and *Cryptomeria japonica*, 3 years for *P. tabulaeformis*, *P. Taiwanensis* and *Cupressus* spp., 2 years for *P. sylvestris* var. *mongolica*, *P. Armandii* and *Cunninghamia lanceolata*, and 1.5 years for *P. massoniana*, *P. yunnanensis* and *P. khasya*. Leaf residence time for other coniferous trees is estimated at approximately 2 years.

Estimation of annual net increment of shrub and herb was by the same method as for trees. Where field measurements were lacking, estimated shrub and herb increments were based upon generalised relationships between shrub, herb and tree biomass for each forest type. The average NPP of the shrub and herb layers was estimated by dividing their biomass by their average stand age [23].

### 2.4. Calculation of LAI

One hundred leaves of each tree species were collected to measure their specific leaf area. Projected leaf area of broad-leaved trees was measured by cutting and

weighing paper replicates. For needle leaves, the following equations were used to calculate projected leaf area:

$$S = (a + b) \times L \text{ (Picea, Pinus)}$$

$$S = (a + b) \times L/2 \text{ (Abies, Larix)}$$

where,  $S$  is projected leaf area of a needle leaf,  $a$  and  $b$  are the width of a leaf at top and bottom, respectively, and  $L$  is the length of a needle leaf.

The specific leaf area of each tree species was then calculated based on the relationship between leaf weight and projected leaf area. Total leaf area index (LAI) of a forest was summed up from that of each tree, which was calculated by the following equation:

$$\text{LAI} = (\text{projected leaf area/leaf weight}) \times \text{total leaf biomass.}$$

### 2.5. Climatic factors

To investigate the role that different climatic variables may play in determining regional patterns of NPP, we analysed the relationships between annual NPP and environmental data, such as mean annual temperature ( $T$ ), growing degree-days on a 0 °C basis ( $\text{GDD}_0$ ) and on a 5 °C basis ( $\text{GDD}_5$ ), annual precipitation ( $P$ ), and annual potential evapotranspiration (PET).

Monthly mean temperature, absolute minimum temperature, precipitation, and percent of sunshine were used for 841 standard weather stations from 1951 to 1980 [5]. Data were interpolated to a 10' latitude  $\times$  10' longitude grid by the smoothing spline method (Wolfgang Cramer, Potsdam Institute for Climatic Impact Research, personal communication). Grid cell data for each NPP estimation site were extracted to calculate  $\text{GDD}_5$ ,  $\text{GDD}_0$  and PET using the methods of BIOME3 [20]. All NPP comparisons to climatic factors used the grid cell data.

### 2.6. BIOME3 model

The equilibrium terrestrial biosphere model BIOME3 [20] represents an attempt to combine the biogeography and biogeochemistry modelling approaches within a single global framework, to simulate vegetation distribution and biogeochemistry (NPP). The logic of BIOME3 model is as follows. Ecophysiological constraints determine which plant functional types (PFTs) may potentially occur. A coupled carbon and water flux model is then used to calculate, for each PFT, the LAI that maximises NPP, subject to the constraint that NPP must be sufficient to maintain this LAI. Competition between

PFTs is simulated by using the optimal NPP of each PFT as an index of competitiveness, with additional rules to approximate the dynamic equilibrium between natural disturbance and succession driven by light competition. Canopy conductance is treated as a function of the calculated optimal photosynthetic rate and water stress. Regional evapotranspiration is calculated as a function of canopy conductance, equilibrium evapotranspiration rate, and soil moisture using a simple planetary boundary layer parameterization. This scheme results in a two-way coupling of the carbon and water fluxes through canopy conductance, allowing simulation of the response of photosynthesis, stomatal conductance, and leaf area to environmental factors including atmospheric CO<sub>2</sub>.

Model inputs consist of latitude, soil texture class, and monthly climate (temperature, precipitation, and sunshine) data. Model output consists of a quantitative vegetation state description terms of the dominant PFT, secondary PFTs present, and the total LAI and NPP for the ecosystem. Comparisons with the mapped distribution of vegetation and with NPP have shown that the model successfully reproduced the broad-scale patterns in potential natural vegetation distribution and NPP worldwide [20] and within China [27, 28].

### 3. RESULTS

#### 3.1. Biomass and NPP

The forests of China are mainly distributed in the eastern and southern parts of the country and in the southeastern periphery of the Tibetan Plateau. A few of them are scattered in the higher mountains and along the rivers in the desert area of the western part of China [13]. The study covered 6 distinct biomes in relation to increasing thermal and moist gradients from north to south (*table I*), i.e., boreal forest, temperate deciduous broad-leaved forest, temperate coniferous forest, subtropical evergreen broad-leaved forest, subtropical coniferous forest, tropical rain forest and monsoon forest, including 17 forest types ranging across a substantial land area from the far north-east (Heilongjiang Province, ca. 53° N, 122° E) and north-west of China (Xinjiang Autonomous Region, ca. 48° N, 86° E) to the southerly Yunnan Province (ca. 22° N, 100° E) and the southernmost part of China (Hainan Island, ca. 18° N, 108° E).

The elevation of the forest study sites ranges from 10 to 4 240 m (mean = 1 385 m), and stand age from 3 to 350 years (mean = 66 years). Estimates of LAI range

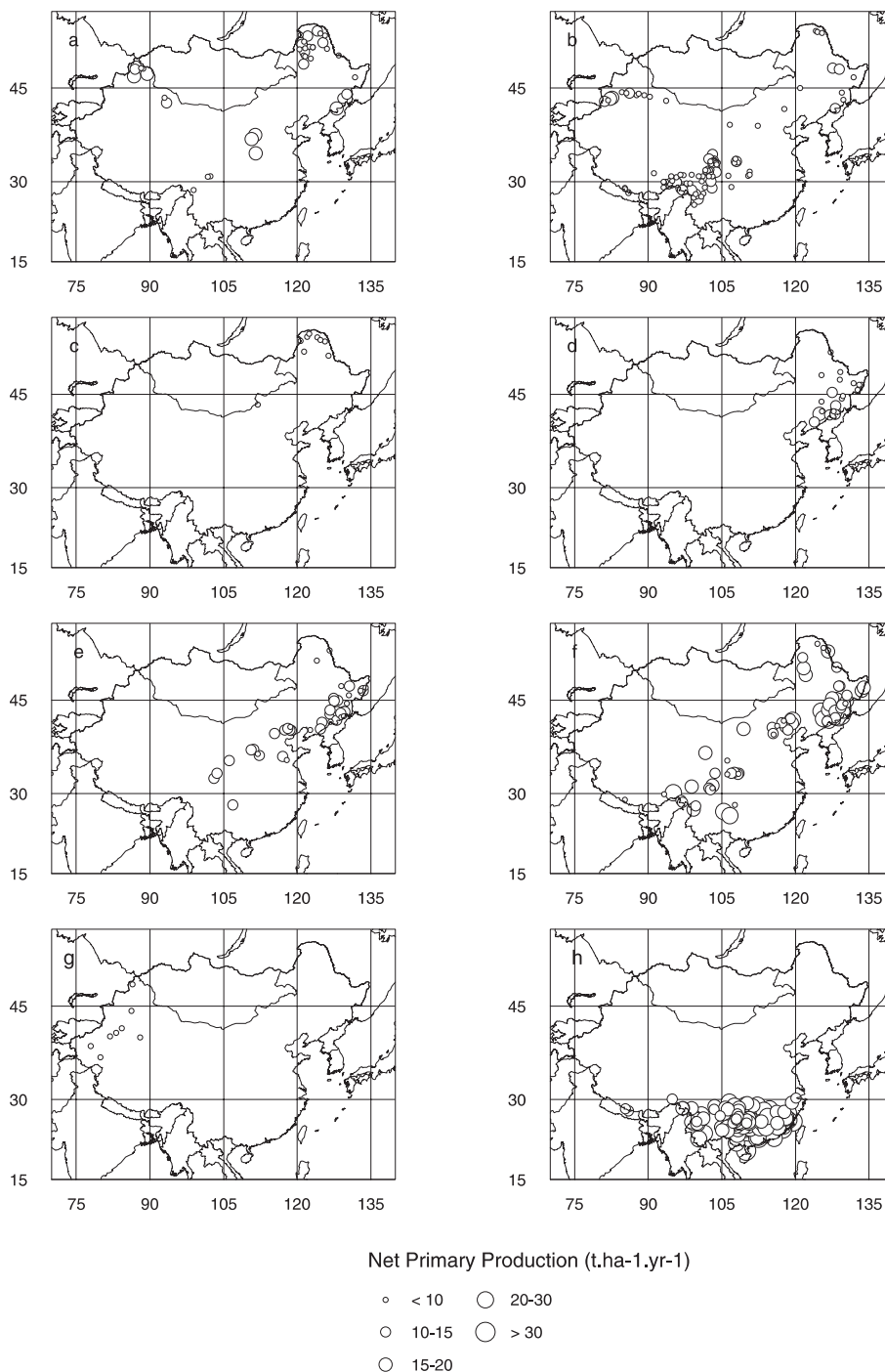
from 0.17 to 41.78 (mean = 8.94), biomass from 31.14 to 1 569.85 t ha<sup>-1</sup> (mean = 185.41 t ha<sup>-1</sup>), and NPP from 2.41 to 40.27 t ha<sup>-1</sup> yr<sup>-1</sup> (mean = 14.4 t ha<sup>-1</sup> yr<sup>-1</sup>). The lowest and highest biomass and NPP occur in the tugai forest in the western desert region, and the rain and monsoon forests in the southern tropical region, respectively (*table II*). In order of biome, the biomass of tropical rain and monsoon forest (mean = 440.04 t ha<sup>-1</sup>) is greater than that of subtropical evergreen broad-leaved forest (mean = 232.27), boreal forest (mean = 180.51), subtropical coniferous forest (mean = 155.89), temperate deciduous broad-leaved forest (mean = 106.9) and temperate coniferous forest (mean = 106.05). NPP of tropical forests (mean = 27.1 t ha<sup>-1</sup> yr<sup>-1</sup>) is greater than that of subtropical forests (evergreen broad-leaved forest, mean = 16.18, coniferous forest, mean = 14.22), temperate forests (deciduous broad-leaved forest, mean = 10.23, coniferous forest, mean = 9.86), and boreal forest (mean = 8.85).

#### 3.2. Spatial pattern

The boreal deciduous coniferous (*Larix*) forest is mainly distributed in the far north east and north west of China, and scattered in the mountainous area of central China. The estimated NPP of this forest varies in different regions (north east China < 10 t ha<sup>-1</sup> yr<sup>-1</sup>, north west China 10.5, and central China 15.0) in relation to various elevations (*figure 1a*). The NPP of boreal and cool temperate coniferous (*Abies-Picea*) forest that is distributed in the higher mountains in the north east, north west of China and south east of Tibet is mostly less than 10 t ha<sup>-1</sup> yr<sup>-1</sup> (*figure 1b*). The *Pinus sylvestris* var. *mongolica* forest with a lower NPP is distributed in the extreme north east of China (*figure 1c*). The mixed coniferous broad-leaved deciduous forest is distributed in the north east China near Russia and Korea (*figure 1d*), with a low to moderate NPP (<15 t ha<sup>-1</sup> yr<sup>-1</sup>). The typical deciduous broad-leaved forest in central and northern areas of east China mostly has a moderate NPP of 10.5 t ha<sup>-1</sup> yr<sup>-1</sup> (*figure 1e*). Montane *Populus-Betula* forest, distributed from northeastern to southwestern China shows a range of NPP, from <10 to 30 t ha<sup>-1</sup> yr<sup>-1</sup> (*figure 1f*). The tugai *Populus* forest along the riverside in western desert region has the lowest NPP (*figure 1g*). The typical evergreen broad-leaved forest, mixed evergreen-deciduous broad-leaved forest and sclerophyllous evergreen broad-leaved forest which are mainly distributed in south east China and the southerly Tibetan plateau, however, have larger NPP, ranging mostly from 15 to 30 t ha<sup>-1</sup> yr<sup>-1</sup> (*figure 1h*). The NPP of tropical rain forest and monsoon forest in Hainan Island and the

**Table II.** Statistics of leaf area index (LAI), total biomass and annual net primary productivity (NPP) of 17 Chinese forests. Mean is the average value for each item in each forest. S.D. is the standard deviation. Min and max are the minimum and maximum values, respectively for each item.

Forest type	Latitude (°)	Longitude (°)	Elevation (m)	Age (yr)	LAI				Biomass (t ha <sup>-1</sup> )				NPP(t ha <sup>-1</sup> yr <sup>-1</sup> )			
					mean	S.D.	min	max	mean	S.D.	min	max	mean	S.D.	min	max
<i>Larix</i>	28.50–52.63	86.83–131.87	441–4240	30–193	7.01	3.44	2.73	15.69	159.13	83.18	53.38	397.11	10.32	3.39	3.77	17.35
<i>Abies-Picea</i>	25.90–52.63	81.10–131.87	410–4180	46–350	10.98	6.51	3.29	40.69	264.51	172.22	69.98	1569.85	8.47	2.60	3.76	16.97
<i>Pinus sylvestris</i> var. <i>mongolica</i>	43.52–53.02	112.05–126.38	500–900	53–180	5.83	0.41	5.09	6.58	125.13	23.39	94.82	157.99	6.66	0.78	5.44	8.14
Mixed coniferous-broad-leaf	40.87–50.72	123.88–133.53	233–770	20–238	8.74	3.01	4.59	17.48	173.27	82.39	42.47	279.20	9.94	2.70	5.40	15.10
Deciduous broad-leaf	27.97–51.70	103.08–134.00	177–2600	20–157	6.67	1.95	4.11	11.39	120.32	42.02	58.16	247.33	10.90	2.45	5.46	14.82
<i>Populus-Betula</i>	26.03–52.53	85.27–134.00	150–3500	25–110	8.27	2.57	3.12	13.95	142.51	49.75	49.73	298.16	14.33	4.84	5.69	27.67
Tugai	37.15–48.03	78.00–88.03	500–950	25–53	0.85	0.96	0.17	2.87	57.89	21.52	34.06	91.37	5.47	2.49	2.41	9.05
Evergreen broad-leaf	20.68–30.27	85.35–120.17	80–3460	3–200	11.18	6.35	3.97	41.78	248.58	111.65	50.86	659.43	21.92	5.25	10.06	33.19
Mixed evergreen-deciduous broad-leaf	25.38–33.78	96.68–117.48	470–2600	20–130	11.27	4.98	5.12	27.29	200.34	90.35	80.82	374.32	15.20	2.98	8.72	23.12
Sclerophyllous evergreen broad-leaf	27.80–29.88	86.00–101.52	2375–3800	76–232	7.07	1.60	3.89	9.50	247.90	53.67	167.97	331.81	11.41	1.55	8.56	13.71
Rain and monsoon	18.70–22.02	100.80–109.83	450–875	22–160	7.90	6.08	4.10	16.88	440.04	290.93	108.27	765.02	27.10	9.16	19.04	40.27
<i>Pinus tabulaeformis</i>	32.65–42.65	103.67–129.53	240–3200	15–95	8.56	3.68	3.68	16.51	106.05	57.64	31.14	285.36	9.86	2.37	5.67	13.40
<i>Pinus armandii</i> , <i>P. taiwanensis</i> and <i>P. densata</i>	26.07–34.62	85.27–119.38	718–3558	20–160	10.90	3.00	5.13	15.81	143.62	63.64	31.26	337.44	11.91	3.31	5.48	17.79
<i>Cunninghamia lanceolata</i>	18.70–33.07	103.37–121.20	20–1910	16–55	6.86	3.34	3.02	18.33	139.08	80.38	46.74	495.13	16.66	7.15	6.91	35.13
<i>Pinus massoniana</i>	21.57–37.98	105.22–120.03	10–1420	15–101	6.92	2.69	2.66	14.47	154.85	77.49	38.42	415.84	17.48	5.25	7.95	30.13
<i>Pinus yunnanensis</i> and <i>P. khasya</i>	24.30–28.63	97.48–106.57	970–3050	22–110	7.78	2.57	5.08	14.05	176.88	74.92	99.37	364.28	12.71	2.48	8.32	16.28
<i>Cupressus</i>	25.37–33.62	85.27–113.08	200–3500	15–220	12.19	4.44	7.28	22.72	165.04	79.51	69.14	293.92	12.36	4.22	7.21	21.54
Summary	18.70–53.02	78.00–134.00	10–4240	3–350	8.94	4.94	0.17	41.78	185.41	116.45	31.14	1569.85	14.40	6.61	2.41	40.27



**Figure 1 (continued on next page).** Geographical patterns of NPP in each forest of China. (a) *Larix* forest; (b) *Abies-Picea* forest; (c) *Pinus sylvestris* var. *mongolica* forest; (d) Mixed coniferous broad-leaved deciduous forest; (e) Typical deciduous broad-leaved forest; (f) Montane *Populus-Betula* forest; (g) Tugai forest; (h) Typical evergreen broad-leaved forest; (i) Mixed evergreen-deciduous broad-leaved forest; (j) Sclerophyllous evergreen broad-leaved forest; (k) Rain forest and monsoon forest; (l) *Pinus tabulaeformis* forest; (m) *Pinus armandii*, *P. taiwanensis* and *P. densata* forest; (n) *Cunninghamia lanceolata* forest; (o) *Pinus massoniana* forest; (p) *Pinus yunnanensis* and *P. khasya* forest; and (q) *Cupressus* forest.

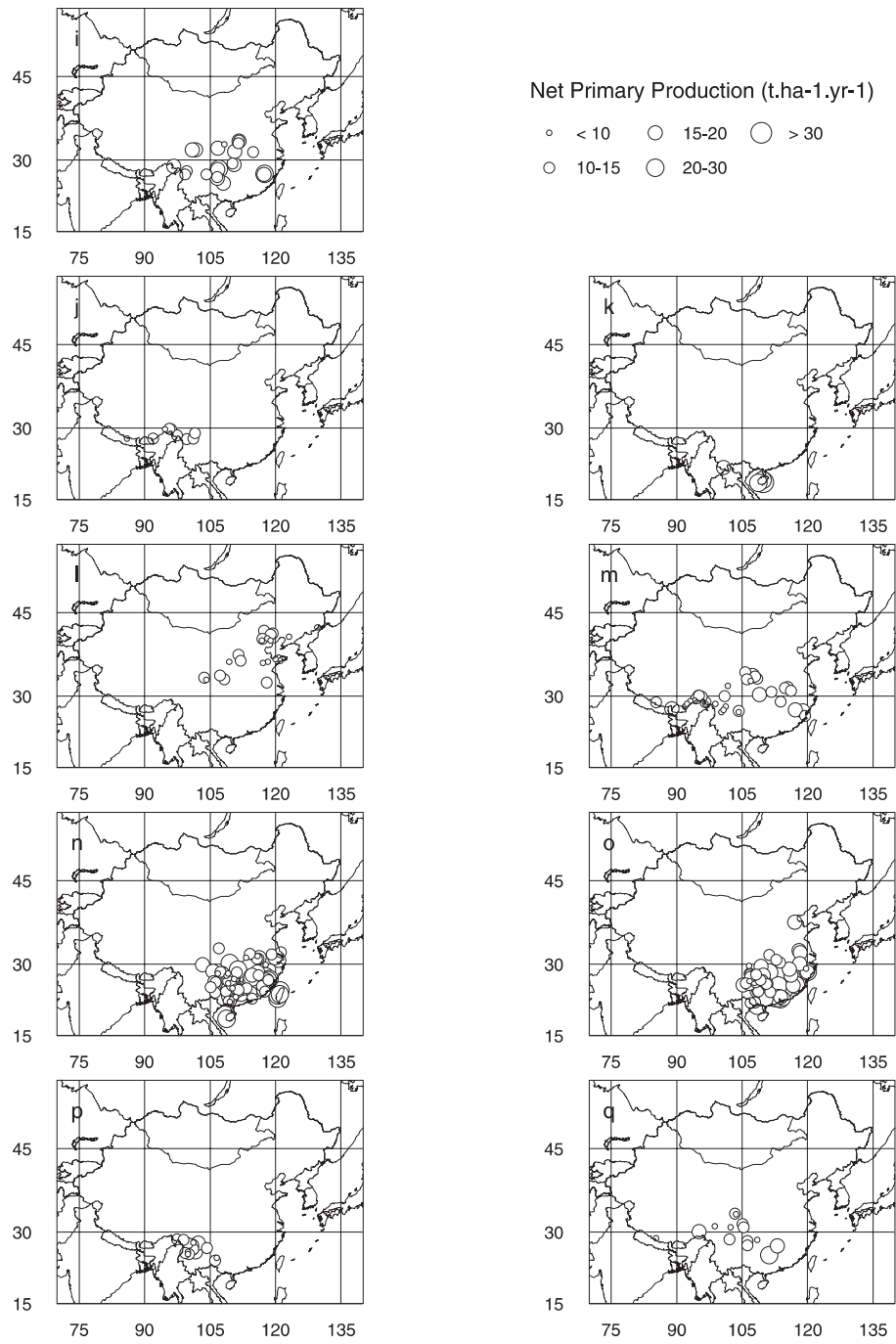


Figure 1 (continued).

Xishuangbanna area of Southern China is the highest, at 20 to 40 t ha<sup>-1</sup> yr<sup>-1</sup> (figure 1k). Coniferous forests usually have lower NPP than broad-leaved forests in the same climatic zone. The temperate *Pinus tabulaeformis* forest with a similar distribution to temperate deciduous broad-leaved forest has lower NPP, <15 t ha<sup>-1</sup> yr<sup>-1</sup> (figure 1l). The subtropical *Pinus armandii*, *P. taiwanensis* and *P. densata* forest, *Cunninghamia lanceolata* forest, *P. massoniana* forest, *P. yunnanensis* and *P. khasya* forest, and *Cupressus* forest, which are distributed in south east China, have larger NPP, mostly from 15 to 30 t ha<sup>-1</sup> yr<sup>-1</sup> (figure 1m-q).

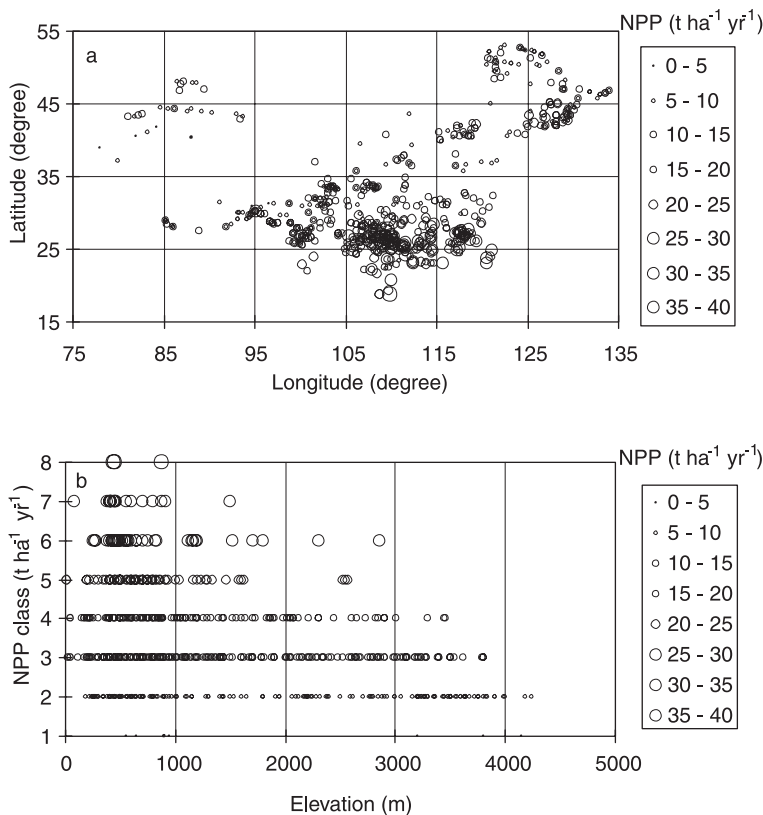
Generally, the NPP of Chinese forests increases from north to south in relation to the increasing temperature and precipitation, and increases from west to east in relation to the moisture gradient (figure 2a). In mountainous areas, NPP decreases with elevation (figure 2b).

### 3.3. Environmental factors controlling NPP

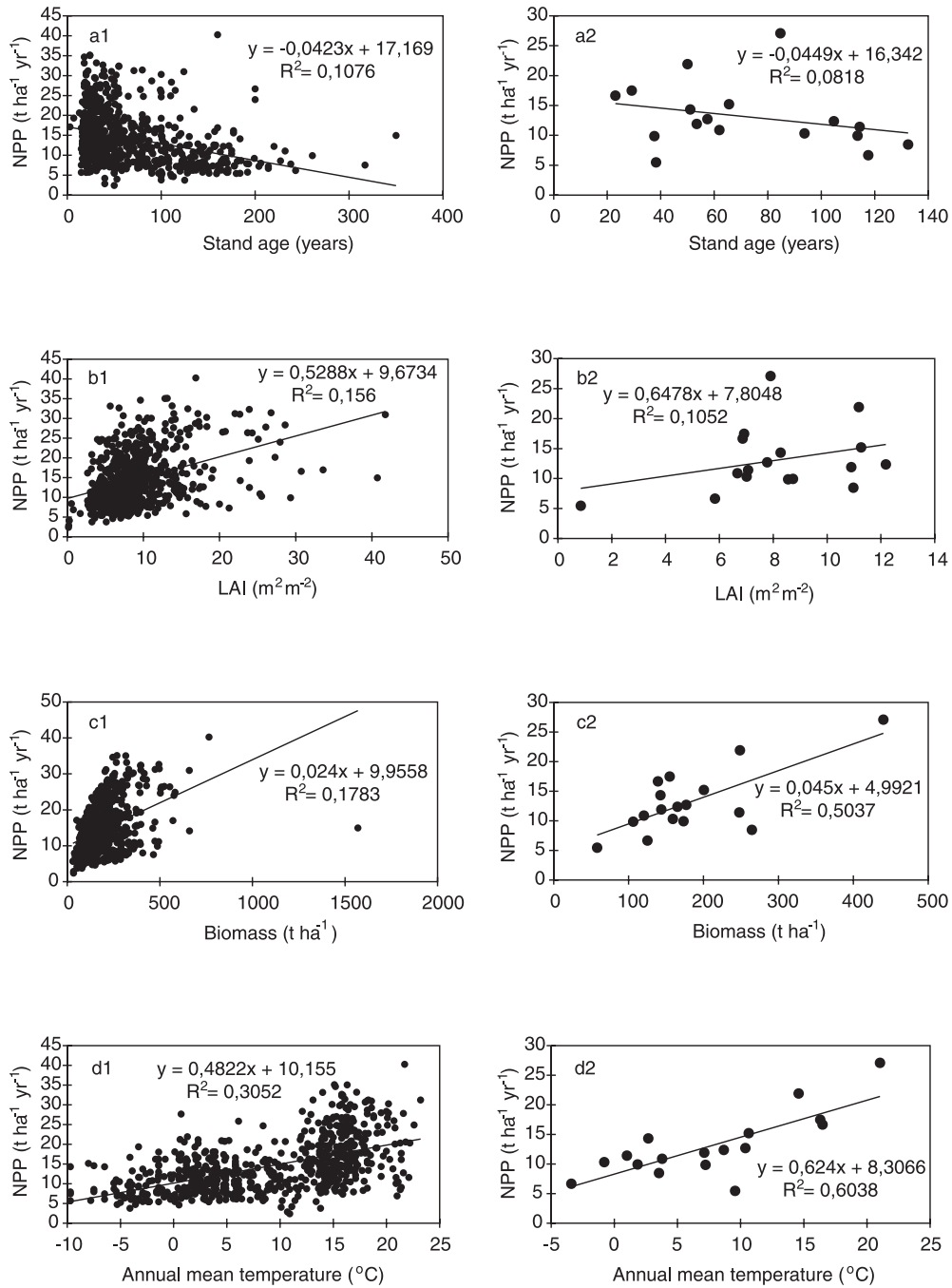
The estimated NPP of the 690 individual forest sites showed no clear relationships with stand age (fig-

ure 3a1), LAI (figure 3b1) and biomass (figure 3c1), but these relationships were more well-defined in a forest type-based comparison (figures 3a2, b2, c2).

Five climatic variables, T, GDD<sub>0</sub>, GDD<sub>5</sub> and P, as well as PET were compared to actual NPP estimates. On a regional basis, forest NPP of China is highly correlated with annual mean temperature (figures 3c1, c2) and rainfall (figures 3g1, g2), especially on the basis of site-based comparison, as well as the annual PET (figures 3h1, h2) which expresses the potential atmospheric demand for moisture. Strong positive correlation also existed between NPP and growing degree-days on a 0 °C base (figures 3d1, d2) and on a 5 °C base (figures 3f1, f2). These results all suggest that temperature and moisture are among the dominant factors controlling the spatial distribution of NPP in China. The importance of each variable in influencing NPP was determined by least-squares regression and correlation analysis (SPSS software). Correlation analysis (correlation significant at *P* < 0.01) showed that spatial distributions of *Larix* forest and typical evergreen broad-leaved forests correlate most highly with T and PET; mixed coniferous broad-leaved deciduous forest, typical evergreen broad-leaved forest, *Pinus*



**Figure 2.** Distribution patterns of Chinese forest NPP classes in relation to the longitude and latitude (a), and elevation (b).



**Figure 3 (continued on next page).** Relationships between NPP and environmental variables: (a) stand age (years); (b) LAI; (c) biomass (t ha<sup>-1</sup>); (d) annual mean temperature (°C); (e) growing degree- day on 0 °C base; (f) growing degree-day on 5 °C base; (g) annual precipitation (mm); (h) estimated annual potential evapotranspiration (mm). Left column, 690 sites- based comparison (1); right column, 17 forest types-based comparison (2).

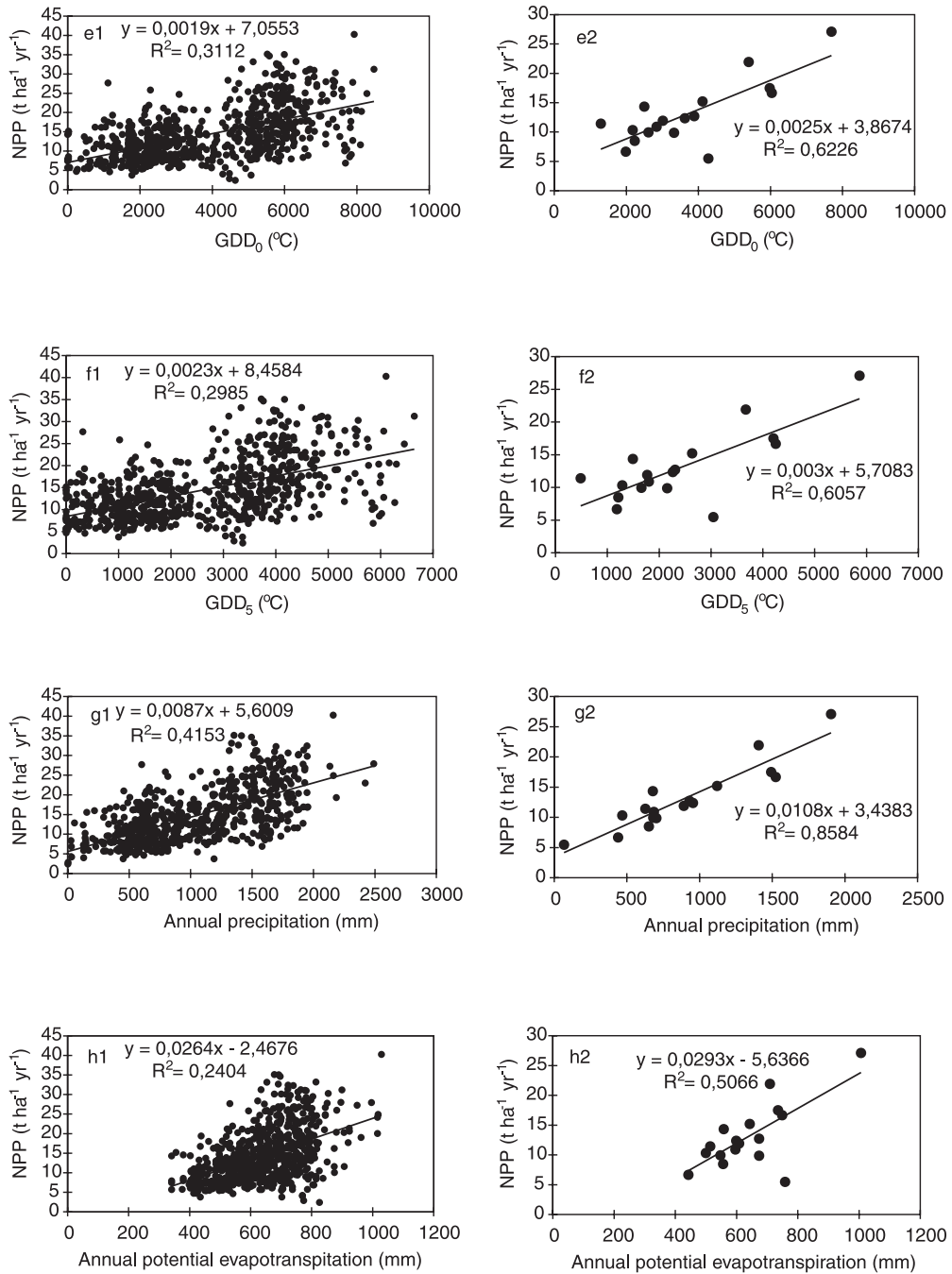


Figure 3 (continued).

*armandii*, *P. taiwanensis* and *P. densata* forest, and *P. massoniana* forest with P; and typical evergreen broad-leaved forest with GDD<sub>0</sub>, GDD<sub>5</sub> and annual PET.

### 3.4. Comparison of estimated NPP to BIOME3-modelled NPP

Reliable field-derived NPP data from terrestrial ecosystems are needed for validating and calibrating global biogeochemical models. These data are also potentially useful to mechanistically model carbon dynamics at global and regional scales. For illustrative purposes, field estimated NPP was compared to NPP modeled using BIOME3 [20]. BIOME3 predictions of total NPP were obtained for each grid cell containing a Chinese forest NPP site, and compared with these 690 site-specific estimates of forest NPP [28]. The resulting comparison showed a fair degree of agreement between the predicted and estimated NPP, based upon linear regression:  $y = 0.85x + 254.38$ ,  $n = 690$ ,  $r^2 = 0.31$  [28].

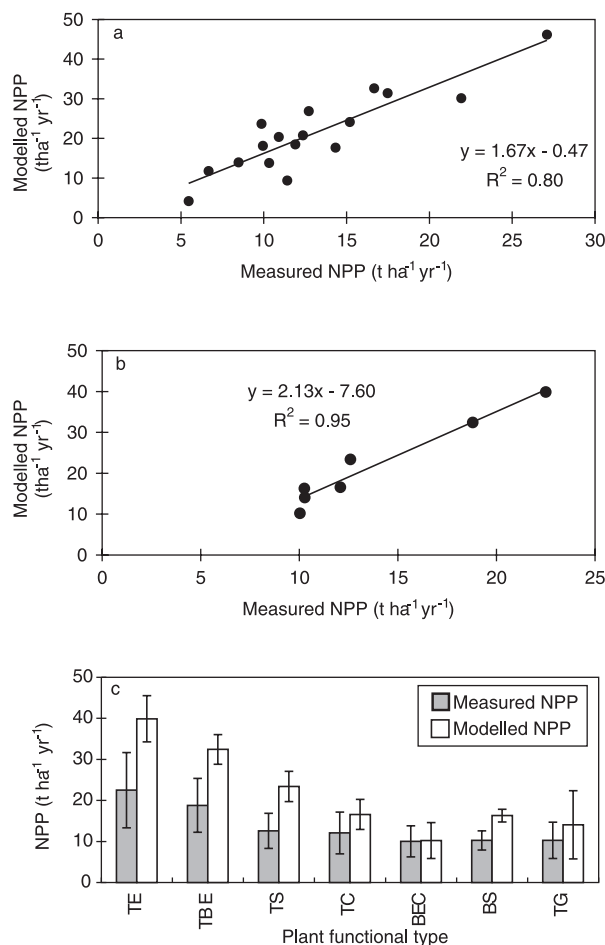
However, forest type-based and PFT-based comparisons are more valuable to simulation of large-scale vegetation dynamic. A higher correlation occurred in the forest-based comparison between estimated NPP and NPP modelled by BIOME3:  $y = 1.67x - 0.47$ ,  $n = 17$ ,  $r^2 = 0.80$  (figure 4a), whereas the highest correlation exists in the PFT-based comparison:  $y = 2.13x - 7.60$ ,  $n = 7$ ,  $r^2 = 0.95$  (figure 4b). Generally, modelled NPP was larger than PFT-based estimates of forest NPP (figure 4c) because the model simulated the average NPP of all vegetation types over a grid cell.

## 4. DISCUSSION

### 4.1. Limitations of data and methodology

The biomass and NPP data sets used in this study were derived from the dissertation of Luo [23]. They are not the original data sets and do not contain all the components of biomass and NPP. Further description and analysis of biomass and NPP components is needed, especially for root production, although these are not available here, since we focussed only on synthesis and analysis. A more detailed biomass and NPP database is under development and analysis (Zhou, personal communication).

The types of field measurements of biomass and NPP that are available for biomes worldwide depend largely on plant growth form and life cycle length. NPP is gener-



**Figure 4.** Comparisons between estimated NPP and NPP modelled by BIOME3 [20]: (a) based upon 17 forest types; (b) based upon 7 plant functional types (PFTs); (c) comparison by PFT. The PFTs are tropical evergreen (TE), temperate broad-leaved evergreen (TBE), temperate summergreen (TS), temperate evergreen coniferous (TC), boreal evergreen coniferous (BEC), boreal summergreen (BS), and temperate grass (TG). The occurrence of TG, a non-forest PFT, is due to some forests that are scattered in the temperate region of northern China where TG is the dominant PFT.

ally calculated as the sum of the positive increments of biomass. Loss of tissue by death or grazing is not always well accounted for, and belowground production is rarely estimated [31, 32]. Measurements are also lacking for some components in the Chinese forestry data set, such as mortality, grazing, belowground biomass, and especially fine root production [23]. Some of these components are customarily estimated from empirical equations based on the relationship between above- and

belowground biomass [23]. Calibrated allometric equations are used to estimate aboveground standing biomass. Wood production is estimated by subtracting the standing biomass value for the preceding time interval, sometimes with corrections for litter and branch fall. Root biomass is rarely available and root production is hardly ever measured directly—most estimates being based on the relationships between above- and belowground production [23]. Detailed ecophysiological measurements occur at very few sites. Therefore, we were unable to determine certain allometric relationships among them because of the lack of some NPP components. Methods of calculating total NPP from partial data sets have recently emerged from a series of workshops, which developed correlative relationships using those more complete data sets [6, 7, 19]. In China, the biomass-volume method of estimating forest NPP has been developed using those better data sets that contain most components of NPP [e.g. 16].

Clark et al. [6] examined how forest NPP (above- and below-ground) may be estimated at ecosystem level based on field measurements. To date, field measurements have been mostly restricted to certain aspects of NPP, and methods are still lacking for field assessment of

other NPP components. Past studies suggest confusion about the types of measurements needed, and, as a result, existing field-based estimates of forest NPP are likely to be significant underestimates [6]. NPP estimates for Chinese forests also have these shortcomings and are therefore likely to be underestimates.

Thus the methodology for the individual site-based estimates of NPP could indeed be improved, but the individual errors in this large-scale analysis are probably lost in the overall mass of data points.

#### 4.2. Comparison with other estimates in China and in the world

Fang et al. [16] estimated the forest biomass of China based on the relationship between stand biomass and volume and using 1984–1988 forest inventory data (*table III*). However, NPP was not estimated in this study. Feng et al. [17] also estimated the biomass and NPP of forest ecosystems in China based on common methodology, using data published since the 1960 (*table III*). For each of the climate zones, the forest biomass according to Fang et al. was much lower than that of Feng et al. and

**Table III.** Mean values of forest biomass and NPP of China in different climate zones.

Climate zone	Fang et al. (1998) [16]		Feng et al. (1999) [17]		This study			
	Biomass (t ha <sup>-1</sup> )	Forest type	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )	Forest type	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )	Forest type
Boreal	134.48	<i>Larix, Picea, Abies, Pinus sylvestris</i> var. <i>mongolica</i>	176.12	5.82	<i>Larix, Pinus sylvestris</i> var. <i>mongolica</i>	180.51	8.85	Boreal forests
Temperate	69.87	Deciduous oaks, <i>Betula, Pinus koraiensis</i> , mixed coniferous and deciduous forests	253.64	7.94	Mixed coniferous-broad-leaf, <i>Larix, Pinus, Abies-Picea, Quercus, Fraxinus, Populus</i>	106.48	10.05	Temperate deciduous broad-leaved forests
Warm temperate	82.77	Lucidophyllous and mixed deciduous forests, nonmerchable woods <i>Cunninghamia, Pinus armandii, P. yunnanensis, Tsuga, Sassafras</i>	364.62	16.11	<i>Cunninghamia lanceolata, Pinus massoniana, P. yunnanensis, P. khasya, Cupressus, Bamboo</i>	184.63	14.89	Subtropical evergreen broad-leaved forests and coniferous forests
Tropic	145.40	Tropical forests	382.66	18.78 (tree layer only)	Rain forest, seasonal forest, mangrove	440.04	27.10	Rain and monsoon forests

**Table IV.** Biomass and NPP of forest ecosystems in the world (from Lieth and Whittaker, 1975).

Forest ecosystem	Biomass (t ha <sup>-1</sup> )		NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )	
	Range	Means	Range	Means
Boreal forest	60–400	200	4–20	8
Temperate deciduous forest	60–600	300	6–25	12
Temperate evergreen forest	60–2000	350	6–25	13
Tropical seasonal forest	60–800	350	10–25	16
Tropical rain forest	60–800	450	10–35	22

also lower than the value of the present study (*table III*). In the temperate and warm temperate zones, the forest biomass estimates of Feng et al. were higher than those of this study, although their estimates for boreal and tropical zones were slightly lower (*table III*). However, estimates of forest NPP are higher in the present study than in Feng et al. [17], with the exception of the warm temperate zone (*table III*).

These differences in estimates of forest biomass and NPP may be attributed to, firstly, different estimation methods although Feng et al. [17] and this study show only small differences, Fang et al. [16] uses quite a different methodology. Furthermore, the three studies treat stand age differently, including only mature forests in some forest types, yet identifying young, middle-aged and mature forests within other types. Lastly, the systems of forest classification differ between the studies.

Lieth and Whittaker [21] summarised the biomass and NPP of major forest ecosystems in the world (*table IV*). According to the present study (*table III*), the biomass of Chinese forests is lower than these world averages (*table IV*). However, their NPP is quite similar (slightly lower or higher on average) for boreal, temperate deciduous and warm temperate evergreen forests (*table III*, *table IV*), but the NPP of Chinese tropical forests is higher than the world mean value.

#### 4.3. NPP and climate

Many studies have shown that climatic factors, specifically temperature and precipitation, were among the major controlling factors of NPP at a large spatial scale [e.g., 21, 33, 34]. In eastern China, mean annual tempera-

ture (from  $-5$  to  $26$  °C) and precipitation (from 350 to 3 000 mm) increase significantly from north to south part of China (*table I*) where major forests are distributed. Estimated forest NPP also increases from ca. 6 to 27 t ha<sup>-1</sup> yr<sup>-1</sup>, associated with the increase of temperature and precipitation (*table II*, *figure 3*). A fair and a good agreement, respectively, existed between climate data and site-based and forest type-based NPP (*figure 3*). However, the climate data used in this study are an interpolation from weather station records, rather than actual measurements from the study sites or nearby weather stations. Errors in the interpolation of climate data due to the low density of weather stations in some areas, and the influence of sharp changes in elevation may lead to uncertainties in the relationship between climate and NPP.

The methodologies or models that were developed to estimate the total NPP generally require independent variables, such as climate. This places a qualifying restriction on the suitability of the secondary data sets to which the rules may be applied – if these ancillary data are not available and cannot be provided, then the secondary data set cannot be used to estimate total NPP with that rule [31, 32]. Thus, in addition to total system NPP (above- and belowground) on an annual time scale, field data should ideally include as complete a picture of NPP as possible, such as the driving variables (e.g. climate, soil, species composition, location, and other information needed to estimate parameters). It is clear that more and better data are needed from Chinese forest biomes before confidence can be placed in scaled-up estimates of NPP for this sector of the world's terrestrial ecosystems.

#### 4.4. Estimated and modelled NPP

It is recognised that there are many problems associated with comparisons of estimated and modelled NPP, including the quality of the data and the fact that the model is simulating the average NPP over a grid square while NPP measurements are made at particular sites [20]. Despite these problems, a positive relationship existed between estimated NPP and NPP simulated by BIOME3, especially for the forest type-based and PFT-based comparisons rather than the site-based comparison (*figure 4*). However, there was poor overall agreement between estimated and simulated NPP. Differences between estimated and BIOME3 modelled forest NPP may be due to:

- i) Spatial reasons. BIOME3 NPP estimates are based on land areas represented by the gridded input data sets used by the model, whereas actual NPP estimates are

based on the quadrat areas actually sampled at each site. This is very important because the model simulated the average NPP of all vegetation types over a grid square, and because the issue of scaling-up of biomass and NPP from the sampling area to a grid cell should be taken carefully into account.

- ii) Errors and uncertainties in NPP estimates, which exist for reasons discussed above.
- iii) Shortcomings of the model. Each biogeography or biogeochemistry model has its limitations and BIOME3 is no exception.

For these reasons, it is recommended to perform and learn from model inter-comparison with respect to various key variables, using common input data sets at global and regional scales [9].

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## APPENDIX

Data on stand age, leaf area index (LAI), total biomass and net primary productivity (NPP) for each sampling site of 17 forest types in China, which was obtained from the Ph.D. Dissertation of Luo [23]. The biome classification and characteristics of each forest type are showed in *table 1*. The methods of measuring LAI, biomass and estimating NPP are described in the Materials and Methods section.

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
<b>1. Boreal forest biome</b>							
<b>Larix forest</b>							
heilongjiang dahailin	43.58	129.35	800	114	9.55	247.42	13.75
heilongjiang tahelinqu	52.32	124.73	550	111	3.62	89.25	4.74
heilongjiang humahanjiayuan	52.07	125.73	441	75	4.26	96.28	7.32
heilongjiang liangshuilingu	46.53	131.87	590	108	6.33	143.15	8.08

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
heilongjiang mulenggonghecun	44.12	130.18	800	158	10.16	251.96	12.55
heilongjiang nanwonghe	51.20	125.33	590	104	7.73	196.37	11.65
heilongjiang tahemengke mt.	52.63	124.17	876	53	6.91	125.05	10.49
heilongjiang xunhexian	49.55	128.47	500	85	5.68	137.90	9.08
jilin changbai mt.	42.03	128.13	880	177	15.08	247.16	16.20
neimeng daxianganlinqu	49.43	121.67	650	100	3.24	56.10	3.77
neimeng daxinganlingjiwen	50.58	123.18	700	55	4.33	100.63	9.22
neimeng daxinganlingqigan	52.17	120.75	800	171	4.66	142.04	6.42
neimeng tulihe	50.47	121.65	800	59	3.33	76.01	7.47
neimeng eergunaxian	50.33	120.50	781	136	6.72	171.32	9.65
neimeng jiagedaqi	50.40	126.07	637	136	5.29	130.05	7.26
neimeng zhuoer	48.40	121.33	820	37	5.53	113.59	11.60
neimeng zhuoer mt.	49.15	122.78	1280	39	2.95	66.86	7.24
neimeng deerbuer	50.98	121.02	812	39	4.91	105.63	10.55
neimeng jiwen	50.58	123.18	676	36	3.35	68.16	7.44
neimeng jinhe	51.30	121.47	774	43	4.20	81.08	8.08
neimeng keyihe	50.65	122.45	810	47	4.44	97.76	8.75
neimeng kuduer	50.00	121.53	887	50	5.49	118.32	10.08
neimeng mangui	52.05	122.15	660	59	6.14	124.68	10.19
neimeng moerdaoga	51.28	120.72	737	31	4.83	96.36	10.99
neimeng wuerqihan	49.53	121.32	846	53	5.39	116.20	9.76
shanxi guandi mt, xiaowen mt.	37.88	111.48	2055	53	7.50	179.47	16.68
shanxi ningwunangoumiao	34.90	111.57	2300	55	7.84	177.53	17.35
shanxi pangquangou reserve	37.20	110.77	1850	31	7.99	159.78	16.17
sixhuan xiaojinrilonggou	30.88	101.88	3638	193	6.54	149.82	7.83
sichuan xiaojinxianlinqu	30.98	102.35	3600	164	7.26	163.81	8.52
xinjiang aletaihalama	47.83	88.20	1650	30	2.73	53.38	8.07
xinjiang balikunxian	43.60	93.02	2100	132	6.60	154.86	6.86
xinjiang buergenbailegen	48.12	87.17	1900	71	11.74	243.95	13.25
xinjiang buerjinbiliti	47.68	86.98	1883	172	11.12	276.82	12.36
xinjiang buerjinbiliti	46.72	86.83	1700	177	14.20	379.51	15.58
xinjiang fuhaixianfuhai	47.78	88.65	1946	107	9.08	199.50	9.56
xinjiang fuyunxian	47.03	89.48	1871	157	15.69	397.11	15.97
xinjiang hamixian	42.83	93.47	2298	139	14.02	314.88	12.88
yunnan deqin	28.50	98.92	4240	100	7.06	156.26	9.10
<b>Mixed coniferous-broadleaved forest</b>							
heilongjiang baishilizi	50.72	127.23	300	21	8.89	50.83	7.73
heilongjiang chaihe	44.75	129.68	400	181	6.64	247.45	8.50
heilongjiang dailinglizi	47.03	129.03	350	101	4.59	107.03	5.40
heilongjiang donglinliangshui	46.53	131.87	378	124	6.00	197.79	9.20
heilongjiang hulindumuhe	46.35	133.53	264	191	5.55	214.22	7.93
heilongjiang huliwanda mt.	46.33	133.00	240	204	4.79	211.57	7.24
heilongjiang linkouxianqingshan	45.63	132.68	450	21	7.31	42.47	6.84
heilongjiang mulengzhongxin mt.	47.68	125.32	600	238	7.19	245.96	7.79

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
heilongjiang niandahailin	44.35	129.47	514	227	9.26	253.48	8.57
heilongjiang shangzhimaoer mt.	45.27	127.50	300	23	11.06	81.94	11.39
heilongjiang yichunwuying	48.13	129.22	403	185	7.27	242.15	8.64
jilin antuxianbaihe	42.47	128.13	650	150	11.25	279.20	14.74
jilin antuxianbaishan	42.10	128.08	770	166	6.09	270.88	12.24
jilin changchunjingyuetan	43.90	125.32	250	48	11.38	104.64	9.12
jilin dongfengxiandayang	42.52	125.40	400	22	9.17	80.81	9.80
jilin dunhuaxianrenyihe	43.37	128.22	696	145	9.21	266.05	12.11
jilin fusongxianlushuihe	42.52	127.80	600	146	8.18	186.29	8.44
jilin linjiangnaozhiling	41.93	127.02	300	24	12.53	100.40	13.58
jilin baihechangbai mt.	42.03	128.13	675	110	10.06	239.41	11.75
liaoning caohekoulinqv	40.87	123.88	233	38	17.48	154.22	12.71
liaoning qingyuanxianwandianzi	42.12	124.90	500	20	9.56	61.96	15.10
<b>Abies-Picea forest</b>							
gansu zhuonixianmaluxiang	34.67	103.13	3280	96	23.92	238.11	12.49
hebei weichangsaibanba	41.93	117.75	1536	55	7.34	94.58	6.82
heilongjiang dailingliangshui	46.53	131.87	508	77	8.04	128.98	8.29
heilongjiang ningandahailin	44.35	129.47	1017	131	13.12	198.27	9.43
heilongjiang tahemengkeshan	52.63	124.17	950	80	9.78	131.01	7.79
heilongjiang taheshibazhan	52.40	125.43	410	50	4.38	69.98	5.47
heilongjiang tahewalagan	52.53	124.53	487	75	6.50	101.70	6.75
heilongjiang taheweidong	47.85	127.67	523	100	14.39	209.13	11.25
heilongjiang yichundafeng	47.70	128.93	800	104	14.83	207.80	10.78
hubei badongxiaoshennongjia	31.03	110.38	3300	87	8.24	129.53	7.35
hubei fangxiandashennongjia	32.05	101.72	3260	159	8.02	128.17	5.40
hubei shennongjia	31.75	110.67	3200	151	7.76	125.69	5.49
hubei xingshandashennongjia	31.22	110.73	3200	125	5.13	78.90	3.76
jilin changbai mt.	42.03	128.13	1286	142	16.41	262.57	12.03
jilin wangqingdahailin	43.35	129.77	900	132	12.01	177.24	8.46
neimeng baiyingaobaoshadi	45.00	121.00	1300	170	8.23	99.38	5.69
neimeng xibuhelan mt.	39.48	106.70	2384	74	17.49	100.44	8.38
shanxi guancenshanqiuqiangu	39.37	112.37	2310	57	10.95	139.82	9.27
shanxi fopingchangjiaobaxiang	33.53	108.00	2680	80	11.64	183.84	10.79
shanxi ningshanxianxinming	33.32	108.33	2250	76	8.72	143.09	8.75
shanxi qinlingna dongtaibai	33.95	107.78	2772	125	9.57	149.66	7.13
shanxi yangxianxingjiangling	33.22	107.55	2770	98	8.73	134.51	7.82
sichuan baiyu	31.23	98.83	3550	184	8.05	199.42	5.50
sichuan zhuosijiataiyanghe	31.80	101.63	3750	178	8.68	318.33	7.39
sichuan daofu	30.98	101.13	3675	165	11.06	330.97	7.88
sichuan ebianlewuchuannan	28.85	103.03	3075	184	10.01	660.04	14.13
sichuan heishuixian	32.07	102.97	3480	166	10.72	358.30	9.13
sichuan jiulongxian	29.02	101.52	3633	169	7.13	311.02	8.39
sichuan lixian	31.43	103.17	2804	163	12.06	328.35	10.83
sichuan lixianmiyaluo	31.67	102.80	3000	169	12.94	341.94	9.18
sichuan maerkangshuajingsi	32.02	102.63	3475	206	9.94	407.74	8.02

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
sichuan maerkangxian	31.92	102.22	3638	243	6.55	287.66	6.18
sichuan maerkangzhuokeji	31.87	102.27	3500	119	18.98	462.00	14.90
sichuan maoxian	31.68	103.87	3178	91	12.86	293.13	10.37
sichuan mulixian	27.92	101.25	3722	144	9.77	269.65	8.31
sichuan nanpingbaihexiang	33.35	104.12	3200	122	10.26	248.51	8.65
sichuan nanpingdaluxiang	33.57	103.67	3200	103	10.75	232.38	8.77
sichuan nanpingheihexiang	33.95	102.38	3200	143	10.79	325.18	10.66
sichuan nanpingjiuzhailinchang	33.28	103.90	3200	171	5.93	201.50	5.73
sichuan nanpinglingjiangxiang	31.03	106.35	3200	134	10.83	228.93	7.91
sichuan nanpinglongkangxiang	33.23	104.20	3238	169	7.50	214.97	5.97
sichuan nanpingmajiaxiang	29.10	106.98	3200	170	8.26	273.75	8.15
sichuan nanpingyonghexiang	33.00	104.00	3200	128	6.24	150.48	5.51
sichuan nuoergaibaxixiang	33.63	103.20	3500	148	10.89	248.43	7.46
sichuan nuoergaibaozuoxiang	33.62	103.35	3500	150	11.70	367.97	10.69
sichuan nuoergaicaopoxiang	33.50	102.67	3500	144	7.85	170.98	5.74
sichuan nuoergailinyeju	33.62	102.95	3500	137	9.36	192.98	6.28
sichuan nuoergailongzhaxiang	33.20	103.20	3500	114	11.12	225.30	10.44
sichuan nuoergaishangbaozuo	33.78	103.40	3238	140	8.59	265.17	8.05
sichuan nuoergaixianqiuixiang	33.70	103.33	3500	133	10.71	237.79	7.56
sichuan nuoergaizhanwaxiang	33.05	102.88	3500	90	8.44	137.99	6.15
sichuan songpan	32.65	103.58	3273	46	14.97	137.36	12.61
sichuan tianquanxiandahe	30.10	102.77	2900	55	15.22	161.28	10.94
sichuan xiaojinxian	30.98	102.35	3208	214	7.32	278.77	6.71
sichuan xinlong	30.95	100.28	3800	317	10.51	465.66	7.53
sichuan yajiangxian	30.03	101.00	3758	164	8.30	221.87	6.25
sichuan wenchuanxianwolongguan	30.98	103.13	2805	133	9.85	289.93	9.55
xizang bomilinqu	29.88	95.75	2750	350	40.69	1569.85	14.97
xizang chayuzhuwagen	28.63	97.50	3500	175	6.33	493.78	11.17
xizang changdu	31.18	97.17	3900	100	10.55	137.65	5.41
xizang changdubianbaxian	30.93	94.70	4150	113	5.98	150.97	4.62
xizang changdubomiyigong	30.15	94.98	2620	50	6.08	101.29	6.48
xizang changdubomizhamu	29.88	95.75	3237	152	5.81	473.00	11.29
xizang changdujiangdaxian	31.52	91.20	3900	120	6.49	217.15	6.02
xizang jiangdaxianjiangda	29.98	93.15	3750	100	9.29	164.20	5.88
xizang changduleiwuqixian	31.20	96.60	3800	100	7.03	135.19	4.74
xizang changduluolong	30.80	95.77	3982	110	8.06	150.57	5.25
xizang changdumangkangxian	29.67	98.53	4180	150	9.31	212.35	6.18
xizang zuogongxianwangda	29.68	97.87	3999	116	9.32	222.68	7.23
xizang gongbujiangda	29.92	93.25	3642	129	6.26	242.49	7.22
xizang linzhixiansiyilin	29.57	94.50	3631	143	4.48	243.27	6.64
xizang milinxiantiemolong	29.17	94.17	3274	140	5.24	283.15	7.61
xizang linzhimafenggou	29.28	94.37	3428	149	6.04	340.91	9.60
xizang lulangxianlulang	29.80	94.72	3540	86	7.24	284.39	11.67
xizang nielamu	28.17	85.98	2590	140	4.02	328.38	8.00
xizang rikazejilongxiang	28.88	85.27	2786	131	3.58	254.23	7.44

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
xizang jilongxianwuyiji	28.75	85.32	3350	192	3.68	258.90	5.74
xizang zhangmuwuyizhang	28.00	86.00	2710	170	4.74	320.10	7.99
xizang shannanlangxian	29.03	93.13	3835	160	6.11	225.84	6.08
xizang shangchayubenzhui	28.80	96.68	2000	76	3.29	334.37	13.59
xizang xiachayushawo	28.50	97.00	3616	144	7.68	367.74	10.05
xizang xuekalonggou	30.02	93.68	3600	125	4.88	265.81	8.36
xinjiang fukangxiantianchi	44.20	88.05	2173	128	15.62	202.78	5.87
xinjiang gongliuxian	43.47	82.22	1870	96	30.72	473.47	16.58
xinjiang gongliuxiaomohe	43.60	82.65	1895	115	33.60	571.25	16.97
xinjiang jimusaer	44.00	89.18	2197	122	19.99	282.87	8.29
xinjiang manasixianliuqu	44.30	86.22	2050	122	25.51	342.52	10.25
xinjiang muleixian	43.80	90.35	2210	86	13.56	166.97	7.87
xinjiang shawangxiaodonggou	44.32	85.57	2240	58	11.56	109.77	6.19
xinjiang tekesikukesu	43.22	81.82	2500	261	29.31	487.35	9.90
xinjiang wulumuqimiquan	43.97	87.68	2285	178	21.25	294.11	7.29
xinjiang wulumuqinanshan	43.18	93.68	2200	108	17.02	222.88	8.91
xinjiang wusutianshandongou	44.47	84.68	2170	97	18.20	224.61	7.72
xinjiang zhaosuxian	43.13	81.10	2283	116	25.29	361.67	10.93
yunnan diqingweixi	27.80	99.70	3390	90	14.51	293.31	10.83
yunnan deqin	28.50	98.92	3790	175	9.45	395.40	10.37
yunnan lijiang	26.87	100.23	3240	120	11.90	392.27	10.91
yunnan ninglang	27.30	100.82	3820	120	9.05	212.35	7.41
yunnan weixi	27.15	99.28	3260	160	6.40	286.02	7.37
yunnan yunlong	25.90	99.37	3055	105	6.24	246.05	8.83
yunnan zhongdianxianjisha	27.80	99.70	3200	155	8.13	293.41	7.30
<b>Montane <i>Populus-Betula</i> forest</b>							
beijing baihuashan linchang	39.87	115.60	1500	31	3.38	49.73	6.11
beijing dongling mt.	40.03	115.45	1492	58	8.24	87.34	10.05
guizhou fenggang	27.97	107.72	680	27	3.22	67.98	8.78
guizhou nayongxiankunzhiq	26.77	105.37	1800	25	11.19	193.76	25.93
guizhou sandu	26.03	106.62	748	36	9.07	228.07	23.80
hebei chengdixianbeida mt.	40.98	117.95	1170	31	6.69	113.23	13.63
hebei chongliheping	40.98	115.25	1600	50	6.53	116.39	11.18
hebei fengning dengshanzi	41.23	116.32	1300	40	5.22	84.24	9.07
hebei kuanchengshigou	40.60	118.50	1400	42	6.94	127.42	12.94
hebei longhuaqianfang	41.67	117.20	1260	33	5.37	89.51	10.37
hebei weichanglongtou mt.	41.98	117.68	1600	37	4.71	82.07	8.93
hebei weichangyinhe	42.28	118.97	1600	30	5.99	96.17	11.75
heilongjiang bolixian	45.73	130.55	350	78	8.47	166.45	12.49
heilongjiang dahailin	44.35	129.47	450	66	6.98	138.20	11.15
heilongjiang humahanjiayaun	52.07	125.73	261	36	3.97	68.81	7.77
heilongjinag humafuergen	51.70	126.65	507	79	6.21	115.68	9.21
heilongjiang humahetan	51.63	126.70	400	44	9.64	190.13	19.38
heilongjiang hulindumuhe	46.35	133.53	226	61	9.72	155.92	16.03
heilongjiang mulengsibingyi	44.90	130.52	880	53	9.42	183.10	16.32

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
heilongjiang mulenghuanguogou	44.52	130.20	800	77	4.59	92.16	6.93
heilongjinag ninganludao	43.87	129.28	650	49	8.17	132.99	12.64
heilongjiang raohe wanda mt.	46.80	134.00	170	81	11.64	160.96	15.81
heilongjiang shangzhi wanshan	45.00	128.27	450	26	9.38	146.04	20.22
heilongjiang shanzhi maer mt.	45.27	127.50	455	32	5.01	175.20	16.63
heilongjinag tahewalagan	52.53	124.53	500	45	7.63	76.13	7.85
heilongjiang wuchangshenglixiang	44.90	127.62	533	44	10.02	176.65	18.26
heilongjiang xunkexain	49.55	128.47	700	63	7.92	152.09	12.98
heilongjiang yichundailing	47.03	129.03	600	68	10.47	161.06	14.77
heilongjiang dailingliangshui	46.97	128.83	400	66	7.90	140.51	12.24
jilin antuerdaobaihe	42.43	128.13	600	35	10.13	93.53	13.96
jilin changbai mt.	42.03	128.13	590	58	8.74	151.05	14.55
jilin changbai mt. linjiang	41.82	126.88	845	83	12.38	213.02	17.88
jilin dunhuaxian renyihe	43.37	128.22	817	40	9.51	137.19	16.04
jilin helongqingshanlinchang	42.45	128.85	650	41	12.11	198.98	21.93
jilin hunjiang wujianfang	41.93	126.43	550	30	5.31	88.10	11.03
jilin liuhexiandabeicha	42.27	125.73	600	30	9.85	168.54	20.74
jilin shulan guijiafang	44.40	126.95	550	78	10.98	201.70	16.58
jilin shulanxian maanshan	43.43	125.20	590	27	9.15	156.75	20.89
jilin wangqingxian	43.35	129.77	650	68	10.59	189.92	17.26
jilin yanjisandaowan	43.17	129.18	800	35	10.81	182.35	21.21
jilin yanjizhixinlinchang	42.65	129.53	847	37	11.72	182.74	20.61
jilin yongjiwangqifenchang	43.57	126.72	650	25	7.88	131.64	18.11
jilin huadianhongshilinchang	42.97	127.12	684	40	10.75	192.11	21.15
liaoning jianpingheishuilinchang	42.07	119.40	500	34	10.40	174.75	20.98
neimeng eerguna	50.80	121.48	712	50	8.76	142.71	14.32
neimeng ningchengheilihe	41.60	119.32	1434	37	9.47	148.48	18.10
neimeng daxingan mt.	49.43	121.67	150	69	9.89	198.58	16.72
neimeng humaxian	51.70	126.65	800	79	5.95	125.03	9.39
neimeng wulashanlinchang	40.75	109.45	800	38	8.22	134.17	15.94
neimeng yaluxianamuniu	48.55	122.13	600	68	12.31	216.77	18.01
ningxia liupanshanlinqu	35.70	106.18	2125	29	4.07	72.45	8.45
qinghai datongxiandongxia	36.93	101.67	2650	39	12.36	67.68	16.24
shanxi fopingxian yilongling	33.53	108.00	2637	44	8.40	141.52	14.26
shanxi lueyang qinlingxian	33.33	106.17	2060	52	5.48	84.49	8.59
shanxi ningshanxian caiziping	33.32	108.33	2137	48	7.51	127.38	13.00
shanxi ningshanxian huoxhitang	33.43	108.43	1950	47	6.77	79.45	8.39
shanxi ningshanxian xunyangba	33.55	108.55	2210	49	8.61	146.76	13.85
shanxi qingling napoxibu	33.67	107.63	1700	56	7.37	153.46	12.91
shanxi qinlingzhongduan	33.50	107.00	1700	65	6.79	119.25	10.06
sixhuan baiyuxian	31.23	98.83	3300	45	9.53	173.60	18.11
sixhuan baoxinxiannaози	30.70	102.72	2580	52	6.42	121.01	10.93
sichuan lixian	31.43	103.17	2600	94	13.23	248.07	16.65
sichuan nanpingdaluxiang	33.57	103.67	3180	110	9.66	171.43	11.86
sichuan xiaojinxian	30.98	102.35	2850	63	8.40	166.14	14.06

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sichuan wenchuanxianwolongguan	30.98	103.13	2185	82	6.42	121.38	8.53
xizang changdubomitongmai	30.15	95.10	2300	50	13.95	298.16	27.67
xizang lasagongbujiangda	29.92	93.25	3355	58	4.17	87.41	7.42
xizang rikazejilongxian	28.88	85.27	3500	50	3.12	64.11	5.69
xizang shangchayumuzhongxiang	28.80	96.68	2335	81	8.80	174.01	14.46
xizang xiachayujiongdong	28.50	97.00	2010	50	9.51	137.62	14.00
yunnan weixixian	27.15	99.28	3012	72	10.98	224.72	17.28
yunnan zhongdianxian	27.80	99.70	3400	26	5.44	84.30	11.04
<b><i>Pinus sylvestris</i> var. <i>mongolica</i> forest</b>							
helongjiang tahe	52.32	124.73	500	134	5.09	131.53	6.20
heilongjiang humahanjiayuan	52.07	125.73	608	84	5.99	102.41	7.19
helongjiang mohefukeshan	52.68	122.05	560	93	5.87	126.55	7.00
heilongjiang mohemaniqi	53.02	122.45	600	150	6.58	145.26	6.94
heilongjiang tahemengkeshan	52.63	124.17	900	53	6.17	94.82	8.14
heilongjiang wudaogouxian	50.25	126.38	890	180	5.88	150.54	5.44
neimeng eerguna	50.80	121.48	832	130	5.60	118.98	6.04
neimeng qiganchangdian	52.17	120.75	633	171	5.69	157.99	6.41
neimeng xinixili	43.52	112.05	700	63	5.62	98.11	6.60
<b>2. Deciduous broad-leaved forest biome</b>							
<b>Typical deciduous broad-leaved forest</b>							
beijing donglingshan	40.03	115.45	1365	61	11.12	115.65	13.59
guizhou banqiaohelinqu	27.97	106.90	540	25	5.85	81.94	10.59
hebei chengdexianbeida mt.	40.77	118.15	1300	26	4.56	84.33	10.29
hebei kuanchengshuigoulinchang	40.60	118.50	1200	30	5.38	109.44	11.96
hebei pingquandawopu	41.02	118.68	1150	33	4.46	86.05	9.05
hebei qinglongdushanlinchang	40.52	118.82	1100	26	5.50	107.71	12.83
hebei xinglongxian wuling mt.	40.60	117.48	1005	32	5.90	120.87	11.84
heilongjiang bolixiantieshan	45.73	130.55	293	38	4.55	82.93	8.34
heilongjiang humaxian	51.70	126.65	350	120	5.25	86.40	6.23
heilongjiang hulindumuhe	46.35	133.53	177	77	7.68	173.92	13.36
heilongjiang hulinwanda mt.	46.33	133.00	190	84	5.41	109.77	7.52
heilongjiang raohewanda mt.	46.80	134.00	218	103	6.31	141.02	8.82
heilongjiang shangzhimaer mt.	45.27	127.50	492	32	7.82	125.64	14.71
heilongjiang shangzhixianwanshan	45.00	128.27	500	37	9.59	138.04	14.82
heilongjiang wuchangshwnlixiang	44.90	127.62	383	40	7.43	145.35	14.49
heilongjiang dailingliangshui	47.03	129.03	500	65	5.40	94.98	7.66
heilongjiang huachuanxian	47.02	130.70	240	69	6.56	135.88	11.11
jilin antuxianchangbai mt.	43.12	128.90	550	140	6.52	204.03	11.02
jilin changbailinqu	42.03	128.13	800	157	8.52	247.33	12.16
jilin dunhuaxianrenyihe	43.37	128.22	650	156	11.25	201.84	12.61
jilin helongxiandongchang	42.53	129.00	615	39	5.00	90.81	9.49
jilin linjianglinyeju	41.82	126.88	700	125	5.17	164.13	7.72
jilin mulengxian	44.52	130.20	650	102	6.62	113.96	8.17
jilin wangqingxiansengongju	43.35	129.77	450	101	8.33	180.22	11.24
jilin wangqingxianqinhe	43.32	129.53	450	38	6.67	125.09	12.65

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jilin yanjixianzhixin	42.65	129.53	450	28	4.22	77.50	9.00
jilin yongjixianwangqi	43.57	126.72	450	20	4.11	79.24	11.15
jilin huadianmaoshanlinchang	42.97	126.73	460	48	7.52	152.25	13.60
liaoning xinbinxiansankuaishi	41.72	125.03	350	51	6.51	156.16	13.05
liaoning kuandianbaishilizi	40.72	124.77	400	24	8.23	88.14	10.66
liaoning fuxinxianzhoujiadian	40.53	122.73	350	26	4.40	80.49	9.01
neimeng jiagedaqizhen	50.40	124.07	498	97	4.46	72.80	5.46
ningxia liupanshanlinqu	35.70	106.18	2050	32	7.61	100.97	13.30
shandong mengyanxiantaoquxiang	35.72	117.93	400	20	5.07	58.16	8.99
shandong taianshitai mt.	36.37	117.08	700	23	5.60	71.48	11.09
shanxi luliangshan jiaokou	37.48	111.13	1785	63	9.73	130.67	12.15
shanxi qinyuanjiangtailinchang	36.50	112.32	1810	55	11.39	151.32	14.81
shanxi sandaochuanxiongchaogou	37.40	110.63	1400	50	7.11	105.44	12.10
shanxi taiyue mt. shigao mt.	36.75	112.03	1400	45	5.71	67.73	7.07
sichuan napingxiandaluxiang	33.57	103.67	2160	80	6.83	121.96	11.08
sichuan songpanmaoergai	32.65	103.08	2600	120	8.22	151.31	12.24
<b>Tugai forest</b>							
xinjiang muoyumazhahetian	37.15	79.92	900	35	0.56	91.37	8.41
xinjiang talimuhe xiayou	40.37	88.03	900	50	0.17	34.06	2.41
xinjiang talimuhe shangyou	39.00	78.00	900	40	0.25	51.87	4.22
xinjiang talimuhe zhongyou	41.02	83.18	925	33	0.80	61.24	6.85
xinjiang yeerqianghetianhe	40.50	81.93	900	40	0.20	34.10	2.87
xinjiang talimuhelutai	41.78	84.28	950	53	0.26	55.56	4.02
xinjiang manasipingyuan	44.30	86.22	650	30	2.87	86.84	9.05
xinjiang habahexain	48.03	86.43	500	25	1.70	48.04	5.90
<b>3. Evergreen broad-leaved forest biome</b>							
<b>Typical evergreen broad-leaved forest</b>							
fujian changtingfuchengwolong	25.85	116.35	400	45	16.64	198.34	17.94
fujian fuzhougushan	26.07	119.38	400	71	22.03	474.05	31.23
fujian huaanjinshandaoshi	24.78	117.30	400	47	22.66	397.03	31.06
fujian jianoufangdaopankeng	27.00	118.13	870	20	7.34	204.39	30.67
fujian jianouxianwanmujing	27.05	118.33	380	120	23.89	396.56	19.32
fujian minqingxianxiongjiangxiang	26.33	118.73	650	50	15.98	300.56	25.84
fujian napingshimaodixiang	26.70	118.05	860	200	27.95	576.58	24.00
fujian napingshimengtuan yang	26.63	118.17	1100	40	9.75	215.15	19.32
fujian puchengxianshibeixiang	27.68	118.58	550	29	8.49	220.48	26.16
fujian sanmingshishenkouxiang	26.22	117.60	423	99	23.67	554.06	26.39
fujian shanghangxianxingyunxiang	25.05	116.40	750	45	14.73	235.79	24.59
fujian shaowujinhangguilin	27.15	117.17	750	40	14.18	318.50	29.81
fujian shaowushinakouxiang	27.15	117.63	793	55	15.83	397.52	32.43
fujian shaowushishuibeixiang	27.33	117.48	438	115	24.29	508.05	26.32
fujian shaowushiminsheshan	27.07	117.68	415	80	26.77	496.95	31.41
fujian zhangpingxianmeishuikeng	25.23	117.52	450	50	16.81	324.62	28.71
guangdong dinghushanlinqu	23.18	112.52	270	200	20.75	428.57	26.68
guangdong haikanglongmenzurong	20.68	110.00	80	22	13.99	209.44	31.21

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guangdong heishiding reserved	23.05	112.45	380	100	18.32	356.36	30.28
guangdong lufengxiannanwanqu	22.95	115.65	400	25	7.59	203.90	25.98
guangdong shixingliujiashan	24.97	114.03	500	25	6.42	163.13	21.01
guangxi gongchengdaopinglinqu	24.85	110.82	500	35	5.04	238.40	24.23
guangxi huanjiang	24.82	108.27	1002	51	15.55	292.85	22.82
guangxi lingui	25.20	110.20	820	35	9.34	247.72	27.72
guangxi lingchuan	25.42	110.35	835	32	12.82	232.08	24.08
guangxi longshen	25.78	110.03	450	29	4.62	92.83	10.06
guangxi longshenmatibaiwan	25.93	110.10	500	31	16.11	263.60	27.56
guangxi mashan	23.70	108.18	700	20	14.36	137.46	23.04
guangxi ronggan	25.22	109.37	700	44	14.37	270.40	22.79
guangxi shangsi	22.15	107.97	1160	41	26.07	240.92	27.81
guangxi tianlin	24.30	106.23	1550	44	10.13	242.24	19.04
guangxi xilin	24.50	105.08	1100	24	4.43	129.52	17.62
guangxi yongfu	24.98	109.98	468	30	10.13	252.50	29.28
guangxi ziyuanxian	26.03	110.63	500	42	10.51	232.73	22.52
guangxi ziyuanhekouyantou	25.47	109.43	560	81	25.09	393.43	24.75
guangxi ziyuanxianwupaihe	26.03	110.63	700	3	7.57	50.86	17.14
guizhou ceheng	25.00	105.80	965	25	4.82	148.88	19.57
guizhou cehengtiluowangbai	24.88	105.82	540	78	20.40	524.46	26.53
guizhou chishui	28.57	105.70	840	30	8.21	167.68	17.67
guizhou congjiang	25.75	108.88	750	30	7.67	152.56	18.25
guizhou danzhai	26.20	107.78	892	35	8.47	148.11	16.78
guizhou daozi	28.88	107.60	1280	20	5.11	137.38	20.09
guizhou dushan	25.82	107.53	1340	31	6.03	184.84	21.44
guizhou hezhang	27.12	104.70	1900	22	4.38	94.77	12.43
guizhou huangping	26.88	107.88	1190	41	8.49	257.79	25.76
guizhou jianghe	26.63	108.58	700	39	17.15	331.72	31.25
guizhou jinping	26.68	109.20	860	50	18.06	336.34	17.81
guizhou kaili	26.58	107.97	950	46	7.31	143.10	11.62
guizhou leigongshan	26.47	107.28	1600	35	10.29	214.74	23.36
guizhou leigongshan shihuihe	26.38	108.22	915	43	8.94	227.46	20.68
guizhou leishanxianlengzhushan	26.37	108.05	1785	80	9.09	215.63	13.98
guizhou liping	26.22	109.15	800	50	7.03	213.53	19.34
guizhou lipo	25.40	107.87	790	20	7.60	145.97	22.42
guizhou longli	26.45	106.97	1462	46	6.97	228.70	21.16
guizhou luodian	25.42	106.73	710	21	6.32	135.00	19.79
guizhou pingtang	25.82	107.33	1090	35	6.80	133.41	14.70
guizhou sandu	26.03	106.62	620	40	10.06	216.95	21.83
guizhou shibing	27.03	108.12	950	25	6.40	116.46	14.35
guizhou shiqian	27.52	108.23	980	50	7.27	159.92	14.32
guizhou songtao	28.17	109.18	850	22	6.90	148.67	19.53
guizhou taijiang	26.67	108.32	1619	25	8.00	172.55	22.65
guizhou tianzhu	26.90	109.20	500	30	9.28	180.74	21.73
guizhou tongjiang	27.75	108.12	420	29	9.49	196.88	21.17

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guizhou wangmo	25.17	106.10	885	25	4.73	149.14	19.54
guizhou wongan	27.05	107.47	740	16	6.76	132.11	23.42
guizhou xifeng xishan	25.67	108.97	1500	37	11.05	350.38	30.05
guizhou xishui	28.32	106.20	990	70	9.20	198.26	15.38
guizhou xingyi	25.08	104.88	1186	40	6.30	196.13	19.74
guizhou yanhe	28.55	108.50	740	32	7.84	163.64	16.40
guizhou yinjiang	28.00	108.40	1030	22	5.76	106.65	15.53
guizhou zhenyuan	27.05	108.42	1010	20	4.20	92.72	13.97
guizhou ziyun	25.75	106.05	1160	21	5.27	159.37	23.43
guizhou fanjing mt.	27.92	108.68	1072	61	11.49	251.46	19.56
guizhou rongjiang	25.93	108.50	851	25	7.54	147.87	17.92
hunan chengbu	26.35	110.32	650	34	10.82	191.89	22.00
hunan chengbuxianpinglinxiang	26.22	110.20	1150	111	28.61	428.13	28.37
hunan huitongguangpinglinqu	26.78	109.62	450	80	12.74	373.83	19.12
hunan jianghua	25.18	111.57	1120	90	12.88	410.35	28.66
hunan jianghuamajiang	25.00	110.00	550	124	41.78	659.43	30.96
hunan jiangyong	25.28	111.33	910	55	23.90	394.78	32.29
hunan jiangyongxiangaozeyuan	25.50	111.50	650	27	9.95	186.14	25.08
hunan jingzhou	26.57	109.68	500	51	14.84	261.38	24.67
hunan mangshanzongshuba	24.98	112.83	700	33	11.73	217.09	23.38
hunan rucheng	25.53	113.68	510	35	12.92	228.72	22.53
hunan sangzhi	29.38	110.18	1440	55	12.92	241.60	18.20
hunan shuangpai	25.97	111.63	430	21	6.24	168.26	25.17
hunan suining	26.58	110.17	860	60	11.17	195.94	14.56
hunan taoyuanxianwajigang	28.92	111.47	390	59	9.68	215.43	18.72
hunan tongdao	26.15	109.77	580	22	6.50	184.15	26.56
hunan wugangyunshan	26.72	110.62	1260	60	8.12	219.87	18.68
hunan yizhang	25.40	112.95	910	29	8.00	214.94	23.86
hunan yongshun	29.00	109.87	570	19	9.47	167.44	25.40
hunan yongxing	26.13	113.12	570	65	8.75	228.92	19.32
hunan yuanling	28.45	110.38	700	65	11.19	294.27	24.81
hunan zixing	25.97	113.22	633	55	13.92	242.94	22.24
hunan lixian	26.50	113.77	1200	55	11.11	278.19	25.50
hunan lixiantaoyuandong	26.00	113.00	827	54	14.81	298.89	26.45
hunan yuanjiangchishan	29.05	112.30	500	20	5.47	163.10	24.70
hunan liuyang	28.15	113.62	1040	29	7.66	208.81	23.86
jiangxi suichuanxianyaqian	26.53	114.47	600	31	13.77	320.11	33.19
jiangxi yifenghuanggangshan	27.87	117.78	688	7	16.38	106.84	19.32
jiangxi yifengshiqiao	27.83	116.20	601	46	10.28	210.05	19.88
jiangxi yifengtianbaofenchang	28.38	114.78	483	43	12.89	272.99	26.85
jiangxi yifengxianhanpomiao	28.00	114.50	538	47	17.27	327.38	29.20
jiangxi yifengshiqiaonandong	26.97	114.33	813	13	11.97	117.52	20.67
sichuan leiboshanlenggang	28.33	103.43	1900	105	6.35	238.45	12.84
sichuan mabianhuanglian mt.	28.85	103.52	1520	53	7.80	263.63	19.71
sichuan chongqingsimian mt.	29.58	106.55	1200	40	6.43	192.14	21.77

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xizang chayulinqu	28.47	97.10	1900	100	10.35	271.12	16.16
xizang bomiyigengnongchang	30.15	94.98	2670	67	4.48	188.49	12.88
xizang jilongwuyiji	28.38	85.35	2980	45	4.28	140.37	12.94
xizang xiachayujiongdong	28.50	97.00	2020	71	9.90	313.20	15.20
xizang zhangmuyouyiqiao	28.00	86.00	2020	50	7.87	259.66	14.57
yunnan diqingweixi	27.15	99.28	2823	100	6.61	330.37	19.30
yunnan ailaoshanxujiaba	23.93	101.50	2550	100	3.97	503.07	24.66
yunnan dali	25.57	100.22	2448	60	9.00	317.40	18.87
yunnan deqin	28.50	98.92	3460	50	8.24	260.96	17.67
yunnan eryuan	26.10	99.93	2480	58	4.81	180.32	14.45
yunnan heqing	26.55	100.18	3450	85	7.29	285.66	19.13
yunnan huaping	26.65	101.23	2040	85	6.47	254.42	17.02
yunnan jianchuan	26.53	99.87	2903	85	7.23	276.15	18.63
yunnan lijiang	26.87	100.23	2860	100	13.63	505.15	25.83
yunnan ningliang	27.30	100.82	2570	25	4.53	197.22	24.70
yunnan nujianglushui	25.98	98.82	2900	70	10.16	313.86	17.95
yunnan puerxiaoheijiang	22.85	100.32	930	42	5.24	170.57	21.34
yunnan yangbi	25.68	99.97	2850	50	4.35	215.01	17.51
yunnan yunlong	25.90	99.37	2526	55	10.29	322.27	20.69
zhejiang hanzhou	30.27	120.17	275	35	8.63	115.24	14.57
zhejiang jiandelongjianglinqu	29.48	119.27	438	35	6.13	142.74	19.09
<b>Mixed evergreen-deciduous broad-leaved forest</b>							
fujian shaowudafugangxiang	27.17	117.33	1330	114	19.13	255.00	16.95
fujian shaowuyanshanxiangxia	27.33	117.48	470	25	12.66	150.66	23.12
guizhou guiyangmengguanshangban	26.40	106.73	1093	87	17.41	275.26	16.40
guizhou kuankuoshui	28.25	107.02	1580	80	27.29	370.92	20.17
guizhou maolanshihuiyan	25.38	108.07	600	100	5.12	167.51	16.93
guizhou tongzibaizhiba	28.13	106.80	1985	121	10.72	366.52	15.42
guizhou weiningdajixiang	27.12	104.22	2150	23	7.35	100.20	14.39
guizhou yueliangshan	26.58	106.70	1420	40	8.68	113.68	10.11
henan xixiahuangshiyan	33.67	111.62	1296	36	9.30	145.03	15.52
henan xixiayanzhen	33.30	111.48	1080	23	6.48	80.82	11.64
henan xinxiianlinchang	31.62	114.85	500	34	9.10	122.49	13.70
henan luanchuanxiandaping	33.78	111.60	1142	51	9.76	146.91	14.00
hubei fangxianshennongjia	31.75	110.67	1827	54	13.02	197.98	15.64
hubei fangxiantaping	32.05	101.72	1600	31	9.02	134.96	16.34
hubei fangxiantianjiashan	32.00	101.00	1730	51	11.71	171.80	15.18
hunan dayongyuanguping	29.13	110.48	500	20	7.31	98.45	16.32
hunan sangzhixianhejiawan	29.38	110.18	1210	130	14.30	209.41	14.68
shanxi shiquan	33.05	108.25	1800	95	11.18	178.99	8.72
sichuan nanjiangxianweijiaba	32.37	106.82	1635	58	13.69	195.44	15.46
xizang shangchayu	28.80	96.68	2075	93	9.53	374.32	15.67
yunnan weixixian	27.15	99.28	2518	75	7.82	251.29	13.87
yunnan zhongdian	27.80	99.70	2600	101	7.34	299.75	14.13

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<b>Sclerophyllous evergreen broad-leaved forest</b>							
sichuan jiulongxianjingqu	29.02	101.52	3800	134	7.35	269.54	10.82
sichuan mulixianlinqu	27.92	101.25	3800	232	9.50	331.81	11.06
xizang chayuxianzhuwagen	28.63	97.50	3000	105	7.15	261.11	12.00
xizang bomixiansongzong	29.77	96.15	3281	87	7.62	253.20	13.71
xizang bomixianzhamu	29.88	95.75	3020	90	5.97	233.39	11.89
xizang linzhilulang	29.80	94.72	2925	76	3.89	167.97	9.81
xizang zhangmuxianwuyizhang	28.00	86.00	2375	95	6.82	170.33	8.56
xizang cuonaxianliebu	27.97	91.93	3103	127	6.63	299.83	12.54
yunnan zhongdian	27.80	99.70	3400	83	8.68	243.90	12.32
<b>4. Rain forest and monsoon forest biome</b>							
hainan jianfengling	18.70	108.78	450	47	4.26	305.20	24.16
hainan jianfeng mt.	18.83	109.83	875	160	16.88	765.02	40.27
hainan limu mt.	19.25	109.78	790	110	6.35	581.67	24.91
yunnan xishuangbanna secondary forest	22.02	100.80	585	22	4.10	108.27	19.04
<b>5. Temperate coniferous forest biome</b>							
<b><i>Pinus tabulaeformis</i> forest</b>							
anhui jiashanguandianlinchang	32.65	118.05	400	18	6.14	66.26	10.10
sichuan nanpinglongkangxiang	33.23	104.20	3200	51	5.39	145.52	9.73
shanxi ningshanxianshangbahe	33.32	108.33	1670	60	13.53	177.01	13.40
sichuan nanpingdaluxaing	33.57	103.67	3114	40	4.87	134.81	12.22
shanxi taibailangtanqv	34.03	107.30	1520	86	6.09	285.36	12.94
shandong taiantai mt.	36.37	117.08	1000	23	4.34	45.89	5.76
shandong yiyuanlu mt. linchang	36.58	118.30	680	27	8.14	74.45	9.45
shanxi yanancqiaoshan	36.58	109.47	1153	45	5.60	120.30	9.05
shandong haiyangxianzhaohu mt.	36.77	121.17	250	15	4.34	42.02	7.56
shanxi taiyuefuniu mt.	36.75	112.03	1445	25	10.36	92.14	12.63
shandong pingduxianandaze mt.	37.03	120.02	240	15	3.68	31.14	5.67
shandong mupingxiankunyuu mt.	37.20	121.67	275	24	7.63	80.73	9.76
shanxi guandi mt.	37.88	111.48	1692	30	16.51	164.42	13.29
beijing miyunzhuifengshan	40.37	116.83	553	30	11.35	57.79	9.16
hebei qinglonglinqu	40.40	118.93	350	26	7.63	50.21	6.35
liaoning qianshanlinqu	41.08	123.12	600	95	12.60	130.64	8.53
hebei chengdebeidashan	40.77	118.15	1100	25	9.11	69.30	8.77
hebei pingyuandawopu	40.65	117.02	898	42	13.32	107.90	10.41
neimeng ningchengliheihe	41.60	119.32	1110	36	9.27	129.45	12.24
hebei weichangyangebai	42.05	117.33	1140	49	14.43	134.01	11.55
neimeng ningchengheilihe	41.40	118.83	843	35	6.94	118.57	10.71
jilin longjingxianzhixin	42.65	129.53	560	30	6.95	75.13	7.60
<b>6. Subtropical coniferous forest biome</b>							
<b><i>Pinus armandii</i>, <i>P. taiwanensis</i> and <i>P. densata</i> forest</b>							
anhui huoshanbaimajian	31.10	116.18	1700	25	14.60	116.37	13.13
fujian fuzhougushan	26.07	119.38	845	102	8.48	217.57	13.43
fujian pingnanxianlingxiexiang	27.08	118.97	1200	160	14.08	254.28	16.94

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fujian shaowushijinkengxiang	27.25	117.18	1200	20	11.57	135.50	16.81
gansu tianshuixiaolongshan	34.62	105.70	1625	26	12.26	65.76	12.16
guizhou weining	26.87	104.28	2200	31	6.64	86.15	9.05
guizhou weiningdajiexiang	27.12	104.22	2225	52	11.58	188.33	14.53
henan shangchenghuangboshan	31.80	115.40	802	48	13.38	157.86	13.84
henan xinxianglingchang	31.62	114.85	718	34	13.81	131.87	13.33
hubei dangyangxianxuetangping	30.83	111.78	1190	20	5.13	83.05	12.07
hubei fangxianniye	32.05	101.72	1800	30	9.46	79.34	9.99
hubei lichuanxianxingdoushan	30.30	108.93	1140	80	14.95	337.44	17.79
hunan pingjiangxianmufushan	28.98	113.82	1433	23	11.86	116.90	13.39
shanxi nandengxiang	33.02	106.95	1435	30	6.49	83.17	7.94
shanxi lueyangerhekou	33.33	106.17	2040	41	7.59	115.19	11.04
shanxi ningshanhuoditang	33.43	108.43	1787	29	11.42	95.05	14.68
shanxi qinlingzhongduan	33.82	108.00	1700	56	14.29	141.57	11.27
shanxi taibaixianfengou	34.07	107.30	2120	35	12.35	174.71	17.41
sichuan mulidingdong	27.92	101.25	3445	64	12.48	107.30	8.53
sichuan yajiang	30.03	101.00	3100	48	15.30	135.65	12.27
xizang changdubomitongmai	30.15	95.10	2414	40	9.16	150.09	11.32
xizang bomixianzhamu	29.88	95.75	2866	70	12.24	256.83	13.60
xizang bomiyigongnongchang	30.15	94.98	2400	40	9.63	164.53	12.57
xizang milinxiantiemolong	29.17	94.17	3210	80	9.35	128.03	7.62
xizang linzhigengzhanglinchang	29.57	94.50	3219	71	14.05	180.48	11.81
xizang rikazejilongxian	28.88	85.27	2651	57	9.40	182.78	14.30
xizang cuonaxianlebu	27.97	91.93	2880	35	5.66	86.09	9.58
xizang shannanlangxian	29.03	93.13	3558	108	8.73	137.02	6.86
xizang shannanlongzixian	28.45	92.43	2900	90	7.31	99.22	5.48
xizang shangchayumuzhongxiang	28.80	96.68	2350	55	9.36	220.48	14.62
xizang shangchayurongyu	28.50	96.60	3000	80	15.81	133.78	9.87
xizang yadongasangcun	27.52	88.97	2900	60	10.15	230.03	16.20
yunnan deqin	28.50	98.92	3360	50	11.10	81.24	7.60
yunnan lijiang	26.87	100.23	3152	60	14.76	121.82	9.97
yunnan ninglang	27.30	100.82	3220	20	7.14	31.26	5.70
<b><i>Cunninghamia lanceolata</i> forest</b>							
anhui huoshanxianfuziling	31.35	116.27	1050	23	8.78	110.34	17.29
anhui huoshan	31.07	116.17	400	20	6.30	81.34	14.48
anhui jinzhai	31.68	115.87	400	20	4.42	50.49	9.27
anhui qimenxianxiwuling	29.87	117.70	450	50	3.69	155.43	9.52
fujian huaanxianjinshan	24.78	117.30	400	21	8.37	101.42	15.76
fujian jianyanghuangkeng	27.57	117.65	703	35	8.97	323.13	26.86
fujian jianounanya	26.87	118.33	403	32	4.33	212.00	13.37
fujian jianoufangcungaoyang	26.82	118.23	400	24	7.25	208.92	20.34
fujian lianchengquxi	25.65	116.93	865	53	6.11	193.98	13.82
fujian nanpingxihou	26.65	117.93	450	20	9.39	256.33	30.14
fujian nanpingxianxiqin	26.57	118.12	400	27	9.10	252.25	22.78
fujian sanmingshishenkou	26.22	117.60	400	17	5.93	135.16	18.04

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fujian jianouxianxidong	27.10	118.62	400	19	7.56	188.25	23.55
fujian shunchangyangkoulinqu	26.80	117.87	210	18	7.51	180.30	16.29
fujian zhangzhoulinxialinchang	24.47	117.60	400	21	3.95	72.68	10.04
guangdong huaijixingang	23.92	112.17	500	18	3.18	136.21	17.25
guangdong huidongxainlianghua	22.98	114.70	200	21	3.88	98.00	11.58
guangdong lechanglaorongkong	25.15	113.35	500	25	3.04	122.31	11.31
guangdong lianpingniulingshui	24.35	114.48	400	16	4.34	95.84	14.75
guangdong xijiangdiqv	24.78	112.60	400	21	3.42	101.54	13.37
guangxi hexiandaguishan	24.52	111.53	400	20	4.47	86.65	11.34
guangxi lingui	25.20	110.20	966	17	3.02	59.84	8.90
guangxi lingshan	22.42	109.28	355	22	4.26	82.74	10.48
guangxi longshenglilu	25.78	110.03	380	28	5.07	122.59	10.82
guangxi pubei	22.27	109.53	400	18	3.36	58.62	8.53
guangxi rongshui	25.07	109.22	400	24	6.44	137.17	15.12
guangxi sanjiang	23.63	110.05	750	16	5.32	109.10	17.01
guangxi tianlinlaoshanlinchang	24.30	106.23	1373	18	6.16	116.58	14.91
guangxi wuxuan	23.60	109.67	250	19	7.12	218.64	28.36
guangxi yishan	24.47	108.67	205	16	3.96	74.91	11.86
guangxi yulinxianliuwan	22.47	109.78	500	20	4.22	134.16	13.76
guangxi cenxiqiping	22.93	110.00	460	16	3.38	56.09	9.10
guangxi tengxian	23.37	110.88	490	25	3.26	62.52	6.91
guizhou chishui	28.57	105.70	1167	22	8.53	113.16	16.69
guizhou congjiang	25.75	108.88	365	19	7.65	110.71	17.13
guizhou dejiang	28.27	108.13	712	20	5.59	66.00	10.64
guizhou jangkou	27.68	108.83	715	20	4.75	53.03	8.72
guizhou jinpingshi	26.68	109.20	860	18	4.92	76.57	11.89
guizhou jinpingshi	26.60	109.12	434	24	13.13	268.81	35.13
guizhou liping	26.22	109.15	430	30	6.20	65.44	9.50
guizhou pingba	26.40	106.27	1402	26	6.90	94.45	12.95
guizhou sanduxianlalan	25.97	107.95	461	18	5.64	264.72	33.15
guizhou shiqian	27.52	108.23	760	19	11.68	114.09	19.99
guizhou songtao	28.17	109.18	560	20	4.04	48.46	7.78
guizhou tianzhu	26.90	109.20	790	16	7.28	90.85	15.75
guizhou tongzi	28.13	106.80	1427	32	4.55	58.67	7.68
huizhou wongan	27.05	107.47	1010	18	9.62	116.90	19.45
guizhou wuchuan	28.52	107.87	1100	20	6.26	79.65	12.55
guizhou xingren	25.43	105.18	1445	16	6.47	71.81	12.87
guizhou zhengan	28.53	107.42	1060	17	5.04	62.90	10.63
guizhou zhijin	26.65	105.77	1400	16	6.53	76.71	13.53
hainan jianfenglingtianchi	18.70	108.78	780	16	4.45	136.17	20.05
henan xinyang	32.10	114.12	200	23	8.21	105.22	12.38
hubei enshitongpenshui	30.27	109.48	600	23	10.17	144.32	23.38
hubei luotianxiantiantangzhai	31.10	115.77	500	21	10.26	138.90	13.64
hubei tongchengxianhuanglongjing	29.23	113.80	500	24	10.58	156.64	24.61
hubei xianfengxianpingbaying	31.32	113.32	1910	22	3.88	46.74	8.05

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hunan anhua	28.38	111.20	220	23	3.12	83.05	10.24
hunan dongkou	27.07	110.57	700	32	3.11	80.99	8.70
hunan huitongguangpinglinqv	26.78	109.62	400	31	6.11	217.29	24.78
hunan huitongguangpingshuxi	27.72	109.67	450	24	12.82	315.77	35.04
hunan huitongpaotuan	26.87	109.52	417	38	6.81	495.13	32.65
hunan jianghua	25.18	111.57	439	23	4.48	121.37	15.27
hunan jianghuaxiantaoyuxiang	24.83	111.50	500	26	3.44	89.15	10.46
hunan jiangyong	25.28	111.33	624	24	3.89	101.03	12.28
hunan jiangyongxiangaozeyuan	25.00	111.00	302	22	3.22	83.97	10.62
hunan jianghuaxianshuikouju	24.97	111.78	343	29	4.18	107.62	12.20
hunan taoyuanlinqu	28.92	111.47	450	21	8.01	142.88	22.57
hunan tongdaoxianboyangxiang	26.20	109.50	450	18	9.61	245.40	34.65
jiangsu rudong	32.32	121.20	20	20	10.27	82.65	11.61
jiangsu jurong	31.95	119.15	50	16	4.12	96.54	10.66
jiangsu yixingxianlinchang	31.35	119.82	400	20	8.23	102.05	16.02
jiangxi anfuxianpengfangxiang	27.38	114.62	400	55	3.22	322.92	20.85
jiangxi fenyixianshanxia	27.82	114.65	400	19	6.80	107.90	16.03
jiangxi nanchangxijiaochangling	28.55	115.93	220	24	9.97	155.22	17.53
jiangxi quannanxianxiaoyeshan	24.73	114.53	600	29	9.62	200.20	23.56
jiangxi suichuanxiandarizhen	26.32	114.50	220	32	8.82	220.55	23.03
jiangxi suichuanxianyaqianxiang	26.53	114.47	300	25	7.71	189.35	21.95
jiangxi yifengshiqiaofenchang	27.83	116.20	500	22	8.56	94.15	13.09
shanxi hanzhongdiqvxiapo	33.07	107.02	680	28	6.23	95.44	11.42
sichuan hongyaxian liushan	29.93	103.37	1200	17	15.23	135.26	18.61
taiwan luandalun liushan	22.97	120.53	1526	21	18.33	296.53	27.93
taiwan puli ribenliushan	23.95	120.95	1287	31	11.89	265.38	23.01
taiwan wenshantonghou liushan	23.70	120.53	460	18	15.68	213.12	27.26
taiwan zhudongguan liushan	24.73	121.08	1707	18	17.37	214.34	27.99
zhejiang beibupingyuan	30.77	120.75	50	18	7.57	129.09	17.70
<b><i>Pinus massoniana</i> forest</b>							
guangxi fangchengqishaxiang	21.57	108.47	10	39	11.57	162.57	20.31
guangxi hexian	24.42	111.53	380	28	6.20	115.43	13.93
guangxi hexiandaguishan	24.17	111.53	450	24	10.83	209.96	26.74
guangxi longshengjinjiexiang	25.78	110.03	520	30	12.81	235.76	27.01
guangxi longshenmatibaiwan	25.93	110.10	500	101	8.25	254.77	14.75
guangxi luocheng	24.78	108.88	490	26	7.62	142.11	17.78
guangxi ningming	22.12	107.05	350	15	3.38	69.09	11.60
guangxi rongxian	22.87	110.53	175	27	7.17	130.23	16.12
guangxi shangsi	22.15	107.97	475	16	3.88	79.25	12.76
guangxi wuyixianlufengshan	23.60	109.67	300	38	7.43	212.35	18.23
guangxi yishan	24.47	108.67	215	28	6.41	119.07	14.38
guangxi yishanxianqingyuan	24.57	108.47	220	31	3.42	272.64	19.12
guangxi ziyuanchetianxiang	26.02	110.47	530	30	8.54	159.97	18.77
guangxi ziyuanfengmuxiang	25.87	110.62	500	28	6.21	119.43	14.26
guangxi ziyuanwupaihe	26.03	110.63	800	30	6.13	122.24	13.63

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
guizhou anshun	26.23	105.92	1420	18	3.10	71.57	11.08
guizhou banqiaohelinqv	27.97	106.90	540	30	5.71	162.63	13.25
guizhou guiyang	26.58	106.70	1106	19	2.66	60.89	9.14
guizhou huangping	26.88	107.88	920	23	4.76	96.54	13.31
guizhou huishui	26.13	106.63	1050	46	6.38	197.70	17.00
guizhou jianhe	26.63	108.58	520	36	5.25	169.24	16.29
guizhou leishan	26.37	108.05	1070	21	4.96	96.12	14.10
guizhou qinglong	25.83	105.22	1390	20	5.48	116.76	17.23
guizhou sinan	27.95	108.23	900	27	3.99	89.10	10.98
guizhou tianzhu	26.90	109.20	500	30	5.31	104.41	12.62
guizhou tongzi	28.13	106.80	1330	28	6.32	113.12	14.56
guizhou zunyi	27.53	106.82	760	26	3.92	89.82	11.22
guizhou meitan	27.77	107.48	1012	28	5.30	94.95	12.21
anhui chuxianhuangpushan	32.30	118.30	400	20	6.02	114.20	17.12
anhui huang mt.	30.08	118.17	500	21	2.66	114.95	16.18
anhui jiashanxianguandian	32.65	118.05	500	19	6.00	98.68	17.91
fujian lianchengxindichendi	25.70	116.73	820	53	6.69	237.73	17.78
fujian yonganxianhongtianxiang	25.85	117.27	550	25	9.41	161.88	21.30
guandong guangzhoubaiyunshan	23.17	113.30	200	23	7.82	155.29	20.34
guandong dinghushanlinqu	23.18	112.52	270	30	14.47	226.53	24.85
guandong dongguandalingshan	22.90	113.83	200	18	6.96	136.14	20.60
guandong huiyangzijindongjiang	23.02	114.50	500	22	6.71	131.26	17.70
guandong zengchenglinqu	23.30	113.82	250	30	8.80	181.31	16.18
henan xinxianglingchang	37.98	117.13	400	30	6.64	167.44	17.83
hubei baokangxianchengguanzen	31.87	111.28	650	18	4.41	82.57	13.37
hubei enshixiliushui	30.30	113.67	1100	22	5.72	105.95	14.99
hubei laifengxianhujiaping	29.57	109.33	680	22	7.29	136.39	19.24
hubei taizishanshilong	30.90	112.85	120	19	4.22	79.52	12.39
hunan anhuamushixi	28.38	111.20	500	21	8.61	163.61	22.81
hunan huitong	26.87	109.72	410	30	7.34	120.80	14.72
hunan huitongguangping	26.78	109.62	350	28	11.04	200.34	24.59
hunan huitongruoshuizhen	27.00	109.97	275	25	10.78	207.53	26.41
hunan huitongtuanhexiang	26.87	109.97	440	52	10.51	415.84	30.13
hunan jiangyonggaozeyuan	25.28	111.33	380	54	8.33	389.50	26.77
hunan mayang	27.87	109.80	615	30	8.31	145.13	17.31
hunan suininghaxi	26.58	110.17	483	54	9.76	384.58	26.88
hunan zixingxianchukou	25.70	113.38	500	19	7.03	143.40	20.65
jiangxi quannanxiaoyeshandong	24.73	114.53	600	29	13.71	245.45	29.50
jiangxi yifengxianshiqiao	27.83	116.20	571	52	6.73	209.51	15.98
jiangxi yongxiuxianyunjushan	29.05	115.80	217	34	8.58	129.99	15.45
sichuan jiangbeixiancizhu	29.73	106.60	450	20	2.83	38.42	7.95
zhejiang jinhuahuangtuqiuling	29.12	119.65	300	20	4.56	69.79	9.60
zhejiang lishuidishandi	28.45	119.90	200	18	7.22	121.08	19.61
zhejiang lishuihuangcun	28.50	120.03	369	18	5.92	153.68	23.00

Sites (Province, site name)	Latitude (degree)	Longitude (degree)	Elevation (m)	Age (yr)	LAI (m <sup>2</sup> m <sup>-2</sup> )	Biomass (t ha <sup>-1</sup> )	NPP (t ha <sup>-1</sup> yr <sup>-1</sup> )
<b><i>Pinus yunnanensis</i> and <i>P. khasya</i> forest</b>							
guangxi leye	24.78	106.57	1011	70	5.96	133.09	8.32
guangxi tianlin	24.30	106.23	970	57	8.71	196.65	13.28
guizhou weining	26.87	104.28	2344	23	5.08	102.92	12.13
sichuan liangshan	27.90	102.27	2068	23	5.44	99.37	16.02
sichuan mulixiangdong	27.92	101.25	2850	93	6.13	130.79	8.58
xizang chayulinqu	28.63	97.48	2200	76	5.29	364.28	13.48
yunnan dali	25.57	100.22	2104	25	5.67	109.77	12.33
yunnan deqin	28.50	98.92	3050	35	5.94	113.07	10.21
yunnan eryuan	26.10	99.93	2400	45	6.04	122.33	9.60
yunnan huaping	26.65	101.23	2833	55	9.14	192.34	13.37
yunnan huapingxianmasangwan	26.47	101.02	2241	71	9.54	205.01	14.49
yunnan lijiang	26.87	100.23	2800	68	9.28	195.28	13.41
yunnan ninglang	27.30	100.82	2730	48	10.40	202.74	15.60
yunnan yangbi	25.68	99.97	1800	35	5.22	104.94	9.42
yunnan yongren	26.07	101.68	2210	58	9.72	204.24	16.28
yunnan yongsheng	26.70	100.73	2850	100	14.05	320.14	14.96
yunnan yongshenglanshuiping	26.42	100.68	2779	77	10.78	235.47	14.81
yunnan yunlong	25.90	99.37	2636	110	9.90	219.95	12.04
yunnan zhongdian	27.80	99.90	2900	22	5.47	108.41	13.20
<b><i>Cupressus</i> forest</b>							
guizhou jinshajingmenxiang	27.45	106.22	1336	74	11.00	142.11	10.37
guizhou xishui	28.32	106.20	1280	36	12.09	133.43	13.75
guizhou yanhe	28.55	108.50	500	29	7.28	69.14	8.47
hunan dupanglingchongtianzhu	25.37	111.27	1235	135	8.67	293.92	21.54
hunan zhutinghuanglongxiang	27.33	113.08	200	15	11.87	79.22	16.85
sichuan baiyuxianarengou	31.23	98.83	3300	214	11.90	135.48	7.21
sichuan mianningzhile	28.60	102.17	3100	220	17.31	276.96	12.21
sichuan nanpingdaluxiang	33.57	103.67	3293	86	8.41	115.17	8.00
sichuan nuoergaibaozuoxiang	33.62	103.35	3500	130	17.86	242.83	12.67
sichuan xiaojinrilonggou	30.98	102.35	3270	199	9.51	193.62	9.22
sichuan zitongxianqiqushan	31.67	105.18	484	30	22.72	129.99	14.24
sichuan zitonglinchang	30.95	105.33	484	27	14.31	86.13	13.04
xizang changdubomitongmai	30.15	95.10	2300	108	9.27	289.56	17.57
xizang rikazejilongxian	28.88	85.27	3445	163	8.40	123.01	7.90