The China plant trait database: toward a comprehensive regional compilation of functional traits for land plants

Article

Supporting information

The China Plant Trait Database: towards a comprehensive regional compilation of functional traits for land plants

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Introduction

Plant traits, or more properly plant functional traits (Lavorel et al., 2007; Violle et al., 2007), are observable characteristics that are assumed to reflect eco-evolutionary responses to external conditions (McIntyre et al., 1999; Weiher et al., 1999; Lavorel et al., 2007). They are widely used to represent the responses of vegetation to environmental conditions, and also the effects of vegetation on the environmental and climate, at scales from individuals to biomes. There is a wealth of empirical studies documenting the relationship between specific traits, or groups of traits, in relation to specific environmental constraints, including climate, nutrient availability and disturbance (see syntheses in e.g. Fonseca et al., 2000; Wright et al., 2004; Wright et al., 2005; Diaz et al., 2006; Craine et al., 2009; Ordoñez et al., 2009; Poorter et al., 2009; Hodgson et al., 2011; Poorter et al., 2012; Diaz et al., 2016). More recent work has focused on theoretical understanding of the relationship between traits, function and environment (e.g. Maire et al., 2012; Prentice et al., 2014; Dong et al., 2016; Wang et al., 2016). This forms the basis for using quantitative expressions of these relationships to model the response of plants and ecosystems to environmental change. However, despite considerable progress in both areas, there are still many questions that remain unanswered including e.g., the relative importance of species replacement versus phenotypic plasticity in determining observed trait-environment relationships (Prentice et al., 2011; Meng et al., 2015), the role of within-ecosystem heterogeneity in the expression of key plant traits (Sakschewski et al., 2015), or the controls of plant trait syndromes and the degree to which the existence of such syndromes (Shipley et al., 2006; Liu et al., 2010) can be used to simplify the modelling of plant behavior (Kleidon et al., 2009; Scheiter and Higgins, 2009; van Bodegom et al., 2012, 2014; Scheiter et al., 2013; Fyllas et al., 2014; Wang et al., 2016). The compilation of large data sets, representing a wide range of environmental conditions and including information on a wide range of morphometric, chemical and photosynthesis traits is central to further analyses (Paula et al., 2009; Kattge et al., 2011; Falster et al., 2015).

Here we document a new database of plant functional trait information from China. In contrast to previously published studies (Zheng et al., 2007 a, b; Cai et al., 2009; Prentice et al., 2011; Meng et al., 2015), this database has been designed to provide a comprehensive sampling of the different types of vegetation and climate in China. Although some of the data have been included in public-access databases (e.g. TRY: Kattge et al., 2011), we have standardized the taxonomy and applied a consistent method to calculate photosynthetic traits.

The climate of China is diverse, and thus it is possible to sample an extremely large range of moisture and temperature regimes. Growing season temperatures, as measured by the accumulated temperature sum above 0°C (GDD0), ranges from close to zero to over 9000 °C days. Moisture availablity, as measured by the ratio of actual to equilibrium evapotranspiration (α) ranges from 0 (hyper-arid) to 1 (saturated): as calculated by Gallego-Sala et al. (2011) (Figure 1). Although gradients in temperature and moisture are not completely orthogonal, it is possible to find both cold and warm deserts and wet and dry tropical environments. As a result, most major vegetation types are represented in the country, with the exception of Mediterranean-type woodlands and forests (Figure 2). China is characterized by highly seasonal (summer-dominant) monsoonal rainfall, and there is no equivalent of the winter wet/summer dry climate of Mediterranean regions. Although much of the natural vegetation of China has been altered by human activities, there are extensive areas of natural vegetation. Access to these areas is facilitated by the creation of a number of ecological transects, including the Northeast China Transect (NECT: Ni and Wang, 2004; Nie et al., 2012; Li et al., 2016) and the North-South Transect of Eastern China (NSTEC: Gao et al., 2003; Sheng et al., 2011; Gao et al., 2013). In addition, the ChinaFlux network (Leuning and Yu, 2006; Yu et al., 2006) provides good access to a number of sites with regionally typical natural vegetation. The China Plant Trait Database currently contains information from **122** sites (Table 1, Figure 1), which sample the variation along these major climate and vegetation gradients (Figure 2).

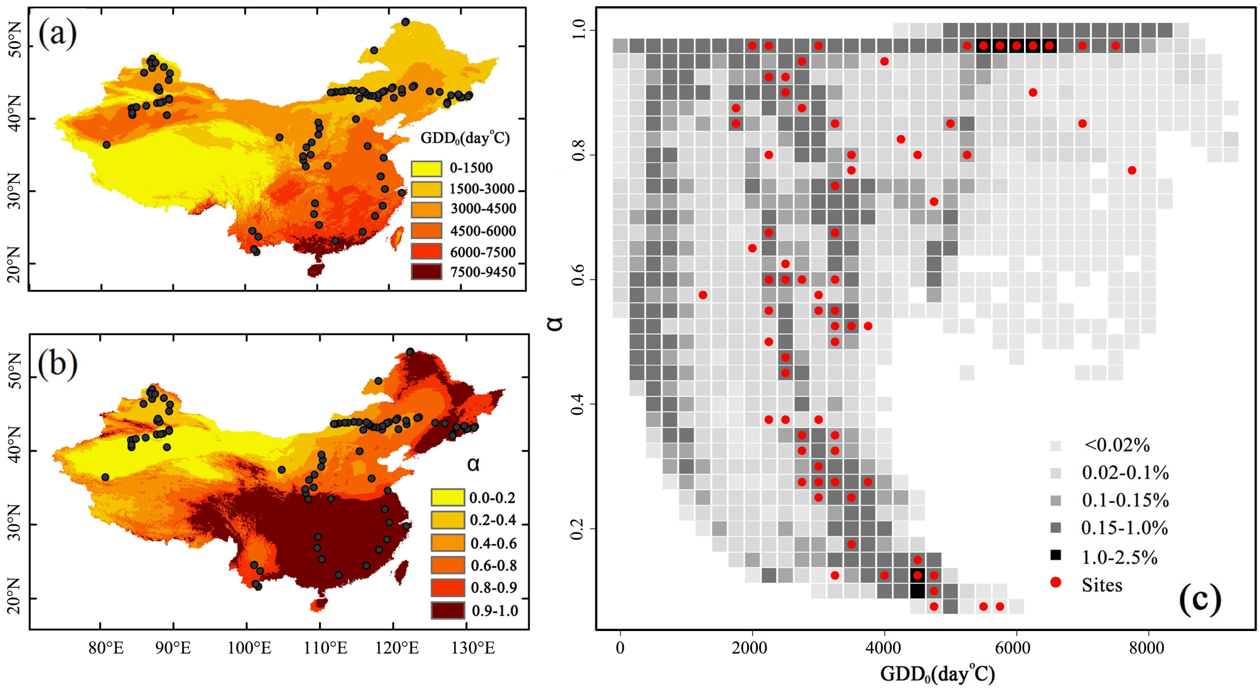

Figure 1: The geographic and climatic distribution of sites in the China Plant Trait Database. The underlying base maps at 10km resolution show geographic variation in (a) an index of moisture

availability (α), which is the ratio of actual to equilibrium evapotranspiration; (b) the accumulated temperature sum above 0°C (GDD0); and (c) the frequency distribution of 10 km grid cells (grey squares) in this climate space. The sites are shown as black dots in panels (a) and (b) and as red dots in panel (c).

This paper is structured as follows: Section A provides information about the database as a whole. The section on the second level metadata (research origin descriptions) is divided into two parts: the first part describes six generic subprojects which apply to all of the data (specifically taxonomic standardization, estimation of photosynthetic capacities, provision of photosynthetic pathway information, plant functional type classification, climate data, provision of standardized vegetation descriptions) while the second part describes the characteristics of the field data collection. This second part consists of eleven separate fieldwork subprojects, each of which used somewhat different sampling strategies and involved the collection of different types of trait data. Most of the fieldwork subprojects included multiple sites. The final sections of the paper describe the data set status and accessibility, and the data structural descriptors.

Table 1: Sites included in the China Plant Trait Database

Site Name	Latitude	Longitude	Collection year	Source	References/Field subproject
NECTS01	42.88	118.48	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS02	43.64	119.02	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS03	43.02	129.78	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS04	42.98	130.08	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS05	43.30	131.15	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS06	43.12	131.00	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS07	43.39	129.67	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**

NECTS08	43.25	128.64	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS09	43.73	127.03	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS10	43.81	125.68	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS11	44.59	123.51	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS12	44.43	123.27	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS13	43.60	121.84	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS14	44.12	121.77	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS15	44.39	120.55	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS16	44.22	120.37	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS17	43.88	119.38	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS18	43.76	119.12	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS19	43.34	118.49	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS20	43.19	117.76	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS21	43.22	117.24	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS22	43.39	116.89	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS23	43.55	116.68	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**

NECTS24	43.69	116.64	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS25	43.91	116.31	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS26	43.90	115.32	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS27	43.94	114.61	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS28	43.83	113.83	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS29	43.80	113.36	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS30	43.72	112.59	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS31	43.63	112.17	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS32	43.66	111.92	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NECTS33	43.65	111.89	2006	Authors	Prentice et al. (2011); Meng et al. (2015); see **NECT2006**
NSTEC01	36.24	117.02	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC02	34.64	119.24	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC03	32.05	118.86	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC04	30.29	119.44	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC05	29.80	121.79	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC06	27.98	119.14	2007	Authors	Meng et al. (2015); see **NSTEC2007**

NSTEC07	26.59	118.05	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC08	24.41	116.34	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC09	23.17	112.54	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC10	25.32	110.25	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC11	26.84	109.60	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC12	28.34	109.73	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC13	33.50	111.49	2007	Authors	Meng et al. (2015); see **NSTEC2007**
NSTEC14	39.95	115.42	2007	Authors	Meng et al. (2015); see **NSTEC2007**
X001	48.19	87.02	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X002	46.40	85.95	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X003	47.04	87.09	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X004	47.83	86.85	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X005	47.94	86.83	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X006	48.17	87.08	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X007	48.11	87.01	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X035	48.33	87.12	2005	Authors	Meng et al. (2015); see **Xinjiang2005**

X008	48.33	87.12	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X009	47.72	87.02	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X010	47.74	87.54	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X011	47.16	88.70	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X012	46.30	89.55	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X013	45.36	89.40	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X014	44.12	87.81	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X015	44.08	87.79	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X016	44.07	88.08	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X017	44.00	88.06	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X018	43.93	88.11	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X034	43.93	88.11	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X019	42.84	89.44	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X020	42.73	89.44	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X021	42.69	89.42	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X022	42.37	88.57	2005	Authors	Meng et al. (2015); see **Xinjiang2005**

X023	42.22	87.76	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X024	41.81	86.25	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X025	40.51	84.32	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X026	40.83	84.29	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X027	41.48	84.21	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X028	41.50	84.51	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X029	41.66	84.89	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X030	42.25	88.23	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X031	43.90	88.12	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X033	40.51	89.11	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
X032	40.83	84.29	2005	Authors	Meng et al. (2015); see **Xinjiang2005**
XBTG Rainforest	21.92	101.27	2012	Authors	Unpublished; see **Yunnan2012**
Unholy Mt	21.98	101.24	2012	Authors	Unpublished; see **Yunnan2012**
Mengla 1 Rainforest	21.61	101.58	2012	Authors	Unpublished; see **Yunnan2012**
Mengla 2 Midslope	21.62	101.58	2012	Authors	Unpublished; see **Yunnan2012**
Long Ling 1	21.62	101.58	2012	Authors	Unpublished; see **Yunnan2012**

Ailaoshan Flux	24.54	101.03	2013	Authors	Unpublished; see **Yunnan2013**
Ailaoshan Dwarf	24.54	101.03	2013	Authors	Unpublished; see **Yunnan2013**
Ailaoshan Mid	24.50	100.99	2013	Authors	Unpublished; see **Yunnan2013**
Mandan Shrub	23.69	101.85	2013	Authors	Unpublished; see **Yunnan2013**
Mandan Wood	23.69	101.86	2013	Authors	Unpublished; see **Yunnan2013**
Ansai_2005	36.77	109.25	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Fuxian_2005	36.07	108.53	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Mizhi_2005	37.85	110.17	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Ningshan	33.43	108.43	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Shenmu_2005	38.78	110.35	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Tongchuan	35.05	109.13	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Yangling	34.27	108.07	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Yongshou	34.82	108.03	2005	Literature	Zheng et al. (2007a, b); see **Zheng2007**
Site 1	21.93	101.25	2004	Literature	Cai et al. (2009); see **Cai2009**
Longwangshan	32.07	118.82	2002	Literature	Sun et al. (2006); see **Sun2006**
Zijingshan	32.05	118.83	2002	Literature	Sun et al. (2006); see **Sun2006**

Cele	36.42	80.72	2008	Literature	Liu et al. (2010); see **Liu2010**
Fukang	44.37	87.92	2008	Literature	Liu et al. (2010); see **Liu2010**
Shapotou	37.45	104.78	2008	Literature	Liu et al. (2010); see **Liu2010**
Ordos	39.49	110.20	2008	Literature	Liu et al. (2010); see **Liu2010**
Otindag	42.86	115.89	2008	Literature	Liu et al. (2010); see **Liu2010**
Naiman	42.93	120.69	2008	Literature	Liu et al. (2010); see **Liu2010**
Hulunbeir	49.48	117.95	2008	Literature	Liu et al. (2010); see **Liu2010**
Changbai 1	42.32	128.12	2014	Authors	Unpublished; see **Bai2012**
Changbai 6	42.28	128.10	2014	Authors	Unpublished; see **Bai2012**
Changbai 15	42.23	128.08	2014	Authors	Unpublished; see **Bai2012**
Changbai 15b	42.18	128.13	2014	Authors	Unpublished; see **Bai2012**
Changbai 46	42.13	128.11	2014	Authors	Unpublished; see **Bai2012**
Changbai 57	42.09	128.07	2014	Authors	Unpublished; see **Bai2012**
Changbai 109	42.07	128.07	2014	Authors	Unpublished; see **Bai2012**
Changbai 54	42.06	128.06	2014	Authors	Unpublished; see **Bai2012**
Mohe Flux	53.47	122.34	2016	Authors	Unpublished; see **NAFU2016**

Mohe Ghost-train	53.46	122.34	2016	Authors	Unpublished; see **NAFU2016**
Mohe Hilltop	53.39	122.25	2016	Authors	Unpublished; see **NAFU2016**
Qinling Mixed Forest	33.44	108.44	2016	Authors	Unpublished; see **NAFU2016**

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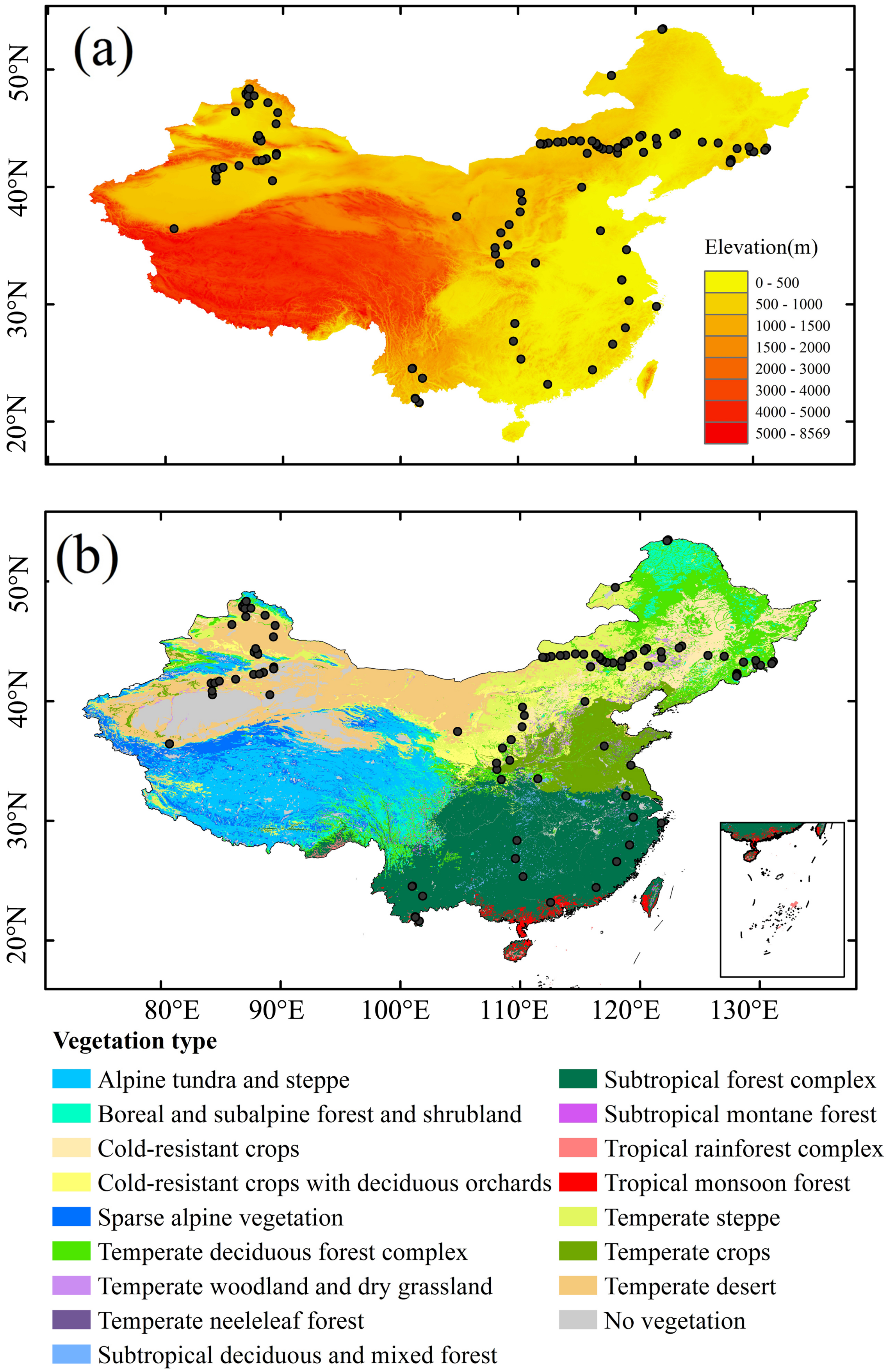

(a)
Elevation(m)
0 - 500
500 - 1000
1000 - 1500
1500 - 2000
2000 - 3000
3000 - 4000
4000 - 5000
5000 - 8569
(b)
20°N
30°N
40°N
50°N
80°E
90°E
100°E
110°E
120°E
130°E
Vegetation type
Alpine tundra and steppe
Boreal and subalpine forest and shrubland
Cold-resistant crops
Cold-resistant crops with deciduous orchards
Sparse alpine vegetation
Temperate deciduous forest complex
Temperate woodland and dry grassland
Temperate neeleleaf forest
Subtropical deciduous and mixed forest
Subtropical forest complex
Subtropical montane forest
Tropical rainforest complex
Tropical monsoon forest
Temperate steppe
Temperate crops
Temperate desert
No vegetation

Figure 2: The location of sites (black dots) in the China Plant Trait Database. The underlying base maps at 10km resolution show (a) topography and (b) vegetation. Vegetation types are derived from Wang et al., (2013).

METHODS

METADATA CLASS I. DATA SET DESCRIPTORS

A. DATA SET IDENTITY

The China Plant Trait Database

B. DATA SET IDENTIFICATION CODE:

C. DATA SET DESCRIPTORS:

1. Originators:

The sampling programme and the database were designed by WH, SPH and ICP. WH and SPH compiled the database. YY assisted with literature searches. NJ provided climate and the vegetation atlas data. All co-authors contributed unpublished or published trait data.

2. Abstract. Plant functional traits provide information about adaptations to climate and environmental conditions, and can be used to explore the existence of alternative plant strategies within ecosystems. Trait data are also increasingly being used to provide parameter estimates for vegetation models. Here we present a new database of plant functional traits from China. Most global climate and vegetation types can be found in China, and thus the database is relevant for global modelling. The China Plant Trait Database contains information on morphometric, physical, chemical and photosynthetic traits from 122 sites spanning the range from boreal to tropical, and from deserts and steppes through woodlands and forests, including montane vegetation. Data collection at each site was based either on sampling the dominant species or on a stratified sampling of each ecosystem layer. The database contains information on 1215 unique species, though many species have been sampled at multiple sites. The original field identifications have been taxonomically standardized to the Flora of China. Similarly, derived photosynthetic traits, such as electron-transport and carboxylation capacities, were calculated using a standardized method. To

facilitate trait-environment analyses, the database also contains detailed climate and vegetation information for each site.

D. Keywords

plant traits, leaf morphometry, leaf economics, leaf chemistry, photosynthetic properties, J_{max}, V_{cmax}

METADATA CLASS II. RESEARCH ORIGIN DESCRIPTORS

B. SPECIFIC SUBPROJECT DESCRIPTION

GENERIC SUBPROJECTS

Taxonomic standardization

Data from: Sandy Harrison; standardization of taxon names as recorded in fieldwork subprojects

1. Site description

All sites in database.

2. Experimental or sampling design

a. Variables included: Species ID, Original genus, Original species, Accepted genus, Accepted species, Site ID, Sample ID, Chinese name

3. Research methods

The sampled taxa were identified in the field by a taxonomist familiar with the local vegetation, most usually using a regional flora. To facilitate comparison between sites, it was necessary to translate these identifications to a common standard. We use the online version of the Flora of China (FoC) as our common standard (http://www.efloras.org/flora_page.aspx?flora_id=2). However, not all of the field-identified species were accepted or included in the Flora of China and thus it was not possible to assign them unambiguously to an accepted taxonomic name. In these cases, we followed a standard procedure to standardize the taxonomy (Figure 4) by first checking whether the name was accepted according to the Plant List (http://www.theplantlist.org/), and then checking to see whether there were any synonyms for these accepted names and whether these synonyms were included in the FoC. In a limited number of cases, either there were several synonyms for an accepted name, or the field-assigned name could not be identified either in the FoC or in the Plant List (or in alternative sources such as the Virtual Herbarium of China or TROPICOS). In these cases we have retained the original name. The decisions about taxonomy are described in the table Taxonomic Standardization. The names assigned originally in the field and the accepted standardized names used in the database are given in the table Species Translations. In the subprojects describing fieldwork measurements, we provided the standardized taxonomy for each species, rather than the original names recorded in the field or in the literature.

The database also includes a Table that provides the Chinese translation of each of the species that is recognized and accepted by the Flora of China. The written Chinese nomenclature system does not follow the Linnaean system. This Table is designed to facilitate the use of the database by botanists in China. There are no translations of names that are not recognized by the Flora of China and are used in the database by default.

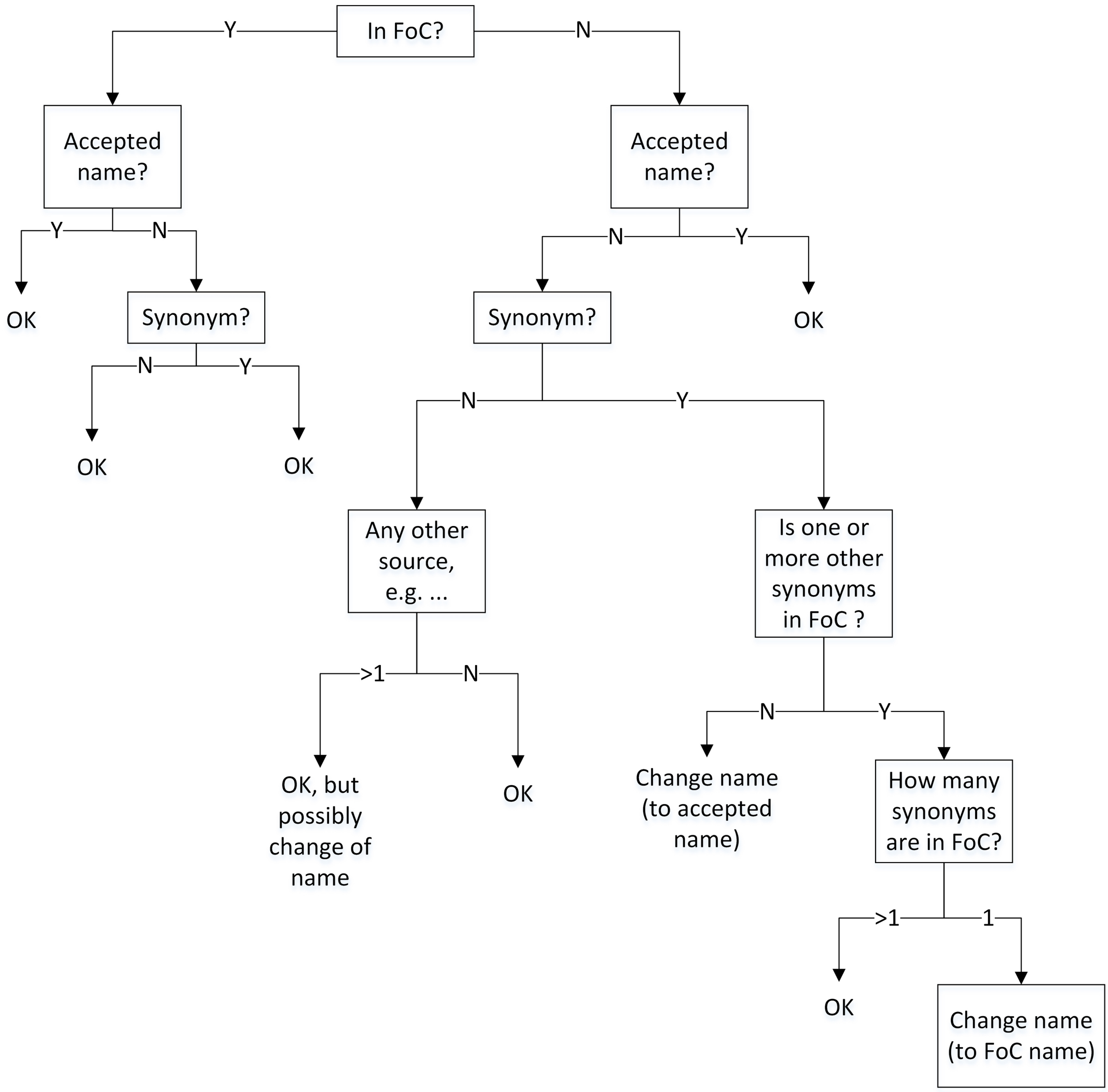


Figure 3: Flowchart showing the decision tree used to determine the names used in the China Plant Database (accepted names) and encapsulated in the Taxonomic Corrections table

4. Study contacts: Sandy Harrison (s.p.harrison@reading.ac.uk)

Estimation of photosynthetic capacities

Data from: Han Wang and Colin Prentice; calculation of photosynthetic capacities from photosynthesis field measurements using standardized methodology

1. Site description

Sites from the fieldwork-based subprojects: NAFU2016, Yunnan2012, Yunnan2013, Cai2009, Zheng2007.

2. Experimental or sampling design

a. Variables included: Vcmax, Jmax

3. Research methods

Carboxylation capacity (V_{cmax}) was calculated from the rate of photosynthesis under light and CO_2 saturation (A_{sat}) using the so-called one-point method, whose accuracy has been demonstrated against a large data set of A-c_i curves by De Kauwe et al. (2016):

$$V_{cmax} = A_{sat}/\{(c_i - \Gamma^*)/(c_i + K) - 0.01\}$$

where c_i is the leaf internal CO2 concentration, Γ^* is the photorespiratory compensation point and K the effective Michaelis-Menten coefficient of Rubisco, both calculated at the measurement temperature and site elevation (mean atmospheric pressure) according to the formulae, *in vivo* reference values and activation energies provided by Bernacchi *et al.* (2001). This method to calculate V_{cmax} depends on the assumption that measurement at saturating light intensity eliminates electron-transport limitation of photosynthesis (De Kauwe et al. 2016). Electron-transport capacity (J_{max}) was then calculated analogously on the assumption that high CO_2 concentration eliminates Rubisco limitation of photosynthesis:

$$J_{max} = 4\,(A_{max} + 0.01\,V_{cmax})\,(c_i + 2\Gamma^*)/(c_i - \Gamma^*)$$

Values of V_{cmax} and J_{max} are given at the temperatures at which A_{sat} and A_{max} respectively were measured; they have not been corrected to a standard temperature.

In a few cases, where field-measured c_i:c_a ratios were not provided but $\delta^{13}C$ measurements were available, estimates of the c_i:c_a ratio were made using the method of Cornwell et al. (2017) to calculate isotopic discrimination (Δ) from $\delta^{13}C$ (correcting for atmospheric $\delta^{13}C$, approximated as a function of time of collection and latitude), and a commonly used simple formula:

$$c_i/c_a = (\Delta - 4.4)/(27 - 4.4)$$

to derive the c_i:c_a ratio from Δ (see e.g. Cernusak et al. 2013).

We include the calculated photosynthetic capacities in the list of variables available for each of the fieldwork subprojects.

4. Study contacts: Han Wang (wanghan_sci@yahoo.com)

Standardization of photosynthetic pathway information

Data from: Sandy Harrison; provision of information on photosynthetic pathway for all species in database

1. Site description:

All sites in database.

2. Experimental or sampling design

a. Variables included: Species ID, Photo Path

3. Research methods

Information on photosynthetic pathway (C3, C4, CAM) was derived based on the identification of the pathway for a specific species from the literature, based either on anatomical or isotopic evidence. There are a large number of literature compilations on the photosynthetic pathway of Chinese plants (e.g. Liu et al., 2004; Wang, 2004; Wang, 2005; Liu and Wang, 2006; Su et al., 2011; Wang and Ma, 2016). Where this information was not available from Chinese studies we used similar compilations from other regions of the world (e.g. Winter, 1981; Ueno and Takeda, 1992; Akani et al., 1997; Bruhl and Wilson, 2007; Atia et al., 2014; Osborne et al., 2014). We do not include information on photosynthetic pathway for any species unless there is confirmation in the literature.

4. Study contacts: Sandy Harrison (s.p.harrison@reading.ac.uk)

Plant Functional Type (PFT) classification

Data from: Sandy Harrison; provision of information allowing classification of species to standardized plant functional types (PFTs) for all species in database

1. Site description

All sites in database

2. Experimental or sampling design

a. Variables included: Sample ID, Life form, Plant phenology, Leaf type, Leaf phenology

3. Research methods

Here we recognize 19 distinct life forms: tree, small tree, low to high shrub, erect dwarf shrub, prostrate dwarf shrub, liana, climber, forb, cushion forb, rosette forb, graminoid, bamboo, cycad, geophyte, stem succulent, succulent, pteridophyte, epiphyte, parasite. Plant phenology is recorded as perennial, biennial or annual. The primary distinction in leaf phenology is between deciduous and evergreen, but the classification used in the database also recognizes facultative deciduousness (semi-deciduous) and leaf-exchangers (i.e. plants that retain their leaves for nearly the whole year but drop and replace all of the leaves in a single short period, rather than replacing some leaves continuously through the year as evergreens do). The concept of leaf phenology is only relevant for woody perennials (trees, shrubs, lianas) and so is not recorded for other plants such as forbs or non-woody climbers.

Although these four pieces of information are used by many modellers in the definition of plant functional types (PFTs) (Prentice et al., 2007; Harrison et al., 2010), we recognize that they are not strictly species-specific traits. Thus, some species can occur as a tree, a small tree or a shrub (e.g. *Cyclobalanopsis obovatifolia*), or as a shrub or liana (e.g. *Smilax discotis*), depending on environmental conditions. Similarly, some species can occur as either a liana or a shrub, depending on the environmental conditions. Some species can behave as an evergreen or deciduous plant, depending on moisture availability (e.g. *Ulmus parvifolia*). Thus, this information is recorded for individual species at each site and no attempt is made to ensure that a given species is classified identically at all sites. There are several different classifications of life form (e.g. Raunkiær, 1934; Box, 1981; Prentice et al., 1992; Cornelissen et al., 2003).

Climate data

Data from: Jian Ni, Yanzheng Yang, Han Wang; Jian Ni provided 1 km resolution gridded climatologies of temperature, precipitation and sunshine hours, Yanzheng Yang extracted climate data for each site, and Han Wang estimated bioclimatic variables for site.

1. Site description

All sites in database

2. Experimental or sampling design

a. Variables included: Site ID, Lat_grid, Long_grid, Temp Jan, Temp Feb, Temp Mar, Temp April, Temp May, Temp June, Temp July, Temp Aug, Temp Sep, Temp Oct, Temp Nov, Temp Dec, Prec Jan, Prec Feb, Prec Mar, Prec April, Prec May, Prec June, Prec July, Prec Aug, Prec Sep, Prec Oct, Prec Nov, Prec Dec, Sunh Jan, Sunh Feb, Sunh Mar, Sunh April, Sunh May, Sunh June, Sunh July, Sunh Aug, Sunh Sep, Sunh Oct, Sunh Nov, Sunh Dec, MTCO, MAT, MI, alpha, GDD0, mGDD0, PAR0, mPAR0, Prec timing, Prec season, MMP, MAP

3. Research methods

We derived the climatologies from records from 1814 meteorological stations (740 stations have observations from 1971 to 2000, the rest from 1981 to 1990), interpolated to a 0.01 grid using a three-dimensional thin-plate spline (ANUSPLIN version 4.36; Hancock and Hutchinson, 2006). We then extracted information on monthly mean temperature, precipitation and percentage of possible sunshine hours for each site, and calculated the mean temperature of the coldest month (MTCO), mean annual temperature (MAT), mean monthly precipitation (MMP) and mean annual precipitation (MAP). The climate data were used as inputs to the STASH model (Gallego-Sala et al., 2011), a generic environmental and water-balance model that simulates radiation, evapotranspiration, plant-available moisture and other bioclimatic variables. Thus, in addition to the more conventional meteorological variables, the database contains information on total annual photosynthetically active radiation during the growing season when mean daily temperatures are >0°C (PAR0), the daily mean photosynthetically active radiation during the growing season (mPAR0), growing degree days above a baseline of 0°C (GDD0), the daily mean temperature during the growing season (mGDD0), the ratio of actual to equilibrium evapotranspiration (α), and a moisture index (MI). We also calculated the timing of peak rainfall and rainfall seasonality, using metrics as described in Kelley et al. (2013).

4. Study contacts: Han Wang (wanghan_sci@yahoo.com)

Standardization of vegetation description

Data from: Jian Ni, Yanzheng Yang, Han Wang, Sandy Harrison; Jian Ni provided the Vegetation Map of China, Yanzheng Yang extracted the vegetation type for each site, Han Wang and Sandy Harrison provided the clustered vegetation type and biome classification.

1. Site description

All sites in database

2. Experimental or sampling design

a. Variables included: Site ID, Fundamental vegetation type, Clustered vegetation type, Biome classification

3. Research methods

The local vegetation was not necessarily recorded in the field at each site; where descriptions were provided, they did not follow a standard, documented classification scheme. We have therefore provided descriptions of the typical vegetation at the location of all the sites in the database using three alternative sources of information. First, we extracted information from the digital vegetation map of China at the scale of 1:1 million (ca. 250 - 500 m: Zhang et al. 2007). This map classifies vegetation according to 55 plant communities (48 natural plant communities and seven cropping systems). We also provide a simpler vegetation classification, which was derived from this map by Wang et al. (2013) using k-means clustering of the 55 vegetation types based on their bioclimatic context. The resulting re-classification recognises 16 distinct vegetation types. Finally, we also classify the vegetation according to biome, broadly following the scheme used in the BIOME4 vegetation model (Kaplan et al., 2003). The biome classification was derived from either the field descriptions or listings of the dominant plant functional types present or on the likely translation of the vegetation map classifications.

4. Study contacts: Han Wang (wanghan_sci@yahoo.com)

FIELD SUBPROJECTS

Bai2012

Data from: Bai Fan (Unpublished)

1. Site description

a. Site(s) type(s): mixed coniferous and broad-leaved forests, mixed coniferous forest, sub-alpine coniferous forest, birch forest, alpine tundra

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 42.32, 128.12, 885; 42.28, 128.1, 946; 42.23, 128.08, 1034; 42.18, 128.13, 1164; 42.13, 128.11, 1322; 42.09, 128.07, 1595; 42.07, 128.07, 1707; 42.06, 128.06, 1859

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: All tree and shrub species on the plots were sampled

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Nmass, Pmass, Narea, Parea

c. Species sampled: *Abies nephrolepis, Acer mandshuricum, Acer pictum, Acer pseudosieboldianum, Acer tegmentosum, Acer ukurunduense, Corylus mandshurica, Deutzia parviflora var. amurensis, Eleutherococcus senticosus, Fraxinus mandshurica, Larix olgensis, Lonicera praeflorens, Maackia amurensis, Philadelphus schrenkii, Pinus koraiensis, Quercus mongolica, Rhamnus davurica, Ribes maximowiczianum, Sorbaria sorbifolia, Spiraea chamaedryfolia, Syringa reticulata subsp. amurensis, Tilia amurensis, Ulmus davidiana var. japonica, Ulmus laciniata, Euonymus verrucosus, Padus avium, Populus davidiana, Ribes mandshuricum, Viburnum burejaeticum, Acer komarovii, Acer barbinerve, Berberis amurensis, Lonicera edulis, Lonicera maximowiczii, Picea jezoensis var. komarovii, Picea koraiensis, Rosa acicularis, Vaccinium uliginosum, Ribes horridum, Betula ermanii, Rhododendron aureum, Sorbus pohuashanensis, Viburnum koreanum*

3. Research methods

a. Year collected: 2014

b. Hard traits:

Hard traits were measured following standardized protocols (Cornelissen et al., 2003) for five individuals per species. Leaf area (LA) was calculated as fresh leaf area with pixel counting software WinFolia (Regent Instruments, Toronto, Canada) from digital scans. For needle-leaved trees, leaf area was estimated using the volume replacement method and vernier caliper measurements to obtain length, width and thickness. Leaves were dried (at 60 °C) to constant weight and weighed. Specific leaf area (SLA) was calculated as leaf area divided by oven-dried mass. Leaf dry mass per area (LMA) is the inverse of SLA. Leaf dry matter content (LDMC) is leaf oven-dry weight divided by fresh weight.

Leaf carbon content (Cmass) and leaf nitrogen content (Nmass) were measured in the laboratory using an elemental analyser (vario EL III). Leaf phosphorus content (Pmass) was measured using Mo-Sb colorimetric method with ultraviolet spectrophotometer. Area based nutrient contents (Carea, Narea, Parea) were derived by the database compilers using the SLA data.

4. Study contacts: Fan Bai (baifan823@ibcas.ac.cn), Han Wang (wanghan_sci@yahoo.com)

NAFU2016

Data from: Unpublished data from Sandy Harrison, Colin Prentice, Han Wang, Meng Wang, Yanzheng Yang

1. Site description

a. Site(s) type(s): boreal deciduous forest, temperate mixed forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 53.47, 122.34, 290; 53.46, 122.34, 325; 53.39, 122.25, 638; 33.44, 108.44, 1514

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: A checklist of vascular species at each site was created, and the most common species from each of the structural components of the community were sampled.

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Nmass, Pmass, Kmass, Narea, Parea, Karea, d13C:12C, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere, Amax_Photo, Amax_Gs, Amax_Ci:Ca, Amax_E, Amax_VPD, Amax_Tleaf, Amax_CO2, Asat_Photo, Asat_Gs, Asat_Ci:Ca, Asat_E, Asat_VPD, Asat_Tleaf, Asat_CO2

c. Species sampled: *Alnus hirsuta, Betula fruticosa, Betula platyphylla, Calamagrostis angustifolia, Equisetum arvense, Geranium wilfordii, Larix gmelinii, Ledum palustre, Phedimus aizoon, Pinus sylvestris var. mongolica, Potentilla fruticosa, Rhododendron simsii, Rosa acicularis, Salix raddeana, Saussurea japonica, Thalictrum aquilegiifolium, Trollius chinensis, Vaccinium uliginosum, Vaccinium vitis-idaea, Vicia sepium, Adenophora tetraphylla, Fragaria orientalis, Populus davidiana, Pyrola asarifolia, Ribes mandshuricum, Sanguisorba officinalis, Sorbaria sorbifolia, Spiraea pubescens, Avena fatua, Gymnocarpium jessoense, Maianthemum bifolium, Rubus arcticus, Rubus clivicola, Paris verticillata, Acer oliverianum, Anemone hupehensis, Carex siderosticta, Carpinus tschonoskii, Celastrus orbiculatus, Cornus controversa, Cornus kousa var. chinensis, Elaeagnus umbellata, Epimedium sagittatum, Euonymus alatus, Fargesia nitida, Hedera nepalensis, Holboellia angustifolia, Ilex pernyi, Juglans mandshurica, Kalopanax septemlobus, Lespedeza buergeri, Litsea pungens, Neillia sinensis, Paederia foetida, Petasites japonicus, Pinus armandii, Pinus tabuliformis, Quercus aliena var. acutiserrata, Rodgersia aesculifolia, Schisandra sphenanthera, Smilax discotis, Smilax stans, Styrax hemsleyanus, Toxicodendron vernicifluum, Tsuga chinensis, Unknown fern, Unknown grass*

3. Research methods

a. Year collected: 2016

b. Hard traits:

At least 10 g of leaves were collected for each species. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and the contents of carbon, nitrogen, phosphorus and potassium. The measurements used are averages of three replicates. Leaf area (LA) was determined by scanning five leaves (or more in the case of small leaves, to make up a total area $\geq 20\ cm^2$ per species) with a laser scanner and measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) is leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf carbon content (Cmass) was measured by the potassium dichromate volumetric method and leaf nitrogen content (Nmass) by the microkjeldahl method. Leaf phosphorus (Pmass) was analysed colorimetrically (Shimadzu UV-2550). Leaf potassium (Kmass) was measured by Flame Atomic Emission Spectrophotometry (PE 5100 PC). The area-based leaf chemical contents (Carea, Narea, Parea, Karea) were derived as a product of mass based content and LMA. $\delta^{13}C$ (d13C:12C) was measured using a Finnigan MAT DELTAplusXP Isotope Ratio Mass Spectrometer (Finnigan Corporation, San Jose, CA).

c. Morphometric traits:

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

d. Photosynthetic traits:

The light-saturated rate of net CO_2 fixation under ambient CO_2 (Asat_Photo) and the light-saturated rate of net CO_2 fixation at high CO_2 (Amax_Photo) were obtained from LiCor 6400 measurements in the field. The data on the conditions under which these measurements were made were also collected, including vapour pressure deficit (Asat_VPD, Amax_VPD), leaf temperature (Asat_Tleaf, Amax_Tleaf), the ratio of leaf internal to ambient CO_2 (Asat_Ci:Ca, Amax_Ci:Ca), stomatal conductance (Asat_Gs, Amax_Gs) and transpiration rate (Asat_E, Amax_E).

4. Study contacts: Sandy Harrison (s.p.harrison@reading.ac.uk) & Han Wang (wanghan_sci@yahoo.com)

NECT2006

Data from:

Prentice, I. C., T. Meng, H. Wang, S. P. Harrison, J. Ni, and G. Wang. 2011. Evidence for a universal scaling relationship of leaf CO_2 drawdown along a moisture gradient. New Phytologist 190: 169-180;

Meng, T.-T., H. Wang, S. P. Harrison, I. C. Prentice, J. Ni, and G. Wang. 2015. Responses of leaf traits to climatic gradients: adaptive variation versus competitional shifts. Biogeosciences 12: 5339-5352)

Additional unpublished morphometric data from Sandy Harrison and Colin Prentice

1. Site description

a. Site(s) type(s): desert, temperate shrubland, temperate grassland, steppe, temperate broadleaf deciduous forest, temperate deciduous woodland, and temperate needleleaf forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 42.88, 118.48, 1024; 43.64, 119.02, 781; 43.02, 129.78, 136; 42.98, 130.08, 114; 43.3, 131.15, 289; 43.12, 131, 244; 43.39, 129.67, 224; 43.25, 128.64, 601; 43.73, 127.03, 390; 43.81, 125.68, 252; 44.59, 123.51, 146; 44.43, 123.27, 150; 43.6, 121.84, 203; 44.12, 121.77, 202; 44.39, 120.55, 448; 44.22, 120.37, 372; 43.88, 119.38, 601; 43.76, 119.12, 729; 43.34, 118.49, 707; 43.19, 117.76, 889; 43.22, 117.24, 1259; 43.39, 116.89, 1267; 43.55, 116.68, 1261; 43.69, 116.64, 1211; 43.91, 116.31, 1199; 43.9, 115.32, 1196; 43.94, 114.61, 1123; 43.83, 113.83, 1166; 43.8, 113.36, 1017; 43.72, 112.59, 974; 43.63, 112.17, 999; 43.66, 111.92, 1005; 43.65, 111.89, 1017

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: all sites were occupied by visually homogeneous uncultivated vegetation. For most of the grasslands, which were grazed and finding undisturbed sites was impossible, sites with minimal signs of recent disturbance were sampled. A checklist of vascular species at each site was created, from which the common species were sampled.

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Nmass, Pmass, Kmass, Narea, Parea, Karea, d13C:12C, d15N:14N, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere, Fv:Fm, QY

c. Species sampled: *Allium senescens, Artemisia frigida, Artemisia gmelinii, Astragalus galactites, Astragalus scaberrimus, Cleistogenes squarrosa, Euphorbia esula, Euphorbia humifusa, Lespedeza davurica, Leymus chinensis, Polygala tenuifolia, Potentilla discolor, Scutellaria baicalensis, Stipa krylovii, Thalictrum sp., Thymus mongolicus, Unidentified forb 1, Unidentified grass 1, Agropyron cristatum, Allium sp., Anemarrhena asphodeloides, Artemisia scoparia, Artemisia sp., Caragana microphylla, Cynanchum thesioides, Delphinium grandiflorum, Echinops sp., Erodium stephanianum, Glycyrrhiza uralensis, Haplophyllum dauricum, Heteropappus altaicus, Medicago ruthenica, Oxytropis sp., Potentilla tanacetifolia, Saussurea japonica, Saussurea parviflora, Scutellaria scordifolia, Serratula centauroides, Sesamum indicum, Stellera chamaejasme, Taraxacum mongolicum, Thalictrum squarrosum, Tragus racemosus, Tribulus terrestris, Unidentified forb 2.1 (scrof), Unidentified geophyte, unidentified scroph, Unidentified semi-rosette forb 1, Unidentified stoloniferous grass, Acer pictum, Astilbe chinensis, Betula utilis, Carex pediformis, Clematis sp., Corylus heterophylla, Dioscorea nipponica, Euonymus alatus, Fraxinus chinensis subsp. rhynchophylla, Hemerocallis middendorffii, Lespedeza bicolor, Lonicera chrysantha, Philadelphus tenuifolius, Populus davidiana, Pteridium aquilinum, Ribes amurensis, Rosa sp., Streptopus streptopoides, Thalictrum tuberiferum, Tilia amurensis, Tilia mandshurica, Ulmus davidiana var. japonica, Urtica angustifolia, Viola sp., Artemisia sylvatica, Asparagus dauricus, Calamagrostis epigejos, Carex sp., Flueggea suffruticosa, Ixeris chinensis, Lathyrus davidii, Phlomis maximowiczii, Pinus tabuliformis, Polygonatum odoratum, Prunus padus, Quercus mongolica, Rhamnus schneideri, Rubia sylvatica, Syneilesis aconitifolia, Vicia amoena, Viola variegata, Acer tataricum subsp. ginnala, Adenophora tetraphylla, Aegopodium alpestre, Agrimonia pilosa, Asparagus sp., Betula albosinensis, Betula platyphylla, Bromus inermis, Campanula glomerata, Crataegus sp., Eleutherococcus sessiliflorus, Equisetum hyemale, Fraxinus mandshurica, Geum sp., Larix olgensis, Maackia amurensis, Mukdenia rossii, Onoclea sensibilis, Parasenecio hastatus, Phellodendron amurense, Phragmites australis, Rhamnus sp., Salix gracilistyla, Salix viminalis, Sorbaria sorbifolia, Viburnum sargentii, Vicia unijuga, Aconitum volubile, Angelica amurensis, Arctium lappa, Aster scaber, Brachybotrys paridiformis, Carex appendiculata, Caulophyllum robustum, cf Prunus/Malus sp., Chloranthus japonicus, Chrysosplenium alternifolium, Eleutherococcus senticosus, Equisetum arvense, Impatiens furcillata, Lonicera maackii, Lychnis fulgens, Paeonia obovata, Pinus koraiensis, Rubia sp., unidentified annual forb, Vitis amurensis, Artemisia keiskeana, Atractylodes japonica, Bupleurum* *longiradiatum, Clematis fusca var. violacea, Convallaria majalis, Dracocephalum argunense, Euonymus verrucosus, Euphorbia lucorum, Peucedanum terebinthaceum, Picea sp., Ranunculus chinensis, Rhododendron sp., Scutellaria sp., Sedum aizoon, Synurus deltoides, Trifolium lupinaster, Viola acuminata, Viola sp. 1, Viola sp. 2, Viola sp. 3, Aconitum kirinense, Actaea asiatica, Carex siderosticta, Clintonia udensis, Fragaria orientalis, Galium dahuricum var. lasiocarpum, Geranium sp., Lilium lancifolium, Monotropa hypopitys, Paris verticillata, Rubus sp., Sambucus sp., Ulmus macrocarpa, Unidentified forb 2, Unidentified forb 3, Acer mandshuricum, Acer tegmentosum, Aconitum paniculigerum, Actinidia arguta, Adiantum pedatum, Aralia elata, Arisaema heterophyllum, Cardamine macrophylla, Carex meyeriana, Carpinus cordata, Dryopteris crassirhizoma, Glycine soja, Hylodesmum podocarpum subsp. oxyphyllum, Juglans mandshurica, Lonicera subhispida, Lygodium alpestre, Matteuccia struthiopteris, Rubia cordifolia, Sanicula chinenesis, Streptopus sp., Unidentified ground creeper, Viburnum burejaeticum, Viola biflora, Allium ramosum, Artemisia lavandulifolia, Artemisia mongolica, Artemisia sieversiana, Carex duriuscula, Clematis hexapetala, Clematis terniflora var. mandshurica, Crataegus pinnatifida, Crepidiastrum denticulatum, Echinochloa crus-galli, Iris lactea, Kummerowia striata, Legousia falcata, Linum stelleroides, Pilosella vaillantii, Platycodon grandiflorus, Potentilla chinensis, Setaria viridis, Siphonostegia chinensis, Sonchus brachyotus, Tripolium pannonicum, unidentified forb, Artemisia anethifolia, Aster ageratoides, Chloris virgata, Inula britannica, Kalimeris integrifolia, Lamium japonicum, Melilotus suaveolens, Polygonum sibiricum, Puccinella chinampoensis, Sanguisorba officinalis, Suaeda glauca, Thalictrum simplex, Amaranthus retroflexus, Astragalus adsurgens, Eragrostis minor, Hieracium denticulatum, Kochia scoparia var. sieversiana, Plantago depressa, Potentilla flagellaris, Taraxacum ussuriense, Xanthium strumarium, Atriplex gmelinii, Chenopodium glaucum, Lepidium apetalum, Limonium bicolor, Metaplexis japonica, Salsola collina, Sphaerophysa salsula, Thermopsis lanceolata, Tournefortia sibirica, Aristida adscensionis, Chenopodium acuminatum, Allium mongolicum, Convolvulus arvensis, Hedysarum fruticosum, Leontopodium leontopodioides, Lespedeza juncea, Patrinia rupestris, Pennisetum flaccidum, Rhaponticum uniflorum, Cuscuta chinensis, Dysphania aristata, Echinops gmelinii, Eragrostis cilianensis, Ferula bungeana, Medicago lupulina, Salix gordejevii, Salsola kali subsp. ruthenica, Agropyron michnoi, Artemisia annua, Ephedra distachya, Polygonum divaricatum, Arnebia guttata, Atraphaxis manshurica, Belamcanda chinensis, Cynanchum acutum subsp. sibiricum, Dianthus chinensis, Geranium transbaicalicum, Potentilla conferta, Saposhnikovia divaricata, Serratula glauca, Sophora flavescens, Bassia dasyphylla, Scutellaria viscidula, Allium neriniflorum, Dontostemon integrifolius, Leonurus japonicus, Carex korshinskyi, Filifolium sibiricum, Potentilla acaulis, Potentilla bifurca, Stipa grandis, Achnatherum* *sibiricum, Allium condensatum, Bupleurum scorzonerifolium, Chenopodium album, Cymbaria dahurica, Galium verum, Kochia prostrata, Nepeta multifida, Orostachys malacophylla, Spiraea trilobata, Cirsium setosum, Poa angustifolia, Psammochloa villosa, Adenophora gmelinii, Adenophora stenanthina, Astragalus variabilis, Gentiana dahurica, Oxytropis myriophylla, Phlomis tuberosa, Caragana stenophylla, Ephedra sinica, Allium polyrhizum, Artemisia pubescens, Convolvulus ammannii, unidentified chenopod 1, Ajania achilleoides, Cleistogenes songorlca, Peganum harmala, Scorzonera divaricata, Allium bidentatum, Allium leucocephalum, Festuca dahurica, Stipa caucasica, Astragalus sp., Atraphaxis bracteata, Caragana tibetica, Hippolytia trifida, Stipa tianschanica, Allium tenuissimum, Haplophyllum tragacanthoides, Krascheninnikovia ceratoides, Limonium aureum, Reaumuria soongarica, Salsola passerina, Scorzonera muriculata*

3. Research methods

a. Year collected: 2006

b. Hard traits:

Hard traits were measured on samples collected in the field following standard methods (Cornelissen et al., 2011). At least 10 g of leaves were collected for each species. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and the contents of carbon, nitrogen, phosphorus and potassium. The measurements used are averages of three replicates. Leaf area was determined by scanning five leaves (or more in the case of small leaves, to make up a total area ≥ 20 cm^2 per species) with a laser scanner. Areas (Average LA) were measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) was expressed as leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf carbon content (Cmass) was measured by the potassium dichromate volumetric method and leaf nitrogen content (Nmass) by the microkjeldahl method. Leaf phosphorus (Pmass) was analysed colorimetrically (Shimadzu UV-2550). Leaf potassium (Kmass) was measured by Flame Atomic Emission Spectrophotometry (PE 5100 PC). The area based leaf chemical contents (Carea, Narea, Parea, Karea) were derived as a product of mass based content and LMA. $\delta^{13}C$ (d13C:12C) and $\delta^{15}N$ (d15N:14N) were measured using a Finnigan MAT DELTAplusXP Isotope Ratio Mass Spectrometer (Finnigan Corporation, San Jose, CA).

c. Morphological traits

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

d. Photosynthetic traits

Fv:Fm (the ratio of variable fluorescence to maximal fluorescence) and quantum yield (QY) were measured using a FluorPen FP100 (Photon Systems Instruments, Czech Republic). Fv:Fm measures the potential rate of photosynthetic electron transport while QY measures the actual rate. QY is correlated with photosynthetic rate, although it also includes the diversion of electrons to non-photosynthetic activities such as the elimination of reactive oxygen species (Cavender-Bares and Bazzaz, 2004).

4. Study contacts: Han Wang (wanghan_sci@yahoo.com) and Sandy Harrison (s.p.harrison@reading.ac.uk)

NSTEC2007

Data from:

Meng, T.-T., H. Wang, S. P. Harrison, I. C. Prentice, J. Ni, and G. Wang. 2015. Responses of leaf traits to climatic gradients: adaptive variation versus competitional shifts. Biogeosciences 12: 5339-5352

Additional unpublished morphometric data from Sandy Harrison and Colin Prentice

1. Site description

a. Site(s) type(s): temperate evergreen needleleaf forest, subtropical deciduous broadleaf forest, subtropical mixed forest, subtropical evergreen broadleaf forest, tropical shrubland, tropical grassland, subtropical evergreen needleleaf forest, temperate shrubland

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 36.24, 117.02, 368; 34.64, 119.24, 59; 32.05, 118.86, 76; 30.29, 119.44, 299; 29.8, 121.79, 231; 27.98, 119.14, 294; 26.59, 118.05, 239; 24.41, 116.34, 195; 23.17, 112.54, 240; 25.32, 110.25, 199; 26.84, 109.6, 390; 28.34, 109.73, 220; 33.5, 111.49, 449; 39.95, 115.42, 1253

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: A checklist of vascular species at each site was created, from which the common species were sampled.

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Nmass, Pmass, Kmass, Narea, Parea, Karea, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere

c. Species sampled: *Broussonetia papyrifera, Grewia biloba, Pinus tabuliformis, Quercus acutissima, Quercus fabrei, Robinia pseudoacacia, Spiraea trilobata, Vitex negundo var. heterophylla, Vitis heyneana subsp. ficifolia, Albizia kalkora, Cerasus japonica, Clerodendrum trichotomum, Dalbergia hupeana, Glochidion puberum, Lespedeza thunbergii, Platycladus orientalis, Platycodon grandiflorus, Quercus serrata var. breviopetiolata, Vitex negundo, Zanthoxylum schinifolium, Acer buergerianum, Alangium chinense, Aphananthe aspera, Celtis sinensis, Cercis chinensis, Cinnamomum camphora, Euonymus alatus, Firmiana simplex, Hylodesmum podocarpum subsp. oxyphyllum, Ilex cornuta, Juniperus chinensis var. chinensis, Kalopanax septemlobus, Ligustrum lucidum, Lindera glauca, Liquidambar formosana, Maclura tricuspidata, Osmanthus fragrans, Paederia foetida, Parthenocissus tricuspidata, Phyllostachys heteroclada, Pinus massoniana, Pistacia chinensis, Pittosporum tobira, Quercus aliena, Rosa cymosa, Rubus parvifolius, Serissa serissoides, Smilax glaucochina, Symplocos paniculata, Trachelospermum jasminoides, Ulmus parvifolia, Vernicia fordii, Castanopsis eyrei, Castanopsis sclerophylla, Cunninghamia lanceolata, Cyclobalanopsis glauca, Diospyros lotus, Eurya rubiginosa var. attenuata, Gardenia jasminoides, Ilex chinensis, Lindera aggregata, Loropetalum chinense, Osmanthus cooperi, Photinia glabra, Rhaphiolepis indica, Rhododendron mariesii, Rhododendron ovatum, Schima superba, Smilax china, Symplocos sumuntia, Vaccinium mandarinorum, Wisteria sinensis, Ardisia crenata var. bicolor, Ardisia japonica, Camellia fraterna, Camellia oleifera, Castanopsis carlesii, Castanopsis fargesii, Celastrus orbiculatus, Cleyera* *japonica, Cyclobalanopsis gilva, Cyclobalanopsis gracilis, Cyclobalanopsis stewardiana, Dalbergia mimosoides, Damnacanthus indicus, Dioscorea cirrhosa, Dioscorea oppositifolia, Elaeocarpus japonicus, Eurya rubiginosa, Lithocarpus glaber, Machilus thunbergii, Morinda umbellata, Myrica rubra, Neolitsea aurata var. chekiangensis, Ormosia henryi, Pleioblastus amarus, Stauntonia chinensis, Styrax japonicus, Symplocos heishanensis, Symplocos stellaris, Symplocos viridissima, Tylophora silvestris, Viburnum erosum, Acer cordatum, Adina pilulifera, Adinandra megaphylla, Ampelopsis cantoniensis, Antidesma japonicum, Callerya reticulata, Callicarpa rubella, Camellia sinensis, Castanopsis fissa, Coptosapelta diffusa, Cryptomeria japonica, Distylium myricoides, Embelia vestita, Euscaphis japonica, Ficus pandurata, Ficus pumila, Ilex pubescens, Indigofera decora var. ichangensis, Itea omeiensis, Kadsura longipedunculata, Lasianthus japonicus, Laurocerasus spinulosa, Litsea wilsonii, Lonicera humilis, Maesa japonica, Oreocnide frutescens, Pericampylus glaucus, Pittosporum illicioides, Premna fordii, Rosa laevigata, Rubus corchorifolius, Sabia swinhoei, Sageretia thea, Smilax glabra, Styrax obassis, Tarenna mollissima, Toxicodendron succedaneum, Trachelospermum axillare, Ulmus changii, Vaccinium bracteatum, Actinidia eriantha, Aidia cochinchinensis, Alyxia sinensis, Ampelopsis grossedentata, Ardisia lindleyana, Camellia cordifolia, Castanopsis fordii, Celastrus hypoleucus, Choerospondias axillaris, Daphniphyllum oldhamii, Diospyros kaki, Diploclisia glaucescens, Eurya nitida, Ficus fulva, Fissistigma oldhamii, Gnetum parvifolium, Helicia cochinchinensis, Ilex viridis, Indocalamus tessellatus, Lyonia ovalifolia var. elliptica, Millettia dielsiana, Mussaenda pubescens, Paulownia kawakamii, Phoebe hunanensis, Photinia bodinieri, Photinia parvifolia, Rubus columellaris, Sarcandra glabra, Sloanea sinensis, Smilax lanceifolia, Styrax calvescens, Styrax odoratissimus, Syzygium austrosinense, Tarennoidea wallichii, Vernicia montana, Dendrotrophe varians, Diospyros morrisiana, Diospyros tutcheri, Elaeocarpus glabripetalus, Engelhardia roxburghiana, Evodia fargesii, Evodia lepta, Glochidion eriocarpum, Ilex asprella, Litsea cubeba, Litsea machiloides, Mussaenda erosa, Rhaphiolepis lanceolata, Rhododendron mariae, Rhodomyrtus tomentosa, Schefflera heptaphylla, Schima remotiserrata, Tarenna attenuata, Triadica cochinchinensis, Acronychia pedunculata, Aporosa dioica, Ardisia divergens, Ardisia hanceana, Ardisia hypargyrea, Blastus cochinchinensis, Calamus thysanolepis, Canarium album, Caryota maxima, Castanopsis chinensis, Cryptocarya chinensis, Cryptocarya concinna, Dasymaschalon rostratum, Diospyros eriantha, Dischidia chinensis, Erycibe obtusifolia, Erythrophleum fordii, Ficus virens, Fissistigma glaucescens, Garcinia oblongifolia, Gironniera subaequalis, Gnetum montanum, Ixora chinensis, Lindera chunii, Machilus chinensis, Melastoma sanguineum, Meliosma cuneifolia, Memecylon ligustrifolium, Microdesmis caseariifolia, Ormosia glaberrima, Picrasma chinensis, Piper chinense, Psychotria serpens, Rourea minor, Sarcosperma* *arboreum, Smilax hypoglauca, Sterculia lanceolata, Syzygium acuminatissimum, Tetracera sarmentosa, Tetrastigma hemsleyanum, Tetrastigma planicaule, Alchornea trewioides, Bauhinia championii, Celastrus hindsii, Croton tiglium, Decaspermum fruticosum, Ficus variolosa, Fordia cauliflora, Ilex hylonoma, Litsea coreana var. sinensis, Maclura cochinchinensis, Myrsine kwangsiensis, Pueraria montana var. lobata, Radermachera sinica, Smilax biumbellata, Triadica rotundifolia, Zanthoxylum bungeanum, Acer coriaceifolium, Camellia furfuracea, Carya hunanensis, Celastrus gemmatus, Clematis armandii, Dalbergia hancei, Dichroa febrifuga, Diospyros miaoshanica, Euonymus dielsianus, Eurya loquaiana, Ficus henryi, Hovenia acerba, Hylodesmum podocarpum subsp. fallax, Laurocerasus zippeliana, Ligustrum sinense, Lindera communis, Lindera megaphylla, Litsea coreana, Machilus pauhoi, Macropanax rosthornii, Maesa perlaria, Mallotus philippensis, Parthenocissus laetevirens, Phoebe sheareri, Photinia beauverdiana, Piper hancei, Piper wallichii, Rubus ichangensis, Rubus irenaeus, Rubus malifolius, Sageretia henryi, Smilax polycolea, Symplocos cochinchinensis var. laurina, Tetrastigma wulinshanense, Toxicodendron sylvestre, Turpinia arguta, Viburnum brachybotryum, Viburnum dilatatum, Akebia trifoliata, Aralia chinensis, Castanea seguinii, Cinnamomum appelianum, Clerodendrum mandarinorum, Cornus wilsoniana, Diospyros cathayensis, Elaeagnus henryi, Eleutherococcus trifoliatus, Eurya alata, Ficus heteromorpha, Ficus sarmentosa var. henryi, Hylodesmum podocarpum, Jasminum lanceolaria, Mahonia japonica, Mussaenda shikokiana, Rhamnus leptophylla, Zanthoxylum echinocarpum, Artemisia capillaris, Asparagus brachyphyllus, Coriaria nepalensis, Cotinus coggygria, Lespedeza bicolor, Lonicera tatarinowii, Periploca sepium, Pyrus betulifolia, Quercus baronii, Quercus chenii, Rhus chinensis, Vitis bryoniifolia, Zelkova serrata, Abelia biflora, Acer pictum, Cornus bretschneideri var. bretschneideri, Corylus heterophylla, Fraxinus bungeana, Juglans mandshurica, Lonicera maackii, Quercus mongolica, Rubus xanthocarpus, Spiraea pubescens, Tilia paucicostata, Ulmus davidiana var. japonica*

3. Research methods

a. Year collected: 2007

b. Hard traits:

Hard traits were measured on samples collected in the field following standard methods (Cornelissen et al., 2011). At least 10 g of leaves were collected for each species. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and the contents of carbon, nitrogen, phosphorus and potassium. The measurements used are averages of three replicates. Leaf area was determined by scanning five leaves (or more in the case of small leaves, to make up a total area ≥ 20 cm^2 per species) with a laser scanner. Areas (Average LA) were measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) was expressed as leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf carbon content (Cmass) was measured by the potassium dichromate volumetric method and leaf nitrogen content (Nmass) by the microkjeldahl method. Leaf phosphorus (Pmass) was analysed colorimetrically (Shimadzu UV-2550). Leaf potassium (Kmass) was measured by Flame Atomic Emission Spectrophotometry (PE 5100 PC). The area based leaf chemical contents (Carea, Narea, Parea, Karea) were derived as a product of mass based content and LMA.

c. Morphometric traits:

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

4. Study contacts: Jian Ni (nijian@vip.skleg.cn), Han Wang (wanghan_sci@yahoo.com) and Sandy Harrison (s.p.harrison@reading.ac.uk)

Xinjiang2005

Data from: Meng, T.-T., H. Wang, S. P. Harrison, I. C. Prentice, J. Ni, and G. Wang. 2015. Responses of leaf traits to climatic gradients: adaptive variation versus competitional shifts. Biogeosciences 12: 5339-5352

Additional unpublished morphometric data from Sandy Harrison and Colin Prentice

1. Site description

a. Site(s) type(s): desert, temperate steppe, temperate shrubland, and temperate deciduous woodland

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 48.19, 87.02, 272; 46.4, 85.94, 701; 47.04, 87.09, 620; 47.83, 86.85, 499; 47.94, 86.83, 481; 48.17, 87.08, 709; 48.11, 87.01, 1100;

48.33, 87.12, 1595; 48.33, 87.12, 1595; 47.72, 87.02, 498; 47.74, 87.54, 521; 47.16, 88.7, 750; 46.3, 89.55, 885; 45.36, 89.4, 1068; 44.12, 87.81, 513; 44.08, 87.79, 583; 44.07, 88.08, 852; 43.99, 88.06, 1060; 43.93, 88.11, 1430; 43.93, 88.11, 1430; 42.84, 89.44, -91; 42.73, 89.44, -136; 42.69, 89.42, -146; 42.37, 88.57, 1721; 42.22, 87.76, 1445; 41.81, 86.25, 1444; 40.51, 84.32, 931; 40.83, 84.29, 921; 41.48, 84.21, 928; 41.5, 84.51, 919; 41.66, 84.89, 902; 42.25, 88.23, 966; 43.9, 88.12, 1935; 40.51, 89.11, 70; 40.83, 84.29, 26

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: Only dominant species were sample at 19 sites; the remaining 16 sites were sampled for a limited number of key species. Details can be found in the 'Sites' table in the database

b. Variables included: Average LA, SLA, LMA, LDMC, Nmass, Narea, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere

c. Species sampled: *Agriophyllum squarrosum, Halogeton sp., Haloxylon ammodendron, Kalidium foliatum, Reaumuria soongarica, Salicornia europaea, Salsola sp., Suaeda microphylla, Amaranthus sp., Artemisia sp., Atriplex centralasiatica, Chenopodium iljinii, Chloris sp., Corispermum chinganicum, Cynoglossum divaricatum, Eragrostis minor, Halogeton glomeratus, Halostachys caspica, Nitraria roborowskii, Nitraria tangutorum, Salsola collina, Stipa sp., Sympegma regelii, Tribulus terrestris, Zygophyllum fabago, Ajania fruticulosa, Alhagi sparsifolia, Allium polyrhizum, Anabasis salsa, Astragalus sp., Ceratocarpus arenarius, Cleistogenes squarrosa, Krascheninnikovia ceratoides, Serratula marginata, Allium chrysanthum, Anabasis sp., Artemisia desertorum, Atraphaxis frutescens, Bassia dasyphylla, Kochia prostrata, Limonium sp., Limonium sp.1, Limonium sp.2, Nanophyton erinaceum, Pyrethrum sp., Setaria viridis, Suaeda salsa, unidentified chenopod, Xanthium strumarium, Aristida adscensionis, Asterothamnus centrali-asiaticus, Calligonum rubicundum, Ephedra intermedia, Saussurea epilobioides, Sonchus oleraceus, Artemisia scoparia, Asteraceae sp., Carex sp., Carlina biebersteinii, Chenopodiaceae sp.,* *Chenopodium sp., Chenopodium vulvaria, Dianthus chinensis, Dracocephalum sp., Echinops sp., Geranium sp., Polygonum aviculare, Achillea millefolium, Juniperus chinensis, Juniperus sabina var. sabina, Spiraea media, Larix sibirica, Cyperus sp., Erodium oxyrrhynchum, Fragaria pentaphylla, Meconopsis sp., Mentha sp.1, Mentha sp.2, Nepeta cataria, Polygonum sp., Potentilla sp., Stachys sp., Thymus mongolicus, Achnatherum splendens, Artemisia kanashiroi, Caragana microphylla, Cynanchum chinense, Myosotis asiatica, Nitraria sibirica, Plantago lanceolata, Polycnemum arvense, Senecio sp., Silene sp., Sophora alopecuroides, Sphaerophysa salsula, Peganum harmala, Suaeda prostrata, Anabasis truncata, Artemisia frigida, Haloxylon sp., Anabasis aphylla, Amaranthus retroflexus, Suaeda physophora, Tamarix sp., Poa annua, Solanaceae sp., Suaeda sp., Askellia flexuosa, Cirsium sp., Urtica cannabina, Euphorbia sp., Medicago sativa, Portulaca oleracea, Potentilla bifurca, Spiraea mongolica, Berberis amurensis, Corydalis pallida, Cotoneaster multiflorus, Populus euphratica, Rosa sp., Rumex sp., Ulmus pumila, Berberis sp., Karelinia caspia, Lycium ruthenicum, Phragmites australis, Tamarix hispida, Ephedra glauca, Zygophyllum kaschgaricum, Zygophyllum xanthoxylon, Brassicaceae sp., Suaeda heterophylla, unidentified forb, Myricaria sp., Anemone sp., Caltha palustris, Picea schrenkiana, Stellaria soongorica, Taraxacum sp., Trifolium sp., unknown sp., Viola sp., Ammopiptanthus mongolicus, Euonymus maackii, Poaceae sp. 1, Poaceae sp. 2*

3. Research methods

a. Year collected: 2005

b. Hard traits:

Hard traits were measured on samples collected in the field following standard methods (Cornelissen et al., 2011). At least 10 g of leaves were collected for each species, except for a few species with very small leaves at the driest sites, where at least 2 g of leaves were collected. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and nitrogen contents. The measurements used are averages of three replicates. Leaf area was determined by scanning three replicate sets of five leaves (or more in the case of small leaves, to make up a total area ≥ 20 cm2 per replicate) with a laser scanner. Areas (Average LA) were measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) is leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf leaf nitrogen content (Nmass) by the microkjeldahl method. Area-based leaf nitrogen contents (Narea) were derived by the database compilers as a product of mass based content and LMA.

c. Morphometric traits:

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

4. Study contacts: Jian Ni (nijian@vip.skleg.cn) and Sandy Harrison (s.p.harrison@reading.ac.uk)

Yunnan2012

Data from: Sandy Harrison, Jian Ni, Colin Prentice, Henrique Furstenau Togashi, Han Wang (Unpublished)

1. Site description

a. Site(s) type(s): tropical evergreen broadleaf forest, tropical shrubland, tropical deciduous broadleaf forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 21.92, 101.27, 502; 21.98, 101.24, 1075; 21.61, 101.58, 668; 21.62, 101.58, 828; 21.62, 101.58, 1034

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: A checklist of vascular species at each site was created, from which the common species were sampled.

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Nmass, Pmass, Kmass, Narea, Parea, Karea, d13C:12C, d15N:14N, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere, Amax_Photo, Amax_Gs, Amax_Ci:Ca, Amax_E, Amax_VPD, Amax_Tleaf, Amax_CO2, Asat_Photo, Asat_Gs, Asat_Ci:Ca, Asat_E, Asat_VPD, Asat_Tleaf, Asat_CO2, Vcmax, Jmax

c. Species sampled: *Acacia pennata, Aesculus lantsangensis, Ailanthus fordii, Albizia lucidior, Alstonia scholaris, Amischotolype hispida, Antiaris toxicaria, Ardisia virens, Baccaurea ramiflora, Barringtonia macrostachya, Bolbitis heteroclita, Canarium album, Castanopsis indica, Elatostema rupestre, Embelia vestita, Ficus auriculata, Ficus cyrtophylla, Ficus subulata, Garcinia cowa, Garuga floribunda var. gamblei, Justicia patentiflora, Knema cinerea var. glauca, Laurocerasus zippeliana, Leea compactiflora, Lepisanthes senegalensis, Macropanax decandrus, Magnolia henryi, Millettia leptobotrya, Parashorea chinensis, Pellacalyx yunnanensis, Phlogacanthus curviflorus, Phoebe lanceolata, Pittosporopsis kerrii, Poikilospermum lanceolatum, Pometia pinnata, Psychotria calocarpa, Psychotria henryi, Pterospermum menglunense, Sterculia brevissima, Stereospermum colais, Syzygium megacarpum, Tetrastigma cauliflorum, Vitex quinata, Xerospermum bonii, Ziziphus fungii, Actinodaphne henryi, Antidesma acidum, Aporosa yunnanensis, Balakata baccata, Benkara sinensis, Betula alnoides, Bridelia stipularis, Campylotropis pinetorum, Canthium horridum, Castanopsis argyrophylla, Castanopsis hystrix, Celastrus paniculatus, Choerospondias axillaris, Cibotium barometz, Crassocephalum crepidioides, Cratoxylum cochinchinense, Dalbergia pinnata, Dicranopteris ampla, Engelhardia spicata, Eurya pittosporifolia, Fordia cauliflora, Gnetum montanum, Ilex godajam, Leea indica, Meliosma arnottiana, Phoebe puwenensis, Sarcosperma arboreum, Saurauia yunnanensis, Schima wallichii, Smilax hypoglauca, Tarennoidea wallichii, Thysanolaena latifolia, Toddalia asiatica, Toona ciliata, Toxicodendron acuminatum, Trema tomentosa, Turpinia pomifera, Urena lobata, Acanthus leucostachyus, Alphonsea monogyna, Anthocephalus chinensis, Antidesma montanum, Boehmeria clidemioides, Byttneria aspera, Caesalpinia coriaria, Capparis fohaiensis, Cinnamomum bejolghota, Cleidion brevipetiolatum, Diospyros hasseltii, Diospyros nigrocortex, Duabanga grandiflora, Dysoxylum gotadhora, Elaeocarpus glabripetalus, Elaeocarpus rugosus, Hopea chinensis, Knema furfuracea, Knema globularia, Maesa permollis, Mitrephora tomentosa, Mycetia gracilis, Orophea creaghii, Ostodes katharinae, Phrynium placentarium, Saprosma ternatum, Sloanea tomentosa, Smilax zeylanica, Terminalia myriocarpa, Tetrastigma planicaule, Uncaria laevigata, Ardisia thyrsiflora, Beilschmiedia purpurascens, Castanopsis echinocarpa, Diospyros sp., Elaeocarpus sylvestris, Elaeocarpus varunua, Lithocarpus grandifolius, Lithocarpus sp., Litsea verticillata, Nephelium chryseum, Polyalthia simiarum, Syzygium oblatum, Actinodaphne obovata,* *Bauhinia erythropoda, Costus speciosus, Desmos yunnanensis, Ficus semicordata, Glochidion lanceolarium, Gnetum parvifolium, Goniothalamus griffithii, Lasianthus verticillatus, Lithocarpus auriculatus, Litsea monopetala, Melastoma malabathricum, Phoebe sheareri, Poikilospermum suaveolens, Pollia thyrsiflora, Sarcosperma kachinense var. simondii, Tabernaemontana corymbosa, Walsura pinnata*

3. Research methods

a. Year collected: 2012

b. Hard traits:

Hard traits were measured on samples collected in the field following standard methods (Cornelissen et al., 2011). At least 10 g of leaves were collected for each species. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and the contents of carbon, nitrogen, phosphorus and potassium. The measurements used are averages of three replicates. Leaf area was determined by scanning five leaves (or more in the case of small leaves, to make up a total area ≥ 20 cm^2 per species) with a laser scanner. Areas (Average leaf area) were measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) was expressed as leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf carbon content (Cmass) was measured by the potassium dichromate volumetric method (Slepetiene et al., 2008) and leaf nitrogen content (Nmass) by the microkjeldahl method (Bremner, 1960). Leaf phosphorus (Pmass) was analysed colorimetrically (Shimadzu UV-2550). Leaf potassium (Kmass) was measured by Flame Atomic Emission Spectrophotometry (PE 5100 PC). The area based leaf chemical contents (Carea, Narea, Parea, Karea) were derived as a product of mass based content and LMA. $\delta^{13}C$ (d13C:12C) and $\delta\delta^{15}N$ (d15N:14N) was measured using a Finnigan MAT DELTAplusXP Isotope Ratio Mass Spectrometer (Finnigan Corporation, San Jose, CA).

c. Morphometric traits:

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

d. Photosynthetic traits:

The light-saturated rate of net CO_2 fixation under ambient CO_2 (Asat_Photo) and the light-saturated rate of net CO_2 fixation at high CO_2 (Amax_Photo) were obtained from LiCor 6400 measurements in the field. The data on the conditions under which these measurements were made were also collected, such as vapour pressure deficit (Asat_VPD, Amax_VPD), leaf temperature (Asat_Tleaf, Amax_Tleaf), the ratio of leaf internal to ambient CO_2 (Asat_Ci:Ca, Amax_Ci:Ca), stomatal conductance (Asat_Gs, Amax_Gs) and transpiration rate (Asat_E, Amax_E).

4. Study contact: Han Wang (wanghan_sci@yahoo.com) and Sandy Harrison (s.p.harrison@reading.ac.uk)

Yunnan2013

Data from: Unpublished contribution from Sandy Harrison, Jian Ni, Colin Prentice, Shuangxi Zhou

1. Site description

a. Site(s) type(s): subtropical evergreen broadleaf forest, tropical shrubland, tropical grassland

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 24.54, 101.03, 2394; 24.54, 101.03, 2637; 24.5, 100.99, 2056; 23.69, 101.85, 758; 23.69, 101.86, 772

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: A checklist of vascular species at each site was created. Common species representing the structure of the whole community were sampled.

b. Variables included: Average LA, SLA, LMA, LDMC, Cmass, Carea, Nmass, Narea, d13C:12C, d15N:14N, Leaf texture, Leaf colour-adaxial, Leaf colour-abaxial, Leaf size, Leaf thickness, Leaf orientation, Leaf display, Leaf shape, Leaf margin, Leaf hairs, Leaf pubescence, Leaf pruinose, Leaf rugose, Leaf waxy, Leaf hypostomatic, Leaf revolute, Leaf involute, Leaf aromatic, Leaf fetid, Leaf driptip, Leaf terminal notch, Leaf surface patterning, Leaf succulence, Leaf spines, Leaf thorns, Leaf retention, Stem form, Stem colour, Stem photo, Stem hairy, Stem pubescent, Stem pruinose, Stem rugose, Stem succulent, Stem spines, Stem thorns, Bark deciduous, Spines elsewhere, Thorns elsewhere, Amax_Photo, Amax_Gs, Amax_Ci:Ca, Amax_E, Amax_VPD, Amax_Tleaf, Amax_CO2, Asat_Photo, Asat_Gs, Asat_Ci:Ca, Asat_E, Asat_VPD, Asat_Tleaf, Asat_CO2, Vcmax, Jmax

c. Species sampled: *Acer campbellii, Actinidia glaucocallosa, Ardisia crenata, Aucuba chlorascens, Camellia forrestii var. forrestii, Carex perakensis, Castanopsis wattii, Celastrus orbiculatus, Daphne papyracea var. papyracea, Disporum sessile, Dryopteris wallichiana, Eriobotrya bengalensis, Euonymus vagans, Eurya jintungensis, Fargesia wuliangshanensis, Gamblea ciliata var. evodiifolia, Ilex corallina, Ilex gintungensis, Illicium simonsii, impatiens rubrostriata, Lithocarpus hancei, Lithocarpus xylocarpus, Machilus gamblei, Machilus yunnanensis, Mahonia duclouxiana, Manglietia insignis, Neolitsea chuii, Plagiogyria pycnophylla, Rhododendron leptothrium, Rosa longicuspis, Rubus paniculatus, Schima noronhae, Stewartia pteropetiolata, Symplocos anomala, Symplocos ramosissima, Symplocos sumuntia, Ainsliaea spicata, Carex nemostachys, Clethra delavayi, Gaultheria griffithiana, Heterosmilax chinensis, Lithocarpus crassifolius, Lithocarpus grandifolius, Lyonia ovalifolia, Lyonia villosa, Pinus armandii, Rhododendron irroratum, Schefflera fengii, Schefflera shweliensis, Smilax menispermoidea, Stranvaesia davidiana, Symplocos dryophila, Ternstroemia gymnanthera, Vaccinium duclouxii, Acystopteris japonica, Alnus nepalensis, Anneslea fragrans, Camellia pitardii, Castanopsis fleuryi, Craibiodendron yunnanense, Dichroa febrifuga, Diplopterygium laevissimum, Eurya trichocarpa, Hypericum uralum, Isodon sculponiatus, Leucosceptrum canum, Lithocarpus dealbatus, Lithocarpus truncatus, Lyonia ovalifolia var. lanceolata, Maesa indica, Millettia dielsiana, Myrica esculenta, Pinus kesiya, Rhododendron microphyton, Rubus alceifolius, Schima argentea, Schima wallichii, Senecio scandens, Smilax ocreata, Tetrastigma serrulatum, Tripterygium wilfordii, Yushania multiramea, Albizia kalkora, Bothriochloa pertusa, Bridelia tomentosa, Buchanania latifolia, Cajanus scarabaeoides, Callicarpa nudiflora, Carissa spinarum, Cipadessa baccifera, Corallodiscus lanuginosus, Crotalaria linifolia, Dendrolobium triangulare, Dinetus racemosus, Diospyros yunnanensis, Fraxinus malacophylla, Geodorum densiflorum, Heteropogon contortus, Isodon amethystoides, Lannea coromandelica, Maytenus hookeri, Myriopteron extensum, Olea europaea subsp. cuspidata, Osteomeles schwerinae, Parthenocissus tricuspidata, Phyllanthus emblica, Pistacia weinmanniifolia, Polyalthia cerasoides, Setaria plicata, Symplocos racemosa, Tephrosia purpurea, Terminthia paniculata, Vitex negundo, Woodfordia fruticosa, Barleria cristata, Boea clarkeana, Bombax ceiba, Bridelia stipularis, Caesalpinia sappan, Campylotropis delavayi, Cryptolepis buchananii, Cyclobalanopsis helferiana, Eriobotrya prinoides, Eriolaena spectabilis,* *Garuga forrestii, Haldina cordifolia, Jasminum subhumile, Panicum sumatrense, Psidium guajava, Smilax ferox, Tarenna depauperata, Trema angustifolia, unknown sp.*

3. Research methods

a. Year collected: 2013

b. Hard traits:

Hard traits were measured on samples collected in the field following standard methods (Cornelissen et al., 2011). At least 10 g of leaves were collected for each species. Sunlit leaves of tree species were obtained with long-handled twig shears. The samples were subdivided for the measurement of specific leaf area, leaf dry matter content and the contents of carbon, nitrogen, phosphorus and potassium. The measurements used are averages of three replicates. Leaf area was determined by scanning five leaves (or more in the case of small leaves, to make up a total area ≥ 20 cm^2 per species) with a laser scanner. Areas (Average LA) were measured using Photoshop on the scanned images. Leaf fresh weight was measured in the field. Dry weight was obtained after air-drying for several days and then oven drying at 75 ˚C for 48 h. Leaf dry matter content (LDMC) was expressed as leaf oven-dry weight divided by fresh weight. Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. LMA is the inverse of SLA. Leaf carbon content (Cmass) was measured by the potassium dichromate volumetric method and leaf nitrogen content (Nmass) by the microkjeldahl method. The area based leaf chemical contents (Carea, Narea) were derived as a product of mass based content and LMA. $\delta^{13}C$ (d13C:12C) and $\delta^{15}N$ (d15N:14N) were measured using a Finnigan MAT DELTAplusXP Isotope Ratio Mass Spectrometer (Finnigan Corporation, San Jose, CA).

c. Morphometric traits:

All the morphometric traits were assessed in the field by the same two people (ICP, SPH) using a standardized reporting sheet.

d. Photosynthetic traits:

The light-saturated rate of net CO_2 fixation under ambient CO_2 (Asat_Photo) and the light-saturated rate of net CO_2 fixation at high CO_2 (Amax_Photo) were obtained from LiCor 6400 measurements in the field. The data on the conditions under which these measurements were made were also collected, including vapour pressure deficit (Asat_VPD, Amax_VPD), leaf temperature

(Asat_Tleaf, Amax_Tleaf), the ratio of leaf internal to ambient CO_2 (Asat_Ci:Ca, Amax_Ci:Ca), stomatal conductance (Asat_Gs, Amax_Gs) and transpiration rate (Asat_E, Amax_E).

4. Study contacts: Jian Ni (nijian@vip.skleg.cn), Han Wang (wanghan_sci@yahoo.com) and Sandy Harrison (s.p.harrison@reading.ac.uk)

Cai2009

Data from:

Cai Z.Q., S.A. Schnitzer and F. Bongers. 2009. Seasonal differences in leaf-level physiology give lianas a competitive advantage over trees in a tropical seasonal forest. *Oecologia* **161**: 25-33

1. Site description

a. Site(s) type(s): tropical seasonal forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 21.93, 101.25, 560

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: 18 evergreen C_3 liana species and 16 evergreen C_3 tree species were sampled. For each tree and liana species, 4 to 6 leaves were sampled from the same individual (2 to 3 individuals per species) at the end of both dry (March to April) and wet (September) seasons.

b. Variables included: Average LA, SLA, LMA, Nmass, Pmass, Narea, Parea, d13C:12C, Asat_Photo, Asat_Tleaf, Asat_CO2, Asat_VPD

c. Species sampled: *Baccaurea ramiflora, Barringtonia macrostachya, Bauhinia glauca, Bauhinia yunnanensis, Byttneria aspera, Callerya oosperma, Carallia brachiata, Castanopsis indica, Celastrus paniculatus, Combretum latifolium, Ficus auriculata, Ficus callosa, Ficus cyrtophylla, Ficus hirta, Ficus subulata, Ficus superba, Fissistigma polyanthoides, Fissistigma polyanthum, Gnetum parvifolium, Hopea chinensis, Iodes ovalis, Leea asiatica, Lepisanthes senegalensis, Litsea panamanja, Mayodendron igneum, Millettia dielsiana, Securidaca inappendiculata, Syzygium* *megacarpum, Tetrastigma planicaule, Tinomiscium petiolare, Uncaria macrophylla, Uncaria rhynchophylla, Ventilago calyculata, Ziziphus attopensis*

3. Research methods

a. Year collected: 2004

b. Hard traits:

Leaf area (Average LA) was measured with a leaf area meter (Li- 3000A; Li-Cor). Leaf dry mass and leaf mass area (LMA) or specific leaf area (SLA) was measured on leaves oven-dried for a minimum of 48 h at 70°C. Leaf samples were then ground for elemental analyses in the Biogeochemical Laboratory of the Kunming Division of the Xishuangbanna Tropical Botanical Garden, The Chinese Academy of Sciences. Leaf nitrogen concentration per unit leaf dry mass (Nmass) was determined using the semi-micro Kjeldahl wet digestion procedure. Leaf phosphorus concentration per unit leaf dry mass (Pmass) was measured by atomic absorption spectrum-photometry (AAS, Type 932GBC; ScientiWc Equipment, Australia). Area based leaf nitrogen and phosphorus contents (Narea, Parea) were derived by the database compilers as a product of mass based nutrient content and LMA. $\delta^{13}C$ (d13C:12C) of all species was measured on 2 mg grounded subsamples of leaves using a Thermo Finnigan MAT stable isotope mass spectrometer at the Stable Isotope Laboratory in Institute of Botany, The Chinese Academy of Sciences.

c. Photosynthetic traits

Branches of trees and the liana species from the upper canopy were collected using a tree pruner attached to a long handle between 9:30 and 11:00 a.m. Stems from the collected branches were cut under water within 10 minutes of collection and immersed in deionized water to maintain the xylem water column prior to photosynthesis measurement. Photosynthetic traits were measured on fully expanded, recently matured sun canopy leaves. The rate of CO_2 assimilation per unit area (Asat_Photo) under a light-saturating irradiance (Photon Xux density > 1,500 mol m^{-2} s^{-1}, provided by an internal red/blue LED light source; LI6400-02B) was measured under ambient CO_2 concentration (~380 ppm, Asat_CO2) with a portable photosynthetic system (Li-6400; LiCor, Lincoln, NE, USA). Leaf temperature and vapor pressure deficit in the cuvette were kept at 25–26°C (Asat_Tleaf) and less than 1 kPa (Asat_VPD), respectively.

4. Study contacts: Yanzheng Yang (yanzheng148@163.com)

Liu2010

Data from:

Liu G., G.T. Freschet, X. Pan, J. H. C. Cornelissen, Y. Li and M. Dong. 2010. Coordinated variation in leaf and root traits across multiple spatial scales in Chinese semi-arid and arid ecosystems. *New Phytologist* **188**: 543-553

1. Site description

a. Site(s) type(s): semi-arid and arid

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 36.42, 80.72, 1318; 44.37, 87.92, 1250; 37.45, 104.78, 500; 39.49, 110.2, 1290; 42.86, 115.89, 1240; 42.93, 120.69, 350; 49.48, 117.95, 550

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: Dominant species, representing 80–90% of total vascular plant biomass of the ecosystem, were sampled in each community. At least 10 individuals of each species were sampled (random sampling within 0.25 ha area) to account for intraspecific variation. All living leaves were collected while fully mature and before the onset of senescence.

b. Variables included: SLA, LMA, Nmass, Narea

c. Species sampled: *Agriophyllum squarrosum, Artemisia sp., Bassia dasyphylla, Calligonum mongolicum, Corispermum heptapotamicum, Halogeton glomeratus, Krascheninnikovia ceratoides, Reaumuria soongarica, Salsola kali subsp. ruthenica, Sympegma regelii, Zygophyllum xanthoxylon, Astragalus oxyglottis, Ceratocarpus arenarius, Eragrostis minor, Horaninovia ulicina, Nitraria sibirica, Petrosimonia sibirica, Salsola sp.a, Salsola sp.b, Salsola sp.c, Seriphidium terrae-albae, Stipagrostis pennata, Allium mongolicum, Artemisia capillaris, Artemisia ordosica, Cleistogenes songorlca, Lespedeza davurica, Salsola laricifolia, Salsola passerina, Stipa tianschanica, Artemisia sphaerocephala, Astragalus melilotoides, Caragana korshinskii, Cleistogenes squarrosa, Corispermum mongolicum, Cynanchum thesioides, Dysphania aristata, Euphorbia humifusa, Ixeridium gracile, Oxytropis racemosa, Poa annua, Setaria viridis, Agropyron cristatum,* *Agropyron desertorum, Agropyron mongolicum, Artemisia frigida, Artemisia halodendron, Artemisia scoparia, Calamagrostis epigejos, Chenopodium acuminatum, Inula britannica, Potentilla acaulis, Salsola collina, Thalictrum squarrosum, Thymus mongolicus, Caragana microphylla, Echinochloa crus-galli, Lespedeza juncea, Medicago ruthenica, Sophora flavescens, Hedysarum fruticosum, Oxytropis hailarensis, Rhodiola rosea*

3. Research methods

a. Year collected: 2008

b. Hard traits:

Ten leaves were scanned individually at 300 dpi resolution for each plant species using a BenQ 5550 scanner, then oven-dried (60°C, 48 h) and weighed. Scanned leaves were analysed using IMAGE J software (http://rsbwebnih.gov/ij/) to obtain the leaf area (LA). Specific leaf area (SLA) was then expressed as the ratio between leaf area and leaf dry mass. Leaf mass per area (LMA) is the inverse of SLA. Leaf nitrogen concentration (Nmass) was measured with Kjeldahl determination (BUCHI AutoKjeldahl Unit K-370) from air-dried sub-samples, which were first ground and subsequently oven-dried for 24 h at 60°C. Area-based leaf nitrogen content (Narea) was derived by the database compilers as a product of Narea and LMA.

4. Study contacts: Yanzheng Yang (yanzheng148@163.com)

Sun2006

Data from:

Sun S., D. Jin, R. Li. 2006. Leaf emergence in relation to leaf traits in temperate woody species in East-Chinese Quercus fabri forests. *Acta Oecologica* **30**: 212-222

1. Site description

a. Site(s) type(s): subtropical decidous broadleaf forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 32.07, 118.82, 130; 32.05, 118.83, 130

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics: All woody dicotyledonous species were sampled at each site. Non-shaded mature individuals within the canopy were sampled for tree species. Mature individuals were sampled for shrub species, but no attempt was made to screen for light attenuation above the plant crown.

b. Variables included: Average LA, SLA, LMA

c. Species sampled: *Acer buergerianum, Acer tataricum subsp. ginnala, Broussonetia papyrifera, Celtis sinensis, Dalbergia hupeana, Diospyros lotus, Flueggea suffruticosa, Grewia biloba, Ligustrum lucidum, Ligustrum quihoui, Lindera angustifolia, Lindera glauca, Liquidambar formosana, Maclura tricuspidata, Morus alba, Pistacia chinensis, Platycarya strobilacea, Pueraria montana var. lobata, Quercus fabrei, Rhamnus crenata, Rosa multiflora, Rubus parvifolius, Smilax china, Symplocos paniculata, Ulmus parvifolia, Vitex negundo, Wisteria sinensis, Aphananthe aspera, Diospyros kaki, Elaeagnus multiflora, Euonymus alatus, Euscaphis japonica, Firmiana simplex, Kalopanax septemlobus, Lonicera japonica, Magnolia denudata, Ohwia caudata, Photinia parvifolia, Premna microphylla, Quercus variabilis, Rhamnus globosa, Rhus chinensis, Rubus swinhoei, Serissa serissoides, Viburnum dilatatum*

3. Research methods

a. Year collected: 2002

b. Hard traits:

More than 50 mature and healthy leaves were sampled for each species. The leaves were scanned and their areas (LA) calculated using MapInfo software. The leaves were oven-dried to constant dry mass at 70 °C. Leaf mass per area (LMA) was calculated by dividing leaf dry mass by leaf area. Specific leaf area (SLA) is the inverse of LMA.

4. Study contacts: Yanzheng Yang (yanzheng148@163.com)

Zheng2007

Data from:

Zheng S. X. and Z. P. Shangguan. 2007a. Spatial patterns of foliar stable carbon isotope compositions of C_3 olant species in the Loess Plateau of China. *Ecological Research* **22**: 342-353.

Zheng S. X. and Z. P. Shangguan. 2007b. Spatial patterns of photosynthetic characteristics and leaf physical traits of plants in the Loess Plateau of China. *Plant Ecology* **191**: 279-293.

1. Site description

a. Site(s) type(s): north subtropical humid evergreen broadleaf forest

b. Geography

Latitude (˚N), longitude (˚E), altitude (m above sea level): 36.77, 109.25, 1125; 36.07, 108.53, 1353; 37.85, 110.17, 1103; 33.43, 108.43, 1614; 38.78, 110.35, 1255; 35.05, 109.13, 1324; 34.27, 108.07, 468; 34.82, 108.03, 1454

c. Site(s) history: natural vegetation

2. Experimental or sampling design

a. Design characteristics:

Representative examples of trees, shrubs, and herbs were sampled. Field measurements were made between 09:00 and 11:30 h on clear days in June 2005. The measured leaves were mostly from the ends of branches in the lower canopy, but about 8 cm below the topmost surface of the shrubs and herbaceous plants. Photosynthetic measurements were made on three or four mature and fully expanded sunlit leaves from 10 individuals of each species. These leaves were then collected for measurements of other traits.

b. Variables included: SLA, LMA, Nmass, Narea, d13C:12C, Asat_Photo, Asat_Tleaf, Asat_CO2

c. Species sampled: *Acer truncatum, Agropyron cristatum, Amorpha fruticosa, Artemisia gmelinii, Artemisia subdigitata, Berberis amurensis, Caragana korshinskii, Carex lanceolata, Cornus macrophylla, Cotoneaster acutifolius, Euphorbia humifusa, Forsythia suspensa, Hippophae rhamnoides, Imperata cylindrica var. major, Lespedeza davurica, Lonicera hispida, Periploca sepium, Pinus tabuliformis, Populus simonii, Potentilla acaulis, Prinsepia uniflora, Pulsatilla chinensis, Pyrus betulifolia, Robinia pseudoacacia, Rosa hugonis, Rubus parvifolius, Sophora davidii, Spiraea pubescens, Syringa oblata, Thalictrum simplex, Ulmus davidiana var. japonica,* *Ulmus pumila, Xanthoceras sorbifolium, Ziziphus jujuba var. spinosa, Acer erianthum, Acer tataricum subsp. ginnala, Artemisia giraldii, Betula platyphylla, Bothriochloa ischaemum, Elaeagnus pungens, Eleutherococcus senticosus, Glycyrrhiza uralensis, Ostryopsis davidiana, Platycladus orientalis, Populus davidiana, Prunus davidiana, Prunus setulosa, Pyrus pyrifolia, Quercus wutaishanica, Smilax vaginata, Sorbus hupehensis var. aperta, Astragalus adsurgens, Cynanchum mongolicum, Lespedeza bicolor, Medicago sativa, Melilotus albus, Themeda triandra, Wikstroemia chamaedaphne, Ampelopsis aconitifolia, Anemone vitifolia, Artemisia argyi, Axyris amaranthoides, Berberis circumserrata, Betula utilis, Clematis obscura, Consolida ajacis, Cornus kousa subsp. chinensis, Cornus officinalis, Corylus heterophylla, Elaeagnus glabra, Lespedeza cyrtobotrya, Lonicera japonica, Medicago lupulina, Onobrychis viciifolia, Paederia foetida, Pinus bungeana, Potentilla fruticosa, Potentilla multicaulis, Quercus acutissima, Quercus aliena var. acutiserrata, Rubus innominatus, Setaria viridis, Thalictrum baicalense, Thalictrum foeniculaceum, Vaccaria hispanica, Salix miyabeana, Prunus pilosiuscula, Tilia mongolica, Atriplex littoralis, Diospyros kaki, Lonicera chrysantha var. koehneana, Populus hopeiensis, Rhamnus arguta*

3. Research methods

a. Year collected: 2005

b. Hard traits:

The projected leaf area was measured with a planimeter (LI-3000A) and the dry mass was measured after the leaves had been oven-dried at 70°C for at least 48 h to a constant mass. The leaf mass per area (LMA) was computed as the ratio of leaf dry mass to leaf area (LA). Specific leaf area (SLA) is the inverse of LMA. The dried leaf samples from each species were combined for chemical analysis; the leaves were ground to a uniformly fine powder with a plant sample mill (1093 Sample Mill), and then sieved with a 1 mm-mesh screen before chemical analysis. A 200 mg sample was used to determine the leaf nitrogen concentration by the modified Kjeldahl method. The digests were used to determine the N concentration (Nmass) with a Kjeltec analyzer (Kjeltec 2300 Analyzer Unit). Area-based N concentration (Narea) was calculated as the product of Nmass and LMA. $\delta^{13}C$ (d13C:12C) was measured on all species using a MAT-251 stable isotope mass spectrometer (Finnigan, San Jose, USA) in the State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences.

c. Photosynthetic traits:

The light-saturated photosynthetic rates (Asat_photo) of the fully expanded leaves of the plant species were measured with an open gas-exchange system (LI-6400, Li-Cor) and 2 by 3 cm broadleaf chamber with integrated light source (LI-6400-02B, Li-Cor). During the measurements, the leaf chamber temperature (Asat_Tleaf) was kept at 25°C, the vapor pressure deficit in the chamber was <1.0 kPa, the CO_2 concentration (Asat_CO2) was set to 390 ppm in the chamber, and the leaves were exposed to a photosynthetic photon flux density (PPFD) of 1800 lmol m^{-2} s^{-1} with the light source. The PPFD was light saturated for all the species measurements. The Asat_Photo was measured 3 min after the rates of photosynthesis and transpiration had become stable.

4. Study contacts: Yanzheng Yang (yanzheng148@163.com)

CLASS III. DATA SET STATUS AND ACCESSIBILITY

A. Status

Latest update: Version 1 of this database described and submitted with this manuscript was processed on 2017-09-05.

Latest archive date

2017-09-05

Metadata status: Metadata are complete to the submitted data.

Data verification:

Nearly **75%** of the sites were sampled by the same team and following standardized measurement protocols. The remaining data were extracted from the literature, but only in cases where the publication provided both an adequate description of the sampling protocol and methods, the individual sites could be accurately located, and where the primary data were provided in Tables.

A number of quality checks were applied to the original data. The largest effort was expended on standardizing the taxonomy (see detailed explanation in subproject Taxonomic Standardization). Quality control procedures were also applied to ensure that units were standardized and reported correctly. We checked individual data types for outliers by plotting the measurements. We also compared the ranges of measurements against expected ranges. We cross-checked for inconsistencies between different measurements, including e.g. comparing scanned measurements of leaf area and field-based CLAMP classifications of leaf area. In most cases where we identified outliers or discrepancies, these issues could be resolved by checking field records or original data sheets. In a few cases, these inconsistencies and/or errors were present in the field records – these doubtful measurements have been removed from the database.

Apart from the data directly collected from the field measurements, some site-specific, species-specific or sample-specific variables were derived systematically by the compilers of database, including species taxonomy, photosynthetic capacities, photosynthetic pathway, plant functional types, vegetation and climate. The method used to derive these variables are described under the respective sub-projects. These variables are thus consistent between sites and make the comparison among sites from different sources plausible.

B. Accessibility

Storage location and medium: The data are stored as the China Plant Trait Database (v1.0) in PANGAEA (https://doi.pangaea.de/10.1594/PANGAEA.871819). Development versions of the dataset will continue to be made available.

Contact persons: Queries about individual specific data points can be directed to the contributing author for that study. For queries about the entire dataset, please contact Han Wang.

Copyright restrictions: The dataset is released under a Creative Commons BY licence. When using the dataset, we kindly request that you cite this article, recognizing the hard work that went into collecting the data and the authors' willingness to make it publicly available.

Costs: None.

CLASS IV. DATA STRUCTURAL DESCRIPTORS

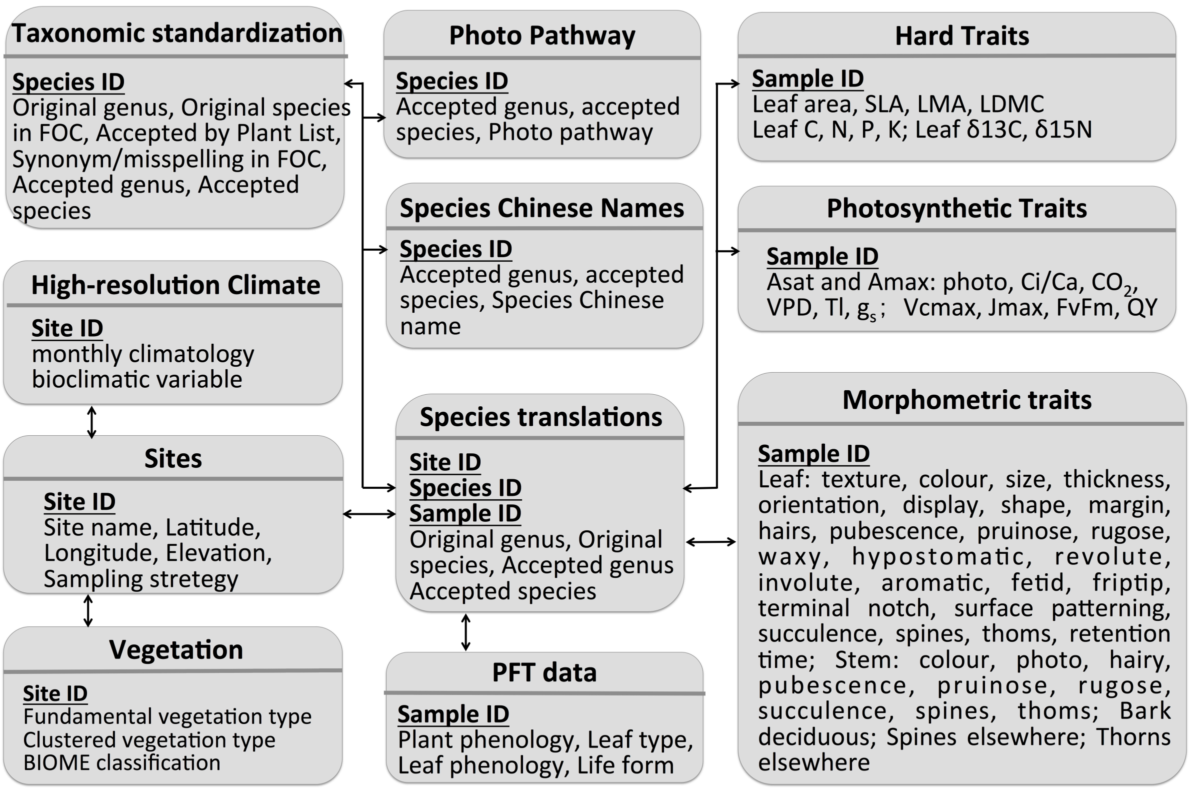
A. Data Set Files

The data are stored a relational database (ACCESS), which is consist of **11** linked tables. Specifically: Sites, Taxonomic Corrections, Species Translations, Chinese Names, Photo Pathway, PFT Data, Morphometric Data, Leaf Hard Traits, Photosynthesis Measurements, Climate Data, Vegetation Data. Figure 4 shows the relationships between these tables, allowing the database to be reconstructed. A detailed description of each of the tables is given below.

Figure 4: The structure of the database, showing the individual component tables and the relationships between these tables

These elements are available as

1. An ACCESS database file
2. a series of csv files.



B. Variable definitions

Table 2: Definitions of the variables included in each of the 11 database tables.

Table Name	**Field label**	**Definition**	**Format**
Sites	Site ID	Unique code identifying each site	Numeric
	Site Name	Site name as given by original authors or as defined by us where there was no unique name given to the site	Text

	Latitude	Latitude in decimal degrees	Numeric
	Longitude	Longitude in decimal degrees	Numeric
	Elevation	Elevation in meters above sea level	Numeric
	Collection month	Month of sampling	Numeric
	Collection year	Year of sampling	Numeric
	Source	Contact person or publication	Text
	Sampling strategy	Method used for sampling, where SS is stratified sampling, PSS is sampling of a limited number of strata, D is sampling of dominant species only, and A is sampling of a limited number of key species at a site.	Text
Taxonomic Standardization	Original genus	Genus as recorded in the field	Text
	Original species	Species as recorded in the field	Text
	Accepted by FoC	Whether taxon is recognized and accepted according to the Flora of China (FoC), recorded as either yes or no	Text
	Accepted by PL	Whether taxon is recognized and accepted according to the Plant List (PL), recorded as either yes or no	Text

	PL synonym	Whether there is one or more synonyms for the accepted taxon given in the Plant List, recorded as either yes or no	Text
	FoC synonym/mis-spelling	Whether the synonym(s) listed in the Plant List are listed as an accepted name in FoC	Text
	Decision	Decision about which version of the name to use in the database, where priority is given to accepted names in FoC and alternatives are only used if there is no accepted name following the allocation scheme described in Figure 3.	Text
	Taxonomic notes	Additional information on taxonomy, including e.g. identification of mis-spellings in FoC, information about the number of synonyms etc	Text
	Accepted genus	Genus name determined through taxonomic checking	Text
	Accepted species	Species name determined through taxonomic checking	Text
	Family	Assignment of the taxon to the higher taxonomic grouping of family	Text
	Species ID	Unique identifier for each species in the database	Text
Species	Site ID	Unique code identifying each site	Numeric

Translations			
	Original genus	Genus name recorded in the field	Text
	Original species	Species name recorded in the field	Text
	Accepted genus	Genus name determined through taxonomic checking	Text
	Accepted species	Species name determined through taxonomic checking	Text
	Species ID	Unique identification of each species, used in species-specific data tables (e.g. Photo Pathway)	Text
	Sample ID	Unique identification of each species for which there are records, i.e. every species at each site	Numeric
Chinese names	Species ID	Unique identification of each species, used in species-specific data tables (e.g. Photo Pathway)	Text
	Accepted genus	Genus name determined through taxonomic checking	Text
	Accepted species	Species name determined through taxonomic checking	Text
	Chinese name	Name of accepted species in Chinese characters	Text
Photo pathway	Species ID	Unique identification of each species,	Text

	Photo Path	Photosynthetic pathway (C_3, C_4 or CAM)	Text
PFT data	Sample ID	Unique identification of each species for which there are records, i.e. every species at each site	Numeric
	Life form	Assignment to life form (tree, small tree, low to high shrub, erect dwarf shrub, prostrate dwarf shrub, liana, climber, forb, cushion forb, rosette forb, graminoid, bamboo, cycad, geophyte, stem succulent, succulent, pteridophyte, epiphyte, parasite)	Text
	Plant phenology	Description of longevity of the plant itself (perennial, biennial or annual)	Text
	Leaf type	Description of leaf type (aphyllous, broad, needle, scale)	Text
	Leaf phenology	Assignment based on longevity of leaves for woody plants (deciduous, semi-deciduous, leaf-exchanger, evergreen)	Text
Morphometric data	Sample ID	Unique identification of each species for which there are records, i.e. every species at each site	Numeric
	Leaf texture	Description of the texture of a leaf, particularly as related to flexibility and/or toughness as distinct from surface characteristics. Six classes are recognized: fleshy, papery, malacophyll, leathery,	Text

		coriaceous, rigidly coriaceous	
	Leaf colour - adaxial	The colour of the upper surface of the leaf (i.e. the surface facing the stem) e.g. bright green, green, dark green, mottled green, pale green, glaucous, yellow-green, yellow, silvery-grey	Text
	Leaf colour - abaxial	The colour of the lower surface of the leaf (i.e. the surface facing the stem) e.g. bright green, green, dark green, mottled green, pale green, brown-green, glaucous, yellow-green, pale brown, purple, reddish-green, white, yellow, silvery-grey	Text
	Leaf size	Categorical classification of typical leaf size as estimated using the modified CLAMP scheme (pico, lepto, nano, micro, noto, meso, macro)	Text
	Leaf thickness	Categorical classification of typical leaf thickness, approximately where thick is >2mm, medium (0.5-2mm), thin (<0.5mm)	Text
	Leaf orientation	Categorical description of the angle of the individual leaf with respect to the stem (erect, semi-erect, patent, pendulous, reclinate)	Text
	Leaf display	Organisation of leaves within the individual plant canopy, either 2D or 3D	Text

	Leaf shape	Description of the shape of the leaf blade (or leaflet in the case of compound leaves) shape (acicular, cordate, deltoid, elliptic, falcate, hastate, lanceolate, linear, lyrate, obcordate, oblanceolate, oblong, obovate, orbicular, oval, ovate, reniform, runcinate, sagittate, spatulate, cordate-lanceolate, elliptic-lanceolate, linear-lanceolate, ovate-lanceolate, fishtail, palmate, pinnatifid, rhomboid, tulip-shaped, trilobite, quinquilobate, septemlobate)	Text
	Leaf margin	Description of the nature of the margin of the leaf of leaflet (entire, finely toothed, toothed, crenate, crenulate, lobed, dissected, highly dissected, incised)	Text
	Leaf hairs	Indication of presence or absence of hairs on the leaf; if hairs are present, the location is also recorded (adaxial, abaxial, on midrib or veins, marginal, basal)	Text
	Leaf pubescence	Indication of presence or absence of very fine hairs or pubescence on the leaf; if present, the location is also recorded (adaxial, abaxial, on midrib or veins, marginal)	Text
	Leaf pruinosity	Indication of presence or absence of a bloom or powdery secretion that can be removed mechanically on the leaf; if present, the location is also recorded	Text

		(adaxial, abaxial, on midrib or veins)	
	Leaf rugose	Indication of presence or absence of surface roughness caused by surface protrusions on a leaf; if present, the location is also recorded (adaxial, abaxial, on midrib or veins)	Text
	Leaf waxy	Indication of whether or not there is a continuous waxy deposit on the surface of the leaf. A distinction was made in the field between waxy and glossy surfaces, presumed to reflect differences in the structure of this epicuticular layer (waxy, glossy, no wax)	Text
	Leaf hypostomatic	Indication of whether stomata were present only on the abaxial side of the leaf	Text
	Leaf revolute	Indication of whether the leaf margin was curled downwards toward the underside of the leaf. A distinction was made between leaves that showed slight and pronounced curling. (yes, slightly, no)	Text
	Leaf involute	Indication of whether the leaf margin was curled toward the upperside of the leaf. A distinction was made between leaves that showed slight and pronounced curling. (yes, slightly, no)	Text
	Leaf aromatic	Indication of whether the leaves contain aromatic compounds, assessed from the smell of the leaves when broken in the	Text

		field	
	Leaf fetid	Indication of whether the leaves have a rank or unpleasant smell when broken in the field	Text
	Leaf driptip	Presence/absence of an elongated and downward oriented extension at the tip of the leaf or leaflet blade, assumed to relate to removal of excess water	Text
	Leaf terminal notch	Presence/absence of a notch or narrow cleft at the tip of the leaf or leaflet blade	Text
	Leaf succulence	Indication of whether the leaf stores water, assessed from whether the leaves are thick and fleshy and whether water is released when the leaf is broken. A distinction is made in the field between slightly succulent (swollen) leaves and truly succulent leaves (yes, slightly, no)	Text
	Leaf spines	Presence/absence of leaf spines; if spines are present, the location is also recorded (adaxial, abaxial, on midrib or veins, marginal, terminal)	Text
	Leaf thorns	Presence/absence of leaf thorns; if thorns are present, the location is also recorded (adaxial, abaxial, on midrib or veins, marginal, terminal)	Text
	Leaf retention	An estimate of the length of time evergreen leaves are retained and	Number

	time	functioning, based on counting the number of cohorts using scarring or branching of the shoots to identify cohorts. The estimate is made in whole years, and is records as <1 for annually-deciduous trees.	
	Stem form	Description of the appearance of the stem, in terms of shape, and/or the presence of protuberances, attachments, or markings (non-distinctive, triangular, quadrangular, winged, ridged, corky, leaves attached directly, deciduous sheath, white lines, white spots)	Text
	Stem colour	Description of the base colour of the stem (black, dark brown, brown, pale brown, green-brown, grey-brown, green-brown, red-brown, dark green, green, pale green, green-purple, yellow-green, red-green, glaucous, silver-grey, grey, yellow, purple, red)	Text
	Stem photo	Indication of whether the stem is photosynthetic or not	Text
	Stem hairy	Indication of presence or absence of hairs on the stem; if present, the density is also records (yes, finely, no)	Text
	Stem pubescent	Indication of presence or absence of very fine hairs or pubescence on the stem; if present, the density is also records (yes,	Text

		finely, no)	
	Stem pruinose	Indication of presence or absence of a bloom or powdery secretion that can be removed mechanically on the leaf	Text
	Stem rugose	Indication of presence or absence of a rough surface caused by protuberances	Text
	Stem succulent	Indication of presence or absence of water-retention in the stem	Text
	Stem spines	Presence/absence of spines on the stem; where spines are defined as for leaves	Text
	Stem thorns	Presence/absence of thorns on the stem; where thorns are defined as for leaves	Text
	Bark deciduous	Indication of whether the bark is shed on a regular basis; bark shedding as a result of specific damage (e.g. insect attack, fire damage) is not taken into consideration. If the bark is deciduous, the way in which bark is detached is recorded (non-deciduous, chunk, strip, fissured).	Text
	Spines elsewhere	Presence/absence of spines on the trunk or major branches; where spines are defined as for leaves	Text
	Thorns elsewhere	Presence/absence of thorns on the trunk or major branches; where thorns are defined as for leaves	Text

Hard traits	Sample ID	Unique identification of each species for which there are records, i.e. every species at each site	Numeric
	Average LA	Average leaf area (m^2)	Numeric
	SLA	Specific leaf area (m^2/kg)	Numeric
	LMA	Leaf mass per unit area (kg/m^2)	Numeric
	LDMC	Leaf dry matter content (mg/g)	Numeric
	Cmass	Leaf carbon content (g/kg)	Numeric
	Nmass	Leaf nitrogen content (g/kg)	Numeric
	Pmass	Leaf phosphorus content (g/kg)	Numeric
	Kmass	Leaf potassium content (g/kg	Numeric
	Narea	Leaf nitrogen content per unit area (g/m^2)	Numeric
	Parea	Leaf phosphorus content per unit area (g/m^2)	Numeric
	Karea	Leaf potassium content per unit area (g/m^2)	Numeric
	d13C:12C	The ratio of ^{13}C to ^{12}C stable isotopes in the leaf (unitless)	Numeric
	d15N:14N	The ratio of ^{15}N to ^{14}N stable isotopes in the leaf (unitless)	Numeric

Photo Traits	Sample ID	Unique identification of each species for which there are records, i.e. every species at each site	Numeric
	Amax_Photo	Rate of photosynthesis under light and CO_2 saturation (umol/m^2/s)	Numeric
	Amax_Gs	Stomatal conductance to water at which Amax was measured (mol/m^2/s)	Numeric
	Amax_Ci:Ca	Ratio of internal to external CO_2 when Amax was measured (unitless)	Numeric
	Amax_E	Respiration rate when Amax was measured (mmol/m^2/s)	Numeric
	Amax_VPD	The vapour pressure deficit at which Amax was measured (kPA)	Numeric
	Amax_Tleaf	The temperature at which Amax was measured (˚C)	Numeric
	Amax_CO2	The CO_2 level at which Amax was measured (ppm)	Numeric
	Asat_Photo	Rate of photosynthesis under light saturation (umol/m^2/s)	Numeric
	Asat_Gs	Stomatal conductance to water at which Asat was measured (mol/m^2/s)	Numeric
	Asat_Ci:Ca	Ratio of internal to external CO_2 when Asat was measured	Numeric

	Asat_E	Respiration rate when Asat was measured (mmol/m^2/s)	Numeric
	Asat_VPD	The vapour pressure deficit at which Amax was measured (kPa)	Numeric
	Asat_Tleaf	The temperature at which Asat was measured (˚C)	Numeric
	Asat_CO2	The CO_2 level at which Asat was measured (ppm)	Numeric
	Vcmax	carboxylation capacity (umol/m^2/s)	Numeric
	Jmax	electron-transport capacity (umol/m^2/s)	Numeric
	Fv:Fm	Potential rate of photosynthetic electron transport (F_v/F_m) as measured by chlorophyll fluorescence	Numeric
	QY	Actual rate of photosynthetic electron transport (QY) as measured by chlorophyll fluorescence	Numeric
Climate data	Site ID	Unique code identifying each site	Numeric
	Lat_grid	Latitude of the centre of the 1 km gridded climatology used to obtain climate data for each site; note this does not correspond exactly to the latitude of the site (˚).	Numeric
	Long_grid	Longitude of the centre of the 1 km gridded climatology used to obtain	Numeric

		climate data for each site; note this does not correspond exactly to the latitude of the site (˚).	
	Temp Jan	Mean January temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Feb	Mean February temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Mar	Mean March temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp April	Mean April temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp May	Mean May temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp June	Mean June temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp July	Mean July temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Aug	Mean August temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Sep	Mean September temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Oct	Mean October temperature as obtained from the 1 km gridded climatology (˚C)	Numeric

	Temp Nov	Mean November temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Temp Dec	Mean December temperature as obtained from the 1 km gridded climatology (˚C)	Numeric
	Prec Jan	Mean January precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Feb	Mean February precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Mar	Mean March precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec April	Mean April precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec May	Mean May precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec June	Mean June precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec July	Mean July precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Aug	Mean August precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Sep	Mean September precipitation as obtained from the 1 km gridded climatology (mm)	Numeric

	Prec Oct	Mean October precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Nov	Mean November precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Prec Dec	Mean December precipitation as obtained from the 1 km gridded climatology (mm)	Numeric
	Sunh Jan	Mean January sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Feb	Mean February sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Mar	Mean March sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh April	Mean April sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh May	Mean May sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible	Numeric

		sunshine hours (%)	
	Sunh June	Mean June sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh July	Mean July sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Aug	Mean August sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Sep	Mean September sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Oct	Mean October sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	Sunh Nov	Mean November sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric

	Sunh Dec	Mean December sunshine hours as obtained from the 1 km gridded climatology and expressed as a percentage of total possible sunshine hours (%)	Numeric
	MTCO	Mean temperature of the coldest month (˚C)	Numeric
	MAT	Mean annual temperature (˚C)	Numeric
	MI	Ratio of actual evapotranspiration to precipitation (unitless)	Numeric
	alpha	Ratio of actual to equilibrium evapotranspiration, or α (unitless)	Numeric
	GDD0	Growing degree days above a baseline of 0°C (° days)	Numeric
	mGDD0	Daily mean temperature during the growing season when temperatures are >0°C (°C)	Numeric
	PAR0	Total annual photosynthetically active radiation (mol photon m^{-2})	Numeric
	mPAR0	Daily mean photosynthetically active radiation during the growing season when temperatures are >0°C (mol photon m^{-2})	Numeric
	Prec timing	The timing of peak precipitation, expressed as a vector where January 1st is	Numeric

		arbitrarily set to an angle of 0°	
	Prec season	The seasonality of precipitation, where 0 means that precipitation is equally distributed in every month of the year and 1 means that precipitation is concentrated in one month of the year (unitless)	Numeric
	MMP	Mean monthly precipitation (mm)	Numeric
	MAP	Mean annual precipitation (mm)	Numeric
Vegetation data	Site ID	Unique code identifying each site	Numeric
	Fundamental vegetation type	Vegetation type at the site as given in the digital vegetation map of China	Text
	Clustered vegetation type	Vegetation type at the site as given by Wang et al. (2013)	Text
	Biome classification	Description of the biome represented at the site, based on field descriptions or the dominant plant functional types represented	Text

Table 3: The total number of trait measurements available for key traits.

Trait	**Level (for measurement)**	**Number of measurements**
Photo Path	species	**1008**
Life form	samples	**2522**
Plant phenology	samples	**2522**

Leaf type	samples	**2522**
Leaf phenology	samples	**2522**
Leaf texture	samples	**1932**
Leaf colour - adaxial	samples	**1952**
Leaf colour - abaxial	samples	**1953**
Leaf size	samples	**1929**
Leaf thickness	samples	**1874**
Leaf orientation	samples	**1916**
Leaf display	samples	**1902**
Leaf shape	samples	**1803**
Leaf margin	samples	**1876**
Leaf hairs	samples	**1859**
Leaf pubescence	samples	**1859**
Leaf pruinose	samples	**1859**
Leaf rugose	samples	**1881**
Leaf waxy	samples	**1881**
Leaf hypostomatic	samples	**1881**
Leaf revolute	samples	**1881**
Leaf involute	samples	**1881**
Leaf aromatic	samples	**1881**
Leaf fetid	samples	**1881**

Leaf driptip	samples	**1881**
Leaf terminal notch	samples	**1881**
Leaf succulence	samples	**1881**
Leaf spines	samples	**1883**
Leaf thorns	samples	**1883**
Leaf retention time	samples	**93**
Stem form	samples	**1870**
Stem colour	samples	**1869**
Stem photo	samples	**1870**
Stem hairy	samples	**1870**
Stem pubescent	samples	**1869**
Stem pruinose	samples	**1870**
Stem rugose	samples	**1870**
Stem succulent	samples	**1870**
Stem spines	samples	**1870**
Stem thorns	samples	**1870**
Bark deciduous	samples	**1975**
Spines elsewhere	samples	**1875**
Thorns elsewhere	samples	**93**
Average LA	samples	**1983**
SLA	samples	**2119**

LMA	samples	**2119**
LDMC	samples	**1607**
Cmass	samples	**1391**
Nmass	samples	**1889**
Pmass	samples	**1263**
Kmass	samples	**1122**
Narea	samples	**1880**
Parea	samples	**1260**
Karea	samples	**1119**
d13C:12C	samples	**987**
d15N:14N	samples	**726**
Amax_Photo	samples	**405**
Amax_Gs	samples	**405**
Amax_Ci:Ca	samples	**405**
Amax_E	samples	**405**
Amax_VPD	samples	**405**
Amax_Tleaf	samples	**405**
Amax_CO2	samples	**405**
Asat_Photo	samples	**599**
Asat_Gs	samples	**423**
Asat_Ci:Ca	samples	**423**

Asat_E	samples	**423**
Asat_VPD	samples	**423**
Asat_Tleaf	samples	**599**
Asat_CO2	samples	**598**
Vcmax	samples	**560**
Jmax	samples	**405**
Fv:Fm	samples	**475**
QY	samples	**477**

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Literature Cited

Akhani, H., P. Trimborn, and H. Ziegler. 1997. Photosynthetic pathways in Chenopodiaceae from Africa, Asia and Europe with their ecological, phytogeographical and taxonomical importance. *Plant Systemics and Evolution* **206**: 187. doi:10.1007/BF00987948

Atia, A., M. Rabhi, A. Debez, C. Abdelly, H. Gouia, C. C. Haouari, and A. Smaoui, A. 2014. Ecophysiological aspects and photosynthetic pathways in 105 plants species in saline and arid environments of Tunisia. *Arid Land* **6**: 762-770.

Bernacchi, C., E. Singsaas, C. Pimentel, A. Portis Jr, and S. Long. 2001. Improved temperature response functions for models of Rubisco‐limited photosynthesis. *Plant, Cell & Environment* **24**: 253-259.

Box, E. E. O. 1981. Macroclimate and plant forms: an introduction to predictive modeling in phytogeography. Springer Science & Business Media.

Bruhl, J.J. and Wilson, K.L., 2007. Towards a comprehensive survey of C_3 and C_4 photosynthetic pathways in Cyperaceae. *Aliso* **23**: 99-148.

Cai Z.Q., S.A. Schnitzer and F. Bongers. 2009. Seasonal differences in leaf-level physiology give lianas a competitive advantage over trees in a tropical seasonal forest. *Oecologia* **161**: 25-33.

Cavender-Bares, J. and Bazzaz, F. A. 2004. From leaves to ecosystems: assessing photosynthesis and plant function in ecological studies, in: Chlorophyll Fluorescence: a Signature of Photosynthesis, edited by: Papageorgiou, G. C. and Govindjee, G., Kluwer, *Dordrecht*, pp 737–755

Cernusak, L. A., N. Ubierna, K. Winter, J. A. M. Holtum, J. D. Marshall, and G. D. Farquhar. 2013. Environmental and physiological determinants of carbon isotope discrimination in terrestrial plants. *New Phytologist* **200**: 950-965.

Cornelissen, J. H. C., S. Schnitzer, E. Garnier, S. Diaz, N. Buchmann, D. E. Gurvich, P. B. Reich, H. ter Steege, H. D. Morgan, M. G. A. van der Heijden, J. G. Pausas and H. Poorter. 2003. A handbook of protocols for standardized and easy measurement of plant functional traits worldwide. *Australian Journal of Botany* **51**: 335-380.

Cornwell W.K., I. Wright, J. Turner, V. Maire, M. Barbour, L. Cernusak, T. Dawson, D. Ellsworth, G. Farquhar, H. Griffiths, C. Keitel, A. Knohl, P. Reich, D. Williams, R. Bhaskar, J.H.C. Cornelissen, A. Richards, S. Schmidt, F. Valladares, C. Körner, E. Schulze, N. Buchmann, L. Santiago, 2017. Data from: A global dataset of leaf $\delta^{13}C$ values. Dryad Digital Repository. http://dx.doi.org/10.5061/dryad.3jh61

Craine, J. M., A. J. Poorter, M. P. M. Aidar, M. Bustamante, T. E. Dawson, E. A. Hobbie, A. Kahmen, M. C. Mack, K. K. McLauchlan, A. Michelsen, G. B. Nardoto, L. H. Pardo, J. Peñuelas, P. B. Reich, E. A. G. Schuur, W. D. Stock, P. H. Templer, R. A. Virginia, J. M. Welker, and I. J. Wright. 2009. Global patterns of foliar nitrogen isotopes and their relationships with climate, mycorrhizal fungi, foliar nutrient concentrations, and nitrogen availability. *New Phytologist* **183**: 980-992.

De Kauwe, M. G., Y.-S. Lin, I. J. Wright, B. E. Medlyn, K. Y. Crous, D. S. Ellsworth, V. Maire, I. C. Prentice, O. K. Atkin, A. Rogers, Ü. Niinemets, S. P. Serbin, P. Meir, J. Uddling, H. F. Togashi, L. Tarvainen, L. K. Weerasinghe, B. J. Evans, F. Y. Ishida, and T. F. Domingues. 2016, A test of the ‘one-point method’ for estimating maximum carboxylation capacity from field-measured, light-saturated photosynthesis. *New Phytologist* **210**: 1130-1144.

Díaz, S., S. Lavorel, S. Lavorel, V. Falczuk, F. Casanoves, D. G. Milchunas, C. Skarpe, G. Rusch, M. Sternberg, I. Noy-meir, J. Landsberg, W. Zhang, H. Clark, and B.D. Campbell. 2006. Plant trait responses to grazing – a global synthesis. *Global Change Biology* **12**: 1-29.

Díaz, S., J. Kattge, J. H. C. Cornelissen, I. J. Wright, S. Lavorel, S. Dray, B. Reu, M. Kleyer, C. Wirth, I. C. Prentice, E. Garnier, G. Boenisch, M. Westoby, H. Poorter, P. B. Reich, A. T. Moles, J. Dickie, A. N. Gillison, A. E. Zanne, J. Chave, S. J. Wright, S. Sheremetev, H. Jactel, C. Baraloti, B. Cerabolini, S. Pierce, B. Shipley, D. Kirkup, F Casanoves, J. Joswig, A. Günther, V. Falczuk, N. Rüger, M. D. Mahecha, and L.D. Gorné. 2016. The global spectrum of plant form and function. *Nature* **529**: 167-171.

Dong, N., I. C. Prentice, B.J. Evans, S. Caddy-Retalic, A.J. Lowe, and I. J. Wright. 2016. Leaf nitrogen from first principles: field evidence for adaptive variation with climate*, Biogeosciences Discussions* doi:10.5194/bg-2016-89

Falster, D. S., R. A. Duursma, M. I. Ishihara, D. R. Barneche, R. G. FitzJohn, A. Vårhammar, M. Aiba, M. Ando, N. Anten, M. J. Aspinwall, J. L. Baltzer, C. Baraloto, M. Battaglia, J. J. Battles, B. Bond-Lamberty, M. van Breugel, J. Camac, Y. Claveau, L. Coll, M. Dannoura, S. Delagrange, J.-C. Domec, F. Fatemi, W. Feng, V. Gargaglione, Y. Goto, A. Hagihara, J. S. Hall, S. Hamilton, D. Harja, T. Hiura, R. Holdaway, L. S. Hutley, T. Ichie, E. J. Jokela, A. Kantola, J. W. G. Kelly, T. Kenzo, D. Kenzo, B. D. Kloeppel, T. Kohyama, A. Komiyama, J.-P. Laclau, C. H. Lusk, D. A. Maguire, G. le Maire, A. Mäkelä, L. Markesteijn, J. Marshall, K. McCulloh, I. Miyata, K. Miyata, S. Mori, R. W. Mori, M. Nagano, S. L. Naidu, Y. Nouvellon, A. P. O'Grady, K. L. O'Hara, T. Ohtsuka, N. Osada, O. O. Osunkoya, P. L. Peri, A. M. Petritan, L. Poorter, A. Portsmuth, C. Potvin, J. Ransijn, D. Reid, S. C. Ribeiro, S. D. Roberts, R. Rodríguez, A. Saldaña-Acosta, I. Santa-Regina, K. Sasa, N. G. Selaya, S. C. Sillett, F. Sterck, K. Takagi, T. Tange, H. Tanouchi, D. Tissue, T. Umehara, H. Utsugi, M. A. Vadeboncoeur, F. Valladares, P. Vanninen, J. R. Wang, E. Wenk, R. Williams, F. de Aquino Ximenes, A. Yamaba, T. Yamada, T. Yamakura, R. D. Yanai and R. A. York. 2015. BAAD: a Biomass And Allometry Database for woody plants. *Ecology* **96**: 1445. doi:10.1890/14-1889.1

Fonseca, C. R., J. M. Wright, B. Collins and M. Westoby. 2000. Shifts in trait-combinations along rainfall and phosphorus gradients. *Journal of Ecology* **88**: 964-977

Fyllas, N. M., E. Gloor, L. M. Mercado, S. Sitch, C. A. Quesada, T. F. Domingues, D. R. Galbraith, A. Torre-Lezama, E. Vilanova, H. Ramírez-Angulo, N. Higuchi, D. A. Neill, M. Silveira, L.

Ferreira, G. A. Aymard C., Y. Malhi, O. L. Ferreira and J. Lloyd. 2014. Analysing Amazonian forest productivity using a new individual and trait-based model (TFS v.1). *Geoscientific Model Development* **7**: 1251-1269

Gallego-Sala, A. V., J. M. Clark, J. I. House, H. G. Orr, I. C. Prentice, P. Smith, T. Farewell and S. J. Chapman. 2011. Bioclimatic envelope model of climate change impacts on blanket peatland distribution in Great Britain, *Climate Research* **45**: 151–162.

Gao, Q., X.-B. Li and X-S Yang. Responses of vegetation and primary production in north-south transect of eastern China to global change under land use constraint. 2003. *Acta Botanica. Sinica.* **45**: 1274-1284.

Gao, Y., X. Liu, C. Min, H. He, G. Yu, M. Liu, X. Zhu and Q. Wang. 2013. Estimation of the North–South Transect of Eastern China forest biomass using remote sensing and forest inventory data. *International Journal of Remote Sensing* **34**: 15, 5598-5610.

Hancock, P.A. and M.F. Hutchinson. Spatial interpolation of large climate data sets using bivariate thin plate smoothing splines. 2006. *Environmental Modelling & Software* **21**: 1684-1694.

Harrison, S.P., I.C. Prentice, J-P. Sutra, D. Barboni, K.E. Kohfeld and J. Ni. 2010. Ecophysiological and bioclimatic foundations for a global plant functional classification. *Journal of Vegetation Science* **21**: 300-317.

Hodgson J. G., G. Montserrat-Martí, M. Charles, G. Jones, P. Wilson, B. Shipley, M. Sharafi, B. E. L. Cerabolini, J. H. C. Cornelissen, S.R. Band, A. Bogard, P. Castro-Díez, J. Guerrero-Campo, C. Palmer, M. C. Pérez-Rontomé, G. Carter, A. Hynd, A. Romo-Díez, L. de Torres Espuny and F. Royo Pla. 2011. Is leaf dry matter content a better predictor of soil fertility than specific leaf area? *Annals of Botany* **108**:1337-1345.

Kaplan, J.O., N.H. Bigelow, P.J. Bartlein, T.R. Christensen, W. Cramer, W., S.P. Harrison, N.V. Matveyeva, A.D. McGuire, D.F. Murray, I.C. Prentice, V.Y. Razzhivin, B. Smith, D.A. Walker, P.M. Anderson, A.A. Andreev, L.B. Brubaker, M.E. Edwards and A.V. Lozhkin. 2003. Climate change and Arctic ecosystems II: Modeling, palaeodata-model comparisons, and future projections. *Journal of Geophysical Research-Atmosphere* **108**: No. D19, 8171.

Kattge, J., S. Díaz, S. Lavorel, I. C. Prentice, P. Leadley, G. Bönisch, E. Garnier, M. Westoby, P. B. Reich, I. J. Wright, J. H. C. Cornelissen, C. Violle, S. P. Harrison, P. M. van Bodegom, M.

Reichstein, N. A. Soudzilovskaia, D. D. Ackerly, M. Anand, O. Atkin, M. Bahn, T. R. Baker, D. Baldocchi, R. Bekker, C. Blanco, B. Blonder, W. Bond, R. Bradstock, D. E. Bunker, F. Casanoves, J. Cavender-Bares, J. Chambers, F. S. Chapin, J. Chave, D. Coomes, W. K. Cornwell, J. M. Craine, B. H. Dobrin, W. Durka, J. Elser, B.J. Enquist, G. Esser, M. Estiarte, W. F. Fagan, J. Fang, F. Fernández, A. Fidelis, B. Finegan, O. Flores, H. Ford, D. Frank, G. T. Freschet, N. M. Fyllas, R. Gallagher, W. Green, A. G. Gutierrez, T. Hickler, S. Higgins, J. G. Hodgson, A. Jalili, S. Jansen, A. J. Kerkhoff, D. Kirkup, K. Kitajima, M. Kleyer, S. Klotz, J. M. H. Knops, K. Kramer, I. Kühn, H. Kurokawa, D. Laughlin, T. D. Lee, M. Leishman, F. Lens, T. Lenz, S. L. J. Lewis, J. Llusià, F. Louault, S. Ma, M. D. Mahecha, P. Manning, T. Massad, B. Medlyn, J. Messier, A. Moles, S. Müller, K. Nadrowski, S. Naeem, U. Niinemets, S. Nöllert, A. Nüske, R. Ogaya, J. Joleksyn, V. G. Onipchenko, Y. Onoda, J. Ordoñez, G. Overbeck, W. Ozinga, S. Patiño, S. Paula, J. G. Pausas, J. Peñuelas, O. L. Phillips, V. Pillar, H. Poorter, L. Poorter, P. Poschlod, R. Proulx, A. Rammig, S. Reinsch, B. Reu, L. Sack, B. Salgado, J. Sardans, S. Shiodera, B. Shipley, E. Sosinski, J-F. Soussana, E. Swaine, N. Swenson, K. Thompson, P. Thornton, M. Waldram, E. Weiher, M. White, S. J. Wright, S. Zaehle, A. E. Zanne and C. Wirth. 2011. TRY – a global database of plant traits. *Global Change Biology* **17**: 2905–2935.

Kleidon, A., J. Adams, R. Pavlick and B. Reu. 2009. Simulated geographic variations of plant species richness, evenness and abundance using climatic constraints on plant functional diversity. *Environmental Research Letter* **4**: 014007.

Lavorel, S., S. Díaz, H. Cornelissen, E. Garnier, S. P. Harrison, S. McIntyre, J. Pausas, N. Pérez-Harguindeguy and C. Urcely. 2007. Plant functional types: are we getting any closer to the Holy Grail? In: Canadell, J., Pitelka, L.F. and Pataki, D. (Eds) *Terrestrial Ecosystems in a Changing World*. Springer-Verlag, pp. 149-164.

Li, Q., Z. Urcely K. Mo and L. Zhang. 2016. Ecohydrological optimality in Northeast China Transect. *Hydrology Earth System Sciences Discussion* doi:10.5194/hess-2016-235

Leuning, R. and G. R. Yu. 2006. Carbon exchange research in ChinaFLUX. *Agricultural and Forest Meteorology* **137**: 123-124.

Liu G., G.T. Freschet, X. Pan, J. H. C. Cornelissen, Y. Li and M. Dong. 2010. Coordinated variation in leaf and root traits across multiple spatial scales in Chinese semi-arid and arid ecosystems. *New Phytologist* **188**: 543-553

Liu, X. Q. and R. Z. Wang. 2006. Photosynthetic pathway and morphological functional types in the vegetation from North-Beijing agro-pastoral ecotone, China. *Photosynthetica* **44**: 365-386.

Liu, X. Q., R. Z. Wang and Y. Z. Li. 2004. Photosynthetic pathway types in rangeland plant species from Inner Mongolia, North China. *Photosynthetica* **42**: 339-344.

McIntyre S., S. Lavorel, J. Landsberg and T. D. A. Forbes. 1999. Disturbance response in vegetation – towards a global perspective on functional traits. *Journal of Vegetation Science* **10**: 621-630

Maire, V., P. Martre, J. Kattge, F. Gastal, G. Esser, S. Fontaine, and J.-F. Soussana. 2012. The coordination of leaf photosynthesis links C and N fluxes in C_3 plant species. *PloS one* **7**:e38345.

Meng, T.-T., H. Wang, S. P. Harrison, I. C. Prentice, J. Ni, and G. Wang. 2015. Responses of leaf traits to climatic gradients: adaptive variation versus competitional shifts. *Biogeosciences* **12**: 5339-5352.

Ni, J. and G. H. Wang. 2004. Northeast China Transect (NECT): ten year synthesis and future challenges. *Acta Botanica. Sinica.* **46**: 379-391.

Nie, Q., J. Xu, M. Ji, L. Cao, Y. Yang, *et al.* 2012. The vegetation coverage dynamic coupling with climatic factors in Northeast China Transect. *Environmental Management* **50**: 405-17.

Ordoñez J. C., P. M. van Bodegom, J. P. M. Witte, I. J. Wright, P. B. Reich, R. Aerts. 2009. A global study of relationships between leaf traits, climate and soil measures of nutrient fertility. *Global Ecology and Biogeography* **18**:137-149

Osborne, C. P., A. Salomaa, T. A. Kluyver, V. Visser, E. A. Visser, O. Morrone, M. S. Vorontsova, W. D. Clayton, D. A. Simposn. 2014. A global database of C_4 photosynthesis in grasses. *New Phytologist* **204**: 441-446

Paula S., M. Arianoutsou, D. Kazanis, Ç. Tavsanoglu, F. Lloret, C. Buhk, F. Ojeda, B. Luna, J. M. Moreno, A. Rodrigo, J. M. Espelta, S. Palacio, B. Fernández-Santos, P. M. Fernandes, and J. G. Pausas. 2009. Fire-related traits for plant species of the Mediterranean Basin. *Ecology* **90**: 1420.

Poorter H., Ü. Niinemets, L. Poorter, I. J. Wright, and R. Villar. 2009. Causes and consequences of variation in keaf mass per area (LMA): a meta-analysis, *New Phytologist* **182**: 565-588

Poorter H., K. J. NIklas, et al. 2012. Biomass allocation to leaves, stems and roots: meta-analyses of interspecific variation and environmental control. *New Phytologist* **193**: 30-50

Prentice, I. C., W. Cramer, S. P. Harrison, R. Leemans, R. A. Monserud, and A. M. Solomon. 1992. A global biome model based on plant physiology and dominance, soil properties and climate. *Journal of Biogeography* **19**: 117–134.

Prentice, I. C., A. Bondeau, W. Cramer, S. P. Harrison, T. Harrison, W. Lucht, S. Sitch, B. Smith, and M. T. Sykes. 2007. Dynamic global vegetation modelling: quantifying terrestrial ecosystem responses to large-scale environmental change. In: Canadell, J., Pitelka, L. & Pataki, D. (eds.) Terrestrial ecosystems in a changing world. pp. 175–192. Springer-Verlag, Berlin.

Prentice, I. C., T. Meng, H. Wang, S. P. Harrison, J. Ni, and G. Wang. 2011. Evidence for a universal scaling relationship of leaf CO_2 drawdown along a moisture gradient. *New Phytologist* **190**: 169-180.

Prentice, I. C., N. Dong, S. M. Gleason, V. Maire, I. J. Wright. 2014. Balancing the costs of carbon gain and water loss: testing a new quantitative framework for plant functional ecology, *Ecology Letters* **17**: 82-91

Raunkiær, C. 1934. The life-forms of plants and statistical plant geography. Clarendon Press, Oxford, UK

Sakschewski B., W. von Bloh et al. 2015 Leaf and stem economics spectra drive diversity of functional plant traits in a dynamic global vegetation model. *Global Change Biology* **21**: 2711-2725

Scheiter, S., and S. I. Higgins. 2009. Impacts of climate change on the vegetation of Africa: an adaptive dynamic vegetation model. *Global Change Biology* **15**: 2224-2246

Scheiter, S., L. Langam, and S. I. Higgins. 2013. Next-generation dynamic global vegetation models: learning from community ecology. *New Phytologist* **198**: 957-969

Sheng, W., S. Ren, G. Yu, et al., 2011. Patterns and driving factors of WUE and NUE in natural forest ecosystems along the North-South Transect of Eastern China. *Journal of Geographical Sciences* **21**: 651

Shipley B., M. J. Lechowicz, I. Wright, P. B. Reich. 2006. Fundamental trade-offs generating the worldwide leaf economics spectrum. *Ecology* **87**: 535-541

Su, X. P., T. T. Xie and Z. J. Zhou. 2011. C_4 plant species and geographical distribution in relation to climate in the desert vegetation of China. *Sciences in Cold and Arid Regions* **3**: 0381-0391.

Sun S., D. Jin, R. Li. 2006. Leaf emergence in relation to leaf traits in temperate woody species in East-Chinese Quercus fabri forests. *Acta Oecologica* **30**: 212-222.

Ueno, O. and T. Takeda. 1992. Photosynthesis pathways, ecological characteristics, and the geographical distribution of the Cyperaceae in Japan. *Oecologia* **89**: 195-203.

Violle C., M. L. Navas, D. Vile, E. Kazakou, C. Fortunel, I. Hummel, and E. Garnier. 2007. Let the concept of trait be functional! *Oikos* **116**: 882-892

van Bodegom, P. M., J. C. Douma, J. P. M. Douma, J. C. Ordoñez, R. P. Ordoñez, and R. Aerts. 2012. Going beyond limitations of plant functional types when predicting global ecosystem-atmosphere fluxes: exploring the merits of traits-based approaches, *Global Ecology and Biogeography* **21**: 625–636.

van Bodegom, P. M., J. C. Douma, and L. M. Verheijen. 2014. A fully traits-based approach to modeling global vegetation distribution, *Proceedings of the National Academy of Sciences of the United States of America. Natl. Acad. Sci. USA* **111**: 13733–13738

Wang H., I. C. Prentice, J. Ni. 2013. Data-based modelling and environmental sensitivity of vegetation in China. *Biogeosciences* **10**: 5817-5830.

Wang H., I. C. Prentice et al., 2016 A universal model for carbon dioxide uptake by plants, *bioRxiv* http://dx.doi.org/10.1101/040246 (preprint)

Wang, R. Z. 2004. Photosynthetic pathways and life form types for native plant species from Hulunbeier Rangelands, Inner Mongolia, North China. *Photosynthetica* **42**: 219-227.

Wang, R. Z., 2005. C_3 and C_4 photosynthetic pathways and life form types for native species from agro-forestry region, Northeastern China. *Photosynthetica* **43**: 535-549.

Wang, R. and L. Ma. 2016. Climate-driven C_4 plant distributions in China: divergence in C_4 taxa. *Scientific Reports* **6**: article 27977

Weiher, E., A. van der Werf, K. Thompson, M. Roderick, E. Garnier, and O. Eriksson. 1999. Challenging Theophrastus: A common core list of plant traits for functional ecology. *Journal of Vegetation Science* **10**: 609-620.

Winter K. 1981. C_4 plants of high biomass in arid regions of Asia—occurrence of C_4 photosynthesis in Chenopodiaceae and Polygonaceae from the Middle East and USSR. *Oecologia* **48**: 100–106.

Wright, I. J., P. B. Reich, M. Westoby, D. D. Ackerly, et al. 2004. The world-wide leaf economics spectrum, *Nature* **428**: 821–827.

Wright I. J., P. B. Reich, J. H. C. Cornelissen et al. 2005. Assessing the generality of global leaf traits relationships. *New Phytologist* **166**: 485–496.

Yu, G. R., X. F. Wen, X. M. Sun, B. D. Tanner, X. Lee, J. Y. Chen. 2006. Overview of ChinaFLUX and evaluation of its eddy covariance measurement. *Agricultural and Forest Meteorology* **137**: 125-137.

Zhang X. et al. (Editorial Committee of Vegetation Atlas of China). Vegetation Atlas of China. 2007. Geological Publishing House: Xi'an, China.

Zheng S. X. and Z. P. Shangguan. 2007a. Spatial patterns of foliar stable carbon isotope compositions of C_3 olant species in the Loess Plateau of China. *Ecological Research* **22**: 342-353.

Zheng S. X. and Z. P. Shangguan. 2007b. Spatial patterns of photosynthetic characteristics and leaf physical traits of plants in the Loess Plateau of China. *Plant Ecology* **191**: 279-293.