1   **A compiled soil respiration dataset at different time scales for forest ecosystems**

2   **across China from 2000 to 2018**

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14   **Abstract.** China's forests rank fifth in the world by area and cover a broad climatic

15   gradient from cold-temperate to tropical zones, and play a key role in the global carbon

16   cycle. Studies on forest soil respiration (Rs) are increasing rapidly in China over the last

17   two decades, but the resulting Rs data need to be summarized. Here, we compile a

18   comprehensive dataset of Rs in China's undisturbed forest ecosystems from literatures

19   published up to December 31, 2018, including monthly Rs and the concurrently measured

20   soil temperature (N=8317), mean monthly Rs (N=5003), and annual Rs (N=634).

21   Detailed plot information was also recorded, such as geographical location, climate factors,

22   stand characteristics, and measurement description. We examine some aspects of the

23   dataset – Rs equations fitted with soil temperature, temperature sensitivity (Q_{10}), monthly

24   variations and annual effluxes in cold-temperate, temperate, subtropical and tropical

25 zones. We hope the dataset will be used by the science community to provide a better

26 understanding of carbon cycle in China's forest ecosystems and reduce uncertainty in

27 evaluating of carbon budget at the large scale. The dataset is publicly available at

28 https://doi.pangaea.de/10.1594/PANGAEA.943617 (Sun et al. 2021).

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30 **Keywords**: Soil carbon flux, Carbon cycle, Temperature sensitivity, Forest, China

31 **1 Introduction**

32 Soil respiration (Rs) refers to the total amount of CO_2 released by undisturbed soil,

33 including autotrophic respiration and heterotrophic respiration, the former from plant

34 roots and their microbial symbionts, and the latter from microorganisms decomposing

35 litter and soil organic matter. As the second-largest terrestrial carbon flux, the recent

36 estimations of global annual Rs (80–98 Pg C year^{-1}) are above ten percent of the

37 atmospheric carbon pool (750 Pg C) (Bond-Lamberty and Thomson, 2010b;

38 Hashimoto et al., 2015; Raich et al., 2002; Warner et al., 2019), thus accelerating soil

39 respiration rates with climate warming have a strong potential to influence atmospheric

40 CO_2 levels. It is thus important to understand better soil respiration dynamics and

41 response to climate changes.

42   Forest area in China ranks fifth in the world (FAO, 2020) and covers a broad climatic

43 gradient, including cold-temperate, temperate, subtropical and tropical zones. In China,

44 most Rs measurements began only after 2001 (Chen et al., 2010), but have rapidly

45 increased during the last 20 years (Jian et al., 2020). Several studies have summarized

46 annual Rs in China's forest ecosystems, but with the small samples (e.g., N=50 in

47 Zheng et al., 2010; N=62 in Chen et al., 2008; N=120 in Zhan et al., 2012; N=139 in

48 Song et al., 2014). Yu et al. (2010) established a geostatistical model with a total of 390

49 monthly Rs data from different ecosystems in China. With 1782 monthly Rs in forest

50   ecosystems across China, Jian et al. (2020) analyzed the spatial patterns and temporal

51   trends from 1961 to 2014. However, amounts of *Rs* data are still unexploited, because

52   they were only displayed in the forms of monthly dynamics in the original papers' figures.

53   *Rs* data at a subannual timescales are important for upscaling global *Rs* (Jian et al.,

54   2018), which may derive different conclusions and deserve further exploration (Huang

55   et al., 2020).

56   The lack of the large-scale and observation-driven *Rs* data is a main constraining factor

57   in quantifying regional- to global-scale carbon budget (Bond-Lamberty and Thomson,

58   2010a; Rayner et al., 2005). *Rs* data and concurrently measured temperature thus

59   provide not only a solid base to understand the critical factors influencing *Rs*, but the

60   opportunity to better simulate *Rs* at the large scale. We attempted to compile a complete

61   forest *Rs* dataset at different temporal scales in China, and analyze temperature

62   sensitivity (Q_{10}), monthly and annual *Rs* in cold-temperate, temperate, subtropical and

63   tropical zones.

64   **2   Data and methods**

65   **2.1 Data sources**

66   The terms of "soil respiration", "soil carbon (or CO_2) efflux", or "soil carbon (or CO_2)

67   emission" were searched from publications before 2018 in the China Knowledge

68   Resource Integrated Database (http://www.cnki.net/), China Science and Technology

69   Journal Database (http://www.cqvip.com), ScienceDirect (http://www.sciencedirect.

70   com/), ISI Web of Science (http://isiknowledge.com/), and Springer Link

71   (http://link.springer.com/). Means, minimums and maximums of soil respiration during

72   the observation periods were usually given in these published studies, and monthly

73   patterns of soil respiration rates and the corresponding temperature were frequently

74   shown with figures. WEBPLOTDIGITIZER, a graphic digitizing software, was used to

75   take data from figures when values were not reported in the text (Burda et al., 2017).

76   **2.2 Data collection criteria**

77   The following criteria were used to ensure data consistency and accuracy: i) *Rs* was

78   measured in the field without obvious disturbances or manipulation experiments, e.g.

79   fire, cutting, nitrogen addition treatments, etc. ii) Forested swamps and commercial

80   plantations (e.g. orchard, rubber, etc.) were not examined. iii) *Rs* was measured either

81   by static chamber/gas chromatography (GC) or by dynamic chamber/infrared gas

82   analyzers (IRGA, model Li-6400, Li-8100, Li-8150 (LI-COR Inc., Lincoln, Nebraska,

83   USA)), which are the most popular methods and provide methodological consistency

84   (Sun et al., 2020; Wang et al., 2011; Yang et al., 2018; Zheng et al., 2010).

85   Based on these criteria, a total of 10288 monthly soil respiration data and 634 annual

86   soil respiration data were assembled from 568 publications. Meanwhile, the related

87   information was recorded, including geographical location (province, study site, latitude,

88   longitude and elevation), climate (mean annual temperature and mean annual

89   precipitation), stand description (forest type, origin, age, density, mean tree height and

90   diameter at breast height), measurement regime (method, time, frequency, collar area,

91   height and numbers) (Table 1). There were 155 study sites from 28 provinces in China

92   (18.61–52.86° N, 84.91–129.08° E, 7–4200 m) (Fig. 1). This forest region encompasses a

93   large gradient of climate regimes, mean annual temperature ranging from -5.4 to 23.8 °C

94   and mean annual precipitation ranging from 105 to 3000 mm. The observation years were

95   from 2000 until 2018.

96   **2.3 Data verification**

97   Soil temperature as a main influencing factor, was usually concurrently measured with

98   *Rs*. Monthly dynamics of *Rs* and soil temperature at 5 cm depth (T_5) and/or 10 cm depth

99   (T_{10}) were shown with figures in many literatures. In this study, most of the *Rs* data (~82%)

100 and the concurrent T_5 and/or T_{10} were extracted with WEBPLOTDIGITIZER, others (e.g.,

101 minimum, maximum) were directly given in the original papers. To verify the accuracy of

102 the digital software, the means (*Rs*, T_5, T_{10}) averaged from the extracted data were

103 compared with the corresponding means directly given in the original papers (Fig. S1).

104 The Root Mean Square Errors (RMSE) of *Rs*, T_5 and T_{10} were 0.09 µmol m^{-2} s^{-1}, 0.35 °C

105 and 0.44 °C, respectively, and the coefficients of determination (R^2) were all larger than

106 0.99, indicating that the accuracy of WEBPLOTDIGITIZER is excellent. Moreover, the

107 data from the same authors and different sources (e.g. master or Ph. D. dissertation and

108 journal article) has been carefully cross-checked and supplemented.

109 **2.4 Monthly and annual soil respiration calculation**

110 Long-term continuous *Rs* could be monitored with infrared gas analyzers (e.g., Li-8100,

111 Li-8150), but there are few published studies of such continuous data (Bond-Lamberty et

112 al., 2020; Tu et al., 2015; Wu et al., 2014; Yu et al., 2011). The observation frequency

113 was 1−12 days per month—high during the growing season, but low in winter. *Rs* was

114 measured throughout the day (16%) or at representative time, e.g., 9:00 a.m.–11:00 a.m.

115 (45%), 9:00 a.m.–12:00 a.m. (22%), etc., which had been validated to be close to the

116 diurnal mean value (Xu and Qi, 2001; Yan et al., 2006; Yang et al., 2018; Yao et al., 2011;

117 You et al., 2013; Zheng et al., 2010). Annual soil carbon efflux was integrated with soil

118 respiration model (i.e. integration method) or interpolated the average soil respiration rate

119 between sampling dates (i.e. interpolation method) (Shi et al., 2014). Finally, monthly *Rs*

120 and annual soil carbon efflux were converted to the common unit of µmol CO_2 m^{-2} s^{-1}

121 and g C m^{-2} year^{-1}, respectively (Bond-Lamberty and Thomson, 2010a).

122 **2.5 Statistical analysis**

123 Monthly and annual *Rs* were averaged arithmetically in cold-temperate, temperate,

subtropical and tropical zones. Independent-Samples T Tests (2 groups) and One-Way ANOVA ($\geq$3 groups) at the $P = 0.05$ significance level were used to test the differences among different forest types in the same climate zone and among the same forest type in different climate zones. Temperature sensitivity (Q_{10}) is defined as the factor by which Rs is multiplied when temperature increases by 10 °C (Davidson and Janssens, 2006; Lloyd and Taylor, 1994), which is usually calculated with the van't Hoff equation ($Rs=ae^{\beta T}$ & $Q_{10}=e^{10\beta}$), where Rs is soil respiration rate (μmol m^{-2} s^{-1}), T is temperature (°C). All statistical analyses were performed with SPSS Statistics 21 (SPSS Inc., Chicago, USA).

3   Results

3.1 Relationship between soil respiration rate and soil temperature

Temperature is often the main factor determining soil respiration rates. The samples of the paired Rs & T_5 and Rs & T_{10} were 6341 (69%) and 2878 (31%) in the dataset, respectively. There were significantly exponential relationships of Rs with T_5 and T_{10} in forest ecosystems across China, which could explain about 48% and 52% of the Rs variations, respectively (Fig. S2). The exponential correlations were all significant in four climatic zones(R^2=0.23–0.93) (Fig. 2). RMSEs in cold-temperate and temperate zones (1.52–1.67 μmol m^{-2} s^{-1}) were larger than those in subtropical and tropical zones (1.04–1.32 μmol m^{-2} s^{-1}), except the smallest RMSE from T_{10} in cold-temperate zone (0.42 μmol m^{-2} s^{-1}).

Q_{10} could be calculated with the exponential equations between Rs and soil temperature. At the national scale, the Q_{10} values in China's forest ecosystems from T_5 (-16.51–33.58 °C) and T_{10} (-16.40–33.46 °C) were 2.05 and 2.17, respectively. The Q_{10} was the largest in cold-temperate zone (T_5: 3.74 & T_{10}: 3.32), secondary in temperate

148   zone (T_5: 2.69 & T_{10}: 3.00), and the smallest in subtropical zone (T_5: 2.15 & T_{10}: 2.20)

149   and tropical zone (T_5: 2.28 & T_{10}: 1.63).

150   **3.2 Monthly dynamics of soil respiration**

151   Monthly *Rs* appeared as a single-peak curve (Fig. 3), which derived from the similar

152   years in cold-temperate (2003–2016), temperate (2002–2018), subtropical (2000–2017)

153   and tropical zones (2003–2015). The largest values occurred in August (4.18–4.36

154   µmol m^{-2} s^{-1}) in cold-temperate and temperate zones, larger than the largest values in

155   July (3.58–3.83 µmol m^{-2} s^{-1}) in subtropical and tropical zones. The lowest values

156   occurred in January in cold-temperate (0.20 µmol m^{-2} s^{-1}), temperate (0.49 µmol m^{-2}

157   s^{-1}), subtropical (1.10 µmol m^{-2} s^{-1}) and tropical zones (1.62 µmol m^{-2} s^{-1}). Monthly

158   variations were largest in cold-temperate and temperate zones, secondary in subtropical

159   zone, and smallest in tropical zone.

160   Annual mean *Rs* in January–December from low to high was cold-temperate (1.63

161   µmol m^{-2} s^{-1}), temperate (1.93 µmol m^{-2} s^{-1}), subtropical (2.47 µmol m^{-2} s^{-1}) and

162   tropical zones (2.57 µmol m^{-2} s^{-1}). Meanwhile, annual soil carbon emissions were

163   calculated with the annual mean *Rs*: 621.91 g C m^{-2} yr^{-1} in cold-temperate zone, 733.31

164   g C m^{-2} yr^{-1} in temperate zone, 937.15 g C m^{-2} yr^{-1} in subtropical zone, and 973.35 g C

165   m^{-2} yr^{-1} in tropical zone. Soil carbon emissions in growing season (May–October) and

166   winter (November–April) accounted for 85% and 15% in cold-temperate zone, 80%

167   and 20% in temperate zone, 69% and 31% in subtropical zone, 61% and 39% in tropical

168   zone. Subtropical and tropical zones still keep high soil respiration rates in November–

169   April, which is the main source of their larger annual soil carbon emissions.

170   **3.3 Annual soil carbon effluxes**

171   There were 634 annual soil carbon effluxes, and most of the observations were

172   conducted in subtropical zone (61%) and temperate zone (32%) (Fig. 4). The spanning

173   years were 2003–2014 in cold-temperate zone, 2000–2018 in temperate zone, 2002–

174   2017 in subtropical zone and 2003–2017 in tropical zone. The annual soil carbon

175   effluxes ranged from 260.10 g C m^{-2} yr^{-1} to 2058.00 g C m^{-2} yr^{-1} in China's forest

176   ecosystems, and the mean was 851.88±12.75 g C m^{-2} yr^{-1}. The annual soil carbon

177   effluxes increased with the increasing of mean annual temperature and precipitation at

178   the national scale (Fig. S3). Mean annual soil carbon emissions in tropical, subtropical,

179   temperate and cold-temperate zones were 1042.01±68.55, 928.91±16.68,

180   697.85±16.39 and 684.29±61.81 g C m^{-2} yr^{-1}, respectively. The former two was

181   significantly higher than the latter two, but the differences were not significant between

182   tropical and subtropical zones, and between temperate and cold-temperate zones. The

183   differences were not significant for evergreen broadleaf forest (EBF), evergreen

184   needleleaf forest (ENF) and deciduous needleleaf forest (DNF) among different

185   climate zones. Deciduous broadleaf forest (DBF) in temperate (748.59±25.18 g C m^{-2}

186   yr^{-1}) and subtropical zones (755.41±58.26 g C m^{-2} yr^{-1}) was similar, both of which were

187   larger than that in cold-temperate zone (284.20±21.36 g C m^{-2} yr^{-1}). Broadleaf and

188   needleleaf mixed forest in subtropical zone (977.35±43.56 g C m^{-2} yr^{-1}) had

189   significantly higher emissions than that in temperate zone (733.44±45.29 g C m^{-2} yr^{-1}).

190   Evergreen forests were usually larger than deciduous ones in the same climatic zone,

191   for example, ENF (866.98±63.74 g C m^{-2} yr^{-1}) and DNF (734.56±83.67 g C m^{-2} yr^{-1})

192   in cold-temperate zone, ENF (699.96±32.77 g C m^{-2} yr^{-1}) and DNF (555.15±24.19 g C

193   m^{-2} yr^{-1}) in temperate zone, EBF (1073.50±26.44 g C m^{-2} yr^{-1}) and DBF (755.41±58.26

194 g C m^{-2} yr^{-1}) in subtropical zone. Broad-leaved forests showed significantly larger

195 annual fluxes than coniferous forests in temperate zone (DBF: 748.59±25.18 g C m^{-2}

196 yr^{-1} vs. DNF: 555.15±24.19 g C m^{-2} yr^{-1}) and subtropical zone one (EBF:

197 1073.50±26.44 g C m^{-2} yr^{-1} vs. ENF: 717.50±17.61 g C m^{-2} yr^{-1}). However, DNF

198 (734.56±83.67 g C m^{-2} yr^{-1}) was larger than DBF (284.20±21.36 g C m^{-2} yr^{-1}) in cold-

199 temperate zone, which was from high-latitude Great Xing'an Mountains (~51° N) and

200 high-altitude Gongga Mountain (2800–2950 m), respectively. Additionally, bamboo is

201 a special type in subtropical areas, exhibiting the highest soil carbon emissions

202 (1133.55±42.74 g C m^{-2} yr^{-1}).

203 **4 Discussion**

204 **4.1 Temperature sensitivity (Q_{10}) of soil respiration**

205 Q_{10} is a key parameter in modelling the effects of climate warming on soil carbon

206 release. The Q_{10} calculated with the exponential equations of T_5 and T_{10} were 2.05 and

207 2.17 at the national scale (Fig. S2), which were lower than the averaged Q_{10} from

208 different studies in the syntheses of China's forest ecosystems (T_5: 2.28–2.51 and T_{10}:

209 2.74–3.00, Peng et al., 2009; Song et al., 2014; Xu et al., 2015; Zheng et al., 2009) and

210 global forest ecosystems (T_5: 2.55–2.70 and T_{10}: 3.01–3.31, Wang et al., 2010 a; b).

211 Our results were close to the Q_{10} of 2 commonly used in many biogeochemical models

212 (e.g., Cox et al., 2000; Sampson et al., 2007) and the mean Q_{10} of 2.11 estimated with

213 inverse modeling in forest soils across China (Zhou et al., 2009).

214 Temperature was the most important limiting factor for soil microbial activity and

215 root growth in cold regions, thus, *Rs* was more sensitive to temperature changes (Lloyd

216 and Taylor, 1994; Peng et al., 2009; Zheng et al., 2009; Zheng et al., 2020). The Q_{10}

217 increased from tropical zone to cold-temperate zone in this study, and varied from 1.63

218 to 3.74. Soil temperature at the depth of 5 cm and 10 cm could only explain 29% and

219 23% of the Rs variations and RMSEs were 1.09 μmol m^{-2} s^{-1} and 1.13 μmol m^{-2} s^{-1} in

220 tropical zone, respectively (Fig. 2d). The difference of the mean Rs between tropical

221 moist forests (1260 g C m^{-2} yr^{-1}) and tropical dry forests (673 g C m^{-2} yr^{-1}) was about

222 2-fold (Raich and Schlesinger, 1992), indicating that soil moisture might play more

223 important roles.

224 **4.2 Comparisons of monthly and annual soil carbon effluxes**

225 The lowest monthly Rs occurred in January, and the largest values occurred in August

226 in cold-temperate and temperate zones and in July in subtropical and tropical zones

227 (Fig. 3). Similarly, monthly Rs of global terrestrial ecosystems reached their minima in

228 February and peaked in July and August (Hashimoto et al., 2015; Raich et al., 2002).

229 Due to the limitation of low temperature, winter observations of Rs were relatively

230 fewer in the cold-temperate and temperate zones. The Rs in winter (November–April)

231 was usually assumed to account for 20% of the total annual Rs (Geng et al., 2017; Yang

232 and Wang, 2005), which was in agreement with the proportion in temperate zone, but

233 greater than 15% in cold-temperate zone.

234 Annual soil carbon emission had been synthesized in forest ecosystems across China,

235 and the mean was 745.34 g C m^{-2} yr^{-1} (Zheng et al., 2010), 764.11 g C m^{-2} yr^{-1} (Zhan

236 et al., 2012), 917.73 g C m^{-2} yr^{-1} (Song et al., 2014) and 975.50 g C m^{-2} yr^{-1} (Chen et

237 al., 2008), and the mean of 851.88 g C m^{-2} yr^{-1} in the present study was in the mid-

238 range. The mean annual Rs in China's forest ecosystems was slightly lower than the

239 mean Rs of 990.00 g C m^{-2} yr^{-1} in global forest ecosystems (Chen et al., 2010). Warner

240 et al. (2019) modelled global Rs and found that the smallest and greatest annual soil

241 carbon emissions were in deciduous needleleaf forest (Mean=344.10 g C m^{-2} yr^{-1}) and

242   evergreen broadleaf forest (Mean=1310.47 g C m^{-2} yr^{-1}), respectively. Compared with

243   the predicted annual Rs, deciduous needleleaf forest in cold-temperate (Mean=734.56

244   g C m^{-2} yr^{-1}) and temperate zones (Mean= 555.15 g C m^{-2} yr^{-1}) had larger values, but

245   those of evergreen broadleaf forest in subtropical (Mean=1073.50 g C m^{-2} yr^{-1}) and

246   tropical zones (Mean=1065.09 g C m^{-2} yr^{-1}) were lower (Fig. 4).

247   Mean annual soil carbon emissions from 634 annual Rs and 5003 mean monthly Rs

248   were 684.29 and 621.91 g C m^{-2} yr^{-1} in cold-temperate zone, 697.85 and 733.31 g C m^{-}

249   ^{2} yr^{-1} in temperate zone, 928.91 and 937.15 g C m^{-2} yr^{-1} in subtropical zone, and

250   1042.01 and 973.35 g C m^{-2} yr^{-1} in tropical zone (Fig. 4 and Fig. 3). The differences

251   between the directly averaged annual Rs and the accumulative mean monthly Rs were

252   smallest in tropical zone (-8.24 g C m^{-2} yr^{-1}), secondary in temperate zone (-35.46 g C

253   m^{-2} yr^{-1}), and largest in cold-temperate and tropical zones (62.38–68.66 g C m^{-2} yr^{-1}).

254   Form Fig. 4 we could also found that the standard errors in tropical and temperate zones

255   (~16 g C m^{-2} yr^{-1}) were smaller those in cold-temperate and tropical zones (~65 g C m^{-}

256   ^{2} yr^{-1}). Mean annual soil carbon emissions in temperate, subtropical and tropical

257   ecosystems were 745 g C m^{-2} yr^{-1}, 776 g C m^{-2} yr^{-1} and 1286 g C m^{-2} yr^{-1} at the global

258   scale, respectively (Bond-Lamberty and Thomson, 2010a), which were comparable

259   with our results.

260   **4.3 Improvements of the dataset**

261   Rs measurements were mainly from Li-8100 (47%) and Li-6400 (33%), secondary

262   from gas chromatography (18%), and Li-8150 only accounted for 2%. The differences

263   of the four common measurement methods had been proved to be small (~10%) (Wang

264   et al., 2011; Yang et al., 2018; Zheng et al., 2010). The sample sizes of annual Rs were

265   50–139 (Chen et al., 2008; Song et al., 2014; Zhan et al., 2012; Zheng et al, 2010) and

634 in the current study, and increased above 4-fold. The global soil respiration database (SRDB-V5) collected 523 undisturbed annual Rs in China's forest ecosystems (Jian et al., 2021), but all methods were included, e.g. alkali absorption, gas chromatography and various infrared gas analyzers. Alkali absorption method could underestimate Rs (Chen et al., 2008; Jian et al., 2020). The total samples of mean monthly Rs were 5003, which was much larger than the other dataset's monthly samples of 1782 in China's forest ecosystems (Jian et al., 2020; Steele and Jian, 2018). Additionally, we extended the dataset with the digital software (WEBPLOTDIGITIZER) from the monthly dynamics figures of the original papers, including the paired Rs & T_5 (N=6341) and Rs & T_{10} (N=2878). Predicting soil respiration from soil temperature has gained extensive acceptance (Shi et al., 2014; Song et al., 2014; Sun et al., 2020). These data could be used to establish the large-scale soil respiration equation and acquire the key parameters of carbon cycle. Compared with the above-mentioned monthly or annual databases, this study collected all available Rs data at different time scales. Fig. S4 showed the length of the individual time series from the different sites, the high frequencies were 12 months (38%), 6–7 months (20%) and 13–24 months (15%). Bamboo forests were seldom considered in the previous databases (Chen et al., 2008; Steele and Jian, 2018; Zhan et al., 2012; Zheng et al, 2010), which exhibited the highest soil carbon emissions (Mean=1133.55 g C m^{-2} yr^{-1}, Fig. 4). With the area increasing at a high rate of 3.1% per year (Song et al., 2017), bamboo forests would play an important role in regional and even national carbon cycle. It's worth noting that the Rs studies were fewer in the regions of latitude larger than 48° (~2%) or elevation higher than 3000 m (~4%). The potentially under-represented forest types might affect the evaluation of temperature sensitivity of soil respiration and annual soil carbon emission at the regional and national scale.

5 Data availability

The soil respiration dataset in China's forest ecosystems used to produce the results in this study is free to the public for scientific purposes and can be downloaded at https://www.pangaea.de/tok/788910d8d3ae0a415c7bad2e7025a3f16f042a1b (Sun et al. 2021).

6 Conclusions

In this study, we reviewed the *Rs*-related literatures and collected in situ *Rs* measurements with common infrared gas analyzers (i.e. Li-6400, Li-8100, Li-8150) or gas chromatography to assemble a comprehensive and uniform dataset of China's forest ecosystems at different time scales. Besides the *Rs* data directly given in the original papers, the monthly patterns of *Rs* and the concurrently measured soil temperature at 5 cm and/or 10 cm depth in the figures were digitized. Meanwhile, we have made a preliminary analysis of the data. The results showed that soil temperature could explain 22.5%–93.4% of the *Rs* variations. Temperature sensitivity **(Q_{10})** was about 2.05–2.17 at the national scale, increasing from 1.63 in tropical zone to 3.74 in cold-temperate zone. Monthly *Rs* showed a single-peak curve, and the largest values occurred in August (4.18–4.36 µmol m^{-2} s^{-1}) in cold-temperate and temperate zones, larger than the largest values in July (3.58–3.83 µmol m^{-2} s^{-1}) in subtropical and tropical zones. Mean annual soil carbon emissions decreased from tropical (1042.01 g C m^{-2} yr^{-1}), subtropical (928.91 g C m^{-2} yr^{-1}), temperate (697.85 g C m^{-2} yr^{-1}) to cold-temperate zones (684.29 g C m^{-2} yr^{-1}). This study provides basic data and scientific basis for quantitative evaluation of soil carbon emissions from forest ecosystems in China.

Author contributions. BJ designed the soil respiration dataset and searched the papers until 2018. HS and BJ collected and digitized soil respiration data and compiled the

315 associated information. HS and BJ prepared the manuscript. ZX provided many useful

316 suggestions and reviewed the paper.

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504 **Table 1.** Variable information of soil respiration dataset in China's forest ecosystems,

505 available at https://doi.pangaea.de/10.1594/PANGAEA.943617. N/A refers to values

506 that are not applicable.

Column	Description	Unit	Numbe	Range
ID	Unique identification number of each record	N/A	11297	1–11297
Province	Province location of study site	N/A	28	N/A
Study site	Name of study site	N/A	155	N/A
Latitude	Latitude (N) of study site	°	208	18.61–52.86
Longitude	Longitude (E) of study site	°	218	84.91–129.08
Elevation	Altitude of study site	m	329	7–4200
MAT	Mean annual temperature	°C	122	-5.4–23.8
MAP	Mean annual precipitation	mm	180	105–3000
Forest type	Forest community characterized by the dominant tree species, or the ecological similarities (e.g. life form and biotope)	N/A	180	N/A
Origin	Stand origin was classified into planted and natural (i.e. secondary, primary) forests	N/A	4	N/A
Age	Stand age, estimated from historical records or dominant tree rings in natural forest, defined since planting in planted forest	years	769	2–400
DBH	Mean diameter at breast height	cm	610	2.40–51.96
H_{tree}	Mean tree height	m	538	2.50–48.00
Density	Stem density and/or canopy coverage	trees ha^{-1}	548	209–17000,0.23–0.98
Instrument	Measurement instrument of Rs, i.e. gas chromatography, infrared gas analyzers (Li-6400, Li-8100, Li-8150)	N/A	4	N/A
Time	Observation time of Rs per day (Beijing time)	Hour:Minute	749	0:00–23:00
Frequency	Observation frequency of Rs, i.e. days per month	days	961	0.5–31
Area	Observation area of Rs, i.e. area of soil collar or base	cm^2	976	50–2500
Height	Height of soil collar or chamber	cm	828	4–50
Replication	Numbers of soil collar or chamber	N/A	968	1–768
Date	Observation month of Rs per year	Year-Month	10288	2000-01–2018-03
Rs	Soil respiration rate, monthly means or a few values per month	μmol m^{-2} s^{-1}	10288	0.01–11.84
T_5	Soil temperature at 5 cm depth concurrently measured with R_S	°C	6341	-16.51–33.58
T_{10}	Soil temperature at 10 cm depth concurrently measured with R_S	°C	2878	-16.40–33.46
Mode	The ways to obtain Rs data, 1. extracted with WEB PLOTDIGITIZER, 2. directly given in the original study	N/A	2	1–2
Period	Period of annual soil carbon efflux	Year-Month	631	2001-01–2018-03
Annual Rs	Annual soil carbon efflux	g C m^{-2} year^{-1}	634	260.10–2058.00
Method	Method to calculate annual soil carbon efflux, i.e. integration method and/or interpolation method	N/A	3	N/A
Reference	Data sources	N/A	568	N/A

507
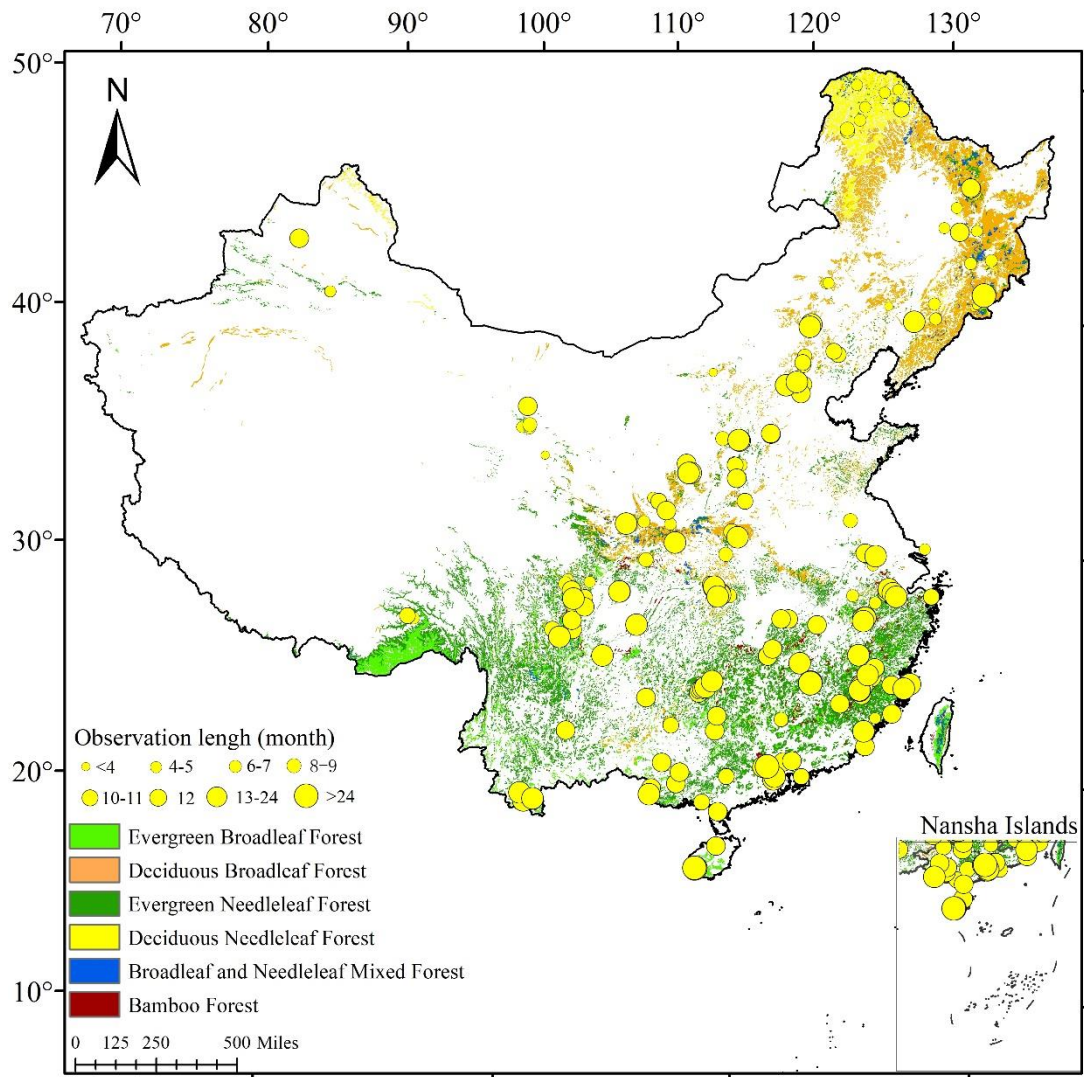
Figure 1. Distribution of study sites used to develop the forest soil respiration dataset

in China.
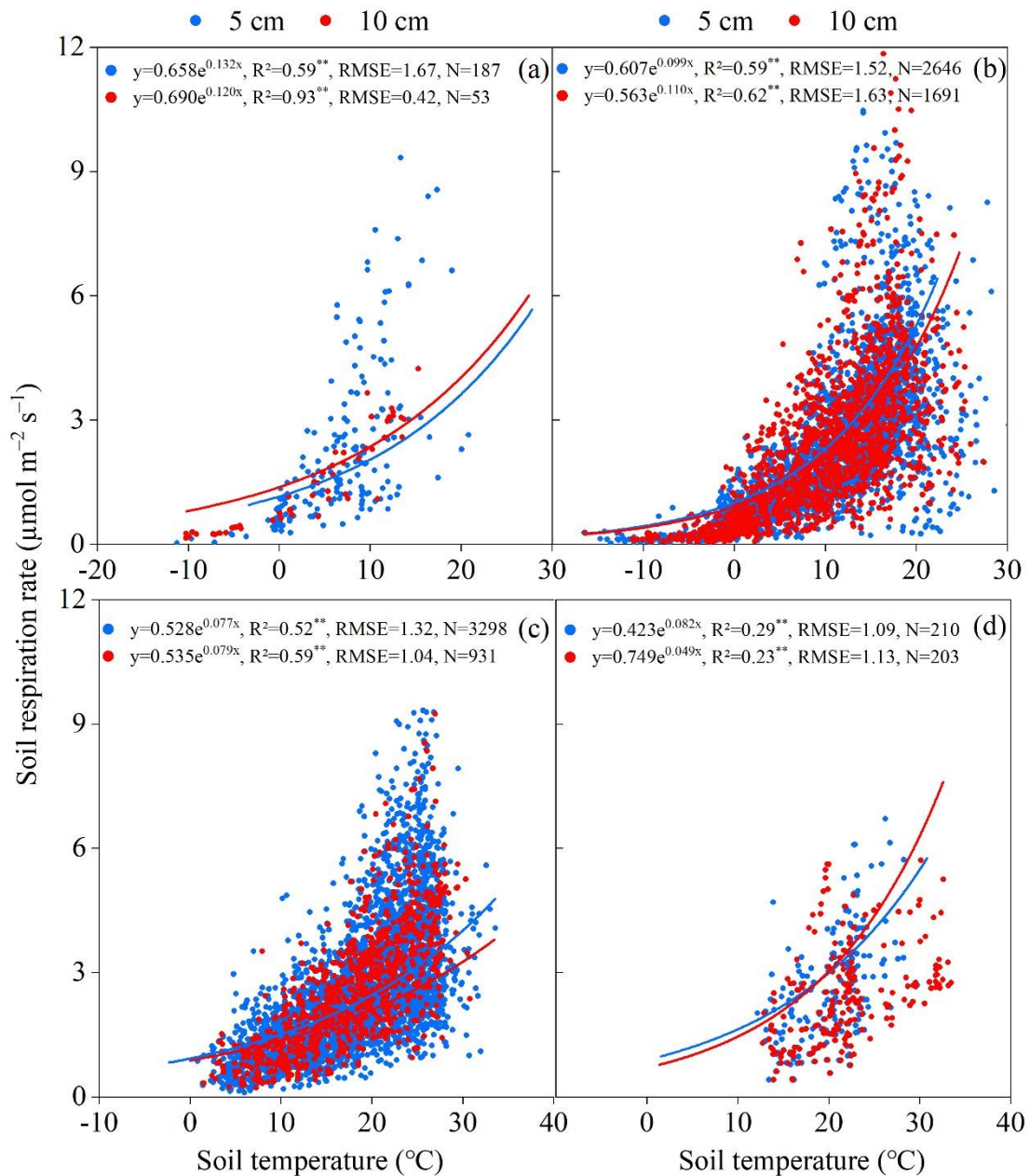
Figure 2. Exponential relationships of forest soil respiration rates with soil temperature at 5 cm depth and 10 cm depth in cold-temperate (a), temperate (b), subtropical (c) and tropical zones (d). *P* value below 0.01 was described by [**]. RMSE: Root Mean Square Error.
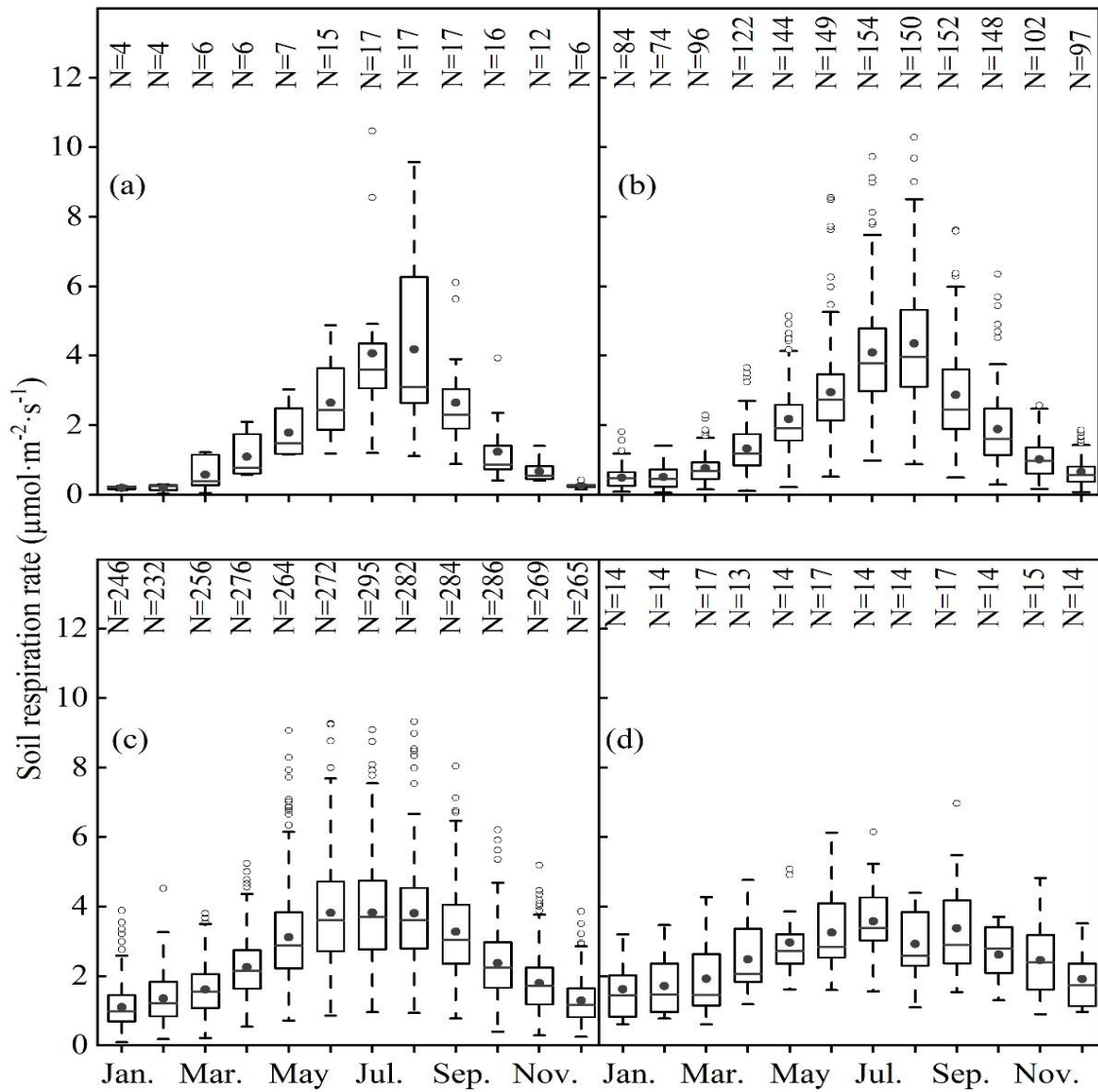
Figure 3. Monthly patterns of forest soil respiration rates in cold-temperate (a), temperate (b), subtropical (c) and tropical zones (d). Solid circle: mean value; Solid horizontal line: median; Box: 25th to 75th percentiles; Whisker: 1.5 times interquartile range; Open circle: data points beyond the whiskers. The samples per month were listed in the upper part of the figure.
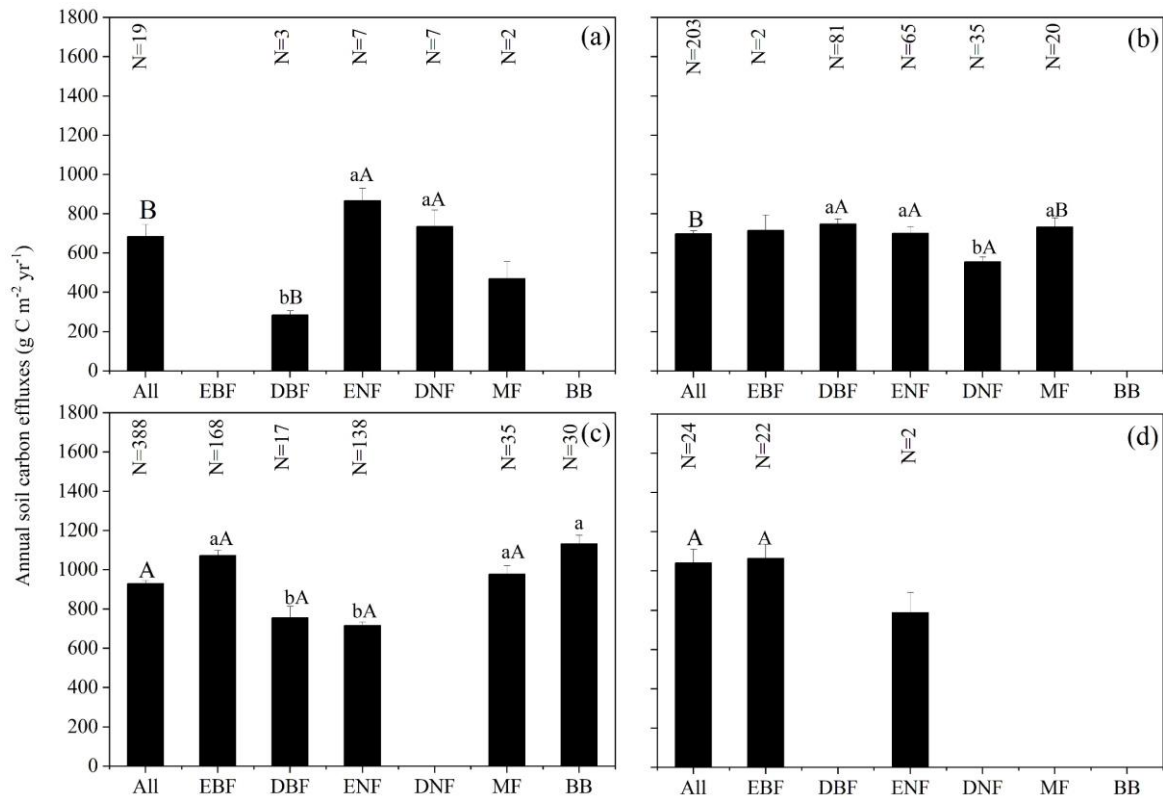
Figure 4. Comparisons of annual soil carbon effluxes (mean ± standard error) among different forest types across China in cold-temperate (a), temperate (b), subtropical (c) and tropical zones (d). Lowercase letters are the comparisons of different forest types in each climatic zone, while capital letters are the comparisons of the same forest type in different climatic zones. The samples were listed in the upper part of the figure, and the samples larger than 3 were compared. EBF: evergreen broadleaf forest, DBF: deciduous broadleaf forest, ENF: evergreen needleleaf forest, DNF: deciduous needleleaf forest, MF: broadleaf and needleleaf mixed forest and BB: Bamboo forest.