生态学报 Acta Ecologica Sinica

许飞,王传宽,王兴昌.东北东部14个温带树种树干呼吸的种内种间变异.生态学报,2011,31(13):3581~3589

东北东部14个温带树种树干呼吸的种内种间变异

Intra- and inter-specific variations in stem respiration for 14 temperate tree species in northeastern China

投稿时间：2010-11-29 最后修改时间：2011-3-29

DOI：

中文关键词: 树干表面CO_2通量 季节动态 胸径 散孔材 环孔材 针叶树

English Keywords:stem surface CO_2 efflux seasonal dynamics diameter at breast height diffuse-porous species ring-porous species coniferous species

基金项目:"十二五"科技支撑项目(2011BAD37B01)；林业公益性行业科研专项(200804001,201104009-05)；国家自然科学基金(30625010)共同资助

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中文摘要:

采用红外气体分析仪--局部通量测定法于2009年6 - 10月原位测定了东北东部山区14个温带森林主要组成树种的树干表面CO_2通量(R_W),旨在量化种内和种间R_W的差异,探索R_W随树木直径和季节的变化规律,为深入理解温带森林生态系统碳循环过程、构建和校验其模型提供基础数据。测定的树种包括:散孔材阔叶树(白桦、枫桦、山杨、紫椴、五角槭)、环孔材和半环孔材阔叶树(春榆、黄菠萝、胡桃楸、蒙古栎、水曲柳)、针叶树(兴安落叶松、红松、红皮云杉、樟子松)。结果表明:树种、月份及其交互作用均显著地影响R_W(P < 0.001)。测定期间平均R_W波动在1.32(黄菠萝)- 3.12 μmol CO_2 · m^{-2} · s^{-1}(兴安落叶松)之间,其中环孔材和半环孔材阔叶树的平均R_W高于散孔材阔叶树,而针叶树的平均R_W变异较大。各个树种R_W的平均值均呈单峰型季节变化模式,其中7月份最高、10月份最低。R_W种内的绝对变异(标准误,SE)波动在0.11 - 0.29 μmol CO_2 · m^{-2} · s^{-1}之间,相对变异(变异系数,CV)波动在61%(红皮云杉)- 89%(白桦)之间。各个树种的R_W均有随胸径(DBH)增大而增加的趋势,但两者之间的回归模型及其决定系数因树种而异。除了春榆和水曲柳之外(P > 0.05),其它树种的R_W与DBH之间的回归关系显著(P < 0.05),表明DBH可作为某些树种R_W预测和上推的一个简便实用的指标。这些结果强调了在树干呼吸能力的比较和上推估测时应充分考虑其种内种间差异的重要性。

English Summary:

The stem surface CO_2 flux (R_W) is the major component of tree autotrophic respiration, and represents tree growth activities and metabolism. The R_W variability, however, has not been well quantified for the Chinese temperate forests. The R_W was *in situ* measured for 14 major tree species coexisting in the temperate forests in northeastern China. The species included diffuse-porous species (*Betula platyphylla*, *B. costata*, *Populus davidiana*, *Tilia amurensis*, and *Acer mono*), ring- and semi-ring-porous species (*Ulmus propinqua*, *Phellodendron amurense*, *Juglans mandshurica*, *Quercus mongolica*, and *Fraxinus mandshurica*), and coniferous species (*Larix gmelinii*, *Pinus koraiensis*, *Picea koraiensis*, and *P. sylvestris* var. *mongolica*). The objective of this study was to (1) quantify intra- and inter-specific variations in R_W for the tree species, and (2) examine changes in R_W with tree diameters and seasons in order to mechanistically understand forest carbon cycling and provide solid data for developing and validating the carbon cycling model for the temperate forests. For each tree species, 12-18 trees were randomly sampled to cover as wide *DBH* (diameter at breast height) range in the stands as possible. A polyvinyl chloride collar (inner diameter 10.4 cm, height 5.0-6.0 cm) was cut and polished to fit the stem surface shape of each sample tree, and installed on the north side at breast height (1.3 m). The collar was attached with waterproof silicon adhesive to the stem surface that was pretreated without causing any injury of the live tissues, and remained in place throughout the measuring period. An infrared gas exchange analyzer (LI-6400 IRGA) was used to measure the R_W once every month from 08:00 to 17:00 within three to four consecutive sunny days during the period from June to October 2009. Stem temperature at 1 cm depth beneath the bark (T_W) was simultaneously measured with a digital thermometer. Tree species, measuring month and their interactions significantly influenced the R_W (P < 0.001). The mean R_W during the measuring period varied from 1.32 μmol CO_2 · m^{-2} · s^{-1} for *P. amurense* to 3.12 μmol CO_2 · m^{-2} · s^{-1} for *L. gmelinii*. The mean R_W for the ring- and semi-ring-porous species was greater than that for the diffuse-porous species, while the mean R_W for the coniferous species varied greatly. The mean R_W for all species showed a unimodal seasonal pattern, with the maximum and minimum occurring in July and October, respectively. The intra-specific mean absolute (standard errors) and relative variations (coefficients of variation) varied from 0.11-0.29 μmol CO_2 · m^{-2} · s^{-1} and 61%-89%, respectively. The R_W tended to increase with *DBH* increasing for all species, but the forms and determination coefficients of the regression models were species-dependent. There were significant relationships between mean R_W and *DBH* (P < 0.05) for all species except for *U. propinqua* and *F. mandshurica* (P > 0.05), suggesting that DBH be a simple and practical proxy for predicting and extrapolating tree- or stand-level R_W. This study highlights the importance of taking the intra- and inter-specific variations in R_W measurements into account in cross-comparing R_W and extrapolating chamber-based R_W measurements to tree- or stand-level estimates.

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