论文摘要2023/8/18

[RSE] Structural and species diversity explain aboveground carbon storage in forests across the United States: Evidence from GEDI and forest inventory data

结构和物种多样性解释了美国各地森林地上碳储存：GEDI和森林清单数据的证据

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摘要

Since biodiversity often increases ecosystem functioning, changes in tree species diversity could substantially influence terrestrial carbon cycling. Yet much less is known about the relationships between forest structural diversity (i.e., the number and physical arrangement of vegetation elements in a forest) and carbon cycling, and the factors that mediate these relationships. We capitalize on spaceborne lidar data from NASA's Global Ecosystem Dynamics Investigation (GEDI) and on-the-ground forest inventory and analysis (FIA) data from 1796 plots across the contiguous United States to assess relationships among the structural and species diversity of live trees and aboveground carbon storage. We found that carbon storage was more strongly correlated with structural diversity than with species diversity, for both forest inventory-based metrics of structural diversity (e.g., height and DBH diversity) and GEDI-based canopy metrics (i.e., foliage height diversity (FHD)). However, the strength of diversity-carbon storage relationships was mediated by forest origin and forest types. For both plotbased and GEDI-based metrics, the relationship between structural diversity (i.e., height diversity, DBH diversity, and FHD) and carbon storage was positive in natural forests for all forest types (broadleaf, mixed, conifer). For planted forests, structural diversity showed positive relationships in planted conifer forests but not in planted mixed forests. Species diversity did not show strong associations with carbon storage in natural forests but showed a positive relationship in mixed coniferous-broadleaf planted forests. Although plot-based structural diversity metrics refine our understanding of drivers of forest carbon balances at the plot scale, remotely sensed metrics such as those from GEDI can help extend that understanding to regional/national scales in a spatially continuous manner. Carbon storage showed stronger associations with plot-based structural diversity than with stand age, soil variables, or climate variables. Incorporating structural diversity into management and restoration strategies could help guide efforts to increase carbon storage and mitigate climate change as nature-based solutions.

由于生物多样性经常增加生态系统的功能，**树种多样性的变化可能对陆地碳循环产生重大影响**。 然而，对森林结构多样性（即森林中植被元素的数量和物理排列）与碳循环之间的关系以及调解这些关

系的因素知之甚少。 我们利用NASA全球生态系统动力学调查（GEDI）的**太空载激光雷达数据**和来自美国毗连地区1796地块的**地面森林清单和分析（FIA）数据**，评估活树结构和物种多样性与地上碳储存之间的关系。 我们发现**碳储存与结构多样性的相关性**比与物种多样性的相关性**更强**，因为基于森林库存的结构多样性指标（例如，高度和DBH多样性）和基于GEDI的冠层指标（ 然而，多样性-碳储存关系的强度是由森林起源和森林类型介导的。 对于基于绘图和基于GEDI的指标，所有森林类型（阔叶，混合，针叶）的结构多样性（即高度多样性，DBH多样性和FHD）与天然林碳储存之间的关系都是积极的。 就人工林而言，结构多样性在人工针叶林中表现出积极的关系，但在人工混交林中则不然。 **物种多样性与天然林中的碳储存没有很强的关联，但在混合针叶-阔叶人工林中表现出积极的关系。** 虽然基于地块的结构多样性指标改善了我们对地块规模森林碳平衡驱动因素的理解，但**像GEDI这样的遥感指标可以帮助以空间连续的方式将这种理解扩展到区域/国家尺度**。 与固定年龄，土壤变量或气候变量相比，碳储存与基于地块的结构多样性表现出更强的关联。 将结构多样性纳入管理和恢复战略可以帮助指导增加碳储存和减缓气候变化的努力，作为基于自然的解决方案。

Keywords

Biodiversity 生物多样性

Biomass 生物量

Carbon stocks 碳库存

FIA

Foliage height diversity 树叶高度多样性

International Space Station 国际空间站

Lidar 雷达

Species diversity 物种多样性

Structural diversity 结构多样性

Temperate forests 温带森林

引用

Erin T.H. Crockett, Jeff W. Atkins, Qinfeng Guo, Ge Sun, Kevin M. Potter, Scott Ollinger, Carlos A. Silva, Hao Tang, Christopher W. Woodall, Justin Holgerson, Jingfeng Xiao,

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[RSE] Multi-city assessments of human exposure to extreme heat during heat waves in the United States

美国热浪期间人类暴露于极端热量的多城市评估

【RS+GIS，1m分辨率】

摘要

There is a lack of understanding of the complex spatiotemporal patterns of heat exposure during heat waves, and the impact of urbanization intensity and urban morphology on heat exposure in urban thermal environments. To address these issues, this study used mean radiant temperature (Tmrt) as an index to indicate human exposure to extreme heat, and generated hourly heat exposure maps at a 1-m spatial resolution in Summer 2020 for heat wave and non-heat wave days across three diversely urbanized and climatically different U.S. cities (Riverside, CA; Des Moines, IA; and Boston, MA) using the SOlar LongWave Environmental Irradiance Geometry (SOLWEIG) model and multi-source remote sensing and GIS data. Based on these high-frequency and microscale maps, we found that heat exposure in urban canyons of downtown areas was high due to relatively low building's height to street's width (H/W) ratio, which resulted in a limited shading effect in the studied cities. Heat exposure during heat waves was enhanced by 6 degrees C to 10 degrees C compared to non-heat wave conditions, with the main differences occurring in the early afternoon between 12 pm and 2 pm. We found that hot cities (Riverside, 63 degrees C) had higher heat exposure than warm cities (Des Moines and Boston, 53 degrees C and 51 degrees C) during heat waves. Heat exposure in urban core areas was approximately 5C higher than that in rural areas during heat waves. Additionally, we found that sky view factor was the most important urban morphology factor influencing heat exposure, with a relative importance of over 67% in these cities, but the role of impervious surface and trees varied among these cities. Impervious surface area (ISA) contributed more to heat exposure than trees in dry and hot regions (Riverside), but not in humid and warm cities (Des Moines and Boston). This study is the first to generate hourly heat exposure maps at a 1-m resolution for heat wave and non-heat wave days, and to investigate spatiotemporal patterns and the impacts of urbanization intensity and urban morphology on heat exposure in multiple cities. The findings of this study can be useful in developing urban policies to improve urban thermal environments in diverse urban settings, and our transferable framework can potentially be applied to other cities for heat exposure studies.

对热浪期间**热暴露的复杂时空模式**以及**城市化强度和城市形态对城市热环境中热暴露的影响**缺乏了解。 为了解决这些问题，本研究使用**平均辐射温度（Tmrt）**作为指示人类暴露于极端高温的指标，并在**2020**夏季以**1-m空间分辨率**生成**每小时热暴露地图**，用于**三个不同的城市化和气候不同的美国城市（Riverside，CA;得梅因，IA; 和BOSTON，MA）**使用**太阳长波环境辐照度几何（SOLWEIG）模型**和**多源遥感和GIS数据**。 基于这些高频和微尺度地图，我们发现**由于建筑物高度与街道宽度（H/W）比率相对较低，市中心地区城市峡谷的热暴露较高，导致研究城市的阴影效果有限**。 与非热浪条件相比，**热浪期间的热暴露增强了6摄氏度至10摄氏度，主要差异发生在下午12点至2点之间**。 我们发现，在热浪期间，炎热的城市（河滨，63摄氏度）的热暴露高于温暖的城市（得梅因和波士顿，53摄氏度和51摄氏度）。 在热浪期间，**城市核心地区的热暴露比农村地区高出约5C**。 此外，我们发现**天空景观因素**是影响热暴露的最重要的城市形态因素，在这些城市中相对重要性超过67%，但**不透水表面和树木的作用**在这些城市中各不相同。 **不透水表面积（ISA**）比干燥和炎热地区（河边）的树木**对热暴露的贡献更大**，但在潮湿和温暖的城市（得梅因和波士顿）则不然。 这项研究是第一个以1-m分辨率为热浪和非热浪日生成每小时热暴露图的研究，并研究时空模式以及城市化强度和城市形态对多个城市热暴露的影响。 这项研究的结果可能有助于制定城市政策，以改善不同城市环境中的城市热环境，我们的可转移框架可能适用于其他城市进行热暴露研究。

关键词

Heat exposure 热暴露

Heat wave 热浪

Urban heat island 城市热岛

Morphology 形态学

SOLWEIG model

引用

Jia Hu, Yuyu Zhou, Yingbao Yang, Gang Chen, Wei Chen, Mohamad Hejazi,

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[IJAEOG] Using Landsat time series and bitemporal GEDI to compare spectral and structural vegetation responses after fire

使用**Landsat时间序列**和双时GEDI比较火灾后的**光谱和结构植被响应**

【Landsat】

摘要

Passive and active spaceborne remote sensing technologies play a key role in monitoring forests across large areas, particularly when combining the advantages of both sensor technologies. This study investigates the link between spectral and structural change metrics following forest fire disturbance, collected from Landsat satellites and the Global Ecosystem Dynamics Investigation (GEDI) mission, respectively. The relationships were analysed across 1849 GEDI sampling locations (footprints), spread across south-east Australian forests. To assess structural change on the footprint level, simulated pre-fire GEDI observations were compared with real GEDI observations from one year after the fires. Results show relatively strong fire responses across Landsat spectral indices, with a median decline to between 46.1 % (Normalised Burn Ratio 2) and 77 % (Normalised Difference Vegetation Index) of pre-fire levels. GEDI's structural change metrics demonstrated a markedly different response, with most showing an even more pronounced decline. In contrast, canopy height demonstrated a less substantial decline, dropping to 82.7 %. Results also suggest that fire severity and forest type impact the fire response of some of the examined spectral and structural metrics. In particular, taller forests and increased fire severity were associated with a more pronounced post-fire decline. The findings of this study highlight the large variation of forest structural responses to fire and their divergence from spectral change metrics, and emphasise the potential of integrating GEDI observations into wall-to-wall spectral forest change monitoring. The concept of bi-temporal GEDI observations as demonstrated in this study is promising, as it captures both pre-and post-disturbance structure on the footprint level and might enhance modelling of forest structural change in future approaches.

被动和主动星载遥感技术在监测大面积森林方面发挥着关键作用，特别是在结合两种传感器技术的优点时。 这项研究调查了森林火灾干扰后的光谱和结构变化指标之间的联系，这些指标分别从Landsat卫星和全球生态系统动力学调查（GEDI）任务中收集。 对分布在澳大利亚东南部森林的1849个GEDI采样点（足迹）的关系进行了分析。 为了评估足迹水平上的结构变化，将模拟的火灾前GEDI观测值与火灾后一年的真实gedi观测值进行了比较。 结果显示，**Landsat光谱指数的火灾响应相对较强**，中位下降至火灾前水平的46.1%（标准化燃烧比率2）和77%（标准化差异植被指数）之间。 **GEDI的结构变化指标表现出明显不同的反应，其中大多数表现出更明显的下降**。 相比之下，冠层高度下降幅度较

小，降至82.7%。 结果还表明，**火灾严重程度和森林类型**影响了一些已检查的光谱和结构指标的火灾响应。 特别是，较高的森林和火灾严重程度的增加与更明显的火灾后下降有关。 这项研究的结果突出了**森林结构对火灾的巨大变化及其与光谱变化指标的差异**，并强调了将GEDI观测纳入墙对墙光谱森林变化监测的潜力。 这项研究所展示的双时GEDI观测的概念是有希望的,因为它捕获了足迹水平上的干扰前和干扰后结构,并可能加强未来方法中森林结构变化的模型。

关键字

GEDI

Simulator 仿真器

Multi-temporal 多时相

Vegetation fire response 植被火灾响应

Landsat

引用

Sven Huettermann, Simon Jones, Mariela Soto-Berelov, Samuel Hislop,

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