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| **Linking canopy and surface fuels: advancing spatial mapping in fire-maintained forest ecosystems** |
| **Introduction/Aim:**  Large-scale mapping of canopy, surface, and ground fuels is needed to support forest management decisions, fire and smoke modeling, and carbon monitoring. Remote sensing, particularly laser scanning systems, is the most cost-effective technology for describing overstory biomass. However, direct estimation of surface and ground fuels is hindered by canopy occlusion and the low sensitivity of these sensors to discriminate the ground from dead and live vegetation on the lowest stratum of the forest floor. Canopy fuels influence the accumulation, structure, and composition of dead surface fuels (i.e., litter and downed woody debris), while these surface fuels further break down and decompose into duff (i.e., partially to fully decomposed organic material). Methods that couple surface and ground fuel inputs to the overstory tree crowns and apply ecological concepts to quantitatively describe the fuel accumulation process have demonstrated potential to capture much of the inherent heterogeneity observed on the forest floor.  **Methods and Results:**  Herein, we describe a comprehensive modeling framework for mapping surface and ground fuel accumulation by leveraging information on canopy structure characterized by airborne laser scanning (ALS) data. Study sites are fire-maintained longleaf pine forests located in Florida, Georgia, and South Carolina (southeastern USA), where prescribed fire is used as a management tool. Our methodology involves first segmenting tree crowns from ALS data and mapping branch and foliage biomass. We partition the total crown biomass into components corresponding to leaves and fine branches using allometric equations and TLS-derived estimates of the proportion of wood components that are in turn upscaled to the tree crown objects segmented from ALS data. We quantify both annual production of these fine fuels and their accumulation using a spatially explicit implementation of the Olson accumulation model (Olson, 1963). The duration of surface fuel accumulation is defined with prescribed fire records and decomposition rates are derived from climate information and literature. Coarse woody debris is incorporated on the surface fuel pool by defining mortality rates assessed from National Forest Inventory (NFI) plot data. We finally simulate duff formation from the breakdown of all these surface fuel components using a soil organic carbon model (Liski et al., 2005).  This modeling workflow enables mapping fine fuel loads at high spatial resolution (≤ 5m), partially resolving the limitations of current methods to describe the inherently heterogeneous surface fuelbed layer in a spatially explicit manner. This project remains in progress to improve the estimates of the different fuel components across different locations. We aim to expand this modelling workflow to other ecosystems such as western sites of the US and applications such as simulation of fuel loads with synthetic forests.  **Conclusion:**  Models such as this can already support decision-making to balance management and ecological needs in the study sites, ensuring the good functioning and maintenance of the ecosystem services, increasing fire resilience, and reducing fire risk.  **References:**  Liski, J., Palosuo, T., Peltoniemi, M., Sievänen, R., 2005. Carbon and decomposition model Yasso for forest soils. Ecol. Model. 189, 168–182.  Olson, J.S., 1963. Energy storage and the balance of producers and decomposers in ecological systems. Ecology 44, 322–331.  https://doi.org/10.1016/j.ecolmodel.2023.110369 |