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# Characterizing leaf area index (LAI) and vertical foliage profile (VFP) over the United States

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Supplement

Leaf Area Index (LAI) is derived from the footprint-level lidar waveform based on beer's law (Equation S1), where $\mathrm{P}(0)$ is the total canopy gap fraction, $G$ is the projection coefficient, and $C$ is a the clumping index which adjusts the linear relationship between effective LAI and true LAI (Chen et al. 1997). The term $\mathrm{R_v}(0)$ and $\mathrm{R_g}$ are the integrated laser energy returns from the canopy and ground respectively, and can be calculated using a Gaussian decomposition method (Hofton et al. 2000). The $\rho_v/\rho_g$ is the ratio of canopy and ground reflectance, and can be estimated using a recursive method (Armston et al. 2013; Tang et al. 2014b).

Vertical Foliage Profile (VFP) is calculated as the integration of vertical foliage density from canopy height $Z_1$ to $Z_2$ (Equation S2), and the vertical foliage density is derived from the vertical distribution of canopy gap probability P(z) (Equation S3) (Ni-Meister et al. 2001; Tang et al. 2014a; Tang et al. 2012).

$$\mathrm{LAI} = \frac{\mathrm{C}}{\mathrm{G}} * \ln\big(1 - \mathrm{P}(0)\big) = \frac{\mathrm{C}}{\mathrm{G}} * \ln\left(1 + \frac{\mathrm{R_v}(0)}{\frac{\rho_v}{\rho_g} \times \mathrm{R_g})}\right) \qquad \text{(S1)}$$

$$\mathrm{VFP}(\mathrm{z_1} \sim \mathrm{z_2}) = \int_{\mathrm{z_1}}^{\mathrm{z_2}} \frac{\mathrm{C}}{\mathrm{G}} * \frac{d\, logP(z)}{dz} \mathrm{dz} \qquad \text{(S2)}$$

$$\mathrm{P}(z) = 1 - \frac{\mathrm{R_v(z)}}{\mathrm{R_v}(0)} \frac{1}{1 + \frac{\rho_v}{\rho_g} \frac{\mathrm{R_g}}{\mathrm{R_v}(0)}} \qquad \text{(S3)}$$

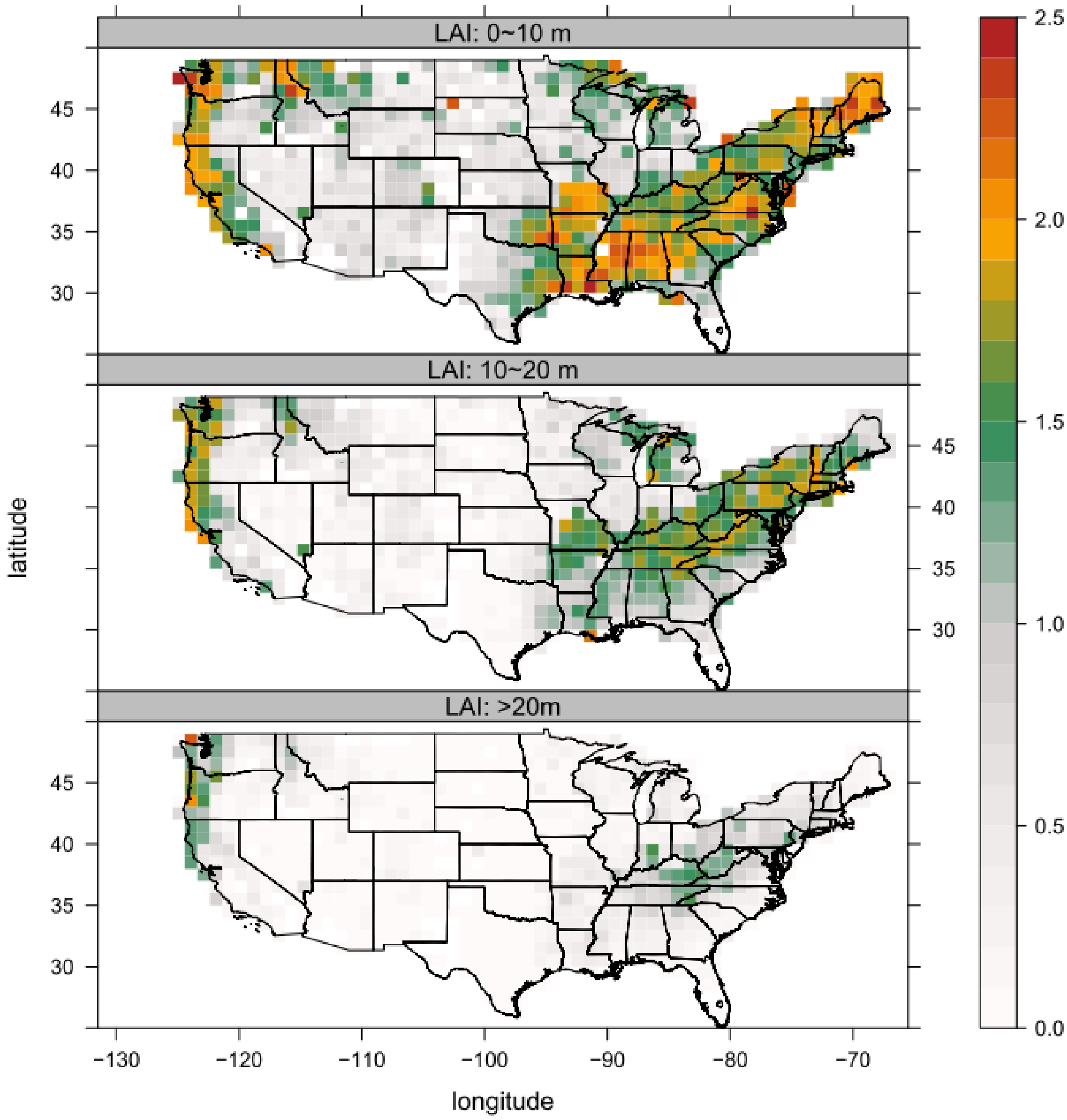


Figure S1. LAI strata distributions aggregated at 1 degree gridded cell. It shows similar spatial distributions of vertical LAI profiles towards those in Fig. 6.

Reference


Armston, J., Disney, M., Lewis, P., Scarth, P., Phinn, S., Lucas, R., Bunting, P., & Goodwin, N. (2013). Direct retrieval of canopy gap probability using airborne waveform lidar. *Remote Sensing of Environment, 134*, 24-38

Chen, J.M., Rich, P.M., Gower, S.T., Norman, J.M., & Plummer, S. (1997). Leaf area index of boreal forests: Theory, techniques, and measurements. *Journal of Geophysical Research, 102*, 29429-29443

Hofton, M.A., Minster, J.B., & Blair, J.B. (2000). Decomposition of laser altimeter waveforms. *IEEE Transactions on Geoscience and Remote Sensing, 38*, 1989-1996

Ni-Meister, W., Jupp, D.L.B., & Dubayah, R. (2001). Modeling lidar waveforms in heterogeneous and discrete canopies. *IEEE Transactions on Geoscience and Remote Sensing, 39*, 1943-1958

Tang, H., Brolly, M., Zhao, F., Strahler, A.H., Schaaf, C.L., Ganguly, S., Zhang, G., & Dubayah, R. (2014a). Deriving and validating Leaf Area Index (LAI) at multiple spatial scales through lidar remote sensing: A case study in Sierra National Forest, CA. *Remote Sensing of Environment, 143*, 131-141

Tang, H., Dubayah, R., Brolly, M., Ganguly, S., & Zhang, G. (2014b). Large-scale retrieval of leaf area index and vertical foliage profile from the spaceborne waveform lidar (GLAS/ICESat). *Remote Sensing of Environment, 154*, 8-18

Tang, H., Dubayah, R., Swatantran, A., Hofton, M., Sheldon, S., Clark, D.B., & Blair, B. (2012). Retrieval of vertical LAI profiles over tropical rain forests using waveform lidar at La Selva, Costa Rica. *Remote Sensing of Environment, 124*, 242-250