# Process-based hierarchical models for coupling high-dimensional LiDAR and forest variables over large geographic domains

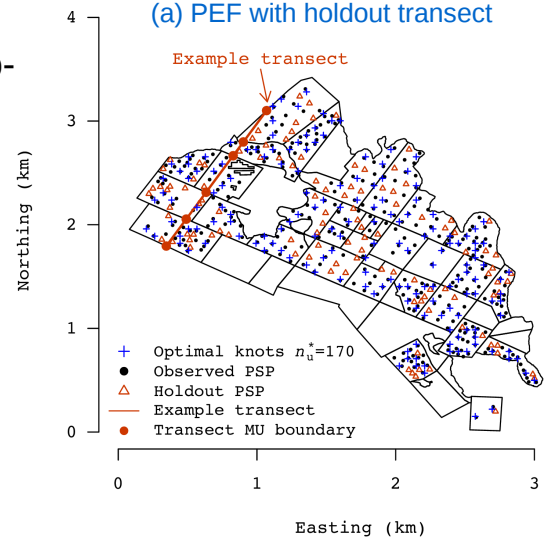
**Challenge:** Few methods are available to deliver wall-to-wall forest variable prediction, e.g., above ground biomass (AGB), with associated uncertainty, using spatially sparse inventory plot data and partial coverage remotely sensed data (e.g., LiDAR transects/strips).

**New methods:** We detail a process-based Bayesian hierarchical model to jointly model AGB and LiDAR signals. The proposed framework address:

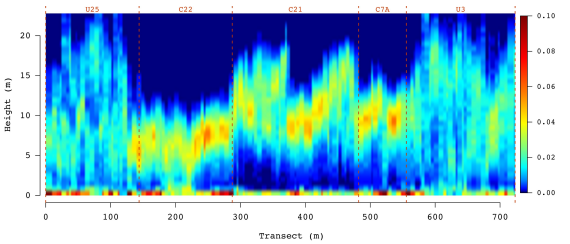
(1) spatial misalignment between the AGB observations and LiDAR signals,
(2) optimal and automated selection of LiDAR signal covariates,
(3) prediction of both AGB and LiDAR signal at any location in the domain,
(4) prediction uncertainty quantification for both AGB and LiDAR signals,
(5) high-dimensional datasets.

**Significance:** Given the anticipated availability of sampling LiDAR and hyperspectral data products (e.g., not wall-to-wall coverage), the proposed model provides a statistically valid approach to use information where available to deliver improved wall-to-wall prediction products with uncertainty.

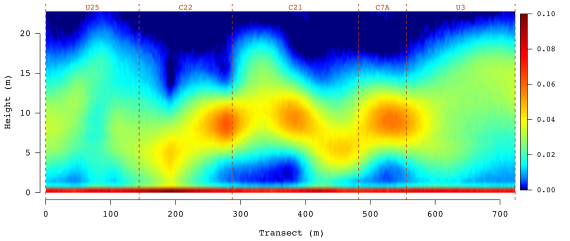
(a) PEF with holdout transect



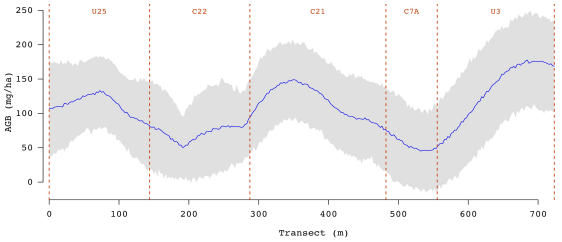

(b) PEF holdout transect G-LiHT signals



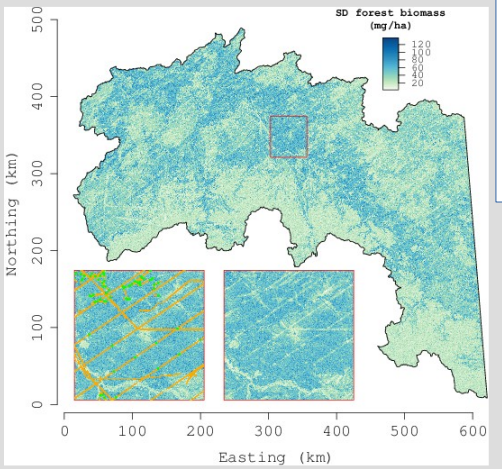

(c) PEF predicted G-LiHT signals

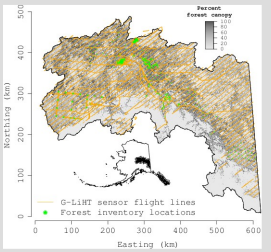



(d) PEF predicted AGB (mg/ha)




(e) Tanana standard deviation of predicted AGB




(f) Tananal G-LiHT flight transects and forest inventory plot locations

**Illustrations:** The proposed model was assessed using LiDAR data acquired from NASA G-LiHT and field inventory data from the Penobscot Experimental Forest (PEF) in Bradley, Maine and Tanana, Alaska.

CMS publication from: Hurtt-03, Dubayah-04, Morton-02, Cook-B-01


Finley, A.O., S. Banerjee, Y., Zhou, B.D. Cook. (2016) Process-based hierarchical models for coupling high-dimensional LiDAR and forest variables over large geographic domains. http://arxiv.org/abs/1603.07409