Geophysical Research Abstracts
Vol. 20, EGU2018-5692, 2018
EGU General Assembly 2018

Tracking tree mortality from Alaska to the Amazon with repeat airborne lidar surveys

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The size and frequency of canopy gaps from tree mortality are fundamental controls on forest demography. Forest inventory plots track long-term changes in mortality rates, including both canopy and understory trees, but provide a sparse spatial and temporal sample of landscape conditions that influence tree mortality. Airborne remote sensing alleviates some of the constraints on frequent inventory measurements over large areas, with distinct advantages for characterizing heterogeneous canopy-tree responses to extreme events. Here, we combine data from NASA Goddard's lidar, hyperspectral, and thermal (G-LiHT) Airborne Imager with existing small-footprint lidar surveys to evaluate patterns of canopy tree mortality across tropical, temperate, and boreal forests. Intervals of 1-5 years between lidar surveys capture background tree mortality across gradients of forest age, topography, and climate. In addition, repeat lidar surveys following drought or storm damages provide an estimate of the upper bound for synchronized canopy tree disturbances. For example, canopy turnover in nine old-growth Amazon forests ranged from 1.2 to 4.6% per year in periods with average precipitation. During the 2015-2016 El Niño drought, canopy turnover increased by 60%, on average, in both intact and fragmented Amazon forests. At each study site, we use the combination of forest inventory and lidar data to calibrate the relationship between canopy turnover and mortality of canopy and understory trees. These findings provide estimates of changing canopy tree turnover by forest type, age, and landscape position to contextualize inventory measurements, examine the impact of extreme events, and model changes in forest structure and demography.