Relationship between LiDAR-derived canopy layering and rainfall redistribution in forests varies with scale

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**Recommended Citation**

Cirincione, Daniel, "Relationship between LiDAR-derived canopy layering and rainfall redistribution in forests varies with scale" (2016). *Georgia Southern University Research Symposium*. 11.

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1. Significance

The arrangement of forest canopy structures intercepts and re-routes rainfall (as throughfall). The resulting spatial patterns in throughfall can affect a variety of hydrological processes, including: infiltration, stormwater runoff, soil microbial communities, and soil moisture dynamics. This affects processes of societal concern:

- How much, and when, runoff occurs
- How quickly streams respond to rainfall
- How much soil erosion occurs from storms
- How much is spent on stormwater infrastructure

2. Objectives

(A) Quantify patterns in forest canopy layering with terrestrial LiDAR.
(B) Measure fine-scale throughfall variability across 100 locations distributed throughout the forest plot by roving 70 gauges between storms.
(C) Determine scale at which LiDAR-derived canopy layers significantly relate to fine-scale throughfall observations.

3. Study Site (Ogeechee River Floodplain)

(Voxelization)

4. Methods

Leica High Definition Scanner C10  Tipping buckets  Manual throughfall gauges

5. Results

Terrestrial LiDAR data processing results:

Throughfall results:

- Throughfall and spatially-averaged voxel layers.

To find the scale at which canopy layering can significantly affect throughfall amount (p<0.05), we averaged values above each gauge using 0.25x0.25 m², 0.5x0.5 m² and 1x1 m² areas.

Results show that normalized throughfall generally decreases as voxel layers increase. But, the relationship is insignificant (and not consistently inverse) when considering canopy layers immediately overhead (0.25x0.25 m²). When averaging layers derived from several voxel profiles at 1x1 m², the relationship between canopy layers and throughfall observations becomes significant.

Example intrastorm throughfall on 10-Oct-2015.

Automated throughfall gauges with heavy layering above (averaged from voxel profiles at 1x1 m²) record lower throughfall values due to high interception.