G-LiHT Plot-Scale LiDAR Metrics

Last Revised 12 November 2020

RETURNS	TAG	DESCRIPTION	UNITS
All	all_d0...all_d9	Density deciles (10% increments) of *all* returns	Fraction
	all_kurt	Kurtosis of *all* return heights	meters
	all_mean	Mean of *all* return heights	meters
	all_p10...all_p100	Height percentiles (10% increments) of *all* returns [3]	meters
	all_qmean	Quadratic mean of *all* return heights	meters
	all_refl_max	Maximum relative reflectance of *all* single returns	fraction
	all_refl_mean	Mean relative reflectance of *all* single returns	fraction
	all_skew	Skewness of *all* return heights	meters
	all_stdev	Standard deviation of *all* return heights	meters
	chm_mean	Mean canopy height from 1m CHM	meters
	chm_rugosity	Standard deviation of canopy height from 1 m CHM	meters
	dsm_mean	Mean canopy elevation from 1 m DSM (DTM+CHM)	meters
	dsm_rugosity	Standard deviation of canopy elevation from 1 m DSM	meters
	pulse_density	Laser pulse density	pulses m^{-2}
	pulse_scan_angle	Mean laser pulse scan angle (from nadir)	degrees
	returns_per_pulse	Mean number of returns per laser pulse	counts
Shrub	shrub_mean	Mean of *shrub* return heights	meters
	shrub_refl_max	Maximum relative reflectance of *shrub* single returns	fraction
	shrub_refl_mean	Mean relative reflectance of *shrub* single returns	fraction
	shrub_stdev	Standard deviation of *shrub* return heights	meters
Tree	tree_aad	Mean Absolute Deviation [1]; (AAD = mean(|height - mean height|) of *tree* returns	meters
	tree_crr	Canopy Relief Ratio [1,2]; (CRR = mean-min:max-min) of *tree* returns	unitless
	tree_d0...tree_d9	Density deciles (10% increments) of *tree* returns	fraction
	tree_fcover	Fraction of first returns intercepted by *tree*	fraction
	tree_fract_all	Fraction of *all* returns classified as *tree*	fraction
	tree_iqr	Interquartile range (tree_p75-tree_p25) of *tree* returns	meters
	tree_kurt	Kurtosis of *tree* return heights	meters
	tree_mad	Median Absolute Deviation [1]; (MAD = median(|height - median height|) of *tree* returns	meters
	tree_mean	Mean of *tree* return heights	meters
	tree_p10...tree_p100	Height percentiles (10% increments) of *tree* returns [3]	meters
	tree_qmean	Quadratic mean of *tree* return heights	meters
	tree_refl_max	Maximum relative reflectance of *tree* single returns	fraction
	tree_refl_mean	Mean relative reflectance of *tree* single returns	fraction
	tree_skew	Skewness of *tree* return heights	meters
	tree_stdev	Standard deviation of *tree* return heights	meters
	tree_vdr	Vertical Distribution Ratio (normalized height range between canopy top and median *tree* returns [4]; [tree_p100-tree_p50]/tree_p100)	unitless
	nmbu_d0...nmbu_d9	Density deciles (10% increments) of *tree* returns [3]	fraction
Ground	ground_aspect	Aspect derived from 1 m DTM	degrees

	ground_elev_mean	Mean of *ground* return elevations	meters
	ground_refl_max	Maximum relative reflectance of *ground* single returns	fraction
	ground_refl_mean	Mean relative reflectance of *ground* single returns	fraction
	ground_slope	Mean slope derived from 1 m DTM	degrees

Definitions:

CHM = Canopy Height Model (typically 1 m spatial resolution)
DTM = Digital Terrain Model (typically 1 m spatial resolution)
Elevation = height above EGM96 (Earth Gravitational Model 1996) geoid
Height = height above ground surface
Shrub returns = non-ground returns below 1.37 meters
Tree returns = returns above 1.37 meters
Reflectance (ρ) *value* = instrument calibrated, range corrected reflectance value for first, single return laser shots

Selected references:

1. BCAL LiDAR tools, http://code.google.com/p/bcal-lidar-tools/.

2. Evans, J., Hudak, A., Faux, R. and Smith, A.M., 2009. Discrete Return Lidar in Natural Resources: Recommendations for Project Planning, Data Processing, and Deliverables. Remote Sensing, 1(4): 776-794.

3. Density deciles are computed using two different methods, where d0 is closest to the ground and d9 is closest to the top of the canopy:

a) all_d0…d9 and tree_d0..d9 use ten, equally-sized bins between minimum height threshold (ground for "all", and DBH for "tree") and maximum return height; and
b) nmbu_d0…d9 uses ten bins between DBH and P95, and returns >P95 are added to the topmost bin (D9).

The later method (3b) is used by Eric Næsset and Terje Gobakken, Norwegian University of Life Sciences (NMBU).

4. Goetz, S., D. Steinberg, R. Dubayah, B. Blair. 2007. Laser remote sensing of canopy habitat heterogeneity as a predictor of bird species richness in an eastern temperate forest, USA. Remote Sensing of Environment 108: 254-263. doi:10.1016/j.rse.2006.11.016.