G-LiHT LiDAR Plot-Scale Metrics

RETURNS	TAG	DESCRIPTION	UNITS
All	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
	all_mean	Mean of *all* return heights	meters
	all_qmean	Quadratic mean of *all* return heights	meters
	all_stdev	Standard deviation of *all* return heights	meters
	all_skew	Skewness of *all* return heights	meters
	all_kurt	Kurtosis of *all* return heights	meters
	all_p10...all_p100	Height percentiles (10% increments) of *all* returns [3]	meters
	all_d0...all_d9	Density deciles (10% increments) of *all* returns [3]	fraction
	all_refl_max	Maximum relative reflectance of *all* single returns	fraction
Shrub	shrub_mean	Mean of *shrub* return heights	meters
	shrub_stdev	Standard deviation of *shrub* return heights	meters
	shrub_refl_max	Maximum relative reflectance of *shrub* single returns	fraction
Tree	tree_mean	Mean of *tree* return heights	meters
	tree_qmean	Quadratic mean of *tree* return heights	meters
	tree_stdev	Standard deviation of *tree* return heights	meters
	tree_rugosity	Standard deviation of gridded CHM values	meters
	tree_skew	Skewness of *tree* return heights	meters
	tree_kurt	Kurtosis of *tree* return heights	meters
	tree_qmean	Quadratic mean of *tree* return heights	meters
	tree_fcover	Fraction of first returns intercepted by *tree*	fraction
	tree_fract_all	Fraction of *all* returns classified as *tree*	fraction
	tree_p10...tree_p100	Height percentiles (10% increments) of *tree* returns [3]	meters
	tree_d0...tree_d100	Density deciles (10% increments) of *tree* returns [3]	fraction
	tree_iqr	Interquartile range (tree_p75-tree_p25) of *tree* returns	meters
	tree_vdr	Vertical Distribution Ratio (normalized height range between canopy top and median *tree* returns [4]; [tree_p100-tree_p50]/tree_p100)	unitless
	tree_mad	Median Absolute Deviation [1]; (MAD = median(|height - median height|) of *tree* returns	meters
	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_refl_max	Maximum relative reflectance of *tree* single returns	fraction
Ground	ground_elev_mean	Mean of *ground* return elevations	meters
	ground_slope	Mean slope derived from gridded DTM	degrees
	ground_aspect	Aspect derived from gridded DTM	degrees
	ground_refl_max	Maximum relative reflectance of *ground* single returns	fraction

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. Næsset, 2002. Predicting Forest Stand Characteristics with Airborne Scanning Laser using a Practical Two-stage Procedure and Field Data. Remote Sensing of Environment 80:88-99.

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.