METADATA FOR NASA GODDARD'S LIDAR, HYPERSPECTRAL AND THERMAL (G-LiHT) AIRBORNE IMAGER v2.0

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1) CONTACT INFORMATION
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2) CAMPAIGN INFORMATION
Date(s): 7 - 14 June 2017
Time of day: Targeted +/-3 hours from solar noon
Location: Various forests in ME, MA, NH, NY and RI)
Description: Mapping of semi-urban forests with signs of insect damage
Research project: Forest Health Protection
Funding source: USFS Durham Field Office

3) FLIGHT PLANS
Large mapping areas with 30% overlap of high interest semi-urban areas with history of insect damage.

4) ACQUISITION DETAILS
Aircraft: USFS C206 (N166Z)
Pilot: Mary Verry, USFS
G-LiHT operator(s): Larry Corp, NASA GSFC
Nominal altitude (AGL): 335 m AGL
Nominal velocity: 110-150 kt
Other:

5) FIELD OBSERVATIONS
Weather: Variable sky conditions
Other notes: VFR

6) OUTPUT FILE NAME(S)
Loudon_Jun2017

7) DATA PRODUCTS
GPS-INS
Trajectory: Aircraft location and orientation (roll, pitch, yaw). Available as 3D Google Earth overlay (KML) and 250 Hz data product (ASCII).

LiDAR
Canopy Height Model: Lidar-derived maximum canopy height (m AGL) and canopy rugosity (i.e., standard deviation of heights within an area equivalent to a 1/24 ac USFS-FIA subplot). Available as Google Earth overlay (KML) and raster data product (GeoTIFF) at a nominal 1 m spatial resolution.

Digital Terrain Model: Lidar-derived bare earth elevation (m, EGM96 geoid), aspect and slope. Available as Google Earth overlay (KML) and raster data product (GeoTIFF) at a nominal 1 m spatial resolution.

Lidar Apparent Reflectance: Mean reflectance for all, single returns from a 1550 nm laser. The lidar is factory calibrated and data corrected for ranging distance, but not scan angle or atmospheric interactions. Available as raster data product (GeoTIFF) at a nominal 1 m spatial resolution.

Lidar Point Cloud: Individual lidar return data, including 3D coordinates; classified ground returns ("Classification" field); AGL heights ("Point Source ID Text" field, using z scale factor and offsets); lidar apparent reflectance ("Intensity" field; -25 to 5 dB for 2 byte range); and lidar ID ("User" field; 1=old, 2=new). Overlapping swaths are co-aligned with coincident ground returns to remove swath-to-swath elevation biases. Available in ASPRS LAS 1.1 format.

Lidar Metrics: Common lidar height, density, fractional cover and return statistics (e.g., mean pulse density, returns per pulse) for all returns +/- 30 degrees of nadir. Available as raster data product (GeoTIFF) at a nominal 13 m spatial resolution (area equivalent to a 1/24 ac USFS-FIA subplot).

Image Spectrometer

All VNIR (418 to 918 nm, 4.5 nm sampling interval) data products are available as orthorectified raster files (ENVI file format) at a nominal 1 m spatial resolution; Google Earth overlays (KML) are available for the NIR band.

Radiance: Calibrated radiance data is provided for individual swaths in radiometric units (W m^-2 sr^-1 nm^-1).

At-sensor reflectance: Computed as the ratio between observed upwelling radiance and downwelling hemispheric irradiance; corrected for differences in cross-track illumination and BRDF using an empirically derived multiplier. At a nominal flying height of 335 m AGL, the at-sensor reflectance is a close approximation of surface reflectance. Available for individual swaths, and mosaicked for mapped areas using swath observations closest to nadir.

Vegetation indices: Computed from at-sensor reflectance data. These products are used as indicators of canopy properties and condition (e.g., greenness, pigment concentrations).

Ancillary data: Contains acquisition time, aircraft location, sun-sensor geometry, incoming PAR, clearness index, swath ID, and flag indicating nearest neighbor resampling during georegistration.

Thermal

Radiant temperature: Computed with 0.98 emissivity and no atmospheric or view angle correction. Available as Google Earth overlay (KML) and raster data product (GeoTIFF) at a nominal 1 m spatial resolution.

8) INSTRUMENT SPECIFICATIONS

GPS-INS

Model/Make: Applanix POS AV V6 (Richmond Hill, Ontario, Canada)
Serial number: 6693 (GPS), 121016 (INS)
Sampling interval: 200 Hz
Differential correction: POSPac MMS v8 with Centerpoint RTX (Real Time eXtended)
Positional accuracy: <10 cm horizontal, <20 cm vertical (RMS)
Yaw accuracy (1 sigma): 0.0050 degree (RMS)
Roll and pitch accuracy: 0.0025 degree (RMS)

Antenna: Trimble AV 39 L1/L2 GLONAS/GPS/GALILEO/QZSS/SBAS/BeiDou

Scanning lidars (1)

Model/Make: VQ-480i; Riegl Laser Measurement Systems, Horn, Austria
Serial numbers: "new" (purchased in 2017) S2220331
Laser wavelength: 1550 nm
Pulse width: 3 ns
Pulse energy: 2817 nJ in 25 mm
Beam divergence: 0.3 mrad
Nominal footprint size: diameter = tan(beam divergence/2)*altitude*2
Laser pulse repetition frequency (PRF): 300 kHz
Effective measurement frequency: 0.5*PRF
Maximum number of returns per pulse: 8
Field of view: 60 degrees (+/- 30 degrees of nadir)
Scan mode: line
Scan rate: 150 lines per second
Nominal distance between points in a scan line: 0.24 m
Nominal distance between scan lines: 0.42 m
Swath size: width = tan(FOV/2)*altitude*2
Lever arm from IMU to antenna (x,y,z; date); 1.491, 1.101, -0.937 m (26 May 2017)

IMU Frame w.r.t. Ref. Frame (x,y,z; date): 0.000, 0.000, -90.000
Lever arm from IMU to “old” lidar (x,y,z; date):  0.543, 0.005, 0.1736 (March 2017)
Lever arm from IMU to “new” lidar (x,y,z; date):  0.004, -0.00039, 0.16958 (March 2017)
Boresight for “new” lidar (roll, pitch, yaw; date): 0.04316, -0.11554, -0.09176 degrees (26 May 2017)
Post-Processing software: RiProcess

Digital RGB Camera
Camera: Phase One iXU1000-R
Lens: Rodenstock HR Digaron-W, 50mm f/4
FOV: 56.2 x 43.6 degrees (cross track x along track)
Pixels: 11608 x 8708 (cross track x along track) = 101 megapixel
Sensor size: 53.4 x 40 mm (cross track x along track)
Shutter speed: 1/1600 s
Aperture: f/5.0
ISO: 200
White balance: daylight
Frame rate: 1 Hz
Image format: IIQ
Quantization: 16-bit

Imaging spectrometers
Model/Make: Microhyperspec E Series with shutter; Headwall Photonics, Fitchburg, MA
Serial Number: UVS-230
Camera: pco edge 5.5
Serial Number: 61001572
Focal plane array: pushbroom, 645 cross track pixels after 2x binning
Frame rate: 75 Hz
Lens/FOV: 8 mm lens, f/1.4, achromatic
Sensor size: 21.8 mm diagonal, 6.5 μm pixel pitch
Integration time: 13.3 msecs (75 Hz)
Sensor range: 400-1000 nm
Spectral band width (FWHM): TBD nm
Sampling resolution: 3.3 nm (185 bands after 2x binning)
Resampled resolution: 400 to 1000 nm in 4.5 nm bands (133 bands)
Quantization: 16-bit

Model/Make: FIREFLY Fluorescence spectrometer; Headwall Photonics, Fitchburg, MA
Serial Number: CFL-001
Camera: pco edge 5.5
Serial Number: 61001572
Focal plane array: pushbroom, 266 cross track pixels after 6x binning
Frame rate: 37.5 Hz
Lens/FOV: 25 mm, telecentric
Sensor size: 21.8 mm diagonal, 6.5 μm pixel pitch
Integration time: 26.6 msecs (37.5 Hz)
Sensor range: 670-780 nm
Spectral band width (FWHM): 0.18 to 0.14 nm
Sampling resolution: 0.05 nm (2160 bands)
Resampled resolution: None
Quantization: 16-bit

Thermal camera
Model/Make: Gobi-640 GigE Vision; Xenics, Leuven, Belgium
Lens: athermalized 14.25mm f/1.2
Serial number: 8708
Sensor: Uncooled microbolometer
Focal plane array: 640 x 480 on 17 um pixels
Data output: degrees Celsius
Frame rate: 50 Hz
Sensitivity: 8 to 14 um
Quantization: 16-bit

Downwelling irradiance spectrometers (2)
Model/Make: FLAME-T, with 350-1000 filter and #3 grating; Ocean Optics, Dunedin, FL
Serial number: FLMT01800
FOV: 180 degrees (cosine diffusor)
Integration time: 33 ms

Sample averaging: 30
Sampling interval: 0.218 nm
Sensor range: 344-1037 nm
FWHM: ~1.5 nm
Resampled resolution: 400 to 1000 nm in 4.5 nm bands (133 bands)
Quantization: 16-bit

Model/Make: QEPro with >590 longpass filter and H6 grating; Ocean Optics, Dunedin, FL
Serial number: QEP01158
FOV: 180 degrees (cosine diffusor)
Integration time: 1 s
Sample averaging: 1
Sampling interval: 0.175 nm
Sensor range: 650-811 nm
FWHM: 0.44 to 0.32 nm
Resampled resolution: None
Quantization: 18-bit

9) PUBLICATIONS

Cook, B. D., L. W. Corp, R. F. Nelson, E. M. Middleton, D. C. Morton, J. T. McCorkel, J. G. Masek, K. J. Ranson, and V. Ly. 2013. NASA Goddard's Lidar, Hyperspectral and Thermal (G-LiHT) airborne imager. Remote Sensing 5:4045-4066, doi:10.3390/rs5084045.