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

CONTENTS

1) CONTACT INFORMATION
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2) CAMPAIGN INFORMATION
Date(s): 5 October 2011
Time of day: See ancillary file for acquisition time
Location: Rochester, NH
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
Pilot: Tony Sleznick, USFS
G-LiHT operator(s): Larry Corp, NASA GSFC
Nominal altitude (AGL): 335 m AGL
Nominal velocity: 110-130 kt
Other:

5) FIELD OBSERVATIONS
Weather: variable
Other notes: VFR

6) OUTPUT FILE NAME(S)
Rochester_Jun2016
White_Mountains_Jun2016
Acadia_NP_Jun2016
Massabesic_EF_10Jun2016
Brookhaven_Jun2016
Rocky_Point_Jun2016
LI_Pine_Barrens_Jun2016
Wertheirm_NWR_Jun2016
Cape_Cod_Jun2016
Plum_Island_Jun2016
Loudon_Jun2016
Bow_Jun2016
Garrison_sites_Jun2016

7) DATA PRODUCTS

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

b) 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); and lidar apparent reflectance ("Intensity" field; -25 to 0 dB for 2 byte range). 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).

c) Imaging 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 provided 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.

d) 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: RT-4041, GPS and GLONAS enabled; Oxford Technical Solutions, Oxfordshire, UK
- Serial number: 663
- Sampling interval: 250 Hz
- Differential correction: OmniStar HP or G2
- Positional accuracy (1 sigma): 10 to 15 cm horizontal (vertical=horizontal*1.5)
- Yaw accuracy (1 sigma): 0.1 degree
- Roll accuracy (1 sigma): 0.03 degree
- Pitch accuracy (1 sigma): 0.03 degree
- Antenna: Antcom G5Ant-42AT1 L1/L2 Glonas/GPS/OmniStar
- Post-Processing software: RT Post-Process

Scanning lidar

- Model/Make: VQ-480; Riegl Laser Measurement Systems, Horn, Austria
- Serial number: S9997785
- 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: 100 lines per second
Nominal distance between points in a scan line: 0.24 m
Nominal distance between scan lines: 0.56 m
Swath size: width = tan(FOV/2)*altitude*2
Lever arm (ahead, left, above; date): 1.380, 1.1440, 1.105 m (22 May 2014)
Boresight (roll, pitch, yaw; date): -0.13475, -0.05952, 0.10745 degrees (June 2016)
Post-Processing software: RiProcess

Profiling lidar: none
Model/Make: LD321-A40; Riegl Laser Measurement Systems, Horn, Austria
Serial number: 9995315
Laser wavelength: 905 nm
Pulse width: 7.6 ns
Pulse energy: 503 nJ in 50 mm
Beam divergence: 2.65 mrad
Nominal footprint size: diameter = tan(divergence/2)*altitude*2]
Laser pulse repetition frequency (PRF): 10 kHz
Pre-Detection averaging: 100 digitized samples
Effective measurement frequency: 100 Hz
Maximum number of returns per pulse: 5 (3 maximum first returns, 2 maximum last returns)
Field of view: 0 degrees (nadir)

Digital SLR
Camera: Nikon D7100
Lens: 20mm f/2.8D lens w/circular polarizer
FOV: 60.7 × 42.6 degree
Image area and size: DX, 6000 × 4000 = 24 megapixel
Shutter speed: 1/250 s, EV -1.3
Aperture: f/2.8
ISO: 100
Focus: manual, infinity
White balance: sunlight
Frame rate: 4 s
Image format: jpg
Quantization: 8-bit

Imaging spectrometer
Model/Make: Hyperspec model 1002A-00451; Headwall Photonics, Fitchburg, MA
Serial Number: G4-105
Camera: Adimec model RA1000m/D_DFG
Serial Number: 830016
Focal plane array: pushbroom, 1004 cross track pixels
Frame rate: 50 Hz
Lens/FOV: 8 mm lens, f/2; ~50 degree
Sensor size: 7.4 mm
Integration time: 20 msecs
Sensor range: 417-1008 nm
Spectral band width (FWHM): ~8 to 15 nm
Sampling resolution: 1.5 nm (401 bands)
Resampled resolution: 418 to 919 nm in 4.5 nm bands (114 bands)
Quantization: 12 bit

Thermal camera
Model/Make: Gobi-384; Xenics, Leuven, Belgium
Serial number: GOBI-1413
Sensor: Uncooled microbolometer
Focal plane array: 384 x 288 on 25 um pixels
Data output: degrees Celsius
Frame rate: 25 Hz

Sensitivity: 8 to 14 um
Quantization: 16 bit

Downwelling irradiance
Model/Make: USB-4000; Ocean Optics, Dunedin, FL
Serial number: USB4H02819
FOV: 180 degrees (cosine diffusor)
Integration time: 33 ms
Sample averaging: 30
Sampling interval: 0.6 nm
Sensor range: 380-1100 nm
FWHM: 1.5 nm
Resampled resolution: 418 to 919 nm in 4.5 nm bands (114 bands)
Quantization: 16 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.