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

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1) CONTACT INFORMATION
Bruce Cook, G-LiHT PI: bruce.cook@gsfc.nasa.gov, 301.614.6689
Larry Corp, G-LiHT Scientist: lawrence.a.corp@nasa.gov, 301.614.6619
Address: NASA Goddard Space Flight Center
Biospheric Sciences Laboratory, Mail Code 618
8800 Greenbelt Rd
Greenbelt, MD, 20771
Website: http://gliht.gsfc.nasa.gov

2) CAMPAIGN INFORMATION
Date(s): March 07-16 2015
Time of day: see ancillary file for acquisition time
Location: California & Nevada
Description: Calibration / validation under flight of Landsat 8
Research project: Landsat
Funding source: Landsat, CLAREO

3) FLIGHT PLANS
Calibration / validation sites were mapped with a series of overlapping flight lines including Algodones Dunes, Railroad Valley, and Alkali Lake.

4) ACQUISITION DETAILS
Aircraft: Piper Cherokee, 934PH
Pilot: Thaddeus Fickel, Infrared Barron LLC
G-LiHT operator(s): Larry Corp NASA GSFC
Nominal altitude (AGL): 335 m AGL
Nominal velocity: 110-150 kt
Other:

5) FIELD OBSERVATIONS
Weather: clear
Other notes: VFR

6) OUTPUT FILE NAME(S)
las_vegas_mar2015
algodones_20150309_eo1
algodones_20150310_a_lines
algodones_20150310_a_lines_low
algodones_20150311_t_lines
algodones_20150312_e_lines
algodones_lg_area
algodones_20150315_ivanpah_west
algodones_20150315_ivanpah_east
algodones_20150316_alkali1
algodones_20150316_alkali2
algodones_20150316_rrvalley
algodones_20150316_rrvalley_low

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); 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 +/- 15 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: 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): 150 & 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 @ 300 kHz, 0.85 m @ 150 kHz
Nominal distance between scan lines: 0.56 m @ 300 kHz, 0.72 m @ 150 kHz
Swath size: width = tan(FOV/2)*altitude*2
Lever arm (ahead, left, above; date): 0.329, 0.142, 0.977 m (07 July 2014)
Boresight (roll, pitch, yaw; date): -0.15543, -0.07890, -0.23791 degrees (07 March 2015)
Post-Processing software: RiProcess

Profiling lidar: none

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.