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

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1) CONTACT INFORMATION
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2) CAMPAIGN INFORMATION
Date(s): March 22 2012
Time of day: All Day
Location: Smithsonian Environment Research Center (SERC), near Edgewater, MD
Description: SERC Leaf-off acquisition
Research project: DART-LiDAR
Funding source: NASA, Remote Sensing Theory

3) FLIGHT PLANS
Series of N-S & E-W mapping lines with ~30% swath overlap to obtain high density, multi-angle
lidar returns over leaf off conditions in research forests.

4) ACQUISITION DETAILS
Aircraft: NASA LaRC UC12 KingAir
Pilot: Rick Yaskey, NASA LaRC
G-LiHT operator(s): Larry Corp, NASA GSFC
Nominal altitude (AGL): 300 m AGL
Nominal velocity: 110-150 kt
Other:

5) FIELD OBSERVATIONS
Weather: Clear Sky Conditions
Other notes: Some spring budding was observed.

6) OUTPUT FILE NAME(S)
Gloucester_Point_Mar2012
SERC_Mar2012

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; -15 to -5 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).

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): 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

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    Nominal distance between scan lines: 0.56 m
    Swath size:  width = tan(FOV/2)*altitude*2
    Lever arm (ahead, left, above; date): 0.398, 0.102, 1.190 m (21 March 2012)
    Boresight (roll, pitch, yaw; date): 0.02125, 0.03393, -0.31415 degrees (21 March 2012)
    Post-Processing software: RiProcess

Profiling lidar
    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: none

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: USB4F02529
    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
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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.