

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

CONTENTS

- 1) Contact information
- 2) Campaign description
- 3) Flight plans
- 4) Acquisition details
- 5) Field observations
- 6) Output file name(s)
- 7) Data products
- 8) Instrument specifications
- 9) Publications

1) CONTACT INFORMATION

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2) CAMPAIGN INFORMATION

Date(s): August - September 2012
Time of day:
Location: CONUS West of the Mississippi River
Description: ICESat GLASS LiDAR under flights & FIA Forest Sampling
Research project: AMIGA-Carb
Funding source: NASA, Carbon Cycle Science

3) FLIGHT PLANS

Series of long ICESat satellite transects and circles surrounding population areas covering a number of USFS FIA plots.

4) ACQUISITION DETAILS

Aircraft: Piper Cherokee, N4118R
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:
Other notes: VFR

6) OUTPUT FILE NAME(S)

AMIGACarb_CFR1_FIA_Sep2012
AMIGACarb_CFR2_FIA_Sep2012
AMIGACarb_CFR4_FIA_Sep2012
AMIGACarb_FB1_FIA_Sep2012
AMIGACarb_FB2_FIA_Sep2012
AMIGACarb_FB3_FIA_Sep2012
AMIGACarb_Flag4_FIA_Sep2012
AMIGACarb_Flag6_FIA_Sep2012
AMIGACarb_G01_Aug2012
AMIGACarb_G02_Aug2012
AMIGACarb_G03_Aug2012
AMIGACarb_G4_Aug2012
AMIGACarb_G05_Aug2012
AMIGACarb_G06_Aug2012
AMIGACarb_G08_Aug2012
AMIGACarb_G09_Sep2012
AMIGACarb_G10_Sep2012
AMIGACarb_G11_Sep2012
AMIGACarb_G12_Sep2012
AMIGACarb_G13_Sep2012
AMIGACarb_G14_Sep2012

AMIGACarb_G15_Sep2012
AMIGACarb_G18N_Aug2012
AMIGACarb_G18S_Aug2012
AMIGACarb_G19_Aug2012
AMIGACarb_G20_Aug2012
AMIGACarb_G21_Aug2012
AMIGACarb_G22_Aug2012
AMIGACarb_G23_Sep2012
AMIGACarb_G25_Sep2012
AMIGACarb_G26_Sep2012
AMIGACarb_G27_Sep2012
AMIGACarb_G28_Sep2012
AMIGACarb_G29_Sep2012
AMIGACarb_G30_Sep2012
AMIGACarb_G31_Sep2012
AMIGACarb_G32_Sep2012
AMIGACarb_G33_Sep2012
AMIGACarb_G36_Sep2012
AMIGACarb_G37_Sep2012
AMIGACarb_G41_Sep2012
AMIGACarb_G43_Sep2012
AMIGACarb_G44_Sep2012
AMIGACarb_GCR1_FIA_Sep2012
AMIGACarb_GCR2_FIA_Sep2012
AMIGACarb_GCR3_FIA_Sep2012
AMIGACarb_GCR5_FIA_Sep2012
AMIGACarb_GCR6_FIA_Sep2012
AMIGACarb_IM1_FIA_Aug2012
AMIGACarb_IM2_FIA_Aug2012
AMIGACarb_IM3_FIA_Aug2012
AMIGACarb_IM5_FIA_Aug2012
AMIGACarb_IM6_FIA_Aug2012
AMIGACarb_IM7_FIA_Aug2012
AMIGACarb_IM8_FIA_Aug2012
AMIGACarb_ND_FIA_Sep2012
AMIGACarb_NW1R1_FIA_Aug2012
AMIGACarb_NW1R2_FIA_Aug2012
AMIGACarb_NW2R5_FIA_Aug2012
AMIGACarb_NW2R6_FIA_Aug2012
AMIGACarb_NW2R7_FIA_Aug2012
AMIGACarb_NW2R8_FIA_Aug2012
AMIGACarb_NW2R9_FIA_Aug2012
AMIGACarb_NW3R10_FIA_Aug2012
AMIGACarb_NW3R11_FIA_Aug2012
AMIGACarb_NW3R12_FIA_Aug2012
AMIGACarb_NW3R13_FIA_Aug2012
AMIGACarb_NW5_FIA_Aug2012
AMIGACarb_NW5R20_FIA_Aug2012
AMIGACarb_NW5R22_FIA_Aug2012
AMIGACarb_NW5R23_FIA_Aug2012
AMIGACarb_NW5R24_FIA_Aug2012
AMIGACarb_NW5R28_FIA_Aug2012
AMIGACarb_NW6_FIA_Aug2012
AMIGACarb_RAT1_FIA_Sep2012
AMIGACarb_RAT2_FIA_Sep2012
AMIGACarb_RAT3_FIA_Sep2012
AMIGACarb_RAT4_FIA_Sep2012
AMIGACarb_SW1R1UT_FIA_Sep2012
AMIGACarb_SW1R2UT_FIA_Sep2012
AMIGACarb_SW1R4UT_FIA_Sep2012
AMIGACarb_SW1R5UT_FIA_Sep2012
AMIGACarb_WY_FIA_Sep2012
Oregon_ARS_Ju12012

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 +/- 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 = $\tan(\text{beam divergence}/2) * \text{altitude} * 2$
Laser pulse repetition frequency (PRF): 300 kHz
Effective measurement frequency: $0.5 * \text{PRF}$
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 = $\tan(\text{FOV}/2) * \text{altitude} * 2$
Lever arm (ahead, left, above; date): 0.371, 0.142, 0.977 m (28 Aug 2012)
Boresight (roll, pitch, yaw; date): 0.01397, 0.01283, -0.39402 degrees (28 Aug 2012)
Post-Processing software: RiProcess

Profiling lidar: none

Digital SLR: none

Imaging spectrometer

Model/Make: Hyperspec model 1002A-00451; Headwall Photonics, Fitchburg, MA
SerialNumber: 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 msec
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

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.