G-LiHT: Multi-Sensor Airborne Image Data from Denali to the Yucatan

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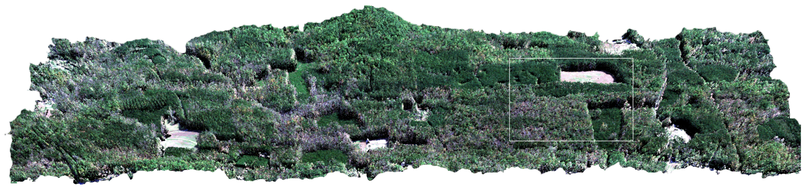
G-LiHT Concept

NASA **G**oddard's **L**idar, **H**yperspectral and **T**hermal (**G-LiHT**) is a portable airborne imaging system that simultaneously maps the composition, structure, and function of ecosystems using:

- **Lidar** to provide 3D information about the vertical and horizontal distribution of foliage and other canopy elements;
- **Imaging spectroscopy** to characterize species composition and variations in biophysical variables (e.g., photosynthetic pigments, nutrient and water content); and
- **IR Thermal camera** to detect vegetation heat and moisture stress, and edaphic conditions such as inundated and frozen soils.

G-LiHT enables **data fusion studies** by providing coincident data in time and space, and provides fine-scale (1 m) observations over large areas that are needed in many ecosystem studies.



G-LiHT at-sensor reflectance draped over canopy elevation at Duke Forest, NC

Instrument Specifications

G-LiGHT installed on Piper Cherokee in Alaska, USA

1x1x2', 80 lbs, 7.5 A

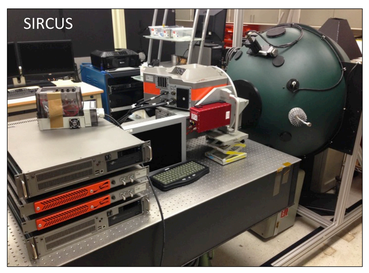
MEASUREMENT CHARACTERISTICS

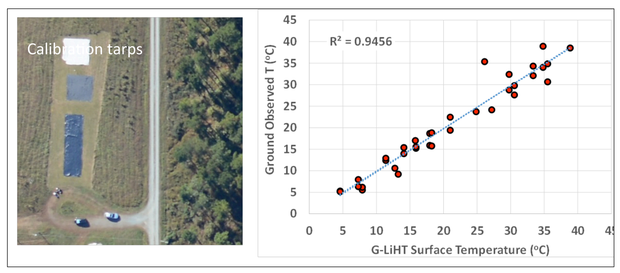
Scanning lidar	
Swath width/FOV	387 m (60°)
Footprint diameter	10 cm (0.3 mrad)
Range precision	5 cm (2 σ)
Sampling density at 300 kHz	6 pulses m^{-2}
Max. returns per pulse	8
Solar irradiance spectrometer	
Swath width/FOV	hemispheric (180°)
Spectral range	350 to 1,100 nm
Sample/Band width	1.5 and 1.5 nm
Acquisition rate	1 Hz
Imaging spectrometer	
Swath width/FOV	310 m (50°)
Cross track pixels	1,004
Spectral range	400 to 920 nm
Sampling interval	1.5 nm
Spectral resolution (FWHM)	15 to 8 nm
Acquisition rate	50 Hz
Thermal camera	
Swath width/FOV	173 m (30°)
Imaging array size	384 × 288
Spectral range	8 to 14 µm
Sensitivity (NETD)	>50 mK at 30°C
Acquisition rate	25 Hz
Spatial resolution of data products	1 m

** Flying at 335 m AGL and 110 kt.*

Laboratory and Vicarious Calibration

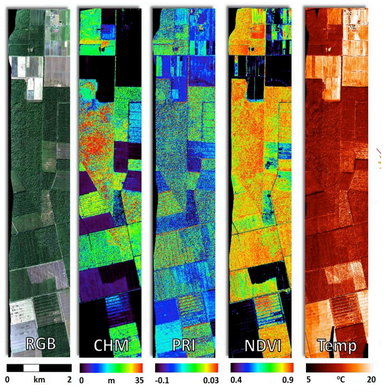
Routine **boresight alignment** and **radiometric calibration** is critical to data fusion and up-scaling to space-based sensors. A portable version of **NIST's laser-based Spectral Irradiance and Radiance responsively Calibrations using Uniform Sources (SIRCUS)** is used to generate absolute radiometric response functions in 1 nm increments across portions of the VNIR spectrum, and *in situ* ground-based observations are used for radiance temperature.





User Friendly, Open Access Data Products

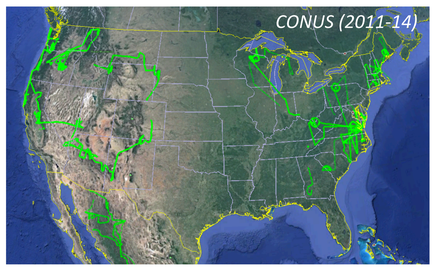
- **LiDAR point clouds** (classified returns and feature heights)
- **Bare earth elevation** and **canopy height** models (DTM, CHM)
- Common **LiDAR metrics** (e.g., return height & density stats)
- **Radiance spectra** (400-920 nm, 4.5 nm sampling interval)
- **At-Sensor reflectance** using observed irradiance spectra
- Common greeness and pigment **vegetation indices**
- Radiant **surface temperatures** (°C)

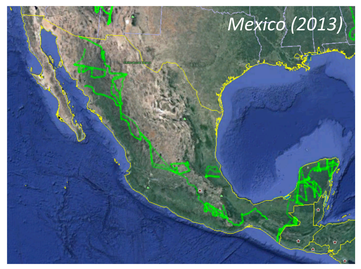


E.g., Parker Tract Loblolly Pine plantation, NC

G-LiHT Acquisitions

Since 2011, G-LiHT has been used to acquire more than **2 million ha of data in Alaska, CONUS, and Mexico** for a broad range of research projects and satellite missions.



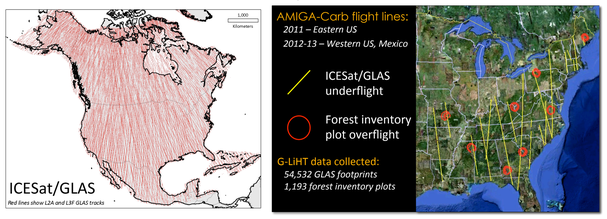


2015-17 campaigns planned for coastal wetlands, mangroves and tropical forests in Florida, Bahamas, and Puerto Rico.

G-LiHT Science

Forest Biomass Stocks, Growth and Disturbance

***AMIGA-Carb*: American ICESat/GLAS Assessment of Carbon**

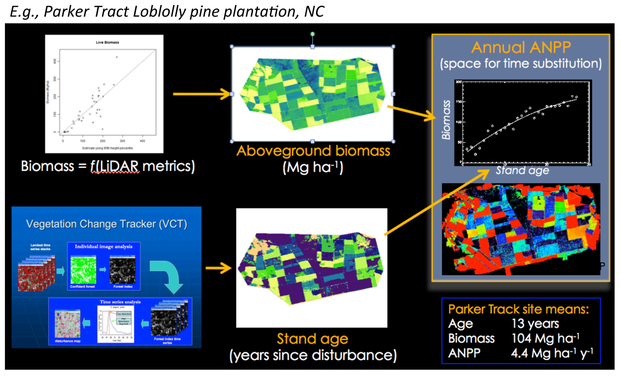


G-LiHT supports various sampling & analysis methods:

1) *Deterministic models using plot- & tree-scale metrics*
2) *Bayesian models with spatiotemporal parameters*
3) *Regional estimation with Model-Dependent (MD) and Design Based Model-Assisted (DBMA)*
4) *Systematic airborne sampling and 3-phase estimation (plot → aircraft → satellite)*
5) *Repeat acquisitions and space-for-time growth rates*

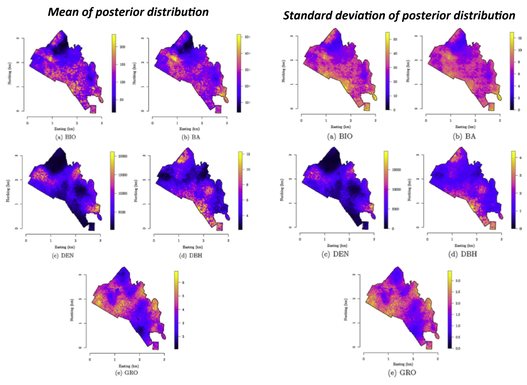
G-LiHT and Landsat "Space-for-Time" Forest Growth Rates

E.g., Parker Tract Loblolly pine plantation, NC

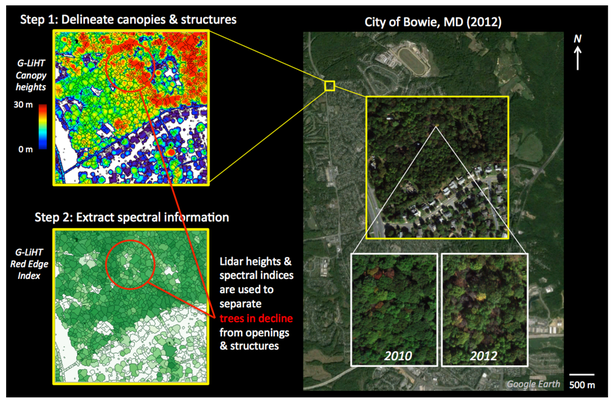


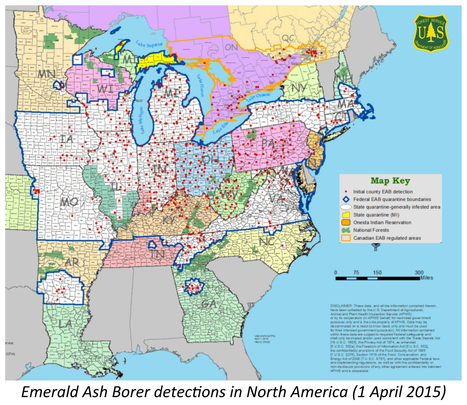
Hierarchical Bayesian spatial model

E.g., Penobscot Experimental Forest, ME



Forest Health *(e.g., Emerald Ash Borer)*

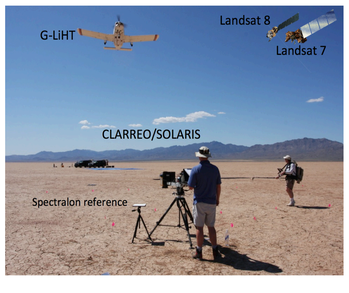


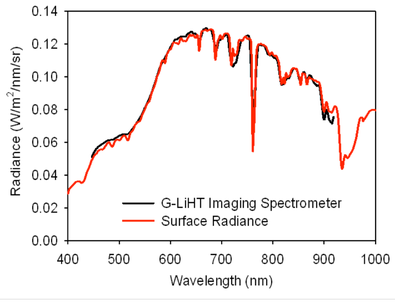


Emerald Ash Borer detections in North America (1 April 2015)

Mission Support

Characterization of Calibration Sites and Satellite Intercalibration





Calibration sites:

- *Railroad Valley; Ivanpah; Alkali Lake, NV*
- *Red Lake & McLaws, AZ*
- *Algodones Dunes, CA*

Satellite underpasses:

- *Landsat 7, 8*
- *EO-1*

For data, publications and more information, go to http://gliht.gsfc.nasa.gov or email bruce.cook@nasa.gov