National Aeronautics and Space Administration
Goddard Space Flight Center

Absolute radiometric and climate variable inter-calibraiton

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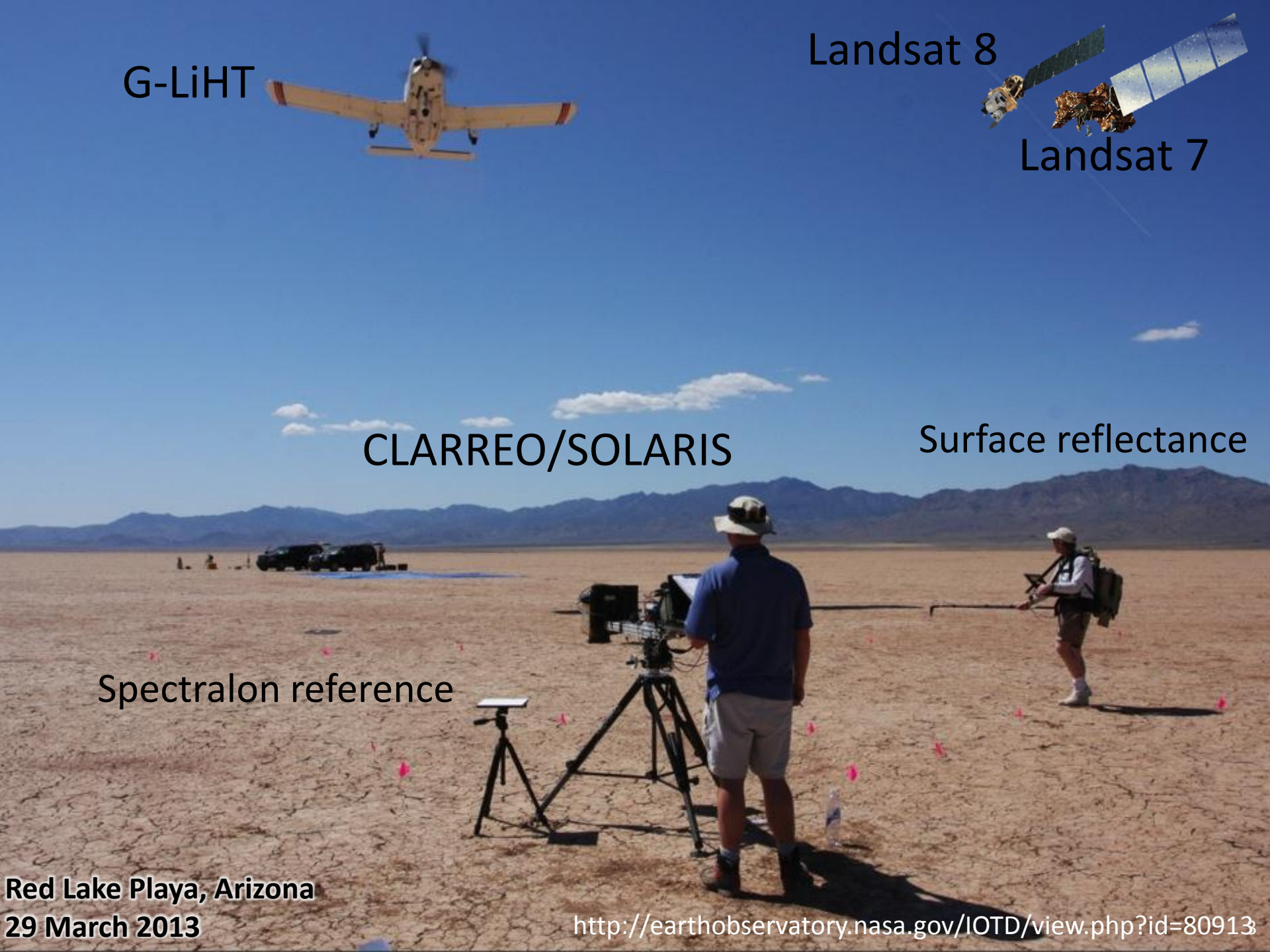
LDCM

Talk overview

- Landsat 8 radiometric calibration
  - Landsat 7/8 tandem overpass field campaign
  - G-LiHT (airborne platform) and its lab calibration
  - Landsat 8 calibration results
- LAI intercomparison
  - Landsat/MODIS comparison data set
  - Landsat/MODIS statistical data assimilation


G-LiHT
Landsat 8
Landsat 7
CLARREO/SOLARIS
Surface reflectance
Spectralon reference
Red Lake Playa, Arizona
29 March 2013
http://earthobservatory.nasa.gov/IOTD/view.php?id=80913

Tandem flight summary

March 29, 2013

ETM+	Path 38
LDCM	Path 38

March 30, 2013

ETM+	Path 45
LDCM	Path 44, pointed to 45

March 31, 2013

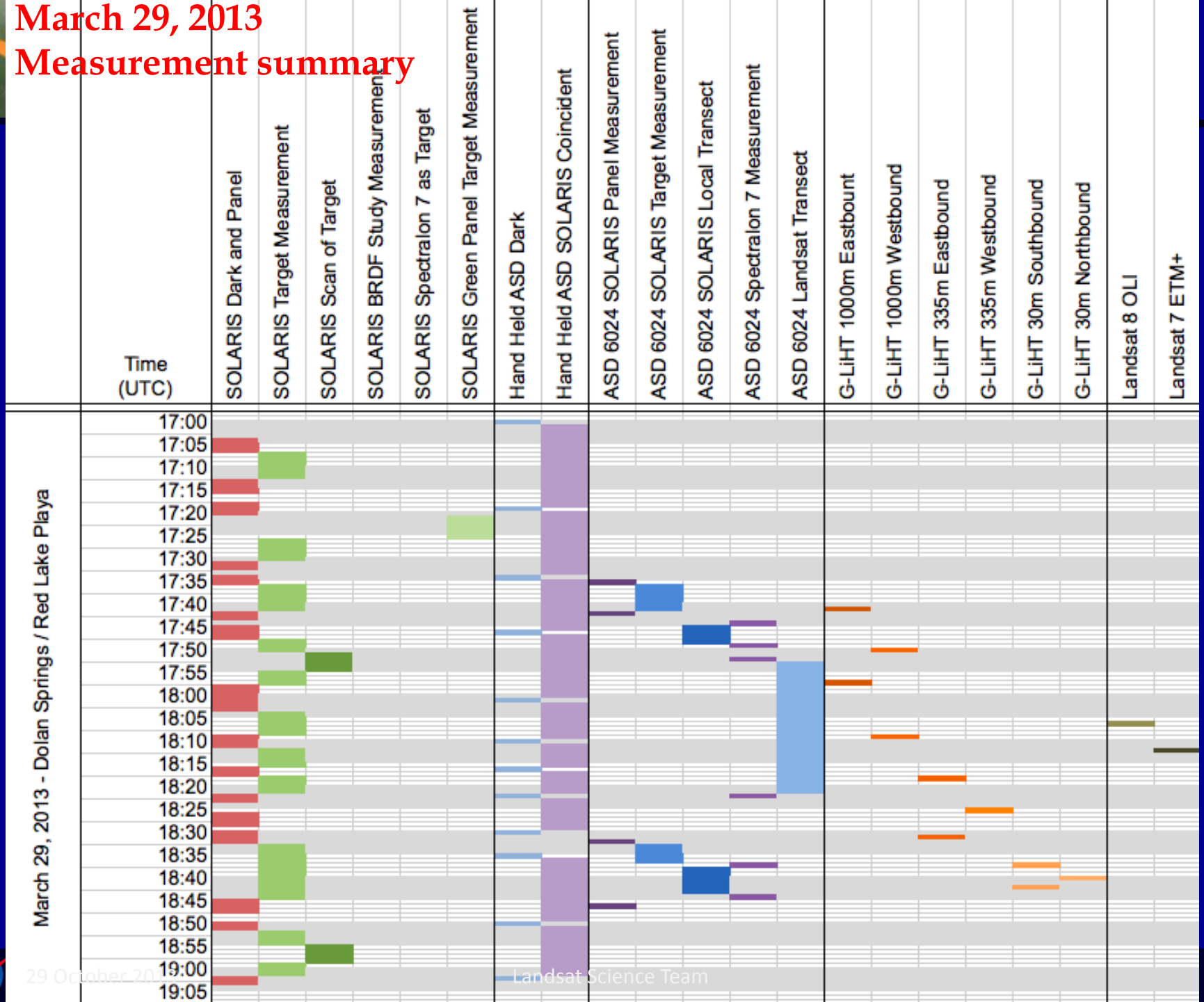
ETM+	Path 36
LDCM	Path 35, pointed to 36

McLaws Playa, cal site

USDA Long Valley Exp. Forest

Red Lake, cal site

March 29, 2013
Measurement summary

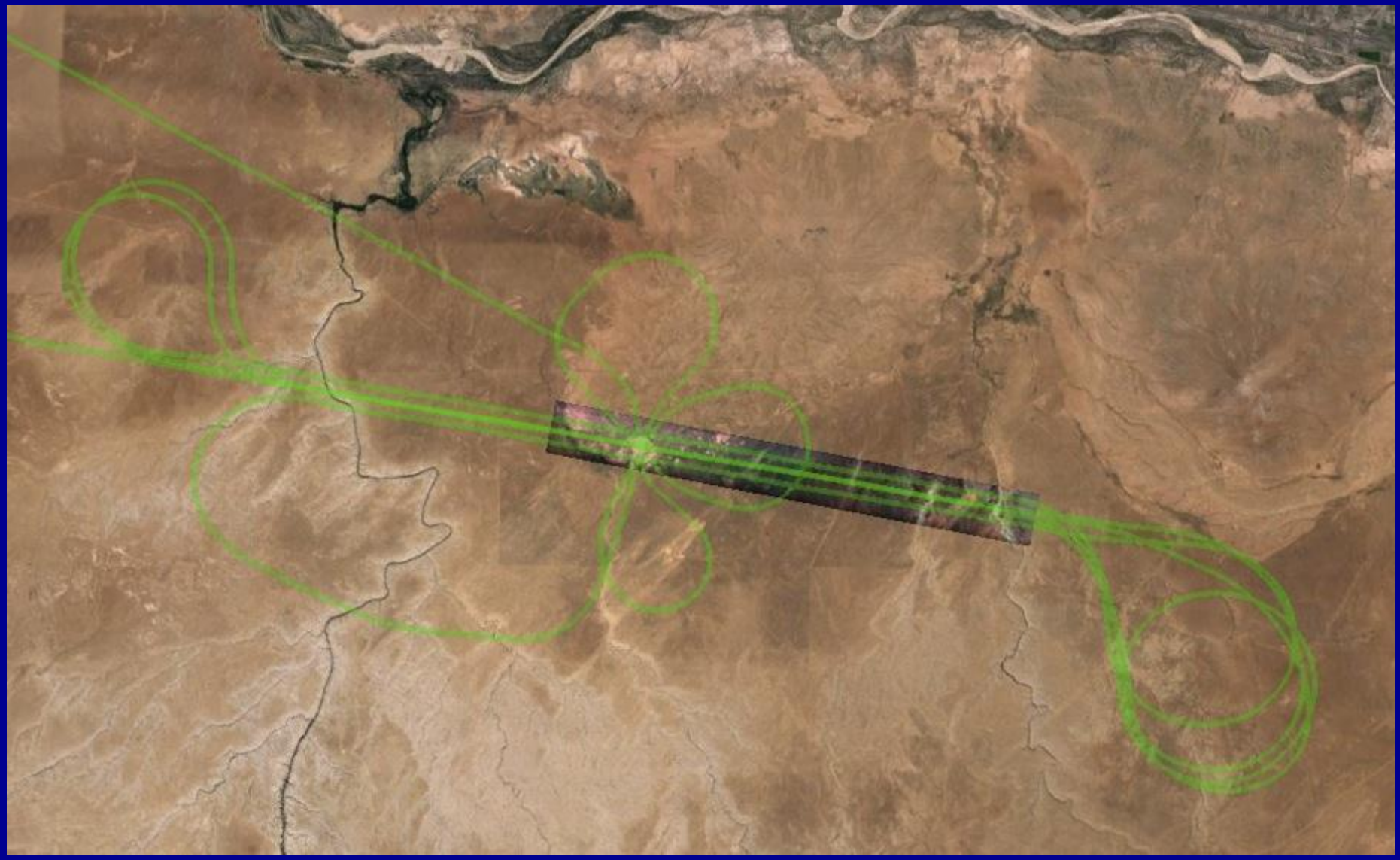


Landsat 7, 8 and G-LiHT at Red Lake

with ground-based atmospheric and reflectance by NASA and UAz

Landsat 7, 8 and G-LiHT at McLaws

with ground-based atmospheric and reflectance by NASA and UAz



All-sky photos on key dates

Landsat 8 18:16 UTC

Landsat 7 18:06 UTC Landsat 8 18:12 UTC

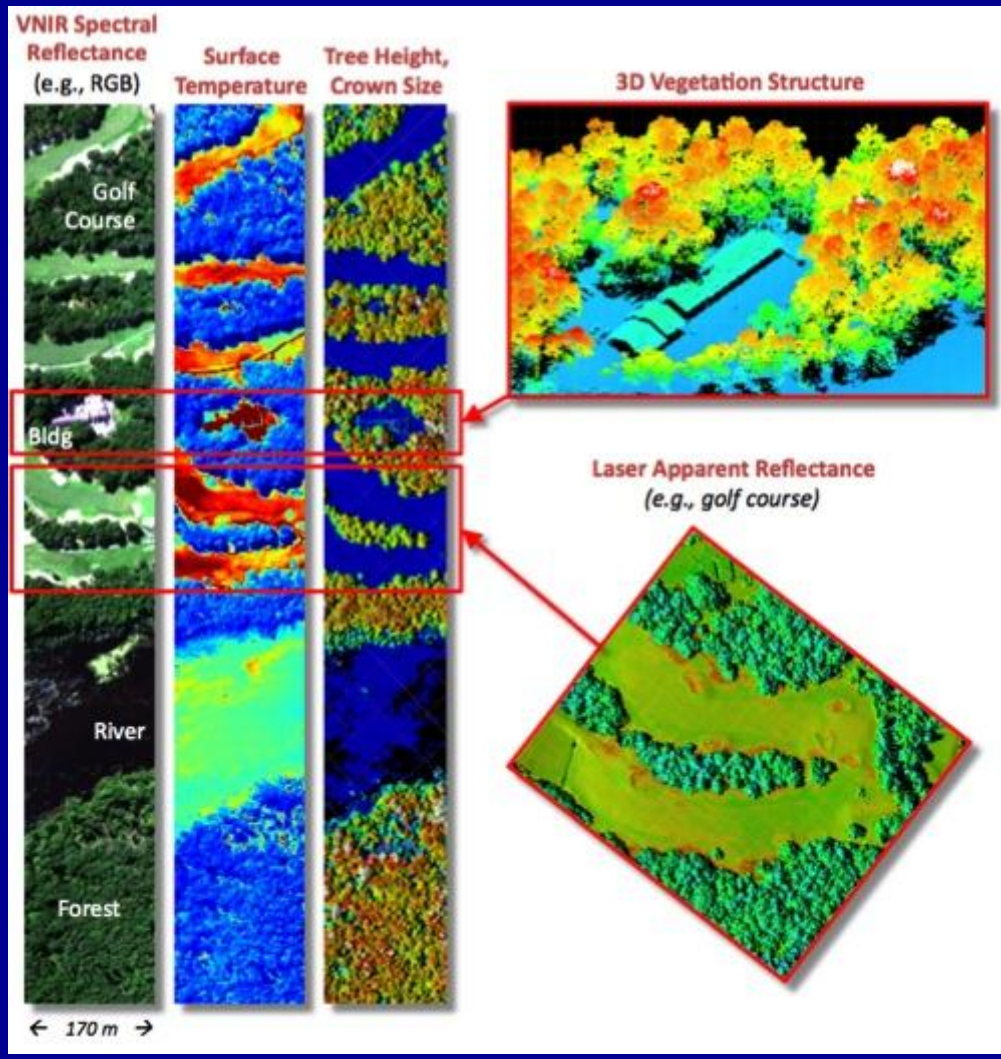
Landsat 7 17:51 UTC Landsat 8 17:53 UTC

Landsat 8 18:29 UTC

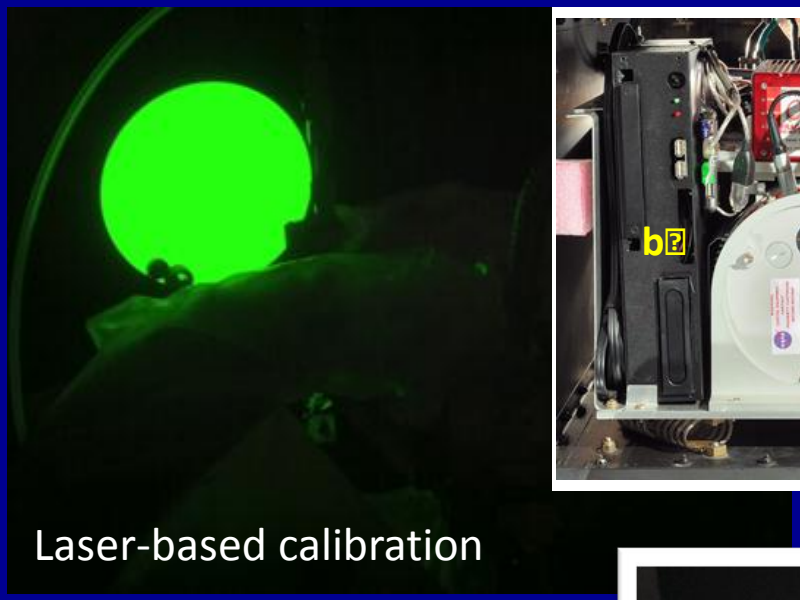
G-LiHT

Goddard's Lidar, Hyperspectral, and Thermal Airborne Imaging System

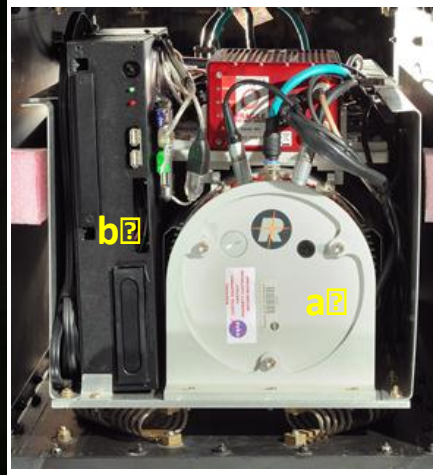
- PI Bruce Cook (GSFC Code 618)
- Lidar
  - 1550 nm
  - waveform
  - 60° scan
  - 7/m^3 pulse density
- VNIR imaging spectrometer
  - 0.4–1.0 µm
  - 1.5-nm sampling
  - 1-m spatial sampling
- Thermal imager
  - Non-cooled microbolometer
  - 8–14 µm broadband
  - 0.45-m spatial sampling
- 335-m AGL, 110 kt

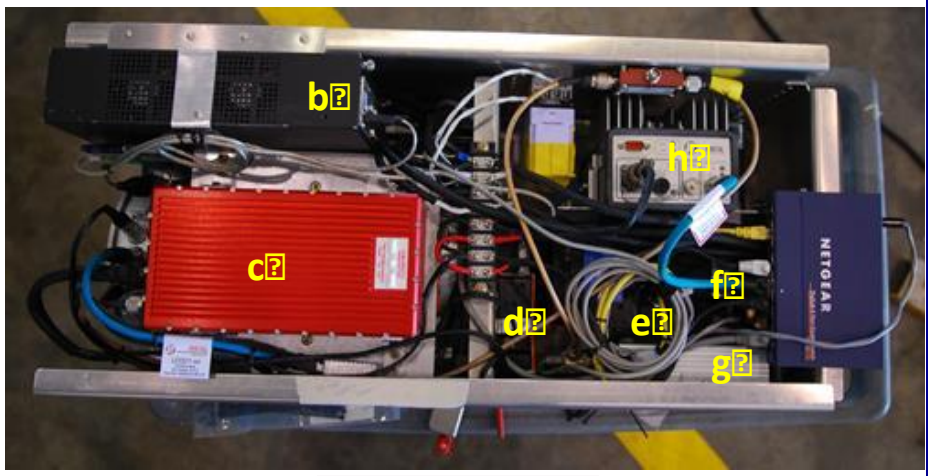


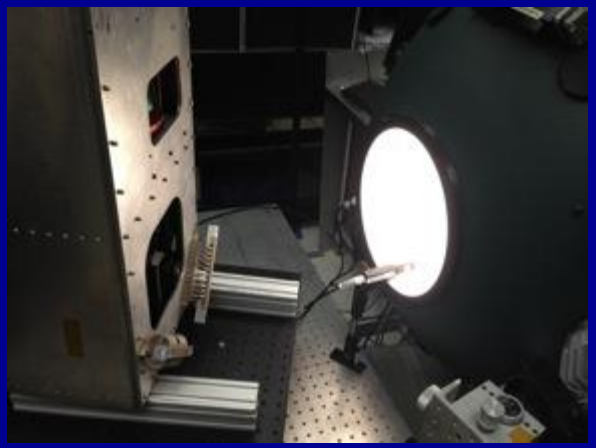
G-LiHT and preflight calibration



Laser-based calibration



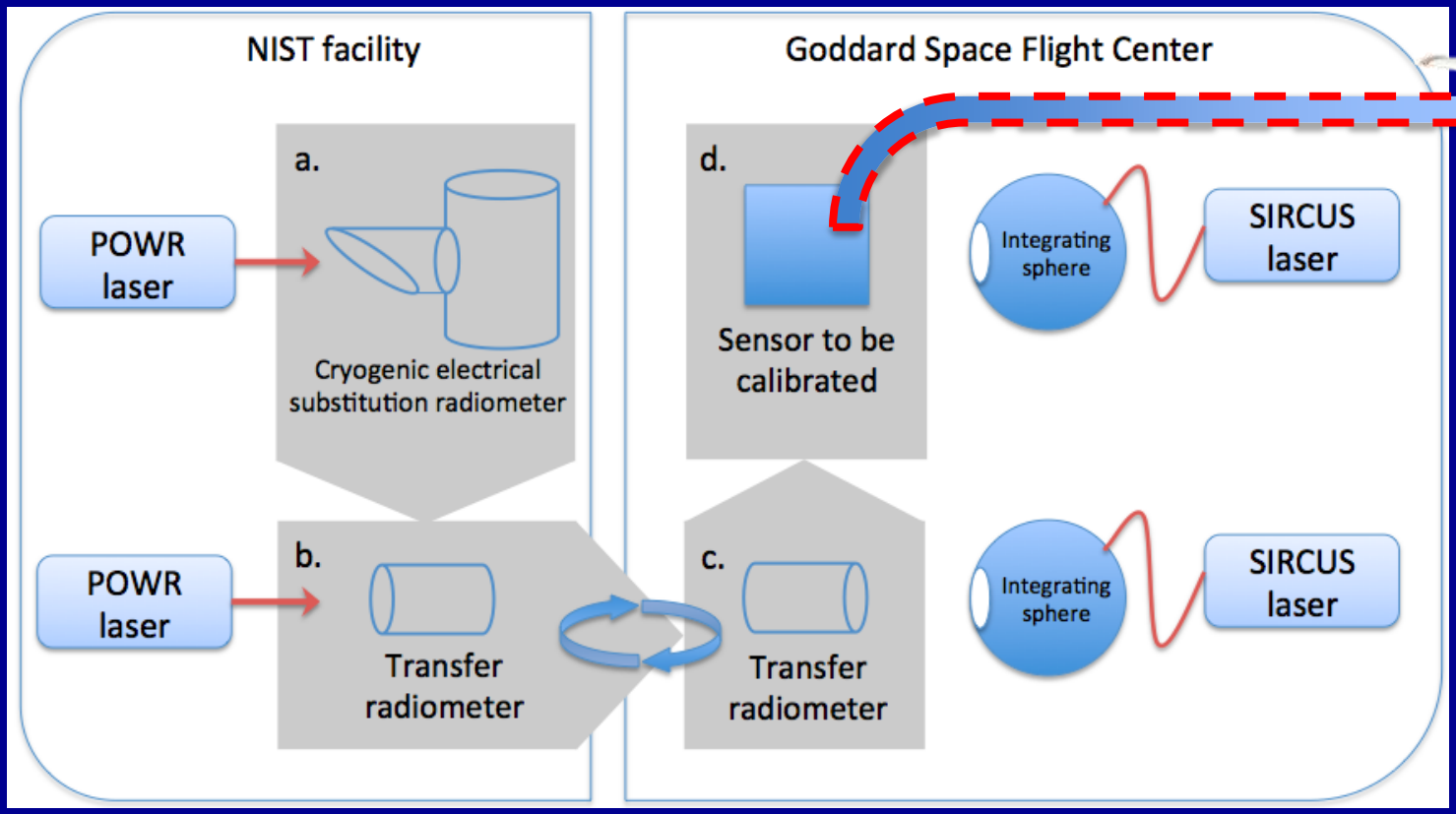


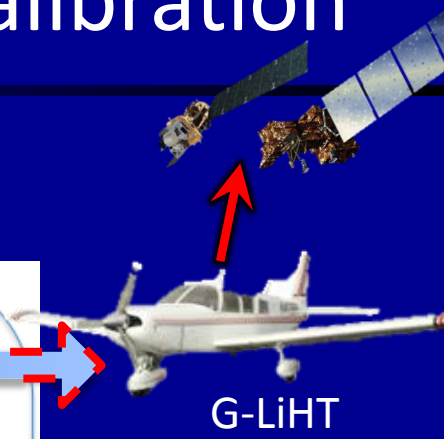


End and top views of G-LiHT instrument package, showing the

(a) scanning LiDAR;
(b) data acquisition computer;
(c) GPS-INS;
(d) irradiance spectrometer;
(e) imaging spectrometer;
(f) thermal infrared camera;
(g) GPS time server; and
(h) profiling LiDAR.

Detector-based calibration





Ground measurements

University of Arizona atmospheric characterization

- Temperature
- Pressure
- Aerosol characterization

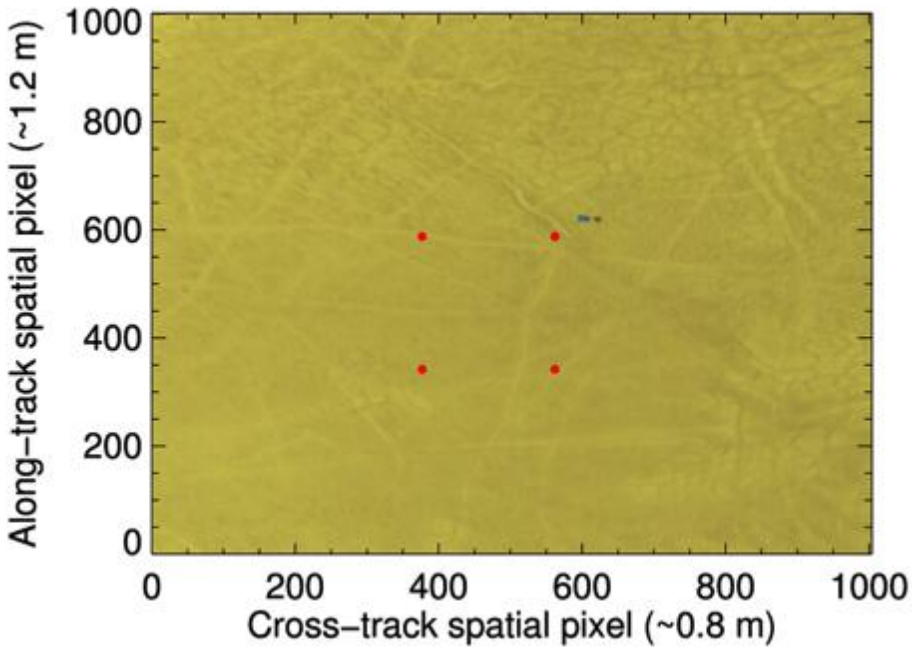
Radiative transfer

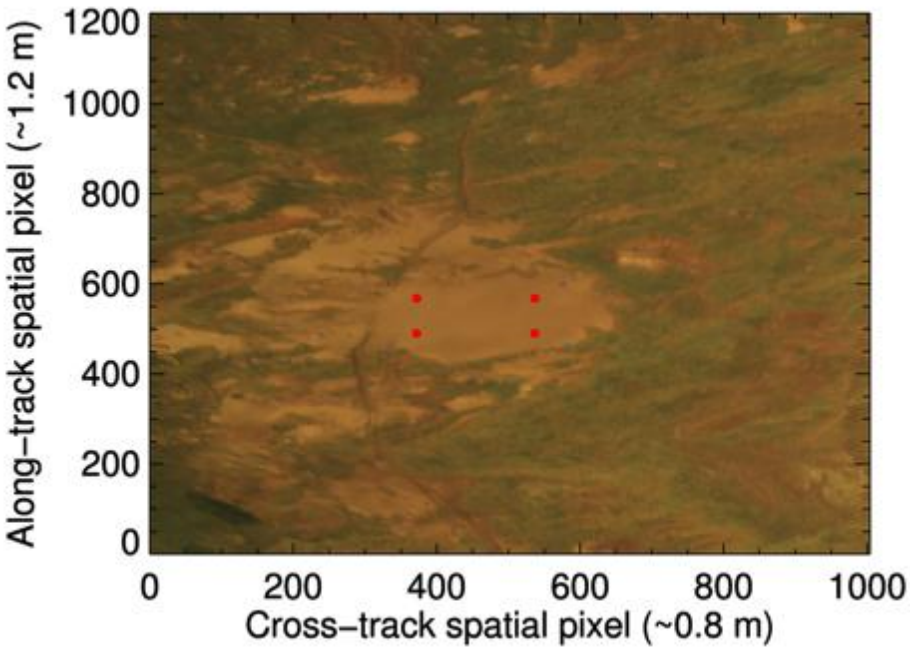
Surface reflectance at overpass time

NASA and University of Arizona reflectance retrieval

G-LiHT images of test sites

Test sites were oriented 10° east of north to align with crosstrack direction of Landsat. G-LiHT flew with headings of 100° or 270°.





Red Lake Playa, AZ on 29 March 2013
120 × 300 m test site

McLaws Playa, AZ on 31 March 2013
120 × 120 m test site

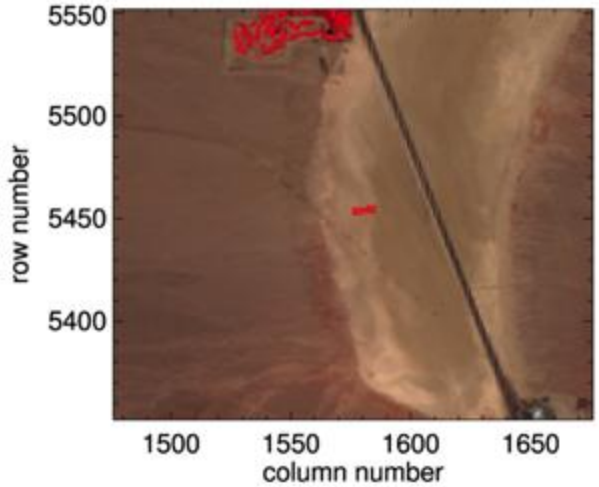
~1000 m AGL 627 nm 529 nm 441 nm

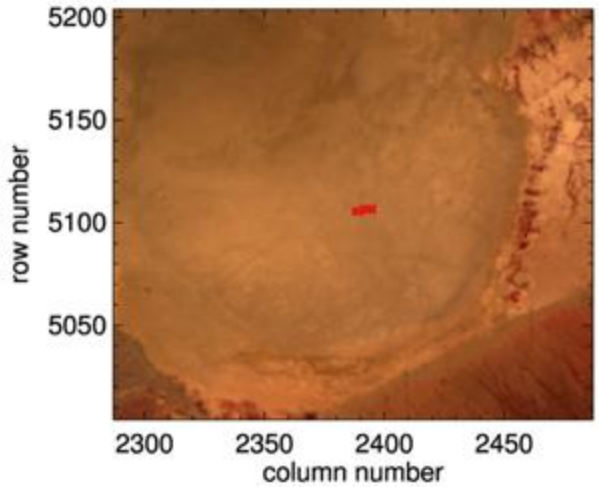
Landsat 8 images of test sites

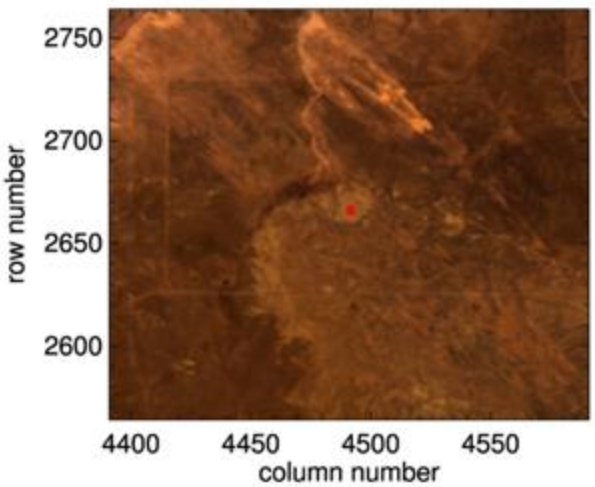
3/24 Ivanpah, path 39

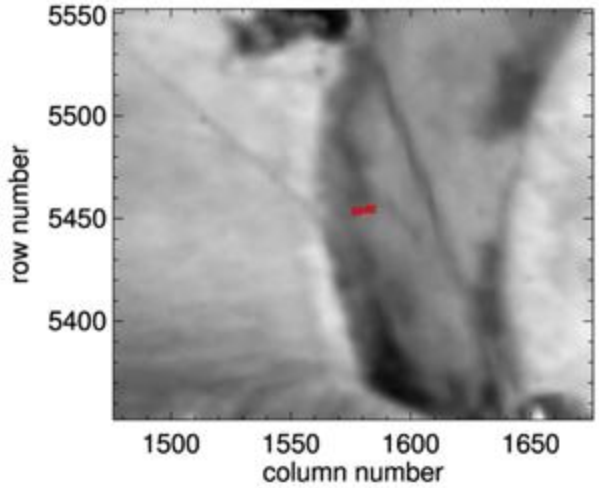
3/29 Red Lake, path 38
tandem with Landsat 7

3/31 McLaws, *pointed 36*
tandem with Landsat 7

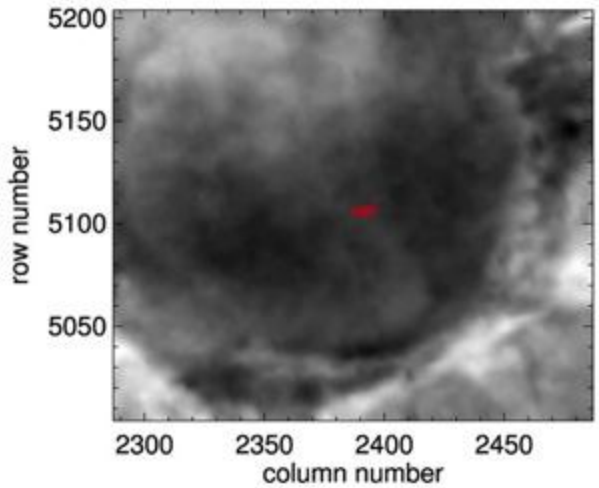




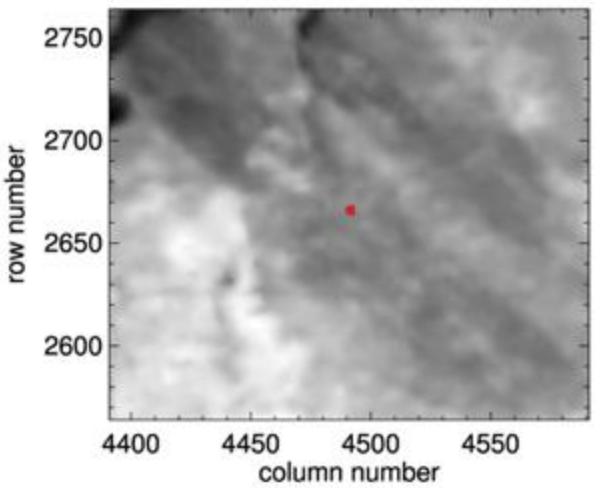




Cirrus channel

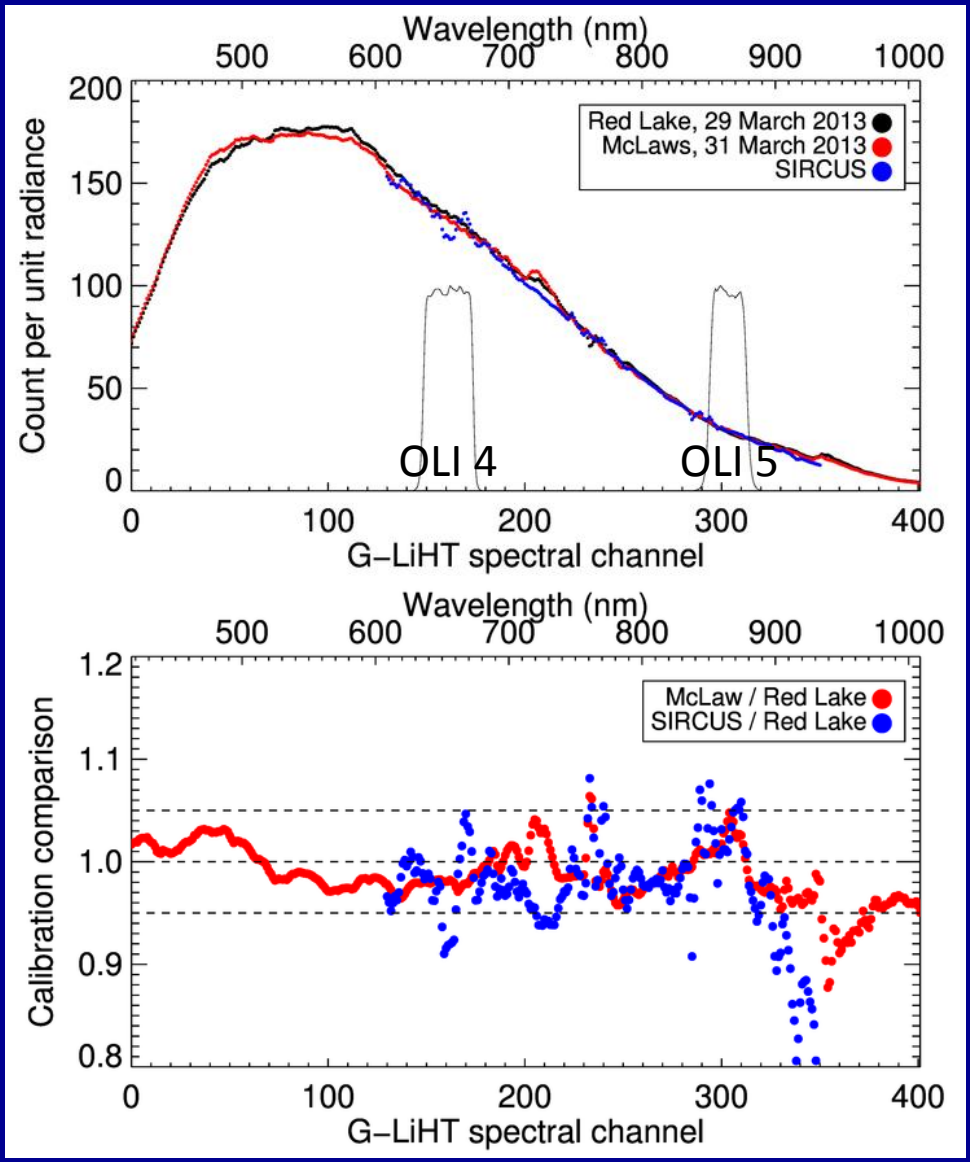


Cirrus channel

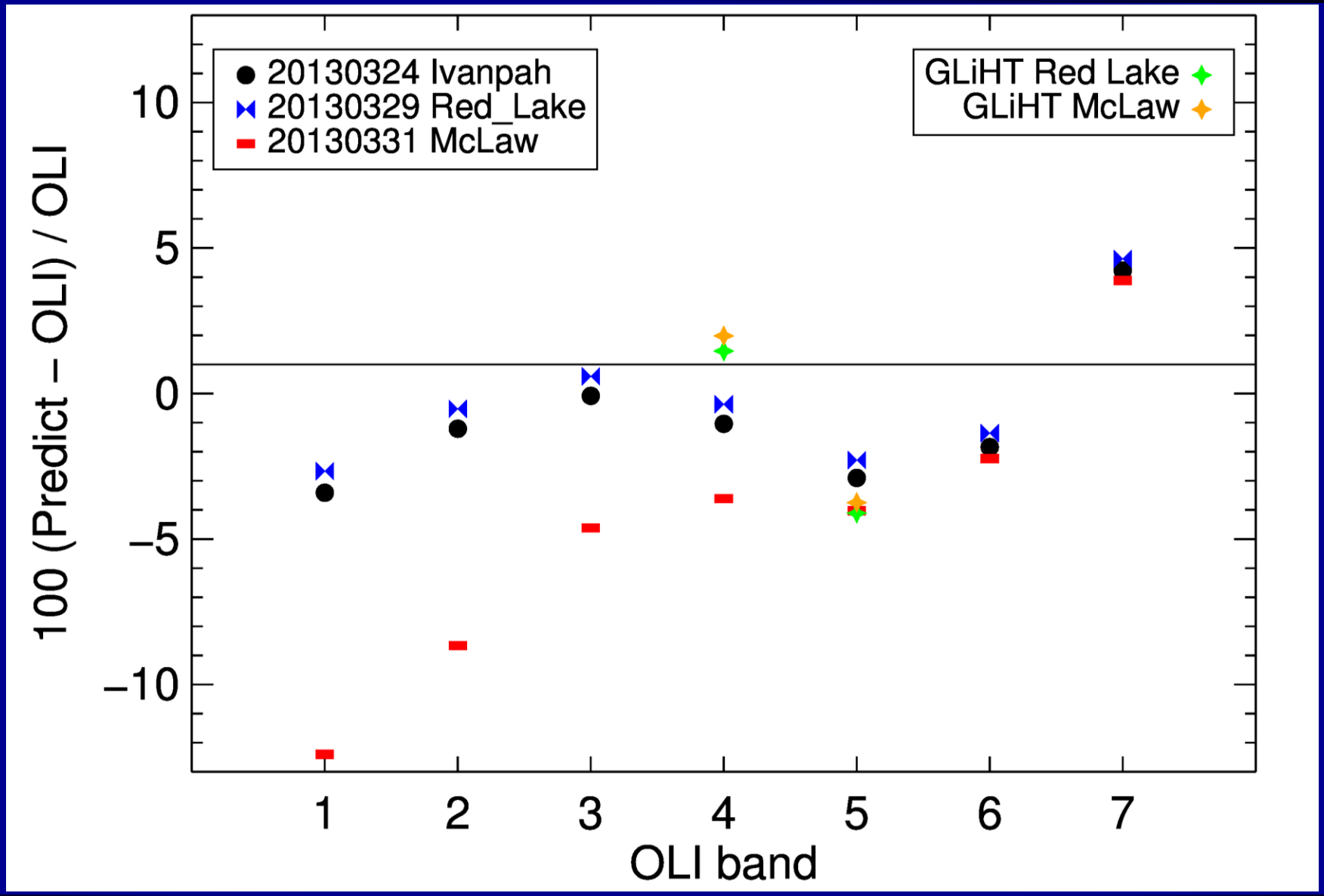


Cirrus channel

G-LiHT calibration results



Landsat 8 OLI calibration results



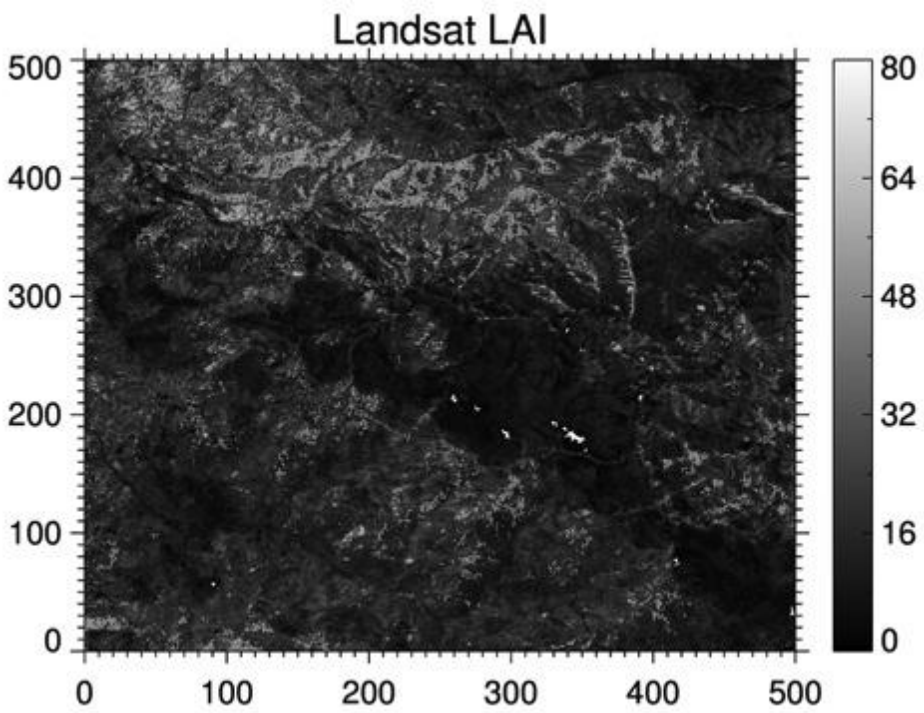
Climate variable inter-comparison

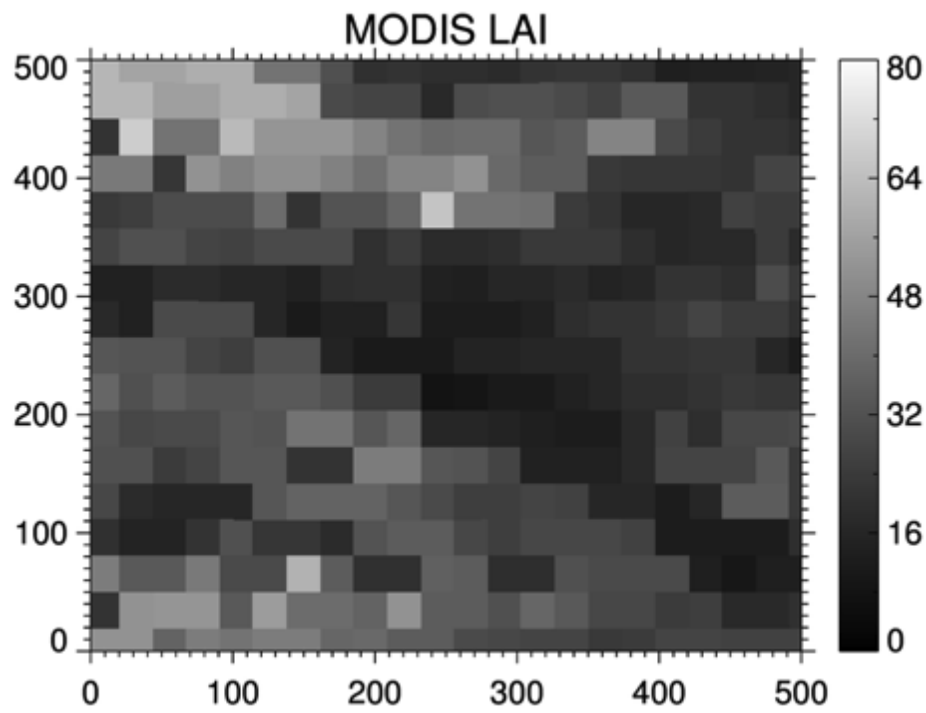
- Landsat provides a critical sampling resolution bridge between current and upcoming satellite, airborne and ground-based observatories (VIIRS, MODIS, NEON, NEON airborne)

- Data assimilation goals
  - Compare/combine data
  - Assess quality of information
  - Trace back to measurement and instrumental requirements/design

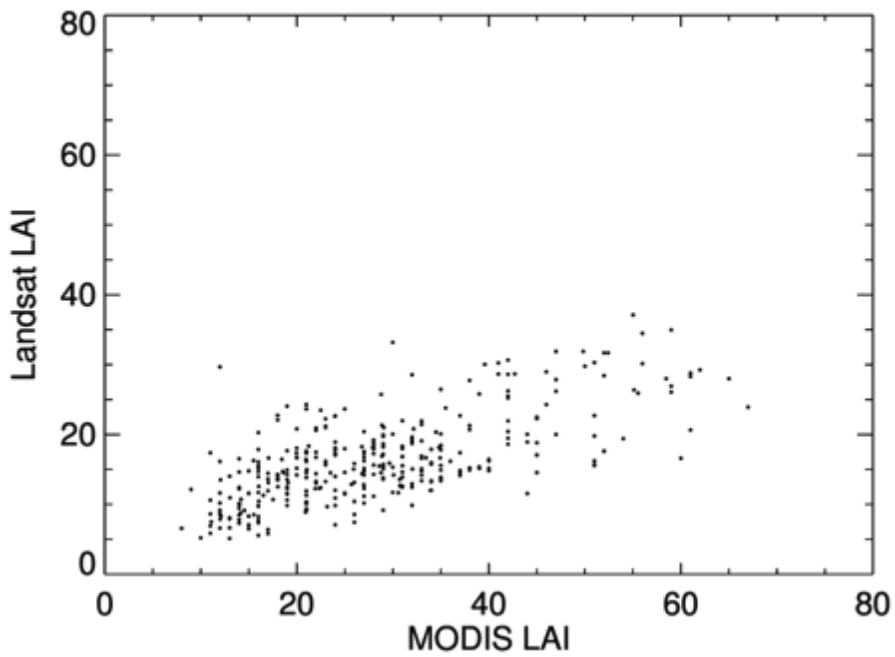
Comparison data set

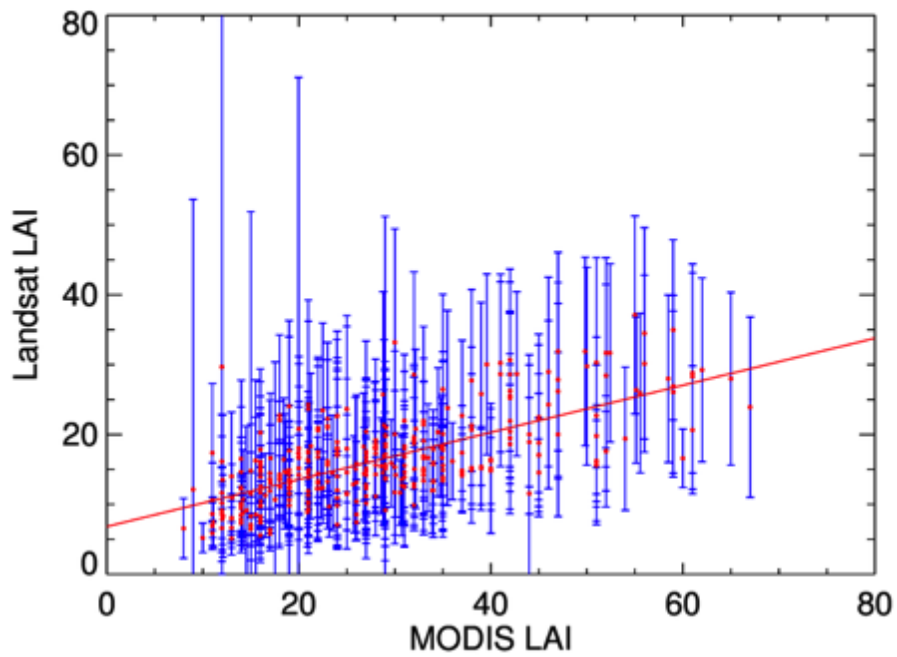
- Landsat-based LAI at 30-m resolution (8/31/2005)
- MODIS-based LAI at ~1-km resolution (8/29/2005)
- Subsets show 15 x 15 km area in Northern California [40.3, -123]
- To put these data on a common spatial grid, MODIS data is resampled to the Landsat grid. Each blob of MODIS data is about 600 pixels that have the same value.





Scatterplot: Landsat vs MODIS LAI





There are about 600 Landsat pixels within each MODIS pixel. This scatter plot shows the mean of the 600 Landsat pixels vs corresponding MODIS pixel.

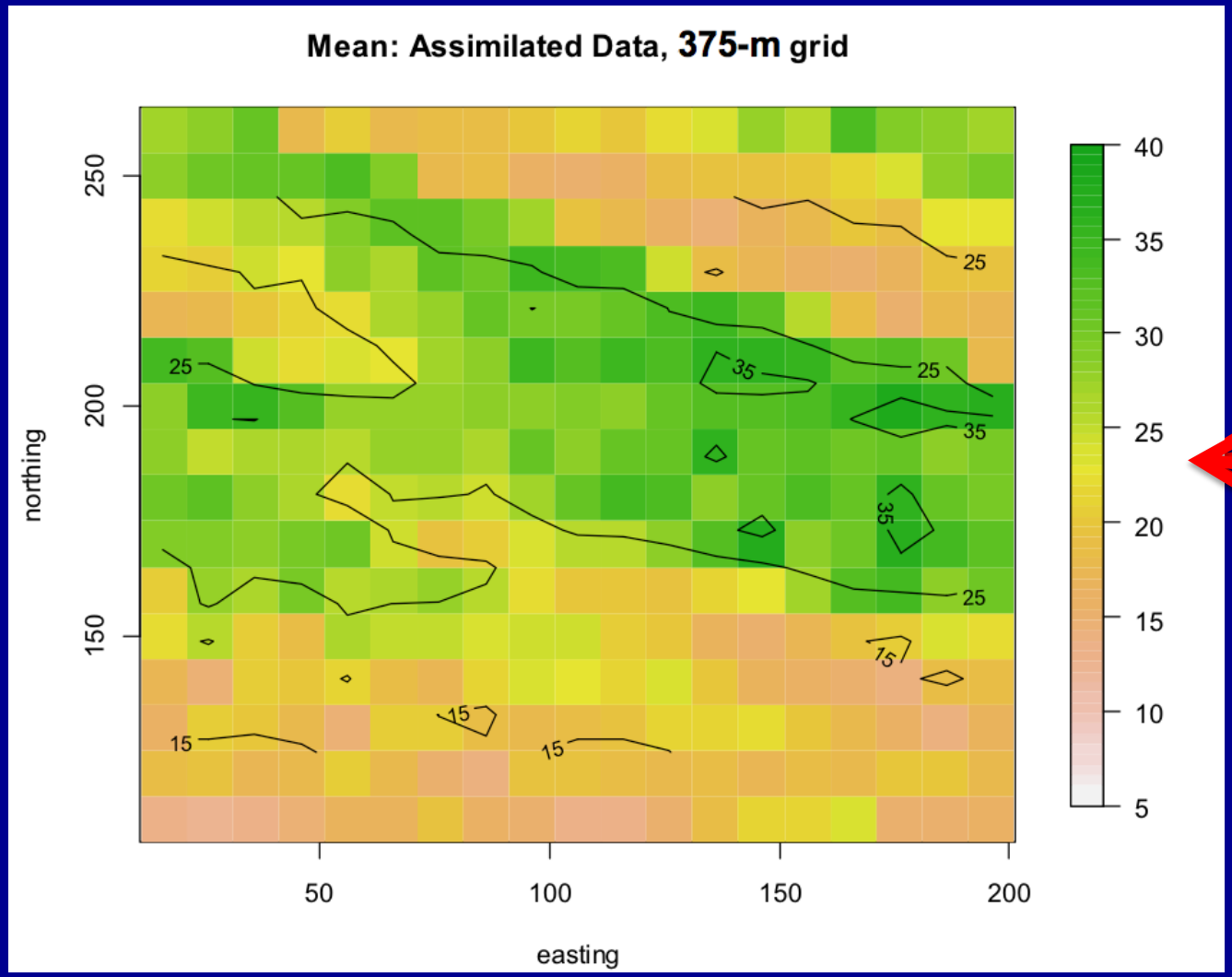
Same plot, but with:

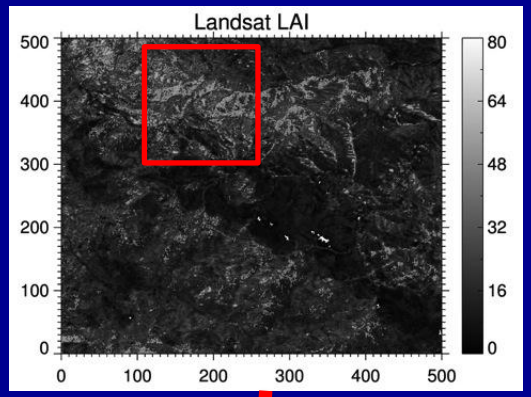
- Blue error bars show +- 1 stddev of each of the Landsat pixel groups
- Red line is linear fit

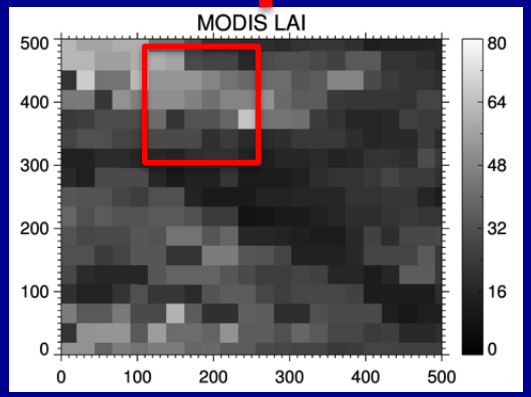
Assimilating Multiple Data Products

- Data model for each source with an error parameter
- Process model is a simple regression with a spatial covariance structure
- This framework is used combine data into a higher level data product

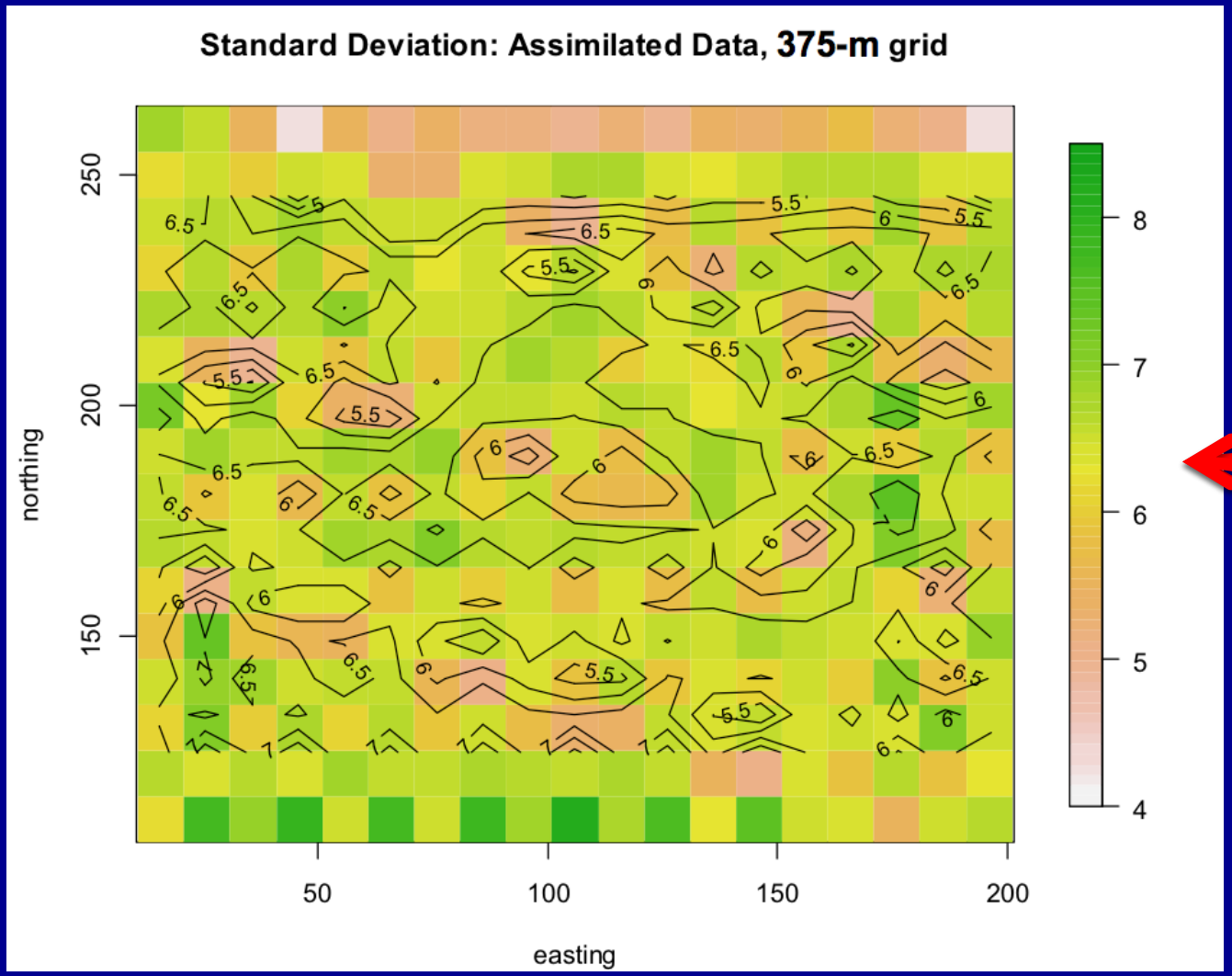
Assimilating Multiple Data Products

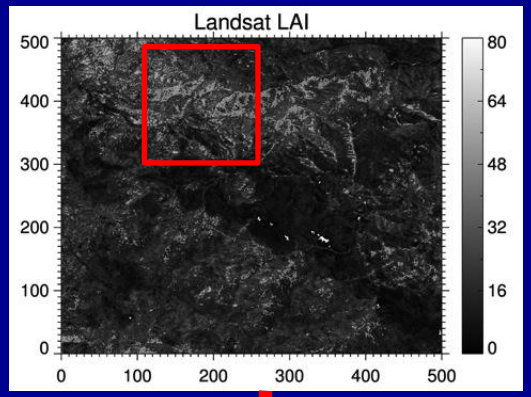


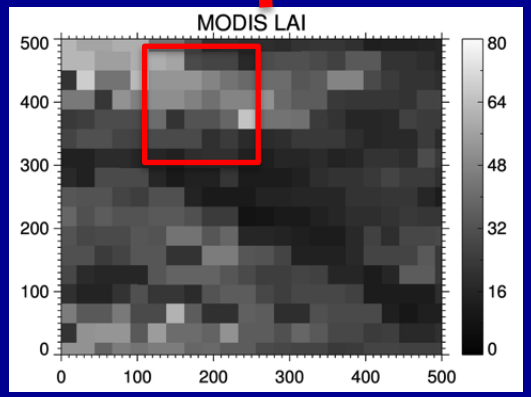




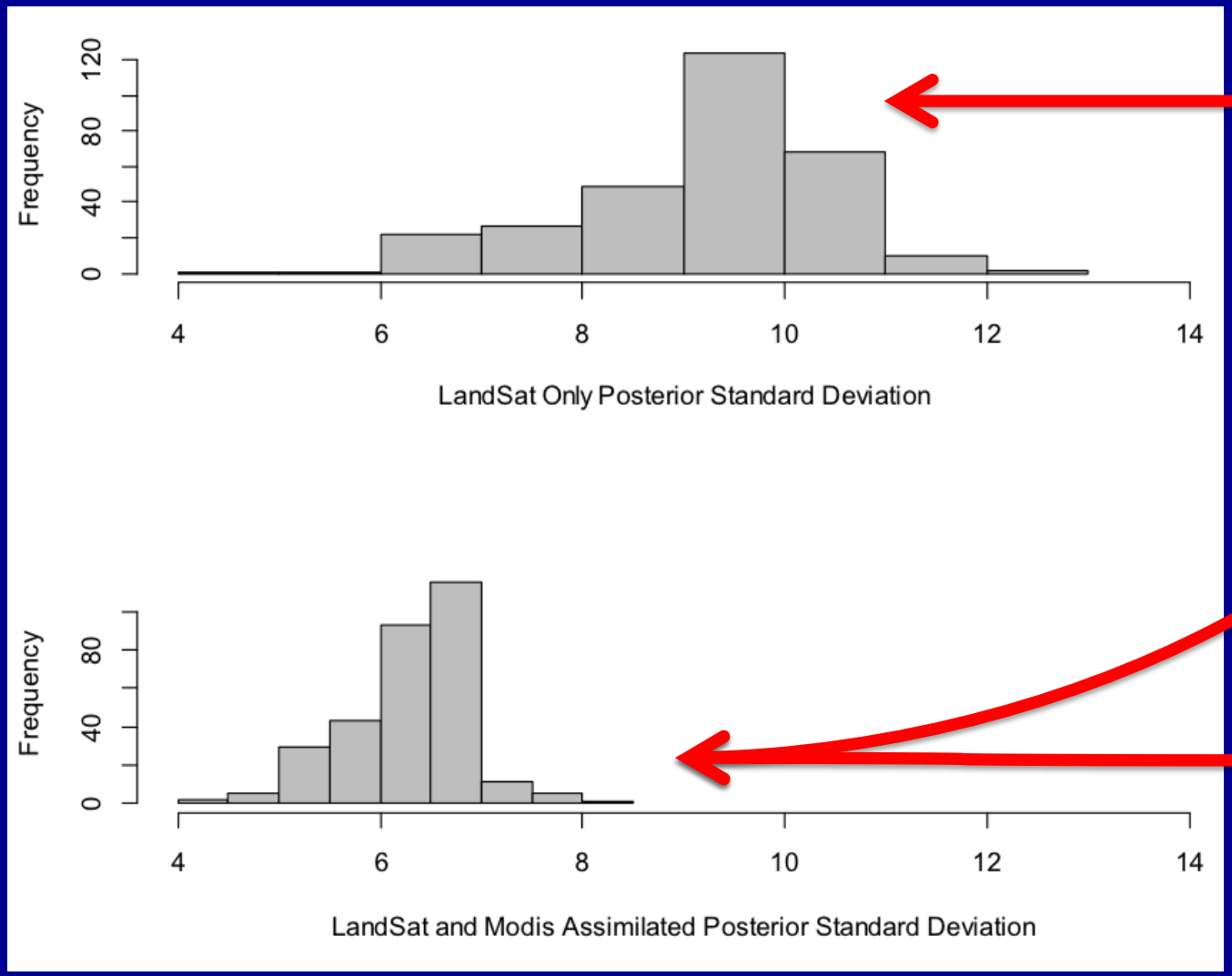
Assimilating Multiple Data Products

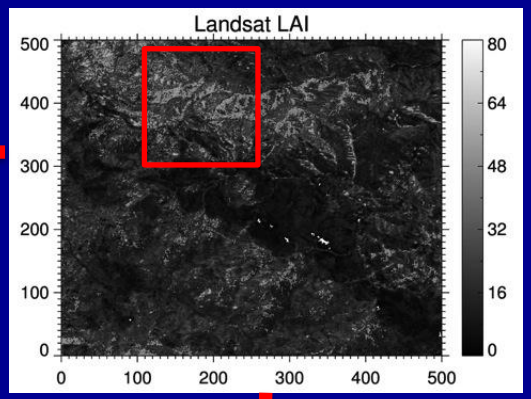


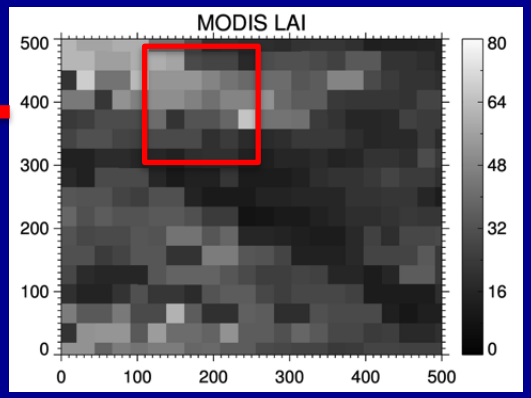




Uncertainty Reduction







Assimilating Multiple Data Products

- Spatially explicit characterization of uncertainty in the higher level data product

- This can be used to:
  - Assess utility of different data sources
  - Constrain the design of data collection

Future work

- Transfer between OLI and ETM+ via G-LiHT
- NASA internal research FY14
  - "Evaluation of the performance of an imaging spectrometer against Landsat requirements"
  - Participants: J McCorkel, P Dabney, J Masek
- Landsat climate variable intercomparison
  - Include airborne/ground data in study (G-LiHT, NEON)
  - Add temporal component
  - Consider other variables in addition to LAI