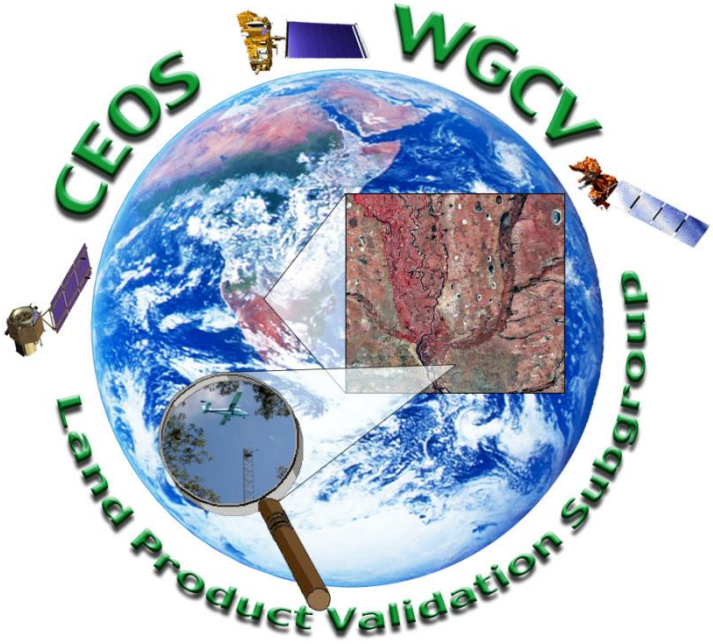


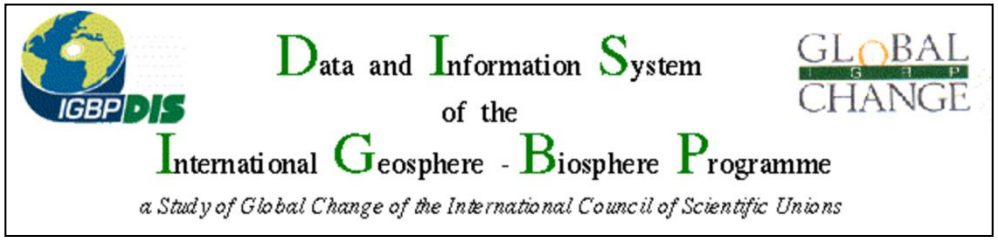

# CEOS/WGCV/LPV 2016 Report

**Miguel Román (NASA GSFC)**
**Fernando Camacho (EOLAB/CGLS)**
**Jaime Nickeson (NASA/GSFC)**

40th Plenary of the Committee on Earth Observation Satellites (CEOS)
Working Group on Calibration and Validation (WGCV)
March 14-18th, Canberra, Australia

# Brief History of CEOS-WGCV-LPV

- The CEOS Land Product Validation (LPV) subgroup was established as a logical extension of the **International Geosphere-Biosphere Programme Data and Information System (IGBP-DIS)** and the MODIS Land Discipline **(MODLAND)** Team Validation initiatives: **http://landval.gsfc.nasa.gov/index.html**





- **<u>LPV arose out of CEOS's recognition that standardized approaches to global product validation were essential for wide acceptance and use of long-term climate data records</u>**. A common approach to validation has encouraged widespread use of validation data, helping the Land program move toward standardized approaches for quantifying errors and uncertainties.

# Focus Areas and Co-leaders

*ECV

| Product | North America | EU / China |
|---|---|---|
| **Snow Cover** (T5)*, **Sea Ice** | Thomas Nagler (ENVEO, Austria / SnowPEx) | Tao Che (Chinese Academy of Sciences) |
| **Surface Radiation** (Reflectance, BRDF, Albedo [T8]*) | Crystal Schaaf (UMB, MODIS / VIIRS / Landsat) | Alessio Lattanzio (EUMETSAT) |
| **Land Cover** (T9)* (GOFC) | Pontus Olofsson (Boston University / CMS) | Martin Herold (Wageningen University, NL) |
| **FAPAR** (T10)* | Arturo Sanchez-Azofeifa (University of Alberta / FLUXNET) | Nadine Gobron (JRC, IT) |
| **Leaf Area Index** (T11)* | Oliver Sonnentag (U. Montreal / ABoVE, FLUXNET) | Stephen Plummer (Harwell, UK) |
| **Fire** (T13)* (GOFC) (Active Fire, Burned Area) | Luigi Boschetti (U. Idaho. MODIS / VIIRS / LCLUC) | Kevin Tansey (University of Leicester, UK) |
| **Land Surface Temperature** (LST and Emissivity) | Simon Hook (JPL, ASTER / MODIS / VIIRS HyspIRI / ECOSTRESS) | Jose Sobrino (University of Valencia, SP) |
| **Soil Moisture*** | Tom Jackson (USDA ARS / SMAP) | Wolfgang Wagner (Vienna Univ of Technology, AT) |
| **Land Surface Phenology** | Matt Jones (OSU, NCA-USGCRP) | Jadu Dash (University of Southampton, UK) |

# Relaying Validation Results to our Users

**LPV Web Site**
**16 years and running..**

**Established in 2000**

Subscribed member list has grown ***to nearly 700 members***.

~600 web hits per month.

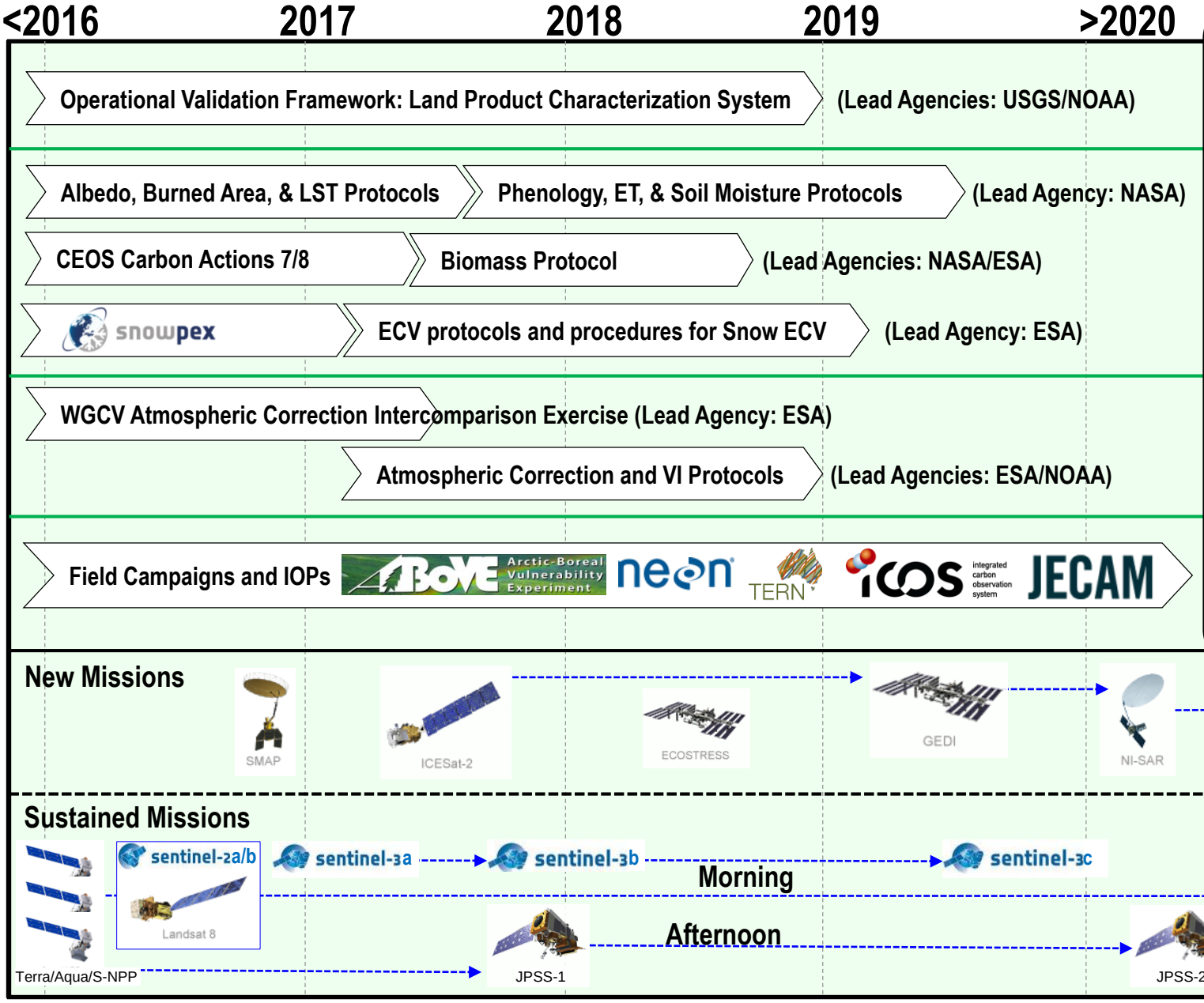
Each focus area (ECV) has pull down menu of links to

- Home page
- References
- Collaboration
- Products


**http://lpvs.gsfc.nasa.gov**

# CEOS-LPV 5-Year Roadmap






## Vision

**All missions** support validation & **validation is on-going**

Uncertainty information determined through **standard practices & protocols**

**Algorithms are iteratively improved** based on validation results

# LPV Biomass Subgroup

**CEOS member agencies have called for the establishment of a 'Biomass ECV' subgroup:**

- **Carbon Action 7:** "Improve and expand upon the availability of the ***in-situ observations needed for the calibration and validation of satellite land data products used for carbon science***".

- **Carbon Action 8:** "The ***CEOS WGCV's Land Product Validation (LPV) Subgroup*** will continue its work to validate satellite land data products and ***expand the number of land variables addressed*** as priorities are identified and available resources permit, and where no other body takes responsibility (e.g., GOFC-GOLD).

Lead Coordinating Agency: NASA

# A Land Validation Framework

## Validation Good Practice Document


Fernandes et al., (2014). Global LAI Product Validation Good Practices. doi:10.5067/doc/ceoswgcv/lpv/lai.002

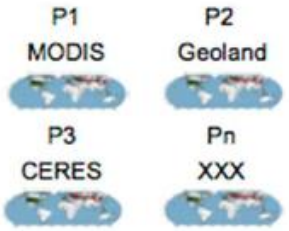
Lead Agency: NASA

## Fiducial Reference Data Sets


Example of fiducial reference data for soil moisture.

Lead Agencies: Various

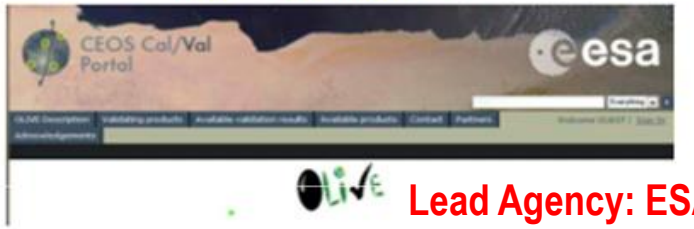
## Global Satellite Product Subsets




Subsets over fiducial reference data sites for each product automatically delivered.

Lead Agencies: USGS/NOAA

## Online Validation Tool

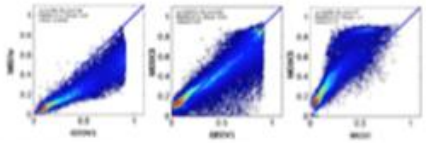



Lead Agency: ESA

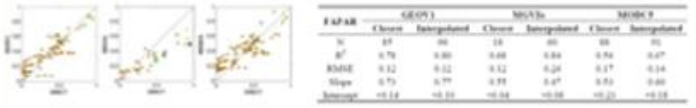
Example of OLIVE validation tool for LAI and FAPAR [3].

Lead Agency: ESA

## Standardized Intercomparison Report



## Standardized Validation Report



# CEOS Agency Contributions to LPV
# &
# Science Highlights

# Global Leaf Area Index Product Validation Good Practices

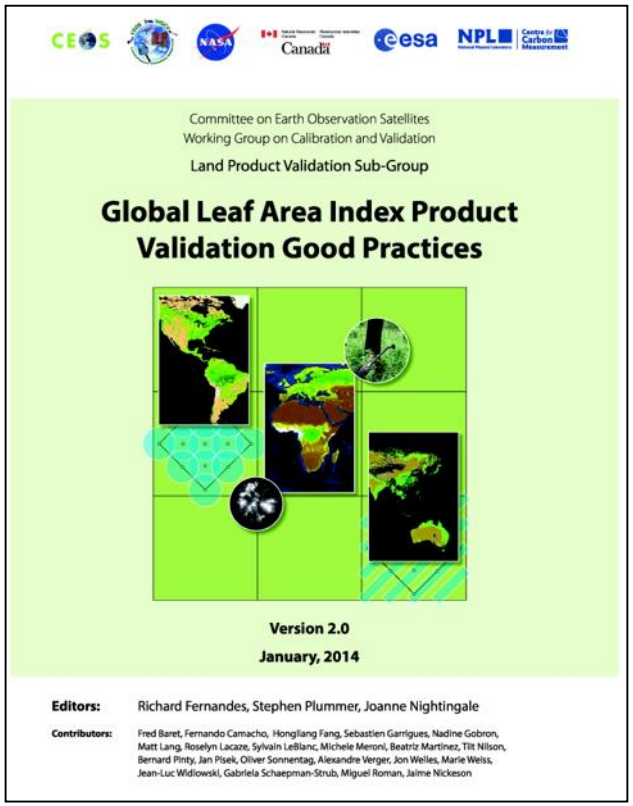



**Figure 1:** Global Leaf Area Index (LAI) Good Practices

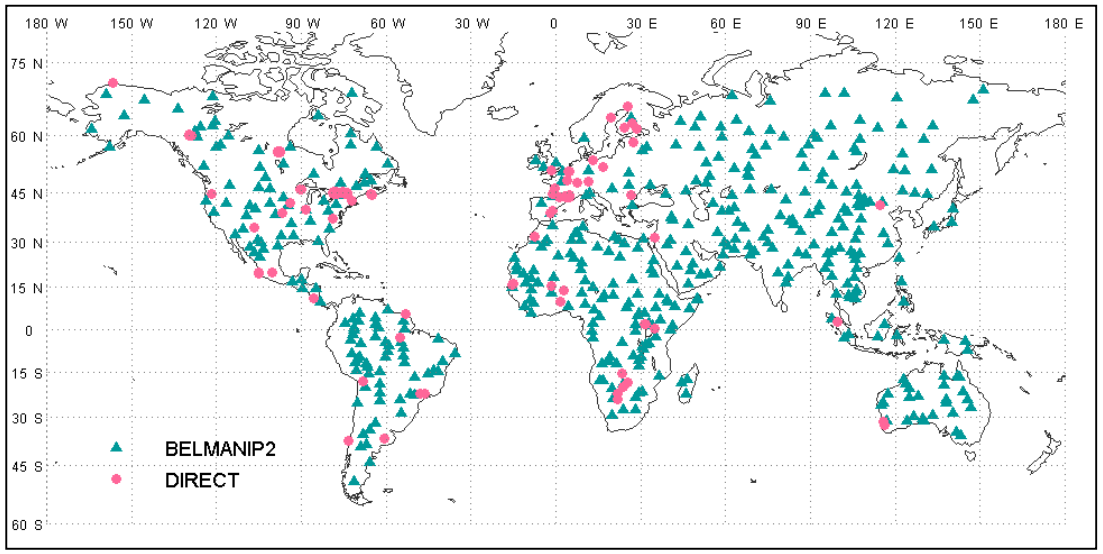



**Figure 2:** Location of reference LAI sites available for direct validation and inter-comparison studies.

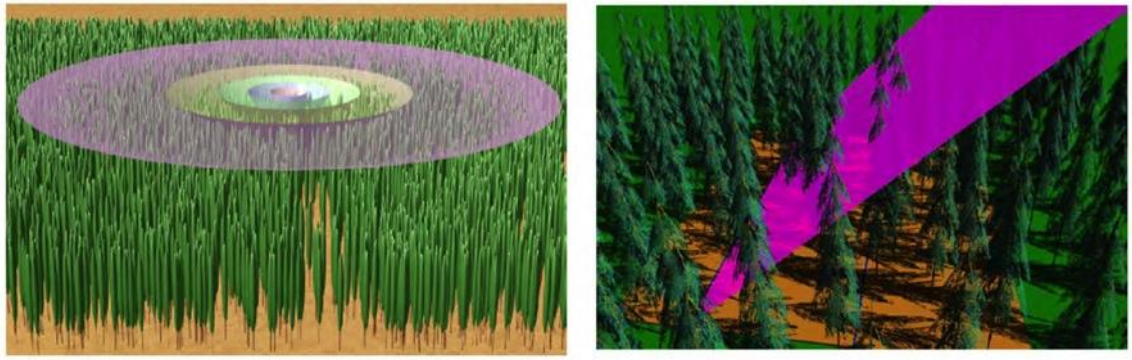


**Figure 3:** Depiction of spatial footprint of a LAI-2000 instrument as a function of zenithal view ring (left) and the TRAC instrument (right) for a given solar illumination condition.

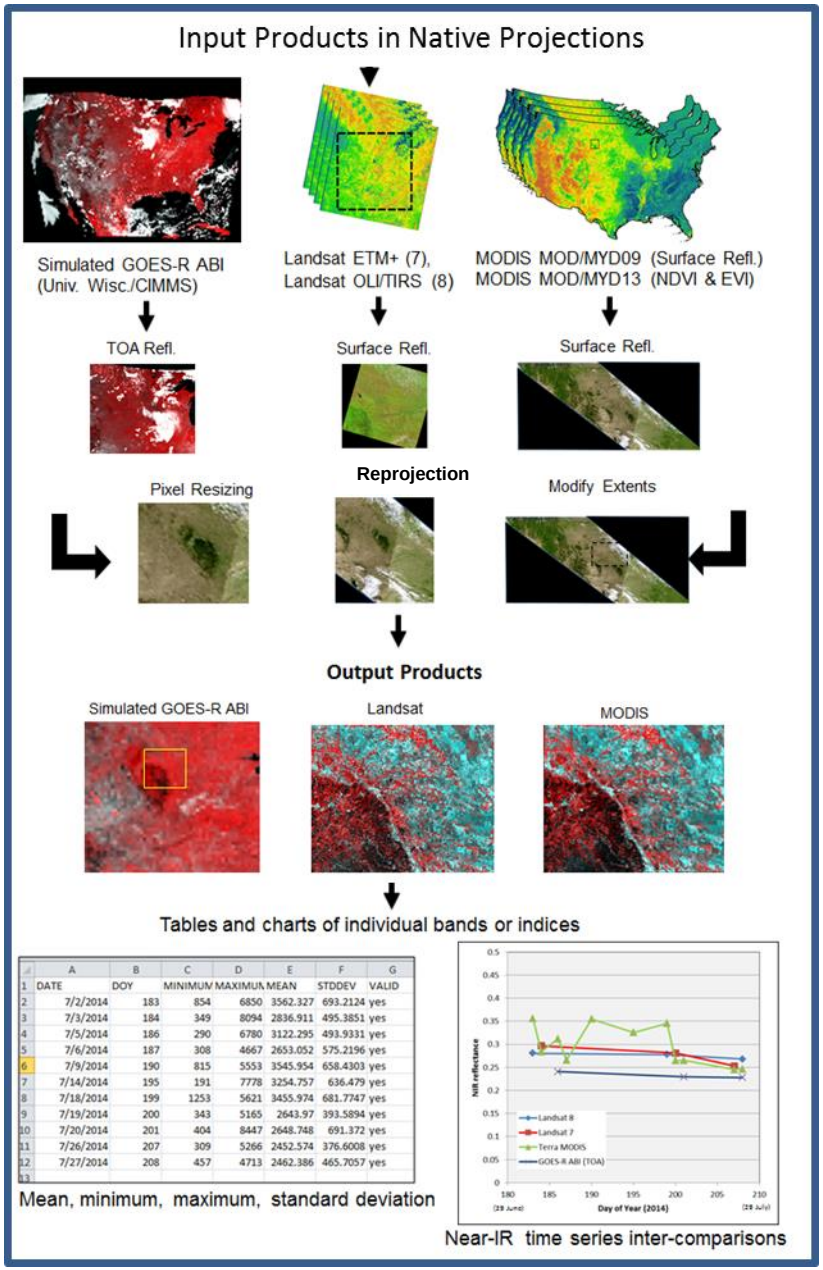
# NOAA/USGS Land Product Characterization System

A web-based system that is designed to use moderate- to high-resolution satellite data for the characterization and validation of CEOS-endorsed time series products, including GOES-R ABI, Landsat-8/Sentinel-2, and the Land Science products from MODIS and VIIRS.

The LPCS includes:

- data inventory
- access and
- analysis functions

that will permit selection of data to be easily identified, retrieved, co-registered, and compared statistically through a single interface.

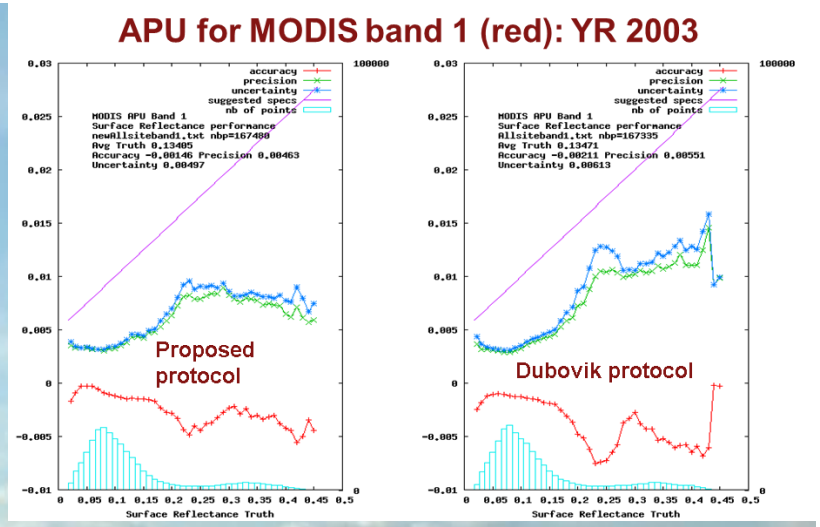



**Kevin Gallo: NOAA/NESDIS/STAR**
**John Dwyer: USGS/EROS**
**Greg Stensaas: USGS/EROS**
**Ryan Longhenry: USGS/EROS**

# CEOS-WGCV Atmospheric Correction Intercomparison Exercise

**The Problem:** A standard land surface reflectance protocol for using reference AERONET products needs to be agreed on by the CEOS Land member agencies.

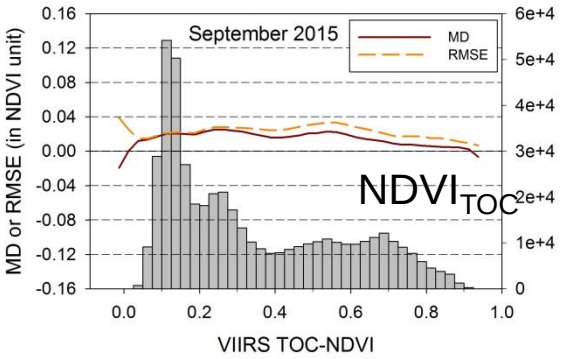
**The Solution:** A validation protocol for Land surface reflectance climate data records that requires the aerosol model for each AETONET site to be readily available.

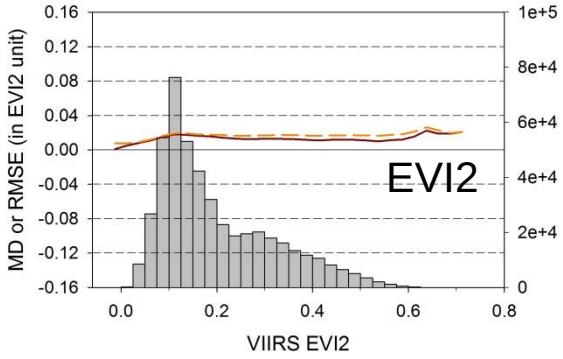



(Lead: Ferran Gascon - ESA-ESRIN)

# Vegetation Index Product Intercomparison (Lead: Tomoaki Miura)

**Goal: To evaluate the radiometric compatibility and long-term stability of Suomi NPP VIIRS and Aqua MODIS Normalized Difference VI (NDVI) (both TOA and TOC), Enhanced VI (EVI), and Two-band Enhanced VI (EVI2).**

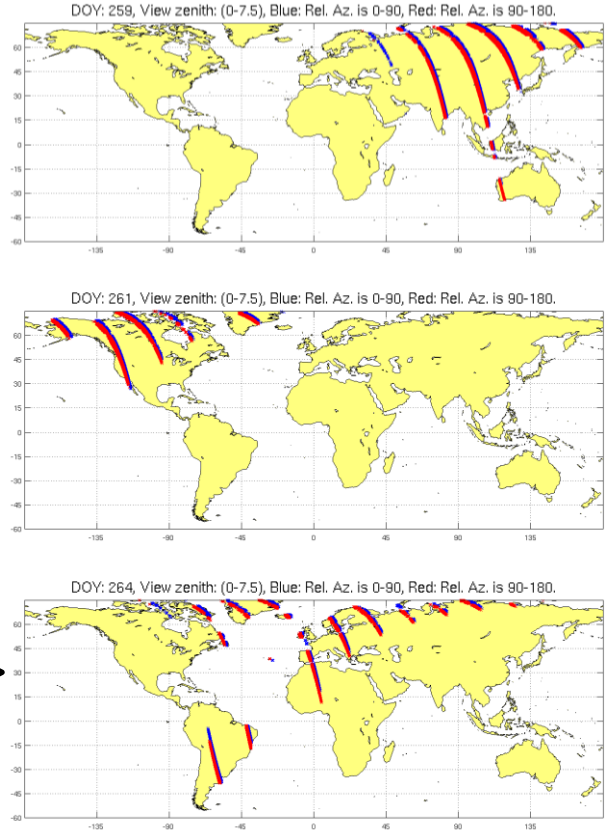



**Mean Difference (MD) and RMSE over Dynamic Range for Sep. 2015**

| Vegetation Index | MD | RMSE |
|---|---|---|
| $NDVI_{TOA}$ | 0.018 | 0.021 |
| $NDVI_{TOC}$ | 0.019 | 0.024 |
| EVI | 0.022 | 0.024 |
| EVI2 | 0.015 | 0.017 |

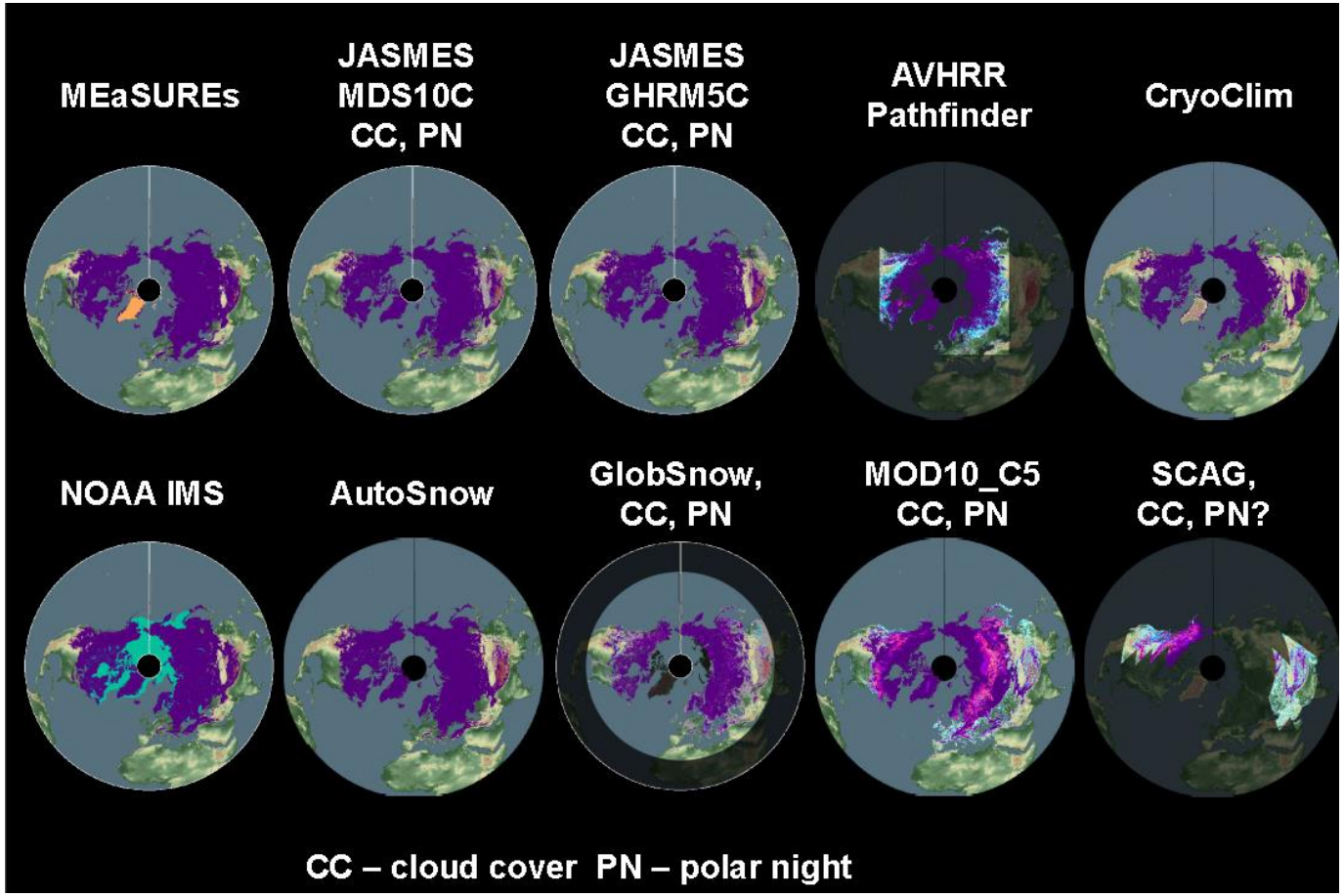
**Difference Summary for Sep. 2015**




MODIS-VIIRS overlapping orbital tracks (Red = forward scattering geometry; Blue = backward scattering geometry)

**(Vargas et al., 2013)**

# Satellite Snow Product Intercomparison




**Major Outcomes: (1) agreed protocols and procedures** for validation and intercomparison of snow products. **(2) agreed reference data sets and approaches** for analyzing temporal trends; **(3) agreed framework for reporting results** (i.e., website, peer-review.)

**Focus Area Lead:**
*Thomas Nagler*

# Intercomparison of MODIS Albedo Retrievals and In-Situ Measurements across the Global FLUXNET Network

- **The LaThuile FLUXNET Synthesis Dataset has offered an unprecedented opportunity to select sites according to their spatial representativeness across a wide range of plant functional types (PFTs) and geographical areas.**

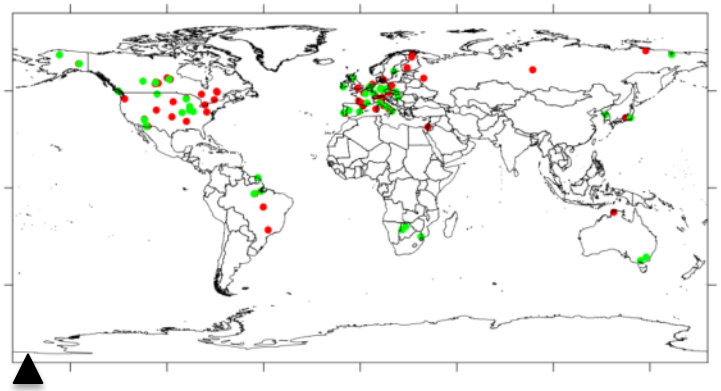


**Figure 1:** Spatial distribution of the 120 FLUXNET sites for which albedo measurements are available.

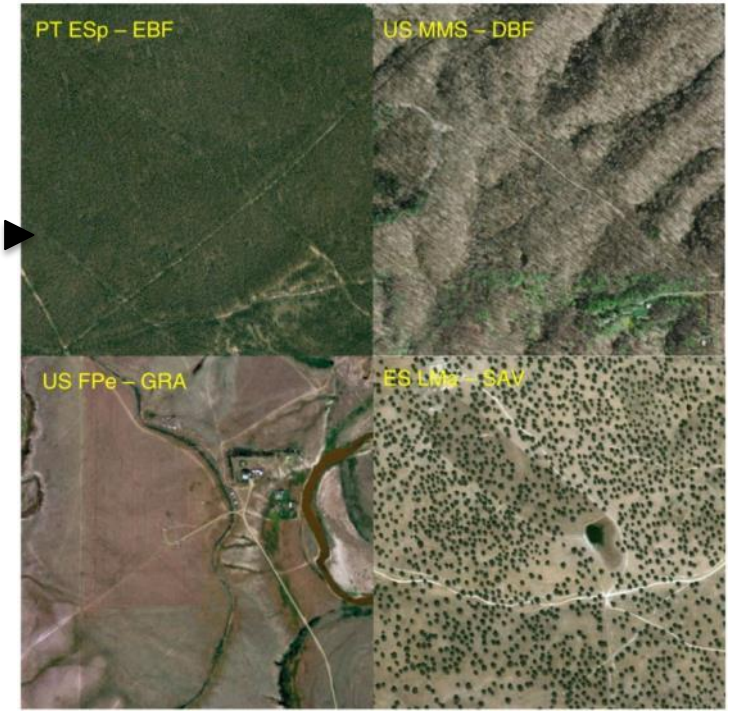



**Figure 2:** Classification of four FLUXNET sites according to their spatial representativeness at the resolution of MODIS satellite imagery (~1 km$^2$).

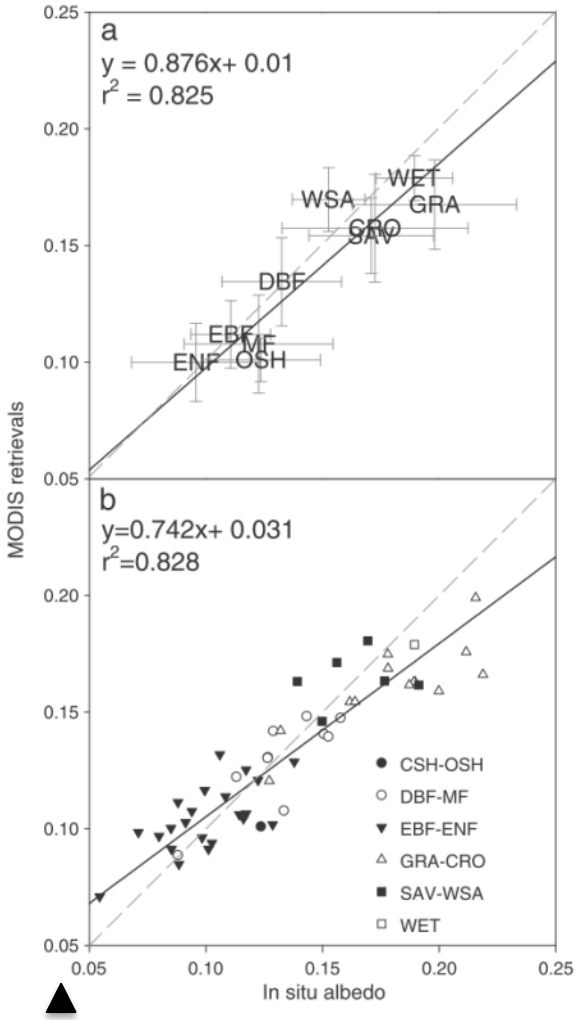



**Figure 3:** MODIS albedo retrievals vs. in-situ observations grouped by plant functional types (PFTs) (a), and by individual sites classified by PFT (b).

**Cescatti et al., (RSE)**

ELSEVIER

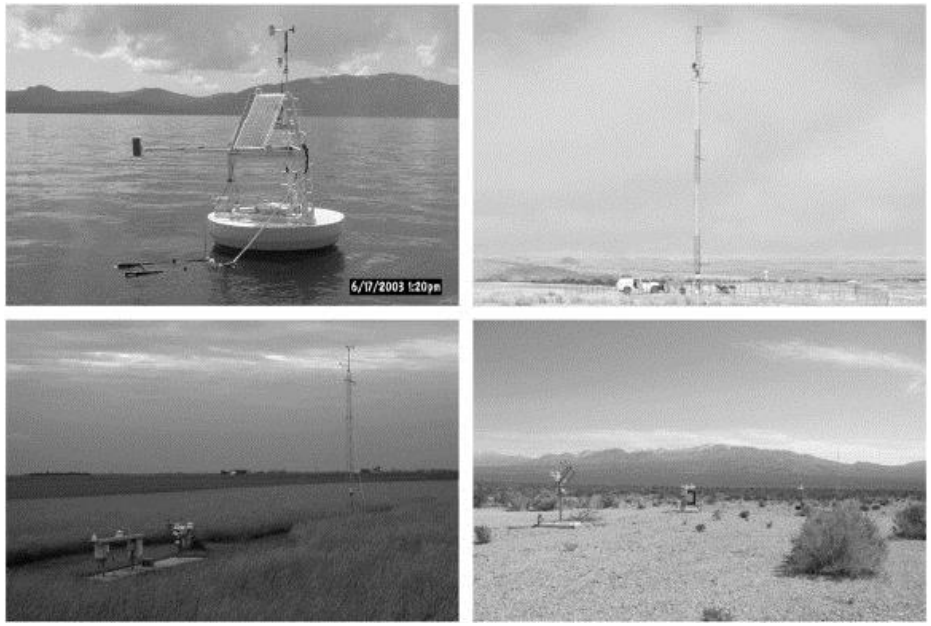
Remote Sensing of Environment

Volume 154, November 2014, Pages 19–37

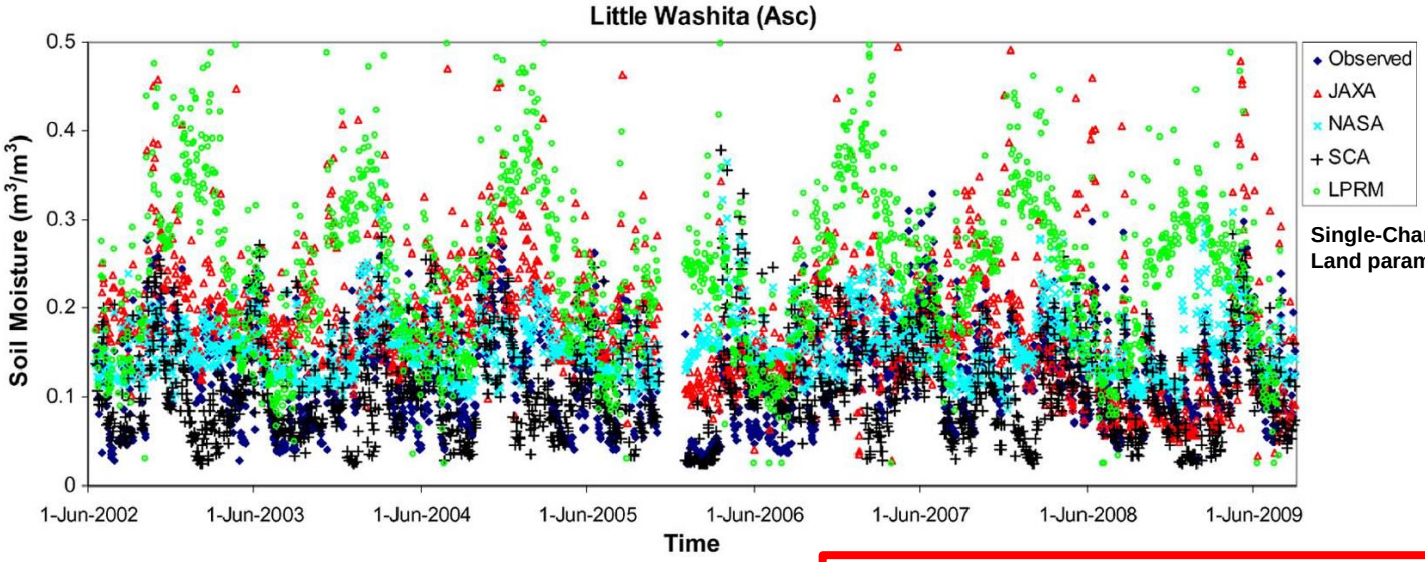
# Validation of Land Surface Temperature products derived from the Visible Infrared Imaging Radiometer Suite (VIIRS) using ground-based and heritage satellite measurements

Pierre C. Guillevic[a], James C. Biard[b, c], Glynn C. Hulley[a], Jeffrey L. Privette[c], Simon J. Hook[a], Albert Olioso[d], Frank M. Göttsche[e], Robert Radocinski[a], Miguel O. Román[f], Yunyue Yu[g], Ivan Csiszar[g]

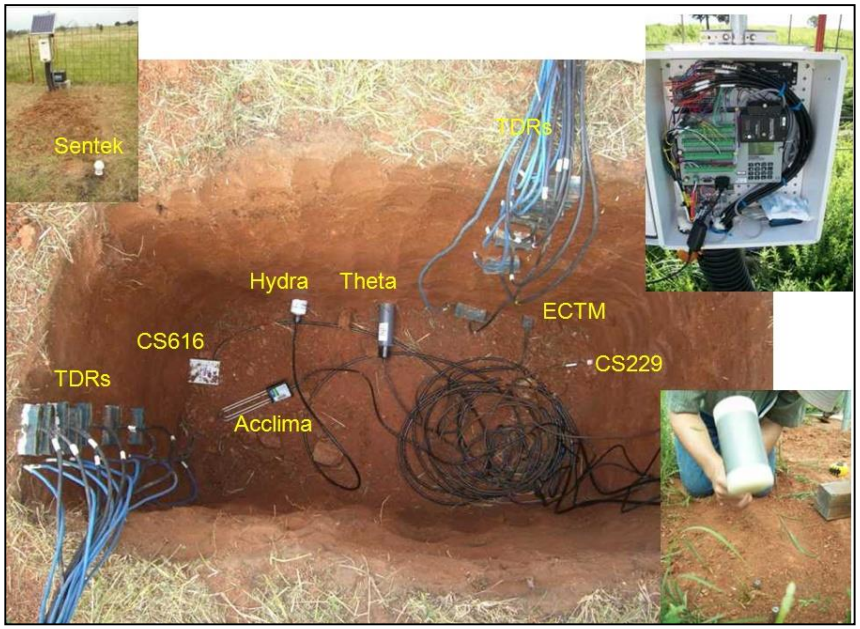
**- V1 LST Protocol Published!**
**- Uses VIIRS as case study**
**- Interagency Collaboration has been key to LST Focus Area team's sucess.**



# SMAP In Situ Soil Moisture Testbed (Oklahoma)




**Single-Channel Algorithm (SCA)**
**Land parameter retrieval model (LPRM)**



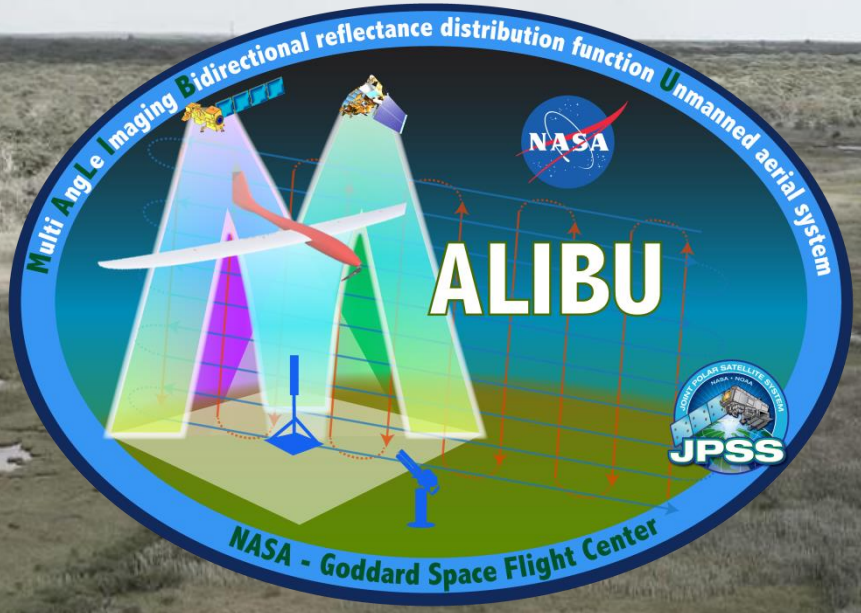

***Jackson et al., (TGRS)***
**IEEE-GRSS Highest Impact Paper Award**

- In order to conduct an efficient validation program we need observations that are calibrated and referenced to the same standard.
- Validation activities show when there is room for improvement in the standard (NASA/JAXA) products, and the potential pitfalls in using the products without a careful evaluation.
- **Announcement: 3rd Satellite Soil Moisture Validation & Application Workshop,** *21-22 September 2016.*

**Lead:** *Tom Jackson (USDA/SMAP)*

| WGCV36 Action Items | Assigned to: | Due Date | Status |
|---|---|---|---|
| WGCV-36-1: LPV to address the specification of the requirements for a worldwide network of land surface spectral directional measurements for validation of spaceborne retrievals. | LPV | WGCV 37 | Closed |

# MALIBU (Multi AngLe Imaging Bidirectional Reflectance Distribution Function sUAS)

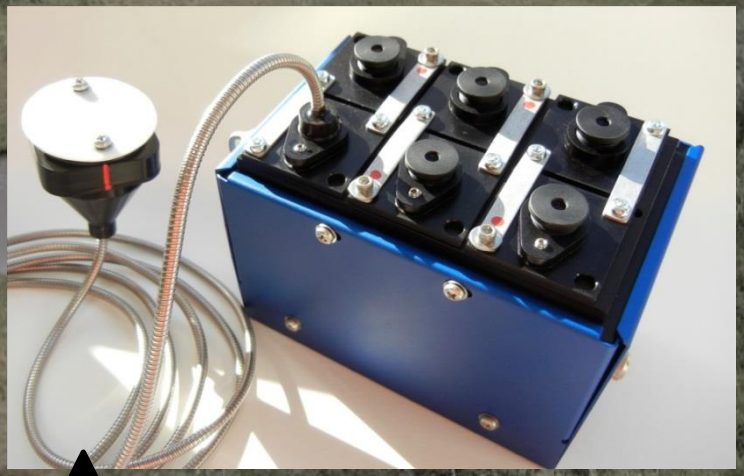



**What is MALIBU:** The first semi-autonomous sUAS platform at NASA/GSFC with a full blanket exemption to conduct operations across the US (FAA-Section 333 ) and Canada (TCAN).

**Driver / Need:** Multi-angular reference datasets for the assessment of terrestrial essential climate variables (ECVs), including: satellite-derived spectral/broadband BRF, BRDF, albedo, VI, PRI, LAI/fAPAR, snow cover, and phenology metrics.

**Benefits:**

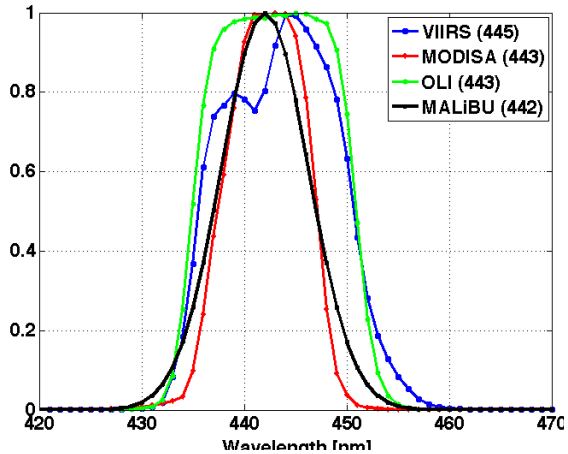
- Follows a "federated approach" for instrument calibration, data processing, and product evaluation.
- Data collection at a fraction of the costs of heritage airborne platforms (~$100 x flight hour).
- Calibration and quality-assurance builds on CEOS-RADCALNET and LPV validation protocols.

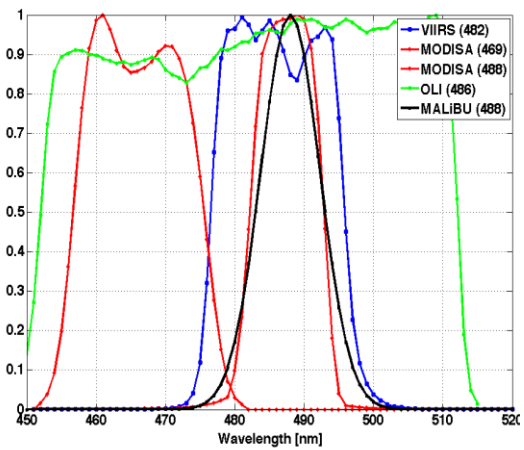


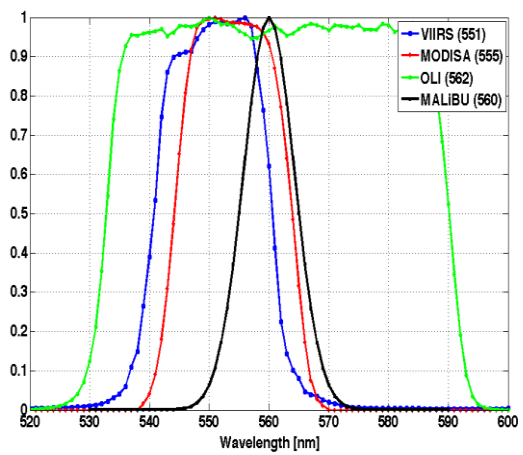
MALIBU's 6-channel optical payload, with one channel attached to a reference diffuser.

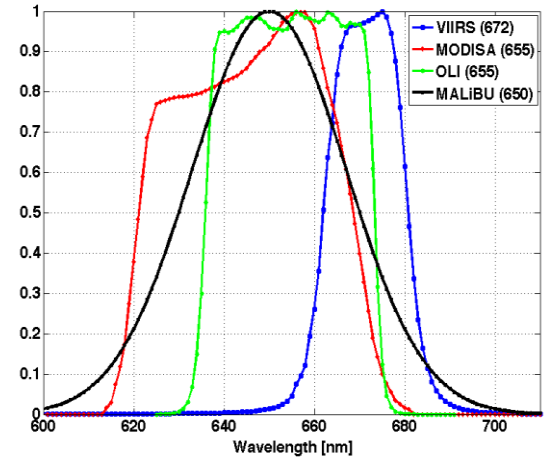
# MALIBU Platform

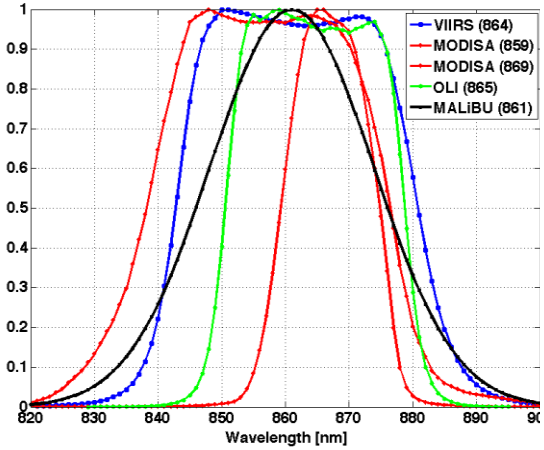

# MALIBU Spectral Response

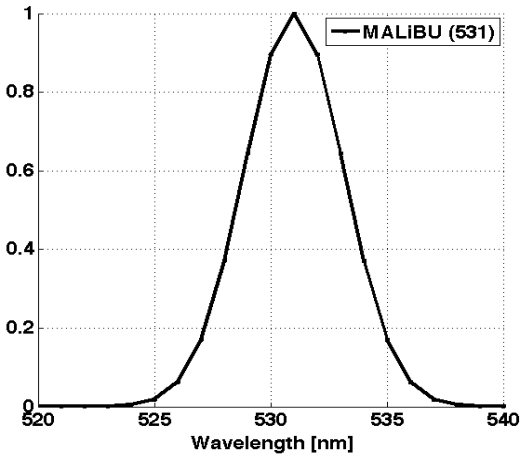



The MALIBU instrument design includes two Tetracam optical units matching the optical Land channels of key Land sensors such as Landsat-8 OLI, Sentinel-2 MSI, Terra/Aqua MODIS, Terra MISR, and Suomi-NPP/JPSS VIIRS.

# CEOS-LPV Core Sites