CEOS/WGCV/LPV Update

Committee on Earth Observation Satellites (CEOS)
Working Group on Calibration and Validation (WGCV)
Land Product Validation (LPV) Subgroup

Miguel Román (NASA GSFC) – LPV Chair

41st Plenary of the Working Group on Calibration & Validation
Hosted by: The Japan Aerospace Exploration Agency (JAXA)

LPV Status Report: WGCV-41

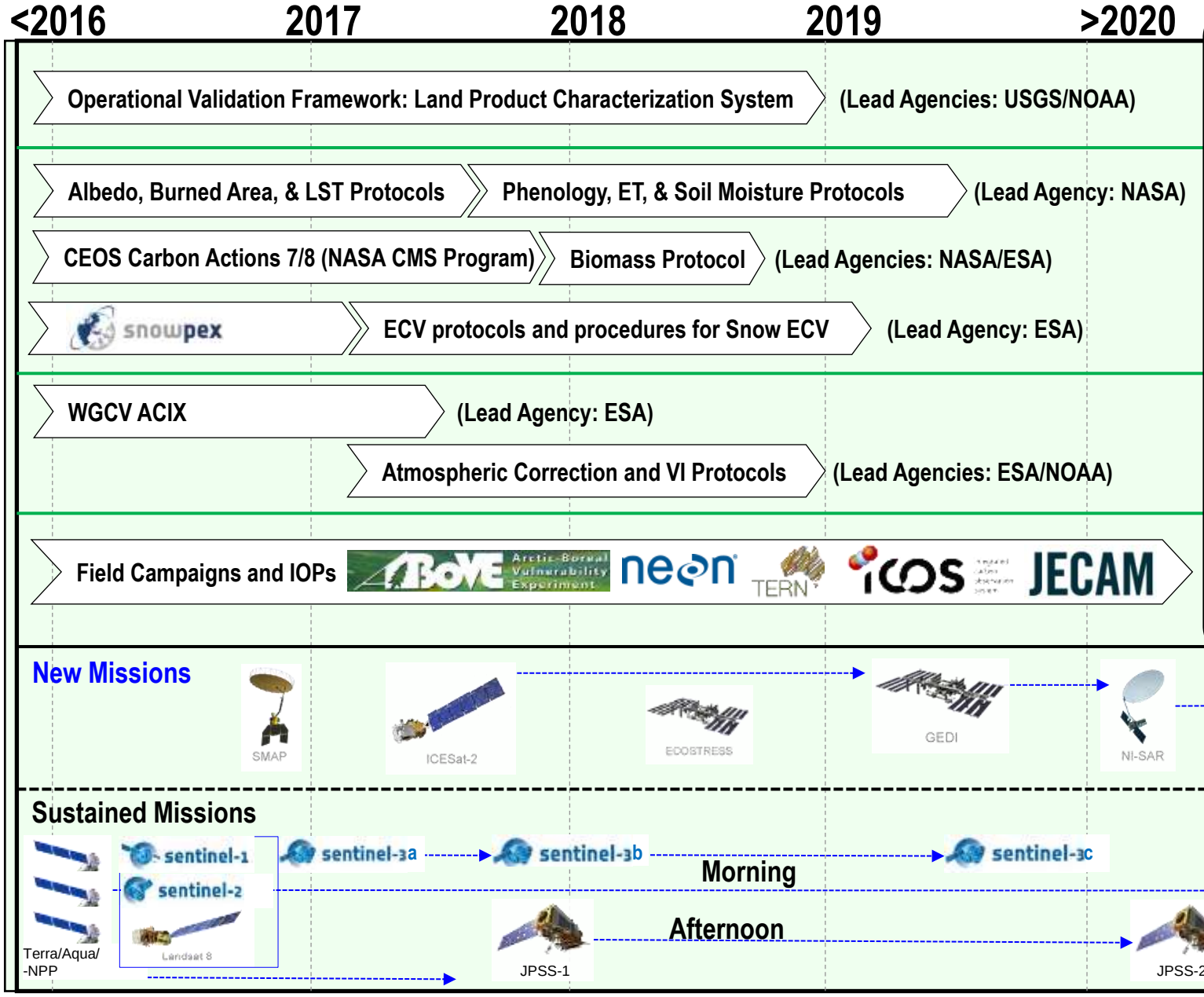
- LPV Chair Transition and Roadmap
- LPV Working Group meeting and participation in ESA's Living Planet Symposium
- Search for LPV focus area co-leads
- TOPC - Land Surface Temperature a recent addition to GCOS list of ECVs
- Vegetation Index & Land Surface Phenology Workshop (November 9-10, 2016)
- LPV special session at AGU'16 (12-16 December, 2016)
- Upcoming Field Campaigns of Opportunity

CEOS WORKING GROUP ON CALIBRATION & VALIDATION

LPV Chair Transition and Roadmap

- Miguel Román began his Chairmanship in March, 2016 and will lead the group forward for the next 3 years.
- Key Deliverables:
  - **Return of a Vegetation Index focus area to LPV,** with close ties to Land Surface Phenology.
  - **Formation of Above Ground Biomass focus area** and associated validation activities.
  - Development of validation protocols, **with a focus on Albedo and Land Surface Temperature**.
  - Engage CEOS Land Agencies in the development of LPV's **Validation Framework**.
  - Participation in **airborne & field campaigns of opportunity** (MALIBU).

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 Working Group Meeting

LPV meeting convened during the **ESA Living Planet symposium (Prague)**

Represented by **NASA, USGS, NOAA, ESA, EUMETSAT, and JRC** scientists (28 total participants).

Topics Discussed:

1. CEOS WGCV Chair Report (Albrecht von Bargen);
2. Review the CEOS-LPV Stages, Definitions, and Metrics for Validation;
3. Finalize response to the CEOS Carbon Strategy and related actions;
4. Discuss ongoing and future calibration/validation activities with international observation networks (e.g., NEON, TERN, and ICOS);
5. Review the latest Implementation Plan from the Global Climate Observing System (GCOS-IP) and the updated requirements for Terrestrial Essential Climate Variables (ECVs).

Search for LPV focus area co-leads

Snow Cover*, Sea Ice	Thomas Nagler (ENVEO, Austria)	Tao Che (Chinese Academy of Sciences)
Surface Radiation (Reflectance, BRDF, Albedo*)	Crystal Schaaf (U Mass Boston)	Alessio Lattanzio (EUMETSAT)
Land Cover* and Land Use Change	Pontus Olofsson (Boston University)	Martin Herold (Wageningen University, NL)
Above Ground Biomass*	Vacant	Vacant
FAPAR*	Arturo Sanchez (University of Alberta)	Nadine Gobron (JRC, IT)
Leaf Area Index*	Oliver Sonnentag (University of Montreal)	Stephen Plummer (ESA)
Fire* (Active Fire, Burned Area)	Luigi Boschetti (University of Idaho)	Kevin Tansey (University of Leicester, UK)
Land Surface Temperature* (LST and Emissivity)	Simon Hook (NASA JPL)	Jose Sobrino (University of Valencia, SP)
Soil Moisture*	Tom Jackson (USDA ARS)	Wolfgang Wagner (Vienna Univ of Technology, AT)
Land Surface Phenology	Matt Jones (Oregon State University)	Jadu Dash (U Southhampton)
Vegetation Index	Tomoaki Miura (University of Hawaii)	Marco Vargas (NOAA/NESDIS/STAR)

CEOS-LPV Subgroup Composition (23)

10 (45%)

10 (45%)

02 (10%)

01 (5%)

Gov't :	10
Academia:	13
Male:	20
Female:	**03**

3-year appointments (9 new openings in Dec 2016).

LPV Chair & Vice-Chair Goals: To ensure geographic, thematic, and gender diversity.

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Land Surface Temperature (LST) ECV

LST & Emissivity focus area made a strong case during TOPC-18 Panel for inclusion as an Essential Climate Variable (ECV). Key players: ILST&E, NASA and the ESA GLOBTEMP project

Terrestrial observation panel for climate (TOPC)-18 met in April in Boulder, CO to prepare input for the new GCOS implementation plan. At this meeting, LPV chair Miguel Roman brought the draft before the panel for inclusion. The motion was carried and LST is now included in the official list of GCOS ECVs.

19 Essential Climate Variables

Current focus of TOPC is to identify measurable terrestrial key variables that control the physical, biological and chemical processes affecting climate and are indicators of climate change.

Biological/Ecological (6)

Land cover and Land Use Change
FAPAR
Leaf area index
Above ground biomass
Soil carbon
Fire disturbance

Hydrological (5)

River discharge
Water use
Ground water
Lakes
Soil moisture

Cryospheric (4)

Snow cover
Glaciers ~~and ice caps~~
Ice sheets and ice shelves
Permafrost

Surface Properties (4)

Albedo
Land surface temperature
Energy fluxes
Anthropogenic greenhouse gases

New, **Revised**, and **Proposed**

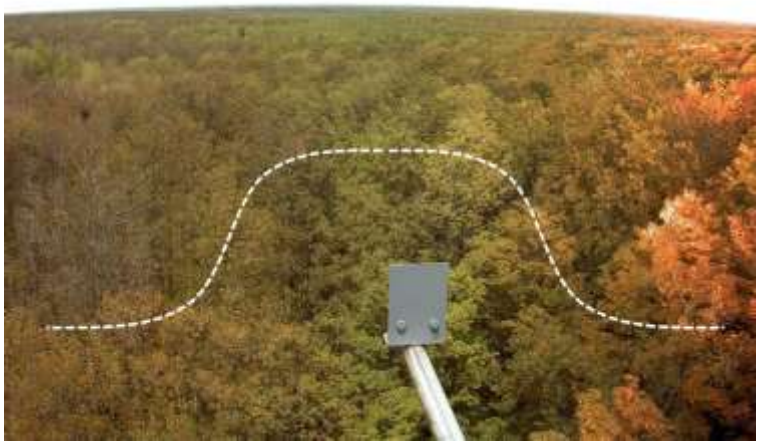
LPV Vegetation Index & Land Surface Phenology Workshop

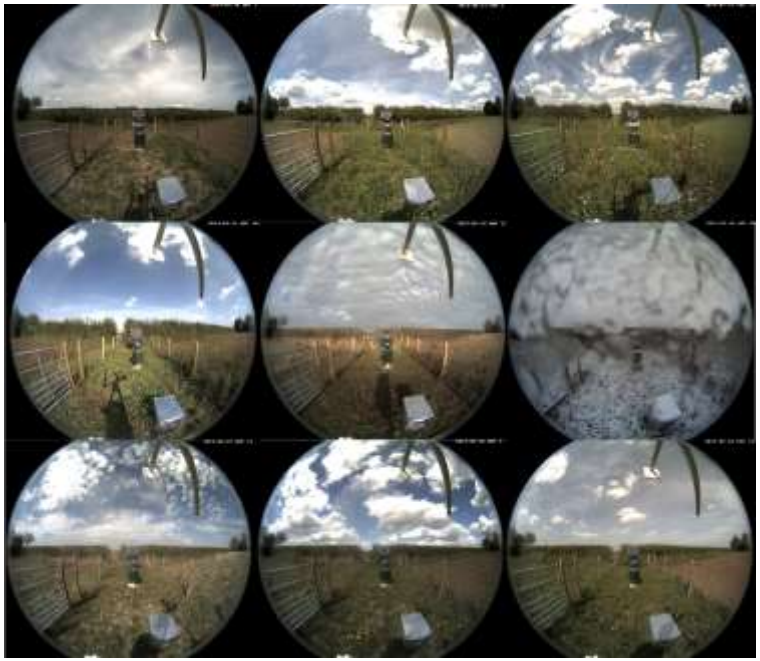
Host: USGS Fort Collins Science Center, Fort Collins Colorado, USA.
November 9-10, 2016

Workshop Goals:

1. Initiate the development of **validation protocols for Vegetation Index and Land Surface Phenology products**.
2. Develop a strategy **to move one or more operational Land Surface Phenology Products and one or more Vegetation Index Products to validation Stage II**.

The targeted participant list (20) aims to have at least one representative or PI from each of the VI or LSP Products, as well as the PhenoCam and Observation Networks, to ensure comprehensive input and representation across products in the development of validation protocols.





CEOS WORKING GROUP ON CALIBRATION & VALIDATION

LPV special session at: AGU FALL MEETING

San Francisco | 12–16 December 2016

(26 Abstracts Received: Ranked 5th in AGU Biogeosciences)

Session Description:

The Land Product Validation (LPV) sub-group of the CEOS Working Group on Calibration and Validation (WGCV) aims to address the challenges associated with the validation of global land products.

This session will offer scientists the opportunity to showcase recent validation efforts covering the following measurements: (1) **Snow Cover**, (2) **Surface Albedo**, (3) **Land Cover**, (4) **Leaf Area Index**, (5) **Fraction of Absorbed Photosynthetically Active Radiation**, (6) **Active Fires**, (7) **Soil Moisture**; (8) **Above-Ground Biomass**; (8) **Land Surface Temperature**; (9) **Phenology**, and (10) **Vegetation Indexes**.

A primary focus will be on global accuracy assessment, intercomparison activities, and the establishment of consensus guidelines for in-situ measurements and derived products.

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CEOS Above Ground Biomass: Terrestrial Scanning LiDAR Scoping Activity

UMB CBL (RIT SICK)	Instrument	RIEGL VZ400
Time-of-flight	Ranging Technique	Time-of-flight
1st and 2nd discrete return	Recorded Data	Multiple discrete return Waveform
0-135 zenith 0-360 azimuth	Scan Configuration	30-130 zenith 0-360 azimuth
905 nm	Wavelengths	1550 nm
0.25 deg 0.50 deg	Angular Resolution	0.04-5.03 mrad zenith 0.04-8.73 mrad azimuth
15 mrad	Beam Divergence	0.35 mrad
1	Laser Class	1
50 Hz	Pulse Rate	100 kHz 300 kHz
3.4 kg	Weight	9.6 kg
40 m	Max. Range	200 m 120 m

Practicality Optimizations:
- 3.4 kg
- 33 second scan
- IP68 waterproof
- Wireless operation

Capability Optimizations:
- 0.04 mrad max resolution
- 200 m max range
- Multiple return / waveform

Fusing GLiHT airborne LiDAR (yellow) with the underlying UMB Canopy Biomass Lidar (CBL) (red) provides additional information on the undercanopy structure.

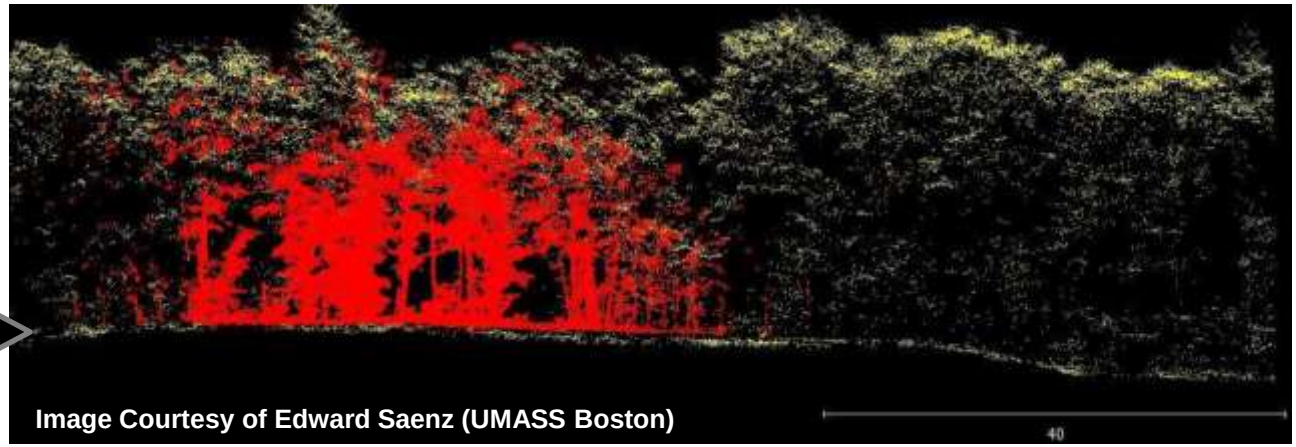

Image Courtesy of Edward Saenz (UMASS Boston)

Validation protocols focusing on: (1) core site selection, (2) field sampling (< 4 ha), (3) scaling techniques, and (4) uncertainty quantification of reference measurements.

CEOS/WGCV/LPV Airborne Campaigns of Opportunity

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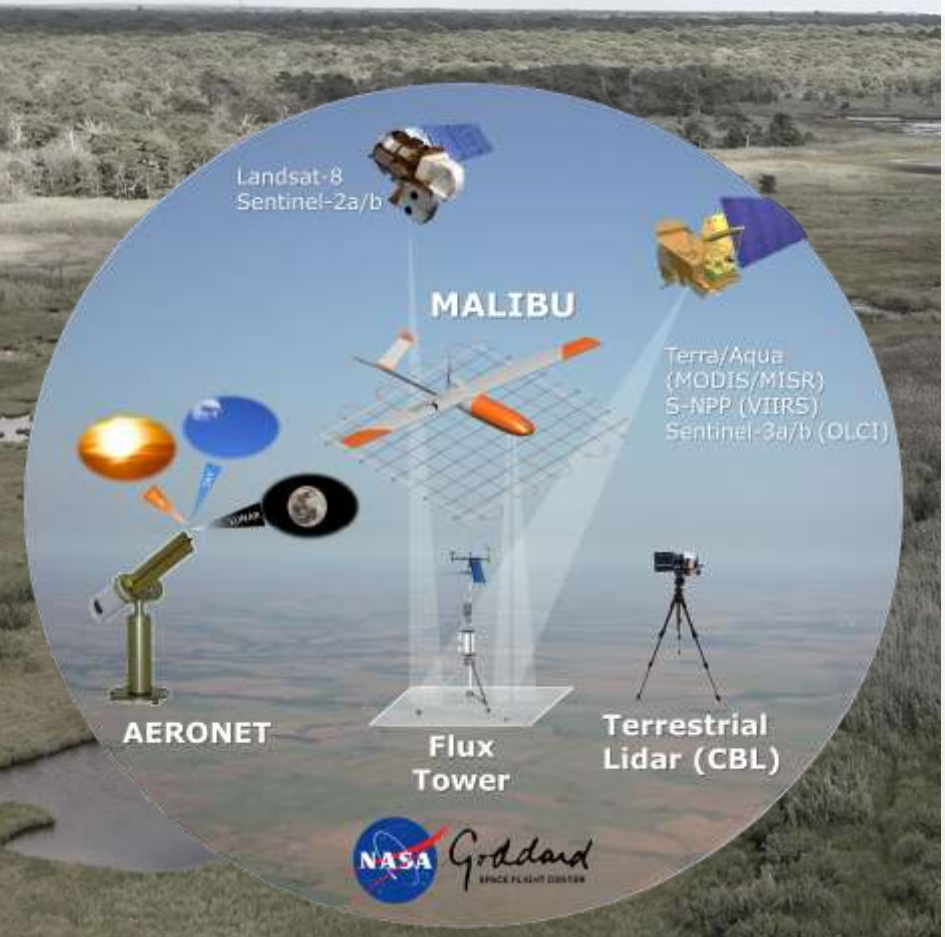
MALIBU Update: (Multi AngLe Imaging Bidirectional Reflectance Distribution Function small Unmanned aerial system)



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

Driver / Need: Multi-angular reference datasets for the assessment of Earth System Data Records (ESDRs), including: satellite-derived spectral/broadband BRF, BRDF, albedo, VI, PRI, LAI/fAPAR, snow cover, and phenology metrics.

Benefits:

- Next Generation Surface Reflectance Validation Approach (BRF, BRDF, and Aerosol Retrieval).
- Calibration and quality-assurance builds on CEOS-RADCALNET and LPV validation protocols.

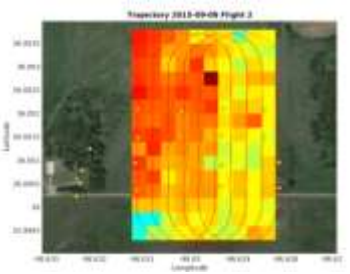
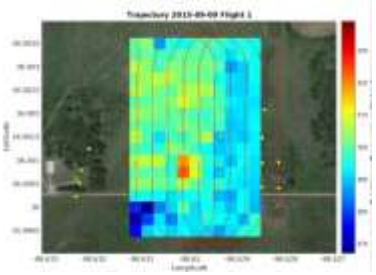
NASA small-UAS Partnerships:

GSFC, ARC and *BlackSwift Technologies LLC*

Two Instrument Systems

Soil Moisture (w/ L-Band Radiometer - SBIR)



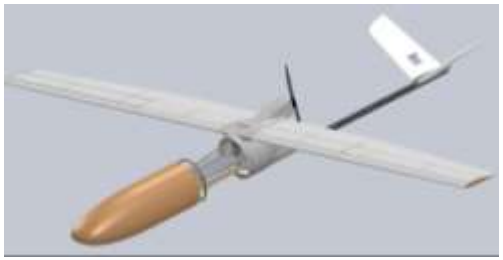




Multiangle, Multispectral imaging sensors (Román, et al - IRAD)
Surface Reflectance/Albedo, VI, LAI&FPAR, and Burned Area.

Two Types of s-UAS

Tempest (Established Platform)

SuperSwift (New, GeoScience Tailored Platform)

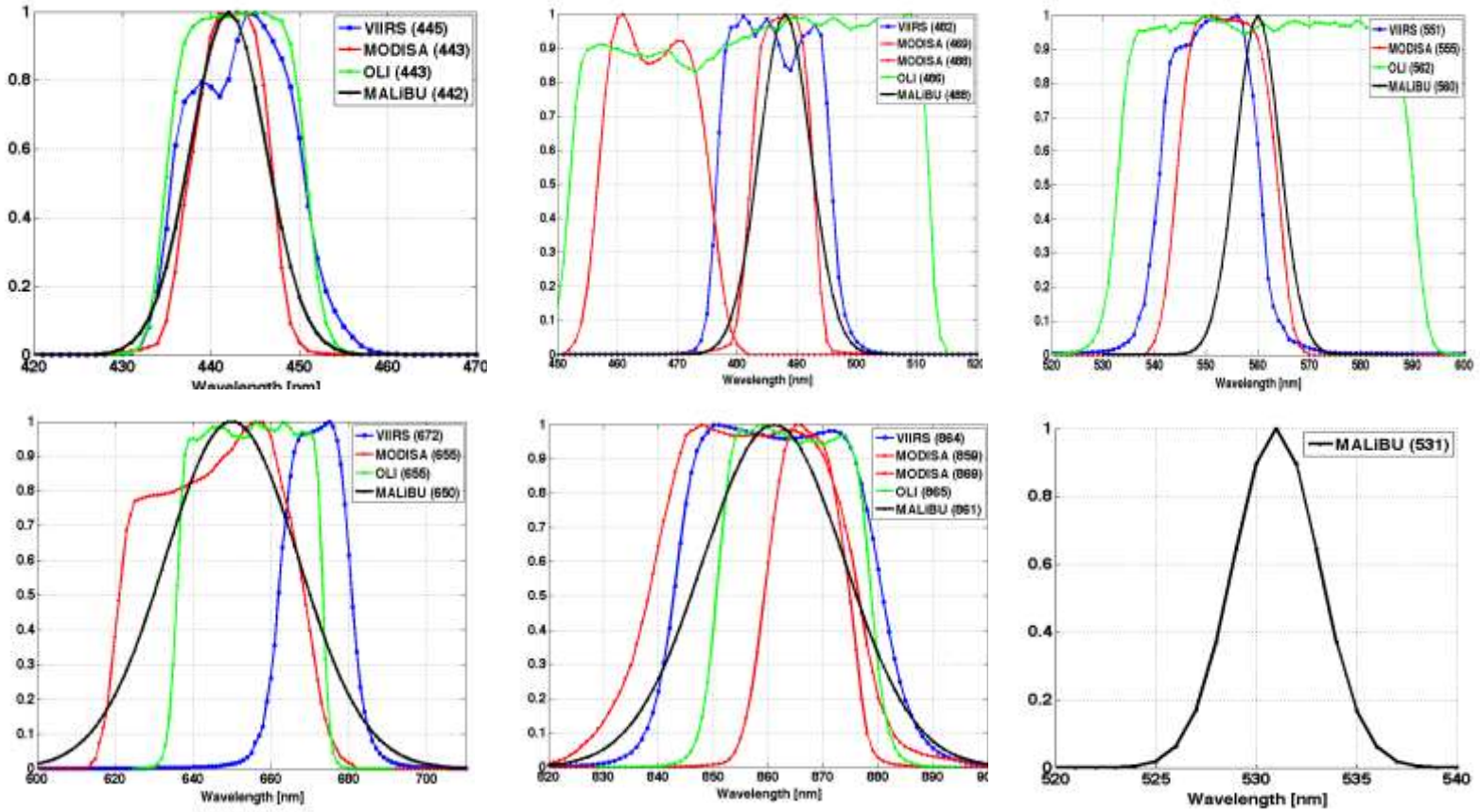


Electric s-UAS (both):
Max Wt. ~15 lbs
P/L Wt. ~5 lbs
Endurance~1 Hr

SBIR·STTR
America's Seed Fund
POWERED BY NASA

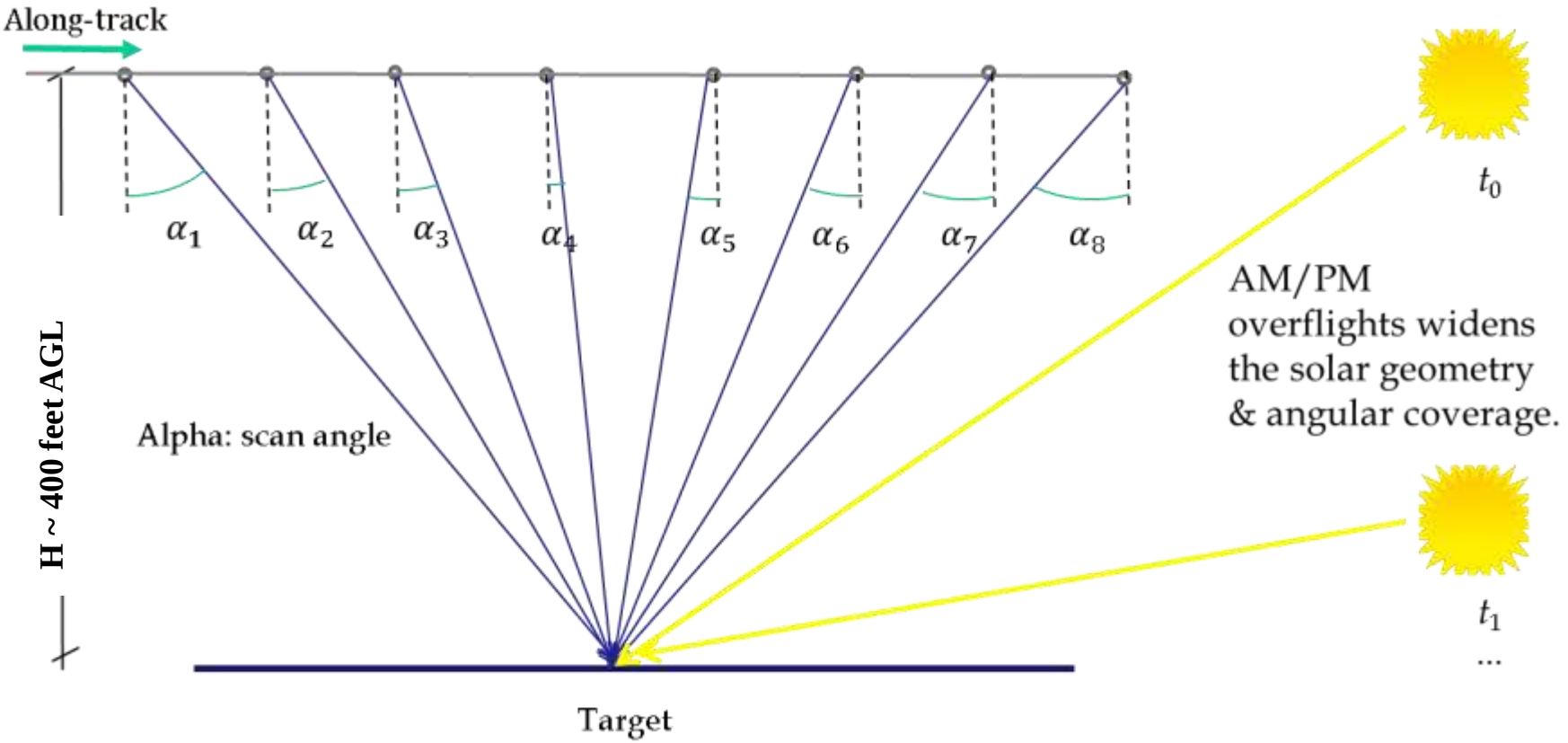
http://sbir.nasa.gov/content/black-swift-technologies-llc

MALIBU Spectral Response



Two Tetracam optical units matching the optical Land channels of key Land sensors such as Landsat-8 OLI, Sentinel-2 MSI, Sentinel 3-OLCI, Terra/Aqua MODIS, Terra MISR, and Suomi-NPP/JPSS VIIRS.

MALIBU Flight Path



Overlapping scenes along-track provide multi-angular retrievals.

MALIBU Field Campaign at Pawnee National Grasslands

Play Video:

https://youtu.be/Vd8c-4rXQOo

[Back Up File: MALIBU_Test_Flights_Pawnee_National_Grasslands_001-003.mp4]

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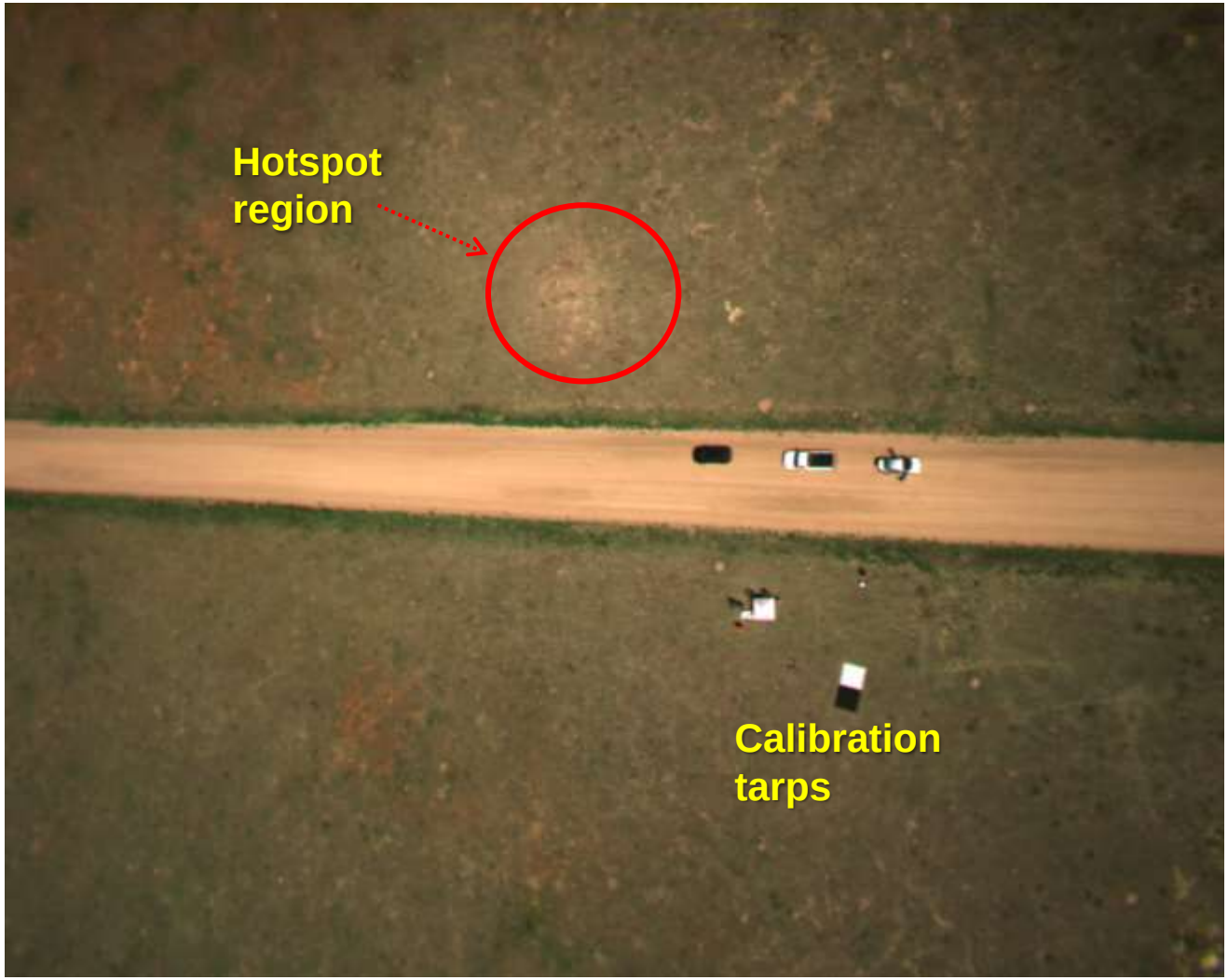
MALIBU First Light Results
(Red: 0-0.3; Green 0-0.3; Blue 0-0.3)



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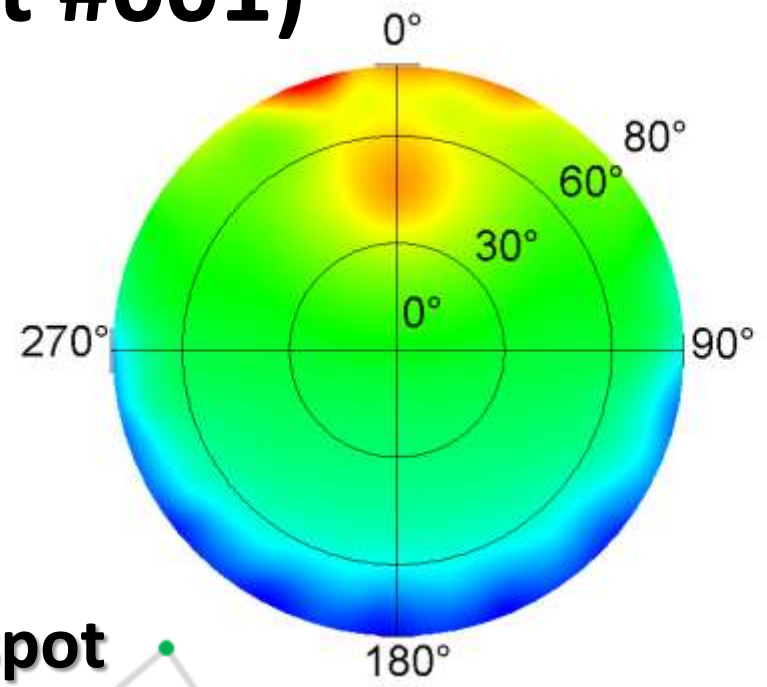
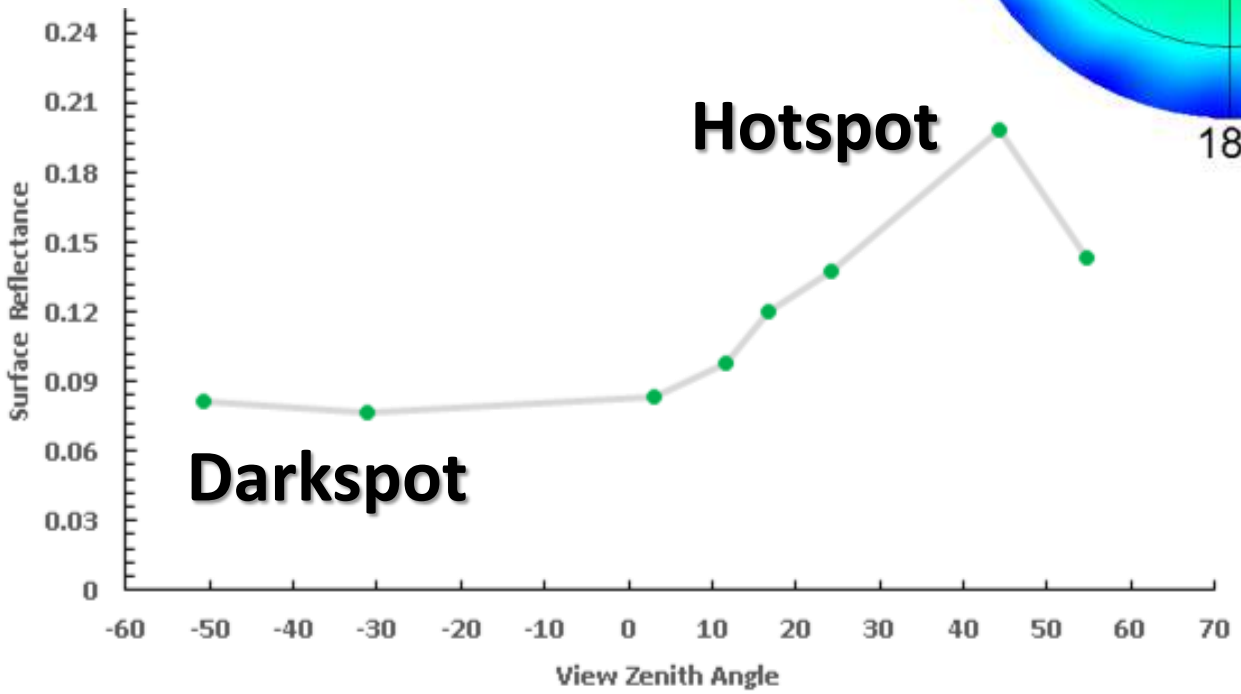
Spectral BRF (0.650 um, 10cm^2) (Flight #001)





WGCV-41: LPV Subgroup Recommendations

- ***LPV-R.2016-1: Formalize a coordination strategy between CEOS agencies (e.g., NASA, NOAA, ESA, USGS, CSIRO) and terrestrial observation programs (BSRN, NEON, TERN, ICOS) to promote collaboration and sharing of resources during intensive cal/val exercises.***
- ***LPV-R.2016-2: Encourage the use and application of Terrestrial LiDAR Scanning (TLS) sensors for validation of Carbon Products.***
- ***LPV-R.2016-3: Formalize agency roles and commitments vis-à-vis the CEOS Cal/Val Portal and associated terrestrial reference networks (BSRN and International Soil Moisture Network).***

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[Re: LPV-R.2016-3] CEOS/WGCV/LPV Validation Framework

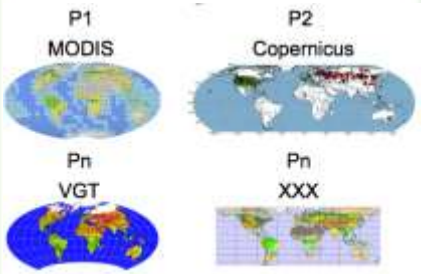
Validation Good Practice Document

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

Fiducial Reference Data Sets

Example of fiducial reference data for soil moisture.

Global Satellite Product Subsets



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

Lead Agencies: Various

Lead Agency: NASA

Lead Agencies: USGS/NOAA

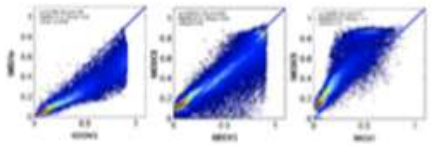
Online Validation Tool

Lead Agencies: Various

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

Lead Agency: Various

Standardized Intercomparison Report



Standardized Validation Report

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lpvs.gsfc.nasa.gov