lpve

→ LAND PRODUCT VALIDATION AND EVOLUTION 2018

27 February – 1 March 2018
ESA–ESRIN | Frascati (Rome), Italy

→PROPOSITION OF CEOS LPV SUPER SITES FOR VALIDATION OF BIO-GEOPHYSICAL SATELLITE PRODUCTS

→**Fernando Camacho** (EOLAB), Miguel O. Román (NASA), Jaime Nickeson (NASA), Arturo Sanchez-Azofeifa (U. Alberta), Laura Ducanson (NASA), Frank Gottsche (KIT) and LPV members.

→William Woodgate (CSIRO), Mirko Karan (TERN), Lorena de la Madrid & Carolina Doña (EOLAB)

Outline

Validation needs

SuperSite for validation of land products

Candidate networks

- TERN
- NEON
- ICOS
- Others (proposed by LPV members)

Selection and ranking of CEOS LPV SuperSites

Examples of SuperSites

Conclusions

Validation needs

Validation of satellite derived products is mandatory to understand the quality of the derived EO dataset. Basically, validation aims to answer a simple question:

How good (accurate, precise, stable) is an EO dataset ?

or to determine the fitness-for-purpose of an EO dataset

What is the compliance of an EO dataset regarding user requirements (eg, GCOS)?

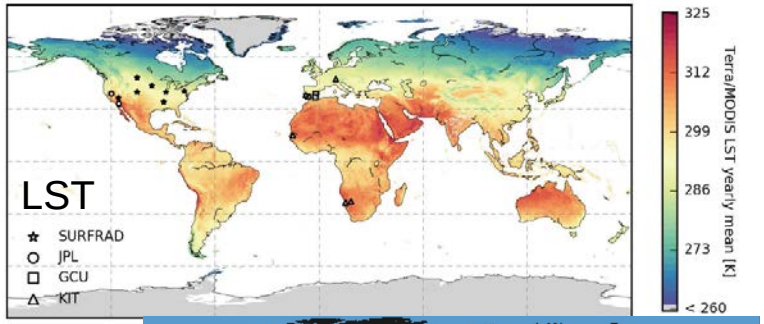
A number of different validation approaches have been developed including comparison with *fiducial ground references*, *inter-comparison with similar datasets*, or *model-based approaches* to accurately simulate the reference value

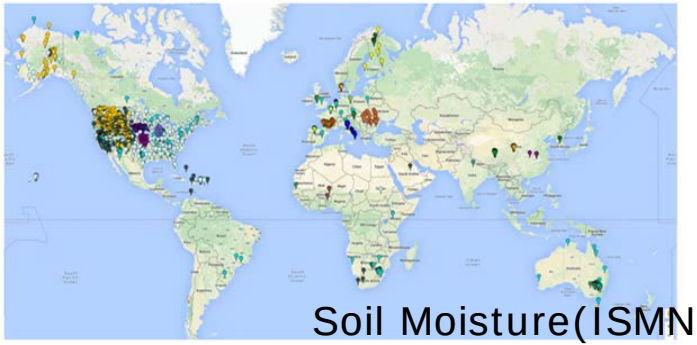
The access to fiducial ground references is a key element for validating a satellite product. Networks of sites must be established to represent global conditions.

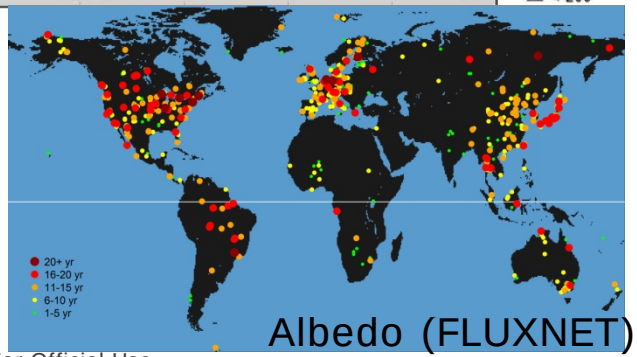
A detailed characterization of the site is needed for a proper interpretation of validation results, and for model-based approaches

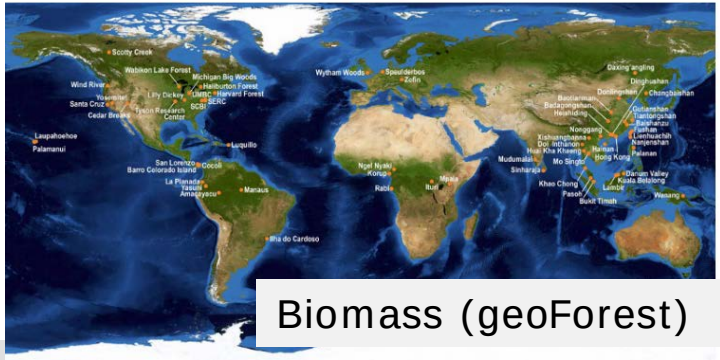
Validation needs

Traditionally, validation of satellite land products has relied on networks of **“core sites”,** which are dedicated to one product or one family of products (Albedo, LST, SM,...):









SuperSite for validation of land products

CEOS WGCV action: Evaluation of validation supersites

Evaluation of well-characterized super-sites with data continuity prospects for validation purposes that allow for testing of products, algorithms, and validation strategies through radiative transfer modeling.

GCOS Implementation Plan 2016

Action T35: Ensure the consistency of the various radiant energy fluxes

(e.g. surface albedo and FAPAR) → **Useful for assessing several land products**

Action T37: Quality of ground-based reference sites for FAPAR and LAI

Improve the quality and number of ground-based reference sites for FAPAR and LAI. Agree minimum measurement standards and protocols. → **Protocols needed**

Action T56: Above Ground Biomass: Forest inventories

Improve access to forest inventories → **Structural knowledge (tree diameter, height) required**

SuperSite for validation of land products

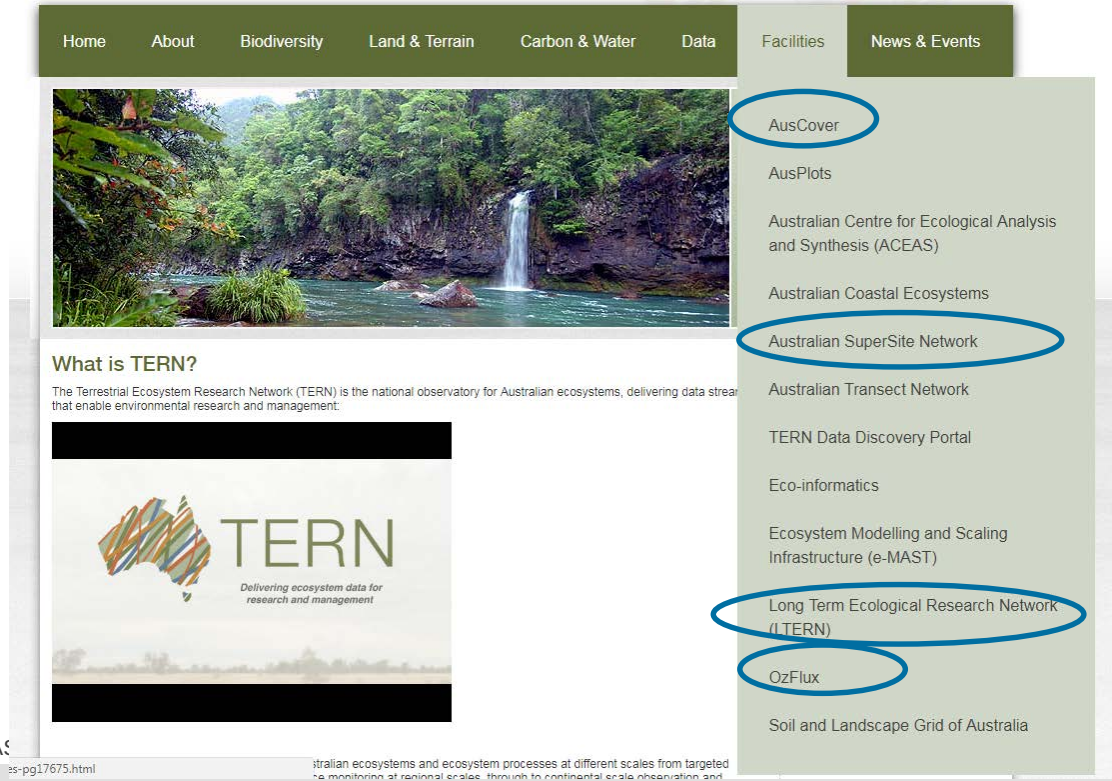
and other important questions ?

1. is the site part of a long term supported network with appropriate funding and infrastructural capacity ?
2. does the site make measurements on a regular basis?
3. are the measurements appropriate for satellite validation ?
4. which variables are measured (or could easily be included)?
5. what would need to be done, if not available, to make measurements appropriate for satellite validation?

LPV SuperSite definition

- Super characterized (canopy structure and bio-geophysical variables) site following well-established protocols useful for the validation of satellite land products (at least 3) and for radiative transfer modeling approaches.
- Active, long-term operations, supported by appropriate funding and infrastructural capacity.
- Supported by airborne LiDAR and hyperspectral acquisitions (desirable).

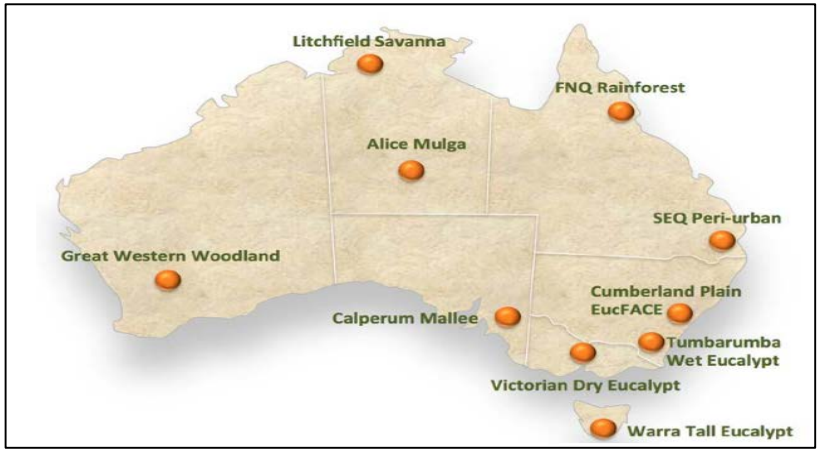
TERN: Terrestrial Ecosystem Research Network



➢The Terrestrial Ecosystem Research Network (TERN) is the national observatory for Australian ecosystems, delivering data streams that enable environmental research and management.

➢TERN's infrastructure is designed to examine Australian ecosystems and ecosystem processes at different scales from targeted monitoring at the local level, regional, scale continental scale observation and modelling.

Australian supersite Network



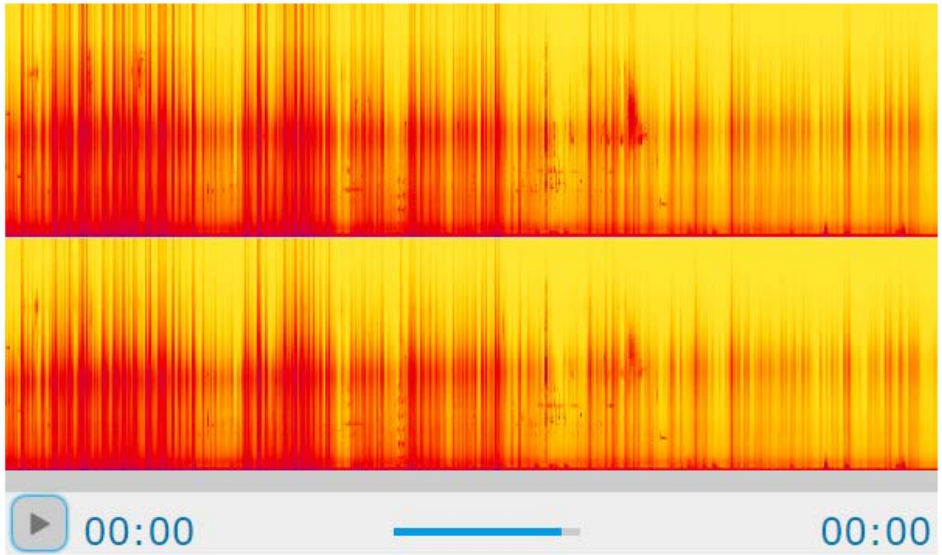
Contact:

- Mirko Karan: Coordinator Australian SuperSites
- mirko.karan@jcu.edu.au

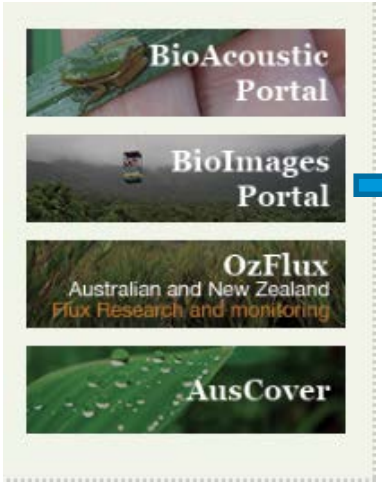
source: http://www.supersites.net.au/

- The Australian Supersite network includes **10 sites located in significant biomes around Australia**, and some of **the sites have several plots.**
- Aims to improve the scientific understanding of how key ecosystems in Australia are responding to environmental change.
- A core set of experiments is conducted at each supersite to measure ecosystem properties in an appropriate manner
- The infrastructure is also used to **provide calibration and validation data for modeling and remote sensing**.
- Data collected from the supersites are described, formatted and indexed to create a **complete record available for use by the scientific, management and policy communities** and the wider public.
- **Open access** to SuperSites data is provided through a dedicated data portal
- The supersite repository is managed by the supersite/LTERN Data Team
- The Australian supersite Network is **managed by James Cook University.**

Environmental sound records



Australian supersite Network



LAI - DHP pictures

Phenocams Photopoint

FNQ Rainforest – Robson Creek supersite

Plot 1 ha

The **OzFlux** network consists of nearly 30 flux towers in Australia and New Zealand, many of which are also members of the Australian Supersite Network (ASN). OzFlux is also a member of the global FluxNet community.

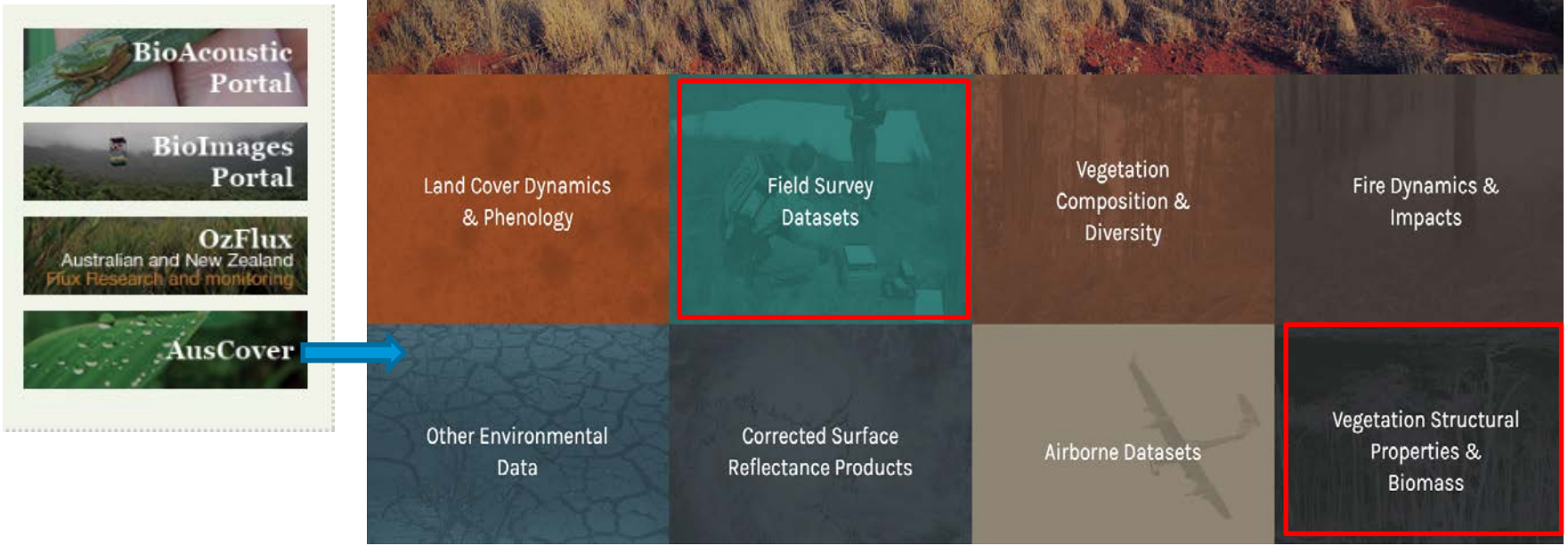
METEOROLOGY AND FLUXES (HOURLY AVERAGES)

- Meteorology (air temp, humidity, wind speed and direction)
- **Radiation** (incoming and outcoming short wave and long wave)
- Soil (temperature, **moisture content, depth to watertable**)
- Precipitation
- Land-atmosphere fluxes of radiation, heat, water vapour, carbon dioxide

TERN SuperSites

WORKING GROUP ON CALIBRATION & VALIDATION

TERN SuperSites



TERN SuperSites

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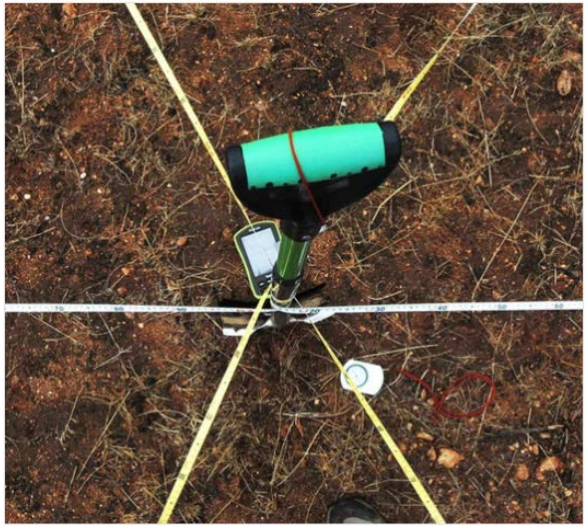
BioAcoustic Portal

BioImages Portal

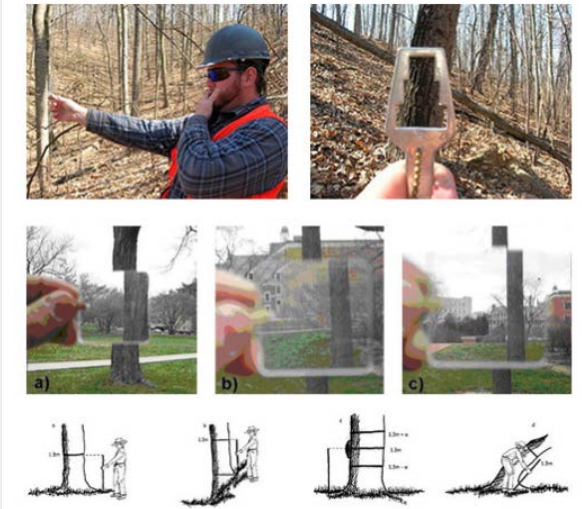
OzFlux
Australian and New Zealand Flux Research and monitoring

AusCover

Australian Ground Cover Reference Sites



Tree structural characteristics



tree height, canopy height, DBH

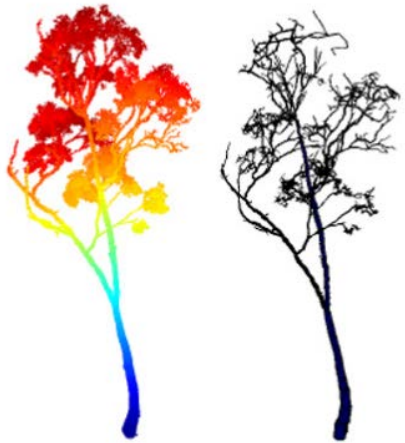
BioAcoustic Portal

BioImages Portal

OzFlux
Australian and New Zealand
Flux Research and monitoring

AusCover

Terrestrial laser scans - Individual tree point



TLS point cloud and cylinder model for an individual *Eucalyptus leucoxylon* tree

Terrestrial laser scans - DWEL, raw and QA

Intensity image for the Himalayan Cedar forest at the National Arboretum Canberra.

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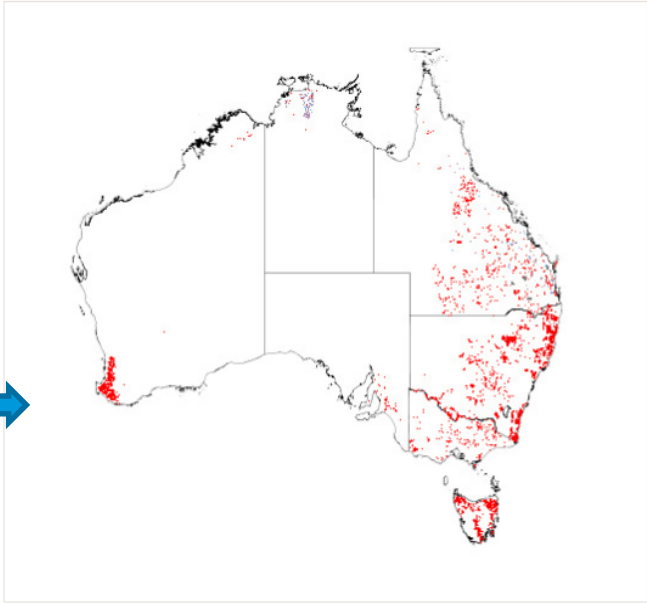
Biomass plot library



The Biomass Plot Library is a collation of stem inventory data ac
state and local government departments, universities, private c
and other agencies, driven by the need for cal/val data to underp
mapping of above-ground biomass. The library will be added to

KEYWORDS:	Biomass
DATA LICENCE & ACCESS RIGHTS: *How do I attribute?*	CC-BY 4.0
SPATIAL COVERAGE & RESOLUTION:	0.05 to 1 ha resolution; Australi
TEMPORAL COVERAGE & RESOLUTION:	1 day composite; 1936 to ongoir dates for each site
PRODUCTION STATUS:	Ongoing updates

Data Access

TERN SuperSites

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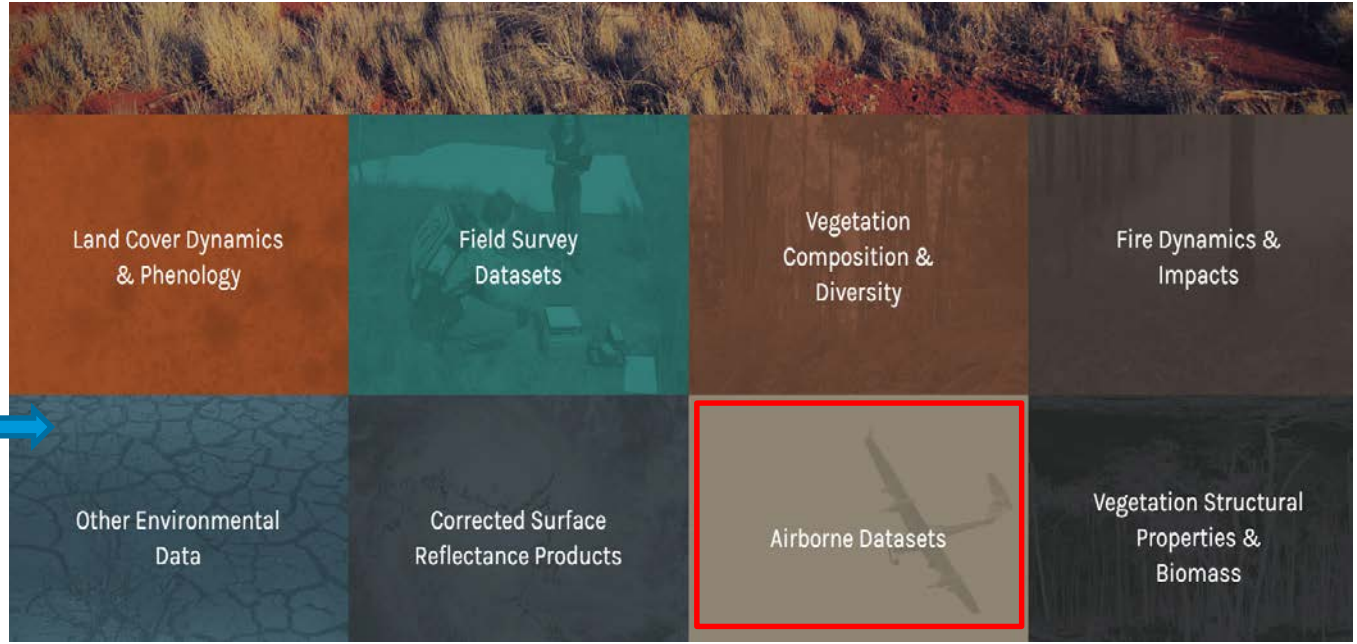

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Flux Research and monitoring

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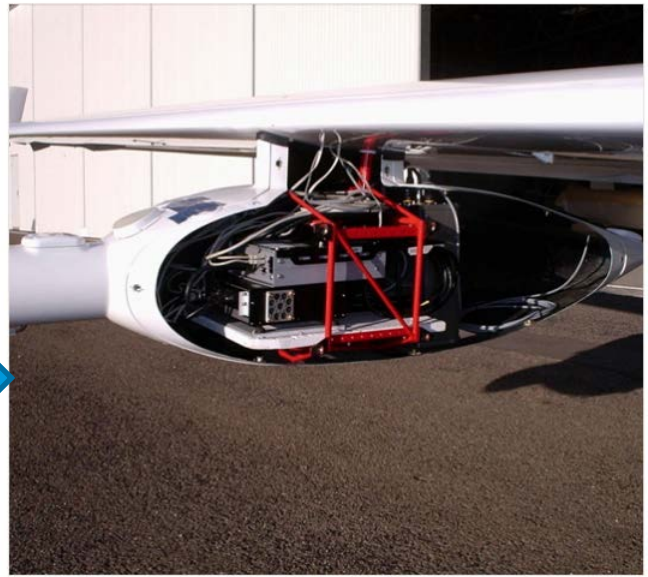
SPECIM EAGLE hyperspectral scanner

- Airborne hyperspectral - raw and QA data



0.5 m spatial resolution

Riegl Q560 laser scanner

- Airborne LiDAR - raw and QA data for all site

0.3 m spatial resolution

TERN Terrestrial Ecosystem Research Network

AusCover Remote Sensing Data Facility

BioAcoustic Portal

BioImages Portal

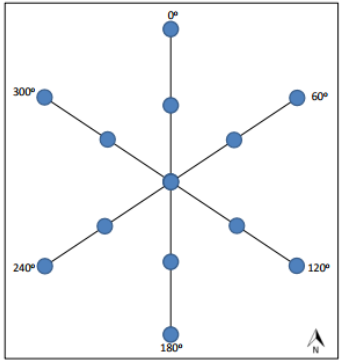
OzFlux Australian and New Zealand Flux Research and monitoring

AusCover

AusCover Good Practice Guidelines

A technical handbook supporting calibration and validation activities of remotely sensed data products

LAI sampling



TERN SuperSites

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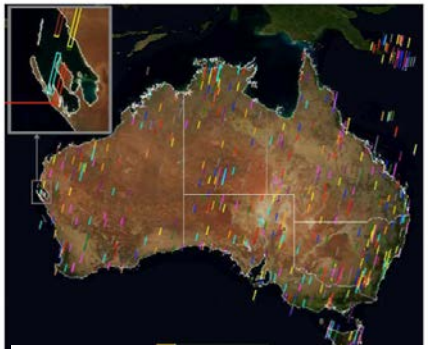
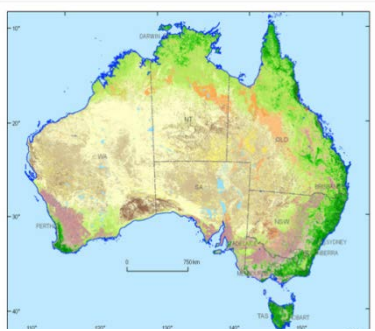
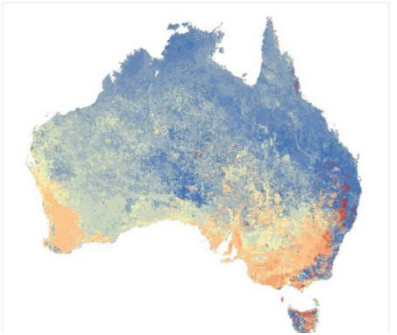
Hyperspectral surface reflectance - Hyperio



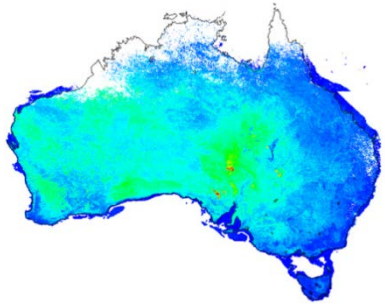
Dynamic Land Cover Dataset - MODIS



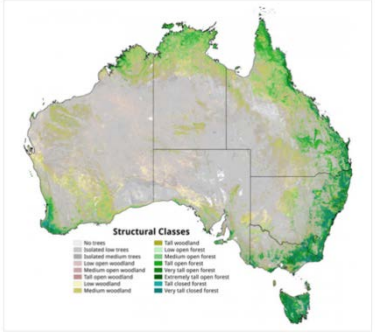
Phenology - MODIS, derived from MOD13C1



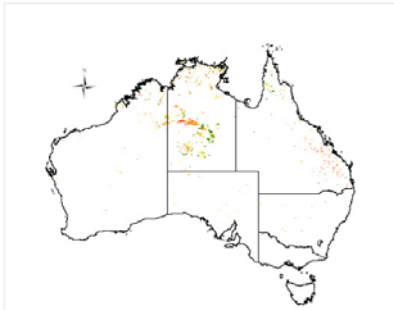
BRDF and Albedo - MODIS, MCD43A(c5) mo



Vegetation height and structure

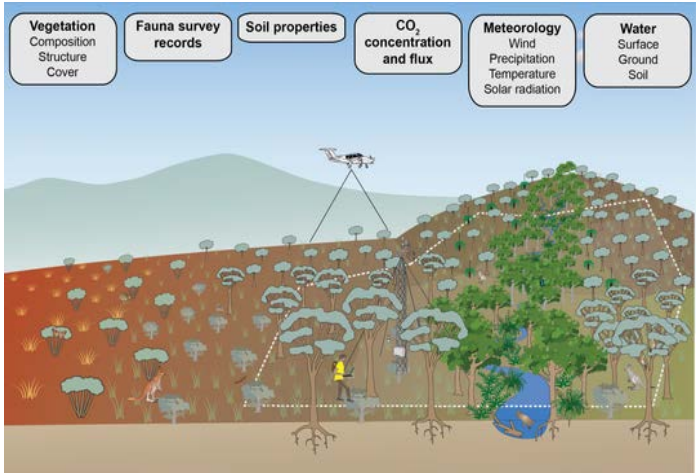


Near real-time burnt area - MODIS



Australian supersite network

➢ High quality data using traditional field observational and sensor methods (flux towers, phenocams, acoustic monitors, sondes, bore sensors etc.) across the network.



METEOROLOGY AND FLUXES (HOURLY AVERAGES)

- Meteorology (air temp, humidity, wind speed and direction)
- **Radiation** (incoming and outcoming short wave and long wave) ✓
- Soil (temperature, **moisture content, depth to watertable**) ✓
- Precipitation
- Land-atmosphere fluxes of radiation, heat, water vapour, carbon dioxide

VEGETATION (DAILY TO ANNUAL)

- Vegetation biodiversity
- Phenocam for **phenology** ✓
- Recruiment dynamics
- **LAI** ✓
- **Terrestial laser scanning** ✓
- **Inventories & AGB** ✓

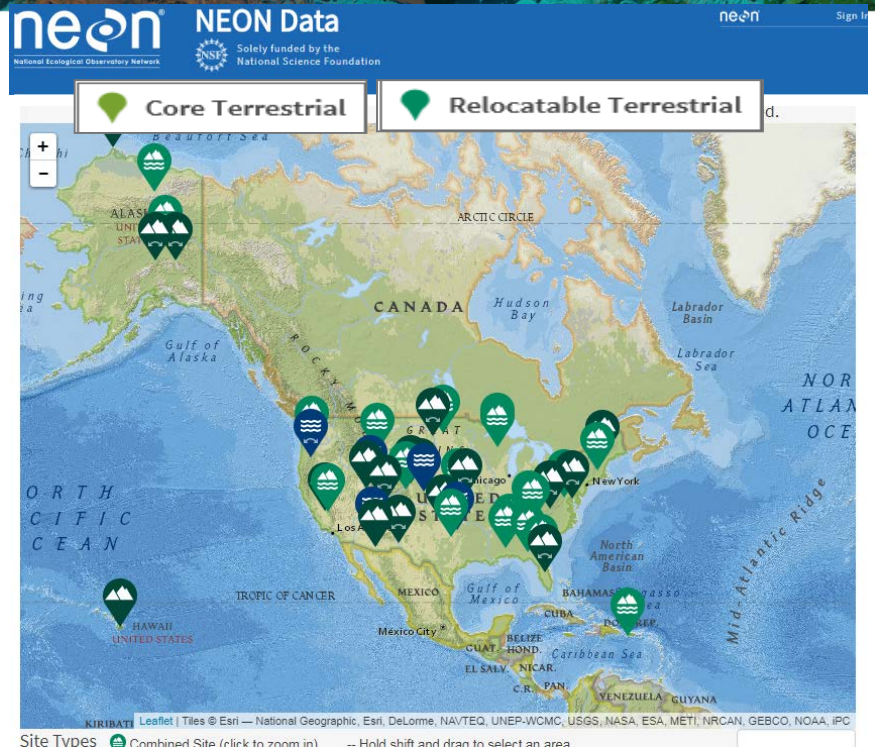
AIRBORNE : ✓
LIDAR, Hyper-spectral

Protocols for cal/val ✓

Free data acces ✓

Very Good candidates to be LPV SuperSites ✓✓

NEON - National Ecological Observatory Network



NEON data portal (http://data.neonscience.org/home).

Continental-scale ecological observation facility sponsored by the National Science Foundation to gather and synthesize data on the impacts of climate change, land use change and invasive species on natural resources and biodiversity

➢**Strategically locates sites** across the U.S. **to capture variability in ecological and climatological conditions** (terrestrial and aquatic stations)

➢NEON network includes core and relocatable terrestrial sites across the U.S. (including Alaska, Hawaii and Puerto Rico). ***Core sites (20)*** are fixed, collect data for a minimum of 30 years and are designed to represent and capture wildland conditions. ***Relocatable sites (27)*** move through time to capture environmental gradients not captured at core sites

➢Coordinates **local measurements in the field with high-resolution airborne** remote sensing.

➢Provide resources for the ecological community to integrate observations and datasets independently, such as collection and **processing protocols**.

NEON - National Ecological Observatory Network

-TIS: Terrestrial Instrument System
-TOS: Terrestrial Observation System
-AOP:Airborne Observation Platform

Data Product Name	Data Level	Science Team
2D Wind Speed and Direction	Level 1	TIS
Barometric Pressure	Level 1	TIS
Herbaceous clip harvest	Level 1	TOS
IR Biological Temperature	Level 1	TIS
Photosynthetically Active Radiation (PAR) ✓	Level 1	TIS
Photosynthetically active radiation (Quantum Line) , LAI (DHP) ✓	Level 1	TIS
Plant phenology observations	Level 1	TOS
Plant presence and **percent cover**	Level 1	TOS
Precipitation	Level 1	TIS
Relative Humidity ✓	Level 1	TIS
Shortwave and Longwave Radiation (Net radiometer) ✓	Level 1	TIS
Shortwave Radiation (Direct and Diffuse Pyranometer)	Level 1	TIS
Shortwave Radiation (Primary Pyranometer) ✓	Level 1	TIS
Single Aspirated Air Temperature	Level 1	TIS
Soil chemical properties (Megapit)	Level 1	TIS
Soil heat flux plate	Level 1	TIS
Soil physical properties (Megapit)	Level 1	TIS
Soil temperature ✓	Level 1	TIS
Soil water content and water salinity	Level 1	TIS
Spectral Sun Photometer - Calibrated Sky Radiances	Level 1	TIS
Triple Aspirated Air Temperature	Level 1	TIS

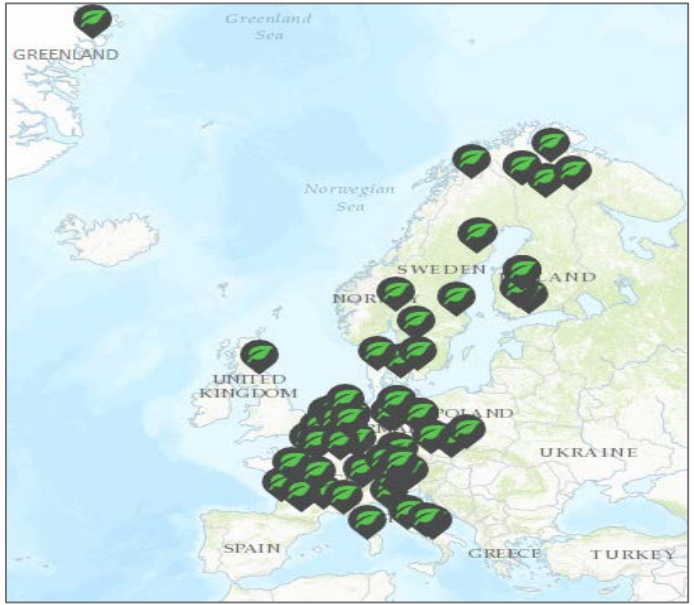
➢NEON collects biological, chemical and physical measurements and samples, using manual field measurements and calibrated sensors.

Data Product Name	Data Product Level	Science Team
Discrete Return **LiDAR** Point Cloud ✓	Level 1	AOP
Ecosystem Structure	Level 3	AOP
Elevation - LiDAR ✓	Level 3	AOP
Field Spectral Data	Level 1	AOP
fPAR - Spectrometer - Flightline	Level 2	AOP
High-resolution orthorectified camera imagery	Level 1	AOP
LAI - Spectrometer - Flightline	Level 2	AOP
LiDAR Slant Range Waveform	Level 1	AOP
Slope and Aspect - LiDAR ✓	Level 3	AOP
Spectrometer Orthorectified Surface Directional Reflectance - Flightline	Level 1	AOP
Spectrometer Orthrorectified at-Sensor Radiance	Level 1	AOP
Vegetation Indices - Spectrometer - ✓	Level 2	AOP

Missing detailed 3D structure characterization (terrestrial LiDAR) ✗

WORKING GROUP ON CALIBRATION & VALIDATION

ICOS Ecosystem Network



Contact:

- Dario Papale: Coordinator ICOS Ecosystem
- darpap@unitus.it

ICOS Ecosystem Thematic Center

- **European Research Infrastructure (ESFRI) for quantifying and understanding the greenhouse gas balance** of the European continent and of adjacent regions (www.icos-infraestructure.eu)
- Three different components (Atmosphere, Ecosystems, and Oceans) when each of them is coordinated by a Thematic Center
- 2 classes of stations: ***Class 1 Station***.- ICOS Ecosystem or Atmosphere Station with a complete equipment setup for measuring the full set of ICOS core variables and ***Class 2 Station***.- Less variables are measured compared to the Class 1 station.
- ICOS RI organization is founded on two pillars: research and measurement infrastructure and ICOS ERIC, a legal entity for ICOS data release, coordination and integration of the whole system
- The Ecosystems network **includes 71 stations located** over the European continent and adjacent regions .
- **Open access to sites data** is provided through the Carbon Portal (https://www.icos-cp.eu/).

ICOS Ecosystem Network

➢The variables collected at the different ICOS sites (Class 1 and Class 2) for the several kind of ecosystems are:

Variable	Forest	Grassland	Cropland	Peatland
CO_2, H_2O and H fluxes (eddy covariance, including profile for storage)	1 & 2	1 & 2	1 & 2	1 & 2
CH_4 and N_2O fluxes (eddy covariance, including profile for storage)	1	1	1	1
Air H_2O concentration	1	1	1	1
Incoming, Outgoing and Net SW and LW radiations	1 & 2	1 & 2	1 & 2	1 & 2
Incoming SW radiation (high quality)	Fac	Fac	Fac	Fac
Incoming PPFD	1 & 2	1 & 2	1 & 2	1 & 2
PPFD below canopy + ground reflected	Fac	Fac	Fac	N.R.
Outgoing PPFD	1 & 2	1 & 2	1 & 2	1 & 2
Diffuse PPFD and/or SW radiation	1	1	1	1
Spectral reflectance	Fac	Fac	Fac	Fac
Soil Heat flux	1 & 2	1 & 2	1 & 2	1 & 2
Air Temperature and RH profile	1 & 2	1 & 2	1 & 2	1 & 2
Backup meteo station (TA, RH, SW_IN, precipitation)	1 & 2	1 & 2	1 & 2	1 & 2
Total high accuracy precipitation	1	1	1	1
Rain precipitation	1 & 2	1 & 2	1 & 2	1 & 2
Snow precipitation	1	1	1	1
Snow height	1 & 2	1 & 2	1 & 2	1 & 2
Soil Water Content profile	1 & 2	1 & 2	1 & 2	1 & 2
Soil Temperature profile	1 & 2	1 & 2	1 & 2	1 & 2
Air Pressure	1 & 2	1 & 2	1 & 2	1 & 2
Trunk and branches temperature	Fac	N.R.	N.R.	N.R.
Groundwater level	1 & 2	1 & 2	1 & 2	1 & 2
Tree diameter (continuous)	1	N.R.	N.R.	N.R.
Phenology-Camera	1	1	1	1

Variable	Forest	Grassland	Cropland	Peatland
Soil CO_2 automatic chambers	1	1	1	1
CH_4 and N_2O fluxes by automatic chambers	1	1	1	1
Wind speed and wind direction (additional to 3D sonic)	1	1	1	1
GAI	1 & 2	1 & 2	1 & 2	1 & 2
Above Ground Biomass	1 & 2	1 & 2	1 & 2	1 & 2
Soil carbon content	1 & 2	1 & 2	1 & 2	1 & 2
Litterfall	1	1	1	1
Leaf nutrients content	1 & 2	1 & 2	1 & 2	1 & 2
Soil water N content	Fac	Fac	Fac	Fac
DOC concentration	Fac	Fac	Fac	Fac
C and N import/export by management	1 & 2	1 & 2	1 & 2	1 & 2
Oxygen and pCO_2 surface concentration	N.R.	N.R.	N.R.	Fac
Oxygen, pCO_2 and pN_2O concentration profile	N.R.	N.R.	N.R.	Fac
Management and distrurbances information	1 & 2	1 & 2	1 & 2	1 & 2

Albedo, Snow, LAI, Fapar, Phenology, Water content, tree diameter, AGB ✓

Protocols available ✓

No detailed vegetation structure (TLS) ✗

Not supported by airborne data (Hyperspectral, LiDAR) ✗

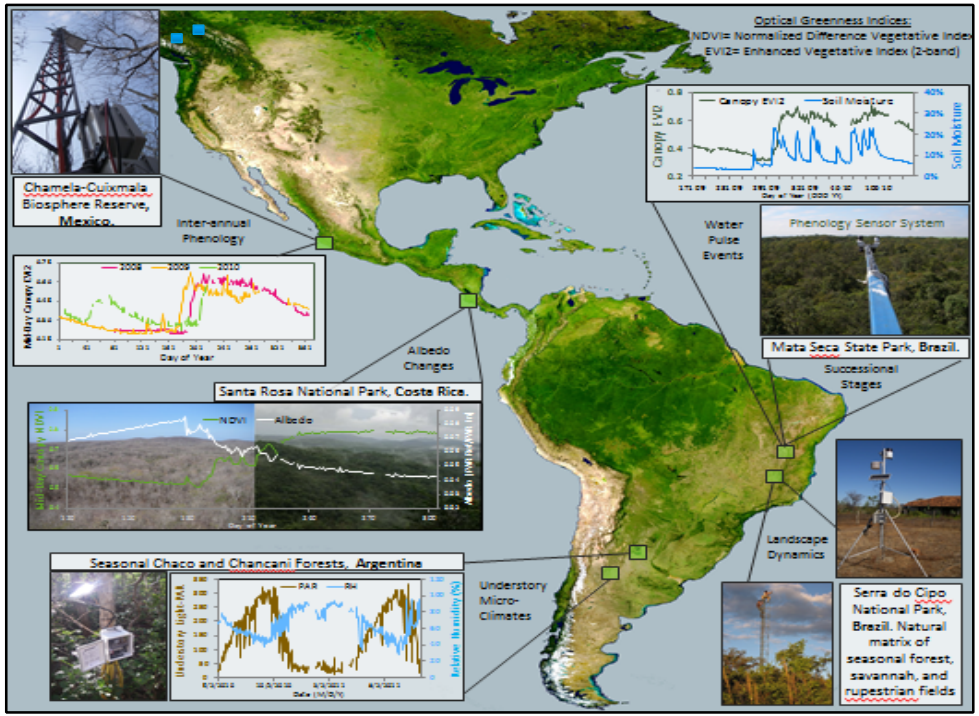
-Fac.- No mandatory variables, where ICOS will prepare and provide protocols and the ICOS-ETC will accept and process the data

N.R.- No Required

*Update 17th Nov. 2016

Others sites from LPV members

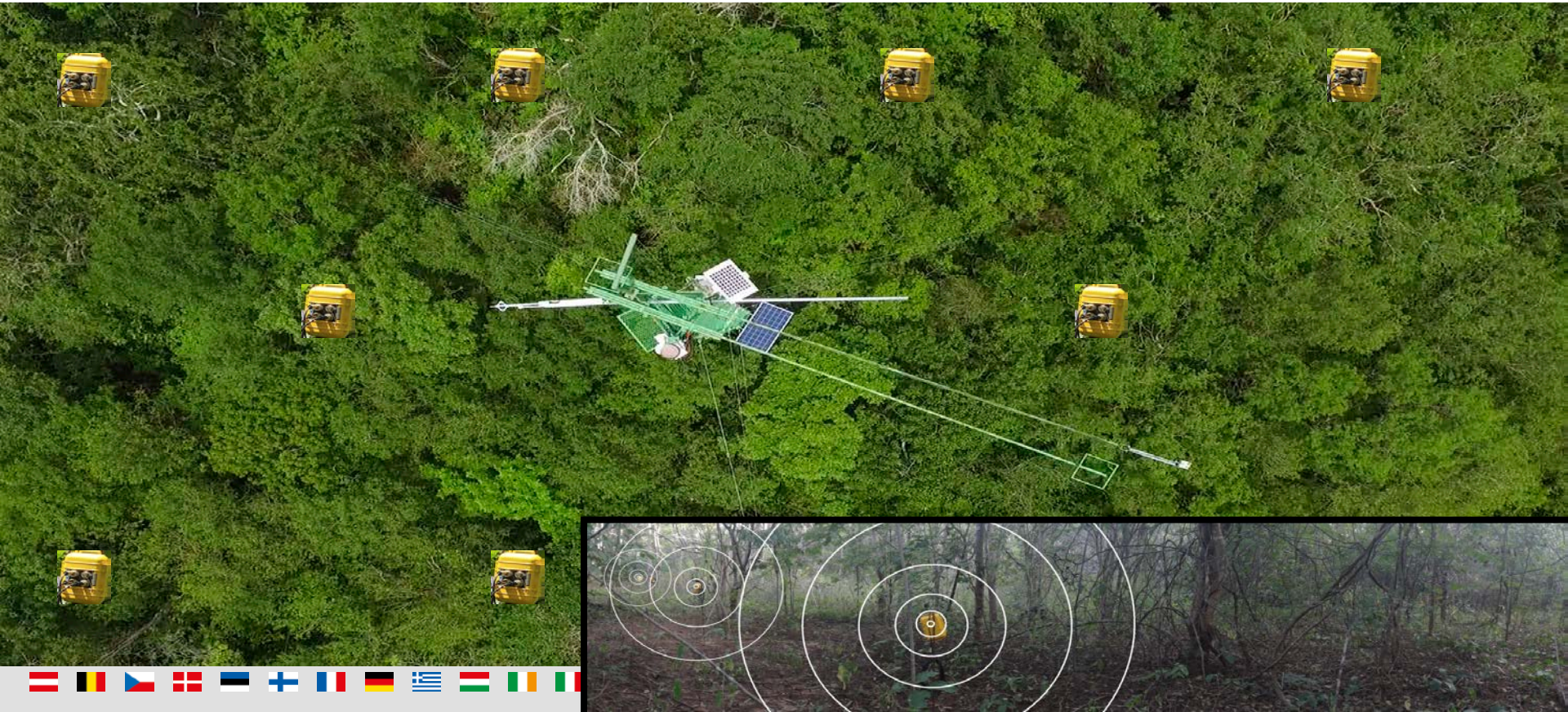
TropyDry / ENVIRONET

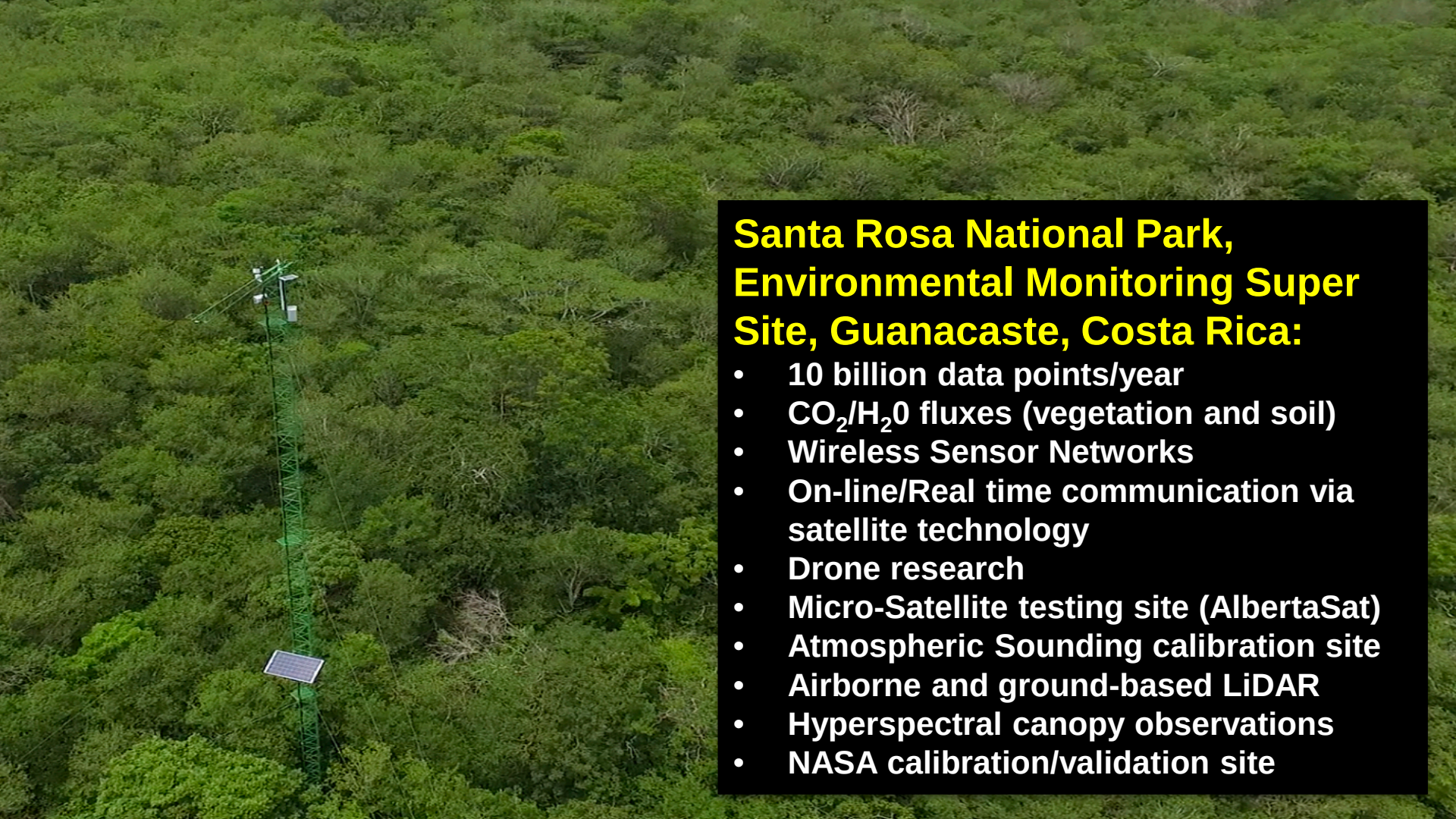


Proposed sites

Site	Country	Network
Mata Seca	Brazil	ENVIRONET
Peace River	Canada	ENVIRONET
Sta. Rosa	Costa Rica	ENVIRONET
Dahra	Senegal	KIT
Farm Heimat	Namibia	KIT
Gobabeb	Namibia	KIT
Évora	Portugal	KIT
Barrax	Spain	JECAM, ImagineS
Collelongo	Italy	EFDC/ ImagineS
Fyodorovskoye	Russia	EFDC
Lägeren	Switzerland	ETH Zürich
Caribou Poker Creek	USA	UAF
Järvselja	Stonia	OLIVE
Wytham forest	UK	forestGEO

Santa Rosa Environmental Monitoring Super Site, Costa Rica





Santa Rosa National Park, Environmental Monitoring Super Site, Guanacaste, Costa Rica:

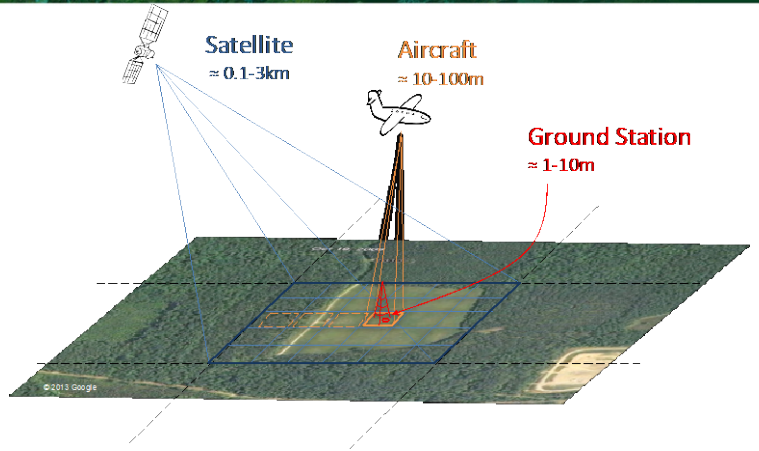
- 10 billion data points/year
- CO_2/H_20 fluxes (vegetation and soil)
- Wireless Sensor Networks
- On-line/Real time communication via satellite technology
- Drone research
- Micro-Satellite testing site (AlbertaSat)
- Atmospheric Sounding calibration site
- Airborne and ground-based LiDAR
- Hyperspectral canopy observations
- NASA calibration/validation site

Candidate sites

Overall

- TERN : 18 sites in 10 Supersites
- ICOS: 71 sites
- NEON: 47 sites
- LPV : 15 sites

TOTAL: 151 potential sites



Typical size of the site: 1 ha

- A major requirement was first applied

Spatial representativeness: to guarantee the highest level of homogeneity and to minimize issues associated with spatial representativeness in the point-to-pixel comparison.

- Using high resolution satellite images (available via Google Earth™), to identify those matching the requirement of homogeneity in the area surrounding the measurement tower
- Only visually homogeneous sites at 3x3 km and 1x1 km are considered.

Candidate sites

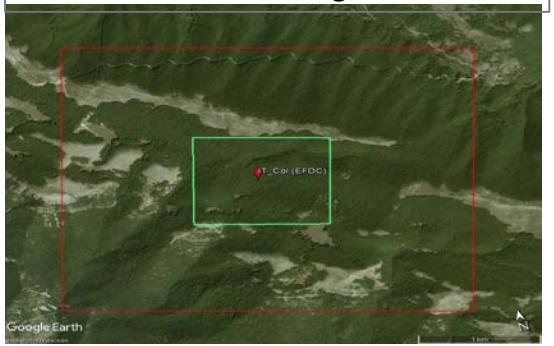
❑ ***Spatial representativeness example***:

-Red line: 3x3km
-Geen line: 1x1 km

3x3 km homogeneous ✓

Robsons Creek site, Australia (TERN/Supersites)

1x1 km homogeneous ✓



Collelongo, Italy (EFDC , proposed by LPV)

heterogeneous ✗

BE-Maa (ICOS)

TOTAL: 60 candidates

Ranking

Variable	Points	Short name
Albedo	1	V1
FAPAR	1	V2
LAI	1	V3
Structural:Terrestrial Laser Scanner (TLS)	2	V4-1
Structural: Inventories, Tree Diameter	0.5	V4-2
Phenology	1	V5
AGB	1	V6
AGB*	0.5	V-6C*
LST	1	V7
SM	1	V8
Airborne data - LiDAR	0.5	V9-1
Airborne data – Hyper-spectral	0.5	V9-2
AOT	0.25	V10
Other variables	0.25	V11

Type of measurements:

1 point is given to those sites providing each of the key land variables (V1 to V9) for LPV corresponding to the albedo, vegetation variables, soil moisture, land surface temperature, and structural information by Terrestrial Laser Scanning (TLS).

0.5 points are given for structural information from inventories, and airborne data (LiDAR or Hyperspectral).

0.25 points are given if atmospheric properties (AOT) and other variables (V11) are available.

1 additional point for under-sampled biomes or regions (eg, Africa, South America)

Ranking

Ranking	Site	Network	Land Cover	Region	Variables	TOTAL SCORE
1	Cumberland Plain SuperSite	TERN-SuperSites, -AusCover, -OzFlux	Shrub	OCEAN	V1,V2,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V11	13,25
2	Tumbarumba Wet Eucalypt SuperSite	TERN-SuperSites, -AusCover, -OzFlux	EBF	OCEAN	V1,V2,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	12,25
3	Alice Mulga SuperSite	TERN-SuperSites, -AusCover, -OzFlux	Shrub	OCEAN	V1,V3,V4-1,V4-2,V5,V7,V8,V9-1,V9-2,V11	11,75
4	Mata Seca	ENVIRONET	Herbaceous	SOAM	V1,V3,V4-1,V4-2,V5,V6-C,V8,V10,V11	11,5
5	Litchfield Savanna SuperSite	TERN-SuperSites, -AusCover, -OzFlux	EBF	OCEAN	V1,V2,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	11,25
6	Robson Creek Rainforest SuperSite	TERN-SuperSites, -AusCover, -OzFlux	EBF	OCEAN	V1,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	11,25
7	Dahra	KIT / UC	Herbaceous	AFRICA	V1,V2,V3,V4-2,V6-C,V7,V8	11
8	Warra Tall Eucalypt SuperSite	TERN-SuperSites, -AusCover, -OzFlux	EBF	OCEAN	V1,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	10,75
9	Great Western Woodland SuperSite (Credo in AusCover database)	TERN-SuperSites, -AusCover, -OzFlux	DBF	OCEAN	V1,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	10,75
10	Gobabeb	KIT	Bare Areas	AFRICA	V1,V4-2,V7,V8,V10	10,75
11	Calperum Mallee SuperSite (Chowilla in AusCover database)	TERN-SuperSites, -AusCover, -OzFlux	Shrub	OCEAN	V1,V3,V4-1,V4-2,V5,V6-C,V7,V8,V9-1,V9-2,V11	10,75
12	Jornada LTER Site	NEON	Shrub	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	9,5
13	Santa Rosa	ENVIRONET	EBF	SOAM	V3,V4-2,V6-C,V8,V9-1,V10,V11	9,5
14	Guyaflux	ICOS	EBF	SOAM	V1,V3,V4-2,V5,V6,V8	9,5
15	Talladega National Forest site	NEON	NLF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
16	Bartlett Experiment Forest Site	NEON,	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
17	Smithsonian Conservation Biology Institute Site	NEON	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
18	Mountain Lake Biological Station Site	NEON	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
19	Moab Site	NEON	Shrub	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
20	Central Plains Experimental Range	NEON	Herbaceous	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	8,5
21	Rushworth creek (Victoria)	TERN-AusCover	DBF	OCEAN	V2,V3,V4-1,V4-2,V6-C,V9-1,V9-2,V11	8,25
22	Svartberget	ICOS	NLF	EURO	V1,V2,V3,V4-2,V5,V6,V8,V11	8,25

Ranking

23	Wytham Woods	ForestGeo - NPL	DBF	EURO	V1,V2,V3,V4-1,V6-C,V9-2	8
24	Cape Tribulation (Daintree Rainforest SuperSite) - Affliate	TERN-SuperSites, -OzFlux	EBF	OCEAN	V1,V3,V4-2,V5,V7,V8,V11	7,75
25	Wombat Stringbark Eucalypt SuperSite	TERN-SuperSites, -AusCover, -OzFlux	EBF	OCEAN	V1,V2,V3,V4-2,V5,V7,V8,V11	7,75
26	Hyytiala	ICOS	NLF	EURO	V1,V2,V3,V4-2,V5,V6,V8,V11	7,75
27	Tharandt	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,75
28	Hainich	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,75
29	Ordway-Swisher Biological Station Site	NEON	NLF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	7,5
30	Oak Rige Site	NEON	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	7,5
31	Guanica Forest	NEON	EBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	7,5
32	Harvard Forest	NEON	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	7,5
33	Steigerwaldt Land Services	NEON	DBF	NOAM	V1,V2,V3,V5,V8,V9-1,V9-2,V10,V11	7,5
34	Aurade	ICOS	Cultivated	EURO	V1,V2,V3,V5,V6,V8,V11	7,25
35	Hesse	ICOS	Herbaceous	EURO	V1,V2,V3,V5,V8,V11	7,25
36	Hohes Holz	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,25
37	Lanzhot	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,25
38	Negrisia - Ponte di Piave	ICOS	Cultivated	EURO	V1,V3,V5,V6,V8,V11	7,25
39	Bily Kriz forest	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,25
40	Osne-le-Val	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	7,25
41	Puechabon	ICOS	NLF	EURO	V1,V2,V3,V4-2,V5,V6,V8,V11	6,75
42	Fontainebleau-Barbeau	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	6,75
43	Castelporziano2	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	6,75
44	Vielsalm	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	6,75
45	Kenttarova	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	6,75
46	Montiers sur Saulx	ICOS	DBF	EURO	V1,V3,V4-2,V5,V6,V8,V11	6,75
47	Collelongo	EFDC	DBF	EURO	V1,V2,V3,V4-2,V7,V8	6,5
48	Zigzag Creek (Victoria)	TERN-AusCover	EBF	OCEAN	V3,V4-2,V5,V6-C,V9-1,V9-2,V11	6,25
49	Selhausen Juelich	ICOS	Cultivated	EURO	V1,V3,V5,V6,V8,V11	6,25
50	Brasschaat	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	5,75
51	Estrees-Mons A28	ICOS	Cultivated	EURO	V1,V3,V5,V6,V8,V11	5,75
52	Loobos	ICOS	NLF	EURO	V1,V3,V4-2,V5,V6,V8,V11	5,75
53	Fyodorovskoye	EFDC	NLF	EURO	V1,V3,V4-2,V8	5,5
54	Peace River	ENVIRONET	Cultivated	NOAM	V2,V3,V4-2,V6-C,V8,V11	5,25
55	Watts Creek (Victoria)	TERN-AusCover	EBF	OCEAN	V3,V4-2,V6,V91,V9-2,V11	5,25

Google Earth View (3x3 km, 1X1 km green square)

Litchfield ASS

Zigzag Creek ASS

Mountain Lake (NEON)

Jornada LTER (NEON)

Dahra (KIT / U.Cophen)

Mata Seca (Environet)

Tharand (ICOS)

Hohes Holz (ICOS)

Examples: Tumbarumba SuperSite (Will Woodgate)

Winter 2016 top, Summer 16/17 bottom

Tumbarumba Australian SuperSite

OzFlux tower

- Open path CO2, H2O
- Sonic anemometer
- Air temperature profile (Thermocouple)
- Air H2O and CO2 profiles
- Net Radiometer
- Pyranometer
- Atmospheric Pressure
- Rh+T
- Rainfall
- Wind Vane
- Soil Heat Flux (2 replicates)
- Soil Temperature
- Soil moisture (Time Domain Reflectometry)
- Direct and diffuse proportion (PAR)

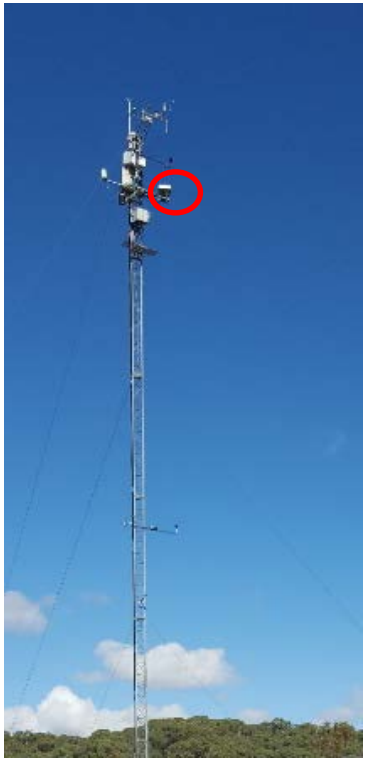
\+ SuperSite (1ha)

- Faunal monitoring
- Soil and hydrology
- Biophysical (biodiversity, structure, recruitment, composition etc.)
- + Sap flow & dendrometers
- + wireless PAR network
- Landscape (topography, drainage, land-use)
- Registered TLS scans

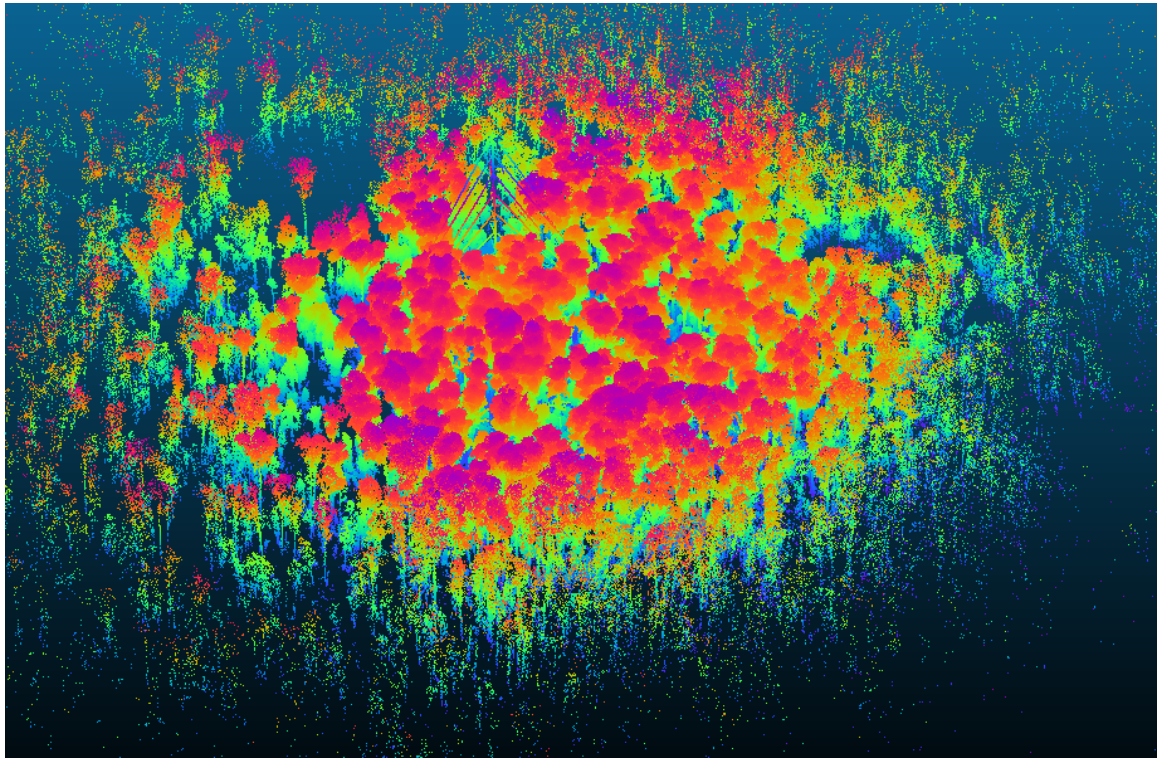
\+ AusCover Site (25km^2)

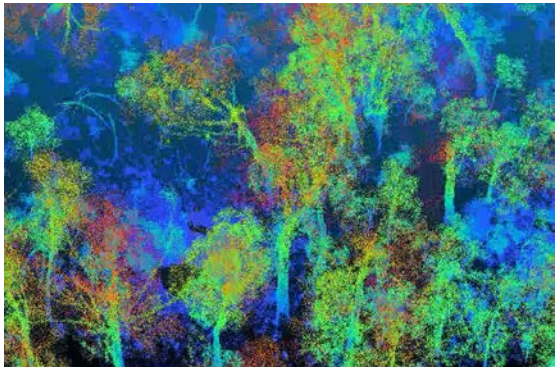
- Airborne LiDAR
- Airborne hyperspectral

⊕ tower-mounted thermal and hyperspectral imaging scanners

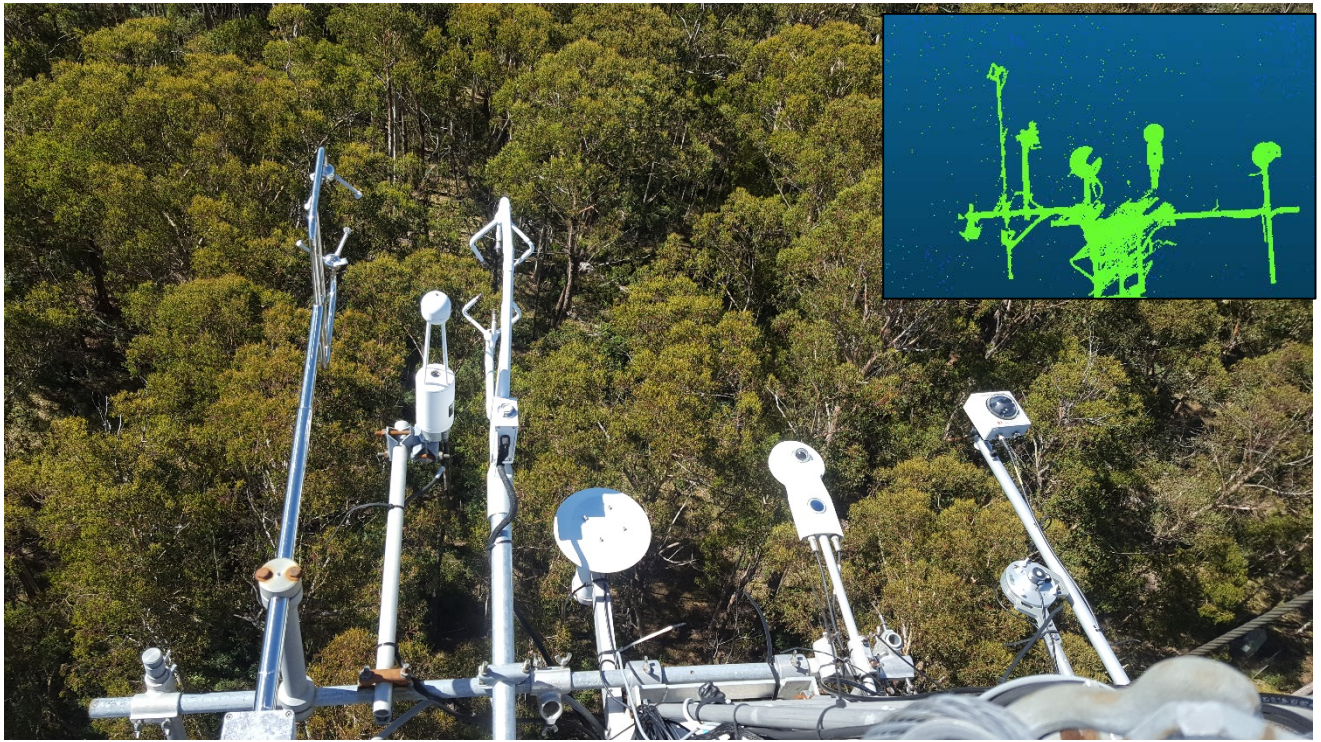


Virtual Tour

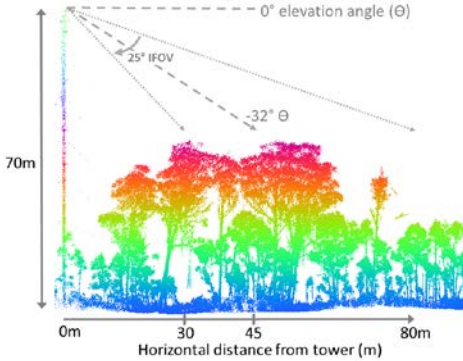


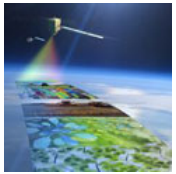


Eddy-flux system



Thermal and Hyperspectral Monitoring System

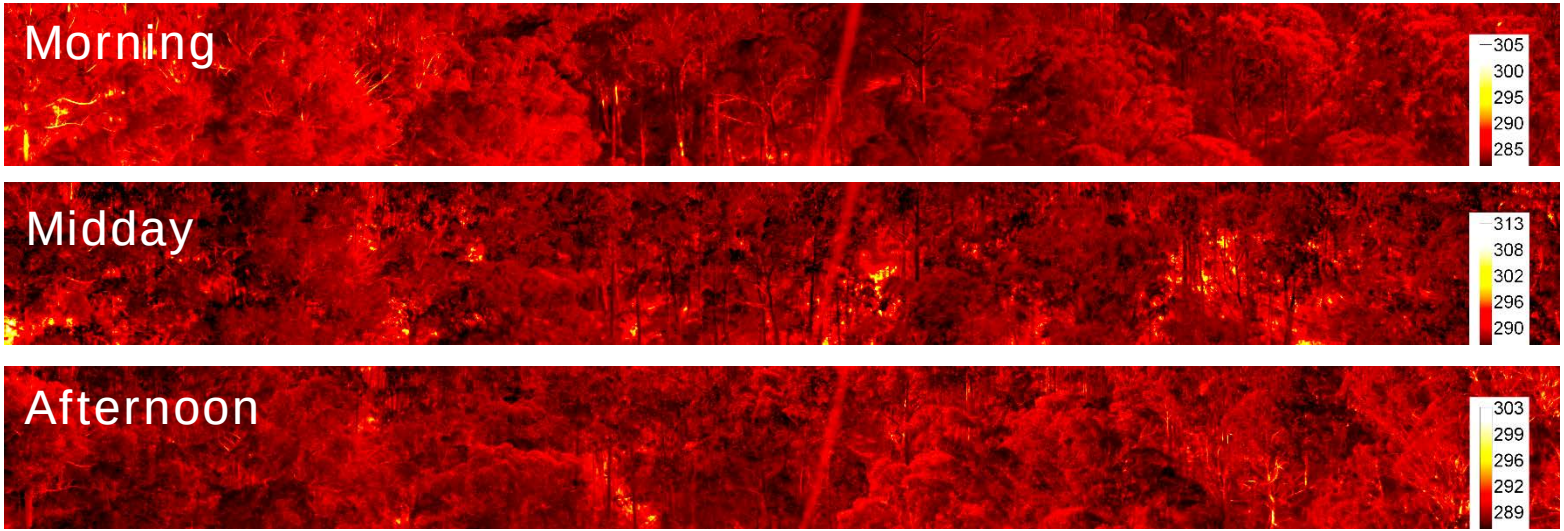


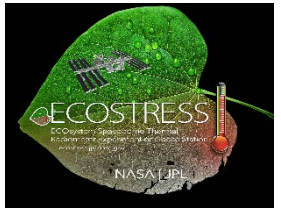


Hyperspectral data very useful for FLEX cal/val activities

TERN

Thermal and Hyperspectral Monitoring System



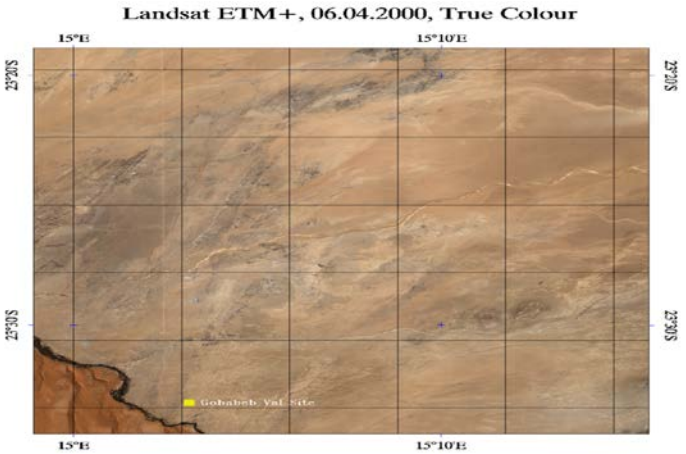


TERN

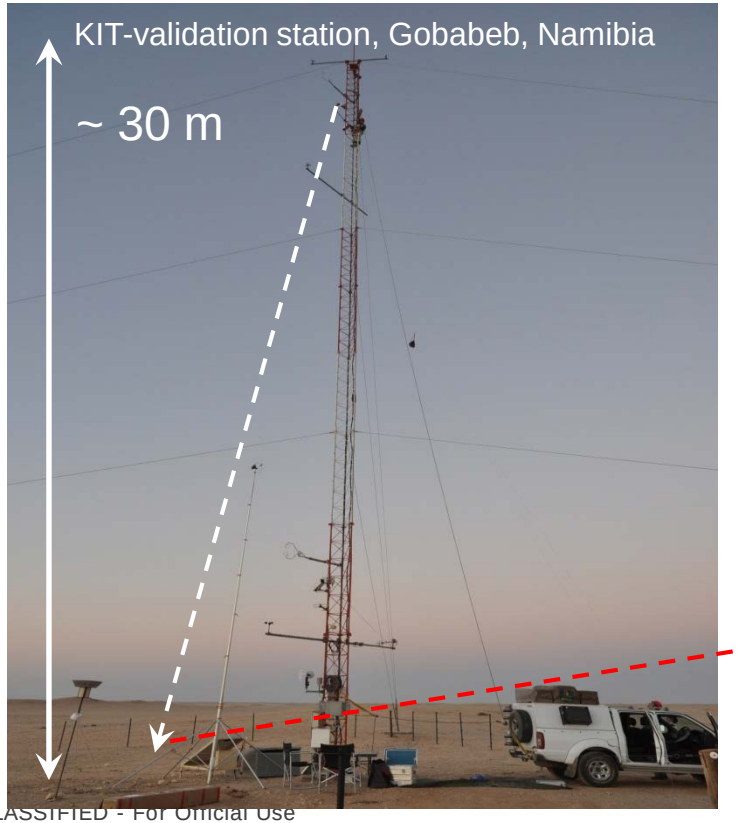
Field work

Examples: Gobabeb, Namibia (Frank Goettsche)

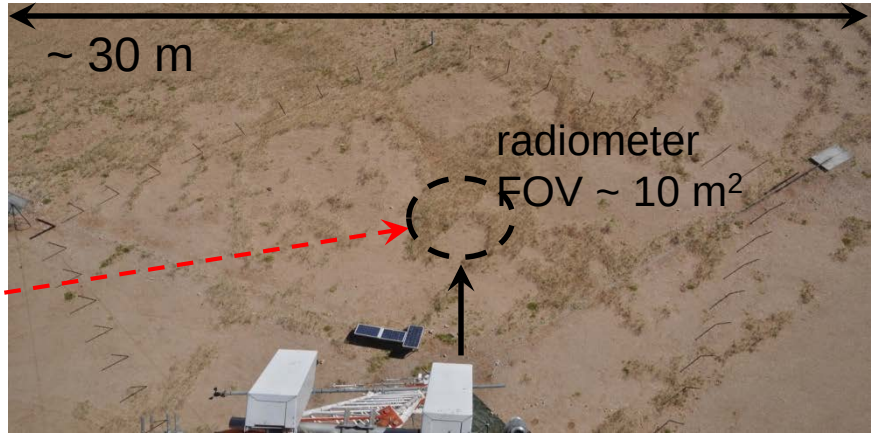
- Highly homogeneous land cover
- Main end-members:
  gravel (75%) and **dry grass** (25%)
- Rain every few years
- Some “rivier” (wadis) and rock outcrops
- Desert climate (~23° South)
- 460 m asl
- Good infrastructure



LST validation at Gobabeb



Primary mast ‘GBB Wind’



LST validation at Gobabeb

Secondary mast ‘GBB Plains’;

LST & BSRN down-welling radiances

fiducial reference temperature measurements

esa

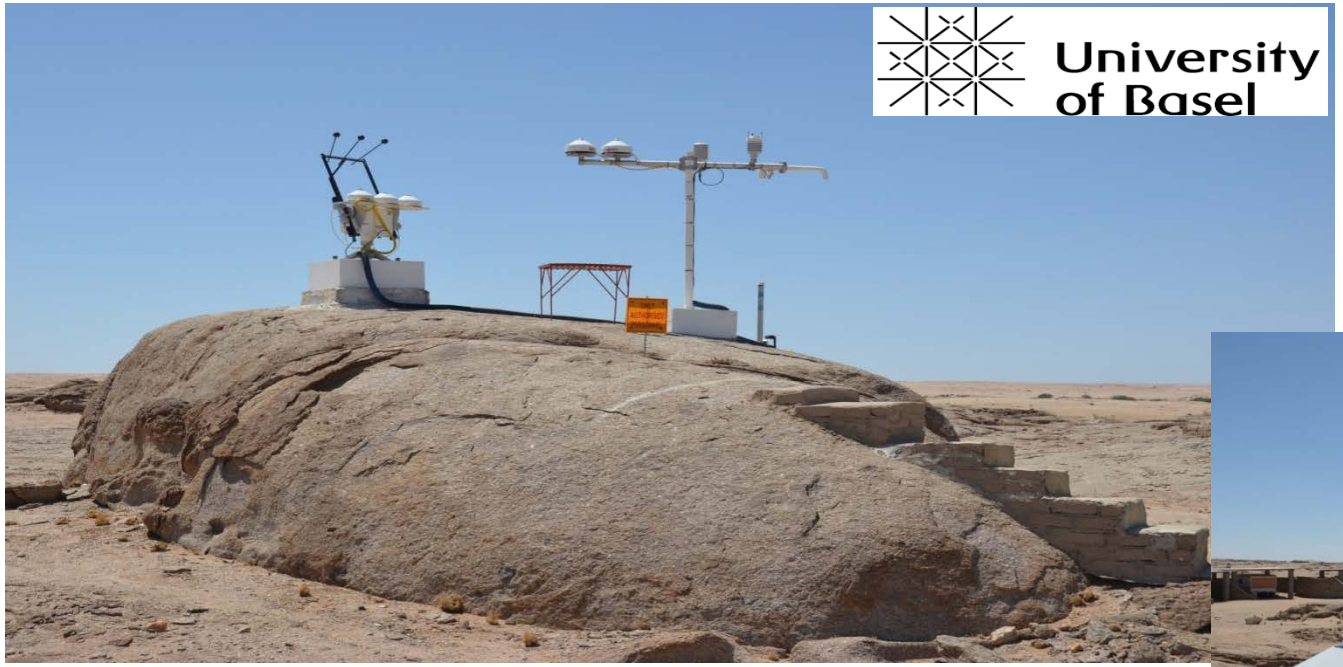
KIT Karlsruher Institut für Technologie

Report from the Field Inter-Comparison Experiment (FICE) for Land Surface Temperature

Frank-M. Göttsche[1], Folke Olesen[1], Laurent Poutier[2], Stéphane Langlois[2], Werenfrid Wimmer[3], Vicente Garcia Santos[4], César Coll[4], Raquel Niclos[4], Manuel Arbelo[5] and Jean-Pierre Monchau[6]

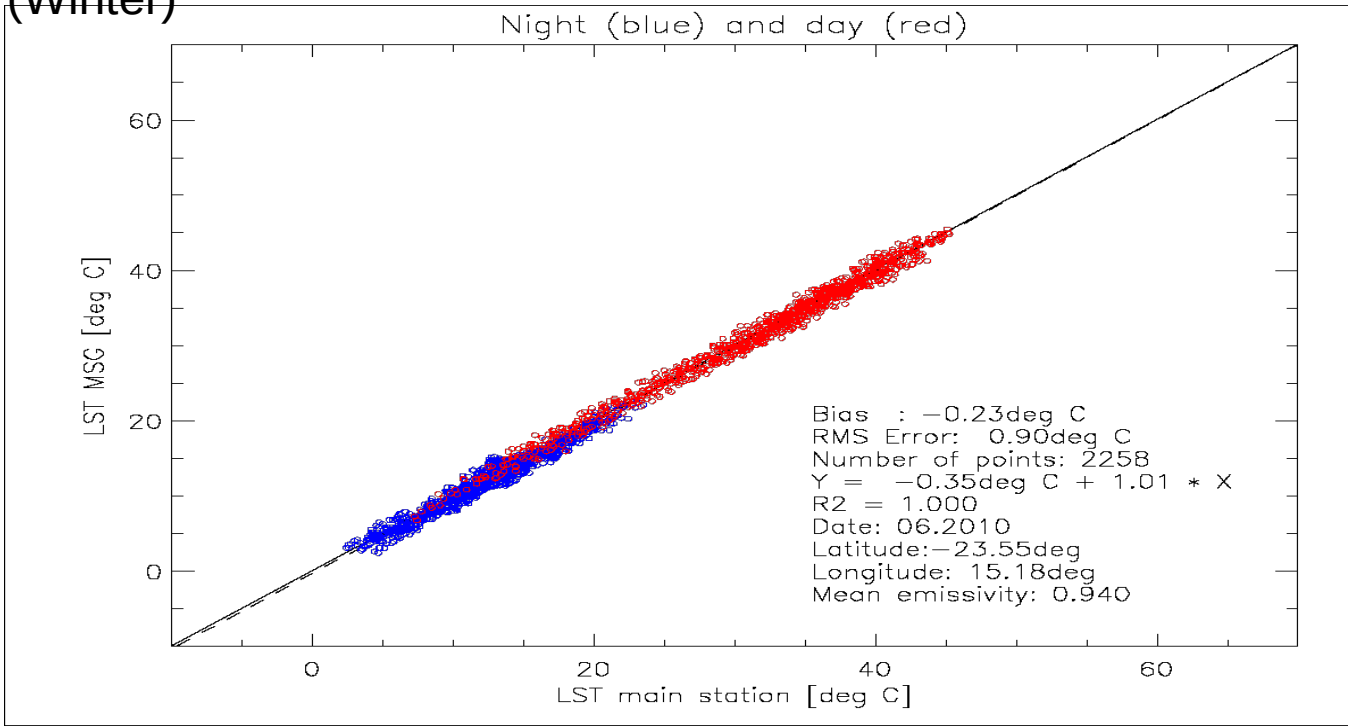
[1]Karlsruhe Institute of Technology, Germany,
[2]Office National d’Etudes et Recherches Aérospatiales, France,
[3]National Oceanographic Centre, United Kingdom,
[4]University of Valencia, Spain, [5]Universidad de la Laguna, Spain,
[6]THEMACS Ingénierie, France

BSRN Station: University of Basel & KIT



Gobabeb Ground LST vs. MSG LST

June 2010 (Winter)

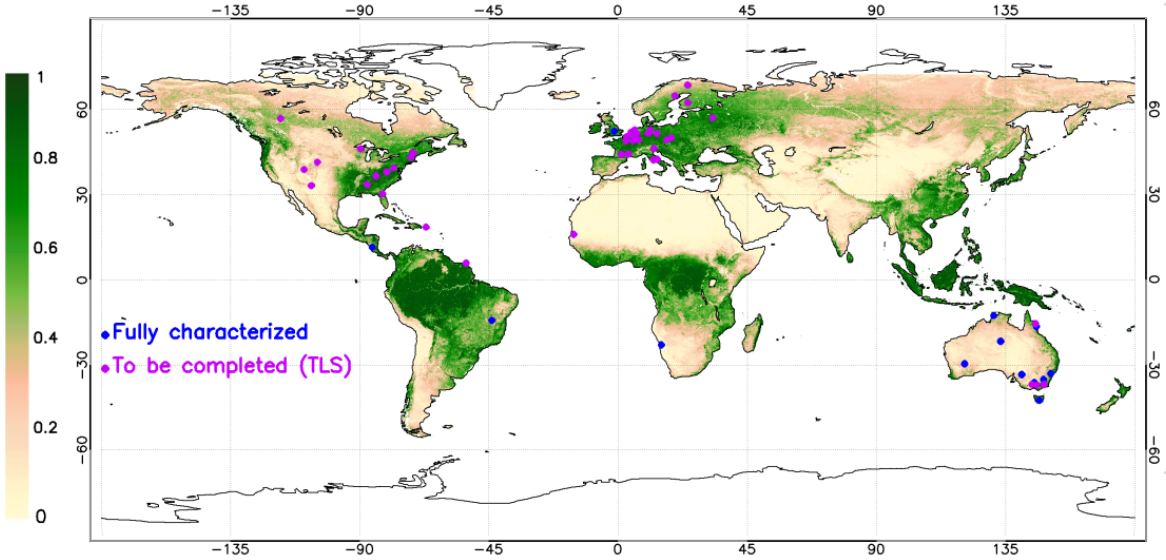


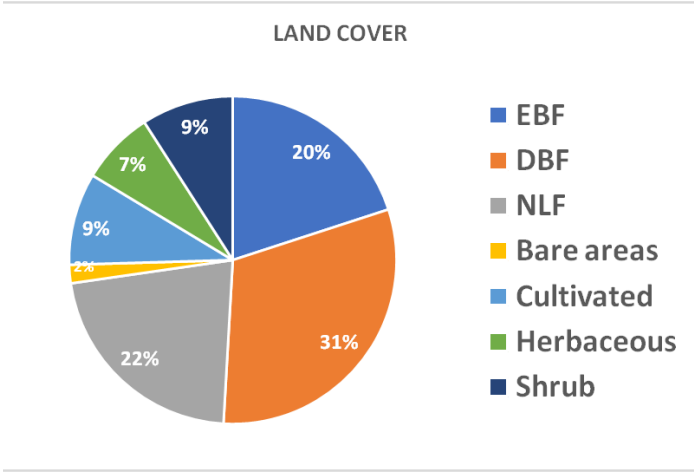
Conclusion

A total of **55 sites** have been identified as LPV SuperSites, **16** sites are **fully characterized** sites.

70% of the sites are forest (Evergreen, Deciduous and Needle-leaf), and 30% for other biomes.

SuperSites are mainly located in US, Europe and Australia, with Asia, Africa and South America under-sampled regions.





Conclusions

- TERN Australian SuperSites are fully characterized, from field scale to space.
- NEON sites over US are well characterized, including airborne campaigns and products, but could be improved with detailed 3D canopy structure (TLS).
- ICOS sites over Europe are well instrumented, but terrestrial LiDAR and airborne campaigns are missing. ***ESA cal/val campaigns over ICOS sites could contribute to fill this gap.***

- Future work will include evaluation of the protocols and quality of the ground datasets for validation.

- Identification of additional sites to improve the representativeness of global conditions. Please, write to fernando.camacho@eolab.es for new candidates sites.

- The list of the LPV supersites V1 will be made available trough the LPV web site.

Thank you

https://lpvs.gsfc.nasa.gov