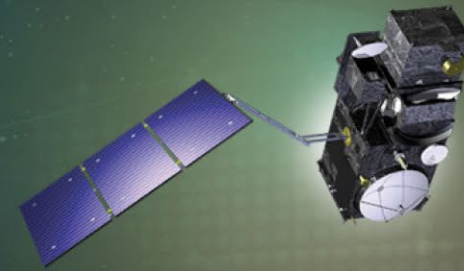




PROGRAMME OF THE
EUROPEAN UNION



co-funded with



7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

Use the European Research Infrastructure networks for validation of Sentinel products: The ICOS example

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The European Research Infrastructures

Established in the context of the European Strategy Forum on Research Infrastructures (ESFRI) are funded by member states and EU with a long term perspective (>20 years), open data access and with the aim to provide data to international users.



ICOS

INTEGRATED
CARBON
OBSERVATION
SYSTEM



The Integrated Carbon Observation System (ICOS)

ICOS is an established ESFRI Research Infrastructure (ESFRI - European Strategy Forum on Research Infrastructures) and this gives **long term (>20 years) perspective and support**.

It is already **operational** and entering in the second five-years program.

Quality and free data access are the main pillars of ICOS and for this reason the ICOS stations are carefully evaluated during a labelling process before being included in the network.



The Integrated Carbon Observation System (ICOS)

www.icos-ri.eu

A networks of sites for CO₂ and other GHGs monitoring.

Four thematic centres that coordinate the activity of the sites

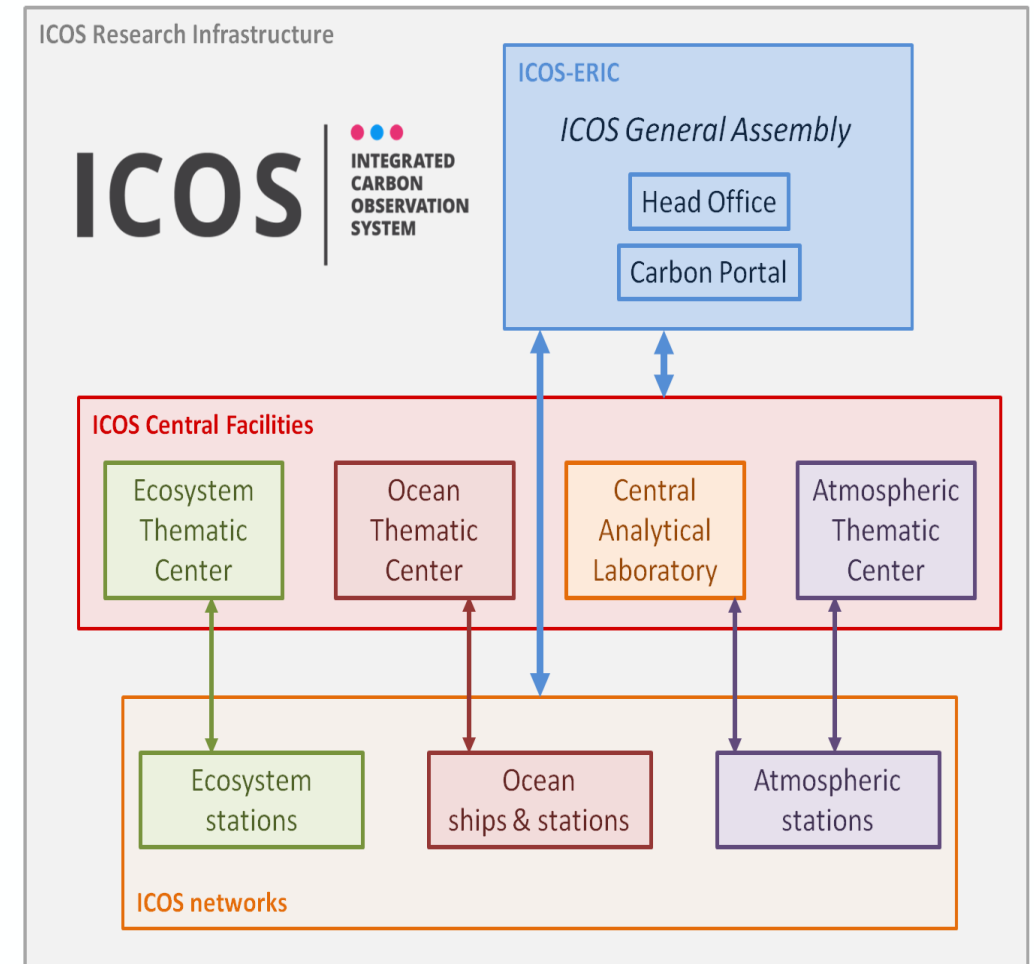
One EU level head-office and data portal (Carbon Portal)

Ecosystem network: 85 ecosystem sites

Atmospheric network: 40 towers

Ocean network: 23 ships and fix stations

The ICOS **Thematic Centers**: coordinate the networks, do the centralized processing, test and development of new methods and sensors.



The Ecosystem Network

Class 1 and Class 2 are the high quality sites (currently 43 in the network), highly standardized, with data and full metadata transmitted daily to the ICOS Carbon Portal. They cover different ecosystems and climatic conditions

Tens of variables are monitored at the sites, following standard protocols that have been developed by the international scientific community and are based on existing standards.

<http://www.icos-etc.eu/variables>

www.icos-etc.eu/documents/instructions





The Ecosystem Thematic Centre (ETC)

Coordinated by Italy (fluxes and meteo) has offices in Belgium (biomass, LAI, etc.) and France (chemical analysis)

The ICOS ETC is responsible for:

- Centralized data **quality check** and **processing**
- Test and **develop** methods, sensors, and protocols
- **Evaluate** the performances of the stations
- Perform **chemical analysis** of soil and vegetation samples
- **Assistance** to the ecosystem network and training
- **Coordinate** with other networks and companies



Radiation measurements

Among the different meteorological parameters in the ICOS stations there are continuous measurements of different radiation components:

- Shortwave Incoming and Outgoing
- Longwave Incoming and Outgoing
- PAR (Incoming, in some cases Outgoing)
- Diffuse radiation (mandatory only in Class 1)

Data (collected at 20 seconds resolution) and full metadata (sensor model, position, calibration etc.) are then processed at the ETC (derived variables)

Working on possibility to estimate optical thickness and canopy temperature



ICOS Ecosystem Instructions

RADIATION MEASUREMENTS

Version: 20180620

INSTRUCTIONS FOR

RADIATION MEASUREMENTS

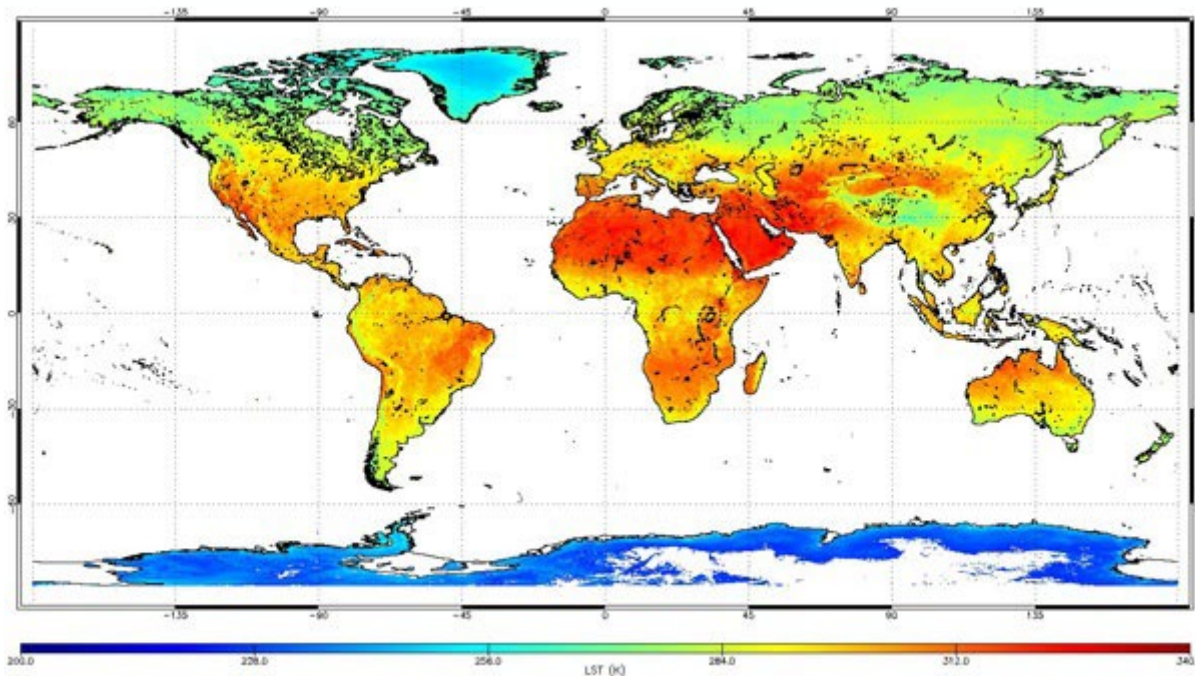
Short-wave radiations

Long-wave radiations

Photosynthetically active radiation

Land Surface Temperature (LST)

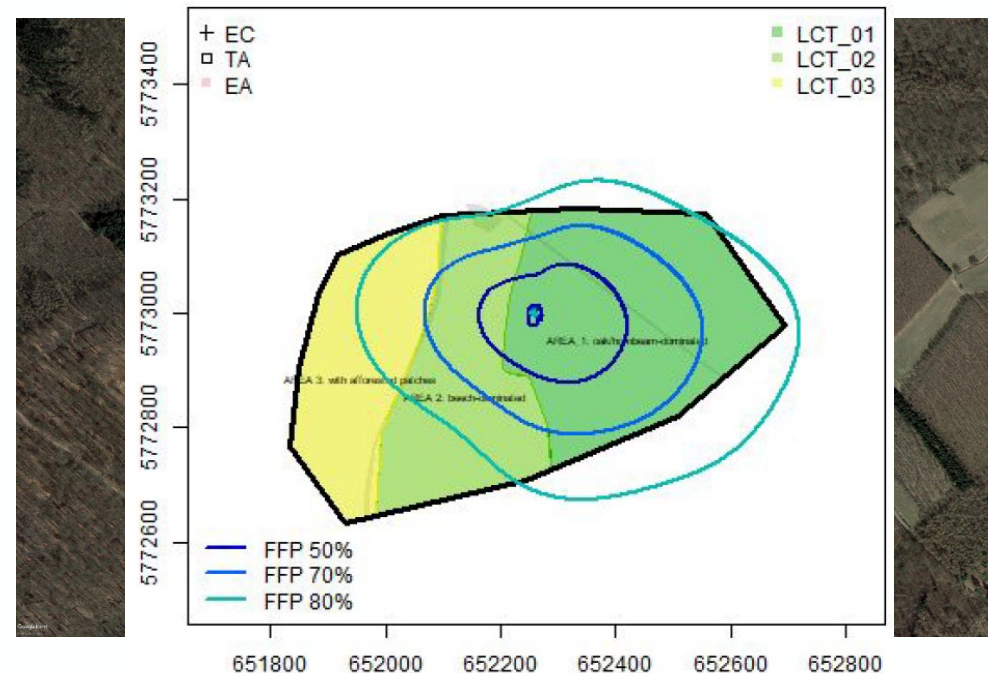
- Pilot study lead by Denis Loustau and Marc Irvine (INRAE) to implement sensors on ICOS towers
- First review of stations that could install sensors
- Coordinated with FRM4STS and CEOS LPV to be compliant with requirements



Characterize the spatial heterogeneity

The Eddy Covariance towers measure fluxes coming from a footprint that is changing every half-hour. In order to ensure quality and link with the RS we defined for each site the **Target Area** as the portion of land that we want to monitor.

The area, delimited by a vector polygon, is analysed in terms of heterogeneity and then it is checked that the EC tower is in fact monitoring the target ecosystem.

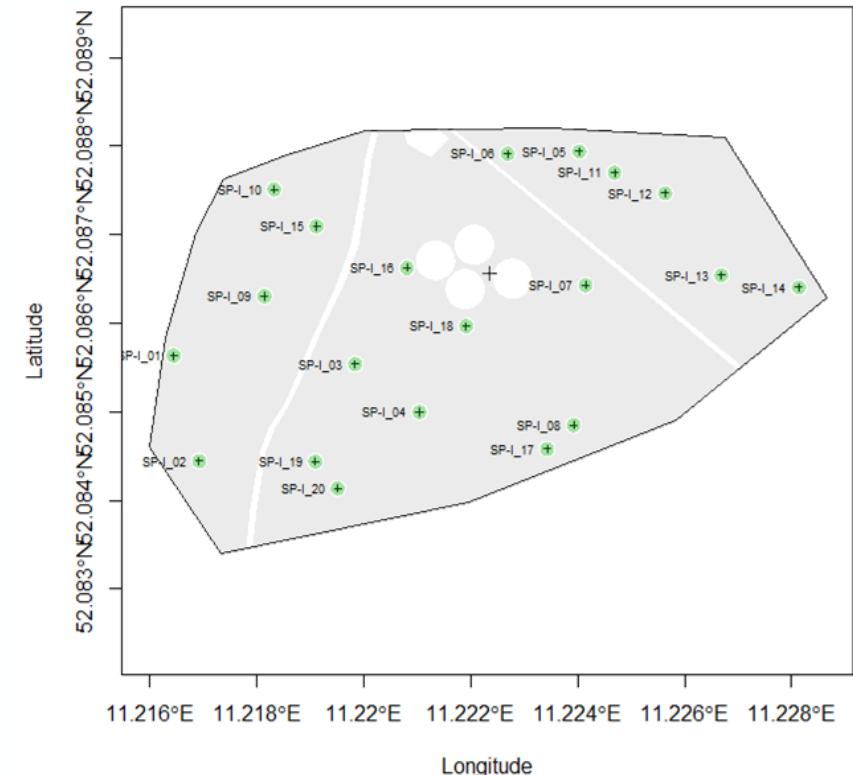


Characterize the spatial heterogeneity

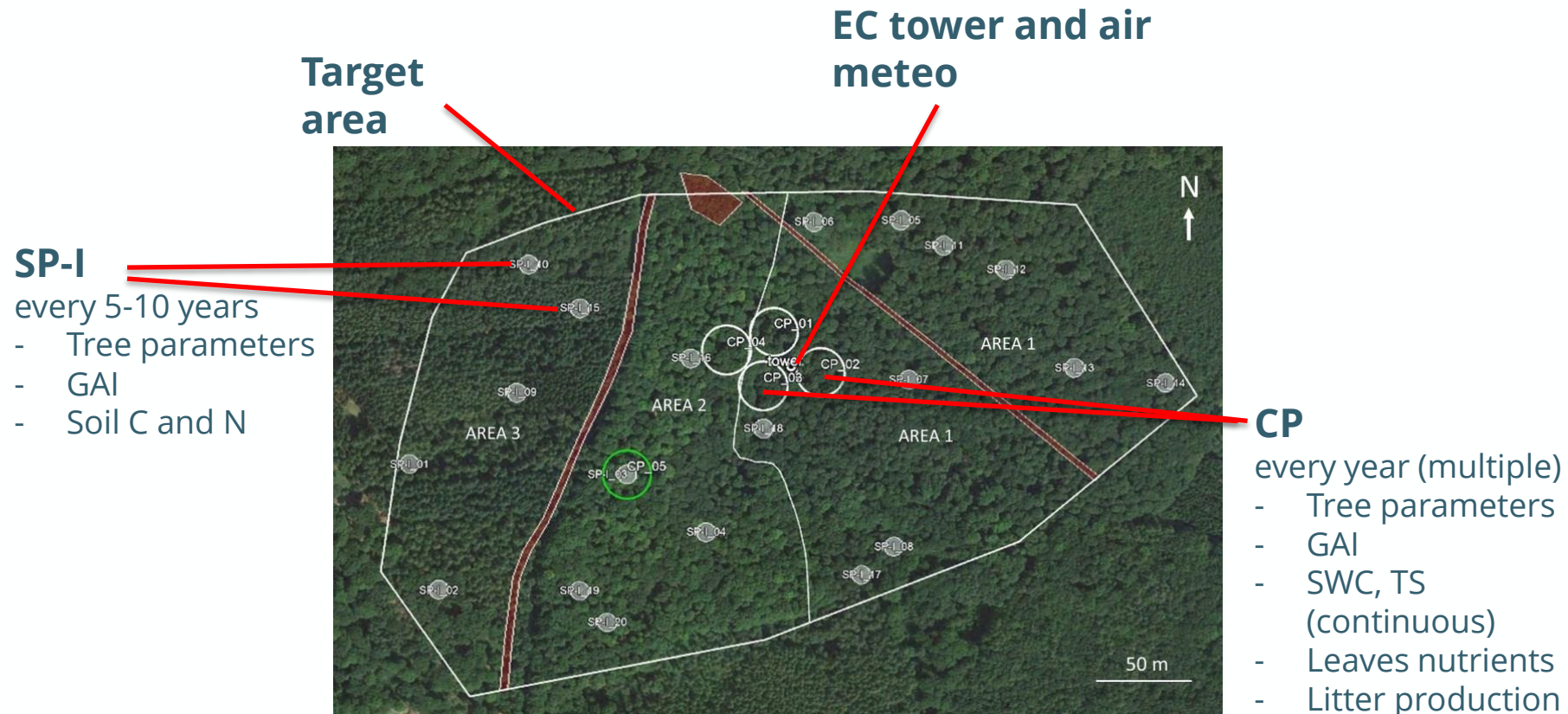
Target Area is characterized with a number of sparse ancillary data measurements (species, biomass, GAI, soil sampling, trees characteristics etc.) following a stratified random design with 20 areas (SP-I).

Each 20 SP-I location is 700 m² (15m radius) and measurements every 5-10 years (and after disturbances) are done for:

- **Tree diameters and heights**
- **Tree species and health status**
- **Green Area Index**
- **Soil organic C and N**



Monitoring strategy summary



Green Area Index measurements

Green Area Index is calculated centrally at the ETC starting from one of these two methods:

DHP (if PAI<6)



Ceptometer (PAI>6)



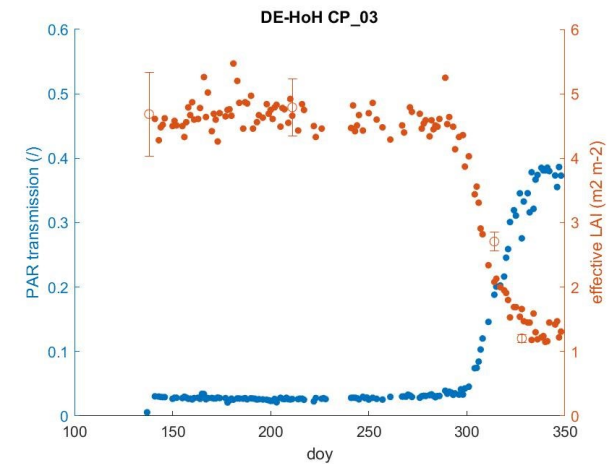
Processing centralized. For DHP a new tool based on an expert meeting held in Antwerp

Hemitool (code on GitHub)



Green Area Index measurements

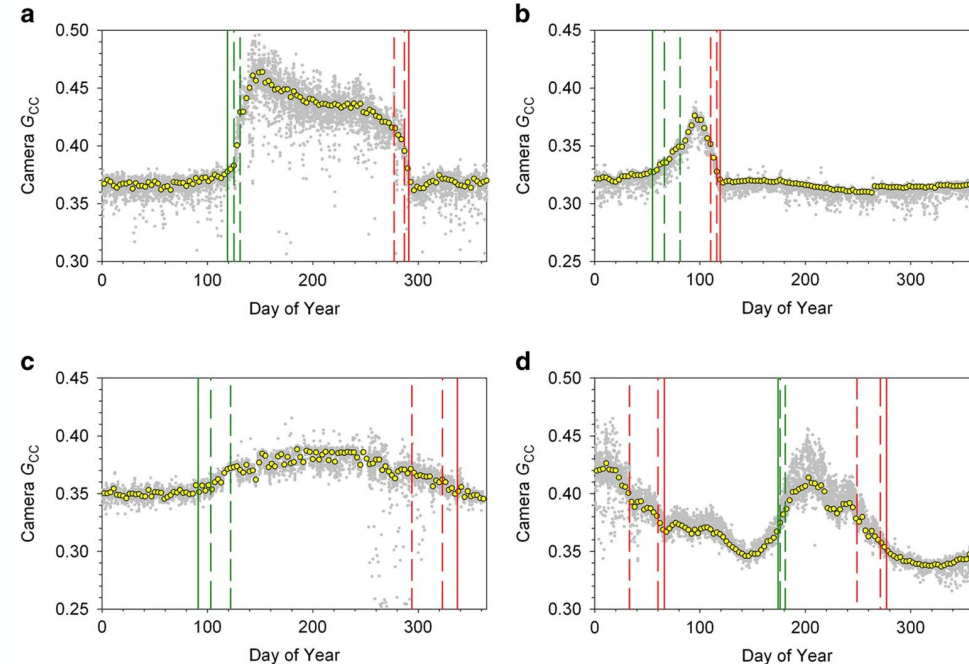
New Method: Introducing Below Canopy PAR measurements for GAI estimation in forests with possibility to extend to FAPAR measurements



Phenology

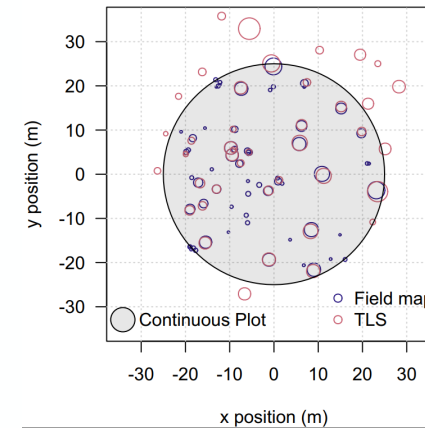
ICOS stations are equipped with the Phenocam (same standard used in the US Phenocam network) for the analysis of the phenology and greenness.

austriacary - NetCam 9C IR - Wed Aug 14 2019 11:00:05 EST - UTC-5
Camera Temperature: 59.5
Exposure: 48



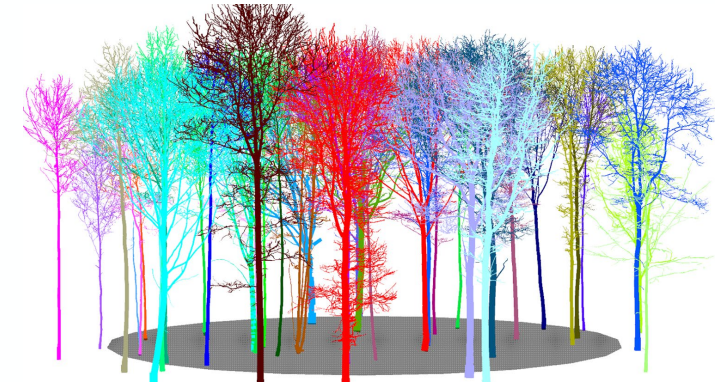
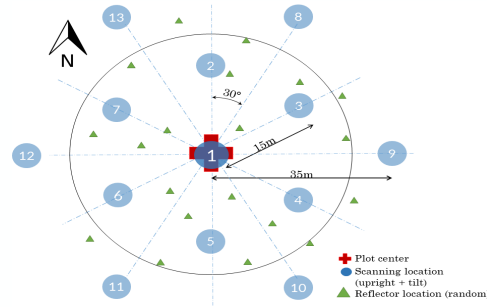
Above-ground Biomass

AGB estimations are based on DBH, height, species and allometric relations. The Allometric relations must be either estimated on site or be related to similar climatic, soil and age conditions.



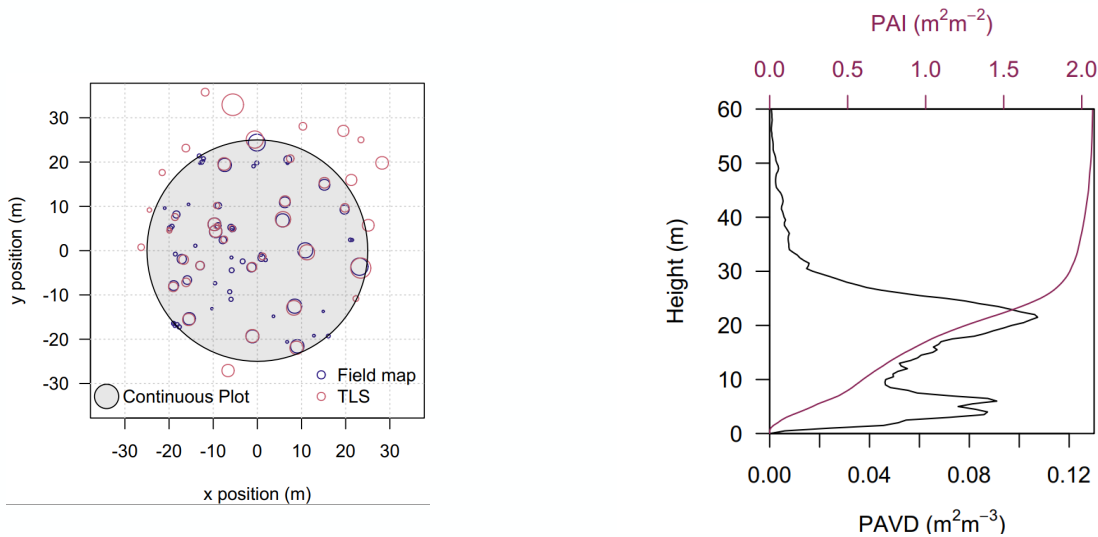
Above-ground Biomass

Current evaluation of Terrestrial Laser Scanning (TLS) for the ICOS forest stations
scanning the CP around the tower (same operator, same instrument, centralized processing)



Above-ground Biomass

Despite the need of further development and validation of the method for the biomass estimation (and changes of biomass), TLS can also provide a set of additional metrics and information that can be important for different applications



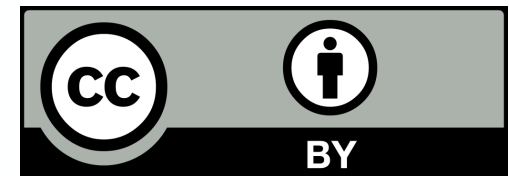


Data products and availability

Different data products released through the Carbon Portal but there is the possibility of additional products/datasets targeted to the needs of specific communities.

Addition of new variables or alternative processing are possible like also the hosting at the ICOS station of third-party sensors. Requests are evaluated and is accepted implemented long term and high quality

ICOS data are all distributed by the Carbon Portal, with a permanent identifier (PID) and under the Creative Common license, timely and also NRT





Conclusions

- ICOS is a **stable, long term** and **sustained** research infrastructure that can ensure **timely, high quality** and **open access** data to the scientific communities
- There is an high level of interest by ICOS and other RIs (e.g. eLTER) in establishing **links with the Remote Sensing community** for validation activities.
- There is the possibility **to discuss new products, adaptation of the protocols** and **new measurements** if needed and critical. A feasibility and sustainability analysis is needed but if added they become standard and ensured long term.



Thanks for your attention

for questions, feedbacks and suggestions:

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