Land Surface Carbon Constellation Study

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CoCO2 Land Surface Modelling workshop, 25 March 2021

LCC project

- ESA funded
- part of ESA‘s Carbon cluster
- 13 partners
- Kicked off Oct 2020
- 30 months duration

Objectives of the project

Investigate the **terrestrial biosphere's net ecosystem exchange** – photosynthetic CO_2 uptake minus respiratory CO_2 release – **response to climatic drivers** by means of combining a process-based model with a **wide range of observations (in-situ and remotely sensed) on local and regional scale**

For this we will:

- Generate a **community land surface model for its application in a data assimilation framework**
- Acquire and analyse **EO and campaign data sets**

Process representation in the D&B model

D&B model based on DALEC and BETHY

- Canopy-Photosynthesis
  - Farquar(C3)/Collatz(C4) model
  - Supply-demand stomatal model
  - Day-nighttime leaf respiration
  - Two-flux radiative balance
- Phenology
  - Approach with fixed periods of leaf expansion and loss
  - Adjust biological activity to climate drivers (temperature, photoperiod) and internal variables such as soil water availability
  - Flexible to test alternate representations
- Water and Energy Cycle
  - Split between bare soil and canopy
  - Modified VIC model with two soil water pools
  - Canopy water balance
  - Snow model
- Carbon Cycle
  - Mass balance approach
  - Respiration models for plants and microbes
  - Flexible to increase pools if required (e.g. coarse woody litter pool)

Observation Operators

Inclusion of observation operators in the data assimilation framework for:

- FAPAR
- SIF
- Active/passive microwave VOD
- Surface layer soil moisture

Data sets: EO data

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Purpose
SMOS L-VOD												Assimilation
ASCAT C-VOD												Assimilation
OCO-2 SIF												Assimilation
Sentinel 5P SIF												Assimilation
S3 FAPAR/LAI												Assimilation
ASCAT backscattering												Validation
SMOS soil moisture												Assimilation
SMOS TB												Validation
AMSR-2 C-VOD												Validation
AMSR-2 X-VOD												Validation
MODIS LST												Auxiliary
MODIS PRI												Auxiliary
S3 LCC												Auxiliary
S3 FVC												Auxiliary

Data sets: Field campaign sites

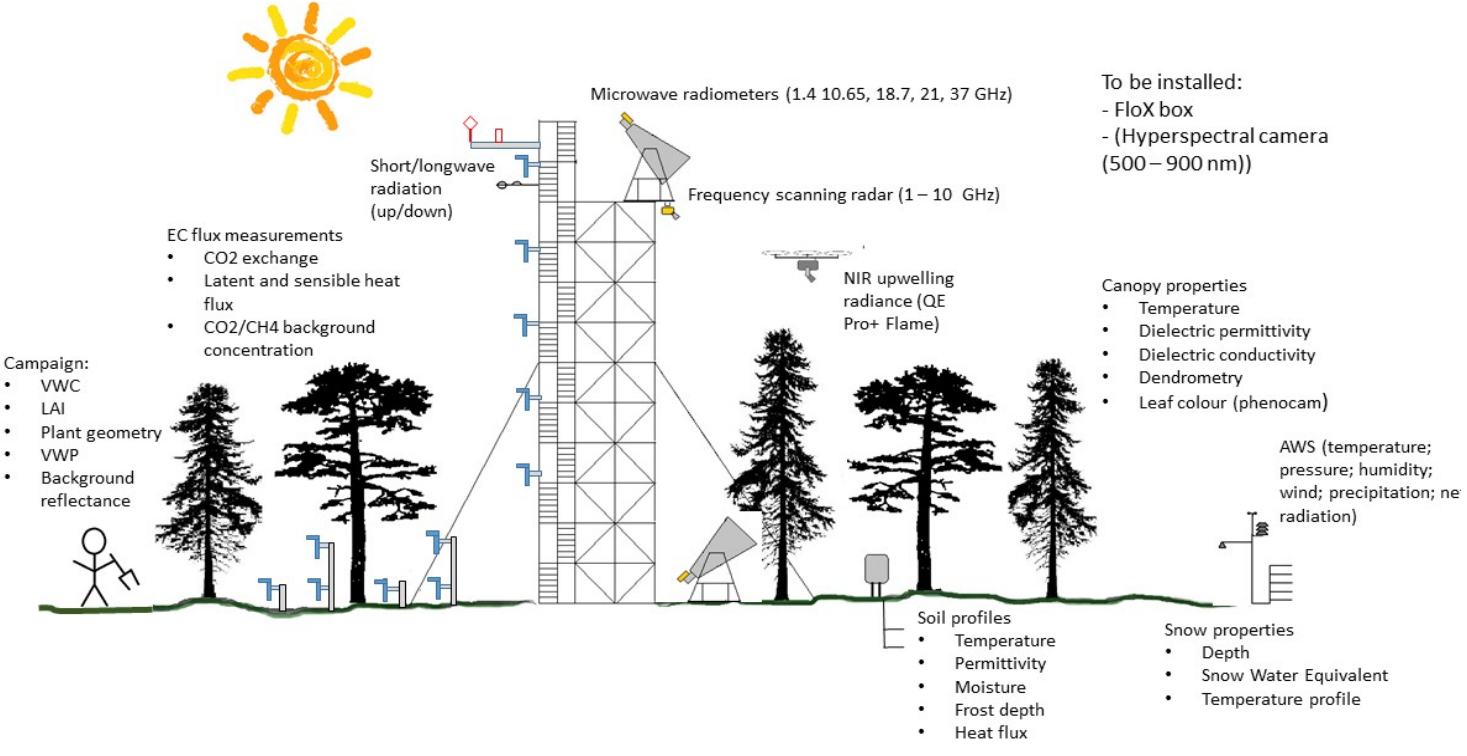
- Sodankylä, FI
  - Boreal forest site operated by FMI
- Majadas, ES
  - Tree-grass savanna site operated by MPI-BGC
- Reusel, NL
  - Agricultural site operated by TU Delft

Sodankylä

Station name	Sodankylä forest
Coordinates	67.36° N, 26.64° E
Altitude (masl)	179
Ecosystem type	Boreal evergreen needleleaved forest
Vegetation type	Pinus sylvestris (scots pine); forest floor: e.g. lichens, mosses and small shrubs
Mean vegetation height (m)	12
Max projected LAI	-1.2
Soil type	Sandy Podzol
Tree density (ha^{-1})	2100
Tree age (years)	60-160
Average temperature (°C)	-0.4
Annual precipitation (mm)	527
Average snow depth at mid-March (cm)	75
Median snow cover start date	Sep 26
Median snow cover end date	May 14

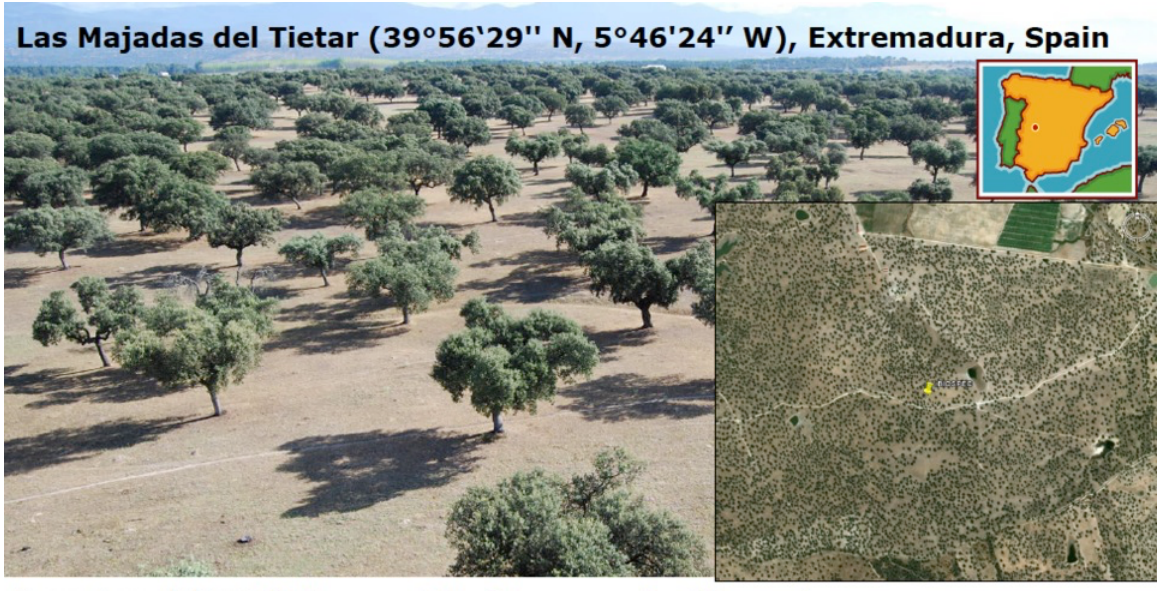
ICOS tower

Campaign and routine setup, Sodankylä



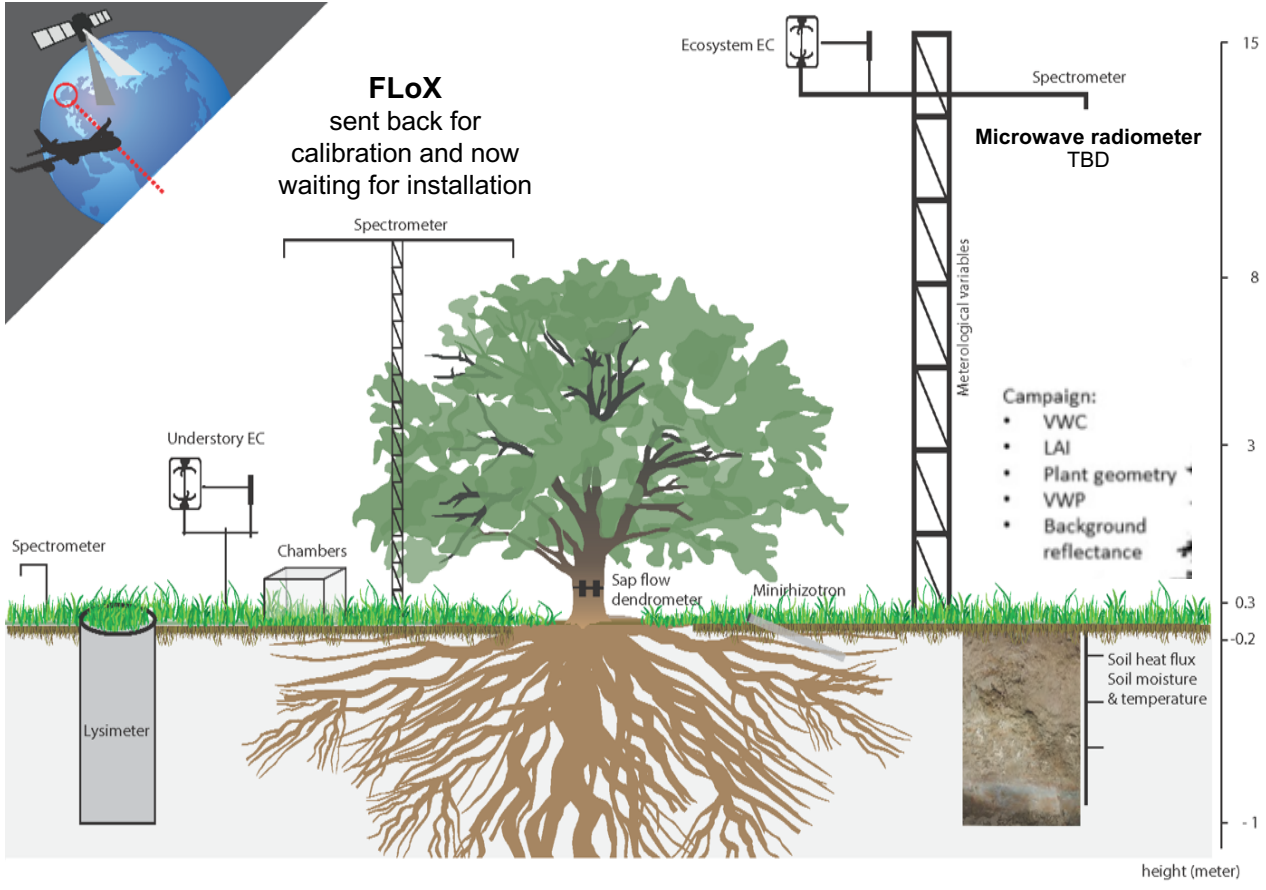
Majadas

Station name	Majadas de Tietar
Coordinates	39.94° N, 5.77° W
Altitude (masl)	260
Ecosystem type	Savanna
Vegetation type	Open holm oak woodland (Quercus ilex, annual herbaceous stratum)
Mean vegetation height (m)	8 m
Max projected LAI	2.5 $m2/m^2$
Soil type	Cambisol
Tree density (ha^{-1})	25
Tree age (years)	> 100 years
Average temperature (°C)	16.7 °C
Annual precipitation (mm)	650
Average snow depth at mid-March (cm)	0
Median snow cover start date	-
Median snow cover end date	-



Ecosystem: ***dehesa*** **Mediterranean Holm Oak open woodland (Savanna)**

Campaign and routine setup, Majadas



Reusel

Station name	Reusel
Coordinates	51.32N, 5.17E
Altitude (masl)	32,0
Ecosystem type	Agricultural croplands
Vegetation type	Rotating crops, dominant typess: potatoe, maize, wheat
Mean vegetation height (m)	Crop dependent
Max projected LAI	6
Soil type	Sandy podzol
Tree density (ha^{-1})	-
Tree age (years)	-
Average temperature (°C)	11
Annual precipitation (mm)	767
Average snow depth at mid-March (cm)	0
Median snow cover start date	-
Median snow cover end date	-

- L-, C-, X-band radar
- Soil moisture profile
- Sap flow
- Leaf wetness
- Crop growth stage & geometry
- Destructive sampling

Modelling and assimilation activities

- Demonstration of synergistic use of observations at local and regional scale
- Regional scale: 250 km x 250 km area around the sites at 0.25 deg resolution