Carbon and water fluxes in mountain forest and grassland ecosystems from leaf to ecosystem level: effects of climate variability and management

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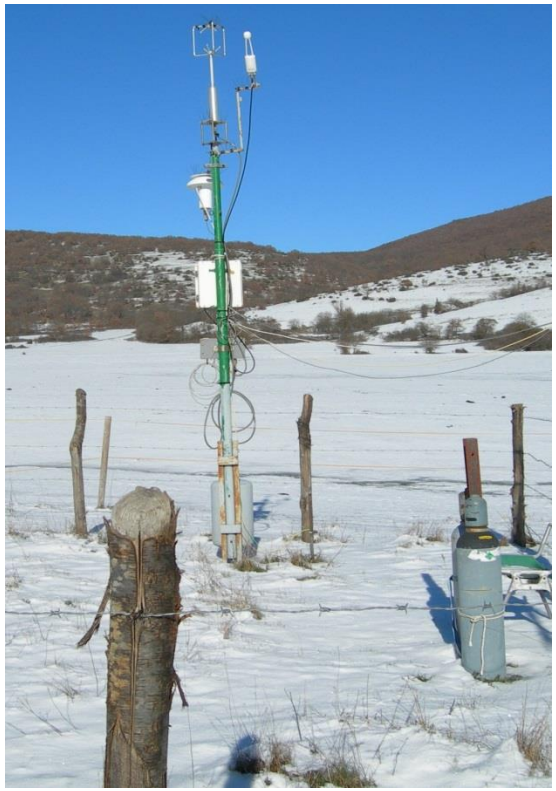
Roma 3-4 Giugno

Objective 1: To bring together CO2, H2O and CH4 eddy fluxes from a number of long-term eddy covariance stations located in Alpine and Apennine forest and grassland ecosystems.

- consolidation of an on-going network of mountain eddy covariance stations: currently 3 sites

Collelongo: 1700m
Fagus sylvatica
Appenine chain
Eddy flux since 1993



Brocon: 1750m
Grazed grassland
East Alps
Eddy flux: 2002-2007

Torgnon: 2100m
Abandoned grassland
West Alps: eddy since 2008

Flux measurements at the sites are made according to the current, accepted protocols and data were and are submitted to centralized databases (CarboEurope, FluxNet, European Fluxes Database Cluster)

Output: database-subset of flux sites specific for mountain areas that could be joined by other sites currently following the same international protocols and located in equivalent areas.

Attualmente **(European Fluxes Database Cluster) (coerente con FluxNet)**:
-Variabili meteorologiche e di flusso in formato ASCII/Excel, poi importate a cura dello Staff del Database (procedure automatiche/semiautomatiche)
- Variabili ecologiche e biologiche e metadati principali: BADM template (Excel table)

BADM (Biological, Ancillary, Disturbances and Metadata template).
The BADM is an international standard used also in Ameriflux and FLUXNET and the format is directly importable in the database structure

Verso ICOS:
- il database “European Fluxes Database Cluster rimarrà attivo sino a che il database ICOS non partirà
-Per i siti “non-ICOS” probabilmente anche successivamente
- ICOS sta sviluppando una serie di protocolli standardizzati (Sett 2014)

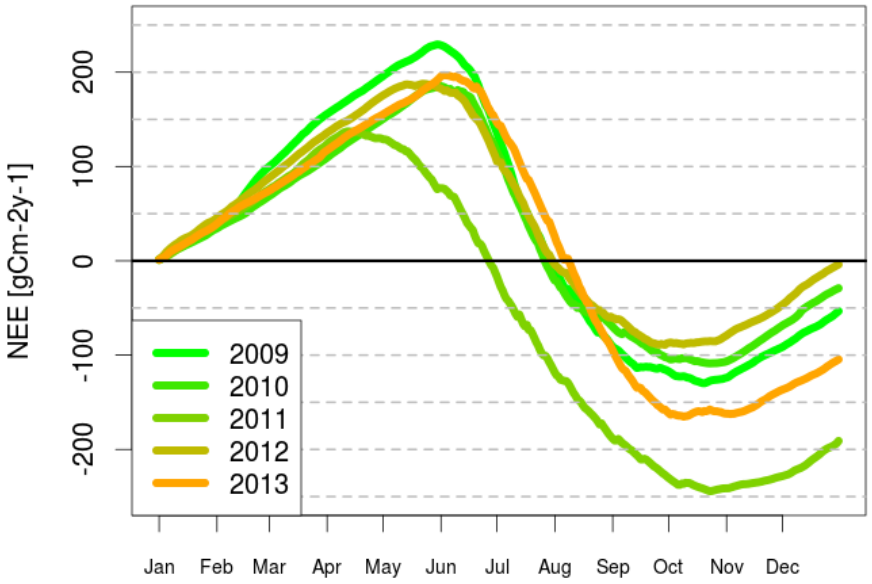
Objective 2: To perform new research activities on some aspects of mountain ecosystem functioning

2.1 evaluation of sensitivity of different parts of ecosystems C cycle to environmental changes and to management regimes

2.2 studying plant C allocation and remobilization strategies with variation of growing season and climate

2.3 monitoring vegetation phenology and productivity based on optical measurements: new measurements, definition of measurement and data-processing protocols.

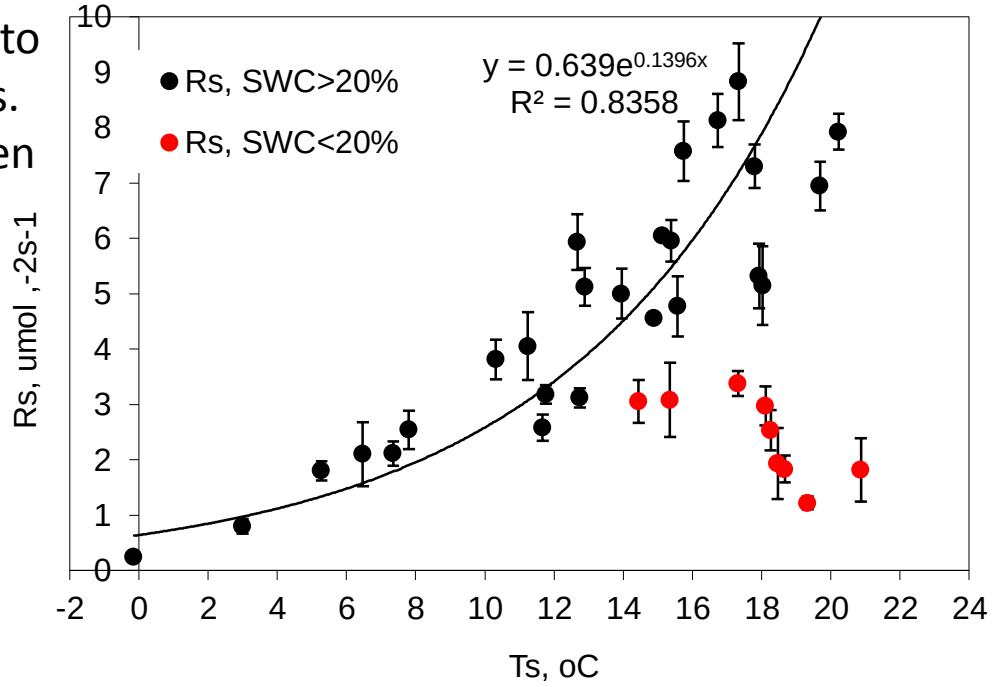
O 2.1-sensitivity of different parts of ecosystems C cycle to environmental changes



- Partitioning of NEE on small plot scale into respiration and assimilation components.
- Investigation of the relationships between daily- seasonal-and interannual flux variability and potential climatic drivers

Involved sites: all

Measurement frequency: from monthly to seasonal (Collelongo and Brocon) to continuous (Torgnon, RS)



- **sO 2.2 C allocation strategies.**

Processes determining a certain ecosystem response to changing climate will be evaluated with stable isotopes

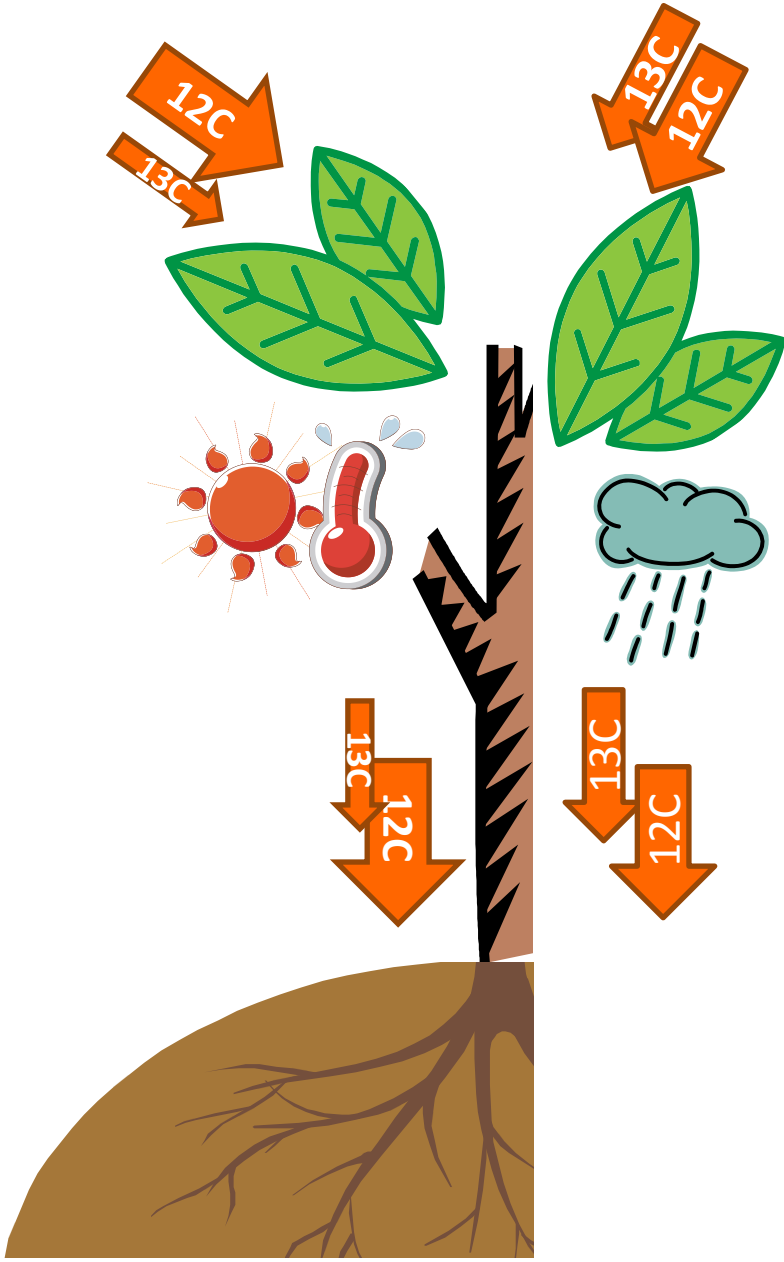
Site: Collelongo

Sampling: Plant material and respired air for 13C analyses

Measurement frequency: from monthly to seasonal.

Main output:

- mechanisms of plant physiological response to summer drought, and recovery capability
- tracing recent assimilates transport and allocation to different sink organs, allocation changes and remobilization of C reserves



sO 2.1. Effects of management on CO2 uptake and emission in grassland ecosystems using small-plot scale cuvette studies and radiocarbon measurements on soil

Sites: Brocon, grazed grassland
Torgnon, abandoned grassland

2014: Installation of additional grazing exclusion plots in Brocon

Measurements: soil respiration and NEE on small plot scale inside and outside fences, partitioning into Rhet with radiocarbon measurements,
above ground and belowground productivity, soil C stocks.

Measurement frequency:
from monthly to seasonal in 2014 and 2015.

Heterotrophic efflux using 14C

Considering steady state conditions the heterotrophic efflux from each soil layer is calculated according the formula proposed by Harrison et al. 2000 considering the SOC stock of each layer and its MRT.

$$\text{Rh flux Mg ha}^{-1}\ \text{yr}^{-1} = \text{C stock Mg ha}^{-1} / \text{MRT yr}$$

Involved sites: Brocon (grazed and ungrazed plots) and Torgnon

Main outputs: Soil carbon stock and annual heterotrophic respiration estimates at both grassland sites. Effect of grazing

Heterotrophic efflux using 14C

Measurement protocol:

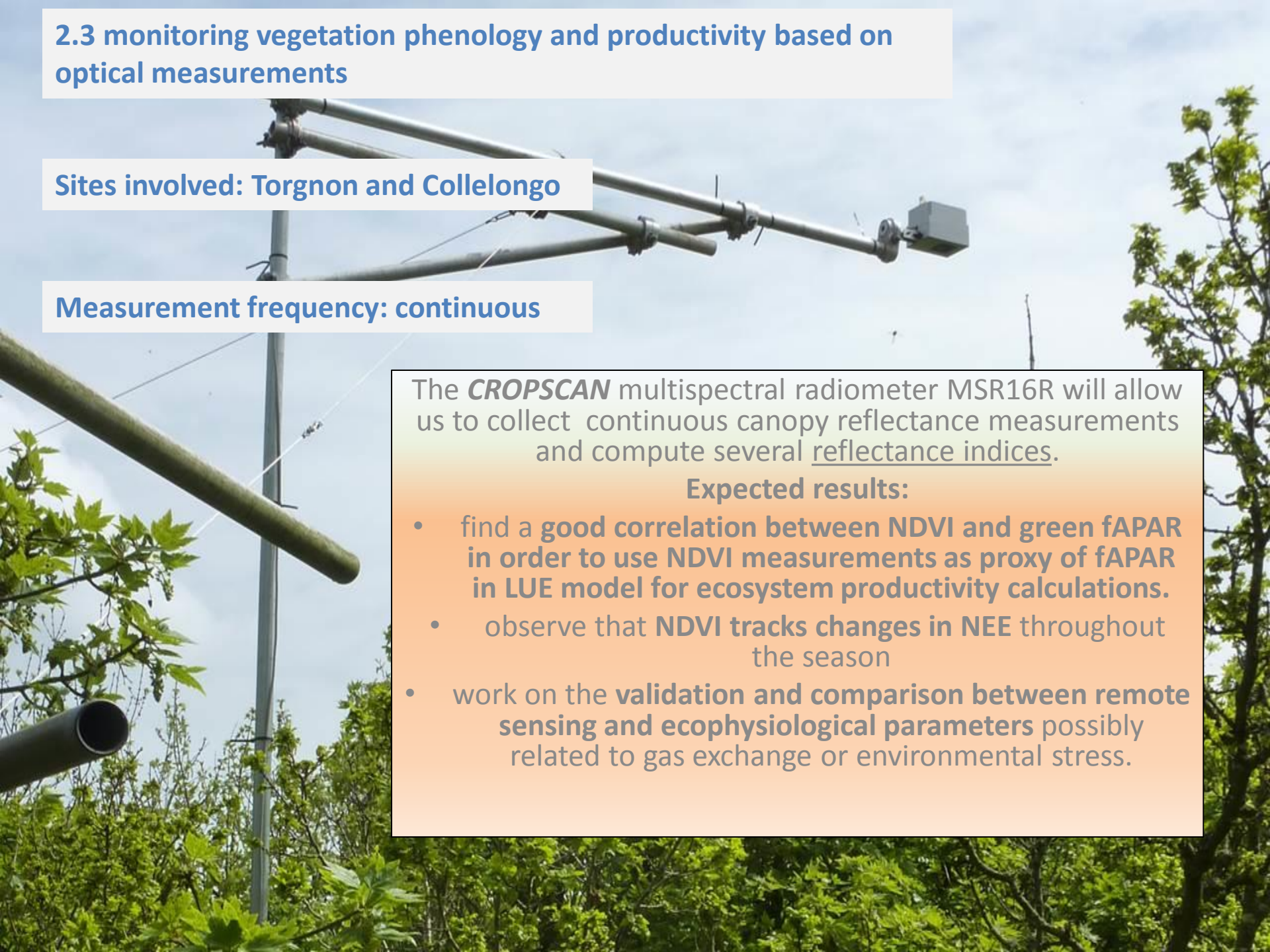
- Individuate the representative plots under the footprint of the eddy towers
- Soil sampling campaign during July to September: bulk soil samples from 0-5; 5-15 and 15-30 cm depth of mineral soil. One sample per plot and three plots per site.
- C analyses expected in October
- 14C analyses expected in november-december (external laboratory)

Rh by 14C will be confronted with Rh calculated from eddy covariance and productivity data: **NEE= NPP-Rh**

2.3 monitoring vegetation phenology and productivity based on optical measurements

Sites involved: Torgnon and Collelongo

Measurement frequency: continuous



The ***CROPSCAN*** multispectral radiometer MSR16R will allow us to collect continuous canopy reflectance measurements and compute several reflectance indices.

Expected results:

- find a **good correlation between NDVI and green fAPAR in order to use NDVI measurements as proxy of fAPAR in LUE model for ecosystem productivity calculations.**
- observe that **NDVI tracks changes in NEE** throughout the season
- work on the **validation and comparison between remote sensing and ecophysiological parameters** possibly related to gas exchange or environmental stress.

- **MULTISPECTRAL RADIOMETER SYSTEM MSR16R** will be placed at Collelongo beech forest site during the second week of June 2014.
- The system will be installed on a 24 m high eddy covariance tower and data will be collected with the standalone operation.
- Several vegetation indeces as NDVI, PRI, MTCI and CI will be calculated using reflectance values.

MSR16R and **PAR sensors** will be essential to estimate productivity of Collelongo forest using a LUE model . The productivity will be then compared to eddy covariance derived GPP, linking spectral information with fluxes measurements .

- The continuous monitoring of **FaPAR** requires the measurement of three fluxes (PARi, PARt and PARr) and ground reflectance (e_{rs})
- Transmitted PAR (PARt) will be monitored with a distributed array of 15 PAR sensors (**Apogee SQ110**) pointing upward under the canopy
- e_{rs} will be monitored with 5 PAR sensors (**Apogee SQ110**) pointing downward and installed at the location of PARt sensors.
- 1 PAR sensor pointing upward (PARi) and 1 PAR sensor pointing downward *(PARr)* are already installed above the canopy.

Where:

PAR_i	PAR incident
PAR_r	PAR reflectance
PAR_t	PAR transmittance
ε_{rs}	soil reflectance