Consiglio Nazionale delle Ricerche

NextData

un sistema nazionale per la raccolta, conservazione, accessibilità e diffusione dei dati ambientali e climatici in aree montane e marine

Project of Interest "NextData"

Proposal for a research project

Topic (number and title):
Research topic n.(2)
Armonizazzione dei dati esistenti e conduzione di nuove misure dei flussi di CO2 e di vapor d'acqua in ecosistemi montani in siti pilota, per stima degli scambi gassosi e della dinamica vegetazione-atmosfera in ambiente montano, e messa a disposizione dei dati relativi in archivi coerenti con gli archivi del Progetto NextData

TITLE OF THE PROPOSED PROJECT:

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

Project duration:
start date (before 31 January 2014): 2 January 2014
end date (no later than 30 September 2015): 29 September 2015

Scientific coordinator of the proposed project:
Dr. Carlo Calfapietra

CNR Institute coordinating the proposed project:
IBAF CNR

Participating units, indicating the scientific responsible for each unit and the motivation for the inclusion in the proposal (in particular, illustrating whether and how the expertise of non-CNR partners is not available at CNR):

Unit 1 (CNR coordinating Institute): Istituto di Biologia Agroambientale e Forestale (IBAF CNR). Scientific coordinator Dr. Carlo Calfapietra.
IBAF has an internationally recognized expertise in gas exchange measurements performed from a leaf and plot level with portable systems to ecosystem level by eddy covariance techniques. IBAF is in charge of a number of long-term monitoring eddy covariance sites located in northern, central and southern Italy. Research activity in these sites has been carried out in the frame of numerous national and international projects like CNR Strategic Project on Mountain Forests, CONECOFOR, EUROFLUX, CANIF, ECOCRAFT, LTEEF-II; FORCAST, CarboEuroflux, MefyQue, CARBOEUROPEIP, FutMon, PON I-AMICA. Currently, activities are carried on within national CONECOFOR and I-AMICA projects and european projects FP7 GHG-Europe, LIFE+ EnvEurope, ManFor C.BD. and CARBOSOIL. IBAF is managing two eddy covariance sites from three included in the current proposal. Apart of flux monitoring activity team of Dr. Calfapietra and his IBAF colleagues are worldwide recognized for the research activity in the field of VOCs emissions, atmosphere-plant-soil interactions, physiological adaptations of plants to environmental stresses by means of gas exchange and isotopic techniques.

Unit 2. Università degli Studi della Tuscia (UNITUS). Scientific coordinator Dr. Tommaso Chiti.
UNITUS and particularly Laboratory of Forest Ecology is a confirmed European leader in gas exchange ecosystem measurements. It carried out flux monitoring and research activities all over

the word: from Africa, to Siberia, Amazonia and Europe. UNITUS participated in numerous national and international projects (EUROFLUX, CARBOITALY, CARBOEUROPE IP, GREENGRASS; NITROEUROPE, CARBOAFRICA, TCOS-SIBERIA, ICOS and others) often in a role of scientific coordinator. In the laboratory of Forest Ecology was given a start for the development of the open access software for eddy covariance data post-processing (currently known as EDDY PRO). UNITUS is in charge of the European Eddy Fluxes Database Cluster aiming in the improvement, standardization, integration and collaboration between databases that make a part of European research projects. UNITUS was in charge of one of the long-term observation sites involved in the proposed project (Brocon, from 2002 to 2010). Group of Dr. Tommaso Chiti in collaboration with his colleagues from Terrasystem s.r.l. (spin-off of the University of Tuscia) have maturated a significant experience in on site cuvette and eddy covariance CH_4 measurements in different ecosystems, from temperate grasslands to temperate and tropical forests. Group of Dr. Chiti is also one of the leaders in the determination of the heterotrophic CO_2 efflux from soil by the use of isotopic (radiocarbon) techniques.

Unit 3. Agenzia Regionale per la Protezione dell'Ambiente della Valle d'Aosta (ARPA). Scientific coordinator: Umberto Morra di Cella
ARPA Valle d'Aosta is in charge of two eddy covariance monitoring sites in the North Western Italian Alps. The older site is located on a grassland and is operating since 2008, whereas the second one is in a larch stand and is operating since 2009.
Apart from eddy covariance measurements, phenology is continuously monitored by optical sensors (NDVI and digital cameras). Both sites belong to various international networks (FLUXNET, PHENOCAM, PHENOCLIM and LTER) and have been recently included in the CEOS LPV Phenology Focus Group. ARPA Valle d'Aosta leaded two INTERREG EU Projects PHENOALP (finished) and e-PHENO (on-going) aiming at developing a phenological network in the Western Alps and standardized sensor-based observation protocols.

1. GENERAL INFORMATION

Abstract of the proposed project (max 1000 characters)

Mountain ecosystems represent important places to preserve for both biodiversity richness and carbon sequestration capacity. In this project we investigate the effect of climate variability both at inter-annual and intra-annual level on various paths of the C cycle in three different forest and grassland ecosystems located on Alps and Apennine. The study will be carried out using both eddy covariance technique and chamber technique and in some sites optical and remote measurements will be coupled with fluxes.
The effect of management will be also investigated at one site.
The project will provide important information on the functioning of mountain ecosystems and will provide insight into the carbon sequestration retention by different plant ecosystems in mountain areas. This information will be crucial also for modelling activity and will allow to understand possible management options under present and climate change future scenarios.

Main goals of the project (max 1000 characters)

The proposed project aims at bringing together CO2, H2O and CH4 (when and where appropriate) eddy fluxes from a number of long-term eddy covariance stations located in Alpine and Apennine forest and grassland ecosystems, as well as performing new research activities on some aspects of mountain ecosystem functioning under changing climate and anthropic pressure. This includes in particular:

- consolidation of an on-going network of mountain eddy covariance stations covering Alpine and Apennine forest and grassland ecosystems harmonization of the already available data

and definition of a common protocol for new flux measurements both in agreement with the existing international accepted protocols (e.g. ICOS) and to the NextData requirements.

- creation of a database storing new and already available data following the NexData requirements, and in agreement with the international protocols already followed in some of these long term sites (e.g. Collelongo). This will allow to create a proper 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.
- performing of new measurements of ecosystem CO2, H2O and CH4 fluxes and auxiliary parameters
- evaluation of sensitivity of different parts of ecosystems C cycle to climate-change-driven extreme events like drought and to management regimes.
- definition of measurement and data-processing protocols for long-term monitoring of phenology and productivity based on optical measurements.

Expected results of the project (max 2000 characters)

- A network of long-term eddy covariance sites in mountain forest and grassland ecosystems fully operational, gathering and providing continuous series of harmonized CO2 and H2O flux data.
- Creation of proper subset of data from Alpine and Apennine sites to be archived within the NextData database. With respect to flux measurements, the standards will be developed according to the development of ICOS within which CNR is involved deeply in the Italian partnership. At present, flux measurements at the sites are made according to the current, accepted protocols and data are or have been (Brocon) submitted to centralized database (CarboEurope, FluxNet), using accepted formats. As there is not a standard for data formats related to fluxes in NextData, the formats currently used for flux data submission to European and international repositories will be checked for possible use also within NextData.
- Study of the inter- and intra-annual variability of ecosystem- and plot-level fluxes in relation to the main climatic drivers like temperature, precipitation, snow cover, length of the growing season. This will include investigation of the relationships between daily- seasonal- and interannual flux variability and potential climatic drivers, whereas processes behind certain ecosystem response to changing climate will be evaluated through data analysis and with ecophysiological approaches like stable isotopes and fluorescence measurements.
- Experimental evidences of the effects of management on the ecosystem C cycling (CO2 uptake and emission) in grassland ecosystems using small-plot scale cuvette studies and radiocarbon measurements on soil to evaluate the differences in contribution of soil carbon decomposition (heterotrophic respiration) to total soil CO2 efflux.
- Estimation of ecosystem productivity using Light Use Efficiency (LUE) model and its comparison with eddy covariance derived Gross Primary Production data. These two estimations will be further used for developing an empirical model of ecosystem carbon uptake in mountainous ecosystems.
- Definition of measurement and data-processing protocols for optical monitoring of phenology and ecosystem productivity.
- Experimental assessment by means of isotopic analyses of the resilience level of beech to summer drought.
- Analysis of the capability of beech leaves to dissipate the excess energy and its variation with changing light regime along the vertical canopy profile and study of the mechanisms involved in the process.

Role of the different units (max 2000 characters)

UNIT 1. IBAF. Project coordinator. IBAF is in charge of Brocon (from 2012) and Collelongo (from 2004, flux data series starting in 1993) eddy covariance sites: IBAF will reactivate full time CO2 and H2O exchange monitoring in Brocon in 2014. Data collection, post-processing and storage of fluxes from these two sites as well as auxiliary measurements (above and belowground primary production, phenology, climate data) and analyses (soil and leaf chemistry) will be under the IBAF responsibility. IBAF will be also in charge of point measurements of respiration fluxes in Brocon and Collelongo sites and will perform a research on the resilience of beech to changing climate by means of isotopic and gas exchange techniques in Collelongo.

UNIT 2. UNITUS. UNITUS will be in charge of radiocarbon measurements on soil in both grassland sites for the evaluation of heterotrophic respiration contribution. UNITUS, having a great expertise in the field, will assist IBAF and ARPA in eddy covariance data post-processing and gap filling. UNITUS with a scientific and technical support of Terrasystem s.r.l. (University spin-off) will conduct eddy covariance measurements of CH4 in the Brocon site.

UNIT 3. ARPA. ARPA is in charge of Torgnon eddy covariance site. Data collection, post-processing and storage of fluxes as well as auxiliary measurements and chemistry analyses from this site will be under the ARPA's responsibility. ARPA unit, having a great expertise in the field, will be also in charge of preparation and diffusion of measurement protocols on long-term phenology and productivity monitoring with optical techniques and will conduct these studies in the selected sites (Torgnon and Collelongo).

2. DETAILED PROJECT DESCRIPTION

State of the art and motivations (max 5000 characters)

Global warming is tremendously influencing the climate of mountain areas through constantly rising temperatures and changes in local hydrological cycle. The last will probably include an increase of precipitation extremes, shifts of the rain events from summer to winter, increasing consequently the probability of seasonal drought and flooding events (Kunstmann et al. 2004; Forkel and Knoche 2006). So far, consequences of such tremendous changes for fragile mountain ecosystems and local economy are only partially investigated. Therefore it is of great importance to maintain and strengthen the monitoring of crucial C-and water cycle related parameters from typical mountainous ecosystems, as well as to introduce new experiments for better understanding the mountain ecosystem's functioning.

In this framework, the creation of a proper subset of eddy covariance sites, specific for Alpine and Apennine areas and following the same international standard protocol (e.g.ICOS), will facilitate the exchange of information among sites in similar areas. As a consequence this will increase the understanding of the dynamics affecting these areas. At the same time, specific experiments will possibly indicate new variables to monitor for detecting the changes these areas are experiencing.

Mountain forests. Case study of Collelongo site:

Beech is the most abundant tree species in the central Europe under moderate dry and moist conditions and in the mountain regions of the south Europe (Ellenberg 1996). It is therefore frequently considered in the local forest management strategies (Gessler et al., 2007). The response of the beech-dominating ecosystems to the changing climate is however uncertain. A positive effect of the increased CO_2 concentrations on the beech productivity may probably be counterbalanced by drought and flooding events which substantially influence beech nutrient uptake capacity, water balance, growth and consequently its competitive capability compared to more tolerant species. As a consequence, a future reduction of the area of distribution of beech forests and its replacement by

other species is probable. On the other hand, beech from south region provenances could be relatively more drought-adapted in respect to beech grown in other European regions and could be potentially considered in the forestry polices for eventual beech regeneration for northern areas. Given these, there is a strong need in a combined ecological and physiological research on the beech growth and functioning under changing climate as well as long-term ecosystem monitoring under natural beech growing conditions. Collelongo site is located in a beech forest (*Fagus sylvatica*) in the Apennines at 1500-1700 m height. It was the first flux tower established in Europe (in 1993) and, since then, has been collecting almost continuously flux data, coupled with auxiliary parameters and functional studies. Such a long-term and complete data set of Collelongo could be of a great importance for models parameterization, for the research community operating in different sectors like forestry, ecosystem functioning, biodiversity as well as for forestry policy makers and local communities. The site may serve as a base for further research in the field of beech eco-physiology.

Mountain grasslands. Case study of Brocon and Torgnon sites:

Some models predict that increasing CO_2, temperature and precipitation in the alpine area will significant increase the productivity of the managed grasslands in Alps (Riedo et al., 1997). However any effect of the climate change on vegetation functioning may be accelerated or counterbalanced by the management type of the respective areas. With global warming, it is very likely that human pressure will substantially increase on the upper subalpine and alpine zone leading to an increase of agricultural and pastoral activities. Brocon site is a grazed grassland located at the 1700 m height in the alpine chain (Trento Province). The site was established in 2002 by the University of Tuscia and CNR IBIMET within the framework of the EU founded project GREENGRASS. Besides, the site was involved in a series of national and European funded projects (CARBOEUROPE IP and CarboItaly).However, in the last six years gas exchange measurements at the Brocon site were discontinued. IBAF CNR, considering the importance of long-term surveys in vulnerable mountain ecosystems, has re-activated the research in Brocon in 2012 in the frame of CARBOSOIL project (2011-2014). The research focuses on plant-soil interactions and it is planned to introduce a study of the effects of grazing regime on different steps of the C cycle on a small-plot scale. In such managed ecosystem, a considerable input of C into the atmosphere is due to methane emissions by ruminants. Therefore methane measurements will be introduced to Brocon, and together with the heterotrophic respiration determined using radiocarbon, will be used to close the C balance of the system. Continuous measurements of CO2 and H2O fluxes with eddy covariance were only partially activated during 2013 due to technical problems with the instrumentation and damages by thunderstorms and will be re-activated completely in 2014.

The Torgnon–Tellinod site is an abandoned grassland at 2100 m asl in the Western Italian Alps. Eddy Flux measurements are collected here since 2008. Since 2009, field campaigns of continuous soil respiration measurements are conducted with automatically-operated soil flux chambers. Image-based phenology and NDVI data are available since 2009. At this study site, the relationship between phenology and environmental drivers is studied, with particular attention to the relationship between the timing and duration of the snow-covered season and plant phenology and productivity.

The sites are (Torgnon, Collelongo) or have been (Brocon) part on national (CarboItaly), international (CarboEurope, GHG-Europe) projects and initiatives (FluxNet). Two of the sites (Torgnon, Collelongo) are candidate ICOS sites (at different level, the italian ICOS sites have still to be selected).

Flux measurements at the sites are made according to the current, accepted protocols and data are (or have been) submitted to centralised database (CarboEurope, FluxNet), using accepted formats.

Advances that project will bring

1. **Network and database**. Adoption of a common protocol, considering the international standards (e.g. ICOS) for data collection and storage. This will facilitate the exchange of information and/or the possibility for other sites, using the same international protocol, to join the network. Creation of a harmonized database, specific for Alpine and Apennine ecosystems, both for fluxes and ancillary data to be stored in the Nexdata archive.
2. **Ecosystem functioning.** Beech resilience to extreme events like drought will be evaluated by means of isotopic indicators, gas exchange and fluorescence measurements. Climate change-management-ecosystem interactions will be studied in grassland ecosystems. Grassland phenology and productivity will be studied in the context of a changing climate, with particular attention to the relationship with the snow-cover duration.
3. **Methodology and protocols.** Protocols for image-based phenology and productivity and NDVI data collection and processing will be developed. Promising radiocarbon tool for the evaluation of heterotrophic contribution to the total flux respired from soil will be applied

Detailed description of the project, including the work plan, deliverables and milestones (explicitly indicating the activities of the different years) (max 8000 characters)

The project is subdivided into five work packages:
WP1. New CO2, H2O and CH4 gas exchange measurements on ecosystem level with eddy covariance technique.
Participants: IBAF (coordinator). ARPA, UNITUS
Sites: Brocon, Collelongo, Torgnon
Description:
During the first months of the project we will replace instrumentation damaged by a thunderstorm and needed for the eddy covariance system reactivation at the Brocon site. In the very beginning of the growing season 2014 continuous measurements of CO2 and H2O fluxes on the ecosystem scale will be completely reactivated there and will be performed regularly during the next project year. Alongside CO2 and H2O fluxes, CH4 eddy covariance measurements will be introduced to the Brocon site with the aim to complete the C budget of this grazed grassland.
CO2 and H2O gas exchange measurements in Collelongo and Torgnon sites will proceed regularly during 2014 and 2015. Institutes involved in this WP will be responsible for maintenance of the acquisition system, regular calibration of gas analyzers and data downloading and transfer.

WP2. Auxiliary measurements in the selected sites
Participants: IBAF, ARPA
Sites: Brocon, Collelongo, Torgnon
Description:
Climate data acquisition: A common set of auxiliary climatic parameters provided by each site to NextData database will be established. Between 2014 and 2015 it is planned to add, where missing, and renew, where obsolete, some sensors of the climatic stations involved in the project.
Biotic data in grasslands: Seasonal sampling of aboveground and belowground biomass in grassland sites, needed for estimation of above- and belowground net primary production, will be performed during 2014 and 2015 growing seasons. Leaf area index and litter decomposition with litterbags will be estimated seasonally. Chemistry analyses of the soil liquid phase will be performed only in Torgnon site.

In the forest site the following biotic data will be regularly collected during 2014 and 2015 growing seasons: soil chemistry of the liquid phase with biweekly-monthly frequency; phenology with weekly frequency; leaf area index will be measured on the annual and seasonal basis; stem growth will be measured seasonally, leaf litter production and decomposition will be estimated seasonally, wet deposition and ozone concentrations will be measured with a weekly frequency. Aboveground and belowground net primary production will be estimated with annual frequency.
The auxiliary data will accompany flux measurements (WP1) and all together will be prepared for the submission to NextData archives no later than 1 year after the start of the data acquisition (WP3).

WP3. Quality control, post-processing and storage of data of new acquisition and already available data in the NextData archives. .
Participants: IBAF (coordinator), UNITUS; ARPA
Sites: Brocon, Collelongo, Torgnon
Description:
Harmonization of the acquisition and data processing protocols between sites according to international standards both for fluxes and for auxiliary data (e.g. ICOS). Storage of the data in the Nexdata archive to create a new database of eddy covariance sites, from Alpine and Apennine areas, already included in other general Networks and databases (e.g Fluxnet, CarboEurope, ICOS, European Flux Database). Fluxes and auxiliary data will be submitted to Nextdata archives no later than 1 year after the data have been obtained.

WP4. Small-plot scale measurements of respiration and assimilation fluxes.
Participants: IBAF, (coordinating), UNITUS, ARPA
Sites: Brocon, Collelongo, Torgnon
Description:
Brocon site: Four small fence areas (3x3 m), which prevent the enclosed plots from grazing, will be installed in Brocon before June 2014, a month when cows are generally conveyed from the valleys to the pastures. One big fence, 10x10 m, which encloses the eddy station was already installed in Brocon in 2002 and corresponds therefore to 12 years of grazing exclusion.
A series of point measurements of soil respiration with portable infrared gas analyzer will be performed inside and outside fenced areas. Measurements will be performed seasonally with intensification of the measurement frequency during the peak of the growing season (June-July) Such experimental design will allow to evaluate the effect of grazing and its progressive exclusion (12 years and 1 year in 2014) on principal components of the C cycle in mountainous ecosystems as well as to give an estimate of the contribution of single components (soil respiration, ecosystem respiration, methane emissions, gross and net primary production - WP1 and WP2) to the total flux acquired with eddy covariance. During 2015 growing season we plan to proceed with point measurements of soil respiration inside and outside fences (13 and 2 years of grazing exclusion) with the same frequency.
Yearly soil sampling in both grassland sites will be conducted for determination of the heterotrophic component (Rh) of soil CO_2 efflux by means of radiocarbon (^{14}C) technique. The sampling will involve only the top 30 cm of soil, representing the soil portion active in exchanging gas with the atmosphere. Following the relation NEE = NPP-Rh, an assessment of the CO_2 heterotrophically respired annually will be done comparing the obtained Rh data with the Net Ecosystem Exchange and the above and below ground NPP determined during this project. Radiocarbon measurements will also allow to determine the mean residence time of the C in soil. Soil will be sampled in 12 years grazing exclusion and in currently grazed plots.
Torgnon site: The site benefits from automated system for soil respiration measurements with soil chambers. These measurements will be continued during the 2014 and 2015 growing seasons. Plots

for determining soil heterotrophic respiration by means of radiocarbon will be also established at this site.

Collelongo site: During the first project year it is planned to introduce seasonal measurements of CO_2 efflux from stems, roots and soil and characterization of its isotopic composition (δ13C). In parallel, sampling of leaves from different heights and from bark at a breast height with further extraction of the water soluble sugars for isotopic analyses will be performed. Isotopic composition of assimilated and respired material will serve as an indicator of the grade of plant physiological response to summer drought and its recovery thereafter as well as for understanding of the internal mechanisms of the organic matter transport, delivery and metabolisation. Photosynthesis and fluorescence measurements at a leaf level will be performed on leaves sampled alongside the canopy profile seasonally. Fluorescence data will help to discover the capability of plants to dissipate the excesses of the energy through the electron transport rate and through non radiative energy dissipation mechanism. Measurements will be carried out also during the year 2015 in order to evaluate annual and inter-annual variability.

WP5. Long-term monitoring of phenology with digital camera imagery and ecosystem productivity with optical parameters. Creation and distribution of measurement and data elaboration protocols.
Participants: ARPA (coordinator), IBAF
Sites: Collelongo, Torgnon
Description:

Torgnon: NDVI data and digital images will be acquired year-round during the whole project. Appropriate protocols/strategies will be defined and made available for establishing the measurements set-up and building the proper infrastructure for data archiving. Particular attention will be devoted to data processing with the development of tools for data filtering and for the extraction of phenological phases from the seasonal trajectories of indexes. All tools will be developed in an open source environment (R software for statistical computing).

Collelongo: In the very beginning of 2014 a number of optical sensors will be purchased and measurements will be conducted in the site during the 2014 and 2015 growing seasons. In particularly, optical measurements will be carried out using spectroradiometer at leaf level as well as NDVI sensors installed on the eddy flux tower and PAR sensors installed both above and below canopy. Optical measurements will be utilized in a LUE model as an alternative method to account for the productivity of the ecosystem.

One of the major advantages of this model is that it can be directly linked to remote sensing. The connection is based on the photosynthetically active radiation absorbed by vegetation (APAR) term, which can be calculated as the product between PAR and the fraction of the PAR absorbed by the green portions of the plant (fAPAR) (Gamon and Qiu, 1999). Several studies have been shown the positive correlation between the normalized difference vegetation index (NDVI) and green fAPAR (Myneni and Williams, 1994).

The results of the LUE model estimation will be compared with the eddy covariance derived GPP.

For grassland sites:

Deliverables:

- A complete fully operating eddy covariance stations Brocon and Torgnon. By September 2014
- Experimental set-up for long-term study of the effects of grazing on C and N cycling in alpine grasslands. By September 2014
- Protocols for measurements and data-processing of image-based productivity and NDVI. By December 2014
- Gas exchange data base. First data submitted no later than April 2015.
- Partitioning of the ecosystem C budget into respiration (soil CO2 respiration and heterotrophic contribution, CH4 efflux) and assimilation (gross and net primary production) components. First data submitted to database no later than April 2015.

- Scientific reports by 31 July and 20 December 2014 and by 31 July 2015 as well as final report at the end of the project.

Milestones:

- Purchasing of the new equipment February-March 2014 and January-February 2015.
- Re-activation of the flux measurements at Brocon site May-June 2014
- Fences installation at Brocon site June 2014
- First year field measurement campaign completed October 2014
- First year flux data processing and storage completed April 2015

Second year measurements campaign completed September 2015. According to NextData requirements, the data will be submitted to the database after a period of validation no later than 1 year after its acquisition

Deliverables forest site:

- Gas exchange data base. First data submitted no later than April 2015.
- Measurements and data-processing of image-based productivity and NDVI. LUE model productivity estimation. Report by the end of the second project year.
- Indications of the resilience of beech to changing climate by means of isotopic indicators and leaf gas exchange and fluorescence measurements. Results in the annual reports.
- Scientific reports by 31 July and 20 December 2014 and by 31 July 2015 as well as final report at the end of the project.

Milestones:

- Purchasing of the new equipment February-March 2014 January-February 2015.
- Start of the point flux, isotopic and optical measurements May-June 2014
- First year field measurement campaign completed October 2014
- First year flux data processing and storage completed April 2015
- Second year measurements campaign completed September 2015. According to NextData requirements, the data will be submitted to the database after a period of validation no later than 1 year after its acquisition

Literature:

Ellenberg H (1996) Vegetation Mitteleuropas mit den Alpen, 5th edn. Ulmer, Stuttgart, Germany, p 1095.

Kunstmann H, Schneider K, Forkel R, Knoche R (2004) Impact analysis of climate change for an Alpine catchment using high resolution dynamic downscaling of ECHAM4 time slices. Hydrol Earth Syst Sci 8:1030–1044.

Forkel R., Knoche R. (2006) Regional climate change and its impact on photooxidant concentrations in southern Germany: simulations with a coupled regional climate–chemistry model. J Geophys Res 111:D12302.

Geßler A., Keitel C., Kreuzwieser J., Matyssek R., Seiler W., Rennenberg H. (2007). Potential risks for European beech (*Fagus sylvatica* L.) in a changing climate. Trees 21:1–11.

Riedo M., Grub A., Rosset M., Fuhrer J. (1997) A Pasture Simulation Model for Dry Matter Production, and Fluxes of Carbon, Nitrogen, Water and Energy. Ecol. Model. 105: 141–183.

Monteith J.L. (1972) Solar radiation and productivity in tropical ecosystems. J App Ecol, 747-766.

Gamon J.A. and Qiu H.L. (1999). Ecological applications of remote sensing at multiple scales. Handbook of functional plant ecology, New York .

Myneni R.B and Williams D.L. (1994) On the relationship between FAPAR and NDVI. Remote sensing of Environment, 49, 200-2011.

Motivations for the required budget and budget on a unit and year-by-year basis (max 5000 characters)

	first year	second year
Unit 1 (coordinator) IBAF	**104000**	**70000**
Unit 2 UNITUS	**8000**	**5000**
Unit 3 ARPA	**8000**	**5000**

IBAF

A great amount of work between field campaigns and data elaboration determine a substantial person-power need, therefore a considerable part of budget will be destinated to hire and train a post doctoral fellow. The second substantial item of the budget will be devoted to the acquisition of the scientific equipment needed for renew/maintenance of the instrumentation installed in the selected sites so to guarantee a high quality of the obtained data and harmonization of the measurement protocols between sites. Sensors of the climate stations will be gradually changed during the first and the second project year. Travel expenses is another important voice of the budget. Numerous field campaigns to remote Apennine and alpine sites are planned between 2014 and 2015 project years. Consumables have been introduced in the budget of 2015 to cover the costs of the laboratory analyses on the collected plant, soil and gas material during the first and second project year.

2014:
Permanent Personnel Cost 48000 €
Newly hired Personnel cost 26100 €
Travel expenses 4000 €
Instrumentation: 5100 €
Overheads 20800 € (20%)
2015:
Permanent Personnel Cost 32000 €
Newly hired Personnel cost 5000 €
Travel expenses 4000 €
Instrumentation 10000 €
Other costs (consumables): 5000 €
Overheads 14000€ (20%)

UNITUS

The proposed budget is destined to cover the expenses of the soil sampling campaigns in both grassland ecosystems (travel expenses) and costs of radiocarbon analysis of the collected soil samples in an external laboratory (third part services). The budget will also cover expenses for the field campaigns which aim in measurements of methane emissions in a grazed grassland where CH4 could be a substantial source of C into the atmosphere. Technical and scientific assistance of the colleagues from Terrasystem s.r.l., which will provide the instrumentation needed for CH4 eddy covariance measurements and support in its installation and data processing, is included in the voice "scientific consulting".

2014: Travel expenses 1400 €
Third part services 3000 €
Scientific consulting 2000 €
Overheads 1600 € (20%)
2015: Travel expenses 1000 €
Third part services 2000 €
Scientific consulting 1000 €
Overheads 1000 € (20%)

ARPA

A total of 7000 EURO for the 2 years are allocated to acquisition/maintenance of sensors and instruments.A total 3400 EURO are allocated to cover travel expenses for meetings and workshops as well as to field campaigns to Torgnon site.
Overheads at a fixed 20% rate total to 2600 EURO.
2014: Travel expenses 1400 €
Instrumentation 5000 €
Overheads 1600 € (20%)
2015: Travel expenses 2000 €
Instrumentation 2000 €
Overheads 1000 € (20%)

Please attach the curricula and the list of relevant publications of the project coordinator and of the responsible of each participating unit, and the summary budget table in attachment.

UNIT 1. IBAF CNR. Project Coordinator - Carlo Calfapietra

PERSONAL INFORMATION

Born in Viterbo 07/03/1973

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Website: www.carlocalfapietra.com

Nationality: Italian

KEY QUALIFICATIONS

Plant ecophysiology and molecular biology in relation to global change, air pollution, VOC, ozone, forestry plantations, forest fires, urban forestry, extreme environments

EDUCATION

1999-2002

Doctoral Degree in Forest Ecology obtained on 14 February 2002 at Università di Padova, Italy

1991-1998

University degree in Forestry obtained on 23 April 1998 at Università degli Studi della Tuscia, Viterbo, Italy. Evaluation score 110/110 cum laude.

1986-1993

Musical degree in Flute obtained on 01 October 1993 at the State Music Conservatorium of Perugia, Italy

1986-1991

Bachelor Degree "Maturità Scientifica", Liceo Scientifico P. Ruffini Viterbo, Italy.

WORK EXPERIENCE

Jul 1st 2007 – to date, Institute of Agro-Environmental and Forest Biology (IBAF), National

Research Council (CNR), Porano (TR), Rome

Oct 1st 2005 – Mar 31st 2007, University of Wisconsin, Department of Botany, Madison USA (Oct 1st 2005 – Sep 30th 2006); University of Tuscia, Department of Forest Environment and Resources, Viterbo, Italy (Oct 1st 2006 – Mar 31st 2007). Employed as temporary researcher to carry out the MARIE CURIE individual project GLOBALVOC

May 1st 2003 - Sep 30th 2005, University of Tuscia, Department of Forest Environment and Resources, Viterbo, Italy. Employed as Scientific Secretary of the EUROFACE project

April 28th 1999 – April 30th 2003, University of Tuscia, Department of Forest Environment and Resources, Viterbo, Italy. Employed for studying the effect of CO2 enrichment on forest ecosystems

June 15th 1998 – December 15th 1998, University of Tuscia, Department of Forest Environment and Resources, Viterbo, Italy. Employed for ozone monitoring using biomonitoring

RECENT SCIENTIFIC ACTIVITIES

- Researcher in FP6-FP7 projects "ECOCRAFT", "ECOVOC", "POPFACE", "MEFYQUE", "PTR-TOF",
- Scientific Secretary of the FP6-EUROFACE (2003-2006)
- PI of the Marie Curie project GLOBALVOC (2005-2007)
- Steering Committee member and PI of the FP7-CAREX (http://www.carex-eu.org/) (2008-2011)
- Italian delegate for the Cost Action FP0701 "Post-Fire Forest Management in Southern Europe" (2008-2012)
- PI in FP7-Hereplus (2008-2011), and in the Bilateral projects CSIC-CNR "Carlos" (2011-2012) and and AVCR-CNR "BVOC-O3 interactions" (2013-2016)
- Member of the Excellence centre for studies on climate change EU-CZECHGLOBE (2010-2013) (http://www.czechglobe.cz/en.html)
- Responsible of 1 of the 4 WPs in the infrastructural project PON-I-AMICA (2012-2014)
- Responsible of UO IBAF for the project RITMARE (2012-2016)
- Chair of the COST Action FP1204 "Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests" (2013-2017)
- Coordinator of the CZ-COST project "Assessing interactions between Volatile Organic Compounds (VOC) and ozone in forests under extreme climatic events" (2013-2017)
- Coordinator of the Commessa CNR TA.P02.002 Cambiamento globale e vegetazione terrestre Scambi atmosfera-biosfera (2013-…)
- WG responsabile of the Smart-Cities project SWaRM - Smart Water Resource Management (2014-1016)
- Responsible of UO IBAF for the PRIN project "Modelli innovativi di analisi dei servizi ecosistemici nell'ambito di formazioni boschive urbane e periurbane (NEUFOR)" (2014-2016)
- Member of the scientific committee "Life, Environmental and Geosciences" of SCIENCE EUROPE
- Member of the Editorial Board of the international journals: "Journal of Environmental Quality", "TheScientificWorldJournal", "Journal of Plants", "The Open Forest Science Journal"
- Referee for "Plant Physiology", "New Phytologist", "Global Change Biology", "Plos One", "Plant Cell & Environment", Environmental Pollution", "Oecologia", "Tree Physiology", "Functional Plant Biology" and other journals

- Member of the evaluation committee for the French Programme ANR "The 6th Extinction" (2009)
- Evaluator of projects and/or institues in USA, France, Italy, Belgium, Czech Rep., Romania, Estonia.
- Opponent for phD thesis at University of Eastern Finland, University of Tartu, Danmarks Tekniske Universitet, during 2012-2013
- Assistant in the courses "Ecophysiology of Trees" and "Global change in forest ecosystems" at University of Tuscia, Viterbo (2001-2006)
- Supervisor of thesis laboratory for Agriculture and Forestry at the joint Degree "Planning and managememnt of the Environment" in Bracciano (Rome) in collaboration between University "La Sapienza" Rome and University of Tuscia, Viterbo (2007-2009)
- Lecturer in Urban Forestry at the International Graduate Degree "Environmental Science for Large Urban Areas" in collaboration between University of Tuscia, Viterbo and PACE University, New York (2008-2010)
- Organizer of the international summer school "Studying life in extreme environments", 13 teachers, 40 students (2010)
- Professor at the Master for Inspectors of Italian "Corpo Forestale dello Stato" (2011-2012)
- Invited seminars in a number of Universities across Europe and USA
- Supervisor of 18 master and phD students (2001-now)
- Key-note speaker at UEP 2012 Amsterdam and UEP 2013 Beijing
- Invited Speaker in a number of International Conferences

MOST RELEVANT PUBLICATIONS OF THE LAST YEARS

55 ISI papers, H index: 28, mean IF 4.4, Total Citations: 2100, from Google Scholar

NORBY RJ, DELUCIA EH, GIELEN B, **CALFAPIETRA C**, GIARDINA CP, KING JS, LEDFORD J, McCARTHY HR, MOORE DJP, CEULEMANS R, DE ANGELIS P, FINZI AC, KARNOSKY DF, KUBISKE ME, LUKAC M, PREGITZER KS, SCARASCIA-MUGNOZZA GE, OREN RE, SCHLESINGER WH. 2005. Forest Response to Elevated CO2 is Conserved Across a Broad Range of Productivity. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 102: 18052-18056.

CALFAPIETRA C, WIBERLEY AE, FALBEL TG, LINSKEY AR, SCARASCIA MUGNOZZA G, KARNOSKY DF, LORETO F, SHARKEY TD. 2007. Isoprene synthase expression and protein levels are reduced under elevated O3 but not under elevated CO2 (FACE) in field-grown aspen trees. Plant Cell & Environment 30: 654-661.

LORETO F, CENTRITTO M, BARTA C, **CALFAPIETRA C**, FARES S, MONSON R. 2007. The relationship between isoprene emission rate and dark respiration rate in white poplar (Populus alba L.) leaves. Plant Cell & Environment 30: 662-669.

CALFAPIETRA C, DE ANGELIS P, GIELEN B, LUKAC M, MOSCATELLI MC, AVINO G, LAGOMARSINO A, POLLE A, CEULEMANS R, SCARASCIA MUGNOZZA G, HOOSBEEK M, COTRUFO MF. 2007. Nitrogen Use efficiency of a short-rotation poplar plantation is increased under elevated CO2. Tree Physiology 27: 1153-1163.

FINZI AC, NORBY RJ, **CALFAPIETRA C**, GALLET-BUDYNEK A, GIELEN B, HOLMES WE, HOOSBEEK MR, IVERSEN CM, JACKSON RB, KUBISKE ME, LEDFORD J, LIBERLOO M, OREN R, POLLE A, PRITCHARD S, ZAK DR, SCHLESINGER WH, CEULEMANS R. 2007. Increases in nitrogen uptake rather than nitrogen-use efficiency support higher rates of temperate forest productivity under elevated CO2. PNAS: 104: 14014-14019.

CALFAPIETRA C, SCARASCIA-MUGNOZZA G, KARNOSKY DF, LORETO F, SHARKEY TD. 2008. Isoprene emission rates under elevated CO2 and O3 in two field-grown aspen clones differing for their sensitivity to O3. New Phytologist, 179: 55-61.

CALFAPIETRA C, FARES S, LORETO F. 2009. Volatile organic compounds from Italian vegetation and their interaction with ozone. Environmental Pollution, 157: 1478-1486.

CALFAPIETRA C, AINSWORTH EA, BEIER C, DE ANGELIS P, ELLSWORTH DS, GODBOLD DL, HENDREY GR, HICKLER T, HOOSBEEK M, KARNOSKY DF, KING J, KÖRNER C, LEAKEY ADB, LEWIN KF, LIBERLOO M, LONG SP, LUKAC M, MATYSSEK R, MIGLIETTA F, NAGY J, NORBY RJ, OREN R, PERCY KE, ROGERS A, SCARASCIA MUGNOZZA GE, STITT M, TAYLOR G, CEULEMANS R. 2010. New challenges and priorities in the next generation of elevated CO2 experiments on forest ecosystems and plantations. Trends in Plant Science, 15: 5-10.

BRUGNOLI E, **CALFAPIETRA C** 2010. Carbonyl sulfide: a new tool for understanding the response of the land biosphere to climate change. New Phytologist 186: 783-785.

LIBERLOO M, LUYSSAERT S, BELLASSEN V, NJAKOU DJOMO S, LUKAC M, **CALFAPIETRA C**, JANSSENS IA, HOOSBEEK MR, VIOVY N, GALINA CHURKINA G, SCARASCIA-MUGNOZZA G, CEULEMANS R 2010. Bio-Energy Retains Its Mitigation Potential Under Elevated CO2. PLoS ONE 5(7): e11648. doi:10.1371/journal.pone.0011648

GUIDOLOTTI G, **CALFAPIETRA C**, LORETO F. 2011. The relationship between isoprene emission, CO2 assimilation and water use efficiency across a range of poplar genotypes. Physiologia Plantarum 142: 297–304

CALFAPIETRA C, BERNACCHI C, CENTRITTO M, SHARKEY TD. 2012. Photosynthetic responses to increased CO2 and air pollutants. In: Ecophysiology of photosynthesis in terrestrial higher plants. Cambridge University Press, pp. 257-271.

UNIT 2. UNITUS – Dr. Tommaso Chiti

PERSONAL INFORMATION

Born in Florence February 24th 1975
Address: Via Arma dei Carabinieri 17, 01100 Viterbo, Italy
Phone number:(+39) 0761 347791, (+39) 333 2048777
E-Mail address: **tommaso.chiti@unitus.it**
Nationality: Italian
Sex: male

KEY QUALIFICATIONS

Dr. Chiti is a PhD specialized in Soil Science with particular focus on soil carbon dynamics by the use of models, laboratory analysis and fieldwork.

EDUCATION

2013 Jan- Ongoing	Assistant professor at the University of Tuscia, Dept. for Innovation in Biological, Agro-food and Forest system (DIBAF)
2008 - 2012	Post-doc position at the University of Tuscia, Dept. for Innovation in Biological, Agro-food and Forest system (DIBAF) on "Analysis and modelling of C in forests and agricultural soils" and "SOC dynamics in primary forests" within the ERC project "Africa-GHG".

2007 Feb-Dec	Grant from the University of Florence on "Isotopic analysis and soil organic carbon fractionation in pools at different stability.
2004 Jan-2007 Jan	PhD course on "Soil Science and Climatology" at the University of Florence (Italy), Faculty of Forestry Science. Supervisors: Prof Ugolini F and Dr. PhD Certini G. Thesis: "Soil organic matter characterization in Alpine forests, grasslands and Mediterranean forests of Italy by the use of ^{13}C NMR and isotopes analysis".
2003 September	Graduated in Soil Science. Faculty of Forestry Science, University of Florence, Italy Grade 105/110. Supervisor: Prof. Sanesi G. Thesis: " Characterization of soil organic matter in afforestation on spoil banks".
2000 Jan.-Jun.	Helsinki, Finland. Erasmus-Socrates program at the University of Helsinki. Faculty of Forestry Science.
1995 June	High school diploma from "Istituto Tecnico per Geometri A. Gramsci", Prato.

FIELD EXPERIENCES

2008 March-on going	Soil sampling responsible within the CARBOAFRICA and ERC (Africa-GHG) projects for the sites located in Ghana, Cameroun, Congo and Gabon.
2006-2010	Soil expert within the framework of the COST action 639 "Greenhouse gas budget of soils under changing climate and land use"; working group 3: monitoring, statistics, simulation models.

OTHER EXPERIENCES

2011-ongoing	Consultant for the TÜV-SUD company for the assessment of soil carbon methodologies within the framework of the Verified Carbon Standard (VCS).
2007 March	Groningen, The Netherlands. Grant from the European Science Foundation (ESF) on "Contribution of the most recalcitrant part of the soil organic matter to total soil respiration". Centrum voor IsotopenOnderzoek (CIO) of the University of Groningen, Supervisor: Neubert R.E.M.
2006 Sept	Obergurgl, Austria. "Summer-school on "Experimental assessment of changes in soil organic matter pools in mountain forests", organized by the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Wien.
2006 March	Groningen, The Netherlands. Grant from the European Science Foundation (ESF) on "Carbon sequestration, isotopic characterization and soil flux partition in different soils under the footprint of a coastal CO_2-eddy-flux tower. Centrum voor IsotopenOnderzoek (CIO) of the University of Groningen. Supervisor: Neubert R.E.M.
2005 Sep-Oct.	Jena, Germany. Grant from the European Science Foundation (ESF) on "Carbon budget and CO_2 efflux from the soil". Max Planck Institute for Biogeochemistry. Supervisor: Schulze E.D.
2005 June-July	Groningen, Netherlands. Exchange student at the Centrum for

	IsotopenOnderzoek (CIO) of the University of Groningen, within a collaboration project on Isotopes characterisation of the Netherlands soils. Supervisor: Neubert R.E.M.
2004 Sept	Trento, Italy. "Summer-school on integrated methodology on soil carbon flux measurements", organized by the European Science Foundation (ESF).
2004 July	Milan, Italy. Course of "Rocks macroscopic recognition", organized by the University of Bicocca, Department of Environmental Sciences and Land Resources.
2003 Jul-Aug	Florence, Italy. Apprenticeship at the "Istituto Agronomico per l'Oltremare" (IAO), on supporting activities on data entries.

LANGUAGES

Italian	Mother tongue
English	Very good standard of written and spoken English
Spanish	Basic knowledge of written and spoken Spanish

SKILLS

Laboratory experience	Routine analyses for soil characterisation, extraction and fractionation of soil organic matter, selective dissolutions, atomic adsorption spectrophotometers, NMR spectroscopy, gas-chromatography for soil respiration measurements, isotopic analysis.
PC	Knowledge of the most widely used programs of writing, data elaboration and graphic of Windows and Macintosh systems. Use of the principal model to investigate the soil carbon dynamics: Century, RothC.

PUBLICATIONS

Chiti T, Grieco E, Perugini L, Rey A, Valentini R (2013) Effect of the replacement of tropical forests with tree plantations on soil organic carbon levels in the Jomoro district, Ghana. Plant and Soil, DOI: 10.1007/s11104-013-1928-1

Collalti A, Perugini L, Santini M, **Chiti T**, Nolè A, Matteucci G, Valentini R (2013) A process-based model to simulate growth in forests with complex structure: evaluation and use of 3D-CMCC Forest Ecosystem Model in a deciduous forest in Central Italy. Ecological Modelling, DOI:10.1016/j.ecolmodel.2013.09.016

Castaldi S, Bertolini T, Valente A, **Chiti T**, Valentini R (2013) Nitrous oxide emissions from a soil of an African rain forest in Ghana. Biogeosciences, 10: 4179-4187

Chiti T, Diaz-Pinez E, Rubio A (2012) Soil organic carbon stocks of conifers, broadleaf and evergreen broadleaf forests of Spain. Biology and Fertility of Soils. DOI 10.1007/s00374-012-0676-3

Chiti T, Gardin L, Perugini L, Quaratino R, Vaccari FP, Miglietta F, Valentini R (2011). Soil organic carbon stock assessment for the different cropland land uses in Italy. Biology and Fertility of Soils. DOI 10.1007/s00374-011-0599-4

Chiti T, Neubert REM, Janssens IA, Curiel Yuste J, Sirignano C, Certini G (2011). Radiocarbon based assessment of soil organic matter contribution to soil respiration in a pine stand of the Campine region, Belgium. Plant and Soil, 344:273-282.

Chiti T, Certini G, Perugini L, Mastrolonardo G, Valentini R (2011). Soil carbon dynamics in a Mediterranean forest during the Kyoto Protocol commitment periods. Regional Environmental Changes, DOI 10.1007/s10113-010-0141-5

Weiner T, Mazeh S, Tamburini F, Frossard E, Bernasconi SM, **Chiti T**, Angert A (2011). A method for analyzing the $d^{18}O$ of resin-extractable soil inorganic phosphate. Rapid Communications in Mass Spectrometry, 25:624-628.

Chiti T, Papale D, Smith P, Dalmonech D, Matteucci G, Yeluripati J, Rodeghiero M, Valentini R (2010). Predicting changes in soil organic carbon in Mediterranean and Alpine forests during the Kyoto Protocol commitment periods using the CENTURY model. Soil Use and Management, 26:475-484.

Chiti T, Certini G, Grieco E, Valentini R (2010). The role of soil in storing carbon in tropical rainforests: the case of Ankasa park, Ghana. Plant and Soil, 331:453-461.

Dalmonech D, Lagomarsino A, Moscatelli MC, **Chiti T**, Valentini R (2010). Microbial performance under increasing nitrogen availability in a Mediterranean forest soils. Soil Biology and Biochemistry, 42:1596-1606.

Piovesan G, Alessandrini A, Baliva M, **Chiti T**, D'Andrea E, De Cinti B, Di Filippo A, Hermanin L, Lauteri M, Scarascia Mugnozza G, Schirone B, Ziaco E, Matteucci G (2010). Structural patterns, growth processes, carbon stocks in an Italian Network of old-growth beech forests. Italian Journal of Forest and Mountain Environments. 65:557-590.

Chiti T, Neubert REM, Janssens IA, Certini G, Curiel Yuste J, Sirignano C (2009). Radiocarbon dating reveals different past management of two adjacent forest soils in the Campine region, Belgium. Geoderma, 149:137-142.

Zenone T, Morelli G, Teobaldelli M, Fischanger F, Matteucci M, Sordini M, Armani A, Ferrè C, **Chiti T**, Seufert G (2008). Preliminary use of ground-penetrating radar and electrical resistivity tomography to study tree roots in pine forests and poplar plantations. Functional Plant Biology, 35:1047-1058.

Chiti T, Certini G, Puglisi A, Sanesi G, Capperucci A, Forte C (2007). Effects of associating a N-fixer species to monotypic oak plantations on the quantity and quality of organic matter in minesoils. Geoderma, 138: 162-169.

BOOK CHAPTERS

Rodeghiero M, Rubio A, Dìaz-Pinès, Romanya J, Jimenez SM, Levy GJ, Fernandez-Getino AP, Sebastia MT, Karyotis T, **Chiti T**, Sirca C, Martins A, Madeira M, Zhiyanski M, Gristina L and Lamantia T (2011). Soil carbon in Mediterranean ecosystems and related management problems. COST ACTION 639

UNIT 3 ARPA - Dr. Umberto Morra Di Cella

Coordinator of the Unit "Effects of Climate Change on the alpine environments" since 2004.

EDUCATION

University degree cum laude in forest sciences at the Turin University, 1995.

PROFESSIONAL ACTIVITY

- Investigation on the influence of climate change on the alpine environment.
- Studies on the relationship between climate and vegetation (phenology e exchanges of CO2 between plant ecosystems and the atmosphere).
- Research on the characteristics and evolution of the snow mantle.
- Management of the ARPA-Valle d'Aosta monitoring stations.
- Data processing and writing of environmental reports.

• Studies on glacial dynamics.
• Measurements of the permafrost over bare soil and rocks.
• Operational management of the research activities and of the cooperation with external institutions.

PROJECTS

Responsible for ARPA VdA for the projects:
2013 – present: Interreg IV ALCOTRA n. 227 "e-PHENO – reti fenologiche nelle Alpi" (ARPA VdA project leader). Budget: 243.000 Euro.
2008 – 2012: Interreg IV ALCOTRA n. 044 "PHENOALP – phénologie alpine" (ARPA VdA coordinator). Budget: 530.000 Euro.
2009 – 2010 - 2011: coordination of ARPA VdA activities within the LIFE07 ENV/D/000218 "FUTMON - Further Development and Implementation of an EU-level Forest Monitoring System" (ARPA VdA subcontractor). Budget: 20.000 Euro.
2009 – 2012: Interreg IV ALPINE SPACE "MANFRED - Management strategies to adapt Alpine Space forests to climate change risk" (ARPA VdA subcontractor). Budget: 75.000 Euro.
2007 – 2013: 7th Framework Programm "ACQWA - Assessing Climate Impacts on the Quantity and quality of Water" (ARPA VdA partner). Budget: 100.000 Euro.
2008 – present: Responsible for ARPA VdA of the LTER 19 "AMBIENTI D'ALTA QUOTA DELLE ALPI NORD-OCCIDENTALI" site, which belongs to the LTER International (Long Term Ecological Research) network.

TEACHING

Responsible for stages and training activities at ARPA – VdA, and support to PhD theses activities.

SELECTED RECENT PUBLICATIONS RELEVANT TO THE PROJECT

M. Galvagno, G. Wohlfahrt, E. Cremonese, M. Rossini, R. Colombo, G. Filippa, T. Julitta, G. Manca, C. Siniscalco, **U. Morra di Cella** and M. Migliavacca (2013). Phenology and carbon dioxide source/sink strength of a subalpine grassland in response to an exceptionally short snow season. Environmental Research Letters, 8, 025008, 2013.

M. Galvagno, M. Rossini, M. Migliavacca, E. Cremonese, R. Colombo, **U. Morra di Cella** (2013) Seasonal course of photosynthetic efficiency in Larix decidua Mill. in response to temperature and change in pigment composition during senescence. International Journal of Biometeorology, Online First Articles, 2012.

Rossini M., Cogliati S., Meroni M., Migliavacca M., Galvagno M., Busetto L., Cremonese E., Julitta T., Siniscalco C., **Morra di Cella U.** and Colombo R. (2012) Remote sensing-based estimation of gross primary production in a subalpine grassland. Biogeosciences Discussion: 9, 1711-1758.

Colombo R., Busetto L., Fava F., Di Mauro B., Migliavacca M., Cremonese E., Galvagno M., Rossini M., Meroni M., Cogliati S., Panigada C., Siniscalco C., **Morra di Cella U.** (2011). Phenological monitoring of grassland and larch in the Alps from Terra and Aqua MODIS images. Italian Journal of Remote Sensing, 43 (3), 83-96.

Meroni M., Barducci A., Cogliati S., Castagnoli F., Rossini M., Busetto L., Migliavacca M., Cremonese E., Galvagno M., Colombo R., **Morra di Cella U.** (2011) The HyperSpectral

Irradiometer HSI, a new instrument for long-term and unattended field spectroscopy measurements. Review of Scientific Instruments: 82, 1-9.

Migliavacca M., Galvagno M., Cremonese E., Rossini M., Cogliati S., Manca G., Diotri F., Busetto L., Colombo R., Fava F., Pari E., Siniscalco C., **Morra di Cella U.,** Richardson A.D. (2011) Using digital repeat photography and eddy covariance data to model grassland phenology and photosynthetic CO2 uptake. Agricultural and Forest Meteorology: 151, 1325–1337;

Meroni, M., A. Barducci, S. Cogliati, F. Castagnoli, M. Rossini, L. Busetto, M. Migliavacca, E. Cremonese, M. Galvagno, R. Colombo, and **U. Morra di Cella,** 2011. The HyperSpectral Irradiometer HSI, a new instrument for long-term and unattended field spectroscopy measurements. Rev. Sci. Instruments, 82, 1-9.

Busetto L., Colombo R., Migliavacca M ., Cremonese E., Meroni M., Galvagno M., Rossini M., Siniscalco C., **Morra di Cella U.**, Pari E. (2010) Remote sensing of larch phenological cycle and analysis of relationships with climate in the Alpine region. Global Change Biology: 16, 2504–2517;

Rossini M., Meroni M., Cogliati S., Panigada C., Migliavacca M., Barducci A., Castagnoli F., Cremonese E., Galvagno M., **Morra di Cella U.**, Gioli B., Miglietta F., Busetto,L., Seufert G., Cescatti A. and Colombo R. (2010). Gross ecosystem productivity estimation by means of ground-based hyperspectral and fluorescence measurements: methods and preliminary results. 4th International Workshop on remote sensing of vegetation fluorescence, Valencia, Spain, 15-17 November 2010;

Rossini R., Meroni M., Migliavacca M., Cogliati S., Busetto L., Cremonese E., Galvagno M., Gioli B., Magnani F., Miglietta F., **Morra di Cella U.,** Siniscalco C., Colombo R. (2010) Estimation of gross ecosystem production by hyperspectral measurements in terrestrial ecosystems. 3rd International Symposium on Recent Advances in Quantitative Remote Sensing: RAQRS'III. 27 September – 1 October 2010. Valencia, Spain;

Galvagno, M., M. Migliavacca, E. Cremonese, L. Busetto, S. Cogliati, R. Colombo, G. Manca, M. Meroni, **U. Morra di Cella,** and M. Rossini, (2010) Eddy covariance measurements of annual carbon dioxide exchange in two natural ecosystems of the northwestern Italian Alps. Geophys. Res. Abst., 12, EGU2010-9575, EGU General Assembly 2010.

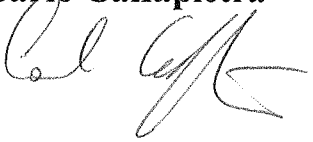
Colombo R., Busetto L., Migliavacca M., Cremonese E. , Meroni M., Galvagno M., Rossini M., Siniscalco C., **Morra di Cella** U. (2009). On the spatial and temporal variability of Larch phenological cycle in mountainous areas. Italian Journal of Remote Sensing: 41(2), 79-96;

Migliavacca M., Cremonese E., Colombo R., Busetto L., Galvagno M., Ganis L., Meroni M., Pari E., Rossini M., Siniscalco C., **Morra di Cella U.** (2008) European Larch phenology in the Alps: can we grasp the role of ecological factors by combining field observations and inverse modelling? International Journal of Biometeorology: 52 , 587-605;

Signatures:

Project coordinator:

Carlo Calfapietra



Director of the CNR Institute coordinating the proposal:

Angelo Massacci