PROPOSAL FOR AN INTEGRATED PROJECT

ASSESSMENT OF THE EUROPEAN TERRESTRIAL CARBON BALANCE

CARBOEUROPE-IP

Proposal full title	**Assessment of the European Terrestrial Carbon Balance**
Proposal acronym	**CarboEurope- IP**
Date of preparation	**01/07/2004**
Type of instrument	**Integrated Project**

List of participants

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1 Contents

2Proposal Summary

(1 page)

Proposal full title **Assessment of the European terrestrial carbon balance**

Proposal acronym **CarboEurope- IP**

Strategic objectives addressed

(If more than one objective, indicate their order of importance to the project)

Proposal abstract

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3B.1 Scientific and technological objectives of the project and state of the art

3.1B.1.1 Scientific and technological objectives

Basic questions addressed (General Objectives)

The overarching aim of the CarboEurope IP is to quantify the processes that drive the carbon balance at local, regional and continental scale in Europe and obtain accurate estimates of the sink strength of the European biosphere and their uncertainty ranges.

The project addresses the following basic questions:

- What is the carbon balance of the European continent, and how is it changing over time? What are the sources and sinks and the geographic patterns of carbon fluxes from local ecosystem to regional and continental scale?
- How do external parameters such as changing nitrogen deposition, climate change and variability and changing land management affect the European carbon balance and future projections of the carbon cycle? Do we do this?
- How can the effective CO_2 reduction in the atmosphere and the carbon sequestration in terrestrial ecosystems best be measured for verification of Kyoto commitments of Europe using a full carbon accounting approach? Clearer link to Kyoto Protocol: full carbon accounting, 2nd commitment period

These questions are also closely linked with major goals of the North American Carbon Program (NACP).

Shall we have a graph here about the major components?

Specific Objectives

- Develop and test a scientifically sound scheme that allows the measurement and verification of changes in soil and ecosystem C pools during a five-years Kyoto commitment period in a range of representative ecosystems.
- Quantify the soil and ecosystem carbon sinks and sources over a simulated Kyoto commitment period via fluxes and stock changes (full carbon accounting).
- Understand the fate of carbon entering the soil, at the scale of the ecosystem, and increase process understanding of carbon immobilization in soils.
- Improve and apply various ecosystem models to allow scaling from local ecosystems to the Eurogrid (50 km) and to understand driving forces of carbon fluxes such as changing nitrogen deposition, climate change and variability and changing land management.
- Determine the seasonal evolution of the regional carbon balance.
- Develop downscaling techniques to determine the variation in biospheric activity over such a region from larger scale (inverse) models.

- Merge top-down with bottom-up estimates of the carbon balance at the Eurogrid (50 km), regional (100-500 km) and continental (1000 km) scale.
- Develop of Carbon Data Assimilation Methods (CDAM) to enable a coherent temporal and spatial integration of CarboEurope-IP data and a projection of the future behaviour of the terrestrial biospheric sink.
- Provide the basic observational data and components of analysis of carbon and other greenhouse gas fluxes and stores and their driving processes in terms of climate, human management and regime of disturbances for the major compartments of the European terrestrial ecosystems.
- Determine the spatially explicit regional balance of CO_2 in an area (500*500 km) in South West France at a minimum resolution of 1-2 km.
- Obtain continental scale (100-500 km) flux estimates from atmospheric observations via
  1) Increasing the spatial coverage of the atmospheric network over undersampled regions,
  2) Assessment of the representativeness error via targeted campaigns and modeling studies
  3) High frequency vertical sampling through the Planetary Boundary Layer (PBL) and aloft using aircraft.
- Inform and consult stakeholders and policy makers about the European terrestrial carbon budget to support the implementation of the Kyoto Protocol and its future developments.

Harmonise terminology for local-regional-continental: resolution and total area

3.2 B.1.2 State-of-the art and enhancement by the proposed project

The global carbon balance is currently not in equilibrium. During the decade of the 1990s, the rate of increase in the atmosphere was 3.3 ± 0.2 Pg C yr^{-1}. The next best-known term in the global carbon balance is the rate of fossil fuel emissions, which is estimated at 6.3 ± 0.4 Pg C yr^{-1} during the 1990s. A large fraction of the emitted CO_2 thus does not remain in the atmosphere. Conservation of mass implies that the missing emissions must have entered the ocean, the terrestrial biosphere, or both. The ocean carbon sink is arguably the best known of these two remaining components of the carbon budget. According to LeQuere et al. (2002), the ocean absorbed 1.9 ± 0.7 Pg C yr^{-1}. By difference, the global net terrestrial biosphere sink must be 1.2 ± 0.8 Pg C yr^{-1}. Estimates of land use change, using bookkeeping models (Houghton, 2002), suggest a source of 2.2 Pg C yr^{-1} within a range of 1.4-3 that is mainly attributed to deforestation. Using remote sensing and similar bookkeeping model, de Fries et al. (2002) arrive at a much lower carbon loss of 0.9 Pg C yr^{-1} (range 0.5-1.4). This indicates that the global terrestrial biosphere took up between 2.1 and 3.4 Pg C yr^{-1}in the 1990s. There are strong indications that there is a large uptake in the Northern Hemisphere land (Ciais et al., 1995) but the precise geographical distribution so far remains elusive. It is also unclear in what compartment of the system e.g. soil, biomass or other, this carbon eventually ends up, and how the driving forces of terrestrial uptake may have affected the distribution of sources and sinks.

Europe's terrestrial biosphere is currently believed to be absorbing 200 Tg C yr^{-1} according to a recent review of available data by Janssens et al. (2003). This C sink of geographical Europe is the net balance between a larger C sink in forests and grasslands that apparently offsets C losses from arable lands and disturbed peatlands. The uncertainties associated with this estimate are considerable. For instance the largest estimate used in the Janssens et al. (2003) analysis is 560 Tg C yr^{-1} and comes from atmospheric inverse models (Gurney et al., 2001), the smallest estimate is obtained from the land based scaling estimate and is a sink of 111 Tg C/yr.

Measurements made by eddy correlation techniques suggest strongly that **European forest** are currently absorbing carbon at rates of up to 470 Tg C/yr (Papale and Valentini, 2003). There is considerable year to year variability and between site variability in these estimates, suggesting that land use history and climate are important driving factors. A particularly important issue to address in this context is the role played by CO_2 and nitrogen fertilization. Do we do this?

The best estimate of soil C changes in **European agricultural soils** indicates that European croplands are losing considerable amounts of C to the atmosphere (300 Tg C a^{-1}; Janssens et al., 2003). This suggests that the agricultural sector is adding C to the atmosphere, at a rate equivalent to roughly half of the net forest sector sink. However, uncertainty in the net agricultural sector exchange is very large.

Grassland ecosystems, in contrast, may constitute a small net C sink (101 Tg C a^{-1}), although the uncertainty surrounding this estimate is larger than the sink itself (Janssens et al., 2003).

The estimates above ignore emissions from land use change, land degradation and fires and other types of **disturbance**, so they probably constitute higher estimates of the land carbon sink in Europe.

When smoothed over time and de-seasonalized, **atmospheric monitoring** stations in the interior of the European continent measure CO_2 concentrations about 5 ppm above those observed by monitoring stations over the North Atlantic ocean. This difference is mainly due to the release of fossil fuel-derived CO_2 over the European continent. After correcting for fossil fuel emissions (about 1700 Tg C yr^{-1}), atmospheric CO_2 concentrations over the continent would be about 2 ppm below those over the Atlantic ocean. This indicates that on the European land surface and continental margins CO_2 is being taken up. Gurney et al. (2001) give a range for estimates from inversion estimates from 80 to 560 C yr^{-1}. Roedenbeck et al. (2003) using the full adjoint of an atmospheric model and NCEP reanalysis suggest a much smaller sink for Europe and even a source for the last five years.

Although the European land-surface is thus currently thought to be absorbing up to 30% of the industrial CO_2 emissions, the terrestrial carbon cycle is still insufficiently understood to fulfil the political need for accurate estimates of regional carbon sequestration. The uncertainties associated with determining the regional or national biospheric sink are considerable. **Reducing this uncertainty** and **tracing the flux of carbon** to its final point of immobilisation are the main driving forces behind the current CarboEurope-IP proposal.

The scientific questions outlined above have to be addressed by integrating research from different disciplines. The **"dual- constraint approach"** that is fundamental to research involves both a bottom- up approach whereby plot- level scientific understanding is up- scaled, and a top- down modelling approach, whereby atmospheric measurements constrain regional and continental carbon balance estimates. This is likely to be the only approach that can eventually help to implement full carbon accounting and verify another principal Kyoto objective, i.e. to track the impact of terrestrial sinks on the reduction of CO_2 concentration in the atmosphere. This system will also help to verify whether emission reduction measures implemented in Europe under the Kyoto protocol are detectable in the atmosphere. To improve the predictive capacity of existing models requires enhancing the observational system, better knowledge of processes and a better use of available data and models.

The **CarboEurope cluster** that started in the Fifth Framework Program has given the European scientific community a leading role in quantifying end improving the understanding of the European terrestrial carbon balance. A prototype observing network and strategy has been implemented in Europe, which is now ready for a new phase of development and scientific understanding. This requires innovation in critical areas, expansion of observation networks, regionalisation and enhanced integration of observations and models.

Insert state- of- the- art of FP5 projects of CarboEurope cluster (cf. Project list and short descriptions in Annex)

Scientific innovation in CarboEurope- IP is described in section B.4.1.

Methods to be applied will be established in close collaboration with international programmes such as the International Geosphere and Biosphere programme (IGBP) and the Global Carbon Project (GCP).

Why and Integrated Project and not a Network of Excellence

4B.2 Relevance to the objectives of the Global Change and Ecosystems Sub-Priority

CarboEurope- IP directly responds to the call for an Integrated Project in the topic I.1.a) Assessment of the European carbon balance, but also links to other areas and topics in the Global Change and Ecosystems Sub- Priority. Results will also find applications in policy- related area **8.1.1. Sustainable management of Europe's natural resources** and in area **1.4.2.3.2 GMES** of the Aeronautics and Space Sub- Priority.

I. Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks

CarboEurope- IP fully fits in the area **I. Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks** of the **Global Change and Ecosystems Sub- Priority**.

The overarching aim of the CarboEurope IP is to quantify the processes that drive the carbon balance at local, regional and continental scale in Europe and obtain accurate estimates of the sink strength of the European biosphere and their uncertainty ranges. We will improve the access of European researchers to facilities and platforms for global change research by encouraging researchers to undertake complementary research on our well- characterized long- term ecosystem measurement sites and by possible enlargement of the original consortium of CarboEurope- IP.

CarboEurope- IP has been designed to fully match the objectives of the topic **I.1. Carbon and Nitrogen cycles: sources and sinks** for the most relevant European ecosystems (forest, cropland, grassland, wetland), specifically on **I.1.a) Assessment of the European carbon balance.** We will quantify the European carbon balance in soils and biomass, and from local ecosystem to regional and continental scale to support the implementation of sinks in the Kyoto Protocol and will also verify the effective CO_2 reduction in the atmosphere as precisely as possible by combining the world´s best integrated network of observations with modelling. We will also investigate how external parameters such as changing nitrogen deposition, climate change and variability and changing land management affect the European carbon balance and future projections of the carbon cycle. In order to achieve these aims we will further develop and integrate the resources of the CarboEurope cluster of the Fifth Framework Program (FP5) by innovation in critical areas (cf. B4.1), expansion of observation networks, regionalisation and novel tools merging observations and models.

The running CarboEurope cluster hosts the European regional office of the Global Carbon Project (GCP); Philippe Ciais (LSCE) – a key partner of CarboEurope – is chairing the International Global Carbon Observation initiative (IGCO) within IGOS, and most key partners of the CarboEurope- IP are actively involved in IGBP. This guranatees close collaboration with all relevant international programmes. Also joint assessments with the North American Carbon Program (NACP) are planned.

The ecosystem component of CarboEurope- IP also addresses aspects of the topic **I.6. Adaptation and mitigation strategies** by providing a synthesis of land management options for carbon sequestration and greenhouse gas mitigation, considering some of the recommendations of the IPCC Third Assessment Report and on the IPCC Climate Change Synthesis Report 2001, as well as monitoring recommendations in the IPCC Good Practice Guidance.

II. Water cycle, including soil- related aspects

For understanding the carbon balance at ecosystem scale, CarboEurope- IP measures and models the hydrological and climatic drivers such as water and CO_2 exchange between biosphere and atmosphere, and soil water dynamics. This links to the topic **II.2. Ecological impact of global change, soil functioning and water quality**. more text

V. Strategies for sustainable land management, including coastal zones, agricultural land and forests

CarboEurope- IP contributes the climate- related aspects of climate impact, greenhouse gas mitigation and carbon sequestration to the development of strategies and tools for sustainable use of land, with emphasis on agricultural lands and forests.

A close link to future projects in the topic **V.1.1.c) Land- use modelling** is envisaged.

VI. Operational forecasting and modelling including global climatic change observation systems

In the frame of the FP5- funded cluster of projects, CarboEurope has established the world´s leading, best integrated observing capacity built on flux networks, systematic ecological sampling and atmospheric long term observations collected in a co- ordinated manner, with in some cases real time data transmission and real time archiving on databases. The CarboEurope nested measurement strategy of harmonised, systematic observations of atmospheric and terrestrial parameters from local, through regional and continental scale served as template adopted in the GTOS- TCO report and will provide an important regional contribution to GTOS- TCO and IGCO through the lifetime of CarboEurope- IP. With regard to area **VI.1. Development of observing and forecasting systems linked to GMES,** specifically **VI.1.a) Earth system observations**, CarboEurope- IP will contribute to the development and implementation of terrestrial and atmospheric in- situ observation and forecasting systems of CO_2 and relevant atmospheric tracers for climate research. This could also support the planned activities in GMES (**1.4.2.3.2 GMES** of the **Aeronatics and Space Sub- Priority**) to enhance the monitoring capabilities of land cover and carbon. The observing network established in FP5 will be maintained, streamlined and expanded in a research mode by CarboEurope- IP for a better understanding of the terrestrial carbon cycle and its main drivers. GMES could make these multiple in- situ data available to a wider community of users and could contribute to the harmonisation, standardized quality control and operationalisation of data streams from in situ observing networks, the data fusion from multiple sources via data assimilation, and in particular, to ground- validate carbon- relevant satellite products of land cover and vegetation for carbon accounting under the Kyoto Protocol.

There is also significant opportunity regarding the **Research Infrastructures** actions 1. Transnational Access and 2. Integrating Activities, since CarboEurope- IP will offer a world- leading infrastructure for CO_2 observations and will integrate ground- based ecosystem- level observations with regional scale and continental scale atmospheric observations.

5B.3 Potential impact

Reinforcing competitiveness and solving societal problems

The European Union has ratified the Kyoto Protocol and has been a key player insisting in the environmental integrity of the UNFCCC in the global climate negotiations. The EU has thus a particular interest in understanding the driving forces of the carbon cycle and the possibilities for mitigation by increasing terrestrial carbon uptake. Furthermore, the European land- surface is currently thought to be absorbing up to 30% of the industrial CO_2 emissions, but also releasing more than 40% of the European CH_4 and N_2O emissions. Despite important and rapid scientific progress, however, the terrestrial carbon cycle is still insufficiently understood to fulfil the political need for accurate estimates of regional carbon sinks and sources because we cannot adequately trace the carbon fluxes nor identify the ecosystem compartments in which carbon is ultimately immobilized.

Key research products of CarboEurope- IP include improved quantitative estimates of the European carbon balance and new technologies that help reduce the associated uncertainties. Collaboration with initiatives that followed the CarboEurope approach outside Europe, in particular joint EU-US assessments of the carbon budget together with the North American Carbon Program (NACP) have already been agreed. In conjunction with our commitments in international science programmes such as the Global Carbon Project (GCP), IGBP and TCO- IGCO, the results of CarboEurope- IP will also contribute to an improved understanding and quantitative estimate of the global carbon balance. For the first time ever, a pre-operational system will be developed within CarboEurope- IP that can provide estimates of the present biospheric CO_2 budget at sufficient spatial resolution for monitoring and verification at national and continental scale under the Kyoto Protocol. This system will also be able to verify the claims of other Kyoto signatories, independent of the UNFCCC submissions, thus strengthening the European position in future UNFCCC negotiations. „Verification“ in this context means the scientifically sound check of the countries´ estimates using independent the flux and concentration data data gathered in CarboEurope- IP.

CarboEurope- IP will also improve our understanding of the attribution of the terrestrial carbon sink to human- induced versus indirect or natural factors via Europe- wide data synthesis, modeling and the development of a carbon data assimilation system. This will also help to develop strategies for greenhouse gas mitigation and carbon sequestration in forestry and agriculture in a multi-functional framework. The project will strengthen Europe’s leading role in terrestrial carbon cycle research, while at the same time generating the knowledge base essential for sustainable land resource management in Europe.

Furthermore, CarboEurope- IP develops general principles for carbon observing systems which will also be applicable at project scale such as under the Clean Development Mechanism (CDM) and eventual future accounting schemes in the Second Commitment Period. Therefore, CarboEurope- IP indirectly helps to alleviate poverty.

Innovation- related activities, exploitation and dissemination plan

Activities relating to the protection of knowledge and IPR

CarboEurope- IP will produce and integrate the following knowledge in an unprecedented manner: Measurement data, model results, software, and auxilliary data sets. Eventually, patents may evolve from the activities dealing with software development, data assimilation techniques and observation technologies and high-precisions analyses. We have set up a plan for the management of this knowledge (B.6) the heart of which is our data policy. The present CarboEurope cluster has already adopted a data policy in March 2000. This data policy has been adjusted to the new level of integration in CarboEurope- IP and will be part of the consortium agreement (Appendix 1). It will allow a fast, efficient exchange of knowledge within the Integrated Project. The meta- database of CarboEurope- IP will be public whilst data and knowledge will be made available to third parties upon request. Consolidated datasets will also be made publically available. This allows a very timely use of the project results for a wider scientific community (cf. also B6).

Exploitation plan

Exploitable results of the CarboEurope- IP encompass a scientifically sound verification system for commitments under the Kyoto Protocol, the world´s best integrated network for CO_2 observations at regional and continental scale, and recommendations for land management with regard to the Kyoto Protocol. There is also scope for operationalisation of the observational network, e.g. in GMES.

Dissemination plan

Communication within the project is described in the management part (B4.4, B6).

We will continue to produce dissemination material for policy makers and the public at large, include secondary schools in the training activities and maintain and expand the good basis of personal contacts to journalists in order to help spread awareness and knowlegde about the carbon cycle related to climate change. The dissemination plan for results to the science, policy and broader public community streamlines and expands the activities in projects of the CarboEurope cluster in FP5 (cf. B4, Activities 5.3- 5.6 of the outline implementation plan and B4, Exploitation of results and dissemination of knowledge – innovation section). The combination of scientific publications, broader dissemination material, virtual and real platforms for consultation and dissemination, personal engagement with stakeholders, policy makers and press and the direct inclusion of end users in the advisory board present a comprehensive, flexible and powerful tool to disseminate the results of CarboEurope- IP to all relevant communities outside the project. Contacts exist with national forest research institutes whcih have helped CarboEurope by supplying regional data and which have been open for discussions and training in Kyoto- related issues. We expect that one of the most efficient strategies for optimal use of project results works via direct interactions with stakeholders, consultations to the European Commission and national governments by project partners, which is proven by past success. We will continue this successful tradition of consultation and dissemination to ensure optimal use of the project results.

Studies on socio- economic aspects

No such studies are envisaged at the moment, since the socio- economic impact of expected results depends a lot on how the political environment for using carbon sinks and verification under the Kyoto Protocol evolves over time. Clearly, aspects of vulnerability of the carbon sink have some socio- economic aspects the analysis of which fits in area I.6 of the Call. We therefore do not take own, parallel actions but will be open for collaboration with emerging projects, also in the Call area of policy- related research (8.1). One direct and strong interaction exists with the German Advisory Board on Global Change (WBGU) who published a first assessment of the Kyoto Protocol in 1998, and who edited a report on the future change of energy systems (WBGU, 2003), in which CarboEurope data and results merged with socio- economic expertise.

European added- value

The assessment of the carbon cycle of the European terrestrial biosphere and its driving forces has to be addressed by integrating research from different disciplines. Under the Fifth Framework Program the CarboEurope cluster of 15 projects, involving 85 institutions in all Member States and some Candidate Countries was set up to improve the European science infrastructure in this field. Building on the established network and know- how, an integrated project is required to further reduce the uncertainties in estimates of the carbon balance via optimising the ground- based and atmospheric observation networks, model improvement and development of carbon data assimilation methods. The European scale at which the Integrated Project operates requires a pan- European consortium since relevant expertise is spread among various research groups and formerly separated consortia in various European countries, and the data observation networks are necessarily pan- European. To arrive at a consistent picture of the European carbon balance, existing and newly developed expertise need to be integrated in a single, unifying manner. A European- wide larger integrated project is essential to achieving temporal and spatial coherence, via adequate coverage of all major European biomes and harmonised protocols for measurements, data processing and archiving. Access to a common European data- base and joint planning and execution of research activities are crucial issues in this respect. This is particularly true for carbon cycle research, which has to deal with continuous exchanges between the atmosphere, biosphere, soils and wood products. Simultaneously and continuously observing these components and exchanges between them allows us to develop a coherent knowledge of sources and sinks. Integration of plot, local and regional scale measurements is fundamental to the dual- constraint approach (Figure 1), but requires considerable investment and a high level of co- operation.

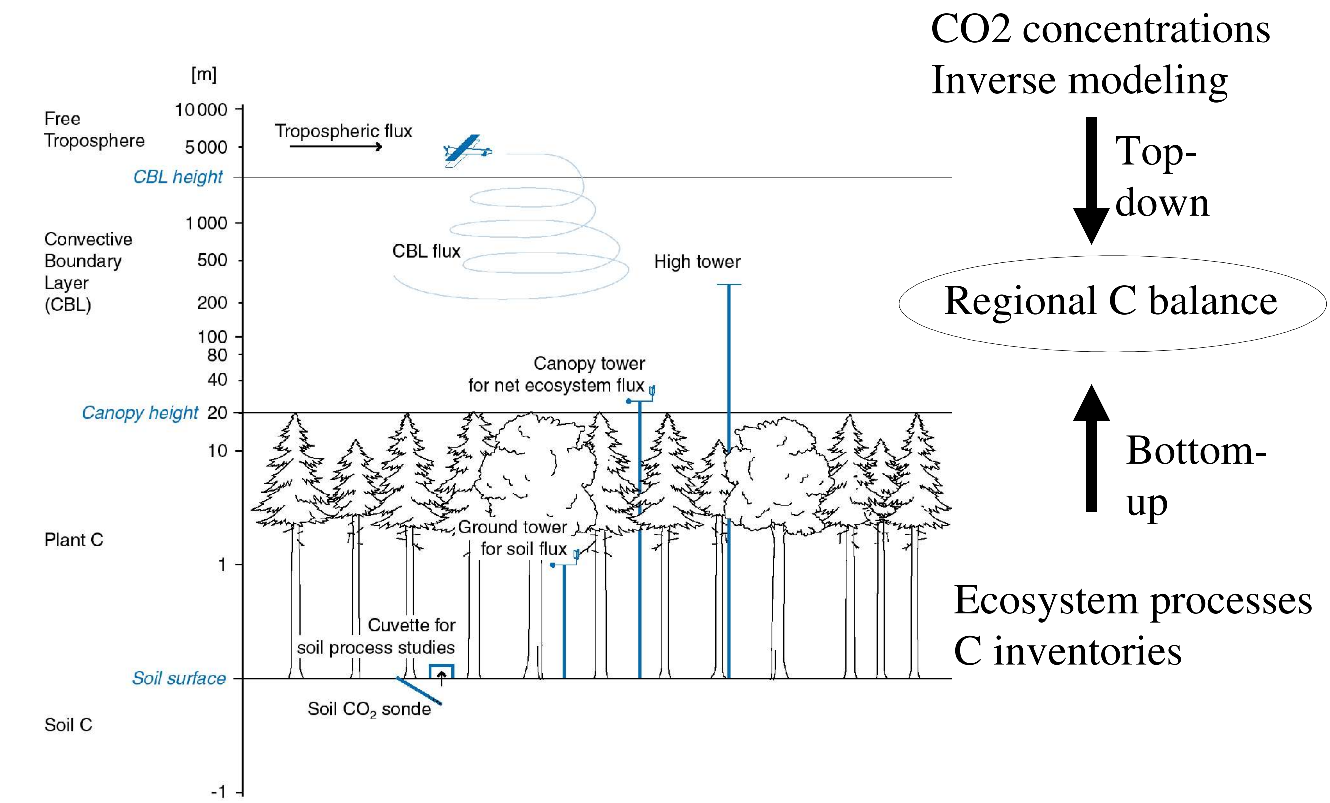

Figure 1 Dual constraint approach: Top- down estimates of the carbon balance constrain bottom- up estimates and should merge at the regional scale. (evtl. simpler graph)

CarboEurope collaborates with key political initiatives that address the reporting requirements under the Kyoto Protocol. CarboEurope- IP maintains close collaboration with the running EU-funded projects CAMELS, CARBOEUROPE-GHG, CARBO- INVENT, CHIOTTO, and TCOS Siberia (cf. ANNEX for details). TCOS Siberia aims at quantifying the Siberian carbon balance and operates research sites in European Russia and Siberia. Thus, the database of CarboEurope- IP reaches further East than to the Candidate countries only and allowes and integrated view of geographic Europe. In the future, at the EU level, we also plan to form an alliance with Ocean Carbon Research by developing a joint Network of Excellence: ENEGACC: European Network of Excellence in Global Aspects of the Carbon Cycle. We will work closely with the Ocean Carbon Cycle Integrated Project (MARCASSA) that will provide essential boundary constraints for the terrestrial data assimilation program and with which we will jointly investigate land to seas fluxes. At the global level we aim to collaborate with the joint IGBP-WCRP- IHDP Carbon project (by running the European Regional Office), the North American Carbon Cycle project (NACP) and other regional and continental based carbon experiments, e.g. in Siberia, China, and the Amazon region, to which we have already established contacts. CarboEurope- IP will contribute to the GMES and to ongoing IPCC activities (Assessments, Special Reports and Good Practice Guidance). The eddy flux sites will continue to contribute to FLUXNET.

We expect a similar level of funding as from the European Commission from participating national programmes and partner institutions. We have integrated components of parallel national research of the programmes LUSTRA „Land use strategies for reducing net greenhouse gas emissions“ (http://www.sml.slu.se/lustra/index.phtml, Sweden), DFG priority program SPP 1090 „Soils as source and sink for CO_2 – mechanisms and regulation of organic matter stabilisation in soils“ (http://www.weihenstephan.de/bk/schpteng/schpteng.htm, Germany), the UK´s NERC Centre for Terrestrial Carbon Dynamics, based in Sheffield University, national flux networks and Kyoto- related monitoring via sites in France, Italy, Ireland, the Netherlands, and Spain. Strong links with the training activities in the ESF programme SIBAE „Stable Isotopes in Biospheric- Atmospheric Exchange“ exist as 60% of the scientists in the SIBAE steering committee are involved in CarboEurope- IP. We will also continue the close relations with the ESF programme RSTCB „The Role of Soils in the Terrestrial Carbon Balance“, e.g. by joint workshops. The research infrastructure of CarboEurope- IP is in principle open to new research groups, and the ecosystem sites will be offered to the science community for complementary measurements. These integrative elements and the large consortium of CarboEurope- IP will form a significant step forward to the implementation of the European Research Area (ERA).

Regarding research on biodiversity, there are also links with the proposal for a Network of Excellence on Biodiversity ("...", co- ordinated by Loreau) and support from the two largest biodiversity experiments in Europe (German DFG-Forschergruppe, BioTree).

5.1 B.3.1 Contributions to standards/ policies/ regulations

The strongest contribution of the proposed project addresses policies related to the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. CarboEurope- IP is a project with direct involvement of its end users such as forest services, private forest and other land owners, industry and policy makers on national and international level in dedicated Activities and as members of the Advisory Board of the IP. The proposed research addresses several aspects of climate change and the land carbon balance, in line with European political interests, integrating European expertise in all relevant disciplines. The expected results of the IP will have great relevance to a number of international treaties and conventions, to which the Union and its Member states are signatories. In particular, the IP will provide scientific methods, understanding, validation and monitoring tools in support of:

1. The **UNFCCC**. Among other obligations, Parties of the UNFCCC have committed themselves to develop, periodically update, publish and make available to the Conference of the Parties (CoP), national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. CarboEurope- IP will develop an integrated methodology based on observations and innovative modeling and best estimates of the land carbon sink to complement national estimates and to enable the European Union to fulfil this commitment, and to provide a scientifically independent verification of reports of land carbon uptake from other Parties of the UNFCCC.
2. The **Kyoto Protocol**, especially the paragraphs that relate to biospheric sinks and sources (3.3.; 3.4.) and to the monitoring and verifiability issues of the Protocol. The lack of an adequate methodology for the attribution of the land carbon sink to human- induced and other factors, and the lack of scientific confidence about the magnitude of the land carbon sink, were among the most important reasons for the failure of the The Hague negotiations (CoP6) on implementation of the Kyoto Protocol. With present knowledge, human- induced contributions to the land carbon sink can be separated from indirect and natural effects by means of models only. Such models, however, have not yet been developed and applied to Europe. CarboEurope- IP will fill this gap by attributing and quantifying the human- induced land carbon sink in Europe and elsewhere.
3. The **Commission Communications** COM(97)481, COM(98) 353 and in particular „Preparing for Implementation of the Kyoto Protocol“ (COM(99)230) and the related Council Decisions Dec93/389 - Council decision of 24 June 1993 for a monitoring mechanism of Community CO_2 and other greenhouse gas emissions and 99/296/EC. The results of CarboEurope- IP will strengthen the Community ´s ability to monitor and verify the land carbon sink, and facilitate the development of a common strategy for monitoring greenhouse gas exchange between land and atmosphere. It will help to fill gaps in national reports of carbon fluxes related to land use, land use change and forestry recently identified in the first progress report under 99/296/EC. CarobEurope- IP will design a system to produce best estimates of the contemporary land carbon sink in Europe and elsewhere, in a transparent and verifiable manner.

4. As directly useful results, CarboEurope-IP could provide annually the **EEA climate change indicator** „carbon uptake in the biosphere“.
5. CarboEurope-IP will provide useful methodologies and results for the international negotiations on carbon sinks in the Second and later Commitment Periods under the Kyoto Protocol.

Dealing with issues of land use and management, CarboEurope-IP also links to **EC Directives** 91/676/EEC on protection of water against pollution caused by nitrates used in Agriculture and 92/43/EEC on habitats and fauna and flora protection and touches issues of the Convention on biological diversity and the related **Council Decision** 93/626/EEC of 25 October 1993.

6B.4 Outline implementation plan

(B4: 25 pages)

- *the project has **clearly defined objectives**.*
- *the objectives represent **clear progress beyond the current state-of-the-art**.*
- *the **proposed S&T approach is** likely to enable the project to achieve its objectives in research and innovation.*

6.1 B.4.1 Research, technological development and innovation activities

6.1.1 Research and technological innovation

Explain how the research/innovation effort of the project is comprised of a number of different components (major elements or blocks of work). Describe each of these components, identify who will carry out each. Show the relevance and contribution of each to the project as a whole.

Innovation

1. Reducing uncertainty through integrating inverse modeling, data assimilation and process studies in a comprehensive experimental strategy

The key innovation in the CarboEurope IP is in its conception as a single comprehensive experimental and modeling, and data assimilation strategy in which all experimental and modelling and integration components cross-fertilize each other in an integrative manner. Similar techniques are being used at local, regional and continental scales. There is repetition of experimental design and common experimental, measurement and data processing protocols facilitating the integration of the various scale dependent components.

At both the regional and continental scale we plan to optimise the spatio-temporal strategy of observation to better resolve the temporal aspects of the carbon cycle. Enhanced spatial resolution of the measurements allows a finer spatial resolution of the sink strength of Europe to be determined. By combining data sources such as land cover and management with atmospheric observations of fluxes and concentrations in a highly innovative modelling framework at the EUROGRID[3] we are able to reduce the overall uncertainty in our estimates, that was outlined above as one of the key driving questions of the CarboEurope IP. New inversion methods at both continental and regional scale play a key role here.

We enhance the previous innovation of the CarboEurope cluster by explicitly integrating across method checking of results at local, regional and continental scale, thereby enhancing the credibility of individual methods (or providing grounds for discarding methods that perform badly). In this context, the planned

[3] DEFINE!

regional experiment will provide for the first time a full annual carbon balance of an entire region of Europe, which will serve as the first fully integrated test area for the dual constraint approach and set the basis for further methodological improvement.

2. Process scientific innovation

The scientific innovation is in filling in gaps in knowledge (WHICH?) that relate to the magnitude and spatio- temporal patterns of the continental and regional carbon balance and process knowledge about the importance of natural and human driving forces of the carbon cycle and the ultimate fate of carbon sequestered in ecosystems. At the continental level, the enhanced spatio- temporal design and comprehensive integration of key observations, the new methods to separate fossil fuel contributions from the total source via CO and radiocarbon tracers and enhanced spatial resolution, with the integration of the tall tower network will greatly enhance our ability to produce estimates of sink strength with a quantifiable associated uncertainty at increasingly higher spatial and temporal resolution.

At the regional scale, the combination of experimental methods allows high resolution estimation of the sinks strength at unprecedented spatial (1- 5 km) and temporal resolution (1 week) in a first test area in Europe. Such an experiment is unique in the world and has not been attempted. The works done in CarboEurope, both in technological innovation (the Sky Arrow observational research aircraft) as in modelling (regional inverse studies) enhances the feasibility of this innovation strategy.

At the local level, the site- cluster strategy, incorporating measurements of the main land use types is a key innovation. The process studies and modelling of allocation of assimilated carbon to compartments and assimilation/transport schemes are novel.

There is an unrivalled level of integration in the measurement protocols for full carbon monitoring at local site/harmonisation, and the linkage of the ground based measurements with the atmospheric measurements (the virtual tower concept) are new. This fully integrated carbon observing system is heading towards an operational monitoring scheme of relevant parameters for the quantification of the European carbon balance.

The CarboEurope strategy provides the data and modelling tools that eventually will allow us to separate natural from direct and indirect human induced effects. Attention to these issues, based on policy demands is new.

3. Kyoto verification

The CarboEurope IP will attempt to track the impact of the biosphere on atmospheric CO_2 and thus help in verifying European reduction measures. This, from a policy perspective, is a key innovation because the CarboEurope- IP approach is based on full carbon accounting. We will deliver a prototype monitoring and data assimilation system, that is unique in the world in its comprehensiveness, its level of integration and breath. This will, for the first time, provide quantitative information to support implementation of the Kyoto protocol.

Furthermore it will, for the first time, provide the quantitative information for full carbon accounting at local, regional and continental scales. Although this is not yet part of the Kyoto implementation, CarboEurope results will contribute to discussions about full carbon accounting that are currently being held and will become important in the international negotiations for the implementation of the Second and later Commitment Periods under the Kyoto Protocol.

4. Vulnerability

We will provide the quantitative information of the vulnerability of carbon pools over the next 100 years, and provide the quantitative information of carbon pools and their changes over the next 20 years. This will allow evaluation of the vulnerability at key timescales of management and suprises in the climate system (20 years) and at longer timescales where gradual and transient global change effects may affect the vulnerability of the carbon pools. The fact that a single project can deliver this is a key innovation, that is made possible by the unrivalled integration of the CarboEurope IP efforts.

5. Changes in the energy system

We will use CO and $^{14}CO_2$ as tracers to quantify the fossil fuel contribution to atmospheric CO2 over the European continent. By comparison with our longer term record, we will bottom- up emission inventories by direct determination of changes in the European fossil fuel emissions over several years. Furthermore, for a test area in Southwest France, we will develop improved fossil fuel inventories with high spatio- temporal resolution and directly verify them with measurements over one year at the scale of a region of 500 km.

Implementation plan

Terminology

Blocks of work

CarboEurope- IP will be structured along five interlinked **components** with several **activities**. Activities are translated to one or several **workpackages** in the 18- months plan, which are again split up in **tasks**, which in turn lead to **milestones** and **deliverables** (Figure 2).

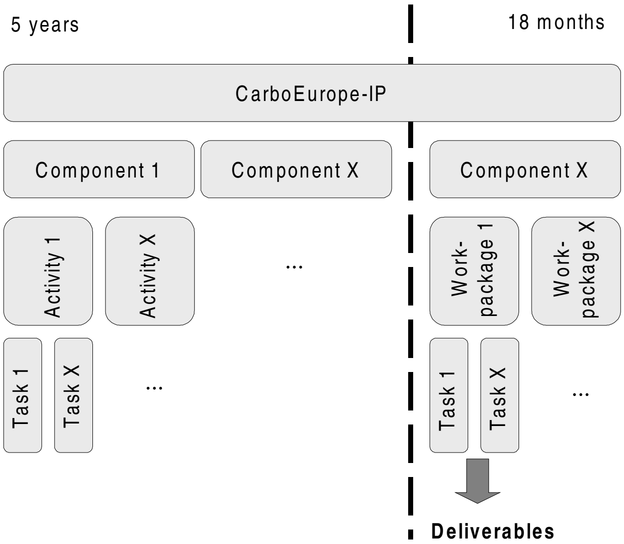

Figure 2 Terminology of blocks of work in CarboEurope- IP

Spatial scales

- **Continental scale**: Geographical Europe encompassing EU-15, Candidate States, new Eastern European States and former Soviet Union up to the Ural (or restrict it to where we have the stations: EU-15 and Candidate States?), with a spatial resolution of the 50- km „Eurogrid“, and a typical temporal resolution of a month.
- **Regional scale**: A region in the order of a grid box of 500km x 500 km, with a spatial resolution of 1- 10 km, and a typical temporal resolution of hours to one day.

tem scale: A landscape with homogeneous land cover in the order of 1 km, with a spatial ion of a few metres, and a typical temporal resolution of eddy flux measurements of 0.5 h.

Ambiguous terms in the science versus policy context

- **Observation**: Measurement, including its calibration, quality control and data processing
- **Monitoring**: Combined measurements and modeling if adequate. The term is used in its scientific sense rather than in the sense of the Kyoto Protocol.
- **Verification**: Scientific check of observations and estimates against independent other observations and estimates. CarboEurope- IP is developing a dual constraint approach to quantify the terrestrial carbon sink at local, regional and continental scale: Estimates by ground- based methods and bottom- up modelling must match with estimates from top- down approaches driven by airborne observations in order to produce a robust estimate of the carbon sink. The term is used in its scientific sense rather than in the sense of the Kyoto Protocol of an expert review of validity of calculations.

Structure

CarboEurope- IP will continue to, further integrate, streamline, and expand research undertaken in the frame of the CarboEurope cluster of projects funded under the Fifth Framework Programme.

The scientific structure of the Integrated Project comprises five components (Figure 3, Figure 4):

1. Ecosystems (UNITUS)
2. Regional experiment (VU- A)
3. Continental atmosphere (LSCE)
4. Integration (MPI- BGC)
5. IP co- ordination, training and outreach (MPI- BGC)

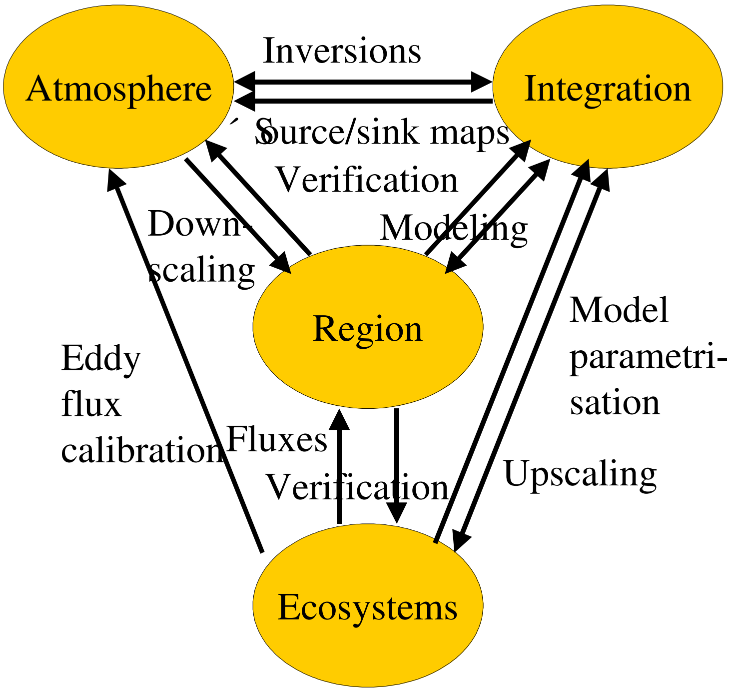

Figure 3 Components and their interactions in CarboEurope- IP. Expand with more explanation

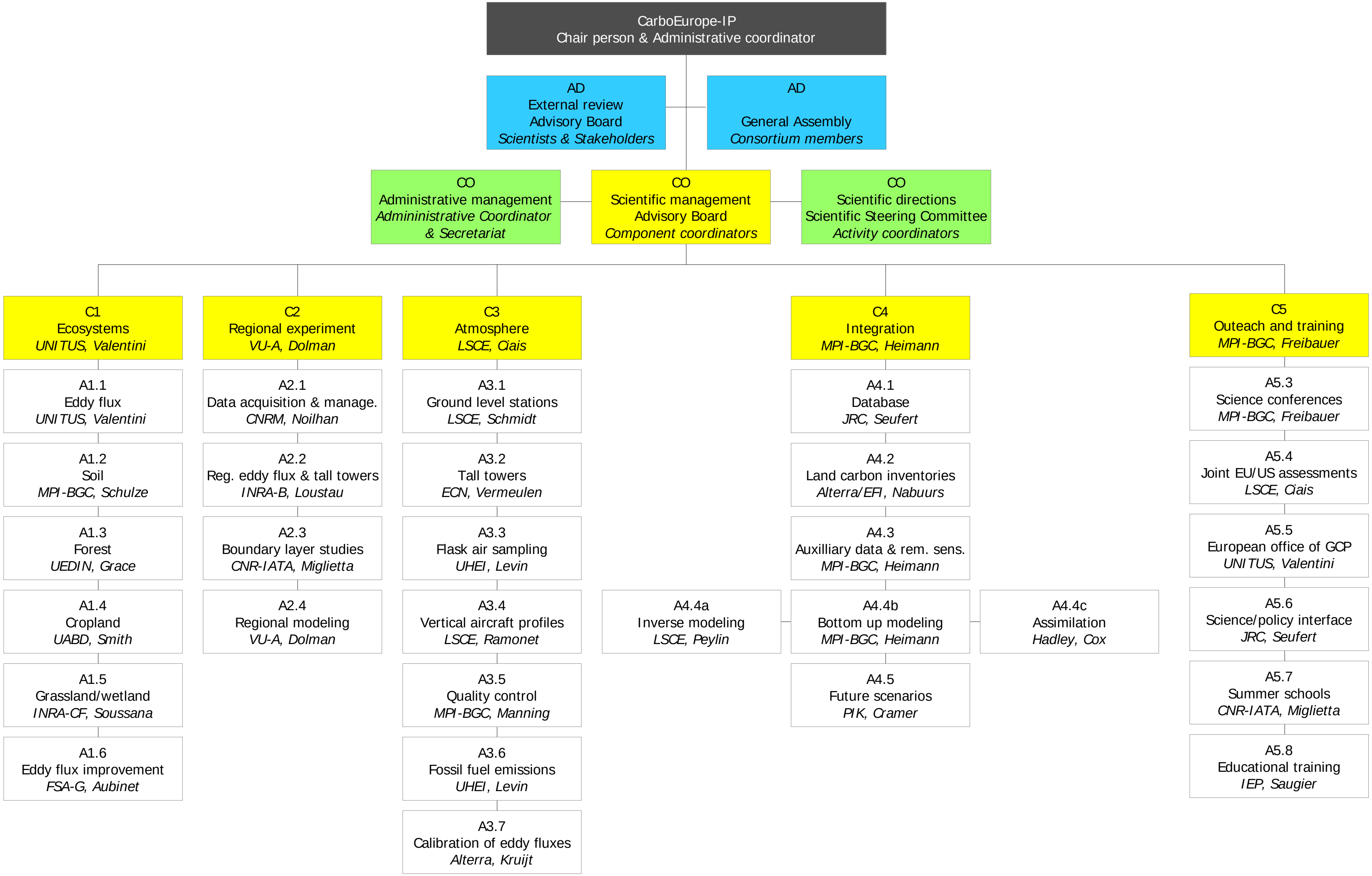

Figure 4 Scientific and organisational structure of CarboEurope- IP.

Relationships of the components

The strength of CarboEurope- IP is primarily in the comprehensive experimental strategy that allows across scale validation and verification through the dual constraint approach. To achieve this the IP is set up with a limited number of strongly linked components (Figure 3). Central in the components is the notion that increased spatial and temporal sampling is required to resolve the regional carbon balance of Europe.

and a better integration between measurements and models

From the atmospheric perspective we intend to extend the atmospheric network spatial coverage over Southern and Western Europe (and Eastern Europe?), by adding new continuous monitoring stations, increase the frequency of vertical profiles sampling through the Planetary Boundary Layer and aloft using aircraft from bi- weekly flights to weekly flights, and finally to optimize the atmospheric data selection, using *in situ* meteorological data and other tracers data such as Rn- 222, to extract from continuous CO2 time series representative measurements of regional sources and sinks activity

The guiding principles for reinforcing the existing Observing System and installing new stations, or new species measurements, relies not only on atmospheric inverse models predictions, but also on geography, and on our present knowledge of regional fluxes across the various European ecosystems and industrial regions.

Clarify, make this paragraph stronger

The measurements at continental scale provide the boundary conditions for both the regional experiment and the integration efforts. Novel in our proposed strategy is the incorporation of CO2- concentration measurements at the flux tower sites to complement the atmospheric monitoring at free troposheric sites, tall towers, and aircraft. This provides a strong link between the ecological and continental scale observations.

The regional component provides a direct link between the ecology and continental scale measurements and models. Continental scale models provide the important boundary conditions for the regional carbon balance. Upscaling of the flux towers is performed with forward meso- scale models and calibrated biogeochemical models for the long term (20 yrs). At the regional scale we will use inverse model techniques similar to those developed at the continental scale, thus establishing a clear methodological link with the larger scale inverse modelling estimates. This level of integration and co- ordination is typical of our comprehensive experimental strategy, comprising repetition of experimental and modelling design at the three main scales: local, regional and continental. The regional experiment will test and provide aggregation algorithms that will be used in the upscaling efforts in the integration component.

Data assimilation will be the key tool to the development of the carbon monitoring system. Both at regional and continental scales this is a considerable effort. We intend to set up a working group in the integration component that provides an efficient platform for the exchange of modelling techniques.

The ecology component will quantify the carbon fluxes of the variety of land cover/use of the European continent thus providing input into the spatial scaling and bottom up modelling efforts. It will provide the basis for parameterization of models for up- scaling of carbon fluxes to the regional and continental scale. and data synthesis and modeling of effects of driving forces on carbon cycle such as disturbance by harvest, management... which are not yet included in larger scale biogeochemical models.

Within the integration component, the generation of bottom up estimates with biogeochemical models and novel spatial extrapolation techniques such as neural networks make use of the flux data to provide a priori estimates for the inverse models. Conversely, when inverse estimates of sources and sinks are available, they provide a check on the bottom up estimates coupled with transport model (forward modelling).

Overall the links between the several components are expressed strongest in the integration component. A central challenge for the integration activity is the bridging of the scales at which the different datastreams arise and at which the different models operate. There are at least two distinct spatial scales where the modeling activities are located: site- specific process models for individual ecosystems within the footprint of a flux tower, or within the domain of a “site cluster” and geographically referenced, grid- based continental ecosystem models. In the CarboEurope IP we separate explicitely the two spatial scales and propose modeling activities to bridge the two scales. The common denominator of the two scales is the “Eurogrid”, i.e. a spatial grid with grid elements on the order of 50km, on which the European carbon balance is calculated.

and figures with details for every component

FEASIBILITY

Component 1. Ecosystem carbon budget and its driving forces ("Ecosystems")

Rationale

The carbon cycle in the land is determined by the flows of carbon between major stores (vegetation, litter and soil) and the atmosphere, and all these component fluxes need to be known in a comprehensive scheme of the European carbon balance. One major problem in achieving this goal is that the European landscape is a mosaic of several different land use/cover types extending from Mediterranean to the Boreal regions with an outstanding degree of human influences and a variety of natural and anthropogenic disturbances regimes. Therefore, both the flows of carbon between these stores and the store contents themselves have a rich spatial and temporal heterogeneity.

The flux network provides the critical interface between ecosystems and atmospheric processes, and thus provides an integrated number at a spatial scale of about 1 km^2. However additional losses occur due to human perturbations which remove carbon by harvest and/or add carbon with import of fertilizers or manure. Also losses occur to groundwater as dissolved organic carbon. This makes it more difficult to assess the full carbon budget. Also, the permanence of ecosystem carbon stocks needs to be addressed.

The ecosystem component provides the basic observational data and elements of analysis of carbon and other GHG gases fluxes and stores and their driving processes in terms of climate, human management and regime of disturbances for the major elements of the European terrestrial ecosystems.

The ecosystem component will investigate net ecosystem fluxes in a large network of land cover/use across Europe and integrate these data with intensive observations on the changes of carbon pools driven by human needs and according to principles of sustainable management. An additional contribution of the component is to verify carbon flux balance and inventory data of biomass at the same plot level to reduce uncertainties in the carbon budget estimation.

The ecosystem component is organized in different activities, in which the eddy flux measurements (Activity 1: flux network) provide the inter- annual variability of fluxes and climate. Also, the flux network will provide the ecosystem C-balance, which needs to be broken down into its components in order to judge the permanence of these sinks or sources. Soils are the ultimate sink, or a large source of C, but they are difficult to study due to their inherent heterogeneity. Activity 2 (soils) attempts to detect carbon changes in soils as partial verification of the C- budget as provided by the flux towers. The carbon that does not enter into soils will have been deposited in biomass, and activity 3, 4 and 5 (forest, grassland and crops) will provide the allocation of C into the plant cover, and the quantity that is removed by management. This leads into a consideration of management issues (e.g. harvest, fertilizer addition) which need to be addressed in relation to land- use.

Activity 6 will provide methodological checks and improvements in the flux network in order to reduce the uncertainty of this important measurement.

Overall objectives

1. Quantify the carbon fluxes of the variety of land cover/use of the European continent
2. Separate the components of sinks and sources according to land use types (GPP, NPP, Ecosystem respiration).
3. Identify the soil carbon pools as a component of the overall carbon balance
4. Provide the basis for parameterization of models for up- scaling of carbon fluxes to the regional scale.
5. Provide an optimisation scheme of "in situ" observational sites for a European carbon balance monitoring.
6. N deposition?

Methodology

The Ecosystem component is based on a strong experimental infrastructure which is common to all the 6 activities of this component.

The infrastructure is a network of sites organized into specific clusters which is representing the mosaic of land cover/use of the European landscapes (see Annex for details).

Each cluster is a combination of land cover/use types (at least 3 different elements) and as well a combination of institutional expertise.

At each site of the cluster network (CN) both biospheric fluxes and ecological measurements are carried out with a high level of standardization and integration.

In the past ecological variables, as well productivity studies have been often decoupled from the flux observational networks. The result was that few examples are today available where the processes of carbon sequestration or release can be documented at the various components and the key patterns identified.

The cluster is also a geographical entity which encompass different land use/cover representing the major elements of the region. It is also a multi- disciplinary consortium of different expertise coming from several institutions.

The cluster network of the ecsosystem component is composed of 16 clusters of sites covering the major elements of the European landscape (see Annex).

Within the cluster there are Main sites (M) (at least 3 with different land use/cover elements) and Associated sites (A).

The main sites have an observational time duration of 5 years and have to follow a full intensive data collection protocol both in terms of fluxes and Ecology. (see Annex).

The associated sites are requested to provide only fluxes, meteorology and basic ecological variables with also radiation balance and albedo. They can have a different time schedule, but at least they must provide one year of data under the same quality check and standard procedures of the IP network. These sites are mainly used for spatialization of fluxes and to validate ecosystem models expanding the range of land use / cover and climate conditions.

In total there are 53 Main sites and 36 Associated sites.

The distribution of sites match reasonably both the land area representation of Europe and the contribution to Net Biome Production (NBP; as derived by Jaanssen et al. 2003).

Eddy covariance measurements and protocols have been well developed in previous European projects (i.e EUROFLUX, Aubinet et al. 2000) and in the global activities of FLUXNET and improved since then in several directions (reliability of data, nighttime fluxes, footprint characterization etc.). CarboEurope- IP will improve the eddy flux methods by …

Soil carbon and its variation in time requires particular care and in- depth investigation. Soil organic matter is here considered as the sum of fine organic matter plus dead coarse organic matter plus the organic layer. Based on previous projects (i.e. FORCAST) a increase or loss between 0.1 and 1.3% of soil organic carbon content can be expected over a five-years period under changing management regimes. For this reason an adequate sampling procedure is put in place to reach the desired accuracy (see Annex).

Measurements of NPP and their components will be carried out at each of the cluster main sites according to the protocols defined by the various Activities (forests, crops, grasslands and wetlands). For some ecosystems in which non- CO_2 gas emissions contribute significantly to the full GHG budget, these other gases will me measured as well. Moreover, ecosystem models will be further developed for each main land use type (forests, croplands, grasslands) and will be evaluated against the experimental data from the site cluster network. These models will be used to simulate the carbon (and GHG) fluxes in relation to land use and land management under current climate and climate change and N deposition scenarios.

Is there also one model which will be used for all main land use types?

Expected results

1. carbon flux balance, its components (GPP, NEP, Respiration) and their inter- annual variability
2. information on changes of soil carbon at selected tower sites
3. data on changes in permanent biomass

4. improvement and validation of ecosystem models as basis for up- scaling
5. establishing relations between carbon and other GHG budgets to management regimes and other disturbances
6. simulated impacts of land management, climate change and N deposition on the carbon (and GHG) balance and its main components in the main land use types of Europe.

Activity 1.1: Eddy flux network

Rationale

Carbon dioxide, water vapor and energy transfer between the terrestrial biosphere and the atmosphere is a key component of the Earth System. In the context of the current IP proposal carbon dioxide exchange and its response to climate, soil and vegetation dynamics is the main focus. The Net Ecosystem Exchange (NEE) of CO_2 is the balance of gross photosynthesis (gross ecosystem exchange; GEE), and Ecosystem respiration by autotrophs and heterotrophs (R). Observed differences in annual NEE between locations may be attributed to climate, nutrition, biome type, physiological differences associated with age, and time since major disturbance (Valentini et al. 2000; Schulze et al., 1999; Schulze et al. 2000). Observations of biospheric fluxes will be used to quantify the spatial differences in net biosphere- atmosphere carbon dioxide and water vapor exchange rates that are experienced within and across ecological and climatic gradients; this information can provide ground truth data for calculations of carbon exchange that are generated by regional and global carbon balance models that are forced with remote sensing information if the spatial heterogeneity of land- cover is taken into account. Another area of investigation is to examine temporal dynamics and variability (seasonal, inter- annual) of carbon, water and energy flux densities. This analysis is needed to examine the influences of phenology, drought events, heat spells, length of growing season, phenology and presence of snow cover at the canopy- scale as well as to quantify the sensitivities of carbon dioxide and water vapor fluxes to changes in solar radiation, temperature, humidity, soil moisture, photosynthetic capacity, nutrition, canopy structure and ecosystem functional type.

Biospheric fluxes are also important in the evaluation of the possible carbon source or sink strength of terrestrial ecosystems and evaluation and verification of the carbon sequestration rates. Ecosystem fluxes are an independent and parallel methodology to inventory type measurements of stock changes in order to estimate the rate of carbon sequestration by land activities (IPCC GPG). However, between both approaches major discrepancies still exist, and these need to be resolved in a bottom up and top down approach of verifying the European Carbon balance.

The eddy covariance method, a micrometeorological technique, provides a direct measure of net carbon and water fluxes between plant canopies and the atmosphere (Baldocchi et al., 1988; Aubinet et al. 2000, Valentini et al. 2000). It is a non-intrusive method that has been automated and made reliable under a variety of harsh climatic and remote conditions. The eddy covariance method is able to measure fluxes continuously over short and long time scales (hour, days, seasons and years) with minimal disturbance to the underlying vegetation. The eddy covariance method is able to sample a relatively large area of land. Typical footprints have longitudinal length scales of 100 to 2000 m.

In the current IP the eddy covariance measurements will be carried out in 93 sites (Figure 5), an advance on the 30 sites of the Framework V CarboEurope, particularly for the increase on the representativeness of the land use/cover components. The 93 flux tower site will be organized in a network of "clusters", each of them contains at least 3 sites representing the land use/cover of the region. Within the clusters, main sites will follow the full protocol of measurements as described in Annex, elaborated together with the soil, forest, crop, grassland activities of IP and be delivering continuously for 5 years. Associated sites (AS) will deliver only a sub- set of the full protocol and can be active for only part of the 5 years period (at least 1 year).

The 93 sites have been selected to represent the European major landscape features as well as for the availability of "in situ" infrastructure and expertise to carry out flux measurements (see Figure 5, Appendix 2). The extensive feature of the flux cluster network will be also used to design an optimization scheme for the future of the operational carbon monitoring system based on ecosystem flux variability and contribution to the overall carbon balance of Europe.

Objectives

- to provide flux data of carbon, water and energy from representative land use/cover types of Europe
- to understand the relationship between climatic variability and the fundamental carbon fluxes (GPP, NEP, R) for different vegetation and land use types
- to validate ecosystem models parameterization with "in situ" observations
- to provide data on fluxes of non- CO_2 trace gases
- to provide an optimal design for an operational long term system for monitoring the carbon balance of Europe and of European countries.

Deliverables

- a comprehensive data base of carbon, water and energy fluxes and their associated variables
- Inter-annual variability patterns of carbon fluxes for different land use/cover
- Partition of ecosystem carbon balance into its components for different land/use cover types in Europe
- Data on non-CO_2 trace gases for selected ecosystems
- Data on soil respiration
- Prototype design of future network

Activity leader: Riccardo Valentini, UNITUS (2)
Activity partners: all partners running eddy covariance tower sites **(NUMBERS)**

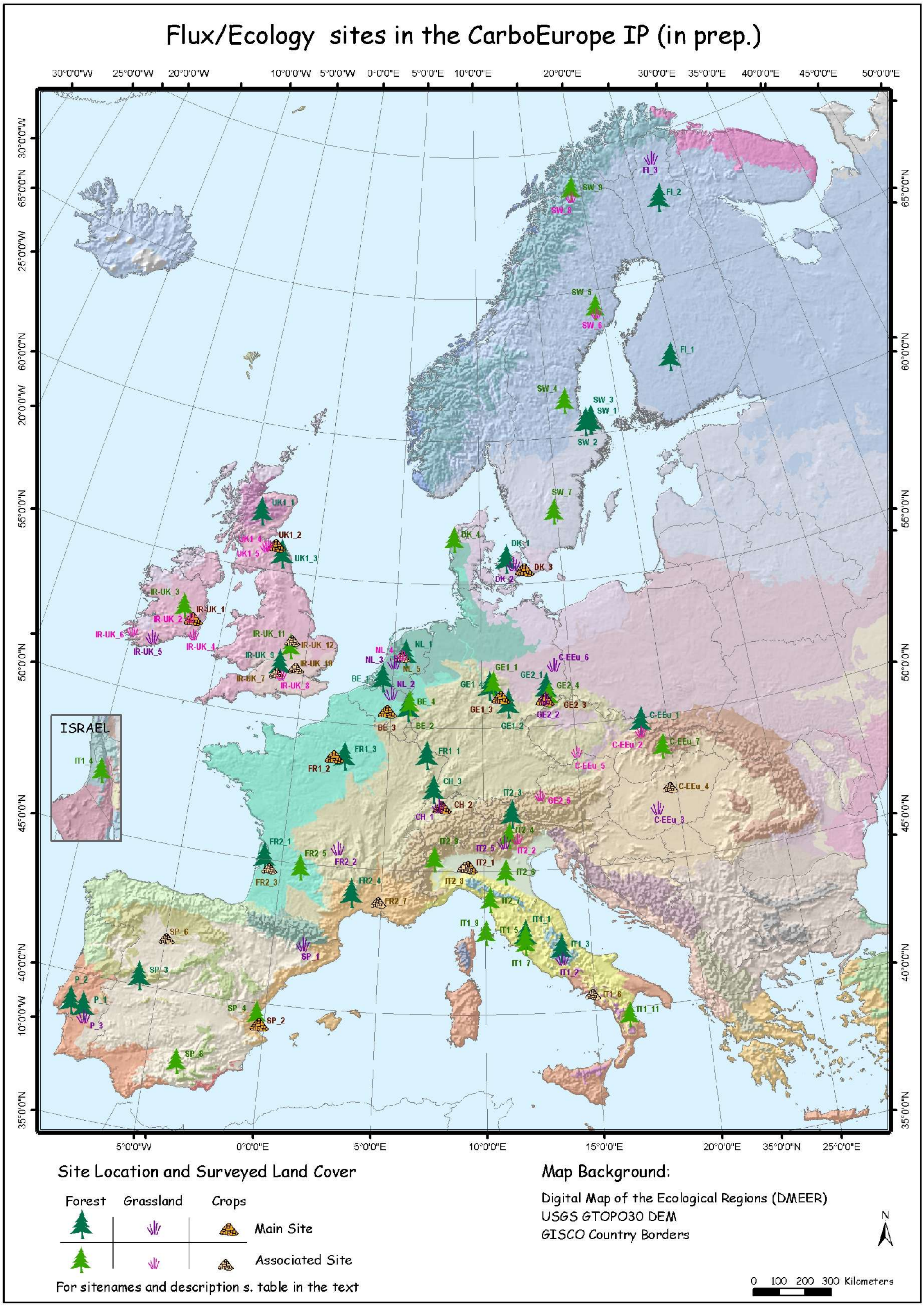

Figure 5 Location of ecosystem sites

Activity 2: Soils (TOO LONG)

Rationale

Existing knowledge of the European flux balance suggests (Janssen et al., 2003), that European croplands are a carbon source, grasslands are a minor sink or carbon neutral and forest are the main carbon sink (NBP=185 gC m^{-2} yr^{-1}), where carbon is being allocated into long-living biomass (75 gC m^{-2} yr^{-1}) and into soils (110 $\pm$ 50 gC m^{-2} yr^{-1}). This latter number was derived from forest inventories as well as from a mass balance approach in which litter fall (leaves and roots) was compared with decomposition and mineralization. Since the aboveground biomass is harvested in managed ecosystems, the soil remains as the ultimate sink (apart for some harvested products), and for verifying the European C balance it becomes utterly important to verify this sink.

Due to the heterogeneity of soils, and the relatively low rate of change in relation to a large existing stock, it is very difficult to demonstrate changes in soil C. Systematic errors may also become important when studying soil C changes over a relatively short period of time. In contrast to the above estimate of (110 gC$m^{-2}yr^{-1}$), direct observations of soils resulted in much smaller C uptake. In a chronosequence of managed forest of *Fagus* and *Picea* the soil C-pool appears to increase by 5 gC m^{-2} a^{-1} over 160 years (Mund, 2003). In the chronosequence approach the comparison of sites introduces additional variability. Therefore the changes of the carbon pools over time were not significant despite of a continuous input of litter of about 300 gC m^{-2} yr^{-1}. If this estimate is true, and not just a result of the site variability, it is necessary to explain the difference between flux balance and the soil C mass balance. In establishing a European Carbon balance, we need to know for different land-use types the status of soils as carbon source or sink.

Following the CarboEurope principle of top down and bottom up verification, the overarching question of the soil activity is

"What is the fate of the organic carbon which enters the soil, and which so far is unaccounted for?"

Overall Objectives

1. To supply the soil information that is necessary to interpret the eddy flux budget at the main tower sites
2. To develop a scheme that leads to a verification of changes in soil C pools
3. To increase process understanding of carbon immobilization in soils

Details of the methodology and feasibility of this activity are given in the Annex

SUMMARISE TASKS

Tasks 1: The soil carbon map

The soils of all main tower sites need to be mapped in a harmonized way. This is a first step to link soil respiration, as measured by the flux sites, to soils. Recent girdling experiments show (Buchmann et al., 2003, Högberg et al., 2000) that soil organisms and roots contribute to soil respiration, but the relative contribution of both components is not constant. It depends on the age and the nutrient conditions of the site. The present task will investigate the soil type, and make an initial estimate of carbon stocks in different horizons as input to the analysis of total soil respiration.

Task 2: Verification of changes in the soil carbon pool

The flux network offers the opportunity to compare and verify the carbon balance as measured by Eddy Covariance by changes in biomass and in soil carbon stocks. Due to the heterogeneity of soils and due to the high carbon pools in soils it is quite clear that a verification of a small flux is difficult, if the measuring period is short, as it is prescribed in the Kyoto protocol (5 years).

Task 3: Compartmentalization of soil C fluxes

The bulk C/N analysis can only give an insight into the mass balance without information about the carbon fraction that is affected nor about the processes that cause this change. Any further analysis requires massive analytical work and cannot be carried out on a large sample size. Therefore a subset of 10 cores will be taken for a detailed analysis of texture, density, ^{13}C, ^{14}C and specific compounds for selected compartments that indicate change.

At this moment it is unclear, which fraction will change and accumulate C. Obviously the light, mobile fraction should respond most, but at the same time there is a significant transport of DOC, in part bound to heavy metals, that appear to originate from old C which is reallocated to deeper layers. Thus, the analyses in Task 3 will lead to a process understanding that can help to improve soil C models in the context of the ecosystem C balance.

Deliverables

- a detailed map of soils in the main footprint area of the towers
- repeated soil sampling which is geo-referenced and detailed enough to possibly detect changes in soil C over a 5 year period

sis of soil compartments which should change in soil C

Activity leader: Ernst-Detlef Schulze, MPI-BGC (1)
Activity partners: 32, 35, 38, 39, 43

So far, this is not innovative, but an indispensable pre-requisite for verification by minimizing the limit for measuring detectable changes in soil carbon stocks, Kyoto-relevant because the compartmentalization allows to determine the direction of change (helps to show whether soil is not a source of carbon), and necessary to understand NEE and allocate carbon fluxes to the components of the UNFCCC reporting formats (biomass, soil, products and fractions of those).

Links to other workpackages and super-sites, which are also covering soil
WP soil should cover the methodological meta-structure for soils (stocks and fluxes)

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Activity 3: Forest

Rationale

Forests occupy about a third of the European land area, and contain six billion tons of carbon in woody biomass alone. Most of these forests are already highly managed, but not for carbon storage. However, in their present state they are thought to constitute a carbon sink of about 0.47 Pg yr^{-1} (Papale and Valentini, 2003). More work is needed to understand the carbon transfers between biomass, soil and atmosphere in order to reduce the uncertainty in the magnitude of this sink; especially to understand the impacts of (i) warming and N-deposition and (ii) a wide range of silvicultural practices associated with afforestation and reforestation. In order to have a complete understanding of the basic processes which makes up the forest carbon balance, "in situ" observations of carbon pools and their changes need to be carried out in the same site where flux measurements are taken. Standard and new methods such as hemispherical photography will be used to measure the spatio-temporal variation of leaf area index (LAI) in the canopy. We will also try to link carbon fluxes to forest inventory data and to forest yield tables to enable upsaling.

Objectives

- To provide data on vegetation, NPP and its components at the forest main sites of the cluster network
- To provide relationships between NPP and NEP and forest structure, age, potential warming and nitrogen deposition
- estigate the effects of management and disturbance, including afforestation and reforestation net carbon balance.

Deliverables

- data on vegetation, NPP and its components at forest main sites of the cluster network
- improvement model parametrizations with effects of age structure, silvicultural practices, nitrogen deposition and warming
- n effects of land use changes on carbon sequestration
- data and albedo

expansion of inventory protocols for needed parameters e.g. fish eyes to estimate the active LAI, could maybe be explored.

N deposition?

Activity leader: John Grace, UEDIN (5)
Activity partners: all ecosystem sites with forest **(NUMBERS)**

Activity 4: Cropland

Rationale

Cropland covers over 23% of Europe's land surface. Cropland accounts for both the largest carbon emission in Europe (up to 300 Tg C y^{-1}) and the largest uncertainty in the European carbon balance (Janssens et al., 2003). The cropland activity will collate cropland data from the cluster network, use these to better quantify cropland C fluxes and improve C flux models, and attempt to reduce uncertainty associated with European cropland carbon fluxes. Model improvement and parametrization will also consider a regional approach to take into account differences in crops varieties, management, soils and climate in European farming systems.

Objectives

- to provide data on vegetation, NPP and its components of cropland sites in the clusters network
- to investigate emissions of other GHG gases under different management

ide data of agriclutural practices on soil organic carbon input (root biomass, organic manure, etc.)

s with crop types, management and climate with carbon source and sinks

d its components at the cropland main sites of the cluster network

cted sites

nd management on carbon fluxes from croplands

Activity leader: Pete Smith, UABDN (6)

Activity partners: (NUMBERS) for main flux sites on cropland, data synthesis, meta-analysis and modeling. Associated partners for associated flux sites on cropland, soil aspects and land use modeling.

Activity 5: Grasslands

Rationale

Grasslands account for between 20 and 30 % of the total land area in Europe. Janssens et al. 2003 best estimate suggest that the agricultural sector is adding C to the atmosphere, at a rate roughly similar to 50% of the net forest sector sink. Within the agricultural sector, the uncertainty in the NBP of grasslands is higher than that of the arable land and above 100% (Janssens et al., 2003). Moreover, non-CO_2 greenhouse gases play a large role in the greenhouse gas budget of agriculturally managed grasslands and the corresponding fluxes are currently poorly understood. The factors controlling the carbon fluxes and N_2O emissions in grasslands are specific, as they relate to a large array of management variables (including fertilizer inputs, animal stocking rate…) and ecosystem processes (e.g. competition and secondary succession, herbivory).

Objectives

- to provide ecological parameters and NPP components of the grassland/wetlands sites of the clusters network including harvest and grazing

- to investigate the full GHG balance at selected grassland/wetland sites
pt, calibrate and evaluate a detailed process-based grassland model
ions of grassland types, management and climate with carbon source and sinks
inter-annual and long-term variations in net trace gas (CO_2, CH_4, N_2O) fluxes for grasslands
th semi-natural and intensive management systems,
zation and up-scaling to the European continent for grasslands

Deliverables

- data on vegetation, NPP and its components at the grassland/wetlands sites of the cluster network
- Data on the full GHG balance for selected sites

tion of the grassland model with the first year data and simulation of fluxes from each main
nd site.
luxes of grasslands for climate change, N deposition and agricultural management scenarios.

Activity leader: Jean-François Soussana, INRA (7)
Activity partners: (NUMBERS) for main flux sites on grassland, N_2O measurements, data synthesis, meta-analysis and grassland modeling. Associated partners for associated flux sites on grassland.

Activity 6: Quality control and improvement of eddy flux data

Rationale

Studies of carbon dioxide exchange between vegetation and atmosphere with high time resolution (hour) require that fluxes be measured accurately all day through, i.e., also during night-time. Results from past experiments have shown that there is an anomaly between the flux measured above the vegetation and the sum of efflux from the soil, as measured by soil chambers, and the rate of change of storage of carbon dioxide during stable nights (Aubinet et al, 2000). The cause of these anomalies is not clear and one possible explanation that has been brought forward is that part of the carbon dioxide produced by respiration could be lost by advection. Another uncertainty is the estimation of the storage component. The variation of carbon dioxide concentration below canopy can be quite large and most estimates of the storage term rely on sampling at very few points. The magnitude of this potential error could amount to several tens of percent. The uncertainties on the night flux must therefore be reduced in order to improve the ecosystem carbon sequestration estimations. The relative importance of these processes may vary highly from site to site. It depends in particular on the site topography.
There are several factors affecting the quality of eddy covariance measurements, which are not or only very poorly investigated for long term flux measurements. Because the possible error due to these effects may be up to approximately 20% of the annual net flux, this topic is not only of scientific but also of political relevance. A methodology is therefore proposed to address these issues.

Comment John: The tone is too negative. The last parag is repetitive of the first parag. To be upbeat about eddy cov., I suggest one talks about quality control as being in collaboration with Flux Net members, a total of several hundred sites in the world, and avoid saying that errors are 20%.

Objectives

- to improve the understanding of the atmospheric processes that develop at night in canopies
- to describe the advection and storage during stable nights at four sites characterised by different topographies
- to better quantify the CO_2 fluxes exchanged by ecosystems at night and thus the net carbon sequestration by ecosystems
- Footprint dependent flux evaluations and data quality tests for all cluster sites
- Develop a common standardized and harmonized protocol of quality assurance and quality control (QA/QC) for all the flux sites

Deliverables

- new algorithms for night flux estimation and their implementation
- new algorithms for data treatment and their implementation
- error analysis of the cluster site network
- influence of coupling and decoupling between the atmosphere and the canopy on NEE

Activity leader: Marc Aubinet, FUSAGx (8)
Activity partners: 45 and all eddy flux sites

Component 2. Regional carbon budget and its driving forces ("Regional Experiment")

Rationale and Objectives

Large-scale inversion based sink/source estimates, obtained from a limited number of stations suffer from a number of errors (e.g. Gerbig et al., 2003). Measurements from a single location are not necessarily representative of larger regions or grid cells causing **representativeness errors**. Solving for fluxes that do not evenly influence the overall concentration may cause **aggregation errors** (Kaminsky et al., 2001) and finally, diurnal and seasonal fluctuations in boundary layer heights are usually poorly represented in large-scale transport models, causing **rectification errors** (Denning et al., 1996). Similarly, measurements at a single tower site suffer also from representativeness errors, which renders the information obtained at these sites unsuitable for aggregation to regional scale.

These errors can be substantially reduced when, at the regional level, a good link between the measurements obtained at the surface flux stations and those from continental scale inversions can be established. This is the main aim of CarboEurope-Regional. To achieve this, a region needs to be monitored equally well in spatial and temporal terms. The methodology proposed in CarboEurope-Regional will produce **aggregated regional estimates that can be meaningfully compared to those from the smallest downscaled information that can currently be expected from a continental scale inversion models** (of order 50 km).

The atmospheric boundary layer over a land surface contains a strong signal of both terrestrial and anthropogenic sources and sinks of CO_2 (Lloyd et al., 1996, Bakwin, and Tans, 1995). This property has been used to determine the sink strength of the biosphere in Siberia, the Amazon and Europe (Lloyd et al., 2001, Laubach and Fritsch, 2002, Levy et al., 1998) with varying success. Both Lagrangian approaches, that track a column of air, as well as Euelerian approaches whereby advective terms need to be estimated have been used by various groups (Laubach and Fritsch, 2002, Gerbig et al., 2002). Gerbig et al. (2003) however, indicate that a significant fraction of the information contained in the signature of boundary layer CO_2 is contained in relatively small spatial and temporal scales**. This requires experimental sampling and model development to resolve the diurnal timescale and to be appropriate at spatial scales of less than 10 km.**

To successfully evaluate the mass balance of a convective, daytime atmospheric boundary layer it has to be perfectly mixed vertically and spatially homogeneous. Furthermore a correct estimate of the depth (volume) and its evolution is required and critical to determine the surface source or sink strength. Equally important is an estimate of the entrainment fluxes at the tope of the boundary layer (Levy et al., 1998). In past studies boundary layer data alone have clearly been identified as not sufficient and **data assimilation** with models-estimates of advection, entrainment velocities, subsidence etc, has been required to close the mass balance equation (Fitzgarrald, 2003). This is also the approach we propose to follow.

The advent of small specialized airplanes in the past decade, measuring fluxes at a resolution of 1-2 km and with comparable accuracy to tower fluxes, has greatly increased the possibilities to provide accurate estimates of spatial heterogeneity (see Crawford , 2003 for a review). In a previous FP-5 project RECAB, a European facility and infrastructure was built to use a small low flying aircraft with **a state of the art mobile flux platform to measure surface fluxes of CO2, heat, water vapour and momentum**. Overall, unexpected good agreement was obtained between tower based estimates and those of the Sky Arrow for a number of test sites in Europe (Miglietta et al., 2003).

Atmospheric mesoscale models have now become available for studies of regional CO_2 exchange (e.g. Dolman et al., 2003). This development has been further taken up in RECAB (Hutjes et al., 2002), so that non-hydrostatic mesoscale models can now simulate the surface atmosphere exchange of CO_2 at resolutions comparable to that of flux aircraft and single flux towers (Eastman, et al, 2002, Chevilard et al., 2003). This makes these models excellent tools to act as a host platform for data fusion of field and model data, similar to the use in for instance past field experiments like (e.g Bougeault et al., 1989). A prime requirement to **use these models for CO_2 assimilation purposes** is the existence of a good spatially and temporally distributed map of fossil fuel sources in the region.

Similarly, downscaling techniques based on a Bayesian, Green Function method for determining regional surface CO2 fluxes have been used in first attempts at **inverse modeling at high-resolution regional scales.** For the RECAB winter campaign in the Netherlands considerable reduction in uncertainty was achieved for fossil fuel emissions, indicating not only the strength of the method, but also is usefulness to check fossil fuel emission inventories.

To separate the biospheric contribution from the anthropogenic (fossil fuel) fluxes tracers are needed. CO is a tracer that shows considerable promise in this respect. As, in the absence of large scale fires, the biogenic CO fluxes are negligible, CO can be used as air mass tracer to eliminate the influence of anthropogenic CO2 advected into the area. We will check this more routine measurement with higher precision, but more expensive C^{14} measurements at two locations.

We propose to execute the experiment in South West France, the les Landes region to **obtain for the first time a spatially explicit regional carbon balance for a full year**. The les Landes region is chosen because it has i) identifiable large areas of homogeneous land cover, ii) at its western edge is is bounded by the Atlantic Ocean, providing an influx of clean air, iii) it contains one major city that allows estimation of the fossil fuel contribution, iv) it has a clear boundary at is Southern edge, the Pyrenees and v) previous atmospheric and hydrological experiments in the region have provided an excellent background data set on soils, vegetation, climate etc. CarboEurope Regional will for the first time establish a true and **testable link between the local and continental scale carbon balance.**

Objectives

- To determine the spatially explicit regional balance of CO_2 an area (500*500 km) in South West France at a minimum resolution of 1-2 km,
- To determine the seasonal evolution of the regional carbon balance

- To develop downscaling techniques to determine the variation in biospheric activity over such a region from larger scale (inverse) models

Methodology

We propose to have a one-year, high intensity experimental campaign in an area that is "measurable"; where we can close the carbon balance i.e. where we both know the fluxes and the advective terms. The area chosen is in South West France including the les Landes forest, the city of Bordeaux and a large agricultural area to the East. The area is chosen because of the good contrast in sea and land, several large areas of identical land cover and existing high-resolution databases and extensive modelling experience of CNRM at Toulouse. The project will have four work packages and will have a test experiment in 2005 and the full one planned in 2005 (autum)-2006 (autum).

The area for the regional experiment is shown in Figure 6.

INSERT FIGURE (satellite picture of Bordeaux region?)

Figure 6 Area for the regional experiment

Figure 7 shows a graphic representation of the relation between the various components of experiment. We propose to install a set of ground based surface flux measurements, extra radiosoundings and wind and temperature profilers and perform aircraft measurements with low flying flux aircraft, perform boundary layer sampling with small commercial aircraft, and perform longer trajectories with a research aircraft. At the in- and outflow boundaries of the domain we will install at two tall towers high precision measurements of CO_2 and ^{14}C and CO.

A special observation period (SOP) of 4 weeks in the summer of 2006 will have high intensity observation of boundary layer development and extra flux aircraft for enhanced spatial sampling. The high temporal resolution will allow us to better parameterise our models to deal with rectification effect. We envisage the deployment also of an extra low flying aircraft with a remote sensing platform, that will enable us to assess the spatial heterogeneity of the area in greater detail and will provide important data for use in improving and testing future and current satellite retrievals.

This set-up will be used to close the top down atmospheric carbon balance of the region. We will apply also bottom up modelling to account for the slowly varying processes. We will produce a downscaled synoptic weather analysis at 8 km resolution by our French partner at CNRM, Toulouse, allows the use of bottom up estimates using biogeochemical models for periods of up to 20 years.

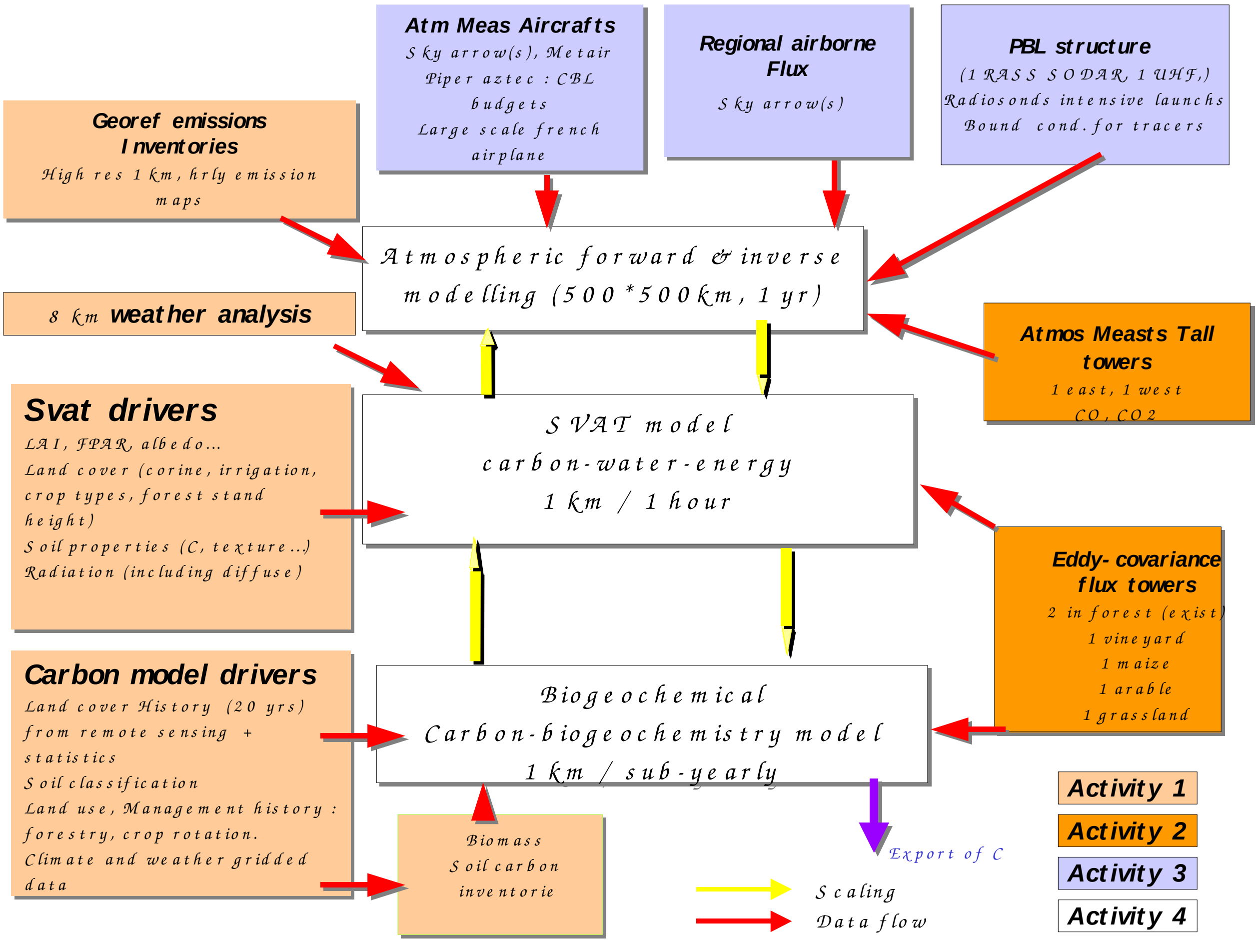

Figure 7 Relation between the activities in the regional experiment

Activity 1: Experiment planning and data consolidation and management

Objectives

- To collect the main driving climate, weather, soil and land use characteristics of the area
- To produce a 20 year dataset of downscaled weather of the region at 8 km
duce a 1 km resolution database of fossil fuel emission for the area
o-referenced set of forest growth and land use data from 1980
nd deployment patterns for the experimental aircraft and ground based systems (TOO mention in TEXT)
accessible system for data storage and archival for all regional modelling efforts (TOO n TEXT)

Methodology

Task 1.1 A considerable amount of the required data has been collected by CNRM for HAPEX-Mobilhy and subsequent hydrological monitoring efforts. This data will be made available for the project and extended where needed. The data consists of land cover maps and associated biophysical characteristics like albedo, roughness, etc. and soil types with associated hydraulic characteristics. New is the development of databases that are required to model the slow carbon storage, e.i. soil carbon, forest biomass, and fossil fuel emissions. For each of these three sets of data new maps at 1 km resolution will be produced. These concern also land cover history from remote sensing and regional statistics, management history and crop rotation at the level of detail to which they remain reliable. It is important that these data are available through a single institution and are maintained at a high level of accuracy. This will be at CNRM in Toulouse. The University of Stuttgart will downscale the regional level emission maps to a 2 km resolution using regional level emission data and land cover maps.

Task 1.2 We plan to execute a small test campaign in spring 2005 to determine the best deployment strategy of the instruments. We will also use this test IOP to acquire high- resolution remote sensing images of the area from the Sky Arrow research aircraft. On the basis of the results from this experiment we will fine tune our experimental plan for the year-long IOP. We pan an extra intensive period in the IOP (EIIOP) when the biospheric activity is high, i.e. in the summer of 2006.

Task 1.3 On the basis of existing data on mesoscale weather at CNRM weather we will use regional inverse models to indicate where flight patterns are best positioned so as to best reduce uncertainty in a priory estimates. This will produce an experimental plan in which the systems are deployed in those areas where they give the greatest contribution to efforts reducing the uncertainty in the a-priory estimate. This will also indicate the preferred time frequency of the measurements and the preferred mode of operation e.g. Lagrangian vs Eulerian. Preliminary testing of this plan is foreseen in the test IOP early 2005.

Task 1.4 We plan to update the French mesoscale model MesoNH with the capability to transport CO2, RAMS already has that capability**.**

Activity leader: Joel Noilhan, CNRM (9)
Activity partners: 3, 4, 6, 56

Activity 2. Intensive Observation Period i) surface flux and tall tower measurements.

Objectives

- To take measurements of CO2 fluxes and energy balance above the main vegetation types in the region during the five year period and during the IOP's
- To take high precision measurements of CO_2 and ^{14}C, CO at two tall towers at the in- and outflow of the domain.

Description of work

Task 2.1 Biospheric surface fluxes of heat momentum, water vapour, CO_2, and, at some sites, O_3 and N will be measured half-hourly using the eddy covariance technique over a representative set of sites. Four permanent sites will be monitored continuously during the entire project. Two of them are main sites of the Southern French *supersite* led by INRA, i.e. one grassland (Laqueuille) and one 35 yr-old Pine forest (Le Bray) monitored since 2001 and 1996 respectively. The two supplementary sites are a forest clearcut regrowing since 1999 (Bilos) and a vineyard (Couhins), respectively. Additional temporary sites will be added for completing the ground flux network during the extensive measurement campaign. They will be measured using portable systems such as a battery-powered open-path system. These systems will be cross calibrated with continuously running systems operating over the main permanent sites. As far as possible, the main land use types will be covered and e.g. a maize crop and a winter crop would be added (how important are these in terms of area and flux?). Mainly other participants of the consortium will manage these temporary sites. Their location will be chosen during the first stage of the project. The sites are listed in Table 1.

Task 2.2 At the inflow and outflow positions of the domain (near Toulouse and Bordeaux) we will establish two towers with high precision gas chromatographs to measure the concentrations of CO_2, and C^{14}, CO. Contacts have been made with the owners of the towers and permission to use them has been granted. The implementation will start in summer 2005.

Activity leader: Denis Loustau, INRA (7)
Activity partners: 4, 9, 13

Activity 3. Intensive Observation Period ii) Boundary layer and plane measurements:

Objectives

- To perform regular measurements of the fluxes of heat, water vapour, CO_2 and momentum with a low flying research aircraft (Sky Arrow)
- To perform regular flight with a small commercial to sample the boundary evolution of CO_2, C^{13} and CO
- To perform at fixed locations (see WP1) continuous measurements of windspeed in the boundary layer with a UHF profiles and windspeed and temperature with a RAS-Sodar system
- To perform twice daily radio soundings at a regular radio sounding site in Bordeaux, augmented with an intensive campaign in the summer of 2006 where bi-hourly releases will track the evolution of the boundary layer.

Description of work

Task 3.1 One Sky-Arrow of the Italian partner fully equipped for flux measurements will be used during the whole campaign from 2005-2006 to perform at least weekly flight in the summer and bi-weekly flights in the winter and autumn period. A second plane will be used in the high frequency observing period in summer 2006 to make additional fluxtransects when the biospheric activity is at its peak. One of the planes, equipped with high resolution remote sensing (visible-infrared) will also make high- resolution images of the area in the visible to infrared wavelengths.

Task 3.2 At selected periods we will use the Sky Arrow to fly transects downwind of the major cities in the area, Toulouse and Bordeaux to have independent checks on the emissions of large cities. This technique was first applied in Rome, and proved to provide highly reliable numbers for CO_2 emission rates.

Task 3.3 A small commercial plane will be rented locally and be used to sample the boundary layer structure for CO_2, C^{13} and CO at weekly intervals and at several occasions during the SOP at high frequency (several times a day) to sample the diurnal evolution. The samples takes will subsequently be analysed in the laboratory of our German partner, MPI-BGC.

Task 3.4 The structure and evolution of the boundary layer is of crucial importance in efforts aimed at improving our regional estimates, so considerable effort is put in acquiring high quality data. We will extend the routine WMO observations at Bordeaux and perform special high frequency soundings during the SOP in the area. Two continuous boundary layer monitoring systems, a UHF windprofiler and a RASS-Sodar system will be used to get continuous measurements of the structure of the PBL and its diurnal and seasonal evolution.

Activity leader: Franco Miglietta, IBIMET-CNR (10)
Activity partners: 1, 3, 9

Activity 4. Modelling, integration and overall management

Objectives
- To manage the CarboEurope- Regional component
- To develop a data fusion system that produces the best possible estimates of the regional carbon balance
- To produce a long term (20 years) bottom up estimate at 1 km resolution of the carbon balance of the region
- To produce a spatially explicit carbon balance at 1 km resolution for the region from autumn 2005 to autumn 2006
- To separate the biospheric sink in the region from the contribution of anthropogenic sources

Description of work
The main purpose of this workpackage is to provide estimates of the carbon balance of the region using all available data and atmospheric model information. This is done for the slow and fast cycle in a slightly different manner.

Task 4.1 For the slow cycle (explain what is slow), we will use the 8 km resolution downscaled weather information that is available at CNRM and will be extended for use in biogeochemical models. These models will be calibrated with flux data for the main land use types and then run for a 20-year period. The required input data on land use history and management is obtained in WP1. The models we intend to use, comprise Orchid, LPJ, ISBA-A-g_s, etc.?

Task 4.2 For the fast cycle (explain) we will use a data assimilation system at mesoscale that mirrors the system developed for the large scale (CAMELS and integration component). We will mainly use the French Arome system developed at CNRM for this purpose and extend it to carry CO_2 in the assimilation procedure. We will also use the high-resolution meso-scale analysis to drive regional inverse models that will use Bayesian green functions to downscale the CO_2 concentrations and fluxes to grids of a few kilometres. This will provide additional checks on the fossil fuel inventory and give an estimate with uncertainty ranges of the biospheric fluxes of the region. We will run both analyses for the full annual cycle.

Task 4.3 Forward mesoscale models with advanced and calibrated land surface schemes will also be run for the region and produce regional scale estimates that can directly compared to those of the EuroGrid. Models used wil be Meso-NH, REMO, RAMS and Arome.

Task 4.4 We purposely include the management of this component in the integration activities and workpackage as this facilitates good planning of the experiment and integration of the several components afterwards. The task leader of integration is also the co-ordinator of the component, facilitating again the overall management of the component.

Activity leader: Han Dolman, VU-A (3)
Activity partners: 3, 9, 13, 27

Deliverables

1.1.Maps of soil (structure C-content) for fast and slow carbon models
1.2 Maps of land use for carbon carbon models
1.3 Maps of biophysical parameters (albedo, roughness etc),
1.4 Climatology based on downscaled synoptic weather dat at 8 km resolution
1.5 High resolution assimilated mesoscale weather.
1.6 Fossil fuel inventory at 1 km resolution.
1.7 Experimental plan for the test IOP and the yearlong IOP with EIIOP

2.1 Set of flux data for the main vegetation sites
2.2 Set of flux data for two additional sites for the IOP
2.3 Set of CO2 concentration measurements and CO and C14 at the two tall towers.

3.1 Datasets of fluxes of watervapour, heat, momentum and CO_2 for selected transects during the test IOP, the IOP and EIIOP.
3. 2 Emission checks on city fluxes with the flux aircraft
3.3 Datasets of convective boundary layer structure from UHF and RASS
3.4 Datasets of boundary layer evolution with radiosounding
3.5 Datasets of concentrations of CBL

4.1. Bottom up Estimates of the regional carbon balance at 2 km resolution for 1980- 2005
4.2 Top down Estimates of the regional carbon balance at 2 km resolution for 2005 and 2006 obtained by the data fusion system
4.3. Data assimilation system capable of fusing land surface, remote sensing, atmospheric data at regional scale
4.4. Ensemble runs of forward regional mesoscale models

Component 3. Continental carbon budget and its driving forces ("Atmosphere")

CO/CO2: the ratio may change over time and regions, depending on fossil fuel mix. Explain how to deal with it.

The state of the art Atmospheric Observing System

The existing atmospheric observing network builds upon the scientific heritage of the former EU and National supported efforts over at least the last decade. More recently, as part of FP5, within projects AEROCARB, CHIOTTO and TACOS, we have set up a coordinated pilot European Atmospheric Observing System to demonstrate the feasibility to infer the Europan carbon balance by means of inverse modelling. We also built up the capacity to measure a suite of carbon cycle related tracers for attributing variabilty and trends in concentrations to the underlying processes : fossil fuel emissions, air-sea exchange and ecosystem sequestration. The pilot Atmospheric Observing System is composed of four complementary components :

- A network of 8 ground level CO_2 and Rn-222 stations with continuous *in situ* measurements, at a „ring“ of background sites along the boundaries of Europe and stations in the interior of the continent at about 2000 km spacing,
- A network of 8 tall towers with continuous in-situ CO_2, CH_4, N_2O, SF_6, CO, O_2/N_2 and Rn-222 measurements,
- A network of 6 aircraft vertical profiles at bi-weekly frequency, including both flasks and at some sites continuous CO_2 and CO soundings, and
- Flask sampling of tracers at 21 air sampling sites within Europe and over the adjacent oceans, with high-precision analysis of CO_2, CH_4, N_2O, SF_6, CO, O_2/N_2, and $\delta^{13}C$, and $\delta^{18}O$ in CO_2 in air samples to attribute carbon fluxes to processes

These data are delivered to atmospheric meso-scale and global tracer transport models run in an inverse mode. They are also analysed with help of forward simulations based on different flux scenarios and using a cascade of spatial resolutions of transport and process models.

The proposed enhanced Atmospheric Observing System

Although significant achievements have taken place in Europe to establish a pilot atmospheric network, enhancing, extending and optimising atmospheric observations is needed.

First, the current observing atmospheric network has still insufficient horizontal spatial coverage, and must be expanded over Eastern and Southern Europe. In addition, we have learned that the current sampling frequency of the atmosphere in the vertical domain using aircraft must be increased to constrain regional fluxes, and that the aircraft measurement strategy is likely to be biased towards fair weather conditions. We must increase the aircraft sampling frequency because the „noise“ on concentrations induced by surface-atmosphere fluxes and atmospheric transport variance is high in the interior of Europe. Third, the current sampling stategy near the ground must be optimised to minimise the influence of local sources and small scale transport, and eventually deliver selected atmospheric records that are fully representative of current models resolution, typically 50 km. To cope with these current limitations we propose to build a denser, and well inter-calibrated Atmospheric Observing System suitable to determine regional fluxes of CO_2 and other greenhouse gases at a typical scale of 100-500km over the whole of Europe. This will be achieved by meeting the following specific objectives :

- Extending the atmospheric network spatial coverage over Southern and Eastern Europe, by adding new continuous monitoring stations,
- Increasing the frequency of vertical profile sampling through the Planetary Boundary Layer and aloft using aircraft from bi-weekly flights to sub-weekly flights, and if possible covering a wider range of synoptic weather contitions,
- Optimising the atmospheric data selection, using *in situ* meteorological data and other tracer data such as Rn-222, to extract from continuous CO2 time series representative measurements of regional sources and sinks activity

The guiding principles for reinforcing the existing Atmospheric Observing System and installing new stations, or new species measurements, should not only rely on atmospheric inverse models predictions, but also on geography, and on our present knowledge of regional fluxes across the various European ecosystems and industrial regions. The reason for this is that we already have some “a-priori“ knowledge of ecosystem source/sink distribution in Europe, as delivered from the FP5 CARBOEUROPE components; and this inforrmation must be used in the atmospheric approach. Further, we expect the other components of CARBOEUROPE-IP to deliver improved bottom-up estimates of ecosystem fluxes and fossil fuel emissions. These new assets will be used synergetically with the enhancement of the top-down atmospheric observations within a dual constraint, because results from one approach often place valuable constraints on the workings of the other two.

Phased implementation of the enhanced Atmospheric Observing System

Consolidate and ensure continuity of the already established atmospheric observations

Some of the newly installed aircraft profiles within AEROCARB and all tall towers within CHIOTTO should be extended over a continuous period of observation during FP6. Database activities, calibration and intercomparison programmes between existing stations must be continued, even after the FP5 projects will have terminated. Optimal sampling, data selection and calibration protocols will in the mean time have to be implemented, with past data re-corrected whenever necessary. Real time data transmission of in-situ CO2 records might be considered in linkage with the GMES initiative, to prepare the conditions for pre-operational analysis of CO2 fluxes.

Establish a methodology to separate fossil and land atmosphere fluxes

The use of CO as a combustion tracer will be generalised as a tool to identify the fossil fuel fraction of CO2. Investigation of fossil fuel emissions in Europe within AEROCARB showed that large temporal and spatial variations exist in their CO/CO2 ratios. A method to accurately determine mean CO/CO2 ratios of European fossil fuel emissions therefore needs to be implemented which is based on an ongoing „calibration“. In order to do so, continuous measurements of CO will be needed at ground level regional stations, located in the vicinity of industrial highly populated areas, accompanied by (weekly integrated) 14CO2 observations for calibration. For important polluted regions where no continuous CO and CO2 observations are available, episodes will be systematically sampled for CO2, CO and 14CO2 measurements to quantitatively determine the CO to fossil fuel CO2 ratio to optimally use CO as a proxy for fossil CO2. Additionally, we will explore the potential of O2/CO2 ratios to disentangle fossil and land atmosphere fluxes.

Planning to install remote sensing instruments of CO2 column integrals
The construction of such instruments will have to rely on spectroscopy expertise already existing within several institutes in Europe and on ongoing technological developments within the USA. Several Fourier Transform Infrared (FTIR) instruments have been operated around the world for a decade or so and inversion of the daily recorded spectra show their capability to measure CO2 and CH4 column integrals with an accuracy of typically 0.5% (3 ppm). Installing such instruments in Europe at few locations (NDSC Network) would provide the basis for cross checking the variability in column integrals with the one of in-situ measurements, and will prepare an efficient validation of future satellite measurements. **Funding for the installation of a small targeted network of upward looking CO2 spectrometers in Europe will be requested from the European Space Agency** (ESA), and if supported, these data will be included in the Atmospheric Component of CARBOEUROPE-IP.

Rationale and objectives

The atmosphere is a fast but incomplete mixer and integrator of spatially and temporally varying surface fluxes, and so the distribution and temporal evolution of CO_2 in the atmosphere can be used to quantify surface fluxes, using numerical models of atmospheric transport.. This approach is known as inverse modeling. However, the atmospheric approach to derive fluxes from observations of concentration on a regional scale needs sites better adapted to the specific circumstances at the regional level, where the precision and representativity of the measurements should match that of the involved major source and sink processes. Because of their long atmospheric life times, the horizontal gradients of greenhouse gas concentrations, which carry the information on the magnitude and spatial distribution of sources and sinks, are quite small, and difficult to detect with a network of stations typically spaced at 2000 km.

Consider uptake by European forests as reported by forest biomass inventories as an illustration. Naaburs et al. recently estimated a sink of 0.3 PgC y-1, located in central European and Nordic forested areas. The induced annual mean horizontal CO_2 gradient induced by this forest uptake would be 0.1 ppm/day in the entire air column over this forested region or 0.3 ppm/day if confined to the boundary layer. This gradient can be captured with the current network of high precision atmospheric stations within Europe. Consider now the release of fossil fuel CO_2 from the Paris urban area, that is 7 million people over 2500 km^2 with a per-capita emission of 712 gC per day. Locally, the emissions from Paris would add 4.6 ppm/day to the boundary layer. This is a higher signal than the one from European forest uptake shown above, but the individual flux from Paris will be more difficult to infer from stations that are presently located at best 1000 km away from the source.

If we are to infer CO_2 fluxes at the **regional level** from atmospheric concentration gradients, it is thus necessary to **sample close to the Earth's surface**, on a continuous basis, and from a higher network density of stations to best capture the signal of surface fluxes. As the variance of the measured concentrations is the most relevant quantity for the precision achievable with inverse calculations, the number of measurements should be as high as possible. In addition, because of the interannual variability in ecosystem carbon exchange, largely driven by changing climate patterns that is superimposed on the mean carbon balance of Europe, we need **long time series** in the atmosphere. The challenge is to operate atmospheric measurements for several years at very high precision, with a stringent quality assurance procedure to check on possible drifts in calibration scales or inter-laboratory differences.

The overarching goal of the Atmospheric Component of CARBOEUROPE is to build the Atmospheric Observing System needed to quantify the European carbon balance and its regional distribution.

The road towards that goal is paved with the following sub-objectives :

- Provide the high precision atmospheric concentration measurements needed to document the contribution of Europe to the Northern Hemisphere carbon budget, placed in the global context,
- Provide the atmospheric concentration time series needed to quantify the inter-annual variability in the European carbon balance, in relation to the controlling mechanisms,
- Provide the high-frequency atmospheric concentration measurements needed to invert sources and sinks at the sub-continental level within Europe, with typical resolution of sources and sink of at least 500 km,
- Develop innovative methodologies using carbon related tracers and isotopes to attribute the CO_2 concentration in the European air shed to each of the components of the fluxes : fossil, oceanic, and terrestrial.

As an added value, and although the focus of our project is CO_2, **CH_4, N_2O, and SF_6 will also be analysed** on a large number of samples, which will provide better understanding of the European sources of these species.

Methodology

The atmospheric CO2 and auxiliary tracers measurements delivered by the Atmospheric Observing System of CARBOEUROPE will serve to quantify the

European carbon fluxes quantified using different atmospheric transport models in an inverse mode. Integration of a continental atmospheric network of CO_2, CH4 and carbon cycle related tracers in Europe is under achievement within FP5, and the approach has demonstrated its potential to downscale carbon fluxes from the hemispheric scale down to the European continent (>1000 km). Obtaining sub-continental flux estimates, with a spatial resolution of at least 1000 km, that are required to verify bottom up model estimates and eddy covariance towers up-scaling results is the next step. This will require a denser atmospheric network than what is already in place. The deployment of such a network has to account for the high diversity of landscapes and the ubiquitous presence of sources releasing fossil fuel CO2 in Europe.

Ideally, to achieve the goals of the proposal, a measurement network would provide us with continuous high accuracy recording of the complete fields of CO2, CO and CH4 and their isotopes as well as a suite of transport tracers like SF6 and 222Rn in the lowermost 3 to 4 km of the troposphere. While the CO, CH4 and 14CO2 fields would give information on fossil fuel and fossil fuel gas contributions to the observed CO2 field, 13C in CO2 would give information on land- biosphere atmosphere CO_2 exchange and transport tracers would help to test the realism of the simulation of air exchange between the planetary boundary layer and the free troposphere in models. The spatial structure of the data - horizontal concentration differences as well as differences between the planetary boundary layer and the free troposphere - and their interpretation with modelling of atmospheric transport would then permit to estimate carbon sources and sinks with high accuracy and high spatio- temporal density. This would build a base for further comparison with process studiescarried out in the Ecosystem Component, to gain insight on the underlying mechanisms which control the European carbon balance.

The current technical possibilities do not permit such high- density and accurate sampling with affordable effort. Measurement methods probe currently small air volumes either continuously (CO2, SF6, CH4, CO, N2O, 222Rn, O2/N2) or on discrete basis (e.g. weekly) with the help of flask sampling and subsequent analysis in the laboratory (13CO2, 14CO2, ...). Continuous analyzers can in principle be used in aircraft to obtain vertical profile information, however the running and personal costs for this approach limit the density in time and space of this approach. The proposed Atmospheric Observing System thus consists of eight complementary activities that use a balanced choice of sampling and measurement strategies to obtain as complete a representation of the CO2 field across Europe in the planetary boundary layer, and as far as possible, also of the concentration differences between the planetary boundary layer and the free troposphere. One important consideration underlying the sampling design is to try to take advantage of the mixing processes in the planetary boundary layer which smooth the high variability of land- biosphere atmosphere exchange CO2 signals close to the ground. Thus, the seven complementary activities which will form the core of the European Atmospheric Observing System are :

- A network of **ground based stations** measuring CO2 and Rn- 222 located at „background“ locations, both around the coasts of Europe, and inside the continent on top of mountains. Sampling at these ground based stations is continuous (Figure 1). This network provides the „backbone“ data to estimate continental fluxes.

- A network of **tall tower stations** that are located roughly on a grid with horizontal distance on the order of 2000 km (Figure 2). Sampling at the tall towers is continuous and a suite of gases is measured (CO_2, CH_4, N2O, SF_6 and CO). In the afternoon, the measurements at the top of the towers sample the well mixed portion of the planetary boundary layer. At night, the concentration profiles along the masts is more related to local respiration sources. This innovative tall towers network will enable us to resolve regional fluxes.
- A ring of **weekly flask sampling** stations along the coastline of Europe, completed by high altitude sites in the interior (Figure 3). Flask samples characterize boundary values of oceanic and free tropospheric reference CO_2. In addition, air in flasks gives access to isotopic signatures and carbon cycle tracers of extraordinary value to apportion the fluxes into fossil, oceanic and biospheric components.
- A transect of **vertical aircraft profiles** of *in situ* CO_2 and flask sampling at key locations where there is also a tall tower station. Airplane profiles will give guidance under which synoptic conditions the tall tower afternoon measurements are representative for PBL values. For the first time, airplanes will probe frequently enough across the entire lower troposphere to deliver high-resolution snapshots of concentration fields that will place a stringent constraint on vertical mixing in transport models, one of the largest sources of uncertainties in current inversions.
- A powerful **quality control system** for atmospheric measurements, based on frequent exchange of intercomparison material for flask analysis and *in situ* stations. Rigorous inter- comparison procedures will detect differences between the European laboratories contributing to the Atmospheric Observing System. Use of this information will greatly improve calibration and measurement protocols, enabling us to reduce over time inter- laboratory differences in measurement scales, and *in fine* to safely merge European data with those of other international networks.
- A network of stations to quantify the fossil fuel component of atmopsheric CO_2 over Europe using radiocarbon (14CO_2) and Carbon Monoxide (CO) measurements. Ingeborg add few good sentences
- A pilot network of **CO_2 concentration records on top of selected eddy covariance towers**. Establishing this pilot network will require a feasibility study to obtain calibrated CO_2 concentration records of moderate accuracy (± 0.5 ppm) at eddy- covariance towers and to test using transport models models constrained with the meteorological and heat flux information from the towers, how such an extension of the Atmospheric Observing System constrain regional fluxes.

Those seven complementary activities will map the CO_2 distribution over Europe with a spatial density of stations and a sampling frequency that is three to four times higher than currently operating over any other region in the world. Based upon these systematic observations, a detailed quantitative “top- down“ estimate of the European carbon balance will be obtained by using **multitracers measurements on air samples**, and by applying **mesoscale transport models** run in an inverse mode, as described in the Integration Component. In return, we will perform model simulations of the atmospheric „network design“ to refine our sampling strategy for adding key stations and optimally sampling vertical profiles.

Activity 1 : Ground level station measurements of CO_2 and Rn-222

Rationale

Europe has a historical leadership in monitoring continental CO_2 concentration in the atmosphere. A number of 13 continuous stations are already in place (Table 1 ; Figure 1), with some records covering more than two decades. They comprise :

High altitude stations such as Plateau Rosa (I), measuring the baseline free-troposphere reference,

Coastal stations such as Mace-Head (Ir), acting as fenceposts to measure the boundary conditions of air coming into or going out of Europe,

Mountain stations of moderate elevation such as Schauinsland (G) measuring the variability and the mean concentration signal related to regional and continental sources inside the continent.

These observations are often funded by national programmes, but need to be strongly supported in CARBOEUROPE-IP for ensuring that the records are available to a wider community, for bringing together the different groups involved in atmospheric CO_2 monitoring, and in the longer term for standardising the measurement and calibration protocols used. We must also continue to support the development of **data selection** procedures at each site. The main issue to interpret ground level records is indeed representativity, i.e. how to compare point-wise station records[i] with transport model results of typical 50 km resolution. Thus, a careful data selection must be applied to these CO_2 records, based on meteorological criteria and if possible on other tracers, to optimally use those records in models. With that respect, Rn-222, a radioactive noble gas with half life of 3.8 days can serve as a tracer of PBL and synoptic transport processes and proves to be very valuable for selecting CO_2 data and evaluating when and where transport models can best represent observations.

Objectives

- To provide quality controled CO_2 records from 13 existing ground level stations in Europe,
- To provide quality controlled continuous Rn-222 measurements at all CO_2 stations for validating transport models and enhancing data selection,
- elop new data selection procedures at each station for obtaining CO_2 records representative onal fluxes and expurged from local influences,

Task 1. The European network of CO_2 stations

In situ hourly mean CO_2 concentrations and meteorogical data from all ground-level stations in will be collected from 11 participating laboratories, documented, and delivered to the database in a harmonized format. Useful data products such as statistics on concentration variability, seasonal cycles, monthly means will be computed and placed in the database. These data and meta-data will be documented and updated each 3-month, to be efficiently used in atmospheric transport modelling studies. Gradients among sites will be interpreted in terms of regional carbon fluxes.

Task 2. Co-sampling of Rn-222 at the stations

Rn-222 is a tracer of air masses under recent continental influences of air masses that is widely used to validate vertical mixing (e.g. PBL depth) and synoptic transport in models[ii]. In Europe, a network of Rn-222 stations already exists, but we need to integrate it with CO_2 observations. Then, Rn-222 recorded on a quasi continuous basis (each 1/2 hour) using the active deposit method will be used to select CO_2 data for regional representativity. At present, Rn-222 is monitored at 9 sites (Table 1). We will add Rn-222 measurement systems at all sites.

Task 3. Quantification of representativity „errors" via data selection

Near the ground, the variability in concentrations (e.g. diurnal cycle) is huge, because the air is to a large extent influenced by local sources. In order to filter out the effect of local (few tens of km) variability from the regional signal of use in inversions, one needs to continuously monitor concentrations. *In situ* CO_2 continuous data will be classified into „local" and „regional" using meteorological information, back-trajectory analysis and when available other species records including Rn-222. The data selection procedures are currently empirical. Alternatively, we will test very-high resolution atmospheric transport models fitted with local emission maps to simulate the concentration variability around each site and model the data selection. This exercice will only be carried out at few sites. Site specific data selection procedures will be reported as auxillary information in the database and included as „data flags" on hourly concentration data files.

Activity Leader: M. Schmidt, LSCE (4)
Activity partners: XXX

Activity 2 : Tall towers continuous measurements of CO_2, CH_4, SF_6, N_2O, CO, ^{222}Rn

Rationale

Deriving fluxes from concentrations on a regional scale needs sites adapted to the specific circumstances at the regional level, where the precision and resolution in time and space of the measurements should match that of the major processes involved, and deliver as high as possible „signal to noise" ratios to infer the mean fluxes out of transport and fluxes induced variability. This calls for measurements in the boundary layer. Tall towers are most promising platforms, where the cost of operations can be maintained relatively modest with the opportunity of using existing infrastructure such as TV transmission towers of heights up to 400m above ground in Europe. If the gases are measured at sufficient height above ground, then a fairly homogeneous signal that integrates fluxes over a footprint on the order of a range of 500 to 1000 km is obtained. Furthermore, continuous observations will enable us to optimise the data selection.

We started in 2002 to establish a new network of 8 tall towers in Europe (Table 2 ; Figure 2) that complement the existing ground based stations. Here continuous measurements of CO_2 and other greenhouse gases like CH_4, CO, N_2O and transport tracers like SF_6 and ^{222}Rn will be sampled. At 5 tall towers, eddy-covariance fluxes are also measured, which will provide clues to connect the variability of tall towers vertical concentration profiles to local NEE patterns. We propose to add one tall tower in the Northern Iberic Peninsula at La Muela (Figure 2) at the beginning of the IP, and later on search for suitable tall tower sites in Eastern European undersampled regions (Romania, Ukraine). This network will be completed by two tall towers for CO2 only in Southern France for one year (2006-2007) as part of the Regional Experiment Component of the IP.

Objectives

- Continue to support the operations of 8 tall towers being established in FP5 after this programme terminates in 2005,
- Add a new tall tower with continuous CO_2 measurements only in Northern Spain by 2004, and
sh new methodologies to connect tall towers concentration profile variability to local fluxes

Task 1 The network of tall towers

We will continue to support the routine operations of 8 tall towers once the FP5 has stopped in 2005. *In situ* concentration and meteorogical records from the tall towers (Table 2) will be delivered to the database in a harmonised format compatible with ground level stations data. One additional tall tower will be equipped in 2004 at La Muella (Table 2) and associated to the ongoing FP5 network to better constrain regional fluxes over the under-sampled Iberic Peninsula. Two tall towers respectively near Toulouse and Bordeaux will be added to the network for one year (2006-2007) during the Regional Experiment planned in the IP (Figure 2)

Task 2 Linking tall towers concentration profiles and local fluxes

At tall towers where there are eddy covariance systems measuring NEE, this information will be used to screen out local influences and assess regional representativity of tall towers concentration time series. However, to establish a methodology for systematic upscaling of fluxes by combining tall towers concentration records, remote sensing information and nearby eddy covariance towers is beyond the scope of this task. At Norunda and Cabauw, we will interpret the vertical profiles of concentration in light of nearby eddy covariance data using 1-D or 3-D high resolution transport models. At all sites, the nocturnal accumulation of atmospheric species and Rn-222 in shallow night-time boundary layers will offer the unique possibility to obtain independent estimate of night-time Ecosystem Respiration, using Rn-222 of known sources to quantify unknown respiratory emissions of CO_2.

Task Leader: Alex Vermeulen, ECN (11)
Activity partners: XXX

Activity 3. Flask air sampling for multiple species analysis

Rationale

Flask sampling sites, 21 in total in Europe for 115 around the Globe (Figure 3), collect discrete samples with weekly sampling frequency. Out of 21 flask sites, 12 are co-located with ground stations or tall towers in situ observatories and the remaining 9 sites are „flask sampling only“ stations which complete the Atmospheric Observing System[iii]. In a 2L flask air sample, a wealth of information can be obtained via multiple species analysis of CH4, N2O, SF6, CO, 13C in CO2, 18O in CO2, O2:N2, and in the future 13C in CH4, Ar:N2, NMHCs. Multiple-species analysis will provide key information on processes controling the CO_2 concentration changes. For instance ^{13}C and O_2/N_2 can be used in models to separate the ocean and the terrestrial components in atmospheric CO_2 and SF_6, CO and CH_4 to characterize air masses exposed to industrial emissions, which thereby serve to filter out local influences when selecting continuous CO_2 records. In addition to flask sites operated by ffive European laboratories, flask data from the CSIRO-DAR (Australia) and NOAA-CMDL (USA) air sampling networks will be available to CARBOEUROPE participants (Table 3). One challenge with flask data is to merge measurements from different European laboratories, and meeting this challenge will be met by pursuing vigorous intercomparison activities as proposed in Activity 5.

Objectives

- Operate a unified cooperative European network of weekly flask sampling sites distributed among five laboratories, and
- Use flask multiple-species information to apportion the European carbon balance into components: fossil, air-sea exchange and terrestrial

Task 1. The European cooperative flask sampling network

Five European laboratories : LSCE (FR), MPI-BGC (G), UHEI (G), UNIBE (SE) and CIO (NL), have capabilities to make high precision multiple species measurements in flask air samples. Those laboratories are well experienced working together within EU programmes since more than 10 years. Common work includes analytical developments, sharing of sampling devices and flasks, and frequent intercomparison procedures. We will collect weekly flask samples analysis at 21 European locations for species CO_2, CH_4, N_2O, ^{13}C, ^{18}O, CO and at a subset of stations for O2:N2 (Table 3) as part of a cooperative effort involving Europe, USA and Australia. All flask data will be reported in a harmonized way to the database. Analytical developments for adding new species high-precision measurements in flask air will be vigorously pursued, focused on Ar:N2 (tracer of transport over land); linear NMHC (tracers of air pollution), and 13C in CH4 (tracer to apportion methane sources).

Task 2. Multiple-species interpretation of the European carbon balance

Coordinated flask sampling at aircraft sites, tall towers and ground-level stations will provide multiple species information of unique value to separate air-sea exchange (using O2:N2), terrestrial fluxes (13C and 18O in CO2), and fossil fuel emissions (CO, SF6, NMHCs). The multiple species inferrences will place strong independent constraints on bottom up estimates of the fluxes. In addition, flask data of CH4 and N2O, joint with tall towers records will enable us to infer the European sources of these gases[iv]. We will analyse ^{13}C and ^{18}O isotope records to determine the large scale time-varying isotopic fractionation of European ecosystems via the isotopic source signature of air added to or removed from the mean atmospheric signal. Of particular interest in Europe is how much C-4 agriculture (15% of the European arable lands and 5% of the total lands) contributes to the atmospheric ^{13}C signal.

Activity Leader: M. Leuensberger, UNIBE (47)
Activity partners: XXX

Activity 4. Vertical airplane profiles of **in situ** *CO_2 and flask samples*

Rationale

Because the variance of CO_2 peaks near the surface, due to proximate sources and sinks and variable transport patterns within the PBL, near-ground observations must be extended into the vertical domain. Frequent vertical soundings using small aircrafts is a cost effective solution, provided that continuous *in situ* CO_2 profiles are obtained through the entire PBL up to the free troposphere, alongside with information on the atmospheric structure. Aircraft soundings will be combined with *in situ* continuous tall towers observations ensuring the temporal continuity between two airplane soundings. Synergetic sampling at tall towers and aircrafts will assess representation errors and constrain vertical mixing of CO2 in models, which is a major source of bias in inversions. A network of six aircraft profiles in the lower troposphere between the ground and 3000 metres is now operational on an East-West transect in Europe as part of FP5 (Figure 4). These profiles carried out each 20 days with flask sampling at 10 altitudes constrain continental budgets at typical scales of 2000 km, and deliver an error reduction on the order of 30% at the best on inverted fluxes. In addition, our current airplane sampling strategy is likely to be biased towards fair weather conditions, to an unknown extent because we do not have all-weather data. Therefore, we must increase dramatically the sampling frequency of aircraft measurements and extend vertical soundings to all weather conditions to deliver a powerful constraint to inversions.

Objectives

- Continue to operate a transect of 4 aircraft vertical profiles sites each 20 days with flask sampling at 10 altitude levels within the boundary layer and aloft, in the interval 2004-2006.
- Install *in situ* CO_2 continuous airborne analyzers at 4 aircraft sites, and increase the sampling frequency to each 5 days in the interval 2006-2008.

Task 1. The European network of aircraft sites (2004-2006)

We will continue the effort undertaken in 2000-2003 within FP5 to characterize the vertical gradients of CO_2 and other species in the lower troposphere using small aircrafts. Two aircraft sites among the 6 operating now will however be stopped : Schauinsland in 2005 and Thuringen in 2004 (Figure 4). We will continue to fly small aircrafts each 20 days in the interval 2004-2006 with flask sampling at 10 altitudes in order to obtain a multiple species dataset of 6-years long on an East-West transect across Europe at Hegyhatsall (Hu) ; Byalistok (P) ; Orleans (Fr) ; Griffin (UK). Those four aircraft sites are geographically co-located with tall towers. The aircraft flask results will be reported to the data base together with *in situ* information on sampling and on atmospheric structure (temperature and humidity). Another aircraft site will be installed in Northern Spain (Figure 4) with national funding.

Task 2. The enhanced European network of aircraft sites (2006-2008)
We willenhance the aircraft observations by taking *in situ* continuous profiles of CO_2. At Orleans (Fr) and Byalistok (P) this is already the case with *in situ* CO being additionally measured at Orleans. We will install continuous CO_2 analyzers at Griffin (UK) and Hegyhatsall (Hu) by 2005 and fly them regularly since then. All *in situ* CO_2, temperature, humidity profiles will be reported to the database. In the interval 2006-2008, we will increase the sampling frequency to each 5 days, covering all possible synoptic weather conditions (Table 4), with flasks remaining sampled each 20 days. Such dramatic increase in airplane soundings is essential to establish seasonal vertical and horizontal CO_2 gradients given the natural variability, and reduce uncertainties in regional budgets. Network design studies will be performed using inverse models in the Integration Component of the IP in order to optimize the aircraft sampling strategy and to check on weather biases.

Activity leader: Michel Ramonet, LSCE (4)
Activity partners: XXX

Activity 5. Quality control of atmospheric measurements

Rationale
At present up to 15 laboratories contribute to the European atmospheric network, which generates a risk of producing systematic concentration differences among stations, that are due to standardization and measurement protocols[v]. Specific accuracy objectives have been established by the WMO-GAW Expert CO_2 panel (Table 5 – Andrew, Ingeborg please insert this table) and are our target for characterizing systematic differences between European laboratories. We established in Europe during FP5 systematic and frequent intercomparisons among stations via the exchange of flask samples, and of low and high pressure cylinders, in close collaboration with CSIRO-DAR (Australia), NIES (Japan) and NOAA-CMDL (USA). Such activities must be pursued with vigour to monitor dynamically the differences between the laboratories, and trace the problems to calibration or instrumental drifts. Intercomparison and calibration work is labour intensive, not often reported in scientific papers, but it is central to the sucess of this project to ensure that European measurements meet the highest quality requirements and can be merged with other networks of the USA, Japan, and Australia.

Objective

- Assess inter-laboratories differences within the accuracy targets set up by the WMO-Global Atmosphere Watch Programme, via frequent exchange of intercomparison material (flasks, high and low pressure cylinders)

Task 1 We will continue after FP5 projects stop in 2005 the frequent exchange each 2 month of flask samples filled with air of known concentration to assess differences in CO_2, CH4, 13C, 18O, N2O, CO between the 4 laboratories with flask analytical capabilities, with UHEI being responsible for intercomparison flasks preparation. After 2005, we will continue to frequently exchange low pressure cylinders for the network of ground level stations, with LSCE being the responsible laboratory. After 2005, we will continue to exchange high pressure cylinders for the tall towers network, with MPI-BGC being the responsible laboratory. Based on the experience gained in ongoing FP5 projects, we will decide in 2006 upon whether high pressure or low pressure cylinders are best appropriate and cost-effective to carry out frequent intercomparisons. Intercomparison results will be reported to the data base using web technology, and to the WMO-GAW international CO_2 expert group.

Activity leader: Andrew Manning, MPI-BGC (1)
Activity partners: XXX

Activity 6. Radiocarbon and CO analysis to quantify fossil fuel emissions

Rationale

The fossil fuel (^{14}C-free) CO_2 component over Europe can univocally be determined only via $^{14}CO_2$ observations. $^{14}CO_2$ is a difficult measurement, than can be performed with adequate precision either using AMS or "traditional" radioactive counting. European researchers pioneered the use of 14CO2 to verify fossil fuel emissions. This requires accurate and precise quasi-continuous measurements of the marine background level, which has to be compared to the respective observations at the continental sites. Carbon Monoxide (CO) can also serve as a proxy for the fossil fuel CO_2 component, but other factors influence the variability of CO, such as oxidation by OH radicals, emissions of CO from other sources than fossil fuel burning. Indeed, investigation of fossil emissions in Europe within FP5 showed a large temporal and spatial variability of the respective CO/CO_2 ratio in addition to expected systematic trends caused by changing fuel types (i.e. replacing oil by gas). Therefore, "calibration" of the fossil fuel CO/CO_2 ratio is required when CO shall be used successfully as a quantitative proxy. Due to the limited detection level even of high precision (better than 3‰) $^{14}CO_2$ measurements (of ca.1 ppm fossil fuel CO_2 with the background 14CO_2 level determined to 1‰) this calibration can accurately be performed only at polluted sites. These „calibration sites" require ongoing parallel (integrated) $^{14}CO_2$ and CO sampling and analysis.

Objectives

- Continue the existing 14CO2 observational network in Europe to directly derive monthly mean fossil fuel CO2 contributions at polluted and background sites.
- Establish „calibration stations“ in Western, Central and Eastern Europe to provide an ongoing calibration of CO as a proxy for fossil fuel CO2 (determine the mean CO/CO2 ratio of fossil fuel sources).

Task 1. Determine the fossil fuel CO2 component in Europe from 14CO2 measurements

We will continue high-precision quasi-continuous 14C sampling and analysis at the marine stations Mace Head and Izaña to accurately define the changing Atlantic 14CO2 background in mid northern latitudes. We will continue high precision (<3‰) 14CO2 measurements at the high altitude Alpine site Jungfraujoch, at the mountain site Schauinsland as well as at the coastal site Lutjewaad for direct determination of the fossil fuel CO2 component over Europe.

Task 2. Provide a calibration of CO as a proxy for fossil CO2 at three urban stations

We propose to establish a set of three CO/fossil CO_2 "calibration" stations in urban/industrial polluted environments representative of Western Europe and Eastern Europe. Those sites are Paris, Heidelberg and Krakow. In Paris, France where 90% of the electricity production is non-fossil, the CO/fossil CO_2 ratio is one of the highest in Western Europe because it reflects car traffic only. In Heidelberg Germany, we have both industrial emissions with a "clean" combustion efficiency and car traffic from recent car fleet. In Krakow Poland, we expect industrial processes with higher CO/CO_2 emission ratio and car traffic from older car fleets. We will continue CO_2, CO and weekly-integrated $14CO_2$ measurements at Heidelberg for calibration of CO as a proxy for fossil fuel CO. We will establish two new "calibration sites" in urbanized/industrialized European regions (Western Europe: Paris (48°30'N, 2°12'E), and Eastern Europe: Krakow, 50°23'N, 19°33'E) with weekly integrated precise (better than 4‰) $14CO_2$ observations and parallel continuous CO_2 and CO observations

Activity leader: Ingeborg Levin, UHEI-IUP (12)
Activity partners: XXX

Activity 7. Calibrated CO_2 concentration measurements at selected eddy-covariance towers

Rationale

In daytime well-mixed conditions, near-surface CO_2 concentrations approaches the middle PBL values, and therefore have a strong potential to constrain regional fluxes in atmospheric inversions. Since CO_2 analyzers are already installed at eddy covariance sites to measure storage components of NEE, it is tempting to improve the calibration of their CO_2 concentration records in order to develop a cost effective extension in spatial coverage of the atmospheric network. First, we will analyze continuous vertical profiles obtained at different heights at tall towers and available scaling information (local meteorology and heat fluxes) in order to determine the „optimal“ conditions (time of the day, synoptic conditions, season) under which near-surface CO_2 concentration can be best scaled to the PBL concentration. In parallel, we will extend the testing of cheap but robust and stable infra-red CO_2 analyzers often used at eddy covariance towers to determine whether and how those instruments can be used for obtaining 0.5 ppm accurate records; preliminary results indicate that this is achievable to ± 1 ppm. Then, we will progressively calibrate CO_2 on top of 10 of the existing eddy flux towers of the IP with a target accuracy precision of ± 0.5 ppm for mid afternoon[vi] instantaneous concentrations measurements.

Objective

- Develop a methodology to calibrate eddy covariance towers CO2 recods with an accuracy target of 0.5 ppm ; establish CO2 calibrated records at 10 existing eddy covariance towers

Task 1. Pilot studies to calibrate atmospheric CO2 eddy covariance towers

We will develop a simple instrumental „kit“ to calibrate CO2 on top of Eddy Covariance towers, and test whether the gas analysers used to measure profiles (CIRAS) are usable for atmopsheric measurements with accuracy of ± 0.5 ppm. We will develop a methodology to use CO_2 records on short towers as surrogates of PBL concentrations, based on careful analysis of tall tower profile data at Hegyhatsal (Hu) and Cabauw (NL), and at the Pallas (Fi) station (Table 1) where there are nearby eddy covariance towers. By 2006, we will begin to implement CO_2 calibration on top of 10 eddy flux towers selected for flat terrain, as a joint activity with the Ecosystem Component of IP.

Activity leader: Bart Kruijt, Alterra (13)
Activity partners: XXX

Note on ground based remote sensing of atmospheric CO2

Using short wave infrared (SWIR) or long wave infrared (LWIR) wavelengths to retrieve the abundance of CO2 in the atmosphere from space borne sensors has recently received a very large interest, and is the object of intense investigations[vii]. Remotely sensed CO2 column integrated concentrations are expected to deliver global coverage and high repetitiveness of extraordinary value for inverting sources and sinks, but they may suffer from large systematic biases. We seek to set up a **pilot network of ground based remote sensing stations** of atmospheric CO2 column integrated content, for which funding will be requested from the European Space Agency (ESA). This network, in synergy with *in situ* measurements within CARBOEUROPE will form the core of ground based calibration and validation activitties for space-based remote sensing of the varying distribution of CO2 as obtained from existing sensors SCIAMACHY, AIRS and IASI, and from the near-future Orbital Carbon Observatory (OCO) mission dedicated to CO2.

Expected results

The primary result expected from the Atmospheric Component of the IP is the establishment of a unified European Atmospheric Observing System to monitor the carbon balance of Europe and its regional distribution. This system will be the European contribution to the global, internationally coordinated effort to enhance the set of in-situ atmospheric observations to diagnose the current distribution of carbon sources and sinks. The European Atmospheric Observing system will reach an umprecedented level of station density and, thanks to stringent intercomparison procedures, will deliver a coherent ensemble of atmospheric CO2 and carbon cycle related tracers to atmospheric transport models. In addition to this European effort, we will benefit from similar efforts being planned over the North American continent, and from the existing lower density networks of European and Japanese aircraft observations over Russia and Siberia to quantify the European carbon balance in the context of Northern Hemisphere and global sinks. We also expect that an ocean carbon Integrated Project centered around the North Atlantic will add systematic atmospheric observations and constraint on the fluxes over that region.

We expect that the synergetic use of atmospheric measurements and inverse models in CARBOEUROPE will enable us to downscale the carbon fluxes using atmospheric measurements to the sub-continental level within Europe (e.g. Eastern European countries, Mediterranean area) and to the level of smaller regions of typical size 1000 km over the best sampled areas within North-Western Europe (e;g. France, Germany, Benelux Countries). Uncertainties on flux estimates will be assessed by using a suite of different atmospheric transport models, and based on different data selection procedures established for each site. We expect an uncertainty for the overall European carbon balance of 20%, that is about ± 0.2 GtC year-1. We expect an uncertainty for regional fluxes in best sampled Western European regions of 30% each month.

Finally, we expect to attribute the European CO2 gradients within the atmosphere to different component of the fluxes : oceanic, terrestrial and fossil, based on the analysis of multiple species in flask air samples and at some *in situ* sites. Assessing the fossil fuel CO2 component will use a unique technique where European laboratories have a strong leadership, that is high precision measurements of 14CO2, 222Radon and CO. This approach will provide fossil fuel CO2 mixing ratio determinations on the order of 20% accuracy in moderately polluted areas and respective emissions estimates with an uncertainty of 25-35%.

No funding is requested from CARBOEUROPE.

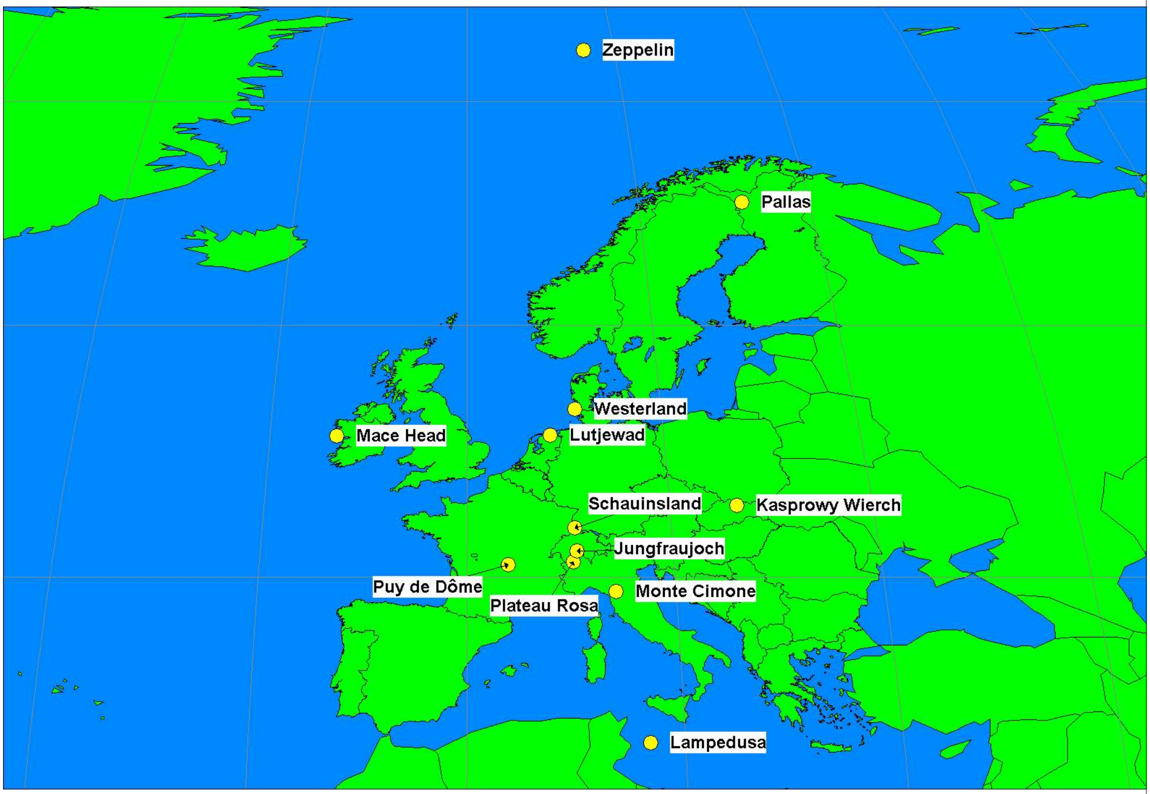

Figure 1. Location of ground-level in situ continuous CO2 and 222Rn stations in CARBOEUROPE-IP

Site	Code	Latitude	Longitude	Altitude m asl	Existing continuous measurements
Mace Head	MHD	53° 19' N	09° 53'W	26	CO2, Radon, CH4, CO, N2O, CFCs
Zeppelin	ZEP	78° 54' N	11° 53' E	475	CO2
Lampedusa	LAM	35° 31' N	12° 38' E	70	CO2
Puy de Dôme	PUY	45° 45' N	03° 00' E	1465	CO2, Radon
Schauinsland	SCH	47° 55' N	07° 55' E	1205	CO2, Radon, CH4, N2O, SF6, CO
Monte Cimone	CMN	44° 11' N	10° 42' E	2165	CO2, Radon
Plateau Rosa	PRS	45° 56' N	07° 42' E	3480	CO2
Jungfraujoch	JFJ	46° 33' N	07° 59'E	3580	CO2
Lutjewad	LUT	53° 23' N	06° 22' E	0	CO2, CH4, CO

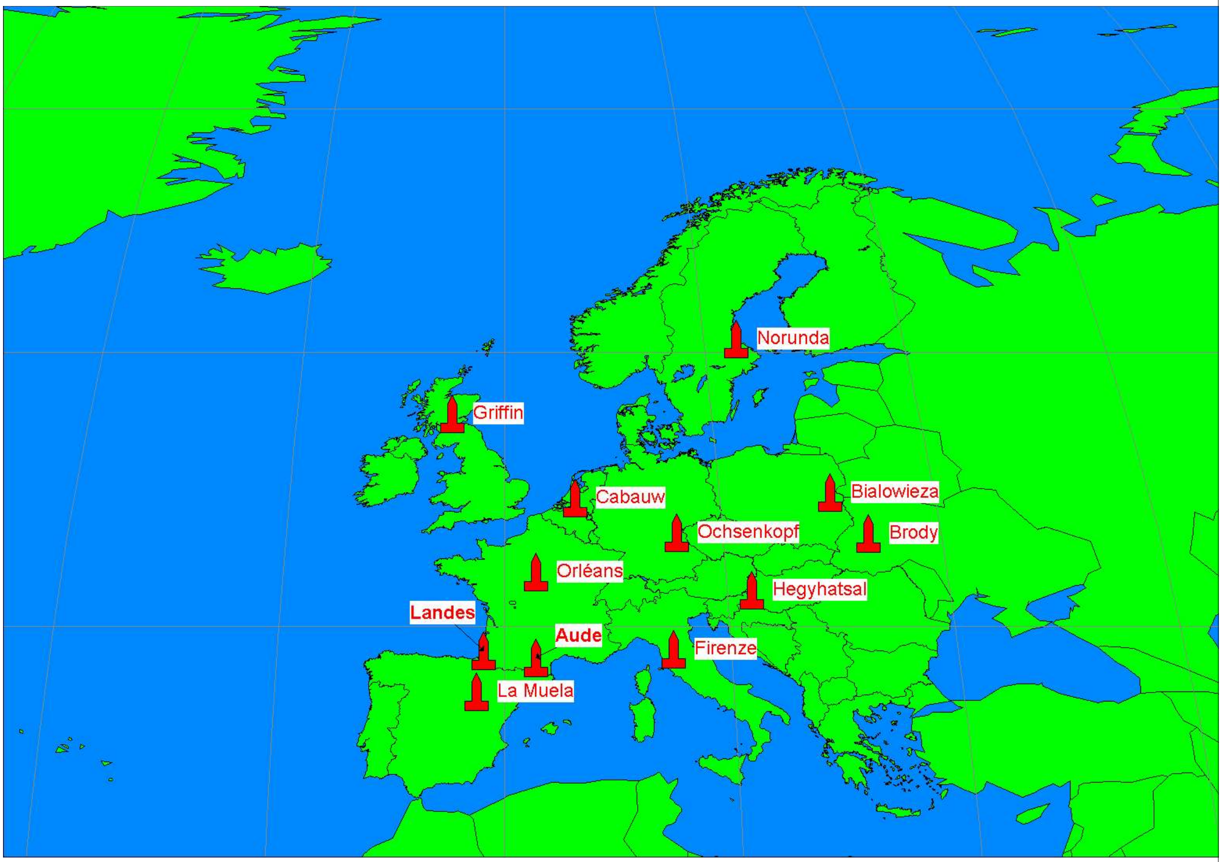

Figure 2. Location of tall towers in CARBOEUROPE-IP (ljh suppess Ukraine tower)

Alex : please add table as for ground stations above with countries code

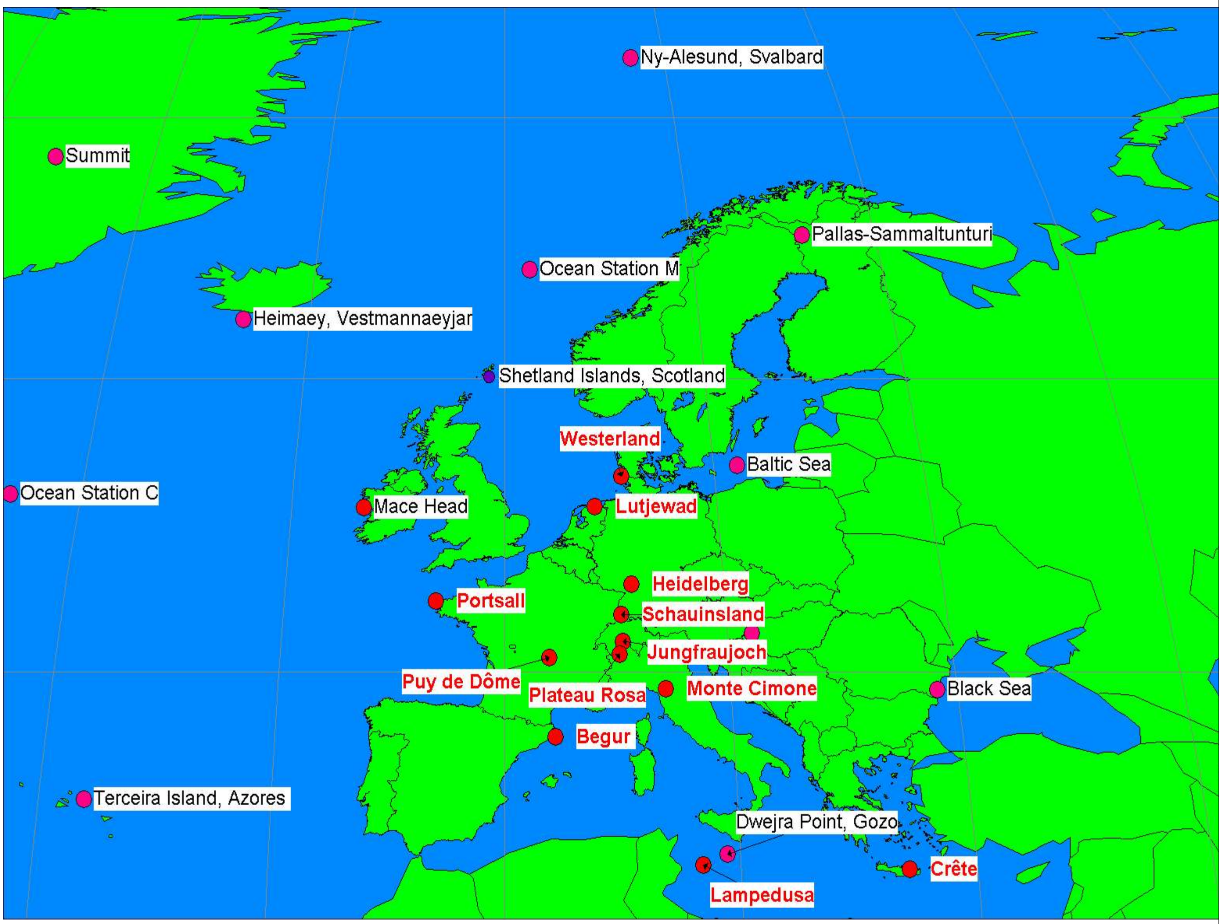

Figure 3. Location of flask sampling sites in CARBOEUROPE-IP, with NOAA-CMDL and CSIRO-DAR sites included No flasks at Westerland and Heidelberg (ljh mark more clearly csiro and cmdl sites

Insert table

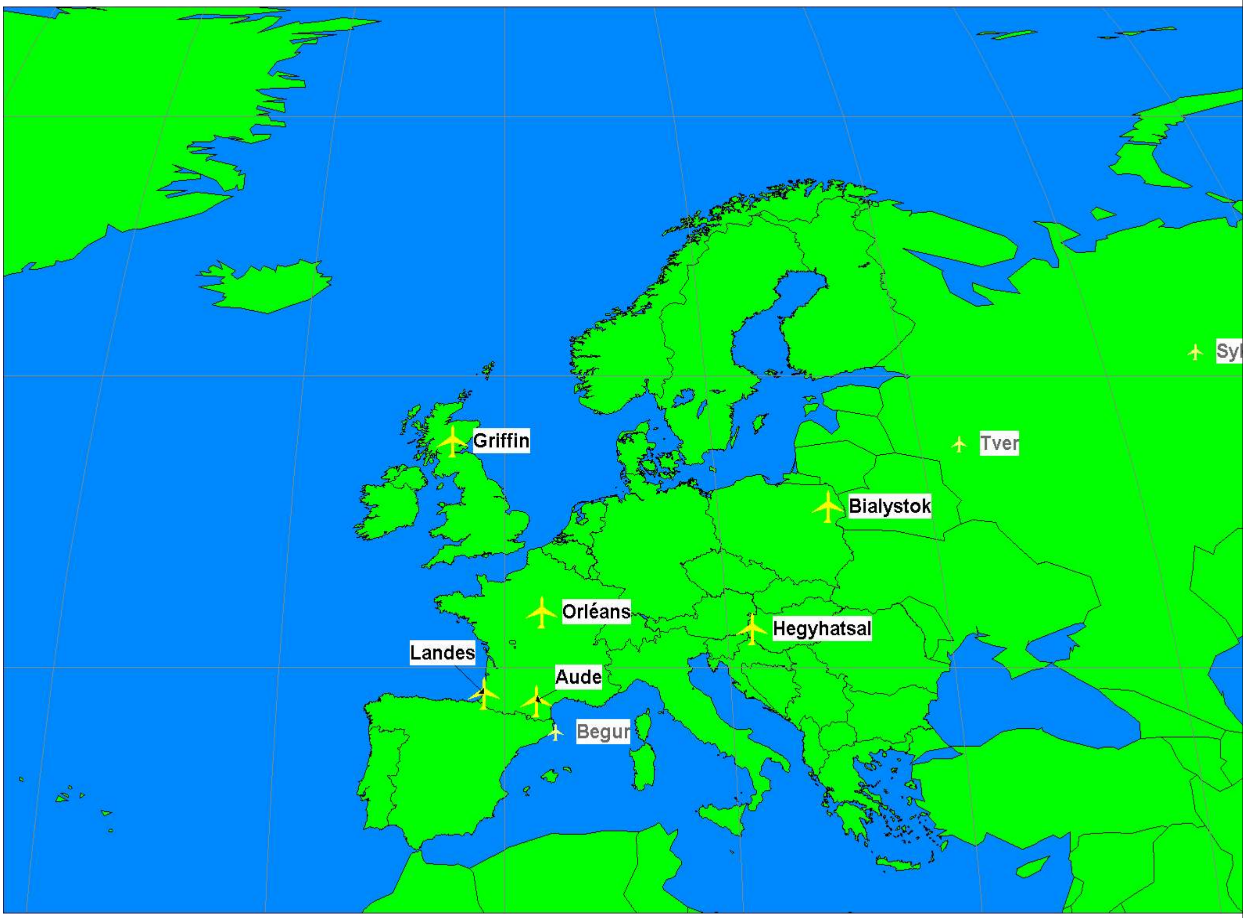

Figure 4. Location of aircraft sounding sites in CARBOEUROPE-IP (add schauinsland and thuringen, tver Syktyvkar with different color ; provide table)

Relevance and contribution of Atmospheric Component and WPs to the project as a whole

Having an atmospheric component in a programme aiming to „quantify and understand“ the carbon balance of Europe is indispensable. This is because the down-scaling of atmospheric concentraton using models of the atmospheric transport is the only independent method to check independently using actual measurements the sum of „bottom-up“ estimates of ecosystem fluxes and fossil fuel emissons at large spatial and temporal scales. Using atmospheric records and inverse modelling alone will deliver quantitative estimates of the fluxes distribution, but if based on atmospheric CO_2 alone it will not deliver understanding of the controlling processes, nor attribute fluxes to the different sources. To cope with that difficulty, we will first increase the number of CO_2 measurements and use high resolution meso-scale models to infer fluxes at the highest possible spatial resolution. This will deliver estimates of the carbon budget over 1000 km regions with rather homogeneous climate conditions and land cover type, and thus provide better insights on the causes of carbon sources and sinks. Second, we will use a set of carbon cycle related tracers that have specific properties to constrain different type of sources. For instance CO, and $^{14}CO_2$ will be used to ascertain the fossil fuel contribution, and ^{13}C and O_2:N_2 will be used to separate terrestrial fluxes from air-sea exchange in the gradients of CO_2 measured across Europe.

- **Link with Integration and Modelling Component:** The atmospheric approach will be applied synergetically (?) with the other Components of the IP, using a multiple constraint approach, where pairs or triads of different carbon observations combined with atmospheric inverse models and biogeochemical flux models will deliver estimates of the European carbon budget. The set of observations of atmospheric concentrations, eddy covariance towers, ecological studies and forest biomass inventories and remote sensing integrates across all multi-faceted aspects of the European carbon cycle: Indeed, the most successful advances in understanding springs from the combination of data and models for the different domains, wherein results from one domain place valuable constraints on the workings of the other two. Include CH4?
- **Link with regional Experiment Component:** A pilot study of intensive observations is planned over the Landes region in Southern France in 2006 to characterize the variability and the atmospheric signals and provide an intensive set of atmospheric and ground based measurements with higher density than achieved over the rest of Europe. This should be approached by installing a denser network over a limited area (300 by 300 km) and over a limited period of time (up to one year). High frequency observations will be acquired. This includes daily vertical profiles whenever possible, and a cluster of few short and 2 tall towers (how tall?). This pilot regional atmospheric network will be coupled with intensive campaigns aiming at direct flux estimates using aircraft and eddy flux towers. High frequency observations will be analyzed with a specifically designed mesoscale model of 1 km resolution. Interpretation of those data will

serve to formulate strategies to optimally estimate regional carbon fluxes, that will be progressively implemented into the continental scale Atmospheric Observing System network, given the amount of available resources.

Component 4. Integration of Scales and Carbon Data Assimilation Methods ("Integration")

Still to do:

- streamline jargon (change ESM to TBM?)
- revise figures
- cross-check activity descriptions
- 18 month workpackage contents
- include inventory text in methods section

Rationale and objectives

CarboEurope provides a unique, highly rich data set covering many aspects of the prevailing state of the European carbon cycle. These range from in situ observations of carbon exchange fluxes, vegetation properties, land use, etc. to data representative for regional and continental scales such as atmospheric CO_2 concentrations or national inventories of forest biomass. An integrative activity is needed to merge these different information streams together in a comprehensive, quantitative way, in order to make inferences on the present and past status of the European carbon balance and it's future based on scenarios of a range of development and management options within the next 100 years. This integration can only be achieved by means of a numerical modelling framework. In this framework, diverse approaches of top-down, bottom-up, sectorial, process based and extrapolation techniques have to be employed, compared for consistency and ultimately merged in a most comprehensive way.

The integration component of CarboEurope addresses this need. It pursues the following overarching objectives:

- To harmonize the different existing data streams and combine them with all the auxiliary information needed for the modelling
- To combine the data streams of flux measurements, concentration measurements, forest and soil inventories and merge them with additional information from remote sensing, process understanding and modeling into a carbon data assimilation system (CDAS) in order assess the European carbon balance and its component processes on a multitude of temporal and spatial scales.
- To determine projections of the likely evolution of European land surface carbon pools in the 21st century, their spatial pattern, inter-annual variability, importance for various sectors dependent on ecosystem services, and the uncertainties associated with the various drivers influencing it.

Methodology

Bottom-up and top-down modeling – spatial and temporal scales

The observational components of CarboEurope generate three primary data streams that directly reflect changes of the local, regional or continental carbon balance:

1. Flux measurements from the Fluxtower network in the ecosystem component
2. Atmospheric concentrations measurements (remote stations, mountain stations, aircraft, tall towers, flux towers, possibly also from remote sensing) from the atmospheric component
3. Changes in forest and soil carbon inventories

These data streams cover particular spatio-temporal domains which are separated several orders of magnitude in space and time from each other (Figure 1). Additional information on state and functioning of terrestrial ecosystems is being compiled in process studies in the ecosystem component, and is available from remote sensing, such as vegetation cover, land use, phenology information, and aboveground biomass.

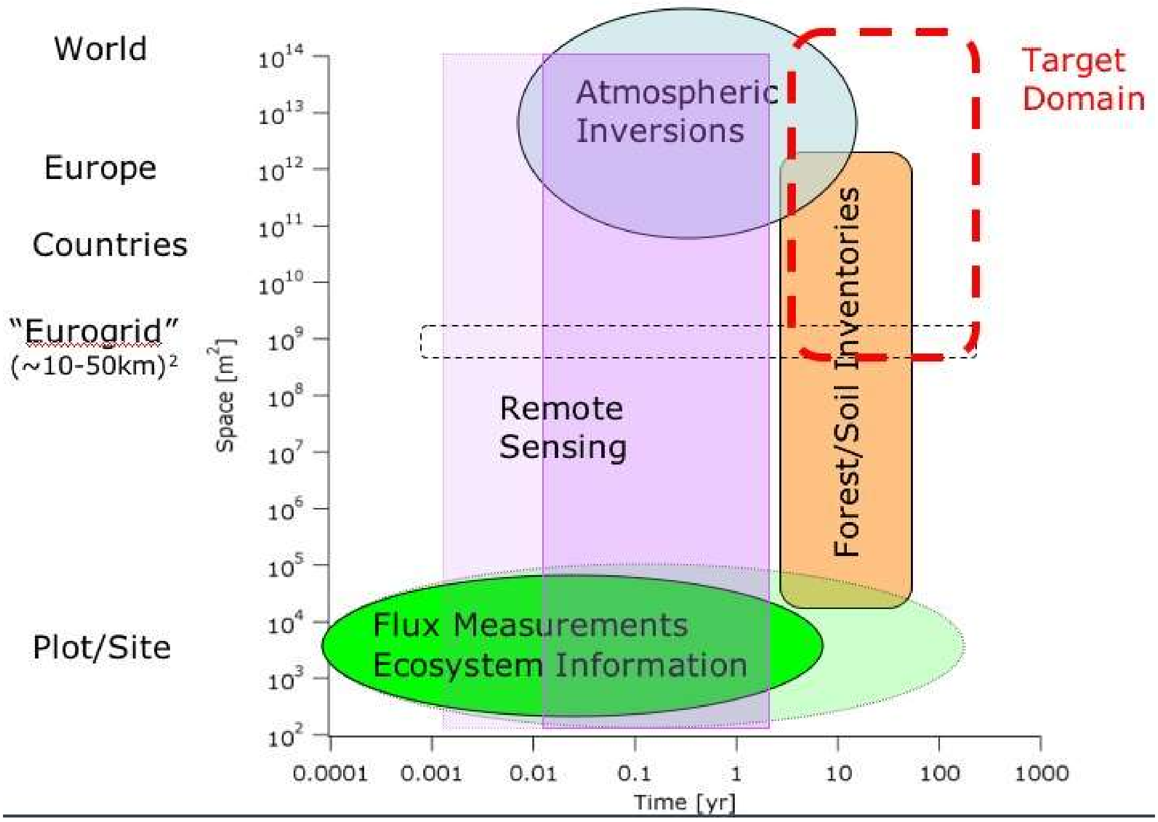

Figure 1: Spatio-temporal coverage of the different primary data streams generated in CarboEurope. *(To be revised)*

Bridging the scales between the different data streams will be performed by several independent bottom-up and top-down methods. Figure 2 shows the available modelling tools that have been or are being developed by the previous and current CarboEurope projects in the 5th framework programme of the EU.

Bottom-up approaches proceed by extrapolating surface in situ process information (e.g. ecosystem functioning, weather and climate, land use, etc.), net ecosystem fluxes observed at individual flux towers, or by extrapolating local or county level carbon inventory data. In the integration component we will use three types of bottom-up modelling approaches with different extrapolation methods:

(1) high-resolution process based soil-vegetation-atmosphere transfer models (SVAT) using detailed landcover and landuse information from remote sensing and georeferenced statistical data to scale up from the footprint of individual flux towers to whole landscapes and individual countries,
(2) neural networks trained on in situ observations or inventory data, using remote sensing and georeferenced statistical data for upscaling cabon fluxes or carbon storage changes in individual sectors,
(3) process based ecosystem models which may be coupled to atmospheric mesoscale models, operating on a grid size of $(10\text{-}50\ km)^2$ tiling the continent or the entire terrestrial biosphere.

In the **top-down** approach spatio-temporal variations of the atmospheric CO_2 concentration are used to infer the net surface exchange fluxes by means of inverse atmospheric modelling. This necessitates the use either of of high-resolution global models of atmospheric transport based on the observed meteorology from weather forecast models, or the use of nested limited area mesoscale atmospheric circulation models.

Ultimately, the bottom-up and top-down approaches will be merged into a carbon **data assimilation** system. In this approach, a coupled land surface – ecosystem model (LSM-ESM) is run coupled in an atmospheric high-resolution global or nested limited area mesoscale model (M-AGCM). In this modelling system, data streams of different quality, temporal and spatial characteristics are merged in an optimal way which is mathematically consistent with the dynamics that govern the evolution of the system. This approach is similar to the techniques employed in numerical weather forecasting.

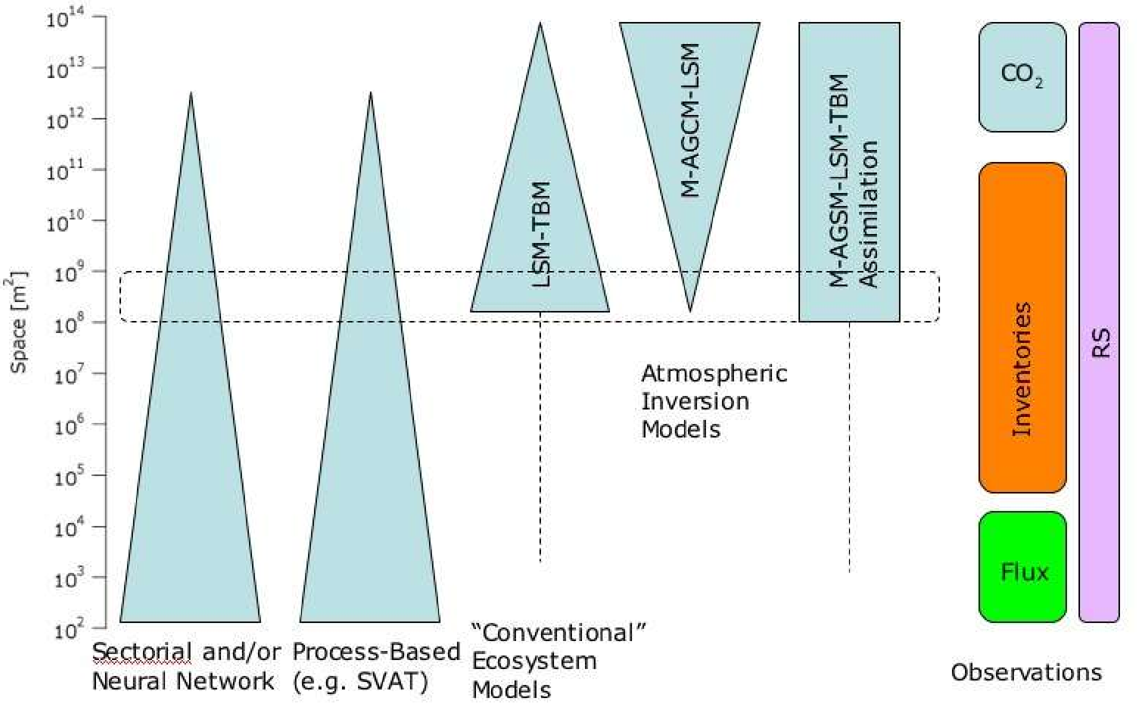

Figure 2: Modeling tools employed in the integration component. The width of the symbols gives a measure of the level of confidence on the respective spatial scale as indicated on the left hand axis. The dashed lines indicate the spatial scale of the "Eurogrid", on which the different models will be rigorously compared and which constitutes the primary spatial resolution for the European carbon balance assessment. Abbreviations: LSM-ESM: coupled land-surface – ecosystem model, M-AGCM-LSM: Mesoscale-atmospheric circulation model with interactive land surface model (or high-resolution global atmospheric circulation model).

A major goal of the integration activity consists in rigorous, **quantitative consistency checks** addressing fully each of the inherent uncertainties of the different modeling and extrapolation approaches. This will be performed by a series of benchmarking exercises in which carbon flux estimates for clearly defined target areas have to be provided by the different approaches and the range of models employed within each approach. An primary focus target will be the region of the regional experiment in south-western France. This activity will be closely coordinated with the modeling activity in the regional experiment component. Additional target areas will be defined in several of the major ecosystems in Europe.

In bridging the spatial scales of the different observation streams, several additional, poorly known carbon flows have to be addressed as well. These include carbon flows through trade products, VOC emissions from the vegetation, CO from incomplete fossil fuel burning, carbon transport by rivers, erosion fluxes, carbon stored in reservoirs and lakes, and carbon fluxes from marginal seas and continental shelves.

Using ESM models evaluated in the benchmarking exercises the likely evolution of the European land surface carbon pools over the next 100 years will be assessed under a range of prescribed drivers: increasing atmospheric CO_2 concentrations, scenarios of down-scaled high-resolution climate change, nitrogen deposition and land use changes.

Synthesis (Expected results)

The integration component will provide several synthesis products:

List of products including (incomplete – has to be harmonized with the entire proposal goals)

- Optimization of observation strategy
- Assessment of present and past continental and national carbon balance for various sectors (agriculture, forest, grasslands), variability, uncertainty based on the different modeling/integration approaches
- Assessment of the future development of the European carbon balance.

Component Activities

Activity 1: Project Database

Activity leader: G. Seufert, JRC

In revision

Activity 2: Forest and soil inventories

Activity leader: J.-G. Nabuurs, ALTERRA

In revision

Activity 3: Compilation of auxiliary datasets

Activity leader: M. Heimann, MPI-BGC (G)

In revision

Activity 4: Inverse atmospheric modeling
Activity leader: P. Peylin, LSCE (F)

In revision

Activity 5: Bottom-up modeling

Activity leader: M. Heimann, MPI-BGC (D)

In revision

Activity 6: Development of carbon data assimilation methods

Activity leader: P. Cox, Hadley Centre (UK)

In revison

Activity 7: Scenario analyses

Activity leader: W. Cramer, PIK (D)

In revision

Component 5. IP co-ordination, training and outreach (MPI-BGC)
Co-ordinator: MPI-BGC, Partners: see B.5, Description of the consortium

Rationale and objectives
This component will set up an appropriate management structure for the whole Integrated Project and act, via the co-ordinator, as the interface with the Commission. Apart from the administrative co-ordination including legal and financial matters and the scientific co-ordination of the Integrated Project, it comprises training activities at the level of undergraduates, PhD students and young PostDocs and at the secondary school level. Furthermore it will produce syntheses of results to formulate policy-relevant conclusions in order to support the implementation of the Kyoto Protocol in the first commitment period and give advice for the development of monitoring schemes in the second and later commitment periods. Also a wider dissemination of results is foreseen.

The objectives are
- To perform the legal and administrative co-ordination of the Integrated Project (A 5.1)
- To perform the scientific co-ordination of the Integrated Project (A 5.2)
- To disseminate results to the science community (A 5.3, 5.5), policy makers (A 5.3, 5.4, 5.6) and the broad public (A 5.4, 5.6, 5.7)
- To train students from the secondary school to the graduate level in carbon science (A 5.7)

.0.0.1Expected results
- Timely, focused management and co-ordination of the Integrated Project
- Policy-relevant synthesis reports published as a self-published CarboEurope-series on emerging questions to support the implementation of sinks in the Kyoto Protocol

d estimates of the „carbon uptake in the European biosphere“ in support of the set of climate indicators of the European Environment Agency (EEA) for 2004 to 2008
on cycle assessments
ncil sinks expert group
an Climate Change Programme of the European Commission)
sm Working Groups

ee that the proposed level of integration will be achieved in a timely, efficient manner.
order to support the implementation of observing and monitoring schemes related to the
tifically sound, independent verification of national and European CO_2 sources and sinks over
First Commitment period and give scientific advice how to deal with sinks in the Second

ers for international, interdisciplinary research about the carbon cycle.

Activities

A 5.1 Legal and administrative co-ordination of the Integrated Project (Co-ordinator: Ernst-Detlef Schulze, MPI-BGC)

The co-ordination and project management aspects are described in detail in the dedicated section B4.4 and B6, and gender-related actions in B10.

A 5.2 Scientific co-ordination of the Integrated Project (Co-ordinator: Ernst-Detlef Schulze, MPI-BGC)

The co-ordination and project management aspects are described in detail in the dedicated section B4.4 and B6, and gender-related actions in B10.

A 5.3 Outreach science conferences (Co-ordinator: Annette Freibauer, MPI-BGC)

Science conferences will be regularly coupled with the annual project meetings, following good experiences in FP5. If useful, the annual meetings and science conferences will be collocated with other ongoing dissemination activities such as in the CarboEurope-GHG Concerted Action for convenience and in order to avoid excessive travel.

A 5.4 Joint EU-US Carbon Cycle Assessments (Co-ordinator: Philippe Ciais, LSCE)

Philippe: XXX

A 5.5 European office of Global Carbon Project (GCP; Co-ordinator: Riccardo Valentini, UNITUS)

The CarboEurope cluster of FP5 is hosting the European support office of the Global Carbon Project (GCP), at UNITUS in collaboration with the cluster secretariat at MPI-BGC. We will continue to support GCP in this constellation.

A 5.6 Science-policy interface (Co-ordinator. Günther Seufert, JRC)

Co-ordinator: JRC
Partners: MPI-BGC, Joanneum, UNITUS, Alterra

In order to respond to emerging requests by the European Commission and policy makers involved in the climate negotiations and the implementation of the Kyoto Protocol, we will form a **Policy group**. This small group of experts acting at the interface between carbon cycle research and policy will ensure that consultations work not only timely and efficiently but also on a broad science basis. The policy group consists of scientists with well-documented expertise at the science-policy interface: G. Seufert, R. Baritz and G. Matteucci (JRC), P. Ciais (LSCE), A. Freibauer (MPI-BGC), G.-J. Nabuurs (Alterra), B. Schlamadinger (Joanneum), P. Smith (UABDN), and R. Valentini (UNITUS). This will make it easy for policy makers to identify contact persons. Periodical meetings and interactions of the same group of advisors with policy makers will establish a basis of trust and routine necessary for good and efficient consultation, which requires mutual understanding of political and scientific questions. Harmonised consolidated statements in behalf of

CarboEurope-IP will have a much stronger impact on the political decision process than the voice of a single scientist.

Direct contact with the European council sinks expert group will be maintained and intensified, also via the representation in the advisory board. Direct contributions to ECCP (European Climate Change Programme of the European Commission) will be delivered via written and oral statements in the ongoing stakeholder process. The working groups of the EU Monitoring Mechanism will be supported via the JRC mandate and additional efforts of the policy group upon request. Upon request, the task force will also provide advice to focal points of individual Member states responsible for preparing/improving the annual reporting of GHG emissions and sinks.

Finally, CarboEurope expertise will be introduced into the ongoing process of developing a EU-carbon sink modul within the monitoring schemes of the New Forest Regulation and the European soil monitoring strategy (COM (2002) 179 final)

Targeted Stakeholders:

- EU Monitoring Mechanism Working Groups 1 and 2
- European Commission, European Climate Change Programme (DG Environment, DG Agriculture)
- European Environment Agency
- National policy makers involved in international negotiations of the UNFCCC, e.g. national ministries and environmental protection agencies
- Regional and national forest administration
- Private forest owners
- SMEs involved in certification and auditing of Kyoto-related projects

Furthermore, policy-relevant synthesis reports will published as a CarboEurope-series on emerging questions to support the implementation of the Kyoto Protocol and its future development regarding biospheric sinks and sources and as policy-maker summaries of annual reports, which should be suitable for distribution at relevant policy discussions (e.g: UNFCCC Conference of the Parties) in B3. They can be separate or coupled with the Joint EU-US Carbon Cycle Assessments.

Analyses and consultation will cover issues such as

1) To analyse, in light of the research results from the activities, some key policy-relevant issues, such as:

   b) as far as possible, the separation of carbon sequestration by terrestrial ecosystems among direct human induced, indirect and natural effects;

   c) suitability of the CarboEurope-developed methods for monitoring and verification of GHG emissions and removals under UNFCCC and the Kyoto Protocol, and how these could be applied on a European-wide basis;

   d) technical possibilities for "full carbon accounting",

   e) effects of land management and land use change on the overall balance of GHG,

   f) linkages between Kyoto Protocol and CBD: integration of biodiversity considerations into the implementation of the Kyoto Protocol

2) To suggest possible implementation of updated and new rules for LULUCF under Kyoto Protocol rules in the second commitment period that would be consistent with the scientifically sound measurement and observation methods such as those developed and applied in this IP.

Dissemination to the wider public is described in the innovation-related activities and exploitation and/or dissemination plans (B.3).

A 5.7 Training – summer schools (Co-ordinator: Franco Miglietta)
Training activities are described in section B4.3.

A 5.8 Educational training (Co-ordinator: Philippe Saugier)
Training activities are described in section B4.3.

6.1.2 Innovation *(0.5 page)*

Activities relating to the protection of knowledge and IPR
CarboEurope-IP will produce and use the following knowledge:
- measurement data,
- model results,

re,
ts.
ve from the activities dealing with software development, data assimilation techniques and
nd high-precisions analyses. We have set up a plan for the management of knowledge (B.6)
data policy. The present CarboEurope cluster already adopted a data policy since the year
s been adjusted to the new level of integration in CarboEurope-IP and will be part of the
ppendix X). It will allow a fast, efficient exchange of knowledge and other innovation within
meta-database of data and other types of knowledge generated within CarboEurope-IP will
e also as gateway for third parties to access project results. Prior to publication, data and
vailable to third parties upon request only. After publication, there will be free public access
s allows a very timely, optimal use of the project results for a wider scientific community (cf.

6.1.3 Exploitation of results and dissemination of knowledge *(0.5 page)*

Exploitation plan
Exploitable results of the CarboEurope-IP encompass a scientifically sound verification system for commitments under the Kyoto Protocol, the world´s best integrated network for CO_2 observations at regional and continental scale, and recommendations for land management with regard to the Kyoto Protocol. There is also scope for operationalisation of the observational network, e.g. in GMES. We will try to use instruments of GMES or similar to develop the research infrastructure of CarboEurope-IP for an operationalisation of the prototype monitoring of the European carbon balance, via operationalisation of monitoring facilities and data

streams. The research infrastructure could then be directly exploited by EU-wide, national and regional authorities and agencies and private companies. In this context, we will also undertake special attempts to include SMEs.

There are clear opportunities for involvement of SMEs in future demonstration activities:

- SMEs working on certification, monitoring and verification of projects under the JI and CDM mechanisms of the Kyoto Protocol
- Hardware developers (Soil coring, eddy covariance systems development, gas analyzers)

re developers (eddy covariance software)

routine soil chemical and physical analyses.

ill be valuable for land owners and industry at large for future land-use planning in a C-

be disseminated in publications in peer-reviewed journals, also as special issues and books if held together with annual project meetings, external conferences and internal and open vities and for specific questions integrating several Activities and Components such as the nt protocols and data – model intercomparison. They will be published in the CarboEurope-ates and standards for similar emerging observation networks. Web-based activities will be cation within the Integrated Project but will also provide a user-friendly interface for policy served with up-to-date information (cf. B4 Outline implemenation plan, Activities 5.3-5.6).

consultation to national and European policy makers in the fields of agriculture, forestry, and tradition in CarboEurope. Dissemination will build on projects of the CarboEurope cluster in lesigned for exploitation and dissemination of data and results by web-based interfaces and s and model results in Carbodata (EVK2-CT-1999-00044), support to European policies for yoto protocol with expert knowledge and information to stakeholders (industries, forestry) ccompanying Measure (EVK2-CT-2000-80007), a series of reports on the synthesis of the dget within CarboEurope-GHG Concerted Action (EVK2-CT-2002-20014). There is a strong research institutes, e.g. in Thuringia.

tinue our strong commitment for the dissemination of results. The dissemination plan errelated activities aiming at scientific, political and broad public audiences, respectively (cf. line implementation plan, B4, section „innovation"). The actions listed below will clearly semination of results and impact of policy advise as compared to FP5.

- Users in the fields of policy, science and administration are represented in the advisory board
- Annual project meetings will be coupled with annual outreach science conferences
- Contributions to joint EU-US carbon cycle assessments
- CarboEurope-IP hosts the European support office of Global Carbon Project (GCP)
- Science-policy interface activity with ad-hoc consultation via a policy group and regular Policy-relevant synthesis papers of results emerging in the Integrated Project
- Material for dissemination to broader public like glossy brochures and educational training at schools

- Dissemination via press, radio and TV, based on personal contacts with journalists and past positive experience
- Joint investigations with forest authorities on questions related to the implementation of the Kyoto Protocol. (Thuringia LAWUF as partner? FUNDING?)

We expect that one of the most efficient strategies for optimal use of project results works via direct interactions with stakeholders, consultations to the European Commission and national governments by project partners, which is proven by past success. We will continue this successful tradition of consultation and dissemination to ensure optimal use of the project results.

The Consortium Agreement will explicitely encourage all partners within CarboEurope- IP to open their institutes for school visits and the broader public on special days.

6.2 B.4.2 Demonstration activities

The type of research performed will not lead to any demonstration activities envisaged within the integrated project. However, there is some scope for operationalisation of the observational network, e.g. for GMES.

There are clear opportunities for involvement of SMEs in future demonstration activities:

- SMEs working on certification, monitoring and verification of projects under the JI and CDM mechanisms of the Kyoto Protocol
- Hardware developers (Soil coring, eddy covariance systems development, gas analyzers)

re developers (eddy covariance software)

routine soil chemical and physical analyses.

forest authorities on questions related to the implementation of the Kyoto Protocol.

er? FUNDING?)

6.3 B.4.3 Training activities

Training activities (A5.7) comprise training activities at the level of undergraduates, PhD students and young PostDocs and at the secondary school level. The gender action plan (B.10) also contains training activities for female scientists.
Strong links with the training activities in the ESF programme SIBAE „Stable Isotopes in Biospheric-Atmospheric Exchange“ exist as 60% of the scientists in the SIBAE steering committee are involved in CarboEurope-IP. We will also continue the close relations with the ESF programme RSTCB „The Role of Soils in the Terrestrial Carbon Balance“, e.g. by joint workshops. We also plan links to emerging Marie Curie Research Networks about the carbon cycle.

6.3.1 CarboEurope Summer Schools Series

Terrestrial Biosphere and Atmosphere Interaction in the Carbon Cycle: From the leaf to the continent
Training activities in the CarboEurope will include a series of events addressing four important components of the IP. Following the multidisciplinary integration science plan of the Integrated Project, CarboEurope Summer Schools will consider in particular biological processes understanding in plants and soils that are at the basis of the most important biospheric Carbon fluxes, ecosystem flux monitoring techniques including gradient and eddy correlation methodologies, regional flux assessment methods with emphasis on airborne flux measurement techniques and mesoscale and atmospheric inversion modelling techniques. The courses will attract a significant number of young scientists from Member and Associated States that will have the possibility to acquire knowledge and direct expertise in those four areas of research. The courses will be organised individually by Institutions that are participating in the IP and will all involve both theoretical lectures and field exercises. Lecturers will be possibly selected among the participants to the IP but in some cases a few non-EU scientists will be also invited as teachers. Each event will have a duration of approximately one week and will attract 10 to 20 students.

The role of soil, plants and ecosystem processes in the Carbon Cycle
Organizer: University of Zurich, Switzerland - Nina Buchmann
The course will consider the most recent advancements in understanding, measuring and modelling some of the most important biological processes that are at the base of carbon uptake and efflux of ecosystems.

Theory and application of ground-based flux monitoring techniques
Organizer: University of Antwerpen, Belgium - Marc Aubinet
This event will provide advanced training about the most important ground-based techniques to monitor carbon fluxes of ecosystems and will provide the theoretical bases of the best micrometeorological techniques that are used to measure gas exchange of plant canopies.

Airborne flux measurements for the regional assessment of the Carbon budget
Organizer: IBIMET-CNR, Italy - Franco Miglietta
The course will address questions relating to the theory and the practicalities of using Small Environmental Research Aircrafts (SERA) to measure surface fluxes at the regional scale. It will aslo include a field exercise where the students will have the opportunity to conduct, together with their supervisors, a short-term airborne flux measurements campaigns.

Meso-scale and Atmospheric Inverse Modelling
Organizer: Free University Amsterdam, The Netherlands - Han Dolman
The course will provide an introduction to the most recent advancement in applied atmospheric meso-scale and inverse modelling for the simulation of atmospheric gas transport associated to to the spatial distribution of the main terrestrial Carbon sinks and sources.

6.3.2 Educational training at the secondary school level

An experimental training activity will be designed for secondary schools in Europe in a perspective of research-education liaison. This will consist in:

- producing innovative educational resources explaining global carbon research stakes, their links with our daily lives and the way European research deals with them;
- mobilising a number of relays with high multiplying effect in order that as many young people as possible in Europe benefit from these resources;
- encouraging direct contacts between secondary school students and CarboEurope scientists.

Focused on science in action in an interdisciplinary and societal perspective, the educational contents will attempt to illustrate:

- what we know, what we discuss, and what we don't know yet in climate change issues;
- how scientists concretely work on the field;
- what is the added value of European co-operation in global change research and its complementarity with other programs world-wide, and how the various components of carbon research interact with each other in a systemic manner;
- how our daily lives impact on the global environment;
- how scientific expertise is taken into consideration in international regulations such as FCCC and in the debate about social, political and economical responses to climate change.

Multipliers will comprise at the European level: European schoolnet, Young reporters for the environment, Science accross Europe, Unesco Associated schools, ECSITE (European collaborative for science and technology exhibitions); at national levels: teachers associations (e.g. Association of Danish Biologists, Association of German Biologists), magazines (e.g. Science et Vie Junior in France), science museums (e.g. National Museums of Scotland).

The described activities will be performed in high priority during Year 1 in order to maximise chances of a lasting exploitation of the produced educational resources throughout the five years of the project. Experiences and contacts will subsequently be used as a prefiguration for a more developed global change education project.

6.4 B.4.4 Management activities

6.4.1 Legal and administrative co-ordination of the Integrated Project (Activity 5.1)

Legal and financial management is executed directly between the co-ordinator and all partners (consortium agreement, financial issues). The IP co-ordinator is the legal and financial contact institution for the European Commission. He issues all partner contracts, prepares the annual progress reports with help of the component co-ordinators, and deals with the distribution of the EC financial contribution and annual financial reports. Decisions about the scientific contents of the partner contracts and budget allocation will be taken by the Executive Board, guided by the Steering Committee, following the advise of the Advisory Board and suggestions by the general assembly of project partners (cf. B.6 for detailed decision structure). In case of non-fulfilment of contractual obligations by a partner the Executive Board can decide about sanctions and dismiss a partner. In case of unresolvable disagreement within the Executive Board the co-ordinator takes the final decision. He also has the right to veto against decisions in the Steering Committee and the Executive Board in case he perceives that the contractual obligations of the Integrated Project towards the European Commission may be violated. The IP co-ordinator, supported by the secretariat, acts on the basis of these decisions.
Having the legal and financial matters in one central hand will organise the administrative work in the most efficient way since many partners are involved in several workpackages and components. This will optimally relieve the component co-ordinators from administrative work, which had been so far scattered throughout the 15 projects in the CarboEurope cluster.

MPI-BGC, represented by its managing director Ernst-Detlef Schulze, is the co-ordinator of CarboEurope-IP. MPI-BGC has a long successful record of co-ordination of international projects, among which three projects in the CarboEurope cluster. MPI-BGC has already been hosting the secretariat of the CarboEurope cluster (FP5) with dedicated staff appointed to it. The General Administration of the Max Planck Society (MPG) will support the IP co-ordination with know-how in dealing with large consortia, and exchange of experiences in project management is assured by the existing MPG-network of EC-project officers. MPI-BGC will enlarge the management team of the present CarboEurope cluster secretariat to form the new IP secretariat to execute the overall legal, contractual, ethical, financial, administrative and scientific management of the consortium under the lead of ED Schulze.

The **management team** comprises

- a scientific co-ordinator with broad background in science and policy, experience in co-ordination and dissemination, and proven organisational skills

- a project administrator with background in administration and financial affairs and organisational skills

aff part-time for bookkeeping

er as consultant in specific situations (e.g. setting up of consortium agreement).

nagement tasks of the scientific co-ordinator

anaging the consortium agreement between the participants

knowledge management and other innovation-related activities

h component co-ordinators, who are responsible for their respective parts

ities conducted within the project

with the gender committee (B.10)

6.4.2 Scientific co-ordination of the Integrated Project (Activity 5.2)

Scientific co-ordination a the level of the Integrated Project as a whole

The co-ordinator will lead the scientific management together with the Chair person and the Executive Board, guided by the Steering Committee and advised by the Advisory Board (cf. B.6 for detailed decision structure). Experience in the CarboEurope cluster in FP5 has shown that this structure allows scientific decisions taken on the broadest possible basis, avoiding the potentially biased view of a single co-ordinating institution.

However, in case of unresolvable disagreement among these panels, the co-ordinator can take the final decision. He also has the right to veto against decisions in the Steering Committee and the Executive Board in case he perceives that the contractual obligations of the Integrated Project towards the European Commission may be violated.

The co-ordinator will also lead the dissemination activities of the IP.

Scientific co-ordination within components

The scientific co-ordination within the IP components will be managed by the component co-ordinators, supported by the activity leaders („Component committee"). The component co-ordinators will involve the IP co-ordinator in decisions of schedules of component meetings, experiments etc., in order to guarantee that the scientific activities are harmonised in time and space. The integration of activities across the components is also facilitated by the fact that

the lead institutions (MPI-BGC, UNITUS, VU-A, LSCE) are involved in four out of five IP components.
There will be dedicated scientific staff in all IP components responsible for the scientific co-ordination of the components.

One short paragraph for each component!

6. Ecosystems (UNITUS)
7. Regional experiment (VU-A)
8. Continental atmosphere (LSCE)
9. Integration (MPI-BGC)

IP co-ordination, training and outreach (MPI-BGC)

7B.5 Description of the consortium

Describe the participants in the proposed project, including the role(s) of any participants, which are not yet identified, and the main tasks attributed to them. Describe how the participants collectively constitute a consortium capable of achieving the project objectives, and how they are suited and are committed to the tasks assigned to them. Show complementarity between participants, describe the industrial/commercial involvement foreseen to ensure exploitation of the results. Show how the opportunity of involving SMEs has been addressed. (Recommended length – five pages)

If there are as-yet-unidentified participants in the project, the expected competence, the role of the potential partners and their integration into the running project should be described. (Recommended length – two pages)

If any part of the work is foreseen to be sub-contracted by the participant responsible for it, describe the work involved and explain why a sub-contract approach has been chosen for it. (Recommended length – one page)

***Other countries:** If one or more of the participants is based outside of the EU Member and Associated states, INCO target countries or countries having an RTD co-operation agreement with the European Community, explain in terms of the project's objectives why this/these participants have been included, describe the level of importance of their contribution to the project. (Recommended length –one page).*

Evaluation criteria: The extent to which:

- *the participants collectively constitute a **consortium of high quality.***
- *the participants are **well-suited and committed to the tasks** assigned to them.*
- *there is **good complementarity** between participants.*
- *the **profiles** of the participants, including those to be included later, have been clearly described.*

*the real involvement of **SMEs** has been adequately addressed.*

Co-ordinator´s institution
MPI-BGC

Key partners
UNITUS
VU-A
LSCE

Partners (Formal members).
Ecosystems:

Fluxes, site clusters: several years experience in using eddy covariance equipment, most sites have been already operating for several years, site cluster teams also have ecologists, biologists and partly modelers in team, many of which are part of FLUXNET and CarboEuroflux, but also extension towards a more representative selection of sites, more croplands and sites in Central and Eastern Europe.

Selected via a competitive call, have committed themselves to contribute significant own resources to the IP

Soil: Key teams of FP5 project FORCAST plus leading soils scientists, brigding to the German and Swedish national carbon research programmes (DFG Schwerpunkt, LUSTRA)

Forest, Cropland, Grassland: partners emerging from FP5 projects (CarboAge, Greengrass) and recent efforts to structure cropland research. Additional commitments for modeling also by Associated Members

Regional experiment: Knowledge (local meteorological service, INRA for soils and ecosystem carbon fluxes, USTUTT-IER for high-resolution emission maps...), equipment and technology (aircraft....) and modeling expertise proven in RECAB

Atmosphere: Infrastructure in terms of long-term monitoring stations, and groups capable to intensify the networks in undersampled regions (Spain, Poland?)

Integration: proven expertise in modeling, data assimilation, scenario development, data harmonisation, databasing, carbon inventories

Outreach: dissemination by groups with long-term active involvement in policy processes

Training: universities and research insitutes for summer schools, SME with experience in international educational projects and good contacts to multipliers at secondary school level

SMEs

Funding provided by CarboEurope-IP: formal members

No funding provided by CarboEurope-IP: associated members

A group of 60 partners from research institutes, universities, forest and meteorological authorities and SMEs has been composed to meet the ambitions of CarboEurope-IP. The group will be led by research institutions previously involved in CarboEurope and new partner institutions. The main partners involved in formulating this Expression of Interest are the current CarboEurope steering committee members and additional members as listed the table below.

Competences!

How institutes were chosen

JRC, the partner in CarboEurope-IP running the meta-database, plays a key role in the EU Monitoring Mechanism for the UNFCCC and the Kyoto Protocol, for improvement of inventory quality and harmonisation within the LULUCF category, which is closely related to results and research in the CarboEurope projects Carbodata and Carboinvent, and also creates the link to the EC soil strategy and ICP Forest monitoring. Stakeholders from EEA, European Council Sinks Expert Group, DG Environment and IPCC are members of the Advisory Board.

The global leadership of key researchers involved in CarboEurope-IP is demonstrated by their intensive contributions to international science programmes and assessments: CarboEurope members constitute two thirds of European authors of the IPCC Good Practice Guidance on LULUCF, and are lead authors in IPCC assessements, are running the European regional office of the Global Carbon Project (GCP) and represent the two European members of the scientific steering committee of the GCP in the field of terrestrial/atmosphere, and include the chair person of the TCO-IGCO (CarboEurope monitoring network as template for other regional initiatives and most advanced regional contribution to global carbon monitoring). The consortium bridges across a wide range of scientific disciplines and even includes specialists of biodiversity and its interaction with the carbon cycle. Therefore, also the link between the UNFCCC and the CBD can be potentially addressed.

Please find enclosed the template A2 for our INRA Institute. 7 different INRA units will actually be involved in the IP: Nancy, Clermont-Ferrand, Grignon,

Lusignan, Avignon & 2 units in Bordeaux, each of them in different components of the IP:

- the 7 in the 2 supersites North France (André Granier, Nancy) and South France (JF Soussana, Clermont)
- Activity 1.5 “Grasslands” coordinated by Jean-François Soussana, INRA Clermont-Ferrand
- Regional Activity in Bordeaux coordinated by Yves Brunet, INRA Bordeaux.

8B.6 Description of project management

Organisational structure and decision-making mechanisms

CarboEurope-IP evolves from the CarboEurope cluster of 15 European projects funded under FP5, which was even larger in size than the proposed integrated project, which, in turn, is restricted to the European continent. The internal organisation and the management of the consortium reflect this successful history, with adjustments to the new dimension of integration (Table 1, Figure 8).

Based on CarboEurope experience in FP5, we believe that the wider integration described in B.4 is best achieved in a structure that involves a **Scientific Steering Committee** as central body for strategic decisions, a strong, efficient, small **Executive Board** for operational decisions and an **Advisory Board** bridging to international programmes, major national activities outside Europe and stakeholders (members listed below). The Steering Committee and the Executive Board will be led by an annually rotating **Chair Person**. The Executive Board will consist of the co-ordinators of the main project components (Component Co-ordinators) and will deal with operational decision-making and project execution, ensuring a high level of integration.

MPI-BGC will act as the single, overall co-ordinating institution (**IP co-ordinator**) responsible for project administration and contact to the European Commission, supported by the **IP secretariat**. In case of unresolvable disagreement in the Steering Committee or Executive Board regarding the scientific co-ordination of the IP, the co-ordinator can take the final decision. He also has the right to veto against decisions in the Steering Committee and the Executive Board in case he perceives that the contractual obligations of the Integrated Project towards the European Commission may be violated.

Past experience has shown that this can provide the highly dynamic and flexible structure required for effective integration, matching the complexity of approaches and research questions, and quick response to emerging new research topics (Table 1, Figure 8).

Component co-ordinators will be responsible for strong interactions between the components and flow of data and information between components.

Within the IP components, **Component Committees** consisting of the component co-ordinator and its activity leaders, will take day-to-day decisions for scientific work within each component and prepare strategic decisions for the development of detailed workplans. Component committee meetings will also be open to all co-ordinators of other components and to the IP co-ordinator.

The **General Assembly of project partners** will have a strengthened role as compared to FP5, which partly results from the evolutionary nature of detailed work plan. The assembly discusses and makes suggestions for strategic decisions about the work plan and financial plan, and approves the accession of new partners and issues of relevance for the entire project partnership. The assembly can also take decisions via emailing and web conferences. Voting rights per partner (institution) will be according to the partner´s share in the EU financial contribution.

The **Gender Committee** promotes gender equality in the IP (cf. B.10 for details).

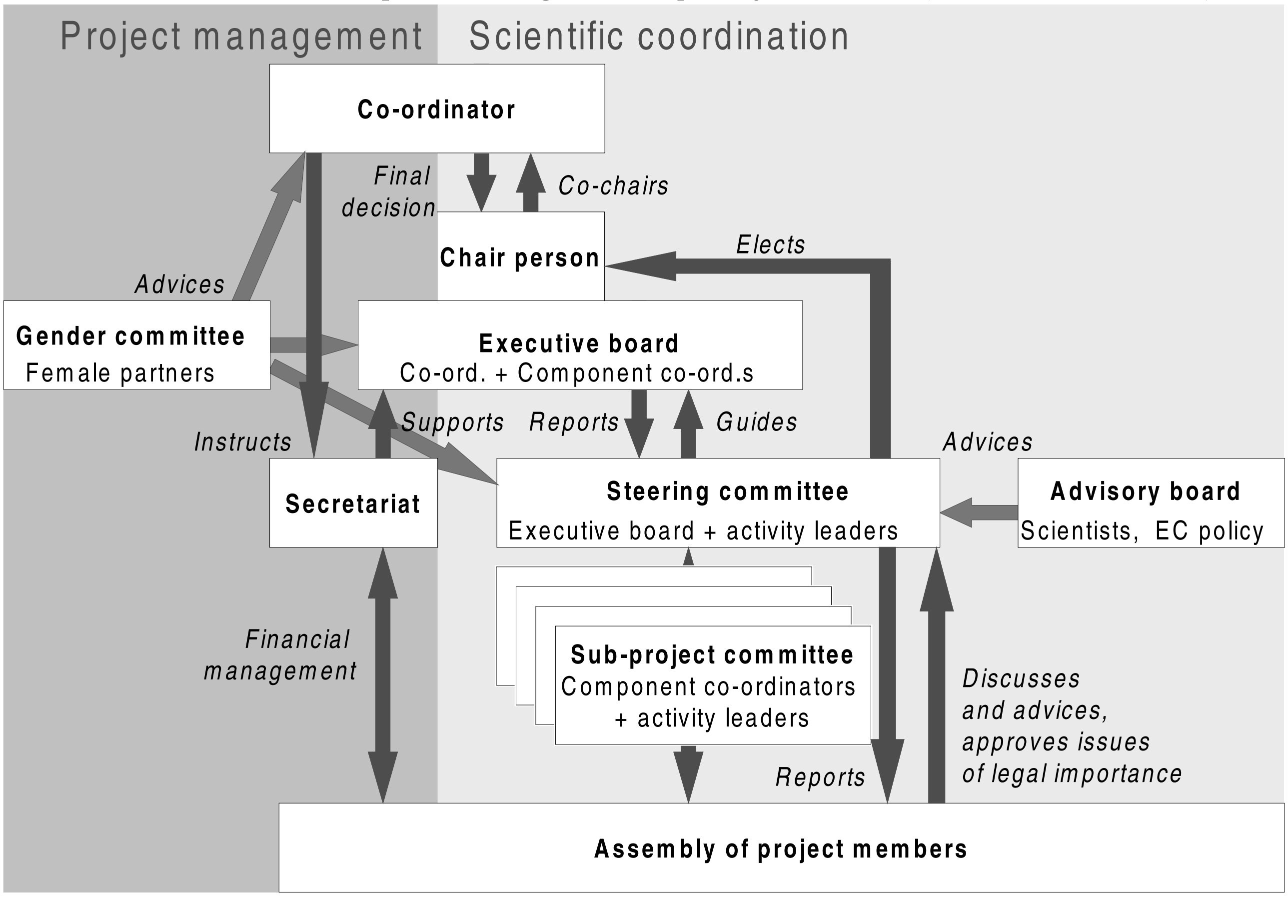

Figure 8 Decision structure of CarboEurope- IP

Table 1 Changes in the internal organisation and management from FP5 cluster to FP6 IP

Role	**FP5 CarboEurope project cluster**	**FP6 CarboEurope-IP**
Co-ordinator	Co-ordination by 15 co-ordinators of EC projects; integration by cluster secretariat	MPI-BGC as overall IP co-ordinator, supported by IP secretariat. Legal, financial and scientific management at IP level. IP co-ordinator can take final decisions in case no agreement can be reached within the main decision-making bodies and has a veto in the Steering Committee and Executive Board.
Chair person	Chair person as scientific representative of cluster, elected annually by Steering Committee	Same. Chair person must be co-ordinator of an IP component
Main body for decision making	Steering Committee consisting of all project co-ordinators + JRC Principal investigators of 15 EC projects	IP co-ordinator can take final decisions and has a veto in the Steering Committee and Executive Board. Steering Committee consisting of ~20 leaders of activities for strategic decisions of work plan and financial plan. Executive Board consisting of co-ordinator and component leaders for day-to-day operational decisions. Component committees if applicable, decide and control the scientific detailed activities in IP components
Secretariat	Project management in support of the Co-ordinator, dissemination	Scientific co-ordination, financial and legal project administration, outreach. Located at co-ordinator.
General Assembly	Discussion of IP proposal, gave mandate to Steering Committee to co-ordinate IP proposal	Discussions and suggestions about strategic decisions of work plan and financial plan and approval of accession of new partners and of issues of relevance for entire partnership.

Advisory board	Scientific advisory board for review of cluster after first two years of execution	Continuous advisory board with external scientists and policy makers. Provide annual scientific review which feeds into work plan.
Gender committee	none	Oversees the gender action plan, writes gender report, promotes gender equality in the project.

Project management

The steering committee has already collaborated for a number of years and has acted as the basis for strategic decisions during the preparation of this proposal. The component co-ordinators, in particular, have been collaborating for more than five years and therefore a strong basis of mutual trust, confidence and scientific understanding of each others domain to ensure a smooth, timely and highly integrated project performance. MPI-BGC has participated in the CarboEurope cluster in FP5 with the greatest diversity of scientific and co-ordination tasks and already hosts the CarboEurope secretariat with dedicated staff., so the institute naturally took the role of the IP co-ordinator.

Scientific co-ordination

As described in detail in section B4.4 and in the decision structure above, the scientific co-ordination follows the logic of the project components and their activities. We expect that working within established consortia for specific tasks within the IP allows best to identify and control scientific progress and to manage the integration between parallel well-identified tasks within and between project components. This structure will maintain high motivation by highest possible maintenance of scientific self-responsibilities of the partners under the clear guidance of the Executive Board, the chair person and the IP co-ordinator.
The component co-ordinators are responsible for the contribution of their respective component to the annual scientific progress reports. Component co-ordinators are assigned by the Steering Committee. Activity leaders are assigned by the respective component co-ordinator in agreement with the Executive Board.

Constitution of the scientific co-ordination

- **Co-ordinator:** Ernst-Detlef Schulze (MPI-BGC)
- **Chair person:** annual rotation, elected by Steering Committee, must be member of Executive Board; at present: Han Dolman (VU-A)

ive Board: Co-ordinator, component co-ordinators, secretariat: Ernst-Detlef Schulze (MPI-
Riccardo Valentini (UNITUS), Han Dolman (VU-A), Philippe Ciais (LSCE), Martin Heimann (MPI-
Annette Freibauer (secretariat, MPI-BGC)
ing Committee: Co-ordinator, component co-ordinators, secretariat, activity leaders
e person per institute per component), co-ordinators of FP5 projects of the CarboEurope
nposition of the Steering Committee may change as activities may be re-organised in the
ject and new activities may emerge.

Dennis Baldocchi (inquired)
Mike Raupach (inquired)

Roger Francey (preliminary acceptance)
Sue Trumbore (inquired)
A. Scott Denning (accepted)
EEA: André Jol (preliminary acceptance)
EC sinks experts group: Jim Penman (accepted)
DG Environment (upon decision of European Commission)
IPCC: Thelma Krug (accepted)

Internal co-ordination and communication

The secretariat plays a central role in the co-ordination and communication between CarboEurope partners. It supports the IP co-ordinator and the component co-ordinators of the IP in the scientific co-ordination and acts as central place to channel information. The overall project management will rely on frequent contacts between the co-ordinators at all scientific levels.

Communication: Communication among partners and timely information about recent developments in the IP and planning for subsequent detailed work plans will be optimally achieved by a combination of direct contacts by email, mail, phone and meetings, and in particular, by a strong, enhanced web-based communication for better interaction between project components and WPs within components. Mailing list will be used to streamline the flow of information between WPs and components and for special integrated task groups. Advanced interactive web-based management software tools will be used to facilitate the project management and to guarantee an efficient, democratic and transparent execution of the Integrated Project.

Meetings: The **Executive Board** will communicate on a regular, at least three-monthly basis via email exchange, phone conferences or meetings of executive board. The secretariat will report the results to the steering committee. The **Steering Committee** will meet at least yearly and upon request. Annual meetings of all project partners will be organised simultaneously at the same venue in order to allow the best integration of WPs, components and cross-cutting activities. Meetings of the components and WPs will take place separately and jointly and mixed, to allow also a well integrated planning of subsequent detailed work plans. These annual meetings may be coupled to conferences to interact with parallel activities inside and outside Europe, international programmes. This strategy has proven to work successfully in the tradition of **CarboEurope meetings** (Torgiano 2000, Budapest 2002, Lisbon 2003). The **External Advisory Board** will be invited to participate at these annual meetings and will prepare an annual project review about scientific achievements, the integration within the project, relevance for stakeholders and give recommendations for the development of subsequent work plans.

Communication with stakeholders and policy makers (cf. also Activity 5.6)

In FP5, the co-ordinators and the secretariat have initiated and maintained an intensive dialogue with policy makers, industry and journalists and with scientists outside CarboEurope, by personal contacts, invited oral presentations, producing dissemination material for policy makers, and the organisation of workshops, meetings, and an international CarboEurope conference. The co-ordinators and the secretariat have significantly contributed to making CarboEurope a well-known label with a clear political visibility (EU: European Climate Change Programme, Sinks Expert Group of the European Council, UNFCCC, lead authors in IPCC assessment reports and Good Practice Guidance for LULUCF). These activities will be continued in the IP. We will also try to establish more formal links to end users of results such as the European Environment Agency and national agencies involved in monitoring and reporting under the UNFCCC and the Kyoto Protocol.

The secretariat also acts as European support office of the Global Carbon Project (GCP), in collaboration with the University of Tuscia (co-ordinator of ecosystem component).

The present CarboEurope homepage has already acted as a frequently contacted interface to stakeholders, but will become more user-friendly in the IP. (http://www.bgc-jena.mpg.de/public/carboeur/).

Financial and legal administration

Cf. B4.4.

Settlement of internal disputes

During the last three years of the CarboEurope cluster, no serious internal disputes asking for official settlement have occurred. Nevertheless, in the unlikely case that such internal disputes will occur in the future, we will deal with them in the most democratic, subsidiary manner:

1. The activity leader tries to settle the dispute with the respective partner.
2. If not successful, the component leader tries to settle the dispute with the respective partner, supported by the component committee.
3. If not successful, the executive board develops a strategy and interfers to settle the dispute with the possibility of sanctions. In case of disagreeement within the executive board, the IP co-ordinator takes the final decision and is responsible for its execution.
4. If step 3 was applied, the co-ordinator reports the case and its solution or consequences to the European Commission.
5. If a component leader is directly involved in the dispute, the procedure starts at step 3.

Gender issues and gender equality

We are dealing with the understanding and quantitative assessment of the terrestrial carbon balance of Europe and to some extent with climate change impacts on the carbon balance of terrestrial ecosystems. There are no gender issues associated with the subject of this proposal.

All partners in the consortium will commit themselves as part of the consortium agreement to attempt, where possible, to reinforce and increase the place and role of women in science and research both from the perspective of equal opportunities and gender relevance of the topics covered if applicable at a later stage of the project. A detailed gender action plan (B.10) has been set up which will become part of the Consortium Agreement. In case of an enlargement of the consortium, new partners will have to adopt the same rules.

A gender committee will oversee whether partners adhere to their gender-related commitments and monitor progress towards **the overall target of CarboEurope-IP to raise the participation of females to 20% or more at all organisational levels in the project, in the frame of the national rules of the partners. This applies to the scientific work as well as to the active participation at workshops, conferences and publications.**

Ethical and safety issues

No research is performed on humans nor animals. We will respect the environmental integrity: the field measurements are non-intrusive whenever possible and disturb the ecosystems as little as possible in order to measure ecosystem properties in conditions as natural as possible. Vegetation and soil samples will be taken with the agreement of land owners and land users. This has been assured for all ecosystem sites. No potential ethical and/or safety aspects of the proposed research regarding its objectives, the methodology and the possible implications of the results were identified. The proposal is in full conformity with the ethical requirements of the 6th Framework Programme. We will also consider ethical and safety issues in each detailed work plan and during a potential enlargement of the consortium.

SMEs

The assessment of the terrestrial carbon cycle of Europe and its drivers is an area of fundamental research in which the integration of SMEs is difficult. We have a collaboration with SkyArrow company for the development and deployment of airborne eddy covariance measurements. We will also involve SMEs to support co-ordination, dissemination and training activities. The training activities at secondary school level will be performed by a specialised SME. Subcontracting of work related to the organisation of annual meetings and potential associated conferences and for editing and publishing dissemination material to SMEs is envisaged if useful. There are clear opportunities for involvement of SMEs in future demonstration activities:

- SMEs working on certification, monitoring and verification of projects under the JI and CDM mechanisms of the Kyoto Protocol
- Hardware developers (Soil coring, eddy covariance systems development, gas analyzers)

re developers (eddy covariance software)

routine soil chemical and physical analyses.

Integration of running FP5 projects and of national projects

In the transition from FP5 to FP6, there will be a temporal overlap for six out of 15 projects of the present CarboEurope cluster. These projects have beed designed to ideally fit in CarboEurope, so they also contain core deliverables of the early phase of the IP and guarantee continuity in research. In order to best integrate these running activities in the IP, key deliverables of the six projects were integrated in the detailed work plan (B.8), so workpackages covered by FP5 projects are marked and will not be duplicated here. The partners of these projects are also all members of the IP consortium without funding for these deliverables during the period in which the FP5 projects are still running. The respective projects are:

TACOS Infrastructure (EVR1-CT-2001-40015) until 31/10/2004
Greengrass (EVK2-CT-2001-00105) until 31/12/2004
TCOS Siberia (EVK2-CT-2001-00131) until 31/12/2004
Camels (EVK2-CT-2002-00151) until 31/10/2005
CarboEurope-GHG Concerted Action (EVK2-CT-2002-20014) until 31/10/2005
Carbo-Invent (EVK2-CT-2002-00157) until 31/10/2005
CHIOTTO (EVK2-2001-00324) until 31/10/2005

During the writing phase of this proposal, many European researchers expressed their interest to contribute to CarboEurope-IP with results from externally funded projects. Since these offers significantly enlarge the resource basis of CarboEurope-IP, a strategy for integration of externally funded research was adopted which will also apply to a potential enlargement of the consortium and is described in detail below. Unfunded partners committing themselves to contribute to the objectives of CarboEurope-IP have the status of „associated members“.

Strategy for enlargement of consortium

At the moment, no further call for enlargement of the consortium is foreseen within the present level of resources of the IP. However, the science infrastructure of CarboEurope-IP will be open to external scientists and consortia of emerging projects upon request. A collaboration should contribute significantly to the objectives of CarboEurope-IP. Only institutes (not projects) can become member in order to set up clear rights and responsibilities. The formal procedure for enlargement of the consortium and collaboration with externally funded research is as follows:

1. The applicant institute commits itself to make a clearly described, significant contribution to activities and workpackages indicated in the 5-years work outline plan and the detailed 18-months work plan.
2. The applicant institute commits itself to adhere to the rules set up in the consortium agreement of CarboEurope-IP, especially to the data policy.
3. The applicant institute becomes a member of the consortium of CarboEurope-IP for a limited period of time for which a significant contribution to the objectives of CarboEurope-IP is proven by the applicant. If the applicant institution receives funding out of CarboEurope-IP it will become a *formal member*, otherwise an *associated member*.

This means, for instance, if an external institution or consortium asks to use the science infrastructure of the supersites, the data taken on these sites must be delivered to the respective managers of the site and supersite and be made available to all members of the IP consortium. Metadata have to be delivered to the central meta-database of CarboEurope-IP. In turn, the external institution or consortium can request data taken in the frame of CarboEurope-IP at an extent related to the significance of the external contribution (e.g. from the site, supersite or all sites, respectively). This transparent strategy will further mobilise resources to achieve the goals of CarboEurope-IP.

As CarboEurope-IP evolves new directions of research or components of demonstration or operationalisation may need to be incorporated in the work plan.

New activities may be set up to respond for future developments, whilst the overall structure of main components will be maintained. The Integration WP, in particular, will be open to new initiatives of coupled earth system modeling and data assimilation, and serve as the contact point for wider integration with emerging research activities. We will particularly try to benefit from the strong observational infrastructure of CarboEurope- IP for training activities within Marie Curie networks. Such emerging projects should be bound to the CarboEurope- IP data policy in the same way as formal members, via membership in the CarboEurope- IP of the project consortium (cf. above).

Wider integration

At the European level we plan to form an alliance with Ocean Carbon Research by developing a joint Network of Excellence: ENEGACC: European Network of Excellence in Global Aspects of the Carbon Cycle. We will work closely with the planned Ocean Carbon Cycle Integrated Project (MARCASSA) that will provide essential boundary constraints for the terrestrial data assimilation program and with which we will jointly investigate land to seas fluxes. At the global level we aim to collaborate with the joint IGBP-WCRP-IHDP Global Carbon Project (by running the European Regional Office), the North American Carbon Cycle program and other regional and continental based carbon experiments. CarboEurope- IP will contribute to the GMES and to ongoing IPCC activities (Assessments and Good Practice Guidance).

Key partners of CarboEurope- IP are responsible for providing European data sets to GTOS and TCO (Cihlar et al., 2002).

Plan for the management of knowledge, intellectual property rights (IPR) and other innovation- related activities

CarboEurope- IP will produce and use the following knowledge: Measurement data, model results, software, and auxilliary data sets.

The present CarboEurope cluster already adopted a data policy in March 2000. Details can be found at http://www.bgc-jena.mpg.de/public/carboeur/data/index_d.html. This **data policy** is adjusted to the new level of integration in CarboEurope- IP and **will be part of the consortium agreement**. The term „data“ will be used in the following for all four types of knowledge produced.

The database will comprise a central metadatabase and decentralized databases for each component and eventually for major workpackages, which will be accessible via the meta- database. Rights and responsibilities of consortium members are defined at the level principle investigators (PIs). A consortium member may have several PIs with different rights and responsibilities. The executive board of the IP determines questions related to dataset documentation, dataset format, and quality level and adjudicates possible disputes relating to the data policy. The data policy contains rules for

- Documentation of datasets: All datasets should be documented according to a standard. This standard is an integral part of the database.
- Access to data: Data access is granted to each PI. Data access is initially restricted to consortium members. All data are immediately available to other

PIs as soon as they have been inserted into the database. Third parties can only access data by direct request to the data owner (PI). Access rights pertain to consortium members for the period of their membership, access to data emerging before or after this period are available only upon request to the author of the data (PI) in case they are not yet published.

- Publication of data: The metadata will be immediately available to the public. All datasets delivered to the database of CarboEurope-IP may eventually be published on CD (or another suitable medium existing at the time of publication). Such publication will open free access to third parties.
- Use of data from CarboEurope-IP: Data which have been accessed must only be used for scientific purposes, i.e., commercial use of data is not allowed. Use of data, to any significant degree, belonging to another PI for the purpose of scientific publication must always be based on an agreement between the PI and the data requester. The database will offer the possibility to trace all downloads of a given dataset. It is prohibited to distribute other PI's data to a third party without the consent of the PI.
- Delivery of data to the database: Data sets, documentation requirements, schedule with deadline, e.g. half-yearly delivery of continuous data like from eddy flux measurements, or for campaign data within a month after the end of the campaign.
- Special rules are set up for composite and external datasets such as remote sensing data and land use maps.
- Quality assurance rules are specified for data submitted to the database. Data quality will be flagged.

This data policy assures high transparency, efficient, timely exchange of data within the consortium, and full confidentiality and justice to authorship of knowledge, intellectual property rights and innovation. Details are found in Appendix 1.

9B.7 Project resources

Evaluation criteria:

The extent to which:

- *the project mobilises the minimum **critical mass of resources** (personnel, equipment, finance...) necessary for success.*
- *the **resources** are **convincingly integrated** to form a coherent project.*
- *the overall **financial plan** for the project is adequate.*

(add text)

Integration of running FP5 projects of the CarboEurope cluster

All partners of the below-mentioned projects are members of the IP consortium. Relevant deliverables of these projects are adopted in the detailed work plan (B.8) without funding by the IP.

TACOS Infrastructure (EVR1-CT-2001-40015) until 31/10/2004

Greengrass (EVK2-CT-2001-00105) until 31/12/2004

TCOS Siberia (EVK2-CT-2001-00131) until 31/12/2004
Camels (EVK2-CT-2002-00151) until 31/10/2005
CarboEurope-GHG Concerted Action (EVK2-CT-2002-20014) until 31/10/2005
Carbo-Invent (EVK2-CT-2002-00157) until 31/10/2005
CHIOTTO (EVK2-2001-00324) until 31/10/2005

9.1 B.7.1 IP Project Effort Form

Complete an IP Project Effort Form (given below) to show the person-months per partner associated with each activity identified in the sections above.

IP Project Effort Form

Full duration of project

(insert person- months for activities in which partners are involved)

CarboEurope- IP

	Partner 1 short name	Partner 2 short name	Partner 3 short name	Partner 4 short name	Partner 5 short name	etc	TOTAL PARTNERS
RTD/Innovation activities							
Ecosystems (C1)							
Regional experiment (C2)							
Continental atmosphere (C3)							
Integration (C4)							
Dissemination (A5.3-A5.6)							
Total research							
Demonstration activities							
Total demonstration	0	0	0	0			
Training activities							
Training (A5.7)							
Total training							
Management activities							
Administrative co-ordination (A5.1)							
Scientific co-ordination (A5.2)							
Total management							
TOTAL ACTIVITIES							

9.2 B.7.2 IP management level justification of resources and budget

Describe the resources needed to carry out the project (personnel, equipment, finance…). Demonstrate how the project will mobilise the critical mass of resources necessary for success; how the resources will be integrated to form a coherent project, and show that the overall financial plan for the project is adequate. (Recommended length – five pages).

Financial plan (in EURO)

10

(add text)

11B.8 Detailed implementation plan – first 18 months

This section describes in detail the work planned to achieve the objectives of the proposed project up to its first 18 months in operation. The recommended length, excluding the forms specified below, is up to 15 pages. An introduction should explain the structure of this 18- month detailed implementation plan and how the plan will lead the participants to achieve the objectives aimed for by that time. It should also identify significant risks, and contingency plans for these. The plan must be broken down into work packages (WPs) which should follow the logical phases of the project during this period, and include management of the project and assessment of progress and results to this point. Essential elements of the plan are:

11.1 B.8a) Detailed implementation plan introduction

explaining the structure of this plan and the overall methodology used to achieve the objectives of the first 18 months. Include a version of the form A3 which is used in Part A of the proposal, but covering just the first 18 months

Overall implementation of project
For clarity within the complex structure of the Integrated project, all work packages (WPs) are directly linked to the Activities described above under the Components.

(add text.)

Component 1: Ecosystems
WP 1.1 Eddy flux
WP 1.2 Soils
WP 1.3 Forest

WP 1.4 Cropland
In this work package we bring croplands within the CarboEurope framework for the first time. The factors controlling C fluxes are likely to be different from those found in grassland and forestry sites. Croplands are, by definition, highly managed. This level of daily and seasonal management (e.g. ploughing, sowing, fertilization, harvest) is more intensive than in most grasslands and forestry systems. Management is a key driver of fluxes in croplands and the management is, of course, specific to croplands. We will use the cropland components of the CarboEurope IP super- sites to better quantify carbon (and other GHG) fluxes from cropland, and to reduce the uncertainty associated with European estimates of cropland carbon flux. Much of the science initially carried out under this work package uses a range of nationally funded projects operating at the CarboEurope IP site clusters to begin to address the objectives of the CarboEurope IP cropland work package.

WP 1.5 Grassland/wetland
WP 1.6 Quality assurance

Component 2: Regional experiment
Component 3: Atmosphere
Component 4: Integration
Component 5: Project co- ordination, outreach and training

11.2 B.8b) Work planning and timing of the different WPs and their tasks

(Gantt chart or similar)

11.3 B.8c) Graphical presentation of the components, showing their interdependencies

(Pert diagram or similar)

11.4 B.8d) Detailed work description broken down into work packages

11.4.1 Work package list (18 month plan)

Work- package No[4]	Work package title	Lead contractor No[5]	Person- months[6]	Start month[7]	End month[8]	Deliv- erable No[9]
1.1	Eddy fluxes	2				
1.2	Soil	1				
1.3	Forest	5				
1.4	Cropland	6				
1.5	Grassland/wetland	7				
1.6	Nighttime	8				

[4] Work package number: WP 1 – WP n.
[5] Number of the contractor leading the work in this work package.
[6] The total number of person- months allocated to each work package.
[7] Relative start date for the work in the specific work packages, month 0 marking the start of the project, and all other start dates being relative to this start date.
[8] Relative end date, month 0 marking the start of the project, and all ends dates being relative to this start date.
[9] Deliverable number: Number for the deliverable(s)/result(s) mentioned in the work package: D1 - Dn.

2.1	Regional experiment – maps/data					
2.2	Regional experiment – ...					
2.3	Regional experiment – ...					
2.4	Regional experiment – ...					
3.1	Continental atmosphere – surface stations					
3.2	Continental atmosphere – tall towers					
3.3	Continental atmosphere – aircraft measurements					
3.4	Continental atmosphere – calibration of eddy towers					
3.5						
3.6						
3.7						
4.1						
4.2						
4.3						
4.4						
4.5						
4.6						
4.7						
4.8						
5.1	Legal and administrative co-ordination					
5.2	Scientific co- ordination					
5.3	Outreach science conferences					
5.4	Joint EU/US assessments					
5.5	European office of GCP					
5.6	Science/policy interface					
5.7	Training					
	TOTAL					

11.4.2 Deliverables list (18 month plan)

Deliverable No[10]	Deliverable title	Delivery date[11]	Nature[12]	Dissemination level[13]

[10] Deliverable numbers in order of delivery dates: D1 – Dn

[11] Month in which the deliverables will be available. Month 0 marking the start of the project, and all delivery dates being relative to this start date.

[12] Please indicate the nature of the deliverable using one of the following codes:

R = Report
P = Prototype
D = Demonstrator
O = Other

[13] Please indicate the dissemination level using one of the following codes:

PU = Public
PP = Restricted to other programme participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).

11.4.3 Work package description (18 month plan)

1 Ecosystems

WP 1.1 Ecosystems – eddy fluxes

Work package number	**WP1.1**	**Start date or starting event:**			**Month 1**	
Participant id						
Person- months per participant						

Objectives

- To establish a pan- European network of flux towers with highly integrated and harmonized standards of measurements
- to provide continuous fluxes of carbon, water and energy from representative land use/cover types of Europe
- to harmonize, quality check and improve eddy covariance measurements of the network
- to understand the role of climate, vegetation type and use on carbon sequestration
- to provide data of non- CO2 trace gases for selected ecosystems
- to provide data for model parametrization and up- scaling to the European continent

Description of work

Continuous eddy covariance measurements will be carried out for the duration of the project, together with climate and vegetation observations (see appendix 1). Flux data as well ecological parameters will be available in the project data base for analysis and models parametrization

Improvement of night time measurements and interpretation will be addressed with a specific task which will include in depth quality assessment of the sites of the network and specific experiments to elucidate the mechanisms and the corrections to apply under the conditions of flux losses.

Error analysis and uncertainties estimation will be delivered on the carbon exchanges of different land use/cover components

Flux data will be collected at 93 flux tower sites with the same protocol and measurement standards. A strict calibration protocol will be carried out in conjunction with the Atmospheric component of IP (WP4).

Measurements of non – CO2 trace gases (methane, N2O) will be carried out in some specific ecosystems where these fluxes represent an important component of the GHG budget. (see Appendix 1).

The 53 flux tower site will be organized in a network of “supersites”, cluster of at least 3 sites representing the land use/cover of the region. Within the supersites, main sites (MS) will follow the full protocol of measurements as described in appendix 1, elaborated together with the soil component of IP (WP2.2) and be delivering continuosly for 5 years. Associated sites (AS) will deliver only a sub- set of the full protocol and can be active for only part of the 5 years period (at least 1 year).

Deliverables

1.1.1 Highly standardized and continuos flux data of carbon, water energy and the associated meteorological and ecological variables

1.1.2 Partition of flux components into : gross ecosystem exchange, ecosystem respiration and net ecosystem exchange

1.1.3 Error analysis and uncertainties on carbon exchanges

Milestones[14] and expected result

Month 1: workshop on approval on new harminization and calibration standards
month 3: full operational status of the networks with new standards
month 3: start data delivery at three monthly interval at the central database
month 6: start of the advection/nigh time project
month 12: Final assessment of data quality of flux towers and improvements
month 18 : Final assessment of carbon exchanges errors and uncertainties at all sites

WP 1.2 Ecosystems – soil

[14] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Work package number	**WP1.2**	**Start date or starting event:**			**Month 1**		
Participant id	MPI-BGC	Soil science, Uppsala	Weihenstephan	Halle	Dept of Ecology Uppsala		
Person-months per participant							

Objectives

- to supply soil information necessary to interpret eddy flux budgets at main tower sites
- to develop a scheme that leads to a verification of changes in soil C-pools
- to increase process understanding of carbon immobilization in soils

Description of work

- to map soil conditions of 12 sites (3 deciduous forest, 3 coniferous forest, 3 cropland, 3 grassland)
- to supply 200 soil cores from 12 sites
- to carry out sample preparation and bulk density measurements
- to measure C/N concentrations in 6000 samples
- to measure texture in 600 samples
- to determine the light fraction in 600 samples

Verification of changes in the soil carbon pool

Methodology

A grid of 10 x 10m lines is established in the 100 x 200 m area of the main footprint of a tower. The L+O- horizon will be sampled with a 0.2x0.2 m frame and10 cm diameter soil cores are sampled at each grid point up to 0.5 m depth. The sampled material will be dissected into 7 layers (L+O, 0- 5 cm, 5- 10cm, 10-20cm, 20- 30cm, 30- 40cm, 40- 50cm). The 200 soil samples are dried for bulk density determination, roots are extracted, and the soils are sieved for final storage. In case of soils with high stone content (Sweden) the procedure will have to be slightly modified.

100 cores are selected from the total of 200. 5 horizons of these selected cores (L+O, 0- 5 cm, 5- 10cm, 20- 30cm, 40- 50cm) are measured for total C/N.

The procedure needs to be repeated pair- wise after 5 years for the 100 cores that were selected initially after 5 years

If the uncertainty in soil Carbon increase is too large, i.e. the increase is equal or smaller than the half confidence limit, it would be possible to analyze additional cores or horizons from the 100 cores that were not used in the initial analysis. However, this decision will be made after re- sampling and analysis. The proposed budget does not cover an intensified analysis density.

Task 3: Compartmentalization of soil C fluxes

The bulk C/N analysis can only give an insight into the mass balance without information about the carbon fraction that is affected nor about the processes that cause this change. Any further analysis requires massive analytical work and cannot be carried out on a large sample size. Therefore a subset of 10 cores will be taken for a detailed analysis of

Texture using the pipette method

C density: we will only determine the light fraction of C- particles as a measure of labile C

Determine ^{13}C, ^{14}C and specific compounds for selected compartments that indicate change.

At this moment it is unclear, which fraction will change and accumulate C. Obviously the light, mobile fraction should respond most, but at the same time there is a significant transport of DOC, in part bound to heavy metals, that appear to originate from old C which is reallocated to deeper layers. Thus, the analyses in Task 3 will lead to a process understanding that can help to improve soil C models

Deliverables

1.2.1 Georeferenced, geostatistical sampling scheme at 12 sites for verification (month 12)
1.2.2 Carbon stock data and their uncertainty of 12 sites as input for verification and modeling (month 18)
1.2.3 Relation between C-stocks and soil physical parameters and land use (month 18)

Milestones [15] and expected result

Month 12: sampling of all sites
Month 18: analysis of samples

[15] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

WP 1.3 Ecosystems – Forest

Work package number	**WP1.3**	**Start date or starting event:**	**Month 1**				
Participant id							
Person- months per participant							
Objectives							
Description of work							
Deliverables							
Milestones[16] and expected result							

WP 1.4 Ecosystems – Cropland

Work package number	**1.4**	**Start date or starting event:**	**Kick- off meeting**

[16] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Participant id							
Person months	60						

Objectives

- to provide data on NPP components of cropland sites in the clusters network
- to investigate emission of other GHG gases
- to provide data of agricluture practices on soil organic carbon input (root biomass, organic manure, straw etc.)
- establish relations with crop types, management and climate with carbon source and sinks

Description of work

This WP will pull data together from all cropland sites to quantify NPP and its components, quantify non- CO_2 GHG fluxes and start to delineate how these are affected by climate, crop and management. It will then be possible to determine what factors are controlling the C and GHG fluxes at each site, i.e. what component is due to crop, what due to climate, what due to management etc. This will involve a range of data being collected under standard protocols, and some meta- analysis and modelling. Standard protocols will be developed for the measurement of all cropland components (e.g. bulking, number of samples, where and how to sample, methods of analysis etc.). Standard protocols will also be developed for data formats (for standardisation and compatibility with flux data). This activity will not only provide the data needed to complement the flux measurements for the clusters, but also some quantitative and predictive understanding of what controls the fluxes in cropland sites.

This WP builds heavily on ongoing work in Europe and its main purpose is to synthesise work funded through other sources. The impact of management (and other factors) on C and GHG fluxes in croplands will be assessed at each super- site. As well as integrating our understanding of cropland fluxes with our understanding of other land- use types (forestry, grassland) as a component of the overall carbon budget for Europe, we will use these data to test and further develop agro-ecosystem models, to incorporate this improved process understanding in pan-European and global SVAT models for scaling- up cropland C and GHG fluxes to the regional level and to Europe.

By collating data from all cropland sites, meta- analysis (e.g. multiple regression, multivariate analysis, general linear modelling) and modelling of the data (using ecosystem models such as Century, MAGEC/Sundial/RothC, STICS, DNDC) will allow the impacts of climate, soil type, crop type and management to be delineated. Later in the project, these results will be used to parameterise and improve cropland ecosystem models and SVATS and regionalised parameters will be provided for up- scaling. This activity will not only provide the data needed to augment the flux measurements at each cluster, but will also provide some quantitative and predictive understanding of what controls the fluxes.

Deliverables

- Standard protocols for measuring all non- flux cropland components (listed in annex)
- Collation and quality control of non- flux cropland components from all cropland sites
- Preliminary analysis of European trends in impact of climate and management on cropland CO_2 (and non- CO_2 GHG) fluxes
- Preliminary evaluation and suggested improvements to cropland ecosystem models using cropland flux data

Milestones

- Month 1: Begin collation and quality control of non- flux cropland site data already available (management, site history etc.)
- Month 3: Draft standard protocols circulated for comment to all cropland sites
- Month 6: Standard protocols finalised
- Month 6: Begin collation and quality control of ongoing non- flux cropland data (e.g. NPP, fertilizer addtion etc.)
- Month 12: Assessment of data quality of non- flux cropland data and improvements
- Month 12: Begin testing data using meta- analysis and cropland ecosystem models
- Month 18: Preliminary report on model performance, data quality and data gaps

WP 1.5 Ecosystems – Grasslands/Wetlands

Work package number	**A1.5**	**Start date or starting event:**	**Month 1**			
Participant id ??						

Objectives

- To provide ecological parameters and NPP components of the grassland/wetlands sites of the clusters network including harvest and grazing
- To investigate the full GHG balance at selected grassland/wetland sites
- To adapt, calibrate and evaluate a detailed process- based grassland model
- To establish relations of grassland types, management and climate with carbon source and sinks
- To simulate the seasonal, inter- annual and long- term variations in net trace gas (CO_2, CH_4, N_2O) fluxes for grasslands and wetlands, including both semi- natural and intensive management systems,
- To provide data for model parametrization and up- scaling to the European continent for grasslands

Description of work

- Standardised protocols for the management of the grassland plots, for the measurement of ecological (eg. vegetation) parameters and of the components of NPP at the grassland/wetland sites will be developed.
- Protocols for the measurement of nitrous oxide emissions will be developed and gas samples from the main grassland/wetland sites will be analysed at a central laboratory.
- At selected sites a standard methodology will be set up to determine the greenhouse gas balance from the net exchange of CO_2, N_2O and CH_4 with grassland/wetland ecosystems.
- The data from the grassland/wetland sites of the clusters network will be checked by quality assurance/quality control procedures and will be analysed to assess the interactions between climate, soil, vegetation and management factors for the carbon balance of these ecosystems.
- A mechanistic grassland ecosystem model (PASIM) developed under the FP5 project ‘GreenGrass’ will be further adapted to predict the net exchange of greenhouse gases from permanent and short duration grasslands.
- The PASIM model will be parametrized and evaluated against the data from the main grassland sites of the cluster network and will be used as the main process modelling tool for trace gas fluxes in relationship to other important properties of the different European grassland/wetland types under the current climate and under climate change and N deposition scenarios.
- A complementary tool to evaluate the greenhouse gas emissions from livestock indoors and from animal waste management systems will be developed. Using this tool and the PASIM model, the potential of greenhouse gas mitigation will be evaluated for the grasslands and wetlands studied at the main sites.
- A coupled version of the PASIM and ORCHIDEE first developed under the FP5 project ‘GreenGrass’ will be parametrised by region and grassland type in order to contribute to the bottom- up simulation of pan- European CO_2, CH_4 and N_2O fluxes over grasslands.

Deliverables

- Data on vegetation, NPP and its components at the grassland/wetlands sites of the cluster network
- Data on the full GHG balance for selected sites
- Calibration of the grassland model with the first year data and simulation of fluxes from each main grassland site.
- Simulated GHG fluxes of grasslands for climate change, N deposition and agricultural management scenarios.

Milestones

- Month 1: workshop on grassland/wetland sites: standardization of experimental plot management rules, measurement protocols of ecological and NPP variables.
- Month 3: full operational status of the network of grassland and wetland sites.
- Month 3: start data delivery at three monthly interval at the central database
- Month 6: quality control of data
- Month 12: Final assessment of data quality and improvements
- Month 18. A version of the PASIM model suitable for long- term simulations of trace gas fluxes and carbon sequestration potentials for sown grasslands, permanent grasslands.
- Month 18 : The annual greenhouse gas balances (CO_2, N_2O, CH_4) at selected sites will show if the grasslands have a net positive or negative global warming potential, given the climatic conditions and management practices

Regional experiment

WP 2.1 Experiment planning and data consolidation and data management

Work package number	WP2.1	Start date or starting event:	Month 1				
Participant id							
Person-months per participant							

Objectives

- To collect the main soil and land biophysical characteristics and land use of the area
- To produce a 20 year dataset of downscaled weather of the region at 8 km
- To produce a 2 km resolution database of fossil fuel emission for the area
- To produce a geo-referenced set of forest growth and land use data from 1980
- To develop and maintain an easily accessible system for data storage and archival for all regional modelling efforts
- To plan optimal flight and deployment patterns for the experimental aircraft and ground based systems for the EOP and IOP

Description of work

Task 1.1 A considerable amount of the required data has been collected by CNRM for HAPEX-Mobilhy and subsequent hydrological monitoring efforts. This data will be made available for the project and extended where needed. The data consists of remotely sensed land cover maps and associated biophysical characteristics like albedo, roughness, etc. and soil types with associated hydraulic characteristics. We will update this data where needed.

New in this project is the development of databases that are required to model the slow carbon storage, e.i. soil carbon, forest biomass, and fossil fuel emissions. For each of these three sets of data new maps at 2 km (and where possible smaller) resolution will be produced. These concern also land cover history from remote sensing and regional statistics, management history and crop rotation at the level of detail to which they remain reliable.

The University of Stuttgart will downscale the regional level emission maps to a 2 km resolution using regional level emission data and land cover maps.

It is important that these data are available through a single institution and are maintained at a high level of accuracy. This will be at CNRM in Toulouse.

Task 1.2 We plan to execute a small test campaign (TC) in spring 2005 to determine the best deployment strategy of the instruments. We will also use this TC to acquire high- resolution remote sensing images of the area from the Sky Arrow research aircraft. On the basis of the results from this experiment we will fine- tune our experimental plan for the yearlong EOP developed in task 1.3.

The TC also serves to test the use of a regional weather forecasting system for flight planning in the IOP and EOP. In WP 2.2. and 2.3 the experimental details of the TC are described. In this WP, it is essentially the evaluation and recommendation that is at stake.

Task 1.3 On the basis of existing data on mesoscale weather at CNRM weather we will use regional inverse models to indicate where flight patterns and additional flux towers are best positioned and so as to best reduce uncertainty in a priory estimates. This will produce an experimental plan in which the systems are deployed in those areas where they give the greatest contribution to efforts reducing the uncertainty in the a- priory estimate. This will also indicate the preferred time frequency of the measurements and the preferred mode of operation e.g. Lagrangian vs Eulerian. Preliminary testing of this plan is foreseen in the TC in early 2005.

Deliverables

1.1.Maps of soil (structure, C- content) for fast and slow carbon models

1.2 Maps of land use for carbon models

1.3 Maps of biophysical parameters (albedo, roughness etc),

1.4 Surface climatology based on downscaled synoptic weather dat at 8 km resolution

1.5 High resolution assimilated mesoscale weather from the Arome prototope mesoscale assimilation system.

1.6 Fossil fuel inventory at 2 km resolution.

1.7 Experimental plan for the intensive IOP and the yearlong EOP

Milestones and expected result T+12 Maps of land cover, biophysical properties, weather at 8 km, soils and forest inventory T+12 experimental plan for EOP and IOP T+12 Surface climatology dataset for driving biogeochemical models T+12 Evaluation of the TC

WP2.2 Intensive Observation Period i) surface flux and tall tower measurements

Work package number	WP2.2	Start date or starting event:	Month 1			
Participant id						
Person- months per participant						

Objectives

- To take measurements of CO_2 fluxes and energy balance above the main vegetation types in the region during the five year period and during the IOP's
- To prepare the installation of high precision measurements of CO_2 and C^{14}, CO at two tall towers at the in- and outflow of the domain.

Description of work

Task 2.1 Biospheric surface fluxes of heat momentum, water vapour, CO_2, and, at some sites, O_3 and N will be measured half-hourly using the eddy covariance technique over a representative set of sites. Four permanent sites will be monitored continuously during the entire project. Two of them are main sites of the Southern French *supersite*, i.e. one grassland (Laqueuille) and one 35 yr-old Pine forest (Le Bray) monitored since 2001 and 1996 respectively. The two supplementary sites are a forest clearcut regrowing since 1999 (Bilos) and a vineyard (Couhins), respectively. Additional temporary sites will be added for completing the ground flux network during the extensive measurement campaign. They will be measured using portable systems such as a battery-powered open-path system. These systems will be cross-calibrated with continuously running systems operating over the main permanent sites. Their location will be chosen during the first stage of the project. We will take account of both C3 and C4 plants as their atmospheric signature is different..

Task 2.2 At the inflow and outflow positions of the domain (near Toulouse and Bordeaux) we will establish two towers with high precision gas chromatographs to measure the concentrations of CO_2, and C^{14}, CO. We will use purposely build CMDL CO_2 sensors for this purpose and test their performance in the first 18 months. Contacts have been made with the owners of the towers and permission to use them has been granted. The implementation will start in summer 2005.

Deliverables

2.1 Set of flux data for the main vegetation sites

2.2 Installation plan and protocol for CO_2 concentration measurements

2.3 Experimental plan for additional sites IOP

Milestones and expected result

T+12 full year of flux data according to Ecology protocol

T+12 identification of tall towers and assessment performance [CO_2] senors

T+12 identification additional sites for EOP based on land use classification and potential contribution to C balance

WP 2.3 Test Intensive Observation Period ii) Boundary layer and plane measurements

Work package number	WP2.1	Start date or starting event:T+16	Month 16			
Participant id						
Person- months per participant						

Objectives

- To perform test measurements of the fluxes of heat, water vapour, CO2 and momentum with a low flying research aircraft (Sky Arrow)
- To perform test flights with a small commercial to sample the boundary evolution of CO2, C13 and CO.
- To perform at fixed locations (see WP1) continuous measurements of windspeed in the boundary layer with a UHF profiles and windspeed and temperature with a RAS-Sodar system during the test IOP.
- To perform twice daily radio soundings at a regular radio sounding site in Bordeaux during the test IOP.
- To test the feasibility of the long term (1 yr) experiment by learning from the test experiment

Description of work In the first 18 months only a test campaign is foreseen (TC) to test the logistics of the EOP and IOP and obtain some preliminary dat for model development. Task 3.1 One Sky- Arrow of the Italian partner IBIMET fully equipped for flux measurements will be used during the test campaign in 2005 to perform at least 8 different transects over the area to quantify the spatial heterogeneity. This plane, also equipped with high resolution remote sensing (visible- infrared), will make high- resolution images of the area that can be used for planning of future flights. Task 3.3 A small commercial plane will be rented locally and be used to sample the boundary layer structure for CO_2, C^{13} and CO for three to five days. The samples takes will subsequently be analyzed in the laboratory of our German partner, MPI- BGC. This is to test the feasibility of the approach over the area. We will pay particular attention to the isotopic effects of C3 and C4 plants. Task 3.4 The structure and evolution of the boundary layer is of crucial importance in efforts aimed at improving our regional estimates, so considerable effort is put in acquiring high quality data. We will extend the routine WMO observations at Bordeaux during the TC This is primarily to test the logistics and feasibility of this in operation with the flight plans of the planes.
Deliverables 3.1 Datasets of fluxes of water vapour, heat, momentum and CO2 for selected transects during the TC. 3. 2 Emission checks on city fluxes with the flux aircraft for the TC 3.4 Datasets of boundary layer evolution with radiosounding for the TC 3.5 Datasets of concentrations of CBL for the TC
Milestones and expected result T+18 datssets of fluxes of CO2, temperature, momentum and heat from the flux aircraft T+18 datasets of high resolution spectral imagery from the aircraft near actual and potential tower sites T+18 First emission estimate from Bordeaux in spring T+18 Datasets of concentrations of CBL for the TC

WP2.4 Modelling, integration and overall management

Work package number	**WP2.2**	**Start date or starting event:**			**Month 1**	
Participant id						
Person- months per participant						

Objectives

- To develop a data assimilation system that produces the best possible estimates of the regional carbon balance at 2 km spatial and hourly temporal resolution
- To produce a long term (20 years) bottom up estimate at 1 km resolution of the carbon balance of the region
- To manage the CarboEurope- Regional project

Description of work

The main purpose of this workpackage is to provide estimates of the carbon balance of the region using all available data and atmospheric model information. This is done for the slow and fast cycle in a slightly different manner. In the first 18 months we will initiate the development of this regional CDAS in parallel with effort in CAMELS.

Task 4.1 For the slow cycle, we will use the 8 km resolution downscaled weather information that is available at CNRM and will be extended for use in biogeochemical models. These models will be calibrated with flux data for the main land use types and then run for a 20- year period. The required input data on land use history and management is obtained in WP1. The models we intend to use, comprise Orchid, LPJ, ISBA- A- g_s. We will concentrate on calibration and model performance in the first 18 months.

Task 4.2 For the fast cycle we will use a data assimilation system at mesoscale that mirrors the system developed for the large scale (Camels and integration component). We will mainly use the French Arome system developed at CNRM for this purpose and extend it to carry CO2 in the assimilation procedure. We will adapt Arome to carry CO2 in the first 18 months.

Task 4.4 We purposely include the management of this component in the integration activities and workpackage as this facilitates good planning of the experiment and integration of the several components afterwards. The task leader of integration is also the coordinator of the component, facilitating again the overall management of the component. Management implies checking the preparation of the TC and the writing and coordination of the experimental plan for the EOP and IOP.

Deliverables

4.1 Calibrated set of biogeochemical and SVAT models

4.2 Arome assimilation system extended with CO2

4.3. Blueprint of a full regional data assimilation system capable of assimilating land surface, remote sensing, atmospheric data at regional scale

Milestones and expected result

T+18 Calibrated set of biogeochemical and SVAT models

T+12 Arome assimilation system extended with CO2

T+18 Blueprint of a full regional data assimilation system capable of assimilating land surface, remote sensing, atmospheric data at regional scale

Component 3 Continental atmosphere

WP 3.1 Surface stations continuous CO2 and Rn- 222 measurements

Workpackage number	3.1	**Start date or starting event:**	T+0				
Participant id							
Person- months per participant:							

Objectives

- Continue to monitor CO2 and 222Rn continuously at a core of 13 European stations

Deliver to the database raw concentration data, selected concentration data, and auxillary information on meteorology and other relevant species.

Description of work

Operate 8 existing continuous CO2 stations : Mace- Head (Ir), Westerland (G), Schauinsland (G), Plateau Rosa (I), Puy de Dome (F), Cimone (I), Alert (Can), Pallas (Fi), which will be mostly funded by national programs but supported by CARBOEUROPE for data processing and delivery to the database in adequate format, quality control, and data selection.

Support 5 additional continuous stations : Lutjewaad (NL), Jungfraujoch (Sch), Lampedusa (I), Zeppelin (No) and Kasprowy (Pl). Those stations already exist or have received national funding to get started and will be associated to the database.

Co- locate continuous monitoring of Rn- 222 with CO2 measurements, by adding Rn- 222 equipment at Lampedusa (I), Plateau Rosa (I), Westerland (G) and Lutjewaad (Nl). At all other sites, Rn- 222 is already monitored.

Report to the database each 3 months raw CO2 and Rn 222 data, meteorology, selected data with minimized local influences, and wherever possible other relevant species data such as CH4 and pollutants.

Deliverables

An atmospheric network of 13 surface CO2 and 222Rn stations

A database of atmospheric measurements, updated each 3-months, with raw concentration data, selected data, and auxillary information

Milestones and expected result

Atmospheric Network : T + 12

Database with 3- month update : T + 18

WP 4.2 Tall towers continuous measurements of CO2 CH4 SF6 N2O CO, Rn- 222

Workpackage number	2	**Start date or starting event:**	T+0				
Participant id	ECN						
Person-months per participant:							

Objectives

Operate a network of 9 tall towers for continuous regionally representative CO2, CH4, SF6, N2O, CO and Rn-222 measurements.

Deliver to the database concentration data, selected concentration data, and ancillary information on meteorology

Description of work

part of CHIOTTO FP5 project (no funding)

Continue to support the 8 tall towers routine operations after FP5 project CHIOTTO terminates at Hegyhatsal (H), Cabauw (NL), Orléans (F), Ochsenkopf (D), Edinburgh (UK), Florence (I), Norunda (S) and Bialystok (P).
Deliver to the database tall tower concentration records with compatible data format as the ones of ground level stations.

part of CARBOEUROPE-IP

Install one additional tall tower site for CO_2 only at La Muella (Sp) by 2005

Deliverables

One additional tall tower at La Muella (Sp) for CO_2 only

Milestones and expected result

Tall tower at La Muella operational in the observing system : T + 18

WP 4.3 Flask air sampling for multiple species analysis

Workpackage number	3		**Start date or starting event:**		T+X		
Participant id	UHEI						
Person-months per participant:							

Objectives

Sample flask air samples at 5 continuous surface stations, 8 tall towers, 4 aircrafts sites (10 altitudes), and 4

„flask sampling only“ sites.

Interpret flask multiple-species measurements of 13CO2, 18OCO, CH4, CO, N2O, SF6, O2:N2 to apportion the European CO2 gradients into components : fossil, biospheric, oceanic, and to infer large scale isotopic fractionation by European ecosystems

Description of work
Continue to support European flask sampling activities at 21 sites, including cross-sampling by different laboratories at common sites to obtain end-to-end information on the intercomparability of flask measurements Interpret flask records 13C and O2:N2 gradients among sites to independently separate terrestrial and oceanic components. Use isotopic 13C and 18O flask records to determine large scale isotopic fractionation patterns of European ecosystems Use tracers such as SF6, and APO (a linear combination of O2:N2 and CO_2 with no land biotic sources) to validate transport parametrisations in atmospheric tracer transport models Report each 6 months flask sample data to database
Deliverables Network of 21 flask sampling stations in Europe Dataset to separate the european CO_2 gardients into components (oceanic, terrestrial, fossil)
Milestones and expected result Network of 21 flask sites T + 12 Database with 6 month flask samples data T+18

WP 4.4 Vertical airplane profiles of in situ *CO_2 and flask samples*

Workpackage number	4	**Start date or starting event:**		T+0		
Participant id	LSCE Ramonet					
Person-months per participant:						

Objectives

Measure regular “low-frequency” each 20-days vertical profiles of atmospheric CO_2 using small aircrafts at 4 sites

Collect flask samples onboard aircraft bi-weekly at 10 altitude levels and analyse them in 13CO2, 18OCO, CH4, CO, N2O, SF6, O2:N2

Description of work

Fly each 20-days over Orleans (F) tall tower before 2006 up to 4 km, with in situ CO_2 and CO, flask sampling

Fly each 20 days over Griffin (UK) tall tower before 2006 up to 4 km with flask sampling

Fly each 20 days over Hegyhatsall (Hu) tall tower before 2006 up to 4 km, with flask sampling

Fly each 20 days over Bialystok (Pl) tall tower before 2006 up to 4 km, with in situ CO_2, flask sampling

Fly each 20 days over Schauinsland until 2005 with in situ CO2 and CO to assess representativity of the mountain station

Equip Griffin and Hegyhatsall aircraft with CO_2 in situ instruments in 2005

Deliverables

Four aircraft sites (each 20 days) on a n East-West transect in temperate Europe

Representativity of Schauinsland mountain station (scientific paper)

Flask multiple-species data of aircraft profiles at 10 levels per flight

Milestones and expected result

Network of 4 aircraft sites with flask sampling profiles each 20 days : T + 6

WP 4.5 Dynamic monitoring of intercomparability between measurement laboratories within Europe

Workpackage number	5	**Start date or starting event:**	T+0			
Participant id	MPI-BGC Manning					
Person-months per participant:						

Objectives

Quantify and monitor differences of Greenhouse Gases and related tracer measurements between the 15 European laboratories contributing to the Atmospheric Observing System

Description of work
Part of TACOS and CHIOTTO FP5 projects (no funding) Continue frequent exchange of flasks and low pressure cylinders between participating laboratories in TACOS Develop frequent exchange of high pressure cylinders among the tall towers being set up in CHIOTTO Develop O2/N2 intercomparison methodologies, with emphasis on linking European measurement scales to the international scales in TACOS
Deliverables Part of TACOS and CHIOTTO FP5 projects
Milestones and expected result

WP 4.6 Radiocarbon and CO analysis to quantify fossil fuel emissions

Workpackage number	6	**Start date or starting event:**	T+X				
Participant id	UHEI						
Person-months per participant:							

Objectives

Continue the existing 14CO2 observational network in Europe to directly derive monthly mean fossil fuel CO2 component at polluted and background sites.

Establish „calibration stations“ in Western, Central and Eastern Europe to provide an ongoing calibration of CO as a proxy for fossil fuel CO2 (determine the mean CO/CO2 ratio of fossil fuel sources).

Description of work

Ingebrog : write as short bullets

Continue high-precision quasi-continuous 14CO2 sampling and analysis at the marine stations Mace Head and Izaña to accurately define the changing Atlantic 14CO2 background in mid northern latitudes.

Continue high precision (<3‰) 14CO2 measurements at the high altitude Alpine site Jungfraujoch, at the mountain site Schauinsland as well as at the coastal site Lutjewaad for direct determination of the fossil fuel CO2 component over Europe.

Continue CO2, 222Radon, CO and weekly integrated 14CO2 measurements at Heidelberg for calibration of CO as a proxy for fossil fuel CO2

Establish two new “CO calibration sites” in industrialised European regions (Western Europe: Paris (48º30’N, 2º12’E), and Eastern Europe: Krakow, 50º23’N, 19º33’E) with weekly integrated precise (better than 4‰) 14CO2 observations and parallel continuous CO2 and CO observations

Deliverables

Network of 5 high precision bi-weekly integrates 14CO2 monitoring sites

Network of 3 CO calibration sites

Milestones and expected result

Monthly mean fossil fuel CO2 component at 5 European sites T+6
Methodology of accurate CO calibration T+18

WP 4.7 Calibrated CO2 concentration measurements at selected eddy-covariance towers

Workpackage number	7		**Start date or starting event:**	T+0				
Participant id	ALTERRA							
Person-months per participant:	4							

Objectives

Develop a methodology to obtain calibrated CO2 atmospheric records of moderate precision (instantaneous accuracy of ±0.5 ppm) on top of eddy-covariance towers.

Implement calibration of eddy towers at 10 sites by the end of the IP

Description of work During mid-afternoon, under well mixed conditions, the CO2 concentration near the ground can get close to the value in the middle of the PBL. Profiles from the tall towers (WP 2) will enable us to determine „optimal" periods where CO2 at 30m above ground approximates CO2 in the mid PBL. Then, calibrating CO_2 concentration routinely measured at key eddy flux towers will allow a cost effective, important extension in spatial coverage of the European atmospheric network. We will progressively transform 15 of the existing eddy flux towers of CARBOEUROPE-IP into "virtual tall towers", with a target precision of ± 0.5 ppm for mid afternoon instantaneous concentrations. Only mid-afternoon selected data will be used in inverse models, because the near ground vertical gradients of CO2 at night-time are not representable for models. Continue as part of TACOS the development of a simple instrumental modification to calibrate CO2 on top of Eddy Covariance towers. Develop a methodology to use CO_2 records on short tower in regional inversion, based on ongoing research in the US, on analysis of tall towers profile data at Hegyhatsal (Hu) and Cabauw (NL), and of the Pallas (Fi) station where there is a nearby eddy covariance tower. By T+18 we will implement CO_2 calibration on top of 3 eddy flux towers selected for flat terrain, and small local sources influence, and for 10 towers by T+60
Deliverables Scientific paper : Methodology to use short towers mid-afternoon CO_2 records in atmospheric inversions Network of 10 eddy-covariance calibrated CO_2 records of moderate precision (instantaneaous accuracy of ± 0.5 ppm)
Milestones and expected result T+12 : scientific paper assessing the use of short towers for atmospheric measurements T+ 18 : 3 eddy covariance towers with calibrated CO2 (±0.5 ppm) records

4 Integration

WP 4.1 Integration – Data base

Work package number	**WP5.1**	**Start date or starting event:**			**Month 1**		
Participant id							
Person- months per participant							
Objectives							
Description of work							
Deliverables							

Milestones[17] and expected result

[17] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

WP 5.2 Integration –

Work package number	**WP5.a**	**Start date or starting event:**			**Month 1**		
Participant id							
Person-months per participant							
Objectives							
Description of work							
Deliverables							
Milestones[18] and expected result							

[18] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

5 IP co-ordination, training and outreach

WP 5.1 IP co-ordination – legal and administrative management

Work package number	**WP5.1**	**Start date or starting event:**			**Month 1**	
Participant id						
Person-months per participant						

Objectives

Description of work

Deliverables

- Legal management
- Financial management

Milestones[19] and expected result

- Month 3 Consortium Agreement signed by all partners
- Month 3 Gender committee established

WP 5.2 IP co-ordination - scientific co-ordination

Work package number	**WP5.2**	**Start date or starting event:**			**Month 1**	
Participant id						
Person-months per participant						

Objectives

Description of work

Deliverables

-

[19] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Milestones[20] and expected result - Month 3 Kick-off meeting - Month 13 Annual meeting of IP

WP 5.3 Outreach – outreach science conferences

Work package number		WP5.3	Start date or starting event:			Month 1	
Participant id							
Person-months per participant							
Objectives							
Description of work							
Deliverables Month 13 First CarboEurope-IP conference							
Milestones[21] and expected result							

WP 5.4 Outreach – Joint EU/US assessments

Work package number		WP5.4	Start date or starting event:			Month 1	
Participant id							
Person-months per participant							
Objectives							
Description of work							
Deliverables Month 18 First Joint EU/US assessment							

[20] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

[21] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Milestones[22] and expected result - Month 12 Contacts to US established

WP 5.5 Outreach – European support office of GCP

Work package number	**WP5.5**	**Start date or starting event:**			**Month 1**	
Participant id						
Person- months per participant						
Objectives						
Description of work						
Deliverables						
Milestones[23] and expected result - Participation at SSC meeting of GCP						

WP 5.6 Outreach – Science/Policy interface

Work package number	**WP5.6**	**Start date or starting event:**			**Month 1**	
Participant id						
Person- months per participant						
Objectives To inform and consult stakeholders and policy makers about the European terrestrial carbon budget as related to the implementation of the UNFCCC and the Kyoto Protocol						

[22] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

[23] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Description of work

- Establish fast reaction task force
- Common web site established with a layered structure suitable for use by both scientific experts and policy makers, which includes dissemination activities of running projects CAMELS and CarboEurope- GHG
- Give give ad hoc consultation to the Commission and other policy makers involved in climate negotiations
- Provide co- ordinated project input to the Member states and scientific bodies (eg: IPCC, IGBP)
- Produce policy- maker summaries of annual report, which should be suitable for distribution at relevant policy discussions (eg: UNFCCC Conference of the Parties)

Deliverables

Website with user- friendly interface for stakeholders and policy makers
Online and ad hoc consultation to European Commission (upon request)
(Month 18 = end of CAMELS 5.3), links to GHG

Milestones [24] and expected result

Month 3 Fast reaction task force established
Month 6 User- friendly website established (linked to training activities)
Month 18 Contribution to report on the contemporary land carbon sink and its causes

[24] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

WP 5.7 Training – summer schools

Work package number	**WP5.7**	**Start date or starting event:**			**Month 1**		
Participant id							
Person- months per participant							

Objectives

- To train activities PhD students and young PostDocs in carbon science

Description of work

A one- week Advanced Training Course in Airborne Flux Measurements will be organised in the vicinity of the SkyArrow airfield in Fiano Romano (Rome) or at the Ampugnano airport, near Siena.

This CarboEurope course or summer school will provide an opportunity for a selected number of post- docs and young scientists to learn both the theory and the practicalities of using Small Environmental Research Aircrafts (SERA) to measure surface fluxes. The students will at first follow a series of introductory lectures given by leading scientists in this area that will explain the theory of airborne eddy correlation measurements. After that, a field exercise will be organised, where the students will have the opportunity to conduct, together with their supervisors and the course organisers' short- term airborne flux measurements campaigns. The CarboEurope Sky Arrow ERA (Environmental Research Aircraft) platform will be available for those exercises. The first part of the field exercise will consist in the planning of the mission, and this will be done by the students themselves that will be asked to develop a proposal and define the main technical aspects of it. The research mission will be conducted also by the support of a specialised SME that has specific experience in conducting aircraft operations. The scientists of IBIMET-CNR (Institute of Biometeorology, Firenze, Italy) will finally provide their expertise in data analysis and will provide the software to access aircraft data and calculate the surface fluxes. The students will have the possibility to learn how to use that software and will become experienced in flux calculations. It is foreseen that part of the mission data will finally translate into a technical report to be prepared by the students and, eventually, into a joint CarboEurope publication.

Course lecturers will include eminent micro- meteorologists and ecologists linked to CarboEurope IP. An overseas aircraft technology specialist will be also invited as a teacher to give the main technical lecture. The scientists of IBIMET- CNR will be finally responsible for the part of the course dealing with mission preparation and execution as well as with flux data analysis and flux mapping.

Deliverables

- Advanced Training Course in Airborne Flux Measurements

Milestones[25] and expected result
Month 8 Advanced Training Course in Airborne Flux Measurements

[25] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

WP 5.8 Educational training

Work package number	**WP5.8**	**Start date or starting event:**				**Month 1**	
Participant id							
Person- months per participant							

Objectives

- To produce a basic set of educational resources for secondary schools in the IP website
- To involve key multiplyers to disseminate these resources to a large number of teachers and young people in Europe
- To stimulate direct contacts between CarboEurope researchers and secondary school students

Description of work

Training at secondary school level:

- Pre- identification of relevant educational scopes through review of bibiography, interviews of scientists and discussions during a consortium meeting;
- Setting up of an informal education advisory group with interested scientists and PhD students
- Early involvement of strategic multiplyers on a mutual interest basis in order to define the scientific focus, contents formats and channels of diffusion (e.g. website contents, teacher training materials, youth magazines, science museums etc.).
- Short field missions in selected research sites to produce basic resources in English (basically stories, reports and illustrations adapted to secondary school audience) through close collaboration between scientists and a science education specialist.
- Constitution of a list of contact- persons for secondary school teachers in CarboEurope sites and institutions
- Integration of these resources in the IP website, and support to multiplyers for adaptations and dissemination.

Deliverables

- Educational package for adaptation and dissemination by involved multipliers (Month 9)
- Educational section for secondary schools on CarboEurope website (Month 12)

Milestones[26] and expected result Month 6 multiplyers identified, dissemination agreements concluded, educational focus defined Month 9 field missions completed, educational package completed Month 12 educational section of website available Month 18 dissemination by multiplyers achieved

[26] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

12B.9 Other issues

If there are ethical issues associated with the subject of the proposal, show they have been adequately taken into account - indicate which national and international regulations are applicable and explain how they will be respected. Explore potential ethical aspects of the implementation of project results. Are there other EC-policy related issues, and are they taken into account? Demonstrate a readiness to engage with actors beyond the research to help spread awareness and knowledge and to explore the wider societal implications of the proposed work; if relevant set out synergies with education at all levels. (No recommended length – depends on the number of such other issues which the project involves)

13B.10 Gender issues

13.1 B.10.1. Gender Action plan

Often female researchers tend to suffer from inequality and conflicts between family and career. Many are married to husbands working in academia as well, so the social plans at institutions should apply to all and also encourage men to care for the family, e.g. by more flexible work structure etc., allowing women more flexibility in their scientific carrier. This will be an evolutionary process lying in the responsibilities of individual institutions. CarboEurope- IP will stimulate and contribute to this development by raising awareness, setting targets and institutional minimum requirements, and by concrete actions.

Institutional gender action plans

Many partner institutions in CarboEurope- IP, including all members of the Steering Committee, have gender action plans at their institutional level. For instance, actions of the co- ordinator MPI- BGC are co- ordinated at the level of the German Max Planck Society by a Working Committee for the Advancement of Women in Science. It acts as a forum for women in difficult situations in the scientific community and as an advisor to research group heads and Max- Planck- Society boards in matters concerning female staff. The advice given includes recommendations for increasing the number of women in leading positions as well as measures aimed at the compatibility of family and profession. C3/C4 (research group leader) position special programs for female researchers and a child daycare program have been launced.

Gender action plan the level of the Integrated Project

1. *Project gender committee*

The gender committee will actively promote the role of women in the Integrated Project at all levels. It will be responsible for raising awareness of gender equality among the project consortium and will control whether the gender action plan is properly applied at the level of the Integrated Project as a whole and of its major components. In particular, it will act as the platform to channel experience and good ideas via web- based tools, but will also deal with complaints. It will produce the annual gender action report of CarboEurope- IP. The gender committee will consist of 3 members elected by all female project participants for a two- years period. Committee members can be re- elected.

2. *Networking*

Under the auspices of the gender committee, a female researchers network will be established within CarboEurope- IP to discuss potential conflicts between carrier and family and exchange experience.

3. *Annual gender action report*

Annual gender action report will contain an inventory what actions to promote gender equality have been performed at the level of the Integrated Project as a whole and of its major components and will document the overall success as compared to targets of promotion of female researchers. The gender committee will produce the report with the input of all partners of the Integrated Project.

4. Recruitment of female researchers

Recruiting young female academics is encouraged in CarboEurope- IP. All job announcements will encourage females to apply. The gender committee will produce school material dissemination „Women in carbon research“ in collaboration with national gender programmes. All project partners are encouraged to participate in national events such as „Girls days“ (cf. also „Training activities“, B4.3).

5. Active promotion of female researchers

11% of the scientists involved in the CarboEurope cluster in the Fifth Framework Programme were female. Against this background, **CarboEurope- IP sets the target to double the participation of females, and to achieve 20% or more at all organisational levels in the project, within the frame of the national rules of the partners. This applies to the scientific work as well as to the active participation at workshops, conferences and publications.**

In order to achieve this target,

- the representation of female researchers has been raised to 14% in the scientific steering committee and 17% in the executive board. The share of women in the advisory board will most likely be 33%.
- a mentoring programme will be launched. Female researchers will have the opportunity to chose directly, or with help of the gender committee, a mentor who helps them to develop perspectives for their research carrier at critical stages when most females drop out of research: when finishing masters degree and at the end of the PhD thesis. The mentor will also encourage and support the mentee to write scientific publications and to co- chair workpackages or workshops (cf. also „Training activities“, B4.3).
- CarboEurope- IP sets the target to invite 20% or more female researches to workshops, as speakers on workshops and conferences organised at the level of the Integrated Project and its major components (cf. also „Training activities“, B4.3).
- As far as logistically possible, business meetings of workpackages will be equiped with video- conferencing upon request so that partners who cannot travel to business meetings can attend virtually. This will specifically help women taking care for their children.

Consortium Agreement

We will set up in the Consortium Agreement the following minimum requirements to promote gender equality which all partners will have to adhere to:

- Take efforts to meet the gender equality targets of the Integrated Projects

- Encourage applications by female researchers in job announcements and make sure that all positions are advertised and given to the best suited person in a transparent, objective way, with full consideration of gender equity.
- Take formal actions to guarantee that employees are properly informed about their parental obligations and rights
- Encourage female employees to participate in programmes for gender mainstreaming (information and coaching workshops and events, ...), coaching programmes (communication and conflict management, self-presentation, mentoring) and seminars on project management
- Report annually the type and success of gender actions taken.

13.2 B.10.2. Gender issues

We are dealing with the understanding and quantitative assessment of the terrestrial carbon balance of Europe and to some extent with climate change impacts on the carbon balance of terrestrial ecosystems. There are no gender issues associated with the subject of this proposal.

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15 Appendices

16 Appendix 1: Data Policy (draft of 17 March 2003)

16.1 Rights and responsibilities

- Each member of the CarboEurope Integrated Project (IP) (full and associated) who handles the CarboEurope database, will produce data from measurements and models to be used within the IP. Each member is represented by one single person, named Principle Investigator (PI) below.
- Each PI owns his/her own data and may make these data available at any time to anyone.
- Each PI is responsible for making data available through the database, according to the rules in this policy document, to other PIs within this IP.
- The CarboEurope- IP database manager, supported by the co- ordinators of the IP Components, (named Review Panel below) determines questions related to the dataset documentation, dataset format, and quality level. The Review Panel also adjudicates possible disputes relating to this data policy.

16.2 Documentation of datasets

- All datasets should be documented according to a standard. This standard is an integral part of the database and consists of the following main elements: (i) Title, (ii) Authors/owners, (iii) Introduction (incl. objectives), (iv) Theory of measurements, (v) Equipment (incl. instrument description, calibration, procedures), (vi) Observations, (vii) Parameter/variable description, (viii) Data manipulations, (ix) Errors, (x) Notes, (xi) References, and (xii) Glossary of acronyms.
- Documentation of a given measurement site or region is done separately from the database. This documentation will be available on the web site of the IP and accessible via hyperlink from the database. The co- ordinators of the IP Components are responsible for making available the site or region documentation.

16.3 Access to data in the CarboEurope IP

- Data access is granted to each PI (full and associated).
- Data access is initially restricted to the members of the IP. Full members have access to the entire database whilst associated members have access to the data of the respective IP Components to which they contribute. All data are immediately available as soon as they have been inserted into the database.
- All datasets delivered to the CarboEurope IP database may eventually be published on CD (or another suitable medium existing at the time of

publication). Such publication will open free access to the published CarboEurope data. A possible publication will take place at latest after the project is finished.

16.4 Data exchange within the CarboEurope IP

- The CarboEurope data policy follows the subsidiary principle, i.e., all datasets are organized in IP Component databases with a reference to a common CarboEurope IP meta- database. This meta- database will contain information about all datasets in the project and about the PIs responsible for them. CarboEurope IP members (full and associated) will be obliged to deliver datasets directly to all other IP members upon request one year after deadline for delivery of a given dataset.
- The meta- database manager, supported by the database managers of the IP Components, will be responsible for the collection of metadata from the IP.
- The meta- database is responsible for publishing, and making available on the Internet, a list of PI names in CarboEurope IP who are authorised to request data from project PIs.

16.5 Use of data from CarboEurope IP

- Data which have been accessed must only be used for scientific purposes, i.e., commercial use of data is not allowed.
- Use of data, to any significant degree, belonging to another PI for the purpose of scientific publication must always be based on an agreement between the PI and the data requester. The meta- database and all IP Component databases offer the possibility to trace all downloads of a given dataset.
- It is prohibited to distribute another PI´s data to a third party without the consent of the PI.

16.6 Delivery of data to CarboEurope IP

- Data delivery implies delivery of (i) a documentation of a given dataset according to the prescribed format, and (ii) a dataset according to the documentation. Data will be inserted into the database when both parts are available.
- Datasets must be specified in advance such thath the database manager and the IP Review Panel can determine whethe a delivery is fulfilled or not. This information is also necessary for the time schedule of the database manager and for identification of hardware requirements. The Review Panel is responsible for collection of information about data intended for submission to the database. Even if the PI does not know exactly what the dataset will look like, she/he should submit tentative information about (i) type and number of

variables, (ii) frequency of collection, (iii) time period covered, and (iv) approximate size of the dataset file. This information will be relatively straightforward to assemble for continuous time-series data but must be subject to specific discussions within the Review Panel when it comes to model output, airborne measurements, campaigns and auxilliary datasets. This information should be gathered as early as possible. Datasets will be registered by the database manager when there are tentative descriptions of them, accepted by the Review Panel. Registration dates for data deliveries from the respective PIs, together with acceptance dates by the Review Panel, will be documented and available as part of the database.

- Data from continuous measurements such as fluxes should be delivered to the database every half year following the start of the IP (i.e., SPECIFY ONCE PROJECT START HAS BEEN FIXED). Meteorological data should be delivered to the database every month and within one month after the measurement.
- Data from time-limited field campaigns should be delivered to the IP database within one month after the end of the campaign.

16.7 Composite and external datasets

- Data provided by organizations external to CarboEurope IP and not bound to this data policy, can be entered into the CarboEurope IP database once the Review Panel has appointed a specific PI for those data. This PI has the same duties towards the database for such data as a PI delivering data from her/his own activity. Datasets used for various modeling and analyses may be composed of a mixture of data from external and internal sources. The Review Panel can appoint a specific PI for such datasets. This PI has the same duties towards the database for such data as a PI delivering data from her/his own activity.
- Delivery deadlines for composite and external datasets should be set by the Review Panel.

16.8 Quality assurance

- Quality control of data in CarboEurope IP relies on a careful review of different components submitted to the database. The Review Panel determines when components are acceptable. Data will be inserted into the database after such acceptance.
- The Review Panel determines what should be accepted as dataset. Technical and scientific reasons may require that several datasets be merged or a given dataset split to achieve functionality of the database.

- Datasets must be submitted to the database before deadline, independent of the quality level of the data. The PI should suggest, and the Review Panel determine, a suitable quality rating for each dataset. The PI has a chance to submit improved versions of a given dataset during the entire running time of the IP.
- Each dataset will have a version number assigned to it where the first digit signifies the quality level, and the decimal number signifies successively improved versions at a given quality level:

Version	Quality requirements	Documentation requirements
0.x	Raw data (it is up to the PI to define the meaning of "raw") which have no physical meaning to an end user (e.g., mV values). Only available to data owner.	A short, simple text file is sufficient.
1.x	Raw data expressed in physically meaningful units (e.g., W m^{-2})	A documentation according to the standard format where only information about PI, equipment, and variable/parameter description need to be complete.
2.x	Removal of erroneous data caused by obvious measurement problems (electronic spikes, etc.) and physically impossible or extremely rare values. Correction of data by standard procedures	A complete documentation according to the standard format. The quality control measures must be documented.
3.x	Removal of erroneous data after comparison with other, independently measured variables (e.g., clear- sky radiation is not accepted during heavy rain), or model- derived variables. Correction of data by novel procedures	High- level documentation of calibration and quality- control procedures.
4.x	Closure of gaps in the dataset with scientifically well- defined interpolation methods	High- level documentation of gap- filling procedures. Documentation of the quality level as a function of time.

The decimal "x" in the version number starts with 1 for the first delivery and is followed by 2, 3, etc. for successive deliveries. Successive deliveries could be caused by new variables added to the dataset, additional time periods, measurement errors being corrected, etc. Each new version should be followed by a documentation stating what has been changed since the previous one.

- Delivery of datasets with version 0.x is primarily meant as a backup service and to simplify data exchange within the IP.
- Delivery of datasets labeled 1.x are intended as a quick way to exchange data for various modeling and analysis purposes within CarboEurope IP.
- It is the goal of CarboEurope IP to publish datasets after peer review in an integral and referable form together with traditional scholarly papers. Datasets will only be accepted for such a publication when they have reached version 2.x or higher.

Santions for non- delivery?

How to deal with external projects –mutual access upon request?

Auxilliary datasets documented according to international standards (ISO in prep.)..

17Appendix 2: Description of Ecosystem Sites (Update)

		No	site	site Main/ Associ-ated	NAME	land covers		co-ord °N	co-ord	mean T	precip	LAI
GE1	S1	1	1	M	Hainich	beech	forest	51°04'45.14	10°27'07.83" E	7.5-8	800	5-6
		2	2	M	Wetzstein	spruce	forest	50°27'12.51"	11°27'27.27" E	5.9	840	4-5
		3	3	M	Gebesee	crop	crop	51°06'00.13"	10°54'51.90" E	8.5	470	4-5
		4	4	A	Afforestation		forest					
GE2	S2	5	1	M	Tharandt	spruce	forest	50°57'49"	13°34'01"E	7.7	820	7.6
		6	2	M	Grillenburg	grassland	grassland	50°57'04"	13°30'51"E	7.2	853	2-5
		7	3	M	Coop Klingenberg	crop rotation	crop	50°58'	13°20'E	9	750	
		8	4	A	Oberbärenburg	spruce	forest	50°47'12"	13°43'20"E	5.5	996	5
		9	5	A	Schönau	grassland	grassland	47°	11°E	7	1400	2-5
FR1	S3	10	1	M	Hesse	beech	forest					
		11	2	M	Grignon	crop	crop					
		12	3	M	Fontainbleu	oak	forest					
		13	4	M	Lusignan	grassland	grassland					
FR2	S4	14	1	M	Le Bray	pine	forest					
		15	2	M	Laqueuille	grassland	grassland					
		16	3	M	Avignon	crop	crop					
		17	4	A	Puechabon	oak	forest					
		18	5	A	Bilos	pine	forest					
		19	7	A	Couhins	wines	crop					
IT1	S5	20	1	M	Roccarespampani	oak	forest	42°24'	11°55' E	14	670	4
		21	2	M	Collelongo	grassland	grassland	41°52'	13°38' E			
		22	3	M	Collelongo	beech	forest	41°52'	13°38' E	6.3	1180	5
		23	4	A	Yatir	pinus	forest	31°20'49"	35°03'07" E	22	275	2.5
		24	5	A	Roccarespampani	oak	forest	42°24'	11°55' E	14	670	1
		25	6	A	Naples	crop	crop					
		26	7	A	Tolfa	shrub	forest	42°11'30"	11° 55' 30' E			
IT2	S6	27	1	M	Parco Ticino	poplar*	forest	45°12' 03"N	09°04' 25" E	12.7	984	3.5
		28	2	M	Monte Bondone	grassland	grassland	46°00'56"	11°02'48"E	5.5	1189	5-6
		29	3	M	Renon	spruce	forest	46°36'	11°28'E	4.1	1010	6
		30	4	A	Lavarone	spruce	forest	45°57'18.93"	11°16'52.23' E	7.8	1150	9-10
		31	5	A	Malga Arpaco	grassland	grassland	46°07'00"	11°42' 10' E	6.3	1200	
		32	6	A	Nonantola	mixed dec*	forest	44° 41.389'	11°05.321 E	14.5	1000	3
		33	7	A	San Rossore	pine*	forest	43° 43' 47"	10° 17' **3**" E	14.2	920	4.2
		34	8	A	Zerbolo'/Parco Ticino	rice	crop	45°12' 03"	09°04' 15" E	12.7	984	
		35	9	A	La Mandria	oak	forest	45°20'	07°70'E	11.8	855	
		No	**site**	**site Main/ Associ-ated**	**NAME**	**land covers**		**co-ord °N**	**co-ord**	**mean T**	**precip**	**LAI**
DK	S7	36	1	M	Soroe	beech	forest	55° 29'	11° 38'E	8.2	660	4.8

		37	2	M	Rimi	grass	grassland	55° 41’	12º 05’E	8	600	1-6
		38	3	M	Risbyholm	crop	crop	55° 32’	12º 33’E	8	580	0-6
		39	4	A	Ulborg	spruce	forest	56° 17’	8º 26’E	7.7	960	8.1
Sw	S8	40	1	M	Norunda	scots pine/spruce	forest	60°5’	17°29’E	5.5	527	4.5
		41	2	M	Skyttorp	scots pine (0 y)	forest	60°7’	17°54’E	5.5	527	0.5
		42	3	M	Skyttorp	scots pine (30 y)	forest	60°7’	17°50’E	5.5	527	3.5
		43	4	A	Knottåsen	Norway spruce, 30 years	forest	60°59’	16°13’E			
		44	5	A	Flakaliden	Norway spruce, 35 years	forest	64°07’	19°27’E			
		45	6	A	Degerö	Aapa mire (Poor sedge fen)	grassland	64°11’	19°33’E			
		46	7	A	Asa	Norway spruce/Scots pine ca 60 y	forest	57°10’	14°48’E			
		47	8	A	Stordalen	Sub-arctic mire	grassland	68°21'	19°02'E			
		48	9	A	Stordalen	Birch forest	forest	68°21'	19°02'E			
SP	S9	49	1	M	Vall de Aliñá (Lleida)	grassland	grassland	42º12´06´ ´	1º26´57´ ´E	13	669	
		50	2	M	El Saler-Sueca (Valencia)	crop	crop	39º17´11.5´´	0º20´37.5´ ´ W	18	550	0-5
		51	3	M	Las Majadas del Tietar (Caceres)	Dehesa (Open Oakland)	forest	39º 56´ 58.4"	5º47´17.2" W	18.5	572	2.5
		52	4	A	El Saler (Valencia)	High maquia + pine	forest	39º 20´ 54.6´ ´	0º19´2.4´´ W	17.85	551	3.2
		53	5	A	Toledo	High maquia + Pine	forest					
		54	6	A	Valladolid	Wheat	crop	41º48´53.5”	4º 55´ 56.9” W	11	440	0-4.5
P	S10	55	1	M	Mitra II	oak woodlands	forest	38º 32' 26.2' '	08º 00' 01.9" W	15.4	665	0.55
		56	2	M	Espirra	Eucalyptus plantation	forest	38º 38’	8º 36’ W	16	709	3
		57	3	M	Mitra IV	grassland	grassland	38º 32' 26.2' ' ;	08º 00' 01.9" W	15.4	665	
NL	S11	58	1	M	Loobos	Scots Pine	forest	52°10'00"	05°44'38" E	9.8	786	1.9-2.2
		59	2	M	Cabauw	grassland	grassland	51°9'1	4.927 E	10	800	1-2
		60	3	M	Horstermeer	natural fen (peat)	grassland	52°24'	05°00' E	10	800	
		61	4	A	Lelystad	grassland	grassland	52° 30'	05° 30' E	10	780	1-2
		62	5	A	Cabauw extension	arable land/grassland	Crop/Grassland	52° 30'	05° 30' E	10	780	1-6
		No	**site**	**site Main/ Associ-ated**	**NAME**	**land covers**		**co-ord °N**	**co-ord**	**mean T**	**precip**	**LAI**
BE	S12	63	1	M	Braschaat	Pinus Sylvestris+*Quercus robur*	forest	51°18’	4°31’ E	9.8	750	2.4-3

		64	2	M	Vielsalm	Fagus sylvatica, Pseudotsuga menziensii	forest	50°18’	5°59’ E	7	1150	3-4.5
		65	3	M	Lonzee	Arable crop (rotation)	crop	50°33’	4°39’ E	10	750	
		66	4	A	Jalhai	mixed forest, planted	forest	50°33’	6°04’ E	6	1200	
UK1	S13	67	1	M	Griffin	Sitka Spruce	forest	56° 36´	3°47´W	8.2	1200	8
		68	2	M	East Saltoun	barley/grass	crop	55° 54´	2,51 W	8.5	600	
		69	3	M	Harwood	Sitka Spruce, chronosequence	forest	55° 14´	2°06' W	9	950	12
		70	4	A	Easter Bush	Grassland	grassland	55° 52´	3°10´ W	8	890	
		71	5	A	Auchencorth Moss	Blanket peat	grassland	55° 46´	3°16´ W	7.4	900	
UK2	S14	72	1	M	Carlow	Arable	crop	52° 51’	6°54’W	5.5-13	804	
		73	2	A	Carlow	Grassland	grassland	52° 51’	6°54’W	5.5-13	804	
		74	3	A	Co. Laois	Forest (Sitka spruce)	forest	52º 57’	7º 15’ W	5.5-13	804	
		75	4	A	Wexford	Grassland	grassland	52° 17' 30"	6° 30' 15' 'W	7.2-13.8	1049	
		76	5	M	Dripsey	Grassland	grassland					
		77	6	A	Killorglin	Bog	grassland					
		78	7	A	Pang/Lambourne	Arable	crop					
		79	8	A	Pang/Lambourne	Grassland	grassland				800	
		80	9	M	Pang/Lambourne	forest broadleaf	forest				800	
		81	10	A	Hertfordshire	Arable	crop	51°46.51’	0°28.26’ W	5.6-13.3	695	
		82	11	A	Hampshire	Forest (broadleaf)	forest	52º 11’	0º 51’ W	5.5-13	790	
		83	12	A	Cirencester	Arable	crop					
FI	S15	84	1	M	Hyytiälä	scots pine 40 yr	forest	61° 51’	24° 17’E	3	700	6-8
		85	2	M	Sodankylä	scots pine 100 yr	forest	67° 21’ 42.7”	26° 38’ 16.2’E	-1	499	3.6
		86	3	M	Kaamanen	grassland	grassland	69° 08’ 26.5”	27° 17’	-1.3	395	0.7
CZ	S16	87	1	M	BKFORES	Coniferous forest	forest	49 ° 30´ ´	E 18° 32´ 28´ ´	4.9	1100	8.2-11
		88	2	M	BKGRASS	Grasslands	grassland	49 ° 30´ 17´ '	E 18° 32´ 28´ ´	4.9	1100	1.2
		89	3	M	Bugac	Grasslands	grassland	46,8 °	E 18,9°	11	500	2.5
		90	4	M	Matra	Cropland	crop	47,5 °	E 19,7°	11	600	3-5
		91	5	A	CZECHWET	wetlands	grassland	49° 01´	E 15°01			

		No	site	site Main/ Associ-ated	NAME	land covers		co-ord °N	co-ord	mean T	precip	LAI
CH	S17	92		M	Swiss1	Grassland	grassland	47°17' N	7°44'E	9	1100	6
		93		M	Swiss2	Arable crops	crop	47°17' N	7°44'E	9	1100	6
		94		M	Swiss3	Forest	forest	47°28'N	7°28E	8.3	1100	12

18 Appendix 3: Atmospheric observation sites

19 Appendix X Ecosystem component – methodologies

Activity 1 Eddy flux network

1.Table of sites (draft incomplete)
2.Distribution of sites (draft incomplete)
3. Representativeness of sites (to be improved)
3.Variables to be measured

Activity 2 Methodology and Feasibility of the soil carbon activity (Component 1 activity 2)

Task 1: Soil Map

A soil map will be created for the area of the main footprint of a tower site in the main wind direction (1:5000). Soils are cored by an augar at 10x10 m scale, a soil pit (or several pits, if soil type varies) will be used to estimate the stone content, bulk density and carbon concentrations at different depth up to 1 m in one profile per footprint. The depth of the horizon will serve as marker for a soil C map.

Task 2: Soil C Change:

A geo-referenced sampling scheme will be installed in the footprint area of the flux stations that takes the heterogeneity of soils into account, and which is sufficiently dense to detect a change in soil carbon over time. The task is to detect an input of 0.01 (as measured by ^{13}C transport) to 0.1 kgC m^{-2} a^{-1} (as estimated by the NPP-decomposition balance) in a C stock of 11 kgC m^{-2} in forest soils (Hainich) exhibiting a small scale heterogeneity of 20% (coefficient of variation). After 5 years the input would result in an increase of 0.05 to 0.5 kgC m^{-2} which is a 0.4 to 4.5% change in total soil carbon over 5 years. This should be detected by an appropriate sampling scheme. Soil organic matter is here considered as the sum of fine organic matter plus dead coarse organic matter plus the organic layer.

Assuming that the change in C takes place in the top 5 cm, where C-concentration is highest, and the variability is largest, the input would change the C-concentration in the top 5 cm by 0.1 to 1.3 % (based on Forcast data). Using measured data from the Hainich forest site, the power analysis shows (Fig. 1) that the detectable change in C-concentration decreases with sample size and diminishing returns. There is only slight improvement beyond 100 samples. In addition, a paired sampling design would clearly allow a lower detection limit. The analysis was based on a conservative overestimate of variability on the smallest scale. The expected average change in C-concentration (0.7% average) would be detectable.

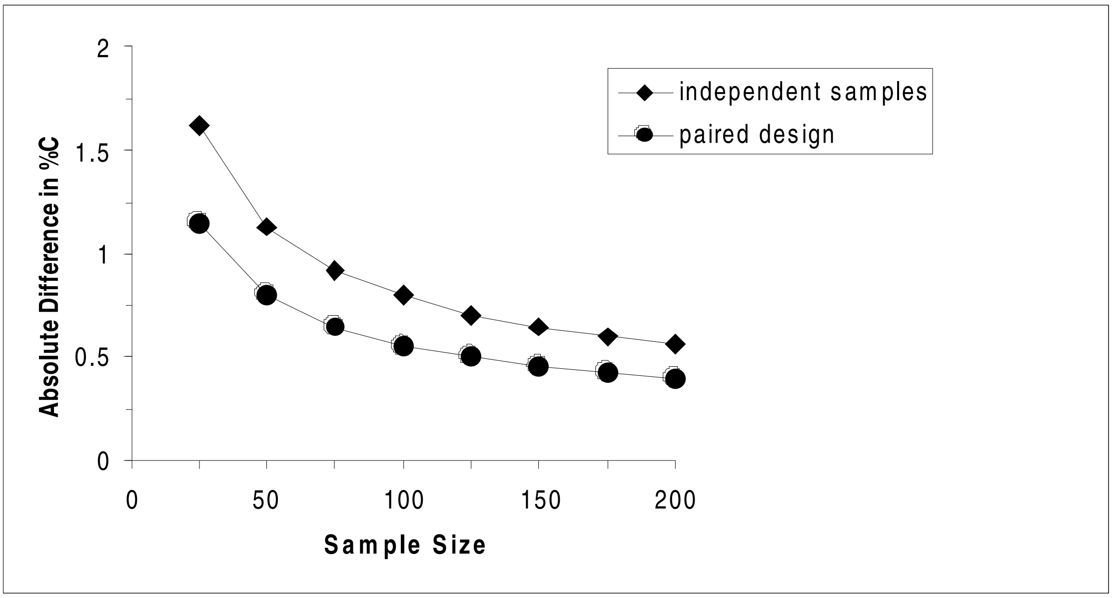

Fig. 1: The detectable change in C-concentration as a function of sample size

- A grid of 10 x 10m lines is established in the 100 x 200 m area of the main footprint of a tower. The L+O-horizon will be sampled with a 0.2x0.2 m frame and10 cm diameter soil cores are sampled at each grid point up to 0.5 m depth. The sampled material will be dissected into 7 layers (L+O, 0-5 cm, 5-10cm, 10-20cm, 20-30cm, 30-40cm, 40-50cm). The 200 soil samples are dried for bulk density determination, roots are extracted, and the soils are sieved for final storage. In case of soils with high stone content (Sweden) the procedure will have to be slightly modified.
- 100 cores are selected from the total of 200. 5 horizons of these selected cores (L+O, 0-5 cm, 5-10cm, 20-30cm, 40-50cm) are measured for total C/N.
- The procedure needs to be repeated pair-wise after 5 years for the 100 cores that were selected initially after 5 years
- If the uncertainty in soil Carbon increase is too large, i.e. the increase is equal or smaller than the half confidence limit, it would be possible to analyze additional cores or horizons from the 100 cores that were not used in the initial analysis. However, this decision will be made after re-sampling and analysis. The proposed budget does not cover an intensified analysis density.

Task 3: Soil Components

- Texture using the pipette method.
- C density: determine the light fraction of C-particles as a measure of labile C

- Determine ^{13}C, ^{14}C and specific compounds for selected compartments that indicate change

Activity 3 Cropland

Methodology annex for crops activity

This activity will pull data together from all cropland sites to quantify NPP and its components, quantify non- CO_2 GHG fluxes and start to delineate how these are affected by climate, crop and management. It will then be possible to determine what factors are controlling the C and GHG fluxes at each site, i.e. what component is due to crop, what due to climate, what due to management etc. This will involve a range of data being collected under standard protocols, and some meta- analysis and modelling. This activity will not only provide the data needed to complement the flux measurements for the clusters, but also some quantitative and predictive understanding of what controls the fluxes in cropland sites.

NPP and its components - what will need to be measured

To deliver the full suite of ecology / NPP data to add to and interpret C flux data, the following parameters will need to be measured:

- Yield of agricultural product (dry weight per ha)
- C and N in product (C and N analyser)
- Dry matter of straw / debris (dry weight per ha)
- C and N in straw / debris (C and N analyser)
- Dry matter of crop stubble (dry weight per ha)
- C and N in crop stubble (C and N analyser)
- Estimates of C and N input to the soil from debris and roots (turnover plus exudates) – by detailed experiments at the same sites where available (e.g. mini- rhizotron) but also by modelling
- Data on soil respiration (using chambers where these have been used)
- Management data – tillage, fertlizer inputs, organic inputs, residue management, irrigation, rotation, site history (dates, amounts and types)

Non- CO_2 GHGs

At sites where non- CO_2 GHG fluxes have been measured, the data will be collated and provided. Standard protocols will be written for each method of GHG measurement (chambers, TDL etc.) to standardise methods and enhance data quality.

Standard protocols

Under the cropland activity, standard protocols will be developed for the measurement of each of the above- mentioned parameters (e.g. bulking, number of samples, where and how to sample, methods of analysis etc.). Standard protocols will also be developed for data formats (for standardisation and compatibility with flux data).

Model parameterisation, development and regionalisation

By collating data from all cropland sites, meta- analysis (e.g. multiple regression, multivariate analysis, general linear modelling) and modelling of the data (using ecosystem models such as Century, MAGEC/Sundial/RothC, STICS, DNDC) will allow the impacts of climate, soil type, crop type and management to be delineated. These results will be used to parameterise and improve cropland ecosystem models and SVATS and regionalised parameters will be provided for up- scaling. This activity will not only provide the data needed to augment the flux measurements at each cluster, but will also provide some quantitative and predictive understanding of what controls the fluxes

20 Appendix – Region

ANNEX 1. Description of the permanent sites

Site	**Le Bray**	**Laqueuille**	**Bilos**	**Couhins**
Statu	**Main**	**Main**	**Ancillary**	**Ancillary**
Institute	INRA	INRA	INRA	INRA
Flux Measurement period	**1996- 2009**	**2002- 2009**	**2000- 2009**	**2004- 2009**
Responsible	**D. Loustau**	**JF Soussana**	**D. Loustau**	**J.P. Gaudillère**
Other staff	J. M. Bonnefond	E. Ceschia (?) P. Loiseau, P. d'Hour, R. Falcimagne	R. Burlett	S. Dayau
Land cover	Forest (maritime pine)	Semi-natural grasssland	Forest (maritime pine)	Vineyard
CarboEurope FP5	Carboeuroflux, Carboage	Greengrass	Carboage	
Age (2003)	32	-	Regrowth	15- 20
Treatment (s)		Intensive & Extensive plots		Standard
Surface (ha)	100	7	60	20
Co-ordinates	44°43'00"" 0°46'12''	45°38'35'' N 02°44'09'' E	44°29'40''N, 0°57'22''O	0°32'56" W 44°45' N
Altitude (m)	62	1040 m	62	20
Mean ann. t°C	13.6°C	7.95°C	13°6C	13.3
Precipitations	900mm	1313mm	900 mm	900mm
Type of soil	Sandy Podzol	Basaltic (andosol)	Sandy Podzol	Sand + pebbles
Sonic	Gill R2	Gill R3	Gill R3	Young 8100
Analyser	Li6262 (open path planned)	Licor 7500	Li6262 (+ open path available)	Li7500
Meteo	Yes	Yes	Yes	Yes
ORE (French Long term ecological research site)	ORE Forest	ORE Grassland	ORE Forest	-

Co-funding for sure	*ORE Forest Regional project national Project CARBOFOR* Carboeurof lux (> 1/3/2003)	Greengrass (> 12/2004) + ORE grassland	Carboage (> 1/3/2003) Regional project national Projects ORE Forest CARBOFOR	-

21Abbreviations

A	Activity
AS	Associated site
BEF	Biomass Expansion Factor
BMBF	German Ministry of Education and Science
C	Component
CBD	Convention on Biological Diversity
CBL	Convective Boundary Layer
CDAM	Carbon Data Assimilation Methods
EB	Executive Board
EC	European Commission
ECCP	European Climate Change Program
EU	European Union
FP	Framework Program
GCP	Global Carbon Project
GEE	Gross ecosystem exchange
GHG	Greenhouse gas
GMES	Global Monitoring for Ecosystems and Security
GPG	Good Practice Guidance
ICP	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests operating under UNECE
IGBP	International Geosphere- Biosphere Program
IHDP	International Human Dimensions Program
IP	Integrated Project
IPCC	Intergovernmental Panel on Climate Change
LAI	Leaf area index
LSM	Land Surface Model
LULUCF	Land Use, Land Use Change and Forestry
LUSTRA	Land Use Strategies for Reducing Net Greenhouse Gas Emissions
MS	Main site
NACP	North American Carbon Program
NBP	Net Biome Production
NCEP	National Centers for Environmental Prediction
NEE	Net Ecosystem Exchange
NPP	Net Primary Production
PBL	Planetary Boundary Layer
Reco	Ecosystem respiration
SOP	Special Observing Period
SS	Supersite
SSC	Scientific Steering Committee
TCO	Terrestrial Carbon Observation
TCO- IGCO	Terrestrial Carbon Observation – International Global Carbon Observations

TEM	Terrestrial Ecosystem Model
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Program
WP	Workpackage

[i] For instance, mountain stations may probe alternatively the free troposphere and the boundary layer and prove difficult to represent in models lacking local circulation effects and local sources ; coastal stations can be affected by see-breeze effects and nearby land sources.

[ii] The emanation of Rn-222 by soils depends on soil moisture content and bedrock type, which hinders a fully quantitative use of Rn-222 to interpret CO_2 data. Modelling of the European wide Rn-222 emissions patterns is a specific activity carried out in the Integration Component of the IP that will improve the use of Rn-222 as an atmospheric transport tracer.

[iii] Given the high variability of concentrations in continental air masses, we acknowledge the fact that bi-weekly CO2 sampling provides less constraint on regional fluxes than do continuous observations, but the power of flasks data is that they give access to more species

[iv] With Greenhouse Warming Potentials at 100 years, CH4 and N2O emisisons currently reported sources account for more than 30% of CO2 equivalent emissions in European countries, with an even higher share for agricultural areas. Further, wherever colocated with *in situ* tall towers records, or aircraft in CO2 CO2 profiles, flask will provide an independent verification of continuous measurements.

[v] At the international level, the WMO-Global Atmosphere Watch programme coordinates infrequent round robin exchange of standard material and differences on the order of * ppm have been reported between laboratories, on the order of the atmospheric signals we aim to characterize within Europe.

[vi] Only mid-afternoon selected data can be used in inverse models, because the near ground vertical gradients of CO2 at night-time are entirely influenced by local sources and boundary layer structure.

[vii] Algorithm development to retrieve CO2 mixing ratios/total column abundance from top-of-the-atmosphere (TOA) radiance that will be delivered by existing sensors SCIAMACHY, AIRS, IASI, HiRs and future sensors (OCO planned in 2007 by NASA), is part of the EU funded COCO project in FP5.