integrated carbon observation system

A European infrastructure dedicated to high precision monitoring of greenhouse gases

Integrated Carbon Observing System

National Profiles

Stakeholders Meeting

May 19-20, 2008

ICOS – Integrated Carbon Observation System

www.icos-infrastructure.eu

A European research infrastructure dedicated to high precision observations of greenhouse gases fluxes

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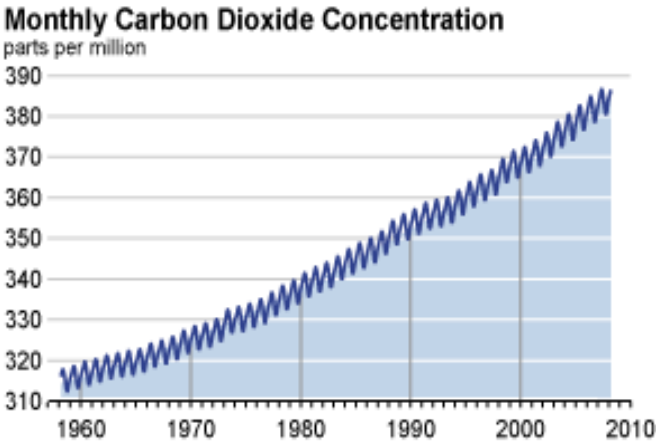
Part 1. A primer to ICOS

Mission statement: Understanding the greenhouse gas perturbation



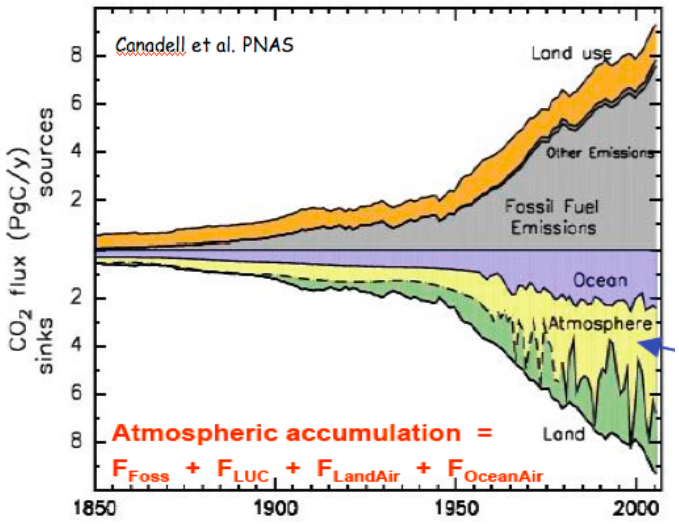
- To provide the long-term observations required to understand the present state and predict future behavior of the global carbon cycle and greenhouse gas emissions

- To monitor and assess the effectiveness of carbon sequestration and/or greenhouse gases emission reduction activities on global atmospheric composition levels, including attribution of sources and sinks by region and sector

Climate change is one the most challenging problems that humanity will have to cope with in the coming decades. The IPCC has established with certainty that the observed rise of temperature is due to increasing greenhouse gases in the atmosphere, driven by man-made emissions overtaking the natural cycles of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The perturbed global biogeochemical cycles of these greenhouse gases are the driving force of current and future climate change.

The concentrations of CO_2 and CH_4 in the atmosphere are at the highest they have been in the past 25 million years. Current levels of CO_2 have increased by 30% from pre-industrial times and they continue to rise, as fossil fuel emissions are climbing up at a high rate. Current levels of CH_4 are nearly triple the pre-industrial value.

These changes are caused by human activities; the primary agents of change are fossil fuel combustion and modifications of global vegetation through land use change, in particular deforestation. The natural carbon cycle offers a discount of 50% on the Earth greenhouse effect by absorbing half of the anthropogenic emissions. At the current atmospheric level of CH_4, the natural oxidizing power cleans up almost all the CH_4 injected by human and natural sources but expected increases of emissions will further raise the CH_4 mixing ratios.



Deeper understanding of the driving forces of climate change requires full quantification of the greenhouse gas emissions and sinks and their evolution. Regional greenhouse gas flux patterns, tipping-points and vulnerabilities can be assessed by long term, high precision observations in the atmosphere and at the ocean and land surface.

Part 1. A primer to ICOS

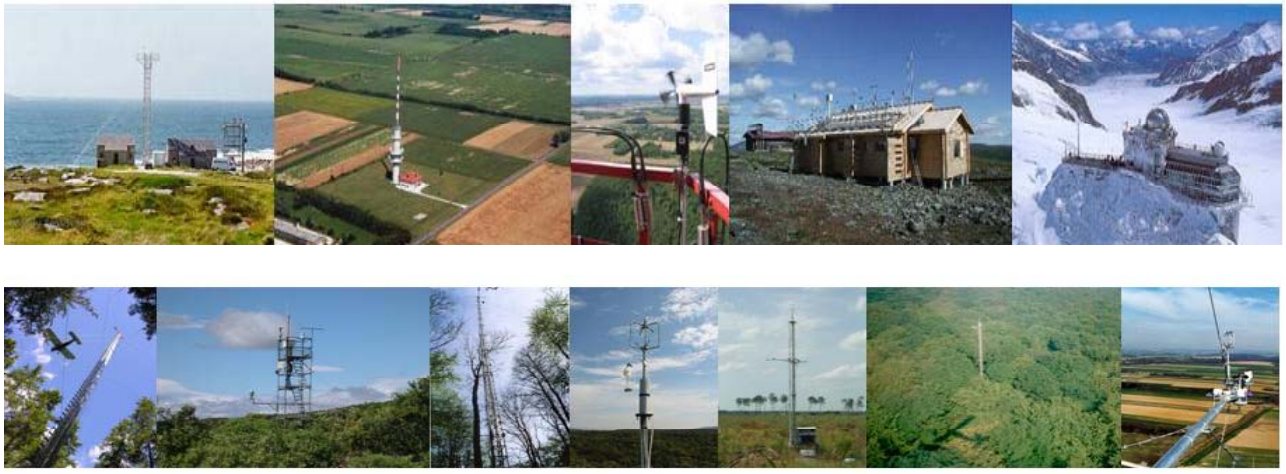
"The Mauna Loa curve, simple and unambiguous, thrust itself before humanity's eyes, changing our view of the world. Keeling's work was far ahead of its time. It was the 1970s before other quality-controlled data sets got going. Had we not had his long backrecord, awareness of global change would have come more slowly. Sudden events, such as the marked fluctuations in global CO_2 uptake after the 1991 volcanic eruption of Mount Pinatubo, may have looked very different in the context of a 15-year rather than a 30-year record." *Euan Nisbet, Nature (2008).*

Advanced science integrating ecosystem and atmospheric observations

It was realized early that, high precision long-term carbon cycle observations form the essential basis of carbon cycle understanding and that these observations must be secured beyond the lifetime of a research project, and must be established at the European level as an infrastructure. ICOS is in the strategic roadmap for Europe in the field of Research Infrastructures (ESFRI).

The concept is a high precision long term network of stations measuring greenhouse gas fluxes from ecosystems and their concentration in the atmosphere, designed around a set of central facilities. The observations collected by ICOS will enable researchers to gain full understanding of the exchange of greenhouse gases over the European continent, and of its driving forces, using:

- Atmospheric greenhouse gas concentrations of CO_2, CH_4, CO and radiocarbon-CO_2 to quantify the fossil fuel component
- Ecosystem fluxes of CO_2, CH_4, H_2O, and heat together with ecosystem variables needed to understand processes
- In parallel, a new strategy is developed for ocean flux observations to be integrated in the infrastructure by 2012.



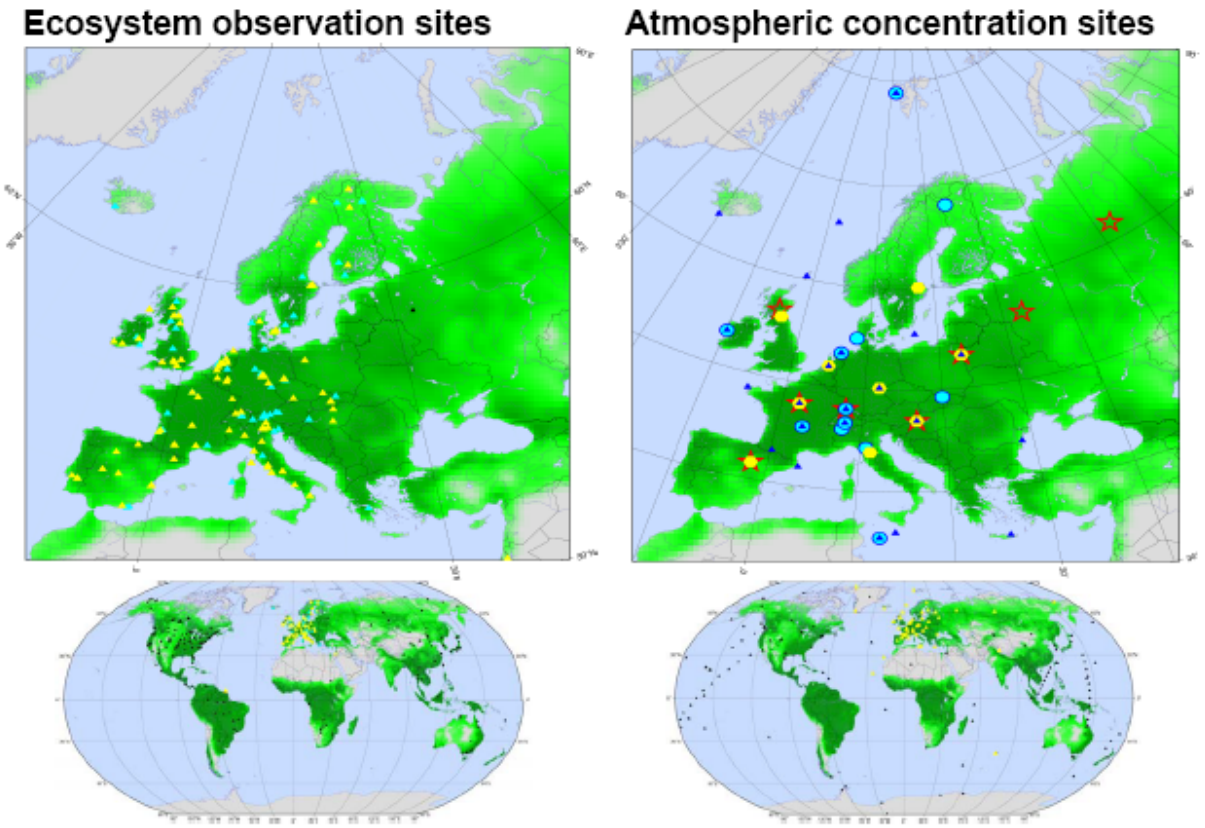
The ICOS measurements will be combined using advanced carbon cycle models into an operational information system, to allow daily assessments of sources and sinks at scales down to about 10 km over European countries. This system will establish a world class standard for understanding the exchange processes between the atmosphere, the terrestrial surface and the ocean. The routine flux diagnostics will

be generated both by research institutes members of ICOS, and by other institutes that will benefit from free access to the infrastructure data. Regular assessment and synthesis of the different flux products, and interaction with policy will be organized by ICOS.

The list of variables covered in ICOS is exactly that of GEOSS (Global Earth Observation System of Systems) recommended to 'support the development of observational capabilities for Essential Climate Variables such as CO_2, CH_4 and other greenhouse gases' according to the 10-years GEOSS implementation Plan. ICOS will also contribute to the WMO Global Atmosphere Watch program, to the Global Terrestrial Observing System (GTOS) and to the international Integrated Global Observing Strategy for Atmospheric Chemistry Observations (IGACO) and for Global Carbon Observations (IGCO) under the GEOSS umbrella.

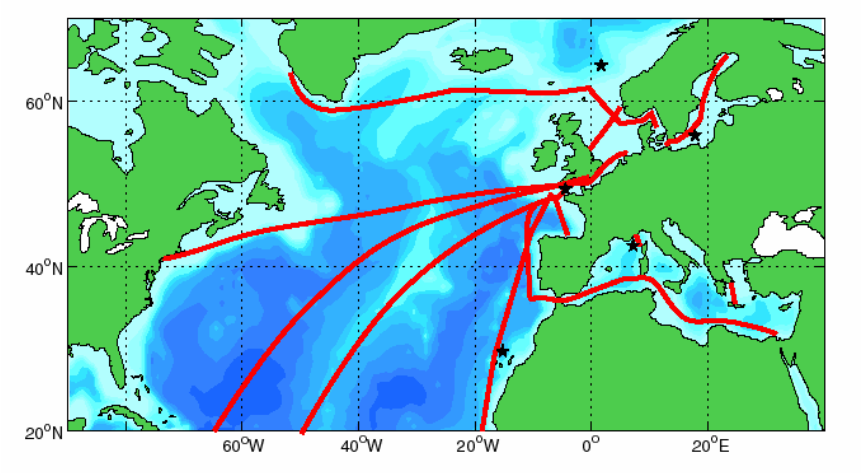
ICOS will enable Europe to become a global player for in situ observations of greenhouse gases, data processing and user-friendly access to data products for validation of remote sensing products, scientific assessments, modeling and data assimilation.

Ecosystem and atmospheric networks



Part 1. A primer to ICOS

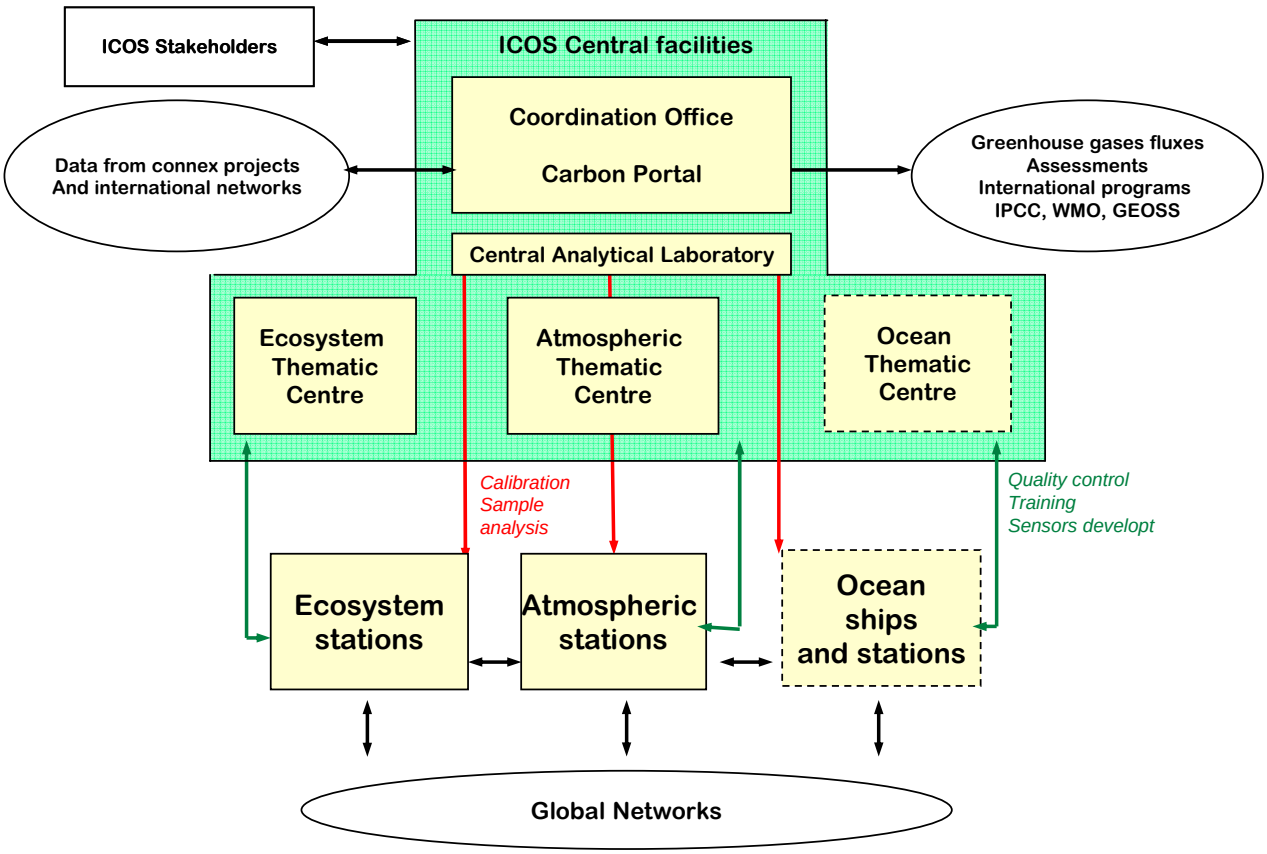
Marine observation routes and stations



A distributed infrastructure constructed around a set of central facilities

The ICOS elements, their function and the resources mobilized for their construction and operation are given below, starting from.

- A **Coordination Office** organizing the data collection programme, the production of routine flux products by participating research institutes, the diffusion and outreach via the Carbon Portal, a web-based data server providing free access to the ICOS data and products,
- The **ICOS network of atmospheric and ecosystem observation** sites, about 30 atmospheric and 30 ecosystem primary long term sites located across Europe, with secured funding coverage for 20 years, and additional secondary sites with same analytical precision,
- The **ICOS network of ocean observations** covering the North Atlantic and European marginal seas using “ships of opportunity” and moorings,
- A **Central Analytical Laboratory** for calibration, and atmospheric analyses for the entire network,
- A **Atmospheric Thematic Center** responsible for continuous and discontinuous air sampling, instrument development/servicing, and online data processing,
- An **Ecosystem Thematic Center** responsible for total ecosystem flux measurements and component fluxes and carbon pools, including data processing and instrument development,
- An **Ocean Thematic Center**, responsible for co-ordinating continuous marine observations, initial data processing from marine network.


ICOS Stakeholders
ICOS Central facilities
Coordination Office
Carbon Portal
Data from connex projects
And international networks
Greenhouse gases fluxes
Assessments
International programs
IPCC, WMO, GEOSS
Central Analytical Laboratory
Ecosystem
Thematic
Centre
Atmospheric
Thematic
Centre
Ocean
Thematic
Centre
Calibration
Sample
analysis
Quality control
Training
Sensors developt
Ecosystem
stations
Atmospheric
stations
Ocean
ships
and stations
Global Networks

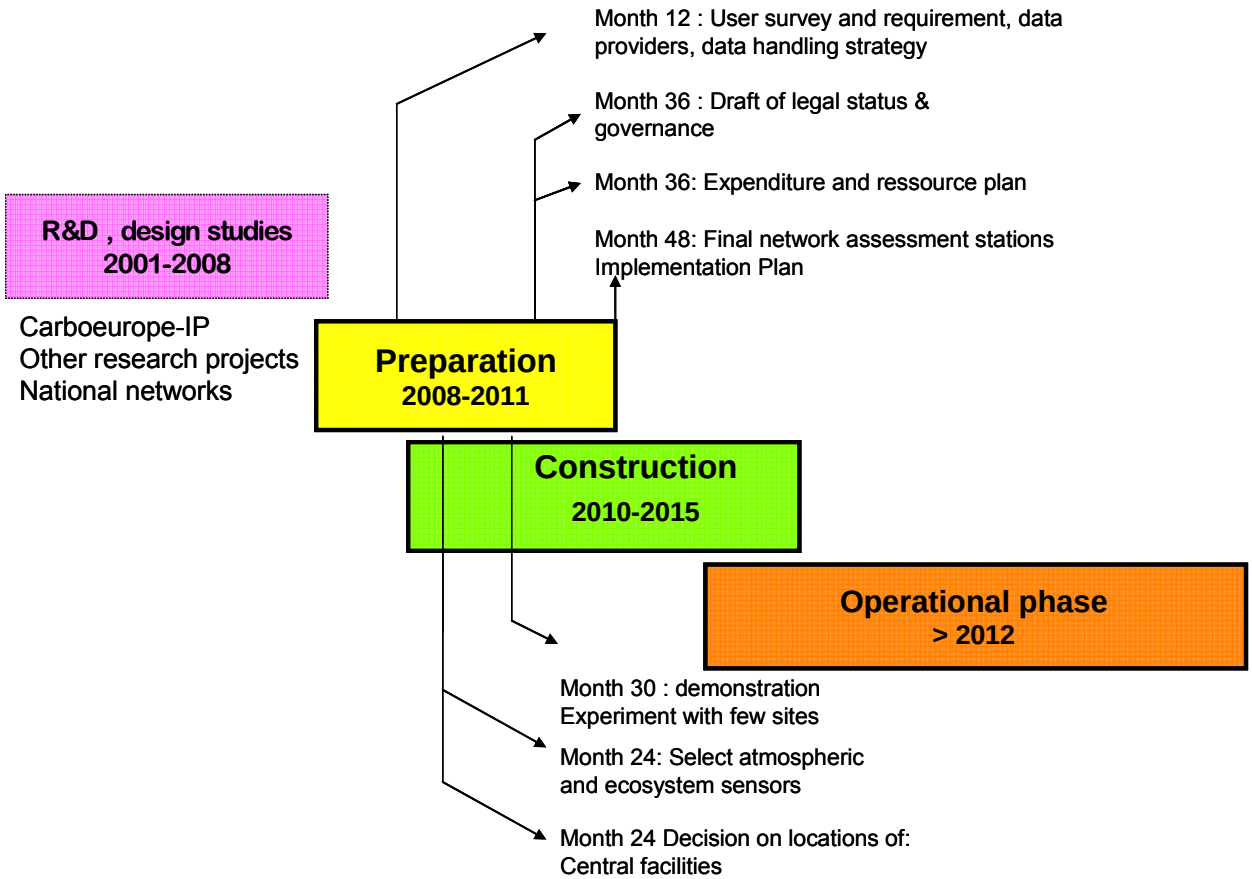
Part 2. Strategy

Implementation strategy

The **Preparatory Phase** starting in 2008 will develop the strategic plan for constructing the Infrastructure, the funding commitments will be endorsed by the funding agencies and stakeholders, and the project will be technically developed up to the level of a demonstration year of full operation, but with a reduced number of observational sites. The preparatory phase has received funding by the EU from 2008 until 2012.

The **Construction Phase** starting between 2010 and 2011 in the different countries, will build and commission the central facilities, and complete the development according to the strategic plan.

The **Operational Phase** starting in 2012 and scheduled to last for 20 years, after the full scale deployment of the network, will be run with the data collection in an operational mode, and greenhouse gas concentrations and fluxes will be determined on a routine basis. Periodic upgrades of the infrastructure will be established and a regular review process of assessment of the network performances.



Part 2. Strategy

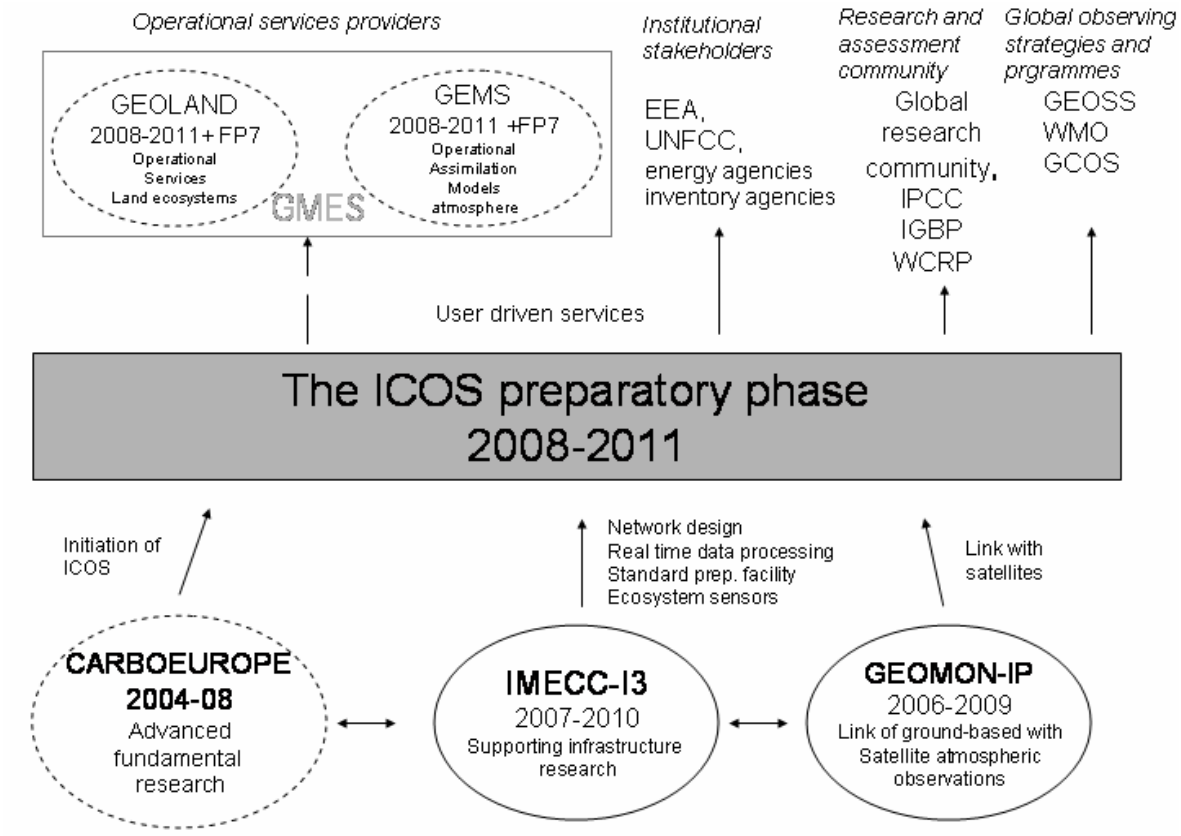
The ICOS workplan of the preparatory phase funded by the EU is organised around eight complementary work packages:

- WP 1 corresponds to the consortium organization and management of the project,
- WP 2 provides legal and governance models,
- WP 3 coordinates the financial/fund raising work,
- WP 4 considers the integration of essential external datasets into ICOS, and involves data providers, in particular for fossil fuel emission data and biomass and soil carbon inventories,
- WP 5 corresponds to the technical work associated with the distributed network of field sites, including network design, equipment selection, testing and optimisation,
- WP 6 will carry out the preparation for building the *atmospheric and ecosystem thematic centers*, as well as the *central analytical laboratory*,
- WP 7 will apply the technical solutions retained in WP 5-6, to execute the Demonstration Experiment, a six month to one year test run where the infrastructure will be operated with a small number of sites,
- WP 8 will organize the project-level outreach, the construction of the web based Carbon Portal, as well as training and capacity building necessary for the future operational phase.

Synergies between ICOS and research and monitoring programmes

- GMES concerns the Atmosphere (GAS) and the land surface elements of this programme. Data generated by ICOS are on the priority list of the GMES requirements for in situ data and products.
- CARBOEUROPE (FP6, IP) will be a prime user of the ICOS data, and provides advanced research tools to use the infrastructure observations.
- CARBOAFRICA (FP6, IP), (Western Africa) and CIRCE (FP6) (Mediterranean regions), and research in third countries such as China, India, and Russia will be able to use the ICOS methodology for establishing new high precision measurements.
- IMECC (FP6, I3) will provide key network design tools to the ICOS Preparatory Phase, funding for ecosystem measurement sensors and standard preparation facilities as well as pilot Near-Real-Time concentration data products.
- GEMS and GEOLAND (FP-6, IP) projects (part of the GMES program), with successors in FP-7, will use the high quality atmospheric and ecosystem validation data provided by ICOS.
- GEOMON (FP-6, IP) will ensure the link to ICOS with forthcoming satellite observations of column integrated CO_2 (NASA/OCO, JAXA/GOSAT missions) and CH_4 (ESA/SCIAMACHY instrument on ENVISAT) and CO (NASA/MOPITT).
- GEOSS will use the European implementation of the Integrated Global Carbon Observation strategy (IGCO) for atmospheric and biospheric observations, and of the Integrated Global Atmospheric Composition Observation strategy (IGACO) provided by ICOS.

- IPCC panel members will have access to unique, high precision long term data to understand the carbon cycle and the current perturbation attributed to anthropogenic activities.
- CARBO-OCEAN (FP6, IP) has developed the techniques for marine observations and shown the power of integrated network observations in the ocean to constrain the carbon budget



Part 3. Infrastructure Elements

Central Facility: Coordination Office

The coordination of ICOS will ensure the management of the Infrastructure at the European level. It will have the mandate and executive responsibility to:

Implement the construction of the Infrastructure, its comissioning and transition to operational mode

- Organize the interface with the stakeholders
- Organize the day to day coordinated management of the infrastructure by overseeing the data collection programme, and the central facilities operations,
- Execute the budget allocated to the common section of ICOS
- Organize the optimal resource coverage and coutries contributions to the central facilities
- Ensure and monitor the optimal long-term consistency of the network,
- Analyze risks and provide solutions to minimize them,
- Organize regular review and assessment of the infrastructure,

Stimulate innovation and cost effective solutions

- Anticipate and stimulate future technological breakthroughs in GHG measurement technology (miniaturization, advanced techniques),
- Find opportunities for expanding and upgrading the infrastructure, in synergy with research institutions and programs,
- Plan future expansion of relevant in situ stations for calibration – validation of satellite observations
- Support capacity building in new countries joining the infrastructure,

Organize the outreach at the project level

- Maintain web based data center (carbon portal)
- Organize the provision of online flux products derived from the ICOS data, regularly updated,
- Contribute to GEOSS, GMES and international networks,
- Organize the optimal diffusion of data and products and the interface with users.

Interface with the rest of the infrastructure

Permanent information from the thematic centers on the data acquisition programme,
Permanent information from the central analytical facilities,
Regular endorsement of the financial and scientific activities by the stakeholders,
Funding by the participating countries

Costs (indicative)

A lump sum to be contributed by each country user of the central facilities, that will be redistributed to their operation. On the order of 10-20% of each national contribution.
Manpower (typical) scientific director +managing director + assistant (3 persons)
Infrastructure office (3-4 administrative persons including 1 communication person)
Carbon portal (2- 3 IT persons including 1 webmaster)

Part 3. Infrastructure elements

Network: Ecosystem station

Each ecosystem site is a field station equipped with standardized high-performance instruments to measure fluxes of greenhouse gases (in particular CO_2, N_2O and CH_4), water and energy between terrestrial ecosystems and atmosphere. Together with fluxes, a number of important ecosystem variables are also measured, such as the full hydrological and radiation budgets, and ecosystem carbon pools in the vegetation and soils. The ICOS ecosystem sites network will be composed by at least 30 *Primary* sites covering different climatic conditions, vegetation types and management practices, particularly for cropland sites.

The fluxes are measured using the eddy covariance method from direct measurement of wind vertical velocity and gases concentrations and the footprint of the tower is on average between 200 and 1000 meters. To avoid differences in the measurements due to different data processing all the raw data collected (wind velocity and concentrations) will be elaborated centrally in the *Ecosystem Thematic Center*. Systematic instruments cross-calibration between sites will be also performed to minimize possible biases in the raw data. An independent quality control team that regularly visits all sites will be established.

Additional *Secondary* sites will be added to the core *Primary* sites; these sites will be equipped with the same standardized instruments and deliver the same precision, but not all the variables requested to the *Primary* sites will need to be collected (only the core variables are mandatory for all the sites).

Output services and users

ICOS Ecosystem stations will provide continuous measurements of GHGs, water and energy fluxes between terrestrial ecosystems and atmosphere together with meteorological variables and sites' characteristics.

These data can be used, as example, to parameterize and validate carbon models applied at continental scale, to detect long term changes in the carbon sink and source of ecosystems, to identify the impact of differences management options to the carbon budget.

Possible users are the carbon and climate modelling communities, the remote sensing community and the scientific community working in the biology and ecology fields.

Interface with the rest of the infrastructure

Ecosystem stations will transfer the data collected on regular basis (daily to monthly) to the *Ecosystem Thematic Center* where standardized quality controls, calculations and corrections will be applied. Some ecosystem stations will be equipped for measurements of atmospheric CO_2 and CH_4 concentrations, using the instrumentation and the expertise from the Atmospheric Network.

Costs (indicative)

Equipment: 700K Euros (7 years)
Running Costs: 50K Euros /year
Manpower: 36/48 Month/year

Type	Parameter	Frequency
Core	CO_2, H_2O, Sensible heat fluxes	Continuous (30 min)
Core	CO_2 vertical profile	Continuous (30 min)
Core	Global, Net, Reflected, Diffused radiation	Continuous (30 min)
Core	Air and soil temperature profiles	Continuous (30 min)
Core	Wind speed profile	Continuous (30 min)
Core	Soil Water Content profile	Continuous (30 min)
Core	Precipitation, Snow height, Troughfall	Continuous (30 min)
Core	Soil Heat fluxes	Continuous (30 min)
Core	Soil carbon content	5 years sampling
Core	Biomass	Yearly
Core	Management and disturbances	Yearly
Additional	CH_4 Fluxes	Continuous (30 min) / Daily
Additional	N_2O Fluxes	Continuous (30 min) / Daily
Additional	Canopy temperature	Continuous (30 min)
Additional	Spectral reflectance	Continuous (30 min)
Additional	Below canopy Photosynthetic Active Radiation	Continuous (30 min)
Additional	Groundwater level	Continuous (30 min)
Additional	Sap flow	Continuous (30 min / 3 hours)
Additional	Soil respiration	Continuous (3 hours)
Additional	Phenology camera	Daily
Additional	N deposition	Biweekly
Additional	Leaves and soil water N content	Biweekly
Additional	Litter fall	Monthly
Additional	C and N import and export due to management	Yearly

Part 3. Infrastructure elements

Network: Atmospheric station

Each atmospheric station is an observatory established to measure continuously the greenhouse gas (CO_2, CH_4, and in the future N_2O) concentration variability due to regional and global fluxes. The ICOS network will have about 30 primary sites, considered as the backbone of the infrastructure. Consequently, a *Primary* site chosen for installing an atmospheric station will be representative of a footprint area of more than 100 km. Additional stations, for instance located in areas of high local emissions (urban and industrial areas) will be associated to ICOS as *Secondary* sites. These secondary sites will meet the same precision requirements than the primary sites.

The footprint of a particular site to quantify regional fluxes can be highly variable, especially for coastal and mountain sites. In such case, continuous measurement of meteorological parameters and additional atmospheric tracers is important to characterize the footprint of each data, as well as the use of high resolution transport model. Measurements from tall towers located in flat areas are particularly important to the ICOS network, since they provide information which can be more easily handle by transport models.

Each atmospheric station will be equipped with a standardized set of sensors, to ensure that atmospheric measurements are collected in a consistent way and at the highest possible accuracy, with minimal risks of data gaps. The concentration data will be elaborated centrally, and routinely assessed, in the *Atmospheric Thematic Center*. Air samples collected at each site each week will be shipped and analyzed in the *Central Analytical Laboratory*. Air sampling and monitoring equipment requires a small building, or shed, and supply of electricity. The room containing the instrumentation must be air-conditioned. Facility for near real time data transmission must be available. Intercomparison exercises and support by a Quality Control team will be organized to ensure full consistency of the atmospheric network.

Output, services and users

Each ICOS atmospheric station will provide high precision continuous measurements of CO_2, CH_4, CO and meteorological parameters. Air samples collected every week will be sent to the *Central Analytical Laboratory*.

These data can be used to detect long term changes in the greenhouse concentrations trends in the atmosphere, or year to year variability associated to anthropogenic emissions, and climate anomalies.

Possible users are the carbon and climate modelling communities, the remote sensing community and the scientific community working on data assimilation/inversion.

Interface with the rest of the infrastructure

Atmospheric data will be transferred on a regular (e.g. daily) basis to the *carbon portal*. Automatic data screening procedures will be completed and the results assessed by the atmospheric stations Principal Investigators. The operation of the

standardized instrumentation deployed at the stations will be supervised by the *Atmospheric Thematic Center*. An independent quality control team that regularly visits all sites will be established.

Flask air samples collected in duplicate on a weekly basis at the atmospheric stations will be shipped to the *Central Analytical Laboratory* where they will be analyzed for CO_2, CH_4, N_2O, SF_6, CO, H_2, O_2/N_2 and stable isotopes in CO_2. On the other hand, the *Central Analytical Laboratory* will provide the working standards needed to calibrate the in-situ measurements at the atmospheric stations. Weekly integrated CO_2 samples will be collected for 14 CO_2 analysis as well as regular diurnal cycle experiments of $^{14}CO_2$ to calibrate the fossil fuel CO_2 proxy carbon monoxide will be performed. Some atmospheric stations will be equipped for measurements of CO_2 fluxes using the instrumentation and the expertise from the *Ecosystem Network*.

Costs (indicative)

Equipement: 465K Euros (5 years)
Running Costs: 70K Euros / year
Manpower: 7 Month/year

Type	**Parameters**	**Frequency**
Core	CO_2, CH_4, CO	Continuous (30 min)
Core	Meteorological parameters: P, T, RH, wind	Continuous (30 min)
Core	Boundary layer height	Continuous (30 min)
Core	CO_2 flux	Continuous (30 min)
Core	CO_2, CH_4, N_2O, SF_6, CO, H_2, O_2/N_2	Weekly sampling
Core	^{13}C, ^{18}O, ^{14}C in CO_2	Weekly sampling
Additional	N_2O, SF_6	Continuous (30 min)
Additional	Radon-222	Continuous (30 min)
Additional	O_2/N_2	Continuous (30 min)

Part 3. Infrastructure elements

Network: marine observations

The marine observing system has until recently been developed separately from the other components of ICOS and was not formally included in the preparatory phase. Consequently planning is at a more outline stage and individual country costs are not as yet available. Overall indicative costs for the marine component of ICOS are given here, but are not included in subsequent tables as they cannot as yet be assigned to countries.

The marine observation system will consist of approx 10 major instrumented "ships of opportunity" and five fixed time series stations. The ships will usually be commercial ships operating regularly repeated routes, e.g. ferry routes in European shelf and marginal seas, and container or tanker vessels on routes across the open Atlantic and through the Mediterranean. The fixed time series will be points in the ocean at which sustained time series observations are recorded by means of moorings and research ship monitoring.

The ships of opportunity and mooring sites will be equipped with a range of automated instrumentation to measure atmospheric and surface ocean p CO_2, surface temperature, salinity and related variables. Measurements will be repeated along similar transects at intervals of days to months. Recent work under the FP-6 CARBO-OCEAN IP has shown that this coverage is sufficient to accurately constrain air-sea ocean fluxes over the entire regions such as the North Atlantic. To achieve this, the observational data is interpolated to these regions by combining with satellite measurements of surface temperature, winds and the output of real-time ocean forecasting models.

Output, services and users

Continuous output of atmosphere and ocean partial pressure of CO_2, sea surface temperature, salinity, wind speed, and atmospheric pressure. There will be regular collection of flask samples of air for CO, CO_2 , CH_4, N_2O, SF_6, H_2, and N_2/O_2.

Interface with the rest of the infrastructure

Data will be co-ordinated at the marine thematic centre which will also provide support for the automated instrumentation Flask samples of air will be analysed at the Central analytical facility which will also provide calibration gases for the in-situ measurements. Some ships and marine stations may be equipped with instruments for measuring CO_2 and CH_4 atmospheric concentrations.

Costs (indicative)

For each marine observation (fixed station or shipping route), indicative costs are 100K Euros for installation and 100K Euros per year running costs, plus 6 man months per year effort.

Type	Parameters	Frequency
Core	atmospheric CO_2, Ocean p CO_2, total atm,pressure,	continuous (30 min)
Core	sea surface temperature and salinity	continuous (30 min)
Core	Meteorological parameters,	4-hourly
Core	CO_2, CH_4, N_2O, SF_6, CO, H_2, O_2/N_2	weekly
Core	^{13}C, ^{18}O, ^{14}C in CO_2	weekly

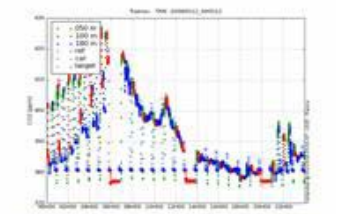
Part 3. Infrastructure elements

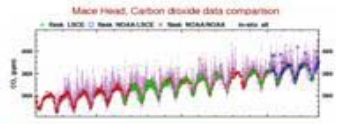
Central Facility: Atmospheric Thematic Center

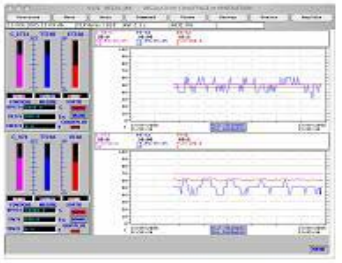
The Atmospheric Thematic Centre will provide four main services to ICOS:

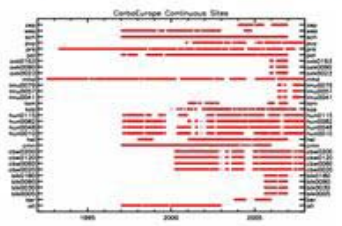
- organize the continuous and discontinuous atmospheric measurements,
- provide technical and logistical assistance to the network,
- online atmospheric data online processing and archive, quicklook tools and generation of data products
- oversee new sensors development and emerging technologies opportunities

The technical and logistical assistance will include instrument servicing, definition of measurements protocols and new sensor development and testing. The atmospheric data center will collect, process and archive atmospheric data both for near real time applications and for long term high concentration data and products. It will evaluate raw data and transfer them to international scales, based on the calibration information received from the *Central Analytical Laboratory*. A thematic centre with parallel functions is also established for the ecosystem network. Both centers will interface with the Coordination Office and carbon portal for data dissemination.









Interface with the rest of the infrastructure

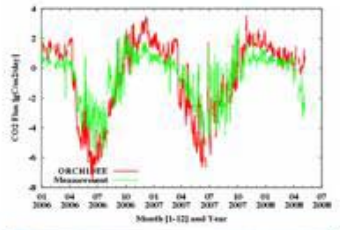
The atmospheric thematic centre will coordinate the global atmospheric network. It will process data from the stations of the atmospheric network. Interaction with research institutes and the industry for new sensor development will be conducted.
Technical and logistical assistance will include instrument servicing, testing, training, measurements protocols and new sensor development.
The atmospheric data centre will collect process and archive atmospheric near real time and long term high precision data. It will ensure traceability to international scales.

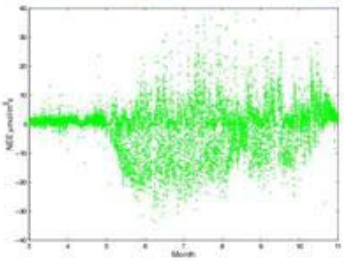
Costs (indicative)

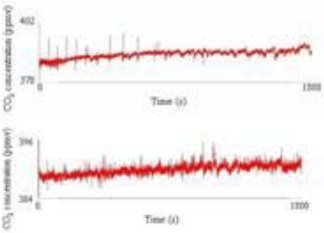
Equipment: 450K Euros (5 years)
Running Costs: 150K Euros /year
Manpower: 9 persons

Central Facility: Ecosystem Thematic Center

The *Ecosystem Thematic Center* is responsible for the coordination of the Ecosystem stations measurements, providing technical and logistical assistance to the network and overseeing standardized and new sensors development. In addition, the Center will collect the data measured at the different Ecosystem stations and will be responsible for the data quality control, calculation, correction, archive and dissemination of the elaborate data trough the Carbon Portal.







Interface with the rest of the infrastructure

The center will deal with technical and logistic issues related to the Ecosystem network.
The *Ecosystem Thematic Center* will have a central role in terms of services offered since it is the collector of all the data from the ecosystem stations and will ensure coordination and management of the network, data processing standardization and distribution, archiving and traceability of the datasets.
The *Ecosystem Thematic Center* is linked to the ecosystem stations network (coordination and data elaboration) and with the *Atmospheric Thematic Center* for coordination and standardization in the data archiving and presentation between ecosystem and atmospheric stations.
Interaction with research institute and industry for new sensors development and new processing methods schemes will be developed.

Costs (indicative)

Equipment: 300K Euros (7 years)
Running Costs: 10K Euros /year
Manpower: 48 Month/year

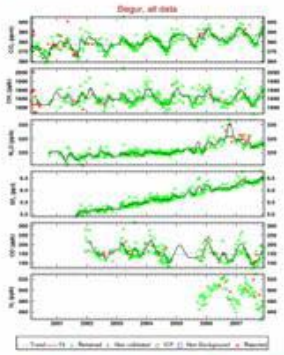
Part 3. Infrastructure elements

Central Facility: Central Analytical Lab

The *central analytical laboratory* provides two main services to ICOS:

1) It prepares and provides the necessary standard gases that are essential to absolutely calibrate the individual atmospheric measurement systems at the in situ network.
2) It analyzes all air samples taken at the entire ICOS atmospheric network for trace gas concentrations and their isotopic composition.

Because of the relatively small temporal and spatial variations of the concentration of the GHG monitored by ICOS, high-accuracy calibrated measurements are indispensable. The World Meteorological Organization in their Global Atmosphere Watch programme has specified guidelines for the required measurement accuracy. The *central analytical laboratory* ensures that these are met, both by providing the standard gases for the entire in situ network and by analyzing all air flask samples taken at the network stations and by the regular aircraft sampling. In addition, it provides the isotopic analyses on the air samples which allow the attribution of concentration variations to source processes with different isotopic signatures. The analysis system in the central analytical laboratory in turn keeps its calibration scales closely linked to the international standards maintained by the WMO-Central Calibration Laboratories.



Interface with the rest of the infrastructure

The input to be included:

- Flask samples (~8000 per year) from the entire ICOS network (atmospheric stations and regular aircraft sampling programs).
- Cylinders with reference air standards from the in situ stations for re-calibration in the central analytical laboratory.
- Cylinders with reference air standards for intercomparison with the WMO-CCL for the different trace gas concentrations and isotopic composition.

The output to be included:

- Calibrated cylinders with reference air standards for the in situ stations (~200 per year).
- Cylinders with reference air standards for intercomparison with the WMO-CCL for the different trace gas concentrations and isotopic composition.
- Concentration and isotope data from the flask analyses.

The *central analytical laboratory* maintains close links to the atmospheric thematic center by providing the data from the concentration and isotope analyses from the flask analyses. It also links to the entire in situ atmospheric network and the regular aircraft program through the logistics of shipping of air flasks and reference air standards.

Costs (indicative)

Equipment: 3.28 Meuros (in construction phase). The initial equipment would have to be replaced once during the nominal 20-year lifetime of ICOS.

Running cost: Laboratory: 240K Euros yr
Manpower: 700K Euros /yr, 13 persons

The Legal status (indicative)

The preference that the ICOS consortium has stated is a legal status in which the European institution is funded by the partner countries (would also administer the other central facilities of ICOS)

Economic model (indicative)

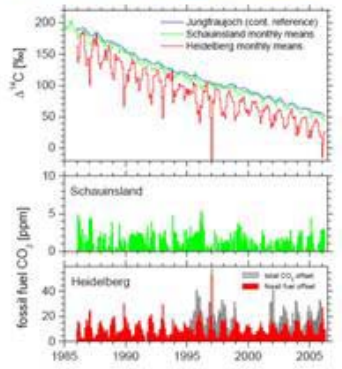
The central analytical laboratory provides analysis services to the entire approved ICOS network through central funding by the partner countries ("ECMWF model").

Part 3. Infrastructure elements

Central Facility: Radiocarbon analytical lab

This central facility will:
- Provide high-precision atmospheric $^{14}CO_2$ analyses for the whole ICOS network
- Improve methodology to measure the atmospheric fossil fuel CO_2 component

In order to measure the atmospheric fossil fuel CO_2 component at all relevant ICOS stations, dedicated very high-precision (better than 2‰) radiocarbon ($\Delta^{14}C$) analyses are needed. A dedicated laboratory within this facility will perform ^{14}C measurements with two different techniques, the very precise and cost-effective conventional counting technique requiring large CO_2 samples and the Accelerator Mass Spectrometry (AMS) technique for small volume flask samples. Outsourcing of AMS analyses to external labs is envisaged/possible.



Interface with the rest of the infrastructure

Input:

- Large volume (≈ 1000 per year) and small-volume flask (≈ 1000 per year) samples from the entire atmospheric ICOS network.

Output:

- Co-ordination of and technical support for the ICOS fossil fuel CO_2 measurement network
- Target preparation for AMS ^{14}C analyses and their co-ordination
- High-precision $^{14}CO_2$ analyses for the entire atmospheric ICOS network

The radiocarbon analytical laboratory maintains close links to the *atmospheric thematic centre* and the *central analytical laboratory* as well as to the entire atmospheric network for co-ordination of $^{14}CO_2$ sampling (i.e. logistics of sample shipment, technical support for sampling at the sites as well as data transfer).

Costs (indicative)

Equipment: 1.84 M€ (in construction phase)
Running costs (incl. depreciation over 10 years)
Laboratory: 280K Euros /yr
AMS analyse: 500K Euros /yr
Personnel: 260K Euros /yr
Manpower: 4.6 persons

Central Facility: Marine thematic centre (under definition)

The marine thematic centre will perform a similar role to its counterpart atmospheric and ecosystem centers:

- Organize and co-ordinate marine observations
- Act as data archive, focal point and information center for marine network
- Integrate the data from marine observations and produce regionally interpolated flux estimates
- Provide technical assistance to marine observation units
- Oversee new sensor development.
-

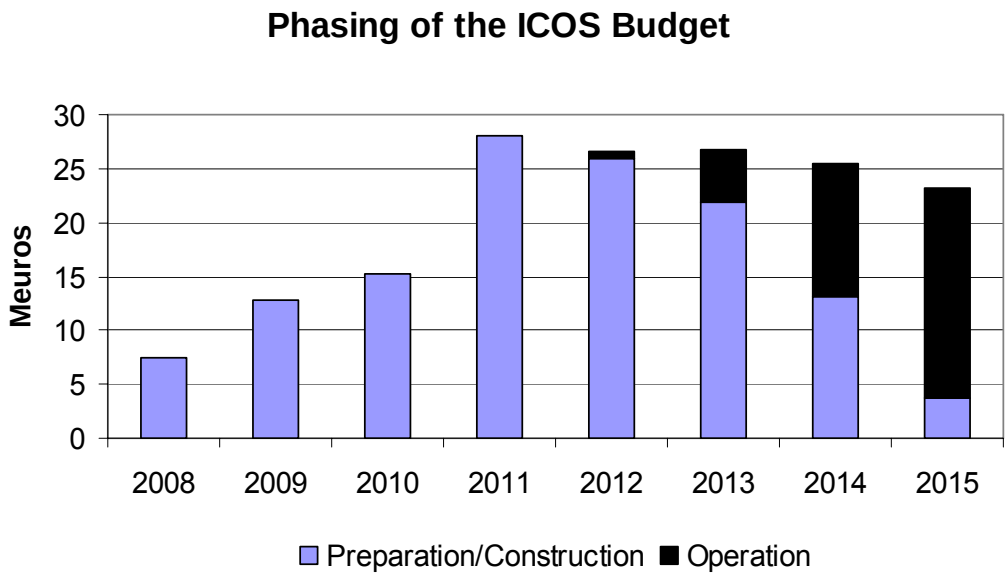
Indicative running costs are 200K Euros per year and 24 person-months per year.

Part 4. Implementation

Total estimated share per country

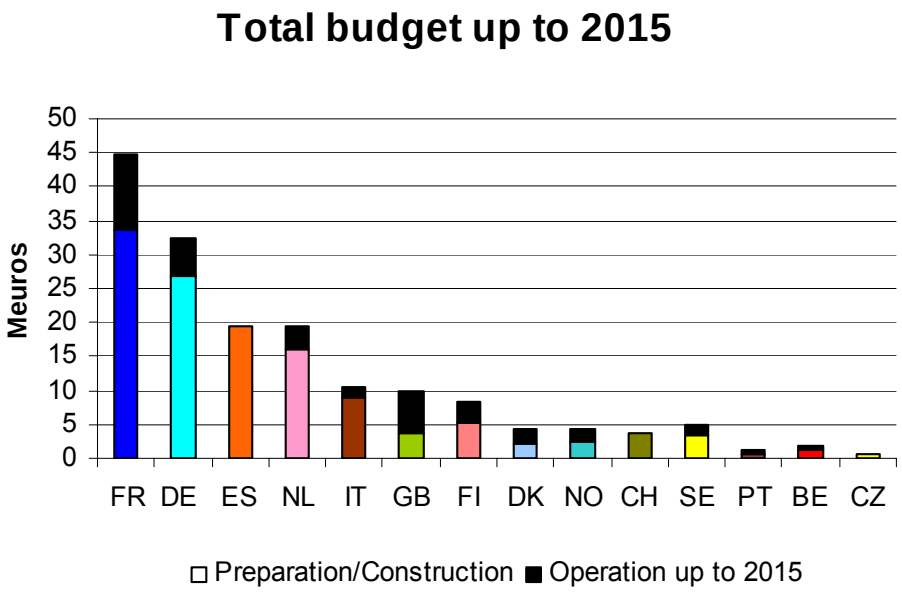
	ICOS Total Budget up to 2015	Preparation/ Construction
FR	44,9	33,6
DE	32,3	26,7
ES	19,5	19,5
NL	19,4	16,0
IT	10,4	9,0
GB	9,7	3,6
FI	8,4	5,4
DK	4,3	2,3
NO	4,2	2,5
CH	3,6	3,6
SE	4,9	3,3
PT	1,1	0,7
BE	2,0	1,4
CZ	0,7	0,5
Total	165,4	128,1

Summary of estimated share in each country between 2008 and 2015. The right hand column gives the preparation/construction cost

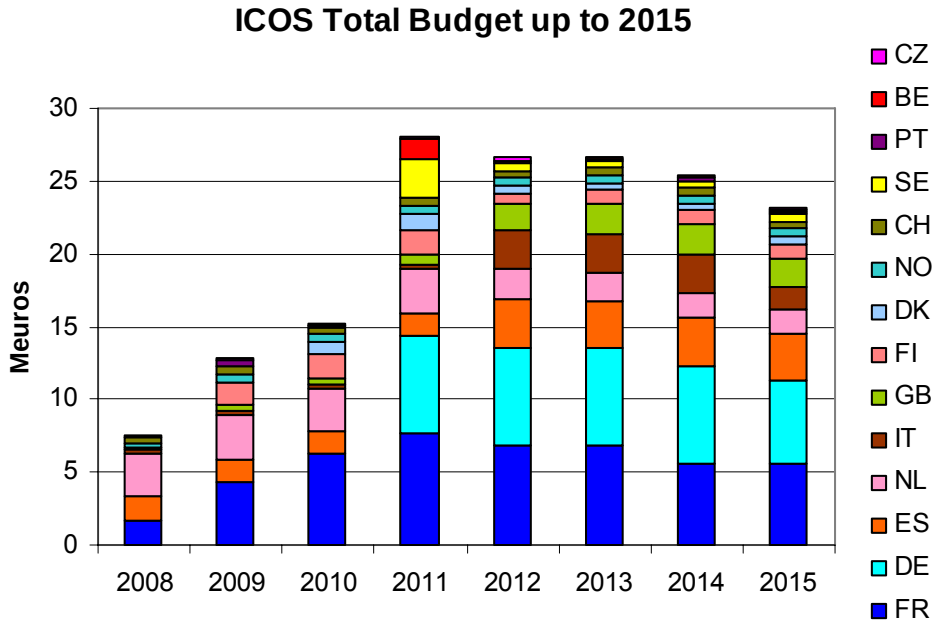


Estimated preparation and construction (blue) + progressive implementation of operational measurements at the ICOS network by 2015 (black)

Estimated costs of preparation + construction + early operation

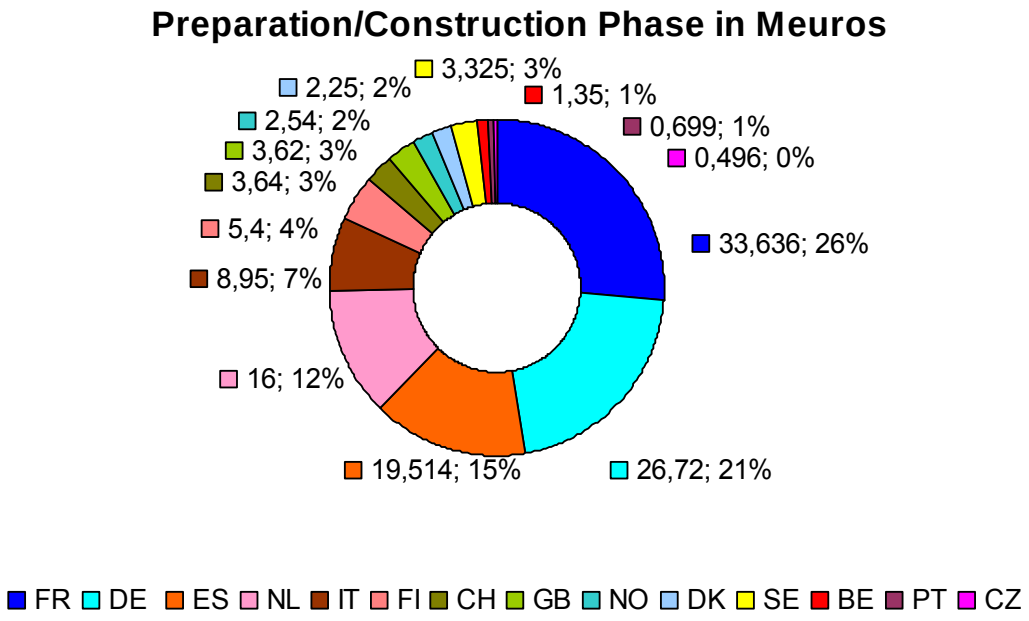


Cost estimates of the infrastructure and possible share between the different countries based on their anticipated contributions, ranked from the largest to the smallest construction

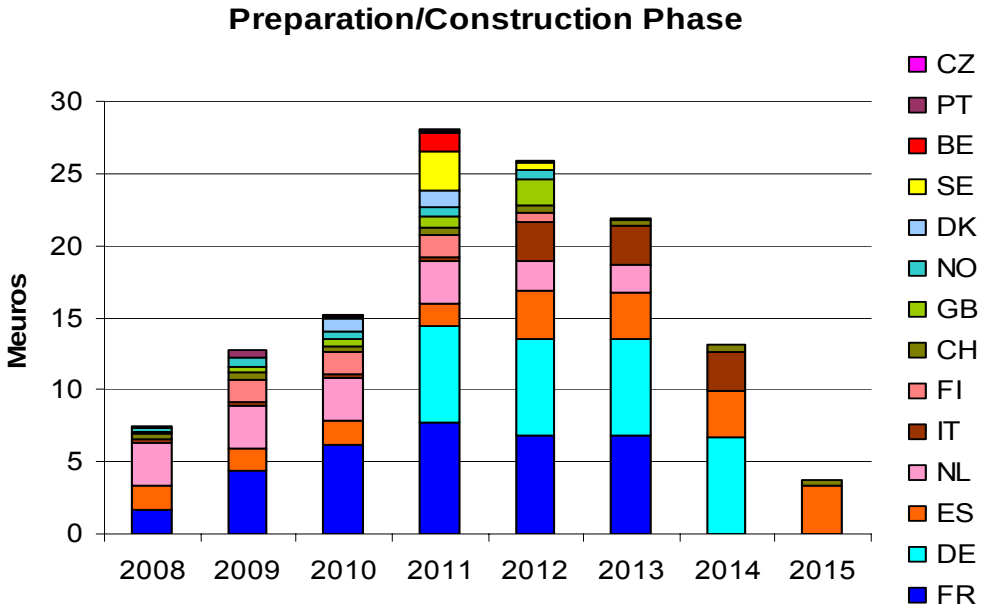


Yearly cost between 2008 and 2015, showing each possible share

Estimated costs of preparation + construction

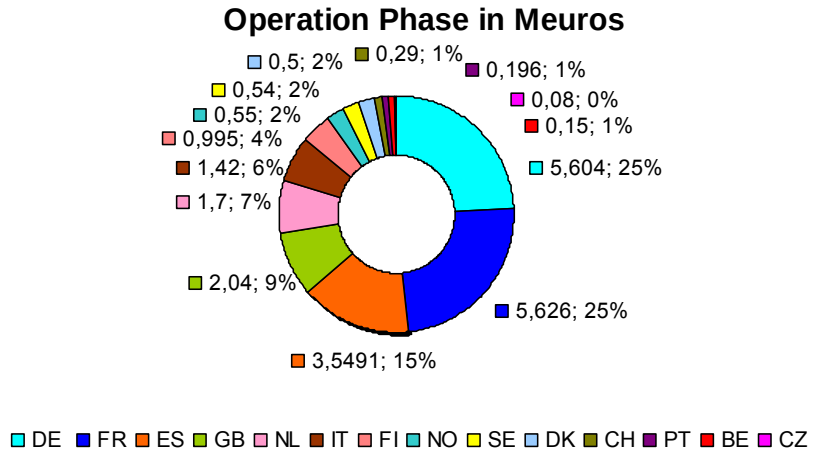


Preparation and construction: possible share between the different countries summed between 2008 and 2015

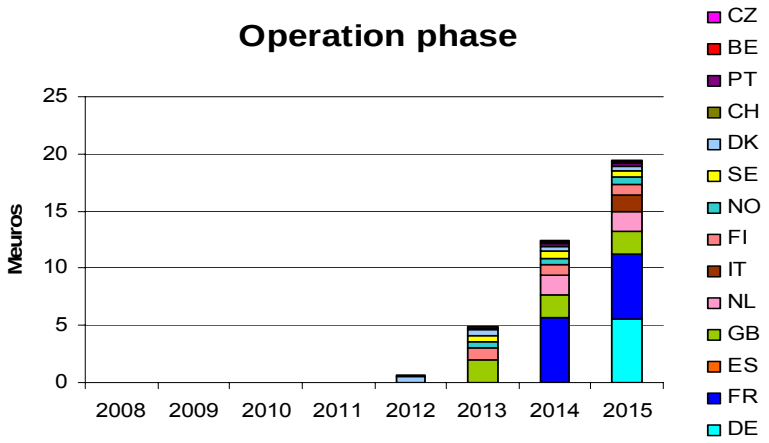


Preparation and construction: yearly cost between 2008 and 2015, possible share between the different countries

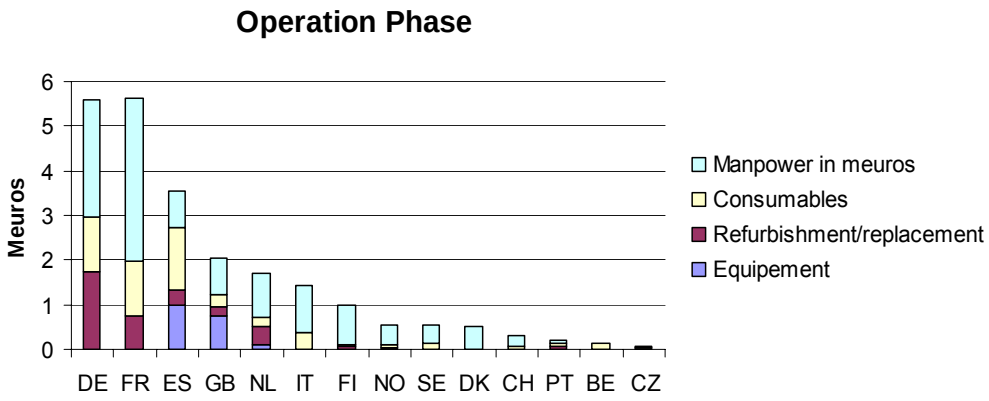
Estimated costs of early operation until 2015



Early operation : possible share between the different countries after 2012

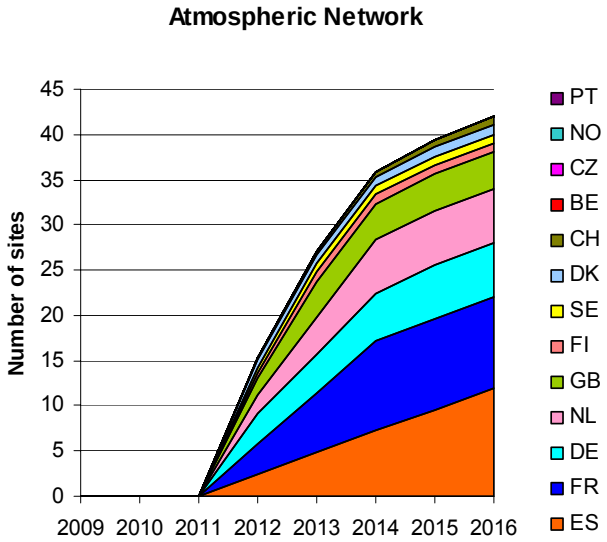


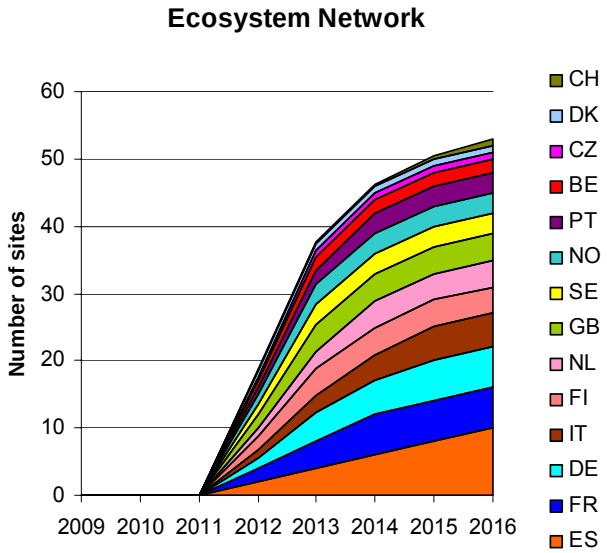
Operation, yearly effort after 2012 possible share between the different countries



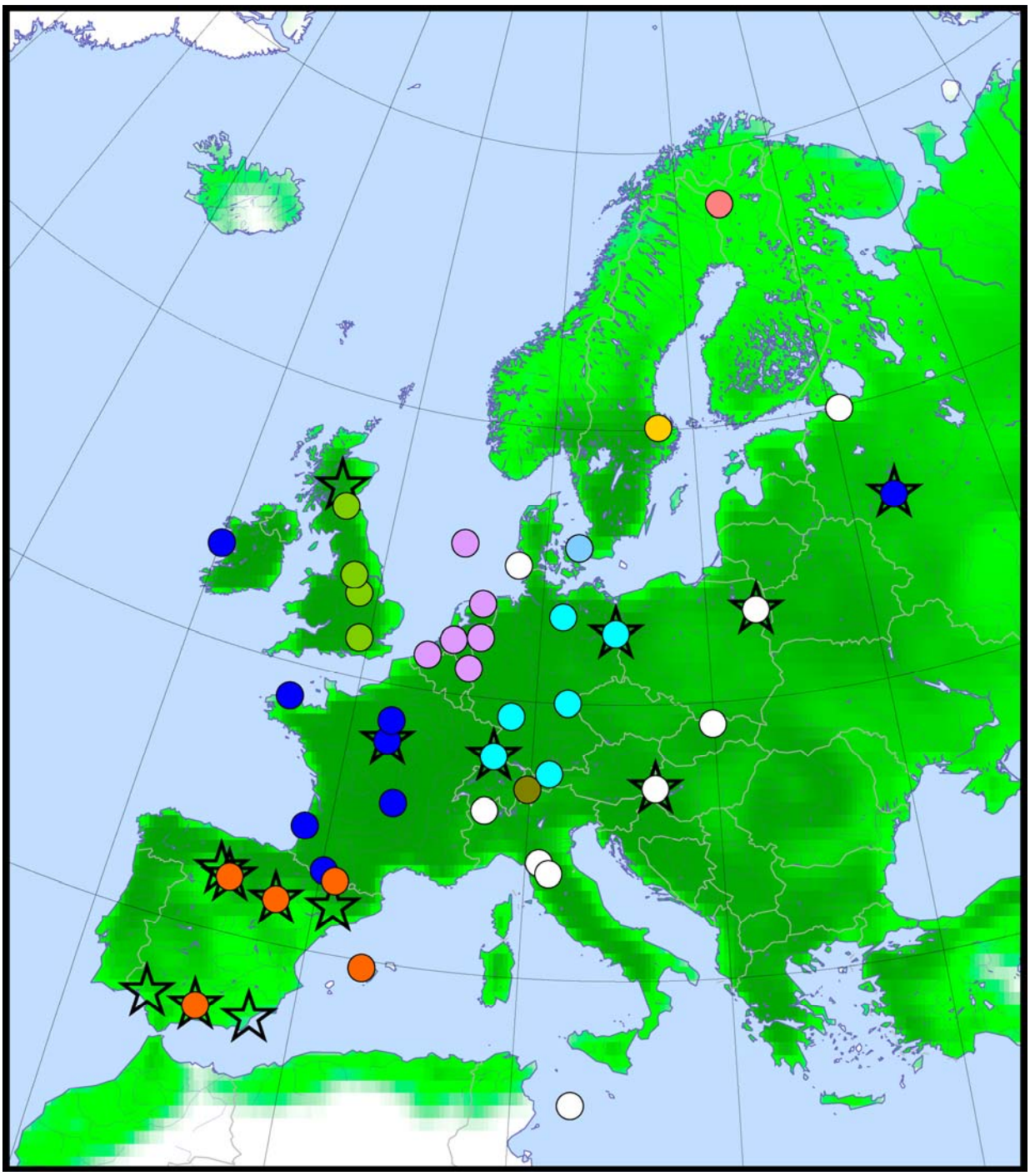
Possible share between the different countries, for early operation of infrastructure

Network implementation

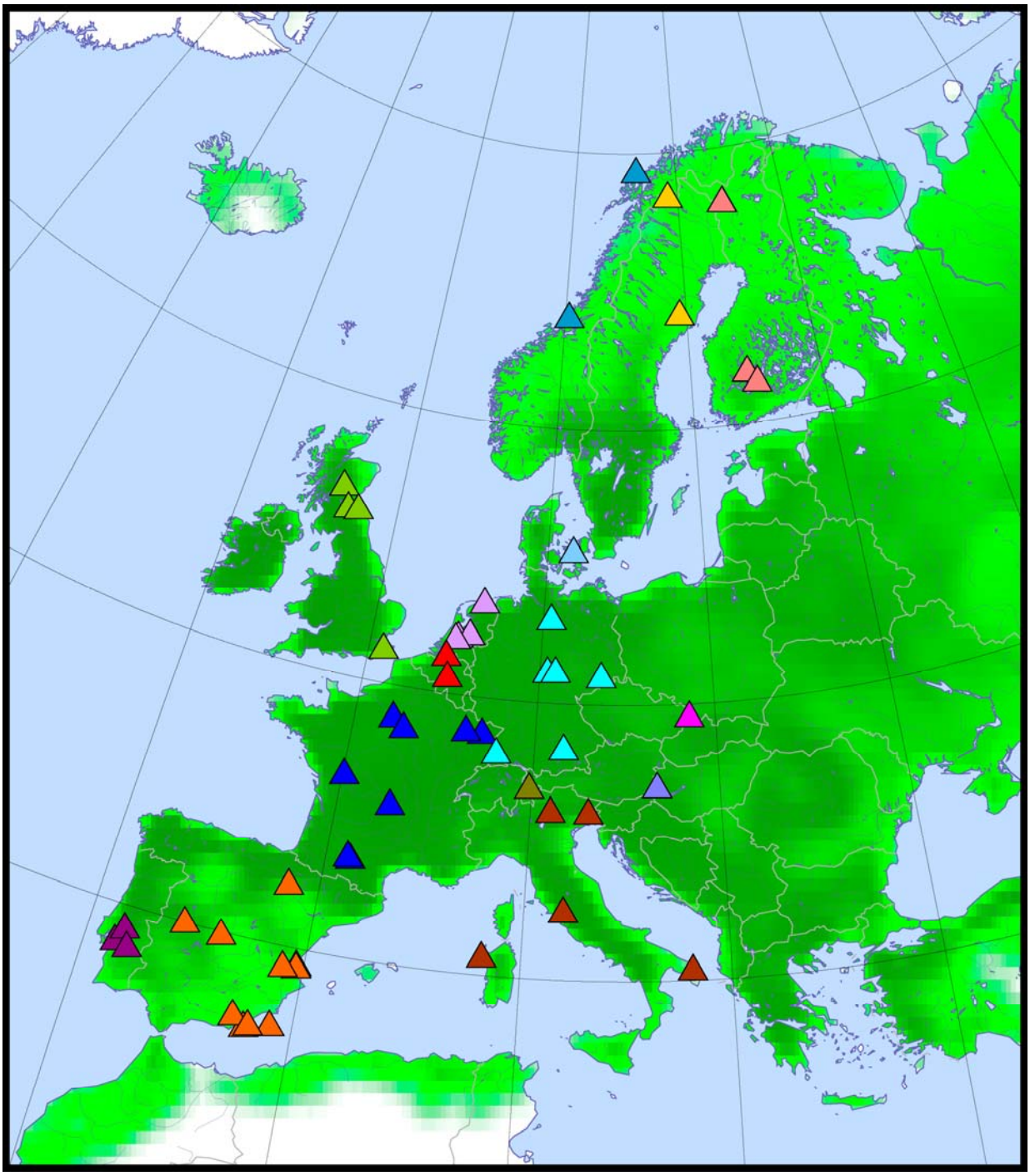




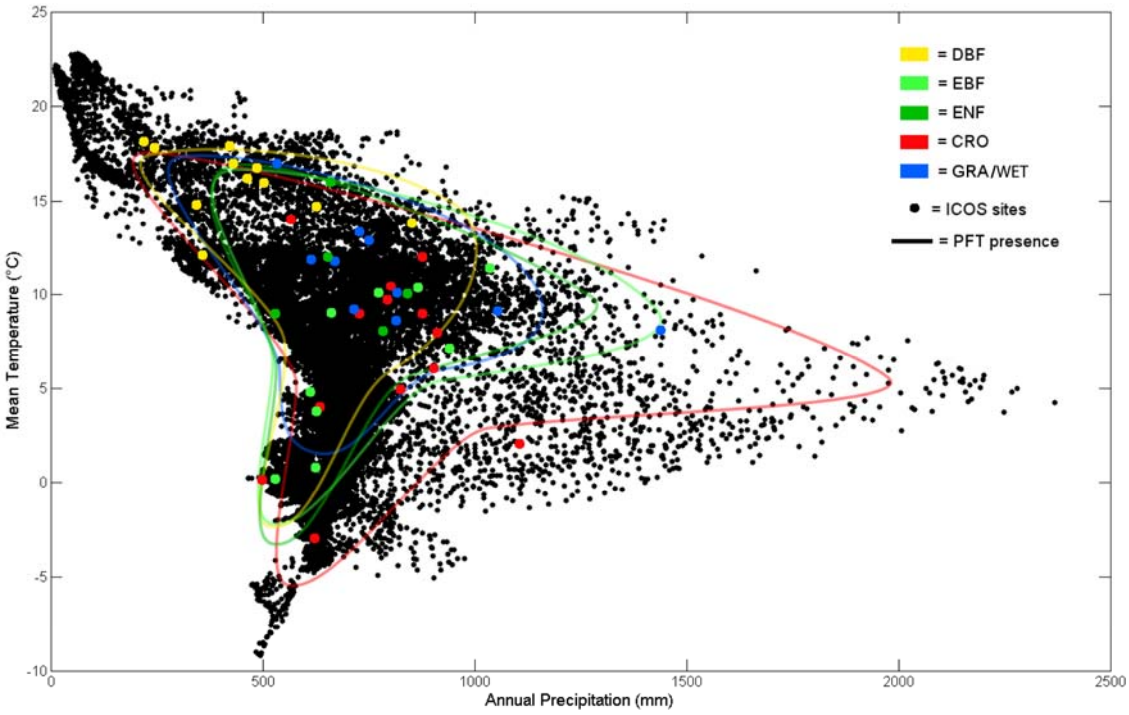
Time course of the implementation of the atmospheric and ecosystem network between now and 2016 (level 1 sites)



Atmospheric sites map. Color code follows country color code used above.
Black stars are aircraft sites. Sites in white are potential level 2 sites.
This map will evolve during the preparation phase



Ecosystem sites map. Color code follows country color code used above.
This map will evolve during the preparation phase



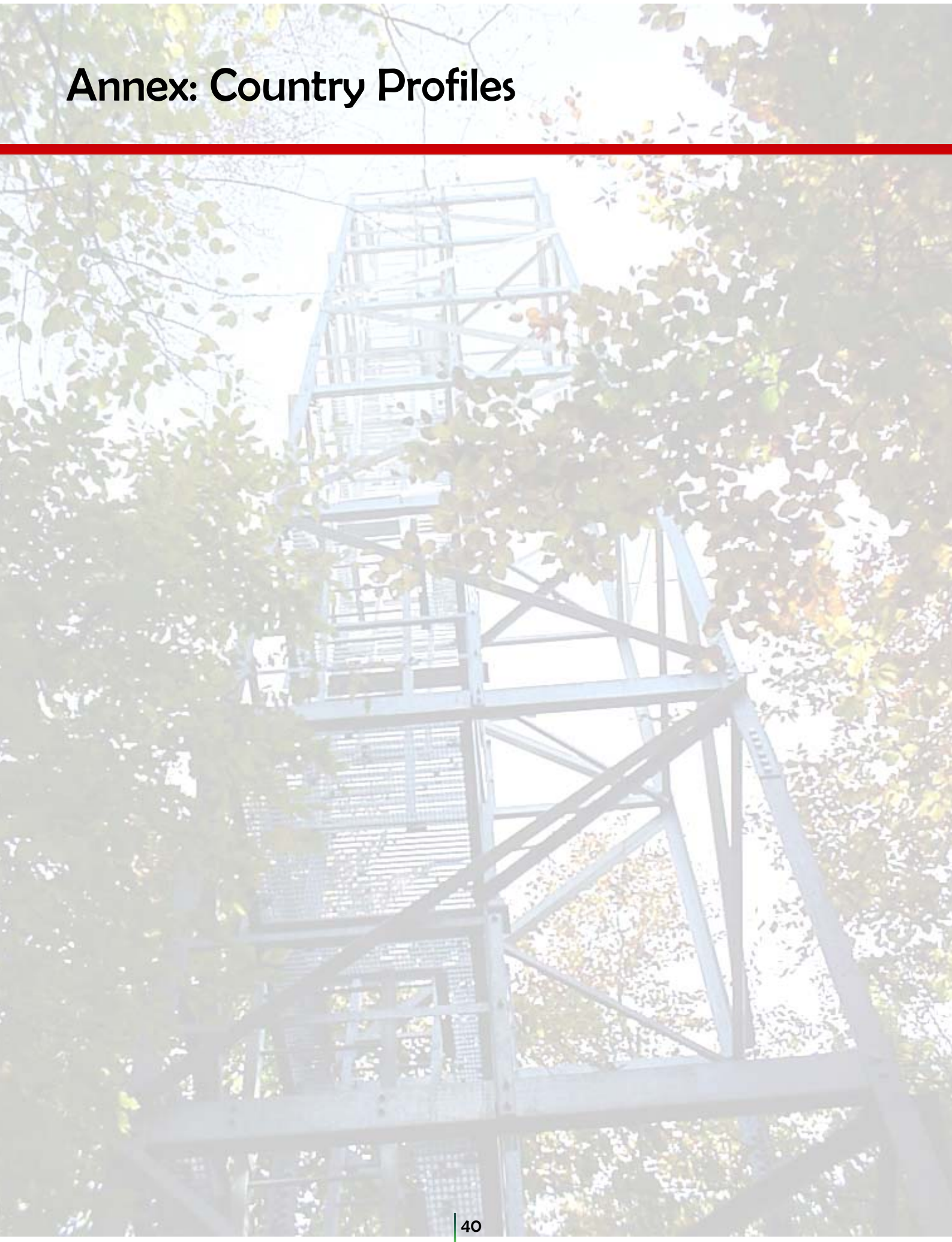
Ecosystem sites by types (DBF = deciduous broadleaves forest,
EBF = evergreen Broadleaves forest, ENF = evergreen needle leafs forest,
CRO = cropland, GRA/WET = grassland and Wetland sites) in the climatic space:
Mean temperature versus annual precipitation.

Belgium	operational	2012
	Ecosystem: 2 sites	
	Brasschaat , Lonzée	
Czech Republic	operational	2013
	Ecosystem: 1 site	
	Bilý Kříž	
Denmark	operational	2012
	Ecosystem: 1 site	
	Soroe	
	Atmosphere : 1 site	
	Risoe	
Finland	operational	2013
	Ecosystem: 4 sites	
	Hyytiala, Siikaneva, Pallas Kenttärova, Pallas Lompolojänkkä	
	Atmosphere : 1 site	
	Pallas	
France	operational	2014
	Ecosystem: 12 sites (6 level 1, 6 level2)	
	Hesse-Nancy, Brey-Bordeaux, Grignon-Versailles, Lusignan, Laqueuille, Puechabon-Montpellier, Fontainebleau-Orsay, Lamasquère-Toulouse, Auradé- Toulouse, Kourou, Mons, Font Blanche	
	Atmosphere : 13 sites (10 level 1, 5 level 2)	
	Ile Amsterdam, Mace Head, Puy de Dôme, Hanle, Trainou, Ivittuut, Biscarosse, Gif-sur-Yvette, Pic du Midi, La Réunion, Ile Grande, Orléans, Tver	
Germany	operational	2015
	Ecosystem: 6 sites	
	Hainich, Gebesee, Tharandt, eco1-NW Germany, eco2-S Germany, eco3	
	Atmosphere: 6 sites including 4 tall towers. Weekly vertical profiles and air sampling by light aircraft at TWO tall tower sites	
	Ochsenkopf, East of Berlin, Wendland, Zugspitze, Schauinsland, Heidelberg	
Hungary	operational	
	Atmosphereic: 1 site	
	Hegyhatsal	
Italy	operational	2015
	Ecosystem: 5 sites	
	Beano (indicative), Monte Bondone (indicative), Noe (indicative), Roccarespampani (indicative), Lecce (arbitrary selected)	
Netherland	operational	2014
	Ecosystem: 4 sites	
	Lutjewad (LUT), Cabauw, Loobos, Horstermeer	
	Atmosphere: 6 sites	
	Lutjewad (LUT), F3 (FFF), Cabauw, TV-tower bij Roermond, NL-undicided1, NL-undicided2	
Norway	operational	2013
	Ecosystem: 3 sites	
	Andøya, eco1, eco2	

Portugal	operational	
	Ecosystem: 3 sites	
	Espirra, Machoqueira, Mitra	
Spain	operational	2016
	Ecosystem: 10 sites	
	El Saler (Valencia), El Saler-Sueca (Valencia), Las Majadas del Tietar (Caceres), Vall d' Alinyà (Lleida), Balsa Blanca, Llano de los Juanes, Laguna Seca, Muela de Cortes, Toledo, Agua Amarga	
	Atmosphere: 12 sites	
	La Muela (Zaragoza), Begur (Girona), Begur (Girona), La Muela (Zaragoza), Paredes de Nava, Linyola, Lac Redon (Lleida), Alfabia (Mallorca), Iznájar (Córdoba), Almonte / Doñana, Iznájar, Vera	
Sweden	operational	2013
	Ecosystem: 3 sites	
	Norunda, Flakaliden, Stordalen	
	Atmosphere: 1 site	
	Norunda	
Switzerland	operational	2016
	Ecosystem: 1 site	
	Davos Seehornwald	
	Atmosphere: 1 site	
	Jungfraujoch	
United Kingdom	operational	2013
	Ecosystem: 4 sites	
	Griffin, Alice Holt, Easter Bush, East Saltoun	
	Atmosphere: 4 sites	
	Scotland, East Anglia, London, Yorkshire	

List of ICOS atmospheric and ecosystem stations possibly operated by each country. The future ocean observing system contribution to ICOS is being defined.

Annex: Country Profiles



Country name: Belgium (BE)

Focal point name: Reinhart Ceulemans, UA

Main scientific organisations
- University of Antwerp: Reinhart Ceulemans & Ivan Janssens; University of Ghent: Pascal Boeckx;
- INBO: Peter Roskams
- Agronomic University of Gembloux: Marc Aubinet
- University of Liege: Monique Carnol

Possible funding organisations
- BELSPO; FWO-Vlaanderen HERCULES Foundation
- FNRS
- Flemish Community
- Walloon Community

The Universities of Antwerp and Gembloux have formed one joint cluster of sites within CarboEurope. They have been collaborating in Federal projects since 1996. The Universities of Ghent and Gembloux have also collaborated in a carbon-cycle related Federal project.
The University of Antwerp has collaborated with INBO in several Flemish projects on carbon cycling (1996-now); and with the University of Ghent in a Flemish project on the greenhouse gas balance of a wetland ecosystem (2005-now).

Experience:

University of Antwerp and Gembloux have been monitoring carbon fluxes continuously at 3 ecosystem sites for more than a decade already (1997-onwards). Two of these sites would be continued within the ICOS network. The new partners would contribute with their expertise on these three sites. Fields of expertise relevant to European network are: eddy covariance; linkages between carbon cycle and water- and nutrient cycles; soil trace gas exchanges; sap flow; microbial nitrogen transformations; nitrogen deposition …

Timeline foreseen:

April 2008: Development of a national strategy & project
2009- 2010: Writing of proposals for funding of infrastructure and for operational cost.
In case of success:
2011: Construction of infrastructure, hiring & training of personnel.
2012 onwards: Belgian ICOS stations fully operational.

Users of the infrastructure

- The two ecosystems provide a broad window of opportunity for researchers from many different research fields (remote sensing, hydrology, ozone & aerosols, microbiology …).
- Users regroup up to 5 external research groups per site + 5 groups within ICOS-Belgium = 15 research groups
- Approximately 20 researchers: 10 PhD & 10 Post-docs
- 15 publications from Belgium + contributions to a large number of synthesis studies (= European-wide analyses of the ICOS network).

Role in the infrastructure

Contribution to the ecosystem network.

The two ecosystem-scale observation sites are fully equipped in terms of climatological sensors and many other instruments relevant to a wide spectrum of research fields), and are therefore likely to serve as platform for research beyond the ICOS objectives. There are, however, no plans yet.

Country name: Czech Republic (CZ)

Focal point name: Michal V. Marek, ISBE

Main scientific organisations

- Institute of Systems Biology and Ecology: Michal V. Marek

Possible funding organisations

- Ministry of Education Czech Republic and Czech Grant Agency
  National programmes:project CzechCarbo (national carbon stock investigation)

Experience:

Network of eddy towers stations (mountain spruce and beech forest, mountain grassland, upland spruce forest, wetland, agro-systems , i.e. 6 stations) unified under the umbrella of the Bilý Kříž Experimental Research Station - basic funded body by ISBE for the long-future, technical support, training centre:. former RI under FW5.

Timeline foreseen:

2008-2011: Focused attention to the finalisation of the technical quality of the National Observation Site (NOS) Bílý Kříž and implementation of the ISBE contribution to the WP3, WP7 and WP8. The CZ national contribution to the ICOS is based on the existing network of the Eddy Tower Sites, running of the special simulation tool (long-term experiment with elevated CO_2 impact on the forest stand scale) and to elaborate RS protocol for the Carbon deposition evaluation. The CP will be used for the small-scale implementation of the instrumentation which will be needed. OP is devoted based on the NOS function, stakeholders support and student training.

Users of the infrastructure

- CZ users of the infrastructure:
  1/ Agency for the environmental Protection – Carbon emission budget unit
  2/ Czech Institute for Meteorology and Climatology
  3/ Czech national Climatic Program
  4/ Czech State Forests
  5/ Ministry of Environment
  6/ Ministry of Agriculture
  7/ Ministry of Education
- Scientific community: national grant agencies, Academy of Sciences, Academic Universities bodies
- Czech State Forests
- Estimated number of total number of users: 7-10
- Approximately 10 PhD and 5 Thesis & post-docs expected to be using the infrastructure network, data or facilities
- 30 scientific publications

Role in the infrastructure

Czech Republic is involved in EU Carbon projects since 1995. Under the umbrella of the projects national network of eddy towers was constructed and national observation site Bily Kříž was established. Carbon observation programme are completed with the impact studies (long-term experiments with elevated CO_2 on the forest stand level. Thus this

type of proposed research plan is of great importance in the Czech governmental research priorities. Basic financial support for the ICOS makes possible to run all proposed phases of the ICOS programme.

ISBE is partner in the PhD. 4 programmes at 2 universities:

-Univ. of South Bohemia Č. Budějovice: Applied and Landscape Ecology and Biophysic

-Mendel Agric. and Forestry University Brno: Applied and Landscape Ecology and Forest Ecology

Future participation of PhD. students on the ICOS was a part of the ISBE – Ministry of Education pre- agreement on the national founds support of the ICOS programme.

ISBE is running some of research activity as a joint research program (CzechCarbo and CzechTerra) with close cooperation with mentioned universities (PhD. thesis objectives, participation of researches). Close cooperation on the filed of carbon cycles was established with the National Forest Research Institute Prague and private institute of Forest Ecosystems Research Prague.

Country Name Denmark (DK)

Focal point name: Kim Pilegaard, Risø DTU

Main scientific organisations

- Technical University of Denmark, Risø National Laboratory for Sustainable Energy (Risø DTU): Kim Pilegaard, Andreas Ibrom, Ebba Dellwik
- University of Copenhagen: Henrik Søgaard
- University of Roskilde: Eva Bøgh
- University of Aarhus, National Environmental Research Institute: Lise Lotte Sørensen, Camilla Geels

Possible funding organisations

- Ministry of Science Technology and Innovation, Danish Agency for Science, Technology and Innovation.
- Ministry of Climate and Environment
- Private funds

The Nordic Centre for Studies of Ecosystem Carbon Exchange and Its Interactions With Climate System, NECC (a so called Center of Excellence funded by the Nordic Council of Ministers and the joint organisation of the national Nordic research councils, NOS-N). This is a collaboration between practically all Nordic groups active in this type of studies. The NECC will come to a formal end by 30 June 2008 but it is anticipated that it will continue as a network (pending application).

Experience:

Danish participation since 1996 in EU-projects such as Euroflux, CarboEurope, CarboEurope-IP, and IMECC. Participation in FLUXNET. Risø DTU has established a number of ecosystem flux sites as part of their long-term research programme. The members of the research team behind this application have all been active within the research areas supported by the infrastructure. Apart from participation in the EU-project, the present research team has formed the national part of the Nordic centre of excellence NECC (Nordic Centre for Studies of Ecosystem Carbon Exchange and its Interactions with the Climate System). Members of the research team have also carried out flux measurements of greenhouse gases in areas outside of Europe (Africa, Siberia, and Greenland). The research team has published a large number of papers utilizing results from the research driven measurement stations. Thus the existing team has demonstrated a high quality and productivity in research utilizing data of the type that the ICOS infrastructure can provide in the future.

The Danish participation can be implemented as a continuation of existing ecosystem flux measurement stations. The station in a beech forest near Sorø has been operational continuously since June 1996 and has gained a position among the top 5 in Europe with respect to data coverage and quality. We have also been running flux stations in other land-use types (agricultural fields, grasslands, spruce forest).
We wish with the ICOS infrastructure also to enter the area of greenhouse gas concentration measurements. These measurements can be established at existing high masts within our organizations (e.g. the 125m Risø mast and/or the 116 m high mast at the test station for windmills at Høvsøre). Decisions within the team preparing ICOS at the European level might have other wishes to type and location of Danish measurement sites than the present. It is therefore a task of the Danish pre-project to systematically identify suitable locations for different types of ecosystems

and source areas of greenhouse gases. Risø DTU has the technical skills and staff to provide national support for the infrastructure.

Timeline foreseen:

2008-01-01 – 2009-12-31: Danish pre-project
1) Identification of localities for atmospheric concentration stations and for flux measurement stations
2) Establishment of research network
3) Outlining of research associated to the infrastructure
4) Model for practical implementation in Denmark
5) Models for financing

2008-2011: Participation in ICOS/EU pre-project
2011-2012: Establishment of ecosystem and atmospheric stations according to ICOS standards
2012-2031: Running phase for stations.

Users of the infrastructure

- Scientific user groups: 4-6
- 3 PhD students per user group
- Danish citizens (scenarios of future impact on climate change)
- 2-5 publications/group/year
- Private enterprise (technical development within sensor development and systems)

Role in the Infrastructure

In a referendum of interest in ESFRI infrastructure projects, The Technical University of Denmark has given a very high priority (no. 2) to Danish participation as a partner in ICOS. The participation is of strategic importance for the efforts of Risø National Laboratory for Sustainable Energy . The participation in ICOS is a natural development of previous efforts within this research area and will enable research to be carried out based on data with an even higher data quality.

The research area and infrastructure are very important to consolidate current research activities at the new environmental institute, ENSPAC, at Roskilde University. It is also strongly supportive to the strategic research planning of ENSPAC which includes spatial environmental dynamics as a core research area.
There will be a large international focus on the role of nitrogen for CO_2 sequestration and climate processes in ICOS. In this area, Denmark has some comparative advantages due to the experience with nitrate pollution during the latter 20-30 years. Environmental pollution caused by surplus production of manure and nitrate leaching have created a large research capacity and the development of advanced model tools to quantify and analyze the transformation and transport of nitrogen in atmosphere, soil and water bodies. With the selection of the strategic research area "Vand – Fremtidens Strategiske Resurse" by the Strategiske Forskningsråd, these model tools will be further improved and consolidated with advantage to Danish CO_2/climate researchers studying the impact of nitrogen deposition on production, CO_2 sequestration and physical and hydrological conditions in the landscape. The research is also likely to involve new types of satellite data to estimate and combine bio-geo-physical parameters at the local, regional and global scales and is therefore supportive to the work of Dansk Rumkonsortium to strengthen Danish applications and international research in Earth observation.

Denmark aims at participating in ICOS with a minimum of one atmospheric and one ecosystem field station. We are also willing to participate in central activities for running the infrastructure.

Country name: Finland (FI)

Focal point: Timo Vesala, University of Helsinki

Main scientific organisations

- University of Helsinki (UHEL): Timo Vesala, Janne Rinne, Sami Haapanala, Mari Pihlatie, Eero Nikinmaa, Jukka Pumpanen
- Finnish Meteorological Institute (FMI) Tuomas Laurila, Tuula Aalto and Juha Hatakka

Possible funding organisations

- The Ministry of Education, Ministry of Transport and Communication, Academy of Finland
- Finnish Funding Agency for Technology and Innovations (TEKES)

Both UHEL and FMI are participating to Carboeurope, Nitroeurope and IMECC projects. FMI belongs also to GEOMON-Integrated project. Both belong also to Finnish Centre of Excellence appointed by the Finnish Academy of Sciences. FMI participates to World Meteorological Organization's Global Atmospheric Watch-programme through measurements at Pallas global background site. The site also belongs to The Arctic Monitoring and Assessment Programme (AMAP) and the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmissions of Air Pollutants in Europe (EMEP) and Forest Focus networks.

Experience:

We propose in this phase 3 sites, which are Hyytiälä SMEAR II ecosystem site (pine), Siikaneva ecosystem site (wetland) and Pallas atmospheric site (Pallas provides also supporting data from Kenttärova (spruce) and Lompolojänkkä (wetland) ecosystem sites). Hyytiälä and Pallas have long records of ICOS-type studies together with other trace gas and aerosol studies and data have been utilized much in international networks. Siikaneva is an associate site to Hyytiälä. All sites provide valuable information from high latitudes. FMI has demonstrated its capability in committing high quality continuous greenhouse gas atmospheric mixing ratio measurements. Measurements are being made at a remote site Pallas, which is valuable contribution to the global network showing the northern boreal zone atmospheric background. Together with Russian Hydrometeorological Service we are starting atmospheric concentration and flux measurements at a tundra site in Siberia. FMI is in administrative level strongly committed to continuing long term greenhouse gas studies and is actively searching and implementing new technologies and methodologies. The UHEL, FMI and ICOS community co-operation would include exchange of measurement results and information regarding new methodologies as well as measurement quality analysis.

Users of the infrastructure

- Research institutes and university researchers and students
- Scientific community: In the beginning 100/year, later several 100/year

Role in the infrastructure

Finland could run Headquarters of ICOS; acting as a link and communicator to other fields of atmospheric sciences (like other trace gases and aerosols).ICOS is very important for long-term funding and research co-operation related to atmospheric sciences, ecology and environmental sciences with University of Kuopio, Tampere University of Technology, Finnish Environmental Research Institute and Finnish Forest Research Institute. ICOS will be linked to European Institute of Atmospheric Research, which is under planning and preparation

Country name: France (FR)

Focal point name: Philippe Ciais, Laboratoire des Sciences du Climat et de L'Environnement

Main scientific organisations

- Laboratoire de Laboratoire des Sciences du Climat et de l'Environnement (LSCE joint research unit of IPSL CEA, CNRS and UVSQ)
- 10 different laboratories in the Institut National de Recherche Agronomique (INRA) and CNRS

Possible funding organisations

- Commissariat à l'Energie Atomique (CEA)
- Centre National de la Recherche Scientifique-Institut National des Sciences de l'Univers (CNRS-INSU)
- Institut National de Recherche Agronomique (INRA)
- Université de Versailles Saint-Quentin-en-Yvelines (UVSQ)

The national service of observation –RAMCES is located within the LSCE. Ecosystems sites are organized in the ORE ACBB and DRILL

Links are foreseen between IAGOS and the atmospheric part of ICOS

Inclusion of ocean observatories (CARBO-OCEAN) in ICOS is in the course of discussion, MeteoFrance and AIRPARIF expressed interest for participating to regional networks of greenhouse gas measurement.

Experience:

For the Atmsophere, LSCE is a renown laboratory that operates the largest network of greenhouse gases measurement in Europe. Oldest site (Amsterdam Islnad) has been collected data for 25 years now. For the ecosystem, most of the laboratories involved are accredited by COFRAC and ISO for the soil and plant material analysis proposed. They are already included in European projects such as the ICP Forest observatory and others.

Timeline foreseen:

The Preparatory Phase (2008-2011) will begin to establish the Research Infrastructure, and obtain the funding commitments and building of the central facilities will be initiated.
The follow-up Construction phase and Operational Phase spanning 2012-2031, will build the central facilities and the network, and then run it in operational mode, with greenhouse gas fluxes (CO_2, CH_4 and N_2O) determined on a routine basis.

Users of the infrastructure

- Access open to the national and international community: data and free products of access; technical support for the installation of new stations by other operators
- A total annual number of researchers users In France, approximately 200 researchers of LSCE, and other laboratories
- Approximately 25 PhD and postdocs per year

Role in the Infrastructure

- contribution to ecosystem network (INRA and CNRS)
- contribution to atmospheric network (CEA and CNRS)
- Coordination of the project, preparation phase
- *Atmospheric Thematic Center*
- Carbon Portal
- Possible interest for European coordination of established infrastructure

Country name: Germany (DE)

Focal point name: Martin Heimann, Max-Planck-Institut für Biogeochemie, Jena, MPI-BGC

Main scientific organisations

- Max-Planck-Institute for Biogeochemistry : M. Heimann, A. Jordan, W. Bran
- Institute for Umweltphysik, University Heidelberg: I. Levin; Johann Heinrich von Thünen-Institut (vTI), Braunschweig, A. Freibauer

Possible funding organisations

- Ministry Bundesministerium für Bildung und Forschung (BMBF)
- Bundesministerium für Umwelt (BMU) via Umweltbundesamt (UBA)
- Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV) via vTI

Experience:

Scientific institutes in Germany have been internationally active in global and regional carbon cycle research since several decades. The longest European CO_2 record stems from the Schauinsland station operated by the German Umweltbundesamt and evaluated in cooperation with the Institute für Umweltphysik of the University of Heidelberg. The Max-Planck-Institute for Biogeochemistry is the coordinator of the current FP6 integrated project CarboEuropeIP. Several of the longest European flux measurements and best studied sites with regard to carbon and greenhouse gas fluxes are located in Germany.

Timeline foreseen:

A pre-proposal has been submitted to the German Ministry for Science and Education (BMBF) in January 2008. In this pre-proposal funding is sought for the build-up phase of the German contribution to the ICOS infrastructure. This build-up phase is planned for 2011-2014.

For the preparation and operation (not construction) of the ecosystem network, coordination and funding is being negotiated with the von Thünen-Institut (vTI).

Users of the infrastructure

- Carbon and GHG modellers
- Ecosystem and climate research
- Secondary schools (e.g. those now involved in CarboSchools+)
- Environmental monitoring: German weather service – interested in producing CO_2 and GHG products and UBA for fulfilling its monitoring commitments under the UNFCCC

Role in the infrastructure

Operation of:

- 2-4 tall towers (tentative locations: Ochsenkopf, Wendland oder Berlin, Ruhrgebiet)
- Weekly vertical profiles and air sampling by light aircraft at the tall tower sites,
- 4 ground level sites selected from existing UBA network and 1 polluted site (Heidelberg)
- 3-6 ecosystem stations, each covering several areas with varying degree of management, with coverage of all GHGs and desired links to nitrogen and biodiversity

Contribution to central ICOS functions:

- Establishment of ICOS *Central Analytical Laboratory* consisting of
    - Laboratory for calibration standards
    - Laboratory for flask analyses
    - Laboratory for 14C analyses

Country name: Italy (IT)

Focal point name: Riccardo Valentini, UNITUS

Main scientific organisations

- University of Tuscia: ecosystems measurements + database.
- National Council of Research (CNR): ecosystems and atmospheric measurements.
- National Agency for New Technologies (ENEA): atmospheric measurements.
- Euro-Mediterranean Centre for Climate Change (CMCC): ecosystems and atmospheric measurements.

Possible funding organisations

- Ministry of University and Research
- Ministry of Environment
- National Council of Research (CNR)
- National Agency for New Technologies (ENEA)
- Euro-Mediterranean Centre for Climate Change (CMCC)

ICOS is one of the Italian priorities as concerns the infrastructures for environmental researches in Italy. Due to the transitory political situation of Italian government, more operational decision will be taken in the next months

Experience:

Different Universities, research institutions (such as the above mentioned CNR, ENEA and CMCC) and national and regional technical agencies (if possible) will cooperate together, contributing according to their respective capacities and funds availability.

Timeline foreseen:

Italian timeline will follow the project workplan. Italian national contribution, to be consistent, needs general guidelines and information on measurements standardisation.

Users of the infrastructure

- Universities and Research Institutes
- Italian regions
- Ministries
- Public Agencies for environment (APAT, ARPA)
- NGOs
- Small and medium enterprise
- Approximately 10 PhD students per year
- 5-10 publications per year

Role in the Infrastructure

The main role shall be to support, and share with the ICOS infrastructure, the Italian monitoring network. The main interest is to play an active role in the database management.

A detailed national organization structure, with specific role has not been defined up to now. The consortium size will include probably more than 10 Italian institutions (considering universities, research institutes, funding agencies, regional agencies, and Ministries).

Italy has been contributing in the preparation of previous, current and future ESFRI road maps. Currently Italy is preparing a document to define the national road map for Italian research infrastructure, and the relative official contribution to the ESFRI roadmap. This document will contain Italian commitments both at national and European level. When the document will be finalized it will be submitted to ESFRI. The ICOS infrastructure is included in the above mentioned document.

Country name: The Netherlands (NL)

Focal point name: Han Dolman, VUA

Main scientific organisations

- VU University : Prof. A.J. Dolman
- Alterra : Eddy Moors
- ECN : Elex Vermeulen
- SRON : S. Houweling
- RUG-CIO : Harro Meijer
- UU : Dr. Roechmann
- KNMI : F.Bosveld
- WUR : Wouter Peters

Possible funding organisations

- Dutch Organisation for Scientific Research (NWO, dr. F. Martens)

Timeline:

The institutional expertise is available. If nationalfunding is obtained, ICOS NM can be operational in 2010-2012.

Users of the infrastructure

- Scientists at universities, research laboratories,, national platform for emission monitoring, Ministries involved in UNFCCC reporting
- Users from the scientific, public and private sectors
- Total estimate of users 10-15
- 15 PhD over 5 years
- Approximately 50 publications

Role in the infrastructure

Special interest in ICOS is the contribution to the pan European observation network with special emphasis on the regional aspects. The Netherlands has as its ambition to build the densest tall tower network around the world and develop methods for seamless determination of sources and sinks from continental to regional scale. The NL contribution would aim for setting up the Quality Control and Assessment facility of the Flux and ecological sites and observations and contribute with existing and extended lab facilities for isotopic monitoring of atmospheric gasses. For flux sites the emphasis would be on peatland fluxes and new methods for observing methane and N_2O emissions; for atmospheric concentration the NL contribution is unique in proposing observations that allow study of the land sea interface with sites both at the land and in the sea. We will aim to develop an assimilation tool that allows seamless determination of sources and sinks from global and continental to regional scales.

- Flux observations including CH_4, N_2O and development isotope flux measurements
- Regional monitoring activities
- Atmospheric observations from tall towers and platforms
- Supporting atmospheric (boundary layer) observations
- Develop tools for seamless determination of sources and sinks from continental to regional scales

- Run the QA/QC facility for fluxes
- Contribute to isotope (^{14}C, ^{13}C, ^{18}O, D, ^{15}N) and concentration (CO_2, CH_4, N_2O, etc) lab facilities
- Develop and implement an EU wide communication strategy

ICOS-NL and ICOS-EU offer unprecedented opportunities to derive new monitoring mechanisms under UNFCC. Monitoring the key components will enable us to identify and understand surprises and changes in the processes that determine the continental scale carbon and GHG balance

The group of institutions listed has collaborated in the last decade or so intensely within EU and national programmes. In fact the reason that they did this so well, is the main reason that ICOS is no. 1 On the Dutch ESFRI Roadmap.

We currently envisage the foundation of a virtual NL institute for GHG research with minimum coordination and overhead cost, located at one of the participating institutes.

Country name: Norway (NO)

Focal point name: Daniel Rasse, BIOFORSK

Main scientific organisations

- Norwegian Institute for Agricultural and Environmental Research: BIOFORSK: Daniel Rasse
- University of Life Sciences (UMB): Lars Bakken
- Forest and Landscape Institute (SKOG OG LANDSKAP): Holger Lange
- Norwegian Institute for Air Research (NILU): Georg Hansen

Possible funding organisations

- The Research Council of Norway
- Norwegian Pollution Control Authority

ICOS is one of the 11 ESFRI infrastructures that have been selected by the Norwegian research council (out of a total of more than 30). The NORFLUX infrastructure is proposed by a national consortium providing complementary expertise to project, implement and operate a national network of flux measurement stations in high-latitude ecosystems. The NORFLUX network has been officially registered under the National Funding Priorities for the 2008-2012 period. It was designed especially to facilitate entry into the ICOS consortium.

Research Network between Bioforsk, NILU and the Smithsonian Environmental Research Center (SERC, MD USA; Dr Bert Drake as leading scientist for SERC). The network has a budget of 220 000 euros for 2008. In May 2008, our network wil start installing the first CO_2 and CH_4 eddy covariance system in terrestrial Norway. The coastal site of Andøya was chosen to be complementary of more continental sites of Sweden and Finland, and is therefore geared especially towards ICOS participation.

The Research council of Norway has large research programs such as NORKLIMA (Climate change and impacts in Norway) that are dedicated to climate change issues.

The goal of the present project is to develop a national infrastructure for continuous monitoring of GHG emissions in Norway in association with the ICOS Preparatory Phase. We are installing the first CO_2 and CH_4 eddy-covariance system in Norway in May 2008. In addition, the NORFLUX network had requested 2.7 million euros between 2009 and 2011 to build three ecosystem monitoring sites. One of these sites will become an ICOS super site in 2011 – 2012.

Experience:

Technical expertise includes:
- UMB, IPM: strong and diverse environment for environmental sciences, special expertise of relevance: microbial gas metabolism (denitrification, methane oxidation, gas fluxes).
- UMB, INA: strong expertise in remote sensing of ecosystems (LiDAR).
- Bioforsk: climate research in terrestrial ecosystems is a main research priority of Bioforsk; Expertise with eddy covariance data, CO_2-flux modeling. International contacts (ESFRI-ICOS) and cooperation (Smithsonian Environmental Research Center, AMERIFLUX).
- SKOG OG LANDSKAP: expertise in data assimilation and GIS/database tools, data fusion, analysis of remote sensing data
- NILU: atmospheric trace gas monitoring, micrometeorological measurements, inverse and trajectory (forward/backward) modeling

Users of the infrastructure

- Environmental Ministry
- Pollution Authorities

In addition to the aforementioned NORFLUX network (Norwegian Institute for Agricultural and Environmental Research, University of Life Sciences, Forest and Landscape Institute, Norwegian Institute for Air Research):

- UiB: The research group of Prof. Christoph Heinze on earth system models including terrestrial C cycling, is a potential user of the data provided by the flux towers
- UiO: The research group of Dr. Dag Hessen: land-freshwater link
- CICERO: upscaling of GWG fluxes by national inventories

Role in the infrastructure

Norway is interested in developing an ICOS ecosystem super site. Following internal discussions and with ICOS (Philippe Ciais) and potential Sweedish partners (Abisko), we have concluded that the Norwegian super site would be best located on the Atlantic coast. At this point, we are building a first site in the arctic domain of the Atlantic coast (Andøya).

In addition, Norway is heavily involved in marine research. CO_2 eddy covariance equipment is currently deployed on Norwegian research ships. The Norwegian Research Community is therefore highly interested in developing a link between ICOS and the GHG-flux marine research. Venues for the participation of GHG-flux marine research, such as through CARBO-OCEAN, should be researched. A potential contact person for such efforts is Truls Johannessen at the University of Bergen.

Country name: Portugal (PT)

Focal point name: João Santos Pereira, Instituto Superior de Agronomia, Universidade Técnica de Lisboa

Main scientific organizations

- Technical University of Lisbon, through the Instituto Superior de Agronomia: João Santos Pereira, Gabriel Pita
- University of Aveiro, CESAM & Department of Environment: Casimiro Pio
- Estação Florestal Nacional, Departamento de Silvicultura e Produtos Florestais
- New University of Lisbon, Faculdade de Ciências e Tecnologia, DCEA - Departamento de Ciências e Engenharia do Ambiente
- University of Lisboa, Fac. Sciences, Cidade Universitária

The group of Portuguese universities involved in the Carboeurope network, helped to develop the pan-European system of carbon balance observation and gained technical expertise, a good data basis – 4 years worth of data on carbon fluxes between the ecosystem and the atmosphere as well as scientific knowledge necessary to fulfill the needs for the proposed "integrated carbon observation system" (ICOS).

Possible funding organizations:

- FCT-Fundação para a Ciência e Tecnologia

Experience:

The Portuguese territory has a high potential net primary productivity of forests. The economy of the country is largely dependent on forest products namely cork and paper. The Portuguese team intends to install 1 tower and install a new, one over an eucalyptus plantation and one over a cork oak woodland, respectively. Machoqueira is the oak woodland and Espirra the eucalyptus plantation. These are rather contrasting systems, covering ca. 700 000 ha each in Portugal. The eucalypt plantation has one highest NEP of Europe. During the experimental period (2003-2006) the eucalyptus plantation was always the strongest sink for carbon (-861 to -399 g C $m^{-2}year^{-1}$). The cork oak woodland has a savanna-type structure and, together with similar Spanish sites, will be part of a gradient of aridity. In both cases, we intend to collect, store and treat the data – CO_2 and H_2O fluxes; meteorology; soil moisture content of these 2 stations, Machoqueira (Coruche) and Espirra (Pegões). We will continuously evaluate other features of the ecosystems, such as, tree age structure, growth of trees and stands. We have good expertise in studying the ecosystem functioning and feeding the data into models which can calculate the net biome production and the country's carbon balance. We have specialized in the combined analysis of water and carbon fluxes, as water availability is a key regional driver for intra-annual and inter annual variation.

Timeline:

2009-2011: Preparatory phase: station prototypes, collaboration with industrial partners, development of the Portuguese ICOS Consortium, verification and validation of data.

2009-2013: development of the network; Collaboration with the national forest inventory.
From 2014: Operational phase, addition of a new regional station, operational production of carbon flux data.

Users of the infrastructure

- Non Scientific Public sector: personnel of the Ministry for the Environment – "Plano Nacional para as Alterações Climáticas" (National Plan for Climate Change)
- Private sector: The cork industry as well as the other forest based industries need to get certification to maintain their positions in their markets and therefore need to estimate the carbon sequestration levels in stands that follow good-practice rules or are certified for sustainability. Both experimental sites planned for the PC phase are certified forests
- 3 Phd and 3 post docs
- 10 during the preparation and construction phase

Role in the infrastructure

ICOS will be crucial to inform the national GEE inventory and help defining the *Plano Nacional para as Alterações Climáticas*. Furthermore the data on carbon fluxes associated with other environmental observation data is needed as a basis for forest management certification.

Long term operation and continuation of ICOS sites will benefit Portugal namely in terms science, but also in terms of policy (e.g., National Plan for Climate Change) because the consortium will provide data wiwth high temporal discrimination that will allow to independently verify the changes in carbon and water fluxes, as well as, in due time other relevant GEE.

Due to ICOS, the cooperation of the Technical University of Lisbon (Universidade Técnica de Lisboa) with the University of Aveiro, Portugal will be assured. It will involve collaborations with the "Estação Florestal Nacional (Ministry of Agriculture and Fisheries), as well as, with the New University of Lisbon and the University of Lisbon, Fac. Sciences

Country name: SPAIN (ES)

Focal point name: Maria José Sanz Sanchez, CEAM

Main scientific organisations

- CEAM, 4 Eddy Ecosystem sites, Maria J. Sanz, Arnaud Carrara
- Universidad de Granada, 2 Eddy Ecosystem sites, Andrew Kowalsky
- EEZA-CSIC, 1 Eddy Ecosystem site, Ana Rey, Francisco Domingo Poveda
- Climate Research Laboratory. Science Park in Barcelona (LRC-PCB)
- Universitat de les Illes Balears (UIB)
- Centre d'Estudis Avançats de Blanes. Consejo Superior de Investigaciones Científicas (CEAB-CSIC)
- Institut Mediterrani d'Estudis Avançats (IMEDEA)
- Centre de Recerca d'Alta Muntanya (CRAM-UB)

Possible funding organisations

- Ministry of Environment and Rural and Marine development.
- Ministry of Education and Science (Funded projects in course; CARBORED-ES and BALANGEIS, ICARO2, plus the projects to apply for a Unique infrastructure network)
- Regional governments (Generalitat Valenciana, Generalitat de Catalunna y Junta de Andalucia)

CARBORED-ES, has consolidated a National network of continuous measurements of CO_2, H_2O and energy fluxes in different ecosystems in Spain, by "Eddy covariance", applying the standards of the world wide networks and following the Implementation Plans of TACOS and IGCO. As a starting point for the network articulation, the stations identified are those established since 1998 by Fundación CEAM both under European research projects and using Fundación CEAM resources. This basic network of stations has been increased and consolidated by CARBORED-ES, and aims to expand towards a national network.

BALANGEIS: A cluster project with the main goal of improves the knowledge of ecosystems carbon sequestration, CO_2 fluxes dynamics, and other GHG emissions in the Iberian Peninsula. This cluster will produce better estimates of soil carbon stocks and new data of N_2O and CH_4 fluxes measured by eddy covariance method at different time scales in addition of CO_2 fluxes.

– ICP Forests monitors the forest condition in Europe, in cooperation with the EU using two different monitoring intensity levels; Level I is based on around 6000 observation plots on a systematic transnational grid of 16 x 16 km throughout Europe. Level 2 comprises 800 plots in selected forest ecosystems in Europe, 50 in Spain. CEAM Foundation has 2 ICP Forests stations instrumented with Eddy covariance towers (Majadas - Open oak forest & Saler - High machia/Pine forest) on the 50 Spanish parcels, with exhaustive measurements on bulk deposition, phenology, througfall, litterfall, meteorology and passive sampling (O_3, NO_2 and SO_2).

Experience:

Spain has an emerging activity in relation to research and systematic observation of the carbon cycle that recently materialized on a terrestrial observation network of 7 eddy flux stations that cover some of the most important as well as peculiar ecosystems in Spain (including rice crop, dehesa, mountainous semi dry grasslands, several dry scrublands, coastal pine/maquia) that constitutes at present the core of the so called CARBORED-ES network that is financed by the Ministry of Education and Science through a 3 year project, as well as supported by the former Ministry of Environment via an annual arrangement, actual Ministry of Environment and Rural and Marine development. Spain will contribute in the terrestrial side with the CARBORED-ES network. The network will apply for a special status of

unique infrastructure under special grants of the Ministry of Education and Science. ICOS provide the perfect framework for continuing the network with the existing support and even increase the support and involvement of institutions (at present CSIC, University of Granada and CEAM Foundation).

As for the atmospheric component, the existing La Muela Tall Tower is a central site in Southern Europe. It receives different background signals from sources located in the northern Iberian Peninsula and the gulf of Biscaie, in the coast of the western Mediterranean and in the southern and central lands of Spain. Major uncertainties appear to be due to the sparse contribution of the Southern Iberian Peninsula, the diffuse Western Mediterranean oceanic contribution, and from the winds crossing over the Pyrenean range ecosystems. Therefore it is proposed to implement with instruments three new sites (two high towers, Alfabia and Iznajar, and one mountain site, Lac Redon) to obtain reliable data to better understand the South-West influence on Europe's Carbon budgets. Moreover, it is demonstrated by the **ICARO 1** and **ICARO 2** national projects that vertical profiles obtained along a geographic parallel during different synoptic situations provided with enough data helping for a well adjusted modeling, by constraining the transport of greenhouse gases in the atmosphere. We propose to add to the existing 42º parallel sampling program, the 37º one with three locations for aircraft vertical profiling.

Timeline forseseen:

Terrestrial component: Core infrastructure as described exist, and ICOS will provide the opportunity to enlarge the number of stations, in the case of terrestrial component, by involving other institutions within CSIC and University of Toledo for example to cover other ecosystems. At least, 3 more eddy flux locations can be added to the network within the construction phase, and may become fully operative by adding running costs as included in the foreseen cost provided.

Atmospheric component: ICOS will also be a great opportunity for the atmospheric component by introducing new institutions into the joint research (CEAB-CSIC, CRAM, IMEDEA, UIB). ICOS will be essential to spread the influence zone characterization in the atmospheric transport modeling of Carbon species and other GHGs. Three new sites in Spain are proposed to minimize uncertainties in the South-Western Europe Carbon budgets.

Users of the infrastructure

- The department of Forest Protection Service against Pest Protection (*Ministry of Environment and Rural and Marine Development*) uses data from two stations to report to ICP Forest.
- The Catalonian Forestry Technology Center (CTFC, Maria Teresa Sebastià) uses the data of one station to report under one EU Project and as a complementary data to their own research.
- Integrated measurements in relation to the Nitrogen deposition (University of Barcelona, and the former Ministry of Agriculture and TRAGSEGA)
- Data from some stations is used for developing better information for the fomer Ministry of Agriculture in relation to CH_4, NO_2 and NH_3 emissions by coupling a TDL to some stations (rice field location and dehsa grassland)
- Ministry of Environment, Rural and Marine Habitats.
- General Directorate of Natural Environment and Forest Policy & General Directorate of Air Quality
- Regional Ministry of Environment.
- Agriculture Regional Ministry.
- SEAE, Spanish Society of Ecological Agriculture
- 7-10 PhD and 7-10 post-docs
- 3-5 papers/year plus several contributions for different government departments scientific reports.

Role in the infrastructure

Spain will contribute with a Spanish network, representing important ecosystems on the terrestrial component.

Spain showed its interest for promotion on the terrestrial observation of the Carbon Cycles at international level, and in that regard existing eddy flux sites are being included in their effort in research and climate change as part of its last National Communication to the UNFCCC. Recently the Ministry of Enviroment (now Rural & Marine Enviroement) promoted a climate change impacts report and a strategic climate change document to promote mitigation, systematic observations and the existing terrestrial network were seen as necessary for a well informed assessment policy decisions due to observed specificities in relation to impacts of climate change, vulnerability and needs of adaptation and appropriated design of mitigation portafolios.

- Fundación CEAM is partner of the CONSOLIDER-INGENIO 2010 Multidisciplinary Research Consortium on "Gradual and Abrupt Climate Changes and their Impacts on the Environment" (GRACCIE), 2007-2011, with 33 National and European Partners with more than 160 Researchers.
- CARBORED-ES will continue alter the Project that lunched the network will finish, the data base is partially funded by the Ministry of Rural and Marine enviroement, that incluyes collaboration with the Univ of Granada, CSIC and CEAM, and intermitent collaboration with the Univ of Toledo.
- Granada University has just finished a proposal for an "Integrated Action " to cooperate with Dr. Sylvain Delzon in Bordeaux
    - Foreseen orgnizationA National Consortium that could be expanded if more institutions at national level show interest. The initial core group will be: CEAM, Univ. Barcelona (X. Rodo), Univ. Granada, CSIC (short term ambition for the terrestrial component to expand to other groups in CSIC and University of Toledo)
    - Multi-funding structure based in research projects from National Plan Research grants, specific consortiums with different departments of the Ministry of Rural and Marine Environment and Regional Ministries of Environment.
    - Application for ESRI type of special funding for unique infrastructures.

Country name: Sweden (SE)

Focal point name: Anders Lindroth, ULUND

Main scientific organisations

- Lund University: Anders Lindroth and Torben Christensen
- Göteborg Univerity: Leif Klemedtsson
- Swedish University of Agricultural Sciences: Mats Nilsson, Achim Grelle, and Tomas Lundmark
- Abisko Scientific Station: Terry Callaghan
- Stockholm University: Patric Crill
- The National Environmental Protection Board: Mattias Lundblad
- The Swedish Meteorological and Hydrological Institute: Markku Rummukainen
- The Swedish National Forest Survey: Göran Ståhl

Possible funding organisations

- The Swedish Research Council
- FORMAS (the research council for agriculture, forestry, environment and spatial planning)
- The Knut and Alice Wallenberg Foundation
- The Kempe Foundation

The Nordic Centre for Studies of Ecosystem Carbon Exchange and Its Interactions With Climate System, NECC (a so called Center of Excellence funded by the Nordic Council of Ministers and the joint organisation of the national Nordic research councils, NOS-N). This is a collaboration between practically all Nordic groups active in this type of studies. The NECC will come to a formal end by 30 June 2008 but it is anticipated that it will continue as a network (pending application).

A group of researchers at Lund University has applied for a so called Linneaus Grant at the Swedish Research Council to form a LUnd Center on Carbon cycling research, LUCC. Application is pending with decision in June 2008. This type of funding schemes are long-term (10 years) and can therefore become an important collaborator to the ICOS.

The Swedish University of Agricultural Sciences has established a number of ecosystem flux sites as part of their long-term monitoring programme.

Experience:

Forests play an important role in the Swedish Climate policy and it is of immense cultural and economic value to the country. Forestry products will be used more in the future and the intensity in the forestry will probably increase because of these demands. Forests and wetlands are also used for recreation and for conservation of biological resources. Climate change might have a big impact on these ecosystems and it is therefore important to understand how they function with respect to the climate system. It is not possible to cover the variations in species, age, management etc in order to have a representative set of forest flux stations. However, if we coordinate our efforts with Finland, which are in a similar situation we can achieve a more reasonable coverage. We propose here that Sweden will set up two forest ecosystem sites on spruce and one wetland site. We suggest further that one atmospheric observation site shall be established. The Swedish scientists have been involved with flux measurements from the beginning of the 'fluxnet' era and have therefore a very good competence within this field. Within this community we also have the

required competence to run the atmospheric stations. We also refer to the experiences and collaboration that has been built up during the NECC which will continue to be beneficial for ICOS.

Users of the infrastructure

- microbiologists to atmospheric physicists involved in climate change research
- User group to include climate modellers
- Authorities (such as: the Environmental Protection Board in Sweden) responsible for the reporting to the UN concerning the national accounting of greenhouse gases.
- The general public and schools
- 10-20 groups of scientific users
- 2 PhD and 1 post-doc in each scientific group
- 2 publications per year per group

Country name: Switzerland (CH)

Focal point name: Nina Buchmann, ETH Zurich

Main scientific organisations
- ETH Zurich: Prof. Nina Buchmann, Prof. Sonia Seneviratne
- ART: Prof. Jürg Fuhrer; WSL (Dr. Norbert Kräuchi)
- EMPA: Dr. Brigitte Buchmann
- University Bern:(Prof. Markus Leuenberger
- MeteoSwiss: Dr. Mathias Rotach
- University Basel: Dr. Roland Vogt

Possible funding organisations
- SBF, BAFU
- SwissFluxnet, CarboEurope IP, NCCR Climate, GCOS, Long-term Forest Ecosystem Research (LWF), Swiss ambient air pollution network (NABEL), Halcilm (Halogenated greenhouse gases at Jungraijoch), Global Atmosphere Watch (GAW), System for observation of halogenated greenhouse gases in Europe (SOGE), The Swiss Soil Moisture Experiment (SwissSMEX), Modelling and experiments on land-surface interactions with atmospheric chemistry and climate (Maiolica)

Experience:

Several Swiss but also international research groups are working at these sites, addressing ecosystem trace gas fluxes, soil processes, ecosystem health and forest dynamics at the ecosystem site as well as trend analysis including assessment of reduction measures, early warning of new compounds, atmospheric chemistry, long-range transport and emission estimates at the atmospheric site.
Profound technical expertises exist in the fields of trace gas concentration and flux measurements at both ecosystem and atmospheric sites, including state-of-the-art technologies such as stable isotope analyses (IRMS; fast, continuous laser-based systems).

Two primary stations will be proposed: Davos as an ecosystem site in a subalpine forest and Jungfraujoch as a high elevation atmospheric site. Both primary sites are well established (Davos: since 1985 air chemistry/tree physiology [NFP14+] and since 1997 as flux-site; Jungfraujoch: since 1972, ICOS related compounds 1996) and have already excellent infrastructure installed. We anticipate that both sites are maintained within ICOS. Secondary/Associated sites without a long-term commitment are available as well, either within the SwissFluxnet (grassland, arable land, forest ecosystem sites) or within GCOS.

Timeline foreseen:

2008-2011: Involvement and funding commitments of stake-holders and further national groups organized by the national focal point. Final decision on primary and secondary/ associated sites.
2012-2015: Involvement and funding commitments of stake-holders and further national groups organized by the national focal point. Additional installation with required equipment according to ICOS recommendations. Extensive testing of innovative laser-based applications to measure isotopic signatures in trace gases at remote places with high precision and time-resolution.Comparison of high precision oxygen measurements using different online techniques. 2016-2031: Maintenance of primary sites as well as secondary/associated sites. Regular updates on equipment. Continuous improvement of measurements.

Users of the infrastructure

- Researchers from universities, research institutions, weather service, national and cantonal administration/offices.
- Research, Federal administration, insurance companies, small enterprises for environmental consulting, NGOs, policy advice committees
- Approximately 80-100 users in total in Switzerland
- 5-10 phD and postdocs at a time
- Approximately10 -20 publications per year in this field

Role in the infrastructure

Common research interest in quantification of trace gas fluxes/budgets and emissions to comply with international conventions, understand consequences of climate change, investigate the role of land-climate and land-use interactions, leading role in advancement of science, information to support sustainable resource use in Switzerland, data for validation of terrestrial greenhouse gas budgets for sites of specific national interest (subalpine forest, high altitude observations), estimate national and European emissions

Long term continuation and operation of Swiss ICOS sites will benefit Switzerland (science and policy) because it provides detailed spatial and temporal knowledge about atmospheric trace gases, it allows to independently verify the changes of fluxes, trends and emissions of relevant atmospheric compounds to assess their reduction efforts as well as to understand changes of these constituents in general.

Expansion of on-going collaborative efforts in global change research, capacity building for students and extension services, knowledge transfer from science to public and private sectors (e.g., administration, insurances, etc.), and to foster interdisciplinary approaches.

Focal point organized by a small board covering both ecosystem and atmospheric research (n = 2 to 4), probably about 20-30 scientists contributing to national consortium, regular briefings of funding agencies, further funding requirements by additional grants, regular national meetings, participation international meetings, more upon demand.

Country name: United Kingdom (UK)

Focal point name: John Grace, UEDIN

Main scientific organisations

- University of Edinburgh: John Moncrieff and John Grace
- University of East Anglia: Andrew Manning
- Royal Holloway College: Euan Nisbet
- Centre for Ecology and Hydrology: D Fowler
- University of Bristol: Colin Prentice
- Met Office: Alistair Manning
- Forest Research: Sirwan Yamulki; Northern Research Station: Mike Perks

Possible funding organisations

- Natural Environmental Research Council (NERC)
- Department of Environment and Rural Affairs (DEFRA)
- Forestry Commission
- Rural & Environment Research and Analysis Directorate, Scotland

It is expected to include four atmospheric stations on UK mainland: Scotland, Eastern England, London, Yorkshire. One of these is already established in Carboeurope-IP, two of the others are operational. It is also expected to include four ecosystem flux stations on UK mainland. Due to the large northern-UK carbon stock there is also a need for a peatland site, but it is not yet identified.

Additionally the University of Edinburgh has a small research aircraft currently operated for concentration and flux measurements at ecosystem and landscape scale; and NERC operates a much larger aircraft which can be used for national concentration measurements.

Experience:

The technical expertise in UK for flux and atmospheric measurement is at Edinburgh, Penicuik, East Anglia, London; technical expertise for atmospheric modelling is at Leeds, Met Office and Edinburgh; technical expertise for land-surface ecosystem fluxes is Edinburgh, Penicuik, Durham, Lancaster and Sheffield; technical expertise for data assimilation modelling is Bristol, Edinburgh.

Timeline foreseen:

ICOS is being placed on the UK Research Councils Infrastructure Roadmap when final version is published in July 2008 (it was initially left off). Negotiations for funding are likely to take two years. Once funding is available, expertise build-up would be one year as there is an energetic group of researchers. New sites usually take two years to establish because of planning permissions etc.

Users of the infrastructure

- DEFRA is the government agency that reports UK greenhouse gas emissions based on inventory analysis- the unit is headed by Jim Penman; the Chief Scientific Advisor of DEFRA is Bob Watson. The Rural &

Environment Research and Analysis Directorate in Scotland oversees environmental affairs in Scotland; the Environment Agency Wales probably may also have an interest.

There is a large academic community interesting in all aspects of climate change, for research and teaching purposes (assume 2000 academics plus their research students) with several centres such as the National Centre for Earth Observation (NCEO) and the Tyndall Centre based at the University of East Anglia. There are pressure groups and newspaper correspondents: not sure how many but estimate 1000 individuals- these people would be interested in 'surprises' like an unusual rise in a GHG in one year versus the rest. There are many carbon management companies that have sprung up in the last ten years, interested in carbon trading opportunities.

- Field and community of users:
    - Scientific community between 1000-3000
    - Non-scientific public sector between 100-300
    - Private sector between 100-300

- Total number of users: Between 1200 and 4000
- 50-200 PhD Thesis & post-docs expected to be using the infrastructure network, data or facilities
- 500 publications over the next 5 years Number of foreseen scientific publications

Role in the infrastructure

The UK Government has accepted the Royal Commission on Environmental Pollution's longer term recommendation that the UK must put itself on a path towards a reduction in emissions of some 60% from current levels by 2050 in order to mitigate the effects of Climate Change. It is accepted now that this will require some further nuclear power stations to be built, and heavier penalties for driving high emission motor vehicles.

The national inventory, drawn up by DEFRA, is the estimate used by government, and is 'state-of-the-art' being based on inventory and models. ICOS is seen as 'validation'.

In regards to a national organisational structure, several possible models could be envisioned, based upon existing patterns. Probably the most likely is a distributed 'Centre' which has a Director, tight reporting guidelines, annual reports, funding in five-year instalments. The scientists are distributed between a number of institutions. An alternative model would be something like the Met Office, a government agency with a specific mission, all on one site, closely linked to national needs but with an element of research subcontracted to universities and other institutions.

ICOS will be on the UK's revised roadmap from July 2008. In environmental sciences, the agency with the responsibility of contributing to *ESFRI* discussions is NERC

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www.icos-infrastructure.eu

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