



# IMECC: Infrastructure for the Measurement of the European Carbon Cycle

**How do you measure the biosphere? How do carbon and water cycles interact? What role does Europe play in the global carbon cycle which lies at the heart of Earth's metabolic processes? Measurements over time and space of greenhouse gases like carbon dioxide are essential to our understanding of the carbon cycle and the way it is changing and imperative for forecasting future CO<sub>2</sub> levels and climate change. Atmospheric scientists need to quantify Europe's terrestrial carbon balance and the magnitude of carbon sources and sinks to help policy-makers keep in line with greenhouse gas emission reduction targets. Measuring CO<sub>2</sub> emissions is one thing, but making sure samples taken either on the spot or by remote sensing are uniformly calibrated and easily comparable is quite another. IMECC, an EU-funded project to build up Infrastructure for the Measurement of the European Carbon Cycle needed by atmospheric researchers to improve precision and uniformity, aims to build an integrated and accessible carbon data assimilation system to gain a better insight into the European terrestrial biosphere.**

## ● STRIKING THE RIGHT BALANCE

Concentrations of carbon dioxide in the atmosphere are higher than ever before and still rising. The primary causes are fossil fuel combustion and deforestation. Globally, the land biosphere absorbs 30% of fossil fuel emissions and so it is effectively slowing down the speed of anthropogenic climate change. Yet our understanding of this carbon sink, its spread between Europe, North America and Asia, its controlling mechanisms and its vulnerability to changes in climate and land management is still uncertain. Climate models suggest that carbon release from existing carbon pools in the biosphere could soon be big enough to offset any attempts at technical CO<sub>2</sub> emission reduction.

Meeting the scientific challenge of establishing with acceptable accuracy the full carbon budget of a continent has high political relevance because the Kyoto Protocol objectives take account of carbon stocks and fluxes in the terrestrial biosphere. Stock changes can be measured by soil and biomass inventories, vegetation properties or changes in atmospheric CO<sub>2</sub> concentrations. This is where the IMECC network of air quality research laboratories and institutes can help improve coordination of the European atmospheric observing system so it is better able to monitor the carbon balance of the whole continent and attribute it to the underlying processes of fossil fuel emissions and ecosystem carbon sequestration or losses.

## ● THE IMPORTANCE OF BEING ACCURATE

An accurate carbon accounting system for the second Kyoto commitment period post-2012 is no mean feat. Atmospheric scientists have long been trying to improve the accuracy rate of measurements. An earlier EU-funded project, CarboEurope-IP, claimed that using a multiple constraint approach could reduce the uncertainty in estimates of the European carbon balance to 10-20%. Currently, the critical measurements are spatially dispersed but their interpretation relies on precise knowledge of the spatial and temporal structures of measured quantities. So measurements must be of the highest quality and precisely calibrated in order to be useful.

all by improving the comparability of atmospheric and ecosystem measurements of greenhouse gases and isotopic composition so that measurements made by diverse and widespread research programmes can be reliably combined. It will provide a web-based tool to calculate the impact of proposed measurements on knowledge of the European carbon cycle and develop a transfer standard between the high-precision surface network and spatially-dense satellite measurements using ground-based remote sensing. This will help tie European terrestrial data into emerging remotely-sensed datasets on atmospheric composition and vastly expand the volume of data available for determining the carbon balance in Europe. The quality of the transfer standard will be tested with routine aircraft profiling.

The IMECC project aims to build the infrastructure for a coordinated, calibrated, integrated and accessible dataset first of

## ● CUTTING THE TIME LAG

A lot of work is being done to set up an integrated system for global carbon observations, like the IGCO coordinated system launched in 2003 to develop a flexible strategy combining both remote and in-situ terrestrial, oceanic and atmospheric observations. In-situ tower flux and other ecological measurements are unique in providing the necessary validation and algorithmic improvements for testing remote sensing models and providing continuous data streams to carbon data assimilation schemes. Europe currently has a network of 52 flux tower sites spanning a range of ecosystems and climates which collect data on carbon, water and energy fluxes every 30 minutes round the clock, providing constant monitoring of biospheric exchanges of CO<sub>2</sub> and energy from daily to seasonal and inter-annual time-scales. The problem is that these data are stored locally at the site and not sent into a central database for 6 months. But there is a growing need for on-line data for modelling and for speedy access to in-situ CO<sub>2</sub> concentration data, especially on the part of weather forecasting centres.

One of IMECC's Joint Research Activities (JRAs) seeks to provide continuous real-time data on carbon, water and energy exchanges in terrestrial ecosystems across Europe through advanced analogue and digital networking connections, feeding into a real-time database accessible to the wider science community.

Another JRA is establishing current and required capabilities for near real-time transmission and processing of atmospheric CO<sub>2</sub>

data, while a third concentrates on calibration of remotely-sensed CO<sub>2</sub> with the help of a new FTIR spectrometer at Orléans.

Networking is an important aspect of IMECC's work and there are a number of Networking Activities. One of them is to build a software system capable of computing the impact of a wide range of carbon cycle measurements on specific estimates. Interoperability of atmospheric composition measurement laboratories (known as GASLABS) and CO<sub>2</sub> monitoring stations will be improved through quality control and a new primary standard for the isotopic composition of CO<sub>2</sub> in air. It is hoped that this will lead to routine reporting of relative calibrations of key greenhouse gases among European laboratories and gradual convergence of measurement scales.

Another long-term objective is to set up a Terrestrial Carbon Data Centre (TCDC) in Europe open to the external community and public and private stakeholders in order to improve access to existing and future atmospheric and ecosystem data for research projects.

As improved measurements become increasingly compatible with the range of global measurements, IMECC's network will reach out to laboratories across Europe and beyond, and even to international organisations like the World Meteorological Organisation and the International Atomic Energy Agency.

## ● INFRASTRUCTURE FOR THE MEASUREMENT OF THE EUROPEAN CARBON CYCLE IN SUMMARY

**Project acronym:** IMECC

**Funding scheme (FP6):** Integrated Infrastructure Initiative (I3)

**EU financial contribution:** €6.7 million

**EU project officer:** Anna-Maria Johansson

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**Completion date:** 31 March 2011

**Project website:** <http://imecc.ipsl.jussieu.fr>

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