



# The carbon exchange

ADC BioScientific's newsletter for Geoscience researchers

Issue 05

## The global carbon cycle

Carbon is the fourth most abundant element in the universe and is the central building block of life.

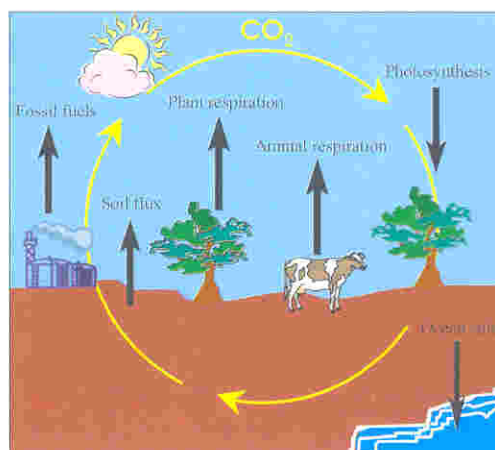
On Earth, carbon cycles through the atmosphere, biosphere and geosphere interconnected by pathways of exchange that undergo various chemical, physical, geophysical and biological processes. These exchanges are very complex and each process change has an impact on other processes within the cycle and on the total carbon balance.

It is widely accepted that man-made activity, by burning fossil fuels, accounts for about 50% of the total  $\text{CO}_2$  released into the atmosphere by carbon sources. Natural biomass respiration and decay release the remainder. Natural carbon sinks such as plant photosynthesis and ocean biota take up most of this released  $\text{CO}_2$ .

However, rapidly rising atmospheric carbon dioxide concentrations and its potential impact on future climate is an issue of global, economic and political significance.

Much emphasis, therefore, is being placed on carbon dioxide exchange research both in specific areas of the carbon cycle and the global carbon budget as a whole. Due to the complexities of these flux exchanges, the research draws on expertise from a number of geoscience disciplines. Some of these areas include:

- Investigating the impact of deforestation, alternative land use and fossil fuel burning on climatic and environmental change.
- Understanding the complexities of the exchange pathways.
- Assessing ecosystem carbon budgets.
- Characterisation and quantification of carbon sinks and sources.



The  $\text{CO}_2$  cycle

## ADC BioScientific: innovation and quality

ADC BioScientific is one of the world's leading developers of high quality, field portable and easy to use gas exchange instrumentation for a variety of geoscience research disciplines. Few manufacturers can claim similar experience, expertise and continued innovation.

Today, in hundreds of research institutes throughout the world, ADC gas exchange equipment is playing a vital role in improving our understanding of the carbon cycle and its impact on life on earth.

ADC BioScientific is committed to quality: quality of product and quality of service. Our global network of over 30 customer support centres provides you with the highest possible level of local support.

## Leaders in geoscience research instrumentation

Our extensive range includes research instrumentation for simple or sophisticated  $\text{CO}_2$  exchange experimentation throughout the carbon cycle.

Whether your interest is in **atmospheric  $\text{CO}_2$ , plant gas exchange, soil flux or total carbon balance**, we have a range of field instrumentation designed to assist you in your geoscience research programs:

### Page 2 Atmospheric $\text{CO}_2$

- Successful Fluxnet evaluation for the OP-2.
- China purchases new  $\text{CO}_2$  profiling system
- OPEC: a fully integrated open path eddy covariance system employing proven components



### Page 3 Plant Gas Exchange

- LCpro+ used in rainforest isoprene emission investigation
- Unique range of photosynthesis leaf chamber heads



### Page 4 Soil Flux

- SRS1000 excels at ESF soil carbon flux workshop
- New SRS2000
- Selected interesting links





# Atmospheric CO<sub>2</sub>

## Successful Fluxnet <sup>new</sup> evaluation for the OP-2

The ADC OP-2, open path CO<sub>2</sub> / H<sub>2</sub>O analyser, has recently successfully completed a two month long practical and technical field evaluation for Fluxnet, the global eddy covariance network.

The evaluation was carried out at the Weidenbrunnen De-Wei, Fichtelgebirge mountains site in Germany, by Christoph Thomas and Thomas Foken from Universitaet Bayreuth. Measurements were carried out from a 33m meteorological tower, 14m above a spruce forest canopy. The OP-2 was combined with an R3-50 Gill Instruments' sonic anemometer and compared to existing open path technology. 30-minute mean CO<sub>2</sub> and H<sub>2</sub>O measurements, excluding rain and fog events, were evaluated along with the resulting flux data.

The group found there to be a close relationship in the shape of the CO<sub>2</sub> and H<sub>2</sub>O patterns over the two month period, between the OP-2 and existing open path technology. The OP-2 was also seen to match the shape of absolute humidity, as measured by a reference psychrometer.

Following ADC's incorporation of an improved calibration procedure that was proposed by the Bayreuth group in earlier studies, the OP-2 flux measurements were deemed reliable with good correlation between the open path systems with relatively small scattering of the data.

In addition, the results also showed that the OP-2 performed well at low fluxes, with evidence to support the specified higher CO<sub>2</sub> resolution (0.02ppm), due to the longer folded path length (80cms) of the analyser.

The group concluded that the OP-2 showed an acceptable overall performance for flux measurements and they would plan to incorporate the OP-2 into their future eddy covariance experimental programs.

*Extracted from "The OP-2 open path infrared gas analyser for CO<sub>2</sub> and H<sub>2</sub>O" report, G. Herold, C. Thomas, T. Foken, Jan 2005.*



## China purchases new CO<sub>2</sub> profiling system

The Chinese Forestry and Ecology Research Network has just purchased a new CPS-12, CO<sub>2</sub> profiling system.

The system that comprises an ADC2250 high performance CO<sub>2</sub> IRGA and a 12-channel multiplexer is used to conduct CO<sub>2</sub> measurements vertically throughout the entire height of an eddy flux tower in a forest environment. CO<sub>2</sub> can be resolved down to 0.1ppm.

The multiplexer allows up to 12 samples to be measured sequentially at different heights with, typically, more samples being measured closer to the forest floor than at the top of the canopy.

The system operates on a continuous basis with all sample points being measured and the data recorded within a 10 minute cycle time.

The data is subsequently processed to provide CO<sub>2</sub> flux information and this forms part of the equation needed to calculate total carbon storage.



## OPEC: a fully integrated open path eddy covariance system employing proven components

The three central components of the ADC OPEC system are all already proven within ecophysiological research applications.

### OP-2 Open Path Analyser:

ADC's high resolution, open path CO<sub>2</sub>/H<sub>2</sub>O analyser.

### R3-50 Sonic Anemometer:

Gill Instruments' highly respected 50Hz research sonic anemometer.

### EDDYSOFT Data Acquisition

**and Post-Processing Software:** For detailed eddy covariance experimentation developed by the Max Planck Institute in Germany.



*OPEC system installed at Rothamsted Research in UK*



# Plant gas exchange

## LCpro+ used in rainforest volatile isoprene emission investigation

Isoprene and monoterpenes (volatile isoprenoids) are trace gases which are emitted from the foliage of many species of vegetation. They are related by their biochemical structure which is built on a 5-carbon isoprenoid skeleton.

These gases have the potential to benefit a plant in a number of ways, e.g. 1) protect against damage caused by high temperature or high oxidant concentrations; 2) protect against pathogens and herbivores; 3) attract pollinators or herbivore predators; 4) communication with other plants / organisms.

Natural isoprenoid gases are harmless in the atmosphere, until they meet with man-made nitrogen oxide pollutants (NOx) from combustion processes. In the right weather conditions (sunny, high temperatures), chemical reactions can occur between isoprenoid gases and NOx that lead to the formation of ozone and particulates.



In an international collaborative effort, Dr. Sue Owen, from the University Autònoma in Barcelona (previously at Lancaster University, UK), is using a specially modified LCpro+ and GC-MS to measure photosynthesis and isoprene emissions simultaneously from vegetation in rainforests in Borneo and in tropical China. Around 100 important forest species were screened for emissions from which canopy-scale fluxes were estimated. These estimates were then used in an atmospheric chemical model to assess the impact of land use change. The results indicate that a very high isoprene-emitting oil palm has the potential to worsen air quality in the SE Asian tropics.

Dr. Owen commented that she had found the LCpro+ to be "a robust instrument and easy to use in demanding tropical conditions".

For more information on these isoprene studies contact:  
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## Unique range of photosynthesis leaf chamber heads

The LCi and the LCpro+ are plant gas exchange systems that offer unparalleled field portability to plant science researchers. The LCi is in fact the most portable and easy to use photosynthesis system, whilst the more sophisticated LCpro+ provides full environmental control and a graphic display.

There is now a range of seven leaf chamber heads available for both the ADC LCi and LCpro+ systems.

The most recent addition to this range is the Small leaf chamber head that is suitable for use on a variety of small leaves. Like the Arabidopsis head, the low profile, Small leaf chamber head features the UNIQUE ADC "position and lock" mechanism that allows you to measure a small leaf, even when it is close to the soil surface, without damaging the sample leaf or others in its proximity.

The LCpro+ range of chamber heads also includes the Conifer leaf chamber with its UNIQUE design of LED light source. Automated light response curves are now possible on conifer leaves and pine needles.



**The complete range is:**  
Broad  
Narrow  
Conifer  
Fluorometer adapter  
Soil respiration  
Arabidopsis  
Small



All chambers are easily field interchangeable, using only a small coin.

In addition to gas exchange systems, ADC BioScientific's range of high quality, portable plant science instrumentation also includes leaf area meters and chlorophyll fluorescence devices.

**Go to [www.adc.co.uk](http://www.adc.co.uk) for more information.**



# Soil flux

## SRS1000 excels at ESF soil carbon flux workshop

In September 2004, the European Science Foundation (ESF) organised a workshop as part of their program to improve the understanding of the dynamics of the soil carbon balance. The workshop, Integrated Methodology of Soil Carbon Flux Measurements, was held at the Centro di Ecologia Alpina at Monte Bondone, near Trento, Italy.

Over 100 researchers attended the workshop that tested and compared currently available techniques in forest and grassland ecosystems. ADC supported the event, making available an SRS1000, ultra compact soil respiration system for the field experiments. The SRS1000 is specifically designed for short-term field measurements.

The SRS1000 won praise from the participants in a number of areas:

**Measurement stability:** There was very little fluctuation or noise in the CO<sub>2</sub> data during diurnal measurements.

**No pressure gradients:** The SRS1000 chamber was found to have "just about immeasurable pressure gradients." This is vital in avoiding CO<sub>2</sub> exchange errors caused by pressure gradients inside the soil chamber.

**Insensitive to wind:** There was no change in results when air was forced over the soil chamber at varying speeds and in different directions.

**Collar design:** Minimal disturbance of soil during placement

**Good correlation:** With other techniques

**Time resolution:** Was fast due to the CO<sub>2</sub> IRGA being directly adjacent to the soil chamber.

**Portability:** Weighing only 2 Kg

**Easy to use:** Intuitive user interface

**Versatility:** Could be easily and quickly converted for plant gas exchange experimentation.



*SRS1000 working on grasslands ecosystem*

### Selected interesting links

For more information on the many issues relating to carbon cycle research:

American Geosciences Union:  
[www.agu.org](http://www.agu.org)

Ameriflux:  
<http://public.ornl.gov/ameriflux>

AsiaFlux:  
[www.cger2.nies.go.jp/asiaflux/](http://www.cger2.nies.go.jp/asiaflux/)

CarboEurope:  
[www.carboeurope.org](http://www.carboeurope.org)

Carbon Dioxide Information Analysis Centre:  
<http://cdiac.esd.ornl.gov>

ChinaFlux: [www.chinaflux.org](http://www.chinaflux.org)

European Geosciences Union:  
[www.copernicus.org/EGU/EGU](http://www.copernicus.org/EGU/EGU)

European Science Foundation:  
[www.esf.org](http://www.esf.org)

Fluxnet:  
[www.fluxnet.ornl.gov/fluxnet](http://www.fluxnet.ornl.gov/fluxnet)

Global Carbon Project:  
[www.globalcarbonproject.org](http://www.globalcarbonproject.org)

International Geosphere-Biosphere Programme:  
[www.igbp.net](http://www.igbp.net)

### new

## SRS2000 intelligent portable soil respiration system

The SRS2000 is a new addition to the ADC range of portable soil respiration systems. It features all of the benefits of the SRS1000 Ultra Compact System with additional facilities for more sophisticated soil flux experimentation.

This includes the same highly accurate and stable fast response CO<sub>2</sub> IRGA and the same soil chamber, proven to have no pressure gradients and not affected by external wind currents.

For enhanced experiments, both CO<sub>2</sub> and H<sub>2</sub>O can be automatically controlled within the SRS2000 soil chamber, allowing soil flux to be determined at different CO<sub>2</sub> concentrations and to help prevent condensation.

A graphic display allows the easy monitoring of soil flux trends and the real time plotting of experimental curves.



- Truly portable
- Highly accurate CO<sub>2</sub> IRGA
- Optimised soil chamber
  - No pressure gradients
  - Insensitive to wind currents
- Automatic control of CO<sub>2</sub> / H<sub>2</sub>O
- Graphic display



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