ACE Automated Soil CO_2 Exchange System

Soil flux: an important component of total carbon budget

Rapidly rising atmospheric CO_2 concentration and its potential impact on future climatic conditions is an issue of global economic and political significance.

Soil respiration can be defined as the net CO_2 production of a soil. The amount of gas exchange taking place is frequently used as an indicator of microbial soil activity and so is used to characterise the “health” of that soil. The rate of soil flux is influenced by a variety of environmental parameters especially organic matter content, soil moisture and soil temperature.

Natural biomass respiration from soil is a major carbon source. Understanding soil flux and its relationship with other sources and sinks within the carbon cycle are currently subject to increasing scientific scrutiny in relation to global climatic change.

The ADC BioScientific ACE system (Automated Soil CO_2 Exchange System) is designed for the long-term, unattended monitoring of soil flux. The system is both easy to set up and robust for field conditions.

- ***Automated operation***

ACE automatically exposes soil area between measurements

- ***CO_2 analyser in chamber***

Highly accurate CO_2 IRGA housed directly next to soil analysis area

- ***Compact complete system***

Fully integrated, independently operational Station

- ***Network***

Up to 32 ACE Stations may be controlled in an ACE experimental network

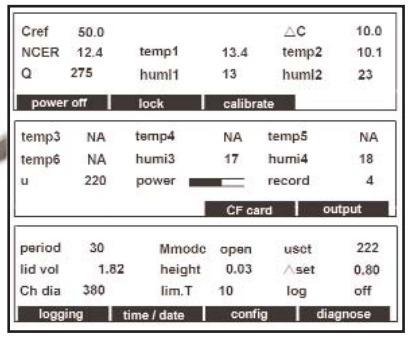
ACE Station

Integral CO_2 analyser inside soil chamber

Each ACE Station features a highly accurate CO_2 infrared gas analyser housed directly inside the soil chamber assembly. There are therefore no long gas tubing connections between the soil chamber and a separate analyser.

The close proximity of the analyser ensures the fastest possible response times to CO_2 changes and also avoids any potential gas “hang ups” in long lengths of tubing. Experimental set up is much simpler and the system is much more field robust.

The open chamber is designed with a pressure release valve and fan to minimise any internal pressure gradients.



Long-term unattended operation

The automated design of the ACE Station allows the soil area being analysed to be exposed to ambient conditions between measurement cycles.

At user-set time intervals, the chamber will automatically cover the soil to carry out soil flux measurements. Once these measurements are completed, the chamber will automatically re-expose the soil area.

The novel “swinging arm” mechanism is designed to be reliable and field rugged and to ensure a good seal when the chamber is covering the soil.

When the chamber is in the exposed position, the Station will powerdown to an idle or low power mode.

Complete system

Each ACE Station is a complete, fully integrated soil flux system comprising the anodised aluminum soil chamber, heat reduction parasol and arm that pivots from the control console, where measurements are both displayed and recorded.

Each ACE Station can operate fully independently for single point measurements.

The power efficient ACE Station can be powered by battery, solar panel or wind turbine. Typically a 40Ah car battery will run an ACE Station continuously for around 28 days.

Easy to set up and program

The ACE Station is easy to set up and program.

As the system is fully integrated, there is no gas tubing or complex gas circuits to set up and connect between an analyser and a separate soil chamber.

The control console features a large display screen. Full programming is achieved using just 5 keys that drive a series of easy to use menus.

Gas exchange data, soil flux calculations and other sensor measurements are all displayed and recorded by the ACE Station. Data storage is on easily exchangeable CompactFlash cards.

Open and Closed system modes

ACE Stations are available in either a closed system or an open system configuration.

In both measurement modes with the chamber in the covered position, a delta CO_2 is determined from the difference between the reference gas entering the chamber and the analysis gas within the chamber at the end of the experiment.

Closed Mode: A measurement is made once the chamber is sealed. CO_2 inside the large 2.6L chamber will then increase due to soil activity. The rate of soil flux is determined from the increase in CO_2 concentration after a user-defined time interval. These measurements are simple and fast.

Open Mode: When the chamber seals, ambient air is passed through the smaller 1.0L chamber at a controlled flow rate. Soil flux or rate of change is then determined at equilibrated conditions within the chamber. These measurements, although slower, are regarded as more accurate by many researchers as they are less influenced by changes within the enclosed chamber or variations in the soil structure.

An open system ACE Station may also be used in a closed mode by the user exchanging the open chamber head for a closed system head.

Transparent versions of both the open and closed chambers are available for measuring net CO_2 exchange within the chamber area. It is recommended that, in applications of high photosynthetic activity, open mode transparent chambers are used.

Zero / Ambient option

For more accurate NCER data, each Station can be fitted with a Zero / Ambient CO_2 concentration re-calculation.

Flux, moisture and temperature data

Soil flux is expressed as Net CO_2 exchange rate (NCER) in $\mu mol\ m^{-2}\ sec^{-1}$.

In addition to the CO_2 exchange data, a PAR sensor is provided, mounted on the ACE Station chamber.

Up to 6 soil temperature sensors and up to 4 soil moisture sensors may also be directly connected to each ACE Station. These measurements may then be displayed and recorded alongside the gas exchange and soil flux data.

The user may configure the system for use with many commercially available soil moisture probes.

ACE Network

Although an ACE Station can function fully independently for single point measurements, it is typical that a number of Stations will be used in combination, as a network, at an experimental field site.

Up to 32 ACE Stations can be connected together in an ACE Network via an ACE Master control unit. This Master control unit will supply power to and collect data from all Stations and control all Stations within the experiment.

Connections between the ACE Master control unit and each ACE Station is by electrical cable only. As each ACE Station is a fully integrated system with an integral CO_2 IRGA, no long lengths of gas tubing are needed to be run over the field site. As a result, each ACE Station can be in excess of 100 meters from the Master control unit.

The ACE network is very power efficient as no large pumps are required to transport gas from the chamber to an analyser several meters away.

Individual ACE Stations can be taken out of the ACE network without the need to stop the whole experiment.

- Up to 32 ACE Station experiment
- 200m diameter experimental area
- Easy to set up and program
- No connecting gas tubing
- Power efficient

ACE Master control unit

The ACE Master control unit is a small, waterproof, steel enclosure that features a graphic display, CompactFlash card drive, 32 ACE Station docking ports and 2 battery ports.

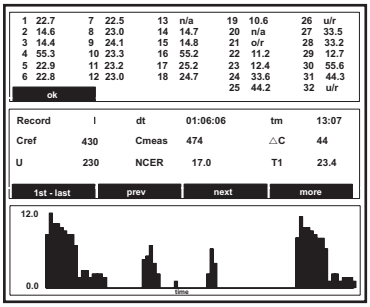
Full programming and control is achieved using just 5 keys that drive a series of easy to use menus.

The ACE Master control unit monitors all Stations within the experimental network and flags any problems encountered.

The Master control unit graphic display may be used to review and plot experiments in the field. The researcher may review:

- One Station, all parameters, one time point
- One parameter, one time point, all Stations
- One Station, one parameter, all time points

Power is via 12V or 24V batteries or a suitable alternative supply.



ADC BioScientific Ltd

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 applications.

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

ACE Station Provisional Specification

Measurement of CO_2:	Standard range: 40.0mmols m^{-3} (0-896ppm at standard temperature and pressure), 0.05mmols m^{-3} (1ppm resolution). Infrared gas analyser housed directly adjacent to soil chamber. Differential open or closed system.
Measurement of PAR:	0 - 3000µmols m^{-2} sec^{-1} Silicon photocell.
Measurement of soil temperature:	6 selectable inputs for thermistor or thermocouples.
Measurement of soil moisture:	4 selectable inputs for commercially available sensors.
Flow control to chamber:	100-500ml min^{-1}
Flow control accuracy:	+/- 2% of f.s.d.
Display:	240 x 64 dot matrix LCD.
Programming:	Each chamber has a user-friendly interface driven by only 5 keys.
Recorded data:	Removable CompactFlash cards.
Internal battery:	12V standby 1.0Ah battery back up. (Networked Station only)
Power supply:	External source battery, solar panel or wind turbine. One 40Ah car battery provides power for approximately 28 days of continuous use.
RS232 output:	User selectable rates of up to 19200 baud.
Electrical connections:	Robust, waterproof 3 pin din.
Dimensions:	82 x 33 x 13 cm
Closed chamber volume:	2.6L
Open chamber volume:	1.0L
Soil collar diameter:	23cm
Weight:	9.0 kg

ACE Master Control Unit

Construction:	Steel electrically sealed enclosure.
Connections:	32 ACE Station docking ports and 2 battery ports.
Dimensions:	30 x 30 x 15 cm
Weight:	7.0 kg

1st Floor, Charles House
Furlong Way
Great Amwell
Herts, SG12 9TA
UK
Tel: +44 (0)1920 487901
Fax: +44 (0)1920 466289
sales@adc.co.uk
www.adc.co.uk