

LI-8100A Automated Soil CO₂ Flux System

Survey, Long-Term, and Multiplexed Measurements

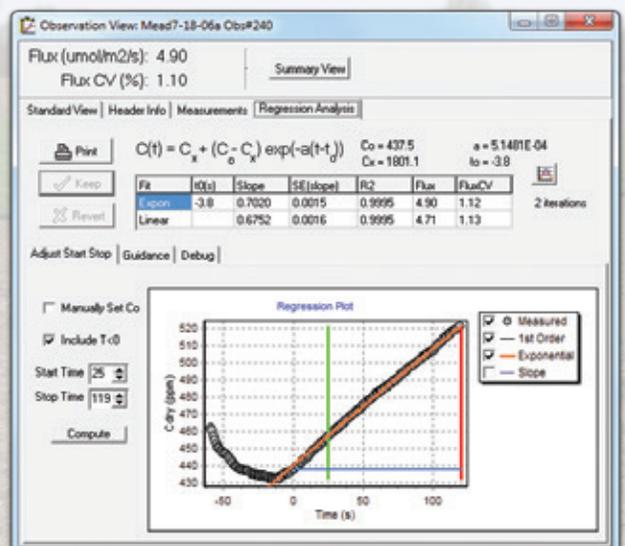


LI-COR[®]

System Features

Integrated, simple to use, and modular by design, the LI-8100A Automated Soil CO₂ Flux System allows researchers to design a setup from a variety of components, customized for their application and research needs. The new LI-8100A builds upon the proven LI-8100 with features that include:

- **Extended CO₂ measurement range** of up to 20,000 ppm, allowing you to make soil CO₂ flux measurements in high CO₂ environments.
- **Ethernet connectivity** with standard TCP/IP networking protocols facilitates two-way communication with networked computers at any remote location. Setup, data collection, and diagnostics can be performed remotely by simply logging on to any LI-8100A connected to your local network.
- **The new LI-8100APP** for iOS allows for wireless remote control of the LI-8100A for long-term or survey measurements. You can perform any action from your iPhone®, iPad® or iPod® Touch that is available from the LI-8100A Windows® Application Software.
- **Novel pressure vent** minimizes pressure pulses at chamber closing, and allows chamber pressure to track the ambient pressure under calm and windy conditions, minimizing pressure pulses at chamber closing.
- **CO₂ flux rate is calculated at the CO₂ concentration of the surrounding ambient air.** This minimizes effects resulting from the necessary increase in chamber CO₂ concentration during a measurement.
- **Data Analysis software** allows convenient ways to view selected summaries of data files and observations logged by the LI-8100A. Plotting, editing, recomputing, and viewing of flux measurements calculated with a variety of regression fits is also available.



LI-8100A File Viewer

Choose Your Configuration...

The LI-8100A System's modular design allows you to build a custom system that fits your particular research needs. All systems start with the LI-8100A, which is the weather tight enclosure that houses system components for gas analysis, chamber control, data storage, and data communications. Next, choose from a variety of soil chambers to attach to the LI-8100A, including survey and long-term chambers. Long-term measurements can be multiplexed to measure up to 16 chambers to address both spatial and temporal variability.



Single Chamber Survey System

- 10 or 20 cm chamber options (8100-102 and 8100-103, respectively)
- Quickly conduct measurements over a number of locations
- Assess spatial variability in soil CO₂ flux



Single Chamber Long-Term System

- Fully automated long-term measurements (8100-104 and 8100-104C)
- Allows assessment of CO₂ flux patterns for weeks or months at a time
- Careful design minimizes perturbations to the soil environment around the chamber



Multiplexed Long-Term System

- Includes LI-8150 Multiplexer to multiplex up to 16 long-term chambers (30m diameter coverage)
- Can combine both clear and opaque chambers in one multiplexed system
- Allows assessment of both spatial and temporal variability

Application Flexibility

Soil CO₂ Flux

The LI-8100A was designed primarily to measure soil CO₂ flux temporally and spatially over the variety of environmental conditions that influence soil CO₂ flux.

Soil CO₂ production is heavily influenced by environmental factors (soil temperature, soil moisture, organic content, etc.) and biological factors (above ground can-



opy size, growth activity, etc.). Soil CO₂ efflux is a physical process driven primarily by the CO₂ concentration diffusion gradient between the upper soil layers and the atmosphere near the soil surface. The challenge of accurate soil CO₂ flux measurements is that the deployment of chambers must cause minimal disturbance to environmental conditions that have an impact on CO₂ production and transport inside the soil profile.

LI-8100A chambers are designed to minimize perturbations to the surrounding environmental conditions and measurement artifacts that can affect the natural soil CO₂ production and diffusion processes. Both survey and long-term chambers close automatically, eliminating variations caused by manual chamber placement, providing accurate, repeatable data.

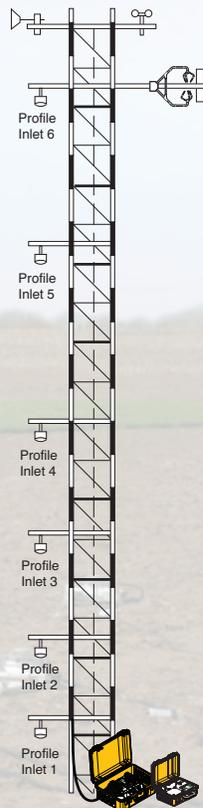
Net Carbon Exchange

A new clear chamber (8100-104C) allows measurements of Net Carbon CO₂ Exchange (NCE), which is the difference between the photosynthetic uptake of CO₂ by foliage and the emission of CO₂ through soil respiration. The clear chamber bowl can be installed on existing 8100-104 opaque chambers, with a simple field upgrade kit.

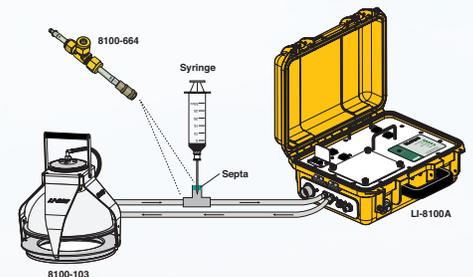


Atmospheric CO₂ Profiling

With a multiplexed system, atmospheric CO₂ profile measurements can be performed at the same time as soil CO₂ flux measurements, by simply adding the atmospheric profiling kit (part #8150-662). Each profiling kit converts 4 of the multiplexer ports to sample air from inlet ports mounted at various heights on a tower or other mounting fixture. The LI-8150 supports tubing lengths of up to 45m for profiling measurements.



Trace Gas Analysis



Air samples can be collected from the same air stream used to measure soil CO₂ flux using the Trace Gas Sampling Kit (part #8100-664). Estimates of the flux rate of trace gases such as methane (CH₄), ammonia (NH₃), nitrous oxide (N₂O), isotopic species, etc. can be made based on the rate of change of the gas species concentration inside the chamber. The sampling kit can be used with any LI-8100A chamber, without any modification to the chamber.

Flask Measurements



By adding either the 8150-670-8 or 8150-670-16 Flask Sampling Kit to the LI-8150 Multiplexer, the system can be modified to explore CO₂ fluxes from discrete samples enclosed in custom chambers, or flasks. The installation includes simple plumbing changes and the addition of an auxiliary pump inside the LI-8150 Multiplexer. The pump serves to continuously flush chambers with ambient or conditioned

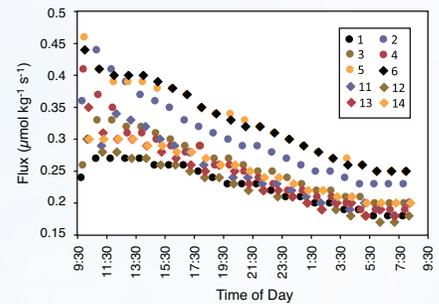


air between measurements. This effectively maintains the chamber atmosphere at or near ambient between measurements

and allows samples to be left in the chamber for extended periods of time, making this system well suited to explore temporal variation in CO₂ flux. These modifications are easily reversible and with the auxiliary pump unpowered the instrument operates as normal.

Flask measurement applications are varied; similar measurement approaches have been applied in entomological studies to

evaluate insect respiration, in studies of postharvest and developmental fruit biology, and for measurement of soil CO₂ flux from isolates soil samples or cores. The multiplexed nature of the LI-8100A system makes it particularly well suited for applications where high throughput is required, due to statistical or sample availability limitations.



Surface Monitoring for Geologic Carbon Sequestration



With the increased concern of global greenhouse gas emissions, scientists are researching ways to limit the amount of CO₂ entering

the atmosphere in an effort to mitigate the atmospheric CO₂ concentration increase. Currently there is a global push to limit CO₂ emissions through Carbon Capture and Storage (CCS) technologies.

One of the biggest concerns with CCS is whether or not the CO₂ remains within the geologic formation into which it was injected. A well organized surface monitoring campaign should include a pre-injection background study to better

understand the natural variation in soil CO₂ flux over the surface of the injection area. By establishing baseline CO₂ fluxes, the researcher can say with confidence that routine post-injection monitoring is effective and can provide quantitative data to prove a leak has not taken place. An active surface monitoring campaign that includes Monitoring, Verification, and Accounting (MVA) can also be used to ease public perception of any potential leak concerns. Even though the risk of a leak in most cases is very low, using surface monitoring techniques is a valid way to convince the public that the CO₂ has not escaped to the surface.

The LI-8100A and LI-8150 are in use for surface monitoring at a number of active and proposed geologic carbon sequestration sites around the world.

Flux Measurements In Areas With High CO₂ Concentrations

The LI-8100A features an extended CO₂ measurement range of 0-20,000 ppm, making it ideal for use in difficult areas like volcanoes. Large reservoirs of gases can be present deep below the surface, from which the gases escape along fissures to the surface. In other extreme environments, CO₂ can build up beneath the snowpack; the LI-8100A is rugged enough to be used in any of these extremes.



Ordering Information

LI-8100A Analyzer Control Unit.

Includes Auxiliary Sensor Interface, Serial Cable Interface, RS-232 Serial Cable, RS-232 to USB Adapter, Spares Kit, Compact Flash Memory Card, PC Card Adapter, Shoulder Strap Kit, Software CD (Windows® and Palm® Interface plus Data Analysis Software) and Instruction Manual (Chamber, Battery and Battery Charger not included).

Chambers

8100-102 Survey Chamber, 10 cm

Includes 8100-201 soil temperature probe, gasket kit, spares kit and six soil collars.

8100-103 Survey Chamber, 20 cm

Includes 8100-201 soil temperature probe, gasket kit, spares kit and six soil collars.

8100-104 Long-Term Chamber

Includes gasket kit, spares kit and two soil collars.

8100-104C Clear Chamber

Includes gasket kit, spares kit and two soil collars.

Multiplexer

LI-8150-8 8-Port Multiplexer

Connect up to eight Long-Term Chambers or gas sampling lines. Includes Spares Kit and Cable/Hose Assembly for connection to LI-8100A Analyzer Control Unit. LI-8100A, Chambers, and Power Supply not included. (Note: LI-8150 powers the LI-8100A Analyzer Control Unit when connected.)

LI-8150-16 16-Port Multiplexer

Connect up to sixteen Long-Term Chambers or gas sampling lines. Includes Spares Kit and Cable/Hose Assembly for connection to LI-8100A Analyzer Control Unit. LI-8100A, Chambers, and Power Supply not included. (Note: LI-8150 powers the LI-8100A Analyzer Control Unit when connected.)

System Packages

LI-8100-M1

Four Chamber Multiplexed Package

Includes LI-8100A Analyzer Control Unit, LI-8150-8 Multiplexer, four 8100-104 Long-Term Chambers and four 8150-705 Cable/Hose Assemblies. Requires AC or DC power (DC not included). Auxiliary sensors sold separately.

LI-8100-M2

Four Chamber Multiplexed Package

Includes LI-8100A Analyzer Control Unit, LI-8150-16 Multiplexer, four 8100-104 Long-Term Chambers and four 8150-705 Cable/Hose Assemblies. Requires AC or DC power (DC not included). Auxiliary sensors sold separately.

LI-8100-NCE

Net Carbon Exchange Package

Includes LI-8100A Analyzer Control Unit, 8100-104C Clear Chamber, 8100-704 2m Extension Cable, 8100-202 Soil Moisture Probe, 8100-203 Soil Temperature Thermistor, Quantum Sensor, Amplifier, 8100-604 Leveling Stake, and 8100-565 Wireless Communications Package.

Specifications*

LI-8100A Analyzer Control Unit

Hand-held Device Requirements:

Apple iOS 4.0 or greater

Power Requirements:

10.5-28 VDC

3A @ 12V (36W) maximum during warm-up with heaters on

1A @ 12V (12W) average after warm-up with heaters on

Operating Range

Temperature: -20 °C to 45 °C

Auxiliary Sensor Interface

Dimensions: 10.2 cm L x 3.8 cm W x 6.4 cm H (4" x 1.5" x 2.5")

Inputs: 4 Thermocouple channels (Type E, J, or T)
4 General input channels (0-5 VDC)

Power Out: 0-5 VDC

Power In: 10.5-28 VDC

Connections: Terminal strip with screw posts

Infrared Gas Analyzer

Measurement Principle: Non-Dispersive Infrared
Traceability: Traceable to WMO standards for CO₂. NIST traceable LI-610 Portable Dew Point Generator for H₂O

CO₂

Measurement Range: 0-20,000 ppm

Accuracy: 1.5% of reading

Calibration Drift

Drift at 0 ppm: <0.15 ppm/°C

Span Drift¹: <0.03 %/°C

Total Drift at 370 ppm: <0.4 ppm/°C

RMS Noise at 370 ppm with 1 sec signal averaging:

<1 ppm

Sensitivity to water vapor:

<0.1 ppm CO₂/mmol/mol H₂O

H₂O

Measurement Range: 0-60 mmol/mol

Accuracy: 1.5% of reading

Calibration Drift

Drift at 0 ppt: <0.003 mmol/mol/°C

Span Drift¹: <0.03 %/°C

Total Drift at 10 ppt: <0.009 mmol/mol/°C

RMS Noise at 10 ppt with 1 sec signal averaging:

<0.01 mmol/mol

Sensitivity to CO₂:

<0.0001 mmol/mol H₂O/ppm CO₂

¹ Residual error after zero correction

10 cm Survey Chamber – 8100-102

Volume: 854.2 cm³

Soil Area Exposed: 83.7 cm² (13 in²)

Dimensions: 15.2 cm L x 15.2 cm W x 25.4 cm H (6" x 6" x 10")

20 cm Survey Chamber – 8100-103

Volume: 4843 cm³

Soil Area Exposed: 317.8 cm² (49.3 in²)

Dimensions: 28.7 cm L x 28.7 cm W x 29.2 cm H (11.3" x 11.3" x 11.5")

Long-Term Chamber – 8100-104/8100-104C

Volume: 4076.1 cm³

Soil Area Exposed: 317.8 cm² (49.3 in²)

Dimensions: 48.3 cm L x 38.1 cm W x 33.0 cm H (19" x 15" x 13")

Accessories

Soil Temperature Probe (Type E): 6.4 mm (0.25") dia., 250 mm (10") immersion length

Soil temperature thermistor:

6 foot cable. Accuracy: ±1.0 °C from -20 to 50 °C

Soil Moisture Probe (ECH2O Model EC-5): 5 cm (2") length

Soil Moisture Probe (ThetaProbe Model ML2)

*Specifications subject to change without notice.

Complete specifications can be found at:
www.licor.com/8100A

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The LI-COR board of directors would like to take this opportunity to return thanks to God for His merciful providence in allowing LI-COR to develop and commercialize products, through the collective effort of dedicated employees, that enable the examination of the wonders of His works.

"Trust in the LORD with all your heart and do not lean on your own understanding. In all your ways acknowledge Him, and He will make your paths straight."

—Proverbs 3:5,6