# Enviro News

Atmospheric / Environmental Science Edition

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## In this issue:



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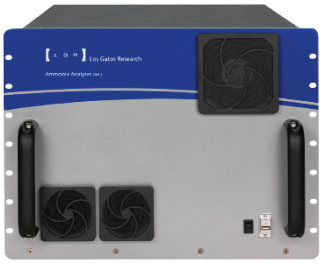

# *Welcome to the fourth edition of EnviroNews - Atmospheric / Environmental Science Edition from Enviro Technology Services.*

It has been two years since our third edition, and a great deal has happened in that time. The impact of the coronavirus pandemic on business, science, and academia has been unprecedented, but thankfully many researchers are still able to do science, and **Enviro Technology** is still supplying, servicing, and repairing instruments as usual. Our engineers have continued to maintain the UK's essential air quality monitoring network throughout the crisis, and our office has remained open, albeit with many of us (including me) now working from home.

Although there has been little going on in terms of conferences and exhibitions, we have been particularly busy seeking out new innovative technologies, trading in new territories, and responding to an encouraging number of new enquiries for scientific instruments.
Understandably, ultrafine and nanoparticles have been of particular interest to the research community recently, but ammonia and $N_2O$ seem to be in the spotlight too.

Despite 2020 being a somewhat dull year, there have been some noteworthy developments here at ET. We were excited to recently supply the first prototype **ABB-LGR** HoverGuard drone-mounted Microportable Greenhouse Gas Analyser ($CH_4$, $CO_2$, $H_2O$) to the Cyprus Institute. This upcoming product has garnered a huge amount of interest from a wide variety of researchers, and we eagerly await its official release.

I was also lucky to be able to escape the home office for a day recently and deliver Enviro Technology's first Micro Pulse LiDAR system to the **British Antarctic Survey.**

We have been marketing the MPL and MiniMPL for some time now, and it's a privilege to know that our first MiniMPL will be deployed on the RSS David Attenborough for research on Southern Ocean clouds. Here is a photo I snapped of the MiniMPL being tested in the BAS storeroom (pointing out of the door at an angle due to the rain!), the instrument in the background is the very same


**Dobson Ozone Spectrophotometer** which was originally used to measure the hole in the ozone layer!

One more piece of news worth mentioning is that **Micro Pulse LiDAR** is now a part of **Droplet Measurement Technologies**, and **Enviro Technology** is now the official distributor for all Droplet products in the UK and Ireland. A few of Droplet's cutting-edge particle measurement instruments are highlighted in this issue, along with a selection of other instruments, some new and some well-established, which we think are particularly relevant to today's measurement challenges.

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# *Airyx ICAD - In Situ $NO_2$ / NOx / NO monitoring and passive remote sensing*

The AirYX range of ICAD (Iterative CAvity enhanced DOAS) $NO_2$ / NOx / NO analysers are portable, fast-responding Differential Optical Absorption Spectroscopy instruments that are ideal for use in the field. The ICAD algorithm provides highly selective, precise, and direct measurements of $NO_2$ in the 430 to 465 nm spectral range. Because DOAS relies on measuring differential absorption characteristics rather than absolute intensities, it is insensitive to variations in temperature, vibrations, and degradation of the light source. This innovative measurement technique is also insensitive to interferences such as glyoxal and HONO, and intrinsically calibrated, so maintenance requirements are very low.

**Three versions of the AirYX ICAD analyser are available:**

- Single channel ICAD $NO_2$ analyser.
- Dual channel ICAD $NO_2$ / NOx / NO analyser. (two cavities, one inlet. Sample passes through an NO $NO_2$ converter after exiting the first cavity, NO is calculated by subtraction)
- Dual channel ICAD $NO_2$ analyser. (two cavities, two inlets. Ideal for comparative indoor/ outdoor pollution studies and laboratory research)


All versions of the ICAD analyser can be powered from 12 VDC (<30 W typical), and have a WiFi interface for controlling the instrument and accessing data. No consumable gases are required, and operation of the analyser is simple, requiring minimal training.

Despite being portable, rugged analysers for field use, the ICAD range were designed by AirYX (a spin-off from the University of Heidelberg Institute of Environmental Physics) to provide exceptional measurement precision and accuracy. With a limit of detection of 0.3 ppb and precision of 0.15 ppb/2% at a 2 second measurement interval, the performance of the AirYX ICAD analysers far exceeds many rack-mounted instruments.

## *Airyx SkySpec*

The AirYX SkySpec range of passive DOAS instruments allow users to make accurate, reliable, and efficient measurements of tropospheric and stratospheric gases, using the sun as an indirect source for the Differential Optical Absorption Spectroscopy technique. A wide range of gases can be measured with high sensitivity and selectivity, including $NO_2$, HONO, ozone, glyoxal, $H_2O$, $SO_2$, and formaldehyde. In addition, the DOAS technique can also provide information about aerosol optical depth, and can be used for other high-precision spectroscopic applications such as surface reflection spectroscopy.

The SkySpec system is available in a variety of configurations to suit different applications. All versions have low power requirements (12 VDC, 20-30 W), low maintenance requirements, and include a telescope heater for operation in cold environments. These features, combined with ease-of-use, and the option of custom spectrometer configurations make the SkySpec a highly versatile measurement system.

*Duncan Mounsor, MD, installing a SkySpec system at the University of Edinburgh.*


**Four versions of the SkySpec Passive DOAS system are available:**

- **SkySpec Mini** (Basic system, no scanning)
- **SkySpec Compact** (Same as Mini, with embedded PC)
- **SkySpec 1D** (Full-size system, elevation-only scanning telescope, option of 1 or 2 spectrometers, with optional high-grade, back-thinned optics)
- **SkySpec 2D** (Full-size system, elevation and azimuth scanning telescope, option of 1 or 2 spectrometers, with optional high-grade, back-thinned optics)

# Monitoring Ammonia

Los Gatos Research
A MEMBER OF THE ABB GROUP

## Los Gatos Research / ABB

With ammonia emissions being an increasingly active area of research, ABB-Los Gatos Research's range of ammonia analysers continue to be popular with field and lab-based researchers alike. Like all ABB-LGR instruments, the ammonia analysers require very little maintenance and no recalibration, and provide high levels of precision and selectivity.

All LGR ammonia analysers use the patented Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS) technique. This cavity ring-down spectroscopy-derived technique makes a direct measurement of optical absorption over a very long (several kilometres) path length, as opposed to the indirect time-based measurement of CRDS. This long path length, combined with continuous wavelength scanning and advanced processing algorithms provide a highly precise measurement with a low sensitivity to interference.

The OA-ICOS optical cavity is insensitive to shocks, vibrations and misalignment. This makes ABB-LGR instruments highly durable, and also means that the mirrors can be removed, cleaned, and replaced by the user should they become contaminated.

User serviceability, minimal maintenance requirements, a 2-year standard warranty, and expert technical support from Enviro Technology services ensure reliability and peace of mind for the many users of ABB-LGR instruments in the UK and Ireland.

**ABB-LGR offer ammonia analysers in four different configurations:**

- Ultraportable Economical Ammonia Analyser (17kg, built into Pelican case)
- Rackmount Economical Ammonia Analyser (19" rack mount, standard configuration)
- Enhanced-Performance Rackmount Economical Ammonia Analyser (19" rack mount with temperature regulation for improved precision and drift)
- Trace Ammonia Analyser (19" rack mount, Quantum Cascade Laser for highly-sensitive measurements in the mid-infrared, liquid nitrogen cooled detector, temperature regulation)

## LSE Ammonia Monitors - 1700/1710

LSE Monitors produce affordable high-precision analysers for the measurement of $N_2O$ and $NH_3$ using photoacoustics.

In this technique, sample gas is pumped through a very small, dumbbell-shaped photoacoustic cavity. The sample gas is irradiated with a Quantum Cascade Laser tuned to the absorption wavelength for $NH_3$, and pulsed at a frequency which is resonant with the optical cavity.


LSE MONITORS

The excitation of the $NH_3$ molecules by the laser causes an expansion and contraction of the gas in the cavity, resulting in a resonant pulsing pressure wave. This sound is detected by miniature microphones in the cavity, and the amplitude of the signal is proportional to the concentration of $NH_3$.

LSE Monitors offer two $NH_3$ analyser models, the $NH_3$-1700, which has a precision of 2 ppb and a time resolution of 60 seconds, and the $NH_3$-1710, with a precision of 25 ppb and a time resolution of 2 seconds.

Both models have a small internal volume, and all components which come into contact with the sample have an inert coating, LSE ammonia analysers therefore suffer from minimal memory effects, and require little time and gas to calibrate. Maintenance requirements are also low, and the user has the ability to tune spectroscopic parameters and view detailed diagnostic data.

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
A Teledyne Technologies Company

## *CAPS True $NO_2$ Analyser - Model N500*

The new N500 from Teledyne-API uses the same Cavity-Attenuated Phase Shift Spectroscopy (CAPS) technique as the well-known T500U $NO_2$ analyser. The N500 also features a Gas Phase Titration (GPT) chamber, in which NO in the sample gas is reacted with an excess of internally generated ozone, to convert it into $NO_2$ for subsequent measurement by CAPS. By alternating between routing the sample gas via the GPT chamber, and directly into the measurement cavity, the N500 can produce alternating measurements of $NO_2$ and NOx. NO is then calculated by subtraction, similarly to how $NO_2$ is calculated by subtraction in chemiluminescence NOx analysers.



## *Direct $NO_2$ measurements with the T500U CAPS $NO_2$ Analyser*

The Teledyne-API T500U measures $NO_2$ directly, with high precision and minimal sensitivity to interferences, using the Cavity-Attenuated Phase Shift Technique.

With a detection limit of just 40 ppt, the T500U is Teledyne-API's most sensitive analyser for $NO_2$, and as it does not have a switching valve, it is also the fastest responding, with a <38 second rise and fall time. Because of the simplicity of the technique, maintenance requirements and power consumption on this analyser are low, making it ideal for use in mobile labs, including Enviro Technology's own Smogmobile.

## *THC-$CH_4$-NMHC Analyser Model N901) with Numaview Software*

The N901 total hydrocarbons/ methane/ non-methane hydrocarbons analyser is a new release from Teledyne-API, using gas chromatography with a flame ionisation detector.

Like the new N500, the N901 is built on Teledyne's new N-series platform, with modular hardware, all DC upgraded electronics, and long life sample filters. During a measurement cycle, the N901 simultaneously fills two sample loops with gas. One loop is passed straight to the FID for THC detection, and the other goes through $CH_4$ separation before being passed to the FID.

DROPLET
MEASUREMENT TECHNOLOGIES

## SP2 - Single Particle Soot Photometer

The SP2 Single Particle Soot Photometer is Droplet Measurement Technologies' premier instrument for detailed particle-by-particle analysis of black carbon.

Particles are measured individually by laser incandescence and light scattering, with BC mass distribution being calculated as a function of the measured particle diameter. In addition, the SP-2 features a split detector, which gives information on the position of the particle in the beam and can be used to determine particle coating thickness. The SP-2 also features a narrowband detector, which when compared with data from the broadband incandescence detector, can provide information about particle coating materials (iron oxide etc.).

With 4 measurement channels, particle-by-particle detection, and detailed multi-parameter analysis, the SP-2 is Droplet's go-to instrument for full particle characterisation. The extremely high sensitivity allows soot to be measured and characterised even at very low concentrations, and the coating analysis capability allows black carbon content to be measured in water, snow, or even ice.


## SP2-XR Single Particle Soot Photometer - Extended Range

The SP2-XR from Droplet Measurement Technologies is a simplified, extended range version of the SP2. The SP2-XR is also much smaller and lighter than the SP2, weighing just 13 kg.


This portability combined with simplified operation and maintenance, and the ability to view processed BC data in real-time, makes the SP2-XR better suited to many field-based applications.

Particles are still measured individually by laser incandescence and light scattering, but the SP2-XR does not include a split detector or narrowband detector, so data on particle coatings is not as rich as that collected by the standard SP2. The SP2-XR does however have the advantage of a decreased lower size range for BC (50 nm as opposed to 70 nm), wider scattering size range (100 – 500 nm as opposed to 150 – 430 nm), and of course a greatly increased particle number concentration range. The SP2-XR is therefore an excellent solution for detailed, real-time particle-by-particle analysis of black carbon in the field.


DROPLET
MEASUREMENT TECHNOLOGIES

## *Wideband Integrated Bioaerosol Sensor (WIBS-5 NEO)*

The WIBS-5/NEO from Droplet Measurement Technologies is the world's only instrument for real-time, single particle measurement of atmospheric bacteria, moulds, pollen, and other bioaerosols.

Particle shape and size is measured via forward light scattering with a 635 nm diode laser. In addition, 280 nm and 370 nm flashlamps excite the particle, and the excitation-emission matrix is used to detect common fluorophores such as tryptophan and NADH with high sensitivity. The rich particle-by-particle data and advanced processing algorithms of the WIBS allow highly detailed analysis of bioaerosol particles.

## *Mini Micro Pulse LiDAR (MiniMPL)*

The MiniMPL is a compact, user-friendly Micro Pulse LiDAR system using a relatively low-powered 532 nm laser, pulsed at 2,500 Hz. The beam can detect, penetrate, and differentiate layers of cloud and aerosol up to 15 km in altitude. The MiniMPL also features polarisation as standard, and the depolarisation ratio can be used to distinguish between different types of aerosol. Unlike many LiDAR systems, the MiniMPL can be run 24/7/365, and does not require specialist training or extensive maintenance. In addition, the user-friendly software suite allows users to view data in real-time or play back old data files, export plots, and automatically determine planetary boundary layer height, cloud base, peak, and top height, as well as atmospheric extinction.



## *Photoacoustic Extinctiometer (PAX)*

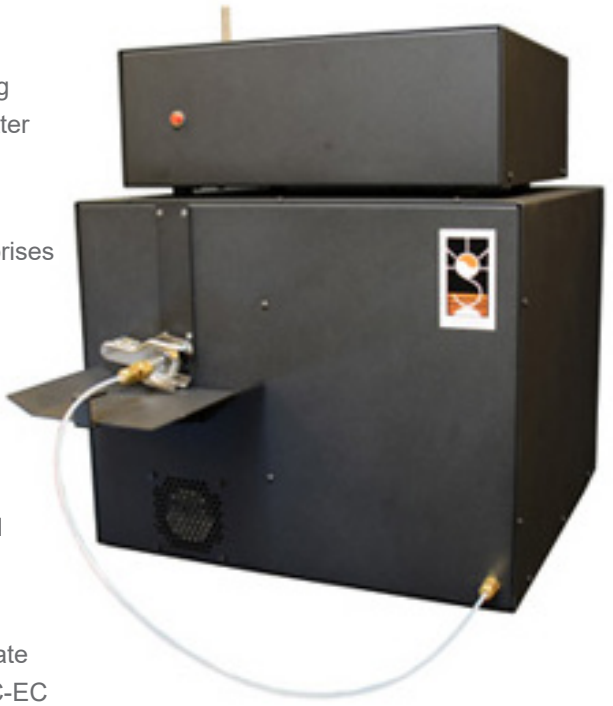
The PAX from Droplet Measurement Technologies is a 19" rack-mounted instrument which measures the concentration of black carbon in air using a two-part measurement cell.
In one half of the cell, absorption is measured with miniature microphones and a modulated laser, using the photoacoustic technique. In the other half of the cell, the scattered light from the laser is measured using a photodiode. Various wavelength options are available, including 870 nm (for black carbon absorption and large particle scattering), 532 nm (visual wavelength range), and 405 nm (for brown carbon absorption and UFP scattering).

# Organic and Elemental Carbon (OCEC)

Sunset Laboratory Inc.

## *OC/EC Lab Aerosol Analyser - (Model 5)*

The Model 5 Lab OC-EC Analyser from Sunset Laboratory is a thermo-optical instrument for the analysis of Organic Carbon and Elemental Carbon on pre-collected filters. Small punches are taken from the filter paper and inserted into the instrument's oven, providing a discrete measurement of OC and EC content in the particulate matter sampled on the filter.



In the thermo-optical method, a filter punch is first exposed to a ramping oven temperature in an oxygen-free environment. This vaporises the organic carbon in the sample, which is then passed through an oxidiser oven (to convert the C into $CO_2$), then through a methanator oven (to convert the $CO_2$ to $CH_4$), before the organic carbon is finally measured as $CH_4$ by the FID or optional NDIR detector.

The filter punch then goes through a second temperature ramp, this time in an oxygen/helium mixture, which will oxidise all of the elemental Carbon remaining on the filter paper, before it is measured by the FID in the same way as the organic Carbon.

The thermo-optical method is a well-established technique for the determination of OC-EC in a sample, and can also be used to calculate brown carbon and carbonate carbon. The Sunset Laboratory Lab OC-EC Analyser is fully compatible with common protocols including NIOSH5040, EUSAAR2, and IMPROVE-A. It features an internal calibration check on every measurement, and a correction for any OC that is pyrolyzed to EC during the measurement. The analyser is available with the option of transmittance-only or dual-optics, and either FID or NDIR detector.

## *Semi Continuous OC/EC Field Analyser (Model 4)*

Using the same thermo-optical measurement technique as the Model 5 Lab instrument, the Model 4 Field OC-EC Analyser from Sunset Laboratory is a semi-continuous instrument designed for long-term monitoring. Unlike the Lab instrument, the Model 4 uses a vacuum pump and 8 L/min $PM_{2.5}$ inlet to collect airbourne particulate matter onto an internal filter over a period of time (typically 30 minutes to 24 hours). Once a sample has been collected on the internal filter, the Model 4 then performs a thermo-optical OC-EC measurement, burning off the previous sample from the filter before beginning another sampling period.

Due to the cycle of collecting, measuring and pyrolyzing, and then collecting again, the Model 4 Field OC-EC Analyser does not require regular intervention by the user, and can be left to gather accurate OC-EC measurements over a long period of time. The Field OC-EC Analyser also reports black carbon in addition to OC and EC, and despite the many concessions to use in the field, the performance is comparable to that of the Lab OC-EC Analyser.

AIRMODUS

## A20 Condensation Particle Counter (bCPC)

The A20 CPC from Finnish company Airmodus is a Condensation Particle Counter designed for the accurate counting of particles in the 7 – 1,000 nm size range. The airbourne particles are exposed to air supersaturated with the n-Butanol working fluid, causing them to grow to a measurable size before being passed from the growth chamber to the optical particle counter for detection. The lower cut-off (50% detection efficiency) can be set anywhere from 5 – 10 nm, with 7 nm being the most common. The A20 CPC can be used as a standalone instrument for counting the total number of particles in air, or integrated into a larger sampling/ speciation system, serving as the particle counter.

## A10 Particle Size Magnifier (PSM)

The Airmodus A10 PSM (Particle Size Magnifier) is a device for growing nano size particles to a size that can be detected with an ordinary Condensation Particle Counter. Airbourne particles entering the inlet of the A10 PSM are exposed to a chamber saturated with diethylene glycol working fluid, which condenses on even the smallest of particles, causing them to grow in size. The diethylene glycol primary growth step will even affect electrically neutral particles, causing them to grow in the same way.



## A11 Nano Condensation Nucleus Counter System (nCNC)

The Airmodus A11 nCNC system combines the primary growth stage of the A10 PSM with secondary growth and subsequent counting in an A20 CPC to allow the measurement of particle counts over the full size range of 1 – 1,000 nm. Airmodus are world-leading experts in the emerging field of 1-4 nm research, and the A11 system represents the Airmodus' "turn-key" solution for nanoparticle research.

**The A11 nCNC system can be operated in three modes:**

- Fixed mode: Measure particle counts with a fixed lower size cut-off.
- Stepping mode: Step between several user-defined cut-offs.
- Scanning mode: Measures the complete activation spectrum of 1-4 nm particles in ~5 minutes.

## *Portable Aerosol Spectrometer Dust Decoder 11-D*

The 11-D Portable Dust Decoder from GRIMM Aerosol is a highly compact (2.1 kg), battery-operated, multi-parameter dust monitor. Featuring an internal pump, self-regulating flow, sheath-air protected optics, and a fast response time, the 11-D is suitable for a wide variety of measurement applications.

Using 90° laser scatter detection with aerosol focussing, the 11-D can measure:

- TSP
- $PM_{10}$, $PM_4$, $PM_{2.5}$, $PM_1$, PMcoarse
- IAQ parameters such as $pm_{10}$, $pm_{2.5}$, $pm_1$, inhalable, thoracic, respirable dust
- Particle number distribution in 31 equidistant size channels, from 0.253 – 35.15 µm
- Temperature and relative humidity

The 11-D includes comprehensive internal data storage with Bluetooth, USB, Ethernet, and serial connectivity. A 47 mm filter holder is also included for providing clean sheath air to the optics, and can be used for post-analysis of collected particulates by methods such as electron microscopy.

## *MiniWRAS*


The GRIMM 1371 MiniWRAS combines 90° laser scatter detection with a Faraday cup electrometer to enable the detection of nanoparticles. The combination of these two techniques allow the MiniWRAS to measure particle number distribution in 41 size channels from 10 nm to 35 µm, as well as $PM_{10}$, $PM_{2.5}$, and $PM_1$.

The 31 optical size channels from 0.253 – 35 µm are measured with a 6 second frequency, while the 10 nano channels from 10 – 193 nm are measured sequentially for 6 seconds each, producing a full scan every minute. Like the 11-D, the 1371 MiniWRAS' optics are protected with a flow of sheath air, and aerosol focussing ensures the total sample volume is measured.

Despite these impressive capabilities, the MiniWRAS is a portable, battery operated instrument. Weighing 7 kg, and with an internal ~8 hour battery, the MiniWRAS is ideal for mobile studies on PM and nanoparticles. Like the 11-D, the MiniWRAS also has comprehensive internal data logging, and connectivity via Bluetooth, USB, and serial.


## *Nano mobility particle size spectrometer (PSMPS)*

The PSMPS combines GRIMM's SMPS+C system (a Scanning Mobility Particle Sizer with Condensation Particle Counter) with the Airmodus A10 PSM (Particle Size Magnifier) to create a system capable of measuring particles as small as 1.1 nm.

Particles go through a primary growth stage in Diethylene Glycol before being passed from the A10 PSM to the SMPS+C for secondary growth in n-Butanol. This two-stage growth process allows the accurate measurement of particles in the 1 – 4 nm range, a size range that is of particular scientific interest in terms of particle formation processes, but is below the detection limit of standard CPCs.

As with standard GRIMM SMPS systems, a range of neutralisers, DMA columns, and configuration options are available to suit different applications.

Met One Instruments


## Particulate Profiler (ES-405)

The new ES-405 Particulate Profiler from Met One Instruments is a compact dust monitor which uses laser scatter technology to measure $PM_{10}$, $PM_4$, $PM_{2.5}$, and $PM_1$ simultaneously. The ES-405 can output data at intervals as fast as 60 seconds, and can be equipped with an optional CCS modem to push data to the cloud automatically.

The ES-405 is built into a weatherproof enclosure suitable for long-term outdoor use, and the modest power requirements (12 VDC, 1400 mA) allow it to be run from batteries or solar panels. The ES-405 also features a flow of rinsing air to protect the optics from contamination, and an automatic inlet heater to reduce moisture related errors. The modestly priced and feature-rich ES-405 is therefore a versatile new tool for consultancies and researchers performing multi-point dust sampling.

## Black Carbon Monitor (BC-1054)

The BC-1054 Multi-Spectrum Black Carbon Analyser from Met One uses a similar reel-to-reel sampling system to the well-known BAM-1020 Beta Attenuation Mass Monitor. In the BC-1054, particulates deposited onto the filter tape are analysed at 1-minute intervals using 10 different wavelengths from 370 – 950 nm, to fully characterise and measure the optical absorption of black carbon.

The BC-1054 is suitable for long-term unattended deployment and requires very little maintenance. The flow can be actively controlled at either 2 or 5 L/min, and the internal storage has capacity for over 1 year of data. The BC-1054 also boasts extremely low detection limits of 1 ng/m3, making it suitable for a wide range of applications including atmospheric background monitoring.


## Portable Black Carbon Monitor (BC-1060)

The BC-1060 is a new portable black carbon monitor from Met One Instruments. The BC-1060 uses a miniaturised reel-to-reel tape sampling system similar to the BC-1060 and BAM-1020, and measures optical absorption of BC at two wavelengths, 370 nm and 880 nm. The BC-1060 includes internal data storage for over a year of data, and can measure at intervals as fast as one minute.

Weighing just 16kg, the BC-1060 is completely self-contained, with the sampler, pump, and data logger all being enclosed in one weatherproof housing. The unit can be powered from both mains and DC power and can be equipped with a multi-parameter meteorological station for applications such as source apportionment.

# *eosAC-LT/LO Automated Soil Flux Chamber*

The new eosAC-LT (transparent) and eosAC-LO (opaque) are automated recirculating soil flux chambers from Eosense. Like the original eosAC chamber, these new large chambers can be used with the eosMX multiplexer or directly connected to a gas analyser, and are fully compatible with Enviro Technology's range of ABB-LGR Greenhouse Gas Analysers. Comprehensive automatic flux calculation software is included, and the chambers include a slow closing stepper motor and pressure relief valve to reduce pressure differentials in the system.

The new large chambers were designed to accommodate larger plants and provide a greatly increased internal volume (72,000 $cm^3$ compared to 1,969 $cm^3$). The chambers also feature a stackable base to enable the height of the chamber to be increased, enabling measurement of even larger plants. In addition, the option of transparent versions enables photosynthesis measurements.

As with the original eosAC chambers, air temperature and pressure inside the chamber are constantly monitored throughout the measurement and used for flux calculation. The eosAC-LT and eosAC-LO also feature two auxiliary sensor ports, so that the user can add a PAR sensor and combined soil moisture/soil temperature sensor to each chamber. These additional sensors further enrich the data collated and processed by the included eosAnalyze flux calculation software, and improve the accuracy of the calculated fluxes.

Up to 12 eosAC, eosAC-LT, or eosAC-LO chambers can be connected to an eosMX multiplexer at any one time. The eosMonitor chamber scheduling software commands the eosMX multiplexer to switch solenoid valves at user-defined intervals, and can run either on a PC, or directly on the connected gas analyser. Just like an LGR Ultraportable or Microportable gas analyser, the entire system, including chambers, sensors, and multiplexer, can be run from batteries and requires minimal maintenance, making it an ideal choice for monitoring soil and vegetation fluxes out in the field.