New capabilities in stable isotope analysis:

The Environmental Chemistry and Microbiology Unit (ECMU) has acquired two new stable isotope instruments through the ARC-LIEF 'MAFIA' project. These gas-phase instruments measure the stable isotope ratios $\delta^{18}O$ and δD in H_2O and $\delta^{13}C$ in CO_2 by Cavity Ring-Down Spectrometry (CRDS). Compared to traditional mass spectrometry, CRDS instruments are field-portable and substantially cheaper and easier to operate, yet provide comparable data quality.

The stable isotope ratios can be determined in a wide range of sample types provided the samples are transformed quantitatively into gas phase H_2O and CO_2. This can be achieved by designing application specific sample delivery modules. Currently ECMU has analytical capabilities in the following areas:

1. Picarro L2130 H_2O instrument:
    a. Atmospheric water vapour analysis - moisture source and precipitation histories
    b. Leaf transpiration analysis - plant physiology and vegetation water source studies
    c. Liquid water analysis - precipitation, surface and ground water hydrology, oceanographic studies

2. Picarro G2101 CO_2 instrument:
    a. Atmospheric CO_2 analysis – climate change and atmospheric circulation studies
    b. Soil, plant and animal respired CO_2 analysis – tracing CO_2 in mixed C3-C4 landscapes
    c. Dissolved inorganic carbon (DIC) in surface and ground water – carbon export dynamics

CRDS instruments enable real-time stable isotope analysis to be carried out in the field. In addition, the instruments can be use in the laboratory to analyse discrete samples and are easily portable between institutions. Some of these capabilities are world-first developments and are currently available only at CDU and JCU.For further information contact ecmu.tech@cdu.edu.au

Continuous measurement of $\delta^{18}O$ and δD in a tidal creek

Measurement of $\delta^{13}C$ in respired CO_2 from savanna soils

Literature:

Bass et al. ISO-CADICA: Isotopic – continuous, automated dissolved inorganic carbon analyser. *Rapid Comm. Mass Spec. (2012) 26, 639– 644*

Bass et al. Contrasting carbon export dynamics of human impacted and pristine tropical catchments in response to a short-lived discharge event. *Hydrol. Process. (in press)*

Munksgaard et al. Continuous analysis of $\delta^{18}O$ and δD values of water by diffusion sampling cavity ring-down spectrometry: a novel sampling device for unattended field monitoring of precipitation, ground and surface waters. *Rapid Comm. Mass Spec. (2011) 25, 3706-12*

Munksgaard et al. First continuous shipboard $\delta^{18}O$ and δD measurements in sea water by diffusion sampling—cavity ring-down spectrometry. *Envir. Chem. Lett. (2012) 10, 301-7*

Munksgaard et al. Extreme short-term stable isotope variability revealed by continuous rainwater analysis. *Hydrol. Process. (2012) 26, 3630-34*

Munksgaard et al. Field-based cavity ring-down spectrometry of $\delta^{13}C$ in soil-respired CO_2. *Isotopes in Envir. Health Studies (2013) 49, 232-42*

'These results also pave the way for the use of real-time natural abundance water isotope 'labels' to trace water associated with discrete rainfall events, captured at high temporal resolution, through the hydrosphere and biosphere and elucidate processes, such as rapid recharge/discharge in groundwater/river systems, operating on timescales from hours to days'

'DS-CRDS has the ability to collect continuous isotope data in real time with high temporal and spatial resolution at a fraction of the cost of traditional isotope analysis of discrete samples. The technique is applicable to studies of coastal and open ocean waters and provides additional discriminatory power for assessing water mass formation processes, histories and mixing'

The described field-based techniques enhance the potential for research on the sources and effluxes of soil-respired CO_2 at higher temporal resolution and increased sample density across a range of mixed C3–C4 landscapes'

'The ISO-CADICA overcomes the laboratory limitation and offers field mobility and high temporal resolution sampling of both DIC and $d^{13}C_{DIC}$. Full automation means that the ISO-CADICA is suitable for long-term field deployment with minimal user interaction'