The Ginninderra greenhouse gas controlled release facility

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GA-CO2CRC controlled release facility

- Collaboration between Geoscience Australia and the CO2CRC
- Hosted at CSIRO Ginninderra Experiment Station
- 800 hectares of cropping/grazing land
- 10km from centre of Canberra
- All year access
Location of horizontal well

CO₂ tank

Groundwater monitoring wells (baseline)
GA-CO2CRC Greenhouse gas controlled release facility, Ginninderra, ACT
Horizontal well and packers

- Based on ZERT facility
- 125mm \( \phi \) HDPE pipe x 120m long
- Slotted every 0.5m over 100m, installed 2m deep
- Six release chambers
- Sandy loams and clays with occasional coarse gravel
CO₂ supply

- 2.5t liquid CO₂ tank
- Maximum CO₂ capacity is 600 kg/d
- First sub-surface release – 100kg/d (over 5 chambers)
- δ¹³C of CO₂ ~ -18‰
  (source is primarily from an ethanol plant)
Pre-release: above ground experiment (2010)

60 kg CO$_2$/d
Atmospheric tomography (Bayesian inversion)

Continuous measurements of atmospheric temperature, and wind speed and direction in all three dimensions allowed characterization of plume dispersion.

Both CO₂ and N₂O were released simultaneously from a small area source to simulate a leak.

Atmospheric sampling at 8 points surrounding the release using University of Wollongong FTIR Trace Gas Analyser and 8 separate Vaisala CO₂ sensors.
Simultaneous localisation and quantification

$\text{CO}_2$ emission rate determined within 3%
Localisation determined within 1m
Scaling up: Atmospheric CO$_2$ sensor array (CO2CRC Otway Stage 2B)

- 9 - 15 t/d controlled CO$_2$ releases
- Sensors 150 - 470m from release pt
1st sub-surface release at Ginninderra (March – May 2012)

- Release rate 100 kg/d CO₂
- 8 x CO₂ (Vaisala GMP343) atmospheric sensors (solar powered, wireless network)
- 37 x 1m deep soil gas wells (8 surveys: CO₂, CH₄, C-13, N₂, O₂)
- Soil flux ~ 150 sample sites
- Eddy covariance (LICOR) tower
- Kr tracer (released in one chamber; soil gas, atmospheric samples)
- Electromagnetic survey (EM31)
- Soil community DNA analysis (0, 3, 15, 30m transect)
Wireless atmospheric CO$_2$ sensor array - Ginninderra
Soil flux

- Soil flux took ~4 weeks to stabilise
- Reasonable quantification
Soil gas vs soil flux

- Detected changes in soil gas after only 4 hrs, 15m from hot spot
- Considerable lag between surface expression of soil flux and sub-surface soil gas (1m deep)
- Detected Kr tracer in 1m deep well, 30m from horizontal well
- Surface CO₂ expression much less than sub-surface footprint (not “V” shaped)
Challenge: locating a surface leak

- Quantification ok, but finding leaks in the first place is tricky
- Model simulations suggest a diffuse leak (100mx100m) 1km from single atmospheric station needs to be ~50t/d before statistically detectable
- Point source ~ 20t/d at 1km

GA-CSIRO Arcturus atmospheric baseline station, Central Queensland
2nd release at Ginninderra (Oct - Dec 2012)

Focus on finding leaks using surface techniques (100 kg/d)

- Airborne hyperspectral
- Ground penetrating radar
- In-field phenotyping
- Electromagnetic surveys
- Walking around!
Flying around?

- UAV rotorcraft equipped with CO$_2$ sensor

Photo courtesy of Florian Poppa, ANU
Summary

• Important facility for testing concepts, technologies and approaches
• Results used as basis for up-scaling (e.g. atmospheric tomography, phenotyping, UAV)
• CO$_2$ surface expression less than sub-surface footprint (no “V”)
• Quantification techniques work but require significant processing
• Finding small surface leaks over large areas is challenging
• Looking for method cross-validation opportunities
Researchers

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