Arcturus, Queensland: An Introduction

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Arcturus: Semi-arid cropping and grazing

- **Site**
- **Purpose**
- **Instruments and Processing**
- **Preliminary results**
- **Where to next?**
Arcturus, Central Queensland, Australia
Purpose

Baseline greenhouse gas monitoring station established July 2010

(EC established April-June 2011)

Collaborative project between Geoscience Australia and CSIRO Marine and Atmospheric Research (CMAR)

• Established in a high priority geological storage CO₂ region

• Field test newly developed GHG monitoring technology

• Demonstrate best practice for regional baseline atmospheric monitoring for geological CO₂ storage

• Container: gas analysers continuously monitor GHGs and CO₂ isotopes (CH₄, H₂O, CO₂, ¹²C and ¹³C)

• EC to compliment these measurements
Purpose

• Moving to coal mine emission quantification
• Significant coal mining in the Bowen Basin
• Focus on fugitive CH$_4$ emissions
Site Characteristics

- 48 km southeast of Emerald, QLD
- EC site 250 m south of GHG container
- Cropping to the east (chickpeas)
- Pasture to the west (cattle)
- Summer wet, winter dry season
- 170 m above sea level
- Mean annual precipitation 572 mm
Site Characteristics

- Predominant wind directions:
  - South-south East, South East
- Nearest BOM stations:
  - Arcturus Downs 20 km South
  - Wyntoon 17 km West
Tower Installation (April – June 2011)

• **Tower:**
  – Steel construction with winch system

• **Sensor direction:**
  – South-south East (predominant annual wind direction)

• **Measurement heights:**
  – CSAT3 and Li7500A: 6.7 m
  – Radiation: 6.7 m
  – 2D wind speed/direction: 6.9 m
  – Temperature/RH: 6.4 m
  – Ground heat flux: 5 and 10 cm
  – Soil temp: 2.5, 5 and 15 cm
  – Soil moisture: 5, 15, 22 and 30 cm
Tower Installation (April – June 2011)

• LI-7700 CH₄ sensor installed but still not recording!

• Telecommunications:
  – Direct Wifi connection to container for storage of 10Hz & 30 min data
  – Data automatically downloaded to CSIRO server daily

• Power:
  – 240 W Solar panel with 2 batteries
Data Processing

- Currently have ~2 years of EC data from 10 June 2011

- Processing method used:
  - OzFlux v2.5
  - Has been reprocessed up to Level 3
  - No gap-filling applied yet

- Loaded to the OzFlux Data Portal every 3-4 months
  - Waiting on lab calibrations for final corrections to Li7500A data before submission of reprocessed data to portal
Li7500A problems

• Our Li7500A was behaving markedly different to replacement CSIRO sensor
  – Sensor drift a major problem and source of uncertainty
  – In 2013 were getting drop-outs at high T’s

• Applied linear corrections to correct $\text{H}_2\text{O}$ measurements

• The effect on $\text{CO}_2$…?
Li7500A problems

Plot of Ah values after L2 processing from the Li7500 vs. the HMP for the year - split into three time periods

- 2012 Jan-July
- 2012 July-Oct
- 2012 Oct-Dec

Jan-July
y = 0.965x + 0.6078
R² = 0.992

July-Oct
y = 0.8858x - 1.7487
R² = 0.9844

Oct-Dec
y = 0.8355x - 2.5317
R² = 0.9297
Li7500A problems

- Linear corrections account for most of sensor drift in H$_2$O
- Sensor problem identified as being in winter mode
- Instrument calibration coefficients assume summer mode
Preliminary Results: Energy Balance

Arcturus L3 from 2012-01-01 00:30:00 to 2013-01-01 00:00:00
Energy Balance

2012 Energy Balance Ratio = 0.704
Preliminary Fast Data Analysis

Ensemble Average Cospectra and Kaimal Model for unstable conditions
Good agreement in spectra and cospectra
CH$_4$ cospectrum variable, grouped around zero

H$_2$O cospectrum drops off at high frequencies
Where to next?

- Obtain calibration coefficients for the Li7500A winter mode and correct $\text{H}_2\text{O}/\text{CO}_2$
- Get the LI-7700 reinstalled and working to pursue $\text{CH}_4$ fugitive emission studies
- Test and assess the suitability of gap-filling methods for our data
Discussion and suggestions

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