Fugitive gas emission determination: Baseline studies and monitoring during operations

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The Problem

Recent high profile studies (e.g. Howarth/Cornell University et al., 2011) suggest that fugitive methane emissions associated with unconventional reservoirs are significant. The referenced Cornell study is not however based on direct measurements, and the specific source(s) of methane were not identified.

What is needed

1) A means of quantifying methane *flux* versus *concentration*. Concentration varies with air exchange (determined by wind speed) and can reach anomalous values during calm evenings in which atmospheric inversion occurs trapping emissions near the ground. Flux measurements require monitoring over time (days to weeks) and integration of methane over the entire field in combination with air exchange measurements.
2) To assess emissions in proximity to oil and gas infrastructure it will be useful to establish a baseline value (measured before drilling operations) and subtract that 'background' as a measure of natural seepage as well as advected methane from other sources. The carbon isotope values of thermogenic versus biological methane aid in discrimination of on and off field sources, but cannot generally distinguish between fugitive and natural seep gas from similar source rocks.
3) To pinpoint methane emissions and the sources of same.
4) To test new methane sensing technologies, a demonstrated ground-based system is required

Measurement program

We will use an array of highly sensitive spectrometers tuned to methane and carbon dioxide to quantify the flux of key greenhouse gas emissions over oil and gas fields by integrating methane concentration measurements with rates of air exchange monitored by atmospheric stations. We will separate off field sources of methane and identify natural and infrastructure related point sources of methane using a mobile methane detection unit (cavity ring down laser spectrometer) that can discriminate biological and thermogenic methane based on isotope capability.

- This array will be deployed in areas of little to no drilling operations to attempt to establish a baseline methane flux in the Cooper Basin from areas in proximity to gas wells to identify sources of methane in the study area
- Measurements will continue on an intermittent basis through drilling and production to identify average flux associated with oil and gas extraction
- Point sources of methane associated with gas and oil production will be identified and quantified.
- This array will be used to ground test new technologies such as LIDAR and satellite born imagers.

Method

1) Identification of local point sources of methane using a mobile methane detector. Transects across a perspective field and to other nearby sources of methane are initially conducted using the University of Adelaide's *cavity ring down spectrometer* mounted in a vehicle specifically designed for this application. This instrument is robust and makes rapid, highly-accurate measurements of methane concentrations to ppb levels. Critically, this instrumentation can record the isotopic composition of methane, which means biological verse thermogenic sources can be separated. It is a cost effective and efficient way of collecting this data and can be deployed immediately.

2) A methane-monitoring array is established to measure flux. Once the primary point sources of methane and general wind directions are determined, an array of 4 methane spectrometers connected to an atmospheric monitor is installed to optimize accuracy. Air mass exchange with methane concentration is used to calculate a total flux. Isotope measurements are used to calculate the fraction of thermogenic and biologically sourced methane. This measurement can be undertaken in an active field, though ideally it should begin before drilling operations to establish a baseline.

3) Monitoring of methane during production operations commences. The array collects data though daily and weather cycles to identify natural cycles of variability and varying contributions of off-field sources. Mobile monitoring units are used to hunt down and quantify major point sources in the field.

4) This approach will be used to provide ground truth for methane monitoring systems such as LIDAR or high altitude sensors.

Timing:

This program can be initiated immediately depending on the drilling currently underway and begin quantifying methane flux associated with operations or establishing baselines. Initial results would be available within several months of project start-up. The final phase of this project will await deployment of initial prototypes of LIDAR and high altitude monitoring technologies. Baseline monitoring and point source identification takes approximately 1 month. Flux measurements with full array require 2 months. Monitoring of an active field will take approximately 2 months. We anticipate gathering data from approximately 6 fields during the three years of the project in addition to deployment and testing associated with LIDAR and satellite imaging programs.

Budget:

	Year 1	Year 2	Year 3
Salary	$171,130	$171,130	$171,130
Travel for data collection	$20,200	$30,200	$20,200
Hardware	$224,000	$171,395	$20,000
Computational development	$20,500	$10,500	$6,000
Independent gas analysis	$10,000	$10,000	$10,000
subtotal	$445,830	$393,225	$227,330
University overhead	$66,875	$58,984	$34,100
Total	$512,705	$452,209	$261,430

Total: (including University overhead)
$1,226,344

Budget Justification

The budget supports one full time PhD level Research Associate named as Dr Michael Hatch. Dr Hatch is a geophysicist with 20 years of field experiment deployment experience. A part time research assistant will be employed to monitor equipment in remote locations and assist in set up of monitoring array. One PhD student will also be identified to work with this project.

Equipment costs include funding for one array of 4 methane concentration instruments (~ $50k/each) weather stations (~$6k each) and one mobile cavity ring down spectrometer with isotope capability allocated to the Cooper Basin monitoring program ~$150k with remote power and security (~ $22k).

Computational costs are incurred by development and integration of atmospheric data with concentration measurements.

Independent gas analyses provide an outside laboratory standard and check of equipment.

Travel for data collection is cost of repeated trips (up to 6 per year) to the Cooper Basin for deployment and monitoring.

University overhead covers some fraction of laboratory and office space for staff

University in kind contribution includes the salary of Kennedy, Hand, Vincent, and Hamilton, laboratory analytical equipment and use in year 1 of a cavity ring down spectrometer.

Further Information:

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