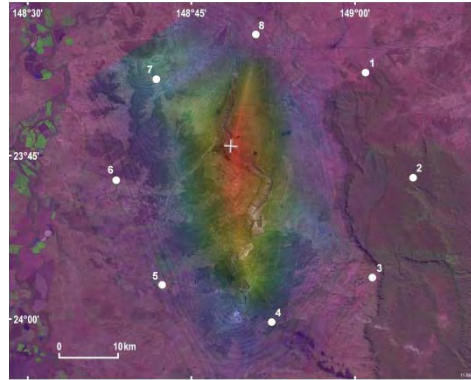




Advances in measuring emissions from open cut coal mines

Andrew Feitz



Acknowledgements

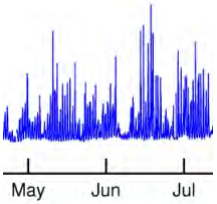


Australian Government
**Department of Resources, Energy
and Tourism**

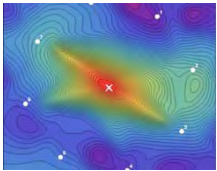
Outline



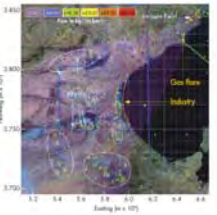
Arcturus



Measurement of CH₄ in a coal region



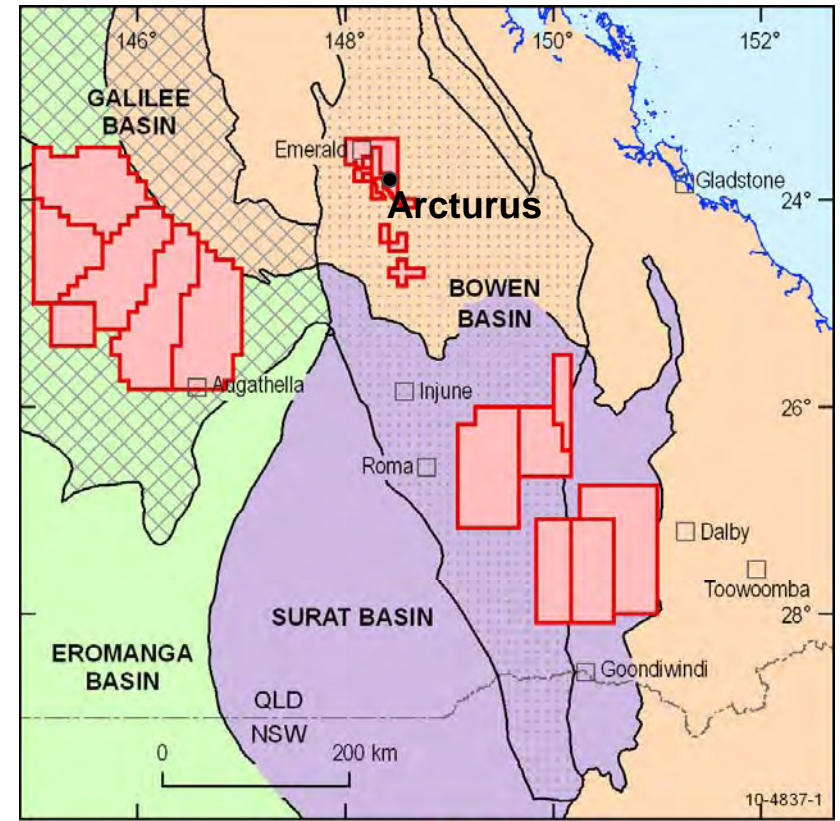
CH₄ quantification developments



Future directions

Arcturus (ARA)

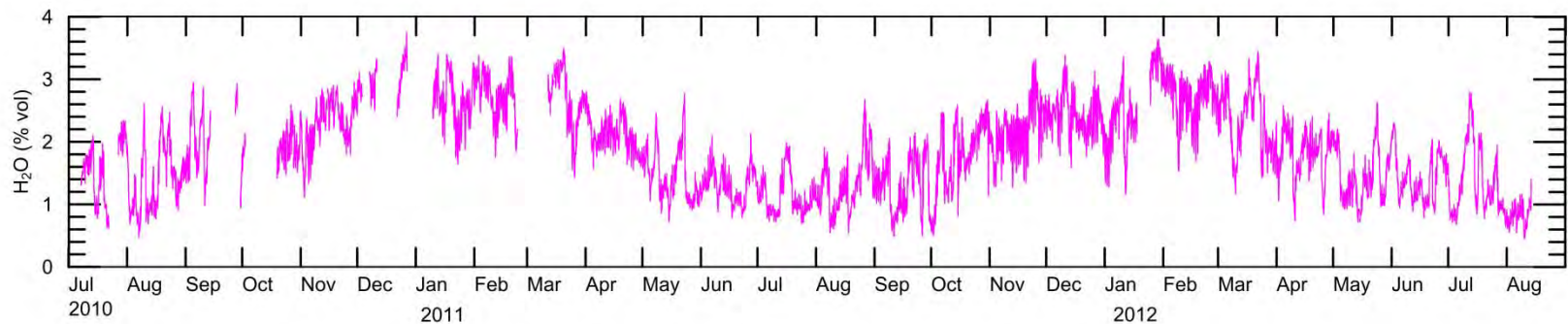
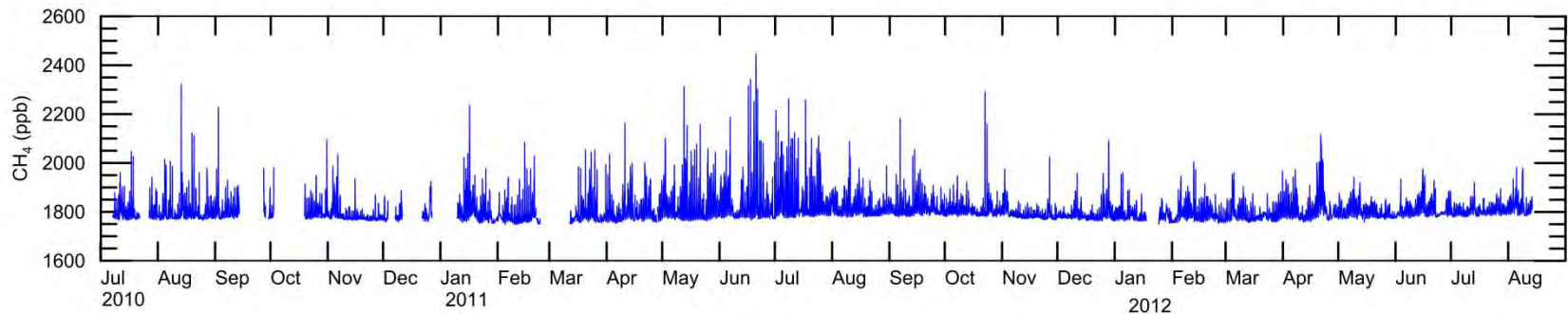
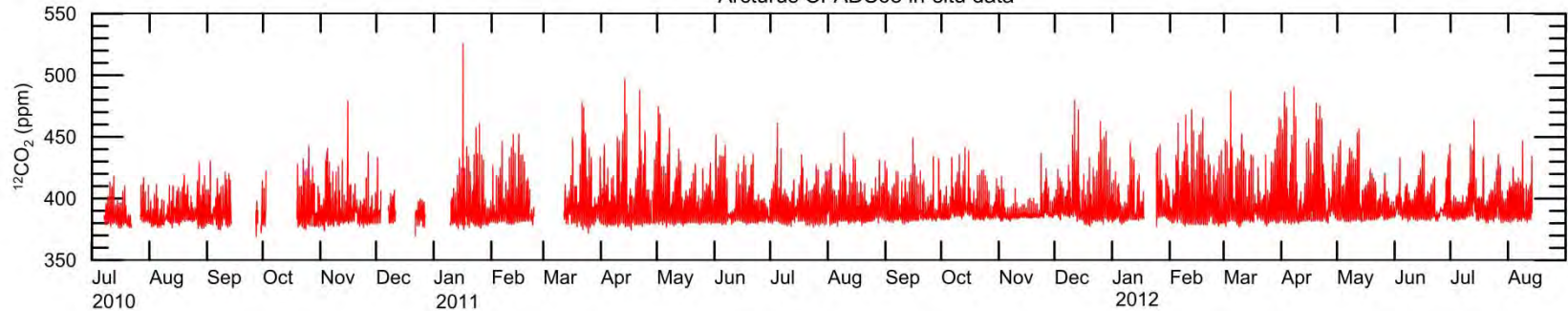
- Joint GA-CSIRO atmospheric station
- Established to evaluate field deployment of new atmospheric monitoring technology
- Baseline monitoring for ZeroGen CCS Project (folded June 2010)



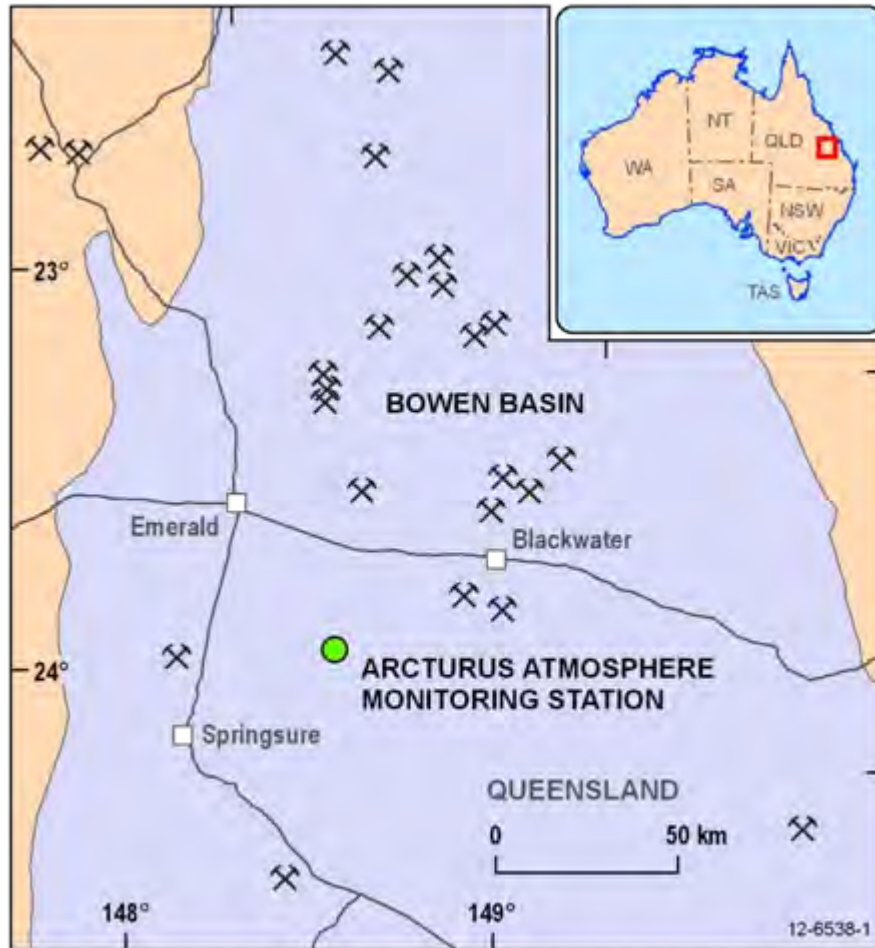





Concentration data for CO₂ and CH₄

Arcturus CFADS63 in-situ data



Lots of coal mines

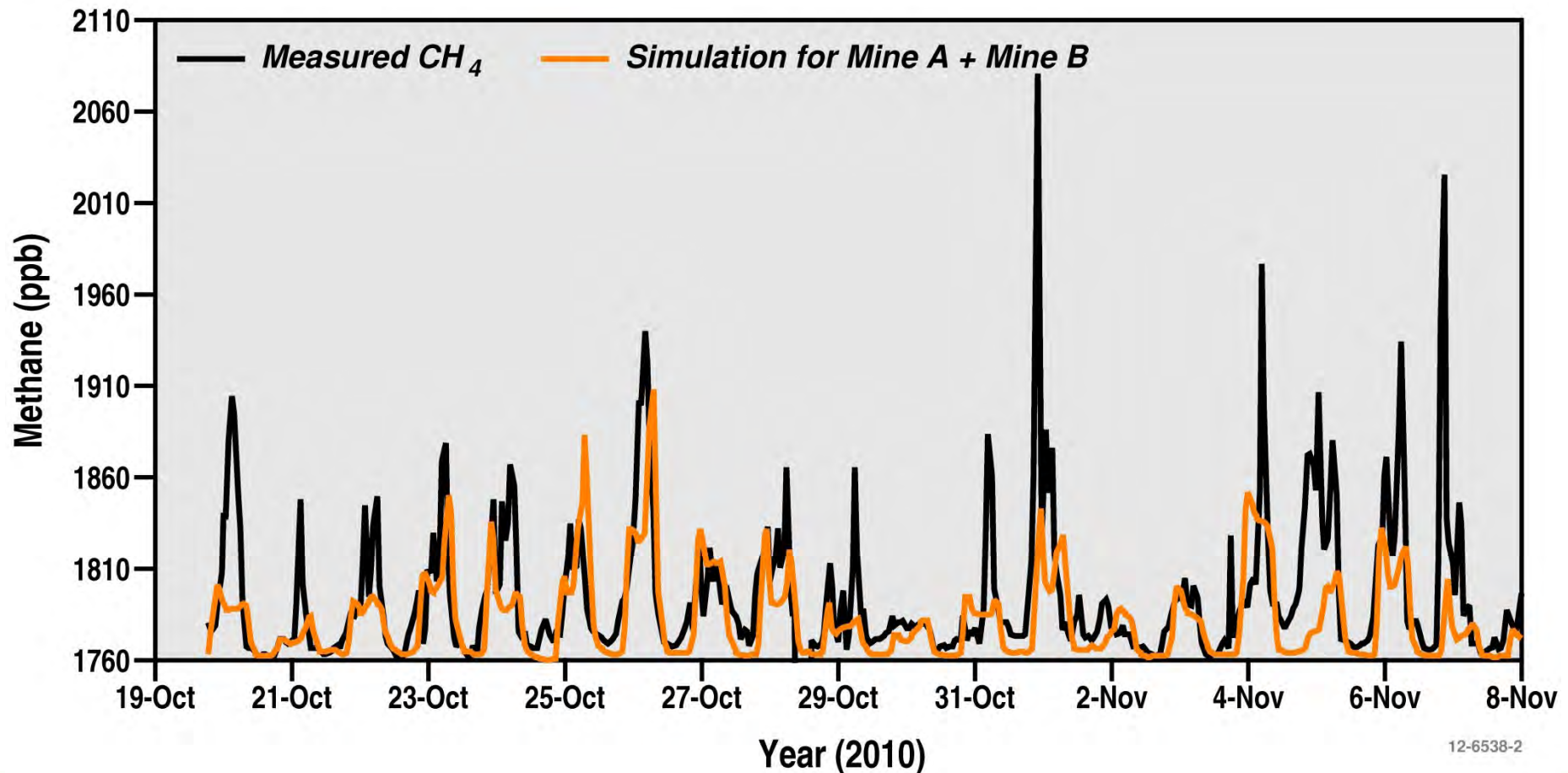


 Bowen Basin  Road  Operating coal mine

Reported emissions + meteorological data = simulation

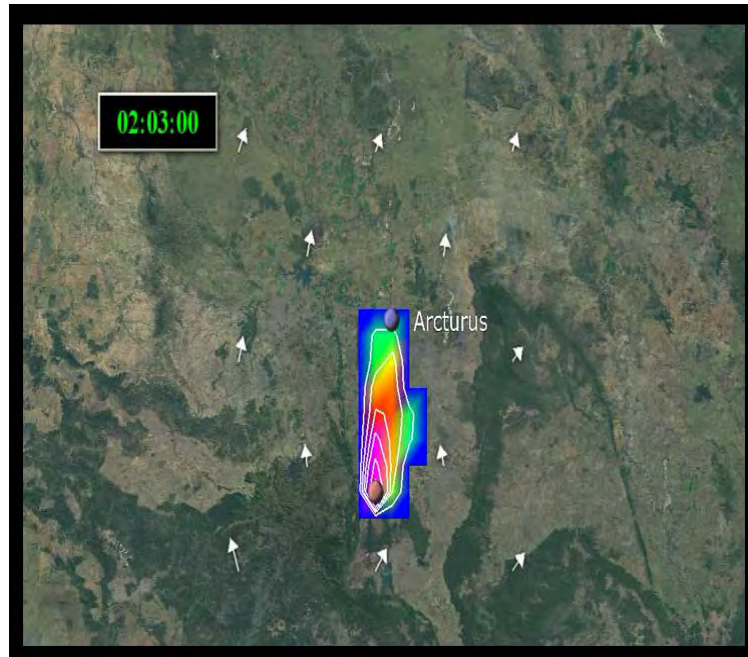
Coal mines

- CO₂ contribution from coal mines is small (~1 ppm)
- Contribute significantly to the above background CH₄

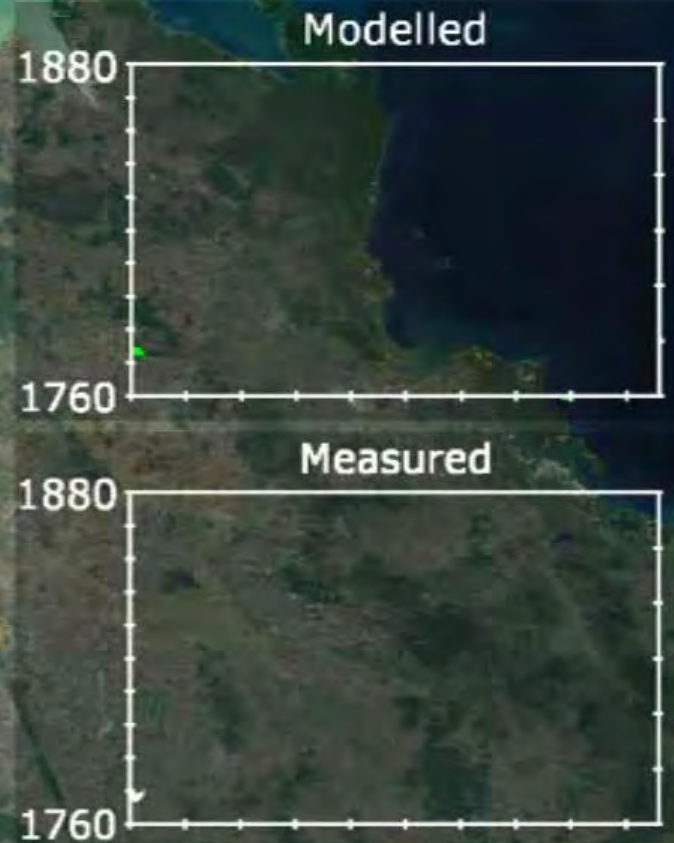
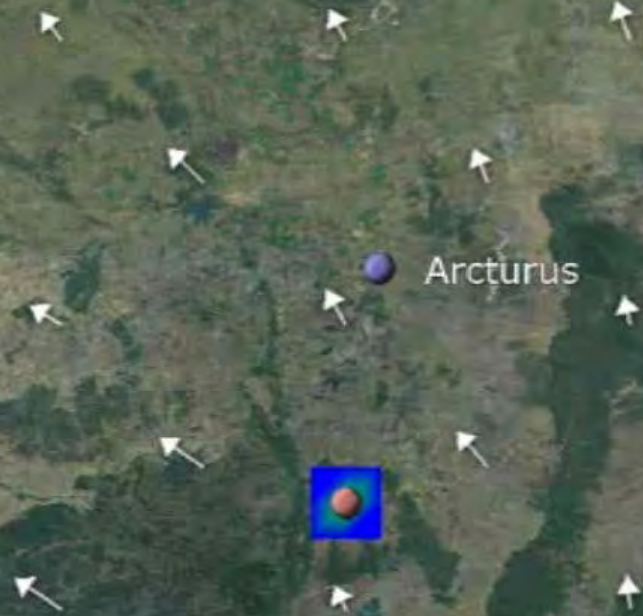


12-6538-2

CH₄ emissions from a coal mine



01:02:00



Forward modelling

- Provides an indication that the magnitude of the annual methane emissions is “about right”
- Copes with multiple sources poorly
- Need alternative approach for better estimates

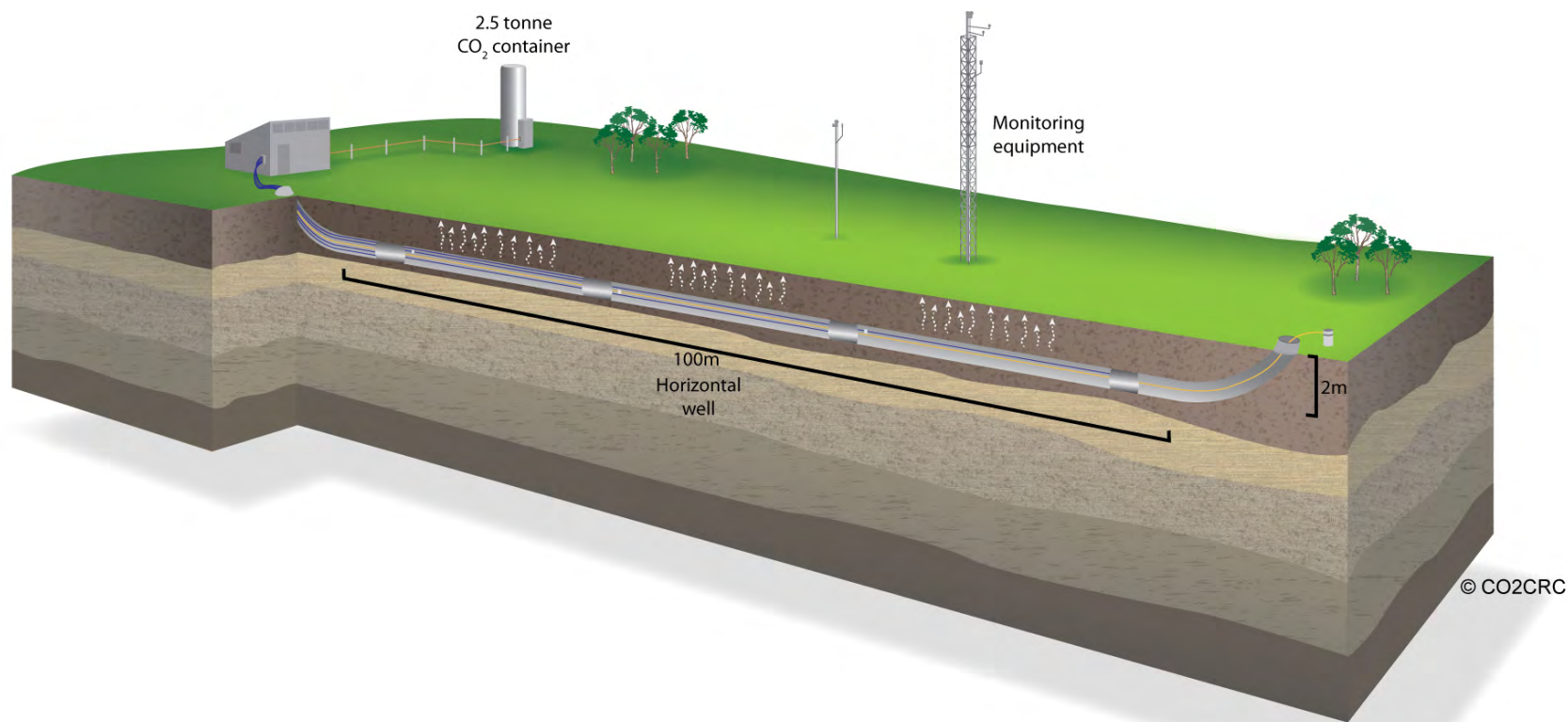
Inverse modelling

Statistical technique that optimises the emissions in a model until agreement between simulated and observed concentrations is achieved

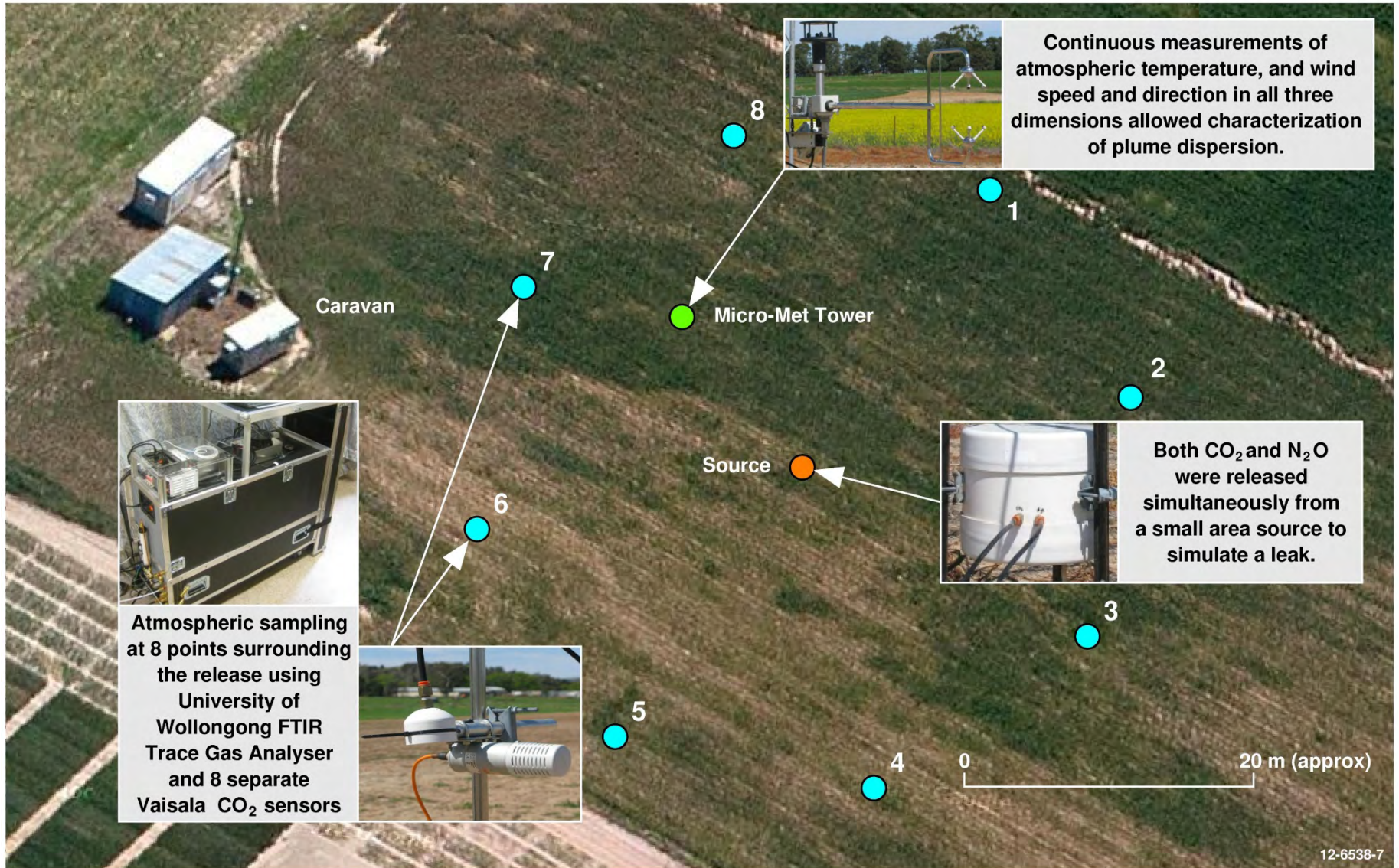
Two examples:

1. Atmospheric tomography for quantifying CO₂ emissions
2. Inverse modelling of Perfluorocarbon (CF₄) in Melbourne

GA-CO2CRC Greenhouse gas controlled release facility, Ginninderra, ACT

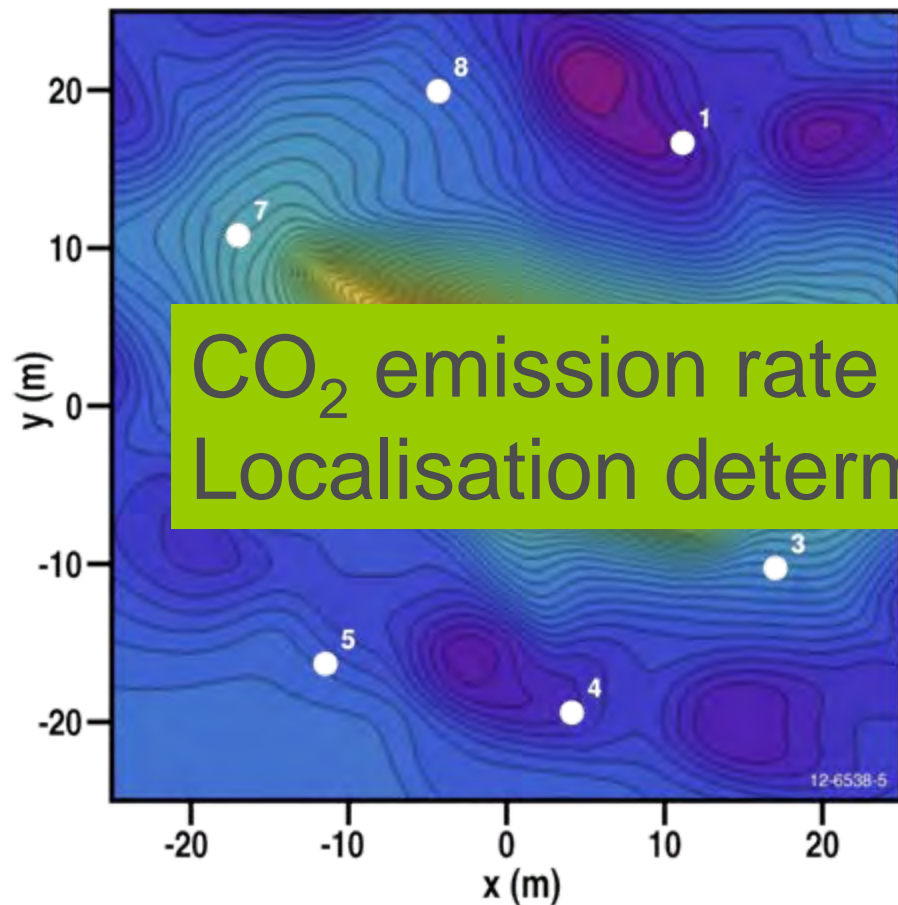


Atmospheric tomography (Bayesian inversion)

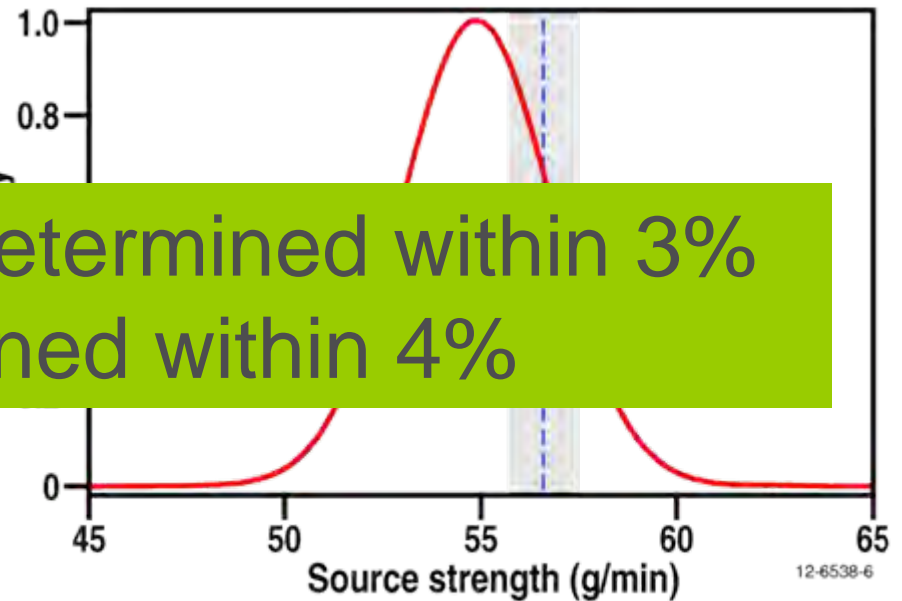


© 2012 Google Maps

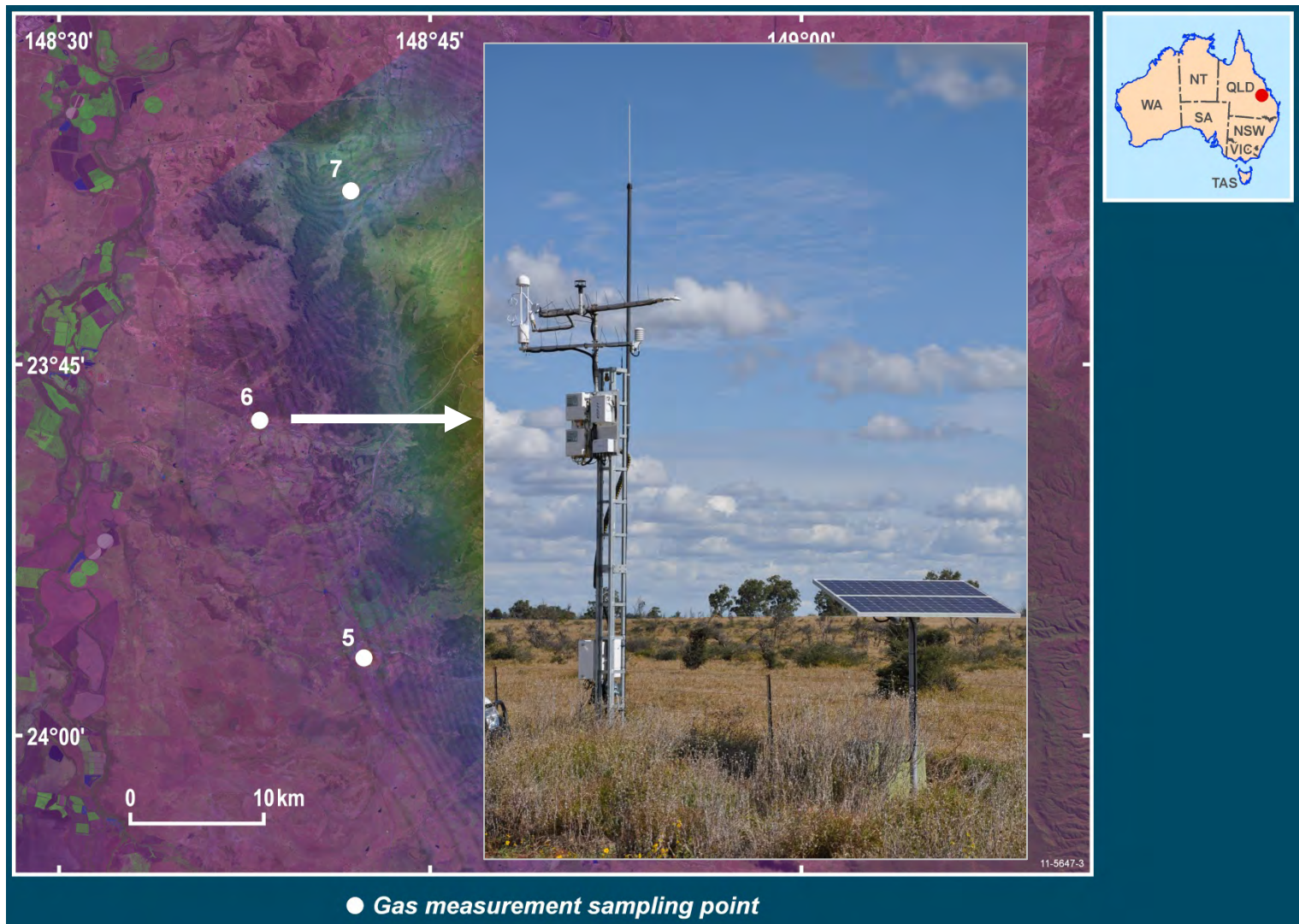
Simultaneous localisation and quantification



CO₂ emission rate determined within 3%
Localisation determined within 4%

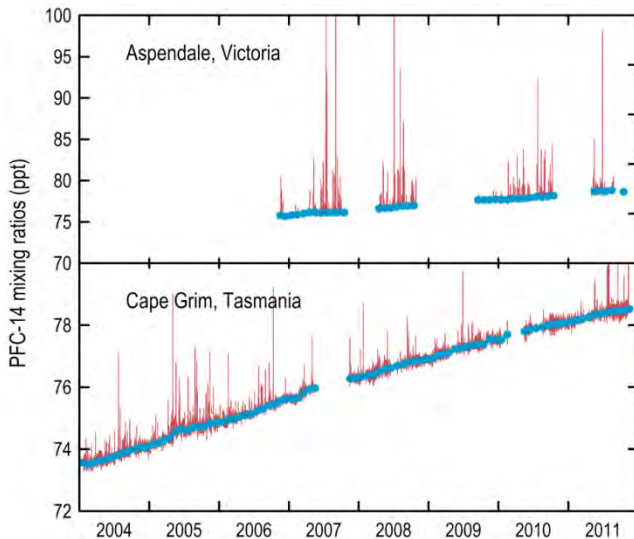
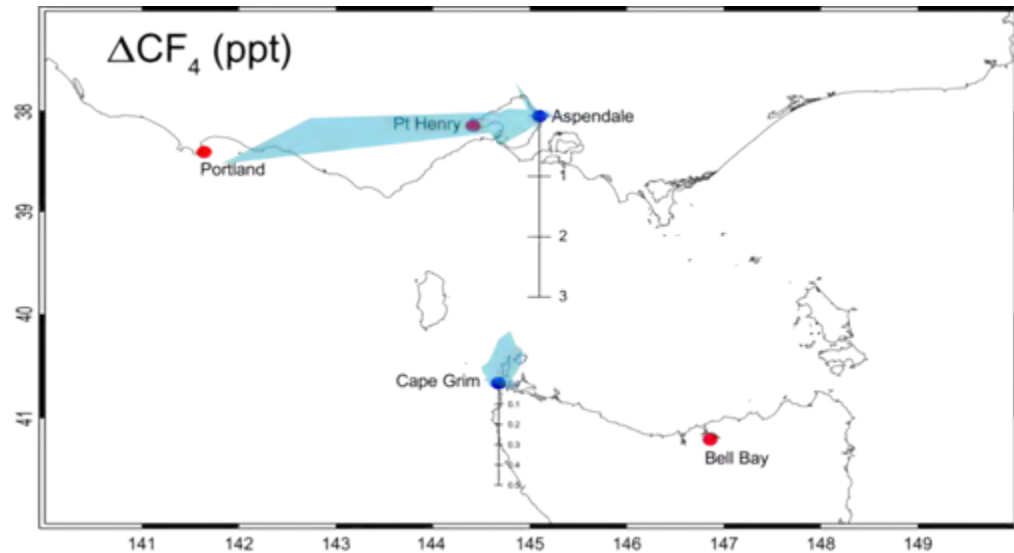


Atmospheric tomography applied to fugitive emissions

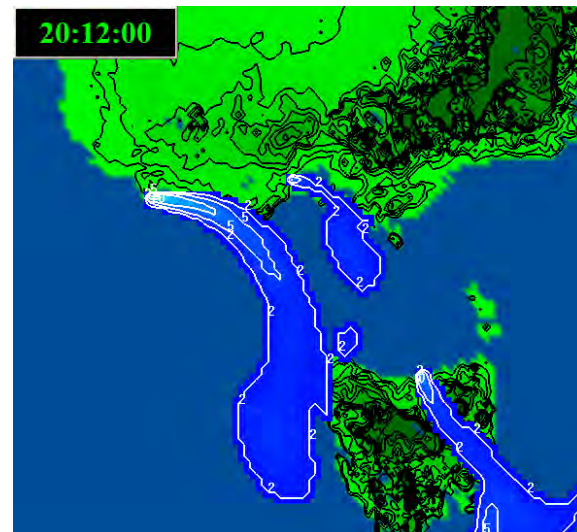


Inverse techniques on a larger scale

e.g. Perfluorocarbon (CF_4) emissions from Al smelters

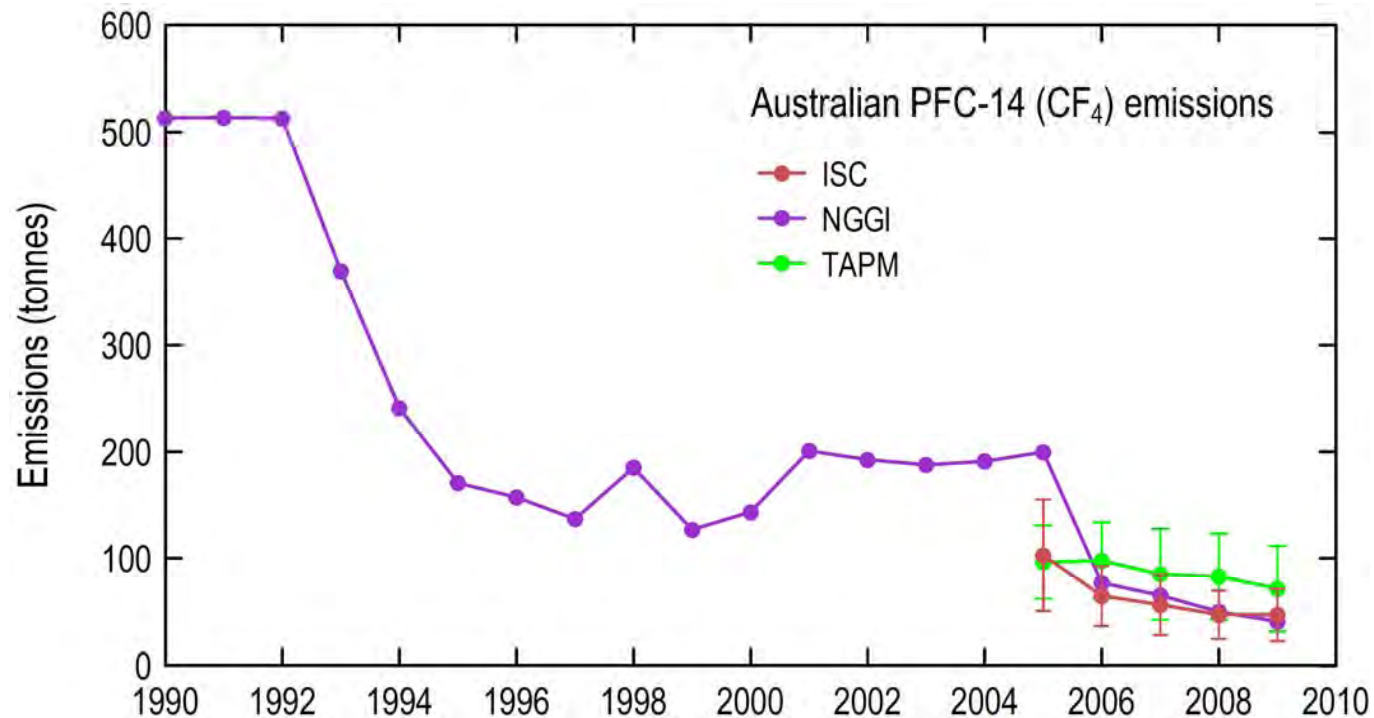


Measured



TAPM-simulated

“Top down” emissions validation

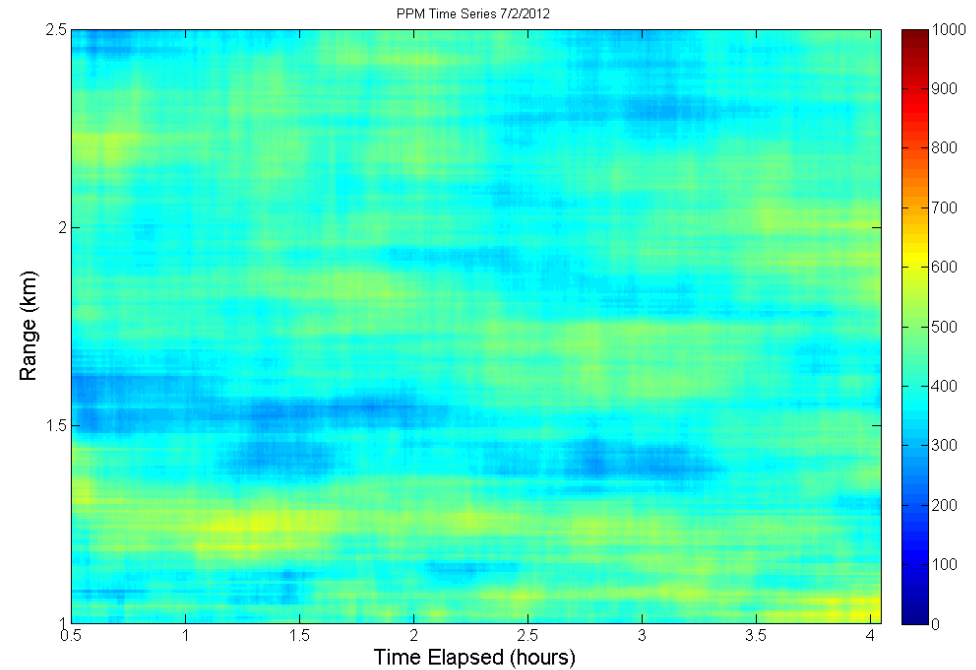


Fraser et al,
2011

Australian PFC-14 emissions from Al smelters (NGGI: [5]) compared to emissions calculated from Cape Grim data by interspecies correlation (ISC) and TAPM atmospheric modelling

Inverse modelling using line sources

- Given a small emission source, line sources (e.g. DIAL) could resolve emissions quicker



CO₂ DIAL system (Figures courtesy of Kevin Repasky, Montana State University)

Inverse modelling using airborne systems

- e.g. looking for leaking wells in a gas field using a laser spectroscopy instrument mounted on a plane
- Taken an inversion of methane measurements + met data over Tunisia

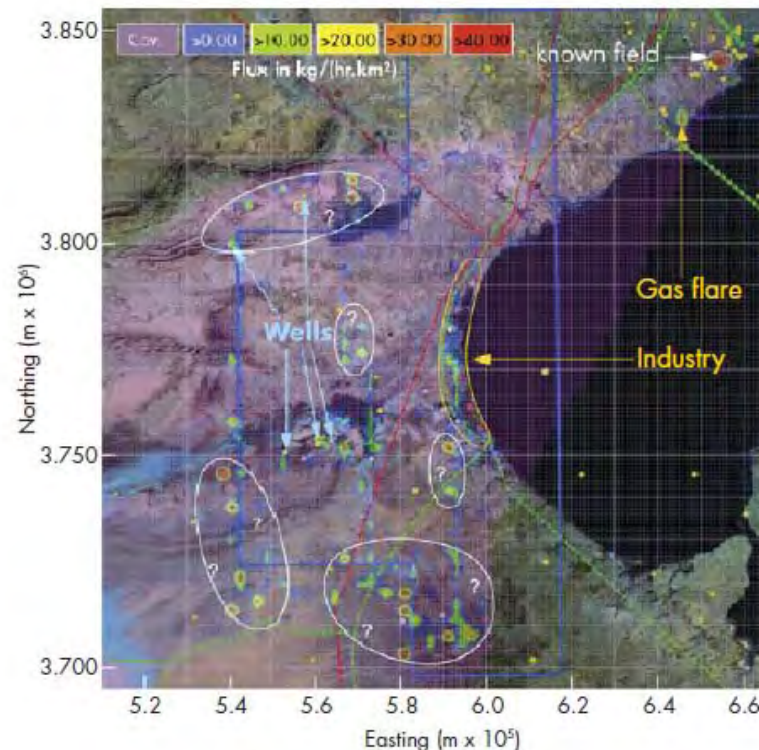


Figure courtesy of Bill Hirst (Shell)

Proposed quantification approaches for different scales

- DIAL + inverse modelling – accurate emissions within a mine (e.g. ~1-3km)
- Atmospheric tomography – accurate total emissions from a single mine (e.g. ~10km)
- Inverse modelling with 1 or 2 high precision stations – potentially good estimates of emissions for a number of individual mines (e.g. ~50-100km)
- Flight + laser spectroscopy – Reasonable single day estimate for a number of mines (e.g. +100km)

Conclusions

- Significant developments in technology and modelling
- Field deployable, remote access
- Different approaches for different scales
 - single mine or regional
- “Top down” methane emissions quantification for coal mines now possible



Australian Government
Geoscience Australia



Any Questions?

Thank you

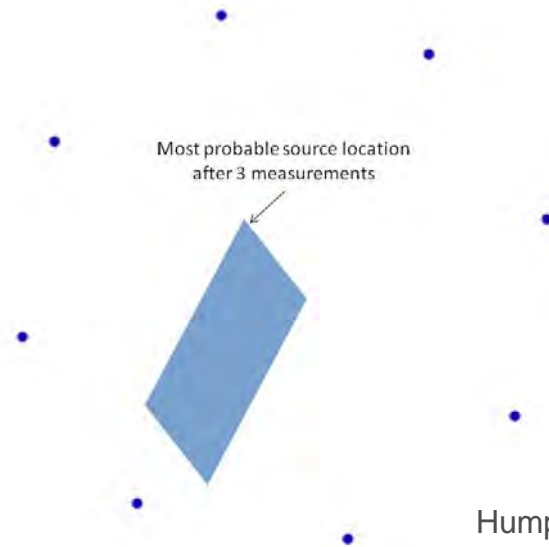
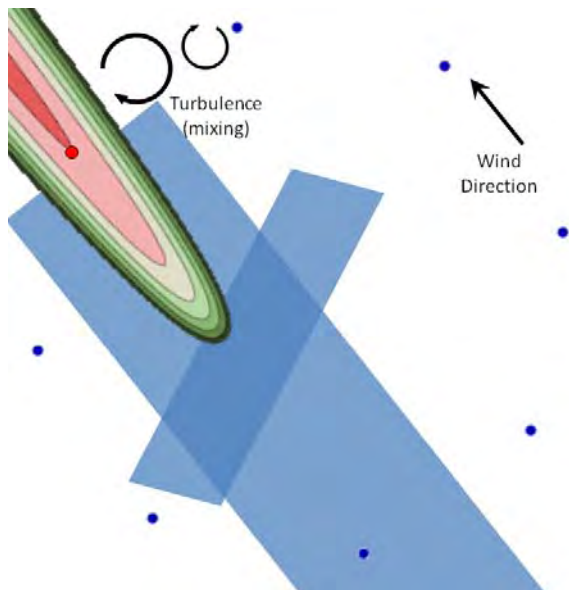
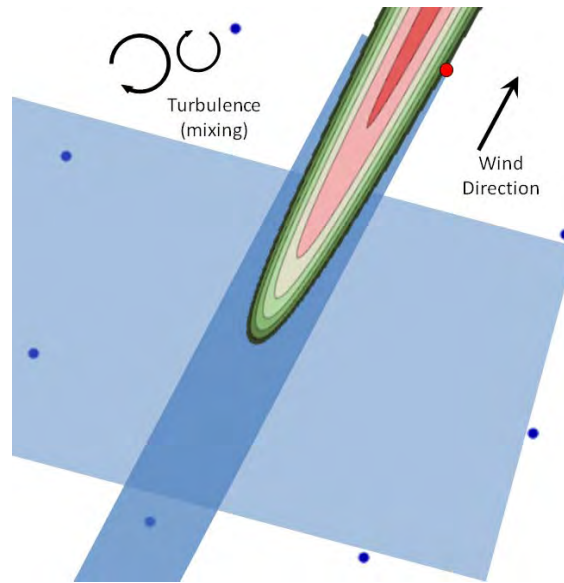
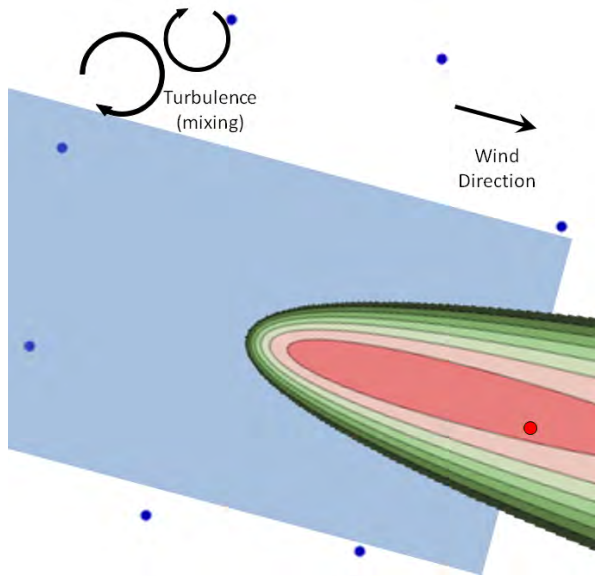
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Humphries et al (2012) ES&T