VIPAC ENGINEERS & SCIENTISTS

Vipac Engineers & Scientists Limited A.C.N. 005 453 627 A.B.N. 33 005 453 627

17-19 King William Street, Kent Town SA 5067, PO Box 2419 Kent Town SA 5071
Telephone (+61 8) 8362 5445, Facsimile (+61 8) 8362 0793, www.vipac.com.au

Joint Select Committee on Australia's Clean Energy Future Legislation
PO Box 6021
Parliament House
CANBERRA, ACT 2600

21st September 2011
Ref: 50D-11-0039-GCO-776518-0

Attention: Committee Secretariat

SUBMISSION TO THE JOINT SELECT COMMITTEE ON AUSTRALIA'S CLEAN ENERGY FUTURE LEGISLATION

INTRODUCTION

Vipac Engineers & Scientists Ltd. leads a Consortium to develop novel, low cost instrumentation to measure carbon dioxide (CO_2) and other greenhouse gases in the atmosphere. This Greenhouse Gas Monitor (GGM) Program, funded through a $2.35m DIISR grant with matched funds from the Consortium members, also will develop advanced atmospheric models to attribute greenhouse gas measurements to sources and sinks and to predict the transport of greenhouse gases through the atmosphere.

The GGM Program plans to establish a national, and eventually global, network of instruments, operating autonomously and continuously measuring CO_2 concentrations in the atmosphere. The data will be processed at a data management centre and combined with traditional measurements, as available, to produce carbon flux maps and related products in near real time.

(Further details on the GGM Program are attached)

SUBSTANCE OF SUBMISSION

A key purpose of the Clean Energy Bill is to introduce a market mechanism for reducing carbon pollution. As soon as a market is created for a commodity there is a parallel market for information about that commodity. Australia's Research & Development capability, along with adoption of this market approach, could leave it uniquely placed to profit from such a market.

The market is large. For Australia as a whole, the uncertainty in fossil fuel emissions is estimated at 3% at best, and is higher for smaller regions. At a price of $23/tonne of CO_2 this translates to about $300 million per year. When considering storage of carbon in soils the numbers convert to about $1 billion per year. For China the uncertainty of fossil fuel emissions is valued at about $15 billion per year. In a carbon market these uncertainties become business opportunities.

Australia is developing capabilities that lead the world to reduce these uncertainties and to improve understanding and management of the carbon cycle. Specifically, the GGM Program will provide scientifically verifiable measurements of CO_2 and CO_2 fluxes that will help to form a carbon market through several mechanisms.

- **Validation of existing carbon emission estimates with measured data.**

  Current methods typically use in-situ measurements or accounting of fossil fuel inputs. Validation through direct atmospheric column measurements provides two advantages: reduced uncertainty through a direct measurement of the pollution produced; and an understanding of the latency and transport of the pollution through the atmosphere.

- **Direct measurement of carbon consumed by sinks, including storage in soil, crops and forests**.

  This is not possible with current technology. Australia's efforts here are world leading and will provide data essential for an effective carbon market.

- **Carbon flux maps**

  We will be able to produce daily maps of CO_2 levels and the corresponding rates of change over micro-, local, state and national regions, thereby supporting carbon tax and emission trading schemes with hard data.

The GGM Program is therefore in a unique position to support the Government's initiatives to deliver a clean energy future for Australia.

- In the short term we can support a carbon tax through additional monitoring of polluters to provide an independent, verifiable measure of emissions
- In the medium term we will support an emissions trading scheme through accurate carbon flux maps, identifying sources and carbon sinks
- In the long term we will provide 'Green Information' to underpin a carbon market.

Australia can profit from these opportunities by helping to establish a carbon market within Australia by providing information that has greater fidelity, is more timely, and has better quality than is currently available.

COMMENTS ON SPECIFIC GOVERNMENT INITIATIVES

Fixed carbon price affecting Australia's 500 biggest polluters

The GGM program will be able to evaluate the effectiveness of setting a carbon price by monitoring the amount of carbon dioxide in the atmosphere.

Through direct measurements over regions spanning micro-sites (such as a single mine, factory or power station) to larger areas (such as the Wimmera, Riverland or Goulburn Valley), we will be able to monitor the quantity and change over time of CO_2 in the atmosphere. This data will provide a valuable supplement to the National Greenhouse and Energy Reporting (NGER) data that is recognised as being

inaccurate due to reporting thresholds and commercial confidentiality provisions under the proposed Carbon Pricing Mechanism.[1]

In addition to validating NGER estimates, uncertainty over emission levels, particularly from fugitive emissions, can be reduced, leading to a more equitable, and effective, economic reform.

If CO_2 pollution estimates are high, industry will have to pay for the uncertainty unfairly. Conversely, if the estimates are low, it will be harder for the Commonwealth to achieve its policy objectives and a cleaner energy future. The GGM Program will provide greater certainty and lead to a better informed monitoring agency.

Remove 460 million tonnes of carbon pollution from the atmosphere by 2050

GGM will provide key information to the farming community to promote agriculture as a means to store carbon. Current methods to estimate carbon sinks are approximate, error prone and unverified. Up to now, there has been no way to measure directly the impact of carbon sinks upon atmospheric carbon. With GGM we have a technology to quantify carbon sinks, thereby informing policy makers, regulators and farmers alike. Programs such as reforestation, for example, can be optimised, monitored and quantified to levels not currently possible.

GGM also will facilitate continuous monitoring of major polluters. This will quantify emissions more accurately and provide more certainty to key industries on the effectiveness of emission abatements efforts.

Support to the Carbon Farming Initiative

The Carbon Farming Initiative (CFI) will encourage farmers to reduce carbon pollution by creating credits for each tonne of carbon pollution that can be stored or reduced on the land. This relies on large-scale but subtle changes in the carbon storage in soils. It is just these kinds of changes, very difficult to measure with direct samples, that GGM is best placed to measure.

Atmospheric column measurements, such as provided by GGM, measure the net effect of carbon storage over a region and are ideally suited to measuring and monitoring carbon storage schemes. Other measurement approaches, in-situ (direct) measurements, aircraft surveys and satellite measurements are usually too local, too expensive or too coarse to be effective to the accuracy needed to support carbon trading at the local (i.e. farm) level.

Quantification of agriculture as a carbon sink will be possible with the GGM Program. This will provide farmers, the agricultural community, and policy makers with the data needed to evaluate the effectiveness of carbon storage schemes and thereby support the CFI.

Establishment of a carbon market by 1 July 2015

International market mechanisms require trust and transparency. Physically based, objective methods of verification like those afforded by GGM provide a basis for both of these.

1 Refer http://www.aph.gov.au/library/pubs/climatechange/CarbonPricing/Companies.htm

The GGM Program will provide key information in a timely manner to a carbon market. GGM will provide the means to validate carbon accounting methods to achieve hitherto unobtained fidelity, providing a more equitable, accountable measure of carbon pollution. Australia therefore will be at the forefront of technology in measuring and monitoring carbon and in a powerful position to shape a carbon market.

By providing more detailed and accurate data, the GGM program will give more certainty to carbon pricing. This, in turn, has the potential to reduce commercial risk to emission-intensive businesses, such as the mining and energy generation industries, potentially leading to greater confidence and resulting in lower emissions over time than if the market was less certain.

Finally, better emission and sequestration data also provides benefits for the agricultural community. Farmers will be better prepared sell carbon credits to industrial polluters and can be less defensive in preparing for extremes of weather.

CONTACT DETAILS

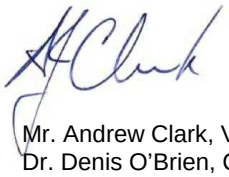
We are happy to provide further information upon request and to appear before the Committee to answer any questions that the Committee may have.

Please address all correspondence to:

Mr. Andrew Clark
Manager, Greenhouse Gas Monitor Programme
Vipac Engineers & Scientists Ltd.
17-19 King William Street, KENT TOWN, SA 5067

Ph: 08 8362 5445
Fax: 08 8362 0793
Mobile: 0421 051 328
Email: andrewc@vipac.com.au

We thank you for your time in considering our submission.



Mr. Andrew Clark, Vipac Engineers & Scientists Ltd
pp Dr. Denis O'Brien, Colorado State University
pp Prof. Peter Rayner, University of Melbourne

Attachments:

GGM_Flyer
GGM Presentation
Letter of Support from the Hon. Mike Rann, Premier, South Australia
Letter of Support from Dr. Greg Ayers, Director of Meteorology, Bureau of Meteorology

Australian Government
Bureau of Meteorology

Dr Greg Ayers
Director of Meteorology
GPO Box 1289
Melbourne VIC 3001
Australia

In reply please quote: Exec 10-0094

Mr. Andrew Clark
Vipac Engineers & Scientists Ltd
17-19 King William St.,
Kent Town, SA 5067

Australian Space Research Program
Greenhouse Gas Monitor (GGM) Program

Dear Mr Clark

I write to express support for the proposed Greenhouse Gas Monitor Program led by Vipac Engineers & Scientists Ltd., supported by the University of Melbourne and the University of Wollongong, which aims to develop the capability to remotely measure CO_2 in the atmosphere.

The program is important as it proposes to facilitate and validate the measurement of CO_2 amount from space by developing instruments both terrestrial and airborne, with the long term aim of allowing carbon accounting at regional and larger scales using a combination of space-based and conventional observations, in addition to the use of carbon transport models. This objective is consistent with the aims of the National Framework for Australian Climate Change Science.

The work is complimentary to the greenhouse gas monitoring program undertaken by the Bureau of Meteorology at Cape Grim and the analysis work will also be undertaken in the framework of the Bureau of Meteorology's ACCESS Earth System Numerical Modelling Capability, an important factor that will provide maximum benefit in terms of understanding local and larger scale climate issues.

The GGM program and its initial work with CO_2, may also be viewed as a first step towards monitoring other greenhouse gases. In addition the program's association with Orbiting Carbon Observatory data may well lead to other benefits such as the development of the capability to measure surface pressure from space.

The team proposed to support this program appear well equipped for this important task and as such we are happy to provide our support and look forward to a successful collaboration.

Yours sincerely

G. P. Ayers

(DR GREG AYERS)
DIRECTOR OF METEOROLOGY

26 August 2010

DPC10D09117

Hon. Mike Rann MP
Premier of South Australia

Mr Andrew Clark
Manager, Defence and Systems Group
VIPAC Engineers & Scientists
17-19 King William Street
KENT TOWN SA 5067

Dear Mr Clark

I am writing to confirm in principle support from the South Australian Government for the Greenhouse Gas Monitor Program proposed by VIPAC Engineers and Scientists and their application for funding under the fourth round of the Australian Space Research Program.

The proposed direct measurement of greenhouse gases by VIPAC in their funding application has the potential to offer independent third party verification of greenhouse gas emission and sequestration accounting methods employed by greenhouse gas emitters and regulators. Their aim to provide scientifically proven, evidence-based measurements of carbon sources and sinks may help to instil greater confidence in businesses, regulators and the wider community regarding action being taken to reduce greenhouse gas emissions. The ability to better verify monitoring data may particularly benefit regional communities supporting emission-intensive industries.

Accurate greenhouse gas emission monitoring is also of importance to the South Australian Government. In 2007, South Australia became the first jurisdiction in Australia to introduce dedicated climate change legislation, which enshrines a number of key targets. Included is a target to reduce greenhouse gas emissions in our State by at least 60 per cent of 1990 levels by the end of 2050. Under the legislation, the Government is required to report progress in meeting these targets.

State and regional governments throughout the world are taking action to address climate change, with an estimated 80 per cent of mitigation and adaption actions occurring at the sub-national level. Independent verification of the effectiveness of these actions has the potential to impact and further improve the effectiveness of climate change policies.

Office of the Premier
State Administration Centre 200 Victoria Square Adelaide South Australia 5000 GPO Box 2343 Adelaide SA 5001
Telephone +61 8 8463 3166 Facsimile +61 8 8463 3168 Email premier@dpc.sa.gov.au www.premier.sa.gov.au

I am further advised that the Greenhouse Gas Monitor Program has the potential to assist the Bureau of Meteorology in improving their forecasting models and as a result, provide better seasonal weather forecasts for regional industries such as agriculture.

Again, for the reasons stated above, the South Australian Government confirms in principle support for the VIPAC Greenhouse Gas Monitor Program and funding application under the fourth round of the Australian Space Research Program.

Yours sincerely

MIKE RANN
Premier

29 / 3 / 2011

Greenhouse Gas Monitor Program

ViPAC Engineers & Scientists

GGM Program

$5.95m, 22 month program (incl. $2.35m Federal grant) to develop:

- **GGM-T:** A low cost, terrestrial instrument to measure CO_2 in the atmosphere
- **GGM-M:** Advanced models to identify CO_2 sources & sinks and transport thru the atmosphere
- A capability to autonomously operate GGM-T and process CO_2 measurements

2

The GGM Consortium won a $2.35m grant through the Australian Space Research Program, administered by the Space Policy Unit of the Department of Innovation, Industry, Science and Research. The GGM program officially began on 5th September 2011 and will conclude on 30th June 2013.

GGM-T

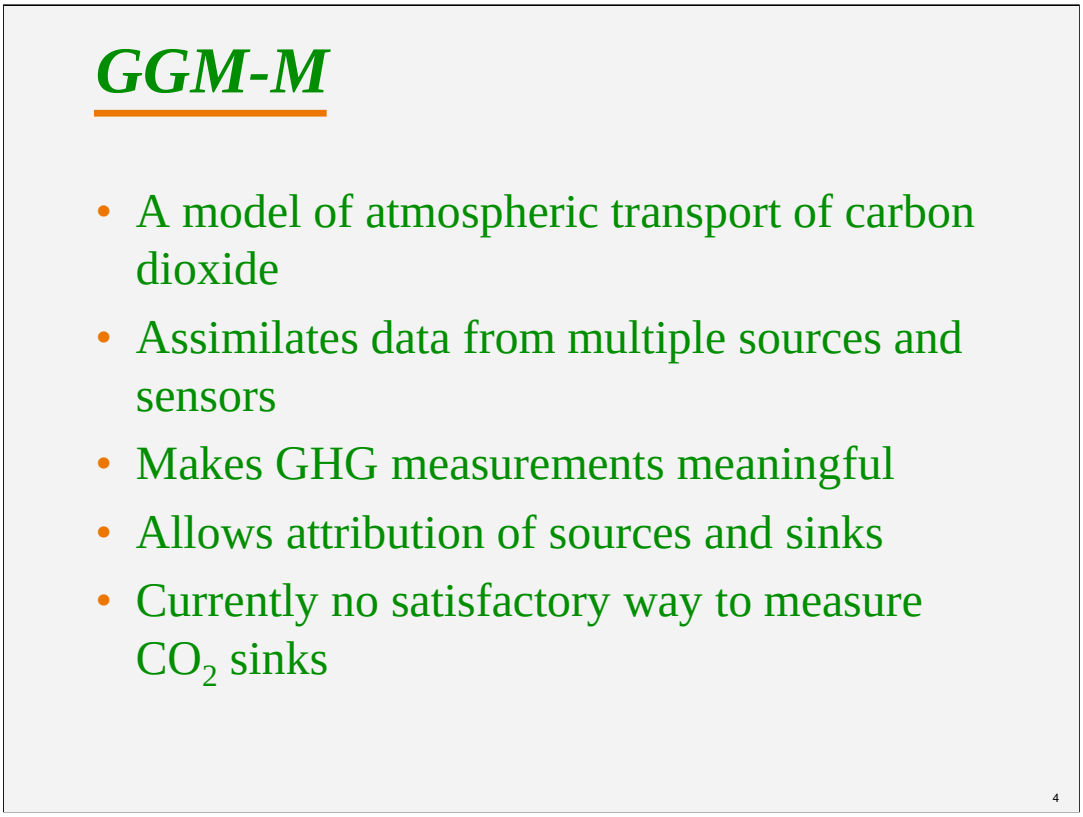
- Land-based, sun staring system to measure carbon dioxide, oxygen and methane
- Uses spectroscopy to give GHG concentrations in air column
- Cheap – 1/10th cost of only competing system
- Fully autonomous
- Novel technology

3

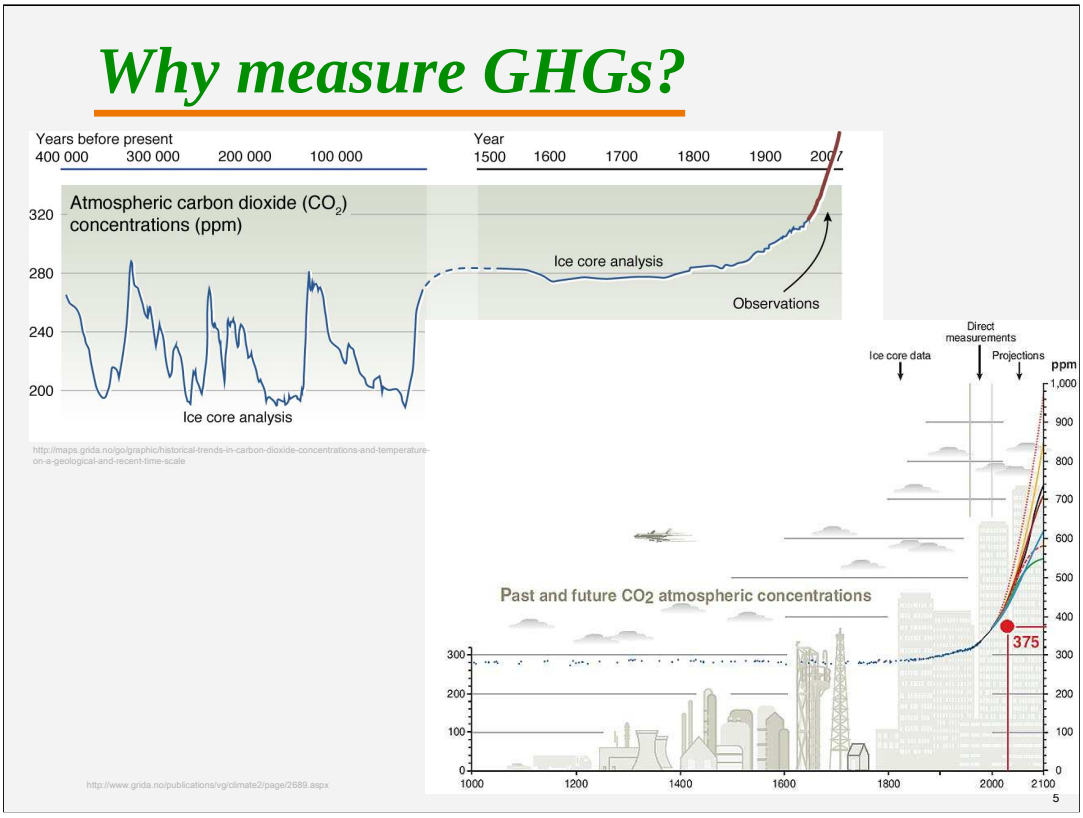
GGM-T will be designed to be self powered and operate autonomously. It will relay measurements back to a data management centre by the most appropriate means available (e.g. land line, mobile phone technology, satellite). GGM-T will take a measurement every few minutes, potentially faster.

GGM-T stares at the sun and, using spectroscopy, measures the concentration of CO2 in the 'column' of atmosphere between the instrument and the sun. These 'column' measurements are more suited than surface, or in-situ, measurements to track the transport of CO2 through the atmosphere and to measure CO2 sinks, such as crops and forests.

The only competing network is the Total Carbon Column Observing Network (TCCON), which consists of (currently) 15 stations around the world, each of which costs ~US$750,000 to establish and additional costs to maintain and process the data. Our aim is for GGM-T to cost 1/10th of TCCON and have minimal operating and maintenance costs apart from periodic calibration. Our aim is also to automate processing GGM-T data.

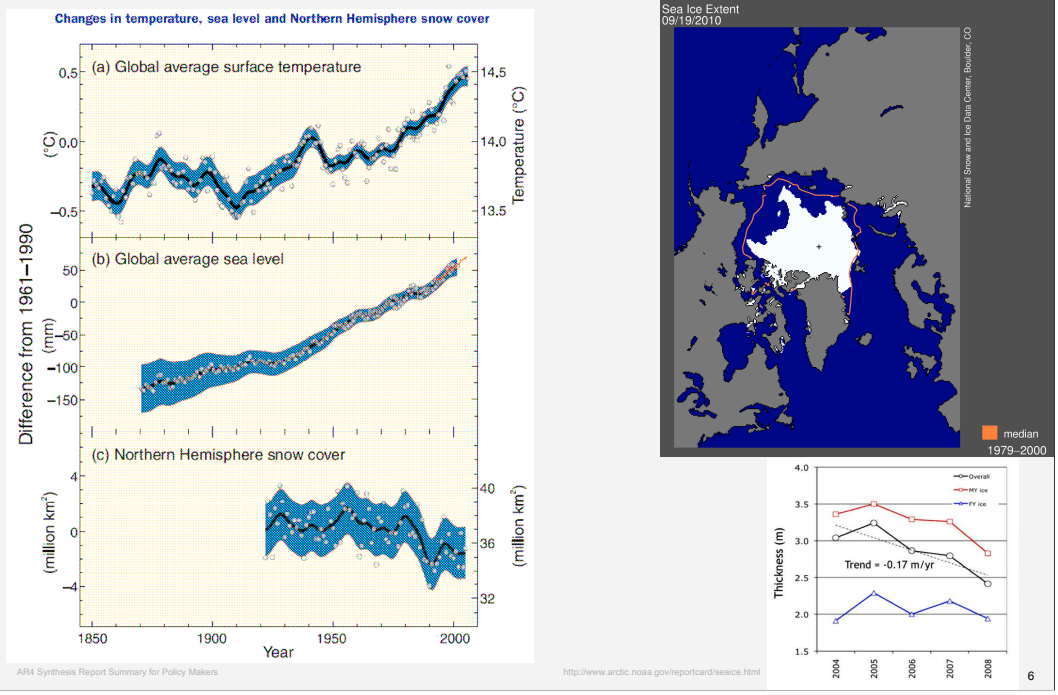


GGM-M will take data from all available sources, including a GGM-T network, in-situ instruments (i.e. sampling of the atmosphere at the surface), flux towers, aircraft measurements and satellite measurements. When combined with Meteorological data, GGM-M will produce carbon flux maps and will attribute CO2 measurements to specific sources and sinks. A further output will be a carbon transport model to predict how CO2 moves through the atmosphere.



Atmospheric CO2 levels have risen alarmingly from an historical level of ~280ppm to over 390ppm since the industrial revolution (current level is 392ppm). Modelling suggests that by 2100, concentrations of CO2 in the atmosphere will reach between 560ppm and close to 1000ppm depending, in part at least, on what actions we take now.

Why measure GHGs?



The body of evidence is overwhelming, consistently showing rising average surface temperatures, rising sea levels and reduced snow cover in the Northern Hemisphere. Multi-year ice at the North Pole is diminishing rapidly. Scientists predict that the North Pole will be completely free of ice for a period each year within 30 years, probably sooner.

Satellite Options

Spaceborne Instruments Capable of Measuring CO2

Specification	OCO	GOSAT	SCIAMACHY	AIRS	IASI
Tropospheric gases measured	CO_2, O_2	CO_2, CH4, O_2, O_3, H_2O	O_3, O_4, N_2O, NO_2, CH_4, CO, CO_2, H_2O, SO_2, HCHO	O_3, CH_4, CO, CO_2, H_2O, SO_2	O_3, N_2O, CH_4, CO, CO_2, H_2O, SO_2
CO_2 sensitivity	Total column including near surface	Total column including near surface	Total column including near surface	Midtropo-shpere	Midtropo-shpere
CO_2 sensitivity (ppm)	1-2	4	14	1.5	2
Horizontal resolution fov/swath - (km)	1.29 × 2.25/5.2	FTS: 10.5/80-790	30 × 60/960	15/1,650	12/2,200
Nominal life	2 years	5 years	7+ years	7+ years	5 years

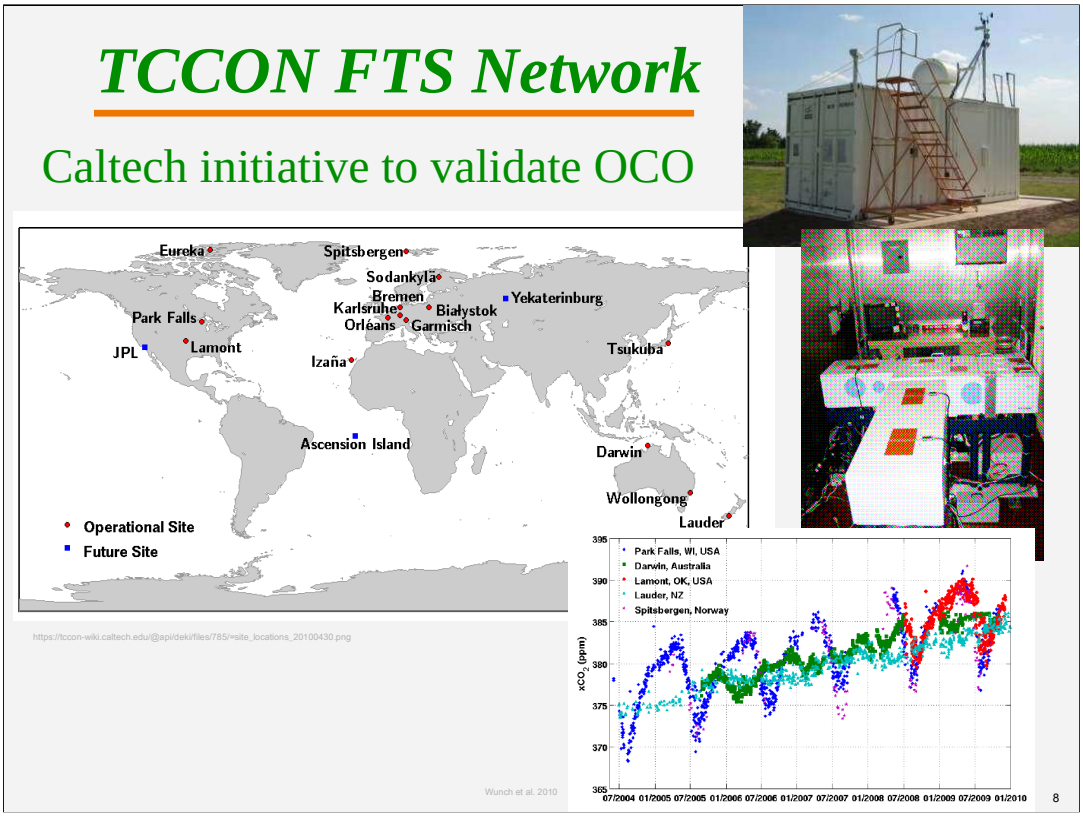
NOTES: AIRS = Atmospheric Infrared Sounder; GOSAT = Greenhouse gases Observing Satellite; IASI = Infrared Atmospheric Sounding Interferometer; OCO = Orbiting Carbon Observatory; SCIAMACHY = Scanning Imaging Absorption Spectrometer for Atmospheric Chartography

National Research Council, Committee on Methods for Estimating Greenhouse Gas Emissions, 2010: Verifying greenhouse gas emissions: Methods to support international climate agreements. ISBN 0-309-15212-7, National Academies Press, Washington, DC, 1-144 pp., URL http://www.nap.edu/catalog/12883.html.

7

GOSAT is the best satellite-based measurements of CO2 but suffers through a lack of ground-based validation measurements (ground-truthing). NASA's OCO failed to reach orbit. A second mission is planned, but it too will suffer through lack of ground-truthing. The other missions are too coarse to support accurate CO2 mapping.

Ground-truthing is required to calibrate satellite measurements to account for atmospheric phenomena that affect the measurement and introduce biases. This includes the presence of water vapour, aerosols, etc.



The Total Carbon Column Observing Network was established as an initiative of the California Institute of Technology (Caltech) to provide a degree of ground-truthing for NASA's Orbital Carbon Observatory (OCO) satellite. TCCON consists of a network of 15 Fourier Transform Spectrometers (FTSs) – currently 15. We calculate that at least 200 are needed, possible 800 or more, to fully ground-truth satellite measurements. Given the cost of each TCCON station (~US$750k) adequate ground-truthing is unlikely to be achieved.

There are only 3 TCCON stations in the Southern Hemisphere, of which two are in Australia, at Wollongong and Darwin, and one at Lauder in New Zealand.

Note that the OCO mission is experimental only, despite costing approx. US$0.25bn, so full ground-truthing was not envisaged by NASA. Following the failed launch of OCO, NASA funded a replacement satellite, OCO-2, which is currently being qualified through testing in the USA.

The GGM Consortium consists of Vipac as the lead Consortium Member with the University of Wollongong, University of Melbourne, the Bureau of Melbourne, the Australian National University and Rosebank the other members.

Benefits

Australian Government

- Able to quantify carbon sources & sinks:
  - More equitable carbon tax reform, ETS
  - Validated carbon accounting

Bureau of Meteorology

- GGM-T network gives accurate carbon map
  - Improved temperature determination
  - Improved forecasts (weather & climate)

10

Benefits

Climate Scientists

- Better understanding of carbon cycle (esp. sinks)
  - Quantifies land use for carbon control
  - Support better transport and radiation models

GHG Measurements from Space

- GGM-T network able to validate satellite data (ground-truthing)
  - Requires 200+ instruments globally (800 better)
  - Unlocks current and future satellite data
  - Performs function TCCON can’t

Support

- From *all* major GHG monitoring programs…

DOMESTIC SUPPORT:

Bureau of Meteorology

Centre for Australian Weather & Climate Research (CSIRO/BoM)

Institute for Photonics & Advanced Sensing

Global Carbon Project

University of Adelaide, the Environment Institute

INTERNATIONAL SUPPORT:

JAXA, Satellite Applications & Promotion Center (Japan)

National Institute for Environmental Studies, **GOSAT** Project Office (Japan)

Research Institute for Humanity & Nature (Japan)

Jet Propulsion Laboratory, **OCO-2** Project (USA)

California Institute of Technology, **TCCON** Project (USA)

National Institute of Water & Atmospheric Research (New Zealand)

Institute of Environmental Physics & Remote Sensing, **GOME-1** & **SCIAMACHY** Projects (Germany)

University of Bremen, **CarbonSat** Project (Germany)

12