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FOI Number: FOI2016/7

Date: 16 February 2016

Request: All communications between the CSIRO and Bureau of Meteorology over the contracts for operating Cape Grim between July 2015 and December 2015, particularly emailed or other written communications on the respective funding arrangements of CSIRO and the bureau for Cape Grim - including the analysis costs for the Gas Lab in Aspendale - for the current financial year (ie 2015-16).

Document(s): 1-18

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**From:** Sam Cleland <S.Cleland@bom.gov.au>
**Sent:** Thursday, 9 July 2015 12:53 PM
**To:** Alastair Williams; Galbally, Ian (O&A, Aspendale); van der Schoot, Marcel (O&A, Aspendale); Keywood, Melita (O&A, Aspendale); Fraser, Paul (O&A, Aspendale); Krummel, Paul (O&A, Aspendale); Steele, Paul (O&A, Aspendale); swilson@uow.edu.au; Lawson, Sarah (O&A, Aspendale); Matt Tully; LeMarshall, John (BoM) - Contact
**Cc:** Bruce Forgan; Cleugh, Helen (O&A, Yarralumla); griffith@uow.edu.au; Terry Stiles; Stuart Baly; Cindy Hood
**Subject:** RE: Cape Grim Science Program Working Group meeting, 10:30am 16 July 2015, BoM, 6th Floor, Conf Rm 1 - DRAFT AGENDA [SEC=UNCLASSIFIED]
**Attachments:** 1516_Governance_Reactive_Gases.doc; 1415 _Governance_Reactive_Gases_completed.doc; Reactive_Gases_ResProp1516.doc; 2015PropOH_1.pdf; Cape_Grim_WGM_Agenda_20150716-V20150709.doc

Hi Guys

A reminder, the Working Group Meeting is next Thursday 16 July 2015, 10:30am, in the BoM building, 6th Floor, Conf Rm 1.

Attached is a discussion paper from Stephen Wilson on some interesting prospects, with an associated agenda item added.

I've received Governance docs and research proposal from the Reactive Gases group, which are attached. Others still to come.

Look forward to seeing you then.

Cheers

**Sam Cleland** | Officer in Charge

Australian Government
Bureau of Meteorology

**Observations and Infrastructure** | Cape Grim Baseline Air Pollution Station
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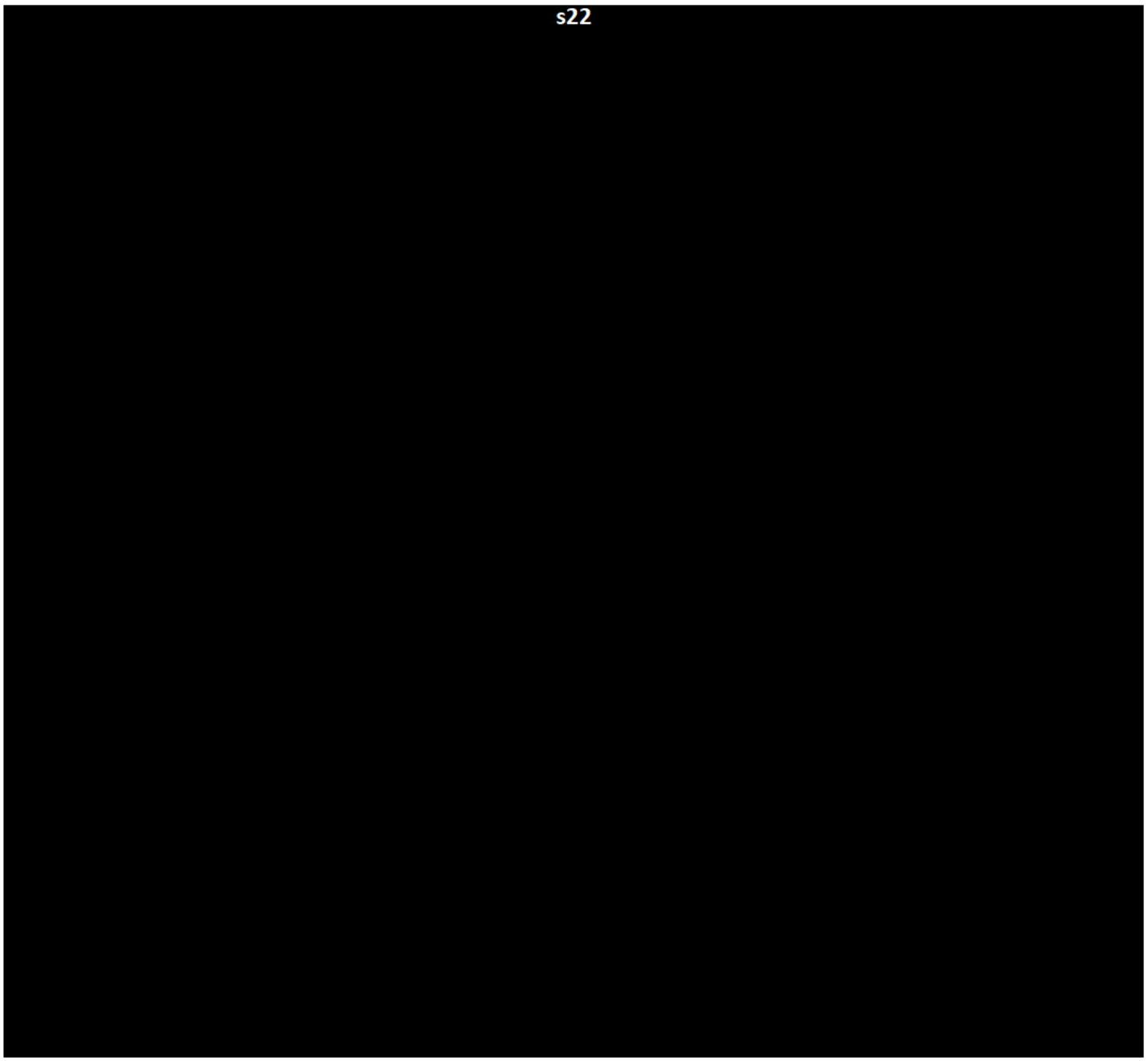
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# Cape Grim BAPS Science Program
# Sub-Program Lead Scientist Governance Form

**Lead Scientists: Ian Galbally and Sarah Lawson**
**Sub-Program: Reactive Gases**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | Raw 2015 data collection > 90% for $O_3$, >50% for NOxy, >50% for VOCs first successful acquisition of data for $NH_3$ | | Data and information collected by the measurement process, and prior to modification by post analysis or quality control. Include information on period of collection |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are: describe (list) quantities and the end period of collection for raw data |
| 3 | All Meta* data to CGBAPS for archival for 2013 by 30 June 2016 | | Meta data includes any information required to process and interpret the data |
| 4 | Annual operation and data summary report 2014 for Baseline to OiC BAPS by 30 June 2016 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by Feb 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least three WGM in FY | | |
| 10 | Four funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# Reactive Gases Research Proposal 2015-2016

## CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** Continuing
**Program or Project Title:** Reactive Gases
**Requested Total Funding:** $68,000
**Working (Short) Program or Project Title:** Reactive Gases
**Program or Project Leaders:** Ian Galbally and Sarah Lawson

### Program or Project Outcome:

*In less that 50 words describe the outcomes of your research, eg: Develop a sulfur isotope technique for use on the Delta-C Mass Spectrometer enabling determination of aerosol source sulfur isotopic signatures and to allow new studies of aerosol chemistry at Cape Grim.*

Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

### Program or Project Summary:

*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and international community.*

Ozone is one of the key constituents of the background lower atmosphere. Ozone has important roles in the chemistry, ultraviolet radiation transmission, greenhouse absorption and health impacts of tropospheric air. The monitoring program at Cape Grim is regarded as one of the best high quality baseline records in the world and is used in definitive studies of tropospheric ozone. Much of the current knowledge of ozone behaviour in the marine boundary layer has been developed at Cape Grim. NOx and VOCs are central (with $O_3$) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region. Data will be submitted to the World Data Centre for Greenhouse Gases. These will be amongst the first ammonia and OVOCs monitoring activities in the background marine atmosphere globally.

### Travel and Personnel Cost Justification:

*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form 2009-2010, then please provide written support for your requirement for these funds.*

6 trips for 5 days for 2 persons to Cape Grim.

### Equipment Required

Replacement items (CAPEX) are required to bring the program up to standard, listed in order of preference:

Ozone Calibrator

Permeation Source for NH3 analyser

CRDS for $NO_2$,

### Report on completion of Targets by 30 June 2015

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.

  *Ozone and NOxy measurements have been maintained throughout the year with 4 visits by the Ian Galbally and Suzie Molloy. Surface ozone measurements continue with monitors TECO#3, TECO#4 and TECO#5. The current calibrator is TECO49CPS with the OMCS2. An additional calibrator TECO49iPS has been bought on line. The OMCS2 zero and span unit, installed in March 2010, has had some unexpected problems with solenoid valves not operating successfully. These valves have been replaced with more appropriate substitutes in*

*March 2015. A rationalisation of the ozone zeros and spans has been undertaken, the new schedule operating from 4 September 2014.*

*The NOxy instrument has continued running. Ian Galbally has been undertaking some data processing. The first results were shown at the Reactive Gases Program Review at the CGASM, November 2014.*

- Commissioning of VOC monitoring equipment for Cape Grim monitoring program. Obtain first hydrocarbon and OVOC data. OVOC measurements are a major step forward in monitoring.

  *System commissioned at Cape Grim by Sarah Lawson and Min Cheng and continuous in-situ measurements commenced November 2014. Hydrocarbon data from November – April has been processed using GCWerks with assistance from Paul Krummel. Faulty Polyscience water bath (for sample drying) lead to 1 month lost data but has since been replaced by alternative system which is working well(Vapourtrap).Identification of OVOC peaks and processing of OVOC data will be undertaken in 2015-16.*

- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring

  *Instrument is not functioning at this stage. Additional help is being sought from the manufacturer, and further tests await the delivery of the ammonia permeation source calibrator.*

- Participate in Summer January-February 2015 Field experiment at Cape Grim

  *Not done due to competing demands of the RV Investigator.*

- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years (Min Cheng).

  *Underway*

- Have two years of NOxy data to December 2014 processed by June 2016.

  *Not done due to time constraints*

- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station involving Jason Ward/ Suzie Molloy/Min Cheng/Sarah Lawson/Ian Galbally.

  *Maintenance schedule for ozone in mature state, NOxy maintenance schedule developed but still undergoing testing and revision.*

- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.

  *Not done, awaiting results from Technical Paper*

- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.

  *This is a major undertaking essential for the long term records of Cape Grim. The task has taken longer than expected and is still underway. The draft report was included in the Reactive Gases Program Review at the CGASM, November 2014.*

- Paper submitted to journal on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics Discussions*

- Paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage and Cape Grim (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics*

- Publish a further paper on ozone trends in the extra-tropical region of the Southern Hemisphere.

  *Not done, awaiting results from Technical Paper*

- Archive hourly provisional data for 2014 with WDCGG

  *2014 ozone data archived.*

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015

  *2014 ozone data submitted*

- Provide 2014 Program report to OiC by 30 June 2015

  *In preparation*

## Conference, Workshop and Other Presentations

"Biomass burning at Cape Grim: using modelling to explore a possible urban influence on plume photochemistry and composition". Sarah Lawson, Aerosol Modelling and Observations Workshop, incorporating the 2014 Frohlich Lecture, August 21st 2014 Aspendale.

"Atmospheric acetonitrile – its life away from biomass burning influences." Ian Galbally, Short seminar, CSIRO Oceans and Atmosphere, Aspendale 16 September 2014.

"Observations of Atmospheric Acetonitrile in the Mid-Latitudes of the Southern Hemisphere and its Global Distribution Away from Biomass Burning Influences". Ian Galbally, Plenary talk at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"The retrospective application of GAW measurement guidelines to existing long term surface ozone records: A case study at Cape Grim, Australia". Ian Galbally, Poster presentation at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"Further developments in background VOC monitoring at CSIRO Marine and Atmospheric Research." Ian Galbally, Invited presentation at the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

"The Cape Grim Reactive Gases Program Summary 2008 - 2014", I. E. Galbally and S. J. Lawson, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The global distribution of atmospheric acetonitrile away from the influence of biomass burning" W. V. Kirstine, I. E. Galbally, E. Dunne, S. J. Lawson, S. Molloy E. Zardin, S. Saunders, É.-A. Guerette and C. Murphy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"First in situ measurements of glyoxal and methylglyoxal over the remote temperate oceans" .S. J. Lawson, P. W. Selleck, I. E. Galbally, M. D. Keywood, M. J. Harvey, C. Lerot, D. Helmig and Z. Ristovski, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Update on the MUMBA Campaign: Measurements of urban, marine and biogenic air" C. Paton-Walsh, É.-A. Guérette, G. Rea, D. Kubistin, R. Humphries, S. R. Wilson, D. W. T. Griffith, R. Buchholz, V. Velazco, X. Shi, I. E. Galbally, M. D. Keywood, S. J. Lawson, P. W. Selleck, M. Cheng, S. Molloy, M. Bhujel, A. D. Griffiths, S. D. Chambers and P. Davy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Progress of Enhanced Atmospheric Composition Measurement Capability at Cape Grim BAPS and the Expanding CSIRO Atmospheric Observation Network" M. V. van der Schoot, Z. M. Loh, M. D. Keywood, J. P. Ward, C. P. Meyer, S. Molloy, I. E.Galbally, S. J. Lawson, D. A. Spencer, J. Ward, N. T. Somerville, P. B. Krummel, L. P. Steele, R. L. Langenfelds, D. P. Thornton, S. A. Coram and R. L. Gregory, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The ACCESS-UKCA chemistry-climate model: exploring long-term trends in atmospheric composition" M. T. Woodhouse, A. K. Luhar, P. F. Uhe, M. Thatcher, I. E. Galbally, S. Molloy, R. L. Langenfelds, L. P. Steele, P. B. Krummel, M. V. van der Schoot, D. M. Etheridge, C. M. Trudinger and P. J. Fraser, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Atmospheric Ozone" a 2 hour lecture to MSc students at RMIT University, Ian Galbally, 1 April 2015.

"Tropospheric Ozone Data Availability for Oceania and Antarctica" Ian Galbally, presentation at the Tropospheric Ozone Assessment Report (TOAR) Workshop 2, Madrid, Spain 27-30 April 2015

"Overview of Reactive gases and aerosol measurement capability at CSIRO Aspendale" Sarah Lawson, Australian Partners In Ice core Science Workshop, 18-19 May 2015, Aspendale, Victoria

## Papers: Journals, Reports, Conference Proceedings and Posters

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang, R. M. Zbinden (2014) Global distribution and trends of tropospheric ozone: An observation-based review Elementa: Science of the Anthropocene, 2, 000029, doi: 10.12952/journal.elementa.000029
http://elementascience.org/article/info:doi/10.12952/journal.elementa.000029

Lawson, S. J., Selleck, P. W., Galbally, I. E., Keywood, M. D., Harvey, M. J., Lerot, C., Helmig, D., and Ristovski, Z.: Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere, Atmos. Chem. Phys., 15, 223-240, doi:10.5194/acp-15-223-2015, 2015.

http://www.atmos-chem-phys.net/15/223/2015/

Lawson, S. J., Keywood, M. D., Galbally, I. E., Gras, J. L., Cainey, J. M., Cope, M. E., Krummel, P. B., Fraser, P. J., Steele, L. P., Bentley, S. T., Meyer, C. P., Ristovski, Z., and Goldstein, A. H.: Biomass burning emissions of trace gases and particles in marine air at Cape Grim, Tasmania, 41° S, Atmos. Chem. Phys. Discuss., 15, 17599-17649, doi:10.5194/acpd-15-17599-2015, 2015.

http://www.atmos-chem-phys-discuss.net/15/17599/2015/acpd-15-17599-2015.html

Martin G. Schultz, Hajime Akimoto, Jan W. Bottenheim, Brigitte Buchmann, Ian Galbally, Stefan Gilge, Detlev Helmig, Hiroshi H. Koide, Alastair A. Lewis, Paul Novelli, Christian C. Plass-Duelmer, Thomas T Ryerson, Martin Steinbacher, Rainer R. Steinbrecher, Oksana Tarasova, Kjetil Torseth, Valerie Thouret, and Christof Zellweger (2015) The Global Atmosphere Watch reactive gases measurement network. *Elementa: Science of the Anthropocene*, submitted.

R.S. Humphries, R. Schofield, M.D. Keywood, J. Ward, J.R. Pierce, C.M. Gionfriddo, M.T. Tate, D.P. Krabbenhoft, I.E. Galbally, S.B. Molloy, A.R. Klekociuk, P.V. Johnston, K. Kreher, A.J. Thomas, A.D. Robinson, N.R.P. Harris, R. Johnson, and S.R. Wilson, (2015) Boundary layer new particle formation over East Antarctic sea ice - possible Hg catalysed nucleation? *Atmos. Chem. Phys. Disc.*, MS No.: acp-2015-336 submitted.

S.D. Chambers, A.G. Williams, F. Conen, A.D. Griffiths, S. Reimann, M. Steinbacher, P.B. Krummel, L.P. Steele, M.V. van der Schoot, I.E. Galbally, S.B. Molloy and J.E. Barnes. Towards a universal "baseline" characterisation of air masses for high- and low-altitude observing stations using Radon-222. *Aerosol and Air Quality Research*, submitted.

S.D. Chambers, A.G. Williams, J. Crawford, A.D. Griffiths, P.B. Krummel, L.P. Steele, R.M. Law, M.V. van der Schoot, I.E. Galbally, and S.B. Molloy. A Radon-only technique for characterizing "Baseline" constituent concentrations at Cape Grim, *Baseline Atmospheric Program (Australia) 2011-2013*, submitted.

"Air-sea gradient fluxes of DMS during Surface Ocean Aerosol Production (SOAP) experiment" Murray Smith, Carolyn Walker, Cliff Law, Mike Harvey, Tom Bell, Sarah Lawson, Eric Saltzman. Poster presentation at Earth Observation for Ocean-Atmosphere Interactions Science Conference , Rome, 29-31St October 2014

### Other significant activities

Ian Galbally continued active involvement with the WMO SAG on Reactive Gases.

Ian attended the 25th Anniversary celebration of GAW and a meeting of the WMO GAW Scientific Advisory Groups, 23 September 2014, Brazil. The newly refined WMO GAW goals are:

- science for services,
- all data must have applications,
- seamless access to data for best service delivery.

Ian also attended a WMO SAG on Reactive Gases and the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

Ian Galbally has contributed to the first WMO GAW measurement guidelines for NOx (draft).

Sarah continued her activities as SOLAS representative for Australia, including production of annual National SOLAS report (with fellow representative Andy Bowie).

Sarah contributed to the 10 year SOLAS strategic plan

Sarah Lawson and Ian Galbally have contributed to the first WMO GAW measurement guidelines for VOCs (draft).

The team participated in two research voyages on the RV Investigator in 2015

## Targets by 30 June 2016

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.
- Maintain the VOC measurements. Identify OVOC peaks. Document data processing steps (GC Werks) and train Min Cheng in processing hydrocarbon and OVOC data...
- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring
- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years with the aim of ensuring compatibility of current and past hydrocarbon measurements.
- Have two years of NOxy data to December 2014 processed by June 2016.
- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station.
- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.
- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.
- Paper submitted to journal on modelling impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)
- Second paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage, in collaboration with University of Cambridge (led by Sarah Lawson)
- Publish a paper involving observations and modelling on ozone trends in the extra-tropical region of the Southern Hemisphere.
- Archive hourly provisional data for 2015 with WDCGG
- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Provide 2015 Program report to OiC by 30 June 2016

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Ian Galbally and Sarah Lawson**
**Sub-Program: Reactive Gases**
**Financial Year: 2014 -2015**

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# DRAFT - CG RESEARCH OPPORTUNITIES

STEPHEN WILSON, CENTRE FOR ATMOSPHERIC CHEMISTRY, UOW

CONTENTS



## 1. ATMOSPHERIC REACTIVITY

In a visit to Australia in 2014 Hartwig Harder (MPIC) expressed an interest in a measurement campaign to study the reactive chemistry of the southern hemisphere atmosphere. Studies of the clean to slightly polluted reactive chemistry are very limited. On a cruise in the southern Atlantic [Hosaynali Beygi et al., 2011] measurements agreed with theory under very clean and in polluted conditions, but in slightly polluted conditions ($10\ pptv < NO_2 < 20\ pptv$) there was a significant discrepancy between measured and calculated $NO_2$ mixing ratios. There have been some questions raised regarding the calibration of the instruments, which could explain the observations. Alternatively, there are reactive processes which are not understood.

*Do we understand the Leighton ratio under slightly polluted conditions? Are there other oxidants that play a role?*

It would therefore be worthwhile revisiting this issue with as complete a measurement suite as possible. Further, there have been very little study of nighttime reactive chemistry at Cape Grim. Nitryl chloride ($ClNO_2$) has been found to be present in significant quantities when polluted air is mixed with maritime air [Phillips et al., 2012]. In principle this could be a significant species when CG is influenced by pollution sources, which could provide an important source of Cl atoms, providing a significant additional atmospheric oxidant.

*Is nitryl chloride important in the marine boundary layer downwind of continents in the southern hemisphere?*

Cape Grim should provide an ideal base for making such measurements, with exposure to a range of air mass types. The measurement list, with suggested instrument sources:

- $NO$,$NO_2$ CG, MPI (Multiple flavours - Cavity ring down, LIF, chemiluminescence,...)
- $O_3$ CG
- $NMHCs$ CG, MPI (?)
- $HCHO$ MPI (Horst Fischer)
- $OH$ MPIC (Hartwig)
- $OH$ reactivity (MPIC, Jonathan W., Hartwig H.)
- $ClNO_2$ (MPI)
- $RO_2$ (UBremen) - note issues with CO used in PERCA detector.
- $J(O\ ^1D)$, $J(NO_2)$ CG
- Atmospheric vertical structure?

1.1. **Campaign concept.** I have stressed that short campaigns at Cape Grim have been of limited success. The aim is therefore for a minimum of 3 months of measurements, but preferably one year. The concept then is that the instruments would be installed, and then require minimum staff during the measurement period. Possibly then specify intensive periods during the year to try to capture seasonal variability. This is probably the most contentious issue given the potential costs. John Burrows (Bremen) has an interest in getting measurements for 1 – 4 years ($RO_2$)! (Could make a good PhD project).

The MPIC has recently commissioned 3 shipping containers for atmospheric measurements. (It is not clear that all three would come!) They have been deployed with one on top of the other. These could provide the base for the MPI measurements listed below.

1.2. **Questions.** There are many unresolved issues. Here are some in no particular order, except for the first one.

(1) Is there sufficient local interest in carrying out these measurements? This is a deal-breaker.
(2) What Australian sourced measurements do we want to include?
(3) How will this be funded. MPI can provide their own funds - and probably can provide partial support for Bremen, but what else would we need?
(4) When? Suggestion is end 2016 – 2017. Is this practical?
(5) Is there a role for AIRBOX?
(6) Are there things that we are missing that we need to seek?

## 2. OH ESTIMATION

I have been approached by Jonathan Williams (MPIC, Mainz) with a research suggestion. He has noted his work on inferring the OH concentration through the

use of radon, CO and three relatively short-lived hydrocarbons. Williams et al. [2001] Due to their lifetime, this provides a regional rather than local estimate of the OH concentration.

In brief, the method used for Amsterdam Island data uses the variability in gas concentrations to infer the concentration of OH, based on the empirical relationships proposed by Ehhalt et al. [1998].

In principle most of the measurement components exist within the Cape Grim community. Radon measurements have been made since in 1986, CO measurements exist for a similar period. There are some measurements of hydrocarbons, although the coverage is less clear. The key species used by Williams et al. were ethane, propane, 2-methyl propane and butane.

Most of the hydrocarbon species have been measured on the Medusa system via AGAGE, starting in early 2004. There are also VOC measurements made in part by the reactive gases group in 1999 (as I understand it). The recent work by Sarah Lawson will add additional species to this list.

In a related study, Ian Galbally would like to compare ozone variability, water vapour and $J(O\ ^1D)$, which spans 2000 - 2006 currently. This will give a measure of the production rate of OH at Cape Grim itself.

## 3. CARIBIC connection

With the retirement of Carl Brenninkmeijer, the management of the CARIBIC program (instrumented container flying on Lufthansa commercial flights) has changed. While Dr. Andreas Zahn (Karlsruhe IT) has taken over the overall lead, the GC analysis of air samples is now being managed by Jonathan Williams (MPI Chemistry), and they have recently commissioned a new GC with ICP-AES elemental detector (C,N,S), primarily for measuring NMHCs. The detector is noted for its sensitivity and linearity. Jonathan is keen to also measure samples from Cape Grim, which could offer a useful cross- calibration between measurements at Cape Grim and the CARIBIC measurements, and potentially offer access to chemical species not currently measured at Cape Grim.

I have asked Jonathan for an estimate of sample volume, frequency, etc., but as yet have not received a response. Perhaps it would be better if Sarah/ Ian contacted Jonathan if they have an interest?

## References

D H Ehhalt, F Rohrer, A Wahner, M J Prather, and D R Blake. On the use of hydrocarbons for the determination of tropospheric OH concentrations. *Journal of Geophysical Research: Atmospheres (1984–2012)*, 103(D15):18981–18997, August 1998.

Z Hosaynali Beygi, H Fischer, H D Harder, M Martinez, R Sander, J Williams, D M Brookes, P S Monks, and J Lelieveld. Oxidation photochemistry in the Southern

Atlantic boundary layer: unexpected deviations of photochemical steady state. *Atmospheric Chemistry and Physics*, 11(16):8497–8513, 2011.

G J Phillips, M J Tang, J Thieser, B Brickwedde, G Schuster, B Bohn, J Lelieveld, and J N Crowley. Significant concentrations of nitryl chloride observed in rural continental Europe associated with the influence of sea salt chloride and anthropogenic emissions. *Geophysical Research Letters*, 39(10):n/a–n/a, May 2012.

J Williams, V Gros, B Bonsang, and V Kazan. HO cycle in 1997 and 1998 over the southern Indian Ocean derived from CO, radon, and hydrocarbon measurements made at Amsterdam Island. *Journal of Geophysical Research*, 106(D12):12719, 2001.

AGENDA

# Cape Grim Science Program – Working Group Meeting
# Thursday 16 July 2015, 10:30 start
# 6th floor, Conference Room 1.
# Bureau of Meteorology
# 700 Collins St, Docklands Vic 3008

1. **Apologies**
   a. Sarah Lawson, David Griffith

2. **Minutes from the last Working Group meeting**

3. **Action items arising from the last Working Group meeting**

4. **Correspondence between Management Group and Working Group**

5. **Operations program report (Sam Cleland)**

6. **Resource planning**
   a. **Review of 2014-2015 expenditure.**
   b. **2015-2016 Research Proposals, 2014-2015 and 2015-2016 governance form presentation and discussion.**
   c. **Asset replacement plans**

7. **CG strategic planning**

8. **Program reviews.**

9. **Baseline update**

10. **Web site update**

11. **40th anniversary commemoration plans.**

12. **Any other business**

    a. **New instruments: progress reports and plans.**
    b. **TCCON: latest happenings**
    c. **Progress on data WDCGG submissions.**
    d. **Cape Grim Atmos. Reactivity & CARIBIC Research Opportunities (Stephen Wilson)**

13. **Date and venue of next meeting (including CGASM).**

14. *Closed meeting for Working Group members only (if required)*

15. **Asset sub-committee (Sam Cleland, Stephen Wilson, Paul Krummel) to convene - (If not done before hand).**

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Friday, 10 July 2015 12:41 PM
**To:** 'Sam Cleland'
**Cc:** van der Schoot, Marcel (O&A, Aspendale); Keywood, Melita (O&A, Aspendale); Galbally, Ian (O&A, Aspendale); Lawson, Sarah (O&A, Aspendale); Steele, Paul (O&A, Aspendale); Fraser, Paul (O&A, Aspendale)
**Subject:** RE: Cape Grim Science Program Working Group meeting, 10:30am 16 July 2015, BoM, 6th Floor, Conf Rm 1 - DRAFT AGENDA [SEC=UNCLASSIFIED]
**Attachments:** CG_ResProp_Salary_2015-2016.doc

Hi Sam,

Please find attached the 'Research Proposal' for the CSIRO salary component. I'll send through our other ones as we complete them.

Cheers, Paul

# CGBAPS One-Page Research Proposal Form 2015-2016

| | |
|---|---|
| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **CSIRO Salary Support** |
| **Requested Total Funding:** | **$279,000** |
| **Working (Short) Program or Project Title:** | **CSIRO Salary Support** |
| **Program or Project Leader:** | **Paul Krummel, Melita Keywood, Paul Fraser, Paul Steele, Ian Galbally, Marcel van der Schoot, Sarah Lawson** |

Program or Project Outcome:
Technical support for Lead Scientists Cape Grim observational activities.

Program or Project Summary:
CSIRO salary support calculated from 2014/2015 requested support ($270,750), plus an estimated 1% salary increase, giving a total of $273,500. CSIRO expected to match this with a salary contribution of approximately $980,000 (this contribution excludes CSIRO Flagship and Corporate overheads). The total funding request above ($279,000) also includes $1000 for Nada Derek to travel to the Cape Grim annual science meeting and $4,500 for the NOAA representative to attend the Cape Grim annual science meeting in 2015.

Travel and Personnel Cost Justification:
The salary support provides the equivalent of approximately 2.5 support positions at CSOF4 level (not including CSIRO Flagship and Corporate overheads).

Equipment Required: None.

Completion of 2014-2015 Targets
Targets are defined under each Lead Scientists programs.

Targets by 30 June 2016
Targets are defined under each Lead Scientists programs.

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Monday, 13 July 2015 2:57 PM
**To:** 'Sam Cleland'
**Cc:** van der Schoot, Marcel (O&A, Aspendale); Steele, Paul (O&A, Aspendale); Fraser, Paul (O&A, Aspendale)
**Subject:** RE: Cape Grim Science Program Working Group meeting, 10:30am 16 July 2015, BoM, 6th Floor, Conf Rm 1 - DRAFT AGENDA [SEC=UNCLASSIFIED]
**Attachments:** CG_ResProp_GHG_2015-2016.docx; LSGovernance_GHG_2014-2015_completed.doc; LSGovernance_GHG_2015-2016.doc

Hi Sam,

Please find attached the Research Proposal and Governance forms for the Cape Grim GHG program.

Cheers, Paul, Paul, Paul & Marcel

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** Continuing
**Program or Project Title:** Greenhouse and Ozone Depleting Gases
**Requested Total Funding:** AGAGE $55.5K (includes $28K station allocation)
$CO_2$ $48K (includes $2K station allocation)
**Working (Short) Program or Project Title:** GHG
**Program or Project Leader:** Paul Krummel, Paul Steele, Marcel van der Schoot, Paul Fraser

Program or Project Outcome:

**Outputs:**

• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
• the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
• regular submission of the Cape Grim data to the relevant national and international data archives;
• enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
• continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;

**Impacts:**

• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Program or Project Summary:

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the two premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into, the global assessments of the Intergovernmental Panel on Climate Change and the WMO Scientific Assessments of Ozone Depletion and the national assessments of greenhouse gas (GHG) emissions, as part of the UNFCCC reporting process.

The Greenhouse and Ozone Depleting Gases Program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived GHGs (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

NOTE that this project is the amalgamation of two previous Cape Grim projects, namely 1) $CO_2$, $CO_2$ isotopes and GASLAB flasks; and 2) non-$CO_2$ greenhouse gases (AGAGE); into one consolidated Cape Grim Greenhouse Gases project.

Travel and Personnel Cost Justification:

| | |
|---|---|
| WGM: | 1 trip to WGM (4 people, 2 days, airfares, ground transport, meals, accomm.) $4K |
| CGASM: | 1 trip to CGASM-Murramarang (4 people, 3 days, airfares, car hire, meals, accomm.) $4K |
| Cape Grim: | 7 trips to Cape Grim (2-3 people, 3 days, airfares, ground transport, meals) $12K |

Equipment Required

| | |
|---|---|
| 1 regulator | $1,500 |
| 1 valco valve | $2,800 |
| 1 MKS pressure control valve | $1,300 |

Completion of 2014-2015 Targets

1. Return a significant subset of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997. *Six of the CSIRO GASLAB $CO_2$ primaries (four existing and two new cylinders) were sent to NOAA and recalibrated during 2014-2015. The remainder will be sent to NOAA during 2015-2016 for*

*recalibration. Reprocessing of the Cape Grim in situ $CO_2$ data from 1986-2004 is currently underway and will continue into 2015-2016.*

2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums. *Done and continuing. Extensive comparisons between CSIRO flasks and in situ analysers at Cape Grim is undertaken regularly as an internal quality control check, some of these results were reported during the Cape Grim Annual Science Meeting in 2014. The CSIRO/NOAA flask same air ICP is done regularly and is ongoing. The 6th WMO round robin is currently underway with measurements completed in GASLAB. Extensive comparisons of international cooperative flask sampling programs at Cape Grim (in particular NOAA) to in situ analysers at Cape Grim is undertaken every 6 months with the results reported/presented at the twice yearly international AGAGE meetings.*
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head). *Further progress has been made towards manuscripts on the $CO_2$ gradient across the Southern Ocean between Cape Grim and Macquarie Island – manuscripts(2) expected to be submitted in 2015/2016.*
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2/CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head). *Ongoing: The LoFlo $CO_2$ analyser continued operation at Baring Head, NZ throughout 2014/2015. A final inter-calibration of Baring Head primary $CO_2$ air standards and LoFlo cal standards will be completed. A detailed comparison will be completed and a decision will be made whether to continue this experiment further.*
4. New instrument installations/upgrades and overlap experiments at Cape Grim:
   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$. *Data now processed with GCWerks-CRDS and testing of control with GCWerks-CRDS to be undertaken shortly and implemented at Cape Grim during 2015/2016. Detailed overlap comparisons of Picarro data to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$ are undertaken/updated regularly (results presented at the Cape Grim Annual Science Meeting 2014) with results showing in general good agreement between the analysers, but with some interesting features.*

   Aerodyne $CO/N_2O$: Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$. *Note Done – plan to undertake this in in 2015/2016.*

   GC-HID for $H_2$ on the GCMD system: Complete method testing at Aspendale and implement at Cape Grim. *Done – system installed in April 2015 as the 5th channel on the AGAGE GCMD system. Results show that $H_2$ precisions are at least 10 times better for this detector (~0.2%) compared with the old mercuric oxide detector (~2%). This detector also measures neon.*

   Add new species to Medusa3 at Cape Grim, as appropriate. *During 2014/2015, the Medusa3 system at Cape Grim was modified in Feb 2015 to enable measurement of nitrogren trifluoride ($NF_3$). In addition to this, 9 other new species were added to the ion list for Medusa3 at Cape Grim in 2014/2015. Specifically, HFC-1234yf, HFC-1234zeE, HCFC-1233zdE, HCFC-21, HCFC-31, HCFC-133a, HCFC-132b, CFC-112, desflurane.*
5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region. *Done - Data submitted in July 2014 and June 2015 for use in GlobalView and ObsPack $CO_2/CH_4$ data products, and for use in the CarbonTracker $CO_2$ simulations.*
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 50 (Dec 2014, La Jolla, USA), AGAGE 51 (May 2015, Bridgetown, Barbados). *Done – Krummel & Mitrevski presented several AGAGE reports (including station report and extensive intercomparison results) and science results at AGAGE 50 in Dec 2014 and Krummel & Fraser at AGAGE 51 in May 2015.*
7. Present results at Cape Grim 2014 Annual Science Meeting (Aspendale). *Done – Cape Grim greenhouse gas data presented in eleven papers.*
8. Submit QA/QC data through to end of 2013 to Cape Grim by 30 June 2015. *Done – July 2015.*
9. Submit non-AGAGE QA/QC data through to end of 2014 to relevant international data archives by 30 June 2015. *Done – July 2015.*
10. Submit AGAGE QA/QC data through to Sep 2014 to CDIAC and WDCGG (WMO) by June 2015. *Done – June 2015.*
11. Provide 2014 Program report to OiC by 30 June 2015, (in Lead Scientist Report, early 2015). *Done – Feb 2015.*

12. Submit 2011-2013 Program reports to *Baseline* editors by 30 November 2014. *Partially done – GASLAB flask report is submitted, with the CO2 in situ and AGAGE reports in draft.*
13. Arrange for provision of 2011-2013 cooperative program reports to *Baseline* editors by 30 November 2014. *Done – reports solicited with submission of two NOAA reports complete.*
14. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs. *Done – see below.*

**Publications: July 2014 – June 2015**

*26 peer-reviewed manuscripts submitted: 20 published/accepted (ACPD/ACP 9, GRL 2, AMOJ 2, Nature 1, PNAS 1, TMS 1, WMO Ozone Assessment 1, Baseline 1, Book chapter 1), 7 with submitted status (GRL 2, JGR 1, AAQR 1, GMDD 1, AMOJ 1, Baseline 1).*

*17 international conference papers presented (not listed).*

1. Allin, S., J. Laube, E. Witrant, J. Kaiser, E. McKenna, P. Dennis, R. Mulvaney, E. Capron, P. Martinerie, T. Rockmann, T. Blunier, J. Schwander, P. Fraser, R. Langenfelds & W. Sturges, Chlorine isotope composition in chlorofluorocarbons CFC-11, CFC-12 and CFC-113 in firn, stratospheric and tropospheric air, *Atmos. Chem. Phys.*, 15, 6867-6877, 2015 (23 Jun 2015). EP147031. (utilises air archive results/data).
2. Carpenter, L. & S. Reimann (Lead Authors), J. Burkholder, C. Clerbaux, B. Hall, R. Hossaini, J. Laube & S. Yvon-Lewis (Coauthors), D. Blake, M. Dorf, G. Dutton, P. Fraser, L. Froidevaux, F. Hendrick, J. Hu, A. Jones, P. Krummel, L. Kuijpers, M. Kurylo, Q. Laing, E. Mahieu, J. Muhle, S. O'Doherty, K. Ohnishi, V. Orkin, K. Pfeilsticker, M. Rigby, I. Simpson & Y. Yokouchi (Contributing Authors), Update on Ozone-Depleting Substances (ODSs) and Other Gases of Interest to the Montreal Protocol, Chapter 1 in Scientific Assessment of Ozone Depletion: 2014, Global Ozone Research and Monitoring Project – Report No. 55, 1.1-1.101, World Meteorological Organization, Geneva, Switzerland, 2014 (published December 2014). EP15578. (utilises air archive results/data).
3. Chirkov, M., G. Stiller, A. Laeng, S. Kellmann, T. von Clarmann, C. Boone, J. Elkins, A. Engel, N. Glatthor, U. Grabowski, C. Harth, M. Kiefer, F. Kolonjari, P. Krummel, C. Lunder, B. Miller, S. Montzka, J. Mühle, S. O'Doherty, J. Orphal, R. Prinn, G. Toon, M. Vollmer, K. Walker, R. Weiss, A. Wiegele & D. Young, Global HCFC-22 measurements with MIPAS: retrieval, validation, climatologies and trends, *Atmos. Chem. Phys. Discuss.*,15, 14783-14841, doi:10.5194/acpd-15-14783-2015, 2015 (May 2015). EP153417.
4. Etheridge, D., R. Leuning, A. Luhar, Z. Loh, D. Spencer, C. Allison, P. Steele, S. Zegelin, C. Jenkins, P. Krummel & P. Fraser, Atmospheric Monitoring, Chapter 15 in: *Geologically Storing Carbon: Learning from the Otway Project Experience*, P. Cook (ed.), 281-292, 2014, CSIRO Publishing, Melbourne, Victoria, Australia (August 2014). EP143413.
5. Fisher, J., S. Wilson, G. Zeng, J. Williams, L. Emmons, R. Langenfelds, P. Krummel & P. Steele, Seasonal changes in the tropospheric carbon monoxide profile over the remote Southern Hemisphere evaluated using multi-model simulations and aircraft observations, *Atmos. Chem. Phys.*, 15, 3217-3239, doi:10.5194/acp-15-3217-2015, 2015 (March 2015). EP149463.
6. Fraser, A., P. Palmer, L. Feng, H. Bösch, R. Parker, E. Dlugokencky, P. Krummel & R. Langenfelds, Estimating regional fluxes of $CO_2$ and $CH_4$ using space-borne observations of XCH4:XCO2, *Atmos. Chem. Phys.*,14, 12883–12895, doi:10.5194/acp-14-12883-2014, 2014 (December 2014). EP144857.
7. Fraser, P., P. Krummel, P. Steele, C. Trudinger, D. Etheridge, N. Derek, S. O'Doherty, P. Simmonds, B. Miller, J. Muhle, R. Weiss, D. Oram, R. Prinn & R. Wang, Equivalent effective stratospheric chlorine from Cape Grim Air Archive, Antarctic firn and AGAGE global measurements of ozone depleting substances, *Baseline Atmospheric Program (Australia) 2009-2010*, N. Derek P. Krummel & Cleland (eds.), Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne, Australia, 17-23, 2014 (June/July 2014). EP127527. (utilises air archive results/data).
8. Ghosh, A., P. Patra, K. Ishijima, T. Umezawa, A. Ito, D. Etheridge, S. Sugawara, K. Kawamura, J.Miller, E. Dlugokencky, P. Krummel, P. Fraser, P. Steele, R. Langenfelds, C. Trudinger, J. White, B. Vaughn, T. Saeki, S. Aoki & T. Nakazawa, Variations in global methane sources and sinks during 1910-2010, *Atmos. Chem. Phys.*, 15, 2595-2612, doi:10.5194/acp-15-2595-2015, 2015 (March 2015). EP151446. (utilises air archive results/data).
9. Hossaini, R., M. P. Chipperfield, A. Saiz-Lopez, J. J. Harrison, R. von Glasow, R. Sommariva, E. Atlas, M. Navarro, S. A. Montzka, W. Feng, S. Dhomse, C. Harth, J. Mühle, C. Lunder, S. O'Doherty, D. Young, S. Reimann, M. K. Vollmer, P. B. Krummel, and P. F. Bernath, Growth in stratospheric chlorine from short-lived chemicals not controlled by the Montreal Protocol, *Geophys. Res. Lett.*, 42, 4573-4580, doi:10.1002/2015GL063783, 2015. EP153404.
10. Kim, J., P. Fraser, S. Li, J. Muhle, A. Ganesan, P. Krummel, P. Steele, S. Park, S.-K. Kim, M.-K. Park, T. Arnold, C. Harth, P. Salameh, R. Prinn, R. Weiss & K.-R. Kim, Quantifying aluminium and semiconductor industry perfluorocarbon emissions from atmospheric measurements, *Geophys. Res. Lett.*, 41, 4787-4794, doi:10.1002/2014GL059783, 2014 (July 2014). EP141222.
11. Klekociuk, A., M. Tully, P. Krummel, P. Gies, S. Petelina, S. Alexander, L. Deschamps, P. Fraser, S. Henderson, J. Javorniczky, J. Shanklin, J. Siddaway & K. Stone, The Antarctic Ozone Hole during 2011, *Australian Meteorological and Oceanographic Journal*, 64, 293-311, 2014 (December 2014). EP1312198. (utilises air archive results/data).
12. Klekociuk, A., M. Tully, P. Krummel, P. Gies, S. Alexander, P. Fraser, S. Henderson, J. Javorniczky, S. Petelina, J. Shanklin, R. Schofield & K. Stone, The Antarctic Ozone Hole during 2012, *Australian Meteorological and Oceanographic Journal*, 64, 313-330, 2014 (December 2014). EP142625. (utilises air archive results/data).
13. Lawson, S., M. Keywood, I. Galbally, J. Gras, J. Cainey, M. Cope, P. Krummel, P. Fraser, P. Steele, S. Bentley[†], C. Meyer, Z. Ristovski & A. Goldstein, Biomass burning emissions of trace gases and particles in marine air at Cape Grim, Tasmania, 41°S, *Atmos. Chem. Phys. Discuss.*, 15, 17599-17649, doi:10.5194/acpd-15-17599-2015, 2015 (July 2015). EP155227.
14. Loh, Z., R. Law, K. Haynes, P. Krummel, P. Steele, P. Fraser, S. Chambers & A. Williams, Methane simulations at Cape Grim, Tasmania, to constrain South East Australian methane emissions, *Atmos. Chem. Phys.*, 15, 305-317, doi:10.5194/acp-15-305-2015, 2015 (January 2015). EP146074.

15. Lunt, M. F., M. Rigby, A. L. Ganesan, A. J. Manning, R. G. Prinn, S. O'Doherty, J. Mühle, C. M. Harth, P. K. Salameh, T. Arnold, R. F. Weiss, T. Saito, Y. Yokouchi, P. B. Krummel, L. P. Steele, P. J. Fraser, S. Li, S. Park, S. Reimann, M. K. Vollmer, C. Lunder, O. Hermansen, N. Schmidbauer, M. Maione, J. Arduini, D. Young & P. G. Simmonds, Reconciling reported and unreported HFC emissions with atmospheric observations, *Proc. Nat. Acad. Sci.*, 112, 5927-5931, doi:10.1073/pnas.1420247112, 2015. EP151630.

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17. Patra, P., M. Krol, S. Montzka, T. Arnold, E. Atlas, B. Lintner, B. Stephens, B. Xiang, J. Elkins, P. Fraser, A. Ghosh, E. Hintsa, D. Hurst, K. Ishijima, P. Krummel, B. Miller, K. Miyazaki, F. Moore, J. Mühle, S. O'Doherty, R. Prinn, P. Steele, M. Takigawa, H. Wang, R. Weiss, S. Wofsy & D. Young, Observational evidence for interhemispheric hydroxyl-radical parity, *Nature*, 513, 219-223, 2014 (September 2014). EP142472.

18. Wong, D., P. Fraser. P. Lavoie & J. Kim, PFC Emissions from detected versus non-detected anode effects in the aluminium industry, *The Journal of The Minerals, Metals & Materials Society (TMS)*, 67 (2), 342-353, 2015. EP1410021.

19. Ziehn, T., A. Nickless, P. Rayner, R. Law, G. Roff & P. Fraser, Greenhouse gas network design using background Lagrangian particle dispersion modelling – Part 1: methodology and Australian test case, *Atmos. Chem. Phys.*, 14, 9363-9378, 2014 (September 2014). EP141159.

Submitted/under review:

Chambers, S. D., A. G. Williams, F. Conen, A. D. Griffiths, S. Reimann, M. Steinbacher, P. B. Krummel, L. P. Steele, M. V. van der Schoot, I. E. Galbally, S. B. Molloy, and J. E. Barnes, Towards a universal "baseline" characterisation of air masses for high- and low-altitude observing stations using Radon-222, *Aerosol and Air Quality Research*, submitted 5 June 2015. EP155382.

Chambers, S., A. Williams, J. Crawford, A. Griffiths, P. Krummel, P. Steele, R. Law, M. van der Schoot, I. Galbally & S. Molloy, A radon-only technique for characterising atmospheric 'baseline' constituent concentrations at Cape Grim, Baseline Atmospheric Program (Australia) 2011-2013, N. Derek P. Krummel & S. Cleland (eds.), Australian Bureau of Meteorology & CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, xx-xx, 2015. Submitted 2014.

Fortems-Cheiney, A., M. Saunois, I, Pison, F. Chevallier, P. Bousquet, C. Cressot, S. Montzka, P. Fraser, M. Vollmer, P. Simmonds, D. Young, S. O'Doherty, F. Artuso, B. Barletta, D. Blake, S. Li, C. Lunder, B. Miller, S. Park, R. Prinn, T. Saito, P. Steele & Y. Yokouchi, Increase in HFC-134a emissions in response to the success of the Montreal Protocol, *J. Geophys. Res.*, re-submitted (Jun 2015). EP1312543.

Klekociuk, A., P. Krummel, M. Tully, P. Gies, S. Alexander, P. Fraser, S. Henderson, J. Javorniczky, J. Shanklin, R. Schofield & K. Stone, The Antarctic Ozone Hole during 2013, *Australian Meteorological and Oceanographic Journal*, submitted (May 2015). EP153407.

Schoenenberger, F., M. Vollmer, M. Rigby, M. Hill, P. Fraser, P. Krummel, P. Steele, T. Rhee, T. Peter & S. Reimann, First observations and emissions of HCFC-31 ($CH_2ClF$) in the global atmosphere, *Geophys. Res. Lett.*, submitted (June 2015). EP155363.

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Wells, K. C., D. B. Millet, N. Bousserez, D. K. Henze, S. Chaliyakunnel, T. J. Griffis, Y. Luan, E. J. Dlugokencky, R. G. Prinn, S. O'Doherty, R. F. Weiss, G. S. Dutton, J. W. Elkins, P. B. Krummel, R. Langenfelds, L. P. Steele, E. A. Kort, S. C. Wofsy, and T. Umezawa, Simulation of atmospheric N2O with GEOS-Chem and its adjoint: evaluation of observational constraints, *Geosci. Model Dev. Discuss.*, submitted May 2015. EP155356.

## Targets by 30 June 2016

1. Return the remainder of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997 and to place the data on the latest WMO $CO_2$ scale.
2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums.
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head).
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2/CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head).

4. New instrument installations/upgrades and overlap experiments at Cape Grim:

   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$.

   Aerodyne $CO/N_2O$: Complete preparation of calibration air standards at CSIRO and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Install active pressure control system for sample cell. Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$.

   Aerodyne $^{13}CO_2/^{12}CO_2$: Prepare calibration air standards and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Investigate use of a single common vacuum pump line for both aerodynes to minimise power and noise. Investigate air dehumidification system options for both Aerodynes.

   Evaluate miniature version of HID for its performance with a view for installation on the GCMD system. The attraction of this miniature detector is its lower consumption of He (by a factor of about 5).

   Add new species to Medusa3 at Cape Grim, as appropriate.

5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region.
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 52 (Dec 2014, Hawaii, USA), AGAGE 53 (May 2015, Ny-Alesund, Svalbald, Norway).
7. Participate in, and present at, the 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2015) to be held at Scripps Institution of Oceanography, Sep 2015.
8. Present results at Cape Grim 2015 Annual Science Meeting (Murramarang).
9. Submit QA/QC data through to end of 2014 to Cape Grim by 30 June 2016.
10. Submit non-AGAGE QA/QC data through to end of 2015 to relevant international data archives by 30 June 2016.
11. Submit AGAGE QA/QC data through to Sep 2015 to CDIAC and WDCGG (WMO) by June 2016.
12. Provide 2015 Program report to OiC by 30 June 2016, (in Lead Scientist Report, early 2016).
13. Submit outstanding 2011-2013 Program reports to *Baseline* editors by 30 September 2015.
14. Arrange for provision of any further 2011-2013 cooperative program reports to *Baseline* editors by 30 September 2015.
15. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs.

# Cape Grim BAPS Science Program
## Sub-Program Lead Scientist Governance Form

**Lead Scientists: Paul Fraser/Paul Steele/Paul Krummel/Marcel van der Schoot**
**Sub-Program: Greenhouse and Ozone Depleting Gases**
**Financial Year: 2014 – 2015**

s22

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Krummel /Paul Steele/Marcel van der Schoot/Paul Fraser**
**Sub-Program: Greenhouse and Ozone Depleting Gases**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > % raw* data collection<br>LoFlo $CO_2$ *in situ* > 90%<br>Picarro $CO_2/CH_4$ >90%<br>Aerodyne $N_2O/CO$ >80%<br>Aerodyne $CO_2$ isotopes >50%<br>GASLAB flasks >90%<br>AGAGE GCMD >90%<br>AGAGE Medusa >85%<br>GC-HID $H_2$ system >90% | | LoFlo, Aerodyne & Picarro raw data are minutely data; Aim to fill ~72 flasks (6 flasks per month subject to good baseline); AGAGE raw data are individual injections into each gas chromatograph system and subsequent output analyses. |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2015. All data collected in '1' above. |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures, inlets. |
| 4 | Annual operation and data summary report 2015 for *Baseline* to OiC BAPS by 30 June 2016 | | Contained in six-monthly AGAGE station reports and lead scientist reports. |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | Steele, Krummel, van der Schoot and Fraser to attend at least 2 WGM each. |
| 10 | Funded LS maintenance visits for FY completed | | Seven |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Monday, 13 July 2015 3:18 PM
**To:** 'Sam Cleland'
**Cc:** Steele, Paul (O&A, Aspendale); Fraser, Paul (O&A, Aspendale)
**Subject:** RE: Cape Grim Science Program Working Group meeting, 10:30am 16 July 2015, BoM, 6th Floor, Conf Rm 1 - DRAFT AGENDA [SEC=UNCLASSIFIED]
**Attachments:** CG_ResProp_AirArchive_2015-2016.docx; LSGovernance_AirArchive_2015-2016.doc; LSGovernance_AirArchive_2014-2015_completed.doc

Hi Sam,

Attached are the Research Proposal and Governance forms for the Cape Grim Air Archive program.

Cheers, Pauls

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Air Archive**
**Requested Total Funding:** **$0 (air archive tanks requested through asset funds)**
**Working (Short) Program or Project Title:** **Air Archive**
**Program or Project Leader:** **Paul Steele, Paul Krummel, Paul Fraser**

Program or Project Outcome:
Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

Program or Project Summary:
The Cape Grim Air Archive is a unique collection of Cape Grim air samples dating back to 1978. The samples have proved invaluable in

(a) determining the background trends (1978-present) of a range of greenhouse and ozone depleting gases for which the measurement capabilities have been developed in recent years;

(b) bridging the sampling age gap between Antarctic firn air and modern air samples, enabling Southern Hemisphere records for several species, for which the measurement capabilities have been developed in recent years, to be reconstructed back to the 1930s.

Travel and Personnel Cost Justification:
None.

Equipment Required

| | |
|---|---|
| Six 34 litre SS tanks (Essex Industries) | $34,000 (asset funding) |

Completion of 2014-2015 Targets

1. Purchase 6 new air archive tanks by March 2015. *Done – purchased from Cape Grim asset funding.*
2. Collect at least 6 air archive samples during 2014/2015. *Done – 5 air archival samples collected – Jul, Sep & Nov(2) 2014, Feb 2015. One due to be filled now.*
3. Submit QA/QC data 1978-2014 to Cape Grim by 30 June 2015. *Done (Jul 2015).*
4. Provide 2014 Program Report to OiC by 30 June 2015 (Lead Scientist Report, early 2015). *Done.*
5. Air Archive program report for *Baseline 2011-2012* submitted to editors by 30 November 2014. *Done – report spans 2011-2013.*
6. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks. *In progress.*
7. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem. *In progress. Transfers of test samples done and analyses of results are almost finalised, verifying the stability of trace gas concentrations except for CO, which shows a slow upward drift. Transfers of any archive air samples have been suspended for the time being, due to the discovery of a contamination problem with some of the Essex cylinders. Essex engineers used (without our knowledge or consent) a lubricant called Christo-Lube MCG 111 on some of the gaskets and flanges. This lubricant is a suspension of powdered PTFE in a perfluoropolyether grease [F-(CF(CF$_3$)-CF$_2$-O)$_n$-CF$_2$CF$_3$], where n ranges between 10 and 60. Slow decomposition of the lubricant causes production of CF$_4$ (and perhaps other species) in the cylinder. Still awaiting results from testing at Scripps, to determine the best method for identifying those cylinders contaminated with Christo-Lube.*
8. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments. *Done – see 2014-2015 Greenhouse Gas program targets for the 7 papers incorporating the use of air archive data.*

Targets by 30 June 2016

1. Purchase 6 new air archive tanks by March 2016.
2. Collect at least 6 air archive samples during 2015/2016.
3. Submit QA/QC data 1978-2015 to Cape Grim by 30 June 2016.
4. Provide 2015 Program Report to OiC (in the Lead Scientist Report), in Feb 2016.
5. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks.
6. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem.
7. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Steele, Paul Krummel, Paul Fraser**
**Sub-Program: Cape Grim Air Archive**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 75% raw* data collection | | 6 Cape Grim air archives |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2014 |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures. |
| 4 | Annual operation and data summary report 2015 for Baseline to OiC BAPS by 30 June 2016 | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016. | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

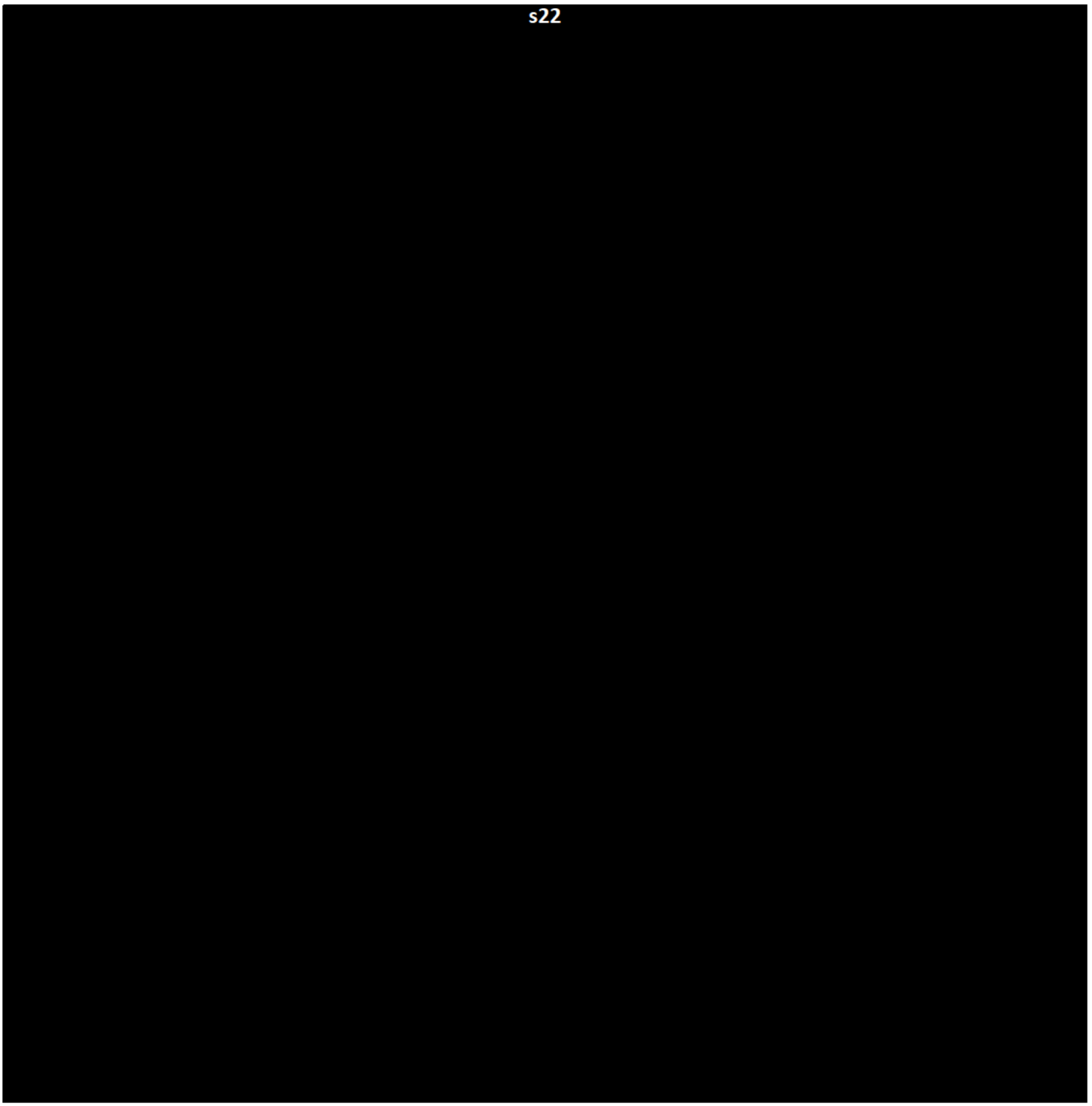
**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# Cape Grim BAPS Science Program
## Sub-Program Lead Scientist Governance Form

**Lead Scientists: Paul Fraser, Paul Steele, Paul Krummel**
**Sub-Program: Cape Grim Air Archive**
**Financial Year: 2014 – 2015**

s22



**From:** Sam Cleland <S.Cleland@bom.gov.au>
**Sent:** Wednesday, 15 July 2015 2:10 PM
**To:** Alastair Williams; Galbally, Ian (O&A, Aspendale); van der Schoot, Marcel (O&A, Aspendale); Keywood, Melita (O&A, Aspendale); Fraser, Paul (O&A, Aspendale); Krummel, Paul (O&A, Aspendale); Steele, Paul (O&A, Aspendale); swilson@uow.edu.au; Lawson, Sarah (O&A, Aspendale); Matt Tully; LeMarshall, John (BoM) - Contact
**Cc:** Terry Stiles; Stuart Baly; Cindy Hood
**Subject:** RE: Cape Grim Science Program Working Group meeting, 10:30am 16 July 2015, BoM, 6th Floor, Conf Rm 1 - DRAFT AGENDA [SEC=UNCLASSIFIED]
**Attachments:** [redacted] CG_ResProp_2015-2016Radiation.doc; CG_ResProp_2015-2016SRAD.doc; CG_ResProp_AirArchive_2015-2016.docx; CG_ResProp_GHG_2015-2016.docx; CG_ResProp_Salary_2015-2016.doc; Governance_2014-2015_Particles&MAC_reconciled.doc; Governance_2015-2016_Particles&MAC.doc; Governance_Radon_2014-2015.doc; Governance_Radon_2015-2016.doc; LSGovernance_2014-2015Radiation.doc; LSGovernance_2014-2015SRWSpectral.doc; LSGovernance_2015-2016Radiation.doc; LSGovernance_2015-2016SRWSpectral.doc; LSGovernance_AirArchive_2014-2015_completed.doc; LSGovernance_AirArchive_2015-2016.doc; LSGovernance_GHG_2014-2015_completed.doc; LSGovernance_GHG_2015-2016.doc; ResProp_2015-2016_P-MAC.doc; ResProp1516_Radon.doc; [redacted] [redacted] CG-AssetRequests20150715a.xlsx

Hi Guys

A large number of attachments:

- Replacement Asset Bids compilation (thanks Krum for pointing out the omissions), let me know if any more variations.
- Latest Agenda, with an additional item from Melita on NOAA particles QAQC system.
- Governance (both years) and Research Proposals (noting RG distributed last week):
    - Radiation
    - Spectral Radiation
    - Air Archive
    - GHG
    - P-MAC
    - Radon

[redacted]

I think that is everything we need? Let me know otherwise.

See you tomorrow.

Cheers

Sam

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Greenhouse and Ozone Depleting Gases**
**Requested Total Funding:** **AGAGE $55.5K (includes $28K station allocation)**
**$CO_2$ $48K (includes $2K station allocation)**
**Working (Short) Program or Project Title:** **GHG**
**Program or Project Leader:** **Paul Krummel, Paul Steele, Marcel van der Schoot, Paul Fraser**

Program or Project Outcome:

**Outputs:**

• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
• the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
• regular submission of the Cape Grim data to the relevant national and international data archives;
• enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
• continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;

**Impacts:**

• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Program or Project Summary:

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the two premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into, the global assessments of the Intergovernmental Panel on Climate Change and the WMO Scientific Assessments of Ozone Depletion and the national assessments of greenhouse gas (GHG) emissions, as part of the UNFCCC reporting process.

The Greenhouse and Ozone Depleting Gases Program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived GHGs (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

NOTE that this project is the amalgamation of two previous Cape Grim projects, namely 1) $CO_2$, $CO_2$ isotopes and GASLAB flasks; and 2) non-$CO_2$ greenhouse gases (AGAGE); into one consolidated Cape Grim Greenhouse Gases project.

Travel and Personnel Cost Justification:

| | |
|---|---|
| WGM: | 1 trip to WGM (4 people, 2 days, airfares, ground transport, meals, accomm.) $4K |
| CGASM: | 1 trip to CGASM-Murramarang (4 people, 3 days, airfares, car hire, meals, accomm.) $4K |
| Cape Grim: | 7 trips to Cape Grim (2-3 people, 3 days, airfares, ground transport, meals) $12K |

Equipment Required

| | |
|---|---|
| 1 regulator | $1,500 |
| 1 valco valve | $2,800 |
| 1 MKS pressure control valve | $1,300 |

Completion of 2014-2015 Targets

1. Return a significant subset of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997. *Six of the CSIRO GASLAB $CO_2$ primaries (four existing and two new cylinders) were sent to NOAA and recalibrated during 2014-2015. The remainder will be sent to NOAA during 2015-2016 for*

*recalibration. Reprocessing of the Cape Grim in situ $CO_2$ data from 1986-2004 is currently underway and will continue into 2015-2016.*

2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums. *Done and continuing. Extensive comparisons between CSIRO flasks and in situ analysers at Cape Grim is undertaken regularly as an internal quality control check, some of these results were reported during the Cape Grim Annual Science Meeting in 2014. The CSIRO/NOAA flask same air ICP is done regularly and is ongoing. The 6th WMO round robin is currently underway with measurements completed in GASLAB. Extensive comparisons of international cooperative flask sampling programs at Cape Grim (in particular NOAA) to in situ analysers at Cape Grim is undertaken every 6 months with the results reported/presented at the twice yearly international AGAGE meetings.*
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head). *Further progress has been made towards manuscripts on the $CO_2$ gradient across the Southern Ocean between Cape Grim and Macquarie Island – manuscripts(2) expected to be submitted in 2015/2016.*
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2/CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head). *Ongoing: The LoFlo $CO_2$ analyser continued operation at Baring Head, NZ throughout 2014/2015. A final inter-calibration of Baring Head primary $CO_2$ air standards and LoFlo cal standards will be completed. A detailed comparison will be completed and a decision will be made whether to continue this experiment further.*
4. New instrument installations/upgrades and overlap experiments at Cape Grim:
   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$. *Data now processed with GCWerks-CRDS and testing of control with GCWerks-CRDS to be undertaken shortly and implemented at Cape Grim during 2015/2016. Detailed overlap comparisons of Picarro data to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$ are undertaken/updated regularly (results presented at the Cape Grim Annual Science Meeting 2014) with results showing in general good agreement between the analysers, but with some interesting features.*

   Aerodyne $CO/N_2O$: Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$. *Note Done – plan to undertake this in in 2015/2016.*

   GC-HID for $H_2$ on the GCMD system: Complete method testing at Aspendale and implement at Cape Grim. *Done – system installed in April 2015 as the 5th channel on the AGAGE GCMD system. Results show that $H_2$ precisions are at least 10 times better for this detector (~0.2%) compared with the old mercuric oxide detector (~2%). This detector also measures neon.*

   Add new species to Medusa3 at Cape Grim, as appropriate. *During 2014/2015, the Medusa3 system at Cape Grim was modified in Feb 2015 to enable measurement of nitrogren trifluoride ($NF_3$). In addition to this, 9 other new species were added to the ion list for Medusa3 at Cape Grim in 2014/2015. Specifically, HFC-1234yf, HFC-1234zeE, HCFC-1233zdE, HCFC-21, HCFC-31, HCFC-133a, HCFC-132b, CFC-112, desflurane.*
5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region. *Done - Data submitted in July 2014 and June 2015 for use in GlobalView and ObsPack $CO_2/CH_4$ data products, and for use in the CarbonTracker $CO_2$ simulations.*
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 50 (Dec 2014, La Jolla, USA), AGAGE 51 (May 2015, Bridgetown, Barbados). *Done – Krummel & Mitrevski presented several AGAGE reports (including station report and extensive intercomparison results) and science results at AGAGE 50 in Dec 2014 and Krummel & Fraser at AGAGE 51 in May 2015.*
7. Present results at Cape Grim 2014 Annual Science Meeting (Aspendale). *Done – Cape Grim greenhouse gas data presented in eleven papers.*
8. Submit QA/QC data through to end of 2013 to Cape Grim by 30 June 2015. *Done – July 2015.*
9. Submit non-AGAGE QA/QC data through to end of 2014 to relevant international data archives by 30 June 2015. *Done – July 2015.*
10. Submit AGAGE QA/QC data through to Sep 2014 to CDIAC and WDCGG (WMO) by June 2015. *Done – June 2015.*
11. Provide 2014 Program report to OiC by 30 June 2015, (in Lead Scientist Report, early 2015). *Done – Feb 2015.*

12. Submit 2011-2013 Program reports to *Baseline* editors by 30 November 2014. *Partially done – GASLAB flask report is submitted, with the CO2 in situ and AGAGE reports in draft.*
13. Arrange for provision of 2011-2013 cooperative program reports to *Baseline* editors by 30 November 2014. *Done – reports solicited with submission of two NOAA reports complete.*
14. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs. *Done – see below.*

**Publications: July 2014 – June 2015**

*26 peer-reviewed manuscripts submitted: 20 published/accepted (ACPD/ACP 9, GRL 2, AMOJ 2, Nature 1, PNAS 1, TMS 1, WMO Ozone Assessment 1, Baseline 1, Book chapter 1), 7 with submitted status (GRL 2, JGR 1, AAQR 1, GMDD 1, AMOJ 1, Baseline 1).*

*17 international conference papers presented (not listed).*

1. Allin, S., J. Laube, E. Witrant, J. Kaiser, E. McKenna, P. Dennis, R. Mulvaney, E. Capron, P. Martinerie, T. Rockmann, T. Blunier, J. Schwander, P. Fraser, R. Langenfelds & W. Sturges, Chlorine isotope composition in chlorofluorocarbons CFC-11, CFC-12 and CFC-113 in firn, stratospheric and tropospheric air, *Atmos. Chem. Phys.*, 15, 6867-6877, 2015 (23 Jun 2015). EP147031. (utilises air archive results/data).
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## Targets by 30 June 2016

1. Return the remainder of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997 and to place the data on the latest WMO $CO_2$ scale.
2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums.
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head).
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2$/$CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head).

4. New instrument installations/upgrades and overlap experiments at Cape Grim:

   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$.

   Aerodyne $CO/N_2O$: Complete preparation of calibration air standards at CSIRO and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Install active pressure control system for sample cell. Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$.

   Aerodyne $^{13}CO_2/^{12}CO_2$: Prepare calibration air standards and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Investigate use of a single common vacuum pump line for both aerodynes to minimise power and noise. Investigate air dehumidification system options for both Aerodynes.

   Evaluate miniature version of HID for its performance with a view for installation on the GCMD system. The attraction of this miniature detector is its lower consumption of He (by a factor of about 5).

   Add new species to Medusa3 at Cape Grim, as appropriate.

5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region.
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 52 (Dec 2014, Hawaii, USA), AGAGE 53 (May 2015, Ny-Alesund, Svalbald, Norway).
7. Participate in, and present at, the 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2015) to be held at Scripps Institution of Oceanography, Sep 2015.
8. Present results at Cape Grim 2015 Annual Science Meeting (Murramarang).
9. Submit QA/QC data through to end of 2014 to Cape Grim by 30 June 2016.
10. Submit non-AGAGE QA/QC data through to end of 2015 to relevant international data archives by 30 June 2016.
11. Submit AGAGE QA/QC data through to Sep 2015 to CDIAC and WDCGG (WMO) by June 2016.
12. Provide 2015 Program report to OiC by 30 June 2016, (in Lead Scientist Report, early 2016).
13. Submit outstanding 2011-2013 Program reports to *Baseline* editors by 30 September 2015.
14. Arrange for provision of any further 2011-2013 cooperative program reports to *Baseline* editors by 30 September 2015.
15. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs.

# Cape Grim BAPS Science Program
# Sub-Program Lead Scientist Governance Form

**Lead Scientists: Dr Alastair Williams**
**Sub-Program: Radon**
**Financial Year: 2014 -2015**

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**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Stephen Wilson**
**Sub-Program: Passive Radiation**
**Financial Year: 2015 - 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90% Raw* data collection | | Assumed maximum 10% downtime |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | All data quality controlled and available in Bureau Database |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Site and instrument description available on Radiation Group website. |
| 4 | Annual operation and data summary report 2014 for Baseline to OiC BAPS by 30 June 2016 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 March 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | The measurements are part of a support program. |
| 9 | Attend at least two WGM in FY | | |
| 10 | Maintenance visits for FY completed | | Visits completed by BoM staff |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# Cape Grim BAPS Science Program
## Sub-Program Lead Scientist Governance Form

**Lead Scientists: Paul Fraser/Paul Steele/Paul Krummel/Marcel van der Schoot**
**Sub-Program: Greenhouse and Ozone Depleting Gases**
**Financial Year: 2014 – 2015**

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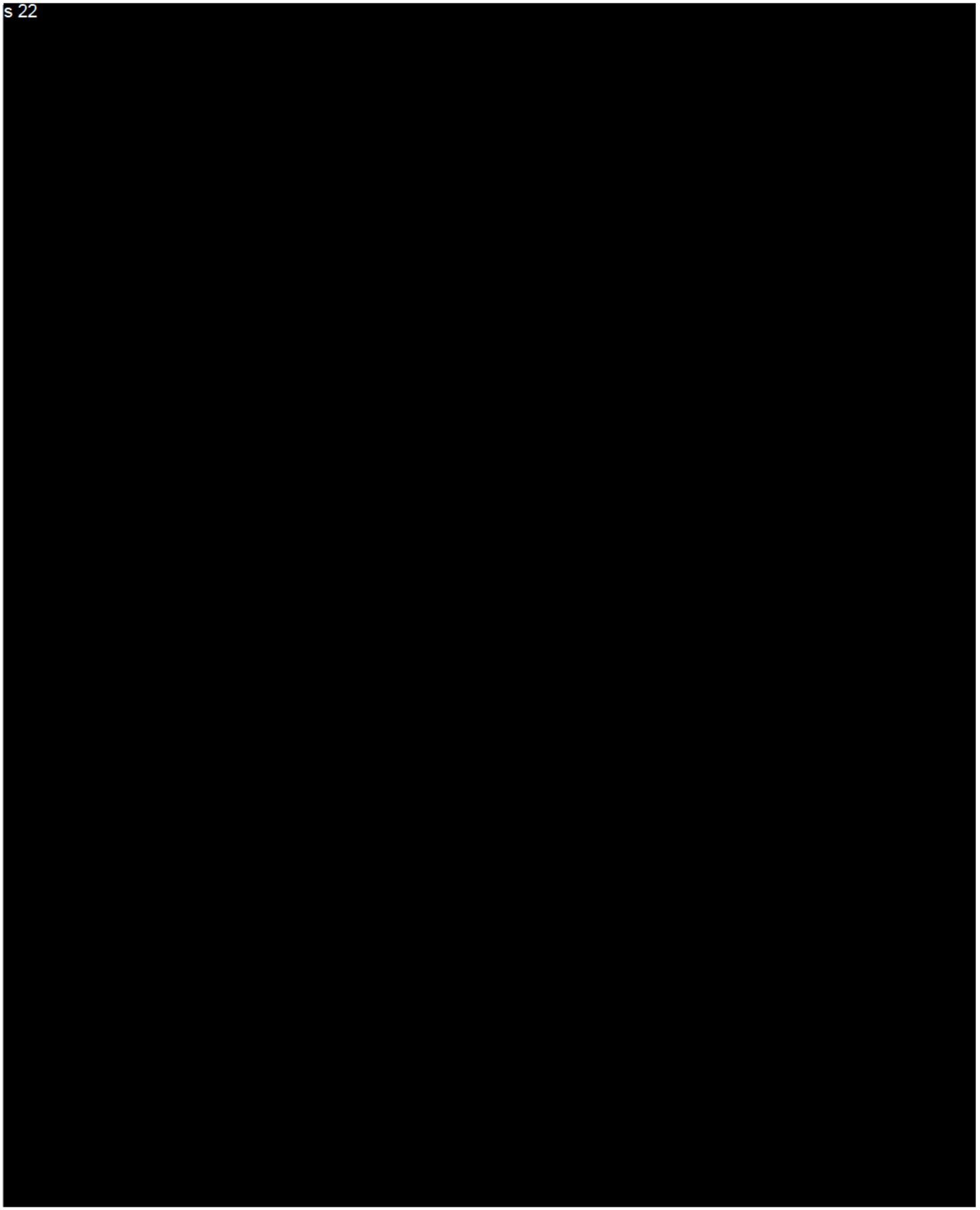

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new): continuing**
**Program or Project Title: Passive Radiation**
**Requested Total Funding: $10,000**
**Working (Short) Program or Project Title: Radiation**
**Program or Project Leader: Stephen Wilson**

Program or Project Outcome:
*In less that 50 words describe the outcomes of your research, eg: Develop a sulfur isotope technique for use on the Delta-C Mass Spectrometer enabling determination of aerosol source sulfur isotopic signatures and to allow new studies of aerosol chemistry at Cape Grim.*

Measurement of solar radiation, including global, diffuse, direct and long wave irradiance.

Program or Project Summary:
*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and international community.*

Solar radiation measurements are fundamental for an understanding of the chemistry of the atmosphere, and for an assessment of climate impacts on a range of human activities, including agriculture. These measurements, as part of the wider Bureau of Meteorology radiation network, provide an important view of the radiation climate in Australia.

Travel and Personnel Cost Justification:
*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form 2011-2012, then please provide written support for your requirement for these funds.*
While the staff at Cape Grim can manage many of the problems with the equipment, travel to Cape Grim is essential for instrument calibration and ensuring the ongoing maintenance and operation of the equipment.

Equipment Required
The funding requested included ongoing equipment maintenance as part of the wider activities of the Bureau of Meteorology Solar and Terrestrial Radiation network, as has been previously agreed to by Cape Grim.

Completion of 2014-2015 Targets
- ✓ Submit QA/QC data from 2014 to Cape Grim by 30 June 2015
- ✓ ~Provide 2011-2013 Program report to OiC by 30 July 2015. (See footnote on Governance forms
- ✓ Continue measurements and provide access to the quality assured data to the research community.

Targets by 30 June 2016
- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Provide 2014 Program report to OiC by 30 June 2016
- Continue measurements and provide access to the quality assured data to the research community.

# CGBAPS One-Page Research Proposal Form 2015-2016

| | |
|---|---|
| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **CSIRO Salary Support** |
| **Requested Total Funding:** | **$279,000** |
| **Working (Short) Program or Project Title:** | **CSIRO Salary Support** |
| **Program or Project Leader:** | **Paul Krummel, Melita Keywood, Paul Fraser, Paul Steele, Ian Galbally, Marcel van der Schoot, Sarah Lawson** |

Program or Project Outcome:
Technical support for Lead Scientists Cape Grim observational activities.

Program or Project Summary:
CSIRO salary support calculated from 2014/2015 requested support ($270,750), plus an estimated 1% salary increase, giving a total of $273,500. CSIRO expected to match this with a salary contribution of approximately $980,000 (this contribution excludes CSIRO Flagship and Corporate overheads). The total funding request above ($279,000) also includes $1000 for Nada Derek to travel to the Cape Grim annual science meeting and $4,500 for the NOAA representative to attend the Cape Grim annual science meeting in 2015.

Travel and Personnel Cost Justification:
The salary support provides the equivalent of approximately 2.5 support positions at CSOF4 level (not including CSIRO Flagship and Corporate overheads).

Equipment Required: None.

Completion of 2014-2015 Targets
Targets are defined under each Lead Scientists programs.

Targets by 30 June 2016
Targets are defined under each Lead Scientists programs.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Dr Alastair Williams**
**Sub-Program: Radon**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90% Raw* data collection | | All data and information collected by the measurement process, and prior to modification by post analysis or quality control. Includes information on period of collection. |
| 2 | All 2015 QA quantities* to CGBAPS for archival by 30 June 2016 | | Calibrated quality-controlled radon hourly time series for 2015 with notes. |
| 3 | All 2015 Meta* data to CGBAPS for archival by 30 June 2016 | | HURD3 and BHURD2 electronic log files for 2015. |
| 4 | Annual operation and data summary report 2015 for Baseline to OiC BAPS by 30 June 2016 | | Will be covered in the 2015 Sub-program Report to be submitted in February 2016 |
| 5 | LS Report for 2015 to be provided at early 2016 Working Group Meeting | | Will be covered in the 2015 Sub-program Report to be submitted in February 2016 |
| 6 | Program budget request for next FY to Chair of Working Group by the February 2016 WGM | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | |
| 10 | Three funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Stephen Wilson**
**Sub-Program: Spectral Radiation**
**Financial Year: 2015 - 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90 % Raw* data collection | | Data and information collected by the measurement process, and prior to modification by post analysis or quality control. Include information on period of collection |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are: service logs – calibration records quantities and the end period of collection for raw data |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Log files |
| 4 | Annual operation and data summary report 2014 for Baseline to OiC BAPS by 30 June 2016 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 March 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | |
| 10 | Three funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |
| 12 | MAX-DOAS @ CG data assessment | | |
| 13 | Deploy UV-B replacement system at CG | | |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal

would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Krummel /Paul Steele/Marcel van der Schoot/Paul Fraser**
**Sub-Program: Greenhouse and Ozone Depleting Gases**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > % raw* data collection<br>LoFlo $CO_2$ *in situ* > 90%<br>Picarro $CO_2/CH_4$ >90%<br>Aerodyne $N_2O/CO$ >80%<br>Aerodyne $CO_2$ isotopes >50%<br>GASLAB flasks >90%<br>AGAGE GCMD >90%<br>AGAGE Medusa >85%<br>GC-HID $H_2$ system >90% | | LoFlo, Aerodyne & Picarro raw data are minutely data; Aim to fill ~72 flasks (6 flasks per month subject to good baseline); AGAGE raw data are individual injections into each gas chromatograph system and subsequent output analyses. |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2015. All data collected in '1' above. |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures, inlets. |
| 4 | Annual operation and data summary report 2015 for *Baseline* to OiC BAPS by 30 June 2016 | | Contained in six-monthly AGAGE station reports and lead scientist reports. |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | Steele, Krummel, van der Schoot and Fraser to attend at least 2 WGM each. |
| 10 | Funded LS maintenance visits for FY completed | | Seven |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

| Priority Rank (within subprogram) | Equipment | Lead Scientist | Program | Justification supplied | Cost | Comments | Timeframe | Actions |
|---|---|---|---|---|---|---|---|---|
| | 6 x Air Archice Cylinders annually. | Fraser/Steele/Krummel | CGAA | Yes | $35,000 | Cylinders now to come from Asset budget, rather than through Science Program | Annually | |
| | Cape Grim air archive partial duplication | Fraser/Steele/Krummel | CGAA | No | $46,000 | Ten Essex Cryogenics 34 litre tanks for the oldest most vulnerable archives. | 2014-2015 | [redacted] |
| | | | | | | | | |
| | Cape Grim air archive duplication | Fraser/Steele/Krummel | CGAA | No | $16,000 | Aus dollars - Four additional Essex Cryogenics 34 litre tanks per year to be filled in parallel with existing CGAA filling One tank to be stored at Aspendale, the other at Clayton. | 2014-2015; 2015-2016 etc | |
| | Continuous O2/N2 | Steele/Krummel/van der Schoot/Fraser | CO2 | No | $100,000 | Prototype system already exists at Aspendale, needs some improvement before any deployment to Cape Grim can considered. Commercially available systems being actively sought and may be available in this timeframe with estimated cost of $100K. | 2015-2016 | Is a reasonable instrument available? |
| | Resumption of Cape Grim overflights | Fraser/Steele/Krummel/van der Schoot | GHG (non-CO2) | No | $70,000 | $70K to purchase aircraft certified Picarro CO2/CH4 analyser. Note this requires aircraft operating costs, which would be significant – ca. $2.5K per flight ($30K per year). | 2015-2016 | |
| | Continuous OH | Fraser/Steele/Krummel/van der Schoot | GHG (non-CO2) | No | $200,000 | Plan for in situ, continuous measurements of hydroxyl radical, the single most important 'cleansing' species in the atmosphere. Need to investigate commercially available instruments. Cost could be significant (US$200K), but payoff in understanding of seasonal cycles of many trace gases would be immeasureable. | 2015-2016 | |
| | Aerodyne N2O-isotopes analyser | Steele/Krummel/van der Schoot/Fraser | GHG (non-CO2) | No | $200,000 | US Dollars, estimate only at this stage - prototype under development. | 2015-2016 | |
| | Aerodyne CH4-isotopes analyser | Steele/Krummel/van der Schoot/Fraser | GHG (non-CO2) | No | $150,000 | US Dollars, estimate only at this stage - prototype under development. | 2015-2016 | |
| | Agilent 7890 GC for the Medusa system | Fraser/Steele/Krummel | GHG (non-CO2) | No | $60,000 | Aus dollars - the new 7890 GC has improved technology including better flow controllers (EPCs) than the current 6890 GC. The 6890 GC was first introduced in 1996 and so is reaching the end of its lifetime. | 2015-2016 | |
| | Replacement UPS for Medusa and GCMD | Fraser/Steele/Krummel/cav der Schoot | GHG (non-CO2) | Yes | $9,000 | Replacement, (slightly upgraded) 8 kVA UPS system for all components running from GCWorks (Medusa, GCMD, etc) | 2015-2016 | |
| | Aerosol Chemical Speciation Monitor (ACSM) | Keywood | MAC | Yes | $250,000 | The Aerodyne ACSM measures aerosol composition (organic and inorganic at 30 minute intervals). It has been designed to operate in remote locations with little technical support. This is the state-of-the art in semi-continous aerosol composition and will significantly enhance our aerosol composition measurement capability | 2015-2016 | |
| | Partisol | Keywood | Particulates | Yes | $45,000 | Replacement for an ageing piece of kit | 2015-2016 | |
| | Replace computers and loggers | Williams | Radon | No | $10,000 | Periodic hardware / software upgrades | 2016-2017 | |
| | Refurbish heads on main detector | Williams | Radon | No | $10,000 | Periodic reduction of instrument background | 2017-2018 | |
| | Replace head on backup detector | Williams | Radon | No | $10,000 | Replacement of BHURD-2 sensing head | 2018-2019 | |
| | Primary Reference Ozone Calibrator | Galbally | Reactive Gases | Yes | $120,000 | Primary calibrator for ozone instruments. Remove necessity for decadal GAW calibration and improve overall accuracy by about 1% | 2015-16 | |
| 3 | Replacement Volatile Organic Compound Analyser | Galbally & Lawson | RG | yes | $570,000 | Price: High Sensitivity PTR-MS incl. SRI and TOF-MS at the moment is approximately. Breakdown of price given (380,000 Euro, February 2014): 12000 PTR-TOF with additional items SRI+, multiport valves, 297,000 Euro<br>Gas calibration unit (required to calibrate PTR-TOF): 25,500 Euro<br>Service contract (4 years maintenance): 58,000 Euro. Ongoing costs are calibration gases approximately $10,000 pa but would be cheaper as they would be for 2 instruments (GC-FID) | 2015-2016 | |
| | Nitrogen dioxide - cavity ringdown | Galbally | RG | yes | $85,000 | Instrument will have considerable OH&S advantages, being compact and not requiring either a vacuum pump nor a compressed air supply (Verbal comment from Ian for Sam 20120628: As yet, not really at sufficient stage of development to be worthy of purchase - but anticipate improvements in near term.) | 2015-2016 | |
| | Formaldehyde (HCHO) and Peroxide ($H_2O_2$) | Galbally & Lawson | RG | No | $140,000 | | 2015-2016 | |
| | TCCON - Central Australia | Griffith? | TCCON ? | | $250,000 | | ???? | |

$2,091,000

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new): continuing**
**Program or Project Title: Spectral Radiation**
**Requested Total Funding: $8,700**
**Working (Short) Program or Project Title: SRAD**
**Program or Project Leader: Stephen Wilson**

Program or Project Outcome:
*In less that 50 words describe the outcomes of your research, eg: Develop a sulfur isotope technique for use on the Delta-C Mass Spectrometer enabling determination of aerosol source sulfur isotopic signatures and to allow new studies of aerosol chemistry at Cape Grim.*

Record the aerosol optical depth at Cape Grim, and identify the factors that impact upon it. Measure the UV radiation field at Cape Grim, and identify the factors that determine UV levels.

Program or Project Summary:
*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and international community.*

Aerosols are one of the great unknowns in climate change. It is believed that they offset the warming of the so-called greenhouse gases, but the magnitude of this effect is unknown. The aerosol optical depths measured at Cape Grim are quite small, but do represent the background aerosol optical properties for a large area. An anthropogenic influence in this region could be significant. It is also important to understand the nature and distribution of the aerosols observed optically, so that both natural and anthropogenic influences can be identified. UV radiation, and UV-B in particular, drive many changes to both the atmosphere and the biosphere. Estimates of UV are crucial in understanding the chemical transformation of substances in the atmosphere.

Travel and Personnel Cost Justification:
*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form 2011-2012, then please provide written support for your requirement for these funds.*
Included within the budget is funding to attend working group meetings, including the annual meeting, as all of this requires interstate travel. The UV-B system has been purchased (except for the diffuser). This system will need to be integrated and tested (UOW), followed by deployment at Cape Grim. The MAX-DOAS system will require a different optics head while issues with the current optics head are resolved. The temporary optical system is currently at UOW, awaiting controlling software. Installation of these systems will require a minimum of 2 visits. It is anticipated that the remote operation of this instrument will have software teething issues.

Equipment Required
Instruments for aerosol Optical Depth, MAX-DOAS and UV radiation now exist. We currently have 2 SPO2 sunphotometers deployed, and the intention is to swap these once during the year with the second calibrated set that is running at Wollongong. However, repair of the SPO2s has been very slow, and this is retarding the process. There are currently no SPO2s at Wollongong.

Completion of Targets by 30 June 2015

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015. Complete – all available data within the Bureau's data system.
- Provide 2011-13 Program report to OiC by 30 July 2015. Draft submitted. Issues with the passive radiation data has slowed submission considerably.
- Purchase of an SRAD replacement and start field measurements. System components purchased in 2015, and testing has begun. MAX-DOAS system operational at Cape Grim, although there are issues with condensation in the optics head.

- Publish paper on J(O $^1$D) and [OH] estimates from CG to an international journal. – *J* (O $^1$D) publication completed: Wilson, S. R. (2015). Characterisation of *J*(O $^1$D) at Cape Grim 2000–2005. *Atmospheric Chemistry and Physics*, *15*(13), 7337–7349. doi: 10.5194/acp-15-7337-2015. [OH] estimates work to be "reframed".
- Analyse recent aerosol optical depth data and compare with the earlier sunphotometer data. A significant re-analysis of 1986 – 2014 has been completed. Remaining is consideration of possible comparison with in situ aerosol data.
-

Targets by 30 June 2016

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2016.
- Provide 2014 Program report to OiC by 30 July 2016
- Deploy the replacement UV-B instrument (SRAD2).
- Report first results from the MAX-DOAS system.
- Compare *J* (O $^1$D) with changes in ozone at CG.
- Complete Analysis of AOD data and submit for publication.
- Submit UV-B data to international database – either directly or via the Bureau of Meteorology.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientist: Melita Keywood**
**Sub-Program: Particles and MAC**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90% Raw* data collection | complete | CN, UCN, CCN, BC, Bsp time series data 2014<br>Raw data are: rainwater and filter samples from ERNI, Eigenbordt, Ecotech 3000 (x2), Partisol; chemical composition and mass of rainwater and filter samples |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2015 | ongoing | CN, UCN, CCN, BC time series hourly data 2014 |
| 3 | All Meta* data to CGBAPS for archival for 2014 by 30 June 2015 | complete | Logbook information additional to station log, includes instrument/inlet description, operation, changes, calibrations 2014 etc<br>QA quantities are: Rainwater, PM10 (HVB and HVC), PM2.5 (Partisol) for Jan 2014 to Dec 2014 |
| 4 | Annual operation and data summary reports (Particles and MAC) for Baseline to OiC BAPS in time for Publication in Baseline 2010/2011 | POPs, Aerosol and Precipitation complete, Particles ongoing | |
| 5 | LS Report for the previous 12 month period to be provided at early 2015 Working Group Meeting | Presented during Feb 2015 WGM | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 May 2014 | Submitted in Feb 2015 | |
| 7 | Program research proposal (2015/2016) and review of targets (2014/2015) to Chair of Working Group by 30 June 2015 | Complete | |
| 8 | Presentation of program for Annual Science Meeting | Complete | |
| 9 | Attend at least two WGM in FY | Complete, attended all | |
| 10 | Four funded LS maintenance visits for FY completed | Complete | |
| 11 | Funding was utilized as allocated | Overspend by $12K | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# Cape Grim BAPS Science Program
## Sub-Program Lead Scientist Governance Form

**Lead Scientists: Stephen Wilson**
**Sub-Program: Passive Radiation**
**Financial Year: 2014 - 2015**

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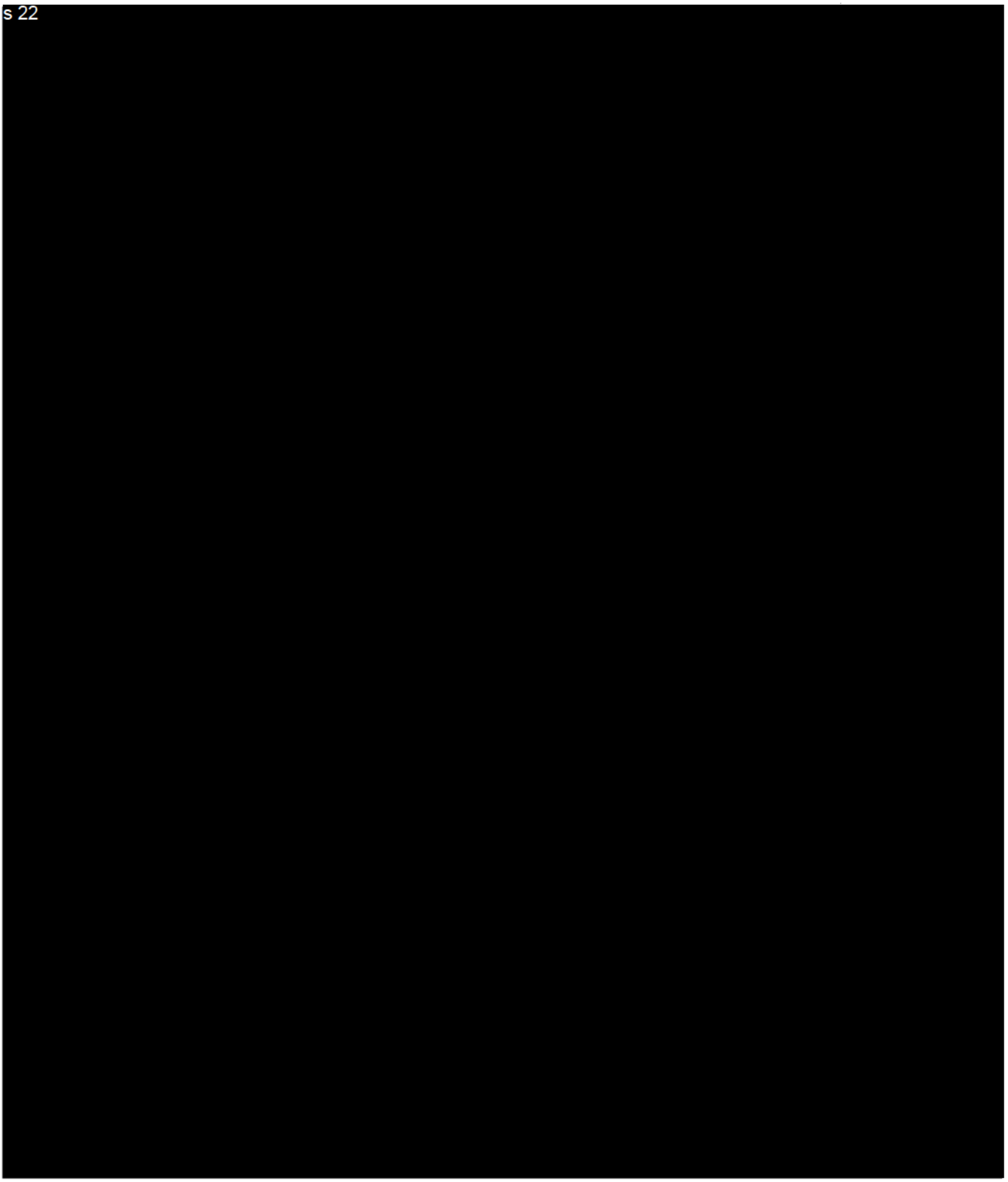

# Cape Grim BAPS Science Program
# Sub-Program Lead Scientist Governance Form

**Lead Scientists: Paul Fraser, Paul Steele, Paul Krummel**
**Sub-Program: Cape Grim Air Archive**
**Financial Year: 2014 – 2015**

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# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Particles and MAC**
**Requested Total Funding:** **$50,000**
**Working (Short) Program or Project Title:** **P-MAC**
**Program or Project Leader:** **Melita Keywood**

Program or Project Outcome:

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
- The continued development and application of chemical transport modelling to the remote marine boundary layer.
- Continued investigation of chemical composition of CCN mode particles.
- Continued investigation of mercury in the remote marine boundary layer
- Review of Particle Program

Program or Project Summary:

The Particles and MAC programs provide long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. Atmospheric aerosol particles play an important role in global and regional climate through direct radiative effects and indirectly through influence on cloud properties. The programs use time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.

The program fills an important role in the GAW Aerosol Program, by providing global baseline data for the remote marine environment. These data can be used to assess the impact of anthropogenic activities on the remote atmospheric environment.

This year the MAC and Particles Programs will continue to work with the chemical transport modellers to develop models for application to Cape Grim atmospheric chemistry and aerosol. This work will form part of a long-term program aimed at developing methodologies that incorporate observations from Cape Grim into process models and ultimately into the development of regional and global climate modelling systems such as ACCESS. Specifically this year, we utilise the modelling system to investigate long range transport of biomass burning smoke to Cape Grim under baseline conditions.

We will continue our investigation of mercury in the remote marine boundary layer and will continue to contribute data on baseline mercury concentrations measured with the TEKRAN Mercury Monitor, purchased to the Global Mercury Observing System (GMOS). We will continue our work on POPs at Cape Grim, collecting passive samples and active samples under all conditions.

This year we will continue to document and operationalise QA/QC procedures for aerosol microphysical data. In particular we will work with NOAA to adopt the QA/QC procedures of the NOAA Aerosol Global Monitoring network to streamline submission of data to the World Data Centre for Aerosol.

A large focus of this year's activities will involve preparation for the review of the Particle Program at the Cape Grim Science Meeting.

Travel and Personnel Cost Justification:

- Three QA/QC visits to Cape Grim by Melita Keywood, Jason Ward, Jeremy Ward or Fabienne Reisen;

- TEKRAN Monitor QA/QC visit Macquarie University
- Precipitation QA/QC visit by Jennifer Powell
- Visit to Cape Grim by Keywood and John Ogren

Equipment Required

N/A

2015/2016 targets

- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2015) to the GAWSIS data base
- Submit QA/QC gaseous elemental mercury data for 2015 to the GMOS data base
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP
- Adoption of NOAA Aerosol Network QA/QC procedures
- Paper published "CCN activity of remote marine aerosol" by Fedele, Keywood, Porter and Hughes
- Particle program review report and presentation at Annual Science meeting
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity)
- Complete manuscript on CCN trends for an international journal (JG as PRF activity)
- Draft paper on long term record of organic composition of marine aerosol (collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll)

2014/2015 targets Reconciled

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015-ongoing
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2013) to the GAWSIS data base-ongoing- CN data up to 2011 submitted
- Submit QA/QC gaseous elemental mercury data for 2014 to the GMOS data base-ongoing
- Paper published on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)-paper published in APCD
- Paper submitted on characteristics of CCN during the 2011 intensive campaign (led by Rosemary Fedele; supervised by Melita Keywood)- PhD submitted, draft of paper complete
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP-ongoing
- Operationalize QA processing for CN, CCN, BC and Bsp data-ongoing; discussions with John Ogren at NOAA to adopt NOAA procedures and become a participant in the NOAA aerosol network
- Write a Baseline report on POPs program-complete
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity) –ongoing, first draft complete and comments provided
- Submit manuscript on CCN trends for an international journal (JG as PRF activity)-ongoing
- Continue collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll) to analyse the composition of organic species in the 20 year PM10 archive by visiting US-ongoing, UNC have analysed winter and summer samples for 1980, 1985, 1990, 1995, 2000, 2005, 2010 and 2013 have identified some N-containing species, isoprene and monoterpene SOA tracers that are higher in summer than winter and a number of fatty acids thought to have biological origin - either bacteria or microorganisms (e.g., phytoplankton)
- Carry our intensive measurement campaign-complete, QUT led this activity

Other achievements

- Melita Keywood attended the meeting for the GAW EPAC Meeting in Geneva in February 2015
- Melita Keywood attended the NOAA ESRL GMD Annual Meeting in Boulder Colorado May 2015
- Consolidation of the MAAP and aethelometer BC record has progressed. Cape Grim data will contribute to an intercomparison of BC measurements by broadband aethalometers with other filter-based absorption photometers in collaboration with John Ogren.
- During the maiden voyage of the RV Investigator in March 2015, the ship spent several days in the baseline sector, measuring aerosol microphysical properties (as well as ozone and greenhouse gases). Initial analysis of the data suggests 2 periods when Cape Grim was in baseline and back trajectories indicate air masses had been in the vicinity of the Investigator.

- Rosie Fedele and Ruhi Humphries submitted their PhDs

Papers published

1. Cravigan LT, Ristovski Z, Modini RL, Keywood MD and Gras JL (2015) Observation of sea-salt fraction in sub-100nm diameter particles at Cape Grim. Journal of Geophysical Research-Atmospheres 120(5): 1848-1864. doi: 10.1002/2014jd022601
2. Lawson SJ, Selleck PW, Galbally IE, Keywood MD, Harvey MJ, Lerot C, Helmig D and Ristovski Z (2015) Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere. Atmospheric Chemistry and Physics 15(1): 223-240. doi: 10.5194/acp-15-223-2015
3. Slemr F, Angot H, Dommergue A, Magand O, Barret M, Weigelt A, Ebinghaus R, Brunke EG, Pfaffhuber KA, Edwards G, Howard D, Powell J, Keywood M and Wang F (2015) Comparison of mercury concentrations measured at several sites in the Southern Hemisphere. Atmospheric Chemistry and Physics 15(6): 3125-3133. doi: 10.5194/acp-15-3125-2015
4. Wang X, Kennedy K, Powell J, Keywood M, Gillett R, Phong T, Bridgen P, Broomhall S, Paxman C, Wania F and Mueller JF (2015) Spatial distribution of selected persistent organic pollutants (POPs) in Australia's atmosphere. Environmental Science-Processes & Impacts 17(3): 525-532. doi: 10.1039/c4em00594e
5. Winton VHL, Bowie AR, Edwards R, Keywood M, Townsend AT, van der Merwe P and Bollhöferf A (2015) Fractional iron solubility of atmospheric iron inputs to the Southern Ocean. Marine Chemistry: Biogeochemistry of trace elements and their isotopes in press.

Reports

1. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 36 8th set of samples Report to Department of the Environment 6 p.
2. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 37 8th set of analytical resultsReport to Department of the Environment 23 p.
3. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 38 9th set of samples Report to Department of the Environment 10 p.
4. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 39 9th set of analytical results Report to Department of the Environment 162 p.
5. Keywood, M and Powell, J (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 40 Draft 2014 Annual Report Report to Department of the Environment 107 p.
6. Keywood, M and Powell, J (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 42 Final 2014 Annual Report Report to Department of the Environment 108 p.
7. Keywood, M, Powell, J and Gillett, R (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 42 Final Report and Options for National Air Sampling System Options to Department of the Environment 235 p.

Presentations

1. Keywood, M. D., P. W. Selleck, R. W. Gillett and J. P. Ward, Aerosol Composition at Cape Grim: the long-term record, in *Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014, Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 25, 2014.

2. Lawson, S. J., P. W. Selleck, I. E. Galbally, M. D. Keywood, M. J. Harvey, C. Lerot, D. Helmig and Z. Ristovski, First *in situ* measurements of glyoxal and methylglyoxal over the remote temperate oceans, *in Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014,

Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 10, 2014

3. Winton, H., R. Edwards, A. Bowie, S. D. Chambers, M. D. Keywood, S. Wercynski and A. G. Williams, Aerosol iron solubility: comparison between the Australian subtropics and Southern Ocean, in *Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014, Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 31, 2014.

4. Keywood M, and Protat, A, (2015) Aerosol, clouds and the Southern Ocean: from Cape Grim to the RV Investigator presentation at the 2015 NOAA ESRL GMD Annual Science Meeting Boulder Colorado May 2015

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Air Archive**
**Requested Total Funding:** **$0 (air archive tanks requested through asset funds)**
**Working (Short) Program or Project Title:** **Air Archive**
**Program or Project Leader:** **Paul Steele, Paul Krummel, Paul Fraser**

Program or Project Outcome:
Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

Program or Project Summary:
The Cape Grim Air Archive is a unique collection of Cape Grim air samples dating back to 1978. The samples have proved invaluable in

(a) determining the background trends (1978-present) of a range of greenhouse and ozone depleting gases for which the measurement capabilities have been developed in recent years;

(b) bridging the sampling age gap between Antarctic firn air and modern air samples, enabling Southern Hemisphere records for several species, for which the measurement capabilities have been developed in recent years, to be reconstructed back to the 1930s.

Travel and Personnel Cost Justification:
None.

Equipment Required

| | |
|---|---|
| Six 34 litre SS tanks (Essex Industries) | $34,000 (asset funding) |

Completion of 2014-2015 Targets

1. Purchase 6 new air archive tanks by March 2015. *Done – purchased from Cape Grim asset funding.*
2. Collect at least 6 air archive samples during 2014/2015. *Done – 5 air archival samples collected – Jul, Sep & Nov(2) 2014, Feb 2015. One due to be filled now.*
3. Submit QA/QC data 1978-2014 to Cape Grim by 30 June 2015. *Done (Jul 2015).*
4. Provide 2014 Program Report to OiC by 30 June 2015 (Lead Scientist Report, early 2015). *Done.*
5. Air Archive program report for *Baseline 2011-2012* submitted to editors by 30 November 2014. *Done – report spans 2011-2013.*
6. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks. *In progress.*
7. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem. *In progress. Transfers of test samples done and analyses of results are almost finalised, verifying the stability of trace gas concentrations except for CO, which shows a slow upward drift. Transfers of any archive air samples have been suspended for the time being, due to the discovery of a contamination problem with some of the Essex cylinders. Essex engineers used (without our knowledge or consent) a lubricant called Christo-Lube MCG 111 on some of the gaskets and flanges. This lubricant is a suspension of powdered PTFE in a perfluoropolyether grease [F-(CF(CF$_3$)-CF$_2$-O)$_n$-CF$_2$CF$_3$], where n ranges between 10 and 60. Slow decomposition of the lubricant causes production of CF$_4$ (and perhaps other species) in the cylinder. Still awaiting results from testing at Scripps, to determine the best method for identifying those cylinders contaminated with Christo-Lube.*
8. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments. *Done – see 2014-2015 Greenhouse Gas program targets for the 7 papers incorporating the use of air archive data.*

Targets by 30 June 2016

1. Purchase 6 new air archive tanks by March 2016.
2. Collect at least 6 air archive samples during 2015/2016.
3. Submit QA/QC data 1978-2015 to Cape Grim by 30 June 2016.
4. Provide 2015 Program Report to OiC (in the Lead Scientist Report), in Feb 2016.
5. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks.
6. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem.
7. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientist: Melita Keywood**
**Sub-Program: Particles and MAC**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90% Raw* data collection | | CN, UCN, CCN, BC, Bsp time series data for 2015<br>Raw data are: rainwater and filter samples from ERNI, Eigenbordt, Ecotech 3000 (x2), Partisol; chemical composition and mass of rainwater and filter samples |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2015 | | CN, UCN, CCN, BC time series hourly data for 2015 |
| 3 | All Meta* data to CGBAPS for archival for 2014 by 30 June 2016 | | Logbook information additional to station log, includes instrument/inlet description, operation, changes, calibrations 2015 etc<br>QA quantities are: Rainwater, PM10 (HVB and HVC), PM2.5 (Partisol) for Jan 2015 to Dec 2015 |
| 4 | Annual operation and data summary reports (Particles and MAC) for Baseline to OiC BAPS in time for Publication in Baseline 2012/2014 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by early 2016 Working Group Meeting | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | |
| 10 | Four funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

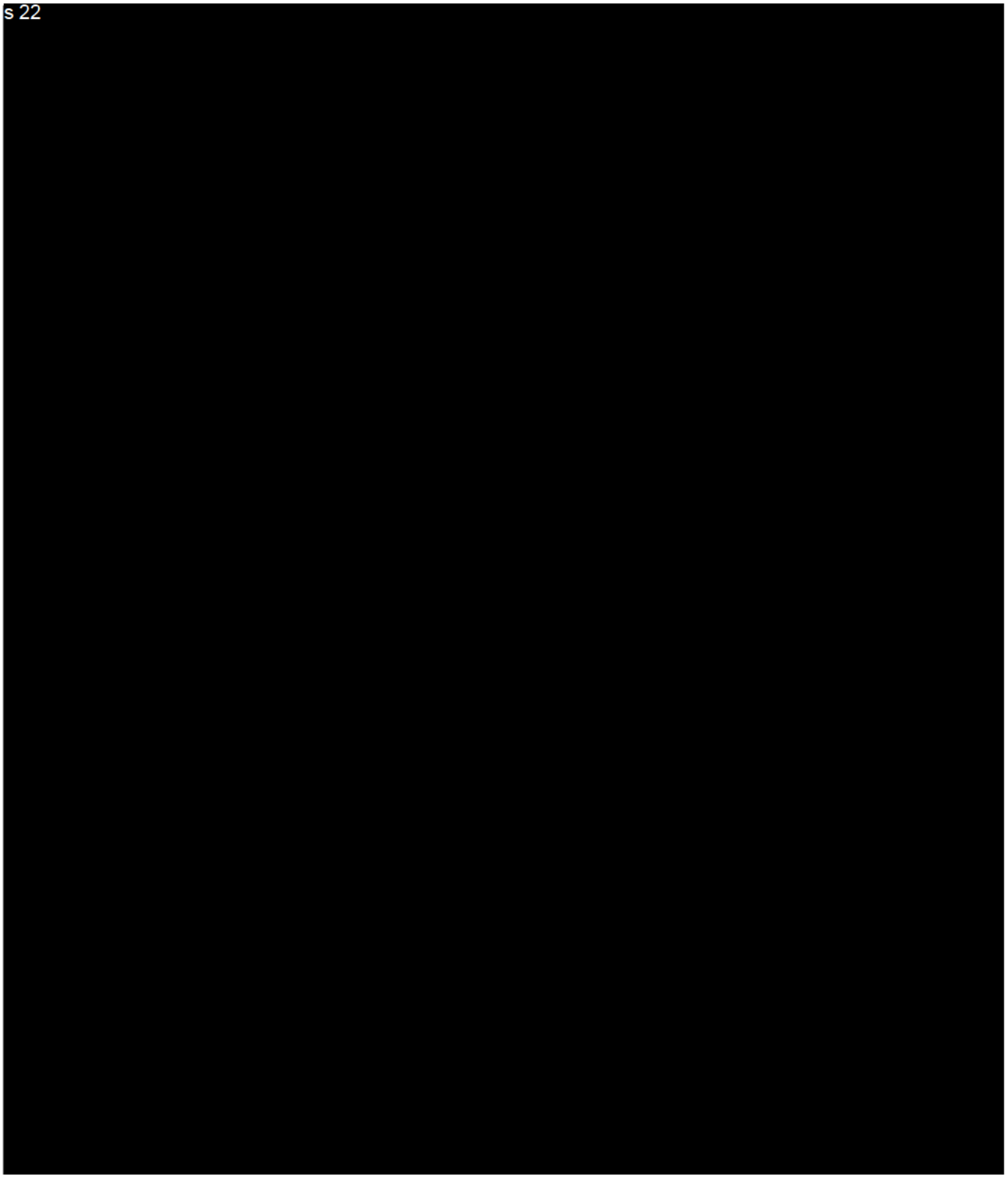
**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# Cape Grim BAPS Science Program
## Sub-Program Lead Scientist Governance Form

**Lead Scientists: Stephen Wilson**
**Sub-Program: Spectral Radiation**
**Financial Year: 2014 - 2015**

s 22




s 22

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Steele, Paul Krummel, Paul Fraser**
**Sub-Program: Cape Grim Air Archive**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 75% raw* data collection | | 6 Cape Grim air archives |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2014 |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures. |
| 4 | Annual operation and data summary report 2015 for Baseline to OiC BAPS by 30 June 2016 | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016. | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type:** **Continuing**
**Program or Project Title:** **Radon**
**Requested Total Funding:** **$24,620**
**Working (Short) Program or Project Title:** **Radon**
**Program or Project Leader:** **Alastair Williams**

Program or Project Outcome:
*In less that 50 words describe the outcomes of your research.*

- Provision of continuous hourly, high sensitivity measurements of atmospheric radon in support of Cape Grim science programs and international climate monitoring efforts.
- Maintenance of the Cape Grim radon program as the international benchmark for measurements of very low radon concentrations in baseline air masses.
- High quality research contributions to the international body of knowledge relating to air pollution and climate monitoring and prediction.

Program or Project Summary:
*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and International community.*

- Radon is an ideal tracer of pollution at baseline stations such as CGBAPS because it is an unambiguous indicator of terrestrial influence on an air mass. Furthermore, the simulation of radon transport is currently one of the best tools for the evaluation of transport schemes in regional and global models. It has also been demonstrated that trace gas emissions originating from large land areas can be estimated using radon.
- At Cape Grim changes in the radon concentration in air are measured to high precision and temporal resolution using ANSTO-built high sensitivity instruments.
- The radon program at Cape Grim is closely associated with radon programs at Mauna Loa Observatory, Cape Point, Jungfraujoch and King Sejong Stations. All these sites are part of WMO's Global Atmosphere Watch Programme, which investigates the role of atmospheric chemistry in global change, assists in the development of a predictive capability for future atmospheric states and feeds into future policy development.

Travel and Personnel Cost Justification:
*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form, then please provide written support for your requirement for these funds.*

- Trips to Cape Grim ($16,030): 3 x 5-day trips for 3 people, including WGM in Smithton
- Working Group Meeting at BoM HQ ($860): 1 day for 1 person
- Annual Science Meeting ($3,230): 4 days for 2 people, including WGM

Equipment Required
See Asset request and justification forms for details and priorities.

- No new asset purchases requested for 2015-2016 financial year

Completion of 2014-2015 Targets

- Provide 2014 Radon Program report to OiC by February 2015. Achieved: The 2014 Radon sub-program report was submitted to the WG Chair in February 2015
- Submit QA/QC Cape Grim radon data from 2014 to Cape Grim OiC by 30 June 2015. Achieved: Data set submitted to OiC.
- Submit historic (pre-2011) Cape Grim radon data to the WDCGG archive. Not achieved: Now planned for second half of 2015.
- Complete a study refining the radon-derived atmospheric "baseline" selection technique at Cape Grim. Achieved: Oral presentation delivered at Nov 2014 Cape Grim Annual Science meeting; manuscript completed and submitted in February 2015 for publication as an article in *Baseline 2011-2013*. A second closely-related article has been submitted to *Aerosol and Air Quality Research* (currently under review).
- Complete the deployment of the 1500L radon detector on board *RV Investigator*, and participate in a short "test" voyage. Achieved: Installation and commissioning of the new radon detector in the aerosol laboratory aboard the *RV Investigator* was accomplished in September 2014 by Scott Chambers and Ot Sisoutham, and a short test voyage was conducted in October 2014 by Sylvester Werczynski. Issues arising with the inlet and calibration unit during the first few months of operation were resolved in a further visit to Hobart in February 2015.

- Submit at least one manuscript relevant to the Cape Grim science program. Achieved: Five refereed journal articles appeared and three submitted. Also, seven conference publications delivered. See publications list below.
- Additional achievements:
  - New 1500L tank (external shell) constructed and installed for backup radon detector BHURD.
  - Eight replacement sensing heads constructed for primary radon detector HURD3.
  - New 1500L radon detector constructed, installed and commissioned at the Baring Head Clean Air Monitoring Station in New Zealand in May 2015.

Targets by 30 June 2016

- Provide 2015 Radon Program report to OiC by February 2016.
- Submit QA/QC Cape Grim radon data from 2015 to Cape Grim OiC by 30 June 2016.
- Submit historic (pre-2011) Cape Grim radon data to the WDCGG archive
- Construct and deploy a new radon detector at Jang Bogo WMO-GAW Station in Antarctica (collaboration with Korean Polar Research Institute).
- Construct and deploy a new radon detector aboard the national "AIR-BOX" facility, an instrumented and environmentally controlled shipping container capable of remote deployment and autonomous operation (Australian consortium led by UniMelb).
- Submit at least one manuscript relevant to the Cape Grim science program.

Publications (of relevance to Cape Grim and other WMO-GAW baseline science programs)

*Refereed journal articles*

Chambers, SD, Hong, S-B, Williams, AG, Crawford, J, Griffiths, AD, and Park, S-J, 2014: 'Characterising terrestrial influences on Antarctic air masses using Radon-222 measurements at King George Island', *Atmos. Chem. Phys.* **14**, 9903-9916. www.atmos-chem-phys.net/14/9903/2014/ ; doi:10.5194/acp-14-9903-2014

Locatelli, R., Bousquet, P., Hourdin, F., Saunois, M., Cozic, A., Couvreux, F., Grandpeix, J.-Y., Lefebvre, M.-P., Rio, C., Bergamaschi, P., Chambers, S. D., Karstens, U., Kazan, V., van der Laan, S., Meijer, H. A. J., Moncrieff, J., Ramonet, M., Scheeren, H. A., Schlosser, C., Schmidt, M., Vermeulen, A., and Williams, A. G., 2015: 'Atmospheric transport and chemistry of trace gases in LMDz5B: evaluation and implications for inverse modelling', *Geosci. Model Dev.* **8**, 129–150. doi:10.5194/gmd-8-129-2015. www.geosci-model-dev.net/8/129/2015/

Loh, Z. M., Law, R. M., Haynes, K. D., Krummel, P. B., Steele, L. P., Fraser, P. J., Chambers, S., and Williams, A., 2015: 'Simulations of atmospheric methane for Cape Grim, Tasmania, to constrain South East Australian methane emissions', *Atmos. Chem. Phys.* **15**, 305–317. doi:10.5194/acp-15-305-2015. www.atmos-chem-phys.net/15/305/2015/

van Noije, T. P. C., Le Sager, P., Segers, A. J., van Velthoven, P. F. J., Krol, M. C., Hazeleger, W., Williams, A. G., and Chambers, S. D., 2014: 'Simulation of tropospheric chemistry and aerosols with the climate model EC-Earth'. Geosci. Model Dev., **7**, 2435-2475, doi:10.5194/gmd-7-2435-2014. http://www.geosci-model-dev.net/7/2435/2014/gmd-7-2435-2014.html

Van der Schoot, M.V., Fraser, P.J., Krummel, P.B., Spencer, D.A., Loh, Z.M., Langenfelds, R.L., Steele, L.P., Gregory, R., Meyer, C.P., Keywood, M.D., Lawson, S.J., Fedele, R., Atkinson, B., Klau, D., and Zahorowski, W., 2014: 'A new pilot Australian tropical atmospheric research station (ATARS)', in *Baseline Atmospheric Program (Australia) 2009-2010*, Derek, N., Krummel, P.B., and Cleland, S.J. (eds.), Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne, Australia, 87-90.

*Journal articles submitted*

Chambers, SD, Williams, AG, Crawford, J, Griffiths, AD, Krummel, PB, Steele, LP, Law, RM, van der Schoot, MV, Galbally, IE, and Molloy, SB, 2015: 'A radon-only technique for characterising atmospheric baseline constituent concentrations at Cape Grim'. Submitted to *Baseline Atmospheric Program (Australia) 2011-2013.*

Chambers, SD, Williams, AG, Conen, F, Griffiths, AD, Reimann, S, Steinbacher, M, Krummel, PB, Steele, LP, van der Schoot, MV, Galbally, IE, Molloy, SB, and Barnes, JE, 2015: 'Towards a universal "baseline" characterisation of air masses for high- and low-

altitude observing stations using Radon-222'. Submitted to *Aerosol and Air Quality Research.*

Williams, AG, and Chambers, SD, 2015: 'A history of radon measurements at Cape Grim'. Submitted to *Baseline Atmospheric Program (Australia) 2011-2013.*

*Conference presentations*

Clare Paton-Walsh, Élise-Andrée Guérette, Ruhi Humphries, Dagmar Kubistin, Stephen Wilson, David Griffith, Rebecca Buchholz, Voltaire Velazco, Xue Shi, Ian Galbally, Melita Keywood, Sarah Lawson, Paul Selleck, Min Cheng, Suzie Molloy, Mahendra Bhujel, Alan Griffiths, Scott Chambers and Perry Davy. M.U.M.B.A. Measurements of urban, marine & biogenic air. 13th IGAC Science Conference on Atmospheric Chemistry "Changing chemistry in a changing world". 22-26 September, Natal, Brazil, 2014.

Élise-Andrée Guérette, Clare Paton-Walsh, Ian Galbally, Sarah Lawson, Suzie Molloy, Ruhi Humphries, Dagmar Kubistin, Stephen Wilson, David Griffith, Rebecca Buchholz, Voltaire Velazco, Xue Shi, Melita Keywood, Paul Selleck, Min Cheng, Mahendra Bhujel, Alan Griffiths, Scott Chambers and Perry Davy: VOC measurements by Proton Transfer Reaction Mass Spectrometry during the MUMBA campaign: a first look at potential source influences. 13th IGAC Science Conference on Atmospheric Chemistry "Changing chemistry in a changing world". 22-26 September, Natal, Brazil, 2014.

Chambers, SD, Willliams, AG, Crawford, J, Griffiths, AD, Krummel, PB, Steele, LP, Galbally, IE, Molloy, S, and van der Schoot, MV, 2014: 'A radon-only technique for characterising baseline constituent concentrations at Cape Grim', Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014, Aspendale Victoria 12-14 November 2014, Abstracts volume (eds. Nada Derek and Paul Krummel), p33. Oral presentation.

Williams, AG, Chambers, SD, Crawford, J, and Griffiths, AD, 2014: 'Radon vertical profiles during the morning transition period', Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014, Aspendale Victoria 12-14 November 2014, Abstracts volume (eds. Nada Derek and Paul Krummel), p32. Oral presentation.

Winton, H, Edwards, R, Bowie, A, Chambers, SD, Keywood, MD, Werczynski, S, and Williams, AG, 2014: 'Aerosol iron solubility: comparison between the Australian subtropics and Southern Ocean', Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014, Aspendale Victoria 12-14 November 2014, Abstracts volume (eds. Nada Derek and Paul Krummel), p31. Oral presentation.

Paton-Walsh, C, Guerette, EA, Rea, G, Kubistin, D, Humphries, R, Wilson, SR, Griffith, DWT, Buchholz, R, Velazco, V, Shi, X, Galbally, IE, Keywood, MD, Lawson, SJ, Selleck, PW, Cheng, M, Molloy, S, Bhujel, M, Griffiths, AD, Chambers, SD, and Davy, P, 2014: 'Update on the MUMBA Campaign: Measurements of urban, marine and biogenic air', Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014, Aspendale Victoria 12-14 November 2014, Abstracts volume (eds. Nada Derek and Paul Krummel), p12. Oral presentation.

Law, RM, Loh, ZM, Ziehn, T, Haynes, KD, Krummel, PB, Steele, LP, Fraser, PJ, Chambers, SD, and Williams, AG, 2014: 'Transport modelling and inversions for the interpretation of greenhouse gas measurements', Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014, Aspendale Victoria 12-14 November 2014, Abstracts volume (eds. Nada Derek and Paul Krummel), p5. Oral presentation.

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Tuesday, 21 July 2015 10:33 PM
**To:** 'Sam Cleland'
**Subject:** RE: text for Letter of Authorisation [SEC=UNCLASSIFIED]
**Attachments:** CSIRO_CapeGrim_2015-2016_fundingrequestsummary_to_BoM.docx

Hi Sam,

Crap, must have just been dreaming that I did the $300K split for the first one! Sorry about that.

Attached is what I meant to send! And yes, I prefer this type of split as well.

Thanks for this.
Cheers, Krum

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**From:** Sam Cleland [mailto:S.Cleland@bom.gov.au]
**Sent:** Tuesday, 21 July 2015 5:50 PM
**To:** Krummel, Paul (O&A, Aspendale)
**Subject:** RE: text for Letter of Authorisation [SEC=UNCLASSIFIED]

Hi Krum

Thanks for that. Just confirming though, the letter describes two equal payments of $229,500, rather than $300,000 then $158,500 split described below. I'm not that fussed, but we've gone the latter formula of recent years, which has the advantage of essentially maintaining a pro-rata for a March payment. Let me know your preference, and I should be able to put the agreement letter together within the next couple of days.

Cheers

**Sam Cleland** | Officer in Charge

Australian Government
Bureau of Meteorology

**Observations and Infrastructure** | Cape Grim Baseline Air Pollution Station
Bureau of Meteorology
PO Box 346 (159 Nelson St), Smithton, Tasmania, 7330
Tel: +61 3 6452 1629 (Office), 6452 2181 (Station) | s.cleland@bom.gov.au
www.bom.gov.au/inside/cgbaps



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**From:** Paul.Krummel@csiro.au [mailto:Paul.Krummel@csiro.au]
**Sent:** Monday, 20 July 2015 9:54 PM
**To:** Sam Cleland
**Subject:** text for Letter of Authorisation

G'day Sam,

As discussed last week at the working group meeting, attached is the updated 'usual' text that we provide to you each year for the Letter of Authorisation for the funding transfer for CSIRO Cape Grim activities.

I have nominally put down August for the first split and have put the value at $300K for this split (like previous years), however, just let me know if you want anything different!

Thanks.
Cheers, Krum

**Paul Krummel**
Research Group Leader | Atmospheric Composition and Chemistry (Earth Health)
Research Team Leader | Greenhouse and Ozone Depleting Gases
**CSIRO Oceans & Atmosphere Flagship**

E paul.krummel@csiro.au T +61 3 9239 4568
CSIRO Oceans & Atmosphere Flagship, Private Bag No. 1, Aspendale, Victoria 3195, Australia
www.csiro.au | www.csiro.au/OandA

Cape Grim Greenhouse Gases - www.csiro.au/greenhouse-gases

## Summary of the CSIRO 2015-2016 Cape Grim project proposals and budget requests:

There are three CSIRO Cape Grim project proposals for the 2015-2016 financial year, namely the greenhouse gases (GHG) sub program, the reactive gases sub-program and the particles/multiphase atmospheric chemistry (MAC) sub-program.

### Cape Grim greenhouse gases sub-program (Lead Scientists: Paul Krummel, Paul Fraser, Paul Steele, Marcel van der Schoot):

*Outputs:*

- To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
- the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
- regular submission of the Cape Grim data to the relevant national and international data archives;
- enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
- continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;
- Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

*Impacts:*

- To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
- to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
- to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
- to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
- to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

*Requested budget for 2015-2016 financial year: $215,750.*

### Cape Grim particles and multiphase atmospheric chemistry sub-program (Lead Scientist: Melita Keywood):

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition;
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region;
- The continued development and application of chemical transport modelling to the remote marine boundary layer;
- Continued investigation of chemical composition of CCN mode particles;
- Continued investigation of mercury in the remote marine boundary layer and establishment of a long-term mercury measurement program.

*Requested budget for 2015-2016 financial year: $124,050.*

### Cape Grim reactive gases sub-program (Lead Scientists: Ian Galbally, Sarah Lawson):

- Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds (VOCs) and ammonia;
- Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

*Requested budget for 2015-2016 financial year: $118,700.*

For further details of each of these and their corresponding governance, please see the full project proposals that were tabled at the Cape Grim Working Group Meeting of **16 July 2015** and are contained in the minutes from that meeting.

**Budget request:**

The total requested budget from the Bureau of Meteorology for the 2015-2016 Cape Grim and associated projects at CSIRO is **$504,350 inclusive of GST**. Below is a table that shows the breakdown into the salary, operating and travel components of the requested budget from the Bureau of Meteorology for each of the projects.

**Breakdown of requested Cape Grim Bureau of Meteorology funding - 2015/2016**

| *project leader/Cape Grim Lead Scientist* | *project* | *CSIRO WBS* | *salary* | *operating* | *travel* | *oper+trav.* | *total* | *1st split (Aug 2015)* | *2nd split (Mar 2016)* |
|---|---|---|---|---|---|---|---|---|---|
| Krummel/Fraser/Steele/van der Schoot | greenhouse gases | R-0xxxx-01-001 | $ 136,750 | $ 52,900 | $ 26,100 | $ 79,000 | $ 215,750 | $ 141,200 | $ 74,550 |
| Keywood | particulates/MAC | R-0xxxx-01-002 | $ 82,050 | $ 22,000 | $ 20,000 | $ 42,000 | $ 124,050 | $ 81,150 | $ 42,900 |
| Galbally/Lawson | reactive gases | R-0xxxx-01-003 | $ 54,700 | $ 38,000 | $ 26,000 | $ 64,000 | $ 118,700 | $ 77,650 | $ 41,050 |
| | Total | | $ 273,500 | $ 112,900 | $ 72,100 | $ 185,000 | $ 458,500 | $ 300,000 | $ 158,500 |
| | | | | | | With GST | $ 504,350 | $ 330,000 | $ 174,350 |

Table notes:

1. This is the budget breakdown of the 2015-2016 CSIRO Cape Grim project proposals submitted to the Bureau of Meteorology and discussed/agreed upon at Cape Grim Working Group Meeting held on 16 July 2015, and subsequently submitted to the Cape Grim Management Group for endorsement.
2. Any queries, please contact Paul Krummel, CSIRO O&A Flagship, 03 9239 4568 or paul.krummel@csiro.au
3. All money values listed above do not include GST, except where highlighted in yellow.
4. The greenhouse gases project above includes the $CO_2$, non-$CO_2$ GHG and Cape Grim air archive sub programs. It also includes the $4.5K of travel funding requested under the 'Salary' proposal, which is for the NOAA representative to the Cape Grim Annual Science Meeting (CGASM), and a further $1K of funding requested under the 'Salary' proposal for additional travel to CGASM for Nada Derek.
5. The particles/MAC project above is the combined particles and MAC sub programs.

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Wednesday, 19 August 2015 4:18 PM
**To:** 'Sam Cleland'
**Subject:** RE: Letter of authorisation [SEC=UNCLASSIFIED]

Hi Sam,

Yep, Cai is the man and the address details are correct – note that as of a few weeks ago we are no longer a Flagship! We are now just CSIRO Oceans & Atmosphere – which I prefer anyway.

Thanks for this.
Cheers, Krum

---

**From:** Sam Cleland [mailto:S.Cleland@bom.gov.au]
**Sent:** Wednesday, 19 August 2015 3:54 PM
**To:** Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>
**Subject:** RE: Letter of authorisation [SEC=UNCLASSIFIED]

Hi Krum

Sorry, it slipped down my list for a tad, then time flew. Back on to it now, thanks for the nudge. Can you confirm Cai is the guy to address the letter to, and that his appropriate details are as below:

**Dr Wenju Cai**
**Research Director - Earth System Assessment Program**
**CSIRO Oceans & Atmosphere Flagship**
**Private Bag 1**
**Aspendale, Vic 3195**

Thanks

**Sam Cleland** | Officer in Charge

Australian Government
Bureau of Meteorology

**Observations and Infrastructure** | Cape Grim Baseline Air Pollution Station
Bureau of Meteorology
PO Box 346 (159 Nelson St), Smithton, Tasmania, 7330
Tel: +61 3 6452 1629 (Office), 6452 2181 (Station) | s.cleland@bom.gov.au
www.bom.gov.au/inside/cgbaps



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**From:** Paul.Krummel@csiro.au [mailto:Paul.Krummel@csiro.au]
**Sent:** Wednesday, 19 August 2015 11:58 AM
**To:** Sam Cleland
**Subject:** Letter of authorisation

G'day Sam,

Just wondering what is happening with the Letter of Authorisation for the CSIRO Cape Grim projects? I will soon need to start making flight bookings for the NOAA attendee at the meeting (John Ogren) and hence will need the project setup at our end to do this, not to mention any other Cape Grim travel and operating expenses!

Thanks for this.
Cheers, Krum

**Paul Krummel**
Research Group Leader | Atmospheric Composition and Chemistry (Earth Health)
Research Team Leader | Greenhouse and Ozone Depleting Gases
**CSIRO Oceans & Atmosphere Flagship**

E paul.krummel@csiro.au T +61 3 9239 4568
CSIRO Oceans & Atmosphere Flagship, Private Bag No. 1, Aspendale, Victoria 3195, Australia
www.csiro.au | www.csiro.au/OandA

Cape Grim Greenhouse Gases - www.csiro.au/greenhouse-gases

**Australian Government**
**Bureau of Meteorology**

HEAD OFFICE
Bureau of Meteorology
GPO Box 1289 Melbourne VIC 3001 Australia

In reply please quote
Our Ref: 30/1269
27 Aug 2015

**Dr Wenju Cai**
**Research Director - Earth System Assessment Program**
**CSIRO Oceans & Atmosphere**
**Private Bag 1**
**Aspendale, Vic 3195**

Dear Dr Wenju Cai

**Letter of authorisation - Contribution to CSIRO for its continuing collaboration with the Cape Grim Baseline Air Pollution Station Science Program for 2015-16**

The Commonwealth of Australia acting through its Bureau of Meteorology (ABN 92 637 533 532) (**Bureau**) is responsible for the Cape Grim Baseline Air Pollution Station Science Program (**Program**). The Management Group of the Program communicated on 27 August 2015 its approval for an initial payment for the attached proposal from CSIRO in relation to the Program extracted from the Cape Grim Working Group Minutes of 16 July 2015. The Management Group has initiated an initial payment for this financial year, with a further payment in the 4th quarter of the financial year to be confirmed at a further Management Group meeting.

Pursuant to the approval of the Management Group, CSIRO is authorised to commence performing work in accordance with the Proposal.

CSIRO will be paid $330,000 (inclusive of GST) in respect of the Proposal on receipt of an appropriate tax invoice from CSIRO. The invoice issued by CSIRO will be paid within 30 days after receipt of the invoice.

CSIRO will undertake the Proposal with professional care and skill.

The terms governing the Proposal (including intellectual property management) are set out in the Cape Grim Governance Manual 2006 and its Addendum.

The parties must not use each other's name or trade marks in a manner that suggests that the other endorses, or is associated with, its business, products or services.

The Bureau and CSIRO agree to resolve any disputes that may arise in connection with this letter of authorisation or the Proposal amicably and through negotiation between the parties.

If the dispute is not resolved within 28 days (or longer period agreed between the parties), the parties must refer the dispute for arbitration by the Australian Commercial Dispute Centre Limited for resolution in accordance with the Centre's Guidelines on Arbitration. The decision of the arbitrator (including any award as to costs) will be final and binding.

If you agree to the above arrangements, I would be grateful if you could sign the attached copy of this letter where indicated and return it to Sam Cleland, Bureau of Meteorology, PO Box 346, Smithton, Tasmania, 7330 and via email to S.Cleland@bom.gov.au.

Yours sincerely

s47F

Dr Bruce Forgan
ADOI
Bureau of Meteorology

1 Attachment

Signed by an authorised representative of CSIRO:

s47F

Signature

WENJU CAI

Name

RESEARCH DIRECTOR

Title

31/08/2015

Date

**Summary of the CSIRO 2015-2016 Cape Grim project proposals and budget requests:**

There are three CSIRO Cape Grim project proposals for the 2015-2016 financial year, namely the greenhouse gases (GHG) sub program, the reactive gases sub-program and the particles/multiphase atmospheric chemistry (MAC) sub-program.

## Cape Grim greenhouse gases sub-program (Lead Scientists: Paul Krummel, Paul Fraser, Paul Steele, Marcel van der Schoot):

*Outputs:*

- To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
- the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
- regular submission of the Cape Grim data to the relevant national and international data archives;
- enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
- continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;
- Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

*Impacts:*

- To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
- to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
- to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
- to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
- to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

*Requested budget for 2015-2016 financial year: $215,750.*

## Cape Grim particles and multiphase atmospheric chemistry sub-program (Lead Scientist: Melita Keywood):

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition;
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region;
- The continued development and application of chemical transport modelling to the remote marine boundary layer;
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- Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds (VOCs) and ammonia;
- Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

*Requested budget for 2015-2016 financial year: $118,700.*



700 Collins Street Docklands Tel: +61 3 9669 4000 Fax: +61 3 9669 4699 www.bom.gov.au ABN 92 637 533 532

For further details of each of these and their corresponding governance, please see the full project proposals that were tabled at the Cape Grim Working Group Meeting of **16 July 2015** and are contained in the minutes from that meeting.

**Budget request:**

The total requested budget from the Bureau of Meteorology for the 2015-2016 Cape Grim and associated projects at CSIRO is **$504,350 inclusive of GST**. Below is a table that shows the breakdown into the salary, operating and travel components of the requested budget from the Bureau of Meteorology for each of the projects.

**Breakdown of requested Cape Grim Bureau of Meteorology funding - 2015/2016**

| *project leader/Cape Grim Lead Scientist* | *project* | *CSIRO WBS* | *salary* | *operating* | *travel* | *oper+trav.* | *total* | *1st split (Aug 2015)* | *2nd split (Mar 2016)* |
|---|---|---|---|---|---|---|---|---|---|
| Krummel/Fraser/Steele/van der Schoot | greenhouse gases | R-0xxxx-01-001 | $ 136,750 | $ 52,900 | $ 26,100 | $ 79,000 | $ 215,750 | $ 141,200 | $ 74,550 |
| Keywood | particulates/MAC | R-0xxxx-01-002 | $ 82,050 | $ 22,000 | $ 20,000 | $ 42,000 | $ 124,050 | $ 81,150 | $ 42,900 |
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| | Total | | $ 273,500 | $ 112,900 | $ 72,100 | $ 185,000 | $ 458,500 | $ 300,000 | $ 158,500 |
| | | | | | | With GST | $ 504,350 | $ 330,000 | $ 174,350 |

Table notes:

1. This is the budget breakdown of the 2015-2016 CSIRO Cape Grim project proposals submitted to the Bureau of Meteorology and discussed/agreed upon at Cape Grim Working Group Meeting held on 16 July 2015, and subsequently submitted to the Cape Grim Management Group for endorsement.
2. Any queries, please contact Paul Krummel, CSIRO O&A Flagship, 03 9239 4568 or paul.krummel@csiro.au
3. All money values listed above do not include GST, except where highlighted in yellow.
4. The greenhouse gases project above includes the $CO_2$, non-$CO_2$ GHG and Cape Grim air archive sub programs. It also includes the $4.5K of travel funding requested under the 'Salary' proposal, which is for the NOAA representative to the Cape Grim Annual Science Meeting (CGASM), and a further $1K of funding requested under the 'Salary' proposal for additional travel to CGASM for Nada Derek.
5. The particles/MAC project above is the combined particles and MAC sub programs.



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**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Friday, 28 August 2015 10:48 AM
**To:** 'Bruce Forgan'
**Cc:** Sam Cleland
**Subject:** RE: 1st payment letter [SEC=UNCLASSIFIED]

OK, thanks for the info! Enjoy your time off!
Cheers, Paul

---

**From:** Bruce Forgan [mailto:B.Forgan@bom.gov.au]
**Sent:** Friday, 28 August 2015 10:46 AM
**To:** Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>
**Cc:** Sam Cleland <S.Cleland@bom.gov.au>
**Subject:** RE: 1st payment letter [SEC=UNCLASSIFIED]

Hi Paul

I leave Monday but Sam has it all in hand. The person who is subbing for me (Ben Haydon) knows it is coming, and has the authority to sign the payment.

Cheers, Bruce

---

Bruce W Forgan
head of Infrastructure Management Branch
Observations & Infrastructure Division
Ext: 4111

---

**From:** Paul.Krummel@csiro.au [mailto:Paul.Krummel@csiro.au]
**Sent:** Friday, 28 August 2015 10:44 AM
**To:** Bruce Forgan; Sam Cleland
**Subject:** RE: 1st payment letter [SEC=UNCLASSIFIED]

Hi Bruce,

Excellent, thanks for this. I heard you will be taking some leave shortly, just wondering when that is so I can hustle this process along a bit.

Cheers, Paul

---

**From:** Bruce Forgan [mailto:B.Forgan@bom.gov.au]
**Sent:** Friday, 28 August 2015 10:11 AM
**To:** Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>; Sam Cleland <S.Cleland@bom.gov.au>
**Subject:** 1st payment letter [SEC=UNCLASSIFIED]

Hi Paul and Sam

The 1st payment letter for 2015/16 is attached and on its way to Cai by snail mail.

Cheers, Bruce

---

Bruce W Forgan
head of Infrastructure Management Branch
Observations & Infrastructure Division
Ext: 4111

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Tuesday, 1 September 2015 8:04 PM
**To:** 'Sam Cleland'; Gibb, Kerry (O&A, Aspendale)
**Cc:** Keywood, Melita (O&A, Aspendale)
**Subject:** RE: Letter of authorisation [SEC=UNCLASSIFIED]

Hi Sam,

Yep, the ball is in our court. I have to get the internal project setup first though, which will take a week or two and then we can invoice. It was to be one of my jobs today but I have been home with a sick kid all day! Hopefully I'll get this started tomorrow.

Cheers, Krum

---

**From:** Sam Cleland [mailto:S.Cleland@bom.gov.au]
**Sent:** Tuesday, 1 September 2015 6:37 PM
**To:** Gibb, Kerry (O&A, Aspendale) <Kerry.Gibb@csiro.au>; Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>
**Cc:** Keywood, Melita (O&A, Aspendale) <Melita.Keywood@csiro.au>
**Subject:** RE: Letter of authorisation [SEC=UNCLASSIFIED]

Hi Kerry, thanks.
Krum, I think the next step is that you guys produce the invoice?

What do you think of making this attention to me? The alternative is a high risk of it floating in the system again.

Cheers

**Sam Cleland** | Officer in Charge

Australian Government
Bureau of Meteorology

**Observations and Infrastructure |** Cape Grim Baseline Air Pollution Station
Bureau of Meteorology
PO Box 346 (159 Nelson St), Smithton, Tasmania, 7330
Tel: +61 3 6452 1629 (Office), 6452 2181 (Station) | s.cleland@bom.gov.au
www.bom.gov.au/inside/cgbaps



---

**From:** Kerry.Gibb@csiro.au [mailto:Kerry.Gibb@csiro.au]
**Sent:** Monday, 31 August 2015 2:54 PM
**To:** Sam Cleland
**Subject:** FW: Letter of authorisation

Hi Sam
Attached is signed letter of authorisation.
I have also send a hard copy to you by post.
Kind regards
Kerry

**From:** Gibb, Kerry (O&A, Aspendale)
**Sent:** Monday, 31 August 2015 2:15 PM
**To:** Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>
**Cc:** Cai, Wenju (O&A, Aspendale) <Wenju.Cai@csiro.au>
**Subject:** Letter of authorisation

Hi Paul
Please find attached signed letter
Cheers
Kerry

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Thursday, 10 September 2015 9:40 PM
**To:** Sam Cleland
**Subject:** Cape Grim project and first invoice

G'day Sam,

Well, it appears as the Cape Grim project was fully approved today and has been entered into our SAP system … I suspect that BD are not fully aware of this! Either way, this will trigger the invoicing process. I am hoping the invoice has some indication of what it is for, unlike last time, but I must admit my confidence is not that high!

I was informed that the invoice will be sent straight to:
Accpayable@bom.gov.au

Is there anyway can you alert them that if an invoice comes in from CSIRO for $300K + $30K GST then it is for Cape Grim work? I asked to get a copy of the invoice (which I didn't initially get last time) and asked that it mentions Cape Grim and/or Bruce Forgan, but who knows what will happen!

Anyway, thought I would give you an update on this.
Cheers, Krum

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Sunday, 13 September 2015 5:08 AM
**To:** Sam Cleland
**Subject:** FW: CSIRO Tax Invoice 6643894
**Attachments:** CSIRO Tax Invoice 6643894.pdf

Hi Sam,

A copy of the invoice from CSIRO to BoM for Cape Grim activities is attached! Looks like my instructions did have an effect!

Cheers, Krum

---

**From:** Ariaratnam, Dharma (Admin Services, Clayton)
**Sent:** Friday, 11 September 2015 5:24 PM
**To:** 'Accpayable@bom.gov.au' <Accpayable@bom.gov.au>
**Cc:** 'b.forgan@bom.gov.au' <b.forgan@bom.gov.au>; Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>; Lamont, Audrey (Admin Services, Waite Campus) <Audrey.Lamont@csiro.au>
**Subject:** FW: CSIRO Tax Invoice 6643894

Dear AP,
Please find invoice for Cape Grim attached.

Thanks,
Regards,

Dharma Ariaratnam CPA
Project Support Advisor (**PSA**)
CSIRO O&A Flagship & L&W Flagship
O&A - Earth System Assessment (Research Program 2)
L&W - Landscape Intensification (Research program 6 )
PH:03 9545 2375 (Clayton) / 03 9239 4438 (Aspendale)
Email: Dharma.Ariaratnam@csiro.au



**From:** Helen McKay [mailto:helen.mckay@csiro.au]
**Sent:** Friday, 11 September 2015 1:10 PM
**To:** Ariaratnam, Dharma (Admin Services, Clayton) <Dharma.Ariaratnam@csiro.au>
**Subject:** CSIRO Tax Invoice 6643894

**CSIRO Accounts Receivable**
**PO Box 883**
**Kenmore QLD 4069**
**Australia PH: 1300 503 758**
**accounts.receivable@csiro.au**
**ABN: 41687119230**



# TAX INVOICE

**Bill-To:**

Bureau of Meteorology
PO Box 1289
DOCKLANDS VIC, 3001
Australia

| | |
|---|---|
| Number: | 6643894 |
| Issued: | 11/09/2015 |
| Customer PO No: | |
| Customer PO Date: | |
| Customer Number: | 210024 |
| Customer ABN: | 92637533532 |
| Customer Fax: | 03 9669 4699 |

| Description | QTY / Unit | Amount (Excl GST) |
|---|---|---|
| Cape Grim projects 2015-16 | | |
| BoM Cape Grim 2015/16 pmt 1<br>As per Leter of Authorisation (Your Ref: 30/1269 dd 27/08/2015)<br>Attention: Dr Bruce Forgan | 1 EA | AUD 300,000.00 * |

| | | | |
|---|---|---|---|
| Internal Reference: | Total Amount (Excl GST) | AUD | 300,000.00 |
| BS Element: R-07848-01 | Total GST Amount * | AUD | 30,000.00 |
| Contract No : 0002018562 | Total Amount Payable | AUD | 330,000.00 |

**PAYMENT DUE : 12/10/2015**

Please quote **000066438942100240** when making payment.

**Payment by EFT or BANK Transfer :**
Preferred method. Email payment advice to accounts.receivable@csiro.au

| | |
|---|---|
| Bank: | Westpac Banking Corporation |
| Branch: | Petrie Plaza, Canberra ACT Australia |
| Bank BSB: | 032-719 |
| Bank Account: | 226787 |
| Account Name: | CSIRO |
| SWIFT code: | WPACAU2S |

BPAY **Biller Code: 172213**
**Ref: 000066438942100240**

**Cheques:**
Please make payment to:
**CSIRO**
at the CSIRO address at top of page.

s22

[redacted]

**From:** Ariaratnam, Dharma (Admin Services, Clayton)
**Sent:** Friday, 11 September 2015 5:24 PM
**To:** 'Accpayable@bom.gov.au' <Accpayable@bom.gov.au>
**Cc:** 'b.forgan@bom.gov.au' <b.forgan@bom.gov.au>; Krummel, Paul (O&A, Aspendale) <Paul.Krummel@csiro.au>; Lamont, Audrey (Admin Services, Waite Campus) <Audrey.Lamont@csiro.au>
**Subject:** FW: CSIRO Tax Invoice 6643894

Dear AP,
Please find invoice for Cape Grim attached.

Thanks,
Regards,

Dharma Ariaratnam CPA
Project Support Advisor (**PSA**)
CSIRO O&A Flagship & L&W Flagship
O&A - Earth System Assessment (Research Program 2)
L&W - Landscape Intensification (Research program 6 )
PH:03 9545 2375 (Clayton) / 03 9239 4438 (Aspendale)
Email: Dharma.Ariaratnam@csiro.au

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**Subject:** CSIRO Tax Invoice 6643894

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**Kenmore QLD 4069**
**Australia PH: 1300 503 758**
**accounts.receivable@csiro.au**
**ABN: 41687119230**



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DOCKLANDS VIC, 3001
Australia

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| | | | |
|---|---|---|---|
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| WBS Element: R-07848-01 | Total GST Amount * | AUD | 30,000.00 |
| Contract No : 0002018562 | Total Amount Payable | AUD | 330,000.00 |

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Preferred method. Email payment advice to accounts.receivable@csiro.au

| | |
|---|---|
| Bank: | Westpac Banking Corporation |
| Branch: | Petrie Plaza, Canberra ACT Australia |
| Bank BSB: | 032-719 |
| Bank Account: | 226787 |
| Account Name: | CSIRO |
| SWIFT code: | WPACAU2S |

BPAY **Biller Code: 172213**
**Ref: 000066438942100240**

**Cheques:**
Please make payment to:
**CSIRO**
at the CSIRO address at top of page.

**From:** Sam Cleland <S.Cleland@bom.gov.au>
**Sent:** Tuesday, 15 September 2015 1:29 PM
**To:** Krummel, Paul (O&A, Aspendale)
**Subject:** FW: CSIRO agreement [SEC=UNCLASSIFIED]
**Attachments:** CSIRO Agreement.pdf

Hi Krum

For info, some folk in CSIRO have contacted us to send the contract back for counter-signing, and have "recalled" the invoice till that is done.

Regards

**Sam Cleland** | Officer in Charge

Australian Government
Bureau of Meteorology

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**From:** Cindy Hood
**Sent:** Tuesday, 15 September 2015 12:37 PM
**To:** robert.seymour@csiro.au
**Cc:** Sam Cleland; Jane Sellenger
**Subject:** CSIRO agreement [SEC=UNCLASSIFIED]

Hi Robert,

I have located the original agreement and sending it to Jane Sellenger at Aspendale via Startrack courier today.

Attached for your reference.

Let me know if you have any queries.

Thanks
Regards
Cindy

---

Cindy Hood

**Cindy Hood** | Office Manager

Australian Government
Bureau of Meteorology

**Bureau of Meteorology -** Cape Grim Baseline Air Pollution Station
PO Box 346, Smithton TAS 7330
159 Nelson Street, Smithton TAS 7330
Tel: +61 3 6452 1629| c.hood@bom.gov.au

www.bom.gov.au/inside/cgbaps

F140

Attachment 1

**Australian Government**
**Bureau of Meteorology**

HEAD OFFICE
Bureau of Meteorology
GPO Box 1289 Melbourne VIC 3001 Australia

RECEIVED
- 3 SEP 2015
BY: .....

In reply please quote
Our Ref: 30/1269
27 Aug 2015

**Dr Wenju Cai**
**Research Director - Earth System Assessment Program**
**CSIRO Oceans & Atmosphere**
**Private Bag 1**
**Aspendale, Vic 3195**

Dear Dr Wenju Cai

**Letter of authorisation - Contribution to CSIRO for its continuing collaboration with the Cape Grim Baseline Air Pollution Station Science Program for 2015-16**

The Commonwealth of Australia acting through its Bureau of Meteorology (ABN 92 637 533 532) (**Bureau**) is responsible for the Cape Grim Baseline Air Pollution Station Science Program (**Program**). The Management Group of the Program communicated on 27 August 2015 its approval for an initial payment for the attached proposal from CSIRO in relation to the Program extracted from the Cape Grim Working Group Minutes of 16 July 2015. The Management Group has initiated an initial payment for this financial year, with a further payment in the 4th quarter of the financial year to be confirmed at a further Management Group meeting.

Pursuant to the approval of the Management Group, CSIRO is authorised to commence performing work in accordance with the Proposal.

CSIRO will be paid $330,000 (inclusive of GST) in respect of the Proposal on receipt of an appropriate tax invoice from CSIRO. The invoice issued by CSIRO will be paid within 30 days after receipt of the invoice.

CSIRO will undertake the Proposal with professional care and skill.

The terms governing the Proposal (including intellectual property management) are set out in the Cape Grim Governance Manual 2006 and its Addendum.

The parties must not use each other's name or trade marks in a manner that suggests that the other endorses, or is associated with, its business, products or services.

The Bureau and CSIRO agree to resolve any disputes that may arise in connection with this letter of authorisation or the Proposal amicably and through negotiation between the parties.

If the dispute is not resolved within 28 days (or longer period agreed between the parties), the parties must refer the dispute for arbitration by the Australian Commercial Dispute Centre Limited for resolution in accordance with the Centre's Guidelines on Arbitration. The decision of the arbitrator (including any award as to costs) will be final and binding.

If you agree to the above arrangements, I would be grateful if you could sign the attached copy of this letter where indicated and return it to Sam Cleland, Bureau of Meteorology, PO Box 346, Smithton, Tasmania, 7330 and via email to S.Cleland@bom.gov.au.

Yours sincerely

s47F

Dr Bruce Forgan
ADOI
Bureau of Meteorology

1 Attachment

Signed by an authorised representative of CSIRO:

s47F

Signature

WENJU CAI
Name

RESEARCH DIRECTOR
Title

31/08/2015
Date

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*Impacts:*

- To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
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1. This is the budget breakdown of the 2015-2016 CSIRO Cape Grim project proposals submitted to the Bureau of Meteorology and discussed/agreed upon at Cape Grim Working Group Meeting held on 16 July 2015, and subsequently submitted to the Cape Grim Management Group for endorsement.
2. Any queries, please contact Paul Krummel, CSIRO O&A Flagship, 03 9239 4568 or paul.krummel@csiro.au
3. All money values listed above do not include GST, except where highlighted in yellow.
4. The greenhouse gases project above includes the $CO_2$, non-$CO_2$ GHG and Cape Grim air archive sub programs. It also includes the $4.5K of travel funding requested under the 'Salary' proposal, which is for the NOAA representative to the Cape Grim Annual Science Meeting (CGASM), and a further $1K of funding requested under the 'Salary' proposal for additional travel to CGASM for Nada Derek.
5. The particles/MAC project above is the combined particles and MAC sub programs.

**From:** Seymour, Robert (BD&C, Dutton Park)
**Sent:** Tuesday, 15 September 2015 2:14 PM
**To:** 's.cleland@bom.gov.au'; 'C.Hood@bom.gov.au'
**Cc:** 'b.forgan@bom.gov.au'; 'B.Haydon@bom.gov.au'; Sellenger, Jane (BD&C, Aspendale); Krummel, Paul (O&A, Aspendale)
**Subject:** Cape Grim Project / CSIRO / Letter of Authorisation

Dear Sam and Cindy

Thank you Cindy for your response to my request this morning and sending the Letter back to Jane Sellenger at Aspendale and for notifying your accounts staff to not process the invoice..

By way of explanation, due to changes in delegate levels in CSIRO as we transition from the old structure that ended in July 2014, we have had some administrative anomalies that in this case resulted in the wrong delegate signing the that Letter of Authorisation. Thus we needed to withdraw the Letter so that we could process it appropriately. I apologise, as I know this has and will add extra work for you and you team.

If you could send me a clean copy of the Letter of Authorisation I will ensure it gets signed off appropriately in CSIRO as soon as possible

I am happy to discuss this by phone if you need more detail. The best contact for me is my mobile (0417779550) as I will be traveling over the next few days.

Regards

Robert

**Robert Seymour**
Business Development Manager
**Oceans and Atmosphere**
CSIRO
E robert.seymour@csiro.au **T** +61 7 3833 5754 **M** 0417 779 550
Address: Ecosciences Precinct, GPO Box 2583, Brisbane, 4001
www.csiro.au | www.csiro.au/en/Outcomes/Oceans.aspx

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Thursday, 3 December 2015 2:34 PM
**To:** Sam Cleland
**Cc:** Keywood, Melita (O&A, Aspendale); Sellenger, Jane (C&G, Aspendale); Cai, Wenju (O&A, Aspendale)
**Subject:** Signed BoM Letter of Authorisation
**Attachments:** Letter of authorisation CSIRO Cape Grim Colaboration August 2015 - received by BoM.pdf

Hi Sam,

As discussed, attached is the copy of the signed (and received by BoM) Letter of Authorisation that I am sending to you again. This is the final version.

Thanks again for your patience on this!

Cheers, Paul

F140

Attachment 1

**Australian Government**
**Bureau of Meteorology**

HEAD OFFICE
Bureau of Meteorology
GPO Box 1289 Melbourne VIC 3001 Australia

RECEIVED
- 3 SEP 2015
BY:

In reply please quote
Our Ref: 30/1269
27 Aug 2015

**Dr Wenju Cai**
**Research Director - Earth System Assessment Program**
**CSIRO Oceans & Atmosphere**
**Private Bag 1**
**Aspendale, Vic 3195**

Dear Dr Wenju Cai

**Letter of authorisation - Contribution to CSIRO for its continuing collaboration with the Cape Grim Baseline Air Pollution Station Science Program for 2015-16**

The Commonwealth of Australia acting through its Bureau of Meteorology (ABN 92 637 533 532) (**Bureau**) is responsible for the Cape Grim Baseline Air Pollution Station Science Program (**Program**). The Management Group of the Program communicated on 27 August 2015 its approval for an initial payment for the attached proposal from CSIRO in relation to the Program extracted from the Cape Grim Working Group Minutes of 16 July 2015. The Management Group has initiated an initial payment for this financial year, with a further payment in the 4th quarter of the financial year to be confirmed at a further Management Group meeting.

Pursuant to the approval of the Management Group, CSIRO is authorised to commence performing work in accordance with the Proposal.

CSIRO will be paid $330,000 (inclusive of GST) in respect of the Proposal on receipt of an appropriate tax invoice from CSIRO. The invoice issued by CSIRO will be paid within 30 days after receipt of the invoice.

CSIRO will undertake the Proposal with professional care and skill.

The terms governing the Proposal (including intellectual property management) are set out in the Cape Grim Governance Manual 2006 and its Addendum.

The parties must not use each other's name or trade marks in a manner that suggests that the other endorses, or is associated with, its business, products or services.

The Bureau and CSIRO agree to resolve any disputes that may arise in connection with this letter of authorisation or the Proposal amicably and through negotiation between the parties.

If the dispute is not resolved within 28 days (or longer period agreed between the parties), the parties must refer the dispute for arbitration by the Australian Commercial Dispute Centre Limited for resolution in accordance with the Centre's Guidelines on Arbitration. The decision of the arbitrator (including any award as to costs) will be final and binding.

If you agree to the above arrangements, I would be grateful if you could sign the attached copy of this letter where indicated and return it to Sam Cleland, Bureau of Meteorology, PO Box 346, Smithton, Tasmania, 7330 and via email to S.Cleland@bom.gov.au.

Yours sincerely

s47F

Dr Bruce Forgan
ADOI
Bureau of Meteorology

1 Attachment

Signed by an authorised representative of CSIRO:

s47F

Signature

WENJU CAI
Name

RESEARCH DIRECTOR
Title

31/08/2015
Date

**Summary of the CSIRO 2015-2016 Cape Grim project proposals and budget requests:**

There are three CSIRO Cape Grim project proposals for the 2015-2016 financial year, namely the greenhouse gases (GHG) sub program, the reactive gases sub-program and the particles/multiphase atmospheric chemistry (MAC) sub-program.

## Cape Grim greenhouse gases sub-program (Lead Scientists: Paul Krummel, Paul Fraser, Paul Steele, Marcel van der Schoot):

*Outputs:*

- To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
- the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
- regular submission of the Cape Grim data to the relevant national and international data archives;
- enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
- continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;
- Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

*Impacts:*

- To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
- to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
- to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
- to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
- to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

*Requested budget for 2015-2016 financial year: $215,750.*

## Cape Grim particles and multiphase atmospheric chemistry sub-program (Lead Scientist: Melita Keywood):

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition;
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region;
- The continued development and application of chemical transport modelling to the remote marine boundary layer;
- Continued investigation of chemical composition of CCN mode particles;
- Continued investigation of mercury in the remote marine boundary layer and establishment of a long-term mercury measurement program.

*Requested budget for 2015-2016 financial year: $124,050.*

## Cape Grim reactive gases sub-program (Lead Scientists: Ian Galbally, Sarah Lawson):

- Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds (VOCs) and ammonia;
- Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

*Requested budget for 2015-2016 financial year: $118,700.*



700 Collins Street Docklands Tel: +61 3 9669 4000 Fax: +61 3 9669 4699 www.bom.gov.au ABN 92 637 533 532

...ner details of each of these and their corresponding governance, please see the full project ...oposals that were tabled at the Cape Grim Working Group Meeting of **16 July 2015** and are contained in the minutes from that meeting.

**Budget request:**

The total requested budget from the Bureau of Meteorology for the 2015-2016 Cape Grim and associated projects at CSIRO is **$504,350 inclusive of GST**. Below is a table that shows the breakdown into the salary, operating and travel components of the requested budget from the Bureau of Meteorology for each of the projects.

**Breakdown of requested Cape Grim Bureau of Meteorology funding - 2015/2016**

| *project leader/Cape Grim Lead Scientist* | *project* | *CSIRO WBS* | *salary* | *operating* | *travel* | *oper+trav.* | *total* | *1st split (Aug 2015)* | *2nd split (Mar 2016)* |
|---|---|---|---|---|---|---|---|---|---|
| Krummel/Fraser/Steele/van der School | greenhouse gases | R-0xxxx-01-001 | $ 136,750 | $ 52,900 | $ 26,100 | $ 79,000 | $ 215,750 | $ 141,200 | $ 74,550 |
| Keywood | particulates/MAC | R-0xxxx-01-002 | $ 82,050 | $ 22,000 | $ 20,000 | $ 42,000 | $ 124,050 | $ 81,150 | $ 42,900 |
| Galbally/Lawson | reactive gases | R-0xxxx-01-003 | $ 54,700 | $ 38,000 | $ 26,000 | $ 64,000 | $ 118,700 | $ 77,650 | $ 41,050 |
| | **Total** | | **$ 273,500** | **$ 112,900** | **$ 72,100** | **$ 185,000** | **$ 458,500** | **$ 300,000** | **$ 158,500** |
| | | | | | | With GST | $ 504,350 | $ 330,000 | $ 174,350 |

Table notes:

1. This is the budget breakdown of the 2015-2016 CSIRO Cape Grim project proposals submitted to the Bureau of Meteorology and discussed/agreed upon at Cape Grim Working Group Meeting held on 16 July 2015, and subsequently submitted to the Cape Grim Management Group for endorsement.
2. Any queries, please contact Paul Krummel, CSIRO O&A Flagship, 03 9239 4568 or paul.krummel@csiro.au
3. All money values listed above do not include GST, except where highlighted in yellow.
4. The greenhouse gases project above includes the $CO_2$, non-$CO_2$ GHG and Cape Grim air archive sub programs. It also includes the $4.5K of travel funding requested under the 'Salary' proposal, which is for the NOAA representative to the Cape Grim Annual Science Meeting (CGASM), and a further $1K of funding requested under the 'Salary' proposal for additional travel to CGASM for Nada Derek.
5. The particles/MAC project above is the combined particles and MAC sub programs.

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Monday, 8 February 2016 8:28 PM
**To:** 'Sam Cleland'
**Subject:** RE: [SEC=UNCLASSIFIED]

G'day Sam,

s22 [redacted]

On another front, the CSIRO parliament and minister liaison office today got asked for specific budget information for the senate estimates for CSIROs Cape Grim projects following Rob Vertessy's grilling (I also heard that he is very happy with CSIRO around all of this, and I do not blame him!). I had a very short time to respond, below is what was sent (summary of the financial reports I send you guys each year, for the last 5-6 years), 2015-2016 might raise a few eyebrows. This table might be useful for the BoM side of things as well. Also, the BoM in kind numbers are obviously estimates by me.

Cheers, Krum

| CSIRO Cape Grim project financials - summary | | | |
|---|---|---|---|
| Financial Year | BoM contribution to CSIRO projects | CSIRO contribution to projects | Total |
| 2015-2016 | $458,500 | $226,246 | $684,746 |
| s 22 [redacted] | | | |

**Bureau In-Kind support:** **In addition to the total funding of approximately $450-500K from BoM each year for all CSIRO Cape Grim projects (CSIRO O&A), the Bureau provide substantial in kind support. CSIRO has full access to the Cape Grim station facilities, including technical personal who undertake day to day running of the facility and instruments, as well as access to a capital equipment replacement program. These in-kind contributions from BoM are estimated at approximately $2.2M per annum, comprised of operating costs of the station (~$400K), labour & overheads (~$1.5M) and capital equipment replacement (~$300k).**

s22 [redacted]

s22

**From:** Krummel, Paul (O&A, Aspendale)
**Sent:** Tuesday, 1 March 2016 12:32 AM
**To:** Wonhas, Alex (Executive, North Ryde); Schiller, Andreas (O&A, Hobart)
**Cc:** Lee, Ken (O&A, Kensington); Cai, Wenju (O&A, Aspendale); Keywood, Melita (O&A, Aspendale); Sam Cleland; Susan Barrell - Bureau of Meteorology (S.Barrell@bom.gov.au)
**Subject:** Cape Grim info and budgets

Hi Andreas & Alex,

Since I will not be in at work tomorrow (Tuesday) I thought I would send through some information on our Cape Grim activities, ahead of your meeting with Rob Vertessy at BoM on Wednesday morning. I have also cc'd our BoM colleagues as this is information that they also readily have as part of our Cape Grim governance & reporting each year.

**s22**

[redacted]

Cape Grim budgets:
The 2015-2016 requested Cape Grim project budget was: 7.25 FTE (spread across about 25 staff members), $215K opex/travel (of which $185K comes from BoM as part of the $460K each year), total cost

$1.9M, BoM contributes $460K to this. NOTE that in order to action the funding transfer from BoM to CSIRO for 2015/2016, we had to reduce the above budget in SAP to meet delegation requirements, however, the above numbers are a true reflection of the effort for this activity.
The table below lists the actuals from the Cape Grim projects from the previous 5 financial years:

| CSIRO Cape Grim project financials - summary | | | |
|---|---|---|---|
| Financial Year | BoM contribution to CSIRO projects | CSIRO contribution to projects | Total |
| s 22 | [redacted] | [redacted] | [redacted] |

**Bureau In-Kind support: In addition to the total funding of approximately $450-500K from BoM each year for all CSIRO Cape Grim projects (CSIRO O&A), the Bureau provide substantial in kind support. CSIRO has full access to the Cape Grim station facilities, including technical personal who undertake day to day running of the facility and instruments, as well as access to a capital equipment replacement program. These in-kind contributions from BoM are estimated at approximately $2.2M per annum, comprised of operating costs of the station (~$400K), labour & overheads (~$1.5M) and capital equipment replacement (~$300k).**

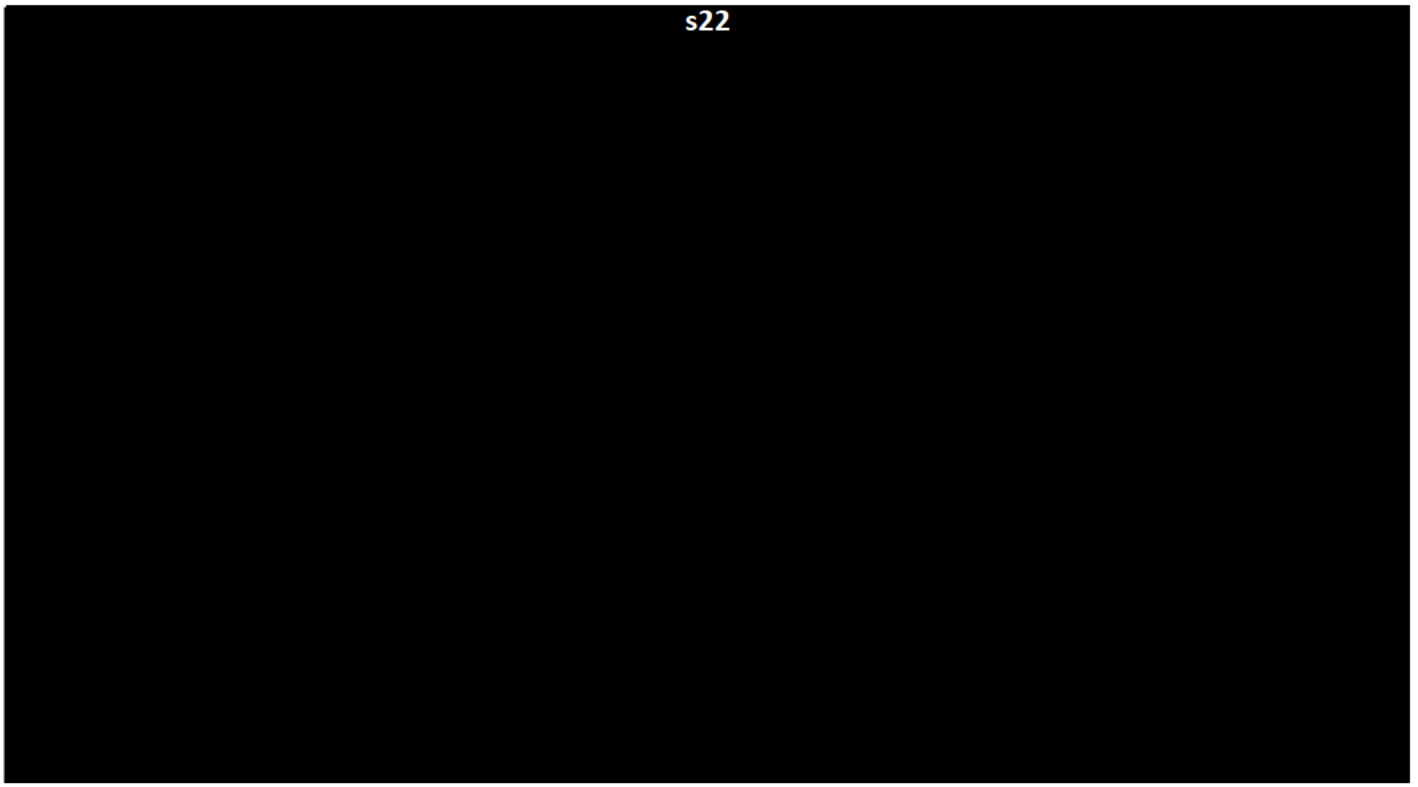
CSIRO appropriation projects that support Cape Grim:
The Cape Grim work is only possible with underlying infrastructure (equipment & instruments/data bases/precise calibration suites etc) and capabilities at Aspendale, and in particular the GASLAB laboratories. The total cost for GASLAB approp activities is: 3.5 FTE, $140K opex/travel, total cost $850K; The total cost for the Aerosols/Reactive Gases approp activities is: ~2 FTE, $20K opex/travel, total cost $330K. It is estimated that there is about $1.5-2.0M of infrastructure (analysers, calibrations suits, cylinders, other equipment & spare parts) in the labs at Aspendale that help support Cape Grim.

I hope this information is useful. There is plenty more info that we can provide, but this is a good starting point.
Best regards, Paul

**s22**

[redacted]

s22


s22

# CGBAPS One-Page Research Proposal Form 2015-2016

| | |
|---|---|
| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **Greenhouse and Ozone Depleting Gases** |
| **Requested Total Funding:** | **AGAGE $55.5K (includes $28K station allocation)**<br>**$CO_2$ $48K (includes $2K station allocation)** |
| **Working (Short) Program or Project Title:** | **GHG** |
| **Program or Project Leader:** | **Paul Krummel, Paul Steele, Marcel van der Schoot, Paul Fraser** |

Program or Project Outcome:

**Outputs:**

• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
• the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
• regular submission of the Cape Grim data to the relevant national and international data archives;
• enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
• continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;

**Impacts:**

• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Program or Project Summary:

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the two premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into, the global assessments of the Intergovernmental Panel on Climate Change and the WMO Scientific Assessments of Ozone Depletion and the national assessments of greenhouse gas (GHG) emissions, as part of the UNFCCC reporting process.

The Greenhouse and Ozone Depleting Gases Program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived GHGs (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

NOTE that this project is the amalgamation of two previous Cape Grim projects, namely 1) $CO_2$, $CO_2$ isotopes and GASLAB flasks; and 2) non-$CO_2$ greenhouse gases (AGAGE); into one consolidated Cape Grim Greenhouse Gases project.

Travel and Personnel Cost Justification:

| | |
|---|---|
| WGM: | 1 trip to WGM (4 people, 2 days, airfares, ground transport, meals, accomm.) $4K |
| CGASM: | 1 trip to CGASM-Murramarang (4 people, 3 days, airfares, car hire, meals, accomm.) $4K |
| Cape Grim: | 7 trips to Cape Grim (2-3 people, 3 days, airfares, ground transport, meals) $12K |

Equipment Required

| | |
|---|---|
| 1 regulator | $1,500 |
| 1 valco valve | $2,800 |
| 1 MKS pressure control valve | $1,300 |

Completion of 2014-2015 Targets

1. Return a significant subset of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997. *Six of the CSIRO GASLAB $CO_2$ primaries (four existing and two new cylinders) were*

*sent to NOAA and recalibrated during 2014-2015. The remainder will be sent to NOAA during 2015-2016 for recalibration. Reprocessing of the Cape Grim in situ $CO_2$ data from 1986-2004 is currently underway and will continue into 2015-2016.*

2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums. *Done and continuing. Extensive comparisons between CSIRO flasks and in situ analysers at Cape Grim is undertaken regularly as an internal quality control check, some of these results were reported during the Cape Grim Annual Science Meeting in 2014. The CSIRO/NOAA flask same air ICP is done regularly and is ongoing. The 6th WMO round robin is currently underway with measurements completed in GASLAB. Extensive comparisons of international cooperative flask sampling programs at Cape Grim (in particular NOAA) to in situ analysers at Cape Grim is undertaken every 6 months with the results reported/presented at the twice yearly international AGAGE meetings.*
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head). *Further progress has been made towards manuscripts on the $CO_2$ gradient across the Southern Ocean between Cape Grim and Macquarie Island – manuscripts(2) expected to be submitted in 2015/2016.*
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2/CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head). *Ongoing: The LoFlo $CO_2$ analyser continued operation at Baring Head, NZ throughout 2014/2015. A final inter-calibration of Baring Head primary $CO_2$ air standards and LoFlo cal standards will be completed. A detailed comparison will be completed and a decision will be made whether to continue this experiment further.*
4. New instrument installations/upgrades and overlap experiments at Cape Grim:
   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$. *Data now processed with GCWerks-CRDS and testing of control with GCWerks-CRDS to be undertaken shortly and implemented at Cape Grim during 2015/2016. Detailed overlap comparisons of Picarro data to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$ are undertaken/updated regularly (results presented at the Cape Grim Annual Science Meeting 2014) with results showing in general good agreement between the analysers, but with some interesting features.*

   Aerodyne CO/$N_2O$: Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$. *Note Done – plan to undertake this in in 2015/2016.*

   GC-HID for $H_2$ on the GCMD system: Complete method testing at Aspendale and implement at Cape Grim. *Done – system installed in April 2015 as the 5th channel on the AGAGE GCMD system. Results show that $H_2$ precisions are at least 10 times better for this detector (~0.2%) compared with the old mercuric oxide detector (~2%). This detector also measures neon.*

   Add new species to Medusa3 at Cape Grim, as appropriate. *During 2014/2015, the Medusa3 system at Cape Grim was modified in Feb 2015 to enable measurement of nitrogren trifluoride ($NF_3$). In addition to this, 9 other new species were added to the ion list for Medusa3 at Cape Grim in 2014/2015. Specifically, HFC-1234yf, HFC-1234zeE, HCFC-1233zdE, HCFC-21, HCFC-31, HCFC-133a, HCFC-132b, CFC-112, desflurane.*
5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region. *Done - Data submitted in July 2014 and June 2015 for use in GlobalView and ObsPack $CO_2/CH_4$ data products, and for use in the CarbonTracker $CO_2$ simulations.*
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 50 (Dec 2014, La Jolla, USA), AGAGE 51 (May 2015, Bridgetown, Barbados). *Done – Krummel & Mitrevski presented several AGAGE reports (including station report and extensive intercomparison results) and science results at AGAGE 50 in Dec 2014 and Krummel & Fraser at AGAGE 51 in May 2015.*
7. Present results at Cape Grim 2014 Annual Science Meeting (Aspendale). *Done – Cape Grim greenhouse gas data presented in eleven papers.*
8. Submit QA/QC data through to end of 2013 to Cape Grim by 30 June 2015. *Done – July 2015.*
9. Submit non-AGAGE QA/QC data through to end of 2014 to relevant international data archives by 30 June 2015. *Done – July 2015.*
10. Submit AGAGE QA/QC data through to Sep 2014 to CDIAC and WDCGG (WMO) by June 2015. *Done – June 2015.*
11. Provide 2014 Program report to OIC by 30 June 2015, (in Lead Scientist Report, early 2015). *Done – Feb 2015.*

12. Submit 2011-2013 Program reports to *Baseline* editors by 30 November 2014. *Partially done – GASLAB flask report is submitted, with the CO2 in situ and AGAGE reports in draft.*
13. Arrange for provision of 2011-2013 cooperative program reports to *Baseline* editors by 30 November 2014. *Done – reports solicited with submission of two NOAA reports complete.*
14. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs. *Done – see below.*

**Publications: July 2014 – June 2015**

*26 peer-reviewed manuscripts submitted: 20 published/accepted (ACPD/ACP 9, GRL 2, AMOJ 2, Nature 1, PNAS 1, TMS 1, WMO Ozone Assessment 1, Baseline 1, Book chapter 1), 7 with submitted status (GRL 2, JGR 1, AAQR 1, GMDD 1, AMOJ 1, Baseline 1).*

*17 international conference papers presented (not listed).*

1. Allin, S., J. Laube, E. Witrant, J. Kaiser, E. McKenna, P. Dennis, R. Mulvaney, E. Capron, P. Martinerie, T. Rockmann, T. Blunier, J. Schwander, P. Fraser, R. Langenfelds & W. Sturges, Chlorine isotope composition in chlorofluorocarbons CFC-11, CFC-12 and CFC-113 in firn, stratospheric and tropospheric air, *Atmos. Chem. Phys.*, 15, 6867-6877, 2015 (23 Jun 2015). EP147031. (utilises air archive results/data).
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Wells, K. C., D. B. Millet, N. Bousserez, D. K. Henze, S. Chaliyakunnel, T. J. Griffis, Y. Luan, E. J. Dlugokencky, R. G. Prinn, S. O'Doherty, R. F. Weiss, G. S. Dutton, J. W. Elkins, P. B. Krummel, R. Langenfelds, L. P. Steele, E. A. Kort, S. C. Wofsy, and T. Umezawa, Simulation of atmospheric N2O with GEOS-Chem and its adjoint: evaluation of observational constraints, *Geosci. Model Dev. Discuss.*, submitted May 2015. EP155356.

## Targets by 30 June 2016

1. Return the remainder of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997 and to place the data on the latest WMO $CO_2$ scale.
2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums.
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head).
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2$/$CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head).

4. New instrument installations/upgrades and overlap experiments at Cape Grim:

   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$.

   Aerodyne $CO/N_2O$: Complete preparation of calibration air standards at CSIRO and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Install active pressure control system for sample cell. Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$.

   Aerodyne $^{13}CO_2/^{12}CO_2$: Prepare calibration air standards and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Investigate use of a single common vacuum pump line for both aerodynes to minimise power and noise. Investigate air dehumidification system options for both Aerodynes.

   Evaluate miniature version of HID for its performance with a view for installation on the GCMD system. The attraction of this miniature detector is its lower consumption of He (by a factor of about 5).

   Add new species to Medusa3 at Cape Grim, as appropriate.

5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region.
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 52 (Dec 2014, Hawaii, USA), AGAGE 53 (May 2015, Ny-Alesund, Svalbald, Norway).
7. Participate in, and present at, the 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2015) to be held at Scripps Institution of Oceanography, Sep 2015.
8. Present results at Cape Grim 2015 Annual Science Meeting (Murramarang).
9. Submit QA/QC data through to end of 2014 to Cape Grim by 30 June 2016.
10. Submit non-AGAGE QA/QC data through to end of 2015 to relevant international data archives by 30 June 2016.
11. Submit AGAGE QA/QC data through to Sep 2015 to CDIAC and WDCGG (WMO) by June 2016.
12. Provide 2015 Program report to OiC by 30 June 2016, (in Lead Scientist Report, early 2016).
13. Submit outstanding 2011-2013 Program reports to *Baseline* editors by 30 September 2015.
14. Arrange for provision of any further 2011-2013 cooperative program reports to *Baseline* editors by 30 September 2015.
15. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs.

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Air Archive**
**Requested Total Funding:** **$0 (air archive tanks requested through asset funds)**
**Working (Short) Program or Project Title:** **Air Archive**
**Program or Project Leader:** **Paul Steele, Paul Krummel, Paul Fraser**

Program or Project Outcome:
Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

Program or Project Summary:
The Cape Grim Air Archive is a unique collection of Cape Grim air samples dating back to 1978. The samples have proved invaluable in

(a) determining the background trends (1978-present) of a range of greenhouse and ozone depleting gases for which the measurement capabilities have been developed in recent years;

(b) bridging the sampling age gap between Antarctic firn air and modern air samples, enabling Southern Hemisphere records for several species, for which the measurement capabilities have been developed in recent years, to be reconstructed back to the 1930s.

Travel and Personnel Cost Justification:
None.

Equipment Required
Six 34 litre SS tanks (Essex Industries) $34,000 (asset funding)

Completion of 2014-2015 Targets
1. Purchase 6 new air archive tanks by March 2015. *Done – purchased from Cape Grim asset funding.*
2. Collect at least 6 air archive samples during 2014/2015. *Done – 5 air archival samples collected – Jul, Sep & Nov(2) 2014, Feb 2015. One due to be filled now.*
3. Submit QA/QC data 1978-2014 to Cape Grim by 30 June 2015. *Done (Jul 2015).*
4. Provide 2014 Program Report to OiC by 30 June 2015 (Lead Scientist Report, early 2015). *Done.*
5. Air Archive program report for *Baseline 2011-2012* submitted to editors by 30 November 2014. *Done – report spans 2011-2013.*
6. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks. *In progress.*
7. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem. *In progress. Transfers of test samples done and analyses of results are almost finalised, verifying the stability of trace gas concentrations except for CO, which shows a slow upward drift. Transfers of any archive air samples have been suspended for the time being, due to the discovery of a contamination problem with some of the Essex cylinders. Essex engineers used (without our knowledge or consent) a lubricant called Christo-Lube MCG 111 on some of the gaskets and flanges. This lubricant is a suspension of powdered PTFE in a perfluoropolyether grease [F-(CF(CF$_3$)-CF$_2$-O)$_n$-CF$_2$CF$_3$], where n ranges between 10 and 60. Slow decomposition of the lubricant causes production of CF$_4$ (and perhaps other species) in the cylinder. Still awaiting results from testing at Scripps, to determine the best method for identifying those cylinders contaminated with Christo-Lube.*
8. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments. *Done – see 2014-2015 Greenhouse Gas program targets for the 7 papers incorporating the use of air archive data.*

Targets by 30 June 2016
1. Purchase 6 new air archive tanks by March 2016.
2. Collect at least 6 air archive samples during 2015/2016.
3. Submit QA/QC data 1978-2015 to Cape Grim by 30 June 2016.
4. Provide 2015 Program Report to OiC (in the Lead Scientist Report), in Feb 2016.
5. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks.
6. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem.
7. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments.

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** Continuing
**Program or Project Title:** Particles and MAC
**Requested Total Funding:** $50,000
**Working (Short) Program or Project Title:** P-MAC
**Program or Project Leader:** Melita Keywood

Program or Project Outcome:

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
- The continued development and application of chemical transport modelling to the remote marine boundary layer.
- Continued investigation of chemical composition of CCN mode particles.
- Continued investigation of mercury in the remote marine boundary layer
- Review of Particle Program

Program or Project Summary:

The Particles and MAC programs provide long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. Atmospheric aerosol particles play an important role in global and regional climate through direct radiative effects and indirectly through influence on cloud properties. The programs use time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.

The program fills an important role in the GAW Aerosol Program, by providing global baseline data for the remote marine environment. These data can be used to assess the impact of anthropogenic activities on the remote atmospheric environment.

This year the MAC and Particles Programs will continue to work with the chemical transport modellers to develop models for application to Cape Grim atmospheric chemistry and aerosol. This work will form part of a long-term program aimed at developing methodologies that incorporate observations from Cape Grim into process models and ultimately into the development of regional and global climate modelling systems such as ACCESS. Specifically this year, we utilise the modelling system to investigate long range transport of biomass burning smoke to Cape Grim under baseline conditions.

We will continue our investigation of mercury in the remote marine boundary layer and will continue to contribute data on baseline mercury concentrations measured with the TEKRAN Mercury Monitor, purchased to the Global Mercury Observing System (GMOS). We will continue our work on POPs at Cape Grim, collecting passive samples and active samples under all conditions.

This year we will continue to document and operationalise QA/QC procedures for aerosol microphysical data. In particular we will work with NOAA to adopt the QA/QC procedures of the NOAA Aerosol Global Monitoring network to streamline submission of data to the World Data Centre for Aerosol.

A large focus of this year's activities will involve preparation for the review of the Particle Program at the Cape Grim Science Meeting.

Travel and Personnel Cost Justification:

- Three QA/QC visits to Cape Grim by Melita Keywood, Jason Ward, Jeremy Ward or Fabienne Reisen;

- TEKRAN Monitor QA/QC visit Macquarie University
- Precipitation QA/QC visit by Jennifer Powell
- Visit to Cape Grim by Keywood and John Ogren

Equipment Required

N/A

2015/2016 targets

- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2015) to the GAWSIS data base
- Submit QA/QC gaseous elemental mercury data for 2015 to the GMOS data base
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP
- Adoption of NOAA Aerosol Network QA/QC procedures
- Paper published "CCN activity of remote marine aerosol" by Fedele, Keywood, Porter and Hughes
- Particle program review report and presentation at Annual Science meeting
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity)
- Complete manuscript on CCN trends for an international journal (JG as PRF activity)
- Draft paper on long term record of organic composition of marine aerosol (collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll)

2014/2015 targets Reconciled

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015-ongoing
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2013) to the GAWSIS data base-ongoing- CN data up to 2011 submitted
- Submit QA/QC gaseous elemental mercury data for 2014 to the GMOS data base-ongoing
- Paper published on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)-paper published in APCD
- Paper submitted on characteristics of CCN during the 2011 intensive campaign (led by Rosemary Fedele; supervised by Melita Keywood)- PhD submitted, draft of paper complete
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP-ongoing
- Operationalize QA processing for CN, CCN, BC and Bsp data-ongoing; discussions with John Ogren at NOAA to adopt NOAA procedures and become a participant in the NOAA aerosol network
- Write a Baseline report on POPs program-complete
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity) –ongoing, first draft complete and comments provided
- Submit manuscript on CCN trends for an international journal (JG as PRF activity)-ongoing
- Continue collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll) to analyse the composition of organic species in the 20 year PM10 archive by visiting US-ongoing, UNC have analysed winter and summer samples for 1980, 1985, 1990, 1995, 2000, 2005, 2010 and 2013 have identified some N-containing species, isoprene and monoterpene SOA tracers that are higher in summer than winter and a number of fatty acids thought to have biological origin - either bacteria or microorganisms (e.g., phytoplankton)
- Carry our intensive measurement campaign-complete, QUT led this activity

Other achievements

- Melita Keywood attended the meeting for the GAW EPAC Meeting in Geneva in February 2015
- Melita Keywood attended the NOAA ESRL GMD Annual Meeting in Boulder Colorado May 2015
- Consolidation of the MAAP and aethelometer BC record has progressed. Cape Grim data will contribute to an intercomparison of BC measurements by broadband aethalometers with other filter-based absorption photometers in collaboration with John Ogren.
- During the maiden voyage of the RV Investigator in March 2015, the ship spent several days in the baseline sector, measuring aerosol microphysical properties (as well as ozone and greenhouse gases). Initial analysis of the data suggests 2 periods when Cape Grim was in baseline and back trajectories indicate air masses had been in the vicinity of the Investigator.

- Rosie Fedele and Ruhi Humphries submitted their PhDs

Papers published

1. Cravigan LT, Ristovski Z, Modini RL, Keywood MD and Gras JL (2015) Observation of sea-salt fraction in sub-100nm diameter particles at Cape Grim. Journal of Geophysical Research-Atmospheres 120(5): 1848-1864. doi: 10.1002/2014jd022601
2. Lawson SJ, Selleck PW, Galbally IE, Keywood MD, Harvey MJ, Lerot C, Helmig D and Ristovski Z (2015) Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere. Atmospheric Chemistry and Physics 15(1): 223-240. doi: 10.5194/acp-15-223-2015
3. Slemr F, Angot H, Dommergue A, Magand O, Barret M, Weigelt A, Ebinghaus R, Brunke EG, Pfaffhuber KA, Edwards G, Howard D, Powell J, Keywood M and Wang F (2015) Comparison of mercury concentrations measured at several sites in the Southern Hemisphere. Atmospheric Chemistry and Physics 15(6): 3125-3133. doi: 10.5194/acp-15-3125-2015
4. Wang X, Kennedy K, Powell J, Keywood M, Gillett R, Phong T, Bridgen P, Broomhall S, Paxman C, Wania F and Mueller JF (2015) Spatial distribution of selected persistent organic pollutants (POPs) in Australia's atmosphere. Environmental Science-Processes & Impacts 17(3): 525-532. doi: 10.1039/c4em00594e
5. Winton VHL, Bowie AR, Edwards R, Keywood M, Townsend AT, van der Merwe P and Bollhöferf A (2015) Fractional iron solubility of atmospheric iron inputs to the Southern Ocean. Marine Chemistry: Biogeochemistry of trace elements and their isotopes in press.

Reports

1. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 36 8th set of samples Report to Department of the Environment 6 p.
2. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 37 8th set of analytical resultsReport to Department of the Environment 23 p.
3. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 38 9th set of samples Report to Department of the Environment 10 p.
4. Powell, J and Keywood, M (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 39 9th set of analytical results Report to Department of the Environment 162 p.
5. Keywood, M and Powell, J (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 40 Draft 2014 Annual Report Report to Department of the Environment 107 p.
6. Keywood, M and Powell, J (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 42 Final 2014 Annual Report Report to Department of the Environment 108 p.
7. Keywood, M, Powell, J and Gillett, R (2015) Phase 1 of the National Monitoring of Hazardous Substances in Air project (Ref: 0910-1570): Milestones 42 Final Report and Options for National Air Sampling System Options to Department of the Environment 235 p.

Presentations

1. Keywood, M. D., P. W. Selleck, R. W. Gillett and J. P. Ward, Aerosol Composition at Cape Grim: the long-term record, in *Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014, Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 25, 2014.

2. Lawson, S. J., P. W. Selleck, I. E. Galbally, M. D. Keywood, M. J. Harvey, C. Lerot, D. Helmig and Z. Ristovski, First *in situ* measurements of glyoxal and methylglyoxal over the remote temperate oceans, *in Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014,

Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 10, 2014

3. Winton, H., R. Edwards, A. Bowie, S. D. Chambers, M. D. Keywood, S. Wercynski and A. G. Williams, Aerosol iron solubility: comparison between the Australian subtropics and Southern Ocean, in *Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014* [abstract], 12-14 November 2014, Aspendale, Victoria, N. Derek and P. B. Krummel (eds.), Bureau of Meteorology and CSIRO Oceans and Atmosphere Flagship, Melbourne, Australia, 31, 2014.
4. Keywood M, and Protat, A, (2015) Aerosol, clouds and the Southern Ocean: from Cape Grim to the RV Investigator presentation at the 2015 NOAA ESRL GMD Annual Science Meeting Boulder Colorado May 2015

# Reactive Gases Research Proposal 2015-2016

## CGBAPS One-Page Research Proposal Form 2015-2016

| | |
|---|---|
| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **Reactive Gases** |
| **Requested Total Funding:** | **$68,000** |
| **Working (Short) Program or Project Title:** | **Reactive Gases** |
| **Program or Project Leaders:** | **Ian Galbally and Sarah Lawson** |

### Program or Project Outcome:

*In less that 50 words describe the outcomes of your research, eg: Develop a sulfur isotope technique for use on the Delta-C Mass Spectrometer enabling determination of aerosol source sulfur isotopic signatures and to allow new studies of aerosol chemistry at Cape Grim.*

Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

### Program or Project Summary:

*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and international community.*

Ozone is one of the key constituents of the background lower atmosphere. Ozone has important roles in the chemistry, ultraviolet radiation transmission, greenhouse absorption and health impacts of tropospheric air. The monitoring program at Cape Grim is regarded as one of the best high quality baseline records in the world and is used in definitive studies of tropospheric ozone. Much of the current knowledge of ozone behaviour in the marine boundary layer has been developed at Cape Grim. NOx and VOCs are central (with $O_3$) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region. Data will be submitted to the World Data Centre for Greenhouse Gases. These will be amongst the first ammonia and OVOCs monitoring activities in the background marine atmosphere globally.

### Travel and Personnel Cost Justification:

*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form 2009-2010, then please provide written support for your requirement for these funds.*

6 trips for 5 days for 2 persons to Cape Grim.

### Equipment Required

Replacement items (CAPEX) are required to bring the program up to standard, listed in order of preference:

Ozone Calibrator

Permeation Source for NH3 analyser

CRDS for $NO_2$,

### Report on completion of Targets by 30 June 2015

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.

  *Ozone and NOxy measurements have been maintained throughout the year with 4 visits by the Ian Galbally and Suzie Molloy. Surface ozone measurements continue with monitors TECO#3, TECO#4 and TECO#5. The current calibrator is TECO49CPS with the OMCS2. An additional calibrator TECO49iPS has been bought on line. The OMCS2 zero and span unit, installed in March 2010, has had some unexpected problems with solenoid valves not operating successfully. These valves have been replaced with more appropriate substitutes in*

*March 2015. A rationalisation of the ozone zeros and spans has been undertaken, the new schedule operating from 4 September 2014.*

*The NOxy instrument has continued running. Ian Galbally has been undertaking some data processing. The first results were shown at the Reactive Gases Program Review at the CGASM, November 2014.*

- Commissioning of VOC monitoring equipment for Cape Grim monitoring program. Obtain first hydrocarbon and OVOC data. OVOC measurements are a major step forward in monitoring.

  *System commissioned at Cape Grim by Sarah Lawson and Min Cheng and continuous in-situ measurements commenced November 2014. Hydrocarbon data from November – April has been processed using GCWerks with assistance from Paul Krummel. Faulty Polyscience water bath (for sample drying) lead to 1 month lost data but has since been replaced by alternative system which is working well(Vapourtrap).Identification of OVOC peaks and processing of OVOC data will be undertaken in 2015-16.*

- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring

  *Instrument is not functioning at this stage. Additional help is being sought from the manufacturer, and further tests await the delivery of the ammonia permeation source calibrator.*

- Participate in Summer January-February 2015 Field experiment at Cape Grim

  *Not done due to competing demands of the RV Investigator.*

- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years (Min Cheng).

  *Underway*

- Have two years of NOxy data to December 2014 processed by June 2016.

  *Not done due to time constraints*

- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station involving Jason Ward/ Suzie Molloy/Min Cheng/Sarah Lawson/Ian Galbally.

  *Maintenance schedule for ozone in mature state, NOxy maintenance schedule developed but still undergoing testing and revision.*

- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.

  *Not done, awaiting results from Technical Paper*

- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.

  *This is a major undertaking essential for the long term records of Cape Grim. The task has taken longer than expected and is still underway. The draft report was included in the Reactive Gases Program Review at the CGASM, November 2014.*

- Paper submitted to journal on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics Discussions*

- Paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage and Cape Grim (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics*

- Publish a further paper on ozone trends in the extra-tropical region of the Southern Hemisphere.

  *Not done, awaiting results from Technical Paper*

- Archive hourly provisional data for 2014 with WDCGG

  *2014 ozone data archived.*

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015

  *2014 ozone data submitted*

- Provide 2014 Program report to OiC by 30 June 2015

  *In preparation*

## Conference, Workshop and Other Presentations

"Biomass burning at Cape Grim: using modelling to explore a possible urban influence on plume photochemistry and composition". Sarah Lawson, Aerosol Modelling and Observations Workshop, incorporating the 2014 Frohlich Lecture, August 21st 2014 Aspendale.

"Atmospheric acetonitrile – its life away from biomass burning influences." Ian Galbally, Short seminar, CSIRO Oceans and Atmosphere, Aspendale 16 September 2014.

"Observations of Atmospheric Acetonitrile in the Mid-Latitudes of the Southern Hemisphere and its Global Distribution Away from Biomass Burning Influences". Ian Galbally, Plenary talk at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"The retrospective application of GAW measurement guidelines to existing long term surface ozone records: A case study at Cape Grim, Australia". Ian Galbally, Poster presentation at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"Further developments in background VOC monitoring at CSIRO Marine and Atmospheric Research." Ian Galbally, Invited presentation at the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

"The Cape Grim Reactive Gases Program Summary 2008 - 2014", I. E. Galbally and S. J. Lawson, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The global distribution of atmospheric acetonitrile away from the influence of biomass burning" W. V. Kirstine, I. E. Galbally, E. Dunne, S. J. Lawson, S. Molloy E. Zardin, S. Saunders, É.-A. Guerette and C. Murphy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"First in situ measurements of glyoxal and methylglyoxal over the remote temperate oceans" .S. J. Lawson, P. W. Selleck, I. E. Galbally, M. D. Keywood, M. J. Harvey, C. Lerot, D. Helmig and Z. Ristovski, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Update on the MUMBA Campaign: Measurements of urban, marine and biogenic air" C. Paton-Walsh, É.-A. Guérette, G. Rea, D. Kubistin, R. Humphries, S. R. Wilson, D. W. T. Griffith, R. Buchholz, V. Velazco, X. Shi, I. E. Galbally, M. D. Keywood, S. J. Lawson, P. W. Selleck, M. Cheng, S. Molloy, M. Bhujel, A. D. Griffiths, S. D. Chambers and P. Davy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Progress of Enhanced Atmospheric Composition Measurement Capability at Cape Grim BAPS and the Expanding CSIRO Atmospheric Observation Network" M. V. van der Schoot, Z. M. Loh, M. D. Keywood, J. P. Ward, C. P. Meyer, S. Molloy, I. E.Galbally, S. J. Lawson, D. A. Spencer, J. Ward, N. T. Somerville, P. B. Krummel, L. P. Steele, R. L. Langenfelds, D. P. Thornton, S. A. Coram and R. L. Gregory, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The ACCESS-UKCA chemistry-climate model: exploring long-term trends in atmospheric composition" M. T. Woodhouse, A. K. Luhar, P. F. Uhe, M. Thatcher, I. E. Galbally, S. Molloy, R. L. Langenfelds, L. P. Steele, P. B. Krummel, M. V. van der Schoot, D. M. Etheridge, C. M. Trudinger and P. J. Fraser, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Atmospheric Ozone" a 2 hour lecture to MSc students at RMIT University, Ian Galbally, 1 April 2015.

"Tropospheric Ozone Data Availability for Oceania and Antarctica" Ian Galbally, presentation at the Tropospheric Ozone Assessment Report (TOAR) Workshop 2, Madrid, Spain 27-30 April 2015

"Overview of Reactive gases and aerosol measurement capability at CSIRO Aspendale" Sarah Lawson, Australian Partners In Ice core Science Workshop, 18-19 May 2015, Aspendale, Victoria

## Papers: Journals, Reports, Conference Proceedings and Posters

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang, R. M. Zbinden (2014) Global distribution and trends of tropospheric ozone: An observation-based review Elementa: Science of the Anthropocene, 2, 000029, doi: 10.12952/journal.elementa.000029
http://elementascience.org/article/info:doi/10.12952/journal.elementa.000029

Lawson, S. J., Selleck, P. W., Galbally, I. E., Keywood, M. D., Harvey, M. J., Lerot, C., Helmig, D., and Ristovski, Z.: Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere, Atmos. Chem. Phys., 15, 223-240, doi:10.5194/acp-15-223-2015, 2015.

http://www.atmos-chem-phys.net/15/223/2015/

Lawson, S. J., Keywood, M. D., Galbally, I. E., Gras, J. L., Cainey, J. M., Cope, M. E., Krummel, P. B., Fraser, P. J., Steele, L. P., Bentley, S. T., Meyer, C. P., Ristovski, Z., and Goldstein, A. H.: Biomass burning emissions of trace gases and particles in marine air at Cape Grim, Tasmania, 41° S, Atmos. Chem. Phys. Discuss., 15, 17599-17649, doi:10.5194/acpd-15-17599-2015, 2015.

http://www.atmos-chem-phys-discuss.net/15/17599/2015/acpd-15-17599-2015.html

Martin G. Schultz, Hajime Akimoto, Jan W. Bottenheim, Brigitte Buchmann, Ian Galbally, Stefan Gilge, Detlev Helmig, Hiroshi H. Koide, Alastair A. Lewis, Paul Novelli, Christian C. Plass-Duelmer, Thomas T Ryerson, Martin Steinbacher, Rainer R. Steinbrecher, Oksana Tarasova, Kjetil Torseth, Valerie Thouret, and Christof Zellweger (2015) The Global Atmosphere Watch reactive gases measurement network. *Elementa: Science of the Anthropocene*, submitted.

R.S. Humphries, R. Schofield, M.D. Keywood, J. Ward, J.R. Pierce, C.M. Gionfriddo, M.T. Tate, D.P. Krabbenhoft, I.E. Galbally, S.B. Molloy, A.R. Klekociuk, P.V. Johnston, K. Kreher, A.J. Thomas, A.D. Robinson, N.R.P. Harris, R. Johnson, and S.R. Wilson, (2015) Boundary layer new particle formation over East Antarctic sea ice - possible Hg catalysed nucleation? *Atmos. Chem. Phys. Disc.*, MS No.: acp-2015-336 submitted.

S.D. Chambers, A.G. Williams, F. Conen, A.D. Griffiths, S. Reimann, M. Steinbacher, P.B. Krummel, L.P. Steele, M.V. van der Schoot, I.E. Galbally, S.B. Molloy and J.E. Barnes. Towards a universal "baseline" characterisation of air masses for high- and low-altitude observing stations using Radon-222. *Aerosol and Air Quality Research*, submitted.

S.D. Chambers, A.G. Williams, J. Crawford, A.D. Griffiths, P.B. Krummel, L.P. Steele, R.M. Law, M.V. van der Schoot, I.E. Galbally, and S.B. Molloy. A Radon-only technique for characterizing "Baseline" constituent concentrations at Cape Grim, *Baseline Atmospheric Program (Australia) 2011-2013*, submitted.

"Air-sea gradient fluxes of DMS during Surface Ocean Aerosol Production (SOAP) experiment" Murray Smith, Carolyn Walker, Cliff Law, Mike Harvey, Tom Bell, Sarah Lawson, Eric Saltzman. Poster presentation at Earth Observation for Ocean-Atmosphere Interactions Science Conference , Rome, 29-31St October 2014

### Other significant activities

Ian Galbally continued active involvement with the WMO SAG on Reactive Gases.

Ian attended the 25th Anniversary celebration of GAW and a meeting of the WMO GAW Scientific Advisory Groups, 23 September 2014, Brazil. The newly refined WMO GAW goals are:

- science for services,
- all data must have applications,
- seamless access to data for best service delivery.

Ian also attended a WMO SAG on Reactive Gases and the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

Ian Galbally has contributed to the first WMO GAW measurement guidelines for NOx (draft).

Sarah continued her activities as SOLAS representative for Australia, including production of annual National SOLAS report (with fellow representative Andy Bowie).

Sarah contributed to the 10 year SOLAS strategic plan

Sarah Lawson and Ian Galbally have contributed to the first WMO GAW measurement guidelines for VOCs (draft).

The team participated in two research voyages on the RV Investigator in 2015

## Targets by 30 June 2016

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.
- Maintain the VOC measurements. Identify OVOC peaks. Document data processing steps (GC Werks) and train Min Cheng in processing hydrocarbon and OVOC data...
- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring
- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years with the aim of ensuring compatibility of current and past hydrocarbon measurements.
- Have two years of NOxy data to December 2014 processed by June 2016.
- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station.
- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.
- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.
- Paper submitted to journal on modelling impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)
- Second paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage, in collaboration with University of Cambridge (led by Sarah Lawson)
- Publish a paper involving observations and modelling on ozone trends in the extra-tropical region of the Southern Hemisphere.
- Archive hourly provisional data for 2015 with WDCGG
- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Provide 2015 Program report to OiC by 30 June 2016

# CGBAPS One-Page Research Proposal Form 2015-2016

| | |
|---|---|
| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **CSIRO Salary Support** |
| **Requested Total Funding:** | **$279,000** |
| **Working (Short) Program or Project Title:** | **CSIRO Salary Support** |
| **Program or Project Leader:** | **Paul Krummel, Melita Keywood, Paul Fraser, Paul Steele, Ian Galbally, Marcel van der Schoot, Sarah Lawson** |

Program or Project Outcome:
Technical support for Lead Scientists Cape Grim observational activities.

Program or Project Summary:
CSIRO salary support calculated from 2014/2015 requested support ($270,750), plus an estimated 1% salary increase, giving a total of $273,500. CSIRO expected to match this with a salary contribution of approximately $980,000 (this contribution excludes CSIRO Flagship and Corporate overheads). The total funding request above ($279,000) also includes $1000 for Nada Derek to travel to the Cape Grim annual science meeting and $4,500 for the NOAA representative to attend the Cape Grim annual science meeting in 2015.

Travel and Personnel Cost Justification:
The salary support provides the equivalent of approximately 2.5 support positions at CSOF4 level (not including CSIRO Flagship and Corporate overheads).

Equipment Required: None.

Completion of 2014-2015 Targets
Targets are defined under each Lead Scientists programs.

Targets by 30 June 2016
Targets are defined under each Lead Scientists programs.

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Air Archive**
**Requested Total Funding:** **$0 (air archive tanks requested through asset funds)**
**Working (Short) Program or Project Title:** **Air Archive**
**Program or Project Leader:** **Paul Steele, Paul Krummel, Paul Fraser**

Program or Project Outcome:
Collect, analyse and store 6 new Cape Grim air archive samples; continue analyses on existing air archive samples.

Program or Project Summary:
The Cape Grim Air Archive is a unique collection of Cape Grim air samples dating back to 1978. The samples have proved invaluable in

(a) determining the background trends (1978-present) of a range of greenhouse and ozone depleting gases for which the measurement capabilities have been developed in recent years;

(b) bridging the sampling age gap between Antarctic firn air and modern air samples, enabling Southern Hemisphere records for several species, for which the measurement capabilities have been developed in recent years, to be reconstructed back to the 1930s.

Travel and Personnel Cost Justification:
None.

Equipment Required

| | |
|---|---|
| Six 34 litre SS tanks (Essex Industries) | $34,000 (asset funding) |

Completion of 2014-2015 Targets

1. Purchase 6 new air archive tanks by March 2015. *Done – purchased from Cape Grim asset funding.*
2. Collect at least 6 air archive samples during 2014/2015. *Done – 5 air archival samples collected – Jul, Sep & Nov(2) 2014, Feb 2015. One due to be filled now.*
3. Submit QA/QC data 1978-2014 to Cape Grim by 30 June 2015. *Done (Jul 2015).*
4. Provide 2014 Program Report to OiC by 30 June 2015 (Lead Scientist Report, early 2015). *Done.*
5. Air Archive program report for *Baseline 2011-2012* submitted to editors by 30 November 2014. *Done – report spans 2011-2013.*
6. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks. *In progress.*
7. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem. *In progress. Transfers of test samples done and analyses of results are almost finalised, verifying the stability of trace gas concentrations except for CO, which shows a slow upward drift. Transfers of any archive air samples have been suspended for the time being, due to the discovery of a contamination problem with some of the Essex cylinders. Essex engineers used (without our knowledge or consent) a lubricant called Christo-Lube MCG 111 on some of the gaskets and flanges. This lubricant is a suspension of powdered PTFE in a perfluoropolyether grease [F-(CF(CF$_3$)-CF$_2$-O)$_n$-CF$_2$CF$_3$], where n ranges between 10 and 60. Slow decomposition of the lubricant causes production of CF$_4$ (and perhaps other species) in the cylinder. Still awaiting results from testing at Scripps, to determine the best method for identifying those cylinders contaminated with Christo-Lube.*
8. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments. *Done – see 2014-2015 Greenhouse Gas program targets for the 7 papers incorporating the use of air archive data.*

Targets by 30 June 2016

1. Purchase 6 new air archive tanks by March 2016.
2. Collect at least 6 air archive samples during 2015/2016.
3. Submit QA/QC data 1978-2015 to Cape Grim by 30 June 2016.
4. Provide 2015 Program Report to OiC (in the Lead Scientist Report), in Feb 2016.
5. Finish the design, test, and implementation of a fail-safe scheme for filling seasonal archive tanks.
6. Finalise evaluation of the procedure for the salvage of Air Archive samples currently contained in 48 litre aluminium tanks, into new 34 litre Essex stainless steel tanks. Begin the process of transferring, but subject to the successful resolution of the Christo-Lube MCG 111 contamination problem.
7. Continue to incorporate measurements from archive samples in suitable peer reviewed journal publications and assessments.

# CGBAPS One-Page Research Proposal Form 2015-2016

| | |
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| **Program or Project Type (continuing / new):** | **Continuing** |
| **Program or Project Title:** | **CSIRO Salary Support** |
| **Requested Total Funding:** | **$279,000** |
| **Working (Short) Program or Project Title:** | **CSIRO Salary Support** |
| **Program or Project Leader:** | **Paul Krummel, Melita Keywood, Paul Fraser, Paul Steele, Ian Galbally, Marcel van der Schoot, Sarah Lawson** |

Program or Project Outcome:
Technical support for Lead Scientists Cape Grim observational activities.

Program or Project Summary:
CSIRO salary support calculated from 2014/2015 requested support ($270,750), plus an estimated 1% salary increase, giving a total of $273,500. CSIRO expected to match this with a salary contribution of approximately $980,000 (this contribution excludes CSIRO Flagship and Corporate overheads). The total funding request above ($279,000) also includes $1000 for Nada Derek to travel to the Cape Grim annual science meeting and $4,500 for the NOAA representative to attend the Cape Grim annual science meeting in 2015.

Travel and Personnel Cost Justification:
The salary support provides the equivalent of approximately 2.5 support positions at CSOF4 level (not including CSIRO Flagship and Corporate overheads).

Equipment Required: None.

Completion of 2014-2015 Targets
Targets are defined under each Lead Scientists programs.

Targets by 30 June 2016
Targets are defined under each Lead Scientists programs.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Steele, Paul Krummel, Paul Fraser**
**Sub-Program: Cape Grim Air Archive**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 75% raw* data collection | | 6 Cape Grim air archives |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2014 |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures. |
| 4 | Annual operation and data summary report 2015 for Baseline to OiC BAPS by 30 June 2016 | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | To be included in the greenhouse gases LS report (Feb/Mar 2016) |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016. | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientist: Melita Keywood**
**Sub-Program: Particles and MAC**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > 90% Raw* data collection | | CN, UCN, CCN, BC, Bsp time series data for 2015<br>Raw data are: rainwater and filter samples from ERNI, Eigenbordt, Ecotech 3000 (x2), Partisol; chemical composition and mass of rainwater and filter samples |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2015 | | CN, UCN, CCN, BC time series hourly data for 2015 |
| 3 | All Meta* data to CGBAPS for archival for 2014 by 30 June 2016 | | Logbook information additional to station log, includes instrument/inlet description, operation, changes, calibrations 2015 etc<br>QA quantities are: Rainwater, PM10 (HVB and HVC), PM2.5 (Partisol) for Jan 2015 to Dec 2015 |
| 4 | Annual operation and data summary reports (Particles and MAC) for Baseline to OiC BAPS in time for Publication in Baseline 2012/2014 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by early 2016 Working Group Meeting | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | |
| 10 | Four funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Paul Krummel /Paul Steele/Marcel van der Schoot/Paul Fraser**
**Sub-Program: Greenhouse and Ozone Depleting Gases**
**Financial Year: 2015 – 2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | > % raw* data collection<br>LoFlo $CO_2$ *in situ* > 90%<br>Picarro $CO_2/CH_4$ >90%<br>Aerodyne $N_2O$/CO >80%<br>Aerodyne $CO_2$ isotopes >50%<br>GASLAB flasks >90%<br>AGAGE GCMD >90%<br>AGAGE Medusa >85%<br>GC-HID $H_2$ system >90% | | LoFlo, Aerodyne & Picarro raw data are minutely data; Aim to fill ~72 flasks (6 flasks per month subject to good baseline); AGAGE raw data are individual injections into each gas chromatograph system and subsequent output analyses. |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are:<br>Data up to end of Dec 2015. All data collected in '1' above. |
| 3 | All Meta* data to CGBAPS for archival for 2015 by 30 June 2016 | | Calibration information and/or updates, any changes to instrument or operating procedures, inlets. |
| 4 | Annual operation and data summary report 2015 for *Baseline* to OiC BAPS by 30 June 2016 | | Contained in six-monthly AGAGE station reports and lead scientist reports. |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by 31 Mar 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least two WGM in FY | | Steele, Krummel, van der Schoot and Fraser to attend at least 2 WGM each. |
| 10 | Funded LS maintenance visits for FY completed | | Seven |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**Cape Grim BAPS Science Program**
**Sub-Program Lead Scientist Governance Form**

**Lead Scientists: Ian Galbally and Sarah Lawson**
**Sub-Program: Reactive Gases**
**Financial Year: 2015 -2016**

| Item | Agreed Outcomes | Complete/ Incomplete | Agreed Quantity Definition |
|---|---|---|---|
| 1 | Raw 2015 data collection > 90% for $O_3$, >50% for NOxy, >50% for VOCs first successful acquisition of data for $NH_3$ | | Data and information collected by the measurement process, and prior to modification by post analysis or quality control. Include information on period of collection |
| 2 | All QA quantities* to CGBAPS for archival by 30 June 2016 | | QA quantities are: describe (list) quantities and the end period of collection for raw data |
| 3 | All Meta* data to CGBAPS for archival for 2013 by 30 June 2016 | | Meta data includes any information required to process and interpret the data |
| 4 | Annual operation and data summary report 2014 for Baseline to OiC BAPS by 30 June 2016 | | |
| 5 | LS Report for the previous 12 month period to be provided at early 2016 Working Group Meeting | | |
| 6 | Program budget request for next FY to Chair of Working Group by Feb 2016 | | |
| 7 | Program research proposal (2016/2017) and review of targets (2015/2016) to Chair of Working Group by 30 June 2016 | | |
| 8 | Presentation of program for Annual Science Meeting | | |
| 9 | Attend at least three WGM in FY | | |
| 10 | Four funded LS maintenance visits for FY completed | | |
| 11 | Funding was utilized as allocated | | Report any significant deviation (±10%) |

**To be forwarded to Chair of Working Group within 1 week of end of FY.**

* The information should include information on the period involved. For example, 'Solar radiation data for 2004' or 'Flasks collected between Feb 2003 and Jan 2004'. The ideal would be to have all three types of data (raw, QA, meta) for a calendar year available at CGBAPS within 6 months of the end of the calendar year.

**CSIRO Accounts Receivable**
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**Kenmore QLD 4069**
**Australia PH: 1300 503 758**
**accounts.receivable@csiro.au**
**ABN: 41687119230**



# TAX INVOICE

**Bill-To:**

Bureau of Meteorology
PO Box 1289
DOCKLANDS VIC, 3001
Australia

| | |
|---|---|
| Number: | 6643894 |
| Issued: | 11/09/2015 |
| Customer PO No: | |
| Customer PO Date: | |
| Customer Number: | 210024 |
| Customer ABN: | 92637533532 |
| Customer Fax: | 03 9669 4699 |

| Description | QTY / Unit | Amount (Excl GST) |
|---|---|---|
| Cape Grim projects 2015-16 | | |
| BoM Cape Grim 2015/16 pmt 1<br>As per Leter of Authorisation (Your Ref: 30/1269 dd 27/08/2015)<br>Attention: Dr Bruce Forgan | 1 EA | AUD 300,000.00 * |

| | | | |
|---|---|---|---|
| Internal Reference: | Total Amount (Excl GST) | AUD | 300,000.00 |
| WBS Element: R-07848-01 | Total GST Amount * | AUD | 30,000.00 |
| Contract No : 0002018562 | Total Amount Payable | AUD | 330,000.00 |

**PAYMENT DUE : 12/10/2015**

Please quote **00006643894210240** when making payment.

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# Reactive Gases Research Proposal 2015-2016

## CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** Continuing
**Program or Project Title:** Reactive Gases
**Requested Total Funding:** $68,000
**Working (Short) Program or Project Title:** Reactive Gases
**Program or Project Leaders:** Ian Galbally and Sarah Lawson

### Program or Project Outcome:

*In less that 50 words describe the outcomes of your research, eg: Develop a sulfur isotope technique for use on the Delta-C Mass Spectrometer enabling determination of aerosol source sulfur isotopic signatures and to allow new studies of aerosol chemistry at Cape Grim.*

Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).

### Program or Project Summary:

*Give a brief description of the background to the research and it's relevance to Cape Grim and the wider Australian and international community.*

Ozone is one of the key constituents of the background lower atmosphere. Ozone has important roles in the chemistry, ultraviolet radiation transmission, greenhouse absorption and health impacts of tropospheric air. The monitoring program at Cape Grim is regarded as one of the best high quality baseline records in the world and is used in definitive studies of tropospheric ozone. Much of the current knowledge of ozone behaviour in the marine boundary layer has been developed at Cape Grim. NOx and VOCs are central (with $O_3$) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the planned addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region. Data will be submitted to the World Data Centre for Greenhouse Gases. These will be amongst the first ammonia and OVOCs monitoring activities in the background marine atmosphere globally.

### Travel and Personnel Cost Justification:

*If you have requested funding for either travel or personnel on the CGBAPS Research Budget Request Form 2009-2010, then please provide written support for your requirement for these funds.*

6 trips for 5 days for 2 persons to Cape Grim.

### Equipment Required

Replacement items (CAPEX) are required to bring the program up to standard, listed in order of preference:

Ozone Calibrator

Permeation Source for NH3 analyser

CRDS for $NO_2$,

### Report on completion of Targets by 30 June 2015

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.

  *Ozone and NOxy measurements have been maintained throughout the year with 4 visits by the Ian Galbally and Suzie Molloy. Surface ozone measurements continue with monitors TECO#3, TECO#4 and TECO#5. The current calibrator is TECO49CPS with the OMCS2. An additional calibrator TECO49iPS has been bought on line. The OMCS2 zero and span unit, installed in March 2010, has had some unexpected problems with solenoid valves not operating successfully. These valves have been replaced with more appropriate substitutes in*

*March 2015. A rationalisation of the ozone zeros and spans has been undertaken, the new schedule operating from 4 September 2014.*

*The NOxy instrument has continued running. Ian Galbally has been undertaking some data processing. The first results were shown at the Reactive Gases Program Review at the CGASM, November 2014.*

- Commissioning of VOC monitoring equipment for Cape Grim monitoring program. Obtain first hydrocarbon and OVOC data. OVOC measurements are a major step forward in monitoring.

  *System commissioned at Cape Grim by Sarah Lawson and Min Cheng and continuous in-situ measurements commenced November 2014. Hydrocarbon data from November – April has been processed using GCWerks with assistance from Paul Krummel. Faulty Polyscience water bath (for sample drying) lead to 1 month lost data but has since been replaced by alternative system which is working well(Vapourtrap).Identification of OVOC peaks and processing of OVOC data will be undertaken in 2015-16.*

- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring

  *Instrument is not functioning at this stage. Additional help is being sought from the manufacturer, and further tests await the delivery of the ammonia permeation source calibrator.*

- Participate in Summer January-February 2015 Field experiment at Cape Grim

  *Not done due to competing demands of the RV Investigator.*

- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years (Min Cheng).

  *Underway*

- Have two years of NOxy data to December 2014 processed by June 2016.

  *Not done due to time constraints*

- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station involving Jason Ward/ Suzie Molloy/Min Cheng/Sarah Lawson/Ian Galbally.

  *Maintenance schedule for ozone in mature state, NOxy maintenance schedule developed but still undergoing testing and revision.*

- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.

  *Not done, awaiting results from Technical Paper*

- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.

  *This is a major undertaking essential for the long term records of Cape Grim. The task has taken longer than expected and is still underway. The draft report was included in the Reactive Gases Program Review at the CGASM, November 2014.*

- Paper submitted to journal on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics Discussions*

- Paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage and Cape Grim (led by Sarah Lawson)

  *Done. Published in Atmospheric Chemistry and Physics*

- Publish a further paper on ozone trends in the extra-tropical region of the Southern Hemisphere.

  *Not done, awaiting results from Technical Paper*

- Archive hourly provisional data for 2014 with WDCGG

  *2014 ozone data archived.*

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015

  *2014 ozone data submitted*

- Provide 2014 Program report to OiC by 30 June 2015

  *In preparation*

## Conference, Workshop and Other Presentations

"Biomass burning at Cape Grim: using modelling to explore a possible urban influence on plume photochemistry and composition". Sarah Lawson, Aerosol Modelling and Observations Workshop, incorporating the 2014 Frohlich Lecture, August 21st 2014 Aspendale.

"Atmospheric acetonitrile – its life away from biomass burning influences." Ian Galbally, Short seminar, CSIRO Oceans and Atmosphere, Aspendale 16 September 2014.

"Observations of Atmospheric Acetonitrile in the Mid-Latitudes of the Southern Hemisphere and its Global Distribution Away from Biomass Burning Influences". Ian Galbally, Plenary talk at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"The retrospective application of GAW measurement guidelines to existing long term surface ozone records: A case study at Cape Grim, Australia". Ian Galbally, Poster presentation at the 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference on 22-26 September 2014.

"Further developments in background VOC monitoring at CSIRO Marine and Atmospheric Research." Ian Galbally, Invited presentation at the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

"The Cape Grim Reactive Gases Program Summary 2008 - 2014", I. E. Galbally and S. J. Lawson, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The global distribution of atmospheric acetonitrile away from the influence of biomass burning" W. V. Kirstine, I. E. Galbally, E. Dunne, S. J. Lawson, S. Molloy E. Zardin, S. Saunders, É.-A. Guerette and C. Murphy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"First in situ measurements of glyoxal and methylglyoxal over the remote temperate oceans" .S. J. Lawson, P. W. Selleck, I. E. Galbally, M. D. Keywood, M. J. Harvey, C. Lerot, D. Helmig and Z. Ristovski, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Update on the MUMBA Campaign: Measurements of urban, marine and biogenic air" C. Paton-Walsh, É.-A. Guérette, G. Rea, D. Kubistin, R. Humphries, S. R. Wilson, D. W. T. Griffith, R. Buchholz, V. Velazco, X. Shi, I. E. Galbally, M. D. Keywood, S. J. Lawson, P. W. Selleck, M. Cheng, S. Molloy, M. Bhujel, A. D. Griffiths, S. D. Chambers and P. Davy, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Progress of Enhanced Atmospheric Composition Measurement Capability at Cape Grim BAPS and the Expanding CSIRO Atmospheric Observation Network" M. V. van der Schoot, Z. M. Loh, M. D. Keywood, J. P. Ward, C. P. Meyer, S. Molloy, I. E.Galbally, S. J. Lawson, D. A. Spencer, J. Ward, N. T. Somerville, P. B. Krummel, L. P. Steele, R. L. Langenfelds, D. P. Thornton, S. A. Coram and R. L. Gregory, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"The ACCESS-UKCA chemistry-climate model: exploring long-term trends in atmospheric composition" M. T. Woodhouse, A. K. Luhar, P. F. Uhe, M. Thatcher, I. E. Galbally, S. Molloy, R. L. Langenfelds, L. P. Steele, P. B. Krummel, M. V. van der Schoot, D. M. Etheridge, C. M. Trudinger and P. J. Fraser, presented at the Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2014 , 12-13 November 2014, Aspendale, Victoria.

"Atmospheric Ozone" a 2 hour lecture to MSc students at RMIT University, Ian Galbally, 1 April 2015.

"Tropospheric Ozone Data Availability for Oceania and Antarctica" Ian Galbally, presentation at the Tropospheric Ozone Assessment Report (TOAR) Workshop 2, Madrid, Spain 27-30 April 2015

"Overview of Reactive gases and aerosol measurement capability at CSIRO Aspendale" Sarah Lawson, Australian Partners In Ice core Science Workshop, 18-19 May 2015, Aspendale, Victoria

## Papers: Journals, Reports, Conference Proceedings and Posters

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang, R. M. Zbinden (2014) Global distribution and trends of tropospheric ozone: An observation-based review Elementa: Science of the Anthropocene, 2, 000029, doi: 10.12952/journal.elementa.000029
http://elementascience.org/article/info:doi/10.12952/journal.elementa.000029

Lawson, S. J., Selleck, P. W., Galbally, I. E., Keywood, M. D., Harvey, M. J., Lerot, C., Helmig, D., and Ristovski, Z.: Seasonal in situ observations of glyoxal and methylglyoxal over the temperate oceans of the Southern Hemisphere, Atmos. Chem. Phys., 15, 223-240, doi:10.5194/acp-15-223-2015, 2015.

http://www.atmos-chem-phys.net/15/223/2015/

Lawson, S. J., Keywood, M. D., Galbally, I. E., Gras, J. L., Cainey, J. M., Cope, M. E., Krummel, P. B., Fraser, P. J., Steele, L. P., Bentley, S. T., Meyer, C. P., Ristovski, Z., and Goldstein, A. H.: Biomass burning emissions of trace gases and particles in marine air at Cape Grim, Tasmania, 41° S, Atmos. Chem. Phys. Discuss., 15, 17599-17649, doi:10.5194/acpd-15-17599-2015, 2015.

http://www.atmos-chem-phys-discuss.net/15/17599/2015/acpd-15-17599-2015.html

Martin G. Schultz, Hajime Akimoto, Jan W. Bottenheim, Brigitte Buchmann, Ian Galbally, Stefan Gilge, Detlev Helmig, Hiroshi H. Koide, Alastair A. Lewis, Paul Novelli, Christian C. Plass-Duelmer, Thomas T Ryerson, Martin Steinbacher, Rainer R. Steinbrecher, Oksana Tarasova, Kjetil Torseth, Valerie Thouret, and Christof Zellweger (2015) The Global Atmosphere Watch reactive gases measurement network. *Elementa: Science of the Anthropocene*, submitted.

R.S. Humphries, R. Schofield, M.D. Keywood, J. Ward, J.R. Pierce, C.M. Gionfriddo, M.T. Tate, D.P. Krabbenhoft, I.E. Galbally, S.B. Molloy, A.R. Klekociuk, P.V. Johnston, K. Kreher, A.J. Thomas, A.D. Robinson, N.R.P. Harris, R. Johnson, and S.R. Wilson, (2015) Boundary layer new particle formation over East Antarctic sea ice - possible Hg catalysed nucleation? *Atmos. Chem. Phys. Disc.*, MS No.: acp-2015-336 submitted.

S.D. Chambers, A.G. Williams, F. Conen, A.D. Griffiths, S. Reimann, M. Steinbacher, P.B. Krummel, L.P. Steele, M.V. van der Schoot, I.E. Galbally, S.B. Molloy and J.E. Barnes. Towards a universal "baseline" characterisation of air masses for high- and low-altitude observing stations using Radon-222. *Aerosol and Air Quality Research*, submitted.

S.D. Chambers, A.G. Williams, J. Crawford, A.D. Griffiths, P.B. Krummel, L.P. Steele, R.M. Law, M.V. van der Schoot, I.E. Galbally, and S.B. Molloy. A Radon-only technique for characterizing "Baseline" constituent concentrations at Cape Grim, *Baseline Atmospheric Program (Australia) 2011-2013*, submitted.

"Air-sea gradient fluxes of DMS during Surface Ocean Aerosol Production (SOAP) experiment" Murray Smith, Carolyn Walker, Cliff Law, Mike Harvey, Tom Bell, Sarah Lawson, Eric Saltzman. Poster presentation at Earth Observation for Ocean-Atmosphere Interactions Science Conference , Rome, 29-31St October 2014

### Other significant activities

Ian Galbally continued active involvement with the WMO SAG on Reactive Gases.

Ian attended the 25th Anniversary celebration of GAW and a meeting of the WMO GAW Scientific Advisory Groups, 23 September 2014, Brazil. The newly refined WMO GAW goals are:

- science for services,
- all data must have applications,
- seamless access to data for best service delivery.

Ian also attended a WMO SAG on Reactive Gases and the 5th WMO-GAW Expert workshop on Volatile Organic Compounds, 20 - 22 October 2014, KRISS, Daejeon, Republic of Korea

Ian Galbally has contributed to the first WMO GAW measurement guidelines for NOx (draft).

Sarah continued her activities as SOLAS representative for Australia, including production of annual National SOLAS report (with fellow representative Andy Bowie).

Sarah contributed to the 10 year SOLAS strategic plan

Sarah Lawson and Ian Galbally have contributed to the first WMO GAW measurement guidelines for VOCs (draft).

The team participated in two research voyages on the RV Investigator in 2015

## Targets by 30 June 2016

- Maintain the Ozone and NOxy measurements, there will be extra focus on processing and interpreting the NOxy data.
- Maintain the VOC measurements. Identify OVOC peaks. Document data processing steps (GC Werks) and train Min Cheng in processing hydrocarbon and OVOC data...
- Full setup of the $NH_3$ analyser and obtaining first quality controlled data. Continuous background $NH_3$ is a major step forward in monitoring
- Undertake comparisons and prepare a report on the VOC calibration standards used in recent years with the aim of ensuring compatibility of current and past hydrocarbon measurements.
- Have two years of NOxy data to December 2014 processed by June 2016.
- Further develop maintenance schedules for the ozone and NOxy measuring systems for the regular maintenance visits to the Station.
- Archive the 1982 to 2003 CG ozone data on the current WMO ozone scale with WDCGG.
- Complete a technical report that fully documents the CG ozone measurement system 1982-2014.
- Paper submitted to journal on modelling impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)
- Second paper submitted to journal on VOC observations during the Surface Ocean Aerosol Production Voyage, in collaboration with University of Cambridge (led by Sarah Lawson)
- Publish a paper involving observations and modelling on ozone trends in the extra-tropical region of the Southern Hemisphere.
- Archive hourly provisional data for 2015 with WDCGG
- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Provide 2015 Program report to OiC by 30 June 2016

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** Continuing
**Program or Project Title:** Particles and MAC
**Requested Total Funding:** $50,000
**Working (Short) Program or Project Title:** P-MAC
**Program or Project Leader:** Melita Keywood

Program or Project Outcome:

- A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
- A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
- The continued development and application of chemical transport modelling to the remote marine boundary layer.
- Continued investigation of chemical composition of CCN mode particles.
- Continued investigation of mercury in the remote marine boundary layer
- Review of Particle Program

Program or Project Summary:

The Particles and MAC programs provide long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. Atmospheric aerosol particles play an important role in global and regional climate through direct radiative effects and indirectly through influence on cloud properties. The programs use time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.

The program fills an important role in the GAW Aerosol Program, by providing global baseline data for the remote marine environment. These data can be used to assess the impact of anthropogenic activities on the remote atmospheric environment.

This year the MAC and Particles Programs will continue to work with the chemical transport modellers to develop models for application to Cape Grim atmospheric chemistry and aerosol. This work will form part of a long-term program aimed at developing methodologies that incorporate observations from Cape Grim into process models and ultimately into the development of regional and global climate modelling systems such as ACCESS. Specifically this year, we utilise the modelling system to investigate long range transport of biomass burning smoke to Cape Grim under baseline conditions.

We will continue our investigation of mercury in the remote marine boundary layer and will continue to contribute data on baseline mercury concentrations measured with the TEKRAN Mercury Monitor, purchased to the Global Mercury Observing System (GMOS). We will continue our work on POPs at Cape Grim, collecting passive samples and active samples under all conditions.

This year we will continue to document and operationalise QA/QC procedures for aerosol microphysical data. In particular we will work with NOAA to adopt the QA/QC procedures of the NOAA Aerosol Global Monitoring network to streamline submission of data to the World Data Centre for Aerosol.

A large focus of this year's activities will involve preparation for the review of the Particle Program at the Cape Grim Science Meeting.

Travel and Personnel Cost Justification:

- Three QA/QC visits to Cape Grim by Melita Keywood, Jason Ward, Jeremy Ward or Fabienne Reisen;

- TEKRAN Monitor QA/QC visit Macquarie University
- Precipitation QA/QC visit by Jennifer Powell
- Visit to Cape Grim by Keywood and John Ogren

Equipment Required

N/A

2015/2016 targets

- Submit QA/QC data from 2015 to Cape Grim by 30 June 2016
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2015) to the GAWSIS data base
- Submit QA/QC gaseous elemental mercury data for 2015 to the GMOS data base
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP
- Adoption of NOAA Aerosol Network QA/QC procedures
- Paper published "CCN activity of remote marine aerosol" by Fedele, Keywood, Porter and Hughes
- Particle program review report and presentation at Annual Science meeting
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity)
- Complete manuscript on CCN trends for an international journal (JG as PRF activity)
- Draft paper on long term record of organic composition of marine aerosol (collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll)

2014/2015 targets Reconciled

- Submit QA/QC data from 2014 to Cape Grim by 30 June 2015-ongoing
- Submit QA/QC data (Gold Top, PM10 mass and soluble ion composition, precipitation composition, CN, UCN, CCN and BC for 2000 to 2013) to the GAWSIS data base-ongoing- CN data up to 2011 submitted
- Submit QA/QC gaseous elemental mercury data for 2014 to the GMOS data base-ongoing
- Paper published on impact of Robbins Island bushfires on remote marine boundary layer (led by Sarah Lawson)-paper published in APCD
- Paper submitted on characteristics of CCN during the 2011 intensive campaign (led by Rosemary Fedele; supervised by Melita Keywood)- PhD submitted, draft of paper complete
- Document all QA/QC procedures for CN, CCN, nephelometer and MAAP-ongoing
- Operationalize QA processing for CN, CCN, BC and Bsp data-ongoing; discussions with John Ogren at NOAA to adopt NOAA procedures and become a participant in the NOAA aerosol network
- Write a Baseline report on POPs program-complete
- Complete manuscript on CCN seasonality and sources for international journal (JG as PRF activity) –ongoing, first draft complete and comments provided
- Submit manuscript on CCN trends for an international journal (JG as PRF activity)-ongoing
- Continue collaboration with University of North Carolina (Jason Surratt) and MIT (Jesse Kroll) to analyse the composition of organic species in the 20 year PM10 archive by visiting US-ongoing, UNC have analysed winter and summer samples for 1980, 1985, 1990, 1995, 2000, 2005, 2010 and 2013 have identified some N-containing species, isoprene and monoterpene SOA tracers that are higher in summer than winter and a number of fatty acids thought to have biological origin - either bacteria or microorganisms (e.g., phytoplankton)
- Carry our intensive measurement campaign-complete, QUT led this activity

Other achievements

- Melita Keywood attended the meeting for the GAW EPAC Meeting in Geneva in February 2015
- Melita Keywood attended the NOAA ESRL GMD Annual Meeting in Boulder Colorado May 2015
- Consolidation of the MAAP and aethelometer BC record has progressed. Cape Grim data will contribute to an intercomparison of BC measurements by broadband aethalometers with other filter-based absorption photometers in collaboration with John Ogren.
- During the maiden voyage of the RV Investigator in March 2015, the ship spent several days in the baseline sector, measuring aerosol microphysical properties (as well as ozone and greenhouse gases). Initial analysis of the data suggests 2 periods when Cape Grim was in baseline and back trajectories indicate air masses had been in the vicinity of the Investigator.

# Preliminary Risk Assessment

(Risk Management Change Tool v1.005)

**BoM Cape Grim 2015-2016**
**R-xxxx-xx**
**Paul Krummel**

| Preliminary Project Risk Rating | Moderate |
|---|---|

**Recommendation: Undertake detailed risk assessment if required by project approver**

| | Common Project Management Risks | Potential Risk | Controls | Exposure |
|---|---|---|---|---|
| 1 | Project complexity | Yes | Yes | Moderate |
| 2 | Inexperienced project leader | No | N/A | Low |
| 3 | Ineffective project team | No | N/A | Low |
| 4 | Ineffective internal communications within the project team | Yes | Yes | Moderate |
| 5 | Competing project stakeholder priorities | Yes | Yes | Moderate |
| 6 | Key dependencies | Yes | Yes | Moderate |
| 7 | Conflicting requirements | No | N/A | Low |
| 8 | Unreliable stakeholders | No | N/A | Low |
| 9 | Ineffective scope control | No | N/A | Low |
| 10 | High profile | No | N/A | Low |
| 11 | Other significant risks | No | N/A | Low |
| | **Preliminary Project Management Risk Rating** | | **Low** | |

| | Common Technical and Scientific Risks | Potential Risk | Controls | Exposure |
|---|---|---|---|---|
| 1 | Unknown research field | No | N/A | Low |
| 2 | The project's technology is no longer desirable | No | N/A | Low |
| 3 | Compliance with regulations | No | N/A | Low |
| 4 | Single untested hypothesis | No | N/A | Low |
| 5 | Multiple untested hypotheses | No | N/A | Low |
| 6 | Late testing of a hypothesis | No | N/A | Low |
| 7 | Research is highly challenging | No | N/A | Low |
| 8 | Competition in the research field | Yes | Yes | Moderate |
| 9 | Unclear path to market | Yes | Yes | Moderate |
| 10 | Insufficient contingency | No | N/A | Low |
| 11 | Other significant risks | No | N/A | Low |
| | **Preliminary Technical and Scientific Risk Rating** | | **Low** | |

| | Common IP and Commercial Risks | Potential Risk | Controls | Exposure |
|---|---|---|---|---|
| 1 | Commercial competition exists in this research field | No | N/A | Low |
| 2 | Commercialisation pathway complexity | No | N/A | Low |
| 3 | Minimal experience with technology transfer | No | N/A | Low |
| 4 | Inexperienced commercialisation partner | No | N/A | Low |
| 5 | Uncertainty with project funding | No | N/A | Low |
| 6 | Confidentiality | No | N/A | Low |
| 7 | Protection of new IP | No | N/A | Low |
| 8 | External IP commitments | No | N/A | Low |
| 9 | Freedom to operate is unclear | No | N/A | Low |
| 10 | Encumbered IP | No | N/A | Low |
| 11 | Blocking patents | No | N/A | Low |
| 12 | Patent opportunity lost | Yes | Yes | Moderate |
| 13 | Other significant risks | No | N/A | Low |
| | **Preliminary IP and Commercial Risk Rating** | | **Low** | |

| | Common HSE Risks | Potential Risk | Controls | Exposure |
|---|---|---|---|---|
| 1 | Project is not covered by HSEACW | No | N/A | Low |
| 2 | New or increased hazards | No | N/A | Low |
| 3 | Staff not covered by HSEACW | No | N/A | Low |
| 4 | New or expanded regulatory requirements | No | N/A | Low |
| 5 | Infrastructure and or site modifications | No | N/A | Low |
| | **Preliminary HSE Risk Rating** | | **Low** | |

| Approvals | Date | Approved |
|---|---|---|
| Theme / Project Leader: <Project Leaders Name> | | |
| Project Approver: <Project Approvers Name> | | |
| Health, Safety and Environment Manager: <HSE Manager> | | |
| **Review if appropriate** | **Date** | **Approved** |
| Product Manager / Commercialisation: | | |
| Divisional Business Development Manager | | |
| Legal Representative | | |
| IP Manager | | |

| Comments |
|---|
| |

# CGBAPS One-Page Research Proposal Form 2015-2016

**Program or Project Type (continuing / new):** **Continuing**
**Program or Project Title:** **Greenhouse and Ozone Depleting Gases**
**Requested Total Funding:** **AGAGE $55.5K (includes $28K station allocation)**
**$CO_2$ $48K (includes $2K station allocation)**
**Working (Short) Program or Project Title:** **GHG**
**Program or Project Leader:** **Paul Krummel, Paul Steele, Marcel van der Schoot, Paul Fraser**

Program or Project Outcome:

**Outputs:**

• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both *in situ* measurements and flask samples;
• the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
• regular submission of the Cape Grim data to the relevant national and international data archives;
• enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
• continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;

**Impacts:**

• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• to use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• to participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• to make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• to verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Program or Project Summary:

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the two premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into, the global assessments of the Intergovernmental Panel on Climate Change and the WMO Scientific Assessments of Ozone Depletion and the national assessments of greenhouse gas (GHG) emissions, as part of the UNFCCC reporting process.

The Greenhouse and Ozone Depleting Gases Program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived GHGs (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

NOTE that this project is the amalgamation of two previous Cape Grim projects, namely 1) $CO_2$, $CO_2$ isotopes and GASLAB flasks; and 2) non-$CO_2$ greenhouse gases (AGAGE); into one consolidated Cape Grim Greenhouse Gases project.

Travel and Personnel Cost Justification:

| | |
|---|---|
| WGM: | 1 trip to WGM (4 people, 2 days, airfares, ground transport, meals, accomm.) $4K |
| CGASM: | 1 trip to CGASM-Murramarang (4 people, 3 days, airfares, car hire, meals, accomm.) $4K |
| Cape Grim: | 7 trips to Cape Grim (2-3 people, 3 days, airfares, ground transport, meals) $12K |

Equipment Required

| | |
|---|---|
| 1 regulator | $1,500 |
| 1 valco valve | $2,800 |
| 1 MKS pressure control valve | $1,300 |

Completion of 2014-2015 Targets

1. Return a significant subset of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997. *Six of the CSIRO GASLAB $CO_2$ primaries (four existing and two new cylinders) were sent to NOAA and recalibrated during 2014-2015. The remainder will be sent to NOAA during 2015-2016 for*

*recalibration. Reprocessing of the Cape Grim in situ $CO_2$ data from 1986-2004 is currently underway and will continue into 2015-2016.*

2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums. *Done and continuing. Extensive comparisons between CSIRO flasks and in situ analysers at Cape Grim is undertaken regularly as an internal quality control check, some of these results were reported during the Cape Grim Annual Science Meeting in 2014. The CSIRO/NOAA flask same air ICP is done regularly and is ongoing. The 6th WMO round robin is currently underway with measurements completed in GASLAB. Extensive comparisons of international cooperative flask sampling programs at Cape Grim (in particular NOAA) to in situ analysers at Cape Grim is undertaken every 6 months with the results reported/presented at the twice yearly international AGAGE meetings.*
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head). *Further progress has been made towards manuscripts on the $CO_2$ gradient across the Southern Ocean between Cape Grim and Macquarie Island – manuscripts(2) expected to be submitted in 2015/2016.*
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2/CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head). *Ongoing: The LoFlo $CO_2$ analyser continued operation at Baring Head, NZ throughout 2014/2015. A final inter-calibration of Baring Head primary $CO_2$ air standards and LoFlo cal standards will be completed. A detailed comparison will be completed and a decision will be made whether to continue this experiment further.*
4. New instrument installations/upgrades and overlap experiments at Cape Grim:
   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$. *Data now processed with GCWerks-CRDS and testing of control with GCWerks-CRDS to be undertaken shortly and implemented at Cape Grim during 2015/2016. Detailed overlap comparisons of Picarro data to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$ are undertaken/updated regularly (results presented at the Cape Grim Annual Science Meeting 2014) with results showing in general good agreement between the analysers, but with some interesting features.*

   Aerodyne $CO/N_2O$: Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$. *Note Done – plan to undertake this in in 2015/2016.*

   GC-HID for $H_2$ on the GCMD system: Complete method testing at Aspendale and implement at Cape Grim. *Done – system installed in April 2015 as the 5th channel on the AGAGE GCMD system. Results show that $H_2$ precisions are at least 10 times better for this detector (~0.2%) compared with the old mercuric oxide detector (~2%). This detector also measures neon.*

   Add new species to Medusa3 at Cape Grim, as appropriate. *During 2014/2015, the Medusa3 system at Cape Grim was modified in Feb 2015 to enable measurement of nitrogren trifluoride ($NF_3$). In addition to this, 9 other new species were added to the ion list for Medusa3 at Cape Grim in 2014/2015. Specifically, HFC-1234yf, HFC-1234zeE, HCFC-1233zdE, HCFC-21, HCFC-31, HCFC-133a, HCFC-132b, CFC-112, desflurane.*
5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region. *Done - Data submitted in July 2014 and June 2015 for use in GlobalView and ObsPack $CO_2/CH_4$ data products, and for use in the CarbonTracker $CO_2$ simulations.*
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 50 (Dec 2014, La Jolla, USA), AGAGE 51 (May 2015, Bridgetown, Barbados). *Done – Krummel & Mitrevski presented several AGAGE reports (including station report and extensive intercomparison results) and science results at AGAGE 50 in Dec 2014 and Krummel & Fraser at AGAGE 51 in May 2015.*
7. Present results at Cape Grim 2014 Annual Science Meeting (Aspendale). *Done – Cape Grim greenhouse gas data presented in eleven papers.*
8. Submit QA/QC data through to end of 2013 to Cape Grim by 30 June 2015. *Done – July 2015.*
9. Submit non-AGAGE QA/QC data through to end of 2014 to relevant international data archives by 30 June 2015. *Done – July 2015.*
10. Submit AGAGE QA/QC data through to Sep 2014 to CDIAC and WDCGG (WMO) by June 2015. *Done – June 2015.*
11. Provide 2014 Program report to OiC by 30 June 2015, (in Lead Scientist Report, early 2015). *Done – Feb 2015.*

12. Submit 2011-2013 Program reports to *Baseline* editors by 30 November 2014. *Partially done – GASLAB flask report is submitted, with the CO2 in situ and AGAGE reports in draft.*
13. Arrange for provision of 2011-2013 cooperative program reports to *Baseline* editors by 30 November 2014. *Done – reports solicited with submission of two NOAA reports complete.*
14. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs. *Done – see below.*

**Publications: July 2014 – June 2015**

*26 peer-reviewed manuscripts submitted: 20 published/accepted (ACPD/ACP 9, GRL 2, AMOJ 2, Nature 1, PNAS 1, TMS 1, WMO Ozone Assessment 1, Baseline 1, Book chapter 1), 7 with submitted status (GRL 2, JGR 1, AAQR 1, GMDD 1, AMOJ 1, Baseline 1).*

*17 international conference papers presented (not listed).*

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2. Carpenter, L. & S. Reimann (Lead Authors), J. Burkholder, C. Clerbaux, B. Hall, R. Hossaini, J. Laube & S. Yvon-Lewis (Coauthors), D. Blake, M. Dorf, G. Dutton, P. Fraser, L. Froidevaux, F. Hendrick, J. Hu, A. Jones, P. Krummel, L. Kuijpers, M. Kurylo, Q. Laing, E. Mahieu, J. Muhle, S. O'Doherty, K. Ohnishi, V. Orkin, K. Pfeilsticker, M. Rigby, I. Simpson & Y. Yokouchi (Contributing Authors), Update on Ozone-Depleting Substances (ODSs) and Other Gases of Interest to the Montreal Protocol, Chapter 1 in Scientific Assessment of Ozone Depletion: 2014, Global Ozone Research and Monitoring Project – Report No. 55, 1.1-1.101, World Meteorological Organization, Geneva, Switzerland, 2014 (published December 2014). EP15578. (utilises air archive results/data).
3. Chirkov, M., G. Stiller, A. Laeng, S. Kellmann, T. von Clarmann, C. Boone, J. Elkins, A. Engel, N. Glatthor, U. Grabowski, C. Harth, M. Kiefer, F. Kolonjari, P. Krummel, C. Lunder, B. Miller, S. Montzka, J. Mühle, S. O'Doherty, J. Orphal, R. Prinn, G. Toon, M. Vollmer, K. Walker, R. Weiss, A. Wiegele & D. Young, Global HCFC-22 measurements with MIPAS: retrieval, validation, climatologies and trends, *Atmos. Chem. Phys. Discuss.*,15, 14783-14841, doi:10.5194/acpd-15-14783-2015, 2015 (May 2015). EP153417.
4. Etheridge, D., R. Leuning, A. Luhar, Z. Loh, D. Spencer, C. Allison, P. Steele, S. Zegelin, C. Jenkins, P. Krummel & P. Fraser, Atmospheric Monitoring, Chapter 15 in: *Geologically Storing Carbon: Learning from the Otway Project Experience*, P. Cook (ed.), 281-292, 2014, CSIRO Publishing, Melbourne, Victoria, Australia (August 2014). EP143413.
5. Fisher, J., S. Wilson, G. Zeng, J. Williams, L. Emmons, R. Langenfelds, P. Krummel & P. Steele, Seasonal changes in the tropospheric carbon monoxide profile over the remote Southern Hemisphere evaluated using multi-model simulations and aircraft observations, *Atmos. Chem. Phys.*, 15, 3217-3239, doi:10.5194/acp-15-3217-2015, 2015 (March 2015). EP149463.
6. Fraser, A., P. Palmer, L. Feng. H. Bösch, R. Parker, E. Dlugokencky, P. Krummel & R. Langenfelds, Estimating regional fluxes of $CO_2$ and $CH_4$ using space-borne observations of XCH4:XCO2, *Atmos. Chem. Phys.*,14, 12883–12895, doi:10.5194/acp-14-12883-2014, 2014 (December 2014). EP144857.
7. Fraser, P., P. Krummel, P. Steele, C. Trudinger, D. Etheridge, N. Derek, S. O'Doherty, P. Simmonds, B. Miller, J. Muhle, R. Weiss, D. Oram, R. Prinn & R. Wang, Equivalent effective stratospheric chlorine from Cape Grim Air Archive, Antarctic firn and AGAGE global measurements of ozone depleting substances, *Baseline Atmospheric Program (Australia) 2009-2010*, N. Derek P. Krummel & Cleland (eds.), Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne, Australia, 17-23, 2014 (June/July 2014). EP127527. (utilises air archive results/data).
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## Targets by 30 June 2016

1. Return the remainder of the CSIRO GASLAB $CO_2$ primaries to NOAA ESRL for recalibration and finalise the reprocessing of *in situ* $CO_2$ data from 1986 onwards, to account for a small upward drift in the $CO_2$ calibration scale during the period 1986-1997 and to place the data on the latest WMO $CO_2$ scale.
2. Continue extensive intercomparison exercises undertaken both internally and with international colleagues: comparisons between CSIRO flasks and *in situ* analysers at Cape Grim (LoFlo, AGAGE, Picarros, Aerodynes); CSIRO/NOAA flask same air ICP; WMO round robins; European sausage flask intercomparison; comparison of international cooperative flask sampling programs at Cape Grim (NOAA-CCGG, NOAA-HATS, SIO, U. Heidelberg, MPI-BGC, UEA) to *in situ* analysers at Cape Grim (LoFlo, AGAGE-MD & -Medusa, Picarro, Aerodynes); and comparisons between *in situ* analysers at Cape Grim. Report results at multiple forums.
3. Maintain and continue to develop the Southern Ocean high precision $CO_2$ network with Cape Grim as the network hub by
    a. Finalise the study of $CO_2$ gradients across the Southern Ocean using Cape Grim and Macquarie Island *in situ* $CO_2$ LoFlo datasets and continue to expand the study with Amsterdam Island and Baring Head LoFlo $CO_2$ systems, with staff from LSCE in Paris (for Amsterdam Island) and from NIWA, Wellington (Baring Head).
    b. Continue operation of a LoFlo $CO_2$ analyser alongside the NIWA NDIR and Picarro $CO_2$/$CH_4$ analysers at Baring Head GAW station to: maintain an overlap air monitoring campaign for atmospheric $CO_2$; conduct a series of inter-calibration experiments using the Baring Head primary $CO_2$ air standards (and LoFlo calibration standards are to be analysed at NIWA), and continue a regular $CO_2$ inter-comparison program. The objective is to, using a common calibration scale, generate a Baring Head $CO_2$ record that can be directly compared to the Cape Grim long term $CO_2$ record and create a unique, precisely inter-calibrated, and long term Southern Ocean $CO_2$ network dataset (Cape Grim, Macquarie Is., Amsterdam Is., Baring Head).

4. New instrument installations/upgrades and overlap experiments at Cape Grim:

   Picarro $CO_2/CH_4$: Convert instrument control to GCWerks-CRDS. Continue detailed overlap comparison to LoFlo Mk2 $CO_2$ and AGAGE GCMD $CH_4$.

   Aerodyne $CO/N_2O$: Complete preparation of calibration air standards at CSIRO and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Install active pressure control system for sample cell. Convert data processing to GCWerks-CRDS. Perform detailed overlap comparison to AGAGE GCMD CO & $N_2O$.

   Aerodyne $^{13}CO_2/^{12}CO_2$: Prepare calibration air standards and setup on instrument. Purchase multi-port valco valve and setup new TDLWintel software for valve control. Investigate use of a single common vacuum pump line for both aerodynes to minimise power and noise. Investigate air dehumidification system options for both Aerodynes.

   Evaluate miniature version of HID for its performance with a view for installation on the GCMD system. The attraction of this miniature detector is its lower consumption of He (by a factor of about 5).

   Add new species to Medusa3 at Cape Grim, as appropriate.

5. Contribute $CO_2$ and $CH_4$ data (flask and *in situ*) to the NOAA ObsPack, & GlobalView $CO_2$ & $CH_4$ data products. Contribute the same data to the NOAA CarbonTracker $CO_2$ and $CH_4$ systems and participate in the evaluation of their performance, especially in the Australian and Southern Ocean region.
6. Prepare reports and present results at AGAGE Meetings, including detailed comparisons between AGAGE and various flask records at Cape Grim: AGAGE 52 (Dec 2014, Hawaii, USA), AGAGE 53 (May 2015, Ny-Alesund, Svalbald, Norway).
7. Participate in, and present at, the 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2015) to be held at Scripps Institution of Oceanography, Sep 2015.
8. Present results at Cape Grim 2015 Annual Science Meeting (Murramarang).
9. Submit QA/QC data through to end of 2014 to Cape Grim by 30 June 2016.
10. Submit non-AGAGE QA/QC data through to end of 2015 to relevant international data archives by 30 June 2016.
11. Submit AGAGE QA/QC data through to Sep 2015 to CDIAC and WDCGG (WMO) by June 2016.
12. Provide 2015 Program report to OiC by 30 June 2016, (in Lead Scientist Report, early 2016).
13. Submit outstanding 2011-2013 Program reports to *Baseline* editors by 30 September 2015.
14. Arrange for provision of any further 2011-2013 cooperative program reports to *Baseline* editors by 30 September 2015.
15. Submit and/or publish up to 10 manuscripts/contributions to/in international journals and international science assessments reporting/utilizing Cape Grim greenhouse gas data and/or related co-operative programs.

# CSIRO Project Lifecycle

**Project Brief & Plan | Instructions**

*Version 2.1.6*

## Background

The Project Brief and Plan Tool contains tools for the:

- Project Proponent through the Brief phase of a Project
- Project Manager through the Plan phase of a Project

The Project Brief helps the Project Proponent capture sufficient information about a project proposal so that the Project Sponsor (e.g. Theme Leader, Portfolio Leader, General Manager, Business Unit Leader) can assess

- If the proposal should be approved by the Authorised Officer to proceed to the planning stage.
- The level of rigour required during the planning stage.

The Project Plan helps the Project Manager capture detailed planning information (e.g. scope, resources, milestones, stakeholders, scheduling) so that

- The Capability Manger(s) of the resources can decide if the resources should be approved to work on the project
- The Project Sponsor can assess if the proposal should approved by Authorised Officer to proceed to the delivery phase

You must also use this tool **in conjunction with the**

- **Common Costing and Pricing Template** to calculate project cost and price for the Brief and Plan
- **Risk Management Tool** to conduct a risk assessment and produce a risk register for the Plan

The tools above can be found on the Project Office page: Off System Tools

## Macros

You **must enable macros** to use this tool. Instructions on how to do this can be found as per the links below

- Instructions for Microsoft Office 2003
- Instructions for Microsoft Office 2007

To test if macros are enabled, press the button below. If a dialog does not present to say that macros are enabled, then please follow the appropriate guide to enable macros.

## Context Help

Most input cells do have context help available. To access this help, select the input cell you require assistance with and press the <F1> help key on the keyboard. If the help is not displayed, please ensure that macros are enabled (see above)

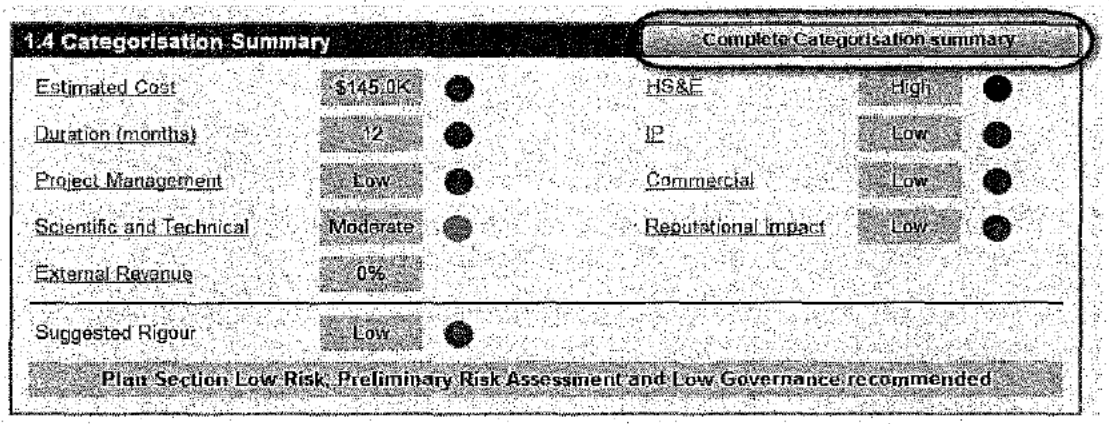
If further assistance is required, please contact your project support officer in the first instance, or direct your query to the PSO inbox: pso@csiro.au

## Project Brief

Complete the Brief tab to capture the minimum required information for a Project proposal.

***Categorisation***

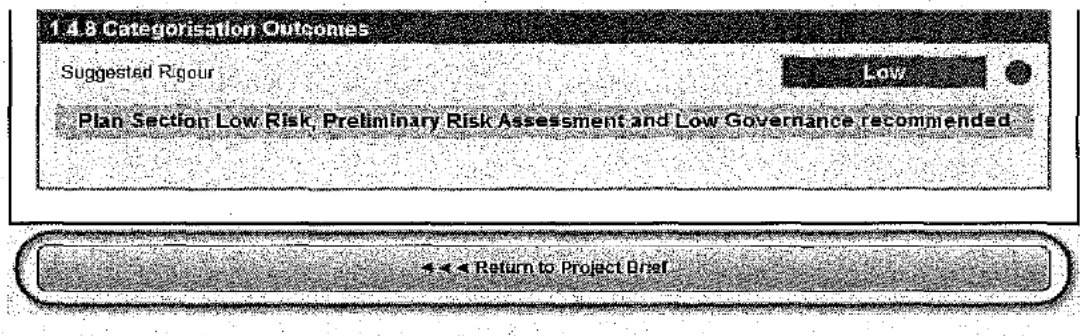
The Categorisation section of the Brief requires completion of the Categorisation summary tab. You access this tab by clicking on the green button shown below




You will need to use the **Common Costing and Pricing Template** to estimate the Project Costs.

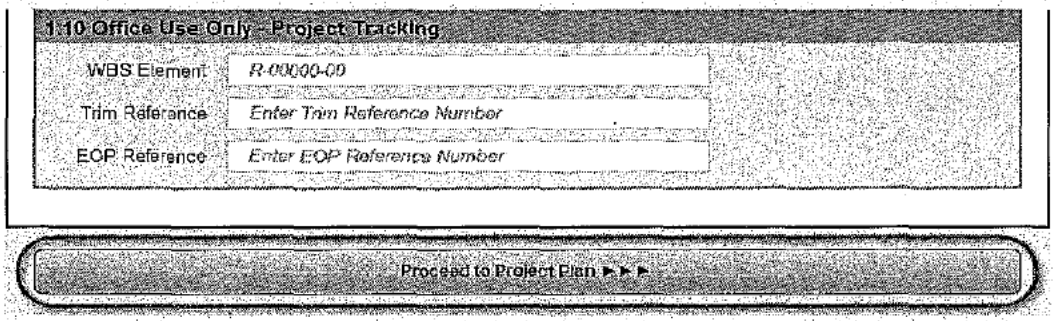
Once you have completed the Categorisation summary tab, the tool will provide instructions on the appropriate **Risk Assessment for the Risk Management Tool** and a suggested Project Governance.

Navigate to the bottom of the page and click on the green button shown below to go back to the Brief




## Project Plan

If the Project proposal has been approved to proceed to the Plan stage, click on the green button below to go to the Plan section.




Complete the Plan section and submit this section with the finalised Common Costing and Pricing Template and Risk Management Tool for approval to proceed to Deliver stage.

# CSIRO Project Lifecycle

**Section 2 | Project Plan**

*Version 2.1.6*

## Oceans and Atmosphere

Project Name BoM Cape Grim

Project Leader Paul Krummel

## 2.1 Plan Risk

Select Plan Risk: Moderate

## 2.2 Scope and Objectives

Description of Project

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the three premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into the international/global assessments, for example the Intergovernmental Panel on Climate Change.

There are 3 CSIRO led sub programs:

1) The Greenhouse and Ozone Depleting Gases program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived greenhouse gases (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

2) The Particles and Multiphase Atmospheric Chemistry (MAC) program provides long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. The program uses time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.

3) Reactive Gases program: Ozone is one of the key constituents of the background lower atmosphere. The ozone monitoring program at Cape Grim is regarded as one of the best long-term, high-quality baseline records in the world

and is used in definitive studies of tropospheric ozone. NOx and VOCs are central (with O3) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Re-development of a continuous VOC monitoring program and addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region.

Execution Rationale

Cape Grim's essential purpose has not changed since the program's inception in 1976. National and global concern that human activity is having an impact on the composition of the global atmosphere requires that the changes be observed and understood. Initially, this was the main focus, whereas now the data are also used for prediction, to guide development of remedial policies, and to verify the effectiveness of global mitigation actions. The critical, but too often unrecognised role of precise in-situ atmospheric observation programs underpinning our current understanding of atmospheric processes and ability to model future climate, is well summarised in a commentary in Nature, titled "Cinderella science" (Nature 450/6 December 2007, pp 789-790).

Past outputs, impact and strategic importance:
High-Profile Outputs:
During the past 40 years there have been ~35 papers in Nature, Science or PNAS that used data generated from Cape Grim observational activities and included CSIRO authors, with 10 of those in the past 4 years alone.
Cape Grim data are regularly submitted to international data archives (for example the World Data Center for Greenhouse Gases), which are freely available to all researchers and the general public alike.

Impact:
National and international policies relating to the impact that human activity is having on the composition of the global atmosphere are based on international scientific assessments, in particular the IPCC climate change Assessments and the WMO/UNEP ozone assessments. Through the use of Cape Grim data, citations of Cape Grim papers, and chapter authorships, we have made significant contributions to all ten WMO/UNEP ozone assessments and have made significant & growing contributions to all five IPCC climate change Assessments.
Some recent specific policy impact examples:
There has been concern for the rapid growth in hydrofluorocarbons or HFCs (based on atmospheric observations at Cape Grim and other global stations), which have relatively high global warming potentials (GWPs). This has seen a recent policy shift in Australia (and other countries, particularly USA) for the control of HFCs to move from a Kyoto Protocol type process which regulates emissions to a Montreal Protocol type process which regulates production of these gases, and which can subsequently phase out HFC production (there are low-GWP alternatives already

available). There is currently no international agreement on the regulation of HFCs, however efforts are ongoing to develop a global approach for the control of HFCs.
Nitrogen trifluoride (NF3 - a potent anthropogenic greenhouse gas) has potential to make a growing contribution to the Earth's radiative budget through its rapidly growing use in the manufacture of modern electronic devices. This substance was discovered in the atmosphere based on measurements from Cape Grim and one Northern hemisphere site, and published initially in 2008. This has subsequently seen NF3 added to the Kyoto Protocol basket of long-lived greenhouse gases in 2012.

Strategic Importance:
This project enables the Bureau of Meteorology to fulfill Australia's obligations to the WMO-GAW program for long-term monitoring of atmospheric composition. Cape Grim is considered to be one of three WMO GAW premier global stations (the other two are in the northern hemisphere; the total number global stations is about 30).
Most of the work programs at Cape Grim fall under the umbrella of public good research (of national and global importance), as stated in the opening paragraph of this section (e.g. long-term high quality observations of atmospheric composition). A good example of the importance of this, is that, it is atmospheric measurements (of CO2, CO2 isotopes and oxygen) that have proven that the continued rise in atmospheric carbon dioxide (CO2) can only be explained by fossil fuel combustion.
The activities and data generated at Cape Grim are also used for other co-investment activities, some examples are: the international MIT/NASA funded AGAGE program (approx $1M external income so far); regional emissions of ozone depleting and synthetic greenhouse gases (Dept or Environment, ~$1.3M over the past 10 years).
Lastly, we have used and continue to use Cape Grim to test/evaluate new measurement technologies. Once successful, these are then used or adopted in other measurement programs, which in turn generate external income.

Deliverables - Outputs

Greenhouse and Ozone Depleting Gases program:
• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both in situ measurements and flask samples;
• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanisms that result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• To use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• To participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• To make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-

To make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• Regular submission of the Cape Grim data to the relevant national and international data archives;
• To verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Particles and MAC:
• A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
• A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
• The continued development and application of chemical transport modelling to the remote marine boundary layer.
• Continued investigation of chemical composition of CCN mode particles.
• Continued investigation of mercury in the remote marine boundary layer.
• Review of the Particle Program.

Reactive Gases:
• Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia.
• Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).
• Data will be submitted to the World Data Centre for Greenhouse Gases.

Deliverables - Outcomes / Impact

All programs:
• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;

Greenhouse and Ozone Depleting Gases program:
• To use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;

• To participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• To verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.
• Use of Cape Grim greenhouse and ozone depleting gas data in high-quality, high impact journal publications, with CSIRO staff as lead authors or co-authors.
Particles and MAC
• The use of Cape Grim aerosol data in state of the climate reporting
• The use of Cape Grim aerosol and multiphase atmospheric chemistry data in high quality, high impact journal publications with CSIRO staff as lead authors or co-authors.
• The use of Cape Grim aerosol and multiphase atmospheric chemistry data to verify performance of earth system models including ACCESS.
Reactive Gases
• The use of Cape Grim reactive gases data in high quality, high impact journal publications with CSIRO staff as lead authors or co-authors.
• The use of Cape Grim reactive gases data to verify performance of earth system models including ACCESS.
• The establishment of VOC monitoring at Cape Grim

## 2.3 Work Plan

Milestone Schedule

| No. | Type | Description (incl Billing Milestone value if required) | Due Date | Client |
|---|---|---|---|---|
| 1 | APG | See attached Cape Grim work plans submitted to BoM | 30/06/2016 | BoM |
| 2 | APG | Organise and run the Cape Grim Annual Science Meeting | 11/11/2015 | BoM |
| 3 | APG | Publish Baseline 2011-2013 | 1/11/2015 | BoM |
| 4 | | | | |
| 5 | | | | |

## 2.4 Intellectual Property

Background IP - CSIRO

This BoM-funded Project utilises IP generated at Cape Grim and, as such, is subject to the IP issues detailed below:
IP material generated at Cape Grim includes, but is not limited to, documents, computer software, equipment, reports, information and data produced and stored by any means whatsoever which is created by either or both CSIRO and the Bureau of Meteorology (the Bureau) during the course of and as a result of performing a joint project under the CGBAPS Program.
Background IP means all material (including the IP rights in it) created before or independently of the CGBAPS Program.
All Background IP, and any improvements to it, which CSIRO or the Bureau chooses to make available for the purposes of the CGBAPS Program remains vested in that party.
From time to time CSIRO may provide or develop experimental instrumentation for use in the CGBAPS Program solely funded by CSIRO and independent of the Cape Grim Program. All intellectual property associated with such experimental instrumentation, and any improvements to it, remain vested in CSIRO.

Background IP - External

This BoM-funded Project utilises IP generated at Cape Grim and, as such, is subject to the IP issues detailed below:
IP material generated at Cape Grim includes, but is not limited to, documents, computer software, equipment, reports, information and data produced and stored by any means whatsoever which is created by either or both

CSIRO and the Bureau of Meteorology (the Bureau) during the course of and as a result of performing a joint project under the CGBAPS Program.
Background IP means all material (including the IP rights in it) created before or independently of the CGBAPS Program.
All Background IP, and any improvements to it, which CSIRO or the Bureau chooses to make available for the purposes of the CGBAPS Program remains vested in that party.
All intellectual property rights in the CGBAPS Material shall vest in the Bureau.
The Bureau grants to CSIRO a non-exclusive, royalty-free, world-wide, irrevocable and perpetual licence to use the CGBAPS Material for any purpose.
From time to time the Bureau may provide or develop experimental instrumentation for use in the CGBAPS Program solely funded by the Bureau and independent of the Cape Grim Program. All intellectual property associated with such experimental instrumentation, and any improvements to it, remain vested in the Bureau.

Other CSIRO Projects using this IP

DoE SGG emissions & ozone hole; AGGON Strategic; MIT-AGAGE; ACCSP SOCO2; Refrigerant Emissions (RRA); GISERA Methane Seeps.

## 2.5 Potential Collaborators

| Collaborator Name (Company) | Contact Name |
|---|---|
| International AGAGE program (MIT, SIO, GIT, U. of Bristol, Empa) | Ron Prinn; rprinn@mit.edu |
| NOAA ESRL GMD | Jim Butler; James.H.Butler@noaa.g |

## 2.6 Potential Customers

| Customer Name (Company) | Contact Name |
|---|---|
| Australian Bureau of Meteorology | Sam Cleland; s.cleland@bom.gov.a |
| | |

## 2.7 Ethics

Does this project involve humans as participants or subjects of the research?

○ Yes ◉ No

## 2.8 Confidentiality Notes

Detail if there are any specific confidentiality considerations

No confidentiality considerations.

## 2.9 Commercial

Agreements related to this project

The formal collaborative agreement with BoM for the Cape Grim projects was finalised in Mar/Apr 2012.

Identify likely pathways for commercialisation of project outcomes

N/A

Is a commercialisation plan included in the project milestones? No

How will project impact be measured?

## 2.10 Major Project Risks

| | |
|---|---|
| Identified Risk | Continued access to the BoM Cape Grim facility and funding for the Cape Grim Greenhouse Gas program, including the Cape Grim air archive |
| Management Plan | Seek alternate sites and funding agencies. |

## 2.11 Communication Plan

Communication to Theme Leader

Reporting through regular ESA Program and EH Group meetings; e-mail correspondence as necessary; Cape Grim Working group correspondence to the Cape Grim Management Group (which includes a CSIRO representative).

Communication to stakeholders

Participation in Cape Grim Working Group meetings three times a year by CSIRO Cape Grim lead scientists.
Interaction with Cape Grim staff members on project/measurement requirements and day to day issues.
Visits to the Cape Grim Station by CSIRO Cape Grim lead scientists and other CSIRO staff.
Active participation by CSIRO staff in the Cape Grim Annual Science Meeting.

Is a Steering Committee required? Yes

Communication to Steering Committee

Steering committee is the Cape Grim Working Group, of which there are seven members from the EH Group, who attend the working group meetings three times a year.

Communication within Project Team

Regular Group & Team Meetings, internal preparation and distribution of regular Project Reports.

Communication outside Project Team

The communication opportunities are usually associated with increased levels of radiative forcing and decreased levels of ozone depleting gases in the atmosphere. These can be achieved through regular media releases, regular presentations to a wider audience (ACCSP, local/international conferences).
Communication of key scientific findings to other stakeholders and regulatory bodies, for example Department of the Environment.

Relationship Management

The primary relationships that have to be maintained to ensure success of the program are CSIRO/BoM. This relationship is maintained by regular exchanges of information at the Cape Grim Working Group meetings, the Cape Grim Annual Science Meeting and by regular and open e-mail exchanges of information pertinent to the running of the program and the interpretation of the resultant data. This has been, and will continue to be a long-term partnership between BoM and CSIRO, that has been very successful in the past.

## 2.12 Performance Indicators

Identify performance indicators for evaluating project success

Attendance at regular Cape Grim Working group meetings by CSIRO Cape Grim lead scientists
Cape Grim data regularly archived in international archives
Cape Grim data regularly published in international, peer-reviewed journals of the highest quality
Cape Grim data used in national and international scientific assessments
Uptake of scientific results by policy makers

## 2.13 Approval for Capability release (email sign-off sufficient - attached and archived )

It is a requirement that formal approval is recorded for the capability release of each staff member participating in this project. Please ensure these approvals (written or email) accompany this Project Plan.

Approval Outcome

## 2.14 Approval to Submit External Proposal (email sign-off sufficient - attached and archived)

I have seen attached proposal and agree to its suitability for submission to the client

Business Development Manager

Name | Signature

Finance Officer

Name | Signature

Contracts Manager

Name | Signature

I approve the submission of this project proposal to the external client

Authorised Officer *Enter Full Name*

Notes

Signature | Date

# CSIRO Project Lifecycle

**Section 2 | Project Plan** *Version 2.1.6*

## 2.15 Approval to Commence Project Delivery (email sign-off sufficient - attached and archived)

**Project Leader Sign-Off**

I, Paul Krummel, verify that the Project Plan contained herein is complete and accurate, and submit it for approval to commence delivery

Notes

Projects and budgets agreed upon at the July 2015 Cape Grim Working Group Meeting and subsequent Management Group Meeting. Final funding total may change.
Please note that the Bureau of Meteorology provides approximately $2.2M per annum of in-kind support for Cape Grim projects. See below for more details.
In-Kind support:
In addition to the total funding of approximately $450-500K from BoM each year for all CSIRO Cape Grim projects (CSIRO O&A), the Bureau provide substantial in kind support. CSIRO has full access to the Cape Grim station facilities, including technical personal who undertake day to day running of the facility and instruments, as well as access to a capital equipment replacement program. These in-kind contributions from BoM are estimated at approximately $2.2M per annum, comprised of operating costs of the station (~$400K), labour & overheads (~$1.5M) and capital equipment replacement (~$300k).
Background & ComEx approval:
All of the CSIRO Cape Grim projects are long-term (commenced in 1976) projects designed to monitor mid-latitude Southern Hemisphere atmospheric composition. The initial agreement between CSIRO and the Bureau for the Cape Grim monitoring activity was for 50 years, with approximately 10 more years left (after which it is likely to continue). As such, in 2007 Jennifer Sutton (on behalf of the then chief of CMAR Greg Ayers) submitted a paper to ComEx seeking approval to enter into an agreement with the Bureau for the rest of the 20 years of the Cape Grim collaboration, on the understanding that it would be reviewed every 5 years. This proposal was endorsed by ComEx in March 2007.

| Signature | Paul Krummel | Date | 2-Sep-15 |
|---|---|---|---|

**CSIRO Authorised Approving Officer Sign-Off**

I verify that I have reviewed the Project Plan contained herein and my decision is recorded below:

| Authorised Officer | *Enter Full Name* |
|---|---|

# CSIRO Project Lifecycle

**Section 2 | Project Plan**

*Version 2.1.6*

| | |
|---|---|
| Approval Outcome | *-- Select --* |

Notes

| | | | |
|---|---|---|---|
| Signature | | Date | |

**2.16 Office Use Only - Project Tracking**

| | |
|---|---|
| WBS Element | *R-00000-00* |
| Trim Reference | *Enter Trim Reference Number* |
| CCF Trim Ref | *Enter Trim Reference for Approved CCF Template* |
| EOP Reference | *Enter EOP Reference Number* |

# CSIRO Project Lifecycle

**Section 1 | Project Brief**

*Version 2.1.6*

## 1.1 Main Project Details

| | | | | | |
|---|---|---|---|---|---|
| Project Name | BoM Cape Grim | | | | |
| Long Title | BoM Cape Grim | | | | |
| Project Leader | Paul Krummel | | | | |
| Project Type | Research | | | | |
| Portfolio | Oceans and Atmosphere | | | | |
| Theme | Earth System Assessment | | | | |
| Stream | Earth Health | | | L1 WBS | *R-00000* |
| Start Month | July 2015 | Duration (Mths) | 12 | End | June 2016 |

## 1.2 Scope and Objectives

Description of Project

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the three premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into the international/global assessments, for example the Intergovernmental Panel on Climate Change.

There are 3 CSIRO led sub programs:

1) The Greenhouse and Ozone Depleting Gases program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived greenhouse gases (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

2) The Particles and Multiphase Atmospheric Chemistry (MAC) program provides long term data on aerosol

2) The Particles and Multiphase Atmospheric Chemistry (MAC) program provides long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. The program uses time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.
3) Reactive Gases program: Ozone is one of the key constituents of the background lower atmosphere. The ozone monitoring program at Cape Grim is regarded as one of the best long-term, high-quality baseline records in the world and is used in definitive studies of tropospheric ozone. NOx and VOCs are central (with O3) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Re-development of a continuous VOC monitoring program and addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region.

Short Rationale

Cape Grim's essential purpose has not changed since the program's inception in 1976. National and global concern that human activity is having an impact on the composition of the global atmosphere requires that the changes be observed and understood. Initially, this was the main focus, whereas now the data are also used for prediction, to guide development of remedial policies, and to verify the effectiveness of global mitigation actions. The critical, but too often unrecognised role of precise in-situ atmospheric observation programs underpinning our current understanding of atmospheric processes and ability to model future climate, is well summarised in a commentary in Nature, titled "Cinderella science" (Nature 450/6 December 2007, pp 789-790).
This project enables the Bureau of Meteorology to fulfill Australia's obligations to the WMO-GAW program for long-term monitoring of atmospheric composition.

Deliverables - Outputs

Greenhouse and Ozone Depleting Gases program:
• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both in situ measurements and flask samples;
• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanisms that result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• To use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;

• To participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• To make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• Regular submission of the Cape Grim data to the relevant national and international data archives;
• To verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Particles and MAC:
• A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
• A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
• The continued development and application of chemical transport modelling to the remote marine boundary layer.
• Continued investigation of chemical composition of CCN mode particles.
• Continued investigation of mercury in the remote marine boundary layer.
• Review of the Particle Program.

Reactive Gases:
• Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia.
• Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).
• Data will be submitted to the World Data Centre for Greenhouse Gases.

## 1.3 Work Plan

Brief Description of Methodology

Greenhouse and Ozone Depleting Gases:
• Produce quality controlled, continuous records of the climatically important species listed above, through rigorous supervision and regular assessments (weekly to 6 months to biennial) and the maintenance of accurate, stable, internationally-accepted calibration standards and procedures;
• Enhance the measurement science at Cape Grim through the introduction of state-of-the-art measurement capability, in particular via technologies such as cavity ring-down spectroscopy and quantum cascade laser spectroscopy, and to improve and expand the range of isotopic measurements leading to new insights into these important drivers of climate change;
• Maintenance and enhancement of the Cape Grim air archive (higher frequency in some years, duplication of the entire archive, fire-safe, secure and controlled storage);
• Regular submission of the Cape Grim data to the relevant national and international data archives;
• Engage actively with developments in CABLE and ACCESS so that Cape Grim data are used in model verification studies;
• Continued collaboration with international laboratories and programs (USA: NOAA-ESRL, AGAGE; NZ: NIWA; Europe: Empa, NILU, U. Bristol, U. East Anglia, U. Heidelberg) at the forefront of developing and implementing state-of-the-art measurement and 2-D and 3-D inverse modelling capabilities;

Particles and MAC:
• The MAC and Particles Programs will continue to work with the chemical transport modellers to develop models for application to Cape Grim atmospheric chemistry and aerosol. This work will form part of a long-term program aimed at developing methodologies that incorporate observations from Cape Grim into process models and ultimately into the development of regional and global climate modelling systems such as ACCESS. Specifically this year, we utilise the modelling system to investigate long range transport of biomass burning smoke to Cape Grim under baseline conditions.
• We will continue our investigation of mercury in the remote marine boundary layer and will continue to contribute data on baseline mercury concentrations measured with the TEKRAN Mercury Monitor, purchased to the Global Mercury Observing System (GMOS).
• We will continue to document and operationalise QA/QC procedures for aerosol microphysical data. In particular we will work with NOAA to adopt the QA/QC procedures of the NOAA Aerosol Global Monitoring network to streamline submission of data to the World Data Centre for Aerosol.
• We will continue our work on POPs at Cape Grim, collecting passive samples and active samples under all conditions.

Reactive Gases:
- To continue the long-term monitoring of tropospheric ozone, NOx and VOCs at Cape Grim.
- Continued development of a continuous VOC monitoring program and addition of the ammonia monitoring program. These will be amongst the first ammonia and OVOCs monitoring activities in the background marine atmosphere globally.
- Data will be submitted to the World Data Centre for Greenhouse Gases.

## 1.4 Categorisation Summary

| | | | | | |
|---|---|---|---|---|---|
| Estimated Cost | $1.9M | ● | HS&E | Low | ● |
| Duration (months) | 12 | ● | IP | Low | ● |
| Project Management | Moderate | ● | Commercial | Low | ● |
| Scientific and Technical | High | ● | Reputational Impact | Low | ● |
| External Revenue | 24% | | | | |
| Suggested Rigour | Moderate | ● | | | |

**Plan Section Moderate Risk, Preliminary Risk Assessment and High Governance recommended**

## 1.5 Potential Collaborators

| Collaborator Name (Company) | Contact Person |
|---|---|
| International AGAGE program (MIT, SIO, GIT, U. of Bristol, Empa) | Ron Prinn; rprinn@mit.edu |
| NOAA ESRL GMD | Jim Butler; James.H.Butler@noaa.g |

## 1.6 Potential Customers

| Customer Name (Company) | Contact Person |
|---|---|
| Australian Bureau of Meteorology | Sam Cleland; s.cleland@bom.gov.a |
| | |

## 1.7 Ethics

Does this project involve humans as participants or subjects of the research?

○ Yes ◉ No

## 1.8 Confidentiality Notes

Detail if there are any specific confidentiality considerations

No confidentiality considerations.

# CSIRO Project Lifecycle

**Section 1 | Project Brief** *Version 2.1.6*

## 1.9 Request to Commence Project Planning (email sign-off sufficient - attached and archived)

I, Paul Krummel, am applying for approval to:

- (●) Complete the project in full
- ( ) Undertake a scoping / proof of concept study at an estimated cost of: $ -

Project Leader: Paul Krummel  Date: 16/09/2014

## 1.10 CSIRO Authorised Officer Approval (email sign-off sufficient - attached and archived)

I verify that I have reviewed the Project Brief contained herein and my decision is recorded below:

Authorised Officer: *Enter Full Name*

Approval Outcome: *-- Select --*

Notes

Signature:  Date:

## 1.11 Office Use Only - Project Tracking

WBS Element: *R-00000-00*

Trim Reference: *Enter Trim Reference Number*

# CSIRO Project Lifecycle

**Section 2 | Project Plan**

*Version 2.1.6*

## Oceans and Atmosphere

Project Name BoM Cape Grim

Project Leader Paul Krummel

## 2.1 Plan Risk

Select Plan Risk: Moderate

## 2.2 Scope and Objectives

Description of Project

Commencing operations in 1976, and in its current facilities since 1981, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability. It is one of the three premier stations in the Global Atmosphere Watch (GAW) network of the World Meteorological Organization (WMO). Cape Grim observations thereby contribute very significantly to the GAW programme, and research outputs are published in peer-reviewed international journals of the highest quality, are very frequently cited, and feed into the international/global assessments, for example the Intergovernmental Panel on Climate Change.

There are 3 CSIRO led sub programs:

1) The Greenhouse and Ozone Depleting Gases program provides long-term, high-quality data that are used to derive trends, inter-annual variability, and regional and global source and sink estimates for the long-lived greenhouse gases (carbon dioxide, methane, nitrous oxide, HFCs, PFCs, sulfur hexafluoride and nitrogen trifluoride) and the ozone depleting substances (primarily CFCs, HCFCs, chlorinated solvents, halons and methyl bromide).

2) The Particles and Multiphase Atmospheric Chemistry (MAC) program provides long-term data on aerosol microphysical and chemical composition, cloud condensation nucleus number concentrations and precipitation chemistry in the Southern Ocean region, as well as investigating important aspects of the formation and processing of marine aerosol. The program uses time series data and process studies to investigate changes in Southern Ocean aerosol properties of relevance to changing climate, particularly cloud condensation nuclei and optically active particles.

3) Reactive Gases program: Ozone is one of the key constituents of the background lower atmosphere. The ozone monitoring program at Cape Grim is regarded as one of the best long-term, high-quality baseline records in the world

and is used in definitive studies of tropospheric ozone. NOx and VOCs are central (with O3) to the photochemistry of the lower atmosphere, including production of hydroxyl radicals that limit the lifetime of many atmospheric gases, and production of secondary aerosol. Re-development of a continuous VOC monitoring program and addition of the ammonia monitoring program will allow the formation potential of secondary aerosol to be estimated over the Southern Ocean, and will give a greater understanding of the processes influencing chemical composition of marine organic aerosol in this region.

Execution Rationale

Cape Grim's essential purpose has not changed since the program's inception in 1976. National and global concern that human activity is having an impact on the composition of the global atmosphere requires that the changes be observed and understood. Initially, this was the main focus, whereas now the data are also used for prediction, to guide development of remedial policies, and to verify the effectiveness of global mitigation actions. The critical, but too often unrecognised role of precise in-situ atmospheric observation programs underpinning our current understanding of atmospheric processes and ability to model future climate, is well summarised in a commentary in Nature, titled "Cinderella science" (Nature 450/6 December 2007, pp 789-790).

Past outputs, impact and strategic importance:
High-Profile Outputs:
During the past 40 years there have been ~35 papers in Nature, Science or PNAS that used data generated from Cape Grim observational activities and included CSIRO authors, with 10 of those in the past 4 years alone.
Cape Grim data are regularly submitted to international data archives (for example the World Data Center for Greenhouse Gases), which are freely available to all researchers and the general public alike.

Impact:
National and international policies relating to the impact that human activity is having on the composition of the global atmosphere are based on international scientific assessments, in particular the IPCC climate change Assessments and the WMO/UNEP ozone assessments. Through the use of Cape Grim data, citations of Cape Grim papers, and chapter authorships, we have made significant contributions to all ten WMO/UNEP ozone assessments and have made significant & growing contributions to all five IPCC climate change Assessments.
Some recent specific policy impact examples:
There has been concern for the rapid growth in hydrofluorocarbons or HFCs (based on atmospheric observations at Cape Grim and other global stations), which have relatively high global warming potentials (GWPs). This has seen a recent policy shift in Australia (and other countries, particularly USA) for the control of HFCs to move from a Kyoto Protocol type process which regulates emissions to a Montreal Protocol type process which regulates production of these gases, and which can subsequently phase out HFC production (there are low-GWP alternatives already

available). There is currently no international agreement on the regulation of HFCs, however efforts are ongoing to develop a global approach for the control of HFCs.
Nitrogen trifluoride (NF3 - a potent anthropogenic greenhouse gas) has potential to make a growing contribution to the Earth's radiative budget through its rapidly growing use in the manufacture of modern electronic devices. This substance was discovered in the atmosphere based on measurements from Cape Grim and one Northern hemisphere site, and published initially in 2008. This has subsequently seen NF3 added to the Kyoto Protocol basket of long-lived greenhouse gases in 2012.

Strategic Importance:
This project enables the Bureau of Meteorology to fulfill Australia's obligations to the WMO-GAW program for long-term monitoring of atmospheric composition. Cape Grim is considered to be one of three WMO GAW premier global stations (the other two are in the northern hemisphere; the total number global stations is about 30).
Most of the work programs at Cape Grim fall under the umbrella of public good research (of national and global importance), as stated in the opening paragraph of this section (e.g. long-term high quality observations of atmospheric composition). A good example of the importance of this, is that, it is atmospheric measurements (of CO2, CO2 isotopes and oxygen) that have proven that the continued rise in atmospheric carbon dioxide (CO2) can only be explained by fossil fuel combustion.
The activities and data generated at Cape Grim are also used for other co-investment activities, some examples are: the international MIT/NASA funded AGAGE program (approx $1M external income so far); regional emissions of ozone depleting and synthetic greenhouse gases (Dept or Environment, ~$1.3M over the past 10 years).
Lastly, we have used and continue to use Cape Grim to test/evaluate new measurement technologies. Once successful, these are then used or adopted in other measurement programs, which in turn generate external income.

Deliverables - Outputs

Greenhouse and Ozone Depleting Gases program:
• To continue long-term, highest-quality observations of all the important, long-lived trace gases that drive climate change and ozone depletion, using both in situ measurements and flask samples;
• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanisms that result in widespread use of Cape Grim data in the modelling and policy-maker communities;
• To use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;
• To participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• To make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-

To make Cape Grim greenhouse and ozone depleting trace gas data directly available to the public via a user-friendly web-based interface;
• Regular submission of the Cape Grim data to the relevant national and international data archives;
• To verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.

Particles and MAC:
• A continued quality-assured long-term record of baseline PM10 and PM2.5 aerosol mass and chemical composition and rainwater chemical composition.
• A continued quality-assured multi-decadal record of aerosol properties and cloud condensation nucleus number concentrations relevant to the Southern Ocean region.
• The continued development and application of chemical transport modelling to the remote marine boundary layer.
• Continued investigation of chemical composition of CCN mode particles.
• Continued investigation of mercury in the remote marine boundary layer.
• Review of the Particle Program.

Reactive Gases:
• Quantitative understanding of the processes controlling, and long term climatology of ozone in the boundary layer at Cape Grim, with supporting studies of odd nitrogen oxides (NOx), volatile organic compounds and ammonia.
• Ongoing conduct of the recently commenced in-situ continuous VOC monitoring program and the addition of the ammonia monitoring program will bridge the gap between the Reactive Gases and the Particles and Multiphase Atmospheric Chemistry programs by providing valuable information about the contribution of secondary aerosol to MBL aerosol over the Southern Ocean (contribution is currently highly uncertain).
• Data will be submitted to the World Data Centre for Greenhouse Gases.

Deliverables - Outcomes / Impact

All programs:
• To ensure that Cape Grim retains its status as a premier Baseline Station in the GAW hierarchy, through leadership in measurement science, and the provision of a data quality assurance and delivery mechanism that will result in widespread use of Cape Grim data in the modelling and policy-maker communities;

Greenhouse and Ozone Depleting Gases program:
• To use the Cape Grim data, through national and international partnerships, to derive, by inverse and other modelling techniques, global and regional sources (emissions) and sinks for these important species;

• To participate fully in all the national and international assessments of climate change and ozone depletion to ensure that Cape Grim data receive the widest possible global recognition and application;
• To verify 'bottom-up' national and global emissions inventories with 'top-down' estimates based on Cape Grim and other global observational data.
• Use of Cape Grim greenhouse and ozone depleting gas data in high-quality, high impact journal publications, with CSIRO staff as lead authors or co-authors.
Particles and MAC
• The use of Cape Grim aerosol data in state of the climate reporting
• The use of Cape Grim aerosol and multiphase atmospheric chemistry data in high quality, high impact journal publications with CSIRO staff as lead authors or co-authors.
• The use of Cape Grim aerosol and multiphase atmospheric chemistry data to verify performance of earth system models including ACCESS.
Reactive Gases
• The use of Cape Grim reactive gases data in high quality, high impact journal publications with CSIRO staff as lead authors or co-authors.
• The use of Cape Grim reactive gases data to verify performance of earth system models including ACCESS.
• The establishment of VOC monitoring at Cape Grim

## 2.3 Work Plan

Milestone Schedule

| No. | Type | Description (incl Billing Milestone value if required) | Due Date | Client |
|---|---|---|---|---|
| 1 | APG | See attached Cape Grim work plans submitted to BoM | 30/06/2016 | BoM |
| 2 | APG | Organise and run the Cape Grim Annual Science Meeting | 11/11/2015 | BoM |
| 3 | APG | Publish Baseline 2011-2013 | 1/11/2015 | BoM |
| 4 | | | | |
| 5 | | | | |

## 2.4 Intellectual Property

Background IP - CSIRO

This BoM-funded Project utilises IP generated at Cape Grim and, as such, is subject to the IP issues detailed below:
IP material generated at Cape Grim includes, but is not limited to, documents, computer software, equipment, reports, information and data produced and stored by any means whatsoever which is created by either or both CSIRO and the Bureau of Meteorology (the Bureau) during the course of and as a result of performing a joint project under the CGBAPS Program.
Background IP means all material (including the IP rights in it) created before or independently of the CGBAPS Program.
All Background IP, and any improvements to it, which CSIRO or the Bureau chooses to make available for the purposes of the CGBAPS Program remains vested in that party.
From time to time CSIRO may provide or develop experimental instrumentation for use in the CGBAPS Program solely funded by CSIRO and independent of the Cape Grim Program. All intellectual property associated with such experimental instrumentation, and any improvements to it, remain vested in CSIRO.

Background IP - External

This BoM-funded Project utilises IP generated at Cape Grim and, as such, is subject to the IP issues detailed below:
IP material generated at Cape Grim includes, but is not limited to, documents, computer software, equipment, reports, information and data produced and stored by any means whatsoever which is created by either or both

CSIRO and the Bureau of Meteorology (the Bureau) during the course of and as a result of performing a joint project under the CGBAPS Program.
Background IP means all material (including the IP rights in it) created before or independently of the CGBAPS Program.
All Background IP, and any improvements to it, which CSIRO or the Bureau chooses to make available for the purposes of the CGBAPS Program remains vested in that party.
All intellectual property rights in the CGBAPS Material shall vest in the Bureau.
The Bureau grants to CSIRO a non-exclusive, royalty-free, world-wide, irrevocable and perpetual licence to use the CGBAPS Material for any purpose.
From time to time the Bureau may provide or develop experimental instrumentation for use in the CGBAPS Program solely funded by the Bureau and independent of the Cape Grim Program. All intellectual property associated with such experimental instrumentation, and any improvements to it, remain vested in the Bureau.

Other CSIRO Projects using this IP

DoE SGG emissions & ozone hole; AGGON Strategic; MIT-AGAGE; ACCSP SOCO2; Refrigerant Emissions (RRA); GISERA Methane Seeps.

## 2.5 Potential Collaborators

| Collaborator Name (Company) | Contact Name |
|---|---|
| International AGAGE program (MIT, SIO, GIT, U. of Bristol, Empa) | Ron Prinn; rprinn@mit.edu |
| NOAA ESRL GMD | Jim Butler; James.H.Butler@noaa.g |

## 2.6 Potential Customers

| Customer Name (Company) | Contact Name |
|---|---|
| Australian Bureau of Meteorology | Sam Cleland; s.cleland@bom.gov.a |
| | |

## 2.7 Ethics

Does this project involve humans as participants or subjects of the research?

○ Yes ◉ No

## 2.8 Confidentiality Notes

Detail if there are any specific confidentiality considerations

No confidentiality considerations.

## 2.9 Commercial

Agreements related to this project

The formal collaborative agreement with BoM for the Cape Grim projects was finalised in Mar/Apr 2012.

Identify likely pathways for commercialisation of project outcomes

N/A

Is a commercialisation plan included in the project milestones? No

How will project impact be measured?

## 2.10 Major Project Risks

| | |
|---|---|
| Identified Risk | Continued access to the BoM Cape Grim facility and funding for the Cape Grim Greenhouse Gas program, including the Cape Grim air archive |
| Management Plan | Seek alternate sites and funding agencies. |

## 2.11 Communication Plan

Communication to Theme Leader

Reporting through regular ESA Program and EH Group meetings; e-mail correspondence as necessary; Cape Grim Working group correspondence to the Cape Grim Management Group (which includes a CSIRO representative).

Communication to stakeholders

Participation in Cape Grim Working Group meetings three times a year by CSIRO Cape Grim lead scientists.
Interaction with Cape Grim staff members on project/measurement requirements and day to day issues.
Visits to the Cape Grim Station by CSIRO Cape Grim lead scientists and other CSIRO staff.
Active participation by CSIRO staff in the Cape Grim Annual Science Meeting.

Is a Steering Committee required? Yes

Communication to Steering Committee

Steering committee is the Cape Grim Working Group, of which there are seven members from the EH Group, who attend the working group meetings three times a year.

Communication within Project Team

Regular Group & Team Meetings, internal preparation and distribution of regular Project Reports.

Communication outside Project Team

The communication opportunities are usually associated with increased levels of radiative forcing and decreased levels of ozone depleting gases in the atmosphere. These can be achieved through regular media releases, regular presentations to a wider audience (ACCSP, local/international conferences).
Communication of key scientific findings to other stakeholders and regulatory bodies, for example Department of the Environment.

Relationship Management

The primary relationships that have to be maintained to ensure success of the program are CSIRO/BoM. This relationship is maintained by regular exchanges of information at the Cape Grim Working Group meetings, the Cape Grim Annual Science Meeting and by regular and open e-mail exchanges of information pertinent to the running of the program and the interpretation of the resultant data. This has been, and will continue to be a long-term partnership between BoM and CSIRO, that has been very successful in the past.

## 2.12 Performance Indicators

Identify performance indicators for evaluating project success

Attendance at regular Cape Grim Working group meetings by CSIRO Cape Grim lead scientists
Cape Grim data regularly archived in international archives
Cape Grim data regularly published in international, peer-reviewed journals of the highest quality
Cape Grim data used in national and international scientific assessments
Uptake of scientific results by policy makers

## 2.13 Approval for Capability release (email sign-off sufficient - attached and archived )

It is a requirement that formal approval is recorded for the capability release of each staff member participating in this project. Please ensure these approvals (written or email) accompany this Project Plan.

Approval Outcome

## 2.14 Approval to Submit External Proposal (email sign-off sufficient - attached and archived)

I have seen attached proposal and agree to its suitability for submission to the client

Business Development Manager

Name | Signature

Finance Officer

Name | Signature

Contracts Manager

Name | Signature

I approve the submission of this project proposal to the external client

Authorised Officer *Enter Full Name*

Notes

Signature | Date

# CSIRO Project Lifecycle

**Section 2 | Project Plan** *Version 2.1.6*

## 2.15 Approval to Commence Project Delivery (email sign-off sufficient - attached and archived)

**Project Leader Sign-Off**

I, Paul Krummel, verify that the Project Plan contained herein is complete and accurate, and submit it for approval to commence delivery

Notes

Projects and budgets agreed upon at the July 2015 Cape Grim Working Group Meeting and subsequent Management Group Meeting. Final funding total may change.
Please note that the Bureau of Meteorology provides approximately $2.2M per annum of in-kind support for Cape Grim projects. See below for more details.
In-Kind support:
In addition to the total funding of approximately $450-500K from BoM each year for all CSIRO Cape Grim projects (CSIRO O&A), the Bureau provide substantial in kind support. CSIRO has full access to the Cape Grim station facilities, including technical personal who undertake day to day running of the facility and instruments, as well as access to a capital equipment replacement program. These in-kind contributions from BoM are estimated at approximately $2.2M per annum, comprised of operating costs of the station (~$400K), labour & overheads (~$1.5M) and capital equipment replacement (~$300k).
Background & ComEx approval:
All of the CSIRO Cape Grim projects are long-term (commenced in 1976) projects designed to monitor mid-latitude Southern Hemisphere atmospheric composition. The initial agreement between CSIRO and the Bureau for the Cape Grim monitoring activity was for 50 years, with approximately 10 more years left (after which it is likely to continue). As such, in 2007 Jennifer Sutton (on behalf of the then chief of CMAR Greg Ayers) submitted a paper to ComEx seeking approval to enter into an agreement with the Bureau for the rest of the 20 years of the Cape Grim collaboration, on the understanding that it would be reviewed every 5 years. This proposal was endorsed by ComEx in March 2007.

| Signature | Paul Krummel | Date | 2-Sep-15 |
|---|---|---|---|

**CSIRO Authorised Approving Officer Sign-Off**

I verify that I have reviewed the Project Plan contained herein and my decision is recorded below:

| Authorised Officer | *Enter Full Name* |
|---|---|

# CSIRO Project Lifecycle

**Section 2 | Project Plan**

*Version 2.1.6*

| | |
|---|---|
| Approval Outcome | *-- Select --* |

Notes

| | | | |
|---|---|---|---|
| Signature | | Date | |

**2.16 Office Use Only - Project Tracking**

| | |
|---|---|
| WBS Element | *R-00000-00* |
| Trim Reference | *Enter Trim Reference Number* |
| CCF Trim Ref | *Enter Trim Reference for Approved CCF Template* |
| EOP Reference | *Enter EOP Reference Number* |

**CSIRO Cape Grim project financials - summary**

| Financial Year | FTEs | Salary/labour | Overheads | Operating | Travel | Total | BoM Contribution to CSIRO projects | CSIRO Contribution | BoM/total_cost % | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 2015-2016 replanned | 2.14 (across 22 staff) | $273,656 | $225,590 | $112,900 | $72,600 | $684,746 | $458,500 | $226,246 | 67% | Replanned and entered into SAP in Dec 2015. The CSIRO contribution here is the number quoted in the senate estimates on Thursday 11 Feb 2016 (although $234K was quoted, and not $226K). |
| 2015-2016 original | 7.25 (across 24 staff) | $917,906 | $756,685 | $142,900 | $72,600 | $1,890,091 | $458,500 | $1,431,591 | 24% | Entered into SAP & activated in Sep 2015. |

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[redacted]

**In-Kind support from BoM for Cape Grim:**

In addition to the total funding of approximately $450-500K from BoM each year for all CSIRO Cape Grim projects (CSIRO O&A), the Bureau provide substantial in kind support. CSIRO has full access to the Cape Grim station facilities, including technical personal who undertake day to day running of the facility and instruments, as well as access to a capital equipment replacement program. These in-kind contributions from BoM are estimated at approximately $2.2M per annum, comprised of operating costs of the station (~$400K), labour & overheads (~$1.5M) and capital equipment replacement (~$300k).

**CSIRO appropriation projects that support Cape Grim:**

The Cape Grim work is only possible with underlying appropriation funded infrastructure (equipment & instruments/data bases/precise calibration suites etc) and capabilities at Aspendale, and in particular the GASLAB laboratories. The total average cost for GASLAB approp activities is: 3.5 FTE, $140K opex/travel, total cost $850K; The total average cost for the Aerosols/Reactive Gases approp activities is: ~2 FTE, $20K opex/travel, total cost $[illegible]K. It is also estimated that there is about $1.5-2.0M of infrastructure (analysers, gas chromatogarphs, mass spectrometers, highly customised components, calibrations suites, cylinders, other equipment & spare parts) in the labs at Aspendale that help support Cape Grim.

Below are the actual expenditures from SAP (except 2015/2016 which are planned values) for the last 6 financial years for the CSIRO GASLAB appropriation project:

| Financial Year | FTEs | Salary/labour | Overheads | Operating | Travel | Total |
|---|---|---|---|---|---|---|
| 2015-2016 | 3.30 (across 12 staff) | $379,669 | $312,984 | $120,000 | $20,000 | $832,653 |

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[redacted]

# CGBAPS Research Budget Request Form 2015-2016

Only make entries in blue boxes. Do not add/remove rows, columns or cells. Use drop down menu for program/project name
If separate justification is required, this should be included in a one page research proposal needed with each budget request

| | |
|---|---|
| **Program or Project** (please use title listed in drop down menu) | **Carbon Dioxide and its isotopes** |
| **Lead Scientist or Project Scientist** | **Paul Steele/Paul Krummel/Marcel van der Schoot** |
| **Year** | **2015-2016** |

| | |
|---|---|
| **Estimated carry over from current financial year** | $0 |

**BUDGET REQUEST**

***Research***

| | |
|---|---|
| **Consumables** | $28,000 |
| **Freight** | $8,000 |
| **Other (please Detail below)** | |
| | |
| | |

***Personnel*** (submit separate justification)

| ***Travel*** | **Trips** | **Days** | **People** | |
|---|---|---|---|---|
| Trips to Cape Grim | 3 | ~3 | 3 | $6,000 |

Other Domestic Travel (submit separate justification)

| | | | | |
|---|---|---|---|---|
| Cape Grim Working Group Meeting | 1 | 3 | 2 | $2,000 |
| Cape Grim annual science meeting | 1 | 4 | 2 | $2,000 |
| | | | | |

***Station Allocation***

| *Program* | *Previous Years Allocation* | |
|---|---|---|
| Archive Tanks | 500 | $ - |
| Carbon Dioxide and its isotopes | 2000 | $2,000 |
| Reactive Gases | 4000 | $ - |
| Non-CO2 Greenhouse Gases | 28000 | $ - |
| Precipitation/Hi-Volume Sampler | 5000 | $ - |
| Particles | 3000 | $ - |
| Radon | 3000 | $ - |
| SRAD | 500 | $ - |
| Meteorology | 1200 | $ - |
| Radiation | 500 | $ - |
| New Proposal | 0 | $ - |

**TOTAL** **$48,000**

| | |
|---|---|
| Percentage of budget that represents the "Keeling" component | 100% |
| Quantum of budget that represents the "Keeling" component | $48,000 |

***Station Allocation***

| *Program* | *Previous Years Allocation* | 2011-12 | 2012-13 (to date) | 2012-13 (extrapolated) | Average |
|---|---|---|---|---|---|
| s 22 | | | | | |

# CGBAPS Research Budget Request Form 2015-2016

Only make entries in blue boxes. Do not add/remove rows, columns or cells. Use drop down menu for program/project name
If separate justification is required, this should be included in a one page research proposal needed with each budget request

| | |
|---|---|
| **Program or Project** (please use title listed in drop down menu) | **Non-CO2 Greenhouse Gases** |
| **Lead Scientist or Project Scientist** | **Paul Krummel/Paul Steele/Paul Fraser** |
| **Year** | **2015-2016** |

| | |
|---|---|
| **Estimated carry over from current financial year** | $0 |

**BUDGET REQUEST**

***Research***

| | |
|---|---|
| **Consumables** | $7,000 |
| **Freight** | $7,000 |
| **Other (please Detail below)** | |
| regulator | $1,500 |
| Picarro silver cover | $1,400 |

***Personnel*** (submit separate justification)

***Travel***

| | Trips | Days | People | |
|---|---|---|---|---|
| Trips to Cape Grim | 4 | 3 | 3 | $6,600 |

Other Domestic Travel (submit separate justification)

| | | | | |
|---|---|---|---|---|
| Cape Grim Working Group Meeting | 1 | 3 | 2 | $2,000 |
| Cape Grim annual science meeting | 1 | 3 | 2 | $2,000 |
| | | | | |

***Station Allocation***

| *Program* | *Previous Years Allocation* | |
|---|---|---|
| Archive Tanks | 500 | $ - |
| Carbon Dioxide and its isotopes | 2000 | $ - |
| Reactive Gases | 4000 | $ - |
| Non-CO2 Greenhouse Gases | 28000 | $28,000 |
| Precipitation/Hi-Volume Sampler | 5000 | $ - |
| Particles | 3000 | $ - |
| Radon | 3000 | $ - |
| SRAD | 500 | $ - |
| Meteorology | 1200 | $ - |
| Radiation | 500 | $ - |
| New Proposal | 0 | $ - |

**TOTAL** **$55,500**

| | |
|---|---|
| Percentage of budget that represents the "Keeling" component | 100% |
| Quantum of budget that represents the "Keeling" component | $55,500 |

***Station Allocation***

| *Program* | *Previous Years Allocation* | 2011-12 | 2012-13 (to date) |
|---|---|---|---|
| s 22 | [redacted] | | |

2012-13 (extrapolated) Average

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[redacted]

# CGBAPS Research Budget Request Form 2015-2016

Only make entries in blue boxes. Do not add/remove rows, columns or cells. Use drop down menu for program/project name
If separate justification is required, this should be included in a one page research proposal needed with each budget request

| | |
|---|---|
| **Program or Project** (please use title listed in drop down menu) | **Reactive Gases** |
| **Lead Scientist or Project Scientist** | **Ian Galbally & Sarah Lawson** |
| **Year** | **2015-2016** |

| | |
|---|---|
| **Estimated carry over from current financial year** | $0 |

**BUDGET REQUEST**

***Research***

| | |
|---|---|
| **Consumables** | $34,000 |
| **Freight** | $4,000 |
| **Other (please Detail below)** | |
| | |
| | |

***Personnel*** (submit separate justification)

| ***Travel*** | **Trips** | **Days** | **People** | |
|---|---|---|---|---|
| Trips to Cape Grim | 8 | 5 | 2 | $26,000 |

Other Domestic Travel (submit separate justification)

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

***Station Allocation***

| *Program* | *Previous Years Allocation* | |
|---|---|---|
| Archive Tanks | 500 | $ - |
| Carbon Dioxide and its isotopes | 2000 | $ - |
| Reactive Gases | 4000 | $4,000 |
| Non-CO2 Greenhouse Gases | 28000 | $ - |
| Precipitation/Hi-Volume Sampler | 5000 | $ - |
| Particles | 3000 | $ - |
| Radon | 3000 | $ - |
| SRAD | 500 | $ - |
| Meteorology | 1200 | $ - |
| Radiation | 500 | $ - |
| New Proposal | 0 | $ - |

**TOTAL** **$68,000**

| | |
|---|---|
| Percentage of budget that represents the "Keeling" component | 100% |
| Quantum of budget that represents the "Keeling" component | $68,000 |

***Station Allocation***

*Program Previous Years Allocation* 2011-12 2012-13 (to date) 2012-13 (extrapolated) Average

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# CGBAPS Research Budget Request Form 2015-2016

Only make entries in blue boxes. Do not add/remove rows, columns or cells. Use drop down menu for program/project name
If separate justification is required, this should be included in a one page research proposal needed with each budget request

| | |
|---|---|
| **Program or Project** (please use title listed in drop down menu) | **New Proposal** |
| **Lead Scientist or Project Scientist** | **Krummel/Keywood/Galbally/Steele/van der Schoot/Lawson/Fraser** |
| **Year** | **2015-2016** |

| | |
|---|---|
| **Estimated carry over from current financial year** | $0 |

**BUDGET REQUEST**

***Research***

| | | |
|---|---|---|
| **Consumables** | | |
| **Freight** | | |
| **Other (please Detail below)** | | |
| Cape Grim Annual Science Meeting | | To be held at Murramarang, NSW |
| NOAA attendee at CGASM | $4,500 | |

***Personnel*** (submit separate justification) $ 273,500.00

| ***Travel*** | **Trips** | **Days** | **People** | |
|---|---|---|---|---|
| Trips to Cape Grim | | | | |

Other Domestic Travel (submit separate justification)

| | | | | |
|---|---|---|---|---|
| Nada Derek travel to CGASM | 1 | 4 | 1 | $1,000 |
| | | | | |
| | | | | |

***Station Allocation***

| *Program* | *Previous Years Allocation* | |
|---|---|---|
| Archive Tanks | 500 | $ - |
| Carbon Dioxide and its isotopes | 2000 | $ - |
| Reactive Gases | 4000 | $ - |
| Non-CO2 Greenhouse Gases | 28000 | $ - |
| Precipitation/Hi-Volume Sampler | 5000 | $ - |
| Particles | 3000 | $ - |
| Radon | 3000 | $ - |

| | | | |
|---|---|---|---|
| SRAD | 500 | $ - | |
| Meteorology | 1200 | $ - | |
| Radiation | 500 | $ - | |
| New Proposal | 0 | | $0 |
| **TOTAL** | | | **$279,000** |

| | |
|---|---|
| Percentage of budget that represents the "Keeling" component | 100% |
| Quantum of budget that represents the "Keeling" component | $279,000 |

***Station Allocation***

*Program* *Previous Years Allocation* 2011-12 2012-13 (to date) 2012-13 (extrapolated) Average

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