# Cape Grim
# Baseline Air Pollution Station
# Annual Scientific Meeting, 2000

Abstracts




*7-8 December, 2000*
*CSIRO Atmospheric Research,*
*Aspendale, Victoria, Australia*

Edited by Neil Tindale & Nada Derek

Bureau of Meteorology

CSIRO

# *Cape Grim Baseline Air Pollution Station*
# *Annual Meeting, 2000*

| **Thursday, 7 December** | | |
|---|---|---|
| ***Chair*** | ***Neil Tindale*** | |
| 09:00 | Neil Tindale | General information on arrangements etc. |
| 09:10 | Arndt Meir | Biomass Burning Plumes above Wollongong – Measurements by Solar FTIR Remote Sensing. |
| 09:35 | David Griffith | Novel FTIR-Based Methods for Estimating Methane Emissions from Cattle. |
| 10:00 | Stephen Wilson | Characterisation of Agricultural $N_2O$ Emission Sources using Isotopic Labelling Studies. |
| **10:25** | **Morning Tea** | |
| 10:50 | Lilia Deschamps | Ozone and UV Index for the Southern Hemisphere during the Antarctic Ozone Hole 2000 |
| 11:15 | Peter Vohralik | Modelling Past and Future Southern Hemisphere Ozone Trends |
| 11:40 | Loretta Kivlighon | Measurements of $C_2$ and $C_3$ Hydrocarbons in Marine Air at Cape Grim (41°S, 145°E). |
| 12:05 | Bronwyn Dunse | Investigating the Emission and Transport of Trace Gases using The Air Pollution Model (TAPM). |
| **12:30** | **Lunch** | |
| ***Chair*** | ***Roger Francey*** | |
| 13:45 | Wlodek Zahorowski | Characterisation of Air Mass Origins using Radon Concentrations in air at Selected Enhanced ACE-Asia Stations. |
| 14:10 | Leong Chow Peng | A new Malaysian Global GAW Station in the Danum Valley, Sabah. |
| 14:35 | Masayuki Katsumoto | Activities of Greenhouse Gases Monitoring in CGER/NIES |
| 15:00 | John Barnes | Variability in Present Stratospheric Background Aerosol over Mauna Loa Observatory |
| **15:25** | **Afternoon Tea** | |
| 15:50 | Neil Tindale | Progress Report on Establishing a Regional Surface Ocean-Lower Atmosphere Study (ANZ-SOLAS). |
| 16:15 | Rachel Law | Assessing Continuous Shipboard Concentration Observations for Estimating Australian $CO_2$ Sources. |
| 16:40 | Dominic Ferretti | Isotopes of Atmospheric Water Vapour and Methane by GC-IRMS. |
| **17:05** | **Close of Papers** | |
| **17:30** | **Poster Wine and Cheese** | **CSIRO-Atmospheric Research Canteen** |
| **19:00** | **Dinner** | **Bridge Hotel (Doyles) – Mordialloc** |

# *Cape Grim Baseline Air Pollution Station*
# *Annual Meeting, 2000*

| **Friday, 8 December** | | |
|---|---|---|
| ***Chair*** | ***Paul Fraser*** | |
| 09:00 | Neil Tindale | General information on arrangements etc. |
| 09:10 | Roger Francey | Current Status and Future Requirements of Observations of the Global Carbon Cycle, Illustrated with a Study of Interannual Variability in the 20-year Cape Grim $CO_2$ and $\delta^{13}C$ Records. |
| 09:50 | Paul Steele | Addressing the Carbon Cycle Measurement Challenge: Initiatives in Measurement Technology and Global Intercalibration. |
| **10:30** | **Morning Tea** | |
| 11:00 | Darren Spencer | The Prototype (MARK I) LOFLO $CO_2$ Analyser Performance and its Comparison with the Existing BASGAM System. |
| 11:20 | Colin Allison | Development of a Consistent Calibration Scale for $CO_2$ Stable Isotope Measurements. |
| 11:40 | Ray Langenfelds | A Multiple Trace Gas Diagnoses of Interannual Variability in the Global Carbon Cycle, 1992-2000. |
| 12:00 | Cathy Trudinger | Reconstructing Atmospheric Records from Firn and Ice Core Measurements |
| **12:25** | **Lunch** | |
| ***Chair*** | ***Greg Ayers*** | |
| 13:30 | Salah Jimi | Characterisation of Postfrontal Flow using Ultrafine Particles and Trace Gases Measured during SOAPEX-2 |
| 13:55 | Melita Keywood | DMS, Marine Aerosol, and Climate: What can we learn from MSA? |
| 14:20 | Paul Fraser | CFC, HCFC and HFC Refrigerants: Port Phillip Regional Emissions Derived from AGAGE GC-MS data |
| 14:45 | Eva Kowalczyk | Global Scale Soil Moisture Estimation from Radon Concentrations. |
| **15:10** | **Afternoon Tea** | |
| 15:35 | Mick Meyer | Ozone Profiles in the Troposphere over South-Eastern Australia during August and September 2000 |
| 16:00 | Ian Galbally | The Global Cycle of Methanol |
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| **17:00** | **Close of meeting** | |

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# Biomass Burning Plumes above Wollongong - Measurements by Solar Ftir Remote Sensing

Arndt Meier[1], David Griffith[1], Stephen Wilson[1] & Curtis Rinsland[2]

[1]*University of Wollongong, Wollongong, NSW 2522*
[2]*NASA Langley Research Center, Hampton, Virginia USA*

***Abstract***

Annual cycles of total column CO, $C_2H_6$ and HCN above Wollongong measured by ground based solar FTIR remote sensing all show maxima in spring (September - October). All three species are tracers for biomass burning, and the spring maximum corresponds to the main biomass burning seasons in Africa and S. America. Using new SFIT2 software we can now obtain some vertical profile information for these gases. Preliminary results of such analyses of CO, $C_2H_6$ and HCN will be presented.

# Novel FTIR-based Methods for Estimating Methane Emissions from Cattle

David Hsu[1], David Griffith[1] & Andy Reisinger[2]

[1]*University of Wollongong, Wollongong, NSW 2522*
[2]*National Institute of Water & Atmospheric Research (NIWA), Greta Point, New Zealand*

***Abstract***

In September 1999 we trialed two novel, non-intrusive methods for measuring methane emissions from free-grazing livestock in the Wairarapa agricultural region of NZ. Around 40 yearling dairy heifers were confined to a long, narrow enclosure oriented across the wind direction 30 m upwind of a conventional micrometorological mast. Nitrous oxide was released at a known rate from the upwind fence of the enclosure, and continuous, simultaneous measurements of $CH_4$, $N_2O$ and $CO_2$ were made by FTIR spectroscopy from four inlets at heights of 1-6 m on the mast. In the first method, $N_2O$ acted as a tracer and the $CH_4$ emission from the cattle was calculated from the measured $CH_4/N_2O$ correlation and the known $N_2O$ release rate. In the second method, a one-dimensional mass balance approach was used to measure the total flux through a plane perpendicular to the wind direction at the mast, and thus to infer the methane release rate from the cattle. The two methods gave very consistent results both between methods and over three separate days, with an average emission rate of 370±30 g $day^{-1}$, equivalent to 22±2 std L $CH_4$ $hr^{-1}$ per head of cattle.

# Characterisation of Agricultural $N_2O$ Emission Sources using Isotopic Labelling Studies

Stephen R. Wilson, David W. Griffith, Fred Turatti & Joanne Menegazzo

*Department of Chemistry, University of Wollongong, Wollongong, NSW 2522*

***Abstract***

Recently there has been a lot of interest in the isotopic composition of $N_2O$. As the two nitrogens are chemically different, there are two $^{15}N$ isotopes, $^{14}N^{15}NO$ and $^{15}N^{14}NO$. The photolysis rates of these two isotopomers are different, as predicted theoretically, measured in the laboratory and as seen in the stratosphere. Based on this evidence it now seems unlikely that there are significant unknown chemical pathways for $N_2O$ in the stratosphere.

There is now also evidence that the sources of $N_2O$ also discriminate between the two nitrogen isotopomers. The largest known source of $N_2O$ is soils.

Two methods currently exist for the identification of these two species, mass spectrometry (under development by a number of groups) and high resolution FTIR (by us at Wollongong). The work presented will illustrate the use of high resolution FTIR for isotopic analysis.

The results presented come from studies at two sites in southern New South Wales, near Corowa and Nowra. At both sites there was significant variability in the nitrogen isotopomers with time. The two sites are very different, but there are similarities in the isotopic signatures, presumably because the underlying processes of nitrification and denitrification are similar.

# Ozone and UV Index for the Southern Hemisphere during the Antarctic Ozone Hole 2000

Lilia Lemus-Deschamps, Greg Roff & Janice Sisson

*Bureau of Meteorology Research Centre, Melbourne, Victoria 3001*

***Abstract***

The Antarctic ozone hole covered a considerable large area this year, and several times the edge of the hole has passed over the southern part South America reaching up to 50?S latitudes. Here some examples of the Southern Hemisphere ozone, UV Index and PV distributions are presented and discussed in relation to some meteorological fields. A comparison of the ozone and UV Index for Cape Grim and Melbourne (Australia), Ushuaia and Buenos Aires (Argentina), Punta Arenas (Chile) is also presented and the area and displacement of the ozone hole are calculated.

# Modelling Past and Future Southern Hemisphere Ozone Trends

Peter F. Vohralik, Lakshman K. Randeniya & Ian C. Plumb

*CSIRO Telecommunications & Industrial Physics, Lindfield, NSW 2070*

***Abstract***

Over the past 20 years, total ozone column amounts at mid latitudes in the southern hemisphere have decreased by 5-10%, with the largest decreases in early summer [*WMO*, 1999]. These changes are comparable in magnitude to those which have occurred at mid latitudes in the northern hemisphere, but the largest changes in the northern hemisphere have taken place in late winter/early spring. It is widely believed that increasing levels of halogen compounds in the atmosphere are responsible for most of the decrease in ozone over this period. However, the difference in timing of the maximum decreases in the two hemispheres also implies that transport processes play an important role. Indeed, it has been proposed that changes in transport may be responsible not only for the considerable inter-annual variations in ozone in both hemispheres, but also for much of the long-term trend. [*Fusco and Salby*, 1999].

As halogen levels in the atmosphere decrease gradually over the next 50-100 years, ozone is widely expected to 'recover' to pre-industrial values. However, the concentrations of several trace gases, including $CH_4$ and $N_2O$, will continue to change with time. In addition, temperatures are expected to change as a result of increases in greenhouse gases in the atmosphere, so it is not at all clear that ozone will return to pre-industrial levels.

In the present work, we use the CSIRO two-dimensional chemical transport model [*Randeniya et al.*, 1997; *Vohralik et al.*, 1998] to simulate atmospheric ozone over the period 1980 to 2100 and compare and contrast results for northern and southern mid latitudes. Lower boundary conditions are specified according to *WMO* [1999] and for the runs into the future, additional scenarios for $CH_4$, $N_2O$ and atmospheric temperatures are examined to determine the sensitivity of ozone recovery to these parameters.

Figure 1 shows calculated ozone trends relative to 1979-80 levels for the latitude band 40° to 50° in both hemispheres, together with TOMS measurements. Calculations are shown for the cases where the model transport was determined from measured quantities (temperature, ozone mixing ratio and cloud cover) for individual years and where the transport was annually repeating, based on average quantities over the 1979-1997 period. As can be seen from the diagram, the inter-annual variations in ozone are captured better when time-varying transport is used, particularly in the northern hemisphere. However, there is little difference in the long-term trend calculated with repeating or variable transport.

Figure 2 shows the calculated future evolution of annual-average ozone at 40° to 50° in both hemispheres, relative to the levels which existed in 1980. It can be seen that recovery in the southern hemisphere is greater than in the northern hemisphere, but in neither case does ozone recover to pre-1980 levels. This is mainly due to increasing levels of $NO_y$ in the atmosphere. The recovery is also sensitive to future levels of $CH_4$ and $N_2O$ in the atmosphere and to changes in temperature. The difference between the recoveries in the two hemispheres is due to the greater importance of heterogeneous cold chemistry at high latitudes in the southern hemisphere and differences in transport.

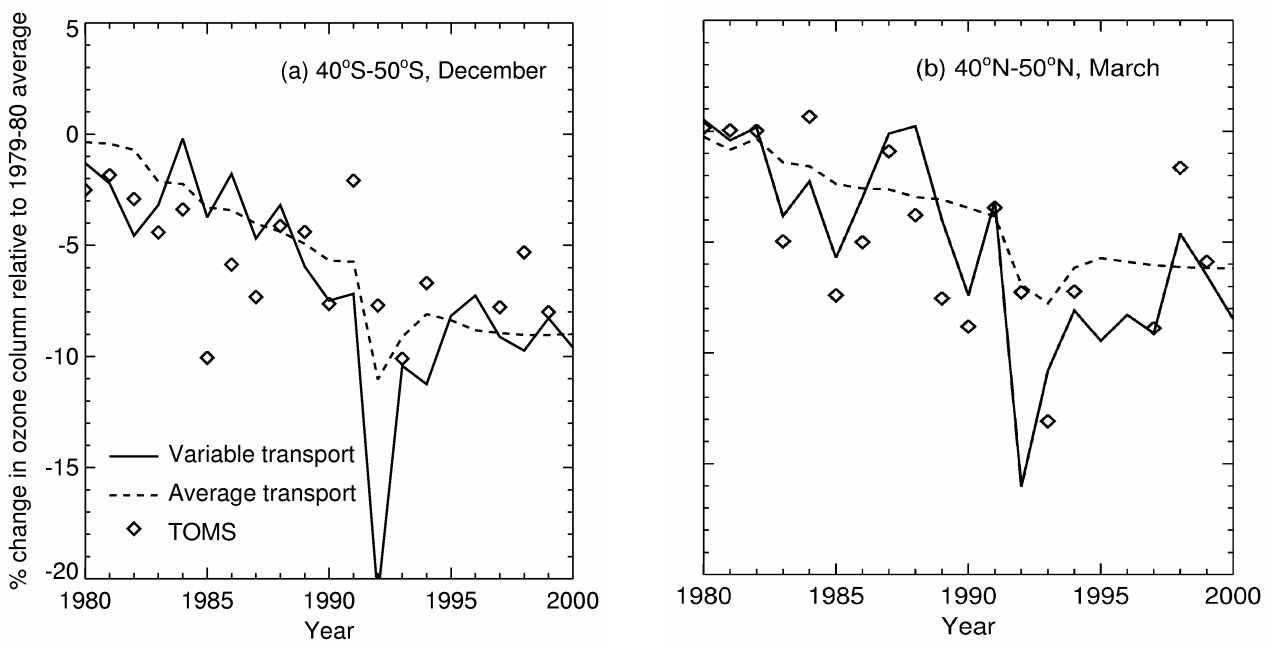



**Figure 1.** Calculated ozone trends for 1980-2000 in the 40°-50° latitude band in both hemispheres relative to 1979-80 values. TOMS measurements for the same period are also shown.

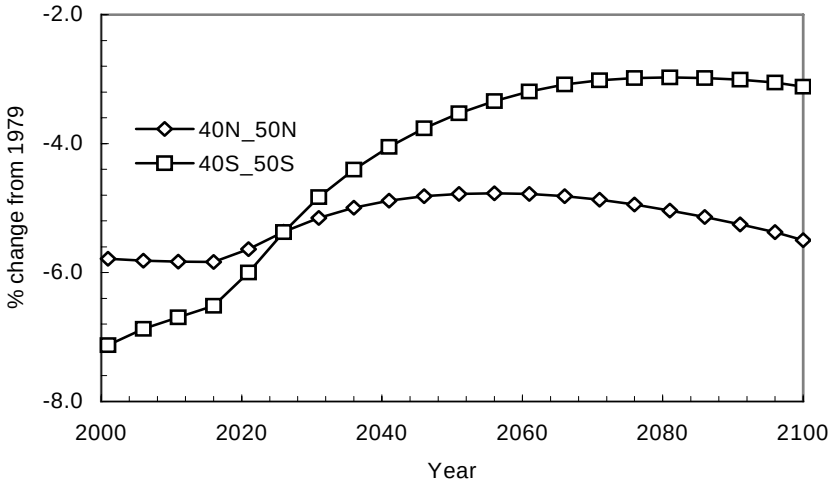



**Figure 2.** Calculated future changes in annual average total ozone relative to 1979 for the latitude bands 40°-50° in both hemispheres.

Fusco, A. C. and M. L. Salby, Interannual variations of total ozone and their relationship to variations of planetary wave activity, *J. Climate*, 12, 1619-1629, 1999.

Randeniya, L. K., P. F. Vohralik, I. C. Plumb and K. R. Ryan, Heterogeneous $BrONO_2$ hydrolysis: Effect on $NO_2$ columns and ozone at high latitudes in summer, *J. Geophys. Res.*, 102, 23543-23557, 1997.

Vohralik, P. F., L. K. Randeniya, I. C. Plumb and K. R. Ryan, Use of correlations between long-lived atmospheric species in assessment studies, *J. Geophys. Res.*, 103, 3611-3627, 1998.

WMO, Scientific Assessment of Ozone Depletion: 1998, *WMO Rep. 44*, Geneva, 1999.

# Measurements of $C_2$ and $C_3$ Hydrocarbons in Marine Air at Cape Grim (41°S, 145°E)

Loretta M. Kivlighon, Ian E. Galbally & Ian A. Weeks.

*CSIRO Atmospheric Research, Aspendale, Victoria 3195*

***Abstract***

Air samples collected between November 1998 and March 2000 at Cape Grim (north-west Tasmania) within a clean marine atmosphere have been analysed for $C_2$ and $C_3$ hydrocarbons. Surface air measurements revealed seasonal cycles for ethane, acetylene and propane all having minima around March and maxima around September. The alkenes, ethene and propene show no pronounced seasonal cycle. Cape Grim overflight data showed higher concentrations of ethane, acetylene and propane in the upper troposphere compared with surface air, and lower concentrations of ethene and propene in the upper troposphere compared with surface air.

An examination is made of all southern hemisphere data for these $C_2$ and $C_3$ hydrocarbons and the differences discussed in terms of spatial and temporal differences in sampling in relation to sources and sinks and possible differences in calibration and analytical procedures.

# Investigating the Emission and Transport of Trace Gases using the Air Pollution Model (TAPM)

Bronwyn Dunse[1,2,3], Paul Steele[2], Paul Fraser[2], Paul Krummel[2], Peter Hurley[2] & Stephen Wilson[1]

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[3]*Cape Grim Baseline Air Pollution Station, Smithton, Tasmania 7330*

***Abstract***

The emission and transport of trace gases from the Melbourne region to Cape Grim is being investigated using The Air Pollution Model (TAPM). TAPM uses the Bureau of Meteorology (BoM) Limited Area Prediction system (LAPS) analysis data to provide the synoptic conditions. Emissions inventory data in the form of spatially distributed source functions for species such as carbon monoxide have been obtained from the Victorian EPA. These emissions have been gridded and are released into the model to study the transport of trace gases from Melbourne to Cape Grim.

Observations of carbon monoxide at Cape Grim will be compared with simulated pollution episodes for a number of time periods. Observed meteorological data will also be compared with the simulated meteorological conditions to assess the performance of the model.

# Characterisation of Air Mass Origins using Radon Concentration in Air at Selected Enhanced ACE-Asia Stations

Wlodek Zahorowski, Scott Chambers & Ann Henderson-Sellers

*Australian Nuclear Science and Technology Organisation, Menai, NSW 2234*

***Abstract***

The International Global Atmospheric Chemistry Program has planned a series of Aerosol Characterisation Experiments (ACE) to reduce the uncertainty posed by tropospheric aerosols in model calculations of the climate forcing caused by anthropogenic changes in the composition of the atmosphere. ACE-Asia is the fourth in the series and will focus on rising aerosol concentrations in East Asia.

A part of ANSTO's contribution to ACE-Asia is the use radon-222 as a tracer for air mass characterisation at four enhanced ground stations within the study domain. Implementation of the project includes the development of a strong regional collaboration across station teams as well as increasing the capacity of climate research at two of the four selected stations. The overall rationale for the project as well as its schedule is in line with that of the ACE-Asia campaign. The project is also linked to other regional and global climate change related projects.

This poster summarises the status to date of the project.

# A new Malaysian Global GAW Station in the Danum Valley, Sabah

Leong Chow Peng & Irene Eu Swee Neo

*Malaysian Meteorological Service, Jalan Sultan, Petaling Jaya, Selangor, Malaysia*

***Abstract***

The Malaysian Meteorological Service will implement a nationally funded project to establish a global GAW station at Danum Valley, Sabah from the year 2001. The site lies amidst tropical rain forest at the fringe of a class 1 protection forest reserve covering an area of 438 sq km. It is about 65 km inland from the town of Lahad Datu in the state of Sabah on the northeast corner of Borneo Island. The station site has been identified near an existing observation tower on top of a small hill, about 1 km from the access road. Lodging, basic laboratory facilities, electricity and a team of trained local research assistants are available at the Danum Valley Field Centre, approximately 5 km from the station site. The site offers an excellent platform for atmospheric constituent measurements to support studies on long-range transport as well as fluxes from the natural rain forest. Within the scientific measurement programme, priority will be given to measurements of ozone, greenhouse gases, precipitation chemistry, aerosol properties, optical depth and radiation. These are measurements which are of significant national and regional interest and there is sufficient capability within the country to carry out the monitoring and data analysis. The Malaysian Meteorological Service intends to use data from this site to verify outputs of regional atmospheric transport models that will be installed at its headquarters and expected to be operational by next year. To sustain scientific interest among the local scientists, the department is encouraging capacity building activities to enable local scientists to acquire expertise in field measurements, data analysis and assessment. Several collaborative projects are being planned with scientists from leading research institutions in Japan, New Zealand, USA, UK, Sweden and Australia.

# Activities of Greenhouse Gases Monitoring in CGER/NIES

Masayuki Katsumoto, Hitoshi Mukai, Yasunori Tohjima, Fumio Sakamaki, Toshinobu Machida, Yasumi Fujinuma, Yukihiro Nojiri & Gen Inoue

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***Abstract***

CGER/NIES has been conducting several Greenhouse Gases (GHGs) monitoring:

1. Long-term baseline trends of GHGs by ground based stations located at remote sites, Hateruma(1993-) and Cape Ochi-ishi(1995-)
2. Vertical profile and trend of GHGs over Siberia by chartered airplane(1992-)
3. Latitudinal change of GHGs and trend along north-south transect between Japan-Australia (1992-) by a ship-of-opportunity.
4. Atmosphere-ocean carbon dioxide exchange over the North Pacific (Japan-Canada) by a ship-of-opportunity (1995-).

$CO_2$, $CH_4$, $N_2O$, NOx, SOx, $O_3$, Rn, and SPM are continuously monitored at the two stations. CFC, CO, $H_2$, and black carbon are also measured at Hateruma. Some parts of monitoring data are available from CGER Web site (http//:www-cger.nies.go.jp/) and WDCGG.

Many GHGs at the monitoring stations showed rapid increases of their concentrations in 1998 after El Nino event. Especially, for $CO_2$ growth rate it exceeded 3.5ppm/y at that time, followed by the rather low growth rate (about 1ppm/y) in 1999-2000. Because of a small size of the island, $CO_2$ data in Hateruma station seemed to offer a background concentration in that region without much influence of the local sources. The absolute concentrations of $CO_2$ in Hateruma were 0-3ppm higher than the data in Minamitorishima Island and Hawaii, which are located in similar latitude, showing the existence of longitudinal distribution in $CO_2$ concentration.

In Siberia, similar increases but different characteristics of their trends in altitude were observed. Monitoring of vertical distributions of GHGs was considered to play an important role to figure out the source of GHGs.

Some other observations have also been carried out personally by using these monitoring platforms. Flask samplings are well done at the stations, on the ships and the airplane to measure several gaseous components, C and O isotope ratios and O2/N2 ratio. $^{13}C$ measurements of $CO_2$ are showing decreasing tendency associated with rapid increase of $CO_2$ concentration, suggesting the light CO2 was produced by the land biosphere.

The outline of monitoring and recent results will be introduced.

# Variability in Present Stratospheric Background Aerosol over Mauna Loa Observatory

John E. Barnes[1] & David J. Hofmann

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*[1]Also at Mauna Loa Observatory, P.O.Box 275, Hilo, HI 96721*

***Abstract***

The stratospheric aerosol layer has been at low background levels for the past five years above Mauna Loa Observatory (MLO), Hawaii. Aerosol backscatter has been measured at MLO since 1974 with a Ruby lidar (694 nm) and since 1994 with a significantly more accurate Nd:YAG lidar at 532 nm. The 532 nm backscatter averaged 1.13E-4 per sr for the past four years and shows a distinct annual variation in the tropical stratospheric aerosol reservoir not seen previously with the Ruby lidar. The maximum (1.51 E-4 per sr) occurs in winter and the minimum (0.92E-4 per sr) in summer. The five annual cycles have included three easterly phases and two westerly phases of the quasibiennial oscillation (QBO). Distinct differences is altitude profiles are seen for QBO phases. Summer averages (when most of the stratospheric aerosol layer is in the same phase) show the stratosphere below 23 km is unaffected but above the aerosol is depleted during the westerly phase. The upper tropospheric aerosol is enhanced at this time. During QBO transition periods the layer is effected at all levels above the tropopause and the specific timing of the transition can be see in the aerosol loading. There is also a natural variation of about +/- 25% on a week to week time scale which may be related to different source regions because the particle size appears to be different indicating larger size in the low backscatter regime. Assumption of a tropical particle source at background suggests that the two regimes are tropical and mid-latitude.

# Progress Report on Establishing a Regional Surface Ocean-Lower Atmosphere Study (ANZ-SOLAS)

Neil W. Tindale

*Cape Grim Baseline Air Pollution Station, Smithton, Tasmania 7330*
*Bureau Of Meteorology, Melbourne, Victoria 3001*

***Abstract***

Following is a progress report on a workshop meeting held at CSIRO-AR in Aspendale on November 8 and 9, to establish a regional, Australian-New Zealand, Surface Ocean-Lower Atmosphere Study (ANZ-SOLAS). Over 20 marine and atmospheric scientists from Australia, New Zealand and the U.S.A. attended the meeting.

SOLAS has been proposed to IGBP and SCOR as an international study of marine biogeochemistry and its interaction with the atmosphere. The objective of SOLAS is to achieve a quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and of how this coupled system affects, and is affected, by climate and environmental change. Further details of the international SOLAS program are at: http://www.ifm.uni-kiel.de/ch/solas/main.html

The Australasian region, including the Southern Ocean, has the potential to be an extremely important area relative to marine biogeochemistry, productivity, and climate change feedbacks. It is also a comparatively poorly studied region.

The objectives of the ANZ-SOLAS workshop/meeting were:

- to formulate the scientific basis and plans for a regional, Australian-New Zealand study of the complex interactions between marine biogeochemistry, atmospheric science and climate.
- to encourage and facilitate coordination and enhancement of opportunities for interdisciplinary scientific collaborative research in this region.

ANZ-SOLAS workshop participants were welcomed by Dr Graeme Pearman, the Chief of CSIRO-AR. Prof. Bob Duce, one of the organisers of the international SOLAS effort, opened the meeting with an overview of SOLAS progress overseas. Highlights included that SOLAS has been accepted and endorsed by SCOR as an international study and that several national SOLAS programs were already being established. Overview presentations on Australasian regional research on biogeochemistry, physical oceanography, atmospheric chemistry, coastal/bays/estuaries and regional modelling followed, before the meeting began discussing specific issues. Discussion topics at the Aspendale meeting included the scope of regional Australasian SOLAS-related study and the key regional issues and/or study areas. Six study areas were identified for intensive observations. These were:

1. Great Barrier Reef.
2. Seasonal Sea Ice Zone
3. Open Southern Ocean
4. Tropical/Temperate Ocean
5. Dust production and impact on ANZ waters
6. Coastal Oceans

Based on the discussions and material presented at the workshop, an ANZ-SOLAS Science and Implementation Plan is being prepared. A draft of the S&I Plan will be circulated to the community before the end of this year.

The next ANZ-SOLAS meeting is being planned for Townsville in Queensland in July 2001, to be held in conjunction with the joint 2001 Meeting of the Australian Marine Sciences Association and the New Zealand Marine Sciences Society in Townsville (3rd-6th July 2001, Jupiters Convention Centre, Townsville, Tropical North Queensland. (http://www.uq.edu.au/amsa/)).

# Assessing Continuous Shipboard Concentration Observations for Estimating Australian $CO_2$ Sources

Rachel Law & Peter Rayner

*CSIRO Atmospheric Research, Aspendale, Victoria 3195*

***Abstract***

Inverse methods are increasingly being used to estimate sources of greenhouse gases from atmospheric measurements using a model of atmospheric transport.

Most of our inversions, particularly as we move to smaller scales are limited by the relatively sparse data network. We have begun to test the potential use of high frequency data for estimating Australian region $CO_2$ sources using a synthesis inversion method.

In particular, we consider data which could be obtained from a shipboard instrument circumnavigating the Australian continent. As a preliminary test we create pseudo observations using known, fossil emissions of $CO_2$ and assess our ability to retrieve these emissions by inverting the pseudo observations. A good inversion requires both low uncertainty and an accurate retrieval of known sources, and we will discuss both aspects here.

# Isotopes of Atmospheric Water Vapour and Methane by GC-IRMS

Dominic Ferretti

*Stable Isotope Lab, Institute of Arctic and Alpine Research, Univ. of Colorado, Boulder, Colorado 80303, USA*

***Abstract***

Recently INSTAAR have moved their isotope facilities to a new laboratory and a new Micromass IsoPrime IRMS has been commissioned for atmospheric $\delta^{13}CH_4$ measurements, replacing the older Micromass Optima IRMS. These and other recent changes to the INSTAAR $CH_4$ GC-IRMS analysis system and sampling program will be summarised.

Work is also underway to measure the deuterium:hydrogen ratio ($\delta D$) in methane and both $\delta D$ and $\delta^{18}O$ in atmospheric water vapour. These developmental GC-IRMS techniques will also be briefly discussed.

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*Brian Weymouth & Randall Wheaton*

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# Measurement of Methyl Bromide and other Trace Gas Saturations in Surface Seawater off Cape Grim

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***Abstract***

Atmospheric methyl bromide ($CH_3Br$) which is of both natural and anthropogenic origin, has been identified as a Class I ozone-depleting substance in the amended and adjusted Montreal Protocol on Substances that Deplete Stratospheric Ozone. Current understanding of the $CH_3Br$ budget is incomplete and points to an unidentified source or the need for a re-evaluation of sinks. In particular, the role of the oceans in regulating the atmospheric burden of this gas is unclear. The number of studies in this field have increased recently - however, they are generally spatially and seasonally dispersed. The only routine investigation of seasonal variations in $CH_3Br$ in coastal waters is that of Baker *et al.*, 1999, who reported supersaturation during the summer and undersaturation during the remainder of the year in the North Sea, England.

We report on the preliminary findings from an analogous study on the coastal waters near Cape Grim, which are being made to establish whether there is a seasonal cycle in the extent of supersaturation of a number of trace gases. Presented here are the data for $CH_3Br$, methyl iodide ($CH_3I$) and methyl nitrate ($CH_3ONO_2$) which are made concurrently. This study was initiated after work carried out during the Southern Oceans Atmospheric Photochemistry Experiment (SOAPEX2) held at Cape Grim in January/February 1999.

Baker, J.M., C.E.Reeves, P.D.Nightingale, S.A.Penkett, S.W.Gibb and A.D.Hatton, Biological Production of Methyl Bromide in the Coastal Waters of the North Sea and Open Ocean of the Northeast Atlantic, *Mar. Chem., 64, 267-285,* 1999.

# Cape Grim Internal Website: Data Accessibility

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***Abstract***

We are working to make available via our internal web site all data collected at Cape Grim. Although internal, this web site is accessible to Lead Scientists and/or their staff.

In general, data stored at the Cape will be downloadable from the site using a self-serve facility. For large quantities of data a request may be placed for staff to extract the data

and forward on CD, for example. Where useful, a facility will be available to create simple plots of the data. A feature will be added to store routine data requests or plots to save time when next they are needed. An important use of the plotting facility is for staff to monitor program data acquisition, and to this end we can provide customised plots and data displays, available with one click of the mouse. Examples of this work will be on display.

# Evidence of Long-Range Transport of Aerosols in the Southern Hemisphere from Measurements of Lead Isotopes

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***Abstract***

The concentration and isotopic composition of lead has been determined in aerosols in boundary layer air from the Southern Ocean, in order to characterize the ambient background in the southern hemisphere. Ultraclean sampling devices and procedures were developed for this purpose and have revealed Pb concentrations to ~1pg/$m^3$, which is comparable with the lowest measured in Antarctica. The isotopic ratios differ significantly from those found in aerosols in urban environments of the most southerly regions of South America, Africa and Australia, but show closer agreement with more northerly regions of South America and Africa. A large proportion of the samples contain small but significant amounts of highly radiogenic Pb which may arise from uranium mining in Africa or Australia.

# UV Spectroradiometer & Ozone Measurements at Mauna Loa, Hawaii & Boulder, Colorado

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Richard L. McKenzie & Paul V. Johnson

*National Institute of Water & Atmospheric Research, Lauder, New Zealand*

***Abstract***

# Optical Depth Measurements at CMDL Monitoring Stations

Barry A. Bohdaine, Robert S. Stone, Gloria L. Koenig, James W. Wendell & Ellsworth G. Dutton

*NOAA-CMDL, Boulder, Colorado, USA*

***Abstract***

# In situ Aerosol Profiling over the DOE/ARM Southern Great Plains Cloud & Radiation Testbed Site

Patrick Sheridan, David Delene*, Elisabeth Andrews* & John Ogren

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***Abstract***

# The Oceanic Uptake of Atmospheric Trace Gases

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***Abstract***

# Halocarbon & Nitrous Oxide Trends in the Troposphere

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***Abstract***

# Oceanic Measurements of Halocarbons in Support of Flux Calculations & Model Verification

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***Abstract***

# Trends of Trace Gases, Total Chlorine & Total Bromine in the Lower Stratosphere from 1991 through 2000

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***Abstract***

## *Presentations – Day 2*

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# Current Status and Future Requirements of Observations of the Global Carbon Cycle, Illustrated with a Study of Interannual Variability in the 20-year Cape Grim $CO_2$ and $\delta^{13}c$ Records

*(forming part of the review of the Cape Grim carbon dioxide program)*

Roger J. Francey

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***Abstract***

Monitoring $CO_2$ isotopes at Cape Grim commenced in 1976 (Goodman, 1980), using $CO_2$ extracted from the air and returned to Aspendale for mass spectrometer analysis. The objective was to distinguish between terrestrial (including biosphere exchanges, deforestation and fossil fuel emissions) and oceanic (physical and biological) exchanges of $CO_2$ with the atmosphere. There are a number of major experimental milestones:

- ***1982***: Upgrade of the Cape Grim *in situ* glass extraction line (with marked improvement in the quality of $\delta^{13}C$ measurements).
- ***1984***: Introduction of parallel 5 litre flask collections from a global network, for $CO_2$ extraction (using a duplicate glass extraction line) and analysis at Aspendale.
- ***1989-92***: Change from a VG602D mass spectrometer plus glass extraction system at Aspendale, to a MAT252 with commercial automated miniaturised metal $CO_2$ extraction system.
  Introduction of 0.5L flask sampling and improved multi-species analyses (in GASLAB) from an expanded global network.
- ***1992***: Introduction of air reference cylinders so that isotopic values in flask air samples are referenced to bracketing extractions and analysis of an air reference rather than the pure-$CO_2$ reference used for Cape Grim 'in situ' samples.
- ***1994***: Significant modification to the MAT252 cryogenic extraction line to permit ice core analyses
- ***1997***: Significant modification to the MAT252 mass spectrometer by supplier to overcome long-standing sample-reference cross contamination effect.
- ***2000***: Start construction of an automated in situ extraction line for Cape Grim to permit air reference for the *in situ* program.

Three major challenges have emerged for the Cape Grim $\delta^{13}C$ record:

1. Major discrepancies are evident between the two-decade Cape Grim time series and the only comparable series from the pioneering Scripps Institution of Oceanography (SIO) program [Keeling *et al*., 1995; Francey *et al*., 1995; Rayner *et al*., 1999].
2. The recognition that atmospheric $\delta^{13}C$ changes can include $^{13}CO_2$ re-equilibration changes (isoflux) not directly linked to net $^{12}CO_2$ changes [Tans *et al*., 1990; Enting *et al*., 1995], complicating interpretation, and
3. Major conflicts have recently arisen between oceanic and $\delta^{13}C$-based estimates of air-sea flux interannual variability [e.g. Le Quéré *et al*., 2000].

The Cape Grim $\delta^{13}C$ record is able to elucidate these three issues. **Point 1** is unquestionably linked to systematic error in one or both of the measurement laboratories. Allison (this meeting) describes the identification and correction for systematic error in the Cape Grim $\delta^{13}C$ records, including a "cross-contamination" likely to have substantially affected SIO records in the 1980s. Steele (this meeting) describes international strategies arising from the Cape Grim programs (also depending on issues

presented by Spencer and Krummel), aimed to eliminate such inter-laboratory calibration errors (in most greenhouse gas measurements) in the future.

A large steadily increasing isoflux is due to fossil fuel (**Point 2**). Two CSIRO studies [Langenfelds *et al*., 2000; Trudinger, 2000] limit the uncertainty in partitioning fossil atmospheric carbon between terrestrial and ocean reservoirs using $\delta^{13}C$ to around ($\pm 1$ PgC $yr^{-1}$).

On inter-annual timescales the isoflux accompanying terrestrial exchange is also important, and has been incorrectly accounted for in past papers. Use of the corrected Cape Grim $\delta^{13}C$ record over two decades, coupled with adjusted isoflux and more careful co-selection of $CO_2$ and $\delta^{13}C$ records, largely reconciles the conflict with ocean estimates of $CO_2$ interannual variability (**Point 3**). The agreement suggests that other potential sources of global isoflux on inter-annual timescales are small, though larger regional effects are not excluded.

Our recommendations for carbon isotope measurements in the future are as part of a multi-species approach to the identification of causes of atmospheric composition changes [Langenfelds, this meeting].

***Addendum**: The Cape Grim $\delta^{18}O$ in $CO_2$ record, accumulated initially for diagnostic purposes, and reconstructed from 1976, is unchallenged for consistency and precision over the whole period. It clearly carries biogeochemical information, most likely linked to the hydrological cycle via gross $CO_2$ exchange with the terrestrial biosphere, including soil $CO_2$ [Ciais et al. 1997a,b].*


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# Addressing the Carbon Cycle Measurement Challenge: Initiatives in Measurement Technology and Global Intercalibration

*(forming part of the review of the Cape Grim carbon dioxide program)*

L. Paul Steele

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***Abstract***

Continuous monitoring of $CO_2$ began at Cape Grim in 1976, and has continued largely uninterrupted since then. The measurement program was initiated by Graeme Pearman, who then carried the role of the program lead scientist for almost 20 years. The experimental methods and their evolution over that time have been well described in Beardsmore *et al.* [2000], and references therein.

The measurement of the long-term trend of atmospheric $CO_2$ was at the beginning of this program, and remains today, an important scientific and social requirement. But the key rationale for such measurement programs has been, and is, to help elucidate how and why the global carbon cycle is changing. This latter requirement places quite stringent demands on the quality of the data, both at Cape Grim and elsewhere, since information about the carbon cycle is often expressed in the atmosphere as relatively small $CO_2$ concentration gradients. This is particularly the case in the Southern Hemisphere. Meeting the stringent requirements has proved a daunting challenge for many years, both in the measurement methodology, and in the propagation of calibration.

The development of the LO-FLO $CO_2$ analyser has provided a powerful tool with which we have begun to systematically investigate our methods of both measurement and calibration. Some preliminary results will be described, (and expanded on by Darren Spencer in a later presentation).

Even though the LO-FLO analyser is providing new insights into the problems of making extremely precise measurements of $CO_2$, the job is not finished. The remainder of this presentation will describe progress to date, and some possibilities for the future. In particular, the following topics will be addressed:

- The Mark II version of the LO-FLO $CO_2$ analyser is being built in C-AR, offering potential advantages over the prototype, and giving a chance to prove the scientific value of measuring small atmospheric $CO_2$ gradients with very high precision.
- The GLOBALHUBS plan (for $CO_2$ and other greenhouse gas species) was conceived by Roger Francey as a way to improve the calibration linkages between the many laboratories worldwide making atmospheric $CO_2$ measurements. The current status of the plan will be outlined.
- Emerging technologies have the potential to significantly improve on current methods of measuring $CO_2$, and some promising examples will be described.

Beardsmore, D. J., G. I. Pearman, L. P. Steele, and F. de Silva, The CSIRO (Australia) Atmospheric Carbon Dioxide Monitoring Program by Infra-red Gas Analysis: Post 1981 Developments and Data, CSIRO-AR Technical Paper (submitted), 2000.

# The Prototype (MARK I) LOFLO $CO_2$ Analyser Performance and its Comparison with the Existing BASGAM System

*(forming part of the review of the Cape Grim carbon dioxide program)*

Darren A. Spencer[1], Grant Da Costa[1], L. Paul Steele[1], Paul B. Krummel[1] & Stuart B. Baly[2]

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***Abstract***

The prototype LO-FLO in-situ $CO_2$ analyser has been operating at Cape Grim since installation during May 2000. It was connected to the 70m intake shared with the existing BASGAM in-situ $CO_2$ analyser, allowing direct comparison of atmospheric $CO_2$ concentrations between the instruments to be made. Automated data retrievals have been implemented, allowing fully processed data to be available the day following the day of measurement. Remote control software also allows operation and monitoring of the instrument from Aspendale.

An analysis of the performance of LO-FLO over it's first 6 months of operation will be made, and include:

- Operation and calibration procedures
- Calibration precision
- Instrument response stability
- Reference tank $CO_2$ drift

The 'overlap experiment' between BASGAM and the LO-FLO analyser has provided important insights into several factors which influence the precise measurement of $CO_2$. Current results from the overlap experiment will be presented and discussed.

# Development of a Consistent Calibration Scale for $CO_2$ Stable Isotope Measurements

*(forming part of the review of the Cape Grim carbon dioxide program)*

Colin E. Allison

*CSIRO Atmospheric Research, Aspendale, Victoria 3195*

***Abstract***

Since monitoring of the stable isotopic composition of atmospheric $CO_2$ at Cape Grim commenced in 1976, a number of different sample collection and preparation methods have been used to extract $CO_2$ from air, and two mass spectrometers have been used for the analysis of the $CO_2$. The task of collating the resultant data into a single record relies on developing a consistent calibration scale that

- Is based upon an accepted international standard and is traceable to a fundamental constant,
- Accounts for modifications to the sample collection and analysis procedures, and
- Compensates for variations in the performance of the mass spectrometers.

Consideration of these factors is important to ensure that measurements can be compared with similar measurements from other laboratories, and will maintain their value over time.

This talk will outline the development of the calibration scale used at CSIRO. Systematic errors that have been identified, and corrected, will be discussed in terms of their significance to the calibration scale. They include:

- The change from the VG602D mass spectrometer plus manual glass extraction system to the MAT252 mass spectrometer with an automated miniaturised metal extraction system.
- The adoption of consistent ion correction procedures.
- The introduction and use of "air standards".
- The modification of the MAT252 sample preparation system to permit ice core analyses.
- The modification of the MAT252 ion source to overcome the "cross contamination" effect.

The final result of this process, a consistent record of the $\delta^{13}C$ of atmospheric $CO_2$ at Cape Grim from 1982 to the present, will be presented.

# A Multiple Trace Gas Diagnoses of Interannual Variability in the Global Carbon Cycle, 1992-2000

*(forming part of the review of the Cape Grim carbon dioxide program)*

Ray L. Langenfelds[1], Roger J. Francey[1], L. Paul Steele[1], Colin E. Allison[1], Bernard Pak[2] & Jon Lloyd[3]

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***Abstract***

Monitoring of background atmospheric $CO_2$ concentration in recent decades has revealed interannual growth rate variations (IAV) that are linked to the El Nino Southern Oscillation (ENSO). However, the nature of this link is not well understood. Different approaches investigating the relative contributions of oceanic and terrestrial carbon fluxes have drawn conflicting conclusions. Studies using $\delta^{13}C$ in atmospheric $CO_2$ have generally called for large, and in some cases opposing, contributions from both oceanic and terrestrial exchange. Recent ocean-based studies suggest that variability in air-sea fluxes is too small to account for the atmospheric signal. Some climate-driven terrestrial ecosystem models are able to accommodate the $CO_2$ IAV through an ENSO effect on imbalance of photosynthesis/respiration in tropical forests.

Air samples obtained from CSIRO GASLAB's global flask sampling network are routinely analysed for multiple trace gases and isotopes. High precision measurements of $CO_2$ and its isotope $\delta^{13}C$, $CH_4$, $H_2$ and CO since 1992 show strong inter-species correlation in IAV, thus providing a new window on understanding the nature of the forcing. We explore the implications of this correlation, in terms of common sources and sinks and possible covariations forced by ENSO-related climatic variability. The multi-species signature points to one mechanism as a likely major influence, and is supported by several independent lines of evidence gathered from ground, aircraft and satellite-based observations.

# Reconstructing Atmospheric Records from Firn and Ice Core Measurements

Cathy Trudinger[1], David Etheridge[1], Georgina Sturrock[1*], Peter Rayner[1], Paul Fraser[1], Ian Enting[1], Paul Steele[1], David Lowe[3] & Andrew Smith[4]

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***Abstract***

Air extracted from polar firn and ice can provide valuable information on the atmospheric history of a number of trace gases prior to direct atmospheric monitoring. Dating of the firn and ice core measurements and their interpretation as past atmospheric levels requires consideration of the processes that occur in the firn (primarily diffusion in the firn and the trapping of air into bubbles at the firn-ice transition). These processes cause smoothing of atmospheric records, and therefore some loss of information. The fractionation that occurs can be significant for isotopic ratios. A numerical model of the firn processes has been used in a number of ways to reconstruct atmospheric records. It is useful for people who use these records to have some understanding of how this is done, and what can and cannot be reconstructed. In particular, the measurements of halocarbons and the isotopes of methane from firn air at the DSSW20K site on Law Dome will be discussed.

# Characterisation of Postfrontal Flow Using Ultrafine Particles and Trace Gases Measured during SOAPEX-2

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Keywords: Ultrafine Particles, Trace Gases, MBL, Free Troposphere, Frontal Passage

***Abstract***

Airborne and ship measurements made during ACE-1 support the idea that the free troposphere is one potential source region for the formation of new particles in the remote marine atmosphere [Clarke *et al*., 1998; Bates *et al*., 1998]. In these studies, a rapid increase in ultrafine (3-12 nm) particle concentration was taken as being indicative of recent particle formation through homogeneous gas phase nucleation.

For the ship measurements, enhancement in ultrafine particle concentration was observed a few hours after frontal passage. Since no evidence of new particle formation was found directly in the Marine Boundary Layer (MBL) during more quiescent conditions, the unusually high concentration of nanoparticles that coincided with the frontal passage may be associated with exchange between the MBL and the overlying Free Troposphere (FT). Several studies, for example Bigg *et al*. [1984], Raes [1995], and Russell *et al*., [1998] have discussed the possible role of FT aerosols in maintaining the aerosol number concentration in the MBL.

In this paper we examine the influences of postfrontal subsidence by presenting aerosol and meteorological data obtained during the SOAPEX-2 field campaign, which was conducted in January-February 1999 at Cape Grim, Tasmania. The focus will be on ultrafine aerosol particles, those particles most intimately linked to new photochemical particle production. Understanding the origin and evolution of fine particles is an essential step towards development of the ability to accurately predict the future influence of aerosols on the earth's climate. In addition to aerosol data, the concentration of trace gases including CO, $CH_4$, $O_3$, NOx and $CO_2$ , will be used to help characterise post-frontal subsidence. This flow is believed to transport aerosol and other free tropospheric materials into the MBL. These composition data will be supported by daily back trajectories to Cape Grim, MSL weather charts and surface wind data. An objective of this study is to identify possible source regions for air masses arriving at Cape Grim with enhanced ultrafine particle concentrations.

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# DMS, Marine Aerosol, and Climate: What Can We Learn from MSA?

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***Abstract***

Fifteen years of the aerosol composition record from Cape Grim has been analysed to investigate the relationship between methanesulfonate (MSA) and meteorological parameters including pressure, temperature, wind speed, wind direction, sunshine hours, as well as condensation nuclei (CN).

MSA, temperature and CN all display distinct seasonal cycles. When these seasonal cycles are removed from the data records, the residual temperature and residual MSA data display significant positive correlation. The exact nature of this correlation is still under investigation. A number of possible explanations will be discussed.

# CFC, HCFC and HFC Refrigerants: Port Phillip Regional Emissions Derived from AGAGE GC-MS Data

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***Abstract***

Chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC), hydrofluorocarbon (HFC) and dichloromethane ($CH_2Cl_2$) data, collected at Cape Grim on the AGAGE GC-MS instrument during pollution episodes identified by trajectory techniques, have been used to estimate emissions of CFC-12 ($CCl_2F_2$), HCFC-22 ($CHClF_2$), HFCs-125 ($CHF_2CF_3$), -134a ($CH_2FCF_3$) and -152a ($CHF_2CH_3$) from the Melbourne/Port Phillip region, using inter-species correlation techniques.

CFCs, HCFCs and HFCs were/are used largely in the refrigeration and air-conditioning industries in Australia. Their approximate annual emissions derived for the 1998/1999 are: 90 tonnes (CFC-12), 200 tonnes (HCFC-22), 100 tonnes (HFC-134a), 25 tonnes (HFC-125) and 3 tonnes (HFC-152a). Emissions of CFC-12 into the Melbourne atmosphere have declined by a factor of 5 over the period 1982-1999 in response to restrictions in CFC-12 consumption imposed by Australia's adherence to the Montreal Protocol.

CFC-12 emissions have been estimated by correlation with both CO and $CH_2Cl_2$, whose emissions of have been estimated independently by EPA Victoria using survey techniques. The agreement obtained for CFC-12 emission estimates, obtained from correlations with both species, attests to the accuracy of the EPA estimate of the ratio of CO to $CH_2Cl_2$ emissions, emissions that are different by more than 3 orders of magnitude.

The Melbourne HFC emission data are scaled to produce the first estimate of Australian HFC emissions. This is the only Kyoto species whose emissions have not yet been included in the National Greenhouse Gas Inventory.

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# Global Scale Soil Moisture Estimation from Radon Concentrations

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***Abstract***

The goal of the project is to determine the feasibility of using radon concentration measurements at a relatively small number of locations around the world to monitor long term trends in soil moisture.

The inspiration was the observation in the early 1990's of strong interannual variations in radon concentrations at Cape Grim. It seemed unlikely that transport alone could explain the variation, leaving source strength as the most likely cause. Soil moisture is the major factor in long term radon flux change. Thus the radon variations at Cape Grim might be a consequence of soil moisture changes.

In 1998 ANSTO initiated a project to investigate the possibility of using radon observations to estimate large scale soil moisture changes. The concept was to measure radon at strategic locations around the world, and use a model to derive the radon flux over the various paths over which air passed on the way to the station. Radon fluxes would then be converted to soil moisture using empirical relationships. The major components of the project were firstly to find out if radon fluxes could be simulated and secondly whether the fluxes are related to soil moisture in a way which is useful for climate modelling.

Tasks proposed for the first component of the study are:

1a. conduct a pilot study in an island small enough to enable the radon flux to be measured reasonably accurately, but large enough that the model used could be scaled up to global scale.
1b. Evaluate the transport coefficients from each model grid point to Cape Grim at times when the fluxes were well known.
1c. When the model simulates radon concentrations at Cape Grim reasonably accurately, reverse the process and use inverse modelling to obtain flux estimates.

Tasks for the second component are:

2a. Conduct a study over a long period in the pilot study region. This will involve combining climate records with simulated fluxes to do a credibility check on the link between flux and soil moisture.
2b. Conduct studies of global modelling with artificial radon fluxes generated from hypothetical soil moistures, to see if the fluxes are likely to be useful if we do succeed in estimating them.
2c. Simulate radon fluxes from mainland Australia and again assess the credibility of deriving soil moisture from radon flux. There are other radon detectors, for example Cape Point in South Africa, Mauna Loa Observatory and Perth, WA, whose records will be valuable at this stage.
2d. Given success in the previous stages, an assessment should be made of how many radon detectors would be necessary to cover the world. Radon detectors cost about as much as anemometers, and are no more trouble to maintain, so it is not unreasonable to envisage global coverage.

The presentation will cover work on parts 1a and 1b, simulation of radon concentrations based on measured radon fluxes. Tasmania was chosen for the pilot study because there are frequent trajectories where the air is radon-free crossing into the island, and with many possible paths over land to Cape Grim. Also, the fluxes are fairly well known because ANSTO has measured radon fluxes at several times and about 100 locations in Tasmania.

Data are shown from a run with DARLAM using a 70 km grid. This proved too coarse to yield good agreement between the simulated and measured radon concentrations. Simulations by the CC model with a 20 km grid size show more promise, and will form the basis for an attempt at inverse modelling in 2001.

# Ozone Profiles in the Troposphere over South-Eastern Australia during August and September 2000

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***Abstract***

Ozone profiles measured using an airborne ultraviolet ozone monitor and balloon-borne electrochemical ozone sondes are presented and compared. The airborne measurements were made on Melbourne to Cape Grim overflights while the ozone sondes were released from Laverton near Melbourne during similar, and on occasions, coincident periods. These measurements were made during the time of the SAFARI II campaign during the seasonal maximum in biomass burning in southern Africa. Biomass burning is known to contribute to significantly elevated ozone concentrations in the mid-latitudes of the Southern Hemisphere. Trace gases from southern African fires have been detected previously on Cape Grim overflights, and with the commissioning of the airborne ozone monitor, it is now possible to explore whether these plumes are also associated with increased ozone production.

# The Global Cycle of Methanol

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***Abstract***

A mechanism is proposed for the production and emission to the atmosphere of methanol by vegetation, based on the demethylation of pectin during plant cell growth. This mechanism is verified by comparison with observed methanol emission rates from plants. A model of the global cycle of methanol is presented involving the terrestrial biosphere, atmosphere and oceans. Plant growth and decay produce about 93% of the global release of methanol, and hydroxyl attack causes about 66% of the global removal. The ocean surface layer holds more than 30 times more methanol than the atmosphere, thereby providing a physically based smoothing mechanism for the atmospheric methanol concentration with a one year time constant. The model demonstrates a new concept in global biogeochemistry, the coupling of this plant metabolic process with the global atmospheric concentration of methanol. Predictions concerning methanol in oceans and ice cores are made from the model.

A potential program for studying atmospheric methanol at Cape Grim will be discussed.