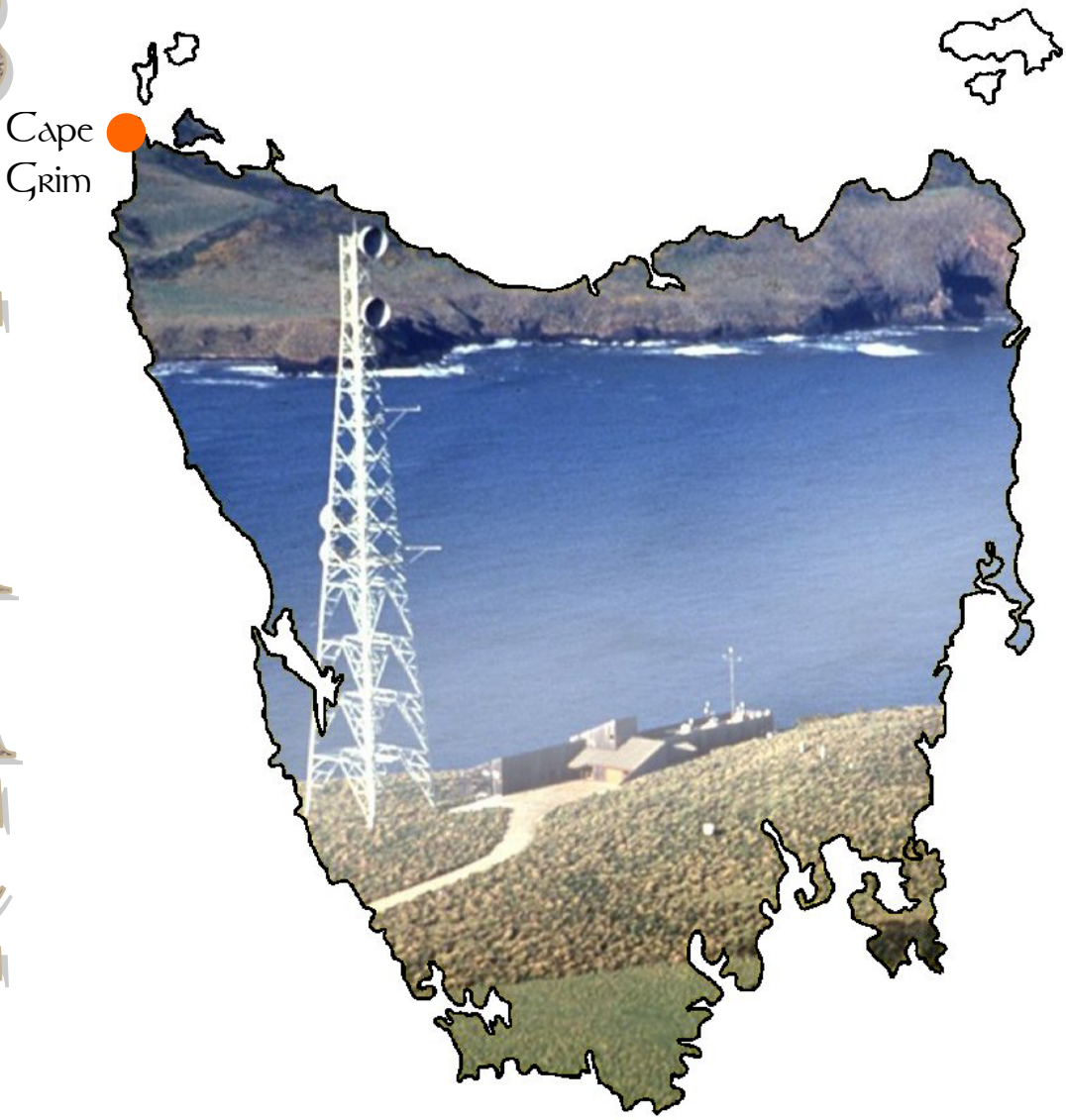
Cape Grim Baseline Air Pollution Station
Annual Science Meeting

ABSTRACTS



Edited by
Neil Tindale & Nada Derek

CSIRO Atmospheric Research, Aspendale, Victoria
7-8 November 2002

CAPE GRIM BASELINE AIR POLLUTION STATION

ANNUAL SCIENCE MEETING, 2002

Thursday, 7 November		
Chair	***Neil Tindale***	
09:00	Convenors / Hosts	General information on arrangements etc.
09:10	Greg Ayers	Welcome to CSIRO-AR
09:15	Paul Krummel	Cape Grim Wind Statistics and their use in Indicators of Baseline Conditions
09:40	Glenn Bryant	Ground-based Near Infrared Solar Spectroscopy for Greenhouse Gas Measurement
10:05	Kim Henville	Estimation of the Emissions of CO from Motor Vehicles in Melbourne
10:30	**Morning Tea**	
11:00	Roger Francey	CO_2 Measurement in the Australian Region – the Next Decade
11:25	Colin Allison	The Cape Grim Stable Isotopes in Atmospheric CO_2 Measurement Program
11:50	Rachel Law	Estimating CO_2 Sources from Continuous Measurements: Australia as a Test Case
12:15	Jill Cainey	Biology and Climate – Not Just a Sulfur Story
12:40	**Lunch**	
Chair	***Stephen Wilson***	
13:40	Andrew Smith	Accelerator Mass Spectrometry: An Overview of the Technique and of Small-mass ^{14}C Antarctic projects at ANTARES
14:05	Quan Hua	Atmospheric Radiocarbon Offset for the Tropics During the Little Ice Age
14:30	Roger Dargaville	LMDz – A New Atmospheric Transport Model with 'Zoom' Capability
14:55	Wlodek Zahorowski	Estimating the Regional Oceanic Radon Flux
15:20	**Afternoon Tea**	
15:50	Paul Fraser	Halon-1211 Emissions from Melbourne
16:15	Bronwyn Dunse	CFC Measurements at Cape Grim, 1978-2002
16:40	Stuart Baly	*In situ* SF_6 Measurements at Cape Grim
17:05	**Close of Papers**	
17:30	**Poster Wine and Cheese Evening**	**CSIRO-Atmospheric Research Canteen** **Presentation to Graeme Pearman**
19:00	**Dinner**	**Lobster Cave**

CAPE GRIM BASELINE AIR POLLUTION STATION

ANNUAL SCIENCE MEETING, 2002

Friday, 8 November		
Chair	***Paul Fraser***	
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09:10	Salah Jimi	Nano-particles at Cape Grim, Tasmania
09:35	Patrick Sheridan	NOAA/CMDL Aerosol Measurements at Trinidad Head, California
10:00	Mick Meyer	A Spatial Analysis of Anthropogenic Non-CO_2 Greenhouse Gas Sources from the Biosphere in Australia
10:25	**Morning Tea**	
11:00	Marcel Van der Schoot	Modification of Trace Gas Concentrations by Diffusive and Surface Processes
11:25	Cecelia MacFarling	Natural and Anthropogenic SF_6 and CF_4 in the Atmosphere
11:50	David Etheridge	Can we explain the causes of methane changes from isotopic information?
12:15	Mick Meyer	The Air Quality Monitoring Station Plans and Progress: The Development of Atmospheric Air Monitoring Programs Located at Aspendale
12:40	**Lunch**	
Chair	***Neil Tindale***	
14:00	Martin Cope	The Use of Long-Range Transport Simulations to Verify the Australian Air Quality Forecasting System
14:25	David Etheridge	Potential Geological Sources of Hydrocarbons to the Atmosphere
14:50	Workshop	Oil & Gas Operations in Bass Strait: Impacts on & Opportunities for Cape Grim
15:30	**Afternoon Tea**	
15:50	Workshop	Continued…….
17:00	**Close of meeting**	

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Kim Henville

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CAPE GRIM WIND STATISTICS AND THEIR USE IN INDICATORS OF BASELINE CONDITIONS

Paul Krummel, John Gras & Paul Steele
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Matt Tully & Arthur Downey
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Laurie Porter & Randall Wheaton
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Abstract

Wind speed and direction are used by almost all investigators conducting research at Cape Grim, as an indicator of air mass origin, as a real-time baseline indicator (in conjunction with CO_2 or CN) for instrument switching or flask filling, or for use in algorithms designed to select baseline conditions for specific species such as CO_2.

We will describe the wind statistics showing particular characteristics of the 10 metre, 30 metre and 50 metre wind frequencies using a type of 'wind frequency rose'. It is apparent that characteristics of the Cape Grim site influence the wind statistics in significant ways. For example, the frequency of winds from the baseline sector (190˚-280˚) depends on the choice of data from the 10 metre or 50 metre height, with baseline wind direction indicated about 10% less often by the 50 metre data, compared to the 10 metre data. This is almost certainly due to a channelling effect of the cliff face on the 10 metre winds from approximately 270˚, where winds from outside the sector (directions > 280˚) are channelled into it. In another example, easterly winds at 30 metre and 50 metre heights are distorted by passing through the tower before reaching the anemometers mounted on booms facing west.

The three real-time baseline indicators currently used at Cape Grim will be defined and brief explanations of their use will be outlined.

Progress towards a unified wind speed and direction dataset will be described. The implications of this work for selecting CO_2 baseline hours will be outlined.

GROUND-BASED NEAR INFRARED SOLAR SPECTROSCOPY FOR GREENHOUSE GAS MEASUREMENT

Glenn Bryant
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Abstract

The limitations of current data in constraining models of greenhouse gas sources and sinks are widely recognised, and efforts are already underway to improve the available spatial resolution within these data sets using satellite-based sensing. The alternative of a widely distributed network of ground-based observations is currently limited by instrument cost and complexity. However, ground-based near infrared solar spectroscopy has the potential to overcome some of these limitations. This talk will discuss the advantages of using the near infrared region of the spectrum for monitoring greenhouse gas total column concentrations, and consider instrumentation options that might be implemented in the field.

ESTIMATION OF THE EMISSIONS OF CO FROM MOTOR VEHICLES IN MELBOURNE

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Abstract

CO emission estimates from Melbourne have been used in attempts to quantify the emissions of a number of other trace gases, through an analysis of Cape Grim data. For such "tracer" studies, it is essential that the tracer emission strength is known, and that the emissions are from the same region as the gases being investigated.

As part of a larger project (INTUITIVE) being run as CSIRO Aspendale, FTIR measurements of CO_2, CO, N_2O and CH_4 are being made. This will be later augmented with isotopic signature measurements. The aim of this project is to identify and quantify sources within the Melbourne air shed. Initial results will be presented from the FTIR measurements on CO and CO_2. Analyses indicate that the emission signal due to motor vehicles is distinguishable from signals resulting from other emission sources.

CO_2 MEASUREMENT IN THE AUSTRALIAN REGION – THE NEXT DECADE

Roger Francey & Paul Steele
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Abstract

The stabilisation of atmospheric greenhouse gases is now on the agenda of most national governments. For scientists monitoring CO_2 in the atmosphere, this presents new and difficult challenges. One or two monitoring sites like Cape Grim quite accurately capture the global change in atmospheric CO_2 on timescales longer than 1-2 years. The challenges are to identify the regions and processes most implicated in global change, to verify the effectiveness of regional measures to reduce anthropogenic CO_2 emissions and to provide early confirmation of possible feedbacks, in particular those that might accelerate climate change. Australia, as a result of innovation in measurement and modelling, and geographical location, is well positioned to make a unique contribution of considerable international significance.

THE CAPE GRIM STABLE ISOTOPES IN ATMOSPHERIC CO_2 MEASUREMENT PROGRAM

Colin Allison & Roger Francey
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Abstract

An update of the Cape Grim stable isotope program will be presented. In particular, issues of calibration that have lead to a difference between results from the *in situ* program and the flask program over the last few years will be addressed.

ESTIMATING CO_2 SOURCES FROM CONTINUOUS MEASUREMENTS: AUSTRALIA AS A TEST CASE

Rachel Law, Peter Rayner, Eva Kowalczyk, Ying-Ping Wang & Paul Steele
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Abstract

The standard practice for estimating CO_2 sources from atmospheric data has been to solve for monthly mean sources using monthly mean baseline data. This type of inversion has produced useful results but the uncertainties on the source estimates remain relatively large due to the limited atmospheric dataset. Continuous CO_2 data, such as that collected at Cape Grim, could significantly improve the inversion estimates because of the information contained in synoptic-scale variations in the CO_2 concentration. However, a number of methodological and modelling developments are required before we are able to incorporate continuous measurements into the CO_2 inversion. In this presentation we will highlight the required developments and demonstrate progress towards achieving these developments using the Australian region as a test case. We have used synthetic data generated from monthly sources to test the inversion methodology and found that we need to solve for sources at higher spatial resolution than in previous inversions. We have begun to extend these tests to cases where sources vary on sub-monthly timescales, using fluxes generated by the CSIRO Biosphere Model. We also assess the impact on the inversion of data quality. Inversions of continuous data will require transport modelling using analysed winds. We will show some recent results from the CSIRO Conformal-Cubic model for CO_2 at Cape Grim and some inversion tests that indicate the quality of transport modelling that may be required.

BIOLOGY AND CLIMATE - NOT JUST A SULFUR STORY

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Abstract

Dimethylsulfide (DMS) is just one of many gases that originate from marine organisms such as phytoplankton and seaweed. The CLAW hypothesis suggests that DMS crosses the air-sea interface to be oxidised to sulfur dioxide, forming new sulfate particles that can then act as cloud condensation nuclei. However in the marine boundary layer the presence of sea salt aerosol critically limits the ability of DMS derived sulfur to contribute to new particles.

DMS related new particle formation may occur in the free troposphere, where existing surface area is lower or it may occur in the marine boundary layer where other species may initiate or contribute to nucleation. It is perhaps time to modify the CLAW hypothesis so that there is not the exclusive dependence on DMS, but instead incorporate a number of biologically generated percursor species for which DMS may be a useful marker.

ACCELERATOR MASS SPECTROMETRY: AN OVERVIEW OF THE TECHNIQUE AND OF SMALL-MASS ^{14}C ANTARCTIC PROJECTS AT ANTARES

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Abstract

Accelerator Mass Spectrometry [AMS] is a technique of unsurpassed sensitivity that is often the only means by which cosmogenic radionuclides can be measured in natural samples. Such measurements have had a significant impact upon diverse disciplines, most notably Archaeometry and the geosciences. In this paper, an overview of the technique will be presented, with emphasis on the methodologies and capabilities of ANSTO's Australian National Tandem for Applied Research [ANTARES] facility.

Additionally, a brief review will be given of past collaborative projects with the AAD and CSIRO-AR which have relied upon our ability to measure $^{14}C/^{12}C$ in samples containing very small masses (10 to100μg) of carbon, focusing on technical issues. We plan to further decrease our useable carbon sample masses, and an example of a new project that could benefit from this capability will be presented.

ATMOSPHERIC RADIOCARBON OFFSET FOR THE TROPICS DURING THE LITTLE ICE AGE

Quan Hua, Ugo Zoppi, David Fink & Geraldine Jacobsen
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Mike Barbetti
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Manas Watanasak
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Abstract

A tree-ring chronology has recently been developed for Thailand [D'Arrigo *et al.* 1997]. This gives us an opportunity to investigate the atmospheric ^{14}C offset for the tropics during the Little Ice Age. Cross-dated tree-ring cores from Thailand, spanning AD 1620-1780, were used for this study. The cores were taken from *Pinus merkusii* trees grown at Phu Kradung, north-central Thailand (17°N, 102°E). During the growing season of Phu Kradung *Pinus merkusii* the atmospheric air movement is from the Indian Ocean, carried by the southwest monsoon. In addition, a cross-dated tree-ring section of Huon pine from western Tasmania (42°S, 145°E), covering the same period of time, was also investigated. We chose Tasmania for this study because it samples the moving air mass of a large part of the Southern Ocean and thus provides a highly appropriate baseline. Both sets of tree rings are typically less than 1mm wide, necessitating the use of AMS for radiocarbon analysis. A total of 16 pairs of decadal samples were extracted to alpha-cellulose [Hua *et al.* 2000] for AMS ^{14}C analysis using the ANTARES facility at ANSTO [Lawson *et al.* 2000].

The $\Delta^{14}C$ results from Thailand for the period of rising atmospheric radiocarbon (1620-1690) are insignificantly lower than those seen in northern temperate tree-rings [Washington, USA; Stuiver *et al*., 1998]. For the period of falling atmospheric ^{14}C (1690-1780), the $\Delta^{14}C$ values for Thailand are 3.9 ± 1.0 per mil lower than Washington. When compared with New Zealand [Sparks *et al.* 1995; McCormac *et al.* 1998], the Thai data are 2.5 ± 1.0 per mil higher, constant across the whole period 1620-1780. The pattern is thus very clear; the Thai data, from 17°N, are close to and follow the trend of the Southern Hemisphere, rather than that of the Northern Hemisphere. This is a surprising result, and we infer that atmospheric ^{14}C for north central Thailand was strongly influenced by the entrainment of southern hemisphere air parcels during the southwest Asian monsoon, when the Intertropical Convergence Zone moves to the north of our sampling site (north central Thailand).

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LMDZ – A NEW ATMOSPHERIC TRANSPORT MODEL WITH 'ZOOM' CAPABILITY

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Abstract

Analysis of continuous CO_2 measurements over the continents currently offers the potential to better understand the carbon fluxes between the terrestrial biosphere and the atmosphere, as well as providing an alternate check on fossil fuel emissions to help monitor future Kyoto type treaties on sub-continental scales. To do so requires much higher spatial and temporal resolution in the transport model than has been used in the past to analyses so called 'baseline' measurements such as those at Mauna Loa and the South Pole which are remote from strong CO_2 fluxes. An optimal way to achieve this increase in resolution is to use a model with a flexible grid such that an area of interest can have higher resolution than others, thus saving computational expense.

We present the LMDz (Laboratiore Meteorologie Dynamique zoom) model, describing its grid set-up and advection and convection schemes. Its ability to model large-scale features such as the seasonal cycle amplitude at baseline stations, as well as high frequency continental stations over Europe will be shown. We present several sensitivity studies using different spatial and temporal resolution, a new advanced planetary boundary layer scheme, and the impact of using different estimates of the surface CO_2 fluxes. We examine the model's behaviour both from a Lagrangian and Eulerian point of view. Finally, we outline the use of the self-adjoint aspect of the atmospheric transport model, and how the model can be used in an inverse mode to retrieve flux information from the atmospheric data at high spatial and temporal frequency.

ESTIMATING THE REGIONAL OCEANIC RADON FLUX

Wlodek Zahorowski, Scott Chambers & Ann Henderson-Sellers
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Abstract

The large difference between terrestrial and oceanic radon fluxes sometimes leads to the oceanic flux being neglected in atmospheric models. However, including a realistic oceanic radon flux within models would improve comparisons between observed and simulated atmospheric radon concentration at remote sites with extended oceanic fetch.

A method for the direct estimation of regional oceanic radon fluxes is presented. The method is applied to a subset of the Cape Grim radon dataset from 1993 to 2001. A simple expression for an average oceanic radon flux is derived and applied using a selection of the Cape Grim observations representative of air parcels with an oceanic fetch. We argue that the selected radon concentrations are minimally perturbed from those in air masses that are in equilibrium with the oceanic radon flux.

The resulting radon flux from the region of the Southern Ocean within the Cape Grim radon measurement fetch is estimated to be 0.0024 atoms $cm^{-2}s^{-1}$. Based on the 10 and 90 percentile radon concentration and wind speed observations, and assuming a mechanically driven mixing height, the regional oceanic radon flux rate may vary from 0.0014 to 0.0035 atoms $cm^{-2}s^{-1}$ with wind induced changes in the sea state.

The result supports the common assumption that oceanic radon flux rates are 2-3 orders of magnitude lower than terrestrial radon fluxes. It is considerably lower than earlier experimental spot estimates of oceanic radon flux rates for a similar region. However, it is in closer agreement with the flux derived from model evaluation studies.

The new method of oceanic radon flux derivation presented here has immediate applicability to other sites around the world where 'clean' ocean air can be clearly identified. The presented method offers an alternative to local/spot estimates of oceanic radon flux such as the accumulation method and gradient methods, it is representative of a large region and reflects different environmental conditions.

HALON-1211 EMISSIONS FROM MELBOURNE

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Abstract

Halon-1211 ($CBrClF_2$), commonly known as BCF, was widely used in portable fire extinguishers until the mid-1990s, when halon consumption ceased in developed countries, under the Montreal Protocol restrictions.

Measurements of Halon-1211 commenced at Cape Grim in early 1998 as part of the AGAGE GC-MS program and the data show the 'tell-tale' pollution episodes, indicating significant emissions from the Melbourne region. The source of these emissions was thought to be leakage from old fire extinguishers and from the halon 'bank', a national facility for the capturing, reprocessing, storing or destuction of halons (and other ozone depleting chemicals), located at Tottenham, 10 km west of the Melbourne CBD.

The Cape Grim data suggest that most of the emissions occur during the decanting phase of the halon reprocessing. The halon bank estimates these emissions gravimetrically on a weekly basis and this could be one of the most accurately known emissions of a trace chemical into the Melbourne airshed.

Halon-1211 may provide a means of estimating other emissions by interspecies correlation techniques and could be an additional 'calibrating' species for estimating Melbourne emissions, together with carbon monoxide (CO), dichloromethane (CH_2Cl_2) and perchloroethylene (CCl_2CCl_2), whose emissions are estimated by the EPA as part of the Port Phillip Region emissions inventory.

CFC MEASUREMENTS AT CAPE GRIM, 1978-2002

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David Oram
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Abstract

CFCs were invented in the 1930s by General Motors Refrigeration Division as safe refrigerants suitable for domestic use. Over subsequent decades CFCs were used extensively as refrigerants, aerosol propellants, foam blowing agents and solvents, with total production exceeding 1.1 million tonnes per year in the late 1980s.

CFCs are the major source of anthropogenic stratospheric chlorine, largely responsible for global and Antarctic stratospheric ozone depletion over the past 25 years. There are five significant CFCs in the background atmosphere: CFC-11 (CCl_3F), CFC-12 (CCl_2F_2), CFC-113 (CCl_2FCClF_2), CFC-114 ($CClF_2CClF_2$) and CFC-115 ($CClF_2CF_3$).

The first atmospheric measurements of CFCs (CFC-11) in Australia were made in 1975 at Aspendale and commenced at Cape Grim, Tasmania, in 1976; CFC-12 measurements at Cape Grim commenced in 1978, CFC-113 in 1981, CFC-114 and CFC-115 in 1998. Measurements of these latter 3 CFCs have been made back to 1978 on the Cape Grim air archive at Cape Grim and at UEA.

CFC levels increased by about 5% per year from 1976 until about 2000, and have now started to decline at about 1% per year. This is a significant achievement for the Montreal Protocol, for the CFCs in the atmosphere will dominate ozone depletion over the next 50 years, and ozone recovery will only occur after CFC levels in the atmosphere have been reduced substantially.

IN SITU SF_6 MEASUREMENTS AT CAPE GRIM

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Abstract

Sulfur hexafluoride (SF_6) is widely used as a dieletric fluid in voltage breakdown transformers. It is a significant greenhouse gas, whose emissions are likely to be controlled by the Kyoto Protocol, or a similar international agreement to control emissions of greenhouse gases.

The current AGAGE GC-MS instrument at Cape Grim measures SF_6 with relatively poor precision. In 2000 it was decided to measure SF_6 in situ at Cape Grim using a proven GC-ECD technology.

This paper describes the measurement methodology, the interim calibration and the first 15 months of SF_6 data at Cape Grim. These data are compared to flask/air archive measurements of SF_6 at Cape Grim by SIO and the University of Heidelberg, extending back to 1978.

ATMOSPHERIC ORGANIC NITROGEN AT CAPE GRIM, TASMANIA

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Abstract

During the Southern Hemispheric spring of 2000 (during the months of November and early December), rain, bulk and size-separated aerosol samples were collected at the Cape Grim Baseline Air Pollution Station (CGBAPS) and analysed for total organic nitrogen (N), urea, and dissolved free amino acids. Rain and bulk aerosol samples contained organic N at concentrations representing ~20% of total N. Urea was not detected in the 6 rain samples analysed. However, urea represented ~28% of the organic N contained in non-baseline aerosol samples, and ~3% of the organic N contained within baseline samples. Trajectory analysis combined with meteorological data indicated that high concentrations of urea within aerosols were mainly due to Tasmanian sources, likely animal emissions, although the application of urea fertilizers cannot be dismissed as a source. In non-baseline samples the highest concentrations of urea were associated with the coarse mode aerosol (>1 μm), although urea was also found in the fine mode aerosol (<1 μm), potentially indicating gas-to-particle conversion of urea. Aerosol samples collected in marine air masses contained urea within an intermediate fraction centred at ~1 μm suggesting the sea surface microlayer as a source. Dissolved free amino acids contributed ~53% of the organic N in rain, but were not a significant proportion of the total organic N fraction in either non-baseline or baseline aerosol samples. Due to their presence in rain, amino acids likely exist in aerosols as un-hydrolysed proteins. In cascade impactor samples highly influenced by marine sources, profiles for amino N were inversely related to urea N, possibly indicating live species and the sea surface microlayer as a source for organic N.

IN SITU AEROSOL PROFILING OVER THE SOUTHERN GREAT PLAINS CART SITE

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Abstract

Aerosol optical properties were measured over the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site using a light aircraft (Cessna C-172N). The aircraft flew level legs at altitudes between 500 m and 3500 m several times per week over the course of a year in order to obtain a statistically representative data set of in-situ aerosol vertical profiles. Instrumentation on the aircraft was similar to that at the surface SGP CART site so that measurements at the surface and aloft could easily be compared. Measured parameters included total light scattering, hemispheric backscattering and absorption coefficients, while calculated parameters included single scattering albedo, backscatter fraction, and Ångström exponent. Statistical plots of aerosol optical properties and their variation in the lower column (0-4000 m) showed that, over the course of the year, albedo, backscatter fraction and Ångström exponent varied relatively little with altitude (at least up to 1800 m). Despite the vertical consistency, the correlation between column average and surface values for single scattering albedo, backscatter fraction, and Ångström exponent tended to be quite low, with r-squared correlation coefficients ranging from 0.2 to 0.5, and linear regression slopes ranging from 0.3 to 0.7. These results suggest that long-term surface aerosol measurements capture the column aerosol properties, but may not be as representative of day-to-day variations in the column. Comparison of aerosol optical depth (AOD) calculated from the vertical profiles with other measurements of AOD made at SGP (i.e., by the Cimel sunspot photometer and the multifilter rotating shadowband radiometer (MFRSR)) showed fair correlation (R2 ~ 0.4 Cimel, R2 ~ 0.8 MFRSR), although the aircraft AODs tended to be 50-75% less than those derived from the radiation instruments, even after incorporating a correction for supermicrometer aerosol and stratospheric aerosol.

SURFACE-BASED OBSERVATIONS OF VOLCANIC EMISSIONS TO THE STRATOSPHERE

David J. Hofmann
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Abstract

Long-term, surface-based observations of the stratospheric aerosol layer are presented and compared. These include three lidars, at Mauna Loa Observatory (Hawaii), Langley Research Center (Virginia), and Garmisch-Partenkirchen (Germany); balloon-borne particle counters at Laramie, Wyoming, solar visible transmission at Mauna Loa Observatory; aerosol optical depth at South Pole Station and Mauna Loa Observatory; and lunar eclipse optical depth, which is a globally-integrating technique. It is concluded that surface-based measurements have provided a useful historical record of volcanic aerosol effects on the stratosphere. The agreement between the various techniques is very good. However, some uncertainties exist when the stratosphere is relatively free of volcanic aerosol and some of the techniques are not able to resolve the very small amount of aerosol from natural and/or anthropogenic sources. The lunar eclipse data, which goes back to the late 1800's, suggest that the Pinatubo eruption in 1991 may have perturbed the stratospheric aerosol layer to a larger extent than that of Krakatau in 1883. This is an important observation as it is one of the few ways to intercalibrate the effects of eruptions prior to modern measurements which began in the late 1950's. At the present time, the stratosphere appears to be at background with the lowest level of aerosol observed since the layer was discovered in 1959.

ONGOING INTERCOMPARISON EXPERIMENTS: IMPROVING THE QUALITY OF ATMOSPHERIC GREENHOUSE GAS MEASUREMENTS

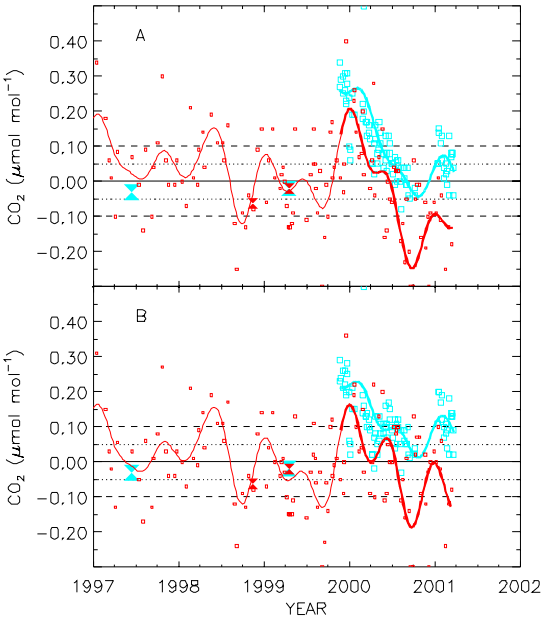
Ken Masarie, Tom Conway, Pieter Tans & Paul Novelli
NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, Colorado USA

Doug Worthy
Meteorological Service of Canada, Canada

Ray Langenfelds
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Abstract

The Carbon Cycle Greenhouse Gases Group participates in ongoing flask air InterComParison (ICP) experiments with CSIRO, Australia (begun in 1992) and MSC, Canada (1998). The purpose of these activities is to establish consistency among atmospheric greenhouse gas observations so that data from these networks can be integrated into larger cooperative observing networks. Key design features of the ICP experiments include 1) routine multiple-species analysis by each laboratory of the same ambient air from a network flask; 2) minimal impact on personnel and equipment; 3) automatic exchange and processing of ICP data; and 4) ready access to monthly updates and archived ICP results. Results from the ICP experiments show that inconsistencies among our measurements do exist and often vary with time. Because observed discrepancies in the ICP results may be due to analytical or calibration problems in one or more of the participating laboratories, identifying causes has been difficult. These ongoing ICP experiments, however, have become important quality assurance tools that we routinely use to further evaluate the performance of our measurement and calibration techniques. By comparing ICP results for different gases, we can potentially determine if a problem is gas specific. By comparing the results from both the CSIRO and MSC ICP experiments, we can potentially identify in which of the 3 laboratories a problem is likely to exist. Information provided by the ICP results is a warning to each laboratory that an experimental problem may exist. Participating laboratories, however, are highly motivated to determine if their procedures may be contributing to the discrepancies revealed by the ICP results. Inconsistencies in the ICP results have spawned further investigations which include careful re-examination of existing procedures and experiments designed to test possible causes. Corrections to data or to procedures are made only if the cause of a problem can be independently verified within the laboratory. Not all corrections result in improved ICP results. While results from these ICP activities often raise more questions than they answer, they have directly contributed to improvements in the quality of CCGG data.



A smooth curve (blue line) is fitted to CO_2 differences (MSC minus NOAA) between independent measurements of the same air in flask samples collected at Alert, Nunavut, Canada (blue squares). Also plotted is the smooth curve (red line) fitted to the CO_2 differences (CSIRO minus NOAA) from the CSIRO/NOAA flask air ICP experiment at Cape Grim, Tasmania (red squares). Mean differences determined from multiple intercomparisons of air in high-pressure cylinders are shown as hourglass symbols. Panel A shows differences before NOAA re-examines the network flask CO_2 analysis system. The coincident trends in the differences suggest that a problem may have developed with the analysis of the ICP flasks at CMDL. Panel B shows curves and differences after test gas and reference gas cylinders have been drift-corrected.

EVIDENCE OF A TEMPERATURE-ALBEDO FEEDBACK IN NORTHERN ALASKA RELATED TO EARLIER SPRING SNOWMELT

R. S. Stone, E. G. Dutton, J. M. Harris & D. Longenecker
NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, Colorado USA

Abstract

This poster describes the advancing spring snowmelt date at Barrow, Alaska and explores its causes.

MONITORING AEROSOL OPTICAL DEPTH AT CMDL POLAR OBSERVATORIES

R. S. Stone, J. Wendell, E. G. Dutton & D. Longenecker
NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, Colorado USA

Abstract

This poster describes the AOD monitoring activities at Barrow, Alaska, and the South Pole, including methods, calibrations, and radiative forcing calculations.

RADIOCARBON VARIATIONS FROM THE SOUTHERN HEMISPHERE, 10,350 – 9,700 CAL BP

M. Barbetti, Y. Zhao & B. Thomson

The NWG Macintosh Centre for Quaternary Dating, University of Sydney, NSW 2006

Q. Hua, U. Zoppi & D. Fink

Australian Nuclear Science and Technology Organisation, Menai, NSW 2234

Abstract

We have made AMS measurements on a series of 10-ring samples from a subfossil Huon pine log found in western Tasmania (42ºS, 145ºE). The results show a pronounced rise in $\Delta^{14}C$ over 200 years, and a decrease over the following 100 years.

Tree-ring width measurements indicate that this log (catalogue SRT-447) can be cross-dated with another subfossil log (SRT-416) for which a series of high-precision radiometric ^{14}C measurements have previously been made. When the two tree-ring series are thus aligned, SRT-447 is the older of the two logs, and there is a 139-year overlap. We then have a Huon pine floating chronology spanning 680 years, with ^{14}C measurements attached. The ^{14}C data sets generally agree well within the period of overlap indicated by the tree-rings.

The ^{14}C variations from Huon pine show excellent agreement with those from German oak and pine for the period 10,350 to 9,670 cal BP. Alignment with the ^{14}C age minimum at 10,100 cal BP allows us to position the floating Huon pine series, and to examine the inter-hemispheric offset in ^{14}C dates in the Early Holocene.

NANO-PARTICLES AT CAPE GRIM, TASMANIA

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&
School of Mathematical Sciences, Monash University, Clayton, Victoria 3800

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Steve T. Siems
School of Mathematical Sciences, Monash University, Clayton, Victoria 3800

Keywords: Cape Grim, Nano-particle events, MBL, ACE-1, Frontal Passage

Abstract

This talk is on nano-particle (3 - 12 nm) measurements made in the marine boundary layer (MBL) at Cape Grim during 1999 - 2000. The study involves two analyses of aerosol measurements; the first is based on wind sector classification of air masses arriving at the Cape Grim monitoring station, and the second on observations following the passages of cold fronts. For the first type of analyses, seasonal diurnal variations for three broad air mass origins, Tasmania, continental Australia and clean maritime were examined. Significant differences were found in the diurnal patterns between the three sectors with a broad daytime enhancement in the Tasmanian sector, attributed to urban/industrial activities. Low nano-particle concentration was observed in the early morning (00:00-06:00) and night (18:00-23:00) in this sector. The diurnal variation for the continental sector had daytime peak concentrations consistent with secondary aerosol production by photochemical processes. In the Baseline sector there was some evidence of photochemical enhancement of concentrations during the day but low concentration during the night-time.

The behaviour of nano-particle concentrations following frontal passages during the same period was also investigated. Nano-particle enhancements were observed following the passage of cold fronts. The enhancements were stronger in summer (480 cm^{-3}) followed by spring (363 cm^{-3}) and autumn (188 cm^{-3}). Winter showed the weakest enhancement (152 cm^{-3}). These results suggest that photochemical processes drive the observed nano-particle enhancements. On average, the nano-particle reached peak concentration 10 - 15 hours after frontal passages and lasted for about 6 - 13 hours. These results are consistent with nano-particle observations made by [Bates *et al*., 1998] during the First Aerosol Characterisation Experiment (ACE-1). Most of the time the enhancements due to individual frontal passage at Cape Grim were of greater magnitude than those from ACE-1. Meteorological observations have been compiled to establish any relationship between strength of the frontal passage and the nano-particle events. These correlations are found to be weak. The enhancement in nano-particle concentration, however, is found to correlate with drier air during post-frontal subsidence, suggesting that the actual frontal passage may not be key factor in the nano-particle production.

References

Bates, T.S., V.N. Kapustin, P.K. Quinn, D.S. Covert, D.J. Coffman, C. Mari, P.A. Durkee, W.J. De Bruyn, and E.S. Saltzman, Processes controlling the distribution of aerosol particles in the lower marine boundary layer during the First Aerosol Characterisation Experiment, *J. Geophys. Res., Vol. 103*, 16,369-16383, 1998.

NOAA/CMDL AEROSOL MEASUREMENTS AT TRINIDAD HEAD, CALIFORNIA

Patrick J. Sheridan, Elisabeth Andrews & John A. Ogren
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Abstract

In mid-April 2002, the NOAA Climate Monitoring and Diagnostics Laboratory (CMDL) began an extended effort to measure radiatively important trace gases, aerosols and radiation at Trinidad Head (THD), California. The start of these measurements coincided with a month-long field intensive for the Intercontinental Transport and Chemical Transformations (ITCT) program, which was designed to investigate how atmospheric pollutants from one continent can influence air quality and regional to global scale climate on other continents. For example, desert dust mixed with anthropogenic pollutants from Asia has been observed over ten thousand kilometers away in the western United States. CMDL's measurements will contribute to understanding the role of intercontinental transport of aerosol particles and trace gases in climate forcing and air quality.

This presentation provides a tour of the new CMDL station at THD and focuses on the aerosol measurements. The first six months of measurements at THD have provided numerous examples of long range transport of dust, smoke, and pollution across the Pacific, as well as local pollution and smoke events. A number of these transport events are discussed. On a longer-term basis, the THD site is a prime candidate for the location of a new CMDL Baseline Observatory. A station on the west coast of the United States will provide information on the inflow of aerosols and other atmospheric constituents to North America and will complement both the remote Baseline Observatories and the regional monitoring stations in the central United States. These early measurements at THD have provided CMDL with the start of a long-term data set for atmospheric monitoring at the site. Alternatively, if a different location is chosen for the CMDL station, the data will provide a point of comparison for spatial and cyclical variability of climatically important atmospheric species.

A SPATIAL ANALYSIS OF ANTHROPOGENIC NON-CO_2 GREENHOUSE GAS SOURCES FROM THE BIOSPHERE IN AUSTRALIA

Mick Meyer & Simon Bentley
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Abstract

The emissions of greenhouse gases from Australian agricultural and natural ecosystems have come under increased scrutiny over the last few years. In 2000, agriculture contributed 18% of Australia's net greenhouse gas production; 11% was methane, (CH_4) produced by enteric fermentation and 7% was produced principally from the agricultural soils under crops and pastures, and by savanna fires. The emissions from agricultural soils have increased by 23% since 1990, an annual rate comparable to the energy and transport sectors and far greater than the national total (6.5% since 1990). The sector is also a major source of uncertainty in the national emissions inventory. While emissions from fossil fuels (energy and transport) are known to ± 3%, the uncertainty in emissions from soils range from –50% to +100% of the mean value, or from 1.6% to 7.3 % of the total national emissions. Inverse modelling studies based upon Cape Grim measurement data can be used to assess and improve the accuracy of source fields derived from this and similar emissions inventories. As a first step we have analysed the National Greenhouse Gas Inventory for the Agricultural Sector at statistical local area in order to identify the regions and agricultural practices which constitute the greatest sources of emission and uncertainty. In this presentation we discuss these sources in detail and analyse the possible pathways towards reducing the uncertainty in their estimates.

MODIFICATION OF TRACE GAS CONCENTRATIONS BY DIFFUSIVE AND SURFACE PROCESSES

Marcel Van Der Schoot, Ray Langenfelds, Darren Spencer, Roger Francey, Paul Steele & Colin Allison
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Martina Schmidt
Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette, France

Hitoshi Mukai
National Institute for Environmental Studies, Tsukuba, Japan

Abstract

CSIRO GASLAB maintains atmospheric measurement programs for various greenhouse and biogeochemically related gases, and seeks to integrate its data with those of collaborating international laboratories. However, for some species (e.g. CO_2), decades of inter-comparison activities have indicated unexpectedly poor agreement among laboratories. This has limited the usefulness of integrated data sets for interpretive studies. The poor inter-comparability reflects the presence of systematic biases whose causes have been difficult to establish. GASLAB's multi-species, high precision measurement capabilities provide an avenue for investigating the cause of such effects and for refining inter-comparison strategies. Recent experiments provide evidence of trace gas modification by various diffusive and surface processes.

NATURAL AND ANTHROPOGENIC SF_6 AND CF_4 IN THE ATMOSPHERE

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University of Melbourne, Melbourne, Victoria 3000

David Etheridge, Cathy Trudinger, Paul Steele & Paul Fraser
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Ingeborg Levin
Unversity Of Heidelberg Institut fur Umweltphysik, Germany

Jochen Harnisch
Max Planck Institut fur Aeronomie

Martin Vollmer
Scripps Institution for Oceanography, University of California, La Jolla, California, USA

Andrew Smith
Australian Nuclear Science and Technology Organisation, Menai, New South Wales 2234

Abstract

Sulfur hexafluoride (SF_6) and carbon tetrafluoride (CF_4) are powerful atmospheric greenhouse gases on a molecule for molecule basis. The radiative forcing of SF_6 and CF_4 is presently small due to their low atmospheric concentrations. Presently, the dominant sources are anthropogenic and relatively minor natural geological sources for both gases have been suggested. Both gases are included in the Kyoto Protocol on climate protection. These compounds are also potentially very useful atmospheric and hydrological tracers, due to their inertness and rapid atmospheric growth. Here we present well-dated measurements of SF_6 and CF_4 in Antarctic firn air, beginning about 1938. The deepest samples predate industrial production of both gases suggesting emissions from natural sources or early anthropogenic synthesis.

CAN WE EXPLAIN THE CAUSES OF METHANE CHANGES FROM ISOTOPIC INFORMATION?

David Etheridge, Cathy Trudinger & Paul Steele
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Keith Lassey & David Lowe
National Institute of Water and Atmospheric Research, Kilbirnie, Wellington New Zealand

Andrew Smith
Australian Nuclear Science and Technology Organisation, Menai, New South Wales 2234

Abstract

The near tripling of the concentration of atmospheric methane in the last 200 years is of concern because of methane's radiative and chemically reactive properties. Large, perplexing variations in the methane growth rate in recent decades show that its secular trend is hard to predict. This presentation will discuss the use of methane isotopic measurements (^{13}C and ^{14}C), which now extend back to the 1930s, to help understand how the methane budget has evolved.

THE AIR QUALITY MONITORING STATION PLANS AND PROGRESS: THE DEVELOPMENT OF ATMOSPHERIC AIR MONITORING PROGRAMS LOCATED AT ASPENDALE

Mick Meyer
CSIRO Atmospheric Research, Aspendale, Victoria, 3195

Abstract

Proposed projects and infrastructure involving monitoring of greenhouse gases, air toxics and particles at Aspendale have been aired at many venues over the last few years. The focus of these projects varies from routine monitoring of ambient air quality, studies of transport of the Melbourne plume to Cape Grim, and acquisition of data for urban source characterisation and inversion modelling of source strengths. There have been significant developments on these fronts in the last year including the establishment of an ambient monitoring station for the criterion pollutants and the routine monitoring of the greenhouse gases by FTIR. The plans and progress of this work and its relevance to other air quality programs within CAR will be presented and discussed.

THE USE OF LONG-RANGE TRANSPORT SIMULATIONS TO VERIFY THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM

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Martin Cope & Sunhee. Lee
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Neil Wong
Environment Protection Authority of Victoria, Melbourne, Victoria 3001

Abstract

The Australian Air Quality Forecasting System (AAQFS) was used in hindcast mode to model long-range transport of CO from Melbourne to Cape Grim, a distance of about 300 km. Three periods of elevated CO concentrations were observed at Cape Grim during a 14-day study period that ran from 18 September to 1 October, 2001. The AAQFS successfully predicted elevated CO concentrations during all three periods when a detecting radius of 0.1° was used. This is a very good result given the expected trajectory error over that distance is about 1.0°. A more quantitative assessment revealed timing errors of up to 12 hours, and the modelled peaks in the Cape Grim CO time-series tended to be shorter in duration and greater in magnitude when compared with that observed. The timing errors were attributed to errors in forecasting the wind trajectories.

It is suggested that the forecasts could be improved by increasing the horizontal diffusion to reduce the 'peakiness' of the modelled CO time-series, and by reducing a slight over-estimation of the height of the marine boundary layer.

Although unverifiable in detail due to insufficient observations, the AAQFS identified a number of interesting plume features. An apparent pulsing of CO out of the Melbourne airshed due to morning and evening peaks in CO production was present during all three periods. These pulses often maintained their identity throughout the crossing of Bass Strait. The presence of varying wind directions across Bass Strait during the second period, and temporal variations in wind direction led to plume folding into a zig-zag-like pattern which brought a succession of peaks to the Cape Grim time-series. The zonal component of the predominantly northerly winds shifted from east to west to east and back to west again throughout the third period, which caused the plume to sweep back and forth across Bass Strait and Cape Grim. Early in the third period fumigation brought the first elevated CO concentrations to Cape Grim, and late in the third period a cold front arrived from the west and cleared the plume from Bass Strait. As it encountered the plume the convergent winds narrowed the plume into a thin line of highly concentrated CO. These plume features are likely to be of greater interest in regions of the globe where long-range transport is more important.

Keywords: Long-range transport, numerical high-resolution air quality forecasting, wind trajectories, horizontal diffusion, carbon monoxide plume behaviour.

POTENTIAL GEOLOGICAL SOURCES OF HYDROCARBONS TO THE ATMOSPHERE

Geoffrey O'Brien
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David Etheridge & Paul Krummel
CSIRO Atmospheric Research, Aspendale, Victoria 3195

Abstract

The release of hydrocarbons from marine geological formations has been detected in several regions around Australia. The releases can be caused by natural seepage and by oil and gas exploration and production activities. Sedimentary basins west of Cape Grim and in Bass Strait are potential sources of emissions that may, if sufficiently large, appear in measurements at Cape Grim, particularly of methane.

CAPE GRIM BASELINE AIR POLLUTION STATION

ANNUAL SCIENCE MEETING, 2002

Thursday, 7 November		
Chair	***Neil Tindale***	
09:00	Convenors / Hosts	General information on arrangements etc.
09:10	Greg Ayers	Welcome to CSIRO-AR
09:15	Paul Krummel	Cape Grim Wind Statistics and their use in Indicators of Baseline Conditions
09:40	Glenn Bryant	Ground-based Near Infrared Solar Spectroscopy for Greenhouse Gas Measurement
10:05	Kim Henville	Estimation of the Emissions of CO from Motor Vehicles in Melbourne
10:30	**Morning Tea**	
11:00	Roger Francey	CO_2 Measurement in the Australian Region – the Next Decade
11:25	Colin Allison	The Cape Grim Stable Isotopes in Atmospheric CO_2 Measurement Program
11:50	Rachel Law	Estimating CO_2 Sources from Continuous Measurements: Australia as a Test Case
12:15	Jill Cainey	Biology and Climate – Not Just a Sulfur Story
12:40	**Lunch**	
Chair	***Stephen Wilson***	
13:40	Andrew Smith	Accelerator Mass Spectrometry: An Overview of the Technique and of Small-mass ^{14}C Antarctic projects at ANTARES
14:05	Quan Hua	Atmospheric Radiocarbon Offset for the Tropics During the Little Ice Age
14:30	Roger Dargaville	LMDz – A New Atmospheric Transport Model with 'Zoom' Capability
14:55	Wlodek Zahorowski	Estimating the Regional Oceanic Radon Flux
15:20	**Afternoon Tea**	
15:50	Paul Fraser	Halon-1211 Emissions from Melbourne
16:15	Bronwyn Dunse	CFC Measurements at Cape Grim, 1978-2002
16:40	Stuart Baly	*In situ* SF_6 Measurements at Cape Grim
17:05	**Close of Papers**	
17:30	**Poster Wine and Cheese Evening**	**CSIRO-Atmospheric Research Canteen** **Presentation to Graeme Pearman**
19:00	**Dinner**	**Lobster Cave**

CAPE GRIM BASELINE AIR POLLUTION STATION

ANNUAL SCIENCE MEETING, 2002

Friday, 8 November		
Chair	***Paul Fraser***	
09:00	Convenors / Hosts	General information on arrangements etc.
09:10	Salah Jimi	Nano-particles at Cape Grim, Tasmania
09:35	Patrick Sheridan	NOAA/CMDL Aerosol Measurements at Trinidad Head, California
10:00	Mick Meyer	A Spatial Analysis of Anthropogenic Non-CO_2 Greenhouse Gas Sources from the Biosphere in Australia
10:25	**Morning Tea**	
11:00	Marcel Van der Schoot	Modification of Trace Gas Concentrations by Diffusive and Surface Processes
11:25	Cecelia MacFarling	Natural and Anthropogenic SF_6 and CF_4 in the Atmosphere
11:50	David Etheridge	Can we explain the causes of methane changes from isotopic information?
12:15	Mick Meyer	The Air Quality Monitoring Station Plans and Progress: The Development of Atmospheric Air Monitoring Programs Located at Aspendale
12:40	**Lunch**	
Chair	***Neil Tindale***	
14:00	Martin Cope	The Use of Long-Range Transport Simulations to Verify the Australian Air Quality Forecasting System
14:25	David Etheridge	Potential Geological Sources of Hydrocarbons to the Atmosphere
14:50	Workshop	Oil & Gas Operations in Bass Strait: Impacts on & Opportunities for Cape Grim
15:30	**Afternoon Tea**	
15:50	Workshop	Continued…….
17:00	**Close of meeting**	

Day 1

Cape Grim Wind Statistics and their use in Indicators of Baseline Conditions **1**
Paul Krummel

Ground-Based Near Infrared Solar Spectroscopy for Greenhouse Gas Measurement **2**
Glenn Bryant

Estimation of the Emissions of CO from Motor Vehicles in Melbourne **3**
Kim Henville

CO_2 Measurement in the Australian Region – The Next Decade **4**
Roger Francey

The Cape Grim Stable Isotopes in Atmospheric CO_2 Measurement Program **5**
Colin Allison

Estimating CO_2 Sources from Continuous Measurements: Australia as a Test Case **6**
Rachel Law

Biology and Climate - not just a sulfur story **7**
Jill Cainey

Accelerator Mass Spectrometry: An Overview of the Technique and of Small-Mass ^{14}C Antarctic Projects at ANTARES **8**
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Atmospheric Radiocarbon Offset for the Tropics During the Little Ice Age **9**
Quan Hua

LMDz – A New Atmospheric Transport Model With 'Zoom' Capability **10**
Roger Dargaville

Estimating the Regional Oceanic Radon Flux **11**
Wlodek Zahorowski

Halon-1211 Emissions from Melbourne **12**
Paul Fraser

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CAPE GRIM WIND STATISTICS AND THEIR USE IN INDICATORS OF BASELINE CONDITIONS

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Matt Tully & Arthur Downey
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Abstract

Wind speed and direction are used by almost all investigators conducting research at Cape Grim, as an indicator of air mass origin, as a real-time baseline indicator (in conjunction with CO_2 or CN) for instrument switching or flask filling, or for use in algorithms designed to select baseline conditions for specific species such as CO_2.

We will describe the wind statistics showing particular characteristics of the 10 metre, 30 metre and 50 metre wind frequencies using a type of 'wind frequency rose'. It is apparent that characteristics of the Cape Grim site influence the wind statistics in significant ways. For example, the frequency of winds from the baseline sector (190˚-280˚) depends on the choice of data from the 10 metre or 50 metre height, with baseline wind direction indicated about 10% less often by the 50 metre data, compared to the 10 metre data. This is almost certainly due to a channelling effect of the cliff face on the 10 metre winds from approximately 270˚, where winds from outside the sector (directions > 280˚) are channelled into it. In another example, easterly winds at 30 metre and 50 metre heights are distorted by passing through the tower before reaching the anemometers mounted on booms facing west.

The three real-time baseline indicators currently used at Cape Grim will be defined and brief explanations of their use will be outlined.

Progress towards a unified wind speed and direction dataset will be described. The implications of this work for selecting CO_2 baseline hours will be outlined.

GROUND-BASED NEAR INFRARED SOLAR SPECTROSCOPY FOR GREENHOUSE GAS MEASUREMENT

Glenn Bryant
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Abstract

The limitations of current data in constraining models of greenhouse gas sources and sinks are widely recognised, and efforts are already underway to improve the available spatial resolution within these data sets using satellite-based sensing. The alternative of a widely distributed network of ground-based observations is currently limited by instrument cost and complexity. However, ground-based near infrared solar spectroscopy has the potential to overcome some of these limitations. This talk will discuss the advantages of using the near infrared region of the spectrum for monitoring greenhouse gas total column concentrations, and consider instrumentation options that might be implemented in the field.

ESTIMATION OF THE EMISSIONS OF CO FROM MOTOR VEHICLES IN MELBOURNE

Kim Henville
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Abstract

CO emission estimates from Melbourne have been used in attempts to quantify the emissions of a number of other trace gases, through an analysis of Cape Grim data. For such "tracer" studies, it is essential that the tracer emission strength is known, and that the emissions are from the same region as the gases being investigated.

As part of a larger project (INTUITIVE) being run as CSIRO Aspendale, FTIR measurements of CO_2, CO, N_2O and CH_4 are being made. This will be later augmented with isotopic signature measurements. The aim of this project is to identify and quantify sources within the Melbourne air shed. Initial results will be presented from the FTIR measurements on CO and CO_2. Analyses indicate that the emission signal due to motor vehicles is distinguishable from signals resulting from other emission sources.

CO_2 MEASUREMENT IN THE AUSTRALIAN REGION – THE NEXT DECADE

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Abstract

The stabilisation of atmospheric greenhouse gases is now on the agenda of most national governments. For scientists monitoring CO_2 in the atmosphere, this presents new and difficult challenges. One or two monitoring sites like Cape Grim quite accurately capture the global change in atmospheric CO_2 on timescales longer than 1-2 years. The challenges are to identify the regions and processes most implicated in global change, to verify the effectiveness of regional measures to reduce anthropogenic CO_2 emissions and to provide early confirmation of possible feedbacks, in particular those that might accelerate climate change. Australia, as a result of innovation in measurement and modelling, and geographical location, is well positioned to make a unique contribution of considerable international significance.

THE CAPE GRIM STABLE ISOTOPES IN ATMOSPHERIC CO_2 MEASUREMENT PROGRAM

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Abstract

An update of the Cape Grim stable isotope program will be presented. In particular, issues of calibration that have lead to a difference between results from the *in situ* program and the flask program over the last few years will be addressed.

ESTIMATING CO_2 SOURCES FROM CONTINUOUS MEASUREMENTS: AUSTRALIA AS A TEST CASE

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Abstract

The standard practice for estimating CO_2 sources from atmospheric data has been to solve for monthly mean sources using monthly mean baseline data. This type of inversion has produced useful results but the uncertainties on the source estimates remain relatively large due to the limited atmospheric dataset. Continuous CO_2 data, such as that collected at Cape Grim, could significantly improve the inversion estimates because of the information contained in synoptic-scale variations in the CO_2 concentration. However, a number of methodological and modelling developments are required before we are able to incorporate continuous measurements into the CO_2 inversion. In this presentation we will highlight the required developments and demonstrate progress towards achieving these developments using the Australian region as a test case. We have used synthetic data generated from monthly sources to test the inversion methodology and found that we need to solve for sources at higher spatial resolution than in previous inversions. We have begun to extend these tests to cases where sources vary on sub-monthly timescales, using fluxes generated by the CSIRO Biosphere Model. We also assess the impact on the inversion of data quality. Inversions of continuous data will require transport modelling using analysed winds. We will show some recent results from the CSIRO Conformal-Cubic model for CO_2 at Cape Grim and some inversion tests that indicate the quality of transport modelling that may be required.

BIOLOGY AND CLIMATE - NOT JUST A SULFUR STORY

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Abstract

Dimethylsulfide (DMS) is just one of many gases that originate from marine organisms such as phytoplankton and seaweed. The CLAW hypothesis suggests that DMS crosses the air-sea interface to be oxidised to sulfur dioxide, forming new sulfate particles that can then act as cloud condensation nuclei. However in the marine boundary layer the presence of sea salt aerosol critically limits the ability of DMS derived sulfur to contribute to new particles.

DMS related new particle formation may occur in the free troposphere, where existing surface area is lower or it may occur in the marine boundary layer where other species may initiate or contribute to nucleation. It is perhaps time to modify the CLAW hypothesis so that there is not the exclusive dependence on DMS, but instead incorporate a number of biologically generated percursor species for which DMS may be a useful marker.

ACCELERATOR MASS SPECTROMETRY: AN OVERVIEW OF THE TECHNIQUE AND OF SMALL-MASS ^{14}C ANTARCTIC PROJECTS AT ANTARES

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Abstract

Accelerator Mass Spectrometry [AMS] is a technique of unsurpassed sensitivity that is often the only means by which cosmogenic radionuclides can be measured in natural samples. Such measurements have had a significant impact upon diverse disciplines, most notably Archaeometry and the geosciences. In this paper, an overview of the technique will be presented, with emphasis on the methodologies and capabilities of ANSTO's Australian National Tandem for Applied Research [ANTARES] facility.

Additionally, a brief review will be given of past collaborative projects with the AAD and CSIRO-AR which have relied upon our ability to measure $^{14}C/^{12}C$ in samples containing very small masses (10 to100μg) of carbon, focusing on technical issues. We plan to further decrease our useable carbon sample masses, and an example of a new project that could benefit from this capability will be presented.

ATMOSPHERIC RADIOCARBON OFFSET FOR THE TROPICS DURING THE LITTLE ICE AGE

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Abstract

A tree-ring chronology has recently been developed for Thailand [D'Arrigo *et al.* 1997]. This gives us an opportunity to investigate the atmospheric ^{14}C offset for the tropics during the Little Ice Age. Cross-dated tree-ring cores from Thailand, spanning AD 1620-1780, were used for this study. The cores were taken from *Pinus merkusii* trees grown at Phu Kradung, north-central Thailand (17°N, 102°E). During the growing season of Phu Kradung *Pinus merkusii* the atmospheric air movement is from the Indian Ocean, carried by the southwest monsoon. In addition, a cross-dated tree-ring section of Huon pine from western Tasmania (42°S, 145°E), covering the same period of time, was also investigated. We chose Tasmania for this study because it samples the moving air mass of a large part of the Southern Ocean and thus provides a highly appropriate baseline. Both sets of tree rings are typically less than 1mm wide, necessitating the use of AMS for radiocarbon analysis. A total of 16 pairs of decadal samples were extracted to alpha-cellulose [Hua *et al.* 2000] for AMS ^{14}C analysis using the ANTARES facility at ANSTO [Lawson *et al.* 2000].

The $\Delta^{14}C$ results from Thailand for the period of rising atmospheric radiocarbon (1620-1690) are insignificantly lower than those seen in northern temperate tree-rings [Washington, USA; Stuiver *et al*., 1998]. For the period of falling atmospheric ^{14}C (1690-1780), the $\Delta^{14}C$ values for Thailand are 3.9 ± 1.0 per mil lower than Washington. When compared with New Zealand [Sparks *et al.* 1995; McCormac *et al.* 1998], the Thai data are 2.5 ± 1.0 per mil higher, constant across the whole period 1620-1780. The pattern is thus very clear; the Thai data, from 17°N, are close to and follow the trend of the Southern Hemisphere, rather than that of the Northern Hemisphere. This is a surprising result, and we infer that atmospheric ^{14}C for north central Thailand was strongly influenced by the entrainment of southern hemisphere air parcels during the southwest Asian monsoon, when the Intertropical Convergence Zone moves to the north of our sampling site (north central Thailand).

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LMDZ – A NEW ATMOSPHERIC TRANSPORT MODEL WITH 'ZOOM' CAPABILITY

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Abstract

Analysis of continuous CO_2 measurements over the continents currently offers the potential to better understand the carbon fluxes between the terrestrial biosphere and the atmosphere, as well as providing an alternate check on fossil fuel emissions to help monitor future Kyoto type treaties on sub-continental scales. To do so requires much higher spatial and temporal resolution in the transport model than has been used in the past to analyses so called 'baseline' measurements such as those at Mauna Loa and the South Pole which are remote from strong CO_2 fluxes. An optimal way to achieve this increase in resolution is to use a model with a flexible grid such that an area of interest can have higher resolution than others, thus saving computational expense.

We present the LMDz (Laboratiore Meteorologie Dynamique zoom) model, describing its grid set-up and advection and convection schemes. Its ability to model large-scale features such as the seasonal cycle amplitude at baseline stations, as well as high frequency continental stations over Europe will be shown. We present several sensitivity studies using different spatial and temporal resolution, a new advanced planetary boundary layer scheme, and the impact of using different estimates of the surface CO_2 fluxes. We examine the model's behaviour both from a Lagrangian and Eulerian point of view. Finally, we outline the use of the self-adjoint aspect of the atmospheric transport model, and how the model can be used in an inverse mode to retrieve flux information from the atmospheric data at high spatial and temporal frequency.

ESTIMATING THE REGIONAL OCEANIC RADON FLUX

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Abstract

The large difference between terrestrial and oceanic radon fluxes sometimes leads to the oceanic flux being neglected in atmospheric models. However, including a realistic oceanic radon flux within models would improve comparisons between observed and simulated atmospheric radon concentration at remote sites with extended oceanic fetch.

A method for the direct estimation of regional oceanic radon fluxes is presented. The method is applied to a subset of the Cape Grim radon dataset from 1993 to 2001. A simple expression for an average oceanic radon flux is derived and applied using a selection of the Cape Grim observations representative of air parcels with an oceanic fetch. We argue that the selected radon concentrations are minimally perturbed from those in air masses that are in equilibrium with the oceanic radon flux.

The resulting radon flux from the region of the Southern Ocean within the Cape Grim radon measurement fetch is estimated to be 0.0024 atoms $cm^{-2}s^{-1}$. Based on the 10 and 90 percentile radon concentration and wind speed observations, and assuming a mechanically driven mixing height, the regional oceanic radon flux rate may vary from 0.0014 to 0.0035 atoms $cm^{-2}s^{-1}$ with wind induced changes in the sea state.

The result supports the common assumption that oceanic radon flux rates are 2-3 orders of magnitude lower than terrestrial radon fluxes. It is considerably lower than earlier experimental spot estimates of oceanic radon flux rates for a similar region. However, it is in closer agreement with the flux derived from model evaluation studies.

The new method of oceanic radon flux derivation presented here has immediate applicability to other sites around the world where 'clean' ocean air can be clearly identified. The presented method offers an alternative to local/spot estimates of oceanic radon flux such as the accumulation method and gradient methods, it is representative of a large region and reflects different environmental conditions.

HALON-1211 EMISSIONS FROM MELBOURNE

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Abstract

Halon-1211 ($CBrClF_2$), commonly known as BCF, was widely used in portable fire extinguishers until the mid-1990s, when halon consumption ceased in developed countries, under the Montreal Protocol restrictions.

Measurements of Halon-1211 commenced at Cape Grim in early 1998 as part of the AGAGE GC-MS program and the data show the 'tell-tale' pollution episodes, indicating significant emissions from the Melbourne region. The source of these emissions was thought to be leakage from old fire extinguishers and from the halon 'bank', a national facility for the capturing, reprocessing, storing or destuction of halons (and other ozone depleting chemicals), located at Tottenham, 10 km west of the Melbourne CBD.

The Cape Grim data suggest that most of the emissions occur during the decanting phase of the halon reprocessing. The halon bank estimates these emissions gravimetrically on a weekly basis and this could be one of the most accurately known emissions of a trace chemical into the Melbourne airshed.

Halon-1211 may provide a means of estimating other emissions by interspecies correlation techniques and could be an additional 'calibrating' species for estimating Melbourne emissions, together with carbon monoxide (CO), dichloromethane (CH_2Cl_2) and perchloroethylene (CCl_2CCl_2), whose emissions are estimated by the EPA as part of the Port Phillip Region emissions inventory.

CFC MEASUREMENTS AT CAPE GRIM, 1978-2002

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Abstract

CFCs were invented in the 1930s by General Motors Refrigeration Division as safe refrigerants suitable for domestic use. Over subsequent decades CFCs were used extensively as refrigerants, aerosol propellants, foam blowing agents and solvents, with total production exceeding 1.1 million tonnes per year in the late 1980s.

CFCs are the major source of anthropogenic stratospheric chlorine, largely responsible for global and Antarctic stratospheric ozone depletion over the past 25 years. There are five significant CFCs in the background atmosphere: CFC-11 (CCl_3F), CFC-12 (CCl_2F_2), CFC-113 (CCl_2FCClF_2), CFC-114 ($CClF_2CClF_2$) and CFC-115 ($CClF_2CF_3$).

The first atmospheric measurements of CFCs (CFC-11) in Australia were made in 1975 at Aspendale and commenced at Cape Grim, Tasmania, in 1976; CFC-12 measurements at Cape Grim commenced in 1978, CFC-113 in 1981, CFC-114 and CFC-115 in 1998. Measurements of these latter 3 CFCs have been made back to 1978 on the Cape Grim air archive at Cape Grim and at UEA.

CFC levels increased by about 5% per year from 1976 until about 2000, and have now started to decline at about 1% per year. This is a significant achievement for the Montreal Protocol, for the CFCs in the atmosphere will dominate ozone depletion over the next 50 years, and ozone recovery will only occur after CFC levels in the atmosphere have been reduced substantially.

IN SITU SF_6 MEASUREMENTS AT CAPE GRIM

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Abstract

Sulfur hexafluoride (SF_6) is widely used as a dieletric fluid in voltage breakdown transformers. It is a significant greenhouse gas, whose emissions are likely to be controlled by the Kyoto Protocol, or a similar international agreement to control emissions of greenhouse gases.

The current AGAGE GC-MS instrument at Cape Grim measures SF_6 with relatively poor precision. In 2000 it was decided to measure SF_6 in situ at Cape Grim using a proven GC-ECD technology.

This paper describes the measurement methodology, the interim calibration and the first 15 months of SF_6 data at Cape Grim. These data are compared to flask/air archive measurements of SF_6 at Cape Grim by SIO and the University of Heidelberg, extending back to 1978.

ATMOSPHERIC ORGANIC NITROGEN AT CAPE GRIM, TASMANIA

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now at
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Abstract

During the Southern Hemispheric spring of 2000 (during the months of November and early December), rain, bulk and size-separated aerosol samples were collected at the Cape Grim Baseline Air Pollution Station (CGBAPS) and analysed for total organic nitrogen (N), urea, and dissolved free amino acids. Rain and bulk aerosol samples contained organic N at concentrations representing ~20% of total N. Urea was not detected in the 6 rain samples analysed. However, urea represented ~28% of the organic N contained in non-baseline aerosol samples, and ~3% of the organic N contained within baseline samples. Trajectory analysis combined with meteorological data indicated that high concentrations of urea within aerosols were mainly due to Tasmanian sources, likely animal emissions, although the application of urea fertilizers cannot be dismissed as a source. In non-baseline samples the highest concentrations of urea were associated with the coarse mode aerosol (>1 μm), although urea was also found in the fine mode aerosol (<1 μm), potentially indicating gas-to-particle conversion of urea. Aerosol samples collected in marine air masses contained urea within an intermediate fraction centred at ~1 μm suggesting the sea surface microlayer as a source. Dissolved free amino acids contributed ~53% of the organic N in rain, but were not a significant proportion of the total organic N fraction in either non-baseline or baseline aerosol samples. Due to their presence in rain, amino acids likely exist in aerosols as un-hydrolysed proteins. In cascade impactor samples highly influenced by marine sources, profiles for amino N were inversely related to urea N, possibly indicating live species and the sea surface microlayer as a source for organic N.

IN SITU AEROSOL PROFILING OVER THE SOUTHERN GREAT PLAINS CART SITE

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Abstract

Aerosol optical properties were measured over the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site using a light aircraft (Cessna C-172N). The aircraft flew level legs at altitudes between 500 m and 3500 m several times per week over the course of a year in order to obtain a statistically representative data set of in-situ aerosol vertical profiles. Instrumentation on the aircraft was similar to that at the surface SGP CART site so that measurements at the surface and aloft could easily be compared. Measured parameters included total light scattering, hemispheric backscattering and absorption coefficients, while calculated parameters included single scattering albedo, backscatter fraction, and Ångström exponent. Statistical plots of aerosol optical properties and their variation in the lower column (0-4000 m) showed that, over the course of the year, albedo, backscatter fraction and Ångström exponent varied relatively little with altitude (at least up to 1800 m). Despite the vertical consistency, the correlation between column average and surface values for single scattering albedo, backscatter fraction, and Ångström exponent tended to be quite low, with r-squared correlation coefficients ranging from 0.2 to 0.5, and linear regression slopes ranging from 0.3 to 0.7. These results suggest that long-term surface aerosol measurements capture the column aerosol properties, but may not be as representative of day-to-day variations in the column. Comparison of aerosol optical depth (AOD) calculated from the vertical profiles with other measurements of AOD made at SGP (i.e., by the Cimel sunspot photometer and the multifilter rotating shadowband radiometer (MFRSR)) showed fair correlation (R2 ~ 0.4 Cimel, R2 ~ 0.8 MFRSR), although the aircraft AODs tended to be 50-75% less than those derived from the radiation instruments, even after incorporating a correction for supermicrometer aerosol and stratospheric aerosol.

SURFACE-BASED OBSERVATIONS OF VOLCANIC EMISSIONS TO THE STRATOSPHERE

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Abstract

Long-term, surface-based observations of the stratospheric aerosol layer are presented and compared. These include three lidars, at Mauna Loa Observatory (Hawaii), Langley Research Center (Virginia), and Garmisch-Partenkirchen (Germany); balloon-borne particle counters at Laramie, Wyoming, solar visible transmission at Mauna Loa Observatory; aerosol optical depth at South Pole Station and Mauna Loa Observatory; and lunar eclipse optical depth, which is a globally-integrating technique. It is concluded that surface-based measurements have provided a useful historical record of volcanic aerosol effects on the stratosphere. The agreement between the various techniques is very good. However, some uncertainties exist when the stratosphere is relatively free of volcanic aerosol and some of the techniques are not able to resolve the very small amount of aerosol from natural and/or anthropogenic sources. The lunar eclipse data, which goes back to the late 1800's, suggest that the Pinatubo eruption in 1991 may have perturbed the stratospheric aerosol layer to a larger extent than that of Krakatau in 1883. This is an important observation as it is one of the few ways to intercalibrate the effects of eruptions prior to modern measurements which began in the late 1950's. At the present time, the stratosphere appears to be at background with the lowest level of aerosol observed since the layer was discovered in 1959.

ONGOING INTERCOMPARISON EXPERIMENTS: IMPROVING THE QUALITY OF ATMOSPHERIC GREENHOUSE GAS MEASUREMENTS

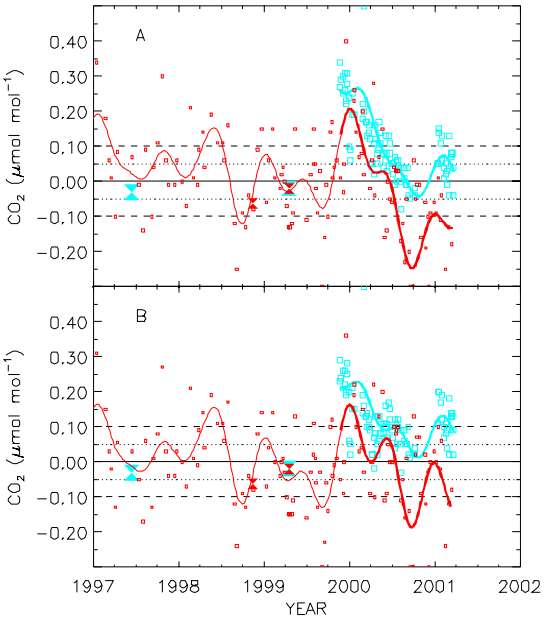
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Abstract

The Carbon Cycle Greenhouse Gases Group participates in ongoing flask air InterComParison (ICP) experiments with CSIRO, Australia (begun in 1992) and MSC, Canada (1998). The purpose of these activities is to establish consistency among atmospheric greenhouse gas observations so that data from these networks can be integrated into larger cooperative observing networks. Key design features of the ICP experiments include 1) routine multiple-species analysis by each laboratory of the same ambient air from a network flask; 2) minimal impact on personnel and equipment; 3) automatic exchange and processing of ICP data; and 4) ready access to monthly updates and archived ICP results. Results from the ICP experiments show that inconsistencies among our measurements do exist and often vary with time. Because observed discrepancies in the ICP results may be due to analytical or calibration problems in one or more of the participating laboratories, identifying causes has been difficult. These ongoing ICP experiments, however, have become important quality assurance tools that we routinely use to further evaluate the performance of our measurement and calibration techniques. By comparing ICP results for different gases, we can potentially determine if a problem is gas specific. By comparing the results from both the CSIRO and MSC ICP experiments, we can potentially identify in which of the 3 laboratories a problem is likely to exist. Information provided by the ICP results is a warning to each laboratory that an experimental problem may exist. Participating laboratories, however, are highly motivated to determine if their procedures may be contributing to the discrepancies revealed by the ICP results. Inconsistencies in the ICP results have spawned further investigations which include careful re-examination of existing procedures and experiments designed to test possible causes. Corrections to data or to procedures are made only if the cause of a problem can be independently verified within the laboratory. Not all corrections result in improved ICP results. While results from these ICP activities often raise more questions than they answer, they have directly contributed to improvements in the quality of CCGG data.



A smooth curve (blue line) is fitted to CO_2 differences (MSC minus NOAA) between independent measurements of the same air in flask samples collected at Alert, Nunavut, Canada (blue squares). Also plotted is the smooth curve (red line) fitted to the CO_2 differences (CSIRO minus NOAA) from the CSIRO/NOAA flask air ICP experiment at Cape Grim, Tasmania (red squares). Mean differences determined from multiple intercomparisons of air in high-pressure cylinders are shown as hourglass symbols. Panel A shows differences before NOAA re-examines the network flask CO_2 analysis system. The coincident trends in the differences suggest that a problem may have developed with the analysis of the ICP flasks at CMDL. Panel B shows curves and differences after test gas and reference gas cylinders have been drift-corrected.

EVIDENCE OF A TEMPERATURE-ALBEDO FEEDBACK IN NORTHERN ALASKA RELATED TO EARLIER SPRING SNOWMELT

R. S. Stone, E. G. Dutton, J. M. Harris & D. Longenecker
NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, Colorado USA

Abstract

This poster describes the advancing spring snowmelt date at Barrow, Alaska and explores its causes.

MONITORING AEROSOL OPTICAL DEPTH AT CMDL POLAR OBSERVATORIES

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Abstract

This poster describes the AOD monitoring activities at Barrow, Alaska, and the South Pole, including methods, calibrations, and radiative forcing calculations.

RADIOCARBON VARIATIONS FROM THE SOUTHERN HEMISPHERE, 10,350 – 9,700 CAL BP

M. Barbetti, Y. Zhao & B. Thomson

The NWG Macintosh Centre for Quaternary Dating, University of Sydney, NSW 2006

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Abstract

We have made AMS measurements on a series of 10-ring samples from a subfossil Huon pine log found in western Tasmania (42ºS, 145ºE). The results show a pronounced rise in $\Delta^{14}C$ over 200 years, and a decrease over the following 100 years.

Tree-ring width measurements indicate that this log (catalogue SRT-447) can be cross-dated with another subfossil log (SRT-416) for which a series of high-precision radiometric ^{14}C measurements have previously been made. When the two tree-ring series are thus aligned, SRT-447 is the older of the two logs, and there is a 139-year overlap. We then have a Huon pine floating chronology spanning 680 years, with ^{14}C measurements attached. The ^{14}C data sets generally agree well within the period of overlap indicated by the tree-rings.

The ^{14}C variations from Huon pine show excellent agreement with those from German oak and pine for the period 10,350 to 9,670 cal BP. Alignment with the ^{14}C age minimum at 10,100 cal BP allows us to position the floating Huon pine series, and to examine the inter-hemispheric offset in ^{14}C dates in the Early Holocene.

NANO-PARTICLES AT CAPE GRIM, TASMANIA

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Keywords: Cape Grim, Nano-particle events, MBL, ACE-1, Frontal Passage

Abstract

This talk is on nano-particle (3 - 12 nm) measurements made in the marine boundary layer (MBL) at Cape Grim during 1999 - 2000. The study involves two analyses of aerosol measurements; the first is based on wind sector classification of air masses arriving at the Cape Grim monitoring station, and the second on observations following the passages of cold fronts. For the first type of analyses, seasonal diurnal variations for three broad air mass origins, Tasmania, continental Australia and clean maritime were examined. Significant differences were found in the diurnal patterns between the three sectors with a broad daytime enhancement in the Tasmanian sector, attributed to urban/industrial activities. Low nano-particle concentration was observed in the early morning (00:00-06:00) and night (18:00-23:00) in this sector. The diurnal variation for the continental sector had daytime peak concentrations consistent with secondary aerosol production by photochemical processes. In the Baseline sector there was some evidence of photochemical enhancement of concentrations during the day but low concentration during the night-time.

The behaviour of nano-particle concentrations following frontal passages during the same period was also investigated. Nano-particle enhancements were observed following the passage of cold fronts. The enhancements were stronger in summer (480 cm^{-3}) followed by spring (363 cm^{-3}) and autumn (188 cm^{-3}). Winter showed the weakest enhancement (152 cm^{-3}). These results suggest that photochemical processes drive the observed nano-particle enhancements. On average, the nano-particle reached peak concentration 10 - 15 hours after frontal passages and lasted for about 6 - 13 hours. These results are consistent with nano-particle observations made by [Bates *et al*., 1998] during the First Aerosol Characterisation Experiment (ACE-1). Most of the time the enhancements due to individual frontal passage at Cape Grim were of greater magnitude than those from ACE-1. Meteorological observations have been compiled to establish any relationship between strength of the frontal passage and the nano-particle events. These correlations are found to be weak. The enhancement in nano-particle concentration, however, is found to correlate with drier air during post-frontal subsidence, suggesting that the actual frontal passage may not be key factor in the nano-particle production.

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NOAA/CMDL AEROSOL MEASUREMENTS AT TRINIDAD HEAD, CALIFORNIA

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Abstract

In mid-April 2002, the NOAA Climate Monitoring and Diagnostics Laboratory (CMDL) began an extended effort to measure radiatively important trace gases, aerosols and radiation at Trinidad Head (THD), California. The start of these measurements coincided with a month-long field intensive for the Intercontinental Transport and Chemical Transformations (ITCT) program, which was designed to investigate how atmospheric pollutants from one continent can influence air quality and regional to global scale climate on other continents. For example, desert dust mixed with anthropogenic pollutants from Asia has been observed over ten thousand kilometers away in the western United States. CMDL's measurements will contribute to understanding the role of intercontinental transport of aerosol particles and trace gases in climate forcing and air quality.

This presentation provides a tour of the new CMDL station at THD and focuses on the aerosol measurements. The first six months of measurements at THD have provided numerous examples of long range transport of dust, smoke, and pollution across the Pacific, as well as local pollution and smoke events. A number of these transport events are discussed. On a longer-term basis, the THD site is a prime candidate for the location of a new CMDL Baseline Observatory. A station on the west coast of the United States will provide information on the inflow of aerosols and other atmospheric constituents to North America and will complement both the remote Baseline Observatories and the regional monitoring stations in the central United States. These early measurements at THD have provided CMDL with the start of a long-term data set for atmospheric monitoring at the site. Alternatively, if a different location is chosen for the CMDL station, the data will provide a point of comparison for spatial and cyclical variability of climatically important atmospheric species.

A SPATIAL ANALYSIS OF ANTHROPOGENIC NON-CO_2 GREENHOUSE GAS SOURCES FROM THE BIOSPHERE IN AUSTRALIA

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Abstract

The emissions of greenhouse gases from Australian agricultural and natural ecosystems have come under increased scrutiny over the last few years. In 2000, agriculture contributed 18% of Australia's net greenhouse gas production; 11% was methane, (CH_4) produced by enteric fermentation and 7% was produced principally from the agricultural soils under crops and pastures, and by savanna fires. The emissions from agricultural soils have increased by 23% since 1990, an annual rate comparable to the energy and transport sectors and far greater than the national total (6.5% since 1990). The sector is also a major source of uncertainty in the national emissions inventory. While emissions from fossil fuels (energy and transport) are known to ± 3%, the uncertainty in emissions from soils range from –50% to +100% of the mean value, or from 1.6% to 7.3 % of the total national emissions. Inverse modelling studies based upon Cape Grim measurement data can be used to assess and improve the accuracy of source fields derived from this and similar emissions inventories. As a first step we have analysed the National Greenhouse Gas Inventory for the Agricultural Sector at statistical local area in order to identify the regions and agricultural practices which constitute the greatest sources of emission and uncertainty. In this presentation we discuss these sources in detail and analyse the possible pathways towards reducing the uncertainty in their estimates.

MODIFICATION OF TRACE GAS CONCENTRATIONS BY DIFFUSIVE AND SURFACE PROCESSES

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Abstract

CSIRO GASLAB maintains atmospheric measurement programs for various greenhouse and biogeochemically related gases, and seeks to integrate its data with those of collaborating international laboratories. However, for some species (e.g. CO_2), decades of inter-comparison activities have indicated unexpectedly poor agreement among laboratories. This has limited the usefulness of integrated data sets for interpretive studies. The poor inter-comparability reflects the presence of systematic biases whose causes have been difficult to establish. GASLAB's multi-species, high precision measurement capabilities provide an avenue for investigating the cause of such effects and for refining inter-comparison strategies. Recent experiments provide evidence of trace gas modification by various diffusive and surface processes.

NATURAL AND ANTHROPOGENIC SF_6 AND CF_4 IN THE ATMOSPHERE

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Abstract

Sulfur hexafluoride (SF_6) and carbon tetrafluoride (CF_4) are powerful atmospheric greenhouse gases on a molecule for molecule basis. The radiative forcing of SF_6 and CF_4 is presently small due to their low atmospheric concentrations. Presently, the dominant sources are anthropogenic and relatively minor natural geological sources for both gases have been suggested. Both gases are included in the Kyoto Protocol on climate protection. These compounds are also potentially very useful atmospheric and hydrological tracers, due to their inertness and rapid atmospheric growth. Here we present well-dated measurements of SF_6 and CF_4 in Antarctic firn air, beginning about 1938. The deepest samples predate industrial production of both gases suggesting emissions from natural sources or early anthropogenic synthesis.

CAN WE EXPLAIN THE CAUSES OF METHANE CHANGES FROM ISOTOPIC INFORMATION?

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Abstract

The near tripling of the concentration of atmospheric methane in the last 200 years is of concern because of methane's radiative and chemically reactive properties. Large, perplexing variations in the methane growth rate in recent decades show that its secular trend is hard to predict. This presentation will discuss the use of methane isotopic measurements (^{13}C and ^{14}C), which now extend back to the 1930s, to help understand how the methane budget has evolved.

THE AIR QUALITY MONITORING STATION PLANS AND PROGRESS: THE DEVELOPMENT OF ATMOSPHERIC AIR MONITORING PROGRAMS LOCATED AT ASPENDALE

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Abstract

Proposed projects and infrastructure involving monitoring of greenhouse gases, air toxics and particles at Aspendale have been aired at many venues over the last few years. The focus of these projects varies from routine monitoring of ambient air quality, studies of transport of the Melbourne plume to Cape Grim, and acquisition of data for urban source characterisation and inversion modelling of source strengths. There have been significant developments on these fronts in the last year including the establishment of an ambient monitoring station for the criterion pollutants and the routine monitoring of the greenhouse gases by FTIR. The plans and progress of this work and its relevance to other air quality programs within CAR will be presented and discussed.

THE USE OF LONG-RANGE TRANSPORT SIMULATIONS TO VERIFY THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM

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Abstract

The Australian Air Quality Forecasting System (AAQFS) was used in hindcast mode to model long-range transport of CO from Melbourne to Cape Grim, a distance of about 300 km. Three periods of elevated CO concentrations were observed at Cape Grim during a 14-day study period that ran from 18 September to 1 October, 2001. The AAQFS successfully predicted elevated CO concentrations during all three periods when a detecting radius of 0.1° was used. This is a very good result given the expected trajectory error over that distance is about 1.0°. A more quantitative assessment revealed timing errors of up to 12 hours, and the modelled peaks in the Cape Grim CO time-series tended to be shorter in duration and greater in magnitude when compared with that observed. The timing errors were attributed to errors in forecasting the wind trajectories.

It is suggested that the forecasts could be improved by increasing the horizontal diffusion to reduce the 'peakiness' of the modelled CO time-series, and by reducing a slight over-estimation of the height of the marine boundary layer.

Although unverifiable in detail due to insufficient observations, the AAQFS identified a number of interesting plume features. An apparent pulsing of CO out of the Melbourne airshed due to morning and evening peaks in CO production was present during all three periods. These pulses often maintained their identity throughout the crossing of Bass Strait. The presence of varying wind directions across Bass Strait during the second period, and temporal variations in wind direction led to plume folding into a zig-zag-like pattern which brought a succession of peaks to the Cape Grim time-series. The zonal component of the predominantly northerly winds shifted from east to west to east and back to west again throughout the third period, which caused the plume to sweep back and forth across Bass Strait and Cape Grim. Early in the third period fumigation brought the first elevated CO concentrations to Cape Grim, and late in the third period a cold front arrived from the west and cleared the plume from Bass Strait. As it encountered the plume the convergent winds narrowed the plume into a thin line of highly concentrated CO. These plume features are likely to be of greater interest in regions of the globe where long-range transport is more important.

Keywords: Long-range transport, numerical high-resolution air quality forecasting, wind trajectories, horizontal diffusion, carbon monoxide plume behaviour.

POTENTIAL GEOLOGICAL SOURCES OF HYDROCARBONS TO THE ATMOSPHERE

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Abstract

The release of hydrocarbons from marine geological formations has been detected in several regions around Australia. The releases can be caused by natural seepage and by oil and gas exploration and production activities. Sedimentary basins west of Cape Grim and in Bass Strait are potential sources of emissions that may, if sufficiently large, appear in measurements at Cape Grim, particularly of methane.