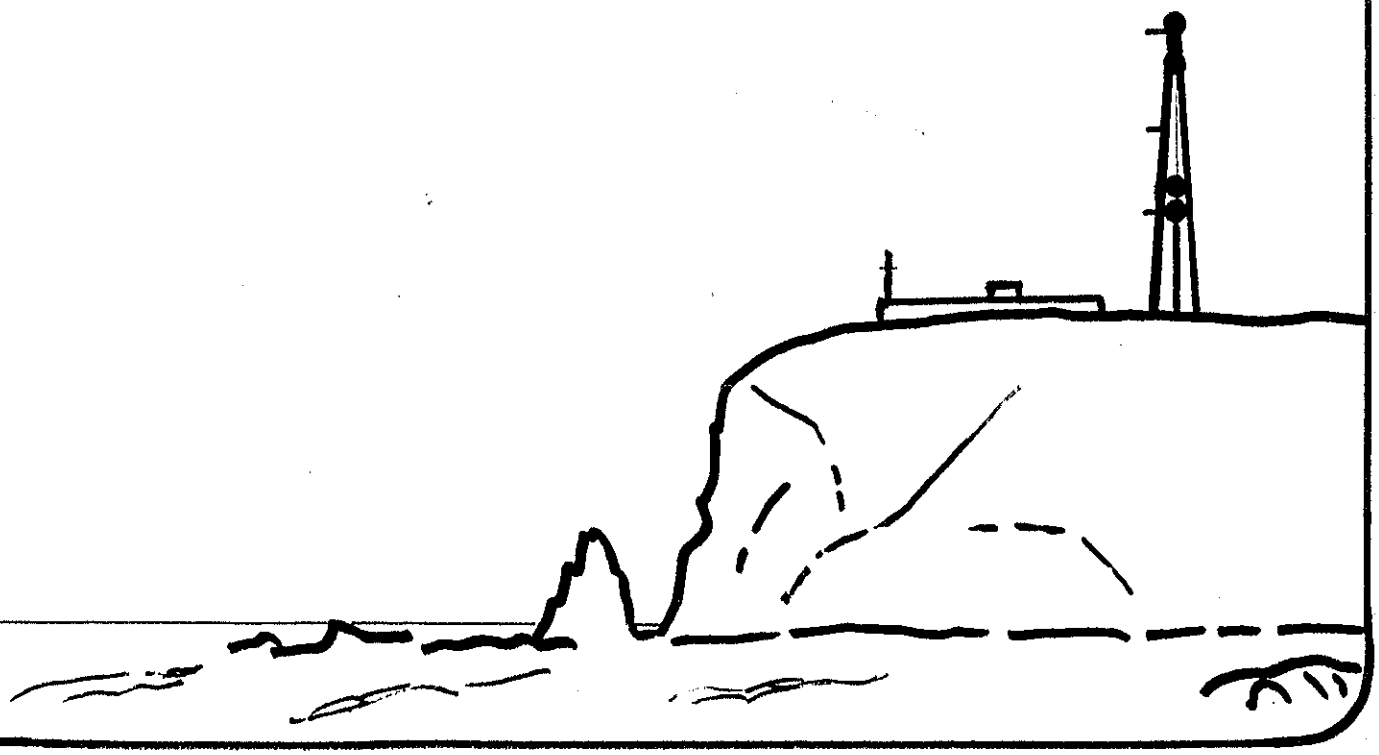
CAPE GRIM
BASELINE AIR POLLUTION STATION

ANNUAL MEETING
1993

UNIVERSITY of TASMANIA
HOBART
4th and 5th November, 1993



Cape Grim Baseline Air Pollution Station

Annual Meeting, 1993

Programme

Thursday 4 November

Chair: Bill Budd

9.00	G. Ayers	Advances in the Cape Grim Sulfur Program.
9.20	S. Wilson	UV-B measurement protocol and results from Cape Grim.
9.40	R. Boers	LIDAR and Liquid Water Radiometer operations during SOCEX.

10.00 Morning Tea

Chair: Tony Chaffey

10.30	P. Walford	Recent developments in the GRIMCO II Project.
10.50	D. Hofmann	Stratospheric ozone depletion: Volcanic aerosol effects in the Antarctic and at home in America.
11.20	W. Zahorowski	Ozone/Radon correlations in Baseline, Australian and Tasmanian wind sectors.
11.40	D. Etheridge	Firn Air: a glacial archive of the atmosphere for the last few decades.
12.00	M. Esler	Spectroscopic measurement of CO: can it rival GC for precision and accuracy?
12.20	S. Whittlestone	Performance of the Cape Grim Huge Radon Detector.

12.40 Lunch

Chair: Dave Hofmann

13.40	G. Pearman	*Strategic Review of Australian BAPMoN activities*
and	G. Pearman	Some thoughts on 20 years of CO_2 measurements over SE Australia and Cape Grim.
14.10	P. Fraser	Halocarbon and N_2O research at Cape Grim,1976 to 2000.

15.05 Afternoon Tea

Chair: David Lowe

15.25	P. Steele	Update of methane, CO and hydrogen measurements at Cape Grim.
15.45	R. Francey	Observations of $\delta^{13}C$ in the atmosphere.

16.40 All **Strategic Review - Initial Discussion**

DINNER **19.00 for 19.30** **Sisco's Restaurant,** (Spanish)
121, Macquarie St., Hobart

Friday 5 November

Chair: Paul Fraser

09.00	B. Budd	Atmospheric modelling of the CO_2 cycles.
09.20	H. Granek	Statistical analysis of global CO_2 data.
09.40	D. Griffith	FTIR methods for the measurement of the exchange of trace gases (eg. N_20, CH_4) with soils.

10.00 Morning tea

Chair: Stephen Wilson

10.30	D. Lowe	What's happening to atmospheric methane? ...tentative evidence from carbon isotopes.
10.50	H. Beggs	Air-sea exchange of CO_2 over the Southern Ocean and its imprint on the atmosphere.
11.10	G. Creswell	Oceanography of Western Tasmania.
11.30	J. Reid	Southern Ocean wave measurements.
11.50	R. Morris	Antarctic middle and upper atmospheric physics - a new direction.
12.10	V. Morgan	All about the Dome Summit South ice-core.

12.30 Lunch

Chair: David Griffith

13.30	J. Ivey	Gas chromatographic analysis of atmospheric dimethylsulphide at the Australian Baseline Air Pollution Station Cape Grim.
13.50	C. Dick	The CG high volume aerosol data record.
14.10	J. Warne	Overview of Regional BAPMoN Precipitation Network.
14.30	B. Wells	New potential techniques for DMS and ion analysis.

14.50 Afternoon Tea and possibly a video of the Chinese Station

Chair: Chad Dick

15.20	P. Price	The CGBAPS Aid Program - a continuing saga.
15.40	L. Porter	The Chinese Global Atmosphere Watch Station at Waliguan, Qinghai Province.
	16.00	**Close of meeting.**

ADVANCES IN THE CAPE GRIM SULFUR PROGRAMME.

G.P. Ayers, R.W. Gillett, J.M. Cainey and P.W.Selleck.
CSIRO Division of Atmospheric Research, Aspendale

A micro-orifice uniform deposition impactor (MOUDI) was installed at Cape Grim at the beginning of September to determine the chemical composition of aerosol in twelve size ranges, between 0.028 and 9.0 μm. Initial results of non sea-salt sulfate, methane sulfonic acid, chloride and ammonium concentrations will be presented. On 18th October a trial run of the new sulfur dioxide measurement system was carried out at Cape Grim. This system is designed to give hourly averaged sulfur dioxide concentrations under baseline conditions; the system will be described, possibly with some initial results. The results of a box model to predict dimethyl sulfide emissions at Cape Grim and Macquarie Island will be discussed.

UV-B MEASUREMENT PROCTOCOL AND RESULTS FROM CAPE GRIM

S.R. Wilson* and B.W. Forgan**
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** Obs and Engineering
Bureau of Meteorology
150 Lonsdale St, Melbourne, 3001

One of the major problems associated with the measurement of UV-B is the calibration of the irradiance measured. Previous assessments of calibration procedures have shown that 10-20% differences have existed between standards that can ostensibly be traced to the same primary irradiance standard. We have therefore been developing an in situ calibration method for UV-B spectral measurements, using the sun as the primary calibration source. Although the sun is a more constant source, the changes in observed irradiance at ground level due to the atmosphere provide a major challenge.

We have combined the measurements made from a UV-B spectral radiometer and a sunphotometer to calibrate the spectral radiometer. In tandem, model calculations have been performed to look at the limits of performance that can be achieved by this technique.

The general method will be outlined, and the resultant calibrations assessed.

LIDAR AND LIQUID WATER RADIOMETER OPERATIONS DURING SOCEX

Reinout Boers, Stuart Young, Peter Manson, Graeme
Paterson, Martin Platt, Matthew Pickett
CSIRO Division of Atmospheric Research

Examination of satellite optical depth records strongly suggests a coupling between seasonal changes in the concentration of naturally occurring cloud condensation nuclei (CCN) and stratocumulus cloud optical depth (Boers, Ayers and Gras, 1993). The Southern Ocean Cloud Experiment (SOCEX) was designed to study in situ the seasonal cycle in thermodynamic, microphysical and radiative properties of marine stratiform clouds which are the result of variability of naturally occurring CCN.

Under the umbrella of SOCEX a program of ground based observations was formulated funded to a large extent by the CGBAPS-program. The primary focus of this program was the remote retrieval of cloud properties using a lidar, microwave radiometer and an infrared radiometer. Cloud properties that were measured by the lidar include cloud base height, cloud top height, cloud optical depth, cloud base extinction, drizzle and subcloud aerosol backscatter. Liquid water path and water vapor path were measured by the microwave radiometer, while the infrared radiometer was used to observe cloud optical depth.

During the presentation we will discuss some of the principles of operation of the lidar and microwave radiometer and show results from our first pass through the data set.

Literature: Coherence between seasonal variation in satellite-derived cloud optical depth and boundary layer CCN concentration at a mid-latitude Southern Hemisphere station. R. Boers, G. Ayers, J. Gras. 1993. Accepted for publication in Tellus B.

RECENT DEVELOPMENTS IN THE GRIMCO 2 PROJECT

Peter Walford
BoM, CGBAPS

Since the last CGBAPS Annual Meeting, the Computer Replacement Project (Grimco 2) has progressed in several directions. A local area network has been installed at Cape Grim, and is presently served by the Solbourne S4000 workstation. A number of PCs for data acquisition and instrument control have been purchased, one of which is collecting data from a biometer using software programmed in Visual Basic and running under Windows. A Hewlett-Packard series 9000 model 715 workstation has also been purchased, together with peripheral equipment and a number of software packages. Progress is at last being made with the wide area network, which will connect CGBAPS to the Bureau of Meteorology's Weathernet, and hence to the Internet. Total capital expenditure on this project for 1993/94 is $165,000.

STRATOSPHERIC OZONE DEPLETION: VOLCANIC AEROSOL EFFECTS IN THE ANTARCTIC AND AT HOME IN AMERICA

D.J. Hofmann, NOAA Climate Monitoring and Diagnostics Lab, Boulder, Colorado

Record low total ozone values were set at many stations in the northern hemisphere in 1993. For example, total ozone was at least 10% below the long-term averages at all U.S. mid-latitude Dobson stations, with ozone deficits exceeding the 2 sigma level 73% of the time during January-May 1993. Total ozone levels at the south pole broke the all-time record with 105 DU on October 11, 1992, during the annual ozone hole period and then clobbered this record on October 6, 1993 with 88 DU. Since the pre-hole ozone levels are about 270-300 DU, this represents a loss of at least 70% of the total ozone present. Other regions of the southern hemisphere seem to have escaped unusual ozone loss during the winters of 1992 and 1993. In 1989 it was suggested that a major volcanic eruption could reduce stratospheric ozone substantially if the aerosol which formed in the stratosphere had effects similar to the particles of polar stratospheric clouds in the polar regions, thus placing the great June 1991 eruption of the volcano Pinatubo under suspicion. In addition to chemical perturbations, stratospheric dynamics are perturbed through the aerosol heating which results following a major eruption. Laboratory measurements indicate that under winter and spring mid-to high-latitude stratospheric conditions (temperatures below 210K, large solar zenith angles), the volcanic sulfuric acid - water aerosol can be effective in chlorine activation leading to ozone depletion. Indeed, ozone loss at Boulder, Colorado occurred in the same altitude region occupied by the Pinatubo aerosol cloud more that 2 years after the eruption, suggesting that dynamic influences are not the dominant process. In the upper reaches of the cloud, above 24km, ozone was observed to be higher than normal. Preliminary detailed modelling of the volcanic aerosol-related heterogeneous chemistry appears capable of predicting both the ozone loss and production. Yet to be addressed properly is why the second northern winter after the eruption saw greater ozone depletion than the first and why the southern midlatitude winters did not appear to have similar effects.

OZONE AND RADON AT CAPE GRIM: A STUDY OF THEIR INTERDEPENDENCE

W. Zahorowski,[1] I.E. Galbally[2] and S. Whittlestone[1]
[1] ANSTO, New South Wales
[2] CSIRO, Division of Atmospheric Research

A discussion of the ozone and radon variations and their interdependence is presented. In particular, the effect of some baseline selection criteria on the quality of the recorded data is demonstrated as are mechanisms responsible for ozone-radon correlations in function of seasonal change and the wind sector. A simple model is proposed to discuss quantitatively the observed correlations in the Tasmanian sector.

FIRN AIR: A GLACIAL ARCHIVE OF THE ATMOSPHERE FOR THE LAST FEW DECADES.

D.M. Etheridge, R.J. Francey, L. P. Steele, J.-M. Barnola*, T. Sowers#, V.I. Morgan+ and J. Schwander°.

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The permeable upper layer of a polar ice sheet is called firn, consisting of compressed snow which gradually metamorphoses into ice at about 60 - 100 metres depth. The firn layer has been studied in detail to understand the transfer function of the atmosphere to the sealed bubbles in the ice below, which are used for reconstructing past atmospheric composition. Air mixes slowly through the firn, primarily by diffusion, so that old air can be found at depth. Samples of firn air have been collected by drilling into the ice sheet and pumping at many levels.
Results will be presented from the 1993 firn air program at DE08-2, a site with very high snow accumulation rate on Law Dome, Antarctica. Air was sampled at 16 levels using 2 Firn Air Sampling Devices (FASD's), 2 types of pump and 5 types of containers. This redundancy allowed any detrimental effects of different materials in contact with the air samples to be avoided. The samples have been analysed for concentrations of CO_2, CH_4, N_2O, H_2, CO and halocarbons and the isotopic ratios $\delta^{13}CO_2$, $\delta^{18}CO_2$, $\delta^{13}CH_4$, $\delta^{29}N$, $\delta^{34}O$ and O_2/N_2.
The results confirm earlier assumptions that the air at the pore isolation depth is about 10 years old, that there is some settling of the heavier components by gravity and that the ice sheet is effectively isolated from the atmosphere at about 70 metres depth where the density is 800 kg/m^3. These factors must be taken into account in reconstructing past atmospheric records from ice cores.
An important outcome of the program is the atmospheric archive that is available in the firn air. At DE08-2 the firn air is about 10 years old at the level where the firn becomes isolated from the atmosphere. Below this there is air in the open pore space that, although sealed from the atmosphere *in-situ*, can nevertheless be collected and may be 20 years old. Rates of change of atmospheric concentrations for this period may be precisely determined from firn air because the measurements are made on the same instruments using the same procedures and calibrations. Air can be retrieved from these layers in much larger quantities than is available from ice cores. Species such as $\delta^{13}CH_4$ which require large sample size are ideal candidates for measurement in the firn air. At lower accumulation rate sites such as Vostok the deepest firn air may be from the 1950s, but with somewhat less resolved air age. Modelling of the diffusion of air in the firn will better determine the air age and help deconvolute the atmospheric records obtained from the firn and from ice cores.

SPECTROSCOPIC MEASUREMENT OF CO: CAN IT RIVAL GC FOR PRECISION AND ACCURACY?

M. Esler, D.W.T. Griffith, S.R. Wilson
Department of Chemistry, University of Wollongong,
Wollongong NSW 2522

and

P.Steele
CSIRO Division of Atmospheric Research

Gas chromatography (GC) is currently used for routine CO monitoring at baseline levels. A Fourier Transform InfraRed (FTIR) spectroscopic approach is being developed as an alternative which offers several advantages over GC methods:

- Being spectroscopic, FTIR is an "absolute technique", characterised by the direct linear relationship between absorption and concentration specified by the Beer-Lambert law. GC is a relative technique where the relationship between detector output and concentration is less well defined.
- FTIR allows the simultaneous monitoring of several trace species with a single experiment and calibration. In this work N_2O, CO_2 and H_2O are measured in addition to CO. The technique is, in principle, easily extended to CH_4 and other trace gas species.

A commercial instrument has been modified for this application. Parallel studies employing calculated absorption spectra (from the HITRAN database) as well as experimental spectra of real air and gas mixtures are being pursued. Two different linear regression calibration algorithms, CLS and PLS (classical and partial least squares analysis, respectively), are being investigated.

For CO in air at baseline levels, say 50 ppbv, a retrieval precision of <1% has been demonstrated. This is already very competitive with the precision of GC techniques. Furthermore, theoretical studies indicate an achievable precision of the order of 0.25% at baseline CO levels. Experimental modifications have been undertaken to bring the experiment closer to this theoretical limit.

PERFORMANCE OF THE CAPE GRIM HUGE RADON DETECTOR

S. Whittlestone and W. Zahorowski
ANSTO, New South Wales

The radon detector operating at Cape grim from 1981 to February 1993 was superseded by an instrument with the background and lower detection limit enhanced by at least one order of magnitude. The paper explains why the improvement was necessary, details the new detector construction, and how it has performed in its first years of operation.

STRATEGIC REVIEW OF AUSTRALIA BAPMoN ACTIVITIES

G.I. Pearman, CSIRO, Division of Atmospheric Research

The development of the observational program at Cape Grim had its beginnings in 1970, when scientists at the CSIRO Division of Atmospheric Research identified the need for a network of observatories spanning the globe, and establishing a repository of information concerning the natural and anthropogenically-influenced variations in the composition of the global atmosphere. Much of the effort required to establish the station was undertaken during the period 1972-1975, during which time a philosophy was established for its operation, key scientific priorities were set, management arrangements and building designs commensurate with the underlying philosophy were developed. Extensive field expeditions collected preliminary data on which site selection could be based, and finally the site at Cape Grim was selected. Observations first commenced at the Cape Grim site in 1976.

In the succeeding years, the observatory has produced many quality results and these have been applied to scientific investigations by Australian and international scientists. However, almost 20 years after the concepts that determined the nature of the observational program were set in place, we find the world of atmospheric chemistry totally different. As a result, the Management Group of the Cape Grim Air Pollution Monitoring Program has requested members of the program's working group to undertake a strategic review of the program.

The brief presentation will provide some early indication of the nature of the review that is envisaged by the Management Group.

SOME THOUGHTS ON 20 YEARS CO_2 MEASUREMENTS OVER SOUTH-EAST AUSTRALIA AND CAPE GRIM

G.I. Pearman, CSIRO, Division of Atmospheric Research

The monitoring of carbon dioxide is no less important today than it was 20 years ago when the CSIRO Division of Atmospheric Research (then Meteorological Physics) first commenced such a program. What has changed is the level of sophistication in the scientific demands for the data, the international attempts to refine the intercomparability of observations at different observatories, and the options for alternative measurement techniques.

This paper will describe some of the major features of a new 100 page technical report soon to be released, which deals with many of these issues from the point of view of the CSIRO program in general and the Cape Grim Observatory in particular. The paper will include discussions of the drifts in the Australian calibration scale during the past decade and methods to allow for this; observations of the vertical variations of carbon dioxide at Cape Grim and the influence of this on data selection; and evaluations of the precision of measurement at the Observatory.

In terms of the future, the paper will briefly mention the refurbishment of the central calibration laboratory at Aspendale; efforts to improve precision and international intercalibration; alternative NDIR analysis systems; improved data handling systems; and prospects for GC methodologies. All of this will be cast in a vision for the next ten years that includes major advances in all aspects of the science of atmospheric chemistry.

HALOCARBON AND NITROUS OXIDE RESEARCH AT CAPE GRIM, 1976-2000

P. Fraser, N. Derek, CSIRO Division of Atmospheric Research
L. Porter, Bureau of Meteorology, Cape Grim Baseline Air Pollution Station

The paper will review the halocarbon (CFC-11, 12, 113; chloroform, methyl chloroform, carbon tetrachloride) and nitrous oxide measurements made at Cape Grim by GC-ECD techniques over the past 17 years as part of the CSIRO-ALE (Atmospheric Lifetime Experiment)-GAGE (Global Atmospheric Gases Experiment) research programs. These species are significant "greenhouse" gases and constitute the major sources of stratospheric chlorine and nitrogen, which are important in global stratospheric ozone destruction. The data have been used to calculate atmospheric lifetimes or emissions of these species, as well as being used to investigate large scale atmospheric transport processes and tropospheric chemistry.

Initial results for brominated species (methyl bromide, halons), several ultra-trace CFC's and HCFC's from a new GC-MS program at Cape Grim will be presented for the first time. Plans for further GC-MS measurements on Cape Grim air will be discussed. An open forum on possible GC-MS measurement projects at Cape Grim will be encouraged.

UPDATE OF METHANE, CO AND HYDROGEN MEASUREMENTS AT CAPE GRIM

P. Steele[1], R. Langenfelds[1], M. Lucarelli[1], and L. Porter[2]
[1]CSIRO Division of Atmospheric Research
[2]BoM CGBAPS

Over the past two years some very significant changes in atmospheric methane have been observed, and their signature at Cape Grim will be described. The corresponding measurements of carbon monoxide and hydrogen will also be shown. Other aspects of the program such as the quality control methods, calibration, and implications for atmospheric chemistry will be discussed.

THE OBSERVED DISTRIBUTION OF THE $\delta^{13}CO_2$ IN THE ATMOSPHERE

R.J. Francey, CSIRO, Division of Atmospheric Research, Aspendale, Victoria

The long term high-precision record of $\delta^{13}C$ in CO_2 extracted in situ at Cape Grim, supplemented by flask data from a global air sampling network and from southern hemisphere aircraft and ships, are used to demonstrate the major influences on atmospheric ^{13}C ratios, where, for CO_2:

$$\delta^{13}C=[(^{13}C/^{12}C \text{ sample})/(^{13}C/^{12}C \text{ standard})-1]1000\ ‰$$

The global trend and distribution of $\delta^{13}C$ of atmospheric CO_2 constrain the carbon budget, and the distribution identifies surface exchange mechanisms. A precision requirement of better than 0.01‰ in annual average values is defined. Instrumental, data correction and selection factors which must be considered to achieve this precision are described.

A major anomaly in the Cape Grim record began in 1988, persisting into the 1990's. The implications of this anomaly on the global carbon budget are explored.

ATMOSPHERIC MODELLING OF THE CO_2 CYCLE

W.F. Budd, Antarctic CRC, University of Tasmania

Tracer modelling for CO_2 with the Melbourne University GCM has given more transport from North to South than reported in some other atmospheric GCM studies, but still not enough to account for the Northern Hemisphere net source, from fossil fuel, and the net source in the tropics. The inclusion of low atmospheric CO_2 concentrations near the Antarctic coast, as implied by the Mawson data, spreads the southern ocean sink further south but does not significantly increase the transport from the northern hemisphere. More attention is now being focussed on the role of the oceans in the CO_2 fluxes and transports by a combination of atmospheric and ocean modelling.

Several approaches are being investigated. From the atmospheric modelling the derived surface fluxes can be used to estimate the range of compatible ocean partial pressure differences which can be compared with those observed. The observed ocean surface partial pressures can be used to derive compatible atmospheric fluxes in a forward simulation with the atmospheric GCM.

For the ocean the observed data sets for surface temperature and mean drift currents can be used along with the ocean models to simulate ocean fluxes and transports as well as to derive partial pressure differences. The models can also be constrained by observations of ocean $\delta^{14}C$ and $\delta^{13}C$ but this requires the additional consideration of the marine biospheric exchanges.

The Antarctic CRC is starting to address these questions by a combination of atmospheric and ocean modelling with observations.

STATISTICAL ANALYSIS OF THE GLOBAL CO_2 DATA

Henry Granek, Ian G. Enting and Graeme I. Pearman
CSIRO, Division of Atmospheric Research

A number of statistical and mixed statistical/deterministic methods of analysing the global CO_2 data are reviewed. These include trend and seasonal cycle analyses, complex demodulation and the Box-Jenkins ARMA/ARIMA model estimation. A fractionally differenced version of the ARIMA model (ARFIMA) will be discussed, together with advantages and disadvantages of analysing the data in the spectral domain. Some practical problems associated with stochastic model fitting to data selected using different selection criteria and/or collected using different equipment will also be discussed.

FTIR-BASED METHODS FOR THE MEASUREMENT OF TRACE GAS EXCHANGE WITH SOILS

Dr. David Griffith
Department of Chemistry
University of Wollongong

Modern Fourier Transform Infrared (FTIR) spectroscopy is capable of simultaneous high precision measurements of many atmospheric trace gases. During a recent study leave at the Swedish Environmental Research Institute in Gothenburg, we field-trialled a number of different FTIR-based methods for measurement of fluxes of CH_4, N_2O, NH_3 and other trace gases between the atmosphere and soils. These methods included both gradient-flux measurements and in-situ chamber measurements in small (0.5 m^2) and large (65 m^2) chambers. The techniques achieved measurement precision of the order of 0.1%, allowing for example measurement of concentration differences of the order of 0.3 ppb for N_2O and 2 ppb for CH_4.

In this seminar I will present the techniques and the results of their application to both forest and agricultural soils in southern Sweden and Denmark. The Denmark measurements were part of an EC intercomparison experiment which included a number of other techniques including conventional chamber/GC and tunable laser diode - based methods. Some preliminary comparisons of the pros and cons of these techniques can be made.

WHAT'S HAPPENING TO ATMOSPHERIC METHANE? ... TENTATIVE EVIDENCE FROM CARBON ISOTOPE MEASUREMENTS AT BARING HEAD, NEW ZEALAND AND SCOTT BASE, ANTARCTICA

D. Lowe, C. Brenninkmeijer, G. Brailsford, K. Lassey, A. Gomez and M. Manning,
NIWA Research Ltd., Atmospheric Division, Lower Hutt, New Zealand

Measurements of ^{13}C in atmospheric methane made at Baring Head, New Zealand, 41°S, over the four year period, 1989-1993, show a persistent but highly irregular seasonal cycle that varies from year to year. Maximum values reach about -46.9‰ in the summer and drop to around 47.5‰ in the winter. Similar features are observed at the New Zealand Antarctic station, Scott Base at 78°S. While the phase of the cycle is consistent with a kinetic isotope effect that preferentially leaves methane enriched in ^{13}C in the atmosphere after oxidation by OH, the amplitude of the cycle is much larger than expected from published laboratory measurements of this effect. We interpret the possible causes of the cycle and the inter annual variability of ^{13}C in methane as due to episodic southward transport of isotopically heavy methane from large scale tropical biomass burning and changes in the rate of inter hemispheric transport in the troposphere.

The Baring Head ^{13}C data showed only a small increase of about 0.05‰ from 1989 to mid 1991. After mid 1991 however, a rapid trend towards less enriched ^{13}C occurred, indicating a major shift in the balance of the sources of atmospheric methane. This coincided with a drop in the growth rate of methane observed at Baring Head with virtually no increase occurring between the latter half of 1991 and the maximum in 1993. The changes in the methane accumulation rate and ^{13}C values are consistent with a decrease in emissions from sources enriched in ^{13}C. Possibilities are a decrease in fossil methane emissions from the ex Soviet Union countries and/or a decrease in methane released by tropical biomass burning. A scenario generated by a simple 2 box model will be presented at the meeting.

AIR-SEA EXCHANGE OF CO_2 OVER THE SOUTHERN OCEAN AND ITS IMPRINT ON THE ATMOSPHERE

Helen Beggs, IASOS, University of Tasmania.
Roger Francey, CSIRO Div. of Atmospheric Research.
Bronte Tilbrook, CSIRO Div. of Oceanography.

The Southern Ocean plays an important role in the net uptake of anthropogenic carbon dioxide due to its low sea surface temperatures and the rapid exchange of surface waters with the large volumes of the deep ocean. Very few measurements of the fugacity of CO_2 in the ocean mixed layer, f_m, have been made south of 60°S, and hence the potential of this region of the Southern Ocean to be a CO_2 source or sink is still unknown.

Data on surface atmospheric CO_2 concentrations collected at Mawson Station, Antarctica (67.6°S, 62.9°E) since 1978 show a relatively strong seasonal variation in the concentrations with a deep minimum in March to April each year (Beardsmore et al. 1984). The amplitude of this seasonal cycle is approximately double that observed at all other atmospheric CO_2 sampling stations south of 20°S. The low concentrations of atmospheric CO_2 measured in austral autumn at Mawson, but not at the other Antarctic coastal stations of Syowa (69.0°S, 39.6°E) (Nakazawa et al. 1991), Halley Bay (75.7°S, 333°E) (Conway et al. 1988), and Palmer Station (64.9°S, 296°E) (Conway et al. 1988), suggests there may be a seasonal oceanic sink for carbon dioxide in the vicinity of Prydz Bay, Antarctica.

The mechanism for this seasonal sink, and its possible magnitude and extent, have been investigated using atmospheric values of fCO_2 and $\delta^{13}CO_2$ from Mawson Station, combined with atmospheric and oceanic fCO_2 and $\delta^{13}CO_2$ data from Southern Ocean cruises on the *MV Aurora Australis* during austral spring, summer and autumn. The extremely low oceanic fCO_2 values obtained on the 5 January to 8 March 1993 cruise indicate that Prydz Bay is a strong ***potential*** sink for atmospheric CO_2. These low oceanic fugacities appeared to be directly linked to enhanced phytoplankton production in Prydz Bay at that time. Preliminary studies indicate that the Mawson autumn CO_2 "anomaly" was more pronounced during years when the average summer wind speeds at Mawson and Davis stations were relatively high.

OCEANOGRAPHY OF WESTERN TASMANIA

George Cresswell and Vincent Lyne
CSIRO Marine Laboratories, Hobart

Various currents - the Flinders, Zeehan and Leeuwin - have been identified as being important off western Tasmania. The circulation has been described as being, on the one hand, consistently southward and, on the other, alternating northward-southward with summer and winter. The early data from thirty years ago were confined to drift card releases/recoveries and water properties and, in fact, very few water property data have been collected since. In this paper we incorporate recent information from satellite-tracked drifters, satellite imagery and moored current meters, to seek the main circulation signals.

SOUTHERN OCEAN WAVE MEASUREMENTS

John Reid,
Division of Oceanography, CSIRO, Hobart

The Division of Oceanography has maintained a wave measurement program in the Southern Ocean since 1985 using Waverider buoys moored near Cape Sorell (Strahan), Cape Grim and more recently in Storm Bay. We have found that frequency spectra of sea surface displacement differ considerably from those obtained by other workers and that wind-seas developing during off-shore winds differ from those developing during on-shore winds. These differences are attributed to the presence of swell which is almost always present at the observing sites. The statistic most closely related to local wind is the fourth moment of the spectrum, m_4. The high correlation between m_4 and wind speed breaks down for wind speeds above about 20 m/s when m_4 appears to saturate.

ANTARCTIC MIDDLE AND UPPER ATMOSPHERIC PHYSICS - A NEW DIRECTION

R.J. Morris
Auroral and Space Physics Section, Australian Antarctic Division, Kingston 7050, Tasmania

It is important that atmospheric research be continued with a more focussed program to increase our understanding of the atmosphere from the ground to where it ends, so that the links and crucial parts can be identified and so that climate change can be identified as it becomes apparent. There are specific reasons why this should be achieved in Antarctica, in particular, as a consequence of the solar variability and the meteorological extreme cold temperatures in the Antarctic stratosphere and mesosphere. The prime example is the discovery of the stratospheric ozone hole over Antarctica from observations which were regarded at the time as relatively unimportant. The coldest region of the atmosphere is in fact the Antarctic mesopause (~ 90km), which is also suspected to be very sensitive to climate change. Indeed the monitoring of upper atmosphere phenomena may provide a measure of the rate at which global change is affecting the atmosphere, since this region is so tenuous that lower atmospheric processes are amplified. The Auroral and Space Physics group is currently developing a strategic program to facilitate these critical observations at Davis, utilising lidar, radar, digisonde, spectrometer, photometer and electric field observations. Progress will be made regarding global climatic change by looking at the interrelationships between the troposphere, stratosphere, mesosphere and thermosphere, and their boundaries with land and oceans below and space above. An overview of the current research activities of the Australian Antarctic middle and upper atmosphere physics program is presented, together with a preliminary discussion on future research directions.

GAS CHROMATOGRAPHIC ANALYSIS OF ATMOSPHERIC DIMETHYLSULPHIDE AT THE AUSTRALIAN BASELINE AIR POLLUTION STATION CAPE GRIM

by

J.P.Ivey and H.Swan

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ABSTRACT

An automated gas chromatograph has been developed for the analysis of the atmospheric concentration of dimethylsulphide at the Australian Baseline Air Pollution Station Cape Grim. The system employs cryogenic concentration of DMS from 3 to 10 liters of air after oxidant removal, capillary chromatography, and detection by ozone chemiluminesence. Calibration imploys post sample injection of known quantities of DMS as internal-external standards. Detection and quantitation of DMS in the range of 20 to 500 ng/M3 typical of the annual concentration variation of DMS at Cape Grim has been achieved with a sampling frequency of 1-3 samples/ hour.

DMS air concentration has been found to vary seasonaly from typical levels of 20-40 ng/M3 in the austral winter to summer concentrations of 200-600 ng/M3 as the seasonal balance between production and distruction shifts.

In addition to the seasonal variation, DMS air concentrations are quite variable over timescales of hours or less as diurnal variation of oxidant species such as the hydroxyl radical (OH*) influence DMS concentrations.

At Cape Grim there are further causes of short term DMS concentration variation as occasional advections of continental air dilute the marine contribution, which is the focus of study.

DMS concentration variation on seasonal time scales has been addressed at Cape Grim using a gold coated glass wool trapping methodology after oxidant removal and capillary GC with FPD or AED detection .

The new instrument is intended to address the DMS concentration variation on hourly time scales and to detect other sulphur gases of importance

The results from these analyses have been compared to gold chemisorpitive trapping and detection employing Atomic Emission.

THE CAPE GRIM HIGH VOLUME AEROSOL DATA RECORD

G.P. Ayers, R.W. Gillett and J.M. Cainey
CSIRO Division of Atmospheric Research

J.P. Ivey and T.Lewis
AGAL, Tasmania

A.L. Dick
CGBAPS

High volume filter samples have been collected at Cape Grim since 1976. The principle analyses that have been carried out have been for Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, NO_3^-, SO_4^{2-} and MSA. Initially these samples were not collected regularly and the early part of the record is rather inconsistent. The sampling unit was changed to the 'Goldtop' unit in 1988, and since then samples have been collected on a weekly basis. This is an intial look at the data, including some comparisons with the 'Quadrupod' sampler, also introduced in 1988. It is intended to carry out a fuller analysis in the near future, including a comparison with the 'baseline' precipitation data.

Overview of Regional BAPMoN Precipitation Network.

Jane Warne (BoM), Greg Ayres (CSIRO, DAR) and Chad Dick (BoM)

For approximately a decade the Bureau of Meteorology has maintained a regional BAPMoN precipitation chemistry network in Australia. This consists of two sites; Wagga Wagga and Coffs Harbour. Also since late 1991 there has been a trial collection facility at Darwin Airport. Wagga Wagga and Coffs Harbour like Cape Grim are weekly wet precipitation sample collector and Darwin is a daily wet precipitation collector. Samples from these sites are analysed at AGAL (Tasmania) for a wide variety of ions including Na^+, K^+, Mg^{2+}, Ca^{2+}, H^+, NH_4^+, Cl^-, NO_3^-, SO_4^{2-}, acetate and formate.

This talk will give a general overview of the data from Wagga Wagga (1984 - 93), Coffs Harbour (1983 - 93) and Darwin (1991 - 93) including a brief history of the sites. It will also include some discussion of the ion sources [1] and deposition rates at Coffs Harbour and Wagga Wagga, preliminary results of the trial at Darwin [2] and analysis of annual cycles at the two NSW sites.

1. Ayers; G. P. and Manton; M. J.; Tellus, 43B, 379 - 389, 1991
"Rainwater Composition at two BAPMoN regional stations in SE Australia."

2. Ayers; G. P., Warne; J. O., Gillett; R. W., Huysing; P., Selleck; P. and Forgan; B. W.; Accepted by the Aust. Met. Mag. 1993
"A Pilot Study on Rainwater Composition at Darwin Airport"

NEW POTENTIAL TECHNIQUES FOR DMS AND ION ANALYSIS

R.J. Wells
AGAL, New South Wales

DMS may be trapped by reaction with methyl iodide or sulfate to form trimethyl sulfonium salts which are heat and air stable solids. Preliminary experiments to determine the quantitative release of DMS from TMS salts will be discussed.

Capillary Electrophoresis (CE) is a rapidly emerging technique for ion analysis. It is complementary to ion chromatography but the elution order of various ions is totally different. Equipment for CE is extremely compact and consumable and column costs are far cheaper than for IC. The advantages and limitations of CE will be outlined and potential uses in the BAPS and Antarctic Programs will be highlighted.

THE CGBAPS AID PROGRAM - A CONTINUING SAGA

Peter Price
Bureau of Meteorology, Melbourne

Initiatives taken at such recent fora as the Second World Climate Conference, and the UN Conference on Environment and Development seek invigorated efforts in several aspects of climate monitoring. Cape Grim BAPS is widely acknowledged as the model Baseline Station, and Australia is being looked to for advice and assistance in establishing new stations within the Global Atmosphere Watch, as well as enhancing the programs at existing ones. The main calls for help are coming from the developing countries in our region which have been identified as key sites in an expanded GAW.

I thought it was an opportune time for us to take stock of the formal and informal arrangements we have which relate to the program at Cape Grim, and make sure that these and future commitments do not impact adversely on the operational monitoring programs.

CHINESE GLOBAL ATMOSPHERE WATCH BASELINE OBSERVATORY (CGAWBO)

Lawrence W. Porter
Bureau of Meteorology, Cape Grim Baseline Air Pollution Station,

A report on my recent visit to the laboratories of China Academy of Meteorological Science (CAMS), Institute of Atmospheric Chemistry (IAC) in Beijing, and the Chinese Global Atmosphere Watch Baseline Observatory (CGAWBO), situated on Mt. Waliguan (36° 17' N, 100° 54' E, 3816m ASL), in Qinghai Province, China. I will report the current progress and show the new observatory building, and discuss proposed future co-operation in CFC's monitoring.

ALL ABOUT THE DOME SUMMIT SOUTH ICE-CORE

Vin Morgan

Australian Antarctic Division, Hobart, Tasmania 7000

Abstract

Not available

THE CAPE GRIM HIGH VOLUME AEROSOL DATA RECORD

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Abstract

Not available