atmosphere

Newsletter of the CSIRO Division of Atmospheric Research

Issue 2 October, 1996

CSIRO AUSTRALIA

50 years of atmospheric research!

This year the Division of Atmospheric Research celebrates its 50th anniversary. It was 23 September 1946, that the then Council for Scientific and Industrial Research appointed Bill Priestley to initiate a meteorological research program.

Priestley, a 31-year-old Englishman, with a degree in applied mathematics, had spent the war years with the British Meteorological Office studying turbulent diffusion in the lower atmosphere. He had also been part of the team that prepared the D-day weather forecast for General Eisenhower.

Having arrived in Australia, Bill Priestley set out in eight foolscap pages a proposed initial work program. From Priestley's four initial scientific appointments, the Division has grown to its current strength of 145 staff members, carrying out research into a wide range of atmospheric phenomena.

Over the years, our research has encompassed micro- and meso-meteorology and turbulence, agricultural meteorology, synoptic meteorology, clouds and radiation, atmospheric composition and chemistry, and studies of climate variability and change.

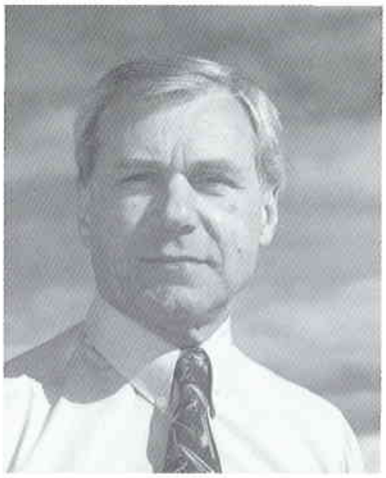
To commemorate our half-century, the Division is preparing a publication highlighting the contribution we have made to meeting the needs of government, industry and the community. Some of the scientific achievements of which we are particularly proud include quantification of evaporative water loss from the Australian continent; characterisation of the atmospheric boundary layer; contributions to integrated airshed studies; monitoring of greenhouse and ozone-depleting gases; a range of remote sensing applications; and development of world-class global climate and limited-area models of the atmosphere.

1996

c.1955

from the chief

During the past year and a half, the Division has been in the capable hands of the Acting Chief, Brian Sawford. I would like to thank him for his efforts, but also say how glad I am to be back from my role as Acting Director of the Institute of Natural Resources and Environment. The experience was most rewarding allowing me to become much more familiar with the wider operations of CSIRO. It also gave me an opportunity to work with the new Chief Executive of CSIRO, Malcolm McIntosh, who I believe will be an outstanding leader.



Dr McIntosh has already indicated his views of CSIRO's role in the national interest. He sees that emphasis on quality basic or basic-strategic research is most important if CSIRO is to be a strong contributor to the national good. He is keen to see a greater emphasis on funding of research than on support, and for CSIRO to be seen as contributing through its interface with the international science community, the production of leading edge science outcomes both applied and basic, and through communication of its work to the wider public.

It is appropriate that from time to time, a national research organisation such as CSIRO should take stock and examine whether we are clear about our role. Is it structured and does it behave in a way that maximises the benefits it brings to the nation? Few would disagree with the view that over the years CSIRO has been besieged by such assessments. The recent restructuring of CSIRO has, however, led to some significant changes in the way we are ensuring that teams applicable to various tasks can be drawn from across the breadth of the disciplinary experience of the total organisation. The coordination of the research effort across 22 'sectors' should facilitate this interaction between scientists in the Organisation. The Division of Atmospheric Research is now part of the Climate & Atmosphere Sector, together with contributions from 13 other CSIRO Divisions. The links through the Sector should further strengthen our interactions with colleagues around CSIRO. We can only hope that now we will be left for a prudent period of time to get on with the job.

Atmospheric Research is well placed to meet the challenge of the coming years in this new framework. We have throughout the past ten years, retained a commitment to a pluralistic role. We have trained apprentices, Ph.D. students, technicians and others; we have provided information to the public as a basis for enhanced quality of the debate on environmental issues; we have forged links with both government and private organisations to provide knowledge and advice and focussed our research on issues of relevance to their policy issues. We have underpinned these activities by forging new areas of basic research which are strategically directed; we have done this at a level of excellence that has provided us, and thus the Australian community, with a seat at the table of leading international atmospheric research groups. We have remained committed to providing the best facilities for our staff to do their jobs whilst striving for efficiencies and greater effectiveness.

There remains much to be done, and I have the greatest confidence that we have the right people to meet the challenges of tomorrow.

I hope you will take the time to read this issue of *Atmosphere*, and where appropriate, contact us as a collaborator, a client or a stakeholder.

Graeme Pearman

Atmosphere

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CSIRO technology "the best under the sun"

Divisional scientists have built a highly sophisticated radiometer to measure the heat emitted by clouds. The radiometer is set to greatly improve scientists' understanding of climate. The instrument, valued at $200,000, has been produced under contract for the United States government.

Scientists will use the new radiometer to probe the make-up of clouds, which greatly influence the world's climate.

"It is a tribute to the sophistication of our scientific and electronics skills that we have been asked to build the radiometer here," said Dr Martin Platt.

Dr Platt leads Australia's contribution to the Atmospheric Radiation Measurement Program, funded by the United States Department of Energy.

"Results from this international measurement project are being used to improve computer-based climate models," said Dr Platt.

"Clouds are the greatest unknown in our understanding of climate," said Dr Platt.

In the past two years, Dr Platt and fellow scientists have measured clouds using prototype radiometers in Tasmania, the Northern Territory, New Guinea and in the United States.

The new radiometer contains infrared sensors that measure variations in the amount of heat radiation reaching the ground. The instrument has been designed and built by Messrs John Bennett and Bernard Petraitis and colleagues from the electronics and mechanical workshops at the Division.

Martin Platt (left) and John Bennett with the new radiometer.

Port Pirie pollutant probe for Pasminco

The Division has completed a major environmental consultancy project at Port Pirie's Pasminco-BHAS lead smelter. The month-long field investigation involved detailed measurements designed to discover the meteorological conditions that cause elevated sulfur dioxide concentrations for local residents.

Pasminco were keen to receive this information so that they could prepare for any future tightening of air emission regulations.

The $250,000 study in South Australia involved a research aircraft, weather balloons and a lidar, which fired powerful laser beams to collect data on the behaviour of the smelter's plumes.

Pasminco's pollution problems typically occur during hot summer days with onshore breezes. This suggested that the plume was being brought down to ground level by a process known as shoreline fumigation, due to strong convective mixing in the lower atmosphere. To confirm this, CSIRO needed to monitor meteorological conditions during pollution episodes, and gather detailed emissions data from the smelter.

The scientists used daily weather forecasts to estimate the likelihood of northerly winds, during which sulfur dioxide pollution could be a problem in the township. The team made detailed meteorological, pollution and plume measurements on 12 days, six of which turned out to be days of elevated sulfur dioxide concentrations.

Following considerable analysis by CSIRO, Pasminco will use the results from the study to investigate technologies to reduce emission problems from their smelter.

The Division worked on this study with the Division of Coal and Energy Technology, Flinders University, and Pasminco-BHAS.

news

Lidar weathers storms

Richard Austin

Late last year, the Division's lidar team travelled to Melville Island in the Northern Territory for the Maritime Continent Thunderstorm Experiment. The experiment, organised by the Bureau of Meteorology, took place during the build-up to the monsoon wet season in December. Thunderstorms occur on the island on about 80% of days in this period, usually in the mid-afternoon.

Scientists from Australia, Japan, and the United States made numerous direct and remote observations of the storms to learn about their convection life cycles, microphysical processes, cloud electrification, and radiative properties.

Martin Platt, Stuart Young, Graeme Patterson and I measured optical properties of the cirrus clouds produced by the storms. Our tools were the Division's multi-wavelength lidar (operating in the visible green at 532 nm) and an infrared radiometer, measuring cloud emissions at 10.86 µm.

The lidar and radiometer data, combined with radiosonde profiles provided by Monash University, allowed us to determine cloud height, emittance and optical depth. These quantities describe the clouds' interaction with incoming and outgoing radiation. We also obtained values of the depolarisation ratio and backscatter-to-extinction ratio, giving information about the form and orientation of ice crystals within the clouds.

We obtained excellent measurements of extensive synoptic cirrus layers near the tropopause, at a height of approximately 17.5 kilometres. The lidar showed that these layers were almost always present, even when invisible to the eye. We also measured several thicker cirrus clouds produced in thunderstorm anvils. These measurements will be compared and combined with microwave and millimetre-wave radar and radiometer data collected by scientists from Pennsylvania State University, the University of Massachusetts, and the NOAA Aeronomy Laboratory. Analysis of this extensive data set is well underway.

Consultancy projects

Significant recent and ongoing projects include:

Aerosol and haze study in Jakarta
CMPF&S for AusAID, for BAPEDAL, Indonesia

Aerosol and rainwater chemistry in Indonesia
World Meteorological Organization

Aerosol and rainwater chemistry in Kuala Lumpur
Tenaga National Berhad, Malaysia

Chemical and physical properties of Australian fine particulates
Environment Protection Agency

Climate change assessment for northern Australia
Queensland Department of Primary Industries,
NT Department of Lands,Planning and Environment, and
WA Department of Environmental Protection

DARLAM Software
WNI Weathernews Pty Ltd

Dry deposition modelling study
Tenaga National Berhad, Malaysia

Dry deposition study, Hunter Valley
Pacific Power

Fine resolution assessment of climate change
Department of Conservation and Natural Resources, Victoria

Fine resolution assessment of climate change
Environmental Protection Authority, NSW

Fluoride in air
Comalco, Tasmania

Gases in building cavities
CSIRO Division of Building, Construction and Engineering

Greenhouse gas emissions reductions and offsets
Woodside Off-Shore Petroleum

Interpretation of IPCC greenhouse gas emissions projections and global carbon dioxide analyses
Department of the Environment, Sport and Territories

Melaka passive gas study
Tenaga National Berhad, Malaysia

Methodology workbook for greenhouse gases from waste
Department of the Environment, Sport and Territories

Performance indicators for the National Greenhouse Response Strategy
Department of the Environment, Sport and Territories

Perth haze study
WA Department of Environmental Protection

Rainwater chemistry in Klang Valley, Malaysia
BHP

Sulfur dioxide and nitrogen dioxide concentrations in Brisbane
Katestone Scientific

Sulfur dioxide in air
WMC

Sulfur dioxide measurements
Boyne Smelters

Territory-wide air quality modelling study for Hong Kong
Environmental Services Australia

Wet and dry deposition study, Hunter Valley
Pacific Power

Japan, Australia test new greenhouse sensor

Extensive global satellite measurements of greenhouse gases are now available following a successful collaboration near Alice Springs earlier this year, between Japanese scientists, CSIRO and Australian industry.

The scientists tested an interferometer, now orbiting on Japan's ADEOS satellite, launched in August.

The interferometer measures concentrations of greenhouse gases such as carbon dioxide and methane, which contribute to global warming. Testing took place at the Amburla research station. Scientists monitored gas concentrations from an F-27 research aircraft owned by Adelaide-based Australian Flight Test Services.

They compared their results with ground level and other airborne measurements to ensure that the sensor operated satisfactorily. These desert measurements were the final stage of testing of the sensor, which had already undergone trials over ocean and snow.

"With the sensor, researchers will be able to determine greenhouse gas levels over virtually all terrains," said Dr Fred Prata.

"Detailed information on changing levels of global greenhouse gases will be invaluable to scientists investigating the way in which industrialisation is likely to affect our climate. The information will also help determine the success of international efforts to limit release of heat-trapping gases," said Dr Prata.

The team of 15 Japanese researchers who visited Australia for the tests were from the Central Research Institute and Electric Power Industry in Tokyo.

Support for the Australian activities comes from the MFP Development Corporation, based in Adelaide, and the Commonwealth Department of Industry, Science and Technology, as well as from CSIRO.

Integrating climate change impacts research

Roger Jones

Improving links between modellers and those assessing likely impacts of climate change is one of my main tasks. I am also keen to identify all those interested in the outcomes of integrated impact and adaptation studies from an economic, social or cultural perspective.

The Division encourages integrated studies of climate change, impacts and adaptation. Typically, these studies aim to determine sensitivity and vulnerability of natural and socio-economic systems and prioritise adaptation options. Researchers, planners, students and others can take advantage of a growing network providing up-to-date information and contacts.

Those with e-mail facilities are encouraged to join the Climate Change Impacts Network (CCIN), by subscribing through the address below.

The Climate Change Impacts Liaison Project is funded by the Department of Environment, Sports and Territories.

Visit our WWW Home Page at
http://www.dar.csiro.au/pub/programs/climod/impacts/liaison.htm
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5th International Carbon Dioxide Conference

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Ultimate honour to luminary scientist

One evening in 1974, Joan Rowland asked her husband how his day had been.

"It's going very well," said Sherwood Rowland. "But it might be the end of the world!"

The work that Professor Rowland was describing was rewarded last year with the Nobel Prize for Chemistry.

That the world is likely to survive the CFC-initiated assault on our protective ozone layer is in large part thanks to Rowland's insight all those years ago at the University of California, Irvine. CFCs are chemicals used in the past as refrigerants, spray pack propellants and in the plastics industry.

Sherwood Rowland spent a few days at the Division of Atmospheric Research recently catching up with colleagues.

What prompted Rowland's original interest in stratospheric ozone?

In 1972 English scientist James Lovelock invented an electron capture detector with which he measured atmospheric concentrations of trace gases.

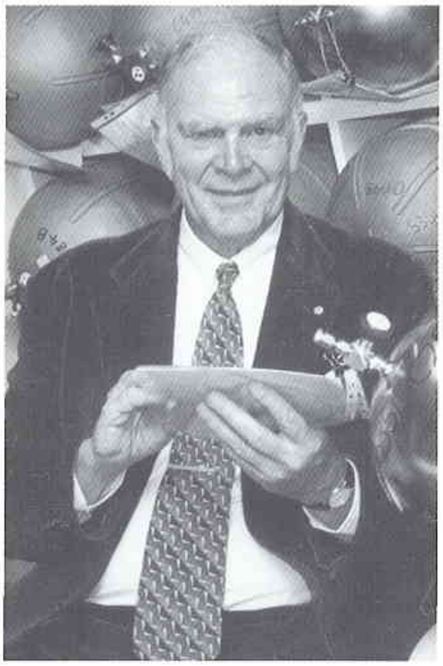
"We had been using CFCs as inert sources of chlorine in nuclear reactors. So we knew something about their lack of chemistry," says Rowland.

"When Lovelock reported finding one of them in the atmosphere it caught my eye."

Shortly after, Rowland learned of new findings showing that chlorine atoms destroy ozone.

With Mario Molina, who had joined his research group, Rowland achieved the breakthrough that would earn the Nobel Prize. The two reported in a now-famous *Nature* paper that CFCs would find their way into the stratosphere. There, intense sunlight would split the molecules, liberating active chlorine. The chlorine would reduce ozone levels by several per cent.

Chlorine atoms destroy ozone by removing an oxygen atom, forming chlorine monoxide (ClO) and an oxygen molecule (O_2). Chlorine monoxide reacts quickly in the



atmosphere with single oxygen atoms, liberating chlorine. The chlorine is again free to react with ozone. In this way, a single chlorine atom can destroy thousands of ozone molecules.

Sherwood Rowland smiled, pointing to a copy of his paper. "Did you notice they had a misprint in the title?"

"... chlorine atomc-atalysed destruction of ozone." Rowland says the mistake was fixed by the time he got his reprints.

The British Antarctic Survey shocked everyone in 1985 when they announced the discovery of a massive ozone hole over Antarctica.

Ozone depletion is severe over Antarctica due to rapid release of molecular chlorine (Cl_2) from reactions on the surface of ice crystals within polar stratospheric clouds.

The chlorine comes from compounds within the ice such as chlorine nitrate ($ClONO_2$) and hydrochloric acid (HCl). Come springtime, the reappearance of sunlight over Antarctica splits chlorine molecules into single chlorine atoms that destroy ozone.

Within two years of discovery of the Antarctic ozone hole, the Montreal Protocol set out a timetable to limit release of ozone-depleting chemicals.

Sherwood recalls a nervous night last year. There was a whisper on the scientists' grapevine that he, Molina and Dutch-born chemist Paul Crutzen were favoured to hear from the Nobel Prize Committee. "I was told that if successful, I would get a phone call at 3.30 a.m."

Sherwood awoke the next morning and glanced up at his bedside clock. 6.30. "I thought, oh well ..."

Five minutes later the phone rang.

The 1995 Nobel Prize shared by the three chemists marks the first time that the Swedish Academy has honoured research into the impact of man-made objects on our environment.

Today, Divisional scientists are measuring declining chlorine loadings in the atmosphere. Ozone depletion will be with us for many years to come, but the signs are good that this is one environmental problem that can be solved.

Air quality in Hong Kong

In the face of strong opposition, an international team including the Division recently won the right to establish a sophisticated air quality modelling system in Hong Kong.

As well as model development, the 18-month project will involve pollutant monitoring to validate model behaviour and production of a range of databases and graphical interface software.

"Our models must be able to simulate Hong Kong's main pollution problems," says Bill Physick.

"These include fine particles, nitrogen dioxide, ozone and toxics."

Modelling will help the Hong Kong government determine the impact on air quality of proposed changes to vehicle fuel types and of urban planning.

Others involved in the project are Victoria's Environment Protection Authority, Environmental Resources Management in Hong Kong, Scientific Applications International Corporation from the United States and China's Zhongshan University.

Tirelessly traversing twisters

A 15-kg pilotless plane with a range of 7000 km and ceiling of 12 km is the result of collaboration with the Bureau of Meteorology. The aerosonde has an on-board navigation system, weather sensors and radio communication.

Successful trials during the Maritime Continent Thunderstorm Experiment in the Northern Territory indicate the aerosonde is ideal for economical meteorological measurements in the eye of a hurricane, upwind of launch sites and continuously at low levels. It is particularly useful for situations in which conventional radiosondes cannot operate.

Charles Tivendale worked with the Bureau's Greg Holland developing the aerosonde, spending three weeks in Washington State with the Insitu Group assembling ten of the planes for the Thunderstorm Experiment.

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Storming the coast

The storm began at 7 pm on the last Thursday of November, 1934. During the next 30 hours an astonishing 144 mm of rain fell on Melbourne. Rivers and creeks burst their banks flooding low lying suburbs. Fourteen people died. Thousands were made homeless.

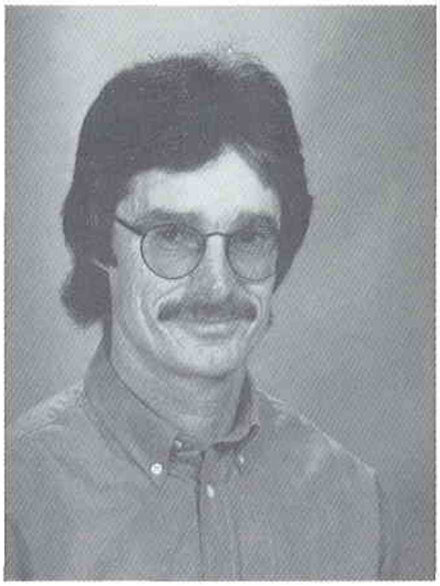
A reading of 1.33 m above mean sea level measured during the storm remains Williamstown's highest recorded tide level.

Kathy McInnes has researched this calamitous storm as part of a study of the likely impact of climate change on coastlines. The cause of the storm was a low pressure system in Bass Strait south of Melbourne bringing gale-force southerly winds and rain to much of Victoria.

This situation is one of two meteorological conditions identified by Kathy as responsible for high sea levels and inundation along Victoria's coast.

Any changes to the severity of extreme weather conditions, compounded by higher sea levels, could be very destructive to our coastline. Kathy modelled past events with a high-resolution storm surge inundation model and then ran CSIRO's global climate model to examine the likely influence of climate change.

Results from the study, undertaken for the Victorian Environment Protection Authority and Melbourne Water, show the sensitivity of different areas of Port Phillip Bay's coastline and will be of use to coastal planners and managers looking ahead to the next century. Collaborating with Kathy on this work was Dr Graeme Hubbert of Global Environmental Modelling Services.



Bill Physick is coordinator of air quality modelling in the Environmental Consulting and Research Unit (ECRU) at the Division. He has been principal investigator for five major air quality modelling studies for Australian government and industry and has participated in a number of others for the minerals and resources industry.

Model solutions to Australia's air pollution problems

Where to site a proposed 2600 MW power station? This was the question facing Pacific Power in NSW in the late 1980s. The energy authority was keen to ensure that any new station would cause minimal pollution problems.

At the time, the Division's air quality modelling team of Dr Bill Physick, Dr Peter Manins, Dr Julie Noonan and Dr Peter Hurley were putting the finishing touches on a new air quality model. Keen to demonstrate the model's value and versatility, Dr Physick approached Pacific Power with a proposal to assess potential sites in the Hunter Valley.

Since that pioneering study, LADM (the Lagrangian Atmospheric Dispersion Model) has been used for more than 20 environmental studies in Australia. LADM consists of a mesoscale meterological model to predict winds and turbulence, and a Lagrangian particle model simulating dispersion from point and area sources.

As well as predicting concentration levels from point sources such as smelters and power stations, LADM has made a major contribution to airshed studies involving our major cities.

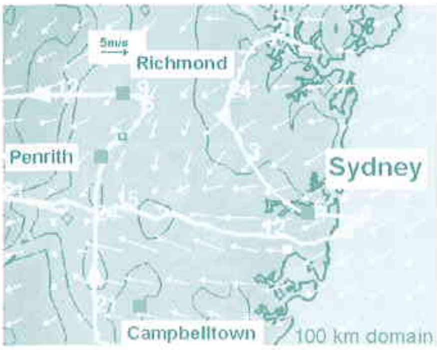
'LADM reproduced accurately the way in which pollutants are recirculated'

Unacceptable levels of smog are reached occasionally in Sydney and Melbourne. Such levels may occur in Brisbane, Perth and Adelaide as these cities grow.

"Our big cities have at least one feature in common when it comes to air pollution," says Dr Physick.

"Emissions are often carried away by prevailing winds, only to return within a few hours. On some occasions, pollution from the previous day also returns to a city. The result is high smog levels."

Colleagues from the Division of Coal and Energy Technology worked with Atmospheric Research on many of the Australian studies.



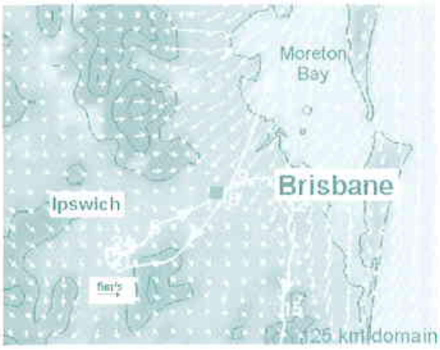
Sydney

The $10 million Metropolitan Air Quality Study examined air quality in Sydney, the Lower Hunter Valley and Illawarra.

"LADM reproduced accurately the way in which pollutants are recirculated," Dr Physick says. "Pollutants travel out over the sea in the morning and return over the city on sea breezes. Cold air drainage flow down river valleys and along other basins during the night and early morning then transports pollutants back to the coast."

Winds predicted by LADM were used by a three-dimensional photochemical model to simulate the levels and locations of smog around the Sydney region.

The New South Wales Environment Protection Authority is using results from the study to produce timely and reliable air quality forecasts, to examine health impacts of air pollution, and to develop planning and control strategies.



Brisbane

Plans for an expanded monitoring network led to CSIRO's simulating windfields with LADM for summer and winter case study days.

"The sea breeze carries afternoon emissions inland. Early next day, south-westerly drainage flows in local valleys bring emissions back towards Brisbane," says Dr Physick.

Similarly, emissions from morning peak hour traffic drift offshore before the sea breeze brings them back over the city and south towards the Gold Coast around midday.

CSIRO's client in Brisbane was the Queensland Department of Environment and Heritage.

Perth

The Division analysed two years of air quality and meteorological data to determine weather patterns under which high ozone concentrations occur.

Again, LADM found that pollutant recirculation was a problem. LADM results helped design Perth's air quality monitoring network.

During the Perth Photochemical Smog Study pollutant recirculation was confirmed with the discovery that morning emissions often head out to sea before being driven back inland by south-westerly sea breezes, reaching the central business district at midday.

Adelaide

The South Australian Department of Environment and Natural Resources commissioned Bill Physick and the Victorian EPA to design a photochemical smog monitoring network for greater Adelaide.

On days of high pollution potential, light offshore winds take morning vehicle emissions out over St. Vincent's Gulf, before a mid-morning sea breeze recirculates them over the city.

As well as stations in Adelaide's east and north-east, the city's new air monitoring network includes Airtrak smog monitors designed by the CSIRO Division of Coal and Energy Technology.

selected publications

The following items have appeared since the last edition of *Atmosphere*. Listed are a selection of major and externally refereed publications. Divisional authors are shown in bold typeface.

For a complete list of the Division's 2,500 publications since 1983, visit our Web site at:

http://www.dar.csiro.au/pub/services/library/pubsearch.html

This list is updated approximately monthly.

Allan, R.J., G.S. Beard, A. Close, A.L. Herczeg, P.D. Jones and Simpson, H.J. (1996) *Mean sea level pressure indicies of the El Nino – Southern Oscillation: relevance to stream discharge in south-eastern Australia*, CSIRO Division of Water Resources, Canberra, 45p.

Reason, C.J.C., **Allan, R.J.** and Lindesay, J.A. (1996) Dynamical response of the oceanic circulation and temperature to interdecadal variability in the surface winds over the Indian Ocean. *Journal of Climate,* 9(1), 97-114.

Reason, C.J.C., **Allan, R.J.** and Lindesay, J.A. (1996) Evidence for the influence of remote forcing on interdecadal variability in the southern Indian Ocean. *Journal of Geophysical Research,* 101(C5), 11,867-11,882.

Ayers, G.P., **Bentley, S.T.**, Ivey, J.P. and Forgan, B.W. (1995) Dimethylsulfide in marine air at Cape Grim, 41°S. *Journal of Geophysical Research,* 100(D10), 21,013-21,021.

Ayers, G.P. and **Galbally, I.E.** (1995) A preliminary estimation of a boundary layer: free troposphere entrainment velocity at Cape Grim. In: *Baseline Atmospheric Program Australia.* 1992, Dick, A.L. and Fraser, P.J. (editors), Melbourne. Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.10-15.

Ayers, G.P., **Gillett, R.W.**, Ginting, N., Hooper, M., **Selleck, P. W.** and Tapper, N. (1995) Atmospheric sulfur and nitrogen in West Java. *Water, Air and Soil Pollution,* 85, 2083-2088.

Ayers, G.P., **Gillett, R.W.**, Ivey, J.P., Schäfer, B. and Gabric, A. (1995) Short-term variability in marine atmospheric dimethylsulfide concentration. *Geophysical Research Letters,* 22(18), 2513-2516.

Ayers, G.P., **Gillett, R.W.**, **Selleck, P. W.** and **Bentley, S.T.** (1995) Rainwater composition and acid deposition in the vicinity of fossil fuel-fired power plants in southern Australia. *Water, Air and Soil Pollution,* 85, 2313-2318.

Ayers,G.P., Malfroy, H., **Gillett, R.W.**, Higgins,D., **Selleck, P.W.** and **Marshall, J.C.** (1995) Deposition of acidic species at a rural location in New South Wales, Australia. *Water, Air and Soil Pollution,* 85, 2089-2094.

Gabric, A.J., **Ayers, G.P.** and Sander, G.C. (1995) Independent marine and atmosphericmodel estimates of the sea-air flux of dimethylsulfide in the Southern Ocean. *Geophysical Research Letters,* 22(24), 3521-3524.

Ayers, G.P., Penkett, S.A., **Gillett, R.W.**, Bandy, B., **Galbally, I.E.**, **Meyer, C.P.**, **Elsworth, C.M.**, **Bentley, S.T.** and Forgan, B.W. (1996) The annual cycle of peroxides and ozone in marine air at Cape Grim, Tasmania. *Journal of Atmospheric Chemistry,* 23(3), 221-252.

Ayers, G.P. and Yeung, K.K. (1996) Acid deposition in Hong Kong. *Atmospheric Environment,* 30(10/11), 1581-1587.

Monks, P.S., Carpenter, L.J., Penkett, S.A. and **Ayers, G.P.** (1996) Night-time radical chemistry in the remote marine boundary layer over the Southern Ocean. *Geophysical Research Letters,* 23(5), 535-538.

Baines, P.G. and **Murray, D.L.** (1995) Topographic influence on the pattern of flow through Bass Strait. *Australian Journal of Marine and Freshwater Research,* 46, 763-767.

Baines, P.G., Majumdar, S.J. and Mitsudera, H. (1996) The mechanics of the Tollmien-Schlichting wave. *Journal of Fluid Mechanics,* 312, 107-124.

Post, D., **Beer, T.** and Moghissi, A.A. (1995) Editorial. *Environment International,* 21(5).

Beer, T. (1996) Risk assessment for environmental management. In: *Risk and uncertainty in environmental management: Fenner Conference on the Environment*, Norton, T.W., Beer T. and Dovers, S.R. (editors), Canberra, Centre for Resource and Environmental Studies, Australian National University, p.74-83.

Beer, T. and Ziolkowski, F. (1996) Environmental risk assessment: an Australian perspective. In: *Risk and uncertainty in environmental management: Fenner Conference on the Environment*, T.W. Norton, T. Beer, and S.R. Dovers (editors), Canberra, Centre for Resource and Environmental Studies, Australian National University, p.3-13.

Norton, T.W., **Beer, T.** and Dovers, S. R., editors (1996) *Risk and uncertainty in environmental management: Fenner Conference on the Environment,* Canberra, Centre for Resource and Environmental Studies, Australian National University, 238 p.

Bentley, S.T. and **Galbally, I.E.** (1996) Improving gas analyses when diluting air samples by using background air. *Atmospheric Environment,* 30(19), 3377-3378.

selected publications

Boers, R.E. (1995) Influence of seasonal variation in cloud condensation nuclei, drizzle, and solar radiation, on marine stratocumulus optical depth. *Tellus,* **47B**(5), 578-586.

Boers, R.E. and **Prata, A.J.** (1996) Thermodynamic structure of the maritime troposphere around the Australian continent. *International Journal of Climatology,* **16**, 633-650.

Cai, W. (1995) Interdecadal variability driven by mismatch between surface flux forcing and oceanic freshwater/heat transport. *Journal of Physical Oceanography,* **25**(11), 2643-2665.

Cai, W. (1995) Global present-day ocean climate and its stability under various surface thermohaline forcing conditions derived from Levitus climatology. *Progress in Oceanography,* **36**, 219-247.

Cai, W. (1996) Surface thermohaline forcing conditions and the response of the present-day global ocean climate to global warming. *Journal of Geophysical Research,* **101**(C1), 1079-1093.

Cai, W. (1996) The stability of NADWF under mixed boundary conditions with an improved diagnosed freshwater flux. *Journal of Physical Oceanography,* **26**(6), 1081-1087.

Cai, W. and **Baines, P.G.** (1996) Interactions between thermohaline- and wind-driven circulations and their relevance to the dynamics of the Antarctic Circumpolar Current, in a course-resolution global ocean general circulation model. *Journal of Geophysical Research,* **101**(C6), 14,073-14,093.

Cainey, J.M., Ayers, G.P., Gillett, R.W., Gras, J.L., Ivey, J.P. and **Selleck, P.W.** (1996) Sulfur aerosol/CCN relationship in marine air at Cape Grim. In: *Baseline Atmospheric Program Australia,* 1993, Francey, R.J., Dick, A.L. and Derek, N. (editors). Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.58-64.

Cawood, R. and **Cechet, R.P.** (1996) Predictability of climate and weather. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.47-55.

Cawood, R. and **Cechet, R.P.** (1996) Climate change. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.56-66.

Cawood, R., **Cechet, R.P.** and **Platt, C.M.R.** (1996) Application of thermal mapping techniques. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.259-281.

Cechet, R.P. (1996) Utility of meteorological data in agriculture. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.283-288.

Cechet, R.P. and Cawood, R. (1996) Climate of Australia. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.5-20.

Cechet, R.P. and Cawood, R. (1996) Climate extremes. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.34-46.

Dix, M.R., and **Hunt, B.G.** (1995) *Climatic modelling: doubling of CO_2 levels and beyond*: final report to the federal Department of the Environment, Sport and Territories, CSIRO Division of Atmospheric Research, Aspendale, 28 p.

Enting, I.G. (1995) Analysing the conflicting requirements of the Framework Convention on Climate Change. *Climatic Change,* **31**(1), 5-18.

Enting, I.G. (1996) Series expansions from the finite lattice method. *Nuclear Physics B (Proc. Suppl.),* **47**, 180-187.

Guttmann, A.J. and **Enting, I.G.** (1996) Inversion relations, the Ising model and self-avoiding polygons. *Nuclear Physics B (Proc. Suppl.),* **47**, 735-738.

Guttmann, A.J. and **Enting, I.G.** (1996) Solvability of some statistical mechanical systems. *Physical Review Letters,* **76**(3), 344-347.

Schimel, D., Alves, D., **Enting, I.G.**, Heimann, M., Joos, F., Raynaud, D., Wigley, T., Prather, M., Derwent, R., Ehhalt, D., **Fraser, P.J.**, Sanhueza, E., Zhou, X., Jonas, P., Charlson, R., Rodhe, H., Sadasivan, S., Shine, K.P., Fouquart, Y., Ramaswamy, V., Solomon, S., Srinivasan, Albritton, D., Derwent, R., Isaksen, I., Lal, M. and Wuebbles, D. (1996) Radiative forcing of climate change. In: *Climate Change 1995: the Science of Climate Change.* Houghton, J.T., and others (editors). Cambridge University Press, p.65-131.

Etheridge, D.M., Steele, L.P., Langenfelds, R.L., Francey, R.J., Barnola, J.-M. and Morgan, V.I. (1996) Natural and anthropogenic changes in atmospheric CO_2 over the last 1000 years from air in the Antarctic ice and firn. *Journal of Geophysical Research,* **101**(D2), 4115-4128.

selected publications

Finn, M.L., and **Manins, P.C.** (1995) *AIRWATCH: the CSIRO kit*, CSIRO Division of Atmospheric Research, Environmental Consulting and Research Unit, Aspendale, Vic., 51p.

Barbetti, M., Bird, T., Dolezal, G., Taylor, G., **Francey, R.J.**, Cook, E. and Peterson, M. (1995) Radiocarbon variations from Tasmanian conifers: results from three early Holocene logs. *Radiocarbon*, 37(2), 361-369.

Francey, R.J., **Allison, C.E.** and **Welch, E.D.** (1995) The 11-year high precision in situ CO_2 stable isotope record from Cape Grim, 1982-1992. In: *Baseline Atmospheric Program Australia*, 1992, Dick, A.L. and Fraser, P.J. (editors). Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.16-25.

Bender, M., Ellis, T., Tans, P., **Francey, R.J.** and Lowe, D. (1996) Variability in the O_2/N_2 ratio of southern hemisphere air, 1991-1994: implications for the carbon cycle. *Global Biogeochemical Cycles*, 10(1), 9-21.

Francey, R.J., Dick, A.L. and **Derek, N.**, editors (1996) *Baseline Atmospheric Program Australia*, 1993. Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, 115 p.

Francey, R.J., **Steele, L.P.**, **Langenfelds, R.L.**, **Lucarelli, M.P.**, **Allison, C.E.**, **Beardsmore, D.J.**, **Coram, S.A.**, **Derek, N.**, **de Silva, F.R.**, **Etheridge, D.M.**, **Fraser, P.J.**, **Henry, R.J.**, **Turner, B.**, **Welch, E.D.**, **Spencer, D.A.** and **Cooper, L.N.** (1996) Global Atmospheric Sampling Laboratory (GASLAB): supporting and extending the Cape Grim trace gas programs. In: *Baseline Atmospheric Program Australia*, 1993, Francey, R.J., Dick, A.L. and Derek, N. (Editors). Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.8-29.

Lloyd, J., Kruijt, B., Hollinger, D.Y., Grace, J., **Francey, R.J.**, Wong, S.-C., Kelliher, F.M., Miranda, A.C., Farquhar, G.D., Gash, J.H.C., Vygodskaya, N.N., Wright, I.R., Miranda, H.S. and Schulze, E.-D. (1996) Vegetation effects on the isotopic composition of atmospheric CO_2 at local and regional scales: theoretical aspects and a comparison between rain forest in Amazonia and a boreal forest in Siberia. *Australian Journal of Plant Physiology*, 23, 371-399.

Dick, A.L. and **Fraser, P.J.**, editors. (1995) *Baseline Atmospheric Program Australia*, 1992, Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, 73p.

Oram, D.E., Reeves, C.E., Penkett, S.A. and **Fraser, P.J.** (1995) Measurements of HCFC-142b and HCFC-141b in the Cape Grim air archive: 1978-1993. *Geophysical Research Letters*, 22(20), 2741-2744.

Downey, A., Atkinson, R., **Fraser, P.J.** and Shanklin, J.D. (1996) The Antarctic ozone hole — 1994. *Australian Meteorological Magazine*, 45(2), 123-129.

Elkins, J.W., Fahey, D.W., Gilligan, J.M., Dutton, G.S., Baring, T.J., Volk, C.M., Dunn, R.E., Myers, R.C., Montzka, S.A., Wamsley, P.R., Hayden, A.H., Bulter, J.H., Thompson, T.M., Swanson, T.H., Dlugokencky, E.J., Novelli, P.C., Hurst, D.F., Lobert, J.M., Ciciora, S.J., McLaughlin, R.J., Thompson, T.L., Winkler, R.H., **Fraser, P.J.**, **Steele, L.P.** and **Lucarelli, M.P.** (1996) Airborne gas chromatograph for in situ measurements of long-lived species in the upper troposphere and lower stratosphere. *Geophysical Research Letters*, 23(4), 347-350.

Fraser, P.J., Cunnold, D., Alyea, F., Weiss, R., Prinn, R., Simmonds, P., Miller, B. and **Langenfelds, R.L.** (1996) Lifetime and emission estimates of 1,1,2-trichlorotrifluorethane (CFC-113) from daily global background observations June 1982-June 1994. *Journal of Geophysical Research*, 101(D7), 12,585-12,599.

Oram, D.E., Reeves, C.E., Sturges, W.T., Penkett, S.A., **Fraser, P.J.** and **Langenfelds, R.L.** (1996) Recent tropospheric growth rate and distribution of HFC-134a (CF_3CH_2F). *Geophysical Research Letters*, 23(15), 1949-1952.

Frederiksen, C.S. and **Frederiksen, J.S.** (1996) A theoretical model of Australian northwest cloudband disturbances and Southern Hemisphere storm tracks: the role of SST anomalies. *Journal of the Atmospheric Sciences*, 53(10), 1410-1432.

Frederiksen, J.S., **Dix, M.R.** and **Kepert, S.M.** (1996) Systematic energy errors and the tendency toward canonical equilibrium in atmospheric circulation models. *Journal of the Atmospheric Sciences*, 53(6), 887-904.

Galbally, I.E., **Bentley, S.T.**, **Weeks, I.A.**, **Ye, R.Y.** and **Elsworth, C.M.** (1995) *A Report on Volatile Compound Sampling During the Perth Photochemical Smog Study: Final Report to Western Power of Western Australia.* Aspendale, Vic., CSIRO Division of Atmospheric Research, 66p.

Zahorowski, W., **Galbally, I.E.**, Whittlestone, S. and **Meyer, C.P.** (1996) Ozone and radon at Cape Grim: a study of their interdependence. In: *Baseline*

selected publications

Atmospheric Program Australia, 1993, Francey, R.J., Dick, A.L. and Derek, N. (editors). Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.30-37.

Garratt, J.R., Hess, G.D., **Physick, W.L.** and Bougeault, P. (1996) The atmospheric boundary layer — advances in knowledge and application. *Boundary-Layer Meteorology,* **78**(1-2), 9-37.

Garratt, J.R. and **Prata, A.J.** (1996) Downwelling longwave fluxes at continental surfaces: a comparison of observations with GCM simulations and implications for the global land-surface radiation budget. *Journal of Climate,* **9**(3), 646-655.

Gras, J.L. (1996) *The Perth Haze Study: a Report to Department of Environmental Protection of Western Australia on Fine-Particle Haze in Perth.* Aspendale, Vic, CSIRO Division of Atmospheric Research, 145, 16p.

Hennessy, K.J., Holper, P.N. and **Pittock, A.B.**, editors. (1995) *Regional Impact of the Greenhouse Effect on New South Wales: Final Report.* Chatswood, N.S.W., N.S.W. Environment Protection Authority, 97p.

Hennessy, K., Holper, P.N. and **Pittock, A.B.**, editors. (1995) *Climate Change in New South Wales: Major Findings of a Five-Year Research Program.* Chatswood, N.S.W., N.S.W. Environment Protection Authority, 13p.

Hirst, A.C., Jackett, D.R. and McDougall, T.J. (1996) The meridional overturning cells of a world ocean model in neutral density coordinates. *Journal of Physical Oceanography,* **26**(5), 775-791.

Langenfelds, R.L., Francey, R.J., Steele, L.P., Fraser, P.J., Coram, S.A., Hayes, M.R., Beardsmore, D.J., Lucarelli, M.P. and **de Silva, F.R.** (1996) Improved vertical sampling of the trace gas composition of the troposphere above Cape Grim since 1991. In: *Baseline Atmospheric Program Australia,* 1993, Francey, R.J., Dick, A.L. and Derek, N. (editors). Melbourne, Department of the Environment, Sport and Territories, Bureau of Meteorology in cooperation with CSIRO Division of Atmospheric Research, p.46-57.

Luhar, A.K. and **Sawford, B.L.** (1995) Lagrangian stochastic modeling of the coastal fumigation phenomenon. *Journal of Applied Meteorology,* **34**(10), 2259-2277.

Vogel, C.A., Baldocchi, D.D., **Luhar, A.K.** and Rao, S. (1995) A comparison of a hierarchy of models for determining energy balance components over vegetation canopies. *Journal of Applied Meteorology,* **34**(10), 2182-2196.

Luhar, A.K., Hibberd, M.F. and **Hurley, P.J.** (1996) Comparison of closure schemes used to specify the velocity PDF in Lagrangian stochastic dispersion models for convective conditions. *Atmospheric Environment,* **30**(9), 1407-1418.

Luhar, A.K. and **Sawford, B.L.** (1996) An examination of existing shoreline fumigation models and formulation of an improved model. *Atmospheric Environment,* **30** (4), 609-620.

Manins, P.C. (1995) Regional air pollution modelling for planners. *Terrestrial, Atmospheric and Oceanic Sciences,* **6**(3), 393-401.

Manins, P.C. and **Holper, P.N.** (1995) Air pollution. In: *Australia: a Leader in Environmental Solutions.* Kelly, R. and O'Neill, M. (editors). Double Bay, N.S.W., Focus Publishing, p.103-111.

Schlünzen, K.H., **McGregor, J.L.** and **Walsh, K.J.** (1995) Regional climate model results for the Weddell Sea area. *Annalen Der Meteorologie,* (31), 141-142.

McGregor, J.L. (1996) Semi-Lagrangian advection on conformal-cubic grids. *Monthly Weather Review,* **124** (6), 1311-1322.

McInnes, K.L. and Hubbert, G.D. (1996) *Extreme Events and the Impact of Climate Change on Victoria's Coastline: Report to EPA and Melbourne Water.* (Environment Protection Authority. Publication, no. 488). Melbourne, Environment Protection Authority, 69 p.

Mitchell, R.M. (1996) Preflight calibration anomaly in the NOAA 14 AVHRR channels 1 and 2. *Remote Sensing of the Environment,* **56**(2), 141-147.

Mitchell, R.M., O'Brien, D.M. and Forgan, B.W. (1996) Calibration of the AVHRR shortwave 1991. *Remote Sensing of the Environment,* **55**(2), 139-152.

Physick, W.L. (1995) *Near-Source Turbulence Parameterization in the NAME Model.* (Met Office (APR) Turbulence and Diffusion Note, no. 218). Bracknell, Berkshire, Meteorological Office, Atmospheric Processes Research, 35p.

Physick, W.L., Hurley, P.J. and **Manins, P.C.** (1995) Environmental impact assessment of industrial development at Gladstone, Australia. *International Journal of Environment and Pollution* , **5**(4-6), 548-556.

selected publications

Physick, W.L. (1996) Photochemical smog studies in Australian cities. In: *Urban Air Pollution, Volume 2.* Power, H. and Moussiopoulos, N. (editors). Southhampton, Computational Mechanics Publications, p.141-184.

Sha, W., Grace, W. and **Physick, W.L.** (1996) A numerical experiment on the Adelaide gully wind of South Australia. *Australian Meteorological Magazine,* **45**(1), 19-40.

Suppiah, R. and **Hennessy, K.J.** (1996) Trends in the intensity and frequency of heavy rainfall in tropical Australia and links with the Southern Oscillation. *Australian Meteorological Magazine,* **45**(1), 1-17.

Pittock, A.B. (1996) Understanding climatic implications of the enhanced greenhouse effect and possible future scenarios. In: *Land Use in a Changing Climate: Maurice Wyndham Series 1996.* Jarman, P. and Johnson, K. (editors). Armidale, N.S.W, Dept. of Continuing Education. University of New England, p.3-16.

Pittock, A.B. and **Hennessy, K.J.** (1996) *The Enhanced Greenhouse Effect: National and International Developments: a Summary of National and International Developments in Climate Change Research Reviewed for the Environment Protection Authority (Victoria).* (Environment Protection Authority. Publication, no. 486). Melbourne, Environment Protection Authority, 47p.

Schreider, S.Yu., Jakeman, A.J. and **Pittock, A.B.** (1996) Modelling rainfall-runoff from large catchment to basin scale: the Goulburn Valley, Victoria. *Hydrological Processes,* **10**, 863-876.

Cawood, R. and **Platt, C.M.R.** (1996) Temperatures in the surface zone and within the crop. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.143-155.

Cawood, R., **Platt, C.M.R.** and **Cechet, R.P.** (1996) Interpretation of temperature and albedo maps. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.173-201.

Platt, C.M.R., **Cechet, R.** and Cawood, R. (1996) Mapping landscape temperatures and albedo using satellite techniques. In: *Climate, Temperature and Crop Production in South-Eastern Australia.* Cawood, R. (editor) (Principles of Sustainable Agriculture, no. 7). Horsham, Vic., Agriculture Victoria, p.156-171.

Prata, A.J. (1996) A new long-wave formula for estimating downward clear-sky radiation at the surface. *Quarterly Journal of the Royal Meteorological Society,* **122**(533A), 1127-1151.

Prata, A.J., Rutter, G.F. and **Cechet, R.P.** (1996) *Thermal Mapping of the Calder Corridor.* Aspendale, Vic., CSIRO Division of Atmospheric Research, Environmental Consulting and Research Unit, 73p.

Ryan, B.F., and Sadler, B.S.(1995) *Guidelines for the Utilisation of Cloud Seeding as a Tool for Water Management in Australia: An Outline of the Australian Experience and Principles for Water Managers*, Agricultural and Resources Management Council of Australia and New Zealand, Canberra, 28p.

Ryan, B.F. (1996) On the global variation of precipitating layer clouds. *Bulletin of the American Meteorological Society,* **77**(1), 53-70.

Wratt, D.S., Ridley, R.N., Sinclair, M.R., Larsen, H., Thompson, S.M., Henderson, R., Austin, G.L., Bradley, S.G., Auer, A., Sturman, A.P., Owens, I., Fitzharris, B., **Ryan, B.F.** and Gayet, J.F. (1996) The New Zealand Southern Alps Experiment. *Bulletin of the American Meteorological Society,* **77**(4), 683-692.

Du, S., **Sawford, B.L.**, Wilson, J.D. and Wilson, D.K. (1995) Estimation of the Kolmogorov constant (C_0) for the Lagrangian structure function, using a second-order Lagrangian model of grid turbulence. *Physics of Fluids,* **7**(12), 3083-3090.

Sawford, B.L., Luhar, A.K., Noonan, J.A., Yoon. I.-H., **Young, S.A., Physick, W.L., Patterson, G.R.**, Hacker, J.M., Carras, J.N., Williams, D.J. and Blockley, A. (1996) *Shoreline Fumigation at Kwinana: a Study to Assess, Validate and Improve DISPMOD: Final Report to Dept. of Environmental Protection of Western Australia on the Kwinana Fumigation Study.* Aspendale: Environmental Consulting and Research Unit, CSIRO Division of Atmospheric Research, 323p.

Wilson, J.D. and **Sawford, B.L.** (1996) Review of Lagrangian stochastic models for trajectories in the turbulent atmosphere. *Boundary-Layer Meteorology,* **78**(1-2), 191-210.

Dlugokencky, E.J., **Steele, L.P.**, Lang, P.M. and Masarie, K.A. (1995) Atmospheric methane at Mauna Loa and Barrow observatories: presentation and analysis of in situ measurements. *Journal of Geophysical Research,* **100**(D11), 23,103-23,113.

Maiss, M., **Steele, L.P., Francey, R.J., Fraser, P.J., Langenfelds, R.L.**, Trivett, N.B.A. and Levin, I. (1996) Sulfur hexafluoride: a powerful new atmospheric tracer. *Atmospheric Environment,* **30**(10/11), 1621-1629.

selected publications

Suppiah, R. (1995) The Australian summer monsoon: CSIRO9 GCM simulations for 1xCO_2 and 2xCO_2 conditions. *Global and Planetary Change,* **11**(3), 95-109.

Chappell, J. and **Syktus, J.I.** (1996) Palaeoclimatic modelling: a western Pacific perspective. In: *Climate Change: Developing Southern Hemisphere Perspectives.* Giambelluca, T.W. and Henderson-Sellers, A. (editors) (Research and Developments in Climate and Climatology). Chichester, Wiley, p.175-193.

Walsh, K.J. and **McGregor, J.L.** (1995) January and July climate simulations over the Australian region using a limited-area model. *Journal of Climate,* **8**(10), 2387-2403.

Wang, Y.P. and Polglase, P.J. (1995) Carbon dioxide in the tundra, boreal forest and humid tropical forest during climate change: scaling up from leaf physiology and soil carbon dynamics. *Plant, Cell and Environment,* **18**, 1226-1244.

Wang, Y.P. and Connor, D.J. (1996) Simulation of optimal development for spring wheat at two locations in southern Australia under present and changed climate conditions. *Agricultural and Forest Meteorology,* **79**(1-2), 9-28.

Kidson, J.W. and **Watterson, I.G.** (1995) A synoptic climatological evaluation of the changes in the CSIRO nine-level model with doubled CO_2 in the New Zealand region. *International Journal of Climatology,* **15**(11), 1179-1194.

Watterson, I.G., Evans, J.L. and **Ryan, B.F.** (1995) Seasonal and interannual variability of tropical cyclogenesis: diagnostics from large-scale fields. *Journal of Climate,* **8**(12), 3052-3066.

Watterson, I.G. (1996) Non-dimensional measures of climate model performance. *International Journal of Climatology,* **16**(4), 379-391.

Watterson, I.G. and **Dix, M.R.** (1996) Influences on surface energy fluxes in simulated present and doubled CO_2 climates. *Climate Dynamics,* **12**(5), 359-370.

Wei, M. (1996) A low-order model of two-dimensional fluid dynamics on the surface of a sphere. *Advances in Atmospheric Sciences,* **13**(1), 67-90.

Whetton, P.H., editor. (1995) *Climate Change Under Enhanced Greenhouse Conditions in Northern Australia: First Annual Report 1994-1995.* Aspendale, Vic., Climate Impact Group, CSIRO Division of Atmospheric Research, 33 p.

Whetton, P.H., **Haylock, M.R.** and Galloway, R. (1996) Climate change and snow-cover duration in the Australian Alps. *Climatic Change,* **32**(4), 447-479.

Whetton, P.H., **Pittock, A.B.**, Labraga, J.C., Mullan, A.B. and Joubert, A. (1996) Southern Hemisphere climate: comparing models with reality. In: *Climate Change: Developing Southern Hemisphere Perspectives.* Giambelluca, T.W. and Henderson-Sellers, A. (editors) (Research and Developments in Climate and Climatology). Chichester, Wiley, p.89-130.

Whetton, P.H., **Allan, R.J.** and Rutherfurd, I. (1996) Historical ENSO teleconnections in the eastern hemisphere: comparison with latest El Niño series of Quinn. *Climatic Change,* **32**(1), 103-109.

Wu, X., Simmonds, I. and Budd, W.F. (1996) Comparison of sea ice simulations with interactive and monthly averaged forcing models. *Journal of Geophysical Research,* **101**(D7), 9359-9374.

Ye, R.Y., **Weeks, I.A.** and **Galbally, I.E.** (1995) *Analyses of Exhaust Samples: Third Progress Report to Environment Protection Agency, Department of Environment, Sports and Territories.* Aspendale, Vic., CSIRO Division of Atmospheric Research, 16p.

Ye, R.Y., **Weeks, I.A.**, **Galbally, I.E.**, Duffy, B. and Nelson, P. (1995) *Benzene, Toluene, Xylenes and 1,3-Butadiene Concentrations in Emissions From a Representative Portion of the Australian Car Fleet: Final Report to Commonwealth Environment Protection Agency and Department of Environment, Sports and Territories.* Aspendale, Vic., CSIRO Division of Atmospheric Research, 43p.

Young, S.A. (1995) Analysis of lidar backscatter profiles in optically thin clouds. *Applied Optics,* **34**(30), 7019-7031

Brian Turner: crafting fine research instruments

In late 1952, a 15-year-old Brian Turner reported to the Division's workshop for his first day as an apprentice scientific instrument maker.

Today, Brian is our longest serving staff member.

"One of my first jobs was to build a sensitive detector for picking up pressure waves set up by nuclear tests in the northern hemisphere," Brian recalls.

"The detector worked well. But you wouldn't have thought so by looking at it. It consisted of a biscuit tin floating in a mercury-filled baby's potty."

As for so many longer-serving staff members, a highlight that stands out in Brian's memory is the field experiments.

In 1967, Brian and many other members of the Division headed to Hay for the Wangara experiment.

"For six weeks we worked 12-hour shifts, measuring wind and temperature structure in the lower atmosphere," says Brian.

Countless projects have passed through the skilled hands of Brian and others in the workshops. A recent challenge for Brian was to design and construct air samplers capable of being carried in a container the size of a suitcase.

These samplers are now being used as far afield as the Amazon and Antarctica.

Apart from the growth of the Division, Brian says that the biggest change during his career has been the introduction of computer-controlled milling machines.

"We can now machine in three planes at once, working with far greater accuracy than ever before," he says.

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