atmosphere
Newsletter of the CSIRO Division of Atmospheric Research
Issue 4 February, 1998
CSIRO AUSTRALIA

New supercomputer facility

One of the world's most powerful scientific tools is now available to Divisional scientists following an agreement between the Bureau of Meteorology and CSIRO.

From their desks, climate modellers will be able to access the new supercomputer, the largest in Australia. The $18.9 million NEC SX-4 supercomputer will help Australian atmospheric scientists and meteorologists deliver world-class services.

Operating from the joint High Performance Computing and Communications Centre, the supercomputer will provide facilities for advanced computation, interactive modelling and visualisation. It will also offer large volume data archiving and high-speed communications access.

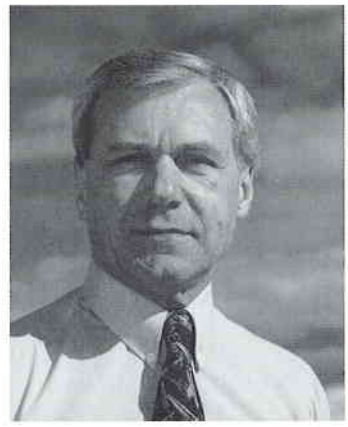
The Division of Atmospheric Research will use the facility for modelling climate change, climate variability, severe storms and air pollution.

The supercomputer's initial modules (delivering 32 billion floating-point calculations each second, or gigaflops) were lifted by crane into the first-floor computing room at the Bureau of Meteorology in Melbourne in August. The second stage of the computer, which will provide 64 gigaflops, is due shortly. The final stage is scheduled for April 2000. By then the 12.8 tonne computer will deliver a massive 104 gigaflops.

'The reward for climate modellers will be that 100-year simulations of climate change that today take six months of computer time will be completed within three weeks,' said Mr Barrie Hunt, Leader of the Division's Climate Modelling Program.

CSIRO has shared the cost of the NEC supercomputer with the Bureau of Meteorology. Both agencies will make equal use of the machine and will also conduct joint research with NEC.

from the chief



CSIRO is a strategic research organisation. We aim at high quality research, internationally competitive and benchmarked, and then use the knowledge generated and assimilated from the global knowledge in the national interest. This can be by assisting our industries to be competitive through new technologies and to be aware of new directions, to advise our leaders in industry and government in all matters pertaining to science and technology, and to contribute to the maintenance of a nation with a high level of science literacy through both personal and public education.

It is easy, under the pressures to improve our delivery of these services, to neglect the fact that, unless we maintain the core competency of scientific excellence, it might all count for little. It was with pleasure, therefore, that I read the recent analysis of citation rates for Australian scientific institutions. Whilst we all know the dangers of depending too much on these as a measure of success, it was pleasing to find that the Division ranks very highly in comparison with other CSIRO Divisions and with other Australian institutions. I believe this reflects the commitment of our scientific staff and the legacy of previous Chiefs of the Division, who aimed to provide the best possible environment, physically and culturally, for our staff to do good science, employed very good people to do the science and support the scientists, and got the balance right between strategic research and its application.

Congratulations to our staff on their efforts. They reflect well on us all. I welcome our colleagues who receive this newsletter, to once again read a little about the exciting things that are driving our work and to encourage you to seek more information through our web site, by email, fax or telephone.

Regards to you all.

Graeme Pearman

Atmosphere

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The uncontrolled experiment proceeds

Human activities are changing the global cycling of carbon between land, oceans and atmosphere. The Division's Chief, Dr Graeme Pearman, made this point during the Fifth International Conference on Carbon Dioxide, held in Cairns, Australia. The Division played a key role in organising the meeting.

'There is no doubt about this change. There is also no doubt that carbon dioxide is increasing in the atmosphere and will continue to do so as we continue to burn fossil fuels,' Dr Pearman said in summing up the conference, which discussed the latest in atmospheric changes to carbon dioxide, the major greenhouse gas.

'Of the two hundred scientists at this meeting, not one would believe that the changes we humans are forcing on our planet are without some risk.'

'Nothing presented at the conference suggests that policymakers or the community should relax, or believe that greenhouse has gone away or will go away,' Dr Pearman warned.

'The latest science also reveals surprising gaps in our knowledge of the carbon cycle and how it will respond over the next century to the continual emission of carbon dioxide into the atmosphere. This uncertainty reflects the complexity of the climate system,' Dr Pearman said.

'Many policymakers seem to believe that the science is solved. We do need more accurate predictions of changes to the atmosphere. But, unless we understand carbon dioxide better we will have a poor insight into whether carbon dioxide reduction policies are really working,' Dr Pearman said.

Earth scientists meet in Melbourne

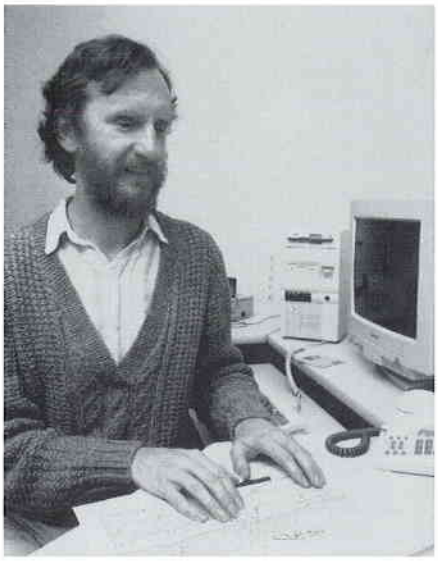
More than four years in the planning, the 1997 conference of earth scientists from around the world was a great success.

Over a thousand meteorologists, oceanographers, atmospheric scientists and geographers converged on the Melbourne Convention Centre for the joint meeting of the International Association of Meteorology and Atmospheric Sciences (IAMAS) and the International Association for Physical Sciences of the Oceans (IAPSO).

The Division was well represented at the conference, with over 50 presentations on topics such as atmospheric chemistry, aerosol, land-surface schemes in meteorological models, Australia's north-west cloud band, the radiation budget over oceans and continents, precipitation studies, and storm surges.

The Division's Dr Tom Beer (Conference Secretary) with invited speakers, atmospheric chemist and Nobel Laureate, Prof. Sherwood Rowland (centre); and oceanographer, Prof. Walter Munk.

Ins and outs of the carbon cycle



During the past 15 years, the oceans have absorbed an average of approximately 1.9 gigatonnes of carbon each year from the atmosphere. In the same period, land and plants have incorporated 0.8 gigatonnes of carbon annually.

This is the finding of Dr Peter Rayner, who has modelled the global carbon cycle. Peter's modelling relies on extensive measurements of atmospheric carbon dioxide concentrations from 12 NOAA/CMDL monitoring stations, and isotopic data and oxygen concentration measurements from Cape Grim in Tasmania.

Peter takes these measurements and uses a mathematical technique known as time-dependent Bayesian synthesis inversion to track where the carbon dioxide is coming from and where it is being taken up. In effect, he is solving mathematical equations to calculate the magnitudes of sources of the gas from observed atmospheric concentrations.

Peter also incorporates additional information on global sources of carbon dioxide such as fossil fuel burning. The results are valuable deductions of global sources and sinks, data on regional variations and assessments of annual changes in emissions and uptake of carbon dioxide.

The results show that the tropical ocean emits large quantities of carbon dioxide, while the rest of the ocean and northern hemisphere land, absorb it. Land in the southern hemisphere represents a small source but data from this area have been sparse until recently.

A fascinating outcome from the research is the apparent link between global carbon fluxes and the southern oscillation index, which measures the strength of El Niño. Anomalies in carbon fluxes seem to lead changes in the southern oscillation index by up to nine months.

'The *least* likely conclusion from this work is that we have come across an El Niño precursor we didn't know about,' cautions Peter Rayner.

As well as working at the Division, Peter is a Research Fellow at the Cooperative Research Centre for Southern Hemisphere Meteorology.

Our Web Sites:

Divisional home page
http://www.dar.csiro.au/

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

Applying our research

Passive gas sampling
Alcoa, BHP, Boyne Smelters, Comalco, NIWA, WMC

Rainwater chemistry in Klang Valley, Malaysia
BHP

Sydney airport study
Coffey Partners

Pacific Atmospheric Chemistry Experiment
COSSA Meteorological Research Institute, Japan; Indonesian Meteorological and Geophysical Agency

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

National greenhouse gas inventory
Environment Australia

Chemical and physical properties of Australian fine particulates
Environment Australia

Territory-wide air quality modelling study for the Hong Kong Environment Protection Department
Environmental Services Australia

Fine resolution assessment of climate change
EPA, NSW

Vehicular fleet emission analyses
EPA, Victoria

Storm surge and sea-level rise studies
Gold Coast Municipal Council, Queensland

Satellite algorithms for the Earth's radiation budget
Japanese Space Agency

Emissions and the environment
MIM

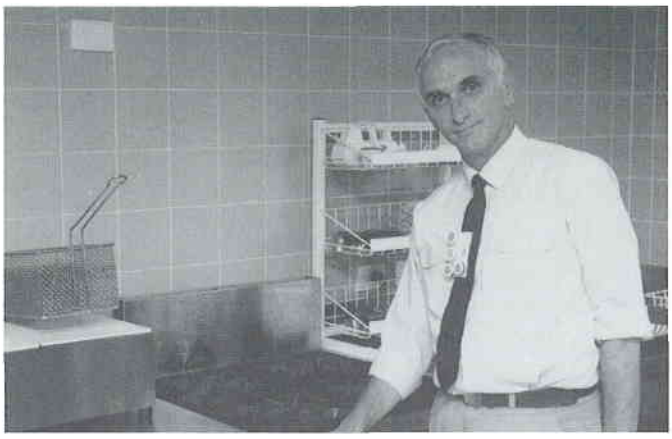
Wet and dry deposition study, Hunter Valley
Pacific Power

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

Passive gas sampling
Tenaga Nasional Berhad, Malaysia

Regional modelling in South-East Asia
United Nations Office for Project Services

If you can't stand the fumes, stay out of the kitchen



Levels of the air pollutant nitrogen dioxide are often higher in the kitchen than anywhere else. This is the finding of Dr Tom Beer, who has spent 20 weeks wearing a personal air pollution sampler.

Dr Beer found indoor nitrogen dioxide levels were generally low, averaging 9 parts per billion (ppb). Outdoors, they were about 16 ppb. In his kitchen however, where there is a gas oven, nitrogen dioxide levels reached 32 ppb, or twice outdoor concentrations.

Indoor air quality is a health concern as Australians spend approximately 95% of their time inside.

Dr Beer wore the air pollution sampler at home, at work and in his car as well as leaving samplers in his kitchen, his office and outdoors.

'I was interested in combining indoor and outdoor measurements to find out what levels of pollutants a person is really exposed to,' said Dr Beer.

Nitrogen dioxide forms whenever fossil fuels such as natural gas or petrol burn. It affects the throat and lungs.

'Outdoor air quality has been monitored for years but we know relatively little about indoor air and people's total exposure to pollutants,' said Dr Beer.

Victoria, as with most States, requires flues for domestic gas heaters.

'Properly fitted flues effectively prevent nitrogen dioxide rising to dangerous levels indoors,' said Dr Beer.

CSIRO's air quality measurements are the first conducted in Australia, comparing personal exposure with concentrations of pollutants indoors and outdoors.

The recently-established National Environment Protection Council will be producing environmental protection measures for outdoor air quality standards for a range of pollutants including nitrogen dioxide.

Space science, down to Earth

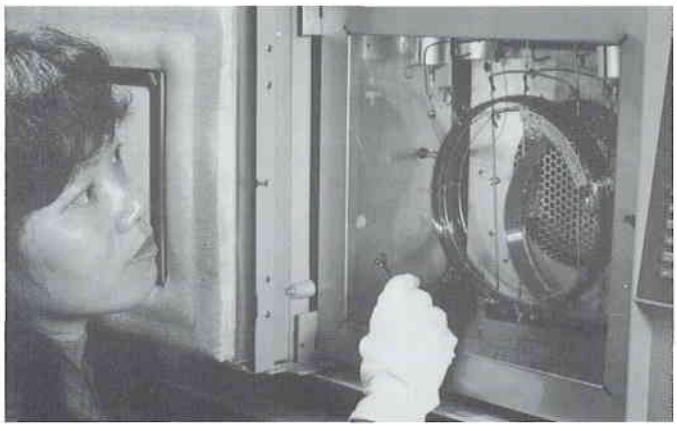
The launch of the European Space Agency's ERS-2 satellite in April, 1995, provided to the scientific community a host of new global measurements, including monitoring of land by the dual-view ATSR-2 instrument. The Along Track Scanning Radiometer probes the earth's surface via narrow-band visible channels, ideal for studying surface processes.

Divisional staff are participating in international programs to make surface measurements to calibrate and check the data collected by the satellite radiometer.

Fred Prata, Ian Grant and Graham Rutter recently travelled to central Australia to make spectrometric observations over a variety of land types to coincide with the ERS-2 satellite passing overhead. The field trip was part of a collaborative program with the CSIRO Division of Wildlife and Ecology and the University of Nottingham in the UK.

Dr Fred Prata records the solar spectrum reflected from the surface of Lake Hart, a salt lake near Woomera in South Australia.

Monitoring the environment



Is our environment improving or getting worse?

This is a difficult question to answer, as there are so many factors to be taken into account. In order to provide accurate information about the health of the environment and to track changes, many countries have come up with environmental indicators. These indicators are physical, chemical, biological or socio-economic measures that can be used to assess natural resources and environmental quality.

During the past few years, Divisional staff have contributed to the Australian Government's development of a State of the Environment report, and to other national environmental studies.

The Government, through Environment Australia, is developing further environmental indicators.

As well its extensive strategic research, the Division of Atmospheric Research collects a great deal of information about the environment nationally and internationally.

Here are some of our activities:

- Air quality: acid deposition
- Air quality: air toxics
- Air quality: passive sampling & personal exposure monitoring
- Atmospheric greenhouse gas levels
- Greenhouse gas sources and sinks
- Indicators of climate change
- Indicators of climate variability: El Niño – Southern Oscillation
- Indicators of stratospheric ozone depletion (ozone-depleting substances and their replacements)
- Urban and regional air quality: indicators for criteria pollutants

Jakarta conference on El Niño

In November, climate scientists from around the world gathered in Indonesia to assess El Niño as the country endured prolonged drought and extensive forest fires. Minister for Research and Technology, Dr Habibie, called the meeting, which was attended by Australia's Minister for Science and Technology, the Hon. John Moore.

Dr Nan Bray, Chief of Marine Research led a CSIRO delegation to the conference. Dr Brian Ryan and Dr Jørgen Jensen represented the Division of Atmospheric Research.

'Australia and Indonesia share a common regional concern about the effects of global climate change and the El Niño phenomenon,' said CSIRO Chief Executive, Dr Malcolm McIntosh.

'CSIRO scientists have been researching El Niño for many years,' said Dr McIntosh. 'The Jakarta conference will enable scientists from all over the world to discuss the research that has already been undertaken on El Niño, and to plan for the future.'

'Jørgen Jensen and Brian Ryan are doing significant work on the importance of aerosol particles on regulating climate change, particularly particles released by bushfires and forest fires,' said Dr McIntosh.

Dr McIntosh said that the CSIRO delegation to the Jakarta conference reflects the commitment of CSIRO to the issue of climate change, and the importance that CSIRO attached to the conference.

Dr Brian Ryan in Jakarta, on his way to the Indonesian Government's conference on El Niño.

Core science

While the rest of us swelter during summer, David Etheridge has been wearing his thermals during an eight-week expedition to Law Dome in Antarctica.

David is working with the Australian Antarctic Division, who are drilling an 80-metre deep core through the firn layer. By extracting air from this uppermost layer of compressed snow, David will be able to accurately determine changes to the composition of the atmosphere during the past century.

As the air is not highly compressed in snow near the surface, David can readily obtain air volumes sufficiently large for him to measure concentrations of radio-isotopes of methane. From this, he will be able to determine how much fossil fuel production and burning has added to atmospheric concentrations of this greenhouse gas.

In Antarctica, David Etheridge is also working with Andrew Smith from the Australian Nuclear Science and Technology Organisation. Dr Smith is collaborating with the Division's Vladimir Levchenko on carbon dating the age of ice-core air.

Windows on Meteorology

The year 1888 was one of great celebrations throughout Australia to honour the colonies' centenary.

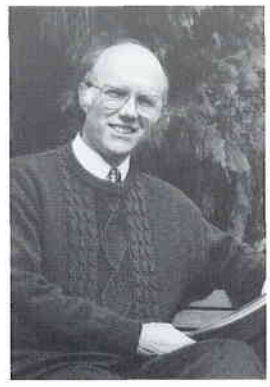
The previous year had seen abundant rainfall throughout the country. Climate seemed to be improving and the one major drought of the previous half century was nigh forgotten.

The rain kept falling until February, 1888. Then came drought. For the next 12 months, rainfall across eastern Australia was lower than ever recorded. For a country so reliant on agriculture, this was devastating. The New South Wales wheat yield dropped by 70 per cent.

The centennial drought broke as 1888 drew to a close. Unfortunately, the hardship was far from over. Drought conditions returned soon after, dominating much of the 1890s.

Dr Neville Nicholls from the Bureau of Meteorology Research Centre vividly describes the centennial drought and its impacts in a chapter of a new CSIRO book, *Windows on Meteorology*. Compiled by Eric Webb, an Honorary Research Fellow at the Division, *Windows on Meteorology* includes 30 well-researched papers on climate and weather in Australia.

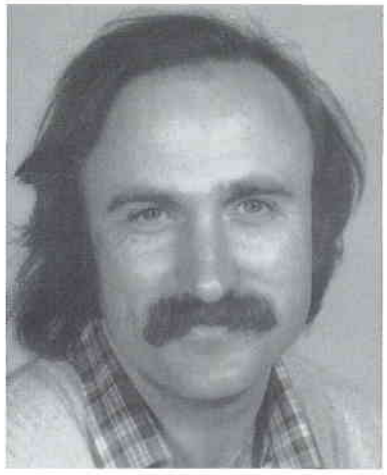
Windows on Meteorology: Australian Perspective is available for $49.95 from CSIRO Publishing,
Telephone: +(61 3) 9662 7666
Facsimile: +(61 3) 9662 7555
E-mail info@publish.csiro.au



Dr Peter Manins has received the Public Service Medal for outstanding leadership and commitment to development of practical applications of research in air pollution and meteorology for use in air-quality assessment and planning.

Longer-term visiting scientists		Host scientist
Dr Grant Branstator	National Center for Atmospheric Research, USA	**Jorgen Fredriksen**
Dr Magnuz Engardt	University of Stockholm, Sweden	**Greg Ayers**
Dr Alec Joubert	University of Witwatersrand, South Africa	**John McGregor**
Dr Thomas Kaminski	Max Planck Institute, Germany	**Ian Enting**
Ms Heidi Kreibich	University of Berlin, Germany	**Rob Gillett**
Mr Zhenxia Long	Institute of Atmospheric Physics, Chinese Academy of Science	**Ian Smith**
Mr David Oram	University of East Anglia, UK	**Paul Fraser**
Dr David Wratt	NIWA, New Zealand	**Jørgen Jensen**

Seeking the Secrets of El Niño



Dr Rob Allan

El Niño — a climate phenomenon in which the Pacific Ocean trade winds and currents weaken or reverse — became a household word during the dry spell affecting much of Australia from 1991 to 1995. It was one of the longest sequences of El Niño events on record and at the peak of the drought (1994-95) Australia's gross domestic product plummeted by $4.8 billion. Again, in 1997, El Niño returned, lowering rainfall over much of the country.

Scientists have every incentive to unravel the secrets of El Niño in a quest for reliable early-warning mechanisms.

One of Australia's foremost authorities on the subject, Dr Rob Allan, has been painstakingly combing historical weather reports to investigate El Niños of the past.

'We're trying to find out what triggers El Niño. We know that interactions between the ocean and the atmosphere are fundamental to the process,' he says.

'In normal times, Pacific Ocean trade winds push surface water west along the equator. Warm water accumulates to the north-east of Australia, heating air in contact with it. The warm, moist air produces clouds and makes rainfall likely.'

'However, from time to time the process falters. Trade winds and tropical Pacific currents weaken. The ocean off Australia cools and rainfall systems move eastward over the Pacific Ocean. Clouds diminish. Frequently, drought overcomes much of the country.'

Dr Allan says that as we dry, others are drenched. Heavy rains brought by El Niño often flood many parts of north and south America. In California, the 1995 floods left eleven dead and caused billions of dollars of damage.

To build a clearer picture of climatic trends, Dr Allan is trying to piece together a year-by-year record of El Niño from weather records dating back to the first scientific observations in the 1700s. He is turning up information on El Niño from some very unlikely sources.

In 1769, Lieutenant James Cook, while charting the tropical Pacific in the *Endeavour,* noted, 'The meeting with Westerly winds within the general limits of the easterly trade is a little extraordinary.' At the same time, India was suffering serious drought-induced famine and rainfall was low in northern China. Dendrochronologists who have examined variations in growth rings of teak trees in Java report that 1769 was a year of lower than normal growth.

'El Niño's effect can even be found in Egypt,' says Dr Allan. 'El Niño influences the discharge and maximum height reached each year by the River Nile in Cairo.' Nile flood height is a particularly valuable record for climate sleuths, as measurements near Cairo go back to the year 700 AD.

'Combine all the evidence and the chances are pretty high that 1769 was an El Niño year,' says Dr Allan.

Dr Allan has published an atlas describing in great detail every El Niño event since 1871, when comprehensive monitoring of sea-surface temperatures and atmospheric pressure began. This is the first time that such a global historical coverage has been prepared.

'The ultimate aim of our work is to provide information that will help produce accurate long-term forecasts,' says Dr Allan.

CSIRO researcher, Mr Barrie Hunt, is using predictions of sea-surface temperature to fine-tune his powerful computer-based climate model. The temperature of the upper layers of the Pacific Ocean fluctuate with the ebb and flow of El Niño and so is a useful predictor of Australia's rainfall.

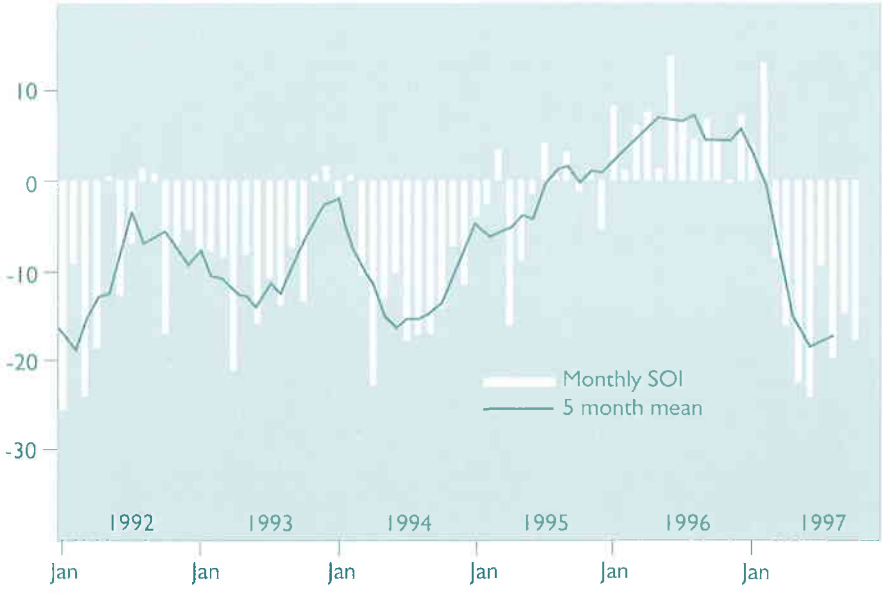
Currently, Mr Hunt is running 'hindcasts', predictions of events that have already happened. He is using predictions of Pacific Ocean surface temperatures from 1972 to 1992 to determine how well climate models can reproduce measured rainfall.

This is no trivial task. Each hindcast is made for 12 months starting from 1 January. For each year from 1972 to 1992, CSIRO runs 10 hindcasts. Each hindcast uses slightly different starting conditions to allow for chaos in the climate system. The computational requirements are enormous. Each set of 10 hindcasts takes five days to run on a Cray supercomputer.

After each year's hindcasts are complete, Mr Hunt checks predicted rainfall with the rains that actually fell across Australia and other parts of the globe where El Niño has an influence. This process of forecasting and checking allows ongoing improvements to the CSIRO model.

Results, according to Mr Hunt, are promising. "We are hindcasting rainfall and winds near the equator reasonably well. The 12-month forecasts are picking up the broad rainfall trends across parts of Australia, but aren't yet satisfactory for general use."

'Our long-term aim is to produce a system capable of reliable predictions out to three or four seasons ahead,' says Mr Hunt.



source: Bureau of Meteorology

selected publications

The following items have appeared since the last edition of *Atmosphere*. A selection of externally refereed or other major publications is listed. Divisional authors are shown in **bold** typeface.

For a complete, searchable list of the Division's over 3000 publications since 1983, visit our Web site. This list is updated monthly.

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Tomorrow will be fine, with clean air and a low particle count

High precision predictions of air quality will soon be part of daily weather forecasts for many parts of Australia thanks to collaboration between the Victorian EPA, the Bureau of Meteorology and CSIRO.

Martin Cope is leading CSIRO's contribution to the project, which will help people plan their activities and will allow the EPA to implement control measures to lower emissions on days of high pollution potential.

A senior modeller with the EPA for many years, Martin brings to CSIRO expertise in air quality models that include the chemical processes that lead to formation of photochemical smog and to high particle concentrations.

'We're aiming for a world-class forecasting system that will be up and running for the Sydney 2000 Olympics,' says Martin.

Martin's interest in computer modelling extends well beyond office hours. 'I love simulation games,' he enthuses. 'I could spend hours playing Sim City!'

However, Martin is more likely to spend his weekends introducing his two boys to the pleasures of sailing on Port Phillip Bay.

Anyway, he can 'play' Sim City in real life.

'Our ambition is to predict tomorrow's pollution levels and then work out how much lower the pollution would be if we were to, say, halve the amount of traffic.'

'We'll also be able to do inverse modelling, in which we work out where the pollution is coming from.'

Fitting award

Jamie Harnwell, a fitting and turning apprentice, is the winner of the CSIRO Arthur Frost Award.

CSIRO's Chairman, Mr Charles Allen, presented Jamie with an inscribed plaque and a cheque for $500.

Each year, CSIRO presents the Arthur Frost Award to the person who demonstrates the highest level of achievement during their apprenticeship.

Mr Charles Allen (left), Chairman of CSIRO, examines an atmospheric monitoring instrument made by Jamie Harnwell (centre), award-winning apprentice. Looking on is, Reg Henry, Engineering and Site Services Manager.

The last straw: Six school children recently volunteered to spend part of their term holidays bringing aesthetic order to the Division's wind tunnel. The intrepid team cleaned and set in place 10,000 straws to form the CSIRO logo.