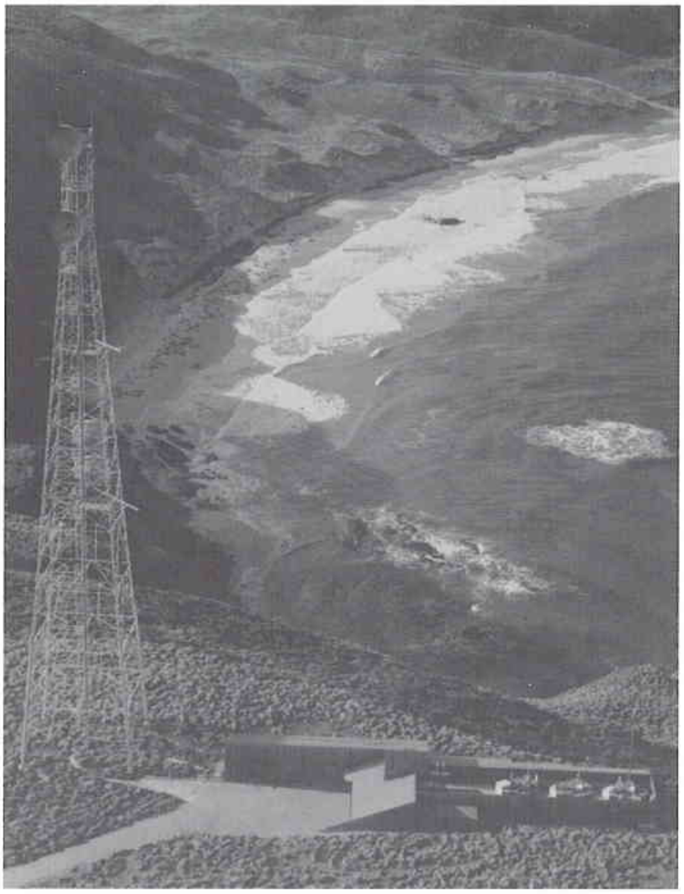
atmosphere
Newsletter of the CSIRO Division of Atmospheric Research
Issue 3 April, 1997
CSIRO AUSTRALIA

Cape Grim
20 years of taking the air

In 1976, Australian scientists chose a treeless cliff top at Cape Grim in Tasmania's north-west as the site for measurements to track the changing composition of background air in the southern hemisphere.



Late last year, scientists and dignitaries gathered at the Cape Grim Station to celebrate the 20th anniversary of atmospheric recordings.

"It's a source of enormous pride to me as Science Minister that we have such a world-class facility contributing in such a meaningful way to some of the most pressing global problems," said Mr Peter McGauran before unveiling a commemorative plaque.

"Measurements at Cape Grim are vital to our understanding of the greenhouse effect, ozone depletion and chemical cycles in the atmosphere," added Mr McGauran.

Tasmania is an ideal location for an atmospheric baseline station. For much of the year the island is battered by the "roaring forties", strong westerly winds that carry pollution-free air thousands of kilometres across the Southern Oceans.

Since measurements at Cape Grim began, levels of the greenhouse gas carbon dioxide have risen by 10 per cent. Among the first gases to be measured at Cape Grim were CFCs, now well known as ozone depleters.

The Cape Grim station is the most sophisticated in the world network. It is operated as part of a joint agreement between the Bureau of Meteorology and the CSIRO.

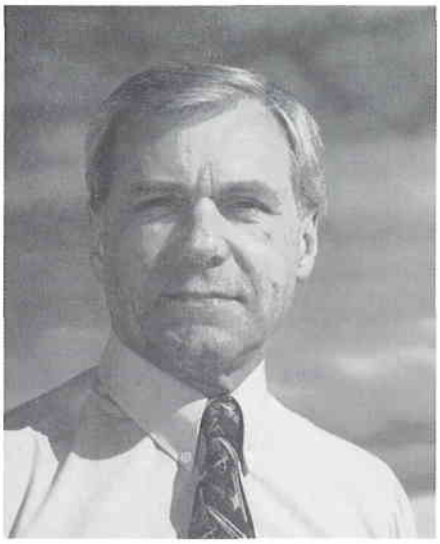
Special guest speaker at the celebration was Professor Mario Molina, 1995 Nobel Laureate in Chemistry.

Also present were Dr Malcolm McIntosh, Chief Executive of CSIRO; Dr John Zillman, Director of Meteorology; Dr Graeme Pearman, Chief of the CSIRO Division of Atmospheric Research; and Dr John Miller, representing the Secretary-General of the World Meteorological Organization.

As well as monitoring a wide range of atmospheric trace gases, Cape Grim scientists measure concentrations of natural and pollutant particles, and meteorological parameters including wind speed and direction, rainfall, temperature, humidity and air pressure. Measurements of solar radiation, including harmful UV-B radiation, are also carried out.

Since beginning operation, the station has made approximately 3 billion measurements!

from the chief



As you will see from our cover story, last year we celebrated the 20th anniversary of measurements at the Cape Grim observatory in Tasmania. The station represents a most successful long-term collaboration between the Bureau of Meteorology and CSIRO, the joint managers of the Station, and a number of other national and international institutions. Many of you will be well aware of the major contribution made by Cape Grim to knowledge of the composition of the background atmosphere through studies of global warming, ozone depletion, aerosol transport and the reactive chemistry of the "clean" atmosphere.

Measurements at Cape Grim underpin a number of exciting research activities. Ying Ping Wang is applying John McGregor's limited-area model to a detailed examination of sources and sinks of carbon dioxide and other gases across Australia and the surrounding oceans. This work promises to be valuable in assessing our greenhouse-gas emission inventory as part of Australia's responsibility within the international framework convention on climate change. Henry Granek and Greg Ayers are using the model for similar studies on sulfur emissions in Australia and South-East Asia. Cape Grim data offer us a way of checking the performance of the model. We see the modelling approach as eventually providing an important resource and environmental management tool for Australia.

The Division's links with Asia remain strong. This newsletter includes stories on a number of activities in the region. Currently I am Chairman of the South-East Asian Regional Committee for START (System for Analysis Research and Training). In February we held the ninth meeting of this group (SARCS) in Bogor, Indonesia. Significant progress has been made in establishing a comprehensive research plan for SARCS and to gaining funds from both within and outside the region. In future, coordination of global change research throughout the wider region is likely to be strongly influenced by the burgeoning Asian Pacific Network (APN). I participated in a science planning meeting of APN in Tokyo recently. From the Division's point of view, our activities throughout Asia offer the chance to tackle scientific issues of relevance to Australia and our neighbours, working collaboratively with the growing scientific community of the region.

Of interest to the atmospheric science community will be two forthcoming conferences. On page 4 are details of the IAMAS-IAPSO Earth, Ocean, Atmosphere meeting scheduled for Melbourne in July. The Division is taking a lead role in organising this meeting. We are also lead organisers for the Fifth International Carbon Dioxide Conference, which will be in Cairns in September. You will find details of the latter meeting on the Web at http://www.dar.csiro.au/pub/events/co2_conf/index.html.

Finally, after two years of significant introspection, CSIRO has largely completed its reorganisation and restructuring processes. We hope now there will be time for consolidation, with our research being carried out within sectors that bring together scientists from across the Organisation to address issues important to the Australian community, economy and environment. Our Division's efforts will contribute primarily to the Atmosphere and Climate Sector, with some work in the Petroleum Sector.

I hope you will find this newsletter interesting and informative. Please contact us if you would like more information about our activities.

Graeme Pearman

Atmosphere

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Climate change: the latest scenarios for Australia

Australia is likely to be between 0.3 and 1.4°C warmer by the year 2030 according to the Division's latest estimates of climate change for Australia. The temperature increase by 2070 is likely to be between 0.6 and 3.8°C.

Southern Australia and inland areas are likely to warm more than northern parts of the continent.

"We base our assessments on the latest international results and on a number of climate models from around the world including the climate models of the Division and the Bureau of Meteorology," says Dr Peter Whetton.

"The scenarios we have released present the range of climate change plausible during the next 75 years," he says.

According to CSIRO's scenarios, much of Australia can expect a decrease in winter rainfall.

In summer the situation is less clear, with different types of climate models yielding different results. Results from newer models that include deep ocean circulation differ from those obtained by older models that include only the shallow surface layers of the ocean. "Difficulty in assessing likely changes to summer rainfall underlines the critical role the oceans have in determining our climate," says Dr Whetton.

'The scenarios ... present the range of climate change plausible during the next 75 years'

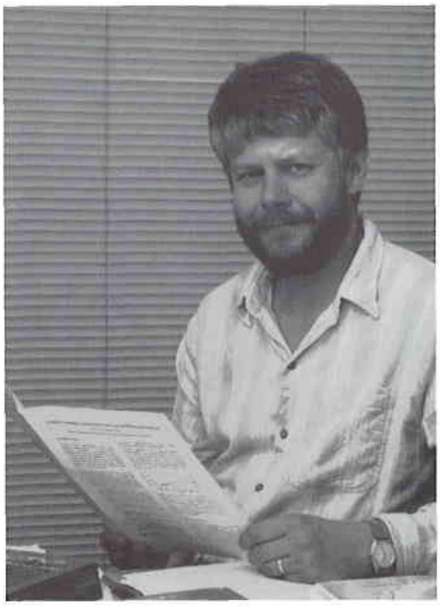
Dr Whetton said that higher temperatures will increase evaporation, which will reduce soil moisture and runoff except where there is a compensating increase in rainfall. Decreases in winter rainfall, and the possibility of further decreases in summer, would have significant implications for water resources, agriculture and biodiversity.

The new scenarios also examine likely changes to tropical cyclones, El Niño events, extreme temperatures and extreme rainfall.

CSIRO has taken the international findings of the Intergovernmental Panel on Climate Change into account when developing the scenarios. Allowance has been made for the likely cooling effect of sulfate aerosol pollution.

The Division issued its last climate change scenarios in 1992. The latest scenarios reduce the likely range of future temperature increase mainly by reducing the maximum warmings anticipated.

Scenarios of winter rainfall changes are similar to those released four years ago. In summer, however, the latest climate models with deep ocean circulations predict rainfall decreases throughout much of the country. The previous scenarios suggested increases, but were based exclusively on earlier models.



Peter Whetton: considering changes to Australia's climate during the next 75 years news

Earth, ocean, atmosphere: Australia to host major scientific meeting

More than 2000 meteorologists, climatologists, oceanographers and geologists from around the world are expected in Melbourne in July for one of the largest scientific meetings ever held in the southern hemisphere.

The meeting is the joint assemblies of the prestigious International Association of Meteorology and Atmospheric Sciences, and International Association for Physical Sciences of the Ocean.

Key speakers at the meeting include 1995 Nobel Chemistry Laureate, Prof. Sherwood Rowland; Prof. Walter Munk from the Scripps Institution of Oceanography; and Prof. W.R. Peltier of the Physics Department of the University of Toronto.

"The Australian scientific community is particularly excited about the meeting," says Dr Tom Beer, secretary of the local organising committee.

"There are so many wonderful scientific developments happening at the moment in the southern hemisphere. The meeting will be an ideal event for sharing knowledge and for advancing earth, ocean and atmospheric science," adds Dr Beer.

Earth, Ocean, Atmosphere: Forces for Change is the theme of the meeting, providing a strong focus on our natural environment.

Scientists will be presenting and discussing a wealth of information on global warming, El Niño, ocean circulation and remote sensing. Also covered will be atmospheric chemistry, cloud processes, ocean-atmosphere interactions, palaeoclimatology, the water cycle, estuarine science, climatic variability and climate modelling.

Many of the world's leading scientists will be participating.

"Judging by the number and quality of abstracts received thus far, we are set for a wonderfully productive meeting," says Dr Beer.

Conference registrants will be able to join in workshops, scientific tours and field trips. Organisers have arranged pre- and post-conference trips to many of Australia's famous tourist destinations.

IAMAS • IAPSO

Further information is available from:

IAMAS/IAPSO Secretariat,
Convention Network, 224 Rouse St.,
Port Melbourne, Vic. 3207, AUSTRALIA

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http://www.dar.csiro.au/pub/events/assemblies

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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 licence and training
LAPAN, Indonesia

DARLAM software
WNI Weathernews Pty Ltd

Dry deposition modelling of Klang Valley
Tenaga National Berhad, Malaysia

Fine resolution assessment of climate change
NSW Environment Protection Authority

Fine resolution assessment of climate change
Victorian Department of Conservation and Natural Resources

Fluoride in air
Comalco, Tasmania

Melaka passive gas study
Tenaga National Berhad, Malaysia

National greenhouse inventory
Department of the Environment, Sport and Territories

Rainwater chemistry in Klang Valley, Malaysia
BHP

SO_2, NO_2, O_3, NH_3 measurements
NIWA

Sulfur dioxide in air
WMC

Sulfur dioxide measurements
Boyne Smelters

Sydney airport study
Coffey Partners

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

Wet and dry deposition study, Hunter Valley
Pacific Power

Seeking bad weather in the name of science

Wet and windy was the ideal weather recently for Divisional scientists taking part in an experiment in New Zealand's South Island.

"The Southern Alps experiment was a thorough examination of how mountains influence weather and climate," says Dr Jørgen Jensen.

"It will help us better predict how much rain and snow falls in mountainous areas and improve estimates of likely flooding," adds Dr Jensen.

The experiment also provided a test of whether computer climate models properly represent mountains and associated cloud systems.

Divisional scientists made measurements on board an Australian F27 research aircraft. The plane flew from Christchurch over and upwind of the mountains to gather information about atmospheric conditions and about the sizes and types of aerosol and cloud droplets.

Representing the Division in New Zealand's largest field experiment since the 1950s were Jørgen Jensen, Sunhee Lee, Dan Gogoasa, Bernard Petraitis and Brian Ryan.

"A highlight for the team was three flights through a storm which dumped 500 mm of rain in four days," recalls Dr Jensen. "A once-in-four-years event!"

Coordinated by Dr David Wratt from New Zealand's National Institute of Water and Atmospheric Research, the Southern Alps experiment also involved scientists from Monash University as well as from Japan, the UK and Canada.

Dan Gogoasa checks the instrumented nose cone on the F27 research aircraft

Helping precipitate Middle East peace

Brian Ryan, an expert on cloud seeding, is playing a key role in the Middle East peace process.

Dr Ryan has been part of an international committee set up to foster co-operation between rainfall enhancement programs in the Middle East and the Mediterranean.

"Water may become a more important commodity than oil in the Middle East," says Dr Ryan. "Disputes over water are increasingly being recognised as the trigger for conflict and even war."

In April 1995, the Australian Government hosted a workshop on water resources as part of its commitment to the Middle East peace process. A second workshop in Bari, Italy, was sponsored by the European Union to build on the scientific foundations set out at the Australian workshop. Dr Ryan gave a keynote address to the Bari workshop.

"The most effective peace initiatives in the Middle East come from the need to collaborate on issues of common concern, such as water," says Dr Ryan. "Australian expertise will have the dual role of facilitating the peace process, and actually improving the supply of water."

"Not only will we be able to share expertise," he says, "but we will operate in an atmosphere of co-operation."

Countdown to 1999

In two years, the National Space Development Agency of Japan will launch Adeos II, a sophisticated polar-orbiting satellite designed to collect information on global environmental change. The Agency has appointed Dr Fred Prata to develop algorithms for analysing data provided by a global imager on the satellite.

The imager is an optical sensor for detecting reflected solar radiation from the earth's surface and clouds as well as emitted thermal radiation transfer through the atmosphere. The result will be new information about the temperature and make-up of land surfaces, insights into the behaviour of clouds, and measurements of vegetation.

To calibrate the imager, researchers will use extensive ground measurements from instrumented sites at Hay in New South Wales and Alice Springs in central Australia chosen for their uniform terrain. Working on the Adeos team with Fred Prata are Reinout Boers, Ian Grant and John Garratt.

feature

Probing Jakarta's hazy days

Every week during the past year, staff from the Environmental Impact Management Agency and East Java Pollution Control Implementation Project climb to the top of a three-storey building at Jalan Thamrin, one of the busiest roads in central Jakarta. On the flat, grey concrete roof is an array of analytical instruments that sample and continually monitor particle levels and haze in the city air. The measurements are part of an exhaustive, 12-month study of fine particles in the air around Jakarta.

Dr John Gras from the Division and Dr David Cohen of ANSTO's Physics Division have monitored haze in the dry and wet season, the composition and amount of fine particles in the air during the day, and variations in concentrations of important pollutant gases depending on local and regional sources such as motor vehicles, industries and other human activities.

"We are providing a scientific basis for assessing the sources and environmental risk of fine particles," says Dr John Gras.

"Indonesian scientists will use the study results to help establish control programs aimed at reducing pollution problems."

"This information is vital for any pollution control program in Jakarta."

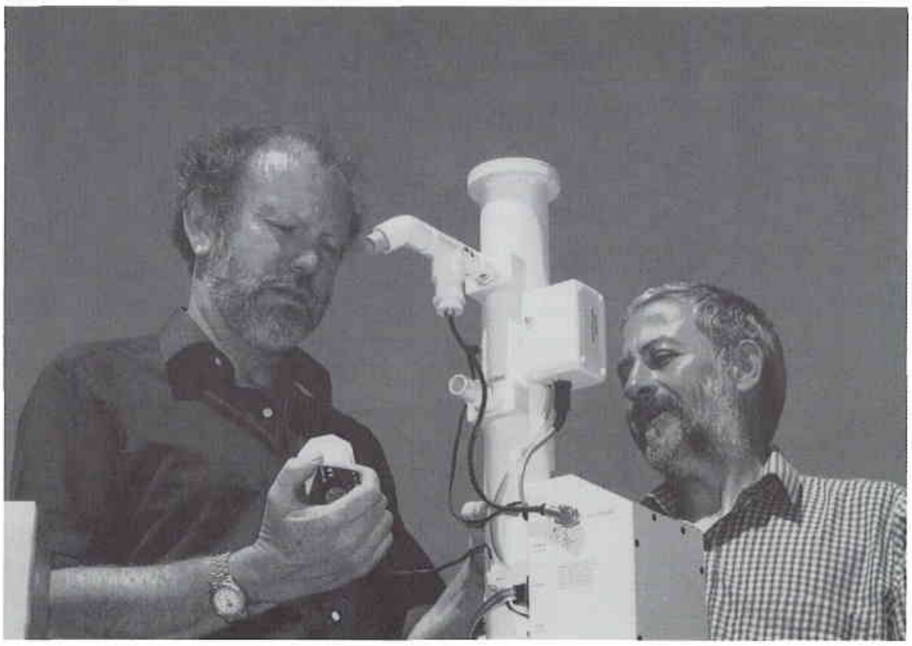
In addition to particle measurements, CSIRO's passive air samplers have measured levels of sulfur dioxide and nitrogen dioxide in the air. The samplers rely on impregnated filter paper absorbing these gases. Data obtained from the passive samplers help scientists understand the role of reactive gases in the formation of urban haze.

Direct measurements of the amount of light scattered by airborne particles using a nephelometer show that local visual distances in Jakarta are poor, typically between 5 and 17 kilometres. Visibility (and therefore fine particle level) is worst at around 7 a.m. and in the evening. The morning peak coincides with peak traffic volume, whereas the evening peak may be the result of a more complex combination of traffic and domestic emissions, chemical reactions in the air and changes in atmospheric stability.

AusAID, the Australian Agency for International Development, is funding the study, which also involves the consulting company CMPS&F.

Around the globe, in many urban and regional centres, particle pollution is emerging as a threat to human health. The finest particles seem to be the greatest problem. The United States Environment Protection Agency estimates that PM10 particles — those smaller than 10 micrometres in diameter — may be the cause of 60,000 premature deaths in the US each year. PM10 particles can penetrate deep into the lungs, causing respiratory difficulties. They also trap toxic pollutants and carry them into the bloodstream.

"Our data should tell us the main sources of the different sizes of airborne particles," says Dr Gras.



John Gras and Tom Firestone install a nephelometer for measuring air-borne particles

in brief

Open Day draws thousands

As part of our 50th anniversary celebrations, the Division recently threw open its doors to allow the public to see our laboratories and talk to scientists.

Three thousand people took up the invitation. Popular attractions included GASLAB, in which pristine air from around the world is analysed for its greenhouse gas content, the Geophysical Fluid Dynamics Laboratory with its enormous water tanks for simulating atmospheric behaviour, and the workshops where so many sophisticated instruments are designed and built.

Comments were very positive, including the following, overheard from a lad aged about 10, as he left the Division: "Mummy, can we come back next weekend?".

Fred Prata woos the crowds at the Division of Atmospheric Research Open Day held late last year

LAPAN training course

During the past few years the Division has conducted a number of successful training courses for overseas scientists.

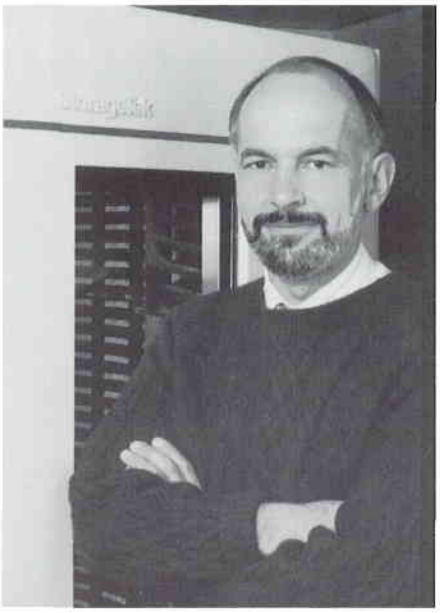
In 1994, we ran a program on climate modelling for 16 Asian scientists under the auspices of the International Geosphere–Biosphere Program. Two years ago, Mrs Tuti and Mrs Sri from the Indonesian Meteorological Agency visited for a month-long course on rainwater, aerosol and acid gas collection and analysis.

Last month, four members of LAPAN, the Indonesian National Institution of Aeronautics and Space, completed six weeks of extensive hands-on experience, lectures and tutorials on CSIRO's limited-area model, DARLAM. The model allows high resolution simulations of climate in regional areas.

Course leader, John McGregor, with (from left) Bambamg Siswanto, Ina Juaeni, Teguh Harjana and Suaydhi

Longer-term visiting scientists		Host scientist
Dr Carmen Nappo	National Oceanic and Atmospheric Administration, USA	**Bill Physick**
Dr Charlie Quon	Bedford Institute of Oceanography, Canada	**Peter Baines**
Dr Shoichi Taguchi	National Institute for Resources and Environment, Japan	**Ian Enting**

feature



Hal Gordon is the Climate Variability Group Leader in the Climate Modelling Program at the Division and he coordinates development of the CSIRO climate model. Currently, CSIRO's coupled model is one of about a dozen in the world used for assessing the effects on global climate of increasing levels of carbon dioxide in the atmosphere.

A model approach to understanding climate

Carbon dioxide levels are rising. How will this affect global climate? When is the next El Niño likely to strike? If ocean current behaviour changes, will Australian rainfall change? What are the likely climatic effects of changing land usage such as tropical deforestation?

Climatologists such as Dr Hal Gordon are seeking answers to such questions using advanced climate models. The models are necessary because atmospheric scientists can't conduct direct experiments on the global climate to test theories or examine responses to different external stimuli.

Climate models are complex, lengthy computer programs based on the physical laws and equations of motion that govern the earth's climate system. It takes the most powerful supercomputers in the world to carry out the necessary computations.

Climate models attempt to mimic the way in which the earth's climate behaves from day to day, and also over the seasons. They have to do this for all parts of the globe: the surface, throughout the atmosphere, and for the depths of the oceans. Quite a task!

Weather forecasting models have much in common with climate models. Weather models use detailed observations of current weather and then predict the state of the atmosphere a few days hence using atmospheric models with high spatial resolution. CSIRO's climate models have a longer-term objective than forecasting models. Our models investigate the way in which the overall climate of the world evolves over years and even centuries, rather than attempting to forecast day-to-day weather variations.

The CSIRO climate model (which comprises 54,000 lines of programming code!) is earning growing international recognition. Alex Joubert and colleagues from South Africa's University of Witwatersrand are using the model to explore the possibility of climate change bringing drier conditions to their country. Dr Joubert assessed the CSIRO model as the most reliable of those he considered. At Pretoria University, Dr Hanness Rautenbach is conducting investigations with the model of El Niño, the phenomenon that often brings drought to much of the planet.

In Japan, Dr Yonetani of the National Institute of the National Institute for Earth Science and Disaster Prevention has fed sea-surface temperature data into the model to assess possible climatic changes over Japan.

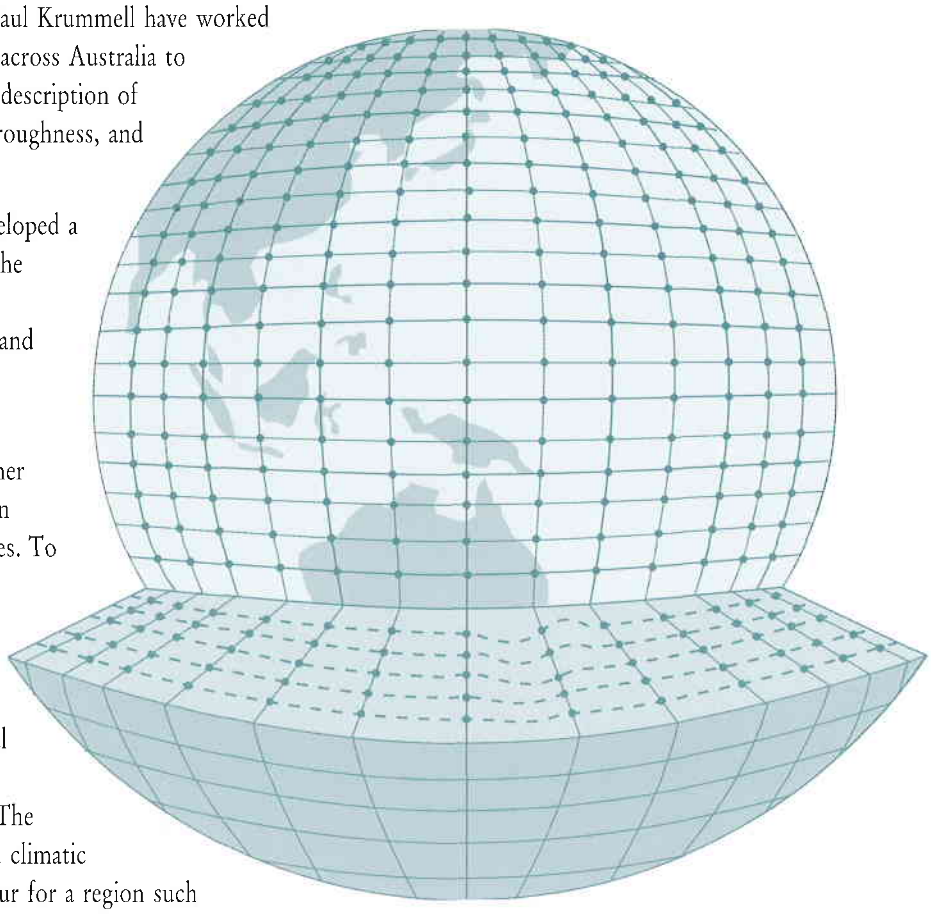
Results from the CSIRO climate model figured prominently in the latest assessments of climate change from the Intergovernmental Panel on Climate Change.

The heart of a climate model

Global climate models contain four main components: the atmosphere, oceans, ice- and snow-covered regions, and land surfaces with vegetation cover. In the real world, all of these components interact with each other in complex ways. A climate model is designed to include all of these interacting parts.

Over the years, John McGregor, Martin Dix and Leon Rotstayn have helped Hal Gordon develop the atmospheric component of the model. Tony Hirst has played a leading role in developing the ocean model that is coupled to the atmospheric model. Colleagues at CSIRO's Division of Oceanography provided assistance and are actively working on improvements to the ocean model.

Siobhan O'Farrell developed the climate model's sea-ice component and its interactions with the oceans and atmosphere. Without forests, world climate would be very different. John Garratt, Eva Kowalczyk and Paul Krummell have worked with fellow CSIRO scientists from across Australia to add to the climate model a realistic description of vegetation, surface reflectivity and roughness, and snow and ice.



Leon Rotstayn has successfully developed a new cloud scheme for inclusion in the latest version of the climate model, which will feature 24 vertical levels and a horizontal resolution of approximately 250 kilometres.

Of course, mountain ranges and other geographic features affect climate on scales far smaller than 250 kilometres. To overcome this problem, John McGregor has spearheaded development of CSIRO's limited-area model that is nested within the global climate model. The global model "drives" the nested model, providing large-scale climatic data. The limited-area model can give detailed climatic information such as rainfall behaviour for a region such as the Australian Alps, with a horizontal resolution of as little as 30 kilometres.

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 almost 3000 publications since 1983, visit our Web site at: **http://www.dar.csiro.au/pub/services/library/pubsearch.html**. This list is updated approximately monthly.

To conserve space future editions of *Atmosphere* will no longer carry this publications list. If you are unable to use our Web service, please contact the Division should you require a publications list.

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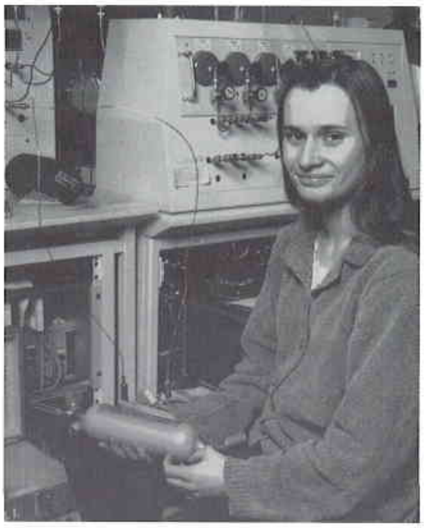
Tracking the make-up of our air



At times, Melbourne's polluted air travels all the way to Tasmania. Bronwyn Dunse is studying this transport of pollution as part of her Masters degree in environmental management from the Victoria University of Technology.

Bronwyn is checking air analyses done at the Cape Grim Baseline Air Pollution Station in north-western Tasmania. A day or two after pollution events in Melbourne, readings of pollutants such as hydrocarbons rise if winds are from the north.

"The fact that we can measure city pollutants hundreds of kilometres away shows the great sensitivity of the equipment at the station," says Bronwyn.

As part of her Masters degree in environmental management, Bronwyn Dunse analyses air collected at the Cape Grim Station in Tasmania

Climate future, climate past

In recent months, the Division has brought out two major books on climate. One looks to the future, examining the likely impacts on our region of the enhanced greenhouse effect. The other is a retrospective view of that major driver of drought and flood, El Niño.

Greenhouse: Coping with Climate Change presents Australia's most wide-ranging examination of greenhouse science, the likely impacts of climate change and assessments of our response options.

The book is designed to play an important role in underpinning policy development and in making numerous assessments available to professionals and interested members of the public.

Featuring 38 papers from experts in Australian and New Zealand, *Greenhouse: Coping with Climate Change*includes detailed climate change assessments, evaluations of energy taxes and discussions on energy efficiency.

Other key topics include the changing composition of our air; the role of forests in absorbing carbon dioxide; impacts on natural ecosystems, agriculture, water resources and fisheries; and international implications of climate change and climate change responses.

Almost every major drought recorded in Australia is caused by El Niño, the reversal in normal Pacific ocean currents and winds.

El Niño – Southern Oscillation & Climatic Variability brings together more than 90 million ocean temperature and air pressure measurements from around the world. This lavishly illustrated book describes every major El Niño event since 1871, showing clearly the climatic see-saw that regularly plunges parts of the globe into drought while other areas suffer deluge.

"Climate researchers now have at their fingertips an invaluable dataset," says Dr Rob Allan, one of the authors.

Divisional scientists are using the data to evaluate how well climate models can simulate past droughts. This work supports encouraging advances in seasonal predictions of drought.

Greenhouse: Coping with Climate Change, edited by Willem Bouma, Graeme Pearman and Martin Manning, RRP: $89.95

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