atmosphere

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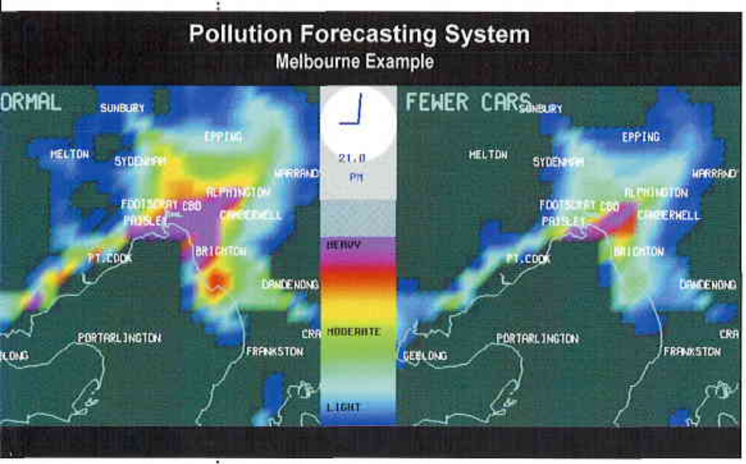
CSIRO

Tomorrow: fine, with clean air and a low particle count

Accurate predictions of air quality will soon be part of daily weather forecasts for many Australian cities thanks to a world-class forecasting system being developed by collaboration between CSIRO, the Victorian Environment Protection Authority (EPA) and the Bureau of Meteorology.

The Australian air quality forecasting system will predict daily levels of photochemical smog and atmospheric particles.



With fewer polluting cars on the road, urban air quality improves considerably.

This information will help people plan outdoor activities, enable the environment protection agencies and industry to test effectiveness of strategies to reduce air pollution and raise awareness of air quality as an environmental issue.

Senator Robert Hill, Minister for the Environment, recently announced the project, which has been funded by the Air Pollution in Major Cities Program under the Natural Heritage Trust.

EPA Victoria will provide methods for use by major Australian cities to calculate daily pollution emissions. The Bureau of Meteorology will generate the high resolution weather forecasts and CSIRO will create computer models to calculate pollution levels.

'We plan to have the air quality forecasting system in place by the year 2000,' says Dr Martin Cope.

'The new Bureau of Meteorology – CSIRO supercomputer allows us to rapidly perform complex calculations that will tell us what tomorrow's air quality will be like, showing how air quality will vary, hour-by-hour over the next 24 hours,' he says.

Two forecasts will be provided. One will show predicted levels of pollutants. The second will show how air quality might improve on high pollution days if there were a concerted public response, such as more people using public transport.

'Forecasts may be used to estimate people's long-term exposure to air pollution as well as allowing the EPA to implement control measures to lower emissions on days of high pollution potential,' says Dr Cope.

'We will even be able to produce an air quality forecast for a single suburb,' adds Dr Cope.

The Australian air quality forecasting system will predict concentrations of pollutants including ozone, carbon monoxide, oxides of nitrogen, air toxics (such as benzene) and sulfur dioxide.

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Northern Australia: a warmer future

During the next 30 years, inland parts of northern Australia are likely to warm by between 0.4°C and 1.4°C, while coastal areas are likely to warm by between 0.3°C and 1.0°C.

These are some of the findings from CSIRO Atmospheric Research's three-year research program examining impacts of climate change. The governments of the Northern Territory, Queensland and Western Australia funded the research.

More hot days and fewer cold days are likely across northern Australia in future, a trend that has been seen since 1950.

'We expect winter rainfall to decrease by as much as 8 per cent by 2030, although winter rainfall in the region is low except in south-east Queensland,' says Dr Kevin Walsh.

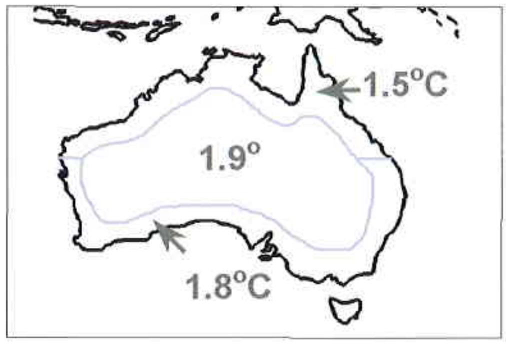
Changes to total summer rainfall are less clear.

However, when rainfall does occur, the weather systems that produce heavy rainfall in northern and central Australia are likely to become more intense in future, producing heavier rainfall events.

'We have found that annual heavy rainfall intensity has increased by over 50 per cent since 1910 in north-western Australia,' says Dr Walsh.

These findings may have implications for design of water storages, irrigation and drainage systems, and for erosion control measures.

Sea-level rise (estimated to be between 4 and 24 cm by 2030) and changes in water runoff from the land will affect coastal ecosystems, such as sensitive mangrove habitats.



Regional scenario from mid-global-warming scenario in the year 2070

'We are now researching the likely impact of global warming on the frequency and severity of El Niño, as well as on tropical cyclone behaviour,' says Dr Walsh.

CSIRO's assessments of the likely future impact of increasing atmospheric concentrations of greenhouse gases are based on results from sophisticated computer climate models, knowledge of the climate system, and from new, high-resolution regional climate models.

Sectors that may be affected by climate change include coastal zones, ecosystems, agriculture, water resources, the mining industry, tourism, human health, fisheries, pests, coral reefs and low-lying islands.

'Climate change due to increases in greenhouse gas concentrations is now inevitable and some adaptation will be necessary,' says Dr Walsh.

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Worried about air pollution? Your own backyard could be part of the problem! CSIRO and Monash University scientists have found that lawns and grasslands release into the air vast quantities of pollutants.

Keep off the grass – reduce air pollution

Firing up the mower and cutting the grass will just make things worse. Emissions of chemicals increase around 100-fold after grass is cut, taking hours to reduce to their original level.

To measure emissions of air pollutants from grass, scientists from Monash and CSIRO set up a transparent chamber in a grass paddock in Gippsland, south-eastern Victoria. The scientists collected and analysed gases released by the grass over a two-year period. Their aim was to learn how emissions are affected by variations in temperature and light intensity, and by drought.

'It's not just cars and industry, or lawnmowers themselves, that cause air pollution,' says Mr Ian Galbally, who leads CSIRO Atmospheric Research's Global Atmospheric Change Program.

'Plants release highly reactive hydrocarbons that can add significantly to photochemical smog problems,' Mr Galbally says.

Mr Wayne Kirstine from the Gippsland campus of Monash University conducted the research with Mr Galbally.

Although grasslands and pastures cover a quarter of the Earth's land surface, this study is one of the first of emissions from grass and clover.

Emissions from grass are at their greatest in warm weather and at around midday, when sunlight is most intense. No gases are released at night.

After the researchers cut the grass in the chamber, gas release from clover rose by a factor of 80, and emissions from grass increased by 180 times.

Ian Galbally measures gaseous emissions from grass

Cattle grazing or trampling will have a similar effect to mowing, increasing emission rates from grass.

Scientists believe that some of the additional gases released by cut grass are natural antibiotics, which act to disinfect the wound site.

Gases released by grass include the volatile organic compounds methanol, ethanol, propanone and butanone.

This study has shown that grasslands around the world may be one of the biggest sources of methanol, and perhaps ethanol, in the atmosphere.

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These are a few of the more than 100 papers published by staff of CSIRO Atmospheric Research during the past six months. For a full list of our publications, visit http://www.dar.csiro.au/pub/services/library/pubsearch.html. Please contact the Division if you would like a printed version of our publications.

Selected publications

Boers, R., Jensen, J. B., and **Krummel, P. B.** (1998). Microphysical and short-wave radiative structure of stratocumulus clouds over the Southern Ocean: summer results and seasonal differences. *Quarterly Journal of the Royal Meteorological Society,* **124** (545A): 151–168.

Case-studies of stratocumulus clouds observed during the summer phase of the Southern Ocean Cloud Experiment, which investigated microphysical properties of clouds. Summertime cloud droplet concentrations were three times greater than in winter.

Dix, M. R., and **Hunt, B. G.** (1998). Transient climatic change to 3 x CO_2 conditions. *Global and Planetary Change,* **18** (1–2): 15–36.

The CSIRO coupled global climatic model has been integrated for transient increasing atmospheric carbon dioxide conditions from current levels up to three times the concentrations. Examination of changes in climatic variables between 1 and 2 x CO_2, and 2 and 3 x CO_2 states reveals an expected general diminution in magnitude of changes for the latter state.

Holper, P.N. (1998) Weather and air: Activities booklet, Cooperative Research Centre for Southern Hemisphere Meteorology, Clayton, Victoria.

A booklet of science experiments for primary and secondary school students. Available free from the Cooperative Research Centre. Ph: 03 9905 9660; E-mail: crc@vortex.shm.monash.edu.au

Keywood, M. D., Fifield, L. K., Chivas, A. R., and Cresswell, R. G. (1998). Fallout of chlorine 36 to the Earth's surface in the southern hemisphere. *Journal of Geophysical Research,* **103** (D7): 8281-8286.

Chlorine-36 is a naturally-occurring radioactive isotope with many applications as an environmental tracer. Southern hemisphere fallout appears to be 2–3 times less than in the northern hemisphere. This may be due to enhanced stratosphere-troposphere exchange north of the equator promoted by the greater area of landmass.

Rotstayn, L. D. (1998). A physically based scheme for the treatment of stratiform clouds and precipitation in large-scale models. II: comparison of modelled and observed climatological fields. *Quarterly Journal of the Royal Meteorological Society,* **124B** (546): 389–415.

Fields from two experiments performed with 18-level versions of the CSIRO global climate model are compared with observed fields, focusing on quantities related to clouds and precipitation. The first experiment employed a new prognostic treatment of stratiform clouds and precipitation.

Wang, Y. P., and Leuning, R. (1998). A two-leaf model for canopy conductance, photosynthesis and partitioning of available energy. I: Model description and comparison with a multi-layered model. *Agricultural and Forest Meteorology,* **91** (1–2): 89–111.

This paper presents a one-layered, two-leaf canopy model which calculates fluxes of sensible heat, latent heat and carbon dioxide separately for sunlit and shaded leaves. The two-leaf model is computationally ten times more efficient than the multi-layered model and is suitable for incorporation into regional and global climate models.

Whetton, P. H. (1998). Climate change impacts on the spatial extent of snow-cover in the Australian Alps. In: *Snow: a natural history; an uncertain future.* K. Green (editor). Canberra: Australian Alps Liaison Committee. p. 195–206.

Climate change impacts on the spatial extent of snow cover in the Australian Alps are examined using the Galloway snow model and the latest CSIRO climate change scenarios. Simulated impacts using a best case scenario are moderate: the area with simulated cover of more than 30 days declines by 18% by 2030. Under a worst case scenario the reductions are very marked: 66% reduction by 2030.

BRIEFS

Greenhouse gases may threaten coral reefs

Rising atmospheric concentrations of carbon dioxide may be threatening coral reefs, according to a report from the Scientific Committee on Oceanic Research.

The report says that the ability of reef plants and animals to make the limestone skeletons that build reefs may be reduced by increases in acidity of surface ocean water caused by increasing carbon dioxide concentrations.

By the middle of the 21st century, carbon dioxide may interfere with skeleton growth by reef builders. Reefs may also be less able to keep up with rising sea level.

Courtesy CRC Reef Research Centre and Quicksilver Connections

'This report represents a breakthrough in terms of recognising a previously unidentified global effect on an ocean ecosystem caused by human-induced changes in oceanic chemistry,' says Dr Barrie Pittock, one of the contributors to the report.

The drive for cleaner air

Despite increases in the number of motor vehicles travelling in Melbourne's central business district (CBD), the air pollution they cause has dropped considerably since the early 1980s. This drop is mainly due to improved motor vehicle emission controls.

Concentrations of hydrocarbons released by vehicles in the CBD are now 61 per cent less than they were 15 years ago. Levels of cancer-causing benzene from vehicles in city air are down by almost two-thirds, and nitrogen oxide emissions have decreased by 20 per cent.

These findings come from tests performed by CSIRO as part of the Victorian Environment Protection Authority's air quality management plan which is assessing emissions into the Melbourne airshed from all sources.

'This is good news for people in the heart of Melbourne. They are exposed to much lower concentrations of these pollutants today than they would have been in 1983-84,' says Dr Ian Weeks.

Variability models 'can't account for 20th century warming'

Climate modellers have successfully accounted for the two major climatic anomalies of the past millennium – the Medieval Warm Phase between the 8th and 14th centuries, and the Little Ice Age. What CSIRO's climatic model cannot explain however, solely on the basis of natural climatic variation, is the sustained warming trend experienced during the 20th century.

'The increase by at least half a degree in average global temperature over the past 100 years lies outside the envelope of natural climate variability,' says Mr Barrie Hunt.

The CSIRO model simulates the dynamic exchange of energy between the lower atmosphere and the top of the ocean, land surfaces and sea-ice across the entire planet. Results from the model match well with real-world records and from measurements of past climate derived from air trapped in ice cores and from annual growth rings in trees.

La Niña: the Little Girl

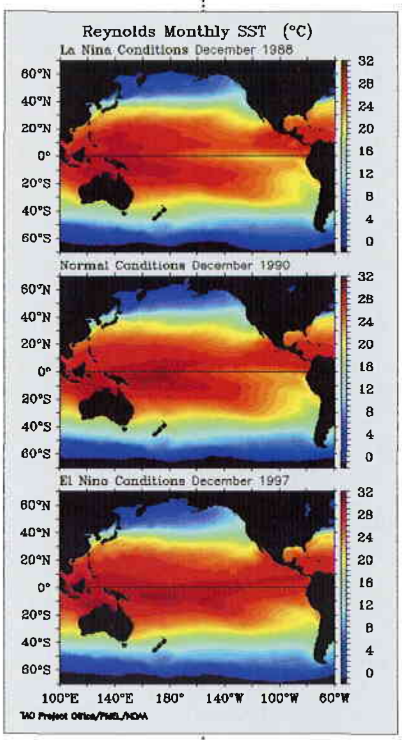
Most Australians associate El Niño with the water shortages and drought that this phenomenon so often brings to our country.

Less well known is El Niño's counterpart, La Niña, which is often responsible for above average rainfall over much of Australia, especially the eastern States.

The birth of La Niña

An early sign of La Niña is warming of the ocean north of New Guinea, a region known as the western equatorial Pacific warm pool. Here, the temperature of surface water may increase from its usual 29–30°C by up to 1.5°C. Meanwhile, in the equatorial eastern Pacific Ocean, the ocean surface cools.

Atmospheric pressure in Tahiti rises relative to that in Darwin and easterly trade winds that blow towards us from the central Pacific intensify.



The warm pool heats the air in contact with it. The warm air rises, lifting tonnes of moisture that condenses in the atmosphere forming massive cloud banks. These clouds bring rain to eastern Australia and parts of South-East Asia.

The 1996 La Niña brought above average rainfall to much of Australia, especially to Queensland and New South Wales. La Niña's warmer seas usually generate more tropical cyclones around Australia.

While the high ocean surface temperatures usually enhance rainfall in our region, the cooler than normal eastern Pacific Ocean often results in low rainfall and sometimes drought in parts of South and Central America, and in the United States.

The Pacific see-saw

La Niña is one extreme of a gigantic see-sawing of atmospheric pressure between the western and eastern Pacific. Known to scientists as the Southern Oscillation, this see-saw causes massive changes to trade winds and ocean currents during La Niña and El Niño events.

La Niña and El Niño events usually arise every two to seven years.

Scientists measure the position of the atmospheric see-saw via a simple calculation that compares surface atmospheric pressure in Tahiti with that in Darwin. High pressure in Tahiti and low pressure in Darwin, typical of La Niña, gives a positive Southern Oscillation Index. The El Niño that endured for much of the first half of the 1990s, returning in 1997, was associated with strongly negative values of the Southern Oscillation Index.

Abbreviation, much beloved of scientists, yields the term ENSO (El Niño – Southern Oscillation) to describe the cycle of changes over the Pacific Ocean. Research during the past decade shows that ENSO's influence can be seen across much of the planet.

The little boy and little girl

The Christ Child, El Niño (literally, 'little boy'), was how 19th century Peruvian fishermen referred to a warm ocean current that appeared each Christmas. The warm water suppressed nutrients rising to the surface of the ocean, temporarily reducing the anchovy catch.

Today, El Niño refers to a far larger equatorial warming of the Pacific Ocean, an event quite different from the annual current observed by Peruvian fishermen. El Niño and its opposite number, La Niña, are massive atmospheric and oceanic changes across the Pacific Ocean, with implications for weather and climate for millions of people around the world.

La Niña is a Spanish term meaning 'little girl'. Less imaginatively, climate scientists often speak of it as 'a cold event', due to below average ocean surface temperatures in the eastern Pacific.

Water temperatures in the Indian Ocean also have effects on Australian rainfall, particularly across the western and southern parts of the continent. The Indian Ocean is mostly independent of El Niño and La Niña, so it can intensify or nullify the effect in some areas.

Scientists at CSIRO Atmospheric Research with colleagues at CSIRO Marine Research and in the Bureau of Meteorology Research Centre are developing sophisticated climate models to determine the likelihood of El Niño and La Niña events up to 12 months ahead. These computer-based models simulate the intricate linkages between the world's oceans and the atmosphere, linkages that drive our climate.

Working with agencies, such as the Queensland Department of Primary Industries, scientists expect to give rural producers and natural resource managers the capacity to plan for climatic extremes.

Obituary: Dr C.H.B. (Bill) Priestley

Born: 8 July, 1915
Died: 18 May, 1998

The founding Chief of CSIRO Atmospheric Research, Dr Bill Priestley died on 18 May, 1998 aged 82.

After graduating in applied mathematics at Cambridge University in 1937, Dr Priestley joined the British Meteorological Office. In 1944, he was part of the team of British and American meteorologists who provided D-day weather forecasts for the allied amphibious assault on Normandy, France.

Dr Priestley arrived in Melbourne in 1946 to head a new CSIR research program in atmospheric sciences. Within two decades, the CSIRO Division of Meteorological Physics was one of the leading atmospheric research units in the world.

Scientifically, Dr Priestley's primary interest was turbulent processes and the links between small-scale and large-scale dynamics in the atmosphere. He won many awards for his contributions to science, including the Order of Australia, in 1976.

In 1972, with Dr Bill Gibbs, Director of the Bureau of Meteorology, Dr Priestley proposed establishment of an Australian observatory to measure 'background' composition of the atmosphere. This resulted in the Cape Grim Baseline Air Pollution Station in north-western Tasmania, which has provided so much vital information on greenhouse gases, ozone depleting gases and other pollutants.

Following his retirement after 25 years as Chief of Division, Dr Priestley chaired the Latrobe Valley Airshed Study, a decade-long examination of air quality in Victoria's power generating region.

Discovery of new ozone-destroying chemical

As positive signs emerge showing that damage to the ozone layer should decline in the next decade, CSIRO scientists have discovered a new ozone-destroying chemical growing rapidly in the atmosphere.

Halon-1202, which has an ozone depletion potential approximately 30% higher than the common CFCs, has increased six-fold in the atmosphere since the late 1970s. During the past two years, the atmospheric concentration of halon-1202 has been growing at 17 per cent per annum.

Halon-1202, unlike other halons used in the past for firefighting, is not controlled by the Montreal Protocol. The source of the new halon is a mystery, adding to scientists' concerns over its potential impact on the ozone layer.

'The rapid growth of halon-1202 comes as a surprise to us,' says Dr Paul Fraser.

Dr Fraser speculates that the gas may be a by-product of inefficient production of other halons in developing countries. Alternatively, he says, some countries might be manufacturing halon-1202 for military applications.

Under the Montreal Protocol, developing countries have until 2010 before they must completely phase out halon production. China, the Republic of Korea, India and Russia are the only countries known to still be producing halon.

Continuing growth of halons in the atmosphere is in stark contrast to what is happening with CFCs.

'Our measurements show that most CFCs are either slowing down their atmospheric growth rate, have stabilised in the atmosphere or are actually falling in concentration,' says Dr Fraser.

'The international community will have to consider extending the ban on production of halons to halon-1202 if we are to protect the ozone layer,' says Dr Fraser.

The Australian Government has recognised the problem of halon-1202. At a recent meeting of Montreal Protocol countries in Geneva, Australia was successful in having the issue referred to the Protocol's Scientific Assessment Panel.

Paul Fraser and Nada Derek check CSIRO's collection of 'vintage' air dating back to 1978.

Dr Fraser expects that ozone recovery is likely to be detected in the next 10–20 years. However, continued emissions of halons will delay this recovery.

CSIRO's discovery comes from measurements of pristine air collected at the Bureau of Meteorology's Cape Grim baseline air pollution station in north-western Tasmania. CSIRO's research into ozone depleting chemicals is being done in collaboration with the Co-operative Research Centre for Southern Hemisphere Meteorology and with the University of East Anglia in the UK.

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Recent El Niños 'unlikely to be caused by past warming trend'

Global temperature increases this century are unlikely to be the cause of the spate of El Niño events during the 1990s, according to Dr Rob Allan.

'We know that El Niño tends to occur every two to seven years,' says Dr Allan.

'I have found two additional longer climatic fluctuations linked with El Niño: one occurs every eleven to thirteen years; the other, every fifteen to twenty years.'

'These climatic fluctuations have probably occurred for thousands of years,' he says.

'This makes me think that the gradual warming we've seen around the globe this century is unlikely to be the cause of the recent series of El Niño events. The dominant influences governing the strength and occurrence of El Niño are the three climatic fluctuations and other natural climatic variations.'

'I know my results will add to debate in the scientific community about the behaviour of El Niño,' acknowledges Dr Allan.

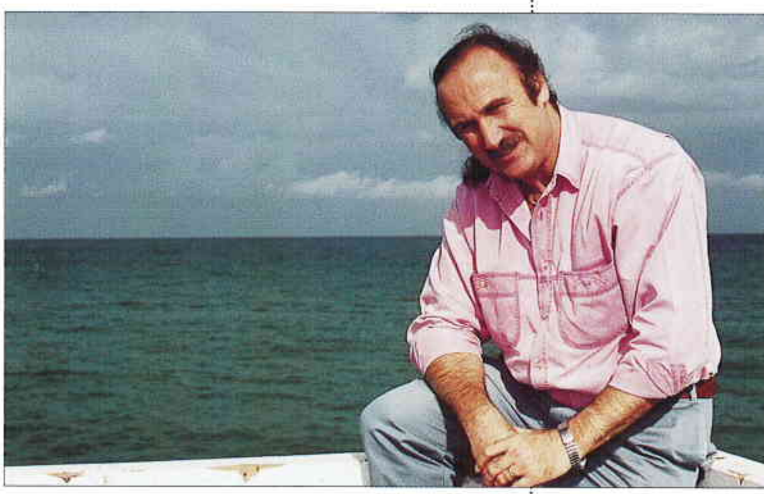
To reach his conclusion, Dr Allan analysed global atmospheric pressure and sea-surface temperature data collected during the past 125 years from almost 700 land locations and from numerous ship measurements.

Dr Allan's research marks a major advance in understanding the nature and structure of El Niño and is an important step towards resolving the physical mechanisms that give rise to the El Niño cycle. The research will also help establish what influence the enhanced greenhouse effect might have on El Niño.

'Agricultural scientists are keen to explore the potential for using this new understanding of El Niño to improve farm management strategies to deal with drought and floods,' says Dr Allan.

Dr Allan spent eight months at the Hadley Centre at the United Kingdom Meteorological Office, where he worked with prominent British scientists tracking down and analysing extensive climatic records from a wide range of sources.

'One of the more interesting records I found was a dog-eared exercise book containing nineteenth century weather reports compiled by British missionaries in Uganda,' says Dr Allan.



CSIRO is now running climate models to assess likely future changes to El Niño caused by increasing levels of greenhouse gases such as carbon dioxide. The climate models, which are run on a powerful supercomputer, incorporate the behaviour of the oceans and the atmosphere, which are crucial to the formation of El Niño. Model simulations show that El Niño events are features of climate that can be expected to continue in future under greenhouse conditions.

Dr Allan and colleagues recently published an atlas featuring global historical atmospheric pressure and sea-surface temperature maps detailing every El Niño event since 1871.

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A new oceanic influence on our climate: the Antarctic Circumpolar Wave

Peter Baines

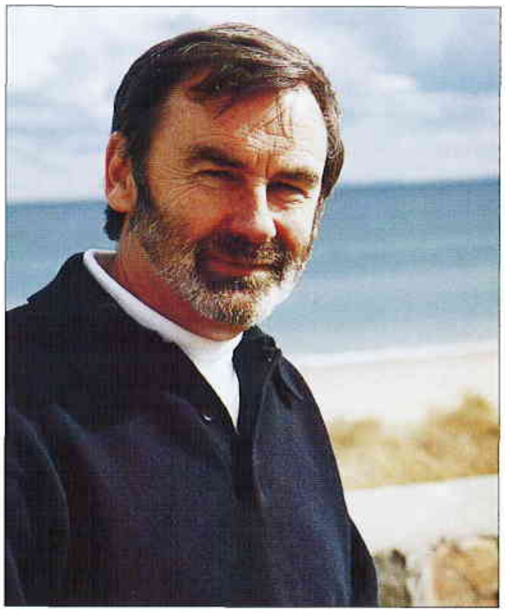
Divisional scientists are eagerly examining southern Australia's rainfall records to determine how the recently discovered Antarctic Circumpolar Wave affects our climate.

The Antarctic Circumpolar Wave is a phenomenon of the Southern Ocean. Within this Ocean, a massive current transports water, taking eight or nine years for a complete, clockwise rotation of Antarctica.

Embedded in this current and carried along with it are two large regions of relatively warm water, thousands of kilometres across, alternating with two equally large regions of relatively cold water. These alternating warm and cold regions, as with El Niño, appear to be due to interactions between the atmosphere and the ocean on a very large scale. Other factors such as the atmospheric pressure and wind patterns, and the extent of the sea ice northward from the Antarctic coastline, all tend to vary in sympathy with this travelling temperature pattern.

As these relatively warm and cold regions pass south of Australia, they often flood the Great Australian Bight and surround Tasmania. Consequently, when the southern Australian States experience winds off the Southern Ocean, these winds are slightly warmer than average when a warm region is present, and they also contain slightly more moisture than usual. Hence, warm regions cause winters (for example) to be warmer and wetter than average, and cold regions make them cooler and drier.

It appears that we are in the last stages of a cold region, and may expect a warm region to arrive next year. It now seems likely that the Antarctic Circumpolar Wave will be more important for rainfall in the southern States of Australia than El Niño. It is a recent realisation, but perhaps no real surprise, that events over our "back fence" may be more important to us than distant events out in the central Pacific that have received more international attention.



Peter Baines is the latest recipient of the Australian Meteorological and Oceanographic Society's Priestley Medal. The Society awards the Medal for excellence in meteorological or oceanographic research.

Peter has been honoured for his extensive contributions during the past 25 years to the science of geophysical fluid dynamics and its applications.

The Priestley Medal is named in honour of the founding Chief of Atmospheric Research, Dr Bill Priestley.

Three oceanic drivers

Variations in Australian climate stem from changes to the Pacific, Indian and Southern Oceans. The effects of each of these wax and wane, adding to and subtracting from each other, making each year different from the last.

As well as patterns of El Niño events in the Pacific Ocean and the Southern Ocean's Antarctic Circumpolar Wave, there is the 'Indian Ocean Dipole'.

Each phenomenon involves both the atmosphere and the respective ocean acting together and affecting each other. Together these appear to be responsible for most of the droughts, floods, dry summers and cold winters (though it is possible that there are other forcing factors with smaller impact on climate, yet to be identified), and most of the other complaints that people express about our variable climate.

There are other comparable variations that have been identified in other parts of the globe, notably in the North Pacific and North Atlantic, but these seem to have little impact on Australia.

The Indian Ocean Dipole has been shown to cause (or at least, be related to) the occurrence of rain-producing disturbances that extend across the Australian continent from north-west to south-east. These north-west cloud bands are the principal means by which rain occurs in the dry centre, although most of the associated rain actually occurs in the south-east of the country (South Australia and Victoria).

The dipole, when it is present, consists of a warm water region in the area around Indonesia and New Guinea, and a relatively colder region in the central Indian Ocean west of Australia. The warm region is fairly common, particularly in La Niña years.

Looking ahead

We are currently using CSIRO's climate models to explore the mechanisms of operation of El Niño, the Indian Ocean Dipole and the Antarctic Circumpolar Wave as well as their interactions.

With improvement in observations of the properties of the oceans surrounding Australia, the science of forecasting the climate for the next few seasons promises some exciting developments in coming years.

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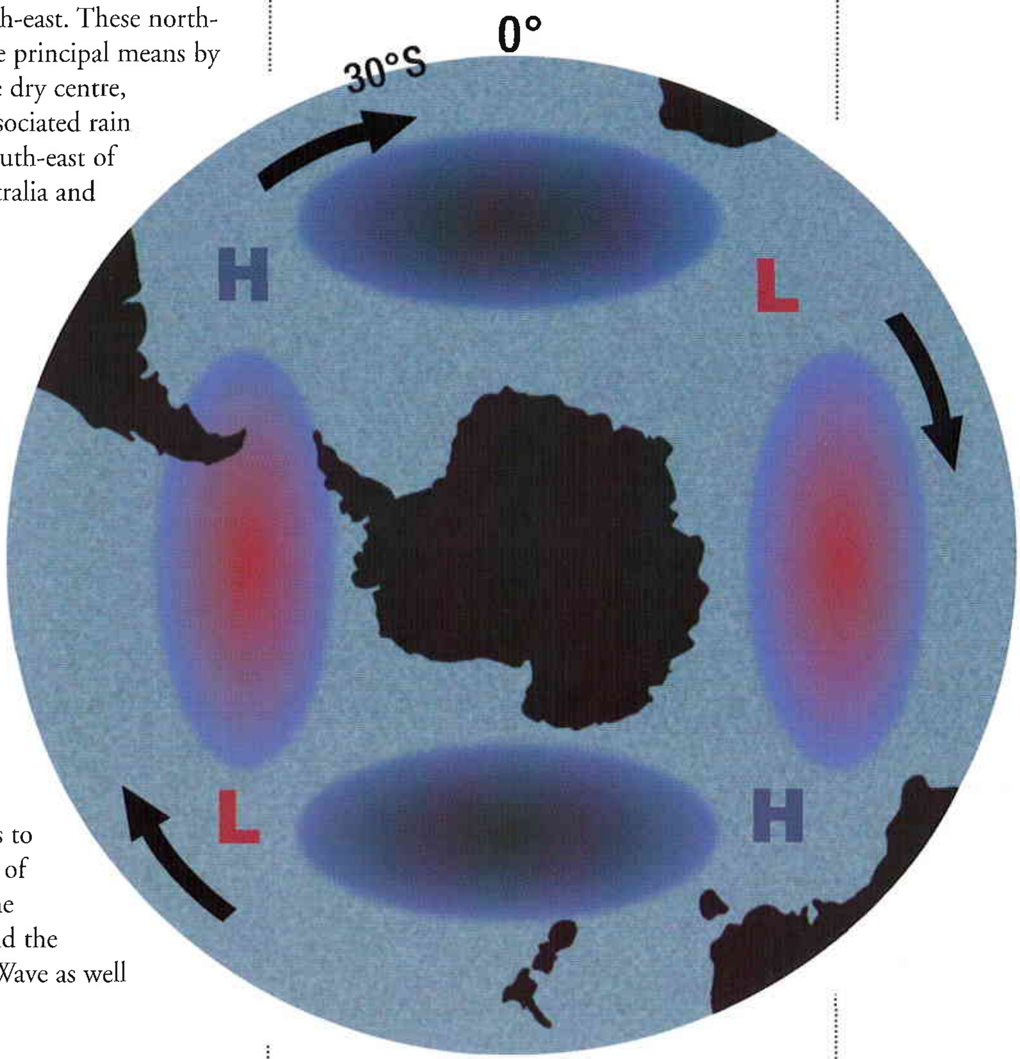
The Antarctic Circumpolar Wave, in schematic form. Regions of relatively warm (red) and cold (blue) water (by about +/–1 °C) are carried around the hemisphere by the Antarctic Circumpolar Current. Sea ice, atmospheric winds and pressure vary in sympathy.



Listening: the key to effective communication

Megan Wong and Matthew Petzke, from Beaumaris North Primary School, prepare to release their weather balloon during National Science Week. Students from across Australia measured wind speed and direction with tethered balloons, observing how wind speed can change with height.

CSIRO and the Bureau of Meteorology joined the Cooperative Research Centre for Southern Hemisphere Meteorology in organising the experiment.

Take 20 CSIRO scientists. Sit them down for a day with 40 leaders of industry, government and community groups. Ask the CSIRO scientists to listen carefully and endeavour to refrain from speaking!

This is what happened at the Climate and Atmosphere Forum, held in Melbourne. CSIRO's Climate and Atmosphere Sector comprises the dozen or so Divisions with research and applications in weather, climate and atmospheric pollution.

The objective of the Forum was to learn from our key stakeholders their views on relevant issues and to identify research needs.

The forum was designed to be very much a listening event. Apart from two brief activity sessions, there were just three 10-minute scene-setting presentations from CSIRO.

What was the result? A really effective forum, from which CSIRO has learnt a great deal. The external participants contributed enthusiastically. The silence of our scientists was very effective: it allowed the debate to flow and remain focussed on the opinions we were seeking.

Feedback forms show that the format was highly appreciated. The great majority of participants described the forum as 'a day well spent'. Almost all said that they would be keen to attend another, similar meeting during the next year or two.

Applying our research

Significant recent and ongoing projects

Greenhouse gas emission assessment	Biologic
National greenhouse gas inventory	Environment Australia
High-resolution climate change modelling	Environment Protection Authority, NSW
High-resolution climate change modelling	Environment Protection Authority, Vic
Assessment of sea level rise under climate change	Gold Coast City Council
Air quality power station siting study	Hong Kong Electric Company Ltd
Air quality modelling systen for Hong Kong	Hong Kong Environmental Protection Department
Emissions and the environment	Mt Isa Mines
Monitoring of pollutant concentrations in outdoor air	NIWA, New Zealand
Climate change under enhanced greenhouse conditions	Queensland Government
Greenhouse science consultancies	Various petroleum companies
Seasonal forecasting and climate variability	Western Australian Government