atmosphere

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CSIRO

Salt lake helps test satellite imager

The CSIRO team making measurements on the white expanse of Lake Frome to calibrate imaging equipment on board a new NASA satellite.

A team of CSIRO scientists have spent a week in a huge barren salt lake in Australia's interior helping to test a new NASA satellite.

The team, from CSIRO's Earth Observation Centre, went to Lake Frome, in South Australia, about 500 kilometres north of Adelaide. Their goal was to make sure that NASA's latest satellite is properly calibrated.

The Earth Observation Centre is now part of CSIRO Atmospheric Research.

NASA's EO-1 satellite, launched last November, contains the 'Hyperion' imaging equipment. Hyperion is the first of its kind in space and it measures much more detailed information about the Earth's surface than previous satellite instruments.

'Hyperion is unique because it records the brightness of the earth in 220 different spectral bands, or 'colours',' says Dr David Jupp.

'One of the best ways to test the satellite is to have it focus on a very white surface, such as Lake Frome, because it is one of the brightest spots on the Australian continent and it is very uniform,' he says.

CSIRO researchers have also tested the instrument at other extreme landscapes – including the darkness of the deep waters of Lake Argyle in Western Australia.

'By interpreting the Hyperion data, we will gain a better understanding of our resources and environment and how to manage them both,' says Dr Jupp.

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Giant rain gauges reveal record of past climate

Scientists are investigating a mysterious decline in water levels in the crater lakes of western Victoria.

'These changes are definitely pre-greenhouse,' says Dr Roger Jones. 'However there are signs that recent warming is affecting evaporation rates from the lakes.'

Researchers liken the crater lakes to giant rain gauges.

'They have no streams coming in or out, so they are dominated by rainfall and evaporation at the water's surface,' says Dr Jones.

In 1841, Lake Bullen Merri, Victoria's deepest natural lake, was recorded as overflowing into its twin crater, Lake Gnotuk. This was the last time it did so.

Since then, lake levels have continued to fall. Some are now dry lake beds, and three — Lakes Keilambete, Gnotuk and Bullen Merri — are still falling.

In the 1960s, Professor Jim Bowler from the University of Melbourne surveyed these lakes, unlocking a history of past lake-level changes dating back thousands of years. Now, a team of scientists including Prof. Bowler has shown that a climate change early in the 1800s initiated the fall we are still observing today.

The researchers reconstructed the historical lake fall from survey records and a long-term record of climate from 1859. Before Europeans arrived, the lakes had been at high levels for almost 2,000 years.

In a paper published in the Journal of Hydrology, the researchers show that modern rainfall on the lakes is only about 80% of lake evaporation. To maintain the pre-European lake levels, rainfall would have to have been about 95% of lake evaporation.

Kate Holper

Lake Bullen Merri, a crater lake of western Victoria. Water levels continue to fall as evaporation outstrips rainfall.

'A climate change is the only explanation for the fall in water level. Rainfall and cloud cover probably decreased, and temperature probably increased but the exact combination is still unknown,' says Dr Jones.

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Looking to the moon for better satellite images

For the first time, CSIRO and US scientists are using the moon to check and calibrate sensors on weather satellites.

The 'moon tuned' sensors are expected to provide a wealth of improved information about climate change and air pollution.

'The moon is the perfect object to point the satellite sensors at in order to check them,' explains Dr Ian Grant.

'The moon's surface is bare and unchanging and there is no air between it and the satellite.'

In the past, scientists have calibrated satellite sensors by checking their views of uniform targets on Earth, such as deserts or clouds. However, the atmosphere gets in the way and vegetation and rainfall can alter the appearance of deserts.

'We are doing lunar calibrations with the imager on the Japanese Geostationary Meteorological Satellite,' says Dr Grant.

Although the moon's surface is unchanging, the brightness of any point on the moon changes with the direction of sunlight and the location of the satellite.

The US Geological Survey accurately maps the moon's brightness from its lunar observatory in Arizona. The satellite imager is calibrated at times when its view of the moon matches the view angle of instruments at the observatory.

'In future, we'll be able to check the imager from a range of viewing angles,' says Dr Grant.

Additionally, the newly calibrated satellite sensor will be able to more accurately monitor smoke plumes from large fires that are prevalent in the tropics. Climate scientists are especially interested in the way in which smoke can affect global warming.

Dr Grant collaborated on the research with a team led by Dr Hugh Kieffer from the US Geological Survey.

There are currently eight geostationary meteorological satellites in orbit, and the lunar technique could be used in future to calibrate all of them. This will make their data more consistent and accurate, and so better able to monitor global climate and smoke plumes.

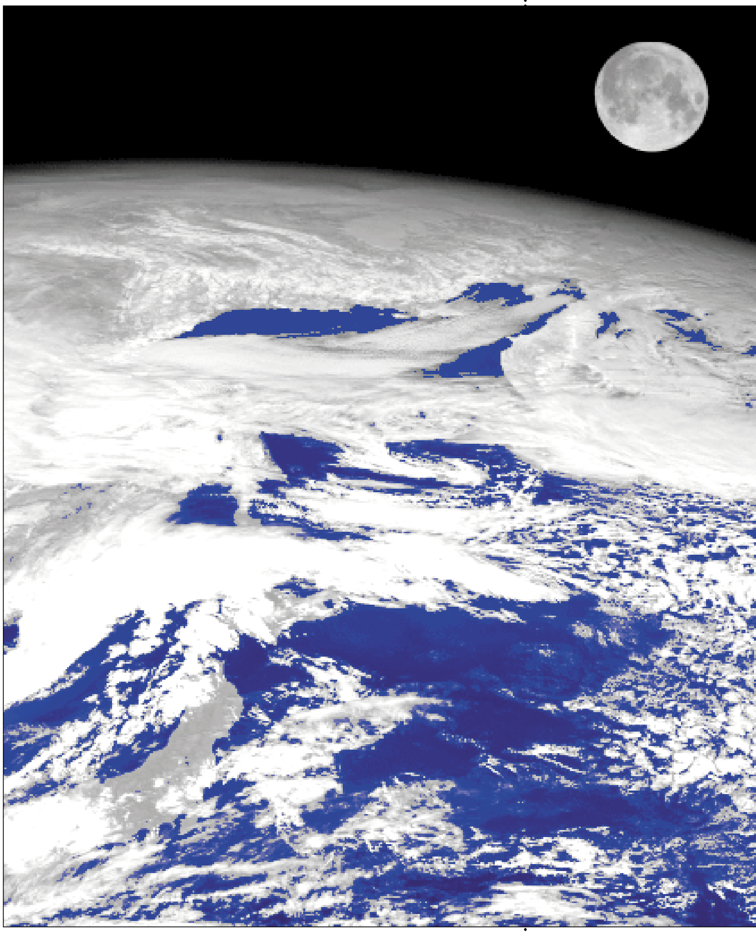

Image courtesy of the Bureau of Meteorology

An image of the moon above the northern hemisphere, taken from the GMS-5 satellite.

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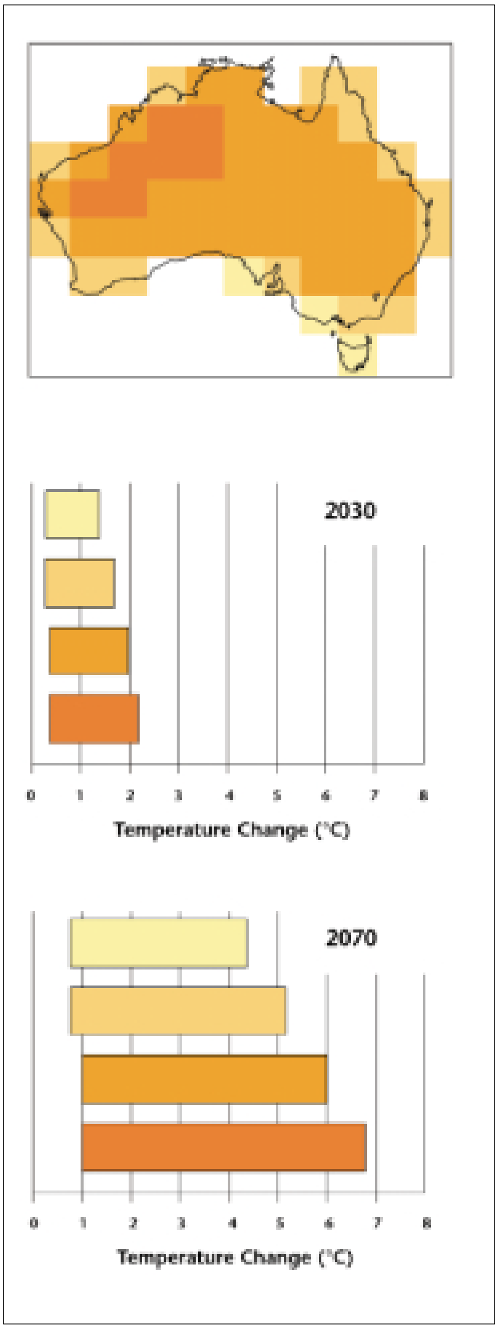
More droughts, more flooding rains

Australia will be hotter and drier in coming decades according to CSIRO's latest climate change estimates.

CSIRO has released its projections of the likely extent of climate change in Australia and the expected impacts across the country.



Ranges of average annual warming (°C) for around 2030 and 2070 relative to 1990. Coloured bars show changes for areas with corresponding colours in the map.

'Warmer conditions will produce more extremely hot days and fewer cold days,' says Dr Peter Whetton.

Over most of the continent, annual average temperatures will be 0.4 to 2°C greater than 1990 by 2030. By 2070, average temperatures are likely to increase by 1 to 6°C. The temperature ranges quoted indicate the scientific uncertainty associated with the projections.

'The warming won't be the same everywhere,' says Dr Whetton. 'There will be slightly less warming in some coastal areas and Tasmania, and slightly more warming in the north-west.'

South-western Australia can expect decreases in rainfall, as can parts of south-eastern Australia and Queensland. Wetter conditions are possible in northern and eastern Australia in summer and inland Australia in autumn.

In areas that experience little change or an increase in average rainfall, more frequent or heavier downpours are likely. Conversely, there will be more dry spells in regions where average rainfall decreases.

'We may also see more intense tropical cyclones, leading to an increase in the number of severe oceanic storm surges in the north. Rises in sea level would worsen this effect.'

Sea level is likely to rise at a rate of between 0.8 and 8.0 cm per decade, reaching 9 to 88 cm above the 1990 level by the year 2100.

'Evaporation will increase over most of the country. When combined with changes in rainfall, there is a clear decrease in available moisture,' says Dr Whetton.

Changing climate is likely to have a profound effect on Australia, with many winners and losers.

Dr Whetton believes that a better understanding of the likely impacts of

climate change can contribute to adaptation strategies designed to minimise adverse impacts and optimise benefits.

'Natural ecosystems most at risk are coral reefs, alpine ecosystems, mangroves and wetlands. Also under threat are tropical forests, savannas, deserts and native grasslands.'

'Natural systems have little opportunity to adapt to climate change. Higher temperatures and lower rainfall will be a threat. Climate change and sea-level rise will add to the vulnerability of many of Australia's wetlands.'

Higher carbon dioxide concentrations will increase plant productivity and the efficiency with which plants use water. A moderate rise in temperature will increase plant growth in temperate areas but may reduce it in the north.

Warmer conditions will reduce frost damage to many crops. However, fruit trees need cold weather to set fruit, so some fruit yields may decline.

Wheat yield will rise with warmer conditions if rainfall doesn't change. A rainfall decline of 20 per cent with temperature increases of more than 1°C will lower yield.

'The net effect on agriculture will be a trade-off between the positive impact of higher carbon dioxide and the negative effect of lower rainfall and higher temperatures,' says Dr Whetton.

Forests will benefit from a carbon dioxide-enriched atmosphere, but gains may be offset by warmer conditions.

'Some tropical pests, like the Queensland fruit fly, may spread southwards. Other temperate pests, like the light brown apple moth, may move to cooler areas,' says Dr Whetton.

'We're also likely to experience more water shortages and less snow.'

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Cloud seeding

Cloud seeding is a way of trying to artificially generate additional rainfall from clouds. It may involve attempting to produce rain when none would normally fall or it may be working to increase precipitation over a particular area.

Before the tiny droplets in clouds can form raindrops, snowflakes or hailstones, they have to join with millions of others to become heavy enough to fall to the ground. They will only do this if particles are present in the atmosphere. These particles are called cloud nuclei and may be dust, salt from evaporated sea spray, sand or other material from forest fires, volcanic eruptions and pollution.

Seed crystals

The particles that scientists add to clouds during seeding mimic the structure of ice and serve as additional nuclei for crystal formation.

Researchers can seed cold clouds with silver iodide particles, which have a crystal structure similar to that of ice particles.

Cold clouds may also be seeded with dry ice pellets, which cool the nearby air far below 0°C. Cloud droplets in the cooled air freeze and form ice particles that can grow as more water freezes on their surface.

Another way of seeding clouds is with a process known as hygroscopic seeding. This involves using flares to generate smoke full of salt. The salt particles act as nuclei that generate large water drops that can readily develop into raindrops.

Seeding using silver iodide burners, dry ice pellets and hygroscopic flares is done from a plane. Clouds may also be seeded from the ground using silver iodide generators.

Australian cloud seeding experiments

Cloud seeding experiments began in Australia just a year after the world's first laboratory trials in the USA.

From 1947 to 1952, CSIRO scientists used Royal Australian Air Force aircraft to drop dry ice into the tops of cumulus clouds. The method worked reliably with clouds that were very cold, producing rain that would not have otherwise fallen.

In the late 1960s, the Governments of Victoria, New South Wales, Queensland, South Australia and Western Australia seeded clouds. Results were either inconclusive or controversial.

On the other hand, CSIRO's activities in Tasmania in the 1960s were successful.

During the 1950s, CSIRO used RAAF Dakotas for cloud seeding.

Seeding over the Hydro-Electricity Commission catchment area on the Central Plateau achieved rainfall increases as high as 30% in autumn.

During the late 1980s, CSIRO Atmospheric Research acted as scientific advisor to Melbourne Water in a cloud seeding assessment conducted over the Baw Baw plateau, a major water catchment area. The experiment generated no statistical increase in rainfall.

Does cloud seeding work?

CSIRO has shown that in Australia cloud seeding is effective only in a limited number of weather conditions. Cloud seeding will never break droughts; cloudless skies will never produce rain. In fact, many types of clouds cannot be successfully seeded.

Cloud seeding is most likely to be effective when used on cumulus or stratiform clouds in air forced up over mountains.

Seeding is unlikely to be effective during winter and spring over the inland plains of southern and eastern Australia. It is also likely to fail in summer over eastern and north-eastern Australia plains and immediately to the north of Perth.

Based on over 50 years' experience with cloud seeding, CSIRO has established procedures for undertaking a cloud seeding experiment. These rigorous guidelines ensure that at the end of seeding operations there will be a clear-cut answer to whether or not the activity was successful. In other words, has the seeding netted a statistically significant increase in rain over the catchment? If the answer is no, there is no point in persevering.

It may be worth again attempting rainfall enhancement experiments in areas where past efforts have failed, but proper planning needs to be done first, along with rigorous independent evaluations.

BRIEFS

El Niño link to Southern Ocean currents

El Niño may be primarily responsible for determining the strength of the Antarctic Circumpolar Wave.

The Antarctic Circumpolar Wave involves large regions of slightly warmer and cooler water within the Southern Ocean slowly rotating around Antarctica.

'El Niño events cause atmospheric linkages, known as "teleconnections", that set up a region of high atmospheric pressure in the South Pacific,' explains Dr Peter Baines.

Associated with this high atmospheric pressure, warm, northerly winds heat the surface waters of the Southern Ocean nearby, slowly raising the temperature. Cold southerly winds also cool a similarly large region adjacent to it.

'The irregular pattern of El Niño events during the past few years has weakened the Antarctic Circumpolar Wave,' says Dr Baines.

'We may expect the next big El Niño to fire it up again,' he says.

Aerosol experiment

Tai-Yih Chen, Academia Sinica

CSIRO researchers studied clouds and aerosol from an instrumented King Air plane during the international Asian Aerosol Characterization Experiment.

Divisional staff have participated in an international experiment designed to increase understanding of how aerosol affect the world's climate.

ACE-Asia, the fourth Aerosol Characterization Experiment (ACE), took place during April and May off the coast of China, Japan and Korea. This region was chosen because it includes aerosol of varying composition and sizes. The aerosol come from human activities, industrial sources, and wind-blown dust.

ACE veteran, Dr Jørgen Jensen, and colleagues Messrs Bernie Petraitis, Charles Tivendale and Justin Peter, undertook 12 flights from Kagoshima in Japan. During the flights, the scientists examined aerosol processes in fronts and clouds, examined the life cycle of cumulus clouds, explored stratocumulus microphysics and made extensive measurements of aerosol.

'These experiments will help us understand how future changes in aerosol concentration and composition may influence climate,' says Dr Jensen.

Why is our climate changing?

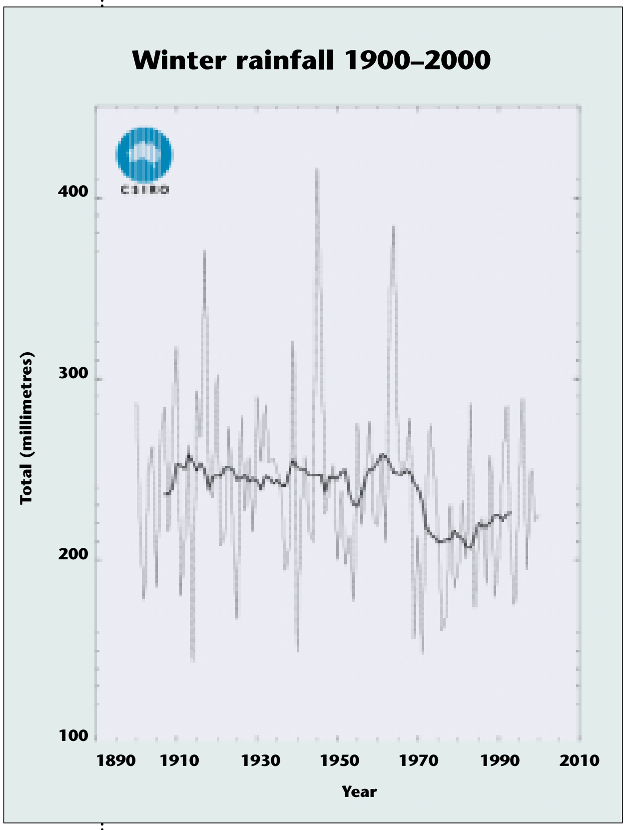
Serious rainfall decreases in south-western Western Australia since the 1970s could have profound implications for the rest of Australia.

Researchers from CSIRO and the Bureau of Meteorology are working to identify the causes of south-west WA's continuing 'dry'.

They hope to use their findings to better estimate what may happen in coming decades.

'Water supply authorities and agencies designing new water catchments need to know whether the region will stay relatively dry, become drier, or return to pre-1970s' conditions,' says Dr Ian Smith.

'We are studying a unique corner of Australia and exploring climatic fluctuations that happen from decade to decade and even over centuries,' says Dr Smith.



The decline in rainfall in south-western Western Australia.

Dr Ian Smith

'Most parts of Australia are affected by climatic ups and downs. People are always asking, "has climate changed permanently, or is this just a temporary change?". Our research is working to answer this in a part of the country where the question is vitally important.'

Rainfall decreases in south-western Western Australia over past decades have coincided with warming of surface waters of the southern Indian Ocean and with fewer low-pressure systems in the area.

If the changes observed in south-western Western Australia are part of a continuing, broader climatic shift, researchers say that it may affect other parts of Australia.

'Changes of this sort are most likely due to long-term natural climatic variations,' says Dr Smith. 'In the case of south-western Western Australia, other factors could be contributing to the drying trend, such as the greenhouse effect. Local or global land-use changes may also be factors.'

'Unfortunately, over the next century the greenhouse effect is predicted to cause further drying in south-western Western Australia,' says Dr Smith.

The Indian Ocean Climate Initiative, involving CSIRO and the Bureau of Meteorology, is funded by the Western Australian Government.

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Selected publications

Here is a sample of the numerous papers published by staff of CSIRO Atmospheric Research during the past six months. For a full list of our publications, please visit *http://www.dar.csiro.au/info/lib/pubsearch.asp*

Grant, I.F. (2001). Towards a climatology of Australian land surface albedo for use in climate models. In: *Remote sensing and climate modeling: synergies and limitations.* M. Beniston, and M.M. Verstraete (editors). (Advances in Global Change Research; 7) Dordrecht: Kluwer. p. 69–84.

Hunt, B.G. (2001). A description of persistent anomalies in a 1000-year climate model simulation. *Climate Dynamics,* **17** (9): 717–733.

Hurley, P.J., Blockley, A., and Rayner, K. (2001). Verification of a prognostic meteorological and air pollution model for year-long predictions in the Kwinana industrial region of Western Australia. *Atmospheric Environment,* **35** (10): 1871–1880.

Jones, R.N. (2001). An environmental risk assessment/management framework for climate change impact assessments. *Natural Hazards,* **23** (2/3): 197–230.

Meyer, C.P., **Galbally, I.E.**, **Wang, Y.P.**, **Weeks, I.A.**, Jamie, I.M., and Griffith, D.W. T. (2001). Two automatic chamber techniques for measuring soil-atmosphere exchanges of trace gases and results of their use in the oasis field experiment [Electronic publication]. Aspendale: CSIRO Atmospheric Research. (CSIRO Atmospheric Research technical paper; no. 51). 30 pp.

Mitchell, R.M. (2001). *In-flight characteristics of the space count of NOAA AVHRR channels 1 and 2 [Electronic publication].* Aspendale: CSIRO Atmospheric Research. (CSIRO Atmospheric Research technical paper; no. 52). 24 pp.

Nguyen, K.C., and **Walsh, K.J.E.** (2001). Interannual, decadal, and transient greenhouse simulation of tropical cyclone-like vortices in a regional climate model of the South Pacific. *Journal of Climate,* **14** (13): 3043–3054.

Noonan, J.A., **Physick, W.L.**, **Cope, M.E.**, Burgers, M., and Olliff, M. (2001). Air quality modelling for the Hong Kong Path Project. In: *Air pollution modeling and its application XIV [papers and poster abstracts presented at the Millennium (24th) NATO/CCMS International Technical Meeting on Air Pollution Modeling and Its Application], Boulder, Colo.*, S.E. Gryning, and F.A. Schiermeier (editors). New York: Kluwer Academic. p. 125–133.

Prata, A.J., and **Grant, I.F.** (2001). *Determination of mass loadings and plume heights of volcanic ash clouds from satellite data [Electronic publication].* Aspendale: CSIRO Atmospheric Research. (CSIRO Atmospheric Research technical paper; no. 48). 38 pp.

Sawford, B.L. (2001). Turbulent relative dispersion. *Annual Review of Fluid Mechanics,* **33**: 289–317.

Tindale, N.W., **Derek, N.**, and **Francey, R.J.**, editors. (2001). *Baseline Atmospheric Program Australia.* 1997–98 ed. Melbourne: Bureau of Meteorology and CSIRO Atmospheric Research. vi, 122 pp.

Walsh, K.J.E., **Hennessy, K.J.**, **Jones, R.N.**, **McInnes, K.L.**, **Page, C.M.**, **Pittock, A.B.**, **Suppiah, R.**, and **Whetton, P.H.** (2001). *Climate change in Queensland under enhanced greenhouse conditions: third annual report, 1999–2000.* Aspendale, Vic.: CSIRO Atmospheric Research. vii, 130 pp. + 1 CD-ROM.

Watterson, I.G. (2001). Decomposition of global ocean currents using a simple iterative method. *Journal of Atmospheric and Oceanic Technology,* **18** (4): 691–703.

Learning about atmosphere and pollution

Bendigo Senior Secondary College in Victoria and CSIRO have joined forces to create a new on-line learning module on the atmosphere. The module (available at *www.bssc.edu.au/community/atchem/*) includes information on layers of the atmosphere, gases in air, the greenhouse effect, ozone depletion and air pollution.

'We set out to create an online learning experience with interesting, up-to-date information for students and teachers,' says Ms Jennifer Moloney, Online Curriculum Co-ordinator at Bendigo Senior Secondary College.

'There are interactive activities and test-yourself questions, all presented in a way that students are likely to find enjoyable,' says Ms Moloney.

The Web site has been supported by the Victorian Education Department through a Science and Technology Awareness Grant.

CSIRO Atmospheric Research provided information on the atmosphere and on atmospheric environment issues for the site.

'The site, which is designed for independent learning, also provides material on careers in science,' says Ms Moloney.

'The site is flexible, suitable for individual tuition and for classroom learning. It caters for different learning styles of students by incorporating interactive visuals and text.'

Australian science's 'Citation Laureates' honoured

Two scientists from CSIRO Atmospheric Research were among 33 Australian 'Citation Laureates' honoured for their contribution to world knowledge, with the first-ever citation awards for Australian authors.

Dr Paul Fraser was recognised for his research on ozone depletion and greenhouse; Dr Paul Steele for greenhouse research.

The 'Citation Laureates' identify scientists who have authored more than six 'high impact' papers – scientific papers that are among the 200 most-cited scientific papers in the world for each year from 1981 to 1998. These papers are considered the most influential in the growth of human knowledge.

The awards, sponsored by international bibliographic database publishers ISI, were the first of their kind in Australia.

Dr Paul Steele (left) and Dr Paul Fraser, among Australia's most-cited scientists.

Applying our research

Significant recent and ongoing projects

Australian air quality forecasting system	Commonwealth Government's Natural Heritage Trust
Assessment of urban monitoring needs	Environment Australia
Support for development of air quality improvement plan for Victoria	EPA Victoria
GLOBALHUBS initiative to measure atmospheric carbon dioxide	European Commission Research Directorates
Development of Airborne Hazard Detection Technologies	Integrated Avionic Systems
Inverse modelling involving greenhouse gases	US agencies
Climate change impacts, adaptation and vulnerability	Victorian Department of Natural Resources

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