atmosphere
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Victoria Prize for greenhouse scientists

CSIRO scientists Dr Roger Francey and Dr Paul Steele have been awarded the prestigious Victoria Prize by the State Government for their internationally-acclaimed work to combat what they describe as perhaps 'the biggest environmental problem the world faces'.

Dr Paul Steele (left) and Dr Roger Francey (right) with the Governor of Victoria Mr John Landy at the Government House presentation of the 2001 Victoria Prize.

Dr Francey and Dr Steele have spent the past decade working to improve ways of tackling global warming. The two scientists established CSIRO's Global Atmospheric Sampling Laboratory (GASLAB).

Their work to improve measurement of greenhouse gases has long been acknowledged internationally and strongly endorsed by recent major international developments based on their approach.

'The Victoria Prize is a great honour for us. It is especially welcome because it allows us to demonstrate to the wider Australian community the importance and relevance of our work, and to heighten awareness of Australian opportunities that arise from the achievements,' says Dr Francey.

The $50,000 Victoria Prize is presented annually to celebrate how leadership, determination and creativity in science or technology innovation can significantly advance the State's knowledge base and future economic growth.

The two scientists lead a team that has developed a range of powerful diagnostic tools to help understand how the Earth's atmosphere is changing, and how plants and oceans struggle to moderate the changes.

Drs Francey and Steele have played a central role in developing and implementing strategies to overcome problems that have prevented effective merging of data from different laboratories.

These initiatives have culminated in a number of international contracts stimulated by their 'GLOBALHUBS' strategy, which has been identified as a priority in 10-year plans, coordinated by the International Geosphere-Biosphere Program/World Climate Research Program and the International Human Dimensions Program, for a global observing system.

The commitment to develop and exploit a major breakthrough in carbon dioxide measurement technology is perhaps the most significant of their achievements. The LOFLO carbon dioxide analyser, while powerfully enhancing the diagnostic GLOBALHUBS activities, also offers for the first time the possibility of high precision low-cost monitoring in the remotest corners of the globe.

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Australian scientists are producing daily forecasts of air quality for Melbourne and Sydney. The forecasts are designed to help people plan outdoor activities, enable environment protection authorities and industry to test effectiveness of pollution controls and to raise awareness of air pollution.

Forecasting tomorrow's air quality in your own suburb

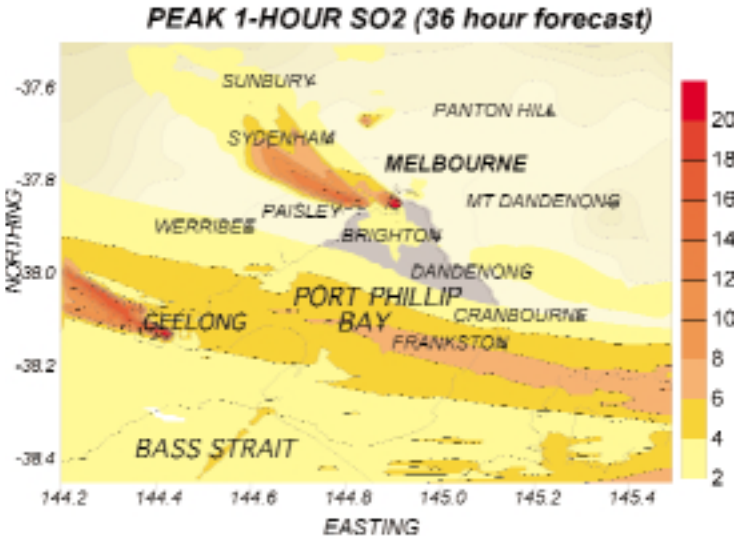
The Australian Air Quality Forecasting System will give urban and rural communities information on their local environment, predicting daily levels of photochemical smog, particle haze, carbon monoxide and other hazardous air pollutants.

The new system has the potential to provide local air quality forecasts for each suburb and town. It can also be used to track the movement of air pollution. This information is likely to be of benefit to people with health problems such as asthma.

Initiated in 1998 as a demonstration project, development of the Australian Air Quality Forecasting System has involved more than 20 scientists, from EPA Victoria, EPA NSW, the Bureau of Meteorology, and CSIRO Atmospheric Research and CSIRO Energy Technology.

The system will also give projections of how air quality might be improved through people's behaviour, such as reduced car use. This is being done by generating two forecasts. One shows predicted levels of pollutants with normal car use. The second shows how air quality might improve on high pollution days if there is a concerted public response, such as more people using public transport.

The Bureau of Meteorology — CSIRO supercomputer generates the forecasts using sophisticated numerical models driven by



Maximum one-hour concentrations of sulfur dioxide predicted for the Melbourne region by the air quality forecasting model.

data from EPA Victoria. The supercomputer rapidly performs complex calculations that result in predictions of air quality, hour-by-hour, over the forthcoming 24 hours.

The Bureau of Meteorology will continue this project, running air quality forecasts for Sydney and Melbourne and looking to extend the forecasts to other locations.

EPA Victoria provides methods to be used by each major Australian city to calculate daily pollution emissions. The Bureau of Meteorology generates high-resolution weather forecasts and CSIRO is responsible for the computer models that determine pollution levels.

The Commonwealth Government's Natural Heritage Trust provided funds for the project.

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Clearing the air

Wendy Pyper

In 1997, forest fires on the Indonesian island of Sumatra blanketed over three million square kilometres of South-East Asia in a pall of choking white smoke. Ten million hectares of rainforest were destroyed, and thousands of people in Indonesia, Singapore, Malaysia and Brunei were admitted to hospital suffering respiratory distress.

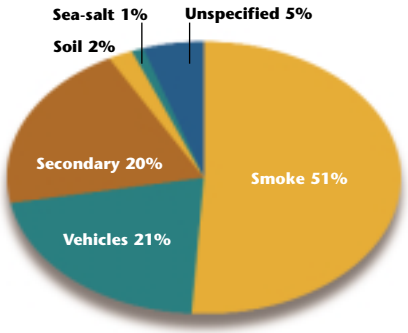
1999 and 2000 saw further episodes of smog. Malaysia has been hardest-hit by the problem, with its air pollution index hitting 650 in September 1998, well above the hazardous levels of between 300 and 500.

Between 1998 and 2000, an investigation into the cause of haze in Malaysia's Klang Valley was conducted by CSIRO Atmospheric Research, the Department of Environment Malaysia, the Malaysian Meteorological Service and Alam Sekitar Malaysia Sdn Bhd. The Malaysian Haze Study, funded by AusAID, measured the chemistry and light scattering ability of aerosol at two sites near Kuala Lumpur: Petaling Jaya and Gombak.

'First we took continuous direct measurement of light scattering by aerosol particles. Then we looked at the chemistry of the particles to work out their sources,' says Dr Melita Keywood.

Dr Melita Keywood cleans an atmospheric aerosol sampler at Gomback, on the outskirts of Kuala Lumpur

Sources of PM2.5 particles



Source: Gomback

Using a 'chemical fingerprinting' method — which combines a knowledge of the chemical composition of particles from different emission sources with measurements of the actual chemical composition of the haze — the scientists identified three major contributors to the haze problem: smoke, vehicles and secondary (photochemical) aerosol production.

The scientists also modelled the movement of pollution using CSIRO's acclaimed air pollution model, TAPM.

The study produced recommendations to help Malaysian authorities deal with domestic pollution sources. Further research has also been proposed, including the development of a photochemical smog model for the Klang Valley region, measurement of particle source chemical profiles for smoke and vehicle emissions, and the development of emission inventories for oxides of nitrogen, sulfur dioxide and volatile organic compounds.

This is an edited version of a story that first appeared in Ecos.

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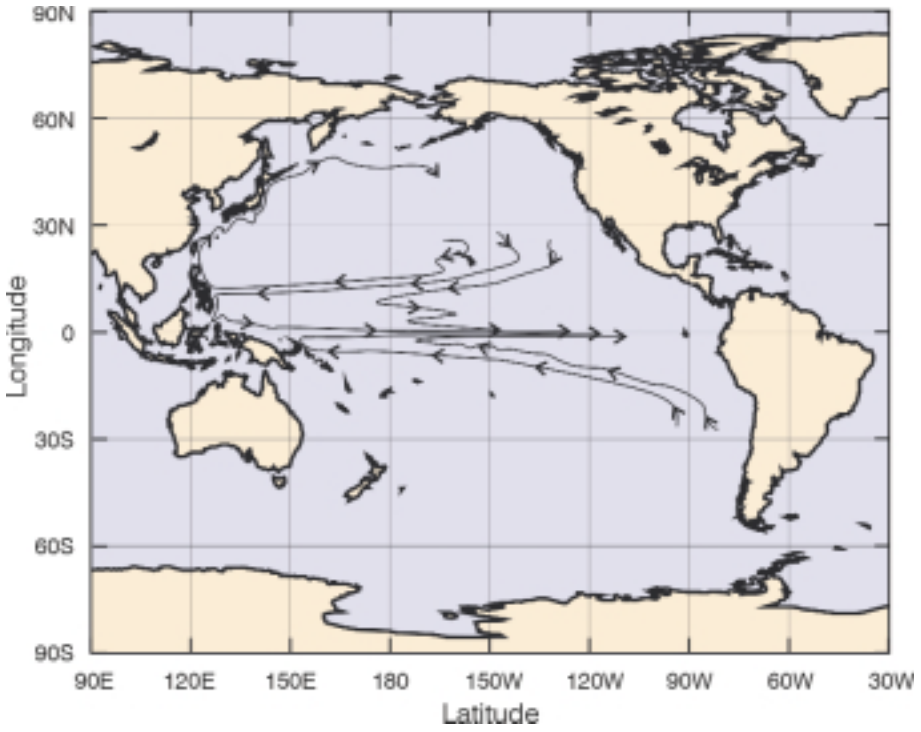
Global climate shift linked to greenhouse



New evidence is emerging that greenhouse gases may have tipped the world into a changed climate pattern, say Divisional researchers.

The researchers are exploring links between a global climate change that began around 1970 and rising greenhouse gas concentrations.

Since the mid-1970s, surface waters in the eastern Pacific Ocean, off the USA and Central America, have been warmer than in the past. Temperatures of the ocean surface in this region have been up to 0.8°C greater than they were in the first half of the 20th century.

Dr Wenju Cai and colleague Dr Peter Whetton have evidence that the change was caused by warm water in the oceans at high latitudes being carried to the eastern equatorial Pacific by deep ocean currents. The process takes about 30 years.

Using CSIRO's global climate model, the researchers have found that higher levels of atmospheric greenhouse gases may be the cause of the climatic shift in the Pacific.

'Our climate models are matching what we see in the real world,' says Dr Cai.

Warmer conditions in the eastern equatorial Pacific are normally associated with El Niño events. These events occur every 2–7 years, and normally lead to lower rainfall in eastern and southern Australia. The last El Niño occurred in 1997.

'The change doesn't mean that we will have more El Niño events, but those that do occur may be stronger,' says Dr Cai.

This finding is in agreement with CSIRO's projections of likely changes to Australia's climate due to the greenhouse effect during the next 100 years. Scientists project warmer, drier conditions for much of the country.

Dr Cai and Dr Whetton have published their findings in the international *Journal of Climate.*

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The question of when and how hard the next El Niño or La Niña will hit can now be answered up to nine months ahead of the event.

CSIRO has begun estimating long-range probabilities of receiving above or below median rainfall over much of the country, based on forecasts of whether El Niño or La Niña conditions will develop in the Pacific Ocean.

El Niño predictions up to nine months ahead

'We use our climate models to predict sea surface temperatures in the equatorial Pacific Ocean. These temperatures provide a measure of the strength of El Niño and La Niña,' explains Dr Ian Smith.

'Our predictions build on over a decade's climatic research by CSIRO.'

La Niña conditions prevailed up until late last year and were accompanied by significantly above-average rainfall over much of Australia. In fact, 2000 was classified as the second wettest on record. Since then, La Niña conditions have waned.

Typically, El Niño means drier than normal conditions over much of eastern and northern Australia.

CSIRO updates its predictions monthly. The National Climate Centre and the Queensland Centre for Climate Applications provide rainfall outlooks three months ahead.

'CSIRO is generating information beyond three months ahead, which can be useful for agricultural, water resource, and agribusiness planners,' says Dr Smith.

The Commonwealth Government's Climate Variability in Agriculture Research and Development Program helped fund this research.

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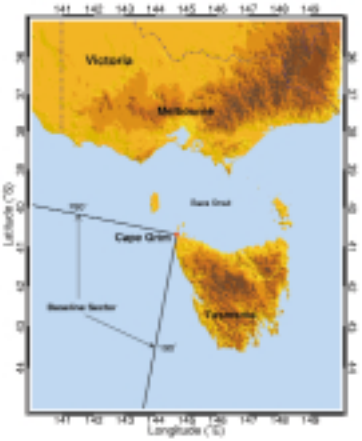
25 years of carbon dioxide measureme



Location map

Telstra tower with 70-metre air inlet

Cape Grim station building tower atop 90-metre cliff

ents

and Telstra

Presented in this graph are some 190,000 hourly measurements of carbon dioxide concentrations made at the Cape Grim Baseline Air Pollution Station in north-western Tasmania.

Red points on the graph represent periods when winds are sustained off the Southern Ocean, in the baseline sector. These 'baseline' data exhibit low variability, and most clearly reveal the upward trend in carbon dioxide concentrations, as well as a small seasonal cycle.

The blue points are designated as 'non-baseline', and reveal the influences of local and regional processes (primarily photosynthesis and respiration of plants).

The higher variability of non-baseline data is real, and not measurement uncertainty.

Measurements such as these can only be maintained by the kind of long-term institutional support provided by the Bureau of Meteorology and CSIRO.

eWeather forecasts for energy industry

Electricity generators and energy users are using CSIRO's new specialised weather forecasts to predict power demand and prices.

eWeatheronline.com predicts temperature, rainfall, humidity, and wind direction and speed at 30-minute intervals during the eight-day forecast period. The new service is produced by EWN Publishing using detailed forecasts generated by CSIRO Atmospheric Research.

Forecasts are prepared twice daily for Adelaide, Melbourne, Sydney, Brisbane and Townsville, and cover 70-kilometre zones over the centres of Adelaide, Melbourne, Sydney and Brisbane. All observations are updated hourly and charted automatically.

The specialist forecasts enable wholesale electricity sellers and buyers, as well as end-users, to estimate demand and price in advance.

'eWeatheronline.com provides a new service to the energy industry and the community,' says Dr Brian Ryan.

'With better information, consumers will be able to manage periods when electricity consumption exceeds capacity.'

Each electricity generator sets the cost of energy production at any given time, based on forecast consumption.

CSIRO's specialised weather forecasts and EWN's analysis of the market dynamics are tools that generators can use to estimate demand.

Energy users will be able to use the forecasts to lower their consumption at times of peak usage, when electricity costs are likely to be high. From 2002, customers will be paying a variable cost based on time of usage.

The National Electricity Market Management Company (NEMCO) is responsible for managing the national electricity market. CSIRO's weather forecasts provide information additional to that used by NEMCO for its energy projections.

'We are delighted to be working with CSIRO,' says Ms Laurel Fox-Allen, from EWN Publishing.

'The forecasts allow planners to look ahead and see risks of very high price spikes in the electricity market, and plan money-saving action,' she says.

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Australia's darkest and brightest

Researchers from the CSIRO Earth Observation Centre recently completed two field campaigns to validate and improve calibration techniques for data from a number of different satellites.

The campaigns are serving a number of purposes. One is to use a lengthy time series of Advanced Very High Resolution Radiometer (AVHRR) data to explore the changing nature of the continent over the past twenty years. Another is part of the CSIRO-led validation efforts in Australia for the Hyperion imaging equipment on NASA's experimental EO-1 satellite.

A satellite image of Lake Argyle produced by the Advanced Land Imager on board the EO-1 satellite.

CSIRO scientists have made measurements at Lake Argyle in Western Australia to calibrate Hyperion imaging equipment on NASA's EO-1 satellite.

Hyperion is the first civilian hyperspectral instrument in space and measures much more detailed information about the Earth's surface than previous satellite instruments. The Earth Observation Centre is one of only three groups outside of the USA to be involved in EO-1 evaluation in its first year of operation.

The two calibration sites were chosen for their darkness (Lake Argyle) and brightness (Lake Frome). Lake Argyle is a large lake in the Kimberley region of Western Australia. Lake Frome is a South Australian salt lake.

The scientific team — comprising Dr Dean Graetz, Dr Edward King, Dr Jenny Lovell, Ms Susan Campbell, Dr David Jupp and Dr Tiit Kutser — collected data at both sites for nine days coinciding with a complete view-angle cycle of the NOAA satellite carrying the AVHRR and at times coinciding with overpasses of the EO-1, Landsat-7 and TERRA satellites.

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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*

Ayers, G.P., Peng, L.C., **Gillett, R.W.**, and Fook, L.S. (2002). Rainwater composition and acidity at five sites in Malaysia, in 1996. *Water, Air and Soil Pollution,* **133** (1/4): 15–30.

Boers, R., and **Rotstayn, L.D.** (2001). Possible links between cloud optical depth and effective radius in remote sensing observations. *Quarterly Journal of the Royal Meteorological Society,* **127** (577A): 2367–2387.

Cai, W.J., and **Whetton, P.H.** (2001). A time-varying greenhouse warming pattern and the tropical-extratropical circulation linkage in the Pacific Ocean. *Journal of Climate,* **14** (16): 3337–3355.

Francey, R.J., **Rayner, P.J.**, and **Allison, C.E.** (2001). Constraining the global carbon budget from global to regional scales — the measurement of change. In: *Global biogeochemical cycles in the climate system.* E.-D. Schulze , *and others* (editors). San Diego, Calif.: Academic Press. p. 245–252.

Langenfelds, R.L. (2002). Anthropogenic impacts on atmospheric oxygen. In: *Encyclopedia of global environmental change.* R. E. Munn (editor-in-chief). Chichester: Wiley2. p. 140–143.

Lovell, J.L., and **Graetz, R.D.** (2001). Filtering pathfinder AVHRR land NDVI data for Australia. *International Journal of Remote Sensing,* **22** (13): 2649–2654.

Luhar, A.K. (2002). The influence of vertical wind direction shear on dispersion in the convective boundary layer, and its incorporation in coastal fumigation models. *Boundary-Layer Meteorology,* **102** (1): 1–38.

Physick, W.L., and **Cope, M.E.** (2001). *A screening procedure for monitoring ozone and nitrogen dioxide in "Small- to medium-sized" cities: Phase 1 — validation of the procedure.* Aspendale: CSIRO Atmospheric Research. ii, 37 p.

Turner, P.J., **Prata, A.J.**, **Howden, R.T.** , Houghton, N.R., and Taylor, A. (2001). An ATSR-2 mosaic image of Australia. *International Journal of Remote Sensing,* **22** (18): 3889–3894.

Wang, Y.-P., Leuning, R., Cleugh, H.A., and Coppin, P. A. (2001). Parameter estimation in surface exchange models using nonlinear inversion: how many parameters can we estimate and which measurements are most useful? *Global Change Biology,* 7 (5): 495–510.

continued from page 1

Dr Roger Francey (left) and Dr Paul Steele at work in GASLAB.

The Division celebrated the award in February, with a presentation by Dr Francey and other talks on the activities of CSIRO Atmospheric Research. Attending the celebration were the Minister for Science, Mr Peter McGauran, CSIRO's Chief Executive, Dr Geoff Garrett, and senior representatives of the Victorian Government.

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About 200 Australians in Sydney, Melbourne, Perth and Adelaide have worn monitors the size of a pen for five days in winter and again in summer in a study of personal exposure to the air pollutants benzene, toluene, ethyl benzene, and xylenes.

Pollution becomes personal

The volunteers, aged 20 to 68, wear the monitors for 24 hours a day during study periods and keep diaries of their activities.

The monitors hold a small amount of powder that passively absorbs the pollutant gases. CSIRO Atmospheric Research uses gas chromatography to analyse the powder. The equipment is sensitive enough to detect exposure over a 24–hour period to air pollutants at concentrations as low as 0.5 parts per billion.

Scientists will use the results of the study to identify the activities that increase people's exposure to pollutants.

The two-year $500,000 study is funded by Environment Australia, through the Living Cities Program. The Department of Environment Protection, Western Australia, leads the study, which is being run in collaboration with the state environmental agencies in South Australia, NSW, and Victoria, CSIRO, Murdoch, Monash and Flinders Universities and the University of Western Australia.

This pen–shaped monitor detects exposure to a range of air pollutants

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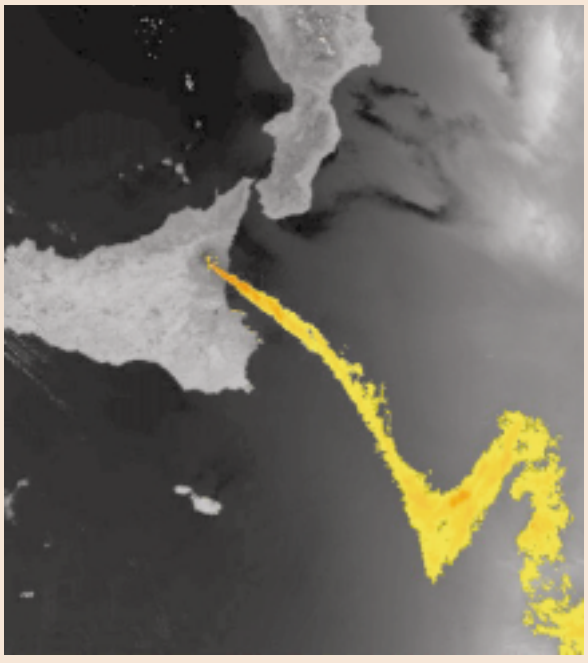


The July 2001 eruption of Mt Etna in Sicily, as captured by the Along Track Scanning Radiometer on board the European Space Agency's ERS-2 satellite. The sensor, a joint UK-Australian instrument, pinpoints the volcanic ash plume against the background of meteorological clouds, land and ocean. Dr Fred Prata produced the image by manipulating the infrared or heat signals measured by the sensor.

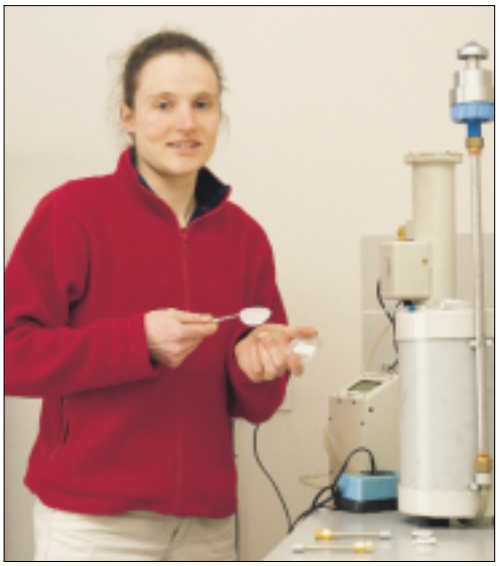
Profile — Jenny Powell

When CSIRO Atmospheric Research offered Jenny Powell a Commonwealth Government traineeship in 1993, she saw this as a great opportunity. She was studying science at Monash University and was interested in environmental science, especially air pollution.

'I began work in a laboratory doing pH measurements and analysis of rainwater,' she says.

Last year, Jenny finished her honours degree scoring top marks in her year for geography. Her thesis looked at the influence of outdoor air quality on that indoors.

'I am now analysing the personal samplers being worn as part of an Environment Australia study of individual's exposure to a range of air pollutants,' says Jenny.



'I enjoy working in this field of science. There is a good mixture of problem solving and analysis, and advanced analytical techniques.'

Applying our research

Significant recent and ongoing projects

ACE-Asia Aerosol Characterisation Experiment	Japan Science & Technology Corporation, Monash University, Airborne Research Australia Pty Ltd
Australian Greenhouse Science Program	Australian Greenhouse Office
Canopy lidar systems for forest inventories	Forest and Wood Products Research and Development Corporation
e-WeatherOnline.com for energy markets	EWN Publishing Pty Ltd
National greenhouse gas inventories	Australian Greenhouse Office
Support for the implementation of a regional haze action plan for ASEAN countries	United Nations Economic and Social Commission for Asia and the Pacific / World Meteorological Organization

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