NEW DEVELOPMENTS

The Australian Bureau of Meteorology is one of the world’s leading national meteorological services. The Bureau has a highly efficient integrated infrastructure and places emphasis on continually improving systems and services leading to the delivery of new and improved products to all Australians. The Bureau seeks to make the most of the Government’s investment in meteorology by continuing research into Australia’s weather and climate, developing and adopting new technologies to observe, model and predict weather and climate, and consulting with the community to further enhance its services to meet national needs.

It is the ongoing task of the Bureau to improve the scientific understanding of the atmosphere and oceans, develop new tools to create better products and services, incorporate new data sources to increase accuracy, achieve efficiencies in routine operations, get information to clients more quickly and effectively, and respond to emerging community needs.

The Bureau also participates in international forums and agreements that advance meteorological and related disciplines worldwide. Australia benefits greatly from this activity in terms of the exchange of scientific knowledge, information and resources, and has been able to assist other countries in similar ways. For example, the Bureau is able to pass some of its expertise to developing nations through collaborations with the Australian Agency for International Development (AusAID).

The purpose of this section of the Bureau’s annual report is to showcase some of the innovations and developments that have taken place during 2006-07.
ADVANCING AUSTRALIA’S WATER INFORMATION

During January the Australian Government announced a $10 billion, 10-point plan to improve water management across the nation. The National Plan for Water Security (NPWS) builds on, extends and accelerates implementation of the 2004 National Water Initiative (NWI) agreed at the June 2004 meeting of the Council of Australian Governments. The cornerstones of the NWI are water resource measurement, water usage metering and comprehensive water accounting, but the NPWS noted that Australia’s water information base is in poor shape and deteriorating with “gross inefficiencies in the way water information is managed across more than 100 different water data collecting agencies nationwide”.

The National Plan for Water Security includes “expanding the role of the Bureau of Meteorology (the Bureau) to provide the water data necessary for good decision-making by governments and industry”. The Bureau’s component of the Plan, agreed through Budget 2007-08, will be funded by the Government at a cost of $450 million over 10 years.

Under the Plan, the Bureau will be responsible for collating water information collected by
the states and territories (through public and private bodies) in an Australian water resources information system, and for facilitating the use of that information in timely, rigorous and independent reports of water availability and use. These functions complement the Bureau’s existing role with respect to weather and climate information and significantly advance the Bureau’s current hydrological services, which are currently focussed on national flood forecasting and warning and the provision of hydrometeorological advice to the water industry. The water data to be collated include all the elements of surface and groundwater budgets and those aspects of water quality required to support assessments of river health. These data represent a significant and synergistic expansion of the data types the Bureau collects currently through the national meteorological infrastructure.

Legislation to enable the take-up of these new functions will be included in a comprehensive Water Act 2007, to go to Parliament in 2007-08, which will sit alongside the Meteorology Act as the authority under which the Bureau of Meteorology operates.

DEVELOPMENTS IN CLIMATE AND WEATHER MODELLING

The Australian Community Climate and Earth System Simulator (ACCESS) is a coupled climate and earth system numerical model being developed as a joint initiative of the Bureau of Meteorology and CSIRO in cooperation with the university community in Australia. The overall aim is to build a national approach to climate and weather prediction model development with a focus on the needs of a wide range of stakeholders. Towards this end, under the ACCESS framework a single atmospheric model will be used for weather prediction, seasonal prediction and climate/climate change applications. ACCESS will form the modelling core of the Centre for Australian Weather and Climate Research (CAWCR), the proposed new joint operation between the Bureau of Meteorology and CSIRO, planned to begin operation early in 2007-08.

In May the Bureau of Meteorology signed a Partnership/Licence Agreement with the UK Met Office, under which the Bureau will take the Met Office’s high-powered computer-based weather and climate prediction program and adapt it for Australian conditions. Known as the Unified Model, the program is recognised as among the best in the world and performs strongly when applied to both weather and climate for research and operational forecasting. It will replace the two separate and ageing computer models used by the Bureau to monitor and forecast climate and weather.

Together with the Met Office’s four-dimensional variational data assimilation scheme and other components developed at the Bureau and CSIRO, the Unified Model will be used as the basis for ACCESS, which will then constitute a meld of the latest scientific and technological advances in atmospheric modelling.

Initial development of the ACCESS infra-

Dr Sophie Valcke, of the European Centre for Research and Advanced Training in Scientific Computation in France, speaks with Dr Kamal Puri, Bureau ACCESS Science Leader at the 18th Annual International Modelling Workshop, held in November, in Melbourne.
structure has been aimed at implementing key ACCESS modules on the Bureau/CSIRO High Performance Computing and Communication Centre (HPCCC) computing environment based in the Melbourne head office of the Bureau. Ultimately, this will enable use of ACCESS by a wide group of researchers across Australia.

Significant progress was made with the integration of the Unified Model into a number of applications within the coupled ocean-atmosphere modelling system of ACCESS, although the system will not become operational until 2007-08. Initial results are encouraging as shown in Figure 5 with substantial gains in the skill of forecasts out to 7 days (168 hours) being obtained with the ACCESS system compared with the current operational Global Assimilation and Prediction System (GASP).

ACCESS has the potential to become one of the most significant environmental modelling initiatives in Australia. The aim is to build on the substantial headway made to date to progressively implement the planned range of applications, leading to the fulfilment of the objective of developing a ‘world class’ modelling system.

Figure 5. Skill score verifications over the Australian region for the UK Unified Model as used in the ACCESS model (solid line), showing the improvement over the performance of two versions of the current operational Global Assimilation and Prediction System employing different initial analysis schemes (dashed lines). The S1 skill score used in these verifications decreases for increasing skill, with zero being a perfect score; the diagrams clearly show the expected decrease in skill for increasing forecast lead time.
NATIONAL AIR QUALITY DATABASE

The National Air Quality Database, which is under development in the Bureau’s National Climate Centre, has been funded by the Department of the Environment and Water Resources under a Memorandum of Understanding between the Department and the Bureau, signed in April 2006. The aim of the project is to create a national database of air quality data, taking input from the eight State and Territory agencies responsible for monitoring air quality within their jurisdiction. Figure 6 shows the current disposition of stations in the air quality monitoring network. The resultant data will be stored in ADAM (Australian Data Archive for Meteorology), with associated station metadata being kept in the Bureau’s SitesDB database. The National Air Quality database will be used in the first instance for cross-jurisdictional retrieval of data and data products.

Full-time work on the project began in October and data have been ingested for around 80 observing stations over several years across all jurisdictions. The database has already been used for ad hoc querying.

Figure 6. Current distribution of monitoring stations contributing to the National Air Quality Database.
SATELLITE ANTENNA INSTALLATION AT DAVIS

During the Antarctic summer, a new satellite reception system was installed at Davis Station in Antarctica. The 2.4 metre tracking antenna, housed in a fibreglass dome for protection against the elements, is used to track polar orbiting satellites operated by the US National Oceanic and Atmospheric Administration (NOAA). The antenna complements an existing system at Casey Station which was installed in 1997 and provides both system redundancy in case of outages, and geographically extended coverage.

Both antenna systems are used in support of forecasting and warning services for Antarctic operations and research. The NOAA satellites provide visible and infrared images of cloud, ocean, ice and land surface - valuable information when operating in one of the harshest environments on the planet. The Davis Meteorological Office provides year-round forecasts and warnings, supporting shipping, aviation and general operations, and is heavily dependent on satellite data. With regular intercontinental flights expected to commence in the summer of 2007-08, the Davis antenna will provide critical information contributing to both increased safety and improved efficiency in the planning and operation of the air service.

The satellite antenna installation at Davis Station, Antarctica.
FIELD OFFICES REPLACED AT WILLIS ISLAND AND CHARLEVILLE

The new Bureau office on Willis Island, in the Coral Sea 450 km east of Cairns, was completed in October with fully-staffed operations resuming before the start of the tropical cyclone season. Since development works were completed, the site has undergone revegetation and rehabilitation to accommodate the various species of migratory birds and marine animals living on and around the island. The office was formally commissioned on 8 November at Townsville by the Hon Greg Hunt MP, then Parliamentary Secretary with responsibility for the Bureau of Meteorology, and the Hon Peter Lindsay MP, Federal Member for Herbert.

The new field office at Charleville was opened in June by the Hon Bruce Scott MP, Federal Member for Maranoa. The facilities include a public visitors’ area to be used for weather-related displays.

The Bureau currently has 49 Field Meteorological Offices around Australia, with an average age of 40 years. Field offices are a vital component of the Bureau’s surface and upper atmosphere observations and service delivery network. Additional funding of $19.8 million over six years provided in the 2005-06 Budget, supplemented by $14.2 million of existing Bureau funding, will be used to rebuild 12 of the Bureau’s older offices. In addition to the completion of the offices at Willis island and Charleville during 2006-07, planning began for construction of new offices at Broome and Esperance in 2007-08.
FIRE WEATHER FORECASTER EXCHANGE
The exceptionally dry winter and spring over large parts of eastern and southern Australia resulted in the 2006-07 fire season commencing significantly earlier than usual. By mid October days of extreme fire danger were being forecast from the Northern Territory to Tasmania, and the occurrence of fires around Hobart early in the season indicated the prospect of an extended, intensive fire weather season likely to place unusual pressure on the Bureau's forecasting and warning staff resources through the more frequent occurrence of extreme fire weather and expanded requirements for spot forecasts for burning fires.

To meet the requirements for additional staff, the Bureau sought assistance late in 2006 from the US National Weather Service (NWS) and the US Bureau of Land Management (BLM). BLM staff visited the Bureau in December, to assess the feasibility of providing assistance to Australia. This visit coincided with an outbreak of fires in northeastern Victoria caused by dry lightning. The fires subsequently merged and would take fire agencies 69 days to contain. During January preparations were made for a total of 15 US meteorologists to provide support between February and April, and in February US meteorologists arrived for training in the Bureau’s Head Office before deployment for a three-week period in one of three Regional Offices – New South Wales, Victoria or Tasmania.

Although the outbreak of new fires declined in February, the US forecasters were valuable in providing forecasts in support of prescribed burning operations during March. The presence of forecasters from the US enabled an exchange of ideas on fire weather forecasting between them and the Australian forecasters with whom they worked. Following the success of this exchange, two Bureau meteorologists assisted the US NWS during the intense US fire season in the middle of 2007, allowing Bureau forecasters the experience of being outposted to fireground incident management centres to provide fire weather forecasting services. It is expected that future exchanges of forecasting staff will enable all agencies involved to call on extra trained assistance at short notice if fire conditions are severe.

Visiting US forecasters in the Victoria Regional Office (VRO) with a map of areas burned to 2 February 2007. From left, John Pendergast (Florida), Rick Davis (Florida), Steve King (VRO), Kent Prochazka (Texas), Joe Solomon (Oregon).
WATER AND THE LAND WEBSITE

A new section of the Bureau’s website called ‘Water and the Land’ (WATL) was launched in August. Figure 7 shows the WATL home page.

WATL aims to present information in a more coordinated and useful way to primary industry and natural resource managers. The initial phase of the project focused on improving the delivery of existing weather forecast information by bringing together products previously only available separately on different parts of the Bureau website. In addition, rainfall forecasts were for the first time presented in a graphical form as broadscale maps. These WATL products use formats that are consistent with information on the climate area of the website, and the WATL site has also pioneered new style and navigation tools which will be gradually extended to the rest of the Bureau’s site. Future phases of WATL will include development of a suite of new climate products which will expand the range of climate and weather parameters presented.

Feedback received from users indicates that the new WATL site has been highly successful. A key feature has been the seamless nature of the design from the user’s viewpoint, with outputs presented as an integrated set, rather than requiring weather, climate and hydrology products to be accessed individually.
CLIMATE PREDICTION FOR THE PACIFIC ISLANDS

Seasonal to interannual climate variability can be quite high over the southwest Pacific, due largely to the vagaries of the El Niño-Southern Oscillation phenomenon. This variability has important practical and policy implications for Pacific Island Countries. To assist the introduction of locally generated seasonal climate prediction services, the Bureau of Meteorology in August 2003 commenced the Pacific Islands-Climate Prediction Project (PI-CPP), with funding provided by AusAID.

Under Phase I of the project, the Bureau’s operational seasonal climate prediction system was transformed into a stand-alone PC software program called SCOPIC (Seasonal Climate Outlook for Pacific Island Countries), which provides the Pacific Island countries with a decision support system for generating probabilistic predictions of rainfall, temperature and other climate related parameters. In-country training on the climate prediction scheme, including the software and its applications to various user sectors, was provided to staff of the National Meteorological Services of the nine participating Pacific Island countries. In addition, in-country awareness workshops were conducted for stakeholders in climate-sensitive industries, and climate prediction information applications in water resource management and agriculture were demonstrated through pilot schemes.

Following successful completion of Phase I of the project in April, AusAID requested that...
the Bureau continue the project with a Phase II, extending until December 2007. Phase II will focus on helping Pacific Island National Meteorological Services to work with their major user groups in fully exploiting the features of the climate prediction software SCOPIC (see Figure 8), which itself will be further modified by the inclusion of dynamic climate model products. Towards this end, one of the main activities of Phase II will be the operation of pilot projects to demonstrate the value and utility of climate information, including forecasts, in various climate sensitive industries.

With the addition of Papua New Guinea, which in 2006 made a formal request to AusAID to be included in the project, ten Pacific Island Countries are now participating in PI-CCP, including the nine Phase I participants: the Cook Islands, Fiji, Kiribati, Niue, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

MAJOR RADAR NETWORK UPGRADE

The radar upgrade initiative commenced in 2003-04 supported by $62.2 million provided over five years by the Australian government. Significant progress was again made in 2006-07.

A high resolution Doppler radar was officially commissioned at Mt Stapylton, near Brisbane, in August. By the end of the year a similar radar system had been installed at Laverton, near Melbourne, and is due to commence operations in October 2007. In addition, at Yarrawonga in northern Victoria, final implementation of the Doppler radar capability installed previously was completed, with services scheduled to commence early in 2007-08.

A replacement (non Doppler) radar was also installed and commenced operations in October at Warrego, east of Charleville in Queensland, and progress was made on plans for installation of the remaining replacement radars at Gympie (Queensland), Bairnsdale (Victoria), Perth and Darwin Airport, as well as the high resolution Doppler radar at Sydney and a new Doppler radar at Tamworth in northeastern New South Wales.

The Bureau’s national weather radar network is highly regarded by the community, as evidenced by rates of access to radar images on the Bureau’s public website, and by requests from the public for
extension of the existing radar services. The high resolution Doppler radar technology provides enhanced measurements of thunderstorm severity and wind and rainfall intensity, and potentially allows for the use of radar data to be extended to flood warning operations and water management in these areas.

AUSTRALIAN TSUNAMI WARNING SYSTEM

The implementation of the $68.8m Australian Tsunami Warning System (ATWS) project continued apace in 2006-07, with the establishment of both upgraded and new infrastructure for monitoring and measuring the occurrence of tsunami, as well as advances in the generation and dissemination of information to the community.

In 2006 and early 2007 all of the pre-existing Australian baseline sea level stations were upgraded to report sea level information in real time, rather than storing it for later retrieval as previously. Similar enhancements were made to the South Pacific climate monitoring sea level stations (operated and maintained by the Bureau under the AusAID-funded South Pacific Climate and Sea Level Monitoring Project) to make them useful for tsunami verification and monitoring. Network design and equipment specifications were also completed for additional stations, which in combination with the existing setup will constitute the ATWS Sea Level Observing System, with site selections being finalised around the Australian coast and in the western Pacific.

Australia’s first Deep Ocean Assessment and Reporting of Tsunamis (DART™) buoy was deployed in April in the southern Tasman Sea approximately 1200 km southeast of Hobart, providing critical tsunami observation capability in a data sparse area. The DART™ buoy is based on technology developed by NOAA in the US with the sole purpose of early detection of tsunamis. This first Australian DART™ buoy will be used to verify the presence of tsunamis originating from earthquakes along the Puysegur fault line (near the South Island of New Zealand) which have the potential to cause widespread devastation along the east coast of Australia. The DART™ buoy instrumentation sits on the sea floor in 5000 m of water and, through the communications surface buoy, will deliver critical sea level data to the Joint Australian Tsunami Warning Centre at the Bureau of Meteorology in Melbourne within three minutes of the detection of possible tsunami triggers such as an earthquake.

During December the Bureau of Meteorology commenced issuing new tsunami bulletins to augment the tsunami bulletins already issued by the Pacific Tsunami Warning Centre (PTWC) by emphasising the potential impact on Australia and its territories. The first operational application of the new system occurred on 2 April when a tsunami was generated off the Solomon Islands (see Figure 9), and the Bureau issued tsunami warnings for the eastern States. This event constituted a challenging test of emergency management arrangements and provided useful material for future development of the warning system.

Also during December, Geoscience Australia established an around-the-clock seismic detection operational centre in Canberra which will form part of the Joint Australian Tsunami Warning Centre being established and operated in conjunction with the Bureau of Meteorology. The Centre will become operational in July 2007, providing Australia with an independent tsunami warning capability.
Further improvements to the tsunami monitoring and warning systems, based on observational and modelling advances, are planned for 2007-08.

The Bureau continues to be heavily involved in the development of the Indian Ocean Tsunami Warning System (IOTWS). The Secretariat of the IOTWS is collocated with the Bureau’s Western Australia Regional Office in Perth, and Bureau staff contribute to working groups of the Intergovernmental Coordination Group for IOTWS.

**IPCC FOURTH ASSESSMENT REPORT**

The most comprehensive assessment yet made of the state of the world’s climate and how it is changing is being completed in 2007. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme (UNEP). Consisting of an international panel of scientists and researchers, its role is to assess the best available peer-reviewed scientific, technical and socio-economic information on climate change from around the world. The IPCC is acknowledged by governments worldwide as the authoritative source of advice on climate change science.

The assessments made every few years by the IPCC help governments and communities understand the scientific basis of the risk of human-induced climate change and its potential
impacts and options for adaptation and mitigation, and contribute to informing government
decision-making. The IPCC does not conduct new research, but bases its reports on the
available peer reviewed and published scientific and technical literature.

The Fourth Assessment of the IPCC being released during 2007 is divided into three
sections that are the province of three separate working groups. Working Group I reports
on 'The Physical Science Basis' of climate change, Working Group II on 'Impacts,
Adaptation and Vulnerability' and Working Group III on 'Mitigation of Climate Change.'

The reports of the three Working Groups were released between February and May, each
accompanied by a Technical Summary and a Summary for Policymakers (SPM). The SPMs
were prepared concurrently with the main reports, underwent a simultaneous expert and
government review, and were debated and accepted in a consensus by all participating gov-
ernments at a plenary session of the relevant Working Group held immediately before the
release of the report, in accordance with the IPCC process. The three comprehensive reports
represent the culmination of work since the Third Assessment Report was released in 2001,
comprising the identification of scientific areas that required further investigation, the assess-
ment of all the relevant scientific literature, and finally a very extensive review process.

The remaining volume of the Fourth Assessment Report - the Synthesis Report - will
link the issues covered in the three Working Group Reports. The report is scheduled for

Bureau staff have been involved in many areas of the IPCC work, contributing as authors
of the scientific papers that have been assessed, as lead authors and review editors of chap-
ters of the IPCC reports, and as scientific and government reviewers the reports. The
Director of Meteorology Dr Geoff Love is one of the six Vice-Chairs of Working Group II of
the IPCC and hence a member of the IPCC Bureau which comprises the Chair of the IPCC
and all Co-Chairs and Vice-Chairs of its various constituent groups. It currently has 30 mem-
bers, each of whom is an expert in the field of climate change, together representing all
regions of the world.

The Australian delegation at the plenary session of IPCC Working Group I in Paris in February. From
left, Spencer Edwards and Ian Carruthers, both from the Australian Greenhouse Office, and Geoff
Love, Director of Meteorology (photo courtesy of the Earth Negotiations Bulletin).