Meteorological and Related Research involves research undertaken in fulfilment of the Bureau's responsibilities as a national research agency to contribute to the advancement of meteorological science in Australia, to develop the application of meteorology to the needs of the Australian community, and to support the Bureau's services.

The Bureau of Meteorology Research Centre (BMRC), in collaboration with the operational areas of the Bureau, carries out the main research activities reported in this chapter and is implemented through four outputs: Weather Research, Climate Research, Ocean Research and Hydrology Research. The research undertaken in the BMRC is complemented by a program of supporting research and development undertaken in the Bureau's Regional Offices and other Head Office branches.
PLANNED OUTCOME 2004-05

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Advancement of meteorological science and understanding of the mechanisms of Australian weather and climate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>To advance the science of meteorology, develop an integrated, comprehensive description and scientific understanding of Australia's weather and climate, develop the application of meteorology in the national interest and improve the operations and services of the Bureau.</td>
</tr>
</tbody>
</table>
| Effectiveness measures | The extent to which:  
• the Bureau of Meteorology Research Centre is recognised for the quality and extent of its contribution to national and international atmospheric science;  
• progress is achieved in the characterisation and understanding of the processes which determine Australian weather and climate;  
• progress is achieved on applied research problems addressed to the Bureau or which arise in the course of its operations;  
• cost effective new applications and services emerge from Bureau research;  
• Bureau research can be shown to have contributed to improvements in the quality of its operations and services; and  
• the scientific health and morale of the Bureau are enhanced. |

OUTPUTS 2004-05

Meteorological and Related Research comprises Output 1.2, one of the Bureau's four output groups, and is also one of the Bureau's major outputs. Output 1.2 is delivered through four individual outputs: Weather Research, Climate Research, Ocean Research and Hydrology Research. Performance targets include original publications on Australian and global meteorology, hydrology and oceanography in the peer-reviewed scientific literature along with reviews, project reports, conference presentations, and the general build-up of scientific expertise, reputation and influence in the international scientific community; together with published and unpublished contributions to the development and implementation of new and improved applications of meteorology and new operational meteorological and related systems and techniques. Outputs also include effective Australian participation in international research programs directed towards improved understanding of southern hemisphere and Australian meteorology and oceanography.
OUTPUT PERFORMANCE 2004-05

Output performance is measured against a number of targets, including quality, quantity and price. The performance against each of these output targets during 2004-05 is provided

<table>
<thead>
<tr>
<th>Quality</th>
<th>Target</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of BMRC scientists invited to serve on external advisory committees etc.</td>
<td>65</td>
<td>59</td>
</tr>
<tr>
<td>Number of invitations received to present papers at external conferences and workshops</td>
<td>&gt;15</td>
<td>61</td>
</tr>
<tr>
<td>Number of system changes, developed by the BMRC, accepted for implementation by operational units (the National Meteorological and Oceanographic Operations Centre and the National Climate Centre)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>The annual report and all workshop and contract project reports produced in good time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of viable research groups focussed on priority research issues</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Number of research publications including refereed journals, articles, book chapters, conference papers and miscellaneous reports, and missions</td>
<td>110</td>
<td>161</td>
</tr>
<tr>
<td>Number of of external collaborative projects undertaken</td>
<td>75</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Research</td>
<td>$6.154m</td>
<td>$7.151m</td>
</tr>
<tr>
<td>Climate Research</td>
<td>$2.608m</td>
<td>$3.366m</td>
</tr>
<tr>
<td>Ocean Research</td>
<td>$1.005m</td>
<td>$2.279m</td>
</tr>
<tr>
<td>Hydrology Research</td>
<td>$1.230m</td>
<td>$1.073m</td>
</tr>
</tbody>
</table>

Comments on output performance

The number of research groups in BMRC was maintained at six (Model Development, Data Assimilation, Climate Dynamics, Weather Forecasting, Climate Forecasting and Ocean and Marine Forecasting) representing a balance between activities related to weather and climate and atmospheric and oceanic processes, and recognising the significance of data assimilation and model development to core Bureau activities. Cross-cutting forums have been established for research areas that involve broader collaboration. The numbers of externally supported staff within these groups continues to increase, via initiatives such as Australian Greenhouse Office-supported projects, and the joint BLUElink project with CSIRO and the Royal Australian Navy (RAN) on ocean prediction.

The number of publications increased significantly this year, partly reflecting the clearance of a backlog of internal BMRC research reports. The number of collaborative projects also increased, although the number was slightly below target. This figure varies from year-
to-year, as the range of projects extends from major collaborations such as the BLUElink project, to small (but important) projects between individual scientists.

The number of system changes in the Bureau’s operational systems associated with BMRC research was higher than the target. This reflects efforts in the development of meteorological techniques to improve a range of forecast products, such as tropical forecasting, severe weather via the Thunderstorm Interactive Forecast System (TIFS), aviation support (Volcanic Ash Warning Preparation System) and forecast guidance utilising the Operational Consensus Forecast (OCF) system.

As a general policy, BMRC is moving to focus its participation in an external expert or advisory capacity to those areas that have direct and tangible benefits for the Bureau of Meteorology and thus limit its overall exposure, as reflected in the slightly reduced numbers on external advisory committees. The standing of BMRC scientists is reflected in the number of invitations to present papers at national and international conferences and workshops. The high level of participation in the fourth assessment of the Intergovernmental Panel on Climate Change (IPCC) is a tangible indicator of quality.

ACHIEVING THE OUTCOME

Meteorological and Related Research is delivered through four individual outputs that contribute to the achievement of the desired outcome. The developments in each of these outputs during 2004-05 and their contribution to the outcome are provided below.

WEATHER RESEARCH

The largest of the research outputs, Weather Research spans three of the six BMRC research groups, and focuses on mesoscale meteorology research, observational system development, advanced data assimilation systems and enhancing the value of numerical weather prediction (NWP) to improve the forecast process. A major component of weather research is a continuing program of field studies aimed at ensuring the Bureau remains informed of advances in observing methods, such as radars, and at improved our understanding of atmospheric processes, such as precipitation, clouds and thunderstorms and the representation of these processes in atmospheric prediction models. Developments of improved atmospheric models and of advanced data assimilation systems are key underpinnings of this output.

Major developments 2004-05

• The Operational Consensus Forecast (OCF) system was implemented in March, providing forecasters with an objective tool to assist forecasting of key weather elements, including maximum, minimum and ground temperatures, rainfall amounts and associated probabilities and sunshine hours, for more than 600 sites throughout Australia. The OCF system statistically combines information from eight separate computer models from Australia and overseas to produce a ‘consensus’ forecast of greater accuracy than that produced by any single model. The OCF system produces forecasts for up to seven days ahead and will underpin Bureau plans to extend the range of its official forecasts beyond the four days currently provided.
Improvements in tropical weather prediction have been achieved with the implementation of a new operational model (TXLAPS) that operates at higher resolution than previous models and includes improved techniques for representing tropical weather systems. The Bureau's tropical cyclone track forecasting system (TCLAPS) performed very well, demonstrating accuracy levels that confirm its place as one of the best performing models internationally. New techniques were also implemented to integrate global and locally-received satellite data into the global (GASP) and regional (LAPS) models (Figure 14). These techniques have resulted in measurable improvements in the accuracy of the predictions from these models.

Systems were developed to support the Automated Thunderstorm Alerting Service, a new automated graphical web-based service that gives airline operations managers up-to-date information on the location and movement of thunderstorms that might threaten airport operations. The development and release of a new operational Volcanic Ash Warning Preparation System for aviation was also an important advance.

Figure 14. Analysis of near-surface winds showing a strong cold front approaching southwestern Australia on 12 February. Satellite-derived winds assist in defining the strength and location of the wind change.
• Significant progress was achieved in the development of a number of critical systems in support of the Radar Network and Doppler Services Upgrade Project. Radar data visualisation and analysis software was upgraded, improved on-screen thunderstorm tracking software was implemented, and new techniques were developed to blend high quality radar data with ground-truth rain gauge data to produce accurate real-time assessments of rainfall intensity (Figure 15).

• Upgrades were completed to the unified BMRC Atmospheric Model, including improved representation of the physics of the land/atmosphere interface, incorporation of a new scheme to model very small scale (microphysical) atmospheric effects, and a complete overhaul of the computer code that generates surface fields.

• Significant contributions to fire danger and smoke plume research as part of the Bushfire Cooperative Research Centre have resulted in the development of wind-change climatologies and associated forecast products. National rainfall and temperature analyses have been used to develop daily charts of fuel dryness and predicted fire danger which are being evaluated for accuracy by operational Bureau forecasters.

Figure 15. Image shows, on the right hand side, a radar image of several thunderstorm cells to the north of Brisbane. The circle with the label 1 indicates an automated cell tracking detection with the line to the cell’s left the previous 30 minute track and the arcs to the right the expected 60 minute forecast track. Cells 21, 9, 13, 16 have similar output. On the left hand side of the image is a wealth of thunderstorm information and time series of the information for cell 1 (ID 1), for example severity ranking, maximum hail size, height of the cell etc. This information will help forecasters provide better severe weather warnings as part of the national radar upgrade project currently in progress.
The UV and Ozone Forecasting System has been upgraded to provide improved daily forecasts and continuous model validation is provided through collaboration with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the Cancer Council. Each spring, the development of the southern hemisphere ozone hole is monitored in the UV and Ozone Forecasting System to provide input to an Ozone Statement from the Bureau’s Atmosphere Watch Section.

The national atmospheric transport (smoke, aerosols, etc) advice service was further developed to assist fire and emergency agencies responsible for managing prescribed burns, wildfires and incidents involving hazardous materials.

Contribution towards outcome

The Operational Consensus Forecast system gives the Bureau an ability to provide automatic daily forecasts for an increased number of specific locations in the Australian region, enhancing and streamlining the forecast service. The hourly guidance in support of public, aviation and fire-weather forecasts improves the operational efficiency in delivering these services.

Improved understanding of wind-change and fuel drying processes have contributed to improved fire weather services through better knowledge of fire behaviour and fire danger (Figure 16).

Contributions to the Radar Network and Doppler Services Upgrade Project result in the
production of advanced data to assist local and international research, advance the understanding of atmospheric processes that determine Australian weather and underpin improvements to some of the Bureau's most important services, including severe thunderstorm and flash flooding warning services.

- The Automated Thunderstorm Alerting Service and the Volcanic Ash Warning Preparation System enhance the Bureau's service to the aviation industry and contribute to the safety and efficiency of airline operations.

- Numerical weather prediction models contribute to improved understanding of the atmosphere and the Bureau's capability to simulate and predict atmospheric behaviour, such as tropical cyclones. The leading-edge modelling research in BMRC ensures that Australia is able to draw effectively on overseas trends and advances, and that the Bureau has the capability to support its services at the level expected by the Australian community.

- Upgrades to the Bureau's UV and Ozone Forecasting System contribute to improved

![Figure 17. An example of a summer clear sky UV forecast for Australia, showing that most of country has extreme (larger than 11) UV Index values, with higher values (up to 16 UV Index) towards the north of the country.](image)
public well-being through increased awareness of natural hazards, in particular through the national promotion of the importance of sun protection (Figure 17).

- Advances in the study and prediction of dispersion of airborne materials such as volcanic ash and bushfire smoke have enhanced the quality and scope of Bureau services. Improvements in the capability to predict short-range transport is especially important for protecting rural communities from outbreaks of air-borne animal diseases.

CLIMATE RESEARCH

Climate research in the BMRC is aimed at improved understanding of Australian climate, including the effects of climate change, and the development of systems to predict climate. Climate models and observations are used to improve the understanding of climate predictability, variability and change. Evaluation and diagnostic studies aim to improve the performance of these climate models. Climate research constitutes a significant part of the Meteorological and Related Research output and enjoys strong support within the Australian Climate Change Science Program. There are strong links to the Bureau Climate Services Output at all levels and there is extensive collaboration with other national institutions and research agencies, and internationally.

Major developments 2004-05

- New insights were developed into the relationship between the Madden-Julian Oscillation (MJO), which contributes to short-term variation in weather in the tropics, and climate predictability. An improved version of the statistical system for predicting the MJO was implemented and studies of the MJO and its predictability in a coupled model were completed.

- A comprehensive study of the interannual variability and predictability of Australian and New Zealand climate using observations and climate models was completed. A study, using the BCM2 (BMRC Coupled Atmosphere/Ocean/Sea-ice General Circulation Model, version 2), showed that oceanic (thermohaline) variability underpins decadal predictability in Southern Hemisphere climate. The same model was used to assess the predictability of decadal changes in the impact of the El Niño-Southern Oscillation (ENSO) on Australia. Studies of the impact of the Southern Annular Mode, also known as the Antarctic Oscillation, on rainfall, winds and temperature, and its impact on the tropical Indian Ocean were completed.

- Climate impact studies are underway or were completed on a range of subjects, including the relationship between climate variability and Ross River virus, drought impacts on suicide, the impact of climate change on Australian birdlife, and the likely impact of climate change on bushfire weather. A project, funded by the Australian Greenhouse Office, to develop a phenological database to determine the impacts of climate change on Australian ecosystems was commenced. Two papers were published documenting changes in extremes in the Asia-Pacific region, based on multi-national workshops conducted by the BMRC and funded by the Asia Pacific Network (APN) for Global Change Research.

- Fresh insight was gained into the cause of rainfall deficiencies in southwest Western Australia with climate change emerging as a likely factor, through continued collaboration
in the Indian Ocean Climate Initiative. A new climate and climate change project, the South-East Australia Climate Initiative, was negotiated (in partnership with CSIRO) with the Murray-Darling Basin Commission, the Australian Greenhouse Office, the Victorian Department of Sustainability and Environment, and Land and Water Australia (Figure 18). Important new understandings of the role of various feedbacks in amplifying warming due to the enhanced greenhouse effect were developed.

- The development of high-quality climate data sets (evaporation, surface humidity, cloudiness) for climate change detection and attribution and impacts research, continued in association with the National Climate Centre. BMRC scientists are making extensive contributions to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment, including the participation of two lead authors and a review editor for the Assessment.
- The BMRC coupled model was used to investigate the ocean/atmosphere interaction in the Indian Ocean and its role in climate variations in Australia and surrounding regions. The relationship between the El Niño and Australian rainfall was analysed using observations and the BMRC coupled model, in order to understand why some El Niño events lead to significant drought while others do not.
- A BMRC-China Meteorological Agency land-use study was implemented, including a study of variable soil and vegetation parameters.
- A joint CSIRO-Bureau initiative to build the Australian Community Climate and Earth System Simulator (ACCESS) was commenced and a blueprint for its development completed.

**Contribution towards outcome**

- The development of improved techniques for predicting influences such as the Madden Julian Oscillation on intra-seasonal climate variability enhances Bureau services and increases the ability of Australians to take tactical actions to reduce short-term climate impacts.
- Model intercomparisons and studies of feedbacks in models lead to improved climate models for climate variability and change research, also contributing to the BMRC's high standing and recognition, nationally and internationally, for the quality and extent of its climate modelling. Expanded model validation and implementation of new physics and increased resolution improve climate models for climate research and seasonal forecasting and so extend and enhance the quality of Bureau services.
- Investigation of the impacts of climate on social, economic, and ecological variables enhances Australia's ability to cope with a variable and changing climate and enhances the quality and effectiveness of Bureau operations.
- Detection and attribution of the causes of climate changes such as the extended decline in southwest Australian rainfall contributes to the improved characterisation and understanding of climate and its impacts.
- The development of improved climate data sets and software for using these data sets contributes to improved understanding of climate and will enhance studies of the impact of climate change and variability, both in the Bureau and in other organisations.
- Documentation of the role of ocean/atmosphere interactions in Australian climate variations provides a basis for improved understanding of El Niño and other key influences on drought.
Improvements in the understanding of soil and vegetation parameters are important for accurately modelling the earth-atmosphere system and provide important insights into the effects of climate on areas such as agriculture and fire behaviour.

The continued development of models such as ACCESS is vital to Australia's continued contribution to global discussions of the causes and impacts of climate change, and to the development of robust systems for carbon accounting. Outputs from ACCESS will provide important information to assist policy makers with decisions pertaining to societal impacts of climate, climate change, and land and water use.

**OCEAN RESEARCH**

Ocean research contributes to an improved understanding of the mechanisms underlying climate variability and the application of this knowledge in coupled ocean-atmosphere systems for seasonal prediction, as well as to understanding, modelling and predicting the ocean and marine environment around Australia. This research involves gathering and analysing ocean and marine data, the development of sea state and ocean models, the development and application of coupled models, and collaboration in national and international initiatives. The research is focussed in the Ocean and Marine Forecasting Group of the BMRC but benefits from contributions and support from CSIRO, the RAN and academia.

**Major developments 2004-05**

- The Predictive Ocean Atmosphere Model for Australia (POAMA) system produced a forecast ensemble ranging from neutral to weak El Niño conditions for 2004-05, with the ensemble average fluctuating near the threshold for El Niño conditions. This agreed well with the observed outcome. These forecasts are used as a basis for the National Climate Centre's El Niño outlook and there has also been strong interest in POAMA.
from international groups. Intra-seasonal forecasts from the POAMA system are also routinely provided to the US Climate Diagnostics Centre as part of an intra-seasonal forecast project.

- A feasibility study was carried out to investigate the potential benefit of incorporating sea surface temperature data directly into the POAMA system. Work has commenced to assemble the next version of POAMA including investigation of the best options for extending the data input system to include sea surface temperature data and evaluation of the new version of the atmospheric model component.

- A set of experiments using the POAMA coupled model was performed to study the processes that lead to El Niño development and to understand any physical limitations to El Niño prediction. An assessment of the differences in impact on Australia between the 2002 and 1997 El Niño events was completed. An analysis of the link between the Madden-Julian Oscillation and El Niño was also completed.

- A workshop was hosted by BMRC that led to the creation of the Australian Climate Ocean Model (AusCOM) project. AusCOM is being jointly developed by the BMRC, CSIRO and several other partners and will form the next generation ocean model for climate applications from seasonal prediction to climate change. A preliminary version was produced at BMRC.

- A global ocean forecast system with enhanced resolution around Australia was developed jointly with CSIRO and the RAN in a project called BLUElink. This system is being evaluated before operational implementation and will provide routine short-range forecasts of ocean currents and temperature. Part of the project included a reanalysis of data stretching back to 1992 to produce a consistent dataset of key oceanic variables (Figure 19).

- Significant progress was achieved in the development of techniques to combine high-resolution satellite observations with buoy observations of sea surface temperature in order to generate an accurate high-resolution sea surface temperature dataset for the Australian region. The accuracy of surface wind predictions from the Bureau's operational numerical models was assessed in detail, using data measured by the QuikSCAT satellite. Monthly error statistics were generated for the years 2003 and 2004, and systematic biases in the predictions were identified.

- The Bureau's operational wave model was upgraded, leading to improvements of almost 10 per cent in the accuracy of wave height predictions.

**Contribution toward outcome**

- Development of numerical models such as POAMA supports the Australian community and Bureau climate services through improvements in seasonal forecasting.

- Research on the predictability of intra-seasonal and seasonal climate variability is contributing to improved understanding of climate and its impacts in the Australian region.

- Collaborative projects such as AusCOM ensure that national ocean research activities are coordinated effectively and are targeted towards the requirements of the community for relevant climate information and applications.
Collaborations with defence agencies, such as with the RAN on BLUElink, ensure that the BMRCs scientific developments enhance and extend Bureau services and support for the operational requirements of the Australian Defence Force.

New types of data, collected from in situ and satellite-based instruments, as well as the output of complex computer models, contribute to improved accuracy in the Bureau's Oceanographic Services. For example, the assimilation of QuikSCAT satellite data is instrumental in evaluating and verifying marine wind forecast products.

Improvements to the Bureau's operational wave models lead to more accurate marine weather services and enhanced safety and efficiency of shipping, small craft and maritime industries.
HYDROLOGY RESEARCH

Hydrology research within the BMRC is undertaken in support of the Bureau’s Hydrological Services output in particular and aims to improve and quantify the accuracy of estimates of mean areal rainfall over catchments, to improve and quantify the accuracy of precipitation forecasts generated by means of the numerical weather prediction (NWP) models or nowcasting techniques, and to improve the representation of land-surface processes within NWP models.

Major developments 2004-05

- The Bureau hosted the 6th International Symposium on Hydrological Applications of Weather Radar in Melbourne.
- Progress was made with the development of an objective short-term rainfall prediction system based on real-time radar observations blended with numerical weather rainfall prediction. Rainfields, the quantitative rainfall estimation system based on calibrated real-time radar and rain gauge data, was further developed in preparation for operational use scheduled for late 2005.
- Techniques to verify the accuracy of precipitation estimates and forecasts through comparison of estimates and forecasts against observations were further developed.
- Siting approval for an experimental polarimetric radar in Brisbane was granted and planning for the installation of the radar progressed.

Contribution towards outcome

- Hosting of international symposia and conferences contributes to the standing and international reputation of the BMRC and supports the Bureau’s role in the international meteorological research community.
- The work on development of rainfall estimation systems assists in understanding the impacts of extreme events that can be hazardous to the community, such as flash floods and tropical cyclones, thereby contributing to the overall quality and effectiveness of Bureau services.
- Studies such as those focusing on the accuracy of precipitation forecasts from numerical models lead to improved representation and understanding of land-surface processes and the hydrological cycle.
- The polarimetric radar will improve the understanding of topographically-induced rain in the tropics and sub-tropics, which is particularly important for analysis and forecasting of rainfall and flooding associated with tropical cyclones and severe thunderstorms.
RESEARCH RELATED ACTIVITIES

SCIENTIFIC PUBLICATIONS

The publication of scientific and technical results is a vital element of the work in BMRC. A total of 161 publications were produced during 2004-05, including refereed journal papers, articles, book chapters, conference papers and miscellaneous reports. Some 60 peer-reviewed papers were published in books and international journals and ten internally reviewed BMRC Research Reports were published.

Research staff are continually involved in the peer review of work carried out across the Bureau, in addition to acting as reviewers for work from other organisations. Staff in BMRC operate the editorial office and oversee the publication of the *Australian Meteorological Magazine* (AMM), the journal on southern hemisphere atmospheric, ocean and related sciences published by the Bureau in cooperation with the Australian Meteorological and Oceanographic Society. Scientists in BMRC serve on the editorial board of AMM and other international scientific journals.

The 2004 BMRC Modelling Workshop publication on the theme of 'The past, present and future of numerical modelling' was published before the workshop in December. A previous backlog in the publication of other BMRC Research Reports was reduced.

COLLABORATION

Meteorological research in Australia is carried out by the Bureau, the CSIRO, a number of university groups and, to a lesser extent, by other government departments and agencies and the private sector. In recent years, the Bureau and CSIRO, as the two major agencies engaged in atmospheric research, have worked closely to ensure that Bureau and CSIRO plans for atmospheric and related research are coordinated effectively and to identify joint research activities and areas of collaboration at the project level. In particular, the Bureau works closely with CSIRO Atmospheric Research (CAR) and CSIRO Marine Research (CMR), which are planned to merge as CSIRO Marine and Atmospheric Research (CMAR) from 1 July 2005. A recent initiative is the agreement between the Bureau and CSIRO to develop the Australian Community Climate and Earth System Simulator (ACCESS). The project will further contribute to effective collaboration between the Bureau and CSIRO on modelling and to the maintenance of world-class climate modelling capability. The BMRC is also contributing to the Australian Research Council (ARC) Earth Systems Science Network. Collaborative research sponsored by the Australian Greenhouse Office, principally within the Australian Climate Change Science Program, and by the RAN, constitute key elements of the Meteorological and Related Research Output.

COOPERATIVE RESEARCH CENTRES

To further improve the coordination of meteorological and related research in Australia and to provide support for the strengthening of programs in meteorology and related sciences at Australian universities, the Bureau actively contributed to the development of multi-agency agreements to establish new research centres in meteorology and related disciplines under the Government’s Cooperative Research Centre (CRC) program. During 2004-05, the Bureau participated in:
• the CRC for Antarctic Climate and Ecosystems with the University of Tasmania, CSIRO Atmospheric Research, CSIRO Marine Research and the Australian Antarctic Division;

• the CRC for Catchment Hydrology at Monash University with thirteen other participants, including Brisbane City Council, CSIRO Land and Water, the Department of Sustainability and Environment (Victoria), Melbourne Water, Monash University, the Murray-Darling Basin Commission, Goulburn Murray Water (Victoria) and The University of Melbourne;

• planning for the new eWater CRC at the University of Canberra with some thirty other participants, including a range of industry, government (national, state and local) and university partners; and

• the CRC for Bushfire Research with 17 other core participants, including Emergency Management Australia (EMA) and relevant State authorities.

NATIONAL RESEARCH PRIORITIES

The Bureau continued to make good progress in its implementation of the National Research Priorities. Both the extension of the Australian Air Quality Forecast System to the southeast capitals and Adelaide (involving collaborations with CSIRO and State Environmental Protection Agencies), and the project to increase awareness of UV radiation (with the Cancer Council and ARPANSA), contribute to the priority goal of ‘Preventive healthcare’. There is also work underway to examine relationships between climate variability and the Ross River virus and drought and suicide.

In collaboration with the Bushfire CRC, research on transport modelling aimed at improving the prediction of fire weather and awareness of fire danger supports the priority goal of ‘Critical infrastructure’. This goal is also supported by the development of high quality datasets and products, which constitute a significant contribution to infrastructure.

Collaborations with NEC and CSIRO at the High Performance Computing and Communications Centre (HPCCC) on optimisation of computer code used for numerical modelling and data assimilation support the priority goal of ‘Smart Information Use’.

Collaborative projects studying the water budget of the Murray-Darling Basin, the Indian Ocean Climate Initiative researching the decrease in rainfall in southwest Western Australia, and the new South-East Australia Climate Initiative all contribute to the priority goal of ‘Water – a critical resource’.

Research, such as investigation of the causes of apparent climate changes (e.g. the recent run of dry years in southeast Australia) and the development of a phenological database for climate change and ecosystems, both supported by the Australian Greenhouse Office, contribute to the goal of ‘Responding to climate change and variability’.

Ocean modelling and ocean prediction system development, as part of the BLUElink project, in partnership with the Royal Australian Navy, contribute to ‘Transformational defence technologies’.