Weather Services encompasses a wide range of forecast, warning and information services to the general public, national and international shipping and aviation, the Department of Defence and other users. It consists of six individual outputs:

- Severe Weather Warning Services;
- Public Weather Services;
- Marine Weather Services;
- Aviation Weather Services;
- Defence Weather Services; and
- Special Weather Services.

In this report Oceanographic Services are reported, along with Marine Weather Services, under the general heading of Marine Services.

Services are provided mainly through the seven Regional Forecasting Centres (RFCs) in the State capital cities and Darwin, and through the National Meteorological and Oceanographic Operations Centre (NMOC) located in Melbourne. All these Centres maintain a 24-hour weather watch every day of the year, issuing forecasts, warnings and other weather information as required.

Many of the Bureau’s offices in rural and remote areas, which function primarily to provide high quality weather observations (surface, upper air and weather watch radar), have an important complementary role in providing current weather information and a range of other services to their local communities. Some 43 such service outlets are distributed across Australia, with an additional two at Australian bases in Antarctica.

A large part of the Bureau’s output of weather services was made available to the Australian community through the mass media (radio, television, newspapers) but services were also accessible via recorded telephone, marine high frequency (HF) radio, facsimile and Internet systems.
Weather Services were provided in line with the Bureau of Meteorology’s Service Charter for the Community. A broad range of consultative mechanisms is in place, involving Commonwealth and State Authorities, and major commercial and community user groups, to help ensure that services evolve and are continually improved in accord with user needs.

**Highlights**

Principal achievements in 2001-02 were:

- the extension of radar imagery providing improved coverage through regional and rural Australia;
- upgrade of the Bureau’s 1900-prefix and 1300-prefix services, through the implementation of text-to-speech (TTS) telephone delivery systems;
- provision of highly effective weather services in support of fire-fighting activities during the New South Wales ‘Black Christmas’ bushfires; and
- the launch of the PremiumWeather™ website, developed by the Bureau’s commercially operating Special Services Unit (SSU) under contract to Telstra Countrywide.

**Resource Use**

The resources committed to Weather Services in 2001-02 are summarised in Table 3 (pg 37) and are given in more detail in Table 8 (pg 74).

**Performance**

Performance during 2001-02 was assessed at two levels in terms of the:

- quality, quantity and price of the outputs directed to the achievement of the planned outcome relative to the agreed target levels; and the
- contribution of the outputs to the achievement of the planned outcome.

The measures used as a basis for performance assessment were as published in the Portfolio Budget Statements 2001-02 for the Environment and Heritage Portfolio (Budget Related Paper No. 1.7). The performance for 2001-02 against each of the performance measures and targets for quality, quantity and price of outputs is summarised in Appendix 11.

The performance of Weather Services is monitored and reviewed on a regular basis through:

- quarterly surveys of public opinion, conducted by an independent company;
- representations to the Minister and Parliamentary Secretary for the Environment and Heritage, and to the Director of Meteorology and Regional Directors by members of the public and industry bodies;
- queries and complaints made directly to the Bureau of Meteorology via the Bureau’s Internet-based user feedback facility;
- public reports of detailed post-analyses of major severe weather events or major seasonal activity (eg the tropical cyclone season, the fire weather season);
- feedback from regular consultative meetings with major user groups such as the media, the Australasian Fire Authorities Council, State Emergency Services organisations, state tropical cyclone liaison committees, the aviation industry and the Department of Defence;
- achievement of milestones for the planned introduction of new services;
- trends in the accuracy of forecasts of weather elements such as maximum and minimum temperature, rainfall and tropical cyclone location;
- trends in the effectiveness of severe weather warnings, using measures such as the advance warning time given prior to the occurrence of dangerous weather events and the false alarm ratio (an indicator of when warnings are issued unnecessarily);
- trends in the volume and variety of
products issued; and
• trends in the resources used in delivering weather services.

Quarterly surveys of users of the Bureau’s weather services, conducted during the year, showed that 90 per cent of users were satisfied or very satisfied with the Bureau’s services and 81 per cent believe that weather forecasts, warnings and information services are received in time for them to make their weather related decisions.

The contribution to achievement of the planned outcome during 2001-02, assessed in terms of the indicators listed in Appendix 12, is reviewed below for each of the individual outputs, drawing on the performance information summarised in Appendix 11.

Severe Weather Warning Services

Severe Weather Warning Services assist the community in preparing for, and responding to, tropical cyclones, severe storms, bushfires and gales over land. These services are provided through the Bureau’s State-based Regional Forecasting Centres (RFCs), with national coordination by the Head Office Weather and Ocean Services Policy Branch and very close links with State and Commonwealth emergency services and disaster preparedness organisations.

The Severe Weather Warning Service performed effectively during the year and contributed to a timely and well-organised community and emergency service response to severe weather situations. The number of weather warnings issued to the general public, together with the numbers of forecasts issued and weather enquiries received, is given in Table 9.

During 2001-02, public access to severe weather warnings was significantly improved with the expansion of the suite of warnings available on 1300-prefix numbers. A dedicated 1300 service was established in each State, and in the case of Western Australia, Queensland and the Northern Territory, there is an additional 1300 number for tropical cyclone advices. All 1300 services are updated automatically soon after the issue of text warnings, using the Bureau’s text-to-speech conversion system. The services are available anywhere in Australia at any time at the cost of a local call.

Tropical Cyclone Warning Services

Tropical cyclone warning services are provided for northwest, north and northeast Australia, from Tropical Cyclone Warning Centres (TCWCs) co-located with the Perth, Darwin and Brisbane RFCs respectively. The planning and operation of the tropical cyclone warning service continued to be closely linked to, and coordinated with, the State Emergency Services in Western Australia, the Northern Territory and Queensland to maximise the effectiveness of community preparedness and response.

Nine tropical cyclones formed in the Australian region during the 2001-02 tropical cyclone season, two of which affected the Australian coastline. Tropical Cyclone Chris was the most severe cyclone of the season, reaching Category 5 intensity prior to crossing the coast between Pardoo and Wallal Stations in northwest Western Australia on 7 February. Effective warnings prior to the cyclone ensured that the community was safely prepared and there was no loss of human life. Due to the remoteness of the crossing point there was little property damage, although stock losses were significant, mainly due to the coastal inundation caused by storm surge. This was the fifth time in four seasons that a Category 5 cyclone has struck the Australian coast, an event that has historically been very rare. In all five cases, the combination of timely warning and well-organised community response ensured that no lives were lost.
Table 8. Weather Services expenses and revenue ($’000), and staff levels for 2001-02 compared with the actuals for 2000-01, the 2001-02 Budget and Budget plus Additional Estimates appropriations*.

<table>
<thead>
<tr>
<th></th>
<th>ACTUAL 2000-01 ($’000)</th>
<th>BUDGET 2001-02 ($’000)</th>
<th>BUDGET &amp; ADD. EST. 2001-02 ($’000)</th>
<th>ACTUAL 2001-02 ($’000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINANCIAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EXPENSES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee Expenses (Appropriation)</td>
<td>26,488</td>
<td>26,084</td>
<td>26,084</td>
<td>27,820</td>
</tr>
<tr>
<td>Employee Expenses (Section 31)</td>
<td>1,128</td>
<td>1,296</td>
<td>1,296</td>
<td>1,660</td>
</tr>
<tr>
<td>Supply of Goods and Services (Appropriation)</td>
<td>3,111</td>
<td>2,580</td>
<td>2,580</td>
<td>3,046</td>
</tr>
<tr>
<td>Supply of Goods and Services (Section 31)</td>
<td>4,035</td>
<td>3,713</td>
<td>3,713</td>
<td>2,863</td>
</tr>
<tr>
<td>Operating Lease Rentals</td>
<td>1,710</td>
<td>1,924</td>
<td>1,924</td>
<td>1,741</td>
</tr>
<tr>
<td>Depreciation</td>
<td>1,836</td>
<td>2,015</td>
<td>2,015</td>
<td>1,608</td>
</tr>
<tr>
<td>Other Goods and Services Expenses (WMO Contribution)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL EXPENSE</strong></td>
<td>38,308</td>
<td>37,612</td>
<td>37,612</td>
<td>38,738</td>
</tr>
<tr>
<td><strong>REVENUE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriations</td>
<td>33,818</td>
<td>31,601</td>
<td>31,580</td>
<td>32,322</td>
</tr>
<tr>
<td>Sale of Goods and Services</td>
<td>4,476</td>
<td>5,415</td>
<td>5,612</td>
<td>5,612</td>
</tr>
<tr>
<td>Miscellaneous - other</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL REVENUE</strong></td>
<td>38,305</td>
<td>37,016</td>
<td>37,192</td>
<td>37,944</td>
</tr>
<tr>
<td><strong>STAFFING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff Years (actual)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Funded from Employee Expenses (Appropriation)</td>
<td>307.8</td>
<td>300.4</td>
<td>300.4</td>
<td>313.8</td>
</tr>
<tr>
<td>- Funded from Supplier Expenses (Appropriation)</td>
<td>3.8</td>
<td>1.1</td>
<td>1.1</td>
<td>4.6</td>
</tr>
<tr>
<td>- Funded from Section 31 Receipts</td>
<td>15.3</td>
<td>12.1</td>
<td>12.1</td>
<td>19.7</td>
</tr>
<tr>
<td>- Funded from Capitalised Salaries (Asset Replacement)</td>
<td>3.0</td>
<td>2.7</td>
<td>2.7</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>329.9</td>
<td>316.3</td>
<td>316.3</td>
<td>339.9</td>
</tr>
</tbody>
</table>

*Resources associated with Oceanographic Services are included under Weather Services

*The operating result (Total Revenue less Total Expense) provides funds required to pay the Capital Use Charge as a dividend from Equity on the Balance Sheet. The Bureau’s dividend is some $20m per annum.
Table 9. Annual numbers of warnings issued to the general public together with the number of forecasts issued and weather enquiries received for the financial years 1997-98 to 2001-02. It also shows the number of forecasts, warnings and other advices provided to the aviation industry.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNINGS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong wind warnings for small craft</td>
<td>4,488</td>
<td>5,647</td>
<td>7,035</td>
<td>8,288</td>
<td>7,238</td>
</tr>
<tr>
<td>Gale / storm warnings for shipping</td>
<td>3,076</td>
<td>2,885</td>
<td>3,444</td>
<td>5,391</td>
<td>5,197</td>
</tr>
<tr>
<td>Flood warnings</td>
<td>573</td>
<td>2,161</td>
<td>1,445</td>
<td>2,088</td>
<td>1,039</td>
</tr>
<tr>
<td>Fire weather warnings</td>
<td>215</td>
<td>70</td>
<td>248</td>
<td>341</td>
<td>378</td>
</tr>
<tr>
<td>Road weather alerts</td>
<td>273</td>
<td>232</td>
<td>387</td>
<td>593</td>
<td>405</td>
</tr>
<tr>
<td>Severe thunderstorm warnings</td>
<td>383</td>
<td>541</td>
<td>788</td>
<td>936</td>
<td>1,063</td>
</tr>
<tr>
<td>Sheep graziers alerts</td>
<td>192</td>
<td>161</td>
<td>181</td>
<td>308</td>
<td>371</td>
</tr>
<tr>
<td>Tropical cyclone warnings</td>
<td>173</td>
<td>448</td>
<td>1,306</td>
<td>1,144</td>
<td>375</td>
</tr>
<tr>
<td>Gale / storm wind warnings for land areas</td>
<td>188</td>
<td>337</td>
<td>244</td>
<td>302</td>
<td>364</td>
</tr>
<tr>
<td>Miscellaneous alerts (frost, brown rot, storm tide, etc.)</td>
<td>290</td>
<td>371</td>
<td>385</td>
<td>308</td>
<td>387</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9,851</td>
<td>12,853</td>
<td>15,462</td>
<td>19,699</td>
<td>16,817</td>
</tr>
</tbody>
</table>

|                  |         |         |         |         |         |
| **FORECASTS**    |         |         |         |         |         |
| States, districts, cities, towns | 296,816 | 303,003 | 206,648 | 218,066 | 175,628 |
| Shipping, boating | 86,580  | 90,399  | 121,850 | 127,716 | 101,730 |
| Fire weather     | 40,012  | 31,099  | 15,255  | 10,258  | 8,590*  |
| Public utilities and other special interests | 13,872  | 13,707  | 11,557  | 12,786  | 11,564  |
| Extended period  | 63,544  | 78,724  | 104,359 | 81,372  | 80,647  |
| Agricultural interests | 2,120   | 2,948   | 1,521   | 1,135   | 1,903   |
| **Total**        | 502,994 | 519,880 | 461,190 | 451,333 | 380,808 |

|                  |         |         |         |         |         |
| **WEATHER ENQUIRIES** |         |         |         |         |         |
| Enquiries (forecasts, current weather, climate etc.) | 787,875 | 802,673 | 949,801 | 900,617 | 812,096 |
| - determined by sampling |         |         |         |         |         |
| Calls to recorded telephone forecasts (Dial It) | 8,082,967 | 5,467,962 | 4,346,086 | 3,571,620 | 3,223,519 |
| Calls to recorded telephone service (1900) | 448,545  | 724,720  | 516,183  | 374,238  | 318,219 |
| Weather by Fax | 1,493,485 | 1,682,860 | 1,129,692 | 782,306  | 557,940  |
| Web hits (www.bom.gov.au) | 2,225,046 | 5,268,176 | 8,651,540 | 12,925,700 | 16,801,400 |
| **Total**        | 13,037,918 | 13,946,391 | 15,593,302 | 18,554,481 | 21,713,174 |

|                  |         |         |         |         |         |
| **BASIC AVIATION AND WARNINGS** |         |         |         |         |         |
| Aerodrome Forecasts | 221,601 | 231,659 | 217,157 | 220,997 | 247,408 |
| Aircraft altimeter settings needed for height above sea level (Area QNH) | 52,629 | 47,020 | 32,829 | 26,945 | 24,204 |
| Route Forecasts | 9,695   | 9,608   | 6,690   | 5,704   | 4,444   |
| Three-hour trend type forecasts | 190,752 | 174,820 | 147,749 | 142,399 | 154,651 |
| Area forecasts | 34,546  | 36,719  | 30,204  | 28,245  | 26,533  |
| Warnings (SIGMET, AIRMET, Airport Hazards) | 2,765   | 2,799   | 2,401   | 1,991   | 1,923   |
| Aerodrome Advices | 0       | 2       | 26      | 19      | 218     |
| Search and Rescue Services | 201     | 132     | 73      | 65      | 45      |
| Pilot Briefing Services | 60,485  | 58,596  | 49,050  | 58,082  | 43,489  |
| Pilot Documentation | 14,457  | 12,103  | 8,008   | 5,583   | 5,034   |
| **Total**        | 587,131 | 573,458 | 494,187 | 490,010 | 507,949 |

*An error was found in the computer program which compiled these statistics. The effect of the error was to over-estimate the number in earlier years
The other cyclone to affect northern Australia was Tropical Cyclone Bernie in early January. Bernie was never severe and weakened to a rain depression as it crossed the coast near the Queensland/Northern Territory border. Cyclones briefly threatened Christmas Island (Bonnie) and Cocos Island (Dianne) necessitating the issue of Tropical Cyclone advices, but the cyclones passed to the south of these islands.

Concern continued regarding the availability on the Internet of tropical cyclone-related forecast and warning information from non-official sources such as overseas meteorological service providers or international media agencies. The Bureau invested significant efforts in ensuring strong linkages were maintained with key sectors of the community, particularly the media and emergency services, in order to ensure that the community received reliable, non-conflicting information during cyclone events.

Improvements in the accuracy of the tropical cyclone warning service were assessed in terms of the decreasing errors achieved for key forecast parameters, specifically the mean error in operational estimates of tropical cyclone position

Figure 30. Average errors in tropical cyclone location in the Australian region as compared with the post-event best estimates. The 00hrs plot shows the accuracy of real time estimation of cyclone position. The 12hrs and 24hrs plots show the accuracy of 12-hr and 24-hr forecasts. The straight lines show the long-term trend.

Figure 31. Average errors in tropical cyclone intensity (central pressure) in the Australian region as compared with the post-event best estimates. The 00hrs plot shows the accuracy of real time estimation of cyclone intensity. The 12hrs and 24hrs plots show the accuracy of 12-hr and 24-hr forecasts. The straight lines show the long-term trend.

Severe thunderstorm warning services

Severe thunderstorms are particularly intense convective storms that produce destructive winds, damaging hail, tornadoes or heavy rain leading to flash-flood-
The Bureau provides forecasts of such thunderstorms in the form of Severe Thunderstorm Advices and Severe Thunderstorm Warnings. The Severe Thunderstorm Advice Service continued to operate over the southern half of mainland Australia, including southeast Queensland (Figure 32), and provided advice of likely areas for the development of severe thunderstorms, up to four hours ahead. Severe Thunderstorm Warnings, usually up to one hour ahead, were issued for capital cities and their surrounding areas where radar surveillance allowed assessment of the severity of thunderstorms that had already developed.

Even with the benefit of continuous radar surveillance, it is difficult to monitor comprehensively the development, movement and intensity of severe thunderstorms. The national network of almost 3000 volunteer 'storm spotters' complements the radar network and continued to make a valuable contribution by monitoring, reporting and confirming occurrences of severe thunderstorms. Observations reported by storm spotters assisted forecasters with both the issue of warnings and the eventual verification of those warnings. A review in 2001 recommended expansion and improved utilisation of the network. Follow-up actions carried out in 2001-02 included an update of the safety advice included on spotter report forms, the development of a storm spotter logo, to assist in establishing network identity, and improvements to the storm spotter web pages.

During 2001-02, there were 362 reports of severe thunderstorms across Australia and 1,063 warnings/advises issued, compared with 311 reports and 936 warnings/advises in the previous year (see Table 9).

The performance measures adopted for severe thunderstorm warnings are the Probability of Detection (POD), which is the proportion of correctly-warned severe thunderstorms (ideally 1; performance target 0.7 or greater), and the False Alarm Ratio (FAR), which is the proportion of ‘false alarm’ severe thunderstorm warnings (ideally 0; performance target 0.4 or less). The targets are based on an assessment of what is achievable using historical records of such statistics in both Australia and the US, but also taking into account an estimate of the accuracy needed for the warnings to be useful to the community. As illustrated in Figure 33, there is significant variation in the nationally-averaged POD and FAR values over the eight year record but no significant trend. The year-to-year variations reflect varying proportions of severe thunderstorms that occurred in capital cities for which the warning task is relatively difficult (e.g. Perth, Adelaide and Darwin) compared with the proportion that occurred in the other capital cities. In 2001-02, the service was unable to achieve the targets set for the probability of detection or false alarm ratio, but performance was broadly maintained at 2000-01 values.

The Bureau achieved some progress in terms of improved 'average lead time' of warnings. A total of 95 severe thunder-
storms was recorded in the metropolitan warning areas in 2001-02 and for the 47 for which warnings were issued, lead times ranged from zero to 120 minutes. Over all events, with lead times of zero minutes allocated for missed events, the average lead time was 23 minutes (slightly below last year’s figure of 35 minutes).

Fire weather warning services

The Fire Weather Warning Service provides the public with routine forecasts of fire danger during the fire season and fire weather warnings when the fire danger is expected to exceed a certain critical level. The service also provides fire management authorities, civil defence organisations, police and other emergency services with detailed routine forecasts, fire weather warnings and operational forecasts to assist in combating ongoing fires. This service includes, where possible, out-posted support, special forecasts for hazard reduction burns and other

Figure 33. Nationally-averaged values of Probability of Detection (POD - fraction of events for which advance warning was provided) and False Alarm Ratio (FAR - fraction of warnings which were false alarms) for the past eight years (1994-2002) for Severe Thunderstorm Warnings (all Australian capital cities except Canberra).

Damaging hail associated with severe storm activity affected Esperance and other parts of the eastern South Coast District of Western Australia on 4 December. The Bureau provided a Severe Thunderstorm Advice to the community three hours before the storms developed.

NSW Regional Director, Kevin O’Loughlin accepts the New South Wales Government’s Meritorious Unit Service Award from Premier Bob Carr at a presentation held at Government House on 21 May. The award acknowledges the overall involvement of the Bureau in combating the New South Wales bushfires in 2001-02.
advice to assist the assessment and management of fire risk.

The Bureau’s Fire Weather Warning Service performed at a high level in support of fire-fighting activities associated with the New South Wales ‘Black Christmas’ bushfires in 2001-02. This event involved more than 30 days of fire activity, with an estimated 750,000 hectares burnt and a combined fire-front of 4360km. Losses included 109 dwellings, 7,000 head of stock and more than 200 vehicles. The Bureau responded effectively to the requirements of the Rural Fire Service State Operations Centre, with out-posting of a liaison meteorologist and a further six operational meteorologists to cope with the unprecedented workload. The fact that no lives were lost is indicative, in part, of the high quality of the weather services provided. The Bureau received an award from the New South Wales Government in recognition of the high performance of its systems and the efforts of operational staff during the event.

The extended length of the season across the entire country placed a significant demand on the Fire Weather Warning Service. Low rainfall and relatively dry air persisted into autumn, which extended the provision of fire weather services (in the southern states) into the middle of May. This also resulted in an early start to the service in the Northern Territory. In New South Wales, a record number of Special Fire Weather Forecasts (1979) was issued, eclipsing the previous record of 943 in 1997-98. A detailed account of the 2001-02 fire season is provided in Appendix 7.

A measure of the effectiveness of the Fire Weather Warning Service is the extent to which the community is accurately warned of severe events. Severe events in the fire weather context are those windy, hot and dry atmospheric conditions which, when combined with dry vegetation, can be conducive to bushfire outbreaks. Performance trends for fire weather warnings over the past nine years are shown in Figure 34 in terms of Probability of Detection (POD) and False Alarm Ratio (FAR). The challenge is to increase POD without increasing FAR. The figure shows that, during 2001-02, the previous downward trend in POD flattened out very slightly and the upward trend in FAR over the previous two years was reversed.

In delivering the Bureau’s fire weather services, Regional Offices in each State and Territory continued their close collaboration and consultation with relevant fire and land management authorities through pre-season planning meetings and post-season review meetings to ensure that, within an overall national policy framework, particular local issues were addressed. A theme across all fire agencies was the continuing need for assistance in the expert provision of fire weather training for fire agency staff. The Bureau continued to assist these activities during 2001-02 across several States, participating in a range of pre and post-season courses. Several new procedures and service improvements were introduced in response to identified needs. These included:

- improved conferencing arrangements between the Bureau and fire control agencies, involving both video and telephone equipment, on both a routine and as-needed basis prior to high-risk days. This assisted in the transfer of information to planners in the fire agencies and was perceived as especially effective in the days

![Figure 34. Trends in Fire Weather Warning Service performance, as indicated by Probability of Detection (POD – fraction of events for which advance warning was provided) and False Alarm Ratio (FAR – fraction of warnings which were false alarms).]
prior to episodes of severe fire weather;

• the transfer of forecast techniques used during the 2000 Sydney Olympic Games into operational use for fire weather forecasting. These involved enhanced observational and display techniques, including the use of low-reflectivity radar data to locate and track wind changes; and

• more effective arrangements for the continuous provision of observational data from fire danger estimate sites.

Other significant activities during 2001-02 aimed at contributing to the improvement of fire weather services included:

• active participation in the development of a proposal for the establishment of a Bushfire Cooperative Research Centre. In the aftermath of the New South Wales bushfires emergency, there were national efforts to improve funding for research in bushfire-related subjects culminating in the bid to establish the Cooperative Research Centre. The proposed Centre will benefit both fire control authorities (from Bureau-led research into fire weather) and the Bureau (improved services through the application of findings from other areas of fire science);

• continued close collaboration and consultation nationally through the Bureau’s Associate Membership of the Australasian Fire Authorities Council (AFAC), including participation in an AFAC funded smoke management project and membership of a Working Group on the Operational Calculation of the McArthur Drought Factor; and

• attendance by Bureau staff at a range of national and international conferences related to fire weather.

Public Weather Services

The Bureau’s Public Weather Services provide a wide range of weather information and forecasting services in the public interest for the benefit of the community at large in all Australian States and Territories. Weather information services include current and recent weather observations from the Bureau’s extensive observing network, satellite and radar imagery, analyses of meteorological conditions and forecasts of a wide range of meteorological parameters covering geographically distributed localities, together with numerous warnings for weather conditions with potential to cause loss of life or damage to property.

Weather forecasts are provided for more than 170 cities and towns and 60 separate forecast districts, according to community needs. During 2001-02, 380,808 routine public weather forecasts and information bulletins were issued. The Bureau continued to keep abreast of community needs for weather services that enhance public safety and support the daily decision making of individuals, households, businesses, community sectors and government organisations.

The quarterly user survey results, primarily measuring user attitudes in the metropolitan areas of Australia’s capital cities, indicated a high level of user satisfaction with Bureau weather services. These were reinforced by the Bureau’s internal forecast verification results, presented for forecast maximum and minimum temperature in Figure 35. The accuracy of temperature forecasts has improved steadily over the past 30 years, most notably since the mid-1980s. This improvement is largely a reflection of improvements in the operational numerical models and in the scientific expertise of the forecasters. The target for this performance measure for 2001-02 was set at 1.4°C. Figure 35 shows that the errors in maximum and minimum temperature forecasts were within this target at 1.29°C and 1.35°C respectively.

A project to upgrade the 1196 telephone weather service, which provides Bureau weather information to the community, commenced in 2001-02. The service will be enhanced using text-to-speech technology, with Legion Interactive as the provider.
The number of calls since January 1995 to the 1196 telephone weather service is shown on a monthly basis in Figure 36. The services are at the cost of a local call and currently cover public weather forecasts for all State and Territory capital cities and some regional centres in Queensland.

The Bureau’s National Media Graphics Unit and Regional Offices continued to work closely with newspapers in the preparation of graphical weather information pages in a range of daily and weekly publications, enhancing the public understanding of meteorology and the effectiveness of the delivery of the Bureau’s public weather services to the community. The number of papers publishing high quality colour and/or black and white graphical weather segments numbered between 60 and 70 in 2001-02.

In response to the increased community concern about susceptibility to sunburn, the Bureau enhanced the ultraviolet (UV) forecast service to include more than 170 regional towns. The extension of the service supplemented the map of UV values across Australia already available to the community. Updated brochures were printed and distributed throughout the Bureau’s Regional Offices and through Anti-Cancer Council offices across

Figure 35. Trends in the mean modulus error in maximum and minimum temperature forecasts for all State capital cities and Canberra.

Figure 36. The number of calls per month since January 1995 to the 1196 telephone weather service.
Australia.

The Bureau continued to investigate the feasibility of introducing a Thermal Stress Advice Service, which aims to alert the public to the thermal stress risk during periods of unusually high temperatures and humidity. Community demand for this service was reaffirmed in 2001-02 and thus a statistical investigation of the effects of heat waves was commenced.

The Bureau continued to foster its partnership relationship with the private meteorological sector through a number of ad hoc meetings and discussions and through maintenance of a dedicated mailing list of private sector specialist service providers.

Marine Services*

During 2001-02, the Bureau developed a number of key initiatives aimed at improving its marine weather and oceanographic services to the community. These included:

- plans for the Bureau’s new marine HF radio weather services. The new HF radio services are related to major changes at the national level concerning arrangements for providing maritime safety information to shipping and smaller marine users in Australian waters;
- the programmed improvement to marine meteorological and oceanographic observing networks;
- the development of the Bureau’s new marine forecasting system;
- plans to consolidate and improve oceanographic services provided by the Bureau.

*The Bureau’s marine services embrace a wide range of marine meteorological services and an expanding suite of oceanographic services. While Oceanographic Services is now identified as a separate Major Output of the Bureau, their performance for 2001-02 is reported here as a subheading of Marine Services.

Marine Weather Services

The second edition of the Mini Guide to Marine Weather Services series, a key element of the marine services public education program, was completed for all states and the Northern Territory. The new editions of the waterproof, pocket-sized brochures include changes associated with the Bureau’s new marine radio services. A revised edition of the more general Marine Weather Services pamphlet incorporating changes made to radio services, was also completed.

The Bureau continued to provide effective marine services for the safety and efficiency of shipping, small craft and maritime industries. During 2001-02, 101,730 shipping and boating forecasts and 13,114 marine warnings were issued.

The Bureau’s website continued to provide marine forecasts, warnings, meteorological observations and charts, as well as links to other relevant and useful marine sites. During the summer of 2001-02, more than 20,000 accesses per month were recorded for the Bureau’s Marine Page, which is an increase of more than 10 per cent on the previous summer. In May, the Marine Page was expanded to include a comprehensive description of the new HF radio services, which resulted in 30,000 accesses to the page in that month.

The new Australian Marine Forecasting System (AMFS), aimed at improving the quality and timelines of marine services to the community, proceeded to the implementation phase in Tasmania. AMFS will provide an entirely new platform allowing forecasters to prepare marine forecasts using interactive graphical screen based techniques. Forecasters will be able to interact with the digital form of the Bureau’s numerical weather and ocean prediction model outputs to produce detailed forecasts of winds, waves and other relevant meteorological and oceanographic conditions. A facility for generating forecast text directly from the data
fields prepared in AMFS was nearly completed and a working prototype was evaluated in Tasmania.

Plans were developed and implemented to transition the Bureau’s HF radio weather broadcast services to a new system to better serve the needs of mariners through provision of significantly more frequent broadcasts of weather for Australian coastal and ocean areas. The new system was jointly developed under contract with Television New Zealand (Australia) Pty Ltd (TVNZ) and is based on newly constructed transmitters at Charleville in Queensland and Wiluna in Western Australia. The call signs and station names for the new broadcast stations are VMC Australia Weather East (for Charleville) and VMW Australia Weather West (for Wiluna). Services, which commence officially on 1 July 2002, will replace voice services for coastal waters and high seas forecasts and warnings (which were broadcast by Telstra) and radio facsimile broadcasts of weather and oceanographic charts (which were broadcast by the Royal Australian Navy). A major campaign to inform the marine public about the new services involved:

- a direct mailing of 6,000 information bundles (posters, brochures and booklets of broadcast schedules) to key marine organisations and businesses;
- comprehensive on-line advice available through the Bureau’s enhanced Marine page; and
- the establishment of a hotline telephone and email enquiry facility.

As part of its commitment to maintaining a range of marine broadcast services, the Bureau consulted with Telstra and the State/Territory marine administrations on future arrangements for VHF broadcasts of coastal marine forecasts and warnings. State/Territory administrations will assume responsibility for providing maritime safety communications for small craft from 1 July 2002. The Bureau provided technical support to enable resumption of several key VHF broadcasting stations in Queensland, which will commence re-broadcasts of Bureau products on Channel 67 in 2002-03. In other states and the Northern Territory, the resumed services will be undertaken by human operators. The Telstra VHF network will continue in areas where the new broadcasts do not operate.

Following the first session of the WMO-IOC (Intergovernmental Oceanographic Commission) Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) in June 2001, the Bureau participated actively in several key groups of the Commission, which is aimed at improving the coordination and provision of marine services to the community. Several Bureau staff continued to serve in senior JCOMM positions including the position of Coordinator of the JCOMM Services Programme Area.

Preliminary action commenced in relation to the legal case that has been mounted by several widows of sailors who died during the 1998 Sydney Hobart Yacht Race. While the time frame for the case to progress is likely to extend well into 2003 and the legal parameters of the case have yet to be fully elaborated, the Bureau continued to prepare relevant documentation.

Oceanographic Services

During 2001-02 the emphasis under the newly formalised Oceanographic Services Program was on maintenance of existing services and planning for future developments. This program will consolidate and build on existing oceanographic activities and establish a framework and structure that will allow the Bureau to respond, to the extent possible within existing resources, to the growing demand for new oceanographic services. The program comprises two components; Coastal Oceanographic Services, which essentially deal with services required in coastal areas, including Australia’s Exclusive Economic Zone (EEZ) and High Seas Oceanographic
Services, covering requirements outside the EEZ.

The Oceanographic Services Program will support the safety of life and property at sea, the conduct of marine-based economic activities, the proper management of marine resources and the marine environment and meet national security requirements.

The National Meteorological and Oceanographic Operations Centre continued to develop the suite of computer-based oceanographic systems that serve as the basis for the Bureau’s operational oceanographic services. Improvements were made to the configuration of the sea state prediction system to allow more detailed calculations of the spectrum of waves and swell, and to use finer scale winds that force the development of the waves in the model. As extra waverider buoy data have become available they have been used to extend the validation of the sea state predictions, as a means of establishing the performance of the system and of identifying areas for further improvement.

The analyses of both surface and subsurface ocean temperature has been enhanced by accessing new data sources as they have become available. For sub-surface temperatures the major addition has been data from the developing network of Argo floats deployed as part of the Global Ocean Observing System. This network provides new data to supplement those from the bathythermograph and moored buoy networks.

Operational implementation also commenced of a coupled global ocean-atmosphere model being developed in the BMRC, in collaboration with CSIRO Marine Research. The model will be used for long-range prediction of sea surface temperature anomalies as part of the guidance available in the preparation of seasonal outlooks.

During the year, the BMRC continued to develop, in collaboration with the Royal Australian Navy and the CSIRO, plans to establish an enhanced operational ocean modelling system that will provide detailed analysis and prediction of ocean currents and thermal structures. This system is expected to be a keystone in the Bureau’s oceanographic program, and will support the provision of a broad range of oceanographic products and services appropriate to user needs.

Liaison continued on the national and international level with users and providers of oceanographic service to ensure that the program will meet future service requirements.

**Aviation Weather Services**

Aviation weather services continued to enhance the safety, regularity and efficiency of national and international aviation operations. Services are provided within the international technical and regulatory framework of the International Civil Aviation Organization (ICAO) and the World Meteorological Organization (WMO) which work in close cooperation. Australian domestic aviation is regulated by the Civil Aviation Safety Authority (CASA) and air traffic management is the responsibility of Airservices Australia. Under this international and domestic framework, the Bureau of Meteorology is the designated Meteorological Authority for Australia for the provision of aviation weather services.

User consultation and arrangements for ongoing service improvements continued to be coordinated by a variety of committees, working groups and focus groups involving the Bureau of Meteorology, CASA, Airservices Australia, the major Australian airlines, the Australian Air Transport Association, the Australian Airports Association and others. International consultation and coordination occurred through the WMO Commission for Aeronautical Meteorology and working groups, the ICAO Asia Pacific Air Navigation Planning and
Implementation Regional Group and a number of ICAO study groups. In conjunction with the major airlines, the Bureau investigated all meteorological incident reports, in order to identify deficiencies and explore opportunities to improve the effectiveness of the Aviation Weather Service.

The requirements and level of resources for provision of aviation weather services are formally agreed, at least annually, with aviation industry representatives. The incremental cost of providing these services was recovered from the industry. In 2001-02, the agreed cost was $14.09 million and the total revenue recovered was $13.872 million. Although major changes in the aviation industry took place following the collapse of Ansett Airlines and the events of September 11 in the USA, the requirements for aviation meteorological services in Australia remained essentially unchanged.

Aviation weather services were generated and delivered through the following major service outlets:

- the Bureau’s Aviation Weather Centre (AWC) which is part of the National Meteorological and Oceanographic Operations Centre;
- each of the Bureau’s capital city Regional Forecasting Centres;
- the Sydney Airport Meteorological Unit (SAMU), which is co-located with Airservices Australia’s Air Traffic Services Unit at Sydney Airport;
- the Darwin Volcanic Ash Advisory Centre (VAAC) located in the Northern Territory Regional Office, which is one of the nine international centres established as part of the ICAO International Airways Volcano Watch; and
- a number of other Meteorological Offices including Townsville, Cairns and Canberra.

The Bureau’s AWC also distributed an extensive range of products generated by the ICAO World Area Forecast System (WAFS) which comprises the two World Area Forecast Centres (WAFC), in London and Washington DC.

During 2001-02, the Aviation Weather Service included an extensive range of forecast products, weather information, warnings and briefings to serve the needs of more than 2450 individual operators. Statistics on the volume of output services can be found in Table 9.

The Terminal Aerodrome Forecast (TAF) continued to be the most frequently distributed of the Bureau’s aviation products. During 2001-02, TAFs were routinely prepared and issued for some 260 locations throughout the country. TAFs provide hour-by-hour forecasts of weather conditions critical to aviation operations such as cloud amount and height, visibility, turbulence, precipitation, wind speed and direction, temperature and pressure. The Bureau also provided information on observed aerodrome conditions and continued to enhance its aviation observation network through the installation of advanced instrumentation such as visibility and cloud height sensors.

Bureau staff participated in numerous aviation events during 2001-02, including a series of flight safety forums to promote safer skies. These seminars, which were aimed at educating members of the aviation industry in the effective use of the Bureau’s aviation weather services, were organised by CASA and held throughout Australia.

Work continued on the enhancement of a TAF verification/improvement system, designed to monitor and provide feedback on performance in terms of the impact of TAFs on aviation operations. Aircraft are required to carry additional fuel if cloud ceiling or visibility are forecast below certain minimum values, indicating the possibility of landing delays. In terms of forecasts indicating no requirement for carrying additional fuel, in 2001-02, the Bureau exceeded the target of 99 per cent. That is, on more that 99 per cent of occasions, aircraft were not required to carry unnecessary fuel reserves because of the forecast. However, for forecasts indicating that additional fuel should be carried, the Bureau
did not meet the target of 35 per cent. That is, on less than 35 per cent of occasions, in 2001-02, aircraft carrying extra fuel because of the forecast conditions arrived to find that the fuel was warranted. This measure relates more to the economy of the operation than safety, since it implies fuel is being carried unnecessarily. The target of 35 per cent reflects the inherent difficulty in predicting critical weather but the Bureau has developed, and will continue to develop, guidance systems and products aimed at improving TAFs and other aviation related weather services.

**Defence Weather Services**

Defence Weather Services continued to enhance the operations of the Australian Defence Force (ADF) through the provision of accurate, timely and relevant meteorological information. Services include the provision of forecasts, real-time meteorological observations and climatological data, meteorological training and professional advice to assist military decision-making processes.

Services are delivered through the Defence Meteorological Support Unit (DMSU) and Defence Weather Services Offices (WSOs). The DMSU, located in Darwin, provides a 24-hour point of contact and coordination for ADF users requiring services from the Bureau. It offers particular expertise in the strategically important areas of tropical Australia, South East Asia and the south-west Pacific and was set up to provide information in a secure environment.

The DMSU complements and supports Defence WSOs located at RAAF bases at Amberley (Queensland), East Sale (Victoria), Tindal (Northern Territory), Pearce (Western Australia) and Williamtown (New South Wales), at the Army Aviation Centre at Oakey (Queensland), and Defence-attributed staff at the Townsville and Canberra Meteorological Offices. These offices continued to provide localised specialist meteorological services to support military aviation.

User consultation was a key element in ensuring the appropriate level of service was provided during the year. The primary relationship was with RAAF Headquarters Air Command, which has responsibility for meeting the bulk of the annual charge for Defence Weather Services. However, consultation occurred at many levels, ranging from individual squadrons and bases to joint ADF/Bureau working groups. The administrative arrangements between the Bureau and Defence were under review, but it is expected that formal consultative arrangements will soon be set down in a Memorandum of Understanding and will include a complementary set of Working Arrangements.

Support for ADF operations and exercises is an important part of the role of Defence Weather Services. During 2001-02, Operations Relex, Cranberry, Slipper and Bougainville were supported by the Bureau. With East Timor’s independence, ADF meteorological requirements in that country were wound back, though low-level support continued.

Through the DMSU, the Bureau also provided support for major exercises, including Leopards Rage, Southern Thunder, Kalkara, Northern Trilogy, Churinga,
Lumbas, Vital Prospect, Aces North, Jabiru, Wallaby and Global Hawk. Defence Weather Services staff were deployed to Kuantan (Malaysia) and Singapore to support 75 Squadron during Exercise Churinga, and to Rockhampton to provide support during Exercise Wallaby. In addition, support was provided for many local-level exercises and was organised and provided through the on-base Defence WSOs.

The Bureau responded to changing requirements for product dissemination procedures amongst ADF users. A wide range of meteorological material, including text, satellite and radar imagery and computer model graphics was made available through a Registered User area on the Bureau’s web site and linked directly into Defence intranet networks. The use of the Internet by Defence users to access tailored weather products trebled during 2001-02 for the second year running (Figure 37). Many products continued to be disseminated by telephone and facsimile and the DMSU developed the capability to do this under encryption.

Specialised observing systems were enhanced to better meet the needs of Defence weather services. In 2001-02, the Bureau commenced the installation of lightning sensors at a number of airfields to provide alerts for aircrew, ground staff and ordnance loaders, and a new tactical AWS, the TACMET AWS, was trialled at Darwin. The TACMET AWS is a highly portable unit designed for easy assembly by non-specialists and will gradually replace the existing tactical units.

The incremental cost of providing the Defence Weather Service to meet ADF requirements is recovered from the Department of Defence. At the beginning of each financial year, a description of the service is provided to the Department of Defence (RAAF Headquarters Air Command) for approval. It details elements of the service, an estimate of the total cost and a breakdown of the cost by base and by activity. During 2001-02, $2.9m (excluding GST) was recovered in respect of staff, equipment, communications and overheads associated with the provision of the service.

**Special Weather Services**

Special Weather Services are provided to meet the needs of the general public, industry and specific clients for weather services and information beyond those available as part of the Basic Service provided through the mass media and the public Internet. Costs for the provision of Special Weather Services are recovered on an incremental or commercial basis, as appropriate.

The service aims to address the needs of four broad categories of weather service users who need more detailed information and/or enhanced products from the Bureau than are available from the basic service:
- private sector meteorological service providers (including some media);
- major primary industry user groups and individual primary producers;
- other people, organisations and sectors involved in weather-sensitive businesses and businesses sensitive to weather information (eg. tourism); and
- members of the public who have a special interest in the weather.

Special forecasting services were provided in the public interest for purposes such as major sporting events, and customised user-specific meteorological services were provided on a commercial basis by the Bureau’s Special Services Unit (SSU) under competitive neutrality conditions with private sector providers of meteorological services.

A highlight of 2001-02 was the launch of the PremiumWeather™ website, which was developed by the SSU under contract to Telstra Countrywide. The website service, which is targeted at selected agricultural sectors, contains information to assist in deci-
sion making and includes both free and fee-based components.

The Bureau’s 1900 telephone weather service was enhanced through implementation of the automated text-to-speech system, achieving considerable efficiencies over the previous manual system. The new system, together with the 1300 service, processes over 12,000 Bureau products per day and can provide the latest Bureau warnings, forecasts and observations to any caller in Australia at any time. The upgraded 1900 and 1300 services complement the long-standing 1196 services run by Telstra using Bureau-provided content. The 1900-prefix services were provided at 77 cents per minute, more from mobiles, satellite phones, public phones and from overseas locations.

During 2001-02, the number of calls to the Weather By Fax service decreased by about 30 per cent in comparison with 2000-01 (Figure 38). As a result of this decline, together with imposition by Telstra of a new fee on low-use services, the Bureau rationalised some of the least-used services. Real-time data access subscription services again received significant use in 2001-02, although the free availability of radar images on the Bureau’s website reduced the number of subscribers to radar data.

Development of the Bureau’s internal Services Information Management System (SIMS) continued in 2001-02, with an emphasis on the provision of clear, comprehensive and easily accessible information about the data, products and services that are available to the public. The product database was transferred onto SIMS and relevant steps in the product development and registration process were clarified. The SIMS Advisory Committee met regularly in 2001-02.

During 2001-02, special weather services provided on a commercial basis through the Special Services Unit (SSU) were focused on consolidating domestic market areas and working with potential customers to expand services in existing sectors. All quality targets were met or exceeded and quantity targets were improved significantly over the 2000-01 achievements.

The special weather service activities of the SSU in 2001-02 included:

- provision of tailored forecasts and tropical cyclone advices aimed at minimising the risk to life and the economic impact of tropical cyclones to operators in cyclone prone areas. These services, provided to about 20 clients in the offshore oil and gas mining industries, were highly valued and general customer satisfaction was demonstrated by renewal of most contracts. There was a small but consistent number of new clients, and market penetration continued to be high (estimated at more than 65 per cent);
- provision of a range of forecast and observational data services tailored to the specific requirements of 26 entities in the competitive energy market. This represents a net increase of three new contracts compared with 2000-01. Four new contracts were signed and all but one of the previous services were renewed, indicating the value placed on accurate and detailed forecasts for the energy sector;
- provision of specialised services aimed at reducing the impact of severe weather and improving the efficiency of opera-
tions in the mining and manufacturing sector. Users indicated a general satisfaction with the service and the number of clients in this sector remained the same as 2000-01;

- the Farmweather service - a valuable service tailored for farmers and agribusiness with a focus on improving the planning and efficiency of farm operations. The reliability of the service was improved, with more than 95 per cent of Farmweather products supplied to the service provider by scheduled deadlines (compared with a target level of 90 per cent). New services were developed for the Sunraysia and Riverland districts, and services were extended to areas of Tasmania;

- the creation of a new SSU office in Adelaide, primarily due to an increased workload related to the PremiumWeather™ service. The Adelaide office also provided services to the energy industry, offshore engineering and the National Aerospace Laboratory of Japan operating from Woomera; and

- provision of tailored data services for internet and mobile telephone services. While the sector more than tripled in the previous year, it stagnated in 2001-02, mainly due to rationalisation amongst telecommunications providers.