WEATHER AND CLIMATE SECTOR[1] FORESIGHT STRATEGY

State-of-the-art forecasts and advice for minimising weather and climate related hazards and maximising opportunities; Clean air and a sustaining climate for all New Zealanders

Coordination:

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[1] A Subsector of the Environment Foresight Strategy

1.0 Introduction

Preparation of this Foresight Strategy has been coordinated by the Meteorological Society of New Zealand and the Royal Society of New Zealand's New Zealand Climate Committee. The Meteorological Society has 320 personal and corporate members including weather forecasters, users of weather and climate information, scientists, farmers and weather observers. The New Zealand Climate Committee is a Standing Committee of the Royal Society of New Zealand. Its mandate includes assessing the current state of climate science knowledge, and encouraging collaboration and communication between scientists and users of climate information.

The submission draws on reports from workshops attended by providers and users of atmospheric information and services ([1] – [5]), the last annual report of the National Science Strategy Committee on Climate Change [6], the Meteorological Society's policy document [7], and foresight discussions during the recent El Niño Workshop (Appendix A). This El Niño workshop was hosted by the New Zealand Climate Committee in October 1998 for managers and researchers in climate-affected industries. Input to the submission has been provided by key users and providers of atmospheric information (Appendix B), and the draft was posted on the Meteorological Society's web site to encourage wider feedback.

2.0 The Vision

Current Situation

New Zealand's equable climate and clean air favour development in agriculture, forestry, horticulture, viticulture, floriculture, and the growth of related processing and manufacturing industries. Our temperate latitude location allows efficient conversion of solar energy into grass, and hence a very efficient livestock industry. The climate and clean air attract tourists and foster our outdoor healthy lifestyle. At the same time, our nation is sensitive to extremes of weather and to seasonal variability of climate. The 1997/98 El Niño related drought cost the country over one billion dollars [8] and was a prime factor in the recent decline in GDP growth. Insurance payments for the 1984 Invercargill / Southland floods, inflation adjusted into 1997 dollars, were $99 million [9]. New Zealanders are concerned about possible changes in climate and sea level driven by global emissions of greenhouse gases, and about skin cancer hazards from stratospheric ozone depletion. We face international pressure to reduce our greenhouse gas emissions, but don't accurately know the magnitude of some of the main agricultural sources.

2020 Vision:

State-of-the-art forecasts and advice for minimising weather and climate related hazards and maximising opportunities; Clean air and a sustaining climate for all New Zealanders

Farmers, horticulturalists, energy producers, civil defence, transport and tourism operators, roading maintainers and all engaged in weather-affected activities including the general public will have ready and efficient access to forecasts targeted

to their particular needs. These forecasts will use new weather satellite technology, accurate computer models, and take full account of New Zealand's complex topography. They will extend beyond weather information alone, to provide quantitative guidance on factors which impinge on users' business (e.g. hydro lake inflows, river flood peaks, wave heights, frost severity, electricity demand, transport hazards). New Zealand forecast providers will have gained substantial overseas business by building on the technical and marketing skills and entrepreneurial attitudes of their staff.

Climate sensitive industries, exporters, and local and regional government will obtain timely warnings of climate hazards or opportunities (droughts, moist growing seasons, warm conditions, good snow seasons). They will use them to plan their activities and marketing, and to manage and adjust to impacts. Improved information will be available on location-dependent weather and climate factors (flood and drought return periods, frost frequencies, strong winds, hailstorms, winter chilling) for farmers, hoticulturalists, foresters, engineers, roading and drainage designers, regional planners, infrastructure investors, and the insurance industry.

The air in our towns, cities and countryside will be clean and clear, despite increases in population, development of new industries, and some incursions of increasingly polluted air from the tropics. Depletion of the stratospheric ozone layer will have reached its maximum, and we will be looking forward to recovery due to sensible science-based constraints on ozone depleting substances. We will have entered the third five year period of legally binding commitments on greenhouse gas emissions under increasingly strict United Nations protocols to protect the global climate from dangerous anthropogenic interference, but these will not have placed serious constraints on our agricultural and industrial activities.

A proactive stance on managing our own agricultural emissions and forest carbon stores will have resulted in international opportunities to assist developing nations in meeting their own greenhouse gas emission targets. Wind power, solar energy and biomass utilisation, upgrades to existing hydroelectricity capacity, and more efficient energy usage, will have reduced our reliance on fossil fuels.

3.0 Drivers of Change

Sensitivity to weather and climate: New Zealand's economy is sensitive to day to day weather changes, year-to-year fluctuations in climate, and longer term climate shifts and changes. These affect the activities of farmers, fishermen, tourist operators, many industries, and the public. Government assistance to groups impacted by droughts and floods has been progressively reduced. Deregulation and competition in the electricity market will make electricity costs increasingly weather and climate sensitive. Development of expensive infrastucture, movement into specialist horticultural crops with tight quality requirements, and market pressures on farmers are also leading to increasing sensitivity. All of these factors will drive demand for user and location specific forecasts of weather and climate conditions (both hazardous and favourable), and for advice on climate-related sustainable carrying capacity.

The global weather marketplace and deregulation: Government deregulation and commercialisation of services, rapid dissemination of information through the internet, and new technology are changing the weather business. These developments are providing overseas opportunities for New Zealand companies, and opening up the local market to competition. Improved technology and communications are leading to increased expectations from users. The advantage will go to those who can provide timely accurate products, tailored to the specific needs of users, and sensitive to local weather and climate conditions.

New Technology and Knowledge: New satellite technology will improve specification of weather systems approaching New Zealand over the data-sparse surrounding oceans. Use of such information in computer models which take full account of local terrain features will improve quantitative forecasts of elements such as winds, rain and frosts. Knowledge about "downstream" weather sensitive processes is also increasingly being quantified in computer models. By linking these "downstream" models to weather forecasting models, quantitative predictions can be improved for parameters such as river flows, erosion risk, storm surges, waves, atmospheric spread of agricultural pests and diseases (including foot and mouth virus), volcanic ash dispersal, air quality, and marine dispersal of pollutants. Satellites are providing new opportunities for monitoring the ocean surface, and data on oceanic processes and interactions with the atmosphere which are essential to understanding the climate system. Methods for monitoring and modelling global and regional climate will improve over the next twenty years, generating improved seasonal climate predictions and more credible climate change scenarios.

Clean, green New Zealand: Public concerns about the environment including air quality, stratospheric ozone depletion and climate change are increasing. Regional Councils have responsibilities for air quality under the Resource Management Act and industries must demonstrate minimal air quality impacts before undertaking new developments. New Zealand's clean, green image, including a clear non-polluted atmosphere, promotes tourism and the international acceptability of our food exports.

International constraints on emissions: New Zealand has signed international conventions and protocols on protection of the ozone layer and on climate change. These already restrict emissions of various ozone depleting substances and are expected to do so for greenhouse gases from 2008 onward. There is increasing international pressure for more specific protocols on greenhouse gases, including methane and nitrous oxide resulting from agricultural activities. To safeguard our national interests during negotiations we need to understand and quantify national sources and sinks for these greenhouse gases, as well as the effects of changing land use and forestry on our national carbon dioxide budget. We also need to understand the operation and impacts of possible financial instruments and voluntary programs for encouraging emission reductions. The complexity of New Zealand's national emission inventory, relative to most developed countries where industrial carbon dioxide emissions predominate, will make it more difficult to demonstrate compliance with international protocols. Observations of greenhouse gases in the air over New Zealand will need to be closely linked to studies of emission processes, both to validate the latter and possibly to satisfy international standards.

4.0 Goals and Outcomes

Goal 1: Documenting and understanding our atmosphere and climate.

A comprehensive understanding of atmospheric and climate processes in our region is needed as a basis for addressing the other goals in this section. Our climate responds to ocean circulations, ocean-atmosphere and land-atmosphere exchanges, as well as to atmospheric processes. Systematic observations of weather, climate and ocean parameters are needed as a basis for weather and climate prediction and research, for tracking climate variability and change, and to provide information for a wide range of design, planning and investment decisions. These knowledge requirements extend beyond the New Zealand mainland to the Ross Dependency and to the South Pacific islands with which New Zealand maintains close relationships. Collaboration in international research and monitoring programmes is essential, as we cannot develop the necessary knowledge on our own.

Outcomes:

- Accessible databases of climate and weather data for the New Zealand and Ross Dependency regions, based on comprehensive observing networks. Databases of related parameters such as river flows, ocean temperature and sea level.
- Documentation of current and past climate[2] variations and trends in our region, and understanding of the climate system dynamics (atmosphere, ocean and atmosphere – ocean) which determine them.
- Detailed knowledge of the physical processes which influence weather and climate over New Zealand, the southwest Pacific and the Ross Dependency, including cloud and precipitation physics, ocean-atmosphere exchange, terrain influences and land-atmosphere exchange.
- Detailed knowledge of the atmospheric chemistry and pollutant transport from the north which control greenhouse gases and stratospheric ozone in our region, of marine processes controlling aerosols, and regional emissions affecting air quality.
- A scientifically based understanding of the variability and likely future change in the New Zealand atmosphere and climate system.

Goal 2: Reducing hazards and improving opportunities through improved forecasts and information.

Weather and climate research results become useful to industries and to the public when they are incorporated in weather forecasts or climate outlooks, and applied to provide guidance about risks and opportunities (e.g. return frequencies for droughts or hazardous floods, projections of future sea levels, design information for wind energy systems). Forecasts, outlooks and guidance may reach beyond the weather into "downstream effects" (e.g. flood flows, volcanic ash dispersal, changes in suitable areas for horticulture under climate change). Such downstream guidance will require better information about sensitivity and vulnerability to climate of natural ecosystems, managed ecosystems, socio-economic activities and health. Climate data for specific locations is needed for a wide range of design and planning tasks and investment decisions. This often requires methods for inferring climate parameters at a location where there are no measurements, using data from other locations.

[2] Including paleoclimate

Outcomes

- Validated regional weather and climate models which incorporate atmosphere and climate knowledge and assimilate state-of-the-art atmospheric and oceanic observations.
- Validated add-on models for simulating downstream effects.
- Improved forecasts of weather, and of weather-sensitive parameters.
- A climate monitoring, assessment and prediction system providing current information and seasonal outlooks to farmers and climate sensitive industries.
- Delivery systems which meet user needs.
- Readily accessible climate information and advice for design, planning and investment decisions, including guidance about the effects of climate shifts and changes on the frequency of extreme events.
- A knowledge base for planners, policy developers and modellers about the sensitivity and vulnerability of biophysical, social and economic systems to climate variability and change.
- Increased resilience to climate fluctuations, greater sophistication in risk management, and greater adaptability to longer term changes in climate.

Goal 3: Keeping New Zealand's air clean and clear.

Maintaining a clear non-polluting atmosphere requires ready access by developers, planners and regional councils to tools and information for ensuring emissions are adequately controlled.

Outcomes

- Quality controlled time-series of urban and rural air quality and visibility observations, for monitoring the state of the environment and identifying problem areas.
- Validated models for simulating and predicting regional and local air quality and visibility.
- Accurate projections of the impact of pollutant emissions from new developments in both rural and urban areas.
- Readily accessible data and science-based advice for resource management and for minimising impacts of industrial, agricultural and urban development on air quality.

Goal 4: Sustainable policies for protecting the global atmosphere.

Politicians, policy developers, industries and the public need the best possible science-based information on our greenhouse gas emissions, our likely future climate and UV levels, and the impacts of likely changes. This will facilitate sensible decisions about national policy on climate change. It will help our representatives negotiate appropriate actions for protecting global (and New Zealand) climate in international conventions, while ensuring constraints on emissions do not unduly impact on our farmers, industry and economy. Such knowledge will also facilitate adaptation to unavoidable changes.

Outcomes

- Scenarios for future New Zealand climate consistent with the best information available world wide and including all relevant regional factors.
- Reduced uncertainty in projections of biophysical and socioeconomic impacts in the New Zealand region arising from changes in the climate system.
- Validated models of regional atmospheric transport and transformations of greenhouse gases, aerosols and ozone, and projections of future changes in background air quality.
- Detailed knowledge of sources and sinks of New Zealand's major greenhouse gases, including methane and nitrous oxide, and of the effects of changing land use and forestry on our national carbon dioxide budget.
- The ability to demonstrate compliance with all international standards on trace gas emissions, and the export of greenhouse gas management technologies to other agricultural countries.
- Knowledge and techniques for adapting to climate change.
- Planners, policy developers, convention negotiators, managers and a general public who are well informed on climate change matters.

5.0 Competencies

Science competencies required to achieve the goals outlined above include meteorologists, climatologists, mathematicians, physicists, oceanographers, atmospheric chemists, biogeochemists, geographers, statisticians, paleoclimatologists, remote sensing specialists and hydrologists. Skills in developing, adapting and implementing computer models, and skills in equipment and measurement will be important.

Measurements and analysis, particularly in atmospheric chemistry and oceanography, require sophisticated equipment and access to observing platforms such as ships and aircraft. Weather, climate and atmospheric chemistry modelling are making increasing demands on computing. Stable, long term observing networks as well as satellite data sets are needed for the research identified in this strategy and for monitoring variability and long term changes in the climate system.

Applications of weather and climate information and assessment of the impacts of climate variability and change require interaction with other disciplines. These include ecologists, agricultural and forestry scientists, fisheries scientists, economists and social scientists. Technical skills will be needed for linking models of weather sensitive systems to atmospheric models, and for producing and delivering the resultant information in suitable form to users.

Skills in identifying user needs, in publicising research outcomes, and in developing and marketing the resulting information, products and services will be vital.

6.0 Achieving the Outcomes

Action and investments are required now from a number of organizations and sectors to put New Zealand on the track to achieving the "2020 outcomes" identified in

Section 4. Roles for key players are identified below, and broader issues of maintaining skill bases and fostering international collaboration are addressed.

6.1 Funders, Providers and Users

Public Good Science Fund. Predominantly invest in:

- A portfolio of research and of observation networks for determining and understanding regional weather and climate[3] patterns and processes, air quality, greenhouse gas sources and sinks, sensitivities of natural and managed systems to climate, and impacts of climate variability and change .
- Development of models and technology which synthesise and apply this knowledge, improve weather and climate predictions, and facilitate mitigation and adaptation strategies.

To ensure efficient delivery of results, funding to research providers must be sufficient to allow continued investment in the necessary staff development and technology. Technology demands will include increasing use of satellites, high technology physical and chemical measurements, increasing automation, and increasingly powerful computer systems.

Marsden Fund: Support high-quality "curiosity driven" research.

Science Providers[4]: Work closely with weather service providers, national and regional government policy developers and planners and other users, to identify research needs and opportunities. Develop appropriate portfolios for PGSF and other funders, and deliver the required research outcomes, technology transfer and practical applications. Invest in staff, equipment, observation networks, databases and information delivery systems. Strengthen international links.

Providers of weather and climate services[5]: Provide forecasts, outlooks, information and advice to users, and low cost public access to data. Make research requirements known, invest in applications development including collaboration with science providers, develop delivery systems to meet user needs, actively market services.

Users of weather and climate research: Regional councils, government departments, agribusiness, farmers, producer boards, energy corporates, transport and tourism providers, roading agencies, insurance companies, economists, engineering consultants, air quality consultants, industry, agriculture: Make requirements known, and seek advice when it will improve decision making. Invest in systematic observations (e.g air quality, river flows) and support the National Cooperative Climate Network. Invest in development of relevant applications.

6.2 Government Departments

Because weather and climate affect all New Zealanders, the government has a role in providing certain public good services. Contracts for a hazardous weather warning

[3] including ocean as well as atmospheric processes, paleoclimate as well as current climate
[4] includes research institutes, universities, private research providers
[5] In some cases, the same organization might provide both science and services

service, and for the core weather observations to support this are in place, currently administered by the Ministry of Transport. However there is no equivalent arrangement for seasonal climate assessment and prediction, and no government department takes prime responsibility for policy in this area. This weakness was identified at the recent El Niño workshop (Appendix A), and must be addressed to achieve some of the Goal 2 outcomes.

Government departments (e.g. MFE, MFAT, the Treasury, MAF, DOC, Ministry of Commerce) are users of climate information in their policy development and economic forecasting roles. Departments with particular contributions to make to the foresight outcomes in this document include:

Ministry for the Environment: Ensure appropriate science advice is sought as input to climate change policy decisions and reporting. Ensure appropriate long term monitoring of climate, sea level and emissions is undertaken ("environmental indicators" programme). Encourage investment from Sustainable Management Fund on appropriate climate and air quality related work.

Ministry of Research, Science and Technology: Support New Zealand involvement in meetings to develop international collaboration. Coordinate New Zealand input to Intergovernmental Panel on Climate Change (IPCC) science assessments. Encourage Government Departments to use climate advice in policy development. Identify a home for climate issues in Government.

Ministry of Foreign Affairs and Trade: Ensure appropriate science advice is sought for formulation of New Zealand's position in international negotiations on atmosphere and climate issues (including climate change and ozone depletion). Consult with science providers over any new science monitoring or research requirements likely to arise out of international agreements, and assist in ensuring funding mechanisms are developed to cover such requirements.

6.3 Skills, Education and Training

Science and service providers: Support and encourage staff to gain new knowledge and skills as priorities and user demands change.

Education Providers: Train students in core science skills, collaborate with CRIs and service providers to develop technical, undergraduate and postgraduate training to meet needs. Foster enthusiasm for science and research.

6.4 Liaison Mechanisms and International Collaboration

Weather forecasts, predictions of climate fluctuations such as El Niño related droughts, climate change detection and prediction, and improvements in all these fields depend on international collaboration in research and systematic observations. Organizations and programmes of particular importance include the World Meteorological Organization (WMO), the World Climate Research Programme (WCRP) and its Climate Variability and Predictability Project (CLIVAR), the Global Climate Observing System (GCOS), the International Geosphere Biosphere Programme (IGBP), and the Intergovernmental Panel on Climate Change (IPCC).

The outcomes listed in this strategy also depend on interaction and collaboration between many players in the weather and climate sector. Important national and international coordination responsibilities are listed below.

Royal Society of New Zealand: Maintain links to international programmes including the WCRP, CLIVAR, and IGBP. Sponsor workshops for users and scientists on climate and climate change related matters.

National Science Strategy Committee for Climate Change: Advise FRST and government departments on climate change research needs and priorities, foster liaison between providers and users of climate change information.

Meteorological Society: Sponsor conferences and workshops which bring together researchers, providers and users of weather and climate services.

Clean Air Society of Australia and New Zealand: Sponsor conferences and workshops which bring together researchers, providers and users of air quality services.

Permanent Representative to World Meteorological Organization (Meteorological Service): Maintain international links necessary for operational weather forecasting, keep other sector players informed of relevant WMO developments and activities.

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[3] NSS Committee for Climate Change, 1997: Industry research priorities for climate change; seminar proceedings. *Misc Series 41*, Royal Society of New Zealand.

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[8] Basher, R.E., 1998: The 1997/98 El Niño Event: Impacts, Responses and Outlook for New Zealand. Report No. 73, Ministry of Research, Science and Technology, Wellington.
[9] The Insurance Council of New Zealand, 1997: Insurance Industry Payouts For Disasters. Table provided by the Insurance Council.

APPENDIX 1: Workshop Report: The 1997/98 El Niño – Lessons and Opportunities for the Future.

The purpose of this workshop was to address how to better handle El Niño events and other climatic fluctuations in future. The Workshop was hosted by the Royal Society's New Zealand Climate Committee on 21 October 1998. It attracted a wide range of participants from industry, government and environmental organisations, including farmer representatives, rural sector consultants, electricity managers, government policy analysts, climate specialists, the Parliamentary Commissioner for the Environment, and the Chair of the National Science Stategy Committee for Climate Change. The Hon Doug Kidd, Speaker of the House and MP for drought-affected Kaikoura, gave the opening address.

The workshop included a breakout session on "Vision for the year 2010". Key points made during this session and the plenary discussions included:

- Events like the recent El Niño drought have major economic, environmental and social impacts on New Zealand, especially in rural areas. The farm gate cost of the 97/98 El Niño was estimated at over $400M, multiplying to a total national cost of about one billion dollars. This does not include the environmental costs.

- There is evidence that the frequency of El Niño events has increased over the last two decades, and there is concern that climate change might lead to greater climate variability and more frequent extremes (like droughts) in future. Another drought and/or El Niño event is highly likely to occur within a few years.

- Climate assessments and predictions are required by a wide range of stakeholders, including agriculture, electricity, financial services, water and environmental services, and infrastructure providers. Climate information is of growing importance to the agricultural and horticulture sector, where market demands are tightening and operating buffers and margins are becoming smaller.

- Scientific knowledge at present allows prediction of the general evolution and broad impacts of El Niño events several months ahead, but not of the different monthly and regional characteristics of each event. Predictions of the 97/98 drought were broadly correct at the general level and were acted on by many farmers.

- The scientific knowledge and detailed climatic information needed to understand and manage drought by rural (and other) communities is not readily or inexpensively available. User needs and expectations will increase - more will be expected of science, and increasingly relevant and accurate information will be demanded.

- Better knowledge and information is needed on how past El Niño droughts have affected agriculture, the environment and the economy, on methods for adapting to climate hazards and increasing resilience, and on how individuals and industries have coped with drought. A systematic assessment and debriefing on the 97/98 drought should be undertaken.

- Better mechanisms are needed to ensure that climate science and information are accessed by government agencies and incorporated into advice to government, for example for use in GDP forecasting and rural management. Suggestions were made that the government's response to the plight of the rural drought stricken areas was too constrained, and that decision management in industry, insurance could have been improved.

- The essential role of climate data networks and databases and underpining research was recognised. Research is needed to improve climate prediction methods and to identify downstream impact sensitivities and adaptation mechanisms. This must include collaboration in international studies. The Workshop felt there was considerable room for improvement in the communication and integration of research and data gathering into decision making.

- New Zealand needs an operational climate assessment and prediction system, to provide current information and seasonal outlooks and to promote their application and related applications research. Queensland's new Climate Application Centre was quoted as a possible model. It was agreed that public funding for this system was required, owing to the widespread impact of El Niños and drought on communities, on the environment and on the whole economy.

APPENDIX 2: Consultation

The initial draft of this strategy drew on reports from five workshops in which providers and users of atmosphere and climate information and services participated during the past three years, reports of the National Science Strategy Committee on Climate Change, and the Meteorological Society's policy document. It was placed on the Met Society's World Wide Web page and publicised through the Meteorological Society's newsletter and a link from the MoRST Foresight pages. Fifty paper copies were distributed to people from the electricity industry, farmers' organizations, the insurance industry, environmental organizations, government departments, regional councils, weather and climate service providers, and science providers.

A foresight perspective on adapting to natural climate variability and its impacts was discussed during the El Niño Workshop on 21 October (Appendix 1). This attracted forty participants from industry, government and environmental organisations, including farmer representatives, rural sector consultants, electricity managers, government policy analysts, climate specialists, the Parliamentary Commissioner for the Environment, the Chair of the National Science Stategy Committee for Climate Change, and the Speaker of the House of Representatives and MP for Kaikoura.

Written and oral responses to the first draft from people listed below, and comments from the El Niño workshop, were then used to revise the strategy document.

Dr Helen Anderson	Chief Scientific Advisor, Ministry of Research, Science and Technology; Board Member Transit New Zealand
Dr Reid Basher	NIWA; RSNZ NZ Climate Committee; Chair WMO Commission for Climatology Working Group on Climate Data
Mr Robin Brasell	ECNZ; NSS Committee on Climate Change
Dr Fred Davey	Institute of Geological and Nuclear Sciences
Ms Georgina Daw	NIWA
Mr Kit Divehall	Managing Director, Aon Re Worldwide, Auckland
Assoc Prof Blair Fitzharris	Geography Dept, University of Otago
Dr Ellen Forch	Manager Environmental Monitoring, Hawkes Bay Regional Council
Mr Gavin Fisher	President, Clean Air Society of New Zealand; NIWA
Dr Chris de Freitas	Division of Science and Technology, Tamaki Campus, Auckland University
Dr Don Grainger	Physics Dept, Canterbury University
Mr Paul Hargreaves	CEO, NIWA
Dr John Hickman	Ex-Director (Retired) of Meteorological Service
Dr John Kidson	NIWA; RSNZ New Zealand Climate Committee
Dr Andrew Laing	NIWA
Mr John Lumsden	CEO Meteorological Service of New Zealand; Permanent Representative to the World Meteorological Organization
Dr Martin Manning	NIWA; NSS Committee on Climate Change; RSNZ New Zealand Climate Committee
Dr Andrew Matthews	NIWA
Dr John Maunder	Climate and Climate Change Consultant

Mr Vince McBride	Acting Director, Environment Division, MFAT
Dr Richard McKenzie	NIWA
Ms Helen Plume	Ministry for the Environment
Dr Jim Salinger	NIWA; Vice President WMO Commission for Agricultural Meteorology
Mr Kevin Steel	Ministry of Agriculture and Forestry
Dr Kevin Tate	Landcare; NSS Climate Change Committee
Mr Tony Trewinnard	Blue Skies Weather and Climate Services
Mr Ian Whitehouse	Landcare