



International Climate Change Science: Australia's role, links and opportunities.

**A report prepared for the
Australian Greenhouse Office**

Australian Academy of Science

December 2003

This paper was prepared by the Australian Academy of Science with the help of Dr Michael Manton, Dr Gina Newton, Dr Michael Raupach, Mr Marty Young, Mr Chris Warris, and Dr John Zillman. The Academy also wishes to thank Professor Graham Farquhar and Dr Will Steffen for their helpful comments.

Professor Kurt Lambeck
Chair
Steering Committee

Table of Contents

1	International Climate Change Science and its Significance to Australia	4
	<i>Objective</i>	<i>4</i>
	<i>Methodology.....</i>	<i>4</i>
	<i>The Global Climate Change Scene- An Overview</i>	<i>4</i>
	<i>The Three Principle Areas of Climate Change Science.....</i>	<i>7</i>
	<i>Significance to Australia</i>	<i>9</i>
2	Alignment Considerations for Australia.....	9
	<i>Alignment with priorities in the IPCC (2001) Third Assessment Report.....</i>	<i>10</i>
	<i>Alignment with the Australian Greenhouse Science Programme Evaluation Report</i>	<i>12</i>
	<i>Alignment with priorities in the Climate Change Forward Strategy.....</i>	<i>14</i>
3	Australia's International Scientific Leverage.....	15
	<i>Inputs.....</i>	<i>16</i>
	<i>Outputs and Benefits</i>	<i>17</i>
4	Recommendations for Australia's International Role and Research.....	19
 Appendix I – Bibliometric Data		
Appendix II – The Sponsoring Organisations Involved in Global Climate Change		
Appendix III – Research Initiatives		
Appendix IV – Observation Initiatives		
Appendix V – Assessment Initiatives		
Appendix VI – Glossary of Acronyms		
Appendix VII – References		

1 International Climate Change Science and its Significance to Australia

Objective

The main objective of this report is to describe the international global climate change research scene and provide a preliminary overview of Australia's current engagement in the various programmes and projects at the international level. Such a preliminary audit may provide useful information with which to underpin decision-making regarding Australia's future involvement in international climate change research and administration. It may also assist with the identification of major gaps with regard to Australia's current participation in international climate change research and the strategic direction of that research. It should be recognised that this report represents a 'first pass' investigation and assessment and should be viewed as 'preliminary' in nature, i.e. it does not attempt to be 'all inclusive'. Notwithstanding these limitations, the recommendations represent sound and 'best available' advice.

Methodology

The report provides an assessment of the relationships and contribution of the international organisations and projects to an ongoing Australian Climate Change Science Programme. Focus is given to how these links and outcomes address the related climate change issues of major importance to Australia. This includes a description of how current linkages with the international projects comply with issues identified in the priorities and gaps identified in the *Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR)*, the *Evaluation of the Australian Greenhouse Science Programme (2002) Report* and the Australian Government's proposed *Climate Change Forward Strategy*. It is important to note that the report does not specifically capture the extensive but *informal* international links and collaborations of Australian scientists working in global climate change research. However, the extensive nature of these informal contributions can be demonstrated by the preliminary bibliometric analyses given in [Appendix I](#), which shows that, despite our relatively small research population, Australia contributes some 5% of internationally published climate change science publications and has a strong record of publishing collaboratively with other nations.

The Global Climate Change Scene- An Overview

The challenge of observing, understanding and predicting anthropogenic climate change in a manner that will support policy responses is beyond the capability of any one nation. Therefore the challenge is being addressed through formal (as well as informal) international programmes. The multitude of international agencies, programmes, projects, systems, committees and relationships involved in global climate change represents a large and complex interwoven web. **Figure 1** represents a 'simplified' view of the hierarchical relationships between the numerous inter-governmental and non-governmental programmes and the various related global climate change projects. It serves as an indicative overview of the international scene

and its various linkages and interdependencies. Although there are a myriad of bilateral and multilateral programmes dealing with global and regional climate change science, a major international effort is carried out under the auspices of a series of global programmes sponsored at both the inter-governmental and non-governmental levels.

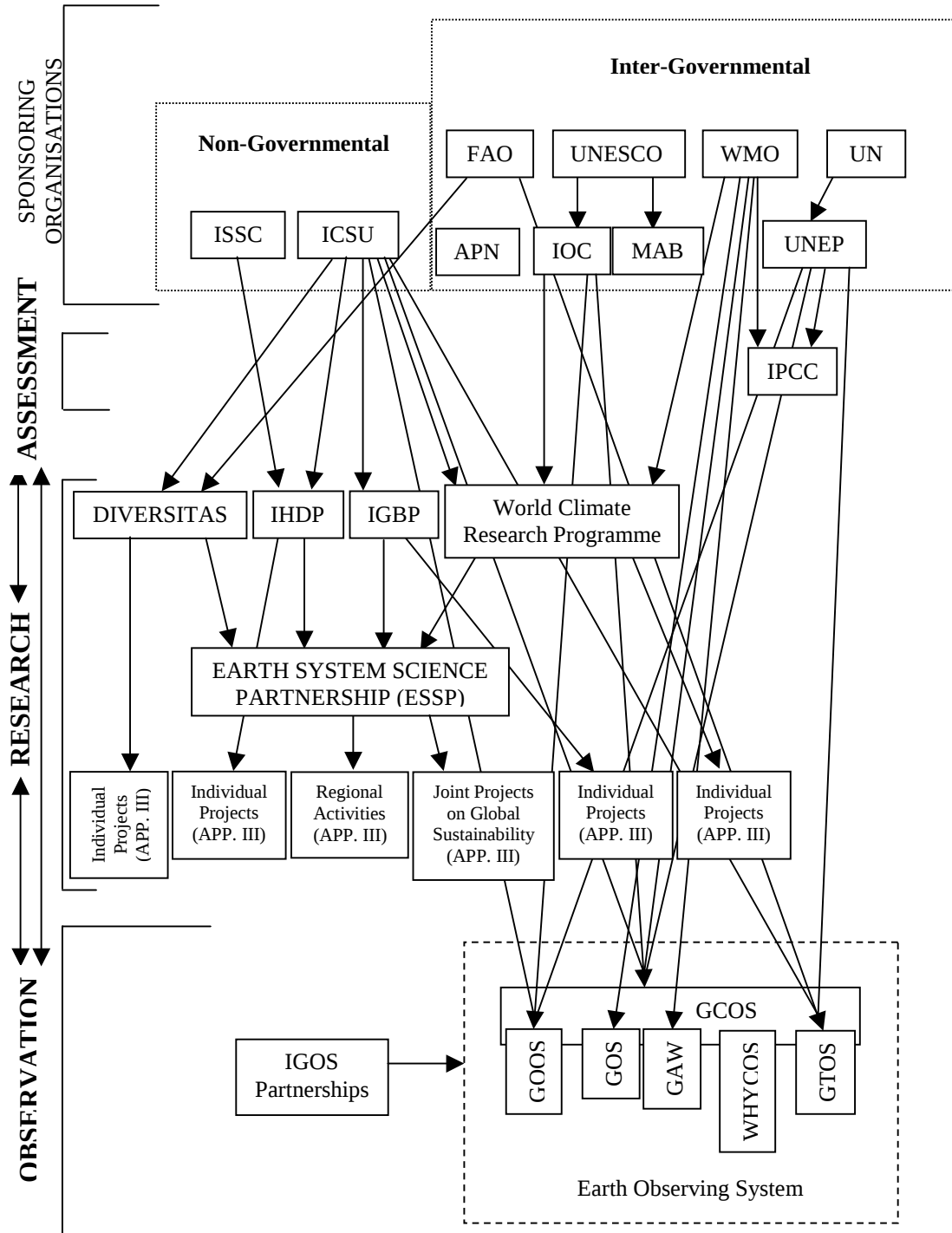


Figure 1: Flowchart of the general structure of the various international programmes.

Appendix II provides a more detailed description of the various ‘umbrella’ (sponsoring) organisations and the global climate change programmes and projects supported and/or operated by them, as well as Australia’s level of involvement in each.

At the non-governmental level these ‘umbrella’ (or sponsoring) organisations are the:

- International Social Sciences Council (ISSC), and
- International Council for Science (ICSU)

At the inter-governmental level they include the:

- World Meteorological Organisation (WMO)
- United Nations Educational, Scientific and Cultural Organisation (UNESCO)
 - Intergovernmental Oceanographic Commission (IOC)
 - Man and The Biosphere (MAB)
- United Nations Environment Programme (UNEP)
- Asia-Pacific Network for Global Change Research (APN)
- Food and Agriculture Organisation (FAO) of the United Nations (*Note: FAO will not be detailed in this document as it does not operate any direct global climate change programmes*).

Non-governmental organisations

The sponsoring organisation ICSU has a mission to “identify and address major issues of importance to science and society, by mobilising the resources and knowledge of the international scientific community”. ICSU achieves this mainly through the development and implementation of international interdisciplinary research programmes. Of primary importance to the global climate change research scene are their current major programmes, the International Geosphere-Biosphere Programme (IGBP) and the World Climate Research Programme (WCRP).

The WCRP was established in 1980 following the First World Climate Conference in 1979, jointly sponsored by the World Meteorological Organisation (WMO) and the ICSU. The IGBP was set up in 1986 by ICSU to provide the integration needed to build a common knowledge base of global environmental change. The actual research is undertaken by research groups and institutions around the world, but coordinated and integrated by the IGBP and the WCRP to provide a coherent programme meeting agreed priority objectives.

An important recent initiative is the Earth System Science Partnership (ESSP) which involves the joining of IGBP and WCRP with the International Human Dimensions Programme on Global Environmental Change (IHDP – co-sponsored by ICSU and the International Social Science Council (ISSC)) and DIVERSITAS (an international programme of biodiversity science – co-sponsored by ICSU and FAO in particular). This new partnership aims to take a much more collaborative and integrative approach to global change and climate change research. The joint projects address four fundamental and interdisciplinary challenges for a sustainable environment. These are (1) the carbon cycle, addressed by the Global Carbon Project (GCP); (2) the impacts of global environmental change on food provision systems, addressed by the Global Environmental Change and Food Systems project (GECAFS); (3) the way in which humans are changing the global water cycle, addressed by the Global Water System

Project (GWSP); and (4) health impacts of global environmental change, addressed by an incipient ESSP project. For further details, see Appendix III.

Inter-governmental organisations

At the inter-governmental level the main umbrella organisations are the World Meteorological Organisation (WMO), UNESCO, UNEP and APN. Importantly, Australia has membership of WMO with strong involvement by the Australian Bureau of Meteorology (BOM) and the CSIRO. Australia also has membership of UNESCO's Intergovernmental Oceanographic Commission (IOC) and Man and the Biosphere (MAB). In addition, Australia serves as a leading member of the 21 countries of the Asia-Pacific Network for Global Change Research (APN). Although Australia is not currently a member state of the governing council of UNEP, it does participate in many climate-related activities of this UN programme.

The Three Principle Areas of Climate Change Science

The study of climate change is undertaken in three principal areas: **observation**, **research** and **assessment** – with strong linkages between each area (see **Figure 1**). International climate change science involves the ongoing **observation** and monitoring of the state of the global climate system, **research** into the mechanisms and predictability of climate variability and human induced change, and **assessment** of the contemporary state of knowledge of the nature, causes and possible future patterns of climate change. The various observation, research and assessment mechanisms are linked to and supported by a number of national, regional and global coordination and consultative mechanisms and national agencies whose total climate change related scientific effort exceeds an estimated \$US5 billion per annum. The various programmes and projects under these three areas are detailed for: Observation in Appendix III, Research in Appendix IV and Assessment in Appendix V.

Assessment

Regarding the assessment area, the major international mechanism for taking stock of the current state of knowledge of climate change science is the Intergovernmental Panel on Climate Change (**IPCC**), which is sponsored jointly by the WMO and UNEP. IPCC is the scientific body of most immediate relevance to global-scale greenhouse policy. It does not direct research initiatives, but rather, on the basis of peer-reviewed scientific literature, carries out an internationally coordinated scientific **assessment** of the magnitude, timing and potential impacts of climate change, and possible response strategies (Chapter 7, *Climate Activities in Australia 2001*). The IPCC provides advice to the Conference of Parties to the UN Framework Convention on Climate Change; it has established beyond reasonable doubt that the anthropogenic greenhouse effect is occurring, and that mitigation and adaptation are of primary importance, requiring a global response. Australia participates in the formal processes of IPCC and plays a significant role in the associated activities, such as conducting research that is included in the assessments, writing contributions for chapters of the reports, compiling the chapters, convening the groups that compile the chapters, and reviewing the assessments.

Research

The four major international research programmes (ie. IGBP, WCRP, IHDP, DIVERSITAS) each involve a substantial number of major research projects, some carried out under joint sponsorship with other programmes and agencies and some carried out on an individual project basis. These major programmes have been brought together to address four fundamental and interdisciplinary aspects for a sustainable environment. Together they form one of the major international coordinated research efforts on global climate change: The Earth System Science Partnership (ESSP), which focuses on the integrated study of the Earth System via collaboration among existing projects/activities of the four constituent programmes, the changes that are occurring to the System and the implications of these changes for global sustainability. The level of Australia's engagement in the research projects conducted individually by the four organisations and jointly under the ESSP is listed in [Appendix III](#).

Observation

The major international observational programme is known as the Global Climate Observing System (**GCOS**) which is built on, and cuts across, the climate relevant components of the various global operational observational systems for the **ocean** (Global Ocean Observing System, **GOOS**), **atmosphere** (World Weather Watch Global Observing System, **WWW-GOS**; and Global Atmosphere Watch, **WWW-GAW**) and **land surface** (Global Terrestrial Observing System, **GTOS** and World Hydrological Cycle Observing System, **WHYCOS**, in particular). GCOS, GOOS and GTOS are all co-sponsored by the WMO, IOC, UNEP and ICSU. GTOS is also co-sponsored by the FAO. [Appendix IV](#) details the various climate change initiatives under the backing of the global observational networks and indicates the extent of Australia's involvement in each. [Appendix V](#) lists the various organisations involved in assessment of the global climate.

A Leveraged Approach

The structure of the network of international organisations, agencies, programmes and projects serves to ensure effective linkages between them without significant overlap or redundancy. For example, GCOS draws on the climate relevant components of the global observing system (eg, GOOS, WWW-GOS, WWW-GAW, GTOS and WHYCOS), with each initiative proving support and benefit to the other. Likewise, collaboration among the existing projects/activities of the IGBP, WCRP, IHDP and DIVERSITAS helps drive the Earth Science System Partnership towards its goal of integrating the study of the Earth's climate and climate change, and the implications of that change. While consideration of the 'formal' bilateral agreements between the various governments and organisations was outside the scope of this report, the Australia-US Climate Action Partnership is briefly covered.

Significance to Australia

Australia is expected to face considerable challenges from global and climate change with concerns of increased drought impacts on agriculture, less secure water supplies in some regions, and increased vulnerability of unique ecosystems. Significantly, Australia's high profile in international climate change science and research ensures:

- Australia's research performance is at international best practice;
- Australia's influence on the direction and approach of large scale international research;
- increased opportunities for collaboration and access to relevant knowledge and data (often at considerable cost saving);
- enhanced capacity for Australia to develop regional climate change projections for adaptation planning;
- adequate coverage of observational information in the southern hemisphere; and
- Australia's scientific and policy positions are visible in many international fora.

Australian scientists play an active and *crucial* role in research on climate change and climate variability, and our geographical location makes Australia the leader in greenhouse research in the Southern Hemisphere (Green and MacRae, 2002). The small population yet large landmass of Australia means that we benefit substantially from active participation in such programmes. In particular, Australia gains from the compounding effect of combining our resources collaboratively with those of other countries to obtain access to knowledge and data. Moreover, active participation means that Australia has significant influence on the direction and outcome of international programmes. This influence is instrumental in ensuring that global observing systems have adequate coverage in the southern hemisphere, that we gain access to global data sets, and that international programmes include a focus on southern hemisphere problems and issues.

Australian scientists have very prominent and influential roles in both the IGBP and the WCRP, proportionally well in excess of other participating countries (Green and MacRae, 2002). Over the past decade, Australian membership with global science programmes has resulted in significant international resources being directed at climate change and global change projects in our region. Through our participation in these programmes, Australian expertise contributes to the global research and policy agenda, and in turn, international research and expertise are made available to our policy and research programmes.

2 Alignment Considerations for Australia

In determining the value and relevance of Australia's role and participation in international climate change research it is necessary to consider the latest findings and evaluations in both the international and domestic science arenas and how these mesh with current strategic policy directions of Government. An assessment was undertaken of the recent documents related to each aspect, namely, the *IPCC (2002) Third Assessment Report*, the report *Evaluation of the Australian Greenhouse Science*

Programme, 2000-2003, and the current form (August 2002) of Government's proposed Climate Change Forward Strategy.

Alignment with priorities in the IPCC (2001) Third Assessment Report

Relevant Major Findings of TAR

The *IPCC (2001) Third Assessment Report (TAR)* provides an assessment of new scientific information and evidence as an input for policymakers in their determination of what constitutes “dangerous anthropogenic interference with the climate system”. It states that “there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities”. It also states that “it is very likely that the 20th century warming has contributed significantly to the observed sea-level rise, through thermal expansion of seawater and widespread loss of land ice”.

Importantly IPCC TAR provides new **projections** of:

- future concentrations of greenhouse gases in the atmosphere;
- global and regional patterns of changes and rates of change in temperature, rainfall, and sea level; and
- changes in extreme climate events.

It examines possibilities for abrupt and irreversible changes in ocean circulation and the major ice sheets. The report also provides an assessment of the biophysical and socio-economic **impacts** of climate change, with regard to:

- risks to unique and threatened systems;
- risks associated with extreme weather events;
- the distribution of impacts;
- aggregate impacts; and
- risks of large-scale, high-impact events.

In addition, TAR provides an assessment of the potential for achieving a broad range of levels of greenhouse gas concentrations in the atmosphere through **mitigation**, and information about how **adaptation** can reduce vulnerability. Australian scientists have a significant role in the development of TAR.

Key Uncertainties and Gaps from TAR

An integrated assessment (including exposure, sensitivity, risk management, adaptability and the cost of adaptability, vulnerability, and sustainable development) of the contributions of natural and human systems to climate change is regarded as vital in the *IPCC TAR*. Also noted is the need for more research to improve the ability to detect, attribute and understand climate change, to reduce uncertainties and to project future climate changes.

The key uncertainties regarding climate change and attribution as determined by the *IPCC TAR* were given as: magnitude and character of natural climate variability; climate forcings due to natural factors and anthropogenic aerosols (particularly indirect effects); and relating regional trends to anthropogenic climate change. Inadequate emission scenarios for ozone and aerosol precursors and factors in modelling of the carbon cycle, including effects of climate feedbacks, were also regarded as key uncertainties. Other gaps highlighted include:

Ocean circulation patterns

- Models predict that increasing atmospheric concentrations of greenhouse gases will result in changes in daily, seasonal, inter-annual, and decadal variability. However, there is no clear agreement concerning changes in frequency or structure of naturally occurring atmosphere-ocean circulation patterns.

Regional scale patterns

- There is insufficient information on how very small-scale extreme weather phenomena (eg. thunderstorms, lightning, hailstorms, etc.) may change.

Ecosystem-based patterns/issues

- Some of the predicted abrupt/non-linear changes in physical and biological systems and in the natural sources and sinks of greenhouse gases could be irreversible, but there is an incomplete understanding of some of the underlying processes.

Socio-economic assessment and adaptation issues

- Numerous possible adaptation options for responding to climate change have been identified that can reduce adverse and enhance beneficial impacts of climate change, but will incur costs. Quantitative evaluation of their benefits and costs and how they vary across regions and entities is incomplete.
- Assessing and predicting response of ecological, social, and economic systems to the combined effect of climate change and other stresses such as land-use change, local pollution, etc.
- Development and transfer of environmentally sound technologies could play a critical role in reducing the cost of stabilising greenhouse gas concentrations.

Australian Links

It is clear that Australia and the global community are working towards implementing projects/policies to reduce the major gaps in knowledge identified in TAR. Australia is committed to reducing domestic emissions, and to developing a more comprehensive global response to climate change. Further, Australia is developing a *Climate Change Forward Strategy* to guide these commitments, while continuing to undertake domestic and international action, including the establishment of a network of bilateral partnerships.

Specifically, there is some alignment of Theme 3 (Future trajectories and carbon management) of the Global Carbon Project (GCP) Science Framework (under the auspice of the ESSP Joint Projects) with the priorities outlined by IPCC TAR Working Group III. In addition, GCP Themes 1 and 2 contribute to the priorities outlined by Working Group I and II with regard to improving carbon-climate models, constraining carbon sources and sinks (in space and time) and identifying the drivers of those fluxes. The GCP is run from a coordinating office in Canberra, and is supported through the Australian Greenhouse Science Programme.

Importantly, the IPCC TAR identified the decline of observational networks as an area of serious concern and stated, “Unless networks are significantly improved, it may be

difficult or impossible to detect climate change in many areas of the globe.” The continuing development of an improved integrated global observation network for the sustained observation and modelling of the global climate (eg, GOOS, IGOS, and IOGOOS for the implementation of GOOS in the Indian Ocean) is addressing this issue through an international effort. Global climate change research depends critically upon the availability of global observations. Scientists in the Australian Bureau of Meteorology Research Centre have been instrumental in the development of the networks needed for the Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS).

The TAR acknowledges that, with respect to climate change, palaeoenvironmental reconstructions are important for an insight into what natural changes have occurred and possibly might recur, prior to the impact of anthropogenic influences. Two of the core international projects under the auspice of IGBP, ie. Past Global Changes (**PAGES**) and Global Analysis, Interpretation and Modelling (**GAIM**), focus on a whole system perspective, from the past into the future, in order to predict what changes are possible or probable. Australian contributions to PAGES are substantial and are conducted predominately by University researchers. However, this contribution may not be widely recognised. Currently, Australia provides no direct funding to PAGES, but does subscribe to IGBP, and GAIM is supported by the Australian Research Council.

The importance of Antarctica and the Southern Ocean in global climate change cannot be overstated. The IPCC TAR highlighted the critical shortage of data from polar regions, and in data required for quantitative assessment of climate extremes on the global scale. Australia has direct involvement in research in Antarctica at the international as well as national level that is relevant to climate change. The international projects undertaking Antarctic research include Scientific Committee on Antarctic Research (**SCAR**- for the initiation, promotion and coordination of scientific research in Antarctica – of ICSU), and PAGES Southern Hemisphere Glacial Chronology Project, which investigates various aspects of the glacial cycles in the Southern Hemisphere. Australia is a full member of SCAR, with an active scientific research programme.

Alignment with the Australian Greenhouse Science Programme Evaluation Report

The report, *Evaluation of the Australian Greenhouse Science Programme* (Green and MacRae 2002) provides a comprehensive review of the effectiveness, efficiency, appropriateness and prospects regarding Australia’s climate change science. As such, the report succinctly articulates key research gaps and opportunities. Many of these relate to the research required to further build upon Australia’s already strong involvement in global climate change science. Many are also aligned with the findings of the *IPCC TAR*, particularly regarding the need for improved understanding of climate change impacts, mitigation and adaptation strategies, and the need for close association between Governments and Industries. Importantly, the evaluation report recognised that Australia gains considerable leverage from its investment in international greenhouse science and technology activities.

Adaptation Assessment

An important focus for future research identified by the Green and MacRae (2002) report is that of impacts, adaptation and socio-economic assessments. As there is strong evidence for continued climate change, early responses to these changes are vital in minimising ecosystem and economic damage/losses.

Ecosystem Approach

An important gap highlighted by the evaluation was the terrestrial biosphere links between climate variability and ecosystem dynamics; the report suggested that scientific knowledge be sought on ecosystem adaptation to climate change. One international programme dedicated to this research is DIVERSITAS, which is “an international global environmental change research programme” (ref. www.diversitas-international.org). As mentioned previously, together with IGBP, IHDP and WCRP, DIVERSITAS forms the Earth System Science Partnership. Australian scientists contribute to various workshops, reports and other activities of DIVERSITAS and Australia provides subscriptions indirectly through ICSU, IUBS (International Union of Biological Sciences) and IUMS (International Union of Microbiological Societies).

Trends and Modelling

A potentially new commitment for Australia, identified by the Green and MacRae (2002) report, is research leading to greater understanding of the potential impacts and adaptation strategies of climate change on natural and managed systems (eg. the effects of ENSO). While this research is regionally important, it does require a global effort for adequate assessment. Past impacts, present trends and model predictions are complementary and necessary in trying to understand possible future trends and extreme events, as is knowledge of the natural variability in global climate change to provide the knowledge required to check the climate models. More work needs to be conducted in understanding the palaeoenvironment (glacial/interglacial cycles, natural progressional events etc) in order to more accurately predict the future trends in climate change. As previously mentioned, Australia is involved (directly and indirectly) in PAGES and GAIM, which address these issues. The Australian Greenhouse Science Programme is providing the foundation for the development of representative, coupled climate models to improve regional simulations and knowledge of regional responses to global change, and also has a significant influence on the international research agenda through involvement in WCRP on natural climate variability.

Aerosol Research

The need for research into the oceanic extraction of greenhouse gases and aerosols of natural and anthropogenic origins is identified in the report. The Australia-US CAP and IGBP's IGAC both have projects covering these fields. The Green-MacRae (2002) review mentioned that recent results on the effects of aerosols as climate-forcing agents have greater climatic impacts than previously understood. This highlights the importance of increased research into this component of global change.

Southern and Indian Oceans Work

Australia has a special responsibility for climate-change related research and oceanic observation in Antarctica and in the Southern Oceans, and the oceans and seafloor around Australia—all are very significant in understanding processes and impacts of climate change. International initiatives such as Scientific Committee on Antarctic Research (SCAR of ICSU), World Ocean Circulation Experiment (WOCE of WCRP), Climate Variability and Predictability (CLIVAR of WCRP) and the Australia-US Climate Action Partnership (CAP) are involved in this component of climate change. There are no current Australian members on the scientific steering committee of WOCE, although funding is provided to WCRP, which operates the programme. Of the 15 working groups/panels run through CLIVAR, Australia is involved in ten. The implementation of the Indian Ocean Global Ocean Observing System (IOGOOS) is helping to increase the understanding of climate change and impacts through increasing the observational capacity in the Indian Ocean and adding to the global ocean observing system. Australian climate observations are integral components of the global observing systems and vital to the understanding of climate changes in the Southern Hemisphere.

Alignment with priorities in the Climate Change Forward Strategy

The Government's proposed (but to-date unreleased) *Climate Strategy Forward Strategy* (CCFS) has four key elements underpinning policy:

- striving for a more comprehensive global response to climate change;
- maintaining a strong and internationally competitive economy with lower greenhouse emissions;
- balancing flexibility with sufficient certainty in domestic policies to allow key decisions on investment, technology development and cost effectiveness to be made; and
- implementing policies and programmes that assist adaptation to the consequences of unavoidable climate change.

International research and observational collaborations provide the scientific underpinning to meeting these priorities. Australia has developed a world-class infrastructure for monitoring, analysing and responding to climate change. However, in order to implement policies and programmes directed at adaptation to unavoidable climate change, it is important that research be undertaken on:

- the likely impacts on Australia;
- how we can lessen those impacts; and
- what adaptation options exist.

Continued monitoring of the effects of activities such as agriculture and tourism on climate change is essential. Other important areas of study are natural systems such as water resources in the Murray Darling Basin. One such project is the Murray-Darling Basin Water Budget Project (MDB), which is a GEWEX Continental Scale Experiment (CSE) under the auspices of WCRP. It aims to enhance the capability of numerical weather prediction models to provide a real-time surface water budget over the Murray-Darling for application by water authorities. Australia is also involved at the

operational level in the System for Analysis, Research and Training (START), co-sponsored by IGBP, IHDP and WCRP, which conducts research on regional aspects of environmental change and assesses impacts and vulnerabilities to such changes.

Close involvement in all four joint projects under the auspice of the ESSP (GCP, GECAFS, GWSP and the developing health programme) is beneficial to a *Climate Change Forward Strategy*, as they contribute to knowledge and understanding of the impacts of climate change, both natural and anthropogenic. For example, the ESSP joint projects will develop generic adaptation strategies, which can be adapted to the needs of various countries/regions. Given the emphasis on adaptation in the CCFS, these joint projects are of direct relevance to Australia's capability to develop sound, scientifically based adaptation strategies.

Another demonstration is the Global Carbon Project (GCP), whose goal is to develop comprehensive, policy-relevant understanding of the global carbon cycle, encompassing its natural and human dimension and their interactions. GCP is managed from an office in Canberra (ie. collocated with the CSIRO Earth Observation Centre, Black Mountain) and this gives Australia the unique opportunity to determine the level of contributions to the international agenda on the carbon-climate-human coupled system, and positions Australia to directly benefit from the activities of the GCP. A key contribution of the GCP to the CCFS is through the goal 'striving for a more comprehensive global response to climate change' and 'implementing policies and programmes'. This is served by the GCP through:

- specific research activities on enhanced observations,
- the coupled carbon-climate-human system, and
- carbon management (especially the integration of mitigation and adaptation strategies in the context of the whole earth system).

The advice based on this work provides an underpinning role for the implementation of policies and programmes that assist adaptation to the consequences of unavoidable climate change – an integral component of the CCFS. Furthermore, the EPPS initiative provides Australia (ie. via its membership) with an opportunity to develop and apply its sustainability science expertise in areas of immediate relevance, such as the global carbon cycle, water resources, and food systems.

A long-term global effort is required to reduce greenhouse emissions. The Australia-US Climate Action Partnership (CAP), set up in February 2002, is working towards finding practical approaches dealing with climate change that will contribute to the reduction of greenhouse emissions globally. There is development of promising low emissions technologies in Australia, and there will be a strong focus on technology development in the CAP agreement with the US. In addition, Australia's involvement in the Asia-Pacific Network for Global Change Research (APN) potentially assists capacity building and developing country participation in long-term global environmental change work, and with strengthening links between the science communities and policy makers.

3 Australia's International Scientific Leverage

The recent evaluation of the Australian Greenhouse Science Programme (AGSP) 2000 - 2003 (Green and MacRae, 2002) provides clear demonstration of the effectiveness,

efficiency, appropriateness of, and prospects for, Australia's involvement with international climate change science:

Effectiveness

- Influence on internationally coordinated research programmes has strengthened the focus on areas of national interest, such as Australian ecosystems, Southern Ocean, and tropical aerosols.
- There has been leverage on observation systems into our regions of interest through active participation in global observing systems.
- Australia's scientific credibility in the international arena has enabled strong input into the IPCC assessments and subsequent international policy formulation.

Efficiency

- There has been substantial leverage of international scientific resources into our fields of interest for a modest investment.
- Influence on international scientific assessments for policy formulation is also high and serving our interests.

Appropriateness

- The modest resources provided by AGSP help to ensure that Australia's scientists engage in important and policy-defining international scientific fora.
- A further benefit of this investment is the formulation of strong partnerships between scientists and policy-makers.

Prospects

- There is ongoing international, collaborative science activity, in particular the IPCC, but also in the other programmes whose research underpins the IPCC results.
- With the focus moving strongly towards impacts and adaptation and socio-economic assessments, involvement in the international scene will continue to grow.

Inputs

The Australian contribution to this network of international activities is substantial, so it is appropriate to attempt assessment of national benefits accruing from this investment. It is not possible in the timeframe of this report to identify the magnitude of the outgoing contributions and the scope of the returns on a component-by-component basis (though information about the type and level of Australian involvement in individual projects is provided in Appendices II-V). Rather, the *generic* nature of Australia's contributions has been identified, together with the consequent benefits, with specific examples given where appropriate.

Australia contributes in three ways (*Note: figures are approximate figures based on best-available advice and much of Australia's current effort is unquantifiable*):

- *Financial contributions:* subscriptions to scientific unions IGBP, WCRP and SCOR total approximately \$80,000 per annum, with a further \$25,000 per annum to ICSU; \$120,000 for (2003-04) from the AGSP to the GCP (*Note: this Australian contribution to the GCP is matched by similar contributions from many other countries for other projects in ESSP and its constituent programmes*).
- *In-kind contributions by individual scientists:* through leadership (count say 20% of a full time position per role) and participation (count say 5% per role) in working groups and committees; this includes IPCC authorship roles etc.
- *Organisational contributions:* eg. The Australian Bureau of Meteorology contribution to the world meteorological observation network (estimates in the order of \$100 million per year), CSIRO contributions to atmospheric composition and ocean observation programmes especially in the southern hemisphere; AGO, ADD, ARC, ANSTO, the Universities and CRC's (*Note: at the time of writing the National Tidal Facility was in transition from Flinders University to BOM*).

Some specific examples of technical inputs to the international process are:

- the Australian component of world weather network;
- long-term atmospheric composition observations in the southern hemisphere (CO₂ and 120 other gases) from the Cape Grim atmospheric baseline station;
- Antarctic and Southern Ocean observations, including currents, temperatures, greenhouse gas exchanges (noting that Antarctica and the Southern Ocean are both major flywheels in the climate system and the carbon cycle, and a better understanding of their roles is required);
- observations of climate-relevant processes on land surfaces (water, energy and carbon cycles, fire, erosion and land use change), especially in subtropical savannah and semi-arid systems.

Outputs and Benefits

Australia's participation in global and regional programmes/projects such as listed above brings benefits to Australia and assists in making regional predictions. Improvements in regional climate predictions are essential in order to assess the risks associated with climate impacts and to develop policy responses through both adaptation and mitigation measures. Given these realities, Australia's major benefits from its contributions to international climate change science activities mainly accrue from better predictions at the global and regional scales, including both climate drift (changes in mean climate over decades) and changes in seasonal to decadal climate variability.

Most of Australia's international climate change science activities work toward global public good and/or defence of the global 'commons' (atmosphere, ocean, biodiversity) – which in turn translates to Australian public good. Some direct flow-back benefits for Australia are:

- more accurate weather and climate forecasts for the Australian region, through better access to global data;
- improved greenhouse impact assessment, allowing better adaptation for economic, environmental and social benefit;
- enhanced access to mitigation technology, options and markets, for economic, environmental and social benefit;

- greater access to global earth observation data (eg. high-level Australian participation in the recent Earth Observation Summit in the USA, which will redefine this activity; and access to European satellite data).
- enhanced scientific underpinning for climate policy, including climate change impact and risk assessment, adaptation strategies, mitigation strategies, and balancing effort in adaptation and mitigation.

As stated by the Green and MacRae (2002) report, “the evidence is clear that Australia is most influential in the international arena and benefits from its active and remarkably high profile in scientific steering committees. Furthermore, the modest investment which Australia makes to these activities is repaid in dollar terms through recovery of costs for attendance at meetings. Australia’s reputation and influence in the international arena stands very high, and it would be not to maintain this position.”

4 Recommendations for Australia's International Role and Research

1. Maintain International Contributions to Major Programmes:

Australia supports climate change research and observation through programs out of numerous institutions, including BOM, CSIRO, AAD and the universities. At this juncture it is not possible to estimate total expenditure, including in-kind contributions, on all climate-related activities by such institutions. However, the fraction contributed by Australia to ensure involvement with the international climate change science scene is insignificant in relation to the total research effort - yet the returns are considerable. The benefits and returns are many and at the research coal-face include the co-ordinated use of scarce and/or expensive resources (eg. shiptime) and making data and science available to a wider range of scientists nationally (such as those of different disciplines or without formal connections). In particular it is important for Australia to have an influential presence in the four international climate change programmes (IGBP, WCRP, IHDP and DIVERSITAS) that form the Earth System Science Partnership. This presence not only enhances the international reputation of Australian Science but also gives Australia an important voice in the development of international priorities in climate research. Concomitant to the value gained from international involvement is our dependence on a sound national database. It is vital to secure a consistent and underpinning system of ongoing, long-term national observations (such as that currently provided by Cape Grim and the laboratories that support its programmes) of past and present climate indicators.

2. Enhance Australian Participation in other International or Regional Programmes:

It seems strategically profitable for Australia to seek membership and involvement in other international and regional groupings so as to enhance Australia's influence in international planning and to increase its access to information and data sets. It is also recommended that an independent co-ordinating role for Australia in these groups is ensured. Three gaps in membership, or in the level of involvement, have been identified. They are:

- **IGFA:** The International Group of Funding Agencies for global change research (IGFA) is a forum for identifying solutions to common issues and interests in global change science. There are no binding obligations for those countries taking part. IGFA works with member countries and organisational observers to assist with international priority setting and information exchange on new initiatives. Currently the national membership stands at 23, including the European Union, UK, US, China, Indonesia, Japan and South Africa. (A description of IGFA and the participating member countries are given in Section 1.5 of Appendix II).
- **APN:** Australia currently has membership of The Asia Pacific Network (APN). This is potentially an important link for improving regional collaboration in climate and global change research and capacity building, and for Australia to develop a leadership role in developing and integrating national programmes. (A description of APN and the participating member countries are given in

Section 1.4 of Appendix II).

- **UNEP:** Australia is currently not a member of the United Nations Environment Programme (UNEP) and may therefore miss opportunities with regard to both climate change and sustainability and environmental science. The work of this group is fundamental to many aspects of biodiversity conservation and natural resource management, both areas with strong links to the outcomes of climate change science. It is recommended that Australia entertain membership of UNEP so as to raise its profile with this important global organisation.

3. Develop an Australian Climate Change Researchers Register:

Currently the profile of Australia on international fora is underexposed – therefore making it difficult for the various (and often disparate) stakeholders to readily ascertain the degree and importance of Australia’s involvement, output and related outcomes. There is currently a strong presence of Australian scientists undertaking internationally collaborative research on climate change, or with involvement in one of the many scientific steering committees or working groups. However, at present, there is no mechanism in place to accurately record such involvement. It is therefore recommended that a national Climate Change Researchers Register be developed with a mechanism put in place to maintain and update the register at regular intervals. The register should be located online to facilitate broad access by various stakeholders.

4. Enhance Communication:

It is recommended that a review of the effectiveness of reporting mechanisms for the various climate change research activities be undertaken. For instance are reporting requirements of the Australians involved consistent across the various programmes, projects, and committees and is the feedback monitored and evaluated by a central agency? This investigation has highlighted the need for there to be support and delivery mechanisms in-place for the communication of Australia’s international involvement in climate change science and related outcomes – both within the scientific community and to the public. Climate change is a high profile and policy-driven field with many stakeholders, and it is strongly linked to ‘sustainability’ science and issues, an area receiving increasing public interest and attention. Greater efficiencies and effectiveness stand to be achieved by improving the overall Communication Strategy of climate change science in Australia. For example, additional assistance may be required to co-ordinate communication of the wide-ranging but fragmented (internationally linked and domestic) climate change related research undertaken across Australia’s University system. The Australian Climate Change Science scene would also certainly benefit from the development and implementation of a dedicated website (ie. one-stop-shop or portal) on Australian national and international related agencies, committees, programmes, and research, observation and assessment activities. It would seem logical for such a site and service to be hosted by the Australian Greenhouse Office.

5. Enhance support for IPCC involvement:

More systematic support for Australian participation in the formal IPCC processes is recommended, especially in contributions to the Assessment and Special Reports. The IPCC assesses at five year intervals the overall international research output on climate change and Australia has played an important role in this activity through participation

in the preparation of the assessment reports at the various levels of writing and coordination. There needs to be a review of the mechanisms used to facilitate active involvement, including participation in the meetings. Within Australia it may be possible to effect greater leverage of disparate expertise through the formation of national study groups within the IPCC framework through bringing together experts from diverse agencies to ‘thank-tank’ ongoing climate change strategy, and to provide coordinated input into the final reports.

6. Membership of Human Dimension of Climate Change:

Australia is involved with the programme on International Human Dimensions of Global Environmental Change Programme (IHDP) through individual scientists in two of the Core Science Projects (GECHS and IDGEC), but there are no Australian members on the IHDP Scientific Committee. The human aspect of climate change is an area of research attracting increasing attention and Australia would be well suited to seek greater involvement in this issue. It is recommended that Australia make a direct contribution to IHDP (as it now does for IGBP and WCRP).

7. Improve Biodiversity – Climate Change linkages:

The issue of climate change in relation to biodiversity in Australia is a growing policy concern. There is currently no Australian representation on the DIVERSITAS Scientific Committee. Australia should seek more direct participation in DIVERSITAS by strengthening the membership of the DIVERSITAS Australian National Committee. This may also provide important linkages and support for the proposed National Biodiversity and Climate Change Action Plan currently under development through the Department of the Environment and Heritage. It should be noted that Australia currently has in place several high-level committees that deal with global change, environment and sustainability issues (eg. Academy Committees, Inter-Academy Forum, DIVERSITAS) – suitable resourcing may provide the opportunity for such committees to be brought together periodically, thereby enhancing Australia’s effectiveness at the international level.

8. Enhance Terrestrial Observation:

Australia is currently involved in a number of global observational networks. These include satellite observation programmes such as INSAR (Interferometric Synthetic Aperture Radar) for monitoring ice movements in Antarctica, or ocean surface monitoring, as well as Global Terrestrial Observing System (GTOS). The benefits of long-term continuity of participation in these programmes would be enhanced through more formal involvement by Australian Government. Collaborations with the USA, UK, Canada and others in activities involving financial support for terrestrial observations already exist.

9. Secure Support for Antarctic and Ocean Circulation and Related Research:

Australia, through AAD, has a special responsibility for climate related research in Antarctica and in the oceans surrounding both the Antarctic and Australian continents. These regions are of critical significance to the understanding of processes and impacts of climate change both on land and in the ocean, both regionally and globally. The

IPCC TAR has highlighted gaps in knowledge of atmosphere-ocean circulation, and the critical role of ocean measurements in understanding deep ocean circulation and its role in climate change. To achieve effective results in this challenging and expensive research area, international links are essential and this is developed through membership of the appropriate Scientific Steering Committees and programmes. Australia has no current involvement in the Global Ocean Ecosystem Dynamic (GLOBEC) project initiated by SCOR and the IOC of UNESCO, and no current membership of the World Ocean Circulation Experiment (WOCE). These are important oversights considering the marine domain represents some 70% of Australia's sovereign territory. Maintained support for Australia's involvement with the Scientific Committee on Antarctic Research (SCAR of ICSU) is also essential if Australia is to retain its leadership role in both Antarctic Science and the preservation of the Antarctic environment.

10. Conduct Full Bibliometric Assessment:

Greater use of the bibliometric tool for reporting on Australia's outputs (involvement) in global climate change research should be considered. A pilot study in this report demonstrated the potential value and outcomes from using this methodology. A full bibliometric assessment of Australia's involvement in aspects of global climate change could further inform the policy process and assist with the setting of research priorities (see [Appendix I](#) for a preliminary bibliometric study).

Appendix I – Bibliometric Data

A preliminary bibliometric study has been conducted in an attempt to quantify Australia's contribution to climate change research outputs. Keywords related to climate change science (see Table I-1 next page) were used to search the ISI Web of Science database for scientific publications containing an Australian institution in the author address. For comparison, the same search was conducted for two other countries, Canada and Sweden. These countries were chosen as they are known to be active in climate change research and their populations represent an even range (Sweden ~ 9 million, Australia ~ 20 million, Canada ~30 million). The results are shown in Table I-1 and Figures I-1, I-2 & I-3.

Additionally, it is also possible to assess the level of collaboration on scientific papers between nations by searching for publications with two (or more) particular countries listed in the author address of the publication. Some examples are shown in Table I-2

This preliminary bibliometric study is included to give an idea of the analysis that can be done. More work would need to be done before solid conclusions can be drawn from the results. In particular, the keywords used will need to be refined with input from climate change experts.

However, some preliminary conclusions can be drawn from the figures below:

- Figure I-1 shows Australia's share of world science publications at around 2.4%, while Figure I-3 shows Australia's share of science publications containing "climate change" keywords at around 5%. This indicates that Australia is approximately twice as active in "climate change" science compared with science in general;
- Canada and Sweden also seem to be around twice as active in "climate change" science compared with science in general;
- Figure I-2 shows that "climate change" science represents an increasing share of all world publications in science, indicating the increasing importance of the field. The figure also shows "climate change" science becoming increasingly important in each of the three countries investigated;
- Figure I-3 indicates that Australia's and Sweden's contributions to world "climate change" science publications have been steady or slightly increasing over the past 10 years, compared with an apparent decline in Canada's share of "climate change" science publications over the same period.

The bibliometric study also indicates that there is significant international scientific activity in climate change research that is conducted outside the auspices of government and non-government international agencies.

Table I-1 – Climate Change Publications For Selected Countries

Year	Total Science Publications	Australian Science Pubs		Canadian Science Pubs		Swedish Science Pubs		World Climate Science		Australian Climate Science			Canadian Climate Science			Swedish Climate Science		
		Total	% of World Science	Total	% of World Science	Total	% of World Science	Total	% of World Science	Total	% of Australian Science	% World Climate Science	Total	% of Canadian Science	% World Climate Science	Total	% of Swedish Science	% World Climate Science
1993	754,304	16,470	2.18	34,448	4.57	12,408	1.64	4,692	0.62	206	1.25	4.39	360	1.05	7.67	122	0.98	2.60
1994	798,222	17,413	2.18	35,256	4.42	13,080	1.64	5,242	0.66	236	1.36	4.50	389	1.10	7.42	124	0.95	2.37
1995	854,610	19,035	2.23	36,641	4.29	14,108	1.65	5,917	0.69	244	1.28	4.12	457	1.25	7.72	130	0.92	2.20
1996	903,657	19,718	2.18	37,069	4.10	15,007	1.66	6,706	0.74	322	1.63	4.80	516	1.39	7.69	188	1.25	2.80
1997	927,162	20,796	2.24	36,732	3.96	15,306	1.65	7,062	0.76	323	1.55	4.57	547	1.49	7.75	185	1.21	2.62
1998	959,748	22,207	2.31	37,128	3.87	16,448	1.71	7,666	0.80	370	1.67	4.83	605	1.63	7.89	215	1.31	2.80
1999	974,186	23,020	2.36	38,525	3.95	16,675	1.71	8,453	0.87	432	1.88	5.11	550	1.43	6.51	289	1.73	3.42
2000	956,595	22,853	2.39	37,871	3.96	16,237	1.70	8,828	0.92	440	1.93	4.98	636	1.68	7.20	283	1.74	3.21
2001	999,657	23,969	2.40	39,121	3.91	17,445	1.75	9,321	0.93	463	1.93	4.97	625	1.60	6.71	279	1.60	2.99
2002	975,007	23,650	2.43	38,277	3.93	16,772	1.72	9,709	1.00	454	1.92	4.68	657	1.72	6.77	307	1.83	3.16
2003*	643,093	16,436	2.56	26,124	4.06	10,859	1.69	7,229	1.12	369	2.25	5.10	486	1.86	6.72	229	2.11	3.17

* the data for 2003 only contains publications up to the end of July 2003

Keywords Used:

Climat* Change* OR Climatology OR climate model* OR greenhouse gas* OR greenhouse effect OR global warming OR climate effect* OR Carbon cycle OR atmospheric CO2 OR atmospheric carbon dioxide OR atmospheric carbon OR CO2 emissions OR carbon emissions OR carbon dioxide emissions OR carbon sink* OR carbon exchange OR CO2 exchange OR carbon dioxide exchange OR Land use change OR Global Change OR vegetat* canopies OR biomass OR biosphere OR normalized difference vegetation index OR El Nino OR Ocean Circulation Or Ocean* Model*

Table I-2 - Collaborations on Climate Change Publications (1993-2003):

Countries	# Publications
Australia & Canada	137
Australia & Japan	85
Australia & Sweden	43
Japan & Canada	103
Canada & Sweden	91
Sweden & Japan	13

Figure I-1 – Percentage Contributions to World Science Publications for Selected Countries:

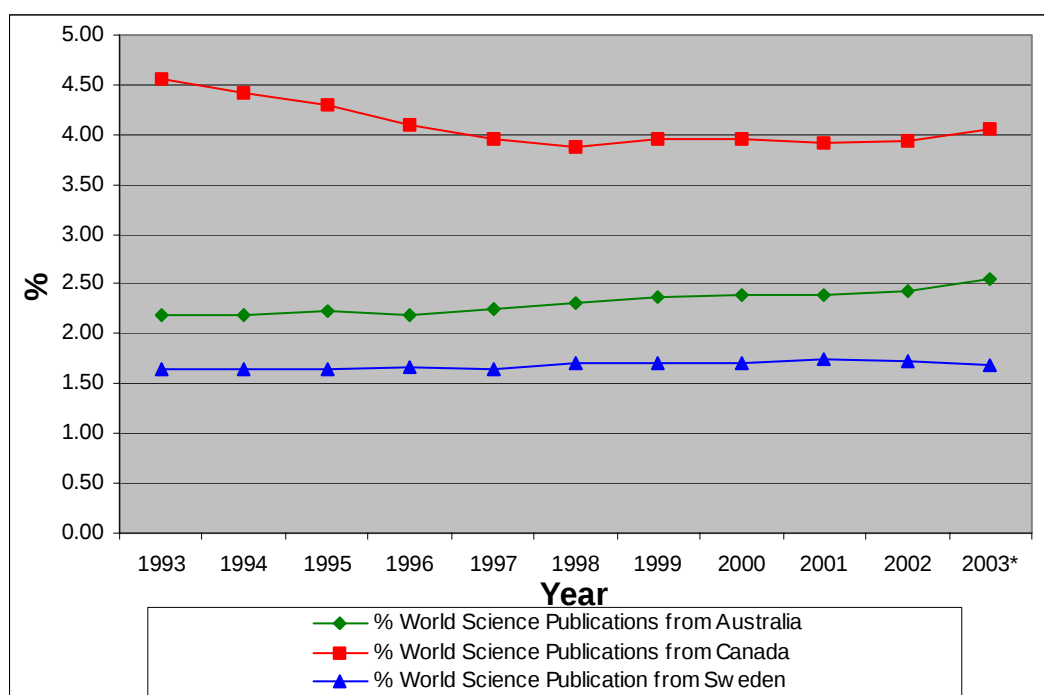


Figure I-2 – Percentage Contribution of Climate Change Science Publications to All Science Publications for the World and Selected Countries:

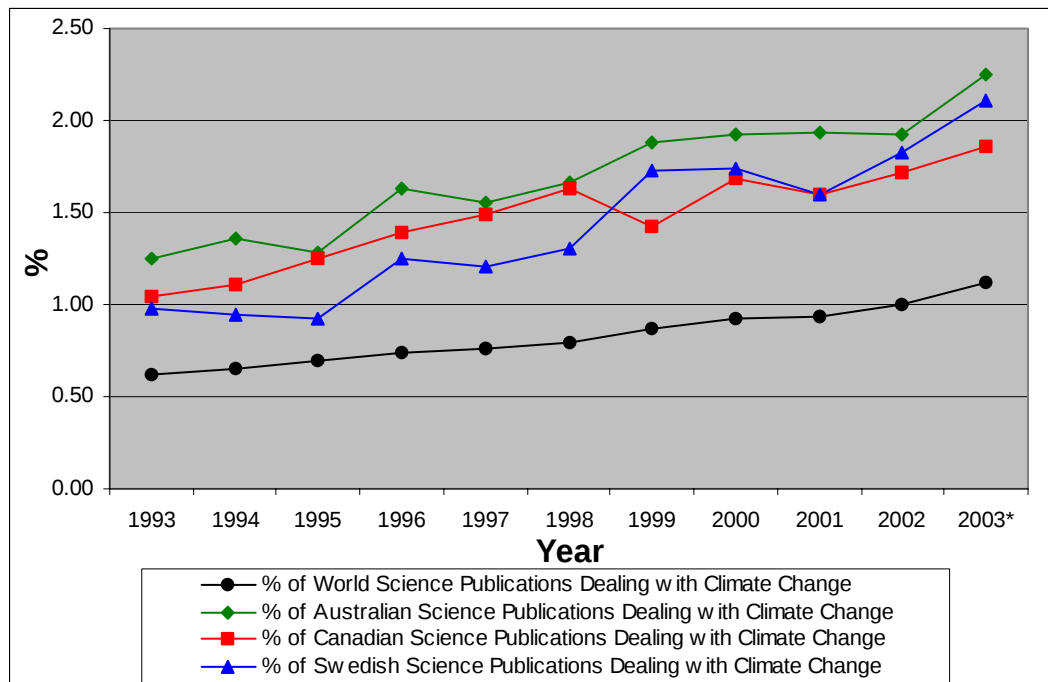
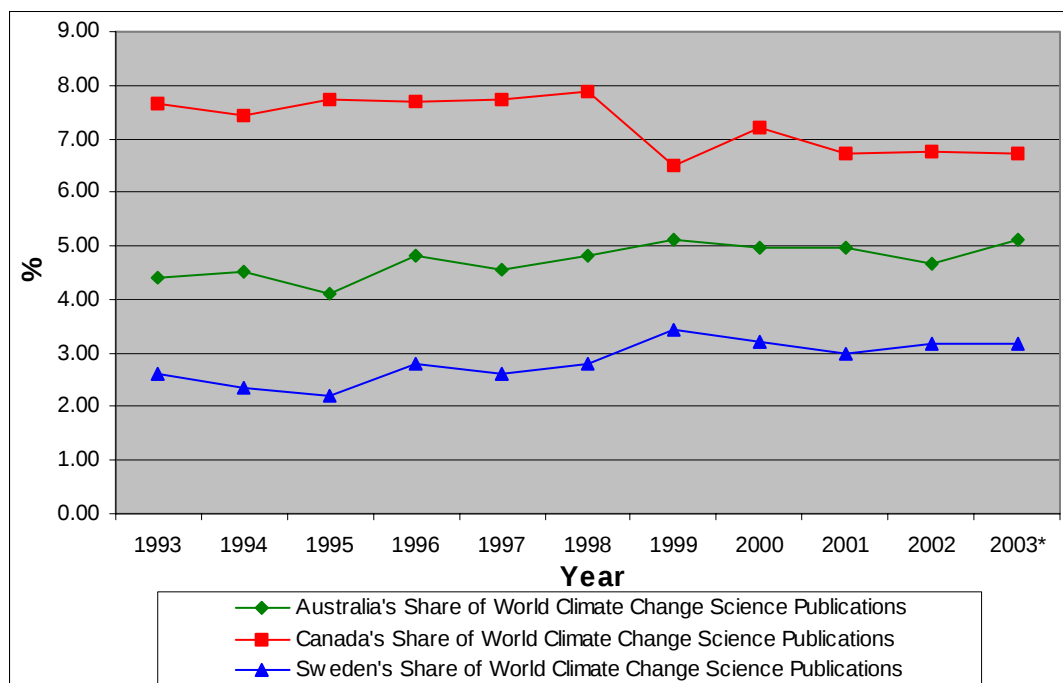


Figure I-3 – Percentage Contributions To World Climate Change Science Publications From Selected Countries



Appendix II – The Sponsoring Organisations Involved in Global Climate Change

Table of Contents

1	Governmental Organisations.....	2
1.1	<i>World Meteorological Organisation (WMO)</i>	<i>2</i>
1.1.1	World Weather Watch (WWW)	2
1.1.2	Applications of Meteorology Programme (AMP)	2
1.1.3	Atmospheric Research and Environment Programme (AREP)	3
1.1.4	Global Climate Observing System (GCOS)	3
1.1.5	Hydrology and Water Resources Programme (HWRP)	3
1.1.6	Technical Cooperation Programme (TCO).....	4
1.1.7	World Climate Programme (WCP).....	4
1.1.8	World Climate Research Programme (WCRP)	4
1.1.9	WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM).....	4
1.2	<i>United Nations Educational, Scientific and Cultural Organisation (UNESCO).....</i>	<i>4</i>
1.2.1	Intergovernmental Oceanographic Commission (IOC).....	5
1.2.2	Man and the Biosphere (MAB).....	5
1.3	<i>United Nations Environment Programme (UNEP)</i>	<i>5</i>
1.4	<i>Asia-Pacific Network for Global Change Research (APN).....</i>	<i>6</i>
1.5	<i>The International Group of Funding Agencies for Global Change Research (IGFA).....</i>	<i>7</i>
2	Non-Governmental Organisations	8
2.1	<i>International Council of Science (ICSU).....</i>	<i>8</i>
2.2	<i>International Social Science Council (ISSC).....</i>	<i>10</i>
2.3	<i>The Earth System Science Partnership (ESSP)</i>	<i>10</i>

1 Governmental Organisations

(Please note that mention of individual scientists is not provided; at this juncture it is not possible to compile a fully comprehensive list).

1.1 World Meteorological Organisation (WMO)

WMO facilitates international cooperation in the establishment of networks for making meteorological, hydrological and other observations, and promotes the rapid exchange of meteorological information for public, private and commercial use. The scientific activities coordinated by WMO include weather predictions, climate change, air pollution, ozone depletion studies and tropical storm forecasting.

As of August 2003, there were 187 Members (including Australia), comprising 181 Member States and six Member Territories, all of which maintain their own National Meteorological and Hydrological Services. Members are grouped into six regional associations (Africa, Asia, South America, North and Central America, South-West Pacific and Europe). Australia has been a member of WMO since its establishment and participates strongly in its programmes (eg. in the formal framework of the constituent bodies, especially the WMO Congress, the Executive Council, Regional Association V (South-West Pacific) and all eight Technical Commissions). The nominated Permanent Representative for Australia with WMO is the Director of the Bureau of Meteorology (BOM).

WMO supports a number of weather research programmes that are directly relevant to climate change research at an International Level. These include:

1.1.1 World Weather Watch (WWW)

WWW is the backbone of WMO's activities, and provides up-to-the-minute worldwide weather information and support for developing international programmes related to global climate and other environmental issues, and to sustainable development.

The World Weather Watch comprises three core components: the Global Observing System (GOS – see Appendix IV, Observation Initiatives), the Global Data-Processing System (GDPS) and the Global Telecommunication System (GTS).

The Australian BOM is involved through one of three World Meteorological Centres in Melbourne, Regional Specialised Meteorological Centres in Melbourne and Darwin, and a Regional Instruments Centre of Regional Association V (for South-West Pacific). Two Australians are presently on the management group of the Commission for Basic Systems (CBS) of the WWW.

1.1.2 Applications of Meteorology Programme (AMP)

AMP consists of four component activities:

- Public Weather Services Programme – several Australians from BOM are involved in expert teams and co-ordination committees;
- Agricultural Meteorology Programme – projects are overseen by the Commission for Agricultural Meteorology (CAgM);

- Aeronautical Meteorology Programme – BOM is involved, but no Australians are involved in the management group;
- Marine Meteorology and Related Oceanographic Activities Programme – part of JCOMM (see below).

1.1.3 Atmospheric Research and Environment Programme (AREP)

AREP is overseen by the Commission for Atmospheric Sciences (CAS). CSIRO Division of Atmospheric Research, is a member of the CAS working group

- Global Atmosphere Watch (GAW – see Appendix IV, Observation Initiatives) – There are several Scientific Advisory Groups under GAW and a Australian scientists are involved in these (Ian E. Galbally, Paul J. Fraser and John Gras from CSIRO Division Atmospheric Research). Australia has observing stations involved with the GAW network;
- World Weather Research Programme – Involved with the Sydney 2000 Olympics.
- Tropical Meteorology Research Programme;
- Physics and Chemistry of Clouds and Weather Modification.

1.1.4 Global Climate Observing System (GCOS)

See also Appendix IV – Observation Initiatives.

The Global Climate Observing System (GCOS) was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. It is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU). GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes. Mike Manton of BOM is Chair of one of the three science panels of GCOS. Australia contributes observational data to GCOS.

1.1.5 Hydrology and Water Resources Programme (HWRP)

The overall objective of the Hydrology and Water Resources Programme is to apply hydrology to meet the needs for sustainable development and use of water and related resources; to the mitigation of water-related disasters; and to effective environmental management at national and international levels.

The programme is implemented through five mutually supporting components:

- Programme on Basic Systems in Hydrology (including HOMS and WHYCOS – see Appendix IV, Observation Initiatives)
- Programme on Forecasting and Applications in Hydrology
- Programme on Sustainable Development of Water Resources
- Programme on Capacity Building in Hydrology and Water Resources
- Programme on Water-related Issues

Projects primarily implemented by regional working groups. Australia is involved with the South West Pacific groups through the BOM's Hydrometeorological Advisory Service (HAS).

1.1.6 Technical Cooperation Programme (TCO)

The objective of WMO's Technical Cooperation Programme is to ensure, through collaborative efforts of Members, for their mutual benefit, the enhancement and development of the capabilities of the national Meteorological and Hydrological Services (NMHSs) so that they can contribute to and participate efficiently in the implementation of WMO Programmes, for the benefit of the global community and in support of national socio-economic development activities. (Note: this is more of a funding/infrastructure programme than a scientific programme)

1.1.7 World Climate Programme (WCP)

WCP comprises the following components, all administered by the Commission of Climatology (CCL), which has involvement from Australia's BOM:

- World Climate Data and Monitoring Programme (WCDMP)
- World Climate Applications and Services Programme (WCASP)
- World Climate Impact Assessment and Response Strategies Programme (WCIRP)
- World Climate Research Programme (WCRP)
- Climate Information and Prediction Services (CLIPS)

1.1.8 World Climate Research Programme (WCRP)

See Appendix III – Research Initiatives

1.1.9 WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)

The WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) is an intergovernmental body of experts, which provides the international, intergovernmental coordination, regulation and management mechanism for an operational oceanographic and marine meteorological observing, data management and services system. Until the formation of JCOMM in 1999, the coordination of these activities was provided by two separate bodies: the WMO Commission for Marine Meteorology (CMM) and the Joint IOC/WMO Committee for the Integrated Global Ocean Services System (IGOSS). JCOMM is the result of the recognition of the increasing demand for integrated marine meteorological and oceanographic data and services, and the efficiencies that may be achieved by combining the expertise and technological capabilities of the WMO and IOC systems. Phillip Parker of BOM is on the nine -member management group of JCOMM

* * * * *

1.2 United Nations Educational, Scientific and Cultural Organisation (UNESCO)

UNESCO has a number of programmes related to climate change at the global level; two of the more important ones are:

1.2.1 Intergovernmental Oceanographic Commission (IOC)

The Commission currently counts 129 Member States who all have a seat in the IOC Assembly; 36 of these (including Australia) are also members of the IOC Executive Council.

The work of the IOC focuses on promoting marine scientific investigations and related ocean services, with a view to learning more about the nature and resources of the oceans. In meeting these challenges, IOC now focuses on four major themes:

- Develop, promote and facilitate international oceanographic research programmes to improve the understanding of critical global and regional ocean processes and their relationship to the sustainable development and stewardship of ocean resources;
- Ensure effective planning, establishment and co-ordination of an operational global ocean observing system to provide the information needed for oceanic and atmospheric forecasting, for oceans and coastal zone management by coastal nations, and for global environmental change research;
- Provide international leadership for education and training programmes and technical assistance essential for systematic observations of the global ocean and its coastal zone and related research; and
- Ensure that ocean data and information obtained through research, observation and monitoring are efficiently handled and made widely available.

1.2.2 Man and the Biosphere (MAB)

MAB develops the basis, within the natural and the social sciences, for the sustainable use and conservation of biological diversity, and for the improvement of the relationship between people and their environment globally. MAB contributes thus not only to better understanding of the environment, including global change, but to greater involvement of science and scientists in policy development concerning the wise use of biological diversity. Australia has one scientist on the MAB National Committee.

* * * * *

1.3 United Nations Environment Programme (UNEP)

The mission of the UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP was established in 1972, and acts as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the global environment. To accomplish this, UNEP works with a wide range of partners, including United Nations entities, international organisations, national governments, non-governmental organisations, the private sector and civil society. Australia is not currently a member state of the governing council, but does participate in some of the climate-related activities (eg, UNEP/GRID-Geneva, which aims to support environmental decision-making within UNEP, and the UN system as a whole, by generating and disseminating information about the state of the world's environment in a timely and understandable manner).

UNEP has a large number of activities encompassing a variety of themes (eg, Environment Assessment, Atmosphere, Biodiversity, Marine & Coastal Areas etc).

UNEP aims to:

- Assess global, regional and national environmental conditions and trends
- Develop international and national environmental instruments
- Strengthen institutions for the wise management of the environment
- Facilitate the transfer of knowledge and technology for sustainable development
- Encourage new partnerships and mind-sets within civil society and the private sector.

* * * * *

1.4 Asia-Pacific Network for Global Change Research (APN)

The Asia-Pacific Network for Global Change Research (APN) was established as an inter-governmental *research-funding* network in 1996.

The primary purposes of the Asia-Pacific Network for Global Change Research (APN) are to foster global environmental change research in the Asia-Pacific region, increase developing country participation in that research, and to strengthen links between the science community and policy makers. It promotes, encourages and supports research activities on long-term global changes in climate, ocean and terrestrial systems, and on related physical, chemical, biological and socio-economic processes.

The 21 APN member countries include: Australia; Bangladesh; Cambodia; China; Fiji; India; Indonesia; Japan; Korea; Laos; Malaysia; Mongolia; Nepal; New Zealand; Pakistan; Philippines; Russia; Sri Lanka; Thailand; USA and Vietnam.

In particular, APN promotes the following objectives:

- Supporting regional cooperation in global change research on issues that are particularly relevant to the region;
- Standardization, collection, and exchange of scientific data relating to global change research;
- Improvement of scientific and technical capabilities and research infrastructure of nations in the region;
- Cooperation with research networks in other regions;
- Providing scientific knowledge to the public, and input to policy decision-making; and
- Development of appropriate mechanisms for transfer of know-how and technology

Existing research programmes created by large scientific unions provide an important basis for APN activities. The programmes which have addressed the need to reduce scientific uncertainties related to global environmental and related social change are the:

1. International Human Dimensions Global Environmental Change Programme (IHDP),
2. International Geosphere-Biosphere Programme (IGBP) and
3. World Climate Research Programme (WCRP).

These three programmes have developed plans for capacity building and strengthening research on regional contributions to and impacts from global change through the Global Change System for Analysis, Research and Training (START). The APN cooperates closely with START, and its regional committees in the APN region, including,

- South Asia START Regional Committee (SASCOM)
- Southern Asia Regional Committees for START (SARCS)
- Temperate East Asia Regional Committee for START (TEACOM)
- START Oceania

Through the APN mechanism, governments can collectively and individually provide necessary support for these scientific processes. The APN collaborates with other inter-governmental networks supporting global change research. IAI, founded in 1992, covers North and South America. ENRICH, also founded in 1992, covers Europe and Africa. The APN can also work with other international organisations that deal with research relating to global change, or with related private and government decision-making (from the APN website).

There are a number of publications, reports, and other useful documents available from the website and from the APN Secretariat detailing the research findings of the APN.

Each year the APN Inter-Governmental Meeting (IGM) decides on the allocation of funds from a budget to support proposals that meet the objectives of the APN.

Projects at an international level include:

- Climate Extremes Indices and Indicators for Monitoring Trends in Climate Extremes (Australia is involved).
- The Budgets of GHGs, Urban Air Pollutants, and their Future Emission Scenarios in Selected Mega-Cities in Asia (no Australian involvement).

There are also a number of more regional projects, of which Australia is involved with (eg, An Assessment of Nutrient, Sediment and Carbon Fluxes, to the Coastal Zone in South Asia and their Relationship to Human Activities)

* * * * *

1.5 The International Group of Funding Agencies for Global Change Research (IGFA).

The goal of the IGFA is to promote global change research. IGFA is a forum through which national agencies involved in funding research on global change can identify issues of mutual interest and determine ways (both nationally and internationally as appropriate) of addressing these concerns. IGFA was established over ten years ago.

Primarily, IGFA is concerned with WCRP, IGBP, IHDP and DIVERSITAS. As such, the focus in IGFA is not on funding single projects, but on the coordination of support for the programmes themselves. IGFA has no binding obligations to those involved,

and is organised in a loose and informal manner. The main emphasis is on mutual information exchange, and there are currently twenty-three countries involved as members to IGFA, although Australia is not one of them. Topics high on IGFA's agenda include assisting with establishing priority settings and information exchange on new initiatives.

The nations and relevant member agencies currently participating in IGFA are:

- Austria – BMBWK and the Department of Environmental Sciences.
 - Belgium – Federal Office for Scientific, Technical & Cultural Affairs.
 - Bulgaria – Ministry of Science and Education; National Science Fund.
 - Canada – Canadian Foundation for Climate and Atmospheric Sciences; Research Council of Canada.
 - China – National Natural Science Foundation of China (NSFC).
 - European Commission – Environment Programme, Directorate General Research, EC.
 - Finland – Finnish Global Research Programme (FIGARE); The Academy of Finland.
 - Germany – BMBF (Bundesministerium fuer Bildung und Forschung); DFG (Deutsche Forschungsgemeinschaft).
 - Iceland – The Icelandic Research Council.
 - Indonesia – Ministry of Maritime Affairs and Fisheries.
 - Japan – Japan Marine Science Technology Centre; Ministry of the Environment.
 - Norway – The Research Council of Norway.
 - Romania – National Agency for Science, Technology and Innovation.
 - Russia – Russian Foundation for Basic Research.
 - South Africa – National Research Foundation.
 - Spain – Centre for Environmental Sciences.
 - Sweden – Swedish Research Council.
 - Switzerland – Swiss National Science Foundation.
 - Taiwan – National Science Council.
 - The Netherlands – Netherlands Organization for Scientific Research.
 - Ukraine – Ukraine Ministry for Education and Science.
 - United Kingdom – Natural Environment Research Council.
 - United States – National Science Foundation.
-

2 Non-Governmental Organisations

2.1 *International Council of Science (ICSU)*

ICSU's mission is "To identify and address major issues of importance to science and society, by mobilizing the resources and knowledge of the international scientific community; to promote the participation of all scientists, irrespective of race, citizenship, language, political stance or gender in the international scientific endeavour; to facilitate interactions between different scientific disciplines and between scientists from 'Developing' and 'Developed' countries; to stimulate

constructive debate by acting as an authoritative independent voice for international science and scientists."

ICSU accomplishes its role by developing and implementing international, interdisciplinary research programmes. Where appropriate this is done in partnership with other relevant organisations. Important programmes of the past include the International Geophysical Year (1957-58) and the International Biological Programme (1964-74). Major current programmes include the IGBP and the WCRP. ICSU also seeks to establish interdisciplinary bodies, which undertake policy and research activities of interest to its members and the broader international scientific community.

ICSU is in contact – through its Members and affiliates – with hundreds of thousands of scientists worldwide, and is frequently called upon (eg, by the UN) to speak on behalf of the world scientific community and to provide advice in matters ranging from ethics to the environment.

ICSU has two categories of full Members: International Scientific Union Members (eg, the International Geographical Union – IGU, the International Union of Geodesy and Geophysics - IUGG, the International Union of Geological Sciences – IUGS) and National Scientific Members (including the Australian Academy of Science). There are currently 27 Scientific Union Members and 73 National Scientific Members. In addition, ICSU has 23 International Scientific Associates (eg, the International Union for Quaternary Research – INQUA, the International Water Association - IWA).

The principal source of ICSU's finances is the contributions it receives from its Members. Other sources of income are the framework contracts from UNESCO and grants and contracts from UN bodies, foundations and agencies, which are used to support the scientific activities of the ICSU Unions and interdisciplinary bodies. One of ICSU's greatest strengths, however, is the time contributed freely by the thousands of scientists committed to the objectives of the Council.

ICSU has nine major joint initiatives in a variety of areas. Joint Initiatives are international programmes organized by ICSU or its Members in partnership with other inter- or non-governmental organisations. Cooperation in such programmes is particularly close with various UN agencies, such as UNESCO, WMO, UNEP and FAO. The climate- important ones are:

For research:

- IGBP
- WCRP
- IHDP
- DIVERSITAS

For Observation :

- GCOS
- GOOS
- GTOS

* * * * *

2.2 *International Social Science Council (ISSC)*

The ISSC is an international non-profit scientific organisation with its aims and objectives being the promotion of the understanding of human society in its environment by fostering the social and behavioural sciences throughout the world and their application to major contemporary problems, and by enhancing co-operation by means of a global international organisation of social and behavioural scientists and organisations, encouraging multi-disciplinary and inter-disciplinary co-operation among the members of the ISSC.

The Council aids cooperation between non-governmental scholarly associations and inter-governmental organisations such as UNESCO. The Council also initiates and sponsors interdisciplinary research projects and programmes. One such programme of importance to global climate change is the IHDP, which is co-sponsored by the International Council for Science (ICSU).

2.3 *The Earth System Science Partnership (ESSP)*

Four international programmes (two well-established and two developing) form ‘The Earth System Science Partnership,’ a partnership for the integrated study of the Earth System, the changes that are occurring to the System and the implications of these changes for global sustainability. These international research programmes involve a substantial number of major research projects, some carried out under joint sponsorship with other programmes and agencies and some carried out on an individual project basis.

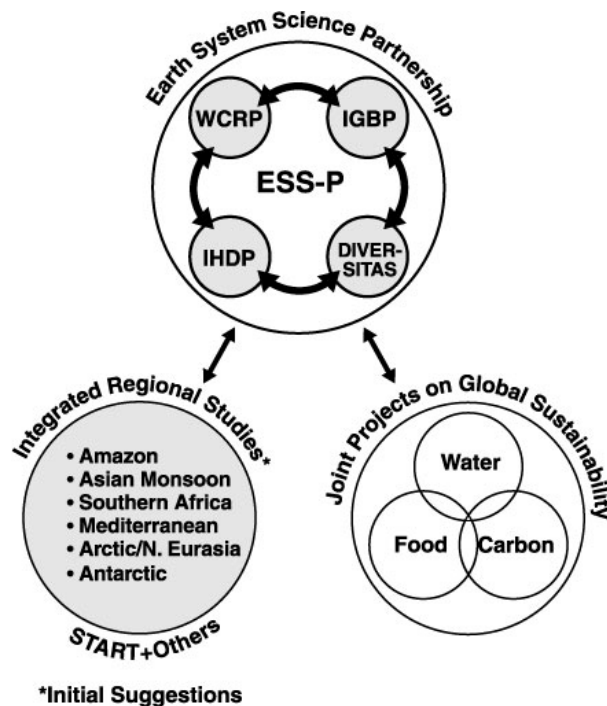
The two well-developed programmes are:

- The World Climate Research Programme (WCRP), which is cosponsored by the WMO, IOC and ICSU, and;
- The International Geosphere Biosphere Programme (IGBP), which is sponsored by ICSU.

The developing projects are:

- The International Human Dimensions Programme (IHDP), which is cosponsored by ICSU and ISSC, and;
- DIVERSITAS, which is cosponsored by ICSU and The Food and Agriculture Organisation of the United Nations (FAO) in particular.

The structure of the Earth System Science Partnership is indicated in the following diagram:



The ESSP undertakes five types of activities:

1. Earth System analysis and modelling, via collaboration among existing projects/activities of the four constituent programmes (eg, see the Model Intercomparison Projects page of the IGBP website: <http://gaim.unh.edu/Structure/Future/MIPs/index.html>).
2. Joint projects on issues of global sustainability, designed to address the global change aspects of a small number of critical issues for human well-being: carbon cycle/energy systems; food systems; water resources and human health. The major Australian contribution to these joint projects is through the Global Carbon Project (GCP).
3. Regional activities, including capacity building, networking and integrated regional studies.
4. Global Change Open Science Conferences, the first of which was Challenges of a Changing Earth, held in Amsterdam in July 2001.
5. Communication activities, currently under development. These will include an ESSP website, a report series, a common design profile for the ESSP and a proposed biannual newsletter.

APPENDIX III – RESEARCH INITIATIVES

Table of Contents

1	International Geosphere-Biosphere Programme (IGBP) Core Programmes	3
1.1	<i>Past Global Changes (PAGES)</i>	3
1.2	<i>Global Analysis, Integration, and Modelling (GAIM) Task Force</i>	4
1.3	<i>Global Ocean Ecosystem Dynamics (GLOBEC)</i>	5
1.4	<i>International Global Atmospheric Chemistry (IGAC)</i>	5
1.5	<i>Land-Ocean Interactions in the Coastal Zone (LOICZ)</i>	5
1.6	<i>Surface Ocean Lower Atmosphere Study (SOLAS)</i>	5
1.7	<i>System for Analysis, Research and Training (START)</i>	6
1.8	<i>Land-Use and Land-Cover Change (LUCC) – finishes in 2005</i>	6
1.9	<i>Global Change and Terrestrial Ecosystem (GCTE)- finishing in 2003</i>	6
1.10	<i>Joint Global Ocean Flux Study (JGOFS)- finishing in 2003</i>	6
1.11	<i>Biospheric Aspects of the Hydrological Cycle (BAHC) – finished in 2002</i> ...	7
2	World Climate Research Programme (WCRP)	7
2.1	<i>CliC (Climate and Cryosphere)</i>	8
2.2	<i>CLIVAR - Climate Variability and Predictability</i>	8
2.3	<i>GEWEX – Global Energy and Water Cycle Experiment</i>	8
2.3.1	<i>Radiation Projects</i>	9
2.3.2	<i>Hydrometeorology Projects</i>	9
2.3.3	<i>Continental-Scale Experiments (CSEs)</i>	9
2.3.4	<i>Modeling and Prediction Projects</i>	9
2.4	<i>SPARC - Stratospheric Processes And their Role in Climate</i>	10
2.5	<i>WOCE - World Ocean Circulation Experiment</i>	10
3	International Human Dimensions Programme on Global Environmental Change (IHDP)	10
3.1	<i>Global Environmental Change and Human Security - (GECHS)</i>	10
3.2	<i>Institutional Dimensions of Global Environmental Change (IDGEC)</i>	10
3.3	<i>Industrial Transformation (IT)</i>	11
3.4	<i>Land-Use and Land-Cover Change (LUCC) – finishes in 2005</i>	11
4	DIVERSITAS	11
4.1	<i>Discovering Biodiversity and Predicting its Changes</i>	11
4.2	<i>Assessing Impacts of Biodiversity Changes</i>	11

4.3	<i>Developing the Science of Conservation and Sustainable Use of Biodiversity</i>	<i>12</i>
5	Joint ESSP Projects On Global Sustainability	12
5.1	<i>FOOD: Global Environmental Change and Food Systems (GECAFS)</i>	<i>12</i>
5.2	<i>WATER: Global Water System Project (GWSP)</i>	<i>12</i>
5.3	<i>CARBON - Global Carbon Project (GCP)</i>	<i>12</i>
5.4	<i>HEALTH - Global Change and Human Health</i>	<i>13</i>
6	Regional Activities	13
7	Other	13
7.1	<i>Scientific Committee on Antarctic Research (SCAR)</i>	<i>13</i>
7.2	<i>Ocean Drilling Programme (ODP) and the Integrated Ocean Drilling Programme (IODP)</i>	<i>14</i>
7.3	<i>Network for the Detection for Stratospheric Change (NDSC)</i>	<i>14</i>
7.4	<i>Australia-US Climate Action Partnership (CAP)</i>	<i>15</i>

The four programmes comprising the Earth System Science Partnership (ESSP) include a number of individual and joint research projects on global climate change. Please note that mention of individual scientists is not provided; at this juncture it is not possible to compile a fully comprehensive list. The main programmes are:

1 International Geosphere-Biosphere Programme (IGBP) Core Programmes

IGBP launched its second phase (IGBP II) in 2002 with a number of scientific and programme changes. While IGBP will continue supporting the more disciplinary research, greater focus will be given to the integrative research agenda and the more holistic earth system science approach. The present form of several core projects will end by the end of 2003 (BAHC has already ceased; GCTE, LUCC and JGOFS are finishing); instead they will become part of the larger, more integrative projects (eg. Land Project with the old GCTE and LUCC together).

The most substantial change is the establishment of the Earth System Science Partnership to support earth system science and global sustainability. Under this new partnership, which includes IGBP, IHDP, WCRP, and DIVERSITAS, three MAIN projects have been established: carbon, food and water. Of these two, carbon (the global carbon project) and food (global environmental change and food systems) are already active.

IGBP has adopted a new structure of eight projects in total. Six projects are centered on the three major Earth System compartments - ocean, land and atmosphere - and the interfaces between them. Two projects - PAGES and GAIM - focus on a whole system perspective, from the past into the future. In general, there is a focus on interaction between and integration across the IGBP projects.

Two of the projects - for the land and ocean compartments - are developing in an evolutionary fashion. A single, integrated land project will be launched in 2004, with the existing land-based projects GCTE and LUCC completing their work in 2003 and 2005 respectively. The ocean project will be built around increasing collaboration and joint research between GLOBEC and new research on ocean biogeochemistry and ecosystems. The existing ocean-based project JGOFS completes its work at the end of 2003.

Australia (through GHA and AAS) provides contributions to IGBP central funding, as do about 50 other countries. Australia is also one of 8 countries to provide direct support to International Project Offices (IPO's). The GCTE IPO has been located in Canberra since the establishment of the project in 1990. The office has recently undergone a transition to support the new Global Carbon Project of the ESSP. Several Australian scientists hold key positions within IGBP and its related committees.

PROJECTS:

1.1 Past Global Changes (PAGES)

PAGES seeks to provide a quantitative understanding of the Earth's environment in the geologically recent past and to define the envelope of natural environmental variability against which anthropogenic impacts on the Earth System may be assessed.

PAGES financial support comes primarily (80%) from matching contributions from Switzerland (SNF) and the United States of America (NSF and NOAA). An additional 10% of PAGES funding is provided by the IGBP. Additional project-specific funding, accounting for approximately 10% of the annual budget, has been provided by numerous sources including:

- 1998- US NSF
- 1999- Netherlands Ministry of Science and Technology, US NSF
- 2000- IGBP, US NSF
- 2001- Euresco, IGBP
- 2002- INTAS
- 2003- Euresco

PAGES has been almost entirely transformed in the recent revision of IGBP, and now supports science initiatives comprising five principal research foci, each overseen by a chair and a small steering group. These include Palaeo-environments of the Northern and Southern Hemispheres (PANASH), PAGES/CLIVAR Intersection, The International Marine Past Global Changes Study (IMAGES), Polar Programmes and Past Ecosystems Processes and Human-Environment Interactions. The Polar Programme is made up of four groups; Circum Arctic Palaeoenvironments (CAPE), Quaternary Environment of the Eurasian North project (QUEEN), International Trans-Antarctic Scientific Expedition (ITASE) and Antarctic Ice Margin Evolution (ANTIME). The Past Ecosystems Processes and Human-Environment Interactions focus is divided into three main activities HITE (Human Impacts on Terrestrial Ecosystems), LUCIFS (Land Use and Climate Impacts on Fluvial Systems during the Period of Agriculture), and LIMPACS (Human Impact on Lake Ecosystems). ANSTO is involved in HITE.

Australia is heavily involved in the various PAGES research foci, however currently there is no Australian membership of the PAGES scientific steering committee.

1.2 Global Analysis, Integration, and Modelling (GAIM) Task Force

The goal of GAIM is to advance the study of the global biogeochemical cycles and their links to the hydrologic cycle and to the physical-climate system as a whole using both data and models that integrate the roles and interactions of physical climate, ecological and human systems. The Task Force analyzes current models and data, and assesses the capability of current models and experimental programmes to resolve key questions. This is done for natural systems and variability as well as anthropogenic influences.

The GAIM modelling effort is structured by Topic and Time Periods. The Topics are CO₂, Trace Gas, and Climate-Vegetation Interactions. The Time periods are Paleo (<20 kyrs), fossil fuel (<200 yrs), contemporary (<20 yrs), and future. In addition to numerous modelling projects, GAIM is involved in collaborative activities with various IGBP core projects. These activities include thematic workshops and various cross-disciplinary and support activities.

The Australian Research Council is one of the funding bodies for the GAIM Office, and has one scientist on the scientific steering committee.

1.3 *Global Ocean Ecosystem Dynamics (GLOBEC)*

GLOBEC was initiated by SCOR and the IOC of UNESCO in 1991, in response to the recommendations of a joint workshop, which identified a need to understand how global change will affect the abundance, diversity and productivity of marine populations comprising a major component of oceanic ecosystems.

The International Project Office (IPO) is co-sponsored by the Natural Environment Research Council of the United Kingdom, The University of Plymouth and the National Science Foundation of the United States. Australia has no involvement in this project.

1.4 *International Global Atmospheric Chemistry (IGAC)*

IGAC was created in the late 1980s to address growing international concerns over rapid changes observed in Earth's atmosphere, and includes the Aerosol Characterisation Experiment campaign in East Asia (ACE-Asia), which ANSTO is participating in.

IGAC is under joint sponsorship of the Commission on Atmospheric Chemistry and Global Pollution (CACGP) of the International Association of Meteorology and Atmospheric Sciences (IAMAS) and IGBP.

1.5 *Land-Ocean Interactions in the Coastal Zone (LOICZ)*

The overall goal of this project is to determine at regional and global scales:

- the nature of that dynamic interaction;
- how changes in various components of the Earth system are affecting coastal zones and altering their role in global cycles;
- to assess how future changes in these areas will affect their use by people and;
- to provide a sound scientific basis for future integrated management of coastal areas on a sustainable basis.

CSIRO is on scientific steering committee

1.6 *Surface Ocean Lower Atmosphere Study (SOLAS)*

SOLAS is a new international research initiative sponsored by IGBP, the Commission on Atmospheric Chemistry and Global Pollution (CACGP) of the International Association of Meteorology and Atmospheric Sciences (IAMAS), and the Scientific Committee on Oceanic Research (SCOR) and the World Climate Research Programme (WCRP).

The Aims are to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and the atmosphere, and how this coupled system affects and is affected by climate and environmental change.

There is no Australian government commitment to this international programme. Involvement comes through the New Zealand-Australian SOLAS-ANZ Dual Tracer Experiment to take place in NZ waters next March. Only three Australian scientists are actually participating in the experiment on the NZ research vessel.

1.7 System for Analysis, Research and Training (START)

START is a non-governmental, non-profit organisation that seeks to establish and foster regional networks of collaborating scientists and institutions in developing countries. These networks conduct research on regional aspects of environmental change, assess impacts and vulnerabilities to such changes, and provide information to policy-makers. START acts to enhance the scientific capacity of developing countries to address the complex processes of environmental change and degradation through a wide variety of training and career development programmes. START mobilizes resources to support infrastructure and research programmes on environmental change within developing regions.

START contains a number of regional and cross-regional programmes, such as the following two (both with BMRC involvement):

- Climate Prediction and Agriculture (CLIMAG)
- Monitoring Extreme Climate Events (MECE)

START is chaired by CSIRO. Some small “in-kind” funding is provided from AAS and the Department of Primary Industries, Queensland. An Australian representative from Adelaide University is chair of the Oceania Regional committee.

1.8 Land-Use and Land-Cover Change (LUCC) – finishes in 2005

LULCC is a Programme Element of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP).

This Core Project is an interdisciplinary programme aimed at improving the understanding of the land use and land cover change dynamics and their relationships with the global environmental change. There is no Australian involvement in this initiative.

1.9 Global Change and Terrestrial Ecosystem (GCTE)- finishing in 2003

The aims of GTCE are:

- To predict the effects of changes in climate, atmospheric composition, and land use on terrestrial ecosystems, including (i) agriculture, forestry, soils; and (ii) biodiversity.
- To determine how these effects lead to feedbacks to the atmosphere and the physical climate system.

The Division of Sustainable Ecosystems of CSIRO was the host for the GCTE International Project Office. Other Australian organisations involved were the Australian Greenhouse Office and the Department for Industry, Science and Resources, both of which supplied yearly grants to GCTE, although the AGO has redirected its grant to support the Global Carbon Project due to the completion of GCTE later this year.

1.10 Joint Global Ocean Flux Study (JGOFS)- finishing in 2003

The aims of JGOFS are:

- To determine and understand on a global scale the processes controlling the time-varying fluxes of carbon and associated biogenic elements in the ocean,

and to evaluate the related exchanges with the atmosphere, sea floor and continental boundaries.

- To develop a capacity to predict on a global scale the response to anthropogenic perturbations, in particular those related to climate change.

Sponsors include:

- International Council for Science or International Council of Scientific Unions (ICSU)
- Scientific Committee on Oceanic Research (SCOR)
- IGBP

Bronte Tilbrook of CSIRO is on scientific steering committee.

1.11 Biospheric Aspects of the Hydrological Cycle (BAHC) – finished in 2002

IGBP-BAHC and its partners (in particular WCRP-GEWEX) developed a series of large-scale land surface experiments, which have contributed to a new understanding of the role of biospheric feedbacks in seasonal to inter-annual climate variability, the effects of land surface heterogeneity on atmospheric processes and the effects on regional water and carbon cycles and water resources. BAHC finished up last year. A new project called ILEAPS is being developed to address some of the land-atmosphere interactions. Australian scientists served on the BAHC Scientific Steering Committee.

2 World Climate Research Programme (WCRP)

The objectives of the WCRP are to develop the fundamental scientific understanding of the physical climate system and the climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate. The programme encompasses studies of the global atmosphere, oceans, sea and land ice, and the land surface, which together constitute the Earth's physical climate system.

Currently, WCRP receive support from:

- U.S. federal research agencies: NOAA-OGP, NSF, and NASA through the U.S. CLIVAR Office, USA
- Natural Environment Research Council through the James Rennell Division of Southampton Oceanography Centre, UK
- Comité National pour la COI (COI = International Oceanographic Commission), France
- Federal Ministry for Education and Research, BMBF, Germany
- Joint Planning Staff for WCRP, WMO, Switzerland

A scientist from the CSIRO Marine Research and the Antarctic CRC is on the 18 member Joint Scientific Committee of WCRP.

WCRP has a broad-based multi-disciplinary science strategy offering the widest possible scope for investigation of all physical aspects of climate and climate change. This multi-disciplinary strategy is reflected in the ongoing WCRP core-projects. All

projects are led by scientific steering or working groups, which normally meet once a year. These projects include:

2.1 CliC (*Climate and Cryosphere*)

The project aims are to:

- Assess and quantify the impacts of climatic variability and change on components of the cryosphere and their consequences for the climate system.
- Improve understanding of the physical processes through which the cryosphere interacts within the climate system.
- Improve the representation of cryospheric processes in climate models.
- Enhance the observation and monitoring of the cryosphere.

Australian involvement is through the Antarctic Cooperative Research Centre, the Australian Antarctic Division (AAD), and a number of universities and other government agencies contributing to the national Antarctic programme. Ian Allison of the Antarctic CRC and Australian Antarctic Division is (in 2001) the Vice Chairman of the CliC scientific steering group

2.2 CLIVAR - *Climate Variability and Predictability*

CLIVAR is an international research programme that addresses many issues of natural climate variability, while extending effective predictions of climate variation and refining the estimates of anthropogenic climate change.

An Australian from the University of Melbourne is on the scientific steering group. Australia not listed as having National programmes associated with CLIVAR (Canada, EU, Germany, NZ, Netherlands, Norway, UK, USA all have national programmes), and no National report was given for Australia at the CLIVAR conference (41 other countries have reports listed on website). However, Australia is involved with 10 of the 15 working groups/panels, including: the Asian-Australian Monsoon Panel; The Expert Team on Climate Change Detection; the Working Group on Coupled Modeling; Working Group on Ocean Model Development; Oceans Observations Panel; PAGES Working Group; Pacific Implementation Panel; Southern Ocean Implementation Panel; and the Working Group on Seasonal to Interannual Prediction.

2.3 GEWEX – *Global Energy and Water Cycle Experiment*.

The goal of GEWEX is to observe, understand and model the hydrological cycle and energy fluxes in the atmosphere, at land surface and in the upper oceans. GEWEX projects are organized by their relationship to the following three research focus areas:

- **Radiation** - Determine atmospheric and surface radiation fluxes and heating with the precision needed to predict transient climate variations and decadal-to-centennial climate trends.
- **Hydrometeorology** - Demonstrate skill in predicting changes in water resources and soil moisture on time scales up to seasonal and annual as an integral part of the climate system.
- **Modelling and Prediction** - Develop accurate global model information on the energy and water budget and demonstrate predictability of their variability and response to climate forcing.

There are no Australians on GEWEX Scientific Steering Group.

2.3.1 *Radiation Projects*

- International Satellite Cloud Climatology Project (ISCCP)
ISCCP has the following objectives:
 - Produce research quality improved infrared and visible radiance data sets, along with basic information on the radiative properties of the atmosphere, from which cloud parameters can be derived; and
 - Improve understanding of the Earth's radiation budget (top-of-the atmosphere and surface) and hydrological cycle.
- Global Water Vapor Project (GvAP)
- Surface Radiation Budget (SRB) Project
- Global Aerosol Climatology Project (GACP)
- Baseline Surface Radiation Network (BSRN)
- Global Precipitation Climatology Project (GPCP)

There is no Australian involvement on Radiation Panel or on Radiation projects

2.3.2 *Hydrometeorology Projects*

- Coordinated Enhanced Observing Period (CEOP)
- Global Runoff Data Centre (GRDC)
- International Satellite Land Surface Climatology Project (ISLSCP)

No Australian involvement on the hydrometeorology panel

2.3.3 *Continental-Scale Experiments (CSEs)*

This involves intensive studies of specific hydrological regions. Not International Scale by themselves, but do they form part of a larger picture.

Australian involvement is through the Murray-Darling Basin Project & Michael Manton. Researchers from ANSTO, co-operating with Macquarie University and the University of Technology (Sydney) have investigated the recent intensification of the Amazon Basin's hydrology and initiated a study of depletion of the Oxygen-18 isotope in the water of the Darling River. The latter is part of the newly approved Murray - Darling Basin GEWEX CSE project.

2.3.4 *Modeling and Prediction Projects*

- Working Group on Numerical Experimentation (WGNE)
- Working Group on Coupled Modelling (WGCM)
- GEWEX Atmospheric Boundary Layer Study (GABLS)
- GEWEX Cloud System Study (GCSS)
NOTE: CSIRO of Australia is involved in this project.
- Global Land/Atmosphere System Study (GLASS)
- Global Soil Wetness Project (GSWP2) Also tied in with the International Satellite Land-Surface Climatology Project (ISLSCP)
- Project for Intercomparison of Landsurface Parameterization Schemes (PILPS) (Project leader Ann Henderson-Sellers, ANSTO, Australia)

2.4 SPARC - Stratospheric Processes And their Role in Climate.

The goal of SPARC is to understand and model stratospheric impacts on climate. SPARC initiatives are designed to document and interpret indicators of stratospheric change such as trends in temperature, ozone, water vapour, and dynamics, and to improve the understanding of stratospheric processes that are needed for proper modelling of the climate system.

2.5 WOCE - World Ocean Circulation Experiment.

WOCE is a fundamental element of the WCRP scientific strategy to understand and predict changes in the world ocean circulation, volume and heat storage, which would result from changes in atmospheric climate and net radiation, by means of a combination of in-situ oceanographic measurements, observations from space and global ocean modelling.

There are currently no Australian members of the scientific steering committee.

3 International Human Dimensions Programme on Global Environmental Change (IHDP)

IHDP is an international, interdisciplinary, non-governmental science programme dedicated to promoting and co-ordinating research. Its aims are to describe, analyse and understand the human dimensions of global environmental change.

No Australians are currently on the IHDP Scientific committee.

IHDP presently has four Core Science Projects:

3.1 Global Environmental Change and Human Security - (GECHS)

The basic objectives of the project are threefold: 1) to promote research activities in the area of global environmental change and human security; 2) to promote dialogue and encourage collaboration among scholars from around the world; and 3) to facilitate improved communication (and cooperation) between the policy community, other groups, including NGOs, and the research community. The primary research question posed by the GECHS project is what are the relationships between global environmental change and human security?

Monash University is on the Scientific Steering Committee. One of the four project offices for GECHS is in Australia.

3.2 Institutional Dimensions of Global Environmental Change (IDGEC)

IDGEC's research agenda centers on the examination of the role of social institutions in causing, exacerbating and solving large-scale environmental problems. The analysis looks particularly closely at concepts of institutional fit, interplay, and issues of scale.

The core activities of IDGEC circle around three themes: ocean governance, forest use and carbon management; the circumpolar North and Southeast Asia are regional foci.

There is currently Australian representation on the Scientific Steering Committee, including a co-chair.

3.3 *Industrial Transformation (IT)*

The IT Project is an international, multi-disciplinary research initiative aimed at understanding complex society-environment interactions; identifying driving forces for change; and exploring development trajectories that have a significantly smaller burden on the environment on a global scale.

There is no Australian involvement in IT.

3.4 *Land-Use and Land-Cover Change (LUCC) – finishes in 2005*

LUCC is a joint project of IHDP and the International Geosphere-Biosphere Programme (IGBP). See Section 1.8 for details on this project.

4 DIVERSITAS

The goals of DIVERSITAS are:

- To promote integrative biodiversity science, linking biological, ecological and social disciplines in an effort to produce socially relevant new knowledge;
- To provide the scientific basis for an understanding of biodiversity loss, and to draw out the implications for the policies for conservation and sustainable use of biodiversity.

The DIVERSITAS secretariat implements the DIVERSITAS programme, and carries out the bulk of the networking activities. Its funding relies mainly (90%) on voluntary national contributions. The remaining 10% are provided by ICSU, SCOPE, IUBS and IUMS.

DIVERSITAS pursues its science plan in the form of 1) three core projects and 2) several cross-cutting networks. The core projects are:

4.1 *Discovering Biodiversity and Predicting its Changes*

Core Project 1 will contribute to assessing current biodiversity, developing the scientific bases for monitoring biodiversity changes, and provide critical knowledge about the processes that determine these changes, with a view to predicting future changes. Attention will be paid, however, to avoid duplication with initiatives that already exist.

Core Project 1 has 3 foci:

- Assessing current biodiversity
- Monitoring biodiversity changes
- Understanding and predicting biodiversity changes

4.2 *Assessing Impacts of Biodiversity Changes*

Core Project 2 will investigate how the biodiversity changes studied and predicted in Core Project 1 affect ecosystem functioning and ecosystem services

Core Project 2 has 2 foci:

- Impacts of biodiversity changes on ecosystem functioning and ecosystem services
- Impacts of biodiversity on health

4.3 *Developing the Science of Conservation and Sustainable Use of Biodiversity*

Incorporating information from Core Projects 1 and 2 into strategies that provide incentives for the sustainable use of biodiversity requires the integration of the natural sciences with political science, sociology and economics. Establishing such an interdisciplinary community of like-minded researchers is a primary aim of DIVERSITAS under Core Project 3.

Core Project 3 has 2 foci:

- Evaluation of the effectiveness of conservation measures and incentives for achieving the conservation and sustainable use of biodiversity.
- Establishing scientific approaches for optimising multiple uses of biodiversity, considering possible trade-offs between economic and environmental goals, and the uncertainty associated with novel developments.

Australia has no direct involvement with DIVERSITAS, and has no members on the Scientific Steering Committee. There is also no formal DIVERSITAS national committee (19 other countries do have these). The CSIRO and the Australian Network for Plant Conservation are involved in the DIVERSITAS collaborative research network.

5 *Joint ESSP Projects On Global Sustainability*

(Co-sponsored by IGBP, IHDP, WCRP and DIVERSITAS)

The aim of the joint projects is to build a global change-oriented research agenda of direct relevance for societies, with particular emphasis on four fundamentally important issues (carbon/energy, food, water and health). These projects aim to help understand the implications of human-driven changes in these systems for the functioning of the Earth System. The major Australian contribution to these joint projects is through the Global Carbon Project (GCP).

5.1 *FOOD: Global Environmental Change and Food Systems (GECAFS)*

The goal of GECAFS is to determine strategies to cope with the impacts of global environmental change on food provision systems and to analyse the environmental and socioeconomic consequences of adaptation.

5.2 *WATER: Global Water System Project (GWSP)*

The overarching scientific question addressed by the GWSP is how are humans changing the global water cycle, the associated biogeochemical cycles, and the biological components of the global water system, and what are the social feedbacks arising from these changes?

5.3 *CARBON - Global Carbon Project (GCP)*

The goal of the GCP is to develop comprehensive, policy-relevant understanding of the global carbon cycle, encompassing its natural and human dimension and their interactions. This is being addressed through three themes: (1) patterns and variability

(the current geographical and temporal distributions of the major stores and fluxes in the global carbon cycle); (2) processes and interactions (the control and feedback mechanisms – both anthropogenic and non-anthropogenic – that determine the dynamics of the carbon cycle); and (3) management of the carbon cycle (the points of intervention and windows of opportunity that exist for human societies to manage this system).

The GCP is run from a coordinating office in the Earth Observation Centre, Canberra, with a staff of two, and is supported through the AGO Australian Greenhouse Science Programme.

5.4 HEALTH - Global Change and Human Health

The fourth joint project is still under development. The objective of this project is to understand better the multi-faceted and complex linkages between global change (including climate change, land and sea use changes, global biodiversity loss and changes, global socio-economic changes) and human health. The initial planning meeting involved researchers from about 15 developed and developing countries, along with about 4-5 international agencies. The project has been approved by the ICSU Board, and is currently seeking funding.

* * * * *

6 Regional Activities

IGBP and the other programmes in the ESSP are responding to the regional challenge by undertaking their own capacity-building activities, carrying out research activities in all parts of the world, and collaborating closely with the Inter-American Institute for Global Change Research (IAI) and the Asia-Pacific Network (APN). In addition, the ESSP sponsors two types of regionally-oriented activities:

- START (the global change SysTEM for Analysis, Research and Training) See Section 1.7 for details on this programme.
- A small set of Integrated Regional Studies (IRS) is being developed to contribute sound scientific understanding to support the sustainable development of the region and to improve understanding of regional-global linkages in the context of Earth System dynamics. The Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) is the first study in this set. A companion study in Monsoon Asia is in the early stages of development.

* * * * *

7 Other

There are a number of organisations with international research projects on global climate change outside of the ESSP. The significant ones are:

7.1 Scientific Committee on Antarctic Research (SCAR)

SCAR is a scientific committee of ICSU, the International Council for Science, and is charged with the initiation, promotion and co-ordination of scientific research in

Antarctica. SCAR also provides international, independent scientific advice to the Antarctic Treaty system.

The membership of SCAR comprises the appropriate bodies of those national scientific academies or research councils which are the adhering bodies to ICSU and which are, or plan to be, active in Antarctic research, together with the relevant scientific Unions of ICSU. It includes the original twelve members and an increasing number of subsequent members.

There are three categories of membership: Full Members, ICSU scientific unions members and Associate Members. Full Members are those countries with active scientific research programme in Antarctica, currently 27 (including Australia); unions members are those ICSU scientific unions that have an interest in Antarctic research, currently 7; and Associate Members are those countries without an independent research programme as yet or which are planning a research programme in the future, currently 6. In addition, there are the Honorary Members of SCAR; those individuals who have, over many years, rendered outstanding service to SCAR and scientific research in the Antarctic.

The principal objectives of SCAR are:

- To initiate, promote, and co-ordinate international scientific activity in the Antarctic with a view to framing and reviewing scientific programmes of circumpolar scope and significance;
- To keep under review scientific matters pertaining to the integrity of the Antarctic environment, including the conservation of its terrestrial and marine ecosystems;
- To provide, upon request, scientific and technological advice to the Antarctic Treaty Consultative Meetings and other organisations, both governmental and non-governmental.

The structure of SCAR has been recently reorganized, and under the new structure several climate change programmes have been proposed. These are:

- Antarctic Climate Evolution (ACE)
- Antarctica and the Global Climate System (AGCS)
- Regional Sensitivity [in the Antarctic] to Climate Change (RiSCC).

* * * * *

7.2 *Ocean Drilling Programme (ODP) and the Integrated Ocean Drilling Programme (IODP)*

ODP is set to end up shortly and become the IODP. Australia's (through GA) membership in IODP (Integrated Ocean Drilling Programme) ceased on 1 July 2003, and whether Australia rejoins depends on how IODP evolves and how the Australian marine geoscience community perceives the need to be involved.

* * * * *

7.3 *Network for the Detection for Stratospheric Change (NDSC)*

NDSC is represented by a series of research stations for observing and understanding the physical and chemical state of the stratosphere (there is a station in

Wollongong). Ozone and key ozone-related chemical compounds and parameters are targeted for measurement. The NDSC is a major component of the international upper atmosphere research effort and has been endorsed by national and international scientific agencies, including the International Ozone Commission, the United Nations Environment Programme (UNEP), and the World Meteorological Organisation (WMO).

The principal goals of the network are:

- To study the temporal and spatial variability of atmospheric composition and structure in order to provide early detection and subsequent long-term monitoring of changes in the physical and chemical state of the stratosphere and upper troposphere; in particular to provide the means to discern and understand the causes of such changes.
- To establish the links between changes in stratospheric ozone, UV radiation at the ground, tropospheric chemistry, and climate.
- To provide independent calibrations and validations of space-based sensors of the atmosphere and to make complementary measurements.
- To support field campaigns focusing on specific processes occurring at various latitudes and seasons.
- To produce verified data sets for testing and improving multidimensional models of both the stratosphere and the troposphere.

* * * * *

7.4 Australia-US Climate Action Partnership (CAP)

The partnership (set up in February 2002) focuses on practical approaches to dealing with climate change and contributes to the global effort to reduce greenhouse emissions. It will foster the exchange of scientific expertise, technology and innovation between our respective businesses and scientists.

The US and Australia have agreed on 19 projects under the Partnership, which include exchanging experience on the research and development of hydrogen fuel cell and clean coal technologies and facilitating the installation of sustainable remote power in developing countries. Each of the selected areas of activity is intended to benefit from joint application of US and Australian expertise, sharing of technology developments and Australia's proximity to key geographic regions in the climate system, such as Antarctica and the Indian and Southern oceans. The cooperation envisaged aims to reduce key uncertainties and improve the capacity of climate science to inform the policy making process.

Key outcomes of the CAP activities are expected to include:

- Enhanced climate models that more accurately represent critical processes such as those associated with radiation, aerosols and clouds;
- More effective integration and sharing of climate modelling results;
- Improved understanding of the role of Antarctica and the Southern and Indian Oceans in the climate system through maintenance of existing observing systems and development of new and enhanced ocean observing systems; and
- More complete understanding of changes in the global carbon budget through expanded observations in the Southern Hemisphere.

One of the key areas of focus for the initial work programme includes Climate Change Science and Monitoring. Under this are a number of projects:

- Evaluation of Climate System Models: to evaluate and improve the capability of climate system models to simulate climate variability and to represent processes, such as clouds, in the climate system. The contacts in Australia are the BMCR, and CSIRO atmospheric research. In the U.S. it is NOAA's Geophysical Fluid Dynamics Lab.
- Aerosols and Clouds: measure and explain the interactions between radiation and aerosols and clouds, and to improve representation of these processes in climate models. Australian contacts are in the BMRC, and CSIRO. And the contact on the U.S. side is the NOAA GFDL, with NASA Goddard, and the Atmospheric Radiation Programme.
- Roles of Southern Ocean and Antarctica in Climate: to advance our understanding of the roles of Antarctica and the Southern Ocean in the global climate system. Australia: CSIRO/CRC. U.S. side is the NOAA Office of Global Programmes.
- Role of the Indian Ocean in the Climate System: advance the understanding of the Indian Ocean's role in the Asian-Australian-African Monsoons and in the global ENSO phenomenon. Australia- CSIRO. U.S.- University of Hawaii.
- NCDC Collaboration Under the Climate Action Partnership NOAA Operational Model Archive and Distribution System (NOMADS): to address the growing needs for remote access to high volume numerical weather prediction and global climate models and data. Australia- Bureau of Meteorology. U.S.- NOAA national Climatic Data Center.
- Expansion of Baseline Atmospheric Measurements in the Southern Ocean: reduce uncertainty in the estimate of carbon dioxide fluxes from atmospheric composition measurements in the Southern Ocean Region. Australia- CSIRO/CRC. U.S.- NOAA Carbon Cycle Group/Climate Monitoring and Diagnostics Laboratory.
- Capacity Building in Developing Countries. Meeting the Needs for Improved Climate Monitoring Systems in the Pacific: to support the establishment and maintenance of robust and sustainable climate monitoring and climate data management systems in the Pacific; to support the training and infrastructure to ensure that all GCOS stations in the region are in sustained operation; and to build capacity among all of the National Meteorological Services in developing countries of the Pacific in the use of statistical climate predictions as a basis for climate-related risk management. Australia- Bureau of Meteorology. U.S.- NOAA/NESDIS.
- Applications of Ocean Observations for the Pacific Islands: determine applications of ocean observations that benefit the Pacific Islands; develop mechanisms to provide access to complex data and model products for developing countries; establish linkages between those who will produce and use the enhanced data products; enable active participation of the PICs in the observational programmes. Australia- Bureau of Meteorology. U.S.- NOAA, International Programmes.

Non-U.S. government projects include the following:

- Quantifying Soil Carbon Changes Accompanying Land-Cover change: to improve model predictions of soil carbon through collection and analysis of

field data and model predictions. Australia- CRC Greenhouse Accounting. U.S.- Woods Hole Research Center.

- Vegetation-Climate Feedbacks in Carbon Accumulation Across Aridity Gradients: investigation through field monitoring and development of models to look at interaction between vegetation type and climate. Australia- CRC Greenhouse Accounting. U.S.- Baylor University.
- Carbon Accounting in Forests at Different Temporal and Spatial Scales: evaluation and verification of carbon accounting methodologies against data collected at different spatial and temporal scales. Australia- CRC Greenhouse Accounting. U.S.- Woods Hole Research Center.

In addition to the US, Australia is progressing bilateral climate change collaboration with New Zealand, Japan and the EU and is working to enhance cooperation with China, and other key developing countries.

APPENDIX IV – OBSERVATION INITIATIVES

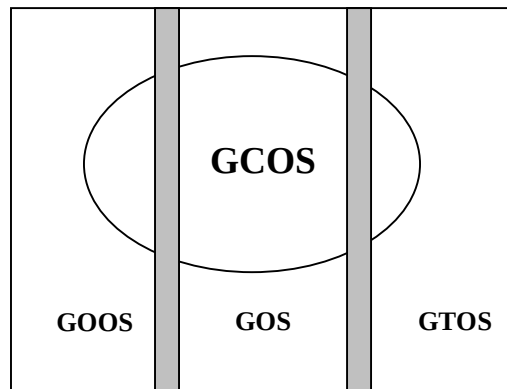
Table of Contents

1	Introduction.....	2
2	The Global Climate Observing System (GCOS).....	2
3	Global Ocean Observing System (GOOS).....	3
4	Global Terrestrial Observing System (GTOS).....	4
5	Global Observing System (GOS) of WMO.....	4
6	Global Atmosphere Watch (GAW) of WMO.....	4
7	Integrated Global Observing Strategy (IGOS).....	5
8	Indian Ocean Global Ocean Observing System (IOGOOS).....	5
9	Global Ocean Data Assimilation Experiment (GODAE).....	6
10	Array for Real-Time Geostrophic Oceanography (Argo).....	6
11	Scientific Committee on Oceanic Research (SCOR)	7
12	Committee on Earth Observation Satellites (CEOS)	8

1 Introduction

In addition to research networks implemented through international cooperation, there are global observing systems that have been established by the international community to ensure long-term consistent measurements are collected, archived and analysed for the benefit of all nations.

The international programme for each component of the Global Observing System is depicted in the diagram below:



There is clearly some (appropriate) overlap between the observing systems in each of the domains, and this is effectively managed by co-sponsorship of the major programmes and their subsidiary working groups and commissions. At this time, there is one significant application that cuts across all three domains, and this is climate. The Global Climate Observing System (GCOS) is the major international observational programme forming a earth observing system with the climate relevant components of the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS), and the World Weather Watch Global Observing System (WWW-GOS) and Global Atmosphere Watch (WWW-GAW). These core elements address the growing concerns over the extent and ramifications of possible climate change (Climate Activities in Australia 2001, Chapter 6). Please note that mention of individual scientists is not provided; at this juncture it is not possible to compile a fully comprehensive list.

* * * * *

2 The Global Climate Observing System (GCOS)

Sponsored by WMO, IOC, UNEP and ICSU.

GCOS was established to ensure the observations and information required to address climate change was readily available to all potential users. GCOS promotes and coordinates the long-term, user-driven monitoring of climate systems and climate change, and assesses the impacts of climate variability and change. While GCOS does not itself directly make observations or generate data products, it supports national and international organisations in their research towards improving the understanding, modelling and prediction of the climate system.

The GCOS Steering Committee has just completed the Second Report on the Adequacy of the Global Observing Systems for Climate. The report was prepared for the Subsidiary Body for Scientific and Technological Advice (SBSTA) to the UN Framework Convention on Climate Change. Australian scientists played a significant role in the preparation of this report, and have been very active in the development of GCOS over the last decade.

The objectives of GCOS are:

- Climate system monitoring, climate change detection and monitoring the impacts of and the response to climate change, especially in terrestrial ecosystems and mean sea-level;
- Climate data for application to national economic development;
- Research toward improved understanding, modelling and prediction of the climate system.
- Reduction of uncertainties in long-term prediction.

* * * * *

3 Global Ocean Observing System (GOOS)

Sponsored by the IOC, WMO, UNEP and ICSU.

GOOS is part of an Integrated Global Observing Strategy (IGOS) in which the UN agencies (UNESCO and its IOC; WMO, UNEP, and FAO) are working together and with ICSU and the satellite agencies (via the Committee on Earth Observation Satellites - CEOS). In that context, GOOS forms the ocean component of GCOS (the Global Climate Observing System) and the marine coastal component of the GTOS (the Global Terrestrial Observing System).

Australian scientists have played substantial roles in the development of GOOS, and in the establishment of the international bodies to maintain standards and coordination.

The vision guiding the development of GOOS is one of a world where the information needed by governments, industry, science and the public to deal with marine related issues, including the effects of the ocean upon climate, is supported by a unified global network to systematically acquire, integrate and distribute oceanic observations, and to generate analyses, forecasts and other useful products.

The primary objectives of GOOS are:

1. to specify the marine observational data needed on a continuing basis to meet the needs of the world community of users of the oceanic environment;
2. to develop and implement an internationally coordinated strategy for the gathering, acquisition and exchange of these data;
3. to facilitate the development of uses and products of these data, and encourage and widen their application in use and protection of the marine environment;
4. to facilitate means by which less-developed nations can increase their capacity to acquire and use marine data according to the GOOS framework;

5. to co-ordinate the ongoing operations of GOOS and ensure its integration within wider global observational and environmental management strategies.

* * * * *

4 Global Terrestrial Observing System (GTOS)

Sponsored by the FAO, UNEP, UNESCO and WMO.

GTOS is being established to provide monitoring of the global land surface. A major component of the terrestrial observing system is related to hydrological observations, and the World Hydrological Observing System (WHYCOS) of WMO provides a framework for the collection and dissemination of relevant data. Another element of environmental monitoring is managed by the Global Environmental Monitoring System (GEMS) of UNEP. It is appropriate to note that monitoring of the terrestrial system is the most fragmented and under-developed of the three domains.

Australia has minimal formal involvement in GTOS through work at the technical level only.

* * * * *

5 Global Observing System (GOS) of WMO

GOS provides comprehensive observations from both in situ and satellite-based instruments to support climate and real-time weather applications. The purpose of GOS is to provide, from all parts of the globe and from outer space, high-quality, standardized observations of the state of the atmosphere and ocean surface. GOS comprises observing facilities at stations on land and at sea, and on aircraft, meteorological satellites and other platforms. These facilities are owned and operated by the 185 Member countries of WMO, which includes Australia.

* * * * *

6 Global Atmosphere Watch (GAW) of WMO

The mission of the Global Atmosphere Watch is to:

- Make reliable, comprehensive observations of the chemical composition and selected physical characteristics of the atmosphere on global and regional scales;
- Provide the scientific community with the means to predict future atmospheric states, and to
- Organize assessments in support of formulating environmental policy.

GAW is considered the atmospheric chemistry component of the Global Climate Observing System (GCOS). Australian scientists continue to contribute significantly to the GAW.

* * * * *

7 Integrated Global Observing Strategy (IGOS)

IGOS is a strategic planning process involving a number of partners (the Global Observing Systems, FAO, ICSU, IOC, UNEP, UNESCO, WMO, CEOS, IGFA, WCRP and IGBP) that addresses how well user requirements are being met by the existing mix of international observational networks, and how these requirements might be better met in the future. Users include international decision-making bodies and organisations, national governments, non-governmental and public service organisations, the scientific community, the private sector, the media and the general public. IGOS serves as guidance to those responsible for defining and implementing individual observing systems (IGOS Bulletin, July 2003).

IGOS aims to:

- 1) Provide an overarching view to help improve understanding by governments of the significance of global monitoring;
- 2) Provide a framework for decisions to ensure continuity in the observation of key variables;
- 3) Offer a forum for exchange of information;
- 4) Identify gaps in existing observation systems;
- 5) Encourage specific activities to develop and enhance individual components of the strategy, and;
- 6) To promote amongst different user groups all aspects of strategy implementation by national and international agencies.

IGOS covers all forms of data collection concerning the physical, chemical, biological and human environment including the associated impacts.

* * * * *

8 Indian Ocean Global Ocean Observing System (IOGOOS)

IOGOOS is an Association of marine operational and research agencies in the Indian Ocean Region established during Indian Ocean Principals' Meeting held on November 8-9, 2001 at New Delhi.

19 organisations from 10 countries have become Members of IOGOOS and agreed to collaborate and work together for the implementation of GOOS in the Indian Ocean and for promoting activities of common interest for the development of operational oceanography in the Indian Ocean region. BOM, CSIRO and Curtin University are members of IOGOOS regional alliance by signing the MoU on November 5, 2002. Dr. Neville Smith is one of the Officers of IOGOOS.

Dr. Neville Smith, Dr. Gary Meyers and Prof. Mervyn Lynch are active contributors to IOGOOS in the field of Ocean and Climate, Ocean Observations and Remote Sensing Capacity Building. IOGOOS is presently formulating various projects for which the above scientists are playing a crucial role. The question of funding and deployment of scientists will arise only after the projects are formulated.

Members of IOGOOS will collaborate and work together to:

- Enhance the Ocean Observing System in the region,

- Promote and facilitate efficient and effective management, exchange and utilisation of oceanographic data,
- Promote programmes and projects in operational oceanography and ocean services in the region meeting the requirements of end-users,
- Strengthen capacity building for enhancing the capabilities in the region,
- Encourage research to support the needs of Users,
- Develop synergies with other ocean programmes and regional GOOS bodies, and Contribute to international planning and promotion of GOOS.

* * * * *

9 Global Ocean Data Assimilation Experiment (GODAE)

GODAE is a global system of observations, communications, modeling and assimilation that will deliver regular, comprehensive information on the state of the oceans, in a way that will promote and engender wide utility and availability of this resource for maximum benefit to the community.

The specific objectives are to:

- Apply state-of-the art ocean models and assimilation methods to produce short-range open-ocean forecasts, boundary conditions to extend predictability of coastal and regional subsystems, and initial conditions for climate forecast models.
- Provide global ocean analyses for developing improved understanding of the oceans, improved assessments of the predictability of ocean variability, and as a basis for improving the design and effectiveness of a global ocean observing system.

Operational and research institutions from Australia, Japan, United States, United Kingdom, France and Norway will be performing global oceanic data assimilation and ocean forecast in order to provide regular and comprehensive descriptions of ocean fields such as temperature, salinity and currents at high temporal and spatial resolution. This demonstration phase will be followed by a consolidation and transition phase from 2005 to 2007 where synthesis and transition to operational systems will take place. The process of defining and executing a range of Pilot Projects, work programmes and implementation tasks (including Argo – see below) has begun. An International GODAE Steering Team and a GODAE Office have been established with the support of GODAE patrons. Partnerships within the Integrated Global Observing Strategy are being used to integrate GODAE needs with other groups.

* * * * *

10 Array for Real-Time Geostrophic Oceanography (Argo)

Argo is a global array of 3,000 free-drifting profiling floats (funded by approximately 16 countries) that will measure the temperature and salinity of the upper 2000 m of the ocean. This will allow continuous monitoring of the climate state of the ocean, with all data being relayed and made publicly available within hours after collection.

Argo deployments began in the year 2000. The Argo array is part of the Global Climate Observing System/Global Ocean Observing System (GCOS/GOOS) and part of the Climate Variability and Predictability Experiment (CLIVAR) and the Global Ocean Data Assimilation Experiment (GODAE).

Australia contributes to the floats through funding from CSIRO – Marine Research (CMR), BMR and the Cooperative Research Centre for Antarctic Climate and Ecosystems, and has proposed a further 163 floats over the next 3 years.

Argo data will be used for initialization of ocean and coupled forecast models, data assimilation and dynamical model testing. A primary focus of Argo is seasonal to decadal climate variability and predictability, but a wide range of applications for high-quality global ocean analyses is anticipated.

* * * * *

11 Scientific Committee on Oceanic Research (SCOR)

SCOR is the leading non-governmental organisation for the promotion and coordination of international oceanographic activities. SCOR does not have the resources to fund research directly, but SCOR science activities focus on promoting international cooperation in planning and conducting oceanographic research, and solving methodological and conceptual problems that hinder research.

Presently, SCOR sponsors 12 working groups, addressing topics that range from coastal modelling to the use of ecosystem indicators in fisheries management and from the Asian monsoon system to transport of substances in marine sediments. SCOR working groups are often joint efforts with other organisations. SCOR has sponsored 109 other working groups in the past 45 years, which have completed their work.

In 2002, scientists from thirty-eight nations were members of SCOR. Australian scientists participate on about 70% of all SCOR groups, and Australia pays dues in Category II Membership (US\$4,820 in 2003). Compared to other nations in Category II, Australia has more representation on SCOR groups and thus gets more benefit from its membership in SCOR (Urban, pers. comm., 2003). There are V Categories for membership within SCOR, with V being the highest (current members of Category V are Japan, USA and Russia, and the 2003 dues are US\$30,485).

Australian Scientists Involved in SCOR Activities (as of July 21, 2003)

Group
WG 109 on Biogeochemistry of Iron in Seawater
WG 111 on Coupling Waves, Currents, and Winds in Coastal Models
WG 112 on Magnitude of Submarine Groundwater Discharge and its Influence on Coastal Oceanographic Processes
WG 113 on Evolution of the Asian Monsoon in Marine Records

WG 114 on Transport and Reaction in Permeable Marine Sediments
WG 115 on Standards for the Survey and Analysis of Plankton
WG 116 on Sediment Trap and Th-234 Methods for Carbon Export Flux Determination
WG 119 on Quantitative Ecosystem Indicators for Fisheries Management
WG 120 on Marine Phytoplankton and Global Climate Regulation
WG 121 on Deep-Ocean Mixing
Joint Global Ocean Flux Study – finishing up at the end of 2003.
Advisory Panel on Ocean CO ₂

* Full members are eligible to have their expenses paid for participating in group meetings. Associate members are able to participate fully in group activities, but must support their own costs of participation.

* * * * *

12 Committee on Earth Observation Satellites (CEOS)

The Committee on Earth Observation Satellites (CEOS) is an international organisation charged with coordinating international civil space-borne missions designed to observe and study the Earth. Comprising 41 space agencies and other national and international organisations (including Australia through CSIRO only), CEOS is recognized as the major international forum for the coordination of Earth observation satellite programmes and for interaction of these programmes with users of satellite data worldwide.

The main goal of CEOS is to ensure that critical scientific questions relating to Earth observation and global change are covered and that satellite missions do not unnecessarily overlap each other.

The three primary objectives of CEOS are as follows:

- To optimize benefits of space-borne Earth observations through cooperation of its participants in mission planning and in development of compatible data products, formats, services, applications, and policies;
- To serve as a focal point for international coordination of space-related Earth observation activities; and
- To exchange policy and technical information to encourage complementarity and compatibility of observation and data exchange systems.

Appendix V – Assessment Initiatives

The major international mechanism for *assessing* the current state of knowledge of climate change science is the Intergovernmental Panel on Climate Change (IPCC), which is sponsored jointly by the WMO and UNEP. Don't need a reference, it is well known and accepted.

Intergovernmental Panel on Climate Change (IPCC)

The joint WMO-UNEP Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to provide a broadly based assessment of knowledge of the science, impacts and response strategy options for dealing with climate change and which continues in existence as the principal international assessment mechanism in respect of human-induced climate change (Zillman, 1995).

The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on both peer reviewed scientific processes and intergovernmental mechanisms to take stock of the published output of the international climate change monitoring and research effort and presents the findings in a policy relevant but not policy-prescriptive form.

The IPCC has broken the assessment task into three major areas of activity dealing respectively with: Climate system science (Working Group I), Impacts and adaptation (Working Group II), and Mitigation (Working Group III)

Several agencies and scientists have key roles in the science aspects of the IPCC, and many work closely with the Australian Greenhouse Office (AGO) as the national focal point for government input to the Panel and its Working Groups. Individual scientists are nominated from a range of organisations such as BMRC, CSIRO, Universities, CRCs and State and Commonwealth government agencies. These scientists have been involved in all aspects of the assessment process since 1988, from conducting research that is included in the assessments, to writing contributions for chapters of the reports, compiling the chapters, convening the groups that compile the chapters, reviewing the assessments and to participating in the formal processes of the IPCC itself.

* * * * *

APPENDIX VI – GLOSSARY OF ACRONYMS

AAD	Australian Antarctic Division
AGO	Australian Greenhouse Office
AGSP	Australian Greenhouse Science Programme
AMP	Applications of Meteorology Programme
ANSTO	Australian Nuclear Science and Technology Organisation
ANU	Australian National University
APEC	Asia-Pacific Economic Cooperation organisation
APN	Asia-Pacific Network for Global Change Research
ARC	Australian Research Council
AREP	Atmosphere Research and Environment Programme
ARGO	Array for Real-time Geostrophic Oceanography
BAHC	Biospheric Aspects of the Hydrological Cycle (of IGBP)
BMRC	Bureau of Meteorology Research Centre
BOM	Bureau of Meteorology
CagM	Commission for Agricultural Meteorology
CAP	Climate Action Partnership
CAS	(WMO) Commission for Atmospheric Science
CCFS	Climate Change Forward Strategy
CEOS	Committee on Earth Observations Satellites
CLIC	Climate and Cryosphere programme (of WCRP)
CLIVAR	Climate Variability and Predictability (of WCRP)
CCFS	Climate Change Forward Strategy
CSE	Continental Scale Experiment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ENSO	El Niño - Southern Oscillation
FAO	Food and Agriculture Organization
GAIM	Global Analysis, Interpretation and Modelling (of IGBP)
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GDPS	Global Data Processing System
GECAFS	Global Environmental Change and Food Systems
GECHS	Global Environmental Change and Human Securities
GEWEX	Global Energy and Water Cycle Experiment (of WCRP)
GLOBEC	Global Ocean Ecosystems Dynamics (of IGBP)
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System
GOS	Global Observing System
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunications System
GWSP	Global Water System Project
HAS	Hydrometeorological Advisory Service
HWRP	Hydrology and Water Resources Programme
ICSU	International Council for Science (formerly International Council of Scientific Unions)
IDGEC	Institutional Dimensions of Global Environmental Change
IGAC	International Global Atmospheric Chemistry project (of IGBP)
IGBP	International Geosphere-Biosphere Programme

DRAFT ONLY

IGFA	International Group of Funding Agencies for Global Change Research
I-GOOS	IOC/WMO/UNEP Committee for GOOS
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions of Global Environmental Change Programme
IOC	Intergovernmental Oceanographic Commission
IODP	Integrated Ocean Drilling Programme
IOGOOS	Indian Ocean Global Ocean Observing System
IPCC	Intergovernmental Panel on Climate Change
ISSC	International Social Science Council
IT	Industrial Transformation
JCOMM	Joint (WMO/IOC) Technical Commission for Oceanography and Marine Meteorology
LOICZ	Land-Ocean Interactions in the Coastal Zone
MAB	Man and the Biosphere
NDSC	Network for Detection of Stratospheric Change
ODP	Ocean Drilling Programme
PAGES	Past Global Changes (of IGBP)
SCAR	Scientific Committee on Antarctic Research (of ICSU)
SCOR	Scientific Committee on Oceanic Research (of ISCU)
SOLAS	Surface Ocean Lower Atmosphere Study (of WRCF and IGBP)
SPARC	Stratospheric Processes and their Role in Climate (of WCRP)
START	System for Analysis, Research and Training (of IGBP)
TAR	Third Assessment Report (of the IPCC)
TCO	Technical Cooperation Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCP	World Climate Programme
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Climate Observing System (of WMO and the World Bank)
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (of WCRP)
WWW	World Weather Watch

Appendix VII – References

- 1) Climate Activities in Australia 2001, *Commonwealth Bureau of Meteorology, Melbourne, Australia.*
- 2) Green, R., & MacRae, D., (2002), *Evaluation of the Australian Greenhouse Science Programme, 2000-2003*, Report to the Australian Greenhouse Office, Canberra.
- 3) IPCC Third Assessment Report, (2001), *Intergovernmental Panel on Climate Change.*
- 4) IGOS – For the Monitoring of our Environment from Space and from Earth, (July 2003), *IGOS Bulletin.*
- 5) Zillman, J., (1995). How the International Climate Organisations and Programmes Fit Together, *World Meteorological Organisation.*