NIWA
Taihoro Nukurangi

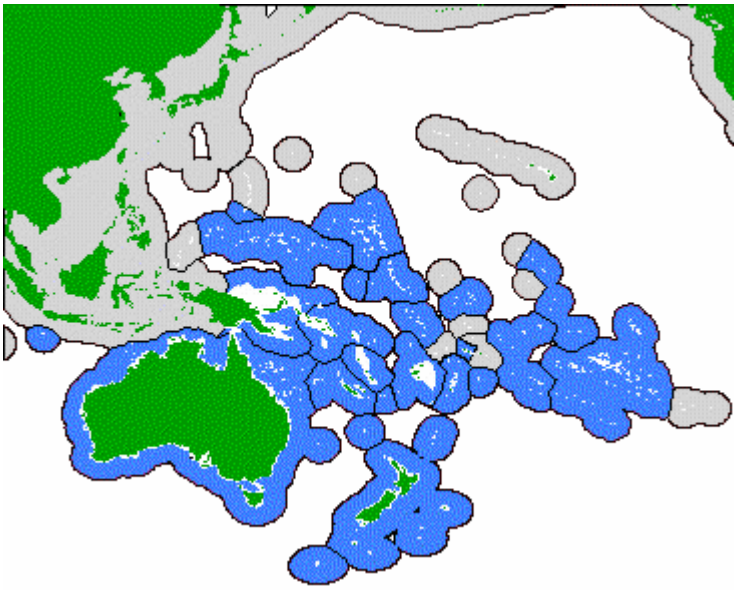
CLIMATE TRENDS AND VARIABILITY IN OCEANIA

Asia-Pacific Workshop on Climate Variability and Trends in Oceania

27 – 29 September 2000

Auckland, New Zealand

WORKSHOP REPORT



Organised by the National Institute of Water and Atmospheric Research
Funded by the Asia-Pacific Network for Global Change Research

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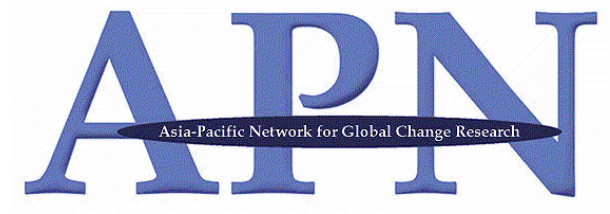

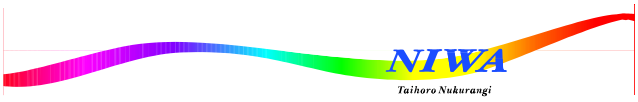

Climate Variability and Trends in Oceania

NIWA Report AK00140

The workshop *Climate Variability and Trends in Oceania* was organised by the National Institute of Water and Atmospheric Research, Auckland, New Zealand from funding provided by the Asia-Pacific Network for Global Change Research.

Workshop Report:
Edited by Dr Jim Salinger
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Climate Variability and Trends in Oceania

SUMMARY

Oceania occupies a large portion of the Pacific Basin, and climate and ocean/atmosphere interactions of global significance occur here on annual to decadal time-scales. These include the El Niño-Southern Oscillation (ENSO), and the Interdecadal Pacific Oscillation (IPO), an ENSO-like variation which modulate climate on time scales of two to three decades, which cause significant climate change in parts of Oceania and beyond. The aims of this workshop are to encourage regional participation in the global studies to monitor and detect trends and variability in climate.

By sharing experiences within the region, and by providing a forum for discussion, with access to resources available from the international scientific community, and specific recommendations for action, it is hoped that the workshop has taken a modest step towards enhancing both regional and national capacity for Oceania countries to determine and understand their climate variability and trends.

The workshop had wide involvement of Pacific Island Countries and national meteorological services in the region. Fiji, Tuvalu and Tonga are key collaborators with New Zealand and Australia, with involvement from nine other Pacific Island Countries, in collaboration with the South Pacific Regional Environment Programme (SPREP) and the WMO Sub-Regional Office in Apia. By this means it established contacts within Oceania to progress research on climate change and variability.

The first session of the Auckland workshop consisted of background papers on observed global and regional climate trends and variability, and climate change detection. A series of papers covered historical data resources and the removing of data biases through homogeneity analyses.

Workshop participants presented overviews on the second day of historical and observed climate data resources available in their own countries to study climate trends and variability, along with indications of analyses that had already been undertaken. There was a large variation in the range of data resources available; with some countries having a high quality reference climate station network, and data stored on Oracle relational databases with metadata, to those with a very sparse climate network and information stored on PCs. Many countries have a significant paper archive of data requiring digitisation.

In the last session on the second day methods of analysis of data for climate trends and variability were discussed, in particular selection of climate indices for analysis, time series analysis and establishment of significance of any trends.

On the final day of the Auckland workshop SPREP and the WMO Sub-Regional office presented regional perspectives. SPREP has surveyed the needs of meteorological services in the region and the results highlight an enormous variation in the resources and expertises of the national meteorological agencies, highlighted in annual budgets varying from US$10,000 to US$5 million. NIWA maintains a subregional Pacific community climate database (SPCCD) for many of the Oceania countries. Participants discussed the restoration of the data archive, access and operation. Individual countries require consultation on any enquires on their data from the SPCCD. It was agreed that Island data providers should receive a share of the costs in return if charges for their data procurement are made. At the moment some data series in the SPCCD are incomplete and NIWA will commence a programme of restoring this data to the SPCCD. It's primary purpose is as a resource for the countries that have lodged their data in the SPCCD, to provide security of the data and as a source of data for climate research.

In the final session of the day participants separated into two breakout groups. These groups addressed issues on Oceania data resources, analysis techniques and local and regional synthesis and collaboration. The breakout groups reported their conclusions to the final plenary session where recommendations were formed.

The participants noted that a follow-on APN workshop in October 2001 would be extremely desirable to progress the worked commenced at this workshop and over the ensuing year. The recommendations for action are that:

1 For the region, real-time data quality guidelines be developed so that all data being used is of similar standard. Countries should be encouraged to support climate data bases, including digitisation of data still only available on paper, with data archaeology to find and protect historical records, and adequate protection of computer climate databases. NIWA and the Bureau of Meteorology will provide assistance. The establishment of a standard meta-database with minimum requirements is very important. Metadata-bases should, where possible, utilise common software such as Microsoft Access. NIWA will establish a 'blank' metadata-base for common use.

2 An application is to be submitted to the Asia-Pacific Network for Global Change Research to hold a second workshop on climate variability and trends in Oceania for a week in late October 2001. This would continue the capacity building begun in the first meeting. The second workshop would prepare a paper on country and regional climate trends and variability for publication, and input into IPCC assessments of regional climate change and prepare reports on climate trends and variability for Oceania country state of the environment reports. This workshop would continue collaboration on climate change and variability work across Oceania, and improve capacity building for analysis of observed climate data.

3 Specific training programmes in statistical data analysis be introduced. Many Oceania states require specific training in statistical data analysis, commencing

from very basic principles and progressing to sophisticated time series techniques, to describe trends and variability in their data.

4The workshop recommendations and proceedings will be reported to the CLIPS participants workshop in Auckland, New Zealand (29 November – 15 December) for discussion.

5This project will provide direct input to the proposed programme on ethnographic perspectives on resilience to climate variability in the Pacific Islands. Knowledge on observed climate change and variability is essential for policy makers to assess and detect climate change. Direct input to this proposed APN programme would assist this process.

Finally, the workshop participants agreed to continue collaboration on this project through e-mail communication to progress the work and prepare for future research and workshops.

The workshop *Climate Variability and Trends in Oceania* was organised by the National Institute of Water and Atmospheric Research (NIWA) with funding from the Asia-Pacific Network for Global Change Research to assist Oceania countries monitor and detect climate change and variability.

Contents

Background to Workshop

The behaviour of the El Niño-Southern Oscillation (ENSO), which causes droughts or floods in many parts of the world, has been unusual since the mid-1970s (Trenberth, 1998). The ENSO is the major cause of global climate variability, after global warming, and is primarily driven out of Pacific basin ocean/atmosphere interactions. Recent analysis has uncovered that ENSO variations are modulated on timescales of two or three decades by the Interdecadal Pacific Oscillation (IPO). This variation is also centred on the Pacific basin, and causes significant shifts in climate on interdecadal time scales (Power et al. 1999, Salinger et al. 2000).

The Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report noted that "Over the Southern Hemisphere, analysis of decadal variability is difficult because of paucity of data" (Nicholls et al. 1996). The relative spareness of information with regard to past and future trends in Oceania indicates that further work is necessary to improve databases for monitoring climate trends and variability, and to develop a network of long-term climate monitoring sites in the region. This requires historical climate data extended back over long periods, and problems arising from changes in site, exposure and instrumentation need to be addressed. Documentation of climate variability and trends is therefore required to answer the above questions that current and future IPCC assessments will address, and extend previous knowledge on regional climate variability.

For the detection and attribution of climate change, particularly in Oceania, assembly of high-quality time series of climate data is required. This is obtained through the correction of time-varying biases as a result of changes in observing practices, instrumentation and sites. Equally important is the continuation of high-quality observations to monitor future variability and changes. Information for the South Pacific region, which is sparse, is critical to both assessing regional and global trends. The huge oceanic area covered (21 million square kilometres) and resource constraints amongst countries means that only limited work has been possible in recovering historical climate data, and analysing these for trends. The aims of the Auckland workshop are to encourage regional participation in the global studies to monitor and detect trends and variability in climate. The agenda is listed in Appendix 1.

1 Introduction

The meeting began with opening remarks from Dr Rick Pridmore (Deputy Chief Executive, NIWA) and Mr Joo Tick Lim (President, World Meteorological Organisation for Regional V).

Dr Jim Salinger outlined the goals of the workshop, which is to provide a focus on the mix of science and policy, with emphasis on inter-country participation and collaboration. The purpose of the workshop is to develop contacts and networks, and to assess the state of data sets and data analysis in the south west Pacific. Specific goals include:

- Identify contacts within Oceania region to progress work on climate change and variability
- Identify the status and availability of relevant historical climate data in the region

- Discuss existing work in the region on the analysis of climate trends and variability
- Identify appropriate methods for analysis of climate trends and variabilty
- Establish a collaborative project to analyse the national climate records for trends and variability across Oceania
- Improve capacity building for improved information on climate change and variability
- Prepare a report on the workshop for the Asia Pacific Network, the Intergovernmental Panel on Climate Change (IPCC), the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP).

Climate scientists were urged by Hilia Vavae (Tuvalu) to travel to South Pacific Island nations, perhaps holding future workshops outside of New Zealand or Australia. Direct visits were perceived as very useful for Island states, where there is often a lack of local scientific support and resources. The APN Extremes workshop held in Melbourne in December 1999 assumed only the simplest hardware (PCs) and the use of standard packages (Excel), a model that would be useful for future meetings and software distribution.

Dr Jim Salinger (New Zealand) presented material on global and regional scale climate variability. Global surface temperatures have warmed by 0.4 to 0.8°C since the late 19th century, and the 1990s were probably the warmest decade of the last millennium. Pacific Island and surface ocean temperatures have risen by 0.5 to 0.8°C during the 20th century and ENSO behaviour has been unusual since the mid-1970s. The IPO causes climate shifts every 20 to 30 years, with changes in mean values of temperature and rainfall. Understanding of observed Oceania trends and variability is essential for the region and globe and provides a basis for detection and attribution of climate variability and change. World Meteorological Organisation (WMO) activities related to climate change were discussed by Luc Maitrepierre (New Caledonia). The WMO Climate Data and Monitoring Programme (WCDMP). WMO plans to make a range of climate analysis products through its Web site, under WCDMP. A recent WMO Commission for Climatology/CLIVAR meeting in Geneva emphasised analysis of extremes and urged the interchange of climate indices amongst research groups. WMO plans to replace CLICOM with CDMS (Climate Data Management System).

2 Historical Data Resources and Removing Data Biases

Climate station histories or metadata are essential in providing base information for removal of data biases. Dean Collins (Australia) outlined the importance of this information. Knowledge of the instrument, station history and exposure is essential for data interpretation and use. These allow correction for non-climatic influences and utilisation of quality control procedures and performance monitoring. Georgina Daw (New Zealand) showed that estimation of climate trends based on imperfect records was inevitable in the Oceania situation because of sparsity of observing networks. The methods used to analyse data must be the best possible to provide information in the circumstances.

David Bishop (Cook Islands Community) outlined how community-based projects can digitise old paper climate records from the Pacific Islands. The Northern Cook Islands are likely to be amongst the first to experience serious impacts of climate change. The main

aim of these community-based projects are to extend climate records and estimates of changes to determine when the islands should be evacuated. Maintenance of observing networks in these situations is quite crucial.

Malcolm Haylock (Australia) discussed homogenisation of time series, the purpose of which is to remove non-climatic human-induced changes is very important. Spatial and temporal scales of interest must be considered when developing homogeneity tests and methods. Site overlaps and the availability of a good network of reference stations is very useful. A number of numerical methods were presented, as described by Peterson et al (1998) (*International Journal of Climatology*, **18**, 1493-1517). Variations related to weather and climate, variability and change are often small compared to data inhomogeneities, which are caused by the movement of the observing station, changes in instrumentation, changes in the environment and changes in observing practice. There are many statistical tests available to detect data inhomogeneities, but all involve subjective decisions. The more details available for a particular climate station improves the ability of producing a high quality data series.

3 Historical and Observed Data Resources in Oceania

Many detailed country reports were received on historical and observed data resources. These are contained in Appendix 4.

Australia

There are currently about 790 daily synoptic reporting stations Australia wide, augmented by a network of more than 2800 real-time and about 4000 non-real-time rainfall stations. Data is stored in ADAM (Australian Data Archive for Meteorology), an ORACLE relational database. A digital metadata database has also been developed - SitesDb. Eventually, data from both these databases will be accessible by the public through the Internet.

A Reference Climate Station network of 104 stations has been established for monitoring long-term climate trends. In addition, a network of 224 homogenised temperature series extends from 1910. Monitoring of rainfall trends is through a network of 379 high-quality rainfall stations. Again, records extend mainly from about 1910.

Cook Islands

The available climate network consists of seven stations in total. The situation has been hampered by a severe cut of staff numbers in the mid-1990s due to the rise of economic rationalism in New Zealand. There is a preference for the development of local expertise in meteorology, rather than the provision of such services by foreign agencies.

Fiji

The available historical database consists of 424 stations, 284 of which are described as currently open. The current operational reporting network consists of 17 synoptic, 27 climate and 11 automatic weather stations. Of these, the Fiji Meteorological Service owns 23.

There has been a gradual shift towards the installation of automatic weather stations, with 7 synoptic stations having been converted. Manual comparisons were performed during the phase-in period. CLICOM software is being used for the digitising of climate data, with all data quality controlled twice, first manually and then through automatic techniques.

French Polynesia

The available network consists of 8 Météo-France manual stations, 4 automatic weather stations, and 79 territory climatological stations providing rainfall observations. 26 climatological stations also provide temperature data and 5 provide solar radiation measurements. Only the Rangiroa station has a relatively long data series, starting from the 1950s. There has been progress towards homogenisation using simple visual checks and also through the use of the objective MASH program.

New Zealand

New Zealand has made considerable progress in the establishment of high-quality historical and operational networks for climate change purposes. Presently, there is a network of 21 reference climate sites with historical documentation and homogenisation completed. Some of these provide climate records back into the 1860s, with earliest records commencing at Dunedin in 1853. There is scope for the expansion of the high-quality data network, and further historical documentation in the future.

New Caledonia

There are a total of 98 stations currently available for climatological analysis, consisting of 6 synoptic stations with Météo-France staff, 27 automatic weather stations, 51 raingauge sites and 15 climate stations with automatic data loggers. The present network is very dense, and generally the data is of high quality. Historically, there are 30 stations with more than 40 years of rainfall data, and 13 stations with more than 40 years of daily temperature recordings. There has been considerable progress in the analysis of data for trends and variability.

Niue

The current observation network consists of 3 stations, with 1 rainfall site, 1 climate site and 1 synoptic site. Data dates back to 1905, but has considerable inhomogeneities due to five site changes. There is a desire to expand the network, but resources are limited.

Papua-New Guinea

There are currently 14 major observing stations run by the Papua-New Guinea National Weather Service, most with records starting from the 1960s. There are about another 20 “allowance” stations and 15 climate stations. Many more stations records are available from the colonial period.

Climate stations that report monthly CLIMAT messages are predominantly run by companies with most observations taken using manual instrumentation. There are

currently five trained meteorologists in the service. CLICOM is used as the climate archive.

Samoa

Samoa has the longest observation series in the Pacific Island (from 1830s). Apia also has a relatively long record, having been run by German meteorologists during the period 1890 to 1920. There are currently two manual surface stations in the observation network with a further 12 AWSs located in Tuvulu, Samoa and American Samoa. Upper-air observations ceased in 1990.

Fifteen current stations are classified as climate stations. Prior to 1988 there were more than 30. The transmission of CLIMAT messages will recommence soon. CLICOM is used for climate archiving.

Tonga

The total available climate network consists of 13 stations, including 7 synoptic, 3 climate, 1 automatic weather station and 2 rainfall-only stations. The longest series commences in 1945. Progress in climatology is slowed by the fact that there are no climatologists on staff. Additional reliance on untrained observers hampers the quality of current observations. There is a real need for climatological training of staff and an upgrade to the archiving facilities for storing meteorological data. Floppy disks are currently used.

Tuvula

There are 12 open observation stations in Tuvalu with one (Funafuti) reporting upper-air observations. Of these, 6 are rainfall-only stations. Data is stored on floppy disks.

Vanuatu

Vanuatu has seven synoptic stations and about another 13 rainfall recording sites. There are a further 16 “auxiliary” rainfall sites run by companies. Data is stored in Excel and Lotus formats.

4 Analyses for Trends and Variability

4.1 CLIMATE INDICES

Malcolm Haylock (Australia) discussed Climate Indices, which are designed to represent some aspect of the climate simply. Indices designed to measure climate extremes are often based on daily rather than monthly mean data. There are two main methods to calculate such indices: parametric and non-parametric. Non-parametric methods include counting the frequency of events above or below a fixed threshold such as days below 0°C.

Analyses using such indices have demonstrated upward trends in the numbers of rain days over Europe and Australia, with strong decreases over parts of southeast Asia and Japan. Results of note from temperature-based indices include increases in the numbers of hot days over Australia and Europe, with decreases in southeast Asia. The frequency of warm nights has increased over Australia and southeast Asia, and decreased over Japan. Generally, numbers of cold nights and minimum temperature variability have decreased throughout the globe.

These are important indicators of change. The indices are required to clearly indicate the climatic elements they have been selected to show, and applicable to a variety of climates. Regional analyses using a consistent approach are very important for detecting large-scale changes.

4.2 TIME SERIES ANALYSIS

The purpose of time series analysis is to determine the behaviour of an element through time by examining trends, persistence and periodicity. Dr Jim Renwick (New Zealand) and Dr David Jones (Australia) discussed various aspects of these.

Time series analysis includes the determination of which timescales of variation are important using techniques such as harmonic analysis, which involves fitting a series with a smooth curve. Fourier analysis is a common method for this purpose.

The degree of persistence within a time series can be investigated using autocorrelation techniques. Strong positive autocorrelation is associated with “smooth” time series with low frequency (red noise), while strong negative autocorrelation is associated with “spiky” time series with high frequency (blue noise). Time series with autocorrelation close to zero are more random in nature (white noise).

Time series can be modelled with autoregression models, eg. the AR(1) model. Large positive AR(1) coefficients of about 0.7 (red noise) are typical of climate systems in which the largest amplitude changes are slow. Near-zero coefficients (white noise) have little memory between data points and are typical of some atmospheric series such as wind data. Strong negative coefficients (blue noise) involve series in which the largest amplitude changes occur rapidly and are generally not relevant to climate studies.

Spectral analysis can also be performed on a timeseries using techniques such as Fourier decomposition which involves representing the series as a sum of cosine/sine functions of differing periodicity.

However, observations of a trend in a time series do not in itself provide information on the causes. Stationary processes can indeed show trends because of sampling, and the significance of observed trends is dependent on the length of the sample. With short noisy data series, a true trend has to be stronger to show significance.

4.3 CLIMATE TRENDS

Some studies of climate trends analyses have been made for some countries. Those for Australia, New Caledonia, Fiji, French Polynesia and New Zealand were described.

Trends in New Caledonia have been analysed from 1951 to 1999. High quality data from four stations show a statistically significant increase in average temperature, but no clear trends in rainfall. New Caledonia is a very active region for tropical cyclone activity in the south Pacific. In Australia high-quality data shows warming, with minimum temperatures rising strongly in all seasons, and maximum temperature changes mixed over the 1950 – 1999 period. Upper air observations from 1958 reveal strong stratospheric colling, with weaker, but still significant warming in the troposphere. There is a decrease in southwest Western Australian rainfall due to a decrease in extra-tropical cyclone activity. Heavy rainfall on the Australian east coast has increased over the 1958 – 1992 period with increased cyclonic events. There has been a downward trend in total number of tropical cyclones in the Australian region from 1970, whilst a slight rise in the number of intense tropical cyclones.

For Fiji 1998 was the warmest year in records back to 1956. There has been a distinct upward trend in mean temperature over the 1956 – 1999 period, with all of two of the last fifteen years being above the normal. Marine and land surface temperature records from the New Zealand region show warming of 0.7°C over the 1871-1998 period. The temperature increase is modulated by the Interdecadal Pacific Osillcation. In French Polynesia three high-quality records spanning the period 1958 – 1999 show warming in the order of 0.2 – 0.4°C per decade.

5 Regional Perspectives

5.1 WORLD METEOROLOGICAL ORGANISATION

Henry Taiki (WMO) described WMO RA-V efforts in the climate variability and change area. WMO has an emphasis on capacity building, to meet Global Climate Observing System (GCOS), UN Framework Climate Change Convention (UNFCCC) and other requirements. It is expected the Climate Information and Prediction Services (CLIPS) workshop to be held in Auckland in November/December 2000 will be useful in this respect.

5.2 SPREP PACIFIC METEOROLOGICAL SERVICES NEEDS ANALYSIS

During 2000 the South Pacific Regional Environment Programme (SPREP) has been conducting a needs analysis of Pacific Island Meteorological Services, coordinated by Mr Penehuro Lefale. The aim of the SPREP Pacific Meteorological Services Needs Analysis is to identify strategies for the improvement of the Pacific Island National Meteorological Services. The outputs include:

- An understanding of the setting.
- The needs of the users in each Island state.
- Proposed projects for the development of the National Meteorological Services.
- Conclusions.

The survey documents consist of a single main report, supplemented with individual national reports from approximately 20 countries. Initial results have highlighted enormous variations in the resources and expertise of individual National Meteorological agencies, highlighted by annual budgets for meteorological services varying from approximately US$10,000 to US$5 million. Total cost of projects recommended by the survey amount to US$40 million.

5.3 SUB-REGIONAL CLIMATE DATABASE

NIWA holds a sub-regional climate database for parts of Oceania, with data from many Pacific Island climate stations. Dr David Wratt (New Zealand) outlined the operational philosophies applied. The data is available to be used and ease of access is most important. Web access is being developed so that it can be widely accessible. There will be a programme of restoration of Pacific Island data, to form a subregional Pacific Community Climate Database (SPCCD). The Pacific Island climate data is available for research and information services. Planned access arrangements are at no cost for contributors for their own data and a modest amount of other data.

5.4 ETHNOGRAPHIC PERSPECTIVES

Dr Jon Barnett (New Zealand) outlined studies the University of Canterbury is planning on how local Pacific communities have prepared for, endured, and recovered from environmental perturbations similar to those expected as a result of climate change. These will provide an understanding of how such communities have coped with environmental change in the past, and identify the contributions that ethnographic accounts can make for increasing preparedness for climate change and sea-level rise throughout Oceania. Cases to be examined include responses to droughts, cyclones, tsunamis and shoreline subsidence from the low-lying coral atolls in Kiribati to the mountainous areas such as those found in New Caledonia and Fiji. The mixture of locations and changes will enable identification between common resilience enhancing responses to climate, and those which are specific to each situation. The information will provide knowledge on how Pacific communities might best respond successfully to future climate change. The work will be strongly linked to the results from this workshop.

6 Breakout Groups

6.1 SOUTH PACIFIC DATA RESOURCES

Subregional Pacific Community Climate Database

Most discussion centred on the subregional Pacific Community Climate Database (SPCCD), and its restoration. There is a need to strengthen both local and regional synthesis and collaboration of data resources. Individual countries require consultation, in the first instance, on any enquires on their data from the SPCCD, maintained by NIWA. It was agreed that Island data providers should receive a share of the costs in return if charges for their data procurement are made. At the moment some data series in the SPCCD are incomplete and NIWA will commence a programme of restoring this data to the SPCCD. This will provide both security against data loss, and provide access for researchers. The SPCCD will be available as a backup for contributors.

Data can be received in various media for input: on paper forms or electronic files. It was agreed that data should be transmitted by the most convenient method, whether this is by facsimile, e-mail or post. Data provision to the SPCCD will be rewarded in kind, such as assistance to Pacific Islands with the development of their own databases, or assistance with the implementation of seasonal climate forecasting capabilities.

Proposed APN Workshop, October 2001

A new proposal for a 2nd Workshop on Climate Variability and Trends will be lodged with APN for October 2001. If the funding application is successful, the workshop will homogenise data, and examine regional and local trends. Participants will select the best climate stations for further analysis, preferably those having more than 30 years record extending back to the 1930s, with a relatively complete record.

Data types proposed for trend analyses include:

Metadata
Rainfall
Maximum and minimum air temperatures
Sea level information
Sea surface temperatures
Tropical cyclones

Metadata-bases should, where possible, utilise common software such as Microsoft Access. NIWA will establish a 'blank' metadata-base for common use.

6.2 ANALYSIS TECHNIQUES

Discussion was wide-ranging, covering many aspects of analysis and general data handling. The participants came from a variety of backgrounds, with widely different computer resources and research support. A few basic features were agreed upon:

- All countries manage some high quality climate data sets
- All countries have a good physical understanding of their local climate variability
- All have access to Microsoft Excel for data analysis

A few general themes emerged from the discussion:

- Most of the Island states would benefit from specific training in statistical data analysis, commencing from very basic principles and progressing to sophisticated time series techniques. Training in the use of Excel would also be useful. Some on-site training at Island Meteorological Services would be desirable.

- Development of a set of software routines (such as Excel macros) or guidelines for standard analyses, such as fitting trends, and homogeneity analysis. These would be distributed by e-mail.

- Discussion of techniques and exchange of information should not be limited only to long term climate change, but should include many aspects of descriptive and other

statistical methods, such as distribution fitting, extremes and return periods, basic summary statistics. Approaches should be aimed at meeting country needs for the community, such as engineering and public works, as well as addressing wider GCOS/UNFCCC requirements.

7 Recommendations

7.1 Regional database and collaboration

It is recommended that real-time data quality guidelines be developed so that all data being used is of similar standard. These would include exposure of instrumentation, type of instrumentation, recording procedures, and transmittal to the database. It was agreed that countries should be encouraged to support climate data bases, including digitisation of data still only available on paper, with data archaeology to find and protect historical data, and adequate protection of computer climate databases. NIWA and the Bureau of Meteorology will provide assistance.

It was recognised that the establishment of a standard metadata database with minimum requirements is very important. The metadata will include details on site locations, exposures, instrumentation and instrumentation types. Metadata-bases should, where possible, utilise common software such as Microsoft Access. NIWA will establish a 'blank' metadata-base for common use.

7.2 Follow-up workshop

An application is to be submitted to the Asia-Pacific Networkfor Global Change Research to hold a second workshop on climate variability and trends in Oceania for a week in late October 2001. This would continue the capacity building begun in the first meeting. The objectives of the second workshop would be to:

- Prepare a paper on country and regional climate trends and variability for publication, and input into IPCC assessments of regional climate change
- Prepare reports on climate trends and variability for Oceania country state of the environment reports
- Continue collaboration on climate change and variability work across Oceania
- Improve capacity building for analysis of observed climate data
- Contribute to CLIVAR and IGBP-START programmes on global change
- Provide direct input into the proposed APN human dimensions programme "Ethnographic perspectives on resilience to climate variability in the Pacific Island Countries"

The follow-on workshop would focus on techniques, and on interpretation of statistical results, with presenters to come from Australia, New Zealand and French Territories as available. All software will be developed in Excel.

The proposed workshop would be preceded by communication by e-mail, to clarify key questions, identify techniques, and to define key data sets for analysis. This preparatory work would include the identification of long climate records in the region, digitisation of

metadata and development of a standard set of standard analysis routines and macros for Excel spreadsheets to analyse trends and variability. A standard set of indices for each country to calculate from the list below is recommend.

Metadata
Rainfall
Maximum and minimum air temperatures
Sea level information
Sea surface temperatures
Tropical cyclones

Potential independent reference data such as sea surface temperatures for homogenising climate data series will be obtained.

The workshop would cover many aspects of statistical data analysis, from purely descriptive approaches, through to more complex time series and possibly multivariate techniques. Techniques to be covered might include pictorial methods (such as scatter plots, histograms, wind roses), descriptive statistics (percentiles, means and variance, definition of extremes), distribution fitting and return periods, correlation and regression, time series techniques (trends, autocorrelation, spectral analysis, time series models), significance testing by classical means and by randomised sampling, homogeneity analysis. The emphasis should be on standardised basic approaches, to ensure all participants have a similar understanding.

As much as possible of the resulting software, ideas and experience should be summarised and distributed electronically, either through the World Wide Web, or preferably by e-mail. Follow-ups to be mostly via e-mail exchanges, with future workshop(s) and on-site assistance desirable.

7.3 Training in Data Analysis

It is recommended that specific training programmes in statistical data analysis be introduced. Many Oceania states require specific training in statistical data analysis, commencing from very basic principles and progressing to sophisticated time series techniques, to describe trends and variability in their data. It was agreed that training in the use of Excel would also be useful. On-site training for capacity building is highly desirable.

7.4 WMO CLIPS Workshop

WMO will be holding a Climate Information and Predictions Systems (CLIPS) workshop in Auckland, New Zealand from 29 November to 15 December 2000. The workshop recommendations and proceedings will be reported to the CLIPS participants.

7.5 ETHNOGRAPHIC PERSPECTIVES ON RESILIENCE TO CLIMATE VARIABILITY

It was agreed that this project would provide direct input to the proposed programme on ethnographic perspectives on resilience to climate variability in the Pacific Islands. Knowledge on observed climate change and variability is essential for policy makers to assess and detect whether climate change is occurring in the region and determine the rate at which climate change is happening. Policy makers are then able to make decisions on the adaptive strategies required and further their vulnerability assessment studies. Direct input to this APN proposed programme would assist this process.

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APPENDIX 1: AGENGA

Asia-Pacific Network Workshop on Climate Variability and Trends in Oceania

Auckland, 27-29 September 2000

Venue: NIWA Conference Room, 369 Khyber Pass Road

Day One: Wednesday 27 September

Introductory Session

13:00 Registration
13:30 Welcome – Dr Rick Pridmore, Deputy Chief Executive, NIWA
13:40 Opening remarks – Dr Lim Joo Tick, President, WMO Regional Association V
13:50 Background to meeting (Jim Salinger)
14:00 Observed climate variability and trends – global and regional perspectives (Jim Salinger)
14:30 Climate change detection (Luc Maitrepierre)
15:10 Tea/coffee break

Session One: Historical Data Resources and Removing Data Biases
15:40 Climate station history documentation (Dean Collins)
16:10 Problems of data (Georgina Daw)
16:20 Data entry (David Bishop, Cook Islands Community)
16:30 Homogeneity analysis (Malcolm Haylock)
17:00 Regional Perspectives (Henry Taiki, WMO Sub-Regional Office, Apia
17:20 Close

17.30 Reception – NIWA, 269 Khyber Pass Road

Day Two: Thursday 28 September

Session Two: Country reports on historical and observed climate data resources
08:30 Dean Collins – Australia
08:50 Arona Ngari – Cook Islands
09:10 Ashmita Gosai - Fiji
09:30 Alex Finet – French Polynesia
09:50 Kirion Kabuateita – Kiribati
10:10 Tea/coffee break
10:40 Luc Maitrepierre – New Caledonia
11:00 Jim Salinger – New Zealand
11:20 Sionetasi Pulehetoa – Niue
11:40 Jimmy Gomoga – Papua New Guinea
12:00 Faatoia Malele – Samoa
12:20 Lunch
13:20 Paul Cheeseman – Tonga

13:40 Hilia Vavae – Tuvalu
14:00 Mercy Nalawas – Vanuatu

Session Three: Climate data analysis for trends and variability
14:20 Analysis of time series (Malcolm Haylock)
14:40 Time series analysis (Jim Renwick)
15:00 Climate trends (David Jones)
15:20 Tea/coffee
15:50 Analyses from Australia – David Jones
16:10 Analyses from Melanesia (PNG, New Caledonia, Vanuatu, Fiji)
16:30 Analyses from Polynesia (Kiribati, Tuvalu, Samoa, Niue, Tonga, Cooks, French Polynesia)
16:50 Analyses from New Zealand and surrounding oceans (Ningbo Jiang)
15:10 Close

19:00 Workshop dinner Pearl Gardens Restaurant 1 Teed Street, Newmarket

Day Three: Friday 29 September

Session Four: The regional view
08:30 Penehuro Lefale – SPREP
09:00 Ethnographic perspective on climate variability – Jon Barnett
09:20 Climate database – David Wratt
09:40 Tea/coffee
10:10 Climate data archive – Stuart Burgess
10:30 Outline of tasks and membership of groups (Jim Salinger)
10:40 Breakout groups: 1. South Pacific data resources
2. Analysis techniques
3. Local and regional synthesis and collaboration
12:30 Lunch
13:30 Break out groups continue
14:30 Tea/coffee
15:00 Plenary: presentations from breakout groups and general discussion
16:30 Follow on research and workshop
17:00 Close

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APPENDIX 3. LIST OF ACRONYMS

ADAM	Australian Data Archive for Meteorology
APN	Asia-Pacific Network for Global Change Research
AWS	Automatic weather station
CDMS	Climate Data Management System
CLICOM	WMO system for inputting climate data
CLIPS	Climate Information and Prediction Systems
CLIVAR	Climate Varaibility and Predictability
ENSO	El Niño-Southern Oscillation
GCOS	Global Climate Observing System
IGBP	International Geosphere Biosphere Program
IPCC	Intergovernmental Panel on Climate Change
IPO	Interdecadal Pacific Oscillation
NIWA	National Institute of Water and Atmospheric Research
SPCCD	Subregional Pacific Community Climate Database
SPREP	South Pacific Regional Environment Programme
START	System for analysis, Research and Training
UNFCCC	United Nations Framework Convention on Climate Change
WCDMP	World Climate Data and Monitoring Programme
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation

APPENDIX 4. COUNTRY REPORTS