PROCEEDINGS OF THE MEETING OF THE CCl OPAG3 EXPERT TEAM ON CLIPS OPERATIONS INCLUDING PRODUCT GENERATION WITH AN EMPHASIS ON COUNTRIES IN NEED

(Arusha, United Republic of Tanzania, 12 - 15 October 2004)

WORLD METEOROLOGICAL ORGANIZATION

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1 OPENING OF THE MEETING

1.1 The Commission for Climatology (CCl) Expert Team (ET) on CLIPS Operations including product generation, with an emphasis on countries in need met in Arusha, United Republic of Tanzania, from 12 through 15 October 2004. Mr Tibaijuka, lead expert for the ET, welcomed the participants, performed introductions and briefly pointed out the role and priorities of the ET.

1.2 On behalf of the Secretary-General of the World Meteorological Organization, Mr Michel Jarraud, Mrs L. Malone welcomed the distinguished guests and invited experts to the meeting. The priorities of the Commission for Climatology (CCl) developed at the thirteenth session of the Commission, in Geneva, Switzerland (21-30 November 2001), including those of this ET were reviewed. The importance and benefits of the work of this ET to the climate community and to all types of users of climate information were highlighted. She thanked the government of the United Republic of Tanzania for hosting the meeting and the Tanzania Meteorological Agency for providing excellent facilities.

1.3 Dr Mhita, President of Regional Association I and Director General of the Tanzania Meteorological Agency (TMA), welcomed the group to Tanzania and declared the meeting open. Dr Mhita spoke of recent extreme weather and climate around the world and the devastating impacts to socio-economic development in many countries. Data, information and products on climate are vital tools in the efforts to help individuals, communities, governments make effective decisions, build effective disaster prevention and mitigation policies, and to thrive in a changing environment. Dr Mhita reviewed the responsibilities of the ET and noted the importance of providing guidance on practical issues such as development of effective tailored products to meet the various needs of users in specific sectors. He highlighted the necessary synergy between this ET, and others (particularly ET on End-user liaison) in meeting these goals. Dr Mhita expressed appreciation to the WMO for its support to CLIPS initiatives and emphasized the importance of CLIPS programmes to many countries, for enhancing knowledge, capacity, partnerships and experience in many technical and service aspects of the work. See **ANNEX III** for the full text of Dr Mhita's address.

2 ORGANIZATION OF THE MEETING

2.1 The participants unanimously approved the WMO nomination of Mr Tibaijuka, the leader of the ET on CLIPS Operations and Mr Kadi (Co-chair of CCl OPAG 3) to be the meeting co-chairmen.

2.2 The provisional agenda was reviewed and approved as written (see **ANNEX I** for the final version). The list of Participants is provided as **ANNEX II**.

2.3 It was agreed that the working hours for the meeting would be from 09:00 to 12:30 and from 14:00 to 17:30 daily, with the close of the meeting at noon, 15 October. The meeting would divide into small breakout groups for discussion of details of development of the Guidelines on best operational practices in generation of products for end-users and other topics as needed.

3 REVIEW OF ACTIVITIES RELATED TO THE TERMS OF REFERENCE OF THE EXPERT TEAM ON CLIPS OPERATIONS INCLUDING PRODUCT GENERATION

3.1 Introduction and background (P. Tibaijuka)

3.1.1 Mr Tibaijuka noted the retirement of Dr Jose (PAGASA, Philippines) and welcomed Dr Hilario of the Philippines to the ET. He agreed to present the status of work on ToR (a), as Mr Chang could not attend this meeting.

3.1.2 Mr Tibaijuka gave a detailed review of the process that established the CCl OPAGs in 2001. He reviewed the Terms of Reference (ToRs) for the ET and indicated that some amendments had been made on them in 2002, in collaboration with the OPAG chair (Dr Mike Harrison), and that a statement of needs and opportunity had been developed and circulated amongst members then as well. Based on these statements a work plan was developed and agreed upon by the leader of the team and the OPAG Chairs. Consequently the team agreed to work on the agreed ToRs with each team member working as a focal point on one of the ToRs.

3.1.3 Two reports had so far been compiled and sent to the OPAG Chair and subsequently the CCl President for compilation of annual reports as necessary. It was pointed out that some amount of work had been done particularly on ToRs (a), (b), (f) and (g). Some work had been done on others but reports had not reached the relevant authorities prior to the meeting. It was however realized that other members had done some work, which would be submitted at during the course of the meeting.

3.1.4 The objectives of the meeting were noted: to review progress made in undertaking various ToRs, to identify gaps and barriers for making progress, and to recommend and plan the way forward before the next CCl meeting in 2005.

3.2 The WMO/CCl framework for carrying out the priorities of the Commission (L. Malone)

3.2.1 The structures and goals of the WMO World Climate Programme (WCP) were discussed, as were the objectives and activities of the World Climate Applications and Services Programme (WCASP) and CLIPS Project. In particular, the core interests of the CCl were presented, along with an overview of the current CCl Management Group structure, which includes three Open Area Programme Groups (OPAGs): Climate Data and Data Management; Monitoring and Analysis of Climate Variability and Change; and Climate Applications, Information and Prediction Services.

3.2.2 It was noted that there are often mandates and activities in common between the ETs within each OPAG, sometimes between ETs in different OPAGs, and occasionally, between activities in different Commissions, particularly the Commission for Hydrology, the Commission for Basic Systems and the Commission for Agricultural Meteorology. It is very important to coordinate similar or related activities amongst all relevant WMO expert groups.

3.3 Actions to update NMHS and RCC requirements for input of dynamic and statistical forecasts, observational data and training for the generation of

climate outlook products (P. Tibaijuka on behalf of W.L. Chang)

3.3.1 Mr Tibaijuka presented a brief summary of the progress made to date by Dr E. Chang on TOR (a) which reads: To keep under review and update the list of NMHS and RCC requirements, as listed in the General Summary of the Session of the Intercommission Task Team on Regional Climate Centres (WMO/TD-No.1070, WCASP-52) for input of dynamic and statistical forecasts, observational data and training activities, to enable the generation of climate out-look products.

3.3.2 In his report Dr Chang indicated that he contacted some NMHSs and other specialized centres to establish their requirements in terms of observational data, forecasts and training activities to enable them to generate climate outlook products. He also indicated that some of the information was obtained from the institution's websites. He rightly pointed out that not a single RCC had been launched officially by the time of review hence the survey would be limited to the existing NMHSs and specialized centres. The survey is not exhaustive, but aims to provide some insight into the parameters most commonly used in the generation of climate outlooks, and the format of the presentation of these outlooks. Preliminary survey results on Climate Outlook Products from various institutions included the following:

a) The Bureau of Meteorology (BOM), Australia, issues seasonal forecasts of the probabilities of temperature and precipitation being above or below the median in the coming three months. These forecasts are based on statistical analysis. Seasonal outlooks on tropical cyclone activity for Northwest and North Australia based on statistical methods are also provided.

b) The National Climate Centre (NCC) of the China Meteorological Administration (CMA) uses dynamic modelling to issue monthly forecasts of temperature and rainfall anomalies.

c) The European Centre for Medium Range Forecasting (ECMWF) uses coupled ocean-atmosphere circulation models to produce, on an experimental basis, outlooks on the mean anomalies of the three variables sea level pressure, surface temperature and precipitation, as well as the probabilities of these variables exceeding their respective climate medians.

d) The Hong Kong Observatory uses statistical and analogue methods in formulating forecasts. The Department of Physics and Materials Science at the City University of Hong Kong issues, in May, outlooks on the number of tropical cyclones occurring in the western North Pacific and the South China Sea as well as the number of tropical cyclones making landfall on the south China coast between Hainan and Xiamen during the year.

e) Using an atmospheric global circulation model, the Tokyo Climate Centre of the Japan Meteorological Agency (JMA) issues climate forecasts up to 28 days ahead. The elements forecast are mean sea level pressure, 500 hPa geopotential heights and 850 hPa temperatures.

f) The Korean Meteorological Administration (KMA) issues three months forecasts of rainfall, 850 hPa, sea level pressure, 500 hPa and 200 hPa height and temperatures.

g) The UK Meteorological Office uses a coupled atmospheric-ocean general circulation model to produce probability forecasts of rainfall and temperatures exceeding their

respective climate normals.

h) The Benfield Greig Hazard Research Centre of the University College London uses regression methods to issue outlooks on tropical cyclone activity in the western North Pacific, Atlantic and Australian regions.

i) The Climate Prediction Centre (CPC) of the United States National Oceanic and Atmospheric Administration (NOAA) gives probabilistic outlooks on seasonal temperature and rainfall for the United States up to 12 months ahead. These outlooks are based on a combination of a coupled ocean-atmosphere model, optimal climate normal and canonical correlation analysis.

k) The Department of Atmospheric Science, Colorado State University, uses a combination of analogue and statistical techniques to issue outlooks on the number of tropical cyclones likely to affect the Atlantic basin during the year.

l) The International Research Institute for Climate Prediction (IRI) use a combination of an atmospheric global circulation model and canonical correlation analysis to issue on an experimental basis probabilistic seasonal outlooks of precipitation and temperature for the entire globe. The Seasonal to Interannual Prediction Project (NSIPP) of National Aeronautics and Space Administration (NASA) issues on an experimental basis forecasts of global rainfall and temperature anomalies up to 3 months ahead. The forecasts are based on a coupled atmosphere-ocean model.

m) The Experimental Climate Prediction Centre (ECPC) of the Scripps Institution of Oceanography uses an atmospheric global circulation model to issue, on an experimental basis, forecasts of temperature and precipitation anomalies for different regions of the world up to 12 weeks ahead.

3.3.3 In summary, some centres formulate their forecasts in deterministic terms, some in probabilistic terms and some give both. A number of centres issue their outlooks on an experimental basis. Empirical, dynamical as well as hybrid statistical/dynamical models are some of the methods used in formulating the climate outlooks. In particular, the dynamical models used include separate atmospheric global circulation models and ocean global circulation models as well as coupled atmosphere-ocean circulation models. The above survey suggests rainfall and temperature are the two parameters included in almost all the climate outlooks. Several centres also issue outlooks on tropical cyclone activity. Information on the data requirements by NMHSs and Centres such as the Drought Monitoring Centres (DMCs) in Africa has been requested and will be added later. Likewise data requirements for South America will be established from relevant centres and included in the report. See **ANNEX IV** for the 2004 report provided by Mr Chang subsequent to the meeting.

3.3.4 In discussion, a number of points were raised:

- ToR (a) is supposed to reflect the requirements for input, but the Chang report focuses on products produced;

- There is much happening in Africa, at DMC-Harare, the IGAD Climate Prediction and Applications Centre (ICPAC) and the African Centre for Meteorological Applications for Development (ACMAD) and in similar centres in other regions, that needs to be captured in this analysis. Websites for these centres would also be helpful information. WCASP Report No. 62 on Organization and Implementation of Regional Climate Centres lists some of these centres and can be downloaded from:

http://www.wmo.ch/web/wcp/clips2001/html/org_implementation_RCC.htm.

- The report needs to highlight training inadequacies in developing countries;
- Some countries do not have access to the data they need for outlook products. Barriers and challenges include data collection as well as data access, and also capacity to ingest and archive. WMO, along with funding agencies and the regional associations will need to work together to ensure data access;
- Model output is a type of data need, and that output needs to be available in a timely manner. Training is needed to be able to effectively use those inputs;
- In some locations, statistical analyses out-perform dynamical models;
- Verification is needed to objectively compare the output from various models, and local people need to be involved in verification of prediction information;
- Funding and sovereignty issues could affect willingness to implement RCCs. A demonstration or showcase project would do much to raise awareness;
- The Kimura report (a survey analysis) and the Pretoria report (CLIPS) will be useful in this exercise. The Kimura report can be downloaded from: http://www.wmo.ch/web/wcp/ccl/CS21C/wgrap_data4.htm. WMO will provide hard copies of the Pretoria report to the ET;
- WMO discussed the revision underway to TN145 on the socio-economic benefits of climatological services, and noted that donors are now often demanding hard data on the benefits as prerequisite to funding. The TN hopes to collect some examples of this type of evidence, and guidance needs to be provided to Members on how to collect and analyse such information sop as to attract funding. Verification can help in assessing the value of climate products.

3.4 A critical review of the status, preparation and presentation of monthly, seasonal to interannual predictions generated by climate outlook forums, NMHSs and various centres (S. Lellyett on behalf of J. Pahalad)

3.4.1 Mr Stephen Lellyett presented a progress report on behalf of Ms Janita Pahalad, who was unable to attend. Mr Lellyett's presentation followed the preparation and presentation components of Ms Pahalad's written report (the complete report with all background aspects is presented in **Annex V)**, and added some details relevant to activities in RAII. Non-exhaustive information was presented for RAs I, II, III and V. Also included was a non-exhaustive list of Problems and Issues relevant to ToR (b), plus some comments with regard to End-user Liaison, the Framework for Weather Information Systems (FWIS) and Climate Database Management Systems (CDMS) which, whilst outside the scope of ToR (b) were nevertheless relevant to the activities of the ET on CLIPS Operations.

3.4.2 Detail on RAV was the most comprehensive. Australia has an advanced operational statistical forecast system and has a dynamic GCM system currently under operational trial and development. Concurrent with this effort it is also undertaking a major AUSAID funded project to develop an NMS based climate prediction capacity and framework for input to agencies and industries in participating Pacific Island Countries (of which there are currently 9 South Pacific nations). This project will include training for NMS staff and end users, necessary hardware and software, and

installation of an operationally functional prediction system in each participating NMS. Australia is also providing support to South Pacific Nations through production and distribution of the South Pacific Seasonal Outlook Reference Material, which is a collection of diagnostic and prediction information of relevance to the region. Fiji operates an operational statistical climate prediction system, which is used to produce monthly forecasts extending 3 months into the future that are included in the Fiji Islands Weather Summary. New Caledonia was reported as internally using three sources of prediction information: An on-site simple statistical prediction system from Météo-France locally, the ARPEGE model from Météo-France in Paris, and the "Island Climate Update" (to be discussed next). These systems are run routinely internal to the Meteorological Service in New Caledonia, and a small number of specialist users receive advice routinely, but information is only released to the public in the advent of occurring or expected significant events. Finally, the Island Climate Update, collaboration between at least 10 contributors, is a consensus based forecast coordinated by New Zealand aimed at South Pacific Island countries involving a monthly teleconference and associated email and Internet exchange of information.

3.4.3 In RAI, COF13 for the Greater Horn of Africa was discussed and noted as a success, but it was acknowledged that for a higher level of completeness, the work needs to report on the activities of ACMAD, DMC-Harare and ICPAC.

3.4.4 In RAII, a Seasonal Climate Monitoring Workshop focusing on Indochina (Lao PDR, Vietnam and Cambodia) was reported on. It was noted that these countries are not yet at the stage of producing prediction outputs, as an urgent need still exists for a functional climate monitoring system. This meeting designed detailed development plans for each country and made a plea for international support in the form of an RCC. It was acknowledged that there is very large variance in capabilities within RAII, and that inclusion of further RAII examples is required for a higher degree of completeness and accuracy.

3.4.5 For RAIII, the COF3 for the west coast of South America was highlighted as a success; however it is also acknowledged that regional collaborations such as Mercosur need inclusion under this ToR.

3.4.6 Further work is clearly needed to expound the situation in RAIV and RAVI, in particular developing nations in the Balkans States of Eastern Europe and those in Central America, including existing regional collaboration in those areas.

3.4.7 The non-exhaustive list of issues identified included the following:

- Difficulty for end users interpreting and understanding probabilities.
- Mistrust of probabilistic information by end users.
- A lack of awareness of product availability on the part of end users.
- A lack of understanding on how to effectively apply forecast information on the part of end users.
- A lack of tailoring of applications toward various end uses.
- Failure of NMHSs to 'disseminate' information – lack of funds or misunderstanding of relevance.

- Costly maintenance and support of networks, including AWS.
- Lack of good quality, continuous records.
- Lack of digitized data holdings.
- Limited telecommunications infrastructure, or high cost of use.
- High end, high cost CDMS prototypes on offer.
- Complexity of objective verification, both for some NMHSs and end users.
- Lack of a consistent verification technique allowing comparison of forecast system performance.
- Lack of cost benefit studies, both on climate prediction, and the value of underpinning observations and their associated collection and archival infrastructure.

3.4.8 In discussion, it was agreed that regions other than RA V need more work, but that a good effort had been made. A need to partner with some other agencies (other sectors) to best reach some end-users was noted. The meeting agreed that wherever possible, economic assessments of the value of seasonal prediction needs to be gathered, for both general and tailored products, and that it is critical to educate the users to understand the forecasts, to work consistently with them while services and products are under development, so the output to users is continually improved. Decisions must remain in the hands of the users (forecasters cannot make their decisions for them), so they need to understand risks and uncertainties as well as forecast skill.

3.5 Research recommendations for consensus methodology, downscaling and multi-ensembles including their implications; and status of development of improved forecast methods to support applications (O. Baddour)

3.5.1 Mr Baddour described consensus methods based on the RCOFs example, and multi-ensembles and downscaling methodologies including their improved scores in comparison with single and ensemble methods. He also provided examples on the added value from downscaling based on the European DEMETER project and IRI. Considerations of the needs of NMHSs in implementation of these methodologies were provided. Potential for using these methods for improved applications was discussed and highlighted with examples from DEMETER project.

3.5.2 Implementation considerations of the various methods were described for consensus methodology and multi-ensemble and downscaling methodologies.

3.5.2.1 With respect to implementation of consensus methodology, factors to be considered include:

- Statistical models used by NMHS (in Africa) need update to include decadal to multi-decadal ocean variability to look for any changes in the relationships between variables;
- Prospect other sources of predictability (especially during neutral ocean conditions) such as pre-season conditions, soil moisture, worldwide precipitation teleconnection (e.g. INDIA-WEST AFRICA, SAHEL-NORTH AFRICA, SAHEL JAS – Caribbean typhoon season)

- Incorporate recent knowledge regarding the role of NAO in assessing and monitoring seasonal forecast (e.g. In North West Africa and Mediterranean area) and the relationships between ELNINO and NAO
- Compile forecast data from various RCOFs and perform score analysis at global scale using WMO verification standards (LEPS, RMSS, and ROCS).

3.5.2.2 With respect to implementation of multi-ensemble and downscaling methodologies, factors to consider include:

- Perform predictability studies using the existing hindcast data from DEMETER project
- Explore statistical downscaling performances at sub-regional and national level by using existing GCMS hind-cast data (EPS, M-EPS)
- Joint research-development work with leading climate centers IRI (USA), ECMWF (Europe), APCN (APEC) for dynamical downscaling of multi-ensemble model (experience OF IRI/ FUNCEME in Brazil is good to adapt in other RCCs and NMHSs).

3.5.3 Recommendations for implementing the various methods also include:

- Undertake good data set management project within each region and sub region to integrate RCOF data, DEMETER outputs, reanalysis data and observations;
- Involve regional and sub regional institutions in the research and development efforts for best coordination for the implementation and resources optimization;
- Use the existing facilities within regions and sub regions as supporting technical plate-forms to run joint projects with advanced centers;
- Run capacity building training on these methods for quick familiarization and startup of research paths (ACMAD/DMCs + CLIPS capacity building experience is good one to apply in this field); and
- Include research on seasonal forecast application in Agriculture, water resources and health sectors (multi-disciplinary research groups).

3.5.4 In discussion, it was suggested that DEMETER and CLIVAR groups liaise with DMCs and RCCs, to involve local people in downscaling and verification. As DEMETER is set for hindcast mode, and use of it requires training, then some capacity-building exercises would be needed before applications in the regions could happen. Mr Baddour was asked to add a paragraph about El Massifa in his report (the 'father' of DEMETER). DEMETER, when (eventually) run in forecast mode, should be able to incorporate statistical methods/systems. It was noted that WMO has set up standard verification methods, which will help with model intercomparisons. The work of OPAG 3 ET 3.2 on verification should therefore feed into the work Mr Baddour is doing on TOR (c).

3.6 Status of climate monitoring activities at various centres and their potential to meet user requirements (Round table discussion)

Noting that no document was available on this Term of Reference, the meeting decided to hold around table discussion on the status of climate monitoring at various centres and their potential to meet end user requirements. It was noted that this was an important item to be covered by the Expert Team and it was recommended that someone should be earmarked to lead this important task as highlighted in the revised work plan. Mr Brad Garanganga (DMC Harare) volunteered to take lead on the TOR.

3.7 Development of recommendations on preparation and provision of deterministic and probabilistic prediction information for various sectors (F. Hilario)

3.7.1 Dr Hilario discussed the fourth Term of Reference (ToR (d)) that is the development of recommendations on the preparations and provisions of deterministic and probabilistic prediction information for various sectors. She compared probabilistic and deterministic forecast and presented examples of these forecasts produced by various global climate prediction centers. She also discussed the flow of information/forecast from global scale through regional and national entities and that the process can follow several paths. She mentioned several issues to consider in the preparation of the forecast. These include among others, the particular needs of the various users, and the use of consensus process in making the final forecast product, how to make the forecast understandable and the limitations of the model used.

3.7.2 She also noted that continuous consultation with the users of climate forecast is important since different sectors have different needs. She also emphasized the need for a survey on the available forecast products (deterministic and probabilistic) in the global, regional and the national level. The conduct of information and education campaign among the various users was also recommended for better understanding of the forecast products.

3.7.3 In discussion, continuous consultation with users, through COFs and similar vehicles, was recommended in order to give the providers and users a chance to get to know each other's perspectives, strengths and weaknesses better, and to promote more effective use of the products. It is important to learn from the experiences of other countries. It was suggested that the work on this ToR take one or two sectors through to the end (for Agriculture, Hydrology, etc.). DMC-Harare and ICPAC are working to develop specific outputs for specific sectors, and could provide this for the work on this ToR. However, by highlighting several sectors in this manner, there is a risk of marginalizing the others.

3.7.4 With respect to skill in the forecasts, it was noted that poor performance can lead to loss of trust by the users, but that relationship-building with user groups must not wait until forecast efforts are perfect. The experience of CBS in dealing with weather forecast improvement revealed that users must be part of the process. The new THORPEX initiative was noted - an initiative that will address the gap period between 3-7 day weather forecasts, and monthly and longer forecasts.

3.8 Progress in creating a 'Terminology' for operational prediction activities (P. Tibaijuka)

3.8.1 Mr Tibaijuka presented a draft glossary of meteorological terminology used in prediction. Sources for the information included WMO, BOM, AMS, IRI, NCEP, UKMO, and others.

3.8.2 In discussion, it was noted that WMO has a multi-language International Meteorological Vocabulary (WMO No. 182) that should be consulted and used where appropriate, and that WMO developed a glossary of climate-related terms for the public as part of the 2003 book on Climate: Into the 21st Century that could also provide WMO-approved definitions for the ET's glossary. WCP provided the latter in soft copy to Mr Tibaijuka.

3.8.3 The ET recommended that the glossary recognise regional differences in terminology, especially with respect to tropical storms, and that it include illustrations whenever this made the topic more understandable to the reader.

3.8.4 The ET might consider publishing a user-level version of the glossary, along with an overview of seasonal forecasting, in a brochure, with some assistance from WMO. Such a document would provide climate scientists consistent, plain language background information that would be useful in describing and marketing products to users. It could present several typical forecast products and an explanation of what the product provides the user, how a decision-maker might use the information, and what questions to ask the specialist.

3.8.5 It was noted that a technical version of the glossary could serve the NMHSs well, to ensure that all prediction terms including those on probability are clearly understood by forecast and service staff. The ET decided to target the scientific/technical community first (NMHSs, research groups, etc.) with the first version of the glossary, and to recommend that a user-friendly version be prepared at a later date, with input from the ET on end-user liaison (ET 3.6).

3.9 Proposed outline for Guidelines for best operational practices in generation of products for end-users (H. Lu)

3.9.1 Dr Lu reviewed a preliminary draft for the Guidelines, which covered an introduction to climate and generation of climate information; elements of climate information; climate monitoring, data, diagnosis, models and simulation, and prediction; and applications of climate information, including products and assessments for climate sensitive industries.

3.9.2 In discussion, it was noted that several of the proposed topics would fall more into the domain of CBS (e.g. communications issues), and several others were perhaps not necessary to meet the terms of reference of this ET. It was noted that the Guidelines could cover how to generate, disseminate and monitor the products required by the users. The ET welcomed this solid first draft for the outline for the Guidelines, which served as an excellent basis for group discussion on the intent and audience for the Guidelines under agenda item 5.

4 OPERATIONAL ACTIVITIES AND FUTURE PLANS OF SPECIALIZED CENTRES (e.g. ICPAC, DMC- Harare, ACMAD, CIIFEN, etc.)

4.1 DMC - Harare (B. Garanganga)

4.1.1 Mr B. Garanganga described the operational activities of the SADC Drought Monitoring Centre and its future plans. The Drought Monitoring Centre was formed in the late eighties as part of a Regional Strategy to mitigate negative impacts of adverse weather climate. It is responsible for 14 SADC Member States. It has been provided financial resources by cooperating partners over the years, initially for all operational activities. However, since 2002, SADC has been providing funds for core activities while the donor community's countries provide resources for programming activities such as the SARCOF attachment programme, etc.

4.1.2 SADC has been providing 10 daily and seasonal forecast products for the region during the rainy season. It carries out capacity building workshops for NMHS personnel and also the user community in order to enable the two to faster better working relationships. The users will understand better how to interpret the products from the NMHS/DMC and other advanced centres through these user workshops.

4.1.3 The centre has helped train personnel from NMHS's in climate monitoring, prediction and application through workshops and attachments. It has helped organize SARCOFS and, in the process, train the user community in application of climate production for particular use. There are plans to carry out more operational research in order to be of better services to the communities. However, there are constraints of human and equipment resources due to inadequate funding. The SADC DMC has made a useful contribution in mitigating negative impacts of adverse climate to socio-economic development.

4.1.4 In discussion, it was noted that data and communications are critical issues for the SACD region. In some countries, observation infrastructure has been damaged or destroyed in conflicts, and communications lines and the Internet are not stable resources. The ET noted the benefits of development of written procedures for operational practices.

4.2 ICPAC (C. Oludhe)

4.2.1 The goals and objectives of ICPAC were reviewed, as well as operational activities, which include data processing, data management, climate monitoring, climate prediction and early warnings, development of climate applications, identification of zones of risk, capacity building activities, COFs, pilot projects, etc. Products include statistics, monthly to seasonal predictions, trends and time series, drought severity indices, and consensus climate outlooks. Climate monitoring indices used include SSTs, SST gradients, ENSO indices, number and severity of tropical cyclones, the QBO, the ITCZ, rainfall, winds, air temperature and humidity.

4.2.2 Achievements of ICPAC include development of a database, identification and monitoring of climate hotspots, capacity building for climate scientists and user groups from the region, and a number of successful pilot projects. As well, there have been numerous training workshops held, on various technical issues and on downscaling for applications to health, food, water sectors, etc.

4.2.3 The meeting was informed that the future plans of ICPAC included the following:

- Strengthen the well established expertise in statistical climate modelling
- Enhance the capacity in dynamical climate modelling by running a running a regional climate models
- Run climate change scenarios using the dynamical models
- Develop techniques for downscaling climate information applicable to different social and economic sectors.

4.2.4 In discussion, it was noted that while much progress has been made, computer

capacity is still low, and the region would benefit from an enhanced data network. The database developed at ICPAC is not for public use, and users requiring data must request it from the countries in the region. Further, ICPAC does not issue warnings. This is the responsibility of the individual NMHSs.

4.3 ACMAD (O. Baddour, M. Kadi)

4.3.1 Dr O. Baddour described the climate activities at the African Centre of Meteorological Applications for Development (ACMAD). Within its Continental Mandate, ACMAD runs major activities on weather monitoring and weather forecast at the continental scale; climate monitoring and prediction; and for capacity building.

4.3.2 With respect to climate monitoring and prediction products, a continental climate watch is issued on the basis of monthly data collected through the WMO GTS. It gives the status of the monthly climate and ongoing various rainy seasons. It highlights important climate anomalies, mainly rain and temperature, and gives climate outlooks. The product used to be sent through various means of transmission including FAX, MDD and email, but it is also now put on the ACMAD web site http://www.acmad.ne. Climate prediction at present is based on what is produced by advanced climate prediction centers, but is mainly based on various Climate Outlook Forums in Africa.

4.3.3 Capacity building in climate monitoring and prediction is done within two programs. First, there is a visiting climatologists and meteorologists program for periods of 3, 6, 9, or 12 months, depending on the period permitted by the home institutions of the visiting experts. Second, there are the Climate Outlook Forums (COFs) and Pre-Forum workshops. These started in 1997, initiated by the Climate Unit, and have proven to be very successful.

4.3.4 Six weeks workshops are run, preceding various Outlook Forums with most focus on West Africa and Central Africa Sub-regions as a technical and scientific preparation for PRESAO and PRESAC, the Outlook Forums for both sub-regions respectively. Statistical Methodology was implemented in each of the participating NMHS's in these two programs. Equipment (PCs) and statistical packages were also provided to each NMHS to ensure minimum technical conditions for sustainability of the process. PRESAO is now at its 6th edition.

4.3.5 With respect to the Organization and coordination of Climate Outlook Forums, ACMAD is actively participating in organizing several Outlook Forums in Africa, and so far is directly coordinating the West African Climate Outlook Forum PRESAO and the Central Africa one PRESAC. An active Role was played by ACMAD in others such as PRESA-NORD (North African Region) and SARCOF (1999) in the South African Region and GHARCOF (1999) in the East African Region. This provided knowledge sharing and assistance in partnership with the two DMCs in Nairobi (now ICPAC) and Harare.

4.3.6 Other capacity building programmes include CLICOM Training for climate data Management with Strong Support of WMO/CLIPS, and the NOAA-supported Radio Internet (RANET) project for climate information delivery toward rural areas. Successful implementation was achieved within several member states such as Burkina Faso, Niger, Senegal, Uganda and Kenya, and an ongoing RANET project in Morocco is being demonstrated.

4.3.7 In discussion, it was noted that there are a number of experimental products sent directly to decision-makers, particularly in the hydrologic sector, to help them

manage water resources. As well, ACMAD is increasingly involved in development of applications for the health sector.

4.4 CIIFEN (P. Tibaijuka, B. Nyenzi)

4.4.1 CIIFEN activities and products were briefly described. As with other centres, CIIFEN does not issue warnings, but produces bulletins for the use of NMHSs in the region.

4.4.2 In Latin America, there are three COF areas. The one in Central America is supported by CCRH, and support is provided to clients such as sugar and banana producers. The MERCOSUR region includes Argentina, Brazil, Paraguay, and Uruguay. They have been holding COFs for more than three years. CIIFEN takes care of the western side of South America – Venezuela, Peru, Chile, Ecuador and Colombia. Three COFS have been hosted at CIIFEN, which was established in 2002. It is hoped to use technology to host virtual forums in future. Methods include statistical and dynamical techniques, using downscaled global products.

5 GUIDELINES FOR BEST OPERATIONAL PRACTICES IN GENERATION OF PRODUCTS FOR END-USERS

5.1 The meeting debated the proposed content of the Guidelines and the intended audience, and proposed that where possible, the Guidelines refer to (but not duplicate) the Guide to Climatological Practices (the draft text of Part 1 of the Third edition of the Guide to Climatological Practices is available at:

http://www.wmo.ch/web/wcp/ccl/CClguide/app_sects3ed/appr_sec_rev_2.html)

5.2 In order to assess the needs for products and information of the end-users, it will be necessary to collaborate with ET 3.6 on End-user Liaison in development of the Guidelines on Best Operational Practices. The focus on end-users will distinguish this product from the Guide to Climatological Practices. The ET agreed to leave techniques such as Canonical Correlation Analysis or Principle Component Analysis out of these Guidelines, as these are more appropriate to producers of high-level global products.

5.3 The final outline agreed by the ET is as follows:

Guide to Operational Practices in the Generation
Of Climate Information and Prediction Products for End-users

Contents

Chapter 1: Introduction

1.1 Objectives of the guide
1.2 Key/ Major/Over-arching Issues
  1.2.1 Benefits of integrating climate information into decision and policymaking process
  1.2.2 Availability (temporal and spatial) and quality of data
  1.2.3 Generation of climate information and products
  1.2.4 Applications of climate information and products
1.3 The target audience
1.4 Overview of the guide

Chapter 2: Climate Diagnosis

2.1 Introduction (including key processes contributing to climate variability and extreme climate events)
2.2 Statistical tools
  2.2.1 Time series analysis
  2.2.2 Probability
  2.2.3 Multivariate analysis
2.3 Physical and dynamical processes related to seasonal to interannual variability
  2.3.1 Major patterns, teleconnections, and causes of climate variability
    2.3.1.1 El Niño-Southern Oscillation (ENSO)
    2.3.1.2 QBO
    2.3.1.3 NAO
    2.3.1.4 MJO
    2.3.1.5 Other significant oscillations
  2.3.2 Longer-term factors modulating seasonal to interannual climate variability (role of the ocean circulation, greenhouse effect, seasonal to longer-term changes of solar factors)
  2.3.3 Aerosols and volcanic activity
2.4 The role of observational and remotely sensed data in monitoring climate variability

Chapter 3: Methods and techniques in generating climate products

3.1 Methods and techniques for handling observations and data (including gap-filling techniques, homogeneity-testing, QA/QC, etc.)
3.2 Analysis methods
3.3 Prediction techniques
3.4 Linkages with national, regional and international specialized centres and institutions

Chapter 4: Climate information and prediction products and their application

4.1 Definitions of climate products
4.2 Types of users (hierarchy, sectors and end-users)
4.3 Types of available climate products (general and sector-specific)
4.4 Product presentation formats (including probabilities, graphs, maps, tables, time series, etc.)
4.5 Product dissemination and communication (in collaboration with ET 3.6 on End-user Liaison)

Chapter 5: Climate Outlook forums and other regional approaches

5.1 Objectives and history (including the role of regional and international institutions/organizations)
5.2 Various RCOFs
5.3 RCOF verification
5.4 Other regional approaches (e.g. RCCs)
5.5 Impacts (including on NMHSs and users)

Chapter 6: Value of climate products (in collaboration with the ET 3.6 on End-user Liaison)

6.1 Various sector applications
6.2 Strategies and methodologies used in assessing value (including field experiments/examples and economic modelling methodologies)
6.3 Marketing approaches

Chapter 7: Policy issues

7.1 Stakeholders and their policymaking processes
7.2 Societal and sustainable development issues
7.3 Linking with other global issues (including environmental)

Chapter 8: Recommendations on the way forward

References

Annexes/appendices if needed

5.4 The overall coordinator for this project will be Dr Lu. The coordinators and potential contributors for each chapter are as follows:

Chapter		Lead author	Potential contributor
1	Introduction	B. Garanganga	
2	Climate Diagnosis	B. Garanganga	W. Chang
3	Methods and techniques in generating climate products	O. Baddour	OPAG 2, M. Kadi
4	Climate information and prediction products and their application	H. Lu, J. Pahalad	S. Lellyett, ET 3.6
5	Climate Outlook Forums and other regional approaches	C. Oludhe, ICPAC	B. Garanganga, CIIFEN, J. Quintana
6	Value of climate products	F. Hilario	S. Lellyett, ET 3.6
7	Policy issues	M. Kadi	WCP (B. Nyenzi)
8	Recommendations, way forward	P. Tibaijuka	WCP (L. Malone)

5.5 The following deadlines have been agreed to for completion of these tasks:

- Submit progress reports to the ET chair by the end of February 2005
- Submit draft texts to the ET Chair by August 2005
- Submit drafts to CCl OPAG 3 Chair by October 2005
- Final Guide will be available by the end of February 2006 (so as to be available prior to the WMO conference on Climate Variability and Change: Understanding the Uncertainties and Managing the Risks (mid-2006).

6 ET 3.3 WORK PLANNING

6.1 Review and revise the Terms of Reference of the Expert Team

6.1.1 To assist the ET members fully understand their responsibilities and to clarify the work planning exercise to follow, each Term of Reference for this ET was reviewed and amended where such action was warranted. Topics discussed included the terms ‘users’ and ‘end-users’; the role of the DMC-H, ICPAC and other such centres in the mandate and work for this ET; the variance in practicality around the world, in implementing the ‘best’, whether that be hardware, software, etc.; the need to keep in mind the special emphasis for this ET of ‘countries in need’; and that the target audience for the guidelines (ToR (g)) is at the level of NMHSs, or regional specialized climate centres.

6.1.2 The proposed Terms of Reference to guide the work of the ET on CLIPS Operations, including product generation, with an emphasis on countries in need, in the lead-up to the fourteenth session of the CCl, are as follows (and the revised ToRs will be sent to the Chair of OPAG 3 for approval of the CCl management Group):

REVISED TERMS OF REFERENCE (14.10.04)

(a) To keep under review and update the list of NMHS, Regional Climate Centre (RCC) and other regional specialized climate centre requirements, as listed in the General Summary of the Session of the Intercommission Task Team on Regional Climate Centres (WMO/TD-No.1070, WCASP-52) for input for dynamic and statistical forecasts, observational data and training activities, to enable the generation of climate out-look products;

(b) To produce a critical review of the status of monthly, seasonal to interannual predictions generated by Climate Outlook Forums, RCCs and other regional specialized climate centres, and NMHSs, regarding the background, the preparation and the presentation of forecasts;

(c) To consider the implication and implementation of research recommendations, especially relating to consensus forecast methodology, downscaling and multi-ensemble modeling, and provide appropriate guidance on the development of improved methods for climate forecasts to support climate applications;

(d) To assess continuously the status (including adequacy and availability) and opportunities of climate monitoring activities, in different scales and their potential to meet user requirements;

(e) To make recommendations on the preparation and provision of both deterministic and probabilistic climate prediction information for sector specific uses, including formats used;

(f) To develop definitions of terminology used in operational climate prediction in order to facilitate understanding of these terms;

(g) To produce and update a guide to best operational practices in the generation of climate information and prediction products for end-users, with an emphasis on countries in need;

(h) To advise the Implementation/Coordination Group and submit reports in accordance with timetables established by the C-OPAG and/or Management Group; and

(i) To maintain close links with CBS on the issues involved.

6.2 Summarize progress; set priorities for ET 3.3 deliverables

6.2.1 The group agreed on the following priorities for the remaining work of the ET:

ToR	Description of ToR	Priority*	Focal Point
(a)	To keep under review and update the list of NMHS Regional Climate Centre (RCC) and other regional specialized climate centre requirements, as listed in the General Summary of the Intercommission Task Team on Regional Climate Centres (WMO/TD-No 1070, WCASP-52) for input for dynamic and statistical forecasts, observational data and training activities, to enable the generation of climate	1	WL Chang

	out-look products.		
(b)	To produce a critical review of the status of monthly, seasonal to interannual predictions generated by Climate Outlook Forums, RCCs and other regional specialized climate centres and NMHSs, regarding the background, the preparation and the presentation of forecasts.	1	J. Pahalad
(c)	To consider the implication and implementation of research recommendations, especially relating to consensus forecast methodology, downscaling and multi-ensembles modeling and provide appropriate guidance on the development of improved methods for climate forecasts to support climate applications.	2	O. Baddour
(d)	To assess continuously the status (including adequacy and availability) and opportunities of climate monitoring activities, in different scales and their potential to meet user requirements.	3	B. Garanganga
(e)	To make recommendations on the preparation and provision of both deterministic and probabilistic climate prediction information for sector specific uses, including formats used.	1	F. Hilario
(f)	To develop definitions of terminology used in operational climate prediction in order to facilitate understanding of these terms.	1	P.F. Tibaijuka
(g)	To produce and update a guide to best operational practices in the generation of climate information and prediction products for end-users, with an emphasis on countries in need.	3	H. Lu

***The priority number refers to the order in which it is anticipated that work on a specific TOR will be competed by the ET before April 2005 as follows:**

1. Deliverables to be completed before April 2005.
2. Good progress will have been made but not fully completed by April 2005.
3. Some work will have been accomplished by April 2005 Progress report will be made, however work on the TOR is expected to go well beyond 2005 for finalization.

6.3 Establish Action Plans with assignments of tasks and deadlines

6.3.1 Detailed actions for each ToR are as follows:

ToR (a)

- Make further review of institutions' requirements from sources such as CIIFEN, Drought Monitoring Centre Harare, ACMAD, ICPAC etc.
- Enhance on the report by specifically addressing requirements for the RCCs as given in Doc (WMO/TD-1070, WCASP-52)
- Make reference to: A workshop Report on "A multi-stakeholder review of Regional Climate Outlook Forums – October 2000 Pretoria, South Africa.
- Make reference to NMHS requirements from WMO/TD-No.1070, WCASP-52
- Work to be completed before April 2005
- A report should be submitted to the ET Leader by 15 March, 2005

ToR (b)

- To improve the report by reviewing on going COF activities conducted by DMC Harare, CIIFEN Countries, ICPAC and ACMAD among others.
- Make reference to the Workshop Report "International Multistakeholder review of Regional Climate Outlook Forums, 16 – 20 October 2000 Pretoria, South Africa
- Work to be completed before April 2005.
- A report should be submitted to the ET Leader by 15 March 2005

ToR (c)

- Make reference to recommendations made by ET 3.2 OPAG 3 of CCl, which is tasked to make relevant recommendations to be addressed by ToR (c) of our team and proceed to improve work on the ToR.
- Consider any other specific recommendations from forums recognized by WMO relevant to the ToR, considerable progresses expected by March 2005
- Progress Report should reach the Team Leader by 15 March 2005
- Final report to the ET chair by end September 2005

ToR (d)

- Work on the TOR is starting from the scratch based on the guidance given by the ET meeting following long discussions on the interpretation of the TOR
- Work expected to go beyond 2005
- Progress report to the Team Leader by 15 March 2005

ToR (e)

- Give some examples sector specific recommendations and preparation and provision of deterministic and probabilistic forecasts.
- References may be made on the available materials including form ICPAC, THORPEX and WMO doc on Climate and Health.
- Work is expected to be submitted to the ET Leader by March 2005

ToR (f)

- More work would be required to improve the glossary based on inputs from the ET members and other experts. Refinements would be made to simplify terminology that is too technical
- References should be made of available official WMO glossaries with 2 levels of users, namely the climate and scientific users and the non-scientific users.
- Much of the work should have been done by April 2005
- Report to be ready by 15 March 2005

ToR (g)

- Continuation of Work on the guide based on the new draft Outline of the guide as approved by the ET meeting October 2004.
- Work is likely to go on well beyond 2005
- Progress report will be sent to Team Leader by end February 2005.

6.3.2 The Team Leader will consolidate the ET report for submission to the OPAG 3 Chair and WMO by 31 March 2005.

7 OTHER BUSINESS

7.1 The group agreed to provide input on the revised ToRs to the ET Chair by 22 October.

7.2 It was noted that some information sent to NMHSs did not always get distributed to centres such as DMCs. It was proposed that WMO add DMCs and such institutions to its regular distribution lists, and WMO offered to make this change where feasible.

8 MEETING REPORT

8.1 Prior to the end of the meeting, WMO prepared and distributed a list of key results and decisions for the meeting, which are as follows:

- WMO and the ET Lead (P. Tibaijuka) will communicate with leads for other ETs as needed, particularly ET 3.6 (End-user Liaison), regarding the new ET 3.3 Guidelines.

- The Terms of Reference for ET 3.3 were revised. It is required to pass the new version through the OPAG3 Chairs to the President of the Commission for CCl Management Group approval. The members of the ET agreed to provide any final comments on the revised ToRs to the lead for the ET by 22 October.

- WMO agreed to provide web links to RCC-related documents or soft copies (WCASP 52, 54, 62), and the individual Guidelines extracts, and will upon request, provide hard copies to members of the ET.

- WMO agreed to provide copies of the Kimura report/survey, the Pretoria CLIPS report, and the results of the RA VI and RA II surveys on RCC requirements to members of the ET (electronic copies or web links if possible).

- WMO agreed to provide to the chair of ET 3.3 a copy of the user-friendly glossary from the WMO book on Climate: Into the21st Century.

- WMO agreed to locate recent WCDMP publications on climate monitoring and to send them to Mr Baddour for the work against ToR (d). Also WMO would provide the web link to WMO/WCDMP set of Climate Monitoring Bulletins.

- WMO agreed to provide the web link to the available chapters of the third edition of the Guide to Climatological Practices (Part I), and will get the outline for Part II from the OPAG 3 chair (P. Bessemoulin) and provide it to the ET.

- Experience has shown that ETs that have meetings are more effective and more productive. WMO agreed to recommend to the CCl Management Group that for the Period following the Fourteenth Session of the CCl meetings for ETs be organized as early in the period as possible wherever feasible.

- WMO agreed to recommend strongly to the CCl Management Group that ET 3.3 needs to be re-established with the current membership at the 14th Session.

- WMO (C/WCAC and SO/WCP) agreed to add the DMC-H, ICPAC and other similar centres to regular WMO distribution lists wherever possible.

8.2 It was agreed that WMO would prepare the full report for the meeting, and make it available as soon as possible for review and comment of the ET.

9 CLOSURE OF THE MEETING

9.1 The participants noted that the objectives of the meeting had been met. The ToRs were revised; one ToR (ToR (d)) that had no assigned lead expert was assigned to Mr Baddour; priorities were set for the ET; the Outline for the Guidelines on Operational Practices was discussed and revised; and a work plan for the ET, with revised assignments and deadlines, was established.

9.2 Participants thanked the meeting chairmen, the hosts and WMO for organizing the meeting, and for providing the forum, which facilitated and energized the work of the team. In turn, Dr Nyenzi thanked the participants for their keen efforts and dedication to the work of the ET, and thanked the Tanzania Meteorological Agency for the excellent facilities and arrangements, and for their warm hospitality.

9.3 Mr Tibaijuka congratulated the team on the progress made and on their enthusiastic efforts. He encouraged continued collaboration and continuation of the excellent dialogue developed during the meeting. He thanked Mr Kadi for co-chairing the event, and the representatives from major centres for adding their efforts to those of the members of the ET. All participants joined Mr Tibaijuka in showing appreciation to Mr Matitu and his colleagues for ensuring the successful set-up and running of the meeting, and the helpful technical and communications support throughout.

9.4 The meeting was closed at 13.30 PM, 15 October 2004.

ANNEX I

AGENDA

1. OPENING OF THE MEETING

2. ORGANIZATION OF THE MEETING

   2.1 Approval of the Agenda
   2.2 Other organizational matters

3. REVIEW OF ACTIVITIES RELATED TO THE TERMS OF REFERENCE OF THE EXPERT TEAM ON CLIPS OPERATIONS INCLUDING PRODUCT GENERATION

4. OPERATIONAL ACTIVITIES AND FUTURE PLANS OF SPECIALIZED CENTRES (e.g. ICPAC, DMC-Harare, ACMAD, CIIFEN, etc.)

5. GUIDELINES FOR BEST OPERATIONAL PRACTICES IN GENERATION OF PRODUCTS FOR END-USERS

6. ET 3.3 WORK PLANNING

   6.1 Summarize progress; set priorities for ET 3.3 deliverables;
   6.2 Establish Action Plans with assignments of tasks and deadlines.

7. OTHER BUSINESS

8. MEETING REPORT

9. CLOSURE OF THE MEETING

ANNEX II

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ANNEX III

ADDRESS BY DR MOHAMED MHITA, DIRECTOR GENERAL, TANZANIA METEOROLOGICAL AGENCY, AT THE WMO EXPERT TEAM ON CLIPS OPERATIONS INCLUDING PRODUCT GENERATION, WITH EMPHASIS ON COUNTRIES IN NEED, ARUSHA, TANZANIA, 12 to 15 OCTOBER 2004

Dr Buruhani Nyenzi, Representative of the Secretary General of the World Meteorological Organization; The Co-chairman of the CCl OPAG on CLIPS, Mr Mohamed Kadi; The Expert Team Leader, Mr Philbert Tibaijuka; Distinguished scientists, Ladies and Gentlemen,

It gives me great pleasure to be given this opportunity to grace the official opening of this important first meeting of the Expert Team on CLIPS Operations including product generation, with emphasis on countries in need. On behalf of the Government of United Republic of Tanzania, and the Tanzania Meteorological Agency I wish to extend a warm welcome to you all to Tanzania and Arusha in particular. I trust that you will have a pleasant stay in Arusha during your meeting and that you will get some opportunity to see some of Tanzania's world famous natural attractions in the vicinity of the municipality. I wish to thank the organizers of this meeting for selecting Tanzania to host this very important meeting, particularly at a time when the effects of climate variability are becoming more pronounced.

Over the years we have noted that nature is beautiful but can also become ugly and brutal. The latest examples of the brutal nature are the devastating effects of hurricanes experienced this year over Atlantic Ocean islands and parts of the United States of America and typhoons in the northwest Pacific Ocean. Floods hit many parts of the world, while some other parts suffered from prolonged droughts. Information on these is necessary to the various users. The change in frequency and intensity of these phenomena may be linked to climate change. The study of climate change and variability is, therefore, very important.

The experience of the last season this year in Tanzania and also in the neighbouring countries had shown very clearly that our socio-economic development was at the mercy of weather and climate. The poor performance of the past seasons has resulted in reduced food production. Accurate and timely weather and climate information could make a lot of difference. Indeed it could mean life or death. This is how important the climate information is to our countries and our people, particularly the rural poor whose livelihood is dependent on exploitation of natural resources.

Distinguished experts, Ladies and gentlemen

The global trend of environmental degradation (air and water pollution, land degradation, uncontrolled depletion of forest resources, etc.) has posed a serious threat to initiatives such as poverty eradication, plan for modernization of agriculture and primary health care. The threat was so great that it could amount to reversing many years of development efforts. The Governments in the developing world have committed themselves to eradicate poverty. The premise of this fight was based on sustainable exploitation of the countries' natural resources, which were now threatened by the global environmental degradation. Despite the small contribution of the developing counties to global environmental degradation we were the most affected by its effects (natural disasters). Environmental degradation also has serious impacts on the global climate system.

It is important to find ways and means to cope with natural disasters. One way is to make effective use and application of climate information in disaster management policies and decision-making process.

Mr Chairman, ladies and gentlemen
I am informed that this Expert Team has a number of very important tasks to be achieved in a given time frame. These include reviewing requirements of data by National Meteorological Services and other centres for generation of climate outlooks, provision of guidance on the development of improved forecasts, developing a glossary of terminology used in operational prediction among others. Based on the list of tasks it is evident that your team is a vitally important one that is intended to handle all practical technical issues of delivering forecasts as far as the interface with users. The team is also covering aspects of service delivery that will translate the science into services being delivered by NMHs and which are covered by other Teams of the OPAG such as the Expert Team on End-user Liaison and the various application areas.

It is therefore important for your team to realise that at the end of the day the biggest achievement will be how much your output will help the end- users understand and use climate information in the planning and decision making processes when undertaking various social and economic activities. This achievement will also be useful to many NMHSs in their service delivery.

Ladies and Gentlemen
Africa and Tanzania in particular have gained a lot from the CLIPS programmes and activities. This has been mainly through capacity building activities in form of training workshops and seminars for our scientists and users on seasonal forecasting and interpretation and use of products respectively. It may be recalled that some of our countries did not have any objective seasonal forecasting model until 1996 when the climate outlook forum started through the coordination of the CLIPS programme of WMO. Since then we have seen advances in the capacities and accuracy of outlooks, which has had a significant bearing on the visibility of National Meteorological Services.

We sincerely wish to commend these efforts and thank the World Meteorological Organization for this useful contribution.

Ladies and gentlemen
Finally, let me once again take this opportunity to thank the Representatives of WMO, and all participants for participating in this meeting. Your presence clearly shows your institutions and governments' commitment to support the efforts of WMO to enhance the application of climate information for sustainable social and economic development of the countries of the world. It is my hope that the meeting will come up with realistic recommendations and develop a plan for their subsequent implementation.

With these few remarks, I wish you a very successful meeting and I now have the pleasure to declare the meeting of the Expert Team on CLIPS Operations open.

Thank you.

ANNEX IV

Report of TOR (a) Focal Point
Commission on Climatology Expert Team on CLIPS Operations

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1. Background

1.1. TOR(a) of the Expert Team on CLIPS Operations asks that selected National Meteorological and Hydrological Services (NMHSs) and all Regional Climate Centres (RCCs) be contacted to seek their requirements in terms of observational data, forecasts and training activities to enable them to generate climate outlook products, with RSMCs undertaking activities relevant to the TOR also be contacted. It also asks that a review be conducted and an updated list of requirements be compiled based on the feedback. The concept and functions of RCCs can be found in WMO (2001).

1.2. As the scientific background to climate outlook products have been provided on their websites by many NMHSs already issuing these products, and consultation indicates that as yet no RCC has been established, it is proposed that elicitation of requirements can be attempted from a survey of the websites of major NMHS already issuing climate outlook product websites. The resulting list of requirements can serve as a reference for RCCs and NMHSs planning to provide climate outlook services. Such an approach has also the advantage of giving intending climate outlook providers a broad picture of the status of what is available globally to facilitate their selection of what is most appropriate for their needs.

2. Survey of Seasonal Products Presently Available on the Web

2.1. Definition

2.1.1 Seasonal products are defined for the purposes here as forecasts of the average values of meteorological parameters on time scales of about a month to a year. This definition is in line with the time scales considered in the Climate Outlook Forums. The history of and advances in climate predictions have been highlighted by Harrison (2000) and the scientific basis for and limitations of climate predictions can be found in WMO (2002a).

2.2. Survey Results

The survey results are based mainly on the work of Chang and Yeung (2003) to give a wide albeit not exhaustive overview of the work of some of the centres. Links can be found on the CLIPS website

http://www.wmo.ch/web/wcp/clips2001/html/index.html

2.2.1. *Australia*

The Bureau of Meteorology (BoM) issues seasonal forecasts of the probabilities of temperature and precipitation being above or below the median in the coming three months. These forecasts are based on the statistical analysis of past data and updated

every month. Seasonal outlooks on tropical cyclone activity for Northwest and North Australia based on statistical methods are also provided.

2.2.2. *Canada*

Environment Canada provides deterministic as well as probabilistic anomaly forecasts of temperature and precipitation for the Canada region. The forecast for the current season is produced numerically or dynamically while longer lead seasonal forecasts are produced by statistical techniques.

2.2.3 *China*

The National Climate Centre (NCC) of the China Meteorological Administration (CMA) issues among other parameters monthly forecasts of mean sea level pressure, temperature and rainfall anomalies. These forecasts are based on dynamic modelling.

2.2.4. *European Centre for Medium Range Forecasting* (ECMWF)

ECMWF uses coupled ocean-atmosphere circulation models to produce, on an experimental basis, outlooks on the mean anomalies of the three variables sea level pressure, surface temperature and precipitation, as well as the probabilities of these variables exceeding their respective climate medians.

2.2.5. *Hong Kong, China*

i) The Hong Kong Observatory issues in March experimental forecasts of the annual rainfall and the number of tropical cyclones affecting Hong Kong. Statistical and analogue methods are used in formulating these forecasts. Details can be found in Chang *et al.* (2003).

ii) The Department of Physics and Materials Science at the City University of Hong Kong issues in May outlooks on the number of tropical cyclones occurring in the western North Pacific and the South China Sea as well as the number of tropical cyclones making landfall on the south China coast between Hainan and Xiamen during the year. Updates are provided in June. Statistical methods are used to formulate the forecasts.

2.2.6. *Japan*

Using an atmospheric global circulation model, the Tokyo Climate Centre of the Japan Meteorological Agency (JMA) issues climate forecasts up to 28 days ahead. The elements forecast are mean sea level pressure, 500 hPa geopotential heights and 850 hPa temperatures. These forecasts are updated every week. Three-monthly outlooks are provided from September 2003.

2.2.7 *South Korea*

i) The Korean Meteorological Administration (KMA) issues forecasts of rainfall, 850 hPa temperature, sea level pressure, 500 hPa and 200 hPa height and temperature up to three months ahead for the East Asian region. The forecasts are generated by an atmospheric global circulation model.

ii) KMA has also been carrying out the Asia Pacific Economic Co-operation (APEC) Climate Network (APCN) project with the aim of producing multi-model superensemble

forecasts for dissemination among APEC member economies. Further information on APCN can be found in Park (2003).

2.2.8 *United Kingdom*

i) The Hadley centre of the UK Meteorological Office uses a coupled atmospheric-ocean general circulation model to produce probability forecasts of rainfall and temperatures exceeding their respective climate normals. These forecasts are issued on an experimental basis.

ii) The Benfield Greig Hazard Research Centre of the University College London through its Tropical Storm Risk website issues in March or April outlooks on tropical cyclone activity in the western North Pacific, Atlantic and Australian regions. Forecasts of the number of tropical cyclones landfalling in Japan are also issued. The forecasts are based on regression methods.

2.2.9 *United States*

i) The Climate Prediction Centre (CPC) of the United States National Oceanic and Atmospheric Administration (NOAA) gives probabilistic outlooks on seasonal temperature and rainfall for the United States up to 12 months ahead. These outlooks are based on a combination of a coupled ocean-atmosphere model, optimal climate normals and canonical correlation analysis.

ii) The Department of Atmospheric Science, Colorado State University, issues outlooks on the number of tropical cyclones likely to affect the Atlantic basin during the year. The outlooks are based on a combination of analogue and statistical techniques. Updates are provided frequently.

iii) The International Research Institute for Climate Prediction (IRI) issues on an experimental basis probabilistic seasonal outlooks of precipitation and temperature for the entire globe. These forecasts are based on a combination of an atmospheric global circulation model and canonical correlation analysis.

iv) The Seasonal to Interannual Prediction Project (NSIPP) of National Aeronautics and Space Administration (NASA) issues on an experimental basis forecasts of global rainfall and temperature anomalies up to 3 months ahead. The forecasts are based on a coupled atmosphere-ocean model.

v) The Experimental Climate Prediction Centre (ECPC) of the Scripps Institution of Oceanography issues on an experimental basis forecasts of temperature and precipitation anomalies for different regions of the world up to 12 weeks ahead. These forecasts are based on an atmospheric global circulation model.

3. Summary of the Survey

3.1. The above survey suggests rainfall and temperature are the two parameters included in almost all the seasonal products. Outlooks on tropical cyclone activity based on statistical predictions are also issued by several centers.

3.2. Empirical or statistical, dynamical as well as hybrid empirical/dynamical models are some of the methods used in formulating the climate outlooks. In particular, the dynamical models used include separate atmospheric global circulation models and ocean global circulation models as well as coupled atmosphere-ocean circulation models.

3.3. Some centres formulate their forecasts in deterministic terms, some in probabilistic terms based on ensemble forecasts and some give both.

4. Updated List of Requirements and Availability

4.1 From the results of the above survey, some of the requirements that may be proposed are listed below. Requirements may differ as needs for RCCs will vary between and across regions (WMO 2001). Where the resources can be found to enable the requirements to be met or partly met is an important consideration, and some suggestions are given below.

4.2 Climate Outlook Products

4.2.1 Temperature and rainfall projections should be among the suite of climate outlook products or services, being the two parameters in which the public holds the most interest. In regions so affected tropical cyclone activity might also be considered as a product depending on the predictability.

4.3 Data and Observations

4.3.1 Changes in the Earth's surface conditions such as sea surface temperatures (SSTs) due to El Niño-Southern Oscillation (ENSO) events are the basis for the predictability of the mean state of the weather on seasonal time scales (Harrison 2000, Goddard *et al.* 2001).

4.3.2 Past SSTs (together with other relevant parameters) can be used to build statistical relations with say, observed precipitation, temperature and tropical cyclone activity (see for instance, Chan *et al.* 2001 for tropical cyclone activity). Future or forecast SSTs can be used to serve as predictands for the future states of these parameters.

4.3.3 For these purposes, historical or observed SSTs can be found on CPC's Comprehensive ocean-Atmosphere Data Set (COADS) website http://www.cdc.noa.gov/coads. Forecast SSTs can be found on the websites of many of the centers or services surveyed in Section 2 above.

4.4 Models and Tools

4.4.1 NMHSs and RCCs might wish to generate climate forecasts on regional scales. This can be done through dynamical downscaling using a regional model with a finer resolution than the global models.

4.4.2 One regional model that can be conveniently used for this purpose is that made available by the Experimental Climate Prediction Centre (ECPC) of the Scripps Institute of Oceanography. Procedures for obtaining the model from ECPC can be found at http://ecpc.ucsd.edu/projects/G-RSM/.

4.4.3 This regional model formulates its forecasts as spectrally resolved perturbations superimposed on the global forecasts. In this way errors arising from boundaries and differences between global and regional model climatologies are reduced making the model attractive for climate forecasting (Hong and Leetma 1999). This model has been successfully adapted by the Hong Kong Observatory in collaboration with ECPC (see Hui *et al.* 2002) as well as by other centres. The global products necessary to serve as initial and boundary conditions are provided by ECPC via ftp.

4.4.4 In terms of statistical approaches, Canonical Correlation Analysis (CCA) is a popular statistical technique for performing long-range forecasts (Landman and Mason 1999), and it can allow forecasts to be made for more than one location (Murphy et al. 2001). The software for CCA analysis is available from IRI's website http://iri.columbia.edu/outreach/software/index.html as well as commercially. For a discussion of the pros and cons of dynamical versus statistical methods, see Goddard *et al.* (2001)

4.5 Verification

4.5.1 The importance for climate outlook products to be accompanied by verification information has been noted in WMO (2001) and elsewhere. The purpose is to give end users an indication of the level of skill and degree of confidence these products carry.

4.5.2 Verification procedures for both deterministic forecasts as well as the data sets to be used have been comprehensively set out in WMO's (2002b) Standardized Verification System (SVS) for Long-range Forecasts (LRF). This should serve as an excellent platform for conducting verification exercises and determining forecast skill.

4.6 Capacity Building

4.6.1 Many centers provide courses, training or workshops on seasonal forecasting. Examples are IRI (http://iri.columbia.edu/outreach/), ECMWF (http://www.ecmwf.int), WMO, etc.

4.6.2 The internet is a powerful medium for technology exchange and training. As already noted in Section 1, excellent scientific and technical information on seasonal forecasting can be found on the websites of many major centers mentioned in Section 2. The CLIPS Curriculum is another illustration of the advantage that can be taken of the economy and convenience of the Internet to provide on-line training materials (See http://www.wmo.ch/web/wcp/clips2001/html/index_curriculum.htm).

4.6.3 The Internet can be used to broadcast climate outlook products very efficiently (Harrison 2000). It is therefore useful to include the utilization of the Internet to deliver user oriented and user-friendly services into account in capacity-building processes.

5. Conclusions

5.1 A proposed list of requirements is compiled for the consideration of RCCs and NMHSs planning to generate climate outlooks. Some of the resources available to help meet these requirements are also listed.

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ANNEX V

Report for the ET on CLIPS Operations (J. Pahalad)

TOR (b): To produce a critical review of the status of monthly, seasonal to interannual predictions generated by Climate Outlook Forums, RCC, and NMHSs, regarding the background, the preparation and the presentation of forecasts.

Introduction

This report covers a range of climate prediction services provided by various climate forums, RCC and NMHS in the Pacific, South American and African regions. The following individuals were consulted or their reports were referred to for contributions towards this report: Mr Grant Beard, Dr Andrew Watkins and Mr Phil Reid (BOM); Miss Ashmita Gosai (NIWA); Mr Simon McGree (FMS); Mr Luc Maîtrepierre (Météo-France); Dr Michael Hamnett (University of Hawaii) and Dr Jose Luis Santos (CIIFEN). The main source for the information on the African region was several relevant Websites.

PACIFIC REGION

Australian Bureau of Meteorology

Each month, the Australian Bureau of Meteorology issues a Seasonal Climate Outlook for the upcoming three months.

Forecasting Process: Seasonal climate predictions have been issued operationally in Australia since mid-1989 and based on a variety of statistical techniques. The first prediction scheme was a linear regression model using values of the Southern Oscillation Index (SOI) to predict rainfall for those parts of the country with reasonable correlation between seasonal rainfall and SOI. The next generation scheme predicted rainfall for the whole country using a combination of statistical models based on phases of the SOI, climatology and recent rainfall trends.

The current operational forecast scheme is based on statistical relationships between sea-surface temperature (SST) variability and the Australian climate. The scheme provides outlooks for both rainfall and mean maximum and minimum temperatures for the coming three months with about a two-week lead-time. Two main patterns of SST variability, one centred in the tropical Pacific Ocean and the other in the tropical Indian Ocean, are used as predictors. The rainfall prediction scheme displays greater predictive skill than previous operational schemes, with the temperature scheme being more skilful than that for rainfall. Operational forecasts of SSTs in the eastern tropical Pacific Ocean are also issued for the coming eight months using a coupled General Circulation Model.

The production of each outlook begins with a meeting between Bureau meteorologists and oceanographers, as well as the occasional visiting scientist or user representative. At this meeting, climate analyses for previous months and available guidance for the coming few months are discussed. The current operational scheme is used for the official outlook, but some subjective interpretation of this outlook is given in a media statement issued a few days later. This statement includes contour maps showing the probabilities of rainfall and temperatures for Australia being above the median for the coming three-month period and is issued via the Internet (http://www.bom.gov.au/climate/ahead), fax and email.

A 23-page booklet is subsequently produced with greater detail, including probabilities for the lower, middle and upper tercile categories, as well as regional and township probabilities.

Forecast Assessment: Generally the Bureau's outlooks appear to be received favourably. On average, respondents to recent surveys have rated the outlooks as being somewhere between "occasionally useful" and "generally useful". However, educating users and media about why the outlooks are probabilistic and how to interpret them remains a constant issue. This education is achieved through information pamphlets, booklets, WebPages, attending agricultural exhibitions and talking directly with users.

Applications: The main users of the Bureau's climate outlooks are involved in activities such as cropping, grazing, forestry, fire management, water supply and research. Other applications include tourism, power supply, banking, health and environmental protection.

Future: It is likely that climate outlooks in Australia will become more customized to suit specific industries. Refinements to the statistical schemes behind these outlooks will continue with further research and as the observational datasets on which they are based become longer and denser.

It has been shown that inter-decadal fluctuations in SST over the Pacific Ocean may influence the ability to predict ENSO-related climate anomalies in Australia. This has serious implications for seasonal climate prediction in Australia, and possibly other countries as well. Further research needs to be undertaken into variability on such long timescales before it can be incorporated into operational seasonal prediction schemes.

The Bureau of Meteorology is currently experimenting a coupled ocean/atmosphere model for suitability in producing seasonal forecasts, including examining its ability to predict El Niño and La Niña events.

The model, called *POAMA* (Predictive Ocean Atmosphere Model for Australia), has been developed from a joint project between the Bureau of Meteorology Research Centre and CSIRO Marine Research and is being analyzed by the National Climate Centre. This type of model assimilates near real time data from the atmosphere and ocean and uses mathematical interpretations of dynamical and physical processes to generate seasonal forecasts of ocean and atmospheric conditions. Unlike existing statistical forecasting systems, coupled models are not limited by historical relationships and can forecast a new set of climatic conditions. For example, because they simulate the real world they have the potential to predict how the impacts of one El Niño might be different from those of another.

Fiji Meteorological Services

Background: The Southern Oscillation Index (SOI) has been proven to be a good predictor for rainfall in the upcoming months or season for Fiji. During 1997/98 ENSO event, there were no rainfall forecasting tools in place at Fiji Meteorological Service, therefore the impact and the duration for the drought was estimated by analyzing the past analogous events and the rainfall records during those events. Climate Services Division (CSD) staff of the Fiji Meteorological Service (FMS) carried out statistical analysis between the SOI and the rainfall, which showed relatively significant correlation, and indicated a lag phase between the two components.

Major Drought-Related Damages and Expenditures for the Drought of 1997-1998 was estimated by the World Bank in 2000 to have to have well exceeded $US157M, this initiated the Fiji Government to approach the Australian Government through AusAid to fund the development of climate prediction services within FMS. The aim of this project was to build on FMS's expertise by producing a scheme, which will provide quantitative predictions of seasonal rainfall for Fiji on a regular basis that would be suitable for inclusion into FMS's operations.

Forecasting Process: The prediction model, known as *FMS Rainfall Prediction Model* (RPM), is based on schemes, which have been running successfully in the Australian Commonwealth Bureau of Meteorology's National Climate Centre (NCC). These are statistical schemes based on the relationship between the SOI and subsequent three months rainfall totals. During the initial stage, forecast was provided for the western and northern divisions of Fiji. The model was on trial from January 1999 and become operational in July 1999. In March 2000, this model was modified by the CSD to include twenty-five individual sites covering all four divisions in Fiji. In each case the probability of low, medium and high rainfall in this following three-month period is provided. There are two sets of forecast for each site: the first scheme uses the SOI averaged over the most recent three month-period and the second scheme uses the SOI averaged the most recent six-month period preceding the forecast period. The results from RPM have been incorporated in Fiji Islands Weather Summary (FIWS), produced by FMS, on a monthly basis since January 1999

Another package known as Australian Rainman has also been utilized by FMS for rainfall forecasting since August 1999. Australian Rainman is a joint product of the Queensland Department of Primary Industries, the Western Australia Department of Agriculture and the Bureau of Meteorology. As for the RPM, this package also incorporates the use of SOI to test its effects on the probability of rainfall except it accommodates up to a month to twelve months. Initially the forecast was provided for the four divisions as whole in the MWS but later twenty-one individual sites around the country was included in the package, and the monthly probabilities for the following three months are now included the summaries. The monthly forecasts, as expected, was had very low skills therefore was later removed from the summaries. The rainfall forecast can be accessed on the FMS's website, http://www.met.gov.fj/MWS.html .

Forecast Assessment: NCC and CSD have tested the skill levels for the both schemes in RPM. In fact the skill levels obtained exceed the levels obtained anywhere in Australia. The agreement between the two schemes is reassuring, particularly during the strong events, but from time to time the two schemes do not agree. Currently, CSD only uses the first scheme for operational purposes. The skill levels for the model is high during the wet season (November to March) and decreases during the dry season (May to September) and during the transition months, April and October. The skill level for the Australian Rainman package is similar to RPM. Skill tests for the period from 1996 to 2002 show 6 to 10 out of 12 correct forecasts annually. For the RPM in 2002, the success or 'hit' rate was 60% with successful three consecutive month forecasts from February to May and October to December. The monthly forecasts from the Australian Rainman model in 2002 weren't as successful which was expected as the skill is lower for monthly forecasts and much lower than three consecutive month period forecasts

Applications: The results from the RPM model are presented on a map of the Fiji Islands in the FIWS and monthly rainfall probabilities for the same three-month period produced from Australian Rainman in tabular format. The monthly rainfall probabilities was introduced in the MWS for May 2000 after a request was made by the users from the forestry and the sugar cane sectors during a seminar on the rainfall prediction models ran by CSD in May 2000. Three-month period forecast was not sufficient to meet their planning needs for planting, harvesting or logging. Other major users for the rainfall predictions are disaster managers, water resource sector, and national electricity authority. There has been increasing demand for quantitative forecast over smaller areas by the agricultural and the forestry sector.

Future: There is an increasing need to customize the forecast to suit the users' needs. Recent interest in the models have come from the health sector as a Project on Climate Variability & Change and Human Health in the Fiji Islands has found that for an increased incidence of dengue fever, it looks at least to successive dry months (below

the threshold of cut off for the monthly rainfall for driest third out of the data set) followed by a wet month, the incidence of dengue fever rises significantly. For Leptospirosis, it looks like higher than normal rainfall in the current month is the variable that is most significant. Air and water temperature forecasting in Fiji may also be important in the future as air temperature the most significant variable for diarrhea outbreaks. Water Managers have also expressed an interest in an increased forecast area which is not only mainly concentrated on the coastline like at present but on inland and highland areas of Fiji.

CSD will continue to interact with the users to identify their needs and if possible further develop its forecasting expertise accordingly. One of the major issues is lack of understanding of probabilities by the users. The seminar on rainfall prediction model included a session on how to interpret probabilities and this was proven useful as evaluated by the participants. CSD will conduct more of these type of seminar as need arises or as requested by the users.

Météo-France, New Caledonia

Forecasting Process: It is a very simple on-site statistical model working with the value of the SOI for the 3 past months and the analysis of the rainfall pattern since 1951. It was first implemented in mid 2001. The value of the SOI in ordinate and the rainfall for the next 3 month are plotted in abscissa. Then the number of times the rainfall occurs in the first, second and top tercile in the area delimited by [SOI-threshold, SOI+threshold] is counted. Finally the forecast is derived in percentage by dividing the tercile value by the total of all the values that fall in the range [SOI-threshold, SOI+threshold]. It is a very simple method but it is working quite well. The validation for the 1951-2000 period shows 67% average hit rate (ranging from 60% to 74% throughout the year, with 74% for DJF quarter). Since this statistical model is not fully operational, Météo-France is anticipating using the new software from the AusAID project.

New Caledonia Met Service also receives climate products and forecasts from Paris: climate analysis and climate forecast from the available models (ECMWF, IRI, etc.) and the Météo-France's Arpege climat model. It is quite similar to the ICU but it is not focused only on one region (e.g. the Pacific Islands).

Island Climate Update remains their main source of seasonal forecast for the country. The Met Service is one of the main stakeholders in the ICU teleconference.

Applications: New Caledonia Met Service does not provide seasonal forecast, but when there is a special event like the last El Niño event; it holds a press conference to alert the public on the event and the possible impacts in New Caledonia. The Met Service does provide monthly information on their web site and via E-mail to special costumers about the climate development.

They have also participated to special information session to South Province's farmers where presentation(s) on El Niño impacts in New Caledonia was given. The media has played important role in disseminating the above information, and Government actions have been taken to help farmers.

South Pacific Seasonal Outlook Reference Material

The South Pacific Seasonal Outlook Reference Material (SPSORM) produced by the Australian Commonwealth Bureau of Meteorology is a non-exhaustive collection of observations and seasonal climate outlooks for the South Pacific region, collated from a number of operational and research centres from around the world. It was created in response to a recommendation at the Sixth SPREP Meeting of Regional Meteorological Services Directors (6RMSD) in Tahiti, 1999. The first issue of the South Pacific Seasonal Outlook Reference Material was released in May 2000 and it has since been supplied to participating South Pacific NMHS by email on a monthly basis.

The document contains information on the Southern Oscillation Index, Outgoing Longwave Radiation (cloudiness), sea surface temperatures, ocean sub-surface temperatures, seasonal and longer range forecasts for both sea surface temperature and rainfall, and any other relevant data that may assist South Pacific NMHS in their own climate policy decisions. New recipients and general feedback are always welcome.

Island Climate Update

The concept of a Small Island Developing States (SIDS) regional climate bulletin was first suggested in a study by WMO in 1991 (Basher et al., 2001). The third annual South Pacific Regional Environment Programme (SPREP) Meeting of Regional Meteorological Services Directors (RSMD) held in Samoa in 1995 unanimously endorsed the concept. It was recognized at the time most of the SIDS of the South Pacific, with the exception of French and US Territories, do not have the resources to locally develop their own global climate models and undertake analyses of climate information and products to be able to produce local climate forecasts. SPREP and the South Pacific Geo-Science Commission (SOPAC) are the regional hosts for the Island Climate Update (ICU). Together with development partners, the Italian Ministry for the Environment and New Zealand Agency for International Development (NZAID), climate research organizations and National Meteorological Services (NMSs) of SIDS in the South Pacific, they form a virtual regional mechanism to produce the ICU. The National Institute of Water and Atmosphere Research of New Zealand (NIWA) coordinates the scientific process involved in the ICU production.

Today, the Island Climate Update is a multi-national monthly climate bulletin. Its primary goal is to assist Small Island Developing States of the South Pacific make informed planning and management decisions relating to climate sensitive sectors like agriculture, water, tourism, fisheries, energy through the provision of timely and accurate seasonal climate forecasts. Seasonal to inter-annual prediction in the six years during and since the 1997/98 El Niño event has become a major research and application issue in the Southwest Pacific. The results so far from the ICU and work have demonstrated unequivocally that short-range climate prediction is achievable with skill. In the Southwest Pacific with the development of the ICU seasonal climate forecasting project useful skill has been achieved in the seasonal forecasting of seasonal rainfall departures and ENSO events with hit rates greater than 70% being achieved in some parts of the region. This new technology offers much promise for disaster preparedness strategies for all end users in the region.

The success of the ICU is solely dependent on the multinational collaboration amongst all the organisations and stakeholders involved in the monthly virtual discussions: The Australian Bureau of Meteorology; Météo-France (New Caledonia and French Polynesia); The Fiji Meteorological Service; The Samoa Meteorological Service; The US National Oceanic and Atmospheric Administration (NOAA); The US National Weather Service; The NOAA Climate Prediction Center; and The International Research Institute for Climate Prediction (IRI). The latest ICU is made available on http://www.niwa.cri.nz/ncc/icu/.

AusAid Project: Enhanced Application of Climate Predictions in Pacific Island Countries (PI-CPP)

Background: The Pacific Meteorological Services Needs Analysis Project (PMSNAP) reported in May 2001 in “Pacific Meteorological Services: Meeting the Challenge (PMS: MC)” a need for assistance programs in two clear priority areas, one of which was to enhance seasonal and climate prediction services.

The PMS: MC included a project concept to expand and enhance prudent use of climate predictions. The aim was to meet the general goals of improving weather and climate services and products to ensure the safety, security and general well being of the people, and achieving sustainable development. In response, AusAid (Australian

Aid) developed a AUS$2.2M project proposal outlining procedures for developing a climate prediction capacity in participating countries, and in particular, providing a framework for incorporating climate prediction information into planning across a broad range of agencies and industries. It is important (for credibility sake) that the prediction scheme be based only on proven technologies, and for this reason the scheme will be based upon the seasonal climate prediction system of the Australian Bureau of Meteorology, which has successfully issued climate predictions for some years.

Objective: To expand and enhance the prudent use of climate predictions by Pacific Island countries in NMSs and in client groups in climate-sensitive industries.

Project description: The project consists of two parts – 1) developing and installing the new prediction service; and 2) training and assisting NMSs and key representatives from climate sensitive industries in the effective use of prediction information for decision-making and planning. In order to demonstrate the benefits of climate predictions to industry, a pilot scheme with the Fiji Sugar Industry (to assist it in developing industry-specific climate predictions and management responses) will be supported technically by the project. Other similar pilots on other islands will be considered for inclusion in the project.

The development/installation phase will make use of a software package based on the Australian seasonal climate outlook statistical prediction scheme. The software will be limited to NMSs who have available at least forty years of climate records (to ensure an adequate period for developing the statistical model), and who are prepared to commit staff resources to run the new system, and maintain client liaison and support after the project.

The uptake and use of the seasonal climate prediction information is fundamental to the success of the project. This will require careful and comprehensive training, and tailoring of the prediction service for its potential beneficiaries, if the predictive information is to be successfully understood and applied.

The Project management group to oversee the project is based at the Australian Bureau of Meteorology (BOM). Installation of prediction software, and training in its utilization, will take place in each of the participating PIC countries.

Duration: Project commenced in July 2003. Initially the project was expected to finish in 3 years, but due to some crucial additional activities, it is now expected to be completed by early 2007.

Expected outcome: At the end of the program the NMSs of each of these should have software tailored for use in their location, and an understanding of how seasonal climate prediction services can be applied to support climate-sensitive industries. Once the information is incorporated into planning and decision-making across a number of agencies and organizations, the wider community will benefit from the improvements that should result.

Regional Partners: The project is seen as a significant activity under the Australian-US CAP (Climate Action Partnership), and the Australian and New Zealand bilateral agreement dealing with domestic matters. It is also seen to be contributing to the objectives of the WMO CLIPS project, to those of SPREP and SOPAC. Both AusAID and the BOM are continuously coordinating project activities with those of other countries and organizations with expertise and interest in climate-related capacity building in the Pacific region such as US NOAA-OGP and PEAC.

Project implementation:

Participating PIC NMS: The Project commenced with a meeting of PIC NMS representatives in Vava'u, Tonga. At this meeting, NMSs were asked to self-assess whether they have the historic records of climate and the personnel and budget to

participate in the ongoing higher level of the project, which was followed by completing of survey reports. The Project Team (PT), consisting of the Project Coordinator (PCo) and the Australian Team Leader (ATL), visited most of the participating PICs to conduct high level discussion with PIC Governments with the aim of seeking agreement on the establishment, as appropriate, of formal MOU. The PT took the opportunity to further assess the NMS to finalize the list of participants. Nine PIC NMS have been included in the list: Fiji, Samoa, Tonga, Vanuatu, Tuvalu, Cook Islands, Solomon Islands, Niue and Kiribati. The implementation of the project in Kiribati has been postponed due to uncertainty in staffing.

Climate Prediction Software: The BOM has developed an alpha version prediction software package, which has been installed in all NMS. A new better version is now been developed which will be called SCOPIC (Seasonal Climate Outlooks for the Pacific Island Countries). It is anticipated that SCOPIC will be released by November 2004. A computer consignment was purchased for 8 of the participating NMSs, 6 of which have received their consignments. The set consists of a desktop PC, a colour printer, a UPS unit and some consumables. PI-GCOS (Pacific Islands – Global Climate Observing System contributed a largely towards the purchase (AUD15000).

NMS Training Workshops: Four-day training workshop for the participating NMS was conducted from June to September 2004. Training included some basic and advance climatology, the new software and prudent use of probability-based climate predictions. It also included a half-day briefing session for the current and potential climate information users, in order to inform them about the new climate service and assess their training needs. Training for Niue Met Service will be conducted in April 2005.

Stakeholders Training Workshops: Workshops will be conducted with identified client groups in each participating PIC from February to May 2005. Training will focus on risk management using climate prediction information. The Project Team will identify at least 2 more pilot projects in other PICs, which commence from mid 2005, with the sugarcane pilot project in Fiji.

Feedback will be sought from the clients and NMSs for tailoring the prediction software and "fine-tuning" the service. Subsequently the system will be experimented in each PIC, leading to further refinements.

This project anticipates addressing a number of existing concerns (see Problems and Issues section) in all participating PICs. More details and the updates on the project are available on http://www.bom.gov.au/climate/pi-cpp/index.shtml.

Pacific ENSO Application Center (PEAC) – North Pacific

Background: In August 1994, the *Pacific ENSO Applications Center (PEAC)* was established as a pilot project to provide ENSO forecasts and information to the US Affiliated Pacific Islands. The University of Guam, the University of Hawaii (UH), the Pacific Regional Office of the US National Weather Service, the US Office of Global Programs at the National Oceanic and Atmospheric Administration (NOAA), and the Pacific Basin Development Council developed PEAC as a joint venture to serve American Samoa, the Commonwealth of the Northern Mariana Islands, The Federated States of Micronesia, Guam, Hawaii, the Republic of Marshall Islands, and the Republic of Palau.

Forecasting Process: PEAC has consisted of several types of coordinated research and applications activities. The research effort has been aimed primarily at developing statistical rainfall models and synoptic climatology. The Office of Global Programs (OGP) had originally assumed that experimental forecasts based on coupled ocean-atmosphere models developed at Scripps, Columbia University, Florida State and other academic institutions could be translated into simple information products to communicate and explain the model forecasts and to educate information users.

However, the spatial resolution of large-scale models used widely by climate researchers and modellers did not meet the needs of the people in the region.

PEAC directed its research effort at the development of canonical correlation analysis (CCA) models. These were designed to assist the Center to forecast rainfall on specific islands using historical data. Two CCA models were developed in close collaboration at the Climate Prediction Center (CPC) within the National Weather Service, and the other at the University of Hawaii at Manoa.

During the first stages of the pilot project, the Water and Environmental Research Institute (WERI) at University of Guam began developing synoptic climatology for the Micronesian Islands. It published simple guides that describe rainfall and tropical cyclone activities expected under "normal," El Niño, and La Niña conditions. A meteorological portion of the newsletter, which was developed as part of PEAC's public information and education program, was written.

Development of the public information and education program involved extensive collaboration and work throughout the Pacific. They conducted workshops, focus group meetings, and local briefings about ENSO in all of the client jurisdictions during 1995 and 1996. PEAC staff also made presentations at regional meetings organized by a wide-range of organizations. The information included a background discussion of the formation and history of ENSO cycles and overview of PEAC, which had been envisioned as a means to provide end-to-end climate forecasts.

From these briefings, PEAC identified the concerns of participants on potential impacts of El Niño and La Niña events, and elicited information about the specific kinds of ENSO forecast information needed. The clients also identified the type of forecast information that they could use. PEAC compiled a mailing and contact list of agencies, individuals, private sector interests, and organizations that would find forecast information useful.

Pacific ENSO Update newsletter, which has been published and distributed in hard copy and on the website four times a year beginning in August 1996, became PEAC's primary information dissemination vehicle http://lumahai.soest.hawaii.edu/Enso/index.html.

The US National Weather Service is slated to continue funding the Pacific ENSO Applications Center through its Pacific Regional Office budget with additional financial support from the US Department of the Interior. The Office of Global Programs has indicated interest in continuing to provide financial support for PEAC efforts in the South Pacific. These efforts have been and will continue to be aimed at helping to establish regional forecast capability for the independent and freely association states of the South Pacific and expanded applications activities in the fisheries and health sectors.

SOUTH AMERICAN REGION

Climate Outlook Forum for the West Coast

From November 19th to 21st of 2003, in the city of Guayaquil, Ecuador, the III Climate Outlook Forum for the west Coast of South America (COF3-WCSA) took place. The event was organized by the International Center for Research on El Niño Phenomenon (CIIFEN) in collaboration with the World Meteorological Organization (WMO), the National Oceanographic and Atmospheric Administration (NOAA), the International Research Institute for Climate Prediction (IRI), the Escuela Superior Politécnica del Litoral (ESPOL), and the International Hydrologic Program of UNESCO and with the support of numerous local and regional organizations

COF3-WCSA brought together more than 50 experts on meteorology, climatology, hydrology and oceanography of the Region, as well as specialists of sectors like health,

hydrologic resources, agriculture, among others; coming from 21 countries and representing private and governmental organizations, with the objective of:

- Review the present atmospheric and oceanic conditions and their implications in the precipitation patterns in the west Coast of South America (Venezuela, Colombia, Peru, Ecuador, Bolivia and Chile).
- To assemble the Regional outlook for the period December 2003 - May 2004.
- To communicate the Climate Perspective to the interested users in the Region
- To train the participants in the methodology necessary to develop objectively and effectively the prognosis of terciles, identifying the standard parameters for each of the diverse regions
- Analyze the mechanisms for an efficient and opportune distribution of products to the diverse socioeconomic sectors of the region.

Taking into account the following aspects:

- The coincidence of the predictions of most models of global and regional scale on the absence of El Niño like conditions for December 2003 and the first trimester of 2004, in other words neutral conditions. This situation represents the most difficult to forecast expected seasonal precipitation patterns on the region due to the absence of a strong signal that could produce seasonal changes.
- The existence of some climatic tendencies that were evaluated, among them:
  - Wind Pulses observed in the tropical Pacific that can have originated Kelvin Waves, which could arrive at the coasts of South America in the next weeks.
  - Positive anomalies in the SST of the Tropical Atlantic
  - Changes in the centres of High and Low pressure of the region that can induce changes in the wind patterns and the position of the ITZC
  - The present situation and the projections of the state of the ocean and the atmosphere evaluated on different scales, from the local, to regional and global; and,
  - All the information shared by the representatives of the Meteorological and Hydrological Services of Venezuela, Colombia, Peru, Ecuador, Bolivia and Chile, as well as of oceanographic centres, universities and other scientific research centres.

Present the Following Climate outlook:

The experts establish probability distributions in forms of terciles to indicate the rain probability above normal, near normal or below normal for each area. Rains over the normal are defined as those that are between the records corresponding to the third part of the greatest values of rains in each region; bellow normal are defined as values within the third part of the driest values; and near normal corresponds to the third part of the values around the climatologic mean. These three categories are the terciles of the rain distribution probability, as the following table summarizes:

Tercile	Condition of rains
A	Above Normal
N	Normal
B	Below Normal

For the use of this perspective it recommends that the following aspects are taken into account:

The Climate Outlook Forum for the West Coast of South America is an estimation on the possible behavior of precipitation made with statistical tools and analogies with

historical events, and analysis of the results of global and regional models, with the objective to complement the forecast activities, which are made at national level in each one of the countries.

The climate outlook elaborated by this forum is applicable only for the average conditions for the indicated months (December 2003 to February 2004), and its nature is of probabilistic type, and nondeterministic. This means that, the most probable scenario that will appear will be similar to the one presented in the same months of other years of reference without the presence of El Niño like conditions.

Although conditions of neutrality for next the six months are expected, we can not discard the probability of extreme hydrometeorological events, that could affect zones with high vulnerability conditions and thus present a high risk, and therefore they can undergo considerable negative impacts if suitable mitigation measures are not taken.

These tendencies will have to be interpreted in a multi-monthly time scale, considering that the conditions can vary a lot in smaller time scales, that is, of weeks or months.

It is advised to the users of this climatic perspective to make contact with their respective national meteorological services for the interpretation corresponding to any region within their national territory, and that these consults are made with regularity.

AFRICA

Thirteenth Climate Outlook Forum for the Greater Horn of Africa

(Source: http://www.dmcn.org/outlooks/cof13_statement.htm)

From 25 to 27 February 2004, the thirteenth Climate Outlook Forum was convened in Nairobi, Kenya by the Drought Monitoring Centre, Nairobi (DMCN) to formulate consensus guidance for the March to May rainfall season in the eastern Africa sub-region (sometimes referred to as the Greater Horn of Africa) comprising of Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Tanzania and Uganda. Users from disaster management, agriculture, health, livestock, wildlife, and media, among other sectors were active participants in the forum. They participated in the development of the outlook and formulated the implications of the outlook for their respective countries and sectors. The forum reviewed the state of the global climate system and its implications for the sub-region. Among the principal factors taken into account were the observed and predicted SSTs in the tropical Pacific Ocean, and over the tropical Atlantic and Indian Oceans.

The Forum was organized jointly by the DMCN, the WMO and IRI within the framework of the United States Agency for International Development (USAID) funded project, “Applications of meteorology to the reduction of climate and weather related risks to food security, water resources, and health for sustainable development in the Greater Horn of Africa sub-region”.

Methodology

The forum examined the current and expected SST anomalies over the Pacific Ocean as well as the Indian and Atlantic Oceans together with other factors that affect the climate of the sub-region. These factors were assessed using coupled ocean-atmosphere models, statistical models and expert interpretation. The current status of seasonal to inter-annual forecasting allows prediction of spatial and temporal averages and may not fully account for the physical and dynamical factors that influence regional and national climate variability.

The experts established probability distributions to indicate the likelihood of above-, near-, or below-normal rainfall for each zone. Above-normal rainfall is defined as within the wettest third of recorded rainfall amounts in each zone; near-normal is defined as the third of the recorded rainfall amounts centred around the climatological median;

below-normal rainfall as within the driest third of the rainfall amounts. Climatology refers to a situation where any of the three categories have equal chances of occurring.

PROBLEMS AND ISSUES

The next three sections focus mainly on the Pacific Region, but a number of issues may be relevant to the South American and African regions.

Many users are still finding it hard to grasp probabilistic forecast which is one of the drawbacks in climate prediction application. Many local users are slowly accepting this new concept but still have doubts on its reliability. In several cases the users are not aware of availability of climate prediction information at the regional or national climate institutions, and in some case users lack know-how in applying such information in their respective sectors. There is also a problem of not having the "right" user-specific information or the information in the "preferred" format is not available.

In several cases, either NMHSs fail to disseminate climate prediction information, which are made available to them (such as ICU) to their users or they themselves do not understand the nature of such information. This could be due to lack of interest from the NMHS or as in many cases local funding is very limited which restricts NMHS from expanding its outputs. Most PICs continue to rely on external funding.

One of the most essential ingredients for any climate prediction models is a digitized good quality continuous long-term climate database, which is not available in most NMHSs. Most NMHSs do not have a software to archive and manage climate data therefore very little or no data have been digitized to date. Some PICs do not even have hard copies of the earlier records, which are kept at other national centres such as NIWA.

The poor or deteriorating standard of several national climate-observing network is also of a major concern. This problem is mainly due to financial constraints faced by the NMHSs. In several cases, AWSs have replaced manual observation, which led to further problems due to their high maintenance costs and lack of local support. This has led to discontinuity in dataset in many climate stations in the Pacific region.

Another drawback is the communication link between the users and the producers of the forecast. Several NMHSs and their clients in this region still have limited or no access to Internet, and if available, it tends to be very expensive. Telecommunication charges are usually high which limits usage of fax machines. In a number of PICs, NMHS have difficulties purchasing simple things like photocopy papers, CDs and printer cartridges due to lack of local supplies or high costs.

FUTURE

A number of issues such will be addressed by the AusAID project PI-CPP in the participating PICs, with the possibility of expanding this project to rest of the region:

- Training of the NMHS and stakeholders in probabilistic forecasts, and their applications in various sectors.
- Supply and further development of the climate prediction model to produce user specific information, as far as possible.
- Initiate and encourage continuous dialogue between the NMHS and its clients.

It is anticipated that project will enable the participating NMHSs to partake in the monthly teleconference held by NIWA for the ICU, which is the only known regional Climate Outlook Forum (COF) for the Pacific. Currently very few selected NMHSs are included in this forum because most of the PICs do not have capacity to actively contribute towards the forum.

NMHSs will be encouraged to organize national climate forum in their respective countries to disseminate seasonal forecasts.

BOM, NIWA, PEAC and East-West Centre continuously collaborate to combine their efforts in similar activities or compliment each other's efforts.

CONCLUSION

In the Pacific region, climate forecasting and its application are still relatively new to many island countries. A lot of people still have doubts about climate forecasts and they are reluctant to accept it for practical purposes. NMSs need to break this barrier first before they can expect the users to apply the climate predictions in their respective fields.

The value of seasonal to interannual climate forecasting in the Pacific Islands meeting has clearly been demonstrated by the Australian Bureau of Meteorology, the Fiji Meteorological Services, and the Pacific ENSO Applications Center which have provided climate forecast to the countries and territories of the Pacific region, and through regional Climate Outlook Forums in the South American and African regions.

There is a need for frequent dialogue between the NMHS and its users as much as the need for educating and training users in interpreting and applying seasonal forecast. NMHSs should have a pro-active role in encouraging use of climate information and forecast at decision-making levels in user sectors.

Due to high turnover continuous capacity building on national level particularly in the NMHSs is important. They should have the ability to disseminate the information effectively and interpret the climate variability to the users. Also, it is important to educate the users on the uncertainties associated with the long-term forecasts.

Establishing National Climate Outlook Forum and/or Regional Climate Outlook Forum may be the answer to enhance the interaction between the NMSs and the users, and set a platform for information exchange and feedbacks from both the parties through active dialogue

About 4 years ago, national climate forecasts was almost non-existent for many PICs in the Southern Pacific, but the commencement of ICU made such information available to this region. Unfortunately, due to lack of understanding of probabilistic forecasts and its applications by most of the NMHSs and their users does not qualify climate prediction service as a success in the region as yet. The implementation of projects such as PI-CPP will address some of the issues in order to establish a successful climate prediction service in a number of PICs, but not all.