

**CLIMATE INFORMATION AND PREDICTION SERVICES (CLIPS)  
FOCAL POINT TRAINING WORKSHOP FOR  
REGIONAL ASSOCIATION III**

**(Lima, Peru, 8–19 August 2005)**

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## **Summary**

This report summarizes the key outcomes of the CLIPS Focal Points Training Workshop for Regional Association III held in Lima, Peru, from 8 to 19 August 2005, attended by experts from twelve South American countries, the United States and Spain. The workshop reviewed the current status of progress in the development of climate information and prediction services (CLIPS) activities in the Region. Discussions focused on four key issues: climate indices and indicators, in particular sub-regional definitions of El Niño/La Niña, further enhancement and development of Climate Outlook Fora (COFs) for the subregion, advances in regional climate modelling and applications. Moreover, the workshop carried out an in-depth assessment of priorities for the region in terms of climate data management, strengthening of observational surface and upper-air networks for South America, education and training, and standardization of procedures for climate data management and modelling. The workshop also held two specialized training sessions, the first on use of the International Research Institute for Climate and Society's (IRI) Climate Prediction Tool (CPT) and the second on the use of the Commission for Climatology/Climate Variability's (CCI/CLIVAR) ETCCDMI Group of Experts Regional Climate Index (RCLimindex) for determining climate change indices.

## **CLIPS Focal Point Training Workshop for Regional Association III**

### **1.0 Opening Session**

1.1 The workshop opened at 9.00 a.m. on Monday, 8 August 2005 in the Auditorium of the National Meteorological and Hydrological Service (SENAMHI). Dr Buruhani Nyenzi, Director, World Climate Programme Department, on behalf of the Secretary-General of the World Meteorological Organization (WMO), welcomed the participants and thanked the Government of Peru for hosting the workshop. He added that this workshop was testimony to the Government of Peru's commitment to supporting WMO activities, particularly in the application of climate information and prediction services (CLIPS) for advancing sustainable development in Peru and the region as a whole.

Major General Juan Oviedo Motta, Director of SENAMHI and Permanent Representative of Peru with WMO, welcomed the participants on behalf of the Government of Peru. He highlighted the responsibility of CLIPS Focal Points in the subregion in terms of delivering appropriate climate information in order to develop regional capacity, improve interaction at the regional level and to contribute to WMO efforts at a global level. Following his presentation, he declared the workshop open.

1.2 The meeting reviewed the draft agenda for the session and adopted it. The opening statements, workshop agenda and list of participants are reproduced as annexes to this report (see Annexes I-IV).

### **2.0 Session I: WMO – CLIPS and the Lima Workshop**

2.1. Session I began at 10.00 a.m., with Ms Ena Jaimes (Peru) being appointed chairperson for the day, and Ms Lucero Crossa (Uruguay) acting as secretary.

Mr Penehuro Lefale (WMO) presented a summary of CLIPS project activities, during which he provided a brief overview of the WMO and its international role in coordinating international climate activities under the umbrella of the World Climate Programme (WCP). He briefed the workshop on the objectives of the World Climate Applications and Services Programme, including CLIPS activities. These included strengthening of the development and applications of seasonal and inter-annual predictions, as well as the establishment of Regional Climate Centres. In his summation, he expressed WMO's willingness to continue supporting inter-agency collaboration in order to improve seasonal and inter-annual predictions and the climate applications within the framework of the climate agenda and other international climate programmes such as the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP) and the Group on Earth Observation/Global Earth Observation System of Systems (GEO/GEOSS).

2.2 Dr Buruhani Nyenzi (WMO) outlined the aims and objectives of the workshop, namely to improve coordination among the climate community in the region, to promote dialogue among providers and users of climate predictions and to assess RA III's climate information and prediction service needs, as well as to make recommendations with a view to meeting these needs.

He encouraged participants to explore the formulation of a strategy for climate monitoring, evaluation and prediction in RA III during the workshop. He also recommended a training programme for the workshop, focusing on the use of:

- IRI Climate Prediction Tool (CPT)
- Climate Change Indices and Indicators Tool.

### **3.0 Session II: ENSO and Regional Association (RA) III**

3.1 Mr Rodney Martínez (CIIFEN) gave a presentation on ENSO – A Regional Perspective, in which he suggested possible implications of the operational definition of El Niño/La Niña Southern Oscillation (ENSO) recently adopted by Member countries from North and Central America (RA IV). The RA IV definition of El Niño is defined as an Equatorial Pacific Ocean phenomenon characterized by a positive anomaly in sea surface temperature greater than or equal to 0.5 °C averaged out over three consecutive months in Niño region 3.4, using 1971 – 2000 as the reference period.

Mr Martínez continued his presentation by explaining that since the 1997-1998 ENSO, no clear teleconnections between ENSO and PDO have been found in South America, despite the possible influence of Pacific Decadal Oscillation (PDO) on variations in the classic ENSO teleconnections. He suggested there is a great need for further research and analysis in these areas.

On the issue of what actions were needed to strengthen climate science in the region, Mr Martínez identified the improvement in seasonal forecasting as highest priority. He recommended that the POE (Probability of Excess) method be implemented within seasonal forecasts. The IRI Climate Prediction Tool (CPT) should also be implemented as an additional tool within the region's COFs, with the corresponding downscaling taking place on a local level. He also advocated the use of tools such as RClimdex and UK Hadley Centre PRECIS for the study of climate change.

3.2 A review of ENSO activities in RA III followed, with participants from Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, France, Paraguay, Peru, Suriname and Uruguay, providing information on the current status of their action in their respective countries, with particular focus on the following areas:

- 1) The current state of prediction of the local impact and effects of ENSO;
- 2) The key challenges to predicting and assessing the local effects of ENSO;
- 3) Requirements, steps to be taken, and possible regional or subregional actions to improve prediction of the local effects of ENSO.
- 4) Possible regional initiatives that might help enhance national capacities and capabilities;

A summary of each country's report is given in Section 16.

### **4.0 Session III: ENSO Regional Indicators and Indices**

4.1 The session of Tuesday 9 August 2005 began with a review and synthesis of the outcomes of Day 1, presided over by Ms Lucero Crossa (Uruguay). Mr Carlos Villanueva (Argentina) was appointed chairperson for the day, with Ms Amelia Díaz (Peru) as rapporteur.

4.2 Mr Penehuo Lefale (WMO) presented the typical features in the evolution of ENSO, explaining that one of the key challenges when assessing El Niño conditions is that there is no globally accepted international agreement identifying the components of an ENSO event. At such times, different meteorological services and agencies analyse, interpret, make predictions and disseminate ENSO information using a variety of methods, definitions and interpretations. Given the confusion that this situation engenders in the media and on the part of the users, the matter needs to be dealt with urgently. WMO is attempting to facilitate such discussions.

Mr Lefale then went on to introduce the El Niño Oceanic Index – NOAA, which is based on readings obtained through monitoring, evaluation and prediction of El Niño, as well as on mean values for three consecutive months in Niño region 3.4 from a homogenized data set of historical sea-surface temperature (SST) values. He noted that this index has been used to place current conditions within an historical perspective.

There is currently a WMO Expert Group from the OPAG 2 on the Monitoring and Analysis of Climate Variability and Change working on El Niño indices and definitions. A catalogue containing El Niño and La Niña indices and definitions used in different regions is being developed and to this end, questionnaires have already been sent to all member countries.

4.3 Mr Rodney Martínez, on behalf of the International Centre on Research “El Niño” (CIIFEN), gave a presentation on Regional ENSO Definition and described the results from the survey carried out in the countries of the region by CIFFEN. He stressed that in order to establish uniform and acceptable regional definition of ENSO, it would be necessary to establish ENSO indicators and/or maps of ENSO impact on the region. He highlighted possible benefits of reaching consensus on a regional definition:

- 1) That the regional early warning systems would be uniform and synthesized, thus reducing the risk of confusion;
- 2) That risk management of the El Niño event can be conducted on a regional scale;
- 3) That it allows for international recognition and therefore for analyses to be carried out by extra-regional scientific and financial bodies;
- 4) That it encourages discussion and dialogue between the scientific community and end-users in the region;
- 5) That it reduces political interference and manipulation in declarations of alerts at individual country level;
- 6) That it will allow for an objective diagnosis based on indicators for measuring ENSO status, with emphasis on their regional impact.

Among the obstacles in establishing a regional definition include:

- 1) The risk that a given sub-region may not be represented by the definition adopted.
- 2) The possible failure of some countries to analyse the indicators that are most effective in evaluating ENSO and its impact at local level.
- 3) The cost and complexity of engaging in a participatory process that is geographically balanced and in which users and decision-makers are truly involved.
- 4) Possible interference by developed countries and their agencies with this process.
- 5) Paradigm shifts at the local level, particularly among the media and the general public.

Finally, Mr Martínez set out some of the basic considerations necessary for achieving consensus:

- 1) A feasible and cost-effective timetable should be defined;
- 2) The indicator(s) should accurately identify numerical values, baseline and persistence over time;
- 3) On the basis of the development of the indicator(s), alert levels should be established;

- 4) Those to be involved in the process should be identified;
- 5) The political body that will oversee and ensure the development of the process within RA III should be established.

## 5.0 Session IV: Working Groups: ENSO Regional Indicators and Indices

5.1 In order to identify the ENSO regional indicators and indices used within RA III, Working Groups (WG) were formed, with the following makeup:

Group 1:

Facilitator: Mr Rodney Martínez (CIIFEN)

Rapporteur: Mr Juan Quintana (Chile)

Representatives from Bolivia, Chile, Ecuador and Peru

Group 2:

Facilitator: Mr Penehuro Lefale (WMO)/ Ms Bárbara Tapia (Chile)

Rapporteur: Mr Carlos Villanueva (Argentina)

Representatives from Argentina, Brazil, France, Paraguay, Suriname and Uruguay

The objectives of the working groups were as follows:

- Identify and document *ALL* the indicators and indices used within RA III, including SOI, MEI, etc.
- Propose new ENSO indicators suitable for RA III (in terms of both climate and impact), e.g. ONI, bio-indicators, environmental changes, indigenous ancestral knowledge, etc.

## 6.0 Session V: Working Session on ENSO Regional Indicators and Indices

6.1 At 2.00 p.m., the coordinating committee gave a presentation of the findings of the WG sessions in plenary. Participants engaged in detailed analysis of the results and offered their own contributions in order to complete the work being presented. Finally, the matrices that resulted from the contributions of all participants were approved. These matrices are set out below.

1) Matrix 1

INDICATOR	EFFECTIVENESS	REMARKS
<i>Atmospheric</i>		
850-hPa trade winds	Kelvin wave generation	Forecasting tool
OLR	Intraseasonal oscillation	Forecasting tool
IOS	Ocean-atmosphere coupling	Diagnostic tool
MEI	Multivariate integrator	Diagnostic tool
200-hPa circulation	Regional influence	Diagnostic tool
<i>Oceanic</i>		
Niño 1 & 2	Direct in coastal zone	Diagnostic tool
Niño 3.4	Central Pacific/South America teleconnection	Forecasting tool
Sea subsurface temperature	Central Pacific	Forecasting tool
Thermocline	Equatorial Pacific	Forecasting tool

2) Matrix 2

IDEAL INDICATOR	PERSISTENCE	REMARKS
<i>Atmospheric</i>		
South Pacific anticyclone index	South Pacific/Bolivian high-pressure system/Regional rainfall teleconnections	To be implemented during the forthcoming COFs
<i>Oceanic</i>		
Multivariate Niño 1 & 2 index	Link between coastal oceanic and atmospheric variables	To be implemented during the forthcoming COFs

## 7.0 Session VI: Seasonal Climate Forecasting

7.1 Mr Penehuro Lefale (WMO) gave a presentation on the Global Seasonal Forecasting Centres and other sources for Climate Monitoring, Assessment, Prediction and Applications (CLIMAP), Information and Services in RA III.

Mr Lefale stated that the objective of the exercise was to create a regional group to review and plan operational activities within RA III, identify needs and make recommendations as to how WMO could assist in its implementation of such activities and plans of work.

7.2 The session on Wednesday 10 August began with a review and synthesis of the outcomes of Day 2, presided over by Ms Amelia Díaz (Peru), after which Mr Gualberto Carrasco (Bolivia) was appointed chairperson for the day, with Mr Dennis Rodrigues (Suriname) acting as secretary.

Mr Juan Coronado (Peru) explained the new challenges facing seasonal prediction in the West Coast of South America, the area given greatest stress because of the predictability it enjoys due to its proximity to the tropical equatorial Pacific and the existence of climate signals such as ENSO and Pacific Decadal Oscillation (PDO). These circumstances encouraged the effective application of models using baseline conditions such as sea surface temperatures (SSTs) and existing teleconnections with forecast variables like rainfall and temperature.

One model used for seasonal forecasting is the CCM3 dynamical model, which has been successfully implemented by SENAMHI with an ensemble forecasting system. This allows forecasting up to nine months in advance and also provides information on the level of uncertainty through an analysis of ensembles. The latest generation of CCSM family models has been implemented and developed in the last five years and contains substantial improvements over the previous version.

Finally, some of the significant challenges faced by the region include developing measures or methodologies to meet the expectations of end-users and establishing links with other institutions to achieve the results expected of meteorological services.

7.3 Dr Simon Mason (IRI) gave a presentation on seasonal climate forecasting in which he described dynamical prediction, based on the physics of the controlling processes and statistical prediction, based on the statistics for these processes.

He noted that in order to make good-quality climate forecasts, there was a need to be clear about the baseline conditions and changes over time, for which coupled models are

required. These involved running oceanic and atmospheric models in tandem, with direct communication between the two models, whilst in decoupled models, first the oceanic and then the atmospheric model is run, i.e. the models are not related and any information is transmitted via a third party.

There are two types of predictions involved in making a seasonal forecast, one global, containing two sources of uncertainty such as errors in initial conditions and errors in initiation of the model. In terms of global prediction, a model that is run several times is referred to as an ensemble, and if different models are ran at different number of times with different initial parameters, this is referred to as a multimodel ensemble. The other, regional, involves more detailed spatial forecasts with different applications, a process referred to as downscaling, i.e. moving global forecasts to finer spatial resolutions than the original.

7.4 Ms Ena Jaimes (SENAMHI – Peru) presented the process used by Peru in collaboration with Chile, Bolivia, Ecuador, Colombia and Venezuela in preparing seasonal forecasts for the West Coast of South America. Updates of the forecasts are issued on a monthly basis and posted on the websites of the meteorological services involved.

The procedures, models and data used in preparing these climate outlooks are carried out by the NMHSs. It is worth stressing that the current state of development in seasonal climate forecasting in the region is helping improvements to be made in the prediction of mean spatial and temporal values, since each meteorological service takes into account virtually all factors contributing to national (and ultimately regional) climate variability, with more meteorological stations being added for forecasting. The climate outlook depends on the quality of predictions of SSTs and such predictions provide useful information, although there is no guarantee as to exactly how SSTs evolve over time. For this purpose, it is necessary to develop regional indices able to contribute to seasonal forecasting in the region. Finally, climate outlooks are only relevant on a seasonal timescale and over relatively large areas; thus, variations on the local level are to be expected.

7.5 Dr Jurandir Zullo Junior (Unicamp – Brazil) introduced the Brazilian National Information System for monitoring meteorological and climatic effects on agriculture. He explained that the agricultural sector relies on climate prediction and weather forecasting because of the great importance of agriculture to the economy in a country where droughts during crop seeding periods were harmful, as was too much rainfall during crop ripening.

He noted that a programme coordinated by the Ministry for Agriculture and the National Institute for Agricultural Research (EMBRAPA) had been developing since 1995, with the aim of reducing climatic risks such as periods of drought or excess rainfall. This evaluation attempted to simulate cumulative water balance with different soil types, sowing times and other variables. Risk analysis based on crop life cycles was also being performed.

Finally, he explained that, thanks to the country's support, it had been possible to establish AGRITEMPO, which shared participation between INMET, CPTEC, local institutions and universities. AGRITEMPO issues a range of agrometeorological information for every Brazilian state over its website: [www.agritempo.gov.br](http://www.agritempo.gov.br). Products available on the website include maps, bulletins, graphs and tables containing agrometeorological information and forecasts. This service receives temperature (minima and maxima) and precipitation data from 950 stations through different sources, e.g. telephone, fax and email, etc; and has historical data from more than 4000 stations. There are more than 40 million registered users of the AGRITEMPO database.

7.6 Dr Simon Mason (IRI) presented the IRI view of ENSO indicators and indices, and discussed variations in current available definitions of El Niño:

- 1) Original definition: The traditional view of El Niño has unfortunately been found to be insufficient for use by the scientific community but has nevertheless become widely accepted within the broader international community, including the public and the media;
- 2) Scientific definition: there is a lack of consensus within the scientific community as to whether El Niño is an oceanic or a coupled oceanic-atmospheric phenomenon. Furthermore, an appropriate index will depend on the type of phenomenon (interannual variations in SST, data resolution, or its operational definition as opposed to retrospective definition, etc.);
- 3) The user's interpretation: this is measured in terms of local impact and meteorologists stress that the same El Niño event can affect a number of areas in possibly different ways. It is precisely this information that users are most interested in.

7.7 Mr Rodney Martínez (CIIFEN) provided information on the Climate Outlook Forums (COFs) in the region, with background on the COF set up for the West Coast of South America and the COF for the MERCOSUR countries.

He went on to mention the possibility of setting up a website and also discussed some of the key lessons learned from ongoing COFs in RA III, particularly the latest developments in the COF for the West Coast of South America:

- The numerical tool reduces subjectivity,
- Coordination and follow-up is required for sustainability purposes,
- The methodology has encouraged application to be initiated on a local level,
- The tool used is being disseminated within countries,
- Validation is important.

Future steps to be taken in the region to encourage development of the COFs include:

- Development of temperature maps,
- Incorporation of validation as a product,
- Implementation of a regional product based on the CPT that gives added value to the current product,
- Implementation of rainfall excess probability.

Mr Martínez then coordinated the discussion on, "Lessons Learned about Climate Outlook Fora in RA III". The following comments by participants were of particular interest:

- Ecuador: Considered it necessary to implement forecasting validation/verification;
- Chile: stated that the COF had been working well for a year and was moving into a second phase incorporating temperature forecasts. It was hoped that the new tools would help improve and offer greater credibility to forecasts, thereby meeting the sectorial requirements of users, particularly in the energy and agriculture.
- Brazil: The fora in Brazil's region had been particularly successful because they were conducted for users and made use of all the technology available from global centres such as IRI, ECMWF and CPTEC and on a monthly basis, from NMHSs, CPTEC and INPE. However, he showed that COFs could not predict extreme events of short duration. Extreme events have increased since 1996 and research in this area has therefore been promoted.

- Peru: Problems with the data used by EXEVER, and the methods to secure raw data in a timely manner at the beginning of each month ought to be dealt with. Peru also recommended that EXEVER be run on a monthly basis;
- Argentina: Stated that it would be useful to have a numerical tool. Argentina also informed that they do validate their forecasts wherever processing problems had been detected;
- Brazil: There are good models in existence that could be employed to help improve on models currently in use, along with the sharing of methodology. It is recommended that working methods be harmonized and standardized, i.e. have a common methodology for the whole of South America;
- Bolivia: Bolivia also informed that they do validate.

7.8 A plenary session was held in which representatives from RA III, WMO, IRI, CIIFEN and other observers established the framework for a draft Action Plan in RA III. The results of this session are given in the following table:

1	Define and extend, where needed, network coverage beyond that of GCOS and GUAN	STATIONS
2	Regional standardization of forecasting, validation/	STATIONS
3	Establish regional database of monthly temperature extremes and precipitation for the period 1960-2000	DATA
4	Education and training in numerical and statistical modelling, funding for training fellowships and media courses for public outreach	TRAINING
5	Data rescue, recovery, and retrieval	DATA
6	Upgrade of computing infrastructure (supercomputer)	COMPUTING INFRASTRUCTURE

## **8.0 Session VII: Climate and Ocean Modelling: Where does Regional Association III stand?**

8.1 The session of Thursday 11 August began with a review and synthesis of the outcomes of Day 3, presided over by Mr Dennis Rodrigues (Suriname), after which Mr Expedito Rebello (Brazil) was appointed chairperson for the day, with Mr Jorge Sánchez (Paraguay) as rapporteur.

Ms Delia Acuña (SENAMHI – Peru) related Peru’s experiences with CCM3, a model implemented and adapted for use by SENAMHI in 2000 and run operationally since 2001 at the Centre for Numerical Prediction (CNP), with validation commencing in 2002.

The following advances in the light of implementation of CCM3 include:

- Generation of more than twelve climate forecasts;
- Disturbances in different regions of the tropical Pacific and atmospheric responses;
- Generation of the climatology model for other parameters expressed in terms of anomalies;
- Work is being carried out on validation of precipitation and other variables;
- Adoption of new configurations for regional climate simulation with RAMS (soil moisture, convection patterns, etc.).

Ms Acuña noted that, for the whole period analyzed, the CCM3 showed high skill in rainfall prediction in the forest and southern highland regions of Peru and low skill in the central/southern coastal and forest region. Forecasts for dry periods in the country also tallied with real behaviour, with an observed high level of sensitivity in the initial conditions in the transitional seasons, as reflected in the poor performance of CCM3 in representing forecast rainfall in the meantime. That reflected a greater degree of confidence in forecasts during summer and winter and showed that the highest confidence in a forecast using CCM3 was for the first three months.

Exchange and integration of information on climate prediction nationally and in the South American region would permit the development and optimization of climate predictions, allowing decision-makers to have access to better forecasts.

8.2 Mr Expedito Rebello (Brazil) spoke of Brazil's experiences with climate modelling and pointed out that INMET does not engage in climate modelling but that the Operations Section works with the Brazilian High Resolution Model (MBAR), which is used to obtain the distribution of heavy rainfall and other parameters for all the Brazilian states and generate forecasts for rainfall and temperature.

Mr Rebello also stated that CPTEC performs climate modelling both for Brazil and South America and that since 2003, both institutions have been coordinating their work.

8.3 Mr Juan Quintana (Chile) gave a presentation on the development of climate modelling in Chile. There were three Chilean institutions engaged in activities related to climate modelling: the Chilean Meteorology Directorate (DMC), the Department of Geophysics at the University of Chile (UCh) and the Department of Geophysics at the University of Concepción (UdeC). DMC has begun running the Regional Climate Model (RCM) supplied by the UK Met Office's Hadley Centre, which corresponds to the PRECIS model. The overall goal is to create future climate change scenarios for the year 2050 in the central/southern region of Chile and to find out which regions will be most vulnerable to increased levels of carbon dioxide. The project also estimated how robust are values resulting from modelling in comparison to observed values in order to validate model scenarios for future time periods.

Among future actions, is the research project Climate Variation in Chile: Evaluation, Interpretation and Projections, financed by the National Fund for Science and Technology (Fondecyt) for the period 2005-2008. The institutions participating in this project are UCh, UdeC and DMC. The project is a joint venture to offer an opportunity to develop research capacity and human resources at national level and enhance research into climate variability, climate change and regional climate modelling at the participating institutions.

8.4 Dr Pierre Soler, Institut français de recherche pour le développement (IRD), Peru, presented some of the research projects into the impact of Global Change in Peru developed by IRD. He stressed that within the framework of its three basic terms of reference (research, expertise and training) IRD is participating in several international scientific programmes examining the relationships between Man and the Environment in South American countries.

Cooperation activities in Peru currently covered a wide number of research areas, including the Earth's crust, evolutionary trends and natural hazards, climates, variability and its impact, development policies and globalization, water and fisheries ecology; and terrestrial ecosystems and resources.

8.5 Mr Kobi Mosquera, Instituto Geofísico del Perú (IGP), gave a paper on oceanic and coupled modelling in the Southeast Pacific, stressing both the regional challenges and opportunities it presented.

The implementation of a regional oceanic model would be high-priority before thinking about “coupling”. Coastal, surface and subsurface currents, and particularly Kelvin waves, would have to be represented in oceanic models if they were to interact with atmospheric models for prediction purposes in the Southeast Pacific. It should also be borne in mind that an agreement would need to be entered into with one or more international institutions conducting ocean structure simulations on a global scale, with the aim of using the information in real time to make our own regional simulations. All of that should go hand in hand with a plan for monitoring oceanic conditions, unfortunately very scarce in the Southeast Pacific region.

8.6 Mr José Pasapera (IMARPE) explained the results obtained from oceanic modelling in Peru with the ROMS model covering the Peruvian coastline. Modelling of physical, chemical and biological processes within the Humboldt Current Ecosystem (HCE) is carried out, along with integrated analysis of processes within the HCE.

Scientific prospects include the following:

- Studying and conducting research into the physical conditions associated with ENSO and prediction of the ecosystem response to regional and global climate change;
- Implementation of research and monitoring programmes for variability in oceanographic and atmospheric conditions under the influence of ENSO interannual variability;
- Implementation of coupled non-linear baroclinical models of intermediate complexity in order to understand, document and forecast El Niño;
- The results could lay the groundwork for the elaboration of products for the fisheries sector, such as the pinpointing of potential, critical or at-risk fishing areas.

8.7 Mr Rodney Martínez (CIIFEN) presented a Regional Agenda for South-East Pacific Modelling, beginning his presentation with a brief overview of the outcomes of the Regional Workshop on this topic, organized under the auspices of CIIFEN in June 2004. That workshop had been sponsored by IAI, ICO, CLIPS-WMO and CIIFEN and had been attended by representatives from the United States, France, Mexico, Colombia, Ecuador, Peru and Chile. During the workshop, the current status of and requirements for regional modelling were reviewed for enhancing the region’s climate prediction capability. Technical progress in the implementation of a regional oceanic model was also discussed. In addition, Mr Martínez explained that the workshop prioritized and agreed to issue early warning of Kelvin waves passing along the coasts of South America and of the implications for convection and circulatory processes, particularly those relating to rainfall generation in the region.

Mr Martínez then proceeded to list possible obstacles to the implementation of a regional modelling:

- A registry of regional data is required in order to find out what data are available and whether it would be possible for countries to exchange their data;
- There must be access to physical parameters such as SST, surface winds, salinity, temperature between 0 and 500 m, and access to the regional database of data obtained from regional research cruises along the South-East Pacific.

Mr Martínez also noted:

- The exchange of meteorological data used in atmospheric models should be defined and required at a regional level;
- Barometric and topographic data can be downloaded from international databases such as ETOPO 2 for modelling purposes;
- Similarly, when it comes to obtaining data, no additional software or hardware is necessary, since Ocean Data and Information Network for IOCARIBE and South America (ODINCARSA) can help South-East Pacific countries in database processing and by providing a regional metadata catalogue over the UNESCO server or the ODINCARSA website;
- It is recommended that CIIFEN and experts from the oceanographic institutions in Colombia, Ecuador, Peru and Chile meet to organize the database with the support and assistance of ODINCARSA.

Finally, certain recommendations were proposed:

- Set up a regional database as soon as possible;
- Work on a high resolution climatology system;
- Produce a regional Meta data catalogue with the cooperation of ODINCARSA;
- Ask PCSP to coordinate data provision with NOAA;
- Obtain funds for setting up preliminary education and training programmes on numerical modelling for coupled models.

## **9.0 Session VIII: Training on Climate Prediction Tools (CPT)**

9.1 The session of Friday 12 August began with a review and synthesis of the outcomes of Day 4, presided over by Mr Jorge Sánchez (Paraguay), after which Mr Juan Quintana (Chile) was appointed chairperson for the day, with Mr Expedito Rebello (Brazil) as rapporteur.

Dr Simon Mason (IRI) devoted the whole day to training on IRI Climate Prediction Tools (CPT), to enable users to assess climate predictability for a region and make real-time climate predictions.

He began by providing a conceptual introduction to analysis of the principal components, providing an efficient means of reducing large volumes of data. They are of use in Modelling Output Statistics (MOS) and dealing with prediction problems, since they permit a large number of predictors to be reduced to a small number, avoiding duplication of effort. In view of this, the principal components are used for regression analysis in CPT rather than original predictors.

Participants spent the rest of the day carrying out CPT-related exercises.

## **10.0 Session IX: Training on Climate Prediction Tools (CPT) (continued)**

10.1 The session of Saturday 13 August began with a review and synthesis of the outcomes of Day 5, presided over by Mr Expedito Rebello (Brazil), after which Mr Maximiliano Henríquez (Colombia) was appointed chairperson for the day, with Mr Hernán Parreño (Ecuador) acting as secretary.

Dr Simon Mason (IRI) spent the day on training in Climate Prediction Tools (CPT) and hands-on exercises.

## **11.0 Session X: Training on Climate Prediction Tools (CPT) (continued)**

11.1 The session of Monday 15 August began with a review and synthesis of the outcomes of Day 6, presided over by Mr Hernán Parreño (Ecuador), who then acted as chairperson for the day, with Mr Maximiliano Henríquez (Colombia) acting as secretary.

Dr Simon Mason (IRI) spent the entire day on training in IRI Climate Prediction Tools (CPT).

11.2 Mr Penehuro Lefale (WMO) set out the work programme for the coming days, calling for the preparation of a draft set of conclusions and recommendations from the workshop. The steps to be followed are set out below:

- 15 August: Participants complete the workshop evaluation questionnaire provided by WMO;
- 17 August: First draft of final report;
- 18 August: Second draft of final report;
- 19 August: Completion of draft final report;
- 28 August: Circulation of final report to participants for final comments;
- 30 September: Publication of final report.

11.3 A working group was formed to establish the meeting's conclusions and recommendations on the following:

- Regional climate indicators,
- Climate fora,
- Climatic modelling,
- CLIPS.

## **12.0 Session XI: Training on Climate Change Tools and Indicators**

12.1 The session of Tuesday 16 August began with a review and synthesis of the outcomes of Day 7, presided over by Mr Maximiliano Henríquez (Colombia), after which Ms Daniele Carnino (France) was appointed chairperson for the day, with Mr Juan Quintana (Chile) acting as secretary.

Dr Enric Aguilar (URV Tarragona, Spain) gave an introductory presentation dealing with the background to the workshops organized under the auspices of ETCCDMI since 2001 and particularly during 2004. These workshops all involved the use of a robust methodology for quality and homogeneity control and calculation of temperature indices and rainfall extremes in order to evaluate the effect of climate change on these values. These workshops created significant improvements in understanding these phenomena at the global and regional level.

Following the initial paper, the 27 indices established by ETCCDMI and available via the RCLindex tool were presented individually in detail.

The issue of errors in climate information was then addressed. It was made clear that moving from isolated observations in space and time to a general analysis of climate change evidences, necessarily entails ensuring that the information is free from isolated errors, through quality control and correction of systematic errors using homogeneity techniques.

Following a brief presentation by participants of the data brought with them for use during the workshop, a detailed explanation of the functioning of the RCLimindex quality control module was provided, after which application of the module was begun.

### **13.0 Session XII: Training on Climate Change Tools and Indicators (continued)**

13.1 The session of Wednesday 17 August began with a review and synthesis of the outcomes of Day 8, presided over by Mr Juan Quintana (Chile), after which Mr Jorge Sánchez (Paraguay) was appointed chairperson for the day, with Mrs Daniele Carnino (France) as secretary.

Dr Enric Aguilar (URV, Tarragona, Spain) gave two further presentations on, respectively, the RCLimindex index calculating module, and the function of and philosophy behind RHTest, a supplementary programme for preliminary homogeneity evaluation. He explained a series of subjective techniques based on graphic processing of time series and indices for detecting non-homogeneity. He also gave a summary of various statistical concepts on the calculation and statistical validation of linear regression models.

The rest of the day was devoted to individual work by representatives of the various countries, which were moving towards a grasp of all climate change indices on the basis of the methodology developed in them.

### **14.0 Session XIII: Training on Climate Change Tools and Indicators (continued)**

14.1 The session of Thursday 18 August began with a review and synthesis of the outcomes of Day 9, with Ms Daniele Carnino (France) presiding, after which Mr Dennis Rodrigues (Suriname) was appointed chairperson for the day, with Mr Gualberto Carrasco (Bolivia) as secretary.

Dr Enric Aguilar (URV Tarragona, Spain) began this final session with the individual work of the participants who, after obtaining the relevant set of indices, evaluated the homogeneity of the stations they had been working on. Once all the material had been processed, each participant prepared an individual presentation to share results with the rest of the group.

During the afternoon, the results of the indices were presented, indicating a general increase in temperatures as well as lower spatial coherence in the results relating to precipitation indices.

The training session ended with a presentation on possibilities for advanced analysis of the products obtained, with a brief reference to spatial coherence, the various possibilities for grouping together in regional series, and multivariate analysis techniques.

### **15.0 Session XIV: Review of the Workshop**

15.1 Mr Penehuro Lefale (WMO) chaired the last workshop session, reviewing the level of progress achieved in meeting the aims and objectives set out at the beginning of the workshop. He also summarized the training activities conducted over the fortnight of the workshop, such as Climate Prediction Tools (CPT) and use of RCLimindex software.

Mr Lefale briefly outlined forthcoming WMO and CLIPS events, both in RA III and internationally.

Mr Rodney Martínez then presented the draft summary of conclusions and recommendations generated during the workshop and, with certain amendments; it was

accepted as the outcome of the meeting. They are provided in full in section 17.0 (pages 21-24).

## **16.0 Country Reports**

### **16.1 Argentina**

Mr Carlos Villanueva provided a summary of the method used for climate prediction (climate trends) and the elements taken into account during prediction, viz.:

- 1) Temperature and precipitation trends in the country for the month prior to the period covered by the forecast and the following three months;
- 2) Sea-surface temperature (SST) trend for the South Atlantic and South Pacific (Niño regions 1, 2 and 3.4 and between 20 °S and 65 °S), as well as anomalies;
- 3) Wind field and anomalies (zonal component) in the equatorial Pacific zone;
- 4) Trend and anomalies in subsurface sea temperature;
- 5) Values for the different indices;
- 6) Output from global climate prediction models and quarterly SST trends.

The quarterly prediction is checked against observations carried during the same period.

The following are some of the effects of ENSO felt in Argentina:

- In general terms, higher precipitation in the northeast of the country and lower precipitation in the northwest.
- An increase in mean temperatures in the above mentioned regions.
- There is no information available on changes in precipitation and temperature for the southern region (Patagonia);
- The modifications in parameters occur at various time periods.

The following are viewed as limiting factors in making climate predictions:

- Available global models are used as a starting point, so that any predictions issued are dependent on the efficiency of the initial models, which often yield differing results;
- There are no forecasts of anomalies in mean pressure fields for surface levels at 500 hPa over medium-term periods;
- The need for more studies, enabling the influence of Atlantic Ocean anomalies on the continental region of South America to be determined.
- The need to establish correlations between the low-layer jet-stream and ENSO;
- The absence of regional level climate models allowing adjustments to be made at national or eastern area level;
- The lack of training and human resources.

### **16.2 Bolivia**

Mr Gualberto Carrasco explained that earlier studies show that El Niño has a fairly significant impact in Bolivia, giving rise to precipitation deficits that cause severe drought in the Altiplano, Valleys, and Chaco regions, and heavy precipitation in other regions, causing flooding, excessive runoff and landslides. The El Niño phenomenon makes itself

most felt during the wet season, i.e. between November and March, thus affecting the Bolivian temperature and rainfall regime.

Following the assessment of the effects of precipitation (deficits and excesses), impact analysis is currently being carried out using the existing network of meteorological stations. Statistical methods have been used to obtain results concerning spatial distribution of precipitation.

Among the limitations on forecasts, mention was made of the fact that the technical team responsible for following up reports from specialized bodies requires continuous education and does not have up-to-date computerized tools at its disposal. The thinness of the meteorological monitoring network is a result of budgetary cuts, with reports on the development of an ENSO event being based on WMO official bulletins.

The following actions to improve ENSO prediction are of particular note:

- Update the technical team responsible for ENSO monitoring;
- Set up websites enabling results to be obtained and then officially issued for the region;
- Run simulation models based on readings obtained for parameters indicating development of ENSO events (SST – SOI);
- Permanent communication between meteorological services during ENSO events.

### 16.3 Brazil

Mr Expedito Rebello stated that in Brazil the El Niño phenomenon had a number of influences and impacts, such as droughts in the northeast, flooding in the south and temperature increases in southern, south-eastern and central Brazil. Another component affecting Brazil is the Decadal Pacific Oscillation (DPO), and it is likely that during this DPO phase, few El Niño events occur.

The Brazilian Government is continuing to take various precautions, including reinforcement of the civil defence system coexisting with drought in the north-east of the country, with a project to divert the river San Francisco and bring water to four additional northeastern states, so as to avoid migration in moderate or strong El Niño years.

### 16.4 Chile

Mr Juan Quintana, in his presentation entitled “ENSO IN REGIONAL ASSOCIATION III: THE SITUATION IN CHILE”, addressed the following four points:

- 1) ENSO: Prediction and its impact in Chile
- 2) Limitations in prediction of localized effects of ENSO
- 3) Ways of improving prediction of the effects of ENSO
- 4) Possible regional initiatives that could help enhance national capacities.

Under (1), he described Southern Oscillation coupling and its relationship with precipitation in Chile, as published for the first time in a scientific paper by Walter and Bliss in 1932. This atmospheric teleconnection mechanism was corroborated years later in 1989 by Karoly and presents the pattern of circulation anomalies in the middle troposphere, with positive and negative nuclei at a geopotential level of 500 hPa, which propagate from the central equatorial Pacific towards sub-polar latitudes during El Niño years. This atmospheric pattern would appear to explain why the majority of years exhibit positive rainfall anomalies in central Chile during El Niño years, and negative anomalies during

La Niña years. Similarly, the global effects of El Niño and La Niña on precipitation and temperature were reviewed, with emphasis on the Chilean and South American region. With regard to Chile, a description was given of how the correlations between Niño 3.4 sea surface temperature anomalies and bimonthly rainfall for forecasting purposes operated, along with the occurrence of circulatory patterns explaining such rainfall anomalies. Reference was made to recent studies conducted in Chile related to the discovery of new indices listing rainfall variability in Chile over the last 50 years. These indices refer to variability in the Southeast Pacific Subtropical Anticyclone and the dipole in pressure anomalies between the subsolar region and middle latitudes of the Southeast Pacific defined as regional Antarctic Oscillation. Finally, a diagram was presented showing the regional effect of El Niño and La Niña conditions on precipitation and temperature in the various seasons of the year.

Under (2) was the use of simple statistical models for predicting precipitation and temperature under the effect of El Niño and La Niña. It was reported that in Chile, the development of regional modelling to enable prediction of the impact of El Niño and La Niña is still in its infancy. One of the main reasons for this lack of progress in climate modelling is the limited computing infrastructure available at climate research centres and the shortage of researchers in climate research and modelling.

Under (3), it was proposed that, to improve prediction of the effects of ENSO on the regional scale (RA III countries), atmospheric circulation mechanisms explaining inter-annual variability in precipitation and temperature under extreme ENSO conditions (El Niño and La Niña) should be identified. A proposal was also made for the creation of conceptual models identifying atmospheric circulation anomalies under El Niño and La Niña conditions and explaining the dry/rainy and cold/hot regions across various seasons in RA III countries. An initial possibility suggested for mitigating the effects of El Niño in Regional Association III involves setting up a bank of monthly data for each country, containing rainfall and extreme temperature variables (over a 30-year period). This information needed to be studied in its entirety using multivariate statistical techniques to identify the most significant forms of regional variability connected with the oceanic and atmospheric indices present during the extreme phases of ENSO (El Niño - La Niña). Once set up, the regional database could also be applied to the validation of the Regional Climate Models which will hopefully begin to be implemented in the next few years in every South American country.

Finally, under (4), concerning the possible regional initiatives that might help enhance national capacities, mention was made of the establishment of permanent working groups, the implementation of projects funded by international bodies with participation by experts from each country, training fellowships at centres of regional climate modelling and the organization of relevant regional workshops and seminars.

## 16.5 Colombia

Mr Maximiliano Henríquez stated that hitherto, climate prediction in Colombia has been subjective, although it is now being made more objective in the near future. Temperature anomalies for both oceans (Atlantic and Pacific) are used in climate prediction along with wind behaviour, long-wave radiation, statistics, past behaviour of the different variables and their effect on economic activities within the country in general terms. The results of Global Climate Models produced by IRI, NOAA, Hadley Centre and others are also taken into consideration. Climate Alert Bulletins (CABs) issued by the ERFEN group are analysed, after which a Climate Prediction Bulletin is prepared and posted on the website for users.

Progress is currently being made on capacity building at Colombia's Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) within the weather and climate numerical modelling group, based on MM5 and involving the preparation of 72 to 120 hour forecasts at three resolutions (4, 12 and 36 km) every 50 mb and on the CAM Model, version 3.1, for climate prediction using a 54-node cluster with 108 processors and 13.5 Gb of RAM on a Linux Debian 3.1 operating system platform. The short-term forecasting and climate forecasting described here has already entered the test phase and is expected to become fully operational at the IDEAM forecasting and alert service from 2006.

Colombia is developing climate change scenarios within the framework of the Integrated National Adaptation Pilot Plan (INAP): High Mountain Ecosystems, islands in Colombia's Caribbean Area and Health (Dengue Fever and Malaria) - INAP, funded by GEF-World Bank. These scenarios are being developed using the Hadley Centre PRECIS model and the MM5 and Japan's MRI. INAP will last five years, at a total cost of \$12.25 million.

#### 16.6 Ecuador

Mr Hernán Parreño explained that there have been no recent recorded instances of adverse conditions resulting from an ENSO event in Ecuador. As part of his description of current conditions, Mr Parreño presented a series of graphs showing percentage negative variation in precipitation on Ecuador's coast between January and June 2005, in comparison with normal values for the same six-monthly period. He also presented a graph of six-monthly positive anomalies in mean air temperature in all cases, as well as two graphs plotting anomalies in mean air temperature and percentage precipitation variation at a national level.

He set out some of the weak points in ENSO forecasting and commented that in order to improve the situation, area models would need to be developed and a regional meteorological observatory established.

Proposed initiatives include the regular publication of ENSO information in popular form, with the aim of fostering greater awareness of the phenomenon and thereby offsetting and mitigating its effects, since prevention should serve as a guidance tool.

#### 16.7 France

Ms Daniele Carnino represented French Guyana, which is an overseas department of France.

The French Meteorological Service, also known as Météo-France, has a *regional service* in French Guyana where observations, forecasts and some climatology studies relating to the effects of ENSO and climate change are carried out. In addition, Martinique hosts the *Inter-regional Directorate for the Antilles and Guyana*, which conducts studies and projects focussed principally on cyclones; it also currently possesses hydrological radar in place. There is also a seasonal forecast research and modelling unit, referred to as Météopole, in Toulouse, metropolitan France.

The impact of El Niño on French Guyana is not easy to determine, owing to the limited extent of the station network, with only 37 stations in the coastal zone and along two of the principal rivers. Nevertheless, it can be concluded that ENSO causes more severe droughts during the dry season and increases in minimum temperatures as compared with maximum temperatures, while La Niña drives up precipitation and lowers temperatures.

The effects are felt more marked in the coastal zone than in the interior, and in any case most flooding and drought recorded in French Guyana are not associated with these events.

Météo-France runs a global climate model called Arpège-Climat, and compares the results of models with solutions from models produced by the CEPMMT, IRI, UKMO and JMA models.

Actions to be taken:

1. - Validation of seasonal forecasts (comparison between the various models and observed conditions);
2. - Downscaling (to be ready within one or two years);
3. - Information sharing with neighbouring countries (particularly Suriname).

#### 16.8 Paraguay

Mr Jorge Sánchez stated that factors limiting prediction of the localized effects of ENSO include: limited human resources, insufficient budgets, low-density observation network, and a lack of coordination with other institutions in managing and using information.

Mr Sánchez also mentioned some of the measures needed to improve prediction of the effects of ENSO, which would involving the promotion of research, training, transfer of knowledge and technology from more developed to less developed countries and a greater degree of participation by bodies such as WMO in training projects.

Possible initiatives in the region include: generation of integrated management projects and creation of interdisciplinary collaborative groups involving meteorological services and academic institutions, research and technical assistance bodies. Studies could also be carried out with the aim of identifying new sources of climate variability in the region, with the establishment of intensive training courses on forecasting methods proven to be effective in neighbouring regions.

#### 16.9 Peru

In her presentation, Ms Amelia Díaz explained that in Peru, prediction of the effects and impact of the El Niño phenomenon is based on analysis of the various components (meteorology, oceanography, biology/fisheries) provided by the relevant institutions and brought together by the Multi-sectorial Committee for the Study of the El Niño Phenomenon (ENFEN).

SENAMHI is responsible for the atmospheric component, with the climate prediction process taking the following form: firstly, the CCM3 global model is applied, with a relatively coarse resolution of around 250 km and using observed and forecast sea temperatures as initial indicators. At the same time, ensembles are conducted and probabilistic results obtained to reduce the level of uncertainty. To improve resolution in a particular area of the country, downscaling is carried out using the RAMS regional model.

The second process involves statistical methods, in cases where it has already been shown that there is a strong relationship between events in the Western Pacific and those in the greater part of Peru. It is carried out using empirical orthogonal functions (EOFs) for longwave radiation, whilst at the same time, other oceanic/atmospheric indices supplied by EXEVER statistical software are employed.

The two prediction approaches are analysed and the precipitation forecast chosen by consensus on the basis of the capability of the models, monitoring of oceanic/atmospheric conditions and especially professional conceptual models.

The limitations in terms of prediction of the El Niño phenomenon are as follows:

- The models do not successfully simulate conditions in the Eastern Pacific zone (South American coastal zone or Niño regions 1 and 2);
- There is no regional oceanic model in operation;
- There is no maritime observation network in this zone;
- Only SSTs forecast by NOAA are available as input for the CCM3 model, there are no grid outputs from other models;
- Dissemination of information on the phenomenon generates high expectations, which are frustrated as financial investments are withheld.

Work is currently being carried out on El Niño in terms of its impact on Peru.

#### 16.10 Suriname

Mr Dennis Rodrigues revealed that ten years ago, Suriname possessed a network of 300 stations across the country, of which 25 were climatic, eight synoptic and the rest were rainfall stations. Today however, in the wake of political and economic difficulties, the country has been left with only 50 stations, which hampers country-wide forecasting and prediction. For this reason, the Meteorological Service concentrates its efforts on the coastal zone, where most of the country's economic activity takes place.

Climate information is available to the public free of charge, as the Meteorological Service is a department of the Ministry for Public Works. Climate information is issued to the health, agricultural and industrial sectors, to students and others.

Floods, landslides or hurricanes are not recorded in Suriname, leading to a lack of interest in weather conditions on the part of members of the public, who are concerned only with knowing when rainfall will cease or why it is so heavy.

Using ENSO monitoring information available on the Internet, medium- and long-term, i.e. seasonal, predictions are made. However, correlations are not always as expected, leading to a certain degree of caution being exercised when it comes to issuing forecasts.

Suriname has four seasons dominated by movement of ITCZ, with ENSO having little or no impact on the country's weather and/or climate. Other significant systems directly affecting the country's weather can be found in the lower atmosphere, for example easterly and localized winds.

In the last two years, it has been noted that the arrival of the rainy season has shifted slightly, with a fall in precipitation at the beginning of February and an increase in mid-March which continues and peaks in early August when it peaks and drops away, stabilizing in October. It can be inferred from this that the rainy season is now starting a month earlier than normal and the dry season is also beginning early.

It would be easier to have one single location in the region, where information from all RA III countries could be stored, enabling any one of them to obtain the information necessary for monitoring El Niño and possibly making it possible for a national or regional index to be later obtained.

## 16.11 Uruguay

Ms Lucero Crossa noted that future research in Uruguay would involve sea surface temperature anomalies in the South Atlantic Ocean, the identification of regional water vapour sources affecting predictions for the Pantanal, Atlantic and Pacific Ocean regions, a study of atmospheric oscillations (10-15 days, the Quasi-Biennial and Pacific Decadal Oscillations), as well as local water vapour sources such as the River Plate, Merim Lagoon, etc, and the study of moisture transfer from the soil to the lower atmosphere and circulation in its lower layers during extreme precipitation events.

Among the regional lines of action at a regional level, Ms Crossa mentioned the need to improve the application of climate predictions, adjusting them to the hydroelectric, agricultural, livestock and tourism sectors, as well as implementing climate prediction downscaling techniques (statistical and/or dynamic) for specific locations and improving capacity at NMSs (material and human resources).

She also mentioned that the Regional Climate Outlook Fora for South East South America within the MERCOSUR region, which have been run since 1997, constitute regional initiatives implemented with a view to enhancing national capacity. Furthermore, in order to capitalize on the similarities in climate variability across the MERCOSUR region, consideration ought to be given, for example, to establishing a regional initiative on climate and agricultural variability.

## **17.0 Summary of Conclusions and Recommendations**

### 17.1 Regional climate indicators and Indices

- 17.1.1 At present, there is no regional consensus on an operational regional definition of El Niño or La Niña or other climate events affecting South America such as PDO.
- 17.1.2 There are many challenges to efforts to develop a region-wide definition of El Niño and La Niña among the Pacific and Atlantic coastal countries of South America and to identify these countries' responses to the effects of ENSO events at a local level.
- 17.1.3 There is an urgent need and demand to further strengthen scientific research into ENSO, teleconnections, PDO and other key climate processes.
- 17.1.4 There has been earlier work in the region relating to the new regional climate indicators and indices, and this requires checking, validation and scientific testing at a regional level.
- 17.1.5 The RClindex tool used at this workshop for climate change indicators based on "open source" software is useful. Regional and sub-regional groups will implement and disseminate this tool in order to improve on present ways of evaluating climate change at the regional level and in each country on a smaller spatial scale.

### **Recommendations**

1. Establish two technical groups to explore and develop regional climate indicators on ENSO (El Niño and La Niña), one technical group focusing on the west coast and the other on the North Atlantic Oscillation (NAO), etc. for the Atlantic coast.

2. Request NMHSs and regional entities to explore funding sources to activate the two groups, and to urge WMO to explore possible support through the regular programme activities.

#### 17.2 Climate Outlook Forums (COFs)

- 17.2.1 The COFs have become very useful mechanisms for producers and users of climate information and prediction services to share and exchange views on the development and application of CLIPS. These have succeeded in maintaining coordinated efforts on the part of NMHSs to become ideal platforms for future regional and sub-regional efforts to promote the use and applications of CLIPS.
- 17.2.2 Among its achievements, the COF of MERCOSUR has highlighted the active participation of users of the information and climatic prediction information among many of its members and their validation through their regional climate model outputs.
- 17.2.3 The COF for the western part of South America has enjoyed significant success in virtual coordination through CIIFEN, using statistical tools for probabilistic analysis, and in the generation of regional climate outlooks.
- 17.2.4 COFs will have to be strengthened through institutional support for the technical officers involved.
- 17.2.5 Sustainability of the COFs will depend on joint collaboration between the countries of the region (NMHSs), support from WMO and other United Nations agencies, exchange with global Climate Producing Centres (GPCs), and proper transfer of the methodology and dissemination of the machinery within each NMHS and through support from the private sector and other user groups in each country.
- 17.2.6 The COF for the western part of the South America could generate new products, through both virtual and real-life meetings at least once a year, using the CPT and through incorporation of other numerical tools in the process of development.
- 17.2.7 There are some valuable methodologies and lessons learned among the COFs of MERCOSUR and western part of South America that can be shared at regional level.
- 17.2.8 There is a need to supplement COF products through the use of and training in more supplementary tools developed by international research centres through training periods, for which funding is required.
- 17.2.9 There is a need to establish and adopt a standardized validation mechanism for outcomes from the COFs that guarantee the confidence, credibility and better use of them by users.
- 17.2.10 The regional coordination role performed by CIIFEN for the western part of South America has helped sustainability and continuity in the generation of climate outlooks for the sub-region.

## **Recommendations**

3. Request WMO and other agencies (UN agencies, GPCs, NMHSs, etc.) to provide technical support, and to help identify financial support for continuing with the COFs.
4. Further enhance and strengthen the COF process through a specific recommendation in the next meeting of Permanent Representatives in Bolivia, November 2005.
5. In the future COFs for the western part of South America, implement the forecasting of maximum and minimum temperatures and rainfall amounts.
6. Strongly encourage the exchange of methodologies in the COFs of MERCOSUR and the western part of South America.
7. Request WMO and other international agencies, and the countries of the region, to continue supporting CIIFEN in its maintenance of the regional coordination in the climatic forum for the western part of South America.
8. Request WMO to facilitate the training in MERCOSUR countries in the EXEVER tool for its application in the COFs.
9. Request the Permanent Representatives in the region to provide institutional support for scientists involved in the production of regional seasonal forecasts.
10. Request WMO, through the CLIPS programme, to work out a medium-term process for merging the COFs into a single forum covering the whole of South America.

### **17.3 Climate monitoring and modelling**

- 17.3.1 The meeting noted that there is a major gap in existing capacities among countries of the region in climate modelling, monitoring, assessment and evaluation, which calls for coordinated efforts and actions at the highest level of RA III.
- 17.3.2 There are national climate centres of excellence in the region that could be useful for knowledge transfer and training for Member countries that are less developed in downscaling and numerical modelling for climatic purposes.
- 17.3.3 A need has been perceived to have one or more regional climate centres working on aspects identified as priorities for South America in coordinating climate activities, and for providing technical assistance to the members.
- 17.3.4 Urge the Permanent Representatives of RA III to discuss climate data recovery and data management needs of the countries with the most serious limitations at the next meeting of Permanent Representatives of RA III, to be held in Bolivia in November 2005.
- 17.3.5 The diagnosis made at the workshop on regional modelling for the Eastern Pacific region held in CIIFEN in 2004 made it possible to establish priorities and future action lines for oceanic and climatic modelling.

## **Recommendations**

11. Request WMO to organize a training workshop on climate modelling and downscaling techniques for RA III.
12. Request CIIFEN to develop a proposal for a region-wide exchange programme which would enable expert visits and training fellowships with relevant centres such as IRI, CPTEC and other NMHSs.
13. Urge members of the Association to take advantage climate change modelling tools.
14. Implement regional climate prediction models in the NMHSs that do not yet have them.
15. Request CIIFEN, in coordination with Member countries and in consultation with WMO and other relevant agencies, to prepare a regional project on data recovery and to designate key stations for validating regional model outputs.
16. Encourage WMO, through the CLIPS programme, to include on the agenda of the next meeting of Directors of NMHSs in Bolivia (November 2005) an item on RA III climate activities.

### **17.4 Climate Information and Prediction Services (CLIPS)**

- 17.4.1 There is a clear absence of reports from CLIPS National Focal Points in RA III countries to WMO which is a far from positive signal for the region so far as WMO initiatives are concerned;
- 17.4.2 The meeting recognized the enormous importance of holding a regional workshop on CLIPS applications in the field of “energy for sustainable development”;
- 17.4.3 The meeting recognized the need to have more than one contact from CLIPS FPs in each NMHS of the countries of RA III;
- 17.4.4 The outcomes of the CLIPS meetings will be limited if the persons appointed do not have relevant training and experience. This will hamper attainment of regional technical coordination goals for ensuring the programme’s success;
- 17.4.5 The meeting recognized progress of the Regional Project on Climate and Health being implemented by CIIFEN in close coordination with countries of the region and supported by WMO; and encouraged development of similar projects in another sectors;

## **Recommendations**

17. Request the national CLIPS focal points to submit CLIPS reports pending from 2004 and 2005 (two annual reports) by December 2005 while the future reception mechanism for these reports by WMO is being worked out.
18. Request WMO to provide guidance for submission of annual reports from CLIPS national focal points.
19. Urge WMO to facilitate holding a workshop on CLIPS applications for the ‘energy for sustainable development’ sector in RA III, bearing in mind the offer from Colombia to host this meeting;
20. Request the Permanent Representatives of the Region to advise WMO of the confirmation of designated CLIPS national focal points and alternates to replace them if they are absent;

21. Urge CIIFEN, in consultation with WMO, RA III and Member countries and regional entities, to prepare a regional strategy to acquire the funding needed to support the initiatives recommended at this workshop.

#### **18.0 Session XV: Workshop Closure**

At 6.30 p.m. on Thursday 18 August 2005, Mr Penehuro Lefale, on behalf of WMO, thanked workshop participants for the great spirit of cooperation and professionalism they had shown and promised to do all in his power to push forward the initiative formulated in Region III. He expressed particular gratitude to SENAMHI for arranging the workshop and declared it closed.

## WORKSHOP AGENDA

### Day 1, 8 August 2005

0830-0900 hrs Registration  
 0900-1000 hrs Opening Session  
 Welcome: Dr Buruhani Nyenzi, WMO  
 Mr Juan Oviedo Motta, Director of SENAMHI

1000-1030 hrs Coffee Break

1030-1300 hrs

#### **SESSION I: WMO CLIPS and the Lima Workshop**

Chair: Ms Ena Jaimes (Peru)

Presentation: Summary of CLIPS Project Activities, Mr Penehuro Lefale (WMO)

Presentation: Workshop Goals and Objectives, Dr Buruhani Nyenzi (WMO)

#### **SESSION II: ENSO and Regional Association (RA) III**

Presentation: ENSO; A Regional Perspective, Mr Rodney Martínez (CIIFEN)

Presentations: Review of ENSO Activities in RA III (15 min. each): Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, France, Guyana, Paraguay, Peru, Suriname and Uruguay

1300-1400 hrs Lunch Break

1400-1530 hrs

Presentations: Country Reports (continued)

1530-1600 hrs Coffee Break

1600-1730 hrs

Presentations: Country Reports (continued)

### Day 2, Tuesday, 09 August 2005

0830-0900 hrs Review and Synthesis of Day 1 Outcomes  
 Ms Lucero Crossa (Uruguay)

#### **SESSION III: ENSO Regional Indicators and Indices**

Chair: Mr Carlos Villanueva (Argentina)

0900-1030 hrs

Presentation: Towards a Global ENSO Definition, Buruhani Nyenzi (WMO)

Presentation: Towards a Regional ENSO Definition, Rodney Martinez (CIIFEN)

1030-1100 hrs Coffee Break

1100-1300 hrs

#### **SESSION IV: Working Groups (WGs): ENSO Regional Indicators and Indices**

WG 1: ENSO Regional Indicators and Indices

Facilitator: Mr Rodney Martínez (CIIFEN)

Rapporteur: Mr Juan Quintana (Chile)

WG 2: ENSO Regional Indicators and Indices

Facilitator: Mr Penehuro Lefale (WMO) / Ms Bárbara Tapia (Chile)

Rapporteur: Mr Carlos Villanueva (Argentina)

1230-1400 hrs Lunch Break

**SESSION V: Working Session on ENSO Regional Indicators and Indices**

Presentation and Discussion of working group reports

1400-1530 hrs

Presentation and discussion by WGs

1530-1600 hrs Coffee Break

1600-1700 hrs

Presentation: Global Seasonal Forecasting Centres and other sources for Climate Monitoring, Evaluation, Prediction and Information and Services Applications (CLIMAP), Mr Penehuro Lefale (WMO)

Group discussion

### **Day 3, Wednesday, 10 August 2005**

0830-0900 hrs Review and Synthesis of Day 2 Outcomes  
Ms Amelia Diaz (Peru)

**SESSION VI: Seasonal Climate Prediction**  
Chair: Mr Gualberto Carrasco (Bolivia)

0900-1030 hrs

Presentation: Seasonal Climate Prediction, Dr Simon Mason (IRI)

Presentation: The Challenges of Seasonal Forecasting in the Eastern Pacific,  
Mr Juan Coronado (Peru)

1030-1300 hrs Coffee Break

1100-1300 hrs

Presentation: Seasonal Forecasting in the Western Coast of South America:  
Challenges and Opportunities, Ms Ena Jaimes (SENAMHI, Peru)

Presentation: National Information System for Monitoring Weather and Climate  
Impacts on Agriculture: Brazilian Experience, Dr Jurandir Zullo  
(UNICAMP, State University of Campinas, Sao Paolo, Brazil)

1300-1400 hrs Lunch Break

1400-1500 hrs

Presentation: View of the International Research Institute for Climate Prediction  
(IRI) regarding ENSO Indicators and Indices, Dr Simon Mason (IRI)

1500-1530 hrs Open Discussion: Lessons Learned about Climate Outlook Fora  
(COF) in RA III, Mr Rodney Martínez (CIIFEN)

1530-1600 hrs Coffee Break

1600-1800 hrs Discussion: Representatives of RA III, WMO, IRI, CIIFEN on a  
Regional Strategy to further enhance Climate Monitoring,  
Assessment, Prediction and Applications in RA III (a draft CLIMAP-  
RAIII Action Plan)

### **Day 4, Thursday, 11 August 2005**

0830-0900 hrs Review and Synthesis of Day 3 Outcomes  
Mr Dennis Rodrigues (Suriname)

**SESSION VII: Climate and Ocean Modelling: Where does RA III stand?**

Chair: Mr Expedito Rebello (Brazil)

0900-0945 hrs

Presentation: Experiences with CCM3 in Peru: Progress and Challenges, Ms Delia Acuña (SENAMHI, Peru)

0945-1030 hrs

Presentation: Experiences with Climate Modelling in Brazil, Mr Expedito Rebello (Brazil)

1030-1100 hrs

Coffee Break

1100-1300 hrs

Presentation: Experiences with Climate Modelling in Chile, Mr Juan Quintana (Chile)

Presentation: Research Projects on Global Change Impacts Conducted by the Institut de Recherche pour le Développement and its scientists and technical officers, Mr Pierre Soler (IRD)

Discussion

1300-1400 hrs

Lunch Break

1400-1445 hrs

Presentation: Ocean and Coupled Modelling in the SE Pacific: Challenges and Opportunities, Mr Kobi Mosquera (IGP)

1445-1530 hrs

Presentation: Ocean Modelling in Peru, Mr Jose Pasapera (IMARPE)

1530-1600 hrs

Coffee Break

1600-1630 hrs

Presentation: Experiences with Climate Modelling in Colombia, Mr Maximiliano Henríquez (Colombia)

Presentation: A Regional Agenda for Modelling in the SE Pacific, Mr Rodney Martínez (CIIFEN)

1630-1800 hrs

Discussion: Enhancing Modelling Capabilities in RA III

**Day 5, Friday, 12 August 2005**

0830-0900 hrs

Review and Synthesis of Day 4 Outcomes  
Mr Jorge Sánchez (Paraguay)

0830-1800 hrs

**SESSION VIII: Training on Climate Prediction Tools (CPT) (all day)**

Chair: Mr Juan Quintana (Chile)

**Day 6, Saturday, 13 August 2005**

0830-0900 hrs

Review and Synthesis of Day 5 Outcomes  
Ms Daniele Carnino (France)

0900-1200 hrs

**SESSION IX: Training on CPT (continued)**

Chair: Mr Maximiliano Henríquez (Colombia)

### **Day 7, Monday 15 August 2005**

0830-0900 hrs Review and Synthesis of Day 6 Outcomes  
Mr Hernán Parreño (Ecuador)

0900-1530 hrs

Chair: Mr Hernán Parreño (Ecuador)

Presentation: Review of the goals, objectives and work plan of the workshop,  
Mr Penehuro Lefale (WMO)

Presentation: Climate and Health Project, Mr Rodney Martínez (CIIFEN)

#### **SESSION X: Training on CPT (continued)**

1530-1600 hrs Coffee Break

1600-1730 hrs Discussion

### **Day 8, Tuesday 16 August 2005.**

0830-0900 hrs Review and Synthesis of Day 7 outcomes  
Mr Maximiliano Henríquez (Colombia)

0900-1730 hrs

#### **SESSION XI: Training on Climate Change Tools and Indicators**

Dr Enric Aguilar (Universitat Rovira i Virgili de Tarragona, Spain)

Chair: Ms Daniele Carnino (France)

### **Day 9, Wednesday, 17 August 2005**

0830-0900 hrs Review and Synthesis of Day 8 Outcomes  
Mr Jorge Sánchez (Paraguay)

0900-1800 hrs

#### **SESSION XII: Training on Climate Change Tools and Indicators (continued)**

Dr Enric Aguilar (Universitat Rovira i Virgili de Tarragona, Spain)

Chair: Mr Juan Quintana (Chile)

### **Day 10, Thursday, 18 August 2005**

0830-0900 hrs Review and Synthesis of Day 9 outcomes  
Ms Daniele Carnino (France)

0900-1030 hrs

#### **SESSION XIII: Training on Climate Change Tools and Indicators (continued)**

Dr Enric Aguilar (Universitat Rovira i Virgili de Tarragona, Spain)

Chair: Mr Dennis Rodrigues (Suriname)

1030-1130 hrs Official visit to SENAMHI

1130-1230 hrs Hands-on Exercises to obtain final climate change indices

1230-1400 hrs Lunch Break

1400-1700 hrs Hands-on Exercises to obtain final climate change indices

1700-1800 hrs

#### **SESSION XIV: Review of the Workshop**

Plenary: Lessons learned and Future challenges

1800 – 1830 hrs

#### **SESSION XV: Workshop Closure**

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**STATEMENT BY DR BURUHANI NYENZI (WMO),  
AT THE OFFICIAL OPENING OF CLIPS TRAINING WORKSHOP  
FOR REGIONAL ASSOCIATION III**

**Major General F.J. Oviedo Motta, Director of SENAMHI and Permanent Representative of Peru with WMO,  
Distinguished participants, Ladies and gentlemen,**

It is a great pleasure for me to be with you on this occasion of the opening of the Climate Information and Prediction Services (CLIPS) Training Workshop for World Meteorological Organization (WMO) Regional Association III. On behalf of the Secretary-General, Dr. Michel Jarraud and that of my own and my colleague Penehuro Lefale, I wish to express my sincere appreciation to the Government of Peru for hosting this important workshop. This is testimony to the commitment of the Government of Peru in supporting the activities of WMO and especially the application of climate information and prediction services and products for sustainable development in Peru and the region as a whole.

I would like to take this opportunity to firstly thank Mayor General FAP J. Oviedo Motta, Director of SENAMHI and Permanent Representative of Peru with WMO for the kind hospitality and warm welcome that has been extended to all of us since our arrival in your beautiful country. I also wish to commend Mr. Julio Canales Falcon, Chairperson of the Local Organizing Committee for the workshop and the entire members of his team for the excellent arrangements they have made, which will no doubt contribute greatly to the success of the workshop. They have done a wonderful job to facilitate our assembling here.

**Ladies and gentlemen,**

This Workshop is being organised by the WMO in collaboration with SENAMHI and CIIFEN. I wish to express WMO's gratitude to CIIFEN for the assistance they have extended to us in supporting the organisation and running of this workshop.

I am also thankful to the National Meteorological and Hydrological Services (NMHSs) in the region, various institutions including Universities and individual experts that will be providing input to this workshop. Representatives from twelve countries in the region are participating in this workshop.

**Ladies and gentlemen,**

Past and recent events in this region, and elsewhere in the world have demonstrated that extreme climate events such as droughts, floods, tropical cyclones and hurricanes often have devastating consequences in terms of socio-economic hardship, loss of lives, damage to infrastructure and property, increasing poverty and political instability, amongst many other consequences. Recent examples still fresh in our memories are the devastating floods in India and China a few weeks ago, which will continue to affect these countries for some time; the severe hurricanes that recently swept across the Caribbean and Gulf of Mexico; and the droughts that are continuing to affect parts of southwest Europe and Africa. These floods and hurricanes were associated with severe landslides and caused loss of lives, damaging infrastructure and property in the affected countries to a tune of many millions of US dollars.

Effective, accurate and timely seasonal forecasting and well established early warning mechanisms can enable Governments and stakeholders to plan and put into motion appropriate response actions for mitigating against the adverse impacts brought by these climate related extreme events. It is within this context, that WMO, in 1997 established the CLIPS with the view to supporting Member countries to optimise the use of climate information and prediction products. Within the context of CLIPS, WMO and many other partners such as the International Research Institute for Climate Prediction (IRI) and National Oceanography and Atmospheric Administration/Office of the Global Programmes (NOAA/OGP) have organized many climate outlook forums in many parts of the world including South and Central America. For example in eastern, western and southern Africa; Central and South America, and the Pacific these have become a routine feature. The forums have provided opportunities for researchers from various climate centres to collaborate with scientists and experts from NMHSs to develop consensus climate outlook products, their interpretation and dissemination to users, and assessment on their potential impact on the various socio-economic sectors.

This workshop is part of WMO's activities providing support to NMHSs through training experts who can in turn produce and deliver climate information and seasonal forecasts, in a timely and accurate manner thus contributing to efforts by all stakeholders to minimize and manage the risks associated with hydrometeorology related hazards and national adaptation to climate change. The workshop also provides an opportunity for participants to meet one another and to exchange information on new developments in the area of seasonal forecasting and climate applications. Thus, the main objective of this workshop is to train experts from this region, who are mainly the CLIPS National Focal Points, in developing climate information and prediction products.

**Ladies and gentlemen,**

Ever since the launch of these training activities, they have established themselves as effective mechanisms for co-ordinating the generation, dissemination, interpretation and application of climate information and prediction products, which are now increasingly incorporated into governments' planning process. These activities have also served as useful mechanisms for assessing and verifying the accuracy and effectiveness of these forecasts and for translating lessons learned into future corrective actions. I would, therefore, like to urge governments, relevant partners and other stakeholders in RA III to identify ways and means of sustaining this process through supporting the NMHSs' initiatives on seasonal forecasting and climate applications. There is also an urgent need for governments in the region to provide adequate and sustainable support to NMHSs, as well as to other climate relevant national and regional institutions and programmes.

Finally, I would like to assure you that for its part, WMO will continue supporting the activities of the NMHSs in the region and will also continue working with its partners in the international community as well as Governments in order to ensure sustainability of these initiatives.

In concluding, I wish once again to thank the Government of Peru for its kind hospitality, and I look forward to the productive and fruitful deliberations and outcomes from this workshop.

Thank you.

**STATEMENT BY THE HEAD OF SENAMHI  
AT THE OPENING OF THE WORKSHOP**

**Head of the Peruvian Maritime Institute, IMARPE,  
Head of the Hydrographic and Marine Navigation Directorate, DHNM,  
Technical Director of SENAMHI,  
Dr Buruhani Nyenzi, Director, World Climate Programme, World Meteorological  
Organization,  
Directors of SENAMHI,  
Invited WMO experts and instructors,  
Distinguished participants,  
Ladies and gentlemen,**

In my capacity as head of Peru's National Meteorological and Hydrological Service, it is a great honour for me to address such a distinguished audience. I first of all want to wish you all a very warm welcome to Peru and particularly to SENAMHI, to the distinguished representatives of the World Meteorological Organization, experts, instructors, guests, participants and heads of institutions who are present here today to open the Climate Information and Prediction Services Focal Point (CLIPS) Training Workshop for Regional Association III, under the auspices of WMO.

As head of the governing body for hydrometeorological sciences in Peru, I am delighted that we have been chosen to host and organize this important workshop and would like therefore to thank the World Meteorological Organization for the confidence entrusted in us and, through its representatives, to make clear our commitment to do everything required to make this event a success and ensure that the confidence shown in SENAMHI is well founded.

As I am sure you are all aware, National Meteorological and Hydrological Services are today organizations of vital importance to the development of states, communities, industry and mankind in general, and they take on yet greater importance as a result of the precarious situation that man has himself created through the untrammelled use of natural resources and large-scale industrialization. It is therefore essential to unite efforts, knowledge and skills in order to turn around this vulnerable position, prevent disasters and put in place plans for sustainable development. You, as CLIPS focal points for your respective countries, are precisely the people whose great responsibility it is to keep abreast of advances in climate science, evaluate and disseminate them, ensuring that decision-makers and instigators of preventative measures have the best information at their fingertips, when they need it.

Peru, because of its geographical position and its high degree of sensitivity to climate and meteorological variations, finds itself exposed to a wide range of threats such as the El Niño phenomenon, rains, mudflows, droughts, frosts, earthquakes, tidal waves and flooding, all of which affect our country and population and which we must be prepared for, so as to take immediate action, in our respective areas of responsibility. That is why this event is of such vital importance to us and why we have taken so much care over its organization and development.

The workshop starting today offers an excellent opportunity to consolidate the Regional Network of CLIPS Focal Points, which should allow for capacity-building within National Meteorological Services through selection and training of individual experts, gradually

moving towards concerted regional interaction, and thereby contributing to WMO's global endeavours.

Against this background, climate information and prediction services exist in order to exploit present-day databases, establish a climate knowledge base with the help of long term models, improve prediction capacity with a view to minimizing the harmful impact of climate variability, and conduct planning activities based on climate science. At the same time, CLIPS represent the link between science and its practical applications, building the bridges needed for promoting development activities of benefit to all: climatologists and climate modellers, decision makers, corporate leaders, the public, in other words, society as a whole.

Let this occasion therefore be a new opportunity for sharing expertise and experience and strengthening the bonds of cooperation and friendship that link as us members of WMO and in particular, RA III. We hope that the forward planning that SENAMHI has put into the organization of this event will live up to the expectations expressed by each of you. From the outset, I can assure you of the utmost support and warmest welcome from our staff, to make you feel at home.

On this note, I declare the CLIPS Focal Point Training Workshop open.

Thank you.