REGIONAL CLIMATE OUTLOOK FORA

Prior to the 1997-98 El Niño event, few individuals and organizations around the world had used climate forecasts in practical decision-making. Weather forecasts were frequently applied to planning on a daily and weekly basis, but longer-term climate predictions had largely been confined to the research realm. With recent technological advances in forecasting climate on seasonal-to-interannual time scales and predictions of the 1997-98 El Niño, the NOAA Office of Global Programs recognized an opportunity to increase awareness of the existence and potential usefulness of climate forecasts among decision makers worldwide. On-going pilot applications activities that the NOAA-OGP Research Applications Division had helped develop since the early 1990s provided a well-positioned set of efforts to serve user demands for information on expected El Niño impacts. The Climate Outlook Fora, aimed at creating consensus seasonal forecasts and better understanding user needs for climate information, coupled with the timing of the El Niño event, provided a real-world laboratory in which to test the practical application of seasonal forecast information.

Working with domestic and international partners, NOAA-OGP organized and implemented Outlook Fora in Africa, Latin America, the Caribbean, and Southeast Asia. At each Outlook Forum, climate scientists fashioned probabilistic, consensus-based, seasonal forecasts, or Climate Outlooks, for given regions. The Fora involved scientists and representatives of university and government forecasting organizations, national meteorological services, and international forecast centers. Many of the Outlook Fora were held in conjunction with pilot applications design workshops, which allowed exploration of the uses of climate forecasts with potential users of the information from sectors such as agriculture, fisheries, water resources, and disaster preparedness. In some instances, adjunct press briefings and conferences were convened to inform the general public of the issued Climate Outlook and its potential applications.

The Climate Outlook Fora concept grew out of a need for unified, consensus forecasts identified in previous pilot forecast applications workshops and related applications activities in Africa, Latin America, and Southeast Asia. The idea was further developed in the sequence of meetings that led to the initial Southern Africa Regional Climate Outlook Forum (SARCOF) in September 1997 (see Africa section of Pilot Program for the Application of Climate Forecasts). Additional Fora were held in Africa, one focused on Western Africa and the other on the Greater Horn of Africa. The Africa Fora contributed significantly to the development and refinement of the

methodology for creating consensus climate forecasts.

As planning and implementation of the SARCOF began, parallel activities were initiated in Latin America and Southeast Asia. In October 1997, NOAA-OGP coordinated and co-sponsored the first Latin American Outlook Forum in Lima, Peru. A sequence of four additional Outlook Fora were implemented by NOAA-OGP and its partners in Latin America and the Caribbean during the 1997-98 El Nino (see Table 1). Southeast Asia conducted its Outlook Forum in February 1998. Forecast applications and user outreach were a major focus at the Latin American, Caribbean, and Southeast Asian Fora, as reflected by the pilot applications design workshops and conferences.

In the following chapter, the general methodology for the planning and implementation of the Outlook Fora is outlined, the basic structure of each Outlook Forum is described, including Outlook maps and accompanying text, an evaluation of each forecast is given, and recommendations from each forum are summarized. A summary of survey results from southern Africa, Latin America, and the Caribbean is also included. The description for each Forum reflects the programmatic emphasis in a particular region. In the Southern Africa section, for example, priority is given to forecast production, while for Latin America, the Caribbean, and Southeast Asia, the primary emphasis is on applications workshops. General recommendations regarding forecast creation, dissemination, and application from all of the Outlook Fora are summarized at the conclusion of this section.

NOAA-OGP's primary partners in the Outlook Fora included the United States Agency for International Development Office of Foreign Disaster Assistance (USAID-OFDA), the International Research Institute for Climate Prediction (IRI), the European Network for Research in Global Change (ENRICH), the World Meteorological Organization (WMO), the Inter-American Institute for Global Change Research (IAI), NOAA's Climate Prediction Center (NOAA-CPC), and the United Kingdom Meteorological Office (UKMO). In addition, each event was supported by one or more local or regional institutions. The date, place, forecast region, local hosts and co-sponsors for the Outlook Forum are listed in Table 1.[17] The institutions listed in the accompanying table represent those institutions which played major sponsoring and organizational roles at each of the Fora; the list of participating institutions is considerably longer, and is included in each Climate Outlook description. The large number of organizations involved attests to the fact that the Outlook

[17]The location of each Outlook Forum is shown on the document cover.

Fora were cooperative efforts that required the dedicated support of individuals and institutions around the world. Without the contributions from these groups, the Outlook Fora conducted during 1997-98 would not have been possible.

Table 1. Climate Outlook Fora, 1997-98

Date	Place	Target region	Local host	Co-sponsors
AFRICA				
September 1997	Kadoma, Zimbabwe	Southern Africa	Zimbabwe Met. Service	NOAA-OGP, WMO, ENRICH, SATCC, IRI, UKMO
December 1997	Windhoek, Namibia	Southern Africa	Namibia Met. Service	NOAA-OGP, WMO, ENRICH, SATCC, IRI, UKMO
February 1998	Nairobi, Kenya	Greater Horn of Africa	DMC Nairobi	USAID-OFDA, USAID-FEWS, IAD, KMD, NOAA-OGP, UNEP, UNDP, WMO
May 1998	Abidjan, Ivory Coast	Western Africa	Côte dí Ivoire Met. Service	NOAA-OGP, World Bank, USAID-OFDA, MEDIAS, START, ACMAD, ICRISAT, ECA, WMO
May 1998	Pilanesberg, South Africa	Southern Africa	S. African Weather Bureau	NOAA-OGP, ENRICH, WMO, SATCC, IRI, USAID-OFDA, UKMO
LATIN AMERICA & CARIBBEAN				
October 1997	Lima, Peru	Pacific S. America	INPESCA, IGP, Sealand Advisory Services, Inc.	NOAA-OGP, IAI, WMO, IGP, INPESCA, IRI, SeaLand Advisory Services
December 1997	Montevideo, Uruguay	Southeast S. America	Uruguay Rural Association	NOAA-OGP, IAI, WMO, IRI, Uruguay Rural Association
January 1998	Fortaleza, Brazil	Northeast S. America	FUNCEME, INPE	NOAA-OGP, IAI, WMO, IRI, FUNCEME, INPE
May 1998	Panama City, Panama	Mesoamerica	CATHALAC	NOAA-OGP, USAID-OFDA, WMO, IRI, CATHALAC, INRENARE, IAI
May 1998	Kingston, Jamaica	Caribbean	UWI, ODPEM	USAID-OFDA, NOAA-OGP, WMO, IAI, UWI, IRI, ODPEM
SOUTHEAST ASIA				
February 1998	Bangkok, Thailand	Southeastern Asia	ADPC	USAID-OFDA, NOAA-OGP

Table 1 Acronym Key:

ACMAD	African Centre of Meteorological Applications for Development
ADPC	Asian Disaster Preparedness Center
CATHALAC	Centro del Agua del Trópico Húmedo para América Latina y el Caribe (Panama)
DMC	Drought Monitoring Centre (Nairobi)
ECA	Economic Commission for Africa
ENRICH	European Network for Research in Global Change
FUNCEME	Fundação Cearense de Meterologia e Recursos Hídricos (Brazil)
IAD	Intergovernmental Authority on Development
IAI	Inter-American Institute for Global Change Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IGP	Instituto Geofísico de Peru
INPE	Instituto Nacional de Pesquisas Espacias (Brazil)
INPESCA	Instituto Peruano de Investigaciones Pesqueras
INRENARE	Instituto Nacional para Recursos Naturales Renovables (Panama)
IRI	International Research Institute for Climate Prediction
KMD	Kenya Meteorological Department
MEDIAS	Réseau de recherche régionale sur les changements de l'environnetment global dans le Bassin Méditerranéen et l'Afrique Subtropicale (France)
NOAA-OGP	National Oceanic and Atmospheric Administration Office of Global Programs (USA)
ODPEM	Office of Disaster Preparedness and Emergency Management (Jamaica)
SATCC	Southern African Transport and Communications Commission
START	Global Change System for Analysis, Research, and Training
UKMO	United Kingdom Meteorological Office
USAID-FEWS	United States Agency for International Development Famine Early Warning System
USAID-OFDA	United States Agency for International Development Office of Foreign Disaster Assistance
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UWI	University of the West Indies (Jamaica)
WMO	World Meteorological Organization

METHODOLOGY

Organizational elements of the Climate Outlook Fora included identifying participants and local organizers, developing a process for Outlook creation and presentation, and recognizing and taking advantage of regional distinctions. Each element was key to meeting the primary objectives of the Outlook Fora, which included:

- Developing and communicating a consensus seasonal Climate Outlook;
- Facilitating research cooperation and data exchange within and between regions;
- Improving coordination within the climate forecasting community; and
- Creating and enhancing a regular dialogue between producers and users of the climate information.

It was also anticipated that conduct of the Outlook Fora would encourage regional development of self-sufficient, and ultimately permanent, forecast production and distribution activities. The following section is divided into three parts, the first which describes initial planning and organization of the Outlook Fora, the second the creation of the Climate Outlooks, and the third is a description of the approach used to compare Climate Outlook projections with observations.

Planning and Organization

Identifying participants

In order to achieve the primary objectives, it was essential that key participants in each region be identified. The science of climate forecasting is in its infancy, and therefore there is a relatively small group of people with background and experience in the field. Much of the current forecasting capability has evolved from university or government research centers, so much of the expertise in global and/or regional climate modelling comes from these institutions. To refine and down-scale the relatively large-scale climate forecasts distributed by government and university researchers, it was recognized that meteorological expertise of National Meteorological and Hydrological Services (NMHS) would be an essential ingredient to a successful Climate Outlook Forum. Representatives of NMHS have access to the historical climate records often used for empirically-based forecasts, the knowledge of local climate (e.g. the effect of mountainous regions

on rainfall distribution patterns) and an extensive network of people and mechanisms in the field capable of disseminating climate forecasts. Each Climate Outlook Forum was multilateral and multi-institutional, bringing together participants and organizations throughout each region to create a consensus.

User-producer interaction

Potential users of the forecast information attended the Climate Outlook Fora to help shape the final product and identify uses of the information. By convening meetings which included both forecast users and producers, dialogue between the two groups developed, allowing for mutual exchange of perspectives, with the intention of maximizing forecast utility within the limits of predictive capabilities. For example, at the Outlook Forum for the Caribbean, members of the natural disaster preparedness community exchanged ideas with the forecasters on how climate information could be applied to help mitigate natural disasters, such as El Niño-related droughts and floods, and what type of information would be most useful (e.g., precipitation, temperature). In return, the forecast producers outlined the limitations of available climate forecasts (e.g., broad spatial resolution, scientific uncertainty) and the methods used to develop them, in many cases a combination of empirically and dynamically-based projections (see Climate Outlook Creation section).

Local hosts

Although NOAA-OGP consulted on the organization and implementation of all of the Fora, much of the logistical and preparatory work for each meeting was conducted by local institutions. For example, in Panama, the Water Center for the Humid Tropics of Latin America and Caribbean (CATHALAC) was the primary organizer of the Mesoamerica Outlook Forum. In each of the three regions in Africa, Outlook Fora activities were catalyzed around a regional meteorological institution: the Drought Monitoring Centre (DMC) Harare for Southern Africa, the DMC Nairobi for the Greater Horn of Africa, and the African Centre of Meteorological Applications for Development (ACMAD) for West Africa and the Sahel. These WMO-supported regional institutions formed the nucleus of partnerships between National Meteorological and Hydrological Services (NMHS), university researchers, and international forecasting and research organizations. Local hosts have a unique knowledge of the region, and their leadership was a critical factor in the success of the Climate Outlook Fora. For climate forecasts to be created and used on a regular

basis in these regions, a sense of ownership of the climate forecasting and application process, such as that fostered through local organization of the Outlook Fora, is essential.

Sponsorship

Co-sponsorship from multiple organizations was a key element of every Outlook Forum convened during 1997-98. The major partners in each of the Climate Outlook Fora included organizations from both the forecasting and applications communities at national, regional, and international levels. Funds provided by these organizations covered not only the cost of the meetings themselves, but also participants' travel stipends. Without travel sponsorship, many key participants would not have been able to attend. Full representation in each region allowed for the creation of what were truly consensus forecasts. By simply assembling members of the climate forecasting community together in one place, the Climate Outlook Fora also encouraged research cooperation and data exchange within and between regions.

Climate Outlook Creation and Distribution

Tercile probabalistic forecasts

There are two main options for producing a consensus climate forecast. The first is a deterministic prediction based on a weighted average of all contributing forecasts. For example, a forecast for "above-normal rainfall for January to March, 1998", accompanied by a statement outlining confidence in the prediction and details of alternate possibilities, would be deterministic. This option, while generally easy to understand, does not necessarily account for the range of possibilities within naturally variable climate system.

Another option is a probabilistic forecast, stated as a probability distribution where confidence information is incorporated into the prediction itself. If a probabilistic forecast of "60% probability of below-normal precipitation", for example, was reduced to a simpler deterministic forecast (i.e. below-normal, or dry) it would ignore the fact that in any given year and location, wet conditions may still prevail. For this reason, climate projections generated at the Outlook Fora were presented in terms of likelihood of above-, near-, or below-normal precipitation. By separating the possible outcome into three categories, and assigning a probability value to each, the

forecasts were presented as tercile probabilistic forecasts (see Climate Outlook maps and Empirical and dynamical models section). Although the probabilistic approach was new and unfamiliar to some forecast users, it better accounts for the chaotic nature of the climate system than deterministic forecasts. Over an extended period of time, probabilistic projections based upon statistical and dynamical modelling can provide an edge in decision-making.

Empirical and dynamical models

Throughout the series of Outlook Fora, national-level forecasts tended to be empirical in nature, that is, based on historically observed climate patterns in a given area. In all cases, the Outlooks were rainfall projections. Precipitation, as opposed to temperature, was the variable of most interest to the users present, since it is the primary factor influencing flooding and drought, the most severe impacts associated with El Niño. The historical precipitation record for a given region was generally divided into thirds, or terciles, of above, near, and below-normal rainfall. For a 30-year record, each tercile would cover 10 years. In a typical year, there is equal probability that rainfall will fall into the above, near, and below-normal categories (33.3% chance for each category); this equal probability distribution is referred to as "climatology". During El Niño years, the probability that rainfall could fall equally into the three categories shifts. For example, in a given area, 70% of El Niño years may fall into the wettest third, 20% into the near-normal third, and 10% into the driest third of the historical record. With the knowledge that an El Niño is underway, or is predicted to occur (based on observations and models of sea-surface temperatures in the equatorial Pacific), the likelihood that precipitation will be in the wettest third of the historical record is 70%, while there is only a 10% likelihood it will fall into the driest third.

The forecasts were also based in part on computer model simulations of the climate system. Computer models simplify the climate system into a series of discrete three-dimensional boxes, where the movement of water, air, and energy between the boxes is described mathematically, based on known physical laws. Observations of the climate system at a given time are programmed into these models, such as unusually warm sea-surface temperatures in the equatorial Pacific during El Niño years, and the models are then run to determine how the climate system will evolve over a given period of time. In some cases models are run multiple times, using slightly different initial conditions. These types of "ensemble" model runs provide a range of possible climate conditions within the model, from which probabilistic forecasts can be made.

Forecast assembly

To create a consensus forecast, it was first necessary to ensure that the Outlook participants understood the forecast methodology used. Preparation and training varied depending on the Outlook Forum. For example, in Southern Africa, the better part of two days were dedicated to training sessions which reviewed statistical and dynamical prediction methods, the proposed consensus methodology, and user community needs, providing participants with groundwork to produce a seasonal climate forecast. In other regions, such as Mesoamerica, descriptions of the forecast methodology and presentation were distributed to participants prior to the Outlook Forum.

The next step was to reach a consensus regarding the likely evolution of sea-surface temperatures (SSTs) and other important factors which would provide boundary conditions for the climate system over the course of the upcoming season. Although Pacific SSTs (and hence the strength and duration of the El Niño) were generally the primary climatic forcing factor considered at the Outlook Fora, individual regions considered other factors as appropriate, such as SSTs in the Indian and Atlantic oceans. For details on the assumptions made for each Outlook, see the descriptions that accompany the Outlook maps.

After reaching a consensus on background climate conditions, individual country rainfall forecasts based on empirical and dynamical methods were presented. In many cases forecasts for a given area or for adjoining countries were very similar, in others there were discrepancies. In the latter case, participants would discuss the opposing forecasts and would eventually reach a common understanding. At each Outlook Forum, the process of creating a consensus forecast was mediated by a representative from the International Research Institute for Climate Prediction (IRI). This person acted as the chair of the Outlook Forum, facilitated discussions among forecasters, and provided a third-party perspective to ensure the forecasts were based on historical patterns, computer simulations, and/or climatic mechanisms typical of El Niño events.

Once the regional map was drawn and agreed upon, forecast probabilities for each climatic subregion were calculated and drawn onto the map. Ideally, the individual forecasts which serve as inputs to the Outlook Fora would have had a consistent format, covering identical regions and time periods, as well has exhibiting standard expressions of forecast skill. Given the relative youth of forecasting science, however, no single method has been agreed upon. Hence, all of the Fora relied upon subjective interpretation of inputs to generate a consensus.

Outlook dissemination

The mere existence of a forecast does not necessarily imply that it will be used. Practical application requires that the forecast be disseminated responsibly to a broad group of potential users. Several methods were employed both during and after the Outlook Fora to distribute the forecasts. Press conferences were given at many of the Fora to inform representatives of government, industry, media, and the general public about El Niño-related climate conditions, possible impacts, and methods to utilize climate information. This venue allowed participants to ask questions about climate forecast products and potential applications in climate-sensitive sectors. Pilot applications design workshops provided opportunities for sector-specific development of projects to utilize Climate Outlook information. Many representatives of NMHS also held press conferences and workshops after returning to their countries.

Outlook maps and accompanying descriptions were posted on the internet by the IRI and NOAA-OGP immediately following each Outlook Forum.[18] Through posting on the world-wide-web, the Outlooks were available to anyone with basic internet access. In the Outlook descriptions, care was taken to outline certain caveats and to refer specific questions to NMHS representatives and other national organizations, many of whom attended the Climate Outlook Fora and were familiar with the capabilities and limitations of the consensus forecasts.

Comparison of Climate Outlooks and Observations

An evaluation of the Climate Outlook maps is necessary to determine the accuracy of the forecast given in each region. Ideally, a measure forecast skill would involve a quantitative comparison of the forecast and observed conditions over several seasons. Since the forecasts at the Outlook Fora were probabilistic in nature, as opposed to deterministic, it is not possible to determine if they were "correct" or "incorrect". An area forecast to have a 60% chance of above-normal precipitation may have received above-normal rainfall, and yet the forecast would not technically be "correct". The forecast was that 6 out of 10 times the precipitation would, on average, fall in the upper-third of historically-observed amounts. Since we have only one sample

[18] Outlook maps and descriptions created at the Outlook Fora were digitized by the IRI and are available at <http://iri.ucsd.edu/forecast/sup/index.html> and on the NOAA-OGP website at <http://www.ogp.noaa.gov/enso/#Global_Climate>.

(in this case a season), as opposed to 10, it is difficult to rigorously test forecast skill.

One way to evaluate a probabilistic forecast is to assume it was effectively deterministic. For instance, if the Outlook indicated a 60% chance of above-normal rainfall, it is assumed that the forecast was for above-normal rainfall. Although this method ignores the probabilities assigned to terciles, it is a necessary assumption when evaluating a probabilistic forecast for a single season. This approach was taken by SARCOF participants, who then quantitatively determined how well the Outlooks for southern Africa matched observations for this region; the methodology used is discussed in the SARCOF portion of the African Outlook Fora section.

Meetings tentatively scheduled for Mesoamerica, portions of South America, and the Greater Horn of Africa and West Africa will evaluate the initial Climate Outlooks in each region.[19] In the mean time, we qualitatively compare expected conditions and actual observations in these regions to determine an approximate measure of forecast reliability.[20] Following each probabilistic Climate Outlook map is a map of estimated precipitation over the forecast period (except for SARCOF). These maps were provided to NOAA-OGP by NOAA-CPC and the IRI. The data for the observation maps is a combination of land-based and satellite-derived precipitation values for the period 1979-1995. Ideally, the observational period would be 30 years or longer, but collection of the satellite data did not begin until the mid-1970s.

For the purposes of the qualitative evaluation presented in each Outlook Forum section, we define a forecast with 45% or greater probability of above-normal precipitation as equal to a forecast for above-normal rainfall. Similarly, a forecast with 45% or greater probability of below-normal precipitation is defined as equal to a forecast for below-normal rainfall. Although the 45% value is somewhat arbitrary, it is significantly greater than climatology (33.3%), indicating the climate system had at least a moderate tendency for producing rainfall amounts in a particular tercile. We recognize that the forecasts were probabilistic in nature, however, and that by definition there will be instances when observed conditions fall into terciles with low predicted probabilities. In terms of the observational data, normal precipitation is defined as the 16-year mean over the period from 1979-1995. We define above- or wetter than normal precipitation as

[19]Please contact NOAA-OGP for names or regional representatives responsible for evaluating the Climate Outlook for a given region.

[20]An assessment for the West Africa Outlook Forum is not included as the forecast period extended beyond the publication date of this report.

greater than 125% of normal (or mean) rainfall while below- or drier than normal is defined as less than 75% of normal.

AFRICAN OUTLOOK FORA

The first Climate Outlook Forum in Africa occurred in Harare, Zimbabwe, as part of the Southern Africa Regional Climate Outlook Forum (SARCOF). This meeting, which occurred during September, 1997, involved the development of a methodology for combining existing climate information into one user-friendly product.[21] Using the methodology developed by SARCOF, additional Outlook Fora were held in the Greater Horn of Africa (February, 1998) and Western Africa (May, 1998). Prior to these meetings, users in Africa were faced with several different seasonal forecasts which were presented in different formats, with a variety of techniques and lead times. SARCOF and similar activities in other parts of Africa provided a regional process for coordinated production, dissemination, interpretation and use of forecast information as well as a framework in which to assess the effectiveness of the season's activities and translate lessons-learned into future actions.

Products from the African Outlook Fora follow in the next several pages. Maps of forecast precipitation are given for:

- Southern Africa, October-December 1997
- Southern Africa, December 1997-March 1998
- Southern Africa, January-March 1998
- The Greater Horn of Africa, March-May 1998
- Western Africa, July-September 1998

Accompanying each map are descriptions of the methodology for producing the Outlook, a brief summary of the forecast conditions, and participating organizations. Also included is a general description of the quantitative evaluation method used by SARCOF participants to evaluate the Outlooks for southern Africa. For the Greater Horn of Africa, a map of observed precipitation amounts expressed in terms of percentage of normal rainfall is provided, along with a qualitative evaluation of the Climate Outlook for this region. An estimated precipitation map and evaluation is not included for Western Africa, as the forecast period extended beyond the initial drafting date for this report.

[21]The SARCOF was a follow-up activity to the Workshop on Reducing Climate-Related Vulnerability in Southern Africa (October 1996, Victoria Falls, Zimbabwe).

Southern Africa Regional Climate Outlook Forum (SARCOF)

SARCOF 1: Pre-Season Outlook - September 1997

The primary purpose of the first SARCOF meeting was to develop a consensus methodology for producing climate forecasts in southern Africa. This meeting included training and capacity building components to address the range of forecasting research and production capacity across the region. Participants in the Pre-Season Outlook meeting included producers of climate information products from regional and international forecasting centers, personnel from National Meteorological Services responsible for national climate forecasts, and a few specialists in food security and disaster preparedness. The SARCOF process helped build a sense of community amongst these groups through overcoming institutional barriers to cooperation.

Activities at the September, 1997 meeting followed the general Outlook methodology, and also included:

- Tutorials on climate mechanics, and the creation and interpretation of climate predictions;
- Training sessions, including forecast verification, probabilities, techniques of forecast application, and user needs;
- Presentation of user/intermediary requirements, based in part on outcomes from the Victoria Falls meeting;
- Presentations of regional climate information products;
- Discussion of products, models, and methodologies; including quality selection criteria, regionalization of forecasts, forecast parameters;
- Investigation of methodologies for consensus Outlook development; and
- Discussions on Outlook distribution and dissemination.

The Outlook Forum process in Southern Africa benefitted from the fact that much of the design for SARCOF occurred prior to predictions of the 1997-98 El Niño event. This lead time allowed for thorough advance planning and resource allocation. This advance planning, combined with the foresight of SARCOF's many cosponsors permitted the funding and preparation for a three meeting approach, which included a mid-season meeting to update the initial outlook and a post-season meeting to evaluate the Outlook Forum process as a whole. Although a mid-season meeting resulted in a significant additional expense, it was climatologically wise as southern Africa covers a relatively large area. It's rainy season also spans several months, from approximately October to March, with temporal differences across the region.

Outlook evaluation

Using input from SARCOF participants, representatives from the Cooperative Institute for Mesoscale Meteorological Studies at the University of Oklahoma, USA, and the Drought Monitoring Centre (DMC), Harare, Zimbabwe, developed a method to quantitatively evaluate the SARCOF consensus forecasts.[22] Total rainfall for the season in question was determined and ranked according to the historical precipitation record from 1961-1994 at any given rainfall measurement station. For example, October-November-December (OND) 1997 was the tenth driest OND from 1961 to 1994 for one observation station, 15th driest for another, and so on. The rankings were then gridded spatially (on a 2° latitude by 2° longitude scale) and it was determined whether each grid box fell into the above-, near-, or below-normal tercile based on the period 1961 to 1994. By gridding the observational data at a small scale relative to the Climate Outlook, it was possible to account for spatial variability within forecast regions.

The forecast map was then overlaid on the gridded rainfall data and scored based on the number of times it matched observations. An exact match was defined as a "hit", and if observations matched one of the two terciles with greatest probability (for example, a forecast for near- to above-normal rainfall), it was considered a "half hit". A hit was worth 1 point, and a half hit was worth 0.5 points. Since there were a total of 124 grid boxes over the southern Africa region, a perfect forecast would receive a score of 124, or hit rate of 100%. A random forecast would, on average, produce a hit rate of 33%. (Similarly, a forecast for above-normal conditions everywhere in the region would have an average hit rate of 33%.) Additional forecast verification techniques (e.g., the Heidke Hit Skill Score, LEPS, and Relative Operating Characteristic) were also used to evaluate SARCOF forecast guidance, but they are not summarized here.[23]

The Southern Africa Regional Climate Outlook Forum produced three precipitation forecasts for the same region. At the first SARCOF meeting, two forecasts were produced, one for October to December, 1997 (Map A), and the other for December 1997 to March 1998 (Map B). The evaluation for the October to December 1997 Outlook indicates the grid boxes in northern Tanzania were all hits. Southern Tanzania, Northern Namibia, eastern Botswana, northeast South

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[22]The information presented here is only a partial summary of the SARCOF validation method and results. Please consult the UKMO website to obtain a comprehensive description of the validation techniques: <http://www.meto.gov.uk/sec5/NWP/NWP_pef_ensarcof/report2/projassess2 html>

[23]For further information consult the website listed in footnote 22.

Africa, and most of Zambia, Malawi, and Mozambique had half hits. Southern Namibia and Botswana, and eastern portions of South Africa experienced hits, while other regions, such as northern Botswana and eastern South Africa had neither hits nor half hits. The overall hit rate for southern Africa over the Outlook period was approximately 50%, well above the chance level (33%), but far from perfect.

The Outlook for December 1997 to March 1998 indicated fewer hits than the OND 1997 Outlook. Most of the region north of the South Africa's northern border was characterized by half hits, with a few grid boxes showing neither hits nor half hits. The Outlook for most of South Africa was off by one tercile (forecast for below-normal, but receiving near-normal precipitation), although a few grid boxes in the extreme northern and western portions indicated hits. Overall, the hit rate for the October 1997 to March 1998 Outlook was 37%, slightly higher than the chance rate (33%). This Outlook was evaluated using rainfall data from only January to March, 1998, however, and the hit rate would likely increase if December precipitation values were included.

Climate Outlook - Rainfall

Statement from the Southern Africa Regional Climate Outlook Forum
12 September 1997, Kadoma, Zimbabwe

CLIMATE OUTLOOK FORUM

From 8-12 September 1997 a Southern Africa Climate Outlook Forum convened to formulate consensus guidance for the 1997-98 season in southern Africa. The Forum comprised Meteorological Services from SADC (Southern Africa Development Community) countries, and climate scientists from universities and international research institutes. These specialists reviewed the state of the global climate system and its implications for southern Africa. One of the principal factors taken into account is the major El Niño event on-going in the tropical Pacific Ocean. Recent El Niño occurrences such as in 1982-83, 1991-92 and 1994-95 resulted in low rainfall across much of southern Africa south of 10 degrees South and disrupted climate patterns around the globe.

Participants at the Forum included representatives of Meteorological Services from eleven SADC countries (Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Swaziland, South Africa, Tanzania, Zambia and Zimbabwe) and climate scientists and other experts from national, regional and international institutes (DMC - Harare; Universities of Witwatersrand, Zululand and Zimbabwe, SADC Food Security Technical and Administrative Unit; SATCC, WMO; IRI; NOAA-OGP, NOAA-CPC; the USAID; the U.K. Meteorological Office, IMGA/CNR-Bologna; and the World Bank.)

OUTLOOK

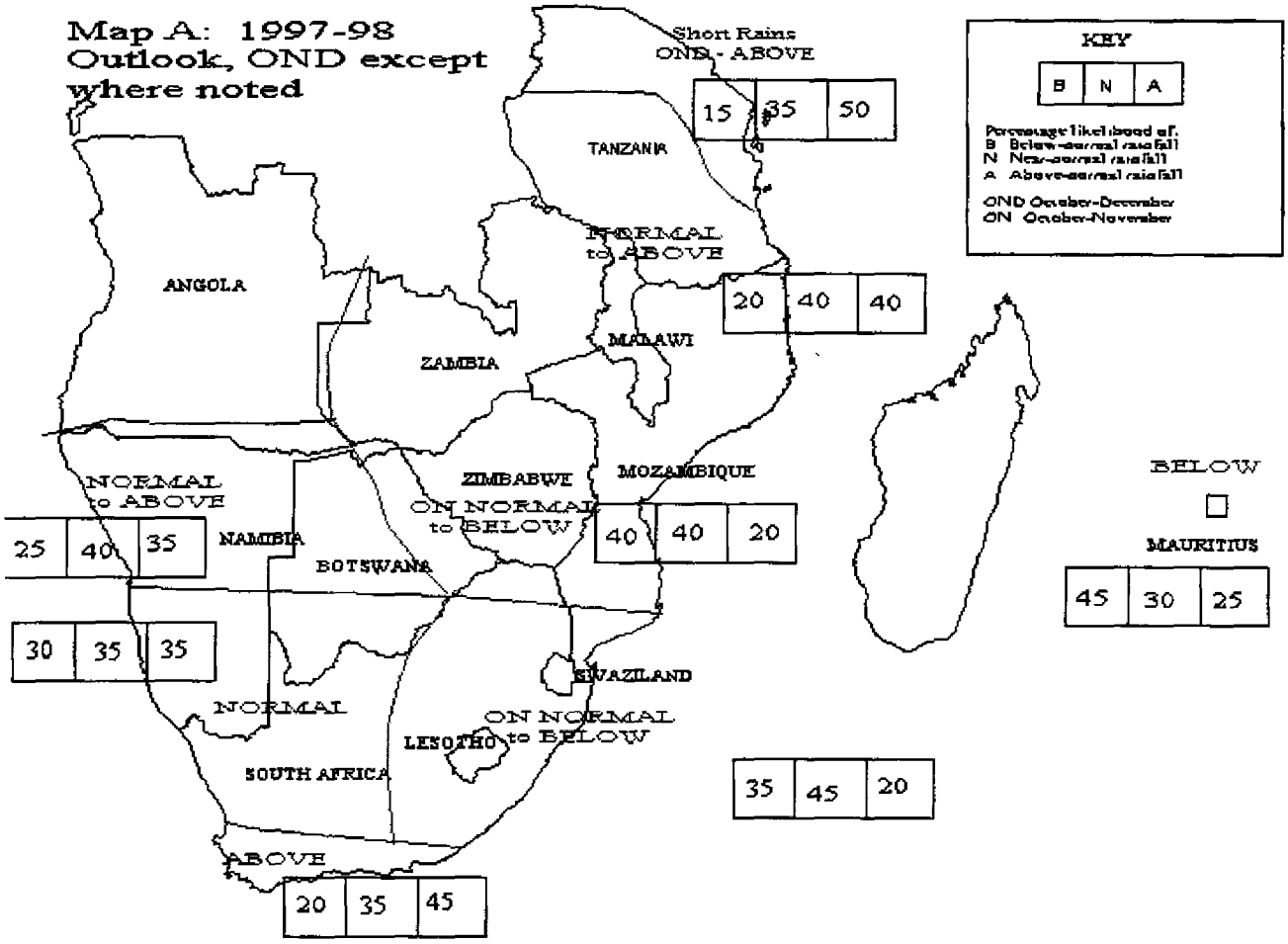
The Outlook divides the 1997-98 season into two periods (October-November December and December-January-February-March; Maps A and B respectively) The experts provided probability distributions to indicate the likelihood of below-, near- or above-normal rainfall for each sub-region (see Maps). Users are strongly advised to contact their National Meteorological Service for interpretation of this Outlook and for additional guidance.

In the first period, above-normal rainfall is expected in northern Tanzania (Short Rains) from October through December (Map A). In October through November, rainfall is not expected to depart significantly from normal throughout much of the rest of the region. Although the seasonal onset may be favourable, the possibility of a later downward trend should be considered. One exception is the extreme southern tip of South Africa, where above-normal rainfall is expected. The other is for Mauritius, where below-normal rainfall is expected.

December through March is the main rainy season for much of southern Africa. During this period, northeastern regions are expected to experience normal- to above-normal rainfall (Map B). Proceeding southward, there is a distinct trend towards below-normal rainfall which may be significantly below normal over South Africa, southern Mozambique, Lesotho and Swaziland. The northern extent of this region over which significantly below-normal rainfall may occur is uncertain at this stage. Above-normal rainfall is expected for Mauritius.

Much of the Outlook is attributable to the severity and expected persistence of the current El Niño event into 1998. This and other factors affecting southern Africa's climate were assessed using coupled ocean/atmospheric models, physically-based statistical models and expert interpretation. In some areas there was lack of agreement among the models. In particular, prospects for Malawi, southwestern Zambia and northern Namibia in December through March were uncertain, uncertainties that are reflected in the probabilities and which may be resolved in a later update.

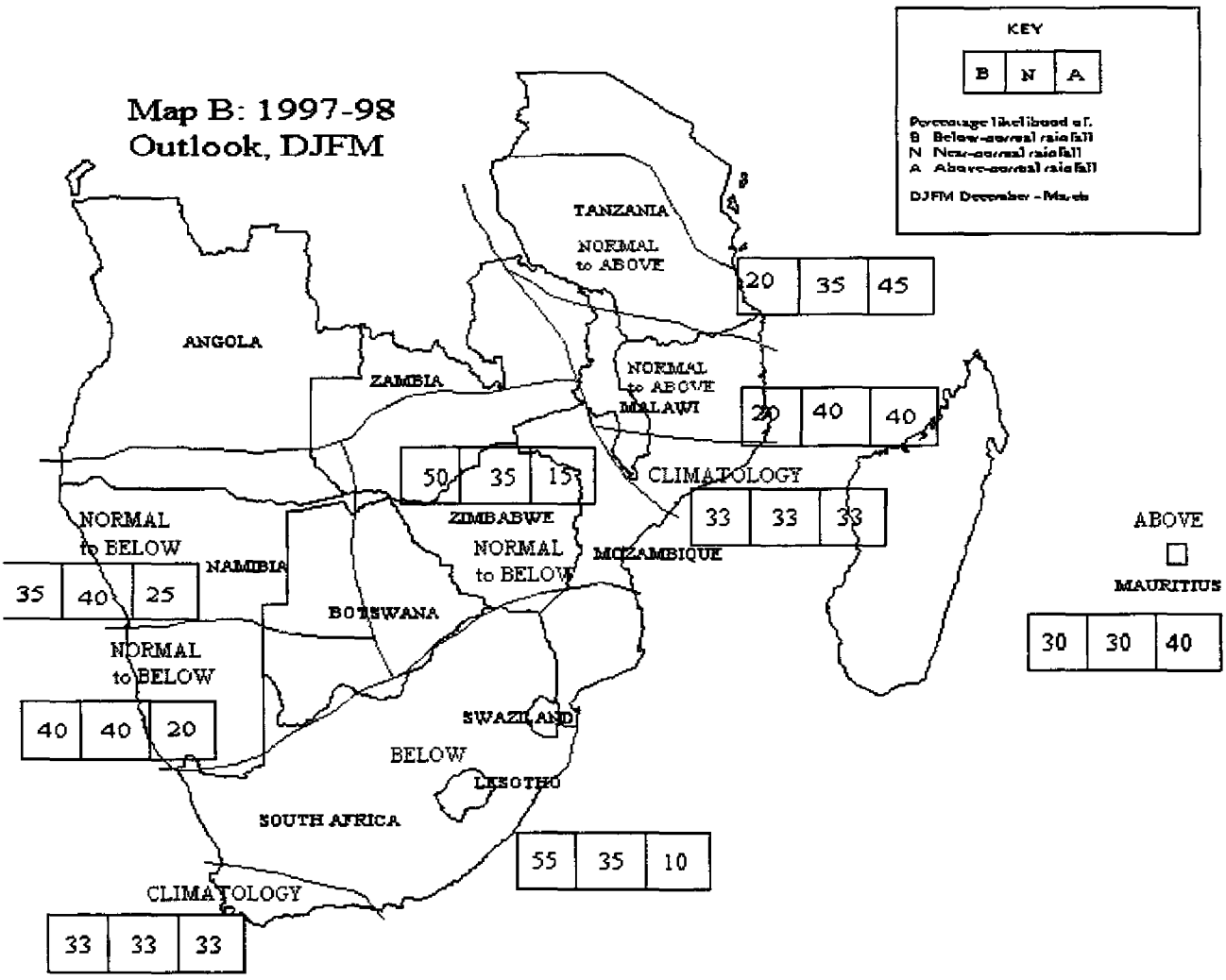
The current status of seasonal to inter-annual forecasting allows prediction of spatial and temporal averages, and may not fully account for all factors that influence regional and national climate variability. This Outlook is relevant only to seasonal timescales and relatively large areas, and local variations may occur.



Users are strongly advised to contact their National Meteorological Services for interpretation of this Outlook and for additional guidance.

All statistics are based on the period 1961 to 1990.
SADC member states as of August 1997 are named.

Source: Southern Africa Regional Climate Outlook Forum, Kadoma, Zimbabwe, September 1997



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All statistics are based on the period 1961 to 1990.
SADC member states as of August 1997 are named

Source: Southern Africa Regional Climate Outlook Forum, Kadoma, Zimbabwe, September 1997

SARCOF2: Mid-Season Correction - December 1997

The Pre-Season Outlook was updated at the December, 1997 Mid-Season Correction meeting in Windhoek, Namibia. The primary objectives of this meeting were to adjust the predictions made at the Pre-Season Outlook meeting and work towards a consensus Outlook for the remainder of the rainy season. Activities at the December, 1997 meeting included:

- Assessment of early-season performance and dissemination;
- Discussion of forecast quality criteria and regionalization of forecasts;
- Assessment of progress with employing standard verification system methodology and standard data set for forecast validation;
- Adjustment of the evolving consensus Outlook methodology;
- Discussion of the current state of the climate system;
- Presentations and discussion of regional climate information products;
- Feedback from users and update on use of forecast and monitoring products; and
- Outlook distribution and dissemination.

At the Mid-Season meeting a set of forecast sub-regions in Southern Africa were proposed based on the first principal component of rainfall over the subcontinent. These regions were shown to be consistent with the main sources of predictability, including sea-surface temperatures in the eastern equatorial Pacific region and in the Indian Ocean. In general, SARCOF participants felt that the regionalization proposed was too large and that additional research needed to be conducted to achieve greater regional detail. It was also recognized that with increased detail, forecast skill would likely decrease. In the end, Forum members elected to defer until future SARCOF meetings the definition of climatic sub-regions and the seasons for which the forecast should be set.

Outlook evaluation

At the second SARCOF meeting a Climate Outlook was created for January to March, 1998.[24] The evaluation for this Outlook indicates hits for grid boxes in northeastern Tanzania, southern Tanzania, northern Mozambique, southern Namibia, most of Malawi and portions of northern Zambia. Half hits were common in the central part of the region, including southern Mozambique and Zambia, northern Namibia, northeastern South Africa, and most of Zimbabwe. Areas with neither hits nor half hits included the northern edge of Zimbabwe, and most of Botswana and South Africa. The hit rate for the Outlook period was approximately 45%, slightly

[24]See the Preseason Outlook meeting section for a general description of the method used to evaluate the SARCOF forecasts.

below that for the October-November-December 1997 Outlook, but above the chance level of 33%.

Climate Outlook - Rainfall

Statement from the Southern Africa Regional Climate Outlook Forum
18-19 December 1997, Windhoek, Namibia

SUMMARY

Below-normal rainfall conditions over the period January-March 1998 are expected over much of continental southern Africa south of about 15°S. The indications for below-normal rainfall are strongest in the western and central parts of this region. Further north, near-normal rainfall is expected, except in northern and eastern Tanzania during January-February, where above-normal rainfall is expected. Over Mauritius and the south-western tip of South Africa near-normal to above-normal rainfall is expected.

THE CLIMATE OUTLOOK FORUM

From 18-19 December 1997 a Southern Africa Climate Outlook Forum convened to formulate consensus guidance for the January-March 1998 season in southern Africa. This Forum was a mid-season meeting to update the information provided by an earlier Forum that convened in Kadoma, Zimbabwe on 8-12 September 1997. The Windhoek Forum reviewed the state of the global climate system and its implications for southern Africa. One of the principal factors taken into account is the major El Niño event on-going in the tropical Pacific Ocean Recent El Niño occurrences such as in 1982-83, 1991-92 and 1994-95 resulted in below-normal rainfall across much of the SADC region and disrupted climate patterns around the globe.

METHODOLOGY

The regional climate assessment began with consensus agreement that the current El Niño will remain over the forecast period (January-March 1998). This and other factors affecting southern Africa's climate were assessed using coupled ocean-atmosphere models, physically-based 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 all factors that influence regional and national climate variability. This Outlook is relevant only to seasonal time scales and relatively large areas, and local variations may occur Users are strongly advised to contact their National Meteorological Service for interpretation of this Outlook and for additional guidance.

The experts provided probability distributions to indicate the likelihood of below-, near- or above-normal rainfall for each sub-region (see Map). Above-normal rainfall is defined as within the wettest third of recorded precipitation totals in each region over the period 1961 to 1990s; below-normal rainfall is defined as within the driest third of precipitation totals; near-normal is the third centered around the climatological median.

OUTLOOK

January through March covers much of the remainder of the rainy season for most of SADC. Exceptions are the northern and eastern part of Tanzania, and the far south-western part of South Africa.

Before the Tanzanian Long Rains, which usually start in March, above-normal rains are expected in northern and eastern Tanzania The guidance on the map for this region is for January and February only and no guidance is provided for March. Near-normal rainfall is expected over the south-western half of Tanzania, northern and eastern Zambia, central and northern Malawi and northern Mozambique. Near-normal rainfall is expected also over north- western Zambia and the far north-western part of Namibia.

Over Mauritius and the south-western tip of South Africa, near-normal to above-normal rainfall conditions are expected.

The rest of continental southern Africa continues to have an increased risk of below-normal rainfall for January- March.

Below-normal to near-normal rainfall is expected in northern Namibia and the southern half of Zambia. There is a strong indication of below-normal rainfall in central and southern Namibia, most of Botswana, Lesotho and much of South Africa.

There was some disagreement amongst models presented regarding how far east the strong indication of below- normal rainfall extends into north-eastern South Africa, Swaziland, southern Mozambique, southern Malawi, and Zimbabwe. The strong risk of below-normal rainfall for eastern regions of southern Africa is a little less than indicated in the previous Forum Outlook, but is still considerable. Most models show no weakening of the risk of below normal rainfall in January to March in these regions.

PARTICIPANTS

Participants at the Forum included representatives of Meteorological Services from eleven SADC countries (Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) and climate scientists and other experts from national, regional and international institutes (DMC Harare and Nairobi; University of Zululand; Clark University; SADC Food Security Technical and Administrative Unit; SATCC, WMO; the Food and Agriculture Organization; IRI, NOAA-OGP; NOAA-CPC; USAID, the UK Meteorological Office; IMGA/CNR-Bologna.)

Other Users at the Forum included representatives from the University of Botswana, Namibia Agricultural Union, Namibia Emergency Management Unit, Purdue University, World Vision, Namibia Department of Water Affairs, Namibia Agronomic Board, Zambia Food Reserve Agency, CICERO, Namibia Early Warning and Information System, Malawi Ministry of Agriculture and Irrigation, DFID / University of Greenwich, US Department of Agriculture, and the South Africa Department of Constitutional Development.

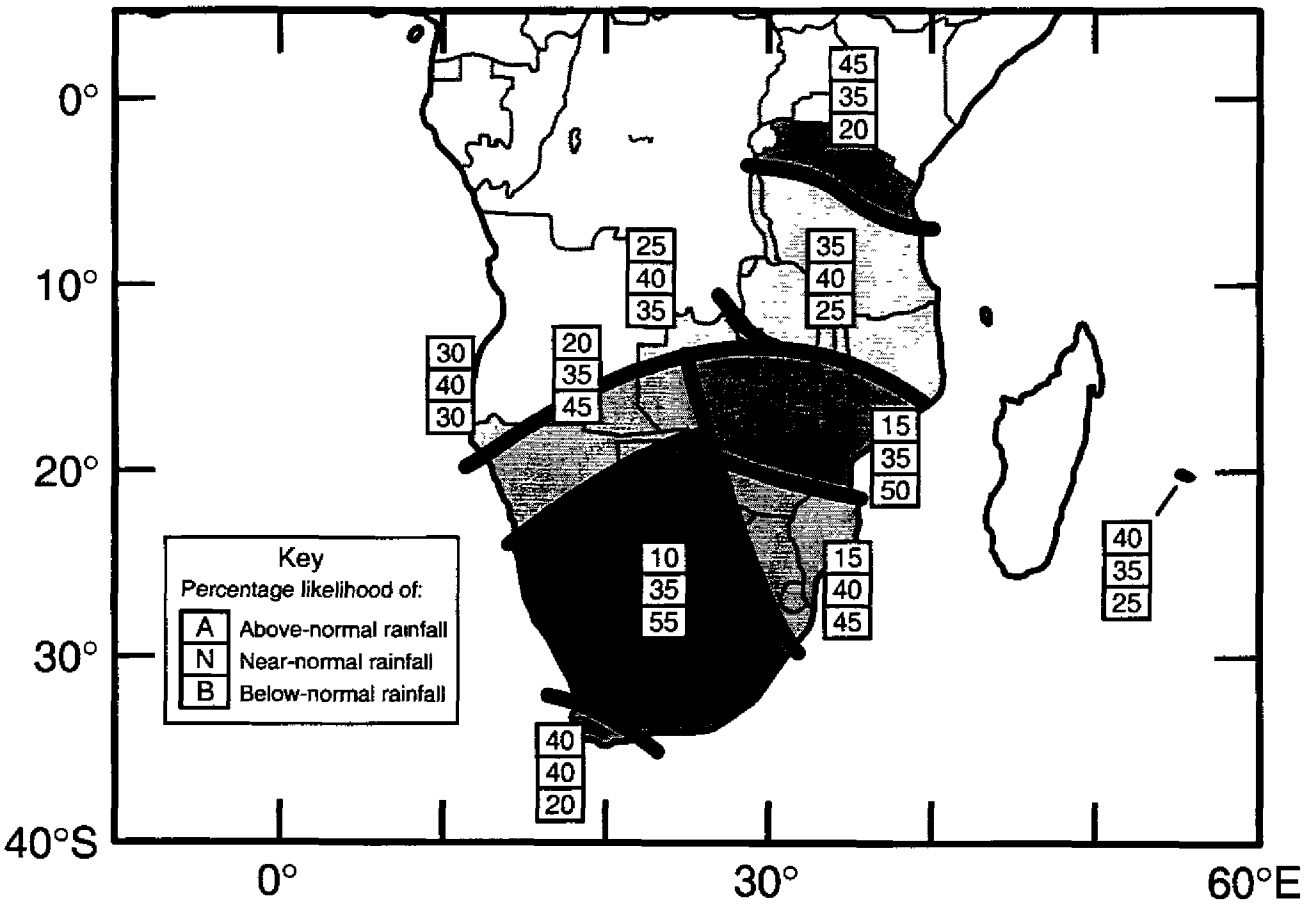
Consensus Climate Guidance

Southern Africa Regional Climate Outlook Forum

December 18-19, 1997 *Windhoek, Namibia*

(for list of participants and explanatory text see associated discussion)

January - March 1998



IRI INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE PREDICTION

EXPERIMENTAL CLIMATE FORECAST DIVISION

IRI is a cooperative agreement between NOAA Office of Global Programs, Lamont-Doherty Earth Observatory of Columbia University and Scripps Institution of Oceanography/University of California, San Diego.

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