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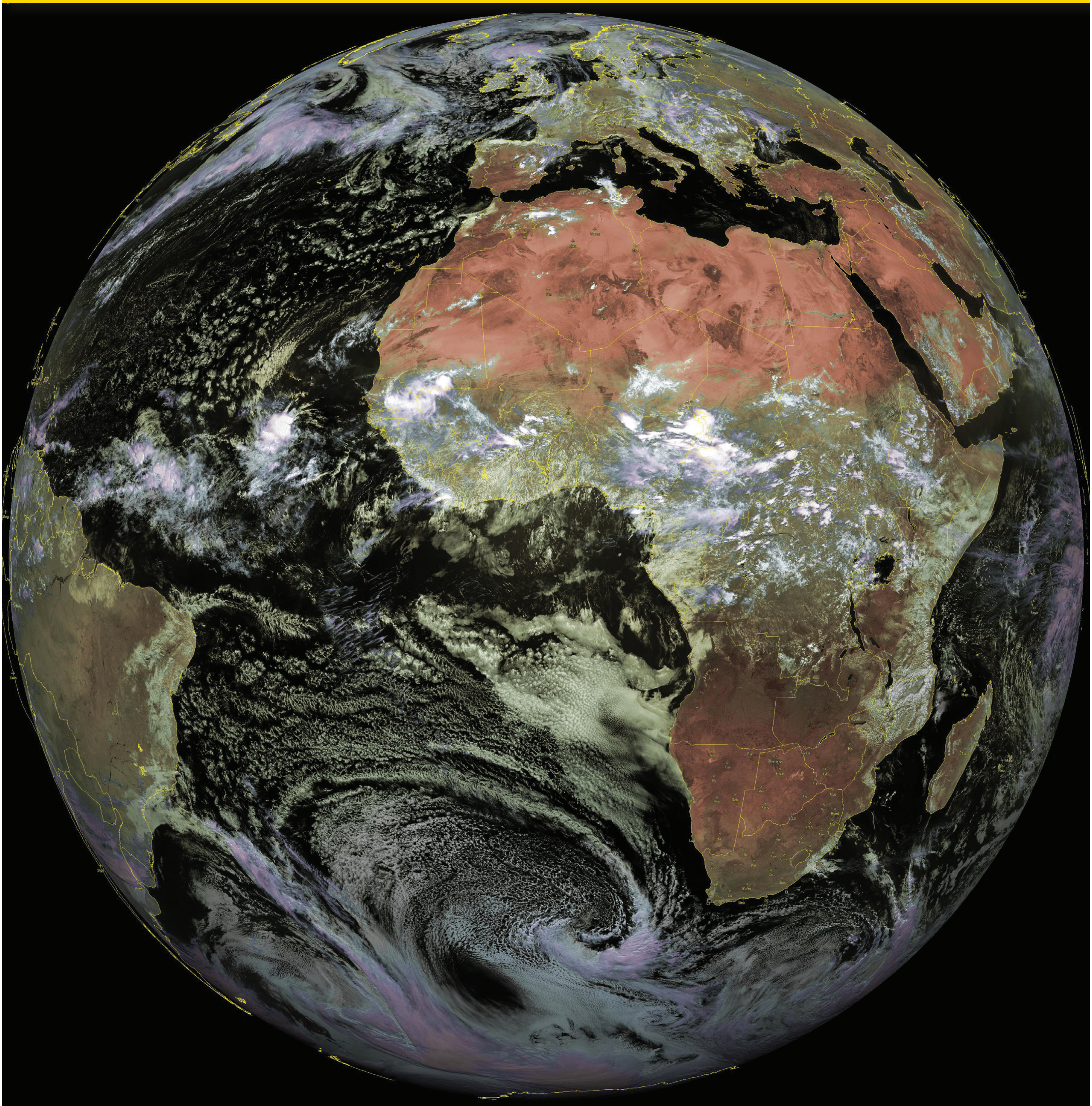

CLIVAR is an international research programme dealing with climate variability and predictability on time-sales from months to centuries. CLIVAR is a component of the World Climate Research Programme (WCRP). WCRP is sponsored by the World Meteorological Organization,the International Council for Science and the Intergovernmental Oceanographic Commission of UNESCO.

Editorial

Roger G. Barry

Director of the International CLIVAR Project Office, National Oceanography Centre, Southampton, UK.

I have just joined members of the team based in Southampton, UK, at the National Oceanography Centre, where I'll be taking over from Catherine Beswick, who has been Acting Director since Bob Molinari's departure at the beginning of the year. After more than 40 years living and working in the USA, I return to the UK where I started my career as a Scientific Assistant in the British Meteorological Office at RAF Worksop. In the USA, I worked for the University of Colorado and since 1977 I had been Director of the National Snow and Ice Data Center (NSIDC) and Distinguished Professor of Geography until I retired in 2010. My teaching and research spanned climate change, arctic and mountain climates, synoptic climatology, snow and ice processes, and climate_cryosphere interactions. A more complete biography can be found at http://www.clivar.org/about/icpo_staff/prof-roger-barry

My new challenge is to support the re-structuring of CLIVAR within the WCRP. At the SSG-19 in La Paz, Mexico, the following CLIVAR challenges were identified for implementation in 2013-14:

1. Intraseasonal, seasonal and interannual variability and predictability of monsoon systems.
2. Decadal variability and predictability of ocean and climate variability.
3. Trends, nonlinearities and extreme events.
4. Marine biophysical interactions and dynamics of upwelling systems.
5. Dynamics of regional sea level variability.

Tiger Teams have been set up to flesh-out these topics and prepare short write-ups on each one.

At the Joint Scientific Committee (JSC) meeting of the World Climate Research Programme (WCRP) in July 2012, plans were developed for the evolution of the four WCRP projects after 2013. Of particular note for CLIVAR, which will be focussed on ocean – atmosphere interactions, is the replacement of the Panel on Variability of the African Climate System (VACS) by an Africa Climate Panel. This new panel will have increased collaboration with the land hydrology and land-atmosphere interactions Global Energy and Water cycle Experiment (GEWEX) project of the WCRP. The evolution of this panel will be of great interest to African climate scientists and meteorologists.

Introduction

Richard Washington, Arame Tall & the CLIVAR Africa Climate Panel

Research into African climate is compelling. For many parts of the continent, weather and climate are not merely a talking point or a short-lived inconvenience. With a population so heavily dependent on rain-fed subsistence agriculture, weather and climate can control the destiny of families, villages and in some years, vast regions. Uncovering the chain of connections between ocean-atmosphere and land, deriving utility from the scientific knowledge of those connections and transferring it into information which is timely and detailed enough to interrupt such negative externalities consequent upon floods and droughts is an enterprise that CLIVAR and WCRP have long held at their core.

Scientifically and thinking beyond the societal importance of weather and climate for a moment, several issues make the study of African climate particularly interesting. First, Africa is influenced by climate variability that originates in all three of the main ocean basins. It is a great receiver of signals or teleconnections and each of these interacts with the annual cycle of rainfall in a complex way. African climate does not make it a priority for her to be understood. Unravelling the mechanics of these interactions is as complex a process for scientists attempting to understand observed climate data as it is for the numerical models to simulate. Second, there are extensive and vitally important regions in Africa, such as the Sahara and the Congo basin for which our understanding of climate processes is, at best, sketchy. The great reward here is to be the first to understand these intriguing regions, both of which feedback in an important way on the large-scale climate system well beyond Africa. Third, African climate contains some genuinely unique features. The planetary circulation is more symmetrically arranged around the African equator than anywhere else on Earth, the Sahel is amongst the finest laboratories for the study of land-atmosphere interactions and phenomena like the Sahel drought are unprecedented anywhere else in the observational record of rainfall.

African climate research is at an exciting juncture. The last decade has seen a profound expansion of research efforts and programmes on African climate. This issue of Exchanges is given over mainly to documenting a sample of climate programmes and initiatives in Africa that are linked to the CLIVAR Africa Climate Panel interests. As a result, this is not an issue of Exchanges that deals with research itself. The CLIVAR Africa Climate Panel intends to promote new research through a forthcoming series of Newsletters. It is worth emphasising that there are many research themes and worthy scientific efforts, such as on air quality, in Africa which are beyond the remit of the programmes summarised here. Similarly, there are new and exciting initiatives such as WASCAL, which have not made it into this issue but which we will be hearing much more of. And there are many initiatives at universities in Africa and beyond which we could not cover individually. What we have done is draw together a set of reports from the regions across Africa, including Southern African Development Community (SADC), Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC) and African Center of Meteorological Applications for Development (ACMAD). The origins and development of CLIMDEV and its associated programmes are presented as are field programmes such as Fennec in the Sahara. For those mindful of the opportunities associated with Climate Services, there is an article of African Climate Services in the context of the Global Framework for Climate Services (GFCS). The recently launched Climate change, agriculture and food security (CCAFS) programme, with two of three areas of global tropical study in Africa, is covered as are developments with the Coordinated Downscaling Experiment of the World Climate Research Programme (CORDEX). The Climate Science Research Partnership between UK Department For International Development (DFID) and the Met Office which has seen an exchange of research Fellows between Africa and the UK amongst many other achievements is summarised along with a demonstration study of climate change projections and hydro power in East Africa. As mentioned earlier, policy and climate science need to be closely connected in Africa. Arame Tall takes us beyond the science and into the dialogue in her article. In the fast moving arena of African climate science, we hope that this issue of Exchanges will be a useful 'one stop' to learn about several African climate initiatives. It is interesting to note that the CLIVAR Africa Climate Panel has had a hand or has a hand in almost all of these initiatives and programmes. A body such as the CLIVAR Africa Climate Panel has never been of more relevance in this rapidly evolving environment.

The DFID-Met Office Climate Science Research Partnership for Africa

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Introduction

In January 2010 the Department for International Development (DFID) of the UK Government and the Met Office Hadley Centre (MOHC) entered into a 3-year partnership known as the Climate Science Research Partnership (CSRP). The CSRP's overarching goal is to increase capabilities for sustainable poverty reduction in Africa through advancing the quality, relevance and uptake of climate services for the continent. Key research priorities, shaped through an initial consultation with African stakeholders, are: improved understanding of African climate and its representation in models, development of experimental user-relevant monthly-to-decadal prediction products and advancement of climate event attribution science for Africa. Research is focussed on the MOHCs new climate model (HadGEM3), which forms the basis of its operational seasonal forecasting system (GloSea4), its regional climate model (HadGEM3-RA) and a new developing monthly-to-decadal prediction system that will allow prediction across these timescales with a single model framework. For further understanding and comparison, analysis of CMIP3 models has also been undertaken. Strengthening the uptake of climate science and services in Africa is being addressed through a fellowship scheme for African climate scientists, climate science workshops and by interaction with African regional climate organisations and climate users, including through Regional Climate Outlook Forums (RCOFs). Further information on the CSRP is at: http://www.metoffice.gov.uk/csrp .

Results

We summarise key results up to May 2012 under each of the programme's five Output areas.

Output 1: Improved understanding and modelling of African climate and its drivers:

HadGEM3 development: Two major upgrades of HadGEM3 have been guided by detailed performance assessments over Africa. The upgrades have improved the model's rainfall climatology for all the important sub-Saharan rainy seasons – steps to correct over production of light rain proving the most effective. Model improvements are being pulled through into systems used for real-time prediction (Output 2).

Assessment of model teleconnections: The ability of current models (HadGEM3 and the CMIP3 ensemble) to reproduce important observed remote influences of sea surface temperature (SST) variability on African rainfall (teleconnections) is consistently poor in some key regions in multi-decadal integrations. The findings are helping to identify and prioritise model development to optimise benefit over Africa. Note that seasonal forecasts have much better teleconnections as their shorter range allows less time for errors to develop.

Simulation of the West African Monsoon: The ability of CMIP3 models to simulate the West African Monsoon (WAM) is generally poor. In contrast, a development version of HadGEM3 has a relatively good representation, including realistic timing of onset in the Sahel (i.e. when the main rain band moves north of 10ºN) (Fig. 1). Through analysis of this HadGEM3 simulation, land-atmosphere coupling in the Sahel and the influence of remote SSTs have been identified as key controlling factors in onset timing.

Output 2: Real-time prediction, monitoring and attribution: Seasonal predictions of season onset timing: These were given high priority by users in the consultation. Experimental onset forecasts using the MOHC GloSea4 operational seasonal forecast system have been developed, found to have skill when assessed over past cases, and are being trialled with African regional climate organisations. In particular, good guidance was achieved for the early onset of the 2011 short-rains season over the Greater Horn of Africa (GHA) (Fig. 2).

Seamless monthly-to-decadal prediction: For consistency in forecasts across timescales, it is preferable to predict all timescales with the same modelling framework ('seamless' prediction). A new monthly-to-decadal system (based on HadGEM3) has been designed and developed. Relative to the MOHC's previous decadal prediction system, the new system has improved skill for multi-annual temperature and rainfall averages over Africa. In addition, prediction skill for ENSO (an important driver of rainfall variability over Africa) is significant up to 18 months ahead, enhancing potential for longer-than-seasonal-range climate warning systems.

Attribution of extreme climate events over Africa: A prototype near-real-time attribution system has been developed and is being applied to analyse the severe drought in the GHA 2010/11 – characterised by failure of both the September-December 2010 short rains and the March-May 2011 long rains. The methodology is based on comparison of two sets of ensemble simulations. One set is forced with observed SST and anthropogenic greenhouse gas (GHG) and aerosol concentrations, the other with pre-industrial GHG/aerosol and SST cooled to remove the estimated anthropogenic warming. First results with this methodology suggest that anthropogenic change had no detectable impact on the short rains season, but may have increased the risk of drier-than-average conditions in the long rains season.

Output 3: Dynamical downscaling:
HadGEM3-RA development: The improved rainfall climatology achieved in the global model is reproduced in HadGEM3-RA over a range of horizontal resolutions (50km, 25km and 12km) with additional bias reduction in some regions due to enhanced resolution and new representations of aerosols including an interactive dust loading scheme. HadGEM3-RA will be implemented at a collaborating African centre (see section 3) and will also become the core of the MOHC's PRECIS (Providing Regional Climates for Impact Studies) downscaling system and contribute to CORDEX (the Coordinated Downscaling Experiment of the World Climate Research Programme).

Output 4: Strengthening climate science in Africa:
Through a fellowship scheme, eleven African climate scientists at African institutes are working on CSRP research themes (Table 1). The fellowships cover regional interests across Africa: with 4 fellowships in each of West and East Africa, 2 in southern Africa and 1 in central Africa. The fellows have visited the

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Fellow and affiliation(s)	Research theme	Project title
Dr Ousmane Ndiaye: National Agency of Civil Aviation and Meteorology (ANACIM), Dakar, Senegal	Model evaluation	Forecasting weather statistics within the climate of the seasonal rainfall over Senegal
Mr Ismaila Diallo: Cheikh Anta Diop University (UCAD), Laboratory for Atmospheric Physics Simeon Fongang (LPASF); Dakar, Senegal		Present day simulations of the West African Monsoon with two kinds of HadGEM3 model (GCM and RCM)
Dr Willem Landman: Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa		The performance of HadGEM3 as a seasonal forecasting and research tool for southern African climate variability
Mr Mekonnen Adnew Degefu: Department of Geography and Environmental Studies, University of Addis Ababa, Ethiopia	Climate process understanding	Association between rainfall variability and global climate teleconnection: the case of southwestern Ethiopia
Mr Wilfried Pokam Mba: University of Yaoundé 1 and Centre for International Forestry Research (CIFOR), Yaoundé, Cameroon		Investigation of processes driving low-level westerlies in central Africa
Mr Arlindo Meque: National Institute of Meteorology (INAM), Maputo, Mozambique and University of Cape Town, South Africa	Seasonal forecasting	Evaluation of the GloSea4 seasonal forecast system over Mozambique: rainfall climatology and predictability
Mrs Mary Kilavi: Kenya Met Department, Nairobi, Kenya		Integrating dynamical products into national and regional climate outlook forum products
Mr Oumar Konte: National Agency of Civil Aviation and Meteorology (ANACIM), Dakar, Senegal		Evaluation of seasonal forecasting of rainfall from the farmer's perspective with Kaffrine and Fatick as case studies
Dr Philip Omondi Aming'o: IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, Kenya	Decadal prediction	Modelling decadal climate variability over the Eastern Africa region
Mr Dominic Soami Pokperlaar: Ghana Meteorological Agency, Accra, Ghana	Meteorological observations	Ghana historical climate data development project
Mr Geoffrey Sabiiti: Makerere University, Kampala, Uganda and IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, Kenya	Regional downscaling	Evaluating MOHC PRECIS system downscaling ability and its climate change projections over the Greater Horn of Africa

Table 1: The CSRP fellows, affiliations, research themes and project titles.

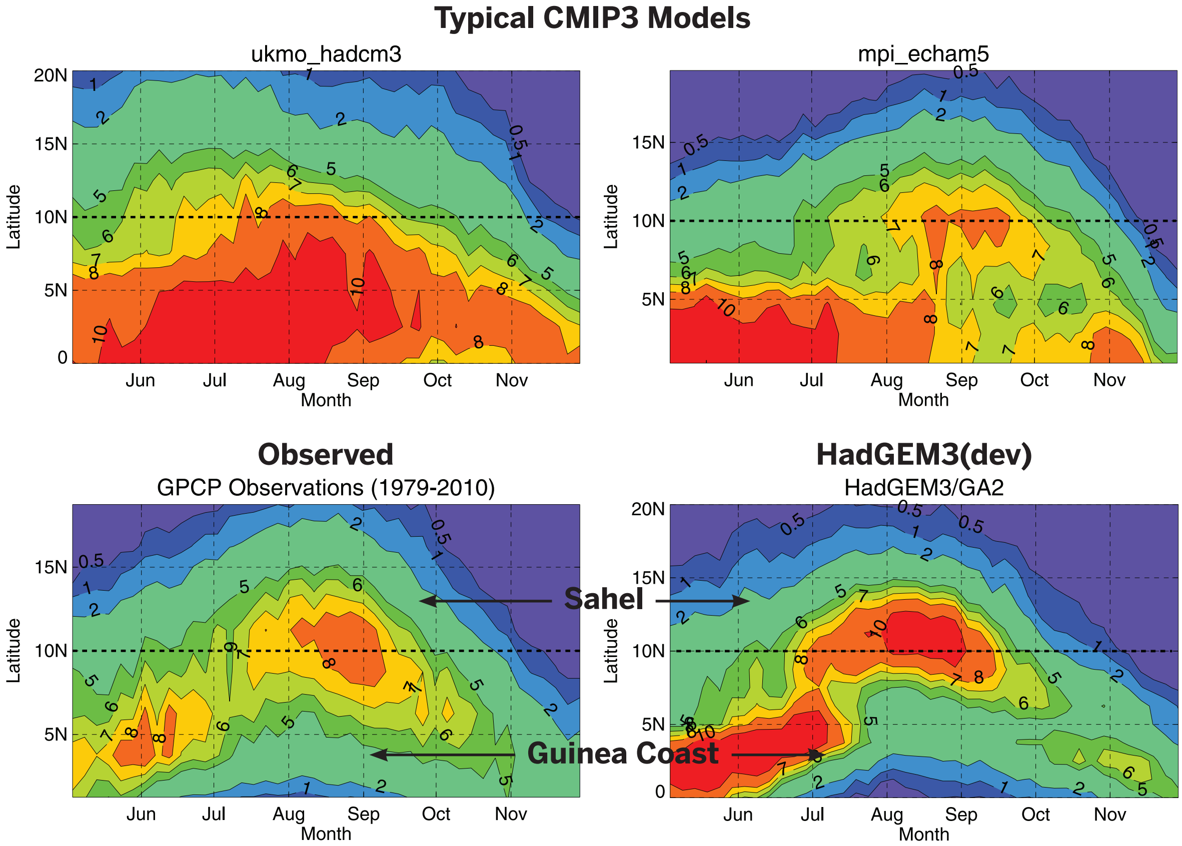
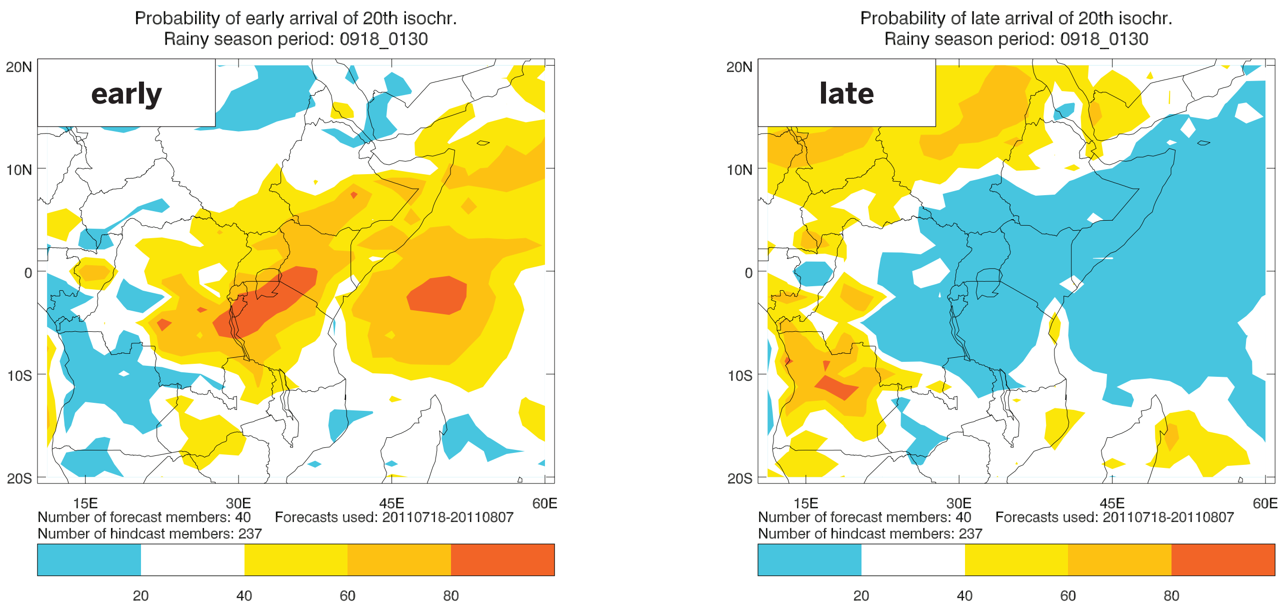


Fig.1: West Africa Monsoon: Modelled and observed mean evolution (May to December) of precipitation rate (mm/day) averaged over 10°W-10°E. Top: Two CMIP3 models representing typical performance. Bottom left: observed (GPCP, 1979-2010). Bottom right: development version of HadGEM3.



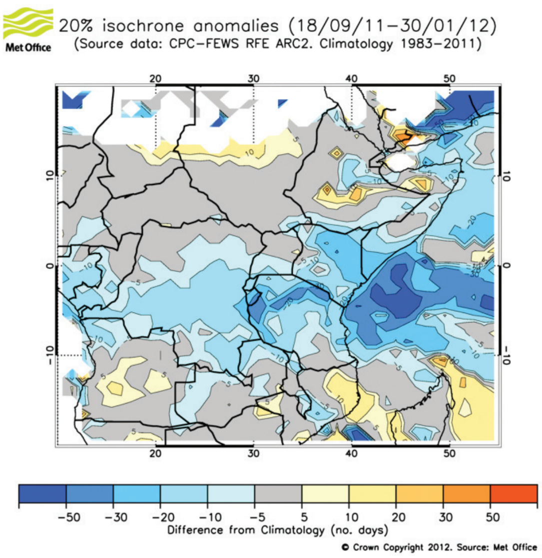


Fig. 2: Top: GloSea4 forecast probabilities (%) for early (left) and late (right) 'onset' of the 2011 short rains (Oct-Dec) over the Greater Horn of Africa, issued August 2011. Bottom: observed deviation in days from long-term average onset date (calculated from CPC FEWS-NET daily rainfall estimates: http://www.cpc.ncep.noaa.gov/products/fews/africa negative values (blue) indicate early onset, in accord with raised forecast probability (orange/red in top left panel)). Onset is defined here as the date on which 20% of the long-term local seasonal average has accumulated.

MOHC to finalise project plans, collect data and interact with other UK scientists working on African climate (notably from the Universities of Reading, Leeds and Oxford).

Output 5: Development of research products that target demand and are accessible to users:
Development and trial of experimental products (see Output 2) is being assisted by workshops and forums with African climate scientists and end users. The first workshop, on "Use of dynamical seasonal forecasts for the GHA", was delivered jointly with the IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi. Fifteen climate scientists from across the GHA attended. The workshop included preparation of the first ever ICPAC outlook for the July-September season in the north of the GHA and delivery to a user forum.

Year-3 plans
Key activities in the third and final year include:
- Assessment of a further major upgrade of HadGEM3;
- Additional experimental user-relevant products including multi-annual range predictions;
- HadGEM3-RA implemented at an African centre for 'proof of concept' downscaling of global model seasonal forecasts;
- End of project conference including presentation of fellowship research.

CORDEX-Africa: a unique opportunity for science and capacity building

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Background to CORDEX Africa
CORDEX is a program initiated by the WCRP task force on Regional Climate Downscaling (RCD), with the objective of developing downscaled regional climate change projections for all terrestrial regions, using both dynamical and statistical methods. To support this aim, CORDEX seeks to address three priority objectives: to develop a framework for RCD techniques to use in downscaling global climate projections, foster an international coordinated effort to produce improved multi-model RCD-based projections, and to promote greater interaction and communication between global climate modelers, the downscaling community and end-users. To a large extent the program has been exceptionally successful in moving forward towards these goals. A common experimental framework has been adopted, a central data repository established, and multiple participants are actively engaged.

Early in the planning phase of CORDEX, Africa was identified as a key domain for priority attention. This arises from the understanding of the continents high vulnerability to climate change, the limited availability of regional data on potential future changes, and the weak capacity to provide this information. In response the regional modeling community placed a priority on undertaking the necessary simulations for Africa, and ~14 groups have so far completed control simulations of the past climate (forced by the ERA-Interim reanalysis), with a number of groups well advanced in completing regional projections forced by data from GCM simulations in the CMIP-5 archive.

Development of complementary capacity building
As the science program of CORDEX-Africa gained momentum it was quickly apparent where the key constraint lay: CORDEX is an unfunded activity focused on the generation of downscaled data. As such there remained a gaping void in undertaking the analysis and translation of the simulation results for benefiting the stakeholder communities. To address this, the Climate System Analysis Group (CSAG) at the University of Cape Town developed a proposal for a series of analysis and writing workshops in Africa, with an expressed focus on capacity building dovetailed with the delivery of relevant knowledge products for Africa. The proposal leveraged funds from five sources (see links at end): START, CDKN, WCRP, SMHI, and CSAG-UCT, and led to the establishment of the CORDEX-Africa analysis program.
The initial focus supported a series of 4 workshops for young and emerging scientists in Africa to work with CORDEX outputs, emphasizing the development of capacity within the continent to evaluate, analyze, and ultimately deliver science and stakeholder products. Three regional collaboration teams have been established for west Africa, east Africa, and southern Africa, each with principal leadership and collaborators from within respective regions. The first three workshops focused on developing skills and the analysis of the control simulation data, while the fourth was a writeshop to develop writing skills and draft an initial suite of journal papers focused on the evaluation of the model downscaling results for the control climate period. While it was hoped that papers detailing CORDEX Africa projections would also be included, the simulations forced by the GCM projections had not been completed by this stage, and so remain a target of the next phase of the CORDEX-Africa analysis program.

Early results
An initial assessment of the multi-model climatology from the simulations is in press (Nikulin et al, 2012), and provides an overview of the regional multi-model model performance over the continental domain. The study evaluates a range of time and space scales down to and including diurnal cycles. As might

be expected, the multi-model mean outperforms individual simulations, but a clear improvement in precipitation over that of the boundary condition data is seen in many of the models. Biases in the diurnal timing of precipitation remains a problem common to most of the models, but the results clearly indicate RCMs are able to provide useful information for the continent.

Projection simulations are still ongoing at many institutes, and it will be some time before a comprehensive multi-GCM multi-RCM data set is fully compiled. Some early results based on ensemble simulations by the Rossby Centre regional climate model RCA4 are shown in Figure 1. While preliminary, the results are generally consistent with other indicators, although an interesting deviation from earlier understanding is the limited wetter conditions over east Africa.

Directions, opportunities, and challenges

CORDEX-Africa has already established solid momentum, and enabled the participation of 30+ young scientists from across Africa in an analysis effort. Initiatives are underway to extend the first phase. The key application challenges at this stage are how to best use and translate the large data resource to enable information and knowledge products tailored to regional stakeholder needs, and how to best communicate and disseminate these products. On the scientific front, the leading challenge is arguably about the methodological approaches to best address the multi-model ensemble and related uncertainty / probability questions in a way that maximizes the interpretation and information content. In conclusion, CORDEX-Africa represents a unique initiative with tremendous potential to change the information availability on regional climate change for the African continent. Equally, the opportunity for participation is large, and we invite and encourage scientists and students across Africa to contact the CORDEX-Africa team to explore ways to join in the research and communication activities (email: cordexafrica@csag.uct.ac.za).

Useful web sites:

WCRP overview of CORDEX design: http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEX.html
START: http://start.org/cordex-africa/
CORDEX data archive: http://cordex.dmi.dk/joomla/
CDKN: http://cdkn.org/project/cordex-africa-enhancing-climate-change-knowledge-in-africa
SHMI: http://www.smhi.se/en
CSAG-UCT: http://www.csag.uct.ac.za

References:

Nikulin, G., C. Jones, F. Giorgi, G. Asrar, M. Büchner, R. Cerezo-Mota, O. Christensen, M. Déqué, J. Fernandez, A. Haensler, E. van Meijgaard, P. Samuelsson, M. Sylla, and L. Sushama, 2012: Precipitation Climatology in An Ensemble of CORDEX-Africa Regional Climate Simulations. J. Climate. doi:10.1175/JCLI-D-11-00375.1, in press.

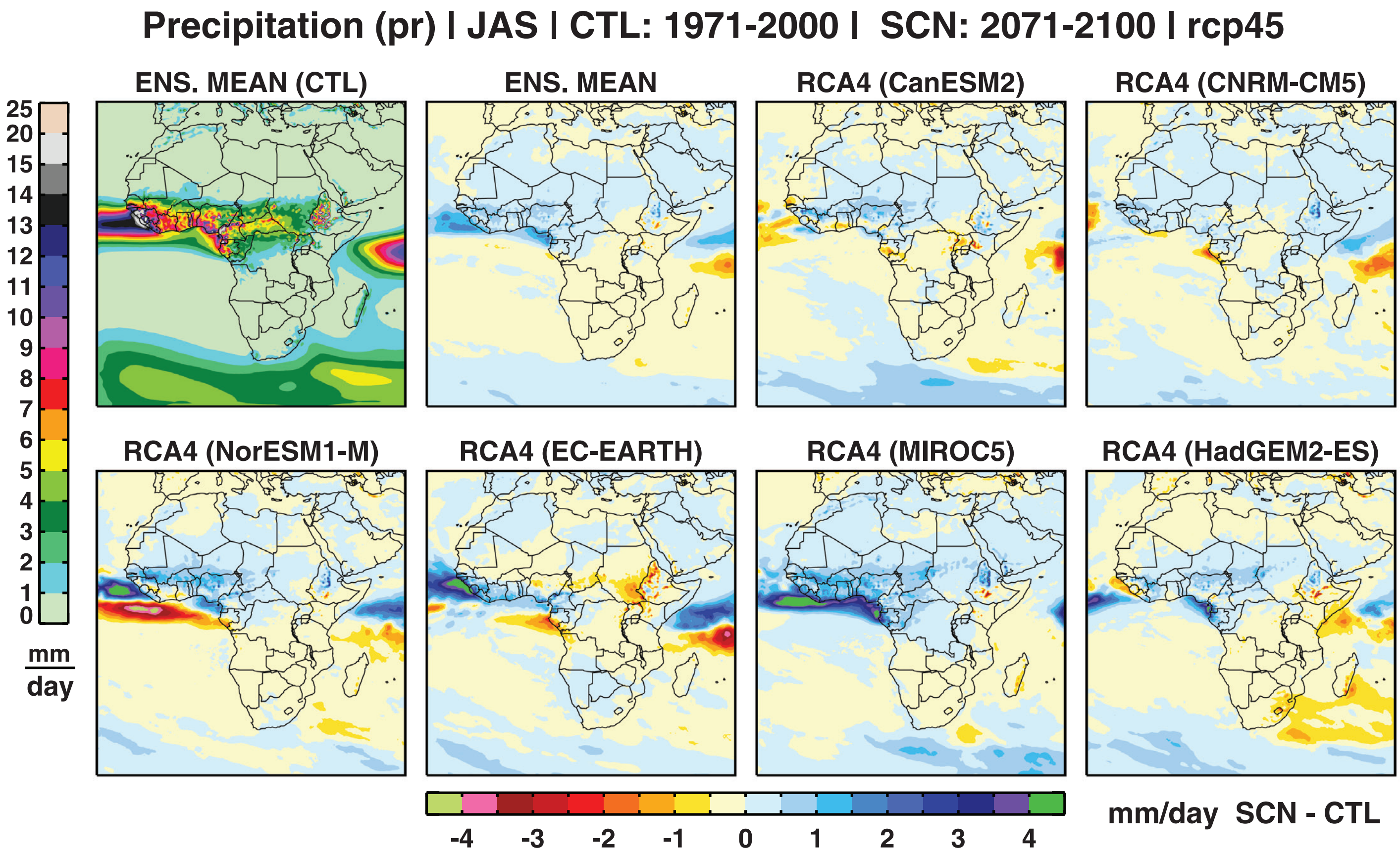

Figure 1: The ensemble mean JAS precipitation for 1971-2000 simulated by the Rossby Centre regional climate model - RCA4 driven by six different AOGCMs (top left-hand panel) and the respective changes of precipitation in 2071–2100 relative to 1971–2000 for the ensemble mean and the individual runs forced by the RCP45 emission scenario.

Presenting the ISACIP/AfriClimServ project: first component of the Climdev_Africa programme

By Mohammed Kadi (ACMAD), Zachary K.K. Atheru (ICPAC)

1. Genesis of the Climdev_Africa program

Developing appropriate climate-related information and the policies to use the information effectively to face adverse impacts of climate variability and climate change promote social and economic development planning is the agreed challenge within the production/science and the users/development communities.

The Climate for Development in Africa (ClimDev_Africa) programme is a joint initiative of the African Development Bank (AfDB), the Commission of the African Union and the United Nations Economic Commission for Africa. It is also the result of a long process that started in early 2000 with consultations within meteorological and climate communities, with the main focus on the meteorological observation network.

Regional workshops were held between 2002 and 2006 in most African sub regions (Eastern & Southern Africa, Western & Central Africa, and in the Mediterranean Basin) and GCOS Regional Action Plans developed. At the same time, the 2005 G8 meeting at Gleneagles, UK, with the twin themes of Africa and climate change, saw several pledges for support for ClimDev (Washington et al, 2006). Based on these reports and a gap analysis conducted by IRI, an action plan for Africa for "Climate Information for development needs: Report and implementation strategy" (WMO TD No. 1358, GCOS No. 108, Nov, 2006) was developed and adopted during the Addis Ababa meeting (http://www.wmo.int/pages/prog/gcos)

2. The Africa Development Bank involvement: launching of the ISACIP/AfriClimServ project

The African Development Bank (AfDB) which identifies climate change as a threat to poverty reduction and sustainable development in the continent took the decision to grant support of 30 million US $ to a project aiming to strengthen the existing operational African Regional Climate Institutions and initiate a strategic "Public Private Partnership". This decision was a response to the January 2007 Addis-Ababa declaration of the 8th Summit of African Heads of State declaration on managing the risk of Climate Change, which noted the need to "strengthen current African Regional and Sub-regional climate centers of excellence to address climate change and variability prediction as well as in the development of climate applications decision tools" and the resolutions taken by the first joint annual meeting of the Conference of Ministers of Economy and Finance of the African Union and the Conference of Ministers of Finance, Planning and Economic Development of ECA (March 2008).

This Knowledge Management and Capacity Development Initiative known as the "Institutional Support to African Climate Institutions Project" or the "AfriClimServ" is fully in line with a the multi donor ClimDev Fund and in support of the first component of the ClimDev-Africa program coordinated by the African Center of Meteorological Applications for Development (ACMAD) which is designated as the "Executing Agency".

Its implementation effectively started in October 2011 in close partnership with the climate centers specific to each regional economic community such as ECOWAS, IGAD, SADC, CEMAC, IOC, and UMA.

The other specialized Climate Institutions beneficiaries of the project are The CILSS-ECOWAS Agro-meteorology and Hydrology Regional Centre (AGRHYMET); the IGAD Climate Prediction and Applications Centre (ICPAC) and the SADC Climate Services Center (SCSC).

3. The ISACIP/AfriClimServ Program: state of its implementation

The primary objective of The ISACIP/AfriClimServ, the first component of the Climdev_Africa program, is to enhance the capacity of the climate centers and African scientists to generate and make widely available appropriate and relevant climate-related information to intended end-users and support development planning processes in Africa. The project activities, structured in two main components, are briefly described along with a short status of their implementation.

3.1 Production and delivery of climate related information and services:

Four activities focus on producing and delivering tailored weather & climate related information at different time and spatial scale to end users (policy makers, support organizations, and the population at large).

a) **Improved access to climate observation and information networks** includes the upgrading of observation networks and infrastructure notably (ground & upper air stations equipment) within the IGAD and SADC regions as well as training and demonstration observatory; the use of modern decision making tool for forecasting and warnings, that answer the specific needs of weather and climate sensitive key sectors and policy makers (social & economic operational and planning activities), a better access to the specific information network (WMO information System, Eumecast)and public internet and the required technical facilities to secure systems operation. It is worth noting that the ISACIP/AfriClimServ supports the initiative Weather Info For All (WIFA), that was initiated by the Global Humanitarian Forum (GHF), the World Meteorological Organization (WMO), and the telecom company, Ericsson in 2008. The activity include a demonstration project that extends the cooperation with civil society and private sector to improve observing networks and forecasting systems and to increase production and access to reliable weather and climate information.

b) **Operationalization of climate information systems** which include integrated systems to improve data and metadata management and data protection and safe archiving, to enhance and better tailor and deliver early warning information through daily, weekly, monthly and seasonal forecasting conducted through production of information and services such as climate monitoring, seasonal forecasting, hydrological forecast, applications for agriculture food security, water resources and energy management and coastal and marine activities.

c) **Downscaling global climate data and scenarios and Climate impacts assessments:**
In partnership with African and International expertise, and by hiring modeling specialists and acquiring and operating dedicated regional climate models along with the required computing capacity and specific workshop, the African Climate Institutions will

- Enhance and / or build a strong modeling infrastructure for downscaling global data and generating climate scenarios and projections appropriate for development at continental, regional, national and sub-national scales. Climate change indices at regional and local scales will be produced to better assess trends in the historical data and ensure their quality.

- Conduct, produce, consolidate and make available validated “vulnerability & impact assessment” studies at regional, national and sub-national level

d) Dissemination strategy development and implementation:
To improve and ensure the easy access and use by the different user communities, the information listed above will be better packaged and disseminated. Computer assisted publication system will be acquired; links with media, Communicators & Rural Radios Agents and other communications agents will be strengthened as will be upgraded institutions websites with a more friendly access and use.

3.2 Institutional Strengthening

a) Enhancement of Capacities of Scientists.

- African scientists and end users are key beneficiaries as they are part of planned workshops related to key issues such as seasonal climate Forecasting, Food Security & Water Resources, climate and health management forums.
- The program encourages project staff to participate in international conferences and benefit from specialized training

b) Student and professional training and sensitization

- Professional and junior scientists are hosted for on job-training session, scientific visits and are granted scholarship within the “in residence and fellowship” programs. The programs cover a range of themes from improvement of weather forecasting/modeling to analysis of vulnerability of human systems and adaptation to climate change)

- A dedicated program focuses on sensitization of parliamentarians, legislators and civil society members by organizing specific workshops, developing training material.

c) The Development of physical infrastructure :
The last but not least sub component of the institutional strengthening concerns the development of physical infrastructure to create a conducive environment and ensure the sustainability of the Centers.

4. Status of implementation of the ISACIP/ AfriClimServ project:

After compliance with the grant conditions, the project implementation started in October 2011 and the following has been achieved:

i. Six workshops on regional climate forecasting and climate change indices have been conducted in West, Central, East and North Africa. The information produced has been provided to decision makers, disseminated and published. Figures 1 and 2 illustrate these products.
ii. The same number of workshop on climate risks management, legislator sensitization, medias, communicators and are about to be held
iii. A number of junior professional (10) , visiting scientists (12) and junior scientists (5) are engaged in on the On-Job-Training, Scientists In-Residence and Fellowship programs.
iv. Twenty experts are about to be recruited and integrate the project staff within the different institutions
v. Technical description and specifications of the required specific systems and support equipments, to access and manage data, to produce tailored early warning, scenarios, to disseminate and package products are being finalized for acquisition.
vi. Terms of reference for acquiring the specialized expertise and consultancy to assist in the implementation of the listed activities are under review for recruitment
vii. Several project management actions have been conducted.

For more information, please visit the websites of the following African Climate Institutions: acmad.org, icpac.net, agrhymet.ne, sadc.org

References and Resources

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2) Climate for Development in Africa: An Opportunity for African NHMSs; GCOS Side Event at the WMO Congress ; May, 17th 2007

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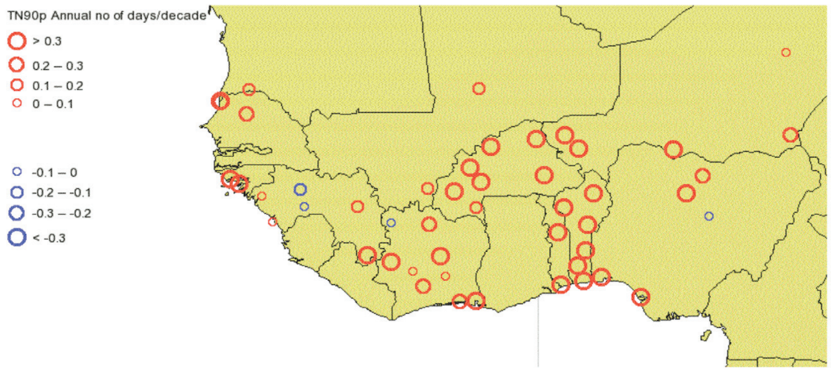

Fig. 1 (above): Change in annual number of warm nights in West Africa. Very strong signal of increasing frequency of warm nights at most stations

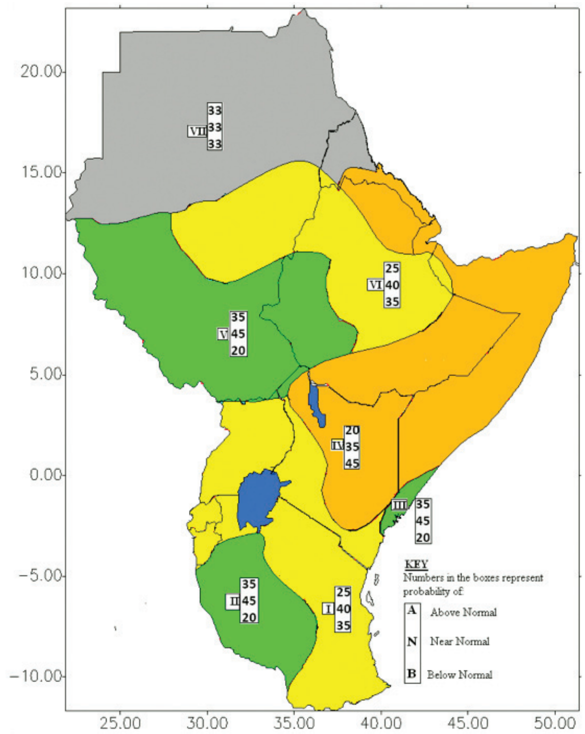

Fig 2. (right): Greater Horn of Africa Consensus Climate Outlook for the March to May 2012

Seasonal Forecasting over West & Central Africa

Mohammed Kadi, Dr Andre Kamga, Dr Neil Ward, Moussa Mouhaïmouni, Sidi Ould Mohamed Lemine , Lamin Mai Touray and Cherif Diop,

Background

Operational seasonal forecasting was established because of the belief that its products could add value to early warnings (Farmer, 1997). Some predictability in seasonal climate variations is known to be a result of interactions between the atmosphere and the underlying oceans and land which are slowly evolving and can sustain influence on the atmosphere over a season or more. Following the increase in understanding and modeling of global climate patterns and oscillations such as El Niño Southern Oscillation (ENSO) since the 1980s, operational seasonal forecasting expanded in the late 1990s. Interest in ENSO intensified with the tremendous impacts of the 1997-98 El Nino event around the world, including vulnerable parts of Africa (Glantz, 2001). In West Africa, the first Regional Climate Outlook Forum (RCOF) was held in 1998. The objective of this paper is to discuss current status and future evolution of seasonal forecasting and its applications in West and central Africa. It presents evolving infrastructure, methods and tools for seasonal forecasting, and discusses the product and its uses in the region. Lessons learnt and suggestions for ways forward are summarized in the conclusion.

Seasonal climate prediction methods & tools

Statistical methods

Effective statistical forecast models can often be linear regression formulas based on relationships between a predictand (e.g., seasonal precipitation or temperature for a location or a region) and predictors (e.g., sea-surface temperature (SST), circulation patterns). The simplest technique predicts a quantity of rainfall for a place as a linear function of SST. Techniques can also predict the likelihood that rainfall at a place will fall within a given range as a non-linear function of the predictor variable. Techniques can also predict the full probability density function of the predictand. The models are easy to run and quick to learn. However, expert judgment is needed to decide on homogeneous regions and the right mix of predictors. Most countries of the regions have developed and used statistical models for seasonal forecasting. Statistical models do not explicitly represent climate dynamics. Therefore, when something unusual occurs in the current year, the model may fail. Because of climate change, relationships between different places and times may be gradually evolving leading to less accurate forecasts based on historical relationships.

Some additional statistical methods are also used to provide additional information. For example, the analog method identifies past years when predictors of climate variations like ENSO and other SST patterns were similar to the current year. Also, using climate data of the past few decades, trends are detected and this provides additional contextual information (sometimes expressed as optimal climate normals).

Dynamical methods

The most complete approach in seasonal forecasting is the use of dynamical models. The forecast is made using the physical/dynamical modeling of atmospheric, oceanic and land processes. The dynamical models predict how state variables develop in the future. Uncertainty is represented by running ensembles of forecasts. There are variants of dynamical models including Atmosphere-only and coupled Ocean-Atmosphere General Circulation Models (GCMs). These GCMs are expensive to run and require costly supercomputers. In the region, a hybrid approach uses GCM outputs as predictors for a statistical model (e.g., as represented in the Climate Prediction Tool (CPT) software). When the predictand is at high resolution, this approach is an example of statistical downscaling.

Operational seasonal prediction combines all available information from all approaches to produce seasonal climate outlooks.

The West and Central Africa RCOFs

The African Centre of Meteorological Applications for Development (ACMAD) as a pan-African institution has been leading specific RCOFs for three African sub-regions: the PRESAO for West African countries, Cameroon and Chad, the PRESAC for central African countries and the PRESANOR for North African countries. A fourth specific RCOF was held in June 2012, for the sub-region formed by Indian Ocean countries. The IGAD Climate Prediction and Application Center, based in Nairobi and the SADC Climate Services Center are respectively conducting RCOFs for the member countries of these two named Regional Economic Communities.
It has been recognized, in the 2000 Pretoria RCOF review[1] and strongly confirmed in the 2008 Arusha review that a major success of RCOFs has been the promotion of dialogue and collaborations between providers and users of seasonal forecasts, and recently, as a prototype of climate service to be delivered through the user interface component of the Global Framework for Climate services (GFCS). Seasonal climate forecasts are an integral part of services provided by NMHSs of all sub-regions to key development sectors such as agriculture, food security, energy, water resources, disaster management and health. This development combined with increasing climate variability impacts on society (loss of lives and property) has raised more awareness generally and for example, since 2007, the Humanitarian Sector in West and Central Africa (through the IFRC regional office) has implemented contingency plans in which climate information is a highly weighted parameter.

1 RCOF review (Pretoria, 2000)

Delivered products and recent evolution: West, Central and North Africa RCOFs

In West, Central and North Africa, the RCOF product is the foot print of the strong collaboration between NMHSs, ACMAD (an emerging WMO Regional Climate Center) and the Global Producing Centers (IRI, MF, UKMO, ECMWF, AEMet & IBIMET). Since 1998, ACMAD has organized 14 annual RCOFs for West Africa, 5 for Central Africa and 2 for North Africa. The latest one for North Africa has included most of the countries from Southern Europe with the intention to develop further into a Mediterranean RCOF process.

The West & central African RCOFs, led by ACMAD, were initially designed to be held once a year for each sub-region, about one month before the target rainy season and preceded by a long training event on climate variability and forecasting methods and tools. Since 2008, this RCOF process has been evolving positively, focusing on all activities, including training, products and users. The enhancements are based on the recommendations of the so called PRESAO Second Generation (Ceron, 2007) such that today this Second Generation Process of PRESAO & PRESAC includes:

- Use of ensemble outputs from global dynamical models, provided by the WMO GPC by countries, with ACMAD adapting forecasts at different scales.
- Post processing of the dynamical model outputs at ACMAD, based on its developed capabilities and infrastructure to allow use of predictors other than SSTs within countries models.
- Updated statistical models, by using the statistics deduced from the most recent reference data observation period.
- While it continues to use the IRI developed CPT software, testing has begun on more generic software (like 'R').
- Development and discussion of new products such the onset date and the intraseasonal parameters
- Engagement of a larger range of users (disasters risk managers and local communities) in understanding and integrating effectively the produced information into their operational activities and planning (seasonal, annual).
- Evolution to a more dynamic and operational activity which facilitate the issuance of forecasts for the most relevant periods and the timely delivery of the products

Lessons learnt and way forward

Relationships between global and regional climate forcing like ENSO and crop yields, food security and trade balance have been demonstrated in some countries. However, the benefits of the use of seasonal forecasts in terms of increased yields, decreased risk of famine etc still need to be better quantified. Also, further improvements are needed in forecast communication using simple non technical language that users can understand. Farmers are aware of seasonal forecasts but would like to receive more local forecasts and statements about the likelihood of onset/cessation and wet/dry spells. There is evidence that water and disaster managers use seasonal forecasts to modify their management decisions and contingency plans. However, more confident, site-specific and well communicated seasonal forecasts are required to achieve the substantial greater benefits in decisions and operations that are possible.

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Igad Climate Prediction And Application Centre (ICPAC)

L A Ogallo, J N. Mutemi, J Ratemo and Z.K. Atheru

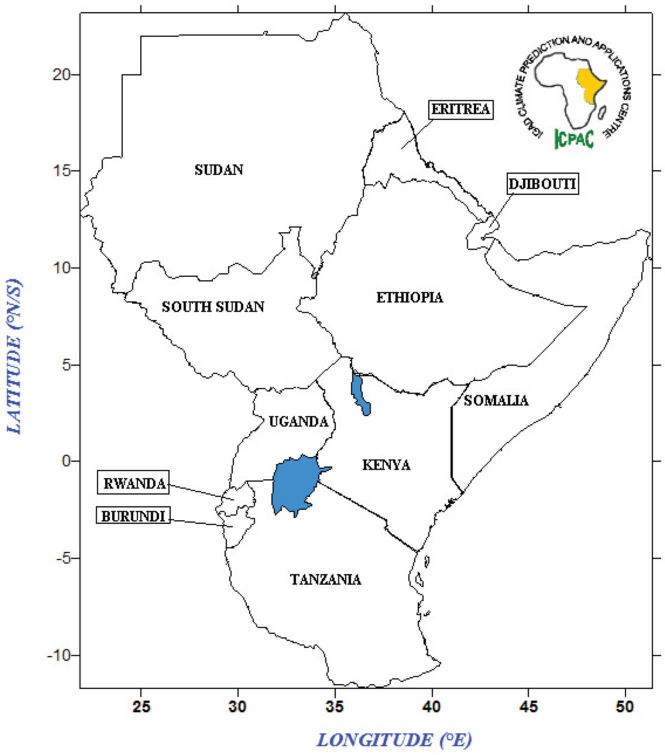
ICPAC was originally established in 1989 as the Drought Monitoring Centre, Nairobi in response to devastating weather-related disasters that adversely affect the Greater Horn of Africa countries. In 2003, the institution was adopted by the Intergovernmental Authority on Development (IGAD) and renamed IGAD Climate Prediction and Applications Centre (ICPAC) in order to better reflect all its mandates, missions and objectives within the IGAD system. ICPAC is a specialized institution of IGAD providing sub-regional real time climate information services for applications in socio-economic sectors especially food security and water resources; technical capacity building and expansion of knowledge base for decision making at sub-regional and national levels. Currently the member countries are -Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, the new Republic of Southern Sudan and Uganda – as well as Burundi, Rwanda and Tanzania.

The vision of ICPAC is to become a viable centre of regional excellence in climate prediction and applications for disaster risk management, environmental management and sustainable development.

ICPAC's mission is provision of timely climate early warning information and supporting specific sector applications to enable the GHA region cope with various risks associated with extreme climate variability and change for poverty alleviation, environment management and sustainable development of member countries.

Key achievements of ICPAC include the facilitation of 32 Regional Climate Outlook Forums which have involved a wide spectrum of providers and users of climate information at national, regional and international levels all working towards mainstreaming of climate information for improving welfare of communities of the region; establishment of a continuously updated data base for development of baseline statistics and mapping of climate hazards and associated risks across the region. A good example is the assessment and monitoring of land degradation and natural habitats for sustainable land management within the auspices of AMESD project for IGAD region. ICPAC is also implementing the East African module of the ClimAfrica Project that is being undertaken in within the EU Seventh Framework programme, involving 18 institutions of which 8 are African, 9 are European and FAO. Information about climAfrica project and activities is available at http://www.climafrica.net/index_en.jsp. ICPAC also continuously produces and disseminates climate information to various stakeholders in governmental and non-governmental sectors including United Nations International Strategy for Disaster Risk Reduction (UNISSDR). Regional capacity building for both the meteorological community and users of climate information has been spearhead by ICPAC in partnership with the World Meteorological Organization (WMO), Korea Meteorological Administration (KMA) facilitated by Korea International Cooperation Agency (KOICA), The Met Office Hadley Centre (MOHC of the UK) among other partners.

These successes have led to improved use of climate information in disaster risk reduction and climate change adaptation. One of the most recent examples is the climate forecast products provided by ICPAC during the 2010 to 2011 which indicated that poor regional rainfall and the consequent failure of rain-fed agriculture in large parts of the region long before the extreme climatic conditions happened and the consequent Horn of Africa crisis during the last quarter of 2011. The role of ICPAC in providing mandatory climate services to GHA and greater Eastern Africa continues to be advance and is recognized as reliable at both regional and international levels, including contributions to UNFCCC, UNCCD, UNISDR, and WCRP. Products and activities of ICPAC are freely available at http://www.icpac.net/



An update on AMMA activities in the CLIVAR framework

Redelsperger J.-L., C.D. Thorncroft, D.J. Parker, S. Janicot, E. Afiesimama, A. Boone, P. Brandt, S. Danuor, A. Dia, A. Diedhiou, A. Diongue, A.H. Fink, R. Folorunsho, M. Kadi, A. Konaré, S. Konaté, T. Lebel, B. Sultan, R. Washington. (AMMA ISSC Members)

AMMA was launched in February 2002 in Niamey (Niger), and has represented the largest coordinated research effort into African weather, climate and environment ever attempted. Following its first phase, which was dominated by a large integrated field programme, AMMA is continuing with a further decade of research more strongly focused on the integration of weather and climate science with decision-making for the West African region. AMMA strives to improve our knowledge and understanding of the coupled West African monsoon (WAM) system and its variability and continues to emphasize daily-to-decadal timescales including climate change. Supported by WCRP, IGBP and WWRP, AMMA is motivated by an interest in fundamental scientific issues and by the societal need for improved prediction of the WAM and its impacts on West African nations. Substantial progress has been made during this past decade through strong international coordination of African, European and US scientists. A thorough review of this progress together with the plan for 2010-2020 is included in AMMA's 2nd International Science Plan, available on the AMMA website (http://www.amma-international.org). The 4th AMMA International conference was held in France (2-6 July 2012) with around 400 papers.

From the perspective of CLIVAR, AMMA highlights of particular note include:

Intraseasonal Variability: The intraseasonal time scale is critical in planning for agriculture, health and water-resources in West Africa, where resources are highly rainfall dependent. Two main timescales of variability have been identified in the WAM; around 15 days and around 40 days. The related modes have a regional scale and can strongly influence precipitation and convective activity. Their initiation and propagation are partly controlled by atmospheric dynamics, including teleconnections from the Indian monsoon (see Fig 1) and from the Mediterranean, and show some interactions with the land-surface over West Africa on these timescales. AMMA has begun developing monitoring of these modes in collaboration with African meteorological services, which offers a substantial opportunity to improve intraseasonal prediction in the future. An e-mail discussion group concerned with intraseasonal variability in the West African region has recently been formed (see the AMMA website for more details).

Monsoon onset: The WAM has a distinctive annual cycle in rainfall that remains a challenge to understand and predict. AMMA researchers highlighted a rapid poleward shift in peak rainfall between the coastal region and the Sahel at the end of June, marking the monsoon onset there. Though inertial instability has been invoked to explain this shift, emphasis has also been given to a thermodynamic explanation of monsoon onset (See Fig 2) involving the seasonally varying surface conditions over the ocean (specifically the establishment of the cold tongue) and over the land (including the evolving heat low). AMMA continues to emphasize and implement observations in the Equatorial Atlantic and over the continent to support research on the monsoon including its onset.

Multi-annual variability (interannual, decadal, climate change): The multi-annual timescale remains extremely important for West African societies. Research concerned with variability and predictability of the WAM at interannual timescales, multi-decadal timescales (i.e. the next 10 to 30 years) and in association with climate change scenarios (up to 2100 for example) remains crucial for AMMA. AMMA remains focused on increasing our knowledge and understanding of key feedbacks in the coupled WAM system that control variability of the WAM on these timescales (see WAMME below). There is a growing interest in analyzing the CMIP5 datasets for the WAM region to carry out work concerned with decadal predictability and climate change. First CMIP5 analysis shows that a strong SST bias persists in the eastern tropical Atlantic, affecting the ability to predict interannual to decadal tropical Atlantic variability as well as climate change. An e-mail discussion list has been formed to exchange ideas and keep people informed of progress on the multi-annual variability (see AMMA website for more information). AMMA will coordinate a report on key outputs of this work so that it can inform interested communities.

WAMME-2 (West African Monsoon Modeling and Evaluation): The first WAMME experiment evaluated GCM and RCM performance in simulating the variability of WAM precipitation, surface temperature, and major circulation features at seasonal and intraseasonal scales (Xue et al., 2009; Druyan et al., 2009; Boone et al., 2009). The analyses indicate that despite deficiencies in many aspects, models generally have reasonable simulations of the spatial distribution of WAM seasonal mean precipitation and surface temperature, as well as the average zonal wind in latitude-height cross-section and low-level circulation. Common deficiencies in model simulations were identified. Analyses based on preliminary results have also revealed that model-simulated WAMs are highly sensitive to SST, land surface, and aerosol forcing and parameterisations.

WAMME-2 aims to improve our understanding of the possible feedbacks involving SSTs, land use change, vegetation, and aerosol forcings at seasonal to decadal scales. Given the complexity of the WAM precipitation variability associated with these forcings, the WAMME-2 objectives are established as follows: (a) to provide basic understanding of the impacts of these forcings on the regional water cycle of the WAM/Sahel, (b) to evaluate the sensitivity of the seasonal and decadal variability of the West African climate to those external forcings, and (c) to assess their relative contributions in producing/amplifying the Sahelian seasonal and decadal climate variability. The strategy is to apply observational data-based anomaly forcing, i.e., "idealized but realistic" forcing, in general circulation model (GCM) and regional climate model (RCM) simulations to test the relative impacts of such forcings. 12 GCMs and 5 RCMs participate so far to WAMME-2. (http://wamme.geog.ucla.edu/)

Land-Atmospheric Coupling: Research in AMMA has highlighted the atmospheric impact of soil moisture on space scales of 5 km upwards, and time scales of several days. Observational and modelling studies have shown how antecedent rainfall patterns affect new storms in the Sahel. The land feedback operates through various mechanisms, including a direct link to afternoon storm initiation from surface-induced mesoscale circulations (Fig 3), and indirectly via a large-scale moisture transport in the nocturnal monsoon. The results suggest potential for significant improvements in weather forecasting through assimilation of satellite data. Intraseasonal variability in soil moisture and vegetation has also been observed, and seems to be coupled to propagating atmospheric modes discussed above. Monitoring of the surface conditions may therefore also contribute to improved intraseasonal prediction in the future.

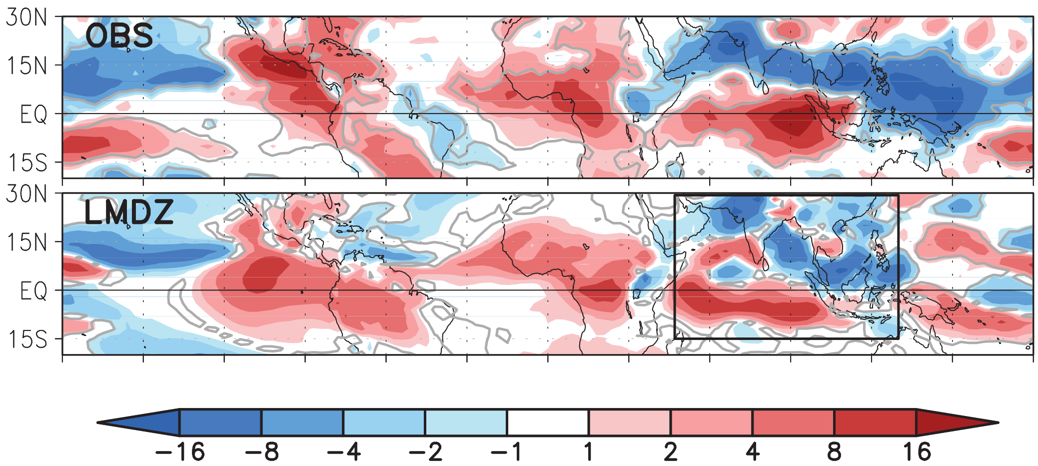


Figure 1: OLR anomalies present in observation and simulation, showing that the Indian monsoon intra-seasonal variability has a significant impact on African monsoon convective activity.

Bottom panel : 1979-2008 summer composites of observed deseasonalized anomalies of OLR (Wm-2) according to the active phase of the MJO signal over India (phase "8"). Grey contours mark 95% significant regions (according to a one sample t test)

Top panel : Same as bottom but for OLR simulated by the LMDZ atmospheric model relaxed toward reanalyses in the box domain.

(From Mohino, E. S. et al , 2011: Climate Dynamics, doi :10.1007/s00382-011-1206-y)

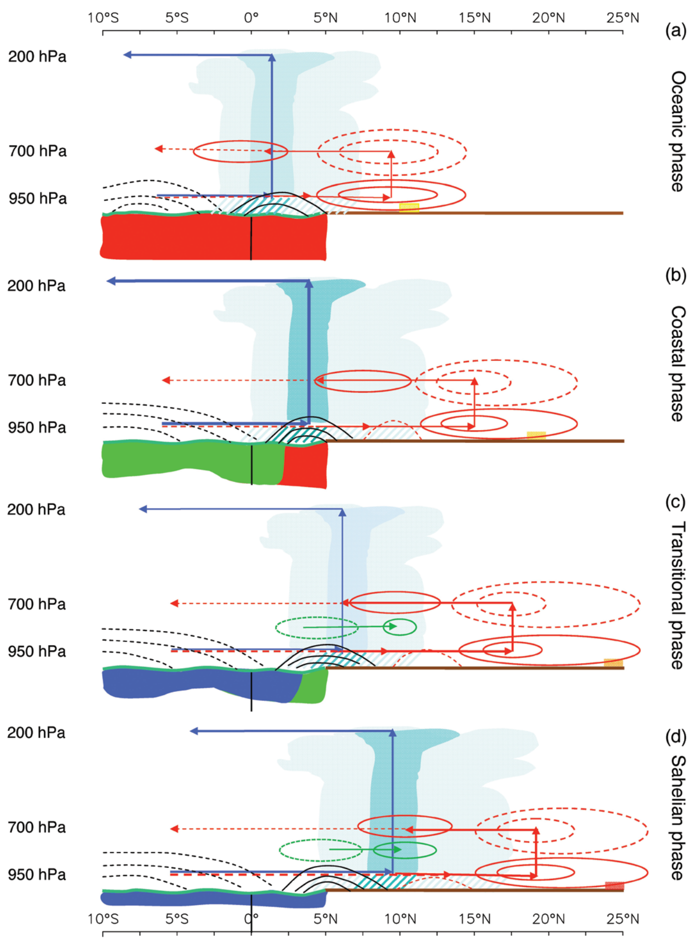


Figure 2
Schematic showing the four key phases of the annual cycle of the West African monsoon. Included for each phase are the following: the location of the main rain band (indicated by clouds and rainfall with peak values highlighted by darker shaded clouds and rainfall), the location of the Saharan heat-low (indicated by yellow, orange and red shading at the surface poleward of the rain band, with increased redness indicating increased intensity). Atlantic ocean temperature and associated mixed-layer depth (with decreased temperatures indicated by the red-to-green-to-blue transition). Moisture flux convergence maxima and minima (solid contours indicate moisture flux convergence and dashed contours indicate moisture flux divergence), and the deep and shallow meridional circulations (blue and red lines with arrows).

(Thorncroft et al 2011, Annual cycle of the West African monsoon: regional circulations and associated water vapour transport Q. J. R. Meteorol. Soc. 137)

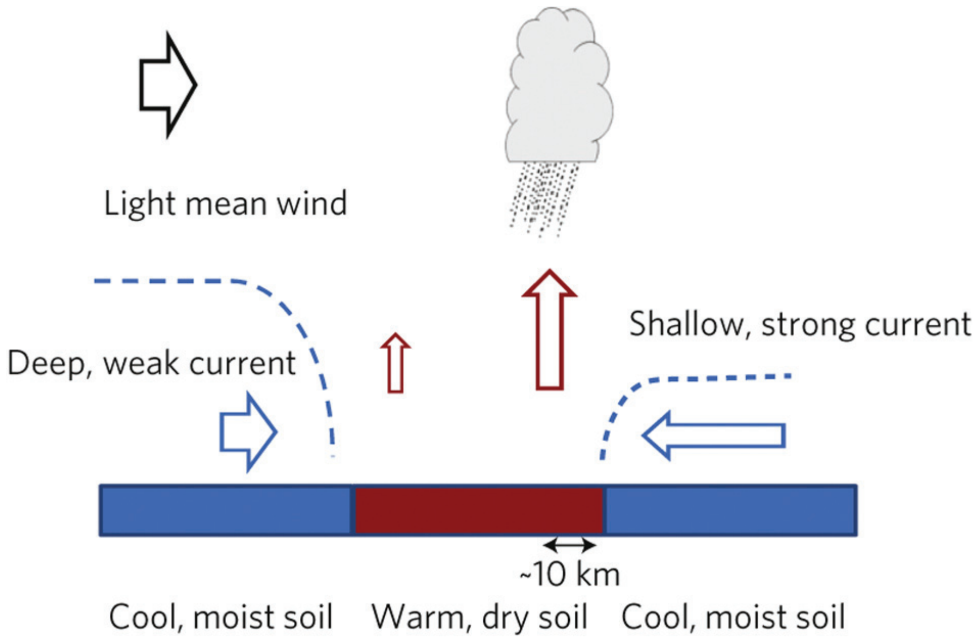


Figure 3 Schematic depicting the impact of soil-moisture heterogeneity on convective initiation.

(From Taylor et al, 2011, Nature Geoscience, 4, 430–433 doi:10.1038/ngeo1173

African climate services: a priority for GFCS and CLIVAR

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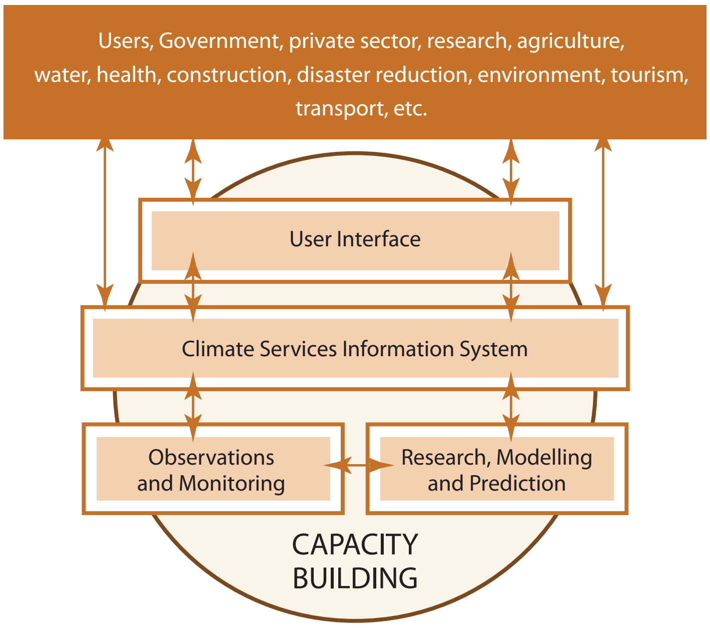
The vision of the Global Framework for Climate Services (FGCS) is "to enable the society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to such risks". Ensuring greater availability of, access to and use of climate services and giving the priority to building the capacity of climate-vulnerable developing countries belong to the main principles guiding the GFCS implementation. GFCS is meant to strongly complement the existing activities contributing to the achievement of the Millennium Development Goals, such as eradication of extreme poverty and hunger, reducing child mortality, improving maternal health, combating HIV/AIDS, malaria, and other diseases, and ensuring environmental sustainability. GFCS has a strong focus on the special needs of Africa, Least Developed Countries, landlocked developing countries, and Small-Island Developing States.

GFCS will be implemented in three time phases, with near-, middle-, and longer-terms of 2-, 6-, and 10- years, respectively. At the near-term the principal strategy is to target the needs of the countries that are currently least able to provide climate services and to carry out several fast-track capacity building projects in them to enable the delivery of climate services in the sectors of food and agriculture, water reserve management, disaster risk reduction, and human health.

Involving stakeholders at the regional level will be a key to success in the GFCS implementation. A wide range of prominent African organizations and institutions, regional initiatives, development partners, service providers and groupings will become partners in the regional development. These entities include the AGRHYMET (Agriculture, Hydrology, Meteorology) Research Centre, the African Centre of Meteorological Applications for Development, the IGAD Climate Predictions and Applications Centre; Climate for Development in Africa programme, the African Development Bank, the United Nations Economic Commission for Africa, and the whole African Union, to name only some of them. In Africa, the productive vehicles for provision of climate services include Regional Climate Outlook Forums and regional climate institutions such as the planned WMO Regional Climate Centres and other institutions supported by the regional economic groups. These institutions and processes will be strengthened in the course of the GFCS build-up. The Meteorological and Hydrological Services in Africa and researchers in academic and research establishments will have to play the central role in implementing and further development of the regional GFCS structures.

The envisioned GFCS structure will include several large categories of activities as shown in the figure below. They are called "pillars". The role of CLIVAR in the observations and monitoring pillar and especially in the research, modelling and prediction pillar will be the key for the success of regional development of GFCS. It is therefore recommended that regional CLIVAR groupings and projects such as the CLIVAR Africa Climate Panel and its various regional affiliated projects consider their involvement in the development of the GFCS in Africa, and their national participants make an effort to get involved in the setup and development of national climate services on the continent. These projects are expected to contribute significantly in building capacity of African climate



researchers. Other WCRP projects and activities, particularly the Coordinated Regional Downscaling Experiment (CORDEX), with its initial focus on Africa, will also participate as key stakeholders.

Climate information is useless if the user cannot access it or apply effectively. The call for "actionable" climate information is thus complemented by the need to build the capacity of users to become considerably more knowledgeable, experienced, and even demanding customers for information providers, and this can only be achieved by establishing a strong community-based system facilitating feedback of providers and users of climate data and information. Thus, in addition to the overarching role of the capacity building, GFCS will have a vehicle for development of such a vibrant community of data providers and users. It is called the User Interface Platform (UIP). UIP will

- identify the optimal methods for obtaining feedback from user communities,
- build dialogue between climate service users and those responsible for the observation, research and information system components
- help to develop monitoring, metrics, and evaluation measures for the performance of the Framework, and
- improve climate literacy in the user community through a range of public education initiatives and on-line training programmes.

Expert communities that generate climate information products will therefore be linked through UIP with other communities that concentrate on the use of this information. For example, in case of water management, the UIP could make an effort to bring together developers of drought monitoring and prediction systems and several levels of water managers including African Ministers Council on Water. The variety of climate outlooks will be very efficiently used if there is interaction between their developers and the user communities professionally studying the causes and ways of addressing the many health issues in Africa, for example, such as the Meningitis Environmental Risk Information Technologies (MERIT) Project of the World Health Organization, malaria programmes, and some others, for which the clear dependence of the disease on the meteorological conditions was firmly established.

Implementation of GFCS in Africa will open multiple opportunities for the development of the climate research on the continent, and the role of the WCRP regional activities and, in particular, CLIVAR regional affiliates in supporting and coordinating such research and translation of its outcomes into the practice of climate information services cannot be overemphasized.

Demonstration Study for the Integration of Climate Change Projections Information into the Planning for the Hydroelectric Power Industry in East Africa

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Introduction

Nalubaale Dam (originally called Owen Falls or Rippon Falls Dam), located at the Lake Victoria coastal city of Jinja in Uganda, at source of the Victoria Nile, was the first major hydroelectric power (HEP) plant to be commissioned in the region in 1959. The Bujagali Dam was commissioned in 2011. The Murchison Falls dam in Uganda and several other multi-million dollar plants in the Sudan are in the planning phase. The flow of the Victoria Nile, and hence the productivity of these dams is determined by the level of Lake Victoria (Fig.1) which is primarily dictated by the rainfall and temperature variability over the Lake Victoria Basin (LVB).

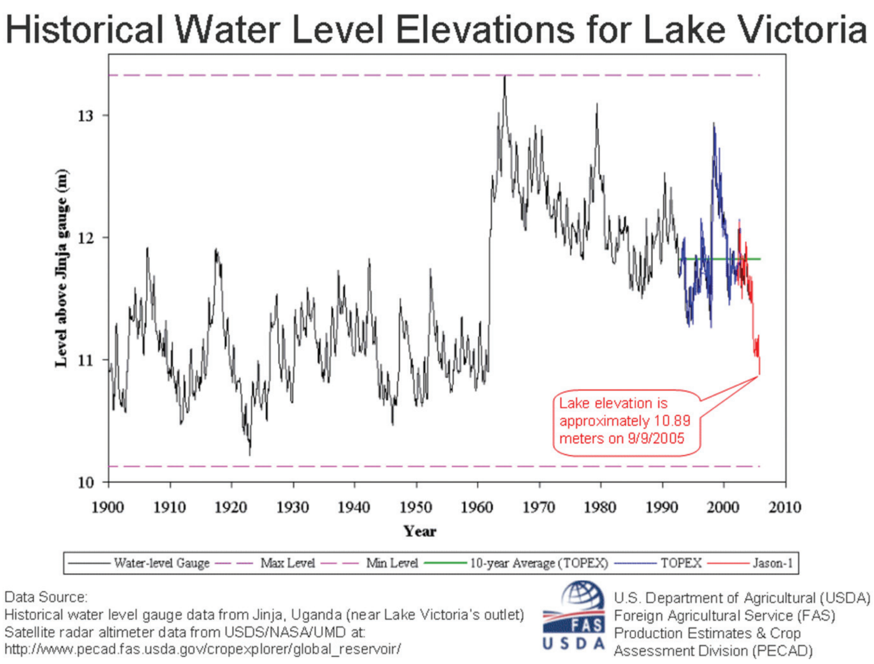

Fig.1: Evolution of Lake Victoria levels (http://earthobservatory.nasa.gov/Features/Victoria). The 0 m, or datum, of the Jinja gage is 1122.86 m above sea level. The actual elevation above sea level of the lake can be computed by adding 1122.86 to the Jinja gage value (www.fas.usda.gov/pecad/highlights/2005/09/uganda_26sep2005). For instance, a lake level of 11 m is equal to 11 + 1122.86 = 1133.86 m above sea level.

1. Primary Objective

Since the commissioning of the first dam (Owen Falls Dam) in 1959 the 'Agreed Curve' Policy-ACP water release rule (approximately 400 m3/s; Institute of Hydrology 1985) has been applied to manage the outflow from LV. It guarantees the amount of water that would naturally flow out of lake, as a function of the lake level, if there were no dams. However, the declining level of Lake Victoria (Fig.1) and population growth around the lake have resulted in chronic and debilitating load shedding and power outage for both residential and industrial consumers in the region. A new hydrological release plan ("Constant Release" Curve Policy-CRCP) has been proposed and others are being considered to improve reliability of hydroelectric power supply for the consumers (http://bankwatch.org/documents/BujHydrologyAnnex.pdf). The CRCP is a binary rule. More specifically, if the lake level (LL) satisfies the condition 10.64 < LL < 12.14 meters at the end of the year it is considered to be the **Low Hydrology** regime and the mean water release through the HEP plant turbines is set at 687 m3/s for the following year. On the other hand if LL satisfies LLV>12.14 meters at the end of the year it is designated as a **High Hydrology** scenario and the mean water release is set at 1247 m3/s for the following year. The CRCP operation rule is designed to result in water release targets that optimize the operation of the electric turbines while also stabilizing the water level of Lake Victoria (http://bankwatch.org/documents/BujagaliEconAnalysis.pdf). However, the development of the CRCP and other release policies recently proposed do not take into account the projected climate change over the Lake Victoria basin (LVB). The objective of this case study is to focus on the HEP industry to develop a research demonstration framework for understanding the interplay among the main components of the end-to-end paradigm involving climate observations, input of metrics from stakeholders, understanding of the physical processes, validation of climate projection models, production of climate change projections, translating model output into end-user relevant metrics, and applying this information to inform planners in their decision making process.

2 Analysis

Lake Victoria hydrologic balance comprises five primary components, namely, tributary inflow (Qin; 15%), rainfall over the lake (P; 85%), evaporation from the lake (E; 80%) and abstraction (Qout; 20%) or outflow through the source of River Nile and change in lake level $\Delta_{\text{lake level}}$ =R+Qin-E-Qout. We adopt the water balance model developed by Tate et al (2004) to estimate Lake Victoria level (LVL). The model uses rainfall as the only input to estimate Qin and P. Evaporation (E) is assumed to be constant (1595 mm/yr; Sene & Plinston, 1994).

The dominant source of water is the rainfall which is directly intercepted by Lake Victoria and it is assumed to be a linear function of the average raingauge precipitation at the following six coastal cities on the shores of Lake Victoria, Jinja, Entebbe, Kisumu, Musoma, Bukoba, Mwanza. The contribution of each of the five main inflow rivers (Nzoia, Yala, Sondu, Awach Kaboun, and Kagera) to the inflow term (Q_{in}) is a nonlinear function with (P) as the input. The outflow (Q_{out}) is determined from the water release rule. The water balance model is initialized with the observed lake level at the end of 1969. For this demonstration case study rainfall at the six coastal rain gauge stations was based on observed rainfall or downscaled rainfall from the UKMO PRECIS (Richard Graham, personal communication) and the RegCM3 (Anyah et al., 2006) regional climate models.

3 Results & research framework

Fig.2a shows that the water balance model faithfully reproduces the observed lake levels. The water balance model is initialized with observed lake levels at the beginning of the entire period only and no correction is made during the rest of the simulation. The climate-model based lake levels have virtually no decadal variability because the model rainfall is based the average of 5-ensemble regional climate model simulations which smoothes out these oscillations. The figure shows that using ensemble average rainfall from the UKMO regional climate model (PRECIS) instead of observed rainfall yields realistic agreement with the observed trend of the lake level with an exception towards the end of the period. Several studies (Kull 2006a; Kull 2006b) have shown that the discrepancy towards the end is due to excessive over-release of water from the lake to increase hydroelectric power production from the dam at the source of River Nile at a higher rate than the ACP rule permits. We note that the regional climate model-based lake levels (Fig.2a) have a slight positive bias. In part this bias could be related to the fact that the climate model does not consider the decrease in rainfall due to the drastically reduced vegetation associated with the prolonged drought conditions over LVB during this time period.

These preliminary results using a water balance model in combination of regional climate projections give us confidence in using it to assess the sensitivity of Lake Victoria water balance components (P, Qin, E & Qout). Comparison of the decreasing trend of LVB rainfall (and corresponding lake levels; Fig 2a) with the projected increase in the later period of the century (Fig.2b) indicates that the trend of declining water resources should bottom out in the next few decades. Future CLIVAR Africa Climate Panel research should focus

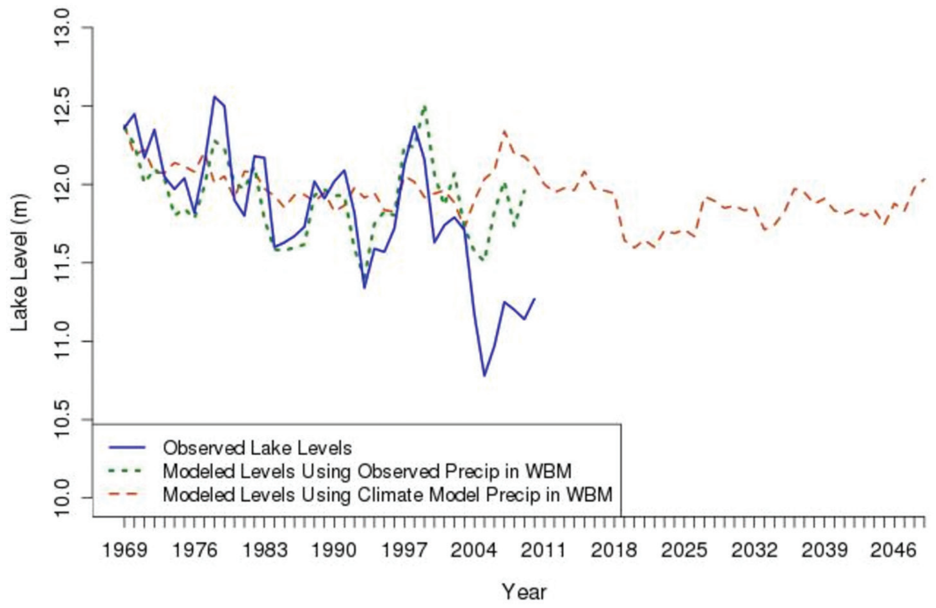

Fig. 2a: Observed levels of Lake Victoria (continuous, blue); Lake Victoria levels estimated using water balance model (dashed, green; Tate et al. 2004); and Lake Victoria levels estimated using a five member multi-ensemble Précis UKMO regional climate model (dashed, brown-Smith (2011)

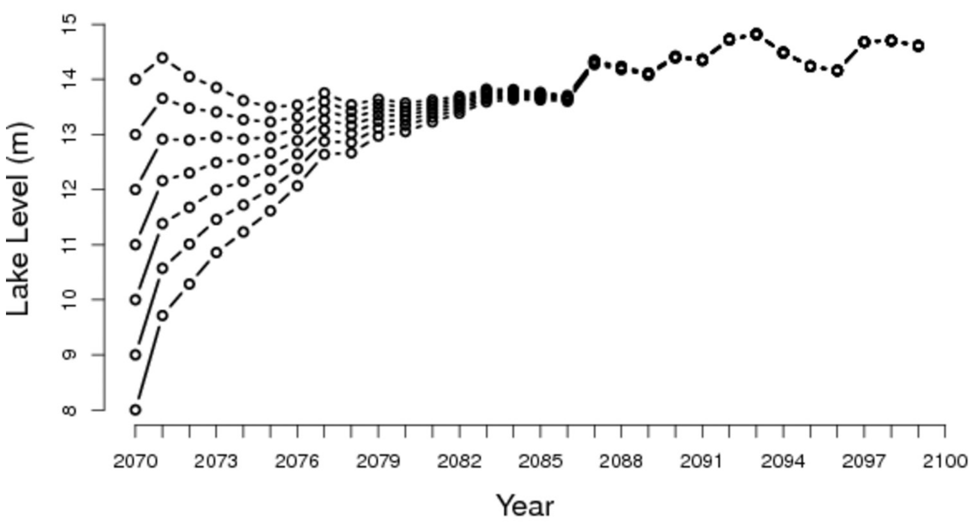

Fig. 2b: RegCM downscaled rainfall for 2071-2100 used as input for the Tate et al (2004) WBM to compute the LL. Since we do not know the starting LL in 2070 several initial values were used but all cases converged to the same level of about 2 meters increase above the present LL (Smith, 2011).

on understanding the relative impacts of the key physical processes on the trend of decreasing water resources during the recent decades and the timing of the anticipated reversal during the next few decades in response to the projected increase in rainfall over the region. This is valuable actionable information for the stakeholders to optimize the management of hydroelectric power generation and the exploitation of other natural resources including the water resources and agriculture sectors.

We show in Fig.3 that the CRCP operational rule outperforms the ACP for the recent decades. The performance of the CRCP operational rule is not as favorable for the future decades compared to the recent decades indicating that caution should be exercised in recommending it to replace the present ACP water release policy. The strategy described above will be applied to the much larger CORDEX (2011) assemble pool of simulations models to improve the estimates of confidence levels.

4. Observational needs

A comprehensive observational network is required to address the critical science questions discussed throughout this article. Recently, the East African Community (EAC, 2011) conducted an extensive feasibility study primarily focusing on the development of meteorological services for the fisheries industry over LVB. The EAC study is an important first step for a full assessment that should be conducted by the scientific community to address the relevant research questions for the rest of the stakeholders.

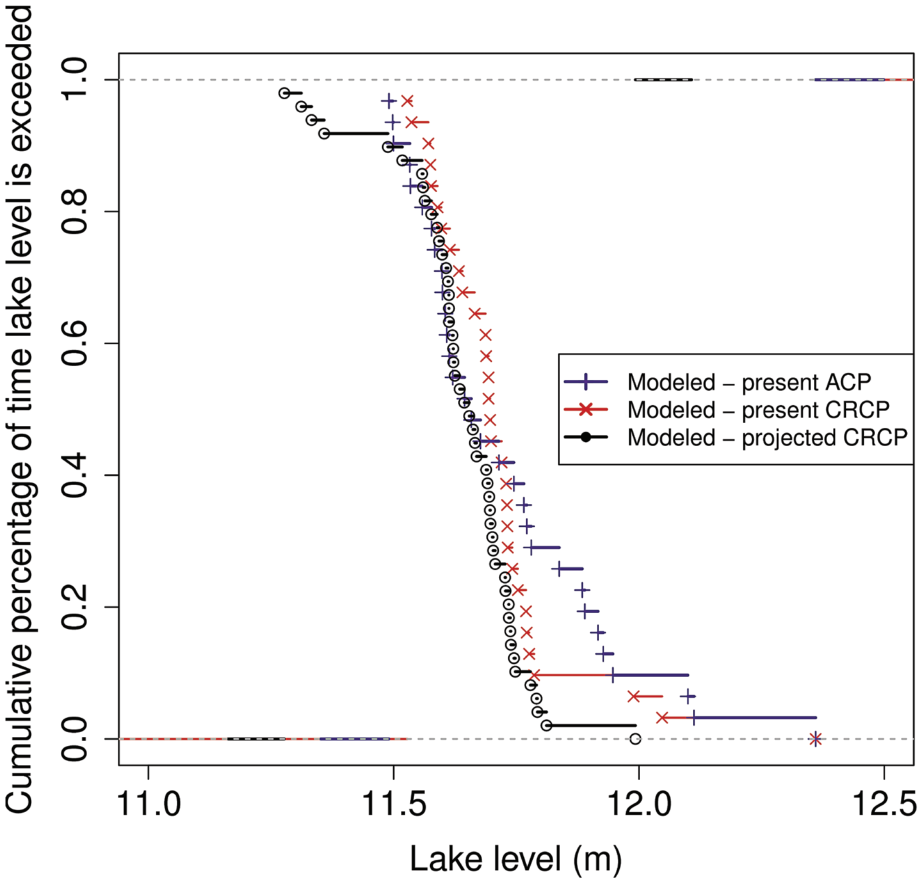

Fig. 3: Cumulative % of the time lake level is exceeded. Desirable to have % of exceeding low lake levels as high as possible thus minimizing frequency of load shading. ACP: 'Agreed Curve' Policy & CRCP: 'Constant Release Curve' Policy.

5. Conclusions

In this demonstration case study we have focused on the hydroelectric energy industry to highlight the key research considerations for the provision of climate services over the LVB region. These considerations are consistent with the implementation plan of the Global Framework for Climate Services (GFCS, 2010). The approach we have developed may be extended to other climate change information application sectors for the LVB and it comprises the following components, (i) acquisition of input from stakeholders for constraining the climate research questions and ensuring responsiveness to the end-user needs, (ii) understanding of the physical processes that are relevant to address the end-user needs to design the appropriate climate projection models, (iii) validation of climate projection models in terms of both traditional and end-user derived metrics, (iv) make climate change projections and translate the model output into end-user relevant information, and (v) apply this information to inform planners in their decision making process.

More specific to the HEP sector for the LVB it is apparent that the global climate change projection models used in previous development and assessment of potential water release rules/policies (including the constant release rule) did not take into account a variety of regionally important physical processes (see Fig. 4). In order to address these issues it is necessary to develop a comprehensive supporting climate observational network and a fully coupled Regional Earth System Model (RESM). The coupled model should comprise, a three dimensional thermodynamics and hydrodynamics model component of lake Victoria, a comprehensive hydrology model component to account for ground and surface inflow to Lake Victoria, a land surface model component which can account for the impacts of urbanization on the regional climate (LVB has the fastest population growth in the world, UN 2011), and a state of the art atmospheric model component. Such a system does presently exist for LVB and it is a high priority of the CLIVAR Africa Climate Panel research agenda. The HYVIC Regional Hydroclimate Project (GEWEX, 2012) has been proposed to investigate the relative role of the hydrological components of the water balance over the Lake Victoria basin in determining the trend of decreasing water resources during the recent decades (Fig.1) and to determine the timing of the anticipated reversal during the next few decades in response to the projected increase in rainfall over the region (Fig.2). It will involve cooperation among GEWEX, CLIVAR, other WCRP programs and international organizations.

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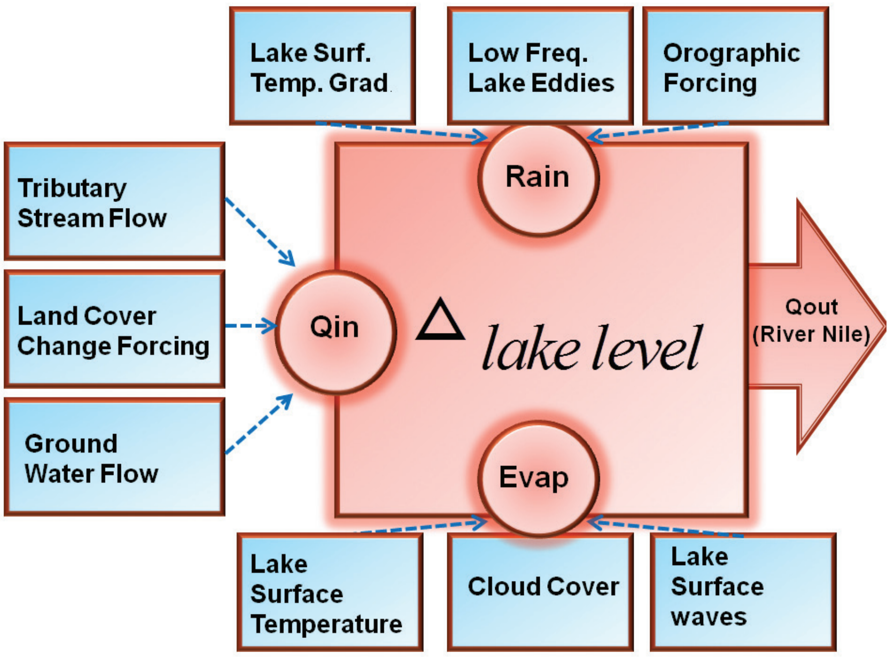

Fig.4: Flow chart showing the primary hydrological balance components and the relevant physical climate processes.

Climate-Related Activities Within The Southern African Development Community (SADC) Region

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Introduction

Over the last century, SADC has suffered from dramatic interannual fluctuations in climate leading to severe droughts, increased occurrence of floods or disturbances in marine or terrestrial ecosystems. Such variability of climate affects the agriculture, water reserves, fisheries and hence the Gross National Product. It has a particularly detrimental effect on rural subsistence farmers and fishermen, human health, particularly the rural community, and the management of a sustainable natural environment. Such natural hardships hamper the accomplishment of the Millennium Development Goals defined at the Johannesburg Millennium Summit in September 2000. The Millennium Development Goals are quantified targets for addressing extreme poverty, hunger, disease, lack of adequate shelter, and exclusion while promoting gender equality, education, and environmental sustainability.

Understanding of factors influencing climate variability at seasonal to interannual time scales has progressed in recent years, which has led to an improvement in the ability to predict seasonal climate variability over the region (Shongwe et. al., 2006; Landman et al, 2009; Landman and Beraki, 2012). Much understanding has been gained on how the oceans can influence the climate of southern Africa at the interannual time scales. Severe droughts often occur in southern Africa during the mature phase of El Niño, when the central and eastern Pacific is warmer than normal. El Niño and La Niña also have an impact on summer and winter rainfall, streamflows, vegetation, soil moisture and the fluxes of nutrients into the ocean. However, there is no linear relationship between the strength of ENSO and the magnitude of the perturbation in southern Africa climate. Other modes of variability affecting southern Africa are the Antarctic Annular Oscillation, Benguela Niño, the Indian Ocean Dipole and the Indian and Atlantic subtropical dipole patterns. An understanding of the processes and mechanisms controlling decadal to multi-decadal rainfall variability is still relatively low. The region also experiences marked intraseasonal variability, which has a significant impact on agricultural systems. However, the ability to predict intraseasonal rainfall characteristics such as rainfall onset and cessation or rainy season duration and dry spell frequency remains low.

A major challenge facing SADC is climate change and its impacts on environmental and socio-economic systems. Modes of climate variability influencing SADC short-term climate are superimposed on long-term trends and changes in the climate system. For instance, closer to Africa, the Agulhas Current, southern Boundary of the Benguela Current system, have significantly warmed up by up to 1.5 °C (Figure 1) since the 1980s due to an intensification of the Agulhas Current system in response to an augmentation of wind stress curl in the South Indian Ocean. A coastal cooling of lesser magnitude is also present to the Southwest of Africa. These changes seem to have been triggered by an intensification of the high pressure systems in the South Atlantic and South Indian Oceans. This demonstrates that southern Africa's climate response to natural and anthropogenic forcing will most likely be influenced or modulated by the future state of the neighboring ocean basins. There is a clear need for further studies aimed at understanding how the main modes of climate variability and climate change interact. There is also a need to improve our understanding of how large-scale modes of variability interact with smaller-scale systems.

The critical question for decision-makers is which response strategies and infrastructure should the available scarce resources be invested in to reduce negative climate change impacts and exploit opportunities? To address this question, reliable climate change scenarios with uncertainties inherent in future climate projections incorporated, are a prerequisite, so is a probabilistic impacts assessment framework to identify robust adaptation options appropriate for country planning. A problem still facing southern Africa is the lack of resources to enable collaborative and regionally coordinated research projects such as equivalent for West Africa in the African Monsoon Multidisciplinary Analysis (AMMA) (see article on AMMA by Redelsperger et al in this edition). There is a critical mass of scientists working on southern African climate problems that can drive such an initiative in a collaborative manner. This article summarizes some activities and initiatives within SADC that attempt to address the aforementioned scientific questions and challenges. Outstanding knowledge gaps and persisting challenges are also summarized.

Seasonal Climate Prediction

State-of-the-art dynamical and empirical forecast systems and dynamical-empirical model recalibration techniques are currently applied to produce operational seasonal forecasts in southern Africa. The South African Weather Service (SAWS), an operational seasonal prediction center, runs the ECHAM GCM in partnership with the Council for Scientific and Industrial Research (CSIR) and the International Research Institute for Climate and Society (IRI). SAWS also incorporate a suite of GCMs in its Multi-Model System (Landman and Beraki, 2012). An example of SAWS operational MMS seasonal forecast for May – July 2012 is shown in Figure 2. Statistical downscaling using model output statistics (MOS) is applied to GCM output at SAWS and at the SADC Climate Services Centre (CSC). The CSC continues to support SADC National Meteorological and Hydrological Services (NMHSs) to produce empirical seasonal rainfall forecasts. The forecasts are made on the basis of covariability between seasonal rainfall and fields of predictors, mainly sea-surface temperatures (SSTs) and archived GCM fields. The IRI Climate Predictability Tool (CPT) is used to perform the statistical analysis. Just before the rainy season, around September, the CSC organizes the Southern Africa Regional Climate Outlook Forum (SARCOF), mostly done in collaboration with the National Meteorological and Hydrological Services (NMHSs), the World Meteorological Organization (WMO) and other development partners. These have assisted to some extent in training of national climate scientists and professionals from key user sectors in seasonal forecasting techniques and application of products, respectively.

Climate Change

Southern Africa has the potential to provide climate information that would enable the development of appropriate response strategies to climate change at the regional to local level. SAWS, CSIR and the University of Cape Town are involved in research on the physical climate science and development of climate change scenarios using the Coupled Model Intercomparison Project (CMIP) CGCMs (e.g. Shongwe et al., 2009; 2011), dynamical downscaling techniques (Engelbrecht et al., 2009) and empirical-statistical downscaling (Hewitson and Crane, 2006). The Climate Systems Analysis Group (CSAG) at the University of Cape Town has developed an Africa-wide climate projections portal.

Several groups, mainly within South Africa, assess the impacts of climate change on the physical environment, and natural and human systems (Midgley et al, 2007). The University of KwaZulu-Natal carries out research on the impacts of climate change on agricultural production and water resources (e.g. Schulze, 2008). The Climate Studies, Modelling and Environmental Health Research Group at the CSIR is leading the development of the Southern Africa Risk and Vulnerability Atlas that will likely provide regional data and information relevant for key sectors such as terrestrial water resources, socioeconomic, human settlements and biodiversity.

There is a clear need to promote innovative application of climate information as well as an interaction and communication between the physical climate science research community which generates climate information for various space and time scales, the impact, adaptation and vulnerability communities, and policy and decision-makers at various levels. For this a number of initiatives have been established.

Relevant Activities and Initiatives

The Africa Centre for Climate and Earth Systems Science (ACCESS; http://www.access.ac.za), is a consortium of several agencies, research councils and programmes, universities and research groups with a common goal of delivering a range of outputs aligned to the South African Department of Science and Technology's (DST) Global Change Grand Challenge (GCGC). ACCESS is a platform for an integrated and end-to-end research and education, services and training outputs related to opportunities and challenges emanating from a varying and changing environment. ACCESS has the potential to establish unprecedented co-operation across a range of CLIVAR and GEWEX related disciplines in Southern Africa.

The Science and Technology Research Partnership for Sustainable Development (SATREPS), Japanese International Cooperation Agency (JICA) – DST bilateral project entitled "Prediction of Climate Variations and its Application in the Southern African Region" aim to enhance capacity for seasonal climate prediction in South Africa for application in addressing climate-related challenges in the SADC region. This program has attracted the interest of most key players in ocean, weather and climate science fields in South Africa, and seeks to extend to the whole of SADC.

The Coordinated Regional Downscaling Experiment (CORDEX) project presents a unique opportunity to undertake multi-model research aimed at informing climate change response strategies in Southern Africa. Further details on this international coordinated effort are presented by Hewitson et al. in this issue of the Exchanges .

The Nansen-Tutu Center for Environmental Research is a joint venture between the Nansen Environmental Centre in Norway and South Africa. The vision is to serve Africa through advancing knowledge of the marine environment and climate system in the spirit of Nobel Peace Laureates Desmond Tutu and Fridtjof Nansen. The Nansen-Tutu Centre is based in Cape Town and operates as a programme complementing the developing South African marine research framework.

The five-year Agulhas and Somali Current Large Marine Ecosystems (ASCLME) project is centered on marine ecosystems of the western Indian Ocean region and has a strong physical oceanography and ocean-atmosphere interaction component. It partners with the Western Indian Ocean Marine Science Asscociation (WIOMSA), which will help to continue the effort.

Le Centre de Recherches de Climatologie (CRC) based in Dijon France is a long-term partner of the University of Cape Town. Various grants are used to support long-term visits of students and young scientists. CRC has managed to become an important and reliable collaborator to South Africa in climate studies as evidenced by several joint publications with the University of Cape Town.
The South African Society for Atmospheric Sciences (SASAS) aims to stimulate interest and support for all branches of the atmospheric sciences in southern Africa. Since 1983, SASAS has been organizing an annual conference, publishes a

newsletter and gives awards to outstanding research outputs and presentations.

The Meteorological Association of Southern Africa (MASA) was established in pursuance of the co-operation envisaged in the Southern Africa Development Community (SADC) Protocol on Transport, Communications and Meteorology which came into force in July 1998. The aims of MASA are to: strengthen weather and climate monitoring systems; improve public and specialized weather services; promote sustainable development with the emphasis on climate change and protection of the environment; and strengthening meteorological research capacity in the region. In line with its purpose, MASA has the potential to establish and/or enhance cooperation and communication across regional and international institutions and the user community.

Additionally, there are many collaboration activities that contribute substantially to the climate research activities and knowledge products. National funding sources within South Africa (NRF and WRC in particular) support a substantial program on climate change research. Additionally, on the international front there are robust partnerships engaged in a wide array of climate change research, many with strong elements focused directly on impacts and adaptation. Many of these partnerships are for example, under the frameworks of the EU FP7, DFID and NERC (UK), USAID (USA),DANIDA (Denmark), Sweden (SIDA), or Germany (GIZ). Further, excellent network-related programs are in place through partnerships with organizations such as START (arguably with the most effective climate network in Africa – CSAG-UCT is the START node of excellence for climate modeling), or the SEI.

Complementing the formal research projects is an extensive array of contract and consultancy activities directly focused on climate change and supporting national and regional policy and adaptation actions. Key funders of these programs are the World Bank and the African Development Bank, among others. This contract work is exceptionally important in helping bridge the science-society divide.

In parallel with the core research activities, and often intimately coupled to them, is a range of capacity building programs. For example, the START fellowship program is particularly instrumental in enabling training and institutional exchanges of scientists. Likewise the UNITAR funded winter school on using climate information (held at UCT, South Africa) directly targets decision makers in the policy and adaptation sectors. Along with these are many ongoing seminars and workshops within the region that address the analysis and application of climate information.

Conclusions

Despite the significant progress mentioned above, some gaps and challenges continue to persist. The spatial coverage, quality and access to climate data and information remain a major challenge in most SADC member states. There is lack of scientific capacity, research infrastructure and skills to communicate knowledge in a way that would translate to implementable actions and solutions. Likely changes in the link between regional climate and slowly evolving boundary conditions such as the oceans, which are the source of skill for seasonal forecasts, deserve more research attention. In a region where some areas experience warming rates about twice the global mean, the likely impacts of the 2°C global target, and critical thresholds and tipping points that are likely to be exceeded due to climate change have not been well investigated. There is lack of capacity to develop research plans that would convince potential funding agencies to support the region's research initiatives. It is important to pool the meager resources to ensure that a SADC-wide approach is taken in order to improve climate change research application through all the member states.

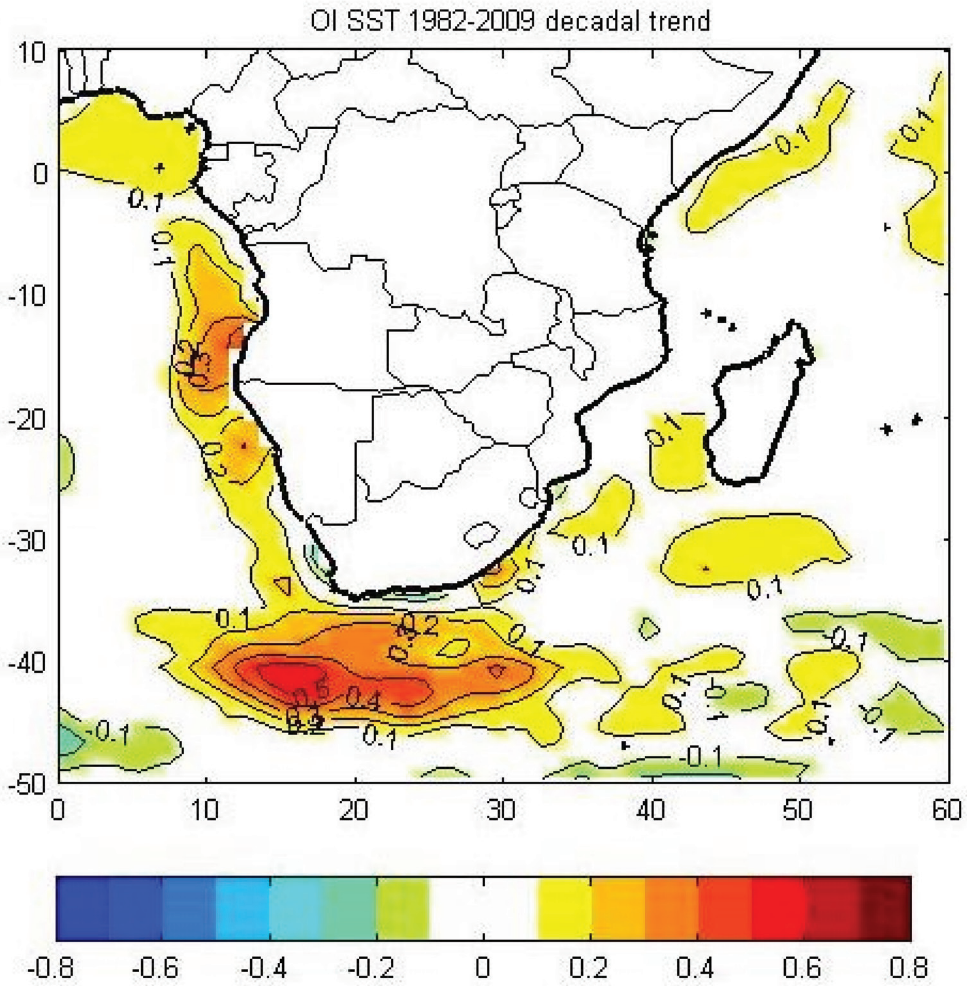

Figure 1: Linear trend (degrees C/decade) of optimally interpolated Reynolds sea surface temperature estimated from merging satellite remote sensing and observation from 1982 to 2009.

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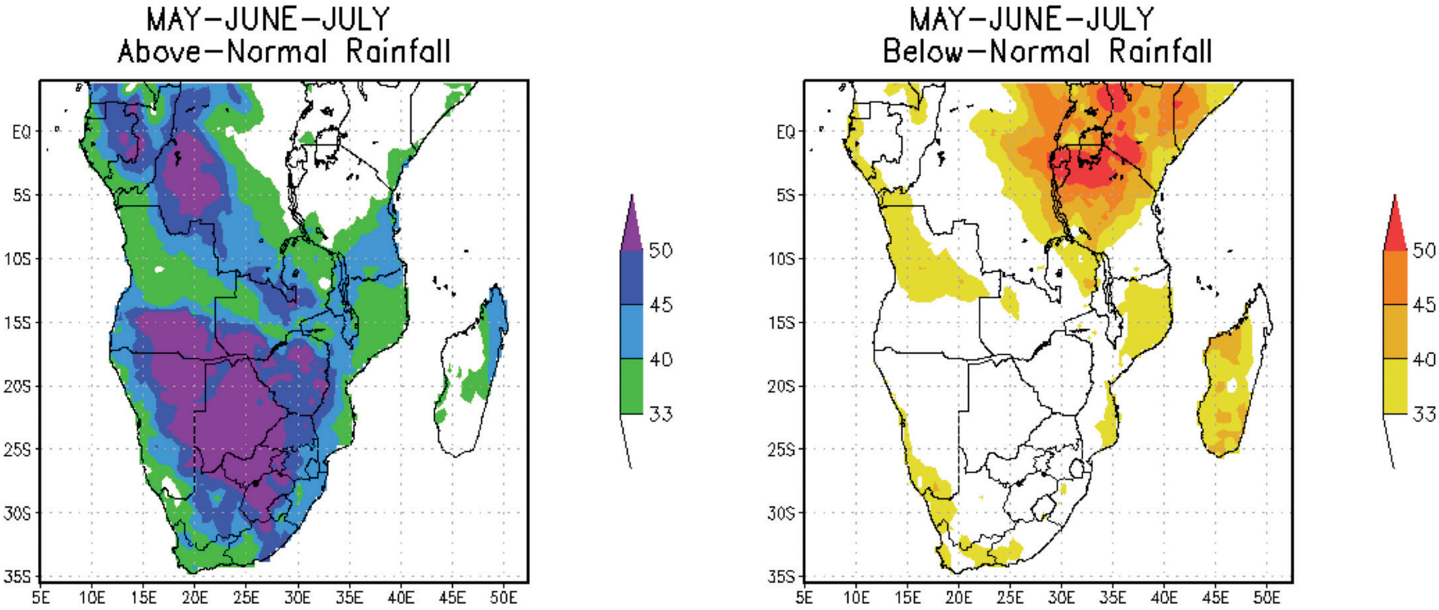

Figure 2: An example of a operational seasonal forecasts for May-July 2012 issued by the South African Weather Service. The left (right) column displays probabilities of rainfall for each season (shown in the title) falling within the above- (below-) normal tercile.

Beyond Science – Policy Dialogues:

Putting climate science at the service of adaptation decision-makers and vulnerable communities in Africa

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Background

The rising number of climate-related hazards and pattern changes observed in recent years in Africa beckons attention to the issue of Climate Change. Impacts of more frequent high-magnitude climate-related disasters on local communities dependent on ecological services for their livelihoods in Africa are of particular concern. Droughts, floods, water-related epidemics, storms and cyclones are increasingly reducing opportunity and wrecking havoc in communities (UNDP, 2007). A case in point is that the continent of Africa, identified by the Inter-governmental Panel on Climate Change as the second most vulnerable zone to climate change impacts in the world, immediately after polar zones (IPCC, 2007), has an average 57% of its active population employed in the agricultural sector, while agriculture remains by and large rain-fed and highly sensitive to rainfall and temperature fluctuations, with only 6.8% of arable land irrigated (FAO, 2009). Furthermore, increasing population densities in ill-planned settlements at the peripheries of Africa's urban centers – in Lagos, Dakar, Nairobi and Johannesburg – are directly exposed to the vagaries of changing rainfall patterns (Pelling and Wisner, 2007). In this context, climate-related hazards generate human development setbacks that have monumental social ramifications (Tall, 2010; UNDP, 2007/08).

A growing number of climate scientists are in accord that rising hydro-meteorological disasters (HMDs) may be but the early manifestations of more pandemonium to come as anthropogenic Climate Change (CC) accentuates in years to come (IPCC, 2012). As a result, and a corollary to the global negotiations on whom should foot the bill for CC, the issue of Climate Change has risen in prominence on national and continental agendas.

Putting climate science at the service of adaptation decision-makers and vulnerable communities in Africa: Learning from Practice

A number of processes have been launched in recent years to put climate science at the service of development in Africa. These efforts to link scientific outputs with adaptation decisions are haphazard, however, and up against manifold obstacles. The most prominent of these remains the sustained gap between scientific research on Climate Change in Africa and climate adaptation research. A number of leading African climate research centers (e.g., the Climate Systems Analysis Group based at the University of Cape Town) and programs (the most notable being AMMA –the coupled West Africa Monsoon system research program) are spearheading world-class research on African climate, however their outputs remain by and large ensconced within the climate community. The still limited number of coordinated cross-continental research programs systematically looking at African climate, in a manner than can serve decision-maker needs, is also to be decried.

This article reviews several prominent efforts ongoing across Africa to link climate scientists (forecasters) with adaptation decision-makers (end users at both national and community levels), and highlights a possible way forward for additional interaction between the two communities of practice.

The Climate Change and Development in Africa Conference (CCDA)

Hosted by the Africa Climate Policy Center (ACPC), Secretariat for the ClimDev Africa Program based in Addis Ababa, Ethiopia, the CCDA Conference is an annual stakeholder forum on Climate Change and Development in Africa conceived to integrate development and climate policy, and emphasize the importance of African ownership of the climate policy formulation and decision making process. In its inaugural round in 2011, the CCDA drew together 300 policy makers, scientists and practitioners, with the aim of developing concrete proposals on how to integrate climate change concerns into existing and future development policies, strategies, programmes and practices in Africa

The second edition of the CCDA Conference will be held this October 19-20, 2012, in Addis Ababa, Ethiopia. Organized with the collaboration of the CLIVAR Africa Climate Panel, the CCDA-2 conference will offer once again a unique platform to engage Africa adaptation decision-makers at all levels (continental, national and sub-national) with new climate science research outputs, to define the climate research needs of the mid 21st century.

The Early Warning > Early Action Workshops

From 2009 to 2011, seven Early Warning > Early Action (EW-EA) workshops were conducted in Africa —three in Senegal, two in Kenya, one in Uganda and one in Ethiopia—to initiate a national dialogue between national climate forecasters and final end-users of climate services and develop a shared understanding on the climate services available to support climate risk management and adaptation in the country.

Hosted in turn by START, the International Federation of the Red Cross/Red Crescent Societies (IFRC) and the UN International Strategy for Disaster Reduction (UNISDR), the National EW>EA workshops consisted of a three-day facilitated dialogue between two distinct communities of practice. On one end of the dialogue table were representatives of the national climate science community, all-knowing scientists directly involved in producing climate and meteorological forecasts. These included forecasters from national hydro-meteorological services (NHMSs), climate modelers from the national university laboratories, hydrologists, remote sensing experts and agro-meteorologists who had for the large majority, however, never reached out in their life to users who did not understand a word of their scientific jargon (people who did not know what convection was, had never heard of El Nino). Facing them at the other end of the table were representatives from a selected community at risk in the country affected by yearly predictable hazards, as well as government planners and boundary organizations able to serve as relays of meteorological/climate information to communities at risk.

Participants in all seven workshops were tasked with defining and jointly agreeing on a plan of action to communicate timely, salient and actionable early warnings to populations in communities at risk from predictable climate hazards, in order to enable climate information access and utilization by these populations.

In the end, a national platform for Early Warning > Early Action was launched in each pilot country, composed of all the major disaster management stakeholders in attendance at the EW>EA workshops from national to community level. In each country, a National Plan of Action was also devised for the launch a National framework for Climate Services, clarifying the institutional basis and mandates of each participating institution in the chain of information flow.

Constraints to up-scaling the EW>EA approach, however, include creating the appropriate institutional conditions necessary to propel the initiative in the country from a pilot limited to disaster management, to a cross-cutting and transversal national Early Warning > Early action programme that spans across all critical climate-sensitive sectors (health, agriculture, water, tourism, livestock and infrastructure), backed up by political leadership and strong national will, to create a climate risk aware and resilient society able to withstand the vagaries of a changing climate.

Such substantive iterative dialogue processes between climate scientists and end users of climate services at the national level now need to supported by the donor community, and appropriated as well as sustained by national governments.

GFCS pilot National Frameworks for Climate Services in West Africa
In July 2012, the Global Framework for Climate Services (GFCS) piloted three important activities to build the user interface platform (UIP) where such platforms are most critically needed: at the national level.

Thus, the three Meteorological Offices of Burkina Faso, Niger and Mali were supported to carry out their own stakeholder mapping at the national level and reach out to key stakeholders across all climate-sensitive sectors in the country (health, agriculture & food security, disaster management, water, infrastructure, transport and energy), potential users of their climate and weather products. A National Workshop on Climate Services in each pilot country followed to launch the dialogue between national providers and users of climate services, and discuss the appropriate institutional mechanisms for establishing a perennial National Framework for Climate Services.

The national workshops of Burkina, Niger and Mali brought together national Met service staff and climate researchers with over fifty representatives from climate-sensitive sectors in each country, as well as vulnerable community spokespersons and representatives from boundary organizations (communicators, rural radios, farmer platforms, community-based organizations, and so forth), adept community relays of climate and weather advisories and alerts.

What came of these interactions were clear user-devised roadmaps to build National Frameworks for Climate Services, and establish an effective chain of information that would link available climate science and early warning information with technical services of all climate-sensitive sectors, and then in turn with farmers, herders and the most vulnerable communities, with built-in channels for feedback and end-user input into climate service development. It is the hope that these National frameworks, rooted in appropriate institutional setups at the national level and resting on multidisciplinary collaboration and cross-ministerial partnerships for the production and communication of salient climate services in the country, will at last overcome the obstacles to climate information access and use by the most vulnerable communities in West Africa, and beyond.

The pilot experiences of Burkina Faso, Niger and Mali will be presented at the Extraordinary Congress of the World Meteorological Organization on the GFCS, to be held this October 26-31, 2012 in Geneva, as a means to encourage other meteorological offices across the world to light the baton, and also go at the encounter of their stakeholders and end-user communities and whet demand, across all climate-sensitive sectors in the country.

Climate & Health Working Groups
Finally, a noteworthy effort to bridge the gap between providers and users of climate science outputs in Africa can be found in the health sector. Since the 1999 Bamako training workshop on Climate and Health in Africa, efforts to bridge the gap between climate forecasters and public heath specialists have generated meaningful lessons on how to link climate forecasts with disease prevention, planning and control, notably for the major climate-sensistive vector-borne diseases of malaria, meningitis and rift valley fever that affect Africa. These culminated in 2011 with the organization of a trans-disciplinary « 10 Years On » Workshop themed « A decade on: What are the lessons, What are the next steps, Where do we need to be by 2020?" for the integration of climate and health. This conference, hosted by the Ethiopian Climate and Health Working Group, along with a steering committee comprised of the African Climate Policy Center, WHO, UNDP, the UK Met Office, Exeter University and the International Research Institute for Climate and Society (IRI), was held in Addis Ababa, on April 4-6, 2011.

The "10 Years On" workshop was a valuable opportunity for various groups to discuss the lessons and results of initiatives over the past decade linking Climate and Health, and served as an opportunity to identify changing perspectives and priority issues.

As an outcome of the meeting the Africa Climate and Health Working Group steering committee was established. This is the mandated body to take forward the "Road Map" for the next steps and initiatives to implement and render disease prevention a reality in a changing climate. These multiple initiatives in the health sector converge to create a potent agency to bridge the divide for more effective control and prevention of climate-driven epidemics.

For more information on the Climate & Health Working , please contact: chwg.ama@gmail.com.

Conclusion

As countries are increasingly faced with the issue of rising HMDs, utilizing climate services to better inform adaptation decision-making offers a win-win approach to equip countries to confront an increasingly variable and changing climate.

A long way remains ahead however for climate science to effectively inform and serve development planning in Africa. More work will be needed at the interface of science and policy for research outputs to effectively serve decision-making needs, and in turn user needs to drive climate research in Africa over the decades to come. Climate scientists and policy-makers at all levels will need to build more common ground.

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Climate change, agriculture and food security (CCAFS): linking research and action in East and West Africa

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CCAFS (Climate Change, Agriculture and Food Security) is a global partnership between the research centres of the Consultative Group on Agricultural Research (CGIAR) and the Earth System Science Partnership (ESSP). It was launched in 2011. In common with all the new CGIAR Research Programs, CCAFS facilitates and integrates thematic work across multiple CGIAR Centres and other global, regional and local partners. The key target groups of CCAFS are resource-poor agricultural producers, and rural and urban consumers of food, in low-income and middle-income countries in the tropics and sub-tropics. The objectives of CCAFS are: (1) to identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods, and (2) to provide diagnosis and analysis that will ensure cost-effective investments, the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in ways that bring benefits to the rural poor (Vermeulen et al., 2011).

The global challenge of making enough food available for growing populations and changing dietary patterns under conditions of escalating resource scarcity and climate change is both well recognised and daunting (Godfray et al., 2011; Beddington et al., 2012). Global society needs both local and global action to accelerate the sharing of lessons on institutions, practices and technologies for adapting to changing climates and for mitigating the greenhouse gas emissions for which agriculture is responsible. Serious commitment is needed to working in partnership, enhancing capacity, and addressing societal differences. CCAFS was developed as one response to this challenge. Work is organised under four themes. Three themes are identifying and testing (through participatory, adaptive research) technologies, practices and policies to decrease the vulnerability of rural communities to a variable and changing climate: adaptation to progressive climate change; adaptation through managing climate risk; and pro-poor climate change mitigation. A fourth theme, integration for decision making, ensures effective engagement with policy communities, grounds CCAFS in wider contexts of biophysical and socio-economic change, and provides demand-driven tools and datasets. The four themes are actively linked in several ways, including via a set of research sites at which participatory action research addresses the themes in concert. The work is currently focused in three regions, two of which are West Africa and East Africa, and CLIVAR Africa Climate Panel was represented in the eight-strong leadership team which drew up the initial successful proposal. In line with its focus on vulnerability, CCAFS also seeks to understand how gender relations and other social disparities influence responses to climate change, and to formulate strategies to enable equitable access. Capacity enhancement is an integral part of research design. CCAFS is putting major effort into policy engagement and communications.

Some examples of activities East and West Africa

CCAFS is undertaking a wide range of activities in East and West Africa. This includes a set of baseline surveys at the CCAFS sites across three levels: households, villages and organizations. These have collected indicators that describe current behaviour in relation to livelihood systems and farming practices in these sites, as well as changes made in the recent past. Other indicators are helping us to understand the enabling environment that mediates these practices and behaviours (policies and institutions, for example), as well as the provision of agricultural and climatic information at each site by the organisations that work there. The baseline survey instruments will be applied unchanged in 3-10 years' time to monitor behavioural changes that have occurred in the sites. The baselines are designed to allow cross-site and cross-regional comparisons to be carried out. The survey instruments, training manuals and the data themselves are openly available at ccafs.cgiar.org, and some of the preliminary results are documented in Kristjanson et al. (2011) and Kristjanson et al. (2012).

CCAFS is also undertaking a regional scenario development exercise in each region. Each includes a variety of stakeholders at the regional level, and the process is designed to explore the key regional socio-economic and governance uncertainties that may affect food security, environments and livelihoods to 2030. In each case, story lines are developed and these are fleshed out using a mixture of qualitative and quantitative methods. The scenarios then function as test beds to evaluate the feasibility of different strategies, technologies and policies under alternate future conditions (Vervoort et al., 2012; and see ccafs.cgiar.org/scenarios).

A recent series of workshops in Kaffrine, Senegal, looked at tailoring climate information to the needs of West African farmers. Farmers and local partners were exposed to probabilistic seasonal forecasts to help them make management decisions that can reduce climate risks. Management options were monitored during the rainy season and a final evaluation evaluated the impact of the forecast products on farmers' decision making. The whole process was followed on national TV and village radio. Similar initiatives are being implemented in partnership with AGRHYMET in four others countries to test the design and communication of downscaled probabilistic seasonal forecasts, evaluate their impact on farmers' management and livelihood outcomes, and identify additional needs of targeted communities and national partners (see ccafs.cgiar.org/blog/putting-climate-forecasts-farmers-hands).

CCAFS is working with CARE and ICRAF in Sustainable Agriculture in a Changing Climate (SACC), a project that is exploring how carbon finance can contribute to more resilient smallholder agricultural livelihoods by overcoming farm-level barriers to the adoption of sustainable agricultural practices. The work is focused on the Nyando River catchment in western Kenya, an area with high levels of poverty and serious environmental degradation. Participating smallholders agree to plant and maintain trees on their farms, sequestering carbon and generating carbon credits and potential carbon revenue. In return, SACC promotes sustainable agricultural activities such as the production of shorter-duration and higher-value crops as well as training in sustainable land management practices. SACC hopes to reach 100,000 smallholders through the life of the project.

Another example is work to improve regional climate information and food system coordination in East Africa. The aim is to create a platform and tools for sharing knowledge and fostering improved coordination among food crisis response, the market-based food delivery system, and agricultural research and development. Consultations have been held with key stakeholders on regional agricultural and food security contingency planning processes, current and potential use of climate-related information, and means of improving planning and coordination in East Africa. This work is involving many partners, including the East African Community (EAC) Secretariat and the IGAD Climate Predication and Application Centre (ICPAC).

A key element of improving climate information is evaluating how climate models perform in the CCAFS regions. Collaboration between CCAFS and the University of Oxford resulted in a recent report that investigates the climate of East and West Africa (and the Indo-Gangetic Plain) and assesses the implications of climate change for agriculture, with a particular focus on those aspects that will have greatest impact on the crops currently grown in each region (Washington et al., 2012). The study investigates the ability of some of climate models used in the IPCC's Fourth Assessment Report of 2007 to reproduce current climates in the CCAFS regions, as one step towards establishing how reliable future projections of climate and crop performance might be.

There are many other examples of the way in which CCAFS is working across disciplines and mandates, and across temporal and spatial scales. These include linking to modelling communities from different fields such as crop modelling and global integrated assessment modelling, and partnering with organisations with skills in the development and provision of downscaled models, decision-tools and datasets that provide the necessary granularity for national and sub-national planning (CCAFS, 2011). As well as linking across scientific disciplines, CCAFS recognises the need to span boundaries across research and policy domains. To link knowledge and action entails involvement of policy-makers in all stages of the research cycle, and an understanding of policy as dynamic and polycentric across the public, private and civil society sectors.

Conclusions

Many research agencies, both public and private, are addressing the profound challenges of food security and climate change. CCAFS, as a joint CGIAR-ESSP initiative, is a practical attempt to add value to these diverse efforts in Africa through partnership, policy engagement and research, and is striving to find a balance between global public goods and local adaptive responses to climate change.

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Fennec – The Saharan Climate System

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Introduction and Programme Rationale

The central Sahara forms an important part of world's climate system. During the northern summer months, the Saharan Heat Low, caused by intense solar heating, develops over a huge, largely uninhabited expanse of northern Mali, southern Algeria and northern Mauritania. Dry convection through more than 5000m of the atmosphere is routine in what is thought to be the deepest such layer on the planet. The Saharan Heat Low also co-locates with the largest atmospheric loadings of airborne mineral dust anywhere in the Earth's atmosphere.

The Sahara is without doubt the least populated region in Africa. So why would anyone need to study a region which is beyond the reach of many and likely to remain so, particularly when there is a mood to demonstrate that expensive climate data should have regional if not local benefit? The answer in this case rests in the primacy of the central Sahara in the large-scale climate system. Here is just one example. The Saharan Heat Low is a crucial part of the West African Monsoon – in particular its position and strength controls one end of the pressure gradient that drives the low-level moisture inflow over West Africa. There is broad agreement that rainfall onset, cessation and dry spells are of vital importance to rain-fed subsistence agriculture across the Sahel and that onset can occur as a jump rather than the smooth evolution of the seasonal cycle. The Saharan Heat Low region has been a missing piece of the puzzle in understanding such intra-seasonal variability. Similarly, understanding the projections of Sahel rainfall in future decades is widely known to be troublesome and challenging since some climate models show a wet future and others a dry one. Climate model simulations show the presence of the Saharan Heat Low but the intensity and strength of the feature varies from model to model. Without the necessary data with which to confront the models, we cannot say which model is better and we cannot say what processes that might be linked to the model biases are missing in these models. Certain process errors in low-resolution weather models are known to be directly applicable to climate models, and this seamless approach is being followed to evaluate errors in both NWP and climate. Of course we might expect model bias to be large given the extreme nature of the Saharan climate, the fact that dust loadings are the highest on the planet and the indications from satellite data that model radiation errors are sometimes >100 Wm-2. Under such circumstances and without a concerted scientific effort in the region, model bias is likely to persist through successive IPCC rounds, along with the consequences for climate prediction and projection, while policy makers are constrained to make important decisions on resource allocation from ambiguous climate information.

In an effort to address the observational deficit in the region, as well as to improve model and satellite –derived product performance, the Fennec programme was conceived as a large-scale, international, multi-platform, extended duration campaign in the Saharan Heat Low (SHL) region. It is the first major climate program in the central Sahara. The ideas for Fennec, which is a British, French and German initiative, grew out of the African Multidisciplinary Monsoon Analysis (AMMA) (see AMMA article in this volume of Exchanges). Fennec is the project name – it is not an acronym.

Fennec Goals

Broad Fennec goals which map on to the programme motivation discussed in the introduction are to:

- Derive a new and definitive data set for central Sahara from aircraft, ground, model and satellite observations
- Characterise thermodynamic, dynamic and compositional structure of central Sahara's atmosphere
- Quantify weather prediction and climate model errors and how these can be reduced
- Establish mechanisms of dust emission, transport and radiative forcing from the planet's largest source

Fennec Observational Programme

The observational programme to measure key elements of the Saharan atmosphere is a defining feature of Fennec. Much of the observational work has taken place in the deep and extremely remote part of the Sahara as close to the core of the heat low as possible. This work would not have been possible without the expertise and experience of the Algerian and Mauritanian National Met Service (ONM) who ran all the ground-based operations in their respective countries. Theirs was a magnificent achievement.

During June 2011 and June 2012, ground-based observations were made at Bordj Badji Mokhtar (BBM) in Algeria on the Mali-Algerian border and Zouerat in Mauritania (Figures 1 and 2). In addition, eight automatic weather stations, transmitting via satellite, were located across the heat low region. These were engineered to operate autonomously in a hot and dusty environment and have now been in place for a year. Instrumentation at BBM in June 2011 included lidar, sodar, 4 to 8 radiosondes daily, a flux tower and aerosol sampling equipment (CIMEL sun photometer, nephelometer, reflectometerand filters). A reduced array (flux tower, radiosondes and CIMEL) operated in June 2012. It is worth mentioning that BBM is some 600km across the open desert from the nearest road. Radiosondes were also released at higher frequency across the Algerian network at In Salah, Tindouf and Tamanrasset leading to a total of 457 radisondes in Algeria in June 2011 and 320 in June 2012. Extensive aerosol sampling was conducted at In Salah, Algeria in the summer of 2012. Mauritanian based operations in June 2011 at Zouerat featured sodar, radiosondes, cimel and flux tower with aerosol sampling in Bir Moghrein. A reduced set of instruments operated at Zouerat in June 2012 (cimel and flux tower).

The Fennec ground-based campaign was complemented by several aircraft campaigns. The instrumented UK FAAM BAe-146 aircraft flew into the central Sahara from Morocco in April 2011 and from the Canaries in June 2011 and June 2012 (Figures 1 and 3). The June 2011 campaign also included the instrumented French Falcon F20. Over all campaigns, more than 200 hours of science flights, many at low level (approximately 70m above the surface), were conducted as part of the Fennec campaign and approximately 300 dropsondes released, many of which were assimilated.

Some Highlights: Two Examples

Data analysis is currently in progress. Thus far, results are pointing to some interesting avenues. The Sahara is well known as a major dust source but previous campaigns have worked largely around the edges of the heat low region. In-situ aircraft observations from dust storms sampled in Fennec show much larger dust particle sizes than previously measured (median 40 microns) with some particles near active sources measured at close to 1000 microns several hundred meters above the surface. The dependence of heating on particle size in models needs to be carefully considered given these observations and the previously assumed particle sizes. While the Sahara is characterised by very low water vapour content, moist convection nevertheless plays a critical role, not only in dust production. Numerical Weather Prediction bias is likely to result from cold outflows of convective origin. Horizontal grid-scpacing >12 km in numerical models is typically incapable of simulating these outflows, leading to one potential error in heat low characteristics.

Conclusions

Fennec is an example of a large-scale programme aimed at addressing critically important climate processes in an extremely data sparse region of the world. It seems likely that Fennec will demonstrate that a prime way to address deficiencies in understanding and modelling such regions is through concerted efforts with major field programmes involving many nations. Observations in the Saharan Heat Low region may not be the absolute priority for any individual West and North African nation, particularly when so few people live there, but are of great collective importance for the region, and indeed the globe, and therefore need to be addressed collectively. Operationally, the observational component of Fennec has been extremely challenging and has taken place at a difficult time politically, but it has succeeded against all odds. Key to the success has been the extraordinary expertise of all those involved in the airborne campaigns and the astonishing achievements resulting from the collaborations between universities and the National Met Services ONM Algerie and ONM Mauritania.

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Observer at Tindouf, Smain BRIK, Fouad SEDDIK

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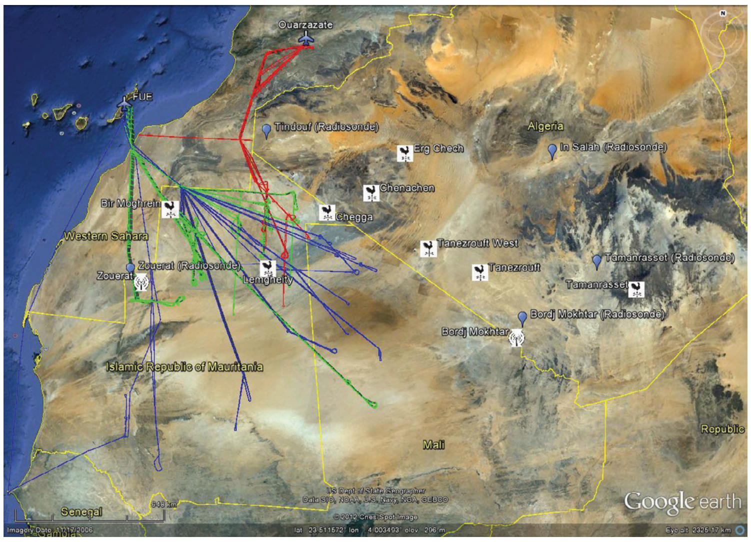

Figure 1 (left) Flight tracks of BAe-146
Red: April 2011
Green: June 2011
Blue: June 2012
Weather vane indicates AWS sites and blue markers radiosondes.

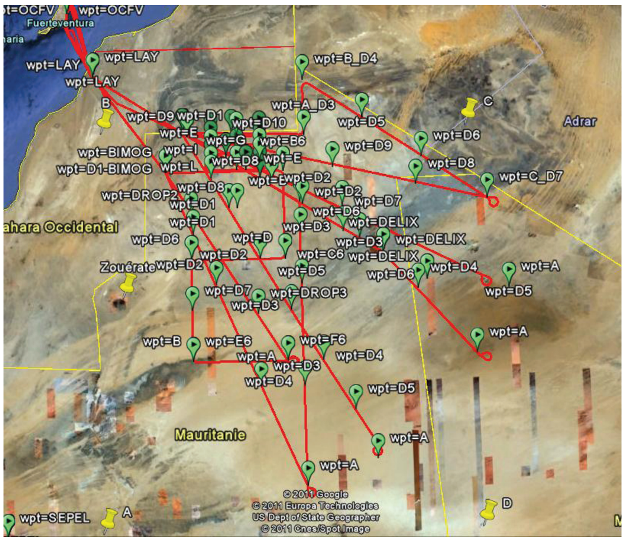

Figure 1 (right)
Flight tracks of F20 (June 2011)
Green symbols = dropsondes

Figure 2 Flux tower at Bordj Badji Mokhtar in Algeria near the Algerian/Mali border.

Figure 3: BAe 146 instrumented aircraft starting a low level sampling run over the southern end of Erg Chech in far northern Mali, June 2012.

The Africa Climate Conference (ACC) 2013 – Setting the priorities for climate research in Africa and delivering climate information into the hands of users

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Limits to knowledge impose tenacious boundaries and restrict the usability of climate information for African decision-makers and communities most vulnerable to current and future impacts of a changing climate. As the continent predicted to be the second hardest hit by Climate Change impacts, immediately following polar zones (IPCC, 2007), Africa has a stake in improving the skill and salience of its climate research outputs. Current and future African climate research must be both informed and driven by the critical adaptation needs of African decision-makers in Africa, at national, regional and local levels, striving to adapt under an uncertain climate future.

There is a clear need to bring together African decision-makers and climate researchers, scientists and practitioners, around the common goals of identifying the state of knowledge on the African climate system, recognizing current gaps in climate knowledge, developing a framework for mainstreaming climate information into decision making, and defining and driving an African agenda for future climate research that will inform adaptation decisions out to the mid- to end 21st Century. Climate-informed adaptation decisions in Africa will make the difference between mal-adaptation and leaps and bounds in building resilience on the continent to enhanced climate variability and climate change.

WCRP and ACPC have started the planning process for the Africa Climate Conference that will be hosted and organized by ACPC in the Africa Union Hall, Addis Ababa, Ethiopia in October 2013. The Conference Steering Committee was launched at a meeting hosted by ACPC at the United Nations Economic Commission for Africa (UNECA), Addis Ababa on 13-14 September 2012 (see here for more information: http://www.clivar.org/organization/africa/ssc/index). The Conference will precede the Third Conference on Climate Change and Development in Africa (CCDA-III) that will also be held in October 2013.

The Africa Climate Conference 2013 proposes to narrow the large gap that currently exists between African decision-makers and climate researchers and scientists, and to bring African climate scientists together to push back the knowledge frontiers of African climate science, to improve climate science outputs so that they may inform adaptation decision-making in Africa. Following the twin-track approach of researching the use of existing climate information for decision-making, while improving predictability and skill of climate science outputs (ACPC, 2011), the Africa Climate Conference 2013 will contribute a significant step to the latter endeavor, catalyzing climate science research for improved and more salient climate science outputs in the near future.

Conference Objectives

The overall goal of the Africa Climate Conference 2013 is to craft an Africa wide agenda on climate research for sustainable development, linked to existing continental policy processes, partners and institutions (regional, national and sub-national) to deliver an Africa agenda on climate research, while addressing global research needs.

The specific objectives of this Conference are as follows:

1) Provide a wide international forum to exchange understanding on the current state of knowledge of the African climate and the drivers of African climate variability and change.
2) Deepen and broaden the consensus, begun at CCDA-II, on the priority knowledge gaps/climate science frontiers that need to be addressed.
3) Review and assess the state of knowledge on each climate science frontier identified (from the mapping of knowledge gaps in 1), through presentations by leading researchers in each field.
4) Identify missing links and obstacles that will need to be overcome in order to bridge African climate science and applications.
5) Develop pan-African climate research program proposals for each critical climate science frontier, for funding submission.
6) Leverage national, regional and international sources of funding to advance climate research for sustainable development in Africa.
7) Develop and strengthen the network of climate researchers and practioners working on the African climate system, building on existing national/regional/continental climate research institutions and knowledge hubs.
8) Create a platform for knowledge sharing, advocacy and consensus building for climate research in Africa to serve sustainable development needs.

As an initial step towards developing the agenda of the Africa Climate Conference 2013, the Steering Committee has collaborated with the Scientific Steering Committee of the Second Conference on Climate Change and Development in

Africa (CCDA-II) to set the agenda of Theme 1: Climate Service Delivery for Development. CCDA-II will be held on 19-20 October 2012.

The CCDA is one of the key activities of the Climate for Development in Africa (ClimDev-Africa) Programme. This joint initiative by the African Union Commission (AUC), the United Nations Economic Commission for Africa (UNECA) and the African Development Bank (AfDB) is meant to provide a forum for dialogue and engagement with various stakeholders involved in climate and development in Africa. It was highlighted in the first Conference on Climate Change and Development in Africa (CCDA-I), held in Addis Ababa, Ethiopia in October 2011 that a clear connection between research, policy and practice is required to explore and implement the opportunities provided by adaptation and mitigation strategies. For example, science-based climate information on variability of rainfall patterns is critical in developing and implementing concrete adaptation strategies to cope with water stress and extreme events. The CCDA-II will concentrate on three sub-themes that aim to highlight strategies and demonstrate best practices in the areas of Climate Services Delivery for Development, Sustainable Energy Access for All Africans by 2030 and Outstanding Issues in Climate Negotiations: Relevance for Africa (http://new.uneca.org/ccda2/home_ccda2.aspx). The Sub-Themes are:

1. Climate Services Delivery for Development:
2. Sustainable Energy Access for All Africans by 2030
3. Outstanding Issues in Climate Negotiations: Relevance for Africa

The SC revised the topics of Sub-Theme 1 of the CCDA2 and identified papers, speakers and posters for each topic. The Sub-Theme 1 Topics are as follows:

Topic 1.1: Bridging the gap: successful experiences and best practices in climate service provision, challenges and lessons learned

Topic 1.2: Climate Information/data collection and Analysis for Adaptation and Risk Management

Topic 1.3: Frontiers of research and development for climate science, services and policy

The SC recognised the importance of the hindrance to progress in climate information delivery caused by data gaps that need addressing before the community can comprehensively tackle the knowledge gaps. Through the CCDA2, and on to the ACC, the research community has the opportunity to address the fundamental issue of data sharing by demonstrating to government representatives what can be possible, what the value of climate information use can be, and then emphasizing what needs to be done in terms of data access at the national level to make that happen.

The opportunity to set the CCDA2 Sub Theme 1 agenda affords the SC with a major opportunity to present what it sees as the major knowledge frontiers in African climate research to the broad array of users (practitioners, NHMSs, government ministries, policy negotiators etc) that will be represented at the CCDA2. The SC expects that this list of frontiers will be assessed and validated in terms of relevance by the CCDA2 participants, as part of its stakeholder consultation that will continue until the end of 2012, in preparation for the launch of the conference Themes and call for abstracts. Secondly, policy practitioners will in turn inform the SC on what are the decision policy options that need to focus climate research so it can provide precise enough information to decide between these options. For example, what are the data issues across the Continent that impede the policy process regionally. Societal and developmental needs need to be reflected in science delivery from the start.

The Africa Climate Conference 2013 will deliver the definition and consensual validation of an African climate research agenda, to be consolidated after the conference in the form of research proposals targeted at new funding opportunities and collaborations. A comprehensive publication will be presented and published on African Climate Research Gaps. This will serve to inform the research community at large, funding entities, stakeholders. It will be presented to the United Nation's Framework Convention in Climate Change (UNFCCC) nineteenth Conference of Parties (CoP19), as well as for review by the IPCC.

The call for abstracts will be opened at the start of January 2013 and will close at the end of March 2013. We invite the community to look out for the announcements that CLIVAR and WCRP will issue by email and in their respective newsletters, or please contact A. Pirani (anna.pirani@noc.soton.ac.uk) for further information.

Exchanges

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