Progress Report to NOAA 2009

NA05OAR4311004

November 2008 - October 2009

The International Research Institute for Climate and Society

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

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NAO50AR4311004
November 1, 2008 - October 31, 2009

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Selected Abstracts, continued

From the Director General

One of the headline activities for IRI over the past year has been preparing for and contributing to the World Climate Conference-3 (WCC-3). As the conference planning increasingly focused on climate services and the role of climate knowledge and information to assist societies in decision-making and policy, the relevance of IRI's work and experience became clear, and we engaged regularly with the International Organizing Committee over the year-long planning of the event. In this context, we were able to share our experiences, our learning, and our partnership-based approaches to address the challenge of bridging gaps in the use of scientific information in the practice of climate risk management. We helped shape the conference concept note, agenda and other documents that framed the eventual deliberations and outcomes. IRI scientists contributed three articles to the book "Climate Sense", which was published in conjunction with the Conference, and were also invited as session chairs, presenters and authors for segments on seasonal and decadal climate variability, climate risk management, extreme events, health, agriculture and water. The WCC-3 venue provided a natural opportunity for the IRI and its partners to demonstrate both the range and depth of their experiences and their relevance to the design and delivery of climate services throughout the world. We are keen to continue the engagement.

With much attention to discussion of climate services in support of new practices of climate risk management, it is important to recall that end results depend critically on innovations in climate and climate-related sciences. This year, IRI has seen advancement in its generalized probabilistic forecast systems, coupled model prediction tools, methodologies for decadal scale climate assessments and more flexible formats for seasonal-to-interannual climate forecasts, among others. There is also innovative work emerging in association with extended-range forecast systems for agriculture in India, remote sensing methods and products, climate thresholds relevant to malaria prediction, extracting useful information from general circulation models for crop modeling, and more. The *Selected Abstracts* section of this report provides highlights of these and other areas of exploration and achievement.

In 2009, we released the second edition of the IRI's Climate and Society Report series, entitled *Index Insurance and Climate Risk: Prospects for development and disaster management*. Our goal with these reports and, more significantly, the process around them, is to draw together information, experience and institutional partnerships – to disseminate what is known and to catalyze further activity advancing climate risk management practices. Climate and Society No. 2 enabled precisely that, in the domain of index insurance as a tool for managing climate risk. Major partners included the United Nations Development Program, the International Fund for Agricultural Development, Oxfam America, Swiss Reinsurance Corporation, NOAA and the World Food Program. The report, launched at the Global Humanitarian Forum in Geneva, highlights the opportunities as well as challenges that must be addressed to allow this innovative tool to achieve widespread uptake and benefit.

And speaking of index insurance, major progress was made this past year in an implementation project to improve financial and food security for farmers in Ethiopia, in partnership with Swiss Re and Oxfam America. Actual insurance contracts were initiated on a voluntary basis in the target community, with widespread participation. Coupled with a national cash-for-work program, credit and agricultural inputs, the insurance tool continues to show promise. Of particular interest are innovations in the contract design that enabled often-assumed barriers to implementation – such as lack of long-term historical climate observations and long-term variability/trends in rainfall – to be overcome. Under new funding committed by the Rockefeller foundation, the project will now be expanded to additional geographic and agricultural settings where the design can be further tested and improved.

Another area of considerable activity over the reporting period pertains to knowledge capture and the creation of dissemination tools for a range of climate risk management decision settings. IRI's interest is to provide mechanisms where the developing knowledge, information resources, support tools, experiences and best practices targeted to specific communities of practice can be accessed and shared – to enable increasingly widespread uptake of these resources. This year, we saw major progress in conceptual design and pilot implementation of prototype platforms, and drafting of initial versions of training manuals for water resources management, fire management and public health – all slated for release in the coming year.

In closing, I would like to acknowledge the support of the IRI Board and its International Scientific and Technical Advisory Committee, The Earth Institute, the IRI Faculty Advisory Committee, and faculty and leaders at Columbia University for their engagement with us in a mission that has been generously funded and actively supported by the NOAA Climate Program Office.

The pages that follow summarize a number of work areas and accomplishments, which are possible owing to the insights and efforts of a remarkable group of scientists and staff. For more information please also visit our web site at http://iri.columbia.edu.

Stephen E. Zebiak

Selected Features *November 1, 2008 - October 31, 2009*

The IRI recognizes the importance of communicating our research, innovations and the practical ways in which decision makers use climate information. One area of effort involves the regular publication of web stories and multimedia presentations, available at **http://iri.columbia.edu/features**. We have been able to generate an ongoing interest in these stories among members of the media, our partners, Columbia University and NOAA CPO. Many features are now linked to a number of humanitarian and relief-oriented news organizations as well. Examples follow.

10/17/2009
The potential impacts of the current El Niño

In many tropical regions of the developing world, El Niño means drought. Rogier van den Esker

International Research Institute for Climate and Society has published two documents designed to walk policy makers through the potential impacts of current El Niño conditions. Readers can use the documents to not only assess how vulnerable different areas of the developing world are to climate-related socioeconomic impacts, but also to see how recent rainfall patterns in these areas have compared to typical El Niño conditions. The IRI staff developed these documents in the context of the El Niño that has developed in the equatorial Pacific, which is likely to continue evolving until early 2010. El Niño conditions occur on average once every 3-5 years, and typically alter climate patterns in many regions of the world, leading to below-normal rainfall in some regions, and above — normal in other areas. Depending on socioeconomic conditions in the affected regions, these out-of-the-ordinary rainfall patterns can often lead to droughts, floods, wildfires, food insecurity and other impacts. (in previous stories, we tackled misconceptions about El Niño as well as its impacts on health.)

Current Rainfall Conditions and El Niño Teleconnections helps assess whether current rainfall conditions are consistent with anomalous — or abnormal — rainfall patterns typical of El Niño years, with a focus on developing countries. This information can help decision makers determine which areas have been hit hardest in recent months. The maps and graphs in this document were prepared using IRI's Data Library, a powerful and freely accessible repository of online data and analytical tools that allows users to view, manipulate and download more than 400 climate-related data sets through a standard web browser.

El Niño Teleconnections in Africa, Latin America and Caribbean, and Asia Pacific provides maps that show the increase in odds that many developing countries have in receiving below-or above-normal rainfall in upcoming seasons, based on an analysis of past El Niño years. Importantly, the report also provides an overview of current socioeconomic conditions, such as dependence on agriculture, prevalence of malnutrition and political stability, for affected countries.

These documents are part of efforts by IRI researchers to inform policy making, mitigate negative impacts, and help make El Niño years less costly in terms of life and property. For a full set of El Niño related resources, please visit IRI's ENSO page. ■

10/07/2009

Living with an Uncertain Monsoon: IRI's work to benefit farmers in India

By Esther Conrad

Professor Danda Reddy with IRI research team and local farmers, in a paddy field. (Haresh Bhojwani/IRI)

In May and June each year, speculation about the coming of the monsoon fills newspapers and conversations across India. Urban dwellers eagerly await respite from overbearing heat. Investors scrutinize forecasts, trying to anticipate possible impacts on food prices. But none have more at stake than India's over 100 million farming households.

In India, where more than 60% of agricultural land is rainfed and the average farm size is only 3.5 acres, a failed monsoon often means complete loss of a crop. Recent increases in suicides among heavily indebted farmers have highlighted the extreme desperation in some areas. A lackluster monsoon can seriously impact food prices and India's overall economic growth. For example, this year's poor monsoon has led to increases in sugar, legume, and potato prices, and many estimate that India's gross domestic product growth rate may drop by a full percentage point. The government also spends massive sums on drought relief. According to the agriculture ministry, relief expenses totaled about $5 billion during the last major drought in 2002.

The magnitude of these human and economic costs particularly as concern grows over the potential for climate change to increase extreme weather patterns has sparked interest in finding more ways to plan ahead. The International Research Institute for Climate and Society at Columbia University is partnering with Indian government agencies and universities in an innovative new research effort led by the government of India designed to improve monsoon forecasts and develop strategies that help farmers and policy makers prepare and act early, based on information tailored to their needs.

The Elusive Monsoon

Forecasting the Indian summer monsoon is one of the oldest challenges in climate science. Droughts in India during the 18th and 19th centuries — which, under British colonial rule, were associated with terrible famines — triggered some of the first inquiries into climate factors that might explain monsoon failures. Sir Gilbert Walker, director of the India Meteorological Department in the early 1900s, laid the groundwork for uncovering the El Niño-Southern Oscillation, a periodic shift in oceanic and atmospheric conditions over the tropical Pacific Ocean that alters climate patterns in many regions of the world. Yet, the vagaries of the southwest monsoon over India remain one of the big puzzles of climate science.

"ENSO only partly explains changes in the monsoon," says scientist Andrew Robertson, who leads IRI's climate research in India. "Temperatures in the Indian Ocean and the tropical Atlantic, and the atmosphere's own chaotic nature, all play a role. Global climate models haven't yet fully reproduced its behavior."

Each April, the India Meteorological Department publishes forecasts on the expected average rainfall between June to September for the whole country. The southern state of Kerala is the first to feel the monsoon rains, which in a matter of weeks will have moved northward across the country, replenishing reservoirs and watering fields. During this time, farmers can receive short-range (5-7 day) forecasts of expected rainfall patterns in their area as well as some advice on crop management from the National Agro-Advisory Service, which is run by the IMD and state agriculture universities. The service is helpful to farmers. However, it doesn't provide information with longer lead times, which could help farmers and local district officials plan better.

"There are several challenges to making this happen," says L. S. Rathore, director of IMD's Agro-Meteorology Division. "Forecasting the monsoon is quite complex, especially when we're talking about 1-to-2-month lead times at sub-national scales. Furthermore, climate information alone isn't enough. It needs to be connected with decision opportunities, as well as sufficient resources for action by farmers."

P. R. Sheshagiri Rao, an agro-climate expert working closely with IRI, knows this full well: he's also a farmer in the southern Indian state of Karnataka. "If there's a forecast for a delayed monsoon, but a farmer has no money or credit to get seeds to plant a different crop, he can't make much use of the information," he says.

Rao and many other Indian colleagues are working with the IRI on a new project led by the Government of India that addresses these two critical, interconnected challenges. The Extended Range Forecast System for Climate Risk Management in Agriculture Project (ERFS), funded by India's Ministry of Agriculture and coordinated by the Indian Institute of Technology Delhi, focuses on one district in nine states affected by the monsoon. In these districts, researchers at the state agriculture university are identifying specific climate-related agricultural risks that farmers contend with, and the kinds of decision options that farmers and local officials have, such as adjusting availability of seeds, fertilizer and other inputs. This information will help guide the climate science, agriculture and policy research aspects of the project.

"We want this project to ultimately deliver useful tools and strategies to both farmers and policy makers," says Shiv Someshwar, who leads IRI's project team. "A key to this is sitting down with both groups, learning how they make decisions and understanding what information they need to make those decisions. India's robust drought relief system has helped alleviate a lot of suffering, avoiding the famines of the past, but looking to the future, it needs to develop more capacity for a proactive, risk management approach, and take advantage of new scientific opportunities."

In the area of climate science, the project will test new approaches to forecasting the monsoon, combining outputs of multiple models from globally-recognized climate research centers into a new experimental forecast. The combination of runs from different models can give a more reliable picture of what is likely to happen. Scientists at the Indian Institute of Technology Delhi and staff from IMD are working closely with IRI's Robertson and Mike Tippett. In fact, four Indian scientists from the two institutions arrived at IRI in July for a six-month visit to contribute to the research. They are working on developing methodologies to create forecasts at a smaller scale and investigating the potential for information such as the likelihood of dry or wet spells and monsoon breaks, which are of great interest to farmers.

IRI agricultural scientists Amor Ines and James Hansen are working with researchers at Anand Agriculture University in Gujarat and the Acharya N. G. Ranga Agriculture University in Andhra Pradesh to analyze the impacts of climate variability on maize, cotton, groundnut and other key crops in these two states. Someshwar's work on the policy side will help integrate climate information into specific agricultural planning and drought-relief preparation policies.

The agenda for the project is ambitious. But IRI scientists and Indian partners alike are excited. "This effort means a lot to this country. It is a new beginning, the first step in a journey toward a climate risk management approach," said IMD director Ajit Tyagi, speaking at a recent project workshop hosted in Hyderabad.

Esther Conrad is a Senior Staff Associate at IRI. She coordinates the Asia and Pacific Program and conducts institutions and policy research.

Suggested Readings

Davis, Mike. Late Victorian Holocausts: El Niño Famines and the Making of the Third World. London: Verso, 2001.

Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

"It Never Rains: An Ancient Curse Strikes India," Economist, August 20, 2009.

Sengupta, Somini. "On India's Farms, A Plague of Suicides." The New York Times, September 19, 2006.

Sinha, Partha. "Will weak monsoon hit GDP, fuel inflation?" The Times of India, August 7, 2009. ■

09/28/2009

Leaders in index insurance expand their commitments in Ethiopia

Members of the Adi Ha community on sign-up day of the HARITA insurance project launch in May 2009. Michelle Katz/Oxfam

Swiss Re, Oxfam America, The Rockefeller Foundation and Columbia University's International Research Institute for Climate and Society announced a joint Commitment to Action at the Clinton Global Initiative 2009 meeting in New York, held from September 22 to 25. The collaboration is aimed at helping communities most vulnerable to climate variability and change. It will expand on previous work by the institutions on using index insurance to improve financial and food security for farmers in the drought-prone village of Adi Ha, Ethiopia.

"This is an exciting partnership among business, philanthropy, development and research institutions," says IRI Director-General Stephen Zebiak. "It has already shown that many presumed barriers to implementing insurance for vulnerable people can be overcome, and in the next phase, it will go further to test the limits of implementation at larger scales. We're thrilled to be a part of this."

Drought-related risks are a primary concern throughout Ethiopia, where 85 percent of the population depends on smallholder, rain-fed agriculture. Education as well as availability of index-based microinsurance, increased access to credit and drought-resistant seeds, and improved risk-management techniques are necessary measures for these populations to effectively adapt to a changing climate.

The IRI and its partners are working to have index insurance play a critical, complementary role to risk reduction interventions such as better agricultural practices by helping farmers bounce back from prolonged droughts and other low-frequency climatic shocks.

Index insurance is an attractive alternative for managing weather and climate risk because it uses a weather index, such as rainfall, to determine payouts. This resolves a number of problems that make traditional insurance unworkable in rural parts of developing countries. With index insurance contracts, an insurance company doesn't need to visit the policy holder to determine premiums or assess damages. Instead, if the rainfall recorded by gauges is below an earlier, agreed-upon threshold, the insurance pays out. Such a system significantly lowers transaction costs.

"Our goal is to design cost effective, robust, scalable index insurance into a package of other development interventions such as risk reduction and micro-credit. These products must meet the needs of low income farmers and also work in data-poor areas of the world," says IRI research economist Dan Osgood.

The new 2009 commitment builds on the success of a 2008 pilot project in Adi Ha, which is in the northern Ethiopian state of Tigray. Two hundred households, approximately twenty percent of the village enrolled in the pilot weather risk insurance project after partaking in workshops on climate change, financial literacy and insurance. Thirty-eight percent of enrollees came from female-headed households — recognized as the poorest of the productive poor. Sixty-five percent also participated in Ethiopia's Productive Safety Net Program, a federal cash-for-work program that serves 8 million chronically food insecure households in Ethiopia.

"The partnership has already shown that many presumed barriers to implementing insurance for vulnerable people can be overcome, and in the next phase, it will go further to test the limits of implementation at larger scales. We're thrilled to be a part of this." Stephen Zebiak, IRI Director-General

"This expanded project will provide further validation on useful techniques that allow communities in developing countries to adapt to the changing climate," says David Bresch, Head of Sustainability & Emerging Risk Management for Swiss Re.

The pilot project is part of the collaborative Horn of Africa Risk Transfer for Adaptation (HARITA) project that includes Swiss Re, Oxfam America, the IRI, the Relief Society of Tigray, Nyala Insurance and Dedebit Credit and Savings Institution.

This year's commitment will expand the program to include at least one new crop and to test the pilot model in four new villages in Tigray, and one in the nearby state of Amhara.

The Rockefeller Foundation has provided additional funding for this commitment, based on the success of the 2008 initiative as well as the potential of the expanded 2009 program. Swiss Re and the Rockefeller Foundation will fund the effort, which will be implemented by Oxfam America. The IRI will provide primary technical support. IRI has been at the forefront of weather index insurance initiatives aimed at meeting the needs of developing countries.

Oxfam America President Raymond C. Offenheiser said, "The expansion of the pilot project is an example of how collaborative projects such as HARITA can promote household food security, increase the impact of our risk reduction programs including climate adaptation and provide guidance on the necessary measures to scale the pilot successfully in Ethiopia and beyond."

08/21/2009

El Nino Impacts on Health

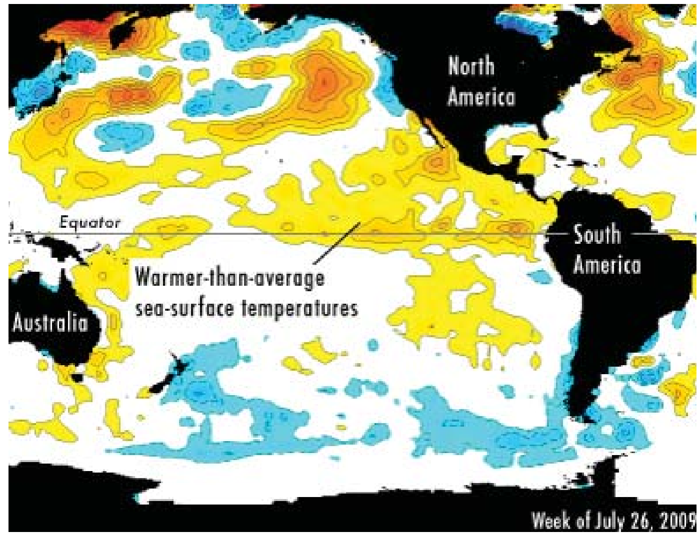
A recent update published by the International Research Institute for Climate and Society provides information on the emerging El Niño and its potential health impacts. Responding to growing concerns about El Niño from organizations such as the World Health Organization and the International Federation of Red Cross and Red Crescent Societies, the IRI produced the document in order to give decision makers key recommendations on how to monitor communities at risk and take steps to reduce their vulnerability. It also provides links to valuable resources and IRI maps.

IRI's Madeleine Thomson discusses the effects — good and bad — that the climate phenomenon could have on public health around the world in an audio interview. This is the second in our series of audio interviews on El Niño. To hear the first, go to our recent story about El Niño Misconceptions.

For a complete list of resources about El Niño and La Niña, visit our ENSO web page. ■

08/06/2009

Top misconceptions about El Niño



This recent map of sea-surface temperature anomalies shows that weak El Nino conditions have developed in the tropical Pacific.

Forecasts by the International Research Institute for Climate and Society and other institutions show that a weak El Niño has developed in the equatorial Pacific, and is likely to continue evolving with warmer-than-normal conditions persisting there until early 2010. What exactly is this important climate phenomenon and why should society care about it? Who will be most affected? We address these questions as well as clear up some common misconceptions about El Niño, La Niña, and everything in between!

First, the basics.

El Niño refers to the occasional warming of the eastern and central Pacific Ocean around the equator (the yellow and orange areas in the image). The warmer water tends to get only 1 to 3 degrees Celsius above average sea-surface temperatures for that area, although in the very strong El Niño of 1997-98, it reached 5 degrees or more above average in some locations. La Niña is the climatological counterpart to El Niño — a yin to its yang, so to speak. A La Niña is defined by cooler-than-normal sea-surface temperatures across much of the equatorial eastern and central Pacific. El Niño and La Niña episodes each tend to last roughly a year, although occasionally they may last 18 months or longer.

The Pacific is the largest ocean on the planet, so a significant change from its average conditions can have consequences for temperature, rainfall and vegetation in faraway places. In normal years, trade winds push warm water — and its associated heavier rainfall — westward toward Indonesia. But during an El Niño, which occurs on average once every three-to-five years, the winds peter out and can even reverse direction, pushing the rains toward South America instead. This is why we typically associate El Niño with drought in Indonesia and Australia and flooding in Peru. These changing climate conditions, combined with other factors, can have serious impacts on society, such as reduced crop harvests, wildfires, or loss of life and property in floods. There is also evidence that El Niño conditions increase the risk of certain vector-borne diseases, such as malaria, in places where they don't occur every year and where disease control is limited.

During either an El Niño or a La Niña, we also observe changes in atmospheric pressure, wind and rainfall patterns in different parts of the Pacific, and beyond. An El Niño is associated with high pressure in the western Pacific, whereas a La Niña is associated with high pressure in the eastern Pacific. The 'seesawing' of high pressure that occurs as conditions move from El Niño to La Niña is known as the Southern Oscillation. The oft-used term El Niño-Southern Oscillation, or ENSO, reminds us that El Niño and La Niña episodes reflect changes not just to the ocean, but to the atmosphere as well.

ENSO is one of the main sources of year-to-year variability in weather and climate on Earth and has significant socioeconomic implications for many regions around the world. The development of a new El Niño episode in recent months offers an opportunity to clear up some common misconceptions about the climate phenomenon:

El Niño periods cause more disasters than normal periods

On a worldwide basis, this isn't necessarily the case. But ENSO conditions do allow climate scientists to produce more accurate seasonal forecasts and help them better predict extreme drought or rainfall in several regions around the globe.

On a regional level, however, we've seen that El Niño and La Niña exert fairly consistent influences on the climate of some regions. For example, El Niño conditions typically cause more rain to fall in Peru, and less rain to fall in Indonesia and Southern Africa. These conditions, combined with socioeconomic factors, can make a country or region more vulnerable to impacts.

"On the other hand, because El Niño enhances our ability to predict the climate conditions expected in these same regions, one can take advantage of that improved predictability to help societies improve preparedness, issue early warnings and reduce possible negative impacts," says Walter Baethgen who runs IRI's Latin America and the Carribbean regional program.

El Niño and La Niña significantly affect the climate in most regions of the globe

Actually, they significantly affect only about 25% of the world's land surface during any particular season, and less than 50% of land surface during the entire time that ENSO conditions persist.

Regions that are affected by El Niño and La Niña see impacts during the entire 8 to 12 months that the climate conditions last

No. Most regions will only see impacts during one specific season, which may start months after the ENSO event first develops. For example, the current El Niño may cause the southern U.S. to get wetter-than-normal conditions in the December to March season, but Kenyans may see wetter-than-normal conditions between October and December.

El Niño episodes lead to adverse impacts only

Fires in southeast Asia, droughts in eastern Australia, flooding in Peru often accompany El Niño events. Much of the media coverage on El Niño has focused on the more extreme and negative consequences typically associated with the phenomenon. To be sure, the impacts can wreak havoc in developing and developed countries alike, but El Niño events are also associated with reduced frequency of Atlantic hurricanes, warmer winter temperatures in the northern half of U.S., which reduce heating costs, and plentiful spring/summer rainfall in southeastern Brazil, central Argentina and Uruguay, which leads to above-average summer crop yields.

We should worry more during El Niño episodes than La Niña episodes

Not necessarily. They each come with their own set of features and risks. In general, El Niño is associated with increased likelihood of drought throughout much of the tropical land areas, whereas La Niña is associated with increased risk of drought throughout much of the mid-latitudes . El Niño may have gained more attention in the scientific community, and thus the public, because it substantially alters the temperature and circulation patterns in the tropical Pacific. La Niña, on the other hand, tends to amplify normal conditions in that part of the world: the relatively cold temperatures in the eastern equatorial Pacific become colder, the relatively warm temperatures become even warmer, and the low-level winds blowing from east to west along the equatorial Pacific strengthen.

The stronger the El Niño/La Niña, the stronger the impacts, and vice versa

Current forecasts show a weak-to-moderate El Niño has formed and will remain through the rest of the year. Does this mean we should expect weak-to-moderate impacts? Not necessarily. The important point to remember is that ENSO shifts the odds of some regions receiving less or more rainfall than they usually do, but it doesn't guarantee this will happen. For example, scientists expected the very strong El Niño of 1997/98 — which triggered wildfires in Indonesia and flooding and crop loss in Kenya — to also increase the chances of below-normal summer rainfall in India and South Africa, but this didn't happen. On the other hand, India did experience strong rainfall deficiencies in 2002, during a much weaker El Niño.

El Niño and La Niña events are directly responsible for specific storms or other weather events

We usually can't pin a single event on an El Niño or La Niña, just like we can't blame global climate changes for any single hurricane. ENSO events typically affect the frequency or strength of weather events. When looked at over the course of a season, regions experience increased or decreased rainfall, for example.

El Niño and La Niña are closely related to global warming.

El Niño and La Niña are a normal part of the earth's climate and have likely been occurring for millions of years. Global climate change may affect ENSO cycles, but the research is still ongoing.

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06/23/2009

Index insurance for development and disaster management

Portion of cover for Climate and Society No.2, Index Insurance and Climate Risk: Prospects for Development and Disaster Management; design by Jason Rodriguez.

Climate has always presented a challenge to farmers, herders, fishermen and others whose livelihoods are closely linked to their environment, particularly those in poor areas of the world. A type of insurance called index insurance now offers significant opportunities as a climate-risk management tool in developing countries, according to a new publication launched today during a workshop at the Global Humanitarian Forum in Geneva. The report, called Index Insurance and Climate Risk: Prospects for development and disaster management is part of the Climate and Society series produced by the International Research Institute for Climate and Society. The IRI published the report in partnership with the United Nations Development Programme, the International Fund for Agricultural Development, Oxfam America, Swiss Re, the US National Oceanic and Atmospheric Administration and the World Food Programme.

"As an innovation, index insurance may hold answers for some of the more obstinate problems faced by the poor and the vulnerable," writes GHF President Kofi Annan in the report's foreword. "I hope this publication will help us to appreciate how much has been learned over the last few years, and show us where we can usefully concentrate our collective efforts."

For poor people, a variable and unpredictable climate can critically restrict livelihood options and limit development. For example, banks are unlikely to lend to farmers if they think a drought will cause widespread defaults, even if the farmers could pay back loans in most years. The farmers' lack of access to credit limits their ability to buy improved seeds, fertilizers and other inputs.

Index insurance represents an attractive alternative for managing weather and climate risk because it uses a weather index, such as rainfall, to determine payouts. This resolves a number of problems that make traditional insurance unworkable in rural parts of developing countries. With index insurance contracts, an insurance company doesn't need to visit the policy holder to determine premiums or assess damages. Instead, if the rainfall recorded by gauges is below an earlier, agreed-upon threshold, the insurance pays out. Such a system significantly lowers transaction costs. Having insurance allows these policy holders to apply for bank loans and other types of credit previously unavailable to them.

However, if index insurance is to contribute to development at meaningful scales, a number of challenges must be overcome. For example, some efforts to implement index insurance failed due to lack of capacity, institutional, legal and/or regulatory issues, lack of data, and other constraints. The new publication looks at the technical and operational challenges that currently limit the growth and spread of index insurance. It highlights a number of case studies of the various applications of index insurance across the world thus far. Among them are:

- A public-private partnership program in Brazil to support farmers
- A multinational scheme in the Caribbean for earthquake and hurricane risk
- A national program in Ethiopia to complement a drought early warning system

- A program to enable access to credit for smallholder farming communities in Malawi

- Public and private programs in India that offer contracts across many states, for many crops, covering a range of risks, from excessive rainfall to extreme temperatures

"Only three percent of the world population is covered by insurance," said Olav Kjorven, UNDP Assistant Administrator and Director of the Bureau for Development Policy. "The world's poor have been completely left out, even though they are the most vulnerable people, most in need of protection. Droughts, floods and hurricanes often strip whole communities of their resources and belongings. Index insurance, however, could finally enable millions of poor people to properly prepare for and recover from climate disasters."

Up to this point, a number of projects have shown that index insurance can be feasible for people living on just two dollars a day. Since 2005, some farming communities in Malawi, for example, have been able to buy small insurance contracts to cover the purchase price of seeds in case of drought. Nearly two million Indian farmers have had access to index insurance programs since 2003. But in order to achieve their full potential, applications of index insurance will need to scale up to reach many more people.

"The excitement here is that we're applying new thinking to confront long-standing problems," says Stephen E. Zebiak, the IRI's Director-General. "As the publication details, we do this by using innovative science and technology, by enhancing the role the private sector plays, by connecting to international risk pooling, and by working with countries to develop the capacity of their people and institutions. This publication highlights the critical importance of tackling this agenda, together."

Relevant Stories:

IRI at COP-14 in Poznan (2008)

Index insurance for Ethiopian farmers (2008)

Fighting poverty with index insurance (2008)

Index insurance and poverty reduction (2008)

Managing drought risks in Malawi (2007)

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06/15/2009

Climate information seen as key in new Early Warning, Early Action Report

Heavy rains flood homes in Dakar, Senegal in July of 2008. Moustapha Diallo/IFRC

The latest World Disasters Report by the International Federation of Red Cross and Red Crescent Societies argues that disaster-relief agencies need to shift focus from expensive response operations to cost-effective prevention measures. An important component of this, the report details, is using climate records, monitoring and forecasts to make planning decisions days, weeks, even months ahead.

The WDR lays out a relatively new operational approach, called "early warning, early action," which the International Federation says will save more lives per dollar spent. It argues that public money buys about four times as much humanitarian 'impact' if spent on preparation before disaster strikes than on response.

"We are pleased to see that the new World Disasters Report stresses the value of climate information in reducing disaster risks," says Stephen Zebiak, Director-General of the International Research Institute for Climate and Society. "Decision makers need reliable, science-based information to know how, where and when to prepare. In developing such information, the IRI aims to make sure its work is guided by real needs and is useable by those who need it."

In late 2007, the IRI partnered with the International Federation to develop tailored forecasting and monitoring products to help the organization improve its capabilities to respond to and prepare for emergencies. The resulting International Federation Map Room is now being used daily in the organization's operations. The collaboration is timely: the number of annual weather-related disasters has been rising steadily since the 1990s, according to the Red Cross/Red Crescent Climate Centre. And last year, hydrometeorological events such as floods, storms, heatwaves and droughts together accounted for nearly 60 percent of the International Federation's internal disaster relief emergency fund (DREF) grants, most of them relatively small-scale events.

"Early warning and early action together can save thousands of lives and livelihoods, reduce vulnerability and strengthen resilience," writes Bekele Geleta, the Federation's Secretary General. "Strengthening communities' capacities to prevent and/or cope with the impact of hazards is a concrete way to prevent disasters from retarding the development of the poorest countries."

User-oriented climate products

While scientific advances have revolutionized forecasting and the communications technology used for warnings, the WDR argues that a more people-centred approach is essential to ensure information and warnings captured by satellites, computer modelling and other technologies reach the most vulnerable communities, which can then act on them. Early-warning products can be too technical and include large uncertainties, and they do not naturally lead humanitarian actors to a decision, the authors contend.

With this in mind, three students in the Climate and Society Master's program embarked on internships with the IRI and the International Federation in 2008 to act as bridges between the providers of climate information and regional offices of the International Federation in Senegal and Panama. The interns' goal was to review the available climate and weather monitoring and forecasting tools and see how the information could be improved to encourage decision makers to understand and use it.

The report details the experience of intern Arame Tall, who spent several months working in the West and Central Africa zone office in Dakar, Senegal. Tall worked with the disaster management team there to increase its understanding of seasonal forecasts and support preparedness strategies. Understanding of this information helped inform the decision by the regional office to issue of a preemptive appeal for preparedness activities, worth nearly $750,000 by the International Federation-the first of its kind. The appeal broke new ground because it was based solely on the threat of future flooding, derived from seasonal forecasts that called for above-average rainfall for the region. While there was no major emergency in any one country, disaster managers were much better placed to deal with the widespread smaller emergencies that did occur-especially in Benin and Togo.

This summer, the internship program has expanded to ten students working in ten countries.

For additional information about the World Disasters Report, visit the International Federation's web site. ■

06/02/2009

SI 2009 Feature — Training public health decision makers

A glimpse from Summer Institute 2008. Daniel Yeow/IRI

Starting this week, 12 public-health professionals and climate scientists from ten countries are visiting Columbia University's Lamont campus, where the International Research Institute for Climate and Society is based, to learn how to use climate information to make better decisions for health-care planning and disease prevention. They're taking part in the second Summer Institute on Climate Information for Public Health, organized by IRI, the Center for International Earth Science Information Network (CIESIN) and the Mailman School of Public Health.

Now that the world's attention is focused on climate change, it is essential for the health community to better understand the role climate plays in determining the fundamentals of health — air, water and food — as well as its role as a driver of specific outcomes related to infectious disease.

"After all, health is fundamental to the way we understand human well-being, and a key indicator of sustainable development", says Madeleine Thomson, who runs the IRI's Health and Africa programs, and is a principal organizer of the course. "Here, we like to think of climate as both a challenge and a resource."

Extreme weather events or prolonged droughts are often associated with negative outcomes, Thomson says, but by understanding climate and its associated impacts and potential predictability, decision makers can start responding proactively to climate challenges. In some situations, they can even get ahead of the game, she says.

"This climate risk management approach is new to the health sector and, therefore, we are particularly excited to have such a talented group of participants and facilitators to explore the most effective ways to use climate information in decision making."

One such facilitator is instructor Patrick L. Kinney, the director of the new Climate and Health Program at The Mailman School. "Climate knowledge is a key input to public-health research and translational program development aimed at reducing future health impacts of a changing climate over both near-term and long-term time horizons," he says.

The course targets professionals who play a research role in the operational decision making or public health-care planning, evaluation, surveillance or control of climate-sensitive diseases. This year's participants include heads of disease-surveillance and epidemic preparedness and response teams, forecast and early-warning specialists, climate scientists and biostatisticians. They come from institutions in Africa, Latin America, Europe and North America.

The students face an intense daily schedule, packed with lectures and exercise sessions meant to introduce them to computational tools that integrate epide-miological data with the wide variety of available climate, population and environmental data.

For example, students will learn the fundamentals of using geographic-information-systems (GIS) to conduct spatial analysis. "GIS allows us to see where people live, the social, economic and physical condi-tions they confront and their level of exposure to potential health threats," says instructor Mark Becker, associate director of CIESIN's geospatial applications division. "Using a GIS-based model, we can look at the coincidence of regions at high risk of malaria and areas of high population density to design a more effective control program for example," he says.

Map of participant locations.

IRI's Gilma Mantilla, one of the Summer Institute's main organizers, believes the course will provide exciting opportunities and exploration for the participants. "I hope they leave here with a better understanding of how the climate and public health fields can be integrated to enhance their own institutions capacity and capability for action," she says.

The Summer Institute will run from June 1 to June 12. 2009. For more information, please visit the SI2009 home page.

About CIESIN

The Center for International Earth Science Information Network, is a research and data center of Columbia University's Earth Institute that addresses human interactions with the environment. CIESIN uses scientific data and advanced information technologies to help bridge the gaps between scientific disciplines and the divide between science and policy.

About the Mailman School of Public Health

The only accredited school of public health in New York City, and among the first in the nation, Columbia University's Mailman School of Public Health provides instruction and research opportunities to more than 1000 graduate students in pursuit of masters and doctoral degrees. Its students and more than 300 multi-disciplinary faculty engage in research and service in the city, nation, and around the world, concentrating on biostatistics, environmental health sciences, epidemiology, health policy and management, population and family health, and sociomedical sciences. ■

05/27/2009

IPCC Chief Rajendra Pachauri new IRI Board Chairman

Rajendra Pachauri at a recent IRI board meeting. F. Fiondella / IRI

Rajendra K. Pachauri, chairman of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with former U.S. Vice President Al Gore, has agreed to serve as the next board chairman of the International Research Institute for Climate and Society.

"I think there's so much that the IRI can do. Climate change gives us an opportunity to reengage with the rest of the world and the IRI is uniquely placed to do that," Pachauri said during IRI's board meeting last week, the first in which he served as chairman.

Columbia University hosted a small event commemorating Pachauri's new role in the institution, as well as honoring outgoing chairman and respected climate scientist Michael B. McElroy, from Harvard University.

"We are very appreciative of Mike's support and counsel, which have helped build the institution from its infancy to where it is today," said IRI Director-General Stephen E. Zebiak. "And we are both excited and honored to welcome Dr. Pachauri as our board chair. He's a recognized global leader in climate affairs, and will assist us in engaging the growing international agenda on adaptation and climate risk management."

The Earth Institute's Jeffrey Sachs, also an IRI board member, praised the IRI's mission, which is to enhance society's ability to understand, anticipate and manage climate risk in order to improve human welfare.

"The IRI was 13 years ahead of its time in seeing the importance of linking climate and society," he said. "The world is catching up now. Climate-change adaptation is front and center, and no other institution in the world has pioneered this field with such depth and skill."

Visit the IRI's Governance pages to learn more about the institution's board and its role. ■

04/21/2009
Betting on the Rains

By Caitlin Kopcik

Farmers in Chile. Curt Carnemark/World Bank

Rising global food prices and favorable rainfall patterns in recent decades have allowed farmers in South America's Southern Cone region to grow crops on formerly marginal lands. But if climate patterns shift and the rains start to fail, the region could face devastating losses in its economy, livelihoods and infrastructure.

The IRI is working with local partners to characterize the climatic variability of the region and to take actions that will allow people in these marginal lands to be more resilient to climate-related risks.

The countries of Brazil, Bolivia, Argentina, Chile, Uruguay and Paraguay, also known as South America's Southern Cone, have seen a major agricultural shift over the past 20 years. The region has become one of the most important producers of staple crops feeding a growing population: corn, wheat and soybeans. Rising global food prices have provided economic incentive for farmers to focus production on these crops to much success. Demand has also led farmers to cultivate large areas of "frontier" land — traditionally used only for raising livestock due to climate and land conditions rendering it unsuitable for agriculture. According to the Food and Agriculture Organization, more than 25 million hectares of frontier lands were converted to agriculture between 1965 and 2005. Despite having been beneficial to farmers thus far, such changes bring to question the conditions that have allowed this shift to happen.

"In the western region of the Argentinian Pampas, for example, there are areas that didn't get enough rainfall to support crops in the 1950s and 1960s. But throughout the later quarter of the 20th century, rainfall during the spring and summer increased, and these places are now able to sustain annual crops," says Walter Baethgen, the head of IRI's Latin America regional program. The ability for farmers to plant crops and expand this frontier clearly has been facilitated by increases in precipitation. What is less clear is the duration of such changes.

"Are these precipitation patterns part of a multidecadal cycle or a permanent, long-term trend? This is of grave importance to the future of farmers in the Southern Cone," Baethgen says. Such uncertainties aren't limited to changing precipitation, however. The frontier soils are often already marginal, characterized by low fertility and high erosion risks- adding another element of fragility to an already tenuous future.

Baethgen and colleagues from the National Agricultural Research Institutes of the Southern Cone, the Inter-American Institute for Cooperation in Agriculture (IICA-PROCISUR) and the International Maize and Wheat Improvement Center (CIMMYT), have been awarded funding from Sustainable Energy and Climate Change Initiative (SECCI) of the Inter-American Development Bank (IDB), to assess the vulnerability of these changes in the agricultural frontier.

"This project could be considered a platform to identify new ways to help the farmers and society of a crucial world region in reducing the vulnerability of food production in the years to come," says Roberto Diaz a senior researcher from Uruguay's Instituto Nacional de Investigacion Agropecuaria (INIA), who is collaborating with Baethgen on the project.

The joint research will compile and examine the climate history of the Southern Cone over the past 80 years to understand how it has varied across decades and how it can possibly vary in the future. By studying how climate change can alter rainfall, researchers have a better understanding of the nature and magnitude of the current and future risks that threaten farming and other livelihoods in the region. "We can then see what technologies, production systems and water resource management practices are available to people there that can help reduce those risks," Baethgen says.

In a separate Fontagro (also IDB) funded project, IRI will be working with the same national agricultural research institutes of the region, IICA-PROCISUR and the International Center for Agricultural Research in Dry Areas (ICARDA) to improve the seasonal climate forecasts available for the Southern Cone. In identifying ways in which forecasts and other climate-relevant information can assist water management decision making, the project seeks to provide information and tools to improve water use efficiency (including irrigation) throughout the region under the threats of a changing climate.

Caitlin Kopcik is a student in the Climate and Society master's program at Columbia. In partial completion of her degree, she will be interning with Americas regional office of the Red Cross/Red Crescent Climate Centre located in Panama, with a focus on increasing their ability to access, interpret and utilize available information on climate-related risks. ■

03/30/2009

Climate and Coconuts

Sri Lankan coconut salesman biking to market. JC Gallard

Millions of people in the tropics depend on coconuts for food, raw materials and livelihood. Coconuts are also a high value commercial crop. But like any crop, coconuts are at risk of drought and other prolonged events. By using climate science and better agricultural forecast models, the IRI has helped increase the resilience of coconut plantations to climate variability in one of the world's major producers, Sri Lanka.

"The uncertainty that characterizes agriculture — much of it due to climate variability — is among the greatest challenges facing farmers and others in the agriculture value chain in much of the world. Any information that reduces the uncertainty about future production or prices has immense value to them," says IRI research scientist James Hansen.

IRI's partners in this work have been the Coconut Research Institute of Sri Lanka (CRI), the Foundation for Environment, Climate and Technology (FECT), and the Sri Lanka Department of Meteorology. Together, the institutions have developed an improved prediction scheme that generates annual coconut production forecasts fifteen months in advance. The CRI has been using these forecasts since 2005 to help calculate projected coconut yields for the upcoming year. In a country such as Sri Lanka, more accurate projections are critical.

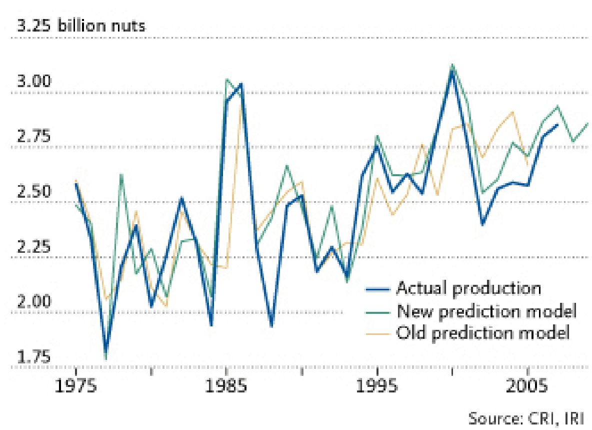
"Coconut cultivation sustains the livelihood of large numbers in the tropics and is the most important crop for food security after rice in Sri Lanka," says IRI scientist Lareef Zubair, who has been working with the CRI and other Sri Lankan colleagues since 2003.

"When we started out on this project, we were not sure whether we could provide an adequate prediction using climate information, as climate is one of many factors that affect production," Zubair says. "In addition, we had to assume that the climate and coconut data were of adequate quality."

Sri Lankans love their coconuts. The country has the highest annual per capita consumption of coconuts in the world- about 110 nuts. Sri Lankans dedicate about 400,000 hectares, more than a fifth of the agricultural land in the country, to grow the crop. These efforts produce on average 2.5 billion nuts every year, which account for 2% of Sri Lanka's gross domestic product, 2.5% of its export earnings and 5% of its workforce.

Coconut Prediction

Sri Lanka's Coconut Research Institute and the IRI have developed a better prediction model, based on seasonal climate information, to forecast annual coconut yields.



"One concern is about how coconut plantations can cope with climatic variability and adapt to climate change," says Neil Fernando, an agricultural economist at the CRI, with whom Zubair and Hansen collaborated. The work was funded through the Assessments of Impacts and Adaptations to Climate Change (AIACC) project from the Global Change System for Analysis, Research and Training (START).

Fernando and Zubair coauthored a paper in 2007 which calculated the economic impacts of climate variability on the Sri Lankan economy. In years of extreme crop shortage, income losses to the economy could be $32 million to $73 million. However, in years of extreme crop surplus, the economy could realize income gains between $42 million and $87 million.

Much like any agricultural commodity, coconuts are bought and sold months ahead of time via futures, or forward contracts. Accurate forecasting is critical for national agricultural planning and for negotiating forward-contract pricing with foreign buyers.

Coconut is a perennial crop with a long development period of about 18 months. The long maturation period makes it vulnerable to severe or prolonged weather events, especially during Sri Lanka's two dry seasons (January to March, June to August).

"Extended dry spells can reduce yield," says Sanathanie Ranasinghe, the head of plant physiology at the CRI. "However, excessive cloudiness during the wet season can reduce photosynthesis, which can diminish the 'dry matter' production needed for nut growth."

"Coconut is quite different from short-season cereal and pulse crops that we've worked with," says Hansen. "We initially thought our ability to forecast rainfall would be the most important factor in forecasting coconut yields months before harvest. Instead, we learned that the history of weather as far as two years before harvest provides quite a bit of information about future yields."

Simply by monitoring rainfall during a dry season, growers are able to predict future yields up to 15 months in advance with good skill. If there's too little rainfall, then they can make management decisions, such as irrigating or increasing fertilizer use, to try to mitigate the impacts on yield.

"Seasonal climate forecasts allow us to extend the lead time of yield predictions from 15 months to 21 months," says Sarath Peiris, the head of the biometry division of the CRI. Growers don't have to wait until the dry season is upon them in order to adjust their yield predictions, he says.

Peiris and Fernando came to the IRI for three weeks of training in 2004 and have been in regular consultation since. Zubair has been to Sri Lanka to help scientists in the country's agricultural research institutions, meteorological services and other institutions on using the IRI's Data Library, and the use of monitored and forecast information.

The predictions are distributed to national policy makers and to the agricultural extension officers in the 12 coconut growing sub-regions, and through them, to 270 major coconut plantations in the country. The predictions have helped the government and growers make informed decisions during droughts. Users have started requesting predictions by season and by region, and the CRI scientists are now working towards this.

"By investing modest resources, we helped them incorporate state-of-the art knowledge on climate variability into their prediction system," says Zubair, "and it turned out to have outcomes that were very useful for the end users."

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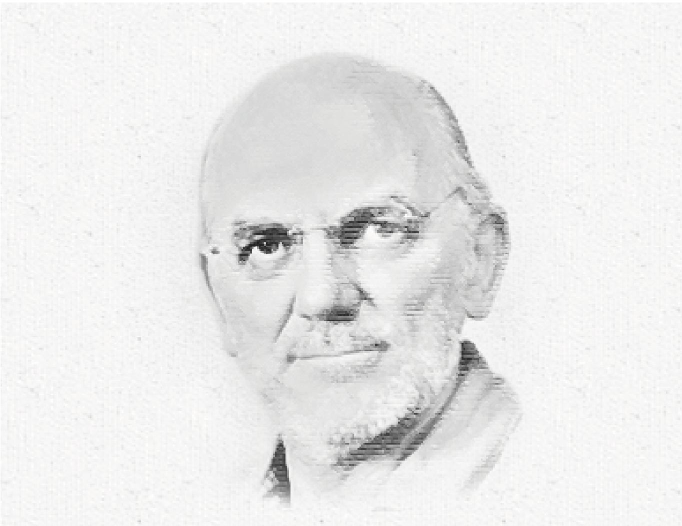
02/05/2009

An Interview with Graeme Hammer



Graemme Hammer sits down for an interview with IRI's Francesco Fiondella. (Audio available online)

This is the first of an ongoing series of interviews with prominent thinkers in the area of climate risk management. Over the next year, we will be sharing their insights on how climate science and information can help meet the goals of development and adaptation. These individuals are pioneers in fields as diverse as climate science, sustainable development, economics and policy. We kick off this series with a Q&A with Graeme Hammer, a specialist in crop ecophysiology and modeling who sits on IRI's International Scientific and Technical Advisory Committee.

Graeme Hammer is a professor at the University of Queensland's School of Land, Crop and Forest Science. Among his many research interests are climate variability and seasonal climate prediction, using models to aid crop management, and regional-scale crop forecasting. The following interview took place during Dr. Hammer's visit to the IRI in late 2008.

IRI: You are recognized for your work in using seasonal forecasts for agricultural management and planning, among other things. Could you describe that work?

Graeme Hammer: In the late 1980s, I started looking at climate risk issues because of their impact in agriculture in Northeast Australia. I was working with agricultural systems, both from the research and management perspectives with farmers and advisors. It was pretty clear that year-to-year climate variability was a huge factor in that system. The 1982 El Niño, for example, had a big impact in Australia. From one year to the next, we could see change in outcomes from one end of the spectrum to the other. For farmers in that system, it would totally dominate their perspective on profit and risk. Risk aversion through conservative practices was the approach adopted to ensure survival through the droughts. I wondered whether the emerging ability to predict seasonal climate, even though limited, might be useful in re-thinking this approach. We undertook some hypothetical studies with our agricultural systems models to simulate the likely value of adjusting management decisions based on an imperfect climate forecast. In order to do this, we developed a climate forecast system that looked at ENSO in a categorical way, based on phases of the Southern Oscillation Index. For each SOI phase, we compiled analogues of seasonal weather from historical data that we could use as input to our agricultural models. In this way, we could predict consequences of decision options associated with different categories of 3-6 month climate forecasts. The initial results were very promising, but even then we could foresee problems with explaining the necessarily probabilistic nature of the information.

IRI: Let's say we have a forecast where there is a greater chance of drier-than-normal conditions than there is of wetter-than-normal conditions. What kind of management decisions could the farmer stake?

GH: In that situation farmers could change their intensity of management, to a less intensive water use layout, for example. Or they might change how much fertilizer they'd put on the crop or the type or variety of crop to plant. These things have a small but significant effect. After a while, we started working more closely with farmers on how they might use the information, rather than how we would use it or suggesting what they should do. It became pretty clear that their whole attitude toward risk drove what they did.

IRI: So if a forecast called for 60% likelihood of drier-than-normal conditions, what would farmers do?

GH: Some farmers might say, "I can use that information", while others would have no use for it. A key part of the whole communication of using forecasts is about trying to make the point that we can't tell you whether this season is going to be a good one or bad one. We're only shifting the odds. Some people can handle that and others can't. It's about their capacity to understand what a climate forecast is and how it's different than a simple weather forecast they might read in the paper. It's also about how to get from the simple piece of forecast information to the understanding of whether it might change a decision. In the Australian context, much of the value for climate forecasts arises from making better use of seasons with good rainfall forecasts by increasing management intensity. This can often increase profitability without much effect on downside risk.

IRI: Oftentimes, we focus on the information gap that exists in developing countries — getting the information to the groups that can use it. But it also seems it's not enough to just give them the information. How do you teach someone how to interpret a forecast and how to act on it?

GH: We're not giving people just a forecast. We're giving them the piece of information on which they need to be able to assess their decision position. People making the decision need to know what the consequence of a forecast would be on an outcome if they were to do this or that. And they have to incorporate the uncertainty of the forecast in that analysis. This was one of the key points we tried to build into the development of the IRI and I'm really pleased to see it's happening. It isn't the climate forecast, stupid! Giving the farmer just a climate forecast is basically useless. The interaction of the forecast with the decision set at the farmer's disposal is where the critical action resides. And this involves profit-risk trade-offs and personal perspectives about them. This basic overall principle is the same for all sectors. It has taken the IRI a while to evolve into this position. It changed [in 2005] from an IRI for Climate Prediction to an IRI for Climate and Society, and now you have a director [Stephen Zebiak] who travels the world talking about risk management and the needs of decision makers.

IRI: Does this make us unique in the world?

GH: It's a very hard space in which to sit. The expectation is: you're either a development person or research person. But to make [climate risk management] work you have to have those ends interwoven, and so you've got to have researchers out there in Central Kalimantan or wherever talking to the people and agencies on the ground — where the rubber hits the road, so to speak. And while the IRI can't do the development it has to be engaged right through to that point in order to be effective. It is hard to do. You need people committed to making that happen. They might not then publish quite as many papers as they would otherwise, but they will probably make a bigger difference in the end.

IRI: What other challenges does the IRI face?

GH: The 'climate change' bubble has burst out into the public domain seriously. But there is a serious disconnect between what people can do now and projections of what the world might be like in 50-100 years' time. There is a clear overlap with climate change and the climate variability/climate risk perspective. If you can manage climate risk, and if you understand the interaction of climate change with risk, then you are really positioning yourself to manage climate change. I think this is the perspective the IRI has to be able to project. No one should be able to say that climate change is really the big issue and you [IRI] are just piddling around on the margins. Working out what to do on the margins [e.g. inter-annual variability] is really the critical piece for being able to work out how to adapt climate change. That has to be really communicated.

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01/27/2009

Reducing Indonesia's Peatland Fires

Farmer from Central Kalimantan, Indonesia. F. Fiondella/IRI

Uncontrolled fires in Central Kalimantan, Indonesia, have destroyed vast peatland forest areas, ruined livelihoods, and led to massive releases of smog and greenhouse gases. Our latest audio slideshow tells the story of how IRI and its partners are using science to develop an early-warning system to reduce the risk of these fires occurring. Please visit IRI's fire and land management page to learn more. ■

01/08/2009

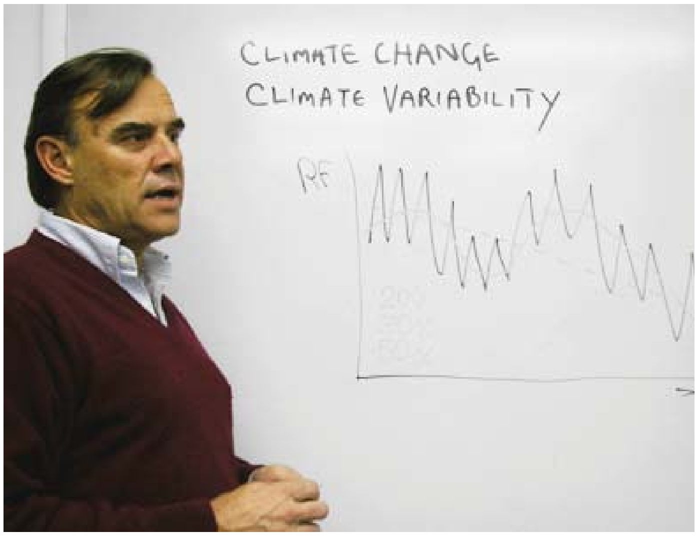
Managing Ethiopia's Water Resources

Rainwater harvesting structure in Koraro, Ethiopia.

IRI's Paul Block describes his recent trip to Koraro, Ethiopia, where there is a cluster of 11 Millennium Villages. Block is working to improve agricultural water management in the area, which is one of the most impoverished in the country and suffers from very poor infrastructure and severe drought. This project has been made possible with support from The Ceil & Michael E. Pulitzer Foundation. ■

12/15/2008

IRI's Walter Baethgen Selected to Prestigious Advisory Post



Walter Baethgen, director of IRI's Latin America and Caribbean program

Walter Baethgen, research scientist and director of the Latin America and Caribbean Regional Program at the IRI, has been invited to become a member of the Scientific Advisory Committee of the Inter-American Institute for Global Change Research (IAI).

Supported by 19 countries, the IAI is dedicated to pursuing the principles of scientific excellence, international cooperation, and the full and open exchange of scientific information to increase the understanding of global change and its socioeconomic implications. This includes understanding how climate variability and change will affect the region's biodiversity, land use and water resources.

"One of the most valuable contributions of the IAI has been the establishment of regional research networks because, on the one hand, it helped the lesser-developed countries increase their research capacity in the global arena and, on the other hand, it provided more developed countries with excellent research issues and problems to establish their studies," says Baethgen.

The IAI's priorities complement IRI's own work in the region, which spans numerous sectors and often enables multi-country cooperation. Its projects work to introduce relevant climate information into the decision-making process and planning for agriculture, water management and public health.

Baethgen has been involved in designing the agenda of the IAI since its creation in 1992. The institute was formed in response to a need for a regional consortium to address global issues. In the 16 years since its creation, IAI has helped bring about a major evolution in the contribution of scientists from lesser developed countries in the Americas. In so doing, Baethgen and his colleagues have made a significant impact on the scientific landscape.

"The IAI is one of the few organizations that have significant funds to support research in global change in the Americas," he says. "Latin American research projects tend to receive less funding from the international community due to the overall relative wealth in the region compared to other regions, such as Southeast Asia or Africa." ■

12/05/2008

IRI at COP14 in Poznan

COP14/Poznan 2008

The International Research Institute for Climate and Society's participation at this year's Conference of the Parties (COP14) in Poznan, Poland centers around two important side events that highlight the importance of climate risk management for adaptation.

Climate risk management enables climate-change adaptation through practical and immediate actions that diminish a society's vulnerability to current and future climate impacts.

On December 3, IRI's Simon Mason discussed the use of climate science in supporting decisions in the humanitarian sector at a side event called "The humanitarian response to climate change: early warning/early action", which was hosted by the International Federation of Red Cross and Red Crescent Societies (IFRC). Mason and representatives from other organizations presented their views and experiences with integrating climate change risk into policies and measures and for strengthening preparedness and response systems.

During the side event, the International Federation also unveiled a new brochure that addresses the challenges that climate-related risks pose to the efforts of humanitarian agencies. Called Early warning > Early action, the document highlights a number of ways in which the International Federation has used IRI's expertise in integrating climate information into decision making.

On Monday, December 8, IRI and the Munich Climate Insurance Initiative co-hosted a side event on climate-related insurance. MCII presented its proposal for climate risk insurance as an adaptation strategy. IRI and its partners showcased their experiences in implementing innovative index insurance to manage climate risks.

IRI's Molly Hellmuth and Dan Osgood spoke at the packed event, which is available as a webcast.
■

11/21/2008
Fighting Poverty with Index Insurance

Design by Jason Rodriguez

Index insurance remains a promising new tool to help alleviate poverty by reducing the impacts of climate shocks in the developing world. It may even increase the poor's resiliency to climate change. In October, IRI co-hosted a workshop to discuss the technical challenges that currently preclude the use of index insurance on a large scale. We share here some of the experiences and resources to come out of that meeting.

"During the workshop, we learned about some of the scientific innovations that could help overcome the hurdles to scaling up insurance programs," says IRI's Molly Hellmuth, one of the event's organizers and editor of the Climate and Society Publication. "However, the innovations must be balanced with the reality on the ground: we need simple, understandable and trustworthy products if impoverished communities are to use index insurance successfully."

More than 30 experts from fields as diverse as reinsurance, climate science, economics and food security participated in the two-day workshop, which was co-hosted by the Center for Research on Environmental Decisions. Among them were representatives from the World Food Programme, the International Fund for

Agricultural Development, the United Nations Development Programme and Oxfam America.

"As a development agency, we strive to support our national counterparts in broadening their options," says Mirey Atallah, who works in the UNDP's Environment Finance Group. "Index insurance is one of many options which we could potentially offer our 160 partner countries. It sends a financial signal to correct policies or practices that may not be viable in the face of climate change and it provides a financial contribution to other social safety nets."

Index insurance contracts are linked to a weather index such as rainfall, rather than a possible consequence of weather, such as crop failure. This subtle distinction resolves a number of fundamental problems that make traditional insurance unworkable in rural parts of developing countries. For example, unlike traditional crop insurance, the insurance company doesn't need to visit a farmer's field to determine premiums or to assess damages. Instead, the insurance contract is designed around rainfall data. If the amount of rainfall is below the threshold stipulated in the contract, the insurance pays out. Since the payout isn't linked to crop survival or failure, the farmer has incentive to make the best decisions for crop survival.

Case studies and pilot programs have shown that index insurance can effectively target a range of critical climate and poverty issues — from national-level food insecurity response to farm-level credit availability (read about IRI's work in Malawi and Ethiopia). These smaller scale projects show great promise but they also have uncovered significant questions which, if ignored during implementation on a larger scale, could lead to failure and even increase people's overall vulnerability.

Perhaps the largest hurdle to successfully scaling up index insurance is how to reduce and communicate basis risk. Basis risk is defined simply as all the risks that the insurance contract doesn't cover. Basis risk can occur for many reasons. It can occur when the amount of rainfall measured at a station differs from the rainfall at a farmer's plot. It can occur when the formula for the index doesn't fully reflect the drought risk or period when a crop is most vulnerable to drought, or if the index doesn't cover a useful risk in the first place. It can also occur if the crop is destroyed in a non-drought year by another factor, such as disease or flooding.

"People need to know what is not covered so they can protect themselves appropriately," says Dan Osgood, who leads IRI's research on index insurance. "The index we choose must of course target the correct risks, and whatever risk remains must be clearly understood by the contract holder."

Osgood says there's a tradeoff between providing complex insurance programs that have low basis risk and more simple ones that cover fewer risks.. "If the contract is too complex, people won't be able to use it or understand it properly, and can set themselves up for disaster.

Among the many other topics discussed during the meeting were how rainfall simulations and remote sensing could be used to design better insurance contracts and or communicate risks to farmers and other insurance users.

These technologies haven't been used on a broad scale for insurance programs that cover crop losses, mainly because of their limited resolution. For example, a remote-sensing product such as the Normalized Difference Vegetation Index (NDVI), an indicator of the amount and health of vegetation as measured by satellites, has a spatial resolution of four to eight kilometers.

"This is a problem for monitoring crops in regions where agricultural production comes predominantly from small holder farms, which are at spatial scales finer than one kilometer," says IRI scientist Pietro Ceccato. "On the other hand, in some instances even this low resolution is still superior to that of many ground-based rain-gauge networks in the developing world."

Another topic of discussion was the role of seasonal climate forecasts in the design of insurance programs. If the insurance is designed without accounting for forecasts but clients such as farmers use forecast information to buy insurance only in years when drought conditions are predicted, then the insurance financing may collapse.

The workshop also represented an important step in the production of the next issue of IRI's flagship Climate and Society Publication, which will take a fresh look at the effectiveness of index insurance for reducing poverty and better managing climate risk. Climate and Society No. 2 will examine the current case studies, and rely on expert scientific opinion to delineate the advances, opportunities and pitfalls faced in scaling up index insurance.

"This next issue will hopefully help policy makers, researchers, donors and practitioners gain a better sense of what needs to be done to move forward," says Hellmuth.

■

The Access and Use of Climate and Weather Information in the International Federation of Red Cross and Red Crescent Societies: Initial observations from the field

Amir Jina (2009)

Background

In December of 2007 the International Research Institute for Climate and Society (IRI) at Columbia University's Earth Institute formed a partnership with the International Federation of Red Cross and Red Crescent Societies (IFRC). The Red Cross Red Crescent (RC/RC) Climate Centre helps facilitate the effort to provide the IFRC with tools and support to improve disaster management and decision making through climate information. Through this collaboration, IRI works to understand the needs of the IFRC and provide accessible and relevant climate information to support humanitarian decisions. Since 2007, IRI has developed ways to better serve the IFRC including: 1) a mapping tool, accessible to Disaster Managers around the world through IFRC's online Disaster Management Information System (DMIS), which displays precipitation forecasts on multiple timescales in the context of how the forecasted rainfall compares to normal rainfall for that time and place; and 2) a Help Desk, through which climate scientists aim to respond within 24 hours to inquiries from IFRC staff and volunteers regarding climate, weather and forecasts. Students from the IRI-affiliated Climate and Society Master's Program at Columbia University also help facilitate the collaboration between the IRI and IFRC through summer internship projects and research.

Climate change demands improved response and a greater emphasis on emergency preparedness and risk reduction.

The IFRC is the largest humanitarian organization with a network of about 100 million volunteers and staff in 186 countries to take action to respond to disasters. But response is only one element in the chain of action to reduce the impacts of disasters. Prevention, preparedness, early warning and early action are necessary to save lives, livelihoods and use resources efficiently. Climate change, rapid population growth, environmental degradation and other ongoing processes require a better understanding of vulnerabilities and risks. These notions are shared by the humanitarian community, as highlighted in the Hyogo Framework for Action, the 2009 Global Platform for Disaster Risk Reduction and the World Climate Conference-3. Early Warning for Early Action was the central theme of the 2009 IFRC *World Disasters Report.*

Opportunities

Effective use of weather and climate information has great potential to improve disaster preparedness and response.

The IFRC can utilize climate and weather information to trigger actions that will save lives and protect livelihoods. The information, however, needs to be readily available, reliable and easy to understand in order to support humanitarian decisions. The usefulness of this information is affected by the policies that are in place for its use, the training and capacity of workers and volunteers, available resources and the type of crisis.

For example, climate information has the potential to greatly benefit work in the following humanitarian areas:

- Disaster Management: Seasonal precipitation forecasts, when accompanied by monitoring of rainfall on shorter timescales and 'no-regrets' strategies for flood preparedness, enable early warnings to be translated into early actions that save lives.

- Food Security and Livelihoods: Climate forecasts could be used to help ensure food aid is sufficient to meet the needs of food insecure populations, or to advise farmers on the best crops to plant based on anticipated rainfall, or when a harvest left to dry is at risk of being spoiled by rains.

- Health: Climate forecasts can also feed into early warning systems that enable disease prevention measures and health promotion activities that reduce suffering and impacts on livelihoods from climate related illness such as malaria, water-borne diseases and heat stress.

Yet the IFRC is not using climate information to its full potential. To better understand the humanitarian needs and current use of weather and climate information, the IRI and the RC/RC Climate Centre set up an initial fact-finding mission involving graduate students from Columbia University. These young scholars conducted surveys, interviews, meetings and workshops over two-month periods in 2008 and 2009. Scientists from the IRI provided technical support to the students, who were supervised by RC/RC Climate Centre staff. Some of the students worked with National Societies, others with small local offices, and others with Zonal or Regional offices that serve multi-country areas (see Figure 1). The US National Oceanic and Atmospheric Administration (NOAA) Climate Program Office provided funding for the project. While the research is ongoing, this report captures the key lessons learned to date.

Current Use of Climate Information

All IFRC offices reported using at least one type of weather or climate information.

In total, students identified 18 different types of weather and climate information used by IFRC offices, ranging from seasonal precipitation forecasts to flood alerts (see Figure 2). Weather and climate information is typically provided by national meteorological services and institutions that specialize in region-specific hazards (e.g. hurricanes or climate-related threats to food security). When asked why they prefer certain sources of information over others, IFRC staff most commonly identified the following reasons:

- The information is provided directly to decision makers or to IFRC staff at large through email, fax, SMS, a printout discussed at regular meetings, or is easily accessible via television or radio.

- The information provider has a good reputation or is widely trusted as a reliable source of information.

- The information is simple, non-technical and easy-to-use or interpret.

- The monitoring product is a "one stop shop" for disaster managers to get information on all types of disasters.

- The information is well displayed and organized.

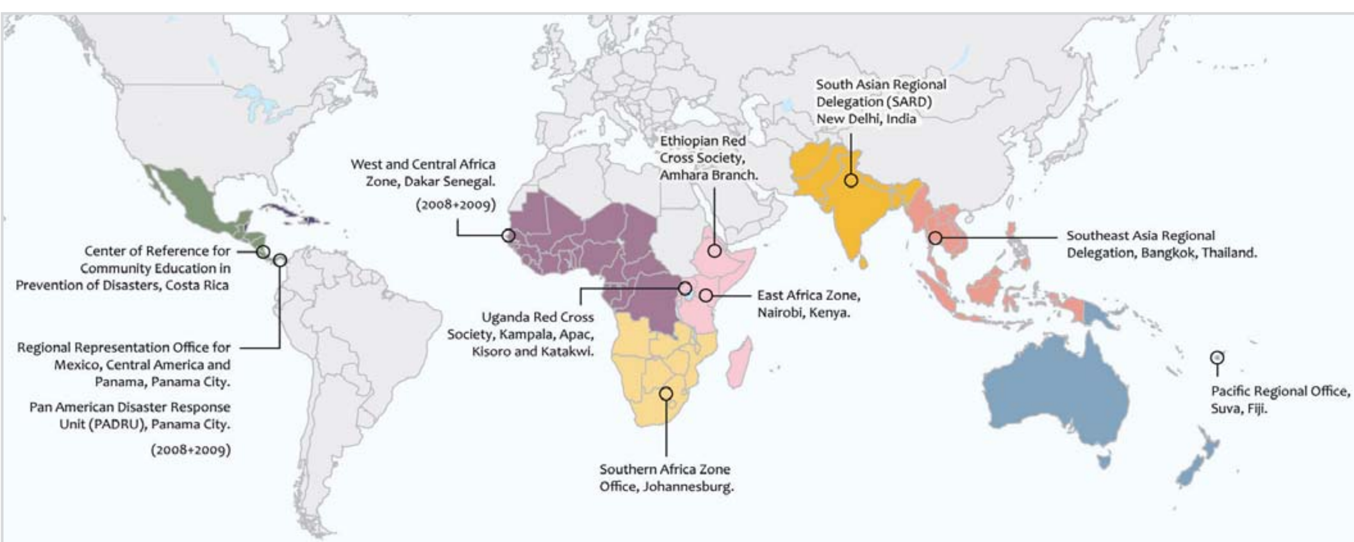


Figure 1. IFRC office locations where students conducted research.

Short-term weather forecasts are utilized most frequently by IFRC offices.

The three most commonly utilized types of climate information are short-term forecasts for cyclonic activity, one- to six-day weather forecasts (temperature and precipitation), and short-term flood forecasts and alerts (see figure 2). Flood forecasts have emerged as a common need across IFRC offices. National Societies and Regional offices in Central America, Southeast Asia, South Asia, East Africa, West and Central Africa all requested improved flood forecasts on various timescales. Currently, disaster managers typically receive flood forecasts no more than 48 hours before a flood. Frequently, alerts are sent as little as 10 hours in advance, or once flooding has already begun.

Although IFRC offices commonly utilize short-term forecasts, the manner and extent to which they are effectively integrated into decision making varies. Decisions for action are taken on a case-by-case basis and depend on many factors including: the type of hazard, the role and capacity of the national society, density and vulnerability of the population at risk and the role of other key stakeholders involved. For example, in Mexico, when a hazard is detected, the national society alerts its branches and mobilizes its national disaster response unit. In the case of a hurricane, the unit will arrive two days before the expected impact in order to prepare people, and to coordinate with state authorities and local Red Cross personnel to manage

	Pan-American DR Unit	Costa Rica Red Cross	Mexico Red Cross	Guatemala Red Cross	El Salvador Red Cross	East Africa Zone	Ethiopia, Red Cross	Uganda Red Cross	West and Central Africa Zone	Southeast Asia Regional Delegation	Philippines Red Cross	Indonesia Red Cross	South Asia Regional Delegation	Bangladesh Red Crescent	Pacific Regional Office	**Total**
Hurricane/Cyclone/Typhoon forecasts and alerts	√	√	√	√	√					√	√	√		√	√	**10**
Weather forecasts (short-term rain and temperature)		√	√	√	√	√		√		√	√	√	√			**10**
Flood Alerts and Forecasts	√	√	√	√	√			√		√	√	√				**9**
Seasonal Hurricane Forecasts	√	√	√	√	√											**5**
General Disaster Monitoring Tools	√	√		√			√			√						**5**
ENSO Forecasts and Information	√	√				√		√				√				**5**
Drought Monitoring							√	√				√				**3**
Food Security or Locust Alerts						√		√	√							**3**
Info from Disaster Management Coordination Tools	√			√						√						**3**
Seasonal Precipitation Forecasts								√	√							**2**
Precipitation Forecasts in Context (On multiple timescales)									√				√			**2**
Seasonal Temperature Forecasts									√							**1**
Monsoon Forecasts									√							**1**
Climate-realted health warnings									√							**1**
Landslide forecast											√					**1**
Rainfall Intensity Forecasts												√				**1**
Real-time High Resolution Satellite Monitoring		√														**1**

Figure 2.Types of weather and climate information reported as utilized by some IFRC offices

logistics, communications, humanitarian assistance, rescue, and pre-hospital medical assistance. In South-east Asia, the Regional Delegation will alert a National Society to a detected storm risk. The National Society then decides whether to request external assistance, position resources and alert volunteers.

West Africa innovation and collaboration in practice

In 2008, the IFRC West and Central Africa Zone used available climate information as an early warning for early action to good effect. After receiving a seasonal precipitation forecast from ACMAD in May 2008, indicating an enhanced likelihood for above-normal rainfall in the following July-September season, the WCAZ held a flood preparedness meeting where disaster managers from flood-prone countries developed contingency plans, country-specific risk maps, an early-warning system, partnerships and better coordination.

In late June, the WCAZ office received an updated seasonal forecast from ACMAD, confirming the earlier forecast. It then held a five-day Regional Disaster Response Team (RDRT) Team Leader's Training. The RDRT Team Leaders were prepared to conduct a rapid assessment of the impact and needs of the most vulnerable victims of the disaster; to write a flood contingency plan and a Disaster Relief Emergency Fund (DREF) request; to mobilize people, as well as logistical, financial and administrative procedures. Visas and medical insurance were secured for RDRT Team Leaders so that their deployment across borders could be expedited.

The Zone was able to use funds immediately available from the DREF to pre-position the emergency stocks around the region in order to be able to meet flood victims' needs within 24-48 hours. As a result, most countries received needed supplies in a matter of days after flooding. In contrast, the year before it took on average 40 days to deliver many relief items and services. A preliminary quantitative comparison between the costs of flood response alone (2006 and 2007) and the cost of flood response with Early Warning/Early Action (2008) also showed a 33% lower cost per beneficiary.

Reference: Braman (2009), Early Warning, Early Action: An Evaluation of IFRC West and Central Africa Zone Flood Preparedness and Response, 2008

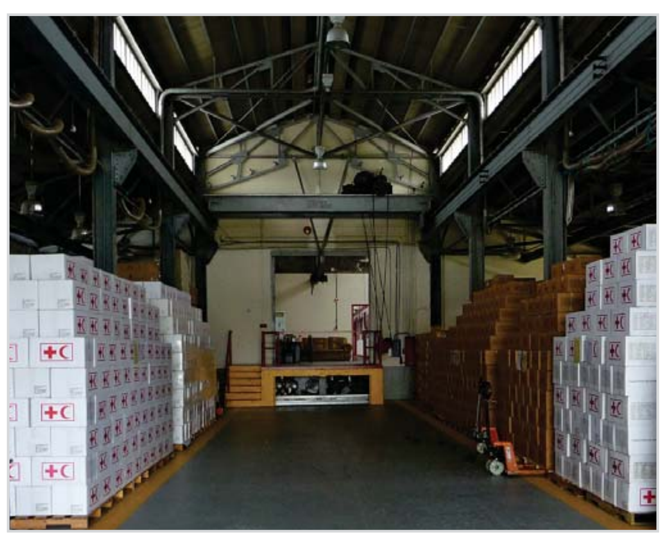
Longer-term forecasts are also utilized, but IFRC offices are often less clear on how to take action or lack capacity to act.

IFRC offices are used to managing the uncertainty in short-term forecasts. Longer-term forecasts, however, are more difficult to translate into action. For example, many offices at the national and community level have a hard time envisioning how a forecast for 50% chance of 'above-normal' rainfall over the southeastern corner of their continent over the next 3 months could serve as a warning that translates into operational decisions on the ground. With the larger uncertainty of precipitation forecasts and their rather tentative connection to actual flooding events, decision-making requires a better understanding of the types of decisions that forecasts with longer lead-time can inform (see Figure 3).

A number of IFRC offices reported using or being familiar with longer-term forecasts for cyclone seasons, El Niño and La Niña, seasonal precipitation, climate-related health concerns and food security. Other offices reported being unaware of long-term forecasts, or unconvinced that they offered any useful information for operations. Even where IFRC offices receive long-term forecasts, it appears that they have trouble taking action based on this information. For example, in Central America and the Caribbean, the seasonal hurricane forecast is announced to disaster managers at the annual pre-hurricane season meeting. However, the seasonal forecast does not seem to influence the level of preparedness activities undertaken in the region--for instance, by enhancing funding and capacity at the start of above-average seasons. In the Pacific Islands region, where precipitation patterns are often influenced by the El Niño-Southern Oscillation (ENSO), offices have not yet begun to monitor seasonal precipitation forecasts and prepare accordingly.

A notable exception can be found in the IFRC West and Central Africa Zone (WCAZ), which began taking action for flood preparedness based on seasonal precipitation forecasts in 2008 (see box). The zone's 2008 success in acting on long-term forecasts was due in part to the collaboration with the RC/RC Climate Centre and information providers, the African Centre of Meteorological Applications for Development (ACMAD) and the IRI. As in West Africa, other IFRC offices need to work with information providers to assess opportunities and develop strategies for using long-term forecasts to improve on-the-ground work.

Although the IFRC is focused on preparedness in addition to response, acting on long-term forecasts is hampered by the reality that when hazards become disasters they trigger media attention, donor support and volunteer engagement. Carefully averted disasters, on the other hand, do not always capture the same kind of attention, and thus new mechanisms are required to trigger funding and support for preparedness activities that reduce risk based on longer-term forecasts.


Brian Kahn (2009)

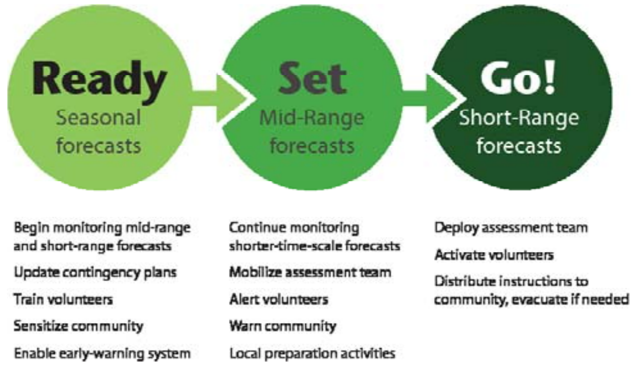


Figure 3: Translating warnings into action using forecasts at multiple timescales.

This figure was adapted from a presentation slide from: Daly, Meaghan. "Translating Climate Information Into Action: Considering Next Steps for Early Warning, Early Action in the West and Central Africa Zone." Columbia University, New York. August 5, 2009

Recommendations

1 Form Partnerships between Information Providers and IFRC Offices for Support, Training and Ongoing Dialogue

Partnerships between IFRC offices and information providers would provide the opportunity for continued support, training and dialogue necessary to realize the potential benefits of using climate information. Specifically, these partnerships should pursue the following goals:

A. Increase the Accessibility and User-Friendliness of Products

Many existing information products should be made more accessible and easier to use. The assumption that climate information will be utilized simply because a provider makes it freely available on a website is false. First, the user must find out that the product exists and then work with the provider to see that the information is delivered in a timely manner through the preferred means of communication (e.g. email, SMS, phone, etc). Ongoing dialogue and interaction between the information provider and end user is also necessary to ensure that relevant information is presented in a well-organized and non-technical format that is easy to understand. New types and sources of climate information should meet the criteria described above for preferred information sources. Regional and global products should be provided in the language of their intended users.

B. Provide New Products to Fill Information Gaps for IFRC Needs -Starting with Improved Flood Forecasting Tools Developed in Close Collaboration with the Designated National Hydrology Service Provider(s).

In some cases, IFRC offices could benefit from information products that do not currently exist. A number of IFRC offices expressed a need for improved flood forecasting tools. Collaboration between climate scientists, meteorologists and hydrologists to produce flood forecasts for the IFRC on multiple timescales is highly recommended. An improved flood tool should incorporate information related to climate, hydrology, population and vulnerability. Translating seasonal precipitation forecasts into flood forecasts would provide disaster managers with the same service that is provided to food security officers when the climate forecasts are translated into food security warnings, or to health officials when those forecasts are translated into dengue or malaria advisories.

C. Provide Training for IFRC Staff in the Use of Climate Tools and How Climate Information Could Trigger Humanitarian Action

Once climate information tools and strategies are identified IFRC staff will need additional training in how to make best use of climate information. This training may include:

- Learning to access and interpret climate information tools.
- Learning how to monitor seasonal forecasts in conjunction with medium-range and short-term forecasts.
- Understanding how to take action through a series of gradually increasing preparedness activities that start with a 'no-regrets' approach (investments that benefit the IFRC even if the forecasted event does not take place like updating contingency plans).
- Establishing channels of communication and decision-making within the IFRC that are prepared to receive and take appropriate action based on time-sensitive climate information.

Ujala Qadir (2009)

Recommendations (continued)

2 Strengthen Organizational Capacity to Scale Up Risk Reduction and Preparedness Activities with Improved Use of Climate Information

The shift from traditional preparedness and response to early warning and early action using climate information could be supported by:

- Monitoring and evaluating the impact of early warning, early action on reducing the number of lives lost and minimizing suffering from climate-related disasters.
- Monitoring and evaluating the financial cost and benefits of early warning, early action over time.
- Educating donors on opportunities for benefiting from effective use of climate information.
- Adjusting mechanisms for donors beyond the DREF to allow for provision of funds before disasters have occurred.
- Considering establishment of a 'Global Safety and Resilience Fund' to capture the interest and highlight the need for increased funding to prepare for the increasing frequency and severity of hazards related to climate change.
- Recognizing IFRC offices and individuals who save lives, funds and minimize suffering through early warning, early action and other preparedness activities.
- Creating opportunities for IFRC offices to share best practices amongst each other in the use of climate information for early warning and early action.

Reference: This document was written for the WCC3 by Lisette Braman, Technical Advisor to the RC/RC Climate Centre. The document is a synthesis of reports, presentations and contributions of the following IRI/Climate Centre/IFRC interns from Columbia University's Climate and Society Masters Program: Sarah Abdelrahim, Julie Arrighi, Lisette Braman, Nickleson Cook, Meaghan Daly, Amir Jina, Brian Kahn, Caitlin Kopcik, Mary Mwangi, Ujala Qadir, Jessica Sharoff, Arame Tall, and Cynthia Thomson.

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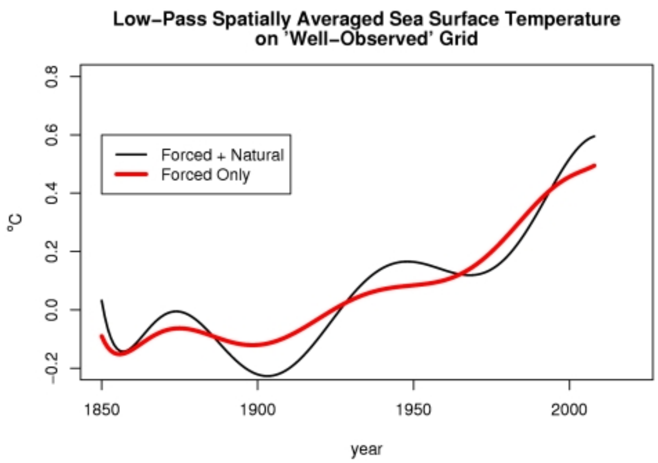
Selected Abstracts

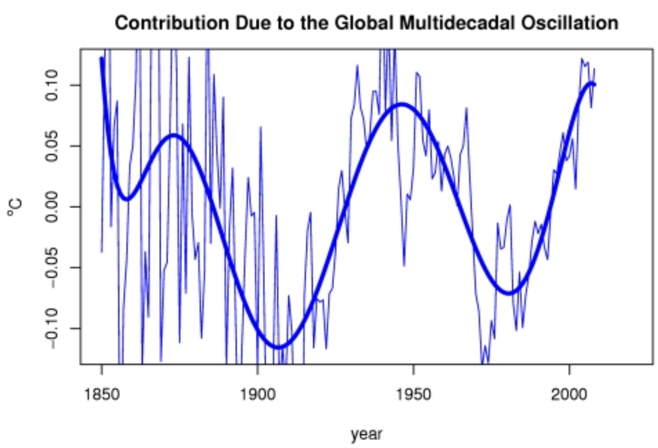
A Global Multidecadal Oscillation

Not only has the global mean temperature risen over the last century, but the rate of warming has increased in the last few decades. An important question is whether this acceleration in warming is due to natural variability or anthropogenic forcing. We address this question with evidence from model simulations and observations of the global sea surface temperature (SST). We identify a natural global multidecadal oscillation (GMO) in model simulations and show that this oscillation accounts for significant multidecadal variations in the observed global average SST.

The top panel of the figure at right shows the low-pass filtered global average SST over the past century and a half with the GMO component (black line) and without the GMO component (red line). The bottom panel shows the contribution of the GMO to the global average SST. We find that the GMO can explain decadal fluctuations in the global mean SST on the order of 0.1C and can account for about half of the observed warming in the last 25 years, thereby explaining a substantial fraction of the recent acceleration in warming.

The GMO is identified from IPCC-AR4 control runs (no external forcing), using a new technique that finds components that maximize the Average Predictability Time (APT). APT is the integral over lead time of the explained variance of a multivariate linear regression model and is essentially a multivariate generalization of an integral time-scale. Components that are predictable on decadal time scales have large values of APT. Finding the SST component that maximizes APT over all available 300-year control runs in the IPCC-AR4 data set yields several predictable components. The most predictable component is the GMO and has a single sign with amplitudes concentrated near the polar oceans in the Pacific, Atlantic and Southern Oceans.





Upper panel shows the low-pass filtered global mean of the forced plus GMO (black) components of SST and that of the forced component alone (red). Lower panel shows the contribution of the GMO to the annual (thin line) and low-pass filtered (thick line) global mean SST.

To test the relevance of this model-derived component to the observed ocean and to obtain the time series in the figure, we use an optimal fingerprinting technique to determine the amplitudes of the GMO and of the forced component as estimated from linear trend analysis of the IPCC-AR4 20th century simulations (with external forcing). This analysis reveals that most multidecadal fluctuations in the observed global average sea surface temperature can be accounted for by these two components alone. We find that the GMO is strongly correlated with the Atlantic meridianal oscillations (AMO), suggesting that the AMO is primarily a natural fluctuation.

*Contributed by T. DelSole, **M.K. Tippett**, and J. Shukla*

A Modified Support Vector Machine Based Prediction Model on Streamflow at the Shihmen Reservoir, Taiwan

The uncertainty of the availability of water resources during the boreal winter has led to significant economic losses in recent years in Taiwan. A modified support vector machine (SVM) based prediction framework was proposed to improve the predictability of the inflow to Shihmen reservoir in December and January, using climate data from the prior period. Highly correlated climate precursors were first identified and adopted to predict water availability in North Taiwan. A genetic algorithm based parameter determination procedure was implemented to the SVM parameters to learn the non-linear pattern underlying climate systems more flexibly. Bagging was then applied to construct various SVM models to reduce the variance in the prediction by the median of forecasts from the constructed models. The enhanced prediction ability of the proposed modified SVM-based model with respect to a bagged multiple linear regression (MLR), simple SVM, and simple MLR model has now been demonstrated. The results show that the proposed modified SVM-based model outperforms the prediction ability of the other models in all of the adopted evaluation scores.

*Contributed by Li, P., H. Kwon, **L. Sun**, **U. Lall**, and J. Kao*

A New Approach to Nesting with Bias Correction for Regional Climate Models

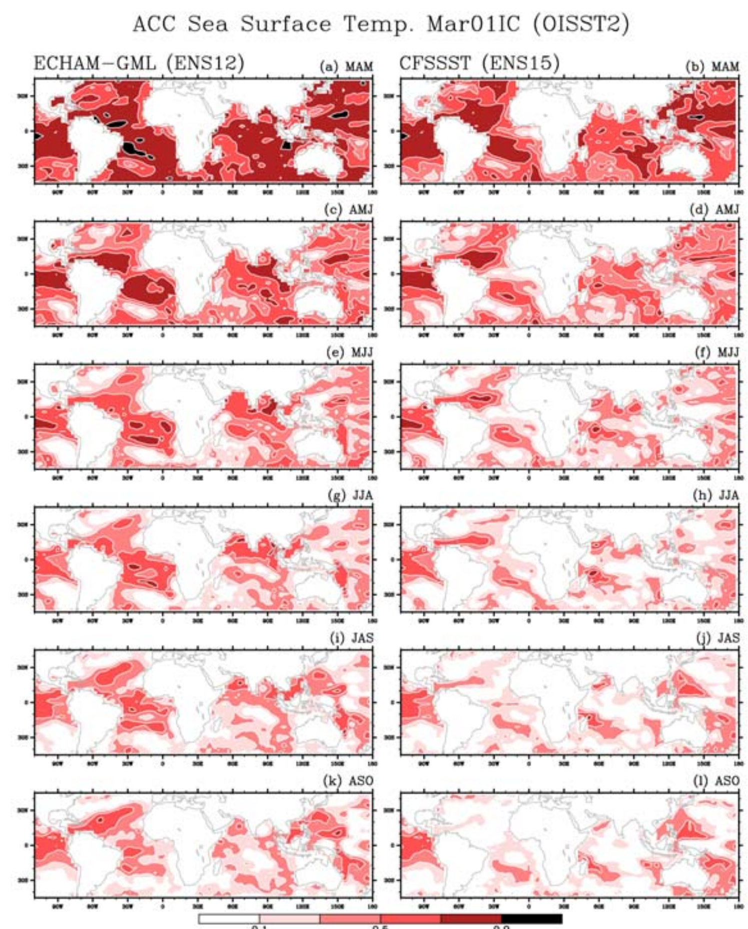
For the conventional one-way nesting method, the full large-scale fields from the General Circulation Model (GCM) are provided to the Regional Climate Model (RCM) with an interval of 3-12 hours. Errors in the large-scale fields of the driving GCM are transmitted to the nested RCM, which often results in poor simulations or forecasts of the RCM. Anomaly nesting that involves replacing the GCM climatology with observed climatology while forcing the nested RCM can improve the RCM performance on RCM climatology, but the improvement on simulation of the interannual variability is limited. In this study, we explore a new nesting approach whereby we not only replace the GCM climatology with the observed (analyzed) climatology, but also correct the GCM anomaly fields statistically. A comparison of the conventional nesting, anomaly nesting and the new nesting approaches for downscaling of ECHAM4.5 GCM seasonal climate over China using the RSM reveals that reduction of errors in the driving GCM anomaly fields can significantly improve the regional model performance on simulation of the interannual variability. More tests on this new nesting approach are underway.

*Contributed by **L. Sun** and H. Li*

A New Hybrid Coupled Forecast System Utilizing the CFS SST Forecasts

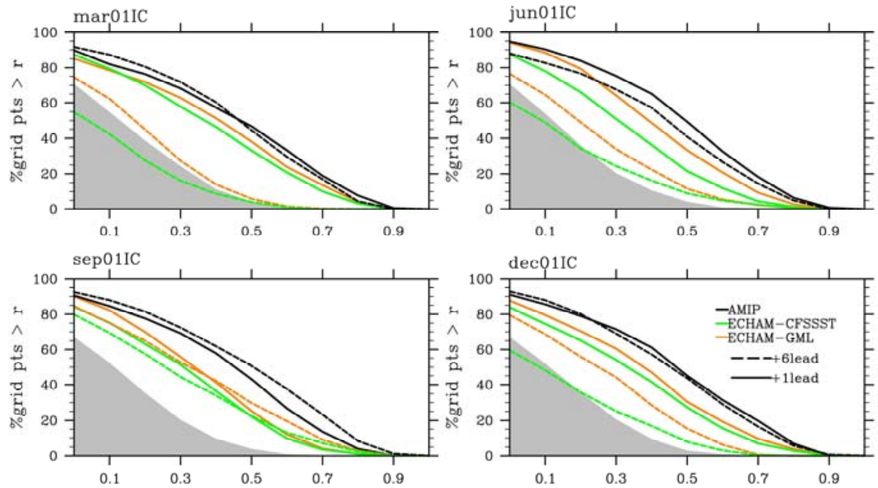
To date, all of the models utilized in the IRI real-time seasonal forecast system have been based on the 2-tier approach. Although this approach has the advantage of reduced systematic error and the possibility of multiple inputs for sea surface temperature (SST) it does neglect the possible benefits of coupling in those regions where the atmosphere drives the ocean. Here, we introduce a new real-time forecasting system, based on the ECHAM4.5 atmospheric general circulation model (AGCM) (Roeckner et al., 1996) and denoted as the ECHAM-GML, which has a hybrid coupling approach. In this hybrid approach, the SST in the central and eastern Tropical Pacific is prescribed to be the forecast SST from the National Centers for Environmental Prediction (NCEP) coupled forecast system (CFS) (Saha et al., 2006). For the remainder of the tropical oceans the SST is predicted using a thermodynamic ocean model. The potential of such a forecast system has previously been diagnosed using observed SST in the central and eastern Pacific (Lee et al., 2009). This new forecast system will be employed at IRI both as part of a multi-model ensemble (MME) system and as a stand-alone model. In the latter context, the model forecasts are being utilized by IRI regional projects, such as the Development and Application of Extended Range Forecast System for Climate Risk Management in Agriculture (ERFS) project in India and the regional Climate Outlook Fora for Western Africa, PRÉvisions Saisonnières en Afrique de l'Ouest (PRESAO).

In the figure at right, we show some results of the promising aspects of the models skill based on retrospective forecasts in comparison to other forecast products utilized at IRI. The skill of the retrospective SST forecasts by ECHAM-GML for the March 1 IC is compared with that from the CFS, for 6 consecutive seasons in the figure. The SST in the central and eastern Pacific in both cases is that from the CFS. ECHAM-GML shows improved skill compared to CFS almost everywhere in the tropics except to the east of Australia at later leads. ECHAM-GML forecasts maintain relatively high (> 0.6) anomaly correlation coefficient (ACC)s in the Gulf of Guinea and the Eastern



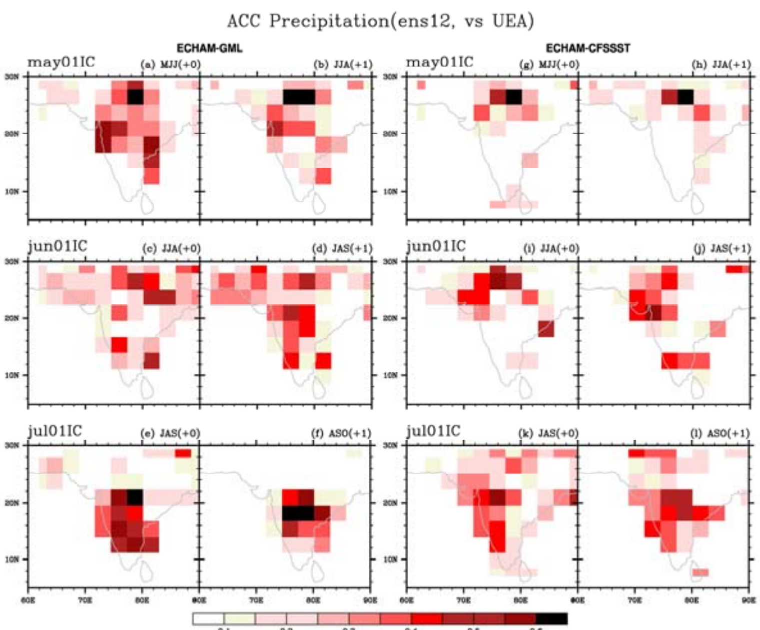
Anomaly correlation coefficient (ACC)s of the seasonal SST forecast from Mar01 initial conditions from ECHAM-GML: (a) MAM, (c) AMJ, (e) MJJ and (g) JJA (i) JAS (k) ASO and from CFS : ECHAM-GML, and bias-corrected SST (b) MAM, (d) AMJ, (f) MJJ and (h) JJA (j) JAS (l) ASO.

Indian Ocean until later leads, whereas the ACCs of CFS forecasts decrease much more rapidly. ECHAM-GML also exhibits higher skill in SST prediction of the important SST indices, such as the ATL3, the Tropical Atlantic gradient, as well as the Indian Ocean Dipole Indices. This improvement in SST forecast is observed for all initial condition months, but is found to be largest in austral winter.



The aggregate ACCs of the seasonal average near surface air temperature forecasts, (a)(b)(c) on Mar01IC, (d)(e)(f) Jun01IC, (g)(h)(i) Sep01IC, and (j)(k)(l) Dec01IC. ECHAM-GML forecasts are in left panels, ECHAM-CFSSST in middle panels, and ECHAM-AMIP in right panels.

The figure above right shows forecast skill for near-surface air temperature and precipitation of the hybrid 1-tier ECHAM-GML compared with that from the 2-tier ECHAM AGCM having CFS SST prescribed everywhere (denoted ECHAM-CFSSST). The aggregate ACCs are presented for near-surface air temperature forecasts of the first and the sixth lead seasons made at four different IC months, for ECHAM-GML, ECHAM-CFSSST as well as for the case of ECHAM forced by observed SST (AMIP). ECHAM-GML is seen to have better skill for this metric for all IC months and both leads. Results for precipitation are more equivocal with both systems showing superior skill for different regions, ICs, and lead. Ultimately, a forecast model's utility in an MME forecast system is in the value of additive skill to the other models in the forecasting system. For instance, as shown in the figure at left, ACCs of total precipitation forecasts over India during the summer are generally higher with ECHAM-GML than with ECHAM-CFSSST. However, the two forecast systems have regions of relatively high skill that are different suggesting they would both contribute useful non-redundant information to a multi-model ensemble (MME) forecast system.

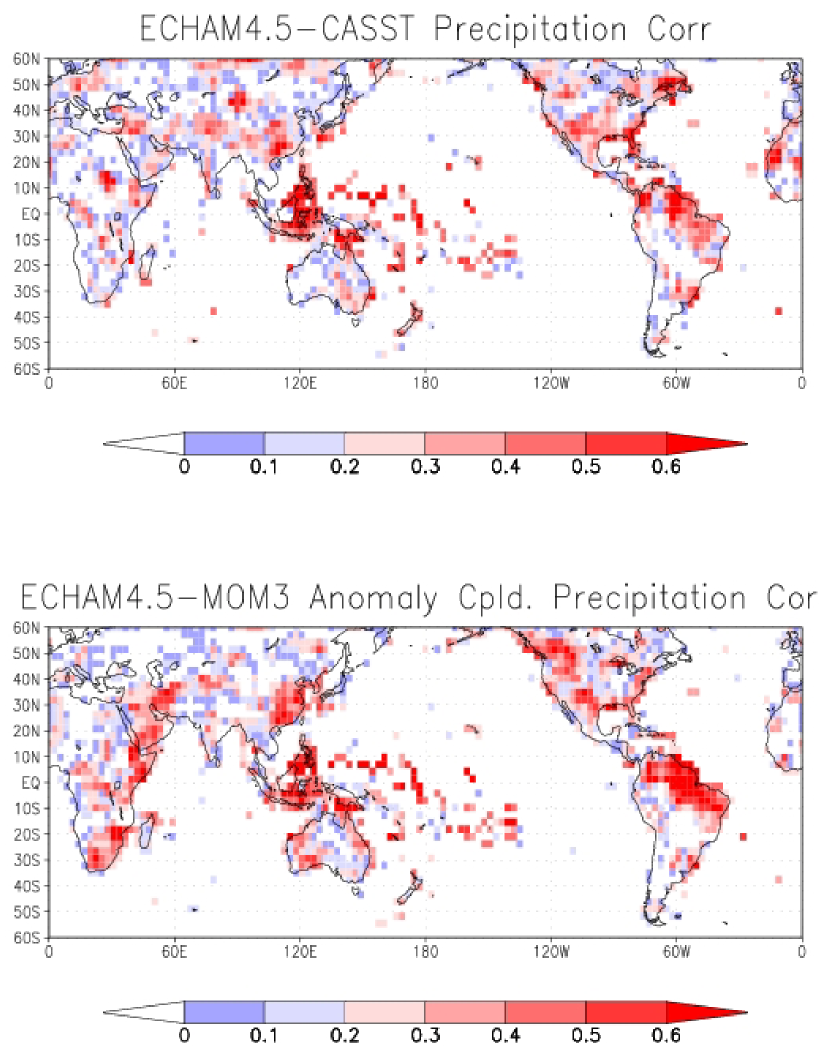


ACCs for the forecasts at the 0th and the 1st leads made with May (a)(b),(g)(h), June (c)(d),(i)(j), and July (e)(f), (k)(l) initial conditions. ECHAM-GML forecasts are on the left and ECHAM-CFSSST are on the right.

Contributed by ***D.E. Lee*** *and* ***D.G DeWitt***

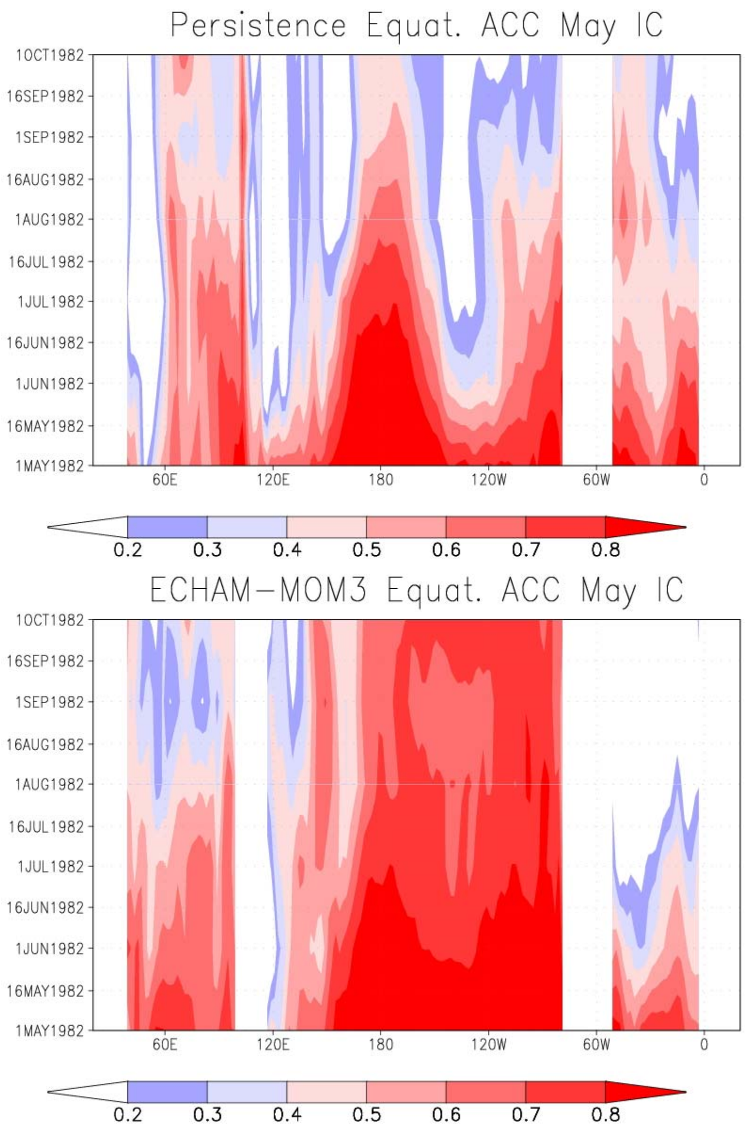
A New Real-Time Coupled Atmosphere-Ocean General Circulation Forecast System at IRI

IRI has implemented a real-time coupled atmosphere-ocean general circulation model (CGCM) forecast system. The model employs an anomaly coupling strategy to minimized drift from the observed climate. This model is an updated version of the previous CGCM (DeWitt, 2005) which utilized the direct coupling strategy. The CGCM component models are the Max-Planck Institute (MPI) ECHAM4.5 atmospheric general circulation model (AGCM) (Roeckner et al., 1996), and the Geophysical Fluid Dynamics Laboratory (GFDL) Modular Ocean Model Version 3 (MOM3) (Pacanowski and Griffes, 1998) ocean general circulation model (OGCM). The OGCM is initialized using an ocean data assimilation (ODA) system developed at GFDL and based on the ideas of Derber and Rosati (1989). The ODA system assimilates only temperature. Initial conditions for the AGCM come from AMIP-type integrations using the ODA sea-surface temperature (SST). Retrospective forecasts have been made for the 1982-present period for each initial condition month. The forecasts are of 8 months length and there are 24 ensemble members. The forecasts from this model are being used in the IRI regional projects including the Development and Application of Extended Range Forecast System for Climate Risk Management in Agriculture (ERFS) project in India. The CGCM forecasts are also being used as part of the new 1-tier multi-model ensemble (MME) forecast system which has been developed at IRI (Li et al., 2009).



Anomaly correlation for precipitation forecasts for November-December-January starting from October 1 initial conditions. Upper panel: Tier-2 ECHAM4.5 using Constructed Analog SST forecast. Lower Panel: Tier-1 ECHAM4.5-MOM3 anomaly coupled.

The figure at right shows an example of the skill of precipitation forecasts for the November-December-January (NDJ) season starting from October 1 initial conditions (IC) for the new CGCM is



Equatorial anomaly correlation for sea surface temperature for May initial condtion. Upper Panel: Persistence. Lower Panel: ECHAM-MOM3 CGCM.

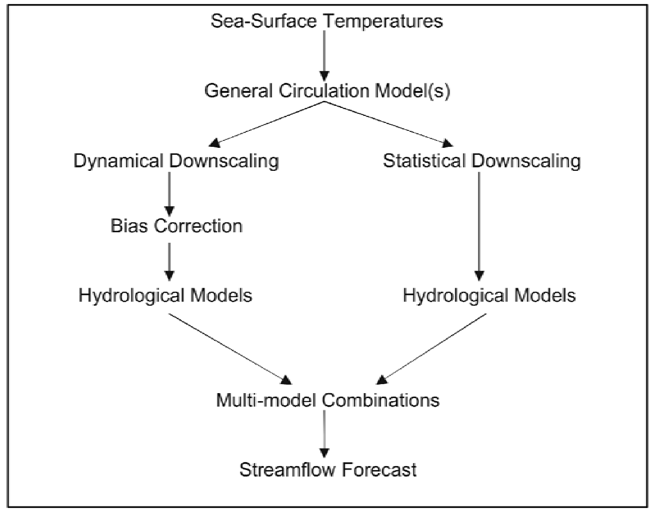
compared with that from the 2-Tier ECHAM4.5 system using the SST forecasts from the Constructed Analog (CA) method of Van Den Dool (1994). The CGCM is seen to have higher skill in the regions of eastern and southern Africa as well as northern South America. The forecast skill of near-equatorial SST for the CGCM and persistence is given in the figure at left. The CGCM is seen to have higher forecast skill throughout the Pacific at all leads. On the other hand, after the first few months the CGCM skill is lower than for persistence in the Indian and Atlantic Oceans.

In more extensive comparisons the CGCM forecast skill of near-surface air temperature and precipitation has been found to be complimentary to that from other dynamical forecasting tools used at IRI for generating MMEs. Therefore, inclusion of the CGCM with these other tools increases the overall skill and hopefully the usefulness of the MMEs for climate risk management applications.

*Contributed by **D.G. DeWitt***

A Streamflow Forecasting Framework using Multiple Climate and Hydrological Models

Water resources planning and management efficacy are subject to capturing inherent uncertainties stemming from climatic and hydrological inputs and models. Streamflow forecasts, critical in reservoir operation and water allocation decision making, fundamentally contain uncertainties arising from assumed initial conditions, model structure, and modeled processes. Accounting for these propagating uncertainties remains a formidable challenge. Recent enhancements in climate forecasting skill and hydrological modeling serve as an impetus for further pursuing models and model combinations capable of delivering improved streamflow forecasts. However, little consideration has been given to methodologies that include coupling



Proposed framework for streamflow forecasting

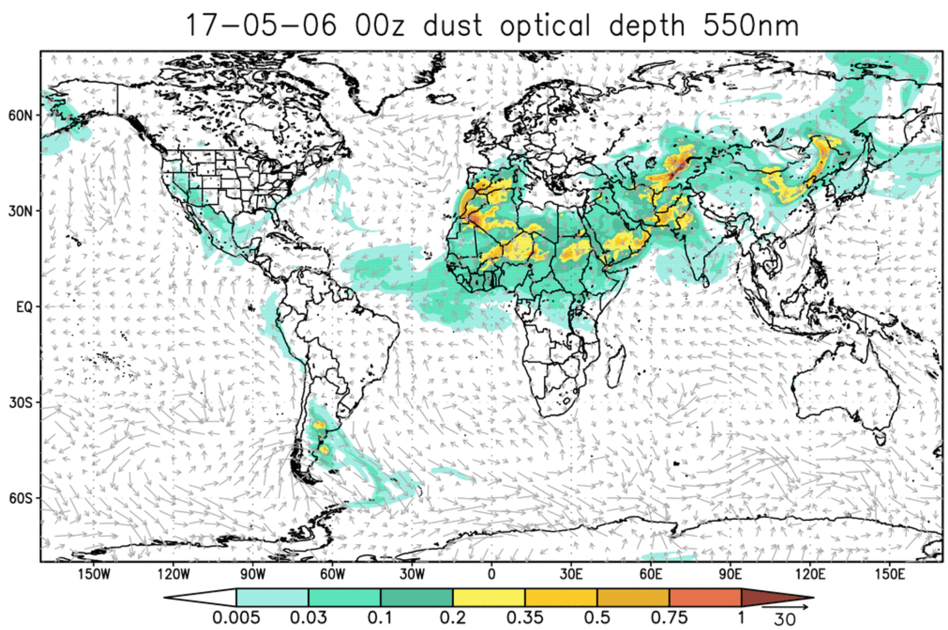
both multiple climate and multiple hydrological models, increasing the pool of streamflow forecast ensemble members and accounting for cumulative sources of uncertainty. The framework presented here (see also figure at right) proposes integration and offline coupling of global climate models (GCMs), multiple regional climate models, and numerous water balance models to improve streamflow forecasting through generation of ensemble forecasts. For demonstration purposes, the framework is imposed on the Jaguaribe basin in northeastern Brazil for a hindcast of 1974-1996 monthly streamflow. The ECHAM 4.5 and the NCEP/MRF9 GCMs and regional models, including dynamical and statistical models, are integrated with the ABCD and Soil Moisture Accounting Procedure water balance models. Precipitation hindcasts from the GCMs are downscaled via the regional models and fed into the water balance models, producing streamflow hindcasts. Multi-model ensemble combination techniques include pooling, linear regression weighting, and a kernel density estimator to evaluate streamflow hindcasts; the latter technique exhibits superior skill compared with any single coupled model ensemble hindcast.

Submitted by ***P. Block****, F. A. Souza Filho,* ***L. Sun****, and H.-H. Kwon*

Atmospheric Dust Modeling within MERIT: Models and Plans

Since the seminal work of Lapeyssonie (1965), meningitis outbreaks have been associated with dry and dusty conditions. While some studies have explored the relationship between meningitis outbreaks and climate/environmental factors, very few focused specifically on quantifying the role of dust aerosols. This is partly due to the very scarce quantitative information about surface levels of dust available in the Meningitis Belt. Existing remote-sensing data do not provide necessary information since they may only partially capture surface conditions, and satellite retrievals have a number of limitations: i) many can't retrieve over the bright, desert surface (a particular problem for the Sahel), ii) some retrievals either depend upon or assume aerosol height, iii) many retrievals are available only every other day or even less frequently, iv) clouds may prevent retrieval. Thus dust models constrained by the available observations could be a useful source of information on dust and allow us to conduct more quantitative analyses of the impact of dust on disease outbreaks.

We are examining the relation between meningitis outbreaks recorded in sub-Saharan Africa and dust aerosol concentrations as simulated by aerosol models in a collaborative study with the NASA Goddard Institute for Space Studies. We use a global model (GISS ModelE; e.g., see



Mineral dust optical depth at 550 nm on May 17, 2006 from the NMMb/BSC-Dust model.

figure that follows) and a regional one (NMMb/BSC-Dust) to run 20-year simulations of dust concentrations over the Meningitis Belt. Model winds are nudged toward observed values so that the circulation and aerosol transport resemble the actual conditions. The outputs of the simulations are compared to dust data where they exist (in situ and satellite) to validate the models' ability to reproduce aerosol conditions over the Sahel. Additionally, model outputs are compared to meningitis records at several time-scales (weekly, monthly, seasonal, annual) to assess meningitis predictability using dust as a predictor in statistical models combining environmental and socio-economic determinants.

The study aims to assess the level of uncertainty in the model dust estimates and to clarify the role of dust in relation to other environmental and climatic variables. The analysis of the different sources of dust are anticipated to provide valuable clues as to why certain areas are more vulnerable to severe epidemics than others. Moreover, a demonstration of capacity to forecast dust from aerosol models could improve anticipation and prevention of epidemics.

Contributed by ***C. Pérez****, J. Perlwitz, R. Miller,* ***S. Trzaska****, and* ***M.C. Thomson***

Climate Prediction for Brazil's Nordeste by Empirical and Numerical Modeling Methods

Climate prediction for Brazil's Nordeste meaningfully uses information through January to forecast the rainfall of March – June. Empirical methods developed at the University of Wisconsin use as predictors preseason (October – January) rainfall in the region and January indices of the fields of meridional wind component and sea surface temperature (SST) in the tropical Atlantic and the equatorial Pacific, as input to stepwise multiple regression to predict the March – June rainfall at a network of 27 stations. The training period is 1921 – 1957, the verification period 1958 – 1989, and real-time forecasting continued to 2000. A numerical model (ECHAM4.5) experiment conducted at the IRI used global SST information through January to predict the March – June rainfall at three grid points in the Nordeste for the years 1968 – 1999. For the same predictand, a complementary empirical experiment was conducted using the gridded rainfall observations, again with training period 1921 – 1957, to yield predictions for 1968 – 1999. Over this period predicted versus observed rainfall are evaluated in terms of correlation, root- mean-square error, absolute error, and bias. Compared with the empirical method the numerical modeling produces larger errors and negative bias. The empirical method captures 59% and the numerical modeling 49% of the variance.

Contributed by S. Hastenrath, ***L. Sun*** *and A.D. Moura*

Climate Risk Knowledge Systems

The knowledge base of climate risk management in public health, land-use management and natural resources management has significantly expanded over recent years, which has raised the issue of the need for more effective knowledge capture, and for innovative ways with which to share knowledge. In light of this, IRI's Climate Risk Knowledge project (CRK) is an initiative to explore and develop interactive tools for the synthesis of research and practical knowledge from the health, agriculture and natural resources sectors into multimedia training curricula and materials for on- and offline use by technical professionals. A significant component of this effort to date has involved learning how to effectively engage in knowledge capture, drawing heavily on research and climate risk management (CRM) demonstration projects, and targeting specific CRM themes. The most substantial effort has been placed in the health and water sectors. More modest efforts are being made in agriculture and fire.

Key to the effort is the identification and incorporation of user-oriented learning approaches and goals. This includes language translation – including shifts in terminology toward terms that are recognized by the targeted sector professionals, as well as translation of the materials into the prevalent language of the user region. Another facet addresses variability in access to technology available to assist knowledge sharing. Limited access to the Internet is a particular problem in many developing countries. In consideration of these factors, the pilot CRKs are being implemented using an open source Course Management System (CMS) called 'Moodle'. Moodle was selected due to its popularity domestically and internationally. This allows us access to a number of modules that provide collaborative capabilities to communicate directly with the audiences who use it. In addition, its reliance on open source technologies allows us to distribute it freely to partners in a variety of off-line methods with the intention being to provide access to the CRK without need of internet access. These aspects of the project have benefited from collaborations among information technology, education, communications, and researcher staff at the IRI and partner institutions, and has also benefitted from engagement with experts at the Columbia Center for New Media Teaching and Learning.

Because effective knowledge systems depend on effective institutional partnerships, IRI is drawing on and expanding its network of partners alongside the development of its training resources and tools. Several global and regional partnerships have been forged by IRI's sectors. For example, in its efforts to enhance capacity in the public health sector, the IRI is utilizing its WHO/PAHO Collaborating Center designation to motivate formal partnerships with the African Field Epidemiology Network. This ensures that the developing knowledge systems are integrated into existing educational frameworks in the public health community in Africa. Our water team has worked in collaboration with UNESCO and other technical partners to develop, deliver and evaluate training materials from the water curriculum at a recent workshop in Ethiopia. The Asia program has collaborated with Bogor University to produce training materials and online content in English and Indonesian, and to deliver onsite training in Indonesia. These efforts demonstrate the strategic vision in our approach to knowledge sharing, in which collaborative planning for training, with partners and alumni from previous training activities, is used to strengthen a broadening network of active participants in climate risk management.

Outcomes to date include training curricula, training manual publications, practical exercises, and an online training system for the support of collaborative training activities in and for the support of a growing network of individuals engaged in climate risk management. The materials can be used as a whole or in parts to support training activities at various levels of formality including training courses and knowledge sharing with project partners. Major components of the online system will be made available in the coming months on CD-ROM for distribution with print publications of the training manuals.

Fire Climate Risk Knowledge (CRK) Moodle Site: http://crk.iri.columbia.edu/fire/ This was constructed for a demand driven project training, and afforded the opportunity to explore the issues of constructing such a site, ahead of more substantial efforts in CRM for the health and water sectors.

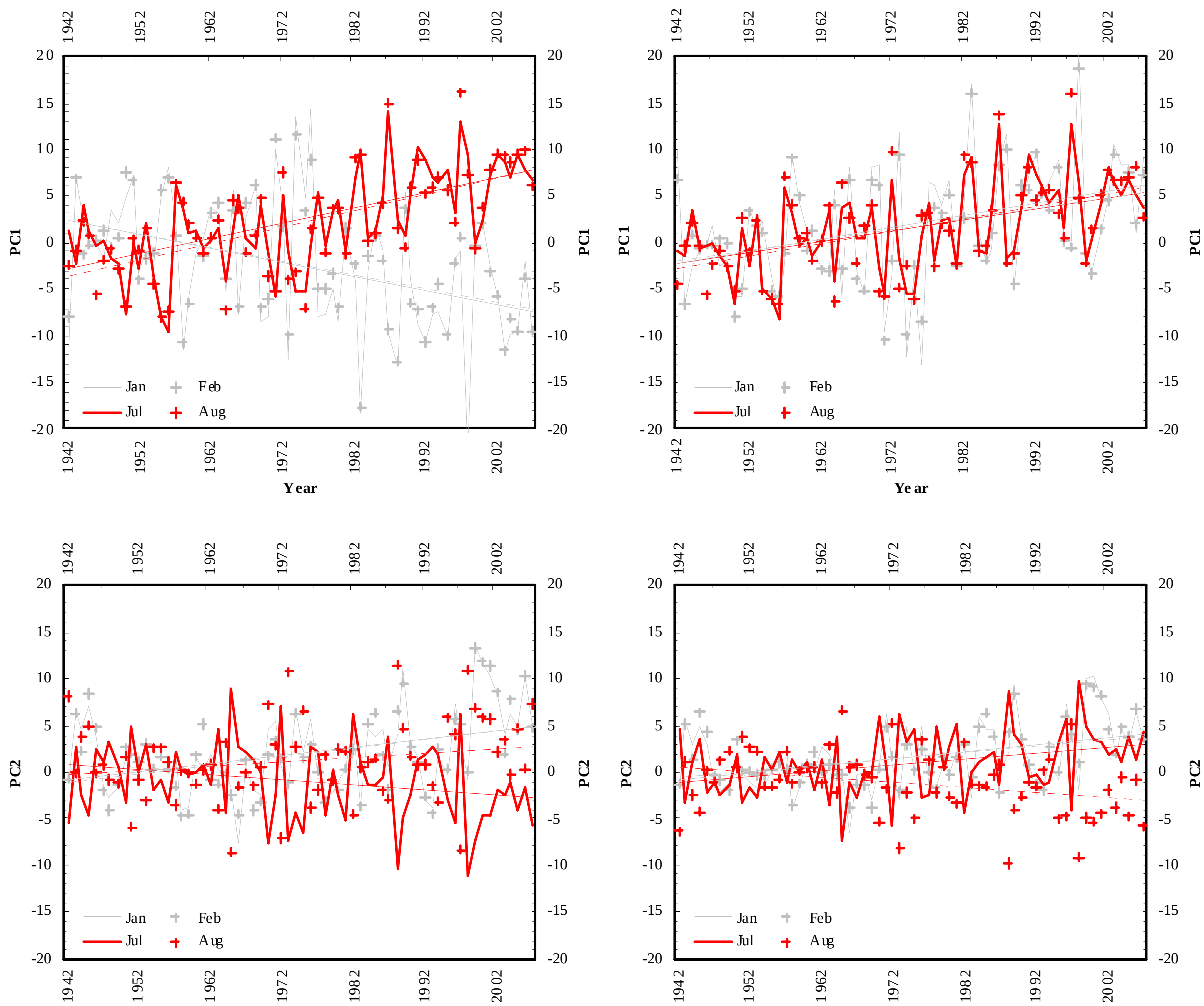
*Contributed by **M. Sheramata**, **M.N. Ward**, **J. Omumbo**, C. Brown, **K. Baroang**, **E. Conrad**, **F. Fiondella**, **J. Turmelle** and **C.-H. Lu***

Climate Variability and Change in High-altitude Watersheds of Colombia

High mountain ecosystems, and especially *páramo* ecosystems, have a delicate balance that can be easily altered by changes in environmental conditions. This project, led by the School of Engineering in Antioquia (Colombia), in collaboration with the IRI, proposes a six-tiered approach to understand the linkages between the ongoing changes in climatic conditions and the observed disruptions occurring in the surroundings of the Claro River high-altitude basin, in the El Ruiz–Tolima volcanic massif, on the west flank of the Central Cordillera, Colombia. Main interests include: (i) analysis of changes in atmospheric stability; (ii) diagnosis of water balance; (iii) assessment of the extent of life zones; (iv) analysis of the occurrence of high-altitude fires; (v) assessment of ecosystem integrity; and (vi) analysis of changes in climatic conditions.

Potential changes in atmospheric stability and the lifting condensation levels were inferred for the experimental period 1950-to present. Changes in hydrological regimes of the Claro River basin and two nearby watersheds (Chinchina and Otun rivers) were studied through the analysis of non-homogeneities in historical time series of minimum, mean and maximum water discharges. Diagnostics and field campaigns were also conducted to further understand the potential impacts of changes in environmental conditions on the water supply in the high-altitude watershed. Potential changes in life zones and likely increases in the spread (frequencies, affected areas, and durations) of high-altitude fires in Los Nevados Natural Park were also explored. Finally, changes in climatic conditions were assessed for three spatial scales: national, regional and local conditions. Ground truth records (sunshine, rainfall, minimum, mean and maximum temperatures, relative humidity, diurnal temperature range, potential evaporation, dew point, vapor pressure, cloud cover, and wind speed/direction), satellite info (optical thickness, cloud cover, and cloud top pressures and temperatures), and sea surface temperatures (see figure) were processed to determine the climatology, historical trends and potential changes in climatic patterns, as well as regional and local drivers. Analyses focused on key climatic variables controlling the conditions of high-altitude ecosystems, such as the total number of foggy/sunny days and the maximum/minimum daily sunshine, the total number of dry days and the maximum daily rainfall amounts, the minimum and maximum temperatures during the coldest and the warmest days, the minimum and maximum diurnal temperature range, and the minimum relative humidity during the driest days. Six documents supporting these lines of interest and one summary for policy-makers (English and Spanish versions) were produced and published.

Preliminary results suggest that these environments are experiencing increases in the climatic stress. Observed changes are currently occurring region-wide and are likely to be irreversible. Predicted future climatic conditions are also indicating that the scenario could be even more critical to páramo life zones. We suggest that ambitious sustainable management strategies are now urgently required to protect these unique, rich, fragile, and highly endangered high-altitude environments.



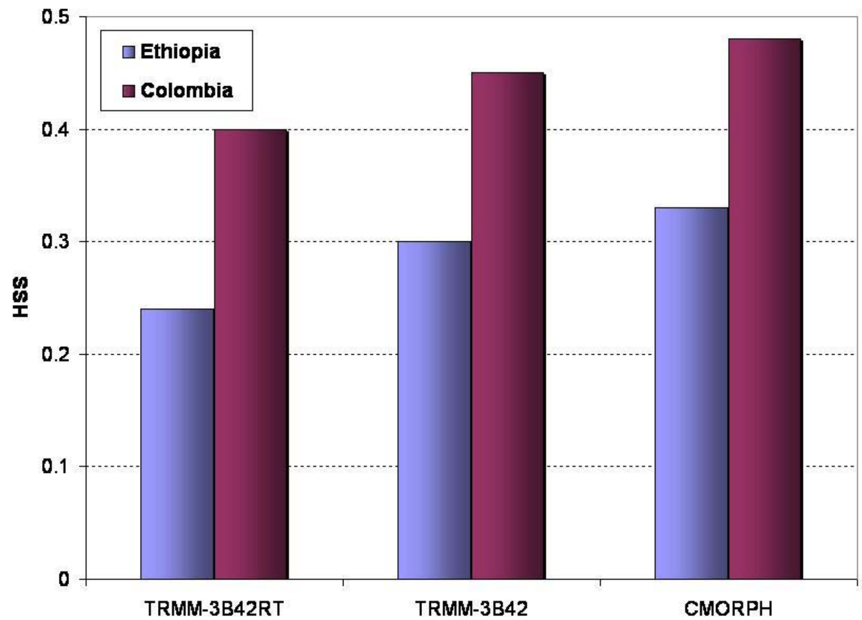
Principal components of SST anomalies observed in the Indo-Pacific region. Months of January, February, July, and August are represented, respectively, by the gray solid line, the gray pluses, the red solid line, and the red pluses. The first principal components (PC1) for the regions extending from 30° S to 30° N and 15° S to 15° N are presented in the top left and top right panels, respectively; the second principal components (PC2) for the regions extending from 30° S to 30° N and 15° S to 15° N are presented in the bottom left and bottom right panels, respectively.

Contributed by ***D. Ruiz***

Comparison of CMORPH and TRMM-3B42 over Mountainous Regions of Africa and South America

Mountainous regions pose unique challenges to satellite rainfall retrieval from both thermal infrared (TIR) and passive microwave (PM) observations. The challenge to TIR rainfall retrieval comes mainly from warm orographic rains. Most TIR algorithms use cloud-top temperature thresholds to discriminate between raining and non-raining clouds. And these thresholds are usually too low for the relatively warm orographic clouds, resulting in underestimation. The rainfall signal for over-land PM rainfall retrieval comes mainly from ice scattering aloft. However, orographic clouds may produce heavy rainfall without much ice aloft, and this may result in underestimation of surface rainfall. Thus, validation of satellite rainfall products over mountainous regions will offer an insight into how the different algorithms perform over such regions.

There has not been much validation over mountainous regions due to lack of raingauge observations or lack of access to available observations. In this study, a relatively dense station network over Ethiopia (Africa) and Colombia (South America) are used to validate two satellite algorithms. The first algorithm is the NOAA-CPC morphing technique (CMORPH), and the second is the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA). From the TMPA algorithm, TRMM-3B42 and its near-real time vision (TRMM-3B42RT) are evaluated here. These algorithms are selected for comparison because (i) they are currently the state of the art algorithms; (ii) have been available for some time and are being used widely; and (iii) are available over both Africa and South America. Validation results show that these products have low correlation coefficients, and underestimated both the occurrence and the amount of rainfall over both validation regions. The performance of CMORPH was slightly better than that of the TRMM products over both validation sites. The overall performance of both satellite products is better over the South America site.



Comparison of the skills of the three satellite rainfall estimates in detecting rainfall over Ethiopia and Colombia.

Contributed by ***T. Dinku****,* ***S.J. Connor****, and* ***P. Ceccato***

Comprehending the Risk Factors for Meningococcal Meningitis Outbreaks in Niger using Expert Opinion within a Systems Thinking Approach

Meningitis outbreaks severely burden Niger. Their occurrence is likely to be driven by multiple determinants but these factors are not yet clear. Understanding the drivers of the meningitis epidemic is critical to improving the control of the disease in the African Meningitis Belt that spans from Senegal to Ethiopia. The project used mixed methods in line with a systems thinking approach. This abstract refers to the qualitative study (a companion abstract in the *Selected Abstracts* entitled '*Predicting cases of meningococcal meningitis in Niger using a systemic approach*' addresses the quantitative aspects of the work). We hypothesized that expert opinion is relevant to (i) define the local characteristics of meningococcal meningitis and its potential drivers and (ii) validate the local significance of variables identified in the scientific literature as potentially associated with the disease.

A qualitative study by key informants was performed to identify the relevant ecological as well as individual phenomena associated with meningitis outbreaks in Niger. Thematic analysis of the experts' quotes was used, in addition to a review of the literature.

The 24 Nigerien meningitis experts who were interviewed had various profiles, working at the national, regional or district levels for public national or international institutions: ten epidemiologists (42%), including three physicians, seven (29%) public health practitioners involved in decision or policy making for meningitis management, four (16%) clinicians and three biologists (13%). According to the experts, the following factors were deemed as impacting meningitis outbreaks in Niger: (i) social and demographic: population density, proportion of children under 15 years, level of education, vulnerability index, main religious celebrations, transhumance season, border with a foreign country, (ii) health factors: number of meningitis cases (outcome of interest), incidence of acute respiratory infections (pneumonia), incidence of mild and severe malnutrition, number of years since last meningitis outbreak, on-going outbreak in a neighboring district, vaccine coverage, number of years since last immunization campaign, type of circulating serogroup, main serogroup, proportion of primary health care centers using rapid diagnostic tests , and (iii) climate: temperature, rainfall, relative humidity, wind speed, position towards the front of inter-tropical discontinuity, visibility, and land cover type.

This study used a systems thinking approach to address the issue of the prediction of meningococcal meningitis in Niger and to map out potential entry points for disease modeling based on social interactive, epidemiological and climate variables.

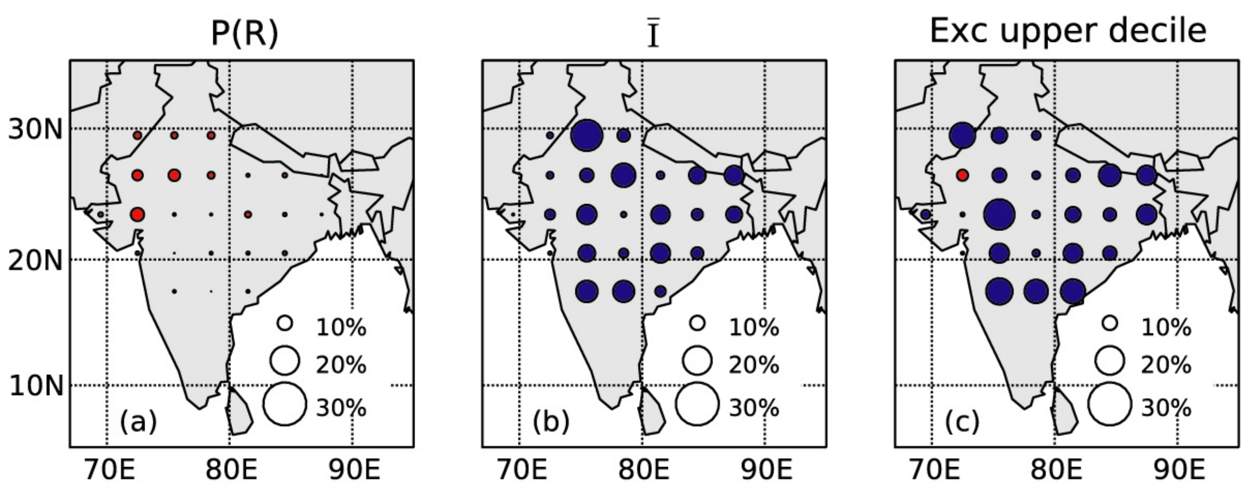
Contributed by ***L. Cibrelus****, S. Djibo, J.-F. Jusot,* ***M.C. Thomson****,*
P. Kinney, S. Morse, E. Bertherat, W. Perea

Downscaling Projections of Indian Monsoon Rainfall using a Nonhomogeneous Hidden Markov Model

Several issues arise in the projection of regional climate change, one being spatial resolution. Recent numerical climate models process information on grids whose spacing is typically 200-400 km, and climate patterns simulated by such models cannot, by construction, contain detail finer than this. Furthermore, even the coarsely-resolved patterns that are produced by such models contain inaccuracies, while the rainfall distributions themselves, particularly in the tropics, tend to produce too much drizzle and too few heavy precipitation events.

In conjunction with researchers at the University of California, Davis, we are presently refining a statistical method that may circumvent all of these undesirable characteristics of model simulations at a single stroke. The method involves *combining* model simulations with the observed history of monsoon rainfall, taking from each of these sources the class of information it is best suited to provide: From the observations we infer the spatial patterns and temporal rainfall distributions, while from the climate models we take only large-scale circulation and moisture changes, as climate change indicators. The observed patterns and distributions are then modified by the climate change signal to infer rainfall statistics for the future. Stochastic rainfall sequences are produced, and can be used to infer many quantities of interest.

The below figure shows shifts in summer monsoon rainfall statistics at a grid of specific locations, in going from the second half of the 20th to the late 21st century. Panel (a) shows that rainfall frequency is projected to decline, i.e., it is likely to rain somewhat less often. Panel (b) shows projected changes in average rainfall amount on wet days, which is projected to *increase.* Thus, on days when it does rain, more rain is likely to fall. Panel (c) shows frequencies with which the 20th-century upper decile is exceeded by the end of the 21st century, a measure of change in the frequency of what are today considered extreme rainfall events. A marked and nearly universal increase is indicated, suggesting an increased likelihood of flooding during the summer monsoon. The analysis shows that such flooding is not inconsistent with a simultaneous reduction in the number of rainy days.



Shifts in summer monsoon rainfall statistics going from 1951-2000 to 2070-2099. (a) Change in rainfall frequency, in. (b) Change in average rainfall amount on wet days. (c) Change in exceedance frequency of the 20th-century upper decile (i.e., change in frequency of extreme rainfall events). Red markers indicate decreases, blue markers increases.

A diagnostic analysis of 20th-century Indian monsoon rainfall, using a hidden Markov model similar to that described above, is presented in Greene et al. (2008). This work is supported through a grant from the U.S. Department of Energy, Climate Change Prediction Program.

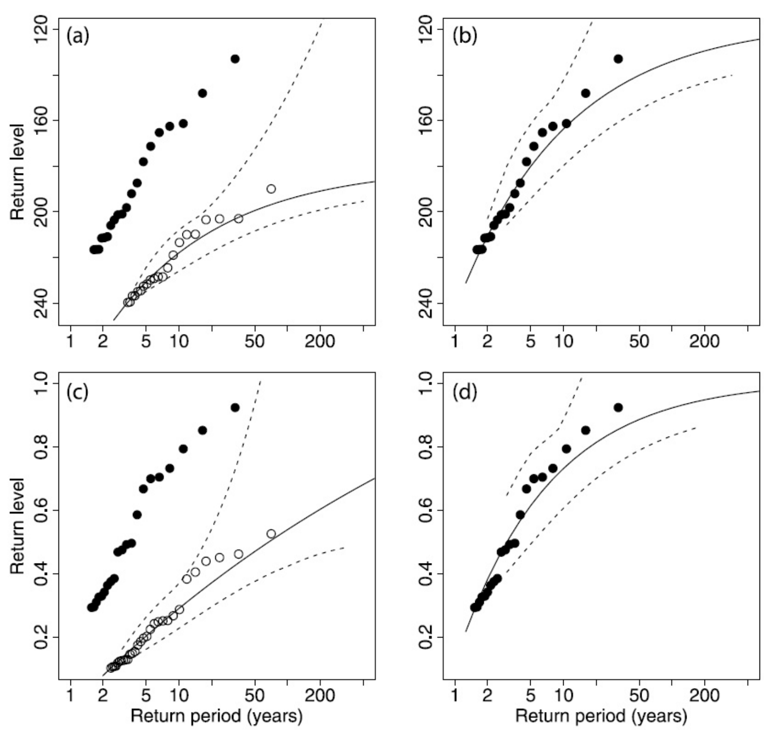
Contributed by ***A.M. Greene*** *and* ***A.W. Robertson***

Drought Return Times in the African Sahel: A Question of Attribution

The African Sahel, the semi-arid region lying to the south of the Sahara desert and extending across the width of the continent, experienced a rapid and profound drying during the decades of the 1950s and 1960s. This was followed by a period punctuated by extreme droughts, imposing significant stresses on the region's predominantly rural population. In particular years during this period drought was both severe and widespread, motivating the question we addressed: How long should we expect to wait before events of similar severity might recur? To put it another way, what is the average "return time" of such particularly extreme droughts?

In this study we compared drought extremes before and after 1970, an approximate boundary between the wetter conditions prevailing beforehand and the drier years afterward. The study's principal conclusion, drawn with the aid of extreme-value theory, was that the drought statistics for these two periods are *incompatible:* under the earlier climate regime, the extreme events of the later period would have been extremely unlikely (and vice versa; see also Greene et al., 2009). This discordance signals a significant shift in the climate processes controlling Sahel rainfall, processes that are not yet completely understood. Since the confident estimation of return times requires an understanding of these processes, the result underscores the need for a better understanding of the physical basis for decadal variations in Sahelian rainfall.

The figure illustrates the discordance between the pre- and post-1970 periods, in terms of return-level curves. These are the solid lines on each of the plots, and show the inferred relationships between recurrence time (x-axis) and event severity (y-axis). The upper row (panels a and b) refers to June-September rainfall, with y-axis units of mm; lower panels (c and d) refer to area fraction experiencing drought. Open circles represent the pre-1970 period, closed circles post-1970. In panels (a) and (c) the return-level curves are fitted to the pre-1970 data; the post-1970 values are seen to fall well outside the 95% confidence intervals (dotted lines). In panels (b) and (d) the curves are fitted to the post-1970 data. These curves indicate that under the post-1970 regime, return times for the more severe events are in the range 25-30 yr.



Return-level plots for average Jun-Sep Sahel rainfall (a and b) and Sahel area fraction experiencing drought (c and d). Open circles are pre-1970 observations; filled circles are post-1970. Solid lines are computed return-level curves, dashed lines are the corresponding 95% confidence intervals. Panels (a) and (c) curves are computed based on the pre-1970 drought record; panels (b) and (d) show estimates for the post-1970 data.

Contributed by ***A.M. Greene***, ***A. Giannini*** *and* ***S.E. Zebiak***

Establishing an Information and Decision Support System for the Agricultural Sector of Chile

For some time now, the IRI has been working with partners in Latin America to establish Information and Decision Support Systems (IDSS) that link existing databases, monitoring of vegetation and climate (with ground observations and remote sensing), weather and seasonal climate forecasts, and simulation tools. The current IDSS project in Chile builds on IRI's experiences and lessons learned in the work on IDSS in Uruguay and Paraguay. Our main goal is to assist the Ministry of Agriculture of Chile in the formulation and implementation of activities to improve Climate Risk Management in the agricultural sector of Chile. The initial stages are establishing and developing products and tools to assist in the preparedness and response to extreme weather (floods, droughts).


Walter Baethgen teaching in Quilamapu

As a first step towards the main activities of the project, Walter Baethgen and Michael Bell held a 4-day workshop in Chillan, Chile in December 2008. The workshop included teaching modules on *Climate Risk Management in Agriculture* and *Introduction to IRI's Data Library*. The workshop was hosted by Chile's National Agricultural Research Institute (INIA) at its Quilamapu campus and helped introduce INIA's staff to climate risk management principles and their applications in agriculture, and to expose them to the IRI's Data Library capabilities. The workshop was organized by Isaac Maldonado Ibarra, coordinator of the Department of Natural Resources and Environment, and current Director of INIA Quilamapu. Most of the ~45 participants were employees of INIA, and came from all of the regional offices that are distributed throughout the country.

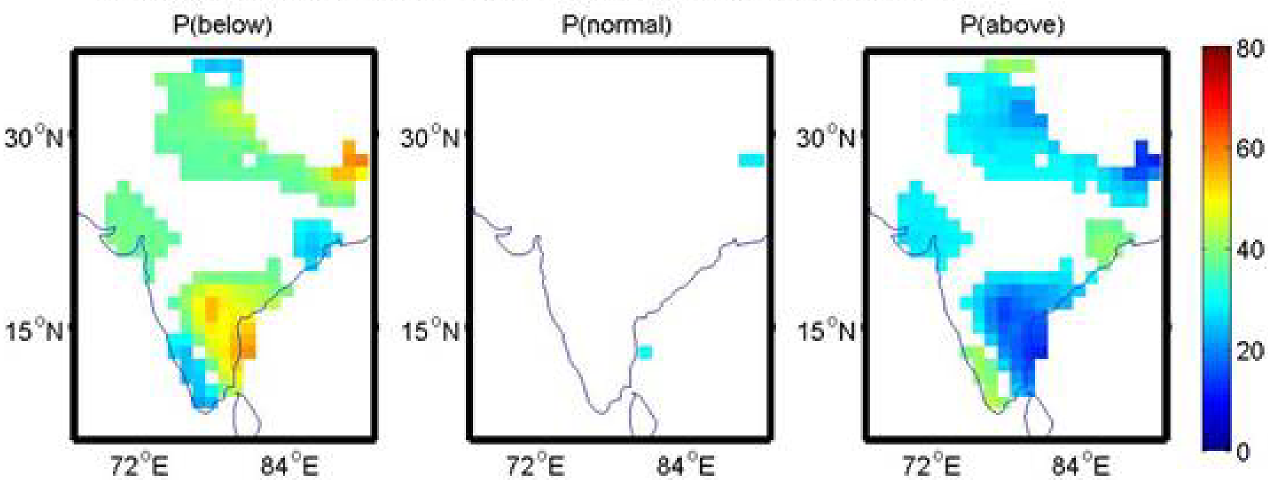
An outstanding result of this activity was that, during the workshop, a group of participants started producing actual climate and agricultural monitoring summaries for several regions of Chile based on satellite information obtained from IRI's Data Library. The workshop introduced some of the tools for agro-climatic monitoring included in the Agroclimate and Information Systems Unit of INIA Uruguay. As a result of the workshop, INIA Chile started its own monitoring system. In its initial stages (http://www.aclimat.cl/tfc/) the system is using databases and information included in IRI's Data Library. Consequently, we are establishing a map room specifically designed for the agricultural sector of Chile. The participants concluded the workshop with the ability to start producing regular reports on climatic and agricultural conditions focusing on the most important crops and pastures of their home regions.

Contributed by ***W.E. Baethgen*** *and* ***M. Bell***

Extended Range Forecast System for Climate Risk Management in Agriculture in India: Development and Launch of Integrated Research Approach

IRI is involved in a project funded by the Government of India to help improve forecasting of the Indian summer monsoon, and to demonstrate approaches to using forecasts and other climate information to benefit agriculture and rural livelihoods. The Extended Range Forecast System for Climate Risk Management in Agriculture in India (ERFS) project was launched in 2009 following intensive collaboration between IRI and Indian scientists to design a research plan that effectively integrates climate science with agriculture and policy research aspects, using a demonstration approach. The ERFS project is funded by the Ministry of Agriculture, with Indian Institute of Technology Delhi serving as the secretariat. The Indian Meteorological Department and the National Center for Medium-Range Weather Forecasting, both part of India's new Ministry of Earth Sciences (MoES), are heavily involved, and the project launch was also discussed in the context of talks to establish a memorandum of understanding between NOAA and MoES. State agriculture universities in nine Indian states are leading demonstration efforts in select districts in nine states that face significant livelihood impacts due to variability in the southwest monsoon: Andhra Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Orissa, Himachal Pradesh, Rajasthan, Tamil Nadu, and Uttarkhand.

IRI serves as the lead international agency in the ERFS project, helping to guide research to improve capacity to forecast the summer monsoon, analyze climate-related agricultural risks in demonstration districts, and develop risk management tools using improved climate information. Research to improve forecast methodologies was launched through a two-week training in Delhi, India (May 2009) and a six-month visit (July-December 2009) from four Indian scientists from IIT Delhi and IMD. Hindcasts have been assembled from 6 seasonal forecast GCMs, including the NCEP CFS, the JAMSTEC SINTEX-F, and three ECHAM4.5 based systems (two of them coupled) developed at IRI. A hierarchy of multi-model ensemble approaches is being tested, including MOS correction of the individual models. The below figure shows an example forecast made using 5 GCMs initialized on June 1, which indicates enhanced probability of below-normal rainfall, and reduced probability of the above-normal category for June–September 2009. This forecast is consistent with the deficient monsoon rainfall observed to date. The potential for



Categorical multi-model ensemble forecasts for June–September 2009 precipitation made from 5 GCMs (ECHAM4.5-GML, ECHAM4.5-CA, ECHAM 4.5-MOM3, CFS, JAMSTEC) initialized on June 1, showing probabilities of below-normal, near-normal, and above-normal categories.

signal-to-noise maximizing techniques to enhance skill is being explored, together with stochastic rainfall downscaling models to link the forecasts with crop-simulation models.

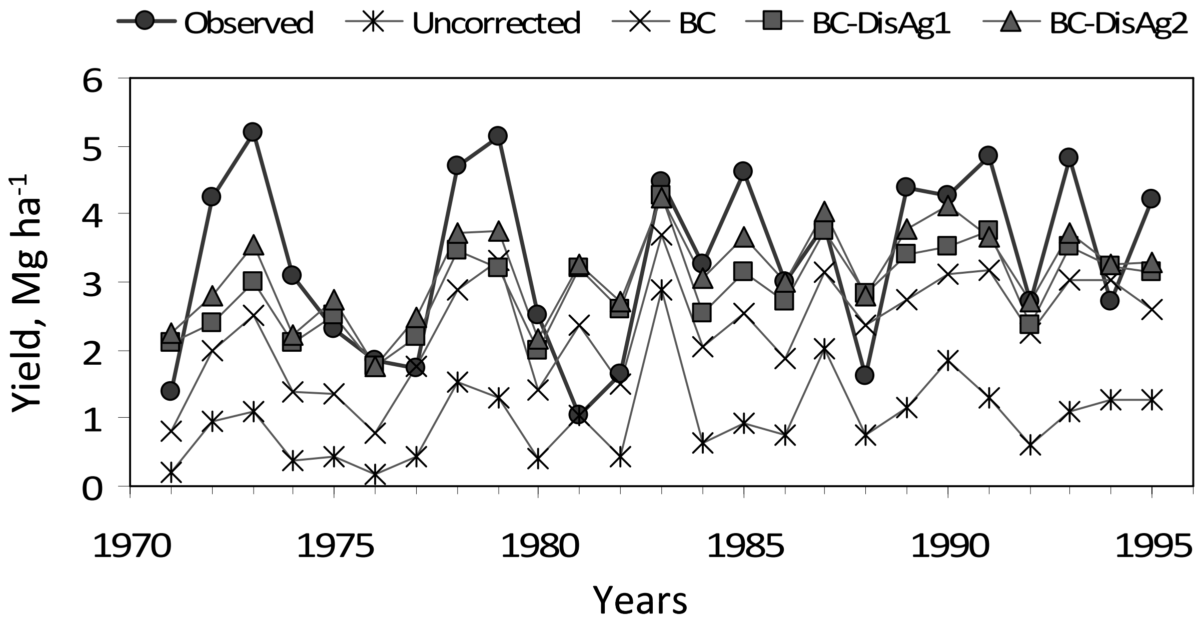
Analysis of agricultural risks and relevant institutional contexts has been initiated in two of the nine demonstration areas, where IRI is focusing its efforts: Mahabubnagar district in Andhra Pradesh and Anand and Kheda district in Gujarat. Work is being undertaken in close partnership with the state agriculture universities in each location. Preliminary analyses have been undertaken to correlate variability in crop yields with monsoon rainfall patterns and assess crop yield predictability. Work has been initiated to identify and analyze potential management options for crops under particular climate conditions, and institutional and policy arrangements that may be necessary to support these. Similar analyses are being prepared for Anand/Kheda district. IRI worked with partners in India to organize and co-lead a workshop in Hyderabad (April 2009) to launch similar approaches in all nine demonstration areas.

Contributed by ***S. Someshwar***, ***A.W. Robertson***, ***M. Tippett***, ***A.V.M. Ines***, ***J.W. Hansen***, *and* ***E. Conrad***

Extracting Useful Information from Daily GCM Rainfall for Crop Simulations

Translating climate forecasts into crop yields is crucial for managing the adverse impacts of climate fluctuations in agriculture. This procedure is not straightforward because of the mismatch between climate forecasts and the data required by crop simulation models. In an earlier study, Hansen and Indije (2004) developed a framework for translating advanced climate information into agricultural terms, in which one proposed method is the use of daily outputs from a GCM. Based on this study, Ines and Hansen (2006) developed a two-step bias correction method to correct the biases in GCM rainfall frequency, intensity and totals relative to a station for crop simulations. Their case study in Katumani, Kenya using ECHAM4.5 showed that bias-corrected daily GCM rainfall improved the simulation of maize yields compared to the uncorrected GCM rainfall case but with a negative bias, which they attributed to the longer dry spells in the GCM data due to the unrealistic temporal structure of daily GCM rainfall.

This follow up study builds upon the notion that by improving the temporal structure of the bias-corrected daily GCM rainfall, we can minimize this negative bias in the simulated yields. Here, we hybrid the GCM bias correction method (BC; Ines and Hansen, 2006) with a stochastic disaggregation (DisAg; Hansen and Ines, 2005) to generate daily sequences of rainfall consistent with the information contained from the bias-corrected daily GCM rainfall. Of particular interest as conditioning data in the stochastic disaggregation is the monthly rainfall frequency, as this contains information of the temporal structure of rainfall in a certain month. The accompanying figure shows performance of the improved method (BC-DisAg) compared to BC only. Further analysis showed that the improvement in the simulation of yields is attributed to the improved simulations of dry spells in the rainfall time series.

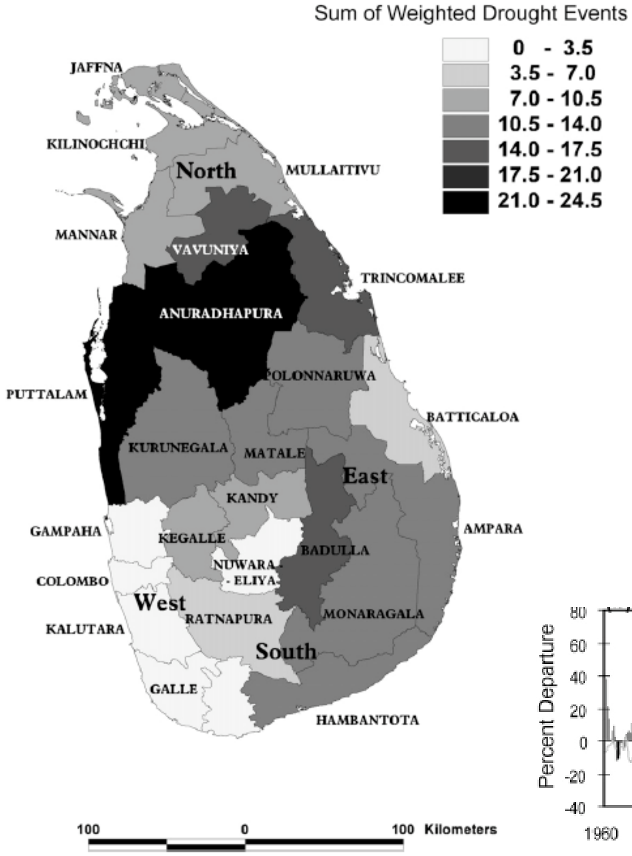


Performance of the bias correction-stochastic disaggregation (BC-DisAg) in maize yield simulation, Katumani, Kenya. BC-DisAg1 – from each ensemble members; BC-DisAg2 – from average of ensemble members.

Contributed by ***A.V.M. Ines*** *and* ***J.W. Hansen***

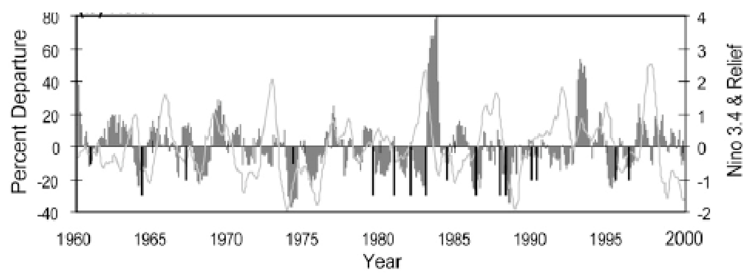
Finescale Evaluation of Drought in a Tropical Setting: Case Study in Sri Lanka

In regions of climatic heterogeneity, finescale assessment of drought risk is needed for policy making and drought management, mitigation, and adaptation. The relationship between drought relief payments (a proxy for drought risk) and meteorological drought indicators was examined through a retrospective analysis for Sri Lanka (1960–2000) based on records of district-level drought relief payments and a dense network of 284 rainfall stations. The standardized precipitation index and a percent-of-annual-average index for rainfall accumulated over 3, 6, 9, and 12 months were used, gridded to a spatial resolution of 10 km. An encouraging correspondence was identified between the spatial distribution of meteorological drought occurrence and historical drought relief payments (see left plot that follows) at the district scale. Time series of drought indices averaged roughly over the four main climatic zones of Sri Lanka showed statistically significant ($p < 0.01$) relationships with the occurrence of drought relief (see right plot that follows). The 9-month cumulative drought index provided the strongest relationships overall, although 6- and 12-month indicators provided generally similar results. Some cases of appreciable drought without corresponding relief payments could be attributed to fiscal pressures, as during the 1970s. Statistically significant relationships between drought indicators and relief payments point to the potential utility of meteorological drought assessments for disaster risk management. In addition, the study provides an empirical approach to testing in which meteorological drought indicators bear a statistically significant relationship to drought relief across a wide range of tropical climates.



(Left) Shading indicates the occurrence of drought relief payments, by district, 1961-2000. The payments were weighted by their relative size before summing over all years.

(Below) Time series (1960–2000) of the detrended PRCT-9 index averaged over a boxed that approximately represents the north climate zone (grey bars). Vertical black bars indicate the occurrence of drought relief payments; their length is proportional to the payment amount in three categories (major 5 1.5, medium 5 1.0, and minor 5 0.5). The Nino3.4 sea surface temperature anomaly index is given by the thin line.

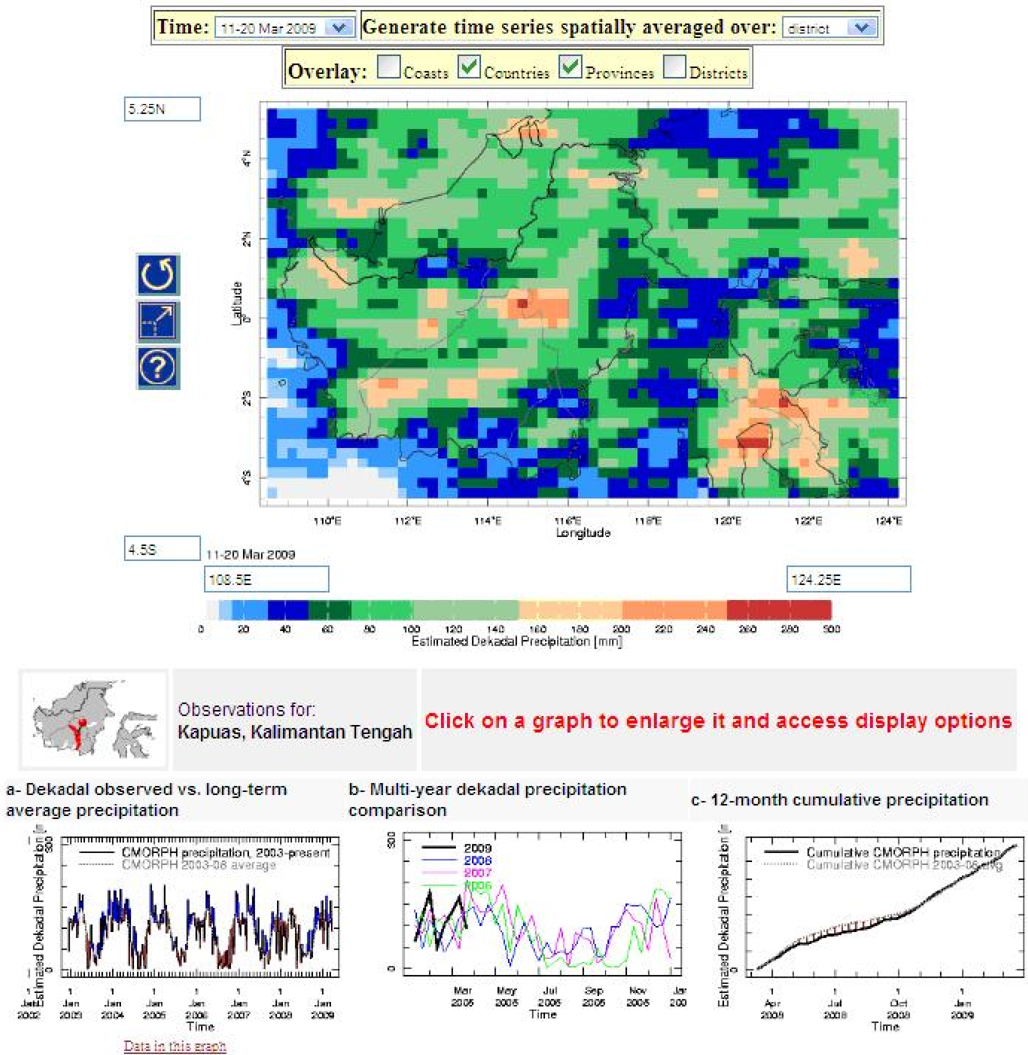


Contributed by ***B. Lyon***, ***L. Zubair***, *V. Ralapanawe and Z. Yahiy*

Fire Early Warning and Response in Indonesia: Building Stakeholder Capacity

Previous NOAA reports have described IRI's work on fire early warning and response in partnership with CARE Indonesia, the Center for Climate Risk and Opportunity Management at Bogor Agriculture University, and the provincial government of Central Kalimantan. These efforts led to improved understanding of rainfall-fire relationships in Central Kalimantan, and experimental forecasts of fire activity based on changes in sea surface temperature (NINO4 index). Following several workshops led by IRI and its partners, provincial officials in Central Kalimantan issued a new regulation enabling use of climate information in assessing the risk of fires spreading out of control when deciding whether to allow farmers to use fire in clearing land. IRI developed an audio slide show describing these results (http://crk.iri.columbia.edu/fire). Building upon these efforts, IRI has developed components of a Climate Risk Knowledge (CRK) system to improve capacity on the part of local stakeholders in using this knowledge about the role of climate in fire risk.

The Fire Climate Risk Knowledge System is composed of an online fire early warning tool, a written guide to using the tool, an in-person training for stakeholders, and a training website. A team of IRI researchers developed the manual, entitled "Seasonal Early Warning for Fire Management: A Draft Guide," which explains rainfall-fire relationships in Central Kalimantan and concepts behind the use of sea surface temperatures to help predict fire activity. It also guides readers through the use of the "Rainfall Analysis" and the "Predicting Fire Activity" Tools, the two components of the fire early warning system in IRI's Data Library. These two tools were revised during the process of developing the manual in order to make them more user-friendly (see also figure below).



Screenshot of Indonesia Rainfall Analysis Tool, available at http://iri.columbia.edu/maproom/fire.

In May 2009, IRI and the Center for Climate Risk and Opportunity Management (CCROM) organized training for provincial-level stakeholders in Central Kalimantan and other parts of Indonesia. This training took place in Bogor, Indonesia and used the new manual as a guide, along with Excel-based and interactive exercises designed to give participants hands-on experience in using the early warning tool. Following the training, IRI developed a training website, containing the manual, workshop exercises, and other resources, available in English and Indonesian.

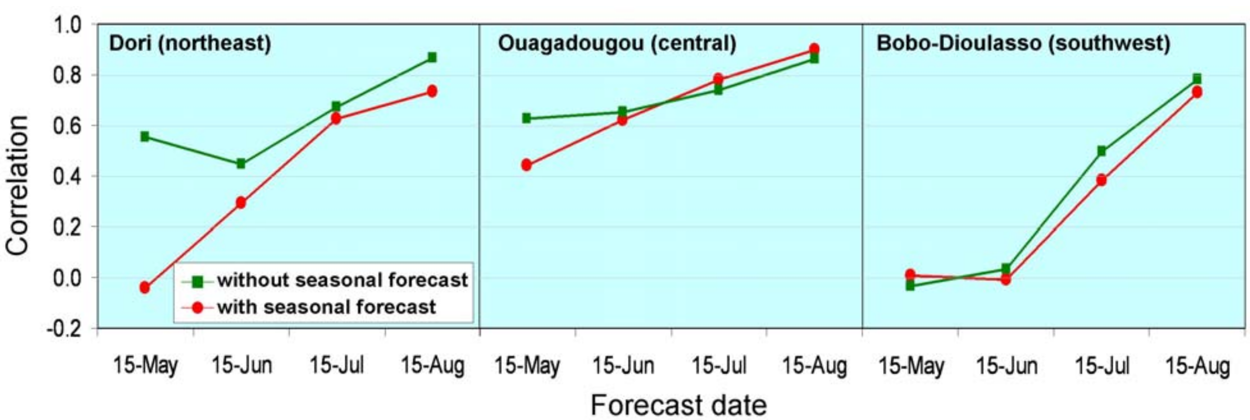
*Contributed by **E. Conrad**, **S. Someshwar**, **P. Ceccato**, **R. Cousin**, **A. Curtis**, **F. Fiondella**, **A.W. Robertson**, **M. Sheremata**, and **K. Venkatasubramanian***

Forecasting Crop Yields at a Long Lead Time in Burkina Faso

Sorghum farmer in Burkina Faso. Photo by ICRISAT, provided by CGIAR Photo Bank

The high variability of rainfall leads to considerable variability in the production of food crops and episodes of food shortage in the Sudan and Sahel savannah regions of West Africa. Early detection and response to an emerging food crisis is crucial for avoiding humanitarian disaster and long-term loss of livelihood potential, as any delay greatly increases the humanitarian and livelihood impacts and the cost of delivering assistance. The current food security early warning system in West Africa uses simple models of soil water balance and crop response, driven by monitored rainfall information, to monitor impacts of rainfall on crop yields and detect any production shortfalls due to drought. Resulting yield estimates are not considered accurate enough to inform food security organizations until quite late in the growing season.

Sorghum is the most important crop for food security in Burkina Faso. In collaboration with the AGRHYMET Regional Center (Niger) and CIRAD (France), we tested the potential to improve the accuracy (at a given lead time) and lead time (at a given accuracy) of sorghum yield forecasts by incorporating seasonal rainfall forecasts at five locations in Burkina Faso (Mishra et al, 2008). Relative to forecasts based solely on monitored and historic weather information, incorporating seasonal forecasts improved the accuracy of yield forecasts made early in the growing season. The benefit from incorporating seasonal forecast information was greatest in the drier northern locations (see also figure below).



Correlation between forecast sorghum yields, and yields simulated with observed weather, under traditional production technology, for three locations in Burkina Faso, 1957-1998.

Although we did not attempt to simulate yields at a district scale, simulated yields were significantly correlated with district-scale production statistics. Crop yield forecasts made during the growing season could be further improved, for example, by: incorporating the best available seasonal forecasts; incorporating observations and forecasts of additional meteorological variables, such as temperature and solar radiation; and using better information about the spatial distribution of weather, soils, crop varieties and management. The results suggest that there is a good prospect for providing useful food security early warning information earlier in the growing season than is currently available. Whether this would translate into earlier response to emerging food crises depends on whether food security institutions have the flexibility to respond to earlier, probabilistic information.

*Contributed by A. Mishra, **J. W. Hansen**, M. Dingkuhn, C.Baron, S.B. Traoré, **O. Ndiaye**, and **M.N. Ward***

Greater Horn of Africa Climate Outlook Forum Forecast Verification Workshop

From 23-28 February 2009, a workshop was held in Nairobi, Kenya, to perform a verification analysis of the first 11 years of Greater Horn of Africa Climate Outlook Forum (GHACOF) forecasts using station data from the participating countries. The Workshop, funded by Google.org, represented the first attempt to integrate the results of the IRI-ACMAD continent-wide verification results (reported last year) into the operations of the Regional Climate Outlook Forums in Africa. More specifically, the workshop objectives were to:

- Perform a verification analysis of GHACOF forecasts using station data from countries participating in the GHACOF.
- Introduce corrections into the subjective forecast combination in response to any demonstrated systematic errors in the GHACOF forecasts.
- Create capacity within the Greater Horn region to verify seasonal climate forecasts and to communicate results to forecast users.

A total of 17 participants were present, representing Burundi, Djibouti, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda, IGAD Climate Prediction and Applications Center (ICPAC), and Nairobi University. There was no representation for Eritrea or Somalia.

In the Workshop, participants were introduced to some of the basic concepts of forecast verification. Different reasons for verifying forecasts were considered, and different ways of describing the goodness of forecasts were debated. The most important attributes of the quality of probabilistic forecasts were defined, and a distinction was drawn between the quality of a forecast for a single season and that of a set of forecasts. A range of verification scores were calculated, from simple measures of forecast bias, and accuracy, to detailed diagnostics of reliability, and estimates of forecast value.

Verification results were obtained in detail for the March – May forecasts, but there was time to generate only preliminary results for the September – December forecasts. Results confirmed the conclusions of the IRI-ACMAD analysis based on gridded global rainfall estimates. Specifically:

- The Greater Horn of Africa has experienced predominantly below-normal rainfall over approximately the last 10 years.
- The forecasts did not provide an indication of this shift towards dry conditions.
- There is strong hedging towards the normal category, and away from the below-normal category.
- The skill of the forecasts is generally poor for the March-May season, and is only slightly stronger for the September-December, although there are differences from country to country. Useful information in the forecasts has been most evident when the forecasts have been highly confident.

The draft GHACOF forecast for March-May 2009 indicated strong hedging towards the normal category, but the forecast was adjusted prior to public release based on the findings of the verification workshop. In particular, based on the verification analyses, the forecasters were encouraged to be more bullish about indicating high probabilities of below-normal rainfall. Although the outcome after a single forecast cannot be taken as a success or failure, this revised GHACOF forecast has generally been well-received given the widespread drought conditions in the region that prevailed during March – May 2009.

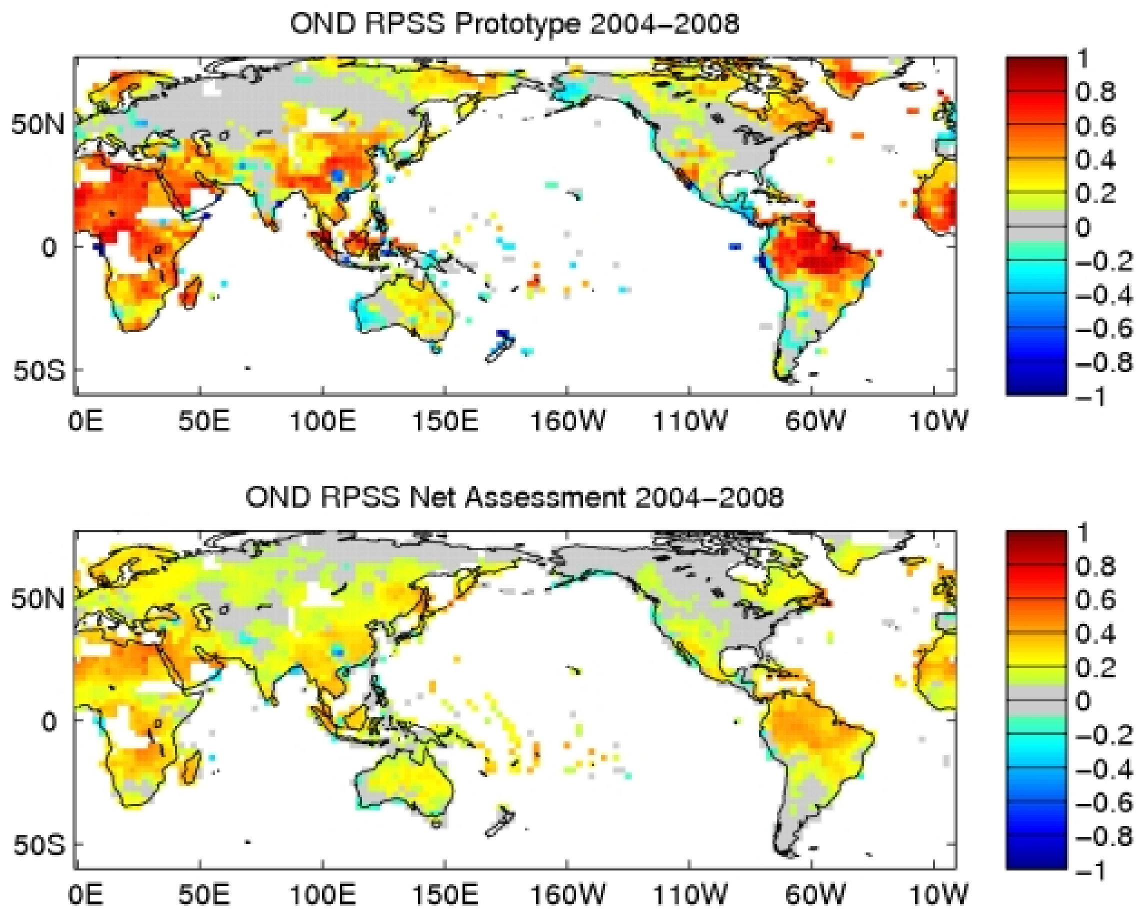
Contributed by ***S.J. Mason***

Improving Seasonal-to-Interannual Forecast Information

Ensembles of atmospheric general circulation models (GCMs) are used in the IRI seasonal prediction system to represent the response of the atmosphere to forecast sea surface temperature (SST). In the current approach, a statistical post-processing is applied to the below-normal, normal, and above-normal tercile category probabilities derived from the ensemble distribution. The IRI Net Assessment is formed from these statistically corrected probabilities. This post-processing is applied on a grid point by grid point basis using parameters derived from GCM simulations of the atmospheric response to observed SST. This procedure has a number of weaknesses. First, the forecast distribution spread is underestimated since the statistical correction is based on GCM response to observed SST and does not include uncertainty due SST forecast error. Second, the statistical correction methodology does not incorporate spatial information.

A new prototype seasonal temperature forecast system has been developed that addresses these issues. The prototype system incorporates spatial structure into the correction of the central tendency of the ensemble distribution. The correction parameters are estimated from retrospective forecasts that use forecast SST, thereby explicitly incorporating SST forecast error and lead-time dependence. The forecast uncertainty about the corrected central tendency is estimated from the corrected retrospective forecasts using a cross-validation procedure. Estimation of the correction parameters as well as the uncertainty from the same retrospective forecast data requires care to avoid selection bias which would lead to underestimation of forecast uncertainty.

The prototype system is currently being compared to the operational IRI Net Assessment for the period 2004-2008 which is independent of the retrospective forecasts period. Moreover, the observation data set available for that period is different from the one used to estimate the correction parameters. The figure below shows spatial maps of the ranked probability skill score (RPSS) of the prototype system and of the IRI Net assessment for one-month lead forecasts of Oct-Dec average temperature tercile category probabilities. Initial results suggest improvement despite the limited number of models in the prototype system; the IRI Net Assessment uses seven GCMs while the prototype currently uses just two (eventually the number of models will be increased to at least four). Importantly, the prototype system produces a complete forecast probability density function, not just tercile probabilities. In the initial prototype system, models are combined using equal-weighting. Future work will explore more sophisticated combination methods.



Spatial distribution of RPSS for 1-month forecasts of Oct-Dec temperature for the period 2004-2008. Upper panel is the skill of the prototype system; lower panel is the skill of the official IRI Net assessment. Positive values indicate skill greater than that of the climatological forecast.

Contributed by ***M.K. Tippett***, ***L. Goddard*** *and* ***D.G. DeWitt***

IRI Collaborating Institute in Southeast Asia: Building Regional Capacity to Manage Climate Risks

In 2009, IRI's first "Collaborating Institute" relationship was established in Southeast Asia, with the new Center for Climate Risk and Opportunity Management at Bogor Agriculture University in Indonesia.

Dr. Rizaldi Boer, Director, CCROM, Bogor Agriculture University

For more than five years, IRI has collaborated with government agencies, research institutes and NGOs in Indonesia and Southeast Asia to help address climate risks in sectors such as water, agriculture, food security and fire management. IRI has conducted much of its work in Indonesia in partnership with researchers at Bogor Agriculture University (Institut Pertanian Bogor, or IPB), a leading research and teaching university in Indonesia. In recognition of the growing need to integrate an understanding of climate risks into development policy, IPB established the Center for Climate Risk and Opportunity Management in Southeast Asia and the Pacific (CCROM) in 2008. Its mission is to "enhance society's capability to understand the impacts of climate variability and change and to manage climate risks and opportunities to improve human welfare and the environment." With core expertise in climate, agriculture, forestry, health, remote sensing and social and economic analysis, CCROM works with government agencies, universities and NGOs across Indonesia and Southeast Asia to formulate tools and approaches to manage climate risks in multiple sectors.

As an IRI Collaborating Institute, CCROM works closely with IRI to put climate risk management into practice in Southeast Asia. By combining CCROM's extensive regional knowledge and ability to engage local stakeholders with IRI's global expertise in climate risk management, this partnership increases potential for sustained uptake of project outcomes. IRI supports CCROM in developing its scientific, technical and organizational capacity to become a regional center serving Southeast Asia and the Pacific. For example, IRI is providing guidance in establishment of climate modeling expertise, and in developing capacity to store and analyze extensive collections of climate, environmental and socio-economic data for the region. Currently, IRI and CCROM are collaborating on agricultural planning and food security in partnership with the Ministry of Agriculture, and to address climate risks in peatland fire management, in partnership with the provincial government of Central Kalimantan, Indonesia. In May 2009, IRI and CCROM organized training on seasonal early warning of peatland fire risk, the first event hosted at CCROM's office and training facilities on IPB's Baranangsiang Campus. Planning is underway for more collaborative projects. In August 2009, CCROM was selected as a finalist in the World Bank's Development Marketplace competition for a proposal developed in partnership with IRI to launch index insurance for agriculture in Indonesia. CCROM is also engaged in a wide range of other projects, supported by the Indonesian government, UNDP, and development agencies.

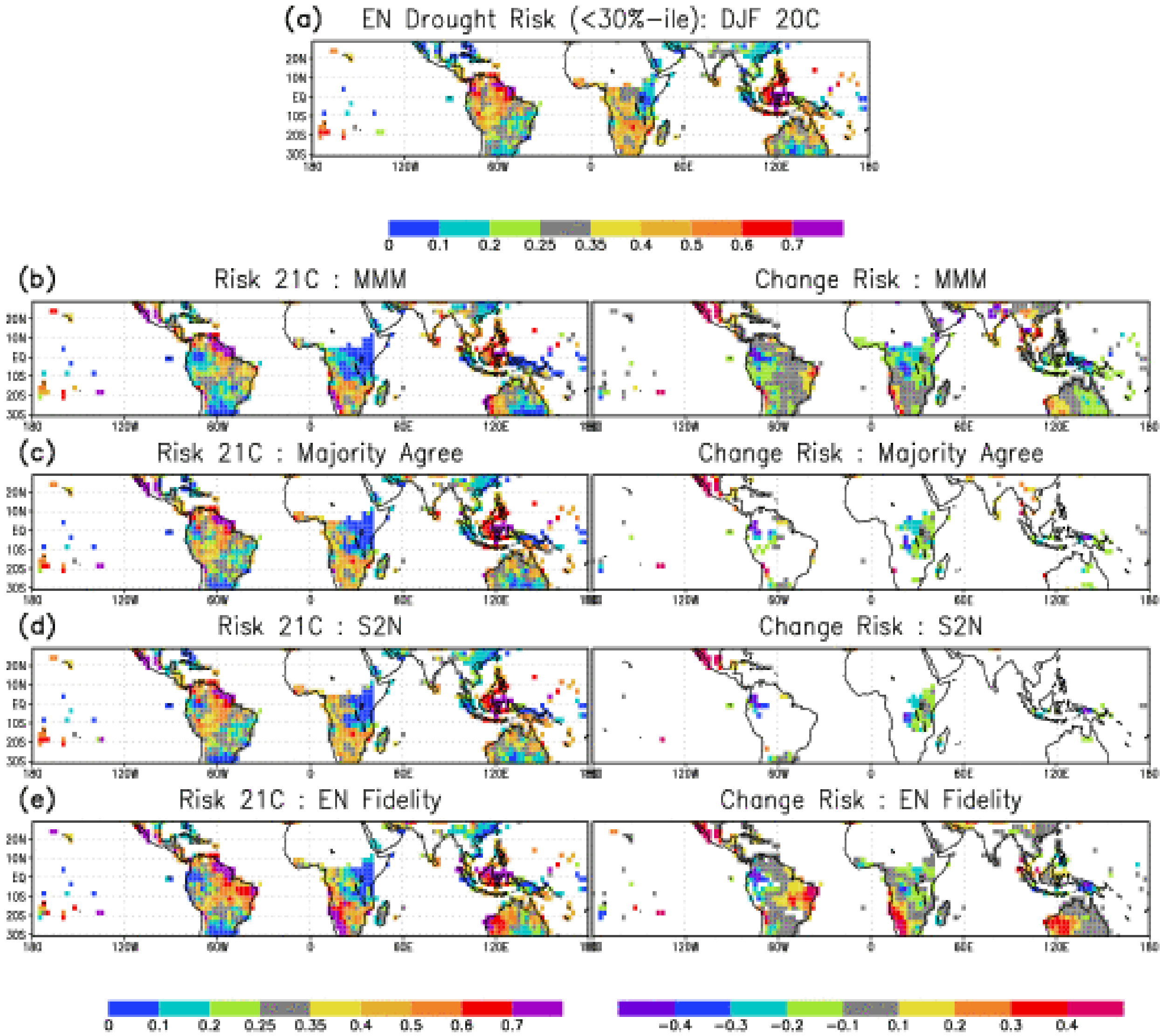
Contributed by ***S. Someshwar**, **E. Conrad**, **H. Bhojwani***

Layering Climate Information at Different Time Scales: El Niño-related Tropical Drought Risk in a Changing Climate

El Niño brings widespread drought (i.e. precipitation deficit) to the tropics. The tropics also contain many developing countries particularly vulnerable to year-to-year drought in addition to potential changes in precipitation patterns related to anthropogenic climate change. Stronger or more frequent El Niño events in the future and/or their intersection with local changes in the mean climate towards a future with reduced precipitation would exacerbate drought risk in highly vulnerable tropical areas. In a study recently published by Coelho and Goddard (2009) projected changes in El Niño characteristics and associated teleconnections are investigated between the 20th and 21st centuries.

For climate change models that reproduce realistic oceanic variability of the El Niño-Southern Oscillation (ENSO) phenomenon, results suggest no robust changes in the strength or frequency of El Niño events. These models exhibit realistic patterns, magnitude, and spatial extent of El Niño-induced drought patterns in the 20th century, and the teleconnections are not projected to change in the 21st century; although a possible slight reduction in the spatial extent of droughts is indicated over the tropics as a whole. All model groups investigated show similar patterns in the changes in mean precipitation for the end of the 21st century, with increased precipitation projected between 10^{o}S and 10^{o}N, independent of the ability of the models to replicate ENSO variability. These results suggest separability between climate change and ENSO-like climate variability in the tropics.

As El Niño induced precipitation drought patterns are not projected to change, the observed 20th century variability is used in combination with model projected changes in mean precipitation for assessing year-to-year drought risk in the 21st century. For example, a pre-defined threshold of drought in the present day climate can be defined, such as the 30th percentile of precipitation in the recent 30 year climatology. One can then define the risk of seasonal precipitation that is at or less than that drought threshold in the present day climate during an El Niño event (see (a) of figure that follows). Since the IPCC models indicate no change in El Niño events or their teleconnections, change of drought risk (defined by precipitation deficiencies) for the future comes from the intersection of climate change trends and interannual variability. The change in mean precipitation at the end of the 21st century due to these trends is taken from a collection of IPCC models. Given the discrepancy between models, at the local scale, in even the sign of the trend, different approaches to model confidence in the multi-model trend are considered. One could just combine the trends of all models considered (see (b) of figure), or following the IPCC approach one could only credit estimates where the majority of the models agree (see (c) of figure) or where the multi-model mean exceeds the spread among the models (see (d) of figure. An additional consideration uses just the subset of the models that have a good representation of ENSO variability, as judged in previous studies. Results suggest more locally consistent changes in regional drought risk among models with good fidelity in reproducing ENSO variability (see (e) of figure). This final result on the robustness of local trend across models with good ENSO variability requires further investigation, as the tropical Pacific SST trend differs between the models within this subset.



Risk of deficient precipitation, defined as the 30th percentile of the observed 20th century distribution, during El Niño conditions for DJF (a) during the period 1959-2001; (b) during 2071-2100, based on the multi-model mean (MMM), lhs, and the difference (b,left)-(a) on rhs; (c) similar to (b) but only considering MMM when 7 of the 9 models agree in sign; (d) similar to (b) but only considering MMM when that value exceeds the standard deviation model set at that point; (e) similar to (b) but only considering the 4 models deemed to have realistic ENSO variability and additionally requiring that 3 of the 4 models agree in sign of the precipitation change. White areas in (a) and left-hand panels indicate 20th century mean precipitation is less than 30 mm for the season. Additional white areas in right-hand panels indicate low confidence in precipitation change, or effectively no ability to predict change in El Niño related drought risk there.

Contributed by ***L. Goddard*** *and C.A.S. Coelho*

Mechanisms of Climate Change in the Semi-arid African Sahel: The Local View

Global warming, as manifested in the increase in global-mean near-surface temperature, is expected to lead to increased evaporation over land. In the absence of credible regional rainfall projections it is often argued that such change in itself could lead to water stress, adversely impacting dryland ecosystems and the services they provide (Adeel et al., 2005). However, in tropical drylands these systems have historically been dominated by variability in rainfall, not in temperature. This study seeks to make sense of temperature and rainfall changes as one, and uses the Sahel, a semi-arid region at the margin of influence of the northern hemisphere summer monsoon, as a case study. Projections of future rainfall change in this region, as in most tropical regions, are inconclusive: about as many models project a wetter as a drier future or insignificant change (Biasutti and Giannini, 2006; Cook and Vizy, 2006; Douville et al., 2006; Christensen et al., 2007).

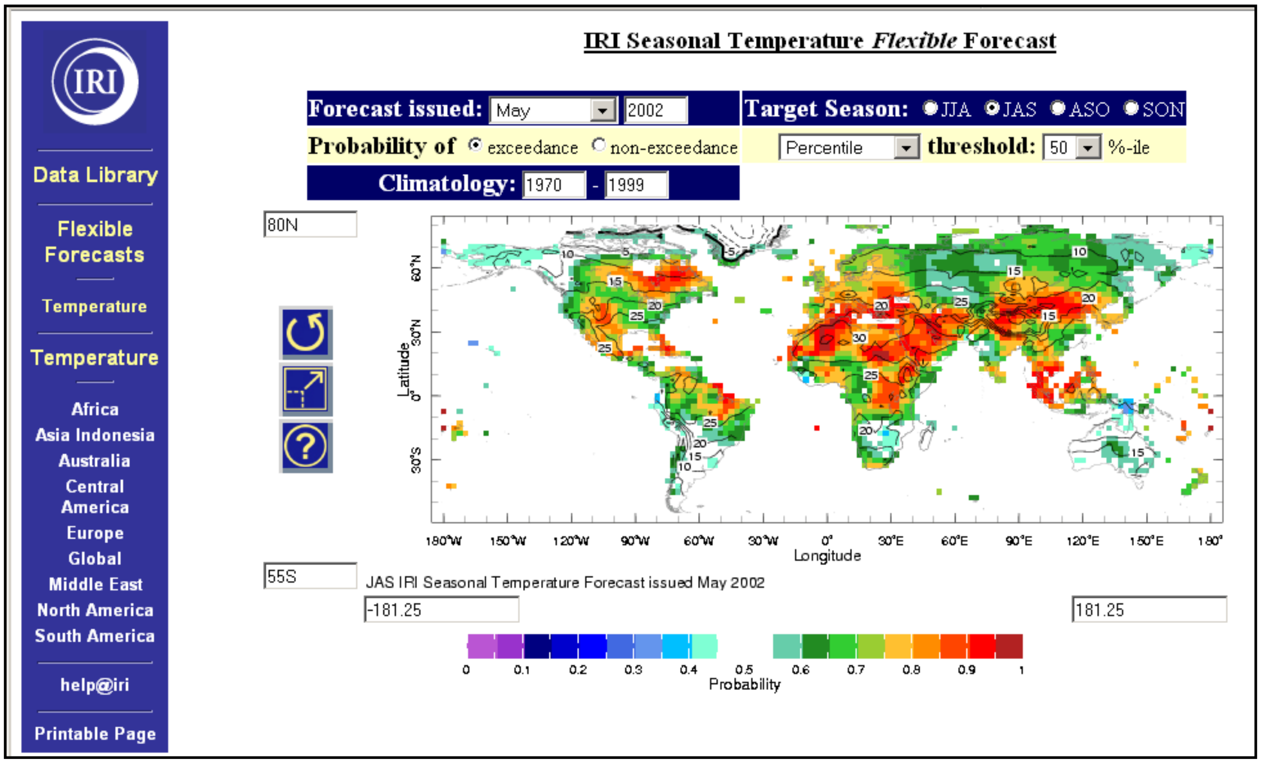
Joint consideration of energy and water cycle changes, aided by the application of the moist static energy framework (Neelin and Held, 1987), sheds light on the divergence of projections. Two distinct pathways are sketched. In one, anthropogenic warming changes continental climate indirectly: warming of the oceans increases moist static energy at upper levels, affecting vertical stability globally, from the top down, and driving drying over the Sahel, in a way analogous to the impact of the El Niño-Southern Oscillation on the global tropical atmosphere (Chiang and Sobel, 2002). In the other, the increase in anthropogenic greenhouse gases drives a direct continental change: the increase in net terrestrial radiation at the surface increases evaporation, favoring vertical instability and near-surface convergence from the bottom up. In both cases the surface warms, but in the first precipitation and evaporation decrease, while in the second they increase. This state of affairs points to the need to research in at least two directions, to improve credibility of projections: 1) an analysis of recent observed changes in terms in the net surface energy budget to identify which of the physical processes sketched actually dominates in the real world; and, 2) attribution of recent trends in mean seasonal as well as in daily extremes of rainfall to patterns of natural variability, on interannual to decadal time scales, or to the impact of anthropogenic forcing.

Contributed by ***A. Giannini***

More Flexible Formats for Seasonal-to-Interannual Climate Forecasts

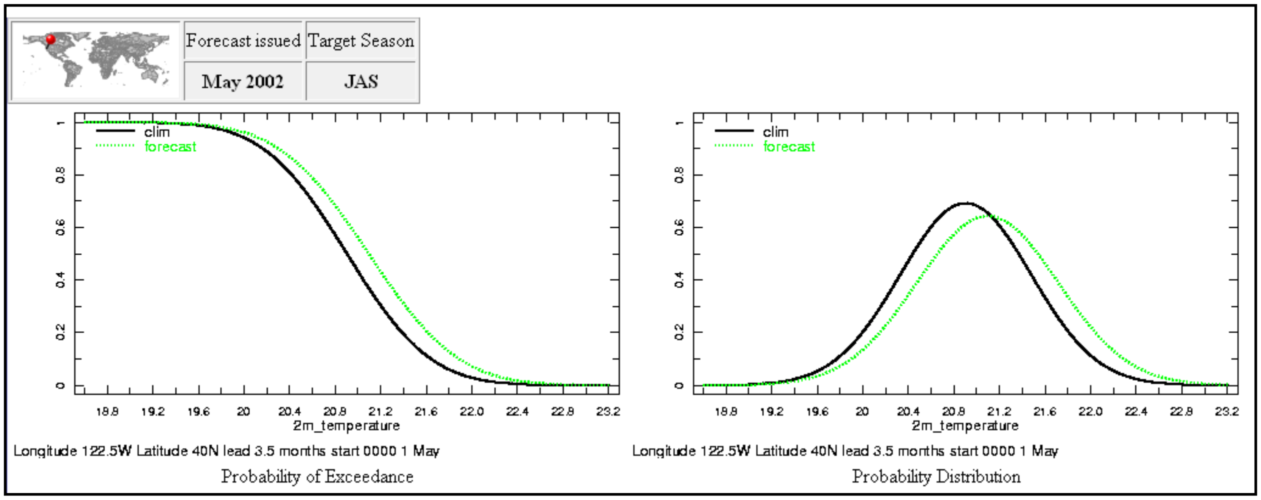
The usefulness of IRI seasonal forecasts for input to decisions and climate risk management has not reached its full potential, due in part to the limitations in the information format. The tercile format, which provides probabilities for the upcoming seasonal mean temperatures or precipitation totals, uses a fixed climatology to define three equi-probable categories. This produces information that is somewhat relative, in that the current probabilities are relative to the frequency of past occurrences rather than relative to quantitative values. Additionally, it puts the burden on the audience to find out what, for example, the “above-normal” tercile category means in terms of temperature or precipitation.

We sought to develop a format for the probabilistic forecast information that allowed for the differing needs of those who might use the information, in particular because many decisions are driven by thresholds (i.e. probability of not getting X cm rainfall over the season) rather than shifts in the odds of relative categories. The new flexible format builds on the improved seasonal-to-interannual climate multi-model climate predictions (see also *Selected Abstract* contribution entitled *Improving Seasonal-to-Interannual Forecast Information*), in which the individual models' ensemble mean is now spatially, and locally, bias corrected prior to combination. The corrected ensemble mean, together with the associated errors, form the basis for an analytical distribution of the forecast distribution, resulting in probabilities that are tied to quantitative values. This means that the forecast probabilities for user-defined thresholds or categories can be easily extracted. And, since similar distributions can be constructed for the climatology, forecast values can still be presented relative to climatological values, if desired, but they are not tied to a specific climatology – even the climatology period can be flexible.



Example of default view of flexible format for seasonal temperature.

When one enters the map room of the flexible format climate forecasts, a default map may be displayed, such as the probability of exceeding the 50^{th} percentile of the historical climatology distribution (see figure above). The climatology period in this case has been chosen to cover 1970-1999, but that could be changed by the individual visiting the page. The colors on the map show the probability of exceeding the median value, which itself is indicated by the contours. On this page it will also be possible to switch to a different target forecast from the same or different issuing month. Since underlying the default map is the full probability distribution for the forecast and climatology, the user can specify the historical percentile for probability of exceedance or non-exceedance. Alternatively he can choose the probability of exceeding (or not exceeding) a quantitative value. As with any map room, the specific geographic region can be delimited. Furthermore, one can click on a grid box on the map to generate graphs of the cumulative distribution and probability distribution functions (e.g., see figure that follows).



Cumulative distribution (left) and probability distribution (right) functions for a point over southern California from the flexible format map, showing the forecast (green) together with the climatological distribution (black) for reference.

In addition to this graphical data, it will be possible for this data to be downloaded for decision systems models and scenario generation. Downloadable data will include the observed time series, the observed quantity associated with quantiles (if appropriate), the parameters of distribution – such as the mean, standard deviation, and power transform information (applicable to precipitation forecasts). Eventually, we can work with regional partners, who may be interested in using their local historical data as the observational reference. This would provide the NMHSs and regional centers the ability to adjust GCM-scale data to their locale by considering the correlation between the GCM-grid (or regional scale) and the local time series, and be able to replot local forecast graphs using the local reference data.

*Contributed by **L. Goddard**, **R. Cousin** and **M.K. Tippett***

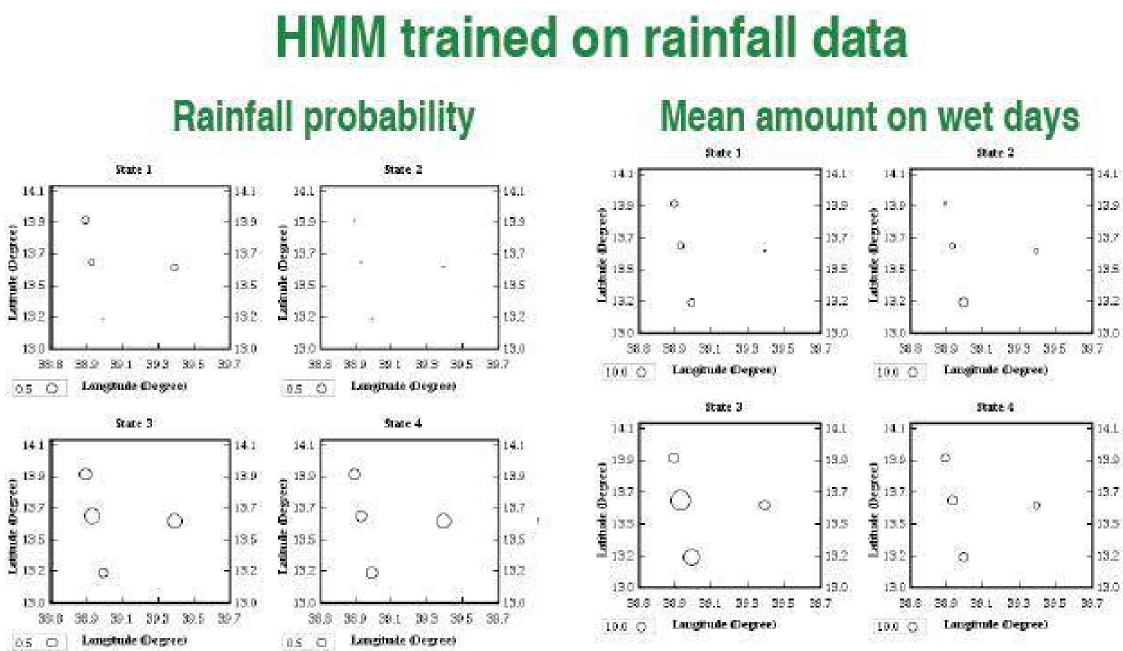
Pioneering the Next Generation of Practical Index Insurance Approaches

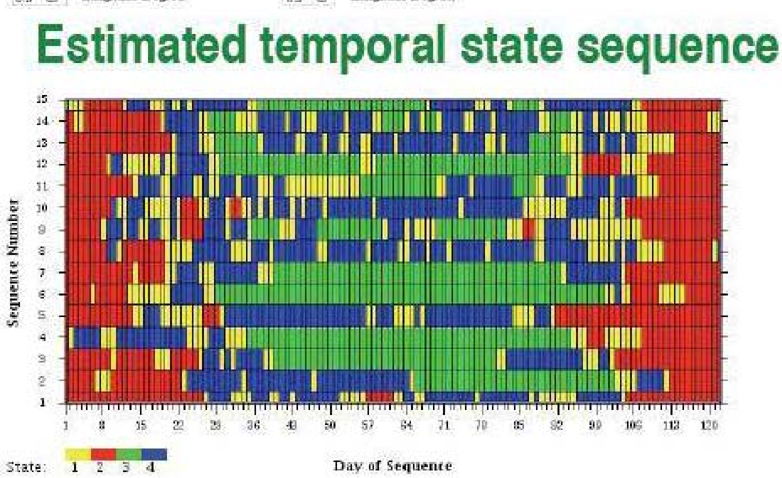
Since early this decade, the IRI has committed itself to the field of technical expertise in weather index insurance. Combining expertise in climate science with a mandate for development, the IRI has pioneered many key facets of the field, and formed partnerships with other leading institutions from government, academia, the UN system, and the private sector.
In early 2008, Oxfam America (OA) invited the IRI to participate in a scoping trip to rural Tigray province in northern Ethiopia to conduct a demand assessment for a planned weather index insurance pilot project. The project was designed to include all relevant stakeholders, from the local to the national scale, in a holistic risk management strategy to enhance climate change adaptation activities that OA was already conducting in the region.

More recently, the IRI has been motivated by a partnership with OA, Swiss Re, and other local stakeholders of the HARITA (Horn of Africa Risk Transfer for Adaptation) project in northern

Ethiopia. IRI's involvement in this project is targeting next generation index insurance products, focusing on practical, stakeholder-driven design, and incorporating a "simpler but smarter" approach to technical product development that uses the latest climate to improve upon earlier more complex weather insurance products with increased skill at identifying key climate risks. Recent problem-driven technical advancements include applied rainfall modeling (see, for example, figure below) and remote sensing technologies, blending diverse data sources and types to form a more cohesive picture of the climate histories of previously data poor regions.

To date, the HARITA project has successfully conducted a pilot transaction in the village of Adi Ha. The HARITA project has made advances upon nearly every stage of weather index insurance, including robust design, transparent pricing, appropriately targeted climate risks, and validation of farmer outcomes. Verification of the impacts of these advances is now being considered in the ongoing monitoring and evaluation phase of the project. With the completion of this rigorous evaluation, it is our hope that the HARITA project will serve as a baseline example for future weather insurance projects around the developing world.





Initial explorations for rainfall simulation using a Hidden Markov Model (HMM). The 4-state model describes spatial rainfall patterns in the region, as well as its sub-seasonal, seasonal, and interannual variability.

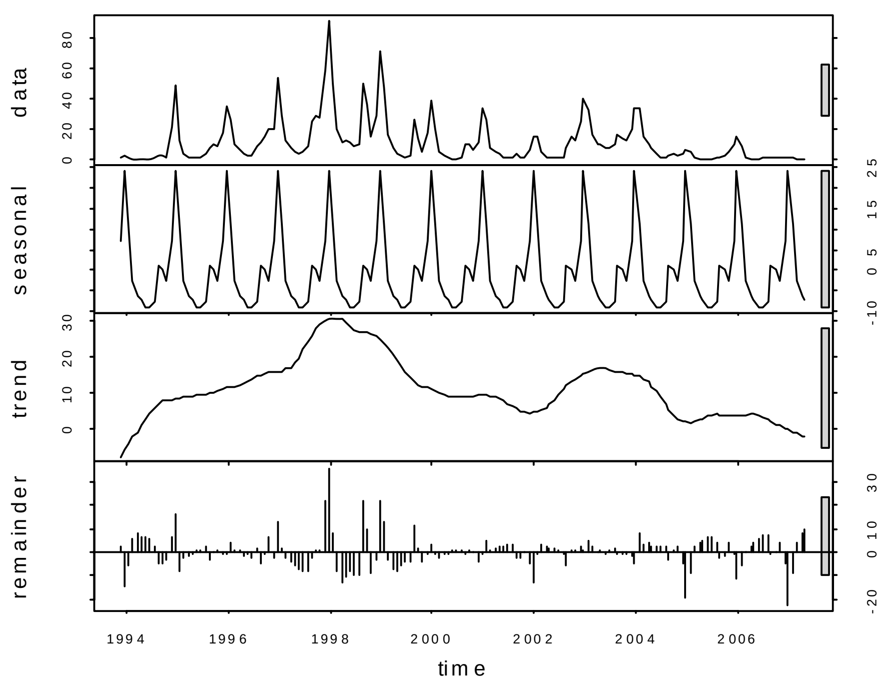
Contributed by ***E. Holthaus****,* ***M. Norton****, and* ***D.E. Osgood***

Predictability of Malaria Epidemics Using Climate Factors in Highland Fringes of Ethiopia

The Rollback Malaria Initiative's 2008 Global Malaria Action Plan identifies malaria epidemics as one of the major risks requiring improved management in affected areas. It calls for strengthening of surveillance-based monitoring systems for prompt detection of risk of epidemics that enable rapid deployment of adequate responses; and the need for systems that anticipate possible epidemics sufficiently well in advance to enable the implementation of effective prevention and response. Traditional epidemiological monitoring of morbidity has limitations due to delays before control interventions can be initiated. Existing surveillance-based monitoring systems are not sufficiently effective in the context of many epidemic prone countries including Ethiopia. One way to strengthen these surveillance systems is to incorporate early warning indicators, derived from climatic and environment factors, into the malaria epidemic prediction systems.

A difficulty in applying epidemic early detection systems regards the definition of the cut-off point below which disease prevalence is considered normal and above which it is considered epidemic. Studies have attempted to develop alert thresholds using empirical evidence (e.g., Teklehaimanot et al., 2004). In areas where long time series data is available and the population has remained stable, epidemic thresholds can be established with relative ease (WHO, 2005). However, many epidemics occur in situations where historical data are either unavailable or irrelevant due to significant contextual changes over time and space. In these circumstances, precise thresholds will not be possible, and an epidemic is declared based on visual evidence of rapid increase in numbers, high case-fatality rate and when existing health services are overwhelmed (ibid).

Our study uses a 162 month time-series of confirmed *P. falcuparum* malaria cases obtained from a government run malaria laboratory in Debre Zeit town, Ethiopia. We develop an epidemic threshold first by smoothing for temporal changes using Loess seasonal decomposition of time-series, which decomposes de-trended morbidity data into seasonal, trend and inter-monthly variation (remainder) (Cleveland et al.,1990), and then applying a uniform cut-off of mean plus one standard deviation on the remainder dataset (see also figure at right). Further, we used



Decomposition of daily average number of cases into annual cycle (seasonal), low-frequency (trend) and inter-monthly (remainder) time-series.

Fisher Iteration for stepwise regression with AIC parameters in R-software to select the best logistic model with the predictors of monthly averages of minimum temperature, maximum temperature, and rainfall obtained from the meteorological sites in Debre Zeit town; and, sea surface temperature (SST) from Niño 3.4 region obtained from NOAA.

Our results indicate that SST from the Niño 3.4 region averaged over a lag of three months provides for a robust prediction (significant at 95%) of malaria transmission exceeding mean plus one standard deviation with 69.1% accuracy rate. The results provide significant capability for making decision in the context of competing priorities for limited resources in the health sector, and can also be used as basis for developing climate based models for similar epidemic prone districts and villages throughout the country.

*Contributed by A. Siraj, **M.C. Thomson** and **S.J. Connor***

Predicting Cases of Meningococcal Meningitis in Niger using a Systemic Approach

Meningitis outbreaks severely burden Niger. Their occurrence is likely to be driven by multiple determinants but these factors are not yet clear. Understanding the drivers of the meningitis epidemic is critical to improving the control of the disease in the African Meningitis Belt that spans from Senegal to Ethiopia. The project used mixed methods in line with a systems thinking approach. This abstract refers to the quantitative study (a companion contribution within the *Selected Abstracts* entitled *Comprehending the risk factors for meningococcal meningitis outbreaks in Niger using expert opinion within a systems thinking approach*, addresses the qualitative component of the study). We hypothesized that the number of meningitis cases is associated after a given period of time with social, demographic, climatic and epidemiological factors identified by Nigerian experts' opinion.

The phenomena associated with the occurrence of meningitis in Niger were identified through a qualitative study by key informants. Because the methodology needed to be tailored to the available information, relevant time period and geographic area were selected by an exploratory analysis after data had been retrospectively collected for secondary analysis. A Poisson and negative binomial regression analysis using a time-lagged dataset with backward model selection were performed to address the association between 261 repeated measurements of the number of meningitis cases per week and the factors identified by the qualitative study in the district of Magaria, 2000-2004. These relationships were examined at a given point in time and until two weeks before in order to cover the incubation period. Several models were built.

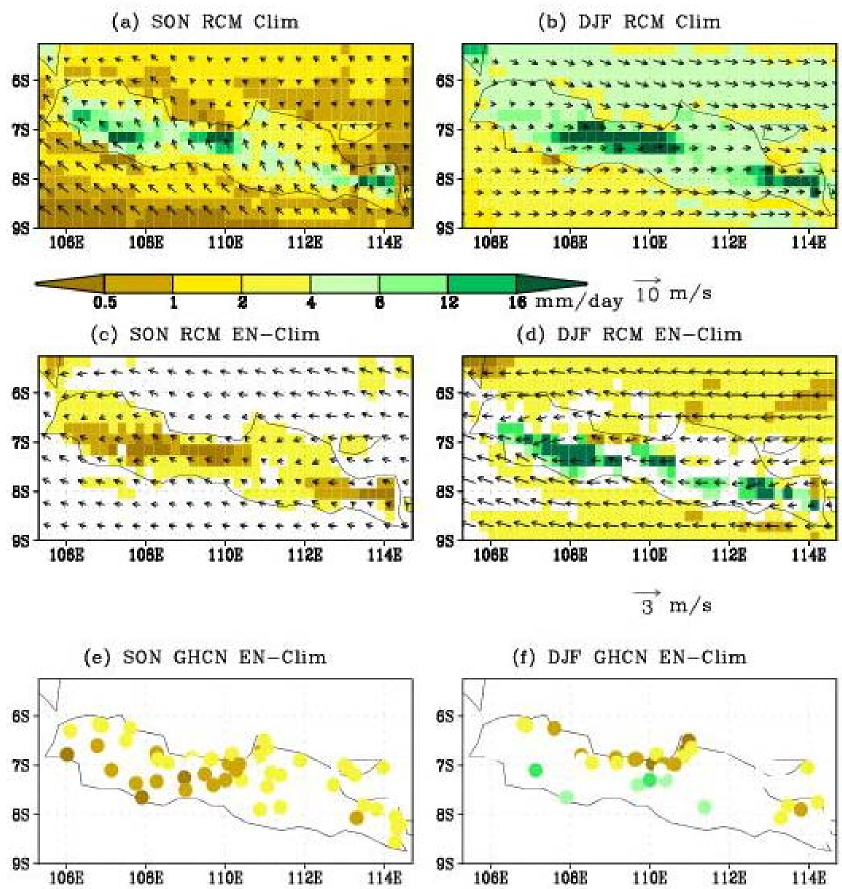
The best model predicted the count of meningitis cases two weeks ahead of time. Based on Wald Chi-square statistics, humidity was the best predictor of the expected count of meningitis cases (Incidence Rate Ratio (IRR) = 0.94, 95% Confidence Interval (CI) =0.93-0.95). The transhumance season increased the count of meningitis cases by an approximate factor 2 after a two-week delay (IRR=1.98, 95%CI=1.41-2.76). Compared to any other main religious celebrations, the Ramadan was unexpectedly a period of significant lower risk (IRR=0.83, 95%CI=0.74-0.94), but differences were not significant when celebrations were considered at once. The existence of an outbreak in a neighboring district two weeks earlier augmented the expected count of meningitis cases by 3.14 (IRR 95%CI=2.04-4.81). The IRR for vaccine coverage was close to one (IRR= 1.04), with a small CI width (95%CI=1.03-1.06).

By using a systems thinking approach with mixed methods, we were able to predict the number of meningitis cases in Magaria with two-week anticipation. We hope this finding will contribute to the improvement of meningitis control in Niger and reduce its burden in the country. If meningitis outbreaks are predictable, vaccine stockpile can be prepared in advance and mass immunization implemented before the onset of the epidemic, therefore moving from disease control to prevention.

*Contributed by **L. Cibrelus**, S. Djibo, J.F, Jusot, **M.C. Thomson**, P. Kinney, S. Morse, E. Bertherat and W. Perea*

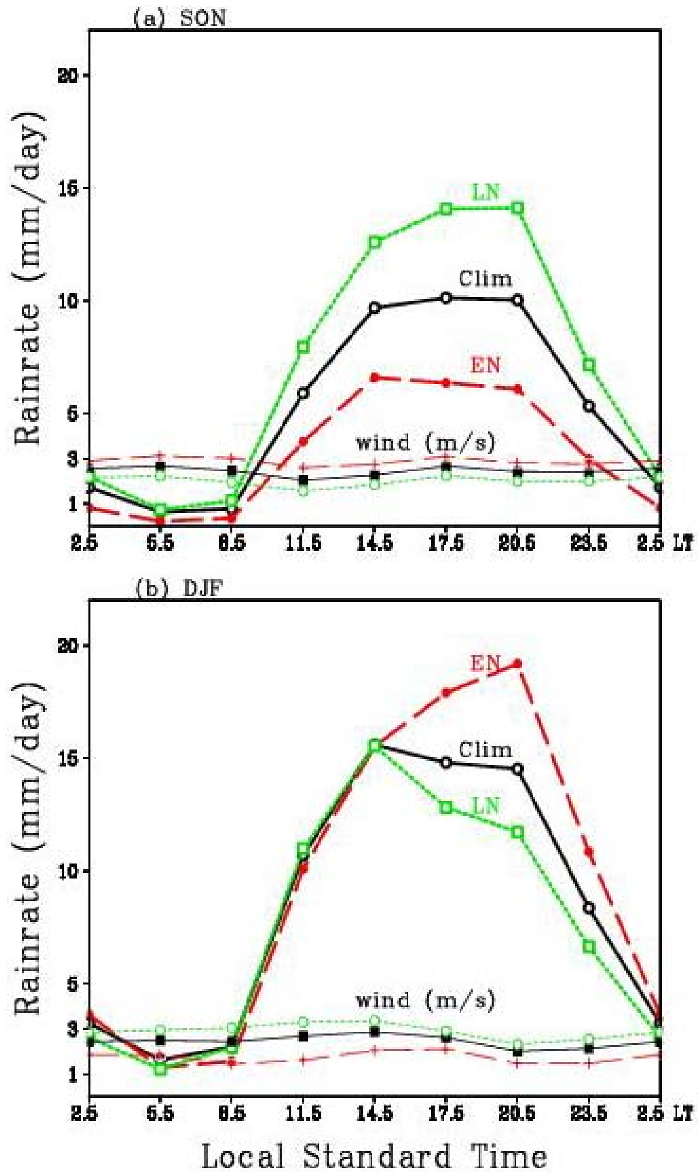
Role of Multi-Scale Interaction Between ENSO, Monsoon and Diurnal Cycles of Winds on the Spatial Pattern of Rainfall Variability in the Transition and Wet Season over Java Indonesia

Using a high-resolution regional climate model RegCM3 and station and satellite observation, we studied the spatial heterogeneity of climate variability over Java Island of Indonesia. Besides the well-known anomalous dry conditions that characterize the dry and transitioning seasons during an El Niño year, analysis of regional model output reveals a wet mountainous south versus dry northern plains dipolar structure of precipitation anomalies associated with El Niño over Java Island during the peak rainy season. Canonical correlation analyses of sea surface temperature and station rain gauge data and composite analyses of the rain gauge data confirm the ENSO-related dipole pattern over Java (see also figure at right).



Climatology of NCEP-reanalysis driving RegCM3 simulated rain (mm/day) and low level winds (m/s) at sigma=0.995 in SON (a) and DJF (b); (El Nino – climatology) composite of RegCM3 simulated rain (mm/day) and winds (m/s) in SON (c) and DJF (d); and (El Nino – climatology) composite of GHCN guage rain (mm/day) in SON (e) and DJF (f).

Modeling experiments indicate that this mountain-plain difference in rainfall anomalies is caused by the interaction of the El Niño-induced monsoonal wind anomalies and the island- and mountain- induced local diurnal cycle of winds and precipitation. In the wet season in El Niño years, large-scale anomalous southeasterly winds are in opposite direction to the climatological northwesterly monsoon, thus reducing the monsoon wind speed. When the monsoon is weakened, the local diurnal cycle of land-sea breezes and mountain-valley winds are strengthened in producing more rainfall over the mountains, which are located closer to the south coast than to the north coast. The variability of the diurnal cycle associated with this local spatial asymmetry of topography is the underlying cause for the wet mountains - dry plains rainfall anomalies in El Niño years.



Diurnal cycles of RegCM3 rainfall (mm/day, thick) and wind speed (thin, m/s) over Java Island in SON (a) and DJF (b) for climatology (black). El Niño year composite (EN - red long dash) and La Niña year composite (LN - green short dash). Wind speeds at 10 m are plotted with the same scale, but with unit m/s.

The rainfall anomalies are also studied by a weather typing cluster analysis based on the large-scale wind circulation field, and the rain gauge and satellite estimated rainfall corresponding to these weather types (see also figure at right). It is found that the frequency of occurrence of the quiescent weak monsoon weather type is more prevalent in El Niño years, while the strong-wind monsoon types are less frequent. In the quiescent-monsoon weather type, rainfall is increased over the mountainous regions near the south coast while decreased over the northern coastal plain and surrounding seas. As such, the seasonal mean southeasterly wind anomalies in December to February of El Niño years are actually the result of more frequent occurrence of the quiescent monsoon weather types, and during these days of weak monsoon weather, the strengthened sea-breeze and valley breeze convergence brings forth above normal rainfall over the mountains.

*Contributed by **J.-H. Qian**, **A.W. Robertson** and **V. Moron***

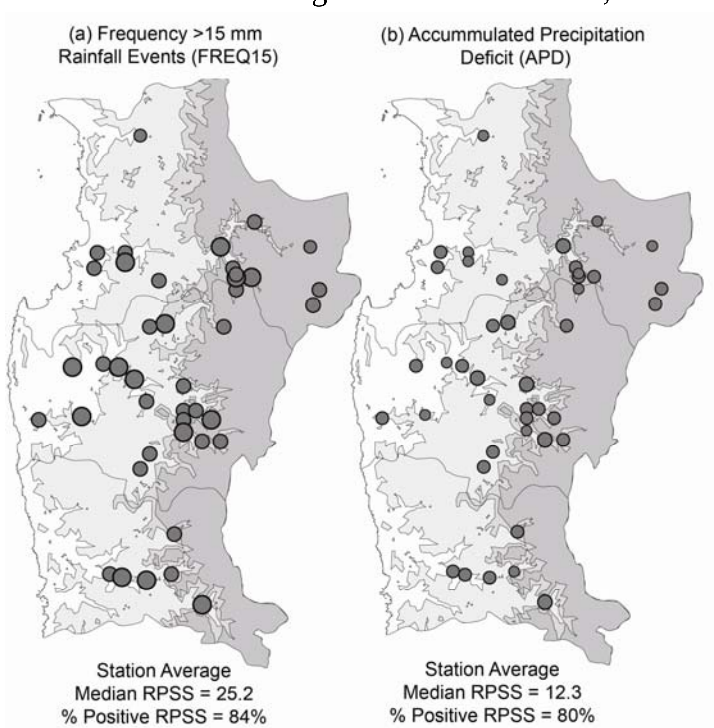
Seasonal Predictability of Daily Rainfall Characteristics in the Coquimbo Region of Chile for Dryland Management

The semiarid regions of Latin America are among the areas of the world most vulnerable to climate variability. The expected increased variability due to changes in climate can magnify even more such vulnerability. The Coquimbo region of Chile is home to some of the country's poorest farmers, whose livelihoods depend on subsistence crops and small herds (mainly goats). Droughts impose huge pressures on these populations and public agencies often must establish special emergency programs to assist them. The Coquimbo region is also home to commercial producers of fruits and horticultural crops that depend on irrigation.

The IRI is collaborating with the Water Center for Arid and Semi-Arid Latin America and the Caribbean (CAZALAC) to assist the Government of Coquimbo to improve preparedness and response to droughts in the rain fed areas. One of the goals of this collaboration is to establish a drought early warning system. This requires developing and testing methods to improve the seasonal rainfall forecasts.

In collaboration with CAZALAC, we have developed downscaled retrospective seasonal forecasts of precipitation to a network of rainfall stations over Coquimbo, to predict daily rainfall statistics pertinent to dryland management. The targeted statistics include winter season total rainfall, rainfall frequency; drought indices including the number of heavy rainfall days, and the (daily) accumulated precipitation deficit. Two methods are being tested: in the first, a canonical correlation analysis (CCA) is employed to the time series of the targeted seasonal statistic, calculated from daily station rainfall observations, together with the GCM (here CFS) retrospective forecasts of gridded seasonal-mean precipitation. In the second approach, a non-homogeneous hidden Markov model (NHMM) is trained on the daily station observations, using the GCM's mean seasonal precipitation as a predictor. The targeted seasonal statistic (total rainfall, rainfall frequency, etc.) is then computed from a large ensemble of stochastic daily rainfall sequences generated by the NHMM.

Both methods are shown to produce seasonal forecasts that perform similarly under cross-validation. Although more complex, the NHMM is able to provide probabilistic information and the daily rainfall sequences that are required for establishing water balances. The figure at right shows the Rank Probability Skill



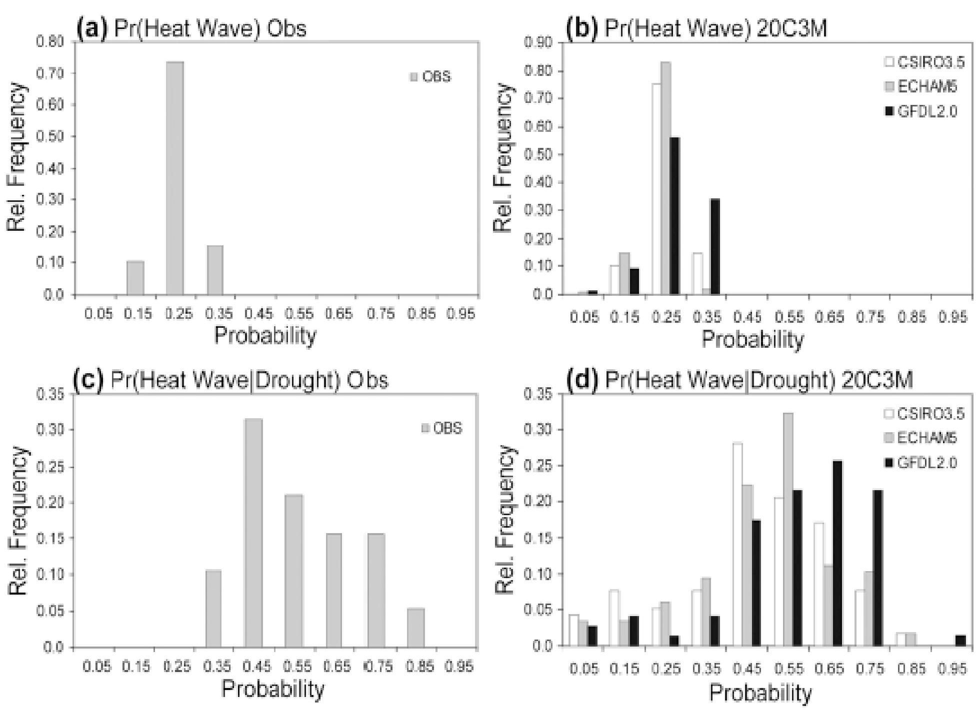
Median Rank Probability Skill Score (RPSS) for hindcasts of (a) the number of days with rainfall exceeding 15mm and (b) the Accumulated Precipitation Deficit.

Score (RPSS) for the NHMM-downscaled hindcasts in terms of: (a) the number of days with rainfall exceeding 15mm, and (b) the Accumulated Precipitation Deficit (Byun and Wilhite 1999), indicating encouraging skill for these drought-relevant variables, both of which are well correlated to declared drought years in the Coquimbo region (Novoa-Quezada 2001); their relatively good predictability is especially encouraging for climate risk management purposes.

*Contributed by **A.W. Robertson** and **W.E. Baethgen***

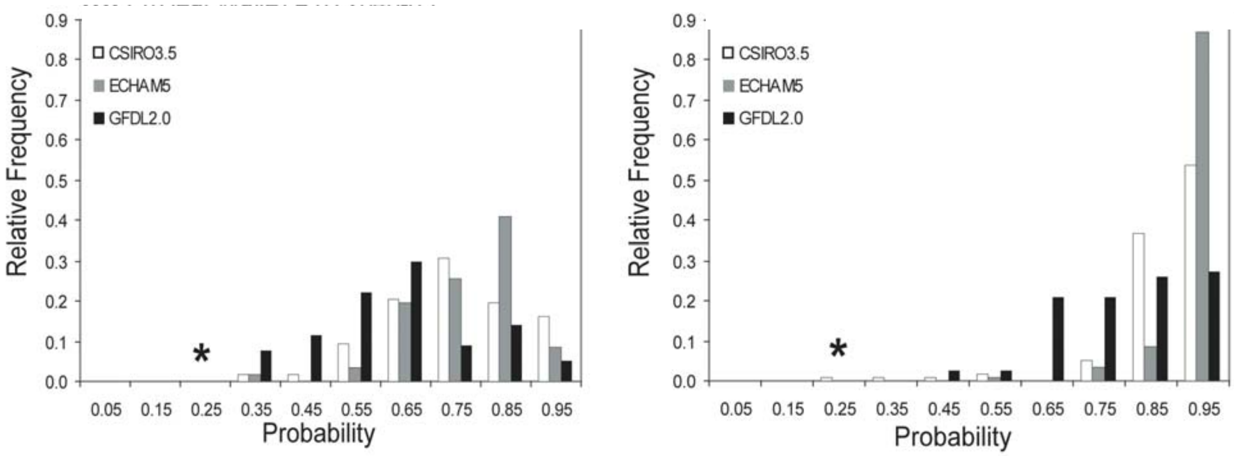
Southern African Summer Drought and Heat Waves: Observations and Coupled Model Behavior

Heat waves and drought are most often studied as separate phenomena yet their joint occurrence has direct consequences in terms of the impacts of these climate extremes. The physical linkage between drought and heat waves is via changes in the surface energy balance, which during drought often favor increased surface heating. The joint behavior of heat waves and drought is confounded by the prospect of climate change, with a warmer climate favoring greater incidence of heat waves whether or not drought conditions exist. This study focused on the joint occurrence of heat waves and drought in the drought-vulnerable region of southern Africa in both observations (1961-2000) and three coupled models used in the IPCC Fourth Assessment Report. A heat wave was defined as at least 3 consecutive days when the maximum daily temperature exceeded the 90th percentile during Dec-Feb. Drought was defined when a 3-month standardized rainfall anomaly index was < -1. Model runs from the 20th century are compared with observations before projections of climate through to the end of the 21st century are considered. For the 1961-2000 period the models were generally able to reproduce the observed characteristics of drought and heat waves, with the probability of a heat wave roughly doubling under drought (see plots below). In climate projections the relationship between the occurrence



Heat waves and drought. (a) The observed relative frequency (across 35 stations in South Africa) of the unconditional probability of a heat wave; (b) The relative frequency of unconditional probability of heat wave based on outputs from 3 coupled models; (c) the conditional probability based on the occurrence of drought (d) the same as (c) but based on output from 3 coupled models.

of drought and heat waves did not change substantially from the 20th century. However, the unconditional probability of a heat wave increases by almost a factor of 4 by the end of the 21st century (see plots below) most likely in response to an overall warming of the region.



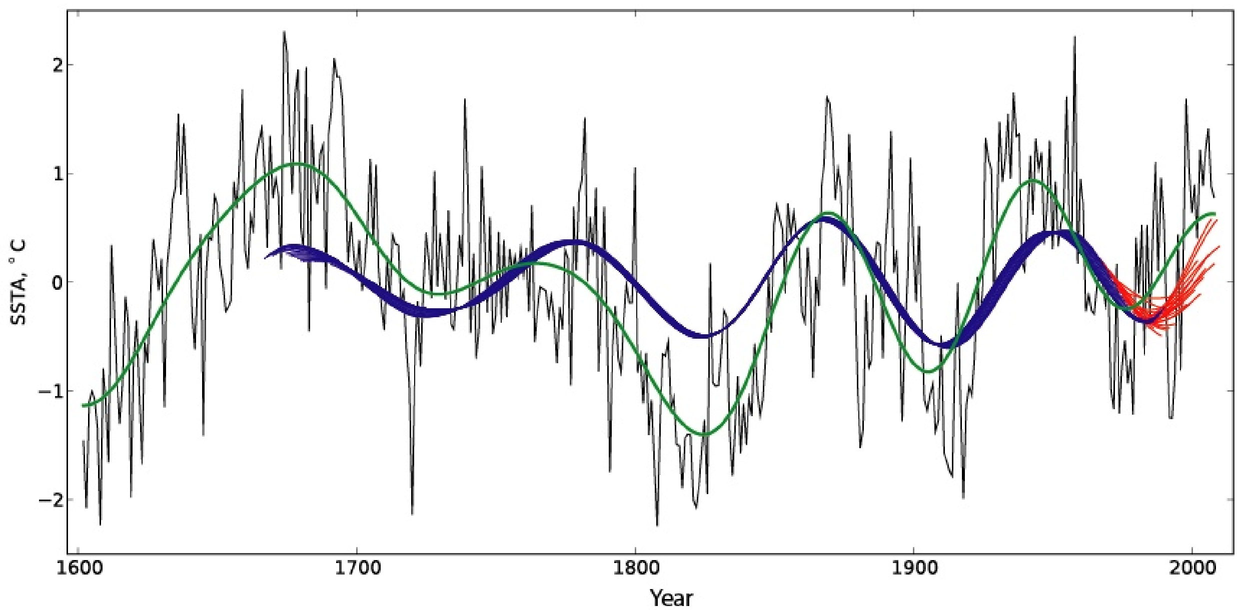
The unconditional probability of a heat wave in the models during the 2046-65 (left) and 2081-2100 (right). Asterisks represent modal value of heat wave probability for the runs from the 20th century.

Contributed by ***B. Lyon***

Statistical Prediction of Decadal Variability: Exploiting Periodicity

Climate change has usually been discussed in the context of 100-year time horizons (Solomon et al., 2007). On these long time scales attention necessarily focuses on the statistics of climate, rather than on its detailed evolution from year to year, or even decade to decade. For purposes of adaptation, however, centennial time horizons are increasingly considered too remote to be actionable, engendering an interest in "decadal" time scales, one to a few tens of years into the future. The processes giving rise to decadal climate fluctuations are not well understood, however, and climate models often do not reproduce them very well. Although the next generation of IPCC experiments will explore decadal prediction (Meehl et al., 2009) using models with initialized oceans, statistical methods can also be fruitfully applied to the decadal prediction problem. Such methods have the potential advantage that, in being trained directly on climate observations, they may capture characteristics of the climate system that are either lacking, or included only incompletely in dynamical models.

The figure illustrates a statistical scheme utilized successfully by Robertson et al. (2001), applied here to the tree-ring reconstruction of the Atlantic Multidecadal Oscillation (AMO) described by Gray et al. (2004). Several oscillatory components in this series can be distinguished from a red-noise background, the most robust of which has period of 85 years. This component was isolated using singular spectrum analysis (Allen and Smith, 1996), then projected forward in time using linear prediction methods (Press et al., 1996). Reconstructions were based on a sliding 300 year window, and were generated for all segments for which the 85 year signal was confidently identified. The AMO signal is shown in black, a smoothed (lowpassed) version used for verification in green, the 85 year component in blue and the forecasts, each of length 20 year, in red. It is encouraging that the forecasts correctly anticipate the upward tendency of the verification signal near year 2000. Parameter optimization, as well as inclusion of higher-frequency components, can be expected to refine phasing and add detail to such forecasts.



AMO reconstruction, prediction plume and verification (Kaplan post-1990). Black line represents the AMO reconstruction of Gray et al., blue "plume" a series of 300 year reconstructions based on the 85 year oscillatory component identified by singular spectrum analysis. Red lines are 20 year predictions based on these reconstructions, the green line an independently constructed verification signal.

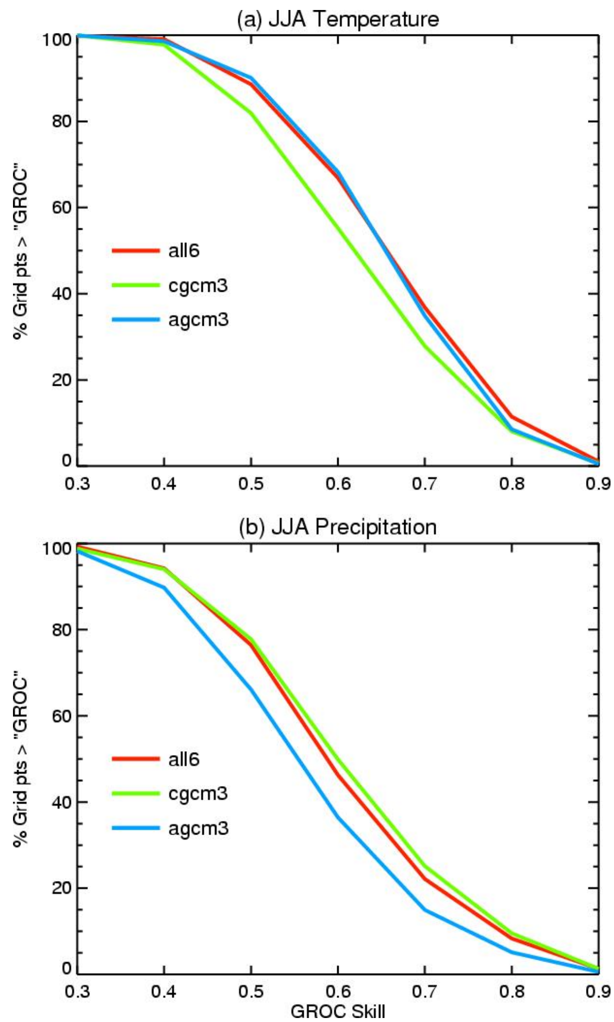
Contributed by ***A. M. Greene*** *and* ***L. Goddard***

Super-combination of 1-Tier and 2-Tier Forecast Systems

A set of hindcast experiments, consisting of both 1-tier and 2-tier global forecast systems, are used to analyze the impact of multi-model ensembling (MME) approaches on seasonal forecast skill. One set of experiments are conducted using three atmospheric general circulation models (AGCMs or 2-tier systems) forced with the NCEP CA SST predictions (Van den Dool, 1994); another set of three experiments are based on coupled GCMs (CGCMs or 1-tier systems). The common period of these experiments is 1982-2002, so the analysis is focused on the 21-year hindcasts of temperature and precipitation.

The MME combination is conducted using two different approaches: the performance-based Bayesian method (Rajagopalan et al. 2002; Robertson et al. 2004) and the pooling or equal-weighting combination. Based on our findings, and for simplicity of presentation, we focus on the results from the pooling MME. We look into the resultant forecast skill from combining the AGCMs or CGCMs separately, as well as all the six models together. The analysis is focused here on the probabilistic skill – GROC (Generalized Relative Operating Characteristics within 30 degrees of the equator). This metric is calculated based on tercile-based categorical probabilities over the 21-year period for 1-month lead forecasts of seasonal precipitation and temperature.

The summarized/aggregate skill of GROC over the tropics for Jun-Jul-Aug (JJA) is shown in the figure at right. The MME forecast from the CGCMs does not necessarily yield better skill than that from the AGCMs, as seen for the temperature forecasts in this season. However, the MME forecast from all the 6 models together corresponds to the best GROC skill. The pooling combination of the three AGCMs typically indicates comparable good skill to that of the CGCMs, which is close to that from the 6-model super-combination for the precipitation forecasts.



The aggregate GROC skill over the tropics for JJA season: (a) Temperature; (b) Precipitation. The curves represent the GROC skill for pooling combination of three AGCMs, three CGCMs, and all the six models together, respectively.

Overall, the MME forecasts from all the 6 models together tend to yield the best forecast skill. Although the performance-based combination of the 6 models together corresponds to the best overall reliability (not shown), the pooling combination of the same models results in the best GROC skill. As a matter of fact, the reliability of the precipitation forecasts from both combination approaches for 6 models together is close to each other. Therefore, the pooling super-combination of multi-model ensemble forecasts, particularly from both AGCMs and CGCMs together, appears to be the optimum scheme towards improving the overall skill of seasonal climate forecasts.

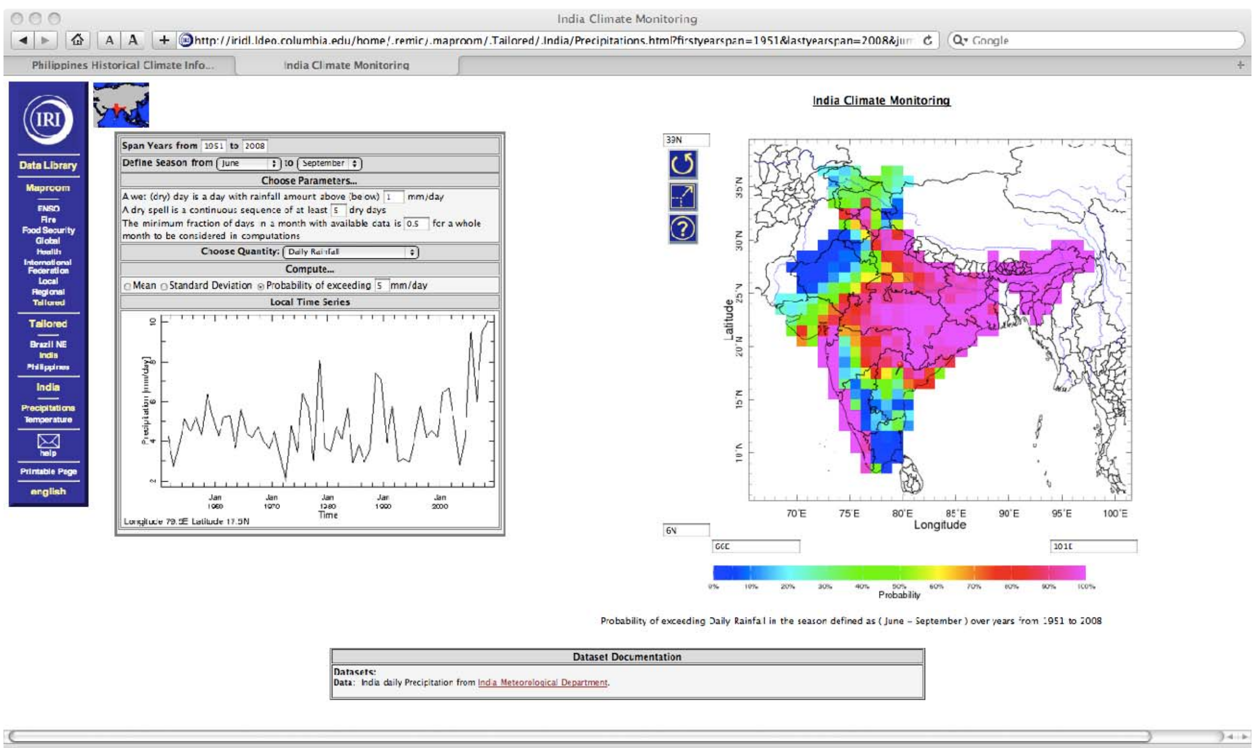
These findings justify the use of pooling of the models. Given the short training period available (approximately 20 years), it is difficult to discern differences in quality among the models. With longer training periods, not shown, more overall advantage appears for the performance-based combination method over pooling.

*Contributed by **S. Li**, **L. Goddard** and **D.G. DeWitt***

Tailored Forecast and Monitoring Products

Improved management of climate-related risks requires probabilistic climate information tailored to specific real-world decision making. Relevant indicators typically need to extend beyond the familiar coarse-scale seasonal averages to include daily weather statistics such as rainfall frequency or monsoon onset dates at fine spatial scales. Probabilistic forecasts need to be expressed in terms of user-defined categories. This project aims to develop flexible indices from historical daily climate information, together with real time seasonal forecasts that include key statistics of daily weather across the season at fine spatial scales, such as rainfall frequency and dry-spell risk.

Virtual maprooms have so far been developed for historical daily climate information over NE Brazil, the Philippines and India, allowing users to easily visualize (and download quantitatively) station-scale (or gridded) daily rainfall statistics, such as the probability of exceeding a given number of dry spells within a season. The figure below illustrates an example for India, showing the historical probability of exceeding on-average 5mm/day over the June–September monsoon season, an amount approximately required for rainfed maize or cotton; one sees large variations across India.

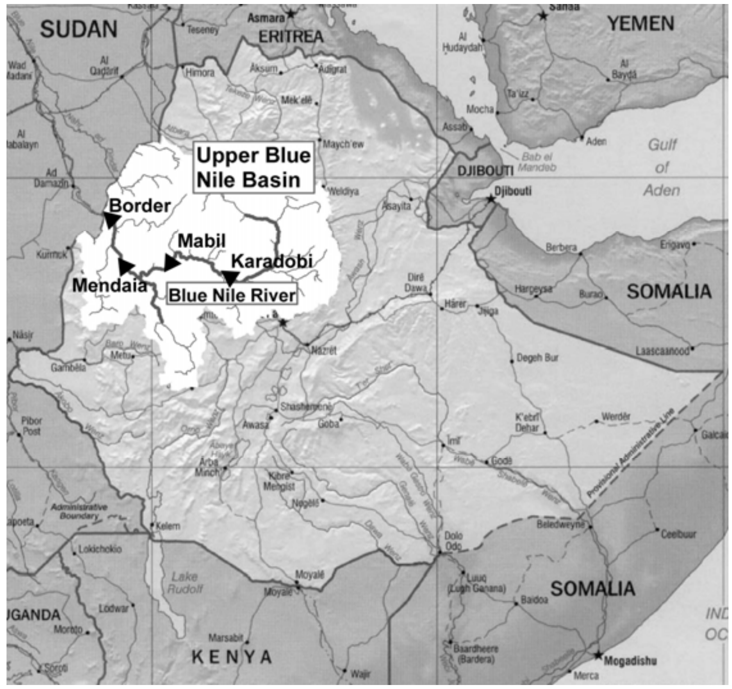


Prototype historical climate information maproom for India (see text for details). Clicking on the map allows the historical quantity at that location to be plotted -- here the mean summer season rainfall from the India Meteorological Department.

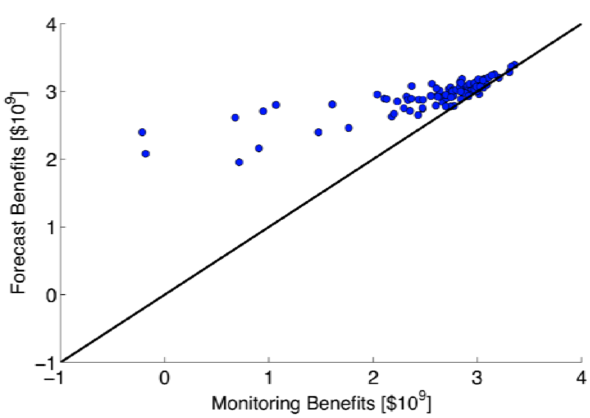
Contributed by ***A.W. Robertson*** *and* ***S.J. Mason***

Tailoring Seasonal Climate Forecasts for Hydropower Operations in Ethiopia's Upper Blue Nile Basin

A framework is proposed for enhancing hydropower benefits through use of a tailored precipitation forecast in the upper Blue Nile basin of Ethiopia. Explicit integration of seasonal precipitation forecasts into water resources operations and planning is practically nonexistent, even in regions of scarcity. This is often attributable to water manager's tendency to act in a risk averse manner, preferring to avoid consequences of poor forecasts, at the expense of unrealized benefits. Convincing demonstrations of forecast value are therefore desirable to support assimilation into practice. A dynamic coupled modeling system approach is adopted, including linked forecast, rainfall-runoff, and hydropower models. Three forecast modes are evaluated: a perfect, an actual, and a monitoring forecast; the latter is based on climatology and response to existing conditions, as is currently practiced for the majority of water resources systems. Processing one hundred decadal sequences demonstrates superior actual forecast-based benefits over the monitoring approach in 68 cases, a respectable advancement, however benefits in a few forecast-based sequences are noticeably low, likely to dissuade manager's adoption. A hydropower sensitivity test reveals a propensity toward poor-decision making when forecasts over-predict wet conditions. The forecast is therefore tailored to dampen precipitation projections in the above normal tercile while retaining critical near normal and dry predictions, subsequently improving reliability to 96-percent. Such tailoring potentially provides strong incentive to risk-adverse water managers cautious to embrace forecast technology.



Upper Blue Nile basin, Ethiopia, and proposed locations for large-scale hydropower dams (base map courtesy U Texas).



Comparison of hydropower benefits between monitoring and actual tailored forecast coupled model approaches for the single-reservoir (Karadobi) scheme. Tailored approach includes dampening of above normal precipitation forecasts.

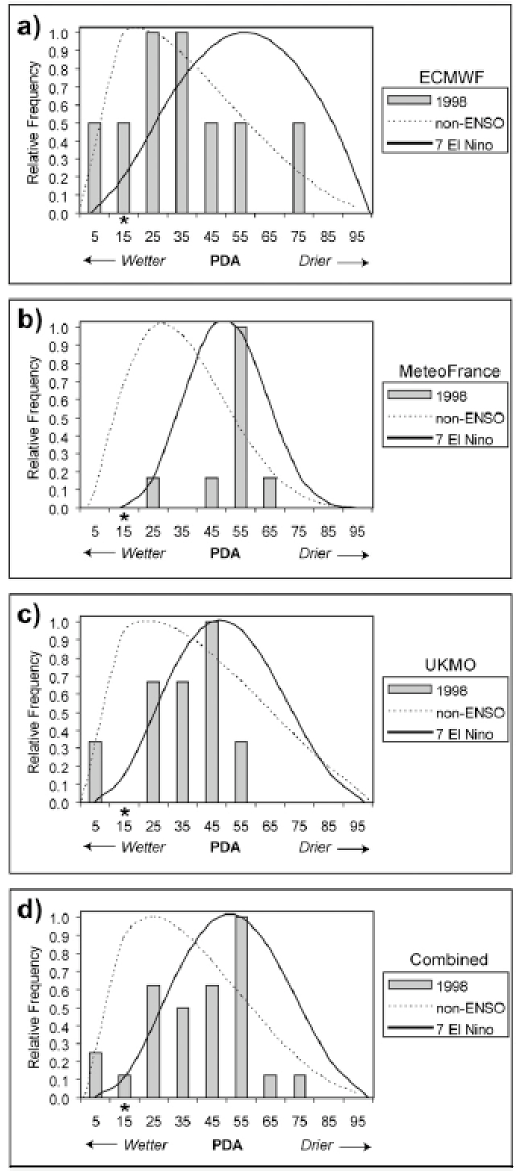
Contributed by ***P. Block***

The 1997/98 Summer Rainfall Season in Southern Africa. Part II: Model Simulations and Coupled Model Forecasts

Output from three atmospheric general circulation models (AGCMs) forced with observed sea surface temperatures (SSTs) and seasonal forecasts from three coupled models are examined to see to what extent the failure of widespread drought in Jan-Mar (JFM) of 1998 (typical of El Niño years) could have potentially been anticipated.

It was found that all three AGCMs generated widespread drought conditions across southern Africa, similar to those during past El Niño events, and did a generally poor job in generating the observed rainfall and atmospheric circulation anomaly patterns, particularly over the eastern and southern Indian Ocean. By contrast, two of the three coupled models showed a higher probability of wetter conditions in JFM 1998 than for past El Niño events (see figure at right), with an enhanced moisture flux from the Indian Ocean, as was observed. However, neither the AGCMs nor the coupled models generated anomalous stationary wave patterns consistent with observations over the South Atlantic and Pacific.

The failure of any of the models to reproduce an enhanced Angola low (favoring rainfall) associated with an anomalous wave train in this region suggests that the coupled models that did indicate wetter conditions in JFM 1998 compared to previous El Niño episodes may have done so, at least partially, for the wrong reasons. The general inability of the climate models used in this study to generate key features of the seasonal climate over southern Africa in JFM 1998 suggests that internal atmospheric variability contributed to the observed rainfall and circulation patterns that year. With the caveat that current climate models may not properly respond to SST boundary forcing important to simulating southern Africa climate, this study finds that the JFM 1998 rainfall in southern Africa may have been largely unpredictable on seasonal time scales.



Plots indicate the fraction of coupled model runs (normalized to have a maximum of 1) where precipitation was in the lowest tercile of the 1961-1990 model base period. The grey bars in each plot are for JFM 1998, the solid black lines for 7 El Niño events, and the dashed lines indicate non-ENSO years. The models are a) ECMWF, b) MeteoFrance, c) UKMO and d) combined runs from all three models.

Contributed by ***B. Lyon*** *and* ***S.J. Mason***

The Weather Index Insurance Education Tool

The Weather Index Insurance Educational Tool (WIIET) has been built by the IRI's index insurance team. Using insight gained in index insurance projects in Malawi, Ethiopia and other pilots, it has been an ongoing collaboration with the World Bank's Commodity Risk Management Group (CRMG), harnessing IRI's software application development capacity.

WIIET was created to bridge the gap between concept and application; the concept of creating an index for an insurance contract is easy to understand but difficult to put into practice, and WIIET teaches in-country users how to design index-based insurance contracts by working through a series of modules. The contract design process is presented step by step, starting with crop growth simulation and continuing to the selection and optimization of financial parameters. The end result is a contract that successfully models and hedges climate risk at a price which is not prohibitively expensive.

By making the design process more accessible, WIIET offers the first step in making index insurance a standardized product in any region around the world regardless of local conditions. It allows local designers around the world to utilize state of the art World Bank index insurance design standards developed in collaboration with IRI. WIIET is currently available in both English and Spanish, with plans to add more languages as projects mature. Future plans also include developing formal lesson plans through educational packages like Moodle or Courseworks and conducting outreach workshops with insurance professionals in Africa and Central America. This underscores our dedication to building capacity in developing countries, which will be the key to making weather index insurance a sustainable and scalable risk management option for the poorest of the poor.

Contributed by ***M. Norton***, ***D.E. Osgood***, ***M. McLaurin***, ***E. Holthaus*** *and* ***L. Song***

Training on Crop Yield Forecasting in the Philippines

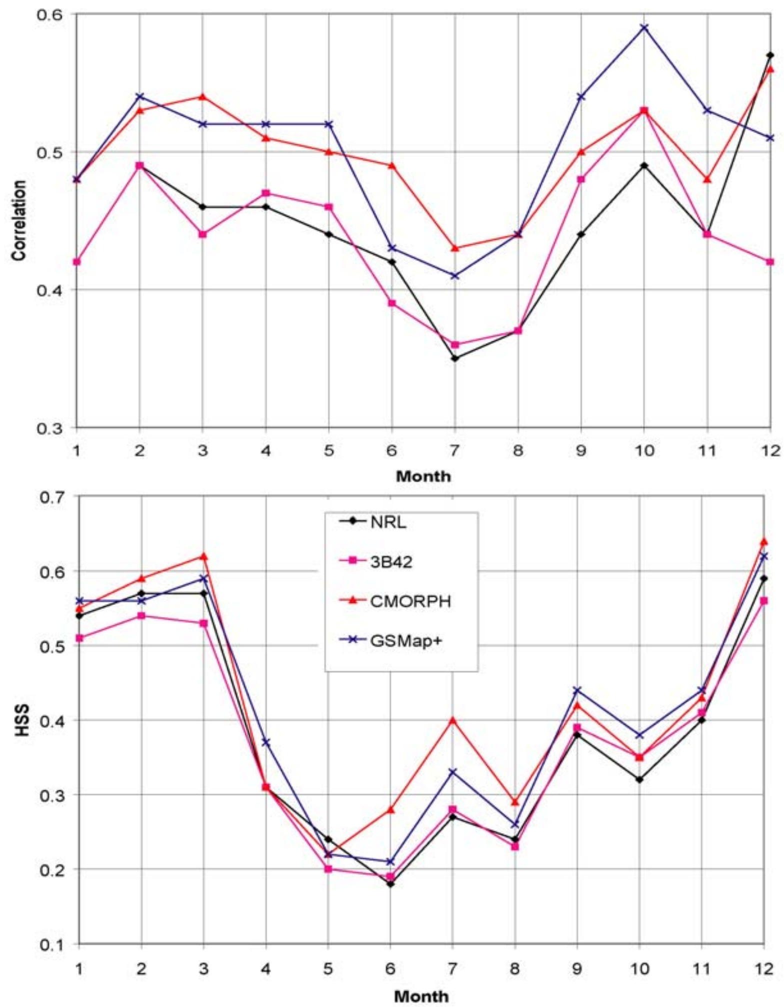
Crop yield estimates before the end of the growing season are critical inputs for food policy decisions. This information provides the government ample time to make decisions in regard to importing or exporting food grains to ensure food security in the country. Because of this, accurate and timely (lead-time) crop yield estimates are paramount. The common practice of monitoring crops and yields is primarily based on crop cuts and random field visits, limiting their spatial extents, because of time, money and labor constraints, and the lead-time of yield estimations, because of the wait-time needed within the growing season to get information. There are now efforts in the Philippines for using remotely sensed vegetation indices-yield relationships to estimate crop yields but these too are not taking advantage of the advances in seasonal climate predictions which can be used to drive more robust crop models to estimate yields at considerable lead time. It is imperative then to develop and implement a robust and automated way of predicting crop yields that can account for both the level of accuracy and lead time needed. Advances in remote sensing, seasonal climate predictions and crop modeling could enhance this procedure. Consequently, the optimal integration of best possible sources of information will improve the accuracy and lead time of crop yield estimates. The general aim of this training was to share state-of-the-art knowledge on the use of seasonal climate forecasts, remote sensing data, crop models and data integration techniques for an improved crop yield forecasting in the Philippines; specifically, to assist in the capacity building of PAGASA and Department of Agriculture (DA) specialists for designing and implementing a climate-informed crop yield forecasting system. The training was conducted at PAGASA, Quezon City, Philippines and attended by more than 20 participants coming from various departments of the government and state colleges/universities. The training materials were developed jointly by Ines and Hansen. The training was made possible through a Balik-Scientist (Returning-Scientist) Program award given to Ines by the Department of Science and Technology (DOST), and PAGASA, as the host institution.

Training participants: Crop forecasting in the Philippines.

Contributed by ***A.V.M. Ines*** *and* ***J.W. Hansen***

Validation and Intercomparison of Satellite Rainfall Estimates over Colombia

Seven different satellite rainfall estimates are evaluated at daily and ten-daily time scales and spatial resolution of 0.25^{o} latitude/longitude. The reference data come from a relatively dense station network of about 600 rain gauges over Colombia. This region of South America has a very complex terrain with mountain ranges that form the northern tip of the Andes Mountains, valleys between the mountain ranges, and a vast plain that is part of the Amazon. The climate is very diverse with an extremely wet Pacific coast, a dry region in the north, and different rainfall regimes between the two extremes. The rain gauge data are obtained from the Institute of Meteorology, Hydrology and Environmental Studies (IDEAM) in Colombia. The evaluated satellite rainfall products are the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) products, NOAA-CPC morphing technique (CMORPH), Precipitation Estimation from Remotely Sensed Information using Artificial Neural Network (PERSIANN), the Naval Research Laboratory's blended product (NRLB) and the Global Satellite Mapping of Precipitation (GSMaP). These products are evaluated at daily and ten-daily time scales and spatial resolution of 0.25^{o} latitude/longitude. The validation and intercomparison of these products is done for the whole as well as different parts of the country. Validation results are reasonably good for daily rainfall over such a complex terrain. The best results were obtained for the eastern plains while the performance of the products was relatively poor over the Pacific coast. Comparing the different satellite products, PERSIAN and GSMaP-MVK exhibited poor performance with significant overestimation by PERSSIAN and serous underestimation by GSMaP-MVK. CMORPH and GSMaP-MVK+ exhibited the best performance among the products evaluated here.



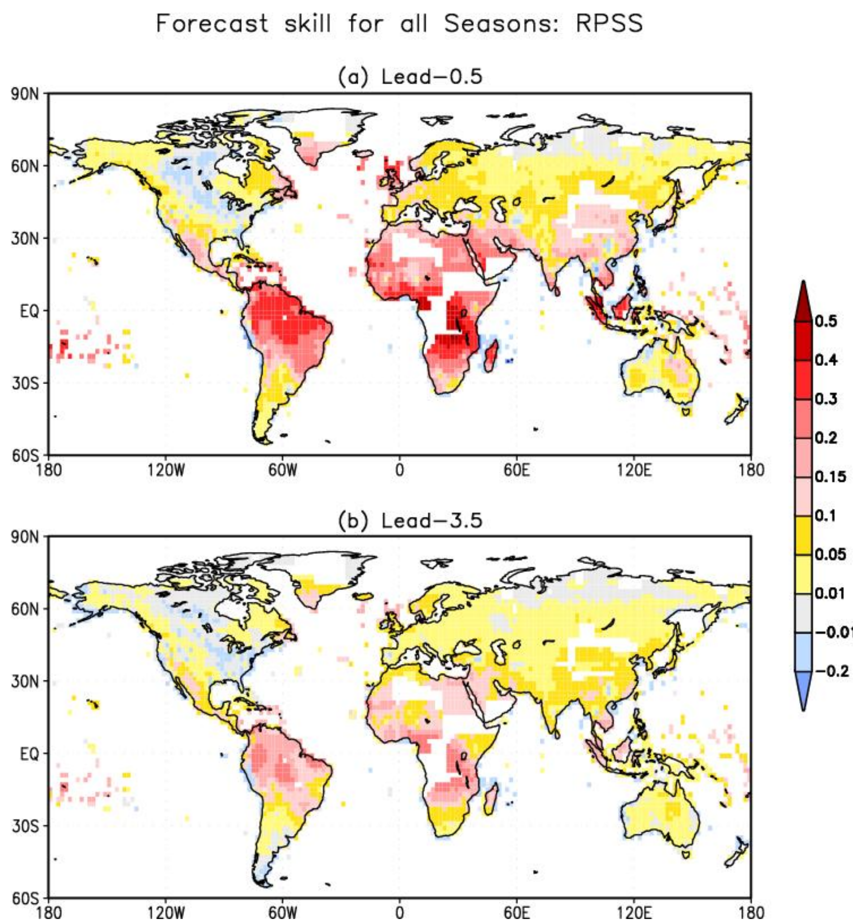
Monthly variation of validation statistics (correlation coefficient and HSS) over the eastern lowlands of Colombia.

Contributed by ***T. Dinku***, ***D. Ruiz***, ***S.J. Connor*** *and* ***P. Ceccato***

Verification of IRI's Seasonal Temperature Predictions, 1997-2008

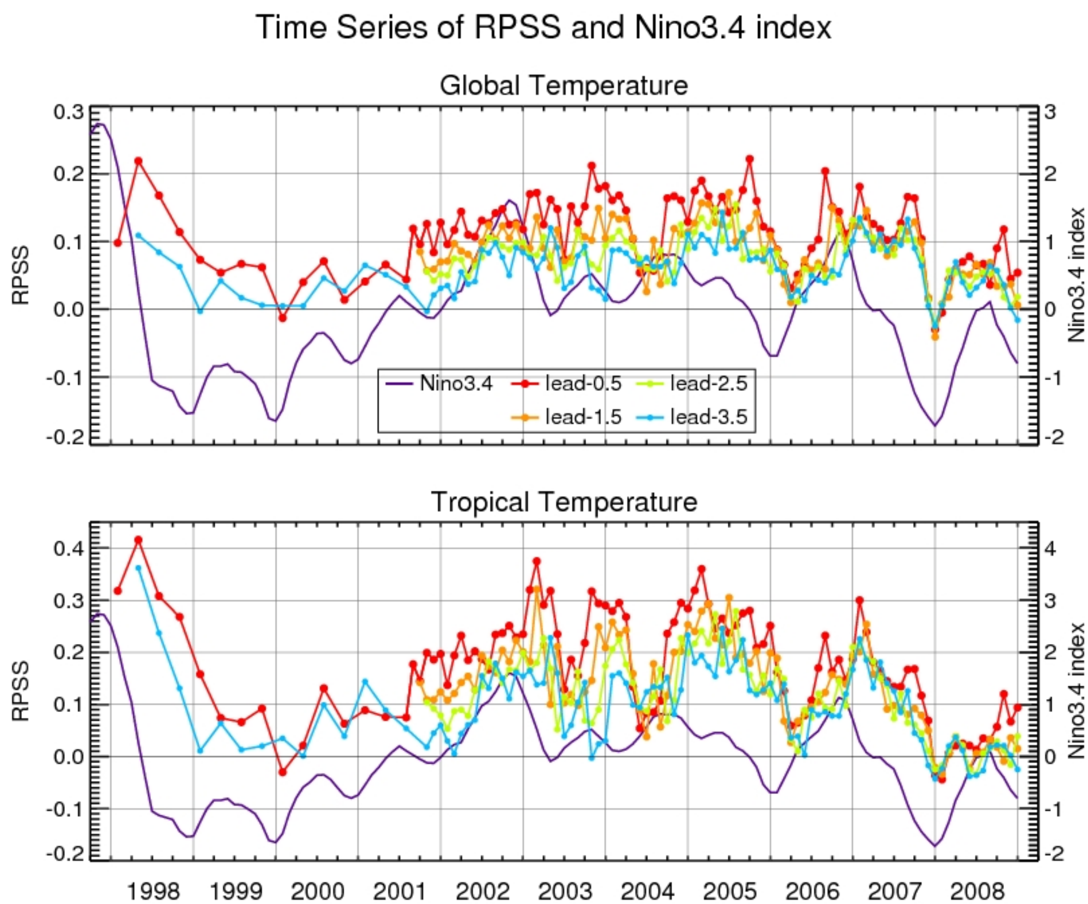
The IRI has produced seasonal forecasts of near-global precipitation and temperature since October 1997, using primarily a dynamical two-tiered prediction system. The first tier, SST prediction, uses both persistence of recently observed SST anomalies, and one or more scenarios of evolving SST predictions based on a combination of dynamical and statistical models. Ensembles from several atmospheric general circulation models are then allowed to respond to the predicted SSTs, resulting in the climate forecasts. The forecasts are probabilistic with respect to the occurrence of the three climatological tercile-based categories of seasonal mean temperature and total precipitation: below-, near-, and above normal with respect to a 30-year base period of observations. The forecasts were issued quarterly from October 1997 to June 2001, and monthly since that time. The forecasts are issued one-half month prior to the beginning of the first 3-month period being forecast, and have included four overlapping 3-month periods, ending with the second consecutive season into the future.

Among other measures, the IRI's probability forecasts are verified using the ranked probability skill score (RPSS). Skills are generally somewhat higher and more spatially uniform for temperature than for precipitation. Precipitation is a useful variable to predict, considering its importance to agriculture and water management, among others. However, temperature is also an important predictand, as it is a key determinant of energy requirements in extratropical regions, and strongly contributes to the likelihood of outbreaks of epidemics, such as malaria, in the tropics. As shown in the figure below, moderate levels of probabilistic skill are realized in predicting anomalies of 3-month mean temperature in most of the tropics and subtropics at 0.5-month-lead-time, with more modest skill at 3.5-month-lead-time.



Geographical distribution of RPSS (level of probabilistic forecast skill) for IRI's 0.5-month-lead (top) and 3.5-month-lead (bottom) temperature forecasts over the globe for all seasons during 1998-2007. Areas colored white over land have insufficient data from which to verify the forecasts.

The temporal variation of global and tropical temperature skill from 1998 through 2008 is shown in the graph below for four forecast lead times. Skill is seen to decay somewhat slowly with increasing lead-time, such that the longer lead forecasts still contain useful information. Skill also varies in response to the ENSO state (purple curve). During and immediately following El Niño, skill tends to be higher, while the opposite is true for La Niña. For example, skill was relatively high in early 1998, early 2003 and early 2005 (near El Niño endings), and lower during 1999-2000, early 2006 and early 2008. This dependence on the ENSO state is caused by the interplay between the influences of ENSO and global warming on temperature—particularly in the tropics. Global warming favors enhanced probabilities for above-normal temperature. During El Niño the degree of enhanced probability for above-normal is amplified still farther in the tropics, leading to particularly confident forecasts for above-normal temperature. During La Niña the influences of ENSO and global warming oppose one another, making the net influence weak and uncertain, and skill results lower. The expected ENSO status is therefore an important factor determining not only the temperature forecast, but also its accompanying confidence level and expected skill.



Time series of RPSS (level of probabilistic skill) for 3-month mean temperature averaged over the globe (top) and tropics (bottom) for forecasts for each of four lead-times (0.5-, 1.5-, 2.5-, and 3.5-months) from 1998 through 2008. The purple curve shows the NINO3.4 SST observed anomaly. The center month of the 3-month period being forecast is indicated on the horizontal axis, with vertical lines separating calendar years at the Dec-Jan-Feb season. Note that the vertical axis scale changes from top to bottom panels.

Contributed by ***T. Barnston****,* ***S. Li*** *and* ***S.J. Mason***

Workshop for Training in Water and Climate Risk Management: Managing Hydroclimatic Risk in the Water Sector

Alessandra Giannini teaching about hydroclimatic risk

The course provided training for water resources professionals from Ethiopia, Sudan, and Djibouti in managing hydroclimatic risk. The specific content covered addressed understanding hydroclimatic risk, prediction of hydrologic variables, and the use of climate information, including seasonal predictions and climate change, in managing climate risks to water supply systems, drawing on case studies. Normal and extreme (drought and flood) conditions were also considered. Other recent advances in hydroclimatic risk management, including market-based instruments and "portfolio" approaches, were additionally presented. The objectives included:

- Understanding limitations of traditional approaches to water management and opportunities for improvement based on new understanding of climate and climate change
- Conducting a basic climate risk assessment
- Developing a simple seasonal forecast model
- Applying dynamic rule curves to utilize forecasts
- Evaluating the benefits of forecasts
- Becoming familiar with market-based tools that can mitigate climate risk

The training lectures and exercise modules focusing on climate risk management in the water sector appeared to be well received by the participants. The lectures served as both a review of common practices in water management, as well as concepts introducing the use of climate information for improved decision-making within these practices. The hands-on exercises were especially popular, helping to solidify new concepts. Lectures addressing local/regional issues and climate information generated the most impromptu discussion. The guided discussion on institutional impediments to the use of climate information, specifically seasonal climate forecasts, also generated substantial discussion.

Faculty for the course on Water and Climate Risk Management

Contributed by ***P.Block***, ***D. Watkins***, ***A. Giannini***, ***T. Dinku***, *A. Makarigakas*

World Meteorological Organization Commission for Climatology Verification Recommendations

Under the auspices of the World Meteorological Organization (WMO) Commission for Climatology (CCl), the IRI has finalized a set of recommendations for the verification of operational probabilistic seasonal forecasts, including those from the Regional Climate Outlook Forums (RCOFs), National Meteorological and Hydrological Services (NMHSs) and other forecasting centres.

The recommendations are meant to complement the WMO's Commission for Basic Systems (CBS) Standardized Verification System for Long-Range Forecasts (SVSLRF), which has the specific objective of providing verification information for Global Producing Centre (GPC) products that are used as inputs to seasonal forecasting processes, including RCOFs. The SVSLRF procedures are targeted at providing information about the quality of ensemble prediction systems. In contrast, the procedures recommended through the CCl are targeted partly at end-users of the forecasts, and partly at the forecasters themselves.

The recommended procedures range in complexity from simple measures for communicating forecast quality to non-specialists, to detailed diagnostic procedures to provide in-depth analyses of the various strengths and weaknesses of forecasts. While the focus of the recommended procedures is on how well the forecasts correspond with the observations (forecast quality), care is taken to measure those attributes that can make forecasts potentially useful (forecast value). Interpretive guides for each of the recommended procedures are included to assist the user in understanding the verification results, and worked examples are included in an appendix. A glossary of technical terms is also provided. The document has been reviewed by the international community, and is currently being prepared for publication by WMO.

*Contributed by **S.J. Mason***

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TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Agriculture and Climate Risk Management Training	Climate risk management in the agricultural sector through training workshop and training materials designed to empower agriculture technical professionals to interface better with policy makers and agriculture extension service.	Centro Internactional de Investigaciones para el Fenomeno El Nino, Ecuador; Instituto Nacional de Investigacion Agropecuaria (INIA); Empresa Brasileira de Pesquisa Agropecuaria	Ward, N.
	Assessment of the Changes in Water Productivity under Different Climate Scenarios in the Southern Cone	Defining plausible climate change scenarios and integrating these into information systems for decision-making processes needed to manage water productivity in South America's Southern Cone given possible effects of climate variability.	INIA, Chile; Instituto Nacional de Tecnologia Agropecuaria, Argentina; Inter-American Development Bank; Empresa Brasileira de Pesquisa Agropecuaria; INIA, Uruguay; Fondo Regional de Tecnologia Agropecuaria; Universidad Mayor de San Andres (Bolivia); Centro de Estudos de Engenharia Rural; International Center for Agricultural Research in the Dry Areas; Programa Cooperativo para el Desarrollo Tecnologico Agroalimentario y Agroindustrial del Cono Sur	Baethgen, W.
	Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa	Building capacity in the climate and health community–both individuals and institutions–to produce and use climate knowledge and information in routine health decision-making with a country focus on Ethiopia and experiences shared in the broader East Africa region.	Ethiopia Ministry of Health; Liverpool School of Tropical Medicine; National Meteorological Agency of Ethiopia; IGAD Climate Prediction Centre; Anti-Malaria Association (Ethiopia); University of Reading, Department of Meteorology (UK); World Health Organization Eastern and Southern African Malaria Control; Climate and Health Working Group (CHWG) of Ethiopia; CHWG of Kenya; CHWG of Madagascar; Meningitis Environmental Risk Information Technologies; Health and Climate Foundation	Connor, S.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Building Index-Based Weather Insurance Contract Design Software: A Prototype for an Education Tool - Phase 1 and 2 *(Completed)*	The index-based weather insurance contract design process piloted by World Bank CRMG and IRI in parts of Africa and Central America has proven to be a robust and flexible approach to designing standardized contracts, presenting the dynamics that characterize water stress impact on crop yields in ways understandable to farmers and stakeholders. The approach also respects key insurance contract design requirements that meet regulatory and risk management standards. In this project phase, CRMG, in partnership with the IRI, shifts the work focus from pilot testing to local ownership and capacity building.		Osgood, D.
	Climate and Development in Africa - Phase 1 *(Completed)*	Partnering in this African Union-led project, we seek to strengthen the resilience of the hunger and health MDGs across the four Sub-Saharan Africa regions through improvements in policy, practice, and climate services and observations. The purpose of the first phase is to provide credible, quantitative assessment of the incremental development benefit of climate risk management and associated climate information services, within ongoing initiatives relating to the hunger and health MDG targets. Major areas of activity are expected in health (including malaria), food security and water.	African Union; Global Climate Observing System Secretariat; African Development Bank; UN-Economic Commission for Africa	Thomson, M.
	Climate and Society Publication 2: Index Insurance for Climate Risk Management and Poverty Reduction *(Completed)*	Through the Climate and Society platform, we examine the use of index insurance to help reduce vulnerability and poverty and adapt to climate change with a focus on capturing the questions, examining current case studies, and relying on expert scientific opinion to delineate the advances, opportunities, pitfalls and limitations faced in scaling up index insurance.	World Food Program; National Oceanic and Atmospheric Administration (NOAA); World Bank; Oxfam America; Swiss Reinsurance Company; United Nations Development Programme; International Fund for Agricultural Development	Hellmuth, M.
	Climate-Related Decision Support Research, Development and Implementation for the Millennium Villages *(Completed)*	Evaluate climate variations and trends that are important to achieving and evaluating the Millennium Development Goals (MDG) at Millennium Villages in eastern Africa	MDG Technical Support Center, Kenya; The Earth Institute at Columbia University; World Agroforestry Centre (ICRAF)	Ward, N.
	Climate Change and Variability in the Expansion of Agricultural Frontier in the Southern Cone: Technological and Policy Strategies to Reduce Vulnerabilities	Identifying the vulnerabilities of agriculture to climate change and variability in the Southern Cone and exploring technological alternatives and policy interventions to improve adaptability.	Inter-American Development Bank; Centro Internacional de Mejoramiento de Maiz y Trigo	Baethgen, W.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Climate Information-Based Water Allocation with Decision Analyses on Multi-Sectoral Applications Research and Tool Development	Integrating rainfall forecasts and climate information to inform and optimize decision systems for improved water resource allocation.	Fundacao Cearense de Meteorologia e Recursos Hidricos; Philippine National Water Resources Board; Metropolitan Waterworks and Sewerage System; Columbia University Department of Earth and Environmental Engineering; University of Nairobi Department of Meteorology	Ward, N.
	Climate Predictability Tool (CPT) Development	The Climate Predictability Tool (CPT) has been designed for producing tailored seasonal climate forecasts using model output statistic (MOS) corrections to climate predictions from general circulation model (GCM), or for producing forecasts using purely empirical approaches, such as from fields of sea-surface temperatures. Although the software is specifically tailored for these applications, it can be used in more general settings to perform canonical correlation analysis (CCA), principal components regression (PCR), or multiple linear regression (MLR) on any data, and for any application. In addition to achieving CPT platform independence, we will enhance availability by the incorporation of dynamic link libraries to create version 10 of the software.	World Meteorological Organization	Mason, S.
	Climate Predictability Tool Training	Foster a network of expertise for improved understanding of climate predictability.	World Meteorological Organization	Mason, S.
	Climate-Related Risk Assessment and Risk Management in the Agricultural and Forestry Sectors of Uruguay	Understanding the impacts of climate variability at different temporal scales (from seasonal/interannual, through decadal, to climate change) on food crops, livestock and forest production will strengthen Uruguay's agricultural community in decision-making at different temporal scales. For example, consideration of seasonal climate variability can help farmers in decisions for the immediate term (crop/cultivar selection, planting dates, input use, buy/sell cattle, etc.). Longer-term climate variability (e.g., decadal scale) can assist farmers and planning agencies to explore less vulnerable agricultural production systems (e.g., crop/pasture rotations, new crop/pasture species). This approach can also provide crucial information for public and private institutions working in rural credit / rural insurance programs, and for government planning agencies. Methods and approaches tested in this project can thereafter be applied to similar projects in other LAC countries and beyond.	Instituto Nacional de Investigacion Agropecuaria; Universidad de la Republica	Baethgen, W.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Climate Risks and Agricultural Planning in Indonesia: Indramayu District *(Completed)*	We work with the Office of the Bupati (district leader), and other key stakeholders to understand water use decision-making processes, and collaborate with Bureau of Meteorology and Geophysics and Bogor Agriculture University to build upon efforts to develop appropriate climate information for agricultural planning.	Center of Agricultural and Rural Development Studies; Bureau of Meteorology and Geophysics (BMG, Indonesia); Asian Disaster Preparedness Center (ADPC); CARE International Indonesia; Bogor Agricultural University	Someshwar, S.
	Climate Risks and Food Security in Indonesia: Nusa Tenggara Timur Province *(Completed)*	Working with key government agencies and CARE Indonesia to develop strategies for using climate information to enable earlier action to help prevent food-security crises.	Bogor Agricultural University; BMG (Indonesia); ADPC; CARE International Indonesia	Someshwar, S.
	Climate Variability and Change in High-Mountain Watersheds, Case Study: Claro River High Mountain Basin, Los Nevados Natural Park, Andean Central Mountain Range, Colombia	Analyzing the integrity and function of Andean high-altitude ecosystems and their associated watersheds, considered among the most vulnerable environments to changes in climate.	World Bank; Escuela de Ingenieria de Antioquia	Ruiz, D.
	Coming Down the Mountain: Understanding the Vulnerability of Andean Communities to Hydroclimatologic Variability and Global Environmental Change *(Completed)*	We collaborate with partners in Chile to characterize current climate conditions and trends impacting people of the Rio Elqui Basin, in particular. This work is IRI's contribution to the University of Regina-led project (funded by the Inter-American Institute for Global Change Research) that studies the impact of climate variability and environmental change on communities living in glacier-fed settings.	University of Regina; Centro del Agua para Zonas Aridas y Semi Aridas de America Latina y El Caribe	Block, P.
	Consultant for Climatic Information Provision – Improving Water Management in Rainfed Agriculture *(Completed)*	A report prepared for the World Bank that: reviews the impact that climate risk has on rainfed agriculture and the role that climate information may play in managing that risk; summarizes ex-ante, model-based methods for estimating the potential benefits of advance climate information on rainfed agriculture; and provides an overview of the gaps to be addressed in order to realize the potential benefits of climate information for rainfed agriculture.		Hansen, J.
	Contributing to an OPeNDAP/OCG Gateway to Support Regional IOOS Interoperability	Contribution to overall design of OPeNDAP/OCG Gateway to Support Regional IOOS Interoperability, with particular focus on semantic mapping necessary to translate data through different interfaces, and the designing of a framework that allows semantic mapping without interfering with or changing the data transport.	Open-source Project for a Network Data Access Protocol	Blumenthal, B.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Data Development and Improvement for the 2009 Global Risk Update: Earthquakes, Drought, and Population Exposure *(Completed)*	IRI collaborates with the Center for International Earth Science Information Network and the Center for Hazards and Risk Research, supporting the effort to improve the evidence base for disaster risk assessment at global, regional, national and subnational scales and its applicability to disaster risk management through contributions on the subject of drought to the 2009 Global Risk Update.	Center for Hazards and Risk Research; Center for International Earth Science Information Network	Lyon, B.
	Data Library Operations	Facilitate data exchange by providing an online data library that provides multi-disciplinary access to data needed to study short-term climate change and its impact.	Thematic Realtime Environmental Distributed Data Services; OPeNDAP Distributed Ocean Data Sets	Blumenthal, B.
	Decentralization and Local Public Goods: How does allocation of decision-making authority affect provision?	Determine under what conditions community participation in projects designed to raise living standards in the community improves project outcomes.	NGO Forum for Drinking Water Supply & Sanitation	Madajewicz, M.
	Decision Support System for Irrigated and Rainfed Conditions in the Coquimbo Region of Chile	Improving preparedness and response to droughts in rainfed areas of Chile's Coquimbo region by collaborating with local partners to establish a drought early warning system and to improve water use efficiency.	Centro del Agua para Zonas Aridas y Semi Aridas de America Latina y El Caribe; Centro de Estudios Avanzados en Zonas Aridas (Chile); Junta de Vigilancia del Rio Elqui; Gobierno Regional de Coquimbo, Chile; Direccion General de Aquas (Chile); University of Gent (Belgium)	Baethgen, W.
	Designing a weather insurance contract for farmers in Adi Ha, Ethiopia *(Completed)*	Enhancing the ability of Adi Ha farmers to manage drought risk and gain better access to credit, with particular focus on precipitation and data quality assessment and verification, draft contract design and stakeholder education.		Osgood, D.
	Designing Index-Based Weather Insurance Contracts for Farmers in Central America *(Completed)*	Developing and evaluating index insurance contracts for small and medium sized farmers in Central America	Inter-American Development Bank; World Bank; Inter-American Federation of Insurances Companies; Latin American Financial Services; Central American Bank for Economic Integration; Zamorano University; Instituto Nicaraguense de Seguros y Reaseguros; Seguros Atlantida, S.A.; Equidad Cia de Seguros S.A.	Ward, N.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Developing and Evaluating Methodologies to Create Information about Land-Surface Characteristics that are Influenced by Hydroclimatic Variability *(Completed)*	Improve our ability to develop decision support information where detailed knowledge of land surface characteristics are needed	Foundation for Environment, Climate and Technology; Mahaweli Authority of Sri Lanka; NASA/Goddard Space Flight Center; National Aeronautics and Space Administration	Zubair, L.
	Development of a Fire Early Warning System Using Climate Information and Institutional Mapping toward Fire Early Response *(Completed)*	Contribute to the development of early action systems for improved fire management in the peatlands of Central Kalimantan, Indonesia, including the identification of how climate information could be best integrated into decision-making	Bogor Agricultural University; Bureau of Meteorology and Geophysics, Indonesia; CARE International Indonesia; NOAA; Provincial Government of Central Kalimantan; Remote Sensing Affairs, National Institute of Aeronautics and Space (LAPAN)	Someshwar, S.
	Development of Coupled Model Products	This project explores improvements to real-time coupled model forecasts, including provision of diagnostics of coupled models provided by collaborating partners, that will aid implementation of operational coupled seasonal forecasting in Africa.	Center for Ocean-Land-Atmosphere Studies; European Centre for Medium-Range Weather Forecasts; National Centers for Environmental Prediction	DeWitt, D.
	Development of Model Systems for Prediction and Predictability Studies	Improve predictive skill and understanding of predictability limits by improving some aspect of global models, including numerics, physics, or boundary conditions.		Sun, L.
	Development of Report on Priority Earth Observation Needs for Environmental Change Parameters that Affect Human Health	Reporting on the environmental change and human health social benefit area (SBA) for Eastern Research Group, as part of a task sponsored by the Group on Earth Observations (GEO).		Ceccato, P.
	Diagnosing Decadal-Scale Climate Variability in Current Generation Coupled Models for Informing Near-Term Climate Change Impacts	With the growing demand for relevant climate-change information–in particular covering the next 1-2 decades, we examine and document the characteristics of decadal-scale variability in coupled general circulation models (CGCMs), in order to prepare for the experimental decadal predictions that are starting to emerge from modeling centers.	The National Center for Atmospheric Research; Geophysical Fluid Dynamics Laboratory/NOAA; U.K. Meteorological Office	Goddard, L.
	Downscaling methods intercomparison project	Provide an assessment of the pros and cons of various GCM downscaling methodologies, particularly dynamical vs. statistical; provide answers to the question "What can statistical and dynamical downscaling of seasonal forecasts offer?"	PAGASA	J. Qian

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Dynamical Downscaling Training	Foster a network of expertise for cutting-edge issues and methods in downscaling.	NOAA Office of Global Programs;Experimental Climate Prediction Center	Ward, N.
	Dynamical Regional Model Development and Downscaling	Improve understanding of the physical mechanisms of regional predictability, underpin statistical downscaling methods, and construct downscaled climate information for regional projects.	Intergovernmental Authority on Development Climate Prediction and Applications Centre; Centro de Previsao de Tempo e Estudos Climaticos; South African Weather Service; Central Weather Bureau, Taiwan; Fundacao Cearense de Meteorologia e Recursos Hidricos; Beijing Normal University	Robertson, A.
	Economics of Adaptation to Climate Change (EACC): Analysis of the Economics of Adaptation to Climate Change for Agriculture, Transportation and Energy Sectors in Ethiopia	Economic analysis of climate-related adaptation strategies for Ethiopia, assisting the World Bank's multi-country Economics of Adaptation to Climate Change (EACC) study.		Block, P.
	Enhancing Malaria Early Warning System (MEWS) with Earth Observation and Modeling Results	Testing satellite-derived rainfall estimation and temperature estimation products against ground observations to inform the development of integrated vectorial capacity maps	United States Geological Survey; National Aeronautics and Space Administration; Pan American Health Organization; World Health Organization;	Connor, S.
	ENSEMBLE-based predictions of climate changes and their impacts	The ENSEMBLES project is supported by the European Commission's 6th Framework Programme as a 5 year Integrated Project from 2004-2009 under the Thematic Sub-Priority 'Global Change and Ecosystems'. IRI is a no-cost partner. IRI's contribution lies in assessing the value of tailored products for end user communities, in this example, the infectious disease community.	Liverpool School of Tropical Medicine	Thomson, M.
	Environmental factors and population dynamics as determinants of meningococcal meningitis epidemics in the Sahel: an investigation of NASA and NOAA products	Exploring the potential of satellite observations and model outputs combined with available epidemiological and demographic information for meningitis risk mapping with a focus on Niger.	NASA Jet Propulsion Laboratory; Center for International Earth Science Information Network	Trzaska, S.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Epi-Meteorology- Towards a New Discipline in the Service of Global Public Health *(Completed)*	Setting in motion a new interdisciplinary teaching and research discipline on the complex influences of climate on human health at the population level	Columbia University Mailman School of Public Health	Thomson, M.
	Establishing an Information and Decision Support System (IDSS) for the Agricultural Sector of Chile	Building on IRI's experiences and lessons learned in the work on IDSS in Uruguay and Paraguay to establish a similar system for Chile in collaboration with the Ministry of Agriculture.	Instituto de Investigaciones Agropecuarias, Chile	Baethgen, W.
	Evaluating Impacts of Sustainable Development Projects	Designing innovative methods to evaluate impacts of the projects we undertake towards sustainable development.	Columbia University Applied Statistics Center; Tropical Agriculture Program of the Earth Institute at Columbia University; Columbia University Department of Mechanical Engineering; Center for International Earth Science Information Network	Madajewicz, M.
	Experimental Crop Disease Outlooks for SE South America	Testing the ability of ENSO and seasonal climate forecasts to establish outlooks of the incidence of two important crop diseases (fusarium in wheat and rust in soybeans) in southern Brazil.		Baethgen, W.
	Exploring the Properties of Market Mechanisms (including Insurance) for Managing Climate Risk	Improved management of climate risk through market/insurance mechanisms; in particular, to explore the theoretical properties of different market mechanisms intended to trigger positive outcomes in the presence of information about climate risk, including seasonal forecasts; and, to provide guidance on the effectiveness of different approaches.	The Commodity Risk Management Group, World Bank; Columbia University Center for Research on Environmental Decisions	Ward, N.
	Extended Range Forecasting and Agriculture Risk Management, India (ERFS)	Integrating risk management and climate science research to improve forecasting capacity and the understanding of climate risks in the context of rural livelihoods.	Indian Institute of Technology Delhi; Government of India Ministry of Agriculture; India Meteorological Department; National Centre for Medium Range Weather Forecasting; Indian Council of Agriculture Research	Someshwar, S.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Fires in Western Amazonia: Understanding and Modeling the Roles of Climatic, Social, Demographic, and Land Use Change	Columbia University's Center for Environmental Research Conservation takes the lead in this collaboration with IRI, and the Department of Ecology, Evolution, and Environmental Biology (E3B) to investigate the relevant processes of change in land use, migration, urbanization, and climate in Western Amazonia, and links to the probability of changes in the incidence, size and severity of escaped fires.	Center for Environmental Research and Conservation; Columbia University Department of Ecology, Evolution and Environmental Biology	Baethgen, W.
	Forecasting Tropical Cyclone Activity Using Atmospheric General Circulation Models	Develop and improve operational tropical cyclone forecasts products, increasing coastal societies' preparedness for tropical cyclone impacts.	Max Planck Institute for Meteorology;South African Weather Service	Camargo, S.
	Identification, access, handling and analysis of remote sensing data products	An activity to engage in further interaction with our sectoral and regional programs to identify data needs and information output requirements.	United States Geological Survey; National Aeronautics and Space Administration; Center for International Earth Science Information Network	Connor, S.
	Impact of Increased Model Resolution on Predictive Skill in Tier-2 Integrations Using Prescribed Sea Surface Temperature	Assess the impact of increased model resolution on seasonal forecast skill, and evaluate the potential benefit to the IRI real-time forecast system from increasing resolution.	Max Planck Institute for Meteorology; The National Center for Atmospheric Research	Goddard, L.
	Implementation of New or Improved Systems, Tools, Software and Products	Implementation of new or improved components into the forecast operations for the production of the global "net assessment" forecasts is considered an essential step in the completion of a successful research activity on forecast combination and / or recalibration. The transition into "real-time" forecasting products and tools is an integral component of predictability research at the IRI.	Max Planck Institute for Meteorology; NASA/Goddard Space Flight Center; Center for Ocean-Land-Atmosphere Studies; Geophysical Fluid Dynamics Laboratory; Climate Prediction Center; Environmental Modeling Center; National Centers for Environmental Prediction; Experimental Climate Prediction Center; Queensland Climate Change Centre of Excellence	Barnston, A.
	Improved SST Prediction	Provide the most accurate and reliable predictions possible of global SSTs and of ENSO probabilities	European Centre for Medium-Range Weather Forecasts; National Centers for Environmental Prediction	Tippett, M.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	International Internships for Climate and Society	Working with IFRC to provide opportunities for students in the Climate & Society MA Program to work on climate risk management in Asia, Africa and Latin America.	NOAA Climate Program Office; International Federation of Red Cross and Red Crescent Societies; Red Cross/Red Crescent Climate Centre; Columbia University Institute of Latin American Studies; Columbia University President's and Provost's Student Initiative Fund	Zebiak, S.
	Investigating Some Practical Implications of Uncertainty in Observed SSTs *(Completed)*	Improve understanding of the implications of uncertainties, such as those due to bias, sampling and random errors	National Oceanic and Atmospheric Administration	Goddard, L.
	IRI CSL Computing Project: Development & Application of Seasonal Climate Predictions	We utilize CSL computational resources to investigate the potential to predict extreme seasonal and sub-seasonal climate variability. The results of this work contribute to better estimates of the skill realizable by real-time forecasts of climate, and in improvements to sector forecasts that incorporate climate factors.	Max Planck Institute for Meteorology; The National Center for Atmospheric Research	Zebiak, S.
	Large Ensemble Impact on Predictive Skill in Tier-2 Integrations Using Prescribed Sea Surface Temperature	Assess the impact of ensemble size on seasonal forecast skill, and assess parameterization of the forecast probability distribution function as a function of ensemble size.	Max Planck Institute for Meteorology; The National Center for Atmospheric Research	Goddard, L.
	Malaria Climate Risk Knowledge Systems	Developing training materials and courses designed to empower public health professionals in the use of climate knowledge and information in routine health decision-making	CIESIN; Mailman School of Public Health; World Health Organization	Thomson, M.
	Malaria Early Warning System: Building on Botswana Work and Scaling Up to Other Epidemic-Prone Countries in Africa	Provide evidence for the role of climate in disease dynamics in African countries and to assess the value of such evidence to improving epidemic prevention and control.	World Health Organization; La Recherche Agronomique au Service des Pays du Sud	Thomson, M.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Managing climate risk for agriculture and water resources development in south-western South Africa: Quantifying the costs, benefits and risks associated with planning and management alternatives	A Climate Change Adaptation in Africa project collaboration with three South African universities and the UNEP-Risoe Center to engage government (water and agricultural departments) and private sector stakeholders to identify and test the feasibility of alternative management options in light of development and climate change in the Western Cape, South Africa	Climate Systems Analysis Group; University of the Free State; UNEP Risoe Centre on Energy, Climate and Sustainable Development; University of KwaZulu Natal, School of Bioresources Engineering and Environmental Hydrology	Hellmuth, M.
	Managing Competing Water Uses in the Philippines: Angat Reservoir *(Completed)*	Demonstrating improvements in managing climate risks in the context of water management, through tool development, capacity building of key sectoral agencies and the national meteorological service.	National Power Corporation; Institute of Strategic Planning and Policy Studies; National Irrigation Administration; Metropolitan Waterworks and Sewerage System; PAGASA; Philippine National Water Resources Board	Someshwar, S.
	Map Rooms - Capability Enhancements	Enhance society's ability to understand climate variability and its synergistic relationships with other environmental factors for applications in various sectors and decision systems.	World Meteorological Organization; United States Geological Survey; Center for International Earth Science Information Network	Blumenthal, B.
	Mapping Institutions and Policy Responses	Develop and pilot methodologies to map institutions and policy processes to manage climate-related problems, initially in the context of diverse demonstration sites in Southeast Asia.	Institute of Strategic Planning and Policy Studies;Center of Agricultural and Rural Development Studies; Udayana University	Someshwar, S.
	Masters Program in Climate and Society	Enable numerous IRI staff in teaching, mentoring, and/or course curricula development; to educate diverse population of master students in climate-informed approaches to problem solving; to stimulate faculty recognition of the importance of climate informed development training at Columbia University.	The Earth Institute at Columbia University	Mutter, C.
	Monitoring Air and Land Surface Temperature using Satellite Derived Products	An analysis of the air and surface temperature derived from satellite images to monitor temperature conditions favorable to vector-borne disease transmissions.		Ceccato, P.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Near Term Climate Change (NTCC)	This project aims to develop methods and products for guidance on near term climate change (NTCC)	Geophysical Fluid Dynamics Laboratory; Centro de Previsao de Tempo e Estudos Climaticos; Lamont-Doherty Earth Observatory; Bureau of Meteorology and Geophysics, Indonesia	Goddard, L.
	New Tools for North American Drought Prediction	The work will develop and test best new tools for drought prediction based on empirical-dynamical forecasting approaches. The goal is to enhance real-time, seasonal drought assessment and prediction capabilities for the U.S. and Mexico.	Universidad Nacional Autonoma de Mexico	Lyon, B.
	A Prototype Earth-Gauging System Integrating Weather and Health Data to Manage Meningitis	Identifying global partnerships and related research opportunities to link understanding of the meningitis-related environmental risks with action for the improved management of meningitis.	University Corporation for Atmospheric Research; North Carolina State University	Thomson, M.
	Provision of Common Baseline Information on Observed Climatic Variability in Support of Climate and Water Work in Africa *(Completed)*	Developing a knowledge base characterizing climate variability in Africa, and a review of methodologies to translate climate change and variability data to the water and land management sector that can be used in common in all the regions where the World Bank conducts its work		Brown, C.
	Real-Time Dynamically Based Climate Diagnostics of Observations and Forecasts	Improve understanding and attribution of real-time observed and forecasted climate anomalies via use of dynamical techniques.	Center for Ocean-Land-Atmosphere Studies; Lamont-Doherty Earth Observatory	DeWitt, D.
	Recalibrating and Combining Ensemble Predictions	Developing and preparing for operations a multi-model ensemble processor for seasonal forecasting that takes advantage of all the innovations in ensemble and multi-model ensemble analyses.	Climate Prediction Center; National Centers for Environmental Prediction	Goddard, L.
	Regional climate-change projections through next-generation empirical and dynamical models	The development of a twin approach of non-homogeneous hidden Markov models and coupled ocean-atmosphere, intermediate-complexity models to identify the potentially predictable modes of climate variability and to investigate their impacts on the regional scale.	University of Wisconsin Milwaukee; University of California, Irvine; National Oceanic and Atmospheric Administration; University of California, Los Angeles	Robertson, A.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Regional Climate Outlook Forums (SE S Am, Western S Am, NE Brazil, Central Am)	Provide climate information (model runs, data library, IRI forecasts); train researchers on the use of the Climate Predictability Tool; and present educational material to stakeholders on probabilistic climate forecasts and their applications in decision making	World Meteorological Organization; Centro de Previsao de Tempo e Estudos Climaticos; International Crops Research Institute for the Semi-Arid Tropics	Baethgen, W.
	Retrospective Forecasts Made Using Using Retrospectively Forecast SST	Estimate real-time forecast skill from two of the operational IRI forecast models using hindcasted SST	Max Planck Institute for Meteorology; The National Center for Atmospheric Research	Goddard, L.
	Risk Assessment and Mitigation Measures for Natural and Conflict-Related Hazards in the Asian Region *(Completed)*	IRI collaborates with the Center for International Earth Science Information Network and the Center for Hazards and Risk Research, forming part of an international team led by the Norwegian Geotechnical Institute in addressing the risks of natural hazards and civil conflict in Asia.	Center for Hazards and Risk Research; Center for International Earth Science Information Network	Lyon, B.
	Routine Forecasts	Routine monthly production of climate and SST forecast products	Max Planck Institute for Meteorology; NASA/Goddard Space Flight Center; Center for Ocean-Land-Atmosphere Studies; Geophysical Fluid Dynamics Laboratory; Climate Prediction Center; Environmental Modeling Center; Experimental Climate Prediction Center; Queensland Climate Change Centre of Excellence	Barnston, A.
	SGER: Investigating the joint occurrence of summer drought and heat waves in climate change projections *(Completed)*	Quantifying the joint behavior of summer heat waves and drought in coupled models and observations over the last half of the 20th century, and examining changes in these relationships in climate projections with emphasis on the drought-prone region of Southern Africa and some global analyses.		Lyon, B.
	Supporting Colombia's National Integrated Dengue and Malaria Surveillance and Control System	Supporting Colombia's national integrated dengue and malaria surveillance and control system by providing the evidence of the role of climate in disease dynamics, the use of climate information and development of tools for disease prevention and control.	Instituto Nacional de Salud de Colombia; Instituto de Hidrologia, Meteorologia y Estudios Ambientales; Conservacion Internacional Colombia	Baethgen, W.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Sustainable development in the Sahel - learning from the recent greening	A seed-funded pilot project bringing together an interdisciplinary team to clarify the relative roles of physical and societal drivers of the recent environmental change -- the 're-greening' -- in the Sahel, in order to lay the groundwork for an in-depth assessment of the potential for sustainable practices to combat land degradation in adapting to climate change.	Center for International Earth Science Information Network; University of California, Irvine; Lamont-Doherty Earth Observatory; MDG Centre for West Africa, Masters in Climate & Society Program	Giannini, A.
	Tailored forecast and monitoring products	This project focuses on the provision of real-time forecasts tailored to specific climate risk management approaches.	Centre Europeen de Recherche et d'Enseignement des Geosciences d l'Environment; Climate Prediction Center; Centro de Previsao de Tempo e Estudos Climaticos; European Centre for Medium-Range Weather Forecasts	Robertson, A.
	Training in Water and Climate Risk Management	Producing training materials and courses in managing hydroclimatic risk for water resource professionals.	World Bank Institute; U.S. Army Corps of Engineers; Global Water Partnership; National Water Resources Board (Philippines); Institute of Strategic Planning and Policy Studies, University of the Philippines; PAGASA	Ward, N.
	Towards improved control of meningitis outbreaks in sub-Saharan Africa	Identifying the relative importance of environmental, demographic and immunological factors in determining the potential for epidemic outbreaks and combine most relevant factors in a statistical predictive system, targeting the forthcoming meningitis season in Niger (February to May 2010) as a proof of concept and carrying on the assessment of the performance of the model at the end of the season	Columbia University Mailman School of Public Health; Center for International Earth Science Information Network	Trzaska, S.
	Using climate information to control malaria: the case of Botswana	Documents and evaluates the experience with the Malaria Early Warning System (MEWS), based on climate information, in Botswana in order to extract lessons from this experience that may improve how effectively Botswana and other countries use climate information to control such climate-sensitive diseases as malaria, meningitis, cholera, and dengue.	Botswana Department of Meteorology, Botswana Ministry of Health, WHO - Regional Office for Africa	Madajewicz, M.
	Validation of Satellite and Other Climate Data Sets	This project compares the performance of various satellite-derived and other climate data sets over different parts of the world, with more of a focus on Africa.		Dinku, T.

TOPIC/ REGION	PROJECT TITLE	DESCRIPTION	PARTNERS	PROJECT LEAD
	Verification of Seasonal Climate Predictions	This project aims to set and implement standards for the verification of real-time seasonal climate forecasts.	African Center of Meteorological Applications for Development; Intergovernmental Authority on Development Climate Prediction and Applications Centre; MeteoSwiss - Federal Office of Meteorology and Climatology; Drought Monitoring Centre	Mason, S.
	Visitors Program	Build a global network of resource managers, innovative senior scientists, and policy leaders dedicated to collaboration in the search of development solutions.	The Earth Institute at Columbia University	Zebiak, S.
	Weather Risk Transfer for Climate Impacts-Millennium Villages Project	A SwissRe, Millennium Promise and IRI collaboration to support research in financial instruments and decision-making for climate risk management with specific applications in the Millennium Villages.		Ward, N.

Technical Training Summary:
Events and contributions by IRI Staff

2008 *Date* *Place* Contributors	**Event** Brief description of efforts, participants, collaborators, and/or activities.
4 Nov - 30 Jan *Palisades, NY* A. Barnston T. Dinku S. Mason	**Capacity building in seasonal forecasting, including use of the Climate Predictability Tool (CPT)** For Kassa Fekadu, Senior Meteorologist, Ethiopia's National Meteorological Agency, for the Google.org project "Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa"
8 - 12 Dec *Palisades, NY* A. Barnston S. Mason	**Climate forecast and use of CPT** For Martin Montero, IMTA (Mexican Institute of Water Technology), Juitepec, Morelos, Mexico, an IMTA-sponsored visit
9 - 19 Dec *Palisades, NY* S. Mason	**Verification and validation of seasonal forecast** For Marco Paredes, SENAMHI (Peru's Meteorological Service), Iquitos, Peru and CIIFEN Associate Researcher, a CIIFEN-sponsored visit for capacity building and tool implementation for the western South America Climate Outlook Forums
9 - 12 Dec *Chillán, Chile* W. Baethgen M. Bell	**Climate Risk Management in Agriculture and an Introduction to the IRI Data Library** • W. Baethgen: Introduction to course objectives; Climate and Agriculture-climate characterization (Exercise); Climate and Agriculture - Climate prediction (Exercise); Agriculture and Climate (Translating climate information into agronomic information); Climate and Vegetation Monitoring; Simulation Models and Agriculture Climate Change and Agriculture • M. Bell: An Introduction to the Data Library; Practical Exercises: Accessing Climate Data via the IRI Data Library; and, Practical Exercises: Describing Climate Data and Data Display Options
2009	
23 - 27 Feb *Palisades, NY* A. Robertson N. Ward	**CPT and other techniques for tailoring climate prediction information and risk management applications** For Deus Bamanya, Uganda Department of Meteorology (Kampala, Uganda); and Peter Kabamba, National Agency of Meteorology and Teledetection by Satellite (D.R. of Congo)

2009, continued *Date* *Place* Contributors	**Event** Brief description of efforts, participants, collaborators, and/or activities.
23 - 28 Feb *Nairobi, Kenya* B. Lyon S. Mason	**ICPAC forecast verification workshop** Verification analysis performed on 11 years of GHACOF forecasts using meteorological station data from participating countries, with 20 participants from ICPAC, Nairobi University, and the met services of Burundi, Djibouti, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda
23 Feb - 6 Mar *Palisades, NY* A. Barnston M. Bell A. Robertson	**Statistical climate modeling; the IRI Data Library** For Luis Alfonso Lopez, Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM) (Bogota, Colombia), in collaboration for the Integrated National Adaptation Project
13 Mar *New York, NY* M. Bell P Ceccato	**The IRI Data Library - Map Room and Remote Sensing** Training on the use of remote sensing within the Data Library – Map Room for Ruth DeFries'students (E3B, Columbia University)
16 - 23 Apr *Bogota, Colombia* R. Cousin	**The IRI Data Library and Map Room** Training and demonstrations for the staff of the INS (national health institute) and IDEAM (national met service)
4 - 9 May *Delhi, India* A. Robertson M. Tippett	**Training on climate forecasting and downscaling methods, and IRI's Climate Predictability Tool** For the project Development and Application of Extended Range Forecast Systems for Climate Risk Management in Agriculture in India (ERFS) project team
6 - 22 May *Niamey, Niger* O. Ndiaye	**CPT and seasonal climate forecasting** Training for participants of the 12th Regional Climate Outlook Forum, PRESAO-12
11 - 12 May *Bogor, Indonesia* E. Conrad R. Cousin S. Someshwar	**Utilizing Seasonal Early Warning for Fire Activity in Central Kalimantan** Co-led with the Center for Climate Risk and Opportunity Management for Southeast Asia and the Pacific (CCROM SEAP); offered to representatives of the provincial and district government in Central Kalimantan, the Indonesian Met Service (BMKG), University of Palangka Raya, CARE Indonesia, AusAID and GTZ

2009, continued *Date* *Place* Contributors	**Event** Brief description of efforts, participants, collaborators, and/or activities.
1 - 12 June *Palisades, NY* A. Barnston M. Bell A. Binder B. Blumenthal P. Ceccato L. Cibrelus S. Connor R. Cousin J. del Corral M. Dervin F. Fiondella A. Giannini B. Lyon G. Mantilla S. Mason A. Murillo J. Omumbo L. Ostwald B. Platzer A. Robertson J. Rodriguez D. Ruiz Carrascal M. Sheremata M. Thomson S. Trzaska J. Turmelle C. Vaughan S. Vitelli S. Zebiak	**Climate Information for Public Health Training Course** A collaboration of IRI, Mailman School of Public Health and the Center for International Earth Science Information Network 12 professionals [climate or meteorological sector (3), and the public health sector or in health research fields (9)] from ten countries [Ethiopia (3), Kenya (1), Madagascar (1), Mali (1), Ghana (1), the United Kingdom (1), Sweden (1), Ecuador (1), Canada (1) and the United States (1)], all professionals A summary of the course is available online at: http://iri.columbia.edu/publications/id=909

2009, continued *Date* *Place* Contributors	**Event** Brief description of efforts, participants, collaborators, and/or activities.
22 - 29 June *Hanoi, Vietnam* S. Mason	**Joint U.S.-Vietnam Climate Training Workshop: Climate Variability and Predictions for the Indian Ocean Basin - Africa and Asia** Funded by the OFDA of USAID, under NOAA's leadership and co-sponsored by WMO Technical support provided on: • Time Series and Correlations • Multivariate Analysis and Best Practices (Parts I and II) • Statistical Significance and Confidence Intervals - Understanding the Relative Operating Characteristics (ROC) • CPT Training
30 June - 2 July *Addis Ababa, Ethiopia* P. Block T. Dinku A. Giannini	**Workshop for Training in Water and Climate Risk Management: Managing Hydroclimatic Risk in the Water Sector** Co-sponsored by UNESCO International Hydrological Programme. Participants included: Ethiopian Ministry of Water Resources staff (25), including staff from regional offices (4); Sudanese university professors (2); and Djibouti's National Research Center (3). Training included climate, data, and water resources lectures and hands-on exercises.
12 - 15 July *Singapore* A. Robertson	**Asia-Pacific Economic Cooperation (APEC) Climate Symposium 2009: Climate prediction and applications: Relevance for climate adaptation strategies** Tutorial session on 'Downscaling of weather within climate'
20 - 23 July *Quezon City, Philippines* J. Hansen A. Ines	**Training on using advanced climate information for crop yield forecasting in the Philippines** Supported by Department of Science and Technology - Balik Scientist Program and PAGASA, Philippines - Attended by 29 participants that included scientists and university students
July - December (various dates) *Palisades, NY* J. Hansen A. Ines A. Robertson M. Tippett	**Capacity building and training activities on CRM in agriculture and on seasonal forecasting and downscaling techniques** For 4-member IIT-Delhi team on a 6-month IRI visit, to collaborate on the project "Development and Application of Extended Range Forecast System for Climate Risk Management in Agriculture (ERFS)," supported by the Government of India's Ministry of Agriculture

2009, continued *Date* *Place* Contributors	**Event** Brief description of efforts, participants, collaborators, and/or activities.
2 - 7 Aug *Maui, HI* L. Sun	**9th International Regional Spectral Modeling Workshop** Short course on dynamical downscaling prediction Lectures: • Introduction to seasonal climate prediction • Development of a downscaling prediction system • Seasonal forecasts using the RSM: current status and outstanding issues Computer practicals: • Demonstration using the downscaling forecasts for Northeast Brazil • Diagnostic methods for interpreting and verifying regional model's forecasts
28 Aug *Pretoria, South Africa* S. Mason	**Implementation and introduction to CPT 10** Offered at the University of Pretoria
5 - 9 Oct *Antananarivo, Madagascar* L. Cibrelus R. Cousin	**Learning Through Doing Project: Cross-Training Workshop for Madagascar's National Meteorological and Hydrological Service and Ministry of Health Staff in the Use of Meteorological, Climate and Health Data** This workshop was developed through a multi-organization partnership involving 2 Climate and Health Working Group-Madagascar coordinators from the Ministry of Health (MoH) and the Ministry of Meteorology, 2 organizers from MoH and Pasteur Institute, 3 disease focal points from MoH, the Headquarters of the WMO and the WHO Malagasy office. 16 participants from the climate (5), human health (10), and veterinary health (1) communities were offered a one-week training relying on a curriculum based on the Summer Institute but using local data and tailored to local expectations and local language.
19 - 30 Oct *Beijing, China* A. Curtis S. Mason A. Robertson L. Song	**IRI-WMO Workshop on Tailoring of Seasonal Forecasts: Training Experts in the Climate Predictability Tool** In partnership with the Beijing Climate Center and offered to seasonal forecast specialists to provide an expert level of technical support for enhancing the capacity of National Meteorological Services around the world, particularly those in the developing and least developed countries. The focus of the training was to provide high quality, tailored seasonal forecast information to sectors that include public health, water resources, and agriculture.

Academic Courses Offerings - Courses designed and taught by IRI staff

EESC 4400 - Dynamics of Climate Variability and Change
Instructor: L. Goddard

This is the comprehensive climate science course in the Climate and Society program. Students learn how the climate system works, primarily on large scales of time and space. It is these large-scale features and processes that dominate variability of the regional and local climate immediately relevant to social and individual decision making.

EESC 4401 - Quantitative Models of Climate–Sensitive Natural and Human Systems
Instructor: Tony Barnston

Quantitative models are used routinely to evaluate impacts of climate variability and climate change. In their subsequent careers, students will be called upon to interpret and evaluate the results of both statistical and dynamical models. This course is intended to equip students with an understanding of how climate-societal and intra-societal relationships can be evaluated and quantified using relevant data sets, statistical tools, and decision models. In addition to experimenting with statistical techniques, students have an opportunity to do some simple decision model experiments and evaluate the results.

EESC 4403 - Managing Climate Variability and Adapting to Climate Change
Instructor: Shiv Someshwar

This spring semester course deals with climate and environment-development issues, and helps investigate ideas and methods for analyzing problems to reduce societal vulnerability and build resilience to climate variability and climate change. In order to integrate learning, the course is structured around modules that bridge several "divides": the social and natural sciences, temporal scales of variability and change impacting various sectors, the developing and industrialized regions, across local, national and international spatial levels, as well as socio-political, economic and ecological dimensions of development. The lectures and discussions move back and forth between theory and practice, required for the effective management of risks from a changing climate. Practicum sessions, in addition, are designed to help integrate learning.

EESC 4404 - Regional Dynamics, Climate, and Climate Impacts
Instructor: M.N. Ward

The dynamics of environment and society interact with climate and can be modified through use of modern climate information. To arrive at the best use of climate information, there is a need to see climate in a balanced way, amongst the myriad of factors at play. Equally, there is a need to appreciate the range of climate information available and to grasp its underlying basis and the reasons for varying levels of certainty. Many decisions in society are at more local scales, and regional climate information considered at appropriate scales and in appropriate forms (e.g., transformed into vegetation stress) is key. Building a sufficient understanding of the science behind the information, and providing examples of how the information can and is being used, mean this course seeks to contribute toward the holistic understanding needed for wise use of climate information.

EVNP U6260 - Climate change in Africa
Instructor: A. Giannini

This course enables students in their appreciation for the complexity of the climate system, and provides a basic understanding of baseline observational features and physical arguments related to climate change in Africa. Students learn how to discern which questions it is reasonable to expect that science can answer, and which it is not. Students become familiar with an interdisciplinary approach to climate change adaptation that encourages the investigation of complementary perspectives in the search for solutions to real-world problems. This includes local, regional and global scales; consideration of perspectives derived from theory or practice; the synthesis of knowledge from different fields of inquiry; and contributions from the physical sciences as well as from the humanities.

Students Engaged in Internships or Project Related Work

Julie Arrighi, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – Uganda
Mentors: P. Block and M. Hellmuth

Sylvain Bories, *Ecole Polytechnique 2010*, Paris, France
Internship: Stochastic Daily Rainfall Modeling for Predicting Flood and Drought Risk Due to Climate Variability and Change.
Mentor: A.W. Robertson

Guillain Chapelon, *Ecole Polytechnique 2010*, Paris, France
Internship: Environmental Remote Sensing and Spatial Statistical Analysis.
Mentors: P. Ceccato and S.J. Connor

Laurence Cibrelus, *Mailman School of Public Health 2009*, Columbia University
Internship: Risk Factors and the Prediction of Meningococcal Meningitis
Mentor: M.C. Thomson

Nickelson Cook, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – South Africa
Mentors: P. Block and M. Hellmuth

Michelle Cordray, *Climate and Society 2010*, Columbia University
Work area: Science and Society Communications; IRI Publication and Project Database Development
Mentors: C. Mutter, F. Fiondella, R. Fullon

Meaghan Daly, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – Senegal
Mentor: S. Trzaska

Rishi Desai, *Climate and Society 2010*, Columbia University
Work area: Index Insurance
Mentor: D. Osgood

Theodore Henderson, *Climate and Society 2010*, Columbia University
Work area: Renewable Energy: Hydroelectricity and Climate Variability)
Mentor: L. Zubair

Kiersten Jennings, *Climate and Society 2009*, Columbia University
Internship: Google Earth Tour, IRI Publication and Project Database Development.
Mentors: F. Fiondella, B. Platzer, R. Fullon, AfRPC

Amir Jina, *Climate and Society 2009*, Columbia University
Internship: IFRC/IR – India
Mentor: E. Conrad

Brian Kahn, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – Costa Rica & Panama
Mentor: W. Baethgen

Caitlin Kopcik, *Climate and Society 2009*, Columbia University
Work area: Science and Society Communications; Project and Publication Database Support
Mentors: F. Fiondella, R. Fullon, C. Mutter
Internship: IFRC/IRI – Costa Rica & Panama
Mentor: W. Baethgen

Students Engaged in Internships or Project Related Work, continued

Luciana Mendiola, *Climate and Society 2010*, Columbia University
Work area: Climate and Meningitis
Mentor: S. Trzaska

Dirk Muench, *Climate and Society 2010*, Columbia University
Work Area: Index Insurance
Mentor: D. Osgood

Mary Mwangi, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI - Kenya
Mentors: S. Mason and S. Trzaska

Sreeja Nair, *Climate and Society 2009*, Columbia University
Internship: Narratives on the Use of Climate Information in Ceará, Brazil: Institutional Mechanisms and Linkages between Science and Policy Domains
Mentors: S. Someshwar, E. Conrad

Whitney Peterson, *Climate and Society 2010*, Columbia University
Work area: Assessing Linkages between Energy Use and Climate in Sri Lanka
Mentor: L. Zubair

Ujala Qadir, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – Ethiopia
Mentors: P. Block and M. Hellmuth

Jessica Sharoff, *Climate and Society 2009*, Columbia University
Internship: IFRC/IRI – Thailand
Mentor: E. Conrad

Shaky Sherpa, *Mailman School of Public Health 2010*, Columbia University
Work area: Climate, Data Library, and Public Health
Mentor: L. Zubair

Amir Siraj, *Climate and Society 2009*, Columbia University
Internship: The Predictability of Changes in Malaria Transmission Based on Associated Climate Factors (MA Thesis).
Mentors: M.C. Thomson and S.J. Connor

Shuchi Talati, *Climate and Society 2010*, Columbia University
Work area: Calibrating Satellite Rainfall Estimates over Maldives
Mentor: L. Zubair

Maya Weltman-Fahs, *Climate and Society 2010*, Columbia University
Work Area: Data Library and Map Room Developments
Mentor: J. Del Corral

Scott Wood, *Climate and Society 2010*, Columbia University
Work Area: Climate and Health Education and Training Initiatives
Mentor: G. Mantilla

Governance at-a-glance

Board of Overseers

Dr. R.K. Pachauri, Chair (2009 -)	Director-General, TERI Chairman, Intergovernmental Panel on Climate Change (IPCC)
Prof. Michael McElroy (Outgoing Chair - 2008)	Gilbert Butler Professor of Environmental Studies, Harvard University
Hon. Kazuo Aichi	Former Member, House of Representatives, Japanese Diet
Mr. Jan Egeland	Director, Norwegian Institute of International Affairs
Mr. Chiang-Lin Hsin	Director General, Central Weather Bureau, Taiwan (Retired)
Prof. Nay Htun	Professor, Stonybrook University
Dr. Chester J. Koblinsky	Director, NOAA Climate Program Office
Prof. Jeffrey Sachs	Director, Earth Institute, Columbia University
Sir Crispin Tickell, GCMG KCVO	Director, Policy Foresight Programme, James Martin Institute for Science and Civilization, Oxford University
Dr. Ching-Yen Tsay	Chair Professor, Chung-Hua Institution for Economic Research, National Central University
Rt. Hon. Simon Upton	Chair, Round Table on Sustainable Development OECD
Dr. Stephen E. Zebiak	Director-General, IRI

International Science and Technical Advisory Committee

Prof. Ed Sarachik (Chair)	Emeritus Professor of Atmospheric Science, University of Washington
Dr. Mark Cane	G. Unger Vetlesen Professor of Earth and Climate Sciences; Director, Climate and Society Masters Program, Columbia University
Dr. Shubham Chaudhuri	Senior Economist, World Bank
Dr. Ulisses Confalonieri	Professor, National School of Public Health, FIOCRUZ (Oswaldo Cruz Foundation)
Prof. Sulochana Gadgil	Professor, Center for Atmospheric and Oceanic Sciences, Indian Institute of Science
Prof. Graeme Hammer	Professorial Research Fellow, University of Queensland
Professor James W. Jones	Distinguished Professor, University of Florida
Dr. Francisco de Assis de Souza Filho	Former President, FUNCEME; Adjunct Research Scientist, IRI
Dr. R. Wayne Higgins	Director, NOAA Climate Prediction Center

Personnel at-a-Glance

Office of the Director-General

Stephen E. Zebiak	Director-General, Senior Research Scientist
Haresh Bhojwani	Institutional Development Officer
Ann K. Binder	Manager, Staff and Operations
Molly Hellmuth	Director, Climate and Society Publication Secretariat; Associate Research Scientist
Carolyn Z. Mutter	Assistant Director for Science Management
Carlos Perez	Senior Analyst for Sustainable Development
Maria Salgado	Executive Assistant to the Director-General

Program Leaders

Walter Baethgen	Director, Latin America and Caribbean Program; Research Scientist
Stephen Connor	Program Leader, Environmental Monitoring Research; Director, PAHO/WHO Collaborating Centre on early warning systems for malaria and other climate sensitive diseases; Senior Research Scientist
Simon Mason	Program Leader, Climate; Research Scientist
Shiv Someshwar	Director, Asia and Pacific Regional Program; Director, Institutions and Policy Systems Research; Research Scientist
Madeleine Thomson	Director, Impacts Research; Senior Research Scientist Chair, Africa Regional Program Committee
M. Neil Ward	Director, Decision Systems Research

Senior Research, Information Technology, and Data Library Staff

Anthony Barnston	Lead Forecaster
M. Benno Blumenthal	Data Library Manager
David DeWitt	Research Scientist
Remi Cousin	Staff Associate
Lisa Goddard	Research Scientist; Adjunct Professor, Earth and Environmental Sciences
James Hansen	Research Scientist
Upmanu Lall	Senior Research Scientist; Professor, Earth and Environmental Engineering
Bin Li	Senior Analyst/Programmer
Bradfield Lyon	Research Scientist
Leo Ostwald	Manager, IRI Computing
Andrew Robertson	Research Scientist
Adam Sobel	Research Scientist, Associate Professor, Earth and Environmental Sciences/Applied Math and Applied Physics
Liqiang Sun	Research Scientist

Senior Research, Information Technology, and Data Library Staff, continued

Michael Tippett	Research Scientist
Jeff Turmelle	Lead Analyst/Programmer
Jian-Hua (Joshua) Qian	Research Scientist

Research Staff

Kye Mesa Baroang	Senior Research Staff Assistant
Michael Bell	Senior Staff Associate
Paul Block	Associate Research Scientist
Daniel Ruiz Carrascal	Graduate Research Student
Pietro Ceccato	Associate Research Scientist
Chao Chen	EI Postdoctoral Research Fellow
Laurence Cibrelus	Staff Associate
Esther Conrad	Senior Staff Associate
Ashley Curtis	Staff Associate
John del Corral	Senior Staff Associate
Tufa Dinku	Associate Research Scientist
Katia Fernandes	Postdoctoral Research Scientist
Alessandra Giannini	Associate Research Scientist
Arthur Greene	Associate Research Scientist
Eric Holthaus	Staff Associate
Amor Ines	Associate Research Scientist
Yasir Kaheil	Associate Research Scientist
Dong Eun (Donna) Lee	Staff Associate
Shuhua Li	Senior Staff Associate
Haibo Liu	Staff Associate
Megan McLaurin	Senior Research Staff Assistant
Malgosia Madajewicz	Associate Research Scientist
Gilma Mantilla	Senior Staff Associate
Ousmane Ndiaye	Graduate Research Assistant
Michael Norton	Staff Associate
Judith Omumbo	Associate Research Scientist
Daniel Osgood	Associate Research Scientist
Carlos Perez Garcia-Pando	EI Postdoctoral Research Fellow
Asher Siebert	Staff Associate
Christelle Vancutsem	Senior Staff Associate
Sylwia Trzaska	Associate Research Scientist
Kalpana Venkatasubramanian	Senior Research Staff Assistant
Lareef Zubair	Associate Research Scientist

Adjunct Research Staff

Sankar Arumugam	Assistant Professor, North Carolina University
Rizaldi Boer	Department of Geophysics and Meteorology, Bogor Agricultural University, Indonesia
Kenneth Broad	Professor, University of Miami

Adjunct Research Staff, continued

Casey Brown	Assistant Professor, University of Massachusetts
Declan Conway	Senior Lecturer, University of East Anglia, United Kingdom
Francisco de Assis de Souza Filho	Universidade Federal do Caerá, Fortaleza Brazil
Peter Diggle	University of Lancaster, United Kingdom
Patricia Graves	Epidemiologist, Malaria Control Program, The Carter Center
Matayo Indeje	Climate Downscaling and Application, MDG Technical Support Centre, UN Millennium Project
Richard Kleeman	Professor, New York University - Prediction Research
Vincent Moron	CEREGE, UMR 6635 CNRS and Université d'Aix-Marseille, France
Hugo Oliveros	Banco Republica, Colombian Central Bank (Retired)
Ben Orlove	Professor, University of CA, Davis
Maartin van Aalst	International Federation of Red Cross and Red Crescent Societies

Affiliates

Mohammed Boulahya	Senior Advisor (Africa)
Lisette Braman	Staff Associate, International Federation of Red Cross and Red Crescent Societies
Suzana Camargo	Associate Research Scientist, Lamont Doherty Earth Observatory, Columbia University
Mark Cane	Vetlesen Professor, Earth and Environmental Sciences/Applied Physics and Applied Math, Columbia University
Roberto Lenton	World Bank, Washington DC
Sabine Marx	Associate Research Scholar, Center for Research on Environmental Decisions (CRED), Columbia University
Cheryl Palm	Senior Research Scientist, Tropical Agriculture Program, Columbia University
Pedro Sanchez	Director, Tropical Agriculture Program, Columbia University
Renzo Taddei	Assistant Professor, School of Communication, Federal University of Rio de Janeiro, Brazil
Jim Williams	Consultant, European partnerships and mobilization

Visiting Research Scientists

Caio Coelho	CPTEC, Sao Paolo,
Simone da Costa	CPTEC, Sao Paolo, Brazil
Kassa Feduka	National Meteorological Agency, Addis Ababa, Ethiopia
Kripan Ghosh	Indian Meteorological Department, Pune, India
Johannes Jenkner	Institute for Atmospheric and Climate Science, ETH, Zurich
Marakand Kulkarni	Centre for Atmospheric Sciences, Indian Institute of Technology, Delhi, India
Haiqin Li	School of Geography, Beijing National University, Beijing, China
Vincent Moron	CEREGE, UMR 6635 CNRS & Université d'Aix-Marseille

Visiting Research Scientists, continued

Jean-François Pekel	Researcher, Environmetry and Geomatic unit, Université Catholique de Louvain, Belgium
Palash Sinha	Centre for Atmospheric Sciences, Indian Institute of Technology, Delhi, India
O.P. Sreejith	Indian Meteorological Department, Pune, India
David Watkins	Associate Professor, Department of Civil and Environmental Engineering, Michigan Technological University

Visiting Students

Sylvain Bories	Ecole Polytechnique, Paris, France
Guillain Chapelon	Ecole Polytechnique, Paris, France

Institutional Support

Office of the Director General

Esteban Andrade	Latin American & Caribbean Program Coordinator
Francesco Fiondella	Communications Officer
Maria Risë Fullon	Project Coordinator
Althea Murillo	Administrative Assistant
Barbara Platzer	Africa Program Coordinator
Jason Rodriguez	Draftsman 1 - WWW and Print Design and Production
Lori Scally	Project Finance Manager
Megan Sheremata	Education Coordinator
Catherine Vaughan Green	Project Coordinator
Sandra Vitelli	Administrative Assistant
Maria (Christie) Walkuski	Senior Research Staff Assistant

Computer Systems

Baaba Baiden	Web Manager
Sara Barone	Analyst/Programmer
Mike Dervin	Analyst/Programmer
Chi-Huei Liu	Junior Web Developer
Lulin Song	Analyst/Programmer

Part-Time Research Assistants

Gino Chen
Kierston Jennings
Amy Lafferty
Monica Quaintance
Shaky Sherpa
Sriramany Sritharan

Selected Publications

Baethgen, W. E., and A. Giménez, 2009: Seasonal climate forecasts and satellite information: improving decisions in the Uruguayan agricultural sector. *Climate Sense*, G.R. Asrar, Ed., World Meteorological Organization / World Climate Conference-3. Tudor Rose, 92-93.

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Björklund, G., R. Connor, A. Goujon, **M. Hellmuth**, P. Moriarty, W. Rast, K. Warner, and J. Winpenny, 2009: Demographic, economic and social drivers. *The United Nations World Water Development Report 3: Water in a Changing World.* World Water Assessment Programme. Paris: UNESCO, and London: Earthscan, 29-40. [Available online at http://www.unesco.org/water/wwap/wwdr/wwdr3/pdf/WWDR3_Water_in_a_Changing_World.pdf]

Block, P., 2008: Mitigating the Effects of Hydrologic Variability in Ethiopia: An Assessment of Investments in Agricultural and Transportation Infrastructure, Energy, and Hydroclimatic Forecasting. *CPWF Working Paper 01*. The CGIAR Challenge Program on Water and Food, 53 pp. [Available online at http://www.ifwf2.org/sites/all/themes/ad_novus/ad_novus-fluid/publications/pub_1003.pdf]

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Block, P., and K. Strzepek, 2009: Economic Analysis of Large-scale Upstream River Basin Development on the Blue Nile in Ethiopia Considering Transient Conditions, Climate Variability, and Climate Change. *J. Water Resour. Plann. Manag.*, in press. [Available online at http://iri.columbia.edu/~pblock/papers/JWRPM_IMPEND.pdf]

Block, P. J., **F. d. A. d. Souza Filho**, **L. Sun**, and H. Kwon, 2009: A Streamflow Forecasting Framework using Multiple Climate and Hydrological Models. *J. Am. Water Resour. Assoc.*, **45,** 828-843, doi:10.1111/j.1752-1688.2009.00327.x.

Brown, C., D. Domeisen, R. Meeks, K. Hunu, and W. Yu, 2008: Exploring the effect of hydroclimate variability on economic growth in Sub-Saharan Africa: a water security index. Report 2 of the Water and Growth Study. *IRI Technical Report 08-04*, International Research Institute for Climate & Society, Palisades, NY, 23 pp. [Available online at http://iri.columbia.edu/publications/id=849]

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Callaway, J. M., D. B. Louw, and **M. Hellmuth**, 2009: Benefits and Costs of Measures for Coping with Water and Climate Change: Berg River Basin, South Africa. *Climate Change Adaptation in the Water Sector,* F. Ludwig, et al., Eds., Earthscan, 205-226.

Camargo, S. J., **and A. G. Barnston**, 2009: Experimental Dynamical Seasonal Forecasts of Tropical Cyclone Activity at IRI. *Weather Forecast.*, **24,** 472-491, doi:10.1175/2008WAF2007099.1.

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Chowdhury, M. R., **A. G. Barnston**, C. Guard, S. Jones, T. A. Schroeder, and P.-S. Chu, 2009: Sea-level variability and change in the U.S-Affiliated Pacific Islands-Understanding the high sea levels during 2006-08. *Weather*, in press.

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Coelho, C. A. S., and **L. Goddard**, 2009: El Niño-induced tropical droughts in climate change projections. *J. Clim.*, doi:10.1175/2009JCLI3185.1, in press.

Connor, R., G. Gallopín, **M. Hellmuth**, and W. Rast, 2009: Climate change and possible futures. *The United Nations World Water Development Report 3: Water in a Changing World.* World Water Assessment Programme. Paris: UNESCO, and London: Earthscan, 68-76. [Available online at http://www.unesco.org/water/wwap/wwdr/wwdr3/pdf/WWDR3_Water_in_a_Changing_World.pdf]

Connor, S. J., 2009: Managing climate related health risks. *Climate Sense*, G.R. Asrar, Ed., World Meteorological Organization / World Climate Conference-3. Tudor Rose, 48-49.

Del Ponte, E. M., J. M. C. Fernandes, W. Pavan, and **W. E. Baethgen**, 2009: A Model-based Assessment of the Impacts of Climate Variability on Fusarium Head Blight Seasonal Risk in Southern Brazil. *J. Phytopathology*, **157,** 675-681, doi:10.1111/j.1439-0434.2009.01559.x.

DelSole, T., and **M. K. Tippett**, 2009: Average Predictability Time. Part I: Theory. *J. Atmos. Sci.*, **66,** 1172-1187, doi:10.1175/2008JAS2868.1.

DelSole, T., and **M. K. Tippett**, 2009: Average Predictability Time. Part II: Seamless Diagnoses of Predictability on Multiple Time Scales. *J. Atmos. Sci.*, **66,** 1188-1204, doi:10.1175/2008JAS2869.1.

Dinku, T., **A. Giannini**, **J. Hansen**, **E. Holthaus**, **A. Ines**, **Y. Kaheil**, K. Karnauskas, **B. Lyon**, **M. Madajewicz**, **M. McLaurin**, C. Mullally, **M. Norton**, **D. Osgood**, N. Peterson, **A. Robertson**, K. Shirley, C. Small, and M. Vicarelli, 2009: Designing Index-Based Weather Insurance for Farmers in Adi Ha, Ethiopia. Report to OXFAM America. *IRI Technical Report 09-04*, International Research Institute for Climate and Society, Palisades, NY, 81 pp. [Available online at http://iri.columbia.edu/publications/id=908]

Dinku, T., **P. Ceccato**, and **S. J. Connor**, 2009: Comparison of CMORPH and TRMM-3B42 over Mountainous Regions of Africa and South America. *Satellite Rainfall Applications for Surface Hydrology*, M. Gebremichael and F. Hossain, Eds., Springer, in press.

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Ghebreyesus, T. A., Z. Tadesse, D. Jima, E. Bekele, A. Mihretie, Y. Y. Yihdego, **T. Dinku**, **S. J. Connor**, and D. P. Rogers, 2009: Using climate information in the health sector. *Field. Actions Sci. Rep.*, **2,** 63-67. [Available online at http://www.field-actions-sci-rep.net/2/63/2009/facts-2-63-2009.pdf]

Giannini, A., 2009: Climate change in the Sahel: Connecting past and future. *IOP Conf. Ser.: Earth Environ. Sci.*, **6,** 342022, doi:10.1088/1755-1307/6/34/342022.

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Giannini, A., **J. W. Hansen**, **E. Holthaus**, **A. Ines**, Y. Kaheil, K. Karnauskas, **M. McLaurin**, **D. E. Osgood**, **A. W. Robertson**, K. Shirley, and M. Vicarelli, 2009: Designing Index-Based Weather Insurance for Farmers in Central America. *IRI Technical Report 09-01*, International Research Institute for Climate and Society, Palisades, NY, 78 pp. [Available online at http://iri.columbia.edu/publications/id=875]

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Goddard, L., **D. G. DeWitt**, and R. W. Reynolds, 2009: Practical implications of uncertainty in observed SSTs. *Geophys. Res. Lett.*, **36**, L09710 doi:10.1029/2009gl037703.

Goddard, L., **W. E. Baethgen**, B. P. Kirtman, and G. A. Meehl, 2009: The Urgent Need for Improved Climate Models and Predictions. *Eos*, **90,** 343.

Goddard, L., Y. Aitchellouche, W. Baethgen, M. Dettinger, R. Graham, P. Hayman, M. Kadi, R. Martínez, H. Meinke, and (additional contributions) **E. Conrad**, World Climate Conference-3, cited 2009: White Paper on Providing Seasonal-to-Interannual Climate Information for Risk Management and Decision Making. [Available online at http://www.wcc3.org/wcc3docs/pdf/WS3_WP_needs.doc]

Graves, P., F. Richards, J. Ngondi, P. Emerson, E. Biru Shargie, T. Endeshaw, **P. Ceccato,** T. Gebre, Y. Ejigsemahu, A. Mosher, A. Hailemariam, and D. Hopkins, 2008: Individual, household, and environmental risk factors for malaria infection in Amhara, Oromia and SNNP regions of Ethiopia. *Am. J. Trop. Med. Hyg.*, **79** (6 Suppl), 294-295. [Available online at http://www.ajtmh.org/cgi/reprint/79/6_Suppl/250]

Graves, P. M., F. O. Richards, J. Ngondi, P. M. Emerson, E. B. Shargie, T. Endeshaw, **P. Ceccato**, Y. Ejigsemahu, A. W. Mosher, A. Hailemariam, M. Zerihun, T. Teferi, B. Ayele, A. Mesele, G. Yohannes, A. Tilahun, and T. Gebre, 2009: Individual, household and environmental risk factors for malaria infection in Amhara, Oromia and SNNP regions of Ethiopia. *Trans. Roy. Soc. Trop. Med. Hyg.*, doi:10.1016/j.trstmh.2008.11.016, in press.

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Visitors to IRI

2008

4 Nov - 31 Jan Kassa Fekadu *Senior Meteorologist, Ethiopia National Meteorological Agency*
IRI training on seasonal forecasting for the Google.org project, "Building capacity to produce and use climate and environmental information for improving health in East Africa"

10-11 Nov Lydiane Agier *WHO intern*
Meningitis work with M. Thomson

11-14 Nov Graeme Hammer *IRI International Scientific and Technical Advisory Committee (ISTAC) member; Queensland Government Department of Primary Industries and Fisheries, Toowoomba, Australia; University of Queensland School of Land, Crop and Food Sciences, Brisbane, Australia*

13 Nov Stanley Wood *Senior Research Fellow, International Food Policy Research Institute (IFPRI)*
IRI Seminar Series on Impact Evaluation for Development Projects: Ex Ante Impact Evaluation

13 Nov Willem Jansen and Svetlana Edmeades *World Bank Sustainable Development Division*; David Lee *Cornell University World Bank project consultant*
IRI visit and presentation: "Vulnerability to Climate Change in Agricultural Systems in LAC: Building Responses"

14 Nov Belay Ejigu Begashaw *MDG Center, Nairobi.*
Visit with J. Hansen, organized by Tropical Agriculture Program, Earth Institute

14 Nov Aida Diongue *Agence Nationale de la Meteorologie du Senegal, Dakar, Senegal and THORPEX Africa co-leader*
IRI Seminar: THORPEX Africa

19 Nov Kevin Trenberth *Head of the Climate Analysis Section at the National Center for Atmospheric Research*
Seminar: The Global Water Cycle and Its Changes

24 - 28 Nov, 7 - 9 Dec Zeenas Samsudeen *Foundation for Environment, Climate and Technology*
Sri Lanka Documentation and preparation of abstracts for the climate and malaria project in Sri Lanka

25 Nov Ingo Richter *International Pacific Research Center, University of Hawaii*
IRI Seminar: The Muted Precipitation Increase in Global Warming Simulations: A Surface Evaporation Perspective

8-12 Dec Martin Montero *IMTA (Mexican Institute of Water Technology), Juitepec, Morelos, Mexico*
IMTA-sponsored visit to work with A. Barnston and S. Mason on seasonal climate forecast and the use of CPT in order to downscale the seasonal climate forecast in the region

9-19 Dec Marco Paredes *Regional Director, SENAMHI (Peru's Met Service), Iquitos, Peru and Associate Researcher, CIIFEN*
CIIFEN-sponsored visit to work with S. Mason on verification and validation of seasonal forecast, a two-week course with the objective of capacity-building and tool implementation for the western South America Climate Outlook Forums

Visitors to IRI, continued

15 Dec Jen-Hsiang Chuang *Director, Office of National Health Command Center* and Yu-Chen Hsu, *International Affairs Representative of the Center for Disease Control, Taiwan R.O.C.*
Visit to IRI to explore possible areas for collaboration

22 Dec Colin Jones *Head, Rossby Centre, Sweden*
WCRP climate downscaling project (CORDEX) meeting

23 Dec Aydin Akkaya *Professor, Kahramanmaras University, Turkey*
IRI informal seminar: Information about field crops, the department of Kahramanmaras University-Turkey, and possible collaborations with IRI regarding the effects of climate change on field crops production

2009

7 Jan David Stephens *Department of Agriculture and Food, Perth, Western Australia*
IRI Seminar: An ENSO monitoring and forecasting system based on new indices of the Southern Oscillation and Eastern Pacific SSTs

8 Jan Amy Luers *Google.org Environment Program Manager, Predict and Prevent Initiative*
Google project meetings

14 Jan Adama Alhassane Diallo *Director General of the African Centre of Meteorological Applications for Development (ACMAD), Niamey, Niger*
Visit and presentation: A Continental Meteorological Centre at the Service of Development in Africa

14 Jan Gilles Jonker *Publisher for Agricultural and Biological Sciences, Elsevier Press, Amsterdam, The Netherlands.*
Visit to discuss a new journal on Climate Risk Management
IRI Seminar: Communicating Science: Pros and Cons of Open Open Access Journals

28 Jan Marjorie Victor *Oxfam America, Boston, MA*
Oxfam project meetings

23 - 27 Feb Deus Bamanya *Uganda Department of Meteorology, Kampala*; Peter Kabamba *National Agency of Meteorology and Teledetection by Satellite, D.R. of Congo*
CPC Africa Desk visits, an IRI-NOAA/CPC collaboration involving a customized work plan for each visitor for exploring CPT and other techniques for tailoring climate prediction information and risk management applications for the visitor's country, with opportunities for discussing aspects in different sectors, drawing from experiences of IRI staff in projects and the visitor in his country's key issues

23 Feb - 6 Mar Luis Alfonso Lopez *Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM), Bogota, Colombia*
Integrated National Adaptation Project (INAP) collaboration; statistical climate modeling with A. Barnston and A. Robertson, and the IRI Data Library with M. Bell

26 Feb Dan Bloom *Director, Welfare and Barriers to Employment Policy Area, MDRC*
Fifth Seminar in the Series on Impact Evaluation for Development Projects: Qualitative Information for Impact Evaluation

27 Feb Akio Morishima *Chairman of the Board of the Japan Climate Policy Center* and Yoko Suzuoki *(Assistant), Tokyo, Japan*
Discussions with the Office of the Director-General (ODG) and the Asia and Africa Regional Programs

Visitors to IRI, continued

6 Mar Tim Palmer *European Centre for Medium Range Weather Forecasts (ECMWF)*
IRI Seminar: Towards the Probabilistic Earth-System Model

9 Mar Carlos Perez *Aerosol Group, Earth Science Department, Barcelona Supercomputing Center; Visiting Scientist, Environmental Monitoring Center, NOAA/NCEP*
IRI Special Seminar: Atmospheric Mineral Dust Modeling and Forecasting - On-Going Activities, Developments and Applications

18 Mar Vicky Pope *Head of Climate Change Advice, Met Office Hadley Centre, UK*
Meetings exploring potential involvement with DfID's Climate Center and other collaborative opportunities with the Hadley Centre

18 - 20 Mar Knut Staring, *WHO OpenHealth*; Peter Diggle, *Lancaster University*; and Amy Luers and Karin Tuxen-Bettman, *Google*
Meetings on the integration of Climate and Health data with the Data Library

24 Mar Benjamin Garnaud, Raphaël Bille, Alexandre Magnan *Institut du Développement Durable et des Relations Internationales (IDDRI), Paris, France*
Meeting to discuss a possible joint workshop on adaptation to climate change and/or on the implementation and construction of an international architecture for adaptation

27 Mar Jan Egeland *Director, Norwegian Institute of International Affairs (NUPI)*

1 Apr Lina Nerlander *IFRC*
Meetings on IFRC work in health

2 - 3 Apr Carolina Vera *University of Buenos Aires, Argentina*
Meeting with Climate Team to discuss ideas for a training course on the use of seasonal predictions for applications in Latin America

13 Apr Delia Catacutan *Center for International Development, Kennedy School of Government, Harvard University*
IRI Seminar: Meeting Climate Change Challenges through Linking Knowledge and Action

15-17 Apr Jan Delbaere, Menghestab Haile, Joanna Syroka *World Food Programme*
WFP-IRI joint planning workshop
IRI Seminar (15 Apr) by Jan Delbaere: Integrating Climate Risk in WFP Food Security Analysis

17 Apr Ana Bucher *Environment Department, World Bank*; Isabel Lavadenz and Esther Lee, *Sustainable Development Network, World Bank*
Explore collaborative climate change training activities for WB staff

20 Apr Frédéric Zanetta *Disaster Information Senior Officer, Operations Support Department, IFRC*

27 Apr Abere Mihretie *Ethiopia Climate and Health Working Group (CHWG) Secretariat, Addis Ababa, Ethiopia*
Discussions on proposed CHWG activities

27 Apr Roger Stone *Professor in Climatology and Water Resources and Director, Australian Centre for Sustainable Catchments University of Southern Queensland, Toowoomba, Australia*
Meeting with IRI staff to discuss collaboration

28 Apr David Mukanga *Executive Director, African Field Epidemiology Network (AFENET)* and Sheba Gitta *Advisor, AFENET, Kampala, Uganda*
Meeting to explore collaborative activities for extending training in climate and health, and integrating climate information in the "Field Epidemiology Training Curricula" in Africa

Visitors to IRI, continued

7 May Felix Kogan *Group on Earth Observations (GEO)*
IRI and NOAA NESDIS collaborations on Malaria Early Warning Systems
7 - 9 May David Grimes *University of Reading*
Planning for Google collaborative activities
11 - 15, 18 - 22 May Ed Sarachik *ISTAC*
15 May for the IRI Board of Overseers Meeting *Palisades, NY*

- R. K. Pachauri *(Board Chair), Director General, The Energy and Resources Institute*
- Nay Htun *Executive Director for Asia and Pacific, University for Peace*
- Chester Koblinsky *Director, NOAA Office of Global Programs*
- Michael McElroy *Gilbert Butler Professor of Environmental Studies, and Director, Center for the Environment, Harvard University*
- Jeffrey Sachs *Director, Earth Institute, Columbia University*
- Crispin Tickell *Director, Policy Foresight Programme, James Martin Institute for Science and Civilization, Oxford University*
- Simon Upton *Chairman, OECD Round Table on Sustainable Development*
- Ming-Dean Cheng *Central Weather Bureau,Taipei, Taiwan*
- Steven A. Cohen *Executive Director, Earth Institute, Columbia University*
- Chet Ropelewski *Program Manager, NOAA Climate Program Office*
- Ed Sarachik *ISTAC Chairperson; Professor, Atmospheric Sciences, University of Washington, Seattle, WA*

18 - 22 May Angelica Giarolla *INPE (Brazil's National Institute of Space Research)*
Work on the estimation of crop yield in Brazil based on satellite monitoring products and crop models
19 May Johannes Woelcke *World Bank*
Meeting with IRI staff to discuss collaboration opportunities in climate change (mitigation and adaptation) and agriculture efforts within Africa at the World Bank
20 May John Jones *Former Deputy Director of NOAA-NWS*
Discussion on IRI projects and activities in Africa, the Climate and Society Publication, ClimDev, collaborations with ACMAD and linking IRI products to the SERVIR platform
27 May Dan Walker *NOAA Climate Program Office, Division Chief Climate Assessment,* with Chet Ropelewski *NOAA CPO, Program Manager-CDEP and IRI*
Meeting for an overview of the IRI's programs, activities and projects
1 - 12 June for the 2009 Summer Institute Climate Information for Public Health *Palisades, NY*

- Mark Becker *Associate Director, Geospatial Applications Division, CIESIN, Columbia University*
- Eric Bertherat *Epidemic and Pandemic Alert and Response, World Health Organization (WHO), Geneva, Switzerland*
- Tom Clark *Meningitis and Vaccine Preventable Diseases Branch, Center for Diseases Control and Prevention (CDC), Atlanta, GA*
- Peter Diggle *Professor of Statistics, Lancaster University School of Health and Medicine, Lancaster, UK*
- Dia-Eldin A. Elnaiem *Research Specialist, National Institutes of Health, Bethesda, MD*
- Patricia Graves *Epidemiologist, Carter Center - Malaria Control Program, Atlanta, GA*
- Patrick Kinney *Associate Professor of Environmental Health Sciences, Mailman School of Public Health, Columbia University*

Visitors to IRI, continued

1 - 12 June for the 2009 Summer Institute Climate Information for Public Health *Palisades, NY,* continued

- Kim Knowlton *Assistant Clinical Professor of Environmental Health Sciences, Mailman School of Public Health, Columbia University*
- Stephen Morse *Professor of Clinical Epidemiology/Founding Director and Senior Research Scientis, Center for Public Health Preparedness,tMailman School of Public Health, Columbia University*
- Bernard Nahlen *Deputy Coordinator, President's Malaria Initiative, Washington, DC*
- Jennie Rice *Independent Consultant, Decision Sciences and Economics*
- Knut Staring *WMO-Open Health, Geneva, Switzerland*
- Pai-Yei Whung *Chief Scientist, Office of the Science Advisor, EPA, Washington, DC*

1 - 12 June Angel Munoz *CIIFEN, Ecuador*
Project collaboration with G. Mantilla and climate researchers

1 - 20 June Vincent Moron *Le Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE); the University of Aix-Marseille, France*
Weather-within-climate work with A. Robertson

5 June Pai-Yei Whung *EPA Chief Scientist*
Summer Institute 2009 Seminar: The Environmental Protection Agency's role in coordinating national and international efforts on climate and health

5 June Michael Bender *EPA, Washington, DC*
Meeting with Data Library staff on the GEO portal

5 June Vijay K. Gupta *Department of Civil, Environmental and Architectural Engineering, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO*
IRI Seminar: Multi-scale Dynamics of Statistical Scaling in Floods on River Networks

8 June Bernard Nahlen Deputy *Coordinator, President's Malaria Initiative*
Summer Institute 2009 Seminar: Recent Policy Changes Associated with Elimination and Eradication of Malaria

9 - 12 June Knut Staring *WMO-Open Health*
Summer Institute seminar speaker and meetings to discuss IRI Data Library-Google-OpenHealth integration

17 June Maarten Van Alst *Associate Director and Lead Climate Specialist, Red Cross/Red Crescent Climate Centre*
Meeting on IFRC-IRI collaboration
IRI Seminar: Early warning, early action: Climate risk management from a humanitarian perspective (illustrated by examples from the IRI-IFRC partnership)

23 June Erick Khamala *Remote Sensing Officer and SERVIR-Africa Project Manager from the Regional Center for Mapping of Resources for Development, Nairobi, Kenya*
IRI-Google.org project briefing; discussion on possible internship collaborations with RCMRD and Climate & Society students

2 July Andrew McDonald *Research Associate, Department of Earth and Atmospheric Sciences, Cornell University / Research Coordinator, New York State Water Resources Institute*
IRI-CWC Seminar: Managing water and climate risks in agricultural systems

Visitors to IRI, continued

10 July Balaji Rajagopalan *Associate Professor and Fellow, Cooperative Institute for Research in Environmental Sciences, Department of Civil, Environmental and Architectural Engineering, University of Colorado*
IRI Seminar: Seasonal Ensemble Streamflow Forecast Using Large Scale Climate Information - Application to Water Resources Management in the Western US

13 July Raghu Murtugudde *Professor, Earth System Science Interdisciplinary Center, University of Maryland*
IRI Seminar: Earth System Predictions: A regional prototype

21 July Ursula King *National Centre for Epidemiology & Population Health, Australian National University, Canberra, Australia*
IRI Seminar: Indigenous-led NRM Projects/General Overview of CC and Health in Australian Context

24 July Weihong Qian *Professor, Peking University, China*
IRI Seminar: Extreme weather and climate events in China

29 July Gisele Ferreira de Araújo and Maria Hemilia Fonseca *University of Sao Paulo, Brazi*l; *Guarani Aquifer Project (SE South America)*
IRI seminar: Climate Change Regime: New Trends for a Society in Transition

14 Aug Nicholas Casey *Reporter, The Wall Street Journal*
Exploratory visit to meet IRI staff conducting work in the Latin America and Caribbean region

27 Aug Joanna Syroka, *WFP*
Meeting with J. Hansen and L. Goddard regarding collaboration

28 Aug Daniel Rodriguez, *Agricultural Production Systems Research Unit (APSRU), Toowoomba, Australia.*
Meetings with U. Lall and J. Hansen regarding CRM for agriculture in Africa.

31 Aug - 1 Sept Koen Verbist *La Serena, Chile*
Meeting with A. Robertson to discuss potential collaborative areas with the Water Center for Arid and Semi-Arid Zones in Latin America and the Caribbean (CAZALAC), in particular, the implementation of a historical/forecast maproom for Chile to show historical station rainfall statistics

17 Sept Erin Towler *Department of Civil, Environmental, and Architectural Engineering, University of Colorado at Boulder, Colorado*
IRI Seminar: Probabilistic Framework for Translation of Seasonal Climate Forecasts and Climate Change Information for Water Quality Decision Making

21 - 23 Sept Neville Nicholls Monash *University, Victoria, Australia*
IRI Seminars: Local and remote causes of the recent decline in southern Australian rainfall; Mortality-temperature relationships. Seasonality, synoptics, & the J-curve

21 Sept - 2 Oct Sheshagiri Rao *Karnataka, India*
Asia Regional Program collaborator on the ERFS project, discussions and research activitities
IRI Seminar: Sustainable Profits from Farming in a Region of High Climatic Risk in India: Perspectives of a Farmer-Researcher

22 Sept Padhraic Smyth *University of California, Irvine, CA*
Discussions with A. Robertson and A. Greene on DOE-funded project “Regional climate-change projections through next-generation empirical and dynamical models”

Visitors to IRI, continued

24 Sept David Bresch *Director of Sustainability and Emerging Risk, Swiss Reinsurance Company, Zurich, Switzerland*
Meeting to introduce IRI's work in climate and CRM and possible collaborations to explore new uses of financial instruments

24 Sept David Bresch *Director of Sustainability and Emerging Risk, Swiss Re, Zurich, Switzerland* and Marjorie Victor *Oxfam America, Boston, MA*
Panel Discussion: Economics and Climate Adaptation: Index Insurance and Climate Risk Management Example in Ethiopia (co-hosted with the M.A. in Climate and Society Program and the New York Committee for Oxfam America in connection with Climate Week NYC)

24 Sept Amir Siraj *Former IRI intern and Climate and Society Masters Program graduate*
IRI Seminar: Predictability of Malaria Epidemics Using Climate Factors in Highland Fringes of Ethiopia

29 Sept Pablo Valdivia *World Bank*
Meeting with D. Osgood on the online Weather Index-Insurance Educational Tool and possible implementation in Central America

5 Oct Jeffrey Sachs *Director*, Steve Cohen *Executive Director, Earth Institute, Columbia University*
Meeting with Directors of Columbia University divisions at the Lamont Campus

9 Oct Dionisio Herrera *Executive Director, Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET), Decatur, GA*
Meeting to explore collaborative activities for extending training in climate and public health, and integrating climate information in the "Field Epimediology Training Curricula"

13 Oct Torleif Markussen Lunde *University of Bergen's Center for International Health, Oslo, Norway*
IRI Seminar: Establishment of an Ethiopian Malaria Prediction System
Meeting with the environmental monitoring and health teams on malaria work in Ethiopia

15 Oct Watson International Scholars of the Environment *Providence, RI*
Visiting scholars from the Global Environmental Program of Brown University in collaboration with United Nations Environment Programme

20 - 21 Oct Chet Ropelewski *Program Director, NOAA Climate Program Office*

29 - 30 Oct Mohammed Boulahya *Regional Advisor on ClimDev Africa, Tunis, Tunisia*
Consultations on Africa Regional Program activities and partnerships

Representing the IRI around the World

Africa

2008

3 - 7 Nov S. Mason *Arusha, Tanzania*
RCOF Review 2008: An International Expert Review Meeting on Regional Climate Outlook Forums; member of the RCOF Review 2008 Scientific Organizing Committee; discussion leader on verification practices in RCOFs; presented position paper from feedback received and views expressed at sessions, along with overall recommendations and way forward

17 - 19 Nov M. Thomson *Bamako, Mali*
Global Ministerial Forum on Research for Health

19 - 21 Nov M. Thomson *Niamey, Niger*
Meetings with Centre de Recherche Médicale et Sanitaire (CERMES) and the African Centre for Meteorological Applications for Development (ACMAD)

1 - 5 Dec M. Madajewicz, M. Thomson, S. Trzaska *Addis Ababa, Ethiopia*
Meningitis Environmental Risk Information Technologies (MERIT) meeting (1-2 Dec)
- Ethiopia MERIT meeting (3 Dec)
- MERIT Steering Committee meeting (4 Dec)
- Climate and Health Working Group (CHWG) meeting, to discuss the setting up of an Ethiopian MERIT initiative (5 Dec)

4 - 6 Dec J. Omumbo, B. Platzer *Nairobi, Kenya*
Preparations for Kenya CHWG Stakeholders Meeting with InterGovernmental Authority on Development Climate Prediction and Applications Centre (ICPAC) and Ministry of Public Health and Sanitation (MoPHS)

8 - 10 Dec S. Connor, J. Omumbo, B. Platzer *Nairobi, Kenya*
- Kenya CHWG Inaugural Stakeholders Meeting; presentations (8-9 Dec):
  - J. Omumbo: Training and capacity building
  - S. Connor: Link between climate change and variability and health
- Google Kenya and ICPAC meetings (10 Dec)

2009

15, 21 Jan T. Dinku *Addis Ababa, Ethiopia*
- Ethiopia's First National Climate Change Conference; invited presentation: The Need for a National Center for Climate and Development in Ethiopia (15 Jan);
- Visit and presentation at Addis Ababa University: Satellite Rainfall Estimation and Validation over Ethiopia (21 Jan)

27 - 28 Jan J. Hansen *Abidjan, Cote d'Ivoire*
Global Water Partnership/West Africa 3rd General Assembly: Integrated Water Resources Management in West Africa, Strategies of Adaptation in a Context of Proven Climate Change; with Casey Brown, acted as discussion resource persons for the conference theme of adaptation to climate change and variability; and project scoping for the Bill & Melinda Gates Foundation's (BMGF) “Climate-Informed Water Management” project

Representing the IRI around the World, continued

Africa, continued

29 - 31 Jan J. Hansen *Accra, Ghana*
BMGF project meetings with potential partners to explore interest, capacity and potential contributions, and gather information about opportunities for project work in Ghana

23 - 28 February B. Lyon, S. Mason *Nairobi, Kenya*
ICPAC Forecast Verification Workshop

26 Feb - 10 Mar E. Holthaus *Adi Ha, Ethiopia*
Oxfam America drought index insurance initiative

25 - 27 Mar J. Omumbo *Nairobi, Kenya*
3rd Annual East African Health and Scientific Conference: Climate Change, Environment and Health; presented: Harnessing Climate Information for Public Health in a Changing Environment; panelist at Climate Change and Malaria symposium

27 - 28 Mar J. Omumbo *Nairobi, Kenya*
Meeting with Kenya's CHWG members to discuss progress in group's activities and possible future research activities; discussions with programme leaders at International Development Research Centre's (IDRC) Climate Change Adaptation in Africa programme in Nairobi

29 Mar - 2 Apr M. Madajewicz Cairo, Egypt
Perspectives on Impact Evaluation: Approaches to Assessing Development Effectiveness Conference

5 May O. Ndiaye *Dakar, Senegal*
Agence Nationale de la Meteorologie du Senegal; presented: Predicting JAS seasonal Sahel rainfall total beyond the spring barrier

6 - 22 May O. Ndiaye *Niamey, Niger*
The 12th regional Climate Outlook Forum (PRESAO-12 Second-Generation): Seasonal climate prediction as tool for water resources management, food security and risk management; provided training on seasonal climate forecasting and the Climate Predictability Tool (CPT)

8 - 23 May E. Holthaus *Adi Ha, Ethiopia*
For the IRI project: Supporting Oxfam America's HARITA (Horn of Africa Risk Transfer for Adaptation) weather index insurance pilot project in Rural Tigray province: finalizing the May 28, 2009 launch of the microinsurance product in Adi Ha, and conducting focus group discussions with farmers in 8 additional villages being considered for 2010 scale-up.

13 - 15 May J. Hansen *Nairobi, Kenya*

- Towards Priority Actions for Market Development for African Farmers, a conference with co-sponsors led by the Alliance for a Green Revolution in Africa (AGRA) and the International Livestock Research Institute (ILRI); presented a paper: “Climate Risk, Information and Market Participation for African Farmers,” in a parallel session on Risk and Risk Management; and,
- Meetings with partners at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the University of Nairobi

13 - 26 May S. Mason *Pretoria, South Africa*
CPT and verification software development

Representing the IRI around the World, continued

Africa, continued

20 - 27 June N. Ward *Casablanca and Marrakech, Morocco*
- Inaugural meeting of the ACMAD Committee of Partners and Donors; ACMAD Board Meeting
- Morocco Met Service; presented: CRM and implications for products for Met Services

30 June - 2 July P. Block, T. Dinku, A. Giannini *Addis Ababa, Ethiopia*
Workshop for Training in Water and Climate Risk Management: Managing Hydroclimatic Risk in the Water Sector, led by P. Block, co-sponsored by UNESCO International Hydrological Programme

3 July P. Block, T. Dinku, A. Giannini *Addis Ababa, Ethiopia*

Visit with the Ethiopian National Meteorological Agency, hosted by Diriba Korecha and Kassa Fekadu
- Giannini presentation on seasonal forecasts, climate variability and climate change, or "How do we integrate climate information on all time scales, research and operations?"
- P. Block presentation on climate risk management for water resources

7 July A. Giannini *Cape Town, South Africa*
"Climate change in the Sahel: past, present and future" seminar conducted at University of Cape Town's Department of Oceanography (hosted by Mathieu Rouault)

9 - 10 July A. Giannini *Pretoria, South Africa*
Africa Task Force Meeting of the Initiative for Policy Dialogue; discussion leader: Climate change and Africa

13 - 17 July T. Dinku *Cape Town, South Africa*
IEEE International Symposium on Geoscience and Remote Sensing Symposium (IGARSS 2009): Earth Observation- Origins to Applications; presentation on the validation of satellite rainfall estimates over different parts of Africa

20 - 24 July S. Trzaska *Ouagadougou, Burkina Faso*
3rd International African Monsoon Multidisciplinary Analyses (AMMA) Conference

21 - 27 Aug S. Mason *Harare, Zimbabwe*
13th Southern Africa Regional Climate Outlook Forum (SARCOF-13) and Capacity Building Workshop

23 - 29 Aug B. Lyon *Nairobi, Kenya*
Greater Horn of Africa Climate Outlook Forum (GHACOF) - 23; work with Kenya Meteorological Department on temperature trends, Millennium Development Goals Regional Office visit

28 Aug S. Mason *Pretoria, South Africa*
Implementation and introduction to CPT 10, University of Pretoria

2 - 4 Sept P. Ceccato *Mombasa, Kenya*
The 5th TEPHINET (Training Programs in Epidemiology and Public Health Interventions Network Inc.) and 3rd AFENET (African Field Epidemiology Network) Regional Science Conference

Representing the IRI around the World, continued

Africa, continued

5 Sept P. Ceccato *Nairobi, Kenya*

Regional Center for Mapping of Resources for Development (RCMRD) meeting with Erick Khamala on: i) SERVIR (Regional Visualization & Monitoring System) development; ii) monitoring agriculture using remote sensing; iii) development of the analysis on Group on Earth Observations (GEO) user need for human health-infectious diseases ; and iv) training activities

28 Sept - 2 Oct M. Thomson *Niamey, Niger*

Participate in CERMES Scientific Steering Committee Meeting; (1-2 Oct) meeting with ACMAD DG to discuss memorandum of understanding (MOU) and preparations for forthcoming MERIT meeting

5 - 9 Oct L. Cibrelus, R. Cousin *Antananarivo, Madagascar*

Facilitators for the "Learning Through Doing Project: Cross-Training Workshop for Madagascar's National Meteorological and Hydrological Service and Ministry of Health Staff in the Use of Meteorological, Climate and Health Data"

11 - 19 Oct M. Norton *Adi Ha, Ethiopia*

Ground truthing to assess potential for incorporating satellite images of vegetation in Oxfam weather index insurance project

Europe

2008

17 - 20 Nov J. Kroeger *Trieste, Italy*

Invited presenter to the Conference on Teleconnections in the Atmosphere and Oceans; presented: Influence of El Nino on the upper-ocean circulation in the tropical Atlantic in different ocean state estimates

19 November S. Zebiak, H. Bhojwani *Geneva, Switzerland*

International Federation of Red Cross/Red Crescent Society (IFRC) Meeting

20 - 21 November S. Zebiak, H. Bhojwani *Geneva, Switzerland*

1st Meeting of the World Climate Conference-3 (WCC-3) High Level Subcommittee

3 - 8 Dec M. Hellmuth, S. Mason, D. Osgood *Poznan, Poland*

Fourteenth Session of the Conference of the Parties and side events:

- IFRC side event; S. Mason presentation: International developments in climate risk assessments tools (3 Dec)
- Munich Climate Insurance Initiative side event: Climate Risk Insurance: Poverty Reduction and Adaptation Index (8 Dec):
  - D. Osgood presentation: Index Insurance for Poverty Reduction and Development at Scale; and panelist
  - M. Hellmuth prepared insurance case studies and lessons learned from Climate & Society No. 2 (as presented by WFP/IFAD, WB-CRMG, IRI, SwissRe & Oxfam) and discussion moderator, Index Insurance in Practice

Representing the IRI around the World, continued

Europe, continued

18 Dec S. Someshwar *London, UK*
Meeting of the Climate Change Adaptation Working Group

2009

25 - 28 Jan L. Goddard *Geneva, Switzerland*
Global Climate Change Research and Education Workshop, sponsored by the University Corporation for Atmospheric Research (UCAR), Globe Program, and the World Meteorological Organization (WMO)

26 - 27 Jan M. Thomson *Barcelona, Spain*
Malaria Eradication Research Agenda (MalERA) Monitoring, Evaluation and Surveillance Consultative Meeting

2 Feb J. Hansen *Rome, Italy*
UN World Food Program meeting to develop a strategy for bringing climate information and climate-informed risk analysis and monitoring tools into WFP activities; plan a workshop for the WFP-IRI joint expert working group in April at IRI

11 - 13 Feb L. Sun *Toulouse, France*
World Climate Research Programme (WCRP) Workshop on Evaluating and Improving Regional Climate Projections; presented: Use of regional climate models for seasonal prediction - Lessons for climate change application

12 - 13 Feb S. Mason, M. Thomson *London, UK*
Imperial College Grantham Institute for Climate Change meeting: Does climate change impact on malaria transmission?

13 Feb S. Mason, M. Thomson *London, UK*
Meeting with Merylyn Hedger, Institute of Development Studies (IDS) and Vicky Pope (UK Met Office) re: UK Department for International Development (DfID) Climate Centre Consortium

16 Feb S. Mason *Exeter, UK*
Hadley Centre meetings

17 - 18 Feb S. Mason *Reading, UK*
The European Centre for Medium-Range Weather Forecasts (ECMWF) seminar (17 Feb) speaker: A Forecast Verification System for Jo(e) Public; and meetings

18 - 19 Feb M. Thomson *Liverpool, UK*
Liverpool School of Tropical Medicine teaching “Climate Information for Public Health” organized by Dr. T. O'Dempsey for students in: MSc Humanitarian Studies, MSc Humanitarian Programme Management, Diploma in Tropical Medicine and Hygiene

Representing the IRI around the World, continued

Europe, continued

10 - 12 Mar J. Hansen, A. Ines *Egmond aan Zee, The Netherlands*

Conference on Integrated Assessment of Agriculture and Sustainable Development: Setting the Agenda for Science and Policy

- J. Hansen: session co-chair, Modeling Adaptation Strategies to Cope with Climate Change; presented: IRI research on Exploring Options to Improve Adaptation to Climate
- Change in Crop Production of Southeastern South America (on behalf of W. Baethgen, with A. Ines, L. Goddard, A. Green)
- Ines presented: Extracting useful information from daily GCM rainfall for cropping system modelling (coauthored with J. Hansen)

11 - 13 Mar M. Hellmuth *Copenhagen, Denmark*

- Conference: Climate Change: Global Risks, Challenges and Opportunities (11-12 Mar)
- UNEP Risoe Centre on Energy, Climate and Sustainable Development meetings (13 Mar)

14 - 19 Mar S. Zebiak, H. Bhojwani *Bonn, Germany*

3rd Meeting of the WCC-3 International Organizing Committee

28 Mar M. Hellmuth *Rome, Italy*

WFP meeting on index insurance

27 April - 1 May T. Dinku *Trieste, Italy*

Abdus Salam International Centre for Theoretical Physics (ICTP) conference: Water Resources in Developing Countries: Planning and Management in a Climate Change Scenario; invited speaker on “Rainfall Observations over Sub-Saharan Africa: Challenges and Prospects” and “Validation of Daily Satellite Rainfall Estimates over Africa and South America;” and gave an IRI Data Library introduction/demonstration

19 - 22 May L. Goddard *Madrid, Spain*

16th Session of the CLIVAR Scientific Steering Group

6 - 11 June M. Hellmuth *Bonn, Germany*

- 30th meeting of the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technological Advice
- Meeting for UNDP risk transfer facility

8 - 10 June J. Jenkner, S. Mason *Helsinki, Finland*

The Fourth International Verification Methods Workshop

- S. Mason presented: Towards Standardized Verification of Seasonal Forecasts (invited)
- J. Jenkner presented: Verification of Probabilistic Calibrations for Deterministic GFS Precipitation Forecasts; and chaired a session

8 - 12 June H. Bhojwani, M. Hellmuth *Bonn, Germany*

UN Climate Change Talks

12 - 14 June J. Omumbo *Cambridge, UK*

WorldWide Antimalarial Resistance Network (WWARN) meeting; attended as a member of WWARN's scientific advisory committee

14 - 17 June J. Omumbo *Cambridge, UK*

Genomic Epidemiology of Malaria Focus Meeting on Genomics and Drug Resistance

Representing the IRI around the World, continued

Europe, continued

16 - 17 June W. Baethgen, J. Hansen *Wageningen, The Netherlands*
CGIAR Science Forum 2009 - Science for development: Mobilizing Global Linkages
- W. Baethgen, presented: Climate Change and the Agricultural Sector: Challenges for Research Programs
- J. Hansen represented the CGIAR Challenge Program "Climate Change, Agriculture and Food Security" (CCAFS) Leadership Group

16 - 19 June H. Bhojwani *Geneva, Switzerland*
2nd session of the Global Platform for Disaster Risk Reduction, and WCC-3 meetings

18 - 19 June J. Hansen *Rome, Italy*
WFP Food Security Monitoring Stakeholder Consultancy; presented: Value-Added Climate Information for Food Security Monitoring

18 - 19 June S. Connor *Geneva, Switzerland*
WMO Forum on Socio-Economic Benefit Applications of Weather, Climate and Water Services

23 - 24 June S. Zebiak, M. Hellmuth, D. Osgood, M. Thomson *Geneva, Switzerland*
Global Humanitarian Forum
- S. Zebiak, M. Thomson, panelists: Health Equity and Climate Change Policy Workshop
- S. Zebiak, panelist: Weather Index Insurance: Prospects for Development and Disaster Management
- M. Hellmuth, D. Osgood launched Climate and Society Publication 2 report, "Index Insurance and Climate Risk: Prospects for development and disaster management"

27 - 30 June E. Conrad, S. Someshwar *Marseille, France*
World Bank's 5th Urban Research Symposium: Cities and Climate Change: Responding to an Urgent Agenda; S. Someshwar presented: From reactive to proactive management of urban climate risks in Asia: Institutional challenges, scientific opportunities (S. Someshwar, E. Conrad, and M. Bhatt)

7 - 9 July P. Ceccato, S. Connor, C. Vaughan *Geneva, Switzerland*
IEEE-GEOSS Workshop XXVIII – Health and the Environment, and session on Earth Observation Needs for Environmental Change and Human Health (IRI, co-organizer)
- P. Ceccato, keynote address: Environmental Information Use and Tools for Health Information Systems
- S. Connor: Overview of Early Warning Systems Applications to Vector-Borne Diseases

9 - 10 July L. Goddard, S. Someshwar *Zurich, Switzerland*
Economics of Climate Adaptation, invited participants by McKinsey & Co. and SwissRe

13 - 17 July H. Bhojwani *Geneva, Switzerland*
WCC-3 consultations

21 - 24 July M. Hellmuth *London, UK*
Institute of Strategic Studies visit

13 - 18 Aug S. Zebiak, H. Bhojwani *Stockholm, Sweden and Oslo, Norway*
Global Water Partnership, NUPI (Norwegian Institute of International Affairs) meetings

Representing the IRI around the World, continued

Europe, continued

31 Aug - 4 Sept S. Zebiak, W. Baethgen, H. Bhojwani, L. Goddard, M. Hellmuth, U. Lall, S. Mason, J. Omumbo, D. Osgood, B. Platzer, M. Thomson; and M. Daly and J. Sharoff (C&S Masters Program students) *Geneva, Switzerland*
WCC-3: Better Climate Information for a Better Future

- Plenary Round Table 1, Climate Risk Management (31 Aug)
  - S. Zebiak, discussant
- Working Group 1, Climate and Human Health (organized by IRI, WHO & Health and Climate Foundation) (1 Sept)
  - M. Thomson, theme leader
  - J. Omumbo,speaker
  - S. Connor, contributing author to white paper on capability, "Health and Climate - Opportunities"
  - S. Connor, G. Mantilla, J. Omumbo, M. Thomson, contributing authors to white paper on needs, "Health and Climate – Needs"
  - Working Group 3, Seasonal-to-interannual climate variability (1 Sept)
  - L. Goddard, speaker; lead author of white paper on needs, "Providing Seasonal-to-Interannual Climate Information for Risk Management and Decision Making"
  - S. Mason, contributing author to white paper on capability, "Understanding and Predicting Seasonal to Interannual Climate Variability - the Producer Perspective"
  - W. Baethgen, contributing author to white paper on needs
  - E. Conrad, contributor to white paper on needs
- Working Group 4, Climate and water (1 Sept)
  - U. Lall, discussant
- Plenary 4, Climate extremes, warning systems and disaster risk reduction (2 Sept)
  - W. Baethgen, discussant
- Forum 4, Capacity-building, education and training (2 Sept)
  - W. Baethgen, discussant
- Working Group 10, Climate and food security (2 Sept)
  - W. Baethgen, contributing author to white paper on "Managing Climatic Risks to Combat Land Degradation and Enhance Food Security: Key information Needs"
- Working Group 12, Regional climate information for risk management (2 Sept)
  - S. Mason, contributing author to white paper on capability
- Side Event: Disaster Risk Management: Challenges and Opportunities Using Climate Information, a Red Cross-IRI Multi-Country Perspective (organized by IFRC Climate Center, IRI, NOAA, ACMAD, IFRC, Columbia University - Masters in Climate and Society) (1 Sept)
  - S. Mason, presenter; with J. Sharoff and M. Daly (Climate & Society MA graduates)
- Side Event: Weather Index Insurance in Practice: Insurers' Experience from China, Ethiopia and India (organized by WFP and IRI) (2 Sept)
  - D. Osgood, presenter
- Side Event: Technical Meeting on Climate Risk Management of Infectious Diseases: MEWS in Southern Africa (co-hosted by WHO and WMO with support from IRI and the Health and Climate Foundation) (3 Sept)
  - M. Thomson, Chair; S. Mason, J. Omumbo, L. Cibrelus, B. Platzer, participants

Representing the IRI around the World, continued

Europe, continued

21 - 25 Sept L. Goddard *Venice-Lido, Italy*
Ocean Obs '09 conference: Ocean information for society: sustaining the benefits, realizing the potential; conference programme committee member, organizer and chair of forecasting session, and member of advisory committee for NOAA's Office of Climate Observations (OCO)

18 - 21 Oct S. Someshwar *Oxford, UK*
Meetings at the James Martin 21st Century School, Oxford University, to explore opportunities for collaborations in education and research (EI team led by J. Sachs)

26 Oct J. Hansen *Copenhagen, Denmark*
Climate Change, Agriculture and Food Security theme leadership interview

Australia, Asia and the Pacific Islands

2008

1 - 6 Nov G. Mantilla *Kuala Lumpur, Malaysia*
5th Global TEPHINET (Training Programs In Epidemiology and Public Health Interventions Network) Conference; meetings with Latin American and Caribbean directors at national and regional levels of FETP (Field Epidemiology Training Program) to discuss potential collaborative work areas

6 - 7 Nov J. Hansen *New New Delhi, India*
Meeting with BMGF and Professional Assistance for Development Action (PRADAN), at the invitation of BMGF Program Manager

10 - 11 Nov S. Someshwar *New Delhi, India*
National Policy Dialogue on Climate Change Adaptation co-sponsored by the Swiss Agency for Development and Cooperation (SDC) and the MS Swaminathan Research Foundation (MSSRF)

15 - 21 Nov M. Hellmuth, D. Osgood *Hyderabad, India*

- Weather Index Insurance Seminar, sponsored by BASIX, World Food Programme and International Fund for Agricultural Development
  M. Hellmuth, design inputs to session on synthesizing lessons learned from the Indian case studies for use in the Climate and Society publication
- D. Osgood, invited presentation: "Weather Science Tools (the potential to help overcome barriers and as well as the challenges)"

2009

12 - 13 Jan B. Lyon *Bangkok, Thailand*
Risk Assessment and Mitigation Measures for Natural and Conflict-Related Hazards in Asia, sponsored by the UN Office for the Coordination of Humanitarian Affairs (OCHA) Regional Office for Asia Pacific and the Norwegian Geotechnical Institute (NGI); presented: Quantifying Drought. Risk Assessment and Mitigation Measures for Natural and Conflict Related Hazards in Asia

Representing the IRI around the World, continued

Australia, Asia and the Pacific Islands, continued

28 Jan S. Zebiak, E. Conrad *Tokyo, Japan*
Japan Agency for Marine-Earth Science and Technology (JAMSTEC) International Symposium on Climate Research Applications: Innovations with Society; presentations:
- S. Zebiak: Climate information for decision-making
- E. Conrad: Managing climate risks - demonstrations in Asia

2 - 3 Feb H. Bhojwani *Tokyo, Japan*
Regional Consultation Meeting in Asia-Pacific on the Development of the Global Climate Change Adaptation Network

5 - 7 Feb S. Zebiak, H. Bhojwani, S. Someshwar *New Delhi, India*
Delhi Sustainable Development Summit 2009 - Towards Copenhagen: An Equitable and Ethical Approach

9 - 13 Feb H. Bhojwani, E. Conrad, S. Someshwar, K. Venkatasubramanian *Ahmedabad and Hyderabad, India*
Demonstration site visits for the Extended-Range Forecasting System for Agricultural Risk Management (ERFS) project

22 Mar A. Giannini *Amman, Jordan*
Launch of the Columbia University Middle East Research Center, Under the Patronage of Her Majesty Queen Rania Al Abdullah; invited panelist on “Sustainable Development in the Middle East,” moderated by Columbia University President Lee C. Bollinger, with Sheikh Salem Bin Khalid Al Qassimi (Associate Planner, Abu Dhabi Urban Planning Council, UAE), Rajendra K. Pachauri, and Jeffrey D. Sachs

24 - 25 Mar K. Baroang (Barnard) *Jakarta, Indonesia*
International Workshop on Climate Information Services in Supporting Mitigation and Adaptation to Climate Change in Energy and Water Sectors; presented: Tools for the Use of Climate Information across Timescales within a Multipurpose Reservoir System

6 - 9 Apr L. Sun *Beijing, China*
- Fifth Session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia (FOCRAII); Chair for the Climate Prediction System and Modeling session; invited lecturer on “Uncertainty in Seasonal Climate Forecasting” and “IRI seasonal Climate Forecast for Summer 2009”
- Beijing Climate Center meetings on the CPT training workshop

9 - 10 Apr L. Sun *Nanjing, China*
Nanjing University of Information Science and Technology visit; conducted a seminar on “Regional Climate Modeling: Status and Open Issues”

27 - 30 Apr E. Conrad, A. Ines, A. Robertson, S. Someshwar, K. Venkatasubramanian *Hyderabad, India*
Workshop on agriculture risk management, co-led by IRI, government and university-based partners, hosted by the Acharya N. G. Ranga Agricultural University (ANGRAU). Participants included researchers from agriculture universities in nine states across India, who are leading demonstration efforts as part of the ERFS project.

Representing the IRI around the World, continued

Australia, Asia and the Pacific Islands, continued

30 Apr - 8 May A. Ines *Hyderabad and Gujarat, India*
ERFS project field visits and demonstration site research at ANGRAU and Anand Agriculture University

3 - 8 May K. Venkatasubramanian *New Delhi, India*
Data collection and research, Dept. of Agriculture Cooperation, Ministry of Agriculture, India

4 - 9 May A. Robertson, M. Tippett *New Delhi, India*
ERFS Climate Predictability Tool Training Workshop

9 - 10, 13 May E. Conrad, S. Someshwar *Bogor and Jakarta, Indonesia*
Meetings with AusAID, Ministry of Agriculture and the Center for Climate Risk and Opportunity Management at Bogor Agriculture University

11 - 12 May E. Conrad, R. Cousin, S. Someshwar *Bogor, Indonesia*
Workshop on Utilizing Seasonal Early Warning for Fire Activity in Central Kalimantan at Bogor Agriculture University

22 - 29 June S. Mason *Hanoi, Vietnam*
Training Workshop: Climate Variability and Predictions for the Indian Ocean Basin – Africa and Asia; presented:
- Time Series and Correlations
- Multivariate Analysis and Best Practices (Parts I and II)
- Statistical Significance and Confidence Intervals - Understanding the Relative Operating Characteristics (ROC)
- CPT Training

29 June K. M. Baroang *Manila, Philippines*
Presentation at the Philippines National Water Resources Board on the water component of the climate risk knowledge practices manual and training materials; meetings to solicit input from partners at University of the Philippines (Los Banos) and the National Hydraulic Research Center, as well as Angat Reservoir stakeholders, including representatives of the national met agency, the national and regional irrigation administrations, municipal water providers, and the national power corporation.

6 - 8 July E. Conrad *Tokyo, Japan*
Japan Meteorological Agency's "Tokyo Climate Conference: Better Climate Information for a Safe and Sustainable Society;" presented: Managing Water and Fire Risks in Southeast Asia

12 - 15 July A. Robertson *Singapore*
Asia-Pacific Economic Cooperation (APEC) Climate Symposium 2009: Climate prediction and applications: Relevance for climate adaptation strategies; presentations on IRI work in seasonal forecasting, downscaling and climate risk management, and tutorial session on "Downscaling of weather within climate"

16 - 18 July A. Robertson *Bogor, Indonesia*
Visit to the Center for Climate Risk and Opportunity Management, Institut Pertanian Bogor (IPB, or Bogor Agricultural University) to explore future collaborations

Representing the IRI around the World, continued

Australia, Asia and the Pacific Islands, continued

17 July - 4 August S. Someshwar *Bangalore, Delhi and Hyderabad, India*
ERFS project meetings

20 - 23 July A. Ines *Manila, Philippines*
Conducted "Capacity Building for Crop Yield Forecasting" at Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) sponsored by Philippine Department of Science and Technology's Balik-Scientist program

1 - 6 Aug L. Zubair *Kandy and Colombo, Sri Lanka and Male, Maldives*
Meetings: University of Peradeniya on proposal to MacArthur Foundation; Energy and Water Managers (Lanka Transformers Ltd, Mahaweli Authority) for proposal development to NSF; Anti-Malaria Campaign on proposal development to IDRC; Ministry of Environment; Maldivian College of Higher Education, Maldivian Department of Meteorology and persons in the Climate and Renewable Energy Sector

27 Sept - 5 Oct M. Madajewicz *Bangladesh*
Fieldwork for NSF project (Columbia University-managed): Decentralization and Local Public Goods: How Does Allocation of Decision-Making Authority Affect Provision

19 - 30 Oct A. Curtis, S. Mason, A. Robertson, L. Song *Beijing, China*
IRI-WMO Workshop on Tailoring of Seasonal Forecasts: Training Experts in the Climate Predictability Tool

North America

2008

2 - 9 Nov P. Block *Mesa, AZ*
Participate in DISCCRS (Dissertations Initiative for the Advancement of Climate Change Research) IV Symposium as a DISCCRS scholar

5 - 7 Nov W. Baethgen *Miami, FL*
28th meeting of the Scientific Advisory Committee of the Inter-American Institute for Global Change Research (IAI)

6 Nov S. Connor *Washington, DC*
Malaria in the Americas Forum: Overcoming the Challenges of a Borderless Disease, sponsored by The Pan American Health Organization (PAHO) and the Center for Global Health at George Washington University (GWU), in commemoration of Malaria Day in the America; invited speaker on "Climate Change and Malaria"

13 Nov J. Hansen *New York, NY*
Earth Institute Seminars on Sustainable Development, "Anthropogenic Climate Change: Are We Ready," sponsored by the Columbia Climate Center; presented: Are the Earth's Rural Populations Ready?

18 - 21 Nov D. DeWitt *Lincoln, NE*
Applied Research Centers Council Meeting and Climate Diagnostics and Prediction Workshop

Representing the IRI around the World, continued

North America, continued

18 Dec P. Block, *Washington D.C.*
World Bank Brainstorming retreat on methodology for modeling and economic sector work on climate change adaptation in Ethiopia; invited talk: Inclusion of Climate Variability in Modeling: Applications for Ethiopia

15-19 Dec D. Lee *San Francisco, CA*
2008 American Geophysical Union Fall Meeting, presented: Exploring the Ocean-Atmosphere Interaction in Observed Surface Heat Flux Datasets and Coupled Model Forecasts for Recent Decades (D. Lee and D. G. DeWitt)

2009

12 Jan M. Bell *Phoenix, AZ*
23rd Conference on Hydrology, American Meteorological Society (AMS) Annual Meeting; presented: The development of objectively-derived, probabilistic, and verifiable drought prediction methodologies (B. Lyon, M. Bell)

13 Jan M. Thomson *Phoenix, AZ*
Panelist for the AMS Town Hall Session, "Integrated Solutions for Environment and Health"

18 - 19 Feb L. Goddard *Washington, DC*
1st Meeting of the National Academy of Sciences Committee on Assessment of Climate Predictability on Intraseasonal-to-Interannual Timescales; attended as committee member, and presented: IRI Seasonal-to-Interannual Climate Forecasts

20 Feb L. Goddard *Silver Spring, MD*
Workshop of NOAA's Climate Program Office on Intraseasonal-to-Interannual Prediction

23 - 25 Feb J. Hansen *New York, NY*
UN Commission on Sustainable Development (CSD-17) Intergovernmental Preparatory Meeting and Side Event, "Farming First"

25 Feb A. Giannini *Pasadena, CA*
CALTECH Environmental Science and Engineering Seminar speaker: Climate Change in the Sahel, Past, Present and Future

3 Mar M. Madajewicz *New York, NY*
Millennium Village Project Annual Health Sector Meeting, Lerner Hall, Columbia University; panelist for the session: Keeping Records/Keeping Score - Using information to change policy, influence decision making and improve quality

4 Mar L.Zubair *Stony Brook, NY*
School of Marine and Atmospheric Sciences, State University of New York; seminar: The Use of Climate Information in the Tropics: Learning from Practice

5-6 Mar S. Zebiak, H. Bhojwani *Washington, DC*
NOAA Climate Program meetings

Representing the IRI around the World, continued

North America, continued

24-27 Mar E. Holthaus, S. Mason *Norman, OK*

Climate Prediction Applications Science Workshop 2009; presentations:

- E. Holthaus (co-authors: A. Siebert, N. Ward, W. Baethgen, M. Brown, D. Osgood, and M. Indeje): Climate Impact Indices for Drought Risk Management, Focusing on Index Insurance and the Millennium Villages Project Sites in Africa

24-27 Mar E. Holthaus, S. Mason *Norman, OK*

Climate Prediction Applications Science Workshop 2009; presentations (continued):

- S. Mason (co-authors: W. Baethgen, M. Hellmuth, S. Trzaska, M. Bell, S. Abdelrahim, L. Braman, and A. Tall): Climate Information for Disaster Risk Management: Early Warning - Early Action

26-27 Mar L. Goddard *San Diego, CA*

2009 Border Governors Conference Water Work Table - Binational Drought Science Conference; presented: Research Towards Improved Interannual to Decadal-scale Climate Predictions (co-authors B. Lyon, A. Greene)

30 Mar W. Baethgen *New York, NY*

Columbia Climate Center launch; speaker

2 - 3 April G. Mantilla, J. Omumbo, M. Thomson *New York, NY*

Symposium at the American Natural History Museum: Exploring the Dynamic Relationship between Health and Environment

6 - 9 Apr S. Zebiak *College Park, MD*

30th Session of the Joint Scientific Committee of the World Climate Research Program; presented: Risk Assessment/Management from the Perspective of Users of Climate Information

9 Apr A. Greene, A. Robertson *Bethesda, MD*

Climate Change Prediction Program (Department of Energy Project) Science Team meeting; presentations:

- Greene: Two-Way Parameterization of Indian Monsoon Rainfall Projections (A. Greene, A. Robertson)
- Robertson: Report on DOE-funded project, Regional Climate-Change Projections Through Next-Generation Empirical and Dynamical Models

20 - 22 Apr M. Bell, B. Lyon *Washington, DC*

Climate Prediction Center visit with collaborators on Climate Test Bed project, New Tools for North American Drought Prediction

24 Apr M. Thomson *Southampton, NY*

Panelist at Stony Brook Southampton's Symposium on Climate Change and Health: Making the Connection

27 - 28 Apr S. Zebiak *Washington, DC*

- UN Foundation and Club of Madrid consultation: guidance on climate adaptation for international discussions at UNFCCC/COP in Copenhagen
- Present seminar at NSF on current research and activities at the IRI

Representing the IRI around the World, continued

North America, continued

29 - 30 Apr L. Goddard *Washington, DC*
Meeting No. 2 of the National Academy of Sciences Committee on the Assessment of Intraseasonal to Interannual Climate Prediction and Predictability

4 - 8 May 2009 J. Hansen *New York, NY*
- Representative of the International Council for Science at the 17th Session of the UN Commission on Sustainable Development held at the United Nations
- Speaker for the International Council for Science event, Climate Change, Agriculture and Food Security on: Managing Current Risks and Preparing for Progressive Change: The Twin Pillars of Climate Adaptation

27 May A. Giannini *University of California, Irvine, CA*
Invited seminar: Climate Change in the Sahel, Past, Present and Future

27 - 28 May L. Goddard *Washington, DC*

3rd Meeting of the National Academy of Science Committee on the Assessment of Intraseasonal to Interannual Climate Prediction and Predictability

1 - 2 June F. Fiondella, J. Rodriguez *Silver Springs, MD*
NOAA Climate Program Office's ClimateWatch Editorial Workshop

1 - 2 June L. Goddard *University of Puerto Rico, Rio Piedras, Puerto Rico*
Intra-American Study of Climate Processes (IASCLiP) Workshop; presented: Applications & Capacity Building

3 - 4 June L. Goddard *University of Puerto Rico, Rio Piedras, Puerto Rico*
12th Annual Meeting of the WCRP/CLIVAR/VAMOS Panel (VPM12), presented:
- IASCLiP - Working Group on Applications and Regional Groups
- VAMOS Extremes
- US CLIVAR Working Group on Decadal Predictability

10 - 12 June M. Sheremata *New York, NY*
International Conference on E-Learning in the Workplace Conference

15 - 18 June D. DeWitt, L. Goddard, A. Greene *Breckenridge, CO*
14th Annual Community Climate System (CCSM) Model Workshop; presented:
- L. Goddard: Decadal Prediction session organizer
- Greene: Statistical Decadal Prediction: Can Periodicity be Useful?

17 - 19 June G. Mantilla *Washington, DC*
13th Meeting of the Roll Back Malaria Partnership Monitoring and Evaluation Reference Group (RBM MERG)

18 - 19 June P. Block *Washington, DC*
World Bank's first workshop on the Economics of Adaptation to Climate Change; presented: Climate Change in Ethiopia: Adaptation in the Energy and Agriculture Sectors

19 June L. Goddard *Boulder, CO*
US CLIVAR Decadal Predictability Working Group Meeting; attended as co-chair of WG

22 - 24 June P. Ceccato *Washington, DC*
NASA Earth System Science at 20: Accomplishments, Plans, and Challenges

Representing the IRI around the World, continued

North America, continued

23 - 24 June A. Barnston, S. Connor *Palo Alto, CA*
Climate Teleconnections and Early Warning Systems for Food, Health and Ecosystem Security (initiative funded by Google.org and the Gordon and Betty Moore Foundation); presented:
- The IRI Seasonal Climate Forecast System (A. Barnston)
- Building capacity to produce and use climate and environmental information for improving health in East Africa (S. Connor)

13 - 15 July M. Hellmuth *Broomfield, CO*
NOAA Climate Program review meeting

15 - 17 July L. Goddard *Annapolis, MD*
US CLIVAR Summit; presentation of status of the US CLIVAR Working Group (WG) on Decadal Predictability (WG co-chair)

19 - 20 July D. Osgood *Boston, MA*
National Bureau of Economic Research Conference

2 - 7 Aug L. Sun *Maui, HI*
9th International Regional Spectral Modeling Workshop; presented: A new nesting approach with bias correction for regional climate models (L. Sun and H. Li); with lectures on:
- Introduction to seasonal climate prediction
- Development of a downscaling prediction system
- Seasonal forecasts using the RSM: current status and outstanding issues

3 - 4 Aug L. Goddard *Pasadena, C*
Committee Meeting 4 of the National Academies of Sciences project, “Assessment of Intraseasonal to Interannual Climate Prediction and Predictability”

10 - 11 Aug W. Baethgen *Washington, DC*
Meetings with: Phil Arkin at University of Maryland's Earth System Science Interdisciplinary Center, Chet Ropelewski at NOAA; Harold J. Stolberg, NSF Program Manager, Pan-American Advanced Studies Institutes Program (PASI); Paul Filmer, Program Manager, NSF, Inter-American Institute fro Global Change Research (IAI)

24 - 28 Aug A. Robertson *Los Angeles, CA*
Meeting for University of California, Los Angeles-Department of Energy Collaborative Research: Regional climate-change projections through next-generation empirical and dynamical models

10 Sept S. Mason *Silver Spring, MD and Arlington, VA*
NOAA Research Roundtable on Sustaining Observation, and NSF Meeting

17 - 18 Sept N. Ward *Washington, DC*
- NOAA visit; presented a CPC seminar on Sahel rainfall with NCEP CFS
- CPC Africa Desk visit to discuss collaborative activities

Representing the IRI around the World, continued

North America, continued

21 - 23 Sept S. Connor, S. Trzaska *Savannah, GA*

NASA Public Health Program Review; presented:

- S. Connor: Enhancing the Famine Early Warning System Network Decision Support System with NASA Earth System Science Data and Modeling Results
- S. Connor: Integrating NASA Earth Science Results into Malaria Early Warning Products to Enhance USAID Food Security and Disaster Management Decision Making
- S. Trzaska: Environmental Factors and Population Dynamics as Determinants of Meningococcal Meningitis Epidemics in the Sahel: An Investigation of NASA and NOAA Products

1 - 2 Oct J. Hansen *Washington, DC*

- AAAS seminar series: Beyond Copenhagen: Scientific Perspectives on Adaptation and Sustainability; panelist; presented: Climate Change and Agriculture: A Crisis of Opportunity?
- Meetings: Congressional Research Service; USAID

7 - 9 Oct B. Blumenthal *Santa Barbara, CA*

2009 Invited participant, 2009 National Center for Ecological Analysis and Synthesis (NCEAS) INTEROP: A Community-driven Scientific Observations Network to Achieve Interoperability of Environmental and Ecological Data

9 Oct L. Goddard *Palisades, NY*

Columbia University Division of Ocean and Climate Physics' Friday Seminars Series Speaker: El Nino-related Tropical Drought Risk in a Changing Climate

9 Oct H. Bhojwani, D. Osgood *Washington, DC*

- USAID brownbag on index insurance for Ethiopia for USAID and State Department staff
- USAID meetings on climate change adaptation, the Data Library, and Africa

16 - 19 Oct P. Block *Washington, DC*

Meeting on the World Bank Economics of Adaptation to Climate Change Study

22 - 23 Oct E. Conrad *Washington, DC*

Dialogue on Forests, Governance and Climate Change (organized by World Resources Institute, Rights and Resources Institute, and Chatham House), participation in the context of fire early warning work in Indonesia's peatland forests

26 - 30 Oct A. Barnston, A. Greene, O. Ndiaye *Monterey, CA*

NOAA 34th Climate Diagnostics and Prediction Workshop; presentations:

- A. Barnston: An evaluation of the skill of ENSO forecasts during 2002-2009 (A. Barnston and M. Tippett)
- A: Greene: Decadal prediction: Periodicity and it's discontents
- O. Ndiaye: Predictability of seasonal Sahel rainfall using GCMs and lead-time improvements using a coupled model (O. Ndiaye, N. Ward and W. Thiaw)

27 - 28 Oct H. Bhojwani *Washington, DC*

USAID meeting

Representing the IRI around the World, continued

North America, continued

29 Oct A. Giannini *Washington, DC*
The Other Green Revolution: How Farmers Reclaimed the Desert to Create an Agricultural Future for Africa (organized by Oxfam America); participation in the context of the EI Cross-Cutting Initiative project on "Sustainable development in the Sahel – learning from the recent greening"

Central America, South America and the Caribbean

2008

16 - 26 Nov C. Perez *Quito, Ecuador*
Planning meetings with McKnight grantees

1 - 5 Dec L. Zubair *Merida, Mexico*
International EcoHealth Forum 2008; presented: Malaria Risk Predictions using Climate and Environmental Monitoring and Prediction: Demonstration in Sri Lanka; and a poster: Impacts of Climate on Malaria in Sri Lanka For Malaria (Z. Yahiya, L. Zubair, A. Giannini, G.A. Galappaththy, M. Siriwardhana, J. Chandimala, and S.J. Connor)

8 - 11 December N. Ward *Guayaquil, Ecuador*
Implementation of Climate Watch Systems, First Workshop for South American Region (WMO RA-III), sponsored by WMO, Instituto Nacional de Meteorología e Hidrología (INAMHI), ESPOL (Ecuador), CPPS (Ecuador), CIIFEN (Ecuador); Scientific Organizing Committee member and presenter; presentations:
- Extreme climate events; risk assessment and management including user needs
- Long range forecasting; Methodologies and available products for climate watches

9 - 12 Dec W. Baethgen, M. Bell *Chillán, Chile*
Conducted Instituto de Investigaciones Agropecuarias (INIA)-sponsored workshop: Climate Risk Management in Agriculture and an Introduction to the IRI Data Library; topics covered:
- W. Baethgen: Introduction to course objectives; Climate and Agriculture-Climate Characterization (Exercise); Climate and Agriculture--Climate Prediction (Exercise); Agriculture and Climate (Translating climate information into agronomic information); Climate and Vegetation Monitoring; Simulation Models and Agriculture Climate Change and Agriculture

9 - 12 Dec W. Baethgen, M. Bell *Chillán, Chile*
Conducted Instituto de Investigaciones Agropecuarias (INIA)-sponsored workshop: Climate Risk Management in Agriculture and an Introduction to the IRI Data Library; topics covered, continued:
- M. Bell: An Introduction to the Data Library; Practical Exercises: Accessing Climate Data via the IRI Data Library; and, Practical Exercises: Describing Climate Data and Data Display Options.

Representing the IRI around the World, continued

Central America, South America and the Caribbean, continued

2009

19 - 22 Jan L. Sun *Fortaleza, Brazil*

11th International Workshop for Climate Forecast in Northeast Brazil; presented: IRI seasonal climate forecast made in January 2009

- Fundação Cearense de Meteorologia e Recursos Hídricos (FUNCEME) visit, meeting with Eduardo Martin, FUNCEME president, on IRI/FUNCEME collaborations in seasonal forecast and crop yield prediction
- Meeting with Francisco de Assis de Souza Filho on collaborations in prediction research

26 - 30 Jan G. Mantilla *Tegucigalpa, Honduras*

Latin American Field Epidemiology Training Program (FETP) Directors Meeting; invited speaker, presented:

- Climate information for publication health
- Use of climate information in the FETP

2, 9 Feb W. Baethgen *Montevideo, Uruguay; Ciudad Obregon, Sonora, Mexico*

2nd Workshop of the World Bank project: Adaptation to climate change in the agricultural sector

10 - 11 Feb W. Baethgen *Hermosillo, Sonora, Mexico*

University of Sonora invited presentation to faculty and graduate students; and meeting to discuss collaborations on CRM for water resources management in northwest Mexico

17 - 19 Mar S. Connor, G. Mantilla *Bogota, Colombia*

Technical Committee Meeting of the Amazon Malaria Initiative/Amazon Network for the Surveillance of Anti-malarial Drug Resistance (AMI/RAVREDA); invited presentation: Climate Change and Malaria

14 - 23 Apr R. Cousin *Colombia*

- *Palmira (*14 - 15 Apr) to participate in the Comision Permanente de Pacifico Sur (CPPS) conference on the management of artesanal fisheries in the Southeast Pacific, demonstrate and explore the creation of a Climate and Fishery maproom for CPPS applications
- *Bogota (*16 - 23 Apr) to conduct Data Library and Map Room training and demonstrations for the staff of the INS and IDEAM (national health and met services, respectively)

23 Apr W. Baethgen *Santiago, Chile*

Inauguration of the Global Change Research Center, Pontificia Universidad Católica de Chile; keynote speaker: "The Impacts of Climate Change on the Agricultural Sector"

25 May W. Baethgen *Montevideo, Uruguay*

UNDP Workshop, Country's Vision on Climate Change Adaptation and Mitigation; invited presentation: Adaptive Measures for Adaptation in Climate Change in the Agricultural Sector of Uruguay

26 - 29 May W. Baethgen, P. Block *La Serena, Chile*

Centro del Agua para Zonas Áridas y Semiáridas de América Latina y El Caribe (CAZALAC)-sponsored International Workshop on Droughts in Latin America; invited presentation: Droughts and Climate Risk Management: the International Experience

Representing the IRI around the World, continued

Central America, South America and the Caribbean, continued

21 - 25 July B. Lyon *Jiutepec, Morelos, Mexico*
Workshop: Variability and Climate Change in the West Coast of North America; meeting with water managers to discuss tailored drought prediction efforts

5 - 6 Aug W. Baethgen *San Jose, Brazil*
INPE (Instituto Nacional de Pesquisas Espaciais, or National Institute of Space Research) visit to meet with Carlos Nobre on INPE-Institute for Earth Studies-IRI LAC program collaborations; meeting with Angelica Giarolla to discuss remote sensing collaboration

21 Aug D. Ruiz Carrascal *Bogota, Colombia*

National Institute of Health workshop (first session) on the development of malaria dynamical models and the implementation of the multi-model ensemble framework, as part of “Simulating malaria transmission dynamics in the pilot areas of the Colombian Integrated National Adaptation Project”

24 - 28 Aug D. Ruiz Carrascal *Los Nevados Natural Park, Colombia*
Presentations of the results of the project “Signals of climate variability/change in surface water supply of high-mountain watersheds” to the World Bank Group, the National Center for Coffee Research, the Colombian Institute of Hydrology, Meteorology and Environmental Studies, the National University of Colombia, and the Caldas Hydroelectric Group

25 - 28 Aug W. Baethgen *Santiage, Chile*
International meeting with UNESCO and the Government of Belgium to discuss Phase III of CAZALAC (Water Center for Arid and Semi-Arid Zones in Latin America and the Caribbean)

26 - 28 Aug A. Barnston *Guayaquil, Ecuador*
Comision Permanente del Pacifico Sur's International Global Climate Meeting: ENSO and its Impact of the South Pacific; invited presentation: An Evaluation of the Skill of ENSO Forecasts during 2002-2009, and Implications for Prediction of Climate Variability in the Equatorial and Southeast Pacific Regions

26 Aug - 12 Sept G. Mantilla *Bogota, Colombia*
Meetings: Integrated National Adaptation Plan (INAP) Integrated Malaria and Dengue Surveillance and Control System Project, National Institute of Health, National Planning Department (DNP)

25 Sept W. Baethgen *Valdivia, Chile*
International Seminar on Agriculture and Expanded Agriculture and Climate Risk Management, sponsored by the Inter-American Institute for Cooperation in Agriculture (IICA); invited speaker: International Initiatives for Climate Risk Management in the Agricultural Sector

Representing the IRI around the World, continued

Central America, South America and the Caribbean, continued

8 - 11 Oct T. Dinku, D. Ruiz Carrascal *Medellin, Colombia*

14th Congress of the Colombian Association of Parasitology and Tropical Medicine; presentations:

- T. Dinku: Integration of remotely sensed and climatic data in International Research Institute malaria early warning system (Vancutsem, C., P. Ceccato, T. Dinku, and S. Connor)
- D. Ruiz Carrascal: Biological models, decision-making process and malaria control (Ruiz, D., S. J. Connor, M. C. Thomson, M. L. Quinones, A. M. Molina, A. T. Zea, M. M. Jimenez, M. E. Gutierrez, and P. A. Zapata)

19 - 20 Oct W. Baethgen *Cali, Colombia*

Regional Consultation on Agricultural Research for Development in Latin America and the Caribbean, hosted by Regional International Center for Tropical Agriculture (CIAT); and coordinator for the Working Group on Challenges of Climate Change

27 - 29 Oct W. Baethgen *Chillan, Chile*

Training course sponsored by the Ministry of Agriculture (Chile) lecturer: Decision Support Systems for Climate Risk Management and Economic Impact in Agriculture

Acknowledgements

The International Research Institute for Climate and Society (IRI) has benefited greatly from the foresight, vision, and support of the National Oceanic and Atmospheric Administration (NOAA) Climate Program Office and Columbia University in the City of New York. The cooperative agreement enables critical exploratory work in climate risk management for development near to the home of the United Nations and the seat of world politics, a setting rich with expertise, intellect, and experience. It leverages significant additional direct and in-kind contributions that advance the collective work of the institution in partnership with over 160 national and international institutions specializing in climate, development, health, agriculture, financial instruments, food security, risk management, water resources, and policy. The result is much needed advancements in best practices for climate risk management, and access to important forums for communicating these. The IRI appreciatively acknowledges program and project funding provided during the reporting period by the: Asia Disaster Preparedness Center (ADPC), CARE, The Earth Institute at Columbia University, The Eastern Research Group, Inc. (ERG), The Gates Foundation, GECAF/U. Oxford, Global Water Partnership Organization (GWPO), Google.org, Indian Institute of Technology, Delhi (IITD), McKnight Foundation, OPeNDAP, OXFAM, Swiss Re, UN Educational, Scientific, and Cultural Organization (UNESCO), (UNOPS), University of the Free State (South Africa), US Department of Energy (DOE), US Geological Survey (USGS), US National and Aeronautical Space Agency (NASA), US NOAA CICAR, US National Science Foundation (NSF), and the World Bank.

Credits: Cover graphics by J. Rodriguez, from World Climate Conference-3, Geneva, Switzerland. This report benefited by contributions from the entire IRI staff. Additional contributions from A. Binder, F. Fiondella, L. Braman, R. Fullon, J. Rodriguez, M. Salgado, L.Scally and S. Zebiak were greatly appreciated. The report was compiled by C. Mutter. Comments should be directed to czm@iri.columbia.edu.

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