

Selected IRI Activities in Africa

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Talk Outline

1. IRI Mission and background
2. IRI Africa Regional Program
3. Improving availability of climate information in Ethiopia
4. Index Insurance
5. Characterizing decadal variability in southern Africa
6. Crop modeling in Kenya
7. High-resolution dust modeling in the Meningitis Belt
8. IFRC Flood Preparation and Precipitation Map Room
9. Climate Information for Public Health
10. Reservoir Management in Ethiopia
11. Climate Predictability Tool (CPT): Used at RCOFs (in Africa)
12. Statistically corrected dynamical forecast for Sahel
13. IRI Net-Assessment Seasonal Forecasts
14. Trend Analysis in East Africa

IRI Mission

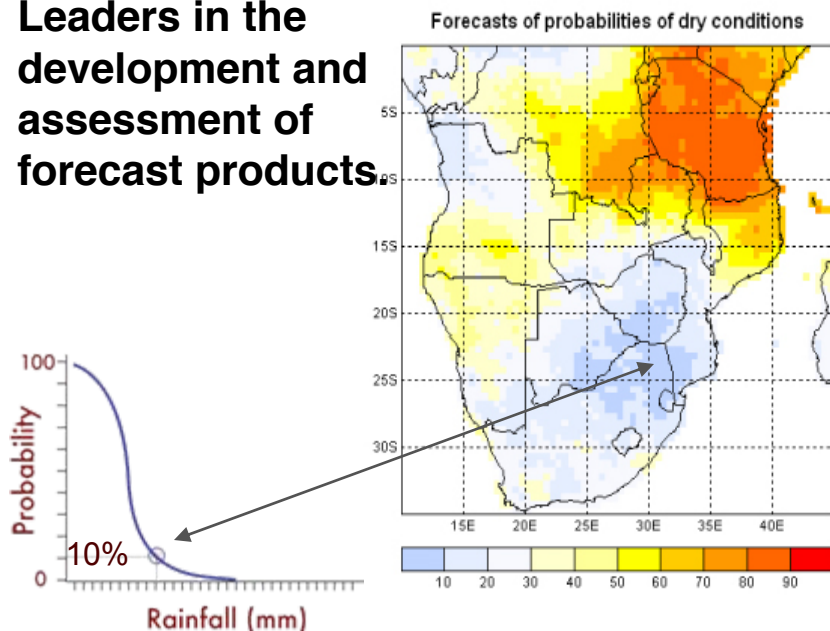
We use a science-based approach to enhance a society's capability to understand, anticipate and manage the impacts of climate in order to improve human welfare and the environment, especially in developing countries.

International Research Institute for Climate and Society

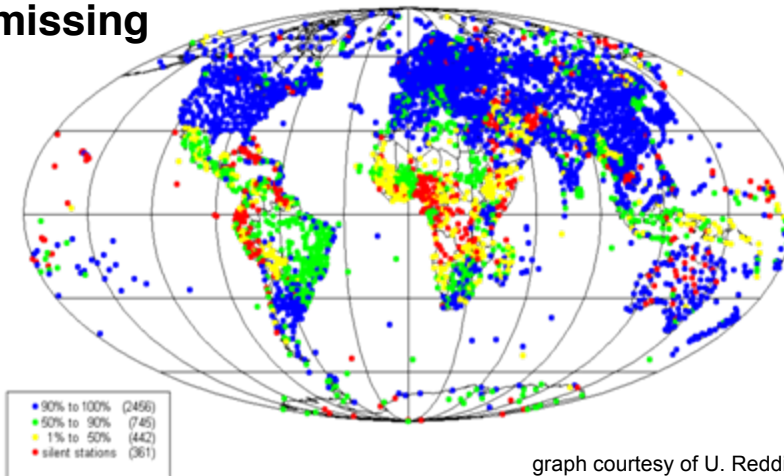
Research in support of climate risk management



Leaders in the development and assessment of forecast products

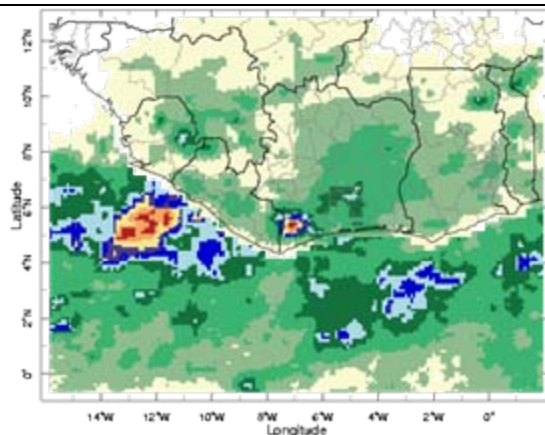


Experts in the use of remotely sensed data to establish regional climate patterns where direct observations are missing



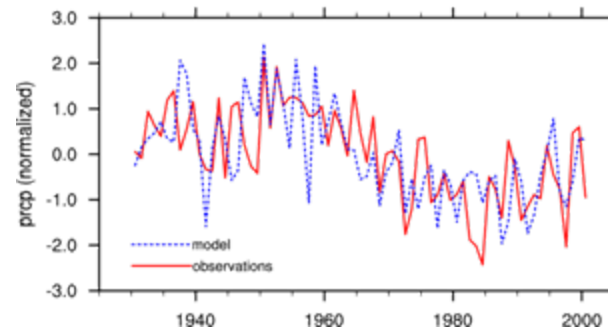
graph courtesy of U. Redding

Innovators in the sectoral analysis of climate impacts (e.g., malaria early warning tool)



11-29 Apr 2008

Sahel precipitation - July-September 1930-2000



Basic research to unravel and understand climate mechanisms

IRI Africa Regional Program



IRI works in over 30 countries internationally with concentrated activities within Africa in **Ethiopia** and **the Sahel**.

Additionally, IRI continues to support cross-regional work, as well as some efforts in Southern Africa (incl. Botswana, Madagascar and South Africa) and in the Greater Horn.

Targeting...

Figure 2

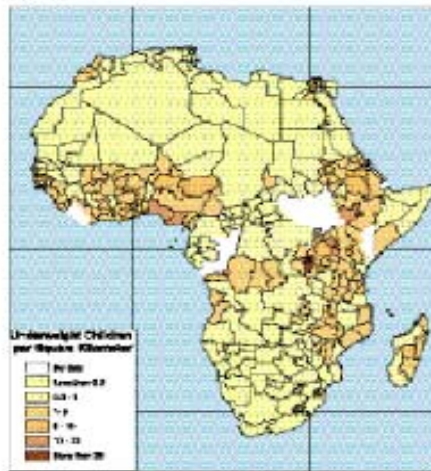


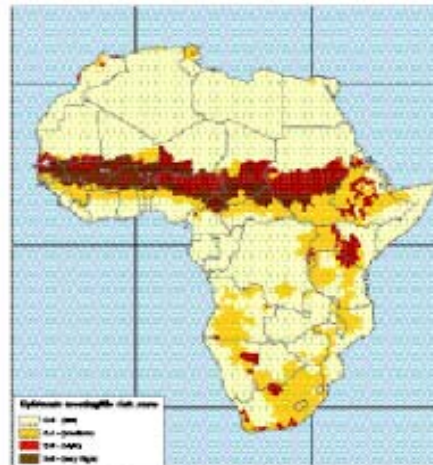
Figure 3



Figure 4



Figure 5



Semi-arid areas:

The inhabitants prone to hunger, droughts, epidemic malaria epidemic and meningitis.

Working across sectors:



Agriculture



Health



Water



Economics & Livelihoods

...Also Disaster Risk Management

Improving Availability, Access and Use of Climate Information Ethiopia

Tufa Dinku

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**International Research Institute for Climate and Society
The Earth Institute at Columbia University**



The International Research Institute
for Climate and Society

The Problem

- Number of weather stations not adequate, and deteriorating
- Most stations located in the cities along main roads
 - ➔ **Limited data over most of rural Africa**
- Serious gaps in observations (missing data)
- Quality of available data not very good
- Limited access and use of the available data



Proposed Solution

Improving availability:

Quality control and combine local observations with global products such as satellite proxies and model reanalysis data

→ Global products help in filling spatial and temporal gaps

Improving access:

- Provide online-access to data, analysis tools, and products

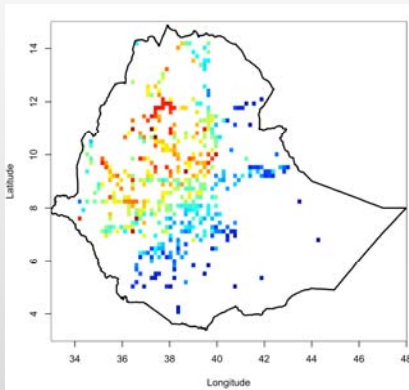
Improving use:

- Develop products for specific applications
- Train users to understand, demand, and use climate data
- Facilitate the formation of community of practice





Ethiopian Climatology Work: Improving Data Availability through Use of Station Observations & Satellite Estimates



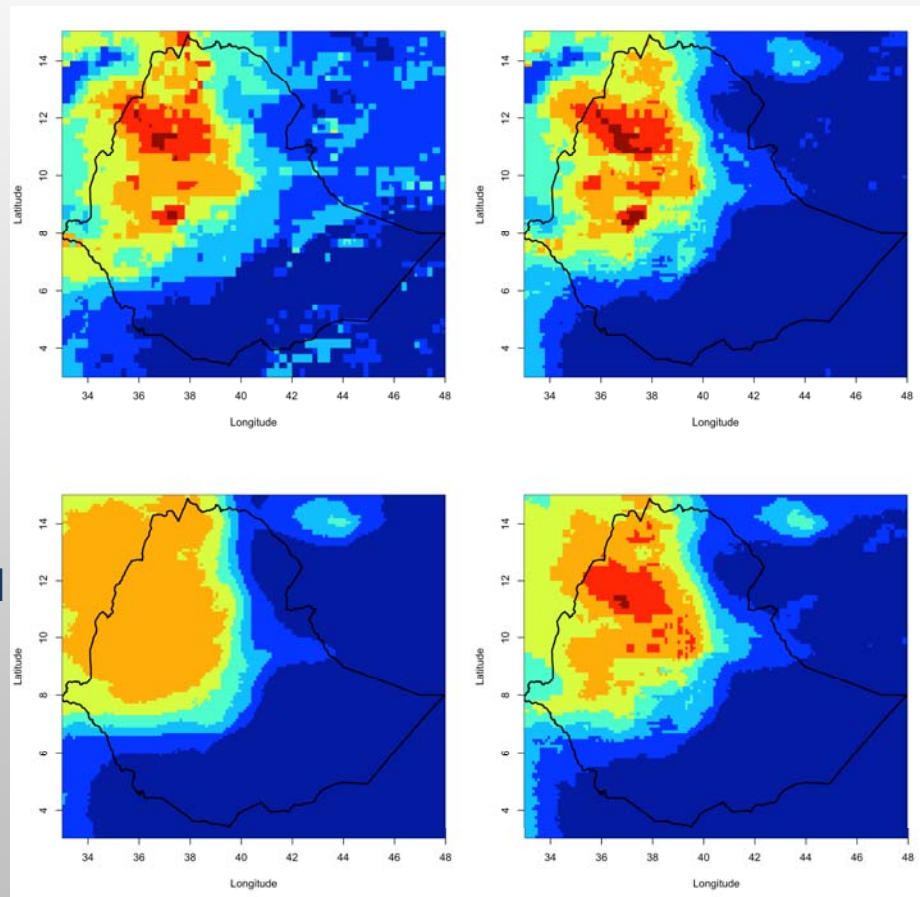
(A) Raingauge data

(B) Interpolated gauge

(C) As in (B) but bias-adjusted
satellite data used as
background

(D) Satellite rainfall estimate

(E) Bias-adjusted (using
raingauge) satellite rainfall
estimate





Ethiopian HARITA project: Connecting Satellites, Climatologies and Farmers for Adaptation

Climate adaptation at local scale

- Improve productivity, reduce vulnerability through
 - Community risk reduction activities
 - Community savings
 - Loans and Drought Insurance
- Scaling from 5 villages to dozens this year

Index insurance against drought

- Insurance payouts triggered by NOAA CPC ARC realtime remote sensing product
- Designed, validated with satellites, gauges, and farmers
 - NOAA CPC ARC satellite climatology
 - Ethiopian NMA/Reading/IRI satellite, gauge climatology
 - Ethiopian NMA gauge network
 - Remote sensing of vegetation
 - Farmer experience, data



Satellite & village info map used by Ethiopian experts to coordinate farmer validation & design process



Farmer remote sensing validation training

In each Village, farmers:

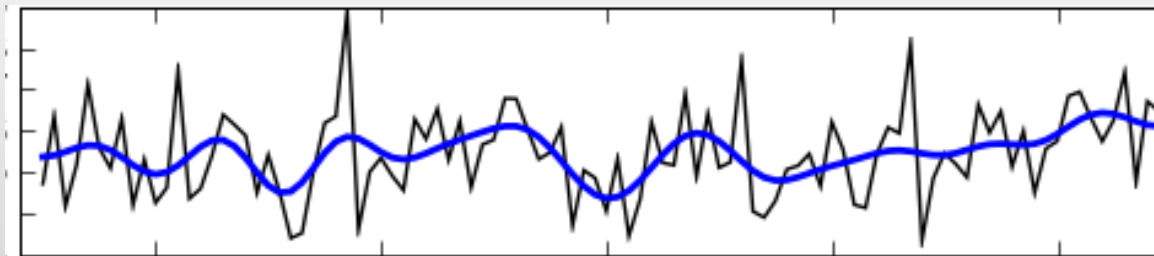
- Design
 - Adaptation package
 - Drought index insurance product
- Validate
 - Remote sensing climatology

With direct funding from Oxfam America-
More partners and technical details at:
<http://iri.columbia.edu/publications/id=1002>



South African Multi-Decadal Work: Managing Climate Risk for Agriculture and Water Resources Development

- Looking at the implications of Near-Term Climate Change on runoff
- Assessing benefits and costs of different adaptation strategies



Rainfall in the western cape:

- What are the implications on water resource management?

May point to reprioritization, reordering, or delay of implementation of options.

- Partners: Universities of Cape Town, Free State, Kwa Zulu Natal, Columbia (IRI), UNEP-Risoe
- Context of Cape Water Mgmt Area: Irrigated activities, wine/table grapes and deciduous fruit exports ~ 86% of GDP ~3.5 million people
- Consumptive Water Use
 - Urban: 54%
 - Ag. : 42%



*With direct funding from Climate Change and
Adaptation in Africa (CCAA) – IDRC/DFID*

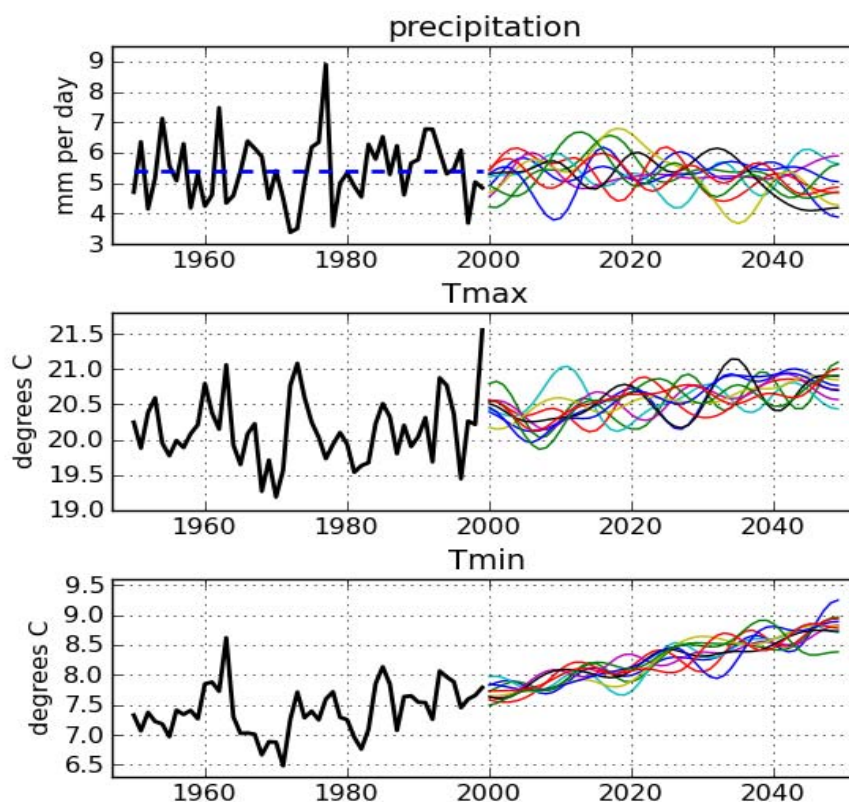


South African Multi-Decadal Work Continued: Managing Climate Risk for Agriculture and Water Resources Development

Stochastic decadal simulations for the Berg River catchment, Western Cape province

Shown is an ensemble of ten stochastic simulations (colors) for one station along the Berg, designed for driving a hydrology model. Rainfall, maximum and minimum temperatures are correlated and must be simulated jointly. The sequences are smoothed; daily values are ultimately generated.

The dashed blue line shows the 1950-1999 precipitation mean. Post-2000 there is a declining trend, consistent with IPCC projections and amounting to a reduction of nearly 10 percent by 2050. Tmax and Tmin show increasing but differing trends. Interannual-to-decadal variations are superimposed on the long-term tendencies, providing a rich set of synthetic data for testing the resilience of proposed adaptations to decadal climate variations, in the context of a shifting background state.



*With direct funding from Climate Change and
Adaptation in Africa (CCAA) – IDRC/DFID*



Raised Temperatures over the Highlands of East Africa: Revisiting the Facts in the East African Highlands Malaria Debate

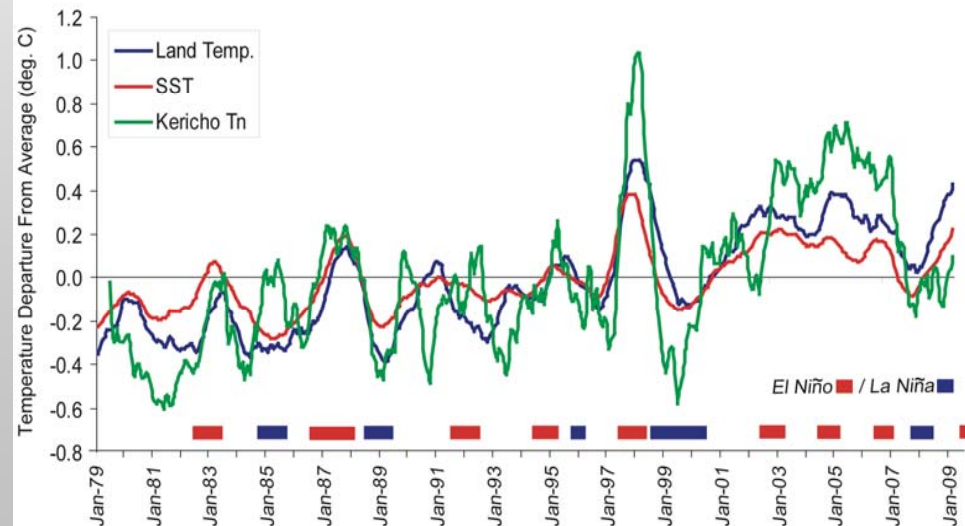
IRI's strategy for the health sector involves building partnerships between national climate services and global health policy in support of data-driven decision making for climate sensitive disease control.

Temperature is a key determinant of malaria transmission.

Using national climate data, we have shown that temperatures in the tea estates of Kericho have been rising by $\approx 0.2^{\circ}\text{C}$ per decade since 1979.

This has important implications for the emergence of malaria in highland regions.

Global climate processes, *eg.* Tropical SSTs are also shown to have varied around the same warming trend as minimum temperatures around Kericho.



Land temp., SST and temp. in the tea estates of Kericho, Kenya



Extracting Useful Information from Daily GCM Rainfall for Cropping System Modeling

Amor VM Ines and James W Hansen

International Research Institute for Climate and Society (IRI)

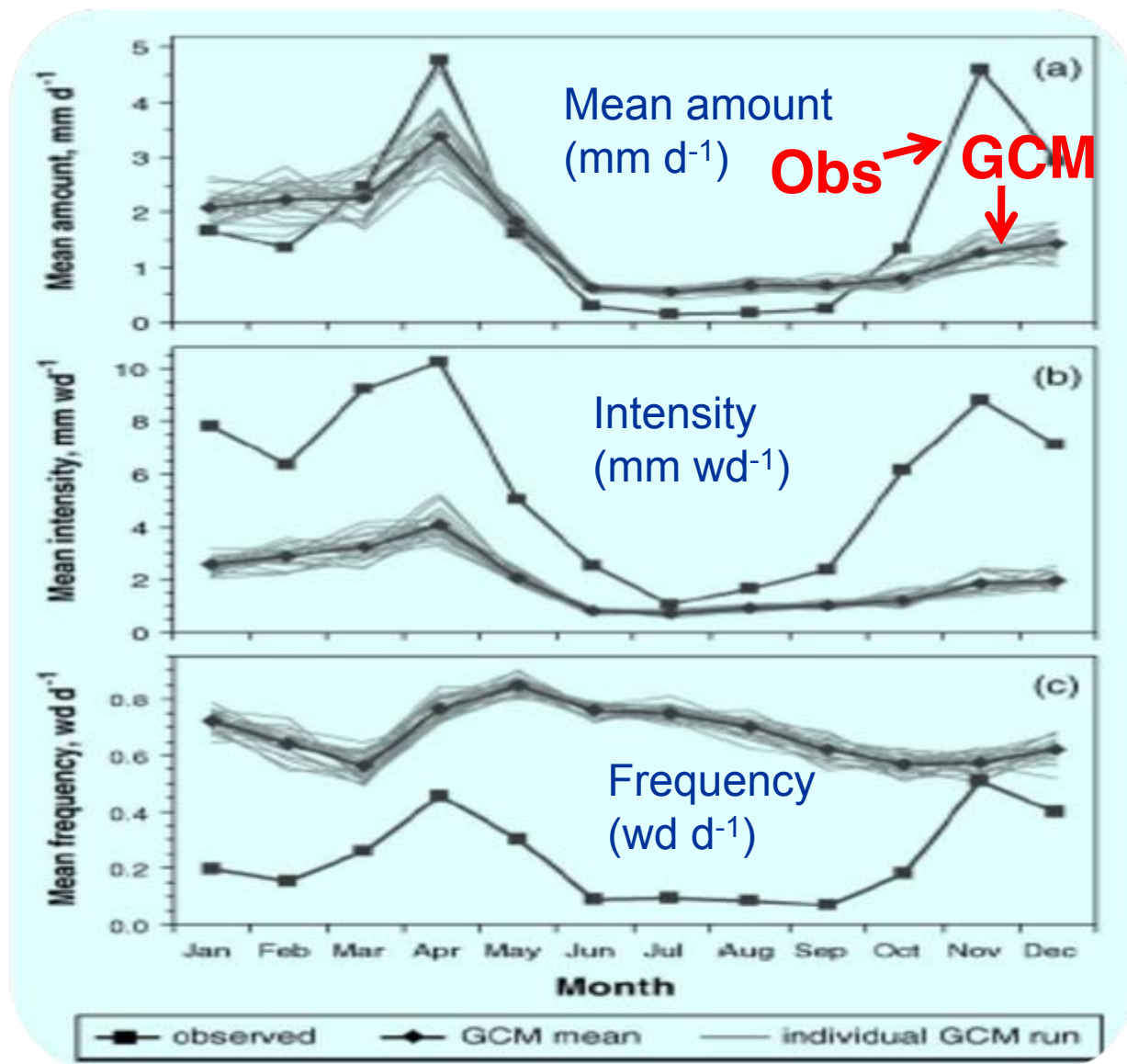
The Earth Institute at **Columbia University**, New York

USA





GCM Rainfall vs. Observed Rainfall



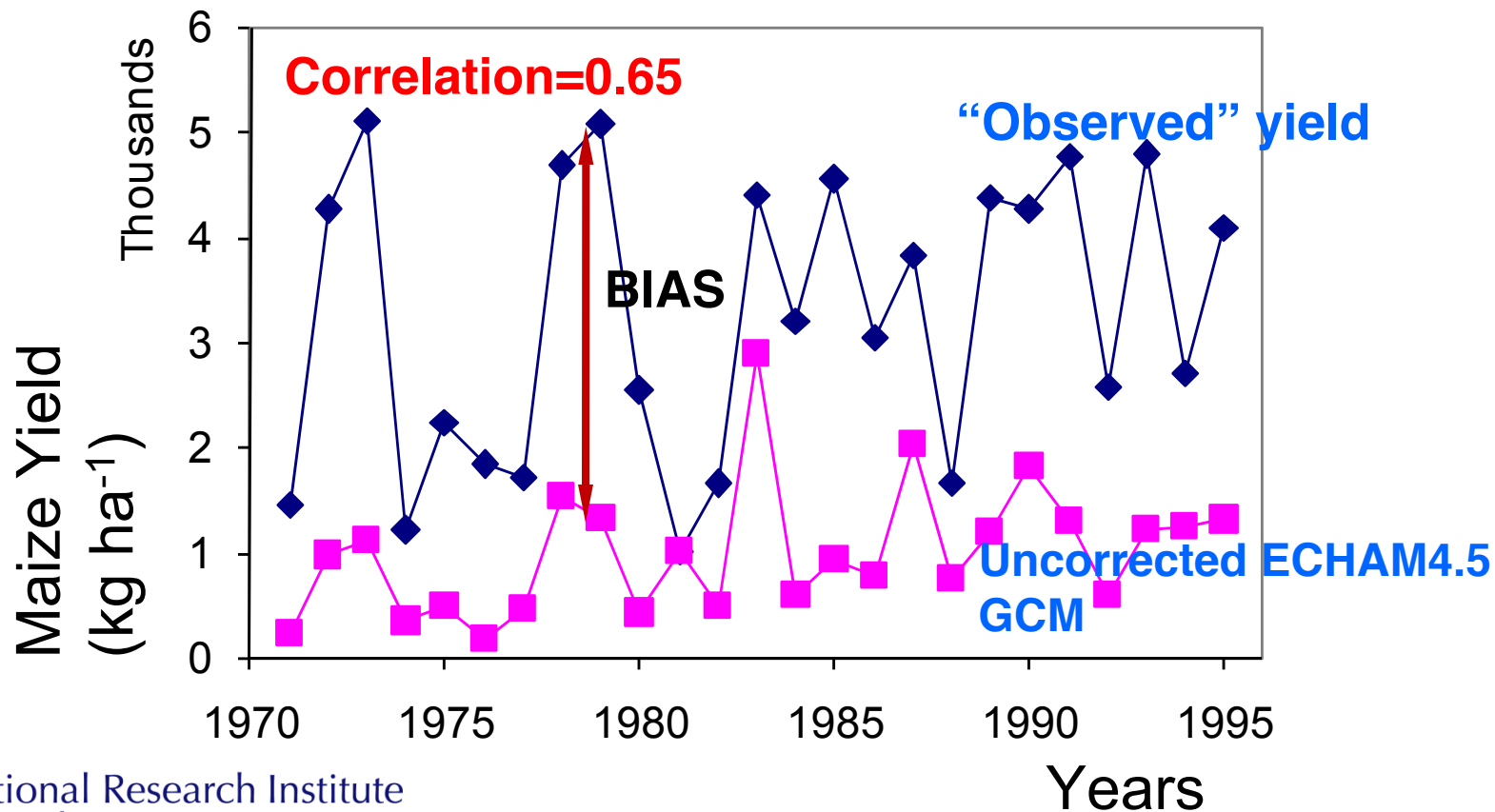


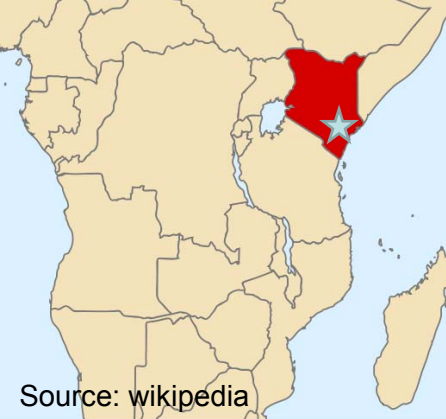
Weather within Climate Hypothesis



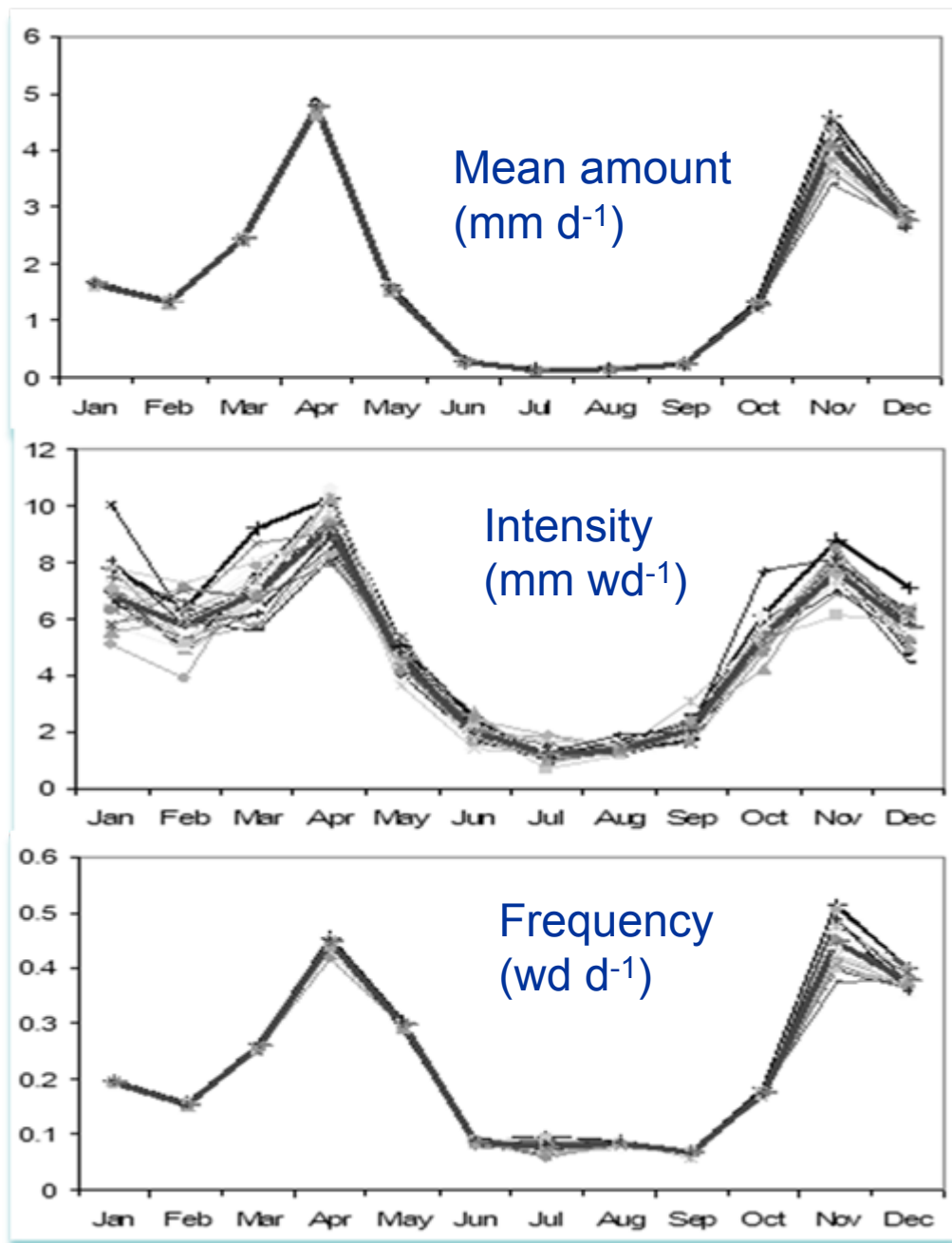
Machakos Southern Province, Katumani, Kenya

Cropping season: Oct-Feb (Maize crop)

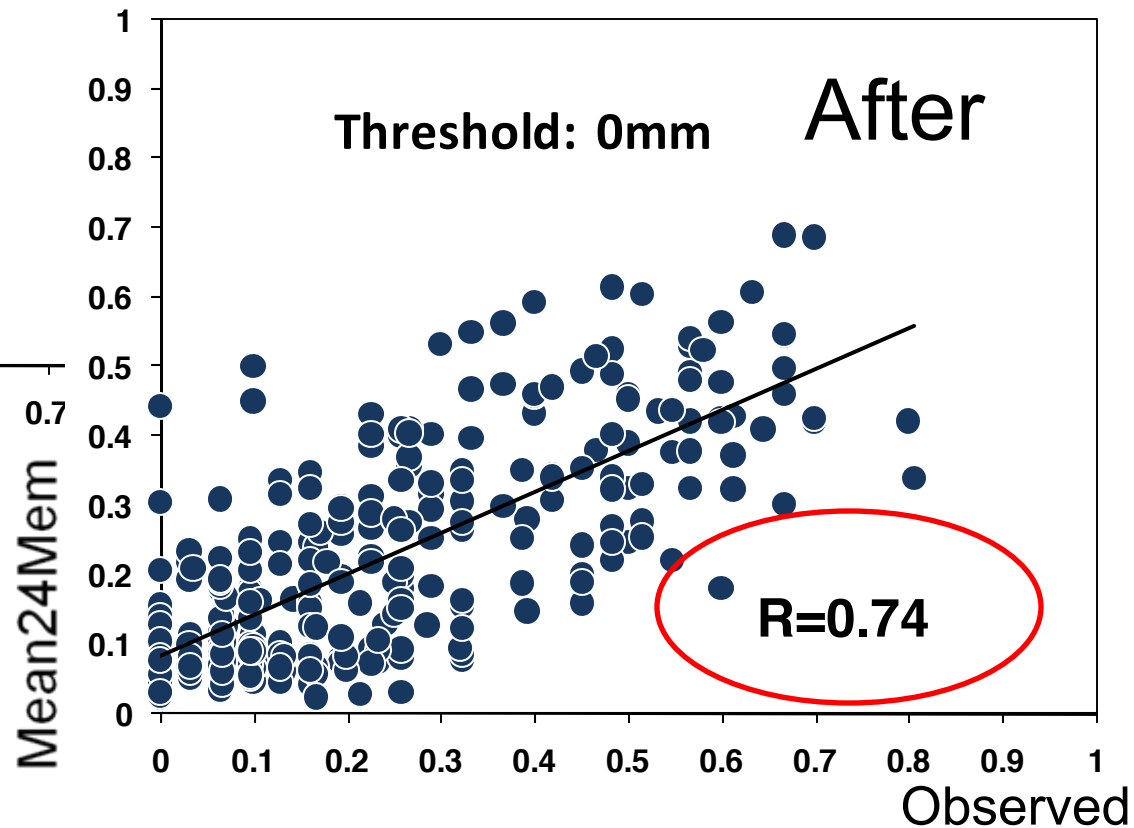
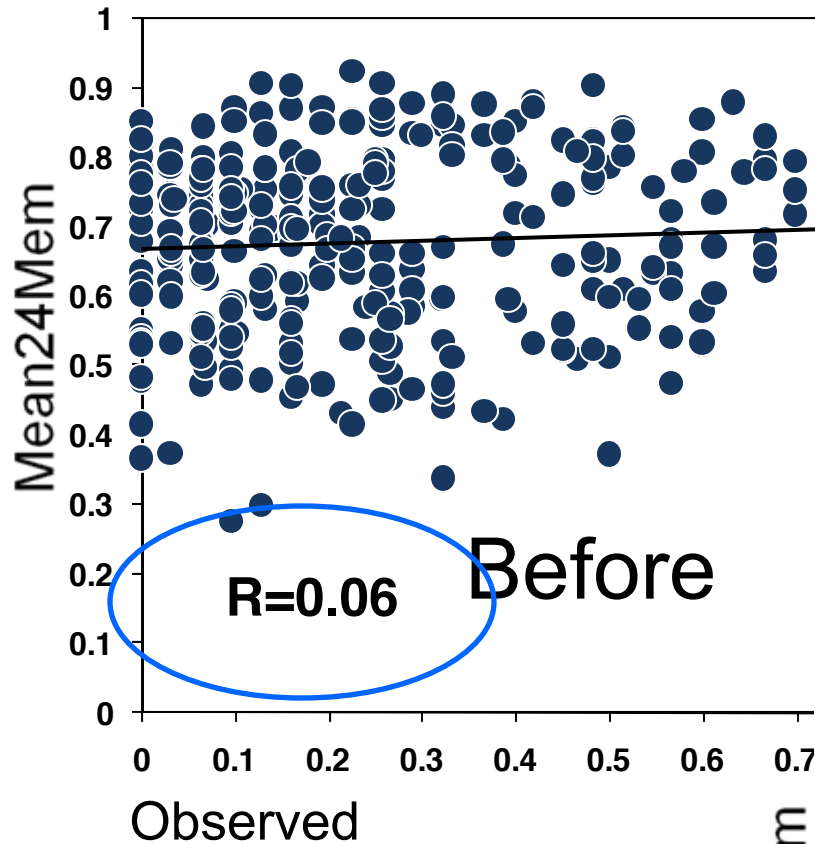




BC-GCM Rainfall vs. Observed Rainfall



Corrected Monthly Rainfall Frequency after BC





THE EARTH INSTITUTE
COLUMBIA UNIVERSITY



A 30-year High-Resolution Model Reanalysis of Dust and Climate for the Meningitis Belt

Carlos Pérez García-Pando

Earth Institute - NASA GISS - IRI

Collaborators:

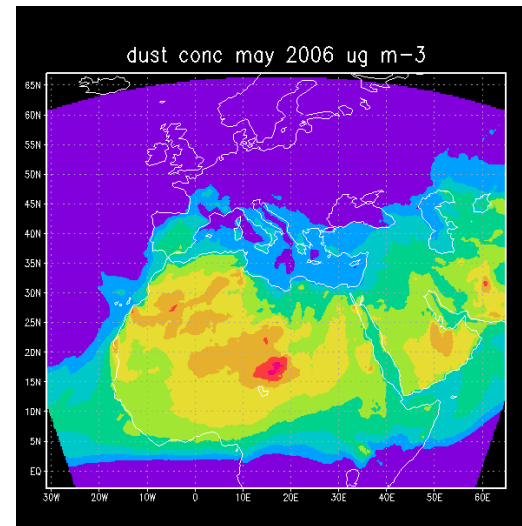
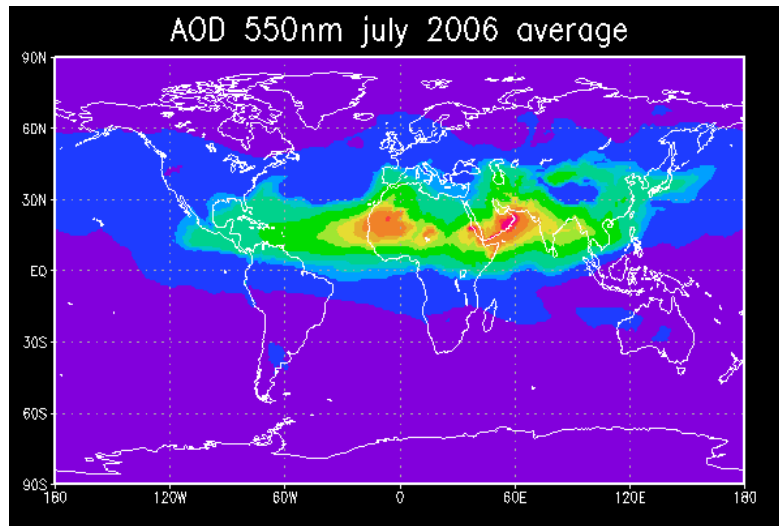
S. Trzaska, M. Thomson, P. Ceccato (IRI), M. Stanton, P. Diggle (CHICAS, U. of Lancaster), R.L. Miller, J. Perlwitz (GISS), S. Adamo, G. Yetman (CIESIN), K. Haustein, J.M. Baldasano (BSC-Spain), E. Cuevas, C. Camino (AEMET-Spain)

IRI Seminar

September 2, 2011

NCEP Nonhydrostatic *Multiscale* Model on B grid (NMM-b) (Zavisa Janjic)

- Further evolution of WRF NMM (Nonhydrostatic Mesoscale Model)
- Intended for wide range of spatial and temporal scales, from *meso to global*, and *from weather to climate*
- The *nonhydrostatic option* as an add-on nonhydrostatic module
- *Global lat-lon, regular grid* ; *Regional rotated lat-lon*
- *Arakawa B grid* (in contrast to the WRF-NMM E grid) and *Pressure-sigma hybrid*



NMMb/BSC-Dust (Pérez et al., 2011)

GOALS

- ✓ Common 'on-line' dust module for regional and global domains
- ✓ Global dust forecasts up to 7-8 days at sub-synoptic resolutions and nested regional domains at high resolution (5-10 km).
- ✓ Intermediate complexity dust emission scheme
- ✓ Include new high resolution databases for soil textures and vegetation fraction.
- ✓ Update deposition schemes
- ✓ Radiative feedbacks between dust and meteorology

MODEL AOD

MISR AOD

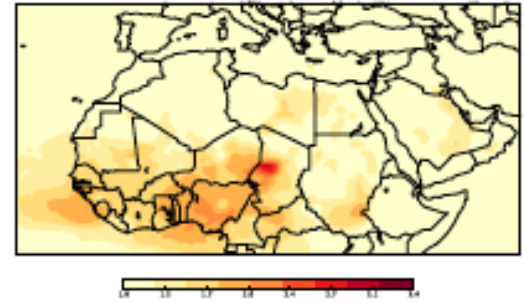
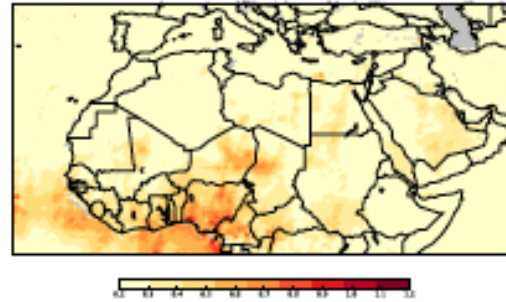
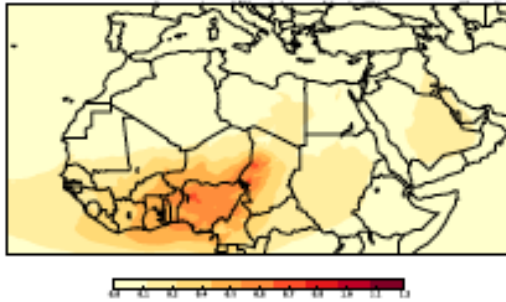
OMI AI

JAN-FEB-MARCH Modeled Dust Optical Depth at 550 nm

JAN-FEB-MARCH MISR Aerosol Optical Depth at 555 nm

JAN-FEB-MARCH OMI Aerosol Index

JFM

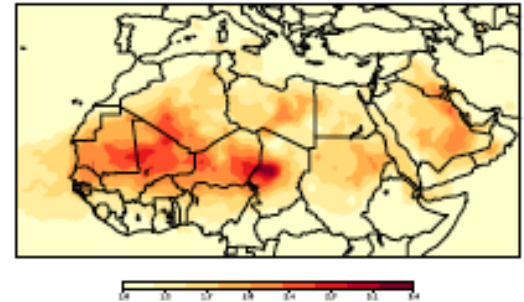
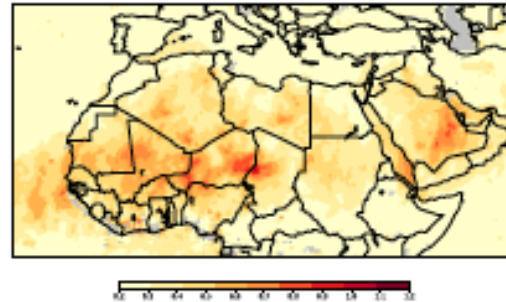
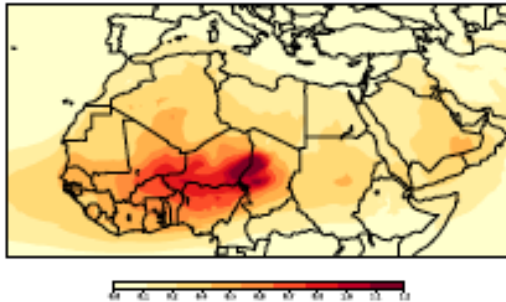


APRIL-MAY-JUNE Modeled Dust Optical Depth at 550 nm

APRIL-MAY-JUNE MISR Aerosol Optical Depth at 555 nm

APRIL-MAY-JUNE OMI Aerosol Index

AMJ

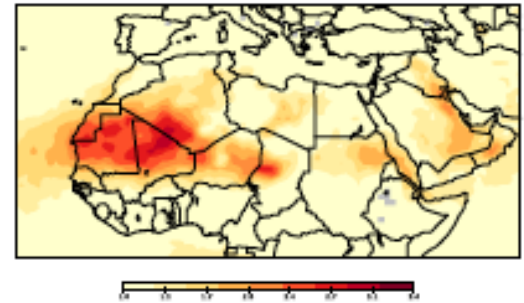
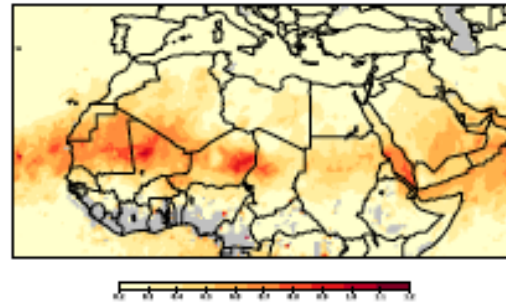
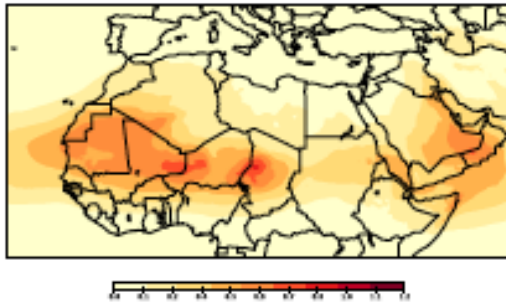


JULY-AUG-SEP Modeled Dust Optical Depth at 550 nm

JULY-AUG-SEP MISR Aerosol Optical Depth at 555 nm

JULY-AUG-SEP OMI Aerosol Index

JAS

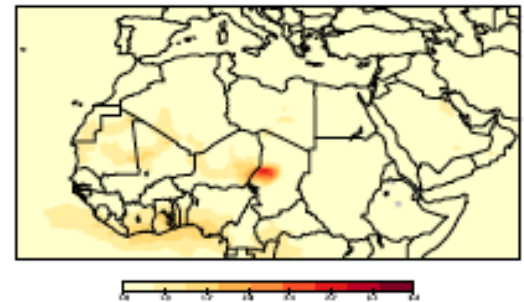
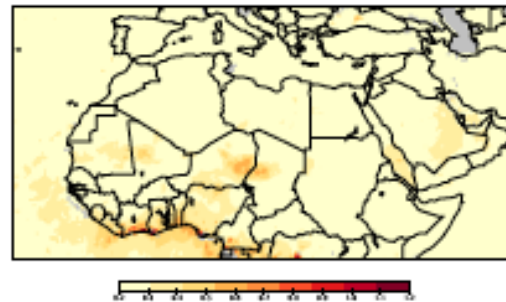
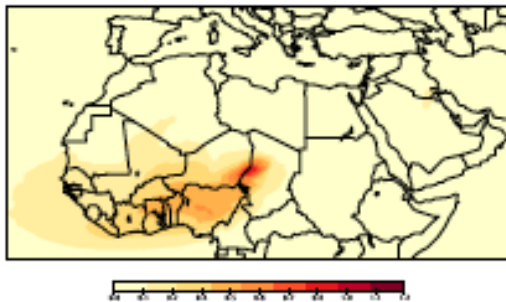


OCT-NOV-DEC Modeled Dust Optical Depth at 550 nm

OCT-NOV-DEC MISR Aerosol Optical Depth at 555 nm

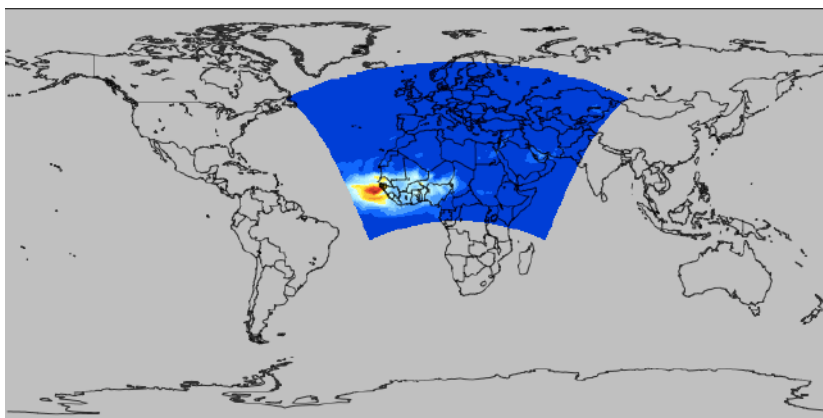
OCT-NOV-DEC OMI Aerosol Index

OND



Long-term integrations

- 2 regional simulations (NA-ME-EU domain):
 - 1979-2008 at 0.5x0.5 deg: boundaries and daily initial conditions with NCEP Reanalysis-2 data for atmosphere and GLDAS-1 for soil conditions (problems in GLDAS period 1995-1997)
 - 1985-2006 at 1x1 deg: boundaries and daily initial conditions with NCEP Reanalysis-1 data for atmosphere and GLDAS-2 for soil conditions



3 hourly output of climate
(humidity, temperature,
winds, precipitation and other)
and dust respirable
concentrations

Summary and preliminary) conclusions

- High resolution reanalysis of dust and climate available for meningitis studies and other applications
- The model developed reproduces satisfactorily the dust variability
- Differences in the seasonal cycle and interannual winter variability of dust concentration and dust optical in Niger -> implications for the use of satellite estimates
- Early season climate (temperature) and early cases explain up to 50% of the year-to-year variability of the seasonal national incidence
- Best district Poisson model achieves a pseudo-R² of 0.6 including population density, early cases (national and district), and early season climate (national and district)

Currently: testing other climate parameters at a district level and other model types (e.g. negative binomial model)

SESSION 4: Case study

IFRC flood preparedness in West Africa, 2008

OUTLINE

1. Background: the 2007 flood season

Overview of predictable losses

Capacity building at IFRC-Dakar

2. The seasonal forecast

“Probability of extreme rains is enhanced from 15% to between 40 and 50%”

3. Forecast-based disaster preparedness

Emergency appeal

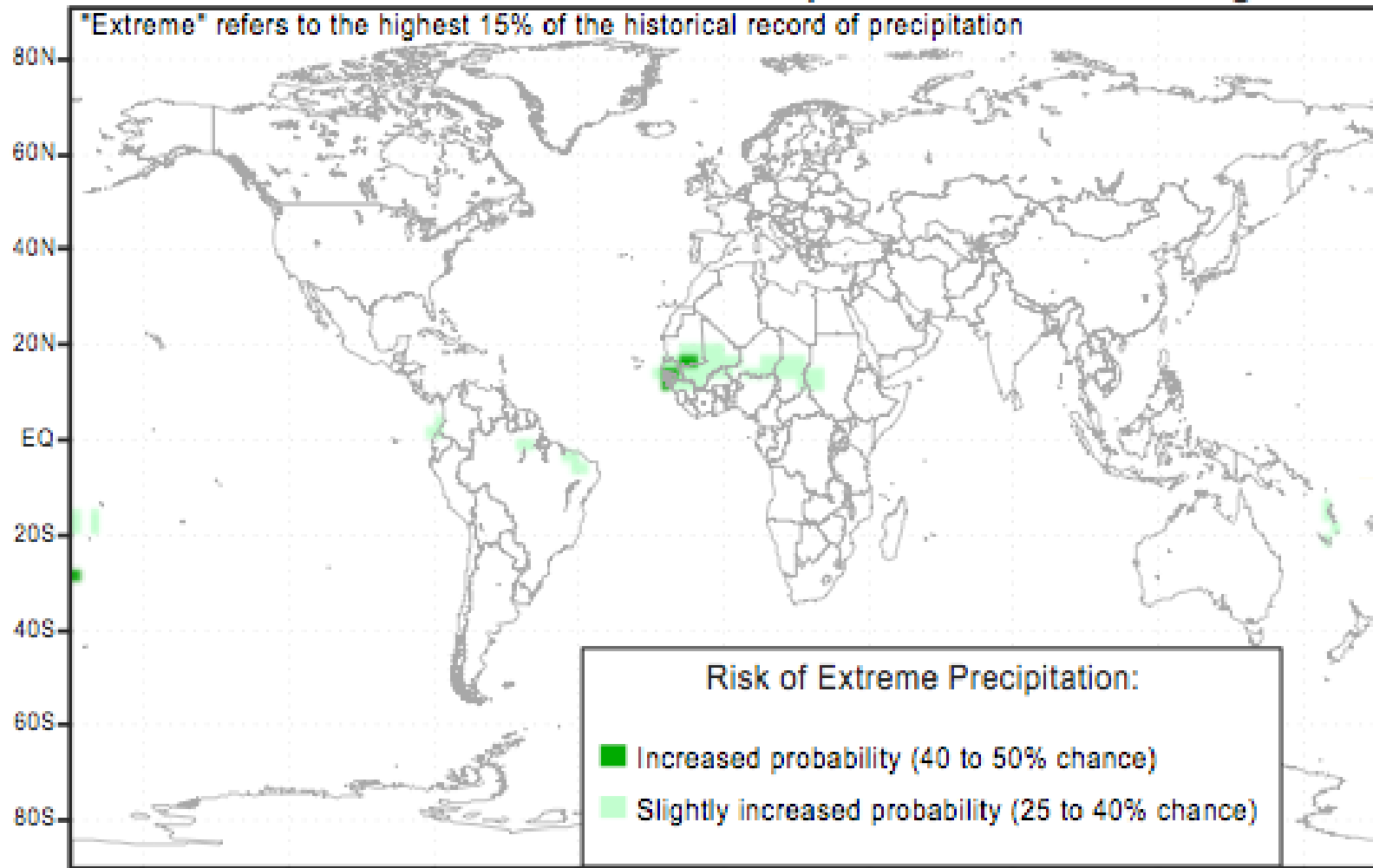
Donor response

Regional, national and local decisions

4. Results

Avoided losses

Seasonal Forecast of Extreme Precipitation for June-August 2008



Given what we know as of May 15 2008, we can say that, in the areas of West Africa highlighted in the map, there is an enhanced probability of extreme precipitation for the period June-August 2008. In other words, the probability of seeing precipitation that would rank in the top 15% of the historical record is now enhanced to between 40% and 50%.

Floods downstream of the Bagre dam (Burkina Faso)



2007

- Inadequate warnings
- 200,000 affected
- 30+ deaths

Recovery

- Integrate resilience
- Model flood-resistant homes
- Dialogue with Met Agencies

2008

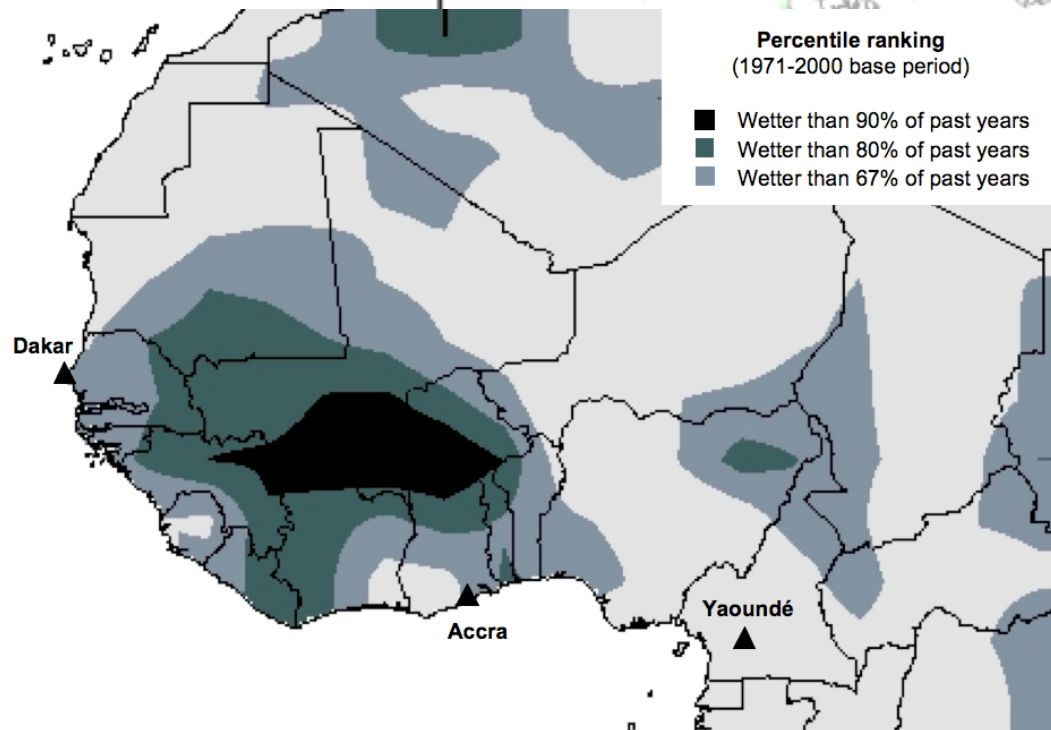
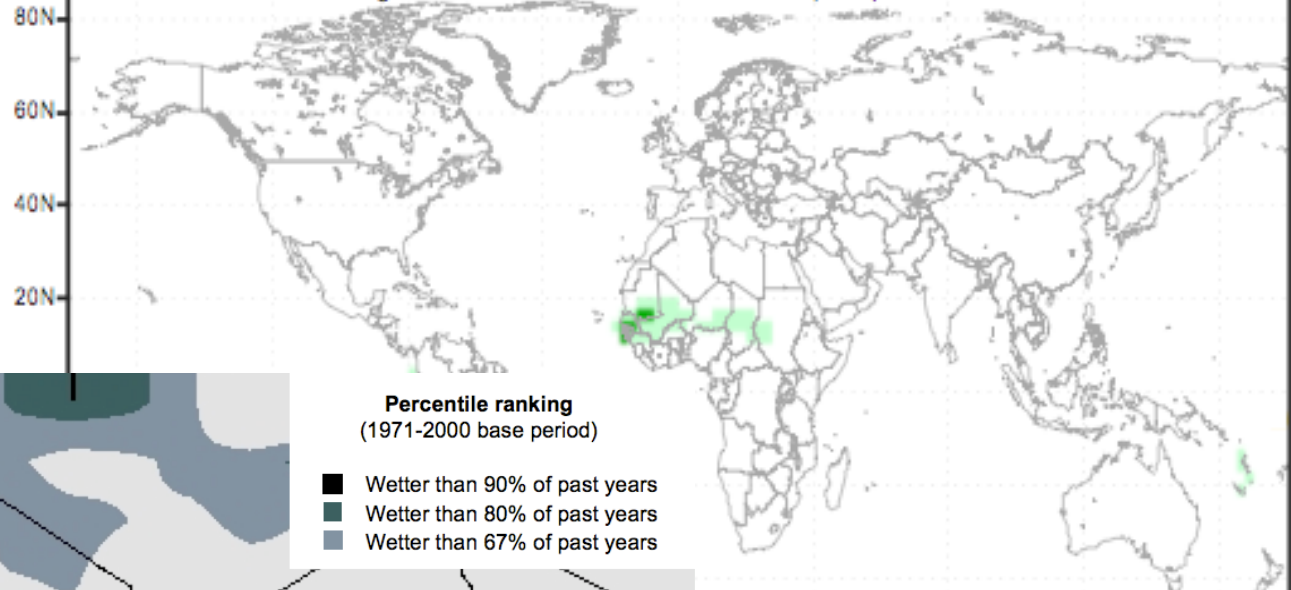
- Bi-country mgmt of dam
- RC community warnings
- Only 2 deaths

Key elements of West Africa success story



Seasonal Forecast of Extreme Precipitation for June-August 2008

Extreme refers to the highest 15% of the historical record of precipitation



Risk of Extreme Precipitation:

Increased probability (40 to 50% chance)

Increased probability (25 to 40% chance)

IFRC-IRI Precipitation Map Room

International Research Institute for Climate and Society

Instructions for Use of this Tool

What Would You Like to Know?

Forecasts for the Next 6 Days

☐ How much rain is expected cumulatively?

☐ Where is it expected to be wetter than average?

☒ Where is unusually heavy rainfall expected?

☐ How heavy is the rainfall expected to be?

Forecasts for the Next 3 Months

☐ Are the next 3 months likely to be unusually wet or dry?

☐ Are the next 3 months likely to be exceptionally wet or dry?

☐ Is it likely that unusually wet or dry conditions will continue?

☐ Is it likely that unusually wet or dry conditions will end?

Historical Conditions

☐ How much rain normally falls at this time of year?

Vulnerability Indicators

☐ Are the areas at risk of heavy rainfall densely populated?

☐ Are the areas at risk of heavy rainfall inhabited by vulnerable populations?

Precipitation Forecast in Context Map Tool

Forecast Start Time: 0000 16 Nov 2010 0000 15 Nov 2010

76.25N 66.25S 170.75E 170.75E

Forecast for 16-21 Nov 2010 issued 0000 16 Nov 2010

Where is unusually heavy rainfall expected?

This map shows areas where cumulative rainfall (or snow) over the next six days is expected to be unusually heavy. The blue areas are where the total 6-day rainfall is expected to be unusually heavy. The darkest blue shading indicates areas expected to be exceptionally wet for this location.

This forecast shows rain over large areas only, and should not be used to forecast cyclone tracks, local rainfall, or as a flood forecast. The map does not distinguish areas where rainfall is expected from areas where snow is expected. Forecasts for the amount of snow are indicated in terms of the equivalent amount of rainfall, so the actual depth of snow would be considerably more than indicated. The forecast data are courtesy of the NOAA ESRL Reforecast project. [\(more information\)](#)

Single-Day (24-Hour) Total Precipitation Forecast Maps

Day 1 Precipitation Forecast Maps	Day 2 Precipitation Forecast Maps	Day 3 Precipitation Forecast Maps	Day 4 Precipitation Forecast Maps	Day 5 Precipitation Forecast Maps	Day 6 Precipitation Forecast Maps
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Single-Day (24-Hour) Total Precipitation Forecast Maps

Day 1 Precipitation Forecast Maps	Day 2 Precipitation Forecast Maps	Day 3 Precipitation Forecast Maps	Day 4 Precipitation Forecast Maps	Day 5 Precipitation Forecast Maps	Day 6 Precipitation Forecast Maps
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Dataset Documentation

Description:

- This tool provides various measures of the relative severity of forecast precipitation events for the globe for 1 to 6 days in advance by comparing the current forecast amounts with those made over a 25 year period (1979 to 2004).
- The tool also provides probabilistic seasonal forecasts of precipitation for the globe, including "predictions in context" (PIC) maps which show regions of the globe which have experienced unusually wet or dry conditions, and where the seasonal forecast indicates an enhanced probability for the continuation or reversal of these conditions in the coming season.
- A map of climatological monthly precipitation is provided as a reference indicating "normal" precipitation totals for each month of the year.
- Population and poverty maps are also provided to allow for the examination of the relative exposure to weather events and seasonal precipitation fluctuations.

How to Use this Map Tool

Datasets:

ESRL GFS Six-Day and Daily Precipitation Forecast Maps

Data: Daily ensemble-mean forecast precipitation totals at 2.5° latlon resolution from the Medium Range Forecast (MRF/GFS) model run daily at 00 UTC by the NOAA ESRL PSD Reforecast project.

Data Source: U.S. National Oceanic and Atmospheric Administration (NOAA), Earth System Research Laboratory (ESRL), Physical Sciences Division (PSD), [ESRL GFS Reanalysis Project](#).

Analysis: Analyses shown here include forecast daily (days 1-6) and six-day precipitation totals, forecast daily and six-day total precipitation anomalies from the 1979-2004 mean, forecast daily and six-day total precipitation as percent of mean monthly total precipitation (1979-2004 base period), and forecast daily and six-day total precipitation percentiles (1979-2004 base period).

IRI Seasonal Precipitation Forecast

Data: Dominant tercile probabilities for seasonal (3-month) precipitation for the first lead time from the IRI Net Assessment Forecast, issued every month at 2.5° latlon resolution.

Data Source: International Research Institute for Climate and Society, [Net Assessment Forecasts](#), [Map Room Forecast page](#), [Data Library](#).

IRI Predictions in Context (PIC)

Data: Forecast data: Dominant tercile probabilities for seasonal (3-month) precipitation for the first lead time from the IRI Net Assessment Forecast, issued every month at 2.5° latlon resolution. Observational data: CAMS-ORI monthly observed precipitation gridded at 2.5° latlon resolution.

Data Source: Analysis data: International Research Institute for Climate and Society, [Predictions in Context](#), [Map Room PIC page](#), [Data Library](#); Forecast data: International Research Institute for Climate and Society, [Net Assessment Forecasts](#), [Map Room Forecast page](#), [Data Library](#); Observational data: NOAA, Climate Prediction Center, [CAMS-ORI Precipitation](#).

Analysis: Shaded areas on the "Same Tendency" map indicate locations where the IRI Net Assessment seasonal precipitation forecast for the next 3-month season shows an enhanced likelihood of above-normal (below-normal) precipitation AND where precipitation received in the 3-month season before the forecast was issued was also above-normal (below-normal). I.e., the forecast has the same tendency as the previously observed precipitation. The "Reversed Tendency" map shows locations where the IRI Net Assessment seasonal precipitation forecast for the next 3-month season indicates an enhanced likelihood of above-normal (below-normal) precipitation AND where precipitation received in the 3-month season before the forecast was issued was below-normal (above-normal). I.e., the forecast has the opposite tendency from the previously observed precipitation.

CPC Merged Analysis of Precipitation Monthly Climatology

Data: CPC Merged Analysis of Precipitation (CMAP) v0703 (March 2007 release) version 2 (merged gauge and satellite estimates) monthly precipitation values at 2.5° latlon resolution.

Analysis: Monthly precipitation climatology using 1979-2004 base period.

Data Source: NOAA, Climate Prediction Center, [CMAP](#).

CESR/SEDAC GPWv3 Year 2005 Projected U.N.-Adjusted Population Counts

Data: Number of persons per 2.5 arc-minute grid box, projected for the year 2005, based upon national statistical office estimates.

Climate information for Public Health

Madeleine Thomson, Stephen Connor



- Understanding of disease transmission mechanisms
- Estimating current populations at risk
 - in geographic space
 - by season
- Predicting changes in risk from season to season (including epidemics)
- Monitoring and predicting long term trends
- Improving the measurement of climate sensitive MDG interventions



PAHO/WHO Collaborating Centre on early warning systems for malaria and other climate sensitive diseases

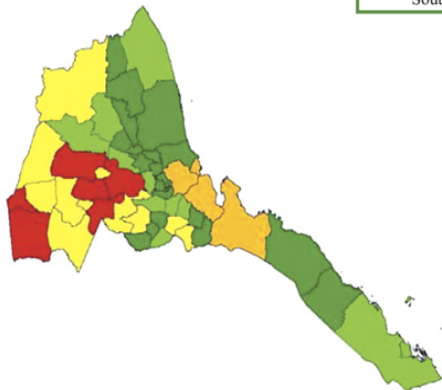
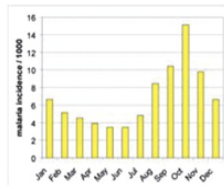
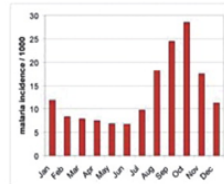


Estimating current populations at risk – in geographic space & by season

Climate – rainfall and temperature is a major determinant of spatial - seasonal risk of malaria

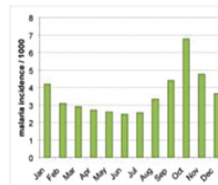
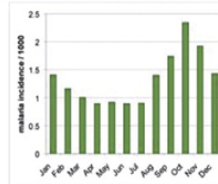
4. High incidence (Oct peak)

- Average 6.8 to 28.5 cases/1000/month
- Clear seasonal peak in October
- Includes most subzobas of Gash Barka.



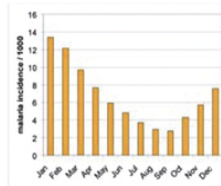
1. Very low incidence year around (Oct peak)

- Average 0.9 to 2.3 cases/1000/month
- Peak incidence in October with second smaller peak in January
- Includes central Northern Red Sea subzobas, most Debub higher altitude subzobas, Asmara city and central subzobas of Southern Red Sea.



3. Moderate incidence West (Oct peak)

- Average 3.5 to 15.1 cases/1000/month
- Clear seasonal peak in October
- Includes some subzobas in Gash Barka and subzobas on the western escarpment in Anseba and Debub.



2. Low incidence year around (Oct peak)

- Average 2.5 to 6.8 cases/1000/month
- Peak incidence in October with second smaller peak in January
- Includes some western escarpment subzobas of Anseba and Debub as well as extreme northern and southern coastal subzobas.

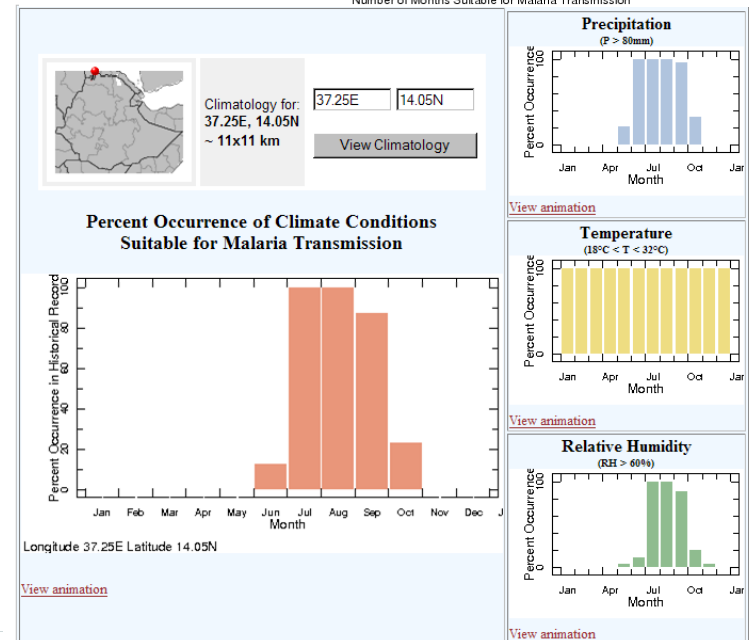
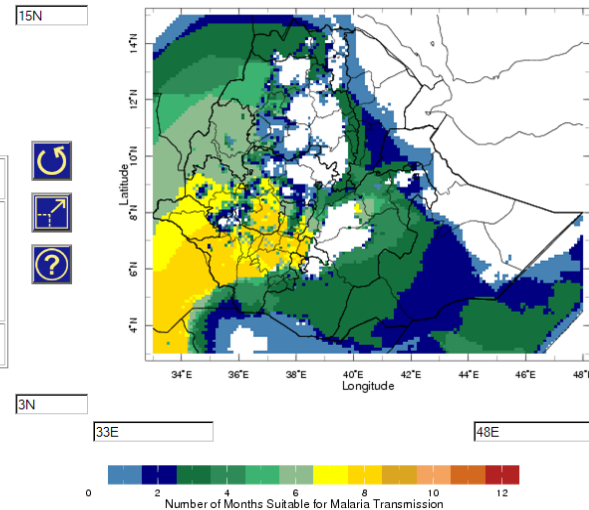
5. Moderate incidence East (Jan peak)

- Average 2.7 to 13.4 cases/1000/month
- One clear peak in January
- Four subzobas in south Northern Red Sea only.

Ceccato et al., (2006)
Am. Soc Trop Med & Hyg

Optional Overlay Maps

- Boundaries
 - ☐ Coasts
 - ☒ Countries
 - ☒ Regions
 - ☒ Zones
 - ☐ Woredas
- Epidemiological
 - ☐ Mask

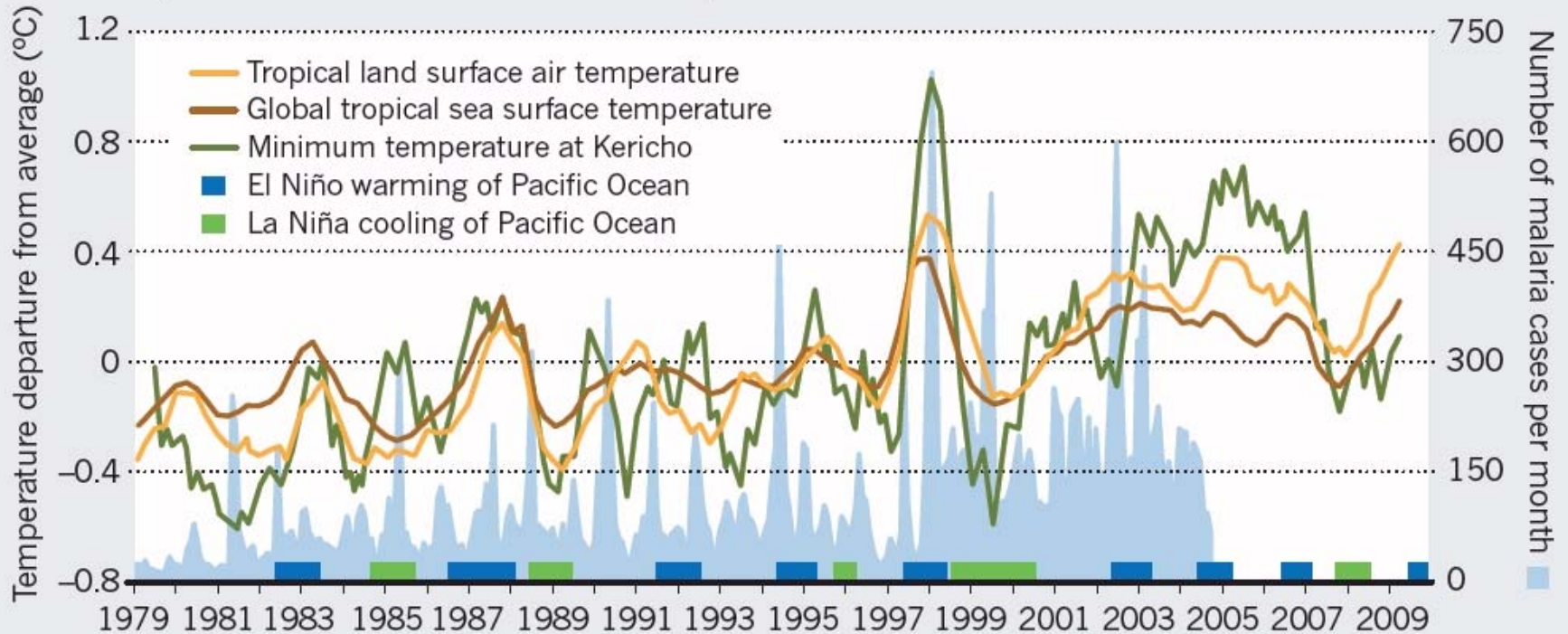


Monitoring and predicting long term trends



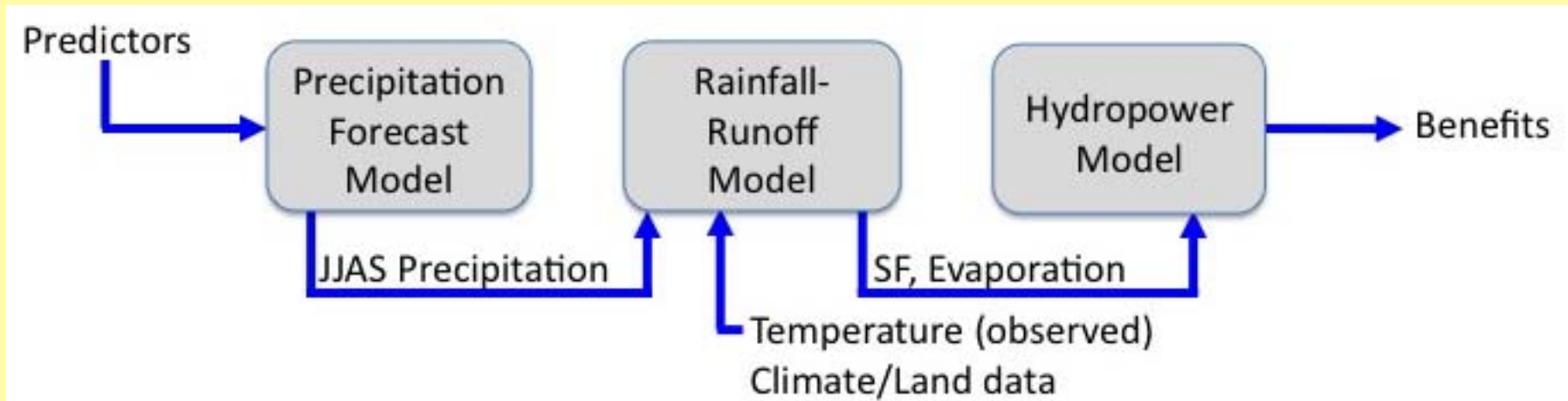
GOING UP

Malaria incidence and temperatures have risen near Kericho in Kenya over the past 30 years; health experts are keen to know whether they are linked.



Blue Nile Basin, Ethiopia

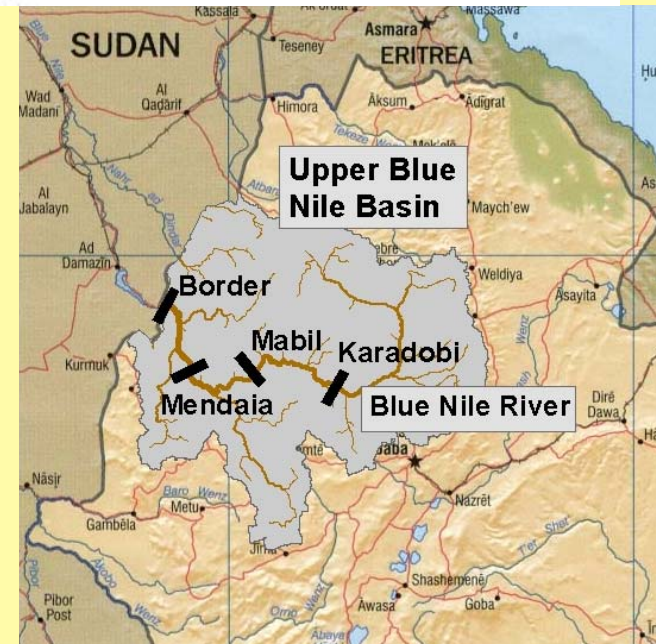
Multi-model streamflow forecasting for hydropower management



Precipitation forecast model = Statistical + CFS

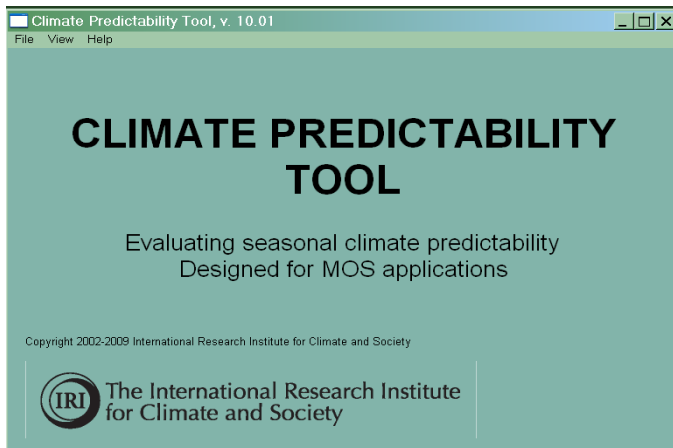
Select precipitation probability of exceedance levels to address manager's risk

Assess hydropower benefits and reliability, compared with no forecast



What is CPT?

Climate Predictability Tool (CPT) is an easy-to-use software package for making tailored seasonal climate forecasts.



Versions:

- Windows 95+ 
- Batch
- Generic GUI version (under development)

DILBERT by Scott Adams



Why CPT?

CPT was developed to address some problems in producing seasonal climate forecasts at a number of the RCOFs:



Slow production time - expensive pre-forum workshops expensive, and limited availability of monthly updates;

Artificial skill, and lack of vigorous performance evaluation;

Minimal consideration of global products.

CPT Use

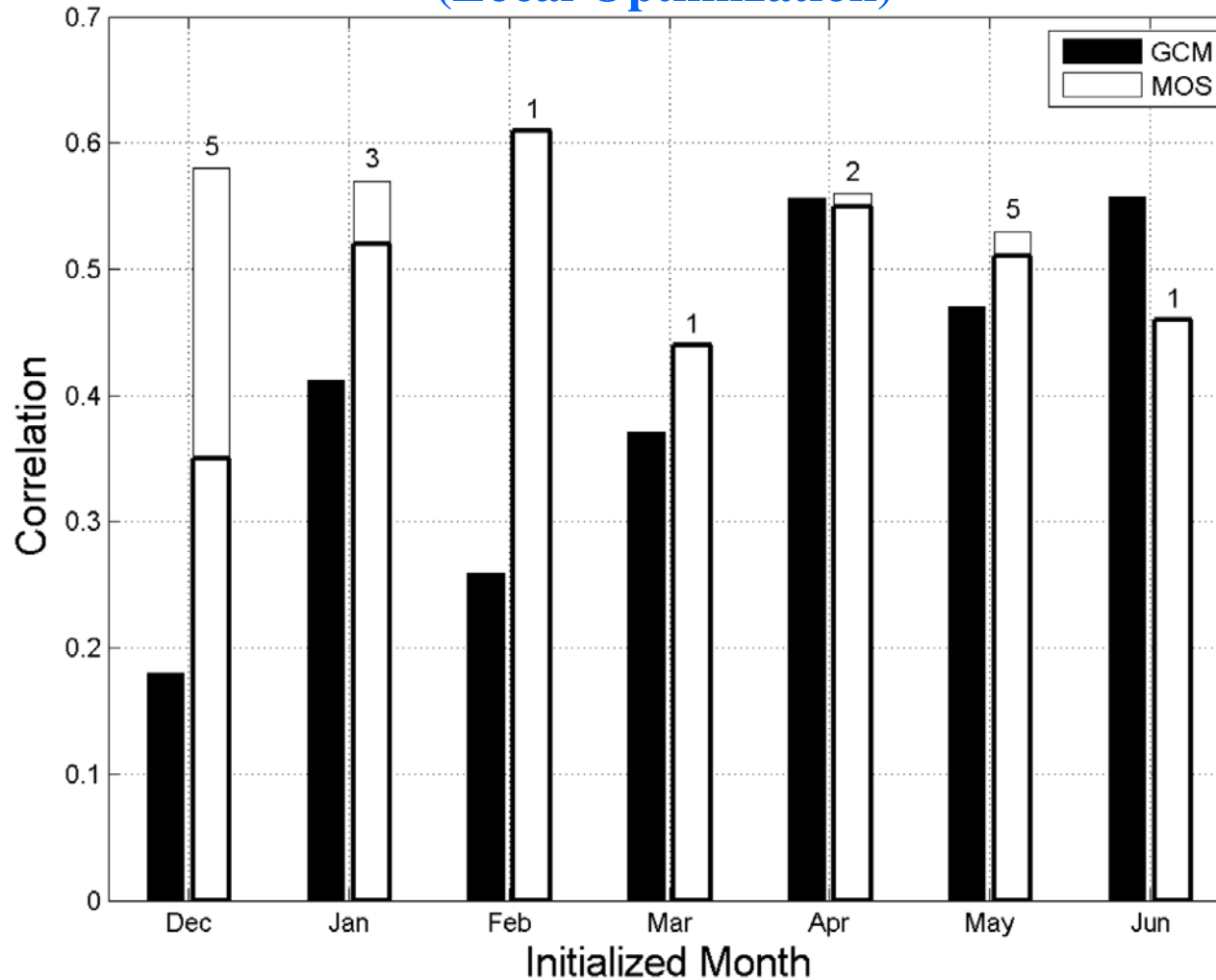
CPT downloads (circles) and known CPT courses (triangles) from 2003 to 2009



CFS JAS Precipitation Correlation Sahel 1981-2008

from raw forecast and MOS correction

(Local Optimization)



Raw CFS skill (shaded bar) MOS skill with one EOF (open)

Materials accepted in Journal of Climate, Ndiaye et al.

IRI's 2-Tiered Climate Forecasting System in 2010

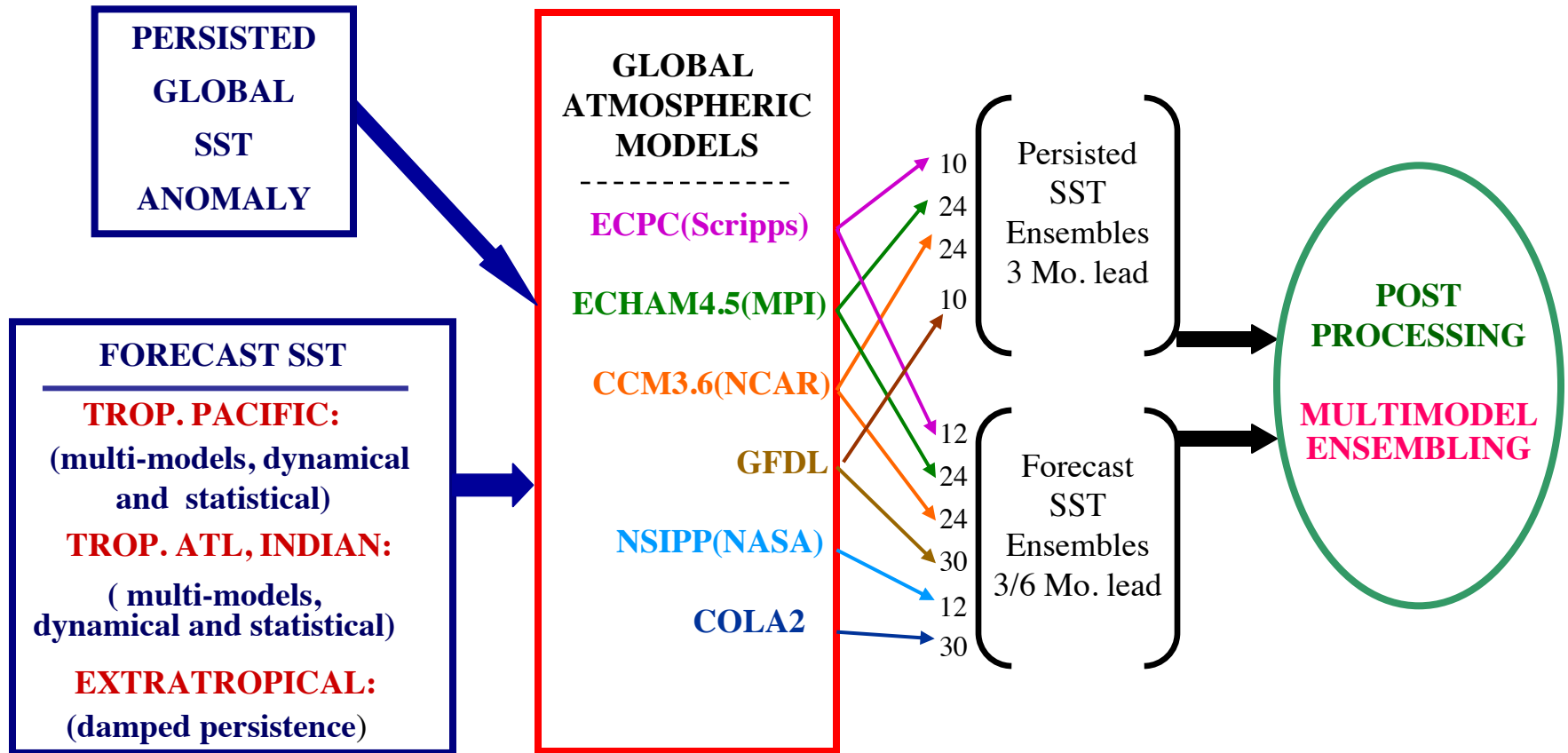


IRI DYNAMICAL CLIMATE FORECAST SYSTEM

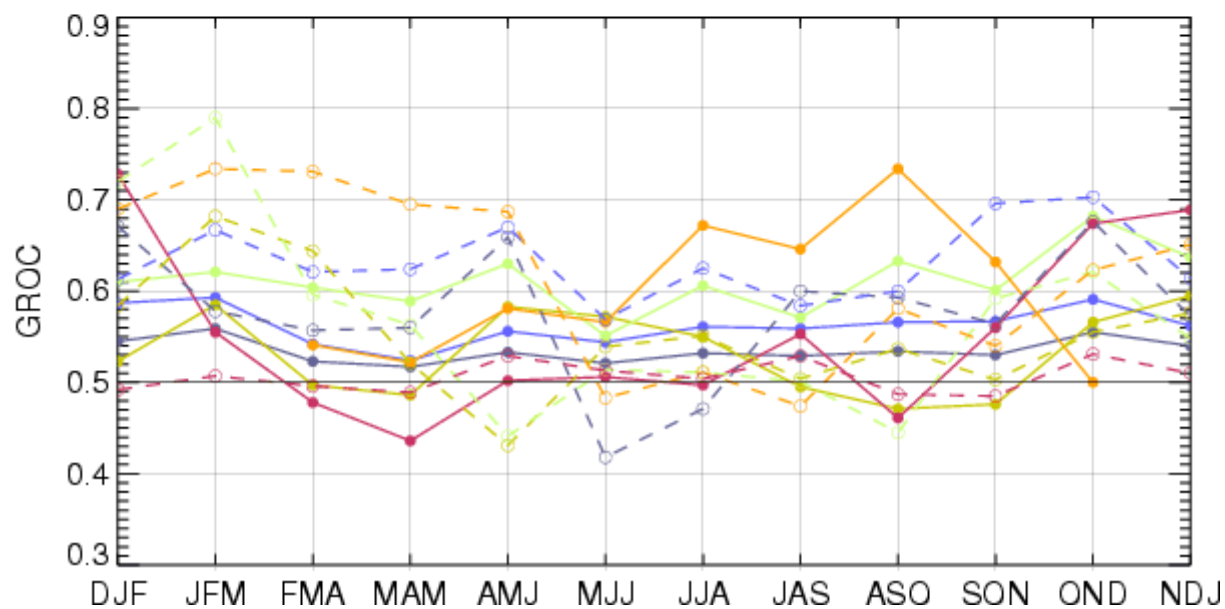
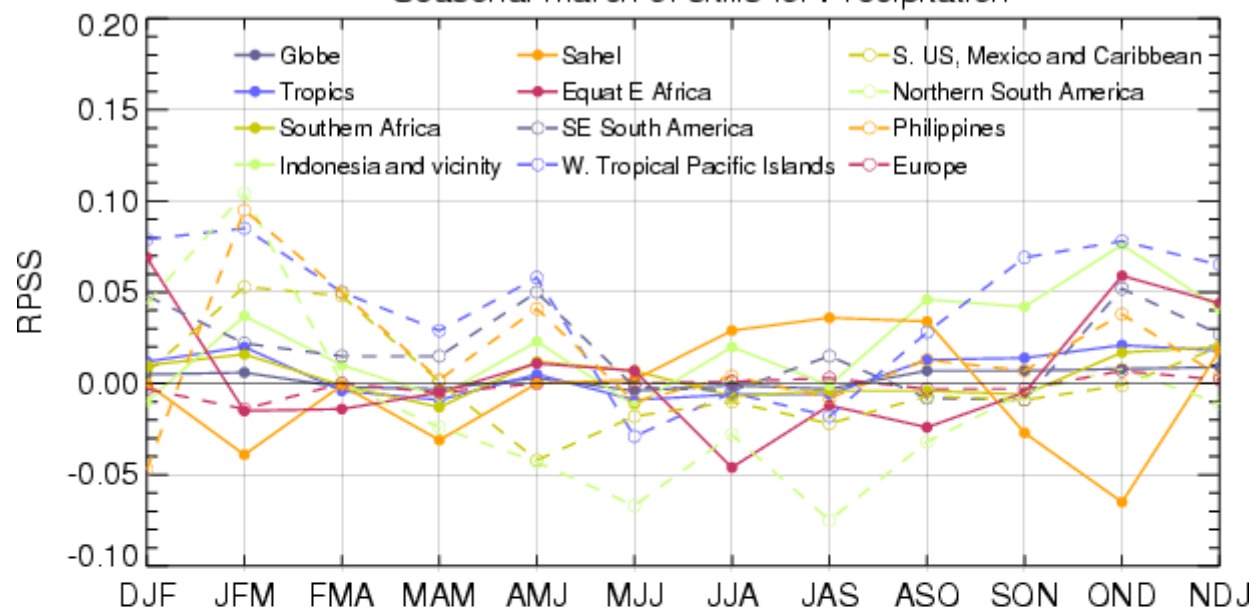
2-tiered

OCEAN

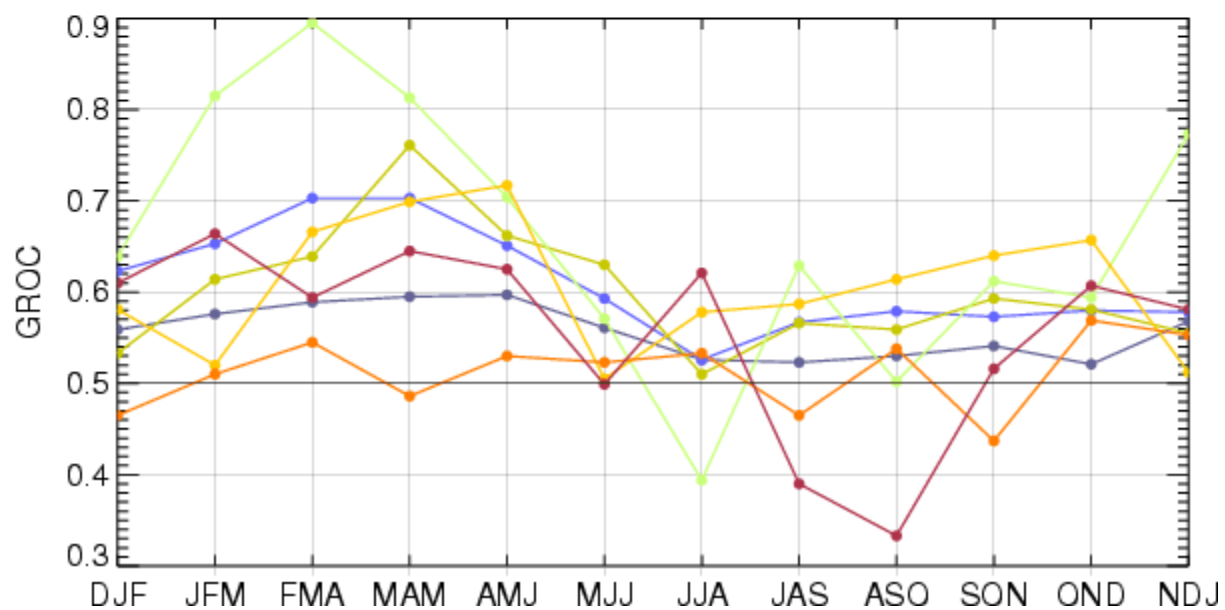
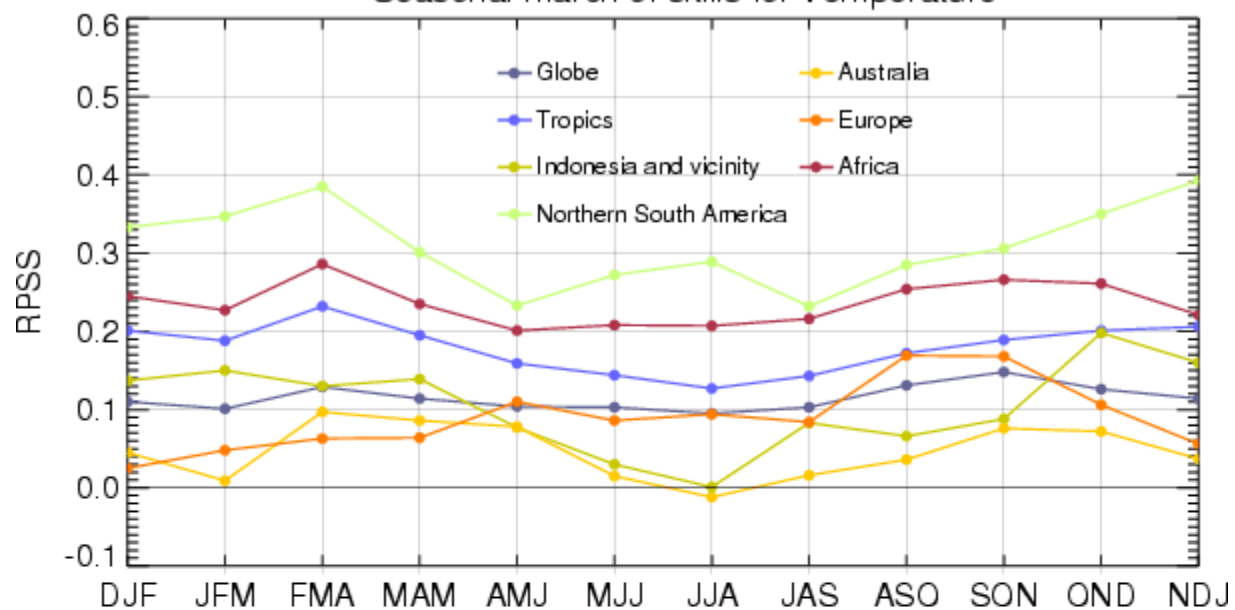
ATMOSPHERE



Seasonal march of skills for Precipitation



Seasonal march of skills for Temperature



Brad Lyon: Obs. Trend Analyses

Has there been an upward trend in Temperature in the Highlands of Kenya?

