The DFID-Met Office Hadley Centre Climate Science Research Partnership (CSRP)

Richard Graham (Met Office Hadley Centre)

Acknowledgements:

Met Office: Cath Senior, Adam Scaife, Richard Jones, Peter Stott, David Parker, Dave Rowell, Michael Vellinga, Wilfran Moufouma-Okia, Caroline Bain, Fraser Lott, Nikos Christidis, Lizzie Good, Ruth Comer, Andrew Colman, Jeff Knight, Martin Andrews

AMMA 4th IM, Toulouse, 6 July 2012

http://www.metoffice.gov.uk/csrp/

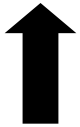
CSRP: Project Goal and Purpose

Goal:

Vulnerable societies and decision makers in developing countries to follow climate resilient development pathways

Purpose:

Improved *knowledge* and climate science *capacity* provides robust evidence on current and likely future climate conditions, for *use* by decision makers in Africa.



Science and Capacity Building outputs

CSRP: climate and modelling research, applications, capacity building – Africa

3-year programme, started January 2010

Initial consultation with African users of climate predictions

- To determine priority prediction and capacity building needs

Science component:

1. **Improved understanding and modelling of drivers of African climate – remote (e.g. ENSO), local (e.g. soil moisture); (C. Senior)**
2. **Develop 'seamless' monthly-decadal system, trial new 'user-driven' predictions, monitoring and 'attribution'; (A. Scaife)**
3. **Regional Climate Model downscaling – towards higher spatial detail in forecasts (PRECIS); (R. Jones)**

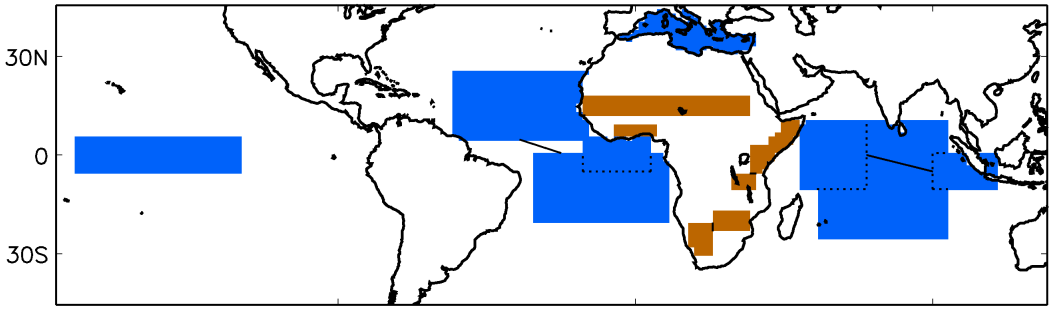
Capacity building component: (R. Graham)

4. **CSRP Fellowship scheme**: 11 fellows appointed;
5. **Workshops:** Capacity building workshops in climate science

Outputs 1: Improved understanding and modelling

How well do models used in IPCC's AR4 represent observed correlations between large-scale sea-surface temperature (SST) and African seasonal rainfall?

Rainfall and SST Areas



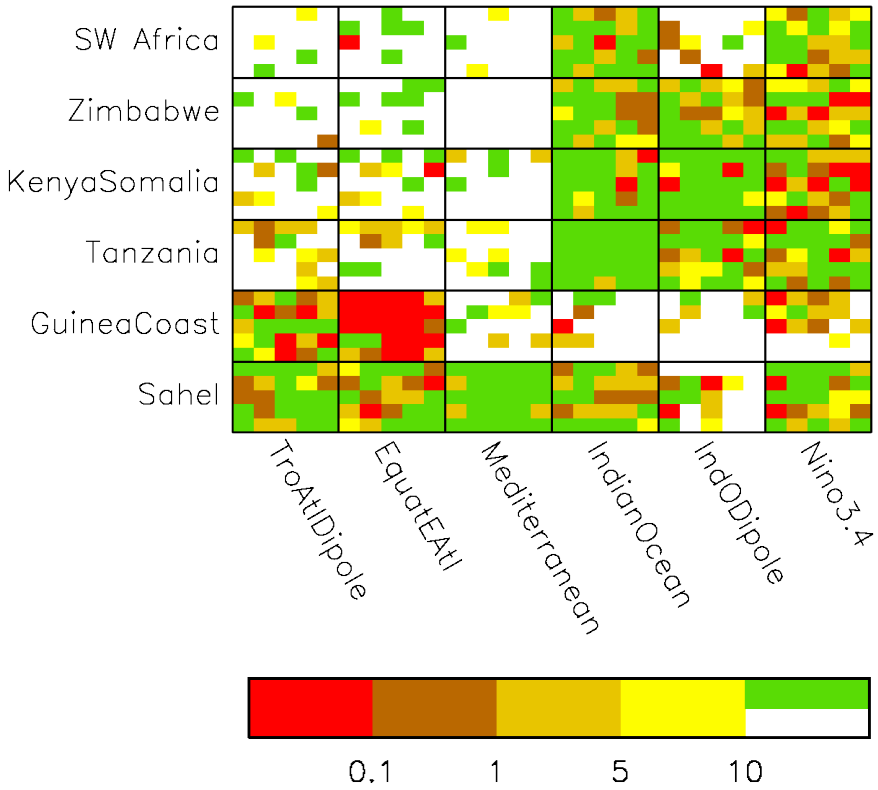
Rainfall regions defined such that interannual anomalies are spatially homogeneous and temporally homogeneous (month-to-month)

1) **Compute timeseries of area-average rainfall for 6 regions over Africa:** Sahel (JAS), Guinea Coast (JAS), Kenya-Somalia (OND), Tanzania (OND), Zimbabwe (ND), SW.Africa (DJF)
2) **Compute timeseries of area-average SST or SST dipoles for 6 tropical regions for each of the above seasons**: Tropical Atlantic Dipole, Equatorial Atlantic, Mediterranean, Central Indian Ocean, Indian Ocean Dipole, Nino3.4
3) **Do this with data from: Observations (CRU3.1 and HadISST1.1) and 25 coupled models**

Dave Rowell

Are Some Teleconnections Easier to Model than Others?

Skill of Model Teleconnections



Skill Indicator: Significance level for rejection of a null hypothesis that model and observed SST-rainfall correlations derive from the same population

- Teleconnections that are easier to model:
  - Indian Ocean – Tanzania
  - Indian Ocean Dipole – Kenya-Somalia
  - Mediterranean – Sahel
- Teleconnections that are hard to model:
  - Equatorial Atlantic – Guinea Coast
  - ENSO – Kenya-Somalia

Dave Rowell

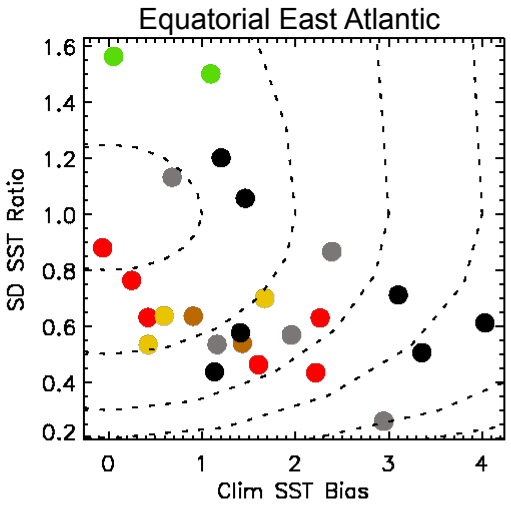
Teleconnections: Role of SST and Precipitation Biases

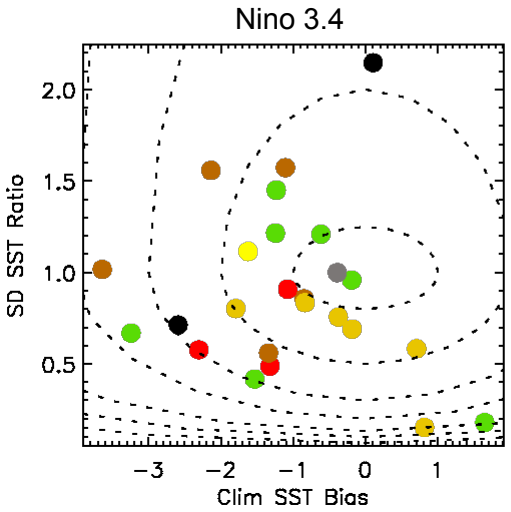
Eq. E. Atlantic
→
Guinea Coast

worst **best**
teleconnections

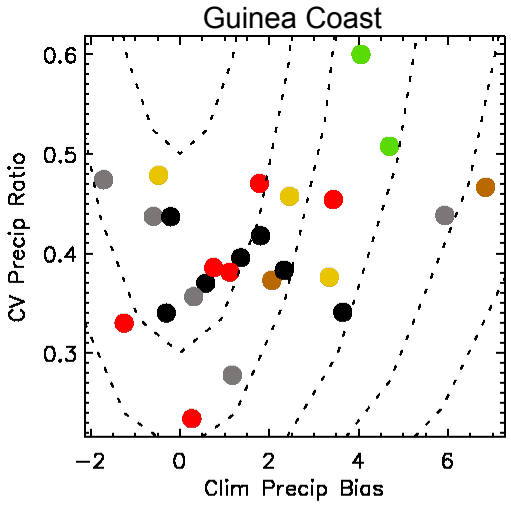
ENSO
→
Kenya-Somalia

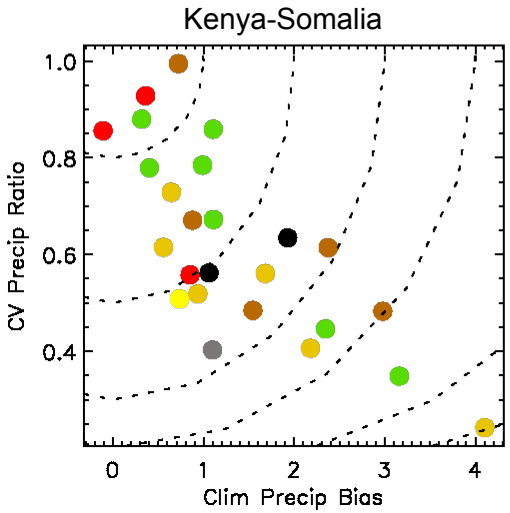
SST Biases





Precip Biases





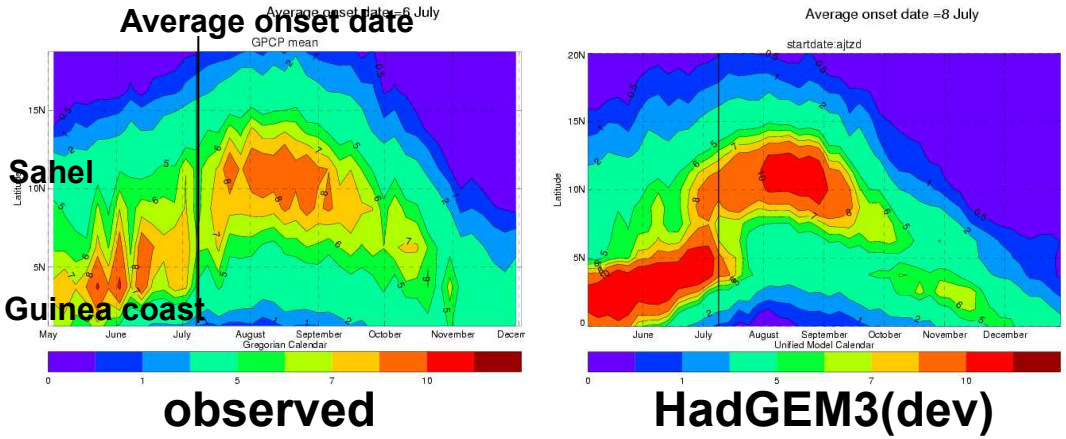
- No obvious relationship between model teleconnection skill and the SST or precip biases in the teleconnection regions.
- The causes of model teleconnection errors are not straightforward!

Dave Rowell

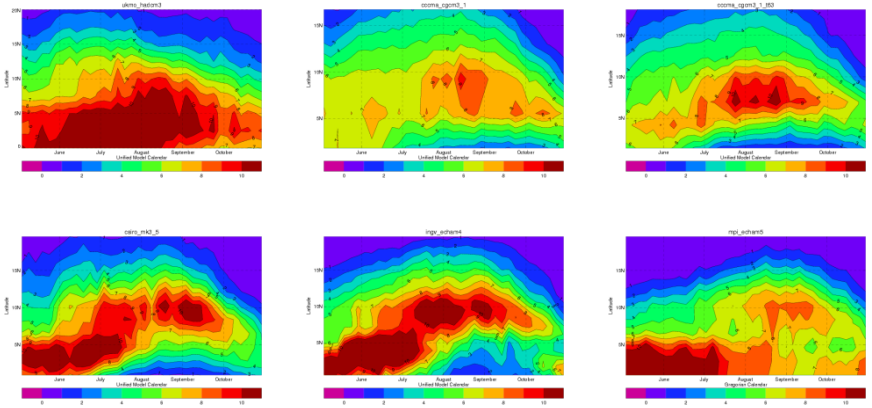
Rainy season onset – focus on West Africa

How well do models used in IPCC's AR4 represent WAM season onset?

West African Monsoon (latitude Vs time)



Sample of CMIP3 models from AR4 (20c3m)



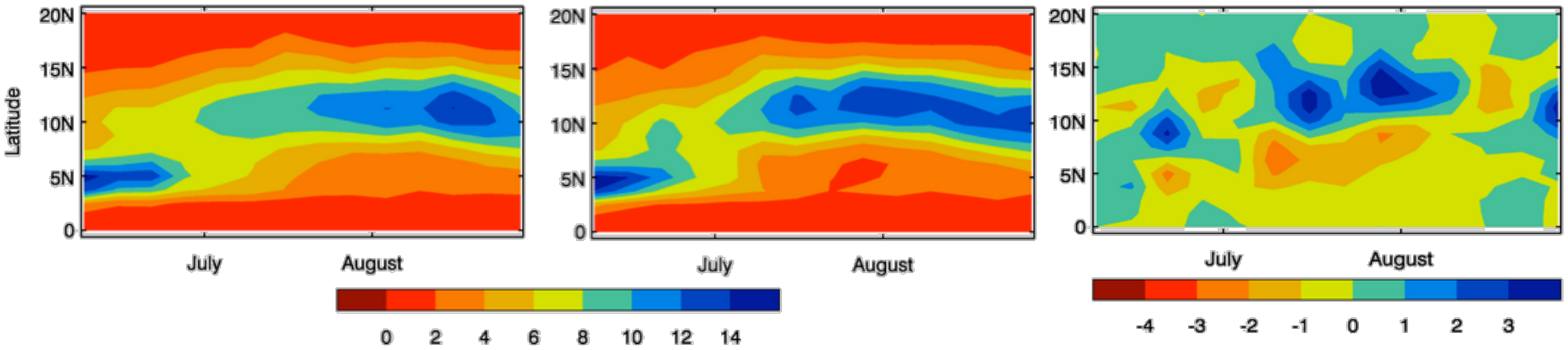
- Most AR4 coupled models do not have a good representation of the West African Monsoon (WAM);
- Implications for confidence in predictions of how climate change will impact the WAM;
- Good representation in HadGEM3 provides opportunity to improve understanding of mechanisms driving onset;
- Good representation of land surface, and the remote influence of sea surface temperature are important for forecasting timing of onset

Michael Vellinga

Land Surface Feedbacks

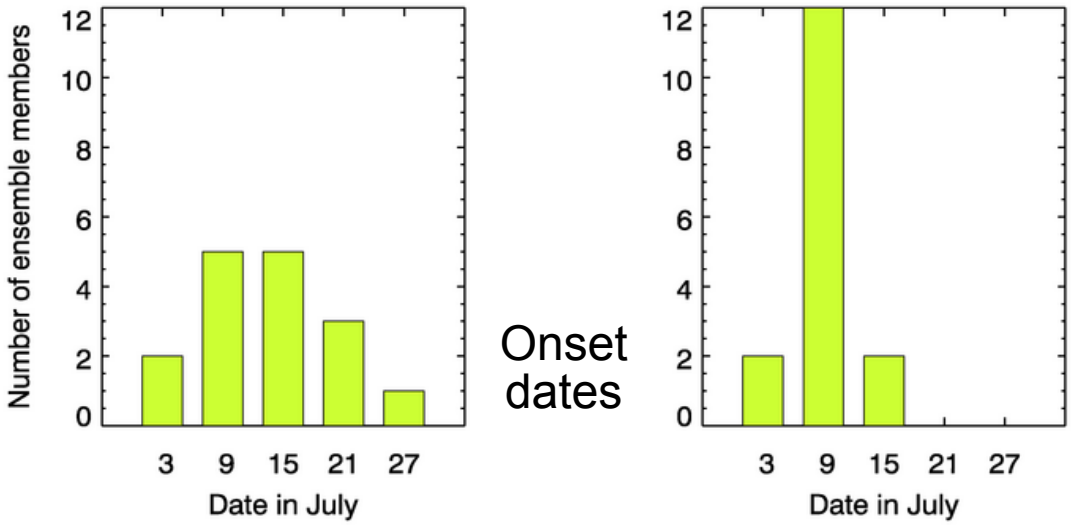
using GLACE framework

Ensemble mean of zonally averaged (10˚W- 10˚E) precipitation (mm/day)



Control | Prescribed Soil Moisture | Difference (prescribed – control)

Onset dates



Onset definition:
pentad when maximum rainfall moves and stays north of 10°N

Ruth Comer

Role of local vs remote forcing: Nudging techniques

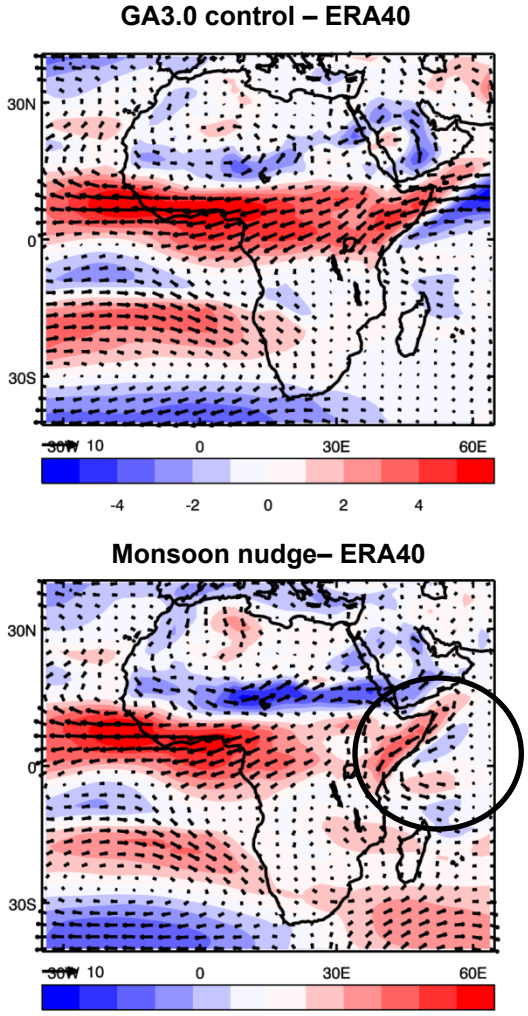
JJA 1983-2002: 600hpa winds

Experiments with relaxing model back to re-analysis over prescribed domains to identify remote influences on African climate and influence of Africa on global climate (following Klinker, 1990)

Initial global studies:

- WAM (10S-40N; 30W-60E)
- S.A Monsoon (10S-40N; 60E-150E)

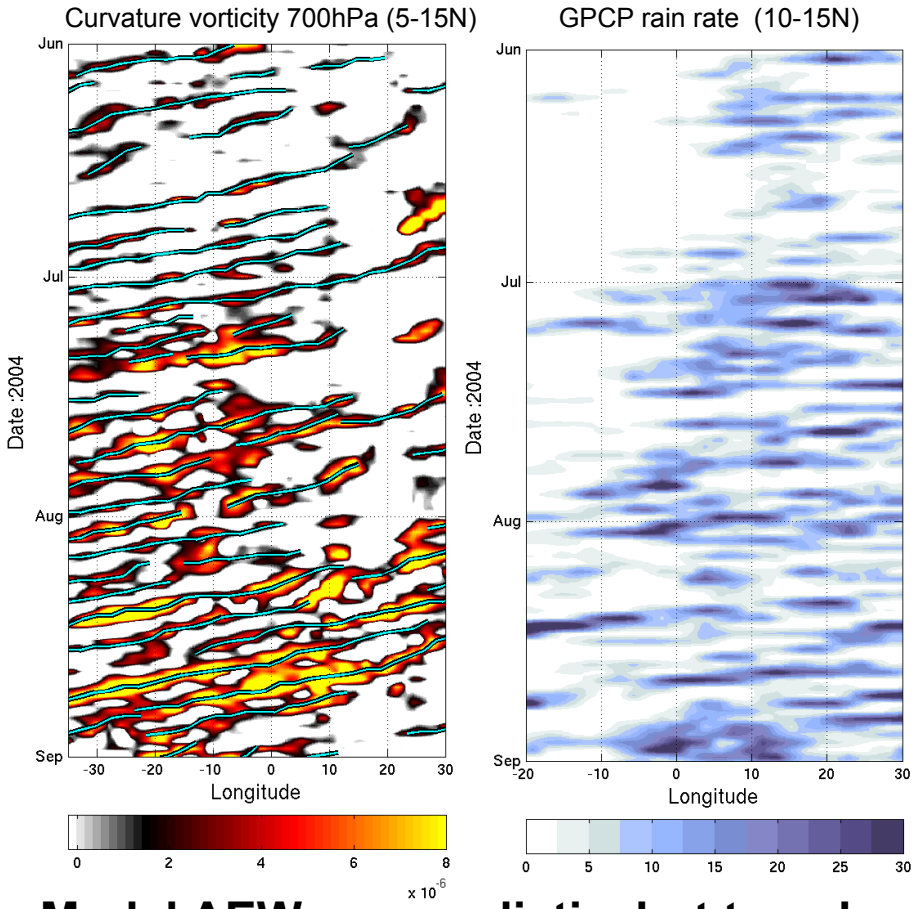
- Similar to Flaounas et al, we find impact of Asian monsoon on simulation of East Africa



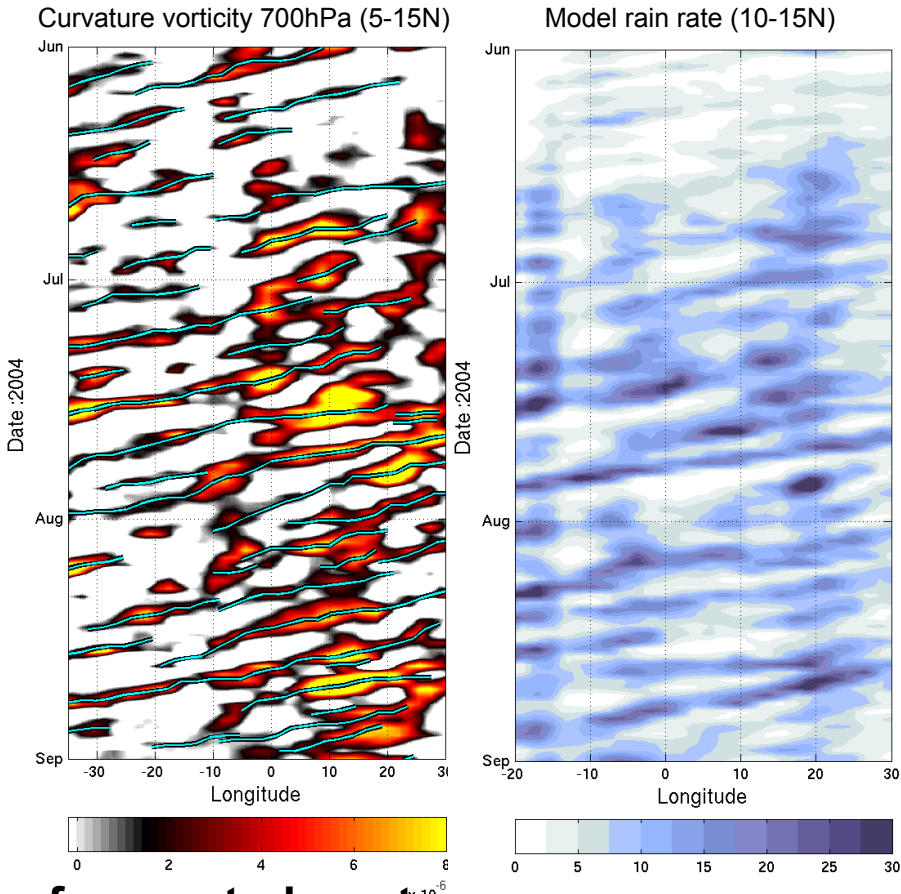
Wilfran Moufouma-Okia

African Easterly Waves: Role of physics

REANALYSIS/ OBS



SEASONAL FORECAST



Model AEWs are realistic, but too slow, less frequent, do not enhance rainfall sufficiently

Caroline Bain

Output 2: Trial new prediction products, monitoring, attribution, seamless monthly-decadal system

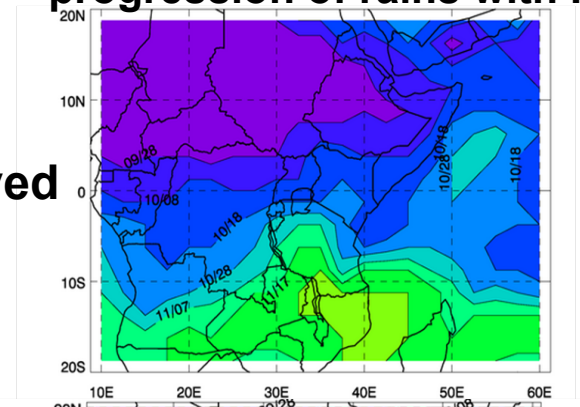
Predicting onset timing

based on local time of arrival of 20% of long-term seasonal average

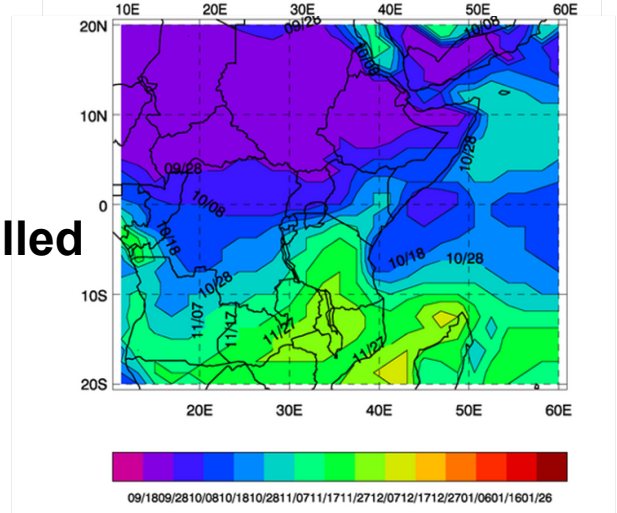
Met Office Hadley Centre

Average southward progression of rains with ITZC

observed

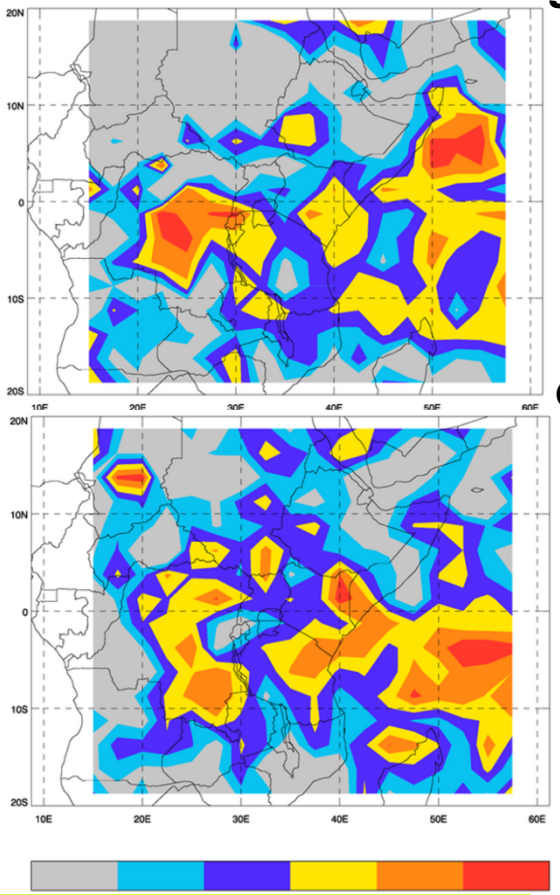


modelled



Example: East Africa short-rains (OND)

Skill of Met Office seasonal forecasts of onset timing



early onset

orange/red = 'good' skill

late onset

Encouraging first results: trial onset forecasts have been provided to Regional Climate Outlook Forums ICPAC, ACMAD and SADC-DMC

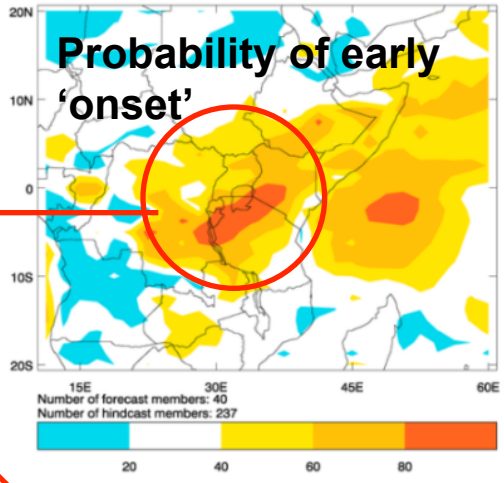
Michael Vellinga

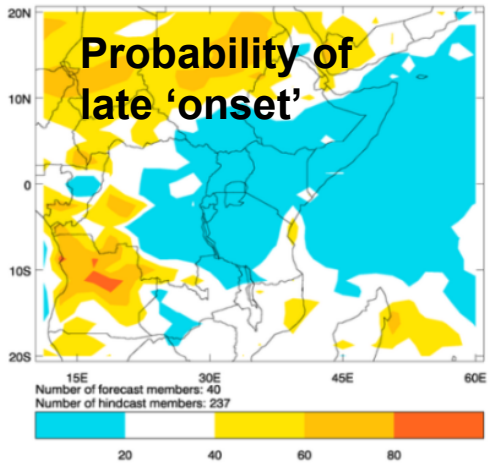
New products: onset prediction and monitoring

Example: Greater Horn of Africa, short-rains season 2011– predicted with one month lead

Early onset predicted most likely

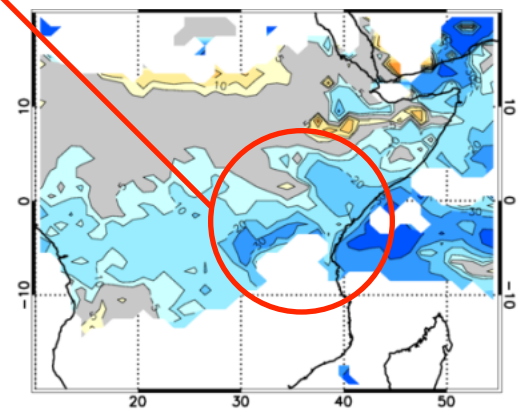
Early onset occurred



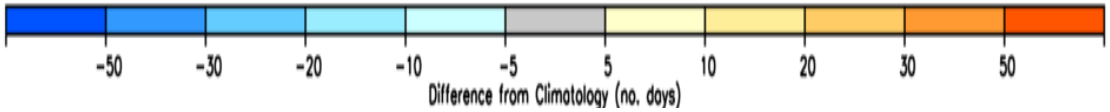


Prediction is based on local time of arrival of 20% of long-term seasonal average

CSRP monitoring product: Observed time of 'onset' (in days difference from long-term average



- **Assessment over retrospective cases indicates forecast can discriminate early/late onset in ~70% of cases (Tanzania/Kenya)**
- **Onset forecasts being trial at regional centres in East, West and southern Africa**

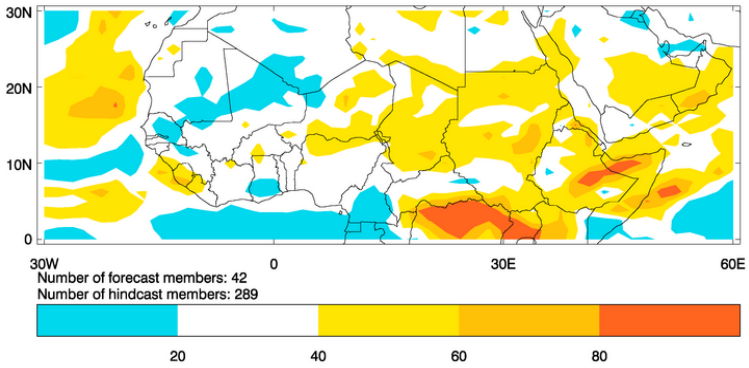


Michael Vellinga/Lizzie Good

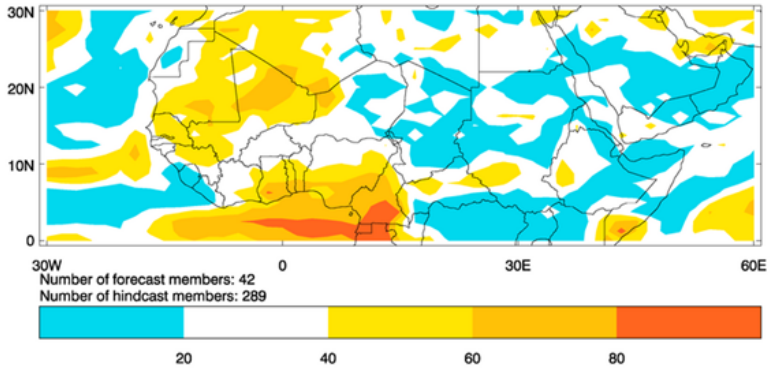
Predicting onset timing: West African season 2011 (July-Sept) predicted from May

based on local time of arrival of 20% of long-term seasonal average

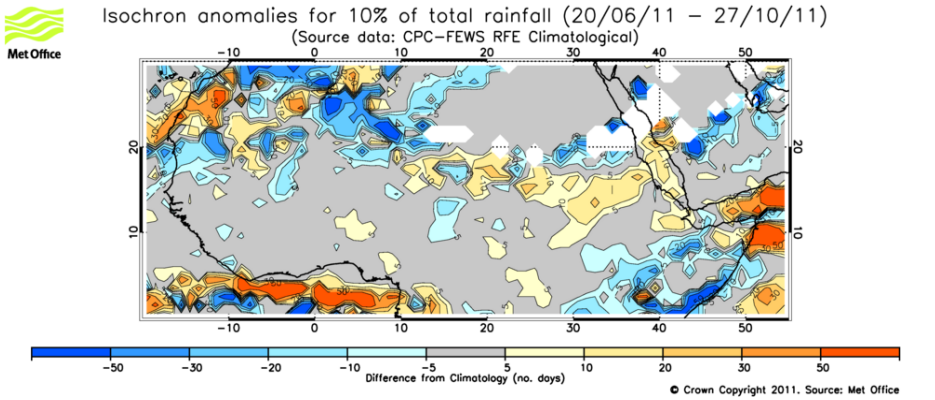
Probability of early arrival

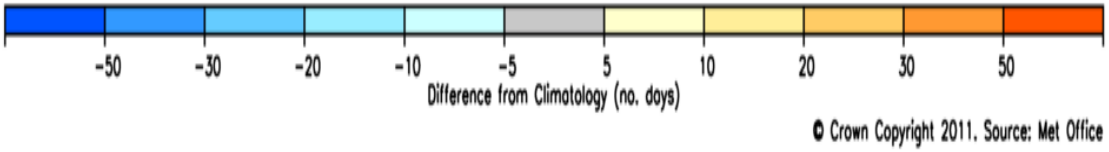


Probability of late arrival



Observed time of arrival

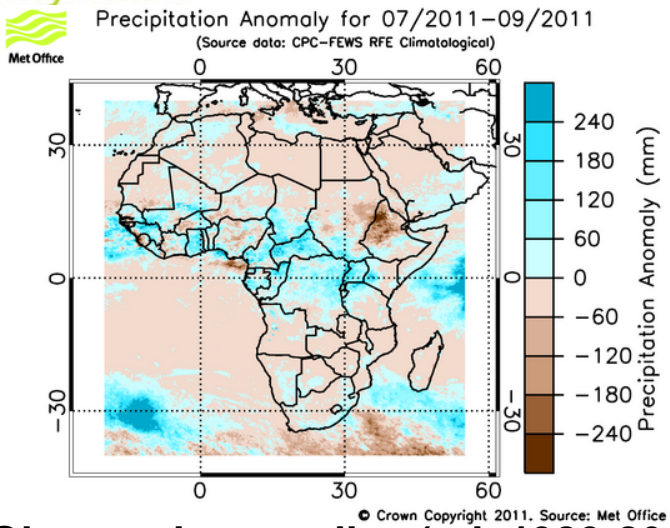




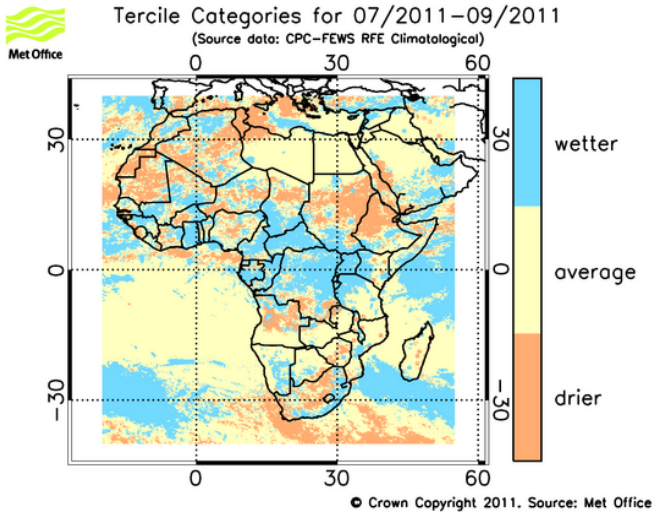
Michael Vellinga/Lizzie Good

Africa observational monitoring

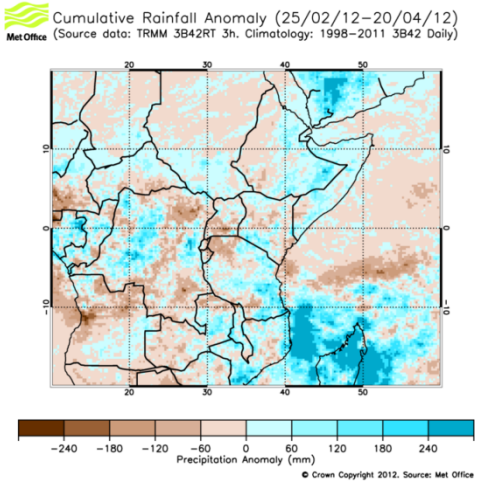
Observed, JAS 2011



Observed anomalies (rel. 1983-2011)



Observed terciles (rel. 1983-2011)



Also…

- **maps showing latest dry spell length**
- **climatological averages**
- **Plots using CPC-FEWS and TRMM**

Also weekly updating plots…

Latest info on East Africa long-rains season March-May 2012

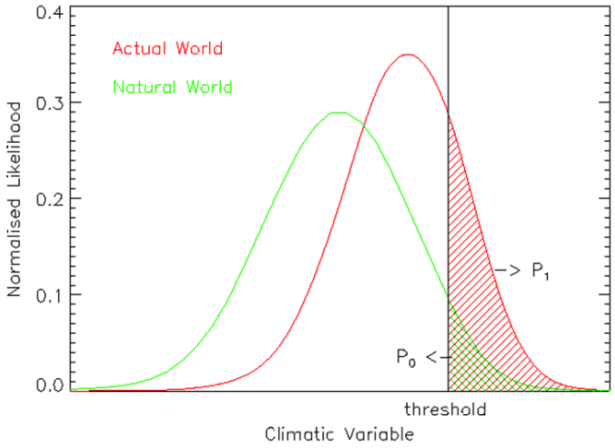
Lizzie Good

Attribution of extreme events

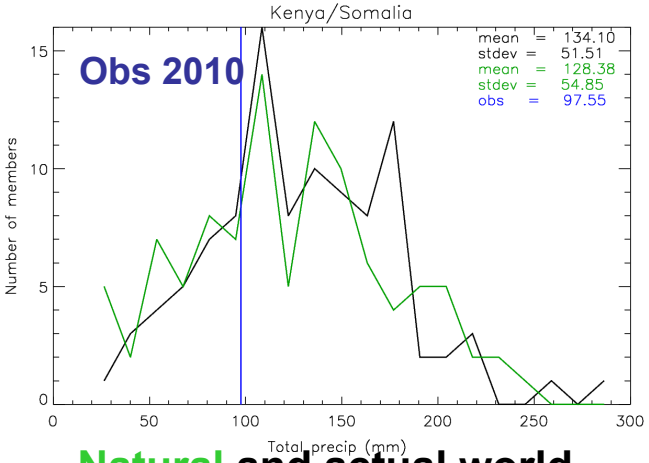
there is a growing tendency to attribute all observed extremes to man-made climate change – bringing potential for mal-adaptation

Met Office Hadley Centre

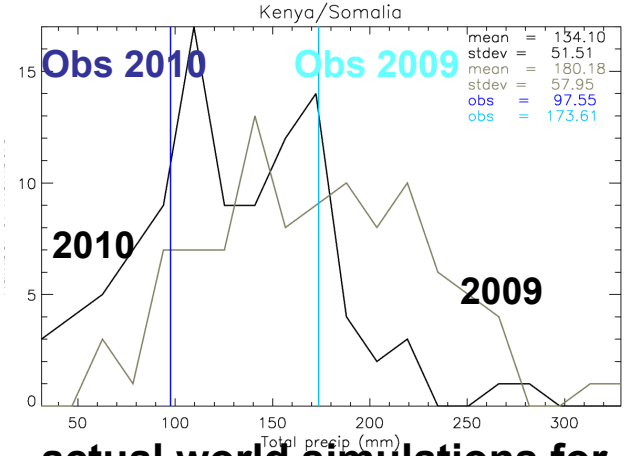
schematic



Greater Horn of Africa short-rains OND 2010



Natural and actual world simulations for OND 2010 (100 realisations each)



actual world simulations for OND 2009 and 2010

- Severe drought characterised by poor rains OND 2010 and MAM 2011

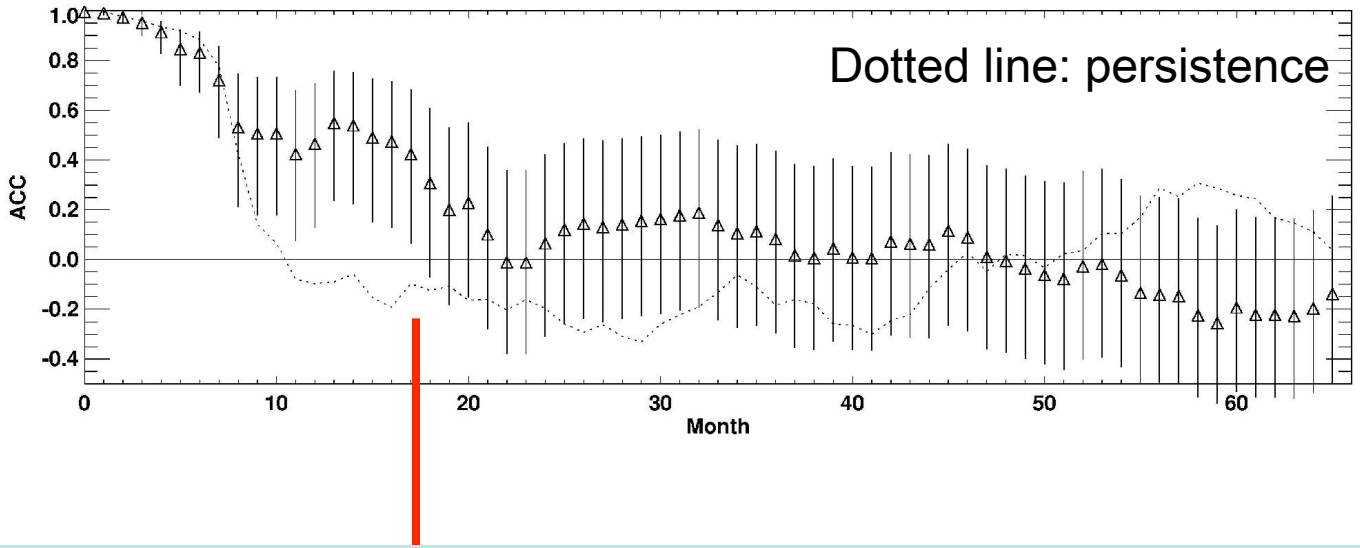
Preliminary results:

- Little 'man-made' influence detected on OND season – natural forcing (La Niña) likely increased risk of dry (consistent with known teleconnections)
- For MAM season: some evidence that man-made influence increased risk of dry (consistent with Funk et al 2008) – but more research needed

Fraser Lott, Nikos Christidis, Peter Stott

‘Seamless’ monthly-to-decadal prediction:
Skill for El Nino/La Nina prediction to 18 months ahead

correlation skill for monthly Niño3.4 index to 5 years ahead; from 22 retrospective forecasts from 1st November – 95% confidence limits

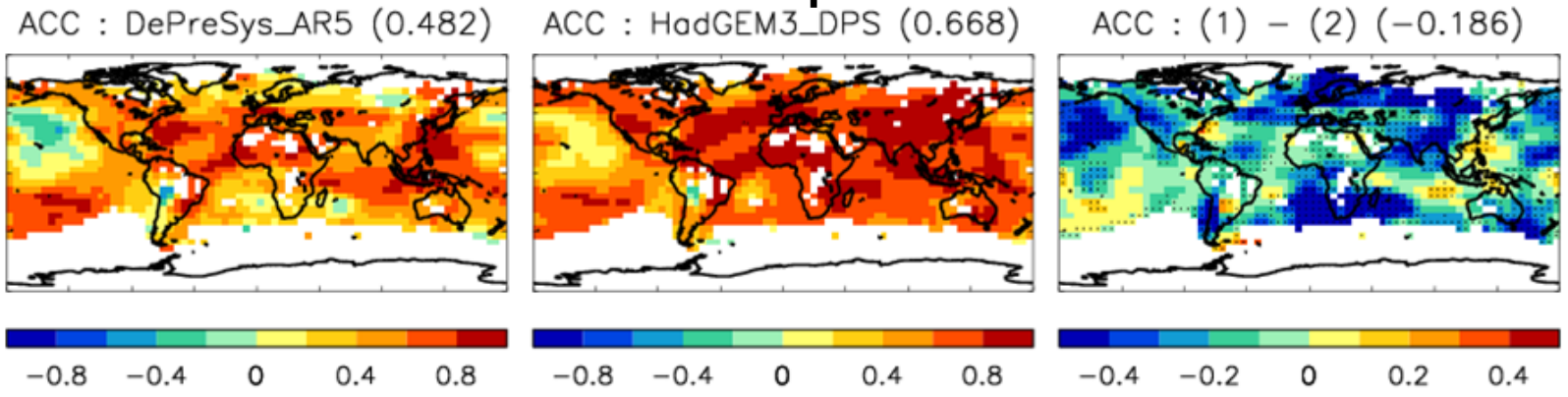


- **Positive skill for El Niño/La Niña prediction retained to ~18 months.**
- **Showing potential for longer-lead rainfall outlooks in regions strongly influenced by ENSO – allowing more time to prepare responses to potential drought/flood.**

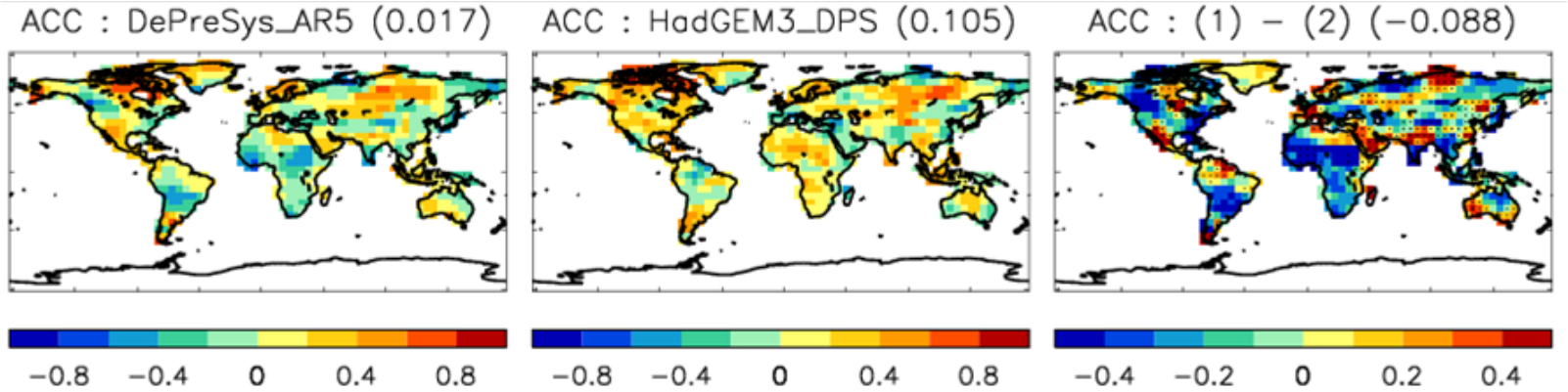
Jeff Knight / Martin Andrews

HadCM3 DePreSys Vs HadGEM3 'DePreSys': November starts yrs2-5

ACC temperature



ACC rainfall



- HadGEM3 is more skilful than HadCM3
- Capability for multi-annual prediction over Africa has been improved

Jeff Knight / Martin Andrews

Output 3: Regional Climate Model downscaling

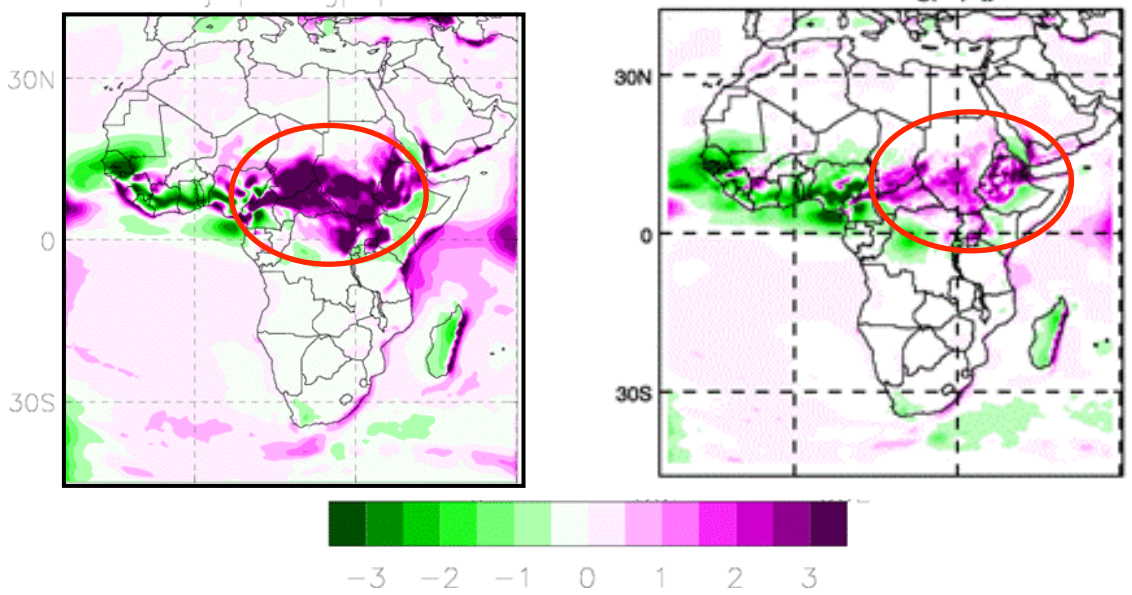
Development of PRECIS V3 for regional modelling over Africa

Wilfran Moufouma-Okia

Bias in HadGEM3-RA 50km simulations of June-August rainfall

Previous model version

Latest model version



Reduced wet bias over Congo basin

- **Improved HadGEM3 RCM (PRECIS V3) will be implemented in an African centre and used in trial downscaling of seasonal forecasts in 2012**
- **Tested at 135km, 50km, 25km, 12km horiz. res.**
- **Exploring potential to provide the greater spatial detail required by users**

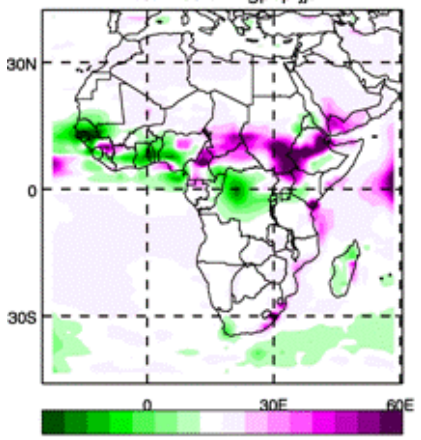
Science component (3): Resolution experiments with HadGEM3-RA (JJA)

Wilfran Moufouma-Okia

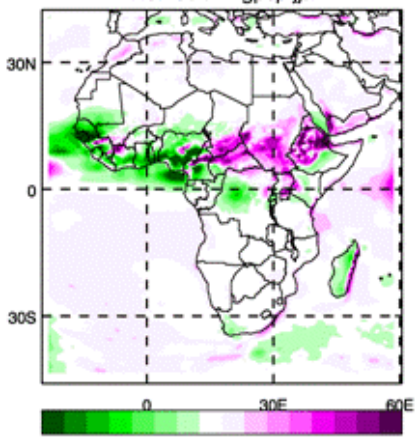
Rainfall bias w.r.t GPCP

Impact of resolution

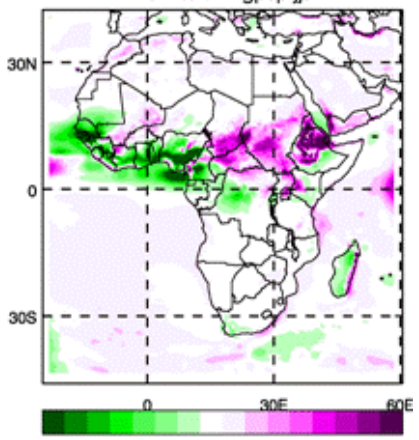
135km

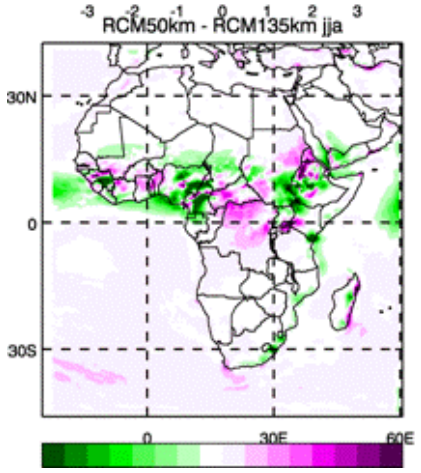


50km

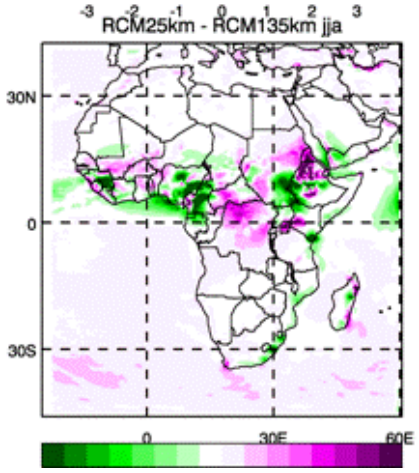


25km

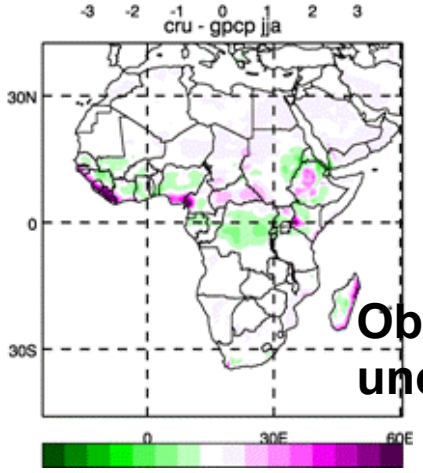




50km-135km



25km-135km



CRU-GPCP

Observational uncertainty

Output 4/5: Capacity Building: Fellowship scheme, climate science workshops, support to Regional Climate Outlook Forums,

Fellowship scheme / workshops:

CSRP Fellowship scheme

- 11 African climate scientists appointed as CSRP fellows;
- 4 West; 4 East Africa; 1 Central and 2 southern Africa;
- Fellows will work on CSRP research themes;
- Each fellow has been assigned a (Met Office) expert as mentor;
- Fellows are based at African Institutes, with 4-week visit to the Met Office

Various Met Office mentors

CSRP fellows

- **Dr Ousmane Ndiaye**: National Agency of Civil Aviation and Meteorology (ANACIM), Dakar, **Senegal**
- **Mr Ismaila Diallo**: Cheikh Anta Diop University (UCAD), Laboratory for Atmospheric Physics Simeon Fongang (LPASF); Dakar, **Senegal**
- **Dr Willem Landman**: Council for Scientific and Industrial Research (CSIR), Pretoria, **South Africa**
- **Mr Mekonnen Adnew Degefu**: Department of Geography and Environmental Studies,University of Addis Ababa, **Ethiopia**
- **Mr Wilfried Pokam Mba**: University of Yaoundé 1 and Centre for International Forestry Research (CIFOR), Yaoundé, **Cameroon**
- **Mr Arlindo Meque**: National Institute of Meteorology (INAM), Maputo, **Mozambique** and University of Cape Town, South Africa
- **Mrs Mary Kilavi**: Kenya Met Department, Nairobi, **Kenya**
- **Mr Oumar Konte**: National Agency of Civil Aviation and Meteorology (ANACIM), Dakar, **Senegal**
- **Dr Philip Omondi Aming'o**: IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, **Kenya**
- **Mr Dominic Soami Pokperlaar**: Ghana Meteorological Agency, Accra, **Ghana**
- **Mr Geoffrey Sabiiti**: Makerere University, Kampala, **Uganda** and IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, Kenya

- Forecasting weather statistics within the climate of the seasonal rainfall over Senegal
- Present day simulations of the West African Monsoon with two kinds of HadGEM3 model (GCM and RCM)
- The performance of HadGEM3 as a seasonal forecasting and research tool for southern African climate variability
- Association between rainfall variability and global climate teleconnection: the case of southwestern Ethiopia
- Investigation of processes driving low-level westerlies in central Africa
- Evaluation of the GloSea4 seasonal forecast system over Mozambique: rainfall climatology and predictability
- Integrating dynamical products into national and regional climate outlook forum products
- Evaluation of seasonal forecasting of rainfall from the farmer's perspective with Kaffrine and Fatick as case studies
- Modelling decadal climate variability over the Eastern Africa region
- Ghana historical climate data development project
- Evaluating MOHC PRECIS system downscaling ability and its climate change projections over the Greater Horn of Africa

Fellowship scheme / workshops:

CSRP Fellowship scheme

- 11 African climate scientists appointed as CSRP fellows;
- 4 West; 4 East Africa; 1 Central and 2 southern Africa;
- Fellows will work on CSRP research themes;
- Each fellow has been assigned a (Met Office) expert as mentor;
- Fellows are based at African Institutes, with 4-week visit to the Met Office

Various Met Office mentors

Workshops in climate science and applications

- 'Use of dynamical seasonal forecasts for the Greater Horn of Africa' – hosted by ICPAC Nairobi (June 2011);
- 15 participants from countries of the GHA;
- Tools and methods developed helping to enhance regional seasonal forecasting;
- Opportunities for longer-range (ENSO-based) predictions explored – potential for longer-lead drought/flood warnings.

CSRP support to African Regional Climate Outlook Forums (RCOFs)

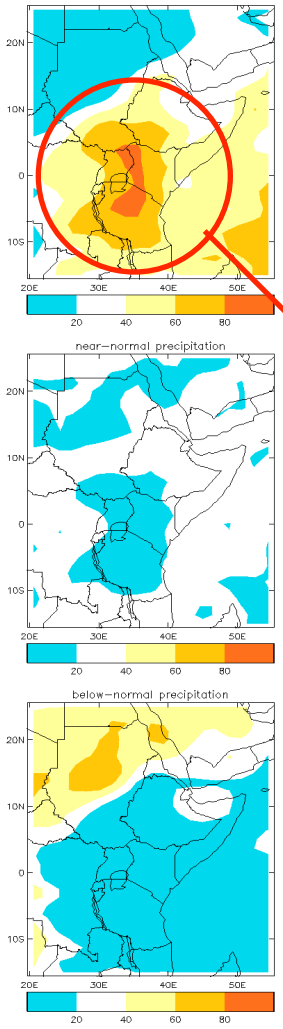
Greater Horn of Africa (GHACOF29) consensus forecast for Sept-Dec 2011 – forecast made at peak of drought crisis

Met Office prediction:

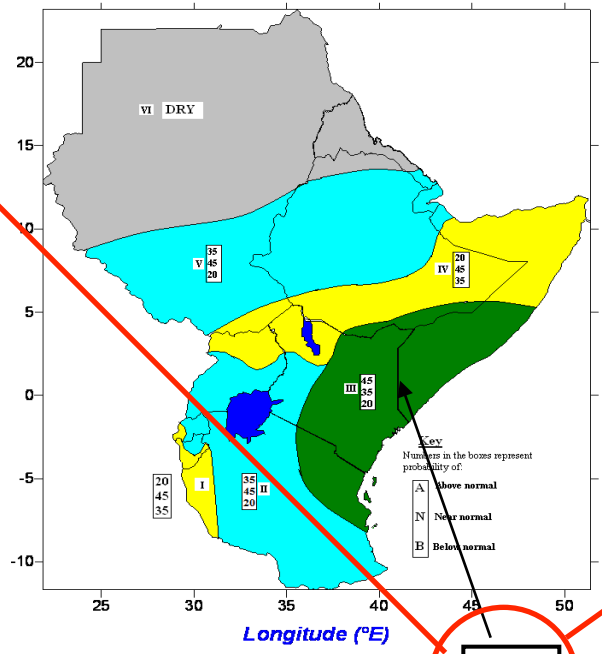
P(abv)

P(avg)

P(blw)

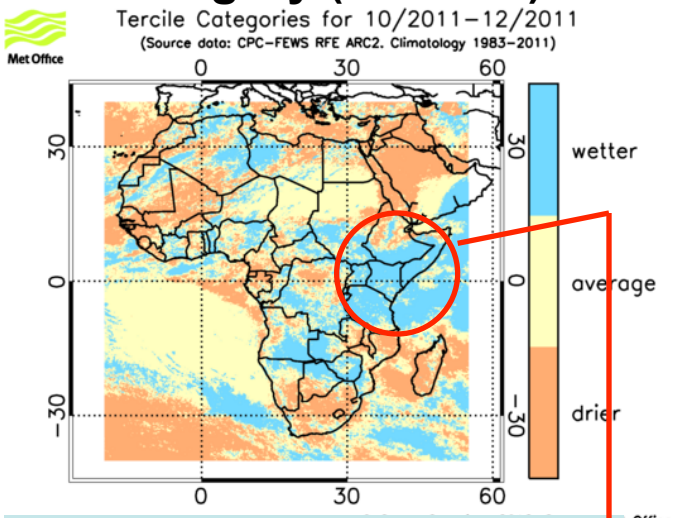


GHACOF consensus forecast



P(abv)	45
P(avg)	35
P(blw)	20

Observed rainfall category (Oct-Dec)



- **Above average rainfall predicted most likely**
- **Above average occurred**
- **Some alleviation from drought**

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CCA Example:CFS prediction of MAM East African Rainfall

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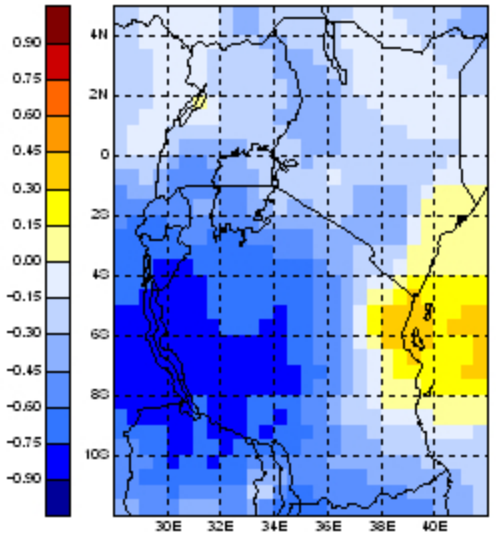
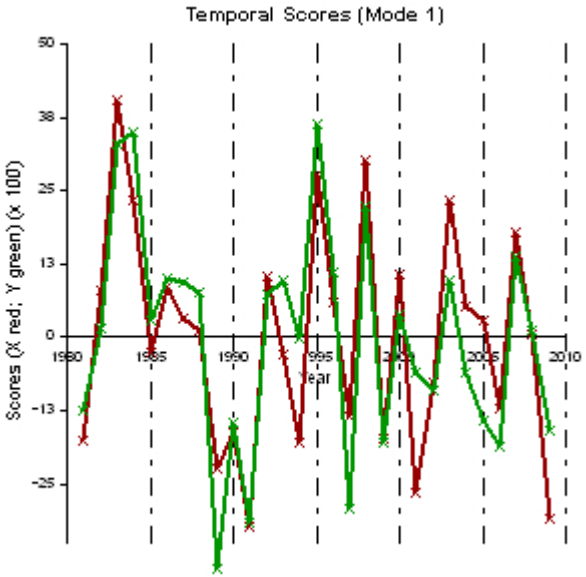
Met Office Hadley Centre

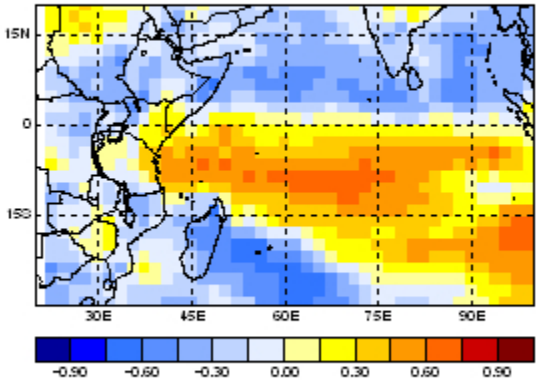
Y:Corresponding Observed rainfall



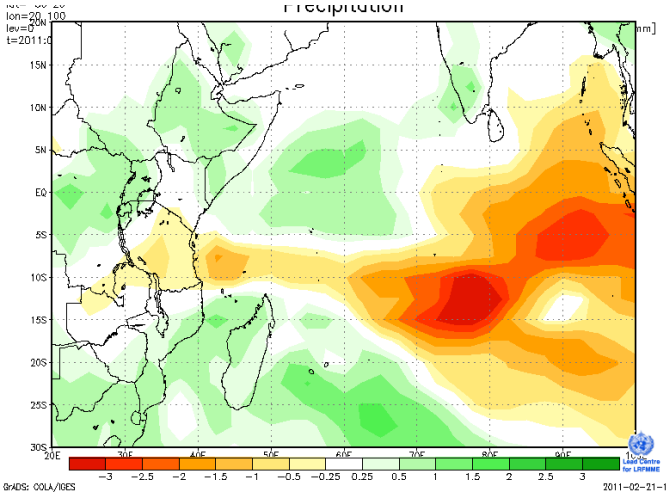
Model (red) v Obs (green)



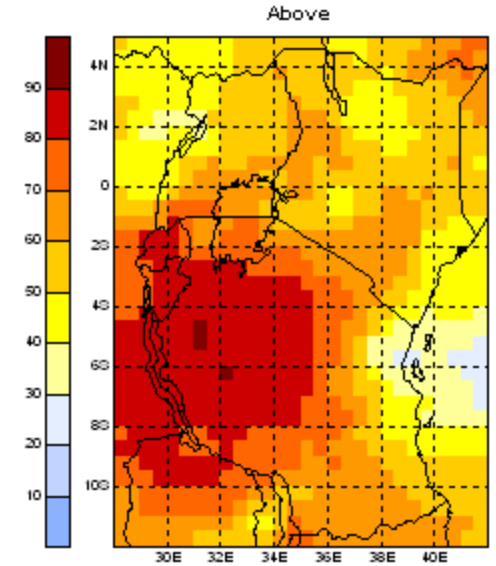
X:CFS model output Rainfall forecast



CFS Rainfall forecast for MAM 2011



Probability of above average rainfall tercile (chance=33%)



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Recommendations to African Climate Policy Centre (UNECA, Addis Ababa)

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First Annual Conference on Climate Change
and Development in Africa

Development First: Addressing Climate Change in Africa

17-19 October 2011 ■ United Nations Conference Centre ■ Addis Ababa, Ethiopia

Outcome Statement

Richard Graham

Met Office
Hadley Centre

http://www.metoffice.gov.uk/csrp

Thank you.
Questions?