Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)

Science Talk

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PERFORMANCE ASSESSMENT OF ECMWF SYSTEM-4 FORECASTS WITH THE LIVERPOOL MALARIA MODEL

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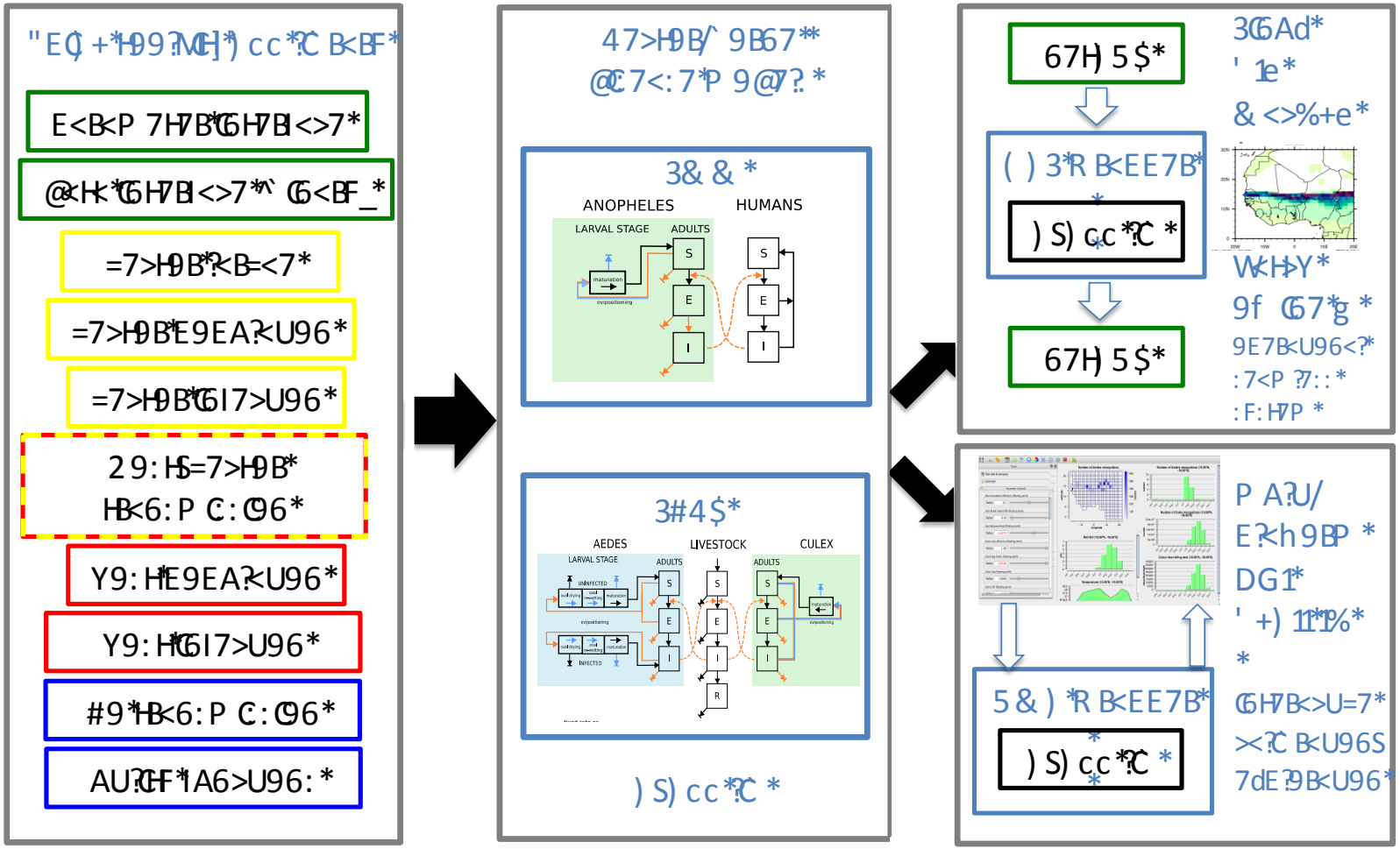
Overview

WP4.1: Seamless climate-disease model integrations

WP 2.1: Performance of dynamical modelling approaches

- Improvements to LMM during QweCI.
- Impact of ERA-Interim rainfall calibration on modelled malaria compared to a range of rainfall inputs (TRMM, GPCP, ERA Interim, SYSTEM-4).
- Progress in seasonal dynamic malaria forecast skill: System-4 versus DEMETER and ENSEMBLES
  - Tier-2 (West Africa, Malawi) vs ERA Interim
  - Tier-3 (Botswana)
  - "Standard" (2004) LMM parameter settings only (so far…)



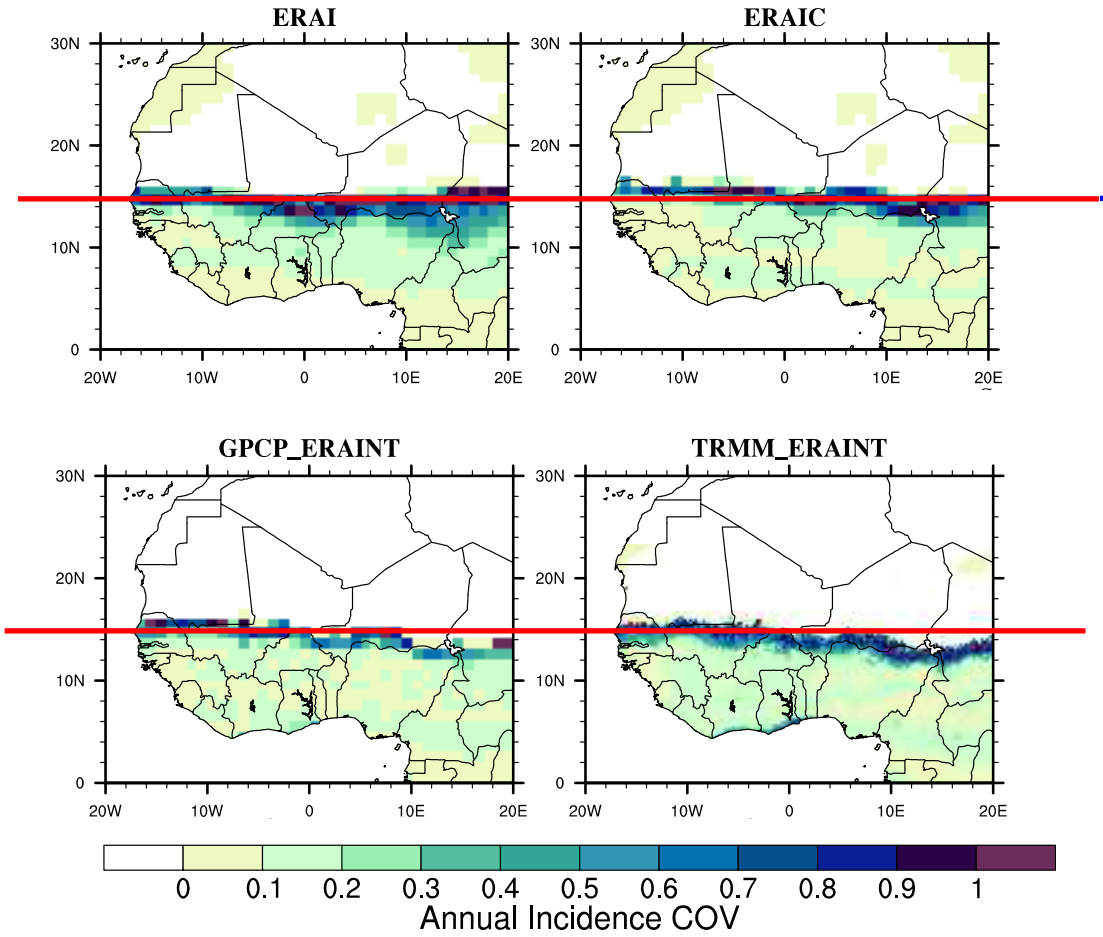
EpiCS: **Epi**demiological modelling toolkit for **C**limate-**S**ensitive disease

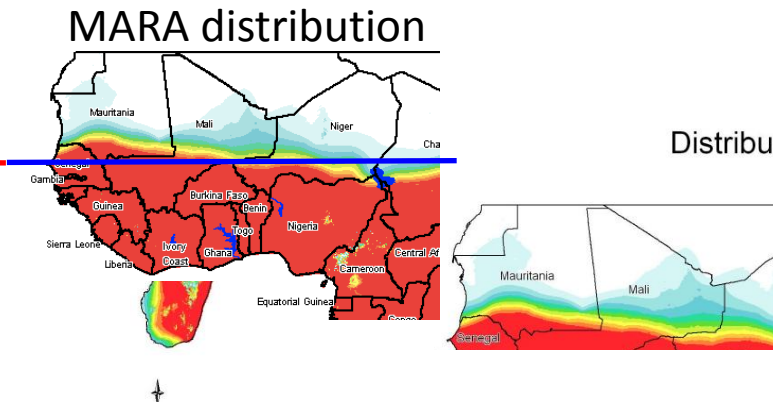
Climate drivers for LMM

Daily rainfall & temperature

	Product	Variable	Description	Archive	Res
observations	ERA Interim	T, P	current state-of-the-art reanalysis from ECMWF	1979-2011	1°
	Calibrated ERA Interim	P	see Di Giuseppe et al., 2012 & Francesca's talk	1979-2011	1°
	GPCP	P	satellite/gauge	1998-2008	1°
	TRMM v6	P	satellite/gauge	1998-2010	0.25°
hindcasts	DEMETER (2004)	T, P	multi-model ensemble	1958-2001	2.5°
	ENSEMBLES (2008)	T, P	multi-model ensemble	1960-2005	2.5°
	SYSTEM 4 (2011)	T, P	15 member ensemble	1981-2011	1.5°
	Seamless system	T, P	5 member ensemble (weekly), uncalibrated & calibrated P	1994-2011	1°

ERA-I calibration – West Africa transmission and variability



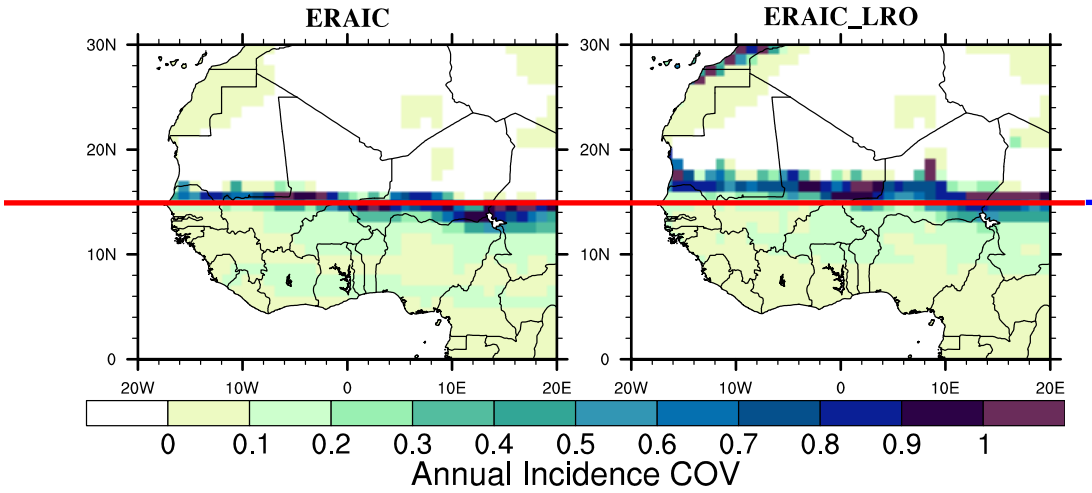


- ERA Interim calibration to GPCP shifts fringe ~1.5 degree northwards in eastern Sahel
- Sharpens fringe in central and western Sahel

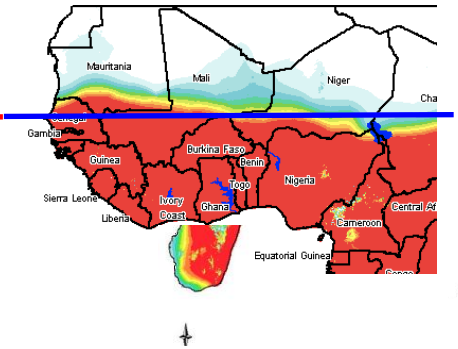
Parameter adjustment – West Africa

Standard LMM parameter settings

Adjusted larval survival parameters



MARA distribution



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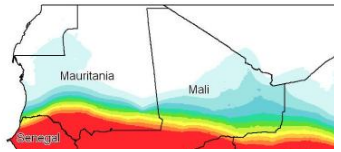
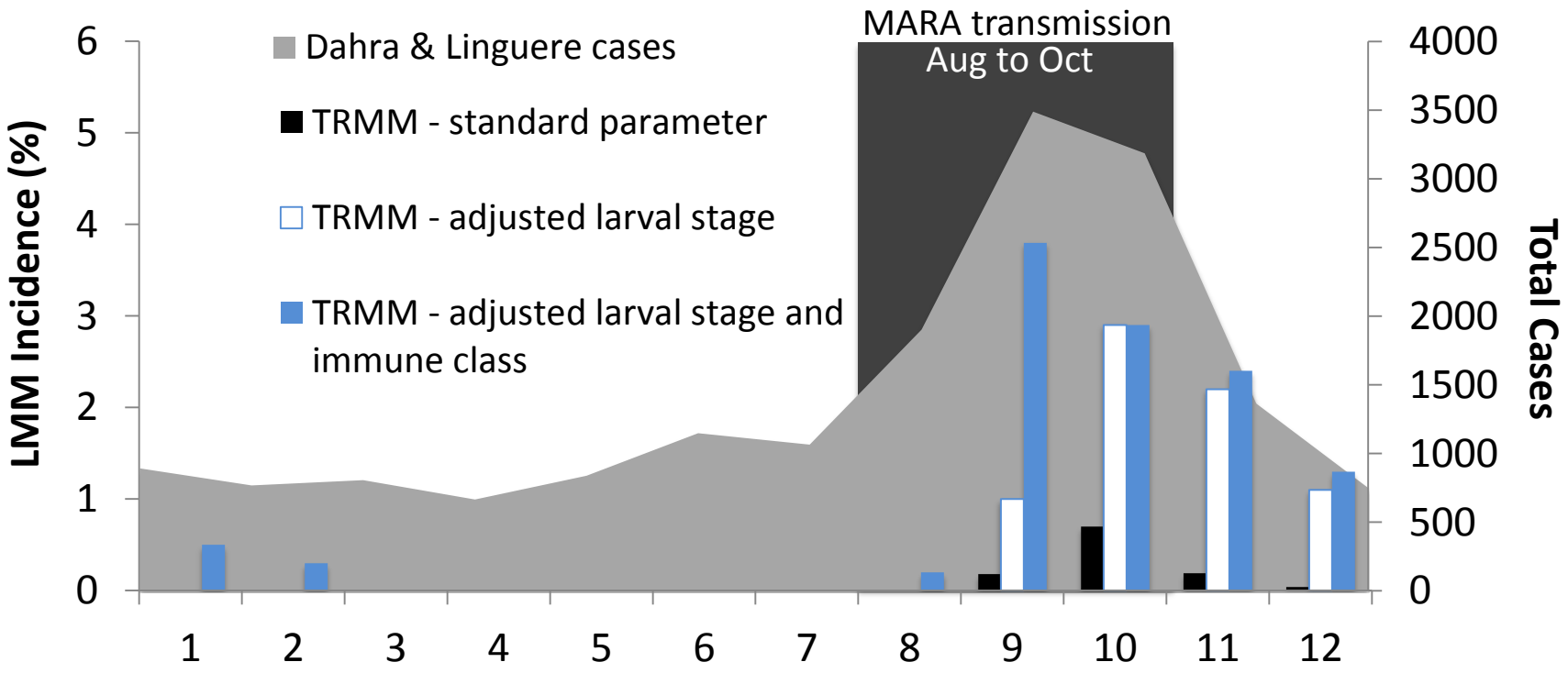


Further improvements to epidemic fringe location (relative to MARA distribution model) are achieved by adjusting larval scheme in the model.

LMM parameter adjustment – Senegal



Improved transmission & reduction in model lag are obtained by:

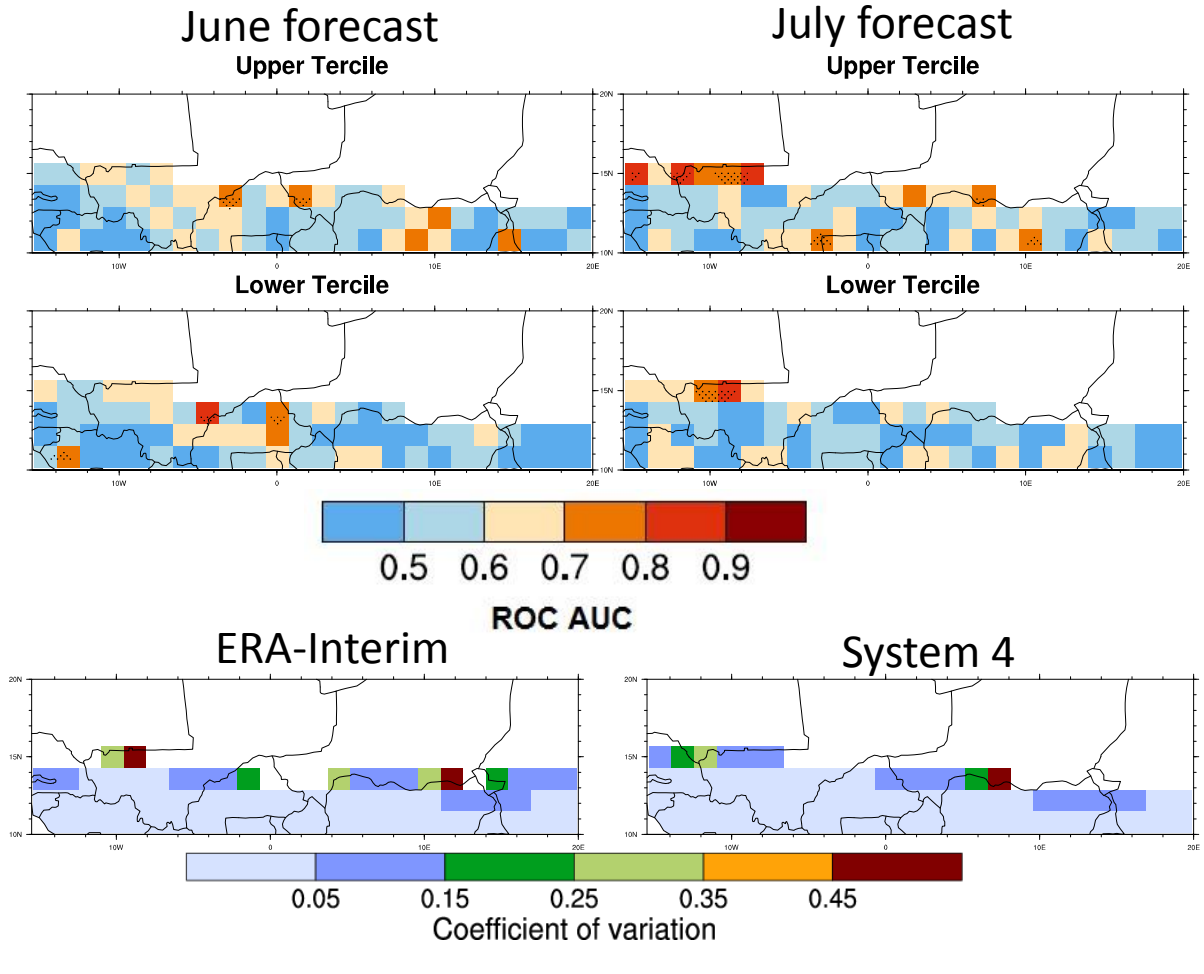
- More permissive larval survival
- Addition of immune reservoir

  -> further refinement needed…

Dahra (15°21'N,15°36'W & Linguere (15°23'N, 15°13'W) mean recorded malaria cases (2001-2009) per month (right axis) from IPD PNLP compared to TRMM-driven LMM for nearest grid point (mean 1998-2010)

System 4 skill: Sahel (tier-2 against ERA-Interim)

standard LMM parameter settings



Plots from Macleod 2013 PhD thesis

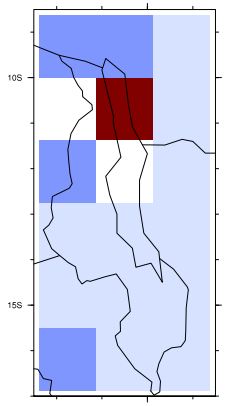
- No skill in DEMETER
- Marginal tier-2 skill in ENSEMBLES (Jones & Morse, 2012, GRL)
- System 4: some skill in W Sahel at epidemic fringe for the July forecast only.
- Not in the same place as ENSEMBLES!

SON malaria incidence
System-4 vs ERA Interim driven LMM
2010
95% significance for ROCA>0.78

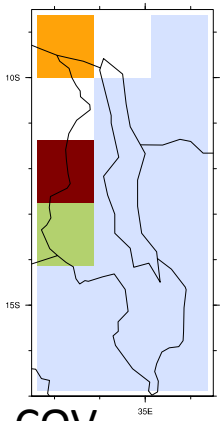
System 4 skill: Malawi (tier-2 against ERA-Interim)

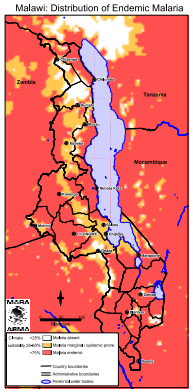
standard LMM parameter settings

ERA-Interim



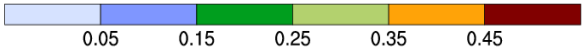
System-4

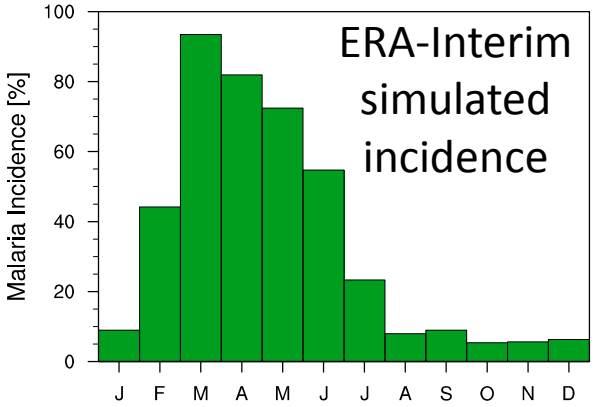




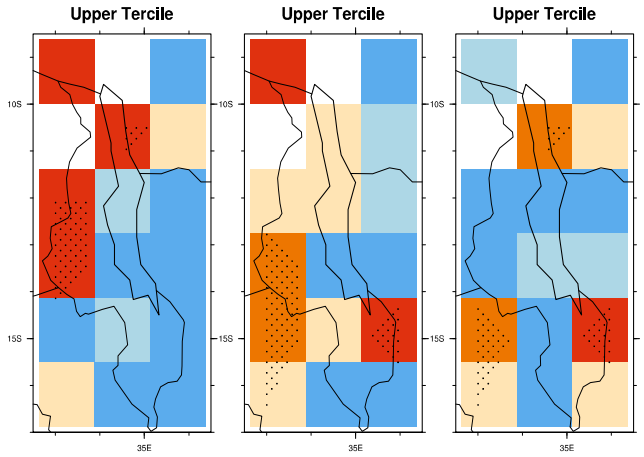
MARA malaria distribution
mara.org.za

Incidence COV

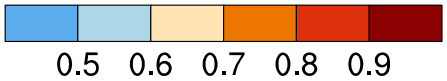




Oct Nov Dec



Upper Tercile ROCA 95% significant >0.78

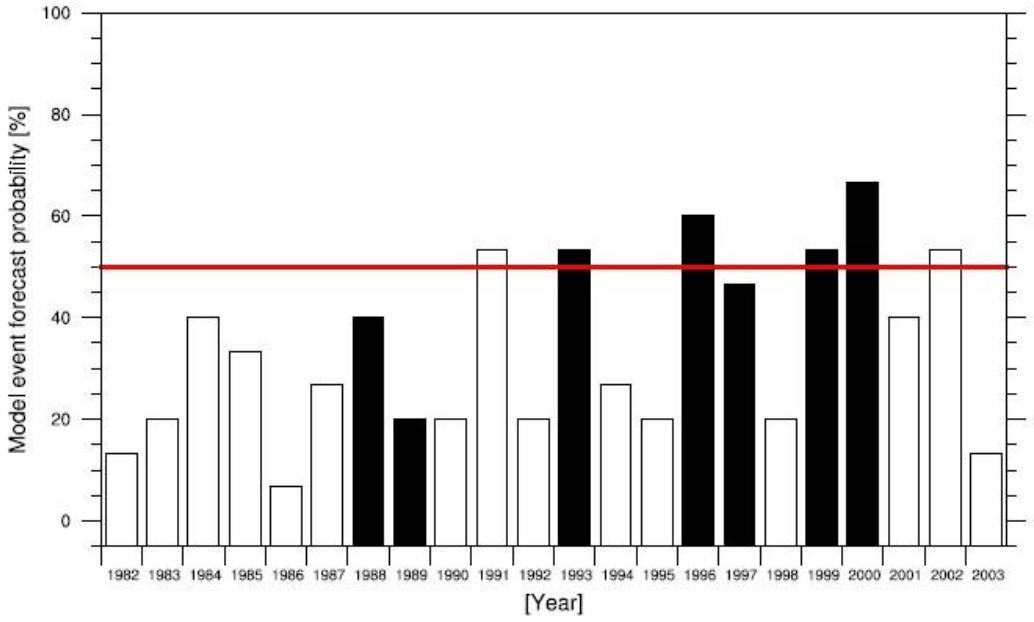


- Malaria Incidence Mar-May
- Some disagreement over position of epidemic fringe
- System 4 Skill over the north west for start dates in October.
- Skill decreases closer to target…

Plots from Macleod 2013 PhD thesis

Seasonal forecast skill assessment

Botswana



System 4 driven LMM incidence forecasts of above upper tercile events issued in **November**.

Black (white) bars indicate years where incidence is above (below) the BMI upper tercile.

Plot from Macleod 2013 PhD thesis

ROC Areas

Model	LT	UT
DEMETER multimodel	**0.84**	0.67
ENSEMBLES multimodel	**0.85**	0.69
DEMETER-ECMWF	0.67	0.44
ENSEMBLES-ECMWF	**0.81**	0.59
SYSTEM-4	**0.77**	**0.89**
ERA-Interim	0.72	**0.91**
ERA-Interim – calibrated rainfall	TBC	TBC

November forecast MAM
Assessment period 1982-2001
(System 4/ERA 1982-2003)
Relative to Botswana Malaria Index
(Thomson et al, 2005)
Bold indicates significance at 95%

Conclusions

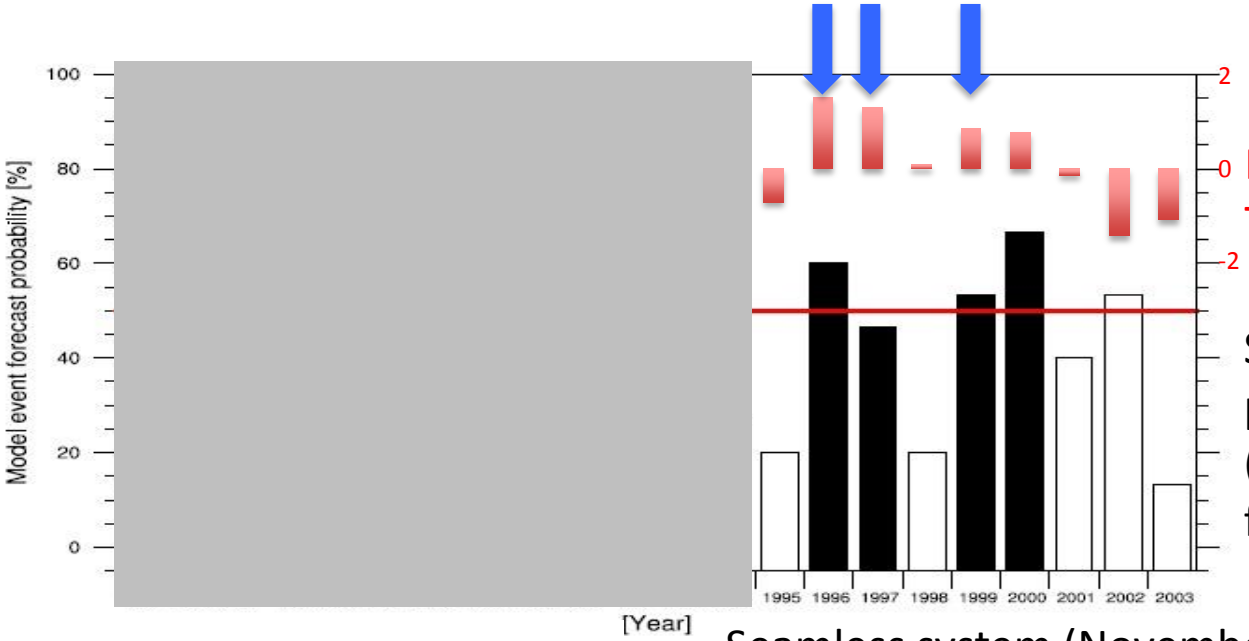
- Evidence of tier-2 skill relative to ERA-Interim in some African regions
  - Treat tier-2 results with caution as ERA-Interim-driven transmission & variability is not necessarily to be trusted!
  - Calibration of ERA-Interim rainfall in WA seems to improve position of fringe relative to obs-driven simulations and MARA transmission maps.
  - LMM adjustment also improves fringe position and DMC/EPICS provides facility for further model refinement.

- Tier-3 skill for System 4 in Botswana - improvement on DEMETER and ENSEMBLES ECMWF results and better than multi-models for high malaria events.

Prospects

- Revisit tier-2 performance assessment with revised LMM settings and calibrated ERA Interim rainfall.
- Investigate Impact of ERA Interim calibration in other African regions.
- Seamless forecasts with the operational system - testing continues.
- Development of the disease models continues in HEALTHYFUTURES.

Seamless forecasts - Botswana

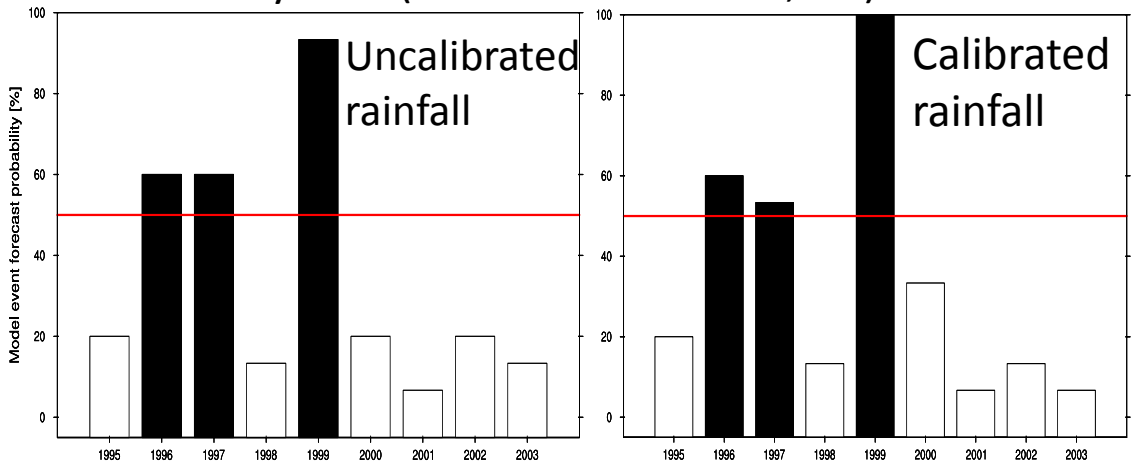


Malaria index anomalies
Thomson et al., 2005

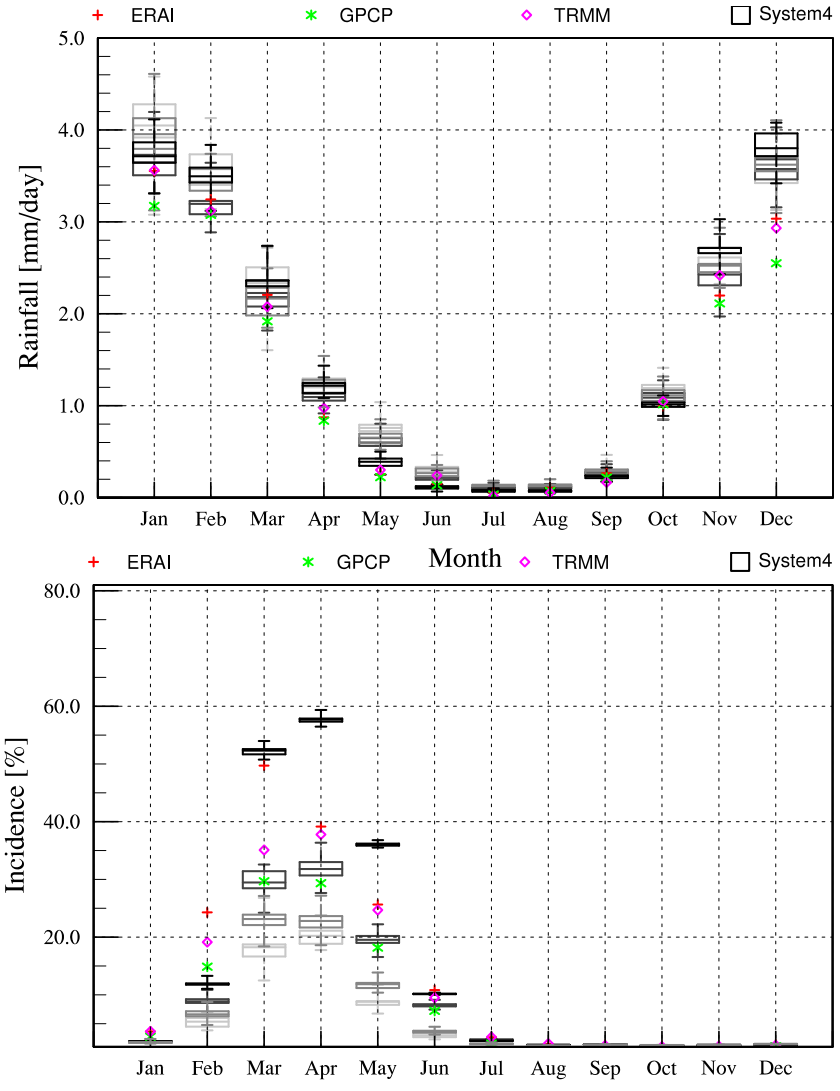
System 4 forecast probabilities (November forecast, UT)

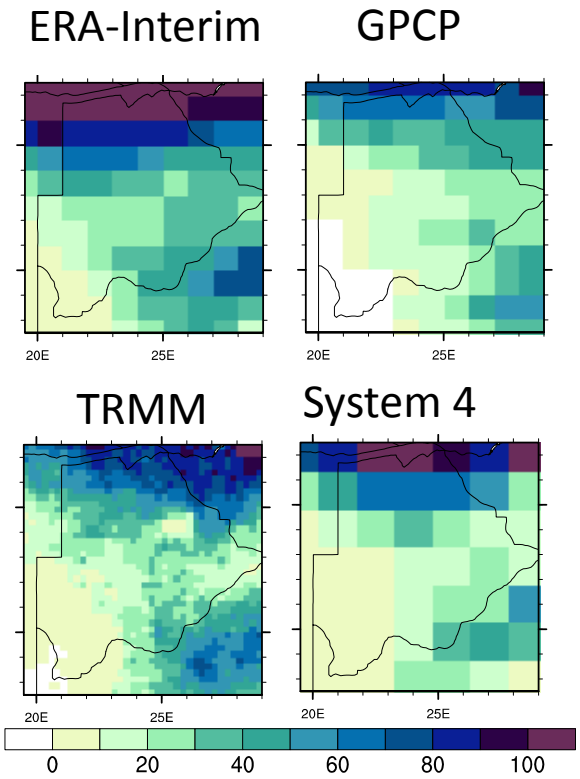
- Seamless drivers differ from System-4 for the first month only (November)
- Difference in prediction for 2000
- Impact of rainfall calibration is marginal
- Seamless system gets 3/3

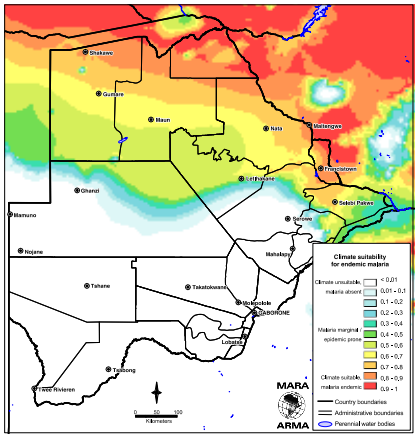
Seamless system (November forecast, UT) 1995-2003



Seasonal cycle and distribution - Botswana







LMM incidence (% pop)
for March
Jan forecast for System 4

Plots Jon Lauderdale