Towards integrating applications within end-to-end seamless ensemble prediction systems – A case for Africa first?

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with acknowledgements to Anne Jones and Alexandre Gagnon

UNIVERSITY OF LIVERPOOL

Talk structure

- WCRP Strategy
- Project links
- African dimension
- Role of users
- Challenges facing users (end-to-end)
- Going seamless towards and beyond
- Summary

A Thought

"Our planet is filled with marvelous science-based opportunities for improving human welfare at a tiny cost, but these opportunities are often unrecognized by policymakers and the public."

Jeffery Sachs, Director, Earth Institute at Columbia University

writing about Neglected Tropical Diseases in Scientific American

WCRP Strategy

Progress in understanding the variability and predictability of individual components of the climate system … and to apply research results for the benefit of society … to address the seamless prediction of the climate system from weekly weather to seasonal, interannual, decadal and centennial climate variations and anthropogenic climate change … and contributing to the socio-economic welfare and the sustainability of modern societies and their supporting environments.

to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. In moving to provide a broader suite of products and services to a larger group of users, the WCRP is re-prioritising its activities to optimise societal benefits.

Source: http://wcrp.wmo.int/About_Strategy.html

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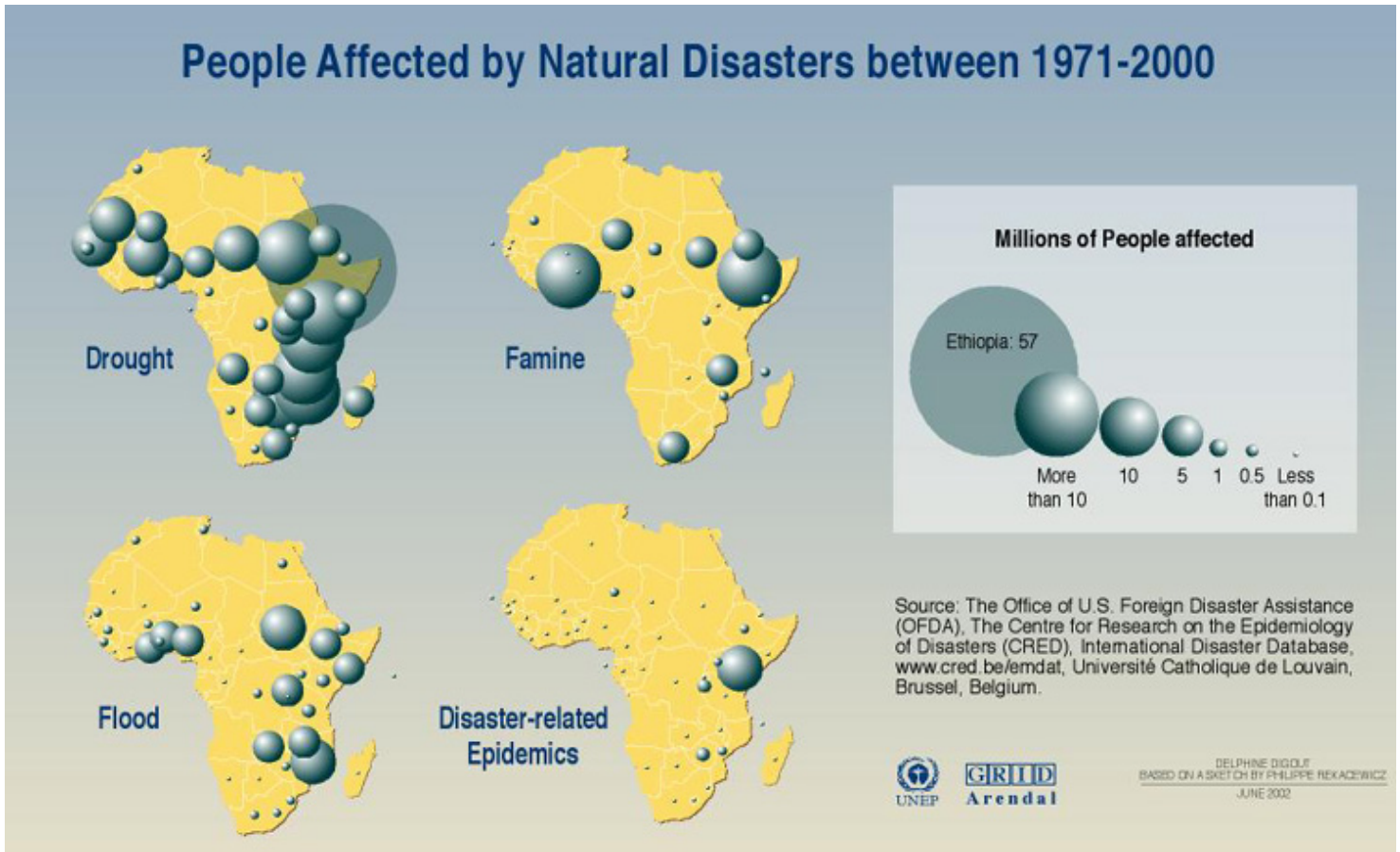
Project links

- EC FP5 DEMETER – seasonal ‘end-to-end’ in practice
- EC FP6 ENSEMBLES – s2d, ACC (AOGCM, ESSM, RCM) – towards seamless ideas and user challenges
- EC FP6 and NERC-UK AMMA –observation, user validation, model development, model applications EPS, training
- THORPEX & THORPEX-Africa out to 15 days

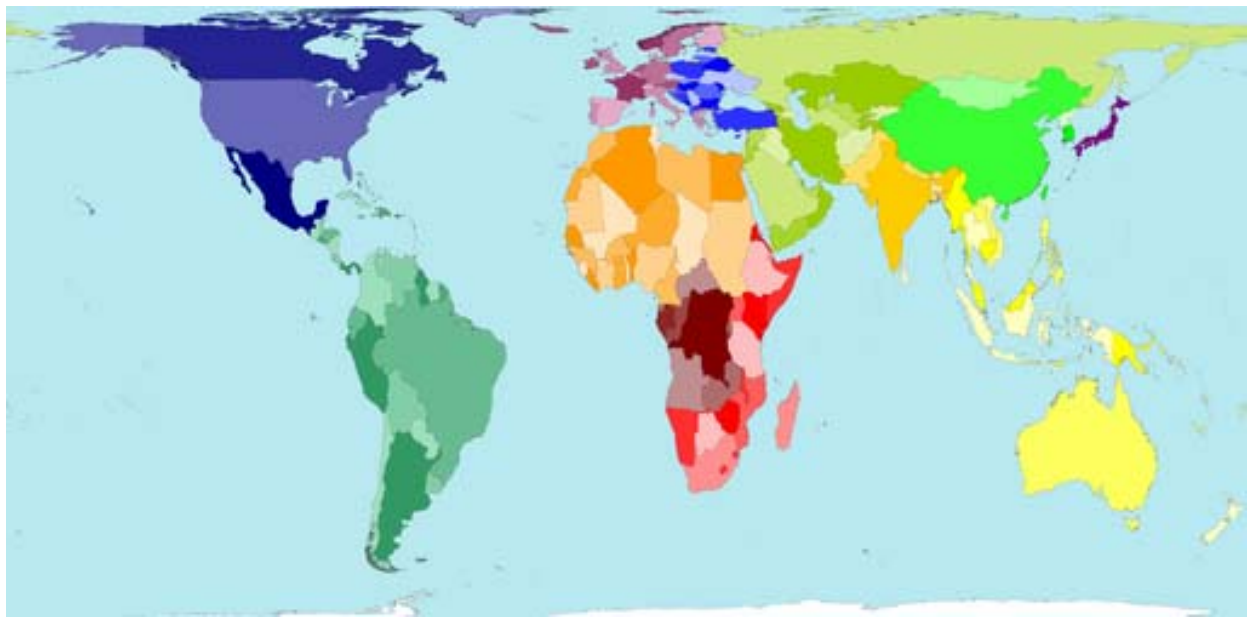
African dimension



Source: UNEP GRID Arendal http://www.grida.no/

African dimension

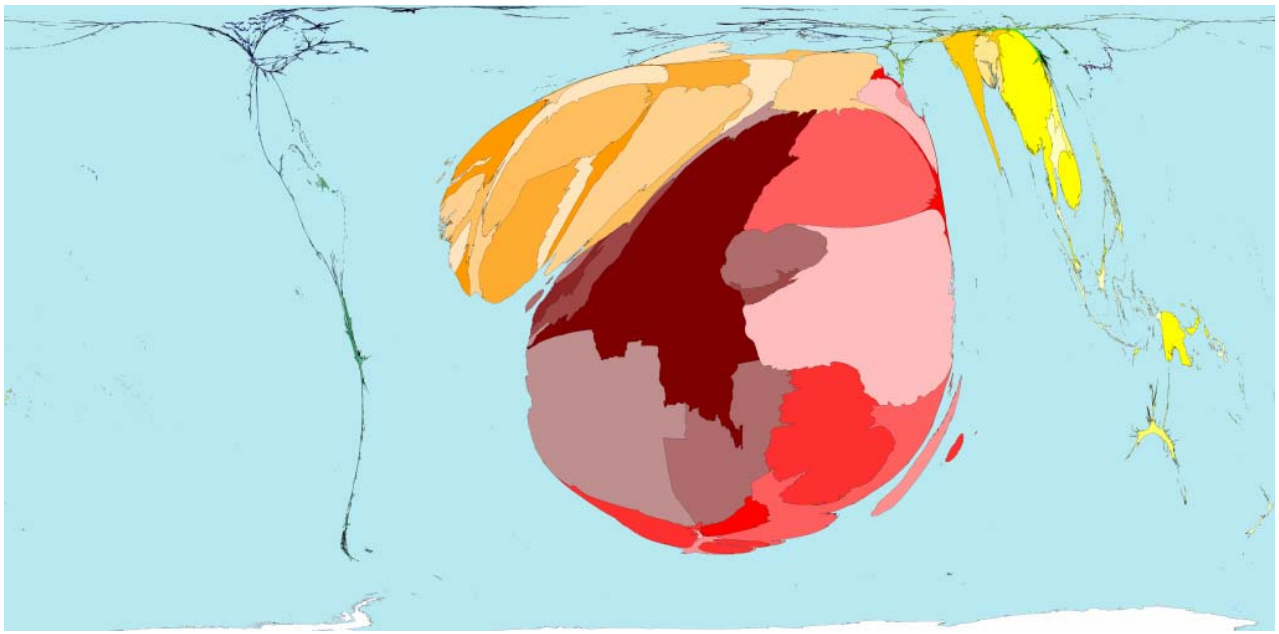
WorldMapper – Peters equal area projection



Source: http://www.worldmapper.org

African dimension

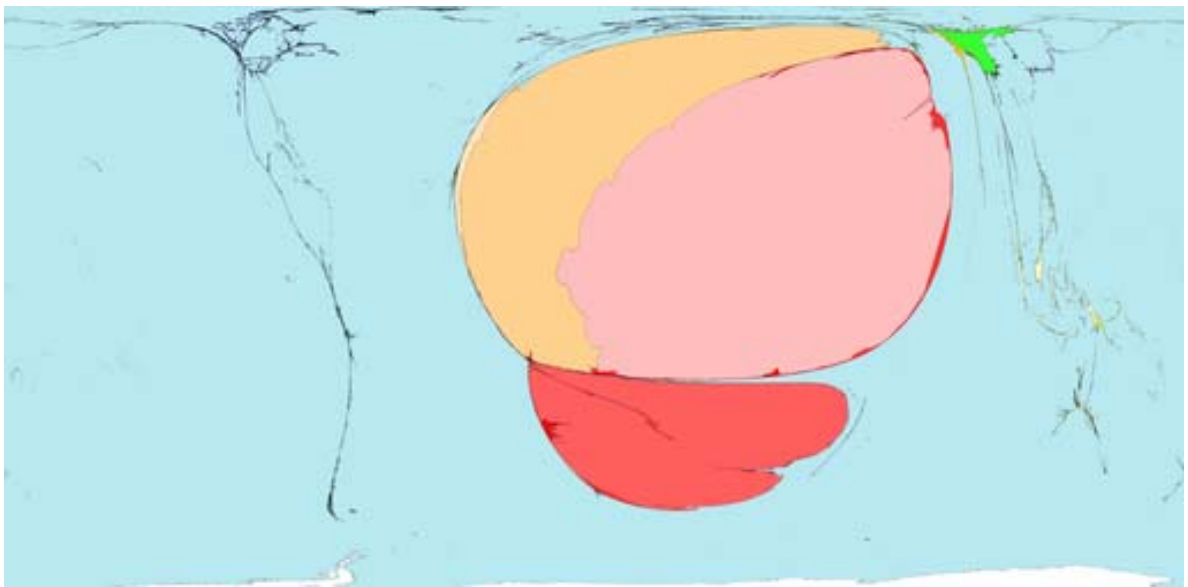
WorldMapper – Malaria Deaths



Source: http://www.worldmapper.org

African dimension

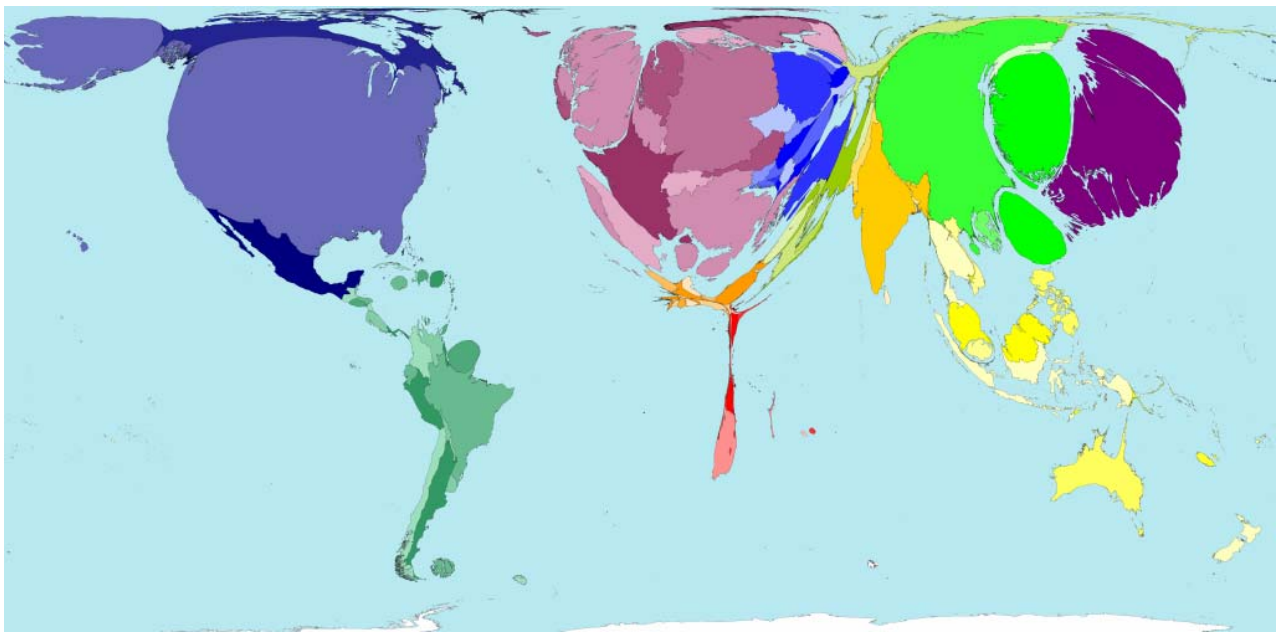
WorldMapper – Killed by drought – 1975-2000



Source: http://www.worldmapper.org

African dimension

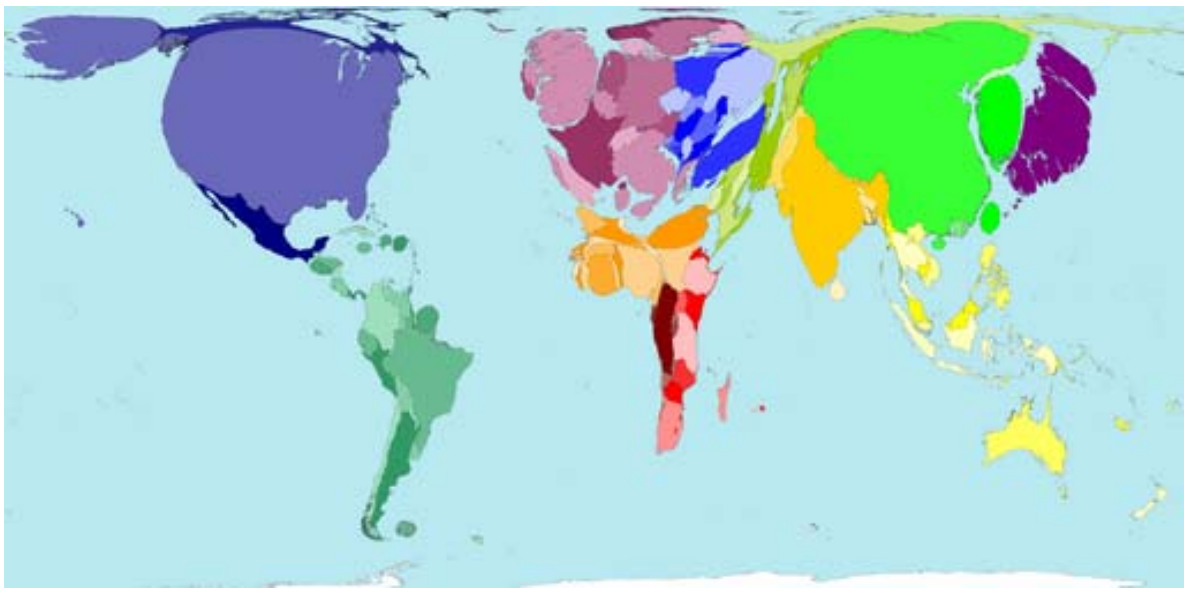
WorldMapper – Internet Users 2002



Source: http://www.worldmapper.org

African dimension

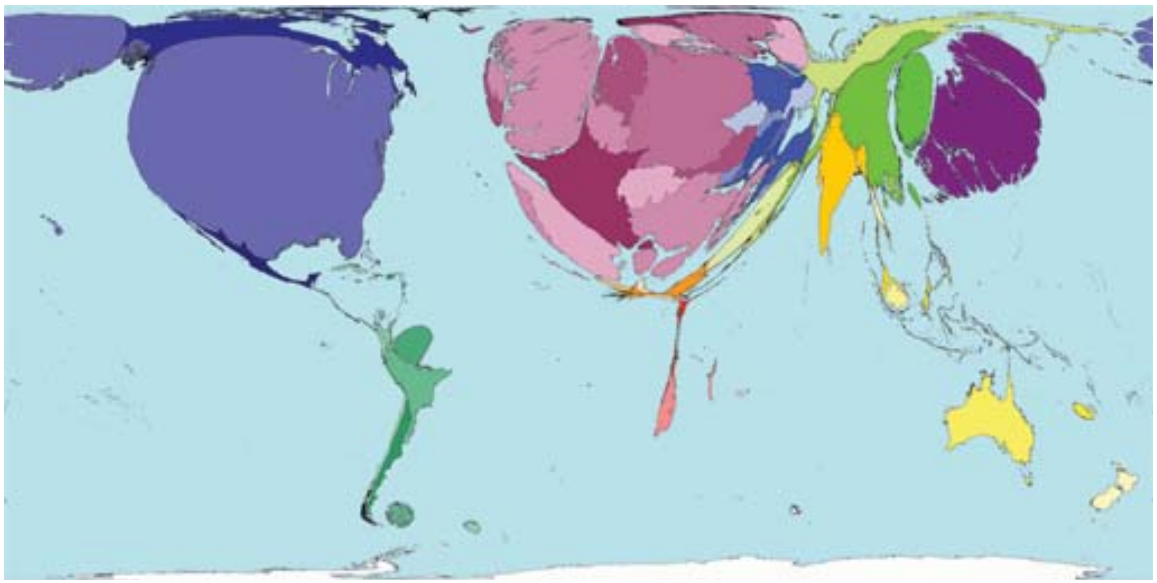
WorldMapper – Radios in use



Source: http://www.worldmapper.org

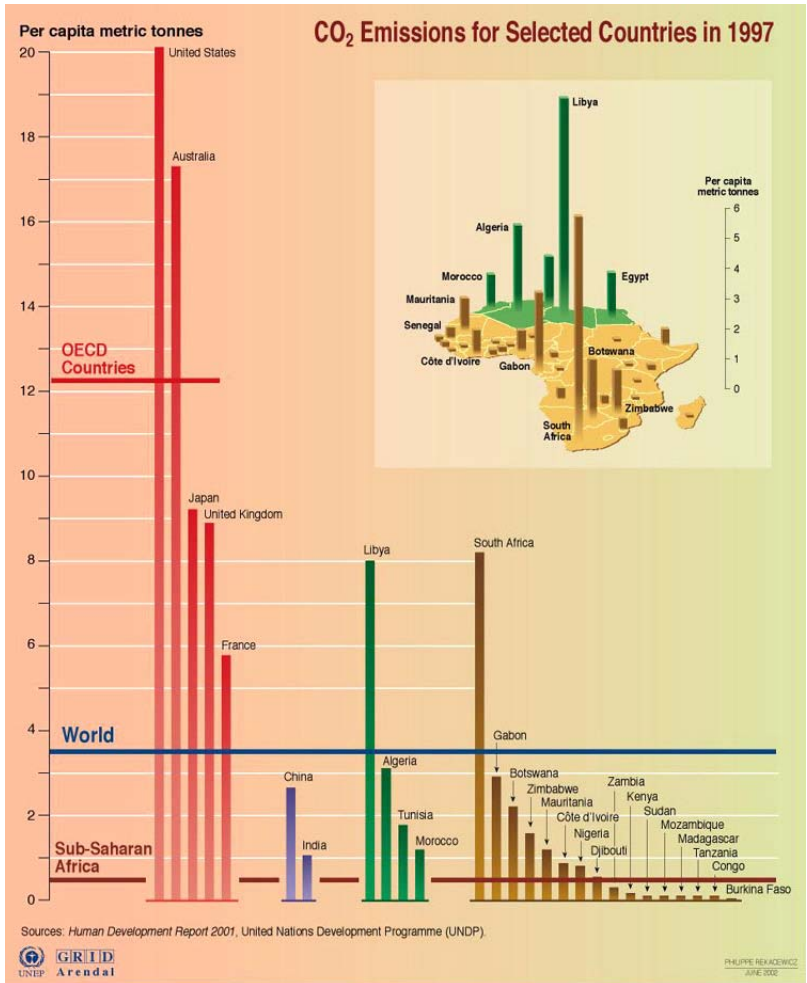
African dimension

WorldMapper – Science Research – based on papers published 2001



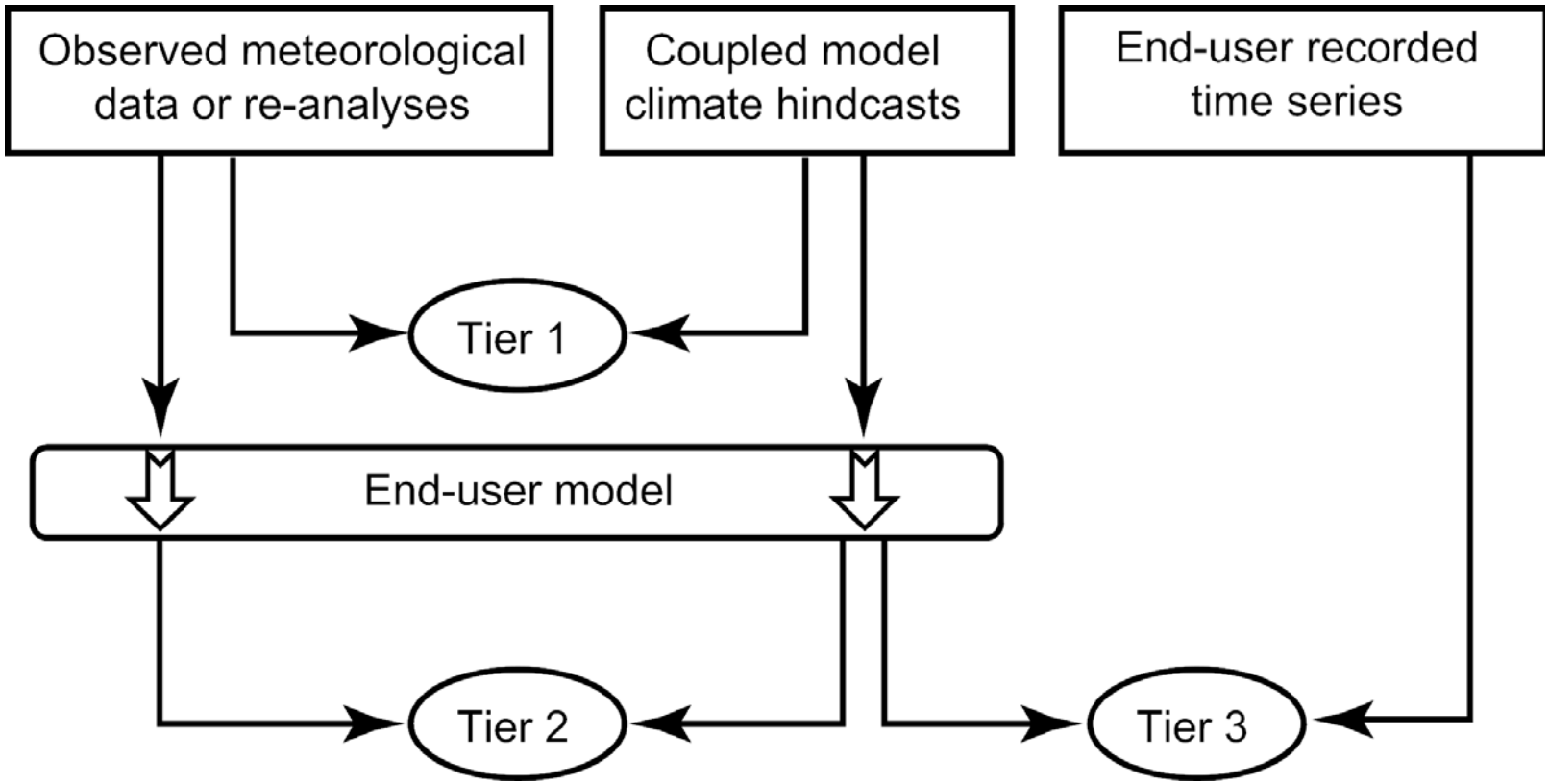
Source: http://www.worldmapper.org

African dimension



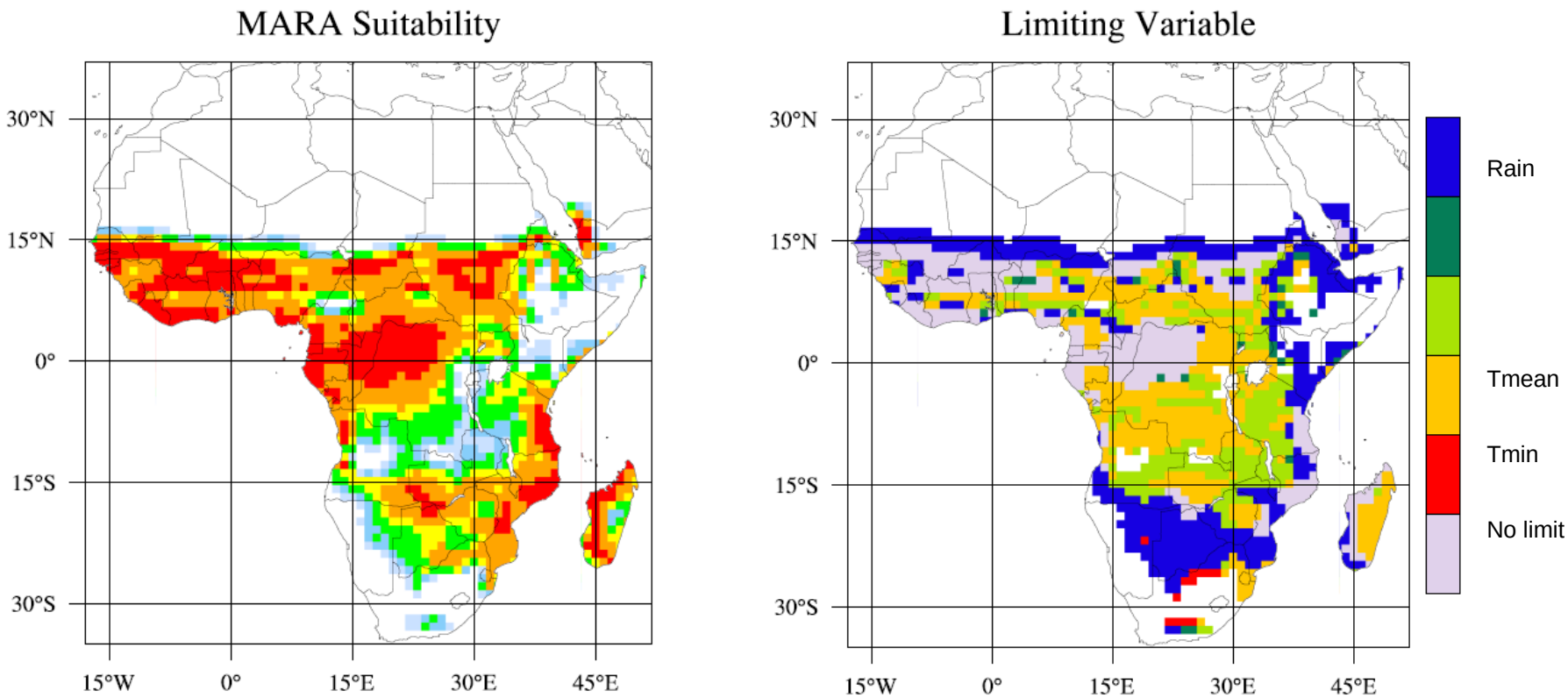
Source: UNEP GRID Arendal http://www.grida.no/

Role of users



from Morse et al. (2005)
Tellus A 57 (3) 464-475

Role of users –MARA transmission map



Based on model Craig et al. 1999 www.mara.org.za
run with ERA-40

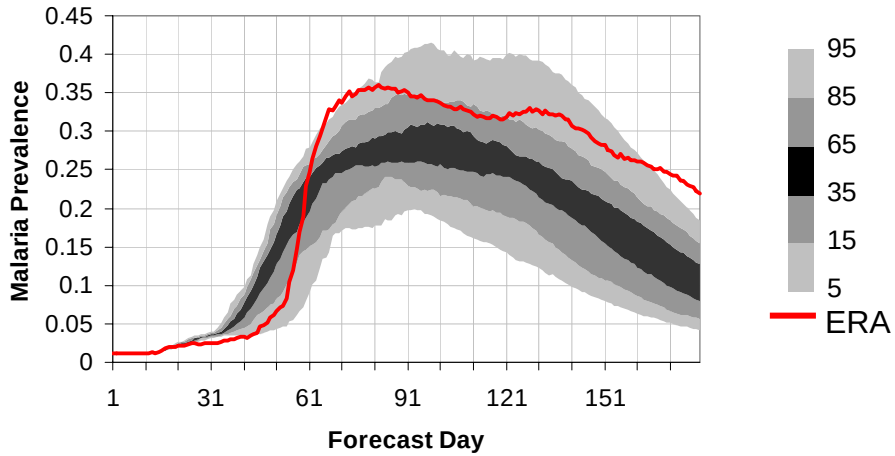
slide from Anne Jones, University of Liverpool

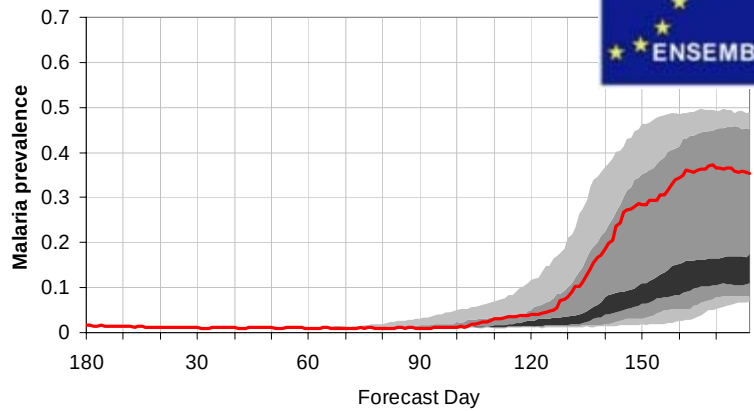
Role of users

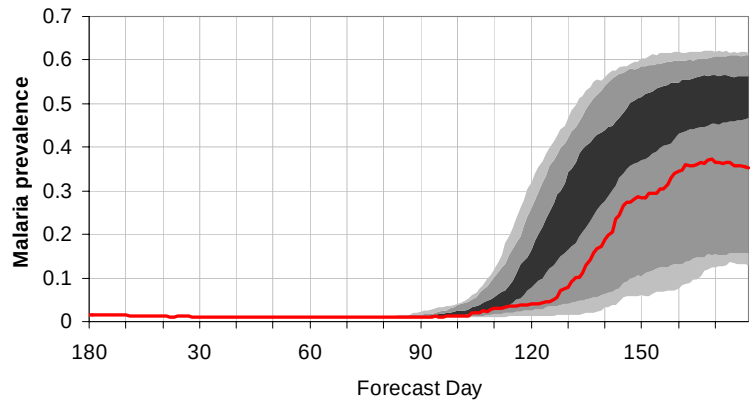
- Allow non-linear mapping of combined ensemble PDFs through time
- Allow assessment of downscaling, dressing of ensembles etc.
- Real test of simple strawman models
- Define forecast skill and potential user/societal value
- Make link to decision makers/stakeholders
- Allow linkage across modelling streams – semi seamless approach
- Allow assessment of skill improvement across model cycles.

- African users – clear forecasting needs for rains – onset, break cycles, cessation – intraseasonal and interseaonal – early warning of high impacts events

Role of users – malaria plumes







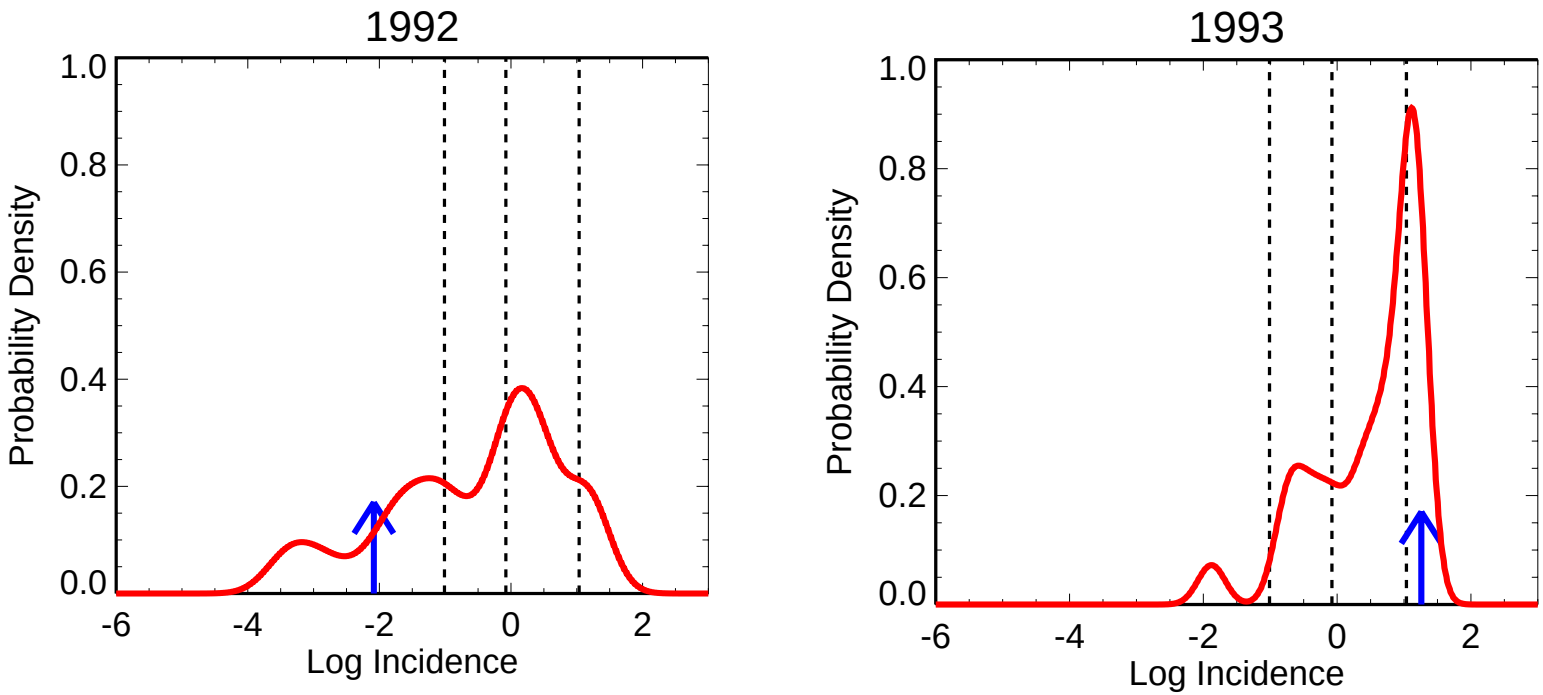
Botswana malaria forecast for February 1989, LMM driven by DEMETER multi-model

(ERA-driven model shown in red)

All plots unpublished Anne Jones, University of Liverpool

- **November 1997 start**
- Improvement in skill due to temperature correction
- If temperatures too low, delay in model is increased

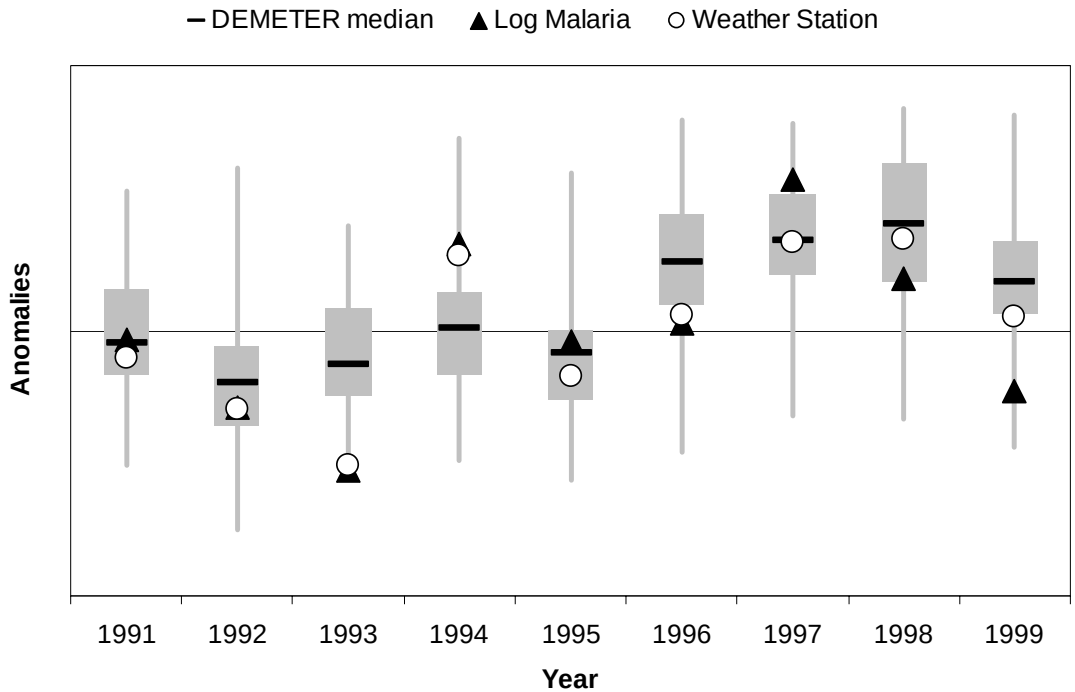
Role of users - Statistical Model Malaria PDFs



The probability distribution functions of predicted standardized log malaria annual incidence for the years 1992 (anomalously low incidence, left) and 1993 (anomalously high incidence, right) computed with the DEMETER multi-model ensemble forecast system are depicted in red. Observations Botswana Ministry of health in blue

from M.C. Thomson, F.J. Doblas-Reyes, S.J. Mason, R. Hagedorn, S.J. Connor, T. Phindela, **A.P. Morse**, and T.N. Palmer (2006). Malaria early warnings based on seasonal climate forecasts from multi-model ensembles, ***Nature***, 439, 576-579.

Role of users - Tanzania statistical malaria model



Jones et al. 2007 Fig 5d (submitted)

Statistical model 'C3' driven by Feb-Jul DEMETER pptn and Aug-Jan. Tmx ob. Giving box-whisker malaria prediction Apr-Sep – obs. driven control, obs. malaria - all standardised anomalies.

Challenges facing users – experience to date

Working with an end-to-end EPS (non exhaustive and seasonal scale experience and still in R&D mode)

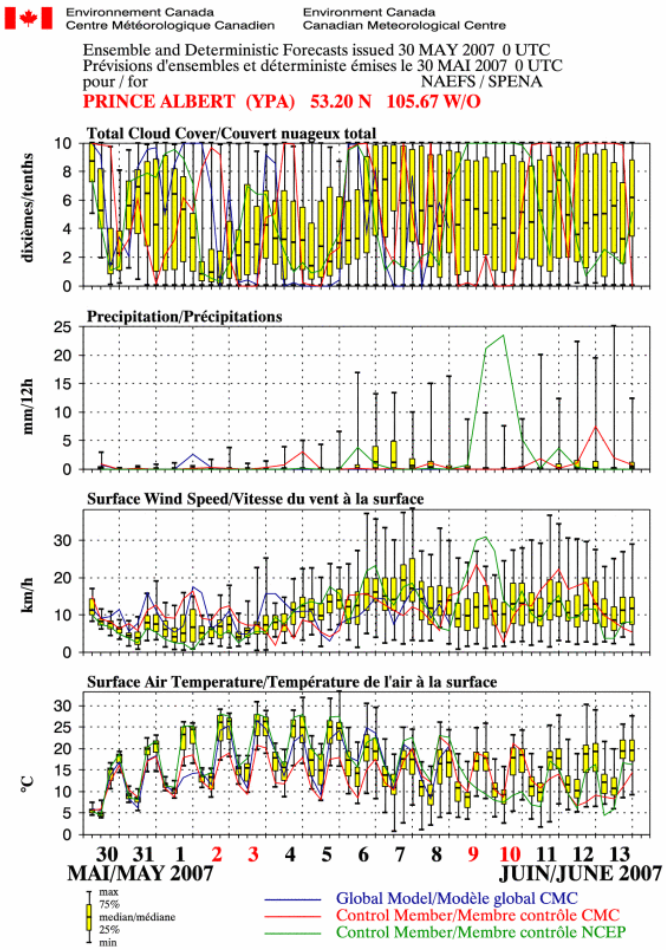
Technical/scientific

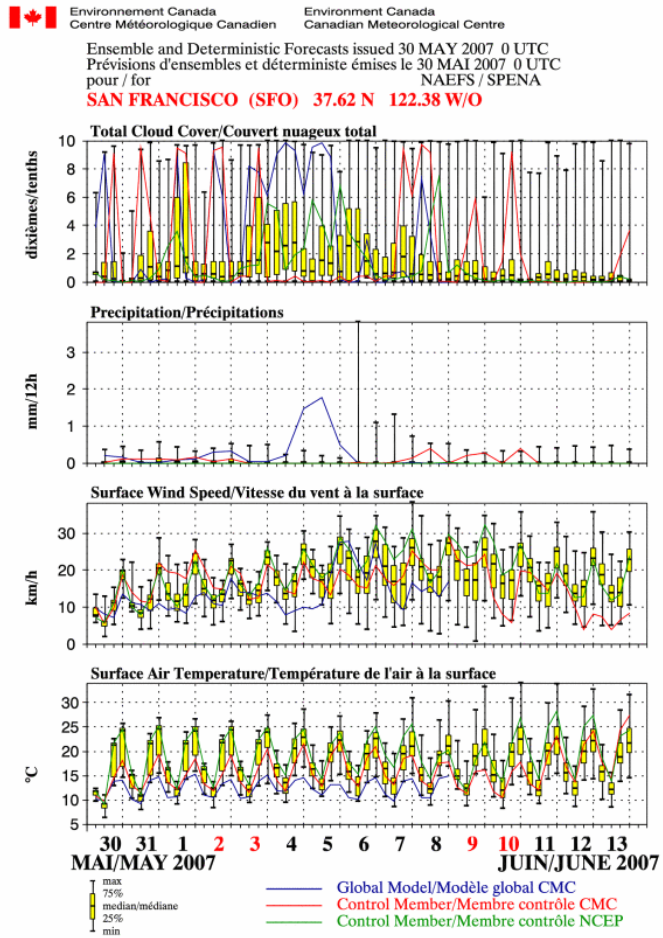
- downscaling and bias correction,
- weighting and dressing of ensemble members
- **model climates**
- development of user methodologies and models
- validation for and by users
- defining skill in forecasts and ultimately their **value**

Structural

- training of forecasters in EPS (with users)
- dissemination of products to users
- lack of feedback to forecasters from users
- buy in of decision makers and social scientists – inclusion in early warning systems

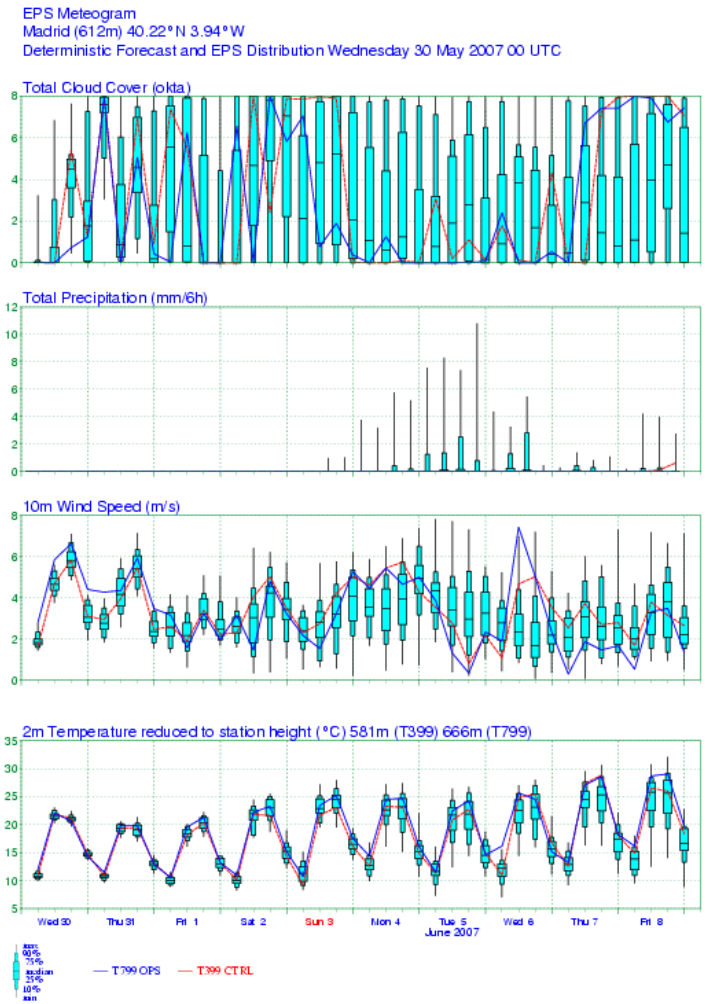
Challenges facing users - EPSgrams – who sees?

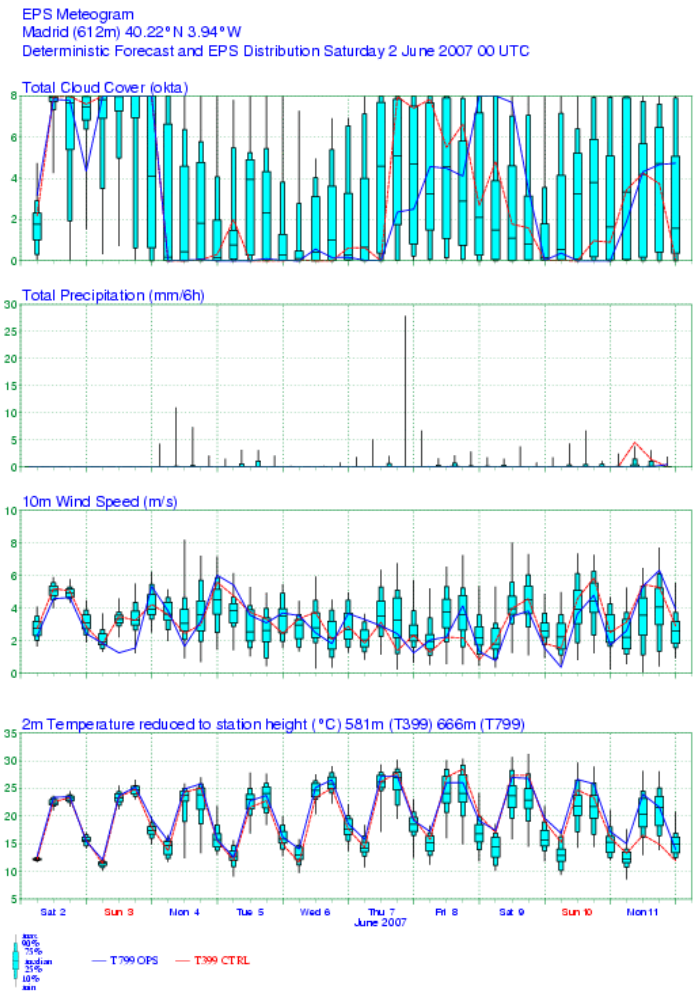




Charts from Environment Canada

Challenges facing users - EPSgrams – who sees?





Charts from ECMWF

Going seamless - towards

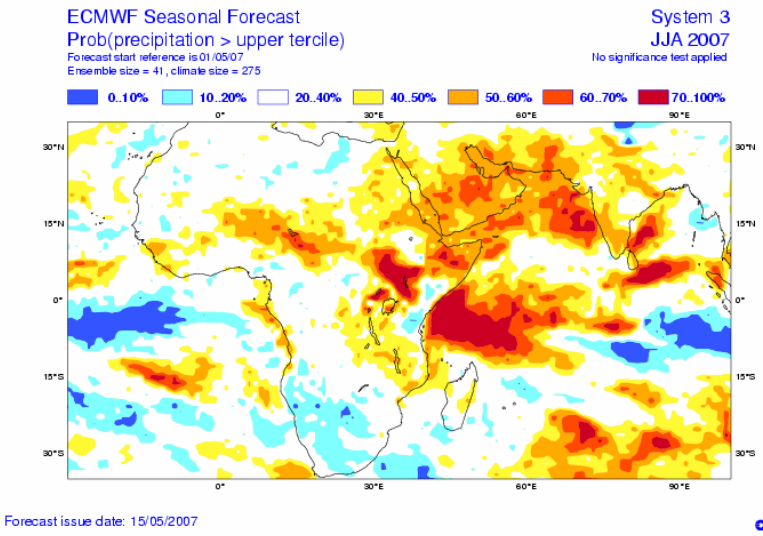
Suggested seamless ranges – open to discussion

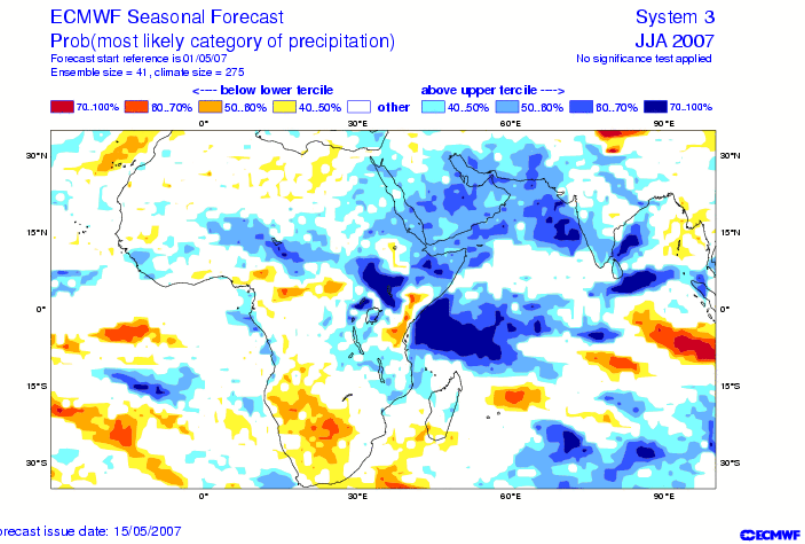
- Medium range, monthly, seasonal – WCRP-WWRP interface
- Seasonal, interannual, decadal - ENSEMBLES
- Seasonal, interannual, decadal, centennial

Suggested seamless approaches

- Application models across modelling streams – ENSEMBLES
- Grand ensemble approach – THORPEX medium range
- Ensemble dressing

Seasonal products – tailoring – not off the peg?





Which one works best for you?

Charts from ECMWF

Is that the same for the user community?

Climagram – Sahel – precipitation area average

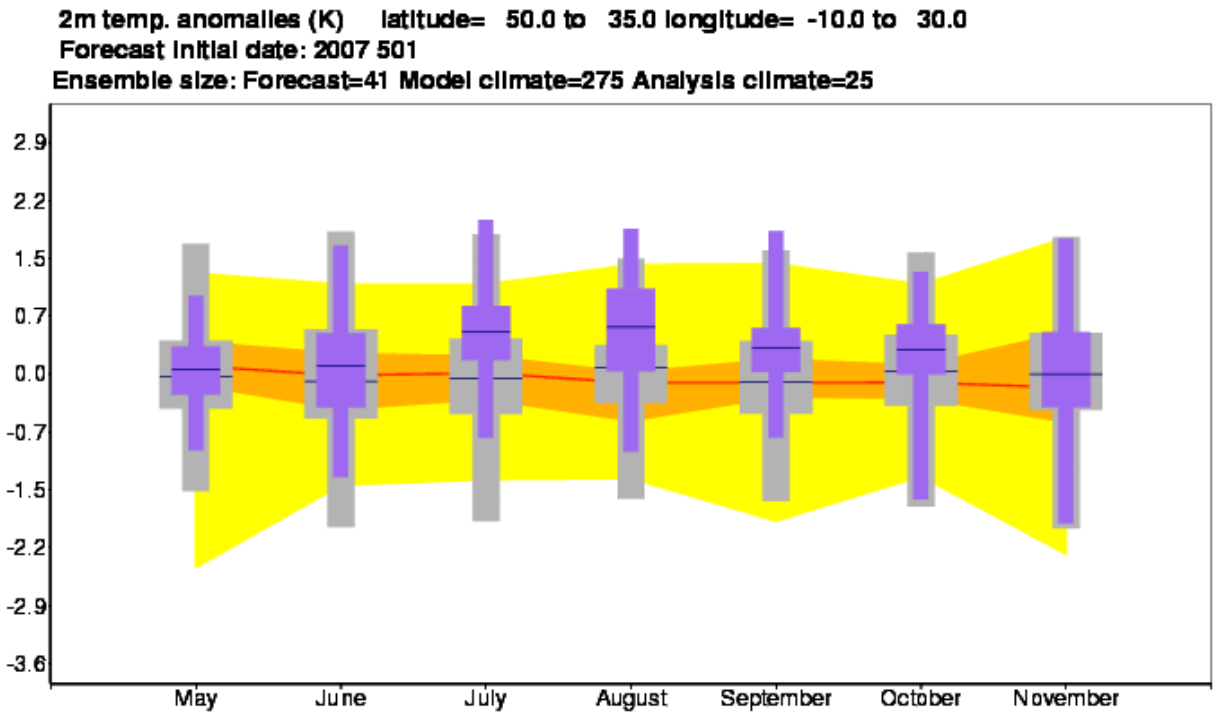


Chart from ECMWF

Purple - seasonal forecast
Grey – model climatology
Yellow-orange – analysis 25 year hindcast period
Whiskers and yellow band 5th to 95th percentile
Box and orange band interquartile range

Going seamless towards and beyond

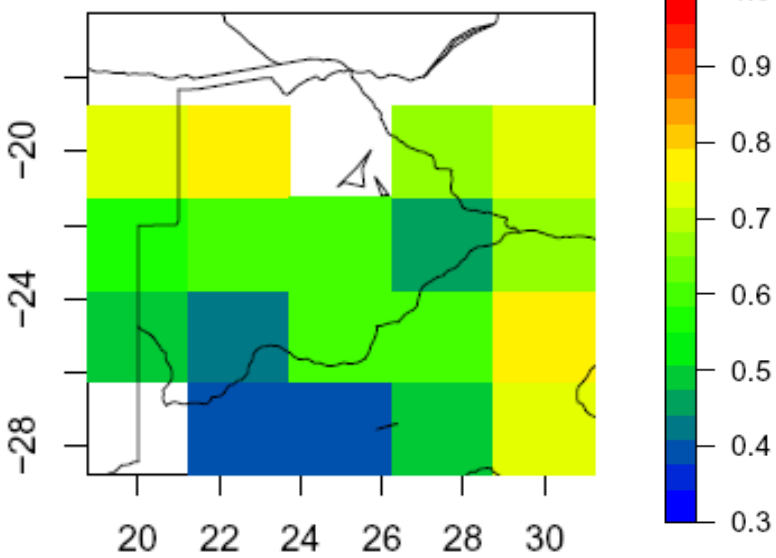
seamless (non exhaustive – other critical challenges will emerge)

- Weighting, dressing, lagging … of EPS pdfs (daily time series)
- Cutting edge science – UK NERC Climate Variability and Change strategy
- Variable model resolution – interpolation, calibration with topography issues?
- **Stock of simple dynamic models** (SDMs) multivariable – Tier 2 validated
- Integration applications models – **seamless user output**?

Botswana malaria & predictability

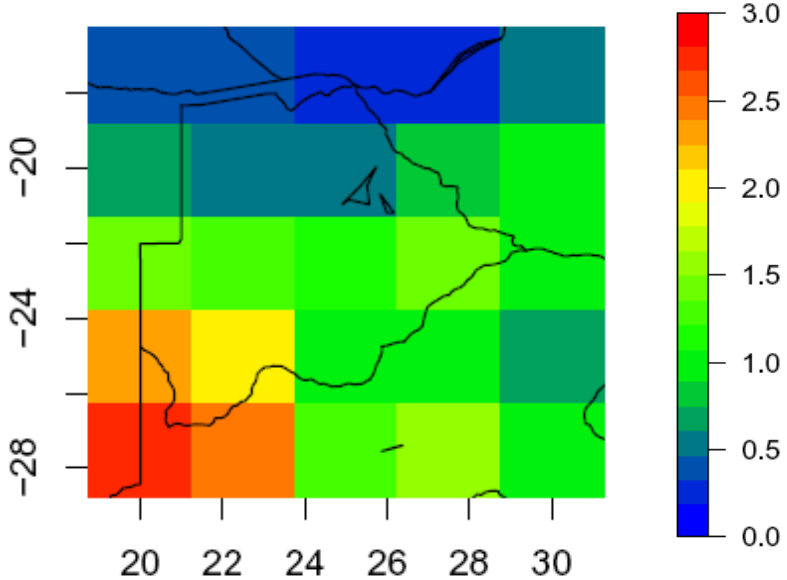
Time-averaged R (after Stern and Miyakoda, 1995) for Botswana Malaria incidence – February forecast

Feb 2-4



R

Feb 2-4

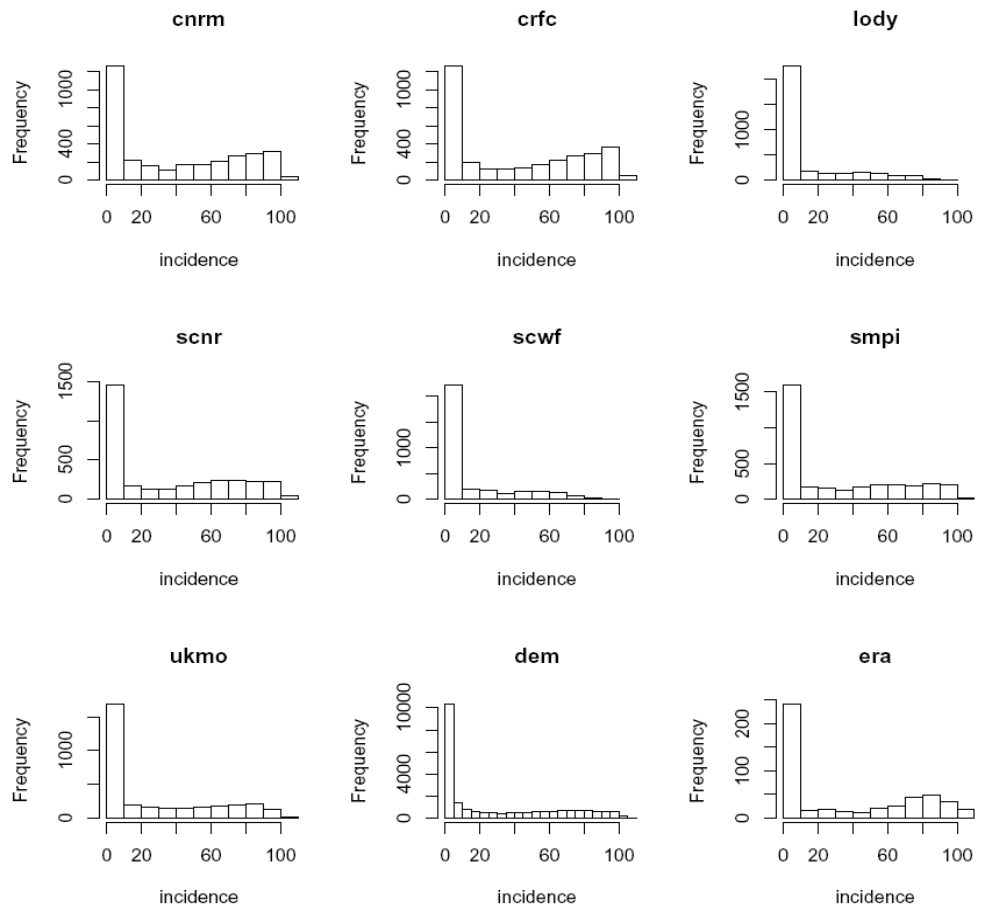


DEMETER CoV

1982-2001 averages of R, malaria incidence for DEMETER multimodel using bias-corrected temperature. Mask ERA<1 case per 100 people per month, CoV<0.5, **slide from Anne Jones**

Botswana malaria & predictability

Distributions of Malaria Incidence for each model and multi-model



"Epidemic" grid points, Feb 2-4

Slide from Anne Jones

Going seamless towards and beyond

Interdisciplinary approach

– continuum forecasters, forecast developers, user models, training of forecasters and users, links to decision and policy makers and economic impacts.

Why Africa? Continent vulnerably - climate variability, sentinel for climate change. Seamless forecasts (days to seasons) impact planning and delivery of humanitarian aid and longer term economic development.

Early warning systems working across a range of time horizons (seamlessly)

Need for training and pilot projects and connection with the Regional COFs - connections with in-region agencies ACMAD, WHO MDSC

Why seamless? Product cut-off – abstract and not real world.

Certain applications only short range others (biological systems) months. All need variability at sub-10 day scale - even daily scale.

Summary

- Experience in integrated EPS – promising results (DEMETER, ENSEMBLES)
- Elements of Integrated Seamless Ensemble Prediction System (**IS-EPS**) in place (ENSEMBLES, THORPEX)
- Clear seamless forecast demand in Africa
- Outreach to users and decision makers (AMMA, THORPEX-Africa)
- Need for pilot projects and training

- Seamless and societal benefit from forecasts cornerstone of the Climate System – Variability and Change WCRP

AFRICA BREAK-OUT SESSION
-Wednesday 19.00 to 21.00 (Chair: A. Morse)

This meeting is being co-organised with UNESCO and is for **all** those who are working on climate variability and its impacts in Africa and for those from the wider forecasting and forecast development communities.

We plan to discuss (i) how to improve the interaction between those with expertise of new forecast products that could improve the prediction of climate variability in Africa to support user applications and (ii) what is required to train and support local forecasters, including the tailoring of products, and the forecast user communities.

Agenda
1. Prediction-user groups interaction
2. Regional prediction
3. New Forecast Products and their tailoring to needs
4. Ocean forecasts for large marine ecosystems (LME) and long range forecasts