P3.1 IMPROVING OUR KNOWLEDGE OF AFRICAN WEATHER AND CLIMATE – CLIMATE SCIENCE RESEARCH PARTNERSHIP (CSRP)

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1. INTRODUCTION

The Climate Science Research Partnership (CSRP) is a 3 year program between the UK Department for International Development and the Met Office Hadley Centre. The project aims to improve our knowledge of weather and climate processes over Africa, to improve model predictions and simulations of the atmosphere and to engage with UK and African partners to facilitate the usability of forecasts and science results. Here we present some key science findings from the CSRP so far to give a broad flavour of current Hadley Centre research.

For more information on all CSRP activities go to: http://www.metoffice.gov.uk/csrp

2. UNDERSTANDING WEATHER AND CLIMATE DRIVERS AND PROCESSES OVER AFRICA

A significant science component of the CSRP has been the evaluation of African Climate in the Met Office Hadley Centre climate and seasonal forecast models. Through assessment, model experiment and observation interpretation, the program aims to improve understanding key local processes of African Climate along with remote influences driving African climate in models. The role of land-atmosphere coupling on the water cycle is being investigated along with other influences on African rainfall systems.

2.1. Land surface to atmosphere interactions

This work investigates the impact that large scale soil moisture patterns have on the onset of the West African monsoon.

The average monsoon rainfall signal from two 16 member ensembles of Met Office Unified Model (MetUM) seasonal runs were inspected. The ensembles were:

a) Control ensemble – free running soil moisture.
b) Prescribed soil moisture: all members were forced to have the same soil moisture, in this case a member where it was dry early in the season was used to prescribe soil moisture to all other members.

In both ensembles, the characteristic WAM onset "jump" could be seen in hovmoller diagrams. A difference plot showed an apparent northward shift in rainfall when soil moisture was prescribed.

The bar graphs in Fig. 1 show onset date for each individual run.

- When soil moisture is prescribed, there was a reduction in the spread of dates.
- The impact of the soil moisture on these West African Monsoon diagnostics suggests that large scale circulation plays a major role in the coupling strength.

Further prescribed soil moisture experiments have been conducted and a similar narrowing of onset dates was found. In general the state of prescribed soil moisture also made a difference to onset date. Ensembles forced with wetter soils produced later onset and ensembles forced with drier soils produced earlier onset. Work on understanding the processes which lead to this relationship is ongoing.

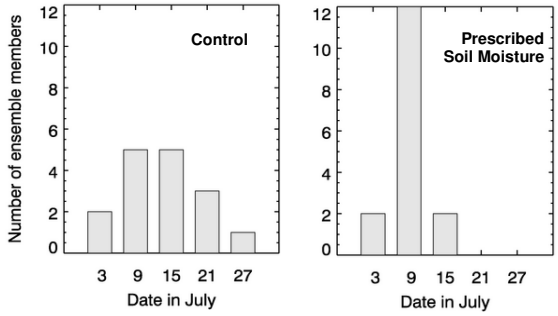

Figure 1: Onset date versus count for (left) control seasonal forecast ensemble; (right) prescribed soil moisture ensemble.

2.2. African Easterly Waves

A new automated tracking algorithm has been developed to identify African Easterly Waves in model data. The algorithm is analogous to manual tracking, can be used on any model resolution and can be used for real time weather, seasonal and climate models.

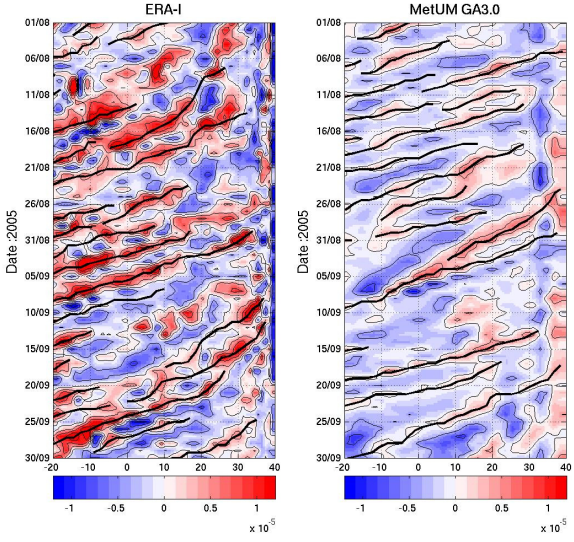

Figure 2: Hovmoller (longitude-time) diagrams of curvature vorcitiy (shaded) with tracked African Easterly waves shown by black lines. LEFT: ERA-Interim reanalysis data; RIGHT: MetUM atmosphere-only climate model

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The algorithm is being used to assess the MetUM family – from operational weather forecasting to climate modeling. Initial findings have identified issues with the strength and frequency of waves in the model, and a reduction in model rainfall coupling compared to reanalysis and observations.

2.3. Teleconnections

Connecting patterns in sea surface temperatures and rainfall trends have long been a source of statistical seasonal forecast skill in many parts of Africa. Current CSRP work has been looking at how well real-world teleconnections are reproduced by the Climate Model Intercomparison Project (CMIP) models.

Findings so far indicate that teleconnections that are difficult to model include:

- Equatorial Atlantic to Sahel.
- El Nino Southern Oscillation to Kenya-Somalia.

Teleconnections that many of the CMIP models represent well include:

- Indian Ocean to Tanzania.
- Indian Ocean Dipole to Kenya-Somalia.
- Mediterranean to Sahel.

In general, it can be said that all CMIP models struggle with some SST teleconnections to Africa and improving teleconnections will likely lead to improvements in seasonal forecasting and climate change modeling over Africa.

2.4. Intertropical Convergence Zone

The ITCZ (the main region of large scale convergence and rain) moves north and south over the African continent with the seasons. It does not follow the same path northwards as southwards. In the northern hemisphere spring time it moves from southern Africa westwards over the Gulf of Guinea. At this time sea surface temperatures (SSTs) in the Gulf of Guinea are at their warmest. In September to November the SSTs are much colder, so the maximum of convection is far more concentrated over the land (Central Africa). This is the maximum time for rainfall for Central Africa – Cameroon and Congo region.

Current research is looking into the migration of the ITCZ in the MetUM, with the aim of reducing the amount of unrealistic light rain in the model and improving representation of deep convection over Africa.

3. IMPROVED EARLY WARNING SYSTEMS AND ADAPTATION PLANNING

Early project consultation with African stakeholders indicated a strong desire for good seasonal forecasts of the onset of rainy season. In West Africa the monsoon onset is typified in climatology by a "jump" in the rains from 5°N to 12°N.

Recent versions of the MetUM seasonal forecasting system GloSea4 have shown good climatology representation compared to older versions and other models. Some predictive skill has also been found, and new products are currently being trialled with African Meteorology Centres

4. REGIONAL CLIMATE MODELING

A configuration of the prototype Regional Climate Model (RCM) version of MetUM has been defined and tested for use in trial downscaling of seasonal forecasts over Africa and downscaling climate simulations within the CORDEX programme. The new configuration will be incorporated into the Met Office PRECIS system (Providing REgional Climates for Impacts Studies).

Resolution

Improvements in mean error were found at 50km and 25km compared to 135km. However the 25km version did not always out perform the 50km, suggesting resolution is not the only factor influencing performance.

Including Aerosols and Desert Dust

Control (no dust) and interactive dust experiments showed cold biases over the Sahara desert and a warm bias the western Sahel and Congo basin. Introducing an aerosol climatology led to significant improvements in the surface air temperature biases over much of northern Africa.

Convection parameterisation

Increasing rates of entrainment in the convective parameterisation scheme improved biases in rainfall over Africa (and the tropics in general) in the MetUM. The entrainment changes are unphysical, so current investigation is looking into why the change is leading to such improvements in convection representation and if this can be replicated by a more realistic change to parameterisation.

5. CAPACITY BUILDING IN AFRICA

The CSRP is sponsoring 11 fellowships for African scientists. The scientists are being mentored by Hadley Centre scientists who are also working on CSRP projects. The fellows' projects will contribute to the overall science objectives.

The CSRP is also providing training workshops to users in Africa of the dynamical-model seasonal forecast products. The workshops aim to introduce more usage of dynamical forecasts (i.e. model forecasts) in addition to the current reliance on statistical indicators for prediction of rainy seasons.

This training will be put into practice during preparation of consensus outlooks during the Regional Climate Outlook Forums (RCOFs) which take place across Africa.

6. SUMMARY

The Climate Science Research Partnership (CSRP) between the UK Department for International Development and the Met Office Hadley Centre aims to improve our understanding of African weather and climate, and ultimately improve forecasts over Africa.

This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

For more information on the CSRP, visit:
http://www.metoffice.gov.uk/csrp