# ASSESSMENT OF GLOSEA4 SEASONAL FORECASTS FOR SADC AND THE GLOBAL OCEANS

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## 1. INTRODUCTION

Seasonal forecast skill over southern Africa may improve through the combination of forecasts. In the southern African region, however, only a small number of institutions have the capability to run global models operationally which can feed into multi-models. Moreover, coupled ocean-atmosphere models have the ability to outscore atmospheric models, also for southern Africa (Landman et al., 2012). The main objective of this paper is to demonstrate the skill of the UK Met Office Hadley Centre's coupled global seasonal forecasting system (GloSea4: Arribas et al., 2011) as a seasonal forecasting tool for SADC and for the global oceans. In addition, the value of including GloSea4 forecasts into multi-model systems is tested. These investigations are conducted by testing the model's ability to predict seasonal rainfall totals during the austral spring (SON), mid-summer (DJF) and autumn (MAM) seasons over the region, and for monthly sea-surface temperature anomalies during mid-summer. The model's ability to simulate SADC's intra-seasonal rainfall and low-level circulation characteristics is also investigated.

## 2. DATA AND METHOD

The deterministic skill of GloSea4 over SADC is tested by downscaling 14 years (1996 to 2009) of ensemble mean (9 members) hindcasts of the 850 hPa geopotential height fields and the model's precipitation, to the University of East Anglia's (UEA) Climate Research Unit (CRU) version TS3.1 seasonal precipitation data at a 0.5°x0.5° resolution using model output statistics (MOS). In addition to the MOS hindcasts, GloSea4's precipitation fields are directly extrapolated onto the CRU grid, thereby enabling the testing of the model's raw precipitation hindcasts. These projections are done using the CCA option of the CPT (http://iri.columbia.edu). The model domain covers an area from 10°S to 40°S and from 5°E to 45°E. The SADC domain used here is the region of the subcontinent south of 15°S. The same downscaling procedure described in Landman et al. (2012) is used here. For SON the hindcasts are available for the initialization months of August (1-month lead-time) and for May (4-month lead-time), for DJF the hindcasts are available for November and for August initialization, and for MAM, February and November. SST hindcasts over the equatorial Pacific Ocean (Niño3.4) are similarly recalibrated, but to the 1°x1° resolution data of NOAA's OI.v2. The intra-seasonal characteristics of the model are assessed through the methods of self-organising maps.

The rainfall hindcasts are also judged probabilistically. In order to generate probabilistic rainfall output, GloSea4 ensemble means are retro-actively downscaled to create a 7-year hindcast period from 2003 to 2009 (the CCA calibration is made on the 7-year period 1996-2002). Discrimination (to determine if the hindcasts are discernibly different given different outcomes) is assessed through the calculation of relative operating characteristic (ROC) scores for all available seasons and lead-times.

## 3. RESULTS

The deterministic skill in predicting seasonal rainfall over SADC is assessed first by calculating Kendall's tau ranked correlations between observed (CRU) and 3-year-out cross-validated hindcasts over 14 years. Figure 1 shows the Kendall's tau differences between raw model rainfall and downscaled rainfall hindcasts

– negative differences are found where the downscaling outscores the results from the raw model precipitation output, therefore justifying the use of statistically post-processing the model data. The best result is found when using 850 hPa heights as predictor in the MOS model.

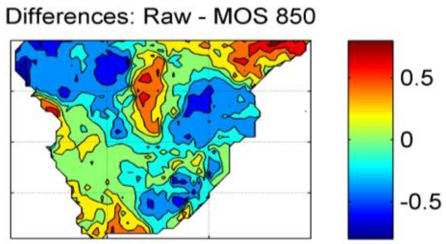


FIG. 1. Skill (Kendall's tau ranked correlation) differences between raw GloSea4 DJF rainfall and downscaled rainfall. Downscaling is performed using the model's 850 hPa geopotential heights of the DJF hindcasts initialized in August.

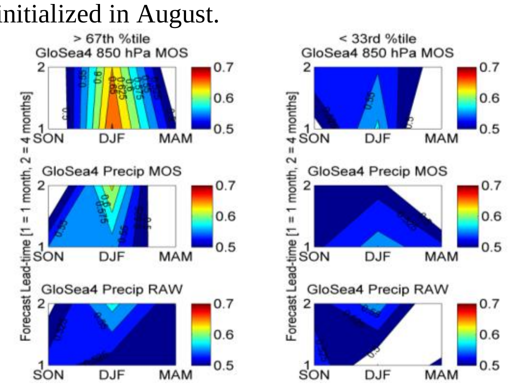


FIG. 2. ROC scores for SADC for the 7-year retro-active test period.

Figure 2 shows the ROC scores for the SON, DJF and MAM seasons at a 1- and at a 4-month lead-time. ROC scores for only the above- and below-normal categories are presented. GloSea4 is best able to discriminate wet DJF seasons from dry seasons, and using the low-level circulation of the model in a MOS system improves on the raw precipitation hindcasts of the model. A weighted combination of GloSea4 hindcasts with ECHAM4.5-GML-CFSSST hindcasts (see Landman et al., 2012) in a multi-model system improves on the skill of each of the models (not shown owing to space limitations), subsequently justifying the use of a multi-model with GloSea4 as one of the component models. Figure 3 shows the mean squared error skill score (climatology is the reference hindcast) of the existing multi-model SST forecast system administered by the CSIR, and of an extended system defined by the existing multi-model plus GloSea4 output to predict Niño3.4 SST anomalies. From the figure a general improvement, albeit marginal, in the skill is found with the multi-model which includes GloSea4 hindcasts – with most improvement in the longer lead forecasts.

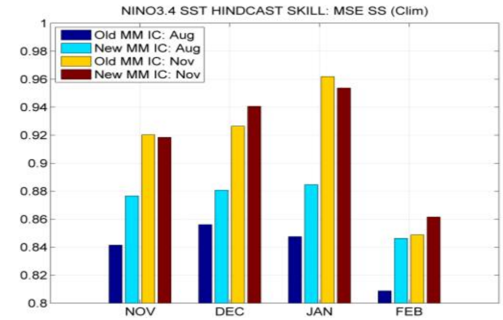


FIG. 3. MSE skill scores predicting Niño3.4 SST with recalibrated hindcasts from the current multi-model system ('old') and from a multi-model system that includes GloSea4 hindcasts ('new').

## 4. CONCLUDING REMARKS

Seasonal forecasts from the GloSea4 system have been tested in this study. It was found that this coupled model has the ability to predict seasonal-to-interannual variability at elevated levels of skill over the larger part of southern Africa and over the tropical oceans. Both of these outcomes are of importance for southern African forecast users as well as modellers responsible for developing forecast systems, including multi-models. The model's ability to simulate intra-seasonal characteristics was also assessed (not shown here as a result of space limitations) and it was found that the model is able to capture some of the well known synoptic structures over the region.

*Acknowledgment: This study was partly supported through a project funded by the UK Department of International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID.*

## 5. REFERENCES

Arribas, A., 13 co-authors, 2011: The GloSea4 ensemble prediction system for seasonal forecasting. *Mon. Wea. Rev.*, **139**, 1891-1910

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