



## **ASSESSMENT OF THE SKILL OF ECHAM 4.5 IN SIMULATING RAINFALL ON SEASONAL TIME SCALES OVER THE GHA REGION**

The study assessed the skill of ECHAM 4.5 in simulating rainfall on seasonal time scales over the GHA region for the period Jan 1961- Dec 2008. The rainfall seasons considered were, March -April- May (MAM) and October- November- December (OND).

The data used in the study included the observed seasonal rainfall totals for January 1961- December 2008 obtained from IGAD Climate Prediction and applications Centre (ICPAC), Nairobi and ECHAM 4.5 model hindcast data sets for the same period obtained from International Research Institute for Climate and Society (IRI). The model has 24 members, where each member represents an ensemble run. The ensemble runs are based on similar initial physical conditions but different initial atmospheric conditions. The atmospheric initial conditions for the 24 members differ because they are generated by adding different small noise perturbations to the same atmospheric state several months before the starting dates.

The methods for analysis included spatial distribution comparison, correlation analysis, root mean square error analysis and the two-sample Kolmogorov-Smirnov test.

The spatial distribution patterns of the observed rainfall did not wholly match with patterns from any of the 24 members or with the pattern of the mean of all 24 members. However, the patterns of some individual members only had small differences with the observation.

The results from correlation analyses indicated bigger coefficients for the equatorial sector (5°N to 5°S) in both seasons. Root Mean Square Error (RMSE) values were also small in the equatorial sector. The northern sector of the region had small coefficients and big RMSE values in both seasons. Large correlation coefficients were obtained for the OND season. RMSE values were also

low for the OND season. Similarly, Two-Sample Kolmogorov-Smirnov test results had higher P values for most of the region in the OND season and in areas with features that enhance convection. For all the analyses made the mean of all 24 members did not show much skill in predicting rainfall, indicating that not all members are appropriate for forecasting in the GHA region. Some individual members, namely, 15, 18, 21, 22 and 24 performed better than the mean of all 24 members in most instances. Comparing the skill of the mean of the 5 members and that of the mean of the 24 members, the mean of 5 members has more skill.

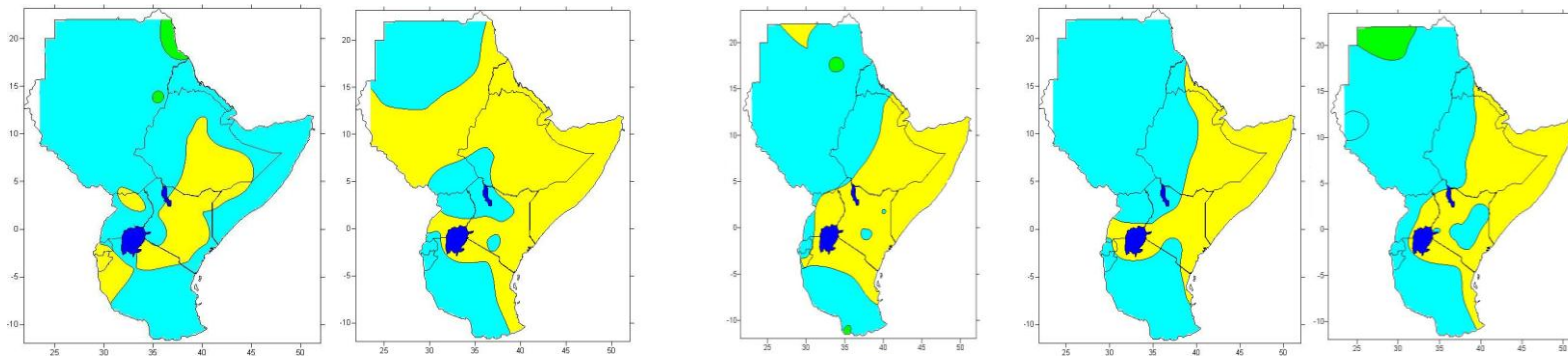
When considering individual members and the mean of all 24 members. The analyses show that the model has higher accuracy and skill in the equatorial sector of the region and the OND season. This shows that the model simulates rainfall better for the OND season and the equatorial sector. When fewer members were used there was considerable improvement of model accuracy and skill in both seasons and mostly in the northern sector of the region.

The simulation of seasonal rainfall over the GHA region by ECHAM 4.5 is better when a few members which showed higher skill individually are averaged. The study therefore recommends that the mean of the 5 members could be used for seasonal forecasting in the GHA region. The use of 5 members would help to reduce the computing time and the long waiting time for releasing early warning climate products that are required to reduce the negative impacts of the climate extremes over the region. Improvement of early warning will reduce negative effects of climate extremes on agricultural production, hydropower generation, water use, and water availability at household level caused by floods and droughts.

Observed and model rainfall anomalies for selected members for MAM and OND seasons over the GHA region for 1961 to 2008. Green,

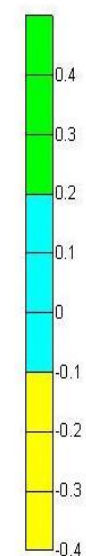
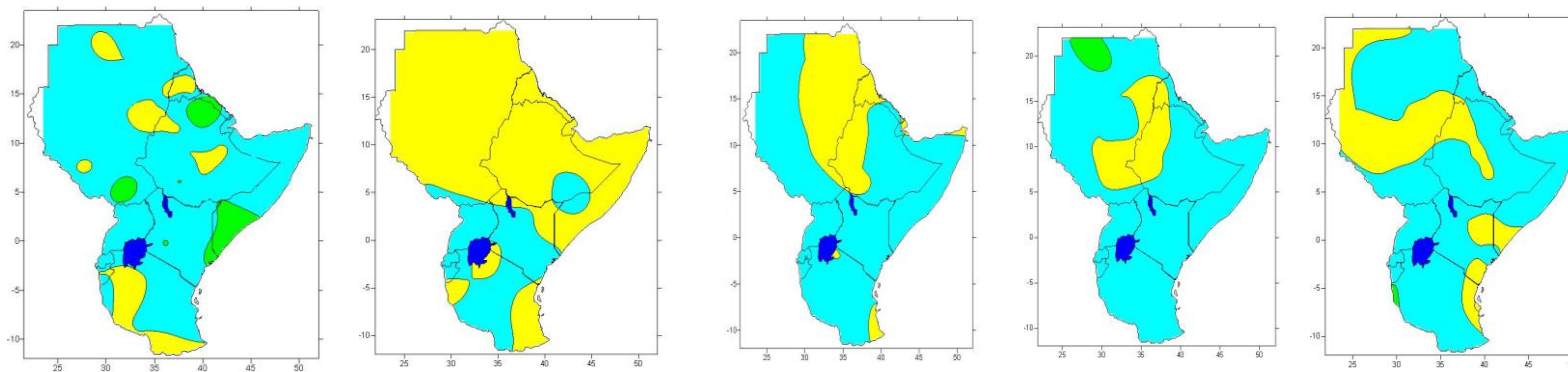
**SEASON**    **(a) Observed**            **(b) Mean of the 24 members**    **(c) Member 24**            **(d) Member 15**            **(e) Member 17**

**MAM**

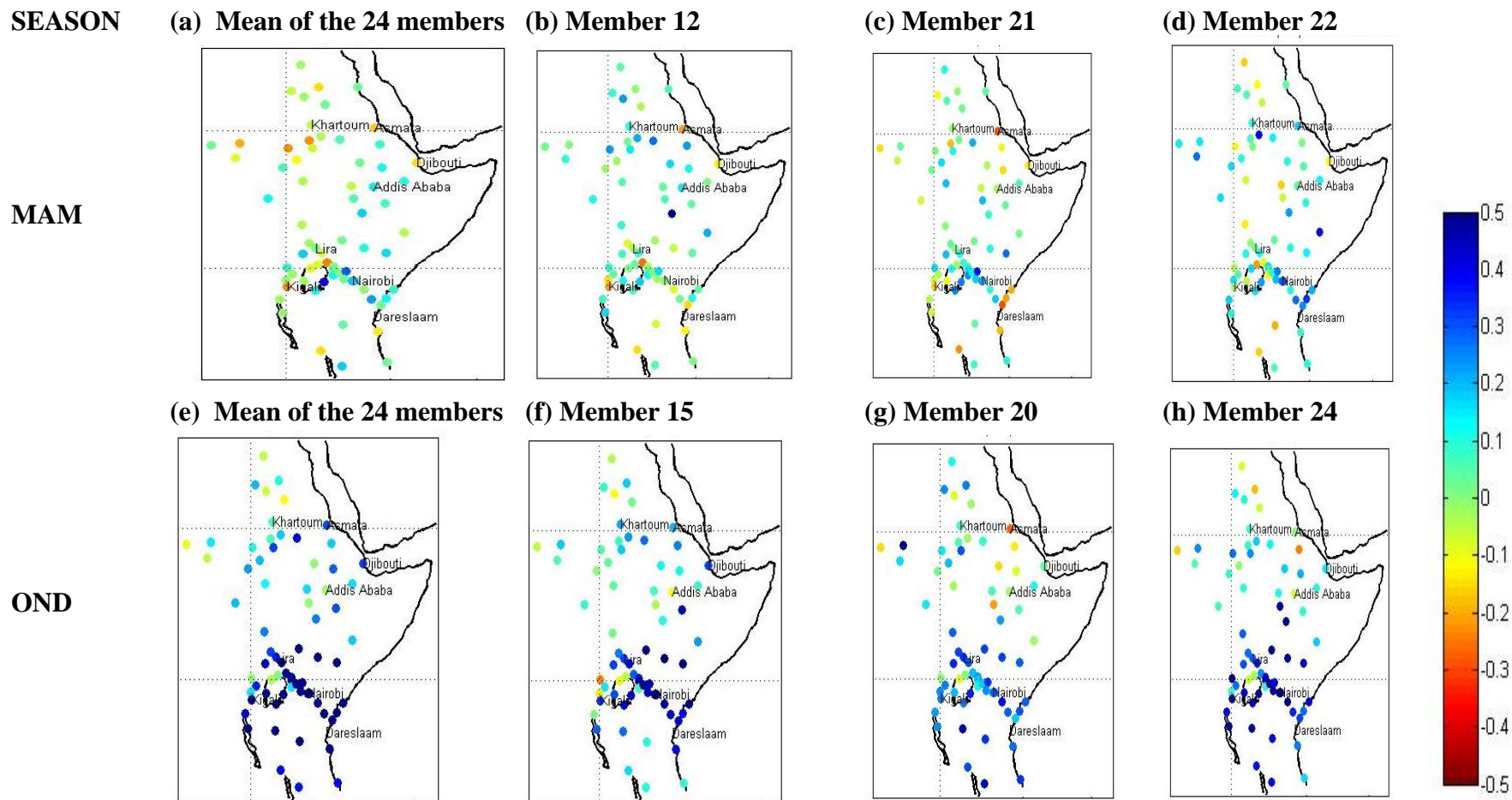


**(f) Observed**            **(g) Mean of the 24 members**    **(h) Member 6**            **(i) Member 15**            **(j) Member 18**

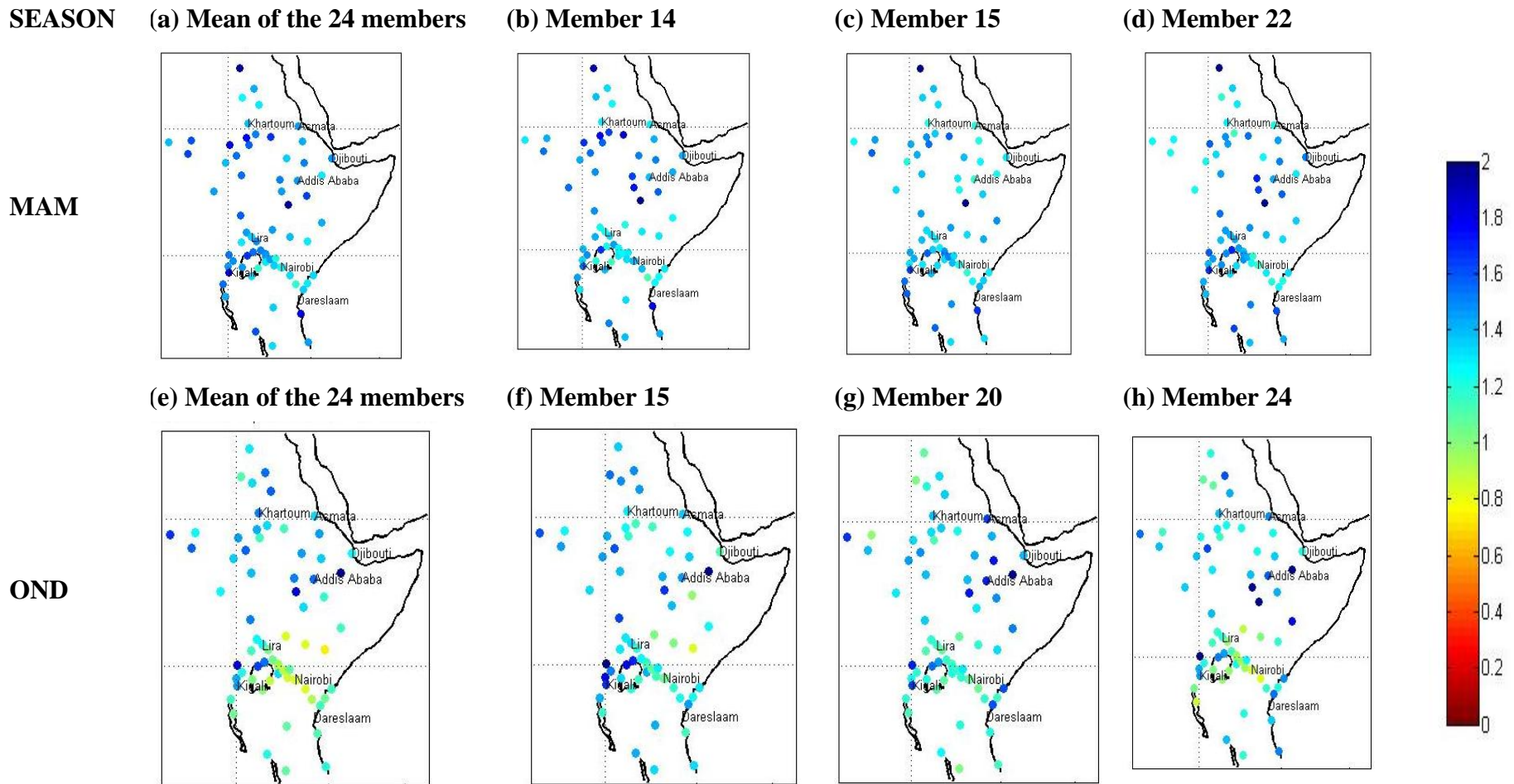
**OND**



blue and yellow shadings represent above normal, normal, and below normal rainfall respectively.



*Spatial distribution of correlation coefficients for selected members over the GHA region for 1961 to 2008. Blue shading represents higher coefficients and red shading lower coefficients.*



*Spatial distribution of RMSE for selected members over the GHA region for 1961 to 2008. Blue shading represents higher errors and red shading lower errors.*

SEASON

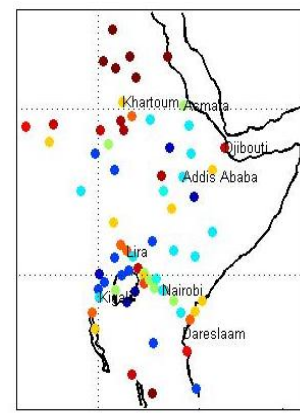
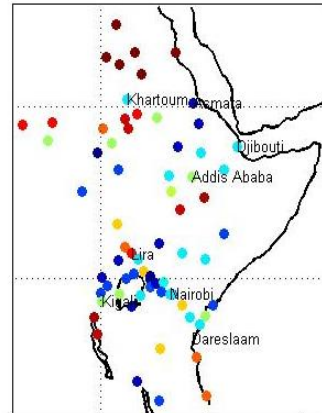
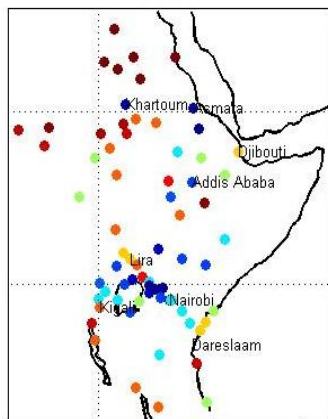
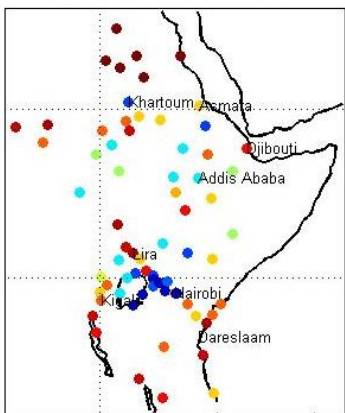
(a) Mean of the 24 members

(b) Member 18

(c) Member 21

(d) Member 24

MAM



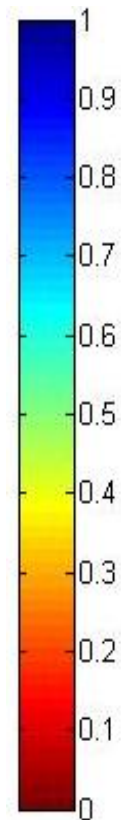
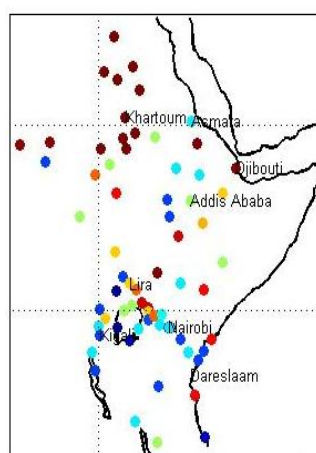
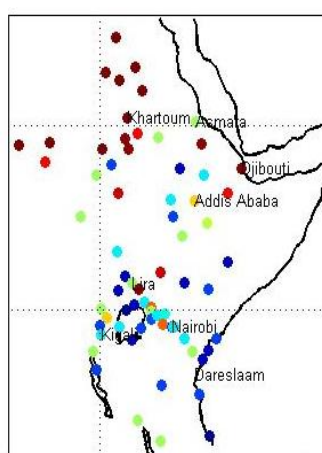
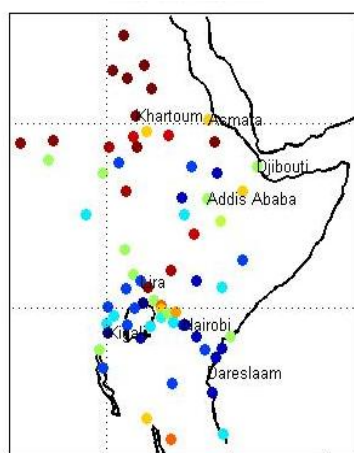
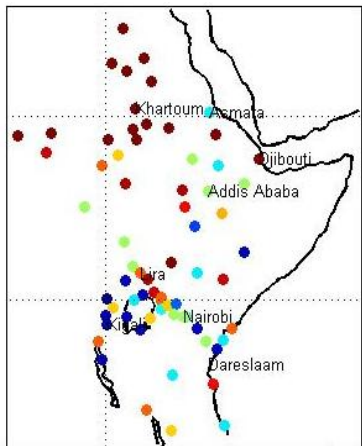
(e) Mean of the 24 members

(f) Member 15

(g) Member 18

(h) Member 24

OND

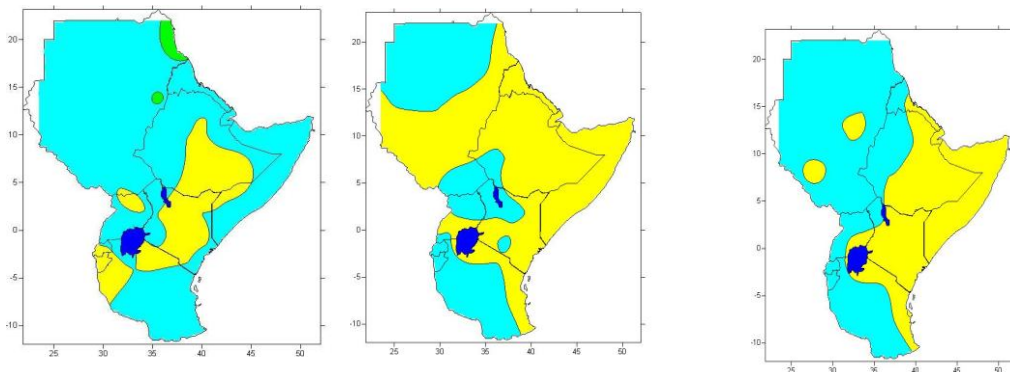


*Spatial distribution of P values for selected members over the GHA region for 1961 to 2008. Blue shading represents higher P values and red shading lower P values.*

# ASSESSMENT OF THE MEAN OF 5 AND 24 MEMBERS

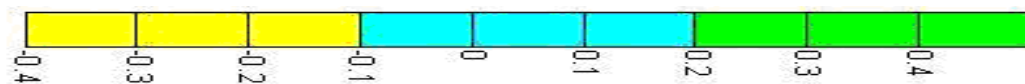
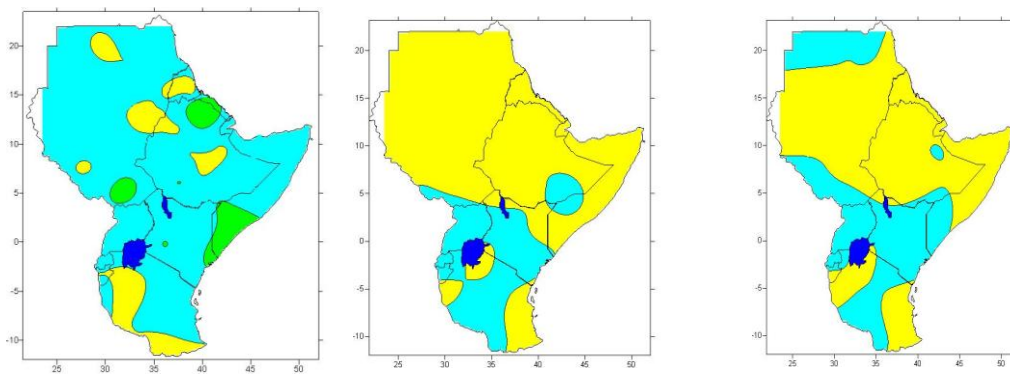
SEASON (a) Observed (b) Mean of the 24 members (c) Mean of 5 members

MAM

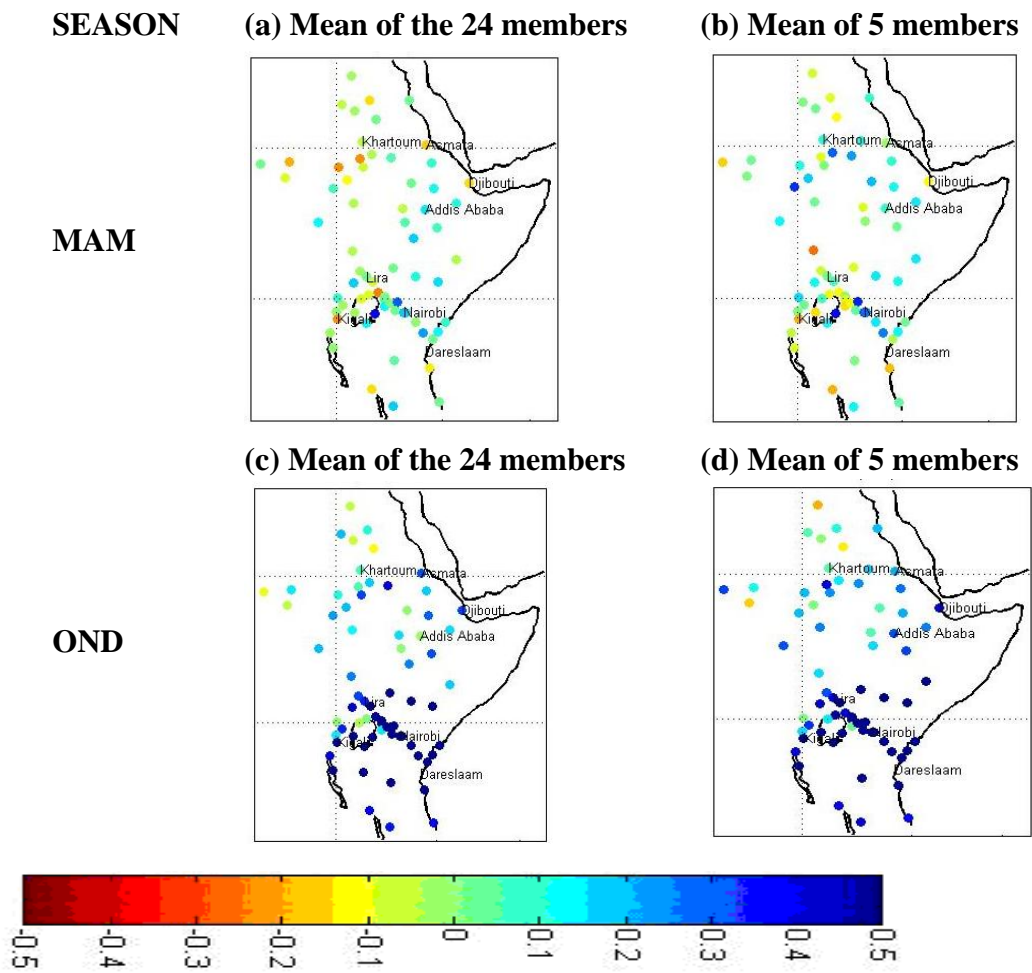


(d) Observed (e) Mean of the 24 members (f) Mean of 5 members

OND

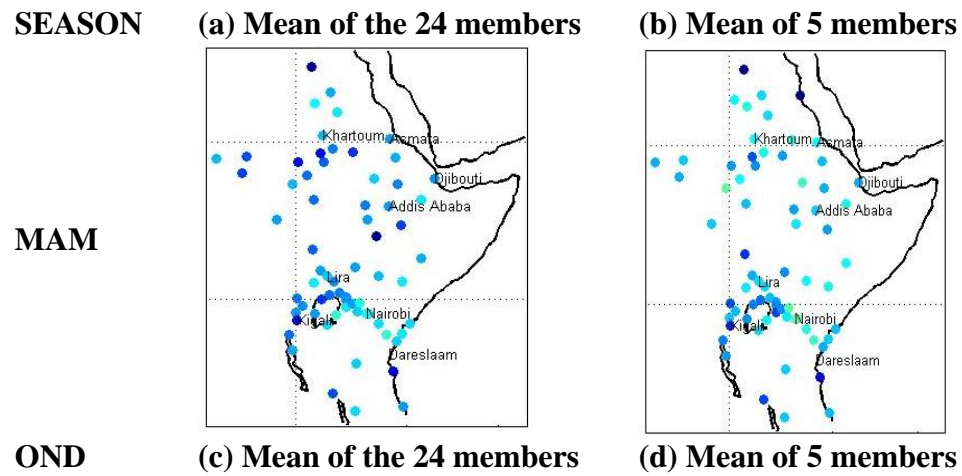


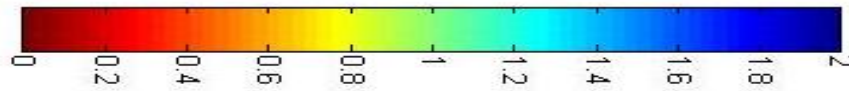
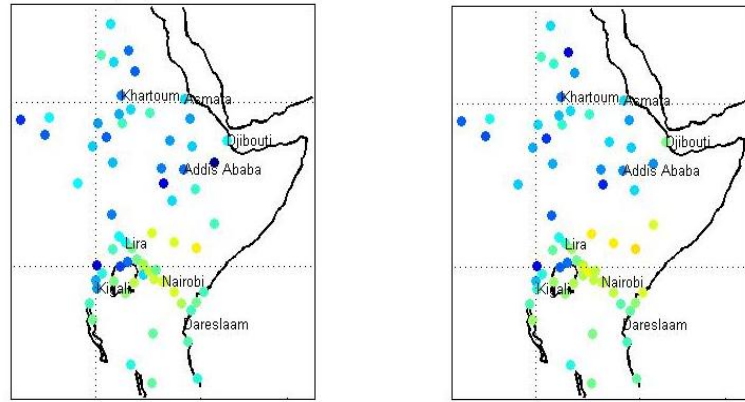
*Spatial distribution of observed (left panel), mean of 24 members (middle panel) and mean of 5 members MAM rainfall anomalies (right panel) over the GHA region for 1961 to 2008. Green, blue and yellow shading represent above normal, normal and below normal rainfall, respectively*





*Spatial distribution of correlation coefficient values for the mean of 24 members (left panel) and the mean of 5 members (right panel) over the GHA region for 1961 to 2008. Blue shading represents higher coefficients and red shading lower coefficients.*





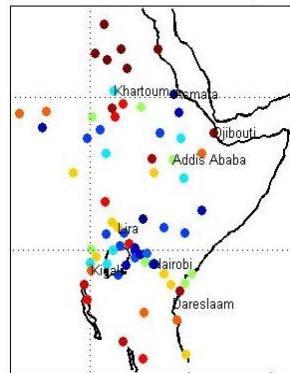
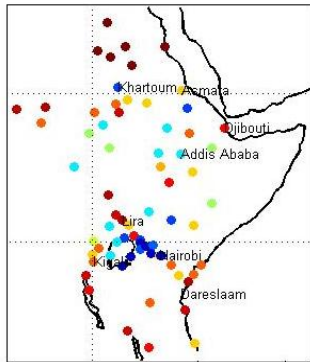
*Spatial distribution of RMSE values for the mean of 24 members (left panel) and the mean of 5 members (right panel) over the GHA region for 1961 to 2008. Blue shading represents higher errors and red shading lower errors.*

SEASON

(a) Mean of the 24 members

(b) Mean of 5 members

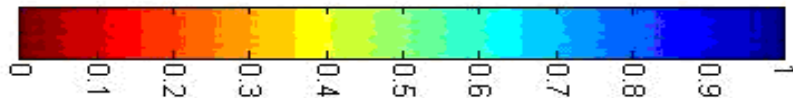
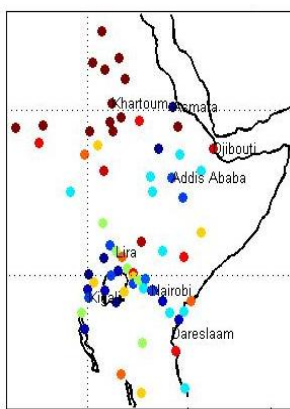
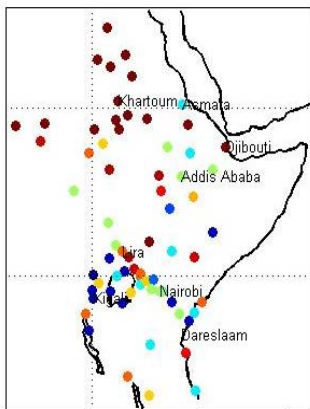
MAM



(c) Mean of the 24 members

(d) Mean of 5 members

OND



*Spatial distribution of P values for the mean of 24 members (left panel) and mean of 5 members (right panel) over the GHA region for 1961 to 2008. Blue shading represents higher p values and red shading lower p values.*