Evaluation of NCEP CFSV2 Forecast over the Greater Horn of Africa

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Background

Greater Horn of Africa (GHA) countries face recurrent extreme climate events, with extensive economic and social consequences. These extremes are mainly related to a lack of or an excess of rainfall, which leads to drought and flood and often affect the livelihood of millions, with a profound impact on rain-fed agriculture, pastoralism, hydropower and food security.

To mitigate these adverse impacts of climate induced risks, there is a need to undertake several biophysical and socioeconomic modeling, make adjustments to different sectorial activities and put in place the necessary disaster risk management plans ahead of time. This in turn requires a skillful seasonal forecast information as a key in put. However, the GHA region lacks access to such skillful forecast products.

Thus, in this study, we evaluate the skill of the NCEP Climate Forecast System Version 2 (CFSV2) over the GHA region in reproducing the spatial and temporal patterns of selected surface phenomena (Precipitation and Temperature) and large scale weather systems (e.g. jet streams) governing climate over GHA region. However, what is presented here is only part of the study.

Data and Methods

Two gridded global datasets have been used in this study to validate NCEP CFS V2 forecast over GHA Region i.e. Global Precipitation Climatology Centre monthly precipitation dataset (GPCC V6) and Climatic Research Unit (CRU) Time-Series (TS) Version 3.22 of High Resolution Gridded Data for Maximum and Minimum Temperature. Both datasets have been re-gridded to match CFSV2 grid configurations i.e. 0.9347^0 by 0.9374^0.

Climate Forecast System (CFSV2) Reforecast time series datasets of rainfall, maximum and minimum temperature for the period from 1982-2009 were downloaded from http://nomads.ncdc.noaa.gov/ website.

Evaluation metrics used in this study include:

- **Absolute Bias**: a 28 years (1982 – 2009) JJAS seasonal climatology was calculated for the observation and hindcast for the three parameters assessed and for 3 forecast lead times (March, April and May forecast of JJAS season with each month forecast being ensemble mean of 24 members) . The reforecast climatologies from the 3 lead times were latter averaged for presentation purposes and absolute bias has been calculated.
- **Pearson correlation coefficient** calculated from observed and hindcast time series over grid by grid bases for three different forecast lead times i.e. March, April and May
- **Inter-annual variability in anomalous** precipitation and temperature (hindcast vs observation) averaged over the entire GHA region and selected homogeneous rainfall zone over Ethiopian highlands-zone A (adopted from previous study by G. T. Diro et al. (2009)) for three different forecast lead times

Results

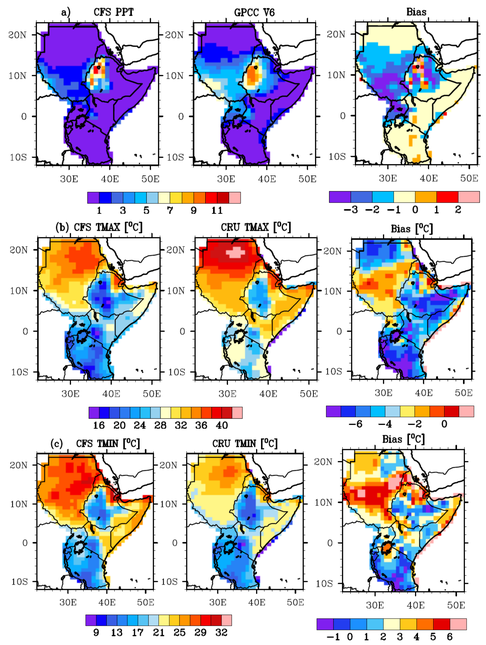

Figure 1. Summer (JJAS) a) rainfall, b) Maximum and c) Minimum Temperature climatologies for the period from 192-2009. First column stands for CFSV2 hindcast that is an average of 3 forecast lead times (1,2,and 3 months). Second column is observation climatology (GPCC V6 for precipitation and CRU TS 3.22 for temperature and third column is bias (difference between hindcast and observed climatologies). Units are mm(day)−1 for rainfall and ^{0}C for Temperature.

- CFS has fairly captured the observed spatial pattern of JJAS precipitation and temperature climatologies
  - It has picked the regions of maximum rainfall located over Ethiopian Highlands and Western South Sudan.
- However, there is significant dry bias over most climatologically wet areas except for areas of North Western Ethiopia
- In addition, CFS has missed most areas getting less than 3mm/day
- For TMAX , it is found out that there is significant cold bias throughout the region with most pronounced bias over Northern Sudan, Southern half of Ethiopia, majority of Tanzania and western parts of Kenya(reaching more than -6^{0}c).
- A relatively better performance is seen with respect to TMIN. Unlike TMAX, the bias is warm with marked bias over a zone covering Northern South Sudan, Southern part of Sudan all the way Eritrea and Northern Ethiopia.

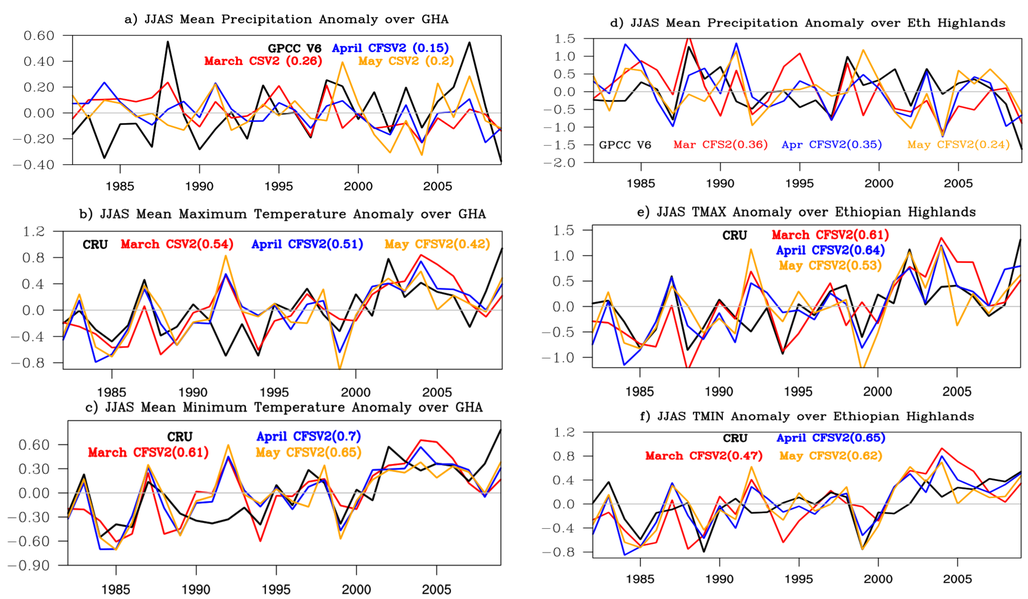

Figure 2. Comparison between observed and hindcast inter-annual variability of JJAS rainfall (a & d), maximum temperature (b & e) and minimum temperature (c & f) at 3 different lead times for the period from 1982-2009 with left column for GHA region as a whole and right column for Homogeneous Rainfall Zone A (Ethiopian Highlands) adopted from previous study by G. T. Diro et al. (2009)). Plotted in black is observation (GPCC V6 and CRU TS V3.22), red is march CFS Forecast, blue is April CFS forecast and orange is May CFS forecast. All rainfalls are given in mmday−1 and respective correlation coefficient values are indicated in bracket.

Results

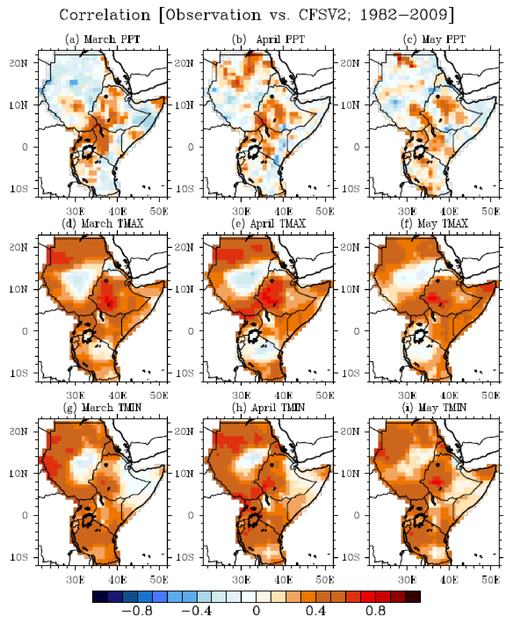

Figure 3. Correlations between the observed (GPCC V6 for precipitation and CRU TS V3.22 for temperature) and predicted (CFSV2) summertime (JJAS) precipitation (a, b & c), Maximum (d, e &f) and Minimum Temperature (g, h & i) anomalies over the GHA Region. The first column stand for 3 month, the second for two month and third for one month lead time hindcast for JJAS season.

- Even though the overall prediction skills are low for precipitation, there are some areas with relatively high skill like Ethiopian highlands, part of South Sudan, Northern Uganda and western Kenya (mostly areas receiving summer rains) where anomaly correlation can be as high as 0.5.
- The maximum temperature hindcast has a positive correlation over majority of location with skills reaching as high as 0.7 over areas like Ethiopian highlands, parts of south Sudan and parts of north western Sudan. In contrast, southern western Sudan all the way across Eritrea as well as northern half of Tanzania have the least correlation under all three lead times.
- For minimum temperature, south western Sudan still have the least correlation and western half of Ethiopia and Somalia (unlike the case with TMAX) being the other areas in the region having lowest correlation in all 3 lead times. Lower values of correlation are also seen over south eastern part of Tanzania.
- It is also noted that prediction skill pattern for all the 3 parameters does not change much (even deteriorates in few cases) with decrease in length of forecast lead times.

Conclusions

- In this study, the prediction of the summertime GHA precipitation and temperature are examined by analyzing the hindcasts by NCEP CFSv2.
- Over all, spatial patterns of rainfall and temperature have been captured by CFSV2. However, some areas in the region were found to have significant biases in all the three parameters evaluated.
- CFSV2 hindcast prediction skill is found to be better for areas like Ethiopian highlands that relatively wetter than the rest of GHA during during summer season
- As the current study only looked at selected surface parameters and a single season (JJAS), there is a need to examine other seasons as well as large scale weather systems governing climate of the area to have the full picture of NCEP CFSV2 skill over the region.

NASA IDS: Seasonal Prediction of Hydro-Climatic Extremes in the Greater Horn of Africa : The Second Participatory Research Workshop, Washington Hotel, Addis Ababa, Ethiopia