Seasonal Prediction Skill of Rainfall in East Africa

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1. Summary

- **GloSea has significant correlations with observations for precipitation during the short rains, however, shows little skill for long rains.**
- **GloSea has large wet bias during short rains, related to Sea Surface Temperature (SST) and dynamical biases.**
- **GHACOF regional consensus forecasts provide positive skill during short rains, however, they are outperformed by GloSea.**

2. Introduction & Background

- East Africa suffers from frequent droughts and flooding events, such as the 2011 drought, linked to large interannual variability of rainfall. These events have a massive impact on a region that has one of the world's most rapidly growing populations.

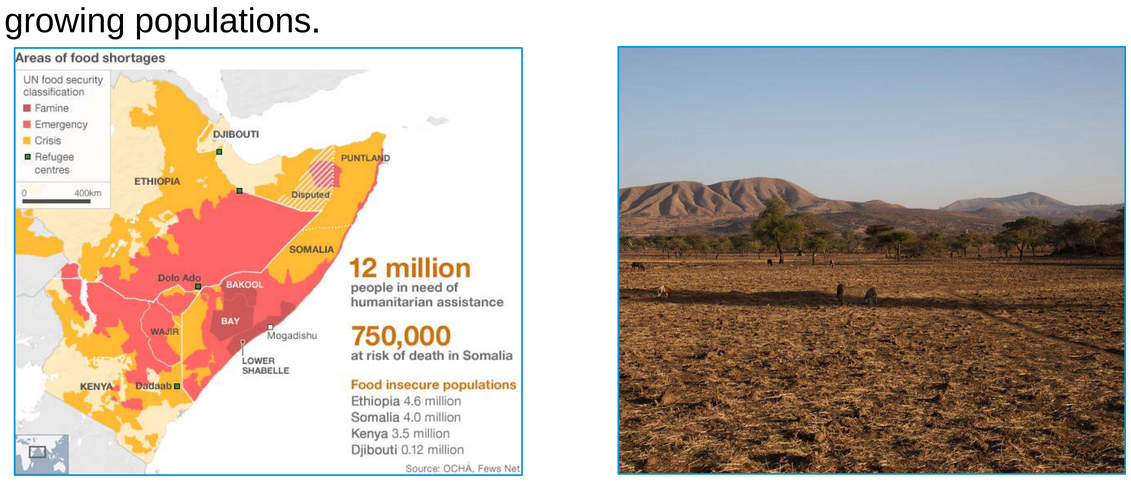


Figure 1: Left: Food shortages in East Africa during the 2011 drought.[1] Right: Drought in Arsi, Ethiopia 2016. Image by OCHA/ Charlotte Cans.[2]

- Improved seasonal forecasting would give governments, aid organisations, and local stakeholders better opportunity to prepare for future droughts.

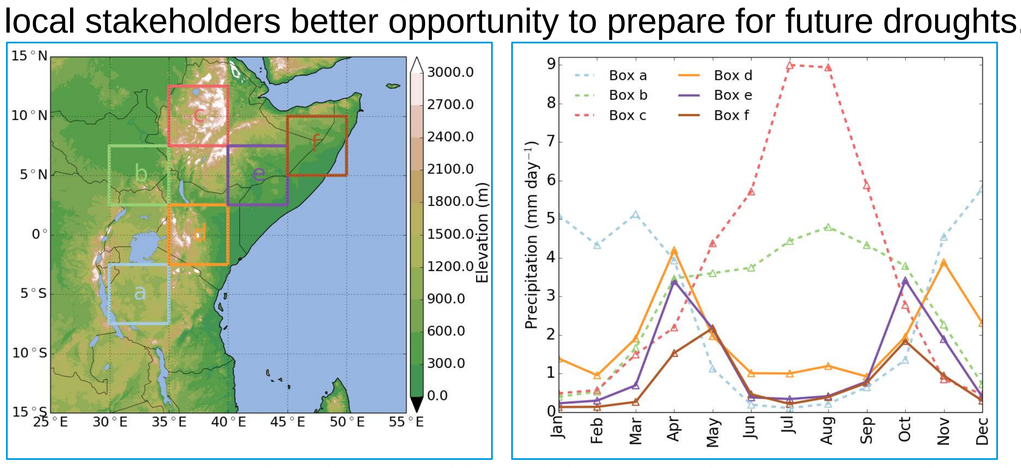
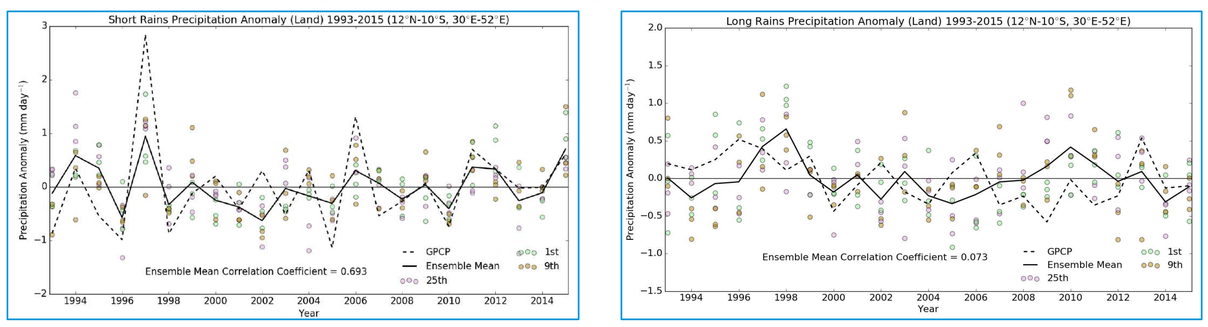


Figure 2: Left: Topography of East Africa. Right: Annual precipitation climatology for boxes shown on left, solid lines show regions with bimodal rainfall.

- A large portion of East Africa has 2 rainfall seasons, the long rains (March to May or MAM), and short rains (October to December or OND).

3. Evaluation of GloSea Precipitation

- UK Met Office operational global seasonal forecast model, GloSea.
- Hindcasts run 23 years (1993-2015), 9 ensemble members* per forecast.[3]



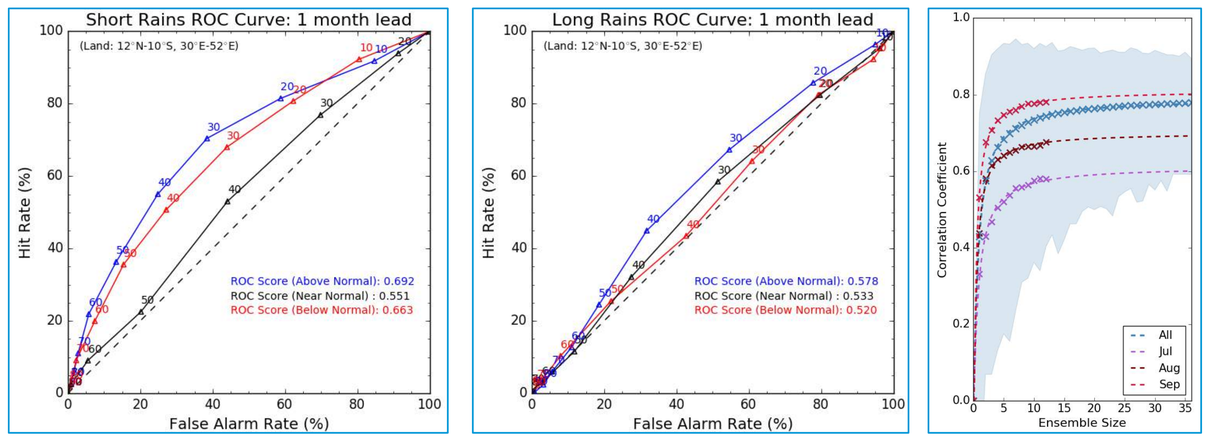


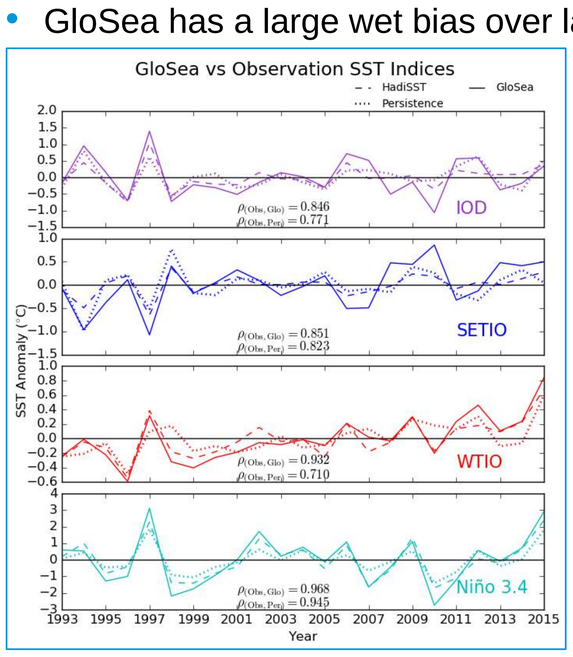
Figure 3: Precipitation anomaly time series for the short (top left) and long rains (top right), for GloSea ensemble mean and GPCP. ROC curves for tercile categories of rainfall for the short (bottom left) and long rains (bottom centre), correlation as function of lead time and ensemble size for short rains, shaded for min and max (bottom right).

- Short rains demonstrate high level of positive skill, although lacking in variability, whilst long rains display very little skill.

* 3 members and 3 initialisation dates, recently upgraded to 7 members per start date, total 21 members.

4. Short rains bias and SST forecasts

- GloSea has a large wet bias over land during the short rains (~50%).



	Regression Variable	Correlation with GPCP
Observations	Precipitation	1.000
	IOD	0.897
	Niño 3.4	0.636
	IOD + Niño 3.4	0.897
	WTIO + SETIO + Niño 3.4	0.897
Persistence	Precipitation	-0.107
	IOD	0.658
	Niño 3.4	0.662
	IOD + Niño 3.4	0.769
	WTIO + SETIO + Niño 3.4	0.771
GloSea	Precipitation	0.693
	IOD	0.755
	Niño 3.4	0.652
	IOD + Niño 3.4	0.804
	WTIO + SETIO + Niño 3.4	0.806

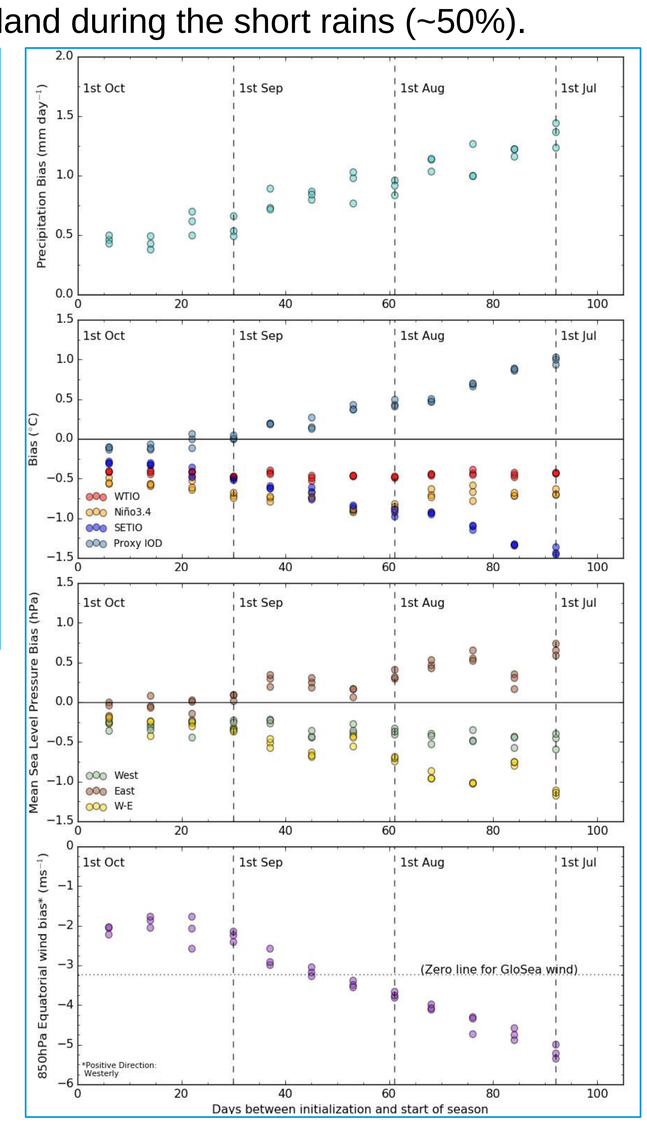


Figure 4: GloSea SST Index forecasts for Indian Ocean Dipole, East and West Indian Ocean, and Niño 3.4 (top left), Multiple Linear Regression correlations (bottom left) using SST predictors to forecast precipitation, and GloSea biases as function of lead time (right) for precipitation (top), SST indices, sea level pressure over Indian Ocean, equatorial zonal winds over Indian Ocean (bottom).

- Wet bias can be partially explained by evolving biases in the dynamics.
- GloSea produces excellent forecasts of Indian & Pacific Ocean SST indices, these can be used to statistically forecast precipitation over the region.

5. Comparison to GHACOF Forecasts

- Greater Horn of Africa Regional Outlook Forums (GHACOFs) take place three times per year, issuing rainfall forecasts for the long and short rains and the summer rainfall season.[4]

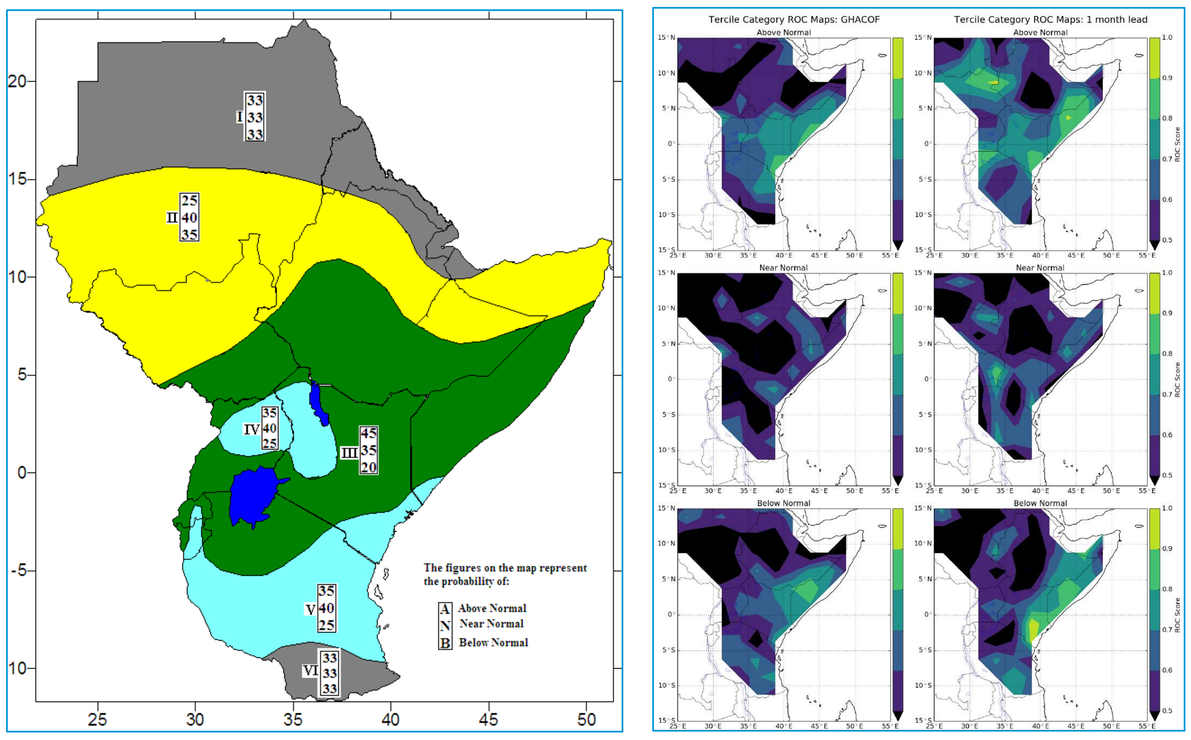


Figure 5: Example GHACOF forecast for OND 2015[4] (left), ROC Score Maps for GHACOF (centre) and GloSea (right) for three terciles (Above, Near, Below) for the short rains.

- GloSea appears to outperform GHACOF, however, both GHACOF and GloSea demonstrate similar regions of high skill, notably coastal Kenya and Somalia. This region is most strongly associated with IOD variability.

6. References

[1] BBC News. http://www.bbc.co.uk/news/world-Africa-15380244
[2] UN News. http://www.un.org/apps/news/story.asp?NewsID=54402#.WATejbN4dvs
[3] MacLachlan, C. *et al. Q. J. R. Meteorol. Soc.* **141**, 1072-1084 (2015).
[4] IGAD Climate Prediction & Application Centre (ICPAC). http://http://rcc.icpac.net/index.php/

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