

The current methods and techniques on short, medium and long-range climate prediction in Ethiopia

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Outline

- **Overview of weather and climate of Ethiopia**
- **Understanding the climatology: Seasonal classifications**
- **Evolution of Weather forecast in Ethiopia**
- **Short and medium weather forecasts**
- **Seasonal Climate prediction**
- **ENSO-based seasonal rainfall prediction skills**
- **Successes**
- **Challenges and opportunities**
- **Ways forward**

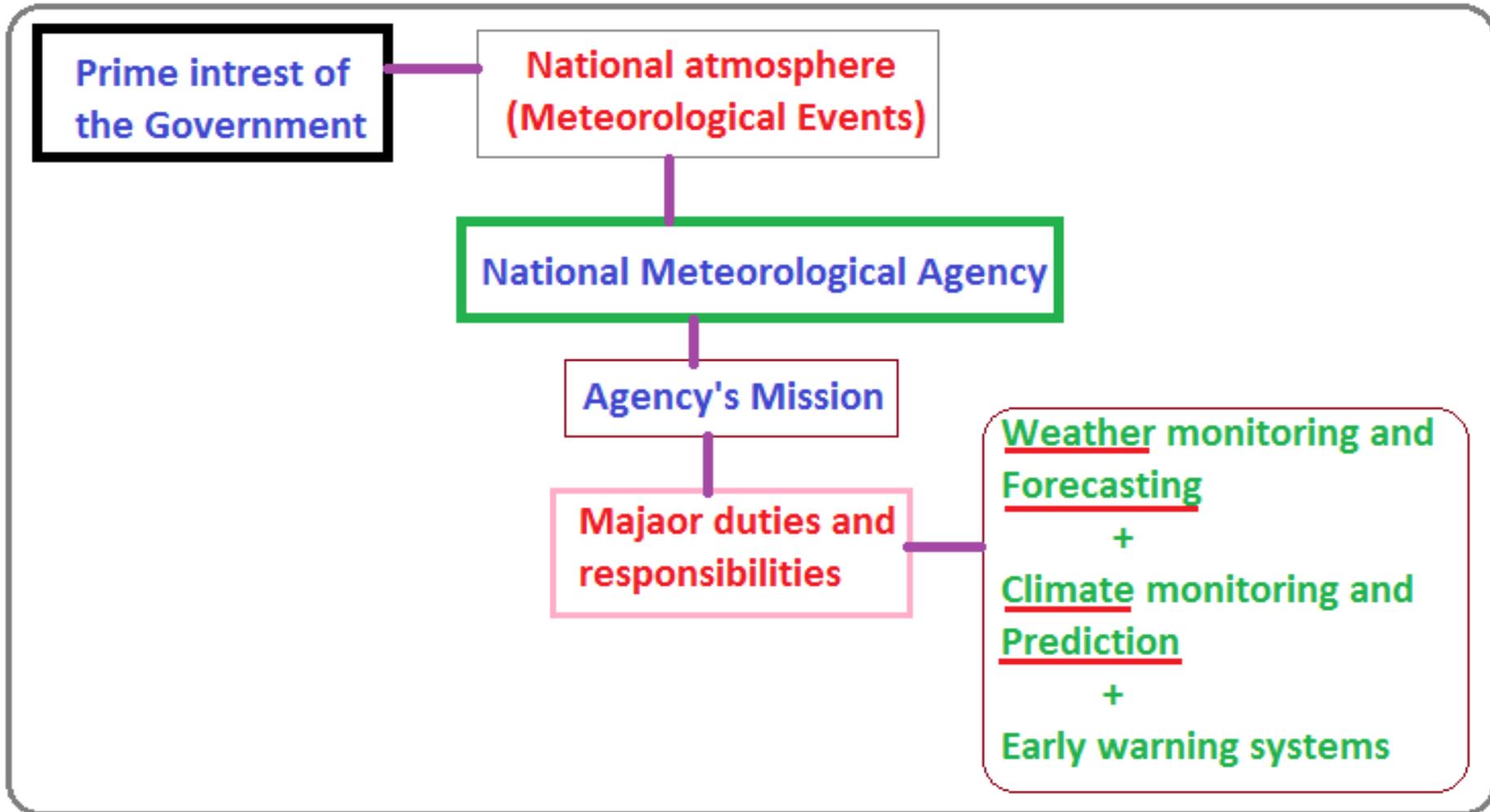
Overview of weather and climate of Ethiopia

- Ethiopia, like many parts of the tropics, is prone to extreme climate events such as droughts and floods.
- In an effort to minimize the negative impacts of extreme climate events, and make use the betterment side of climate, the Government of Ethiopia established the National Meteorological Services Agency(currently, National Meteorological Agency; NMA) in 1980
- Since then, there have tremendous efforts been made to realize the climate of the country and provide reliable and timely weather forecast and climate predictions

Short and medium weather forecasts

- Operational for more than half a century
- Previously the forecast is issued based on interpreting synoptic systems
- Based on ECMWF medium range weather charts
- Setting up, Customizing and running WRF model on routinely basis

Government institution



Understanding the climatology:

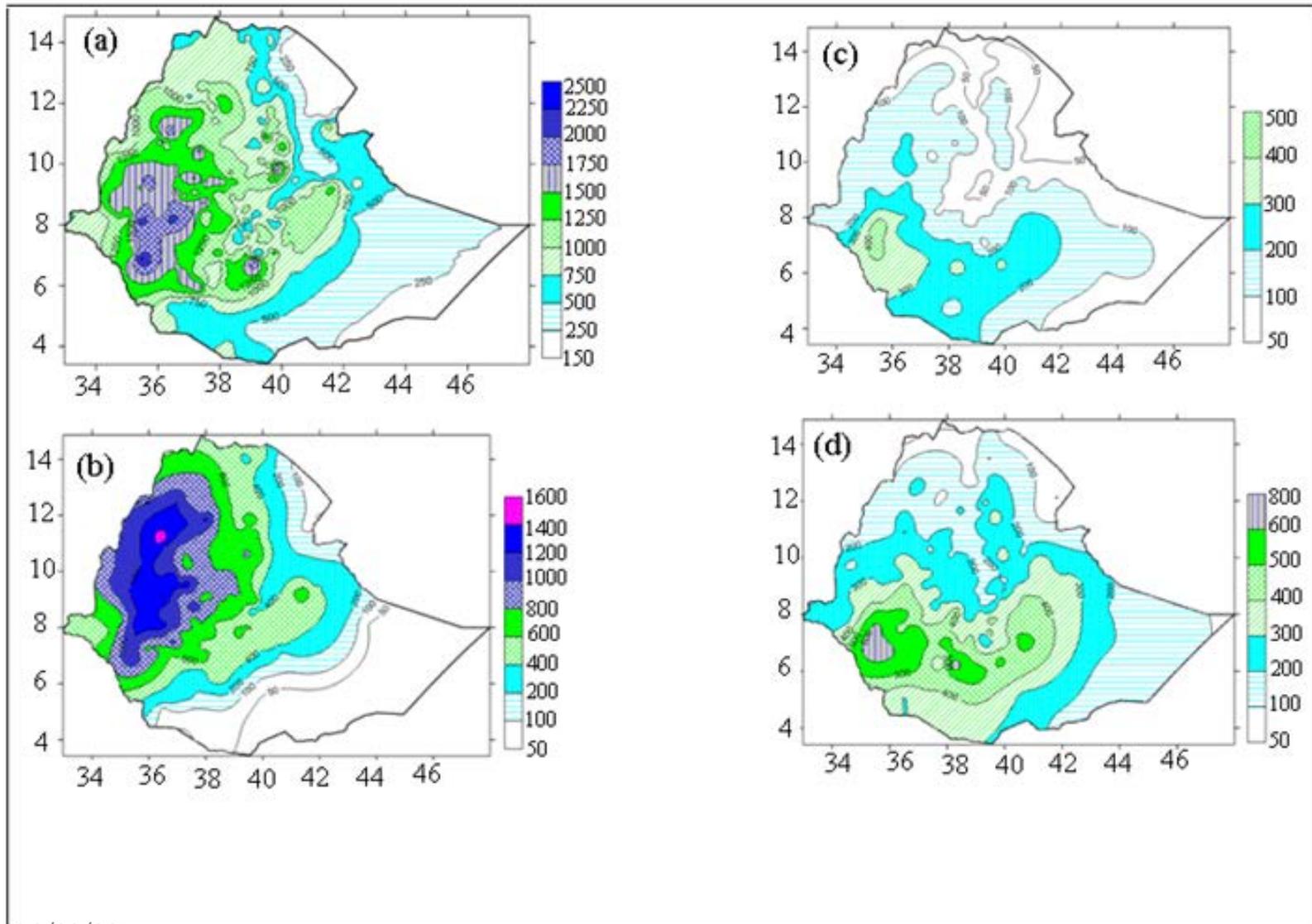
Seasonal classifications

- Observational evidence and scientific research reveal that there are different seasons with irregular demarcation across Ethiopia.
- Nevertheless, three major seasons have been identified: February to May (FMAM) (short rainy season, or Belg), June to September (JJAS) (main rainy season, or Kiremt), and October to January (ONDJ) (dry season, or Bega) (NMSA, 2006).

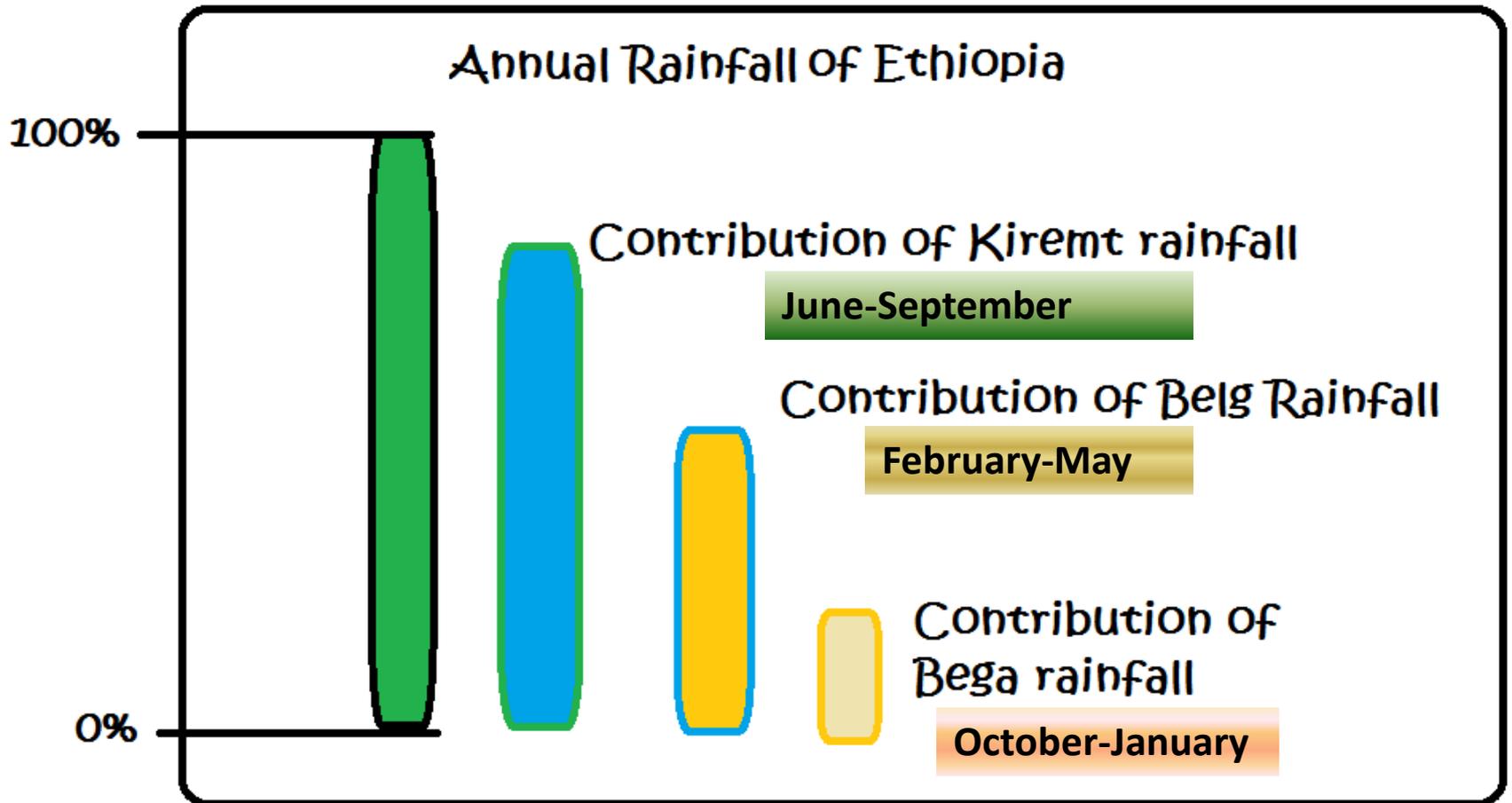
Understanding ...

- Two contrasting features became evident; namely monomodal-rainfall-type from an aggregated national rainfall and typical monomodal and bi-modal rainfall patterns from regional perspective.
- Taken together the annual rainfall totals recorded at 200 meteorological stations for periods varying from 15 to 50 years, maximum mean annual rainfall (mm) is confined to southwest Ethiopia, but stretching into northern sectors of the country.
- By contrast, northeast and southeast lowlands receive their rain during JJAS (kiremt) and in seasons other than summer kiremt, respectively, and have the lowest annual total rainfall in Ethiopia

Seasonal rainfall climatology



Rainfall characteristics in Ethiopia



Evolution of Weather forecast in Ethiopia

Pre-1970s	During 1970-1990s	From 1990s to present	Future perspective
Service delivery mainly for aviation sector	Daily and weekly weather forecast	Daily, dekadal, monthly, mid-season, seasonal forecast	Area specific Up to global
Aeronautical forecast	Agro-meteorological advisories	Agro-meteorological, hydromet, bio-meteorological impact forecast	Time bounded Daily –decadal- century long
	Seasonal weather forecast	Extended climate outlook	Sector-oriented
	Early warning on adverse impact: unseasonal rains	Forecast for each Regional state	More reliable and accurate
		Climate change projection	Easily deliverable and applicable

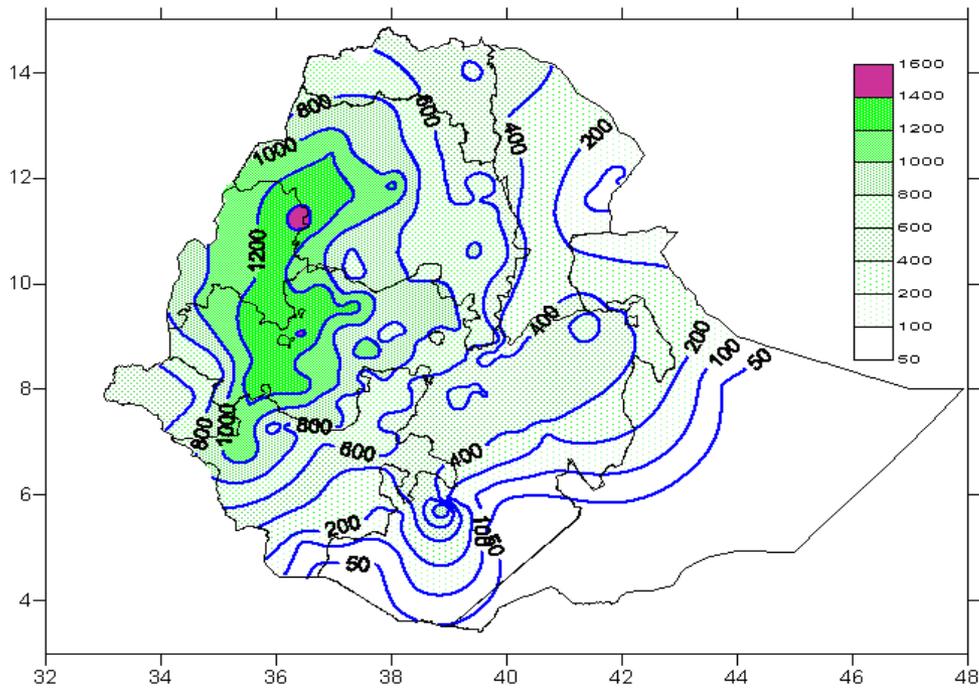
Associated social and economic impacts

Belg	Kiremt	Bega	Remark
Prolonged drought water shortage Late sowing	Drought FAMINE Water shortage	Drought Crop failure	Varies from region to region
Continuous rain Land preparation	Flooding Land slide	Unseasonal rain Disturb harvesting activities	Year to year
flooding	Water born disease	Flooding	Occasional
Hot weather Health problem	Hot weather Health problem	frost	

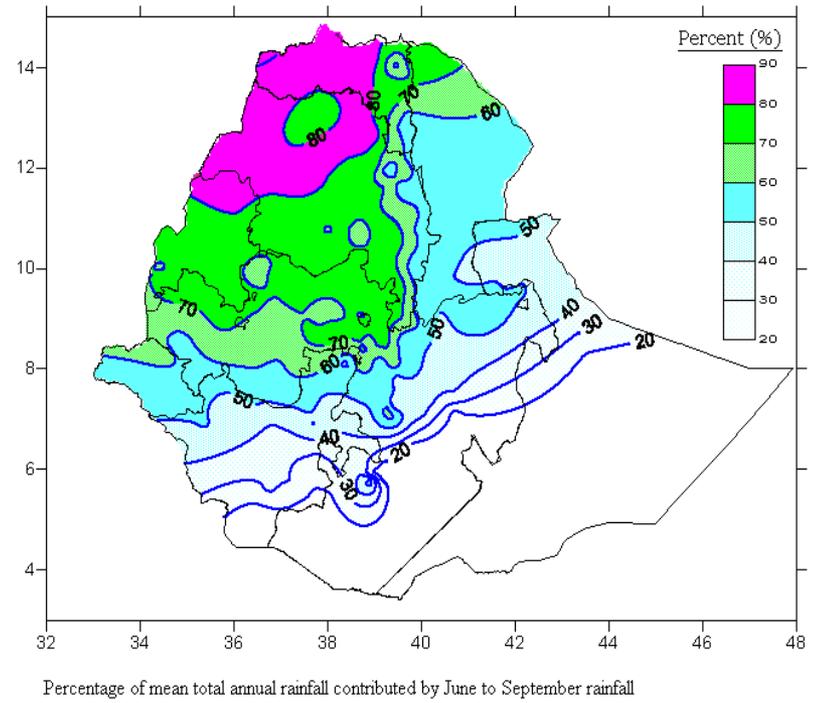
Special interest: Seasonal Climate prediction

- **Prediction Technique**

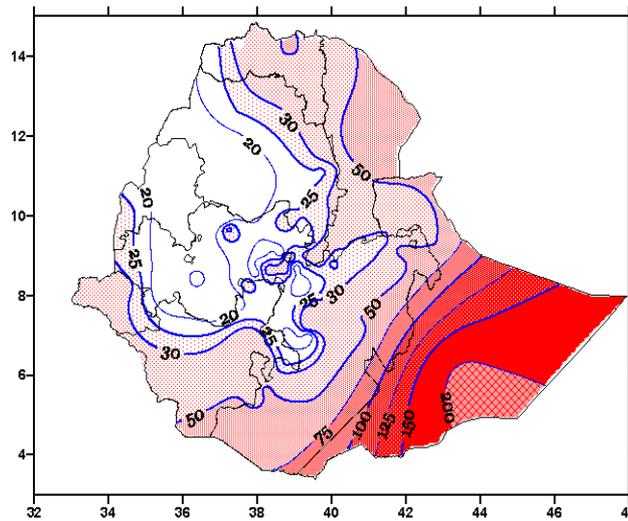
- ENSO-based analogue years



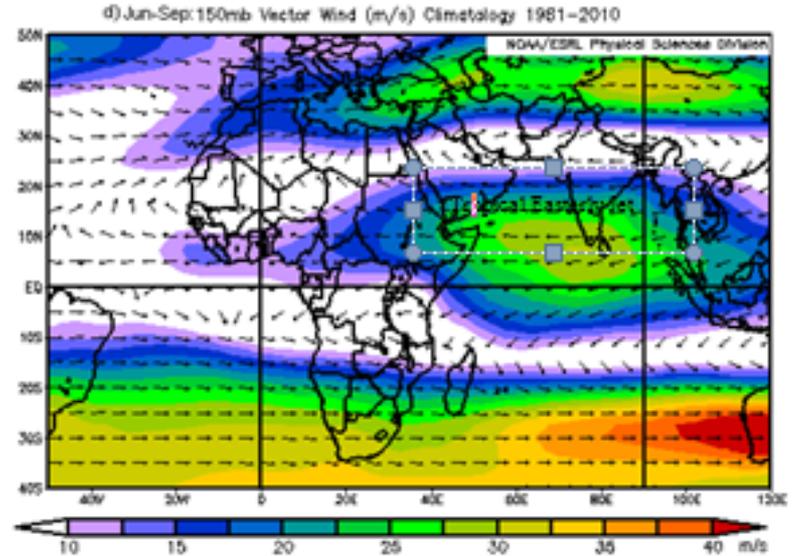
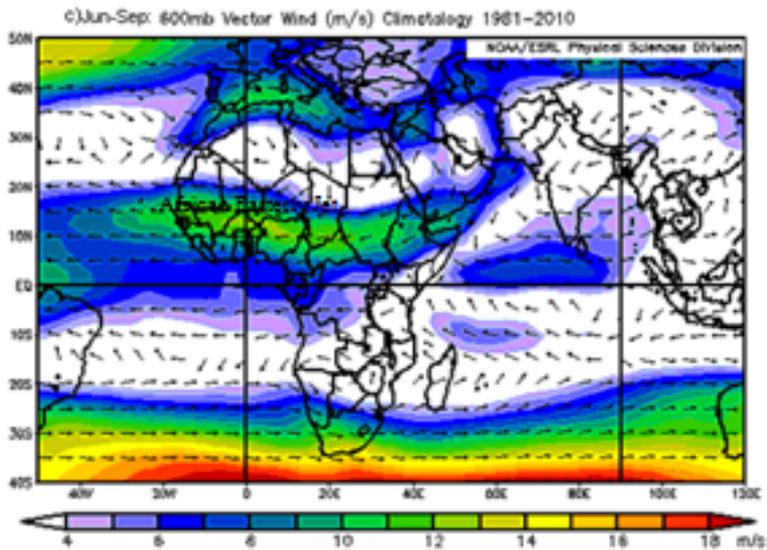
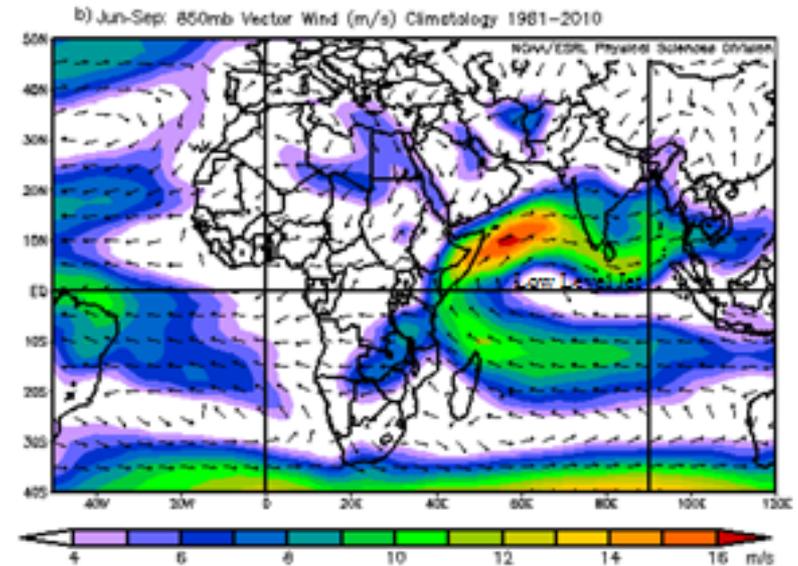
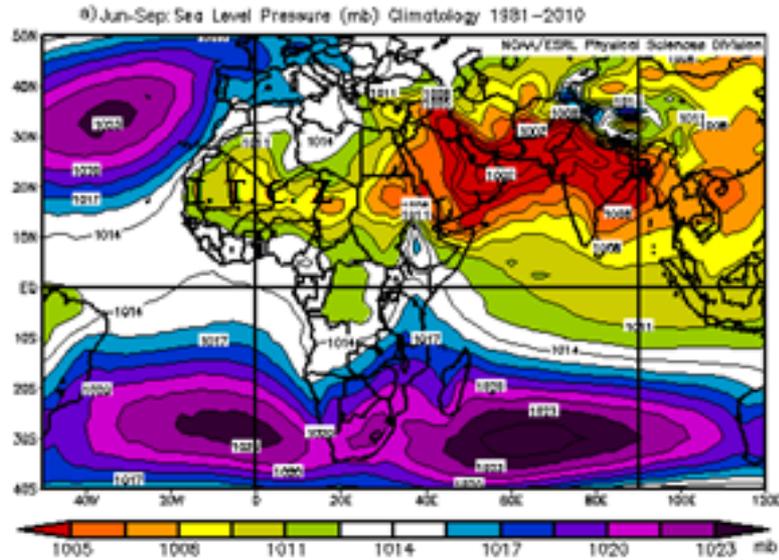
Total June to September rainfall climatology (mm) over Ethiopia



Percentage of mean total annual rainfall contributed by June to September rainfall

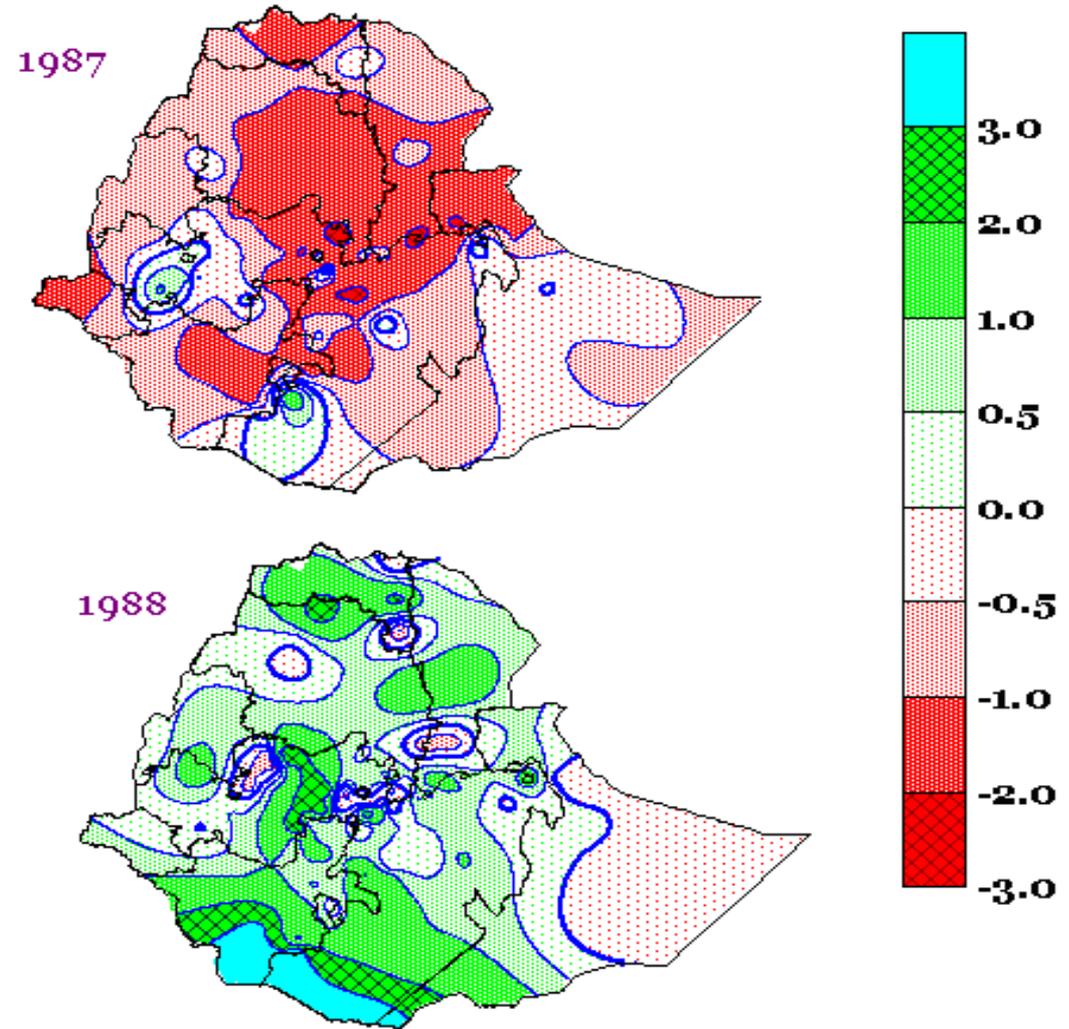


Underlying features



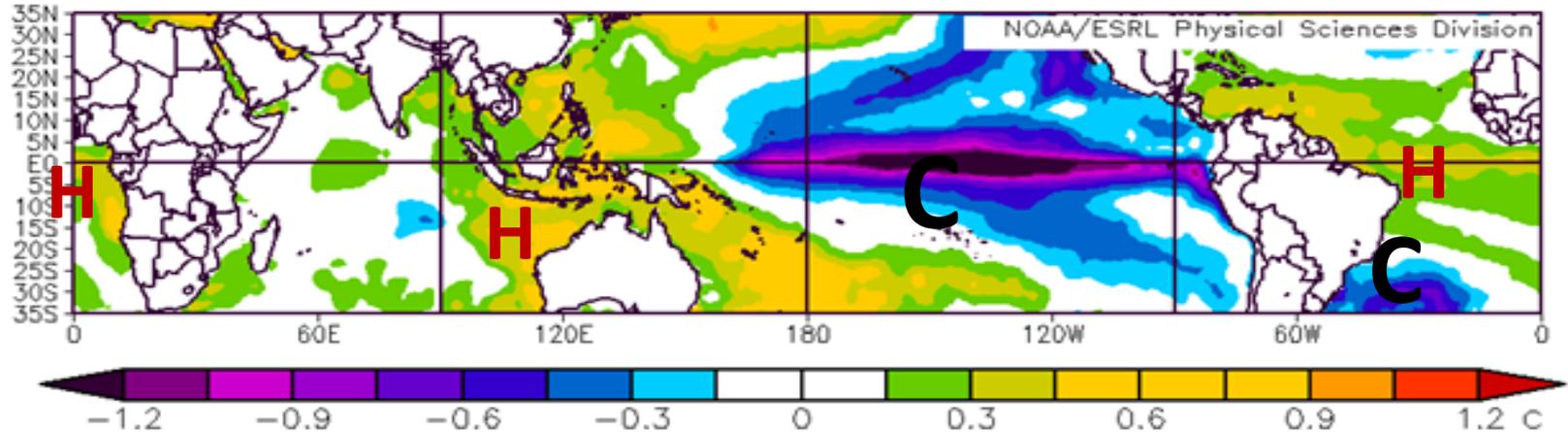
Intra-seasonal rainfall variability:

Can we use climate persistency as prediction tools? **NO**

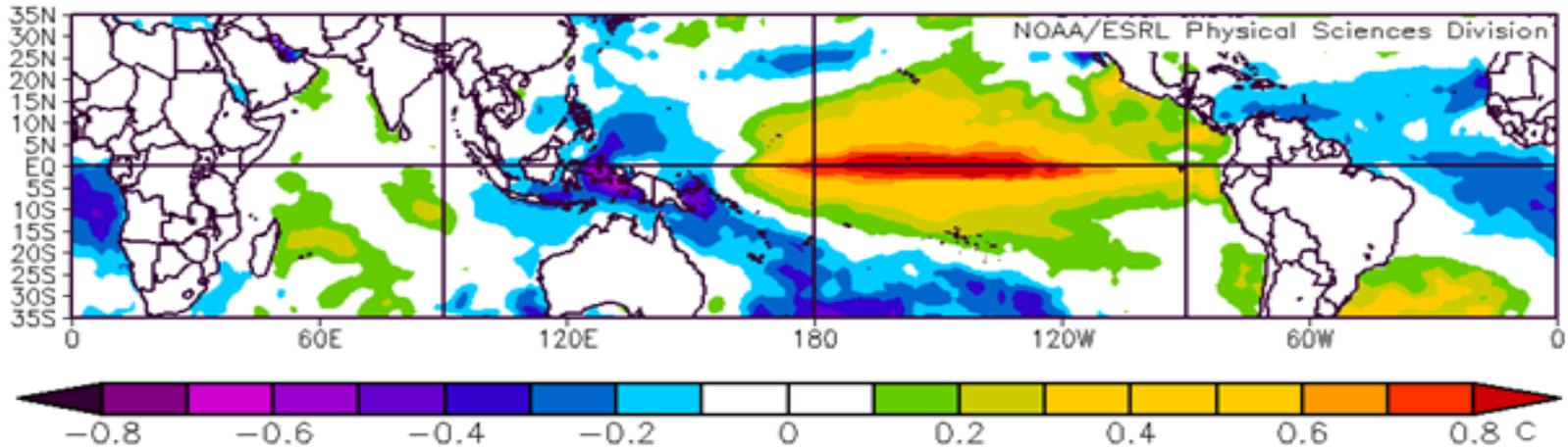


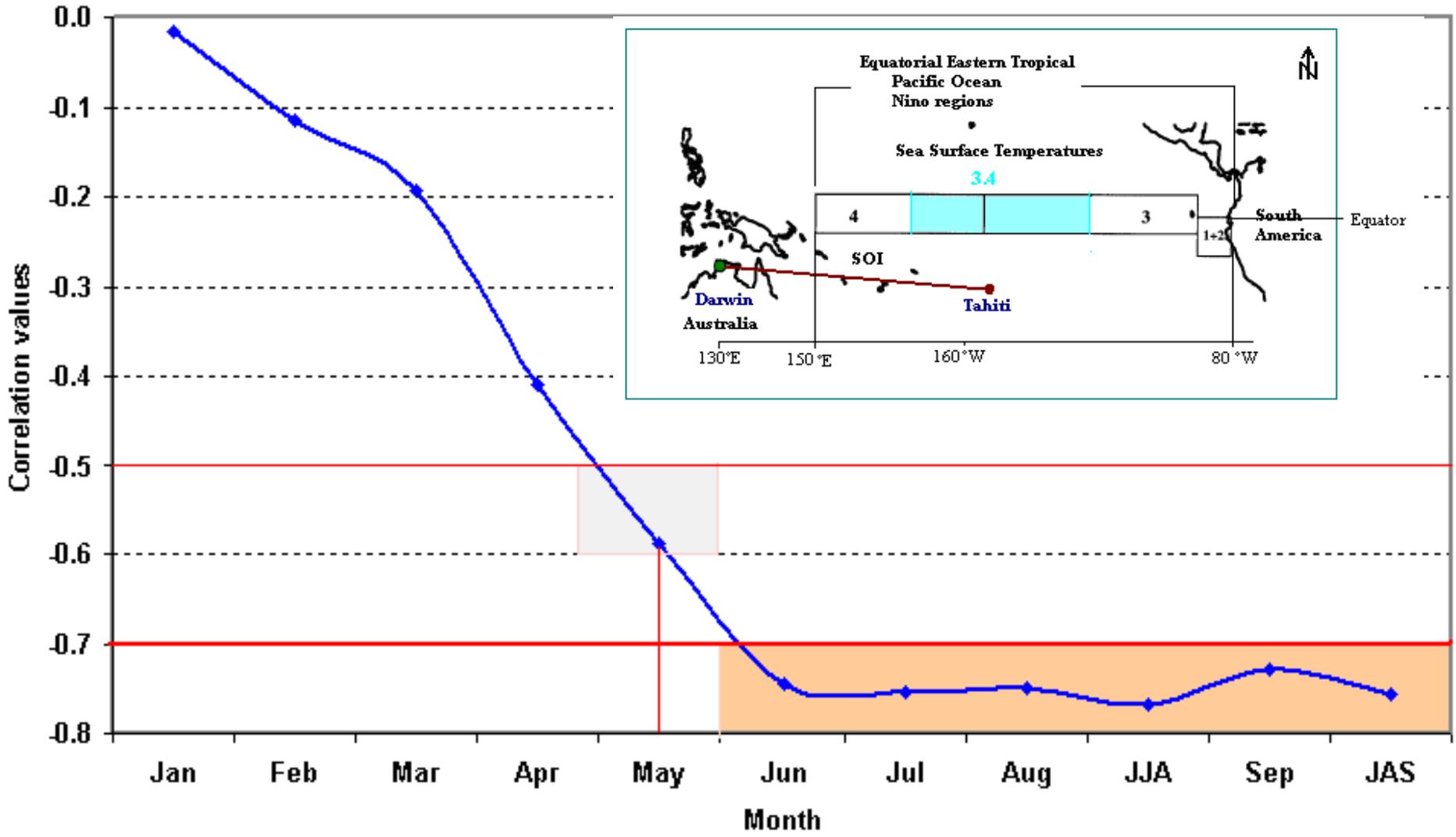
ENSO composite years

c) Jun-Sep: Surface SST (deg C) anomaly for La Nina composite years

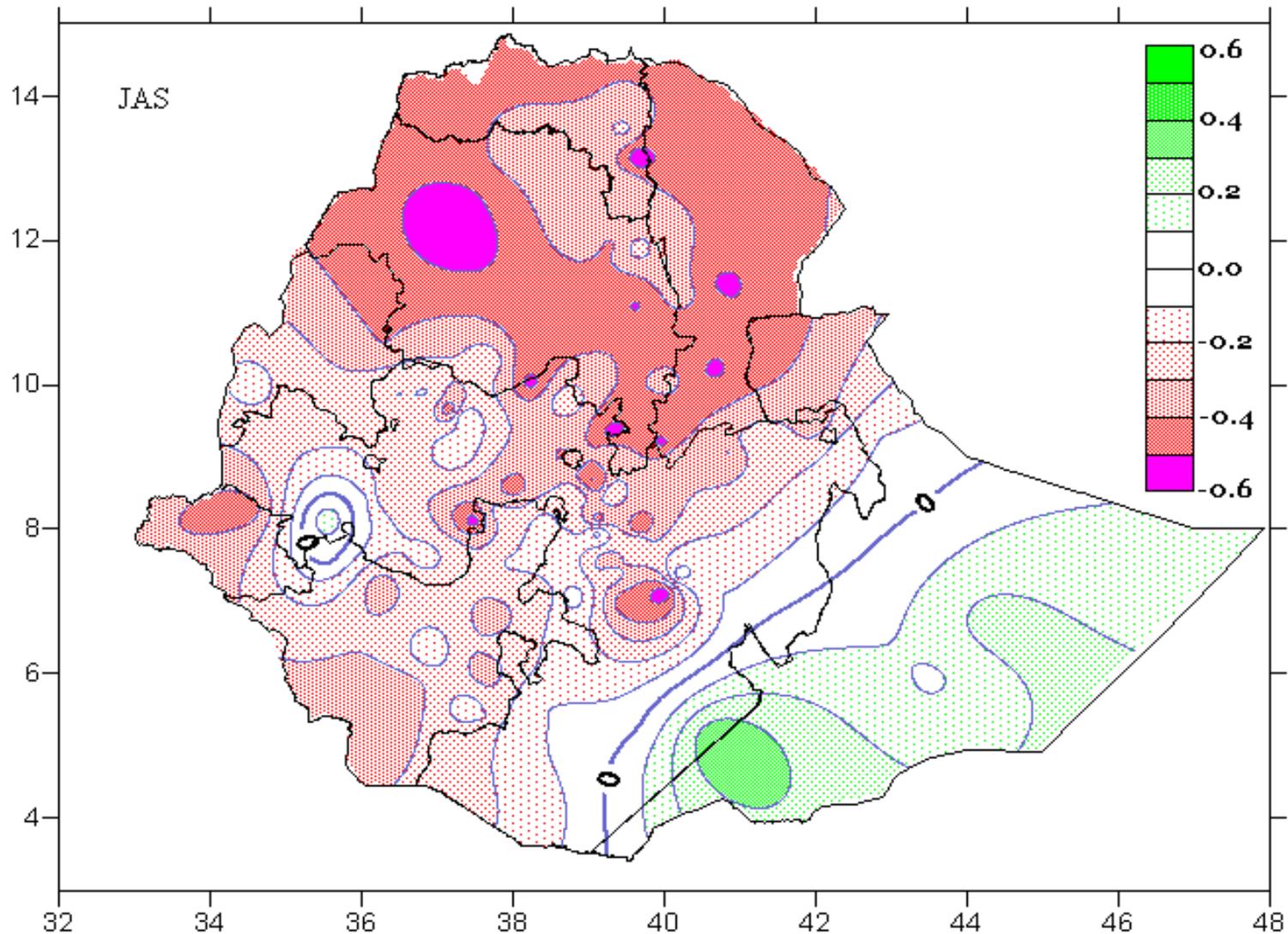


d) Jun-Sep: Surface SST (deg C) anomaly for El Niño Composite years





Linear correlations between Nino 3.4 SST and all-Ethiopia JJAS rainfall totals with lag periods extending back to January of the same calendar year

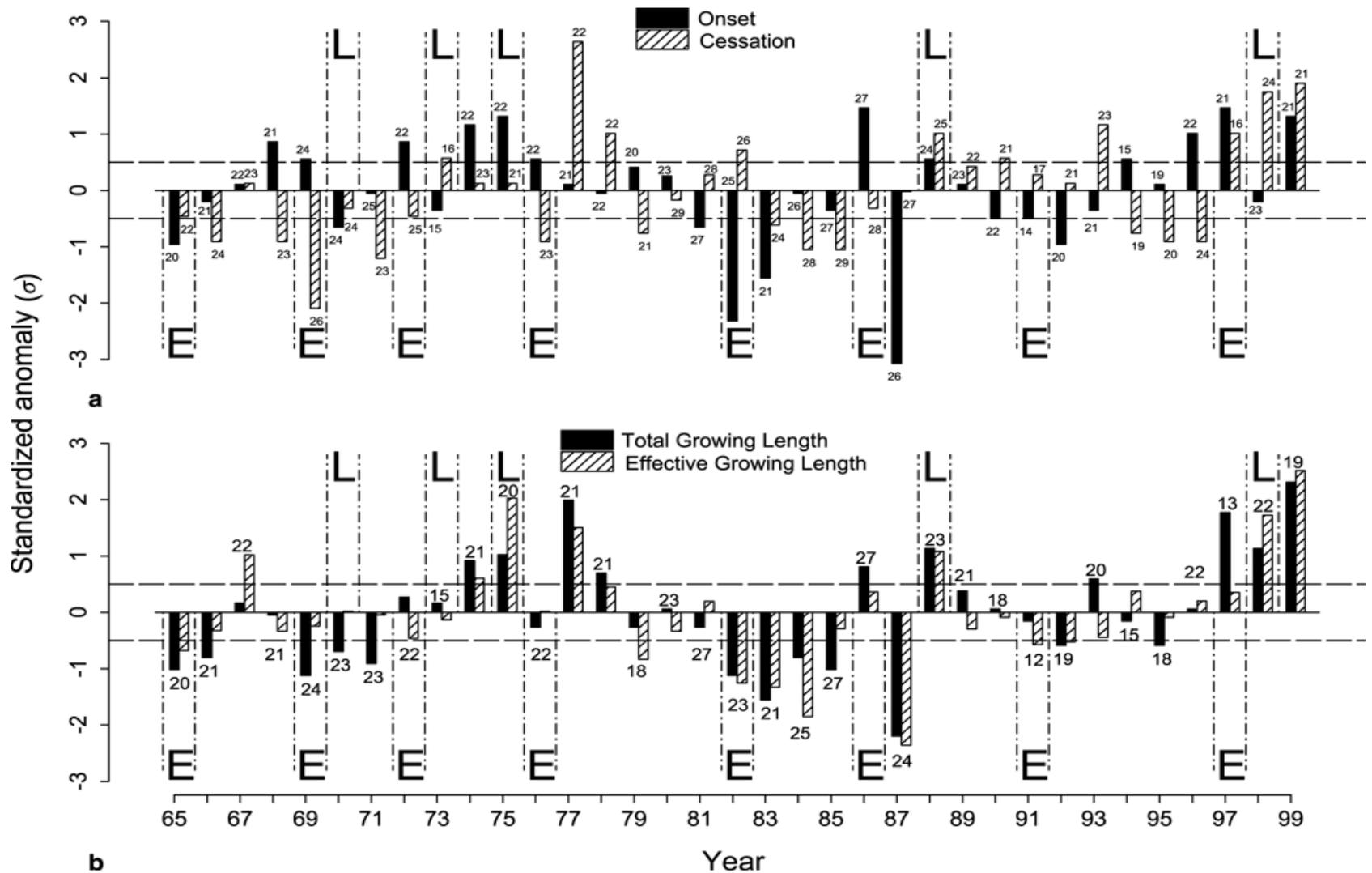


Spatial correlation patterns between Nino 3.4 SST and JJAS rainfall totals over Ethiopia

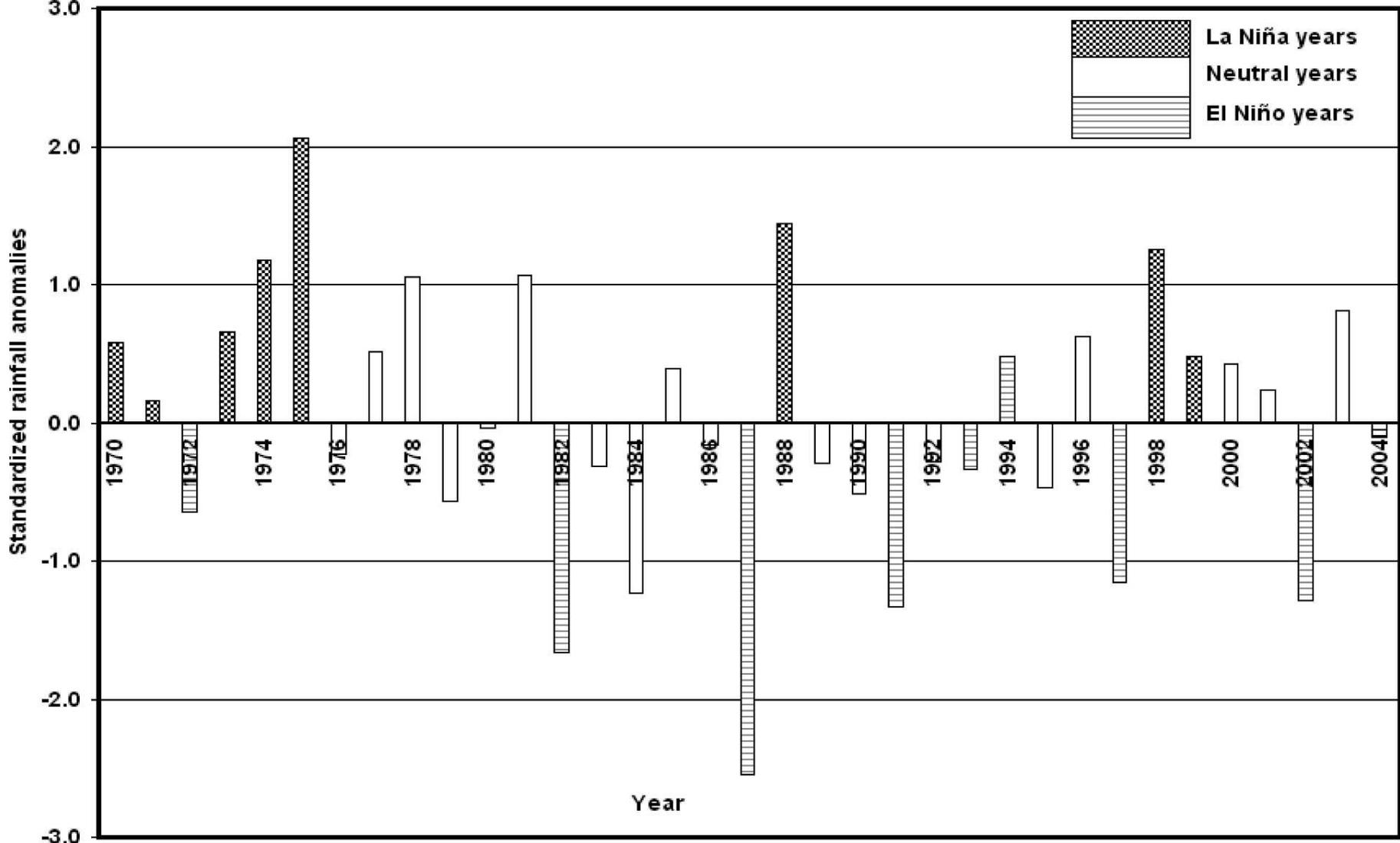
Why ENSO?

Research finding from Korecha and Barnston (2007) on the association between the ENSO state and all-Ethiopian JJAS rainfall, based on the 1970–2004 period indicated that

Seasonal rainfall category	ENSO phase			Significance
	El Niño (9 yr)	Neutral (18 yr)	La Niña (8 yr)	
Dry (10 yr)	6 (67%)	4 (22%)	0 (<5%)	$P < 0.01$
Normal (12 yr)	2 (22%)	9 (50%)	1 (12%)	
Wet (13 yr)	1 (11%)	5 (28%)	7 (>85%)	



1965–99 time series of yearly Kiremt characteristics averaged over a maximum of 32 stations in the highly drought prone northeastern Kiremt region east and north of thin solid line. E and L denote onset years (Year 0) of warm and cold tropical Pacific ENSO events, respectively (After Segele and Lamb, 2005)



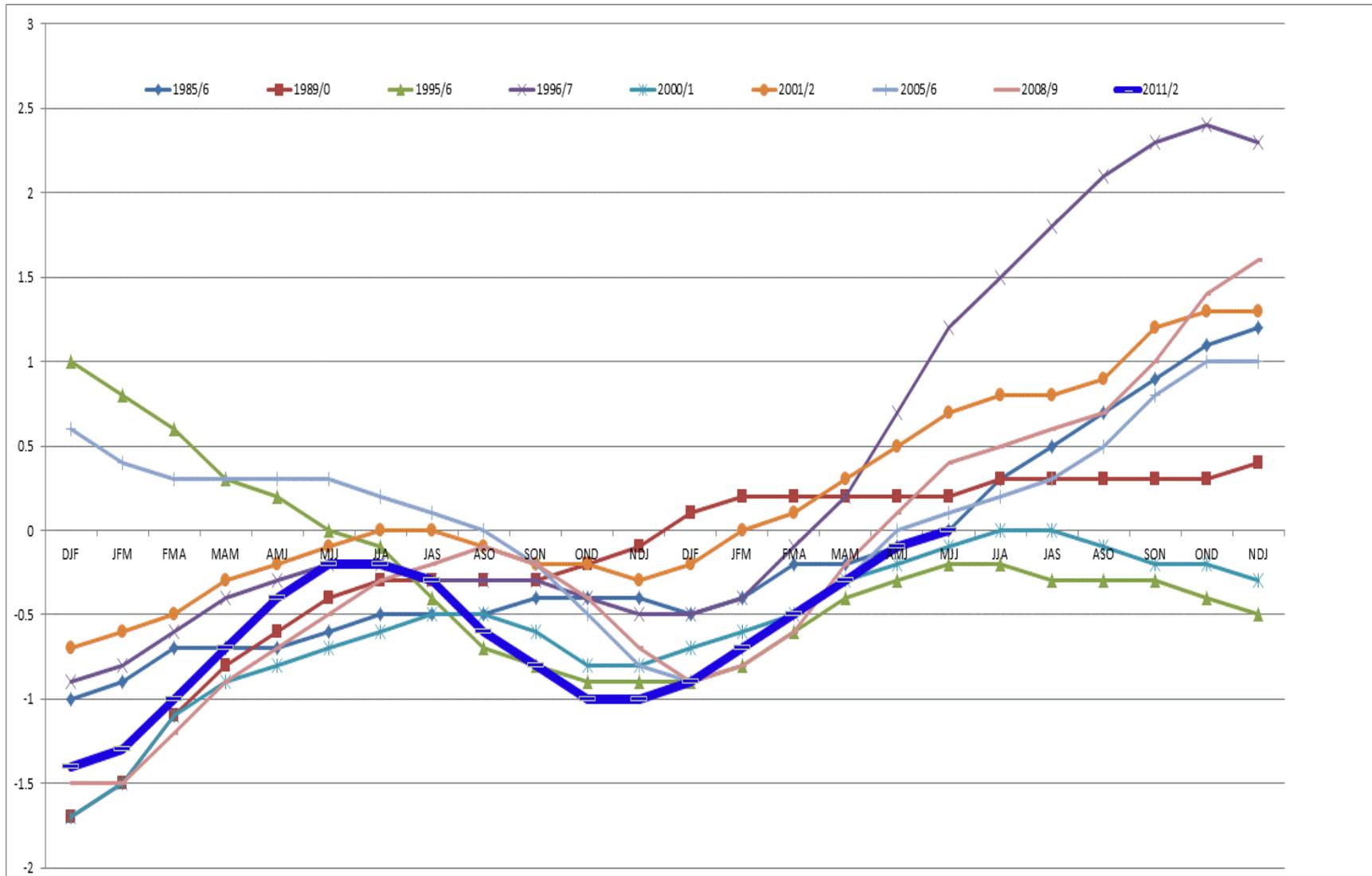
Standardized JJAS rainfall anomalies of all-Ethiopian rainfalls for the 1970–2004 period. Years having El Niño, La Niña, and neutral conditions during JJAS, based on the NOAA/CPC ENSO classification, are denoted by the patterns inside the bars (After Korecha and Barnston, 2007)

Impacts of ENSO phases on JJAS rainy season

- **La Nina => enhances rainfall amount
and distribution**
- **El Nino => suppresses rainfall amount
and distribution**

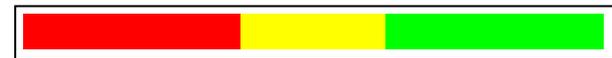
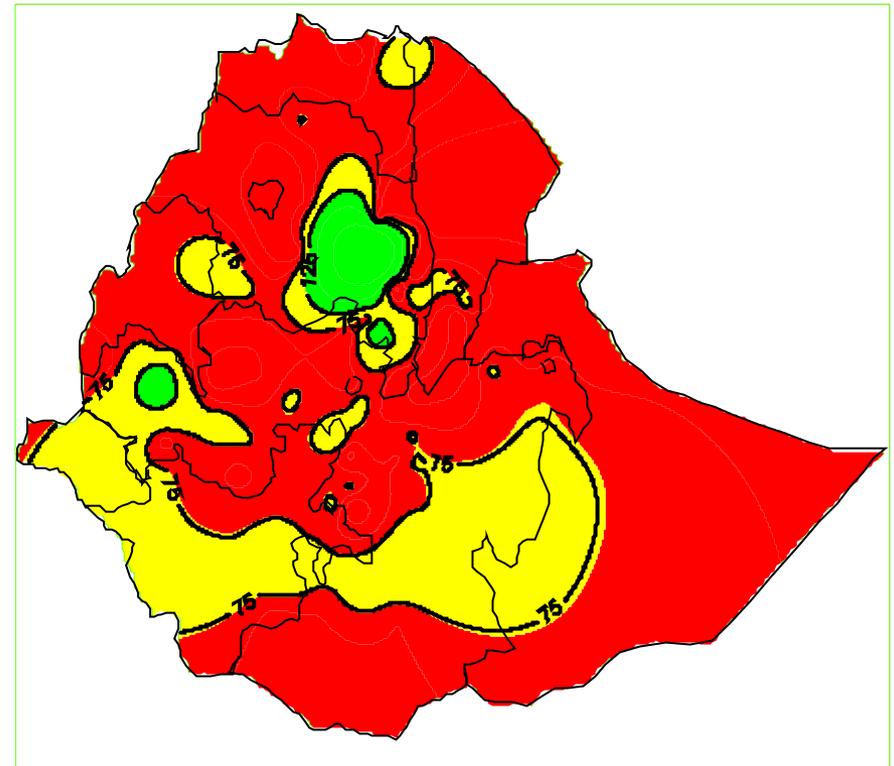
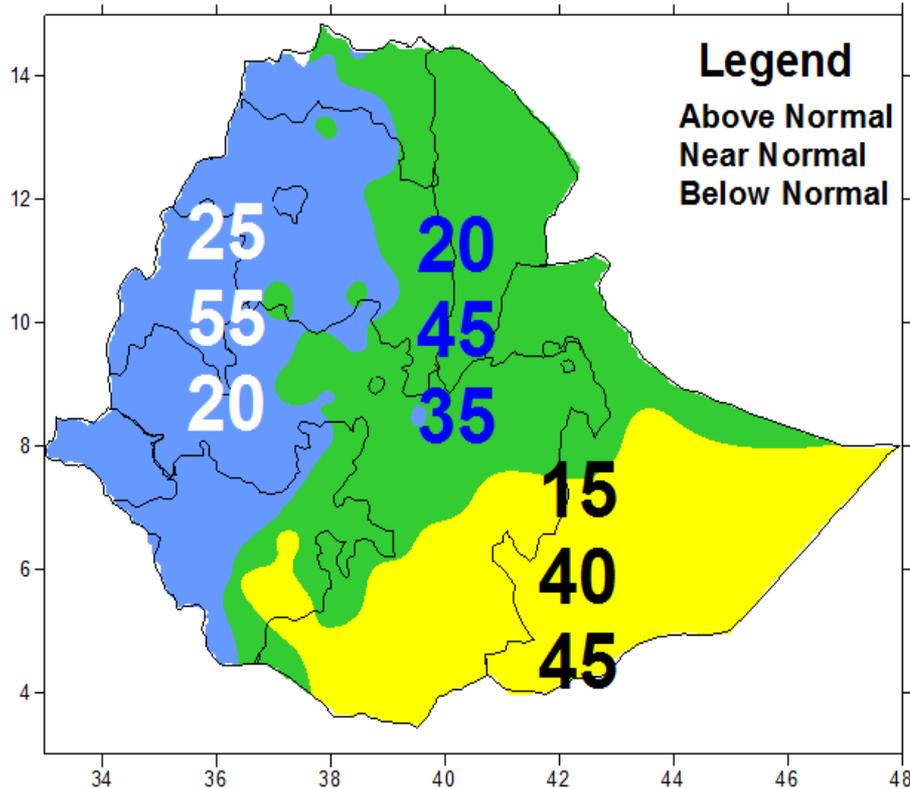
ENSO-based seasonal rainfall prediction skills

Selection of the best analogue years



Seasonal rainfall performance for Belg 2012 as represented by percent of normal

Rainfall Tercile Probability for Belg 2012



BN

NN

AN

Any predictability skills?

Why ENSO?

- Evidences have shown that there is strong lag and concurrent relationship between Ethiopian seasonal rainfall and ENSO parameters

Season Rainfall prediction

- precursor indicators for various social and economic planning and activities

Prediction skill

- Forecast verification showed promising results

Verification

- national seasonal forecasts scored relatively better skills than the climatological forecasts

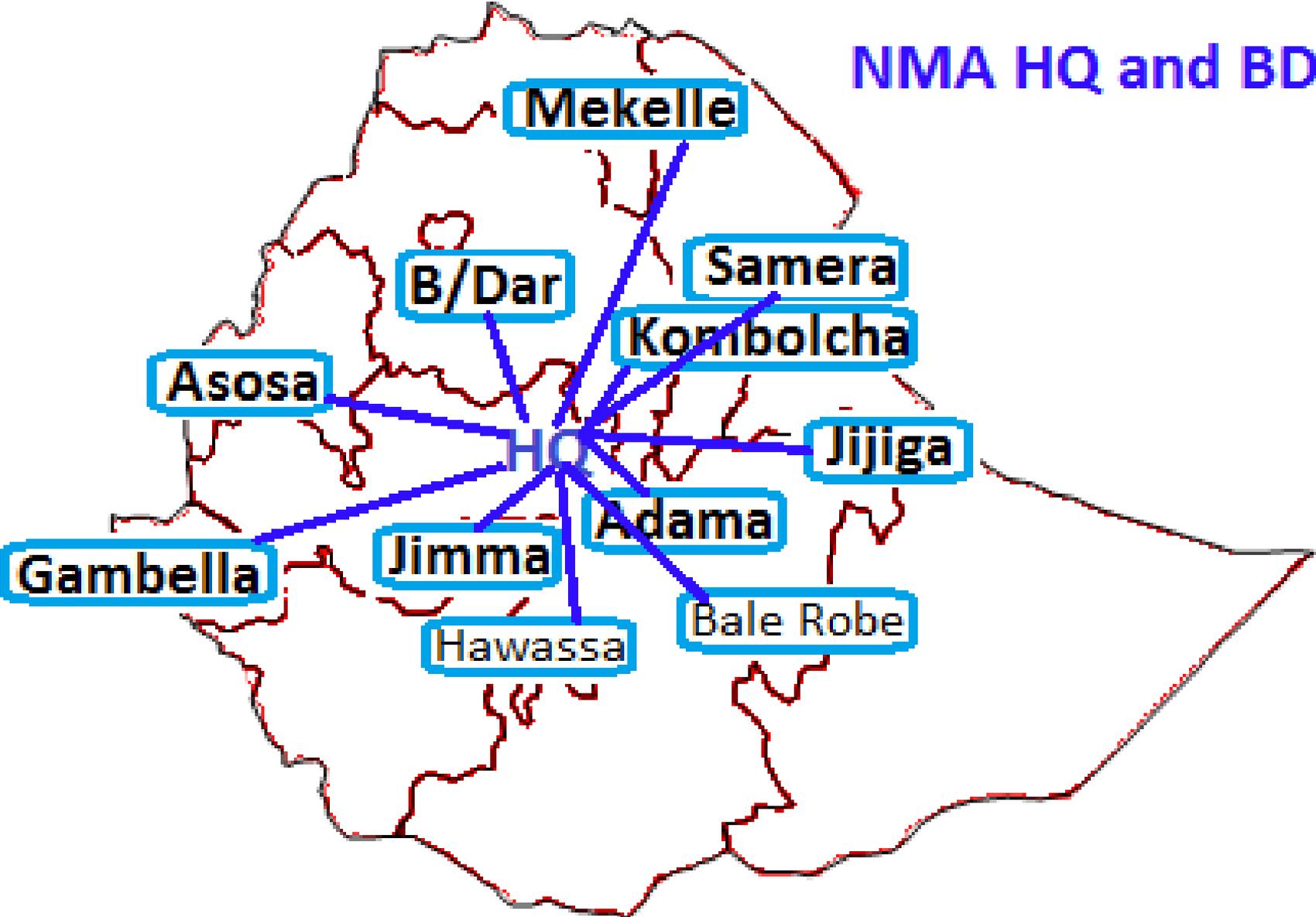
From the users sides

- Encouraging and positive feedback

Successes

- **Leading national weather monitoring, forecasting and early warning on the extreme weather events both at short and medium term time scales**
 - Monitoring short-term weather extreme, particularly heavy rainfalls (floods), heat waves, frost and cold waves, fog, dust storm, hails ...
- **Medium weather forecasts**
 - Weather advisories for agriculture, water resources, water dams management, disaster risk management
- **Seasonal climate prediction and beyond**
 - The system has been operational since 1987
 - Applications
- **Decentralization of weather and climate prediction services**

NMA HQ and BDs



Challenges and opportunities

Challenges

- **Experimental seasonal rainfall forecasts**
- **Coarse resolution forecasts**
- **Over-confidence of regional and international organizations in use of regional and global forecasts**
- **Poor performance/low confidence/no predictability signal from many global products**
- **Societal perception: Forecast is always perfect or wrong**
- **Computational intensive/expensive**
 - Demanding Facility and expertise
- **Time and spatial resolution**
 - Lead time; seasons ahead; localized forecasts

Opportunities

- **Building public trust**
 - Past extreme events well captured/predicted
- **Regional and international innovations and research outputs**
- **Supply-demand approach**
- **User-tailored products: Climate information as a package**
- **Services provisions based on the interest of public and government**

Ways forward

- **Legitimacy**
- **Local vs global products**
- **Experimental vs operational products**
- **Collaboration in Research and capacity building**
- **.....**

Thank You!!