Understanding the link between ENSO and drought over Southern Africa

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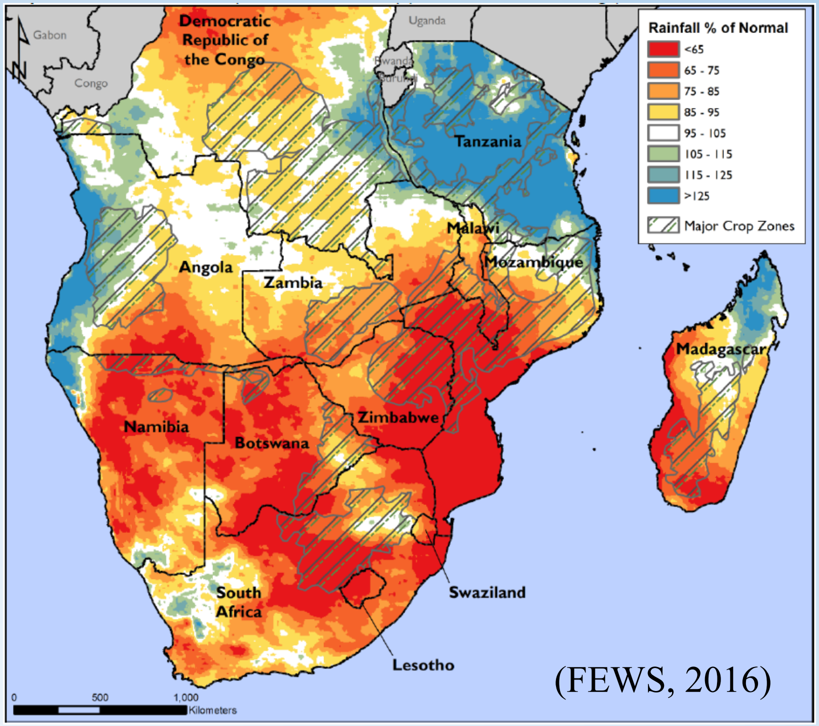
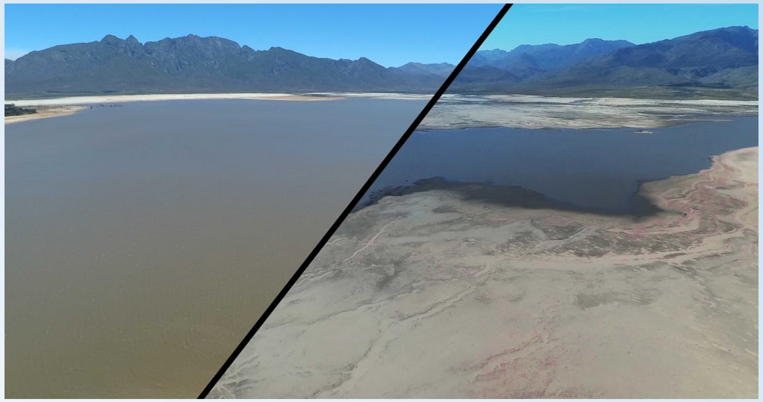
Impact of Drought in Southern Africa

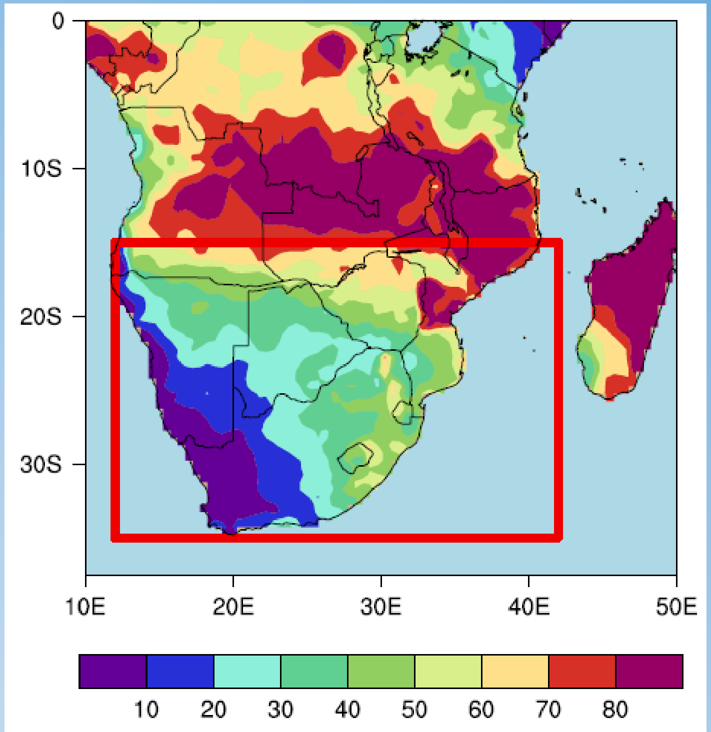


- Crop failures and livestock losses
- High economic and agricultural losses
- Food shortages
- Socio-economic impacts
- Water scarcity for human and animal consumption
- Waterborne diseases

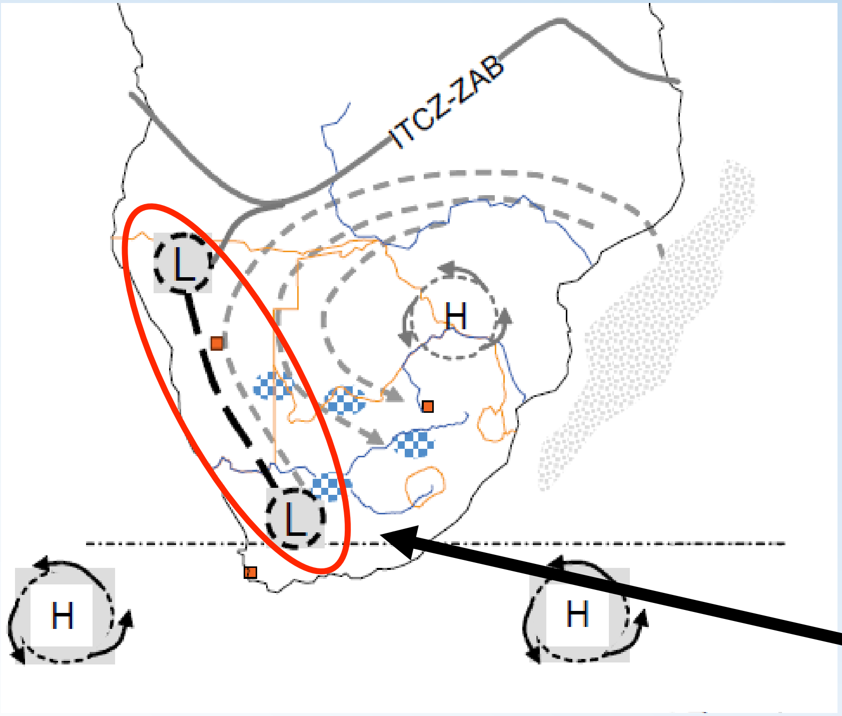


Rainfall in Southern Africa

- northern region receives the highest rainfall, whilst the south western region receives the lowest rainfall.
- austral summer (DJF) is the wet season



(Johnson, 2013)



(van Wyk, van Tonder & Vermeulen, 2011)

Synoptic Systems

- ITCZ
- Tropical temperate troughs
- Cut-off lows
- Mid-latitude cyclones
- Angolan/Kalahari low pressure belt

El Niño Southern Oscillation in Southern Africa

El Niño events = **drought**

La Niña events = **pluvial**

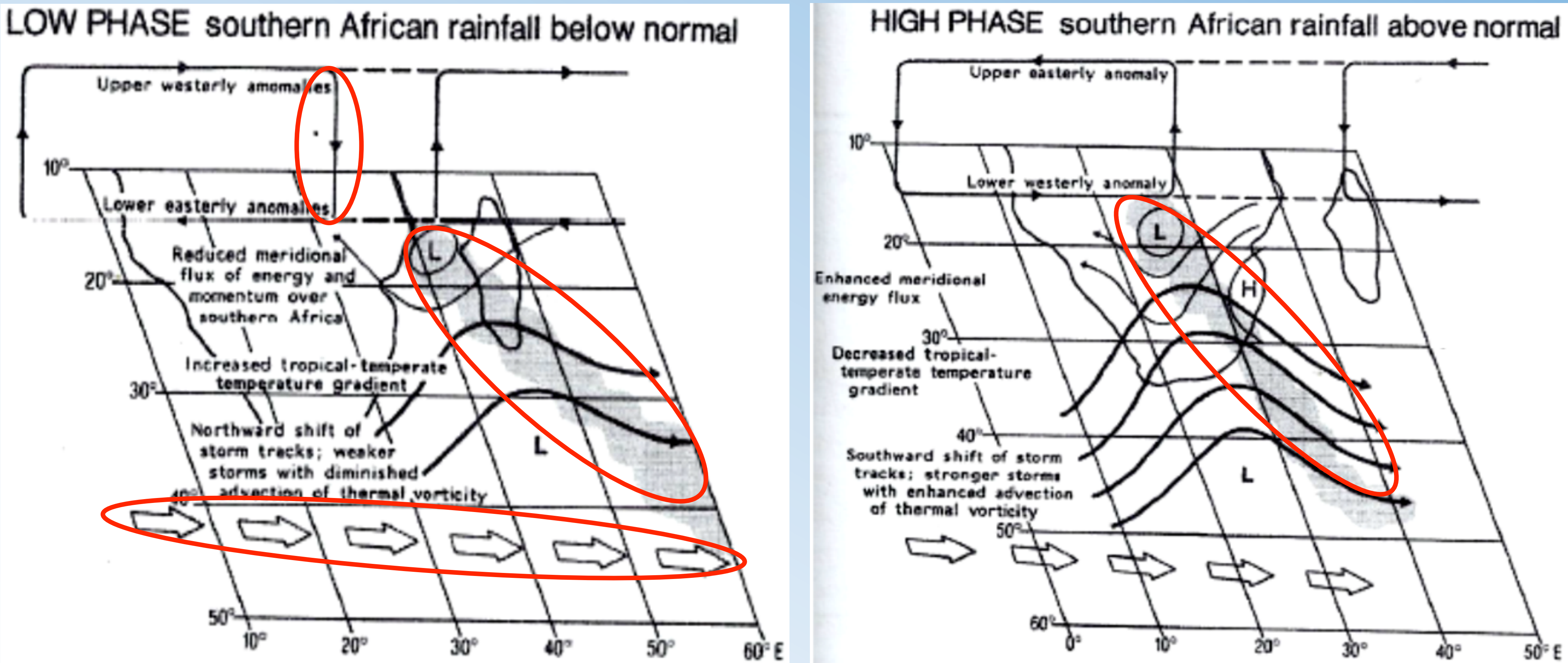


Figure 1 – Circulation patterns over Southern Africa associated with El Niño and La Niña phases (Tyson & Preston-Whyte, 2000)

Patterns of ENSO

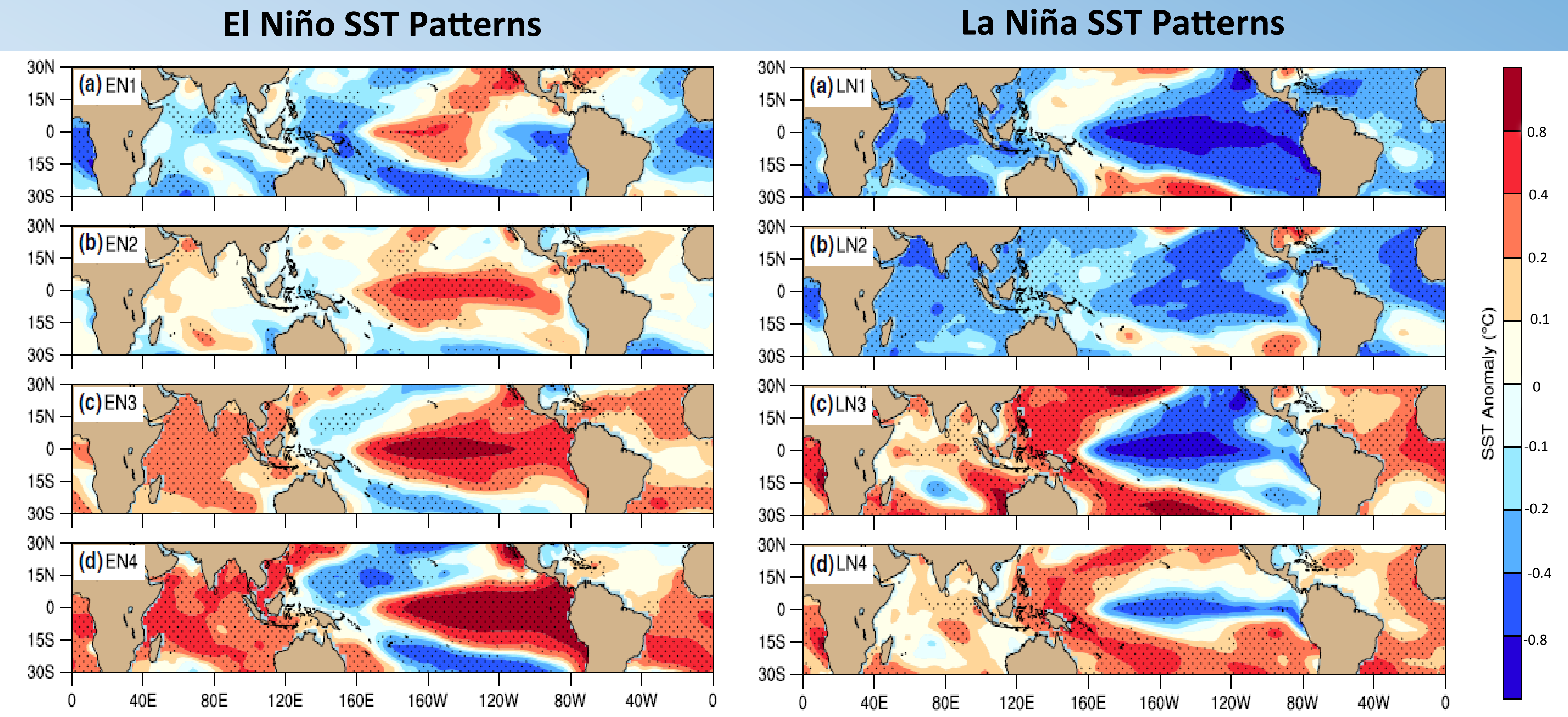


Figure 2 - Composite SST anomaly for El Niño and La Niña phases during September – February 1950-2010 identified by Johnson (2013) (as cited in Hoell et al., 2014)

Precipitation Anomalies over Southern Africa associated with each ENSO pattern

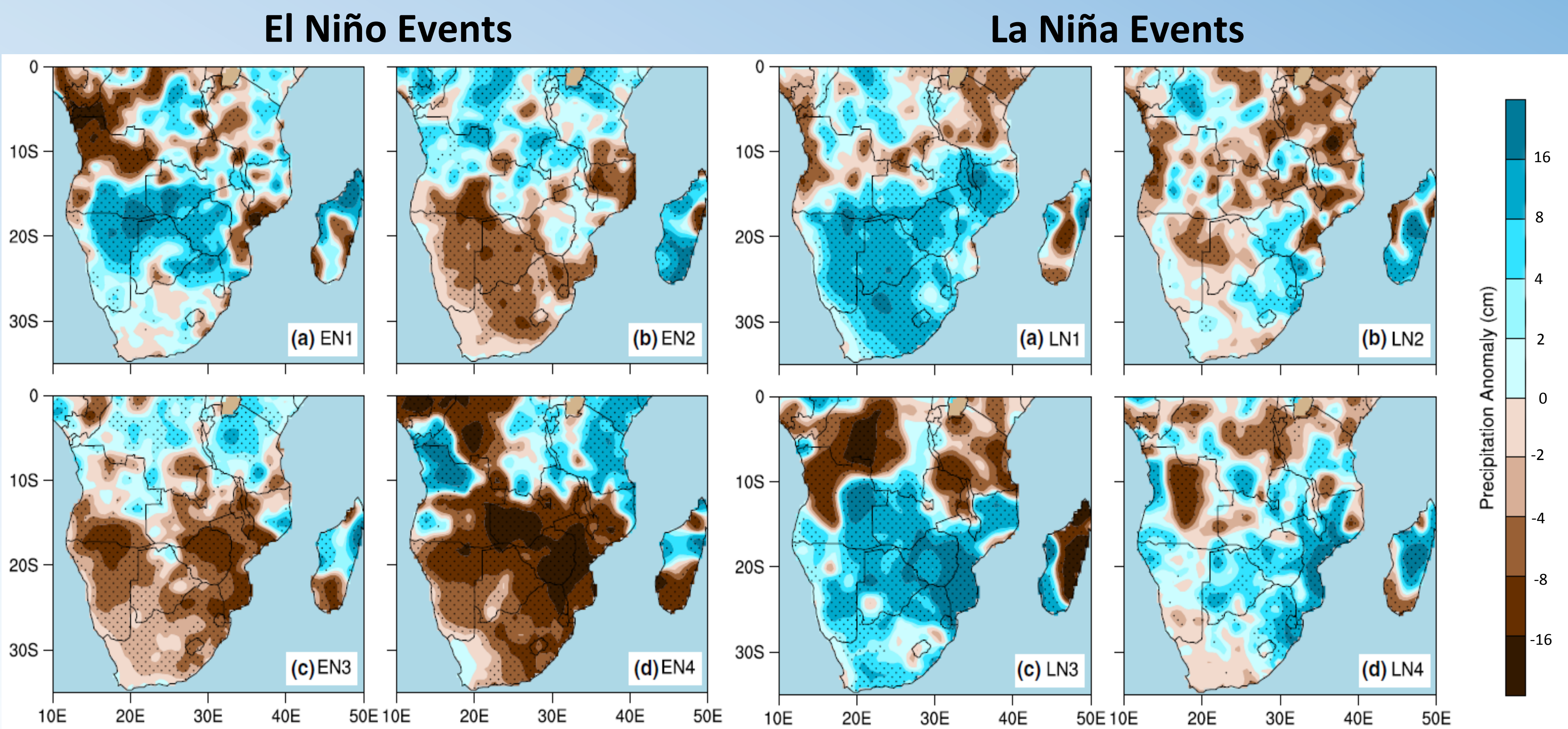


Figure 3 - Composite precipitation anomalies (cm) for El Niño and La Niña phases during DJFM 1950-2010 (Hoell et al., 2014).

Standardized Precipitation Evapotranspiration Index

takes into account both precipitation and potential evapotranspiration (proportional to temperature).

SPEI values			Drought severity categories
≥2			Extremely wet
1.50	~	1.99	Severely wet
1.00	~	1.49	Moderately wet
0.99	~	0	Mildly wet
0	~	-0.99	Mild drought
-1.00	~	-1.49	Moderate drought
1.50	~	-1.99	Severe drought
≤-2			Extreme drought

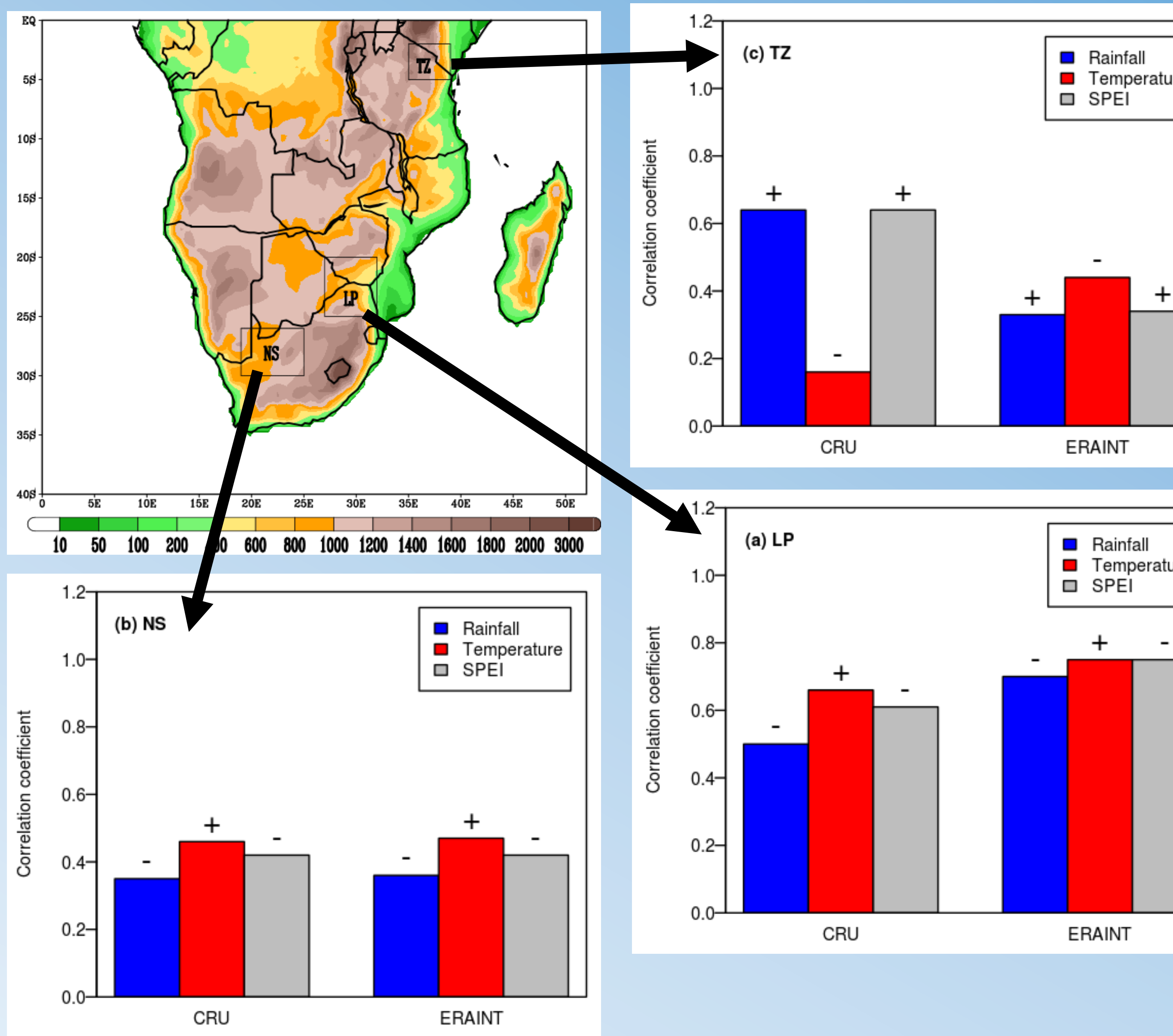


Figure 4 – The correlation between ENSO and climate variables (rainfal temperature and SPEI over a) Limpopo (LP) b) North-western South Africa (NS) an c) Northeastern Tanzania (NT) (adapted from Meque & Abiodun, 2015) .

Aim

To investigate the link between the different ENSO patterns and drought over Southern Africa using ICTPAGCM (SPEEDY)

Objectives

- Evaluate SPEEDY (t63) over Southern Africa.
- Impose SST anomaly patterns onto the model in order to examine how each ENSO pattern influences drought (SPEI) over Southern Africa.

Experiment Set-up

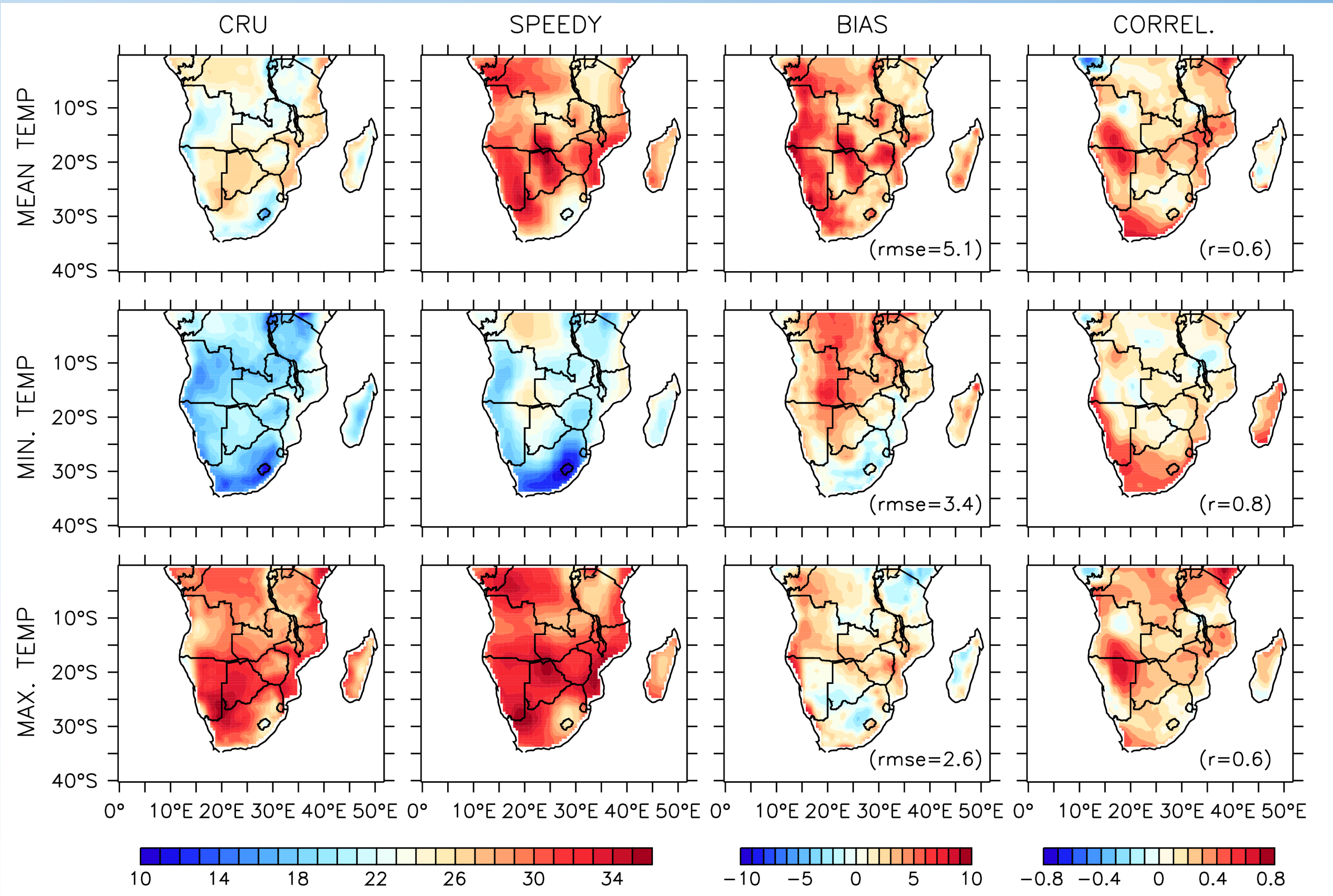
- **Model Data: ICTPAGCM SPEEDY**
  - Horizontal resolution (T63) ~ 1.875° x 1.875°
  (Molteni, 2003; Kucharski, Molteni and Bracco, 2006)

- **Observed Data: Climate Research Unit** (CRU TS3.24.01)
  - Monthly climate data
  - Horizontal resolution ~ 0.5° x 0.5

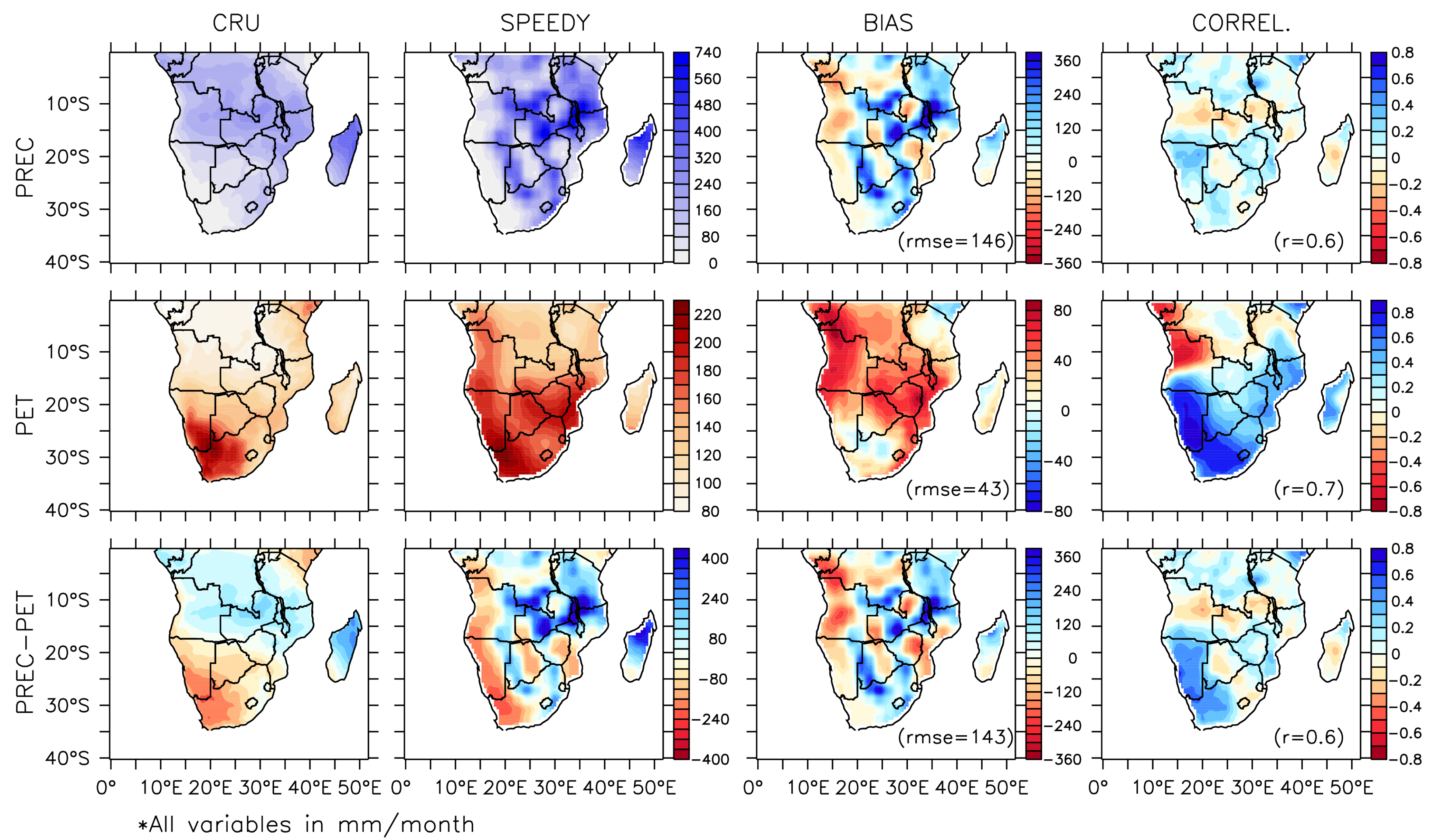
  - **Evaluate climate variables**
    – DJF 1970 – 2010 single simulation
    – Bias, RMSE and correlation (spatial and temporal)
    – temperature (mean, maximum, minimum), precipitation, potential evapotranspiration, moisture balance and SPEI.

  - **Capability to simulate ENSO patterns**

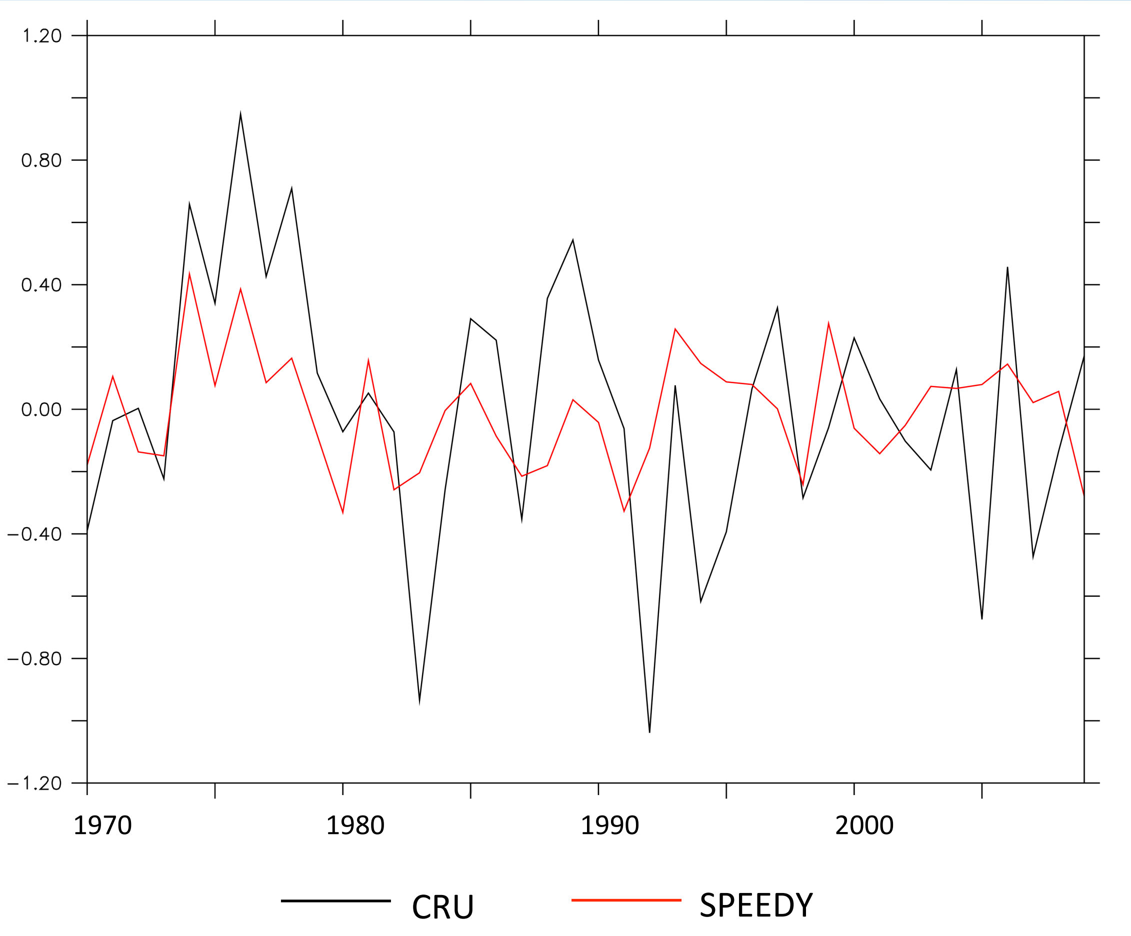
Temperature (DJF)

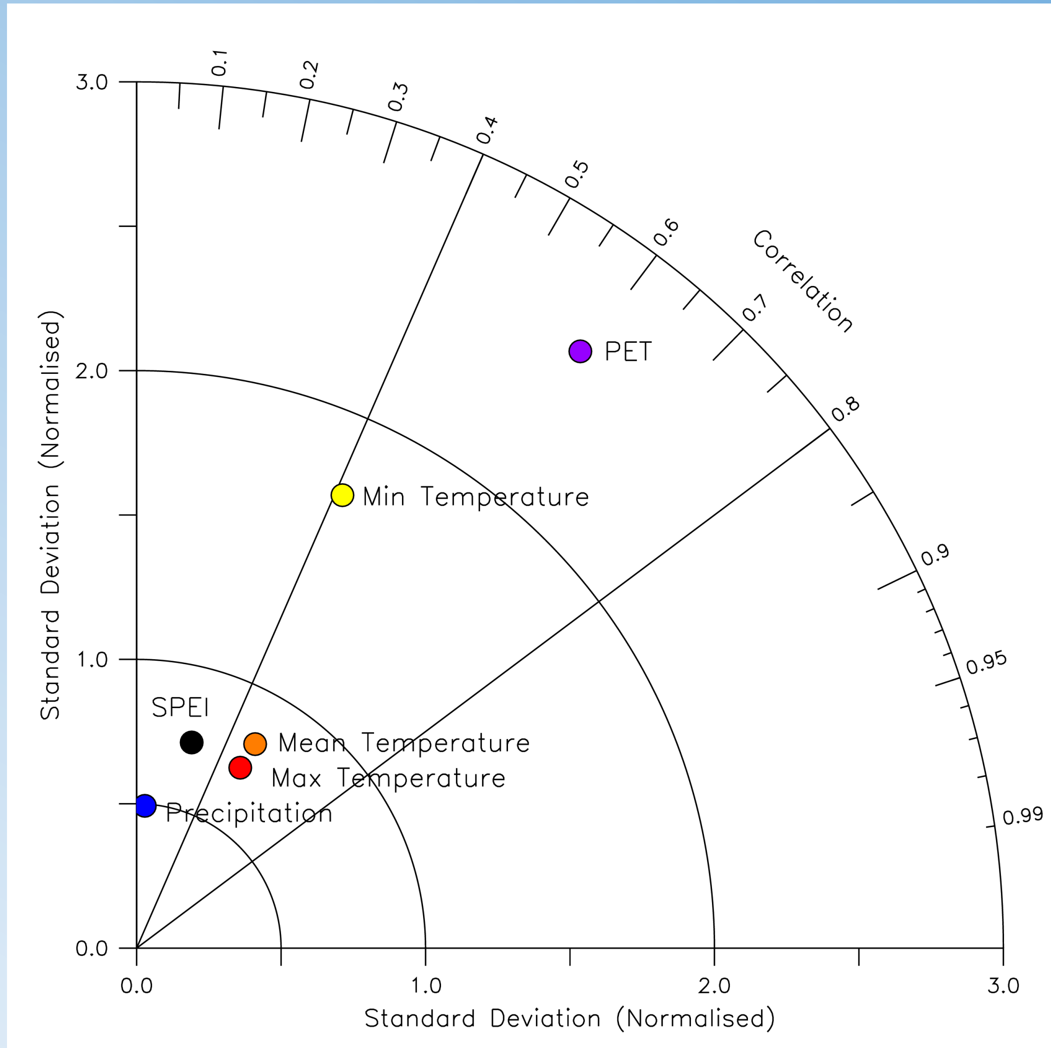


Climate Moisture Balance (DJF)



DJF 3-month SPEI





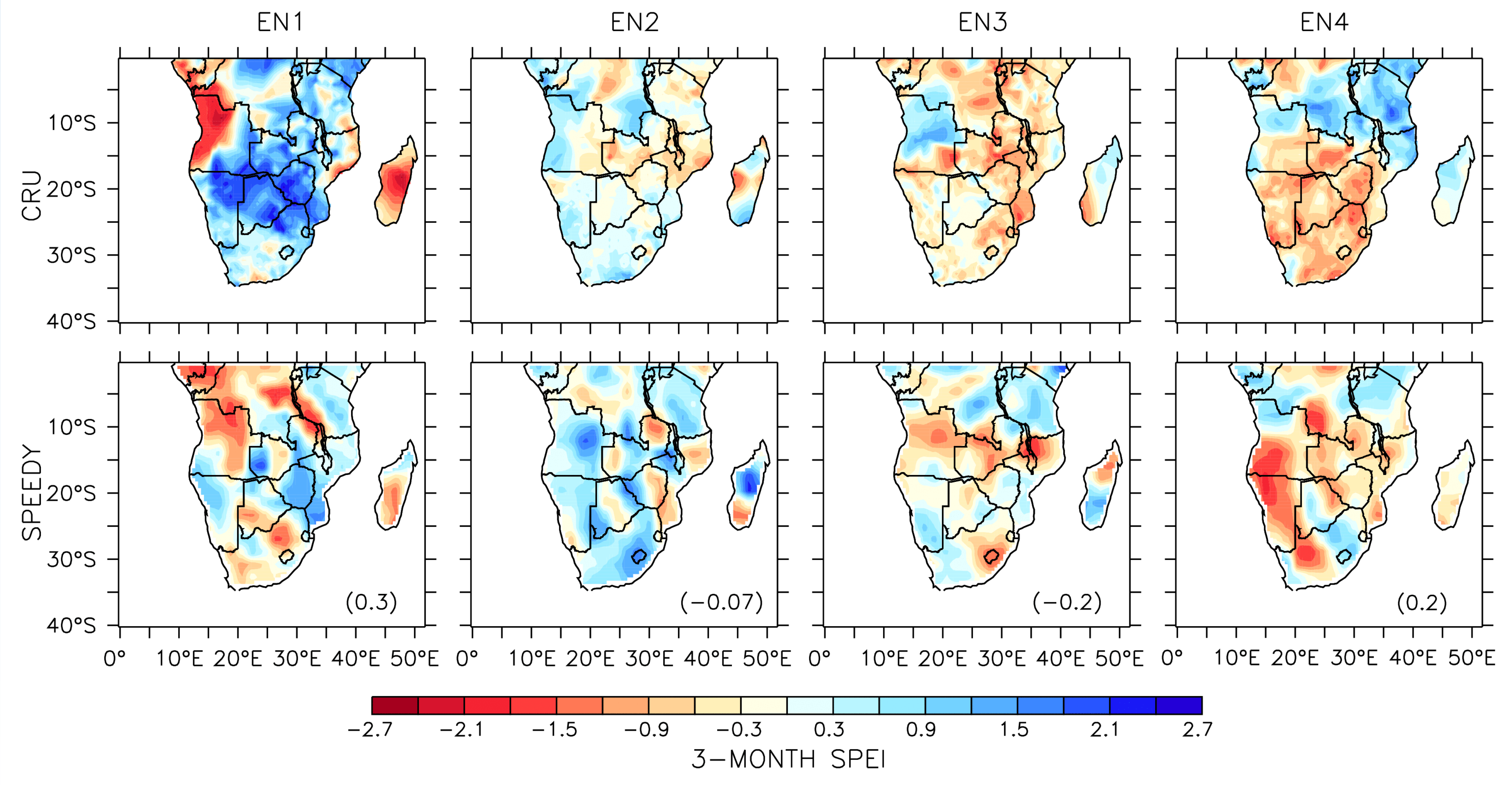
Capability to Simulate ENSO Patterns

EN1	EN2	EN3	EN4
1953–1954	1951–1952	1957–1958	1972–1973
1958–1959	1963–1964	1965–1966	1982–1983
1977–1978	1968–1969	1986–1987	1997–1998
	1969–1970	1987–1988	
	1976–1977	1991–1992	
	2004–2005	1994–1995	
		2002–2003	
		2006–2007	
		2009–2010	

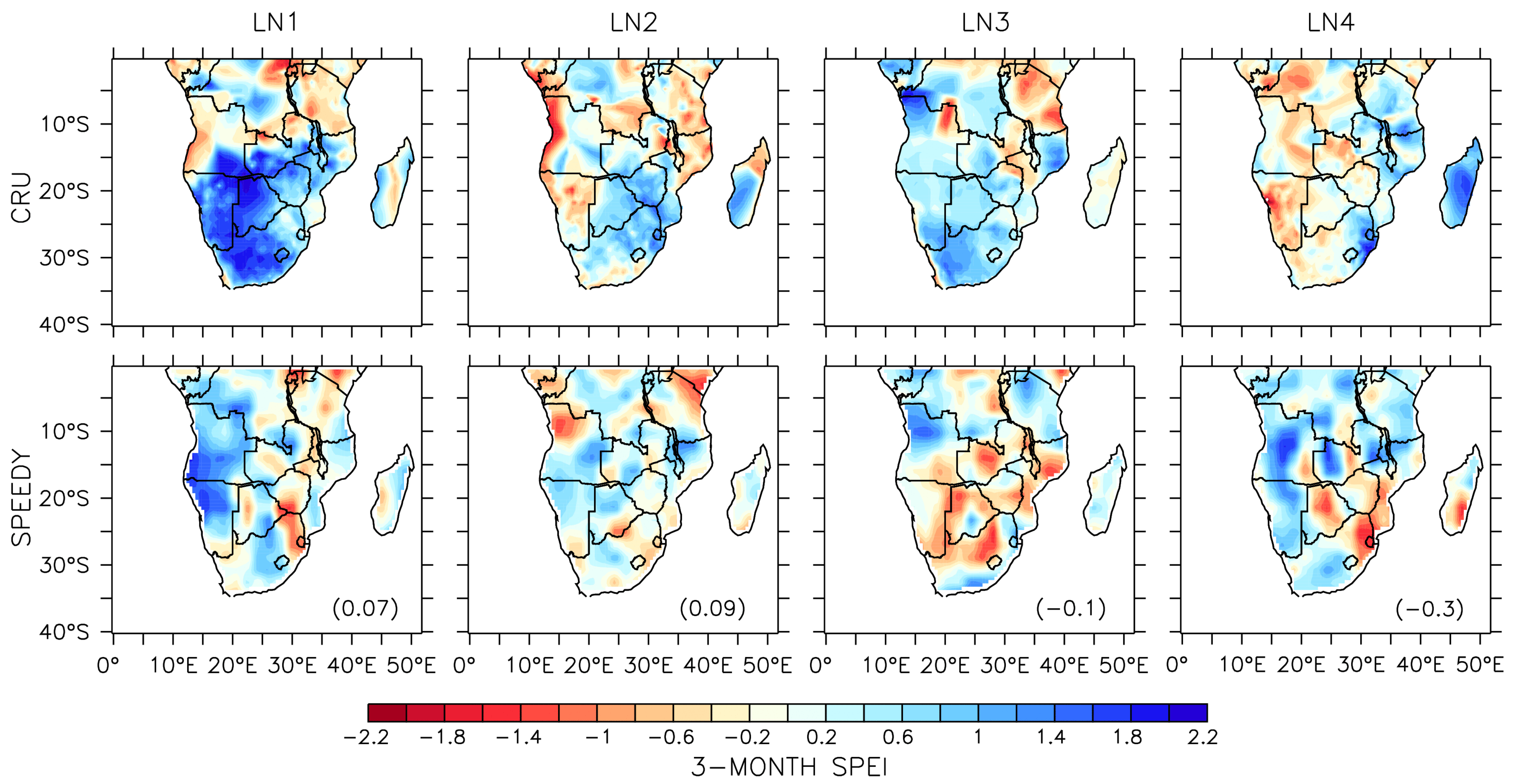
LN1	LN2	LN3	LN4
1950–1951	1956–1957	1998–1999	1983–1984
1954–1955	1964–1965	1999–2000	1995–1996
1955–1956	1971–1972	2007–2008	2000–2001
1970–1971	1974–1975	2010–2011	2005–2006
1973–1974			
1975–1976			
1988–1989			

(Hoell et al., 2014)

El Niño Patterns



La Niña Patterns



Conclusions

- SPEEDY simulates a warm bias over the majority of Southern Africa
- Higher PET values limits the efficiency of SPEEDY in simulating the moisture balance and SPEI
- Correlation is quite weak when simulating the ENSO patterns
- Next steps… look at geopotential height and pressure fields
- Look at ways to improve the performance of the model before conducting sensitivity tests and imposing the SST anomaly patterns.