Facing Climate Variability & Change

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YUNIBESITHI YA PRETORIA

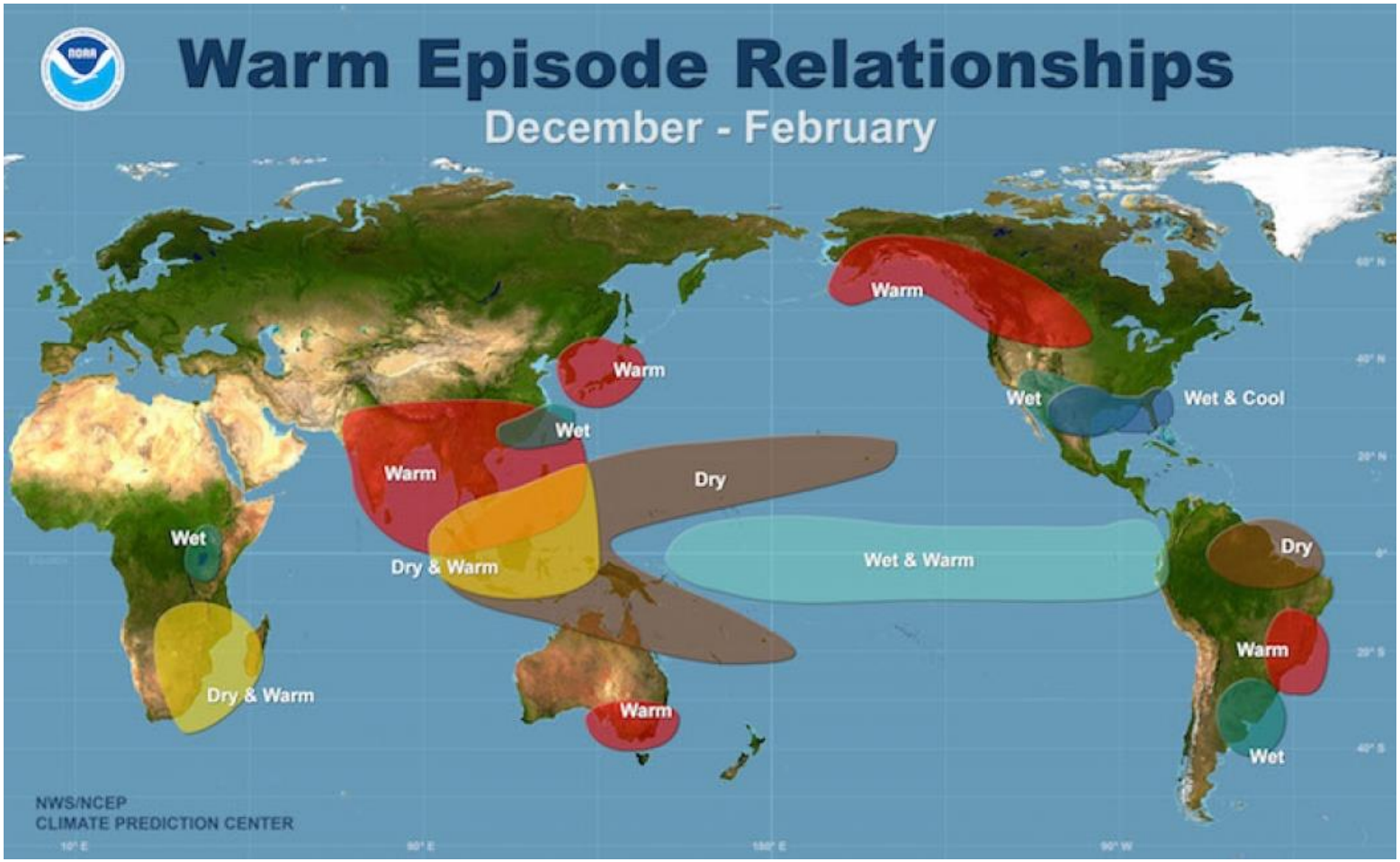
CSIR
our future through science

South African Weather Service
ISO 9001 Certified Organisation

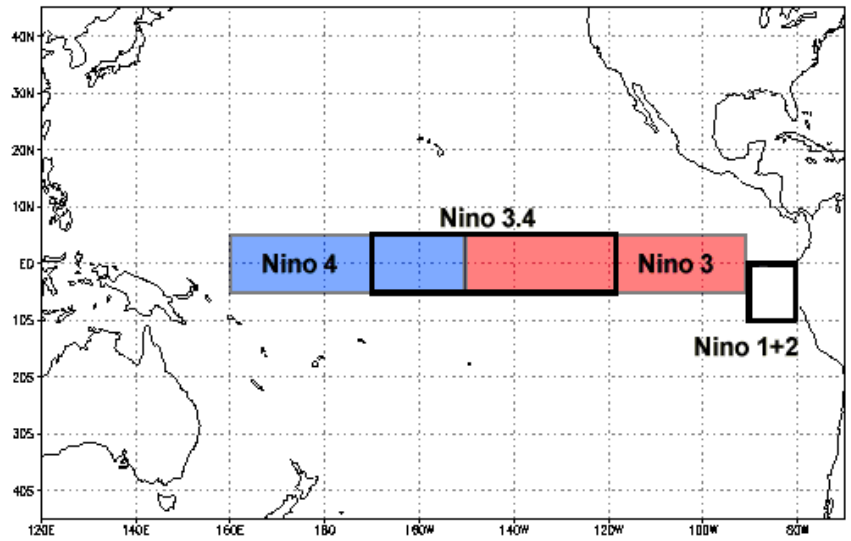
First, definitions

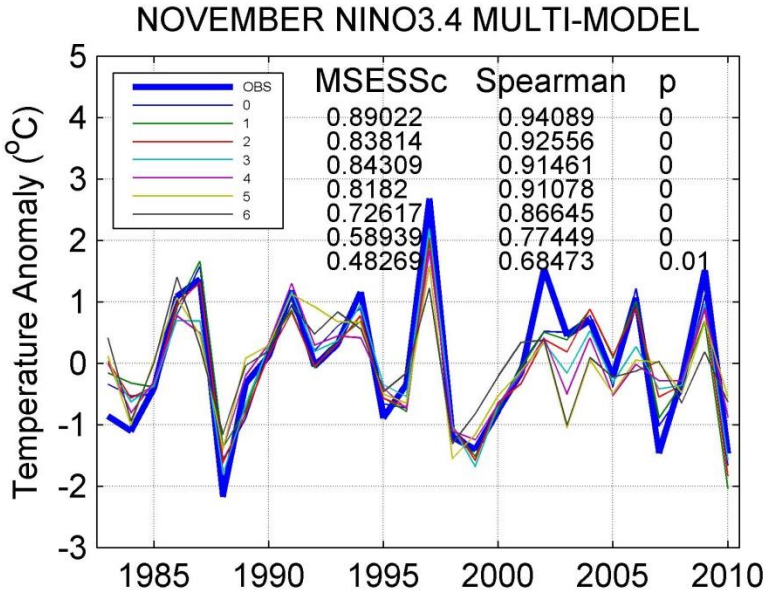
- **Climate variability**
  - **The temporal variations of the atmosphere– ocean system around a mean state. Typically, this term is used for timescales longer than those associated with synoptic weather events. The term "natural climate variability" is further used to identify climate variations that are not attributable to or influenced by any activity related to humans.**
- **Climate Change**
  - **Any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. Climate change may be due to natural external forcings, such as changes in solar emission or slow changes in the earth's orbital elements; natural internal processes of the climate system; or anthropogenic forcing.**

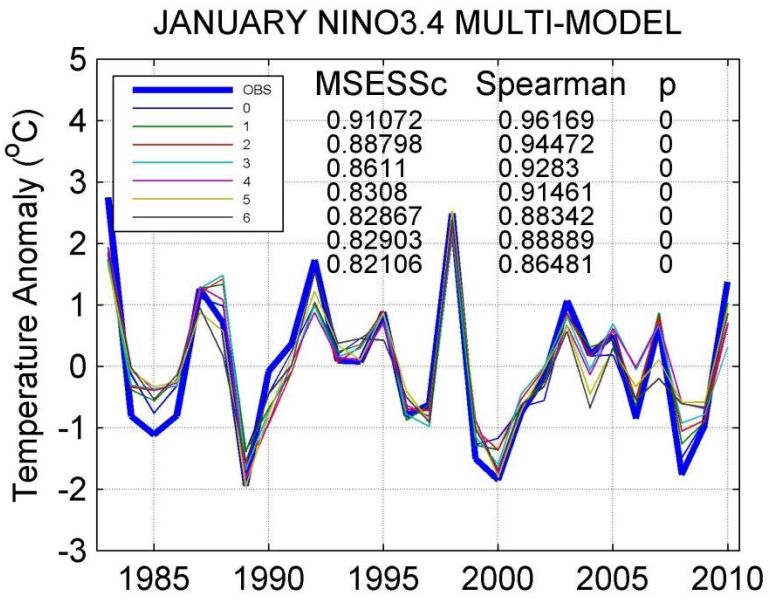
The Classics: 1980s

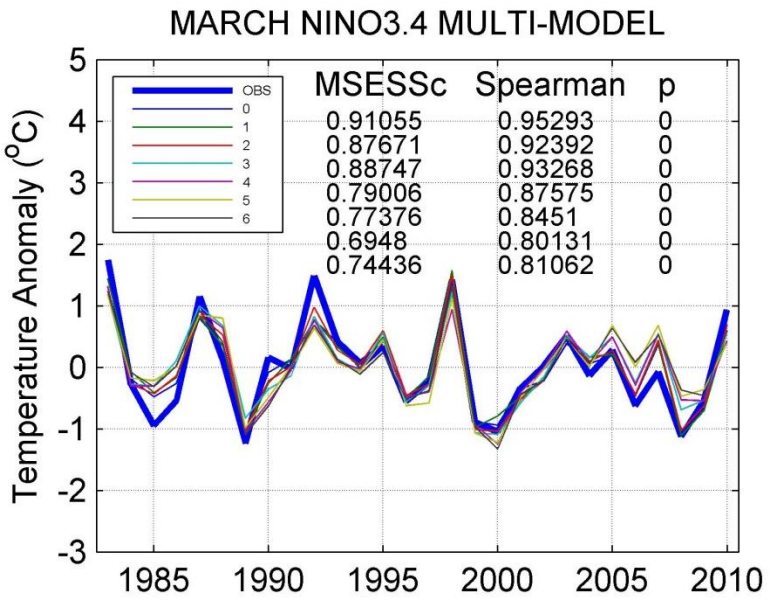


Typical skill predicting El Niño and La Niña events









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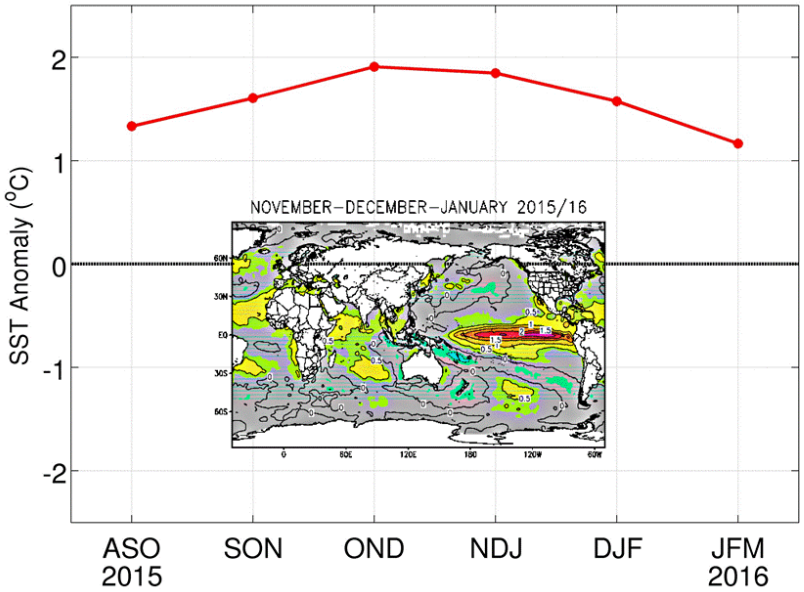
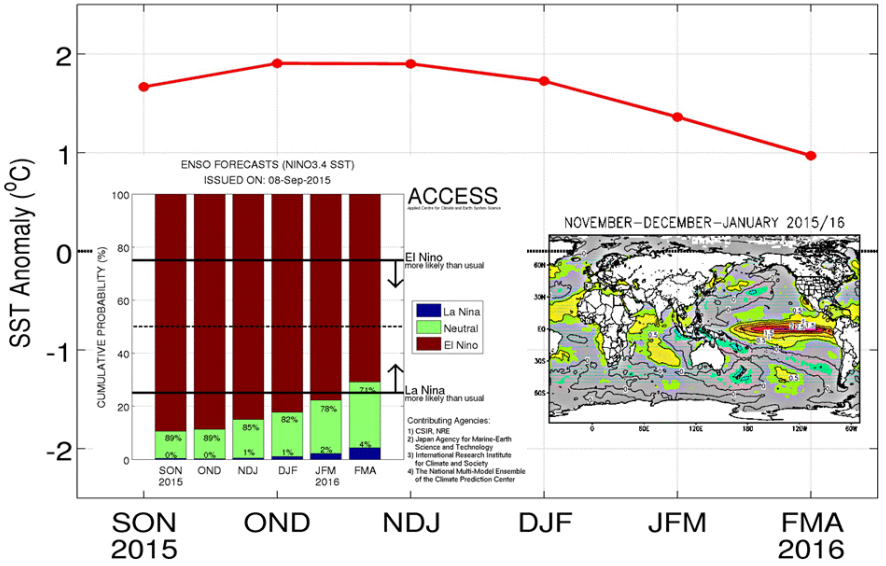
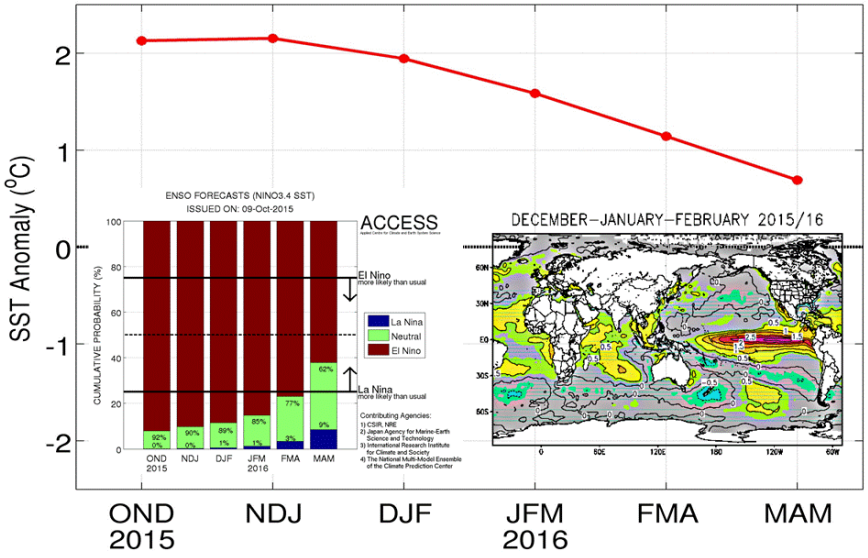
CSiriMM Nino3.4 SST Forecast
Issued on: 11-Aug-2015

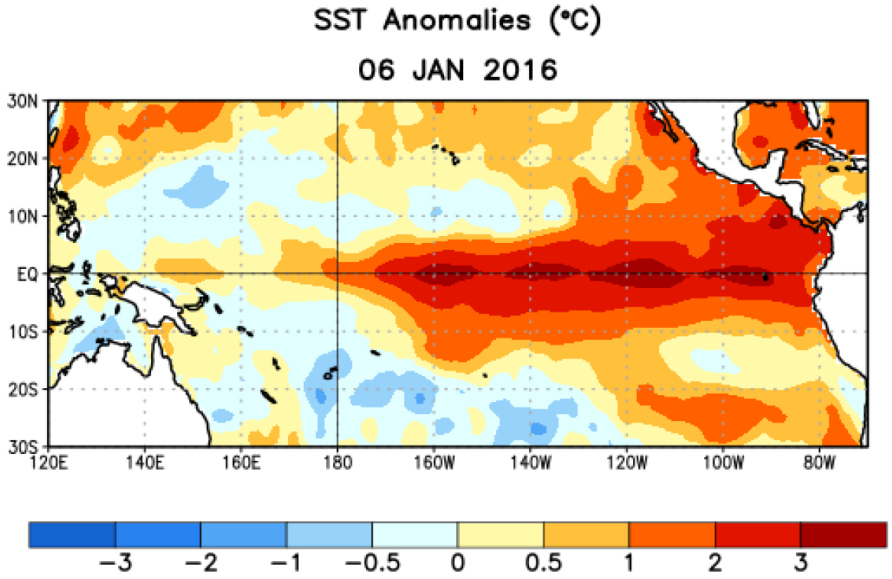


CSiriMM Nino3.4 SST Forecast
Issued on: 08-Sep-2015



CSiriMM Nino3.4 SST Forecast
Issued on: 09-Oct-2015





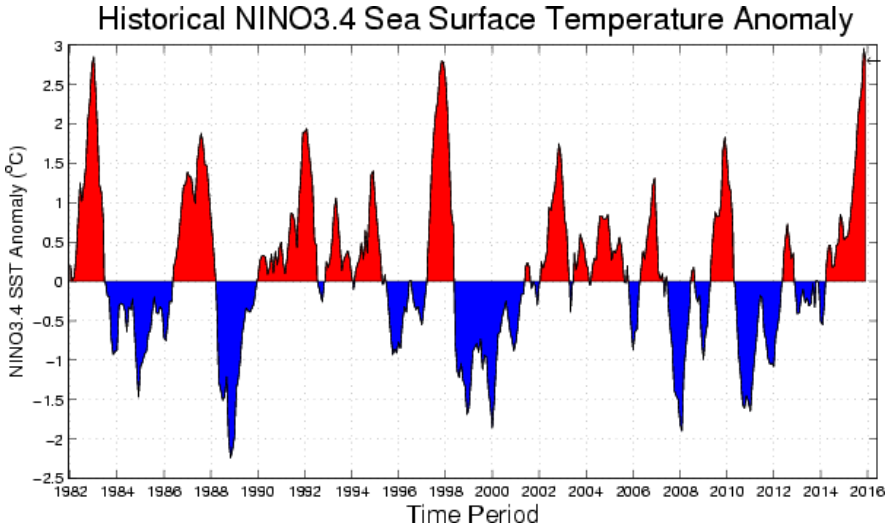
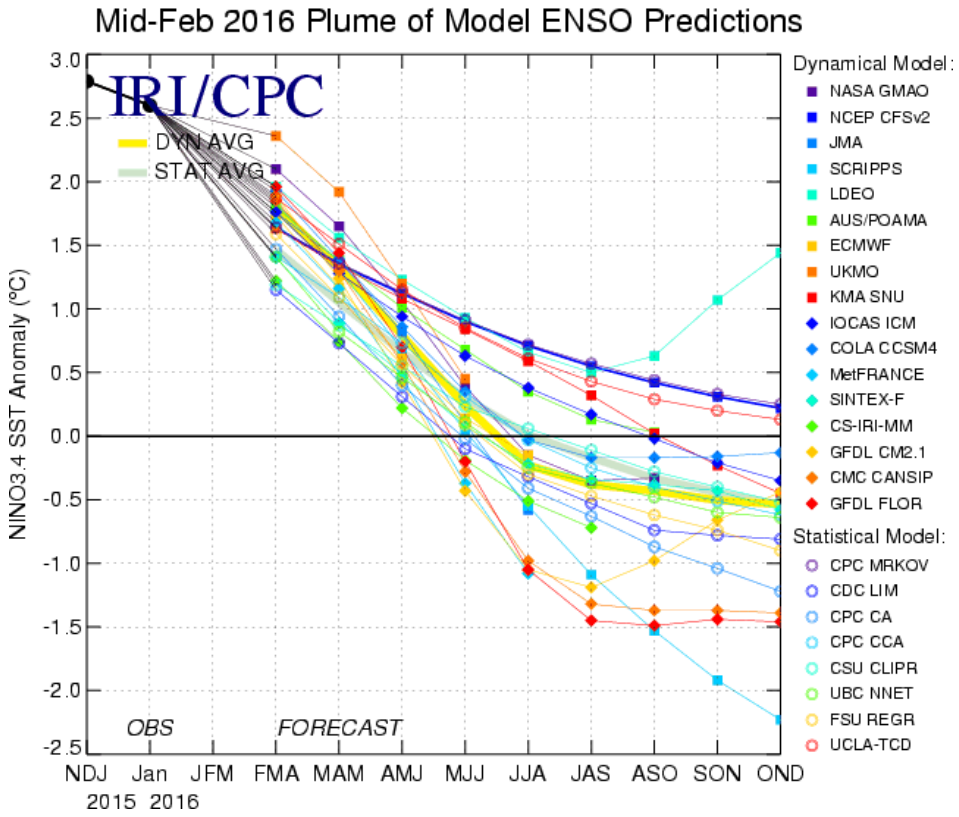
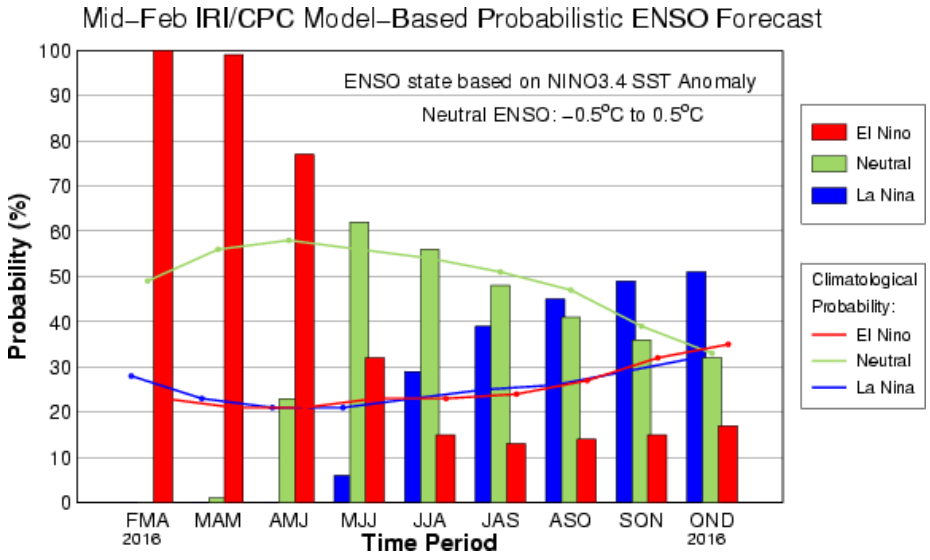


Figure 1. Average sea surface temperature (SST) anomalies (°C) for the week centered on 6 January 2016. Anomalies are computed with respect to the 1981-2010 base period weekly means.

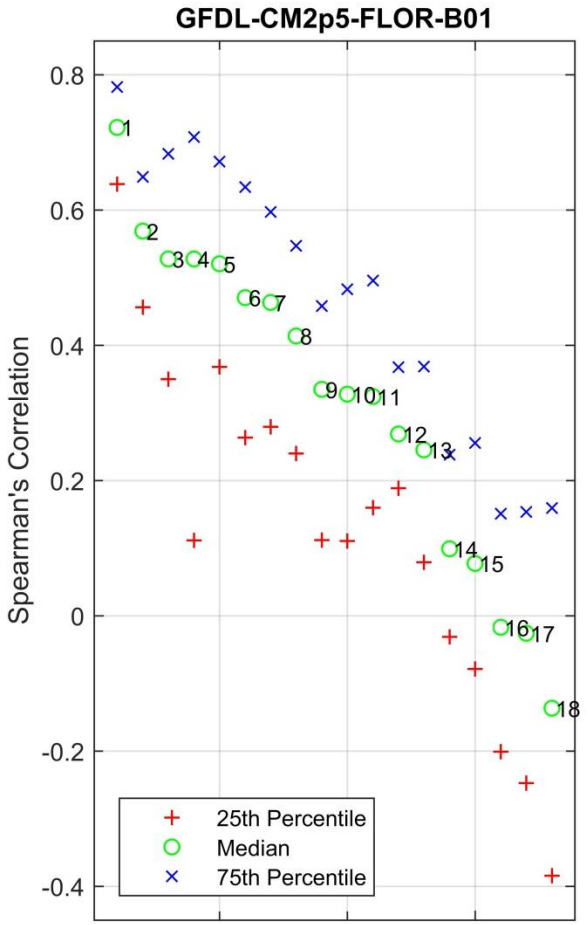
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1997	-0.5	-0.4	-0.2	0.1	0.6	1.0	1.4	1.7	2.0	2.2	2.3	2.3
1998	2.1	1.8	1.4	1.0	0.5	-0.1	-0.7	-1.0	-1.2	-1.2	-1.3	-1.4
1999	-1.4	-1.2	-1.0	-0.9	-0.9	-1.0	-1.0	-1.0	-1.1	-1.2	-1.4	-1.6
2000	-1.6	-1.4	-1.1	-0.9	-0.7	-0.7	-0.6	-0.5	-0.6	-0.7	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.3	-0.2	-0.1	0	-0.1	-0.1	-0.2	-0.3	-0.3
2002	-0.2	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0	-0.2	-0.1	0.1	0.2	0.3	0.4	0.4	0.4
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.5	0.5	0.4	0.2	0.1	0	0	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.2	0.0	0.1	0.2	0.3	0.5	0.8	0.9	1.0
2007	0.7	0.3	0	-0.1	-0.2	-0.2	-0.3	-0.6	-0.8	-1.1	-1.2	-1.3
2008	-1.4	-1.3	-1.1	-0.9	-0.7	-0.5	-0.3	-0.2	-0.2	-0.3	-0.5	-0.7
2009	-0.8	-0.7	-0.4	-0.1	0.2	0.4	0.5	0.6	0.7	1.0	1.2	1.3
2010	1.3	1.1	0.8	0.5	0	-0.4	-0.8	-1.1	-1.3	-1.4	-1.3	-1.4
2011	-1.3	-1.1	-0.8	-0.6	-0.3	-0.2	-0.3	-0.5	-0.7	-0.9	-0.9	-0.8
2012	-0.7	-0.6	-0.5	-0.4	-0.3	-0.1	0.1	0.3	0.4	0.4	0.2	-0.2
2013	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
2014	-0.5	-0.6	-0.4	-0.2	0	0	0	0	0.2	0.4	0.6	0.6
2015	0.5	0.4	0.5	0.7	0.9	1.0	1.2	1.5	1.8	2.1	2.2	2.3

La Niña 2016/17?



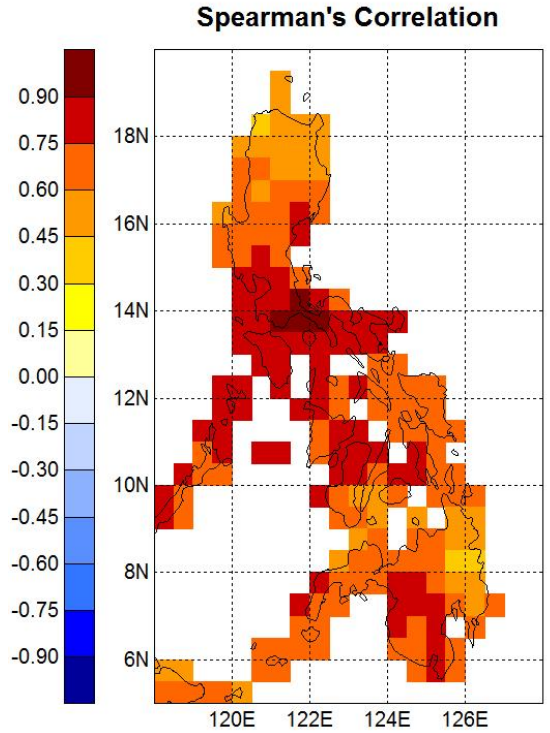


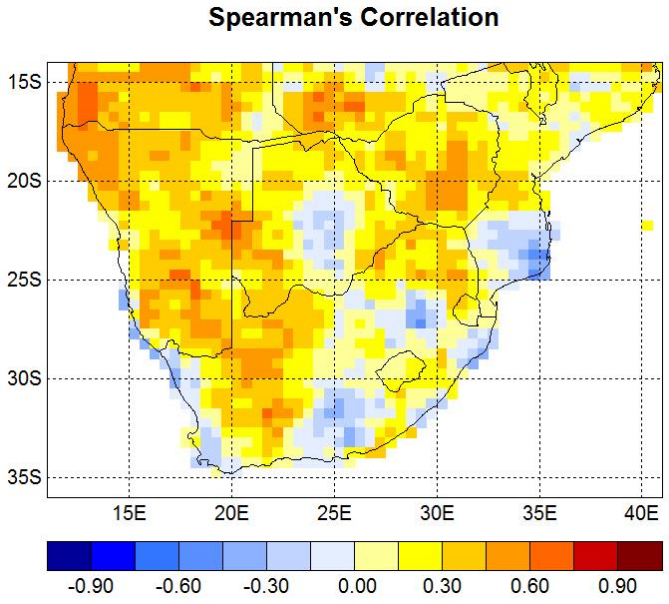
Spearman’s correlation



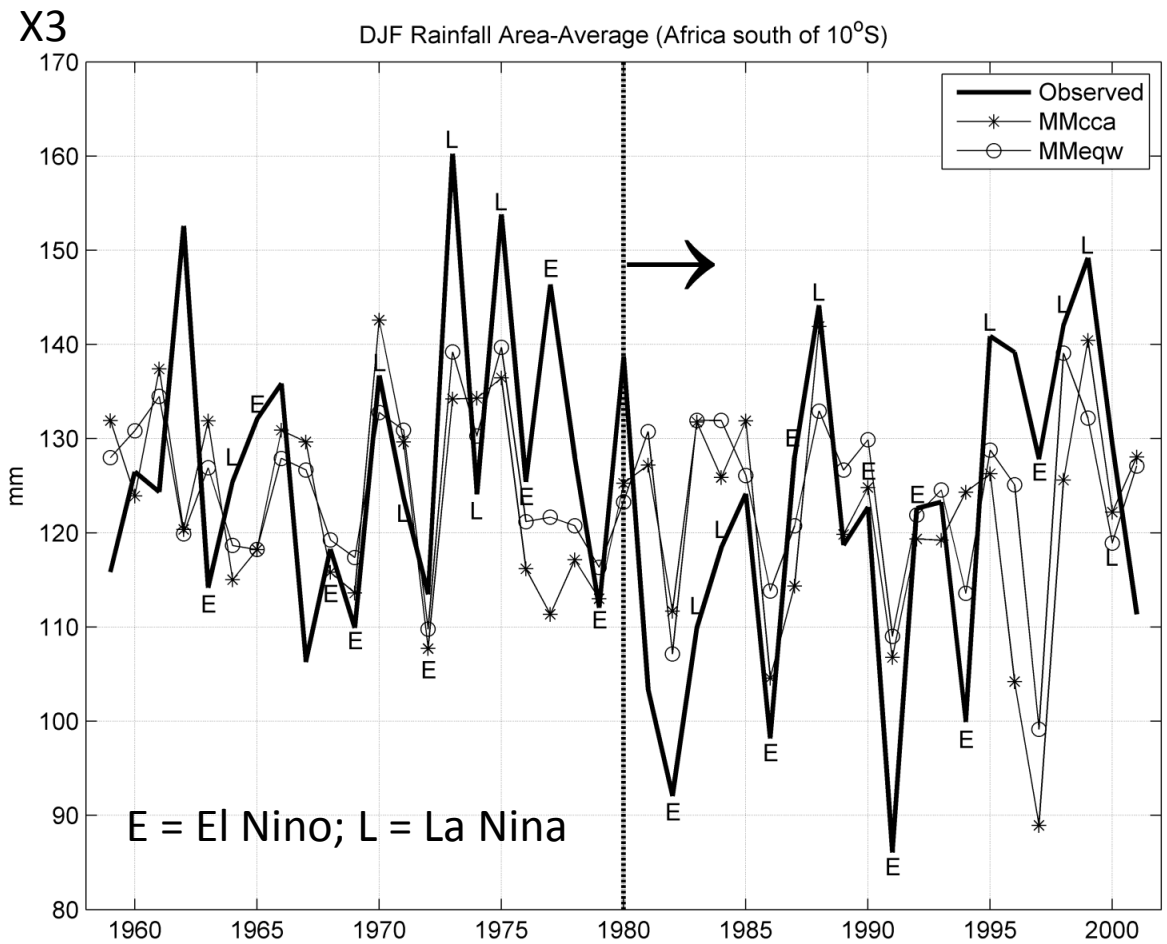
1. Philippines
2. East Australia
3. East Equatorial Africa
4. Northern South America
5. Southeast South America - IBSA
6. Indonesia
7. Nordeste - IBSA
8. Southern USA
9. India - IBSA
10. Central Southwest Asia
11. Sahel
12. Central Chile
13. Southern Africa ***
14. Southeast China
15. Europe
16. South-central, SW Canada
17. Southeast Asia
18. Coastal Ecuador, Northern Peru

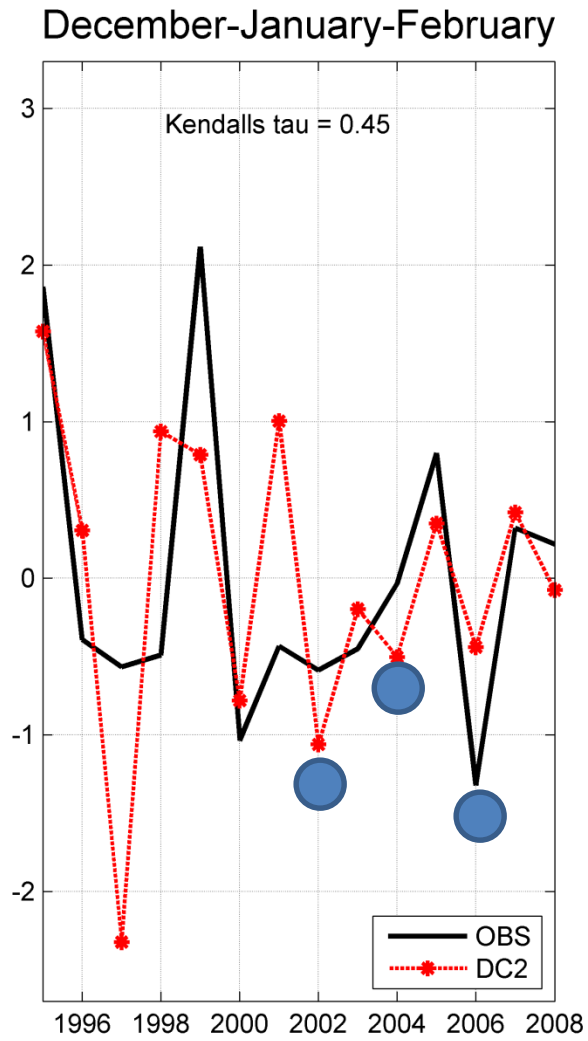
Percentile values (25th, 50th [median] and 75th) over all grid-points



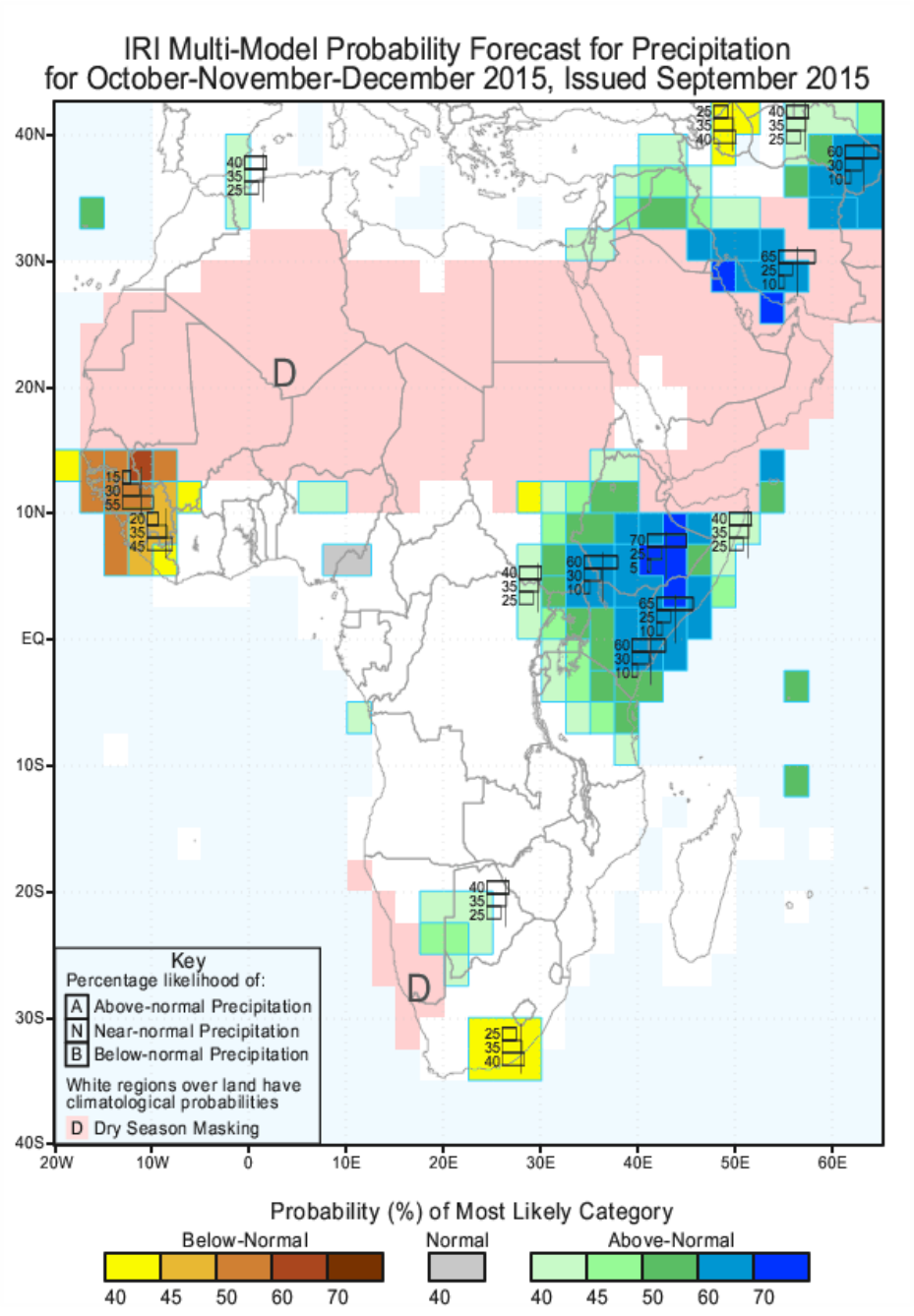


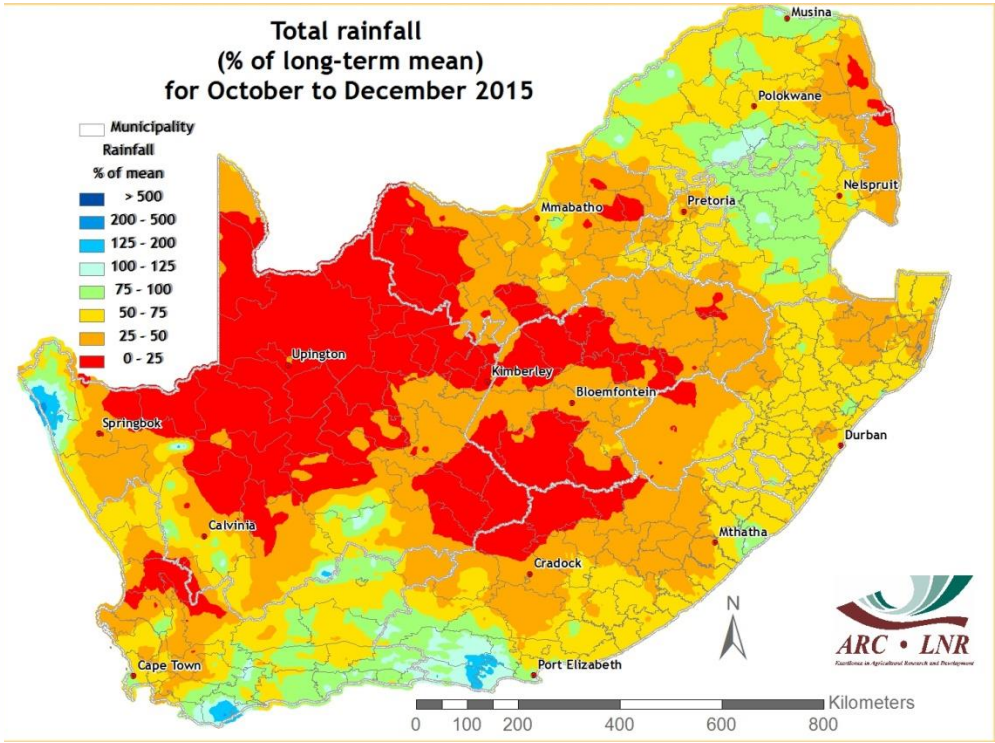
Do forecasts work?

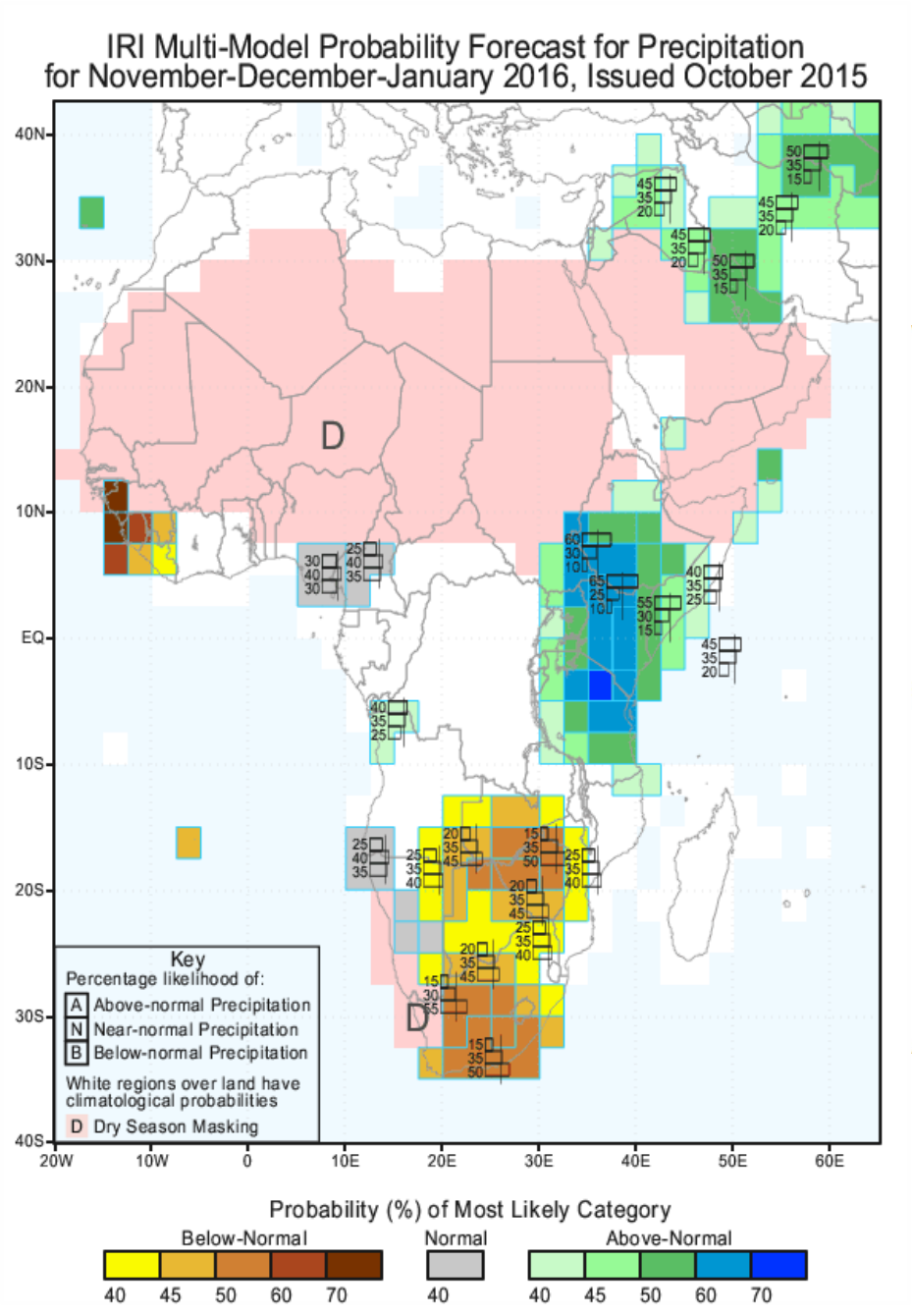


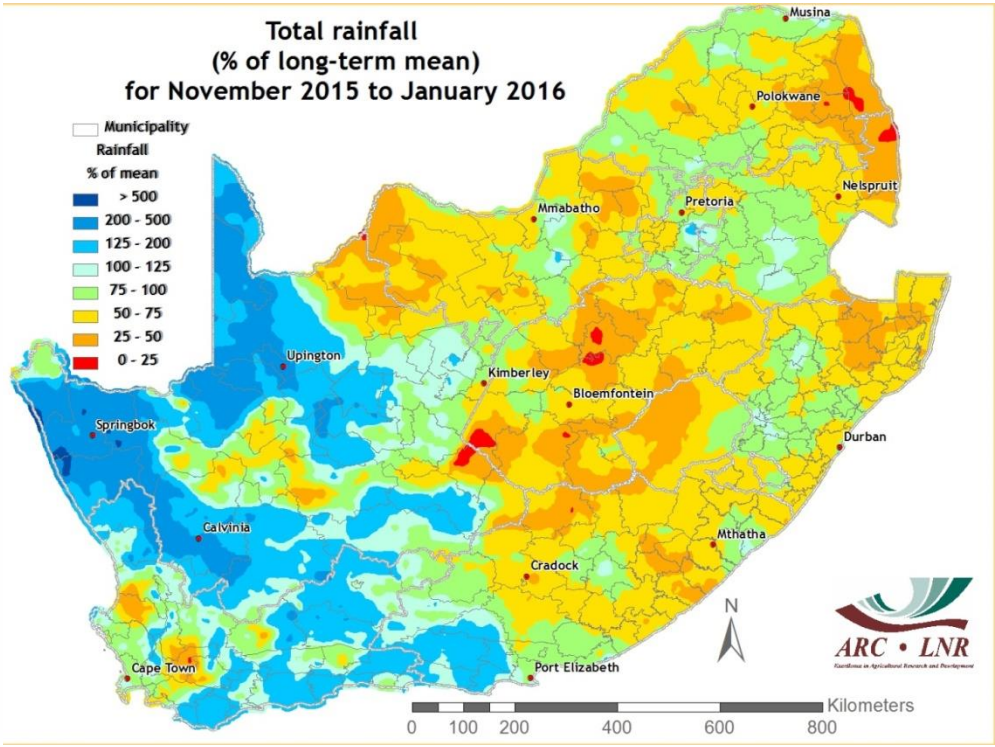


South Africa (only)


IRI Multi-Model Probability Forecast for Precipitation
for October-November-December 2015, Issued September 2015
40N
30N
20N
10N
EQ
10S
20S
30S
40S
20W
10W
0
10E
20E
30E
40E
50E
60E
D
D
Key
Percentage likelihood of:
A Above-normal Precipitation
N Near-normal Precipitation
B Below-normal Precipitation
White regions over land have climatological probabilities
D Dry Season Masking
Probability (%) of Most Likely Category
Below-Normal
40 45 50 60 70
Normal
40
Above-Normal
40 45 50 60 70

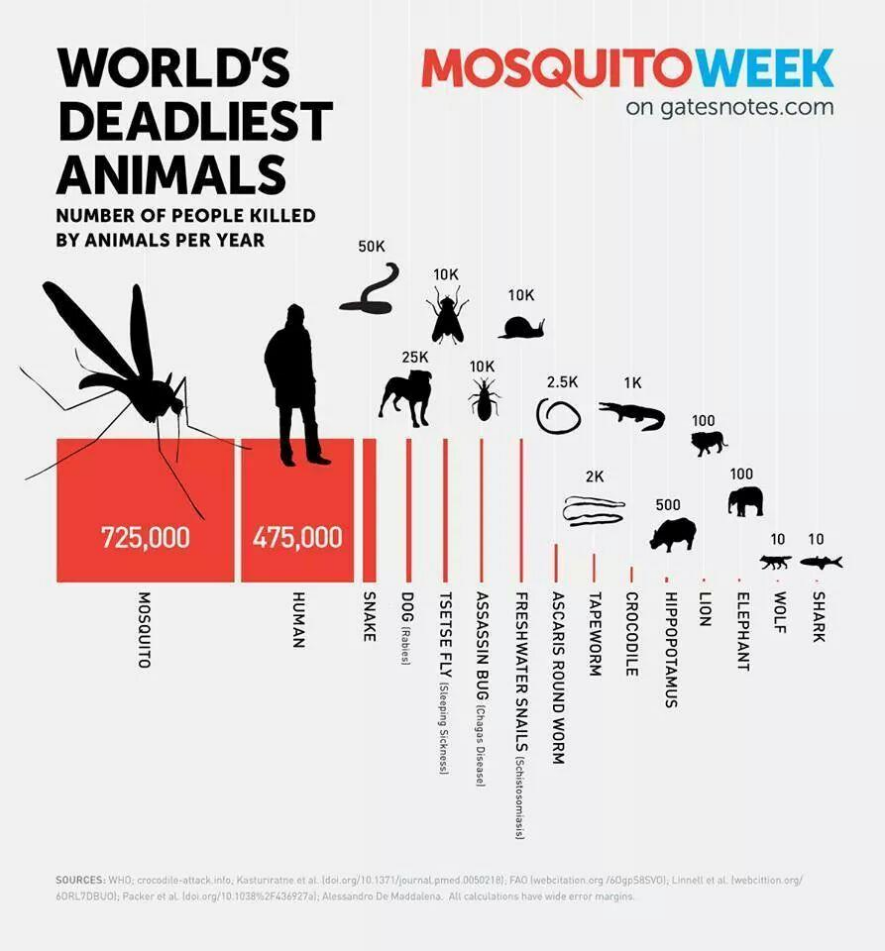

Total rainfall
(% of long-term mean)
for October to December 2015
Municipality
Rainfall
% of mean
> 500
200 - 500
125 - 200
100 - 125
75 - 100
50 - 75
25 - 50
0 - 25
Musina
Polokwane
Nelspruit
Mmabatho
Pretoria
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
ARC • LNR
Kilometers
0 100 200 400 600 800

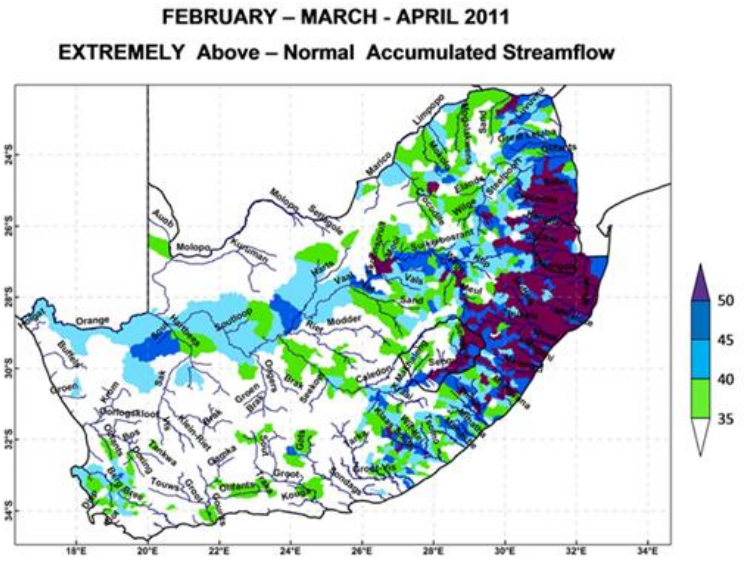

IRI Multi-Model Probability Forecast for Precipitation
for November-December-January 2016, Issued October 2015
40N
30N
20N
10N
EQ
10S
20S
30S
40S
20W
10W
0
10E
20E
30E
40E
50E
60E
D
D
Key
Percentage likelihood of:
A Above-normal Precipitation
N Near-normal Precipitation
B Below-normal Precipitation
White regions over land have climatological probabilities
D Dry Season Masking
Probability (%) of Most Likely Category
Below-Normal
40 45 50 60 70
Normal
40
Above-Normal
40 45 50 60 70

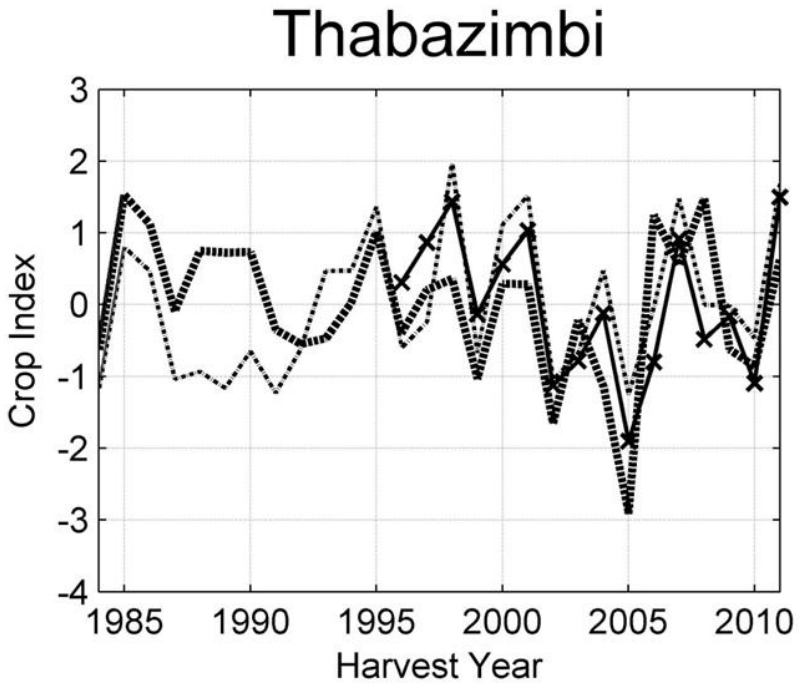

Total rainfall
(% of long-term mean)
for November 2015 to January 2016
Municipality
Rainfall
% of mean
> 500
200 - 500
125 - 200
100 - 125
75 - 100
50 - 75
25 - 50
0 - 25
Musina
Polokwane
Nelspruit
Mmabatho
Pretoria
Upington
Kimberley
Bloemfontein
Springbok
Durban
Calvinia
Mthatha
Cradock
Cape Town
Port Elizabeth
N
ARC • LNR
Kilometers
0 100 200 400 600 800

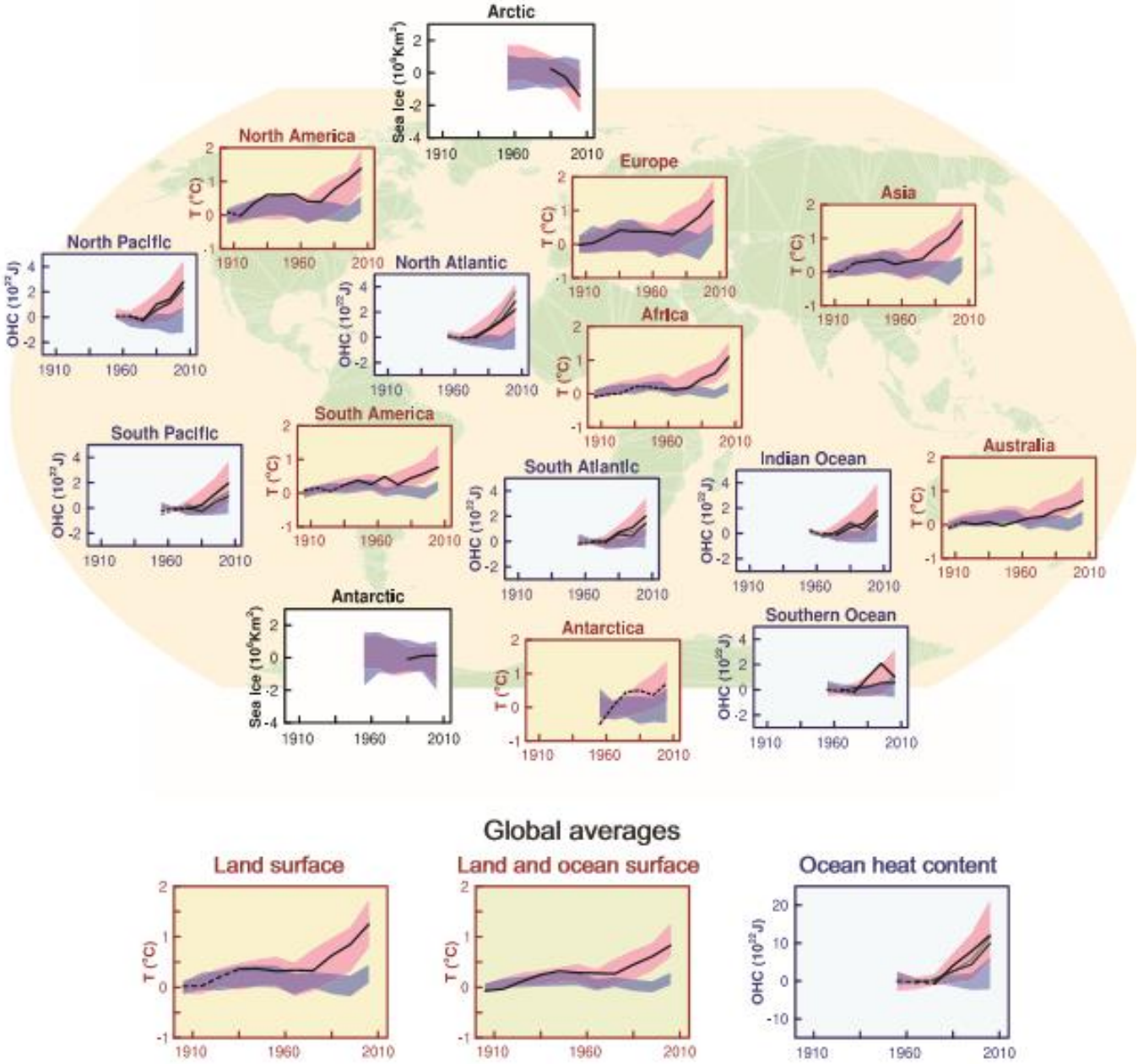
Forecast Application

Application modelling examples









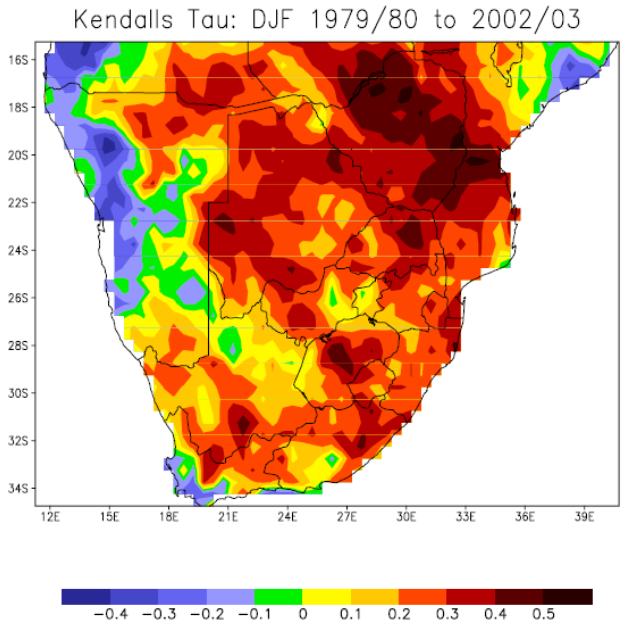
Global averages

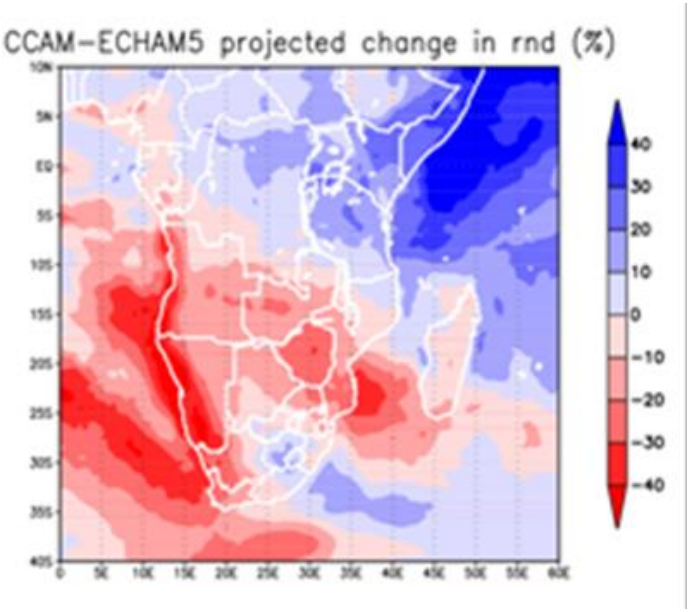
Observations

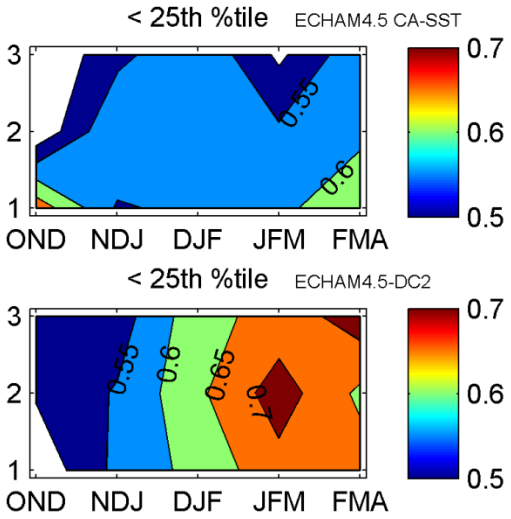
Models using only natural forcings

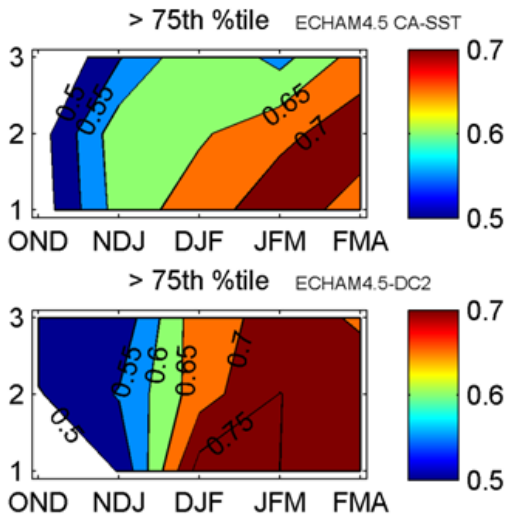
Models using both natural and anthropogenic forcings

Modelling: variability – change link

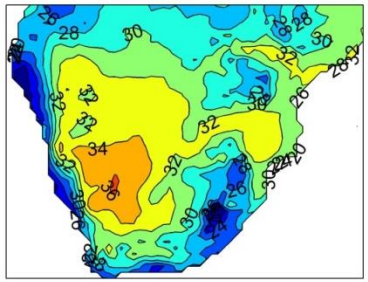




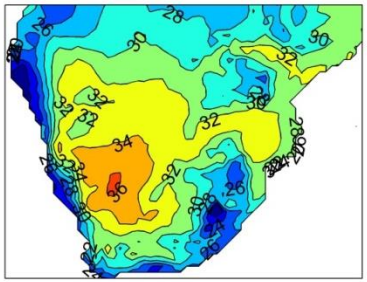




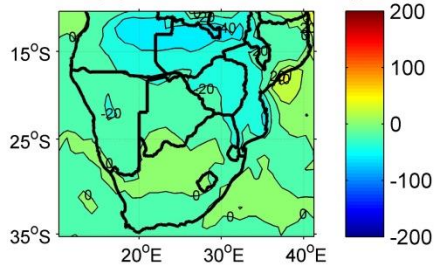
CCAM-AR4 DJF Max Temp: 1980/81-2009/10



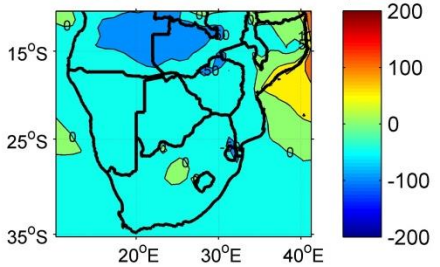
Perfect Prog DJF Max Temp: 1980/81-2009/10



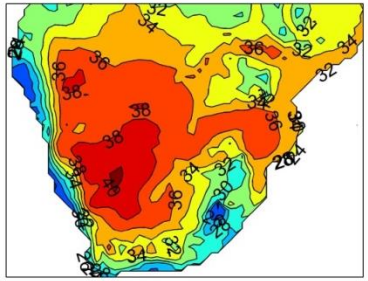
DJF Precip (2010-2039 - Present Day)



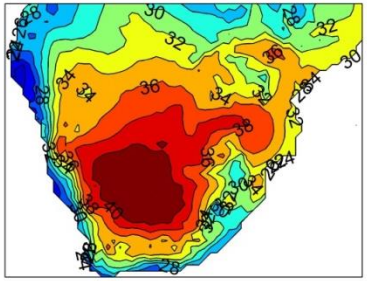
DJF Precip (2040-2069 - Present Day)



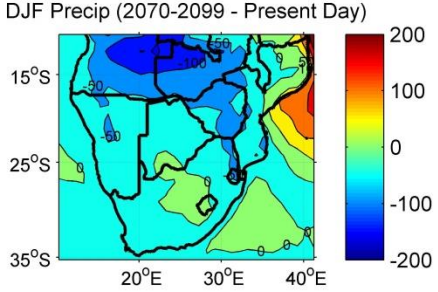
CCAM-AR4 DJF Max Temp: 2070/71-2099/00

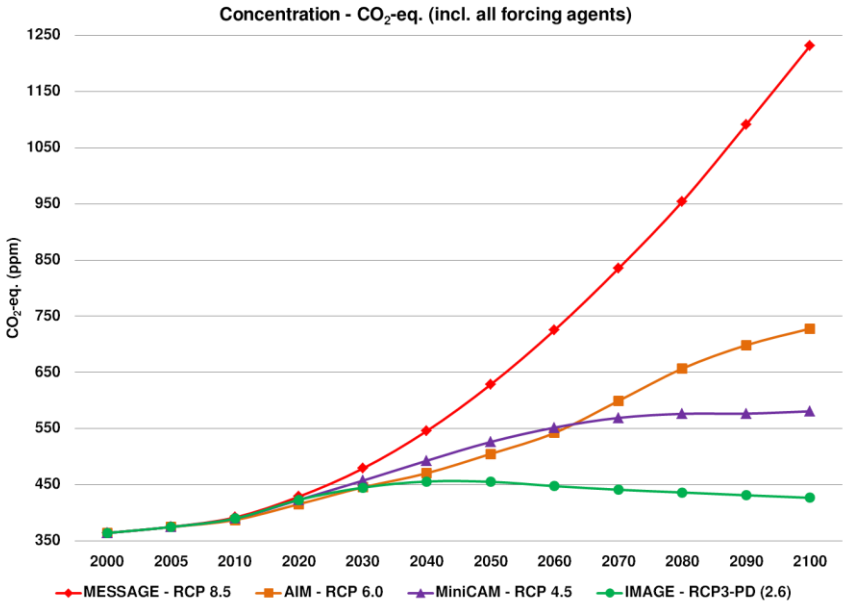


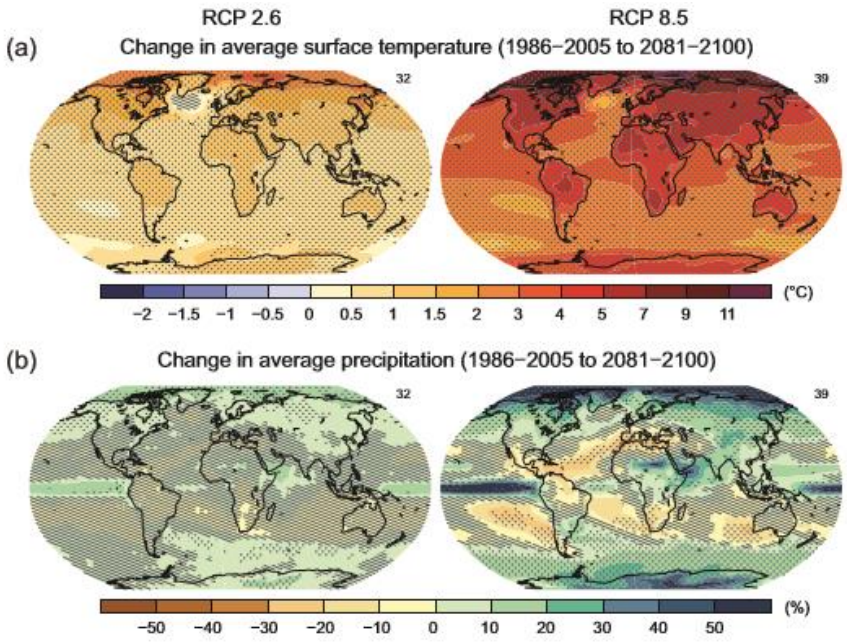
Perfect Prog DJF Max Temp: 2070/71-2099/00

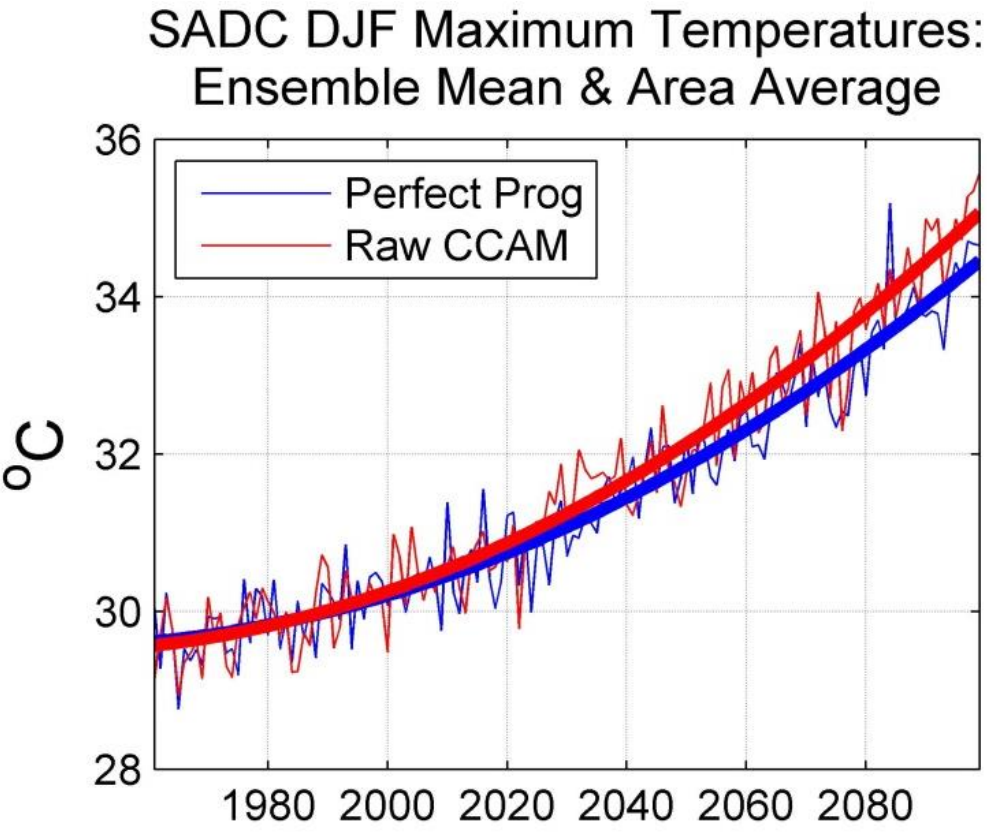


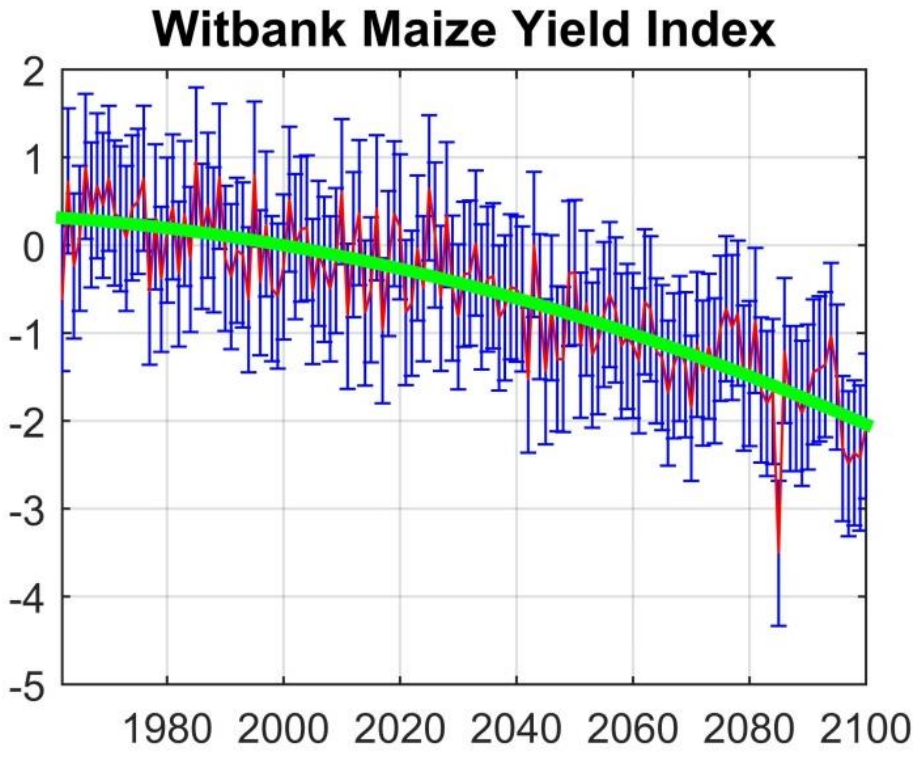
DJF Precip (2070-2099 - Present Day)





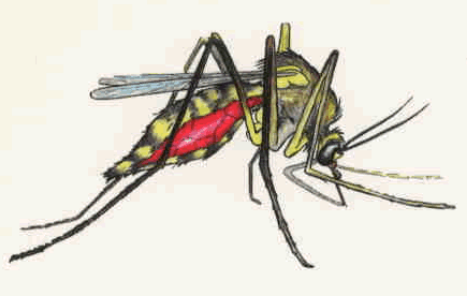



SADC DJF Maximum Temperatures:
Ensemble Mean & Area Average
Perfect Prog
Raw CCAM
°C
36
34
32
30
28
1980
2000
2020
2040
2060
2080

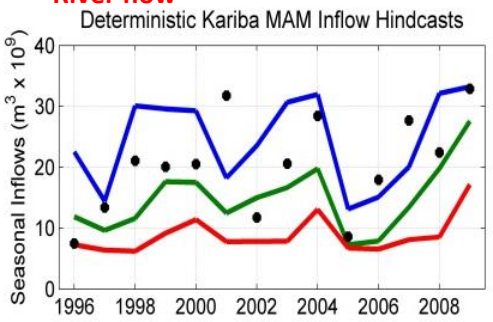

Witbank Maize Yield Index
2
1
0
-1
-2
-3
-4
-5
1980
2000
2020
2040
2060
2080
2100

Co-production

Diseases



River flow



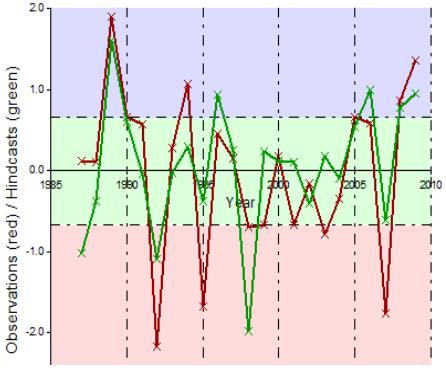
Seasonal forecast system

Extended-range (beyond 10 days)

Decadal, multi-decadal

USERS

Maize yield



Livestock

In conclusion

- Difference between climate variability & change
  - Can you, first of all, cope with variability?
- South Africa has limited, albeit useful, seasonal predictability
- Climate change
  - Rising temperatures – reliable
  - Decreasing rainfall – less reliable
  - Consequence for agriculture: reduced crop yield
- Tailored forecasts and projections possible through co-production