

Attributes of predicted rainfall patterns over Southern Africa and Southeast South America associated with the El Niño–Southern Oscillation

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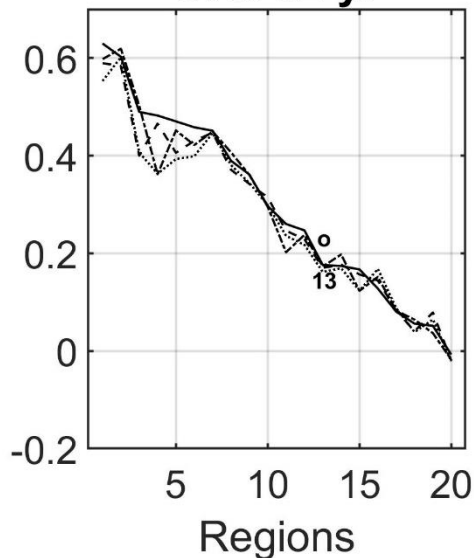
ICSHMO
2022

HYBRID WEEK: 8-12 February 2022
University of Canterbury, Christchurch, New Zealand/Aotearoa
VIRTUAL WEEK: 15-17 February 2022

Main objective:

Assess to what extent a state-of-the-art seasonal forecast model is able to capture the main rainfall seasons over southeast South America and southern Africa during ENSO events, and to explore a possible link between the two regions

GFDL: 5-yr-out CV over 32 yr

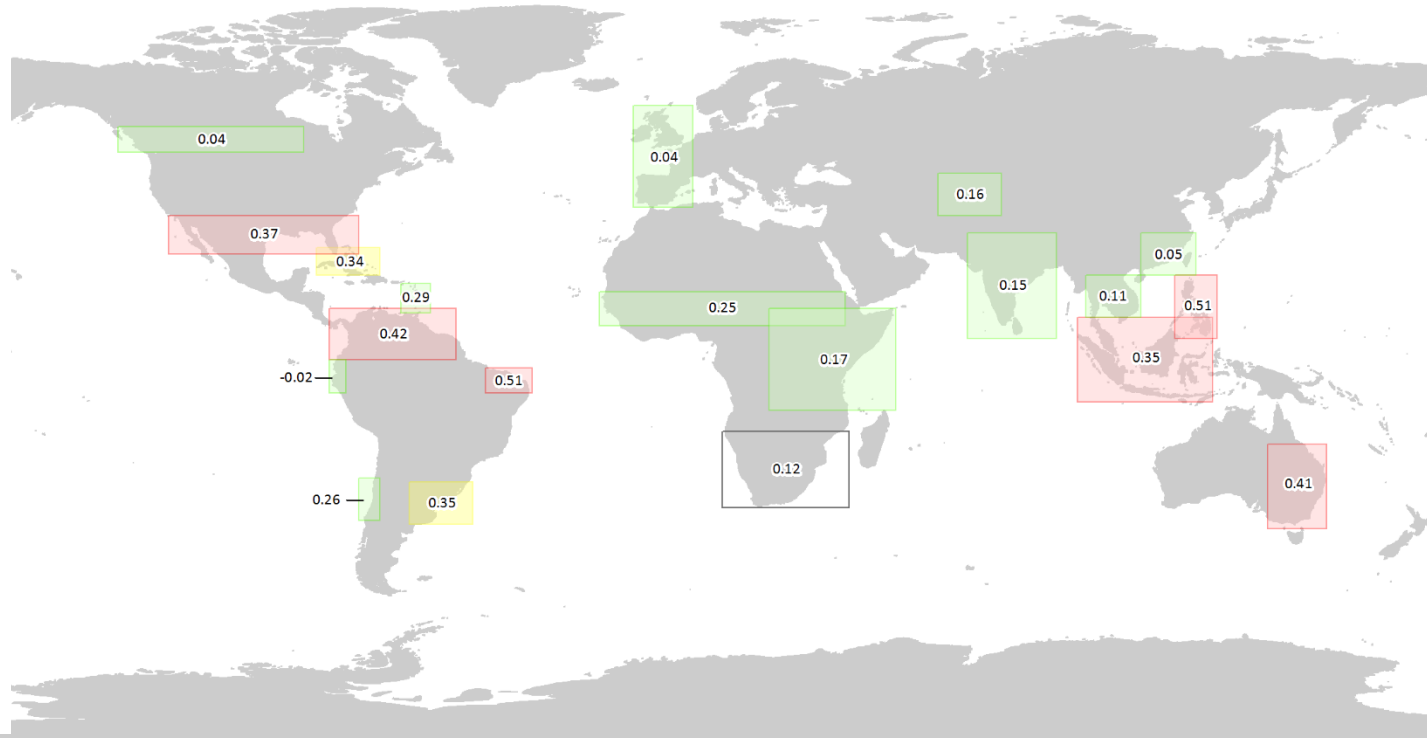


1. Philippines
2. Nordeste
3. Northern South America
4. Northwest Caribbean
5. Indonesia
6. Southern USA
7. Eastern Australia
8. Southeast South America ←
9. Sahel
10. Central Chile
11. Southeast Caribbean
12. Equatorial East Africa
13. Southern Africa ←
14. India
15. Coastal Equador, Northern Peru
16.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

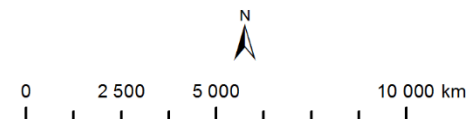


SADC (17°S to 32°S; 16°E to 36°E)

SESA (22°S to 35°S; 48°W to 60°W)



- Southern Africa
- Statistically indistinguishable skill levels
- Marginally statistically different skill levels
- Statistically different skill levels



Anomaly correlation skill

Numbers show skills; colours show skill differences from southern Africa

Map produced by: Janique Savy
Unit for Geoinformation and Mapping

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RESEARCH ARTICLE

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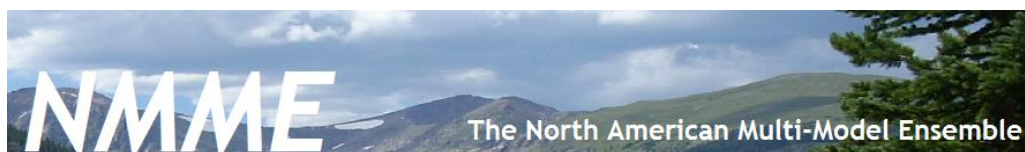
Use of El Niño–Southern Oscillation related seasonal precipitation predictability in developing regions for potential societal benefit

Willem A. Landman¹ | Anthony G. Barnston² | Coleen Vogel³ | Janique Savy¹

Cold & Warm Episodes by Season (ONI)

1991	0.4	0.3	0.2	0.3	0.5	0.6	0.7	0.6	0.6	0.8	1.2	1.5
1992	1.7	1.6	1.5	1.3	1.1	0.7	0.4	0.1	-0.1	-0.2	-0.3	-0.1
1993	0.1	0.3	0.5	0.7	0.7	0.6	0.3	0.3	0.2	0.1	0.0	0.1
1994	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.6	0.7	1.0	1.1
1995	1.0	0.7	0.5	0.3	0.1	0.0	-0.2	-0.5	-0.8	-1.0	-1.0	-1.0
1996	-0.9	-0.8	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5
1997	-0.5	-0.4	-0.1	0.3	0.8	1.2	1.6	1.9	2.1	2.3	2.4	2.4
1998	2.2	1.9	1.4	1.0	0.5	-0.1	-0.8	-1.1	-1.3	-1.4	-1.5	-1.6
1999	-1.5	-1.3	-1.1	-1.0	-1.0	-1.0	-1.1	-1.1	-1.2	-1.3	-1.5	-1.7
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.4	-1.1	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5	-0.6	-0.7	-0.7
2001	-0.7	-0.5	-0.4	-0.3	-0.3	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3
2002	-0.1	0.0	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	-0.3	-0.2	0.1	0.2	0.3	0.3	0.4	0.4
2004	0.4	0.3	0.2	0.2	0.2	0.3	0.5	0.6	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.4	0.4	0.3	0.1	-0.1	-0.1	-0.1	-0.3	-0.6	-0.8

2006	-0.9	-0.8	-0.6	-0.4	-0.1	0.0	0.1	0.3	0.5	0.8	0.9	0.9
2007	0.7	0.2	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-1.1	-1.3	-1.5	-1.6
2008	-1.6	-1.5	-1.3	-1.0	-0.8	-0.6	-0.4	-0.2	-0.2	-0.4	-0.6	-0.7
2009	-0.8	-0.8	-0.6	-0.3	0.0	0.3	0.5	0.6	0.7	1.0	1.4	1.6
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2010	1.5	1.2	0.8	0.4	-0.2	-0.7	-1.0	-1.3	-1.6	-1.6	-1.6	-1.6
2011	-1.4	-1.2	-0.9	-0.7	-0.6	-0.4	-0.5	-0.6	-0.8	-1.0	-1.1	-1.0
2012	-0.9	-0.7	-0.6	-0.5	-0.3	0.0	0.2	0.4	0.4	0.3	0.1	-0.2
2013	-0.4	-0.4	-0.3	-0.3	-0.4	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.3
2014	-0.4	-0.5	-0.3	0.0	0.2	0.2	0.0	0.1	0.2	0.5	0.6	0.7
2015	0.5	0.5	0.5	0.7	0.9	1.2	1.5	1.9	2.2	2.4	2.6	2.6
2016	2.5	2.1	1.6	0.9	0.4	-0.1	-0.4	-0.5	-0.6	-0.7	-0.7	-0.6
2017	-0.3	-0.2	0.1	0.2	0.3	0.3	0.1	-0.1	-0.4	-0.7	-0.8	-1.0
2018	-0.9	-0.9	-0.7	-0.5	-0.2	0.0	0.1	0.2	0.5	0.8	0.9	0.8
2019	0.7	0.7	0.7	0.7	0.5	0.5	0.3	0.1	0.2	0.3	0.5	0.5
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2020	0.5	0.5	0.4	0.2	-0.1	-0.3	-0.4	-0.6	-0.9	-1.2	-1.3	-1.2



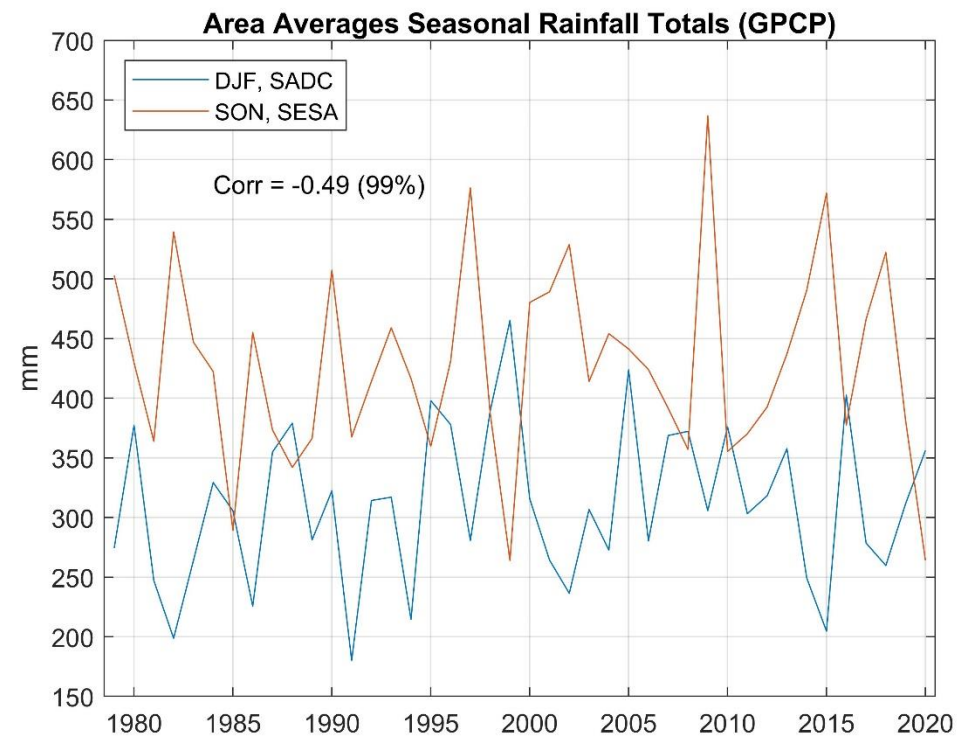
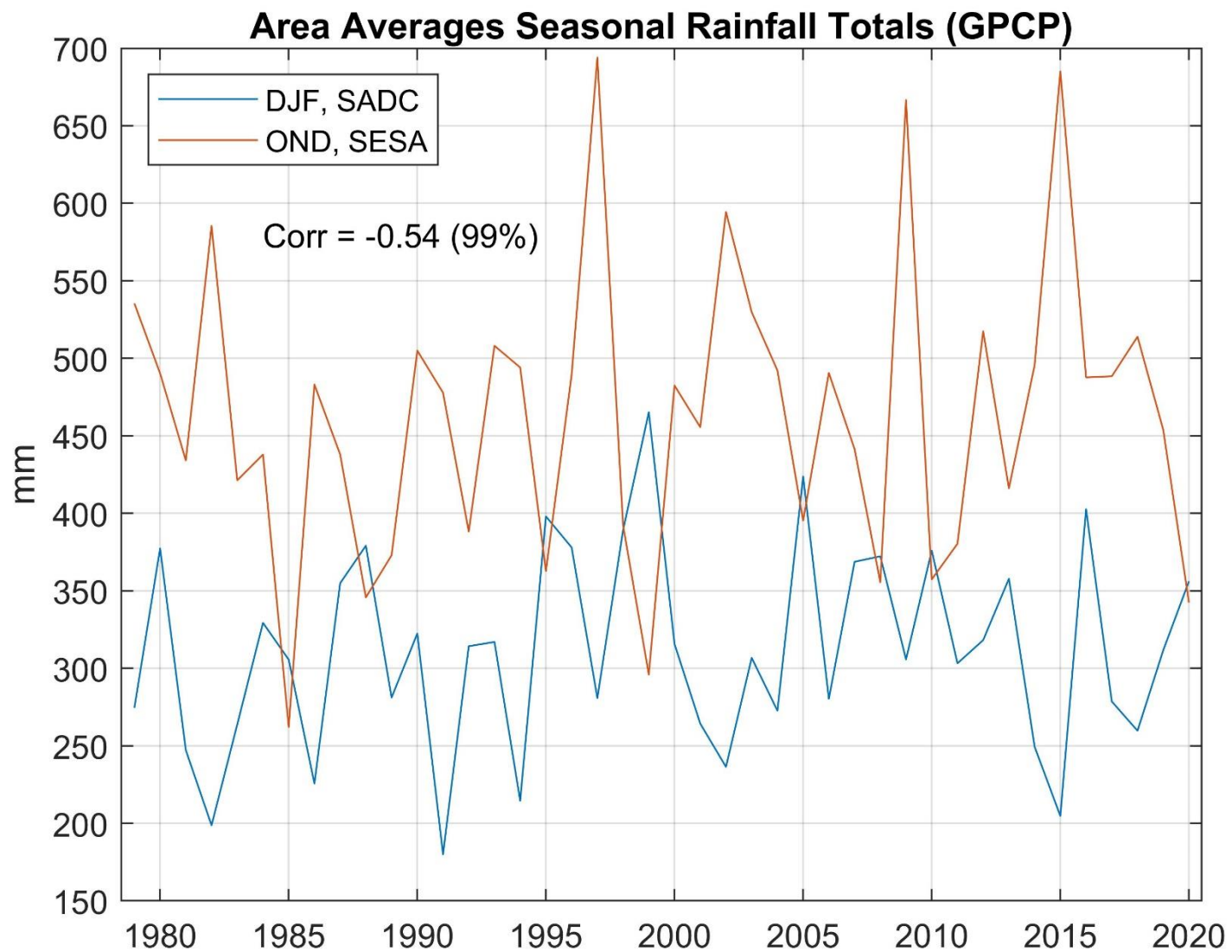
GFDL Spear: The Next Generation GFDL Modeling System for Seasonal to Multidecadal Prediction and Projection
15 ensemble members

- Seasons
 - Oct-Nov-Dec for SESA
 - Also Sep-Oct-Nov
 - Dec-Jan-Feb for SADC
- GFDL initialisation
 - September for Oct-Nov-Dec
 - November for Dec-Jan-Feb

NASA GPCP V2p3 CDR precip:
 NOAA Climate Data Record (CDR)
 of GPCP Satellite-Gauge Combined
 Precipitation data

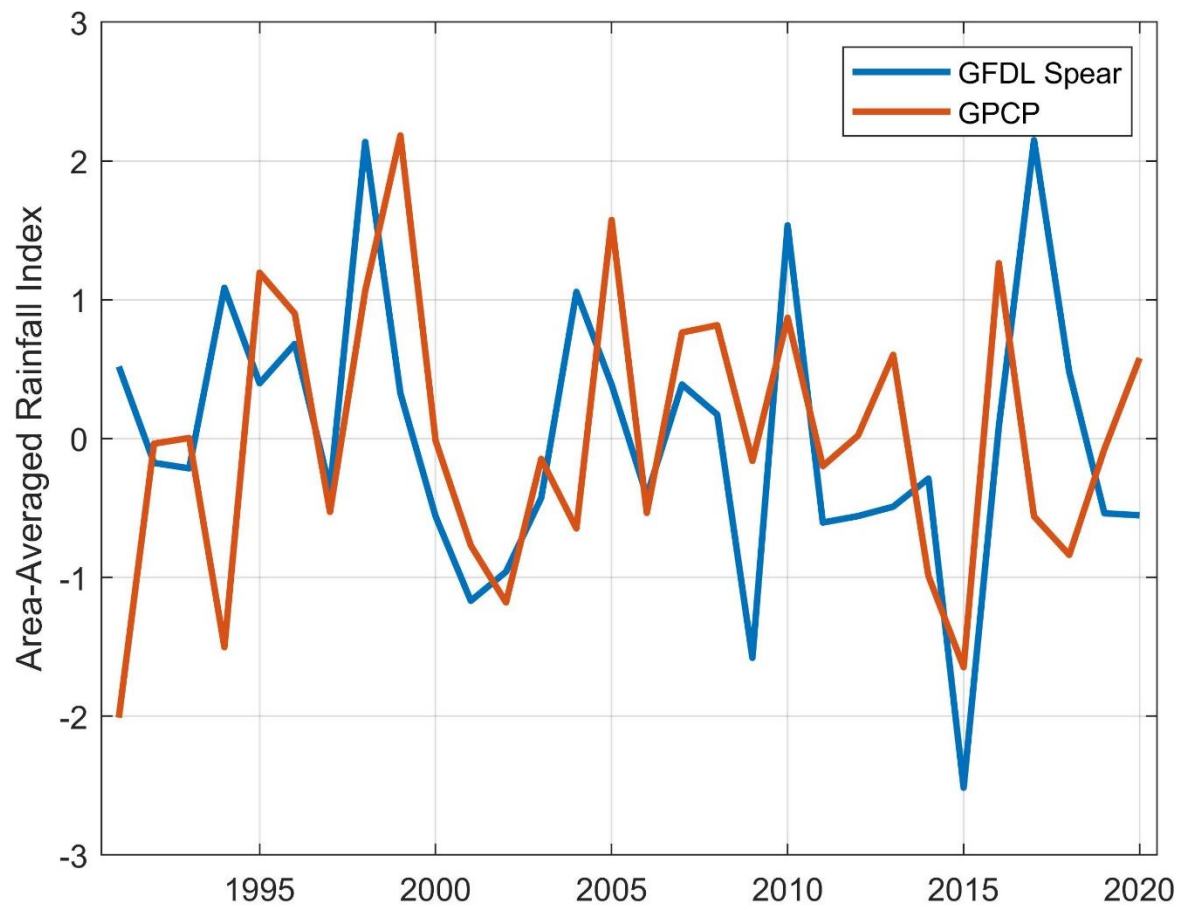
For three categories with thresholds defined by respectively the 33rd (dry category) and 67th (wet category) percentile values of the climatological record

AREA-AVERAGES FOR BOTH OBSERVED AND HINDCAST DATA

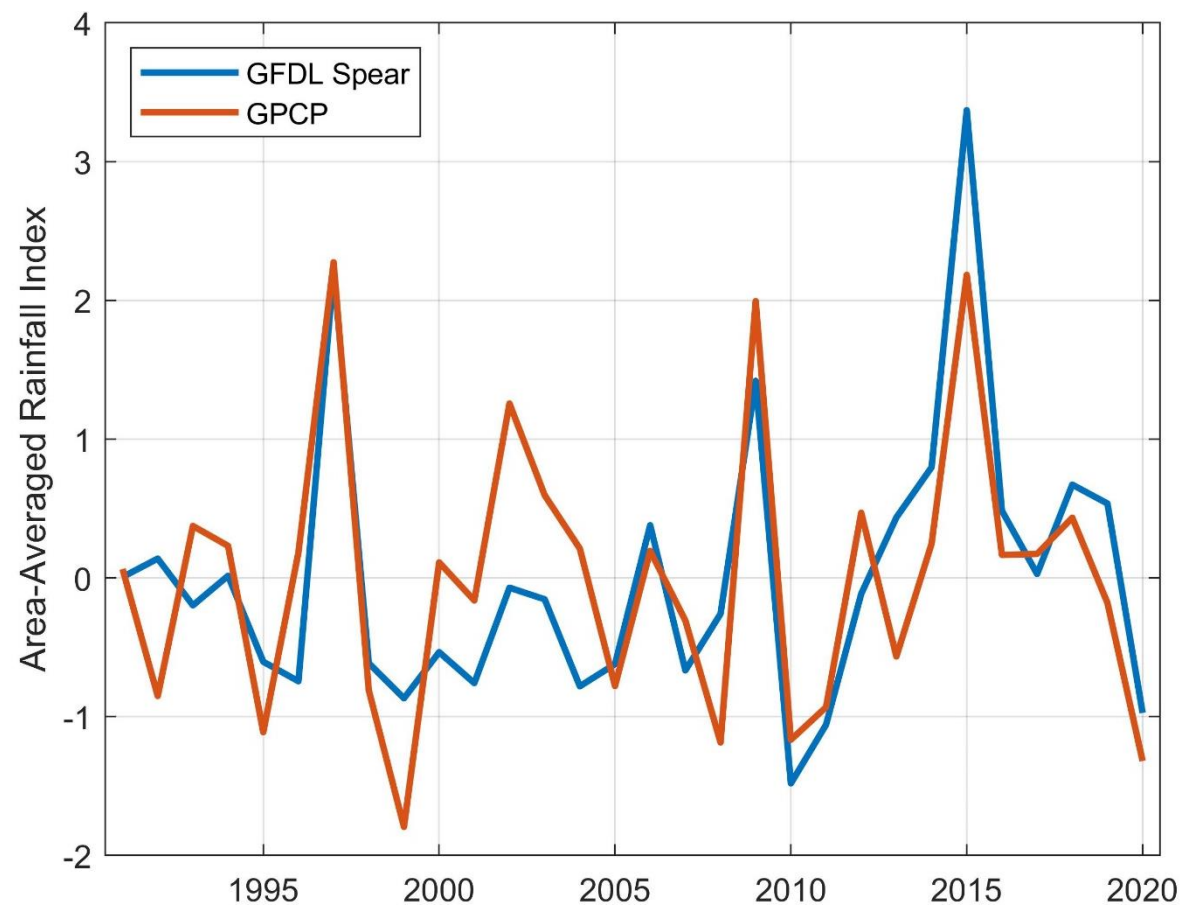


Strong negative association between SADC and SESA main rainfall seasonal totals

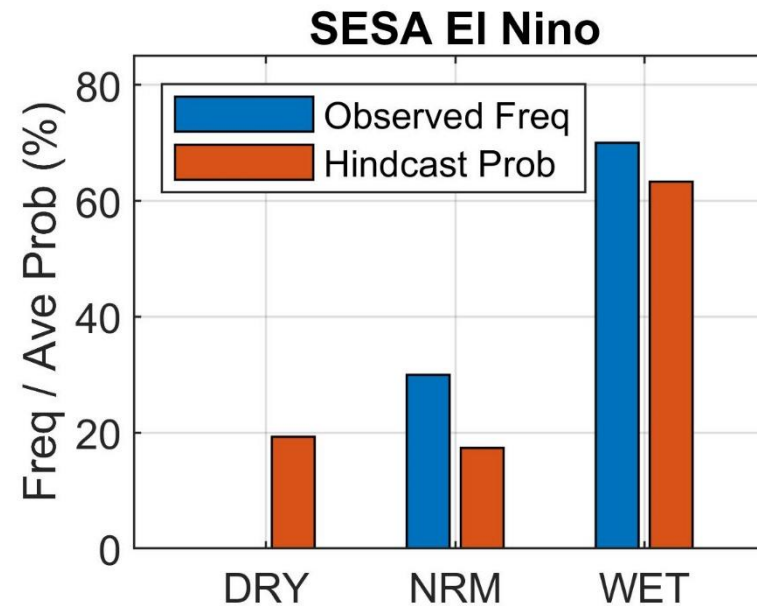
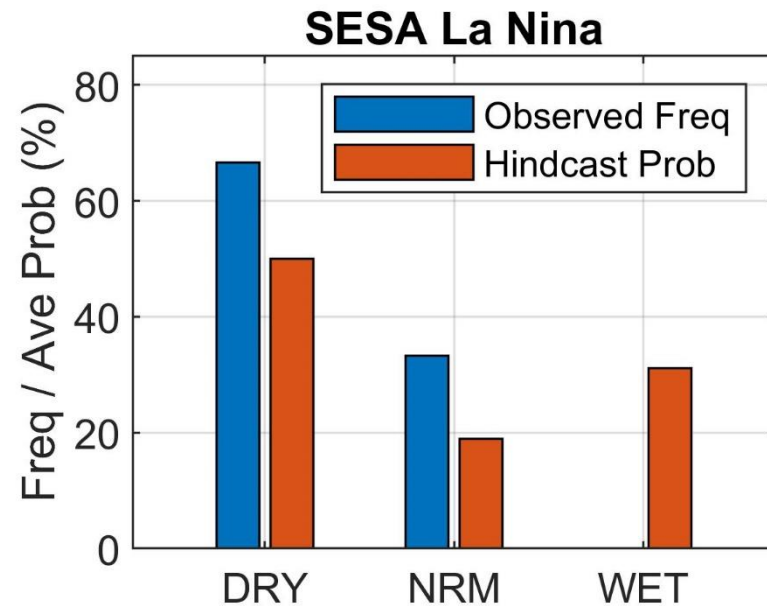
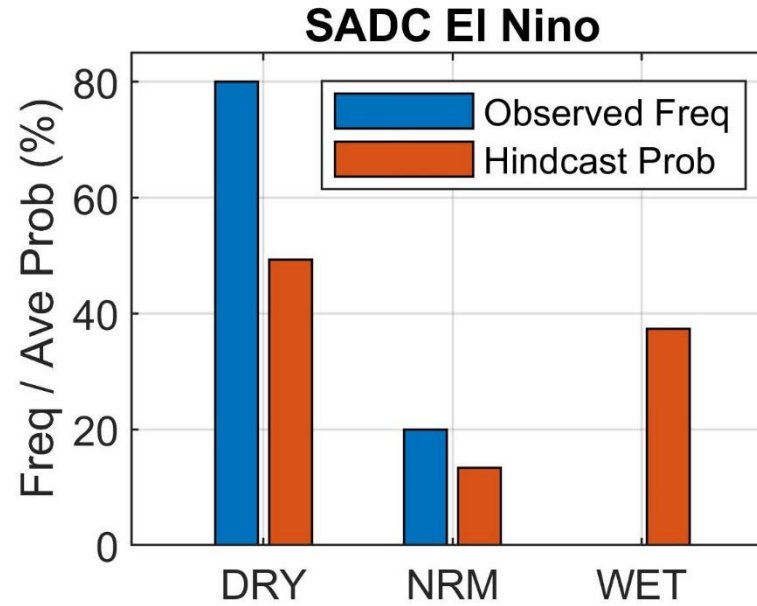
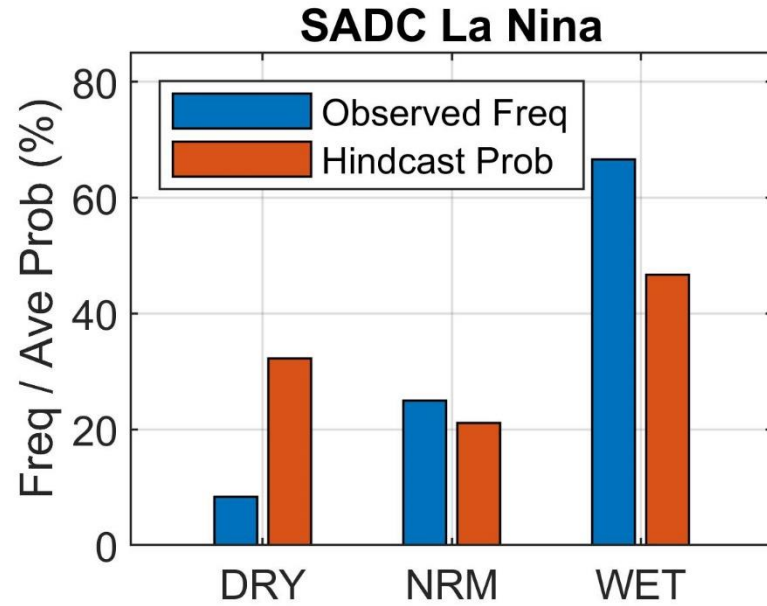
SADC DJF; Corr=0.29 (90%)



SESA OND; Corr=0.78 (99%)

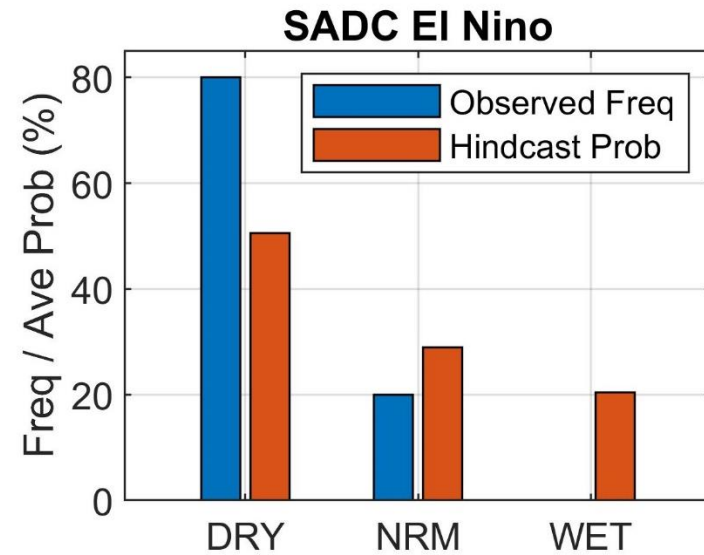
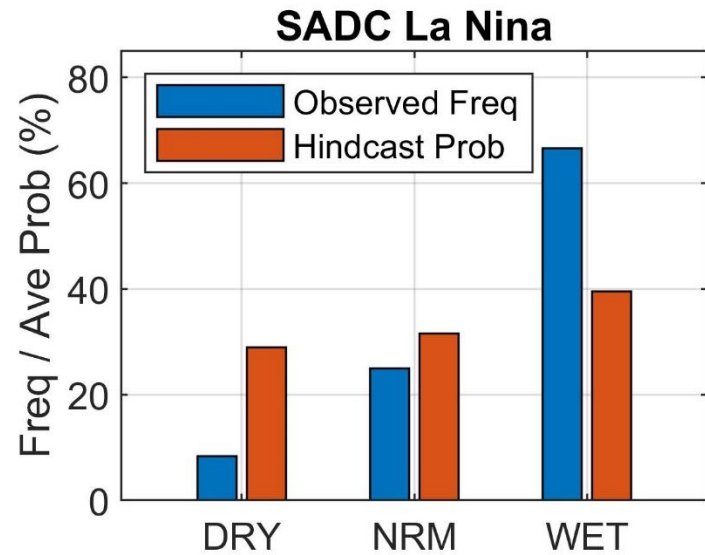


For reliable forecasts, the observed relative frequencies are expected to be approximately equal to the average probabilities

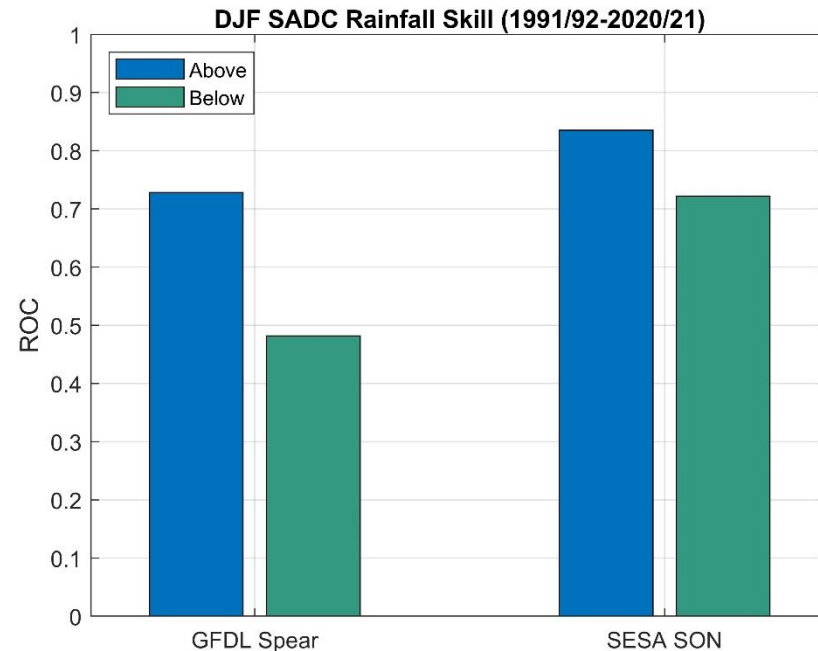
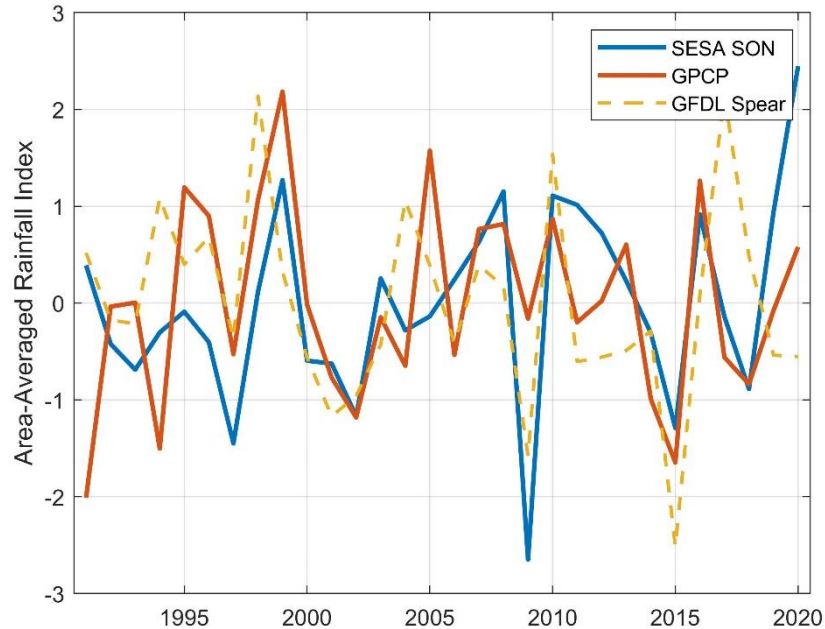


- The model was able to replicate ENSO-related probabilistic precipitation outcomes for the two regions.
- Model does not capture the observed marked reduction in probability in the non-favoured rainfall categories.
- This model weakness may be related to an apparent bias towards under-forecasting the middle rainfall category and displacing probability to the least likely category, whose probability is then over-forecast.

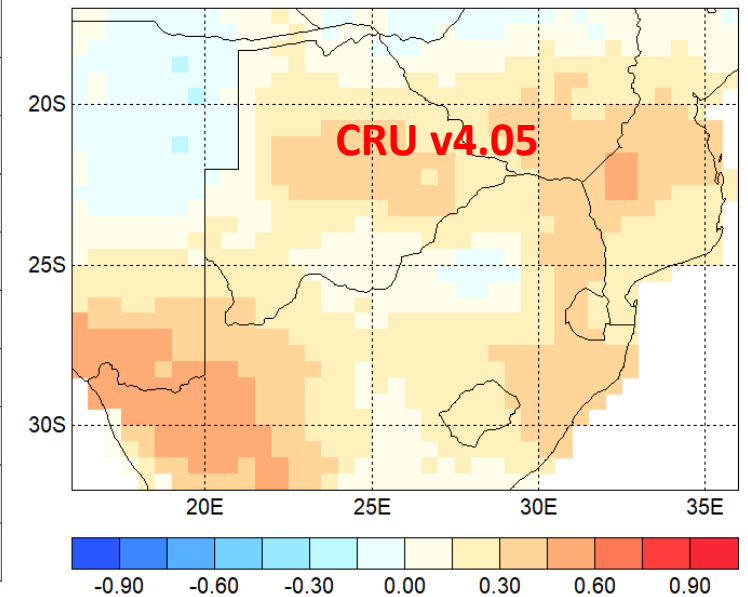
SESA's SON rainfall predicting SADC's DJF rainfall



SADC DJF; Corr=0.45 (99%)



SON sesa predicting DJF sadc (1991-2019); Correlation



Main objective:

Assess to what extent a state-of-the-art seasonal forecast model is able to capture the main rainfall seasons over southeast South America and southern Africa during ENSO events, and to explore a possible link between the two regions

In conclusion...

- A global model replicated ENSO rainfall seasons over the two regions
- Probabilistic forecasts were mostly reliable
- The model struggled to capture the observed marked reduction in probability of the non-favoured rainfall categories
- This model weakness may be related to an apparent bias towards under-forecasting the middle rainfall category and displacing probability to the least likely outer category, whose probability is then over-forecast
- This bias was largely absent in a simple linear statistical model that used SON rainfall over southeast South America to predict DJF rainfall over southern Africa
- Is this result indicative of the importance of westerlies in the mid-latitudes when predicting seasonal climate over southern Africa?
 - Are westerly, extra-tropical weather systems that drive SESA weather in SON (and OND) also assisting DJF weather in SADC? I.e. Is the westerly wind belt anomalously north during La Nina when we have DJF rainfall which is in an in opportune position for SESA rainfall?
 - What is the role here of upper tropospheric processes such as Rossby wave breaking?

Thank you