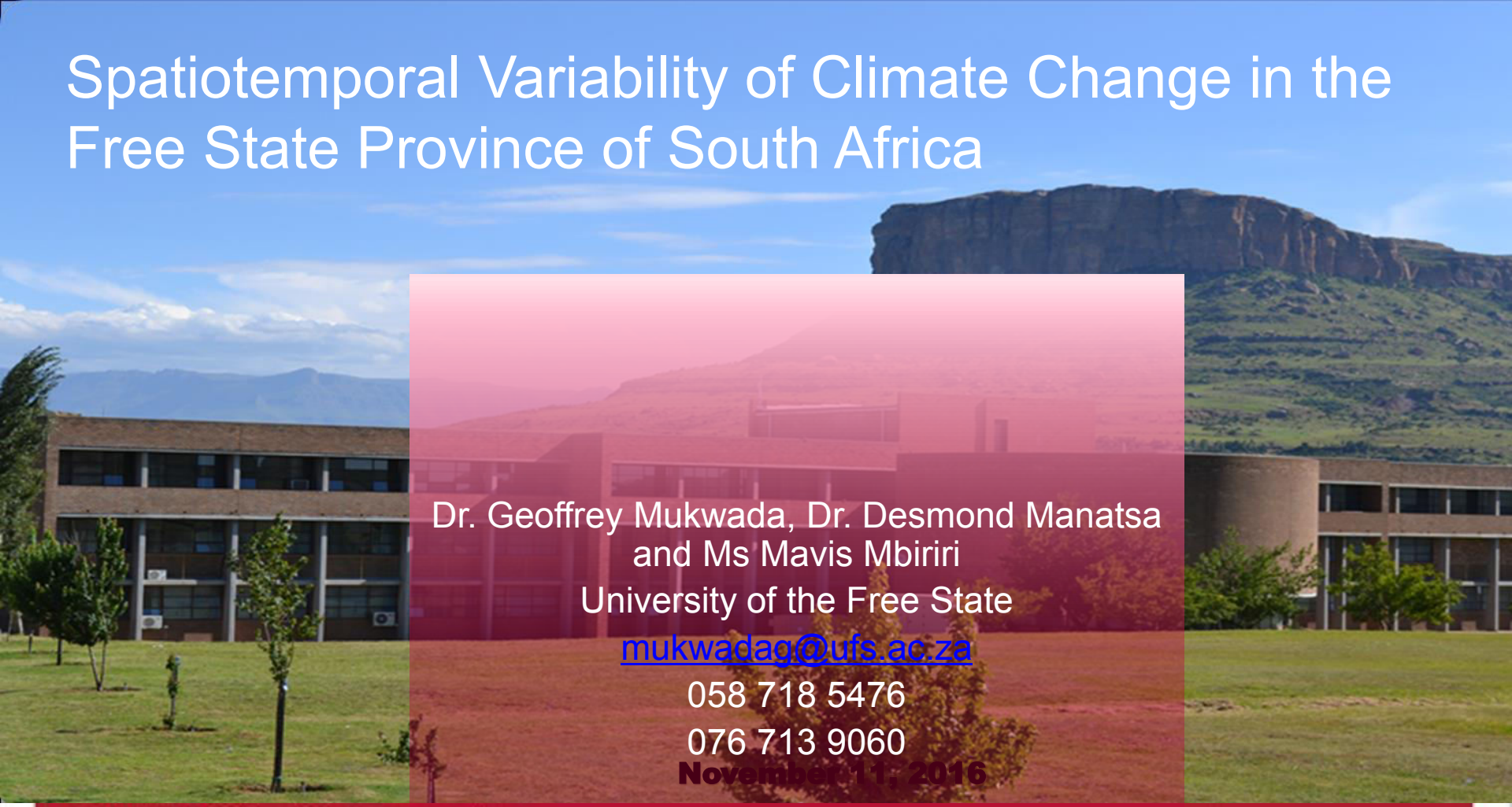
Spatiotemporal Variability of Climate Change in the Free State Province of South Africa



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November 11, 2016

Overview

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November 11, 2016

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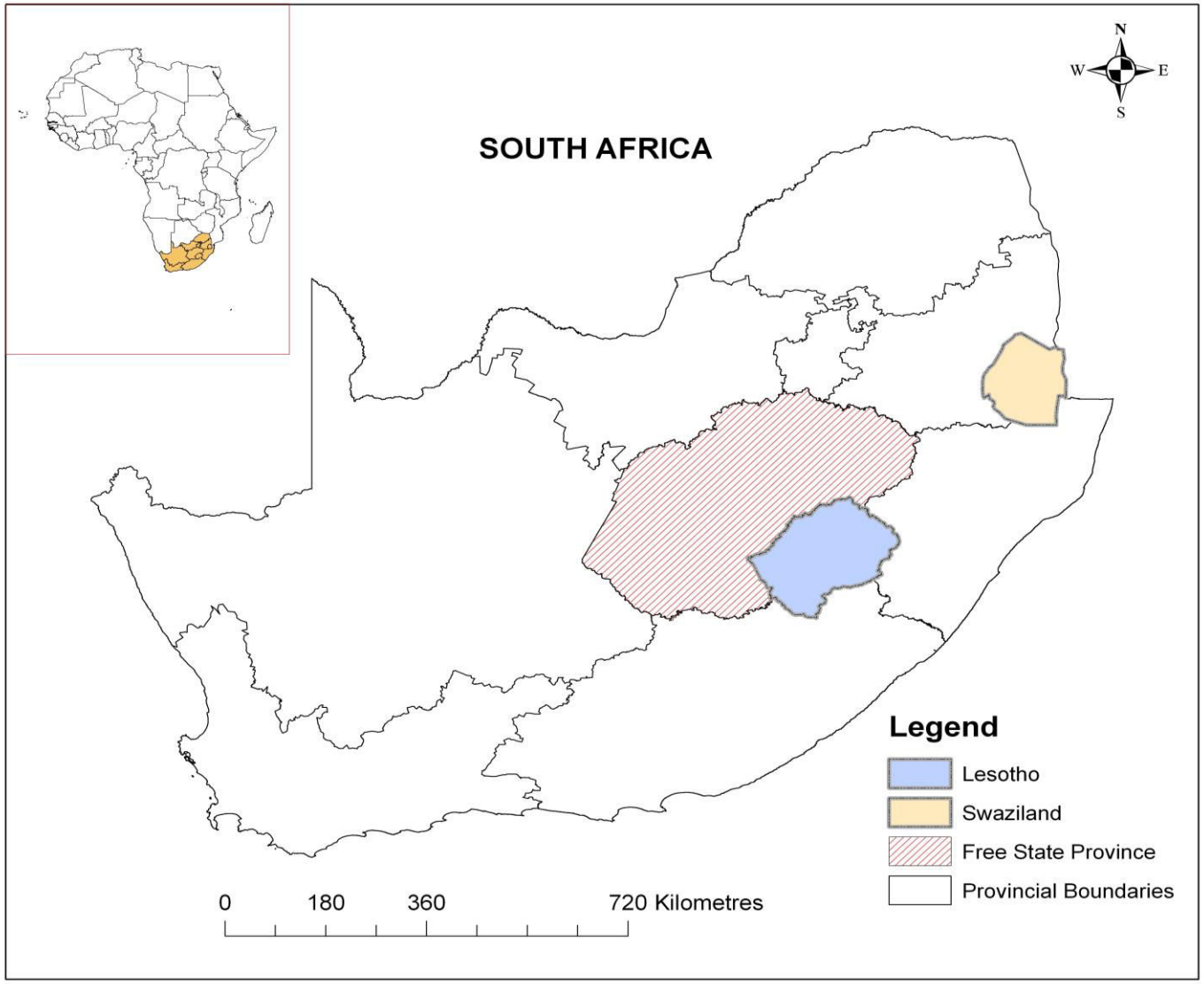
Study Area



- The Free State Province is characterized by a considerable range of climatic regimes
- Semi-desert in the west and humid montane climatic conditions in the east
- Dominated by ranging in the west and cereal production and mixed farming in the east
- Bread basket of the country – the Maize Triangle
- The province is also characterized by a variety of ecosystems and natural resources

Research Question and Objective

Research Question:

- Has the climate of the Free State Province changed, and if it has how have the changes varied through space and time?

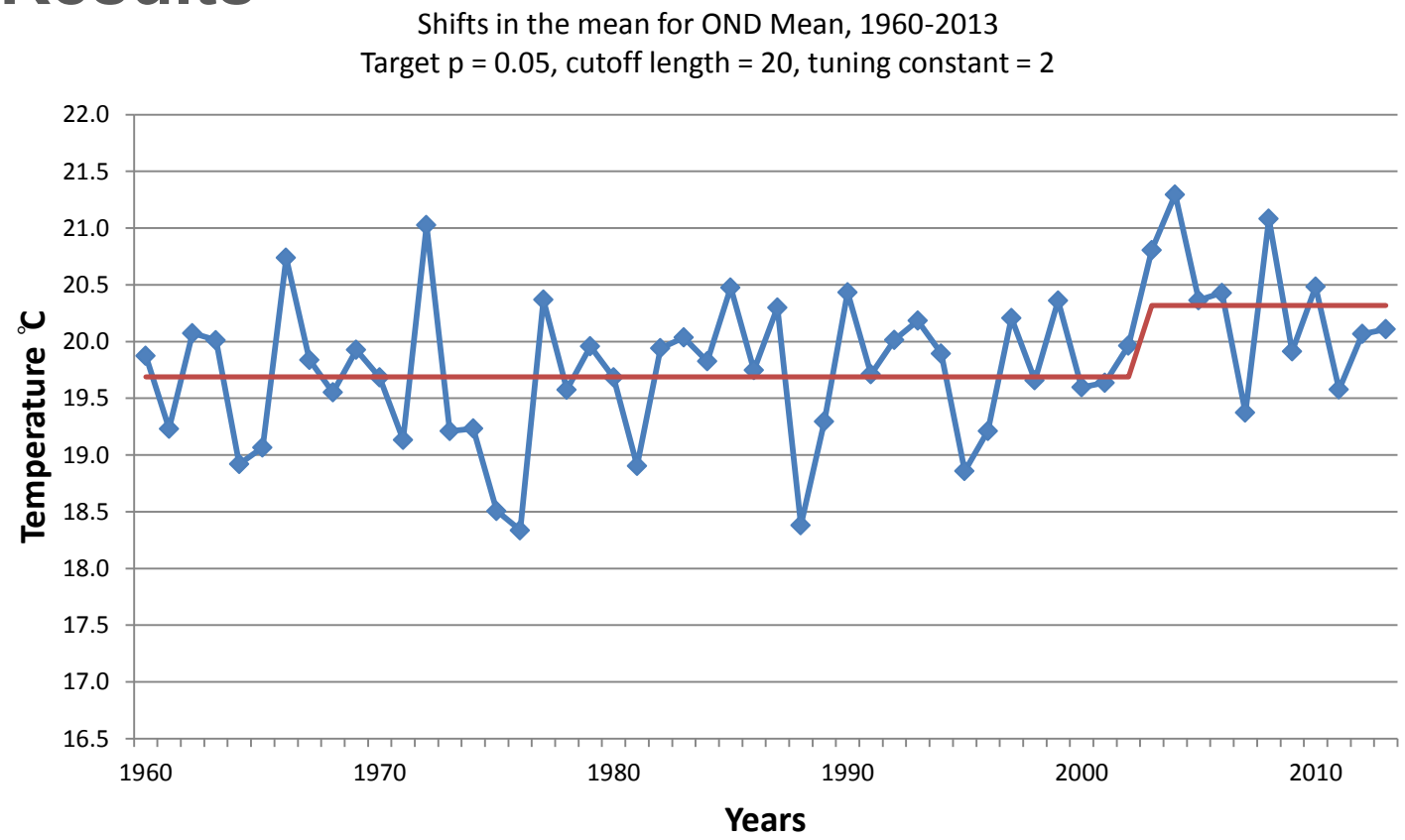
Research Objective:

- To investigate whether the climate of the Free State Province has changed and how the changes have varied through space and time.

Methodology

- Gridded rainfall, temperature and SPEI data for the period 1960-2013 were acquired from Climate Explorer while SPIs were calculated from rainfall data
- The data were used to identify temporal changes and the resultant epochs
- Sequential Regime Shift Detection Software (RSDS) – Version 6.1(Rodionov, 2015) was used
- The data were also rendered using ArcGIS (Version 10.1) to determine spatial clusters and trends were analyzed in each cluster.
- PCA was performed on precipitation and PC1 was correlated with other variables

Results



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- OND Mean Temperature increase of 0.6 °C (p=0.006611)
- However, even though this change was “global”, it was not uniform throughout the province

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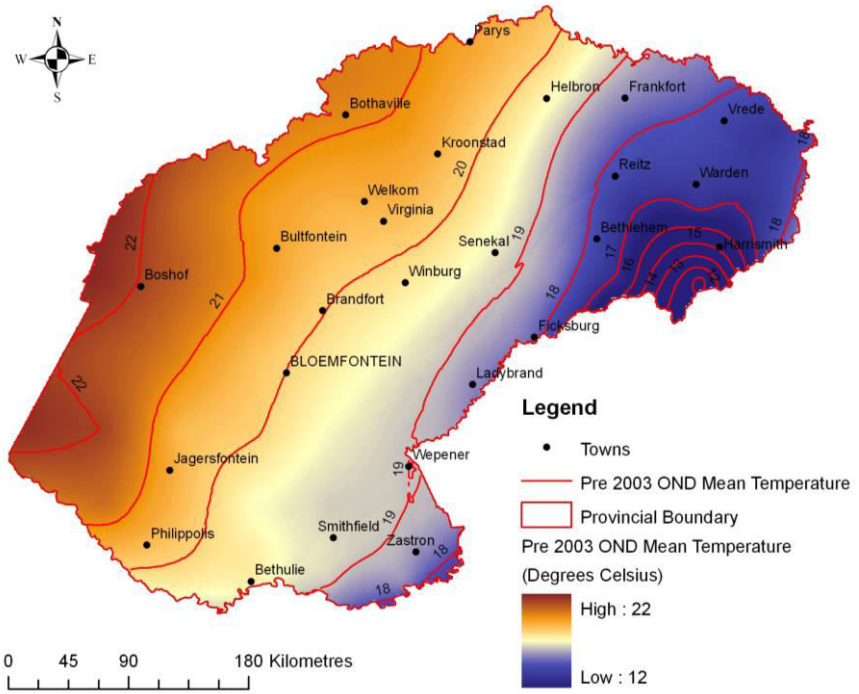
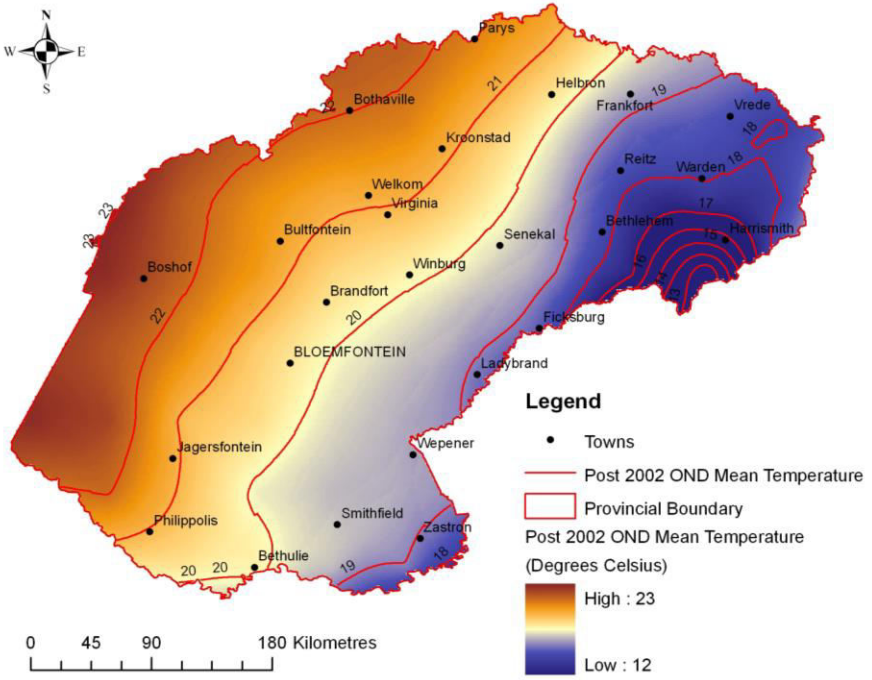
OND Mean Temperatures





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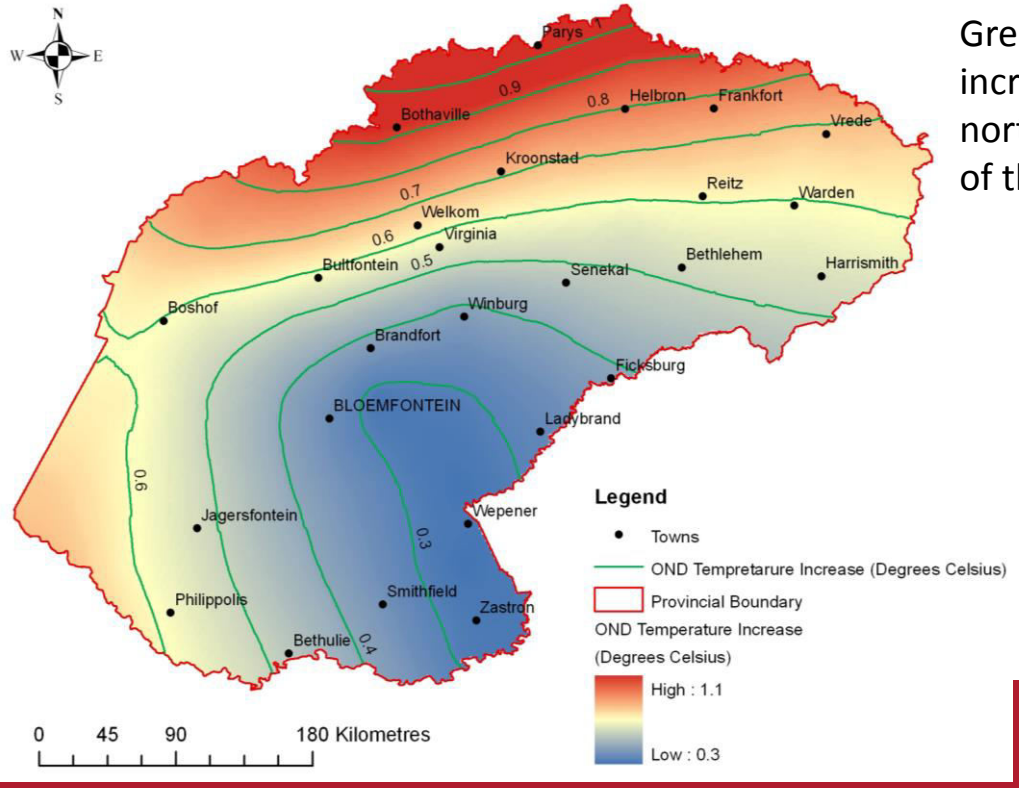
OND Mean Temperature Increase



Greatest temperature increases recorded in the northern and western parts of the province

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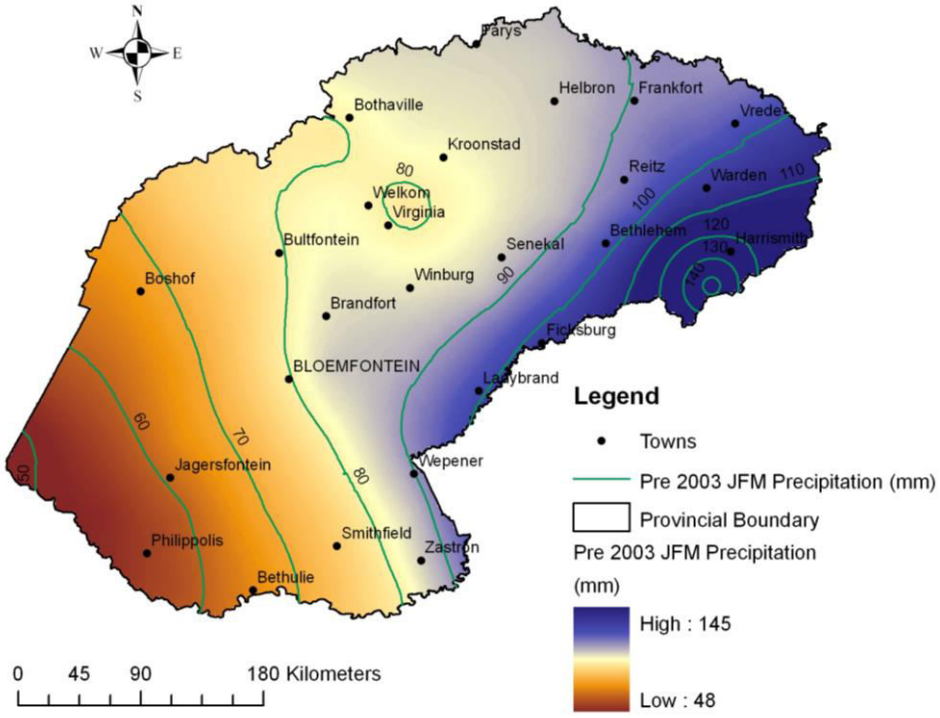
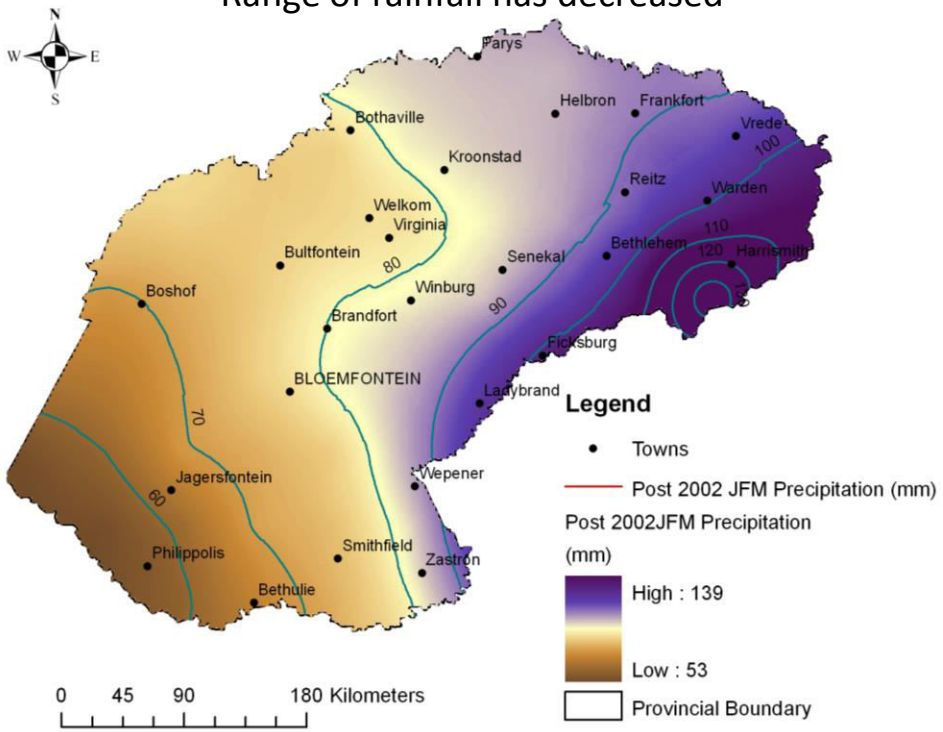
JFM Precipitation Changes

Range of rainfall has decreased





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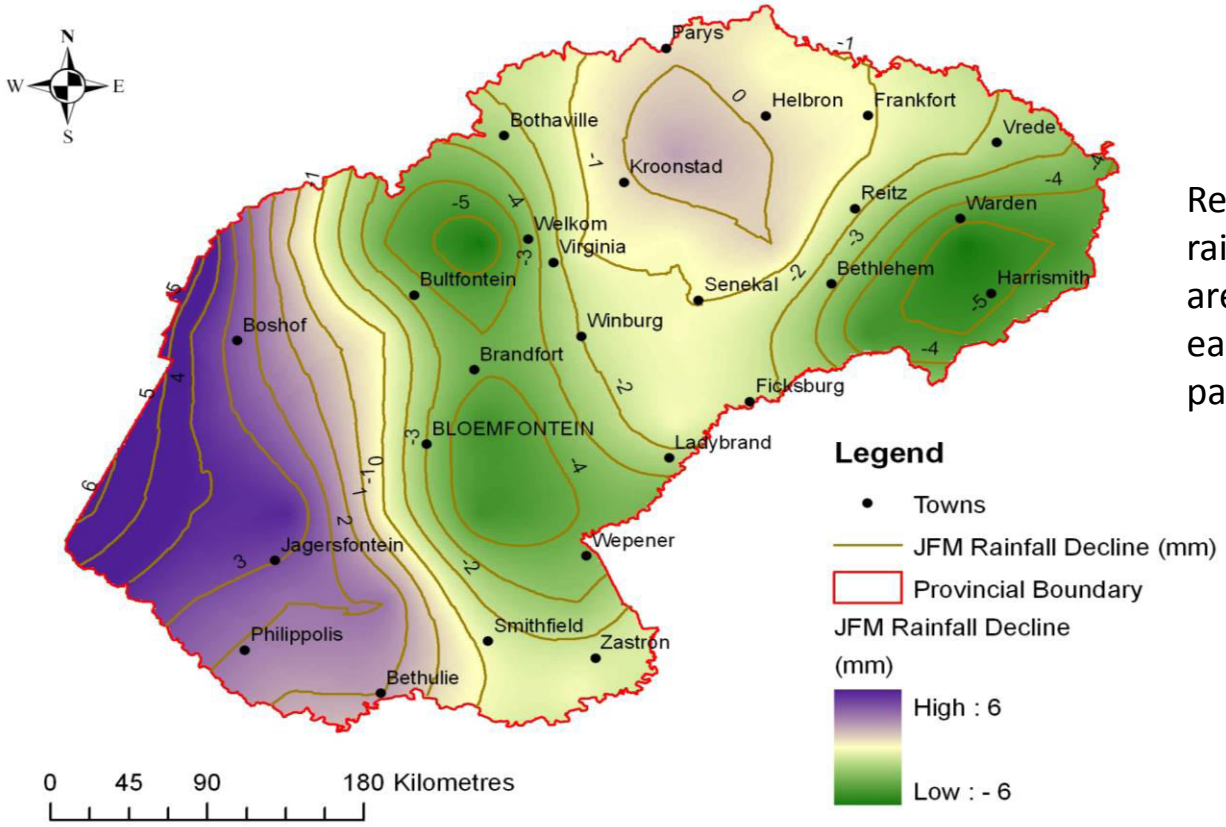
JFM Precipitation Variability



Regions in which rainfall has declined are confined to the eastern and central parts of the province

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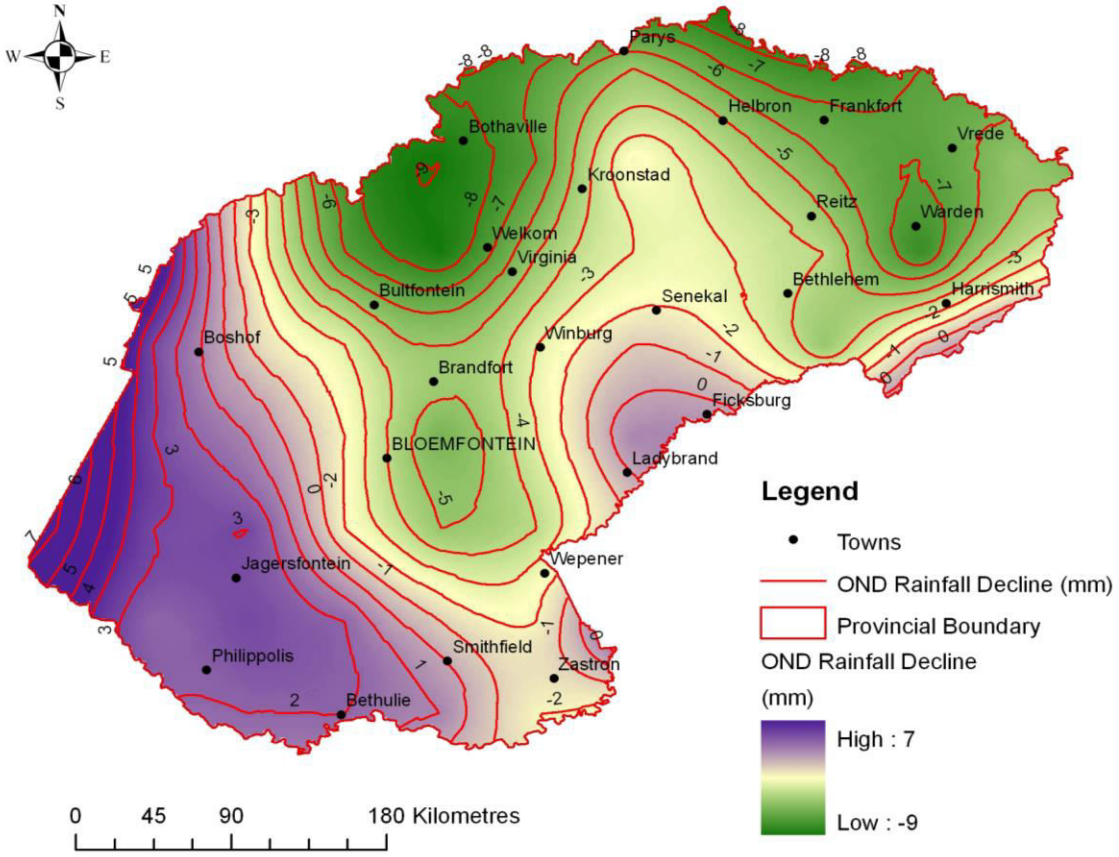

Regions in which rainfall has declined are confined to the eastern and central parts of the province

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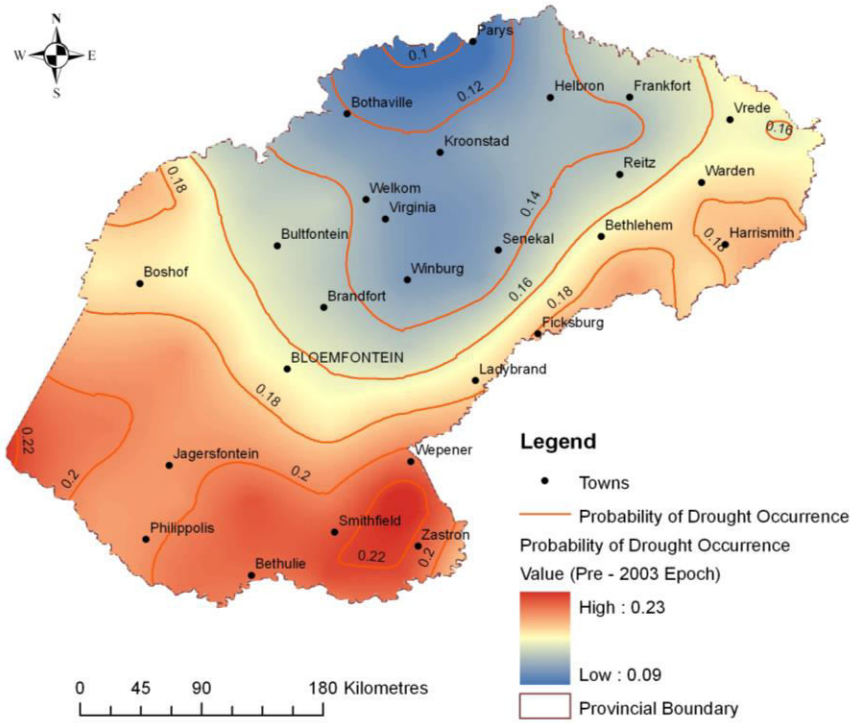
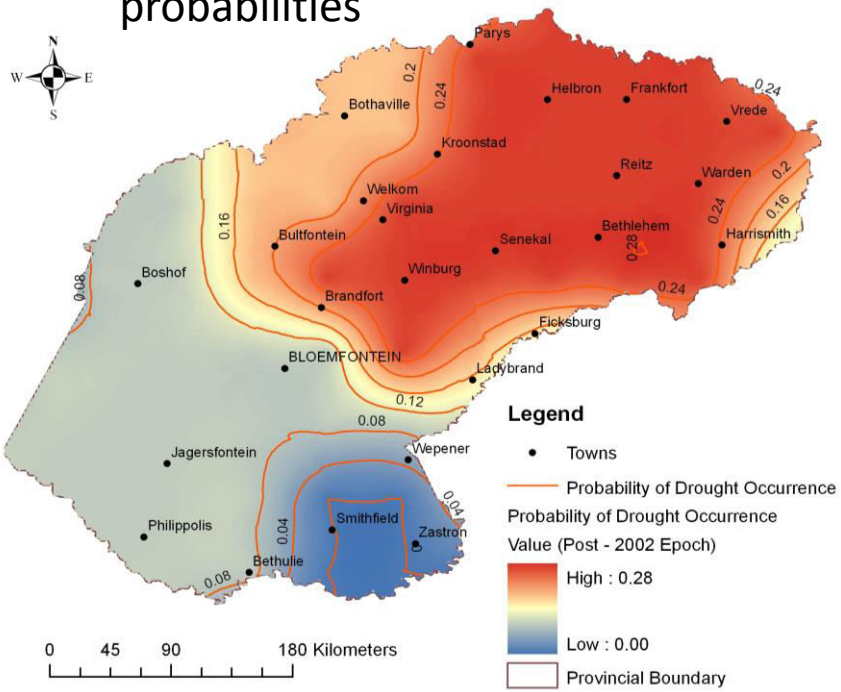
Drought Intensity - SPIs

Reversal of region of higher drought probabilities





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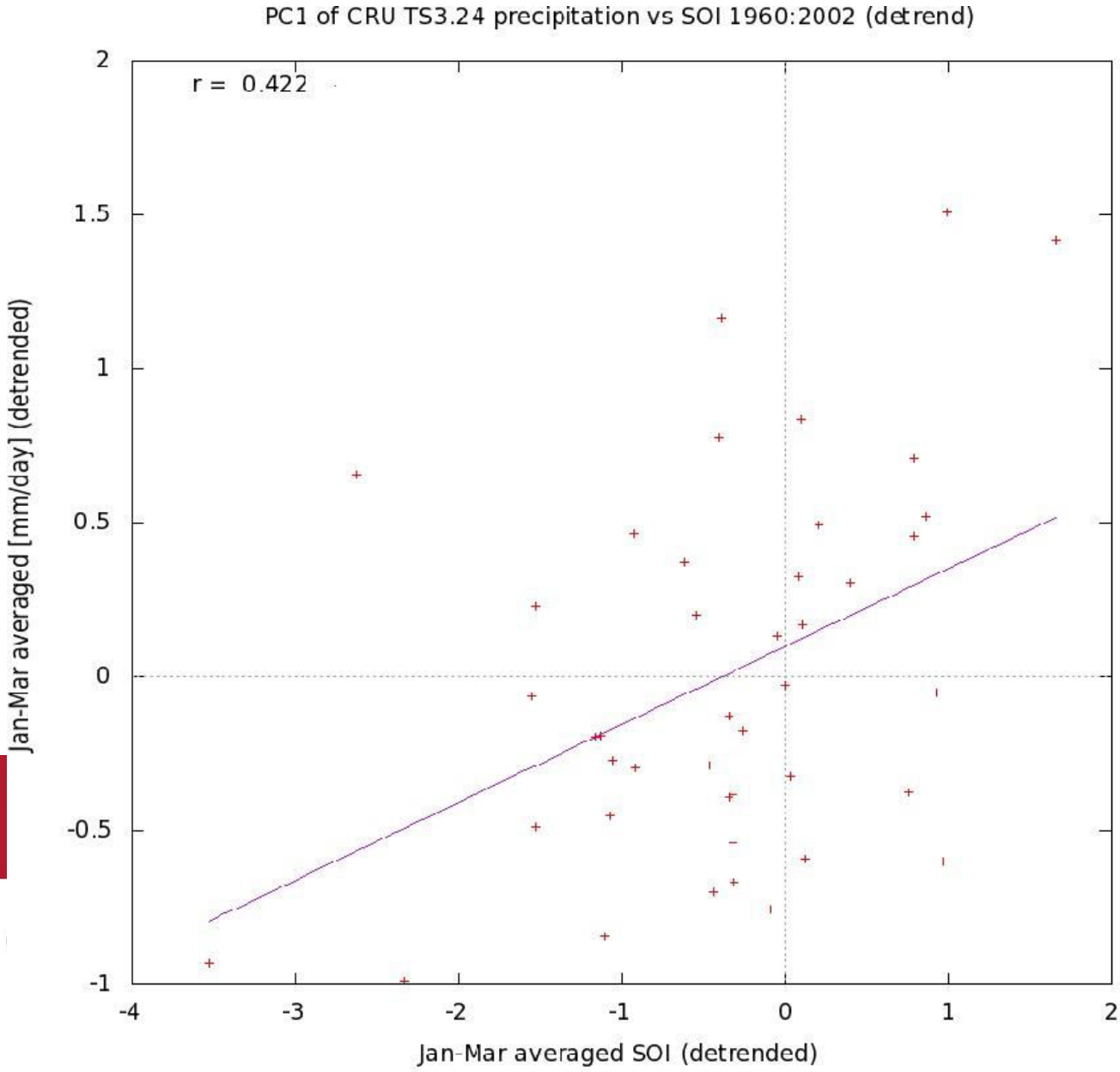
PCA Results

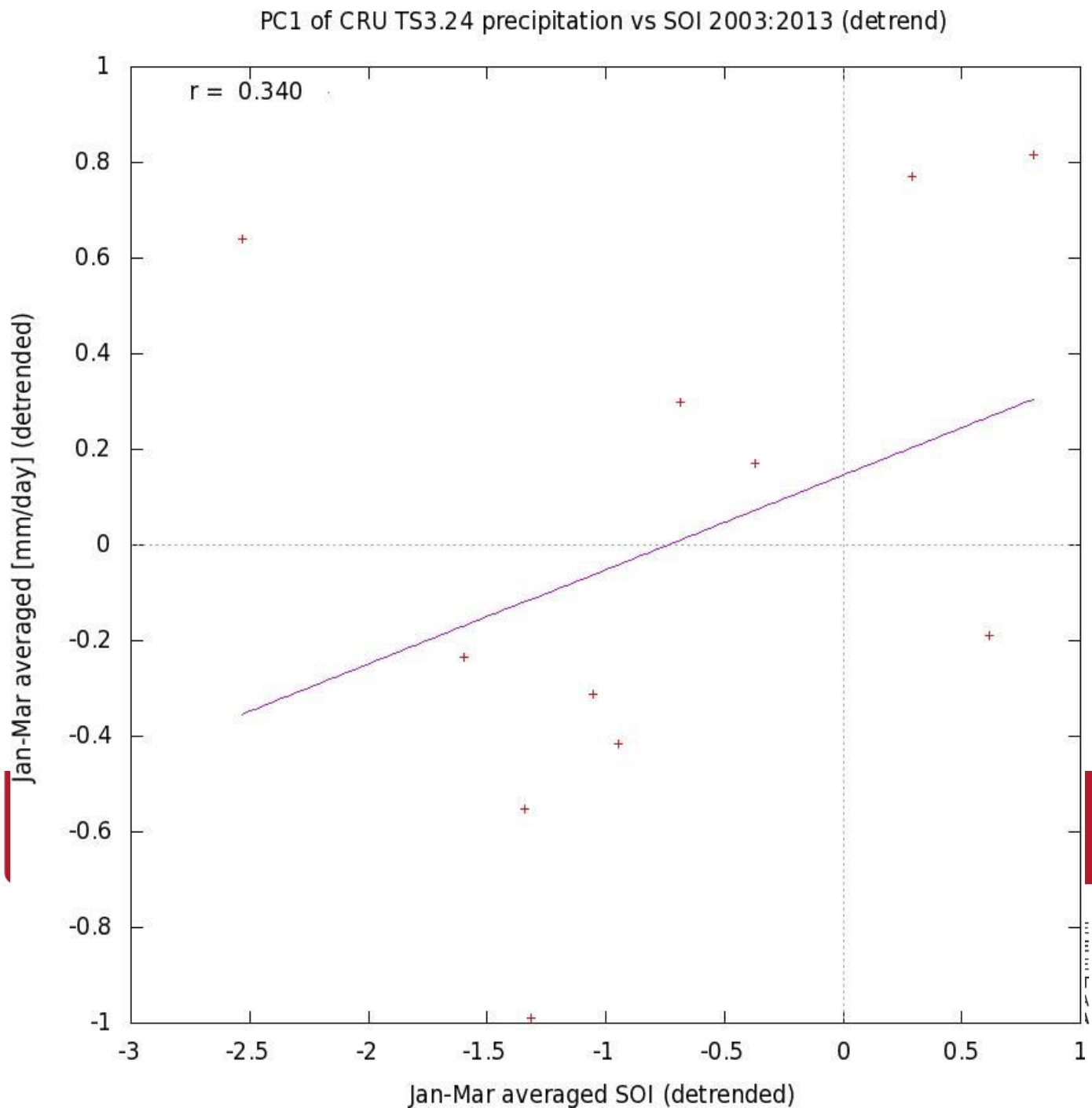
1960 - 2002

#	eigenvalue	explained variance	cumulative
1	21.218	69.21%	69.21%
2	2.4816	8.10%	77.31%
3	1.3861	4.52%	81.83%
4	0.82253	2.68%	84.51%

2002 - 2013

#	eigenvalue	explained variance	cumulative
1	14.446	87.23%	87.23%
2	1.0878	6.57%	93.80%
3	0.61442	3.71%	97.51%
4	0.22743	1.37%	98.89%


PC1 of CRU TS3.24 precipitation vs SOI 1960:2002 (detrend)
r = 0.422
Jan-Mar averaged [mm/day] (detrended)
Jan-Mar averaged SOI (detrended)
2
1.5
1
0.5
0
-0.5
-1
-4
-3
-2
-1
0
1
2


PC1 of CRU TS3.24 precipitation vs SOI 2003:2013 (detrend)
r = 0.340
Jan-Mar averaged [mm/day] (detrended)
Jan-Mar averaged SOI (detrended)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1

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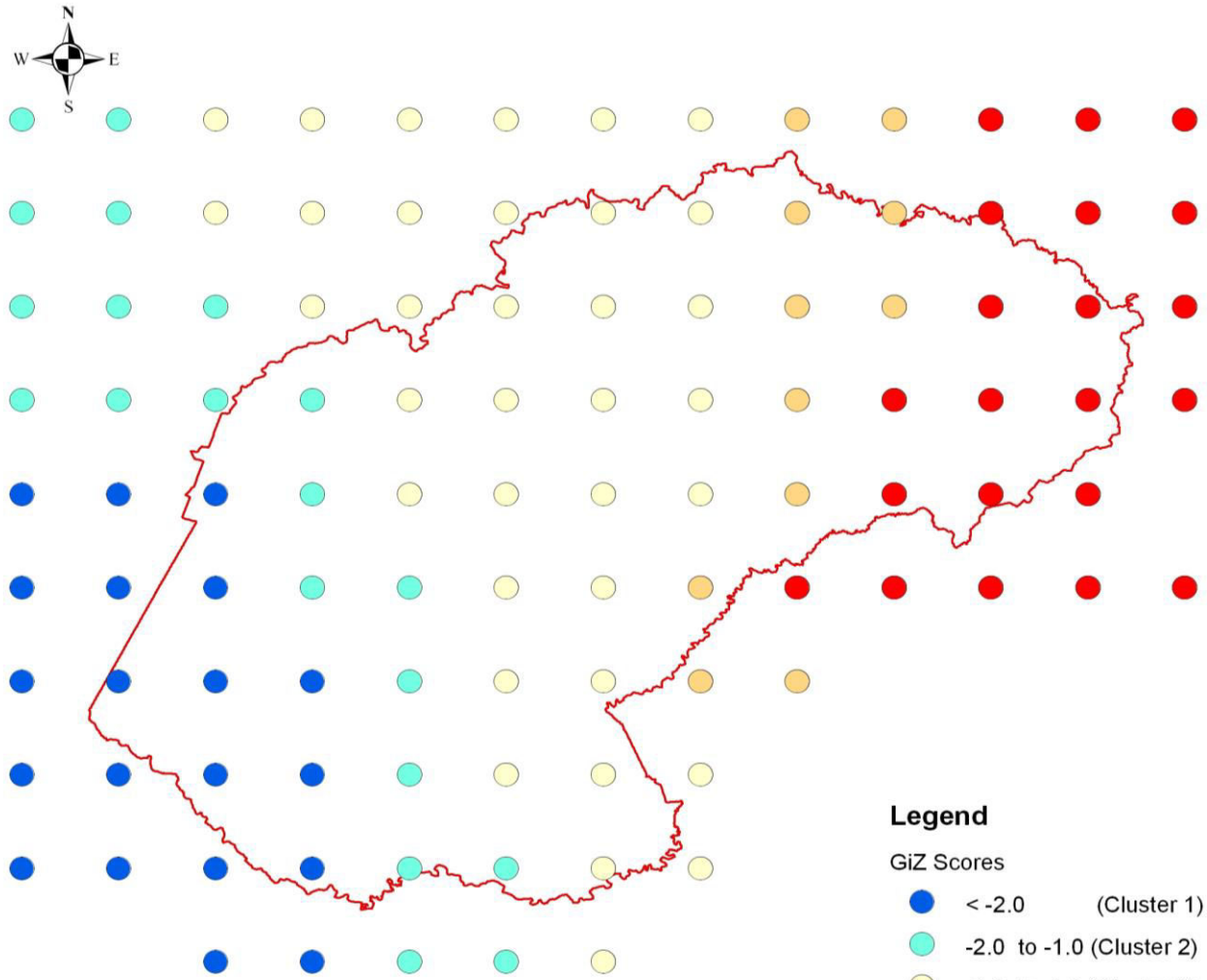
Hotspots Clustering



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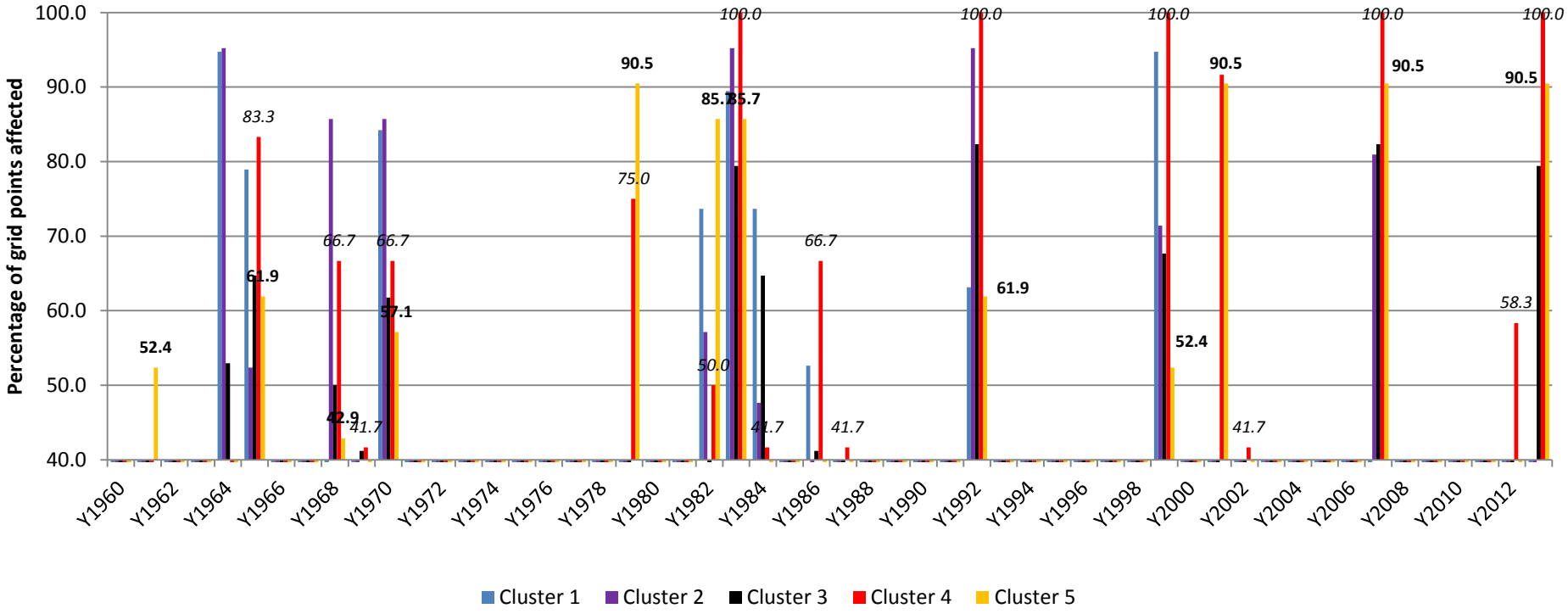
Percentage of Area Affected by Drought Based on SPEI Values



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Yu et al (2014)

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Discussion

- Climate change has brought both wet and dry conditions to the Free State Province
- The western parts of the province have received wetter conditions since 2003, while the opposite is true in the eastern parts of the province
- These differences have important implications for water resources, agriculture, food security, rural livelihoods and biodiversity conservation in the province
- Different planning and management regimes have to be adopted for different parts of the province

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Conclusion

- Climate change has occurred in the Free State Province, leading to two epochs
- Warming has occurred across the Free State Province
- Hotspot clustering revealed five different clusters, each with its own characteristics in terms of rainfall, temperature and drought trends and patterns
- More research is needed to determine the actual effect of climate change on agriculture, natural resource management and conservation

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