

Spatial and temporal patterns of agrometeorological indicators in maize producing provinces of South Africa

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Introduction

- According to the IPPC 2021, Global warming is very likely to reach 1.8 ^oC under low gas emission scenario in 2081-2100.
- Reduction of total precipitation and increasing temperature has been reported in Central and South Africa.
- If the trend keep continues, it leads to reduction of agriculture production around 15% up to 50% in 2080.
- South Africa as the highest maize producer in the Africa continent. Maize become as staple food and source of socio-economic livelihoods.



Materials

- AgERA5 0.1^o x 0.1^o resolution
- 1990 to 2021
- Annual and Growing season
- Growing season (October-March)
- Historical maize yield data : the Statistic and Economic Analysis of Agriculture, Forestry and Fisheries Department South Africa
- Land Cover: Copernicus Global Land Service (CGLS)



- Historical agrometeorological need to be understand to assist mitigation, adaptation planning, and predict future impact of climate change.
- Issues: climate data misinterpreted and no report explicitly describing spatiotemporal patterns.

Objectives

Results

- Identify and quantify the trends in **agrometeorological indicators** for the period 1990-2021.
- Investigate the statistic relationship: 2. agrometeorological indicators and maize yield.
- Identify changes in spatial temporal 3 **patterns** during the maize growing season.

Distribution of land (maize-purple) in Free State, Kwazulu-Natal, field crop Mpumalanga, and Northwest.

Conclusions

- Temperature, precipitation, and wind speed trend was identified in all 1. regions during annual and maize growing season, except for solar radiation.
- The maize yield variability in Free State and Mpumalanga were influenced by all agrometeorological indicators, in contrast with Kwazulu-Natal.
- The leading mode of the variability of agrometeorological data further imply 3. that climate variability and extreme events uniformly affected the regions through out the regions.

2. Statistical relationship

Methods

- Prior test: autocorrelation (ACF and PACF)
- Trend Analysis: Mann Kendall test
- Magnitude: Sens's Slope
 - Land cover and elevation: linear regression
 - Temporal and maize yield: **Pearson** correlation
 - Dominant temporal spatial pattern: **EOF** (Empirical Orthogonal Function) using Climate Data Operators (CDO)

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• EOF analyze the change oscillations over time

1. Agrometeorological trend

| - | Indicators | Free State | | KwaZulu-Natal | | Mpumalanga | | North West | |
|---------|------------|------------|-------|---------------|-------|------------|-------|------------|-------|
| Time | | Z | β | Z | β | Z | β | Z | β |
| Annual | Temp | 3.64** | 0.04 | 3.26** | 0.03 | 3.26** | 0.03 | 2.82** | 0.04 |
| | Prec | -2.14* | -0.01 | -1.29 | -0.01 | -0.61 | -0.01 | -1.66 | -0.01 |
| | Solar | 1.70 | 0.01 | 0.82 | 0.01 | 0. 23 | 0 | 0.82 | 0.01 |
| | Wind | 2.75** | 0.004 | 1.97* | 0.002 | 0.61 | 0 | 2.04* | 0.003 |
| | Temp | 3.06** | 0.04 | 2.82** | 0.02 | 2.04** | 0.02 | 2.69** | 0.04 |
| Growing | Prec | -1.73 | -0.02 | -1.05 | -0.01 | -0.30 | 0 | -0.91 | -0.01 |
| season | Solar | 1.05 | 0.02 | 0.71 | 0.01 | -0.03 | 0 | 0.31 | 0 |
| | Wind | 2.31* | 0.01 | 1.29 | 0 | 0.14 | 0 | 1.83 | 0 |

The trend and the magnitude of Agrometeorological indicator annually and seasonally in major maize producing provinces.



Agrometeorological Free State Kwazulu-Natal Mpumalanga North West⁺

| Temperature | -0.51** | -0.13 | -0.28 | -0.65** |
|-----------------|---------|-------|---------|---------|
| Precipitation | 0.60** | -0.02 | 0.43* | 0.74** |
| Solar radiation | -0.60** | -0.22 | -0.48** | -0.73** |
| Wind speed | -0.43* | 0.24 | -0.12 | -0.43* |
| _ | | | | |

Pearson correlation coefficient (r) between growing season data of agrometeorological variables and maize yield.

3. Spatial and Temporal patterns

EOF Mode Free State (1990-2021)



- Three dominant modes of EOF
- The first EOF patterns explains more than 50% of the variance
- Even positive loading >> spatially uniform
- Dipole pattern indicate opposite pattern
- The corresponding temporal pattern capture extreme event for the last 31 years >> highlighted with yellow band
- Mode-2 and -3 display dipole pattern where positive loading and negative loading are located apart

PC Component Free State (1990-2021)











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