

# VARIABILITY OF SOIL MOISTURE PROXIES AND HOT DAYS ACROSS THE CLIMATE REGIMES OF AUSTRALIA



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**EXTREME TEMPERATURE AND DEFICITS IN SOIL MOISTURE (SM) PROVIDE IDEAL CONDITIONS FOR BUSHFIRES. THE MECHANISMS AND STRENGTH OF THIS RELATIONSHIP VARY SIGNIFICANTLY DEPENDING ON ENERGY PARTITIONING AND CLIMATE WITHIN A REGION. THIS STUDY INVESTIGATES THE RELATIONSHIP BETWEEN THE NUMBER OF HOT DAYS (TX90) AND FOUR SM PROXIES (SPI, API, KBDI, MSDI) ACROSS THE CLIMATE REGIMES OF AUSTRALIA.**

## Introduction

- ▶ The frequency of extreme events such as heatwaves is expected to increase due to the effect of climate change, particularly in semi-arid regions such as areas of Australia. Extreme temperatures and deficits in soil moisture provide ideal conditions for bushfires.
- ▶ As such the land-atmosphere mechanisms behind these extreme conditions is of much importance not only for the mitigation but the forecasting of such events.

## Data

- ▶ AWAP Tx, Pr, SM, ET, Rn at 0.05°. 1950/1971-2015
- ▶ Monthly SOI at Darwin
- ▶ SM proxies ; Antecedent Precipitation Index, Standardized Precipitation Index, Keetch-Byram Drought Index and Mount's Soil Dryness Index.

## Results

### (A) Transitional Zone

- ▶ Figure 1 shows the variation of climate drivers based of yearly averages between 1950-2015 across Australia. In particular, Fig 1a, shows that each climate regime has distinctly different evaporative and dryness ratios and that in 34 out of 46 years, the semi-arid region has a dryness index in excess of 3 and is moisture limited.
- ▶ Fig 1c, 1d, shows that the transitional zone spans the majority of the Australian coastal regions excluding S.A and parts of W.A.

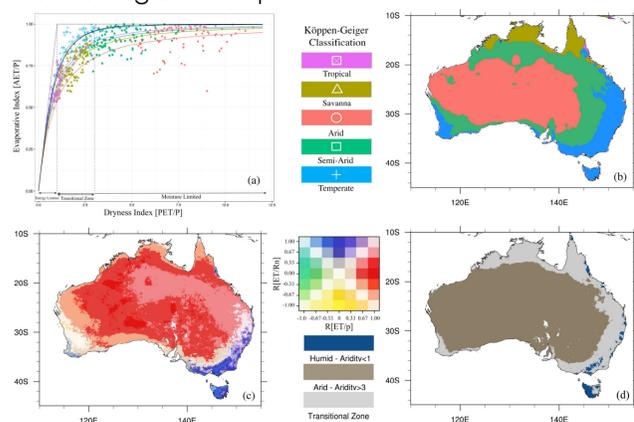


Figure 1. Climate drivers using yearly averages between 1950 and 2015 at 5km resolution. (a) Budyko scatter plot of evaporation index versus the dryness index for each Köppen-Geiger region. (b) Köppen-Geiger classification for Australia, based on Peel et al (2009). (c) Bivariate map of evapotranspiration drivers, i.e. correlation coefficients between evapotranspiration, incoming solar radiation and precipitation indicating the distribution of moisture and radiation limited regions. (d) Distribution of arid (brown) and humid (blue) zones as well as the "transitional" regime (grey)

## Results

### (B) Tx90-SM

- ▶ Figure 2 shows the relationship between Tx90 and each moisture proxy for the 5 main climate regimes in Australia.
- ▶ API and SM appear to have a logarithmic like relationship with Tx90 increasing as SM decreases, whereas there is a clear linear relationship between Tx90 and SPI, KBDI and MSDI.

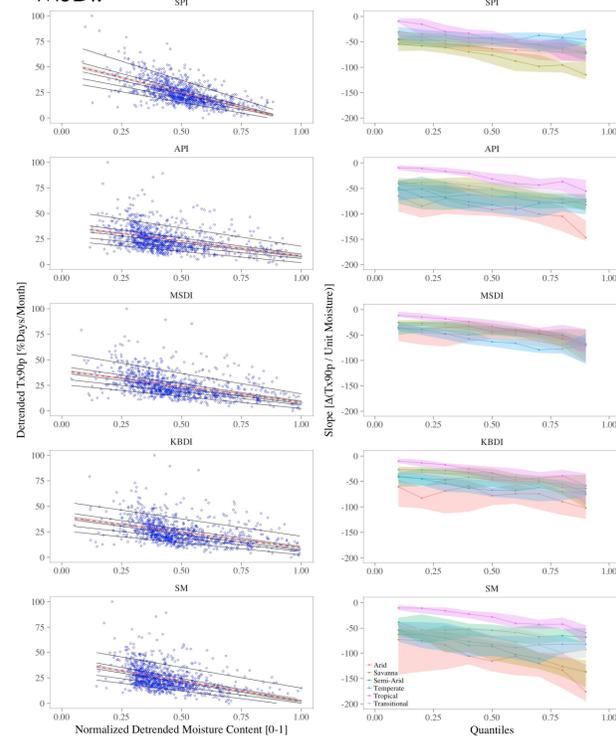


Figure 2. (Left) Scatter plots of monthly DJF Tx90p versus SPI, API, MSDI and KBDI. Soil moisture indices are normalized between 0 and 1. Also shown are linear regression lines for a selection of quantiles (0.1, 0.3, 0.5, 0.7, 0.9 and the median). (Right) Quantile regression slopes of monthly DJF Tx90 and SPI, API, MSDI and KBDI for each Köppen climate regime. The 95% confidence intervals of the calculated slopes for each climate regime are shaded. All data are spatially averaged for Australia between 1971 and 2015.

- ▶ SPI, API and MSDI have the smallest change in the regression slopes as the quantiles increase which indicates that the Tx90-SM relationship is more consistent with these proxies.
- ▶ The overall slope is the greatest with both SPI and API indicating that these proxies have the Tx90-SM relationship..
- ▶ The temperate, savanna and semi-arid regimes show the most consistent and strongest relationship between Tx90 and SM. This is in agreement with the transitional zone as identified in the first results (a).

## Results

### (C) ENSO

- ▶ Figure 3 shows the correlation coefficients between Tx90 and SM for each SM proxy for Australia for all DJF months as well as a break down for El Niño, La Niña and neutral months.
- ▶ As with previous results the strongest correlations are seen in regions which are in the transitional zone.
- ▶ On average across Australia there is little between the proxies. Generally correlation coefficients are stronger for La Niña months indicating that the relationship improves when there is greater precipitation due to the majority of Australia being moisture limited. This is with the exception of KBDI which is known to be heavily wet biased already.

## Conclusions

- ▶ The Transitional zone is very different in Australia than what literature suggests for other regions.
- ▶ There is a strong negative Tx90-SM relationship in the Transitional zone

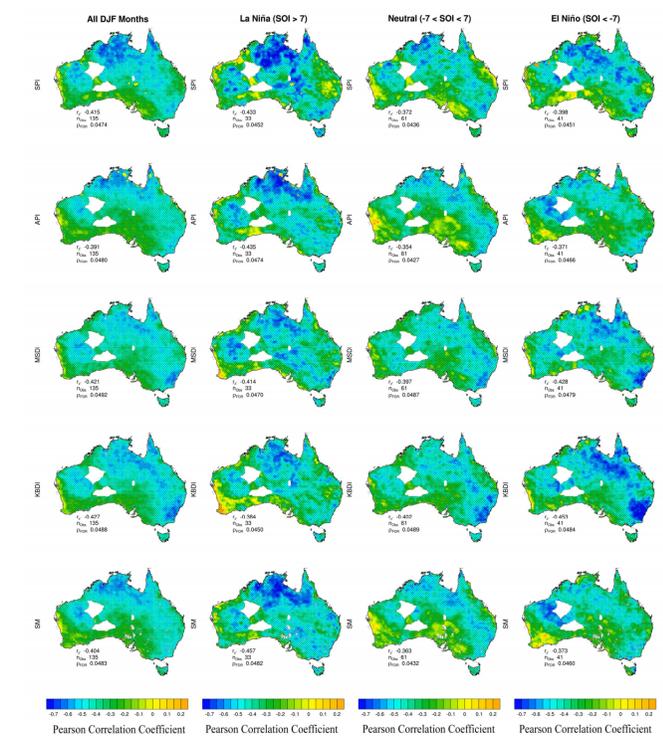


Figure 3 (rows) Pearson correlation coefficients between Tx90 and moisture indices for winter DJF months between 1971 and 2015 for Australia. (column 1) Calculated over time-series. (column 2) El Niño months with an SOI index less than -7. (column 3) neutral months with an SOI index between -7 and 7. (column 4) La Niña months with an SOI index less than -7. (column 5) Separated into Köppen-Geiger climate regions with each color shading depicting a different region. Stippling is indicated for significant correlation coefficients using the False Discovery Rate transformation (level is denoted as  $p_{FDR}$ ). Also shown are the mean correlation coefficients across Australia using the Fisher-z transformation ( $r$ ) and the number of observations ( $n_{obs}$ ) used for calculations.

