Investigating the effect of soil moisture, temperature and precipitation extremes on fires risk and intensity in Australia

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The frequency of extreme events such as heatwaves are 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 ample conditions for bushfires. This study investigates these associations both past, present and future.

Introduction

- Historical and projected future changes in FFDI (McArthur Forest Fire Danger Index; scaling the Antecedent Precipitation Index to the drought factor component) and its components for Australia between 1979 and 2100. More specifically, historical CMIP5 model data, used to derive FFDI are compared against historical AWAP-produced FFDI. Projections of two CMIP5 forcing pathways, namely, the RCP 4.5 (medium climate change forcing) and RCP 8.5 (high climate change forcing) pathways are also compared against each other. An ensemble of simulations from six global climate models each with a minimum of three simulations is analysed, resulting in 29 members for each forcing pathway. Anomalies in cumulative FFDI are assessed both on the seasonal and annual scale for the various climate regimes across Australia.

Data

- AWAP: Tx, pr, SM, ET, Rn @ 0.05° between 1979-2015
- MODIS: FRP (Fire Radiative Power), Fire hotspots @ 500m, 2000-2015
- CMIP5: Tx, pr, hurs, sfcwind @ various between 1979-2100
- ERA-Interim: Tx, pr, hurs, sfcwind @ 0.25° between 1979-2015

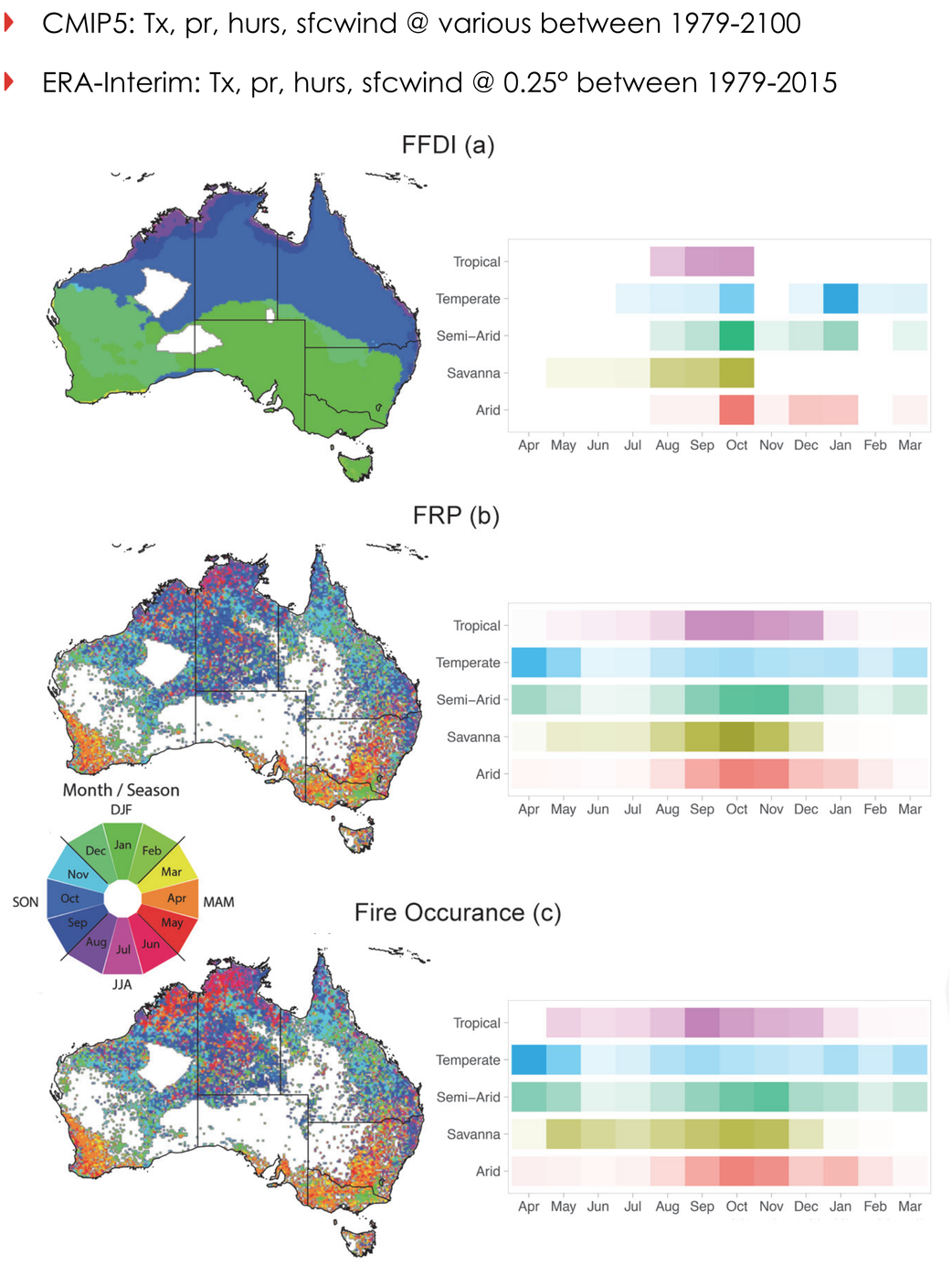

Figure 1. Month in which the maximum FFDI (a), maximum mean FRP (b) and number of fires (c) occur, for all fires detected by MODIS between 2000 and 2015. Also shown are density plots indicating the month of peak occurrence (pixel count) per Koeppen-Gieger Climate regimes (colour scheme is unrelated to maps).

Results

(A) FFDI, FRP & SM

- From Figure 1, typically, the FFDI varies temporally with the fire season shifting from north in the June/July months, progressively further south through SON, then to the south-east in DJF and the south-west later in the DJF season. This was similar to previous studies, however, unlike previously, the seasonality of maximum FFDI does not necessarily coincide with either the month of the maximum number of fires nor with the maximum FRP.
- Both the number of fires and FRP increase with decreasing soil moisture for each indices.
- Generally, both the number of fires and the FRP occurred succeeding the month of the maximum FFDI, with FRP lagging both marginally. Beyond this, the largest FRP fires occur in the temperate/transitional regime further underpinning the effect of soil moisture on synoptic weather conditions in these regions.

(B) FFDI Trends

- With the exception of coastal eastern and southern Australia, the majority of Australia has experienced an increase in FFDI between 1979 and 2015. The largest positive changes in FFDI have occurred during the last 15 years with changes being observed almost uniformly across Australia.
- By the end of the century the change in FFDI is likely to increase by about 20% and 30% for climate pathways, RCP 4.5 and RCP 8.5, respectively. The change in FFDI over the 21st century is not uniform, spatially nor seasonally, with the largest changes being observed in northern Australia during MAM and JJA. There is also a large variation between models,

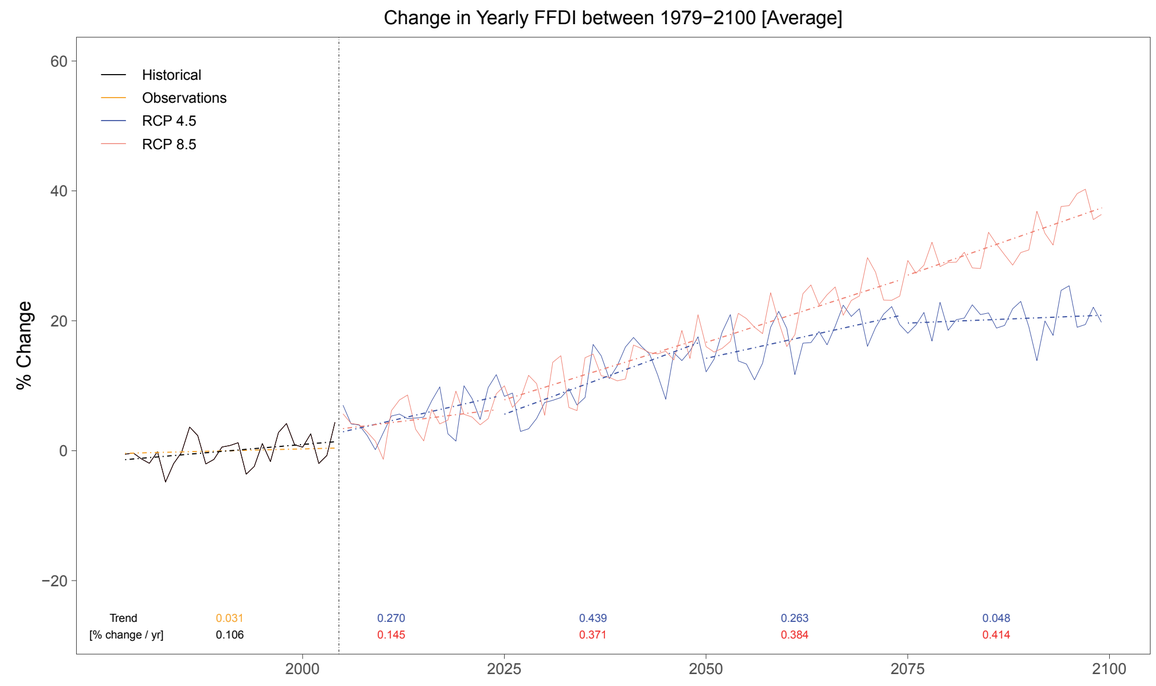

Figure 2. Percentage change (compared to base period: 1979-2005; anomaly) in yearly cumulative FFDI between 1979-2100 averaged for Australia for historical (black line), RCP 4.5 (blue line), RCP 8.5 (red line) ensemble CMIP5 models. Also shown are observational FFDI derived from AWAP with the drought component driven by KBDI (orange line). Trend values are displayed per decadal period for RCP pathways and for the total period for historical and observational data. Shaded areas indicate the 75th and 25th percentiles of the ensembles. In total 29 ensemble members are used from 6 CMIP5 model outputs.

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