Supplementary Information for:

Connections of climate change and variability to large and extreme forest fires in southeast Australia

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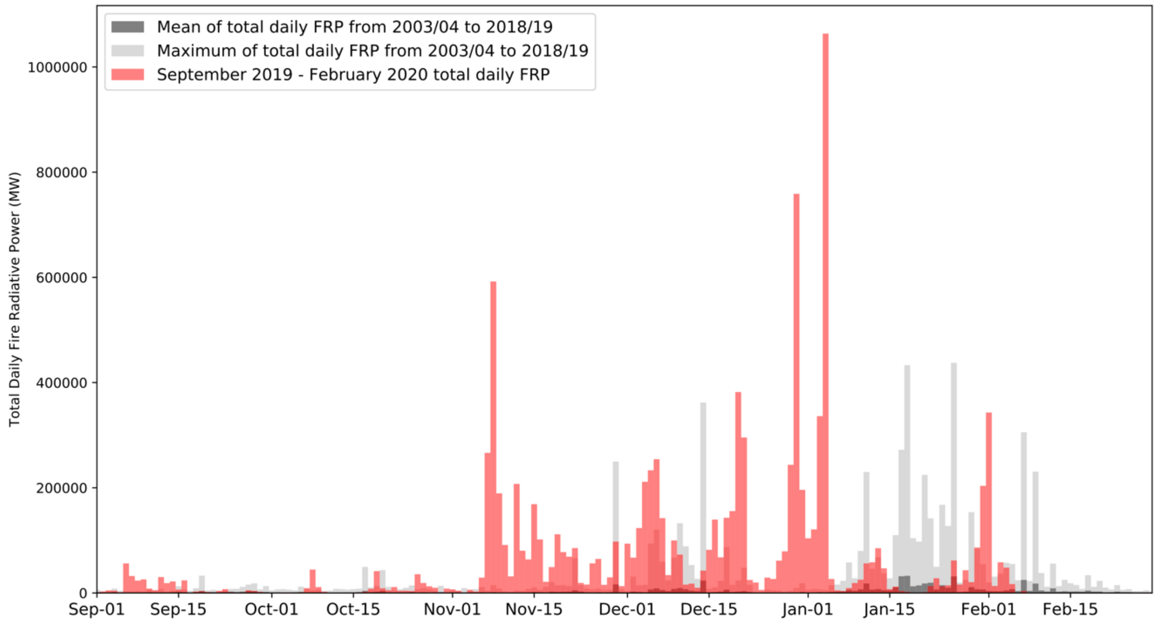
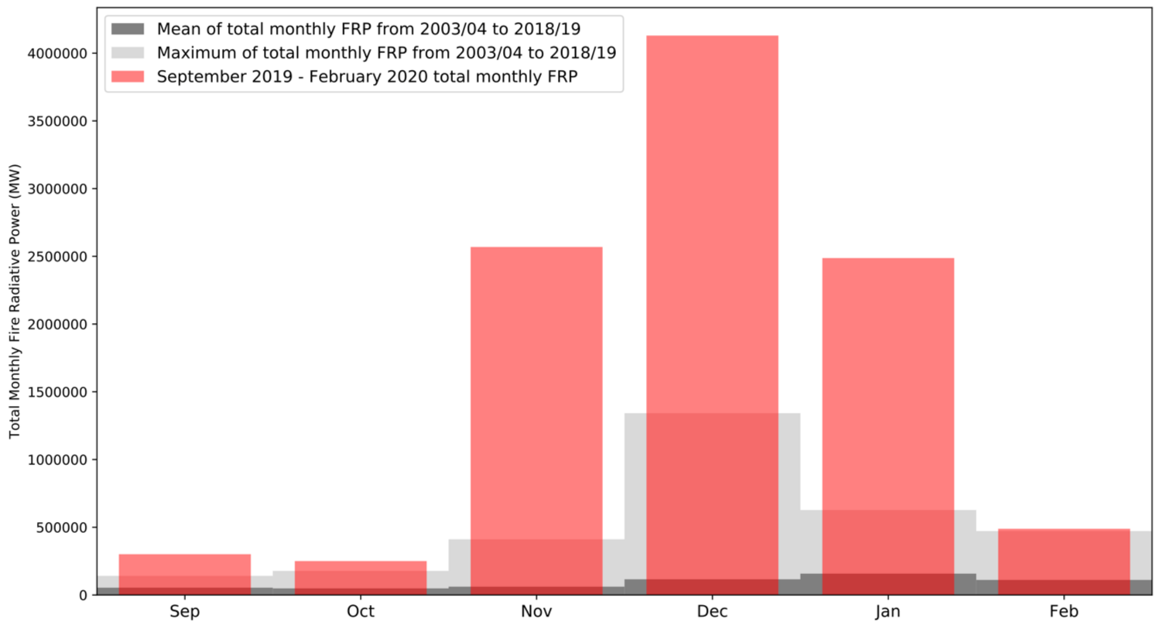
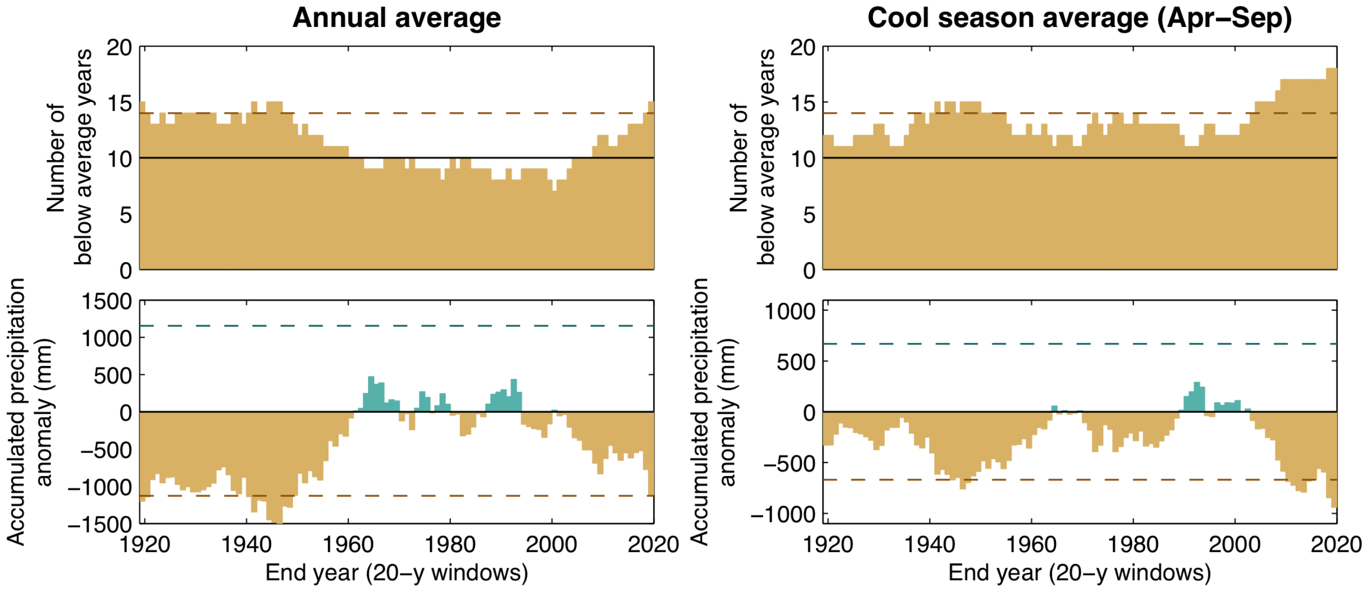
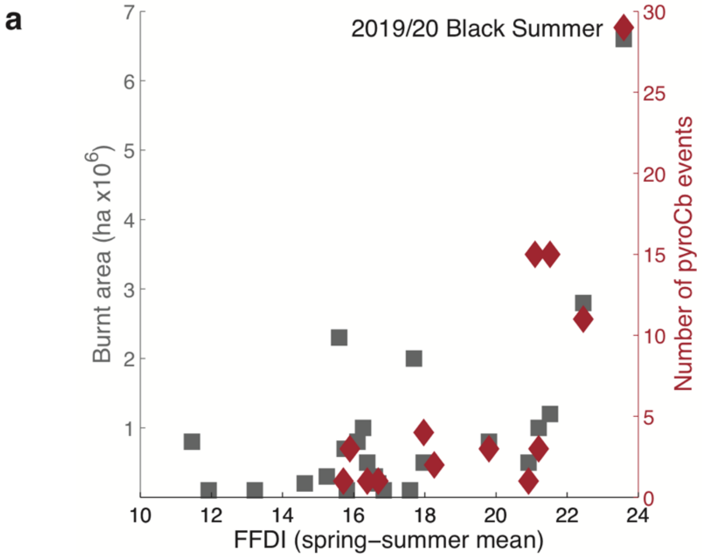


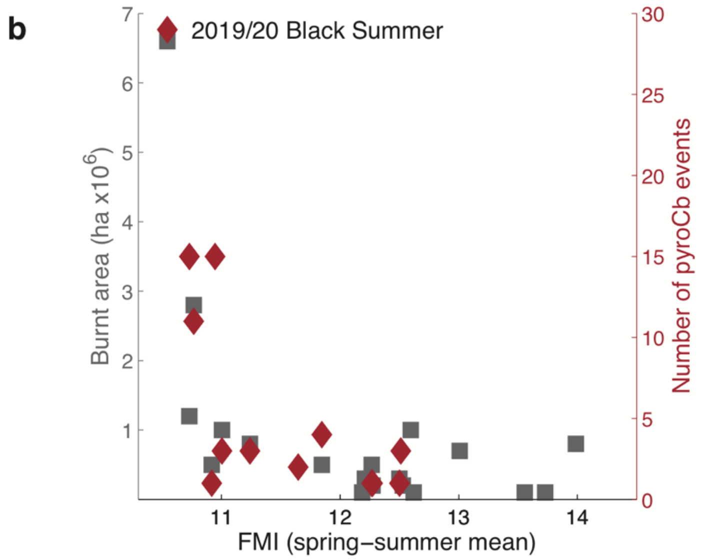


Supplementary Figure 1: Fire Radiative Power (FRP) in southeast Australia. Upper: Daily total FRP derived from MODIS observations made from the Terra and Aqua satellites (Methods)[1,2] is shown for September 2019 to February 2020 (red), and compared with the daily mean (dark grey) and daily maxima (light grey) over the same spring and summer interval from September 2003 to February 2019. Exceptionally high FRP between 29th December 2019 and 4th January 2020 included at least 18 extreme pyroconvective (pyroCb) events that impacted circulation and atmospheric chemistry into the stratosphere[3]. Lower: as in upper but for total monthly FRP. The fire radiative power in southeast Australia was highest on record for every month in the spring and summer of 2019/20 since MODIS observations began in 2003.

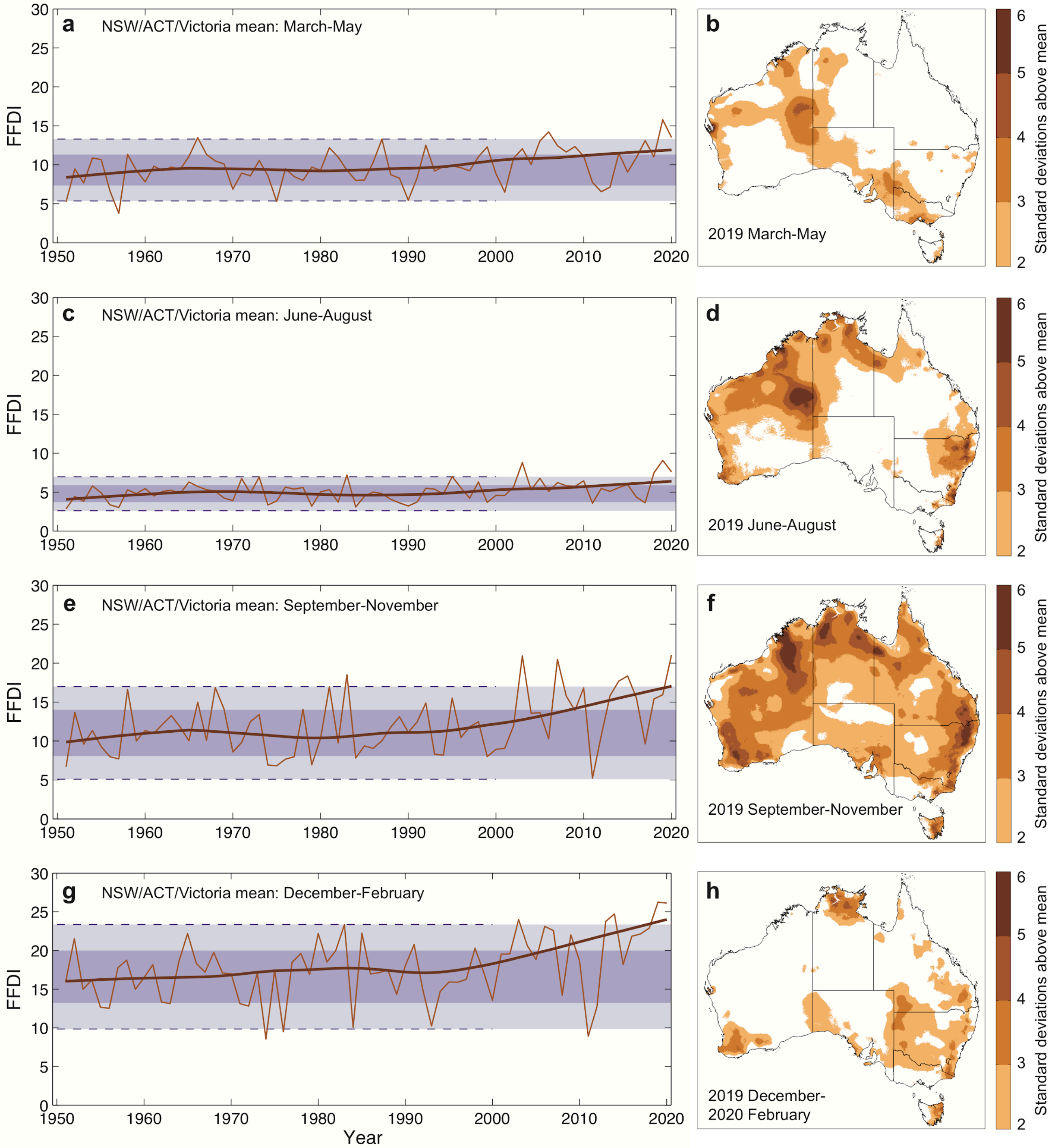


Supplementary Figure 2: Accumulated meteorological drought indicators in southeast Australia. Analysis of the number of years in southeast Australia with below average rainfall in 20-year windows (top row) and accumulated 20-year precipitation anomalies (bottom row). Anomalies are relative to 1961-1990 climatology, and dashed lines indicate the 95% level from 10,000 Monte Carlo simulations. Solid line in top panels indicates the midpoint (10 years) of possible years below the mean in a 20-year analysis window. Analysis carried out for annual average rainfall data (left) and cool season (April-September) averages.





Supplementary Figure 3: Comparison of fire risk indices with observed fires in southeast Australia. a. Mean spring/summer FFDI (September-February mean) compared with historical evidence of area burnt for significant forest fire seasons in southeast Australia (grey squares; as in Fig. 3c; Methods), and compared with the number of documented extreme fire events (pyroCb events; red diamonds). PyroCb event numbers used here are updated from ref. [4] and Sharples (unpublished data). All pyroCb events in this classification involved extreme pyroconvective fires, and are either confirmed or suspected pyroCb events. b, as in (a), but comparing historical fire data with the mean spring/summer FMI in southeast Australia.



Supplementary Figure 4: Time of emergence analysis of the seasonal FFDI. Left column: Time series of mean seasonal mean (mid brown) FFDI in southeast Australia, and the long-term signal as a 30-year lowess filter of seasonal means (dark brown). Variability of seasonal FFDI values in the 1950-1999 historical reference interval (dashed lines) is used to define the ±1σ (dark purple shading) and ±2σ (light purple shading) noise level around the historical mean (Methods). Right column: Spatial plot of the level of the seasonal mean FFDI in 2019, expressed as standard deviation level above the historical reference. Values that do not exceed the +2σ level of historical variability are masked out. Analysis shown for (a-b) autumn (March-May), (c-d) winter (June-August), (e-f) spring (September-November), and (g-h) summer (December-February).

Supplementary References

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