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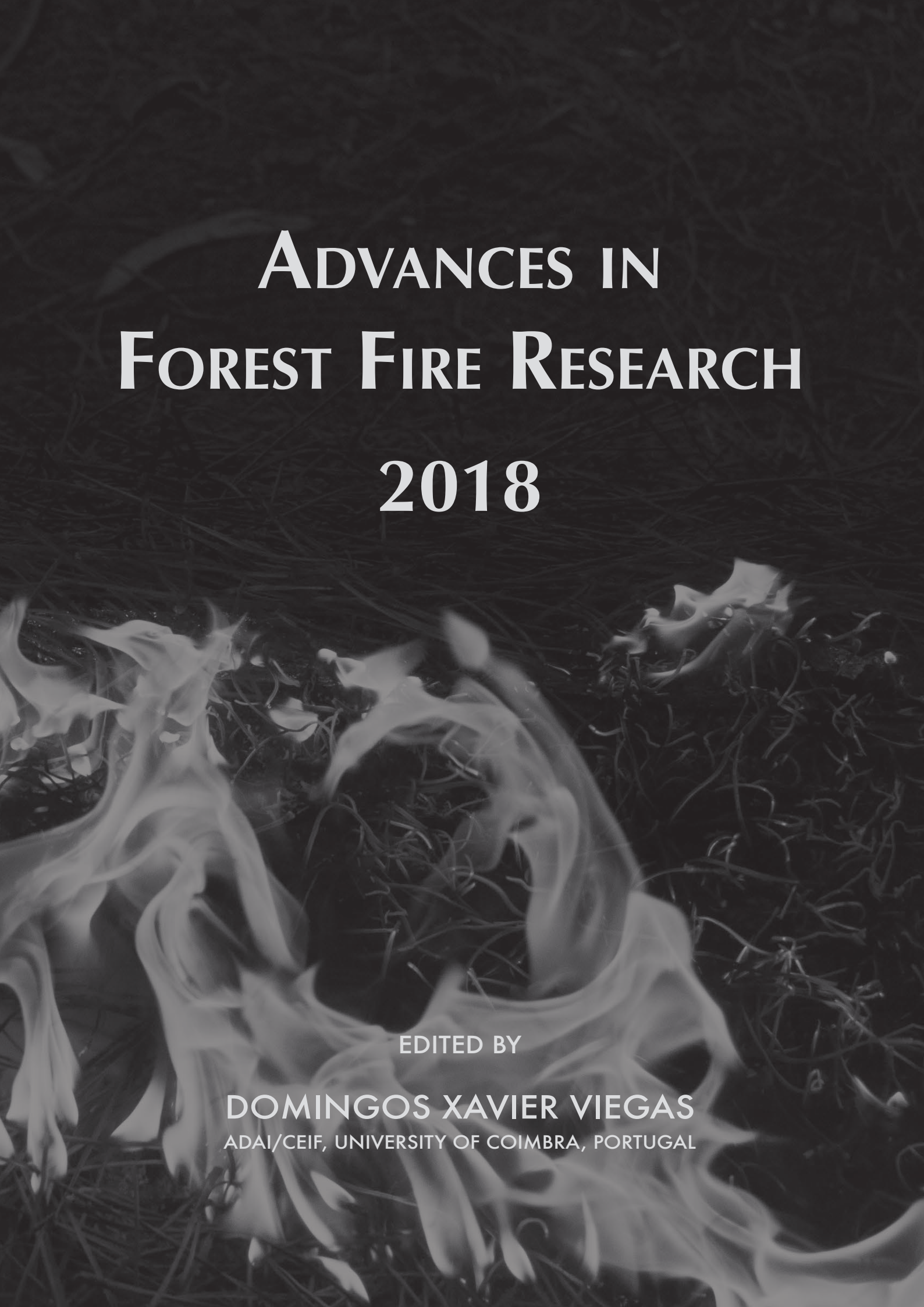

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Short contribution – Decision Support Systems and Tools

The relative contributions of climate drivers on extreme Australian fire weather

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Modes of climate variability have been linked to fire weather around the globe. Variations in sea surface temperatures alter atmospheric circulations, resulting in a change to global distributions of temperature and rainfall. Australia has a high degree of interannual climate variability, modulated by several modes of climate variability. Logically, these modes should also impact the variability of Australian fire weather, but the relationships are not entirely clear. The mechanisms behind this influence, its spatiotemporal variability and the relative contributions of the different climate drivers remain to be understood. Understanding the interactions between climate drivers and Australian fire weather are a step towards improved seasonal forecasts of fire weather, potentially resulting in more effective fire planning and resource management.

In this study, we examine the seasonal relationships of three climate drivers that are known to affect Australia – El Niño Southern Oscillation (ENSO), Southern Annular Mode (SAM) and Indian Ocean Dipole (IOD) with the annual cumulative and seasonal 90th percentile McArthur Forest Fire Danger Index (FFDI) at 39 locations across Australia. We also determine the relative contributions of the climate drivers using partial correlations and regression analysis, as well as considering the seasonal lag effect.

We find that the relationship between ENSO and extreme fire weather (90^{th} percentile of FFDI) is significant and widespread across most of the country throughout winter, spring and summer. The strongest values occur in spring and the relationship with cumulative fire weather is stronger than with the concurrent seasonal extreme fire weather. Considering the lag relationships with ENSO indices there is high predictability for both one- and two- seasons in advance for the summer FFDI for most of the country. This is important because this is a critical high fire danger period for southern and eastern states. Additionally, predicting spring FFDI is possible for many parts of the country up to one season in advance. This is particularly important for early season fires that have been found to occur in New South Wales(NSW)/Australian Captial Territory (ACT), although ENSO was not statistically significant along the coast. For the autumn period there is some ability to predict fire weather in the NSW/ACT region; this may be useful for prescribed burning planning or for late season bushfires. Finally, in the winter months there is some predictability of FFDI for northern parts of Australia, which is useful as this is the beginning of their peak burning period. Overall, the relationship between cumulative FFDI and ENSO was stronger than for those found between seasonal extreme fire weather.

For SAM, extreme fire weather in the inland areas across Australia is significantly related to SAM in autumn, however for all other seasons SAM is strongly related to fire weather across the eastern states, with the peak occurring in spring and highest values across coastal NSW. When lag seasons are considered for SAM there appears some advanced predictability for the summer fire weather for the south east of the country, particularly Victoria, Tasmania and South Australia (AS). A negative SAM in the spring results in higher FFDI values in summer. Additionally, for the spring fire weather there is some predictability one season in advance for northern NSW and southern Queensland (QLD). Overall seasonal SAM is more strongly related to seasonal extreme fire danger than to cumulative fire danger.

The relationship between IOD and extreme fire weather in winter is patchy across southern Australia with the strongest relationships in the west. In spring the relationship is stronger and concentrated in the south east of the country including stations from NSW/ACT, Victoria, SA and Tasmania. There are both one- and two-season lag relationships with summer extreme fire danger in Tasmania. The cumulative fire danger is not as strongly related with IOD as extreme fire danger but there are more stations with cumulative FFDI significantly related to IOD in Western Australia (WA) during spring than was found for extreme fire weather during the same period.

When the combined effect is considered to identify the dominant drivers we find in autumn SAM dominates central and western stations and ENSO has a weak relationship with stations in the south east of NSW/ACT. In winter the IOD is the dominant driver over the south of SA, the south and western coast of WA along with northern Australia. ENSO dominates much of north central Northern Territory (NT) and QLD along with NSW, whereas SAM dominates some of the stations in southern QLD, parts of NSW and Tasmania. In spring, the whole of QLD extending across central Australia is dominated by ENSO whereas SAM dominates NSW, and IOD dominate in parts of SA and Tasmania. In spring for Victoria there are no dominant drivers when the combined effect are considered suggesting that extreme fire weather requires the combined effect of IOD and ENSO to predict the variability. However, the relationship between IOD in winter with winter FFDI values is stronger than ENSO for WA and SA (with the exception of the inland SA site of Woomera). In summer, for the combined drivers, (noting that IOD is not included during this period) ENSO dominates most of the country particularly the Eastern coastal regions with the exception of SAM, which is the dominant driver in north east of NSW. When considering the lag effect of spring climate drivers on summer extreme fire weather ENSO dominates the entire eastern coast extending up to Darwin and also dominates in central WA. Whereas, SAM is the dominant climate driver across SA, Victoria and Tasmania. Their annual results also indicate that other drivers dominate over the rest of the state, which corresponds to the locations of the two Tasmania stations in this study, particularly IOD and ENSO in the north of the state (where Launceston AP is located). Overall, SAM and ENSO have little impact on the independent relationships with fire weather, however ENSO and IOD are not independent of each other in relation to fire weather.

Our study demonstrates that using a varying combination of climate drivers throughout each season there is considerable potential for producing long-range seasonal forecasts of fire weather. This advanced warning of fire weather may be useful for fire agencies making decisions around resource allocation and risk management.