There is no strong, resilient Australia without deep cuts to greenhouse gas emissions

An open letter on the scientific basis for the links between climate change and bushfires in Australia.

This open letter is supported by 274 scientists with research expertise across the fields of climate, fire and weather science. This open letter is composed of the **full statement**, **a summary statement**, and lists of **co-signatories** and **references**. Co-signatures last updated: 00:00 AEST, 3rd February 2020.

Click here, if you are a scientist with expertise in a relevant field and would like to sign the letter.

The Orroral Fire on the outskirts of Canberra on Tuesday 28th January 2020. Photograph taken by Prof. Eelco Rohling.

Acknowledgement of Country

We acknowledge the Traditional Custodians of the lands and seas across Australia. We recognise their continuing connection to Country. We acknowledge their continued custodianship of the continent, including the role of Indigenous knowledge and practices in land management and Indigenous fire burning. We pay our respects to Elders past, present, and emerging, and extend that respect to all Aboriginal and Torres Strait Islander peoples.

Executive summary and call for action

Scientific evidence unequivocally links human-caused climate change to the increasing risk of frequent and severe bushfires in the Australian landscape. That same science tells us these extreme events will only grow worse in the future without genuine concerted action to reduce global emissions of greenhouse gases.

We, the undersigned climate, weather and fire scientists, call on our country's leaders and policymakers to develop science-informed policies to combat human-caused climate change. To be successful, these policies must urgently reduce Australia's total greenhouse gas emissions and lead to constructive engagement and agreements with other world leaders for coordinated global climate action.

We call on our leaders to unite to develop non-partisan, long-term policies that will enable the managed transition to net zero greenhouse gas emissions by 2050 that the scientific evidence shows is required to avoid dangerous human-caused climate change. The science is clear. It is time to show leadership and set a clear path to protect our country and way of life for future generations.

This statement summarises the scientific basis for the links between climate change and bushfires in Australia, and the climate action that is required to limit further worsening of our bushfire risk and build a stronger and more resilient Australia.

Key points:

- Human-caused climate change is worsening fire-weather and bushfires in southern and eastern Australia.
- Observations show a trend towards more frequent and extreme fire-weather conditions during summer, and an earlier start to the fire season, particularly in southern and eastern Australia.
- Australia's year-to-year climate variability is being altered by climate change. This variability, combined with regional rainfall trends and human-caused warming, contributed to the extremely dangerous bushfire conditions this summer.
- Dry fuel loads related to widespread drought provided conditions for extensive burning in the 2019/20 bushfires.

- Australia's dangerous fire-weather is virtually certain to worsen in the future with ongoing human-induced climate change, making fire management increasingly challenging.

- Australia is part of the Paris Agreement and has a commitment to pursue efforts to limit warming to 1.5°C above pre-industrial levels, which would significantly reduce the intensification of Australia's bushfire risk along with many other climate change risks. The current emission reduction targets of Australia and the world are insufficient and will commit us to 3°C or more of warming by the end of this century.

The scientific basis

The severity, destructiveness and unprecedented scale of the 2019/20 bushfires in eastern and southern Australia[1] have generated public discussion on the role of climate change in this crisis. This statement summarises the scientific knowledge on how human-induced (anthropogenic) climate change is affecting bushfires in Australia.

Human-caused climate change is increasing the risk of fires in various regions of the world, including Australia[2-6]. Fire activity is controlled by four limiting factors[7]: (i) a fuel load (vegetation biomass); (ii) the fuel being dry enough to burn; (iii) an ignition source (anthropogenic or lightning); and (iv) weather that is conducive to carrying that fire through the landscape (e.g. high temperatures, wind speed and low humidity). Climate influences all four of these factors[7-10].

Australia's 2019 climate in perspective

Australia's climate is warming as part of an unequivocal global warming trend[11,12]. Human activities have so far caused 1.0°C of global warming above pre-industrial levels[13].

2019 was Australia's hottest and driest year on record[14]. The average temperature for the whole of Australia in 2019 was 1.5°C above the 1961–1990 climatological average, and 1.9°C above the 1911–1940 average, noting that the national temperature dataset commences in 1910.

Drought and fuel loads

Drought, high temperatures and low relative humidity all lead to low fuel moisture content. Extremely hot and dry conditions in 2019 were preceded by a widespread and sustained drought across eastern Australia that began in 2017. Drought conditions meant that fuel availability (leaf shedding) and fuel dryness created ideal conditions for extensive burning at the start of this fire season across millions of hectares of forest, including temperate forests and rainforest ecosystems.

Drought in southern and eastern Australia in recent years has occurred against a backdrop of long-term precipitation decline across southern Australia. Cool-season rainfall (April–October) in southwest Australia has declined by 20% since 1970, and in southeast of Australia there has been an 11% decline since the late 1990s[12]. These long-term trends of declining cool-season rainfall across southern Australia are expected to continue if greenhouse gas emissions remain high[15,16].

Forest Fire Danger Index

December 2019 had the highest fire potential of any month since Forest Fire Danger Index (FFDI) records began in 1950[14]. The FFDI is a metric calculated using temperature, relative humidity, wind speed, and a drought factor to represent fuel availability. Days with high FFDI are indicative of conditions where fuels burn readily and fire containment is less likely, leading to large fires that travel long distances[17] as seen across broad swathes of southern and eastern Australian in 2019/20[1].

Changes to Australia's bushfire season

Human-caused climate change has already contributed to more dangerous weather conditions for bushfires in Australia[18-19]. This includes observed trends towards more dangerous conditions during summer, and an earlier start and later end to the fire season, particularly in southern and eastern Australia[18-20]. The frequency of major bushfires in southeast Australia has approximately doubled since 1900[21]. Urgent studies to quantify how much additional risk human-caused climate change brought to the 2019/20 fire season in Australia have already begun[22].

Further lengthening of the fire season and more frequent and more extreme fire-weather are expected into the future due to ongoing human-caused climate change[23,24]. Fire management measures such as hazard reduction burning are of diminishing effectiveness under extreme wildfire conditions[25,26]. The future availability of suitable hazard reduction burning days is highly uncertain[27].

Fire-induced weather (PyroCb events)

Large, intense fires can develop thunderstorms in their plumes — a phenomenon known as pyrocumulonimbus (pyroCb). PyroCb events are characterised by erratic fire behaviour, swarms of embers, lightning, and strong and variable winds. Large pyroCb events can have catastrophic impacts on society and the environment, as seen for the 2009 Black Saturday and 2003 Canberra bushfires.

There has been a steady increase in the frequency of pyroCb events recorded over southeastern Australia since monitoring began in the late 1990s[21]. During the 2019/20 bushfires, approximately 30 pyroCb events have been observed so far, grossly exceeding the number of events to have occurred in any previous year[28]. This is consistent with observed climate trends over the last several decades towards more dangerous weather conditions that are conducive to pyroCb development[21,29]. Climate models indicate that ongoing warming will cause further increases in the potential for extreme bushfires with pyroconvective conditions over southeast Australia[23,30].

Climate variability that contributes to Australia's fire risk

Variability in the climate from one year to the next acts on top of long-term human-caused climate warming and regional rainfall trends, and is an important contributor to Australia's climate extremes. Human-caused climate change is altering this variability in ways that can further increase Australia's fire risk:

The *El Niño-Southern Oscillation (ENSO)* is a leading cause of natural year-to-year variability in Australian weather, with *El Niño* events generally causing an increased risk of dangerous bushfire conditions[18,31]. It is noteworthy that the 2019/20 extreme fires occurred despite the absence of a strong *El Niño* event. However, extreme *El Niño* and *La Niña* events are expected to increase in frequency through the 21st

century[32-34], which may also intensify bushfire hazards in the future.

During 2019 a very strong positive *Indian Ocean Dipole (IOD)* event occurred in the tropical Indian Ocean, and contributed to the extreme heat and extreme dry conditions experienced across Australia during the second half of 2019. There has been an increase in the frequency and intensity of positive IOD events since the 1960s[35-37], which has worsened drought and fire risk in southeastern Australia[38,39]. It is projected that similar strong positive IOD events will be three-times more frequent in the 21st Century compared to the 20th Century with continued high greenhouse gas emissions in the absence of effective climate policies[40,41].

The *Southern Annular Mode (SAM)* has become more positive since the mid-20th Century, caused by both rising greenhouse gases and ozone depletion[15,42-44]. A more positive SAM has resulted in a shift in the storm tracks that bring rain bearing systems across southern Australia and caused a long-term decline in winter rainfall across southern states[5,12,15]. This rainfall decline is expected to continue into the future, but has the potential to be reversed through strong greenhouse gas mitigation that halts further warming and stabilises global climate[15,16].

During spring and summer of 2019 a rare sudden stratospheric warming event occurred over Antarctica and caused the SAM to temporarily shift to a negative state. A negative SAM at this time of year increases the forest fire danger in eastern Australia by reducing cloud cover and drawing hot and dry air across the continent to the eastern states[45]. It is not yet known if climate change will alter sudden stratospheric warming events over Antarctica in the future.

Communication of climate change impacts on bushfire risk

Scientists have studied and communicated the increasing risks that climate change will bring in Australia and other continents in the form of altered fire regimes for more than three decades. This includes reports prepared at the request of governments to aid in policy decisions.

Observed changes in Australian climate and fires, including the 2019/20 fire crisis, have confirmed scientific warnings that human-caused climate warming is virtually certain to increase the duration, intensity and frequency of fires in southeast Australia[5,24,46,47]. These trends will continue to worsen with ongoing climate warming and changes in extreme weather phenomena, making fire management increasingly challenging[5].

Climate action

Urgent and ambitious action to reduce greenhouse gas emissions is needed if we are to pursue efforts to limit global warming to 1.5°C above pre-industrial levels, in accordance with the Paris Agreement[13]. Current Australian and global emission reductions are not sufficient, and Australia's current emissions per person are near-to the highest in the world.

Scientific evidence indicates a need for immediate action to reduce total greenhouse gas emissions and manage a rapid transition to net zero emissions by 2050[13] if we are to limit the many climate change risks facing the Australian people, economy and environment. Australia has an important role to play in reducing our total emissions, while also taking a leadership role in international climate negotiations to foster a spirit of global cooperation and urgent action on climate change at the level documented in the scientific assessment of the IPCC Special Report on Global Warming of 1.5°C[13].

Globally coordinated greenhouse gas emission reduction would curtail further climate change-related intensification of Australia's bushfire risk, and give fire management and adaptation measures the best chance of success.

Co-signatories

This open letter is co-signed by research scientists with expertise across the fields of climate, fire and weather science (including physical processes and impacts). Hyperlinks are provided for the team of scientists who coordinated the development of this statement.

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