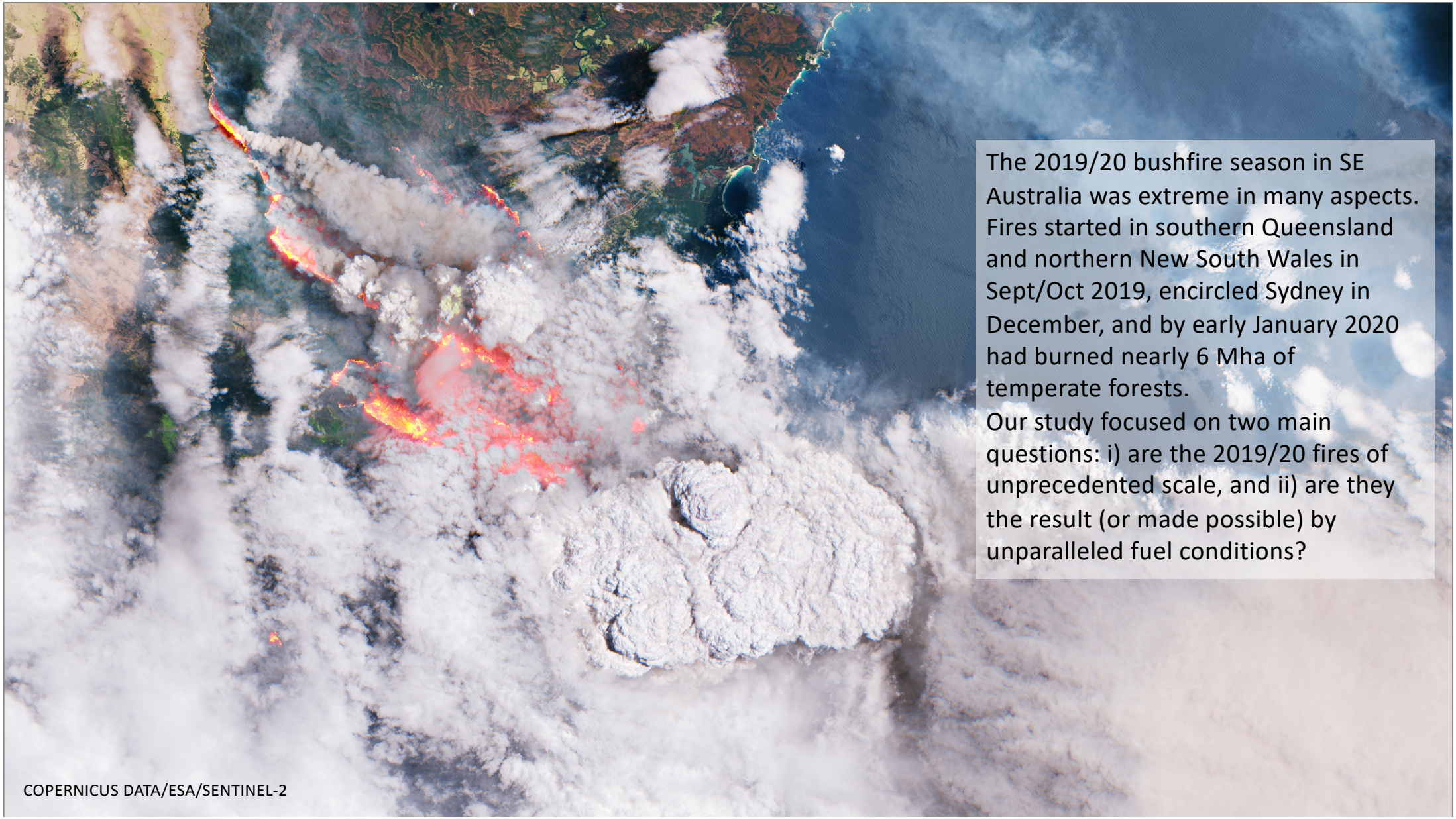
The 2019/20 eastern Australian mega forest fires a global forest perspective

Matthias M. Boer[1]
Víctor Resco De Dios[2,3]
Ross A. Bradstock[4]

1. *Hawkesbury Institute for the Environment – Western Sydney University, Richmond, NSW, Australia*
2. *School of Life Science and Engineering, Southwest University of Science and Technology, Mianyang, China*
3. *Joint Research Unit CTFC–AGROTECNIO, Lleida, Spain*
4. *Centre for Environmental Risk Management of Bushfires, University of Wollongong, Wollongong, New South Wales, Australia*



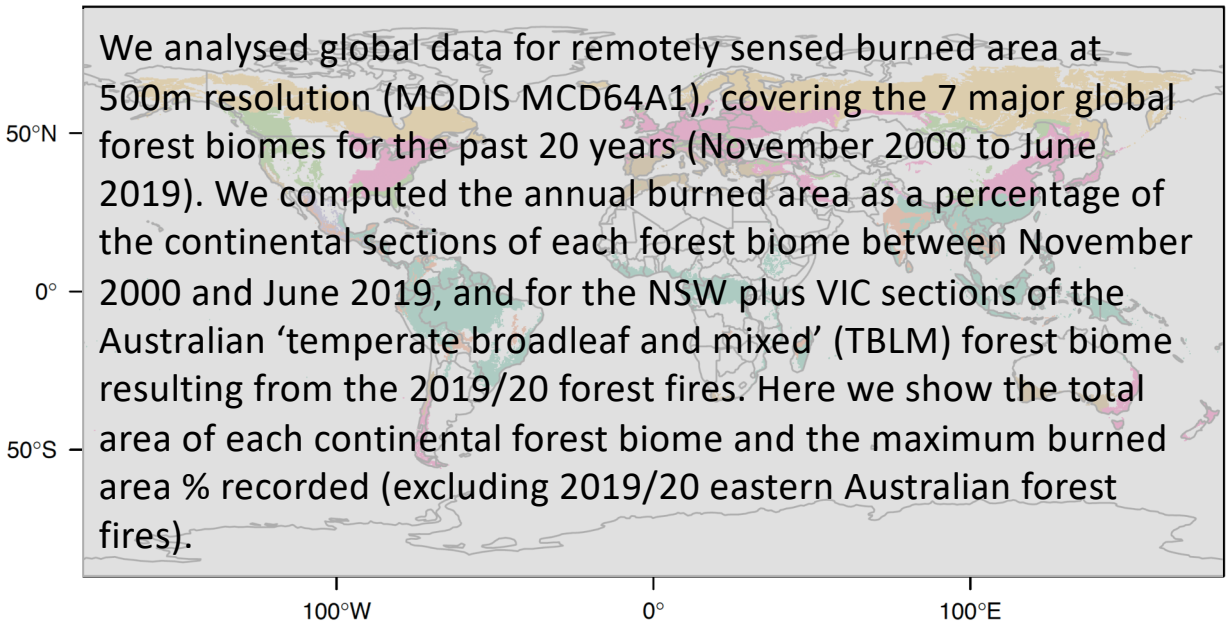
The 2019/20 bushfire season in SE Australia was extreme in many aspects. Fires started in southern Queensland and northern New South Wales in Sept/Oct 2019, encircled Sydney in December, and by early January 2020 had burned nearly 6 Mha of temperate forests.

Our study focused on two main questions: i) are the 2019/20 fires of unprecedented scale, and ii) are they the result (or made possible) by unparalleled fuel conditions?

COPERNICUS DATA/ESA/SENTINEL-2

Global forest biomes – remotely sensed burned area (2000-2019)

We analysed global data for remotely sensed burned area at 500m resolution (MODIS MCD64A1), covering the 7 major global forest biomes for the past 20 years (November 2000 to June 2019). We computed the annual burned area as a percentage of the continental sections of each forest biome between November 2000 and June 2019, and for the NSW plus VIC sections of the Australian 'temperate broadleaf and mixed' (TBLM) forest biome resulting from the 2019/20 forest fires. Here we show the total area of each continental forest biome and the maximum burned area % recorded (excluding 2019/20 eastern Australian forest fires).



N-AMERICA

Biome	Area (km²)	Max BA %
1	348,424	3.4
2	244,029	2.4
3	311,987	4.2
4	1,501,325	0.2
5	1,457,099	1.3
6	2,841,153	1.0
12	NA	NA

S-AMERICA

Biome	Area (km²)	Max BA %
1	6,411,693	1.1
2	277,395	6.5
3	NA	NA
4	158,297	0.0
5	NA	NA
6	NA	NA
12	16,453	3.3

AFRICA

Biome	Area (km²)	Max BA %
1	2,294,889	3.1
2	98,795	13.1
3	NA	NA
4	NA	NA
5	3,790	4.8
6	NA	NA
12	44,436	4.9

WWF Biomes:

1. Tropical and subtropical moist broadleaf forests
2. Tropical and subtropical dry broadleaf forests
3. Tropical and subtropical coniferous forests
4. Temperate broadleaf & mixed forests
5. Temperate conifer forests
6. Boreal forests/taiga
7. Mediterranean forests, woodlands and scrub

AUSTRALIA

Biome	Area (km²)	Max BA %
1	18,247	7.3
2	NA	NA
3	NA	NA
4	267,517	3.6
5	NA	NA
6	NA	NA
12	121,176	3.7

EUROPE

Biome	Area (km²)	Max BA %
1	NA	NA
2	NA	NA
3	NA	NA
4	1,187,425	0.6
5	158,078	0.1
6	1,711,596	0.1
12	238,793	1.6

ASIA

Biome	Area (km²)	Max BA %
1	3,698,622	2.3
2	325,089	10.7
3	50,269	4.7
4	1,376,903	1.6
5	661,376	1.9
6	5,355,209	1.2
12	64,551	0.3

OCEANIA

Biome	Area (km²)	Max BA %
1	35,436	0.1
2	1,266	0.8
3	NA	NA
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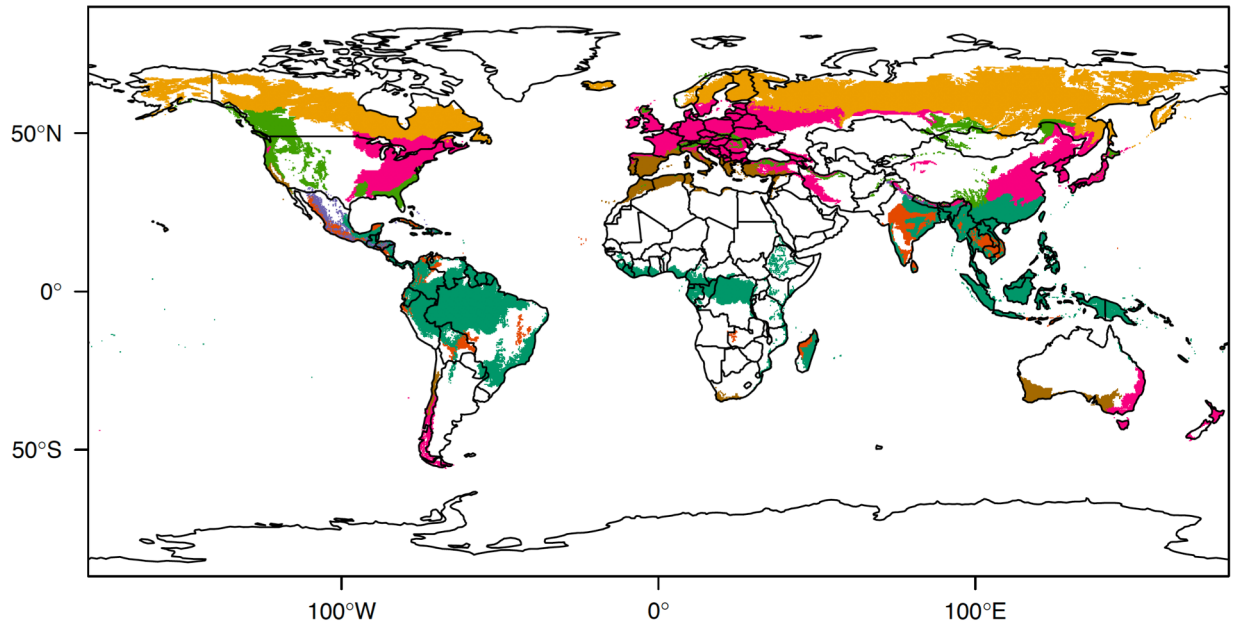

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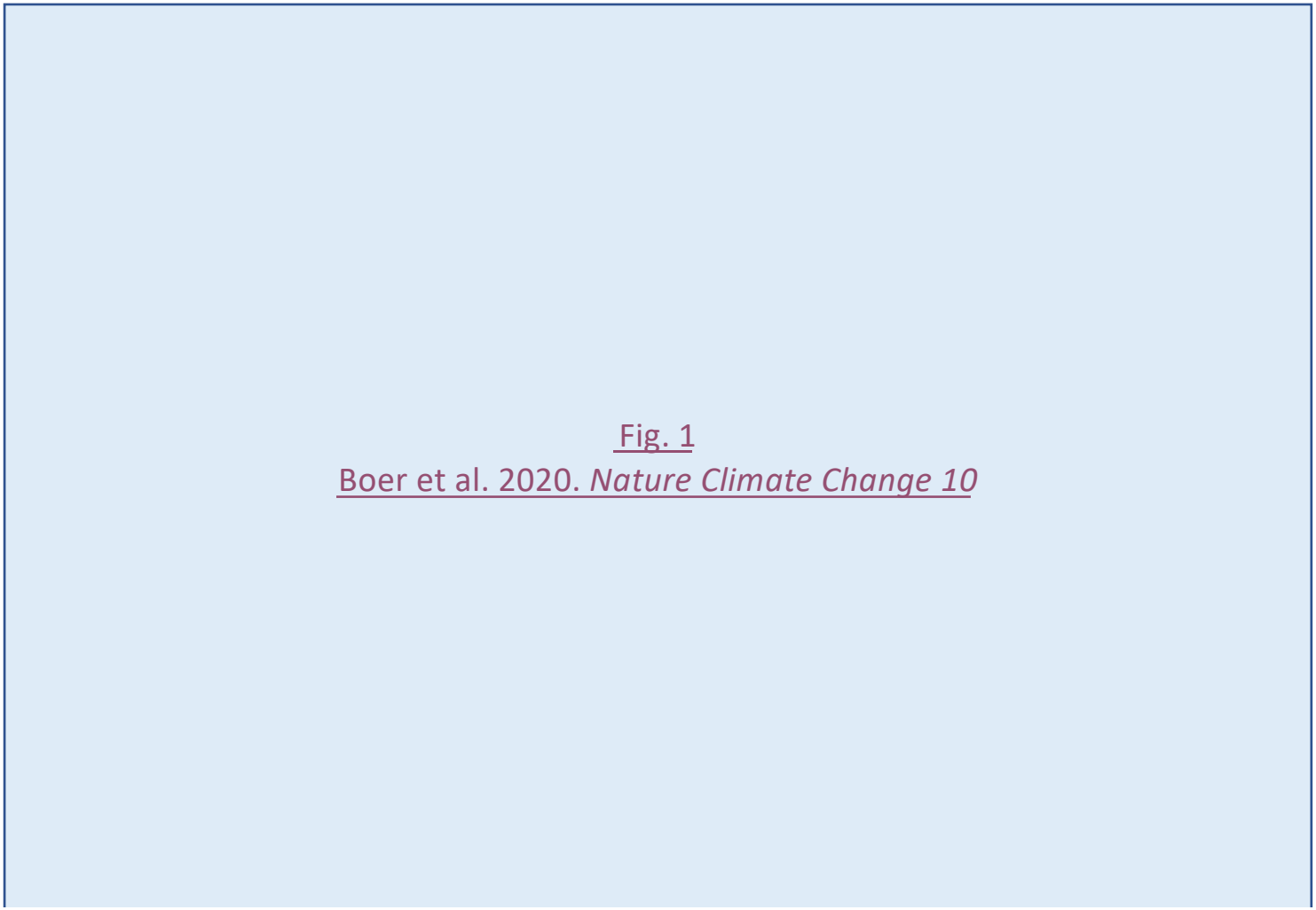

Fig. 1
Boer et al. 2020. *Nature Climate Change 10*

Fuel moisture content – the ‘on/off’ switch for forest fire

Fig. 1
Boer et al. 2017. *Earth’s Future 5(12)*

Boer et al. 2017, *Earth’s Future* 5 (12)

Fig. 2a-c
Caccamo et al. 2012. *Geophysical Research Letters 39*

According to Bradstock’s (2010) four switch concept, fire activity is a function of the frequency or probability that four fundamental constraints are overcome. In most forests there is abundant fuel, such that the moisture content of the fuels becomes the critical ’on/off’ switch for fire. The figure above shows the dry-down of forests in the Sydney basin in 2001, with subsequent fires burning preferentially in spatially continuous areas of dry fuels.

Widespread and prolonged drought set the stage for 2019/20 mega fires

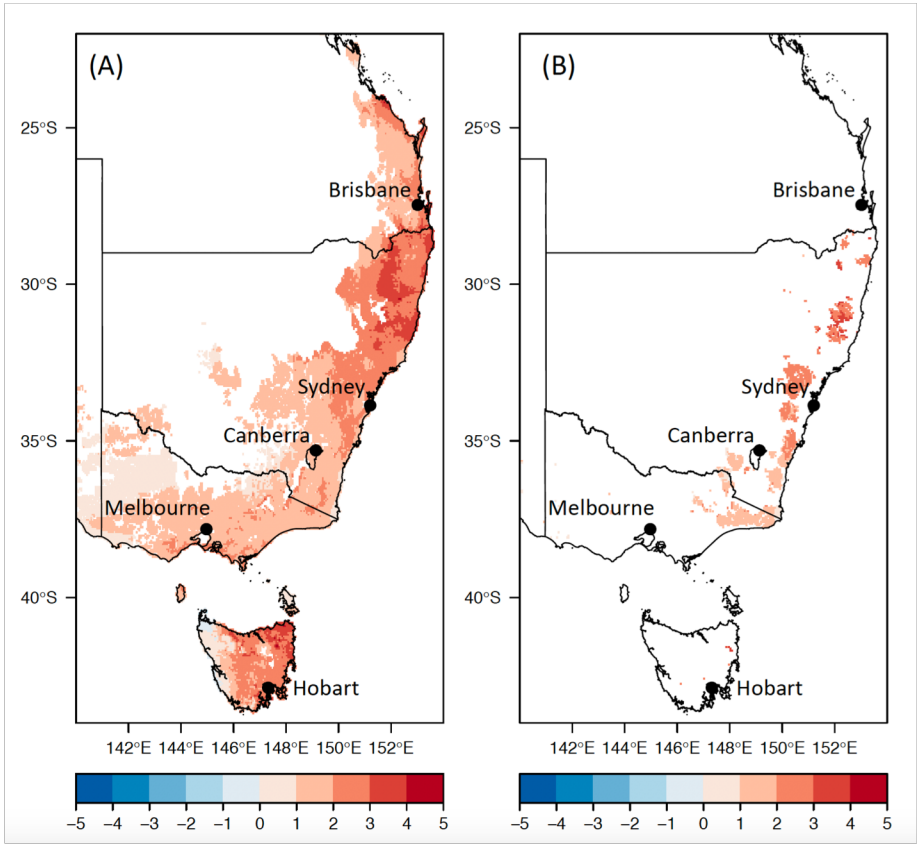

Fig. 1 | A) Z-scores of the number of days of predicted dead fuel moisture content <10% in 2019 relative to 1990-2019 reference period for all forest areas in eastern Australia, B) Z-scores for forest areas that burned during the 2019/20 mega forest fires (as of 13/01/2020). Boer, unpublished data.

Fig. 2
Boer et al. 2020. *Nature Climate Change 10*

Fig. 2 | Forest area in critically dry fuel state, eastern Australia (1990–2019). Annual variation in the duration and cumulative area of large forest patches (>100,000 ha) in a critically dry fuel state. The horizontal black line indicates the 30-year mean value; light and dark grey bands indicate mean value ± 1 and 2 standard deviations, respectively. To identify forest areas in a critically dry state, spatially explicit predictions of fine dead fuel moisture content (DFMC) were based on gridded daily vapour pressure deficit (Resco de Dios et al. 2015) , and a threshold of DFMC <10% was used (Nolan et al. 2016).

Boer et al. 2020. *Nature Climate Change* 10


Greetings from the Blue Mts (NSW)
~ 4 months post-fire