Dynamic fire propagation and extreme wildfire development

Prof. Jason Sharples – School of Science, UNSW Canberra and Bushfire and Natural Hazards CRC

France & Australian Bushfire Science Workshop, 15-17 September 2020.

Photo: Stephen Wilkes

Blow-up fires and extreme wildfire development

The South Canyon Fire on Storm King Mountain in Colorado 1994 claimed the lives of fourteen wildland firefighters. The fire burn about 900 ha.

Blow-up fire*

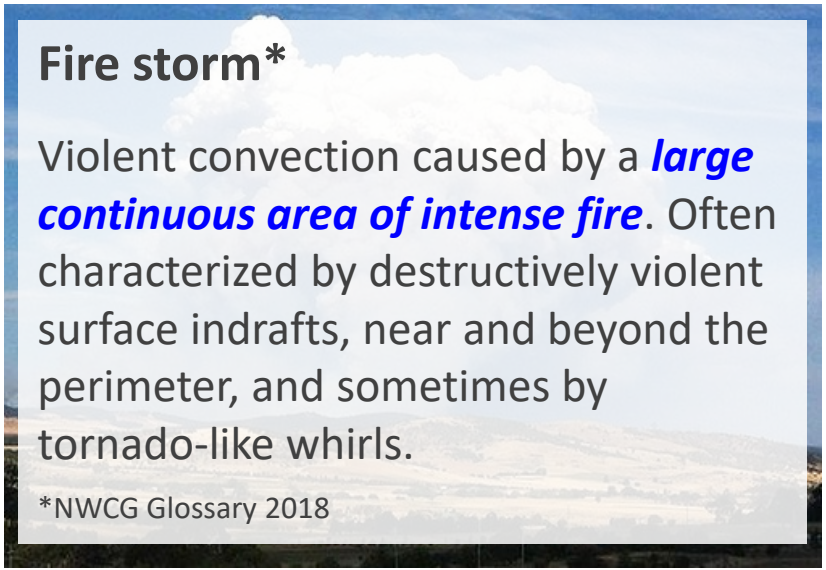
Sudden increase in fireline intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans. Often accompanied by violent convection and may have other characteristics of a fire storm.

Blow-up almost always occurs due to some form of dynamic fire propagation.

*** National Wildfire Coordinating Group Glossary of Wildland Fire, 2018**

UNSW CANBERRA

Blow-up fires and extreme wildfire development



Fire storm*

Violent convection caused by a ***large continuous area of intense fire***. Often characterized by destructively violent surface indrafts, near and beyond the perimeter, and sometimes by tornado-like whirls.

*NWCG Glossary 2018

The Forcett-Dunalley Fire in Tasmania 2013 destroyed the township of Dunalley and affected many others. The fire burnt around 20,000 ha.

Extreme wildfire†

A fire that exhibits ***deep or widespread flaming*** in an ***atmospheric environment conducive*** to the development of violent pyroconvection, often manifesting as towering pyrocumulus (pyroCu) or pyrocumulonimbus (pyroCb)

This involves a ***coupling of the fire with the atmosphere*** well above the mixed layer, which modifies or maintains the fire's propagation (e.g. mass spotting, lightning).

† Sharples et al. (2016) Natural hazards in Australia: extreme bushfire. *Climatic Change*, 139: 85-99

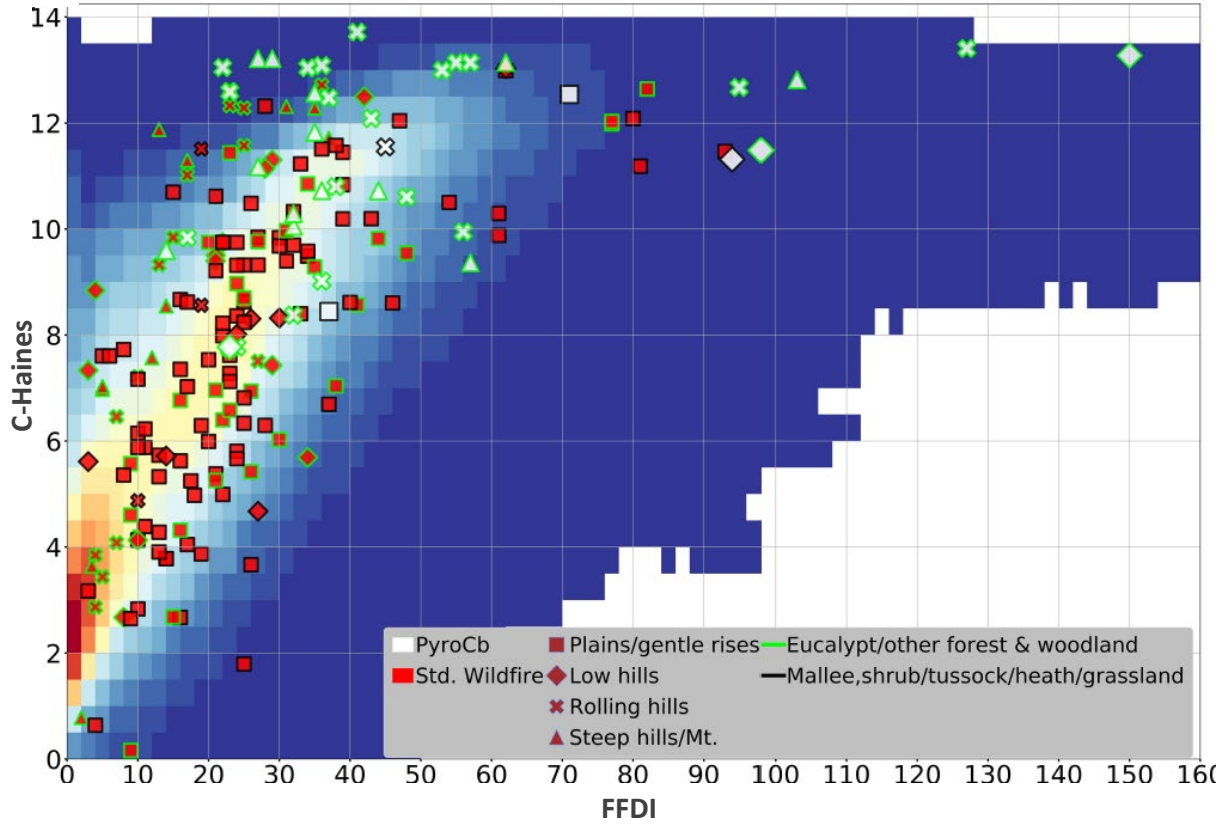
UNSW CANBERRA

Blow-up fires and extreme wildfire development

Important notes:

- Extreme wildfires will comprise one or more blow-up fire events, but not all blow-up fire events develop into extreme wildfires;
- Not all pyrocumulonimbus events qualify as extreme wildfires;
- Mega-fires are very large requiring a large commitment of suppression resources for an extended (campaign) period. They are borne out of long-term changes to the state of vegetation across key landscapes, as well as changes in fire management and suppression doctrine.
- **Extreme wildfires and mega-fires are not related beyond the fact that mega-fires may exhibit extreme wildfire characteristics on an episodic basis...**

Understanding extreme wildfire development



Data comprises 206 fires in SE Australia between 1990-2016.*

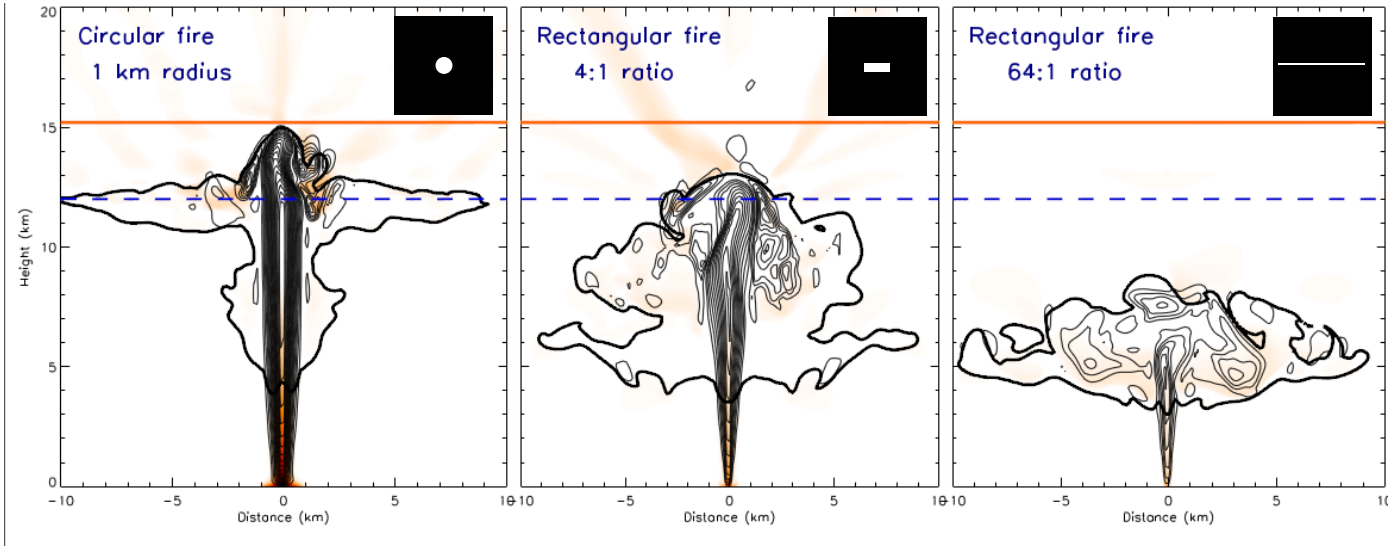
- 40 confirmed as pyroCb
- 166 non-pyroCb (Std. Wildfire)

*Di Virgilio et al. (2019) *Geophysical Review Letters*

UNSW CANBERRA

Understanding extreme wildfire development

- McRae et al. (2015) demonstrated a spatiotemporal link between regions of deep flaming produced by dynamic fire behaviours and strong pyroconvection.
- Badlan et al. (2020) further confirmed the link using numerical modelling…



McRae et al. (2015) *Natural Hazards and Earth System Science*
Badlan et al. (2020) *International Journal of Wildland Fire*, Under review.

UNSW CANBERRA

Understanding extreme wildfire development

Triggers of deep flaming

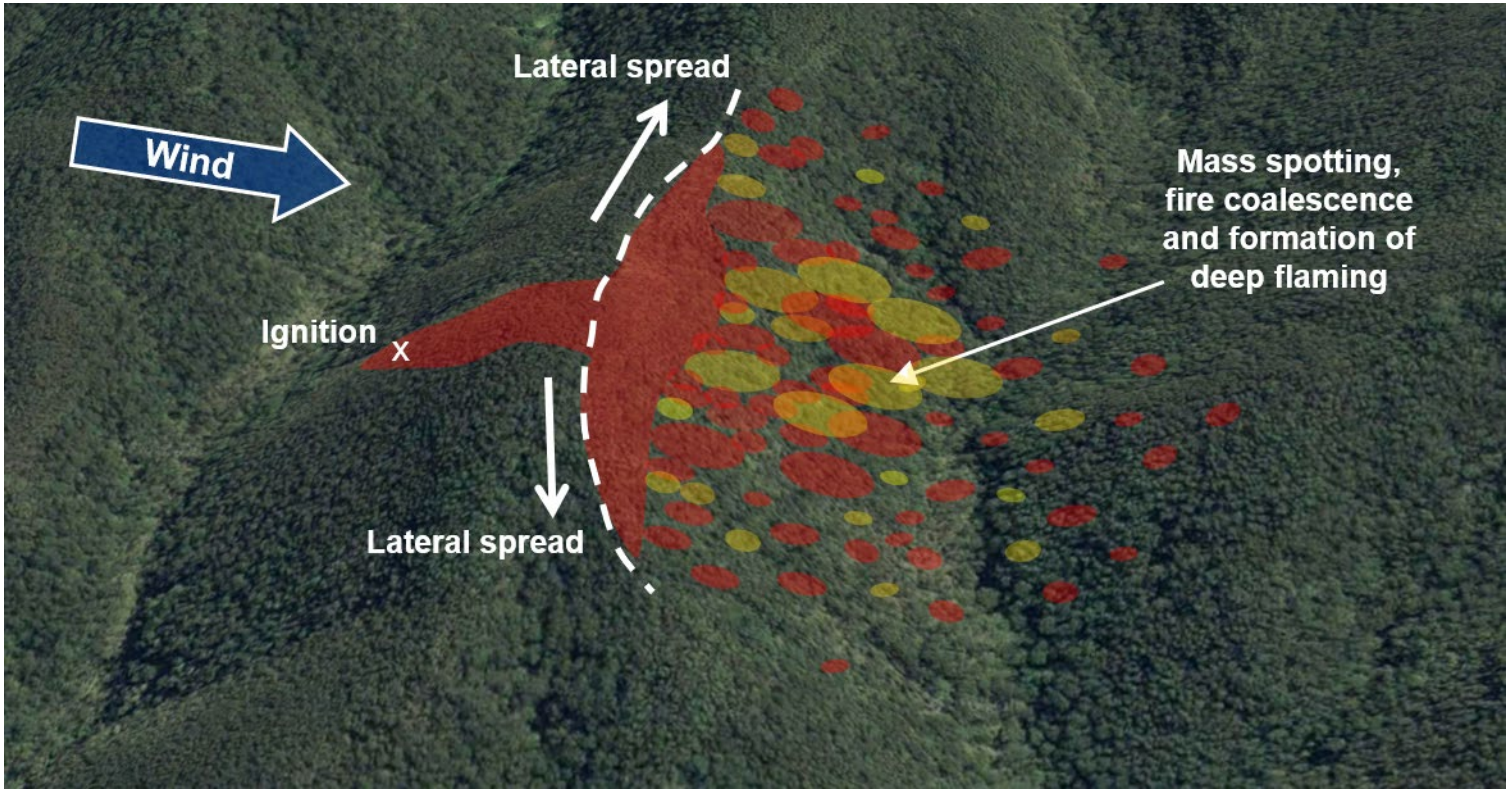
- Strong winds
- Wind change
- Vorticity-driven Lateral Spread (VLS)
- Mass spotting and fire coalescence
- Fire eruption
- 'Overzealous' use of incendiaries

Involve dynamic fire propagation...

- feedbacks between the fire and the environment
- subject to threshold behaviour

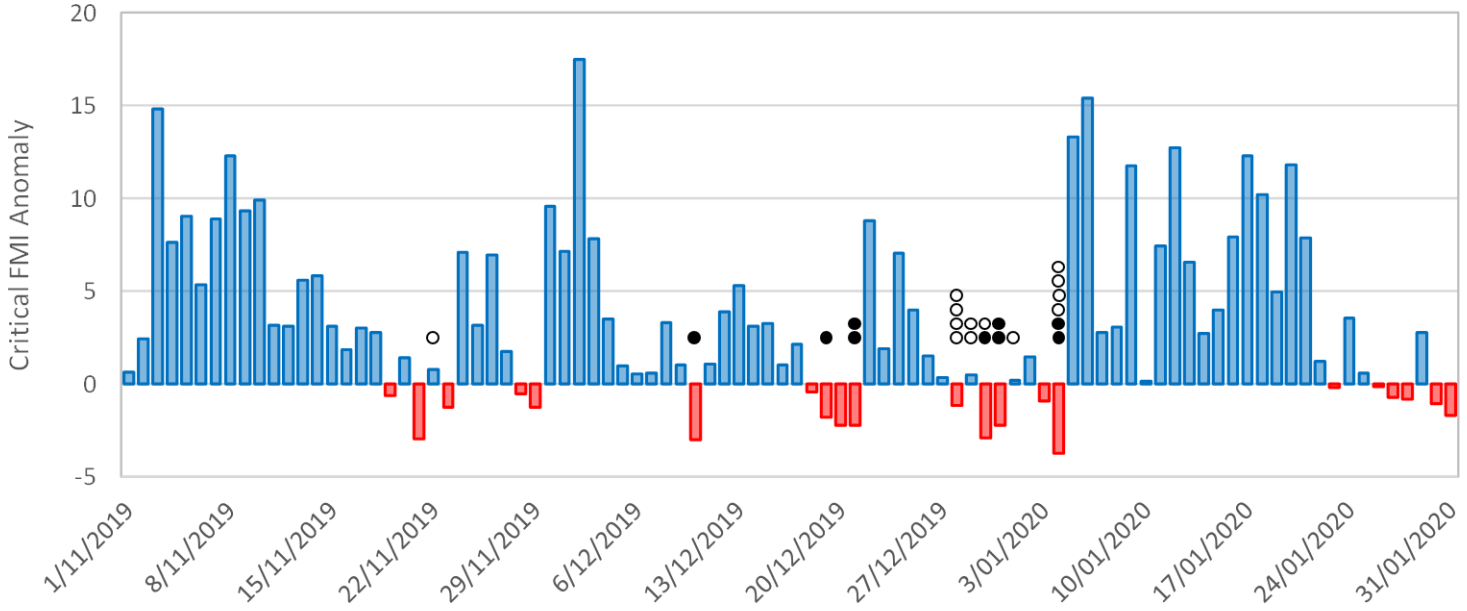
Currently there is poor operational capacity to account for these behaviours!!!

VLS and extreme wildfire development



VLS and extreme wildfire development

Fuel moisture and extreme wildfire development



The critical FMI anomaly plotted here is: $\Delta^c FMI = FMI - 5$, where $FMI = 10 - 0.25(T - RH)$.