Green Wattle Creek fire flare up, NSW December 2019

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The 7.30 Report ran this story the other night, presumably to show how dangerous the bushfire workplace is. The flare-up was spectacular but it was not a danger to the fire fighters because it rose and fell in the one place, and they had ample options to make safe distance.
https://www.abc.net.au/7.30/professional-fire-crews-pitch-in-to-help/11790776

However, this footage reveals more important things, things that can benefit us in property protection. But first we need to understand some core bushfire behaviour principles, eg, – (1) Flame on a given site burns according to the fuel bed that is on site. [A site with no fuel has no flame. A site with low fuel has a low flame. A site with tall undergrowth has tall flame with superheated convection that can ignite from below the eucalypt leaves that clump in the crowns.] (2) High density ember attack is an expected part of a bushfire attack where the mother flame is close. (3) Embers can only ignite in a flammable fuel bed. (4) Bushfire flame starts in surface fuel (on the ground) and spreads in continuous surface fuel bed. (5) Flame spreads horizontally through surface fuel bed and rises vertically through vertical fuel bed layers. (6) Duration of tall flash flame on a site (= residence time) is a few seconds, duration of shorter smoulder flame is much longer.
Let's look for these principles in the following sequential stills. Maybe we self-defenders can learn something.

#abc730

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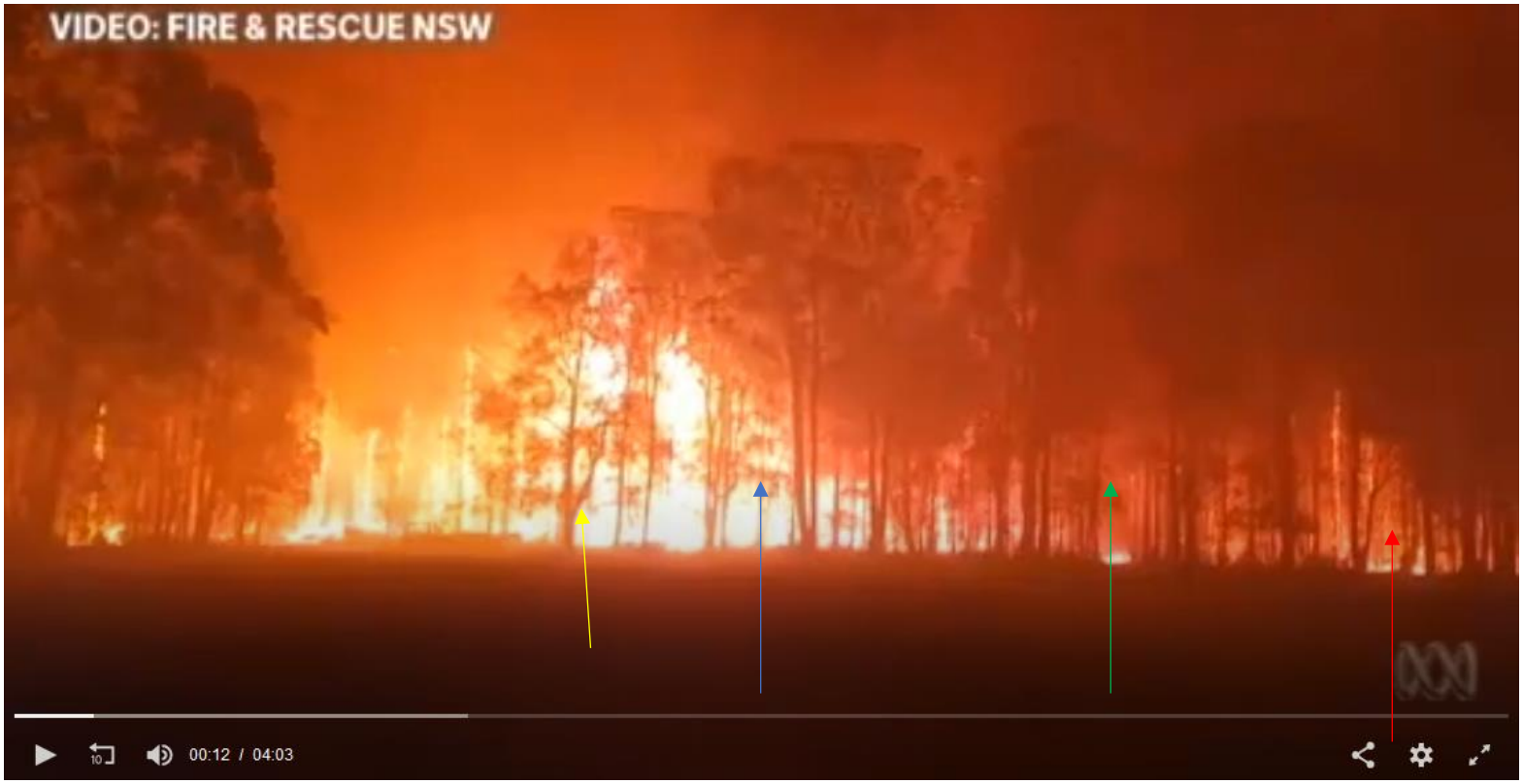
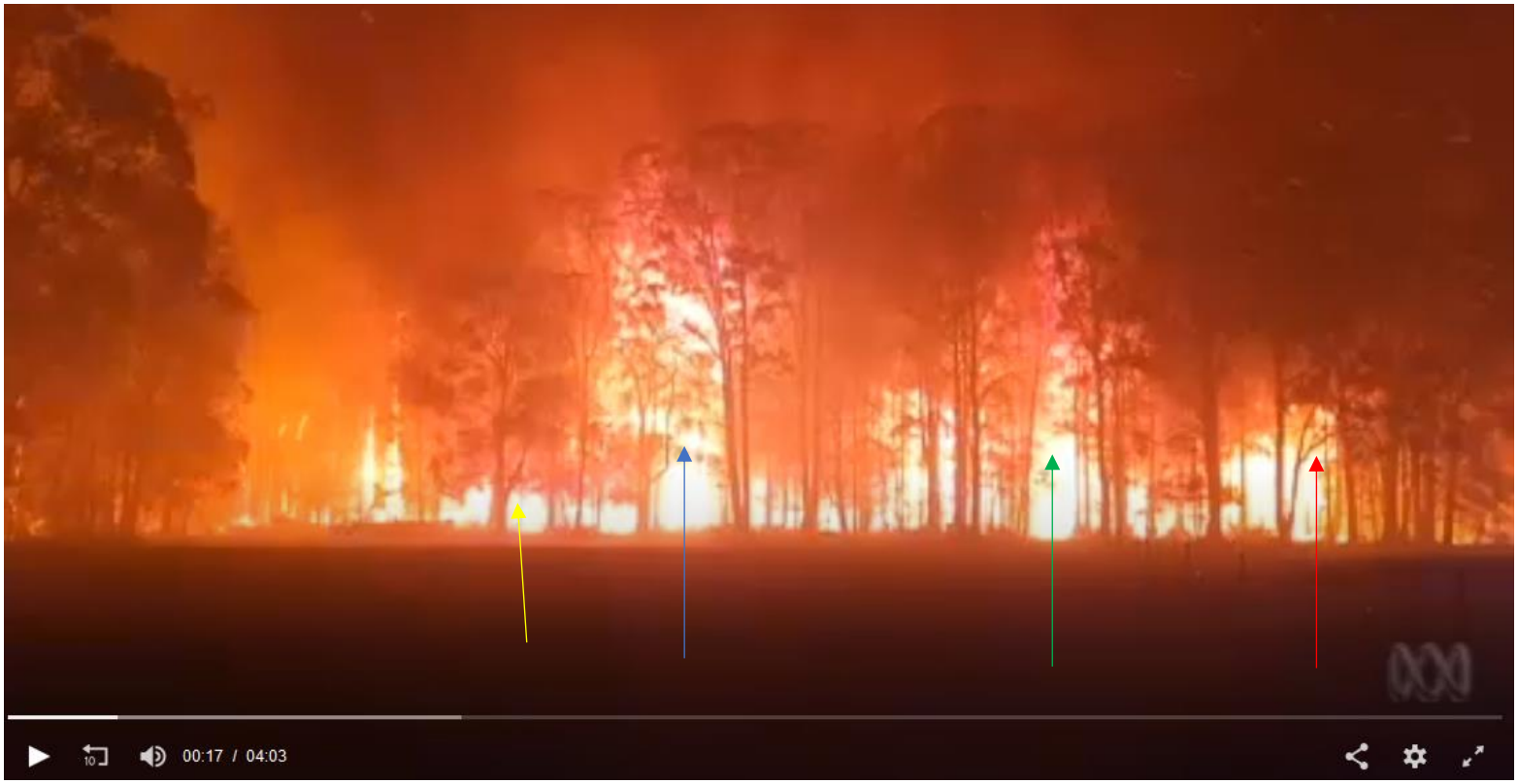


This flame is a narrow spot fire or a leading tongue of a wider fire front that has already spawned two or three spot fires to its right, and is now running into a patch of taller undergrowth.
Flame at blue arrow is 6m tall, and flame just to its left is 10m tall, each burning in tall undergrowth on site.
Flames at green and red arrows are small spot fires.
Yellow arrow is a foreground tree in paddock.



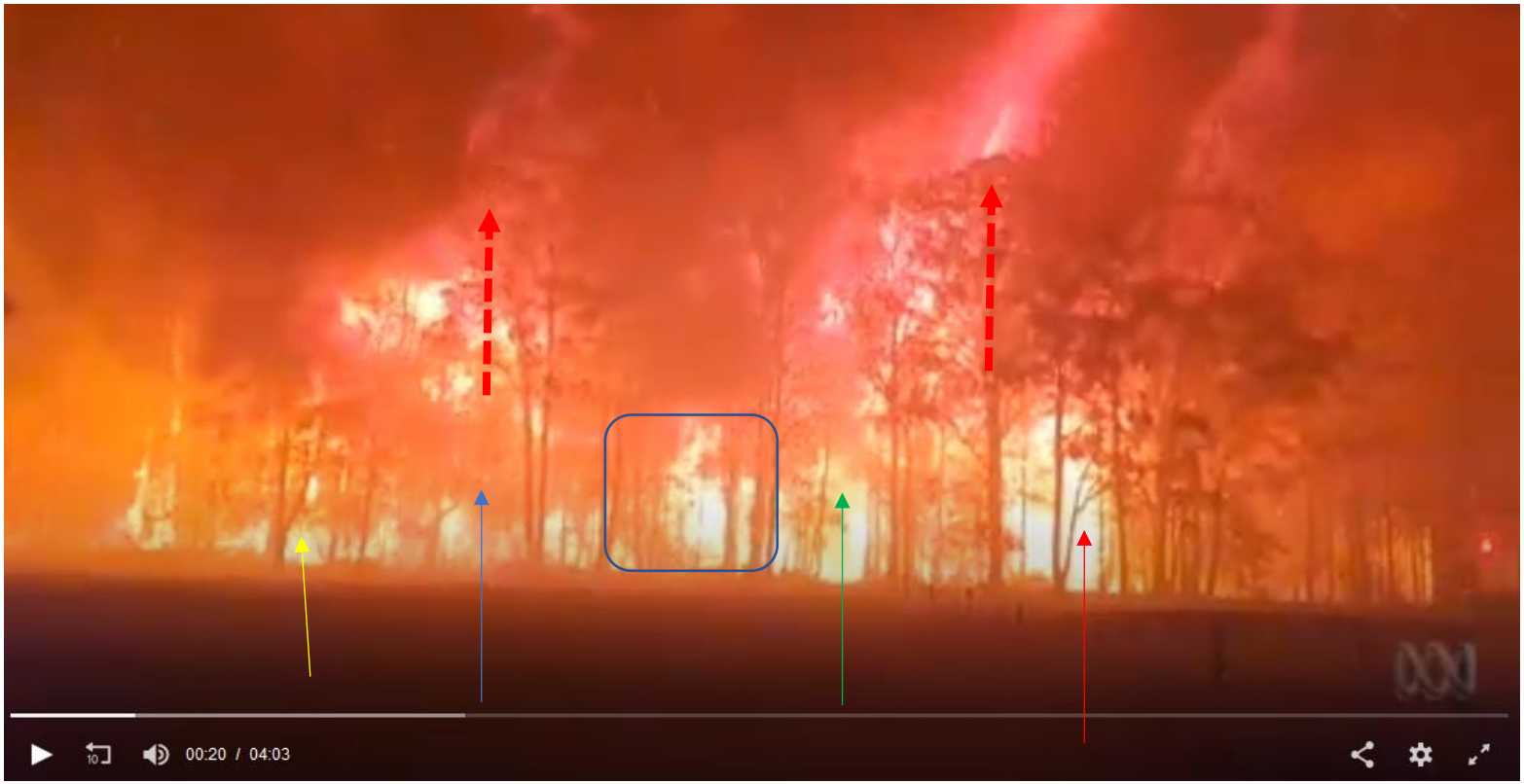
The terrain here is not known to me. Based on subsequent flame growth, this flame is either rising up a steep slope and / or entering a patch of thicker taller undergrowth in the adjacent forest. The narrow front is probably travelling diagonally left to right. Note, there are no embers in foreground, meaning the fire's front is not travelling towards camera, the flank is.

Behind blue arrow, flame is now 10+m tall, probably in a 6+m tall undergrowth patch. Flames at green and red arrows are a bit shorter.

I suspect flames on left-side of blue arrow are flank flames burning with approx 2 - 3m flame height in 1 m tall undergrowth, still within the adjacent forest.

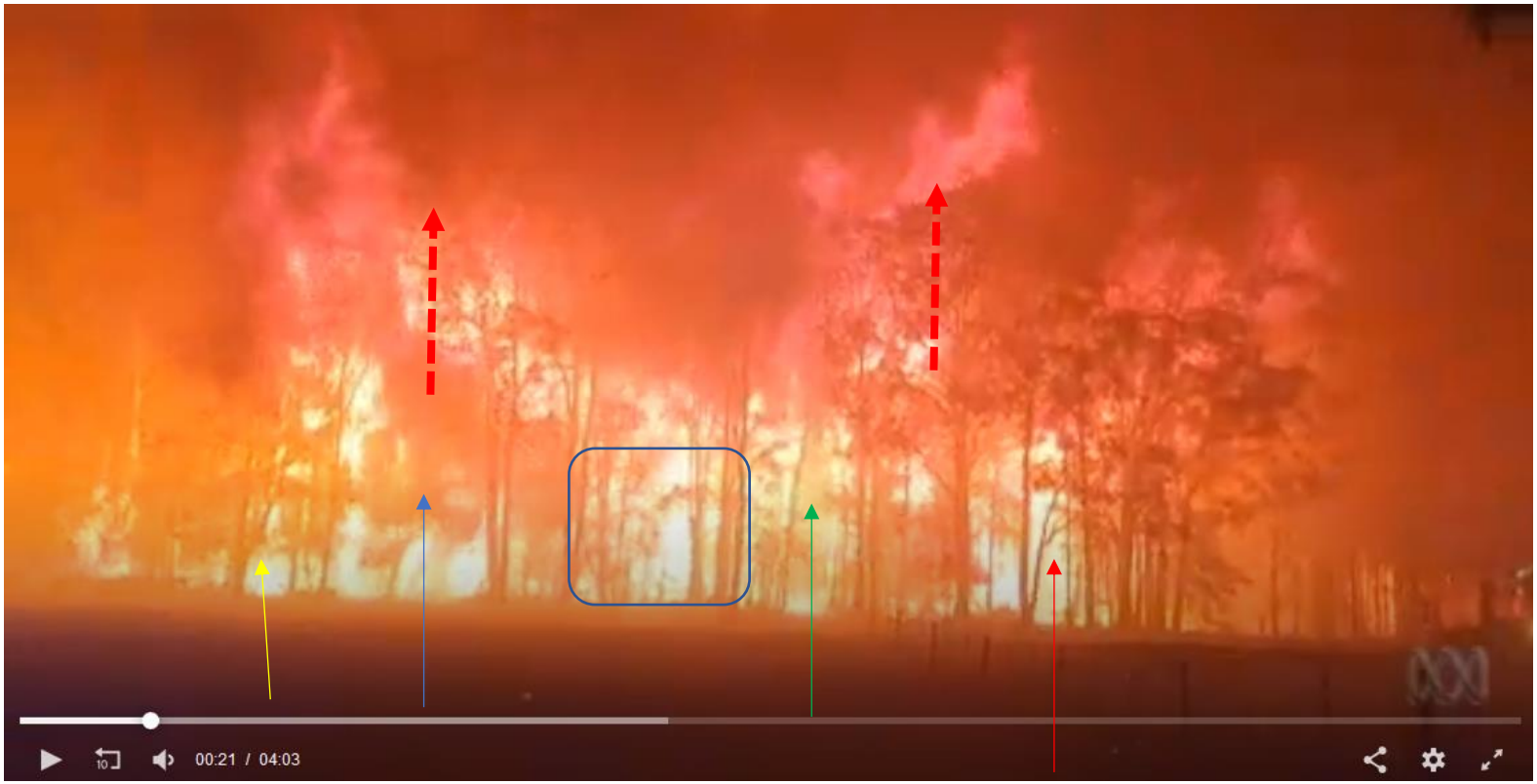
In the foreground, there is a nice wide paddock with minimal fuel on ground (black in the picture). But we see in next pics how flammable it is.

The foreground trees on this property are approx 20m tall, with short undergrowth beneath.

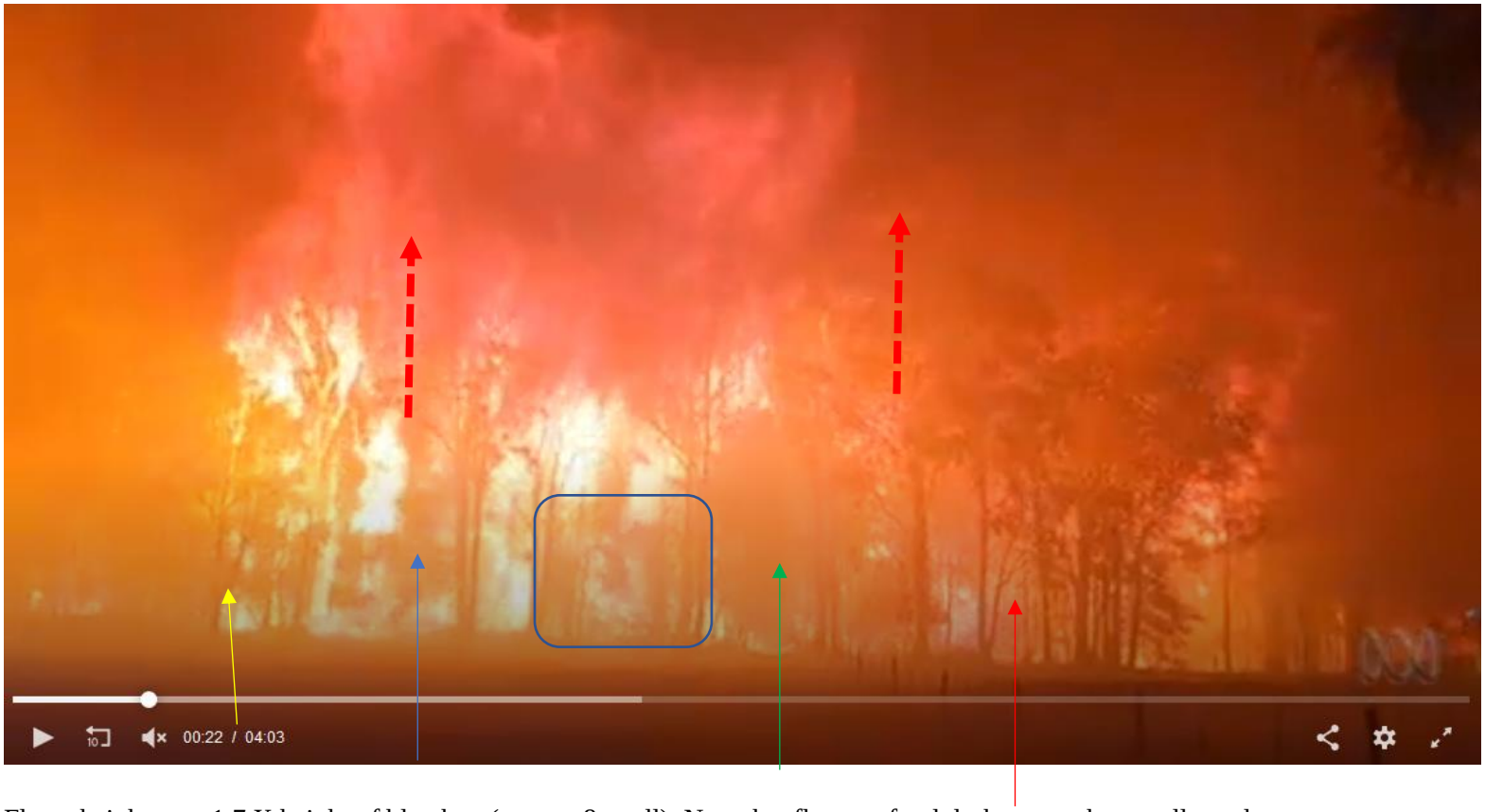


3 sec later, the 10m flame at blue arrow has subsided and returned to ground. Flame at green arrow is taller because it has hit taller denser undergrowth whose convective heat has now ignited clumps of live leaves in the canopy. Flame at red arrow is taller than before.
I suspect there are two spot fire fronts – red dash arrows, and they are about to merge.
Rounded blue box is flame height in probable junction zone at 20 sec.
The flames are behind the foreground trees, but getting closer. Flames are getting closer to yellow arrow tree.
Fire is spreading laterally via flank fire expansion towards the camera in continuous fuel bed.

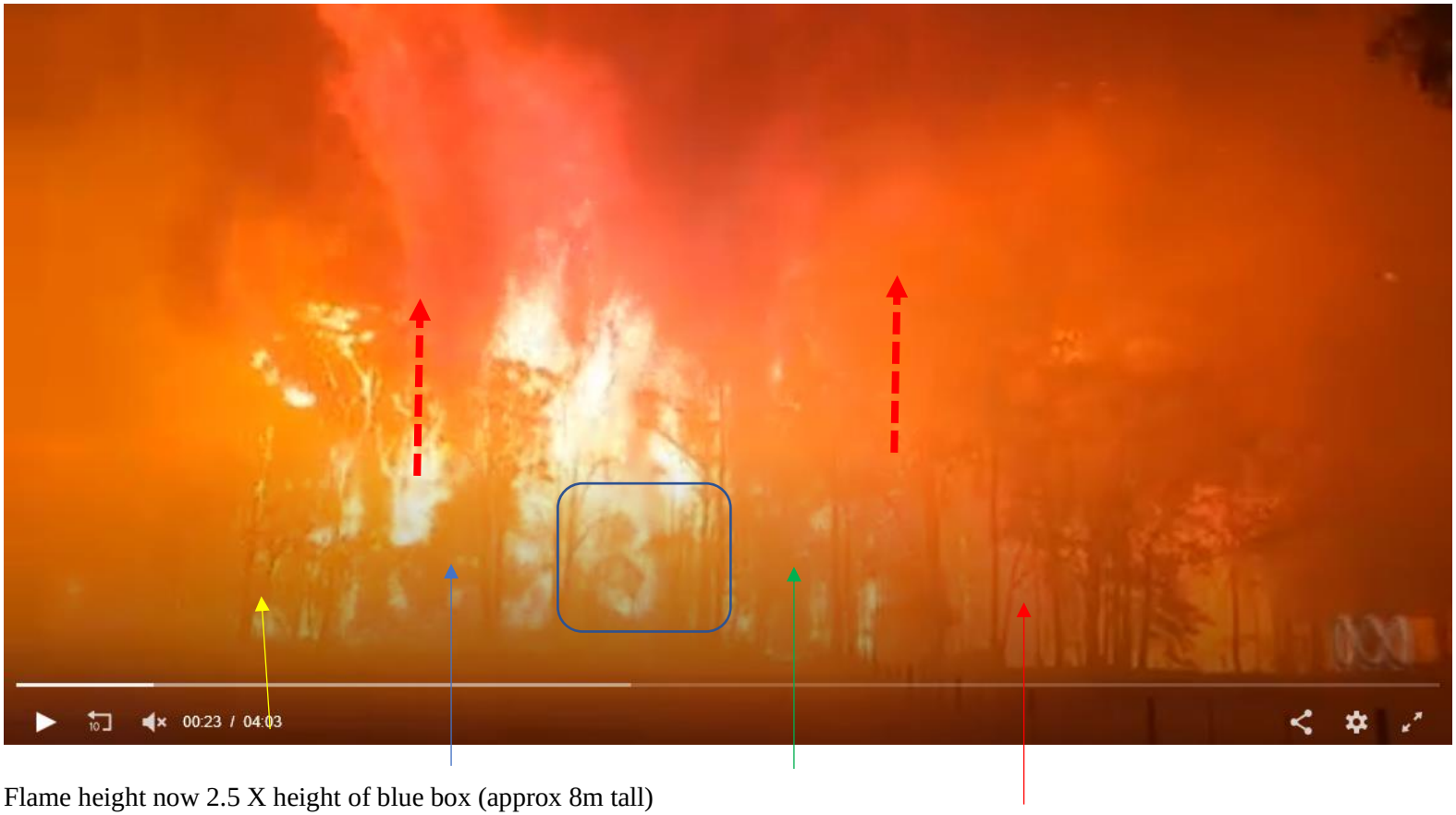
Note how the tall flames rise up from the ground and then fall down to the ground.
Note how the tall flames do not spread horizontally through elevated fuel bed layers unless flame base is connected to the surface fuel bed.



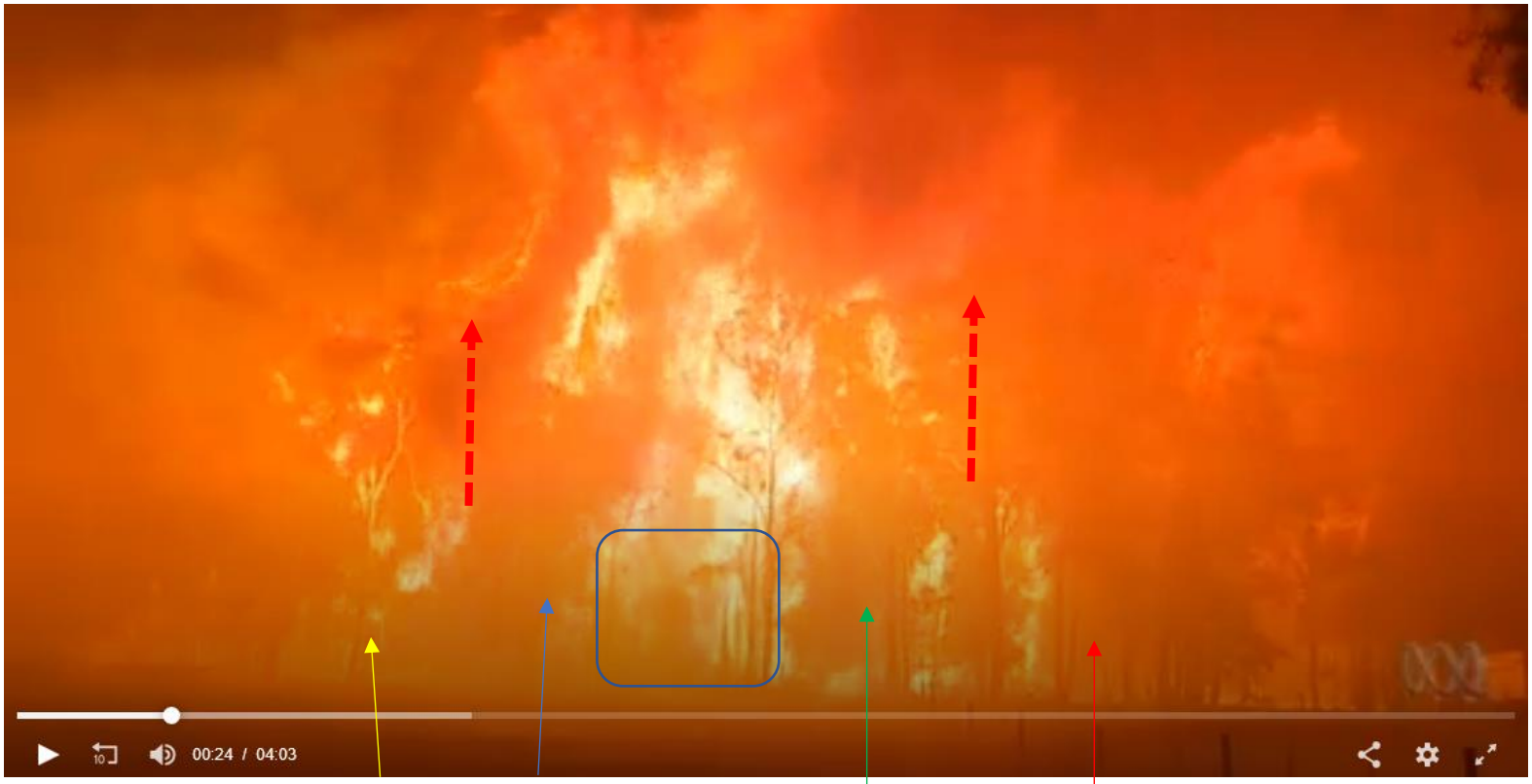
Flame height in probable junction zone now 1.5 X height of blue box (approx 8m tall)



Flame height now 1.7 X height of blue box (approx 8m tall). Note that flames of red dash arrows have collapsed.

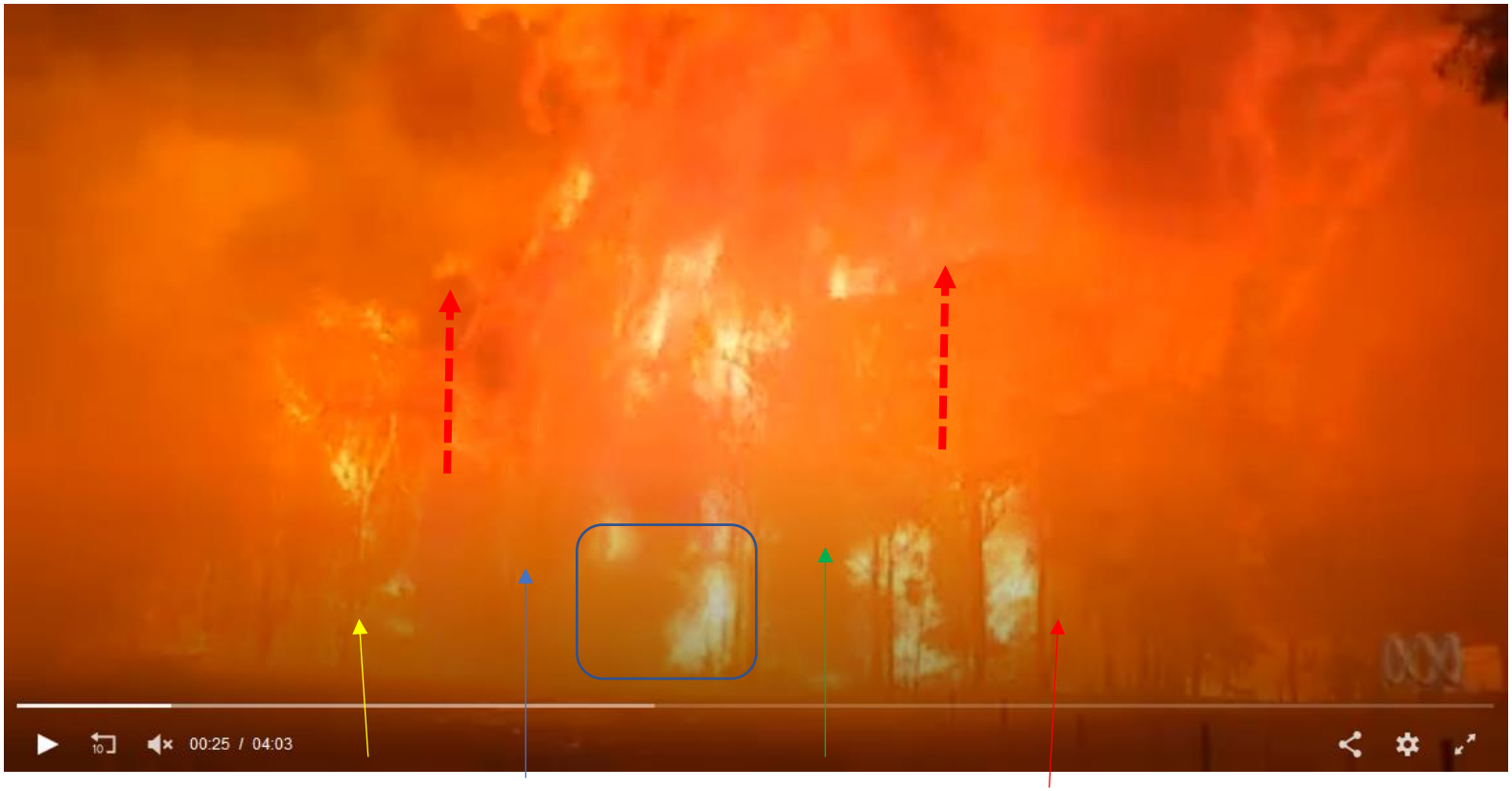


Flame height now 2.5 X height of blue box (approx 8m tall)

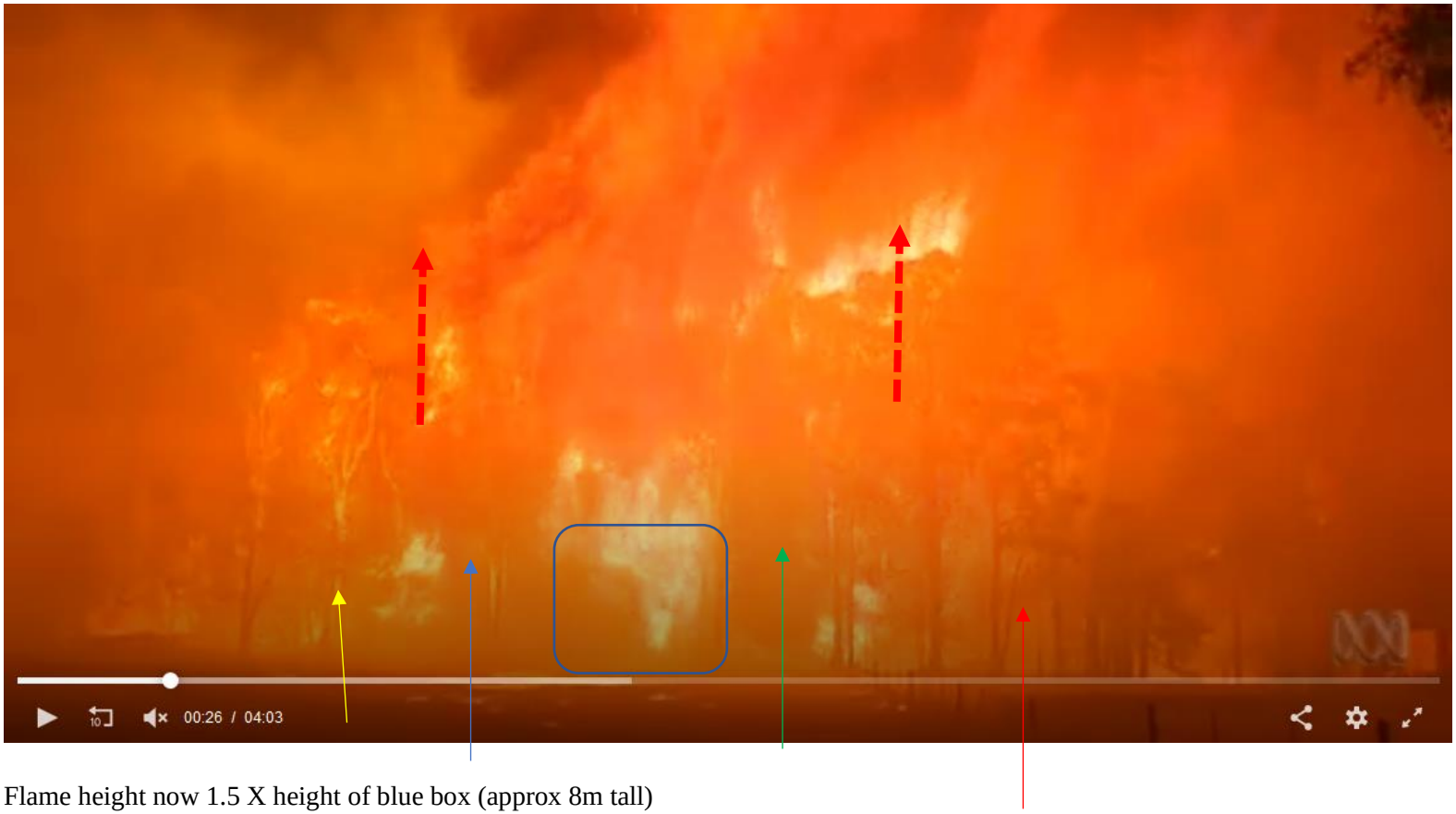


Yellow arrow tree now alight via flammable trunk and branches, lit from surface flame beneath. Flame behind yellow arrow has expired. More canopy ignitions behind blue arrow. Tall flame behind green arrow has expired.

Flame height now 3 X height of blue box (approx 8m tall)

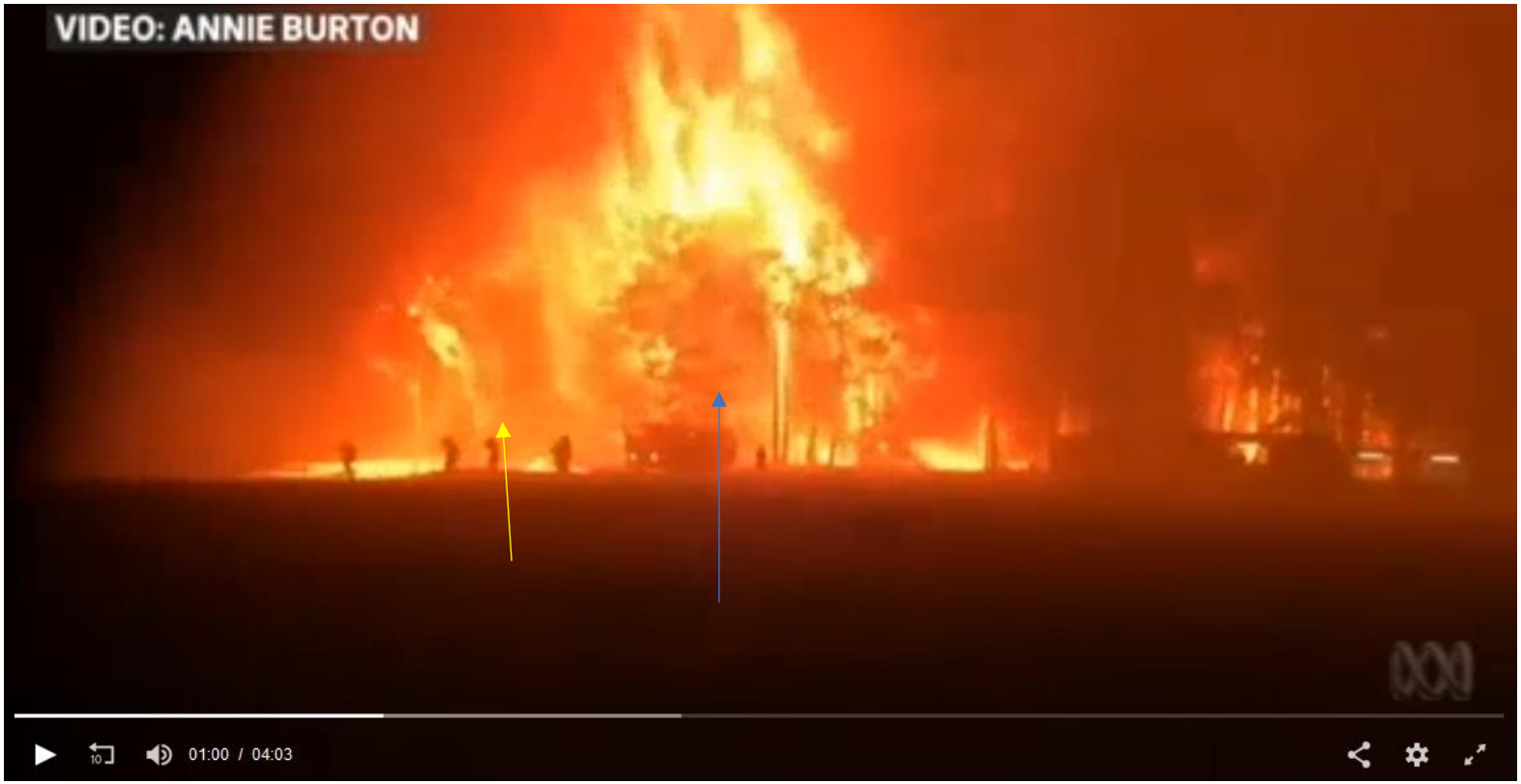


Flame height now 3 X height of blue box (approx 8m tall), but central bit has collapsed. Top bit of flame is separated flame bubble.



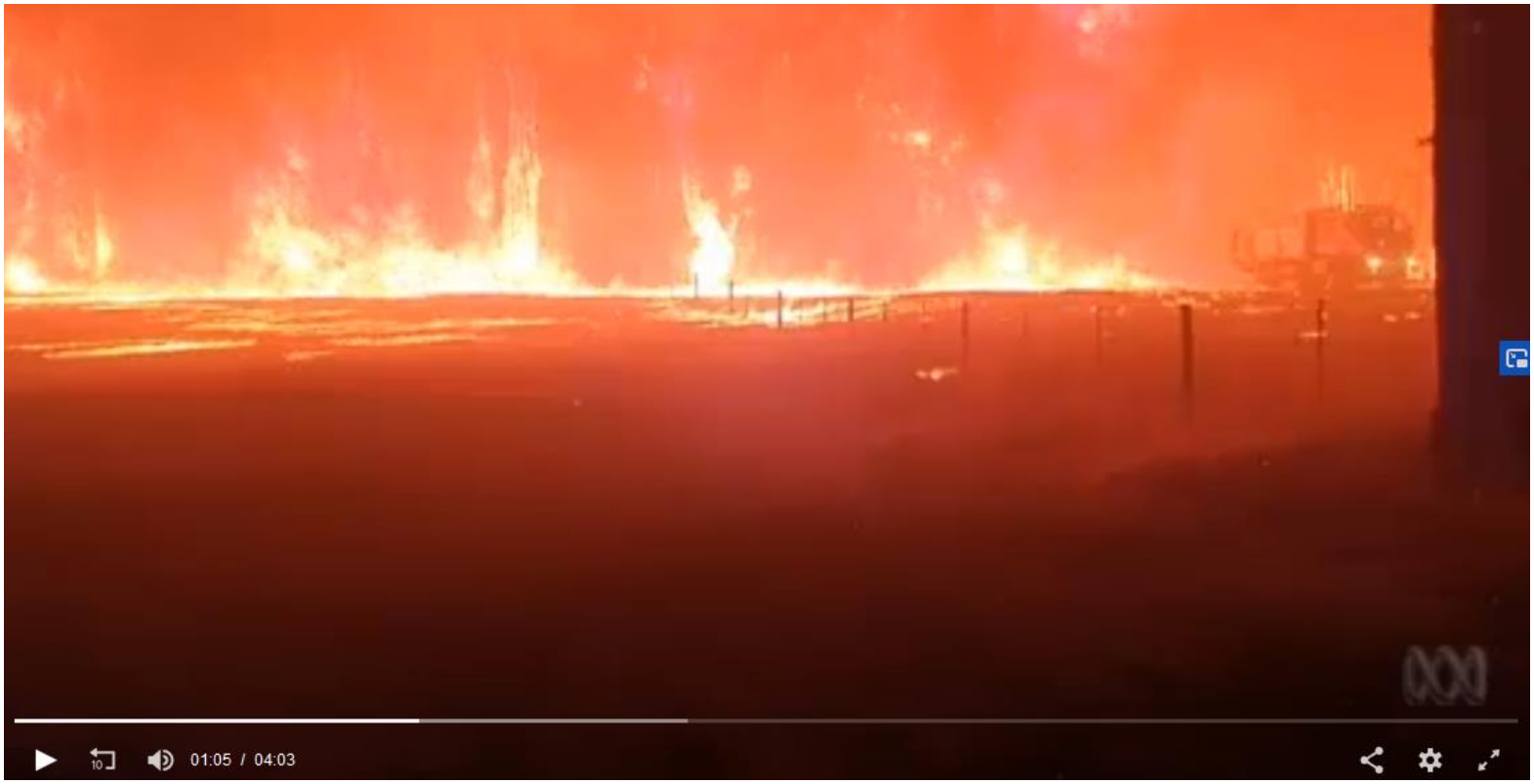
Flame height now 1.5 X height of blue box (approx 8m tall)

Between 22sec and 26 sec, flame height doubles (at 24sec) then falls to original level. The speed of rise and collapse suggests a non-fuel cause such as flame merging or trenching (= flame attachment) up a steep slope.
[Explanation - if flame height doubles because of foliage in the canopy, the flame will last at least 10-15 sec till the leaves burn out.]

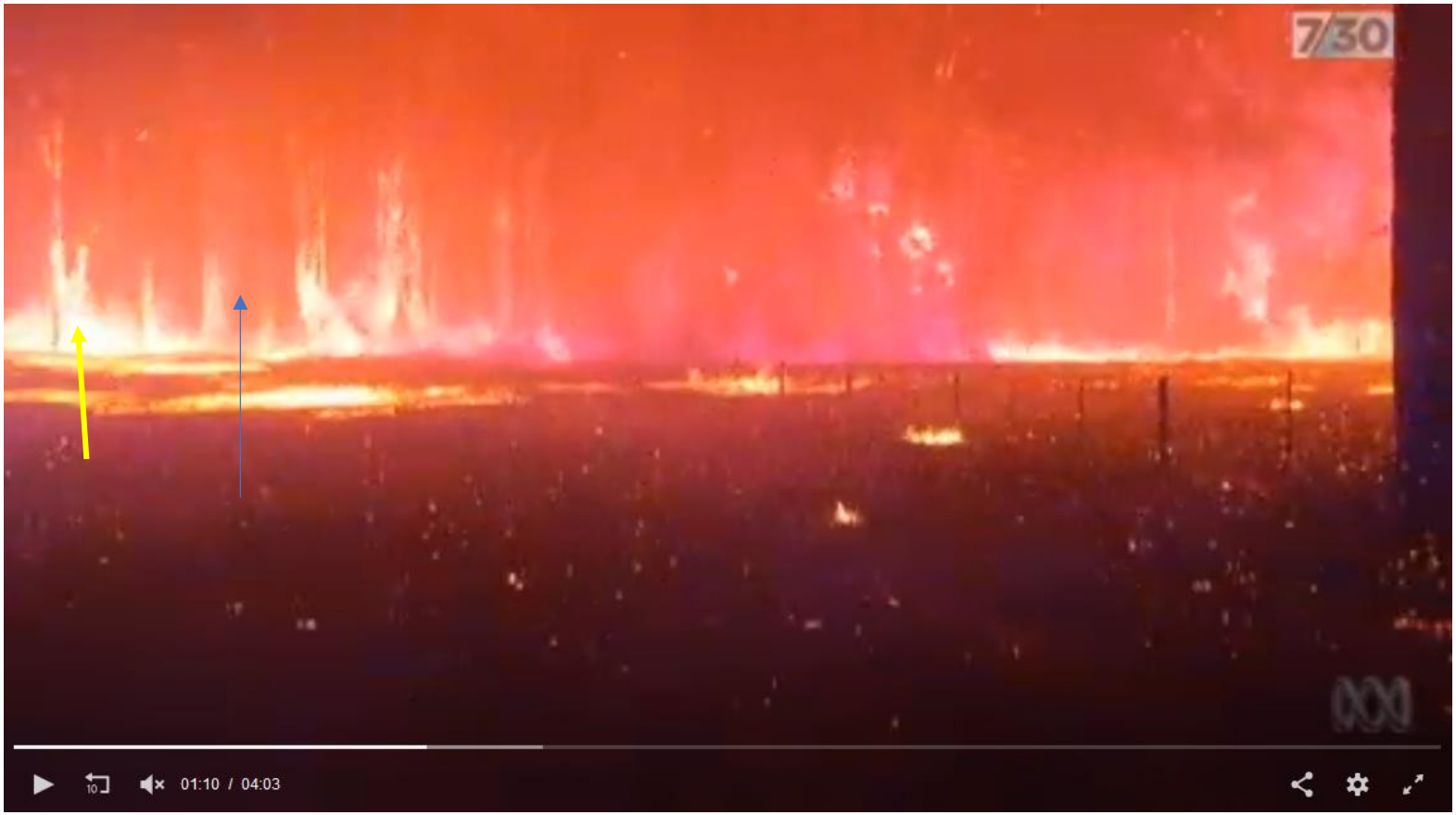


Foreground trees have flame spikes up the trunks, (lit by surface flame of flank fire that is spreading laterally towards camera). Some trees have ignited the clumps of canopy leaves. Fire truck appears close to the flare-up, may have felt some radiation as troops withdraw. Halo of flame in canopies in behind blue arrow requires tall flame underneath.
Still no embers in the black paddock

This video probably corresponds with T = 24 sec screen-shot above.



Flame height 1m or so in short undergrowth beneath trees. Trunk flame spikes. Flames in canopy have expired.
Low carpet flames in short grass of paddock, were lit by a dump of embers from nearby mother flame from the left.
Once burnt out, the burnt area cannot ignite again. Spot fires can be our friend.
Fire is spreading laterally via flank fire expansion towards the camera in continuous fuel bed.



Five seconds later, residual burning persists in low shrubs and tree trunks. Carpet flames spread in wide paddock
Another dump of embers is occurring now from left side, igniting short grass immediately. Probably originates from a new spot fire front a bit closer to the camera. Easy to spray out when small, but there are a lot over a large area.
Fire is spreading laterally via flank fire expansion towards the camera in continuous fuel bed.

What can we learn?

(1) Flame on a given site burns according to the fuel bed that is on site. [fuel bed comprises surface fuel bed, and elevated layers]

A variety of flame heights, but flame height on each site depends on its fuel bed.

We see short carpet flames in the short grass paddock.

We see tall trunk flame spikes.

We see tall flames in undergrowth that is proportionately tall.

We see ignition of multiple clumps of eucalypt leaves by superheated convection from tall flames below.

We see low height / longer duration smoulder flames on the ground after the flash flame in the undergrowth subsides

Learning point If fuel bed has no fuel on ground, it will have no flame.

(2) High density ember attack is an expected part of a bushfire attack where the mother flame is too close.

We see two high density ember dumps into the paddock from close mother flames.

Learning point: If site of mother flame is fuel reduced, ember generation is curtailed.

(3) Embers can only ignite in a flammable fuel bed.

The wide foreground of short grass is flammable and continuous. When dumped on by high density embers, many ignited and spread with low flame. Truck was wise to move because there was no fuel free safe area. Fire fighters could have found refuge in burnt out patches, but better strategy for self defence is a pre-prepared fuel free area.

Learning point: If the embers land on a non-flammable area, there is no ignition.

(4) Bushfire flame starts on the ground in surface fuel bed and spreads in continuous surface fuel bed

We see spot fire flames in paddock enlarging because fuel bed is continuous.

We see the fire spread laterally by the flank fire from the adjacent forest into the paddock.

Learning point: Fuel free areas on the ground prevent expansion of surface flames, without need for suppression.

(5) **Flame spreads horizontally through surface fuel bed and rises vertically through vertical fuel bed layers.**

Flame spreads horizontally through elevated fuel beds only if flame spreads horizontally through surface fuel bed below.

Learning point: Remove surface fuel from a site to prevent tall flame spread in elevated fuel layers above that site

(6) Duration of tall flash flame is shorter than smoulder flame

Smoulder flame burns hotter for longer in larger diameter sticks, is at ground level, has smaller but hotter flame, kills cambium if at base of tree, bakes soil to few cm depth.

Learning point: Damage is prevented by removal of fuel piles.