



The Kilmore East fire, 7 February 2009: behaviour and spread

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Anatomy of a catastrophic wildfire: The Black Saturday Kilmore East fire in Victoria, Australia

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ABSTRACT

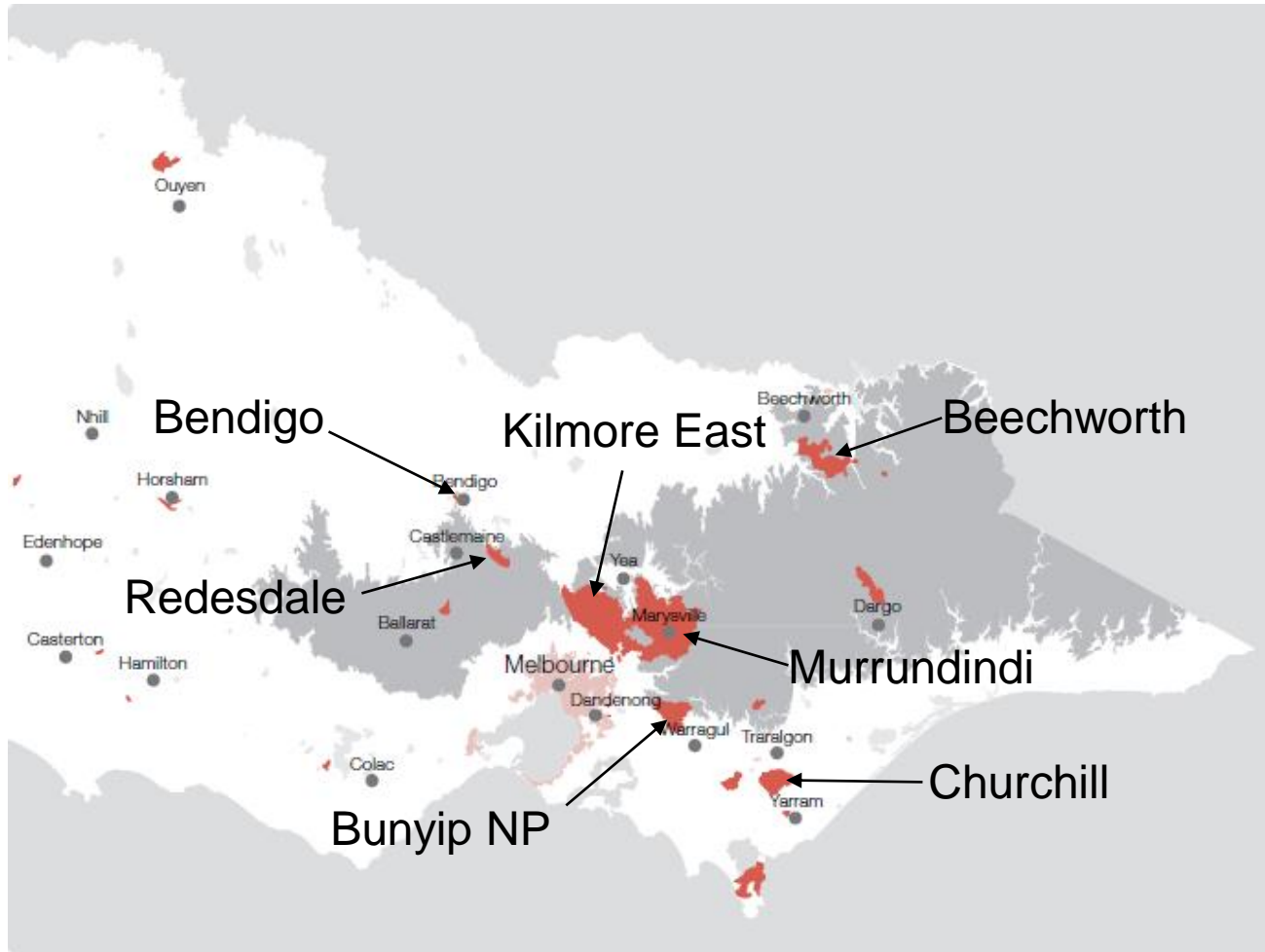
The 7 February 2009 wildfires in south-eastern Australia burned over 450,000 ha and resulted in 173 human fatalities. The Kilmore East fire was the most significant of these fires, burning 100,000 ha in less than 12 h and accounting for 70% of the fatalities. We report on the weather conditions, fuels and propagation of this fire to gain insights into the physical processes involved in high intensity fire behaviour in eucalypt forests. Driven by a combination of exceedingly dry fuel and near-gale to gale force winds, the fire developed a dynamic of profuse short range spotting that resulted in rates of fire spread varying

Black Saturday fires

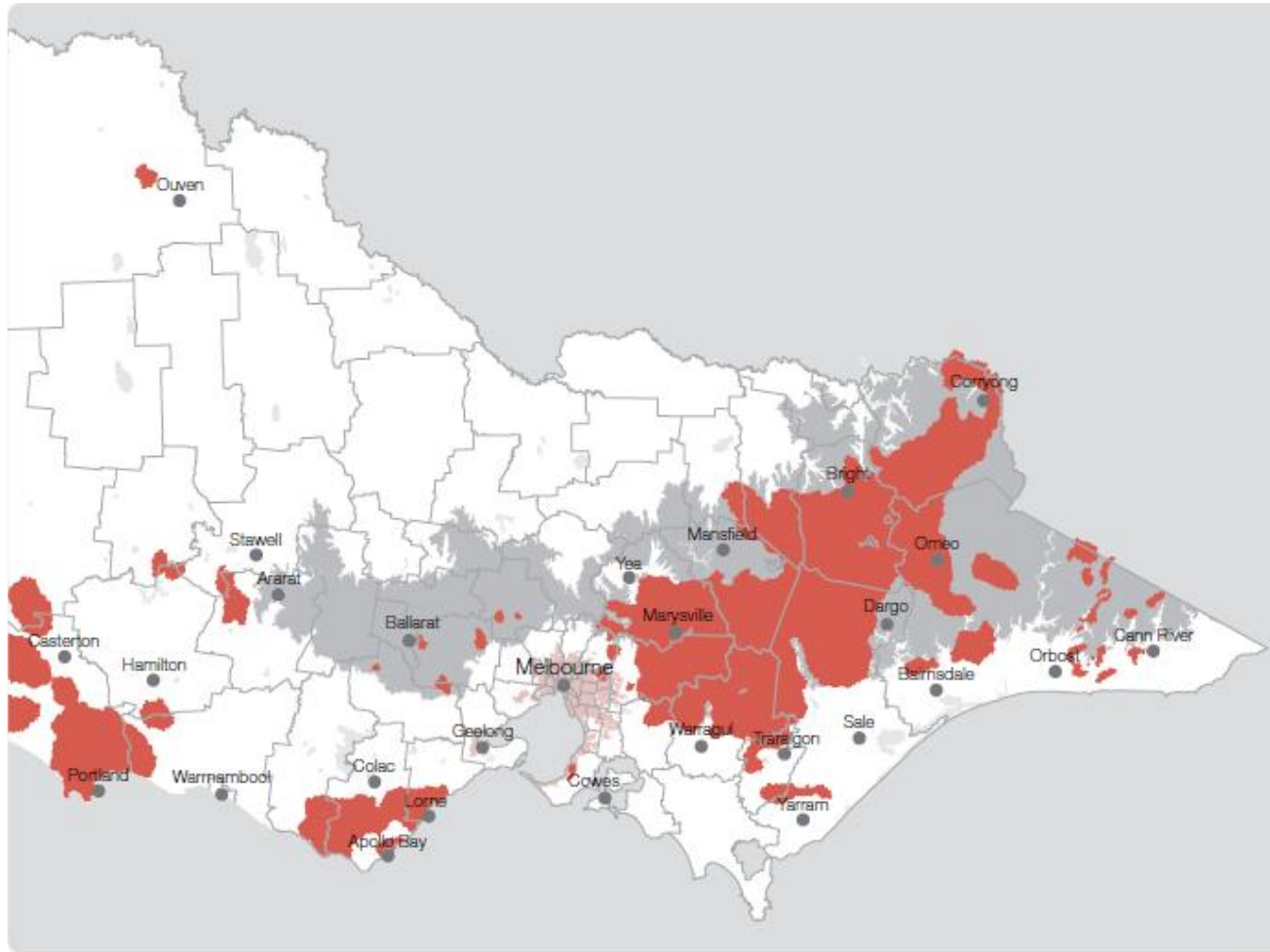
- 593 fires broke out on 7 February 2009
- 13 fires developed into significant incidents
- 173 people died in 5 fires
- Over 2000 houses were destroyed
- 78 townships destroyed or seriously affected
- 1000s of people displaced
- 22,500 people registered for assistance



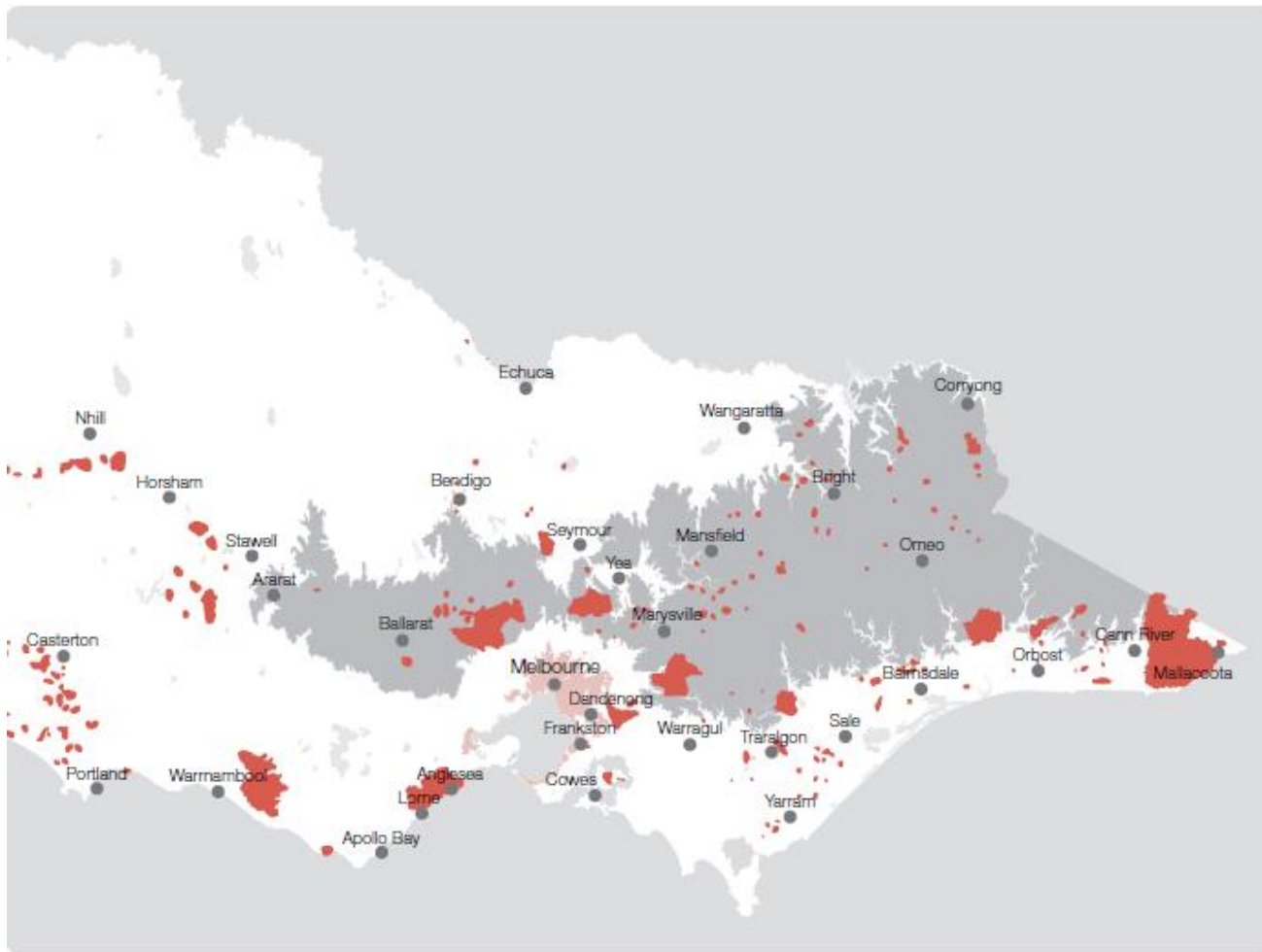
Black Saturday: Major fires



1938-1939 fires



1982-1983 (inc. Ash Wednesday, Feb 16 1983)

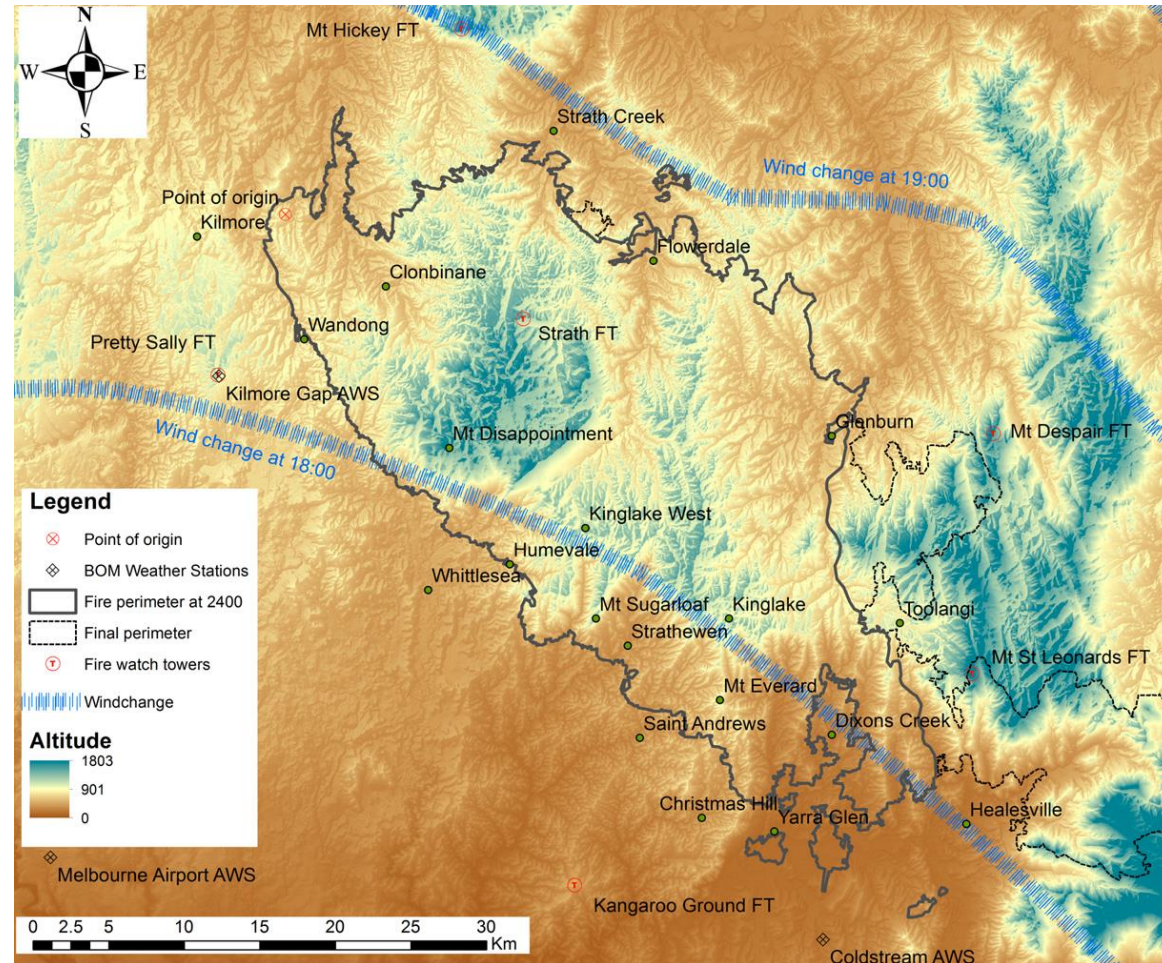


2002/2003 (inc. Alpine fires)



The Kilmore East fire

- Started on farmland east of Kilmore before noon
- Burnt a total of 125,000 ha in less than 12 hours
- 121 people killed
- Townships affected included
 - Kinglake, Kinglake West, Flowerdale, Steel's Creek, Humevale, Strathewen, St Andrews



The Kilmore East Fire



The Kilmore East fire

Reconstruction of the spread and behaviour:

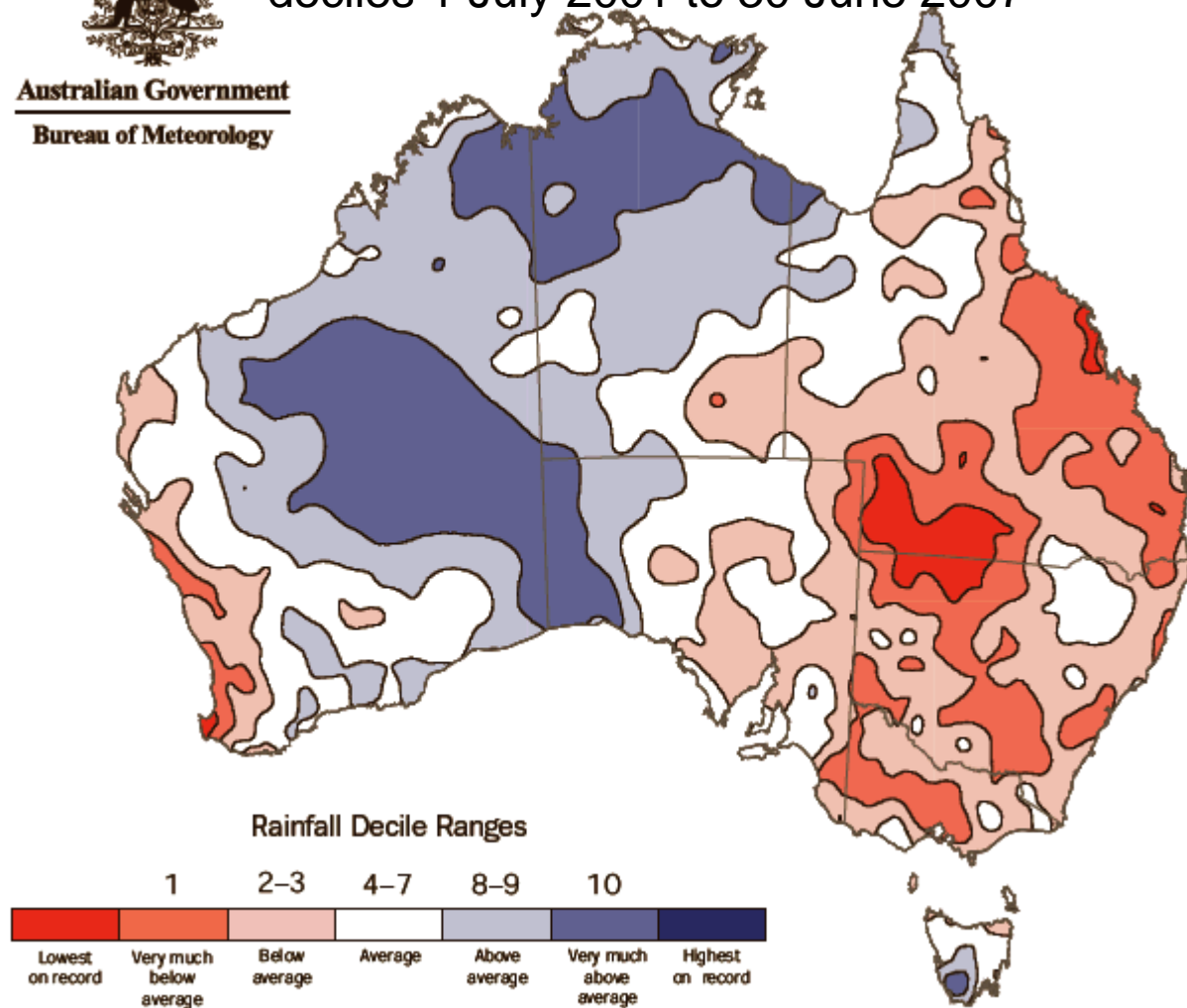
- Collect and collate any and all data that may be pertinent:
 - Weather information from AWS
 - Physical evidence of fire behaviour (fuel consumption, intensity, leaf freeze)
 - Fuel information from fire history records, fuel assessments, etc
 - Remotely sensed data on fire:
 - Post-fire aerial photography
 - Pre- and post-fire satellite imagery
 - Eyewitness accounts of fire behaviour
- Analyse using fire behaviour knowledge and modelling to build understanding and chronology of events

Black Saturday: long-term drought

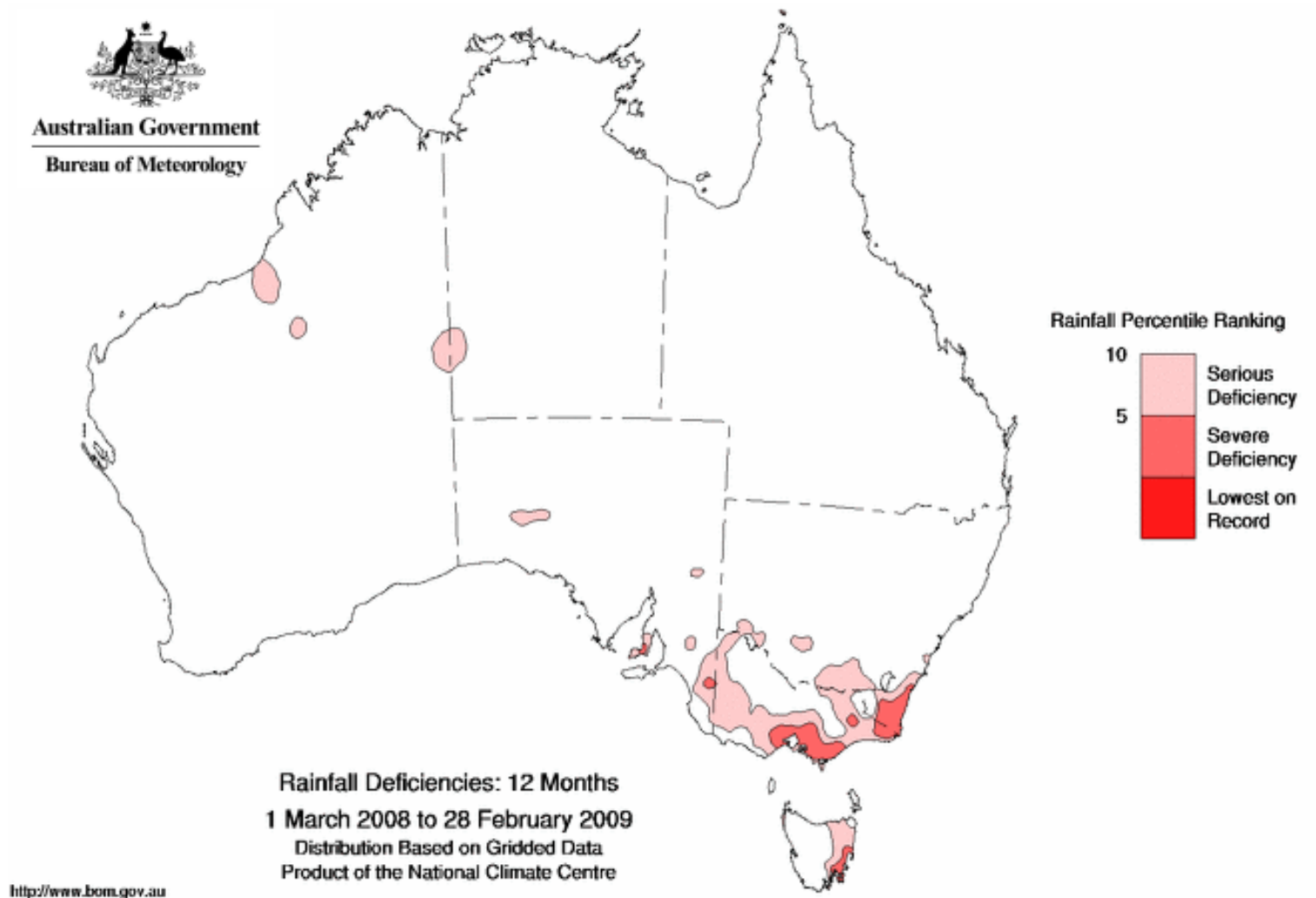


Australian Government
Bureau of Meteorology

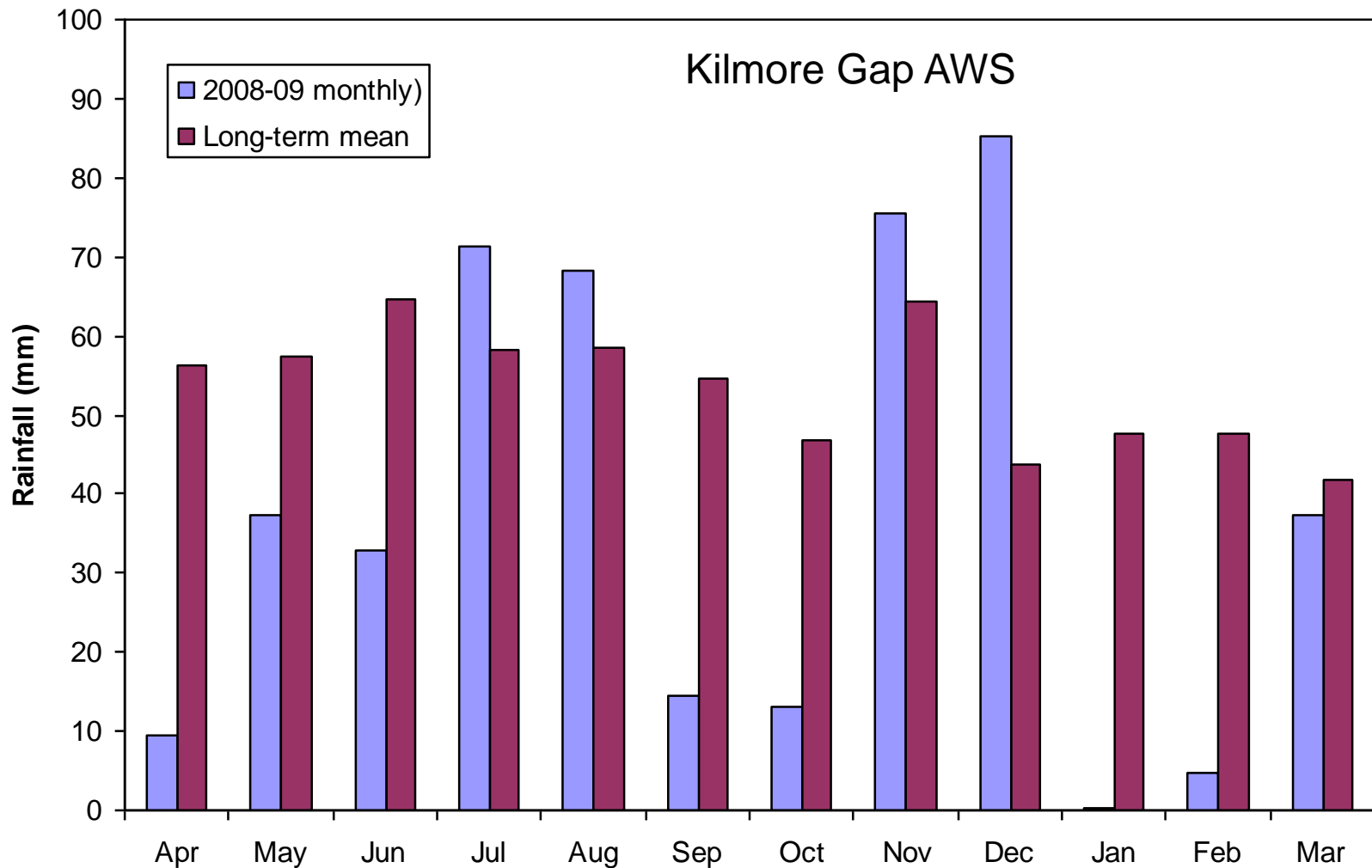
deciles 1 July 2001 to 30 June 2007



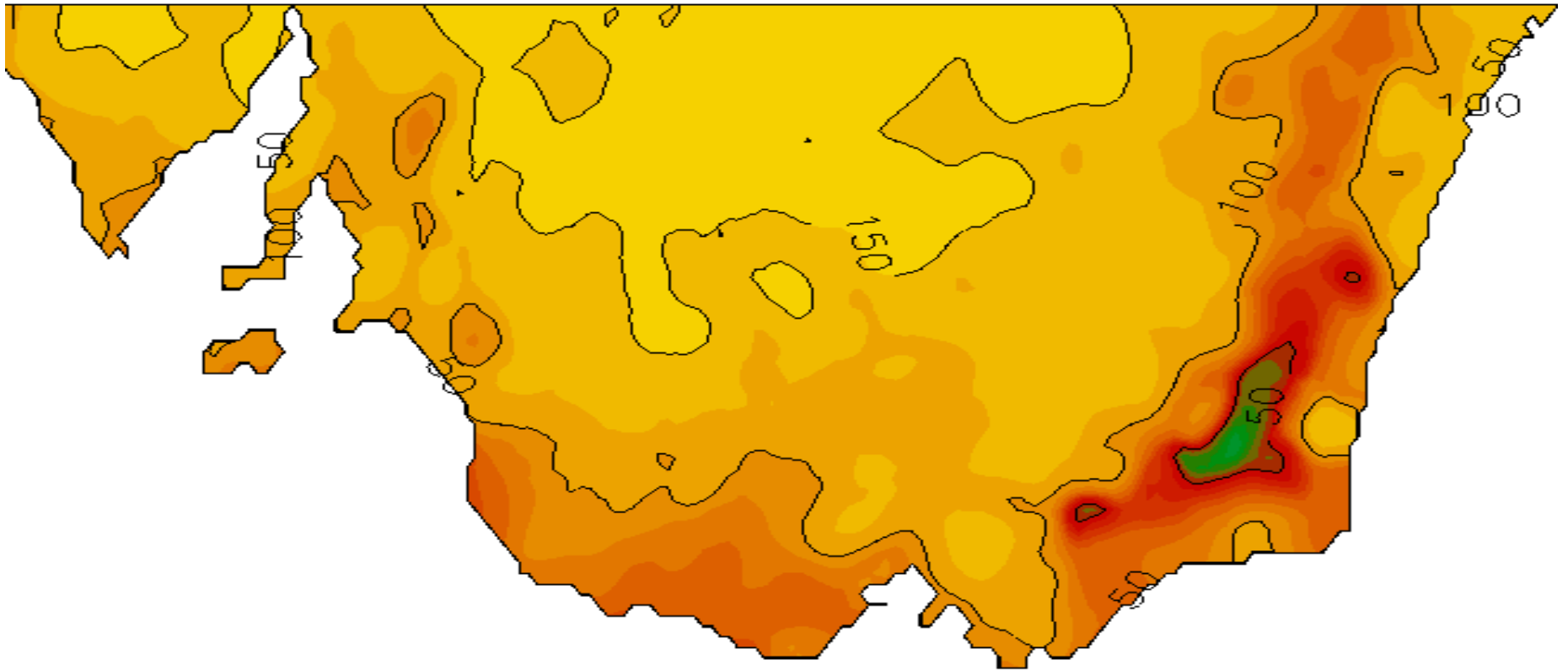
Black Saturday: Short-term drought



Black Saturday: Short-term drought

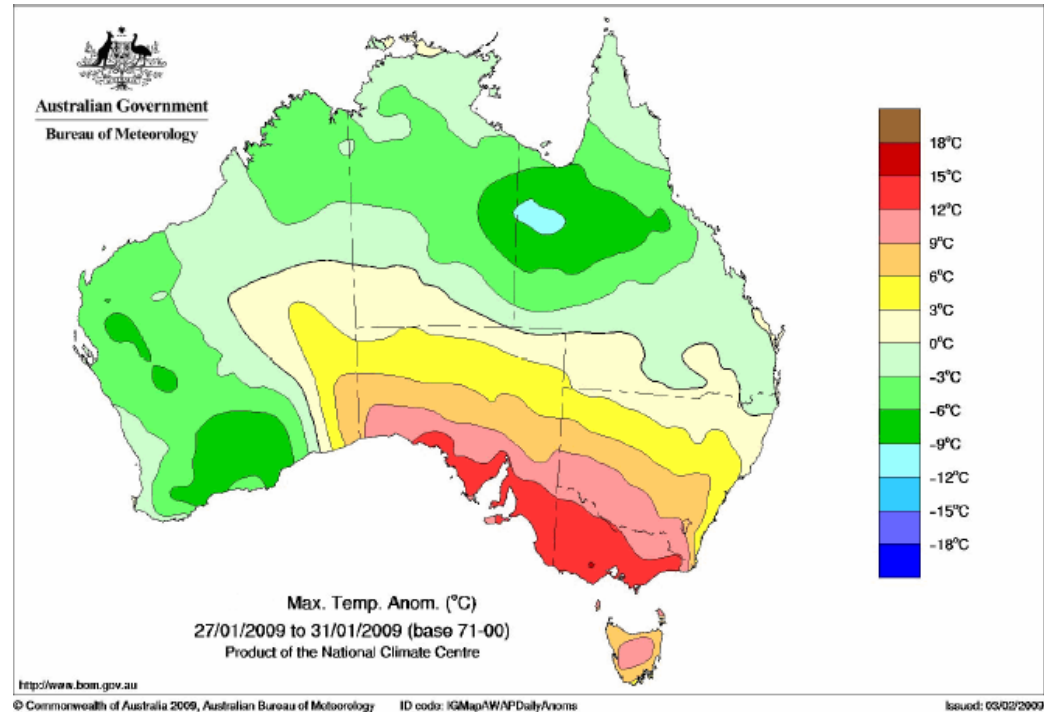


Black Saturday: Short-term drought

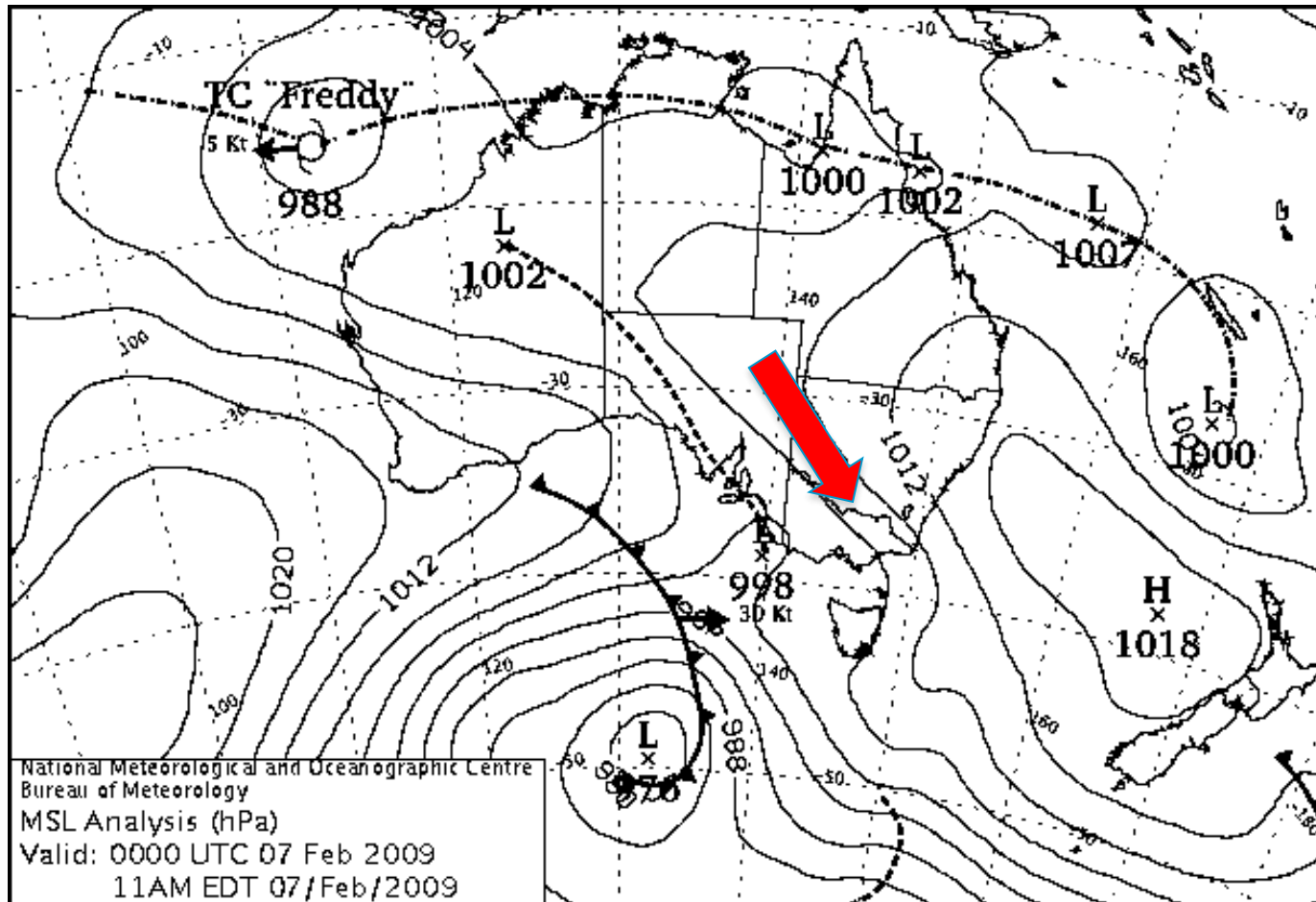


Black Saturday: Weather

- Heatwave 27-31 January
 - 3 consecutive days above 43°C.
 - 374 deaths above the normal death rate.
- February 7 (Melbourne)
 - Max. temp: 46.4°C
 - Min. RH: 3-4%
 - Mean wind speeds: 50 - 70 km h⁻¹
 - Most of the state 46-48°C

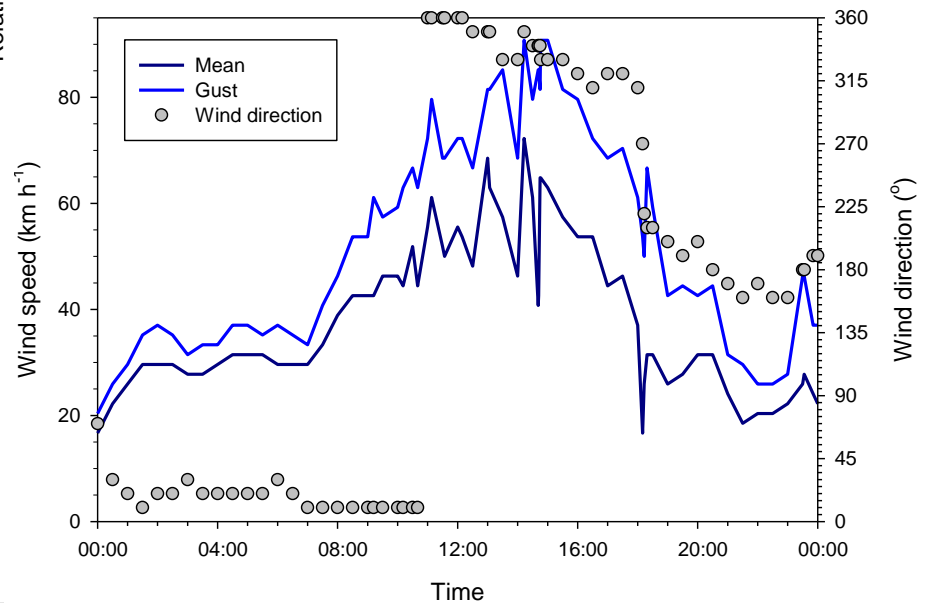
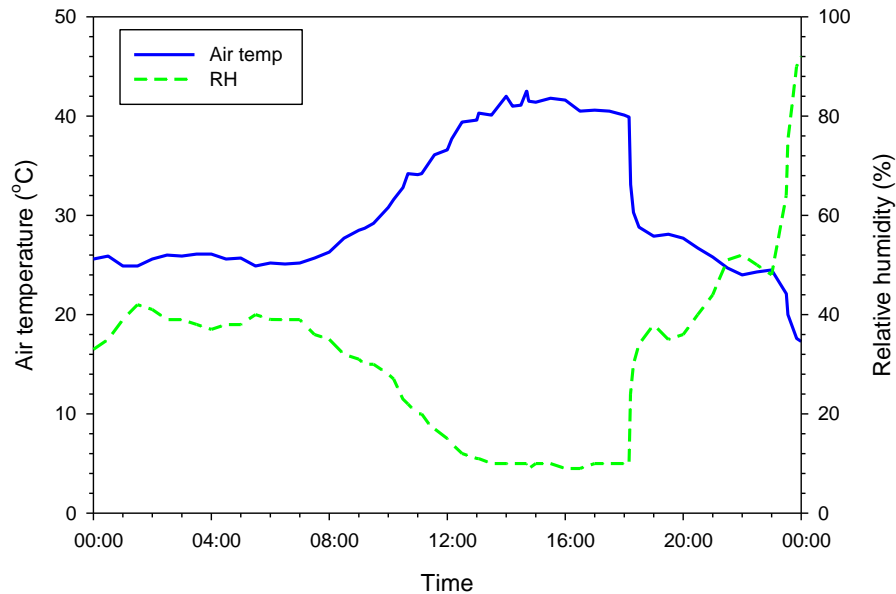


Black Saturday: Weather

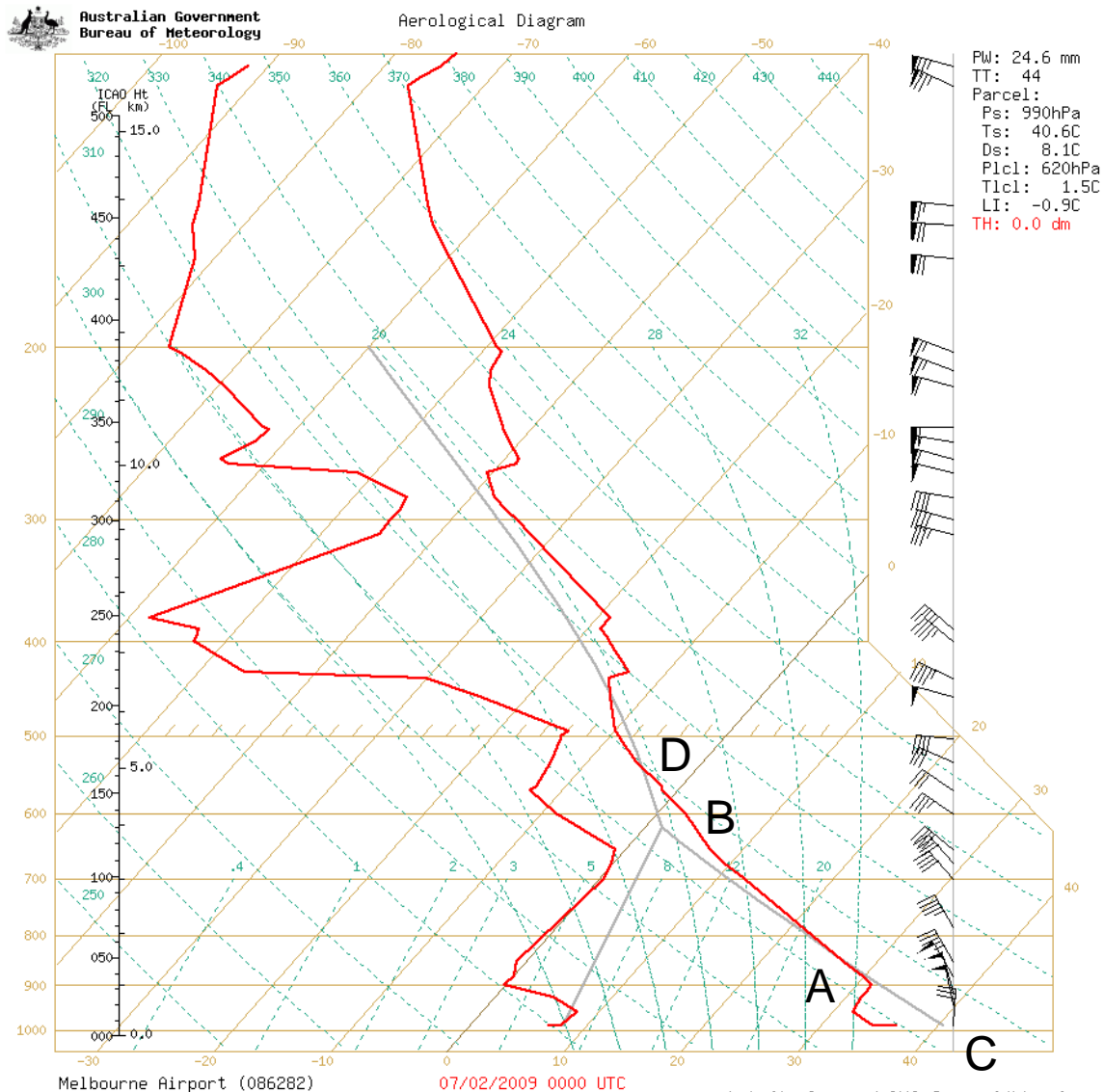


Black Saturday: Weather

- Kilmore Gap AWS 7 February 2009



Black Saturday: Weather



Ignition

- Started at approximately 1145 hours
- Believed to be caused by arcing from broken electrical (SWIR) line on private property
- Fire reported by fire tower observer (Mt Hickey) at 1147

1201 h (16 min after ignition)



1252 h (67 min after ignition)



1426 h (2:41 after ignition)



Fire spread: 1200 hours



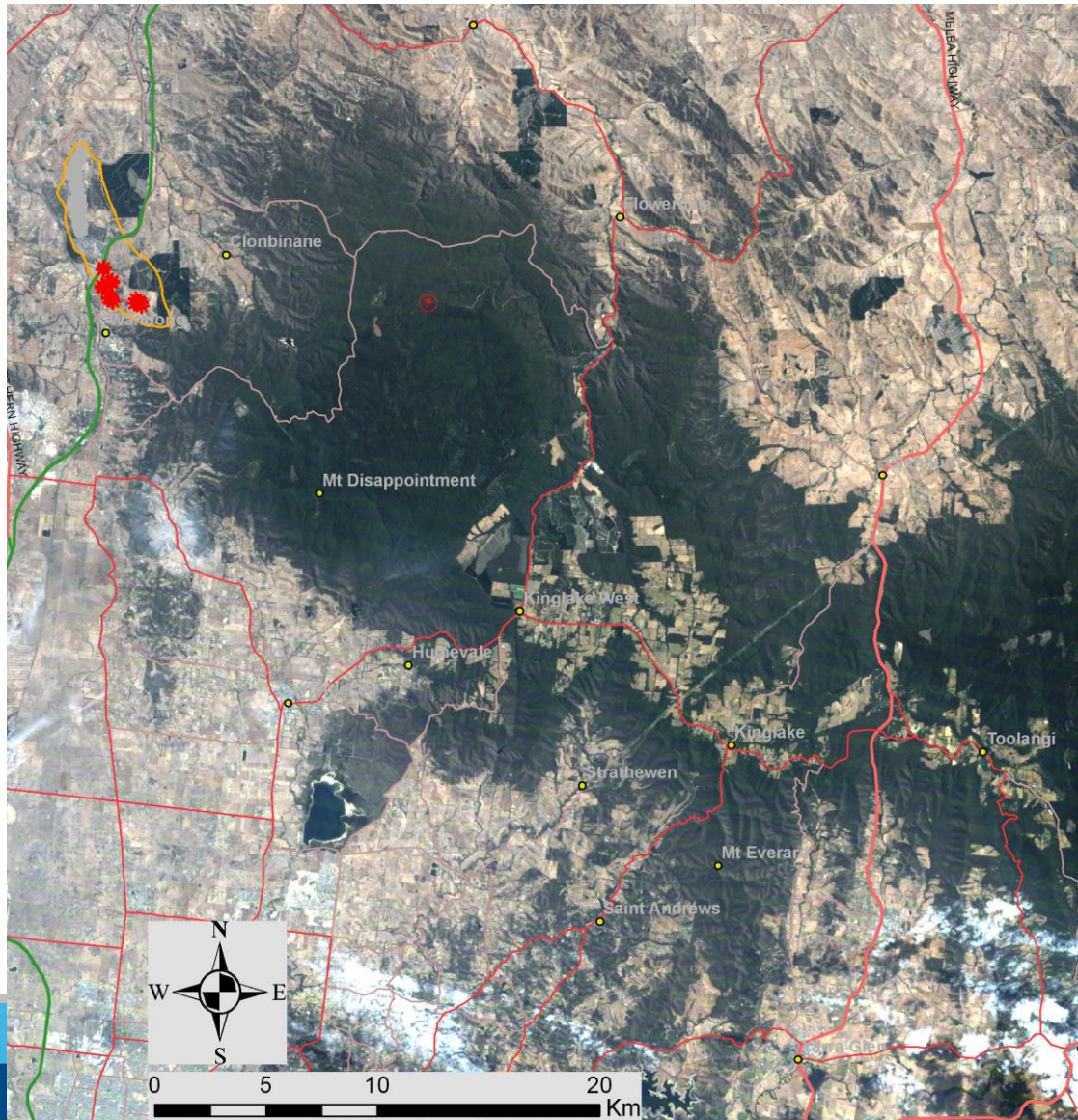
- Spread rapidly through heavily grazed farm paddocks and open woodland
- Undulating topography
- ROS: 2 km/h

Fire spread: 1300 hours



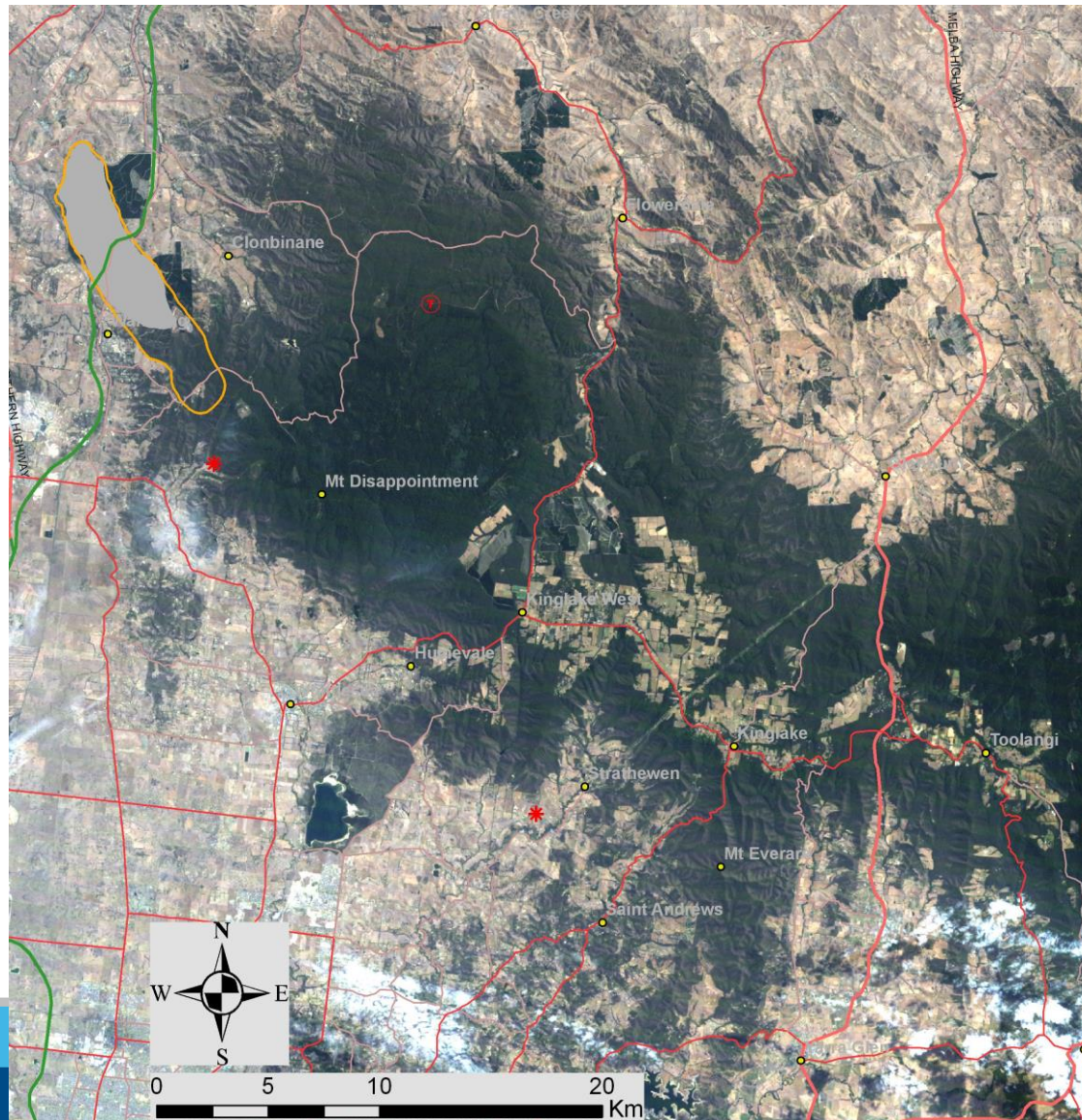
- Continued spread through heavily grazed farm paddocks and open woodland
- Some logged radiata plantation and denser woodlands, Ignition at 1145 hours
- Individual tree torching
- Short-medium distance spotting
- ROS: 4.3 km/h

Fire spread: 1400 hours



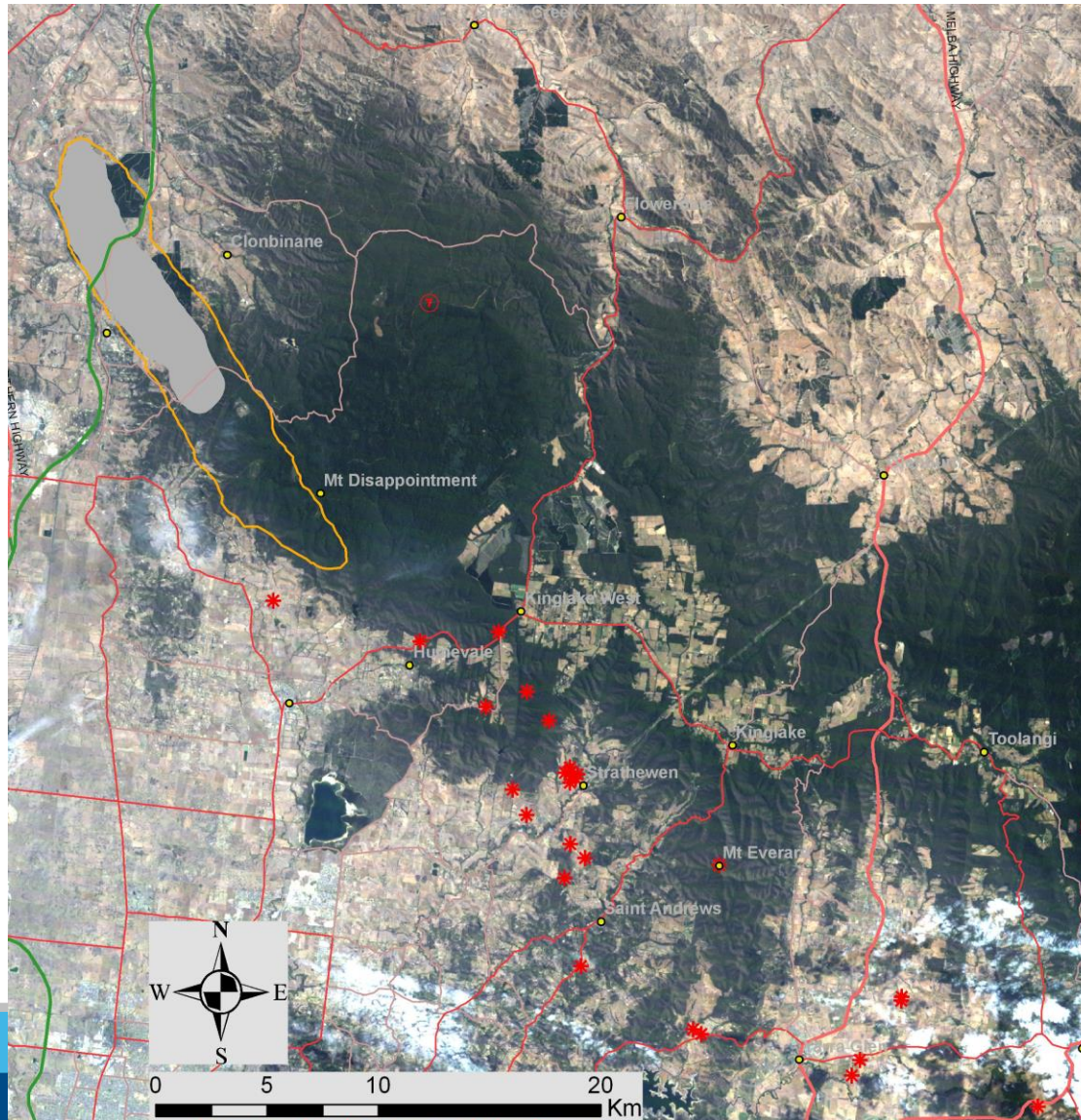
- Crossed over Hume Highway at 1336
- Continued spread through heavily grazed farm paddocks and open woodland
- Some denser pockets of dry woodland
- Large bluegum and radiata plantations
- ROS: 4.4 km/h

Fire spread: 1500 hours



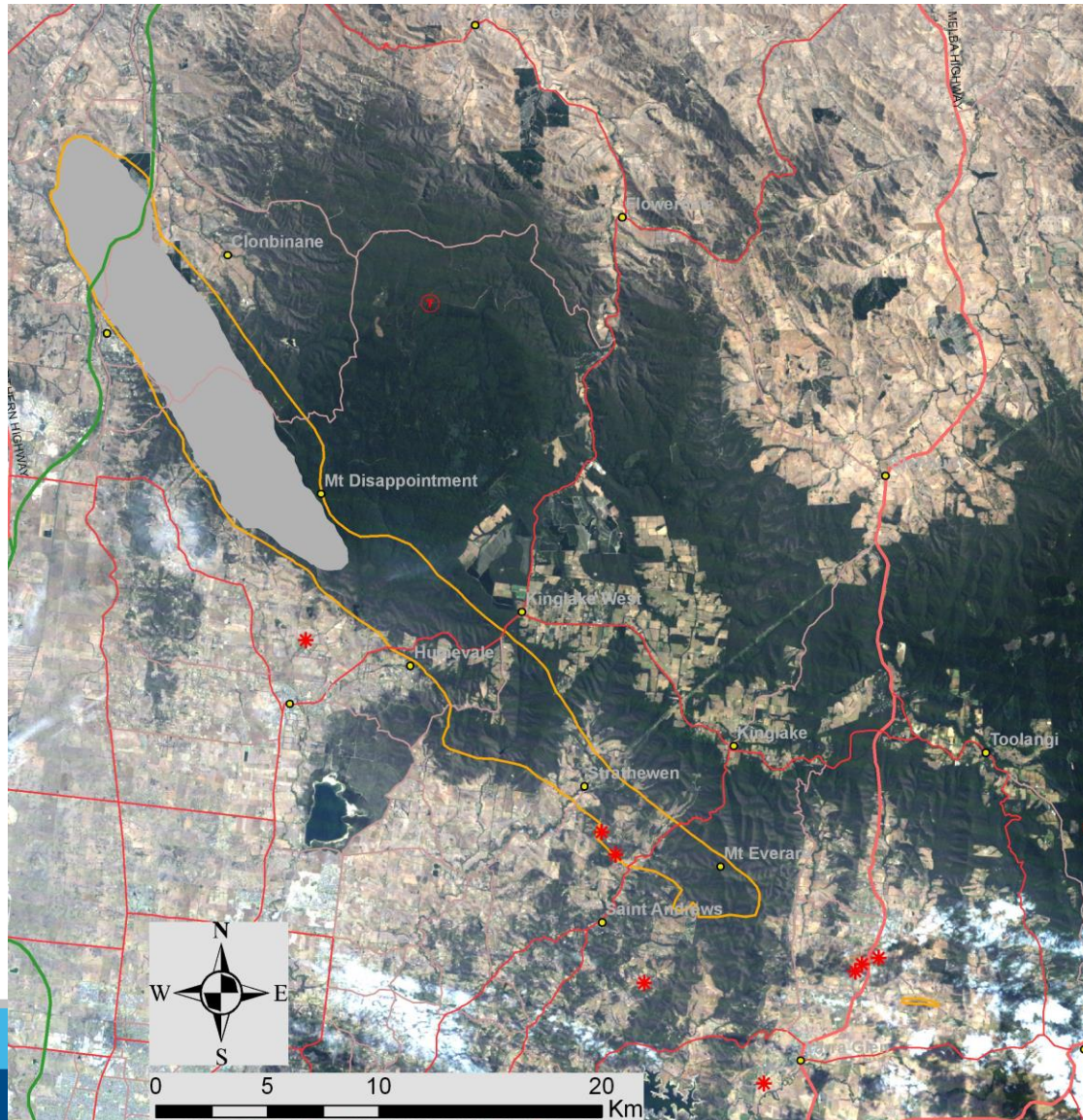
- Transition into more complex topography in foothills of Hume Range
- Steeper topography
- Shift out of farmland into dry eucalypt forest with low understorey, scattered areas of mixed dry-wet euc. forest.
- Increased spotting in long-unburnt forest
- Spotting dominant propagation mechanism
- ROS: 4.1 km/h

Fire spread: 1600 hours



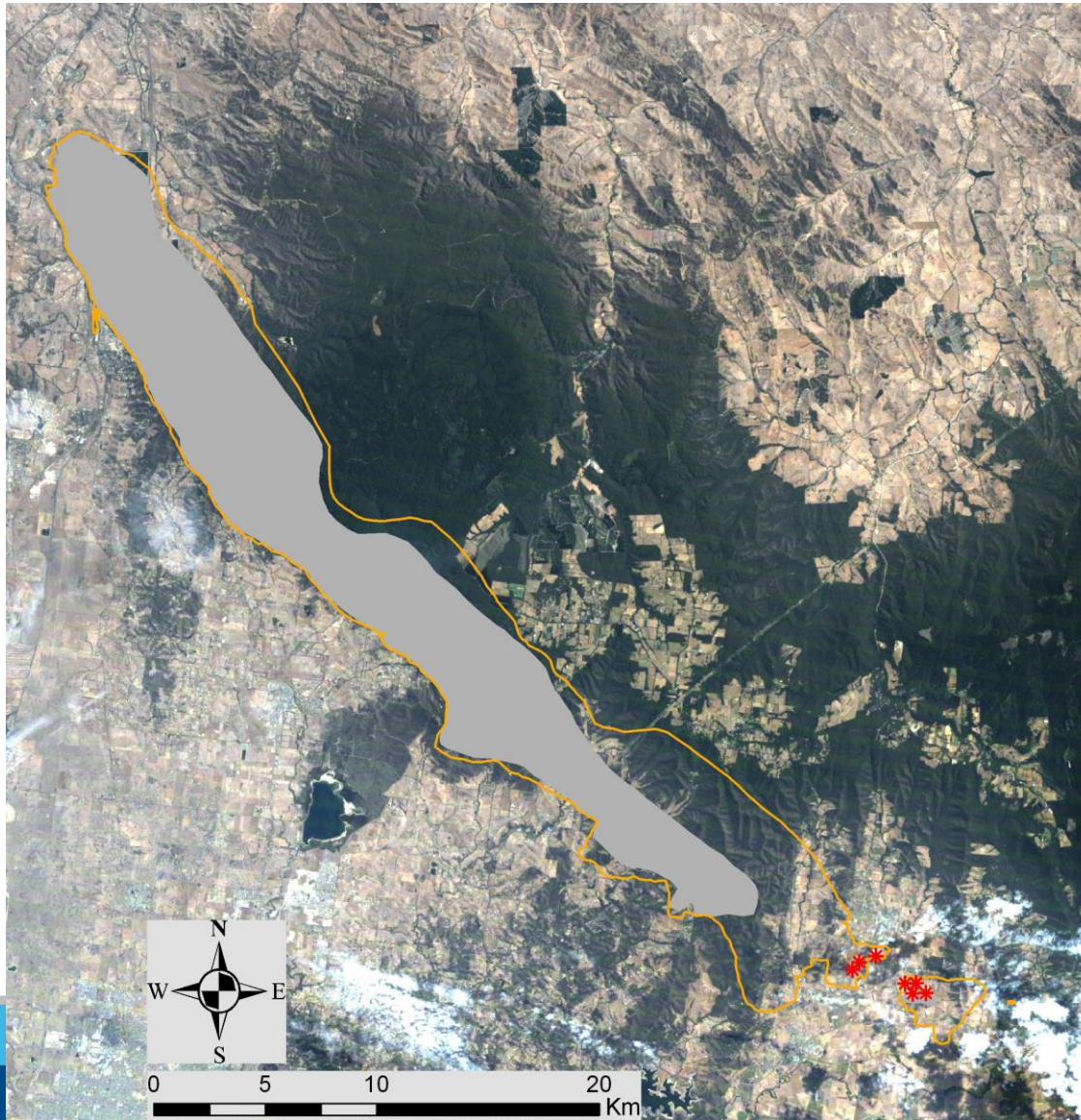
- Fire activity escalates as it approaches Mt Disappointment
- Heavier mixed dry-wet forest which sustained higher intensity spread.
- Profuse short range spotting drives fire spread
- Long range spotfires up to 40 km occur from 1515 hours
- Spotfires develop rapidly
- ROS: 9.2 km/h

Fire spread: 1700 hours



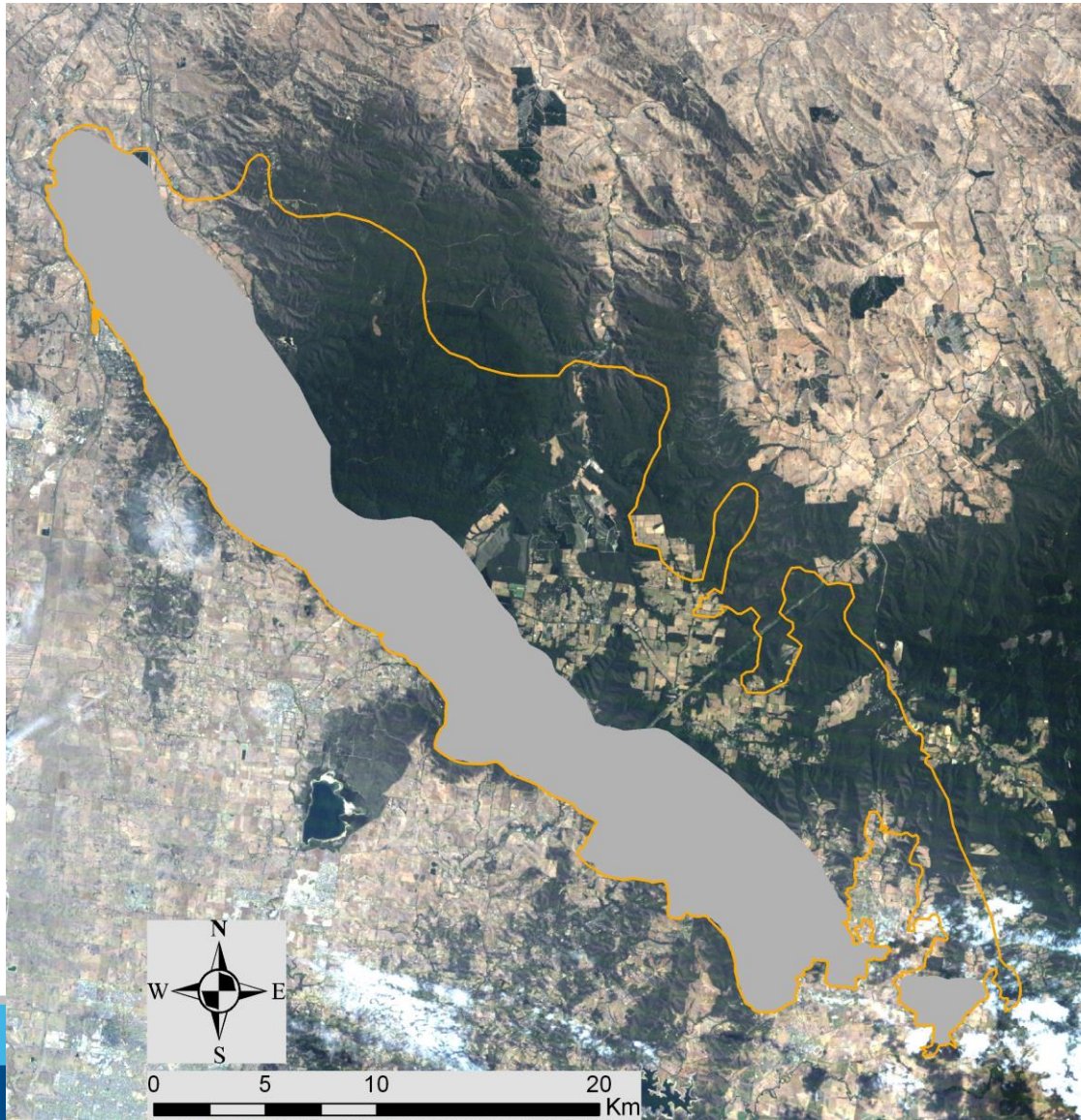
- Large number of independent fires in leading zone of fire activity between Humevale and Strathewen and in Yarra Glen
- Mass spotting and coalescence with firestorm characteristics
- Active fire zone covering approx 17,500 ha.

Fire spread: 1800 hours



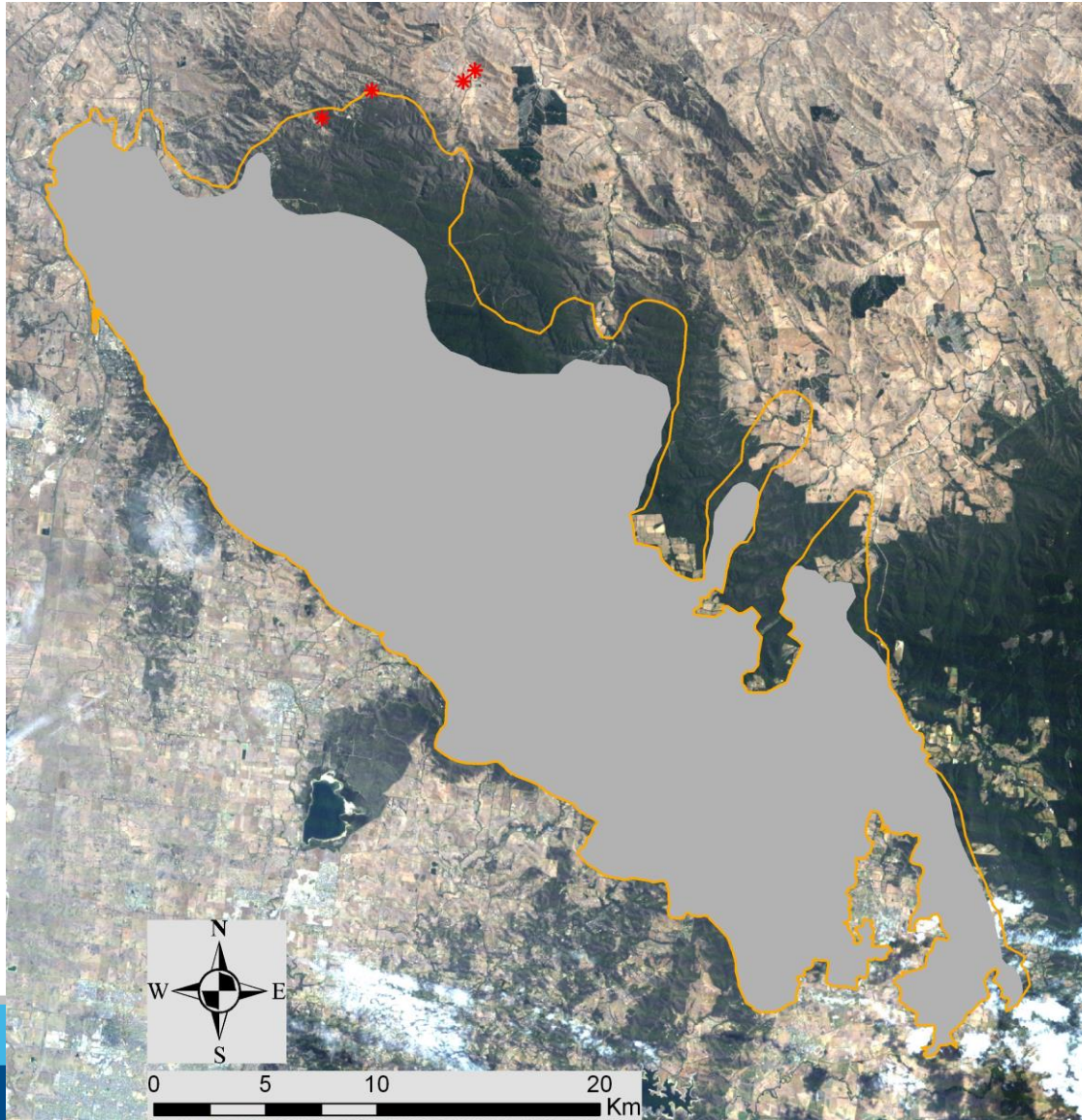
- Fires in light, grazed fuels controlled due to fuel discontinuity which constrains spread
- High intensity, erratic fire behaviour as fire fills in unburnt heavy fuel areas within fire area
- Interaction with slope effect of Hume Range escarpment increased erratic behaviour.
- High intensity crown fire in dry euc.
- Wind change arrives between 1745 and 1800 on south-western flank

Fire spread: 1900 hours



- Wind change from 315 to 250 degrees in ~20 mins.
- Immediate impact was launch of firebrands along full extent of NE flank.
- Major change in fuel distribution along range-agricultural lands fragments fire spread.
- Reduced curing stops spread in paddocks.
- Broad active flame front in native forest.
- ROS: 7.6 km/h
- Fire area: 63,000 ha
(cumulative period: 27,000 ha)

Fire spread: 2000 hours



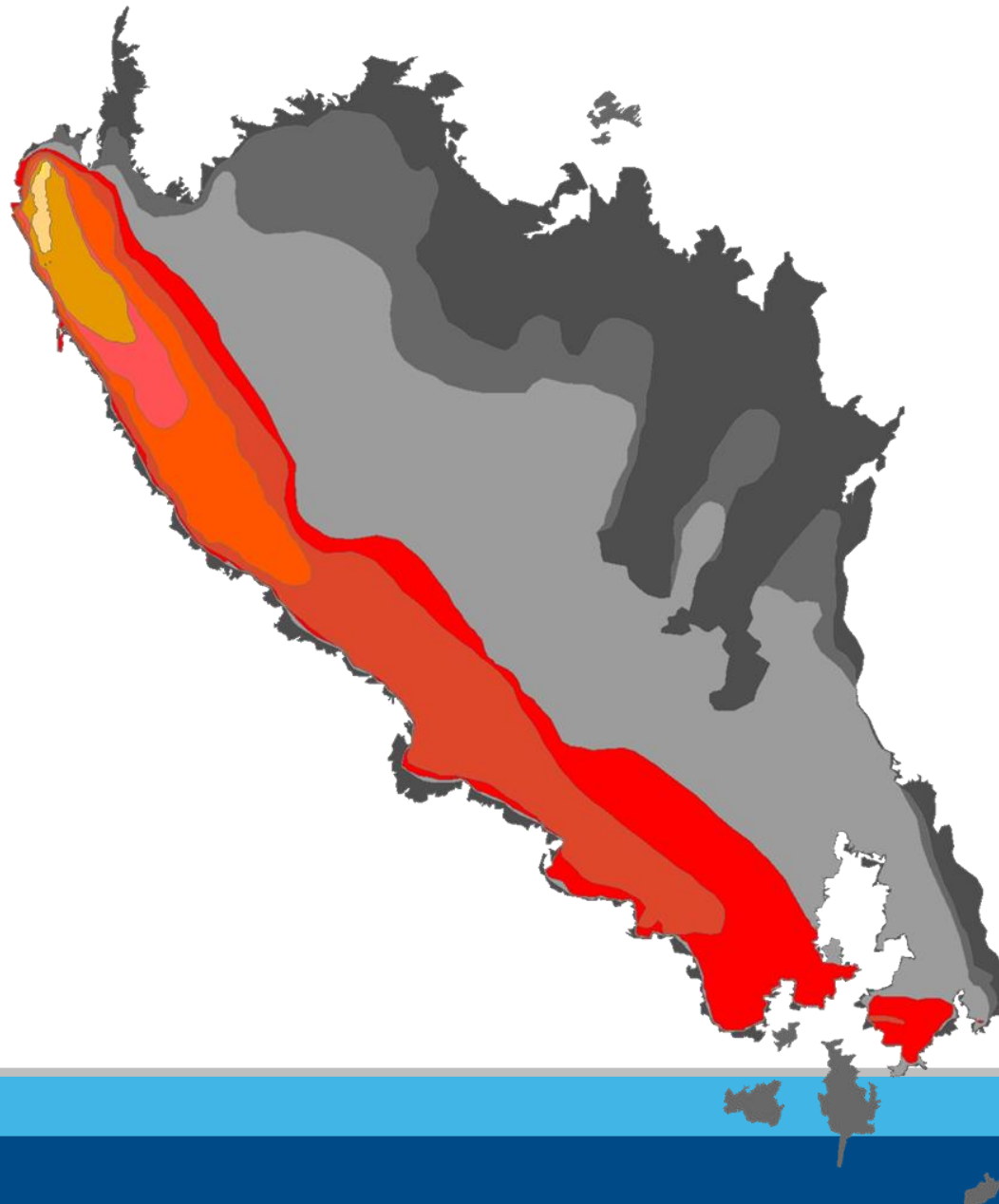
- 20-25 km extended fire front
- Predominant fuel dry euc.
- Short range spotting followed by crown fire
- ROS: 5.4 km/h

Fire spread: 2400 hours

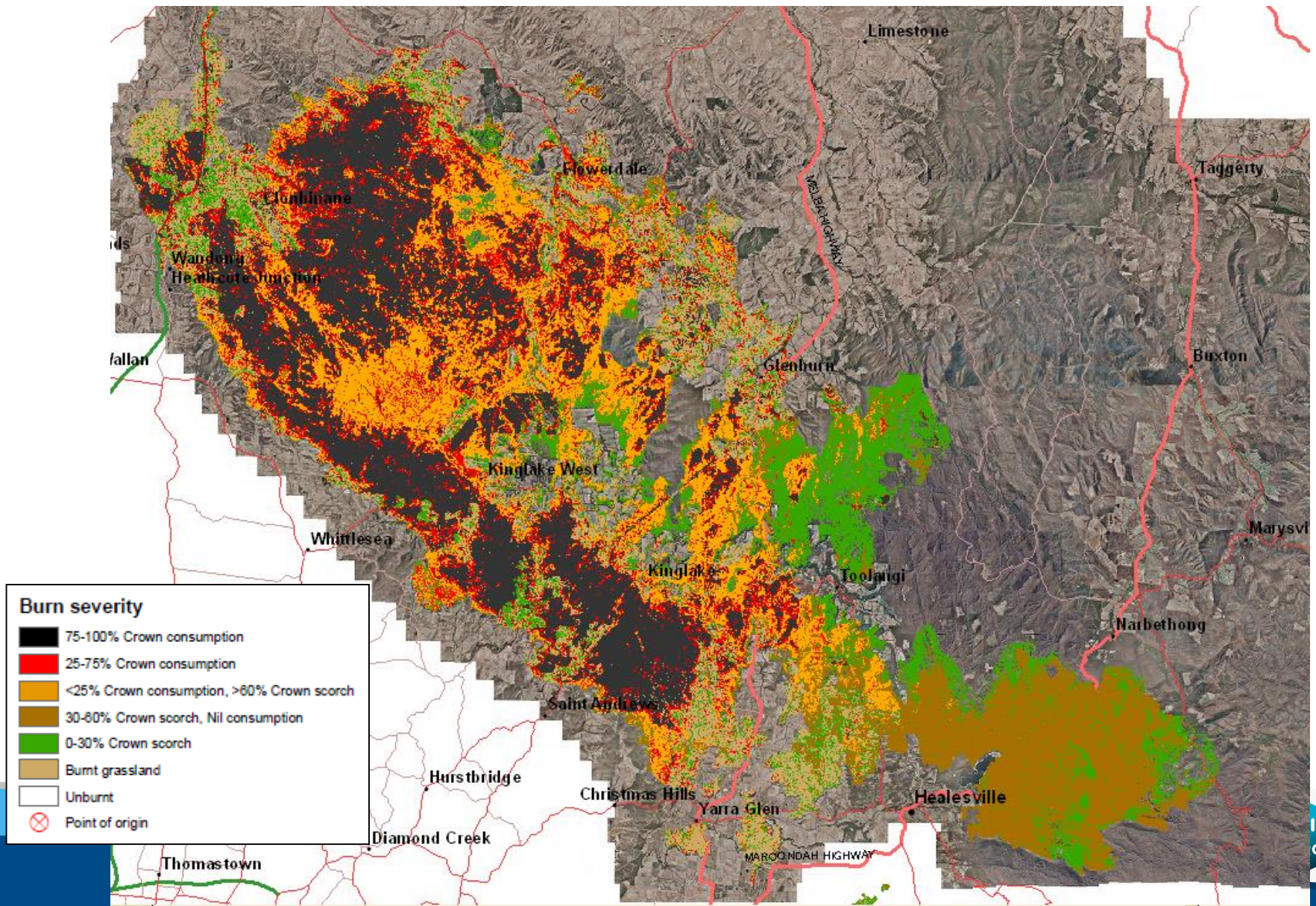


- Fire ran into grazed paddocks on NE extent of forest
- Low fuel continuity and high FMC stopped fire spread
- Localised rain showers occurred.
- Almost all fire spread ceased by next morning with little increase in area.
- Toolangi sector continued to burn for 3 weeks.

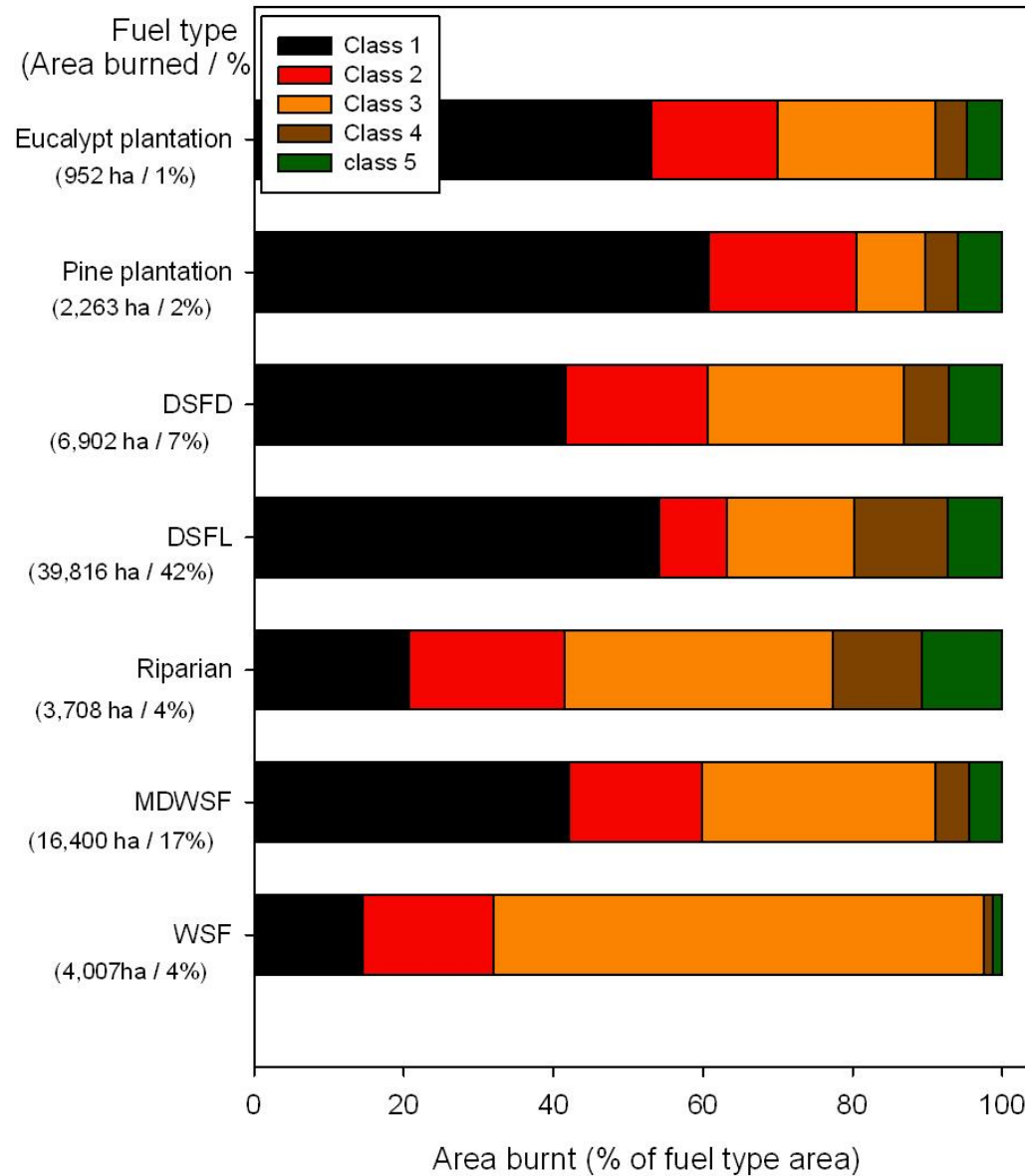
Fire spread: over life of active behaviour



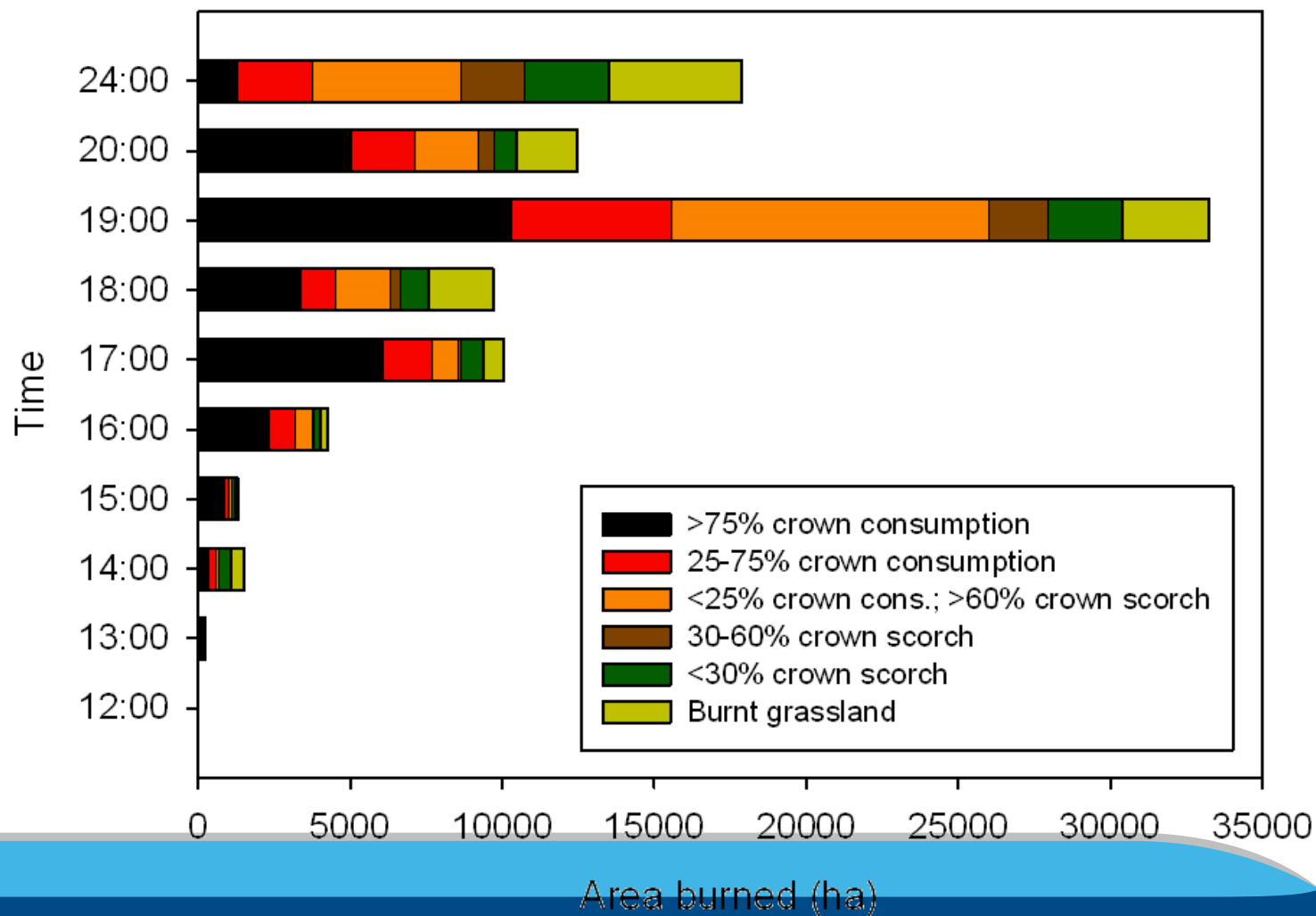
Fire intensity



Burn severity and fuels



Burn severity and time



Fire behaviour summary

BP	Fuel type	Fine fuel load (t/ha)	Total fuel load (t/ha)	Rate of fire spread (km/h)	Fireline intensity (kW/m)	Heat released (kJ/m ²)
1	Grass	--	---	nd	--	--
2	Grass	3	3	4.26	6,603	5,580
3	Grass, DSFL	--	--	4.4	na	na
4	DSFL	18.6	53	4.1	39,209	98,580
5	DSFL	18.6	53	9.2	88,220	98,580
6	na	--	--	nd	--	--
7	na	--	--	nd	--	--
8	DSFL	18.6	53	7.6	73,228	98,580
9	MDWSF	21	134	7.6	82,677	249,240
9	DSFL	18.6	53	5.4	51,894	98,580
9	MDWSF	21	134	5.4	58,590	249,240

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Thank you

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