

## 2.0 Conditions leading up to the February fires

### 2.1 Weather

#### 2.1.1 Overview

Tolhurst (2009) explains that weather elements, such as seasonal conditions (droughts), shorter term episodic events (heatwaves and storms), dynamic situations (extreme temperature combined with low air moisture, strong winds, atmospheric patterns and passage of low pressure troughs and cold fronts) are critical to fire behaviour.

#### 2.1.2 Temperature

Several experts in fire behaviour and climatology have noted that the preceding weather and climate played a significant role in the severity of the fires (Tolhurst 2009, Sullivan and McCaw 2009, Karoly 2009). The Bureau of Meteorology has documented how an exceptional heat wave affected south-eastern Australia during late January and early February 2009. The Bureau noted that extreme conditions affected most of Victoria and adjacent areas of New South Wales, northern and eastern Tasmania and southern South Australia.

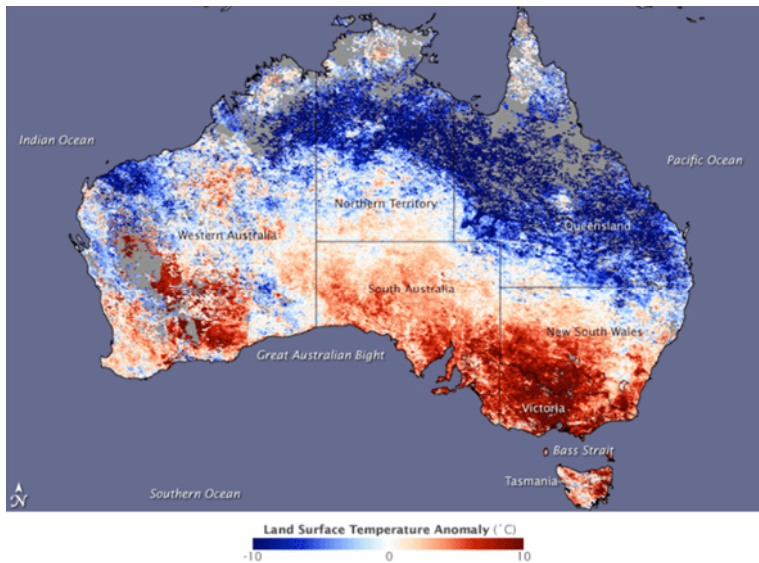
The Bureau of Meteorology observed two major episodes of exceptionally high temperatures, 28-31 January and 6-8 February, with slightly lower but still very high temperatures persisting in many inland areas through the entire period. The Bureau of Meteorology (2009) stated that this was caused by the presence of a slow-moving high-pressure system in the Tasman Sea combining with an intense tropical low off the north-west coast of Western Australia and an active monsoon trough. This provided the conditions for hot air of tropical origin to be directed over the southern parts of the continent.

Figure 2.1 details the temperature anomaly observed over the heatwave period of late January and early February 2009. In the areas affected by the fires the Bureau observed temperature anomalies of 10°C. This was particularly evident around the Kilmore East and Murrindindi locations where the two largest fires started.

The first stage of the heatwave (27-31 January 2009) damaged infrastructure throughout Victoria. This included warped train tracks and the temporary closure of businesses and government offices. The heatwave severely disrupted transport services, with more than 1,000 train services being cancelled. Houston and Reilly (2009) estimate the damage cost the economy in the order of \$100 million.

The impact on human health was significant. Assoc. Professor Mark Fitzgerald, Director of Emergency at the Alfred Hospital, said on ABC TV's Four Corners on 16 February:

*"We had the heat wave where we had to call in extra people and enact a sort of mini disaster plan the week before and we've been having an average of one major burns patient per day up until the bushfires and we did have a discussion on the Friday about one, what would happen if there was another heat wave and secondly our response if there was a bushfire".*



**Figure 2.1 Land surface temperature anomaly between 25 January and 1 February 2009** (Source: <http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=36900>, accessed 13.04.08)

According to Koch (2009), the Victorian state morgue was taking in the bodies of more than 50 deceased persons per day, more than three times the average. According to Fyfe (2009), the heat wave period may have been responsible for the deaths of 100 people in Melbourne and more than 200 people across south-eastern Australia.

### 2.1.3 Rainfall

The report provided to the Royal Commission by the Bushfire Cooperative Research Centre (CRC) (Sullivan and McCaw 2009) said there was a strong association between drought and the occurrence of major bushfires in central and eastern Victoria. The Bushfire CRC report stated that the cumulative effect of successive years of below normal rainfall in the decade prior to 2009 was likely to have significantly affected groundwater levels, soil moisture and the dryness of large dead woody fuels. The report said in the decade between January 1999 to December 2008 cumulative annual rainfall was 885mm below normal at Toorourrong Reservoir and 1877mm below normal at Wallaby Creek. Only 1.0mm was recorded there during January 2009. The long-term median rainfall for January is 55mm. Overall, this trend of rainfall deficit was replicated across most of Victoria (Sullivan and McCaw 2009). Karoly (2009) believes the lack of rainfall contributed to extremely low fuel moisture (3-5 per cent) on 7 February 2009.

### 2.1.4 Drought indices

Sullivan and McCaw (2009) explain that Melbourne had reached Keetch-Byram drought index (KBDI) value greater than 100 on 7 February 2009. The KBDI uses a method for tracking soil moisture loss, recharge and use simplified evapotranspiration relationships based on daily maximum temperature to estimate moisture loss and daily rainfall corrected for interception by forest canopies for recharge. Sullivan and McCaw (2009) explain that the area north and east of Melbourne, particularly in the Yarra Valley, experienced KBDI values between 125 and 150. They note that these values were at least 50 points above the normal level expected at that time of year. This contributed to most

of Victoria (excluding the Otways and the Alpine area) having a drought factor of 9.5 or greater on 7 February 2009. The drought factor aims to encapsulate the effects of slowly varying long-term rainfall deficits and short term wetting of fine fuels from recent rain (Lucas et al 2007).

## 2.2 Impacts on fuels

### 2.2.1 Grassland fuels

Sullivan and McCaw (2009) report that grass-curing maps prepared from NOAA satellite imagery show that by 7 February, grasslands and pastures in the north and west of Victoria were approaching full curing (>95 per cent). They note that curing ranged from 65 to 95 per cent in the Upper Plenty Valley, Yarra Valley, eastern parts of the Goulburn Valley and Gippsland. They say curing was less advanced at higher elevations in central Victoria that remained moister and cooler during January and in sites along rivers and gullies.

Luke and McArthur (1978) found the curing of grass occurs when the percentage of moisture in the grass in relation to its Oven Dried Weight (ODW), decreases from 350 per cent when green to around 10 per cent when it is 100 per cent cured. Tolhurst (2009) notes the high degree of desiccation throughout grassland areas resulted in further fuel being available to burn. This is significant as the Kilmore East and Murrindindi Fires started on pastoral and agricultural land (Clancy 2009, Four Corners 2009).

Noble (1991) notes that throughout the world grasslands are traditionally regarded as highly flammable plant communities that require frequent burning. He notes that the intensity of grassfires can reach 20,000 KW/m and can achieve speeds of 22km/h. Tolhurst (2009) notes that fuel loads on 7 February were about 1.5 t/ha in eaten out paddocks.

### 2.2.2 Forest fuels

Luke and McArthur (1978) stated the overall availability of fuels in forests is relatively low and thus only a small proportion of the total fuel is consumed in a fire, even a fire of high intensity. In some forests the total dry weight of dead and living plant material may be 500 tonnes per hectare or more. Luke and McArthur (1978) provided a breakdown of the fuel components in a dry sclerophyll forest in south-eastern Australia:

Component	Weight (t/ha)	Percentage
Fine fuel	10.0	3.8
Scrub species	10.8	4.0
Bark	27.3	10.3
Wood: 0.6 to 2.5cm diameter	4.8	1.8
Wood: 2.5 to 12.5cm diameter	46.0	17.4
Wood greater than 12.5cm diameter	166.0	62.7
<b>Total</b>	<b>264.9</b>	<b>100</b>

Tolhurst (2009) notes that due to the drought conditions, many of the normally moist forests were dry and carried the fire easily. He estimates mountain forests carried around 45 t/ha. Tolhurst notes the heatwave in late January desiccated, to a high degree, the green vegetation adding to the total fuel available. In this case, as with grassland fuels, more

energy was available to drive the fire instead of being used to dry the fuel and heat it to the kindling temperature.

## 2.3 Fuel/fire relationship

Sullivan and McCaw (2009) explain that the factors influencing the speed of ignition of the fuel and the length of the flame include:

- Fineness of the fuel particle (the finer the particle the faster it will ignite)
- Height of the fuel bed (the higher the fuel bed the longer the flames)
- Compactness of the fuel bed, which determines whether the fire first bums across the top of the fuel bed and then down into lower layers or whether the fuel is mostly consumed at the same time. (There is an optimum compaction that yields the maximum rate of spread: If the fuel is too compact the fire will spread slowly; or, if the fuel is too widely spaced the flames from one fuel particle cannot easily heat and ignite the next fuel particle.)
- Amount of water held by the dead fuel, determined by the antecedent weather conditions
- Fraction of live to dead material (green material generally has a moisture level greater than 120)
- The moisture content of the fuel, measured as a percentage of Oven Dry Weight (ODW. Green material can dampen the fire spread or contribute to the length of flame particularly if it is fine and elevated above the surface fuel; after prolonged drought the live moisture content can reduce to 80 per cent and require less heat for ignition
- Total amount of fuel consumed
- Continuity of the fuel bed

Sullivan and McCaw (2009) group fuels into specific types with similar characteristics, such as grassland, scrubland (heath) and forest fuel. They accept that the fuel contributing most to the flame front and to the heat flux that ignites new fuel is the fine fuel with a circumference of <6mm diameter. Larger fuel does either not ignite or bum well behind the leading edge of the fire and does not contribute to the flame front.

## 2.4 Leading up to 7 February 2009

Multiple fires were ignited in the period leading up to 7 February 2009. One of the earliest was the fire at McCrae, where 40 hectares of grassland was burnt alongside the Mornington Peninsula Freeway (ABCa 2009). However, the fires in the area surrounding Mirboo North and Boolarra were the most significant in this period. These fires were deliberately lit and affected 6,300 hectares of plantations, farmland and native forests (ABCb 2009, AAP 2009). They destroyed 28 houses and 60 sheds. The fires were contained by 1 February (AAP 2009).

Following the first period of the heatwave, a period of cooler temperatures relieved the southern half of Victoria. However, during this cooler period, 23 new fires were ignited in the Bunyip State Park and in areas in south and west Gippsland. According to news reports on the ABC (ABCb 2009), these fires were the results of lightning strikes. A spokesperson from the DSE said high humidity resulted in the fires being kept at a small scale. However, Miller (2009) reported in the *Berwick & District Journal* that what was to become the major fire in the Bunyip region was deliberately lit, under the cover of lightning, early on Wednesday 4 February.

The Coldstream station recorded temperatures approaching the mid 40s C on 28, 29 and 30 January 2009. The relative humidity was as low as 10 per cent at 3pm on 28 January. Luke and McArthur (1978) note that low relative humidity has a significant effect on fuel moisture content. The Bureau of Meteorology forecast a Forest Fire Danger Index above 50 for these three consecutive days. The region experienced a period of extreme fire danger which reached a peak of 73 on 29 January 2009.

Despite a short period of relief from the high temperatures in the days following 31 January 2009, maximum temperatures again reached the mid 30s from 4 February with the highest temperature, 44.8°C, recorded on 7 February.

Two days earlier, on 5 February 2009, the Office of the Emergency Services Commissioner issued a news statement warning of fire conditions forecast to exceeding those reached during the 1983 Ash Wednesday fire disaster. On Friday 6 February, the Chief Officer of the Country Fire Authority, Russell Rees, provided a briefing for 7 February, stating:

*"The situation is quite clearly in a weather sense for tomorrow that we are in almost uncharted territory.*

*"And when I say uncharted territory, there are no records that show the sort of fire conditions tomorrow predicted."*

*"I looked at it and I thought these figures have got to be wrong, there's got to be a glitch in the computer. In effect our weather conditions for the state if I said they are bloody horrible I am underestimating them, I have never seen figures like this."*

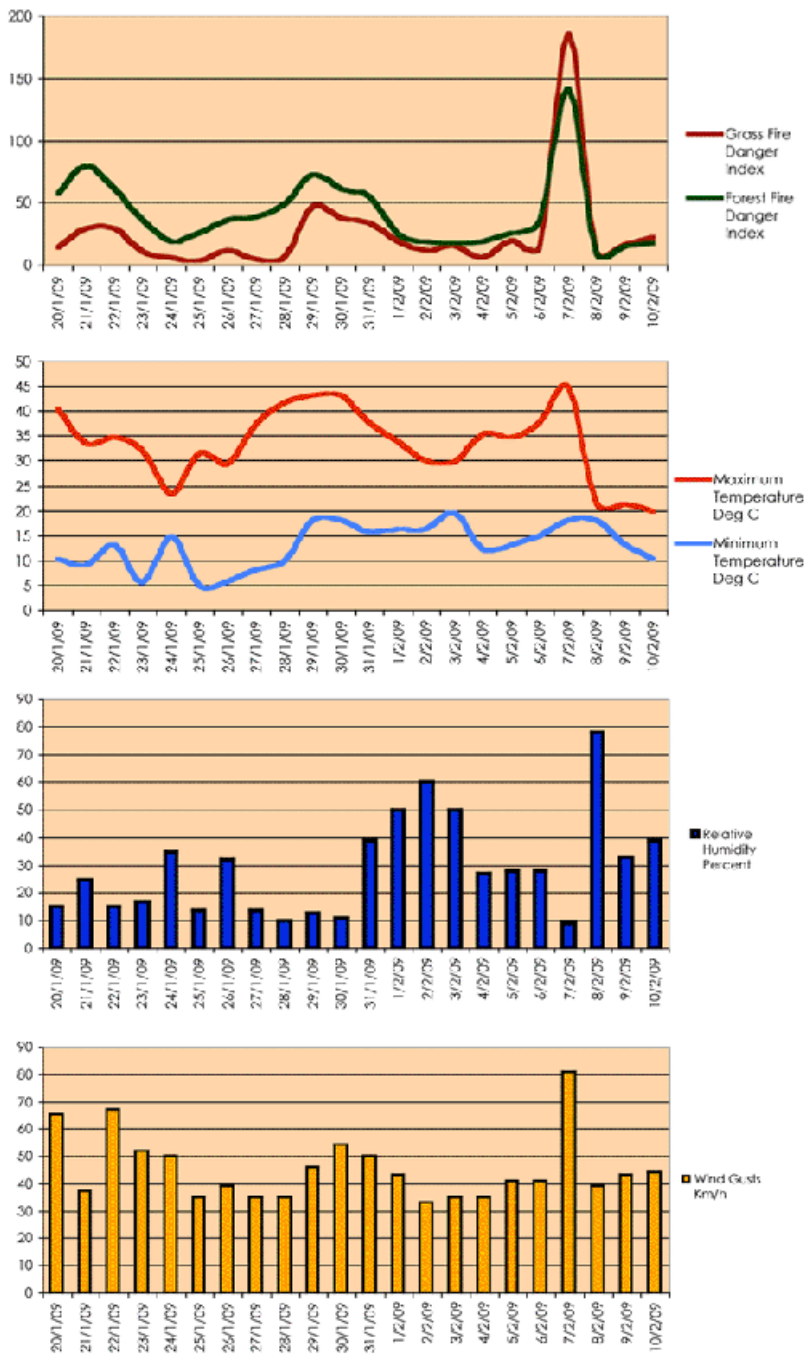


Figure 2.2 Chart measuring, maximum and minimum temperatures, relative humidity and maximum wind gusts, along with record predictions for the forest and grass fire danger index at the Coldstream weather station. Source: Bureau of Meteorology, 2009