Chapter 4

Case Studies

4.1 Introduction

A number of fire events have been previously used for case studies involving Fire Danger Indices. Several are presented here. The format used in each case is the same. Variables plotted are:

- national maximum FFDI for the day of the event
- the monthly mean, FFDI
- Point values of FFDI, GFDI, CFWI, Fd, at the model grid point nearest to the fire location,for the month of the event.
- Fire Weather ingredients, Tdd, T, Wsp, RH & Mills Index etc for 03, 06 and 09 UTC on the event day

Tables comparing the 4 fire danger indices at 0300 UTC on the day of the event are also shown.

The days examined are:

- CS1. Ash Wednesday Anglesea Victoria and Mt Gambier S.A., Feb 16 1983
- CS2. Berringa Fire Victoria, Feb 25 1995
- CS3. Big Desert Fire Victoria, Dec 17 2002
- CS4. NE Vic Fires, Jan 7 2003
- CS5. Canberra Fire ACT, Feb 18 2003
- CS6. Wangary Fire S.A., Jan 10 2005
- CS7. PyroCu Newcastle NSW, Nov 22 2006
- CS8. PyroCu East Gippsland Swifts Ck (Alpine Fires) Victoria, Dec 14 2006
- CS9. PyroCu Delburn Fire Victoria, Jan 30 2009
- CS10. Black Saturday Kinglake Victoria, Feb 7 2009

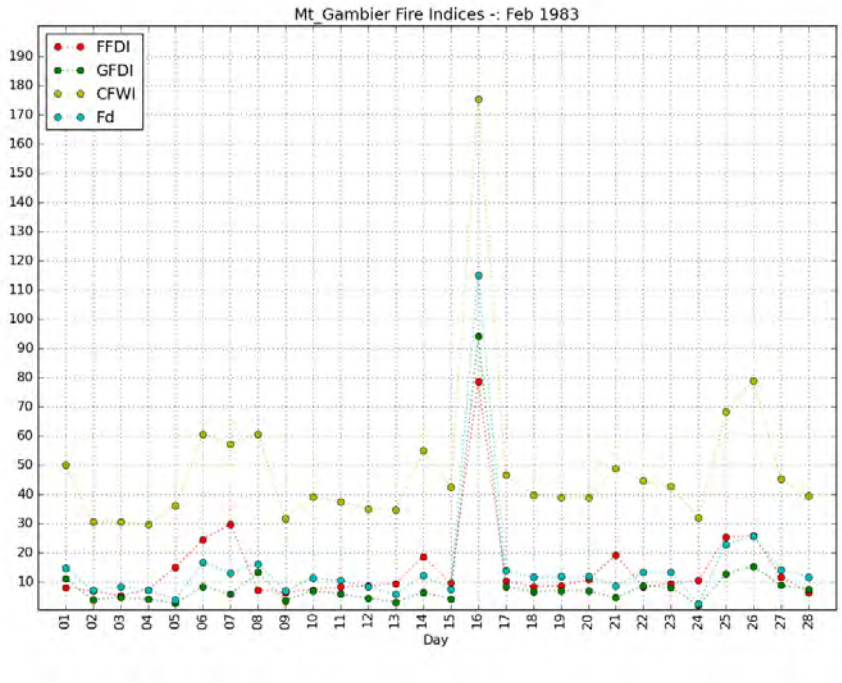

Figure 4.1: Comparison of 4 ERA-I Fire Danger Indices for Mt Gambier, February 1983

Index	Calculated	Mean	Median	P99
FFDI	92.4	16.9	14.6	47.8
GFDI	93.6	9.5	7.5	34.8
CFWI	152.6	45.4	44.2	101.2
FDI	199.3	15.5	12.6	60.5

Table 4.1: ERA-I Fire Danger Indice values Mount Gambier, 0300 UTC 16 February 1983

4.2 CS1. Ash Wednesday Feb 16 1983

Multiple bushfires burned over 4000 km^2 in Victoria and South Australia. Data are presented for two locations, Deans Marsh in Victoria near the source of a major fire in the Otway ranges, and Mt Gambier in South Australia, near another major outbreak which claimed 14 lives.

Model fire danger indices for Mount Gambier on February 16 were all above the 99th percentile range with FFDI of 92, GFDI of 94, CFWI over 152 and Fd almost 200.

Model winds at 0300 were calculated at 46 km.h^{-1} decreasing at the next 2 time steps. Observed winds at Mt Gambier Airport (pre-aws) show a maximum of 61 km.h^{-1} (33 knots) at 0730 UTC, after the passage of a cool change. By 1030 UTC winds had reduced to 33 km.h^{-1}. Ahead of the change winds were 33-40 km.h^{-1} (18-22) knots.

The max temp observed was 40.3 while max T-Td was also 40.3, both recorded at 0130 UTC

Observations near Deans Marsh in 1983 are hard to find. No AWS at this

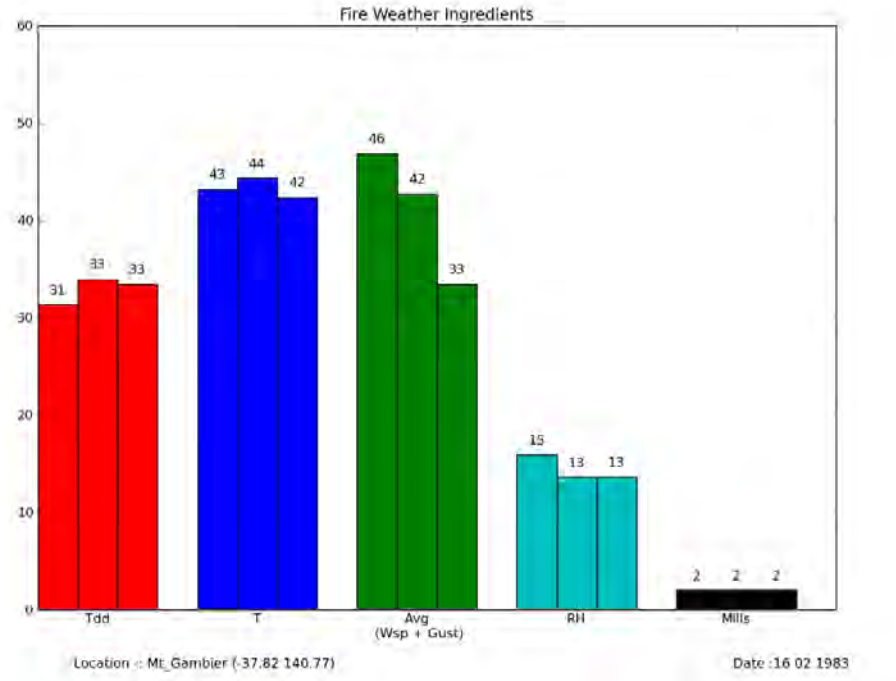

Figure 4.2: ERA-I Fire Weather Ingredients for Mount Gambier, 16 February 1983

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2230	30.6	27.6	31.5 (17)
0130	40.3	40.3	33.4 (18)
0430	40.1	38.1	40.7 (22)
0700	21.7	8.7	61.1 (33)

Table 4.2: Mt Gambier Airport (26021) Observations, 16 February 1983

Index	Calculated	Mean	Median	P99
FFDI	52.5	6.9	5.2	30.9
GFDI	40.4	5.2	3.8	23.5
CFWI	101.7	22.5	20.7	75.8
FDI	71.8	6.7	5.2	34.0

Table 4.3: ERA-I Fire Danger Indice values Deans Marsh, 0300 UTC 16 February 1983

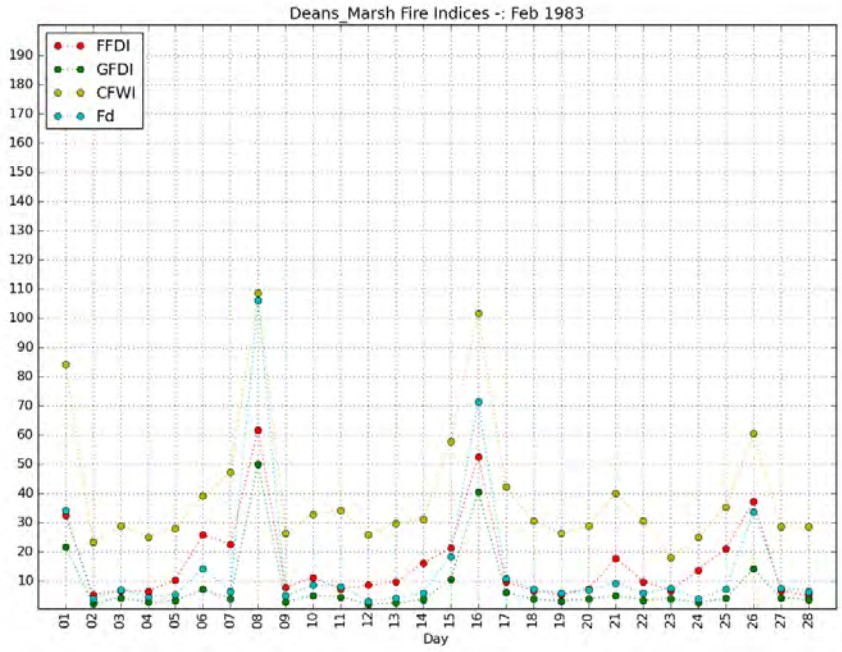

Figure 4.3: Comparison of 4 ERA-I Fire Danger Indices for Deans Marsh, February 1983

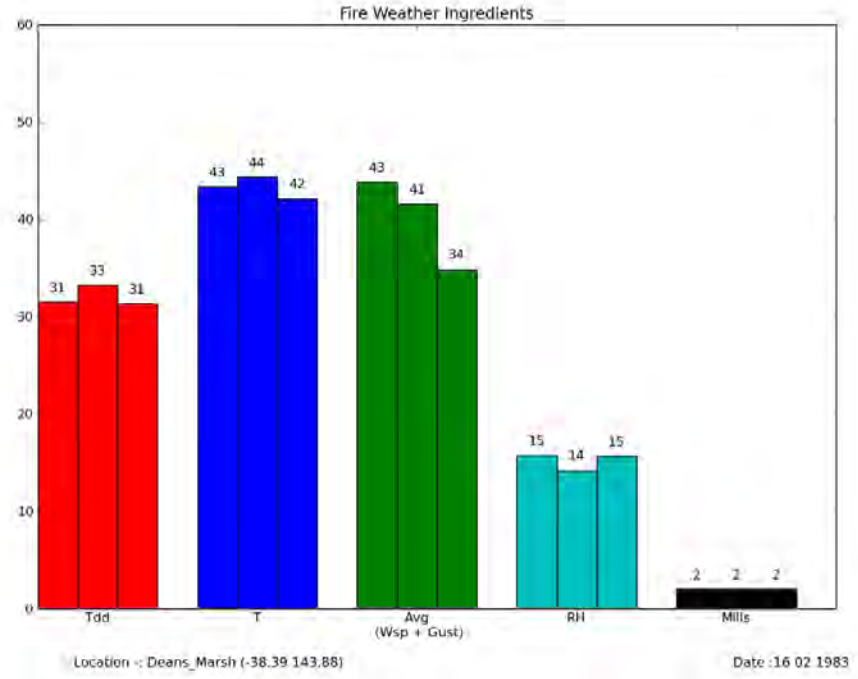

Figure 4.4: ERA-I Fire Weather Ingredients for Deans Marsh 16 February 1983

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	23.6	9.6	0 (0)
0100	38.5	36.5	33 (18)
0400	43.1	32.1	52 (28)
0700	42.5	38.5	46 (25)
1000	28.0	15.0	55 (30)

Table 4.4: Laverton RAAF (87031) Observations, 16 February 1983

Index	Calculated	Mean	Median	P99
FFDI	37.5	16.9	14.6	47.8
GFDI	21.5	9.5	7.5	34.8
CFWI	71.4	45.4	44.2	101.2
FDI	40.3	15.5	12.6	60.5

Table 4.5: Fire Danger Indice values for Berringa, 0300 UTC 25 February 1995

time. The major meteorological feature to affect the fire was the passage of a cool change across the area between 0700 and 0800 UTC (6-7pm local). The Cape Otway Lighthouse (90015) recorded a maximum temperature of 40.6 at Cape Otway with 46 km.h^{-1} (25 kt) winds and T-Td 34.6. Only 22UTC and 04 UTC records were available. At Laverton RAAF the maximum temperature was 43.1 at 0400. Winds ahead of change were 46-52km.h^{-1} (25-28knots), the T-Td maximum was 38.5 at 0700 UTC but >36 from 0100-0700 UTC. The DSE report Billing (1983) describes lookout reports of winds of over 100 km.h^{-1} after the change as being consistent with the Dines anemometer trace from Avalon Airport. This trace shows winds remained above the pre frontal values for 3-4 hours after the change. The windspeed in the reanlysis, with the addition of the gust product, appears to give a reasonable value for the pre-frontal winds but does not discern the post-frontal speed increase. Values of model parameters appear to be reasonable.

4.3 CS2. Berringa Fire Feb 25 1995

On February 25 1995 a fire burned 11,000 ha near Berringa in Victoria. This event was notable for a large convection column above the fire with the plume reaching an estimated height of 10000 metres (Tolhurst and Chatto, 1999)

Unlike the previous case study the fire danger indices for the Berringa fire are all below the 99th percentile. The model FFDI of 37.5 is approximately 50% of that reported for 0230 UTC at the SheOaks AWS 48km to the SE. This value of 77 assumed a DF of 10 occurred with a maximum temperature of 36, RH of 6% and NW winds 33km.h^{-1} gusting to 50 km.h^{-1}. After this the winds dropped off rapidly to around 20 km.h^{-1}. A portable AWS, which began operating at Staffordshire Reef at 1740hrs local time (0640 UTC), recorded a maximum FFDI of 40 at 1800 local (0700 UTC) Temperature at this time was 36.2, the RH 12 (Leggett, 1999).

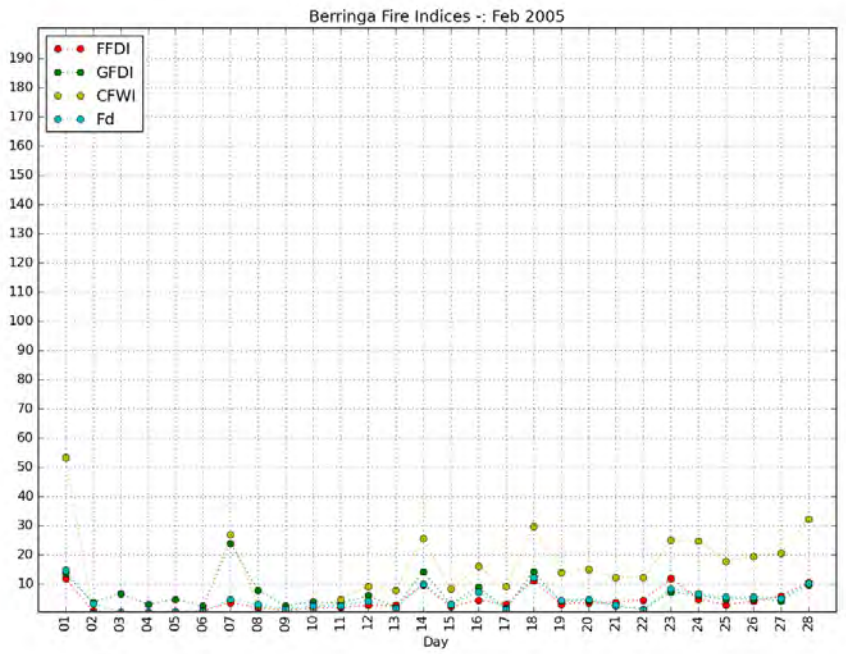

Figure 4.5: Comparison of 4 Fire Danger Indices for Berringa, 25 February 1995

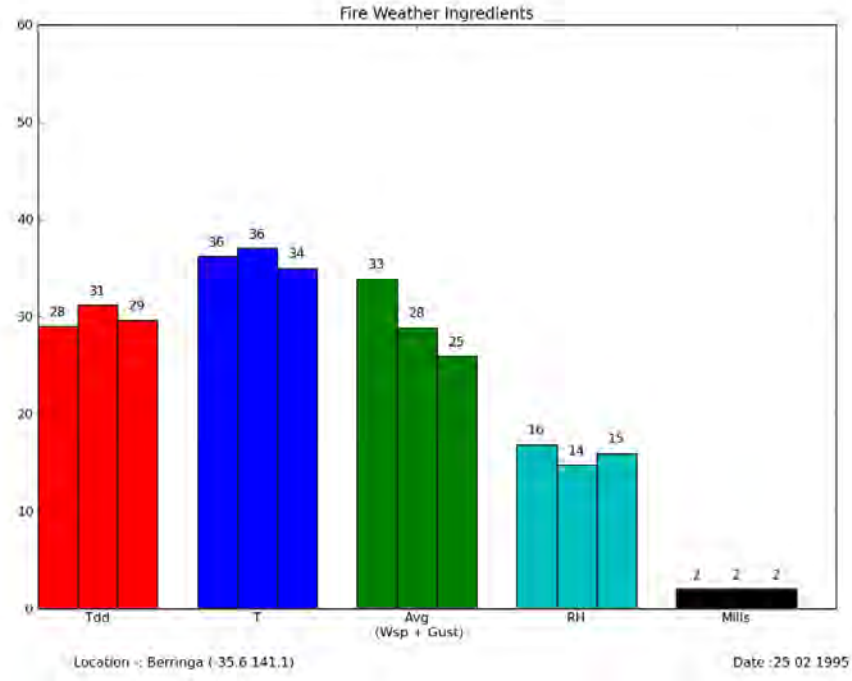

Figure 4.6: Fire Weather Ingredients for Berringa 25 February 1995

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	27.8	20.2	27.8 (15)
0130	34.6	36.9	31.5 (17)
0430	36.7	40.6	25.9 (14)
0700	35.9	41.2	9.3 (5)

Table 4.6: SheOaks AWS (87168) Observations, 25 February 1995

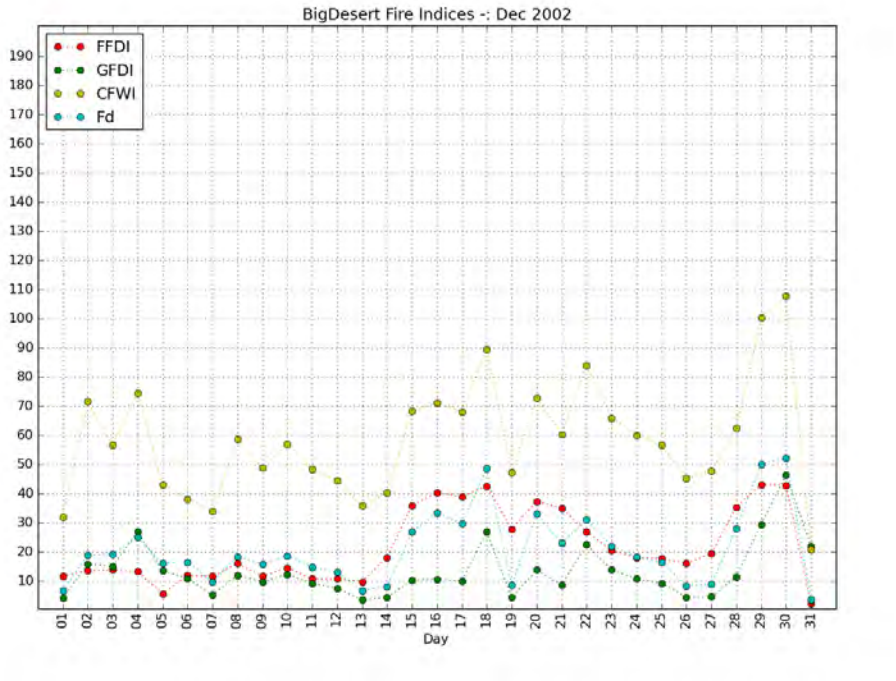

Figure 4.7: Comparison of 4 Fire Danger Indices for Big Desert, December 2002

Compared to the observations at SheOaks the model temperatures and winds are reasonable but the models dewpoint depression is about 10 degrees too low. This indicates that model environment is moister than the observations, lowering the model FFDI.

4.4 CS3. Big Desert Fire Dec 17 2002

Lightning was responsible for the ignition of a major fire in the Big Desert in northwest Victoria on 17 December 2002. Not contained until Christmas eve the fire burned over 180000 hectares and displayed some extreme fire behaviour (Wareing and Flinn, 2003)

None of the fire indices were above the 99th percentile threshold for either 17 or 18 December 2002

Walpeup is the nearest AWS, 80 km east from the fire site. Lameroo, a manual station 60 km west of the fire recorded a maximum temperature of 41.8 C with winds of a similar strength to the Walpeup observations. Model temperatures appear reasonable while the winds are a little stronger than

Index	17 Dec	18 Dec	Mean	Median	P99
FFDI	38.8	42.5	13.9	11.9	48.4
GFDI	9.9	26.8	10.5	8.3	44.9
CFWI	68.1	89.3	43.8	41.8	108.9
FDI	29.6	50.3	13.8	10.9	79.4

Table 4.7: Fire Danger Indice values for Big Desert, 0300 UTC 17-18 December 2002

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	29.7	24.0	16.7 (9)
0100	38.3	40.0	7.4 (4)
0400	39.5	42.1	11.1 (6)
0700	38.0	39.9	20.4 (11)

Table 4.8: Walpeup AWS(26021) Observations, 17 December 2002

the observations. The model is slightly moister than the observations. The value of the Mills Index here is 4, the highest of all case studies presented.

4.5 CS4. NE Vic Fires Jan 7 2003

Late on 7 January 2003 lightning from a number of thunderstorms began a series of fires in eastern Victoria, southern NSW and the ACT. The major fires that susequently developed were the largest since the 1939 fires, burning over 1 million hectares.(Wareing and Flinn, 2003)

Observations from the Wangaratta Airport AWS, 55km away, show evidence of rapid drying at the surface, the dewpoint depression reaching 48.6 at 0400 UTC.

4.6 CS5. Canberra Fire Jan 18 2003

Fire indices are all in the 99th percentile. Model has overestimated the temperatures by 5 degrees and slightly underestimated the windspeed

Index	Calculated	Mean	Median	P99
FFDI	42.4	15.3	13.7	47.1
GFDI	16.6	9.5	7.8	39.2
CFWI	66.9	33.2	31.9	88.3
FDI	46.7	14.0	11.0	61.2

Table 4.9: Fire Danger Indice values for Mt Buffalo, 0300 UTC 7 January 2003

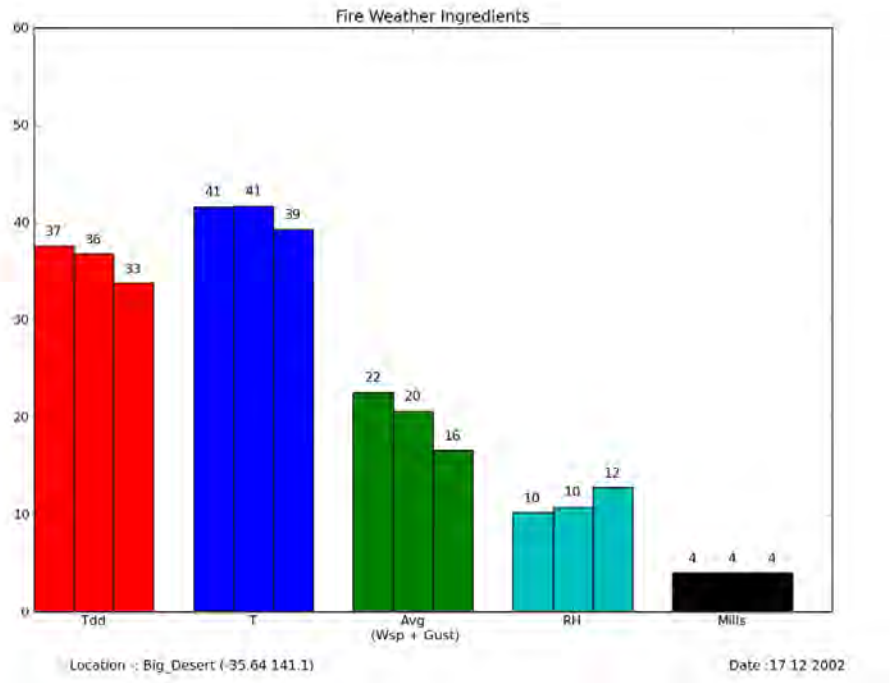

Figure 4.8: Fire Weather Ingredients for Big Desert 17 December 2002

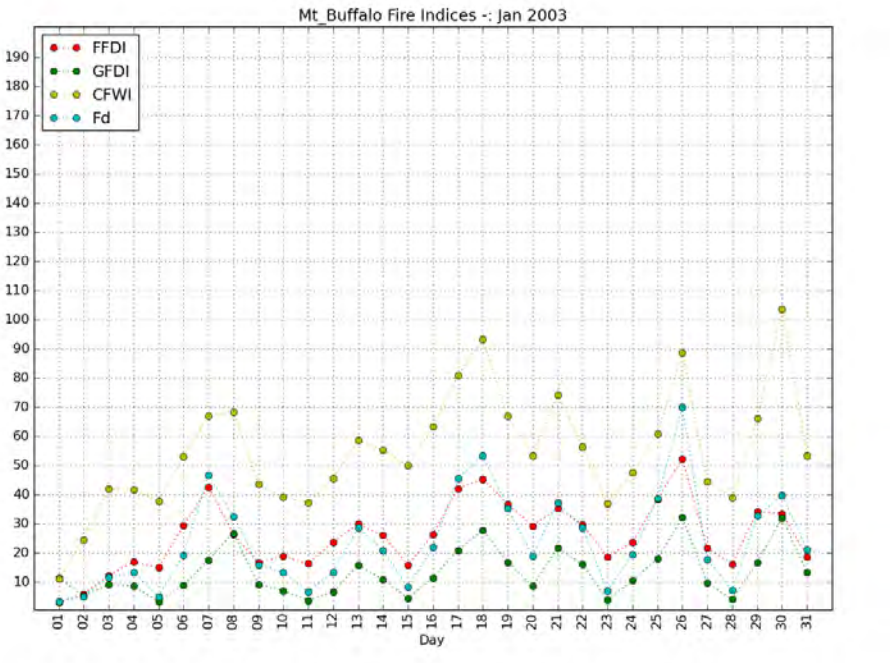

Figure 4.9: Comparison of 4 Fire Danger Indices for Mt Buffalo, January 2003

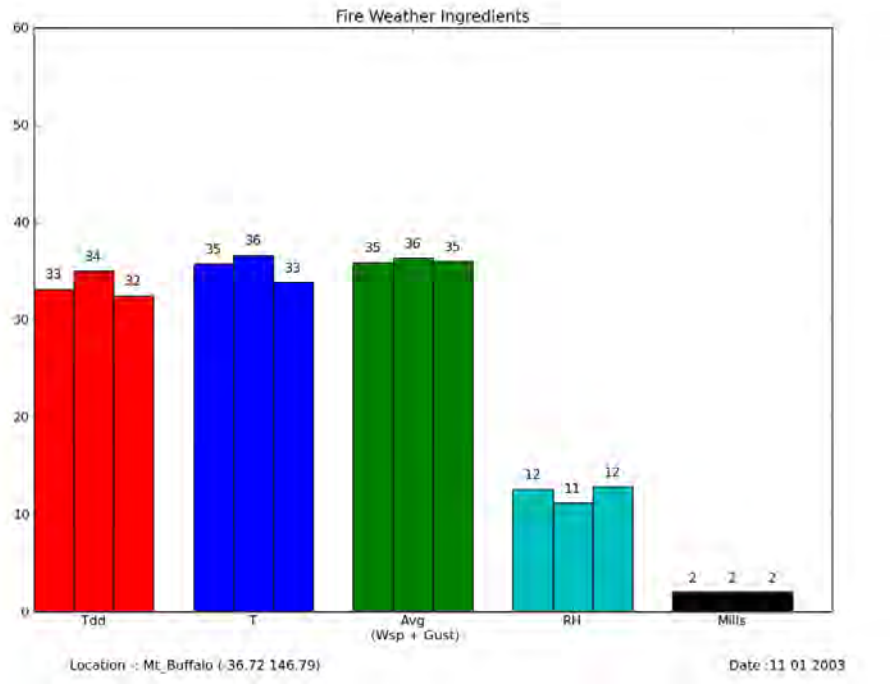

Figure 4.10: Fire Weather Ingredients for Mount Buffalo, 11 January 2003

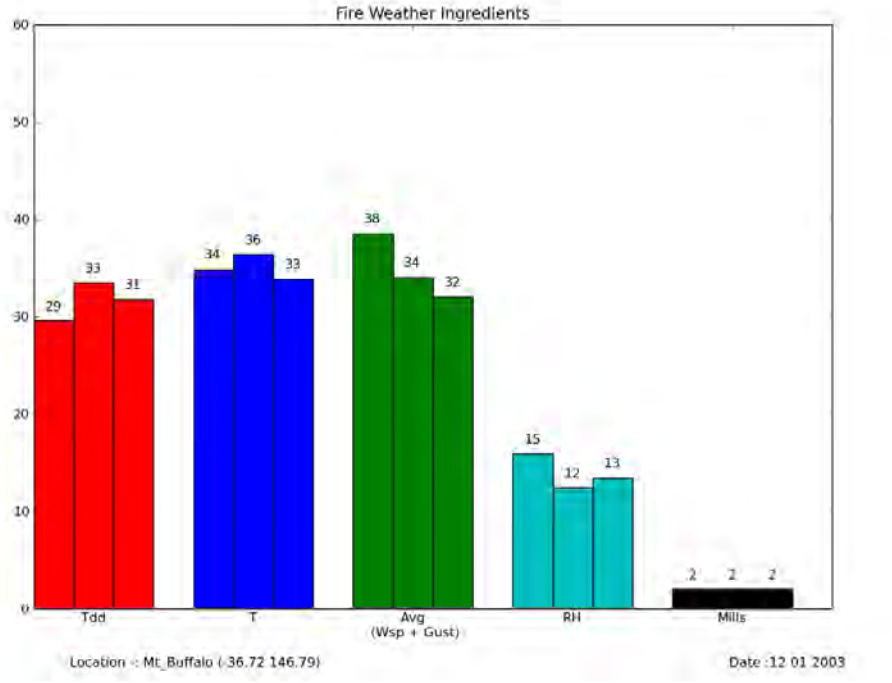

Figure 4.11: Fire Weather Ingredients for Mount Buffalo, 12 January 2003

4.7 CS6. Wangary Fire Jan 10-11 2005

The Wangary fire began on Monday 10 January and broke through containment lines on the morning of 11 January propelled by mean winds of 40-50km.h^{-1}.(Nairn et al., 2005)

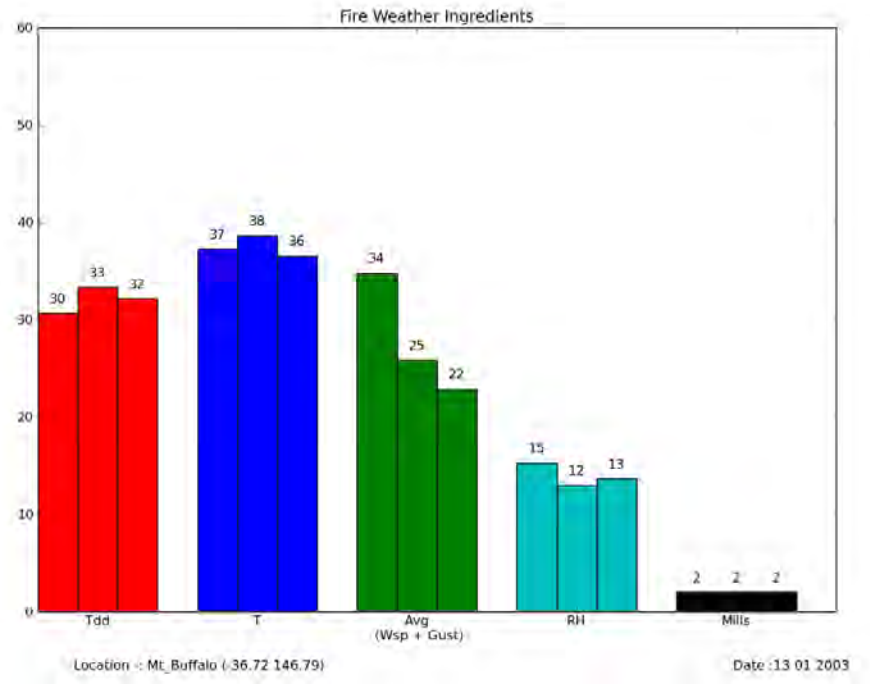

Figure 4.12: Fire Weather Ingredients for Mount Buffalo, 18 January 2003

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	23.7	13.3	5.6 (3)
0100	34.3	36.0	18.5 (10)
0400	37.1	48.6	27.8 (15)

Table 4.10: Wangaratta Airport (82138) Observations, 7 January 2003

Because the fire was on the Eyre Peninsula and the nearest model grid points were over the ocean, the fire danger index calculations presented here are for Lock about 100 km north of the fire location.

Only CFWI is in the 99th percentile on the 11th although the other indices exceed the 95th percentile. Model temps appear to be consistent with the observations as are the dewpoint depressions.The BoM report (Nairn et al., 2005) notes that the Coles Point AWS is more representative of conditions than that at Port Lincoln. However both have higher windspeeds and lower temperatures than the model does for Lock.

Fire Indices table for Coles Point shows very low values for all products

Index	Calculated	Mean	Median	P99
FFDI	64.0	12.8	11.7	41.3
GFDI	50.5	8.9	6.7	34.3
CFWI	107.7	27.2	24.8	83.3
FDI	98.7	11.6	8.8	48.1

Table 4.11: Fire Danger Indice values for Canberra, 18 January 2003

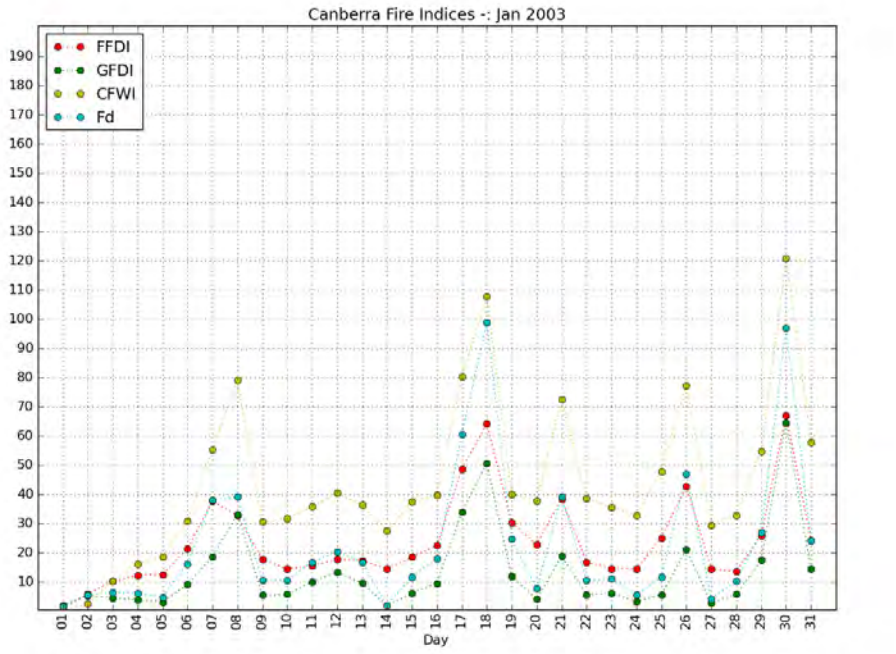

Figure 4.13: Comparison of 4 Fire Danger Indices for Canberra, January 2003

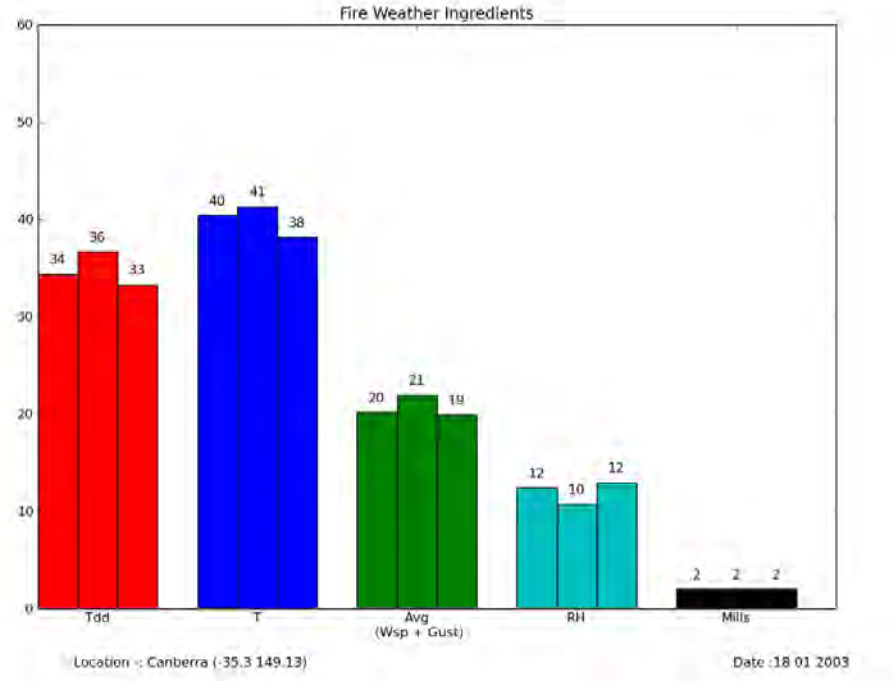

Figure 4.14: Fire Weather Ingredients for Canberra 18 January 2003

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	27.9	19.1	0 (0)
0100	35.8	30.6	24.1 (13)
0400	35.6	39.3	24.1 (13)
0700	35.2	45.2	24.1 (13)

Table 4.12: Tuggerong AWS (70339) Observations, 18 January 2003

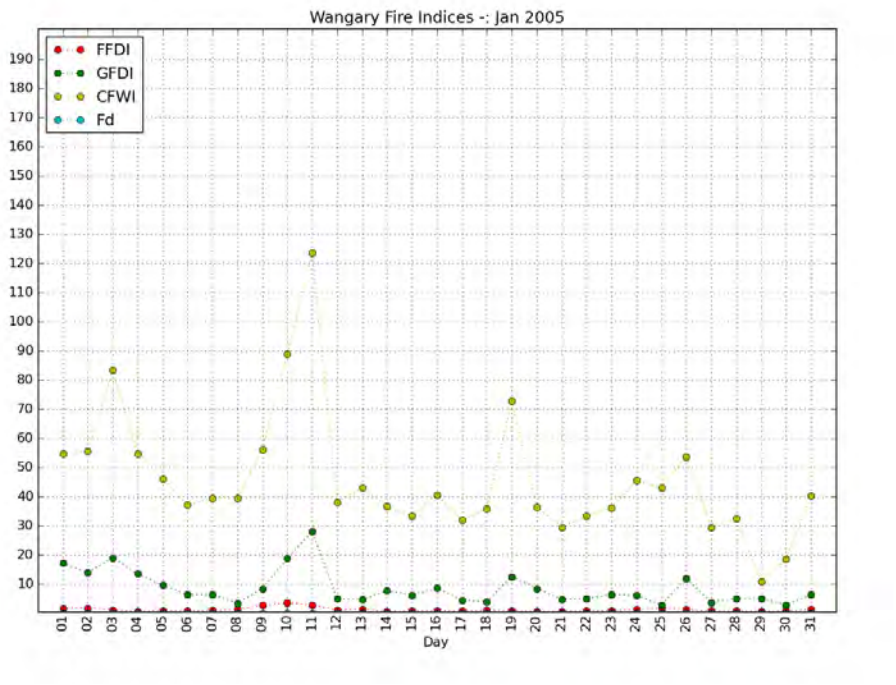

Figure 4.15: Comparison of 4 Fire Danger Indices for Wangary, January 2005

Index	Calculated	Mean	Median	P99
FFDI	52.2	16.5	12.8	58.2
GFDI	40.0	9.9	8.0	43.4
CFWI	130.5	47.5	44.4	111.7
FDI	66.6	16.5	12.7	89.9

Table 4.13: Fire Danger Indice values for Lock, 11 January 2005

Time	Temp	T-Td	Windspeed km.h-1 (knots)
2230	30.9	28.7	38.9
0130	27.7	26.8	25.9
0430	27.5	46.1	29.5
0730	21.7	43.4	29.5

Table 4.14: Coles Point AWS (18191) Observations 11 January 2005

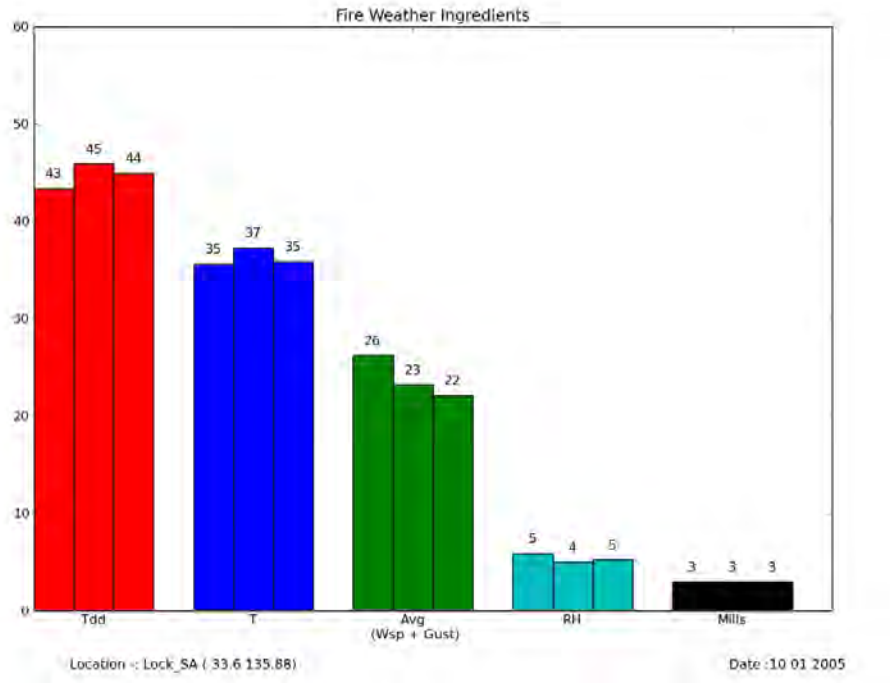

Figure 4.16: Fire Weather Ingredients for Lock 10 January 2005

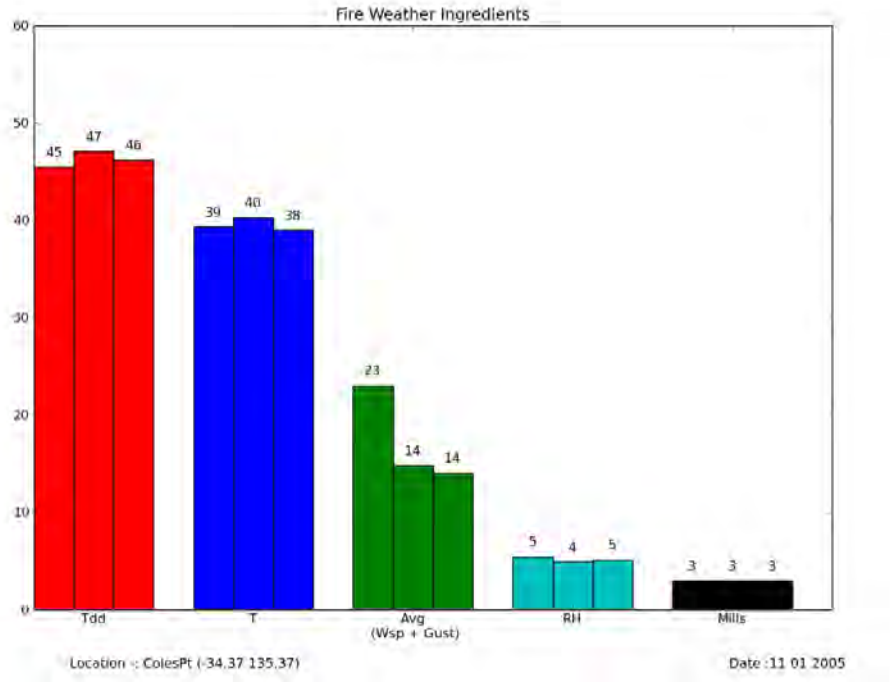

Figure 4.17: Fire Weather Ingredients for Coles Point 11 January 2005

Index	Calculated	Mean	Median	P99
FFDI	0.4	0.4	0.3	1.0
GFDI	8.5	6.2	5.7	16.9
CFWI	86.0	38.2	36.4	93.7
FDI	0.0	0.0	0.0	0.0

Table 4.15: Fire Danger Indice values for Coles Point

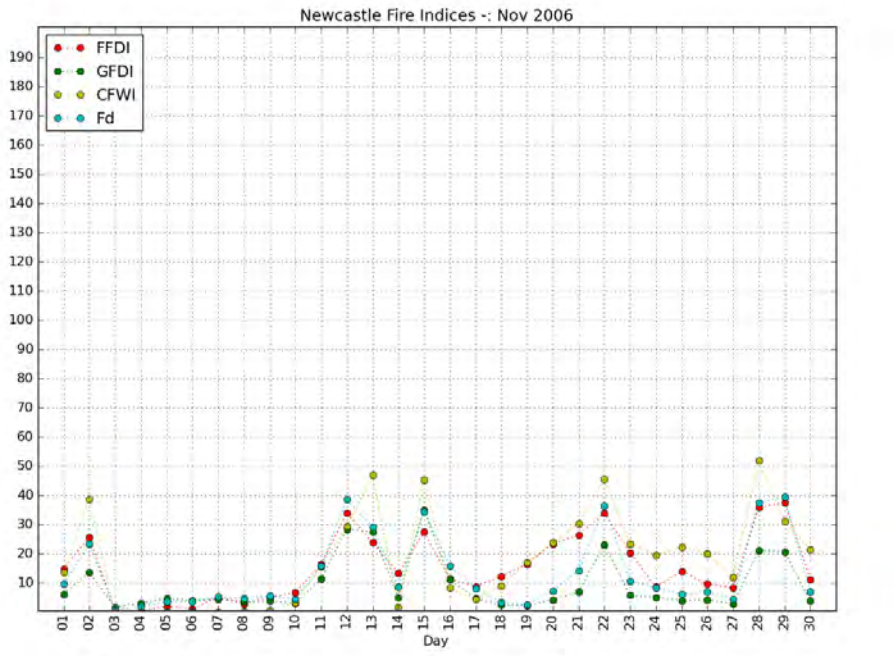

Figure 4.18: Comparison of 4 Fire Danger Indices for Newcastle, November 2006

utilising the DF in their calculations. The 99th percentile for FFDI is only 1.0 while Fd does not register. The observed FFDI for Coles Point reached a maximum of 38 while at Port Lincoln a peak of 122 was recorded. (Nairn et al., 2005)

4.8 CS7. PyroCu Newcastle Nov 22 2006

Despite lower values the 2 of the 4 indices (FFDI and Fd) here are almost in the 99th percentile. The model would appear to be dryer than the observations and have slightly higher temperatures but the AWS is near the ocean while the fire location is slightly inland.

Index	Calculated	Mean	Median	P99
FFDI	28.8	6.8	4.8	34.3
GFDI	23.1	6.0	4.0	30.6
CFWI	45.4	12.9	8.5	61.3
FDI	37.1	6.3	4.0	37.6

Table 4.16: Fire Danger Indice values for Newcastle, 22 November 2006

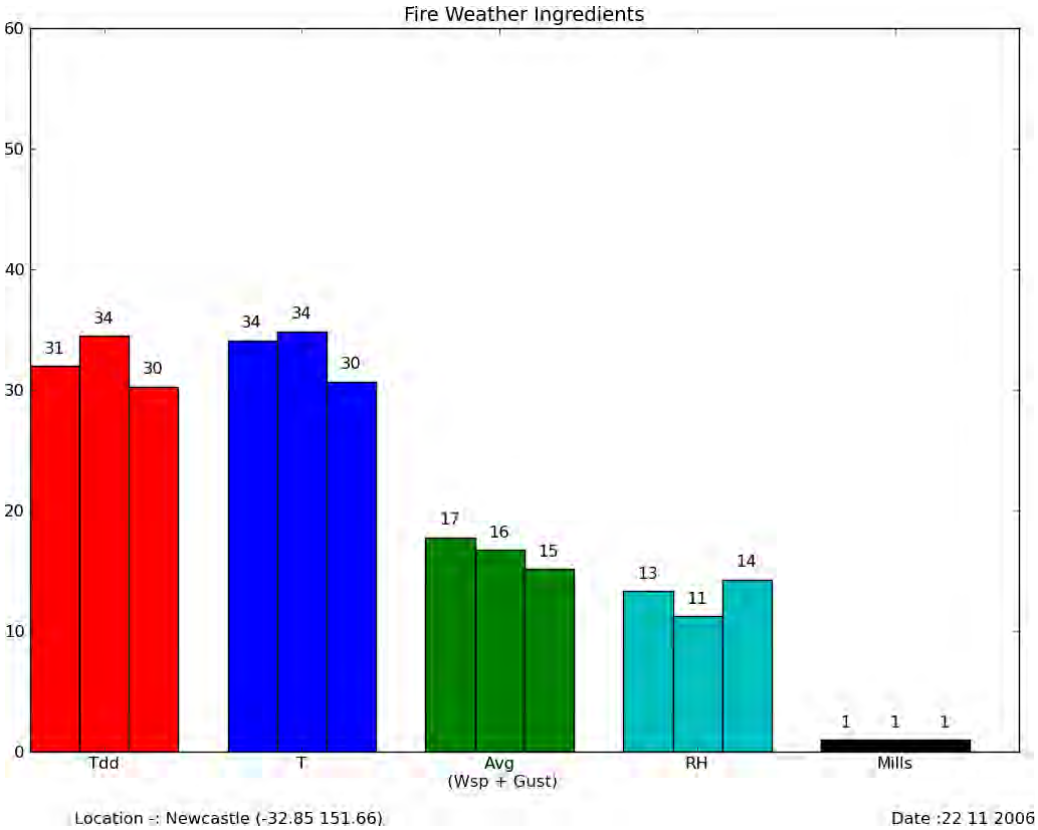

Figure 4.19: Fire Weather Ingredients for Newcastle 22 November 2006

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	28.8	20.3	33.3 (18)
0100	30.1	20.5	22.2 (12)
0400	33.3	23.9	33.3 (18)
0700	29.6	19.9	35.2 (19)

Table 4.17: Newcastle AWS (61055) Observations, 22 November 2006

Index	Calculated	Mean	Median	P99
FFDI	36.5	6.4	5.1	24.5
GFDI	27.1	5.4	4.0	20.6
CFWI	79.3	16.1	13.5	60.9
FDI	40.8	5.7	4.1	24.1

Table 4.18: Fire Danger Indice values Swifts Creek, 14 December 2006

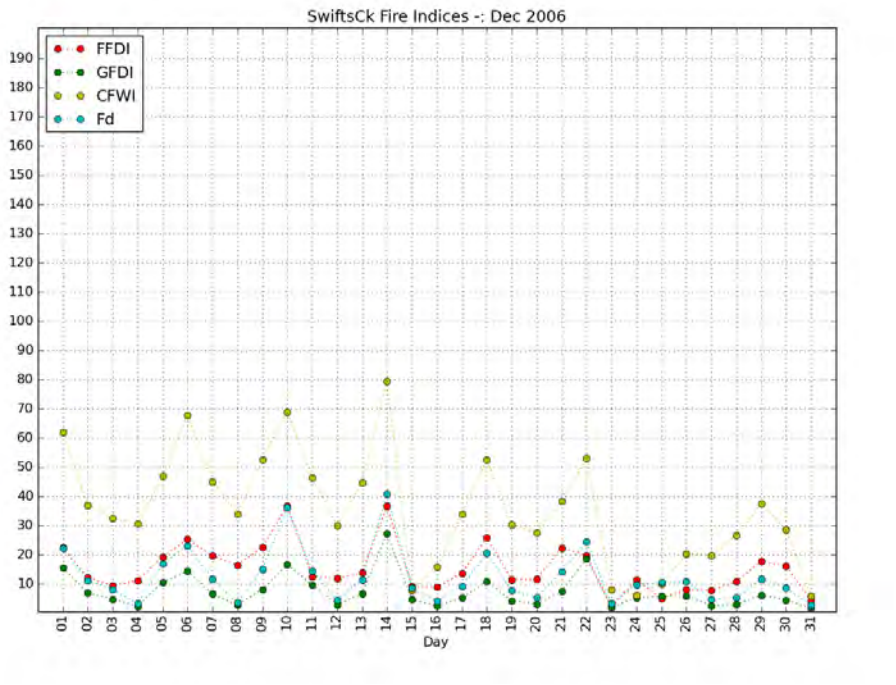

Figure 4.20: Comparison of 4 Fire Danger Indices for Swifts Creek, December 2006

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	17.7	13.0	0 (11)
0100	28.3	30.0	25.9 (14)
0400	29.2	30.2	29.6 (16)
0700	27.0	27.9	27.8 (15)

Table 4.19: Omeo AWS (83090) Observations, 14 December 2006

4.9 CS8 PyroCu East Gippsland Swifts Ck (Alpine Fires) Dec 14 2006

The values of all indices may appear low for this event but all exceed the 99th percentile value. The model temperatures appear on the high side compared to the observations but the Omeo AWS, while only 20 km away, is 400 metres higher than Swifts Creek.

4.10 CS9 PyroCu Delburn Fire Jan 28-30 2009

This fire began on January 28,at Delburn, west of Boolarra. On January 30 a large pyro-cumulus was observed above the fire by one of the authors (aw)

On January 28 none of indices are in the 99th percentile but FFDI and Fd are in the 95th percentile and CFWI is close (0.4 below). GFDI is fairly low.

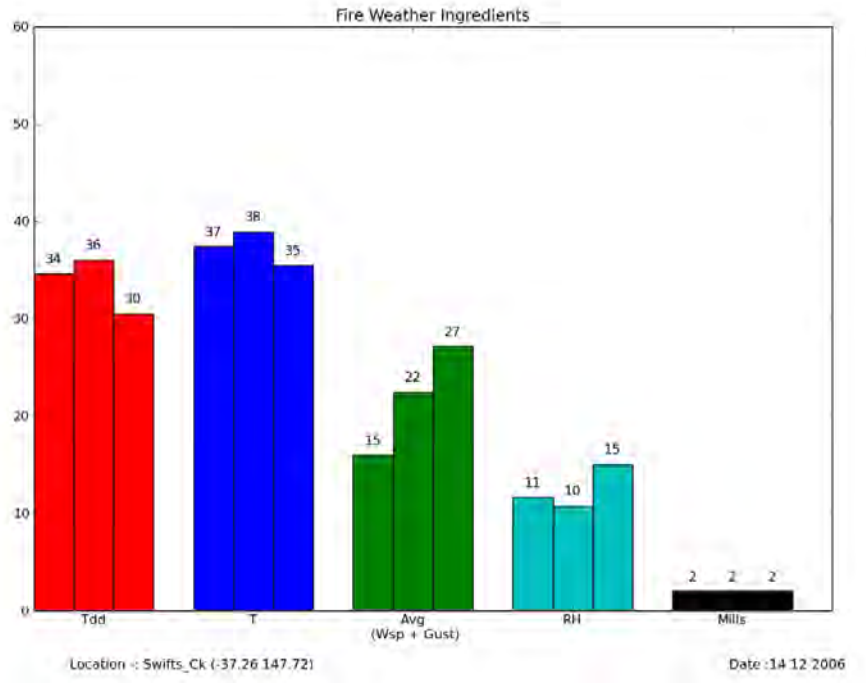

Figure 4.21: Fire Weather Ingredients for Swifts Creek 14 December 2006

Index	Jan 28	Jan 29	Jan 30	Mean	Median	P99
FFDI	34.8	43.5	40.5	8.9	6.7	39.0
GFDI	11.4	21.7	13.0	6.5	4.9	34.4
CFWI	47.7	60.2	54.7	17.0	14.2	65.4
FDI	27.6	48.7	37.1	8.7	6.6	45.4

Table 4.20: Fire Danger Indice values Delburn, 28-30 January 2009

Figure 4.22: Cloud above Delburn fire viewed from the Princes Fwy west of Morwell (authors photo)

January 29th indice values for FFDI and Fd exceed the 99th percentile value while CFWI is within the 95th percentile. Model temperatures are 3-4 degrees below the observations as are the T-Td values. Windspeeds would appear to be over estimated

Only FFDI exceeds the 99th percentile value on January 30. Windspeeds are much higher in the model, temperatures 3-4 degrees cooler at 0300 when the indices were calculated but OK at 0600 and 0900

4.11 CS10 Black Saturday Kinglake/ Feb 7 2009

Extreme values were calculated for all indices. FFDI and GFDI were more than double the 99th percentile value, Fd was nearly 4 times more than the 99th percentile and CFWI 1.6 times.

Of all ERA-I FFDI values calculated for Kinglake, February 7 2009 provided the record values for 00, 03, 06 and 09 UTC. The early morning FFDI (21 UTC on Feb 6) was only ranked 16th of 2970 entries. At 00 UTC FFDI was 60, 13 index points above the next highest. By 03 UTC FFDI was 92 and at 06 UTC reached 104 some 30 points above the previous record value. At 09 UTC the FFDI value had declined to 53 but was still 10 points higher than the 2 next best days,one of which was Ash Wednesday 1983.

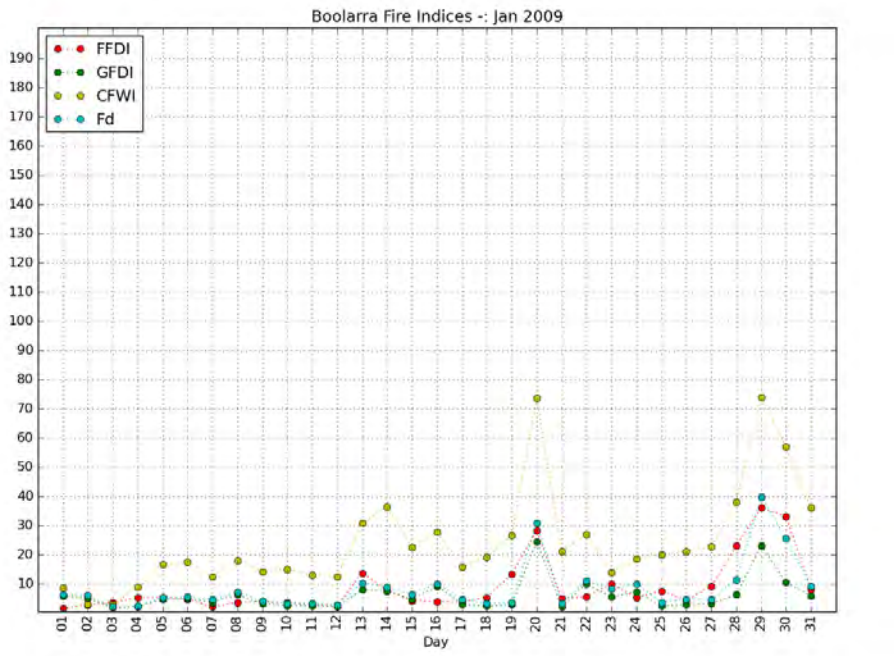

Figure 4.23: Comparison of 4 Fire Danger Indices for Boolarra, January 2009

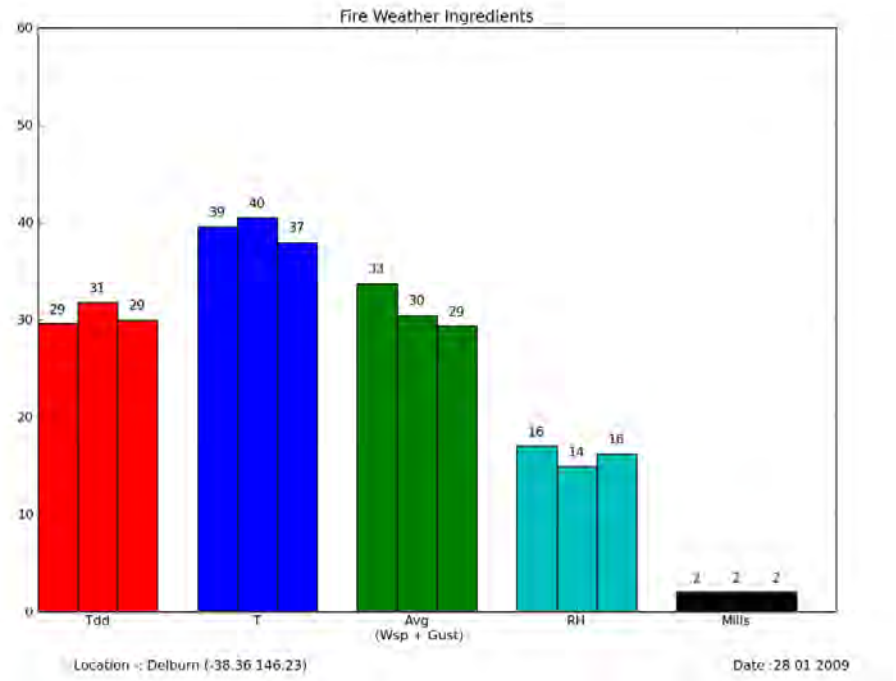

Figure 4.24: Fire Weather Ingredients for Delburn January 28 2009

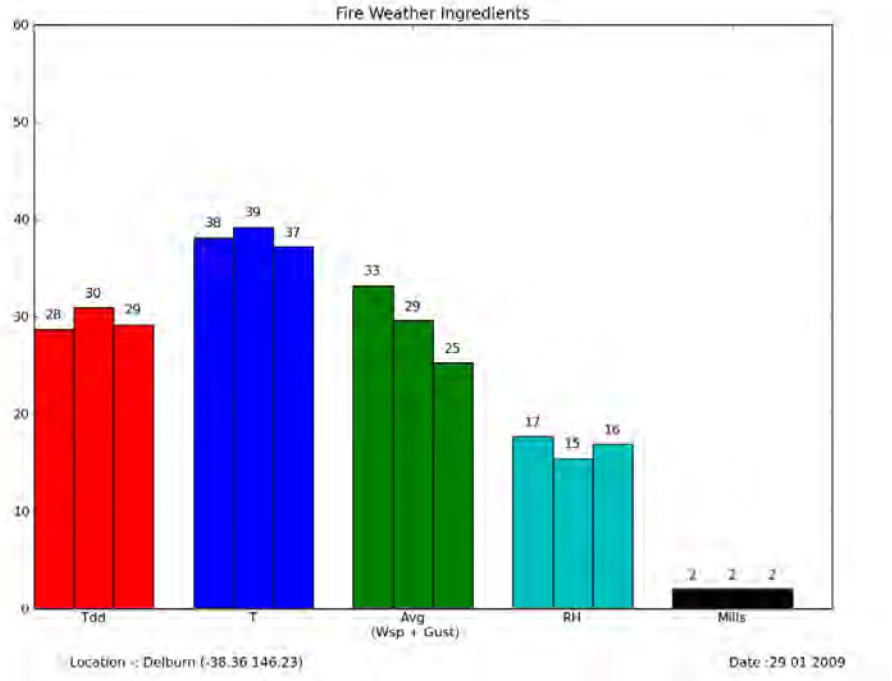

Figure 4.25: Fire Weather Ingredients for Delburn January 29 2009

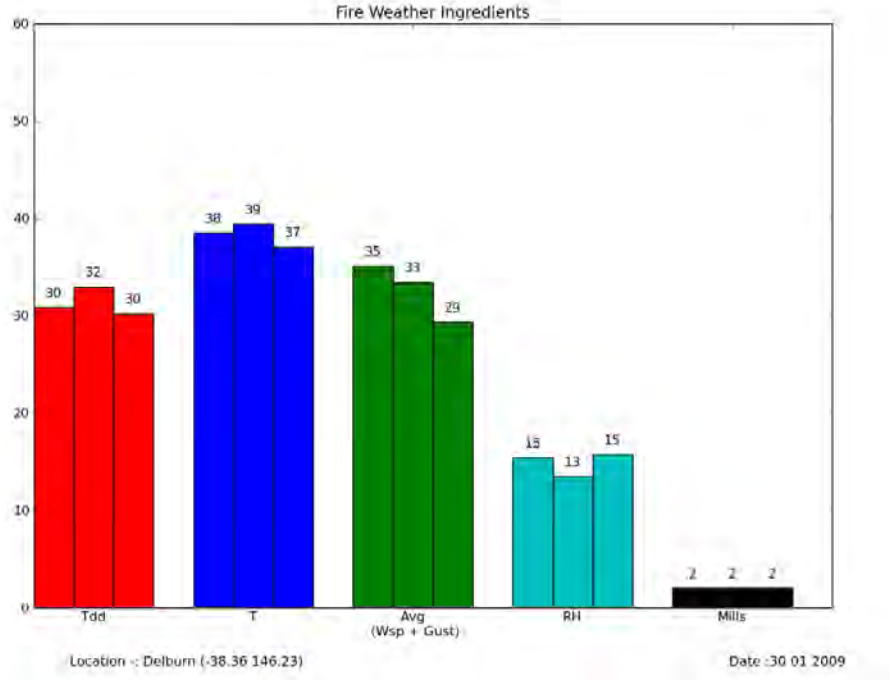

Figure 4.26: Fire Weather Ingredients for Delburn January 30 2009

Time	Temp	T-Td	Windspeed km.h-1 (knots)
2200	22.4	10.6	9.3 (5)
0100	35.8	27.2	9.3 (5)
0400	41.4	37.7	20.4 (11)
0700	38.5	30.3	22.2 (12)
Jan 28 2009			
2200	29.0	15.8	5.6 (3)
0100	41.1	32.8	27.8 (15)
0400	43.2	36.8	24.1 (13)
0700	42.8	36.7	16.7 (9)
Jan 29 2009			
2200	29.7	14.2	9.3 (5)
0100	42.3	35.3	16.7 (9)
0400	43.3	36.8	13.0 (7)
0700	38.3	26.9	7.4 (4)
Jan 30 2009			

Table 4.21: Latrobe Valley Airport AWS (85280) Observations for 4 times on January 28,29 and 30, 2009

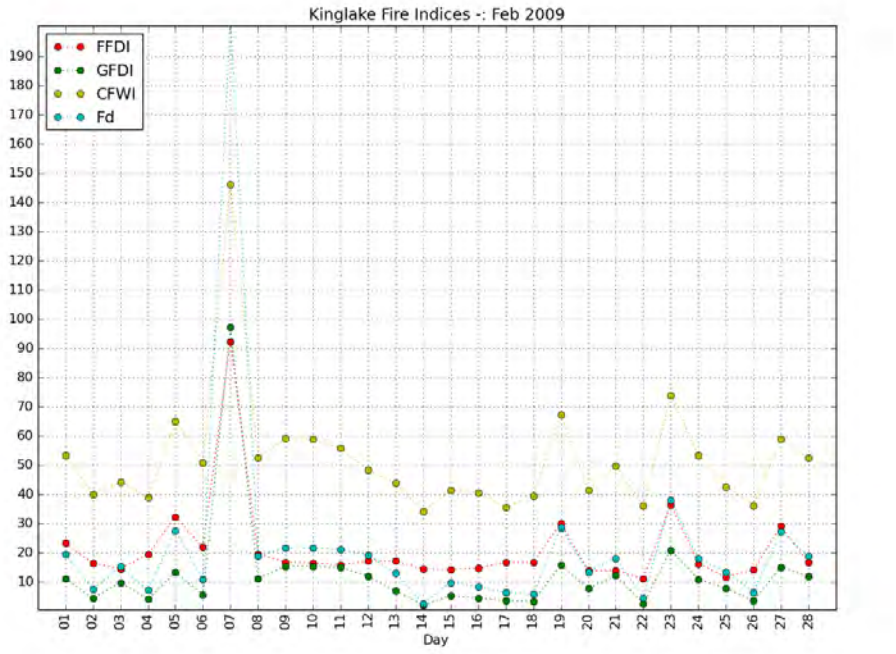

Figure 4.27: Comparison of 4 Fire Danger Indices for Kinglake, February 2009

Index	Calculated	Mean	Median	P99
FFDI	92.2	13.1	11.6	45.5
GFDI	97.1	9.0	7.1	40.9
CFWI	146.1	33.0	31.6	91.1
FDI	204.0	12.7	10.1	55.6

Table 4.22: Fire Danger Indice values Kinglake, 0300 UTC 7 February 2009

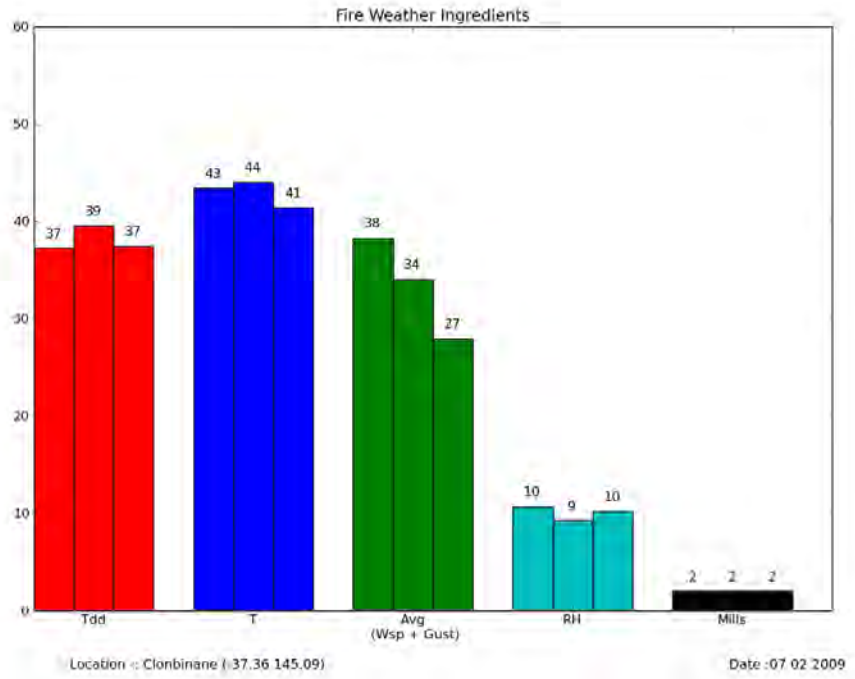

Figure 4.28: Fire Weather Ingredients for Clonbinane (near Kinglake) 7 February 2009

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	35.2	24.9	9.3 (16)
0100	41.9	34.1	16.7 (21)
0400	44.3	40.0	13.0 (22)
0700	32.8	19.8	7.4 (26)

Table 4.23: Coldstream AWS (86383) Observations, 7 February 2009

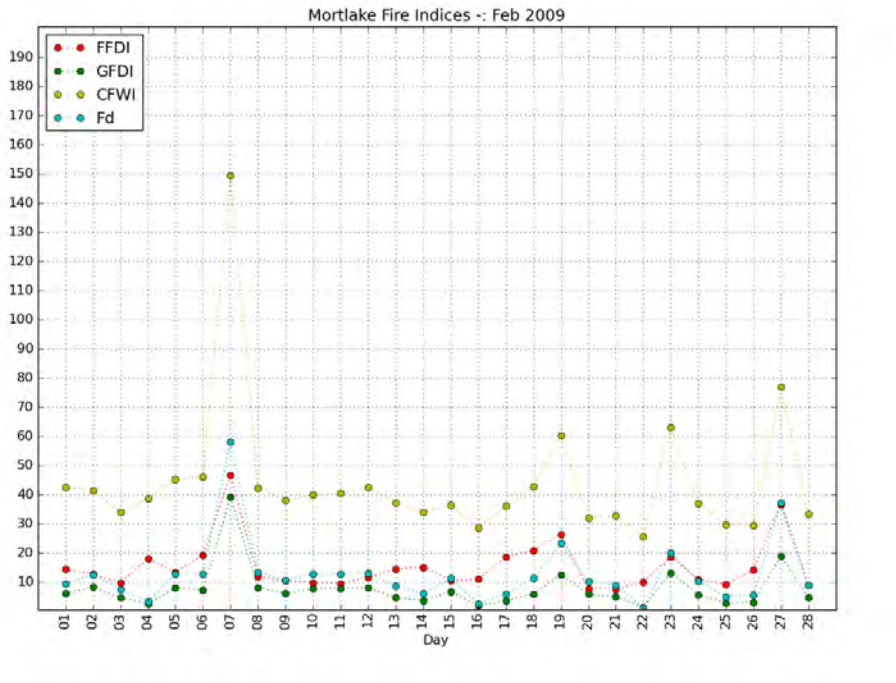

Figure 4.29: Comparison of 4 Fire Danger Indices for Mortlake, February 2009

For Mortlake all indices exceeded the 99th percentile value but not to the same extent as for the Kinglake grid point.

Index	Calculated	Mean	Median	P99
FFDI	46.5	11.3	9.2	40.2
GFDI	39.1	6.8	5.2	29.7
CFWI	149.4	29.6	28.2	82.7
FDI	58.5	10.1	8.0	44.9

Table 4.24: Fire Danger Indice values for Mortlake, 0300 UTC 7 February 2009

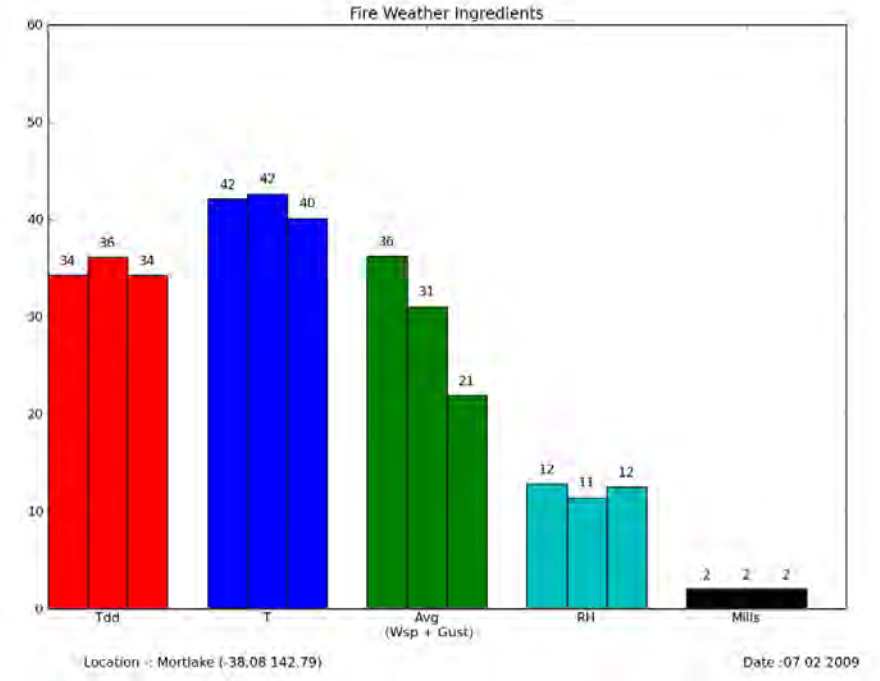

Figure 4.30: Fire Weather Ingredients for Mortlake 7 February 2009

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	30.4	19	24.1 (13)
0100	41.7	37.8	51.9 (28)
0400	28.5	13.8	40.8 (22)
0700	30.4	16.7	27.8 (15)

Table 4.25: Mortlake AWS (90176) Observations, 7 February 2009

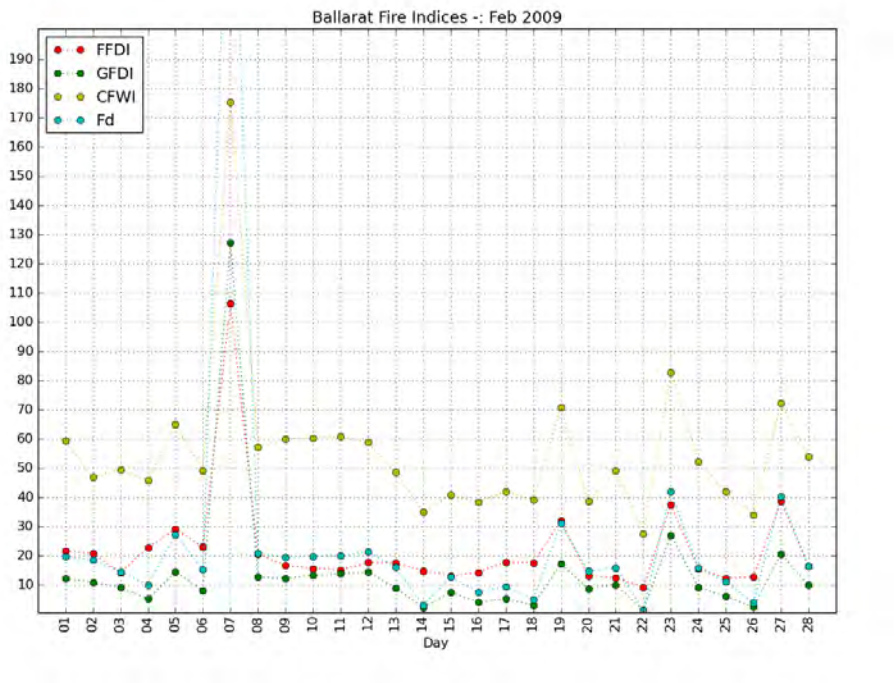

Figure 4.31: Comparison of 4 Fire Danger Indices for Ballarat, February 2009

Index	Calculated	Mean	Median	P99
FFDI	106.3	14.1	12.4	48.3
GFDI	127.1	9.7	7.5	41.8
CFWI	175.3	39.0	38.2	107.0
FDI	273.4	13.9	11.4	60.1

Table 4.26: Fire Danger Indice values for Ballarat, 7 February 2009

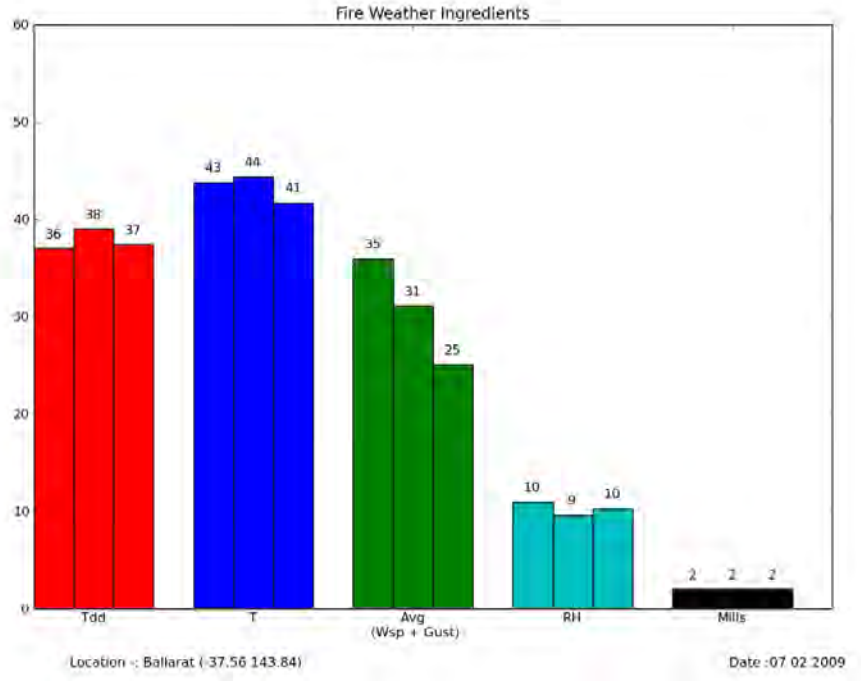

Figure 4.32: Fire Weather Ingredients for Ballarat 7 February 2009

Model winds underestimate the values observed at Ballarat. Model temperatures and dewpoint depression appear reasonable. All indices exceed the 99th percentile, GFDI and Fd exceed the threshold by a factor of 4.

Pretty good agreement between model data and observations at Latrobe Valley Airport. All fire indices in the 99th percentile by a large margin

4.11.1 Case Study Summary

- Black Saturday the most extreme case study in terms of index values
- Almost all of observations for these events have maximum values for dewpoint depression >35 C. The exceptions are the Newcastle event where the AWS is near the ocean and the Swifts Creek event where the nearest AWS is at Omeo at an elevation 400 metres higher
- For all case studies the values of all Fire danger indices are well above the median values for that location.
- Based on the evidence of these few case studies ERA-I appears to be quite good at capturing historical events.

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	30.3	22.2	38.9 (21)
0100	39.2	37.1	48.2 (26)
0400	43.1	45.2	61.1 (33)
0700	27.6	16.0	24.1 (13)

Table 4.27: Ballarat AWS (89002) Observations, 7 February 2009

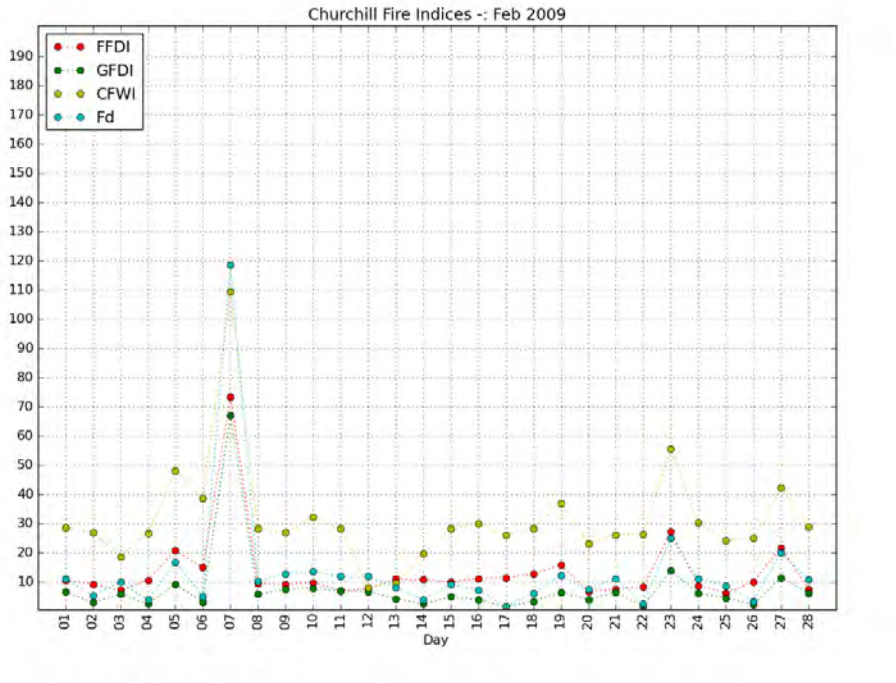

Figure 4.33: Comparison of 4 Fire Danger Indices for Churchill, February 2009

Index	Calculated	Mean	Median	P99
FFDI	73.4	9.0	7.4	37.7
GFDI	66.9	5.8	4.4	30.2
CFWI	109.3	17.5	15.3	63.4
FDI	118.5	8.5	6.5	43.3

Table 4.28: Fire Danger Indice values for Churchill, 7 February 2009

Time	Temp	T-Td	Windspeed km.h^{-1} (knots)
2200	25.7	10.0	1.9 (1)
0100	42.7	36.7	31.5 (17)
0400	44.5	38.5	42.6 (23)
0700	42	37.9	37.0 (20)
1000	28	13.7	0.0 (0)

Table 4.29: Latrobe Valley Airport AWS (85280) Observations, 7 February 2009

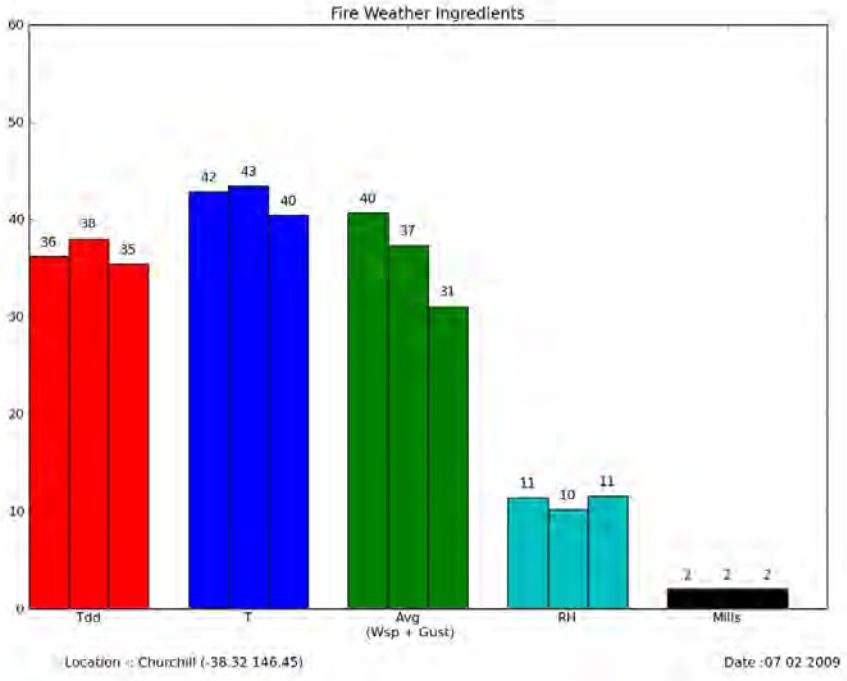

Figure 4.34: Fire Weather Ingredients for Churchill 7 February 2009