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# Proceedings of the 2011 Fire Weather and Risk Workshop

Science workshop held following AFAC/BCRC 2011 Conference

*G.A. Mills, R.P. Cechet, and R.H.D. McRae*

Record
2012/35
GeoCat # 73777

# Proceedings of the 2011 Fire Weather and Risk Workshop

Thursday Sept. 1st to Sunday Sept. 4th 2011
Peppers Craigieburn, Bowral,
Southern Highlands (NSW)

Workshop Convenor: Graham Mills

A science workshop that was held immediately following the
AFAC/BCRC 2011 Conference (held at Darling Harbour, Sydney).

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RECORD 2012/35

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**ISSN 1448-2177**
**ISBN web 978-1-9222103-12-3**
**ISBN CD/DVD 978-1-9222103-13-0**
**ISBN Hardcopy 978-1-9222103-14-7**

**GeoCat # 73777**

**Bibliographic reference**: Mills *et al*, 2012. Proceedings of the Fire Weather and Risk Workshop, Bowral, 2011. Geoscience Australia Record 2012/35, GeoCat #73777

Cover Image: Molonglo Brigade crews working on the Bendora Fire overnight. Dave Tunbridge, ACTRFS.

# Preface

This document is intended to provide a record of the participants, program, and discussions of the Fire Weather and Risk Workshop, held at Peppers Craigieburn in Bowral, from 1st -4th September 2011. The workshop was attended by 77 delegates and was sponsored by the ACT Emergency Services Agency, Geoscience Australia, the Bureau of Meteorology, and the Federal Attorney Generals Department.

These proceedings include the:

- Executive summary by the workshop organizers
- Workshop program
- Catching up
- Session summaries of presentations and discussions (compiled at the workshop by the session chairs and scribes)
- Abstracts
- Survey of participants' expectations of the workshop (received prior to the workshop)
- Results of a post-workshop evaluation
- List of participants.

This document also includes an invited journalistic-styled article by science journalist, Nick Goldie (Senior Deputy Captain, Colinton Rural Fire Brigade, NSW RFS) that provided an independent view on the activities that occurred over the three days.

Presentations from the workshop are available on-line at http://www.highfirerisk.com.au/fwrw2011/fwrw_home.htm

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# Executive Summary

## Background

Browsing through the Bureau of Meteorology Library, reports of the following workshops addressing Fire Weather were found:

1st Fire Weather Workshop Adelaide 1958
2nd FireWeather Workshop Melbourne 1985
Fire Weather Services Workshop Hobart 1989
Fire Weather Workshop Mt Macedon 1991
Fire Weather Workshop Craigieburn (Bowral) 1993
Fire Weather Workshop Hahndorf 1995
Fire Weather Workshop Hobart 1997.

These had varying services/research emphases, but there are two surprising gaps in this sequence given the number and impact of major bushfires in Australia. The first is the gap between 1958 and 1985, and the second is the failure to maintain the two-yearly sequence of the later workshops after 1997.

The 1989-1997 workshops formed a series which became increasingly successful as part of the Bureau of Meteorology (BoM) Severe Weather Program, as they brought researchers, Bureau fire weather policy and forecasters, and fire agency practitioners and managers together in an environment where both formal and informal exchanges were extraordinarily productive.

Unfortunately after 1997 the workshops ceased to be held, and while exchanges between the staff of the different organisations continued through planned inter-departmental meetings, as well as at a variety of conferences and workshops (the “Bushfire” series of conferences, AFAC meetings, Bushfire CRC meetings etc) it was frequently mentioned that the particular focus of the Fire Weather Workshop meetings had been lost, and that it would be wonderful to reinstate such meetings.

Late in 2010, Mr Bob Cechet of Geoscience Australia and Mr Rick McRae of the ACT ESA took the next step and actively sought sponsorship and endorsement for such a meeting to be held immediately after, and as part of, the AFAC 2011 Conference. This move was influenced by the outcomes of the 2009 Victorian fires Royal Commission (where extreme weather was a critical factor), as well as the emerging role of risk assessment in the draft of the National Disaster Resilience Strategy (NDRS) established by the Attorney Generals Department, (Commonwealth government). From the outset, the organizers decided that the workshop would focus on bushfire hazard and risk assessment, and that the issue of bushfire risk management was not to be covered by this workshop.

Dr Graham Mills, recently retired from the Bureau of Meteorology, was approached to act as program consultant, meeting convenor, and editor of publications arising from the meeting. The program (see next section of this report) is the result of many hours of idea exchanges between the three mentioned above, and includes extensive feedback from sponsoring agencies.

## The Venue

The venue was Peppers Craigieburn in Bowral, NSW. This was the venue of the 1993 Fire Weather Workshop, and there remained some fond memories of this event amongst the fire-weather alumni who were associated with previous workshops.
Bus transport to and from Sydney was provided, and ably assisted by the NSW Rural Fire Service. All those who sent in responses with their feedback forms were extremely positive about the venue, and having such a meeting away from home offices does facilitate informal discussions over meals and breaks.

## The Program

It was felt that after such a long hiatus between workshops (1997 to 2011) one of the important factors in organizing the program was to familiarize participants with the work and needs of other agencies, while reflecting the main themes of Fire Weather and of Risk. We were also slightly constrained by time, as the workshop was held following the four days of the AFAC Conference and the Bushfire CRC Science Day. Thus many who attended this workshop had already been involved in four days of meetings and conferences, and we did not want to stretch their time away longer than necessary. This meant that we were faced with two significant compromises.

First, we wished to have as many presentations as reasonable, but still retaining adequate discussion time. This meant that presentations were required to be short, focusing on the purpose and the results of the research, but not the scientific detail. As it is intended that papers from the workshop be published in a Special Issue of the Australian Meteorological and Oceanographic Journal, this is the vehicle for the science part of these presentations to be made public.

The second compromise was that the program needed to focus on major current issues in the Australian fire weather and risk community, and so we focused many of the research presentations on aspects of meteorology relevant to the development of the new National Fire Danger Ratings System (NFDRS), the National Disaster Resilience Strategy (NDRS). The other major theme was the Bureau's introduction of the NexGen forecast system, which provides a new paradigm for the provision of fire weather services.

## The main issues

The issue of probability and uncertainty in fire weather forecasts kept returning during discussions. It appears that this will continue to be an issue, becoming even more important as the Bureau's NWP forecast models are upgraded to higher and higher resolution, and Ensemble Prediction Systems come on-line.

The issue of national consistency came through in a number of the discussions (NexGen, NFDRS, fire behavior modeling, vegetation data sets, fire behaviour data sets), and the US Predictive Services Unit was mentioned several times in this context (albeit with the caveat that state/federal balances differ between the USA and Australia).

Issues of research adoption continue to crop up. Several of the feedback forms stated that a greater understanding of other agencies' needs would help understanding of research needs/research results. Adequate resourcing of appropriate "champions" on each side of the fence would facilitate research adoption, and communication at workshops such as this one would be of great benefit if the workshops continued on a regular basis.

There were few specific and formally endorsed recommendations from the meeting, but two came from the discussion session on the NFDRS. These were

- The NFDR System adopt physical units to define each of the indices and the ratings. These do not necessarily need to be conveyed to the public.
- The FIRE DST team from the Bushfire CRC engage with researchers from the National Fire Danger Ratings System team to rationalize approaches and share models and data.

## Customer Feedback and Future Directions

The summaries of the feedback forms are presented in detail in the later part of this report. Overall the respondents appear very happy with most parts of the program, with most sessions attracting a well above average rating. There was a slight bias towards there being too many talks (but not too strong), and a slightly stronger bias towards there being insufficient discussion time.

The balance of the program was assessed as being quite good, while the perceived gaps in the program provide a strong guide if planning for a future workshop. The focus of the risk part of the workshop was on objective (physical and measureable evidence-based) risk assessment and not risk management. This resulted in a number of comments relating to "Why did we not hear from the fire agencies" in this session.

The comments here, and to the "any other comments" question (reproduced in full, but without attribution, in Section 6) are quite instructive. Encouragingly, a number of responses support a future workshop, and there also appears to be a desire for it to be a "stand-alone" meeting, rather than as an addendum to a larger meeting.

It had been intended that a topic for discussion in the final session would be "will we have another meeting?". However, informal discussions had essentially resolved this in the affirmative by breakfast on Saturday, with an offer to host from WA agencies (led by Ralph Smith, Fire and Emergency Services Agency, FESA, WA). A two-year time gap between meetings was considered appropriate for this type of workshop. The next workshop will therefore be held in Western Australia in mid/late 2013.

# Program

**Fire Weather and Risk Workshop**
**Peppers Craigieburn, Bowral. 1st - 4th September 2011**

## *THURSDAY Evening*

**1900 Dinner : Peppers Craigieburn, Bowral**

**2030-2130**

Setting the scene, riding instructions, (The Organising Committee)
Summary of participant's expectations survey (Graham Mills)

## *FRIDAY*

**0845-0900 Housekeeping and ensuring set-up**

**0900-0920 Opening Remarks (**Chair Andrew Stark**)**

Sponsor – Andrew Stark, ACT Emergency Services Authority
Sponsor – Brad Smith, Attorney General's Department
Sponsor – Bob Cechet, Geoscience Australia
Sponsor – Robin Hicks, Bureau of Meteorology

**0920 – 1115 General Review (**Chair Simon Heemstra**)**

| | | |
|---|---|---|
| 0920-0940 | Tony Bannister - | Lessons from international forecaster exchanges |
| 0950 | John Nairn | Heat waves and fire weather |
| 0955 | Rick McRae | Posters and software |
| 1000 | Michael Grose | What I'm interested in |
| 1005 | Angeline Prasad | NT RFC fire weather products |
| 1010 | David Edworthy | Telemetry Enabled Weather Stations |
| 1015 | Grant Pearce | NZ fire climates |
| 1020 | Sarah Harris | A Victorian gridded fire weather data set |
| 1025 | Wendy Anderson | Power of fire and loss |

**1030-1115 Coffee Break** (includes any posters, technology displays etc)

**1115 -1230 Research Review** (Chair John Nairn)

1115-1145 Mike Fromm, Naval Research Laboratory, Washington. Off the charts: unifying pyrocumulonimbus and wild fire behavior to define new extremes

1150-1205 Tony Bannister, Bureau of Meteorology (Vic) - Black Saturday radar video

1210-1220 Paul Fox-Hughes, Bureau of Meteorology (Tas)
Two extreme fire danger days in Tasmania

**1230 -1330 Lunch**

**1330-1730 Research Review** (Chair Ralph Smith)

1330-1400 Brian Potter, US Forest Service, Seattle. Plume Development and Fire Behavior: Expanding Understanding Of Fire Risk In the Third Dimension

1410-1420 Mika Peace, Adelaide University and Bureau of Meteorology (SA) The Layman burn –"up"

1425-1435 Rachel Badlan, Melbourne University. 'Modelling of topographically-induced increases in FFDI with WRF

1440-1450 Jason Sharples, Australian Defence Force Academy
Foehn winds and other extreme drying events

1455-1505 Grant Pearce (Scion NZ). Validation of satellite assessment methods for grassland curing in NZ

1510-1530 Discussion

**1530-1600 Coffee Break**

**1600-1745 Research Review (cont.)** (Chair Beth Ebert)

1600-1610 Tom Duff and Derek Chong, Melbourne University.
Validating the Phoenix fire spread model with real world inputs

1615-1625 Andrew Dowdy and Graham Mills, CAWCR.
Predicting environments conducive to dry lightning and resulting ignitions

1630-1730 Discussion

**1745-1945 Break plus Dinner**

## 1950-2200 Wildfire Risk Review (Chair Martine Woolf)

2000-2015 Brad Smith (AGD). National Disaster Resilience Strategy; NDRS
2020-2035 Damien Killalea (TFS). AFAC's position on the safety and protection of people and community assets during bushfires
2040-2055 John McAneney (Risk Frontiers). Bushfire risk assessment
2100-2110 Trevor Jones (GA). Wildfire Risk Assessment Framework
2120-2130 Andy Ackland (DSE). "First-steps" towards bushfire risk assessment in Victoria
2130-2140 Margaret Mackisack (Consulting Statistician). Bushfire Risk and Electricity Supply

2140 Discussion

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# ***SATURDAY***

## 0900 – 1230 Forecast practice (Chair Malcolm Cronstedt)

**Modelling**

0900 – 0920 Beth Ebert (CAWCR). Modelling developments with ACCESS

**NexGen**

0930-0945 John Bally (CAWCR). The NexGen rollout and the future of weather forecasting
0950-1005 Andrew Treloar (CAWCR) NexGen Fire Weather Module
1010-1025 Gary Featherstone (Manager RLM, AFAC). Opportunities for a National Set of Fire Weather Products

**1030-1100 Coffee Break**

Bureau RFC and Fire Agency perspectives on NexGen (Chair Jason Sharples)

1100-1110 Claire Yeo (Bureau of Meteorology, Vic)
1110-1120 Paul Brockhoff (DSE, Vic)
1120-1130 Michael Logan (Bureau of Meteorology, NSW)
1130-1140 Rick McRae (ACTESA)
1140-1150 Simon Heemstra (NSWRFS)

1150-1230 Discussion

## 1230-1330 Lunch

## 1330-1430 NFDRS (National Fire Danger Rating System)

**(**Chair Trevor Jones**)**

1330-1340 Darren Bretherton (AGD)
1340-1350 Jeff Kepert (CAWCR)
1350-1400 Andrew Stark (ACTESA). End-user Expectations

1400-1430 Discussion

## 1430-1540 New Research Directions (Chair Damien Killalea)

1430-1435 Phil Zylstra (DEH, NSW). Development of Rapid Fuel Assessment Techniques for the FFM
1435-1440 Bob Cechet (GA) FIRE-DST
1440-1445 Beth Ebert/Jeff Kepert (CAWCR)
1445-1450 Jason Sharples (ADFA)
1450-1455 Jason Sharples (ADFA). Review of university research
1455-1500 Ian French (GA). Vegetation mapping
1505-1510 David Bruce (BCRC). The Fire Institute

1510-1540 Discussion (where are the gaps?)

## 1540-1730 Research Adoption (Chair Noreen Krusel, BCRC)

1540-1550 Noreen Krusel (BCRC) – Setting the questions

**1550-1610 Coffee Break**

1610-1620 Rick McRae (ACT ESA) Red Flag Warnings and Watchouts
1620-1639 Brian potter (USDA-FS). A case study of researchers working with practitioners

1630-1730 Group Activity

## 1730-1745 Allocation of tasks and structure to Sunday morning

## 1900 Pre-Dinner Drinks

## ***SUNDAY***

### 0900 – 1030 Discussion and recommendations reports

(Led by chairs of individual sessions, Session Chair Justin Leonard, CSIRO**)**

| | |
|---|---|
| 0900-0910 | General Review-(Simon Heemstra) |
| 0910-0930 | Research Review (John Nairn, Ralph Smith and Beth Ebert) |
| 0930-0940 | Risk (Ian French) |
| 0940-0950 | Forecast Practice (Malcolm Cronstedt and Jason Sharples) |
| 0950-1000 | NFDRS (Trevor Jones) |
| 1000-1010 | Research Directions (Damien Killalea) |
| 1010-1020 | Barriers to Adoption (Noreen Krusel) |
| 1020-1030 | Thoughts from the international visitors (Brian Potter/Mike Fromm) |

### 1030 – 1100 Coffee Break (working coffee break)

1100 - 1200 Report drafting

### 1200 – 1210 Closing Remarks **(**Organising committee**)**

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### 1230-1330 Lunch

### 1400 Farewell**; Bus for Sydney Airport and Sydney CBD departs**

The following is an invited journalistic-styled article by science journalist, Nick Goldie (Senior Deputy Captain, Colinton Rural Fire Brigade, NSW RFS) which provided an independent view on the activities that occurred over the three days. Nick combines interviews with selected attendees with his own thoughts on the meeting. This article conveys the thoughts of individuals, not of research projects or organisations.

# "Catching-up!"

**Fire Weather and Risk Workshop (Sept 1-4th, 2011)**

*by Nick Goldie,*
*science journalist and*
*Senior Deputy Captain of the Colinton Rural Fire Brigade (NSW RFS).*

More than a thousand weather, fire and emergency services delegates attended the 2011 annual conference of the Australasian Fire and Emergency Service Authorities Council (AFAC) at Darling Harbour, jointly held by AFAC and the Bushfire Cooperative Research Centre (BCRC).

At the end of the AFAC/BCRC conference about eighty delegates left Sydney for a Fire Weather and Risk Workshop at *Craigieburn* (Bowral) in the Southern Highlands. The last fire weather workshop was held in 1997, and we had a lot of catching-up to do. There was a strong presence from the Bureau of Meteorology (BoM), fire agencies, Geoscience Australia as well as the universities and the commercial sector.

Day one of the workshop introduced several themes to the workshop. Some were consciously articulated. Some were the expressions of cultural difference between academics, operational fire managers, even 'weather' and 'climate' experts.

The first presentation, after the Opening by Andrew Stark of the ACT RFS, was from the BoM's Tony Bannister, returned from secondment to the US National Interagency Fire Center in Boise, Idaho. This Center, he pointed out, is a national entity, not – as would probably be the case in Australia – a State-based organisation. As such it is able to co-ordinate research and operational activities from the entire country in a most efficient manner.

In particular, Tony Bannister described the workings of the DTPI, or Dry Thunderstorm Potential Index. As in many parts of Australia, lightning strikes are a significant form of bushfire ignition. The DTPI goes a long way towards taking the guesswork

"It's all in the nose" says **Mike Fromm**, US Naval meteorologist. "I went up to Canada with a NASA plane in search of fires. I got into the cockpit of the DC8 aircraft and flew through smoke plumes. I could smell the smoke in the cabin. One day, we were flying above a pyroconvective storm, up in the upper troposphere and I could smell the same smoke in the cabin as we flew through that icy cloud as we did when we flew through a low fire front down below. So my *nose* told me that we were smelling smoke which had come up through one of these convective storms."

out of forecasting the next area at threat. Using a combination of storm data, vegetation types and condition, weather instability and moisture, matched to a 40x40 km grid, the DTPI has achieved remarkable results in predicting real fires in real locations, mainly in the US north west.

Back in Australia, John Nairn (BoM) has been researching the occurrence and the consequences of heat waves, using a gridded data set to establish the Excess Heat Index (EHI), leading to real time forecasts important to both health and fire authorities. As he pointed out, while the Black Saturday inferno of 2009 took a terrible toll of lives and property, it is still not widely recognised that some five hundred lives were lost (350 in Victoria, 150 in South Australia) in the heat wave which immediately preceded the fires.

One of the most engaging presentations of the workshop came thanks to the US Navy which is unexpectedly interested in bushfires. This is because, as Navy meteorologist Mike Fromm pointed out, the Navy has an interest in being able to 'see' in the stratosphere, and they had problems with aerosols and particulates. In the first instance, the Navy researchers blamed volcanoes, but they soon discovered that a large proportion of the stratospheric pollution came directly from major wildfires in the US North West and Canada.

Subsequently, Mike Fromm was able to identify material from Australia, including from Black Saturday. Some of this material, he says, remains for very long periods in the stratosphere. Mike has tracked smoke from our fires around the globe; some has circled the globe up to four times.

Mike Fromm described himself as a 'basic researcher' and hoped that his research would be of use to meteorological forecasters. He was especially interested in what he has named pyrocumulonimbus clouds, which spread their shadow into uncharted territory as they transport smoke particles from the ground into the frozen stratosphere. He showed spectacular graphics from the Big Desert fire (Vic. 2002), as well the Victorian Black Saturday fires (2009).

Pyrocumulomibus clouds and their associated wild weather are generally the result of fires which "blow up" into major fires, but the question remains: why do some fires blow up, while others apparently similar, remain docile?

Why do fires tend to blow up in the evening, rather than in the heat of noon?

And finally, why do big fires 'pulse'?

There's a chicken and an egg, says Mike Fromm. Ice-capped pyrocumulonimbus clouds are certainly affected by the fires beneath them; but as they create their own winds and weather and electrical storms, do they in turn affect the fires? No doubt about it, he says.

Mike Fromm's US experiences were complemented by Paul Fox-Hughes (BoM, Tas.), who described two extreme fire weather days (2002, 2006) in Tasmania. Paul showed how important it was to understand the vertical structure of the hot dry air masses that reach Tasmania from the mainland.

Nick Gellie (Vic Dept. Sustainability & Environment) commented that with a blazing forest canopy, a large amount of moisture as well as heat was being projected into the atmosphere, thus enhancing the pyrocumulonimbus cloud and the general instability of the weather. There's a real need, he said, for more comprehensive vegetation mapping to assist fire managers.

Fromm's fellow American Brian Potter of the US Forestry Service in Seattle has also

made a study of plume dynamics. There are three linked phases in the development of a plume, he said, and an Incident Controller at a fire needs to be able to read the behaviour of the plume.

The 'surface stage' is simply the reaction of a fire to the surface air. Next is the 'deepening' stage, where the plume forms, convection begins, and there are unpredictable mixed-layer winds. Finally in the 'penetration' stage the behaviour becomes very unstable as the plume carries heat and water vapor into the upper air. And, said Brian Potter, "the things that you can't see are the things that will kill you!"

"What I find interesting is, could we have anticipated the burn getting out of control?" says **Mika Peace**. "It was a very good case which shows that we need to re-think the way we are producing fire weather forecasts. It's a lot more complicated than the way we are doing things at the moment. I think most forecasters would agree that we could do better. The way that we're doing our fire weather forecasting now is based on the McArthur indices which were developed forty-odd years ago. The information we have available now is far more advanced, and far more detailed, more comprehensive. We know now that there are atmospheric processes which impact fire behaviour. It's a more complex way of doing it, but it's worth doing!"

In Western Australia, questions have been asked in Parliament about a disastrous 'prescribed burn' which went wrong, the Layman-Ballan fire of October 2010. It was not the huge extent of the fire, said Mika Peace (BoM and University of Adelaide), but the unexpected ferocity which left up to three quarters of the forest severely scorched, dramatic ecological implications, and a bill approaching a million dollars.

'Normal' fire weather parameters of temperature and relative humidity and wind speed did not explain what had happened with the Layman fire behaviour, she said. "We had a very deep vertical circulation in the convection column, it was an unstable atmosphere to about twelve thousand feet, and we had convergence in three different sea breeze directions, and that created a fire intensity which was completely unexpected."

Ms Peace said that in her research she had also looked at a similar blaze during the Kangaroo Island (SA) fires, where a similar case-study showed that conditional instability and convergent sea breezes triggered an unexpectedly intense fire.

A totally different type of "breeze" considered at the workshop was Foehn winds. Traditionally, it's the Foehn winds which make the Swiss bad-tempered, even suicidal, and this occurs when the warm wind comes off the mountains. Foehn winds occur in most mountainous regions (including in Australia), when a moist wind is forced upwards, losing its moisture as rain or snow, and then rapidly downwards as a dry wind on the lee slopes, gaining in warmth as it gains in density. Writing about Los Angeles in the 1960s, Joan Didion said: … *tonight a Santa Ana will begin to blow, a hot wind from the northeast … we will see smoke back in the canyons, and hear sirens in the night … the Santa Ana, which, with its incendiary dryness, invariably means fire.*

"We noticed some very strange fire behaviour in the high country, " says J**ason Staples** (UNSW/ADFA). "Fires crowning at night, while it was raining just across the range, very unexpected fire behaviour. Part of the HighFire Risk project of the Bushfire CRC was trying to understand what was going on, and Foehn winds were the probable explanation.

"It's to do with the way the winds line up with the mountain ranges in the Australian Alps, the Blue Mountains, and in Tasmania. There are warm dry winds in the lee of the mountains.
"Given the long history of fire research in Australia, It's remarkable to think that our research has identified some interesting research that needs to be undertaken …"

The question for Jason Sharples, a mathematician and fire weather researcher at the University of New South Wales, was whether Australia has its own version of the Foehn. And the answer, he says, is quite definitely yes.

Hot dry winds mean bad fire weather, and Foehns are extremely relevant in those parts of Australia where there are real highlands – the south coast of NSW, Gippsland, the Australian Alps, the Canberra region. This is not because foehns affect the temperament of Canberrans, but because of the extreme changes in temperature and humidity which can occur. Twelve degrees rise in an hour is quite normal during a Foehn wind event, said Dr. Sharples.

Unexpectedly, he said, the high country is normally much dryer than land below 1500 metres, and equally unexpectedly, the high country can be at its driest early on a summer morning. This Foehn-related behaviour is of great significance to fire fighters and anyone planning a hazard reduction burn.

Like Tony Bannister, BoM forecaster Claire Yeo has had three working visits to the United States, most particularly to a weather station situated in the Okefenokee Swamp (home of Pogo) in Georgia, working with fire behaviour specialists. Claire noted that in the US, where funding can be more readily available than in the Australian States, fire management involves a team of more than a hundred "incident meteorologists" on call at any time to be sent to a fire in any part of the country. In Australia, there is one fire weather forecaster at a time in each State, whereas in the US they have 120 offices, with fire weather specialists in each office, as well as the dedicated pool of incident meteorologists.

Claire Yeo gave the workshop a detailed comparison between the old and the new: before 2008, the standard was 'point forecasting' concentrating on extremes and weather maxima. In 2008, 'NexGen' (Next Generation Forecast and Warning System) was introduced by the BoM in Victoria. It was not, she said, the best time to introduce a radically new style of forecasting, with temperature records and Black Saturday around the corner.

**Claire Yeo** was literally in the hot seat, working at the Victorian State Control Centre in the week leading up to the Black Saturday fires. The forecaster on duty does a forecast for the day, and the week out from there.

"On the Monday I had a lot of confidence in what the computer models were showing me," she says. "Every model was in alignment. This was the worst conditions I had ever seen. I really tried to change my language, so people would take notice. *Come on guys*, I said, this is going to be as bad as Ash Wednesday was.

"As a result I was instrumental in putting together a letter that went to the Premier on the Wednesday, and on the next day the Premier told the media that it would be the worst fire weather day we've ever seen.

"Unfortunately in Australia there was an attitude: 'Oh those bloody weather forecasters always get it wrong!' Since Black Saturday I think people are listening and taking notice of what we have to say …"

NEXGEN, she said, requires a new way of thinking. Instead of thinking in points, the forecaster needs to think in pictures, and "think in time". The system is underpinned by a set of forecast weather element grids, quality controlled by forecasters, for time intervals out to 7 days ahead. Each weather element, for each time, is stored in the Australian Digital Forecast Database (ADFD) on a 6 kilometre by 6 kilometre square grid and maps are generated for display in the Bureau's Forecast Explorer web interface.

Among the researchers and academics attending the fire weather workshop, one presenter stood out: Dave Edworthy, a volunteer firefighter from the Windellama (NSW) Rural Fire Brigade, who might well have shown the way of the future. A quick glance at the brigade's website demonstrates his story:

http://www.windellama.bushfirebrigade.com.au/windellama_rfs_about_us.php

Dave Edworthy has taken modern technology and put it at the service of small rural fire brigades. Like so many, Windellama Brigade relies on metropolitan weather reports and forecasts, which can be very inaccurate for local conditions. Edworthy and a technological colleague started with a fairly sophisticated automatic weather station at their fire station, which provides local information in real time.

Then they became ambitious: using solar panels and mobile phones, they are able to assess weather conditions at a variety of sites and even use text messages to operate devices such as sprinklers when conditions cross pre-determined limits.

Not surprisingly, more and more small rural brigades want to be part of the action.

"We've got an ageing volunteer group," says fire-fighter **Dave Edworthy**. "I wanted to come up with something very user friendly, which originally would let us know when the dreaded Easterly was coming in.

"Local internet connections weren't good, so we looked at a good quality weather station and associated telemetry, and married this to the Next-G mobile phone network, and some effective antennas.

"When we set up the website, we started getting emails, and we found that we were getting more and more web visits from locals and people with weekend retreats. The result was that we were able to get messages – high fire danger, TOBANs, that sort of thing – out into the community. "Next thing is to get the system into zones, with weather stations, all linked. As it is I've got at least ten other brigades knocking the door down to get this technology …"

Fire weather and risk are closely linked. Martine Woolf is a risk modeler, and believes that it is their role to look at the sum of the components of a situation, while others concentrated on individual components. A risk model and a decision support tool are not necessarily the same thing, she said. Risk models are typically used in the insurance industry, which wants to know what might happen in the next year; similarly, governments need to be able to assess what might happen, and can we afford to cope?

"A risk model is the helicopter view," says **Martine Woolf**, "looking down on the whole situation from very high above. Risk modeling is not necessarily immediately useful to the decision-maker on the ground.

"Looking at the needs of the people at this workshop shows there a whole range of requirements," she says.

"What I want to see is that the various groups are quite clear in what they need.

"And - for someone who comes from a classical risk-modeling background – fire management is quite different. Something like an earthquake simply happens. But fire is not like that. Fire fighters actually go in and change the course of events during a fire. This means that the risk itself is changing, and we have to build quite a different model. I don't know how yet, but that will be very interesting to do …"

In any conference of meteorologists and fire weather scientists, the question of climate change has to be present, often as an unspoken motif behind the science.

As in the United States, there is at least a perception that the Australian States and Territories are taking the threat more seriously than their Federal colleagues. In July 2011 the Act government released a report by the commercial consultants AECOM which detailed the probable effects of a two degree temperature rise, with suburb-by-suburb maps showing vulnerability to heat, water stress, and bushfires.

"Tasmania is a small area, but there are a number of distinct regions," says **Michael Grose**. "For weather extremes relating to bushfires, we need a high-resolution view at what's possible. Tasmania is bushfire prone, especially the southeast.

"Much of the work on climate change projections is being done in the northern hemisphere. Australia does a lot of work for the region and the Pacific. But for Tasmania, it was a real niche that our group felt was worth looking at. And there's a lot of Southern Ocean research being done in Hobart … and you can't look at Tasmania without looking at the Southern Ocean."

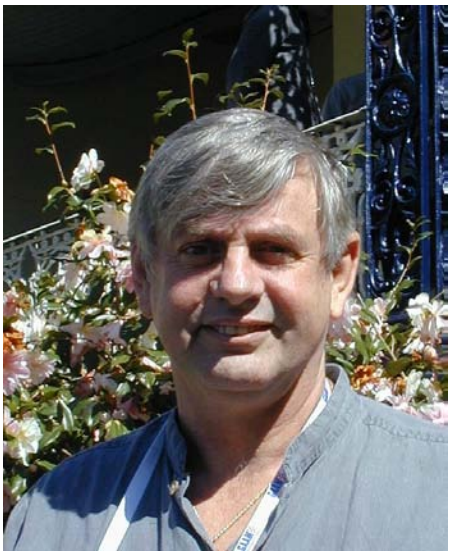
The Tasmanian Government has taken a similar initiative, with the *climate futures for Tasmania* initiative, which has the sub-heading 'local climate information for local communities'.

Michael Grose, of the Antarctic Climate and Ecosystems CRC, based in Hobart, is lead author of *Climate Futures for Tasmania* (ACE 2010). He spoke to the workshop about the effects of climate change on fire frequency and fire behaviour. Tasmania's unique alpine regions in particular will be vulnerable to warming, decreased rainfall, and an increase in the number of high fire danger days. A marked increase in lightning strikes has been recorded especially in western Tasmania, and it is predicted that the interval between fires will also decrease.

Climate change, said Michael Grose, inevitably impacts on fire, as it affects the weather, the fuel types, and the frequency and cause of ignitions. A human response, in the form of policy, is inevitable and essential.

Grahame Douglas is Climate Change and Sustainability Coordinator for the NSW Rural Fire Service. He started his career as an environmental biologist before moving on to fire-related matters. Fire authorities are taking an increasing interest in environmental integrity, while climate trends show increasing drought – and therefore increasing numbers of bushfires.

Grahame Douglas spends a part of his time at the University of Western Sydney, teaching a bushfire protection program, looking at the impact that fire has on buildings and structures, and how to design for a bushfire-prone environment. The importance of climate change here is changes in fire behaviour, and how this will affect design and planning.



"There used to be a conflict in the community between those who understood the need for hazard-reduction burns, and those who opposed them," says **Grahame Douglas**.

"Being a committed conservationist, but at the same time someone who builds his life on science, my job has been about trying to get reconciliation of those two competing positions. We have to get a proper balance between environmental values and community safety.

"There's more acceptance that fire is a part of the Australian landscape, but we will certainly have to adapt to a changing world and a changing climate. In the end, we've got to take care of the planet."

All the delegates to the 2011 Fire Weather and Risk workshop knew the story of a previous gathering, when the emergency services 'operationals' lost patience with the academic 'theoreticals' and staged a walk-out on to the pleasant lawns of *Craigieburn*. This time, although there was robust debate, good relationships were made better, and there was general agreement about the need for a follow-up meeting.

It is likely that the next meeting will be held in Western Australia in 2013. Please visit the following website for more information:

http://www.highfirerisk.com.au/fwrw2011

# Workshop Session Summaries

This section contains the session summaries as compiled at the workshop by the session chairs and scribes. While the Editor of this report has done some re-formatting of these individual documents to reduce differences in format between sessions, and has done some minor editing to remove typographic errors or to enhance understanding for a reader who was not present at the Workshop, these reports are largely as compiled. They are presented in the order of the Workshop Program, and where themes, such as Research Review, ran through more than one session, the reports from individual chair/scribe are presented sequentially.

1. General Review
2. Research Review (1, 2, 3)
3. Wildfire Risk Review
4. Forecast Practice (1, 2)
5. National Fire Danger Rating System (NFDRS)
6. New Research Directions
7. Research Adoption

## ***General Review: Friday 0920-1115***

This session comprised a series of short presentations highlighting projects that were supported at the conference by posters, technology displays, or software systems, and was followed by an extended coffee break so that specific interests could be followed up with individual presentations.

Chairperson : Simon Heemstra
Scribe : Kylie Egan

**Tony Bannister : Lessons from international forecaster exchange**
There were two main points made based on Tony's recent posting to Boise.
(1) Capability of forecasting dry lightning – NOAA's Storm Prediction Center issues spatial forecasts of dry lightning potential: something the Australian forecaster doesn't do well? Is there scope to use this research here?
(2) The US Predictive Services Centre: Resource management on a national scale, meteorologists and fire behaviour analysts working closely together.

***Discussion and questions following:***

Verification of US lightning forecasting is done on a 40 km grid against observed lightning strikes. Currently the forecast is out to 3 days but there are plans to extend this and to also include ensemble forecasts. Currently the NCEP NAM model is used (http://www.nco.ncep.noaa.gov/pmb/products/nam/)
but there are plans to use other models.

Can Australia set up a Predictive Services Centre? Fire agencies would need to work closely together on a national scale. It was noted that the states in the US are not as strong as the states in Australia. The different State/Commonwealth balance in Australia would have to be taken into account if such a Centre was to be mooted here.
The complexity of fuel data was better understood by the US forecaster. More detail and knowledge of fuel type and fuel state is needed in Australia.

### John Nairn : Heat waves and fire weather.

There is a need for a nationally consistent approach to lead to a warning system. Showed that many major fire events are preceded by heat wave events. Proposed indices such as the Excess Heat Index to quantify heat waves.

### Rick McRae: High Fire Risk project

Web page displaying resources map of various sites in SE Australia was presented.

### Michael Grose: Regional Climate Modelling

Climate impacts on bushfire risks focusing on Tasmania.

### Angeline Prasad: BoM weather products

An overview of fire weather products produced by the Bureau of Meteorology in the Northern Territory.

### David Edworthy: Weather information at the local scale

Live localised weather streaming to website, mobile phones. Alarms to notify of certain thresholds.

### Grant Pearce: View from “the other side of the ditch”

NZ fire weather research. Current projects and research needs.

### Sarah Harris: Gridded fire weather data set for Victoria.

Climate record over the fire seasons from 1972-2009 is being generated using mesoscale NWP models and reanalysis data sets.

### Wendy Anderson: Fire danger and community loss

Fire Danger Ratings correlated to community loss.

# Research Review

The research review comprised a series of invited and submitted presentations focusing primarily on fire weather. The three sessions each included a short question time after each presentation, and a longer discussion period before the session break. At the end of Session 3, a longer and more general discussion concluded this theme.

## ***Research Review (1): Friday 1115-1230***

Chairperson : John Nairn
Scribe : Mike Wouters

**Mike Fromm** : **Off the charts: unifying pyro-cumulonimbus and wildfire behaviour to define new extremes**.
Features of pyro-cumulonimbus (pyro-cu) events noted were

- frequency of pyro-cu activity on first day of a fire
- surprising activity overnight
- pulsing/puffing pyro-cu – how does that cycle reflect or interact with surface conditions and fire behaviour
- noted frequent presence of pileus cloud over pyro-cu.

Collaboration of researchers is required to pull together coherent data sets - what has to happen?
***Questions***: plenty of interest in pulsing/puffing - not conclusive.

**Tony Bannister** : **Black Saturday radar video**

- "radar 101" was helpful
- exposed traps for uninitiated
- would be useful as a training tool for agency staff
- Nic Gellie's Kilmore fire time line matched to 3D radar imagery
- quite reasonable fit between the post-analysed fire position, fluctuations (increases) in radar reflectivity, and local heavier fuels
- lesson that radar could be developed for real-time fire column mapping
- limited by range and intervening topography
- strong reinforcement of Mike Fromm's convective pulsing/puffing

**Paul Fox-Hughes** : **Two Extreme Fire Danger Days in Tasmania**
First event : frontal passage combined with air trajectory from Nullarbor Plains, plus shallow maritime boundary layer. Delivered very dry continental air buffered from ocean moisture source by shallow stable internal boundary layer. Dry mixing into Tasmanian boundary layer in lee of highlands produced enhanced fire behaviour. This occurred during a continental-scale heatwave.
Second event : frontal passage combined with dry slot which was linked into boundary layer, resulting in drier air in fire zone.
Noted that model captured air transport in both events, although forecast near surface humidity was too moist. *(NB : this was a bias in LAPS and meso-LAPS models. Ed)*. Awareness of the potential mechanism should result in forecasters reviewing model diagnostics as guide to potential drying process.

***Session Discussion***:

- Great deal of discussion over burning vegetation contributing to latent heat release in pyro-cu. Examples forthcoming from several people around room.
- Deeper discussion need for inclusion of moisture release from burning vegetation in assessing atmospheric stability. Could that be introduced as a viable decision tool for pyro-cu forecasting? Need for research was highlighted on how to develop thresholds.

- Pyro-cu "chicken and egg" discussion: Is enhanced fire behaviour enhancing pyro-cu or is pyro-cu producing enhanced fire behaviour?

Personal comment from session chair:
Is a pyro-cu needed before vegetation moisture is released on a scale of significance, or is a particular scale of fire required to get the pyro-cu going at all? Sounds like a dynamics or static stability question. Maybe both in play with dynamics contributing to pulsing/puffing cycle.

## ***Research Review (2): Friday 1330-1530***

Chairperson : Ralph Smith
Scribe : Sarah Harris

### Brian Potter – Plume development and fire behaviour: expanding understanding of the fire risk in the third dimension

Brian proposed a three-stage model of fire progression, where fires interact progressively with the surface layer, the mixed layer, and finally penetrate above the mixed layer. Fire activity is not linear between these stages.
Brian proposes that downward stability is a partner with upward stability, but not an equal partner, and that it needs more research.
The addition of temperature and moisture by the fire to the atmosphere changes the vertical coupling between the fire and the atmosphere. Based on the literature, 2 K / 2 g/Kg is a conservative increment (literature not extensive with regards to increment as a result of combustion to temperature/moisture to assess the changes in stability).

***Discussion***

- John N. – there's nothing simple about convective modelling, use decision tree; Victoria has moved on from using convective indices.
- Graham M. – The ingredients are important, not the index. Indices can draw attention to a particular area, but they don't provide understanding.
- **Q** – Why 2 K heating? **A** – Some field studies have observations in this range.
- Comment – Thermodynamics of the Black Saturday pyrocumulus could not be modelled without adding moisture from combustion.

## Mika Peace – The Layman fire burn-"up"

Layman/Ballan burn (WA) –a 10 000ha, fuel reduction burn October 2010
The surprise was not so much the larger than intended area burnt but the unexpected intensity of this burn. Ended with a crown scorch of 70-80%. Why did this occur?
While traditional surface and upper air patterns were not particularly threatening, there was:

- Convergence on a broad scale
- Long term rainfall deficiencies (record)
- Dry air aloft that had subsided under the high pressure system –
  Fuel moisture – 6% further dried by 1-2%
- A strong sea-breeze front advancing from the south

These combined factors led to unusual fire behaviour: deep convective column, fire-atmosphere instability. In this case couldn't rely on McArthur, need to include other variables in order to anticipate this type of fire behavior.

### *Discussion*

- **Q**. Any weather obs near the site? **A**. Yes a couple, and one showed the seabreeze with a dewpoint of 7-8 deg.; then dropped to 4.5.
- **Q**. (Mike F.) Did you look at the radar, also should look at geostationary satellite imagery?. **A**. Radar too far away, satellite analysis yet to be done.
- Comment – apparently suitable conditions for the prescribed burn, then things went bad. Did fire feed atmosphere or atmosphere feed fire - which one came first?
- Andrew S. – fuel moisture, soil moisture, RH are all increasingly sensitive/responsive when values are already very dry.

## Rachel Badlan – Modelling topographically-induced increases in FFDI with WRF

Presented two enhanced fire weather events south of the ranges in eastern Victoria.
Event 1. WRF modeling shows strong cross-mountain flow, with foehn-induced downslope winds, and reductions in RH, increases in temperature in East Gippsland. Strong trapped gravity waves on downwind side of ranges. Enhanced FFDI, detailed structure.
Event 2. Latrobe Valley 29th Dec 2001
Early morning stable boundary layer shields surface from upper warm, dry air until radiation heating breaks inversion - then there is a rapid increase in the Forest Fire Danger Index (FFDI). Wave structures again apparent in WRF simulations - non-hydrostatic processes are important

### *Discussion*

- **Q**. In the two cases the waves are different but the driving winds are the same?
- **A**. Both trapped waves, but detailed diagnosis still being done.
- **Comment**. (Tony B.) - At Sale, it is hard to know when and where mountain waves are going to touch down, even if one suspects they are likely.
- Comment. (Will T.) Compared with what can be seen from the AWS network, WRF shows huge variability with time and space
- **Comment**. (Graham M.) – events such as the second happen regularly on frontal wind-change days

### Jason Sharples – Foehn winds and other extreme drying events

*Foehn conditions* – strong winds with increased temperature and decreased humidity from mountains can lead to abrupt increases in FFDI (20 fold increase in the fire danger levels within one hour). Example at Wilson's Promontory of a 16 fold increase in fire danger in one hour.

*NWP modelling* demonstrates and predicts Foehn effects. These can occur in areas along the NSW coast, Gippsland, and Tasmania.

*Nocturnal dewpoint* decreases at high-elevation sites. Showed spectacular cases for Mt Ginini. Events generated by nocturnal low level jets, subsidence inversions. Frequency - extreme events occur about every 9 days. Early mornings are particularly prone as significant drying events in the high country

### Grant Pearce – Validation of satellite assessment methods (grassland curing in NZ)

Curing is important, as it is an input in the fire behaviour models.

Developing methods to assess and predict curing using remote sensing and modeling.

Pilot trial provided 4 products. Best products varied between NZ and Aust, and products performed differently at different times of the season.

Recommendations are being prepared – not operational yet.

#### *Discussion*

- **Q**. What are the differences between the models? **A.** They are variations of NDVI.
- **Q**. Did trial people know which maps were used (as this could be a bias)? **A**. Y
- Comment – need to move on ground to a GIS

#### *GENERAL DISCUSSION*

- Q. to Jason. Pyro-Cu and Foehn effects. Can you combine these interactions? Jason - Haven't looked at such cases with fire conditions.
- Question to audience – we have shown higher resolution NWP provided more detail and more accurate forecasts - what are the expectations from the fire agencies?
- John Nairn – we don't have the resources to issue more complex forecasts.
- Graham Mills- can we afford not to do it?
- Andy Ackland– Fire behaviour analysts overseas are highly trained to know what to look out for. Fire behaviour analysts here need training to get to that level.
- Comment: This discussion is assuming BoM has a product that indicates foehn conditions for fire agencies to use.
- Tony B. - We may not know the detail but we know the context – we can forecast likely regions not exact locations - get science right to then develop tools.
- Jason S. – we can identify precursor conditions so we could use these as some type of warning.
- John N. - if we miss it?
- Graham M. - this sort of product can be developed using similar techniques to those used in the National Thunderstorm Forecast Guidance System to identify regions with higher than normal probability of particular types of thunderstorms, so we could take a couple of ingredients to produce a map to give to informed audience.
- Andrew Stark – provide users with best data.
- Tony B. – think in terms of ensembles, risk, probability
- Rick McC. – need better dialogue between modellers and end users. And agency users need to know what BoM forecasters are putting into their models. Climatology has to be included in probabilities. Metric required for this.

## ***Research Review (3): Friday 1600-1745***

Chairperson : Beth Ebert
Scribe : Simon Metcalf

***PRESENTATIONS***

**Tom Duff and Derek Chong :**
**Validating the Phoenix spread model with real-world inputs.**

- They are developing spatial/physical methods for verifying fire spread predictions; need more fires with good observed progression data for verification.
- Accuracy of verifications improved by tweaking wind directions from nearest AWS. Observations reported in 10-degree intervals.
- Meteorological input needs to be accurate, and gridded data is preferred. Reanalysis data project having some difficulties, such as difficulties with wind speed.
- Using only surface variables is possibly inadequate for modelling fire spread. What other vertical levels are worth examining?
- Recent work in incorporating convection column physics into the model.

***Discussion***

- Time consuming/expensive work to prepare, run and analyse verifications.
- The landscape mapping of fuels in Phoenix may be too simplistic.
- Confidence limits and ensemble analysis could be used for fire spread modelling to make a more quantitative buffer zone around the likely fire spread area, which could be used strategically for risk analysis.
- Concerning operational use of Phoenix, there is a lack of alternative models that can provide rapid results in Australia, so we need to just use what we have for now. In NSW it is used for triage. It should be compared against a human fire analyst.
- The standard of training and meteorological knowledge for fire behaviour analysts is generally much greater in Canada and USA than Australia.
- The CLIPER (climate-persistence) paradigm used as a baseline to "beat" for tropical cyclone forecasting could be useful for fire spread prediction as well.
- Fire spread understanding is critical; not just after a better-tuned McArthur index.
- Physical and statistical models both have their place, and there is advantage in combining them. Easier to remove bias from statistical models.

**Andrew Dowdy and Graham Mills : Predicting environments conducive to dry lightning and sustained ignitions** (Graham Mills presenting for Andrew Dowdy)

- Variability and trends in determining dry lightning were based on a 10-year data set.
- They related observations of dry lightning to a number of factors - modelled lapse rates and dew point depression, seasonal and diurnal cycles, rain amount.
- Lends itself to ingredients-based forecasting approach
- Work in development of a dry lightning index - it could be useful as a fire weather diagnostic.

***Discussion***

- It was suggested that a lightning index could be derived from aerological profiles, which would be possible for both observed and modelled (forecasted) profiles.
- Lightning forecasts should be added to the NTFGS.
- In the US lightning probabilities are calculated for grid cells.

***GENERAL DISCUSSION***

**Probabilistic forecasts**

- At the State Control Centre the meteorologist is often asked by the Minister to estimate the chance of something happening.
- Traditional forecasts are deterministic. Are probabilistic forecasts something that fire agencies could use, and if so how?
- Agencies responded that probabilistic information may be more useful for longer-term decisions (e.g., campaign fires, strategic planning), but for next few minutes to hours they prefer more definitive guidance.
- To use probabilistic information for rapid decisions there needs to be a well understood policy in place. (i.e., if prob>X% then do Y)
- Currently meteorologists make the decisions on behalf of fire agencies by expressing uncertain information as a deterministic forecast, but logically the risk decisions should be made by agencies.
- Fire agencies are concerned about data overload from large number of gridded products. That said, the 25-50-75% rainfall products have been well received.
- It is useful for the meteorologist to help interpret the large amount of guidance (including probabilistic information) for the fire agency.
- Brian presented on the psychological advantages and disadvantages of probabilistic model results. An example of temperature forecast shown as 10% chance greater than x degrees and 10% chance less than y degrees was used.
- NOAA has an office devoted to helping users understand probabilistic forecasts.

**Ensemble forecasts**

- We live with risk everyday, and cannot account for every source of uncertainty or the magnitude of the sources that are well understood when building an Ensemble Prediction System (EPS).
- There may be a danger in developing false confidence from EPS results - sometimes the truth falls outside the envelope of the ensemble.
- We need to be careful combining uncertainty ranges in variables that are physically linked (i.e., in reality temperature, relative humidity and wind speed vary together).

## ***Wildfire Risk Review: Friday 1950-2200***

Chairperson : Martine Woolf
Scribe : Ian French

***Presentations from***

**Brad Smith, Attorney General's Department**
**"**National Disaster Resilience Strategy; NDRS"

Brad outlined the "National Strategy for Disaster Resilience" as a long-term roadmap for partnership between the community and all levels of government (and agencies), with the aim to build capability to respond and to bounce back. Three main themes were covered; the ability to understand and communicate the risks; mitigation and reducing risk; and the approach to disaster resilience being a shared responsibility/partnership.

**Damien Killalea**, **Tasmanian RFS** & **AFAC**
"AFAC's position on safety and protection of people and community assets during bushfires"

Damien presented on the AFAC position on best practice in bushfire safety. He highlighted the gaps in the "stay or go" policy as: ignoring those who "wait and see"; too home/building centric and ignoring visitors, elderly etc; being too simplistic (ignoring catastrophic days).He outlined the drivers for change in the policy as well as the process that was undertaken to draft a new policy. The new policy has "Life protection" as the highest priority. AFAC wants in principle endorsement of the new policy by all agencies.

**John McAneney, Risk Frontiers, Macquarie Uni**
"Bushfire risk assessment"

John provided an overview of the Risk Frontiers probabilistic and loss model that is currently in use for insurance and re-insurance. The model uses actual historical building loss information since 1994, current exposure and dwelling vulnerability as well as GIS information that provides a spatial probability.

**Trevor Jones, Geoscience Australia**
"Wildfire Risk Assessment Framework"

Trevor explained that there is a gap between risk assessment and fire research which needs a consistent approach to assessing risk. The "National Disaster Resilience Plan", Risk management standards (such as ISO3100:2009) and the newly released "National Emergency Risk Assessment Guidelines" lead into the need for having a specific document for risk definition and assessment for bushfires. The CRC's FIRE-DST project aims to produce an initial "Bushfire Risk Assessment Framework" document that will be used by the Bushfire CRC and AFAC to engage everyone in defining a final framework to fill the gap.

**Margaret Mackisack, Consultant**

"Bushfire Risk and Electricity Supply"

Margaret outlined how she was going to revisit a risk assessment that she had undertaken 9 years ago that looked at bushfire risk to the electricity supply. The pervious assessment examined the engineering risk, legal risk and economic risk to the electricity supply from bushfires.

**Andy Ackland, DSE Victoria**

"First-steps towards bushfire risk assessment in Victoria"

Andy explained how he had used the Phoenix fire modelling system (developed by the University of Melbourne) to look at the eternal dilemma "Protection from fire as transposed against protection of the environment". He developed a baseline set of data for "maximum risk" days for Victoria. The information was then used in multiple Phoenix fire simulations to examine the Otway area of Victoria. The results indicated that despite the best-simulated burn regime there was still a high residual risk mainly due to private land management.

### *Overall summary*

- **Risk Assessment and risk modelling fits in with strategic top down approach:**
  - National Disaster Resilience Strategy
  - AFAC plan on safety and protection
- **Best practice following international standards requires:**
  - Bushfire Risk Assessment Framework
  - Common terminology and approach
- **AFAC and Attorney General's Dept: have endorsed risk-based approach.**
  - How it is implemented is left to Agencies
- **Three approaches to modelling risk**
  - Actuarial (past experience data analysis)
  - Monte Carlo set of scenarios, using simplified statistical model
  - Operational model capturing processes driving fire, run in risk context
- **All three answer different questions**
  - Methodology must be appropriate for question

In discussion it was pointed out that in assessing risk, resources and capacity must be part of the assessment process.

# *Forecast Practice (1): Saturday 0900-1030*

This session focused on new and emerging Bureau of Meteorology forecast technologies, and the implications and effects on users of fire weather forecasts. The first four presentations were from the developer/planner perspective, while the series of talks after morning tea were from the forecaster and fire agency perspective.

Chairperson : Malcolm Cronstedt
Scribe : Andrew Burton

## *Modelling*

**Beth Ebert, CAWCR - Modeling developments with ACCESS**

Talk detailed the Strategic Radar Enhancement Project and ACCESS modeling developments, focusing on high-end/severe weather. A number of resolution increases and modeling improvements will be coming on stream over the next few years. These will include Ensemble Prediction Systems and more frequent update of the higher-resolution (mesoscale) predictions.

***Discussion***

- Audience question/comment: Some concern about workload implications of increases in information coming from SREP.
- Audience question/comment: Topography resolution in fine scale models:? Jeff Kepert indicated that topographic resolution needs to be smoothed to >=6 times the grid spacing to prevent instabilities in the model, hence topographic resolution will be around 3km for a 400m model. Time resolution also queried, time steps are small, (seconds) but the data is only written out at larger intervals.

## *NexGen forecast system*

**Andrew Treloar on behalf of John Bally, CAWCR – NexGen rollout and future of weather forecasting**

Detailed pre-NexGen forecast process and compared with NexGen forecast process. Outlined the service advantages and ongoing challenges associated with NexGen.

**Andrew Treloar, CAWCR – NexGen Fire Weather Module**

More detail on Graphical Forecast Edior (GFE) forecast process with specific reference to fire weather. Examples of new information that can be derived (and ultimately displayed) as products to fire agencies) using NexGen.

### *Discussion*

- Audience question/comment: How will this affect private met providers? – data will be made available to private Met providers so they can create products based on BoM information – similar to US model of private/public sector service delivery.
- Audience question/comment: Skill of Optimum Consensus Forecasts (OCF)? – not uniform, less skill in mountainous areas, coastal zones and the tropics.
- Audience question/comment: Resolution and the importance of small details in some situations? Pointed out by several agency reps that we don't have that level of detail at present, and that NexGen advances well beyond the largely point-based service delivered in most regions at present.

## Gary Featherstone Manager, RLM, AFAC – Opportunities for a national set of fire weather products

Fire Weather Technical Group : described vision and objectives, structure and mission. Have included everything below the seasonal scale in the table of products, including all aspects of planning, preparedness and response. Mitigation activities included and products currently delivered under agency funding arrangements in NSW & VIC.

### *Discussion*

- John N. – commented on the need to balance standardisation and innovation. There should be the ability for additional products to be created outside of BoM.
- Strength of NexGen - amount of data; weakness – need to interpret all that data
- **Q.** How are we going to keep an archive of products?
  BoM will archive grids and the products that it creates.
  Plug from DSE for having access to the grids to create in-house products.

### *Summary of NexGen discussion*

- The tension between standardisation and tailoring/innovation;
- Change management and implementation issues i.e. training, understanding and adapting to the quantity and presentation of information concepts;
- Capacity for in-house value-adding.

## ***Forecast Practice (2): Saturday 1100-1330***

Chairperson : Jason Sharples
Scribe : Nic Gellie

This session followed the session that detailed the NexGen framework from the system perspective. The intent of the session was to examine the utility of the NexGen framework from a forecaster and fire agency perspective. Five speakers delivered 10-minute overviews of their experiences, highlighting positive outcomes and issues requiring further attention. The speakers represented Victorian, NSW and ACT viewpoints.

Firstly, **Claire Yeo** from the Bureau of Meteorology (Victoria) discussed the challenges faced by forecasters in moving from a point-based forecast framework to one that required delivery of a spatiotemporal product. Claire noted that providing point-based forecasts were in some ways easier than providing gridded forecasts, which require the forecaster to incorporate more data types and to provide a far more detailed output. One issue faced by Victoria was having to deal with Black Saturday in the first season of NexGen implementation. Claire also noted the fact that, despite the many advantages of a gridded forecasting system, many situations would still require delivery of spot forecasts. Claire also noted the value of gridded forecasts as a tool to facilitate improvements in the fire weather products provided to the end-user. In particular, the NexGen system was valuable in showing the limitations and deficiencies in the McArthur-based fire danger rating system.

Following Claire, **Paul Brockhoff** provided the Victorian fire agency (DSE) perspective. Paul noted the value of the suite of new tools that the NexGen system provided fire managers, but also noted there were some issues with the readiness of fire agency staff to move away from point-based forecasts. In particular, he reported that the lack of readiness had resulted in limited uptake of the NexGen system by field staff. Paul discussed the value of a system like NexGen in providing briefings to agency staff and in assessing preparedness levels. He felt that in this respect the NexGen system offered a significant opportunity to enhance the capability of Fire Behaviour Analysts, but that this required more training for agency staff in interpreting the gridded weather outputs to ensure the greatest efficacy. Paul also emphasised the need for further dialogue between the Bureau of Meteorology and Fire Agency staff to make sure that the end product can meet operational needs, through the provision of appropriate Watchouts, for example. Paul also noted that keeping up with the significant changes implicit in the roll-out of the NexGen system, posed an on-going challenge to agency staff.

In providing the perspective from the NSW Regional Forecast Centre, **Michael Logan** from the Bureau of Meteorology noted that the NexGen roll-out presented the biggest operational change in 20 years. Michael also noted the advantage of adopting the system after the Victorian RFCs - the lessons learnt in the Victorian experience allowed a relatively smooth (ongoing) transition in the NSW case. He also felt that the NexGen system had given forecasters an enhanced freedom to innovate and facilitated closer and more meaningful communication between Bureau forecasters and fire agencies. Michael noted the important point that the products delivered through the NexGen system needed to be pitched at a level appropriate for fire agency personnel and in a way that fostered a broad understanding of the products. This will be best achieved in an iterative manner, perhaps accompanied with changes in management practices. Michael also noted that the mild fire season meant

that the NexGen system remained essentially 'untested' in the context of fire weather forecasting, and as such the system remained in a state of transition.

**Rick McRae** from the ACT Emergency Services Agency next gave the perspective from a fire agency working in and around the ACT. Rick highlighted the major improvements provided by the NexGen system but also noted some issues with adequately resolving important micro- and meso-scale weather phenomena associated with complex topography. As an example he noted that only about 20% of anomalously low dew point occurrences in the high-country were correctly identified by NexGen. Despite the areas requiring further development, Rick felt that the NexGen system was fairy robust and represented a significant advance compared to the older point-based forecast methodology.

The final speaker was **Simon Heemstra**, who offered the NSW Rural Fire Service's perspective. Simon also stressed the need for the system to be tested under more severe fire weather conditions. Moreover, he noted issues concerning how best to interpret the spatiotemporal outputs of hourly and daily forecast FFDI as they apply to the issuance of total fire bans. Simon also noted issues surrounding the integration of continuous fuel layers with a grid-based system. In particular he discussed the issue of how best to declare a grid cell as being made of forest or grassland, when in reality there was a mixture of both present. Furthermore, he reported on some preliminary efforts made by the NSW RFS on resolving this issue, which involved satellite data analyses. Better integration of satellite data with the NexGen system was cited as an important area that deserved further investigation.

### *Discussion*

The floor was then opened for 30-40 minutes of discussion on the topics discussed by the speakers. This included discussions on how to best validate curing model output and climatologies, the on-going need for spot forecasts and issues arising from cultural differences between the Bureau of Meteorology and the fire agencies. Emphasis was given to the problem of how to integrate spot forecast information with NexGen output – the issue of the correct spatial and temporal scales was highlighted as significant. The discussion also noted that many fire-fighters remain attached to deterministic output and that there was a need for better communication amongst Bureau staff, fire-fighters and agency staff. It was suggested that these issues might be addressed through better connectivity between the Bureau and fire agencies, in what might be termed enhanced 'fire weather diplomacy'. One specific suggestion called for the instigation of a Predictive Services Unit that would involve forecasters, fire behaviour analysts and other fire agency personnel working in a cooperative manner to better integrate the respective data realms. This suggestion appeared to have widespread support amongst the workshop attendees.

# ***National Fire Danger Rating System: Saturday 1330-1430***

Chairperson : Trevor Jones
Scribe : Michael Joyce

**Main points from presentations**

**Darren Bretherton**
3 projects - science working group, system to communicate the science to land managers, combat agencies and the public

- 2009 - national review of FDR
- Why? - shortcomings of McArthur FDI, outcomes from Black Saturday
- What will it do? Needs to be national, replace McArthur, modular, based spatially, communicate to public and fire managers, 5 year timeframe
- What's been done - changes to McArthur FDI thresholds, clearer public messaging
- Public messaging- communications working group, minor changes , used at highest level
- NEMC appointed working group to manage - 2 groups, science and public communications
- Governance - see flow chart from presentation
- Funding made available for project officer this financial year
- Agreement of FDR system- risk based, compliant, modular approach
- Main research - ignition potential, fire weather indices, fire behaviour indices damage indices
- Need funding for the project over next five years

**Andrew Stark**

- Ratings - simple models used across forest and grass gives us FDI – the public question is " can I have a BBQ?"
- Discussed all the weather elements that are not in our indices
- Looking for new FDR which means behavioural change particularly at the public end
- Model will have a lot of different connections - fire weather, fire ignition, fuel conditions , fire behaviour, fire suppression, topography
- End user focus - broad message to community, output of more accuracy in descriptions of how fires will behave under extreme conditions
- We need to be more robust about what we can do and go to government to get funding for the system. Talked about funding for Counter Terrorism compared to fire management

**Jeff Kepert**

- Modules will be independently verifiable and upgradeable
- Both indices and physical data will be passed between modules
- Nationally consistent approach
- Where you need richness of numbers these will be passed around the system along with the indices
- Aim to be fuel type agnostic, probabilistic framework
- Weather - climate, temperature, humidity etc, landscape dryness, probabilities
- Not currently considered - wind changes, (in)stability, inversions, sudden surface drying, preceding heat waves

- Aim is for 3 FWIs, e.g., (1) hot, dry, windy,(2) vertical links and circulations, (3) variability in regard to wind changes
- One master FWI that combines all factors
- Ignition - human, natural causes of ignition, probability of ignition

## ***Q& As***

**General question – who will put all the modules together? Who will set the FDI**? A number of agencies will be inputting data. e.g, house loss potential will be an index not treated by the BoM. Each rating will come from the responsible agency. The NFDRS team will need to address capacity within jurisdictions. Not sure how computationally expensive this will be.

**Will the project consider 3D weather for example in developing the indices?**? We may end up with one number with a range of consequences. Having 3 indices may be able to give a visualisation aid that could aid interpretation. There are scientific questions to answer, such as how much instability is equivalent to a given change in wind-driven fire behaviour. A number of variables can be changed and then drawn back onto map. The group has been looking at all the things they would like and how to build into the system. Can't be perfect because it's extremely complex situation. Some of the inputs will be probabilistic but others won't. That will come out as part of the research.

**Note that it won't be business as usual for the BoM down then track**. In five years' time the BoM may have new products. BoM will need to revisit some of the data they give out. How will this hang together? This has been discussed by the group already. If a rating is coming out of the system then there may be a need for legislative change in some areas and will need to be looked at.

**Agencies and researchers in the US are also doing a similar thing – revising their Fire Danger Rating system.** With the proposed approach, Australia will be leap frogging US. To learn about history of US system, a presentation from 2005 is available on the history of fire danger ratings. Lessons were that the indices in a fire danger rating system should have real physical units, but currently energy release component is the only one that does. This approach allows agencies to improve the indices without fabricating new ones. Two nice things about a physical unit - can be verified and as you improve the science you don't change definition. McArthur may correlate well with aspects of fire behavior, but is not a relationship.

**The Victorian office of the BoM is pleased that they now separate the FDI grid from the FDR grid**. In recent fires the decision on code red came down to forecaster and this is not appropriate. Glad that the forecaster can concentrate on the weather and not the FDR. Fire commissioner in Victoria will be the ultimate decision maker.

**We're trying to achieve the ultimate in public communication. To have the threat profile across the area would be a good outcome**. To have the navigability back through the assembling process - each component will be measurable. Decisions can be traced back through model. Message can be interpreted better.

**Are we going to keep a record of current FDI to see how they relate to the new ones**? The BoM has confirmed that the current indices will still be available and will also be calculated in future. We will let people continue to use McArthur FDI but this is more a research option than one that will just continue. It will be validated. There's strong evidence that we need to change. We need to continue to collect the inputs such as KBDI so that this is not a constraint to projects that want to historically re-create.

**Differences between states - prior to Black Saturday - agencies decided on TOBANs**. Since 2009 the greater sensitivity of leaders means that some agencies want to make the decision on code red. BoM provides the inputs. Fire chiefs have been looking at the hazards from McArthur. Suppression is an input into the model so this can be considered as well.

**Did the committee consider decoupling the fire prediction model?** If you consider the biogeographic and biophysical variation in Australia, you'll get lots of different variations in vegetation-fuels, fire climates, and landscapes. Will a one size fit all fire danger model be capable of predicting fire behaviour across the range of priority fire-prone landscapes? It is within scope. Fire behaviour models will consider the changes across the landscape. Idea is that the messages are standardized across the nation. In the Canadian case, the Fire Behaviour Module is separate from the Fire Weather Module and all sub-components of the Canadian FWI are transparent and easy to produce as outputs.

**Index or indices to estimate lives lost.** Note that it's wrong to say that the McArthur Index or any improved index will show a good correlation with lives lost. The relationship between weather and deaths will always be stochastic. For example superficially similar fire weather in SA and Victoria in 2009 resulted in no deaths in the former state and 173 in Victoria. A fuels database (if it had existed) would have had a much stronger correlation with deaths.

In any severe fire the outcomes in terms of lives and property lost will depend on whether the fire intercepts a community or not and the spatial layout of homes with respect to the fire front. We are operating in probability space. If the index were perfect, then there might never be any further losses of life assuming appropriate behavioural patterns. Thus the correlation between lives lost and the index would be zero.

*[Later comment in the workshop by John McAneney: People's understanding of probabilities. A lot of behavioural science leads us to the conclusion that people are only capable of distinguishing between five categories:*

1. *almost a sure thing;*
2. *more likely than not;*
3. *about even odds*
4. *less likely than not;*
5. *almost never*

## RECOMMENDATIONS

1. The NFDR System adopt physical units to define each of the indices and the ratings. These do not necessarily need to be conveyed to the public.
2. The FIRE DST team from the Bushfire CRC engage with researchers from the National Fire Danger Ratings System team to rationalize approaches and share models and data.

## ***New Research Directions: Saturday 1430-1540***

In this session a series of brief presentations outlined research projects underway or planned. While these were intended to set the context for the later discussion that was aimed to identify "research gaps", it must be acknowledged that there are other relevant research programs being undertaken around Australia that are not included in this list.

Chairperson : Damien Killalea
Scribe : Tim McGuffog

**PRESENTATIONS**

**Phil Zylstra**, (DEH NSW). Forest Flammability Model (FFM)
Development of rapid fuel assessment techniques for forest flammability model. FFM uses physically based inputs. For example, heat waves dry out species differentially.
FFDI simplified too much to reflect seasonal conditions.
How will this impact on structures at the interface?
Many parameters, but may be used to answer a variety of questions.
Databases can now be used to store wide range of data and many new means of measuring variables such as LIDAR, remote sensors etc are available.
Most sensitive parameter is the mid story canopy layer and second most sensitive is the ground fuel layer.
Model needs a good vegetation map and data.

**Bob Cechet**, (GA). FIRE-DST (new BCRC research project)
Poster explaining the FIRE-DST (Fire Impact and Risk Evaluation Decision Support Tool) was displayed and discussed. (FIRE DST - computational impact & risk assessment tool).
Core of tool is the Phoenix fire spread model. Not a comprehensive risk evaluation model but likely to develop further in that direction.
Strong end-user focus for the project. A research tool that is validated against past events and designed to progress to operationalisation.
**Q**. What are the implications for other than human values – water catchments, plantations, tourism? **A**. Project will eventually look at environmental and social risks (current funding cycle focused on housing and human health impacts).

**Beth Ebert**, CAWCR fire science
Overview of projects currently underway and those proposed/desirable.
High resolution modelling of severe event (eg Black Saturday) case studies.
Fire spread – ember transport, wind variability.
Fire Danger Rating project.
Transition from research to operations is still an issue for BoM but improving

**Jason Sharples**, **ADFA .**

**University-based Fire Weather Research projects**
Interaction of bushfire and lee rotors
Foehn flows and local atmospheric structures
Projections of fuel loads into climate projections, fire risk
Mesoscale dynamics of severe fire weather
Study of Black Saturday using ACCESS
Small scale processes on fire spread.
Rossby wave break and severe fire weather

Large eddy simulation of Canberra fire
Climate change impacts on bushfire risk and natural hazards in TAS.
2007 Kangaroo Island fires : studying fire behaviour using WRF

### Ian French, GA. Vegetation Mapping

Fuel classification evaluation
National grassland fuel curing model
Using LIDAR to classify fuels
Justin Leonard explained model components of interface fuel loads and vulnerability.
In the longer term can also look at severity.

### David Bruce, Bushfire CRC. "The proposed Bushfire Institute"

History of BCRC. 2003-2010 +3 years to 2013.
No future certainty for Bushfire research - where to for BCRC.
Victorian Bushfires Royal Commission (VBRC) recommendation to establish an ongoing capability for bushfire research.
Build upon nationally-focused research driven by end users.
Will look much the same as current, broader focus, all hazards approach, ready to begin as soon as funded.
Structure of institute is for a distributed model where researchers are located around Australia with small administration core.

### Discussion Where are the Gaps?

**Q**. Operational techniques for dead fuel and live fuel moisture estimation use very simplistic science. Fuel moisture changes with environmental conditions and also includes availability of fuels.
**A**. CRC program looking at this through new fire danger project.
**Q**. Don't have good databases for fuels and fire – how to get data available and accessible.
**A**. No system developed to capture information coming back from fire grounds- training of field base fire fighters to capture relevant data and get it back into data systems. Building databases for post fire analysis.
**A**. US has dedicated fire behaviour teams to go onto fire ground to collect data. Look at US findings before jumping into evaluations and projects. Data absence is common in US as well. Need twice as much data in order to validate the original model. Need collaboration to ensure no duplication and silos. Collaborate with US to see what they have found and some possible solutions.

## ***Research Adoption: Saturday 1540-1730***

The introduction to this session briefly covered the Bushfire CRC Experience in developing a Research Utilisation Strategy, based on the experience of the previous seven years. A survey of end-users' agencies experiences, practices, needs and barriers was analysed and then the findings and their implications were explored at a workshop to help formulate a plan of action.

Chairperson : Noreen Krusel
Scribe : Andy Ackland

**Noreen Krusel**

Six factors critical to the success of research utilisation were identified, and actions to address them were presented:

**Relationships and partnerships**

- TRUST
- Who are your partners/stakeholders and what sort of relationship do you need to have with them?

**Engagement and active involvement**

- Conferences – think about how time is used
- Use the events guidelines– train people in how to engage
- Consider how to have two way conversations in the different events
- 'How to engage your audience 101'
- Allow or encourage debate

**Nurture a responsive and learning culture within end users**

- Conduct trials that might not always work
- Rewarding new and challenging risk taking
- The CEO drives it – people take their cues from the leaders
- Engage with the people who make the change
- Build into individual key research areas (KRA's)
- Engage in planning processes → alignment of strategy

**Build research utilisation capacity and capability within end user agencies**

- 'How to' guides
- Professional development program
- Share Best Practice ideas
- Ambassador-at-large (dedicated extension officer promoting utilisation)
- Team of translator/facilitators
- Change agents/mentors from within
- Industry placements for students
- Build networks people can call upon

**Create high quality products**

- Clearly articulate product requirement
- Video, podcast - new media
- Interviews with researchers and practitioners
- Keep the 'who' - the personality
- Evaluate products – identify the successful approaches
- See processes as a product
- Identify assumptions – test assumptions
-

**Make the research meaningful for the context**

- Facilitate conversations around which meaning is formed
- Ask the 'so what' question
- Discuss rather than just forward material
- Find translators
- How does/is the individual affected by this material
- Work at grass roots
- Recognise process matters – think first
- Develop feedback and evaluation process

The following two speakers presented examples of research utilisation with which they have been involved:

**Rick McRae – High Fire Risk Project outputs**

- Goal to disseminate science to end-users
- Structure material to subsets of end users (eg. FBANs, operational, planning)
- Particular importance firefighter safety
- Operational tools: - Augment watchouts? Red flag warnings?
- Enable fire controllers to rapidly amend strategies, particularly for safety
- Consultation is critical amongst IMT leaders (IC, Planning, Situation, FBANs etc).

**Brian Potter** – Presented an example of the benefits of researchers working within a fire agency context during an on-going incident.

- Research learnt a lot from experiencing the real-time demands dictating information needs
    - Enable filtering of pros and cons of various tools
    - Appreciation of end user timescales
- TRUST is critical.
- BEER – researchers and operational staff spending social time together is a powerful way of establishing rapport and building relationships.
- RESPECT - Behaving in a way that was respectful of the circumstances was important.

## ***GROUP ACTIVITY – Research Adoption***

The workshop participants were divided into five groups to discuss the following headings, and to come up with three points for each heading – the purpose of this was to allow more people to participate in conversation in the short amount of time available, and to encourage people to speak who may not do so in a room of 80 people.

**CRITICAL SUCCESS FACTORS**

People were asked to consider the critical success factors presented by Noreen to see if they resonated with their experiences, and people were asked to modify them as appropriate. The following comments were provided:

- Mutual understanding of each other's business and willingness to accept others' position
- National body of communication/knowledge transfer
- Utilise other measures of success besides papers
- Must aim at service delivery. Is it leading to a major gain?
- Have proper conceptual framework – evaluation of projects – who would do that; innovation important; proper governance structures
- Competition could produce better products, but need publicly funded research made available
- Engagement between all levels of end-user agencies
- Learning culture within researchers and end-users
- High quality research (not just high quality products)

These comments generally 'fit into' the 6 generic success factors outline by Noreen, but a couple of clear differences were identified, these being;

- The need to have a learning culture within an end user agency was also pertinent to research agencies, and
- High quality research should underpin high quality utilisation products.

**THINGS THAT CAN BE DONE TO IMPROVE RESEARCH UTILISATION**

The groups were also asked to brainstorm, discuss and agree to the top three actions that would improve research utilisation. These are recorded below (number of similar responses in brackets:

- Better define end-user needs (1)
- Resource capacity-building in agencies; people with industry experience needed (3)
- Mixed communications; different styles (e.g. face-to-face, Facebook) (5)
- Recognise strategy for research process and operational development are different (4)
- More collective forums (5)
- Register of research gaps (1)
- Understand end-user needs (1)
- Training and awareness (5)
- Survey and evaluation (2)
- More money is needed to accommodate integration of researchers and end-users (4)
- Researchers need to better explain relevance to end-users and vice versa (1)
- Audit end-user take-up of projects (2)
- Reward successes of research-end-user interactions (2)
- Resources to enhance engagement (separate positions for knowledge transfer etc) (3)
- Researchers directly engage with end-users (e.g. have opportunistic meetings) (5)
- Produce expanded list of participants from workshop – backgrounds, skills, hobbies (5)

## ***GROUP ACTIVITY – Summary***

The actions people suggested that could be undertaken to improve research utilisation could be grouped into:

1. Defining and understanding user needs, including a two-way sharing of relevance/significance between researchers and end users
2. Monitor, review and REWARD (successful) researcher-end user interactions
3. Specific resources (people) are needed to facilitate research utilisation and they need industry experience
4. Have appropriate and resourced strategies in place to support research AND its operationalisation
5. Support a variety of interactive communications processes such as face to face, social networking tools, training and awareness, meetings, including the sharing of contact and background information of workshop participants
6. A stand-alone action to develop a register of research gaps was also put forward.

# Abstracts

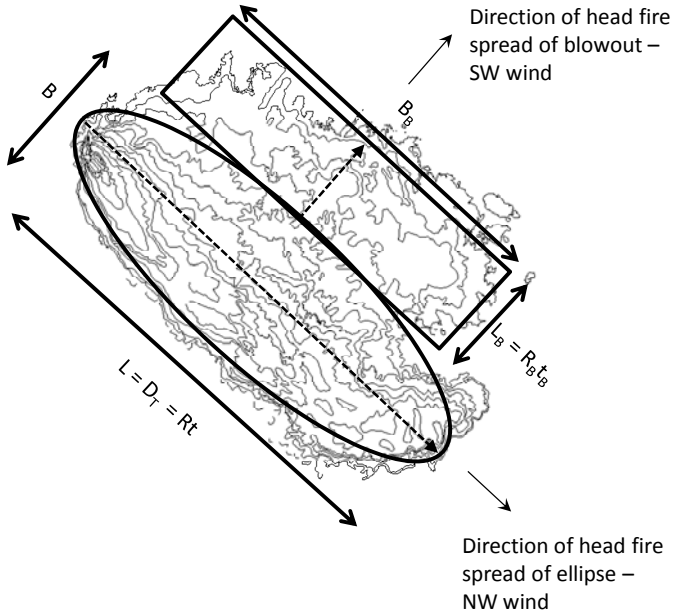
Abstracts were solicited from speakers prior to the workshop, at the workshop, and in a post-workshop email. Nineteen abstracts have been received, and these are presented in this section in alphabetic order by lead author. The abstracts have been edited for consistency of layout and font, and very minor grammatical or spelling corrections, but are essentially as received (without review) from the authors. The list of abstracts is presented in the table below.

# Establishing a link between the power of fire and community loss: The first step towards developing a bushfire severity scale.

**Wendy Anderson[1] and Sarah Harris[2]**

[1]Australian defence Force Academy and [2] Monash University

Current fire danger scales may not reflect the potential destructive force of a resulting bushfire in Australia, and therefore may not provide fire prone communities with an adequate warning for the potential loss of human life and property. To determine options for developing a bushfire severity scale based on community impact and whether a link exists between energy release rate (power) of a fire and community loss, this project reviewed observations of 81 wildfires (from 1939 to 2009) across Victoria, Australia and other southern states. A methodology for estimating fire power based on fuel loading and fire progression rate is presented. McArthur's existing fire danger indices (FDI'S) as well as fuel and slope adjusted FDI's, were calculated using fire weather data. Analysis of possible relationships between community loss, fire power and FDI's was performed. Preliminary results showed that a stronger relationship exists between community loss and the power of the fire than between loss and FDI; although fuel adjusted FDI was also a reasonable predictor of loss. The database developed for this study and the relationships established are essential for undertaking future studies that require observations of past fire behaviour and losses, and also to form the basis of developing a new severity scale.




**One example of applying shapes to actual fire events, in this case the Murrundindi fire: B is breadth of ellipse, L is length of ellipse, $B_B$ is the breadth of the blow out (in this case a rectangle) and $L_B$ is the length of the blowout**

# Modelling topographically-induced increases in FFDI with WRF

**Rachel Badlan**
Department of Earth Sciences, Melbourne University

Sudden drying events are associated with an increase in surface temperature and wind speed, along with a decrease in atmospheric moisture. As the name suggests, this has implications for the Fire Danger Index (FDI) and requires further investigation. Two such events were chosen as they occurred in different times of the year to determine the processes that could be responsible for each event. One took place in winter at East Sale, Victoria in 2007 with the second occurring in the summer in the Latrobe Valley, Victoria in 2001. The first was examined using a hydrostatic numerical model (mesoLAPS) in 2010 and was believed to occur due to a föhn wind and was associated mountain wave; this study is now revisited using a non-hydrostatic model with the aim of resolving any non-hydrostatic processes. The other case study was examined using the same model and with the same aim.

The East Sale event highlighted presence of a föhn due to blocked flow and a mountain wave which developed in an evolving flow regime; this is confirmed, with trapped lee waves also identified. These standing waves are responsible for localised, enhanced fire danger, and areas of gustiness. Although the same abrupt change in variables is not observed for the East Sale AWS, it seems likely that the rapid fluctuations observed are due to the meandering or shifting of the trapped waves; areas of enhanced conditions being associated with the wave troughs.

The Latrobe Valley event indicates that the sudden change in conditions was due to the deepening of the mixed layer upwind of the mountains from heating, ending the blocked flow regime. There is also the presence of a mountain wave, which eventually leads to warmer, drier air from above reaching the ground. Both these cases show that a change of flow regime is involved with localised increases in FDI. This leads to the question of possible identification of more cases to determine how common these processes are, and eventually the possible need for forecasting.

# Black Saturday Radar Video

**Tony Bannister**
Victorian Regional Office, Bureau of Meteorology

The Victorian Black Saturday fires of 7 February 2009 were the worst bushfires in Australia's recorded history. One of the most devastating in terms of loss of life (120 out of a total of 173) and homes (1200 out of about 2000) was the Kilmore East fire, which occurred about 40-50 km to the northeast of the Melbourne CBD. Situated at Laverton some 20km to the west-southwest of Melbourne's centre, the Bureau of Meteorology's Melbourne weather radar, although normally used to identify and locate precipitation, had a unique view of this fire. The Melbourne radar has a six minute radar volume update cycle, effectively giving a 3D volume of radar information every six minutes, with the lowest scan some 700-800m above sea level when scanning over the Kilmore East fire area. With the importance of these fires, Victorian fire agencies put a large amount of resources into creating very detailed fire spread reconstructions of what were very difficult fires to interpret, including the Kilmore East fire. Combining these two information sources gives some unique insights into the Kilmore East fire.

This presentation relates details seen on radar data with what was occurring on the ground in terms of where the Kilmore East fire was and its intensity. It concentrates on two periods, firstly the initial few hours of the fire and then the period when the southwest wind change hit the fire and changed its forward direction from towards the southeast to towards the northeast. Although only initial work has been done there is solid evidence that given good coverage, radar data can be used as another source of fire intelligence, especially when combined with more traditional forms of information about a fire's location and behaviour.

# Fire Impact & Risk Evaluation Decision Support Tool (FIRE DST)

**Bob Cechet[1], Ian French[1], Kevin Tolhurst[2], Justin Leonard[3], Jeff Kepert[4], Kevin Tory[4] and Mick Meyer[5]**

[1.] Geoscience Australia [2]. University of Melbourne [3.] CSIRO Ecosystem Science
[4.] Bureau of Meteorology [5.] CSIRO Marine and Atmospheric Research

FIRE-DST is the largest of the projects within the extended Bushfire Cooperative Research Centre (BCRC). It is addressing the sub-theme of *evaluating risk* by developing a framework and computational methodology for evaluating the impacts and risks of extreme fire events on regional and peri-urban populations (infrastructure and people) applicable to the Australian region. The research is considering three case studies of recent extreme fires employing an ensemble approach (sensitivity analysis) which varies the meteorology, vegetation and ignition in an effort to estimate fire risk to the case-study fire area and adjacent region.

Outcomes from recent extreme fires have demonstrated a need for a tool to assess future bushfire impacts and risk on regional and peri-urban communities. Such a tool would illustrate (map) bushfire impact and risk across the urban fringe and will also enable fire and land management authorities to develop and assess the effect of appropriate fire risk treatment options at local, regional and national levels. The tool would, based on the characteristics of extreme fire weather, vegetation, firespread and smoke production, estimate the consequences of extreme fires on communities. The tool will be validated using conditions from 3 case-study events. In addition, the tool will be used to explore alternative scenarios reflecting the sensitivity of the outcomes to ignition, fuel load and state, meteorology and fire spread, as well as alternative suppression strategies. Results from these scenario analyses and associated reports and papers will be communicated via the project website and through structured workshops.

At the end of the three year project (Dec 2013) we aim to have developed a *"validated simulation system"* consisting of the outputs of mesoscale numerical weather prediction systems coupled to a fire spread model and smoke dispersion model. This will have been validated against three extreme events and will be ready for further evaluation by end-users (with limited regional support and underpinning datasets requiring a state/national focus). Following evaluation we envisage the requirement for further software engineering and systems-evaluation (to assess reliability/robustness) which will lead to a real-time operational tool within three years of the end of this project. The prototype computational tool and the associated databases have the potential to address major issues from the outcomes of the 2009 Victorian fires, to inform tactical responses to extreme fires, and to underpin initiatives related to the COAG risk management reforms on natural hazards and bushfires, the National Risk Assessment Framework and the National Disaster Resilience Strategy.

# Validating the PHOENIX fire spread model with real world data.

**Derek M.O. Chong, Thomas J. Duff and Kevin G. Tolhurst**

Department of Forest and Ecosystem Science, University of Melbourne / Bushfire CRC

The PHOENIX fire characterization model has been developed to model wildfires in the south eastern Australian landscape for operational and research purposes. However due to the complexity of spatial fire spread patterns, there are few methods available for validating wildfire simulations against real events. In response to the catastrophic Victorian wildfires of 2009, the Department of Sustainability and Environment (DSE) has produced detailed progression maps for the major wildfires. This has allowed for a more rigorous validation of PHOENIX's performance. This paper addresses the challenges faced in the process of validating PHOENIX. The three most destructive wildfires in terms of life loss from 2009 were selected as case studies for this purpose.

Simulation error may result from poor quality inputs, user error or flawed model assumptions. Obtaining accurate input data is the greatest challenge for any wildfire simulator validation. Weather is one of the most difficult inputs to gather due to high spatial and temporal variability and the limited number of automatic weather stations (AWS) available in the vicinity of the wildfire, and the tendency for large fires to affect local weather conditions. Other major inputs such as fuel levels and fire history also pose challenges as they generally fall under the 'best available' data category and are often sourced from a number of convenient datasets rather than data that has been specifically mapped, classified and validated for the purpose of fire modelling. Determining sources of error is critical for evaluating and calibrating spread model performance.

To date, fire spread model goodness of fit has been generally quantified using the area overlap of predicted versus actual wildfire perimeters or subjectively, with terms like 'reasonable', 'good' and 'acceptable' often appearing. A new approach to quantifying spread model goodness of fit is discussed in the context of model validation.

This analysis has shown that whilst there is a good overall agreement between the modelled output and the reconstructed fire development, there are differences in spatial and temporal detail of the simulated fires that are important to understand and quantify.

# Predicting environments conducive to dry lightning and resulting ignitions

**Andrew J. Dowdy and Graham A. Mills**
Centre for Australian Weather and Climate Research

Lightning occurrence data are matched to a data-base of fires attributed to lightning ignition over southeastern Australia, and compared with the atmospheric and fuel state at the time of the lightning strike. Factors influencing the chance of fire per lightning stroke are examined, including the influence of fuel moisture and weather parameters, as well as seasonal and diurnal variations. The fuel moisture parameters of the Canadian Fire Weather Index System are found to be useful in indicating whether or not a fire will occur, given the occurrence of lightning. The occurrence of 'dry lightning', i.e. lightning which occurs without significant rainfall, is found to have a large influence on the chance of fire per lightning stroke. Through comparison of the results presented here with the results of studies from other parts of the world, a considerable degree of universality is shown to exist in the characteristics of lightning-fires and the atmospheric states associated with them, suggesting the potential for these results to be applied more widely than just in the area of the study.

# ACCESS Modelling Directions

**Beth Ebert**
CAWCR Weather and Environmental Prediction Program
Bureau of Meteorology, Melbourne

The Australian Community Climate and Earth System Simulator (ACCESS) is a weather and climate prediction model being jointly developed by the Bureau of Meteorology and CSIRO in collaboration with the UK Met Office. The ACCESS model has state of the art representations of physical processes such as radiation, turbulence, and cloud processes. It also uses advanced variational assimilation methods to specify initial conditions for the model simulations based on atmospheric, land, and ocean observations. ACCESS is a "unified" model, which means it can seamlessly represent weather processes at spatial scales of 1 km or less, all the way out to seasonal climate prediction and global climate projection.

Starting in September 2009, the ACCESS model became the Bureau's operational numerical weather prediction (NWP) model. Compared to the previous NWP model, ACCESS provides an improvement of about one day lead time for 3-day forecasts. Improvements to the ACCESS model that will be implemented in late 2011 include increased horizontal and vertical resolution, more accurate model physics, and assimilation of new sources of observational data. Work is underway to assimilate radar-derived winds and rainfall, which will improve the model's accuracy in predicting the evolution of storms and high impact weather in regions with (or near) radar coverage, including the populated regions of southeastern Australia. Starting in about 2013, the ACCESS model will provide numerical forecasts at 1.5 km resolution for regional domains around the major capital cities, with 3-hourly updates. A relocatable version can be targeted to regions of anticipated high impact weather to provide additional detailed forecasts of wind, temperature, and humidity fields that are essential for bushfire prediction and management.

Another important ACCESS model development on the horizon is the ACCESS Global and Regional Ensemble Prediction System (AGREPS). This strategy involves running the model multiple times with slightly different initial conditions, representing the uncertainty in the initial state. AGREPS will facilitate probabilistic and scenario predictions, and has the potential to greatly enhance the Bureau's bushfire weather service. The POAMA dynamical seasonal ensemble forecasts, also based on the ACCESS model, will provide probabilistic and scenario information for conditions several months into the future.

In addition to providing the Bureau's operational weather and climate forecasts, the ACCESS model will be used as a research tool to investigate bushfire weather, including modelling extreme cases such as Black Saturday, and developing improved fire weather indices for decision making on bushfire mitigation.

# Telemetry Enabled Automatic Weather Stations

**D. Edworthy[1], B. Vilnis[1] R. McRae[2]**

[1]Rural Fire Service (NSW) Volunteers, and [2]ACT Emergency Services Agency

Incident Management Teams rely on a good, reliable flow of weather information. In this "New World" of climate change and frequently occurring extreme weather events our application of "New Thinking" has created innovative technical development and ability to deliver accurate and dynamic real-time local area weather information to and from firegrounds, including up to the minute FDI.

Using Telemetry Enabled Automatic Weather Stations (TeAWS)'s users can request weather data by sending a command via SMS, and receive the latest data in return. This means that instant weather information can be achieved on demand. In itself this is an innovation, however there is another important role the Te-AWS can fulfill for busy frontline firefighters & IMTs.

One of the most powerful features of the Te-AWS is its ability to send SMS alarms based on this weather data to selected users. Twitter and email alarms can also be triggered. These alarms can be set to be activated by conditions exceeding various significant weather thresholds. These include strong winds, heavy rainfall rates and in particularly, elevated FDI.

Different alarms can be sent to different end-users who may have varying levels of interest in each event. For example a brigade captain may like to know when the wind speed reaches 75 km/h and the FDI reaches 50, subsequently the IMT may receive alarms when the FDI reaches 70 and then at increments of 80, 90, 100 etc. In heavy rain events, SES crews can receive a series of rain rate alerts, giving indications of the passage of storm systems through the day.

TeAWS's have proven successful in providing live weather information to local communities (www.windellamarfs.com.au as an example) increasing awareness of FDI and how it changes throughout the day. Moreover, utilising the remote placement and interactive features of TeAWS's we have developed of a system that can remotely monitor as well as protect unattended critical infrastructure from bushfire.

# Two extreme fire danger days in Tasmania

**Paul Fox-Hughes**
Tasmania-Antarctica Regional Office, Bureau of Meteorology

Springtime fire weather is a feature of many parts of the globe in general and of parts of Australia in particular. In recent decades it has become an increasingly prominent part of the fire weather climatology of Tasmania. As part of a program to understand this phenomenon, two days of exceptional fire weather are examined in some detail. Both days, 7 November 2002 and 12 October 2006, were characterised by periods of very dry air. On both days, the immediate airmass origin was the Australian continent, which had been subject to prolonged drying during the months leading to the events. It is clear from archived operational mesoLAPS numerical model output that maritime boundary layers prevented an increase in moisture content of the airmasses as they crossed Bass Strait, and that the prefrontal northwesterly airstreams were subject to a foehn effect as they encountered the elevated topography of central Tasmania on each occasion, resulting in further drying and warming.

Substantial differences between the cases are evident, however. The continental origin of the airmasses was quite different, and the local fuel moisture state varied considerably. The most marked difference between the events, however, is detectable from plots of the weather parameters during the days. On both days, mixing through a deep boundary layer occurred by the middle part of the day, with substantially negative dewpoint temperatures evident. Largely similar, albeit extreme, conditions persisted on 12 October 2006 until the passage of a cool change during the evening. On the other hand, on 7 November 2002, it is clear that a different airmass mixed to the surface during the afternoon and early evening, resulting in an abrupt increase in fire danger. There is strong evidence from satellite imagery and numerical model output that the increased fire danger resulted from an intrusion of dry, high momentum stratospheric air ahead of the passage of evening cold fronts.

Common characteristics of the two events lead to a suggested guide for identifying potential extreme fire weather events, both operationally and in climate change studies. The method uses 850 hPa temperature and dewpoint depression, and identifies a number of dangerous fire weather days including the cases studied.

# New Research Directions - Vegetation Mapping

**Ian French[1] and Justin Leonard[2]**

[1]. Environmental Geoscience Division, Geoscience Australia, [2]. CSIRO Ecosystem Science

One of the components of the Fire Impact and Risk Evaluation – Decision Support Tool (FIRE-DST) project investigates fire modelling in the urban and peri-urban interface at the local neighbourhood scale. Each building in the interface will be examined to assess its vulnerability to the approach of a fire for ember attack, radiant heat and flame contact. The vulnerability is dependent on a multitude of factors in the environment including the building construction, roof type, fences and other barriers. The vulnerability will then be used to calculate the expected impact of a fire on the urban area.

To be able to model the fire movement and the effect on the built environment there has to be an accurate categorisation of the interface vegetation fuels. In this presentation we focus on the creation of a 3D model of the neighbourhood scale vegetation and buildings.

The neighbourhood scale environment is created by including individual building information (like building age, wall construction type, roof type and occupancy) from the Geoscience Australia NEXIS database. There also has to be an accurate categorisation of the interface fuels, therefore details of additional objects such as individual trees, fences and forest will be obtained from high resolution LiDAR. LiDAR will also be used to provide both the height and vertical profile of the vegetation in the urban interface. Other geographical information such as roads and a digital elevation model are also included. All this neighbourhood information is then processed to generate a 3D Model of the local environment.

# Off the Charts: Unifying Pyrocumulonimbus and Wildfire Behavior to Define New Extremes

**Mike Fromm**
Naval Research Laboratories, Washington DC

Pyrocumulonimbus (pyroCb) storms may be an extreme subset of pyroconvective storms, which themselves are a phenomenon that is manifested in only a small proportion of fires (or in a single fire's lifetime). Taking into consideration that pyroconvection is a result of particularly large instantaneous heat energy release, it then seems logical and valuable to investigate the fire behavior associated with such evidence and thereby determine the predictability of such phenomena. This is especially important in light of the associated risk with extreme, unmanageable nature of fire blowups. PyroCb and their "lesser" but more frequent pyrocumulus (pyroCu) relatives can be well characterized by satellite and groundbased radar data. Thus it may be possible to combine these independent, objective measures of extreme fire behavior to data that are more conventionally utilized by forecasters and other stakeholders in fire research and prediction, to address the question of how extreme fire behavior can be.

We explore those questions by presenting evidence for the occurrence of pyroCb in Australia and elsewhere globally. We will show cases where pyroCbs formed:

1. on a fire's first day of existence
2. where fires seemingly blew up in marginal fuel conditions,
3. where the blowup occurred in the middle of the night,
4. where an individual fire exploded in several pyroCb pulses in one particular afternoon/evening of activity.

Further, we will demonstrate that a pyroCb "climatology" database is under construction, availing the researcher of a unique resource for strategically mining satellite, radar, weather, and fuel data to determine predictors of these most extreme and dangerous fire events.

# Victoria Bushfire Weather-Climatology Project

**Sarah Harris**
Monash University

The Victoria Bushfire Weather-Climatology Project will consolidate historic bushfire weather data into a comprehensive database from which to conduct a detailed analysis of the spatial and temporal distribution of bushfire weather events and changes under synoptic conditions, climate forcings and future climates. This will be achieved by analysing modelled weather data that includes temperature, relative humidity, wind speed, wind direction, precipitation, Ketch-Byram Drought Index, Drought Factor and Fire Danger Indices from 1972 to 2009. The frequency and distribution of extreme, severe and catastrophic conditions will be demonstrated along with an analysis of the preceding and concurrent synoptic conditions and climate forcings. Finally, an examination of how bushfire weather risk may change under various climate change scenarios will be undertaken. This groundbreaking project that will use previously unavailable data to review historic fire weather and future fire weather conditions and will provide outputs that can be utilised for practical and policy purposes taking a proactive approach to bushfire hazard management.

# A computational Bushfire Risk Assessment Framework (BRAF)

**Trevor Jones, Martine Woolf, Bob Cechet and Ian French**
Environmental Geoscience Division, Geoscience Australia

Living with bushfires is a part of life for many Australians. However, bushfire can cause significant losses to economic, social, and environmental assets and values. Decisions about mitigating the harmful impacts of fires on assets and values, as well as operational management of fires, are critical. A Bushfire Risk Assessment Framework (BRAF) is being developed as an output for the Bushfire Cooperative Research Centre (BCRC) project Fire Impact & Risk Evaluation Decision Support Tool (FIRE-DST). The framework will incorporate the computational model structure being developed in the FIRE-DST project, which is effectively a subset of the BRAF. . The primary driver for the framework (BRAF) is to assist the development of improved, consistent information on bushfire risk that supports effective bushfires risk management. The framework will be designed to encompass the outcomes of other BCRC research projects. It will support various national initiatives such as the National Strategy for Disaster Resilience (NSDR) and the Climate Change Adaptation Framework, and will address issues arising from the Victorian Bushfires Royal Commission and the 2004 report to COAG 'Report of the National Inquiry on Bushfire Mitigation and Management'. This COAG report examined risk management but did not examine the risk assessment methodology. The COAG inquiry considered that the Australian Risk Management Standard (AS/NZS 4360; 1999) should be applied in relation to bushfire by all relevant agencies in all jurisdictions.

BRAF focuses on impact and risk assessment for severe and extreme fires. Financial, socio-economic, casualty, political and environmental risks arising from bushfires will be covered by the framework. Roles in the framework are described for a number of stakeholders including jurisdictional agencies, national committees and non government organisations including the private sector and peak industry bodies. The bushfire risk assessment framework should be coupled with a structured risk-management process, to provide unbiased information for the determination of the most appropriate management solutions for formulating effective mitigation and management actions in relation to bushfires (especially since risk management focuses not only on hazards and emergencies but also on communities, the environment and resources).

The BRAF builds on the National Risk Assessment Framework[1,] developed by the National Risk Assessment Advisory Group (NRAAG) for the Australian Emergency Management Council (AEMC), which addresses issues identified in the 2002 report to the Council of Australian Governments (COAG) 'Natural disasters in Australia: Reforming mitigation, relief and recovery arrangements'. This COAG report stated that in Australia there was a 'lack of independent and comprehensive systematic natural disaster risk assessments, and natural disaster data and analysis'. The BRAF also builds on the National Emergency Risk Assessment Guidelines (NERAG)[1] which will assist practitioners at all levels of government to undertake risk assessments that support the National Risk Assessment Framework. The BRAF only considers bushfires, and makes specific mention to quantitative assessments. The NERAG and BRAF are key steps in the Implementation Plan for the National Risk Assessment Framework that has been developed to meet the outcomes sought by Reform Commitment One (RC1) from the 2002 COAG report on natural disaster mitigation, relief and recovery in Australia: 'RC1 - 'develop and implement a five-year national program of systematic and rigorous disaster risk assessments'.

1. http://www.ga.gov.au/hazards/governance/policy/national-risk-assessment-framework.html

# Quantifying heatwave as a hazard

**John Nairn**

South Australian Regional Forecast Centre, Bureau of Meteorology

In January and February 2009 southeast Australia experienced an extreme heatwave sequence culminating in Black Saturday on 7th February (National Climate Centre, 2009a). Figure 1 shows the accumulated heat load from gridded climate data (Jones et al., 2009) across southern Australia encompassing this period.

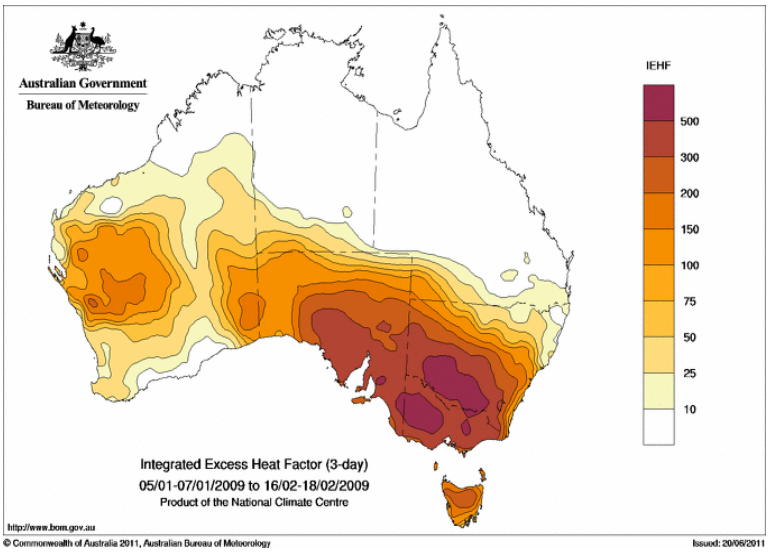



Figure 1. Accumulated Excess Heat Factor (EHF) from 5 January to 16 February 2009.

Catastrophic bushfires in the state of Victoria at the end of the heatwave resulted in the death of 173 people (Teague et al., 2010). Prior to this bushfire over 400 excess deaths occurred in the states of South Australia and Victoria (Mason et al., 2010; State of Victoria, 2009). Accumulated EHF over 400°C$^2$ in these two states is broadly indicative of the area impacted.

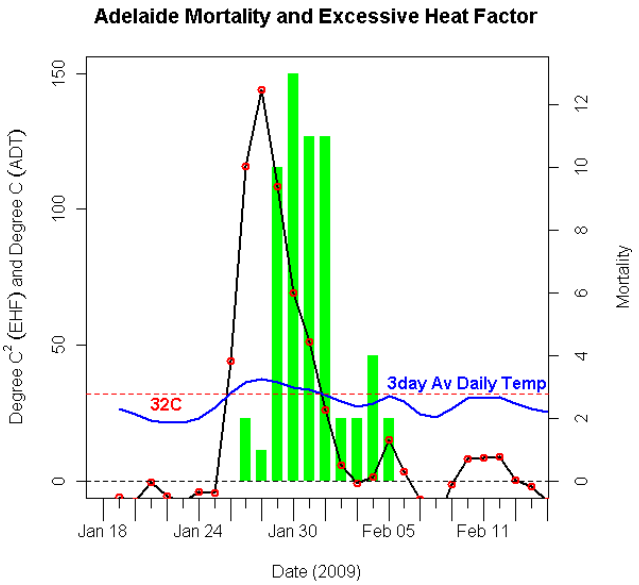



Figure 2. Mortality and EHF for 2009 severe heatwave in Adelaide, South Australia. Heat related mortality (green bars), Excess Heat Factor (black lines with red dots) and three day average daily temperature (blue line). Severe EHF threshold of 32°C$^2$ .

The time sequence for EHF and day of death shown in Figure 2 shows a similar power response to this extreme heatwave. Each EHF value on the chart is an expression of the average heat load over a three-day period, inclusive of the current and following 2 days. Calculated in this manner EHF shows a predictive capacity for the mortality response.

In Adelaide's 120 year climate record the EHF peak amplitude of 144°C$^2$ is the top ranked event. The accumulated EHF for this event is 586°C$^2$, also the top ranked event. Adelaide's second ranked heatwave occurred in January 1939. This severe heatwave also coincided with devastating bushfires, with 438 deaths reported in South Australia, Victoria and New South Wales (EMA, 2007).

### *References*


EMA, 2007: Heatwaves – In My Backyard? www.ema.gov.au/www.ema/schools.nsf/Page/LearnAbout_HeatwavesIn_My_Backyard

Jones D.A., Wang W. and Fawcett R., 2009: High-quality spatial climate data sets for Australia. Australian Meteorological and Oceanographic Journal. Aust. Met. & Oc. J 58(2009) 233-248.

Mason K., Nairn J., Herbst J. and Felgate P., 2010: Heatwave – The Adelaide Experience. 20th International Symposium on the Forensic Sciences, Sydney Australia.

Nairn J., Fawcett R., Ray D., 2009: Defining and predicting Excessive Heat events, a National System. Understanding High Impact Weather, CAWCR Modelling Workshop, 30 Nov to 2 Dec 2009.

National Climate Centre, 2009a: The exceptional January-February 2009 heatwave in southeastern Australia. Bureau of Meteorology, Special Climate Statement 17 (http://www.bom.gov.au/climate/current/statements/scs17d.pdf).

State of Victoria, 2009: January 2009 Heatwave in Victoria: an Assessment of Health Impacts. www.health.vic.gov.au/chiefhealthofficer/downloads/heat_impact_rpt.pdf

Teague B. (The Hon. AO), McLeod R. (AM), Pascoe S. (AM) 2010: The 2009 Victorian Bushfires Royal Commission final report. www.royalcommission.vic.gov.au/Commission-Reports/Final-Report.

# The Layman burn -“up”

**Mika Peace**
University of Adelaide, Bureau of Meteorology, and Bushfire CRC

From time to time, bushfires and fuel reduction burns exhibit fire behaviour that was never anticipated given the prevailing environmental conditions. The Layman burn, in scenic southwest Western Australia, was one such fire.

The fire started as a fuel reduction burn in mid-October 2010. Weather conditions were benign and similar conditions were forecast to continue for the next few days. Late morning on the day following ignition, fire activity escalated rapidly; a convection column developed with a deep vertical circulation that extended through the lower part of the atmosphere. The ensuing intense crown fire and high flames burnt outside the specified area, resulting in home evacuations and ecological damage.

The intense fire activity was driven by a combination of meteorological processes not routinely assessed in fire environments. Low level sea breeze convergence in the wind field combined with potential instability realised by Fire- CAPE, entrainment of dry air from aloft desiccating already climatologically dry fuels and vertical circulation on the sea breeze front were all present. It is believed that these co-located elements produced the intense conflagration.

The financial cost of the burn so far is approximately $700K and the event has been the subject of several enquiries in parliamentary session. Fall-out on the impact of the fire has not hinged on the escape area (which exceeded the intended burn area by 25%), but on the fire’s intensity. The intensity of the burn caused extensive (70-80%) crown scorch, with ensuing concern focussed on regeneration, biodiversity and impact to endangered species in the area.

Numerous case studies and anecdotal evidence show that meteorological elements other than near surface temperature, relative humidity and wind speed frequently impact bushfires in the Australian landscape. In order to anticipate fire behaviour vertical, temporal and spatial structure of the atmosphere must all be considered. The Layman case study exemplifies how meteorological processes not currently embedded in fire science can combine to produce an environment conducive to intense fire activity. Making significant changes to the way in which weather information is used by fire managers is a challenging prospect, but it may mitigate against such events in the future - or at least better anticipate their potential in advance.

# Validation of satellite assessment methods for grassland curing in New Zealand

**Clifford, V.R.; and Pearce, H. Grant**

Scion, Rural Fire Research Group, PO Box 29-237, Fendalton, Christchurch 8540, New Zealand. Email: grant.pearce@scionresearch.com

Grassland curing is a crucial input into fire danger and behaviour models. It describes the stage of seasonal die-off in grasses, which has a significant effect on a fire's ease of ignition, rate of spread and suppression difficulty. Satellite-based techniques to estimate the degree of grassland curing at regional and national scales for Australia and New Zealand have been investigated as part of a Bushfire Cooperative Research Centre (CRC) project. This research identified four satellite-derived map products based on combinations of different wavelengths of MODIS (Moderate Resolution Imaging Spectroradiometer) data that were compared against field observations of curing from sites across Australia and New Zealand.

In New Zealand, the four map products were tested during a part-season pilot trial in 2009/10. This recommended that a further full-season trial be conducted using the best two of these MODIS algorithms (maps B & C), based on different representations of the Normalised Difference Vegetation Index (NDVI). This full-season trial was conducted over the 2010/11 fire season. Feedback was sought from fire managers on a roughly fortnightly basis on which of these two satellite map products best represented the levels of curing around the country. Results were inconclusive, with Map B being preferred early in the fire season, but a change to Map C favoured during mid- to late summer. Map B also tended to underestimate while Map C tended to overestimate curing. Based on end-user feedback and consultation, neither product (Map B or C) would currently be recommended for operational use in New Zealand. Further evaluation and improvements to the map algorithms are required before an operational system could be supported.

Clifford, V.R.; Pearce, H.G. 2011. Validation of grassland curing satellite assessment methods for New Zealand. In: Proceedings, 2011 Fire Weather and Risk Workshop, 1-4 September 2011, Bowral, NSW. ACT Emergency Services Agency, Bureau of Meteorology and Geoscience Australia, in conjunction with Australasian Fire Authorities Council (AFAC) & Bushfire Cooperative Research Centre (CRC).

# Describing New Zealand's current and future fire climate

**Pearce, H. Grant**

Scion, Rural Fire Research Group, PO Box 29-237, Fendalton, Christchurch 8540, New Zealand. Email: grant.pearce@scionresearch.com

Understanding likely changes in fire risk associated with weather and climate is important for New Zealand rural fire agencies. Over the past decade, considerable research has been undertaken to improve the understanding and description of New Zealand's fire weather and climate. This has included development of a fire weather climatology database, and analyses comparing the severity of fire climates in different parts of the country, comparisons and prediction of fire season severity, and investigation of the effects of interannual variability and longer term climate change on fire danger. Scion's Rural Fire Research group also recently completed two further fire climatology analyses providing updated descriptions of New Zealand's current and future fire climate.

The first provided an improved description of current fire climate severity across the country, based on analysis of fire weather and fire danger data from a network of fire weather stations across the country. Regions of the country with the highest fire climate severity values were Marlborough, the inland South Island, Canterbury and eastern North Island. The areas with the lowest fire climate severities were found on the South Island's West Coast, Southland, the west of the North Island, and central North Island. The results will inform a range of rural fire management planning activities, including describing wildfire risk, identifying further weather station requirements, and assisting with delineation of boundaries for Enlarged Rural Fire Districts.

The second analysis provided updated estimates of the effects of climate change on future fire danger. Fire danger ratings for the 2040s and 2090s were estimated using changes in weather inputs (temperature, humidity, wind speed and rainfall) from current climate (based on the 1980s baseline). These changes were obtained from downscaling of 16 of the IPCC's 4th Assessment global climate models for the A1B emissions scenario applied to daily weather station observations. Results indicate that fire climate severity is likely to rise significantly with climate change in many parts of the country as a result of increases in temperature or wind speed, and lower rainfall or humidity. However, in other areas fire danger may remain unchanged, or in fact decrease by the 2090s, due mainly to increased rainfall.

Further research is also required on a number of fire weather and climate related issues, including: fire weather station network coverage and data quality; spatial interpolation of fire danger; prediction of extreme fire weather days (e.g. from Australian synoptic conditions, or atmospheric stability); impacts of climate change (including RCM modelling); and improving the FWI System (e.g. through use of soil moisture measurements or models).

# Foehn winds and other extreme drying events

**Jason Sharples**
Australian Defence Force Academy

Fire weather in southeastern Australia can sometimes exhibit abrupt changes, which cause significant localised escalations in fire danger levels and bushfire risk. Fire fighter safety can also be seriously compromised in such events. In this context, recent research has highlighted the significance of synoptic events that occur in connection with the topography of the region such as foehn occurrence. Foehn winds can result in abrupt increases in temperature and wind speed, and accompanying decreases in relative humidity, which can result in more than ten-fold increases in fire danger rating over relatively short (sub-hourly) periods of time. The Gippsland and NSW south coast regions have been shown to be particularly prone to foehn occurrence.

In addition to impacts in the lee of mountain ranges, high-country locations above approximately 1500m, can also consistently experience abrupt deterioration in fire weather conditions. These cases have been associated, through the use of meso-scale numerical prediction models, with subsidence inversions and low-level jet occurrence. These events consistently result in anomalously low dewpoint temperatures and are observed to occur preferentially in the early morning at times when fire weather conditions would otherwise be expected to be benign.

# Development of Rapid Fuel Assessment Techniques for the Forest Flammability Model

**Phil Zylstra**
Department of Environment and Heritage, NSW

The Forest Flammability Model is a physically-based fire behaviour model which calculates flame characteristics from the architecture of a forest and the factors influencing the flammability of its component species. By modelling the physical processes as part of a complex system, the model is capable of assessing the relative influence of different weather metrics such as the impact of a heatwave compared to single hot day, a drought or a wind event. The significance of this is demonstrated in an example where the FFDI is kept constant but its component values are altered. Modelled flames in the example vary from low surface fires to active crown fires, with widely varying impacts on structural bushfire threat considerations. Because the model utilises physical plant measurements rather than subjective indices, collection of fuel parameters is possible using remote sensing. Work is currently under way as part of the FIRE-DST project to establish systems whereby fuels may be measured on a landscape rather than point basis using technology such as MODIS, LiDAR, Quickbird and ADS40 imagery, and where localised measurements can be collected quickly and objectively with instruments such as the CSIRO 'Echidna'.

# Pre-workshop expectations survey

Shortly before the workshop all those who were registered at the time were asked to send the organisers a list (not greater than 3) of expectations that they had for the workshop. There were 14 replies, some of which reflected a corporate perspective, and so a larger number of individuals were represented in the final list.

The full list of dot-points is presented below. The sources of the replies have been removed, but each point is listed. Some replies did not have 3 points, and so the fact that there are not 42 dot-points is not a result of selective editing.

**ASPIRATIONS AND EXPECTATIONS SUMMARY** (14 respondents)

- Opportunity to build a network of researchers and user practitioners with an interest in fire weather
- Opportunity to contribute to the ongoing promotion and sharing of contemporary knowledge in fire weather
- Identification of major knowledge gaps/research challenges
- Broad general awareness of the field
- Recommendations on accountability mechanisms to ensure forum recommendations are implemented (perusing the old conference proceedings, it seems the same issues keep appearing).
- Refinement on the relationship between research and operational need (certainly something pertinent to our experience). Which drives which?
- Recommendations on interagency protocols for achieving change - principally in data and information gathering, and user acceptance testing.
- To see what research is currently being done and what people see as the gaps in knowledge that need addressing.
- Learning – I would like to come away with a greater knowledge of current methods and practices of bushfire meteorology and danger ratings.
- Coordination/collaboration – I'd like to link up with all the relevant people doing similar work around Australia, so as to coordinate what I'm doing with them or even collaborate on projects. I'd also like to offer insights from our experience.
- Contribute to joint projects – I'm keen to contribute to proposed projects and papers for AMOJ as listed on the website.
- Network with other bushfire risk analysts
- Learn more about anything do with pyrocumulus
- What meteorological inputs are required by agencies from Bureau services so that more realistic measures of fire danger (than the current McArthur indices) can be developed and a more discriminating warning service can be provided to the public.
- To initiate further research on the meteorological components of bushfire hazard and combine with environmental intelligence on spatial measures of vulnerability and exposure so that more effective measures of bushfire risk can be determined

- Interested in bushfire related physical sciences, especially meteorological influences on fire behaviour.
- We hope to have the opportunity to meet others working in fields related to the above, and have the opportunity to discuss the science.
- We request the format allow ample time for questions and discussion after all presentations.
- Would like to get out of the workshop a basic understanding of what a whole range of terms and phenomena (dry slots, dynamic channelling, low level jets etc) actually mean when specialists mention these terms/phenomena to me so I can interpret these and make some sense of what I am being told by specialists
- Enhanced understanding fire weather extremes in terms of upper physical limits and likelihood
- Characterisation of the weather events over different time scales, eg for certain regions of Australia are there signature build up conditions that are associated with an extreme fire weather event. How can these be characterised? As they can become very important parameters for determining asset vulnerability prior to fire arrival.
- What will the suit of weather mapping products be in 2 and 5 years time? So we can set up our asset vulnerability models to draw on these products.
- Discussion on why BoM doesn't do lightning detection.
- Re-standardising calculations of Drought Indices and Drought Factors.
- A nationally coordinated observation and reporting system for violent pyro-convective events
- To find out what the current frontline of research looks like, particularly Fire Danger Rating and Index
- I'm very interested in the two international speakers you advertise
- In seeing where the technology is up to
- Directions for new Fire Danger Ratings - replacement of current system.
- Better methods for identifying extreme hazard days - it would be nice if meteorologists and fire agencies could identify these days from an ingredients approach rather than from a single index.
- How can we take best advantage of the rapidly improving NWP.
- To be made aware of the current state of knowledge in fire weather and risk
- To have some confidence/understanding of how this knowledge is to be implemented operationally and/or incorporated into fire management training materials
- To leave with an appreciation of where the research is heading.

# Post-workshop feedback survey

The feedback form sent to all participants is shown at the end of this section. Twenty-three evaluation forms were returned, and evaluations compiled. Where rankings were requested, the results have been consolidated into tables. The numbers do not exactly "add up" as some responses did not provide evaluations for all sessions due either to absence or to conflict of interest. After the ratings a series of questions were asked, and each response is listed for completeness under the question heading, although a few responses were notably lengthier than the general response and these have been paraphrased and are indicated in italics.

## QUESTION 1

This question asked for a ranking of the different sessions on a scale of 1 to 5. The table below gives the number of responses by ranking to each session.

**FOR EACH OF THE SESSIONS LISTED BELOW, COULD YOU RATE YOUR IMPRESSIONS FROM 1 (NOT SO GOOD) TO 5 (EXCELLENT)**

| Session / Rating | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| General Review (Friday 0920-1115) | 0 | 0 | 5 | 13 | 4 |
| Research Review (Friday 1115-1745) | 0 | 0 | 2 | 14 | 6 |
| Wildfire Risk Review (Friday 1950-2200) | 1 | 2 | 5 | 13 | 2 |
| Forecast Practice (Saturday 0900-1230) | 0 | 0 | 4 | 14 | 4 |
| National Fire Danger Rating System (Sat 1330-1430) | 0 | 0 | 6 | 12 | 4 |
| New Research Directions (Sat 1430-1540) | 0 | 0 | 3 | 17 | 2 |
| Research Adoption (Sat 1540-1730) | 0 | 2 | 6 | 11 | 2 |

## QUESTION 2

This question asked whether there were two few to too many talks, again on a scale of 1-5, and the number of responses in each category are shown in the table below.

| Question / Rating | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Were there too many talks? (1 – far too few, 5 far too many) | 0 | 0 | 16 | 6 | 2 |

## QUESTIONS 3 AND 4

The next two questions addressed the balance of the workshop : was there sufficient time for formal and for informal discussion. This time rankings were from 1 (too little time) to 3 (too much time). Again the number of responses in each category are shown in the body of the table below.

| Question / Ranking | 1 | 2 | 3 |
|---|---|---|---|
| Was there sufficient time for discussion? | 8 | 15 | 0 |
| Was there sufficient time for general schmoozing? | 7 | 16 | 0 |

## QUESTION 5.

### DID THE VENUE HELP OR HINDER THE SUCCESS OF THE WORKSHOP TO YOU?

All replies were particularly positive about the venue.

## QUESTION 6

### HOW WAS THE BALANCE OF THE PROGRAM – TOO MUCH OF WHAT, TOO LITTLE OF WHAT?

Only attended the first day but wanted to hear more of how research could relate to the practical nature of fire-fighting and prescribed burns etc.

Not sure if us weather heads got too nerdy for the fire operational people, they seemed a bit quiet during those parts. Apart from that pretty good

I don't know why, I thought it would be a little more operationally oriented …….

A little more from fire agency perspective rather than the meteorological research perspective perhaps. More discussion on how fire officers use weather data.

Too much time spent on NexGen

Perhaps a greater time for discussion at the expense of some presentations, or alternatively a slightly longer conference

Good. Sunday was a bit thin for content (especially as we weren't getting paid).

It would be useful to have more time to discuss the implications of the various initiatives; to ask ourselves 'so what?

The Risk component did not work for me, and we did not hear enough from the fire and land management agencies

Overall the workshop was fantastic. Initially the program looked to full; however all participants did a great job at sticking to their allotted time. The way lunch and dinners were group events also helped promote time for 'smoozing' which is invaluable.

I liked it – I thought it was well managed – congrats.

I think the balance was the best it could be. It would have been great if each speaker had a little extra time and the discussion time after each speaker was a little longer. The breaks always seemed to be over too quickly but I could not suggest any topics that could have been left out. It would also have been difficult to be away for any longer (perhaps another half day of content?) and I thought the evening session was a good use of time.

It felt like a wasted opportunity being at such a beautiful venue and not spending more time outdoors (I should have done better research and brought the family down for Sunday).

A bit less formal presentation and more (smaller groups) group discussion.
Attempt to incorporate both fire weather and risk themes was too much to cover, especially given catch-up nature of workshop; risk theme was given too little time to address properly, so should probably have been left for another workshop

Balance was good.

I found it quite evenly balanced

There needs to be more emphasis on identifying areas for collaboration (both between researchers and between researchers & end users). While some of this can be achieved informally, some time dedicated to this would be a useful addition.

Good balance, perhaps a little too much crammed in some times

Not enough general discussion/schmoozing

Only one session on risk in the entire workshop and it was the weakest session. However, so far, there's not a lot to talk about with regards to research in fire risk assessment. There is however plenty to talk about in **FIRE RISK MANAGEMENT**, especially since the 2009 Victorian fires and the recent WA fires and this could be more of a focus in any future workshop around fire risk assessment

Fire risk component was a little light on, there seemed to be a bit of confusion between hazard and risk in some of the presentations.

Balance was excellent

## QUESTION 7

**IS THERE A PARTICULAR THEME YOU WOULD LIKE ADDRESSED NEXT WORKSHOP?**

How different weather parameters affect fire behaviour and risk

Application of research needs a stronger emphasis; particularly the interaction and use of weather research in fire behaviour prediction & analysis. Weather & prescribed burning is another emerging theme which could be looked at

More discussion on science behind a NFDRS.
More discussion on BoM interface to fire models like Phoenix.
Some talks on how fire agencies actually use BoM forecasts

Maybe the risk theme could be addressed properly next time; however, is important to retain the core fire weather theme; new research directions, and research adoption topics should also be included at each workshop

Perhaps a little more on fire agency implementation?

Transitions – from business as usual to a hazardous event.

With such a group being together it could be an opportunity to spend a session looking to the future. Where is the world of fire weather and fire behavior heading? Spend some time in the futuristic innovative frame of mind. It would need to be a carefully run session to keep it at least somewhat grounded with reality but it would be great to hear the ideas coming from the collective minds of a group like this.

Yes I would like more integration between fire weather research, and the application of that research by operational people in both BOM and other agencies

Not a theme, but perhaps a talk or two on how the fire agencies use the forecasts? Perhaps a session on what are the observational needs and priorities?

Wind change forecasting

Next Gen implementation SWOT Research to practice

So, yes making research more operationally relevant yes. But also a tap on the shoulder to managers and a broader canvassing of their opinions on what do we really need, rather than what do we have and how do we use it. To do this we'd need either a wider representation from fire agencies or a series of targeted workshops that assist in the identification of operational needs.

The FIRE DANGER RATING SYSTEM will still be an issue of interest in two years time it appears given the timetable outlined at the workshop. It's a contentious area with a mix of legal, political, scientific and risk management issues

Some of the presentations were a bit too centered on policy, project management and administration which I could have done without. Would prefer more nuts and bolts scientific presentations.

I would like a theme on what lessons have been well learned and effectively implemented versus those that appear to have been missed or ignored or incorrectly formed.

## QUESTION 8
### ANY OTHER COMMENTS?

It was a fantastic opportunity of people from any disciplines to communicate. Thought everyone got on really well and got to meet many different people

I thought it worked really well, had the flavour of the sevwx conferences of old. May it continue.

I am really looking forward to seeing more of Mika's and Brian's work. It contains a series of messages that are really easy to digest and are very relevant to field based decision makers.

An excellent venue and a well-planned program. I realise there are benefits of reducing overall travel costs, but having it following four days of AFAC conference / BCRC workshops meant that I was less alert than I could have been. It would be preferable to hold it separate from the AFAC conference or perhaps before the main conference?

Overall very good – the style of the workshop (self-contained venue, all meals together and provided) helped a lot with enabling interaction, as did the longish coffee breaks, etc. An instruction to sit somewhere different each day would have taken this further. Content and breadth of the talks was good – I learnt a lot. The workshop did finish with a bit a whimper rather than a bang, and Sunday was not all that well utilized given that it kept us from our families for another day. Having a venue with good recreation possibilities is good. The wine was a bit substandard.

Dinner was fine, though the quiz was oriented towards the meteorologists, and therefore somewhat exclusive.

We definitely need to continue this forum. I think an opportunity to discuss HOW the forum might continue would be worthwhile.

Well done to Graham and Rick (and all the other organizers). At times it still seems hard to 'see' the pathway to transition research into operations. The role of the funded fire weather meteorologists in NSW and Vic, and the expanding world of fire behavior analysts may help. Agency commitment could come from creating designated roles or contacts that play this role.

I greatly appreciated the opportunity to attend the workshop as I have only recently been working in fire behaviour and weather. I hope I would make a greater contribution in future. The workshop organisation was fantastic and the mood felt extremely positive.

Well organized, great venue, good workshop.

It seemed that a number of key end-users and agency representatives (including the BFCRC) were not present when they might have otherwise been expected to attend.
The workshop program needs to be finalized earlier and made available prior to coming to the workshop. The link from the main conference website to the workshop webpage was also a bit obscure (at the bottom of the page, only after scrolling all the way down), so needs to be more obvious.

Obviously time was a serious limitation, and the organizers did an excellent job with what was available. It was great to see the enforcement of strict time limits for presentations. If in the future more time is available I believe it is important to maintain the short presentation format, and add more free time for social activities and informal science discussions. It is in the social and informal meetings where strong links are made, and enthusiasm generated.

A very enjoyable and productive time. It is so important to have close links between the BoM and the fire community. Hard to understand why these stopped in 1997.

The workshop needs an 'owner'. That is, if recommendations are to be made, we need someone to make them to. AFAC, BF-CRC are options; or the Wx Tech Group.
Separate the workshop from the AFAC Conference. There are already too many things happening in this space & many of the participants didn't attend the full conference.

Well pitched. I hope there is a transitional arrangement where the next organisers can benefit from your experience.

While the theme of the workshop was 'risk', it was only a minor part of the program, and stuck late after dinner after a long first day. IMO it would have been better to have the Friday evening off for schmoozing and have the session the next day (making room for it by having fewer talks in each session, perhaps). I realise that risk was my personal interest, so this may not match other people's perspective, but it seems a shame to have a 'weather and risk' workshop and not really have proper discussion about risk because it comes at a time in the program that nobody has any interest and energy left.

1. An excellent workshop and congratulations to the hard working and creative organising committee. Excellent input and collaboration from end user fire agency people
2. Excellent value to have 'state of the art' international visitors and this initiative should be continued at the next workshop
3. Be selective about the quality of talks for the next workshop. This means, more effort needed in vetting proposed presentations, e.g., through submission of abstracts (ie more work for the organizers). There was the occasional dud or talk with little effort put in.
4. I'm uncertain if the 'risk' part sat well with the 'fire weather' part. Seemed to me there was some element of three-way disconnect between the meteorologists (eg the forecasters), the end users and the risk modelers (except in the case of some individuals who cross the 'boundaries' easily). If there's more interesting material on developments in risk assessment next time then this criticism may dilute. However, there would still need to be some obvious and clear linking of the two main subject areas, preferably with a stronger input on end user interests and needs from the research.
5. A major theme or themes could be proposed for the next workshop. Eg a focus on one major research problem or a small number of these. The next workshop will be very near to the end of the current BCRC extension so the workshop could focus on scientific achievements and outstanding research problems (all of interest to fire agencies)

Is there a way to modify the program to get the end users to play a stronger formal role, eg in presentations on their current programs related to fire weather and risk and their priority needs for weather, firespread and risk assessment research?

Best part of AFAC in my opinion, really enjoyed the short presentations which encouraged presenters to get to the point rather than waffle on. Would prefer more of them in the next one, some of the longer presentations were a bit painful.

The session after dinner Friday was substandard for two reasons. The audience (speaking for myself) was set up for poor listening because of the late hour and the heavy dinner. Secondly, most of the speakers that evening gave presentations that were heavy on perceived canned scripts and delivered mechanically (instead of impassioned or individually owned).

## FIRE WEATHER AND RISK WORKSHOP
## BOWRAL, 1-4 SEPTEMBER 2011

## FEEDBACK FORM

NAME (optional) …….

For each of the sessions listed below, could you rate your impressions from 1 (not so good) to 5 (excellent)

| Session / Rating | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| General Review (Friday 0920-1115) | | | | | |
| Research Review (Friday 1115-1745) | | | | | |
| Wildfire Risk Review (Friday 1950-2200) | | | | | |
| Forecast Practice (Saturday 0900-1230) | | | | | |
| National Fire Danger Rating System (Sat 1330-1430) | | | | | |
| New Research Directions (Sat 1430-1540) | | | | | |
| Research Adoption (Sat 1540-1730) | | | | | |

Were there too many talks? (1 – far too few, 5 far too many)

Was there sufficient time for discussion? (1 – not enough, 3 too much)

Was there sufficient time for general schmoozing? (1 – not enough, 3 too much)

Did the venue help or hinder the success of the workshop to you?

How was the balance of the program – too much of what, too little of what?
……
……
Is there a particular theme you would like addressed next workshop?
……
……
Any other comments?
……
……
……
……

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