6th Fire Weather Workshop

Hahndorf
South Australia

18-22 June 1995

Presentation Abstracts

Bureau of Meteorology

Total Fire Ban Declarations and the Causes of Bushfires

Noreen Krusel
Scientific Officer
Country Fire Authority of Victoria

On days of forecast extreme fire danger, the Country Fire Authority of Victoria (CFA) may declare a day of Total Fire Ban (TFB) for the whole or parts of the State. The Authority determined that five TFB districts were appropriate to provide the compromise between declaring TFBs where needed and unnecessarily restricting activities in areas where the declaration may not be required. The boundaries of these districts were aligned to municipal boundaries. In response to the recent amalgamation of municipalities in Victoria, the CFA are reviewing the Total Fire Ban District boundaries. It is pertinent at this time to review what impact the declaration of a TFB has on the cause-profile of bushfires, as the TFB declaration is intended to reduce the number of human-caused fires. Four years of data from the Fire and Incident Reporting System database were used to compare the causes of bushfires on TFB days versus non-TFB days. As the TFB declaration is based on the forecast FDI, days of the same FDI were compared to eliminate the bias that would otherwise exist.

Noreen Krusel
Country Fire Authority of Victoria
PO Box 701
Mt Waverley, Vic, 3149

phone (03) 9262 8414
fax (03) 9262 8399
e-mail n.krusel@cfa.vic.gov.au

Bureau of Meteorology's Automatic Weather Station Program

David Evans
Observations and Engineering Branch
Bureau of Meteorology, Melbourne

The Bureau of Meteorology has installed, and maintains, a network of 200+ Automatic Weather Stations (AWS), increasing at a rate of some 30 per year.

Funding for AWS installations comes from a number of Bureau programs: the Basic Network (including marine, agriculture and climate), Severe Weather (including fire and cyclone), Aviation, and Equipment Upgrade. This program-based funding is evident in the distribution of AWS's throughout the country.

The program is also complemented by a number of AWS which have been funded partially or wholly by external organisations.

In implementing the AWS installation program, every endeavour is made to satisfy as many requirements as possible from as many of the above programs as possible. As a consequence, all Bureau AWS are designed to stand up to extreme weather conditions whilst maintaining climatological standards.

A comprehensive maintenance/calibration program ensures the AWS operate at optimum level.

The Bureau's Observations & Engineering Branch has the dual roles of implementing the Bureau's own AWS program, and of advising external organisations and individuals in their AWS purchases. Expertise is available to advise on all aspects of AWS.

David Evans
OEB, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4205
fax (03) 9669 4168
e-mail d.evans@bom.gov.au

Fire Weather Outposting in Victoria

Ray Kollmorgen
Severe Weather Section
Bureau of Meteorology, Melbourne

Fire weather outposting is a joint project between the Victorian Regional Office of the Bureau of Meteorology and the Victorian Department of Conservation and Natural Resources (CNR). During the last 2 years there have been 3 fire outpostings; Katoomba, Halls Gap and Yarram. Contributions to this abstract were made by Peter Billing, CNR Fire Management Branch.

Aim of the service : To improve the safety and efficiency of major fire suppression operations by providing on-site specialist weather support.

What we do? : Constantly monitor local conditions using a portable AWS, regular visual and upper air observations. Synoptic scale weather trends are monitored via modem connection to the Regional Forecasting Centre. Become familiar with the immediate tactical and strategic planning issues that are weather dependent. Interact with and respond to these issues by direct advice to the fire-line through the planning officer. Provide written and verbal elaborative weather briefings to the fire agencies.

What we have achieved? Provided support to major fire operations, particularly involving major backburns and aircraft operations. Provided increased safety and performance through direct tactical fire fighting response and an improved efficiency of resources. Assisted the change from a reactive fire fighting approach.

Equipment : A fire weather trailer containing meteorological equipment, theodolite, balloon gear, camping and office supplies. Visual balloon flights are conducted by trained CNR officers. A Monitor Sensors portable AWS deployed close to the fire reports via radio/modem link to a laptop PC at fire headquarters, providing 10 minute updates of wind, temperature (wet and dry bulb) and relative humidity. Four laptop computers and associated peripherals are used for AWS data display and for connection to the Bureau's computer system.

Software : DIFACS - numerical model output; MDMS - AWS display; PC-Rapic - radar data; Paintshop Pro - for displaying visual satellite pictures; and standard word processing software. Data transfer using C-Kermit software.

Training : At least one training day per year usually at the start of the fire season. This is held jointly with the Bureau and CNR. All severe weather staff are involved as well as 3 or 4 RFC forecasters and about 5 CNR officers. The training mimics the real situation, so we go to a field site, set up the equipment, deploy the AWS and practice.

Standards : To ensure the outposting is justified and will always function we have minimum standards ie. trailer and all equipment ready, access available to vehicles and radios, staff trained and available, immediate contact with fire HQ to ensure 2 phone lines/power/command structure is in place.

Future Plans : A 3-4 station portable AWS network, with technical support by the Bureau's Engineering Branch. To maintain support for other activities eg. aviation events.

Ray Kollmorgen
Bureau of Meteorology
PO Box 1636M
Melbourne, Vic, 3001

phone (03) 9669 4973
fax (03) 9669 4964
e-mail r.kollmorgen@bom.gov.au

Demonstration of Country Fire Authority of Victoria's Operational Management System (OMS) Computer System -

Ken Stephenson
Country Fire Authority of Victoria

The development of the CFA's OMS has concentrated on building a number of data layers and integrating them into a software package that will make available timely information about fire conditions and fire behaviour. This software is currently running throughout every CFA Regional Office.

The current system integrates fire and incident information such as status, size, brigade and resource involvement; CFA and BOM RAWS networks; the grassland curing images developed in conjunction with CSIRO; front location; drought index; rainfall; fire restrictions and rate of spread models. Many of these elements or information layers are required for fire behaviour modelling. These elements are combined to display a real-time 'snapshot' of fire status and fire conditions across the state. All data is stored in a relational distributed database and utilises Client / Server database technology.

The next stage of the system, now under development, will allow the operator to 'zoom in' on any of the fires represented on the OMS and be able to map the area of concern using GIS data, map the fire shape at various times (taking feeds from external plotting software eg ARMS), the resource deployment and provide the basis with which to build and link to the fire reporting system. The overall OMS will track an incident from its inception as a dispatch message through its life as a 'going' incident through to the fire report stage. Any incident should be able to be 'recreated' with weather conditions, fire plots, resource and personnel deployments.

A predictive fire model incorporating community warnings is seen as the final stage of the system.

Ken Stephenson
Country Fire Authority of Victoria
PO Box 701
Mt Waverley, Vic, 3149

phone (03) 9262 8418
fax (03) 9262 8399
e-mail k.stephenson@cfa.vic.gov.au

CFA's AWS Network and Meso-models.

Ian French
Mathematics Department
University of NSW, Canberra

This talk follows on from the previous presentation on The Country Fire Authority of Victoria's Automated Weather Station network. In this talk I will outline my PhD project and how it is proposed to use meso-scale meteorological models within the CFA AWS. This research project has commenced only recently and so I encourage discussion on how and what objectives should be studied as part of this research.

This project is funded by an ARC Postgraduate Scholarship (Industry) and by the Country Fire Authority of Victoria.

Ian French
Mathematics Department
University of NSW, University College
Northcott Drive Campbell, ACT, 2600

phone (06) 268 8883
fax (06) 268 8886
e-mail iaf@maadfa.adfa.oz.au

The Bureau of Meteorology Modernisation Program - Impacts for Fire Weather Services

Peter Gigliotti
Central Operations and Systems Branch
Bureau of Meteorology, Melbourne

The Bureau of Meteorology has commenced a major program to modernise the computing infrastructure in Regional Forecast Offices around Australia. The centrepiece to this program is the development of the Australian Integrated Forecast System (AIFS) which will replace old operational computer systems in Regional Offices.

The present computing infrastructure in Regional Offices consists of a number of legacy systems which have overlapping functions and inconsistent data stores. These systems are difficult to manage, hard to maintain, not easily up-gradable or extendable and unable to keep pace with the changing requirements of internal and external users.

AIFS has a number of key features which include

- interactive access to data and to the forecast preparation and delivery systems;
- integrated data set design to enable coherent overlay or 'window' display of heterogeneous data;
- advanced colour graphics facilities to enable visualisation of complex meteorological fields and data; and
- integration, within a 'window' environment, of functions such as display of observations, analyses and prognoses data; diagnostic presentation; product preparation; dissemination; and decision support.

AIFS will allow the Bureau to better service fire or other emergency management agencies by providing a flexible, robust infrastructure for access to Bureau data and products using modern communications methods. The use of more graphics-based products such as high resolution satellite imagery, radar, lightning, high resolution numerical weather analysis and prediction data, dispersion modelling and graphical representation of forecasts and warnings will allow emergency managers to better assimilate Bureau products in real-time. Evolving multimedia technology such as video conferencing and pay-TV will also provide increasing opportunities for the Bureau to tailor products to meet changing user requirements.

AIFS will be implemented on a Region-by-Region basis commencing in Victoria in late 1995 and extending to all other regions by 1998. The modernisation program will provide the technology base for the development of new and improved services to emergency management agencies.

Peter Gigliotti
Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4909
fax (03) 9669 4500
e-mail pag@bom.gov.au

Pedagogical Strategies for Fire Weather Education via the World-Wide Web: towards an Hypertext Book

Chris Trevitt, Michael Ryan
School of Resource and Environmental Management, and
Centre for Educational Development and Academic Methods,
Australian National University, Canberra,
and
Keith Colls
Policy and Secretariat Section,
Bureau of Meteorology, Canberra

Bushfires and specific fire weather scenarios cannot be scheduled for teaching and learning purposes. Anyone involved with teaching and training in rural and forest fire science knows that scheduling practical exercises of any sort is always a challenge. This paper looks at the opportunities presented by the World-Wide Web (WWW) for an hypermedia approach to curriculum materials, including the use of case study animations to aid in the visualisation of the more abstract or difficult concepts. This may help compensate students for the all too frequent lack of actual field experience. It may also assist students whose disciplinary background is not in the physical sciences to appreciate more clearly the reasoning adopted by meteorologists and weather forecasters. The design of an hypermedia approach to the presentation of case studies of some Australian conflagration fires and associated fire weather situations is described, as is WWW access to these materials. Possible future developments in education and training, and professional development for forestry using the WWW are canvassed.

Chris Trevitt
School of Resource and Environmental Management
Australian National University
Canberra, ACT, 0200

phone (06) 249 2938
fax (06) 249 0746
e-mail chris.trevitt@anu.edu.au

Why Meso-scale Meteorological Models?

David Packham
Service Policy Branch
Bureau of Meteorology, Melbourne

In the quality Australian Monthly, *The Independent*, Eric Roth has taken the role of fire in our environment into public debate with an article entitled 'Bushfires are good for us' (May 1995).

Roth points out what all fire managers and almost all environment managers know and that is fire is a positive management technique for achieving environmental and forest health. It was also the major tool for our oldest Australian environmental managers, the aboriginal people.

Fire management for the next two decades and even further will involve the active use of fire under well known conditions of fuel availability, fire behaviour and fire weather. The meso-scale meteorological model (MMM) will be a major tool for positive fire management, now that we have almost completely licked the 24 hour broadscale or synoptic fire weather forecast problem.

The meso-model will require considerable research and partnership between meteorologists and fire scientists. It will also require considerable local computing power and the best automatic weather station network that we can afford, especially in our most fire sensitive areas.

The meso-model will provide information about topographically modified winds and will also provide information and prediction on the feedback between fire and local weather. This capability will warn of sudden, embarrassing, expensive and dangerous fire behaviour and provide predictions of convective development, spotting distance and smoke dispersion. In times of wildfire, MMMs will warn of sudden changes in local fire weather that has so often killed firefighters and citizens.

I suspect that MMMs will be a major technique as we take our next step beyond empirical and semi-empirical fire behaviour models into actually understanding fire spread.

What a lot to do but what a hopeful and exciting basket full of possibilities. Who knows, we may catch up to the traditional fire managers. As Roth said of the aboriginal environmental managers..

'By intelligence and minute observation, they modified the land to suit themselves. And they made a wondrous job of it '.

To deserve this country we should do no less.

David Packham
Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4705
fax (03) 9669 4695
e-mail d.packham@bom.gov.au

Mesoscale Modelling and Fire Weather

Lance M. Leslie
School of Mathematics
University of New South Wales, Sydney

Milton S. Speer
Regional Forecasting Centre
Bureau of Meteorology, Sydney

The presentation will centre on mesoscale modelling and hazardous weather starting with the standard questions: - ***What*** is mesoscale modelling? ***Why*** is it needed? ***How*** is it carried out? Then follows a case study (see below). There will be some discussion on how mesoscale model output can be best be used.

Case Study : Simulation of the January 1994 Bushfires over Eastern New South Wales using a High Resolution NWP Model

The period from 27 December 1993 to 14 January 1994 was the worst bushfire period experienced in eastern New South Wales for nearly three decades. The worst days in the Sydney area were 7 and 8 January. Forecasters were alerted to the possibility of extreme fire weather conditions by the Bureau of Meteorology's Global Assimilation and Prediction System (GASP) up to four days beforehand. However, forecasters and fire managers were still faced with the major problems of the timing, strength and position of local variations in the wind field. In this study, a high resolution limited area model (HLAM) was run at both 25 km and 5 km horizontal resolution, over a region centred on NSW in order to assess the value of the model predicted fields in relation to the following critical factors:

- the easterly breeze across the Sydney metropolitan area on the morning of 8 January;
- uncertainty about the timing and strength of northwest winds that eventually occurred in eastern Sydney on the afternoon of 8 January; and
- uncertainty about the timing, direction and strength of the wind change through Sydney and the central coast late on 8 January.

Lance Leslie
School of Mathematics
University of NSW
Sydney, NSW, 2052

phone (02) 385 3307
fax (02) 385 1071
e-mail l.leslie@unsw.edu.au

Coupled Atmospheric-Fire Numerical Modelling: Effects of Fire-Line Length and Ambient Wind Strength

Mary Ann Jenkins
University of York, Canada

Terry L Clark
National Centre for Atmospheric Research, USA,

Ian Knight
CSIRO, Australia

David Packham and John Bally
Bureau of Meteorology, Australia

While significant progress has been made in developing forest-fire danger ratings or the forecasting of weather relating to fire danger, there does not exist a physically based and verifiable forest fire model. One of the biggest obstacles to simulating wildfire behaviour is how to accomplish the desired level of atmosphere-fire coupling. Wind drives the fire, which in turn drives the wind. This feedback means that the wind and fire are essential parts of the system and cannot be separated, or the understanding of both will suffer.

A fire module has been incorporated into the Clark-Hall meteorological model, where the central object is to develop a numerical, three-dimensional, time-dependent wildfire simulation model, based on the primitive equations of motion and thermodynamics, that is capable of representing the fine-scale dynamics of convective processes and capturing ambient terrain and meteorological conditions. The goal is to provide a first-generation coupled model that can be used to realistically simulate the interaction between the fire and atmosphere to successfully study forest fires and their physics, behaviour and structure, and propagation mechanisms.

We give a brief description of the meteorological and fire models and how they are coupled, and we present the numerical atmospheric-fire model simulations designed to examine the combined effect of constant ambient wind field and fire-line length on fire-line geometry and fire-line breakup.

The first aspect of fire behaviour suggested by these simulations is 'convective fingering', where the 'parabolic' curved shape of a short line fire and the multiple parabolic shapes or protrusions - 'fingers' - in a much longer wind-driven line fire are the result of a feedback of the near surface convergence patterns on the winds at the fire front. Multiple fingering occurs in the long line fire when the convection column is dynamically unstable and cannot maintain a single column of hot air; the convection breaks up into multiple columns of hot air resulting in multiple convergence patterns feeding back on the fire-line, forming the observed 'fingers'.

The second aspect of fire behaviour suggested by these simulations is 'non-linear fire-scale instabilities', where, for very low constant ambient wind conditions, non-linear vortex dynamics result in vertically oriented fire-scale rotors - or fire-line instabilities - in the vicinity of the fire front that can lead to fire-line breakup.

Mary Ann Jenkins, Associate Professor
Department of Earth and Atmospheric Science
Faculty of Pure and Applied Science
York University, North York,
Ontario M3J 1P3, CANADA

phone (416) 736 2100 x 77713
fax (416) 736 5817
e-mail maj@unicaat.yorku.ca

Coupled-Atmospheric Fire Modelling:
Effects of the Convective Froude Number and Near Surface Shear.

Terry L Clark
National Centre for Atmospheric Research, USA,
Mary Ann Jenkins
University of York, Canada

Ian Knight
CSIRO, Australia
David Packham and John Bally
Bureau of Meteorology, Australia

A simple fire model is coupled to a general atmospheric mesoscale model to study forest fire behaviour. The rate of fire spread is modelled using the local wind at 15 m above ground level with an empirical MacArthur formula. The fuel characteristics are treated as a homogeneous dry eucalyptus forest with both ground and canopy fuel. Preliminary results from three-dimensional simulations will be presented discussing some controlling influences of the convective Froude number, F_c, and near surface shear on the fire behaviour.

F_c is the ratio of the kinetic energy of the ambient air over the potential energy provided by the fire, and is a measure of the fires ability to influence the air motion. Two examples of line fires burning in weak downslope flow will be presented showing how the atmospheric-fire dynamics vary with changes in F_c. One case has a single fire line burning down hill with the wind while the second case has an additional fire line burning slowly uphill against the wind. The increased heating provided by the backburn and the preheating of the air prior to its entering the main fire significantly alter the fire dynamics.

It has been noted in fire meteorology that blowup fires tend to be accompanied by strong low level shear or jets (eg., Byram, 1954). One possible mechanism associated with negative shear near the surface is what we will term 'dynamic fingering'. The tilting of the shear by fire induced updrafts can lead to vertically oriented rotors. Given appropriate conditions, these rotors may couple with the fire and cause fingers of hot air and flame to burst forward causing perhaps an increased rate of spread with an increase in the fire intensity. It is hypothesized that this dynamic fingering mechanism may be involved in initiating blowup fires. Some preliminary tests of this hypothesis were made by performing simulations of a fire being forced by low level jets. Results will be shown indicating some weak fingering effects. We found that fingering results are to some extent model resolution dependent. Providing the model has sufficient resolution, this type of dynamic paradigm is difficult to simulate, while on the other hand, poor model resolution appears to make it quite easy to simulate these effects.

Our earliest simulations of the 1967 Hobart fire had poor model resolution with the result of some extreme feedback effects including intense dynamic fingering. These results will be presented as they are instructive in helping us understand how and why such events may occur. In this case coarse model resolution led to extremely small values of F_c. A brief discussion on model resolution issues will also be presented.

Terry Clark
National Center for Atmospheric Research
Boulder
Colorado, USA

phone
fax
e-mail clark@oak.mmm.ucar.edu

BMRC's Limited Area Model - Activities and Plans

Kamal Puri
Bureau of Meteorology Research Centre
Bureau of Meteorology, Melbourne

The BMRC has developed a new limited area analysis/forecast NWP system which is intended to replace RASP and TAPS with a common set of codes. In it's operational trial form the system has a grid spacing of 0.75 degrees and 19 sigma levels in the vertical, and covers an area from 65E to 185E, 65S to 15N. The forecast model uses high order numerics and has been coded to take full advantage of the Bureau's CRAY YMP-4 vector and multi-processor architecture. The model contains a detailed parameterisation of physical processes which include deep and shallow convection, large-scale rain, radiative transfer, diagnostic clouds, stability dependent constant flux layer and iterative soil moisture. The digital filtering technique of Lynch and Huang (1992) is used to initialise the model.

The analysis scheme is a multivariate statistical interpolation scheme (Seaman et al. 1995), and analyses geopotential height, layer thickness and zonal and meridional wind on the latitude/longitude/sigma coordinate grid of the forecast model. Moisture is analysed using a 3-dimensional univariate SI analysis module. Complex error checking and quality control is included, super-obbing of closely spaced data is included, divergent wind increments are analysed, and significant level wind and moisture observations are included. Options for data assimilation (as in RASP) or nudging (as in TAPS) are included. The system has been running in parallel with RASP since December 1994, and both objective and subjective verification statistics show significant gains over the operational RASP system. Examples of forecasts and the verification statistics will be presented at this meeting.

Following the operational implementation of this system, further improvements in physical parameterisations are already being tested. An important component of the design of this system was the provision for an interior fine mesh option, and early examples of these forecasts with a 0.25 degree grid spacing will be presented elsewhere in this conference.

Dr Kamal Puri
BMRC, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4433
fax
e-mail k.puri@bom.gov.au

NMC's Plans for Operational Mesoscale Modelling

Terry Hart
National Meteorological Centre
Bureau of Meteorology, Melbourne

A new Australian region numerical analysis and prediction system is now being considered for operational implementation in NMC as a replacement for the current RASP system. Details of the new system will be presented by Kamal Puri and Graham Mills of BMRC during the conference. A feature of the new system is the capability of running a nested higher resolution sub-domain. NMC is keen to implement this option as a new dimension of operational numerical weather prediction.

Once the new system is operational our plans are to begin testing the nesting option, with a view to routine running. Our initial plans are for a 25 km resolution sub-domain located over south-eastern Australia. This choice is based partly on population distribution, but also on the topography of the area. It is likely that the impact of a high resolution system will be most evident over mountainous areas, but also that such areas could present the greatest modelling problems. Some aspects to be resolved are the need for a high resolution analysis and treatment of discontinuities at the sub-domain boundary.

The ultimate configuration of the system will need to be determined. One option is to move the sub-domain to the most synoptically significant area and choose a 'domain of the day'. Another is to select one or more fixed sub-domains. Resource limitations will obviously be significant factors in this choice, as will evaluation of the usefulness of the products. The best starting-time and forecast duration also need consideration, as the standard 00 UTC base-time may be too late. An 18-hour forecast from 1800 UTC may provide more timely advice to Regional Offices. Comments and suggestions would be appreciated.

Regional Office access to the mesoscale model for non-real-time purposes (case studies, phenomenological studies, etc.) is also being considered and BMRC staff are developing a suitable interface to allow remote operation of the system. The linking of offices by Weathernet makes this possible, as is evident in the real-time operation of the tropical system TAPS from Darwin Regional Office. Darwin are able to monitor the TAPS job remotely and have output directed to their printers or screens. Over the last two years Gordon Jackson has considerably developed the system to suit Darwin's needs using software located on the central computing facility. This has been one successful method of operation. The relative disposition of computing tasks between regional and central computing could easily vary, depending on factors such as the facilities and expertise available locally, the dead-lines for the output, magnitude of the computing task, access to data and analysis systems, and the requirements for customisation and local processing of the final output.

Terry Hart
NMC, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3003

phone (03) 9669 4030
fax (03) 9669 4023
e-mail t.hart@bom.gov.au

CSIRO-DAR Limited Area Model : 15 km Prognoses for Victoria

Jack J. Katzfey
CSIRO Division of Atmospheric Research

The CSIRO Division of Atmospheric Research (DAR) has been experimentally running it's Limited Area Model (DARLAM) nested within the operational BMRC RASP forecast for 36 hour prognoses. The procedure used is to download the 15 pressure level RASP analyses and the 12, 24 and 36 hour RASP forecast data. Using a locally generated topography, these data are then vertically interpolated to 18 sigma levels for the same domain and horizontal grid as RASP. The model is initialised and a 36 hour prognosis is completed using the RASP forecast as boundary conditions, taking about a half hour on a DEC ALPHA workstation. Upon completion of the 75 km run, the prognoses are horizontally interpolated to a 15 km grid centred over Victoria. A 15 km 36 hour prognosis is then run using the 75 km DARLAM prognosis for boundary conditions This run takes about 3 hours to complete.

In this presentation, examples of the types of output generated by the model will be presented, including time traces at several grid points in the Melbourne area. In particular, the performance of the model for the 25 February 1995 fire case and the cool change the following day will be presented. The model correctly identified the development of the seabreeze over western Victoria, although the change did not penetrate inland far enough. The next day, the model was slow in the movement of the cool change. Subsequent experiments suggest the importance of sub-cloud evaporation beneath the cloud band offshore in accelerating the movement of the surface cool change.

Jack J. Katzfey
CSIRO Division of Atmospheric Research
Private Bag No. 1
Mordialloc, Vic. 3195

phone (03) 9586 7562
fax (03) 9586 7600
e-mail jjk@dar.csiro.au

A Preliminary Analysis of the CSIRO fine mesh Mesoscale Meteorological Model in the context of Fire Weather Forecasting in South Australia

Andrew Watson
Severe Weather Section, Bureau of Meteorology, Adelaide

Significant improvement in fire weather forecast quality occurred during the late 1980's and early 1990's due largely to substantial upgrades in the automated surface observation network and to the implementation of dedicated fire weather forecasters and rosters. However, indications over the past few years are that, statistically at least, the improvement in 24 hour forecast accuracy is levelling off. Forecast quality for burning fires has historically been questionable because of such things as forecaster uncertainties in the mesoscale meteorology of areas where the climatology has not been identified, and poor quality observations from the fire.

To significantly improve the usefulness of forecasts of these kind there is a clear requirement for high quality mesoscale meteorological prognostic data. The data should be in a format which can be easily and appropriately processed and customised for on-forwarding to the user as the forecast product.

During March 1995 an informal arrangement between Jack Katzfey of the CSIRO Department of Atmospheric Research and Andrew Watson of the Bureau of Meteorology South Australia was struck. Since then the Bureau has been provided with numerical output from the CSIRO mesoscale meterological model twice daily (via email). Model output comprises surface grid point data for four locations in SA - Adelaide Airport, Mt Crawford, Kingscote and Mt Gambier. Temperature, dewpoint, relative humidity, wind speed and direction, mean sea level pressure, rainfall and cloud cover data is provided at half-hourly intervals for 36 hours hence.

The domain of the CSIRO mesoscale model extends over a portion of southeastern Australia, including the southern part of South Australia It has a grid resolution of 15 km and is nested within a CSIRO 75 km model. The 75 km run has a time step of 900 sec, with output saved every 6 hours. The 6 hour output is linearly interpolated in time at every time step of the 15 km run for boundary conditions. The 75 km model uses approximately the same domain as the Bureau RASP (Regional Assimilation and Prediction System) model. The boundary conditions for the 75 km model are interpolated from the RASP forecast (See abstract and presentation by Jack Katzfey for full detail of model).

To assess the skill of the model and thus its potential as a forecasting tool, model output data was compared to observations at each of the four localities. Hourly model forecast data for temperature, dewpoint, relative humidity, wind speed and direction, and mean sea level pressure was both subjectively and objectively compared to observational data from automatic weather stations at the four localities. Data from two of the stations (Adelaide Airport and Mt Gambier) are presented here. Model temperature data accuracy was also compared to Bureau maximum and minimum temperature forecasts.

Comparisons were made on 16 days between mid March and mid May 1995. Days were selected quasi randomly although there was a focus on situations including frontal passages, since weather elements on these days are typically the most difficult to accurately forecast, and are most critical to the behaviour of fires.

Qualitative comparison revealed that the model had significant skill in depicting the magnitude and trends of temperature and mean sea level pressure. It also showed skill in dewpoint, wind direction and wind speed forecasts, although its performance was somewhat more variable with respect to these elements. Diurnal trends were generally well modelled. Sea breeze effects were often but not always resolved, and the strength of the breeze was underestimated on some occasions. Frontal passages were modelled well in some situations, although in others the wind change was either late (possibly due to bad positioning in the initial conditions or a problem with the 75 km run) or took place over an exaggerated period.

Quantitatively, for all comparison days, the difference between model forecast temperature and observed temperature was less than 2.5^{0}C. For dewpoint, the difference was less than 3.5^{0}C and for wind speed it was less than 4 knots (7.5 km per hour). These figures compare very favourably with the Bureau forecaster verification statistics for the most recent fire season. The model performed slightly better at Mt Gambier than at Adelaide in all elements apart from mean sea level pressure. This may be a result of Adelaide being closer to the northern extremity of the model domain, and being influenced in some situations by poor boundary conditions. Comparison of root mean square temperature errors of the model with temperature (maximum and minimum) forecasts issued by Bureau forecasters for Adelaide showed the Bureau forecast to be superior (1.5^{0}C) but also that the model performed quite well (2.6^{0}C).

Although at this stage possibly not as accurate for specific tasks such as maximum or minimum temperature forecasting, the model already offers more than is provided routinely by the forecaster. Site specific, half hourly time series output of all the relevant meteorological elements can be provided to the user in an easy to digest graphical format. The future of fire weather forecasts may well lie in the provision of this type of information.

Andrew Watson
Bureau of Meteorology
PO Box 421
Kent Town, SA, 5071

phone (08) 366 2295
fax (08) 362 2285
e-mail a.watson@bom.gov.au

A Preliminary Investigation - Use of the CSIRO Division of Atmospheric Research's Mesoscale Meteorological Model for Fire Weather Forecasting Purposes

Tony Leggett
Severe Weather Section
Bureau of Meteorology, Melbourne

Predictions from CSIRO's mesoscale meteorological model were verified over a six week period using observations from Melbourne Airport. Over this period a subjective assessment of the model's ability to predict diurnal trends gave the following results:

- the diurnal trend in temperature is depicted quite well during daylight hours in situations when there were no significant cool changes;
- diurnal trends and absolute values of dewpoint are often in error. Improvements are anticipated if an improved vegetation scheme could be incorporated into the model.

The highlight of this study was the model's ability to predict the development of a temporary and shallow mid-afternoon cool change over southwest Victoria on 25 February 1995. This cool change development is a significant forecasting problem in Victoria, coinciding on that day with a major bushfire near Ballarat. The fire was in the Enfield State Forest and burnt around 10,400 hectares. However this optimism is tempered by the forecast time of arrival of a cool change on 26 February 1995; this being 12 hours late. Further trials are being carried out by CSIRO to ascertain whether the use of an evaporation scheme would produce a better result. Results from these trials are expected to be presented at this workshop.

A comparison between the model's skill at forecasting maximum temperature and the forecasts issued by the Bureau's Victorian Regional Office showed both predictions had similar RMS errors. A similar result was obtained when comparing the predictions for the dewpoint at the time of maximum temperature.

This paper is still being prepared and will not be presented at the workshop. Interested people can contact the author for copies once it is available.

Tony Leggett
Bureau of Meteorology
PO Box 1636M
Melbourne, Vic, 3001

phone (03) 9669 4907
fax (03) 9663 2059
e-mail t.leggett@bom.gov.au

Fire Behaviour at the Mesoscale

Ian Knight
Division of Forestry
CSIRO, Canberra

The current bushfire spread meters and the forecasts they produce are based on remotely measured wind speeds. Mesoscale models can offer improvement merely by producing the wind speed at the specified point in the terrain without including any effect of the fire at all.

The fire itself is a mesoscale phenomenon, with fire behaviour at all points around the perimeter being linked to the overall convection and ambient wind.

The ultimate goal of researchers is to incorporate fire propagation dynamics within the mesoscale model. The scale of fire propagation is of the order of the scale of the fuel elements. A meteorological model would have to span scales from several kilometres down to a sub-canopy fuel size of only few centimetres unless a spectacular innovation in the parameterization of the combustion process can be made.

Until this is done we cannot expect modelled fires to propagate at realistic speeds or to exhibit the natural tendency towards parabolic shapes.

The suggested intermediate step is to constrain the fire at the shape, heat output and rate of spread of an observed fire so as to investigate the wind fields existing in the quasi-steady state at a scale which is practical for available computers.

Ian Knight
Division of Forestry, CSIRO
PO Box 4008
Queen Victoria Terrace
Canberra ACT 2600

phone (06) 281 8370
fax (06) 281 8348
e-mail ian.knight@cbr.for.csiro.au

Smoke Dispersion in the Adelaide Region using a Mesoscale Model

W.L. Physick
Division of Atmospheric Research
CSIRO, Mordialloc, Victoria

This video presentation illustrates the capability of coupled mesoscale and Lagrangian dispersion models, in combination with a good graphical display system, for predicting the pathways of smoke from fires. Examples are shown for the Adelaide region and emphasise the importance to dispersion of such local wind systems as the gully winds, and sea breezes from St. Vincent's Gulf and from the coastline to the southeast of the Mt. Lofty Ranges.

Dr W L Physick
Division of Atmospheric Research, CSIRO
Private Bag No 1
Mordialloc, Vic, 3195

phone (03) 9586 7666
fax (03) 9586 7600
e-mail wlp@dar.csiro.au

Modelling Smoke Transport

G.A.Mills
Bureau of Meteorology Research Centre
Bureau of Meteorology, Melbourne

At the last fire weather conference the forecasting of days when smoke from controlled burning in forests south of Perth would affect the Perth area was identified as a significant problem. Since then a similar request has been made from the NT.

BMRC is currently in an advanced stage of development of two systems which, when merged, will provide useful guidance in the forecasting of these events. The first is the application of the HY-SPLIT dispersion and transport model to first the TAPS model domain and then to both global and mesoscale areas, while the second is the development of a mesoscale model which will be nested within the Bureau of Meteorology's limited area NWP system (Puri, this meeting).

A pollution event in late 1994 has been chosen to demonstrate the behaviour of both these systems: results both from the transport model (using TAPS wind fields) and the 0.25 degree LAPS forecast model for this event will be presented.

Graham Mills
BMRC, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4582
fax (03) 9669 4660
e-mail gam@bom.gov.au

Imagine flood waters flowing off the lee edge of a causeway.

Some Observations and Simulations of the *Gully winds* of the Mount Lofty Ranges of South Australia.

W. J. Grace
Bureau of Meteorology, Adelaide, South Australia

W Sha
University of Electro-Communications, Nagoya, Japan

W.L. Physick
CSIRO, Aspendale, Victoria

Downslope winds occur in the lee of mountain ranges in all parts of the world. In the Adelaide region these downslope winds are locally enhanced easterly winds occurring predominantly on summer nights and are often manifest as gusty, strong to gale force winds about the foothill suburbs of the city. The Adelaide region downslope winds are more pronounced over locally steeper lee slopes and in gully sites. The local term for these downslope winds is, in fact, *gully winds*. They can be a significant problem for fire-fighting operations because they are a mainly summer-time feature exhibiting great spatial and temporal variability and are difficult to forecast. Some examples of these features are presented.

Typically, they occur if the synoptic stream is a stable and vigorous east to southeasterly. A common observation is of moderate easterly winds at the mountain top with strong gusty easterly winds about the lee foothills, while a few kilometres further leeward the flow is light and may even be weakly reversed. One explanation for this apparently anomalous behaviour invokes the existence of a hydraulic jump. Maps of the hydraulic jump derived from a variety of observations and clues are already available and these are shown.

In this study, we use a three-dimensional, non-hydrostatic, terrain-following local wind numerical model with an appropriate turbulence scheme to simulate the gully wind. The main purposes are:

1. to identify various environmental preconditions for their occurrence;
2. to determine the extent of the gully wind;
3. to determine the existence and spatial variation of the hydraulic jump.

From theory, two triggers for gully wind are the pre-existence in the environmental flow of either a stable layer or a wind shear layer located below some threshold altitude which is typically about three times the height of the ranges.

A description of the numerical model and the design of the numerical experiments is given. Conclusions are drawn from the results of the experiments in which either the shear layer or the stable layer is removed or varied. The more important effect seems to be the wind shear layer; in particular, the existence of a zero wind in the environmental flow.

A sensitivity study of the numerical model showed that a grid size of $A x = A y = 1$ km is required to resolve the fine structures (that is, the surface wind reversals) of the gully wind.

Dr Warwick Grace
Bureau of Meteorology
PO Box 421
Kent Town, SA, 5071

phone (08) 366 2264
fax (08) 366 2293
e-mail w.grace@bom.gov.au

Forecasting Strong to Gale Force Winds using Mesoscale Models.

Rod Dingle
Regional Forecasting Centre
Bureau of Meteorology, Adelaide

Wind velocity is the difficult parameter to forecast on extreme fire danger days. The high temperatures are usually relatively easy to predict. Strong to gale force winds at 10 metres above the surface are usually produced by the mixing down of high wind speeds from the 500hpa level and above, in the vicinity of a vigorous cold front or low pressure system.

The forecasting meteorologist uses MSL analyses, and prognoses for 24 and 48 hours, and a knowledge of current 2000 ft and 850 hPa winds to form an estimate of the wind at a height of 10 metres, during the time of high temperatures. The MSL prognoses from global models give the surface wind from the geostrophic relationship. The forecast 850 hPa wind is available from the GASP and RASP prognoses but the 2000 ft wind is not.

The GASP and RASP models are essentially based on a series of upper wind and temperature observations spaced about 300 nautical miles or 500 km apart. Consequently, the scale of atmospheric processes and wind maxima shown in the forecast model output is fairly broad, even if high resolution calculation grids are used. The use of a mesoscale model for a particular area based on, say. a 20 km grid length, and nested in the output of the broad scale GASP or RASP model is an attempt to predict more detailed variation in the wind speeds and directions.

However, the atmospheric processes producing extreme fire danger wind speeds are generally broad scale processes, which can be predicted by the GASP or RASP models, provided these models are given enough upper wind and temperature observations as input. If the GASP or RASP models fail to predict the high wind speeds, then it is unlikely that a nested mesoscale model will be able to predict high wind speeds and extreme fire dangers.

Rod Dingle
Bureau of Meteorology
PO Box 421
Kent Town, SA, 5071

phone (08) 366 2296
fax (08) 366 2283
e-mail r.dingle@bom.gov.au

The Enfield Fire - LAPS Model Results

G.A.Mills
Bureau of Meteorology Research Centre
Bureau of Meteorology, Melbourne

The synoptic situation over Victoria on the weekend of 25-26 February 1995 was rather complex, and one of the larger fires in Victoria in recent years occurred at Enfield, south of Ballarat.

Results of modelling this event using the new LAPS NWP system will be presented. The model has a grid spacing of 0.25 degrees, and is nested within a 0.75 degree model. Performance of the model on this case and the sensitivity of some aspects of the forecast to initial state specification will be discussed.

Graham Mills
BMRC, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 4582
fax (03) 9669 4660
e-mail gam@bom.gov.au

Meteorological Study of a Bushfire Smoke Plume and Associated Convective Cloud in South East Australia

Andrew Treloar
Regional Forecasting Centre
Bureau of Meteorology, Melbourne

A bushfire near Berringa in western Victoria, Australia, burned an area of approximately 10,500 hectares on 25 February 1995. The fire was located 90 kilometres west of the Bureau's weather radar and upper air sounding station at Laverton. This, together with automatic weather station data from near the fire site, has enabled characteristics of the smoke plume and its associated convective capping cloud to be studied in some detail.

The day was characterised by very hot, dry and unstable conditions. The fire initially spread southeastward through the Enfield State Forest driven by a west northwest wind of 20-30 km/h. The wind decreased to about 10 km/h later in the afternoon prior to a shallow southwest wind change that reached the fire site around 1830 hours. Relative humidities rose from 10% to 30% in about 20 minutes after the wind change.

Following the change, the fire re-intensified and a large convective cloud developed on top of the fire's smoke plume for several hours. Analysis of a photograph taken at 2000 hours shows this cloud extending to a height of around 10 km. Reports from the USA indicate that downbursts of air from similar clouds, have driven fires across control lines endangering personnel. No evidence has been found of downburst activity from this cloud, however possible mechanisms which may produce downbursts from fire-generated clouds are investigated.

Three-dimensional radar data revealed that during the more intense convective phases that evening, radar echo height reached around 11.5 kilometres. The maximum radar reflectivity of around 36 dBZ occurred at a height of 2.4 kilometres, which was well below the convective condensation and freezing levels of the cloud. This suggests that high radar reflectivity within the smoke-cloud complex are associated with larger particulate matter and intense turbulent fluctuations within the plume updraught, a phenomena known as Bragg scattering, rather than condensation products produced within the convective cloud.

Behaviour of the plume was investigated with a one-dimensional plume and cloud model, PLUMP, developed by Latham (1994). Preliminary results indicate PLUMP was successful in modelling general plume development. Convective parcel theory was found to account for the large cloud development in the moist conditions following the southerly wind change.

Andrew Treloar
Bureau of Meteorology
PO Box 1636M
Melbourne, Vic, 3001

phone (03) 9669 4900
fax (03) 9663 2059
e-mail a.treloar@bom.gov.au

Monitoring the 1994 Drought Using Satellite Derived NDVI over SE Australia

Guy Tuddenham
Bureau of Meteorology Research Centre
Bureau of Meteorology, Melbourne

Data obtained from the NOAA-9 and NOAA-12 satellites between October 94 and March 95 was used to construct normalised differential vegetation index (NDVI) maps to monitor the progression of the drought into Victoria. This data will be presented to the meeting. Using these two satellites it was possible to track the vegetative changes on an approximately fortnightly basis. The data was compiled in near real-time employing a rigorous cloud clearing algorithm which uses data from the regional assimilation model.

This procedure was originally implemented in September 91 and was used to monitor vegetative change across the Australian continent between December 91 and March 94. Following the change into the UNIX environment and the subsequent loss of data output from NOAA-11 in September 94, the system was modified to take input from NOAA-9 and NOAA-12. Since March/April 1995, NOAA-14 (replacing NOAA-11 with a mid-afternoon overpass) data has been available, and work is now proceeding to include this data into the system. Currently NOAA-9 data is being used to maintain a fortnightly NDVI output schedule, with daily updates as available, dependent on cloud cover and satellite track.

* Basic hyperspectral analysis of AVHRR - not directly addressing drought onset. Needs to be "seasonally corrected" after building up a number of years experience.

Guy Tuddenham
BMRC, Bureau of Meteorology
PO Box 1289K
Melbourne, Vic, 3001

phone (03) 9669 689
fax (03) 9669 4660
e-mail wgt@bom.gov.au

Monitoring Wildfires in the Northern Territory
Using AVHRR Satellite Imagery

Jon Gill
Severe Weather Section
Bureau of Meteorology, Darwin

AVHRR (Advanced Very High Resolution Radiometer) is a five-channel scanning radiometer mounted aboard operational US NOAA meteorological satellites. The AVHRR sensor detects radiation at five channels, one at visual wavelengths (band 1), one in the near-infrared (NIR, band 2), and three in the infrared (IR, bands 3, 4, and 5). The 3.55 - 3.93 micron IR channel (band 3) is particularly sensitive to high temperature sources. The detection of burning fires can be achieved by comparing locations defined by 'hot spots' in band 3 data with the occurrence of visual smoke plumes in band 1 data.

Operational procedures have been established in the Northern Territory (NT) Regional Office of the Bureau of Meteorology to routinely monitor AVHRR data received at the Darwin ground-station. These data provide coverage over the sparsely populated NT and permit the remote detection of wildfires that may otherwise go unreported. A routine service to provide AVHRR-based wildfire location fixes to the Bushfires Council of the NT will commence from the beginning of the 1995 northern fire season.

* Uses IR to locate hot spots & VIS to locate attendant smoke plume.
* BoM doing fire detection in NT.

Jonathan Gill
Bureau of Meteorology
GPO Box 735
Darwin, NT, 0801

phone (089) 82 4721
fax (089) 82 4729
e-mail j.gill@bom.gov.au

Lightning Data - Use in NSW

John James
Regional Forecasting Centre
Bureau of Meteorology, Sydney

Real time lightning data has been available since May 1992 within the New South Wales Regional Forecasting Office using a Lighting Positioning and Tracking System (LPATS) which was installed by Kattron Electro Technology Pty Ltd. An initial evaluation of the impact of the lightning data on the provision of weather services within the Regional Office was undertaken from May 1992 through until the end of March 1993 by Ryan (1993).

Although the evaluation was based on a very limited survey sample, it clearly showed that the lightning data had quickly become an important tool for forecasting and monitoring convection. It was found that the data was usually referred to every 5 minutes during convective situations, showing the usefulness of the real-time nature of the system. It is also worth noting that the data was referred to on average once every hour when no convection was occurring or expected as part of the basic weather watch routine within the office. In more than half the surveyed shifts, the lightning data provided the first indication of thunderstorm activity and most frequently preceded other observations by 60 minutes. Apart from the real-time aspect, perhaps the greatest benefit is the geographical coverage of the entire state, compared to the rather limited radar coverage.

These qualities therefore make LPATS an ideal data set for a comprehensive and consistent climatological analysis of thunderstorm activity across the state both spatially and temporally. Laudet et al, (1994) derived a preliminary climatology of lightning in NSW for an 18 month period from September 1992 to February 1994. Spatial variations of flash days showed an axis of maximum flash days running parallel to the Great Dividing Range during summer. During winter the maximum axis of flash days was located over the sea with a smaller maximum near the ranges. It was noted that the highest data gradient was just inland of the coast suggesting the possible effect of coastal sea breezes.

Lightning was found to be a temperature-related variable more dominant during summer than during the rest of the year and diurnally the most active lightning occurred during the afternoon. Under normal operations, the lightning strikes are colour coded according to the time interval since the strike was first detected in ten minute intervals up to one hour. This enables the forecaster to calculate the movement, dissipation and any new redevelopment of storm activity.

The replay mode is of particular use to review the history of lightning strikes during the day, as it can provide an alert to fire authorities to investigate any remote locations where strikes have occurred that may have generated a fire, allowing control measures to be taken earlier than perhaps would normally occur.

References

Ryan, C. 1993. New South Wales Lightning Detection Network Evaluation:
Results of the Forecaster Survey, Services Policy Branch, Bureau of Meteorology Melbourne.

Laudet, T., P. King, and J.R. Colquhoun, 1994. A Preliminary Climatology of Lightning in NSW. Preprints , 4th Severe Thunderstorm Conference, 8-12 August 1994, Australian Emergency management Institute. Mt Macedon, Victoria, Bureau of Meteorology, Australia..

Preliminary NSW Lightning Climatology
P. King et al.

* current version
• ≤1km accuracy in SE aust.
• 1 hour updates for Weather Watch.

John James
Bureau of Meteorology
PO Box A737
Sydney South, NSW, 2000

phone (02) 269 8555
fax (02) 269 8506
e-mail j.james@bom.gov.au

Preliminary Report -
Ability of the LPATS Lightning Detection Network to Locate Wildfires Ignited by Lightning in Victoria during the 94-95 Fire Season

Tony Leggett
Severe Weather Section
Bureau of Meteorology, Melbourne

The expanded LPATS lightning detection system in southeastern Australia was used during the 1994-95 fire weather season to locate lightning activity over Victoria. The system's accuracy was assessed using a database of wildfires either known or suspected to have been ignited by lightning. During the period 1 December 1994 to 17 February 1995, 20% of the fires in the database were found to have lightning strikes recorded within three days of the fire report and within 0.05 latitude (approx 5.5 km) and 0.05 longitude (approx 4.5 km) of the reported fire ignition point. Further work is focussing on the effect of various system faults on this locational accuracy.

* Poorly calibrated sensors & other technical problems lead to poor performance last summer.
* Access - McIDAS, AIFS, PC-Windows software ↓ Fire agencies.
* BoM looking at ↓ STAND-ALONE sensors for airport AWS c̄ voice generator for pilots, etc.

Tony Leggett
Bureau of Meteorology
PO Box 1636M
Melbourne, Vic, 3001

phone (03) 9669 4907
fax (03) 9663 2059
e-mail t.leggett@bom.gov.au

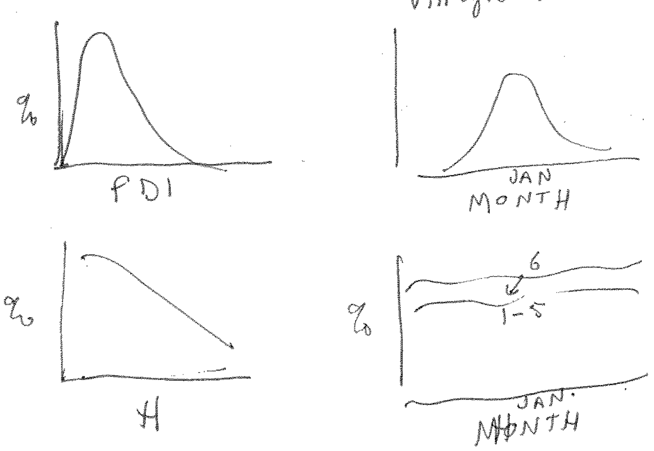
The Haines Index as a Predictor of Fire Activity in Tasmania.

John Bally
Severe Weather Section
Bureau of Meteorology, Hobart

In Australia, surface conditions as expressed in the MacArthur fire danger meters are used as predictors of fire activity. Upper atmospheric conditions are acknowledged as important but are rarely used quantitatively. Research in the United States has shown that upper atmospheric instability and dryness, as expressed in the Haines index, are very good predictors of fire activity and wildfire growth rates.

Wildfire activity data extracted from Forestry Tasmania's database has been compared with the Haines Index measured at Hobart and the MacArthur Forest Fire Danger Index (FFDI) measured at about 25 sites around Tasmania. The Haines Index predicts fire behaviour about as well as the FFDI. These indices are not strongly correlated and provide complementary information about the impact of the meteorological situation on fire behaviour. They can be combined to form a more skilful predictor of fire behaviour than either index is alone. Case studies of some large fires from the 1994/95 season support these conclusions.

Hobart



poorly correlated

∴ need to combine H & FDI to get a more skilful predictor of fire danger.

Suggest Warnings if FFDI ≥ current warning level AND H = 5 or 6.

H now a continuous function.

John Bally
Bureau of Meteorology
PO Box 727G
Hobart, Tas, 7001

phone (002) 20 6655
fax (002) 23 5454
e-mail j.bally@bom.gov.au

Severe Fire Weather Conditions in the Thomson Catchment and Central Areas of Victoria

Tony Leggett
Severe Weather Section
Bureau of Meteorology, Melbourne

The Thomson catchment provides part of metropolitan Melbourne's water supply. Melbourne Water research has shown that the age and stand conditions of the ash type forests there will significantly influence the amount of water reaching the Thomson dam. Management of the catchment includes a risk assessment of the economic value of the timber there versus the loss in water that might occur due to either logging or wildfires. The Bureau of Meteorology was commissioned by Melbourne Water to undertake a study of weather conditions related to severe fires in this area as part of this risk assessment. The study area was expanded to cover Central Victoria allowing the inclusion of more data sources.

The study's aims were:

1. to develop a climate survey for the study area;
2. to develop an understanding of the weather conditions which lead to fire spreading in the ash type forests of the central highlands of Victoria and, in particular, the Thomson catchment;
3. to develop a probability analysis of the occurrence of the weather conditions which could lead to the spread of fire.

The study has shown that:

1. ***Serious fires*** (defined as those that caused significant damage or large loss of life, or burnt areas > 2500 acres) occur at intervals of about 1 every 22 years. 67% of serious fires occur in January and February. There is a 10 to 13 year cycle of relatively minor fires. Three common synoptic patterns were identified for serious fire days.

2. ***Catastrophic fires*** are a subset of serious fires that have been subjectively analysed as fires which have caused widespread destruction (eg. Black Friday on 13 January 1939 and Ash Wednesday on 16 February 1983). Catastrophic fires occur in Victoria every 40 to 50 years with all occurring in January or February. While catastrophic fires are relatively rare, they account for a large percentage of the area burnt and the damage.

3. ***Return periods*** of the MacArthur fire danger rating index were estimated using a Log Pearson Type III distribution. When combined with a site-specific model incorporating terrain, fuel type and fuel load to predict the area burnt under defined weather conditions, the return period of this burn area could be approximated by the return period of the fire danger index.

Contact Tony re ① getting a copy of the report
② giving him a copy of Kulik's works

Tony Leggett
Bureau of Meteorology
PO Box 1636M
Melbourne, Vic, 3001

phone (03) 9669 4907
fax (03) 9663 2059
e-mail t.leggett@bom.gov.au

The January 1994 Bushfires in NSW

Bruce Buckley
Regional Office, Bureau of Meteorology, Sydney

The January '94 bushfire event in NSW was actually a period of extensive fire activity over the period from 29 December 1993 - 14 January 1994, during which time fire agencies had to combat over 800 separate fire outbreaks. The fires are attributed as the cause of 4 deaths, burnt out an estimated 1.2 million hectares of land, destroyed 185 houses, 3 home units, 2 town houses, 10 cars, 2 service stations, 5 factories, 2 shops and 1 church. Nearly 25,000 people were evacuated and all the arterial roads and rail links into Sydney, with the exception of the Hume Highway, were closed for a period of time.

NSW Regional Office Activities:
The Bureau was operating in normal 'fire season' mode at the commencement of this event. In the NSW Regional Office the severe weather roster was extended to 24 hour per day operations from 5-14 January. Even after calling upon all available non-operational meteorologists from within the region, there were insufficient staff available to maintain the extra coverage required. For the first time since cyclone Tracy hit Darwin, external assistance was called for. One meteorologist each from the Bureau's Offices in Hobart, Adelaide and Melbourne were flown into Sydney on short notice to bolster the coverage. The situation was exacerbated by the fires directly threatening the homes of 5 RFC forecasting staff at the peak of the fire episode, thereby temporarily reducing their availability.

Department of Bushfire Services - Rosehill (DBFS) Strategic Outposting:
The outposting liaison role was initiated at the (DBFS) request on Wednesday 5 January. Twenty four hour per day coverage was maintained until Monday 10 January, when the service reduced to a 6.30am-9pm coverage. This coverage continued until Friday 14 January, when the outposting ceased. Most staff involved in this outposting were senior professional officers, who worked long hours and extra shifts to ensure continuity of coverage.

Blue Mountains Tactical Outposting (The 'Bell's Range' Fire Command Centre, Katoomba):
The professional fire fighting unit from the Victorian Department of Conservation and Natural Resources (CNR) were allocated the task of combating the major fire in the Blue Mountains, identified as the 'Bell's Range' fire. They were accompanied by a team of three specialist meteorologists from the Victorian Regional Office, which they sponsor. They were tasked with the provision of on-site, highly specific tactical meteorological advice and forecasts. This unit had access to additional meteorological information from two portable automatic weather stations, from additional weather balloon flights conducted by CNR staff and from a lightning detection system loaned to them by Prospect Electricity. The National Parks and Wildlife Service assisted the team through the loan of a Geographical Information System (GIS) terminal, enabling access to topographical and vegetation data not normally available to Bureau officers in NSW.

Head Office Services
The Head Office of the Bureau of Meteorology played an important supportive role during this fire event. This role included contributions from the Severe Weather Program Office, Satellite Section, Bureau of Meteorology Research Centre (BMRC), National Meteorological and Oceanographic Centre (NMOC) and the Regional Computing Section.

Performance of the Services
The range of services provided by the various arms of the Bureau met with praise from a wide cross section of the community, although subsequent debriefing sessions highlighted areas for improvement.

Bruce Buckley
Bureau of Meteorology
PO Box A737
Sydney South, NSW, 2

phone (02) 269 8528
fax (02) 269 8506
e-mail b.buckley@bom.gov.au

The November 1994 Pine Plantation Fires in Southeast Queensland.

Sue Dargie
Severe Weather Section
Bureau of Meteorology, Brisbane.

Fires that occurred in southeast Queensland during the 5th to the 8th of November 1994 were the worst in Queensland's plantation history. The fires, which burnt for five days, swept through 4000 hectares of pine plantation and in excess of 11,500 hectares of native forest. The losses to pine plantations alone are estimated to be close to $45 million.

Prolonged drought through most parts of the state ensured maximum curing of fuels providing an extreme fire risk. This coupled with temperatures in the mid 30°C's, dewpoint temperatures below 0°C, and winds gusting to 60 - 70 km/h combined to produce fire danger ratings well above 50 (using the McArthur Grassland Meter) driving the fires through plantations at speeds in excess of 4 km/h.

Meteorological factors resulting in the extreme fire danger situation of November 1994 are examined with particular detail to the behaviour of the seabreeze and it's influence on fire weather conditions. The Toolara bush fire event of September 1991 is discussed and compared with that of November 1994.

Sue Dargie
Bureau of Meteorology
PO Box 413
Brisbane, Qld, 4001

phone (07) 864 8760
fax (07) 864 8776
e-mail s.dargie@bom.gov.au

Planning and the Response - Issues for Fire Weather Services

Peter Billing
Fire Management Branch
Dept of Conservation and Natural Resources, Victoria

Fire is the only natural disaster situation in which the managers or controllers of the response to the episode can bring about a marked reduction in the extent, damage or costs by the tactical and strategic use of weather services.

It is also clear that where preparedness arrangements deliver rapid response action, in many instances, this is sufficient to mitigate the development of a disaster.

There are four applications of weather services for the suppression and management of fire:
- seasonal preparedness
- daily preparedness
- strategic planning and response actions to control fires
- tactical interactions between the resources and the perimeter of the fire to control the fire.

What are the priorities in the fire agencies and the Bureau for the application and delivery of these services?

How is weather information presented to meet these needs?

On reflecting on our fire experiences - such as the recent Berringa (Enfield) fire, the tragic South Canyon or Storm King Mountain fire and the complex NSW fires - there are many questions that arise about how the fire agencies and the Bureau can work together to achieve improved safety and efficiency in fire operations.

The purpose of this discussion is to clarify the opportunities and the challenge we have, and to consider some of the things we need to do, such as to design information systems, to use technology and to apply specialist skills in a way that will make a difference at every fire.

There are also opportunities to make a difference if we look at some of the issues from a national perspective.

Peter Billing
Dept of Conservation and Natural Resources
PO Box 41
East Melbourne, Vic, 3002

phone (03) 9412 4777
fax (03) 9412 4750
e-mail prb@cnr.gov.au

Wind - Terrain Interactions - A Model for Emergency Response Uses

Rick McRae
ACT Emergency Services Bureau, Canberra

A model for local wind terrain interactions has been developed to assist with estimating wind speed and direction during emergency response. The broad-scale forecasts or even spot forecasts cannot take into account local terrain features.

The model is based on spatial filtering of terrain, removing large and small scale variations. The mid-scale residual has proven useful for predicting areas prone to lightning ignitions. Certain 'terrain features' on the residual surface lead to key wind-terrain interactions :

a) a compact terrain feature with high residual (ie an isolated hill) will force the wind to veer around and over it, accelerating wind speeds around the flanks and just before the top.

b) a linear terrain feature with large negative elevation residual (ie an incised valley) will steer and, at times, accelerate the wind.

c) a linear terrain feature with high residual elevation (ie a long isolated ridgeline) will steer and, at times, accelerate the wind.

d) a change in elevation residual that persists for some distance (such as a cliff line or monocline) will steer and, at times, accelerate the wind.

The model has been tested against extensive storm damage in Canberra on the 6th November 1994. The performance of the model was good, providing a basis *for apriori* expectations of damage patterns for any storm event.

The model can be used for refining the wind speed and directions used for wildfire behaviour prediction.

This paper will be presented as a poster display at the workshop.

Rick McRae
ACT Emergency Services Bureau
PO Box 104
Curtin, ACT, 2605

phone (06) 207 8607
fax (06) 207 8367
e-mail -