LESSONS FROM THE JANUARY 2003 FIRES – ADVANCING BUSHFIRE RISK MANAGEMENT IN THE HIGH COUNTRY

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- Much of the prior basis for bushfire risk management was found insufficient for understanding the January 2003 bushfires.
- Lessons must be learnt from the event to ensure future safety of threatened communities.

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- Arising from the fires, the Federal Government has given the BushfireCRC funding for the HighFire Project.
- One of the research projects within HighFire is a bushfire risk study.
- Developed in co-operation with land- and fire-managers, its research outputs will provide a scientific evidence-base to support decisions made regarding policy and practical issues for land- and fire-management.

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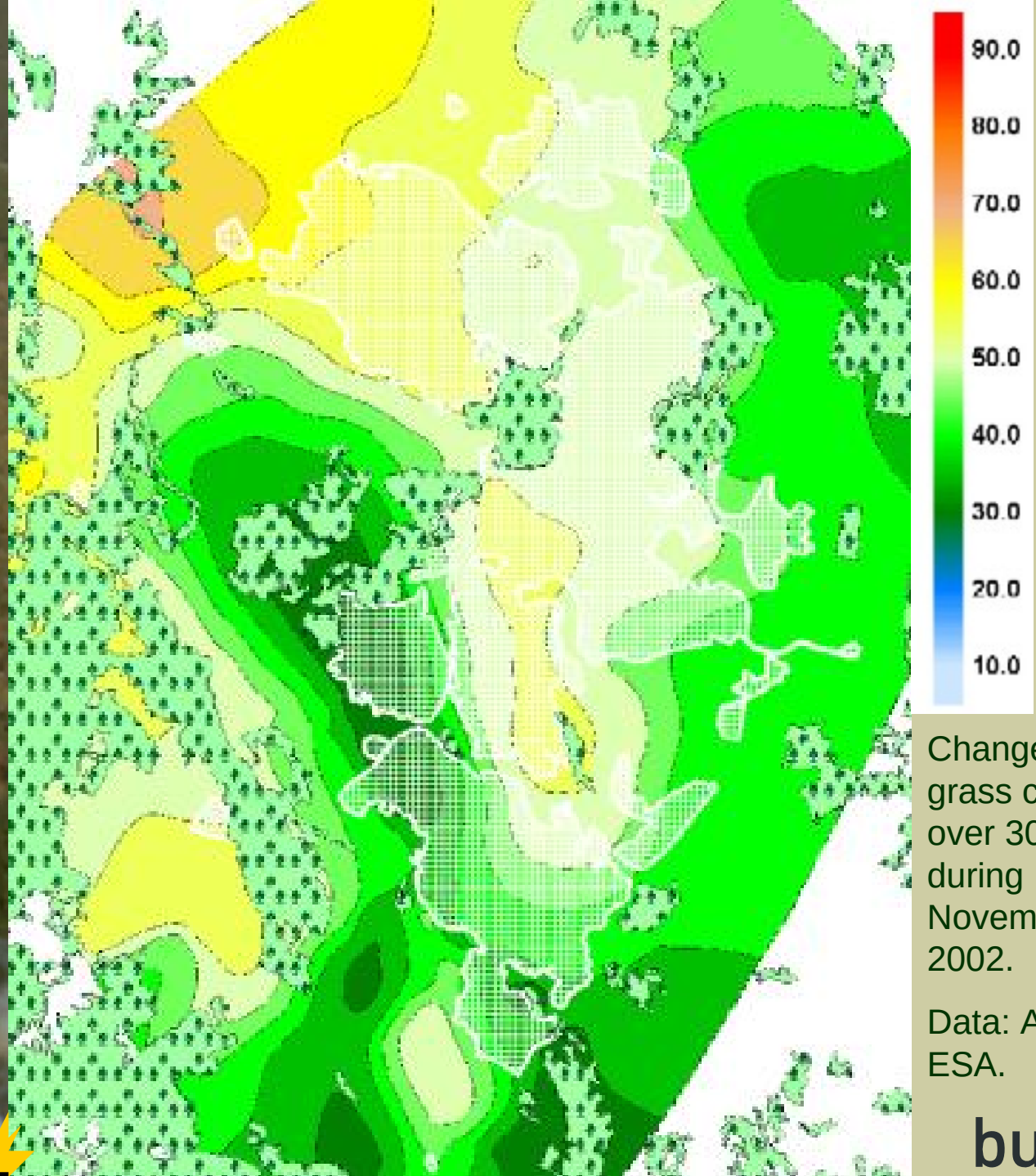

Change in grass curing over 30 days during November 2002.

Data: ACT ESA.

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- A multi-disciplinary approach will be applied, spanning:
  - Field data collection
  - Modelling
  - Analysis of fire data and
  - Risk methodologies

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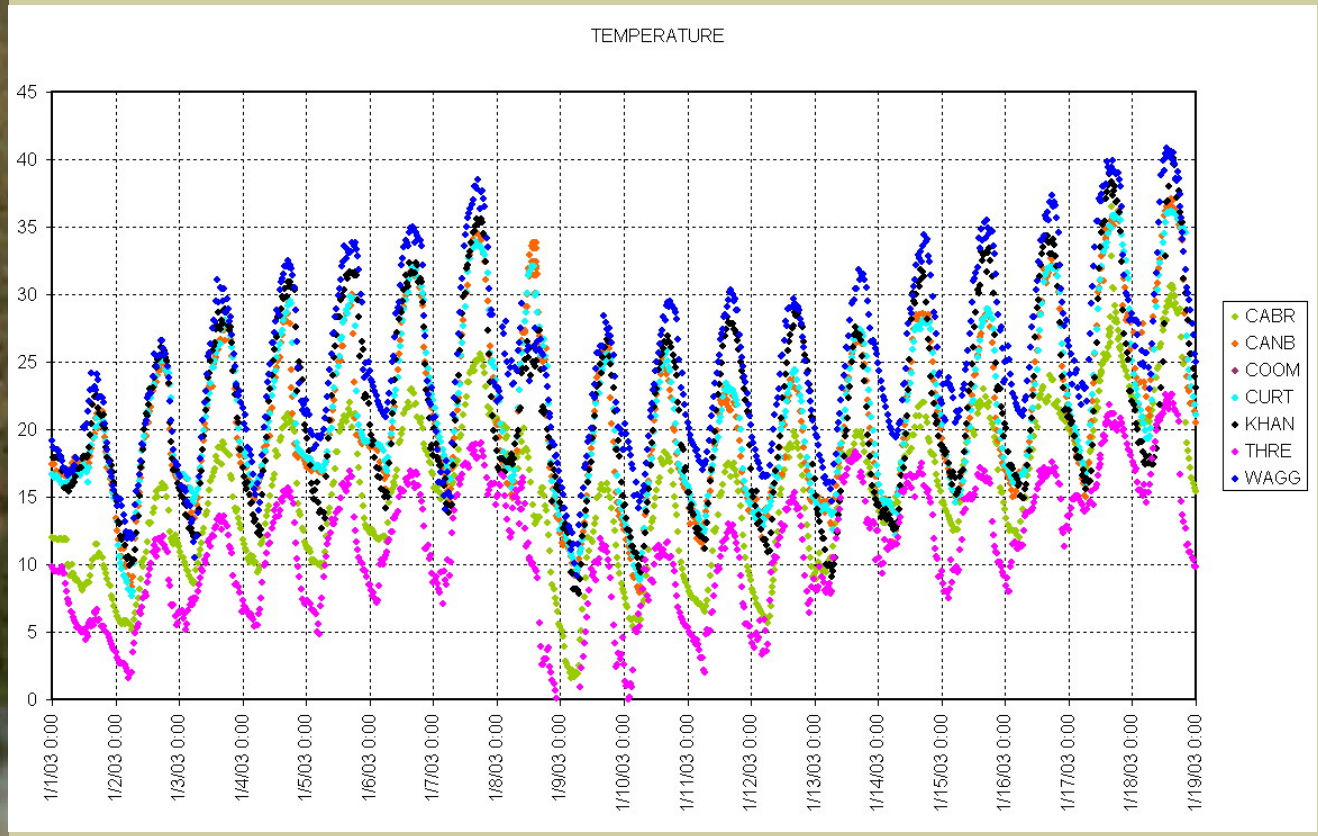
- While much of the initial effort will of necessity be meteorological, many aspects of fire management will be integrated.



Time series of Temperature data for January 2003.

Data: BoM, ACT ESA.

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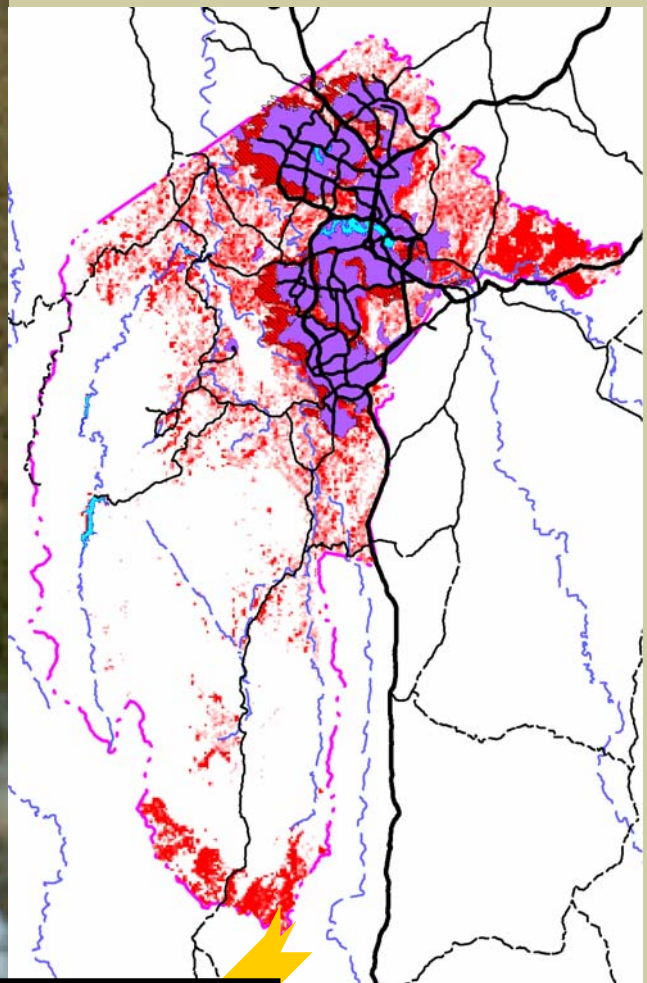
- There were always “To Do” lists in bushfire risk studies.

An ember storm strikes Duffy, Jan 18 2003.

Photo: WIN NEWS

- The bushfire risk framework used across the ACT is a foundation of the ACT Government's Strategic Bushfire Management Plan, 2005.



A composite map of fire spread potential from the SBMP.

ACT ESA.

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- The ACT risk model is evolving.
- It now is incorporating transitions between scales of fire size as fires escalate or decay.

Nature strips as ember generators. Duffy, Jan 18 2003.

Photo: WIN NEWS

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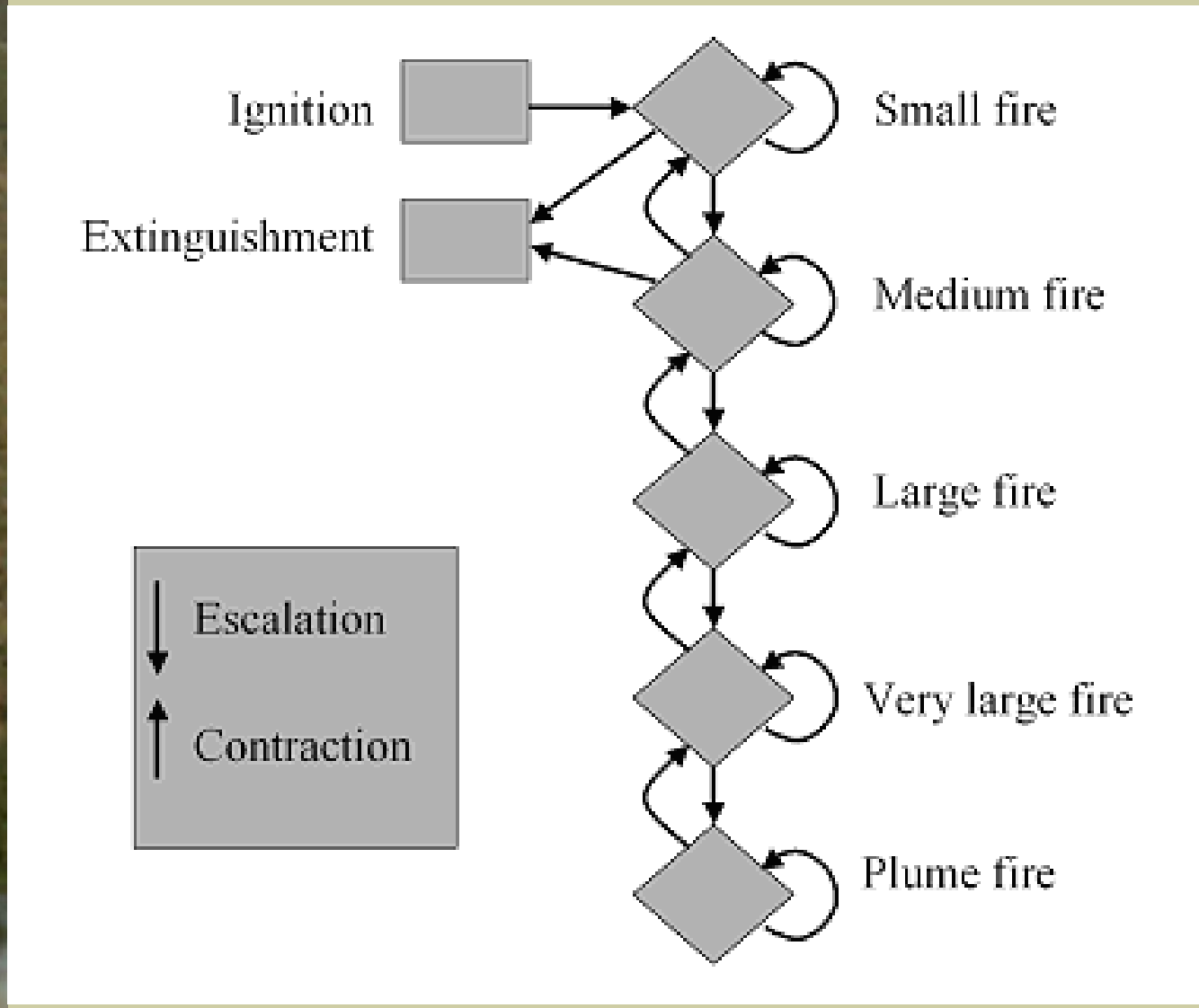
Transition model



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Key new findings…

- Nocturnal low-level jets
- Dynamic channelling
- Non-stoichiometric combustion
- Violent pyro-cumulonimbus development
- Dry slots

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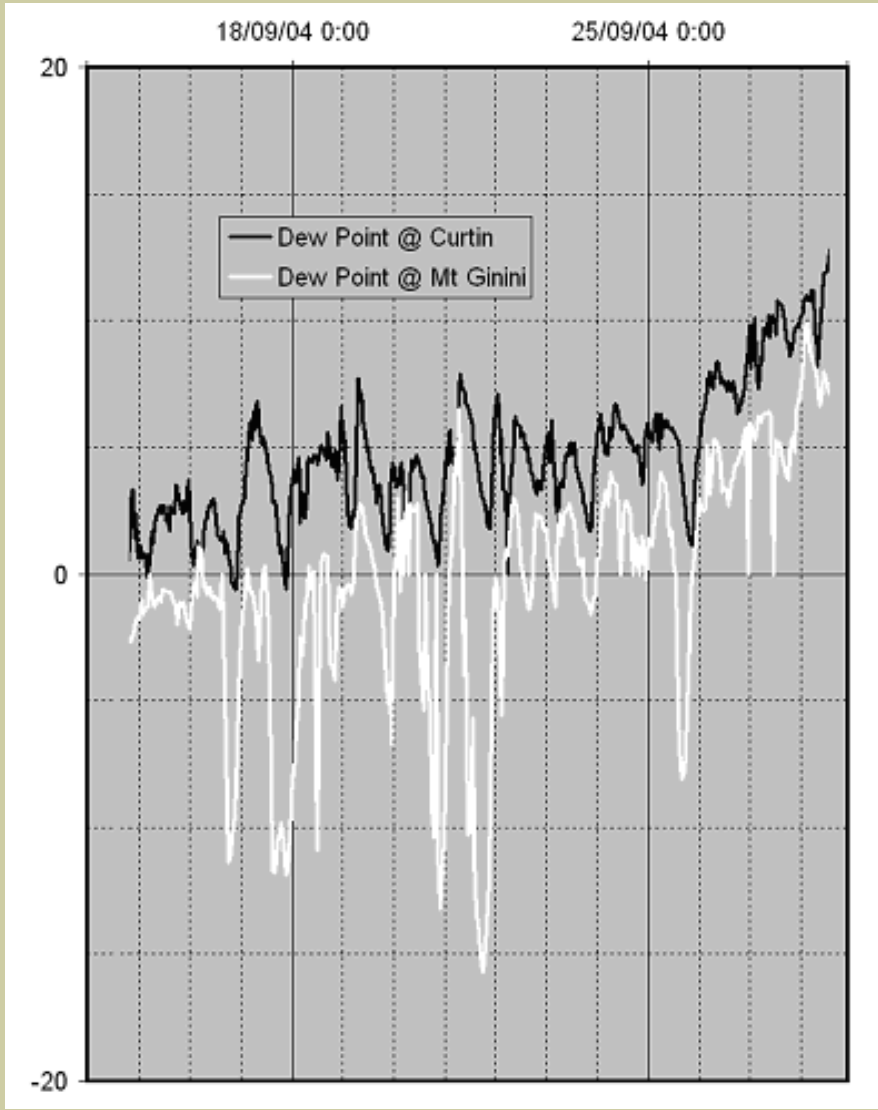
- What are believed to be “nocturnal low-level jets”



Dew Point time series for lowland [black] and highland sites [white], showing the characteristic DP drop-outs.

Data: BoM & ACT ESA

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- Dynamic channelling (Kossmann, *et al.* 2001; McRae 2004)

Channelling close to Canberra – Uriarra Crossing.

Photo: Stephen Wilkes, NSW RFS.

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- Unusual fire behaviour, in the form of non-stoichiometric combustion (Dold *et al.* 2005).

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- The formation of plume-driven fires and the associated violent pyro-cumulonimbus storms (Fromm *et al.* 2006).

An upwind view of the massive pyro-Cb formed over the Flea Creek Fire.

Photo: Stephen Wilkes, NSW RFS.

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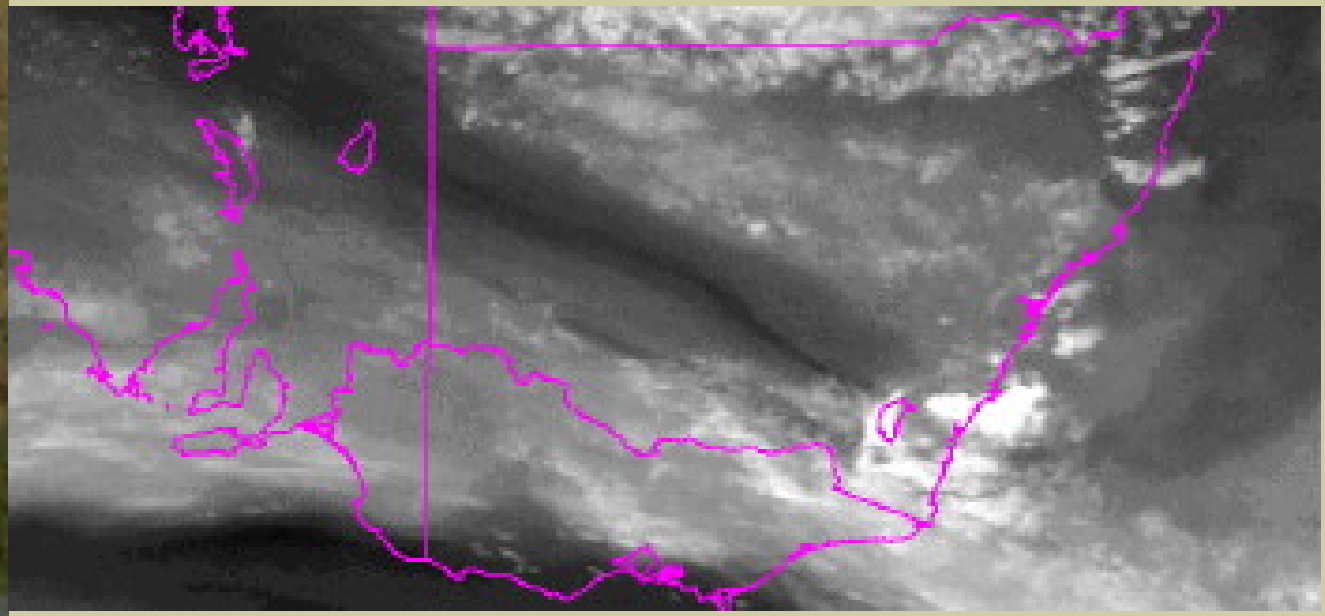
- Mills' work on dry slots: the passage of dry upper air over a fire-driven deep mixing layer.
- Ability to forecast ahead for violent fire development.



The dry slot departing Canberra on 18 Jan 2003.

Image: Graham Mills / BoM

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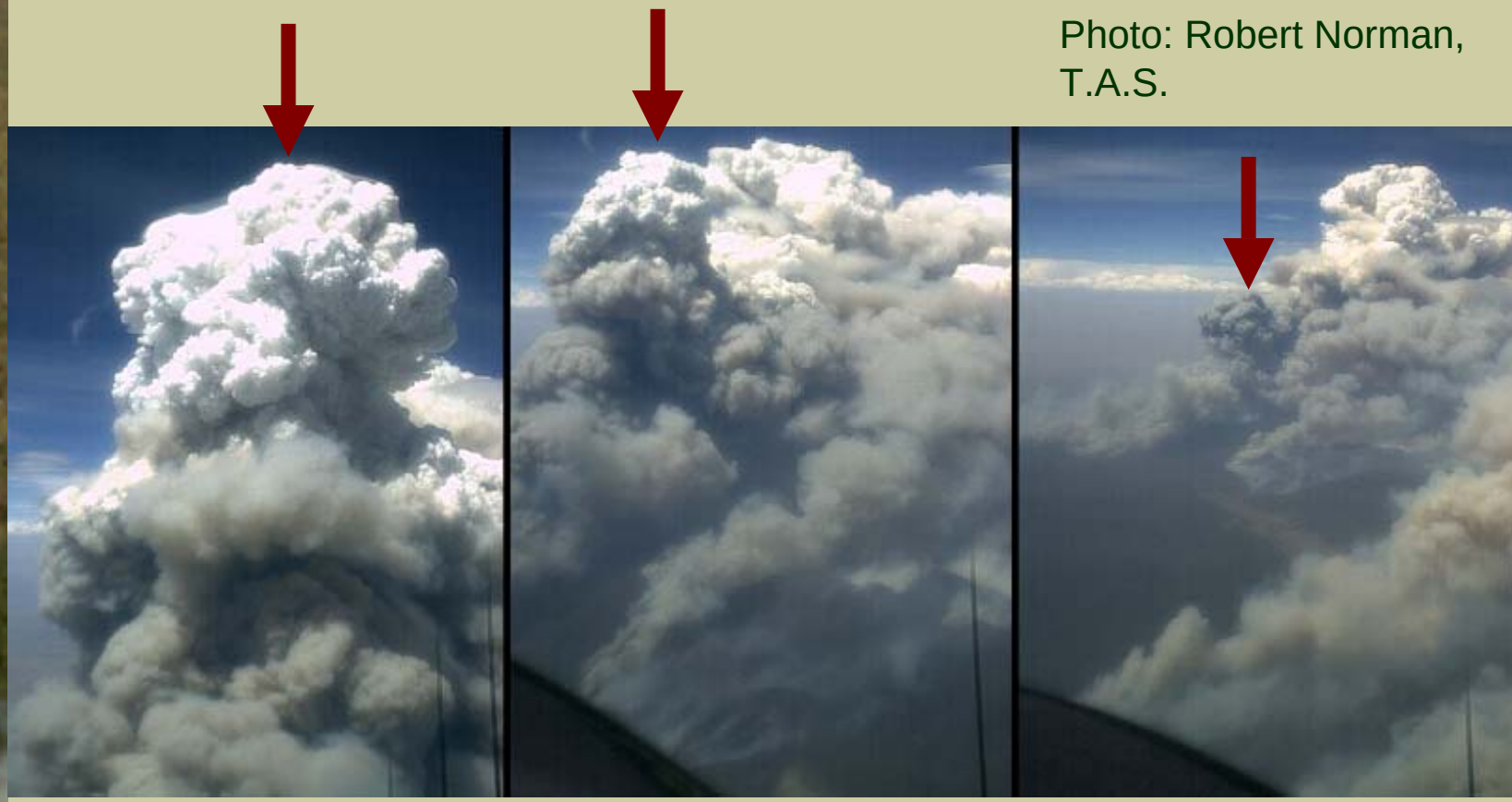
- Vertical movement.

Three photos of a plume-cell descending. It drops 4 km in 80 seconds.

Photo: Robert Norman, T.A.S.



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Factors for a very large fire

VERY LARGE FIRE [LANDSCAPE FIRE]

ORIGIN:

Escalation of Large Fire before suppression.

BEHAVIOUR

CODE	EVENT	CONDITIONS	MITIGATION
VA	Decay of Very Large Fire into one or more Medium or Large Fires	Loss of coherence in convection. OR Diurnal cycle drops FDI. Rain.	Burn-out pattern to form mosaic to drop coherence. Containment [indirect]
VB	Persist as Very Large Fire	Most likely path.	Containment [indirect] Spotfire patrols Fuel-age mosaic at landscape level Strategic broadacre fuel reduction
VC	Escalate to Plume-driven Fire	Massive flaming zone causes coherent plume to form,	Avoid fire convergence. Prioritise keeping fire out of areas prone to channelling.

STRATEGIC GUIDANCE FOR INCIDENT MANAGEMENT TEAMS

- Containment on or around **each** key landform element – generally, requiring multiple shifts. A goal should be to break the fire up.
- Prevent spotfires taking fire outside of containment.
- Avoid arrangements conducive to development of coherent plume.
- Control might be difficult in rugged terrain, due to weather interactions, or in flat areas, where there are no downhill runs to allow crews to catch-up. Other areas may provide fallback options.

DEFINITION

Coherent plumes occur when the size of the flaming zone allows the convection column to avoid mixing with surrounding air for some considerable vertical distance. The column, and the fire products that it contains, may then be pushed along by upper air. At this point the fire's behaviour is driven by that rather than by fuel, weather and terrain. Requires extreme fire intensity, atmospheric instability and escalation of flaming zone dimensions, usually by channelling or fire convergence.

Channelling is a process where air flow is diverted by terrain arrangements such as to expand the fire laterally as well as ahead.

Fire convergence occurs when two flaming zones come close together, creating a much larger effective flaming zone.

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Transitions for a very large fire

Transition	Probability increases if…			
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
VA	ROS drops	Coherence dissipates		
VB	{NOT VA and NOT VC}			
VC	Instability	Dry upper air mixing down	Channelling	Convergence
VD	In very large firepath			

NOTES

- In general, each factor generates a probability for that transition. The greatest probability for the set of factors listed in the table row determines the likelihood of the transition occurring.
- ROS must be calculated at the appropriate scale (correcting slope for scale, etc).
- Suppression is a sequence of detection, response and achieving objectives.
- Fuel is a complex set of descriptors, covering size, layering and availability.
- Firepaths are zones within which fire behaviour, at that scale, would present a direct and immediate threat to an asset.

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Probabilities:

- P(VC) = probability of escalation into a plume-driven fire
- Background: p(VC)=0
- If a very large fire exists, what is p(VC)?
- Is p(VC) a spatial variable?
- What are the correlations between the drivers?
- Bayesian Decision Trees

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Plume-driven fire transition chain

The recipe for a plume-driven fire is:

A small fire that…	Travels, and is not suppressed and has suitable fuel, and so is able to escalate into a…
Medium fire that…	Travels, and is not suppressed, and is not ranked on and has suitable fuel, and so is able to escalate into a…
Large fire that…	Travels (or spots ahead) onto multiple landform elements, and is not effectively suppressed, and does not break up into a series of smaller fires, and has suitable fuel, and so is able to escalate into a…
Very large fire that…	Travels and maintains coherent convection, or experiences instability, or mixing of dry upper air, or channelling, or convergence, and so is able to escalate into a…
Plume-driven fire.	

DO NOT ATTEMPT TO READ THIS – I'LL GO THROUGH IT NEXT…

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- A small fire that…
  - Travels,
    and
  - Is not suppressed
    and
  - Has suitable fuel,
- and so is able to escalate into a…

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- Medium fire that…
  - Travels,
    and
  - Is not suppressed,
    and
  - Is not rained on
    and
  - Has suitable fuel,
- and so is able to escalate into a…

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- Large fire that…

  – Travels (or spots ahead) onto multiple landform elements,
  and

  – Is not effectively suppressed,
  and

  – Does not break up into a series of smaller fires,
  and

  – Has suitable fuel,

- and so is able to escalate into a…

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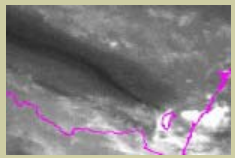
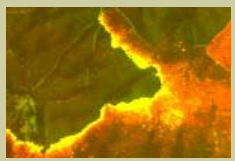
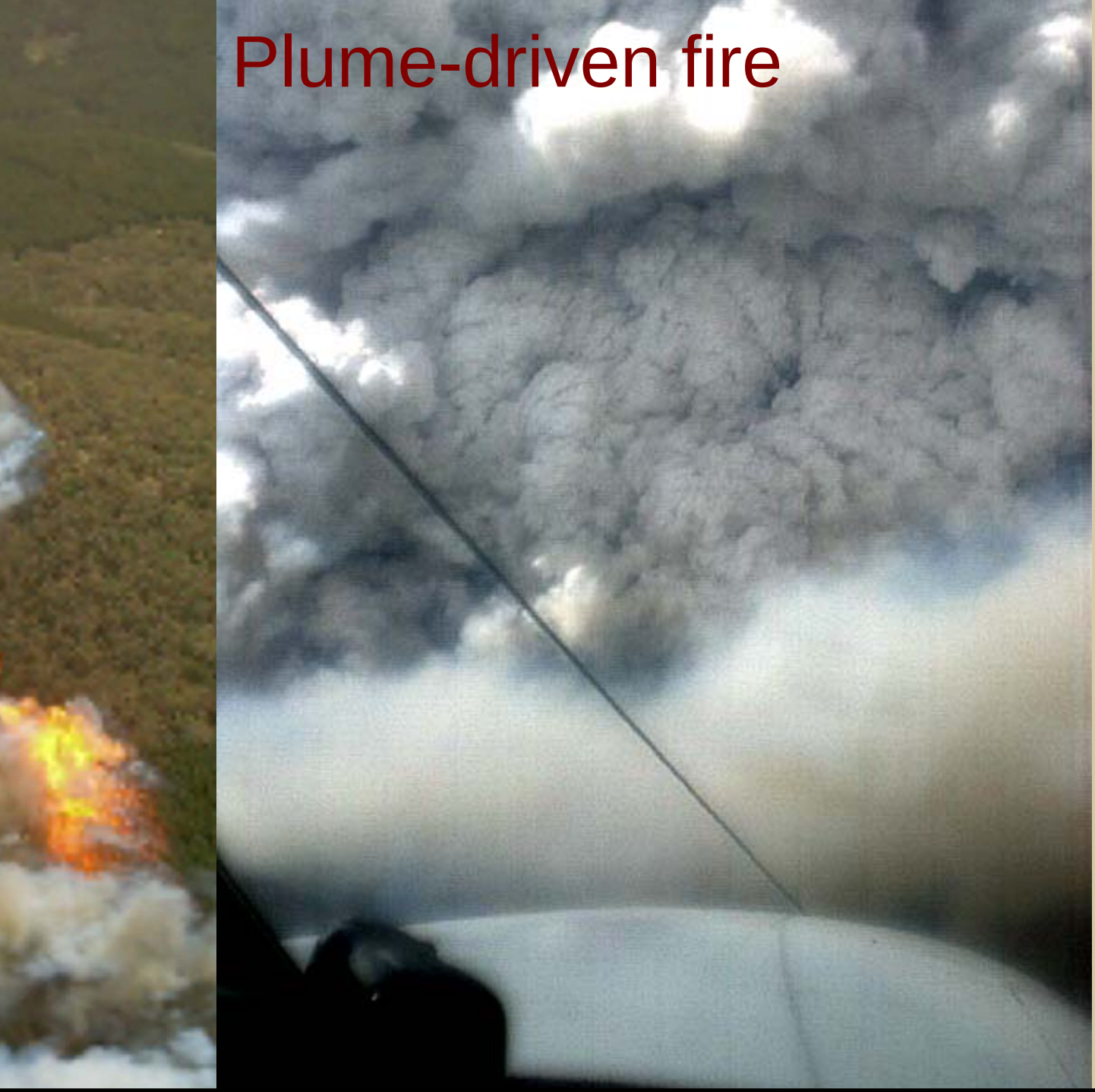
- Very large fire that…
  - Travels and maintains coherent convection,
    or
  - Experiences instability,
    or
  - Experiences mixing of dry upper air,
    or
  - Experiences channelling,
    or
  - Experiences convergence,
- and so is able to escalate into a…







Plume-driven fire



A vigorous plume expanding against surrounding air past a height of 5 km AGL.

Photo: Robert Norman, T.A.S.

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Outputs

- By methodically studying the bushfire risk process in the high country, we seek to:
  - Formalise the basis of risk assessment for the largest fires
  - Allow better understanding of the relative risks from each fire size class in the high country
  - Identify options for risk mitigation and for incident management.
  - Develop and provide material to pass these findings on across the industry.

Acknowledgements

- NSW RFS for photos from:
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QUESTIONS?