THE BREATH OF THE DRAGON

• The January 2003 ACT Bushfires
ACKNOWLEDGEMENTS

• Linescans = NSW RFS
• Photographs:
  – NSW RFS
  – Public (off the web)
  – ESB staff
• Weather data from Bureau of Meteorology
• MODIS image from NASA
### ENERGY BUDGET, pm 18/1/03

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area burnt in 12 hours</td>
<td>$9.0 \times 10^4$ ha</td>
</tr>
<tr>
<td>Fuel loading</td>
<td>$3.0 \times 10^4$ kg/ha</td>
</tr>
<tr>
<td>Energy content</td>
<td>$2.0 \times 10^4$ kJ/kg</td>
</tr>
<tr>
<td>Fuel consumed</td>
<td>$2.7 \times 10^9$ kg</td>
</tr>
<tr>
<td>Energy released</td>
<td>$5.4 \times 10^{13}$ kJ</td>
</tr>
<tr>
<td>Blast energy TNT</td>
<td>$4.7 \times 10^3$ kJ/kg</td>
</tr>
<tr>
<td>TNT equivalent</td>
<td>$3.5 \times 10^5$ t</td>
</tr>
<tr>
<td>Time period</td>
<td>$4.3 \times 10^4$ s</td>
</tr>
<tr>
<td>Power</td>
<td>$1.3 \times 10^9$ W</td>
</tr>
<tr>
<td>Earthquake equivalent of fire</td>
<td>5.7 M(Richter)</td>
</tr>
<tr>
<td>Newcastle earthquake, 10:27, 28/12/1989</td>
<td>5.6 M(Richter)</td>
</tr>
<tr>
<td>Average tornado</td>
<td>4.5 M(Richter)</td>
</tr>
<tr>
<td>Domestic energy usage</td>
<td>$2.0 \times 10^7$ kJ/person/annum</td>
</tr>
<tr>
<td>ACT usage</td>
<td>$6.0 \times 10^{12}$ kJ/annum</td>
</tr>
<tr>
<td>ACT usage in 12 hr</td>
<td>$8.2 \times 10^9$ kJ</td>
</tr>
<tr>
<td>Ratio of fire to ACT domestic energy usage</td>
<td>$6.6 \times 10^3$</td>
</tr>
</tbody>
</table>

Based on $WTNT = c \times Wf \times Hf / HTNT$, where $c=0.03$
ASYMMETRIC WIND/TERRAIN INTERACTION
LEE SLOPE CHANNELLING

• Broken Cart Fire, 17/1/03
• Bendora Fire, 18/1/03.
• Left = 14:50
• Right = 15:40

NW Wind
• Eddy winds of lee-slopes of hills produced lateral [right-angles to wind] push of embers.
• Resulted in lateral flank expansion up to 5 km/hr.
• Fire spills over landscape downwind across entire width.
FORCED CHANNELLING
[VALLEY BURN-OUTS]
• McIntyres Fire 18/1/03.
• Small initial fire breakout.
• Massive lateral expansion, contained to incised gorge.
• Spill-out over landscape
• Bulk winds blowing over deep valleys are channelled into the valleys.
• May also be pressure-driven with opposite effect.
• Form a type of “archimedes screw” and push embers rapidly at right-angles to wind.
• Stockyard Spur Fire 18/1/03.
• Main run to ESE
• Lee slope channelling to SSE
• Major upslope runs
• Spotting ahead

WNW Wind
TORNADO PATH
THE VERTICAL KILOMETRE
• Was the vertical kilometre from Goodradi gbee River to Mt Ginini done in one lick?
LARGE FUEL

- Grasslands eaten out, carried fire.
- Short-range spots frequent.
• Short residence time [7 minutes later…]
• Note helicopter
Bendora Fire 13/1/03
PLUME FIRES

• Previous work – downbursts
• This event:
  – Cumulonimbus clouds to 16 km height
  – F2 tornadoes
  – Lightning
  – No wind-terrain interaction
  – Poorly correlated with fuel
FACTORS THAT EXPLAIN CROWN FIRES MAPPED FROM JANUARY FIRES

- High forest fuel loads
- Low forest fuel loads
- TERRAIN
  - Mountain valley
  - Mountains
  - Mountainous
  - High plateau
- Undulating lowlands
- Plateau
- Main tableland
- Dissected foothills
- RELIEF
- Rugged
- COMPOSITE MODEL
  - Model 1 (Mountainous or pine or steep)
  - Model 2 (rugged or pines)

Note that the models predicted areas that weren't crown fires - not all areas burnt under conditions conducive to crowning.
RESEARCH TOPICS

1. Effects of large fuels on fire suppression models and tactics
2. Implications for mountain meteorology on fire management in the vertical parts of Australia
3. Predictive models for development of plume-driven fires
1. LARGE FUELS

- The high level of drought made large downed fuels fully flammable. Reliance on fine-fuel based models caused significant operational difficulties. The switch to new models must proceed as rapidly as possible.
2. MOUNTAIN WEATHER

- Mountainous terrain interacted with wind to produce extraordinary fire behaviour due to two forms of channelling. Firefighting in mountainous areas must be supported by an understanding of these processes. Channelling appears to have aided the formation of plume fires.
3. PLUME FIRES

- Plume-driven fires developed locally in at least 7 instances. They also occurred in adjacent fires in NSW. We do not have the tools to forecast this, and desperately need those tools.