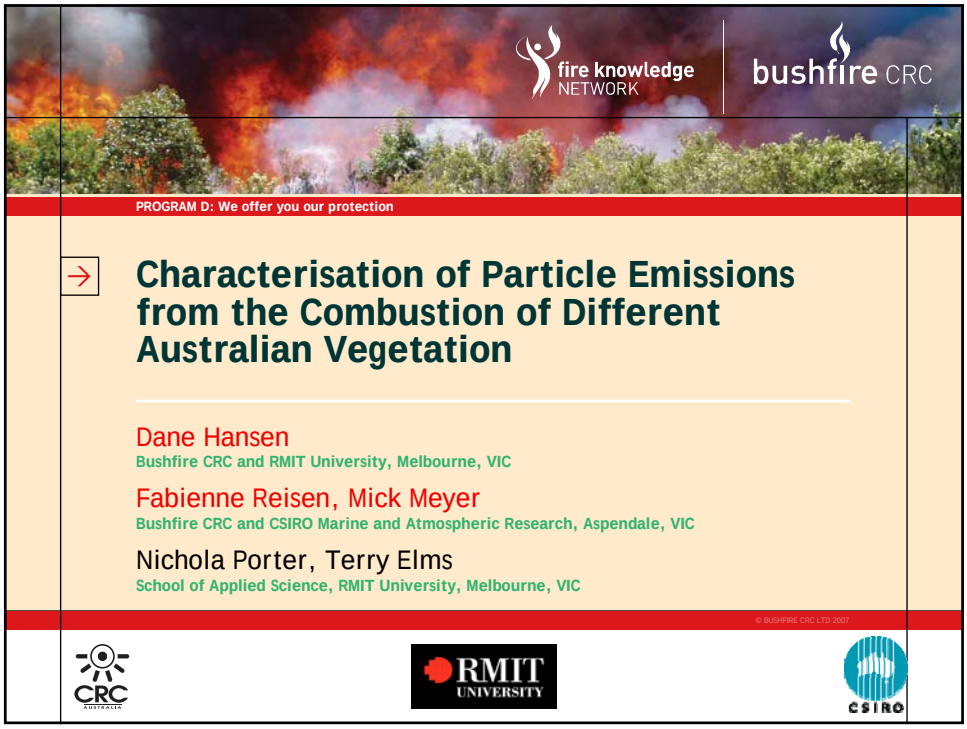
fire knowledge NETWORK
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PROGRAM D: We offer you our protection
Characterisation of Particle Emissions from the Combustion of Different Australian Vegetation
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Acknowledgements
Bushfire CRC – for funding and project support
CSIRO – for in kind support and access to laboratories and equipment
Fire / land management agencies - for logistical, technical, and in kind support

Background

Bushfires generate smoke which contains a range of air toxics

Including: Carbon Monoxide (CO),
Aldehydes,
Volatile Organic Carbon (VOC's),
and…
Particulate Matter (PM).

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Particulate Matter

Health Effects

- PM exposure linked to acute or chronic cardio-respiratory disease
- Eye / respiratory irritant
- Small particle size with large surface area
- Transport of toxics into respiratory system

Current Research

- Particle characterisation studies in US/Europe
- US firefighter exposure
- No Australian bushfire smoke particle characterisation
- No Australian specific firefighter exposure studies

Project aims

"To characterise the volatile organic components and heavy metals adsorbed to particulates generated in bushfires"

1. To Determine smoke particle composition
2. Smoke particle size
3. Australian vegetation emission factors
4. Firefighter exposure

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Two Directions

1. Laboratory Burns

2. Field monitoring

Laboratory Burns

Objectives

- Determine vegetation emission factors
- Evaluate particle chemical composition / size distributions
- Effect of fuel characteristics on air toxics emissions

- Fuel types – Eucalypt, pine, heath, grasses, noted "smoky" species
- Fuel moisture
- Fuel size
- Combustion conditions – flaming/smouldering

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Particle collection using 'The Woozle'

A high volume sampler (0.9 to 1 m^3 min^{-1}) originally intended to sample dioxins emitted from bushfires.

Including:

- An 8 x 10" quartz filter
- A PM 2.5 Dustrak upstream of the filter.
- A CO_2 gascard, a Q-trak and a hydrocarbon analyzer, all drawn from the main sample line downstream of the filter.
- $[CO_2]$, $[CO]$, $[CH_4]$, [NMHC], [PM], enable carbon mass balance EF's

Results - TSP Emission factors

Fuel type	Fuel Moisture (%)	Emission Factor (g/Kg fuel)
Eucalyptus	5	11.7
	10	17.6
Pine	10	11.3
	26	21.4

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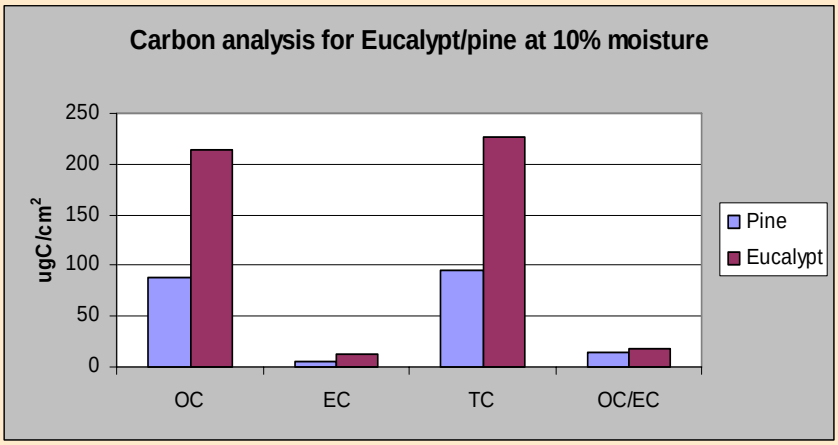
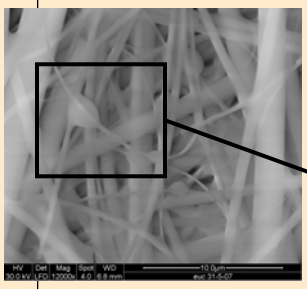
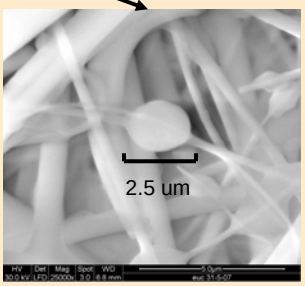
Results - Carbon content

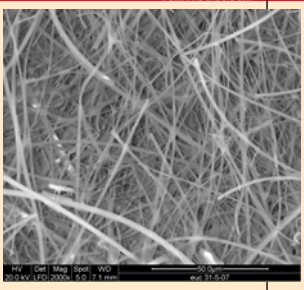


Results - SEM



Smoke particles collected on filter





Blank quartz filter

Further work

1. **Chemical analysis**
   a) Water soluble ions (WSI)
   b) Polycyclic aromatic hydrocarbons (PAH) analysis
   c) Analysis for metals
   d) Scanning electron microscope (SEM)

2. **Experiments**
   a) Measurement of particle size distributions
   b) Separate sampling of different stages of burn
   c) Further investigation of fuel type/moisture/size
   d) Fuel carbon content

Field Monitoring – Sampling design

1. Ideal – sampling in breathing zone of firefighter
2. Robust, small, light weight equipment
3. Long battery life, and large data storage/appropriate filter media
4. Comfortable, unrestrictive, versatile
5. Local area monitoring
6. Quick and easy to mount to vehicles

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Field monitoring - personal

Samples collected in the breathing zone of active firefighters

Devices
TSI SidePak w/ 10 mm nylon Dorr-Oliver cyclone
TEI *personal* Data-logging Real-time Aerosol Monitor (pDR)
Gravimetric sampling 25 mm glass fibre filter Conductive plastic cyclone
Draeger Pac III Gas Monitor w/ Carbon Monoxide sensor

Field monitoring - local environment

Collected with vehicle mounted instrumentation

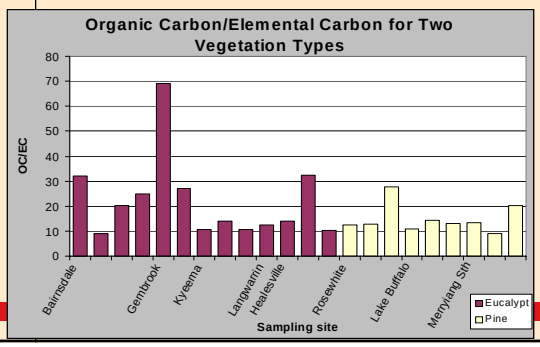
Devices
TSI DustTrak w/ 10 mm nylon Dorr-Oliver cyclone
MicroVol for $PM_{2.5}$ sampling with 47 mm Teflon filter
32 mm quartz filter followed by a polyurethane foam





Results – Carbon content

Samples from 06-07 Bushfires and 2007 Victorian prescribed burns have been analysed for TC, OC, and EC



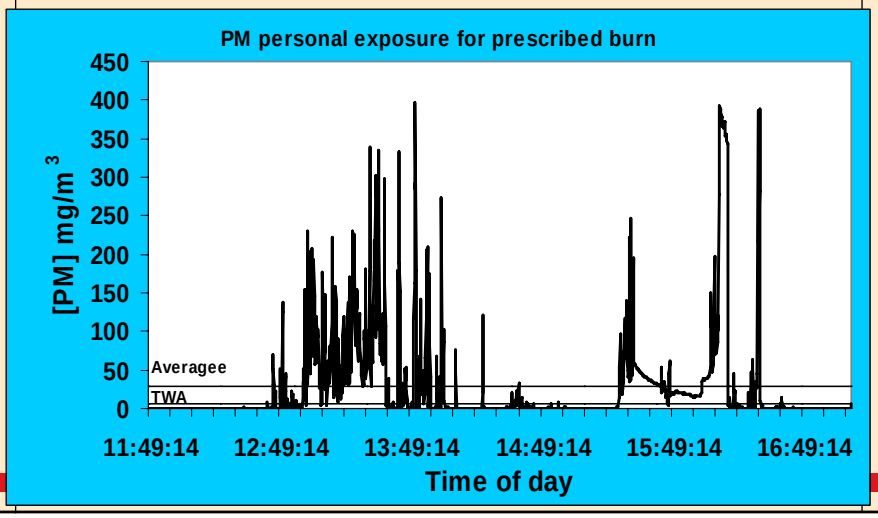
- The results show high OC/EC ratios for both eucalypt and pine samples
- The high OC/EC ratio may indicate the formation of secondary organic species
- The high OC/EC ratio may also indicate the presence of harmful organic species

PM occupational exposure standards

Air Toxic	TWA	STEL
Carbon monoxide	30 ppm	200 ppm (15 min) 400 ppm (0 min)
Respirable particles	**1-5 mg/m^3**	-
Graphite dust	3 mg/m^3	
Hardwood dust	1 mg/m^3	
Softwood dust	5 mg/m^3	
Nuisance dust (US)	5 mg/m^3	

No exposure standard specific for bushfire smoke particles

Results – PM 2.5 exposure - Firefighter



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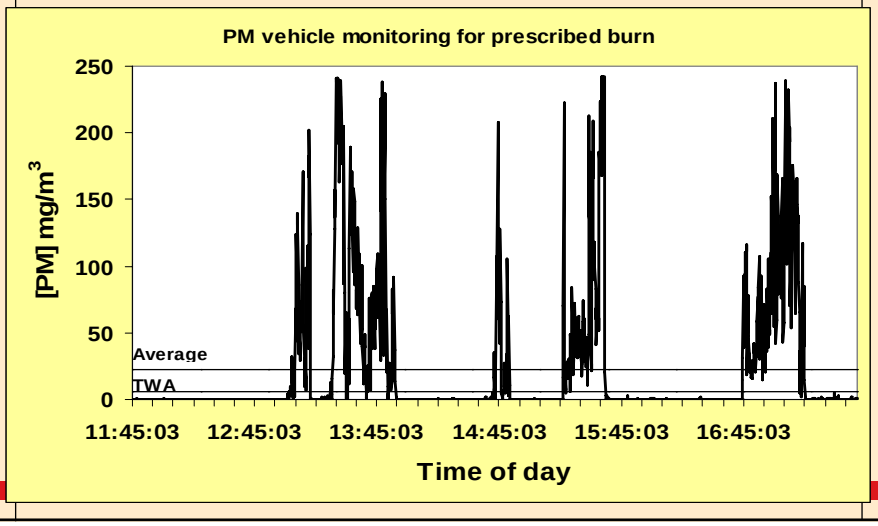
Results - PM 2.5 exposure - Fire truck



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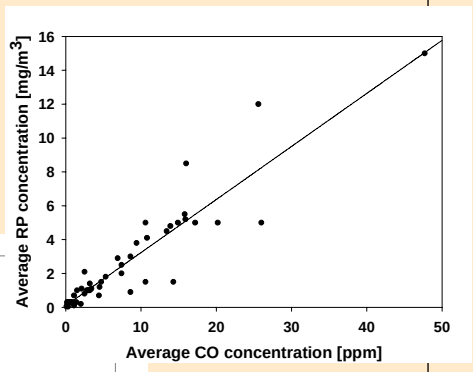
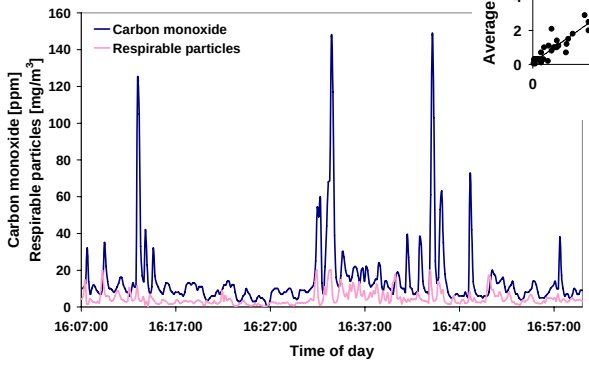
Results - CO / PM relationship





Further work

1. **Chemical analysis**
   a) Water soluble ions (WSI)
   b) Polycyclic aromatic hydrocarbons (PAH) analysis
   c) Analysis for metals
   d) Scanning electron microscope (SEM)
   e) Carbon analysis of personal gravimetric samples

2. **Field monitoring**
   a) Prescribed burns in WA
   b) Experimental burns in Ngarkat SA
   c) Prescribed / bushfires in NSW
   d) Possible further QLD monitoring

Conclusion

1. This work is ongoing
2. Laboratory burns will provide information on emissions of particles
3. Field samples will evaluate chemical nature and possible exposure
4. Chemical composition / size distribution of particles.
5. Allowing for appropriate exposure standards helping to protect firefighter health and safety.

Questions ?