Assessing population exposure risk to smoke from bushfires

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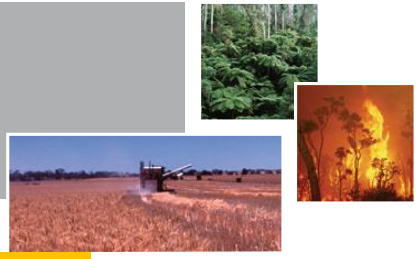
Smoke Impact

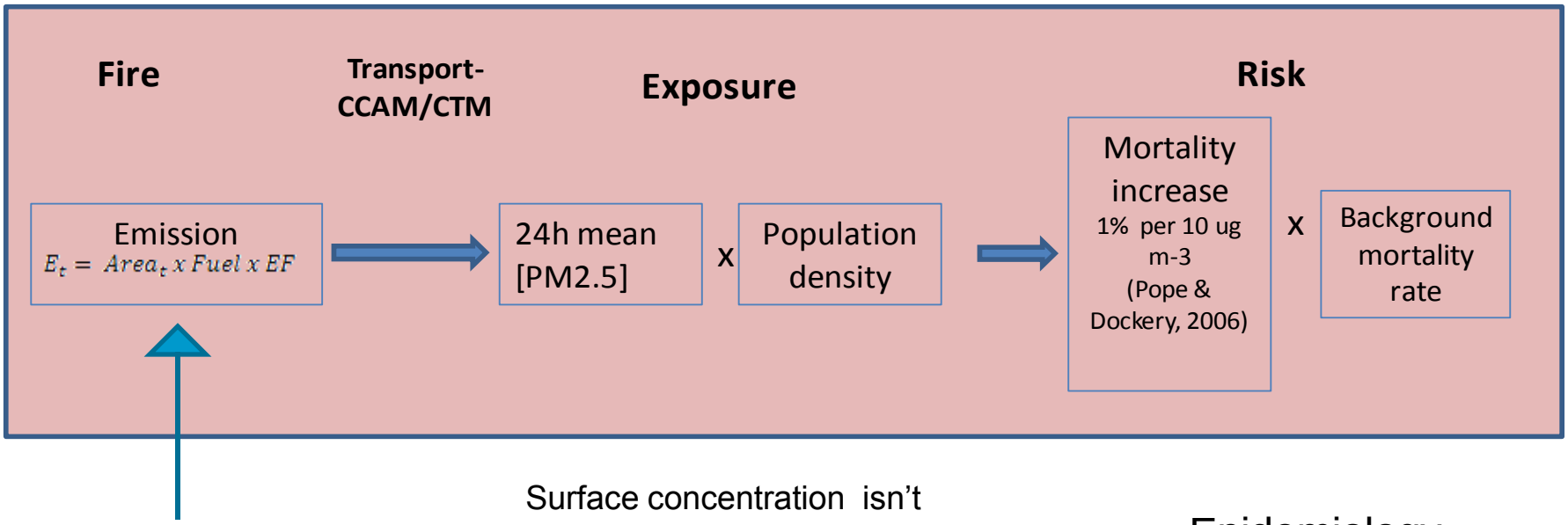


1 μg m^{-3} increase in PM10 → 1% increase in mortality

Pope and Dockery,2006

Location	Health Risk	Reference
Harvard Six Cities study (8096 white participants from various cities of the USA followed since the mid-1970 to 1998)	Increase of 10 μg m^{-3} 16 % increase in mortality, 28% increase in cardiovascular disease, 8% increase in respiratory disease	Laden and Dockery 2006
Women's Health Initiative cohort study, including 65,893 post-menopausal women	Increase of 10 μg m^{-3} 76% increase in cardiovascular mortality	Miller et al. 2007
ACS-CPS-II study linked air pollution data with the individual data of approximately 500,000 adults from the USA, followed from 1982 to the end of 1998	Increase of 10 μg m^{-3} 6 % increase in all mortality, 12% increase in cardiovascular disease	Pope et al. 2002; Pope et al. 2004
Los Angeles October 2003 wildfires	Increase of 10 μg m^{-3} 3 % increase in respiratory hospital admissions, 5% increase in asthma hospital admissions, 4% increase in chronic obstructive pulmonary disease admissions	Delfino et al. 2009
Madrid 2003-2005	Increase of 25 μg m^{-3} increase in hospital admissions of 7%, increase in cardiovascular admissions was 8%, increase for respiratory admissions was 7.	Linares et al. 2010

From emission to Risk



Surface concentration isn't exposure:

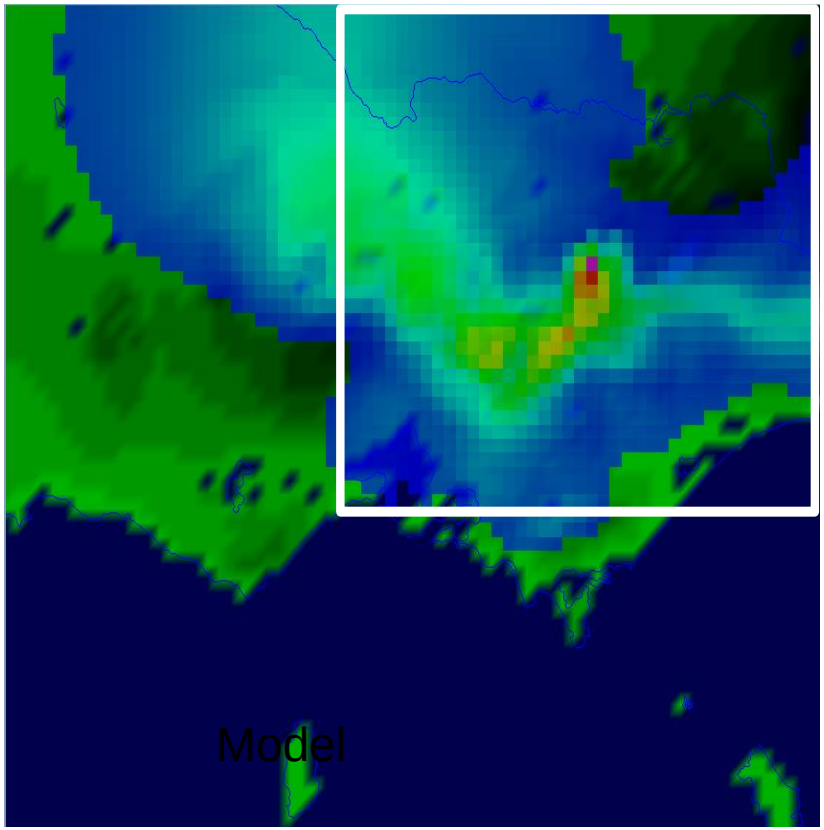
- Infiltration into buildings
- Location of people

Epidemiology

Fire spread model;

- Heat release -> plume rise
- Hourly progression-> emission timecourse
- Need CDW combustion dynamics

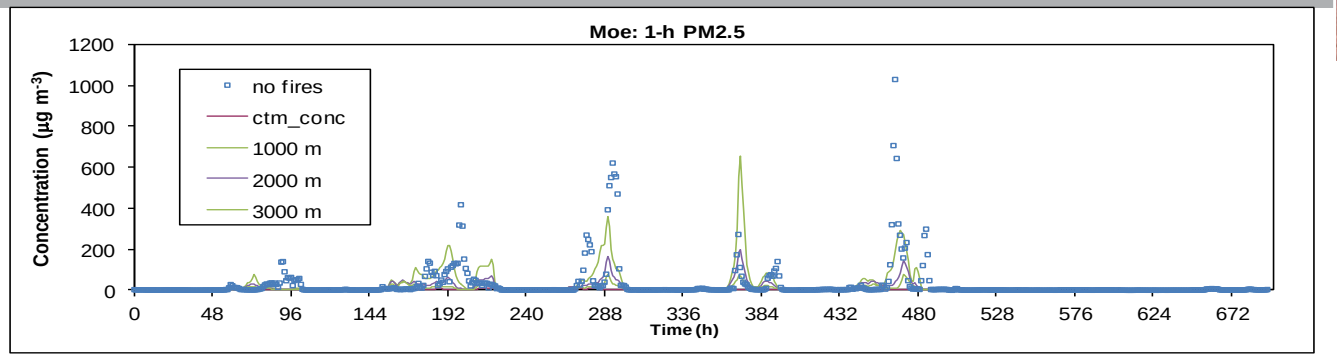
Transport modelled and verified

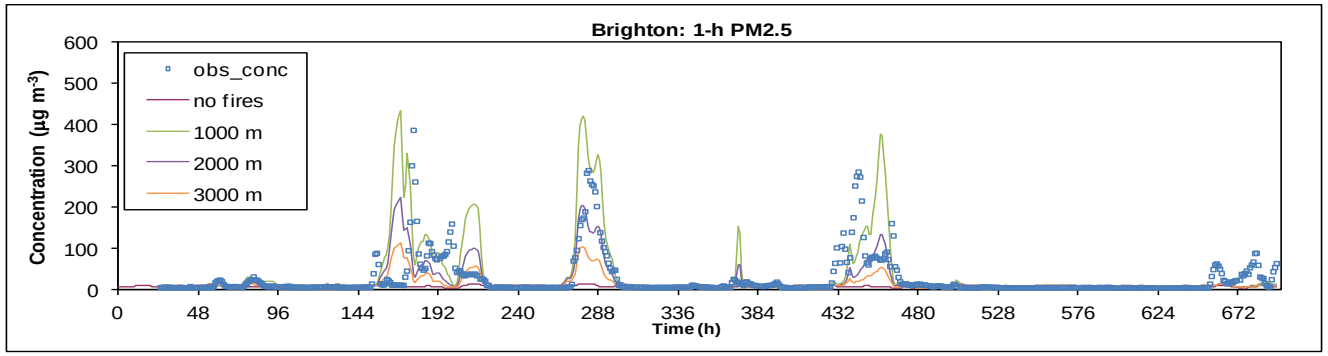


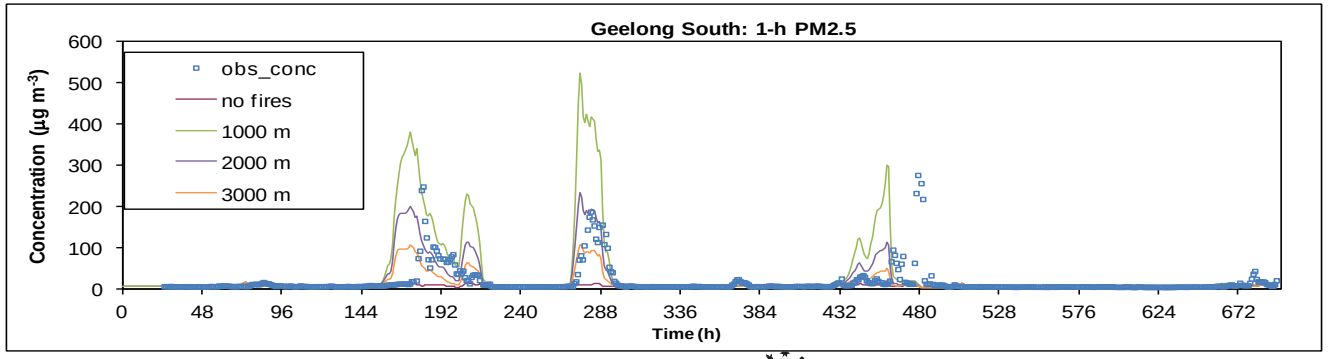
MODIS Obs

8th December 2006

Plume Rise







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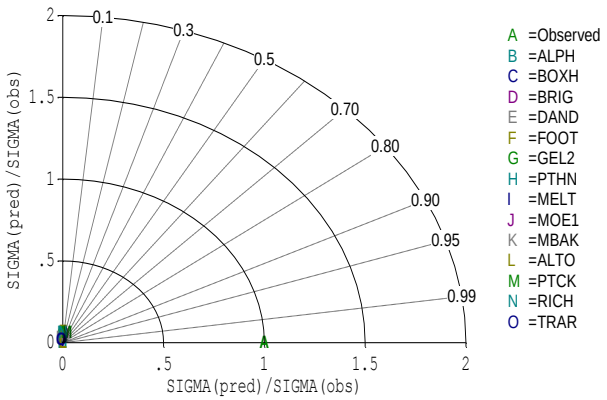
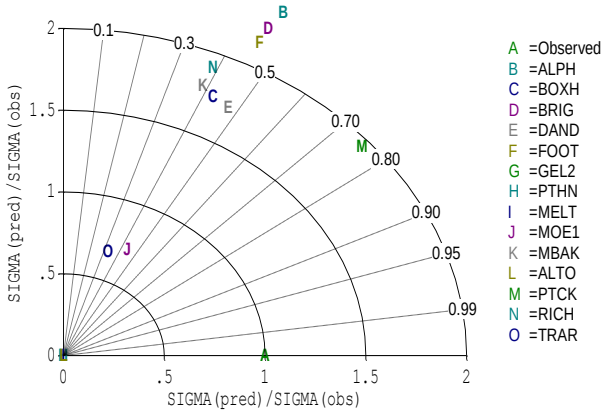
Plume rise optimisation (PM2.5)

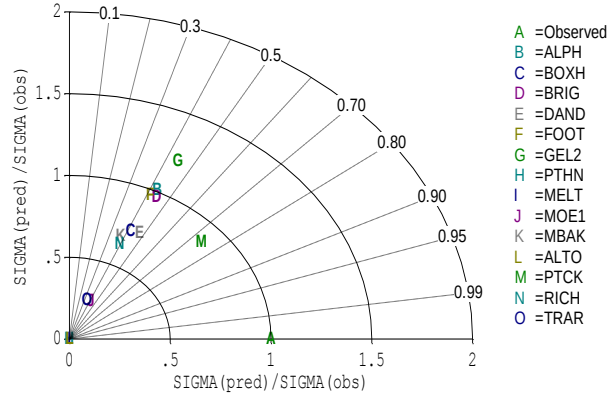
Scenario-0 Base



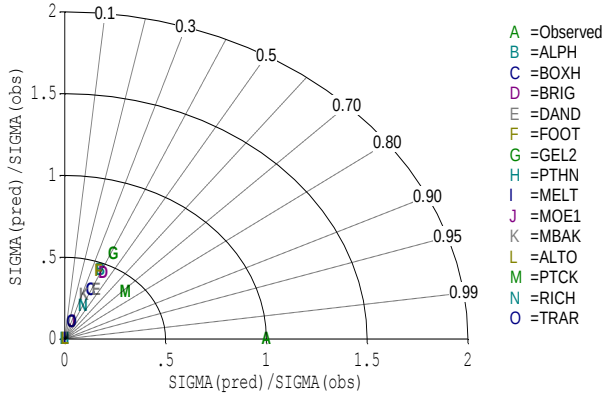
Scenario-1 1000 m



Scenario-2 2000 m

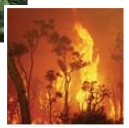


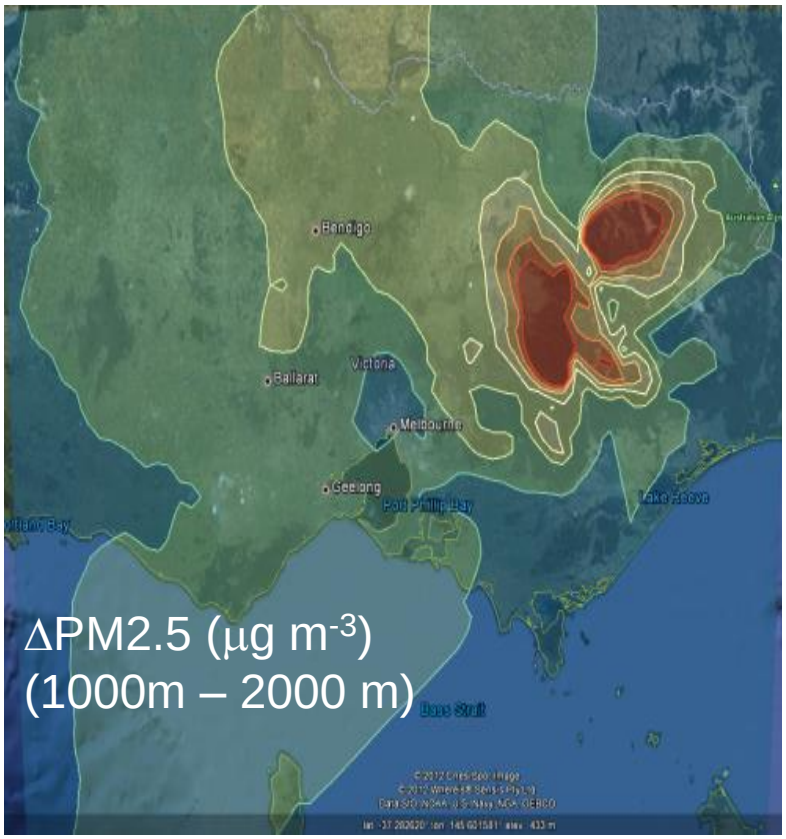
Scenario-3 3000 m

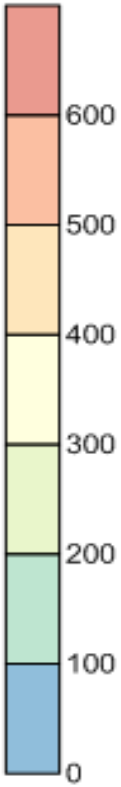


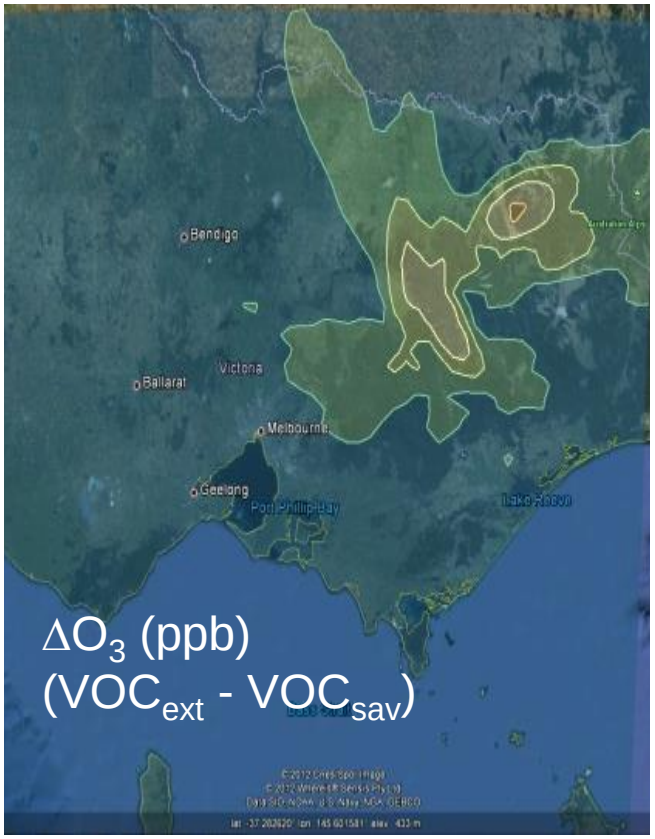
2000 m gives the best overall fit

Widespread air quality impacts from the wildfires





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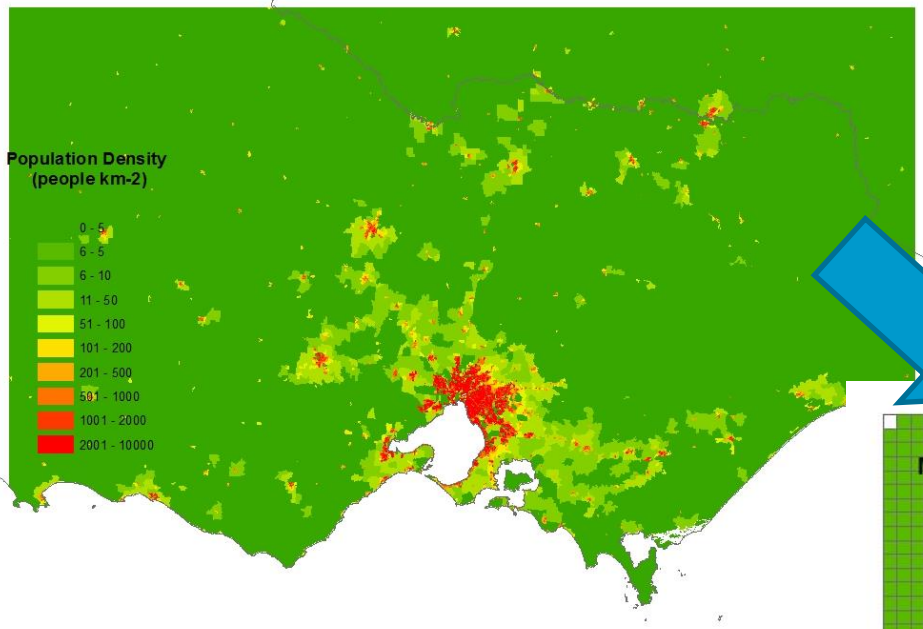
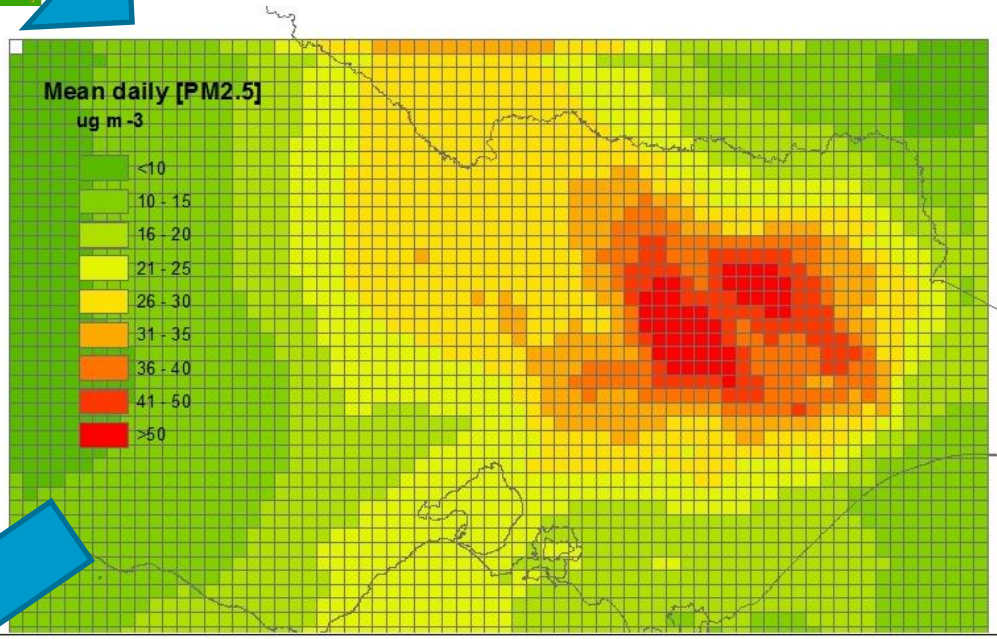
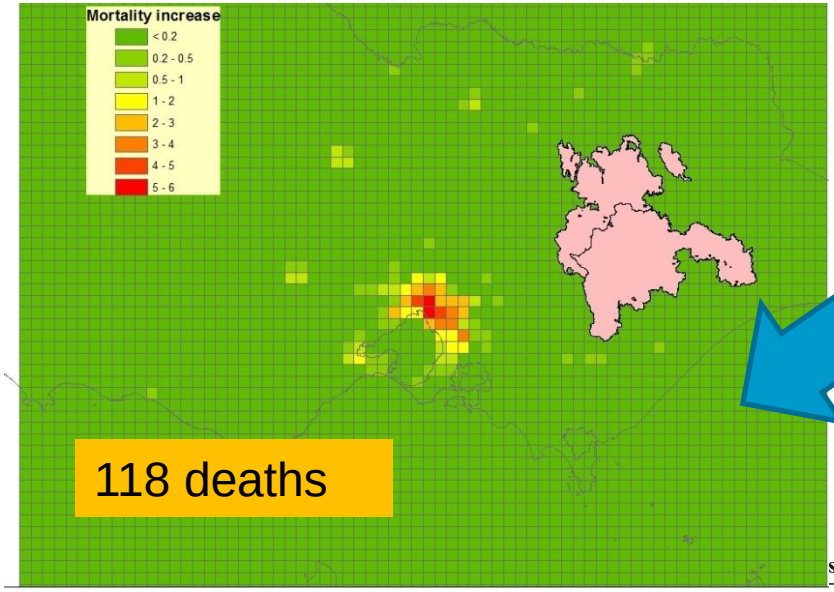
Alpine Fires 2006/7



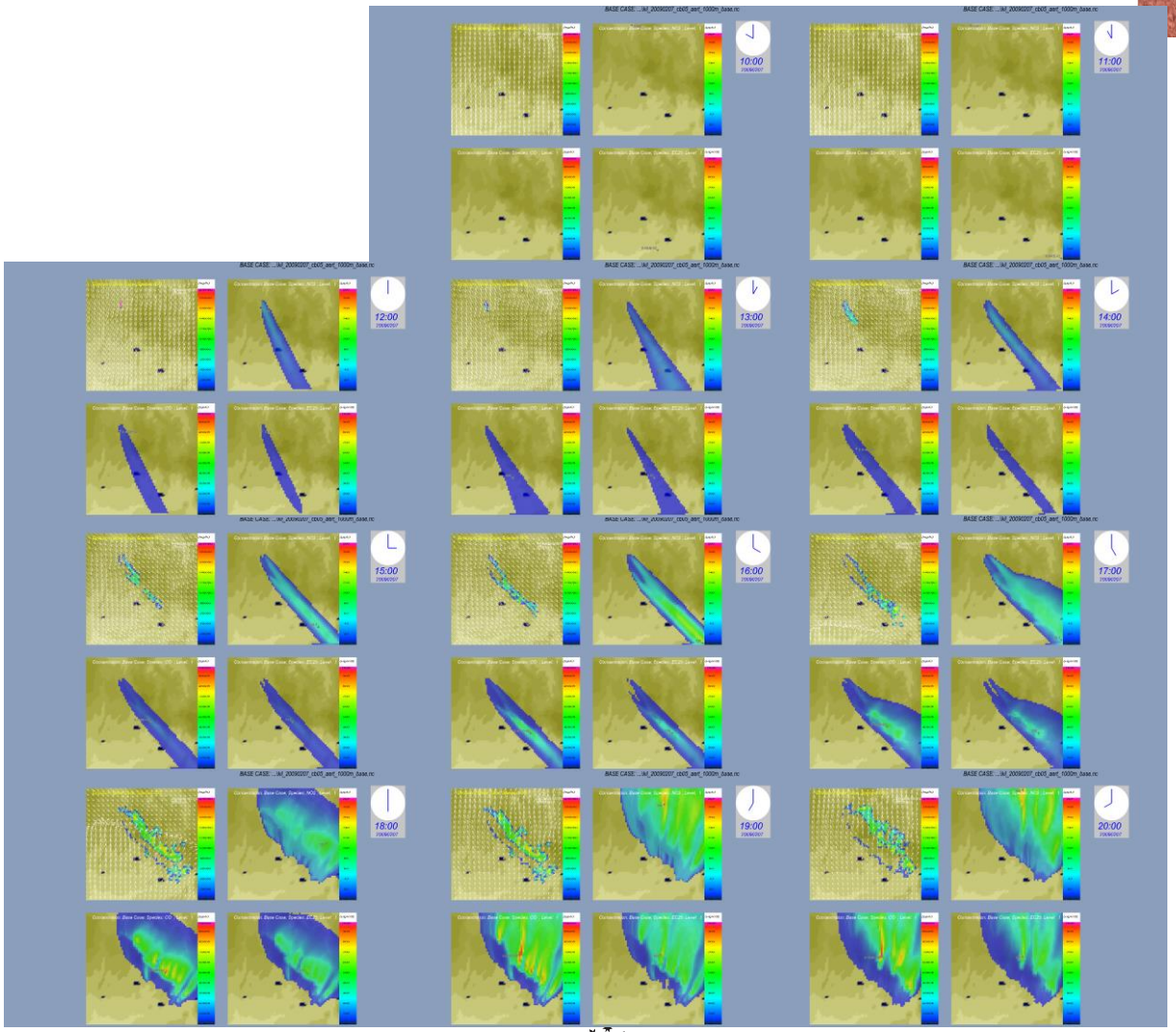
60 Days duration
Assume 1%/ 10 μg m^{-3}



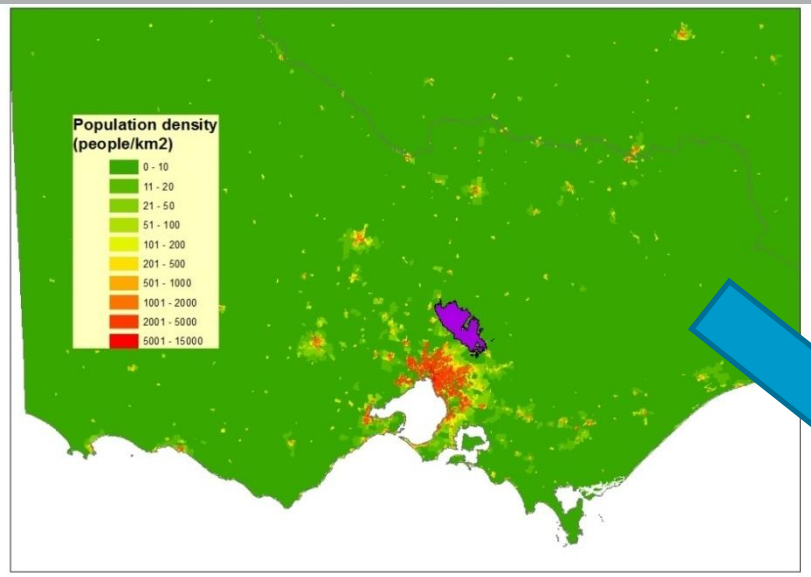


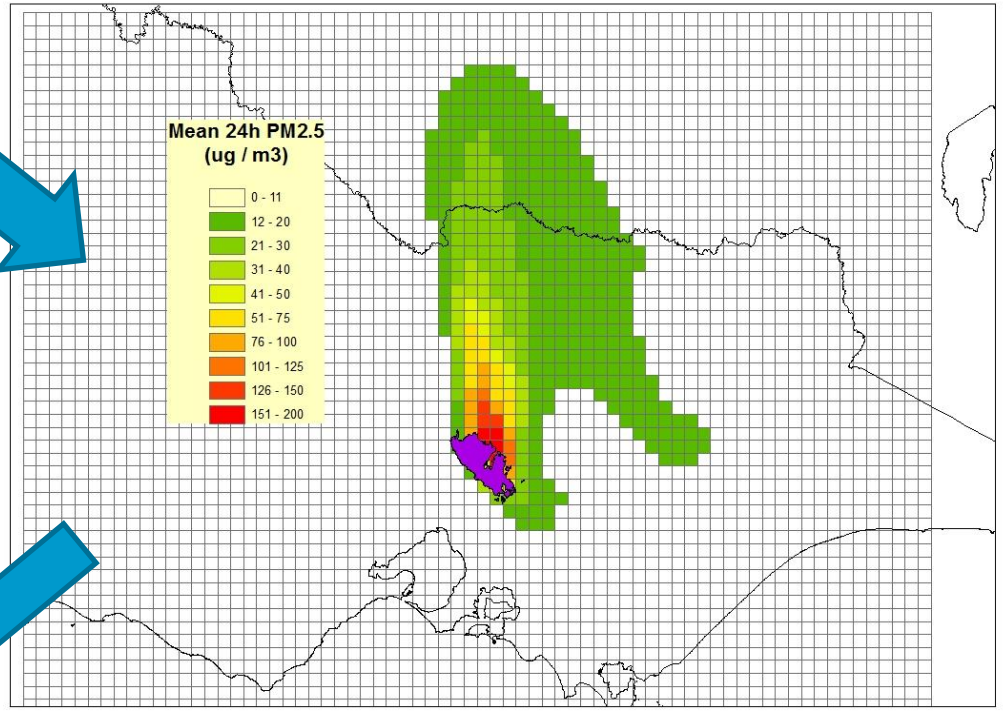
118 deaths

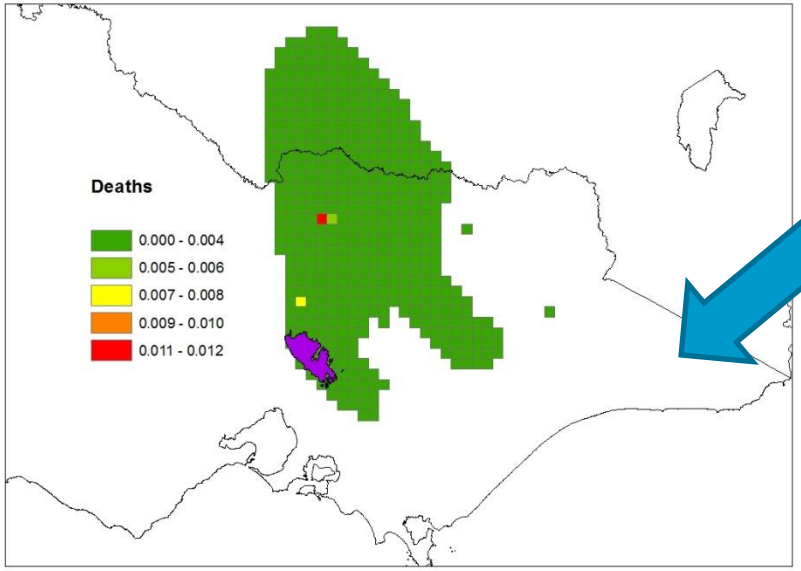
Case 2: Kilmore East



From emission to impact: Kilmore E







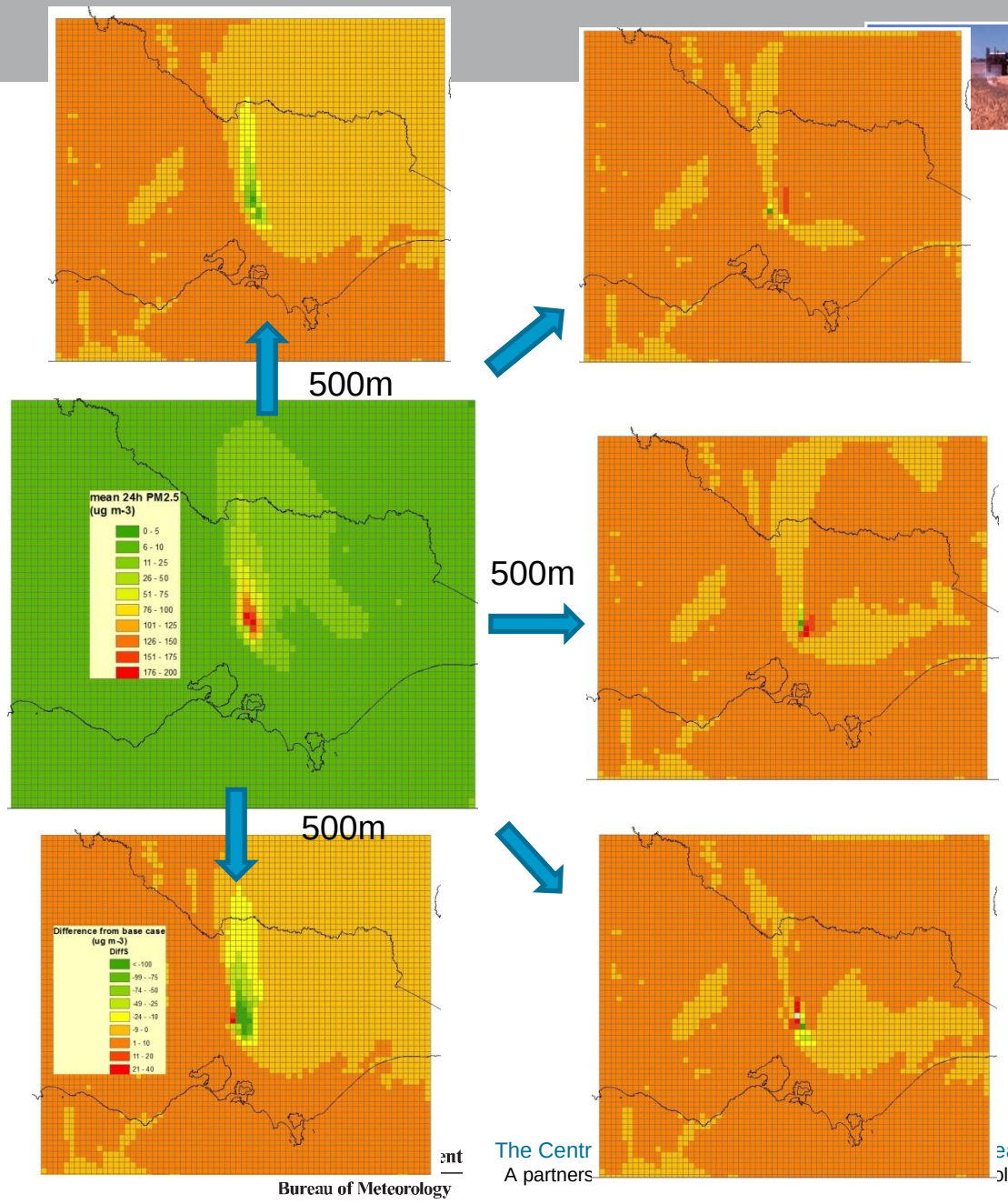
Duration:2 days
Impact: 0.1 deaths

Case 2: Kilmore East, Ensembles

What happens if the fire spread scenario changes?

The smoke dispersion also changes, sometimes substantially

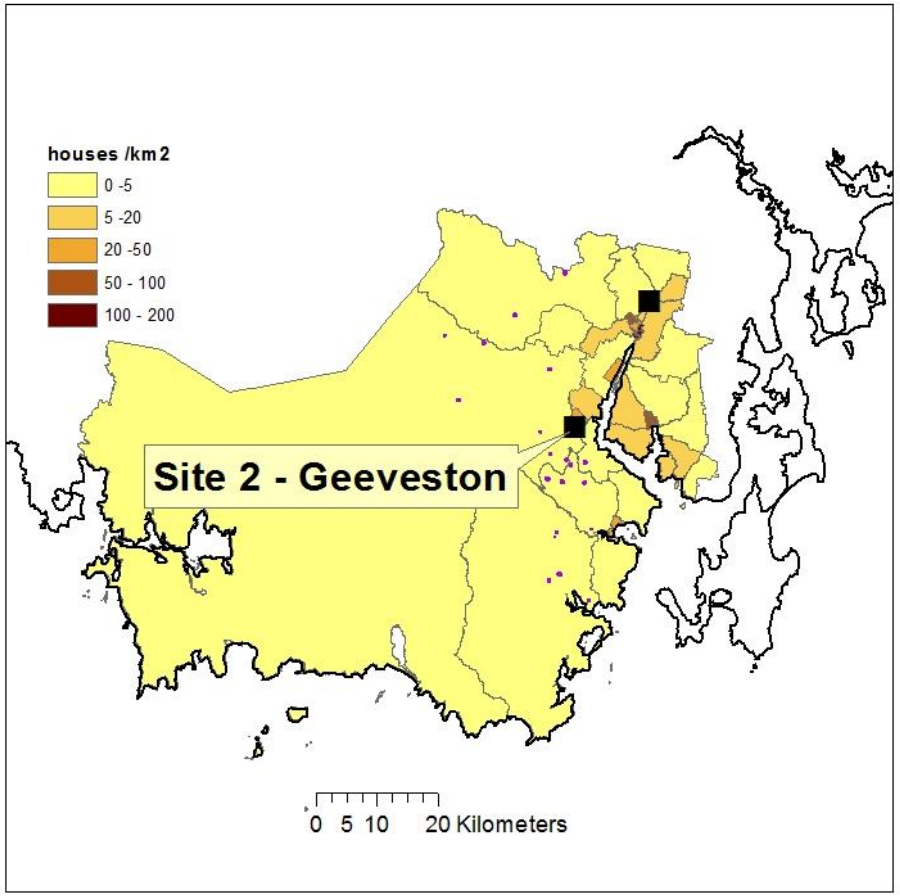
The ignition points of the fire were moved 500m from the base case scenario



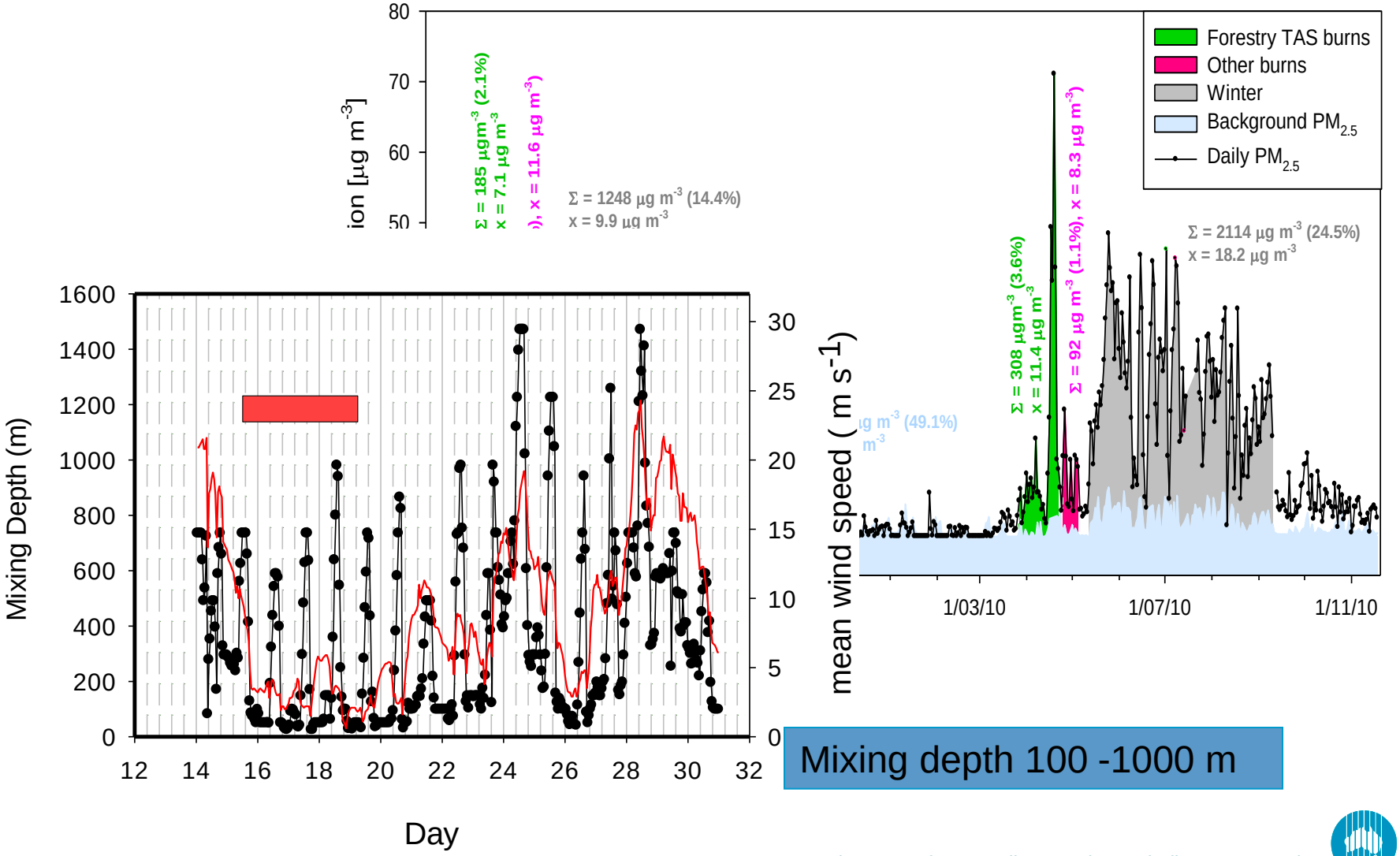
Ensembles?

- Further development required detailed sensitivity analyses of emissions and transport
- The transport scenarios are slow to run;
- Impact on exposure and health risk needs further investigation.
- Model/data fusion?

Case 3: Huon Valley regeneration burns

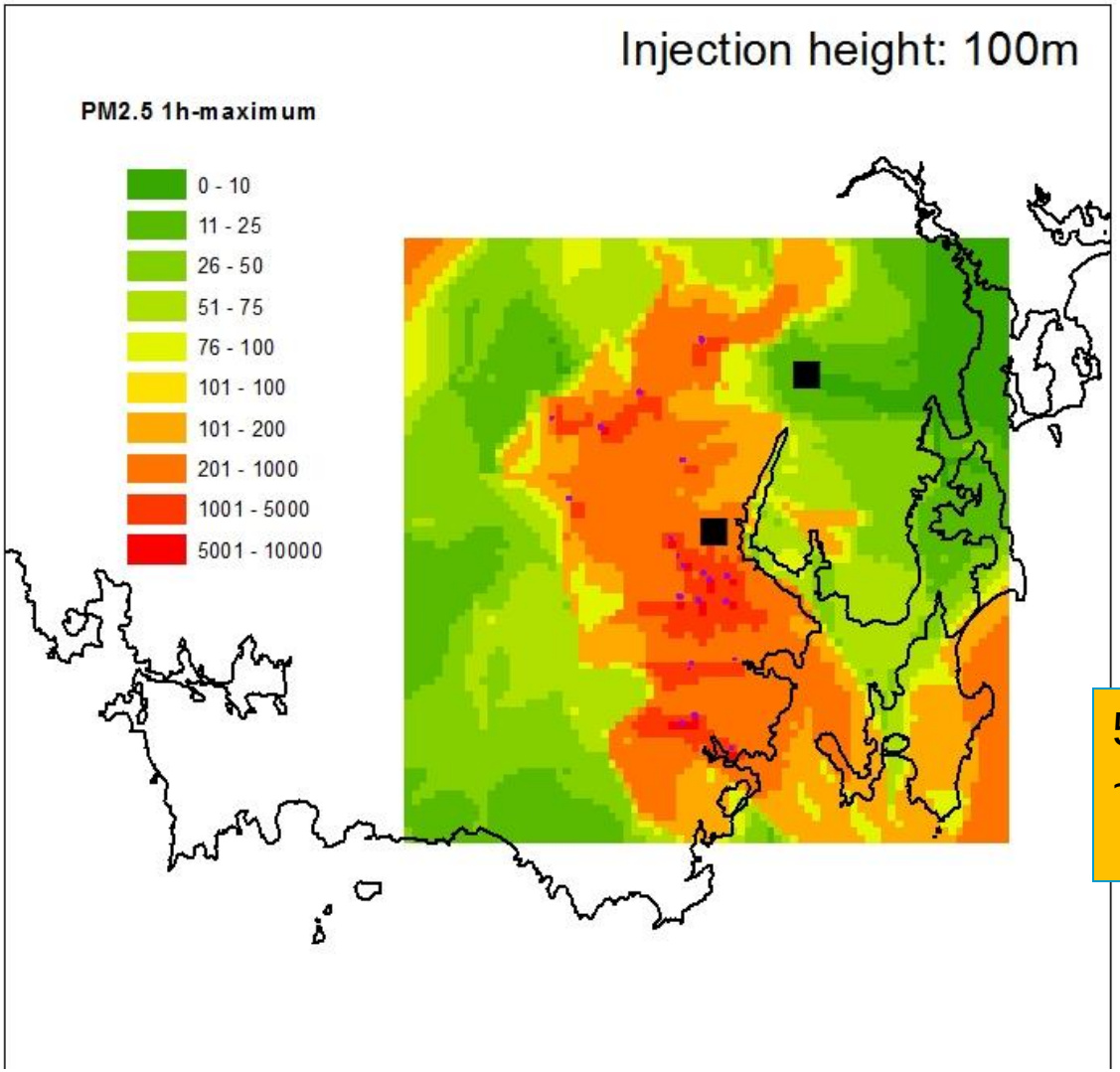


April 2010 event



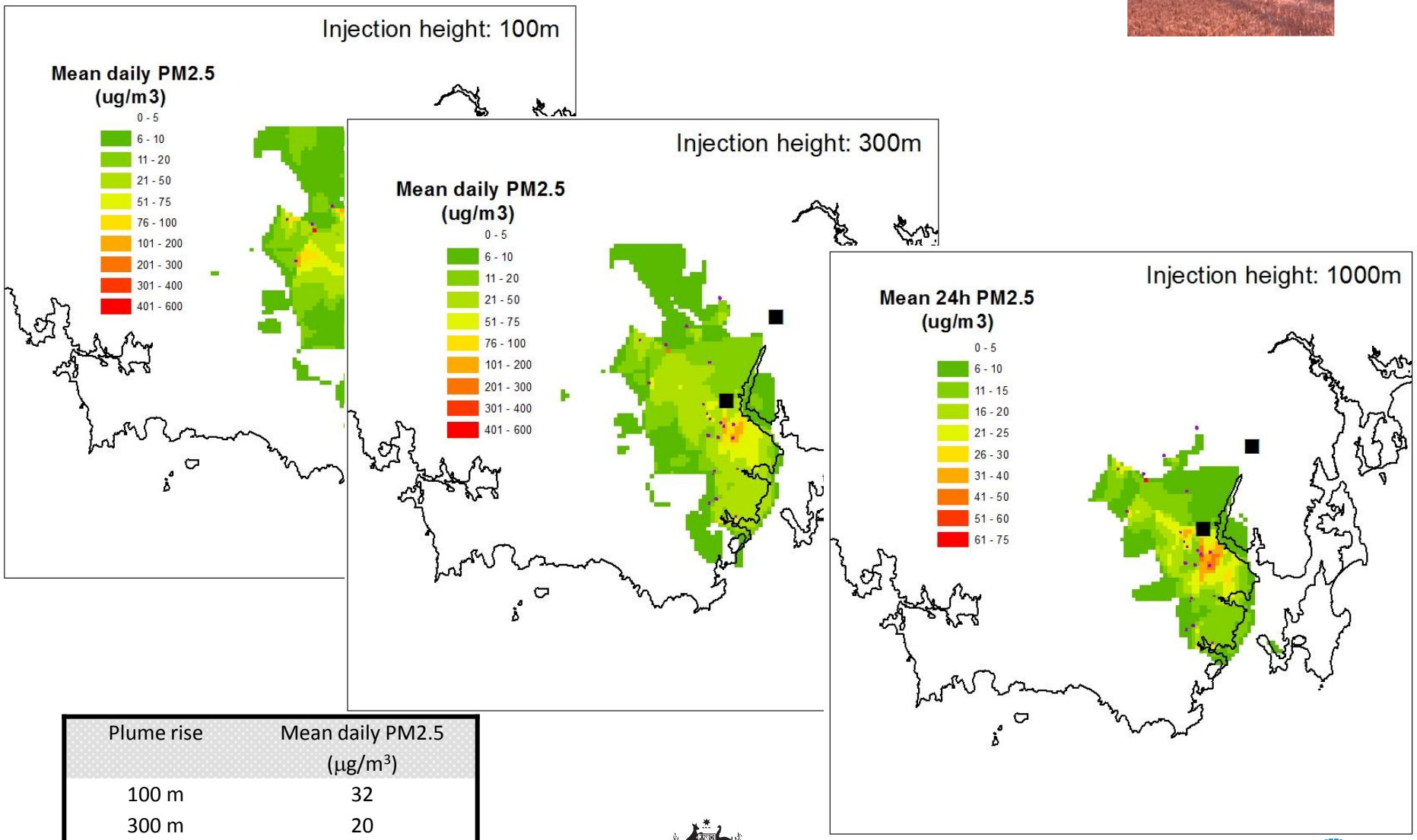
Mixing depth 100 -1000 m

Peak PM concentration: where the plume spread



500 ha burned
~ 25 kt C

Effect of mixing depth



Plume rise	Mean daily PM2.5 ($\mu g/m^3$)
100 m	32
300 m	20
1000 m	9.2

Some thoughts

These 3 case studies show the range of possibilities

- The biggest health impact was from a large, fire of long duration that produced protracted exposure of large population centres. The region health impact outweighed the risks at the fire ground

- A fast intense fire of short duration- most wildfires, have relatively small risk from the smoke. The impact is at night when the shrinking boundary laer brings smoke back the surface.

- Prescribed burning poses challenges for predicting smoke dispersion- very dependent on getting the plume rise characterised. As in Case 2, the impact depends on the conditions of the day.

Challenges: Implementing ensembles; data assimilation, emissions timecourses,