

# THE AUSTRALIAN AIR QUALITY FORECASTING SYSTEM - Lessons Learned and Looking Forward

[www.cawcr.gov.au](http://www.cawcr.gov.au)



**Martin Cope, Sunhee Lee,  
Alan Wain and Dale Hess**



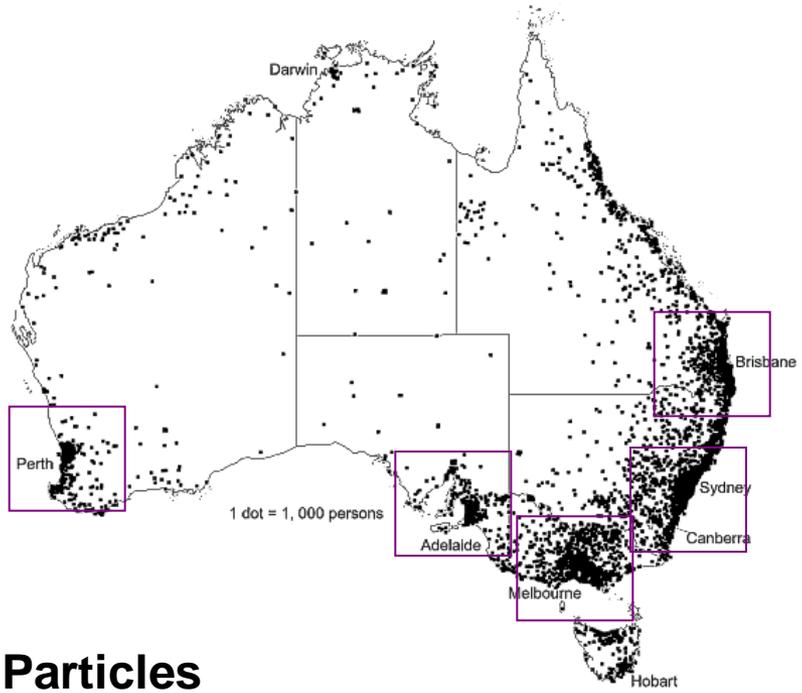
**Australian Government**  
Bureau of Meteorology

**November 2011**

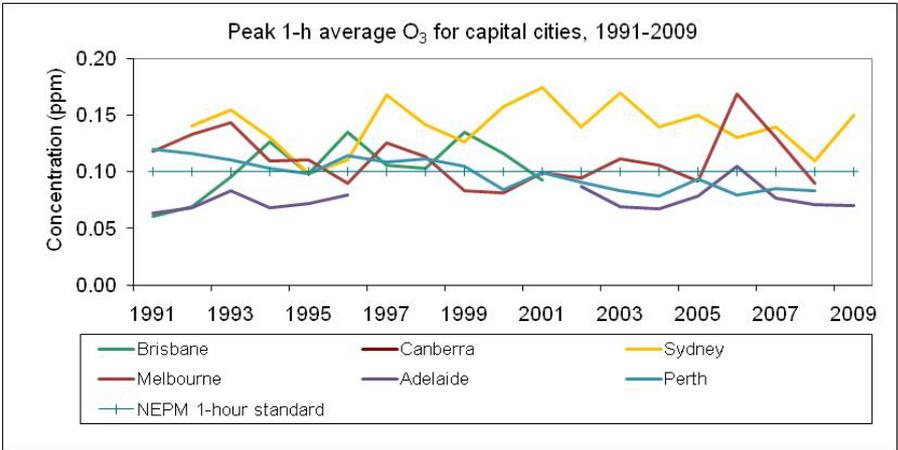
The Centre for Australian Weather and Climate Research  
A partnership between CSIRO and the Bureau of Meteorology



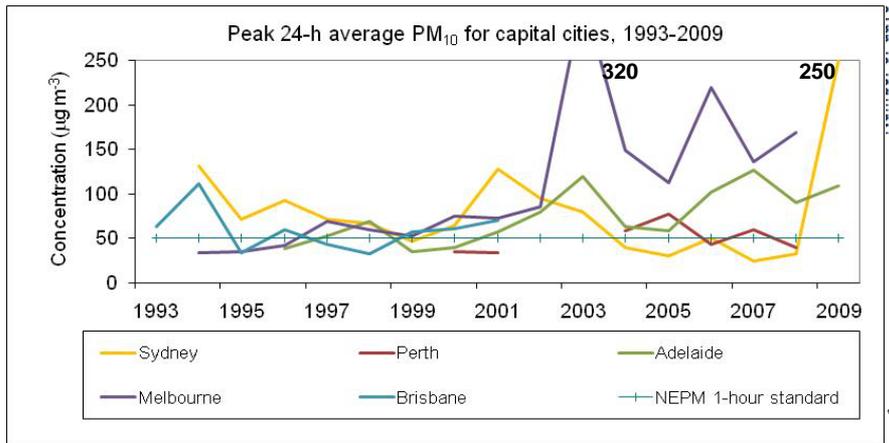
# Air Quality- Australian Coastal Airsheds



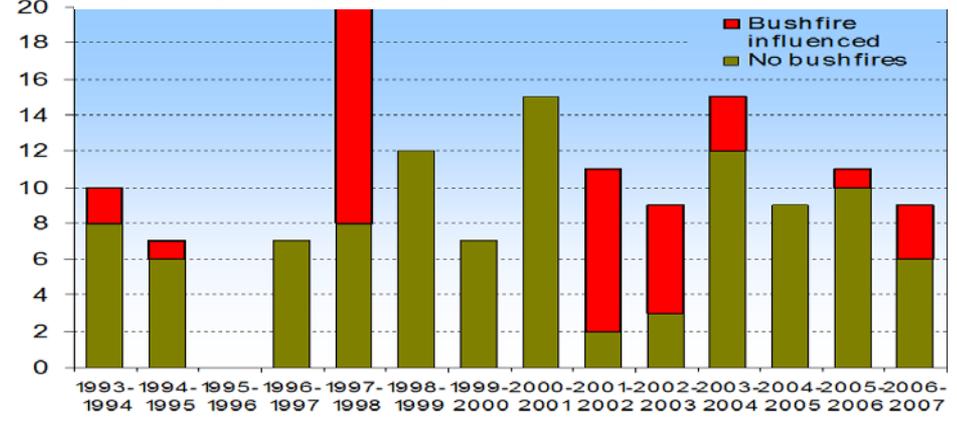
## Ozone



## Particles



## Sydney: Days per year 1-h O<sub>3</sub> > 0.1 ppm



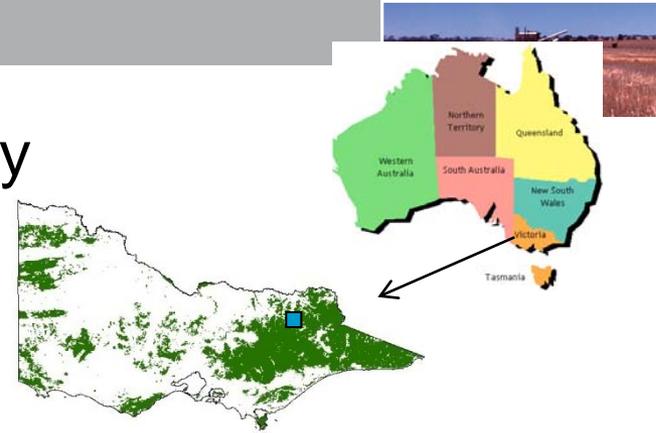
(DECC- Trends in air quality in New South Wales 1994-2006)



# Air Quality- Rural Cities

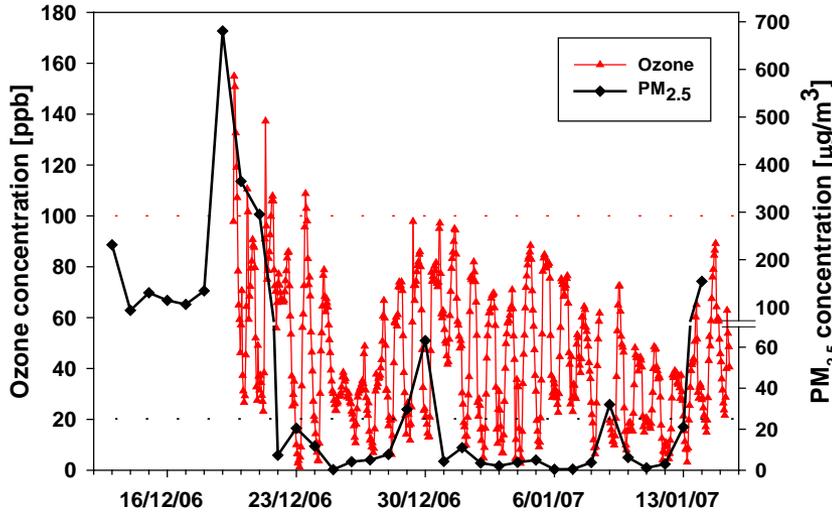


## A fire impacted rural site- Ovens Valley



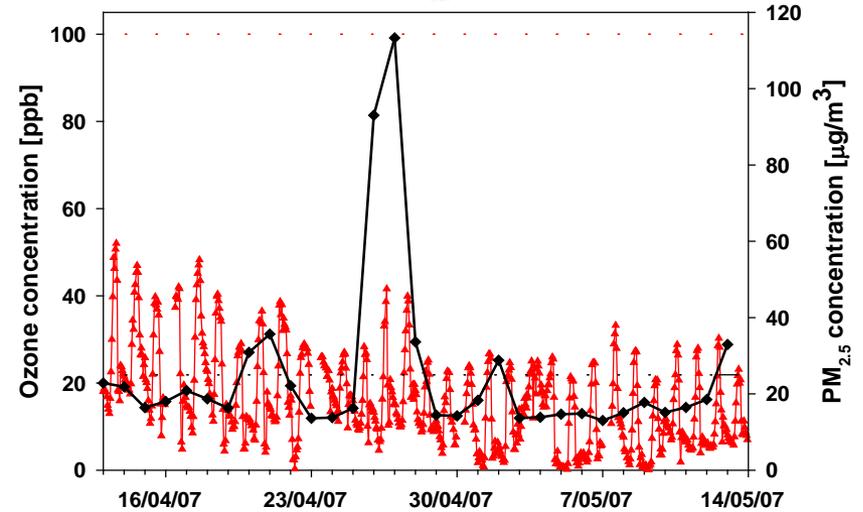
Daily PM<sub>2.5</sub> levels

Hourly O<sub>3</sub> levels



Wildfires 2006/2007

AAQS exceeded on 13 days



Prescribed burning

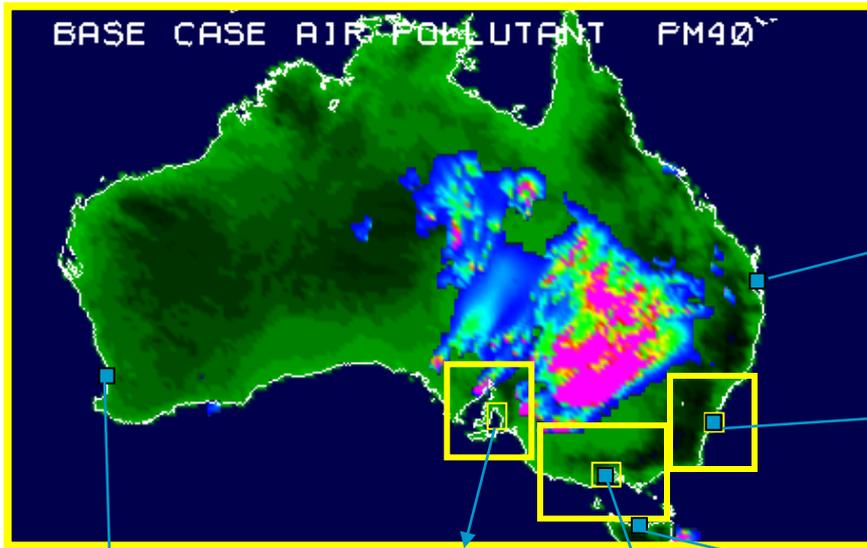
AAQS exceeded on 7 days



# Air Quality Forecasting Systems in Australia



AQ forecasts typically for 24 to 48 h



**AAQFS forecast domains**  
Dust, smoke, O<sub>3</sub>, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, AQI

**Expert System**  
Ozone, visibility  
(EPA->Bureau)

**Expert System**  
ozone, visibility  
(EPA)

**Statistical**  
PM<sub>10</sub>  
(Bureau)

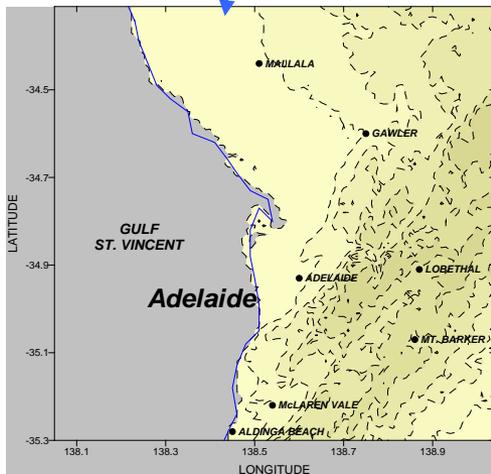
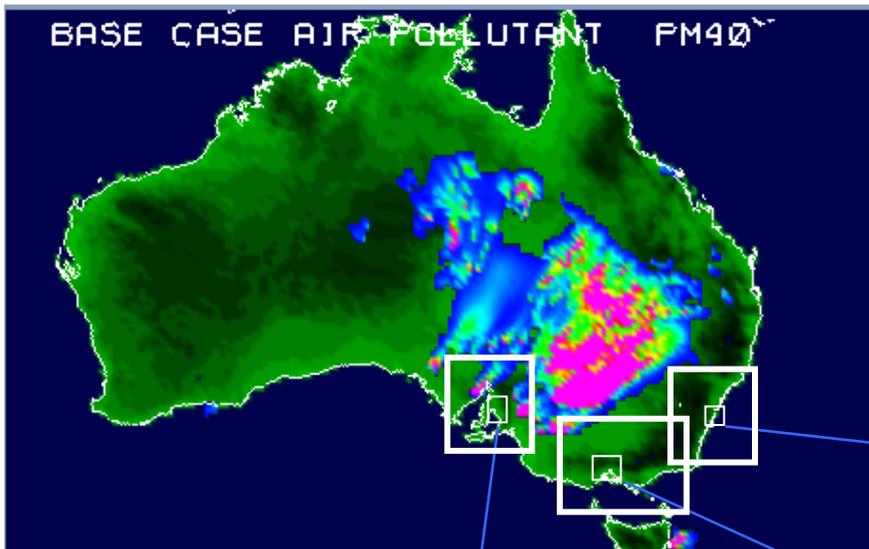
**CFS- smoke**  
(EPA)

**Haze-bot**  
Winter wood smoke  
Low visibility  
(EPA-> Bureau)

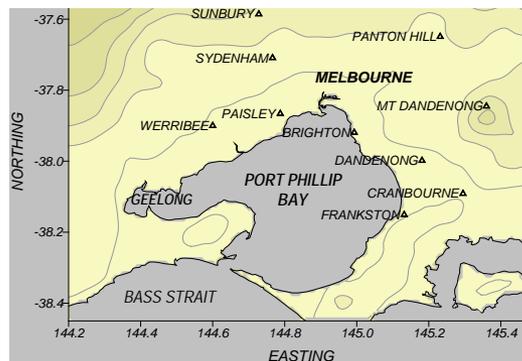
**Expert System**  
Ozone, visibility  
**Heuristic + Bureau**  
Smoke  
(EPA)

# Australian Air Quality Forecasting System

(Set up for the Sydney 2000 Olympics)



Regional and urban grids  
-NWP meso\_LAPS (0.05°)  
-CTM (0.05 and 0.01°);  
-gas-phase primary and photochemical smog species;  
- aerosol species include dust, sea salt, primary aerosols (domestic wood combustion, motor vehicle) + secondary (simple) inorganic.  
-24-36 hour forecasts issued twice per day



Australian Government

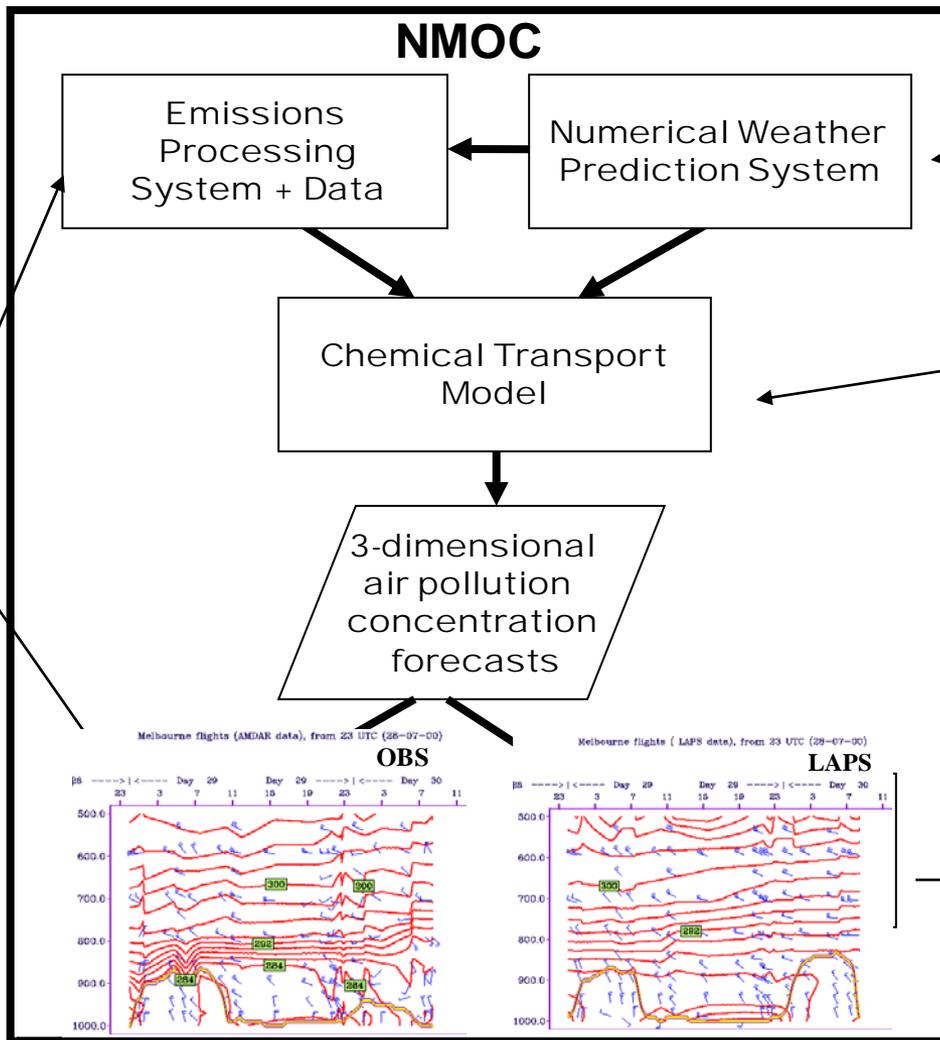
Bureau of Meteorology

<http://www.dar.csiro.au/information/aaqfs.html>



CSIRO

# Australian Air Quality Forecasting System



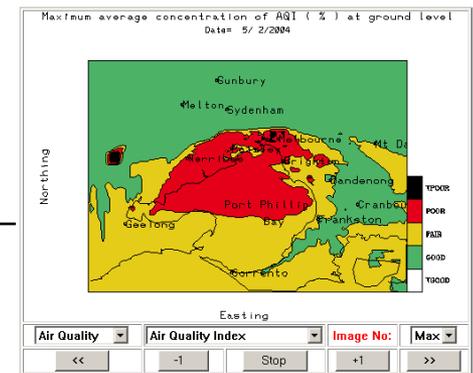
Provided by the State Environment Departments

Bureau of Meteorology

CSIRO

00 UTC and 12 UTC forecasts

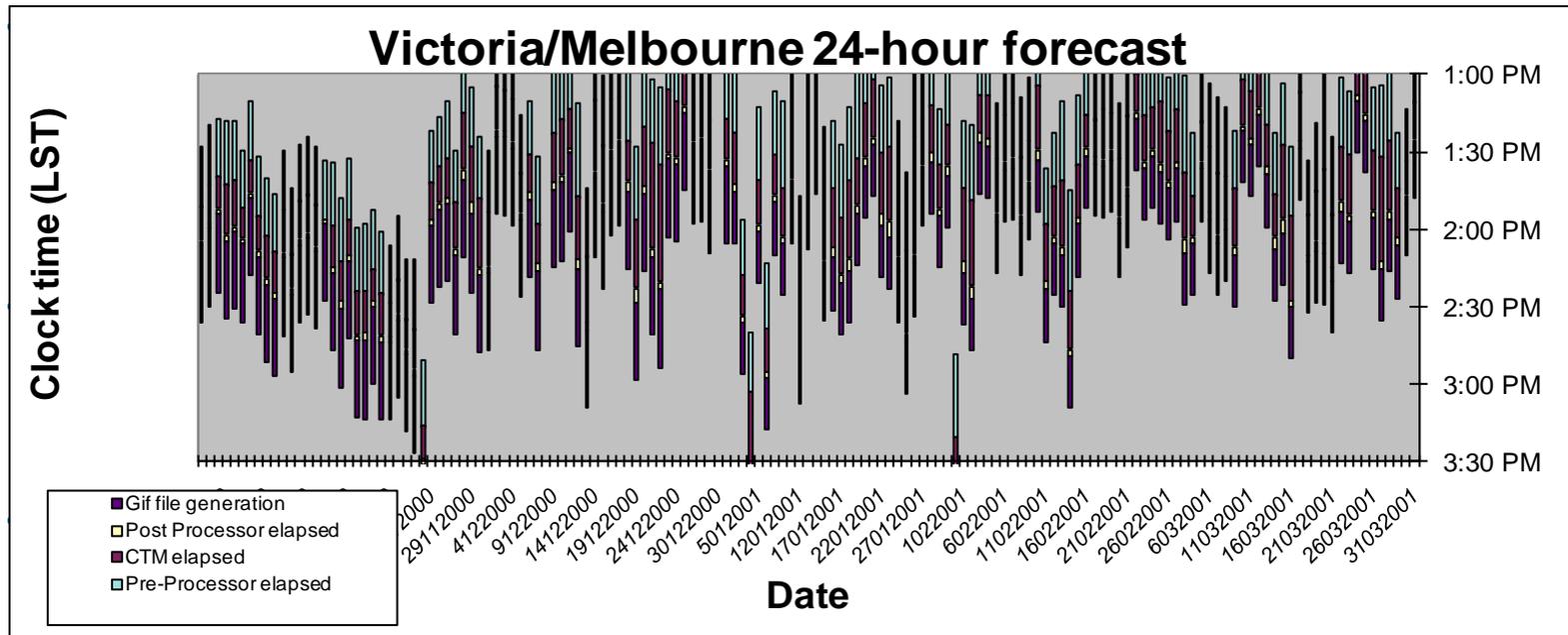
Today's forecast-Melbourne



# AAQFS processes



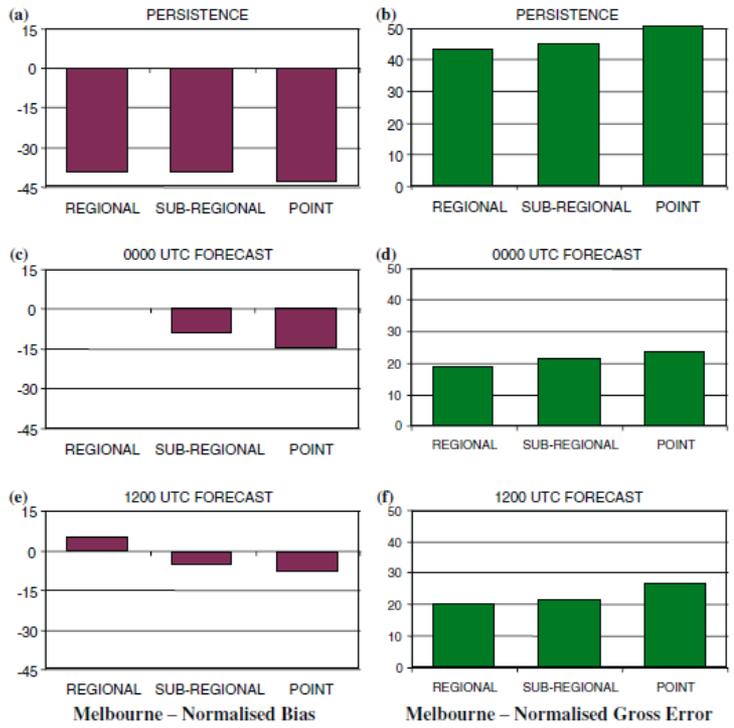
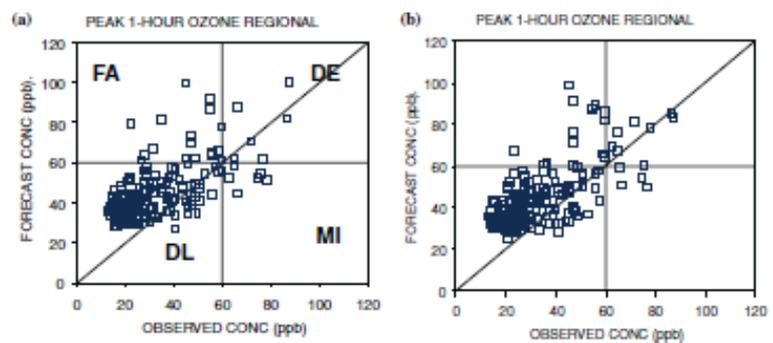
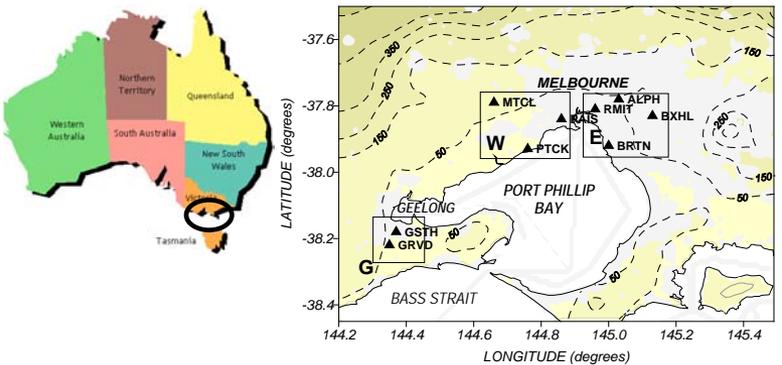
- Offline chemical transport. Clean- or warm-start initial conditions for the CTM



- Single moment, multi-section, multi-component aerosol scheme.

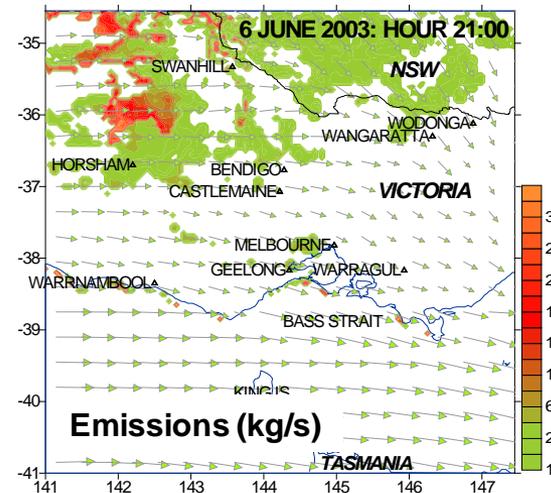
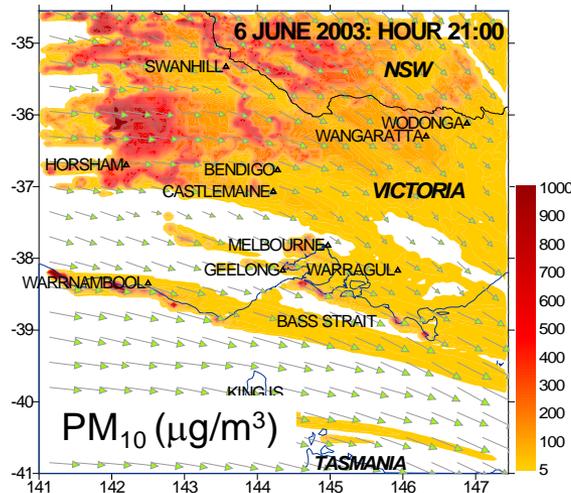
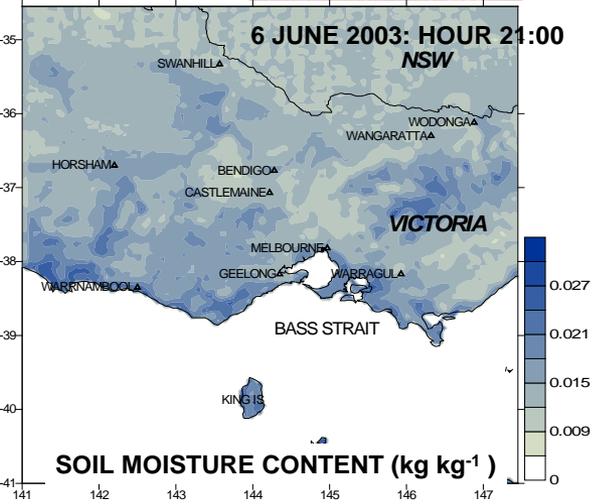
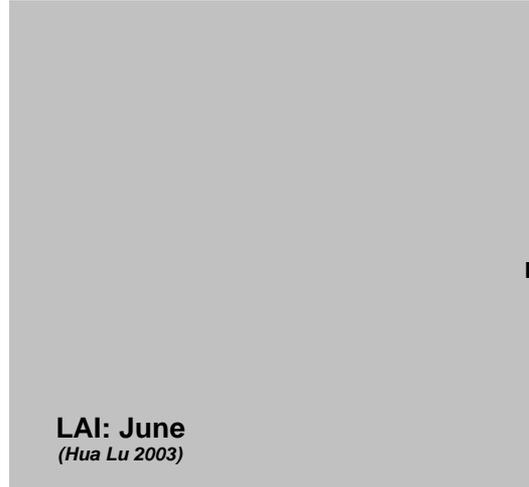
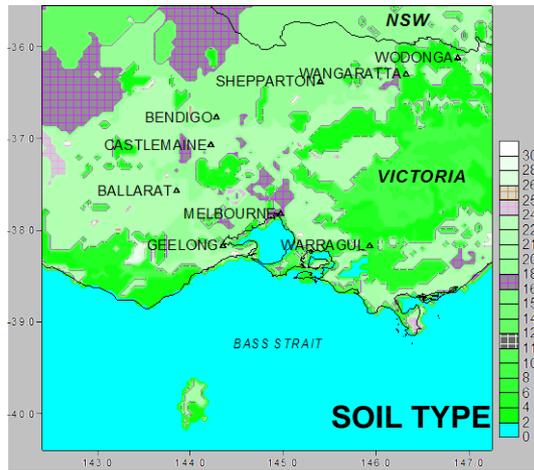


# Ozone forecasting



<b>POD</b>	<b>Melbourne</b>
	60 ppb
Persistence	
Regional	0.13
Sub-regional	0.12
Point	0.13
1200 UTC	
Regional	0.73
Sub-regional	0.33
Point	0.23

# Dust Forecasting



Lu, H. and Y. Shao dust scheme



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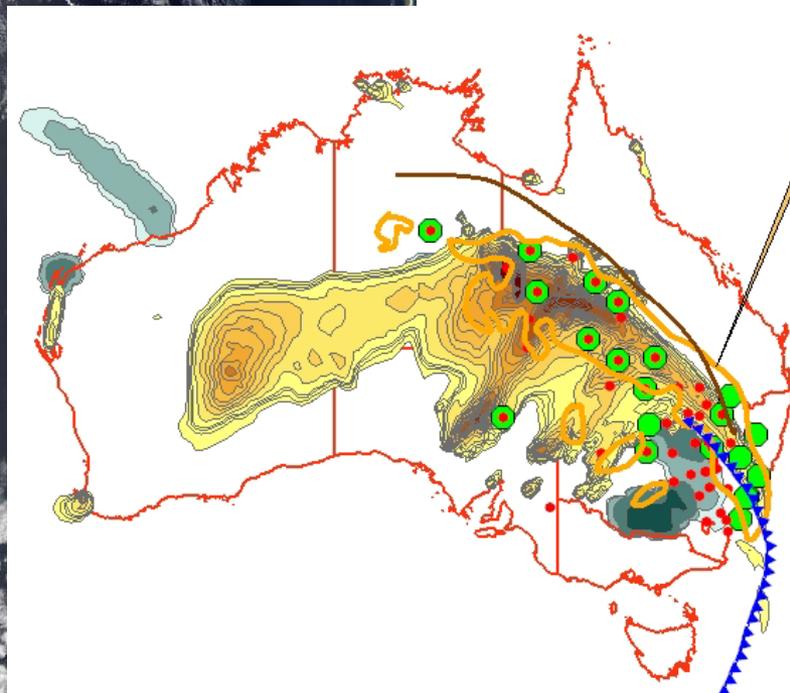
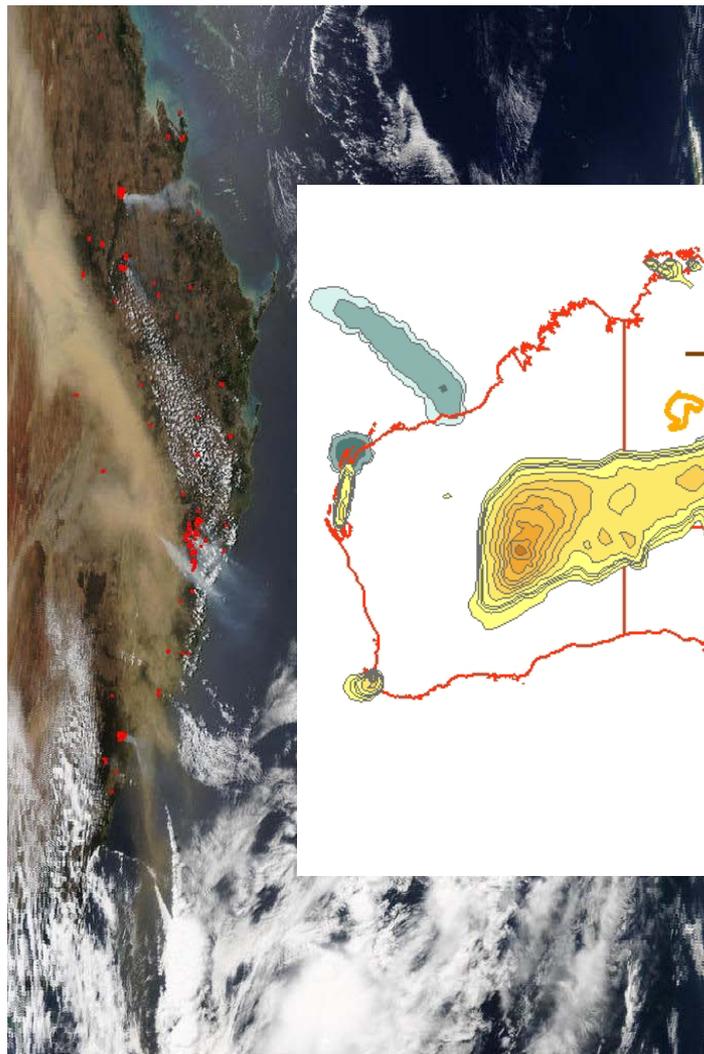


CSIRO

# Dust Forecasting



## Verification through analysis of extreme events



Extent of Dust visible in Satellite Image

10:00 EST October 23<sup>rd</sup> 2002

Nov-Jan 2006	d_fac 0.5 (Op)	d_fac 0.75
forecast	4	4
missed	1	1
false alarm	4	1

<http://rapidfire.sci.gsfc.nasa.gov/>

Wain et al.



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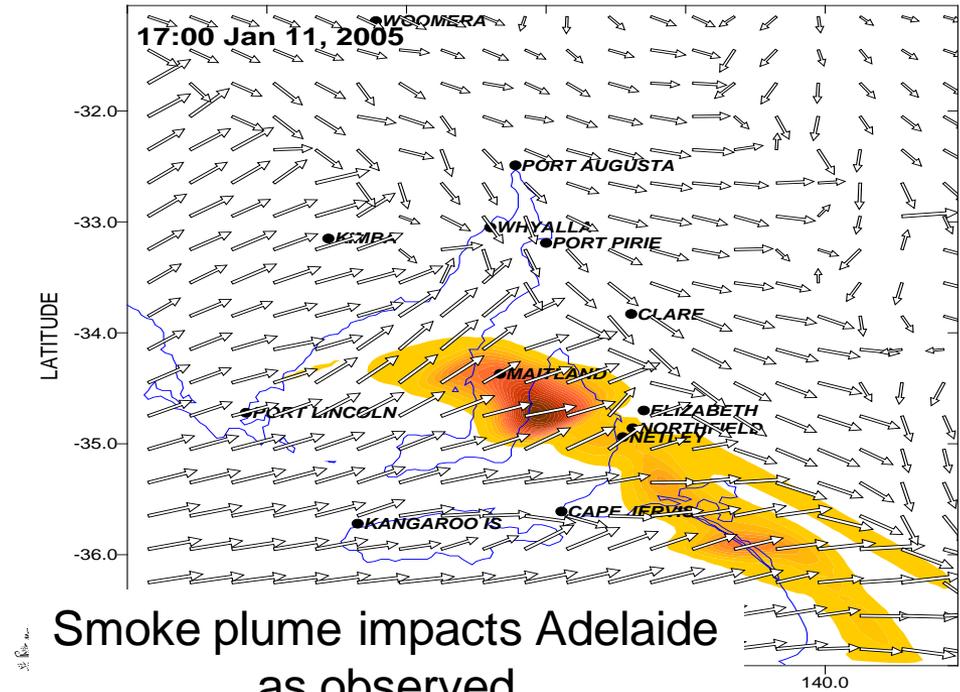
[http://www.dar.csiro.au/pollution/docs/AWain\\_files/frame.htm](http://www.dar.csiro.au/pollution/docs/AWain_files/frame.htm)



# Smoke Plume Envelope Forecasting



- Retrieve automated hotspot locations via satellite images
- Process the data to determine fire locations
- Initiate qualitative emissions at source locations and compute transport and dispersion as a passive scalar



Smoke plume impacts Adelaide as observed

# AAQFS- lessons learned



## SCIENCE

- Ozone (non-fire), large dust storms and fires are forecast reasonably well.
- Urban particles are not well predicted.
  - 0.05° NWP meteorology is above urban scale; and the nocturnal pbl is poorly represented.
  - Air emissions inventories for particles were problematic (but have since improved).
- Smoke is modelled as a tracer, hence no coupling between smoke and ozone/secondary particles.
- Dust forecasting relies on some climatological data (not good for droughts)



# AAQFS- lessons learned



## LOGISTICAL

- Inventories are not readily updated by the EPAs
- Little on-going support in-house to maintain the system and address science and logistical problems
- Little on-going support to promote AQ forecasting to external stakeholders



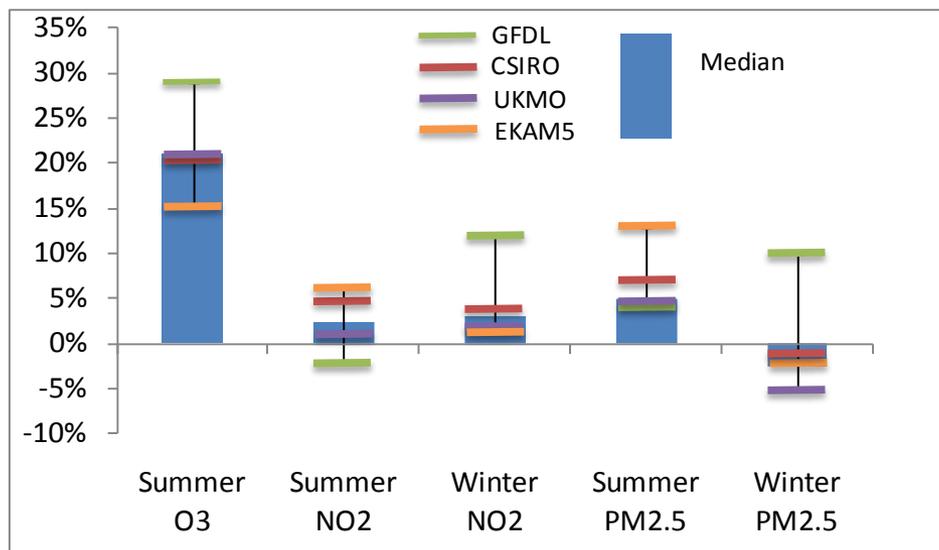
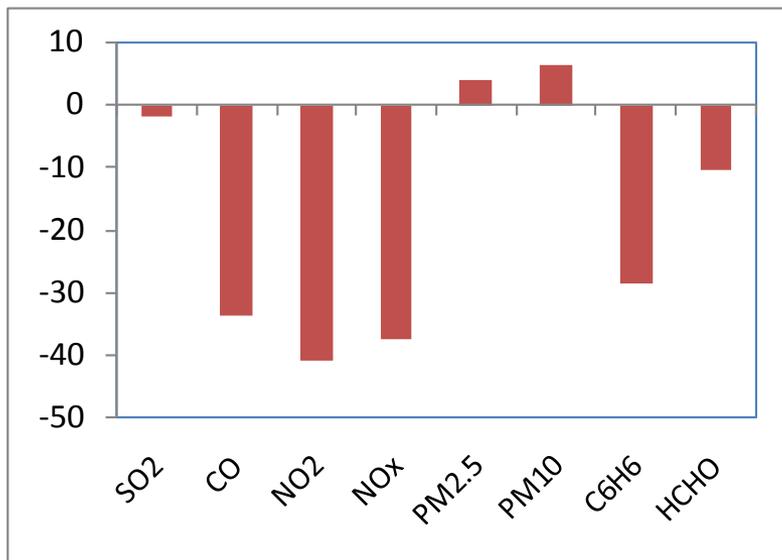
# LOOKING FORWARD



Melbourne, Victoria, population 4 million.  
 - projected to increase by 20% in 2030

**Emission Changes 2030-2006 (%)**

**Population Exposure Change 2070-2006 (%)**

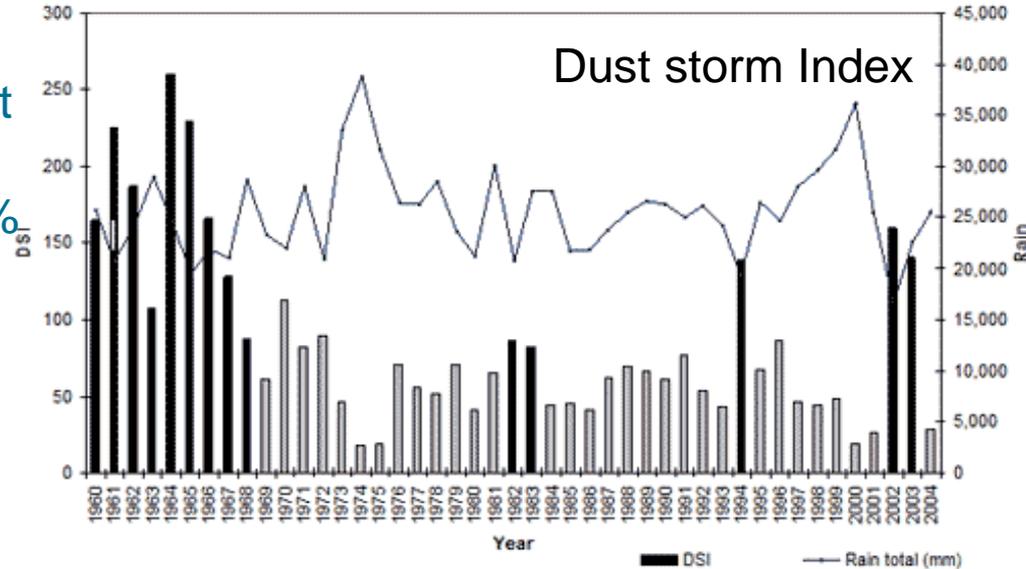
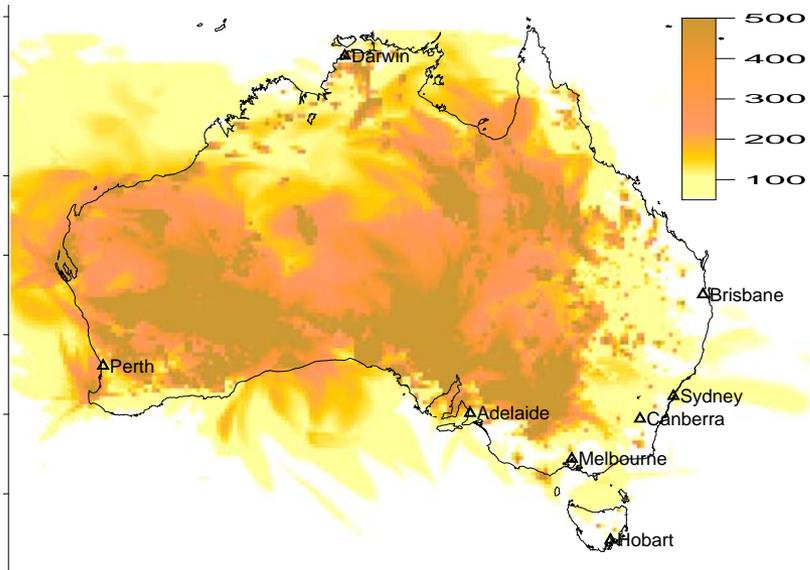


# Wind blown dust



The frequency of drought is projected to increase by up to 20% by 2020 over most of Australia. By 2070, drought frequency increases of 20-80% in the south, 20-40% in Qld and 0-20% elsewhere (except central WA) are projected.

## Forecast peak 24-h PM10 2004-2008



(G.H. McTainsh, J.F. Leys and E.K. Tews 2006)

**“Desert Dust. An Unrecognized Source of Dangerous Air Pollution?”**

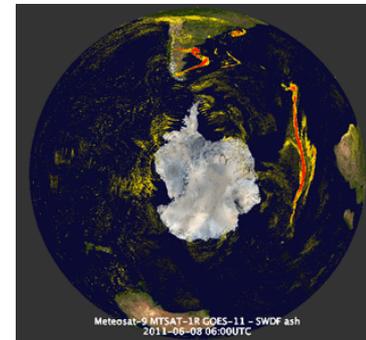
**Thomas Sandstrom and Bertil Forsberg  
(Epidemiology 2008;19: 808–809)**



# Australian AQ forecasting- looking forward



- Focus on improving our forecasting capability for dust and smoke
  - Large scale impacts, likely to increase under a warming trend;
  - Significant local-regional scale impacts of extended planned burning season
    - Particles and photochemical smog
  - No coherent forecasting methodology currently used in Australia;
  - Multiple stakeholders, federal to local government + industry (DEWHA; jurisdictions, landuse managers, energy (e.g. solar), agriculture (e.g. grape growing), aviation.
- Volcanic ash forecasting for aviation





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