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

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Martin Cope, Sunhee Lee,
Alan Wain and Dale Hess

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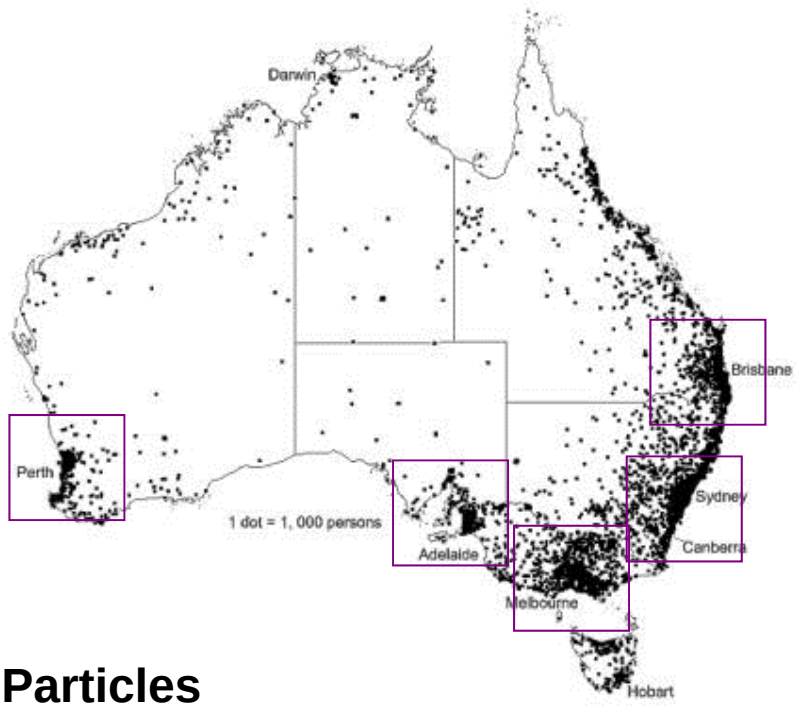
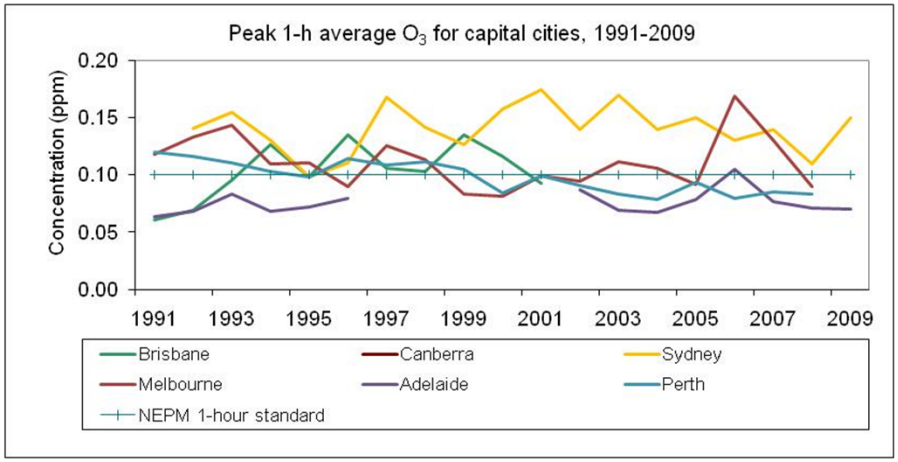
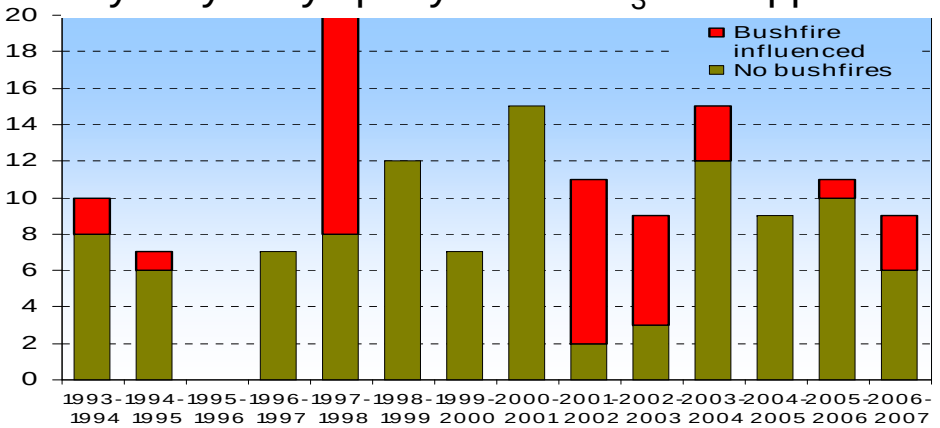
Air Quality- Australian Coastal Airsheds



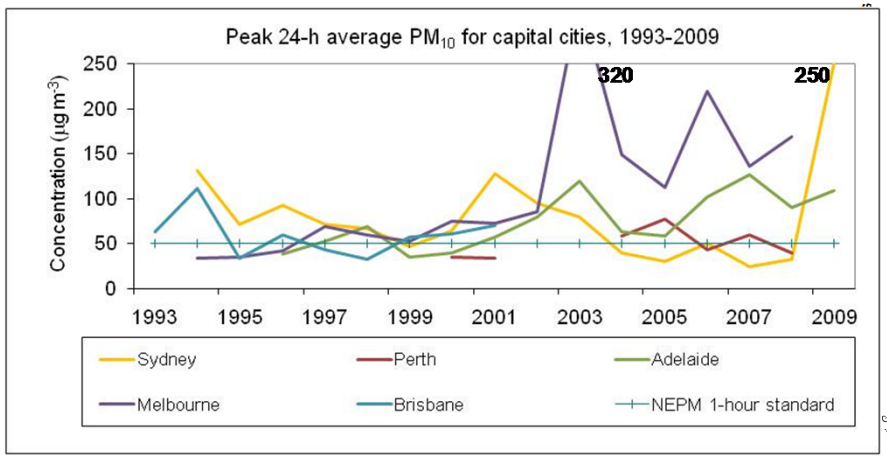
Ozone



Sydney: Days per year 1-h O_3 > 0.1 ppm



Particles



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

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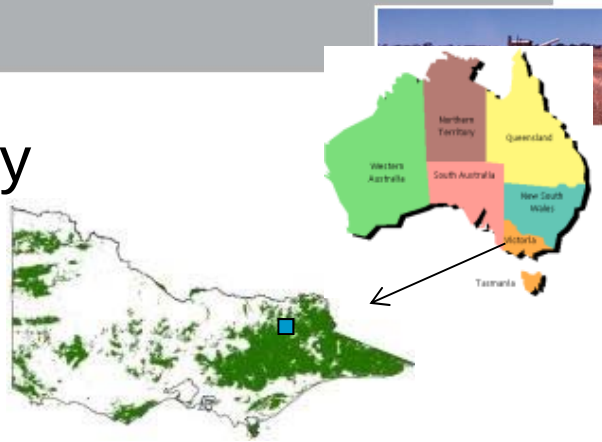
Sydney 2009 Sept dust storm at Sunrise

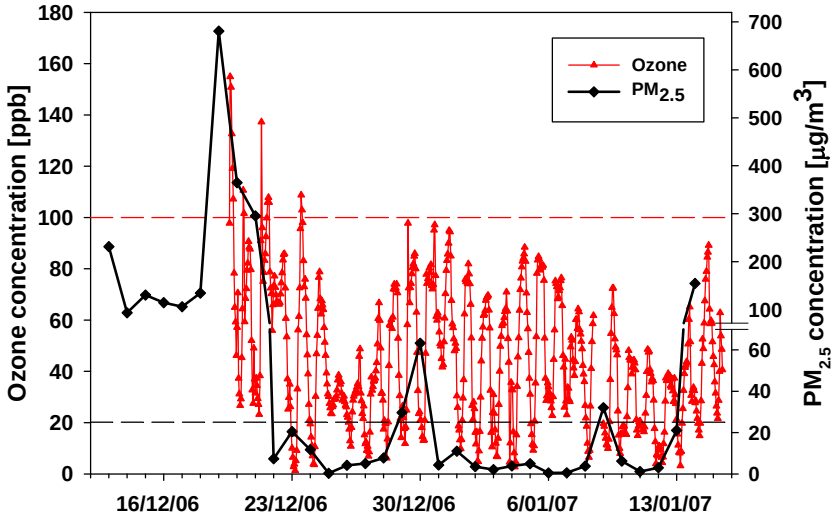
Air Quality- Rural Cities

A fire impacted rural site- Ovens Valley



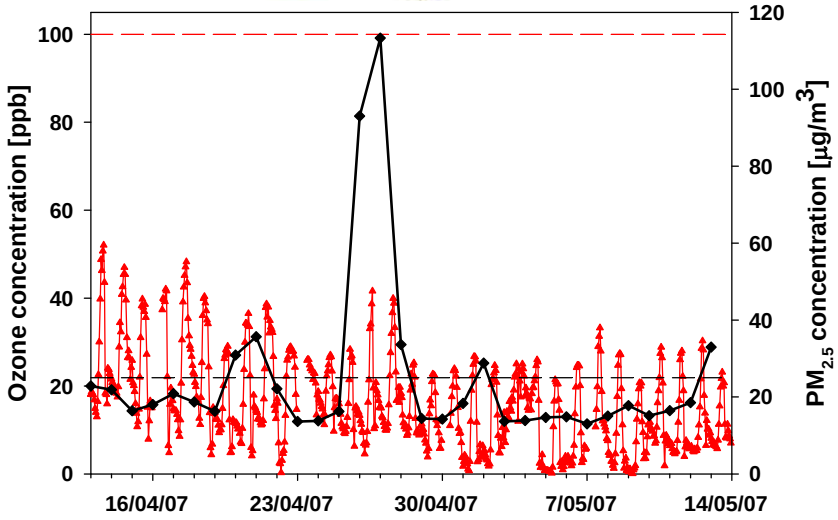
Daily PM2.5 levels

Hourly O_3 levels



Wildfires 2006/2007

AAQS-PM exceeded for 13 days



Prescribed burning

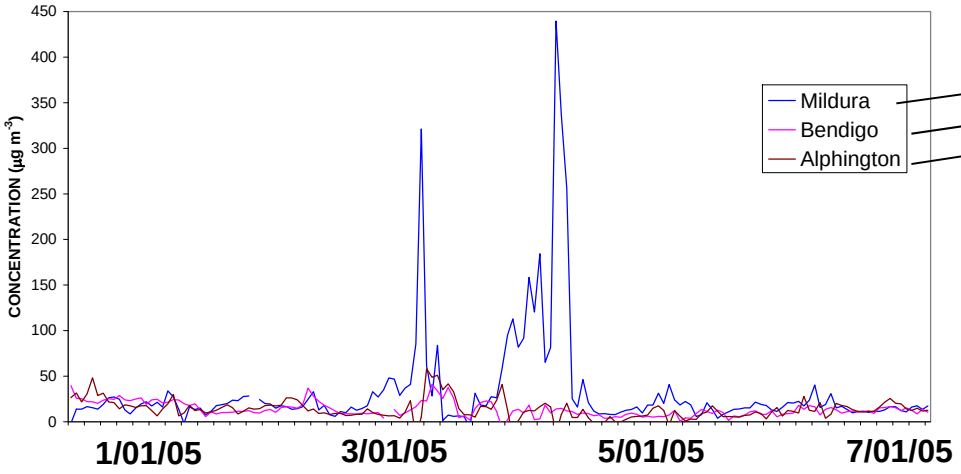
AAQS-PM exceeded for 7 days

Air Quality- Rural Cities

A dust impacted rural site- Mildura

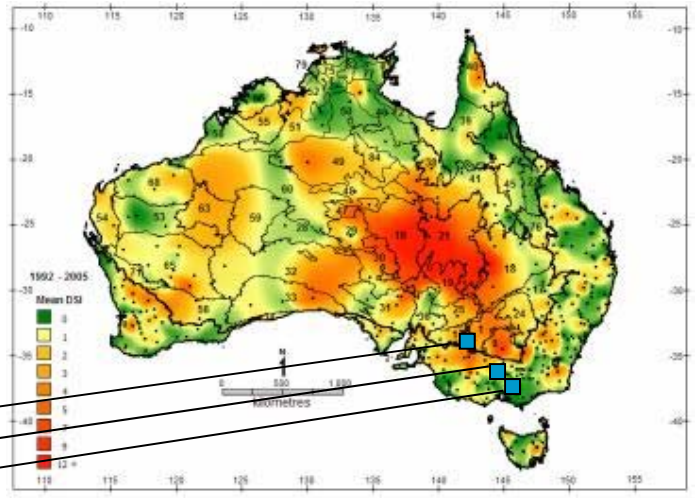
- Many of the largest dust impacts (frequency and magnitude) are experienced by rural cities.

PM_{10} (hourly average)



(Data- EPA Victoria)

(DSI- dust storm index)



Map of mean DSI for the period 1992 to 2005

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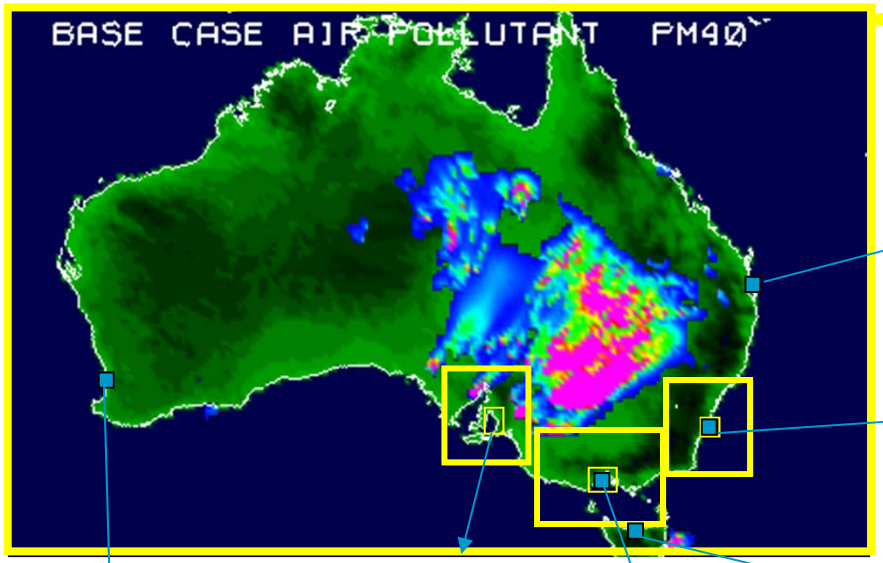
Air Quality Forecasting Systems in Australia

AQ forecasts typically for 24 to 36 h



AAQFS forecast domains

Dust, smoke, O_3, NO_2, PM_{10},$PM_{2.5}$, AQI

Expert System
Ozone, visibility
(EPA->Bureau)

Expert System
ozone, visibility
(EPA)

CFS- smoke
(EPA)

Statistical
PM_{10}
(Bureau)

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

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

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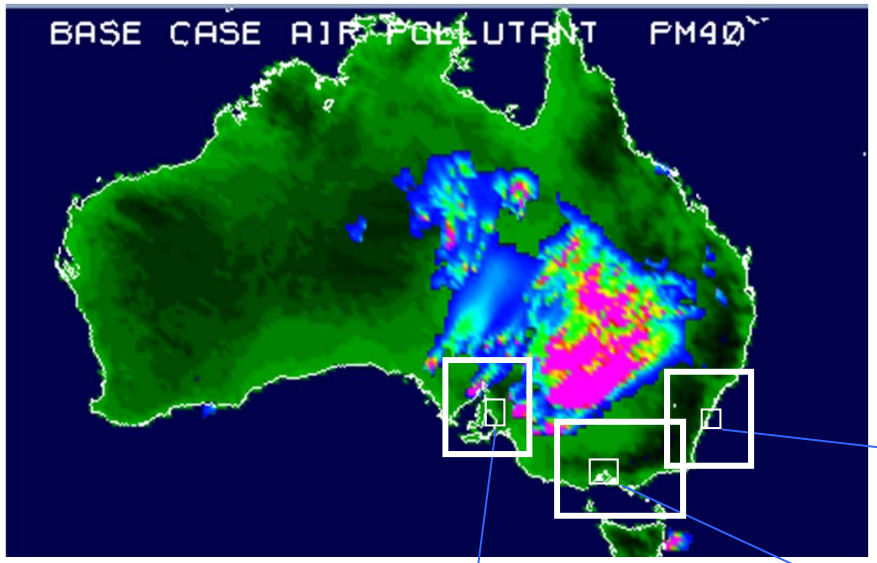
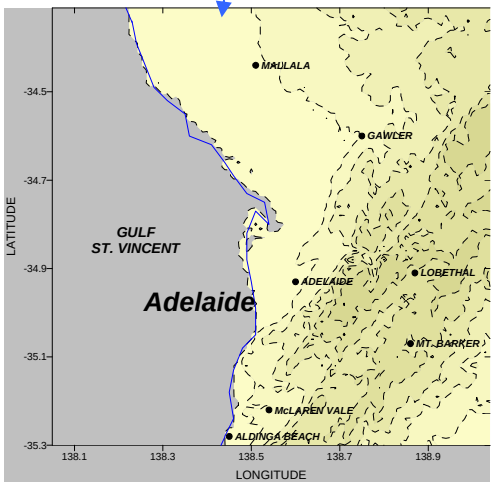
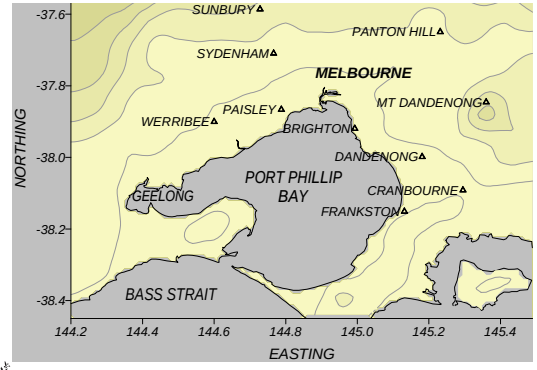
Australian Air Quality Forecasting System

(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



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http://www.dar.csiro.au/information/aagfs.html

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Australian Air Quality Forecasting System

NMOC

Emissions Processing System + Data

Numerical Weather Prediction System

Chemical Transport Model

3-dimensional air pollution concentration forecasts

Verification System + AQ data

Web + Graphical Display Systems

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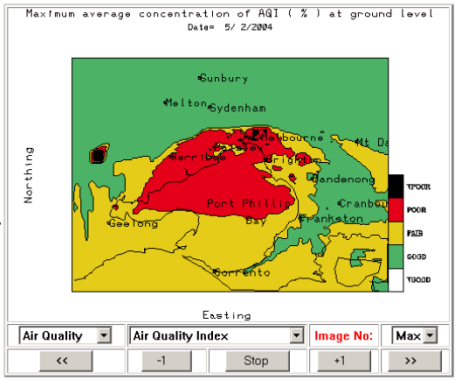
Provided by the State Environment Departments

00 UTC and 12 UTC forecasts

Today's forecast-Melbourne



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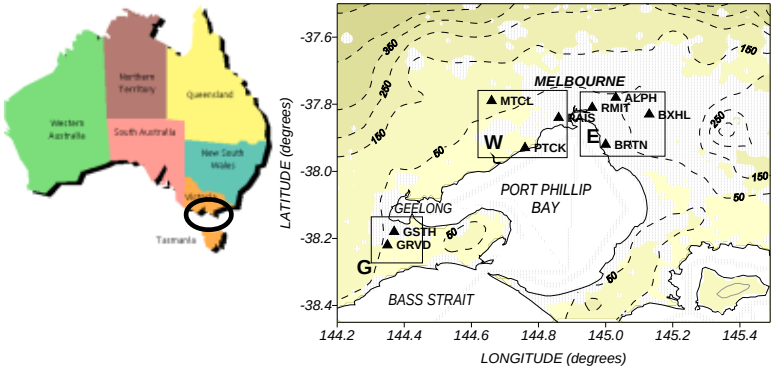
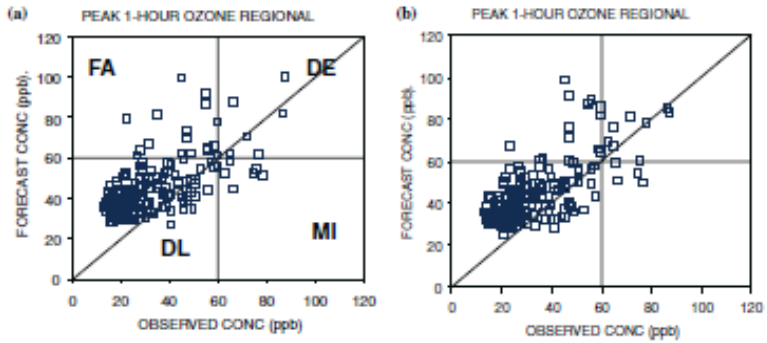
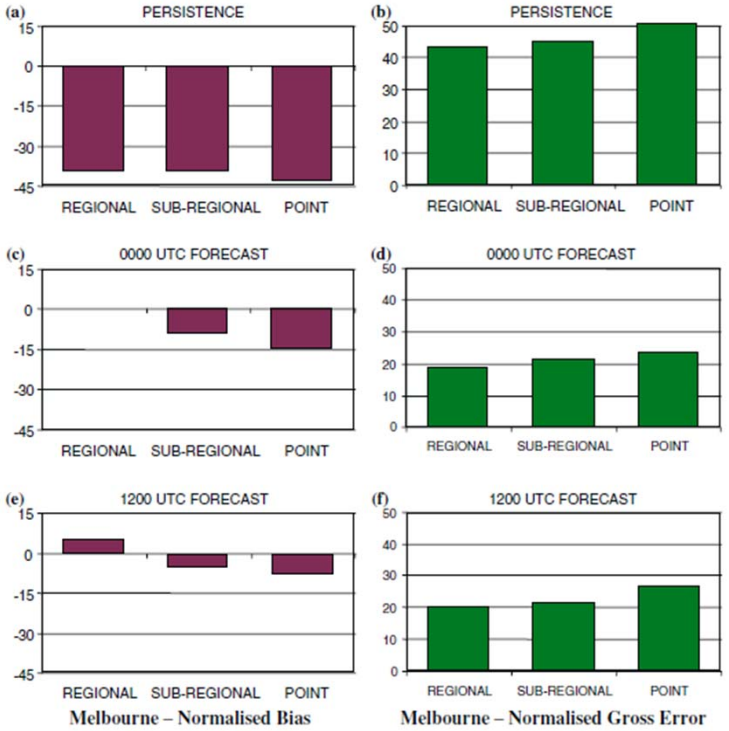
Ozone forecasting





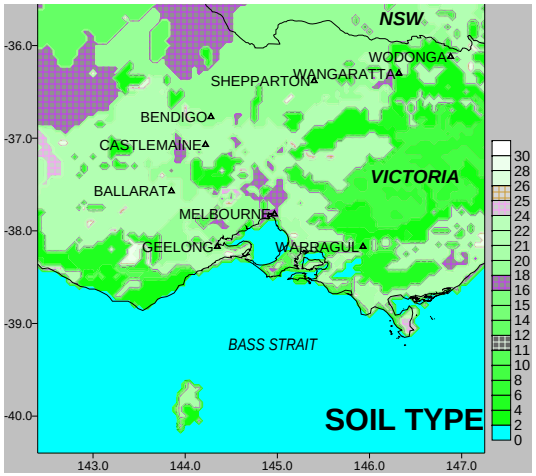


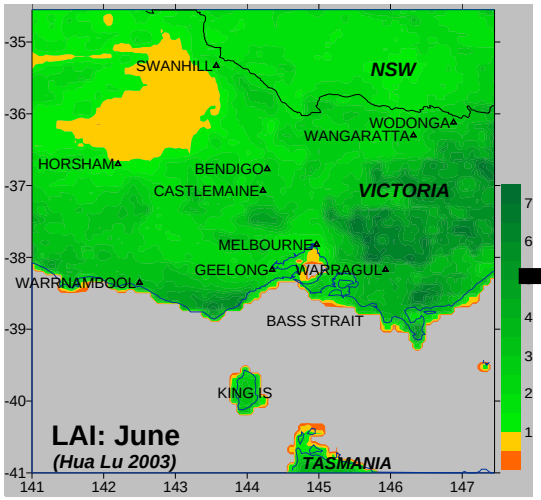
Melbourne – Normalised Bias

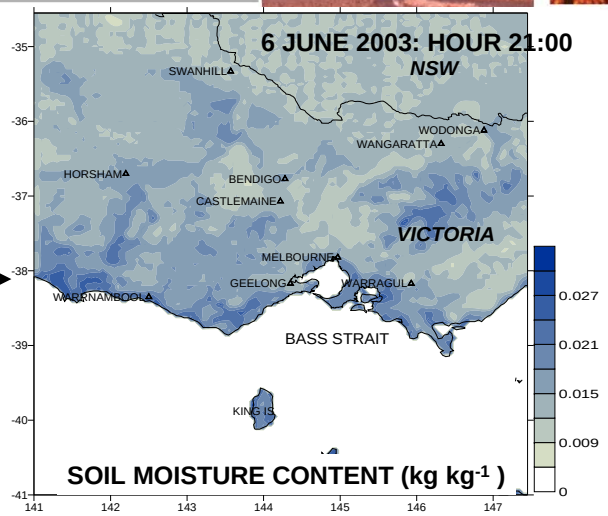
Melbourne – Normalised Gross Error

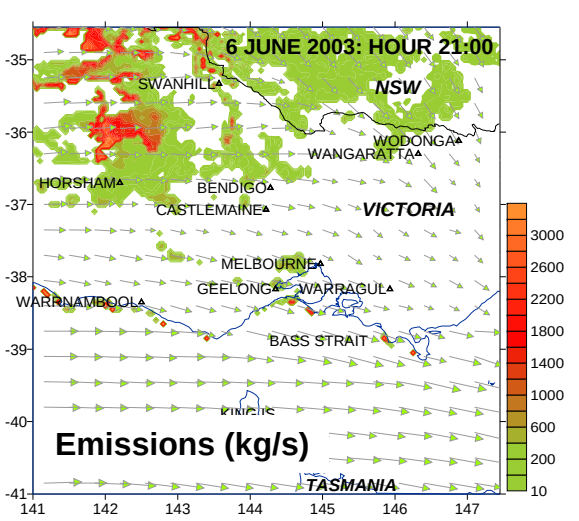
POD	Melbourne
	60 ppb
Persistence	
Regional	0.13
Sub-regional	0.12
Point	0.13
1200 UTC	
Regional	0.73
Sub-regional	0.33
Point	0.23

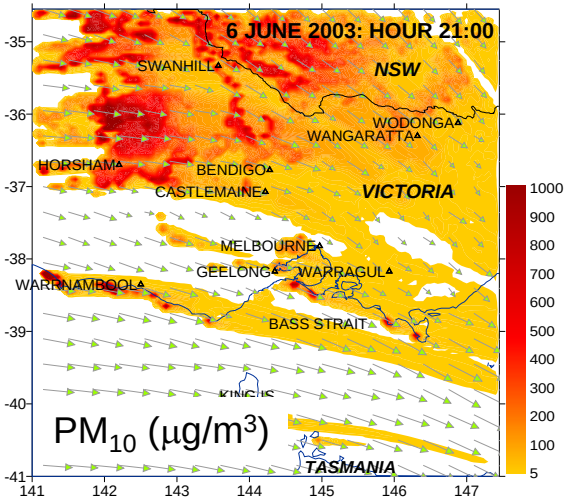
Wind-blown Dust Forecasting











Lu, H. and Y. Shao dust scheme

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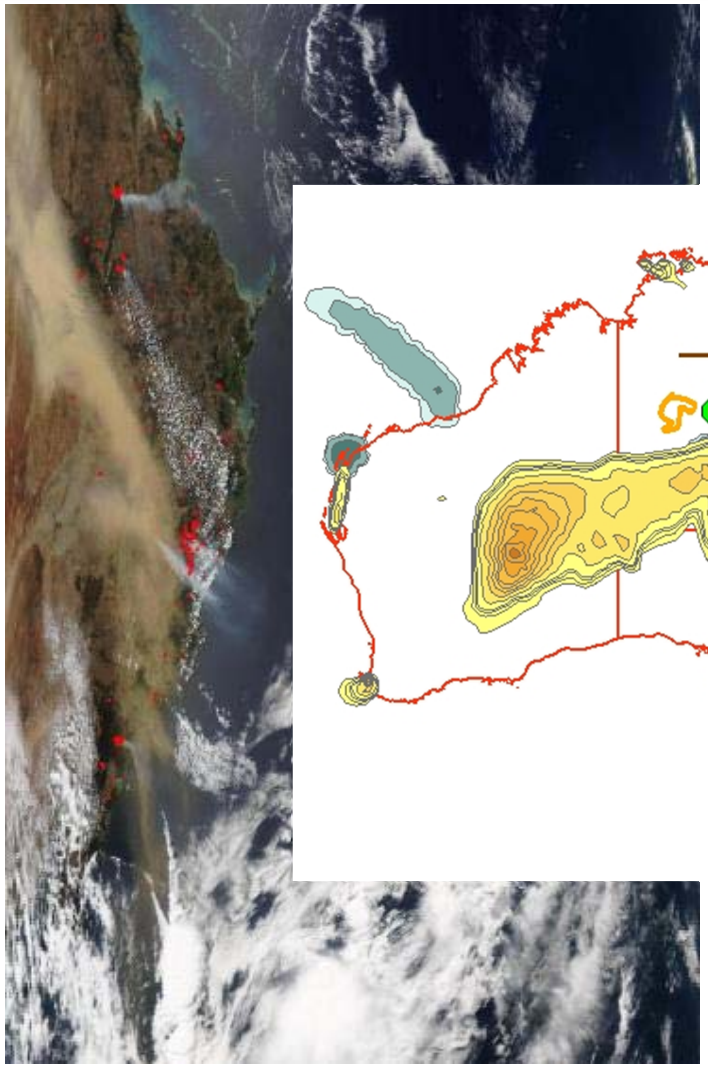
AAQFS-dust verification with MODIS



Verification through analysis of extreme events

10:00 EST October 23rd 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/

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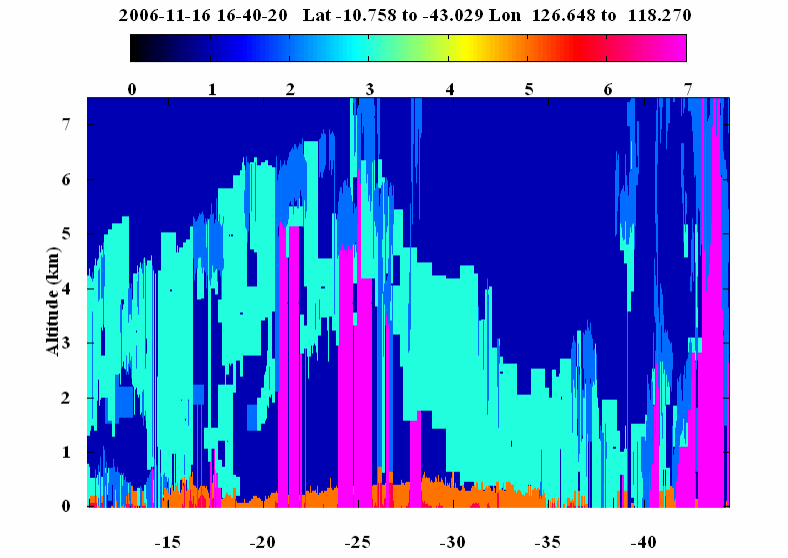
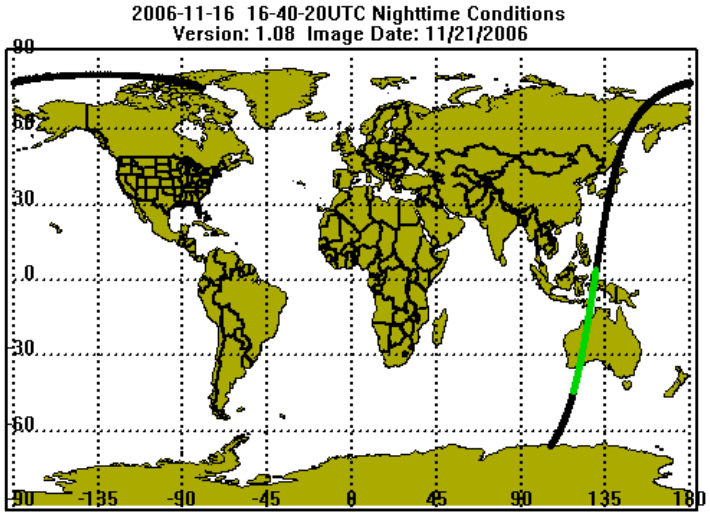
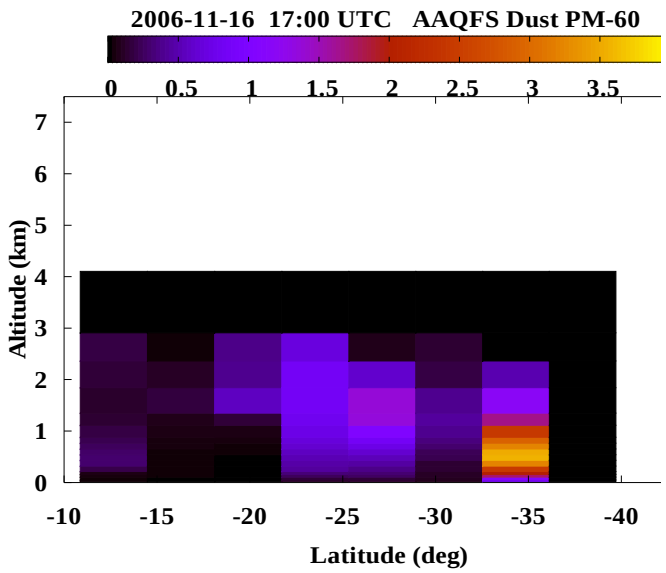
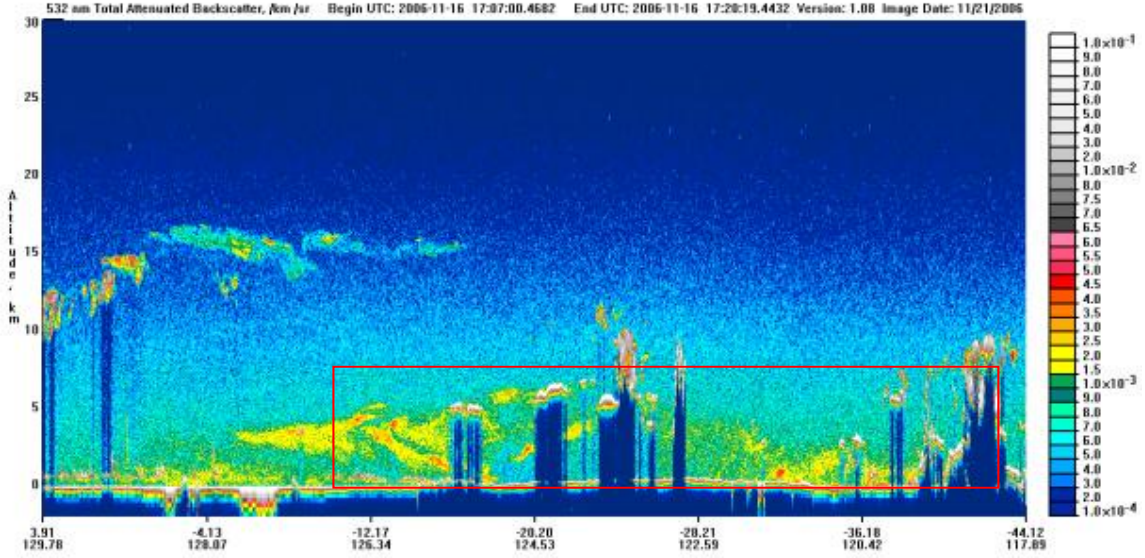
AAQFS-dust validation with CALIPSO









Meteorology

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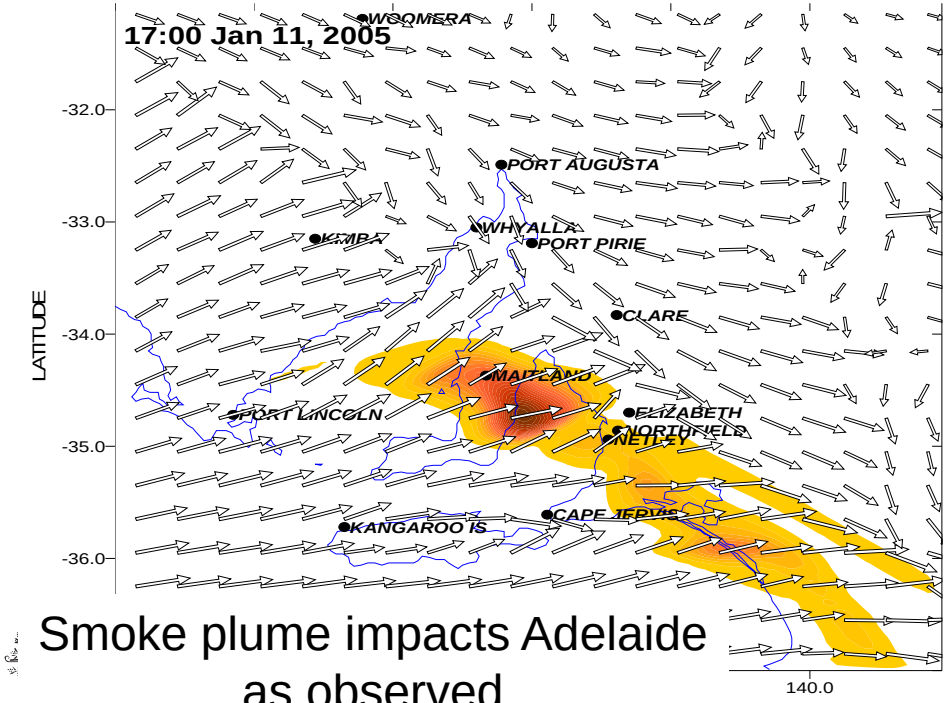
Smoke Plume Envelope Forecasting

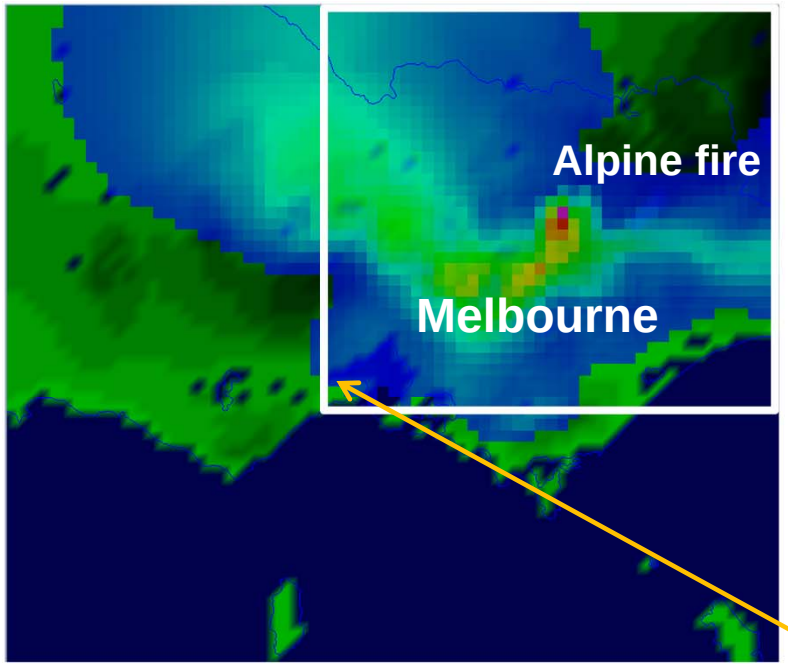
- Retrieve automated hotspot locations via satellite images
- Process the data to determine fire locations
- Initiate qualitative emissions at source locations and compute transport and dispersion as a passive scalar

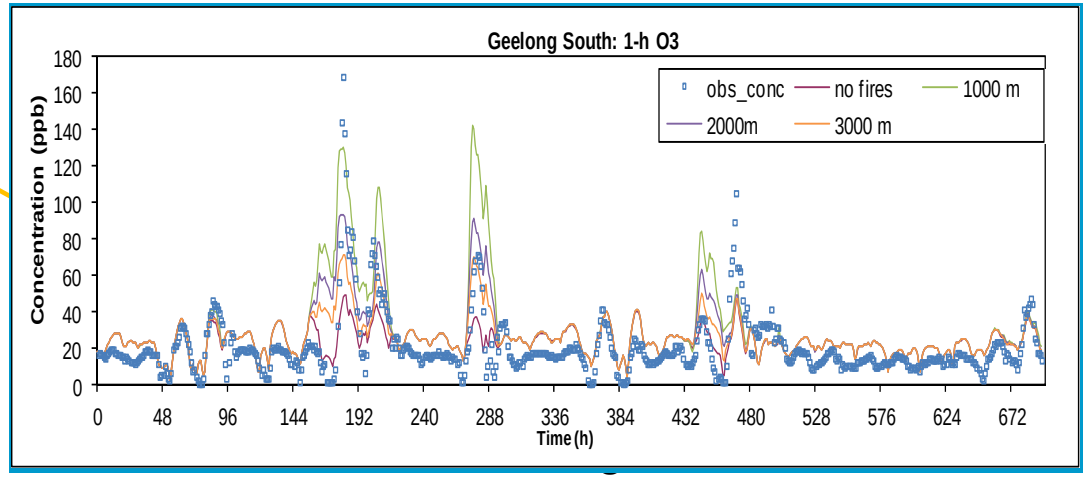
http://sentinel2.ga.gov.au/acres/sentinel/index.shtml



Smoke plume impacts Adelaide as observed

Latest fire module in CTM





8th December 2006

TAPM-CTM

Inline chemical transport Carbon Bond V chemistry; VBS for SOA; ISORROPIA-II

Ozone concentration time series are for December 2006. Three plume rise scenarios

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AAQFS- lessons learned

SCIENCE

- Ozone (non-fire), large dust storms and fires are forecast reasonably well.
- Urban particles are not well predicted.
  - 0.05º 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

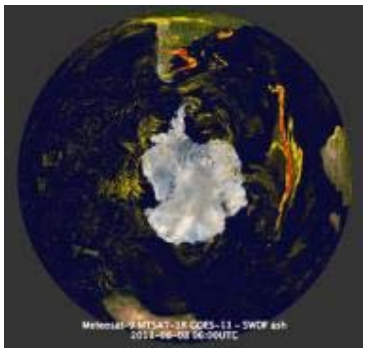
LOGISTICAL

- 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

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

- Volcanic ash forecasting for aviation



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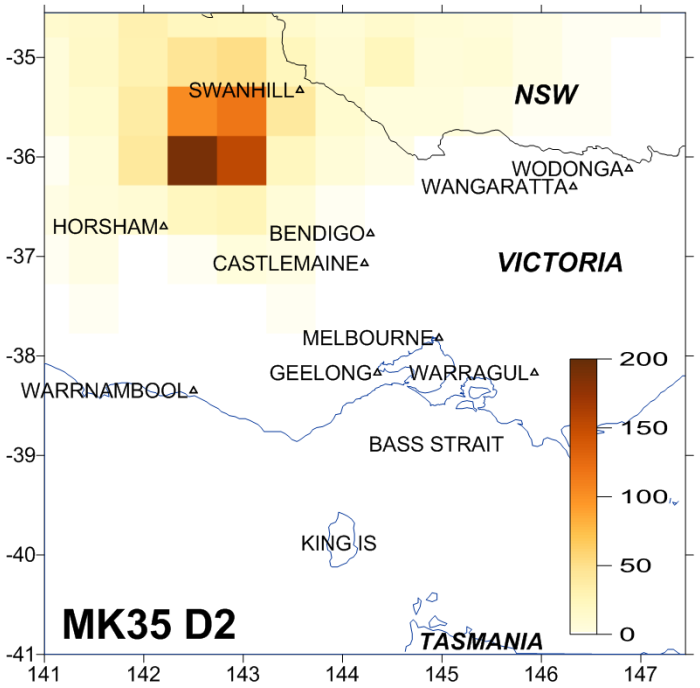
Projection of dust events for summer months in Victoria, Australia

- Dynamical downscaling
  - ESM -> Regional Atmosphere -> Dust emission + transport;
  - Four GCM model ensemble
  - 50 km resolution across Australia;
  - Decadal simulations of dusty months (Jan and Feb)
    - 1996 – 2005; 2065 - 2074



10 year frequency (PM10 > 50 μg/m³)

	Dust Event PM10 >50 μgm^{-3}			*Extreme Dust Event PM10 >100 μgm^{3}*		
	Decade 1	**Decade 3**	Change	Decade 1	**Decade 3**	Change
MK35	207	**206**	-0.5%	128	**135**	+5%
ECHAM	201	**192**	-4%	125	**125**	0%
UKMO	194	**177**	-9%	122	**120**	-2%
GFDL	204	**213**	+4%	133	**140**	+5%
Average			-2% ± 6%			+2% ± 4%

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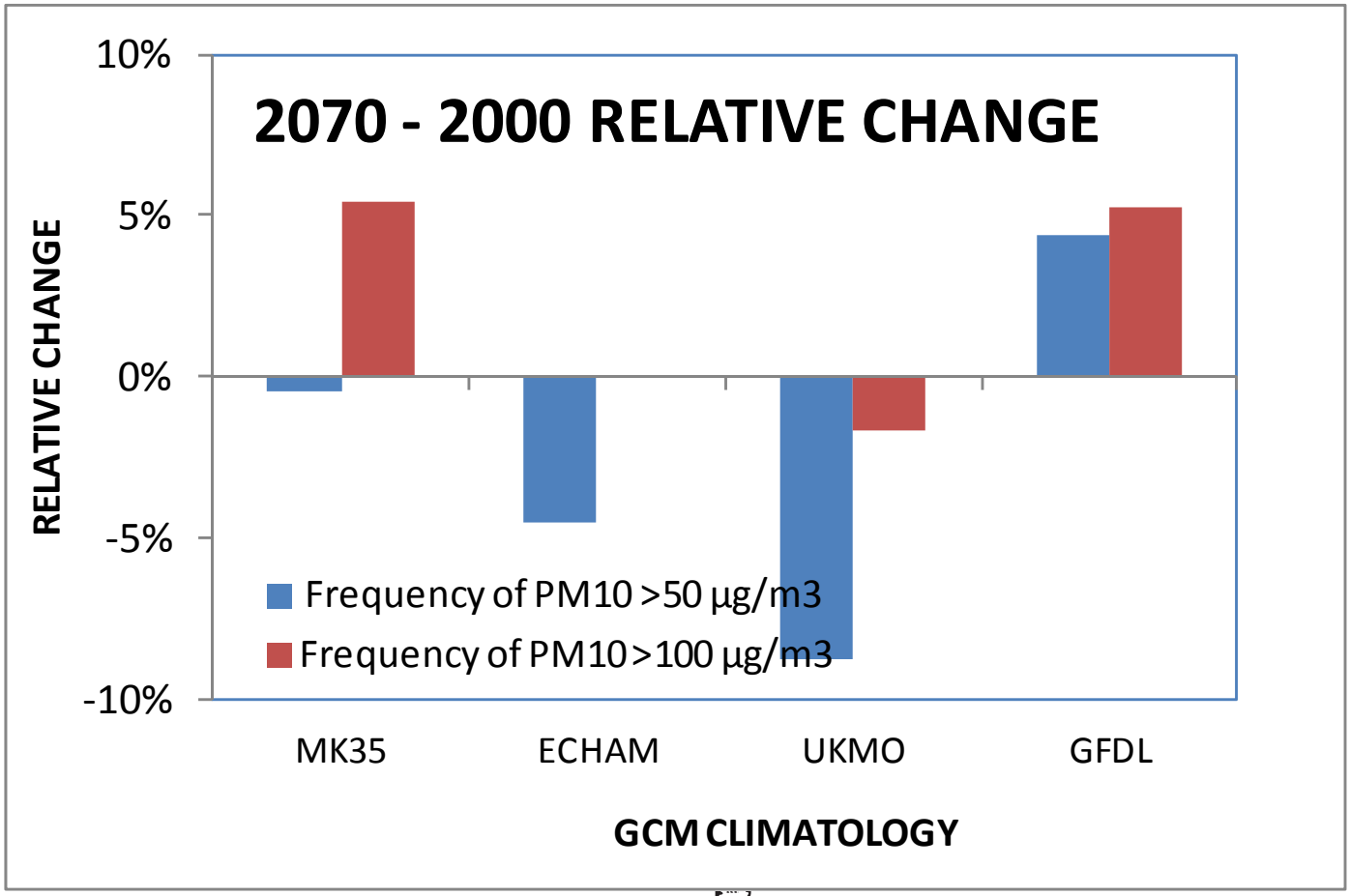

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