# PRESERVING OUR BUSHLAND THREATS, SOLUTIONS & ACTIONS

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### **THREATS - Biological**

Weeds

Animals – domestic and feral

 Dieback 'biological bulldozer' (16% of WA forests affected so far)

Loss of species biodiversity - flora and fauna

#### **THREATS - Demands of humanity**

Development – metropolitan (especially urban expansion) and regional (such as mining)

Wetlands and bushland may disappear entirely or be fragmented. Many of these contain TEC's or rare and endangered or vulnerable flora and fauna including TEC's (less than 10% of Forrestfield Veg'n Complex remains)

Pollution/contamination

Nitrate and phosphorus from manures and fertilisers in rivers and aquifers

Decreasing groundwater resources

Due to excessive drawdown and reducing rainfall resulting in drying wetlands, rivers, caves.

# THREATS - southwest WA weather shifting southward

- Global average temperature increase changes pattern of heating and winds
- Changing weather/climate patterns affect rainfall
- Stresses placed on ecology by rapid temperature and rainfall pattern changes
- Rapid changes, fragmentation and topology constrain adaption of species

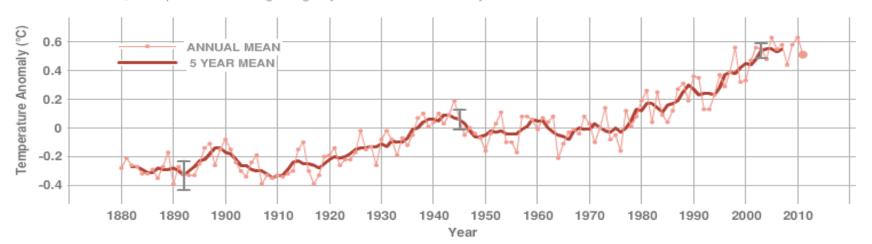
#### Global Surface Temperature

download data

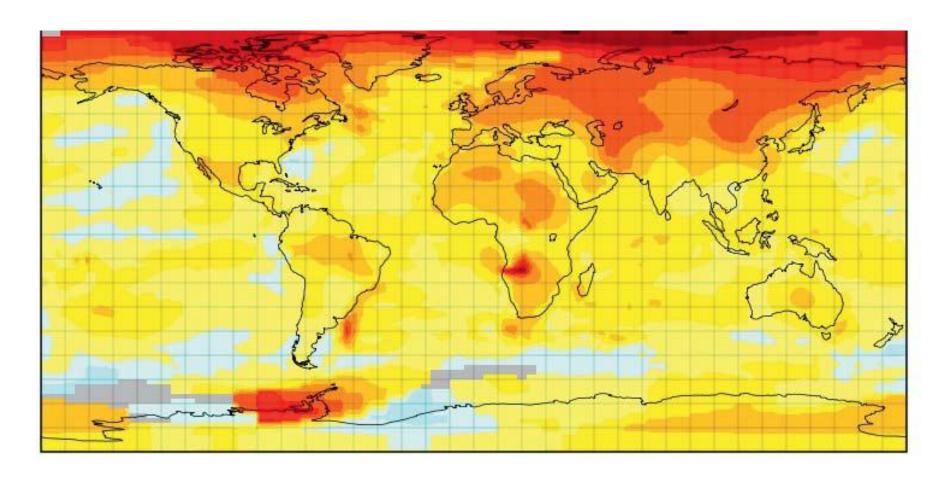
Data updated 1.20.12

#### GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS) This trend agrees with other global temperature records provided by the U.S. National Climatic Data Center, the Japanese Meteorological Agency and the Met Office Hadley Centre / Climatic Research Unit in the U.K. Credit: NASA/GISS



#### Global changes in temperature patterns

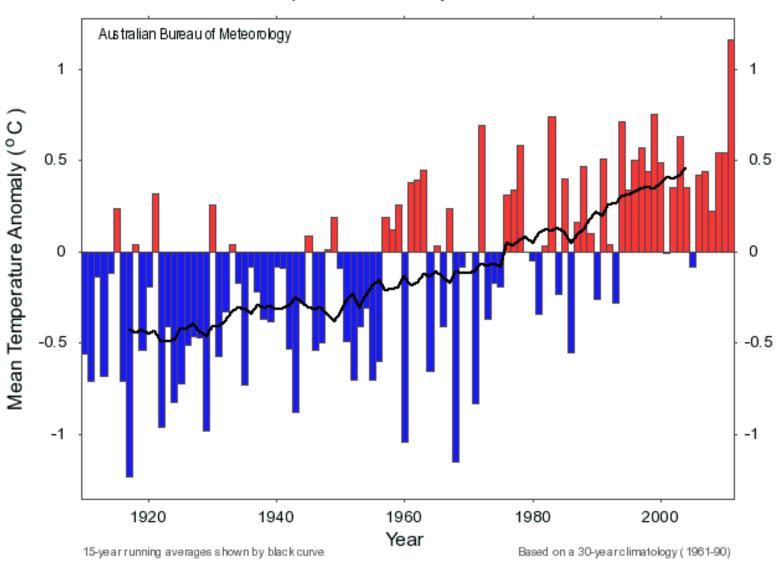


Global surface temperature anomalies for the period 2005-2009, relative to 1951-1980 as a baseline, from surface air measurements at meteorological stations and ship and satellite sea surface temperature measurements. Note that warming is greatest over continental interiors and where there is no urban heat island effect (e.g. Antarctic Peninsula, Siberia).

Ref: "The Science of Climate Change", August 2010 by Australian Academy of Science <a href="http://data.giss.nasa.gov/gistemp/maps/">http://data.giss.nasa.gov/gistemp/maps/</a>

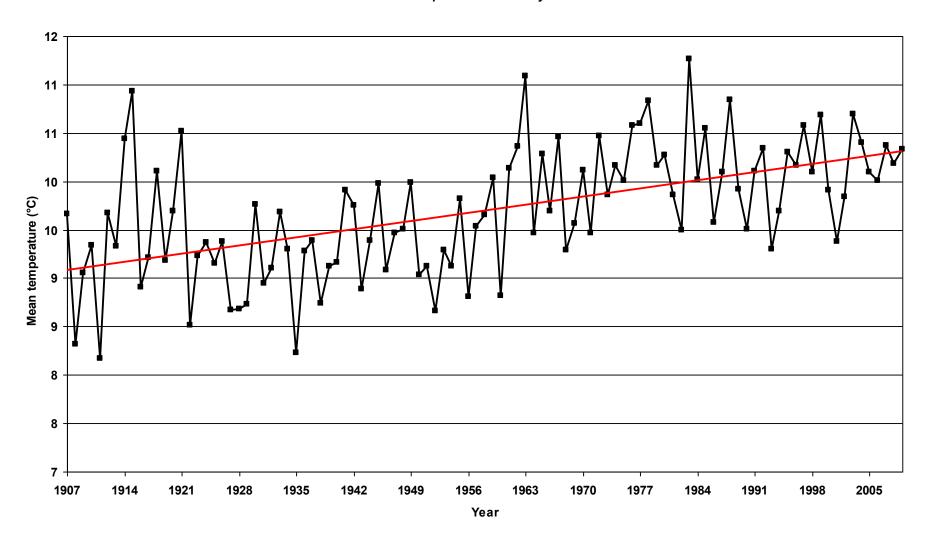
#### Local temperatures increasing

Annual Mean Temperature Anomaly - Southwestern Australia



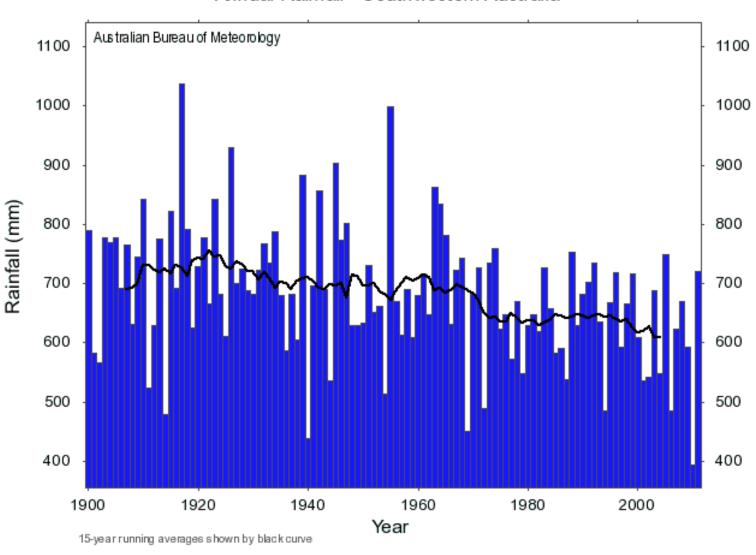
#### Mean minimum temperatures at Donnybrook

Mean annual minimum temperature for Donnybrook from 1907-2009



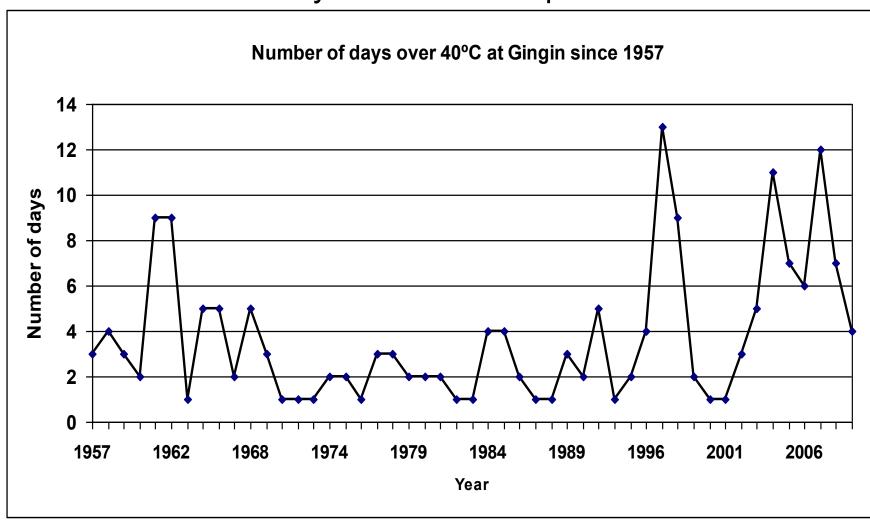
#### Local rainfall reducing

#### Annual Rainfall - Southwestern Australia

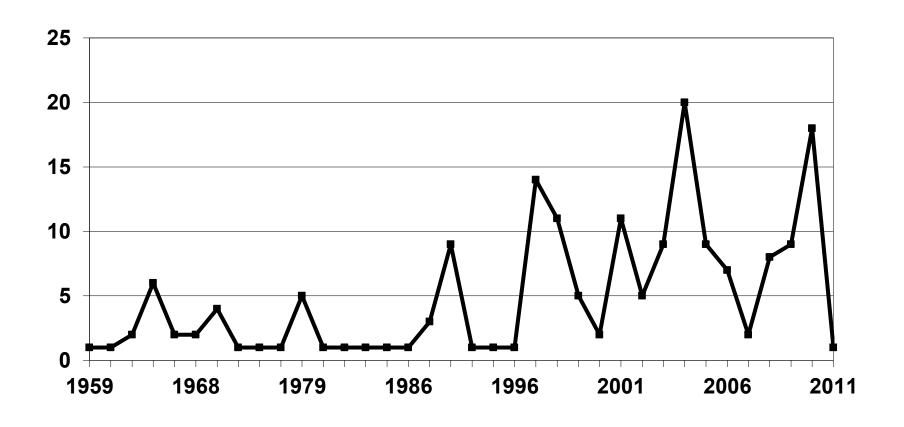


#### Local weather becoming more extreme

Number of days when the temperature exceeded



#### **Number of frost days at Gingin**



# How can species react to climate change?

- Stay and change behaviour eg plants change their flowering time, animals reproduce earlier/later
- Stay and adapt requires genetic diversity which decreases with fragmentation of areas
- Move to a suitable habitat if available (not possible with plants or with fragmentation of areas)
- Die out

#### Solutions - what we can do

- Restoration and amalgamation of natural areas including ecological and/or passive recreation corridors (Biolinks, Kalamunda Wildlife Corridor Strategy & Kalamunda Biodiversity Strategy)
- Directions 2031 must set aside all natural areas/wetlands as greenways/wildlife/passive recreation corridors (incl Hasluck Greenmap/Foothills Regional Park, NRPG comments, J Day confirmation letter).
- Ensure Federal airports & lands preserve remaining natural areas/wetlands.
- Stop logging native forests

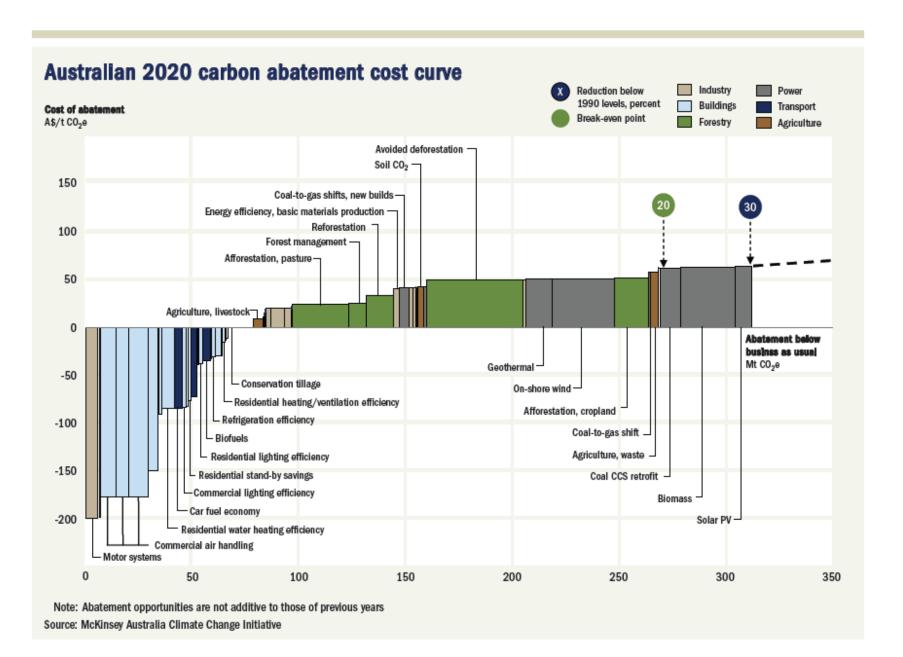
#### Solutions – what we can do

- Reduce and avoid over-engineering/management of natural biological resources. Bringing back natural variability and natural disturbance routines to native ecosystems makes ecosystem processes sustainable and more resilient to ecosystem surprises such as invasive species
- 'Decarbonise' the Australian economy for economic, social & environmental benefits (renewable energy, smartgrids, public transport, electrified transport, reafforestation/biomass)

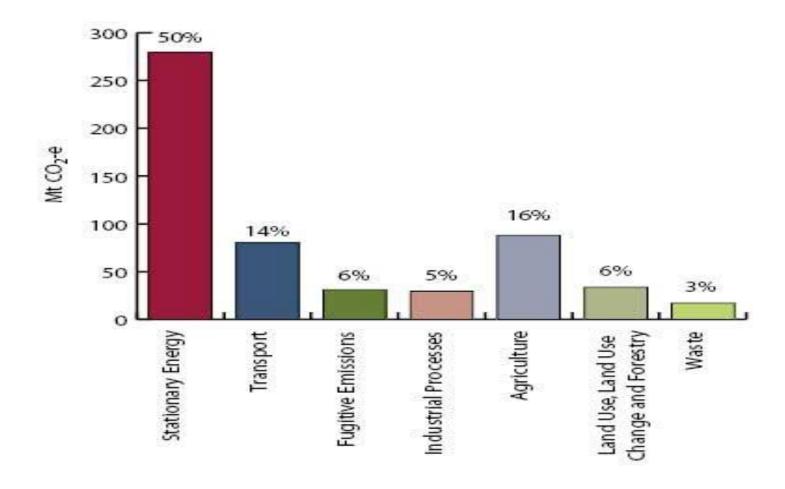
#### Solutions - what we can do

- Put a price on water currently no drivers exist for agriculture to use water efficiently. No leaching = no contamination of groundwater
- Restore water to natural ecosystems and use water-sensitive urban design (includes sympathetic management of riparian zones)
- Legislate for a ban on invasive weeds
- Funding to adequately control weeds and dieback in all national/local parks
- Continue working to develop a cure for dieback

#### **Solutions - reduce GHG emissions**



#### **Solutions - reduce GHG emissions**



Greenhouse Gas Emissions – Australia Ref: AGO Aust GHG by Sector 2005



### Actions needed -big picture items

- Lobby for acknowledgement that population growth is the main stressor on the earth's systems and processes.
- Lobby for triple bottom-line accounting in all areas of economy and society (gives economic value to environmental and social aspects for optimal outcomes, ref: WorleyParsons EcoNomics)
- Water is the key factor that will determine our future ability to feed ourselves
- Educate MP's and other persons of influence on climate science
- Lobby strongly for actions to decarbonise Australian economy

#### Actions needed - on a more local level

- Work towards a price on water
- Work with Minister Day & WAPC for best outcomes on Directions 2031
- Federal funding for weed/dieback control & legislation in National and State Parks

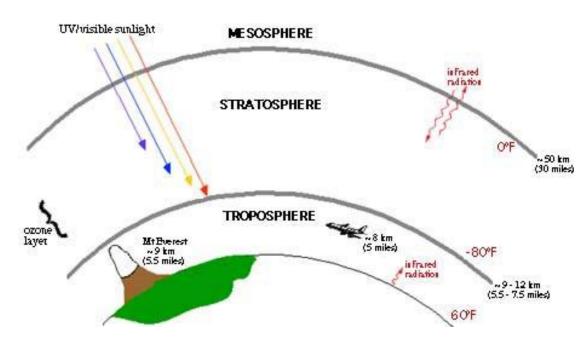


# EVIDENCE FOR HUMAN-EFFECTS ON GLOBAL WARMING

- In the last 650,000 years there have been 7 cycles of glacial advance and retreat.
   The abrupt end of the last ice age (about 7,000 years ago) marks the beginning of the modern climate era and of human civilization.
- Most of these previous climate changes have been attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.
- BUT the current warming trend is of particular significance because most of it is very likely human-induced and proceeding at a rate that is unprecedented in the past 1,300 years.

### EARTH'S TEMPERATURE RESULTS FROM A DELICATE BALANCE OF ENERGY FLOW

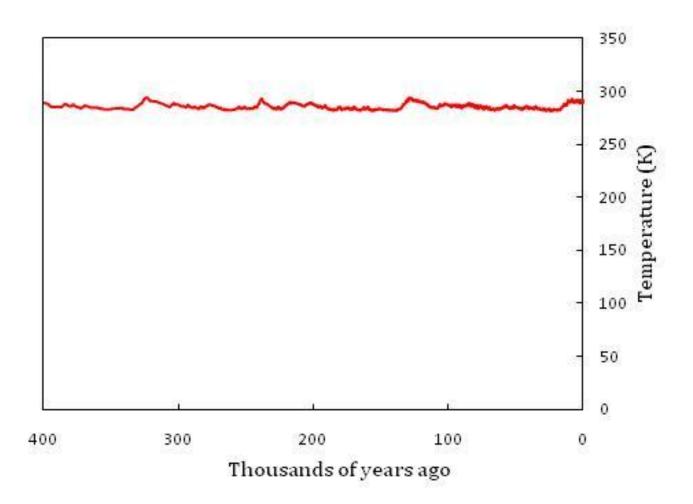
#### REGIONS OF THE ATMOSPHERE



•We know that carbon dioxide and other 'greenhouse' gases trap heat energy (Infrared light).

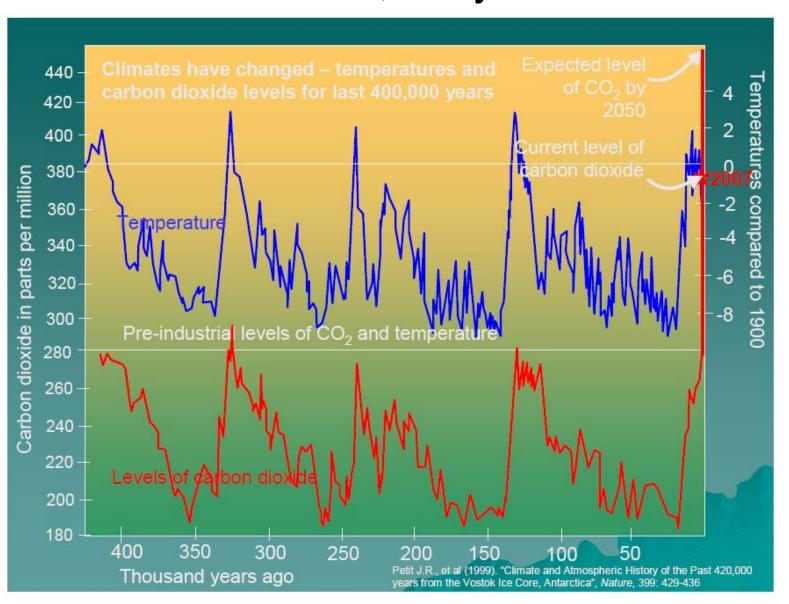
- Ref: <a href="http://www.research.noaa.gov/climate/t\_ozonelayer.html">http://www.research.noaa.gov/climate/t\_ozonelayer.html</a>
- Increased levels of greenhouse gases must cause the Earth to warm in response.

#### Small temperature changes make big differences

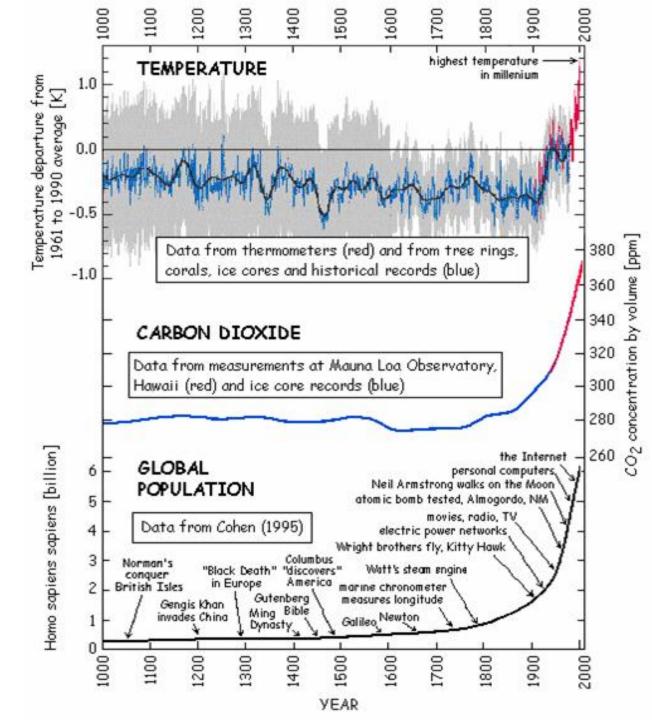


The graph is the temperature calculated over the past 400,000 years in Antarctica from the Vostok ice core. The tiny peaks are a bit like today and the tiny troughs would force hundreds of millions from their homes. A few degrees of warming makes the difference between Ice Ages and warm periods.

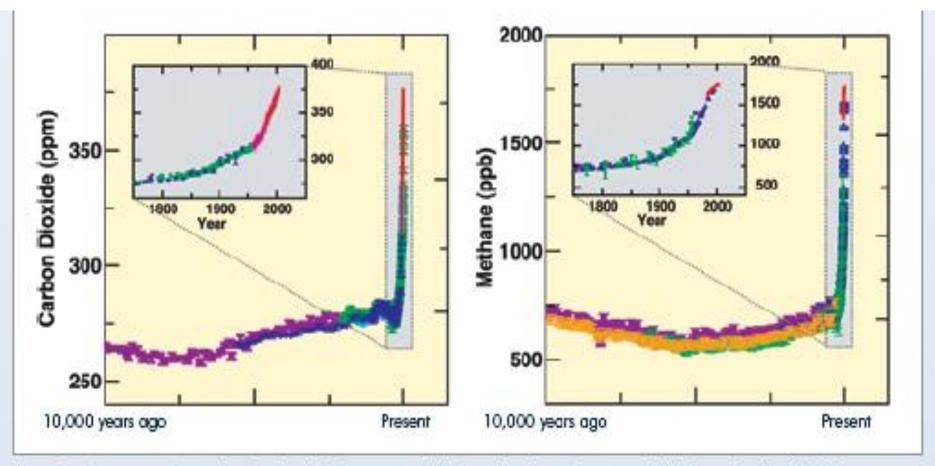
# Global average temperature and carbon dioxide over 450,000 years



Temperature carbon dioxide and population

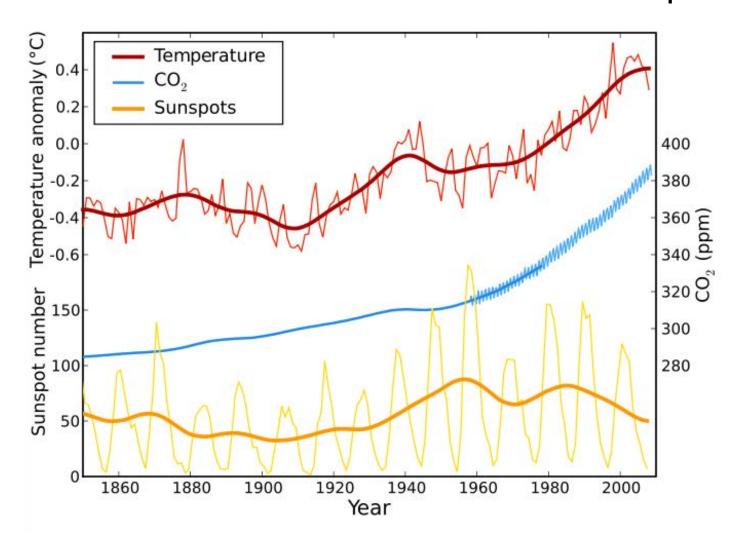


# Carbon dioxide and methane concentrations over the last 10,000 years

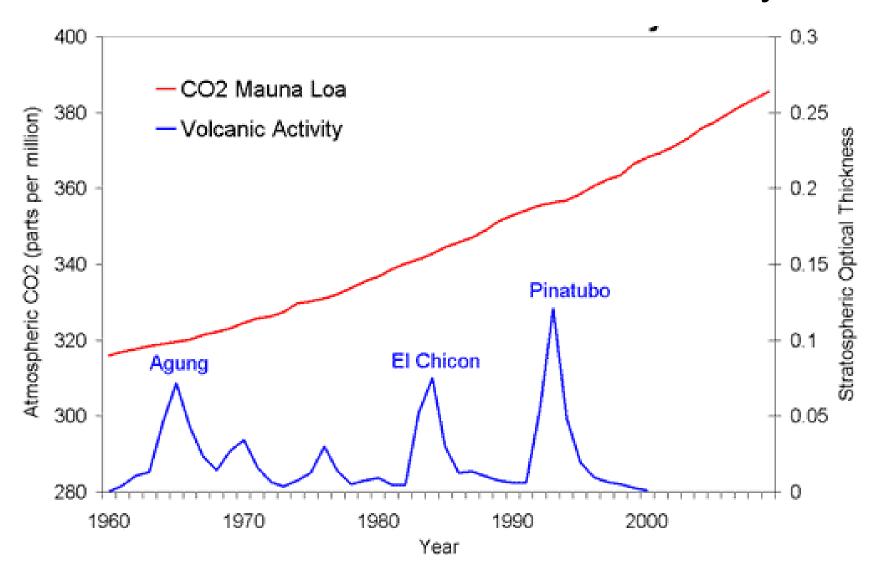


Atmospheric concentrations of carbon dioxide (in parts per million) and methane (in parts per billion) over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). Source: IPCC, 2007

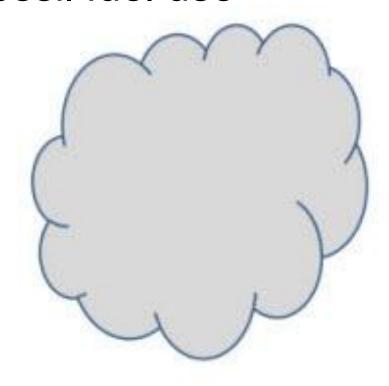
## Global average temperatures compared with carbon dioxide levels and solar radiation/sunspot activity



#### Carbon dioxide and volcanic activity



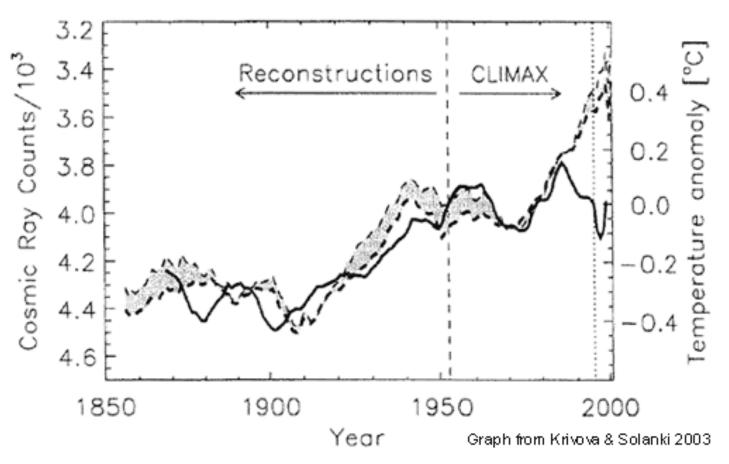
## Carbon dioxide emissions from volcanoes versus fossil fuel use





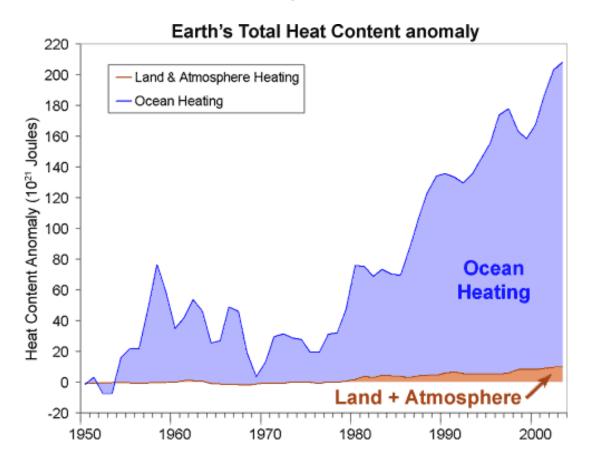
Total volcanic CO2 emissions 65-319 million tonnes/year (min-max estimates) World CO2 emissions from fossil fuel use 29 billion tonnes/year EIA 2007

# Recent temperatures do not correlate with cosmic radiation



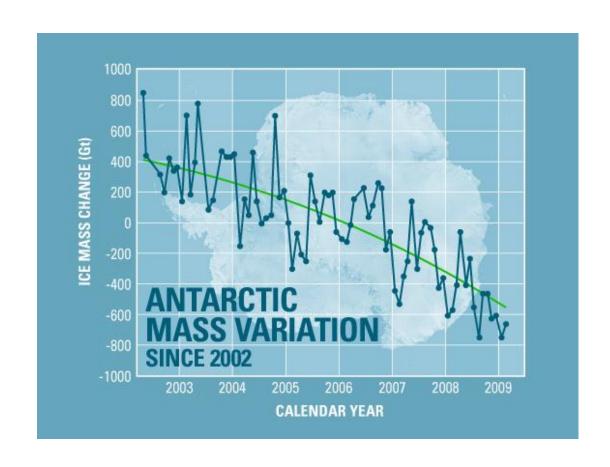
Reconstructed cosmic radiation (solid line before 1952) and directly observed cosmic radiation (solid line after 1952) compared to global temperature (dotted line). All curves have been smoothed by an 11 year running mean (Krivova 2003).

#### Warming oceans



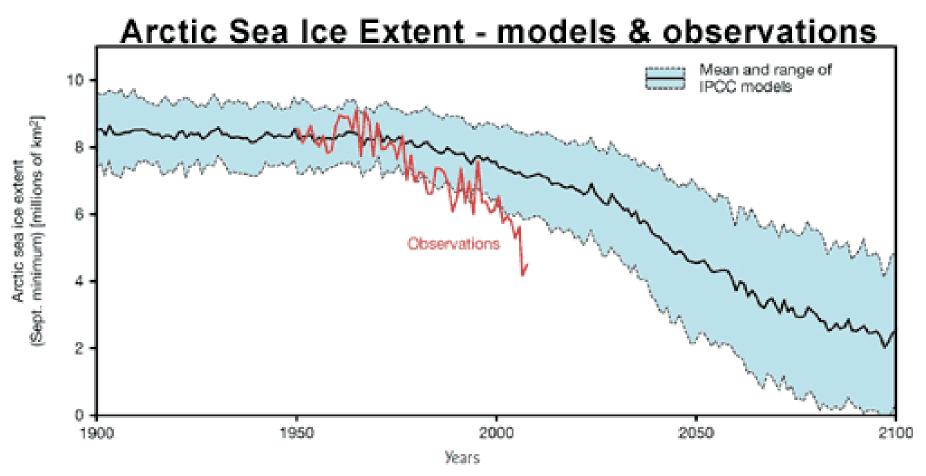
- Oceans have absorbed much of the increased heat energy, with the top 700 meters of ocean showing warming of 0.302 degrees Fahrenheit since 1969.
- While this might not seem much in terms of temperature the colossal volume of water means it is a huge amount of heat.

#### Shrinking ice mass



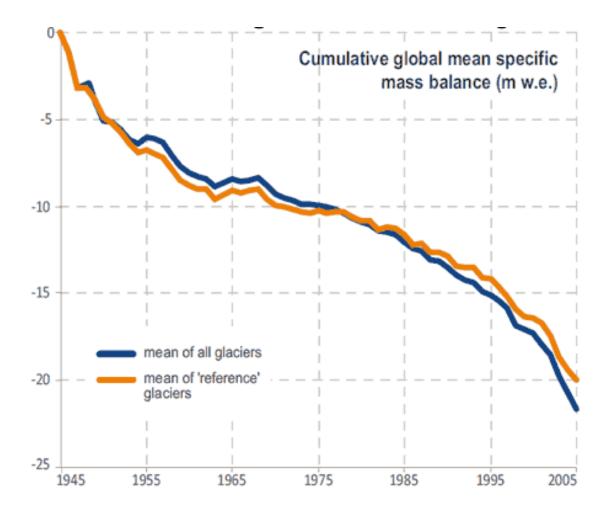
Greenland lost 150 to 250 cubic kilometers of ice per year between 2002 and 2006

#### Shrinking arctic ice extent



Observed (red line) and modelled September Arctic sea ice extent in millions of square kilometres. Solid black line gives the average of 13 IPCC AR4 models while dashed black lines represent their range. The 2009 minimum has recently been calculated at 5.10 million km2, the third lowest year on record and well below the IPCC worst case scenario (Copenhagen Diagnosis 2009).

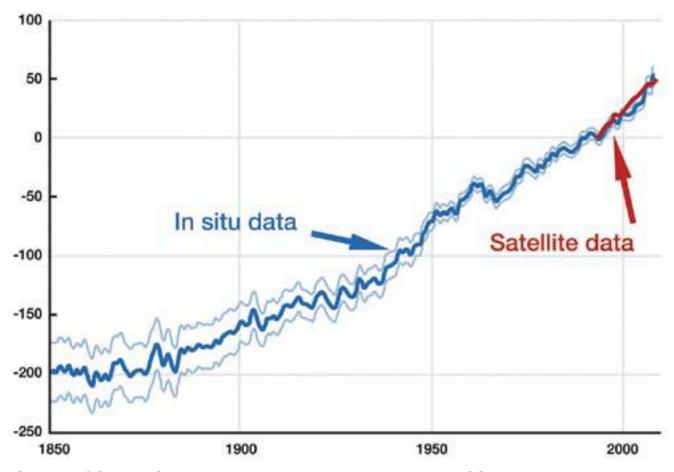
#### Shrinking global average glacier mass



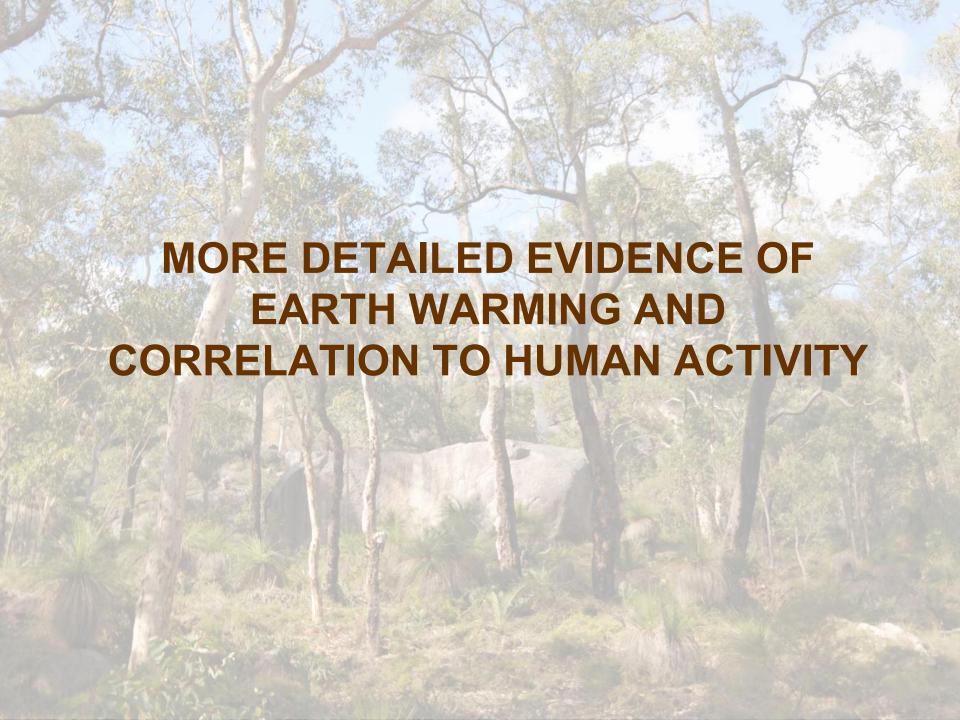
Cumulative mass balance curves for the mean of all glaciers and 30 'reference' glaciers (WGMS 2008).

#### Rising global average sea level

Global sea level rose about 17 centimeters in the last century. The rate in the last decade, is nearly double that of the last century.



Ref: 'The Science of Climate Change, August 2010' Australian Academy of Science



### Temperatures - global

Global and continental temperature change

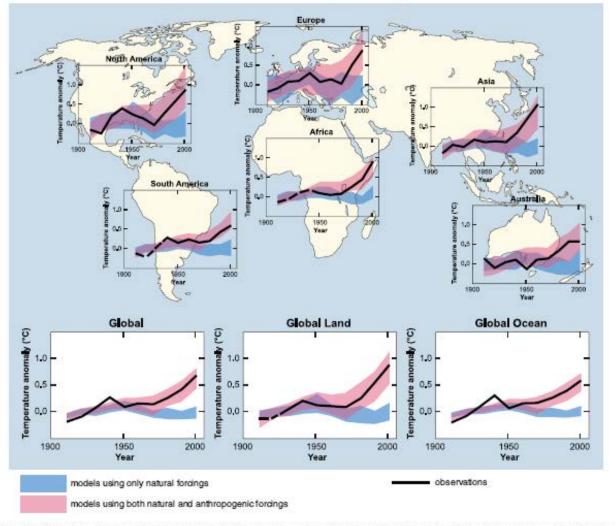
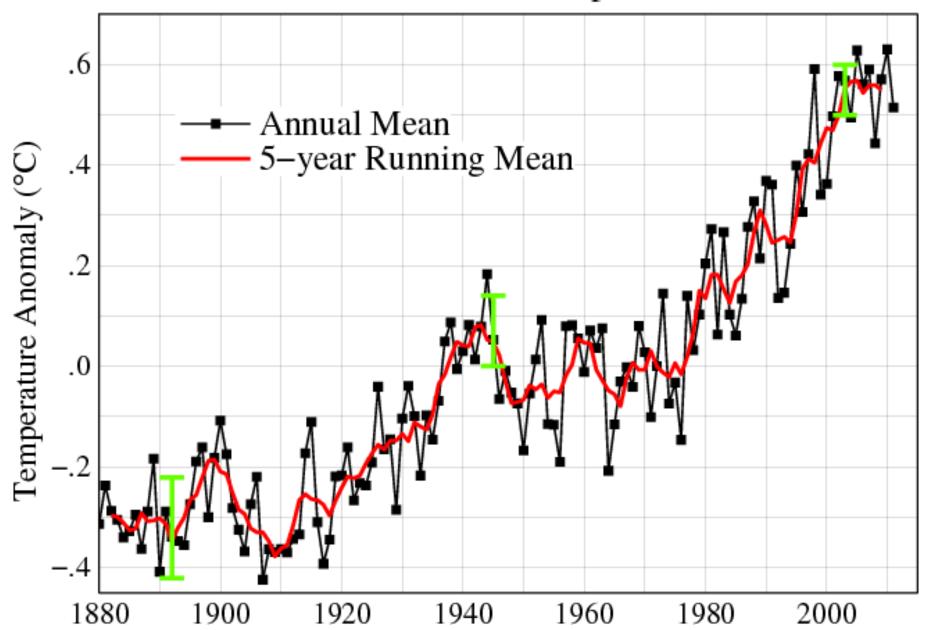


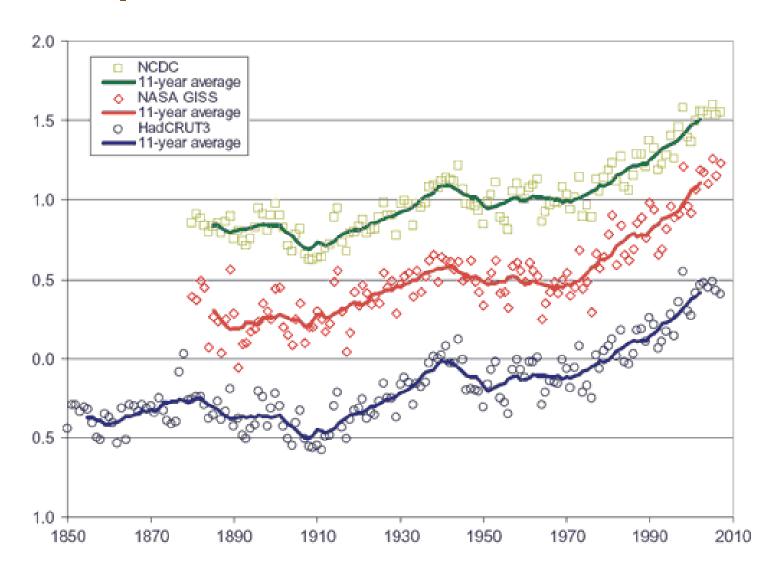
Figure 2.5. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2006 (black line) plotted against the centre of the decade and relative to the corresponding average for the 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. (WGI Figure SPM.4)

Ref: IPCC 4<sup>th</sup> Report (2005)

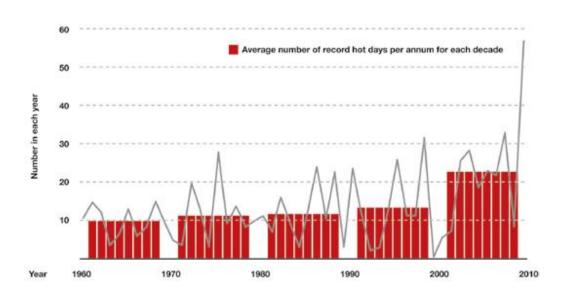
### Global Land-Ocean Temperature Index

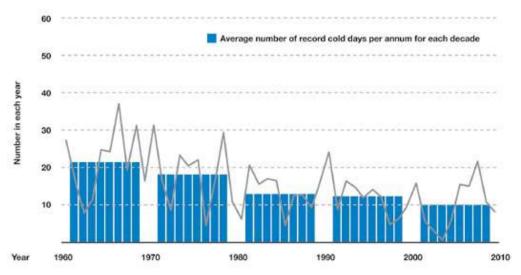


### Temperature measurement correlation



## Temperatures - Australia

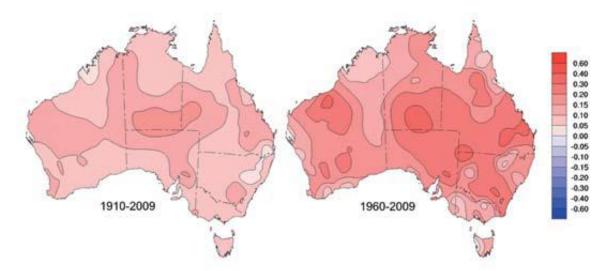




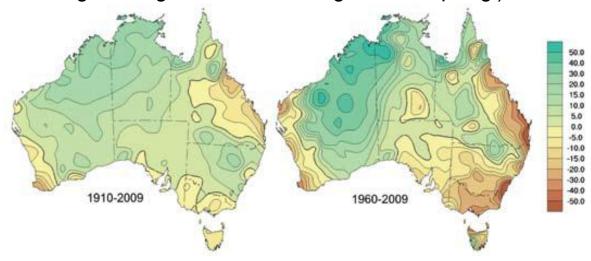
Changes in the number of record hot day maxima and record cold day maxima at Australia's climate reference stations.

The number of days with record hot temperatures has increased each decade over the past 50 years; there have been fewer record cold days each decade; and 2000 to 2009 was Australia's warmest decade on record.

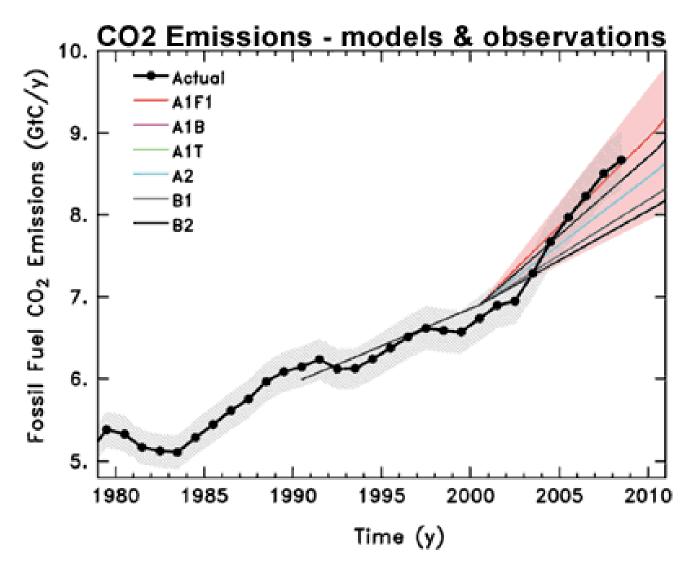
Source: CSIRO, Bureau of Meteorology (2010) "State of the Climate".



**Figure 3.5** Trends in Australian annual temperature (°C/decade) over the periods 1910–2009 (left) and 1960–2009 (right). Source: Australian Bureau of Meteorology (http://www.bom.gov.au/cgi-bin/climate/change/trendmaps.cgi)



**Figure 3.6** Trends in Australian annual rainfall (in mm per decade) over the periods 1910–2009 (left) and 1960–2009 (right). Source as for Figure 3.5

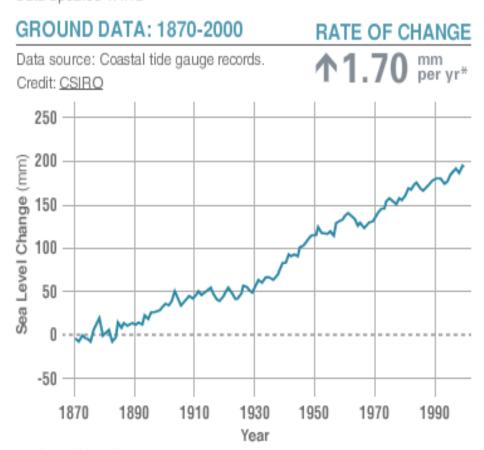


Observed global CO2 emissions from fossil fuel burning and cement production compared with IPCC emissions scenarios. The coloured area covers all scenarios used to project climate change by the IPCC (Copenhagen Diagnosis 2009).

### Sea Level

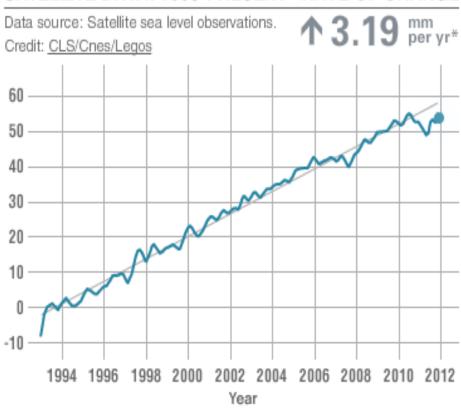
Data updated 1.4.12

download data



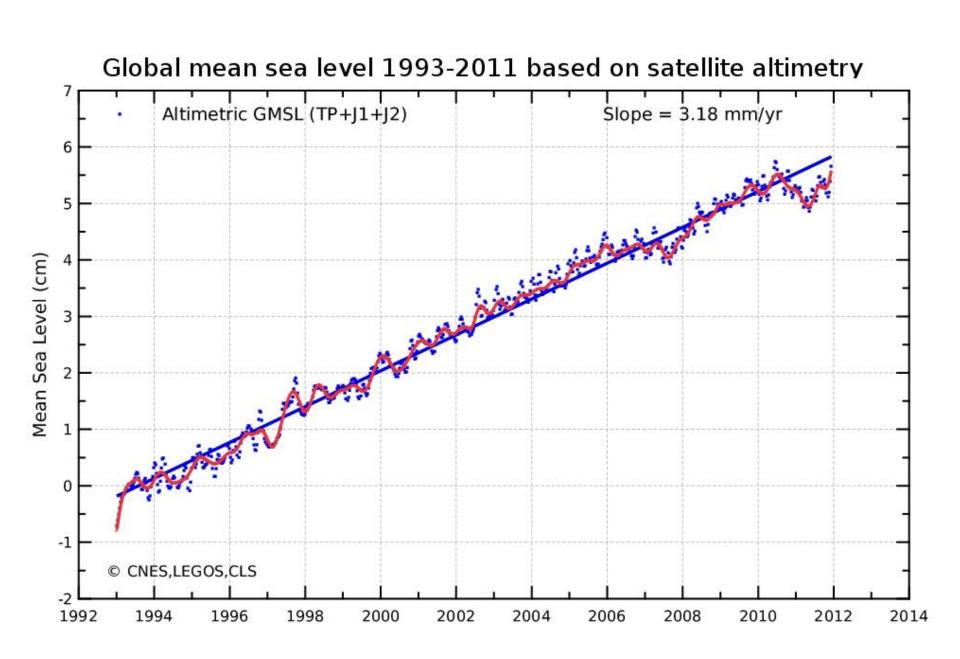
<sup>\*</sup>estimate for 20th century

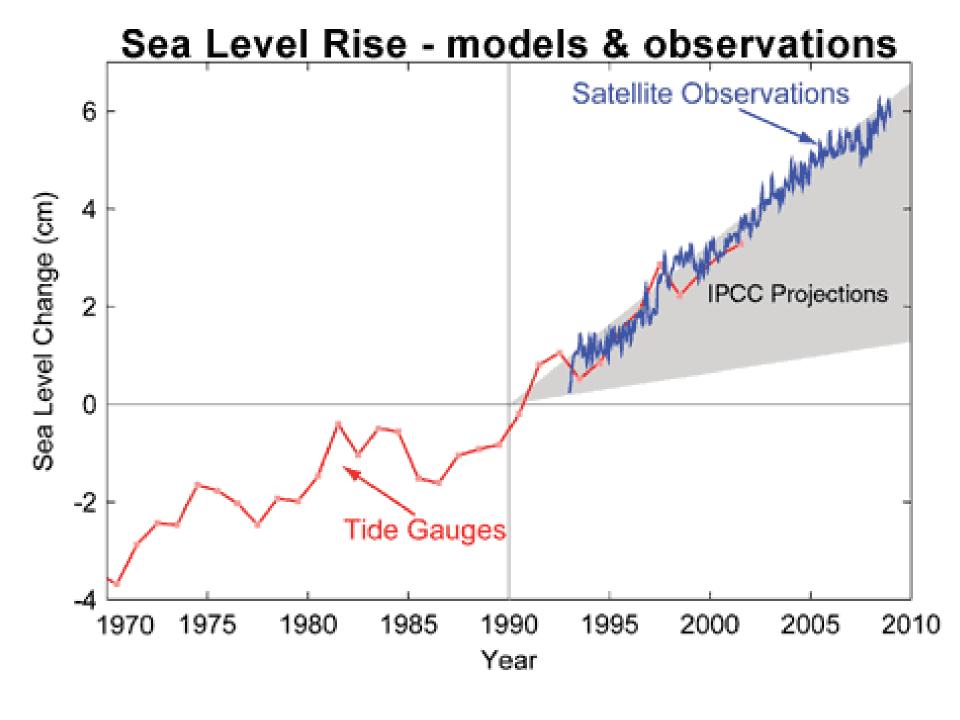
### SATELLITE DATA: 1993-PRESENT RATE OF CHANGE



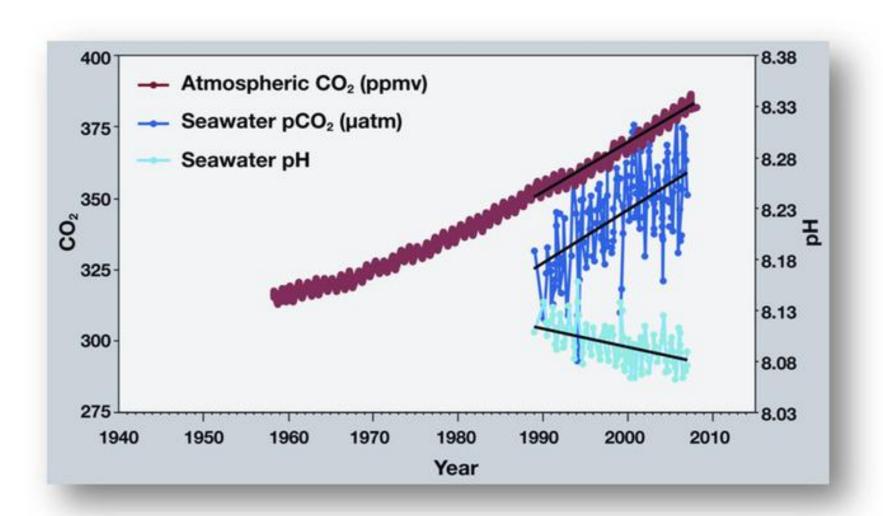
Inverse barometer applied and seasonal signals removed.

<sup>\*</sup>estimate for 1993-2010

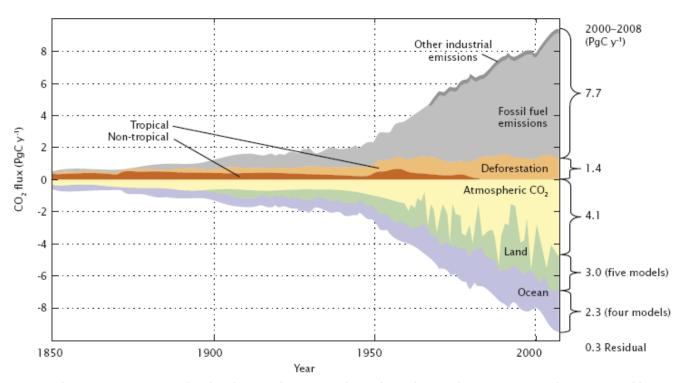




### Ocean acidification



### Sources and sinks for carbon dioxide



▶ Figure 2.5: Sources and sinks of atmospheric  $CO_2$ . Those above the zero-line represent anthropogenic additions to the atmosphere (inflows); those below are sinks for  $CO_2$  (outflows), together with the accumulation in the atmosphere. Units are in petagrams of carbon per year (Pg = petagram; 1 petagram =  $10^{15}$  grams = 1 billion tonnes). The small residual reflects minor discrepancies in independent measurements of different terms. 10

Cumulative mass balance curves for the mean of all glaciers and 30 'reference' glaciers (WGMS 2008).



### **CLIMATE REFERENCES**

- http://climate.nasa.gov/
- http://www.noaa.gov/
- http://www.bom.gov.au/climate/change/
- http://www.bom.gov.au/climate/extremes/
- http://www.csiro.au/en/Outcomes/Climate/Understanding.aspx
- http://climatechangeinaustralia.com.au/
- http://www.dec.wa.gov.au/content/view/2870/2288

### RENEWABLE ENERGY REFERENCES

SEN website - www.sen.asn.au

Beyond Zero Emissions - http://beyondzeroemissions.org/about/bze-brand

Bright Source - <a href="http://www.cleanenergyauthority.com/solar-energy-news/brightsource-adds-molten-salt-thermal-storage-080911">http://www.cleanenergyauthority.com/solar-energy-news/brightsource-adds-molten-salt-thermal-storage-080911</a>

Solar Reserve – <a href="http://www.cleanenergyauthority.com/solar-energy-news/solarreserve-completing-largest-solar-tower-project-in-world-021412">http://www.cleanenergyauthority.com/solar-energy-news/solarreserve-completing-largest-solar-tower-project-in-world-021412</a>

Torresol Energy - <a href="http://www.torresolenergy.com/TORRESOL/gemasolar-plant/en">http://www.torresolenergy.com/TORRESOL/gemasolar-plant/en</a>

Geodynamics - www.geodynamics.com.au

Nanosolar - www.nanosolar.com

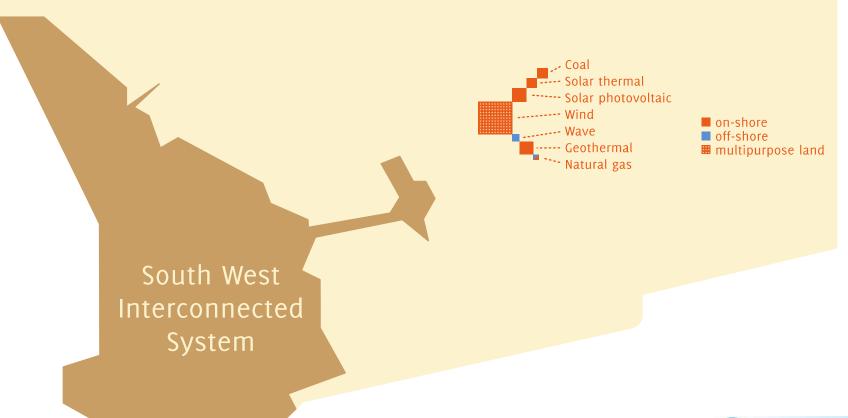
Carnegie Corp Wave Energy - <a href="http://www.carnegiewave.com">http://www.carnegiewave.com</a>

Energy Science - www.energyscience.org.au

Latest renewable energy developments: <a href="http://www.gizmag.com/ecogizmo">http://www.gizmag.com/ecogizmo</a>

### Solutions – use renewable energy

The relative area required for each renewable energy source (as compared to coal) to provide our entire Southwest electricity needs





## Renewable energy costs decreasing while fossil energy costs are increasing

Average case cost - wind, biomass, geothermal, small-hydro 2005-2050

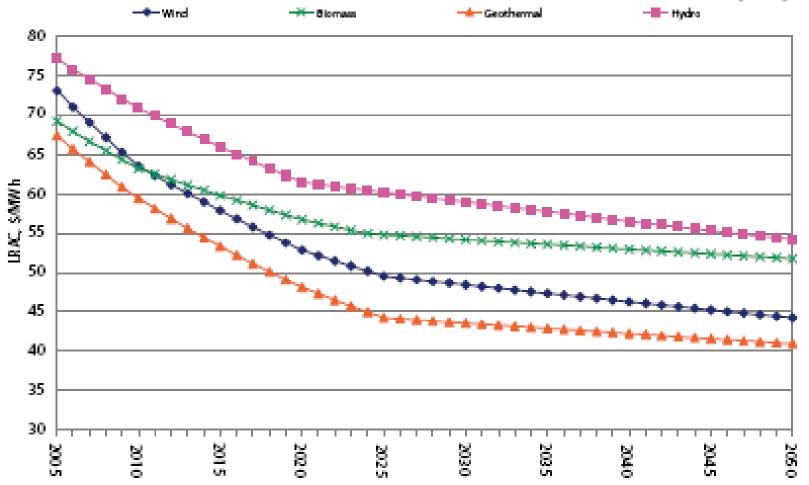
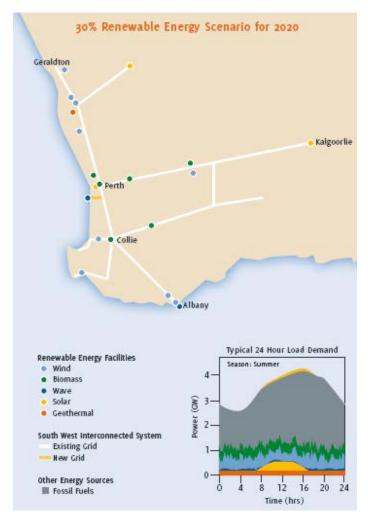
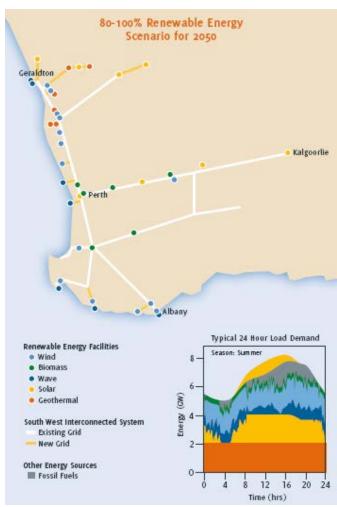
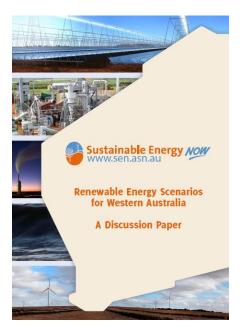


Figure 5.45 Average case costs for various renewable energy conversion technologies. Source: McLennan Magasanik Associates, 2006.

# Solutions - WA renewable energy scenario options

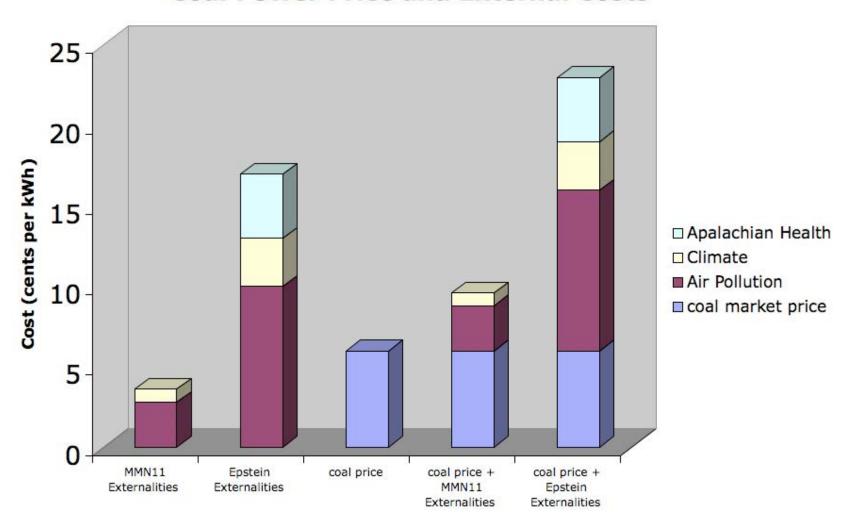








### **Coal Power Price and External Costs**

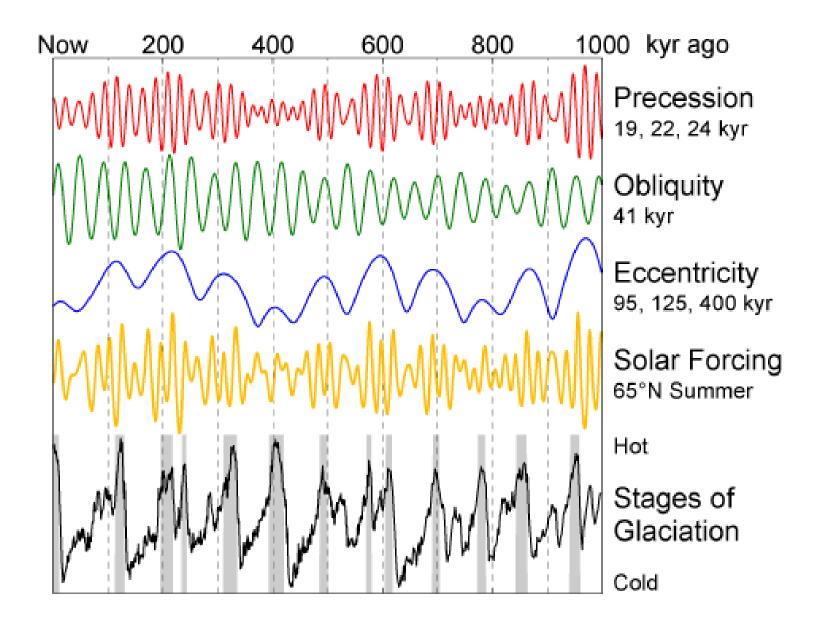


Average US coal electricity price vs. MMN11 and Epstein 2001 best estimate coal external costs.

### Rainfall decline in WA

Place	Annual rainfall (mm)			
	Early 1900s	Mid 1900s	Late 1900s to current	% change from early 1900s
Nabawa	470	455	418	-11.1
Geraldton	474	444	411	-13.3
Three Springs	399	404	357	-10.5
Coorow	404	398	355	-12.1
Moora	469	461	440	-6.2
Walebing	539	493	389	-27.8
Gingin	790	777	637	-19.4
York	464	458	415	-10.6
Wandering	686	609	541	-21.1
Wokalup	1021	962	874	-14.4
<b>Brunswick Junction</b>	1044	1025	915	-12.4
Capel	906	840	762	-15.9
Donnybrook	1045	1051	906	-13.3
Bridgetown	877	839	762	-13.1
Margaret River	1164	1180	1040	-10.7
Manjimup	1080	1022	929	-14.0
Mt Barker	777	770	670	-13.8
Albany	1013	935	882	-12.9
Average for all locations				-12.3

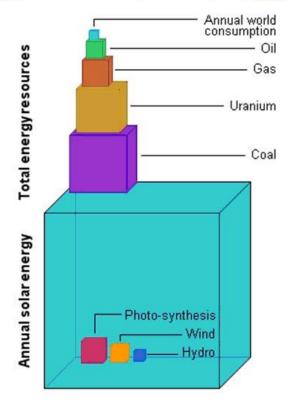
## Solar energy fluctuations



### World energy use versus how much is available



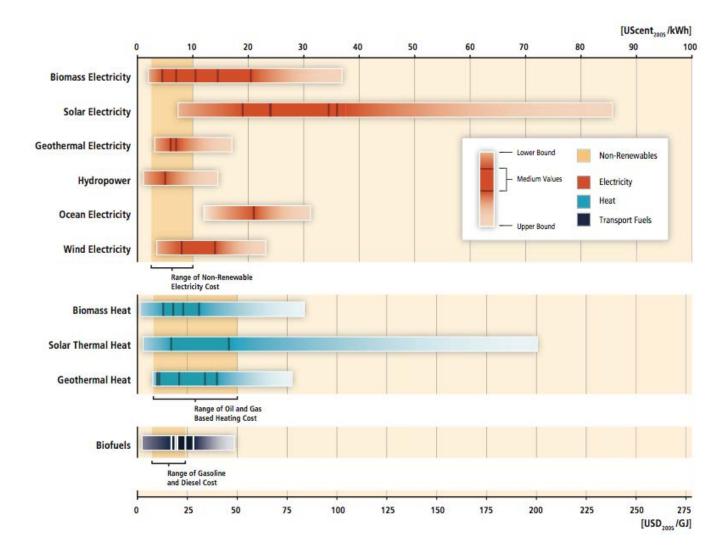
### Order of Magnitude of Energy Resources



Ref: World Energy Council (Conseil Mondial de L'Energie)

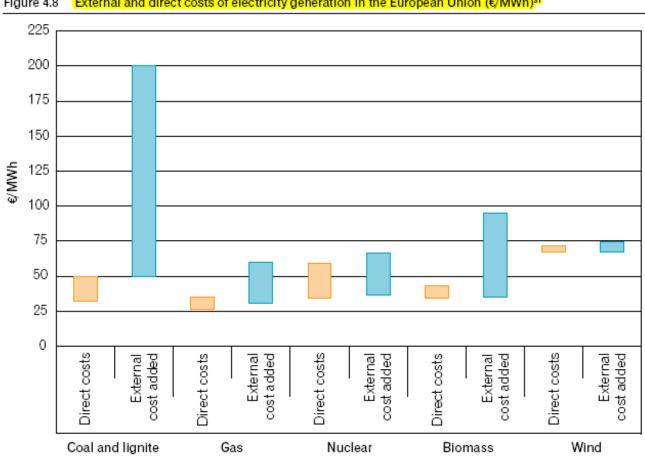


### Renewable energy costs



<u>IPCC SRREN 2011 figure</u>: range in recent levelised cost of energy for selected commercially available RE technologies in comparison to recent non-renewable energy costs.

### 'Externalised' Energy Costs



External and direct costs of electricity generation in the European Union (€/MWh)31 Figure 4.8

Source: ExternE<sup>[77]</sup>

<sup>31 €1 =</sup> A\$1.66, approximately