"The fatal consequences of atmospheric CO2-e levels over 350 ppm“ Implications for the Australian Capital Territory

Presentation to the ACT Government
Standing Committee on Climate Change, Environment and Water

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Australian National University

SUMMARY AND PRINCIPAL RECOMMENDATIONS

- The sensitivity of the atmosphere to greenhouse gas forcing has been underestimated.
- The atmosphere is tracking toward critical tipping points
- Canberra, as one of the CO_2 emission-intensive cities world-wide, is in the position to sent an example, by:

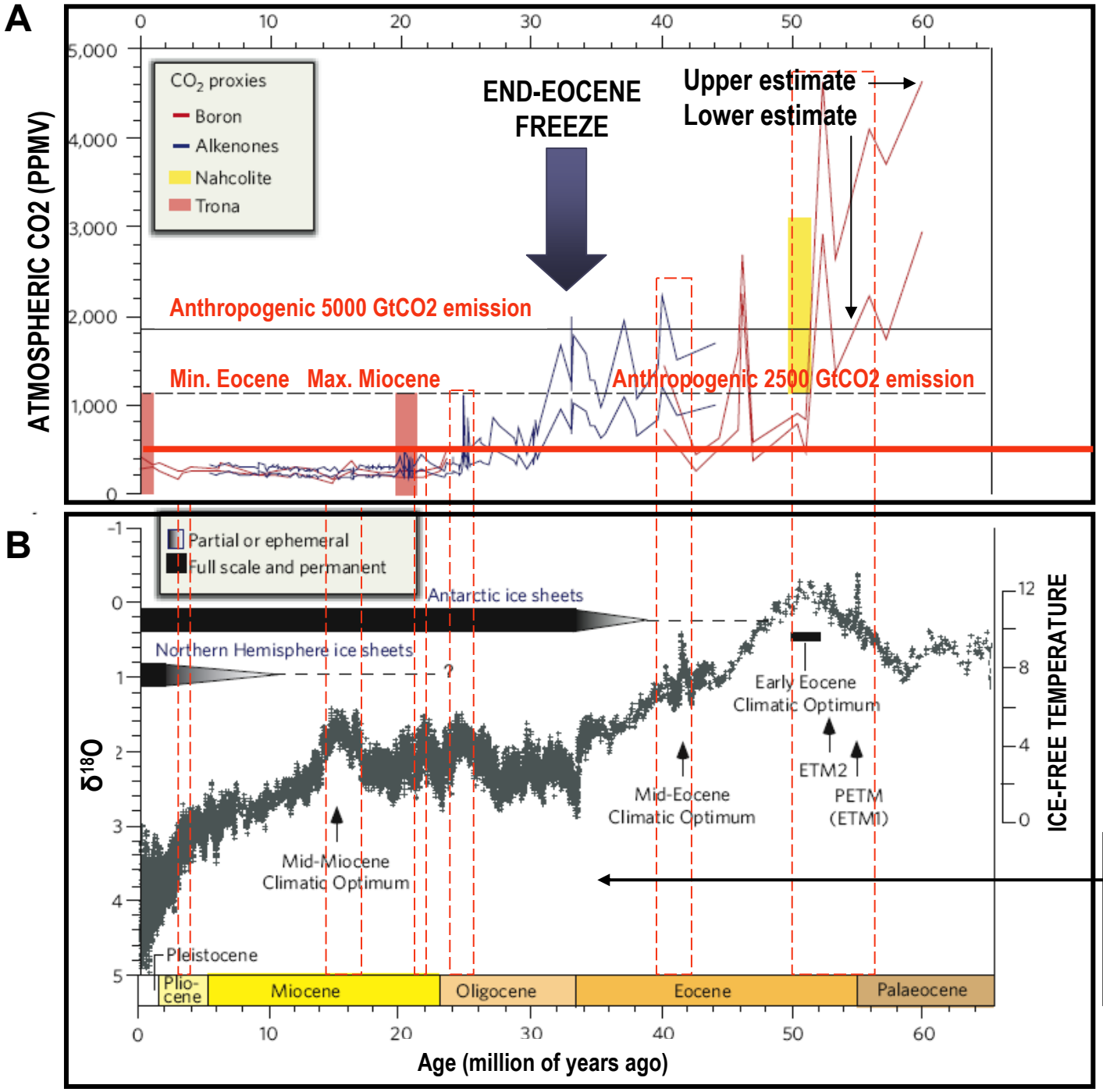
  A. Transition to electric train and bicycle transport system, restricting/taxing access of private fossil fuel vehicles into town centres

  B. Encouraging solar-thermal electricity generation.

  C. Located at the centre of a drought-stricken region, encouraging the Federal government to invest in North-South water pipeline systems

IT IS NOT TOO EARLY TO START THINKING IN TERMS OF LOCAL FOOD PRODUCTION (VEG GARDENS, CHOOKS ETC.)

THE HUMAN AND FINANCIAL COST OF INACTION WILL EXCEED THE COST OF ACTION BY ORDERS OF MAGNITUDE



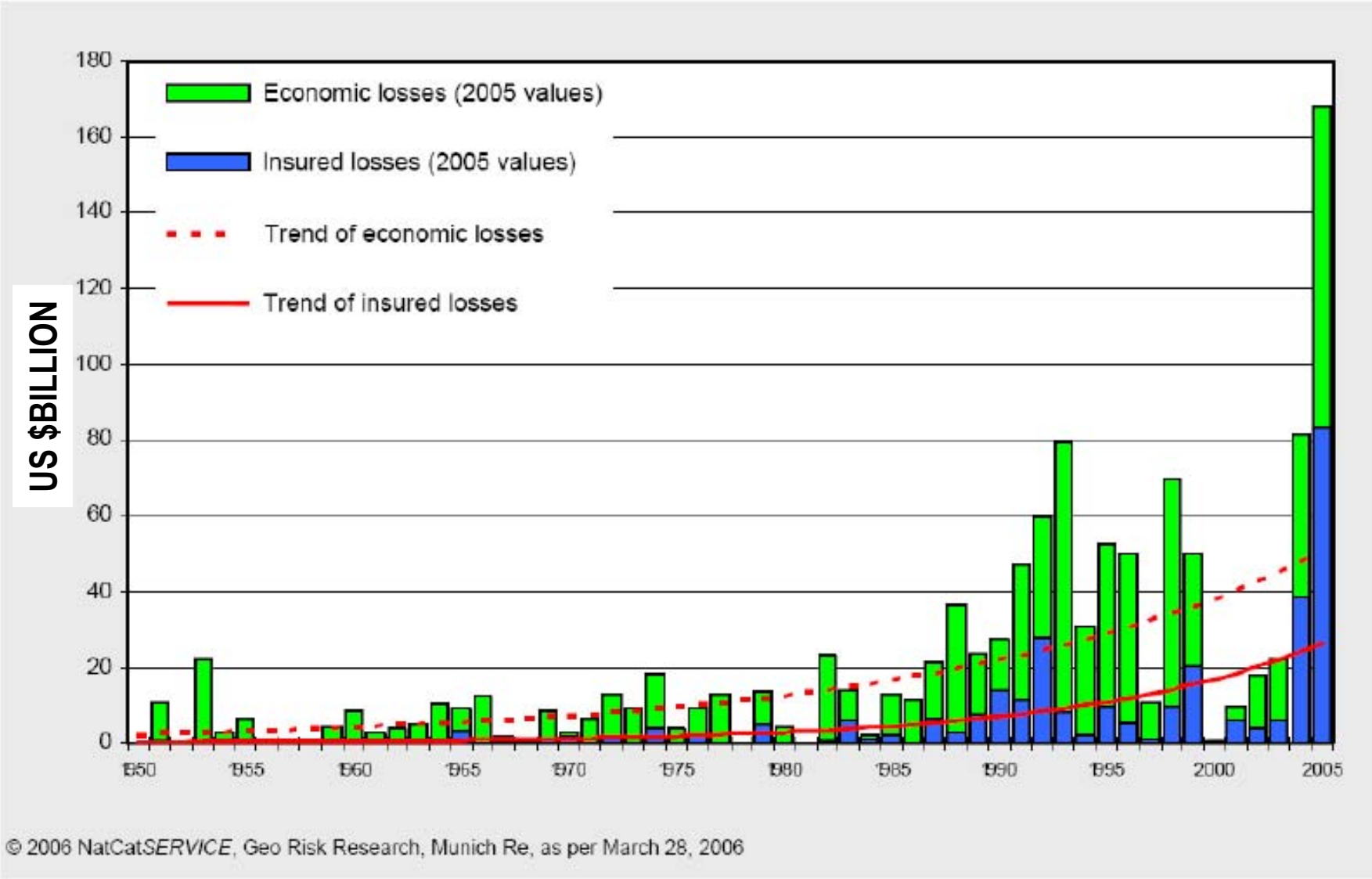
A. pCO2 compilation of marine and lacustrine proxy records.

500 ppm CO2

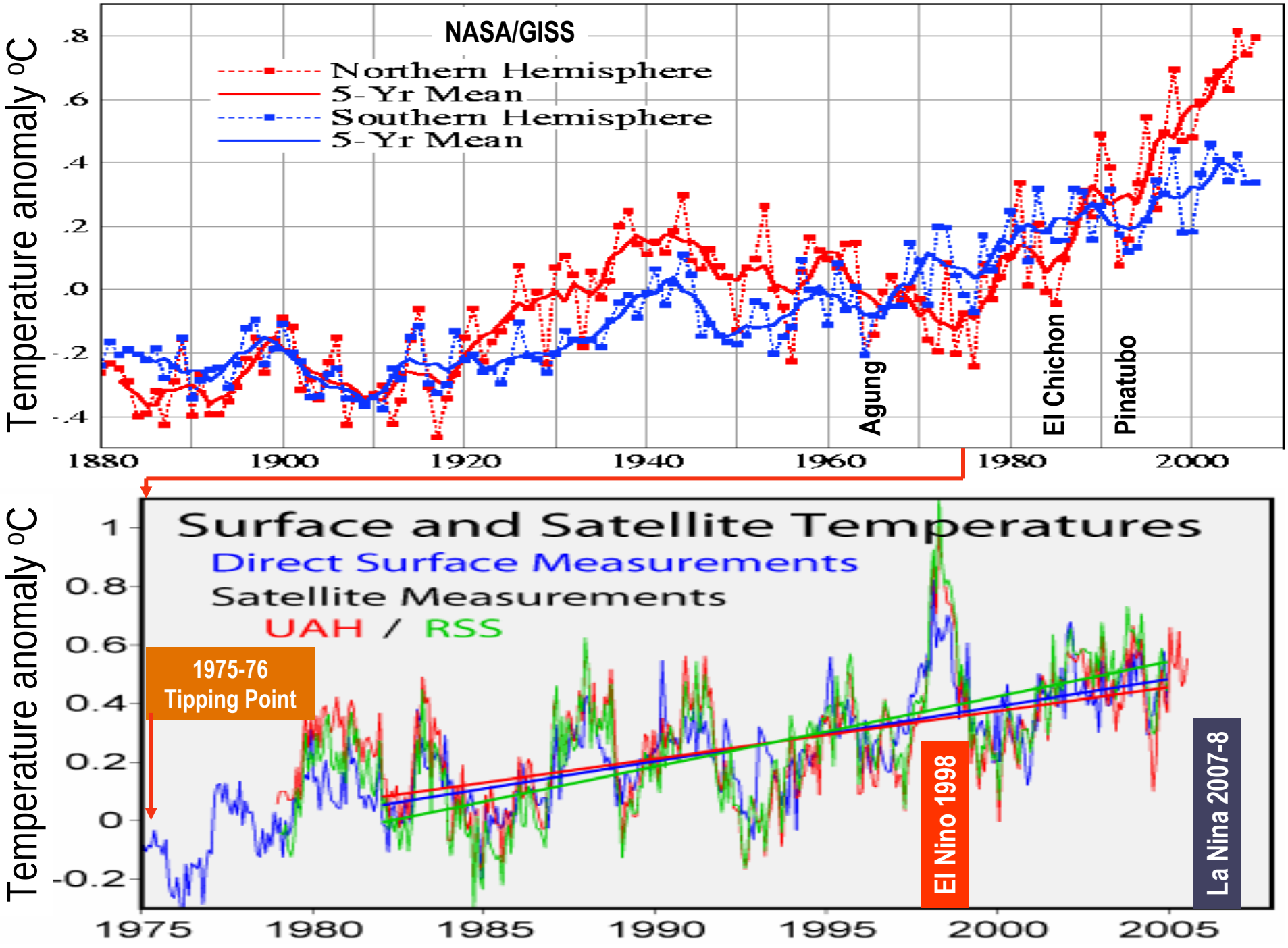
B. The climate for the same period (0 to 65 million years ago).

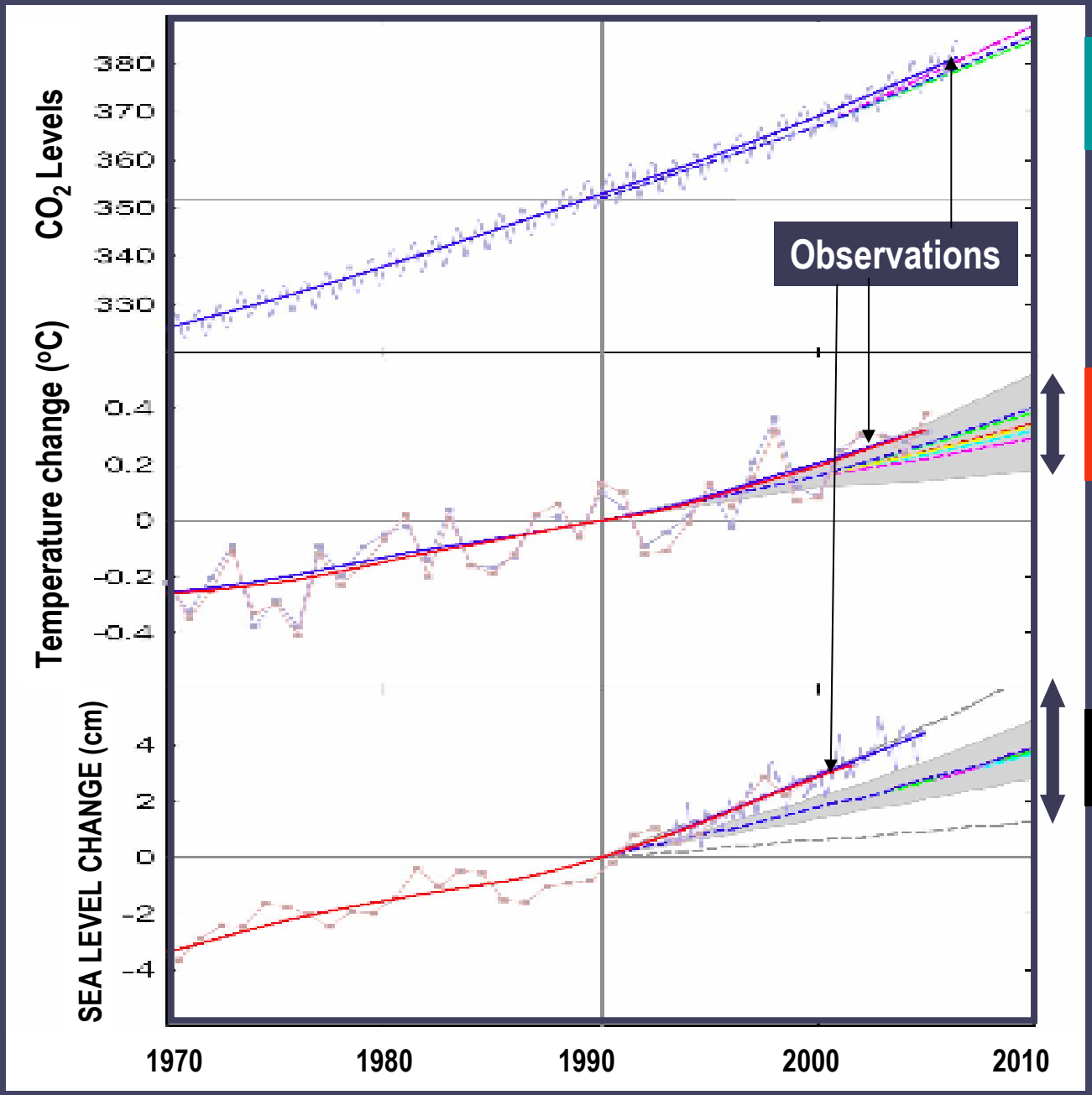
Zachos et al., 2008

Opening of Drake passage Isolates Antarctica from tropical warm water transport



Great weather disasters 1950-2004. NatCat*SERVICE*, Geo RiskResearch, Munich, 2006.

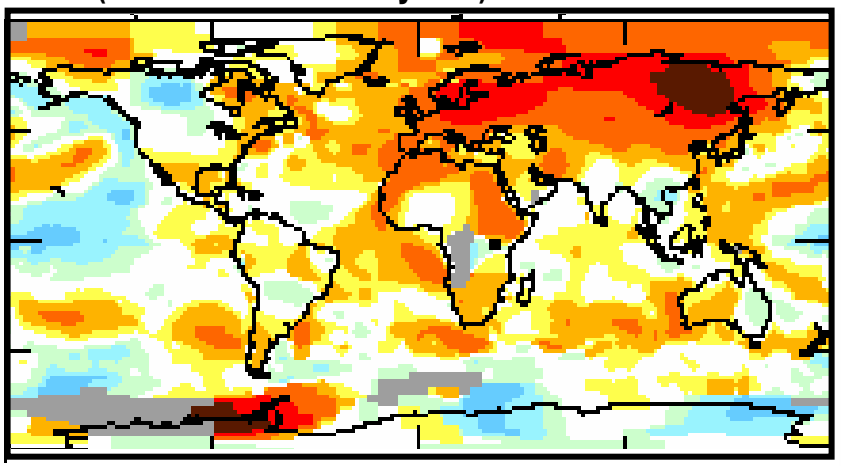

NASA/GISS
Northern Hemisphere
5-Yr Mean
Southern Hemisphere
5-Yr Mean
Temperature anomaly °C
.8
.6
.4
.2
.0
-.2
-.4
1880
1900
1920
1940
1960
1980
2000
Agung
El Chichon
Pinatubo
Surface and Satellite Temperatures
Direct Surface Measurements
Satellite Measurements
UAH / RSS
1975-76
Tipping Point
El Nino 1998
La Nina 2007-8
Temperature anomaly °C
1
0.8
0.6
0.4
0.2
0
-0.2
1975
1980
1985
1990
1995
2000
2005



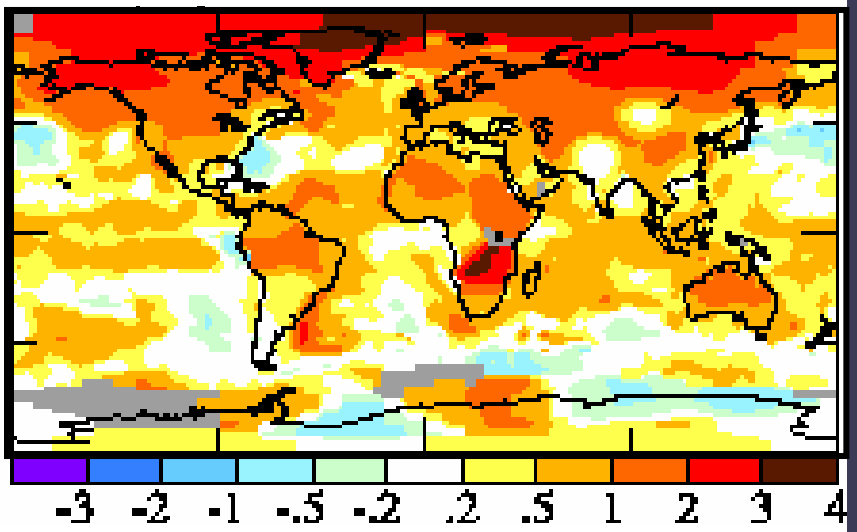
Rahmstorf et al., 2007 Recent Climate Observations Compared to Projections

RECENT GLOBAL WARMING

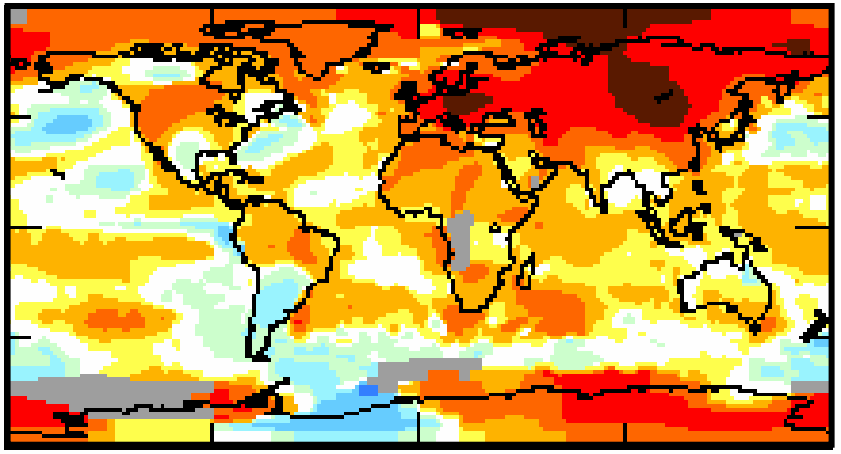
2008 (14th warmest of 129 years) +.0.37

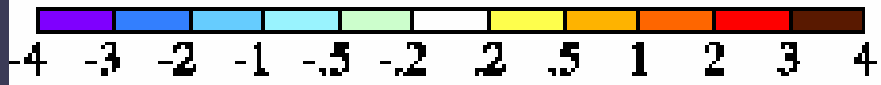


2005 (4th warmest of 129 years) +0.61



2007 (3rd warmest of 129 years) +0.61





Base period: 1951 - 1980

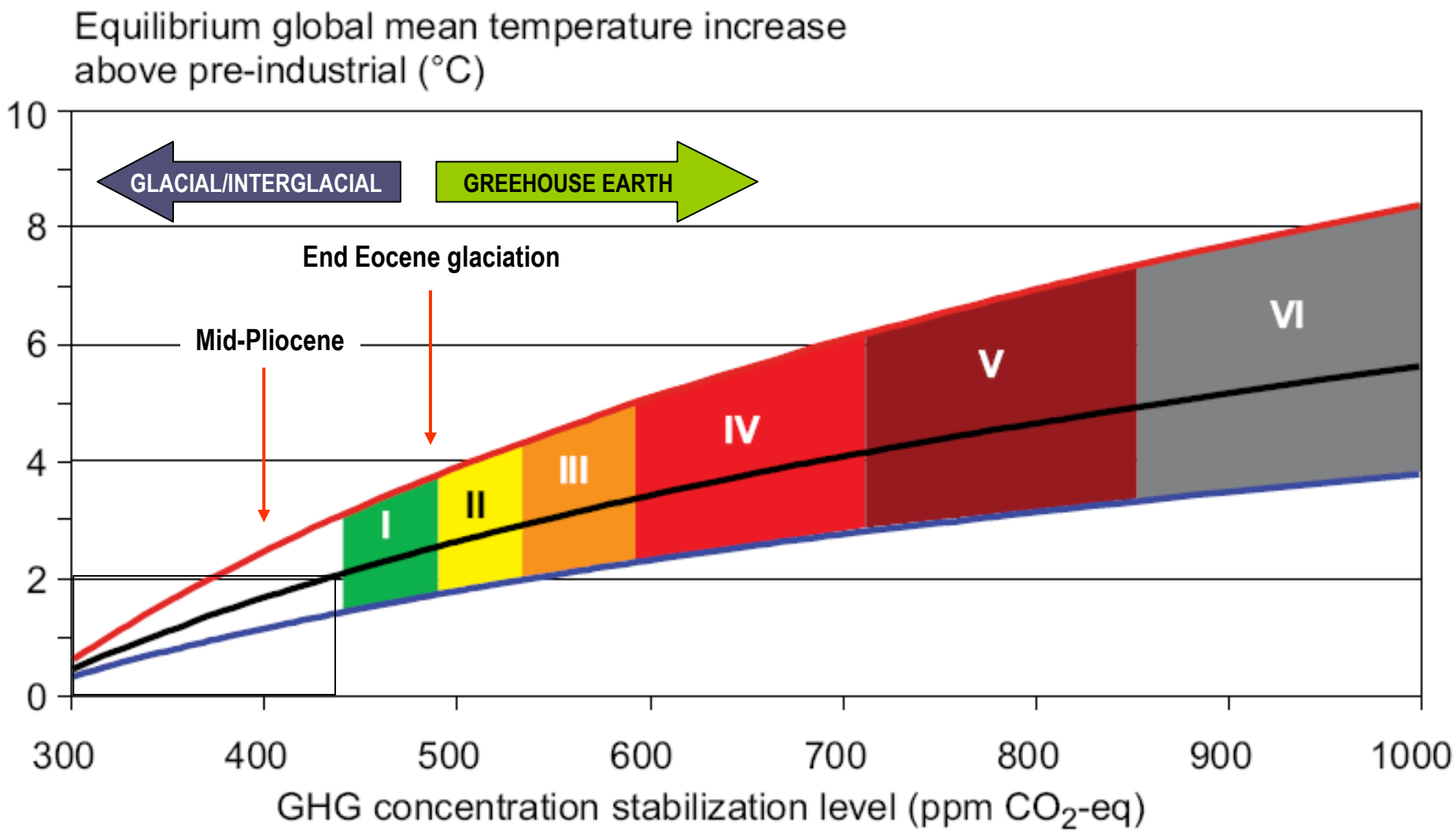
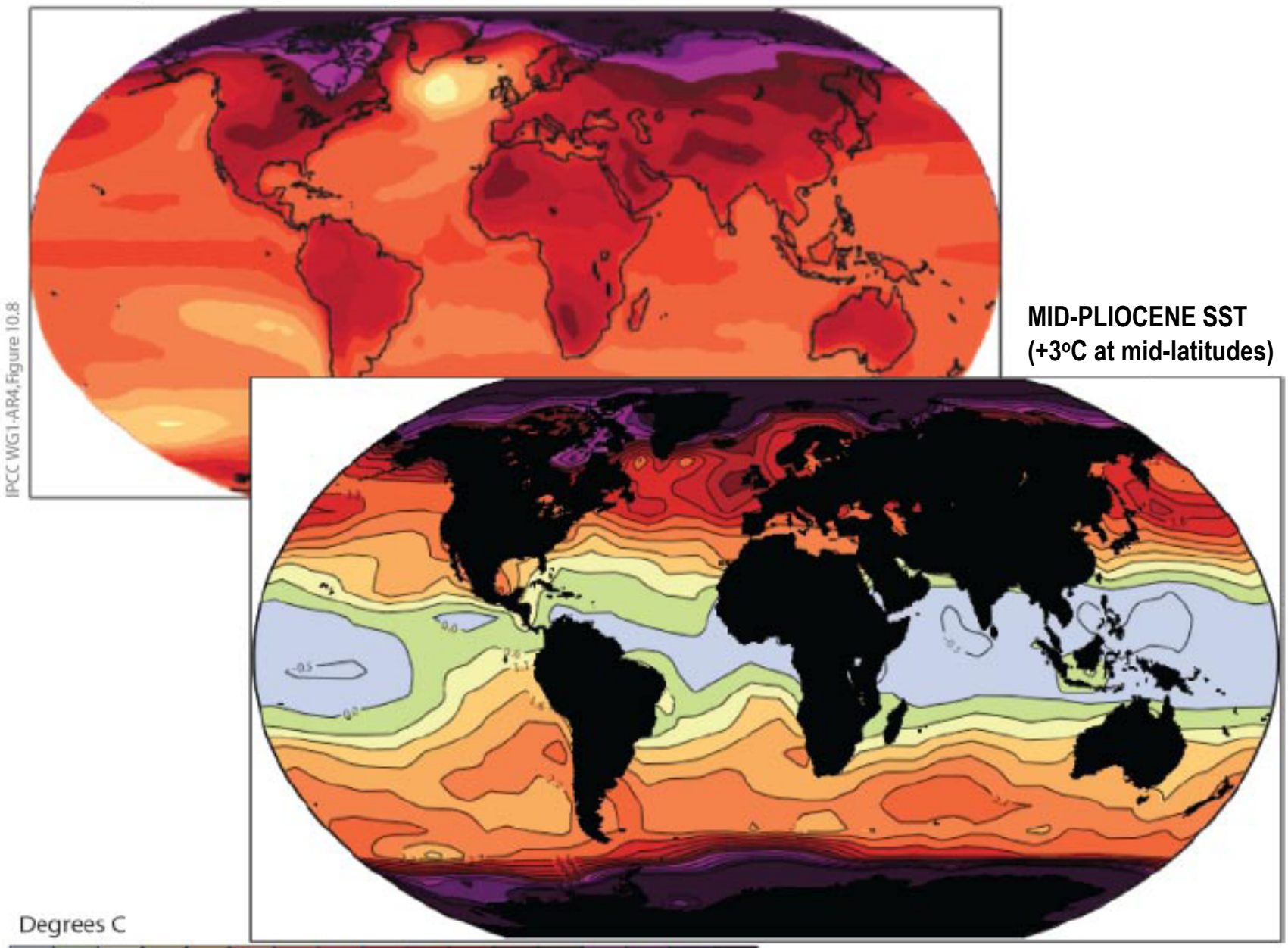


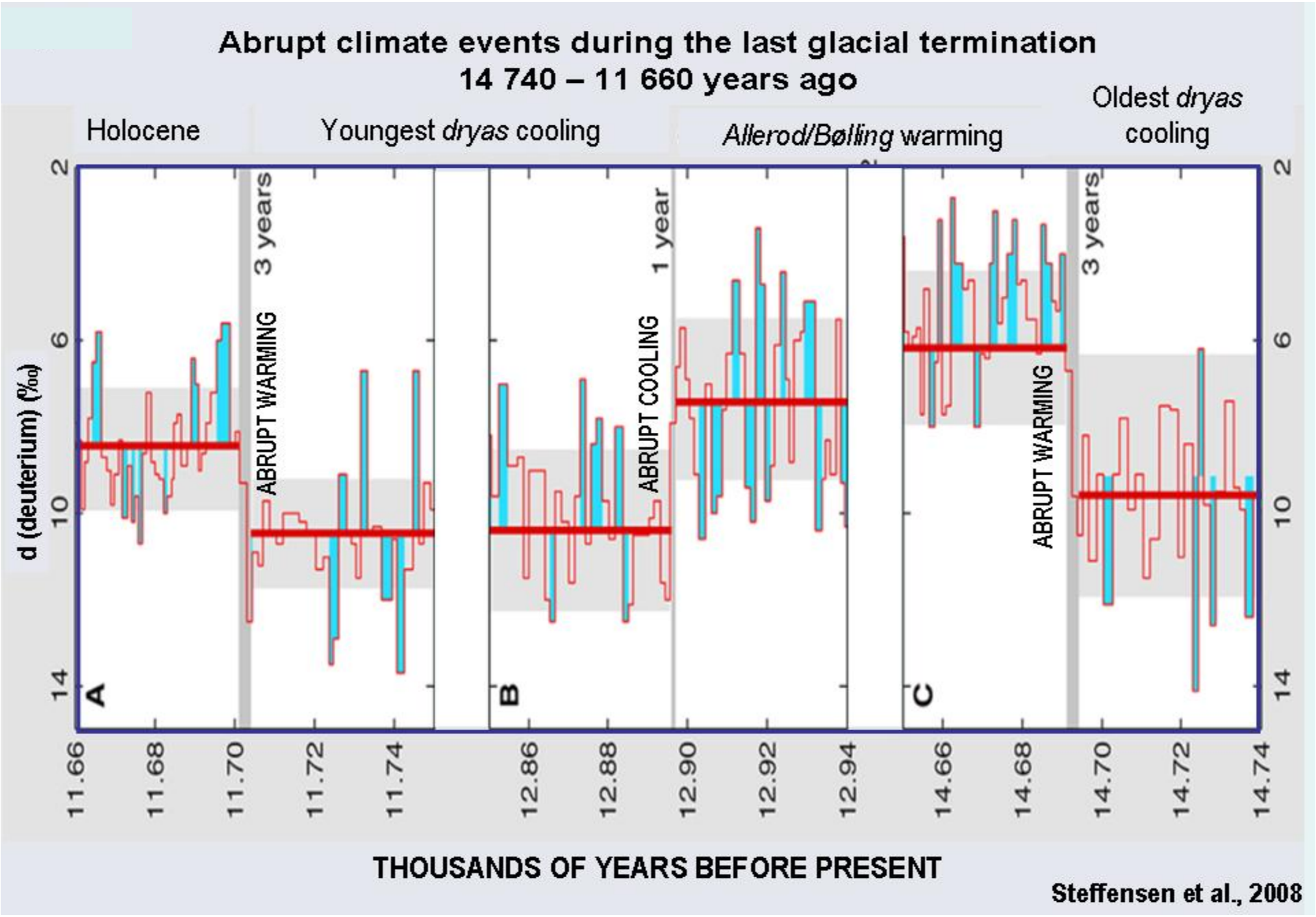
Figure SPM.8: *Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3°C (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5°C (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2°C (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories I to VI as indicated in Figure SPM.7. The data are drawn from AR4 WGI, Chapter 10.8.*

IPCC AR4 A2 SCENARIO (+ 2 – 5°C) (2090-2099)



Robinson et al., 2008,
Eos Vol. 89, No. 49, 2 December 2008

TIPPING POINTS: GLACIAL TERMINATIONS



2080-2099 relative to 1980-1999

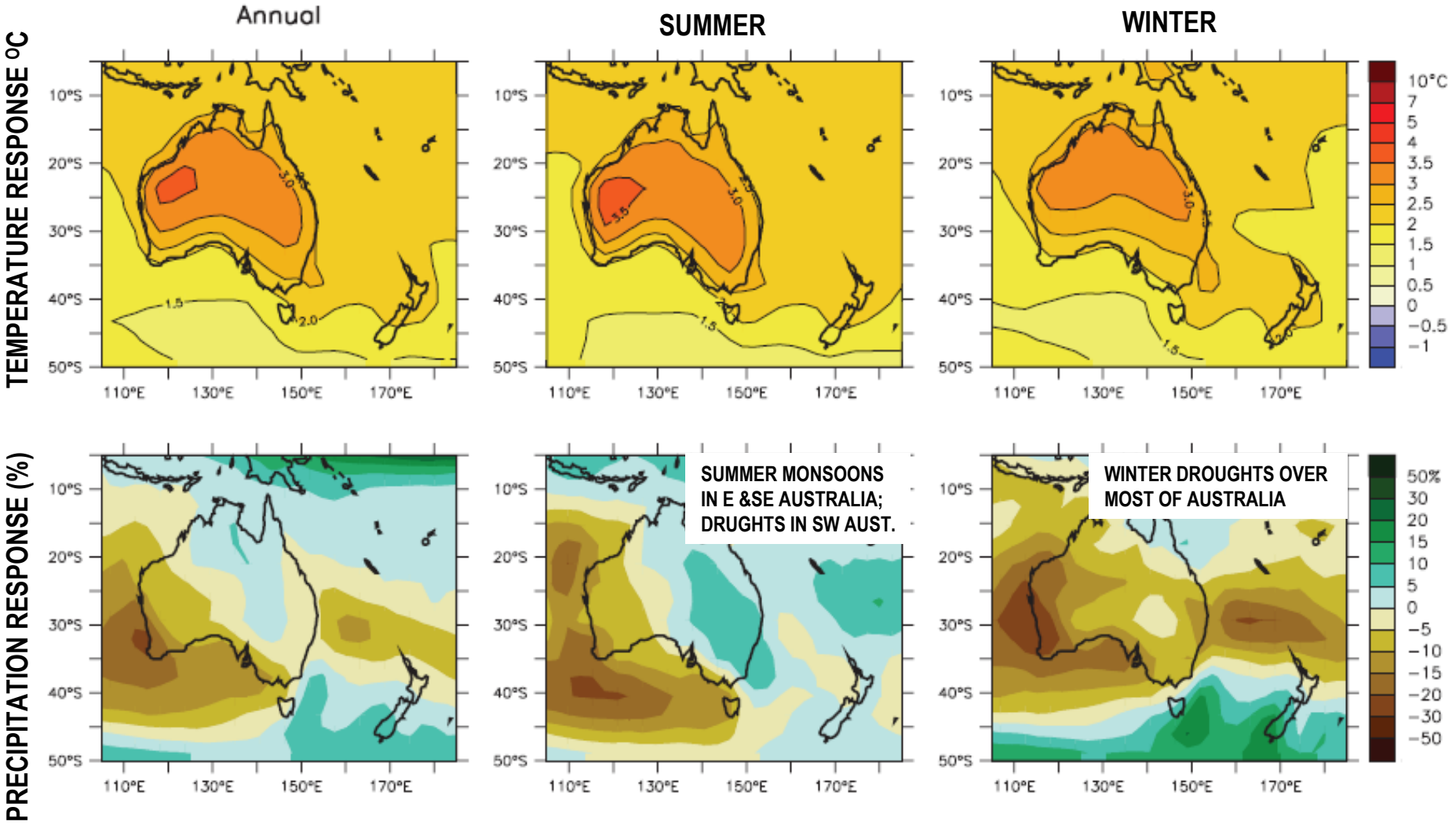
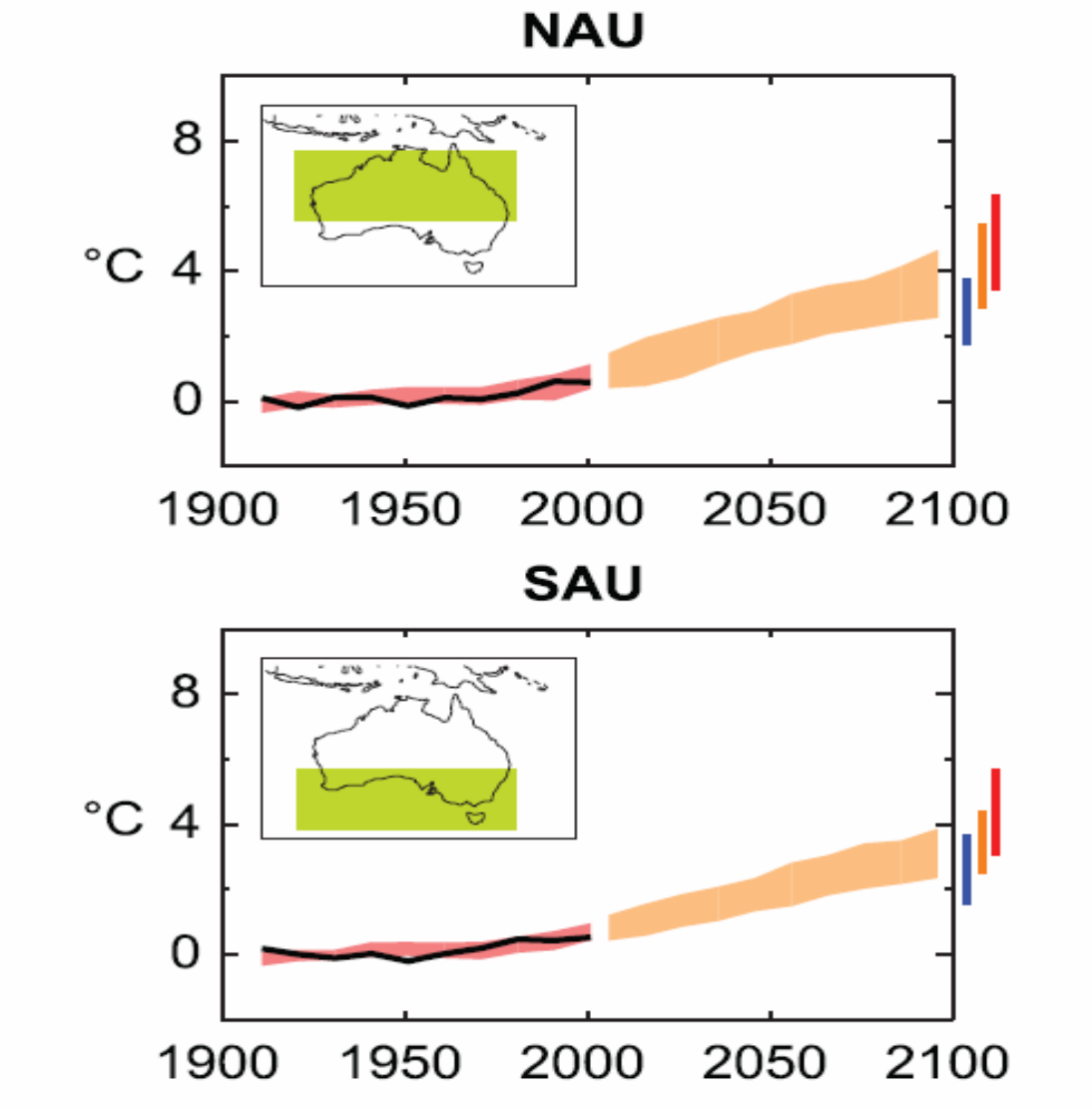


Figure 11.17. *Temperature and precipitation changes over Australia and New Zealand from the MMD-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation.*

http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch11.pdf



http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch11.pdf

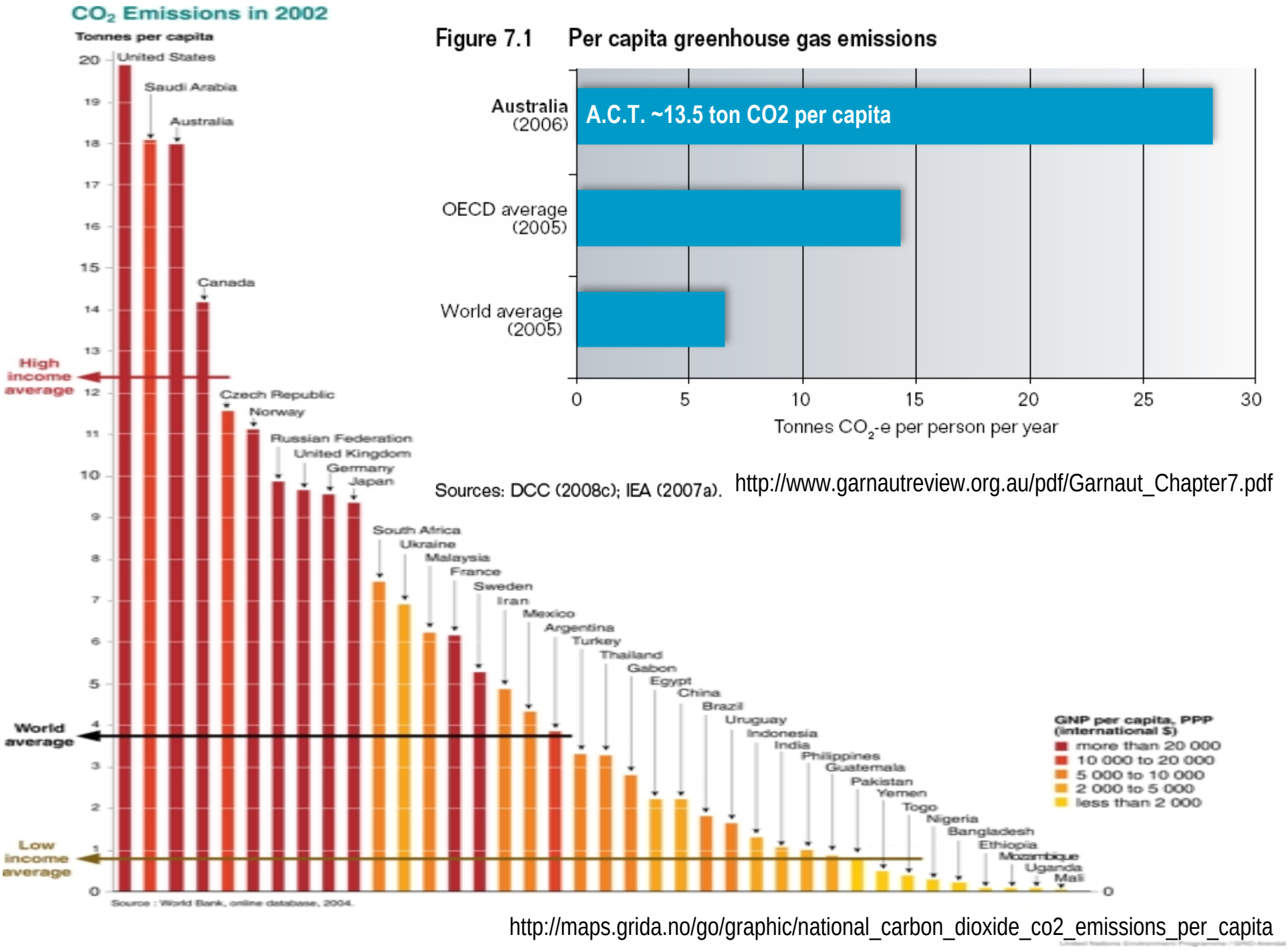


Figure 7.1 Per capita greenhouse gas emissions

Sources: DCC (2008c); IEA (2007a). http://www.garnautreview.org.au/pdf/Garnaut_Chapter7.pdf

http://maps.grida.no/go/graphic/national_carbon_dioxide_co2_emissions_per_capita

Emissions sources	Emission estimates (Mt carbon dioxide equivalents)			
	1990	1997	2000	2008*
Gas	0.128	0.264	0.292	0.495
Electricity	2.238	2.243	2.363	2.658
Transport	0.787	0.921	0.954	1.043
Waste	0.335	0.346	0.305	0.341
Other	0.068	0.071	0.670	0.067
Total	3.557	3.846	3.980	4.605

X3.8

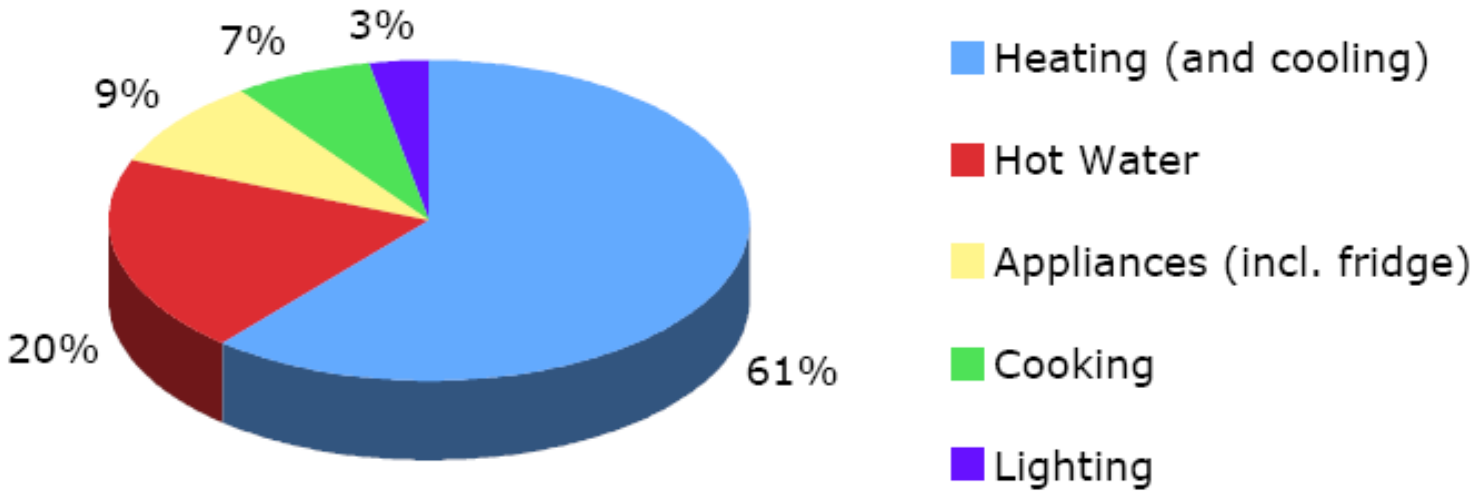
X1.2

X1.3

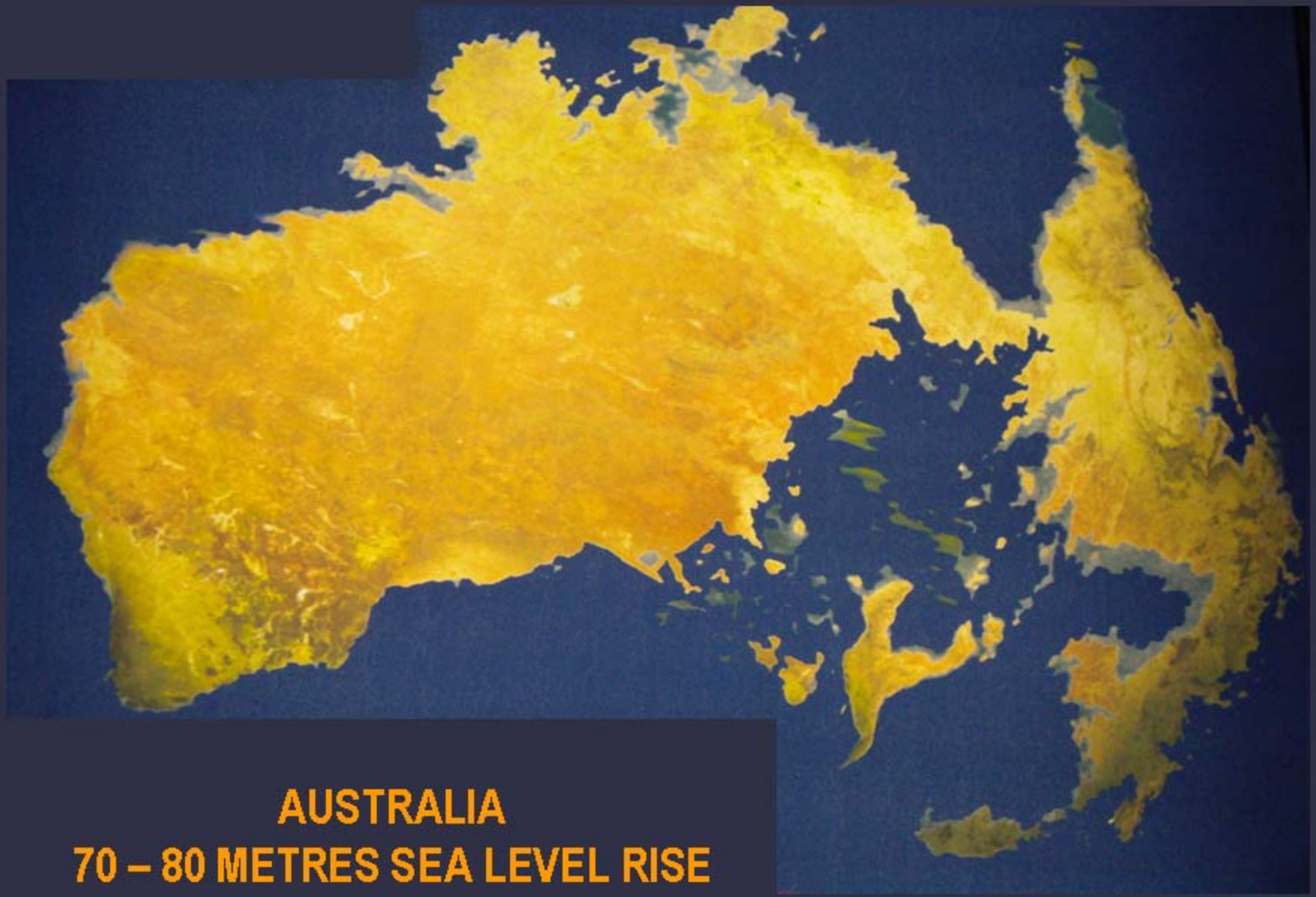
X1.29 in 18 yr
1.6% per year

Source: http://www.environmentcommissioner.act.gov.au/soe/2003actreport/climateandgreenhouse03

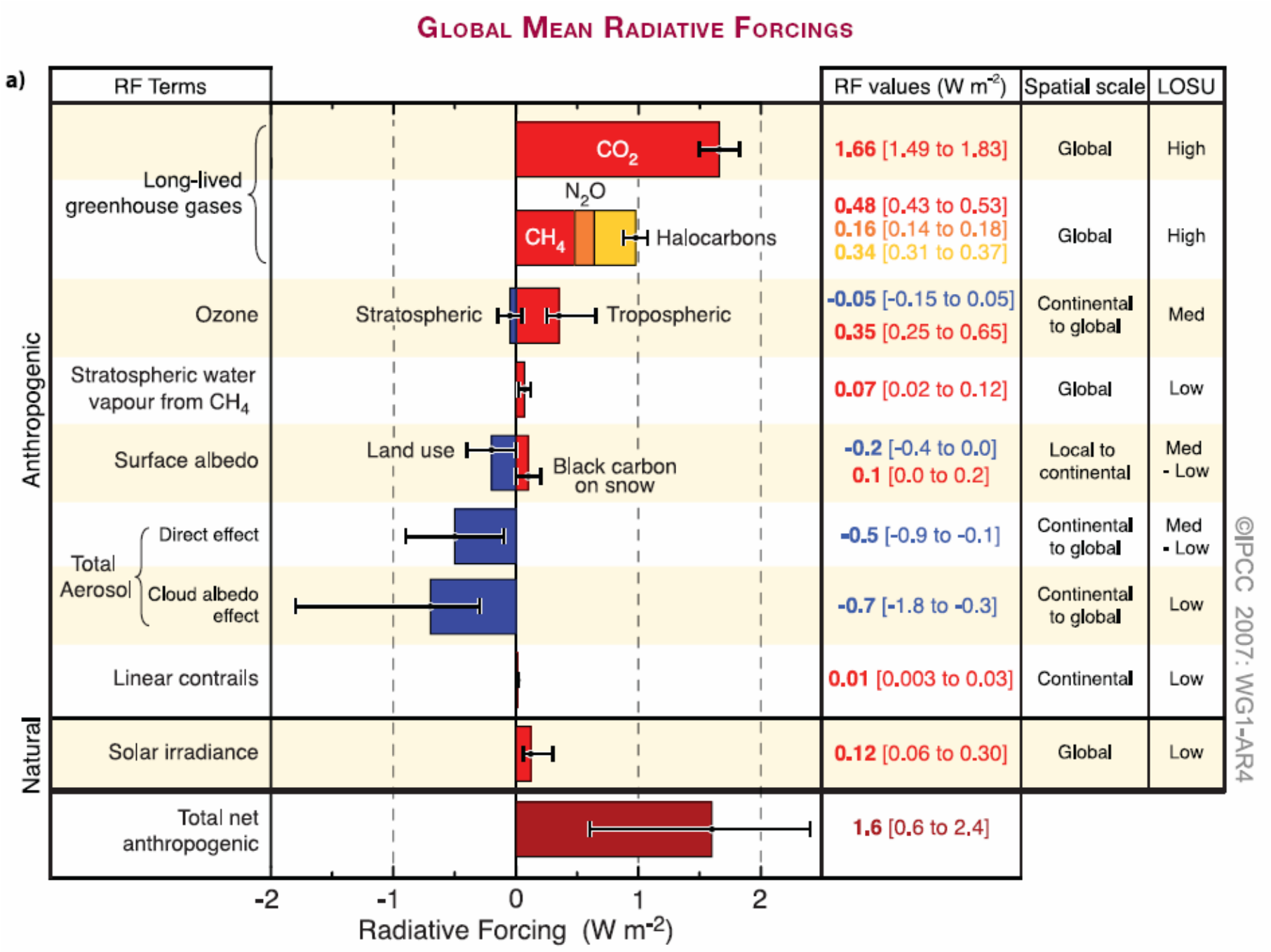
Global 2008 1.66 ppm/yr



Energy use in the average Canberra household


AUSTRALIA
70 – 80 METRES SEA LEVEL RISE

THE ROLE OF CARBON GASES


GLOBAL MEAN RADIATIVE FORCINGS
a)
RF Terms
RF values (W m-2)
Spatial scale
LOSU
Anthropogenic
Natural
Long-lived greenhouse gases
CO2
N2O
CH4
Halocarbons
1.66 [1.49 to 1.83]
Global
High
0.48 [0.43 to 0.53]
0.16 [0.14 to 0.18]
0.34 [0.31 to 0.37]
Global
High
Ozone
Stratospheric
Tropospheric
-0.05 [-0.15 to 0.05]
0.35 [0.25 to 0.65]
Continental to global
Med
Stratospheric water vapour from CH4
0.07 [0.02 to 0.12]
Global
Low
Surface albedo
Land use
Black carbon on snow
-0.2 [-0.4 to 0.0]
0.1 [0.0 to 0.2]
Local to continental
Med - Low
Total Aerosol
Direct effect
-0.5 [-0.9 to -0.1]
Continental to global
Med - Low
Cloud albedo effect
-0.7 [-1.8 to -0.3]
Continental to global
Low
Linear contrails
0.01 [0.003 to 0.03]
Continental
Low
Solar irradiance
0.12 [0.06 to 0.30]
Global
Low
Total net anthropogenic
1.6 [0.6 to 2.4]
-2
-1
0
1
2
Radiative Forcing (W m-2)
©IPCC 2007: WG1-AR4

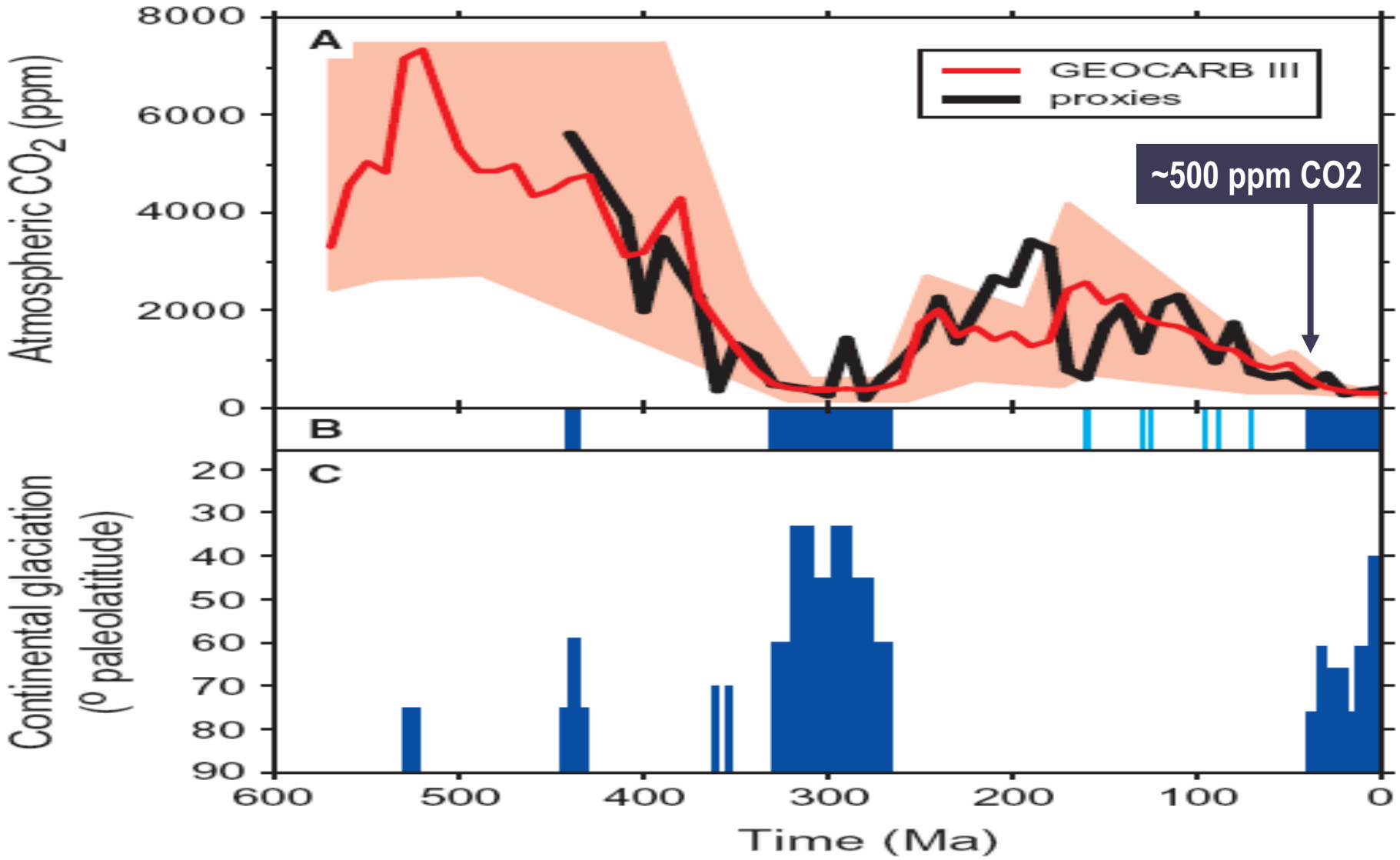
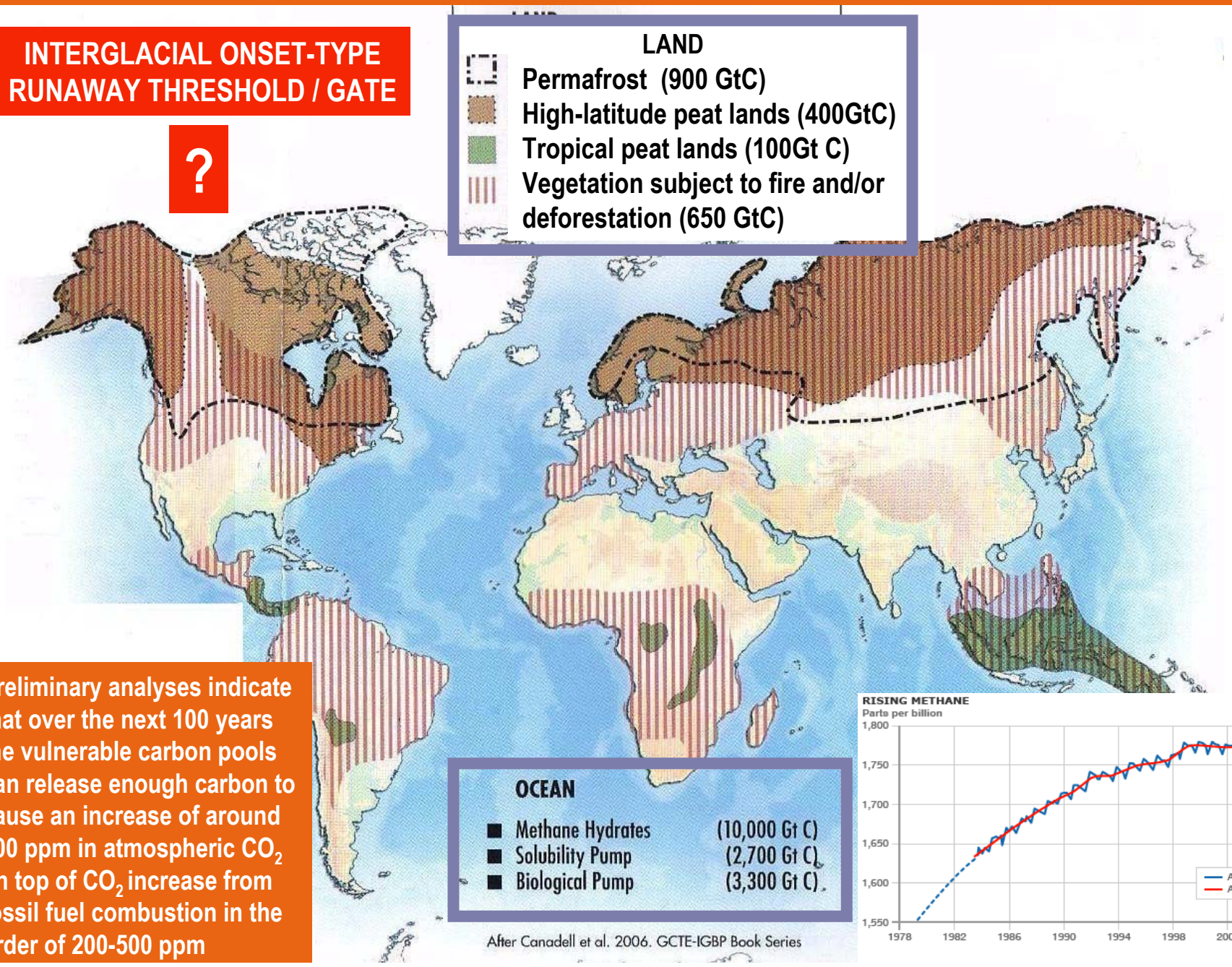


Figure 2. CO_2 and climate. **A:** Comparison of model predictions (GEOCARB III; Berner and Kothavala, 2001) and proxy reconstructions of CO_2. 10 m.y. time-steps are used in both curves. Shaded area represents range of error for model predictions. **B:** Intervals of glacial (dark blue) or cool climates (light blue; see text). **C:** Latitudinal distribution of direct glacial evidence (tillites, striated bedrock, etc.) throughout the Phanerozoic (Crowley, 1998).

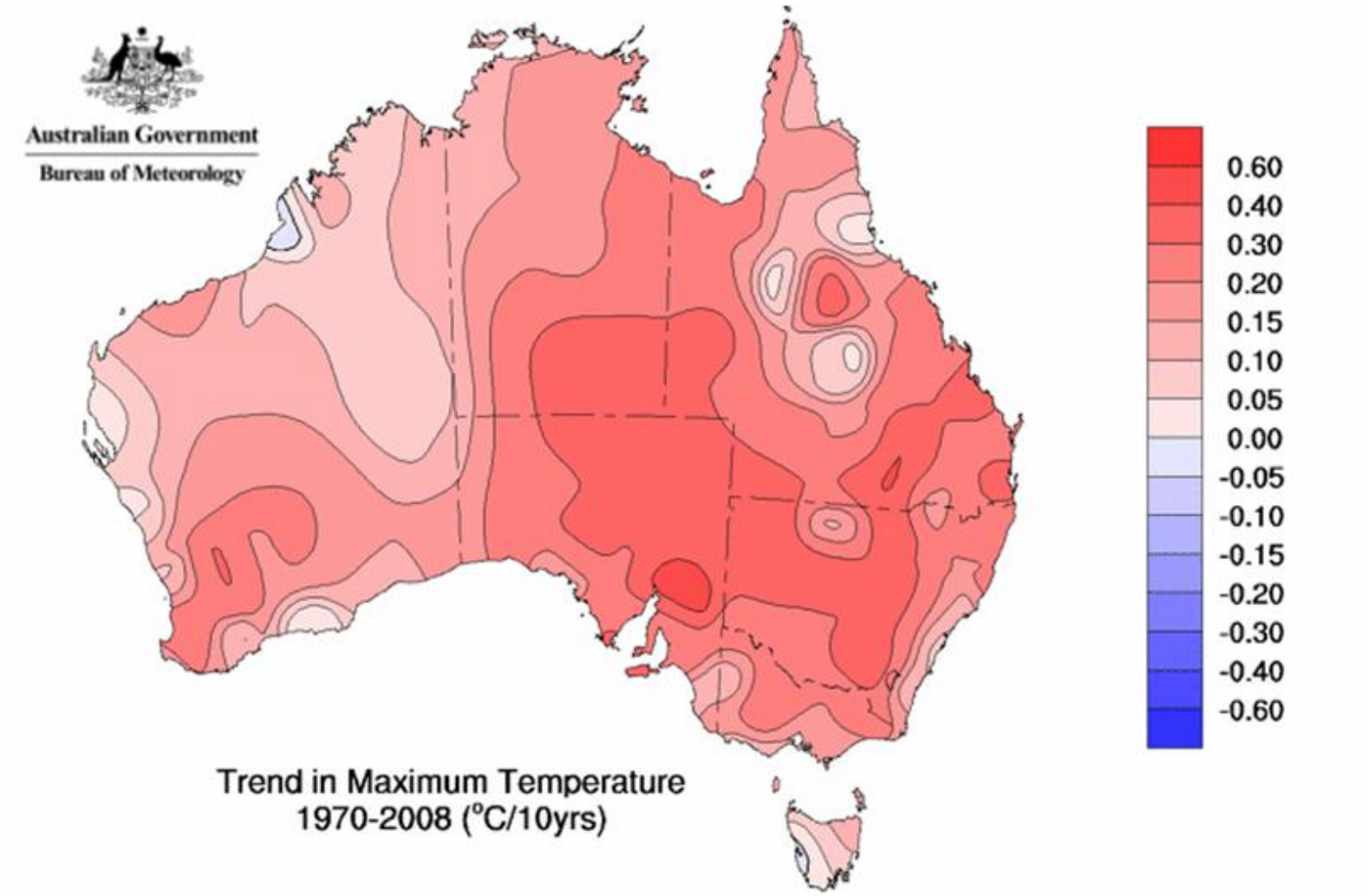
Future risk: Vulnerable carbon sinks

INTERGLACIAL ONSET-TYPE RUNAWAY THRESHOLD / GATE

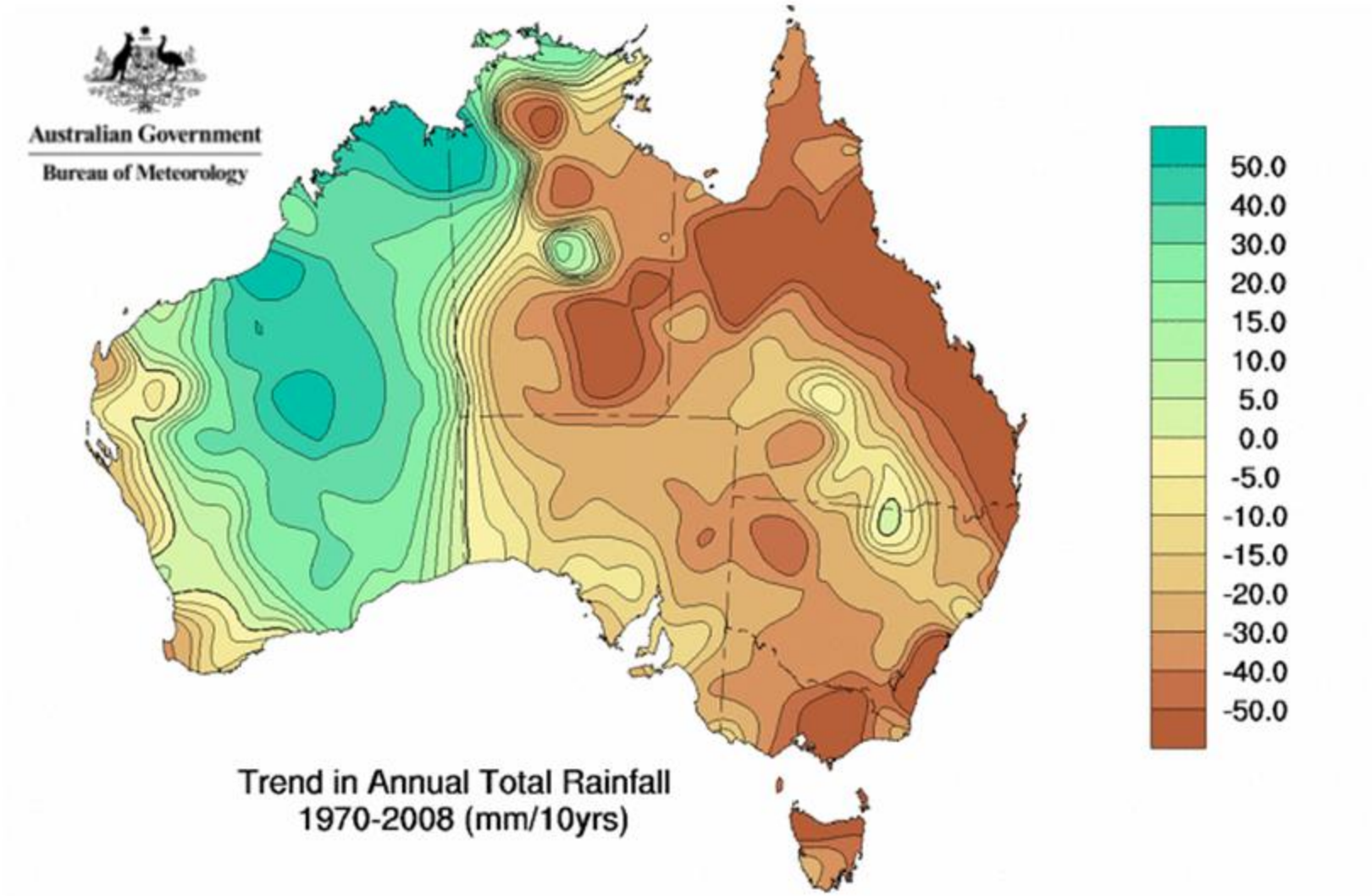
?



Preliminary analyses indicate that over the next 100 years the vulnerable carbon pools can release enough carbon to cause an increase of around 200 ppm in atmospheric CO_2 on top of CO_2 increase from fossil fuel combustion in the order of 200-500 ppm



Issued: 05/01/2009



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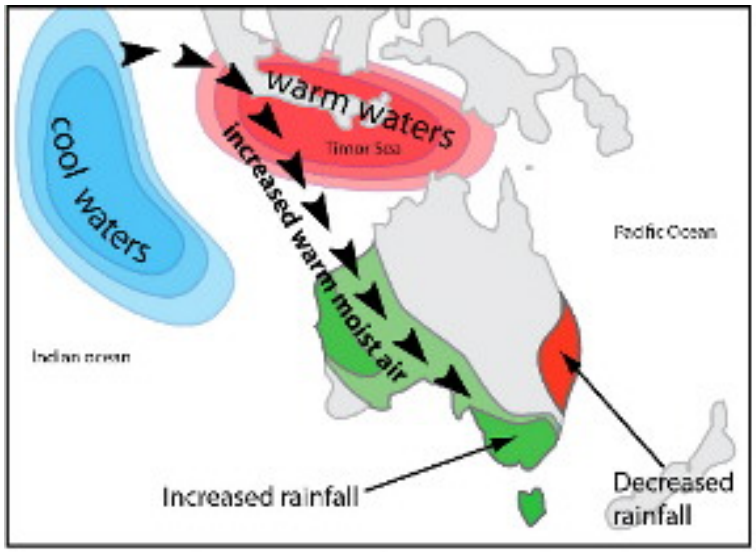
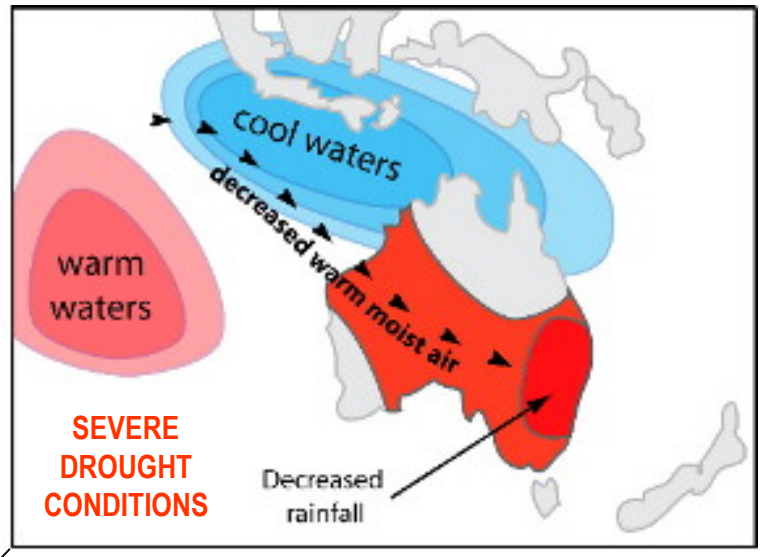
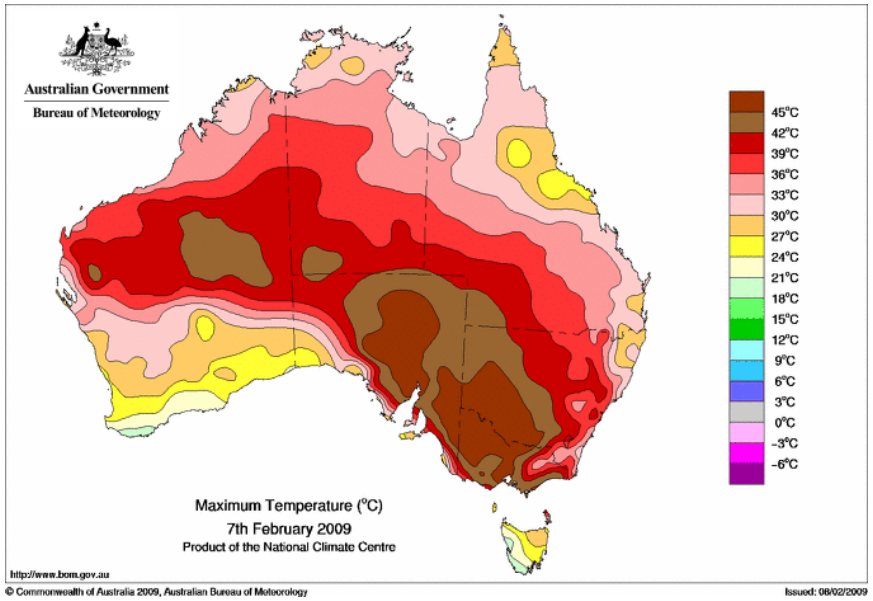


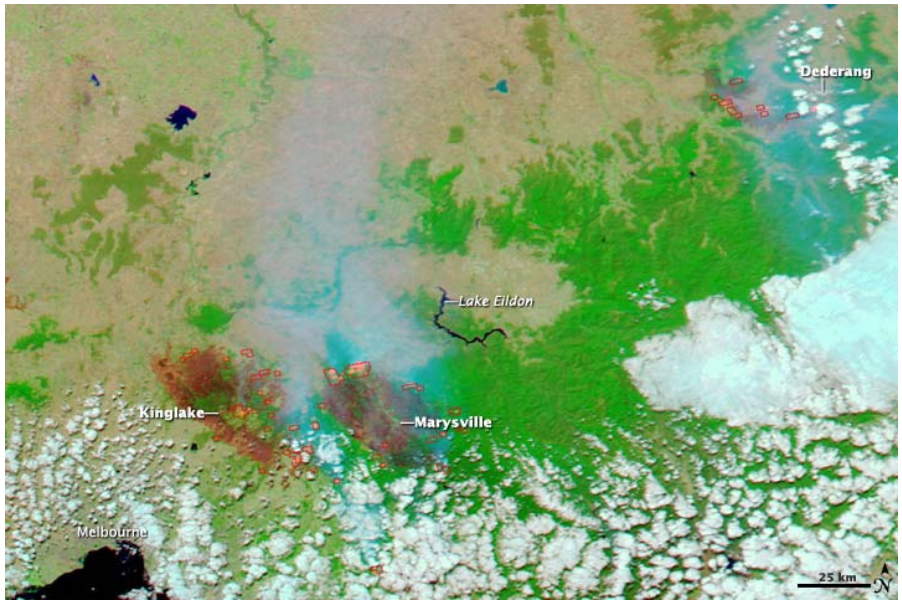
Negative phase: cool Indian Ocean water drives moist warm air and brings normal rainfall.



Positive phase: warm Indian Ocean water leads to weaker, drier winds and less rainfall.
http://www.science.unsw.edu.au/news/indian-ocean-drought/

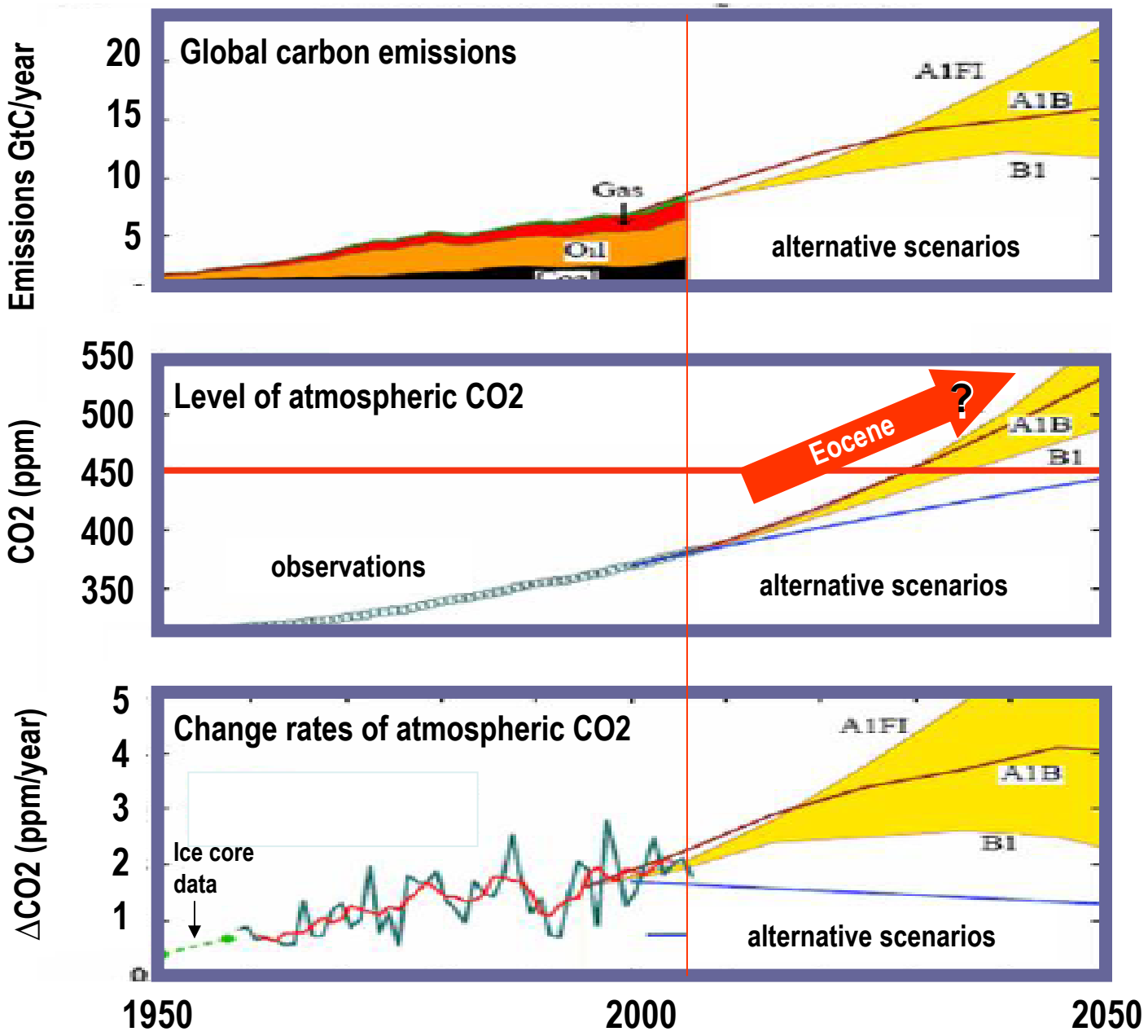
Maximum temperatures for 7 February 2009



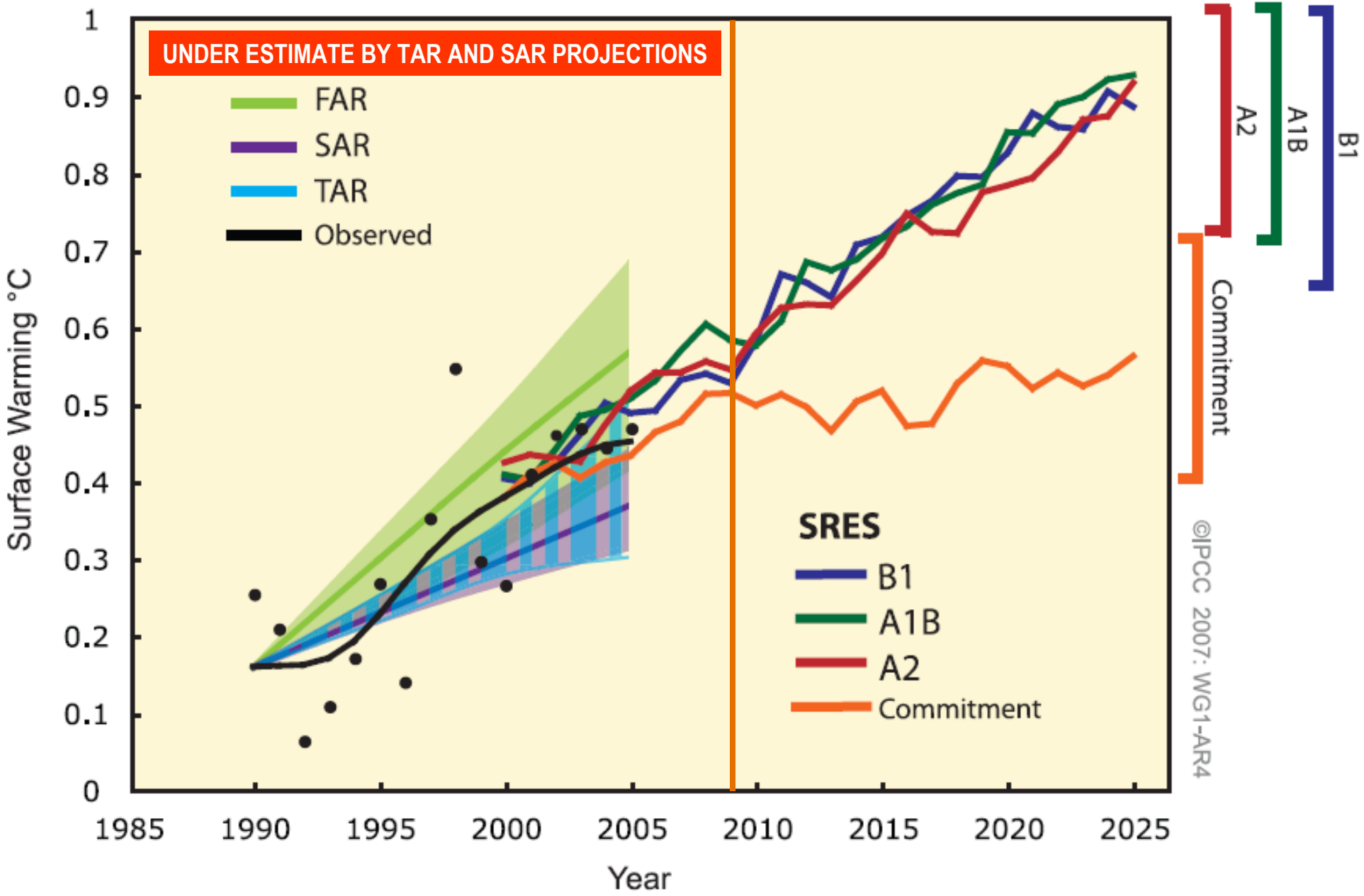


PROJECTIONS AND MIITIGATION

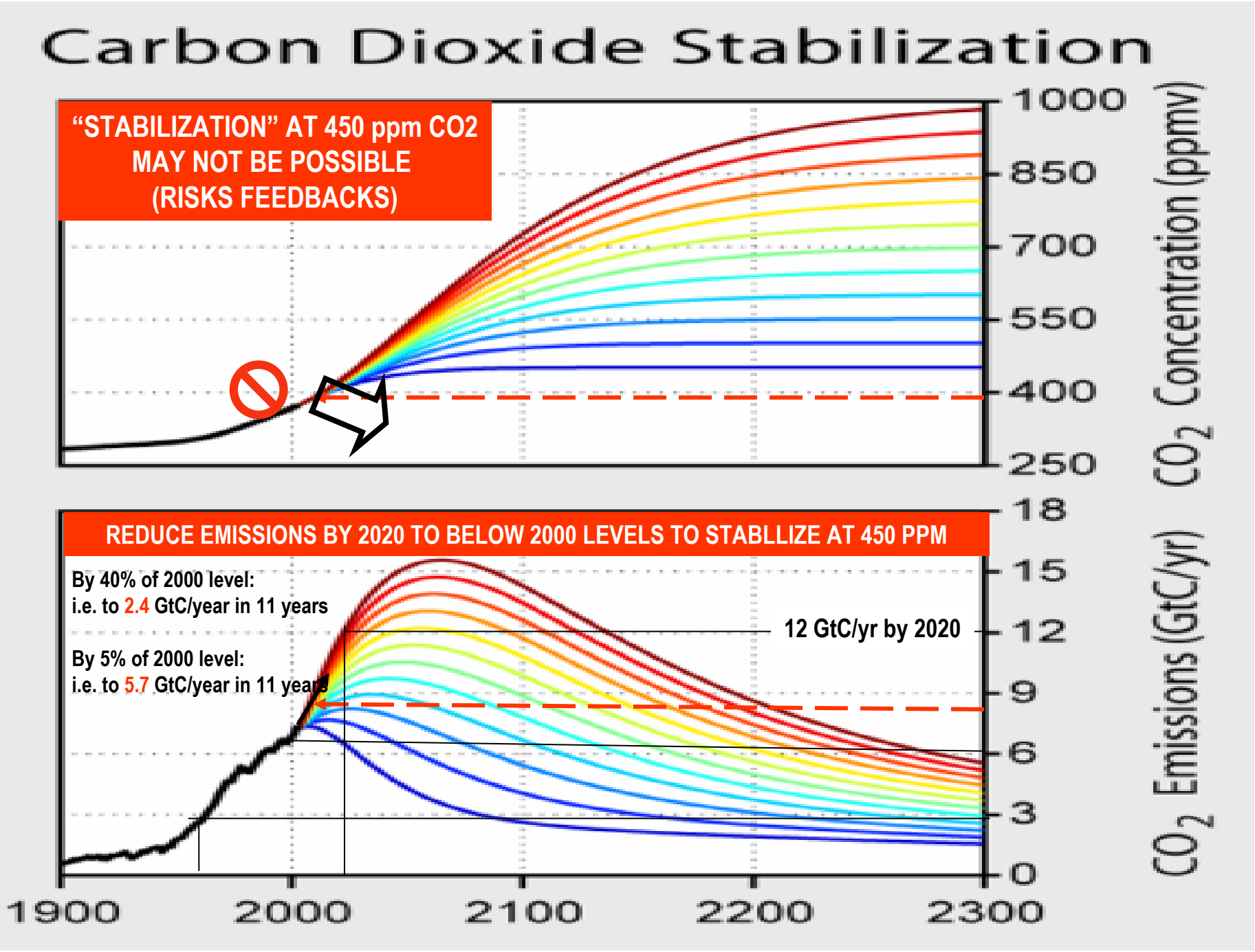
CARBON EMISSIONS AND ATMOSPHERIC CO2 LEVELS 1950 - 2008



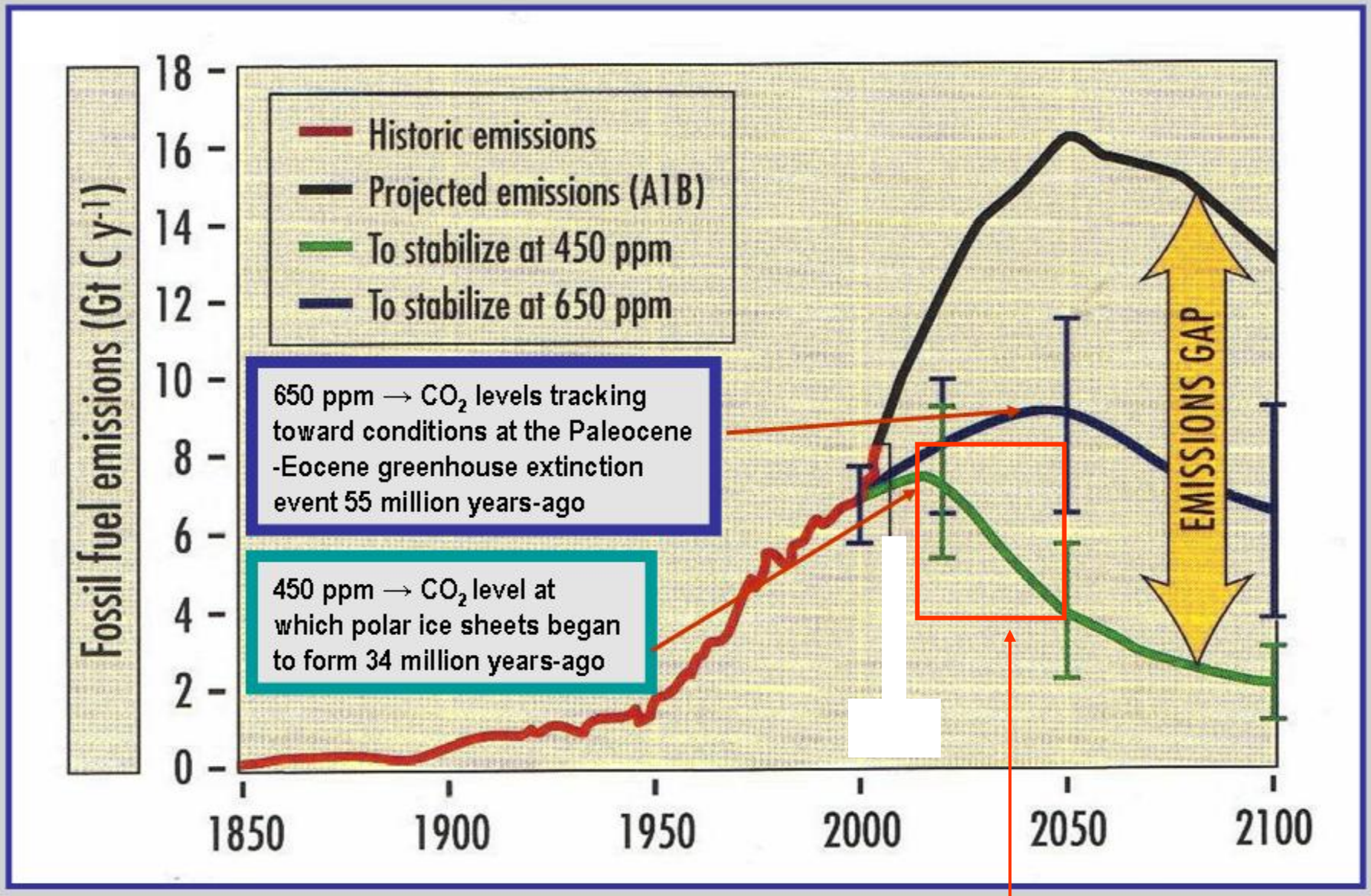
Hansen et al., 2008


GLOBAL MEAN WARMING:
MODEL PROJECTIONS COMPARED WITH OBSERVATIONS
UNDER ESTIMATE BY TAR AND SAR PROJECTIONS
FAR
SAR
TAR
Observed
SRES
B1
A1B
A2
Commitment
A2
A1B
B1
Commitment
Surface Warming °C
Year
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1990
1995
2000
2005
2010
2015
2020
2025
©IPCC 2007: WG1-AR4

Carbon Dioxide Stabilization



http://www.globalwarmingart.com/wiki/Image:Carbon_Stabilization_Scenarios_png



- 0.1 GtC/year = 1.25% Emission reduction each year

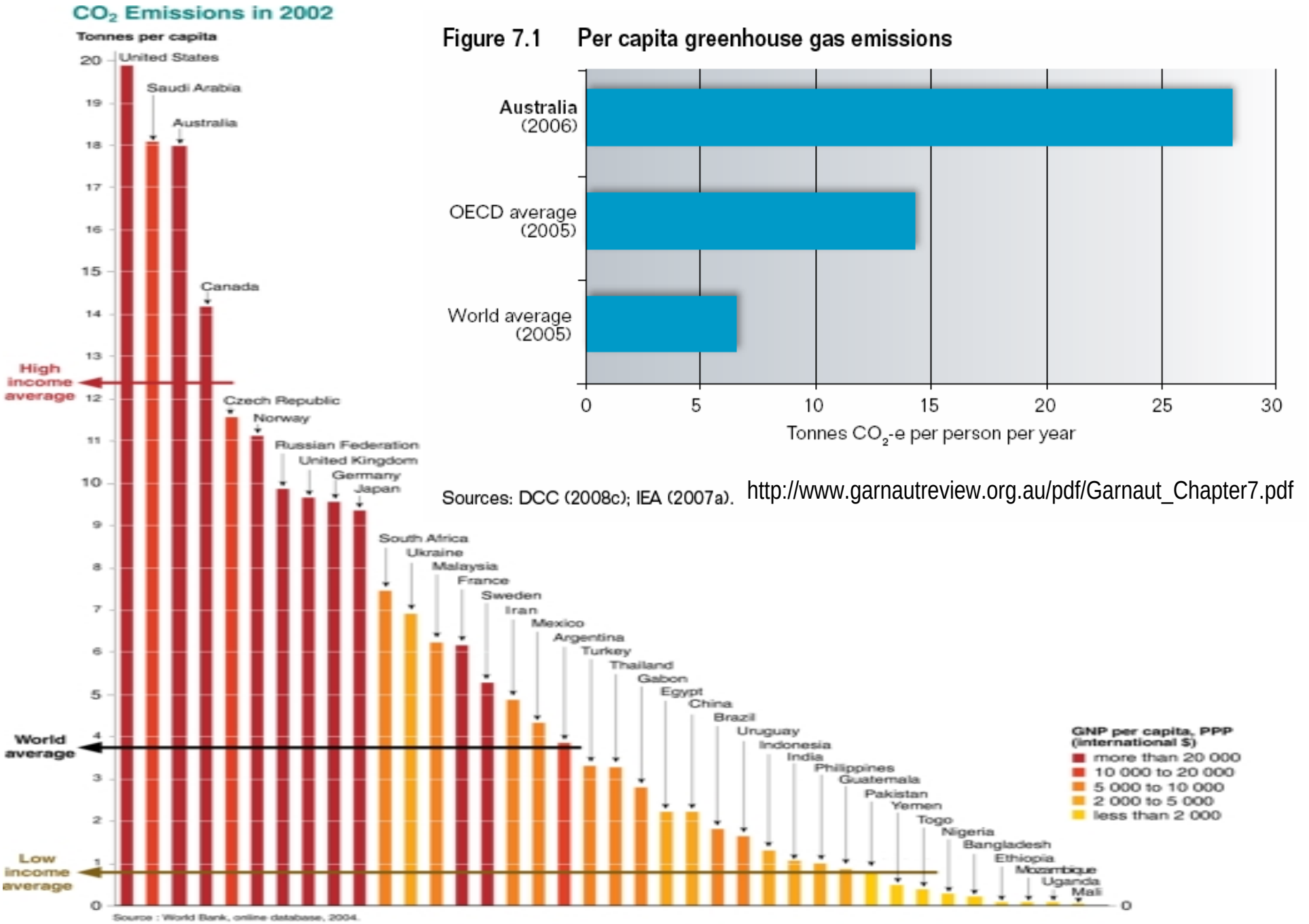


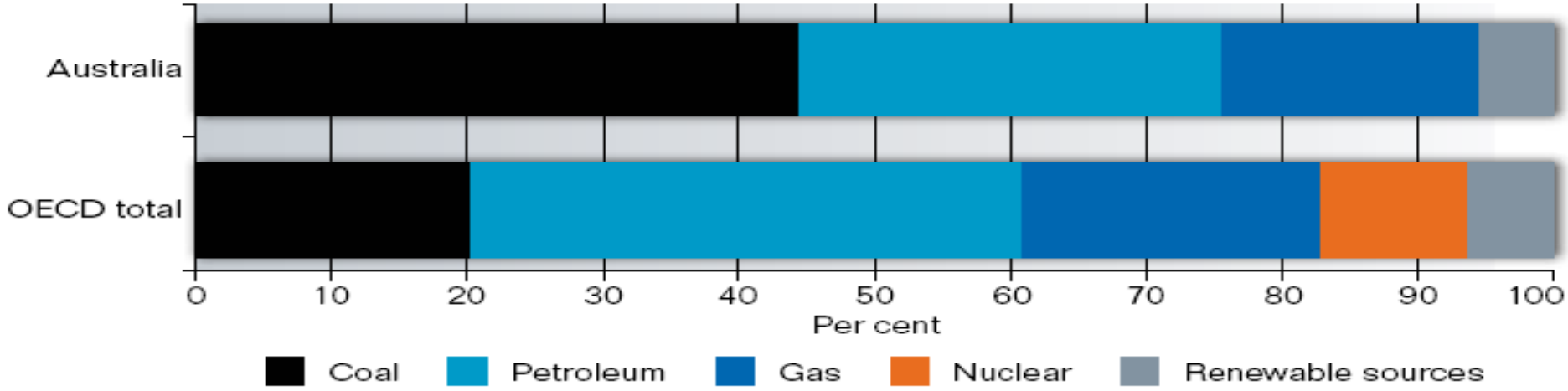
Figure 7.1 Per capita greenhouse gas emissions

Sources: DCC (2008c); IEA (2007a).

http://www.garnautreview.org.au/pdf/Garnaut_Chapter7.pdf

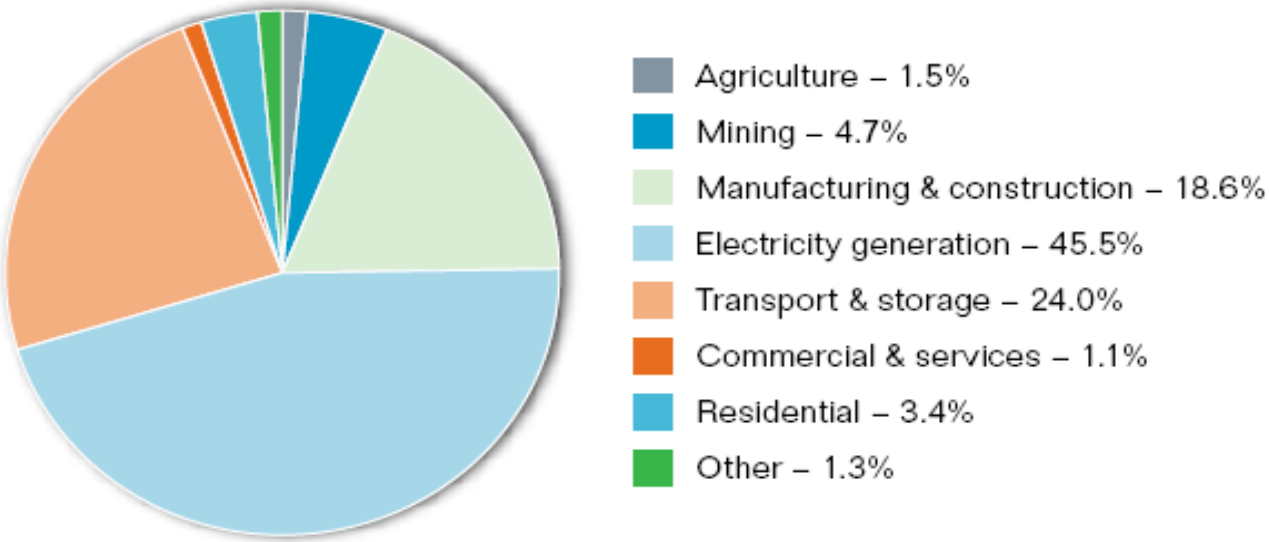
http://maps.grida.no/go/graphic/national_carbon_dioxide_co2_emissions_per_capita

Figure 7.6 Fuel mix contributing to total primary energy supply, 2005



Source: IEA (2007b).

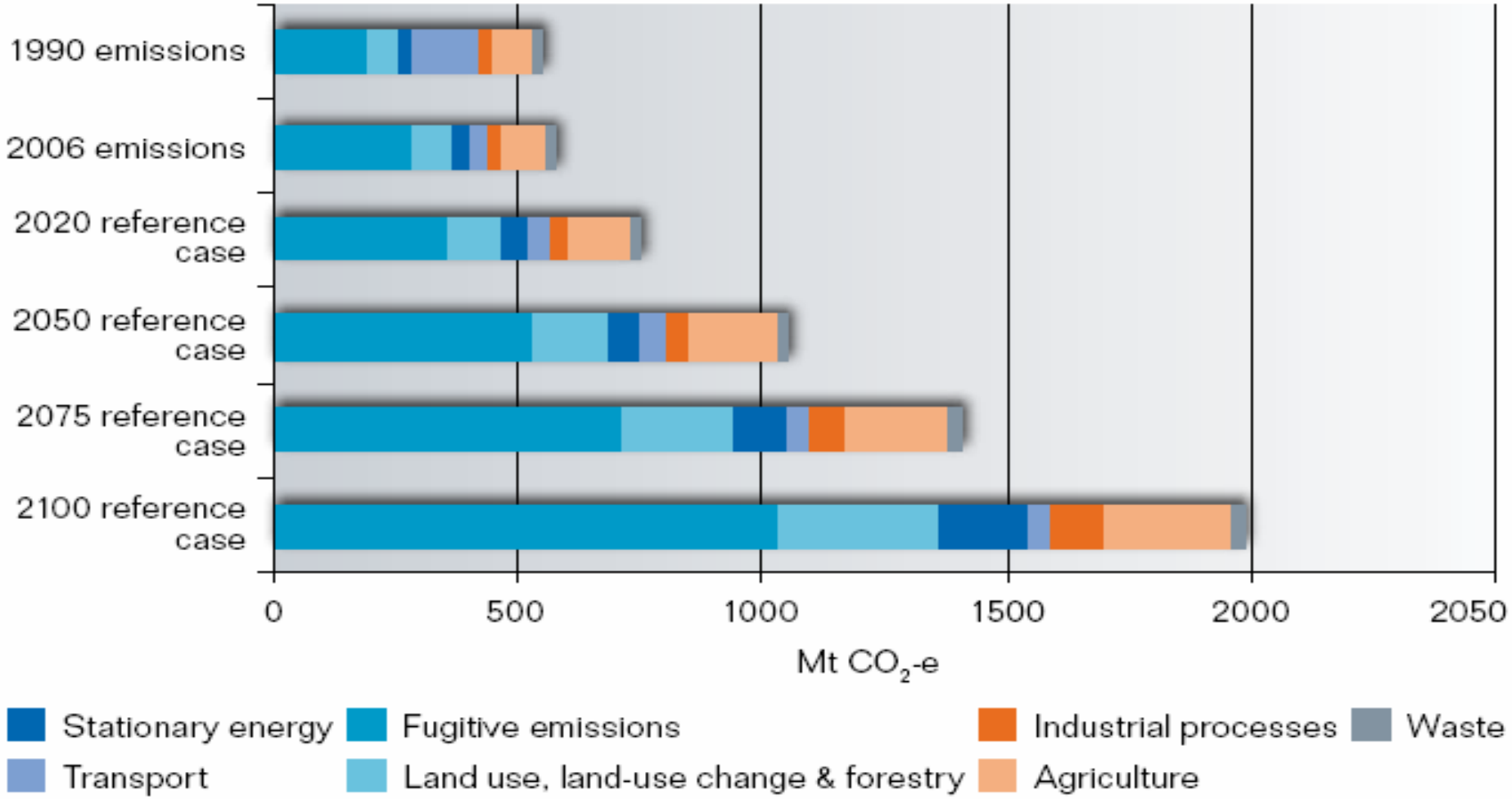
Figure 7.8 Primary energy consumption in Australia, by sector, 2005–06



Source: Syed et al. (2007).

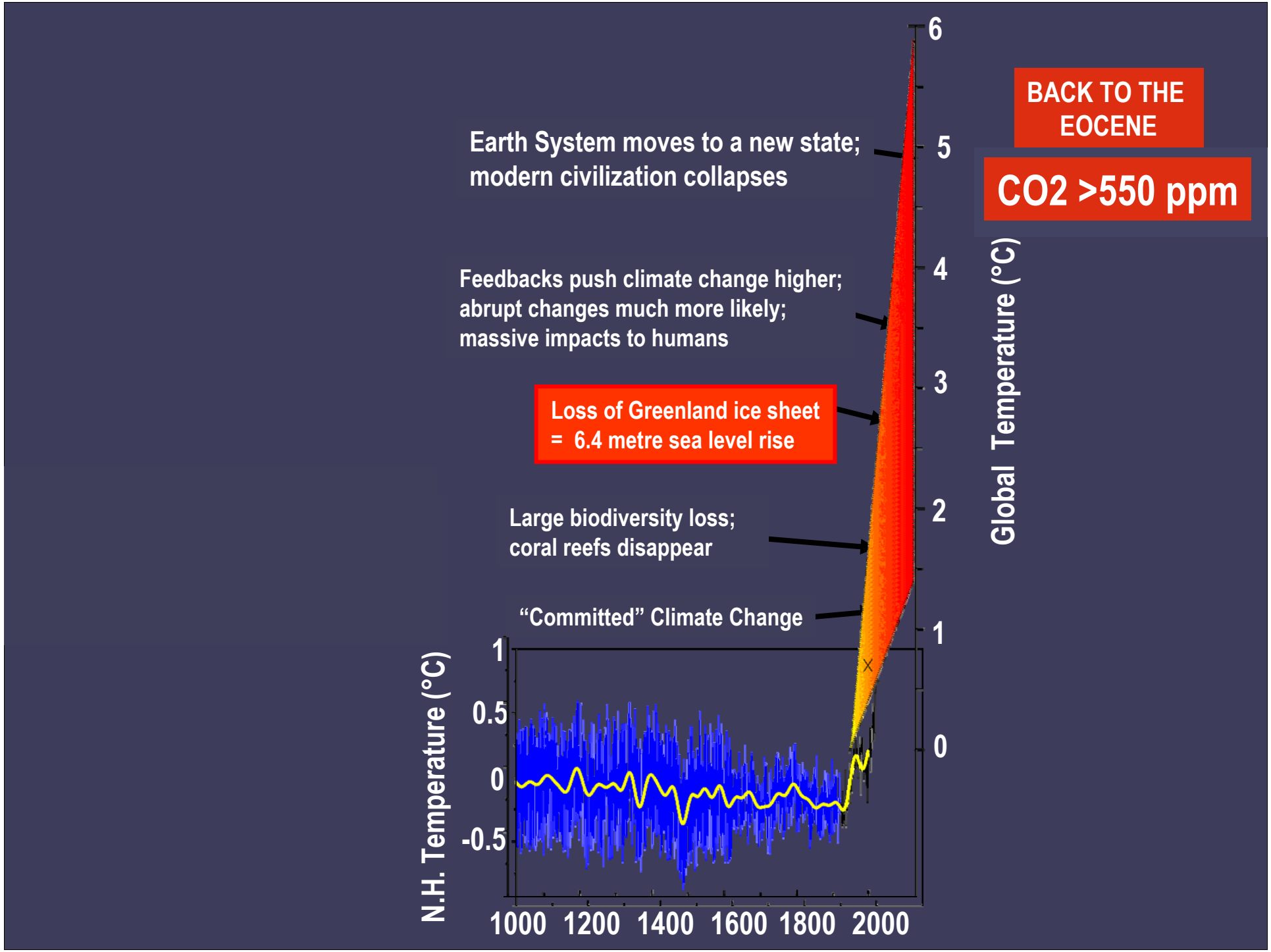
http://www.garnautreview.org.au/pdf/Garnaut_Chapter7.pdf

Figure 7.3 Greenhouse gas emissions by sector: 1990, 2006 and reference case scenarios



Sources: 1990 and 2006 emissions are from the most recent National Greenhouse Gas Inventory (DCC 2008b); 2020–2100 projections are from the Monash Multi Regional Forecasting model.

http://www.garnautreview.org.au/pdf/Garnaut_Chapter7.pdf


BACK TO THE EOCENE
CO2 >550 ppm
Earth System moves to a new state; modern civilization collapses
Feedbacks push climate change higher; abrupt changes much more likely; massive impacts to humans
Loss of Greenland ice sheet = 6.4 metre sea level rise
Large biodiversity loss; coral reefs disappear
"Committed" Climate Change
Global Temperature (°C)
6
5
4
3
2
1
0
N.H. Temperature (°C)
1
0.5
0
-0.5
1000
1200
1400
1600
1800
2000

SUMMARY AND PRINCIPAL RECOMMENDATIONS

- The sensitivity of the atmosphere to greenhouse gas forcing has been underestimated.
- The atmosphere is tracking toward critical tipping points
- Canberra, as one of the most CO2 emission-intensive cities world-wide, is in the position to sent an example, by:

  A. Transition to electric train and bicycle transport system, restricting/taxing access of private fuel vehicles to town centres

  B. Encouraging solar-thermal electricity generation.

  C. Located at the centre of a drought-stricken region, encouraging the Federal government to invest in North-South water pipeline systems

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