



# Key findings from the IPCC Fourth Assessment report

**R K Pachauri**

**Chairman,  
Intergovernmental Panel on Climate Change**

**Director-General,  
The Energy and Resources Institute**

**Director,  
Yale Climate & Energy Institute**

**Copenhagen University  
15th December 2009**



**IPCC**

# The IPCC Fourth Assessment Report (2007)

**+2500** scientific expert reviewers

**800** contributing authors

**450** lead authors

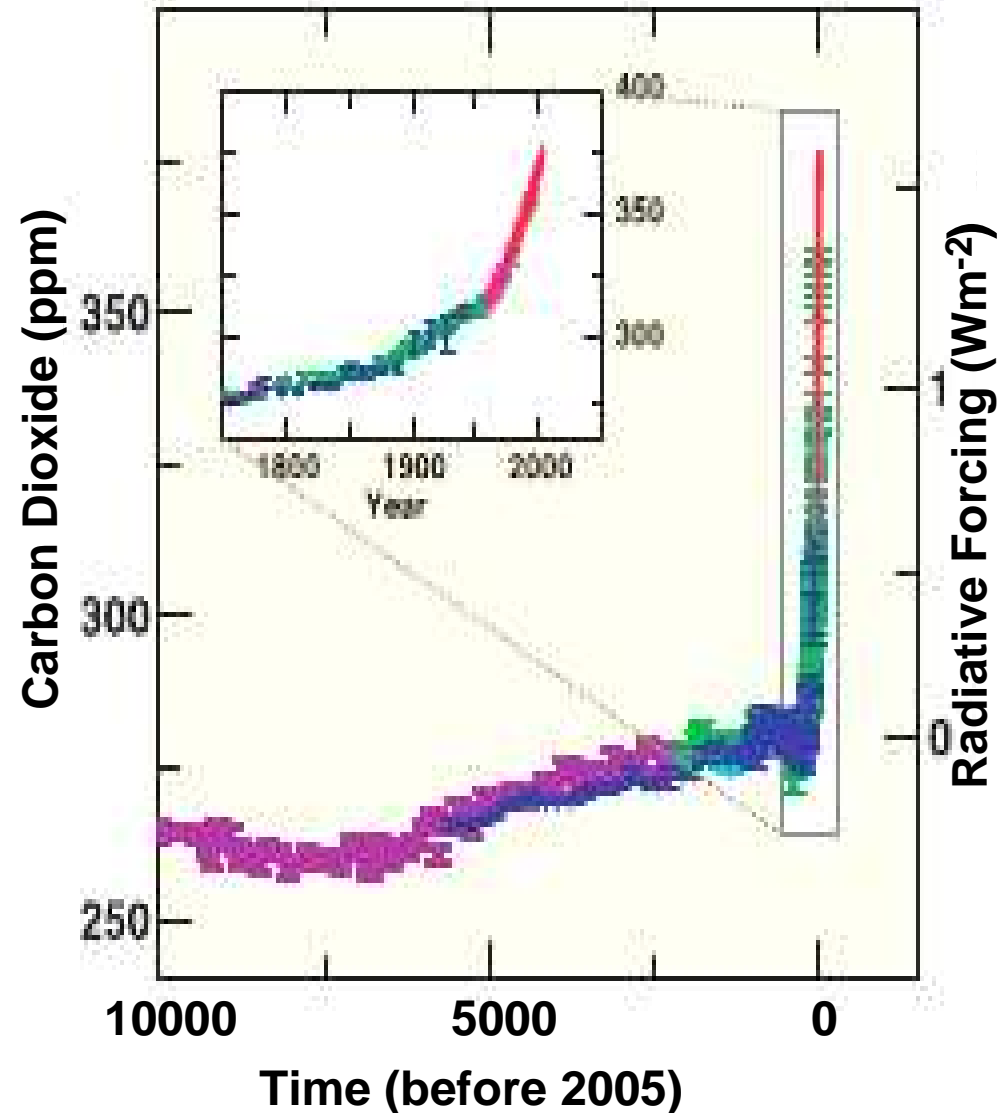
**+130** countries

**“Warming of the climate system is unequivocal”**

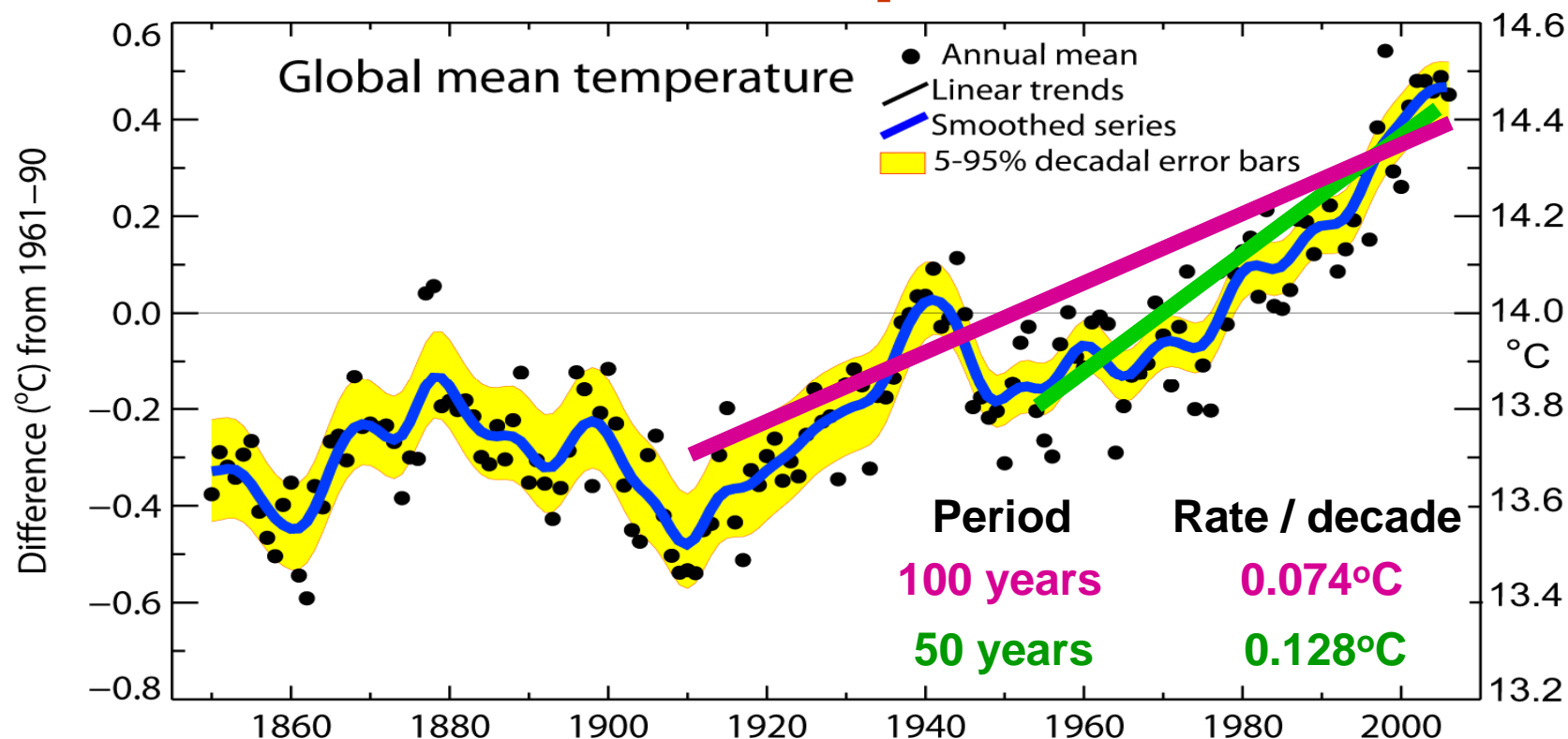
**- IPCC Fourth Assessment Report**

# Carbon dioxide emissions

Global atmospheric concentrations of greenhouse gases (GHG) increased markedly as a result of human activities, with an increase of **70% in 1970-2004**

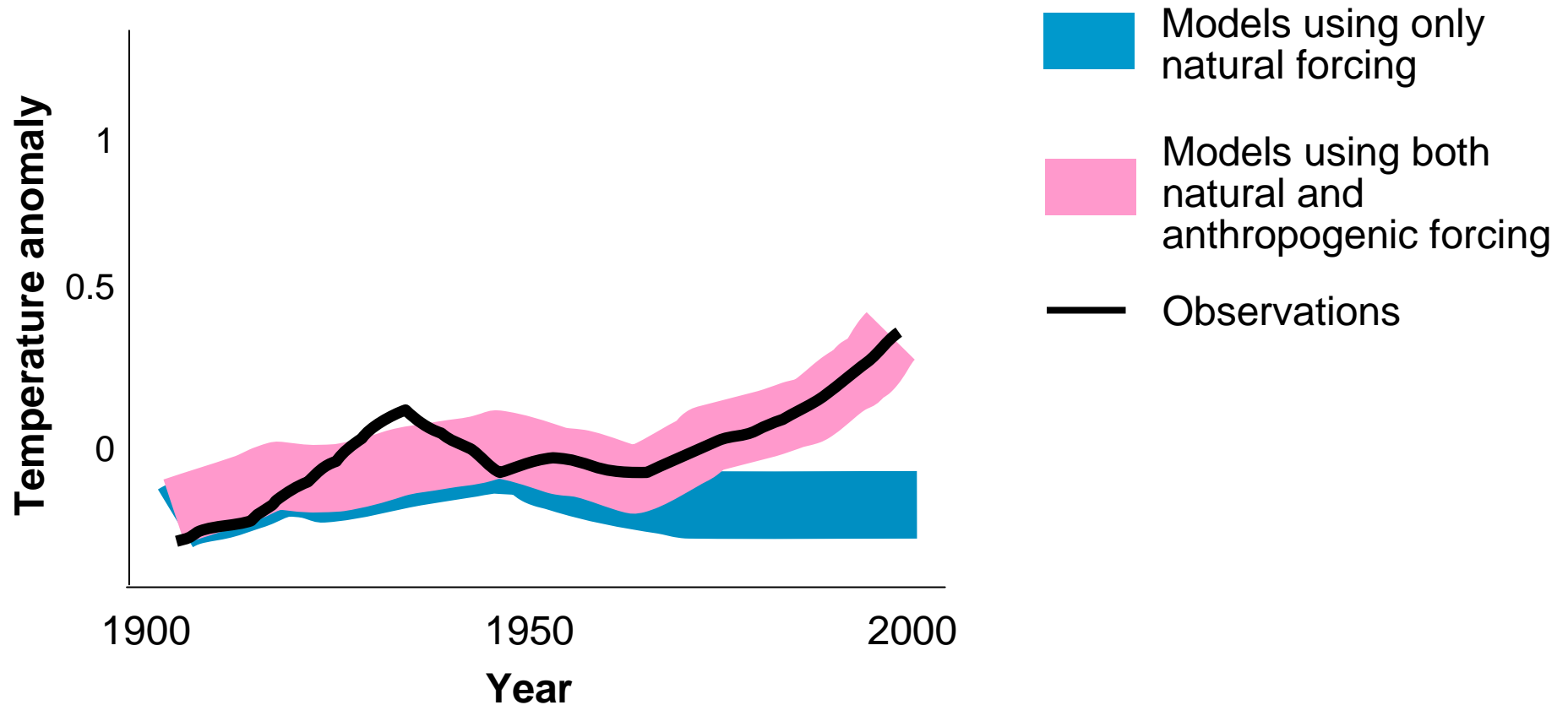


# Changes in global average surface temperature



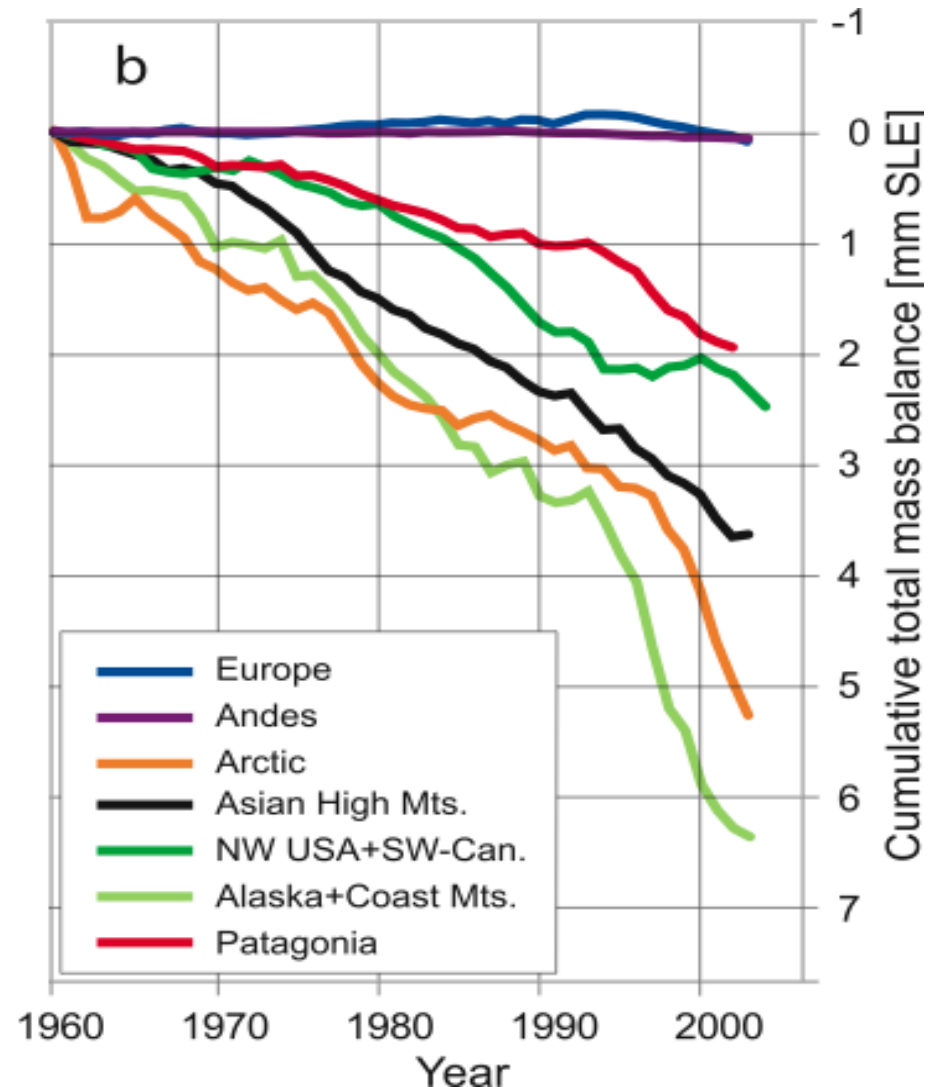
Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature

# Changes in Global Temperature

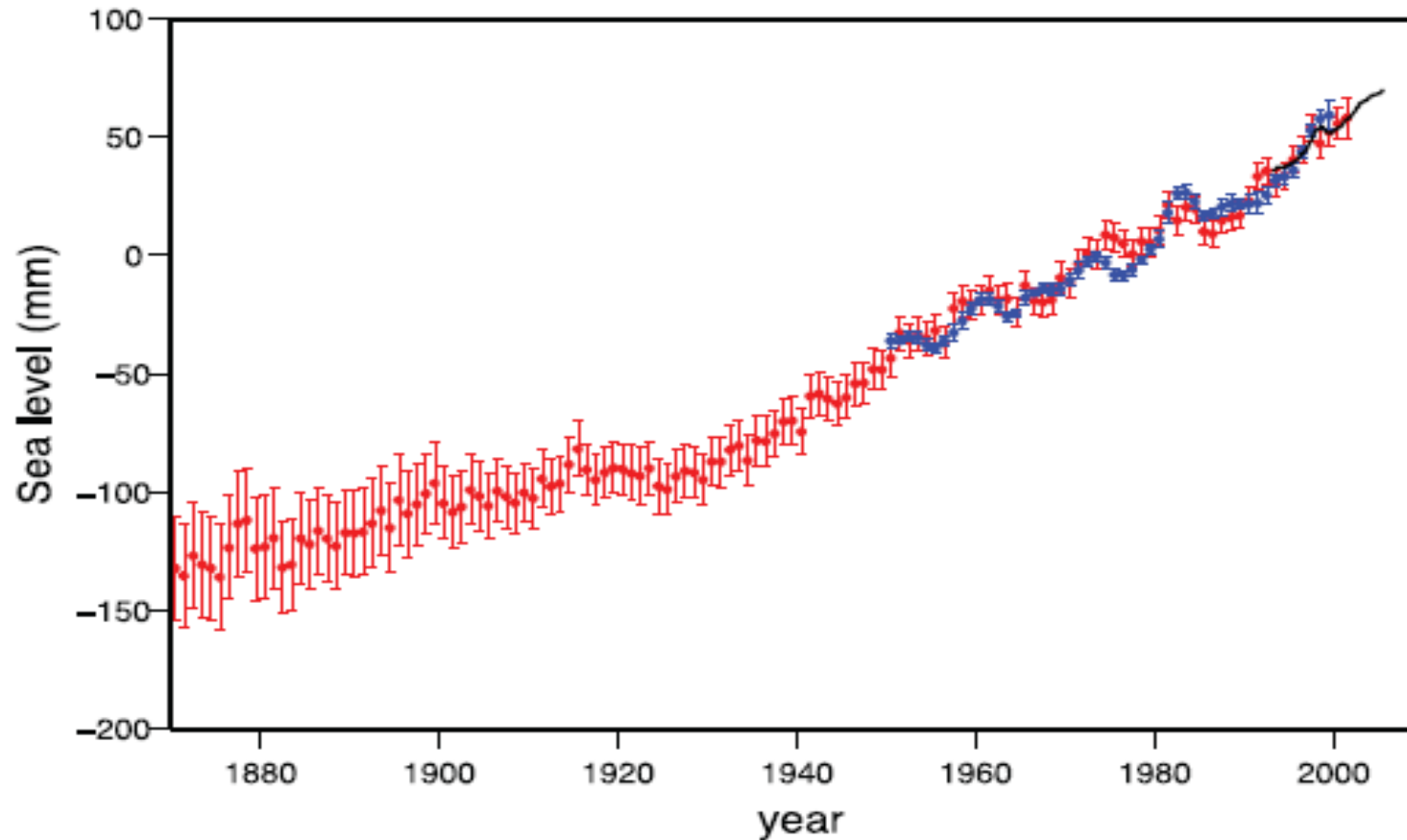


# Cumulative balance of glacier mass

Water supplies stored in glaciers are projected to decline in the course of the century



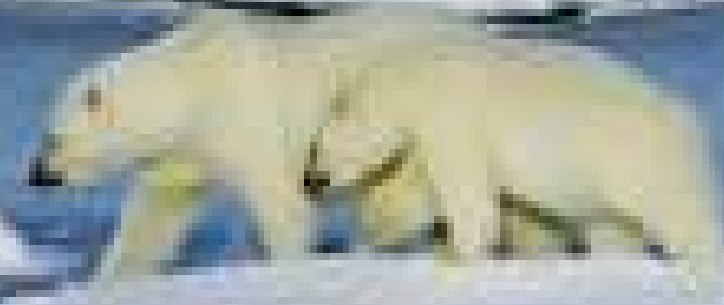
# Changes in global average sea level



**Global average sea level has risen since 1961 at an average rate of 1.8mm/yr and since 1993 at 3.1mm/yr**

Average arctic temperatures increased  
at almost twice the global average rate  
in the past 100 years

- *Annual average arctic sea ice extent has  
shrunk by 2.7% per decade*



The frequency of heavy precipitation events has increased over most land areas

- *Rainfall in Mumbai (India), 2005:  
1 million people lost their homes*





The proportion of tropical cyclones reaching higher intensity have increased over the past 3 decades

- *Cyclone Nargis in Myanmar, 2008:  
100 000 estimated deaths*

Intense tropical cyclone activity has increased  
in the North Atlantic since about 1970

- *Hurricane Katrina, 2005: up to \$200 billion cost estimate*





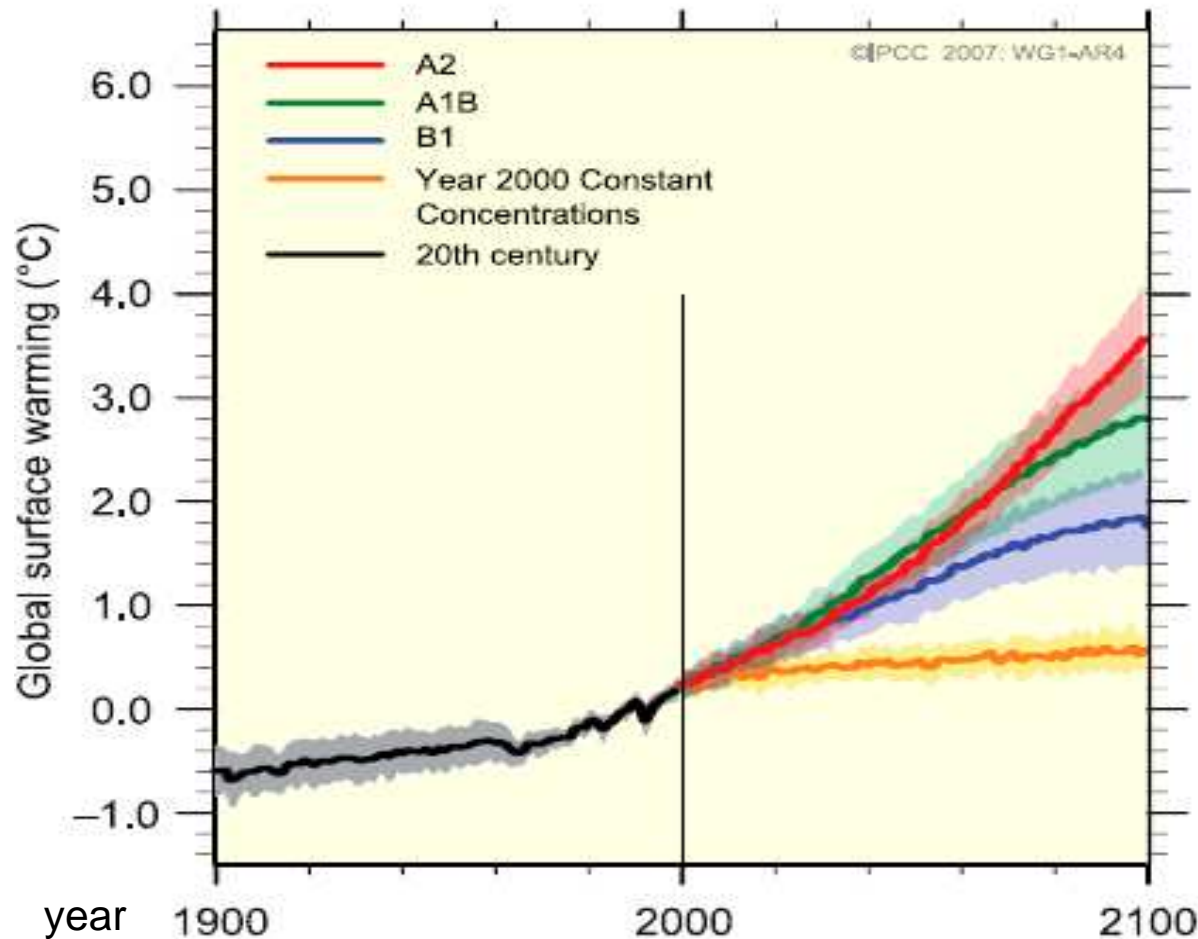
Heat waves have become more frequent  
over most land areas

*- Heat wave in Europe, 2003: 35 000 deaths*

“Continued GHG emissions [...] would induce many changes in the global climate system during the 21<sup>st</sup> century that would very likely be larger than those observed during the 20<sup>th</sup> century”

**- IPCC Fourth Assessment Report**

# Ranges for predicted surface warming



Continued emissions would lead to further warming of **1.1°C to 6.4°C** over the 21<sup>st</sup> century (best estimates: **1.8°C - 4°C**)

# Systems and sectors likely to be especially affected

**Water resources** in some dry regions at mid-latitudes and in the dry tropics, due to changes in rainfall and evapo-transpiration, and in areas dependent on snow and ice melt

**Agriculture** in low-latitudes, due to reduced water availability

**Low-lying coastal systems**, due to threat of sea level rise and increased risk from extreme weather events

**Human health** in populations with low adaptive capacity

**Particular ecosystems**: tundra, boreal forest, mountain regions, mediterranean-type ecosystems, tropical rainforests; mangroves and salt marshes; coral reefs; the sea ice biome

# Regions likely to be especially affected

**The Arctic**, because of the impacts of high rates of warming on natural systems and human communities

**Africa**, because of low adaptive capacity and projected climate change impacts

**Small islands**, which are highly vulnerable to projected sea level rise

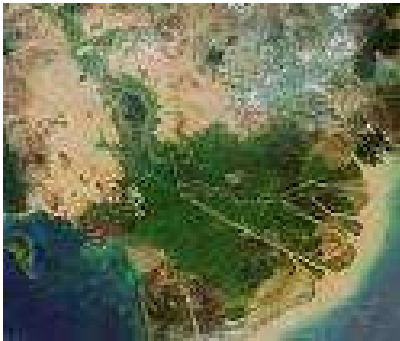
**Asian and African megadeltas**, due to large populations and high exposure to sea level rise, storm surges and river flooding

# Vulnerability of coastal deltas



- Extreme (> 1 million people potentially displaced by current sea-level trends by 2050)
- High (50 000 to 1 million)
- Medium (500 to 50 000)

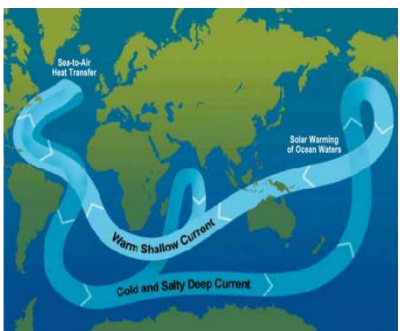
# Climate change could lead to some abrupt or irreversible impacts



Partial loss of ice sheets on polar land could imply metres of **sea level rise**, major changes in coastlines and inundation of low-lying areas



20-30% of **species** are likely to be at risk of extinction if increases in warming exceed 1.5-2.5°C



Large scale and persistent changes in **Meridional Overturning Circulation** would have impacts on marine ecosystem productivity, fisheries, ocean CO<sub>2</sub> uptake and terrestrial vegetation

# Expected impacts on poor regions

People exposed to increased water stress by 2020:



- 120 millions to 1.2 billion in Asia
- 75 to 250 millions in Africa
- 12 to 81 millions in Latin America

Possible yield reduction in agriculture:



- 50% by 2020 in some African countries
- 30% by 2050 in Central and South Asia
- 30% by 2080 in Latin America

**Crop revenues could fall by 90% by 2100 in Africa**

# Some implications for global security



By the end of the century, **hundred of millions of people** could be forced from their native land by rising sea levels, extreme events, floods and famines

Food scarcity and the resulting higher food prices are pushing poor countries into **chaos**

- Such “failed states” can export disease, terrorism, illicit drugs, weapons and refugees

Rising ethnic conflicts can be linked to competition over increasingly **scarce natural resources** (E.g. Jordan River)

**“Delayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts”**

**- IPCC Fourth Assessment Report**

# Role and limits of adaptation

Adaptation is **necessary** to address impacts resulting from the warming which is already unavoidable due to past emissions

Climate change requires **forward-looking** investment and planning responses that go beyond short-term responses to current climate variability

- ➡ **But adaptation alone is not expected to cope with all the projected effects of climate change**

# Stabilisation scenarios

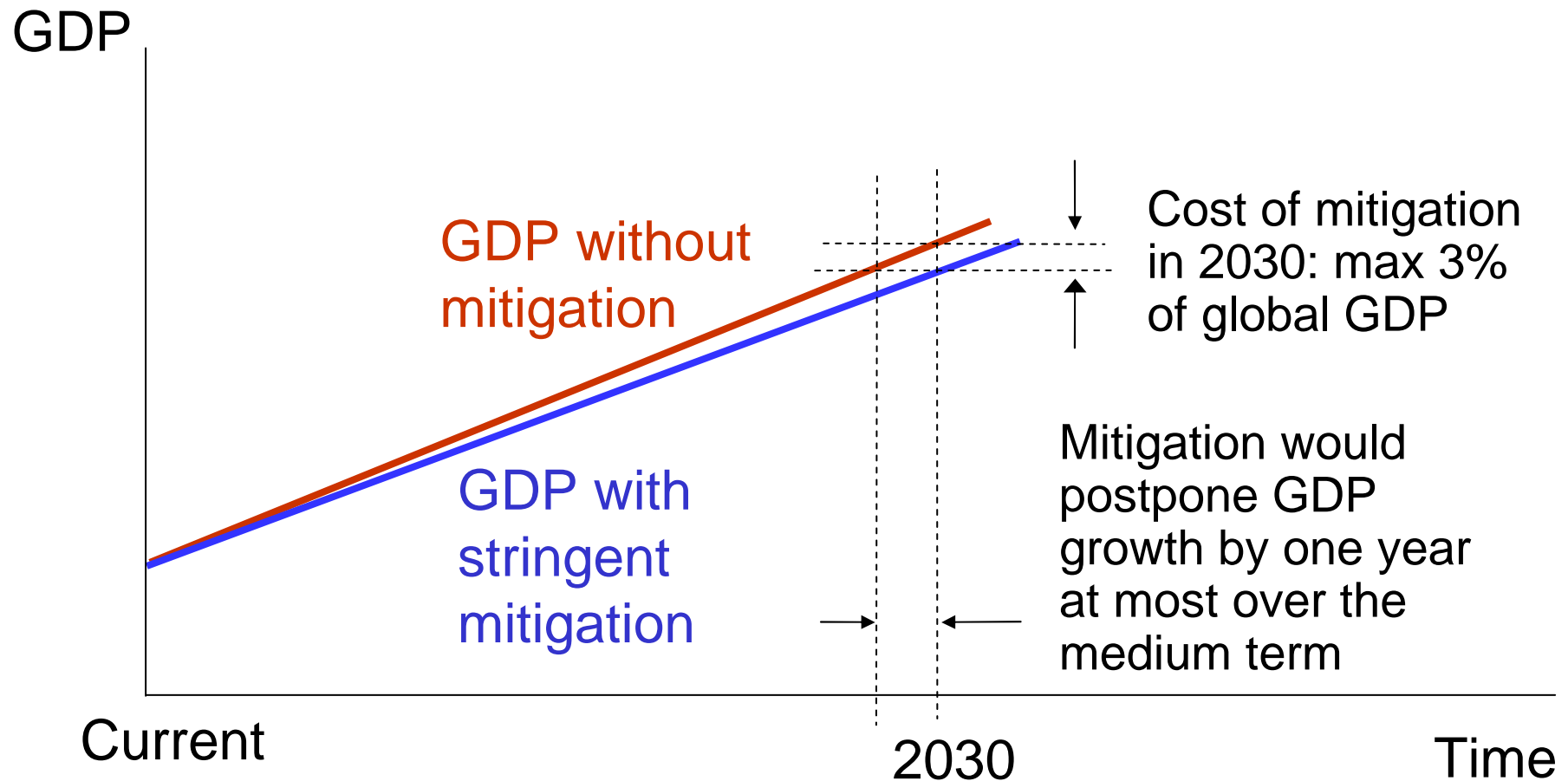
Stabilization level (ppm CO <sub>2</sub> -eq)	Global mean temp. increase (°C)	Year CO <sub>2</sub> needs to peak	Change in global CO <sub>2</sub> emissions in 2050 (% of 2000 emissions)
445 – 490	2.0 – 2.4	2000 – 2015	-85 to -50
490 – 535	2.4 – 2.8	2000 – 2020	-60 to -30
535 – 590	2.8 – 3.2	2010 – 2030	-30 to +5
590 – 710	3.2 – 4.0	2020 – 2060	+10 to +60

# Costs of mitigation in 2030

Stabilisation levels (ppm CO <sub>2</sub> -eq)	Range of GDP reduction (%)	Reduction of average annual GDP growth rates (percentage pts)
445 - 535	< 3	< 0.12
535 - 590	0.2 – 2.5	< 0.1
590 - 710	-0.6 – 1.2	< 0.06

**Mitigation measures would induce 0.6% gain  
to 3% decrease of GDP in 2030**

# Impacts of mitigation on GDP growth



# Main co-benefits of mitigation

- ✓ **Health** co-benefits from reduced air pollution
  - Benefits range from 30-50% of estimated mitigation costs up to a factor of 3 to 4
- ✓ More **employment**
  - Solar PV and wind-energy generate 5.7 person-years of employment per 1 million US\$ investment (over ten years); while coal industry generates only 4
- ✓ Increased **energy security**
- **Mitigation actions can result in near-term co-benefits that may offset a substantial fraction of mitigation costs**

“There is substantial [...] potential for the mitigation of global GHG emissions over the coming decades that could [...] reduce emissions below current levels”

- IPCC Fourth Assessment Report



All stabilisation levels assessed can be achieved by deployment of a portfolio of **technologies that are currently available or expected to be commercialised** in coming decades

This assumes appropriate and effective **incentives** are in place for their development, acquisition, deployment and diffusion



# Key technologies currently available

## Energy Supply



Efficiency; fuel switching; renewables; combined heat and power; nuclear power; early applications of CO<sub>2</sub> capture & storage

## Transport



More fuel efficient vehicles; hybrid vehicles; biofuels; modal shifts from road transport to rail and public transport systems

## Buildings



Efficient lighting; efficient appliances; improved insulation; solar heating and cooling; alternatives for fluorinated gases in insulation and appliances

# Technologies expected to be commercialised before 2030

## Energy Supply



CCS for gas, biomass & coal-fired electricity generating facilities; advanced nuclear power & renewable energy, including tidal and wave energy, concentrating solar, and solar PV

## Transport



2<sup>nd</sup> generation biofuels; higher efficiency aircraft; advanced electric & hybrid vehicles with more powerful & reliable batteries

## Buildings



Integrated design of commercial buildings including intelligent meters that provide feedback and control; integrated PV

# Key mitigation instruments, policies & practices



Research, development and demonstration



Appropriate energy infrastructure investments



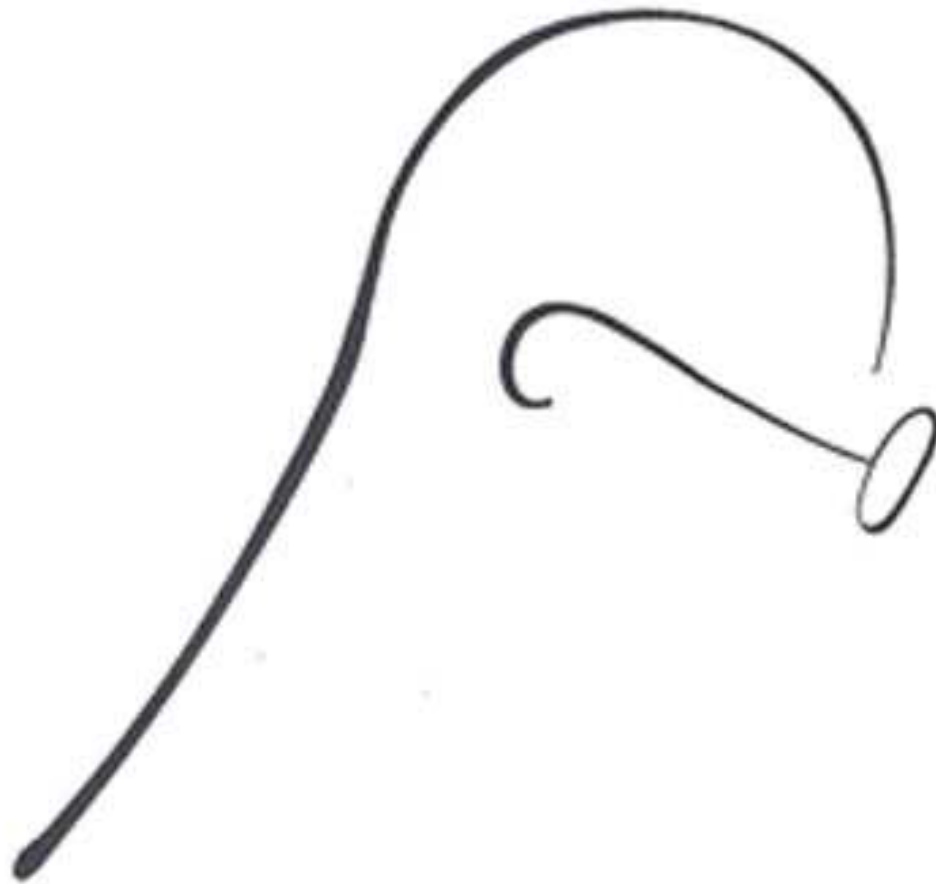
Regulations and standards

Taxes and charges

Change in lifestyles & consumption patterns



**Effective carbon-price signal**



Be the change you want to see in the world