Climate change, mitigation strategies and their impact on health - policy issues

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13 December 2012

Structure

This session will explain

1. Basic science of climate change
2. Indicators and projections
3. Mitigation of CO2 and other GHGs
4. Mitigation action and health
5. International efforts

Learning outcomes

An understanding of the:

- How greenhouses gases affect climate
- Projections of climate change and their limitations
- Mitigation strategies, options and technologies and links between mitigation action and health
- Political and economic challenges involved in tackling climate change

1. Basic Science of Climate Change

The Atmosphere from Space

Australian Bureau of Meteorology

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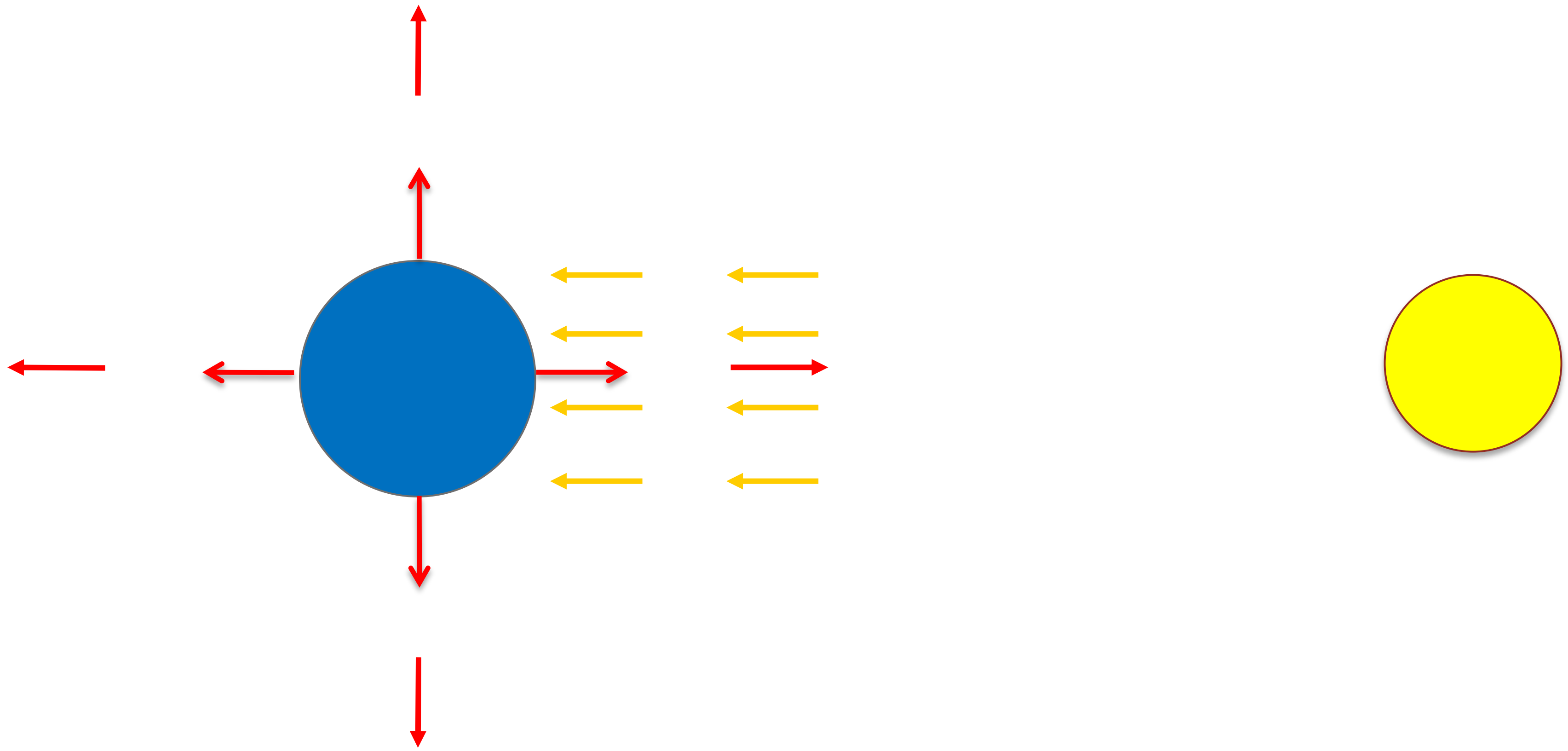
The Energy Budget of the Earth



Without atmosphere, earth's surface temperature would be approx. minus 18 degrees C!

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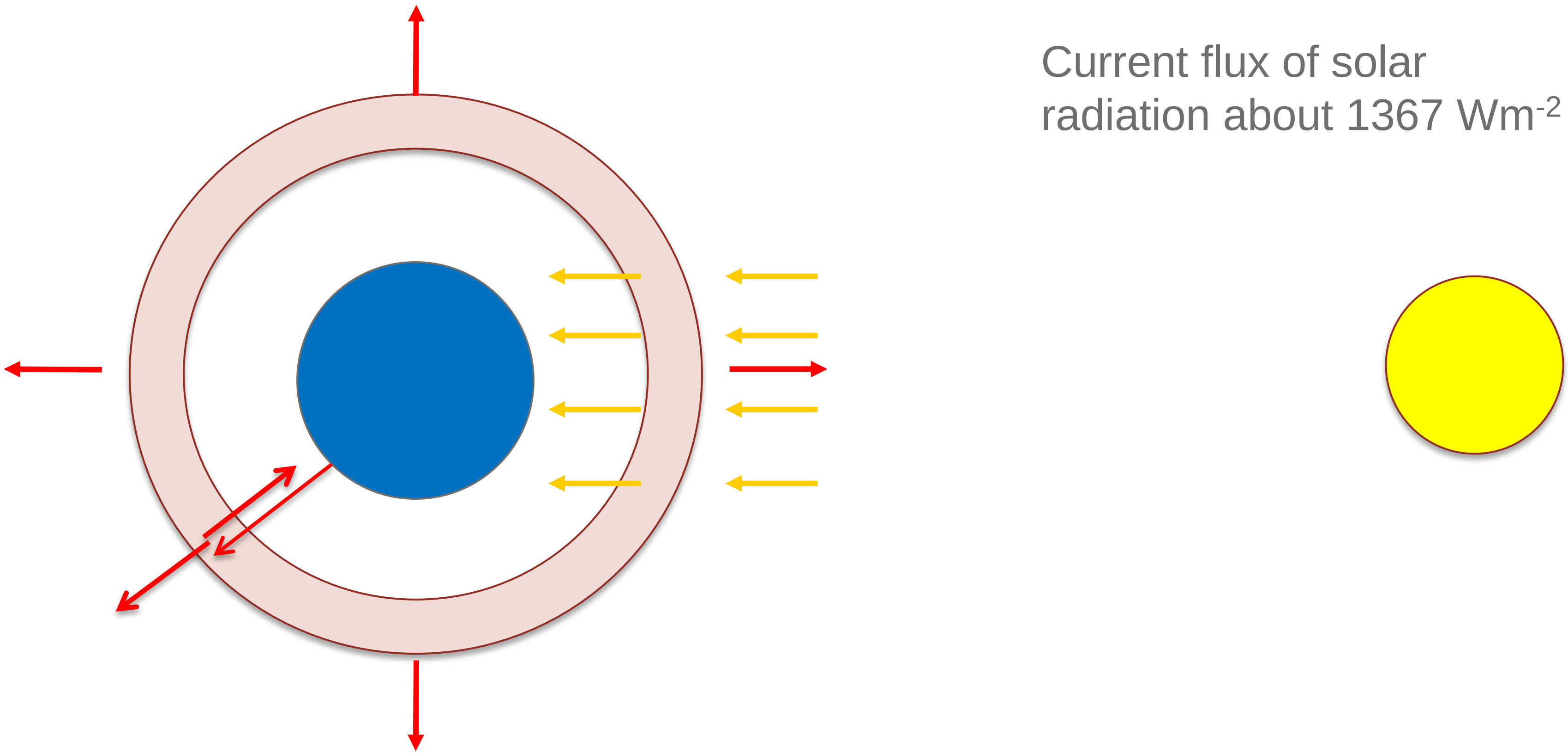
Greenhouse effect on surface temp



Current flux of solar radiation about 1367 Wm^{-2}

(water vapour) carbon dioxide, methane,…

Fourier (1827), Tyndall (1861)

Surface temperature is +14.9 degrees Centrigrade

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Earth's energy Balance (updated)

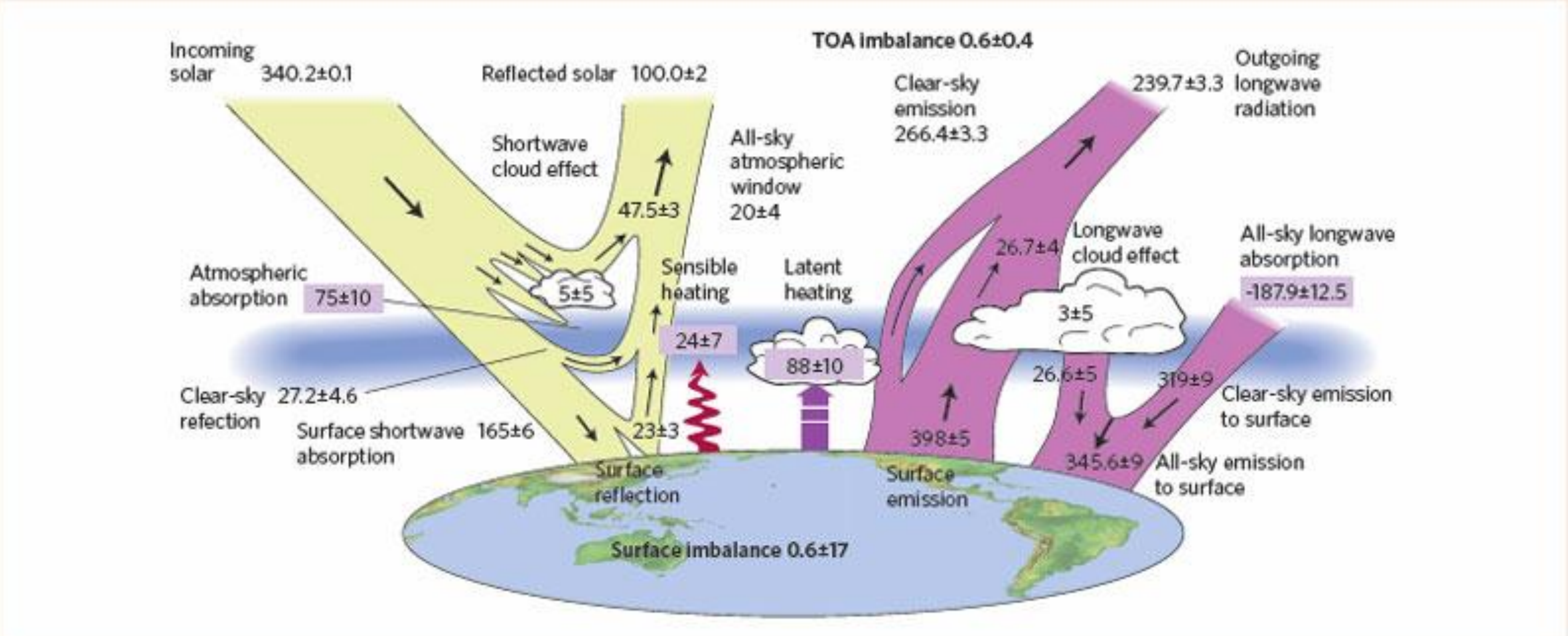

Figure B1 | The global annual mean energy budget of Earth for the approximate period 2000–2010. All fluxes are in Wm^{-2}. Solar fluxes are in yellow and infrared fluxes in pink. The four flux quantities in purple-shaded boxes represent the principal components of the atmospheric energy balance.

Source: An update on Earth's energy balance in light of the latest global observations, Graeme L. Stephens et al, Nature Geoscience **5**,691–696 (2012) doi:10.1038/ngeo1580

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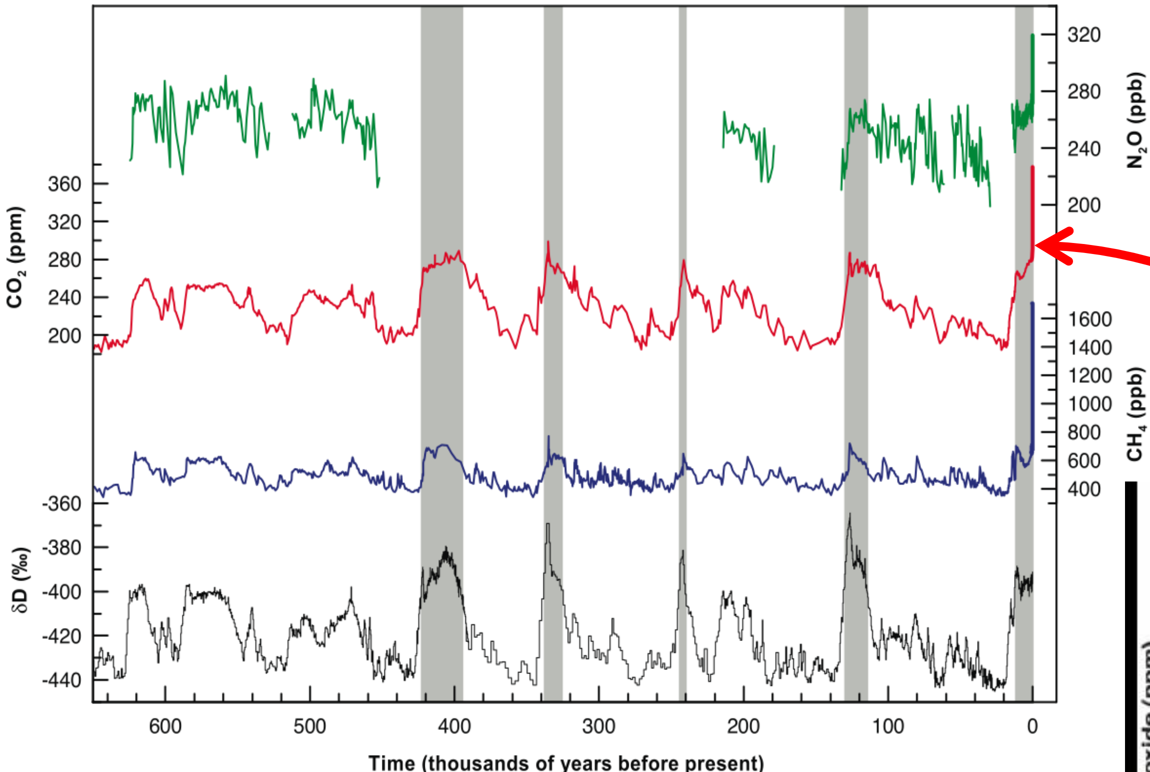
Temperature and GHGs over 650,000 years

nitrous oxide

carbon dioxide

methane

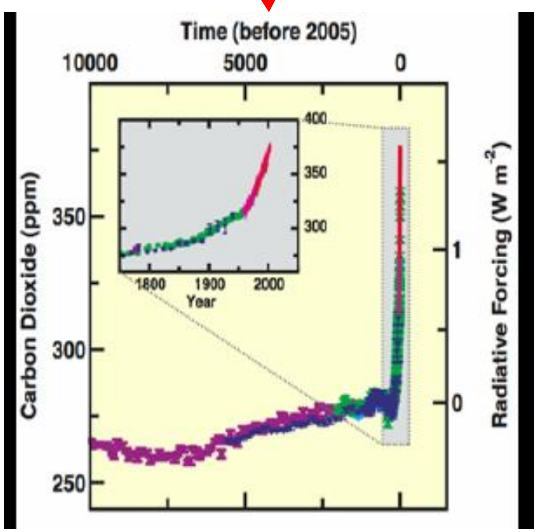
Temp proxy



past

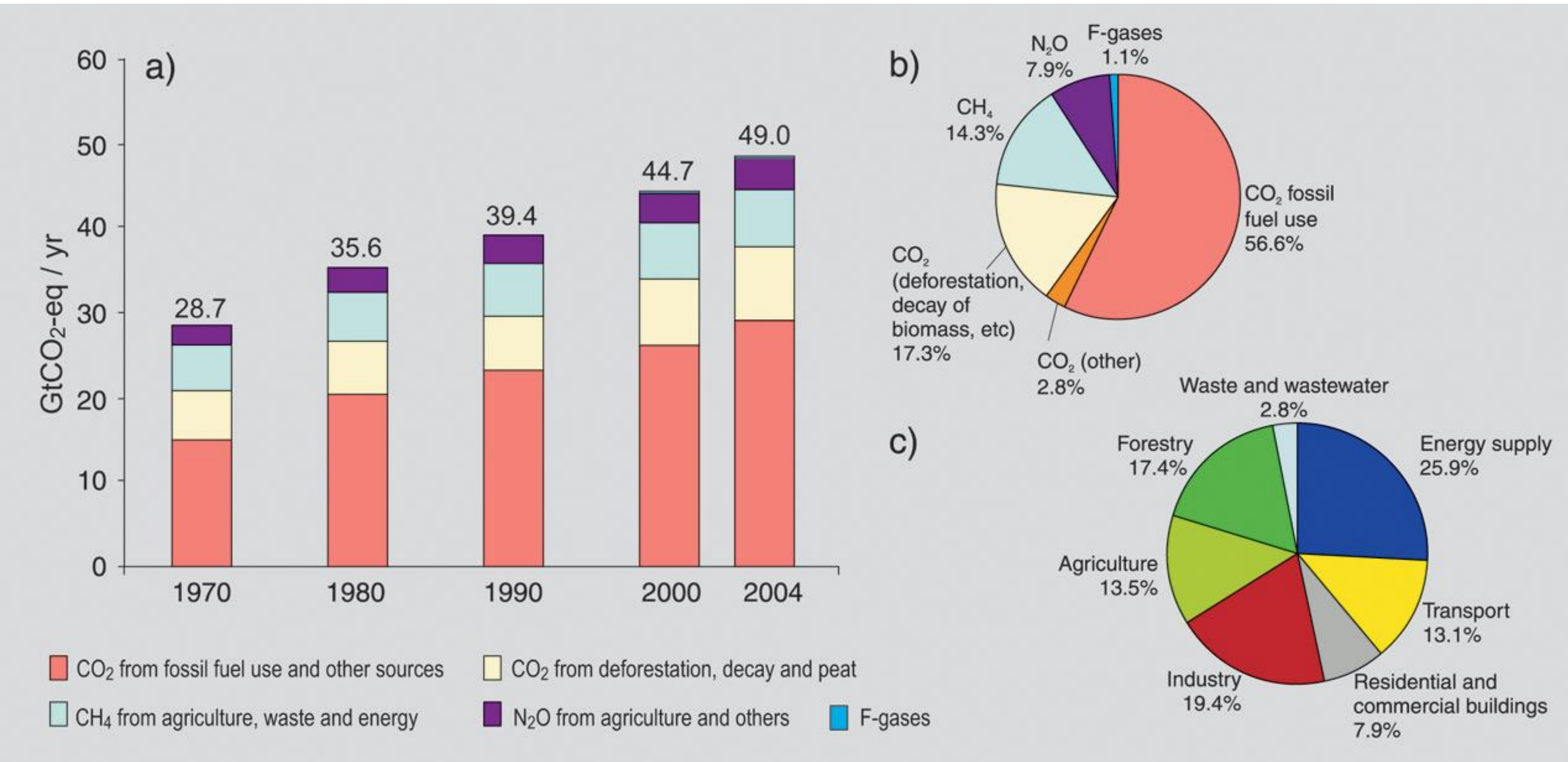
time

today



Source: IPCC 2007

Change and composition in GHG emissions



Source: IPCC

2. Indicators and Projections

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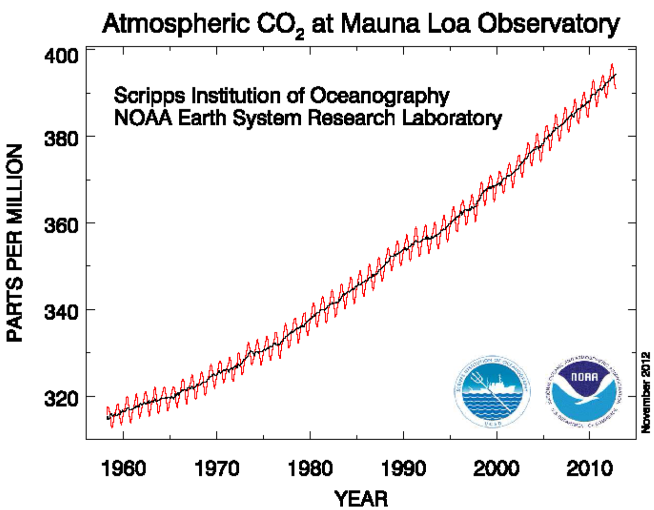
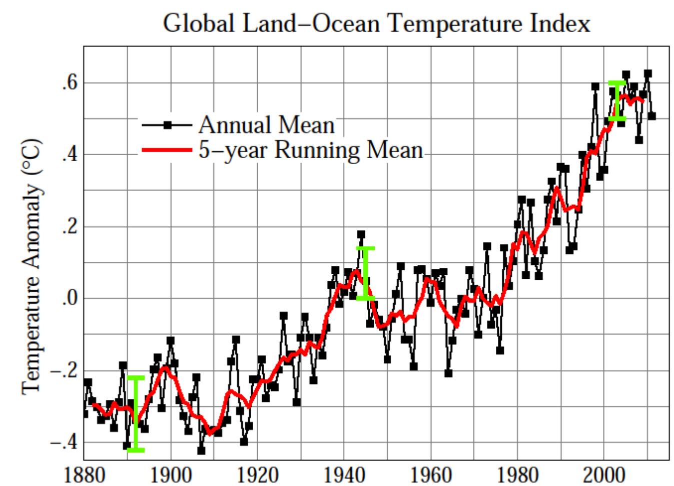
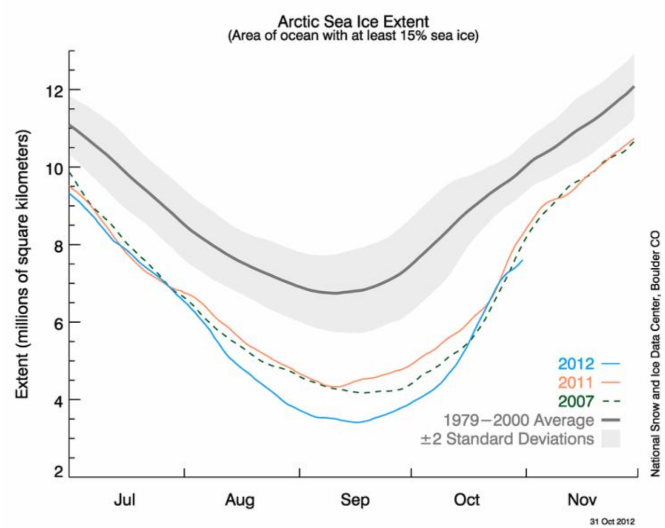
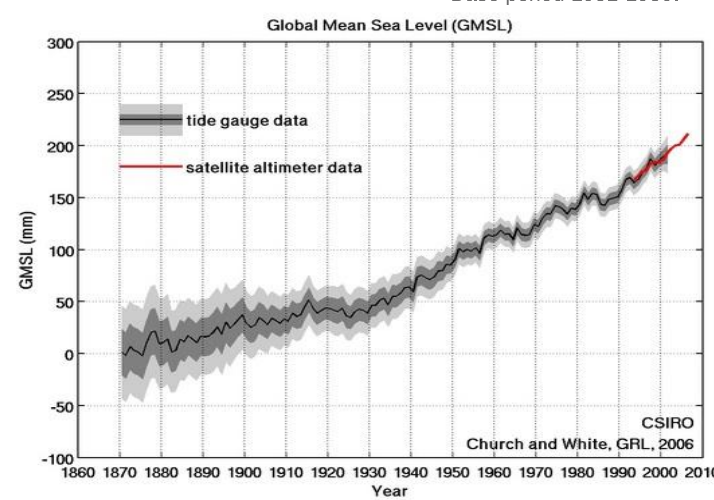
Indicators





Source: NASA Goddard Institute Base period 1951-1980.





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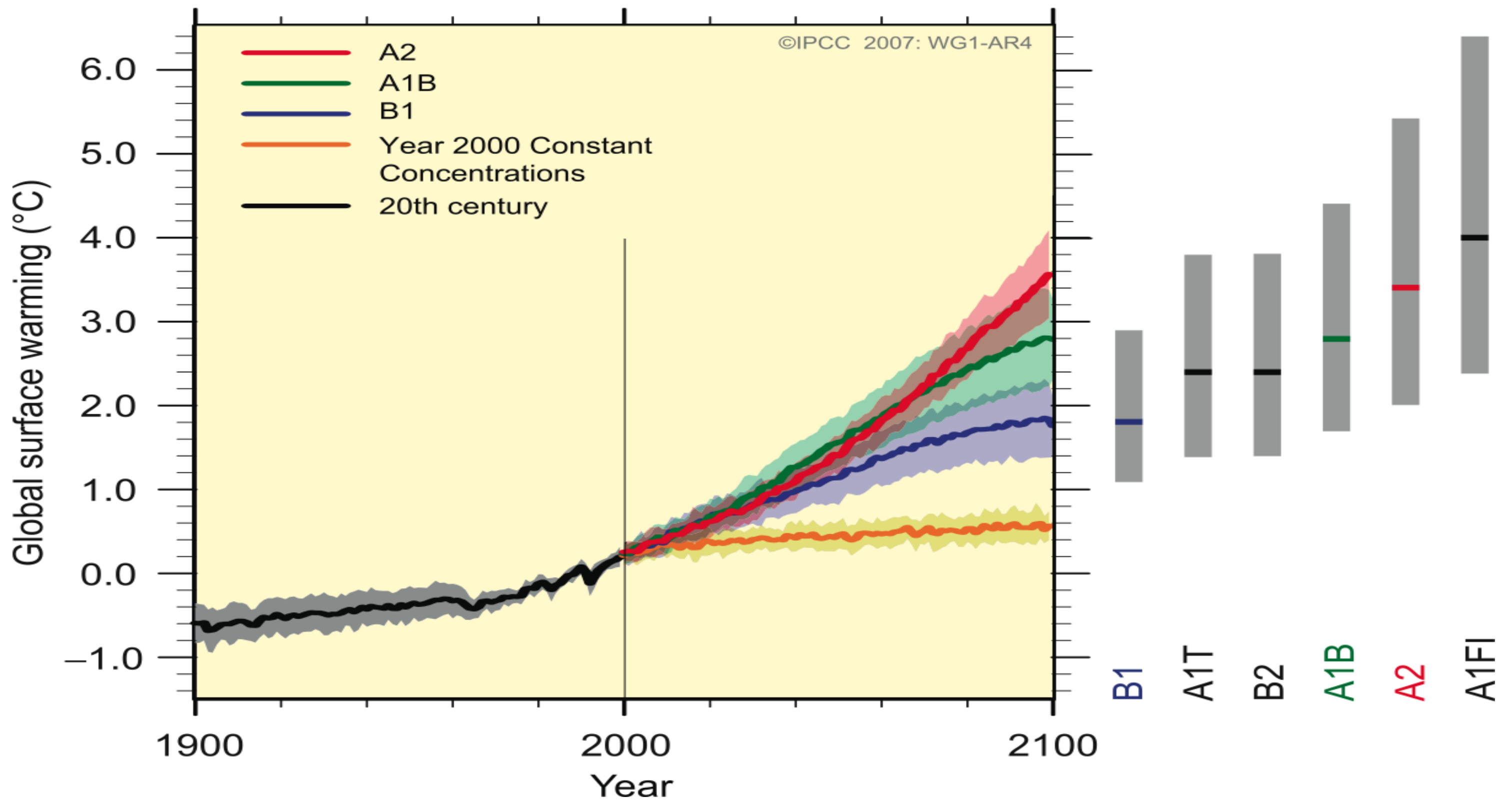
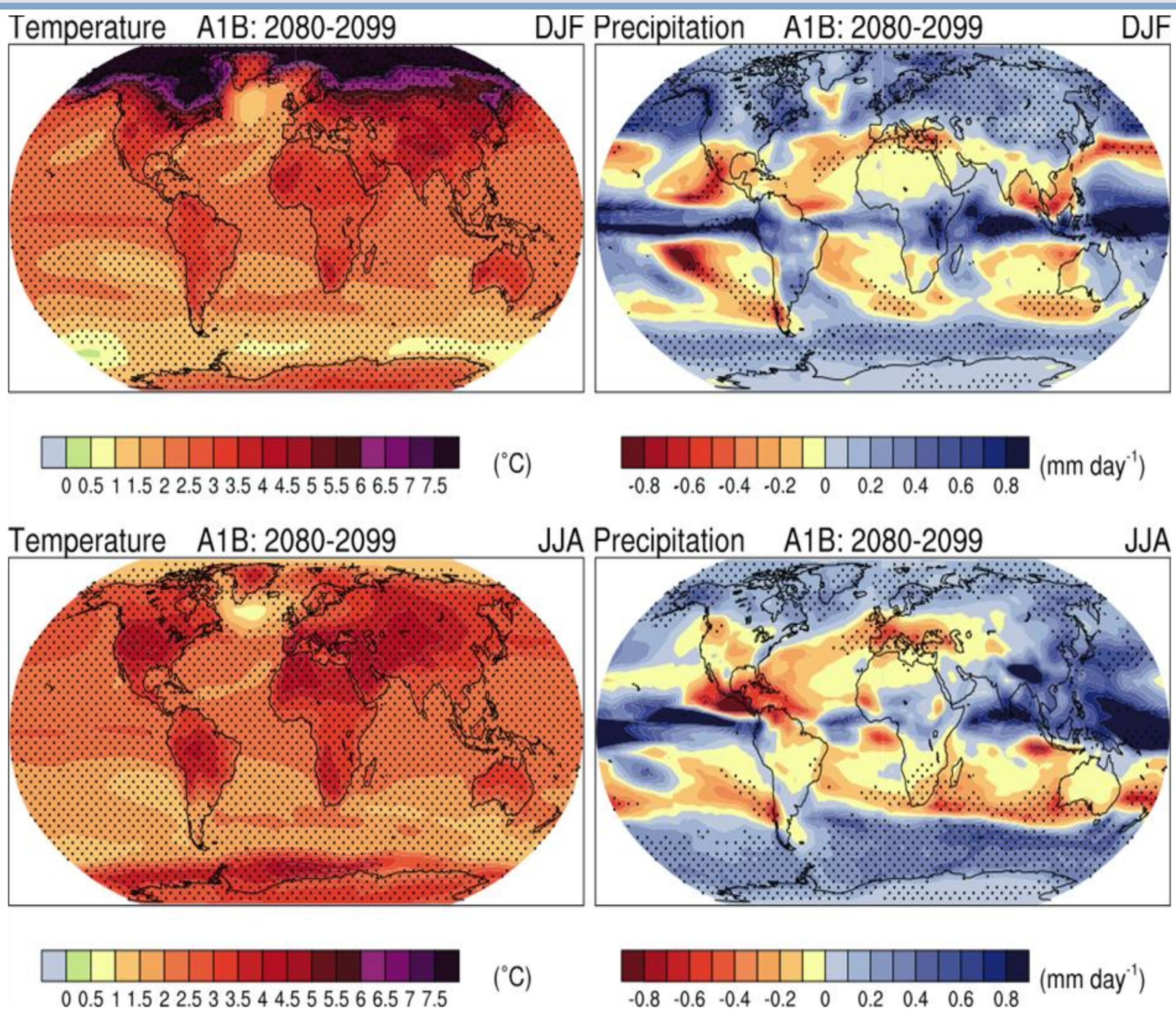
IPCC AR4 projections



- Warming unequivocal; and
- Most warming since mid- twentieth century very likely due to human activity
- Average temperatures likely to rise by 1.8-4.0°C by 2100 (range 1.1-6.4°C).
- Change already visible e.g. loss of Arctic sea ice; timing of Spring events.

Projected changes in temp and precipitation



Source: IPCC AR4

Uncertainty and imperfection

Earth's climate system is a **complex dynamical system**.

i. Forcing uncertainty, e.g.: solar variability; emissions scenarios
ii. Initial condition uncertainty – well known problem of sensitivity of results
iii. Imperfect models
   a. Omitted processes, e.g. carbon cycle, grid resolution etc. Serious – 'missing processes' more likely to exacerbate change rather than moderate it.
   b. Parameters or parameterisation schemes (e.g. Clouds, aerosols)

   Leading to:

Failure to simulate well some crucial phenomena e.g. "blocking"
(key to 2003 and 2010 European summers as well as 2009/10 winter)

Therefore need better understanding of key physical processes to interpret results and improve models (e.g. better identification and representation of internal variability, earth system feedbacks)

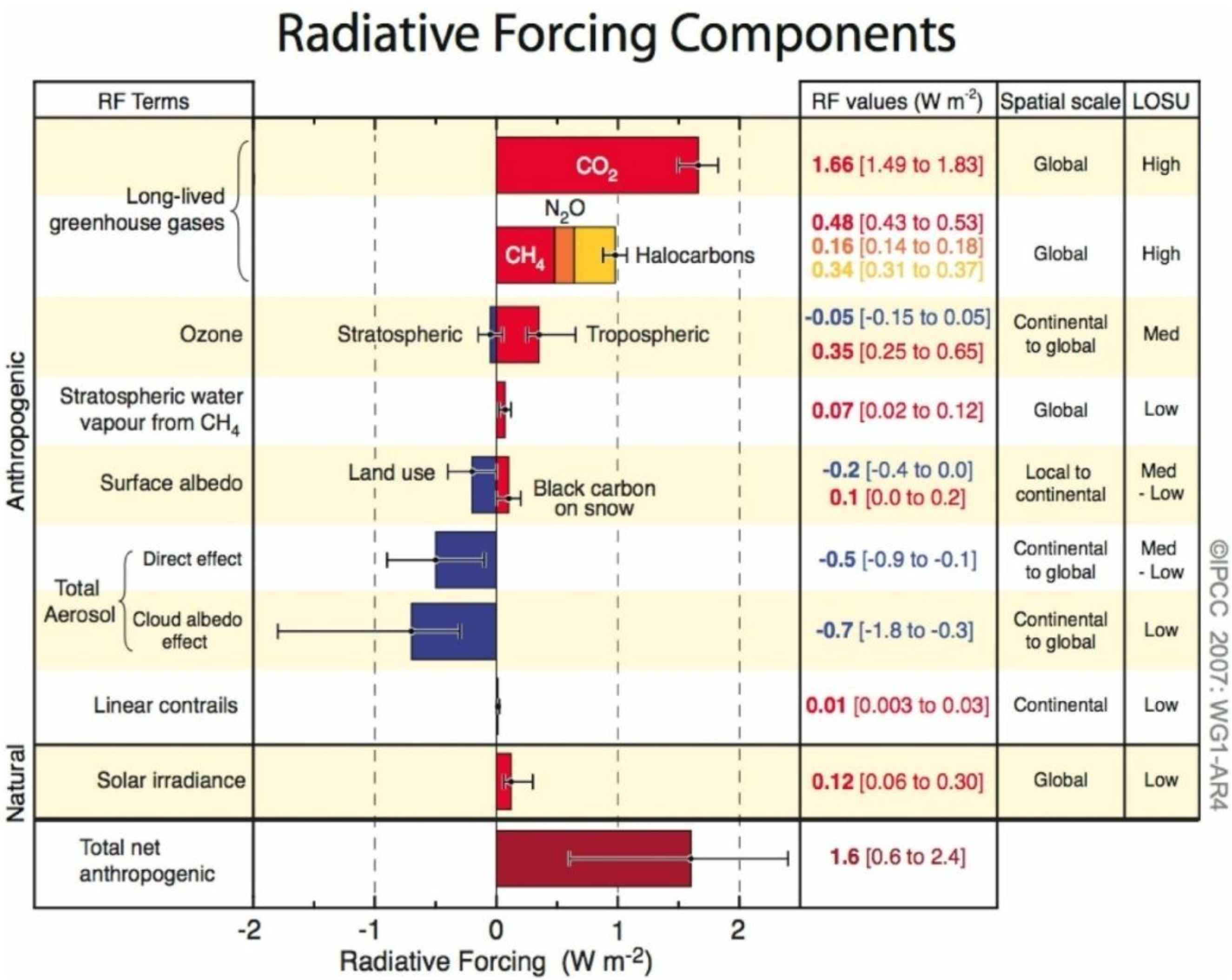
Some possible mechanisms for extreme changes/ climatic thresholds

- Large dynamical ice sheet loss: Greenland & West Antarctic
- Reduced carbon absorption/emission: soil, vegetation, ocean
- Methane emission from melting tundra, peat, hydrates
- Rapid change in the circulation of the atmosphere/ocean

> - Current state of the art climate models are “too smooth”
> - No reason to expect they can provide reliable early warning of possible major shifts in future climate system

3. Mitigation of CO2 and other GHGs

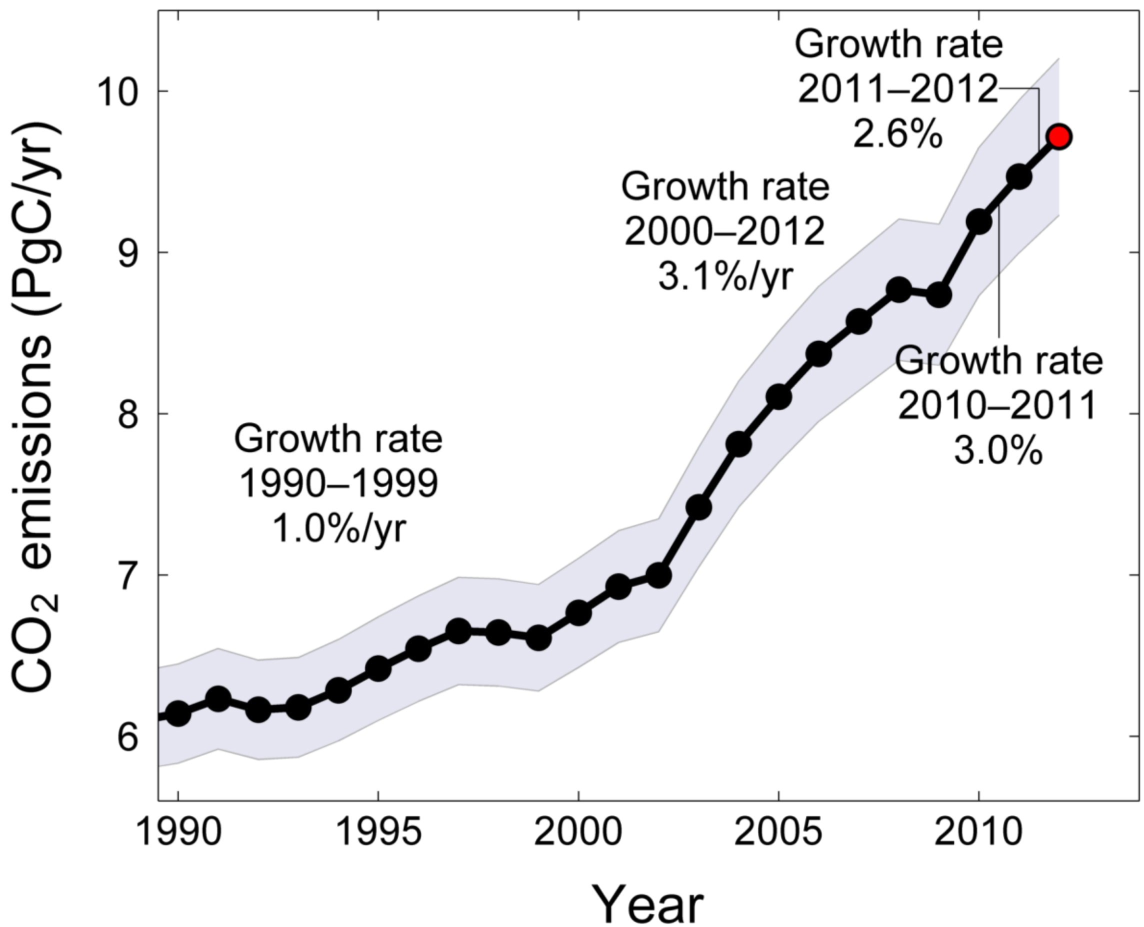
GHGs and climate change



Fossil and Cement Emissions

Global fossil and cement emissions: 9.5±0.5PgC in 2011, 54% over 1990

Projection for 2012: 9.7±0.5PgC, 58% over 1990



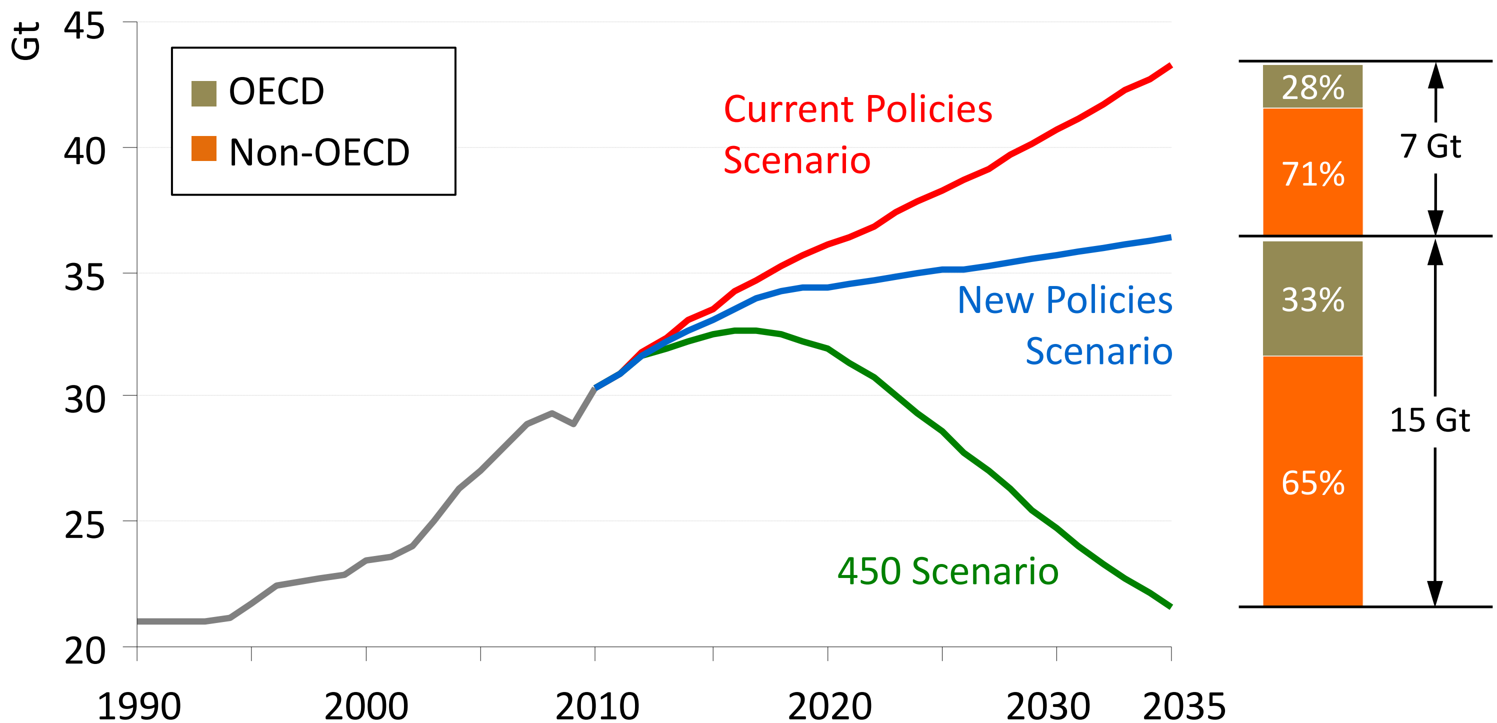
Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Source: Peters et al. 2012a; Le Quéré et al. 2012; CDIAC Data; Global Carbon Project 2012

The 450 Scenario illustrates what the 2^{o}C goal will require

WORLD ENERGY OUTLOOK 2011

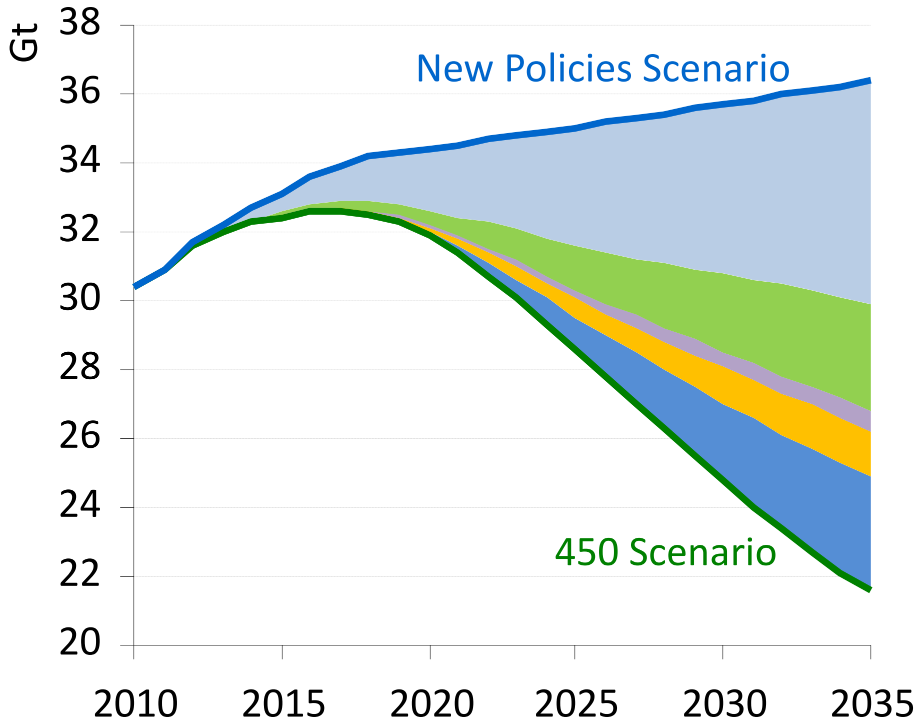
World energy-related CO_2 emissions by scenario



Restricting the greenhouse-gas concentration to 450 ppm would limit temperature increase to 2^{o}C, compared with 3.5^{o}C in the New Policies Scenario & 6^{o}C in the Current Policies Scenario

Efficiency gains can contribute most to emissions reductions

World energy-related CO_2 emissions abatement in the 450 Scenario relative to the New Policies Scenario



	Abatement 2020	Abatement 2035
Efficiency	72%	44%
Renewables	17%	21%
Biofuels	2%	4%
Nuclear	5%	9%
CCS	3%	22%
Total (Gt CO_2)	**2.5**	**14.8**

Energy efficiency measures – driven by strong policy action across all sectors – account for 50% of the cumulative CO_2 abatement over the Outlook period

Some key considerations

- **Systemic change** and a whole-systems approach required
- **Affordable solutions** will:
  - Deploy a broad mitigation technology portfolio
  - Use fossil fuel for energy generation only with CCS
  - Cut across sectors, integrate supply and demand
  - Exploit demand reduction and efficient/intelligent energy use
- **Some fossil fuel** may still be required **for transport in 2050** (e.g. heavy goods, long distances); emissions will need to be offset. NB competing uses for biomass.
- **Technical and economic feasibility** will depend on:
  - Early demonstration and deployment of key technologies like CCS
  - Overcoming market failures to accelerate low-carbon innovation and uptake

4. Mitigation and health

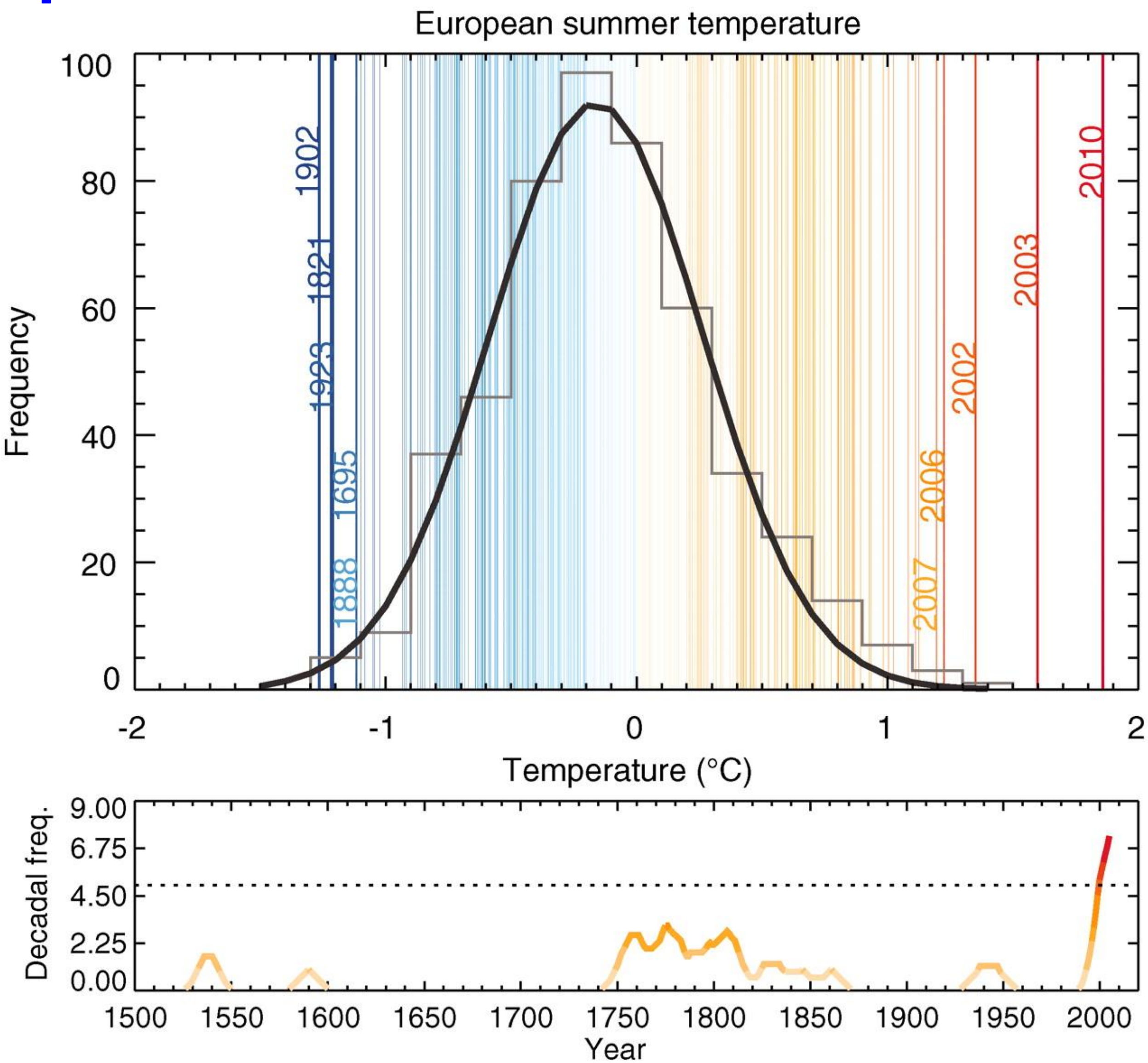
Impacts of global warming in different sectors

- **Water**:
  - Increases & decreases;
  - More exposed to water shortage
- **Ecosystems**:
  - Species shifts & extinctions
- **Food**:
  - Changes in possible crops & productivity;
  - Eventually more reductions than increase in production
- **Coasts**:
  - Sea level rise, storm surges: increases in coastal erosion & flooding
- **Health**:
  - Reduced deaths from cold
  - Increased burden of malnutrition, diarrhoea
  - Changes in infectious diseases e.g. malaria;
  - Increases in deaths from heat, floods & droughts

Increasing atmospheric CO2 also inevitably leads to increasing acidification of the ocean

Large impacts from extremes - European summer temperatures for 1500–2010

"Mega-heatwaves" in 2003 and 2010 "likely broke the 500-year-long seasonal temperature records over approximately 50% of Europe"



D Barriopedro et al. Science 2011;332:220-224

Science AAAS

Mitigation of non-CO2 GHGs

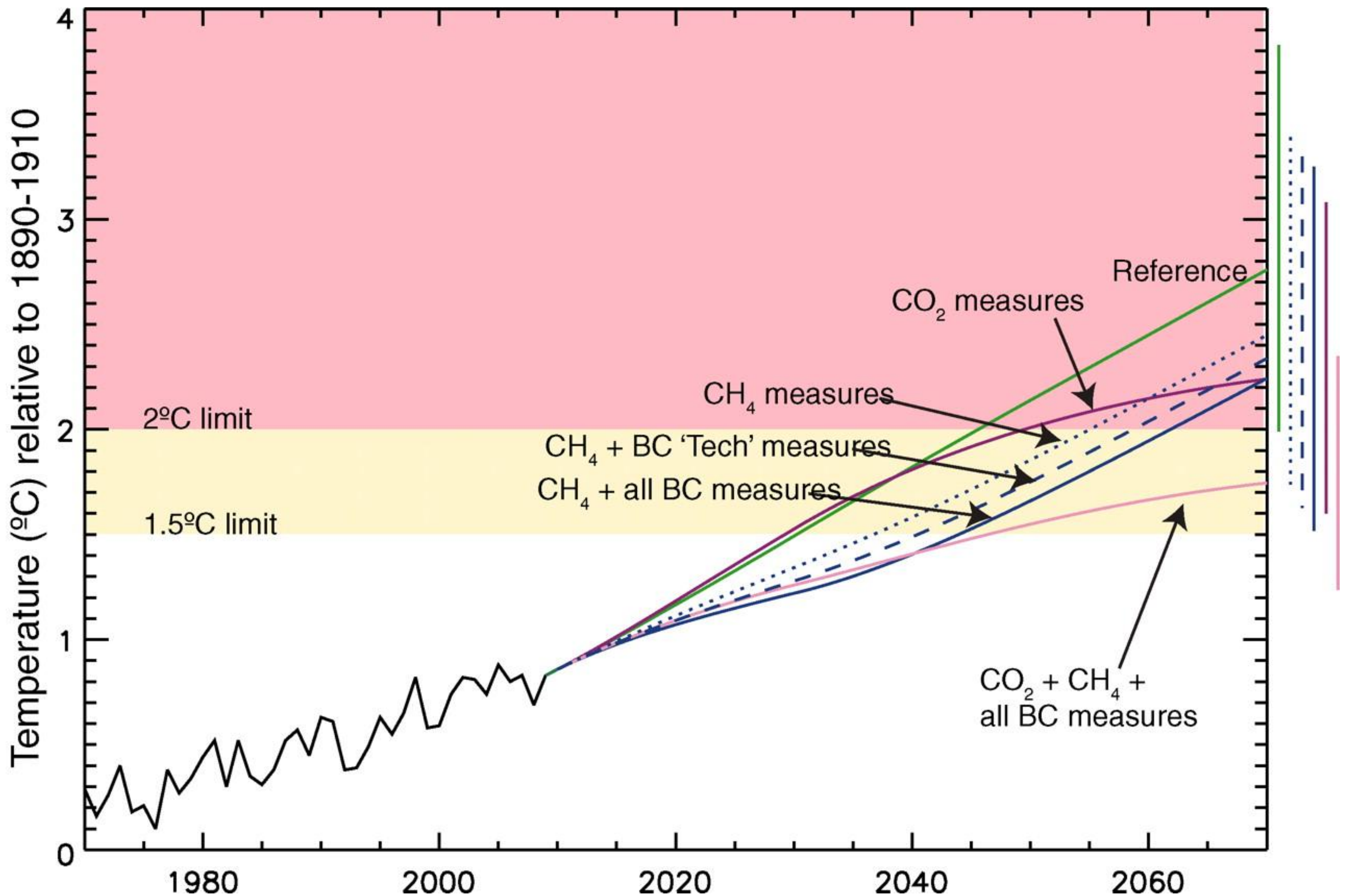
- Tropospheric ozone and black carbon (BC) contribute to both degraded air quality and global warming... 14 measures targeting methane and BC emissions that reduce projected global mean warming ~0.5°C by 2050.

- This strategy avoids 0.7 to 4.7 million annual premature deaths from outdoor air pollution and increases annual crop yields by 30 to 135 million metric tons due to ozone reductions in 2030 and beyond.

- The selected controls target different sources and influence climate on shorter time scales than those of carbon dioxide–reduction measures. Implementing both substantially reduces the risks of crossing the 2°C threshold.

D Shindell et al. Science 2012;335:183-189

Observed temperatures through 2009 and projected temperatures thereafter under various scenarios, all relative to the 1890–1910 mean



D Shindell et al. Science 2012;335:183-189

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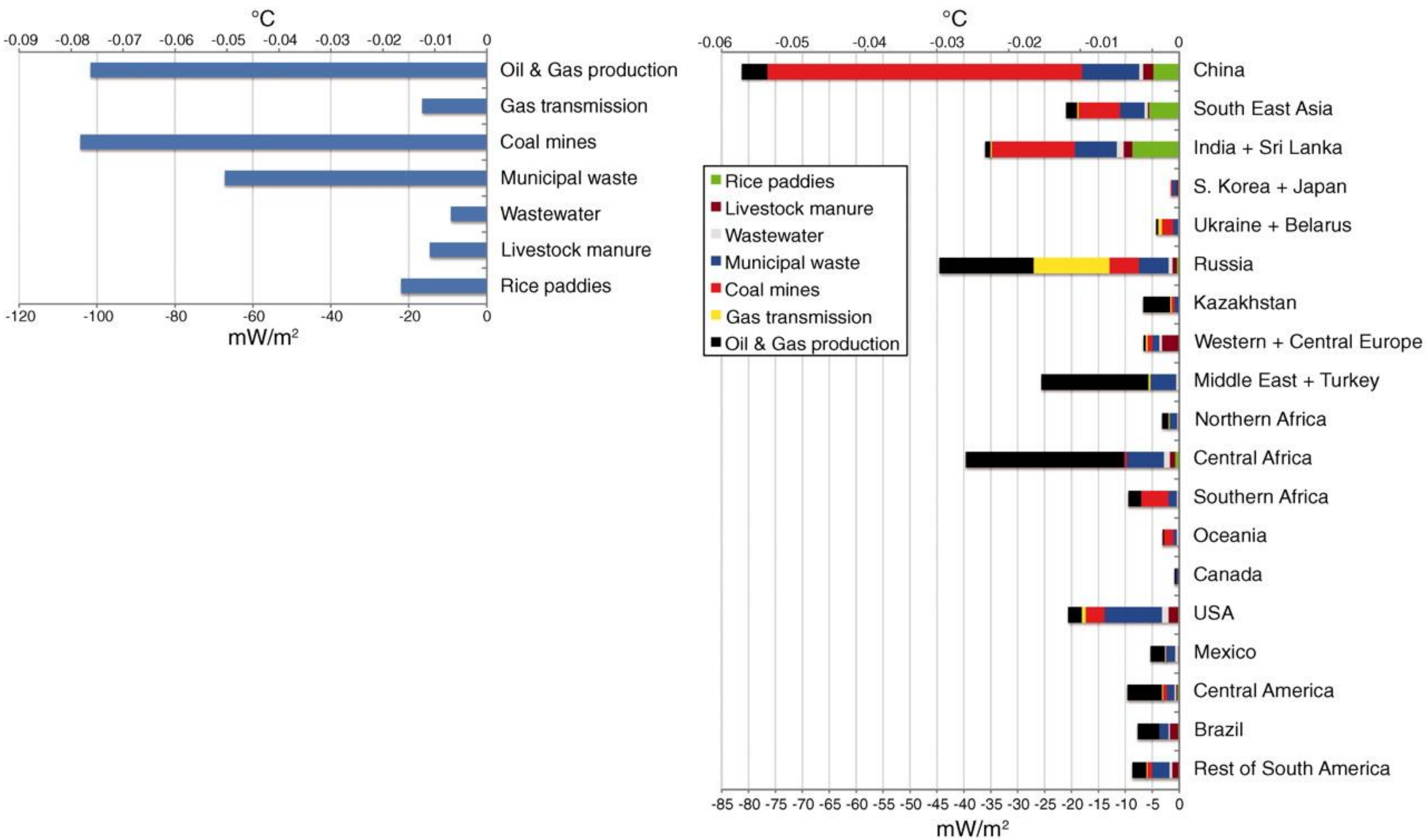
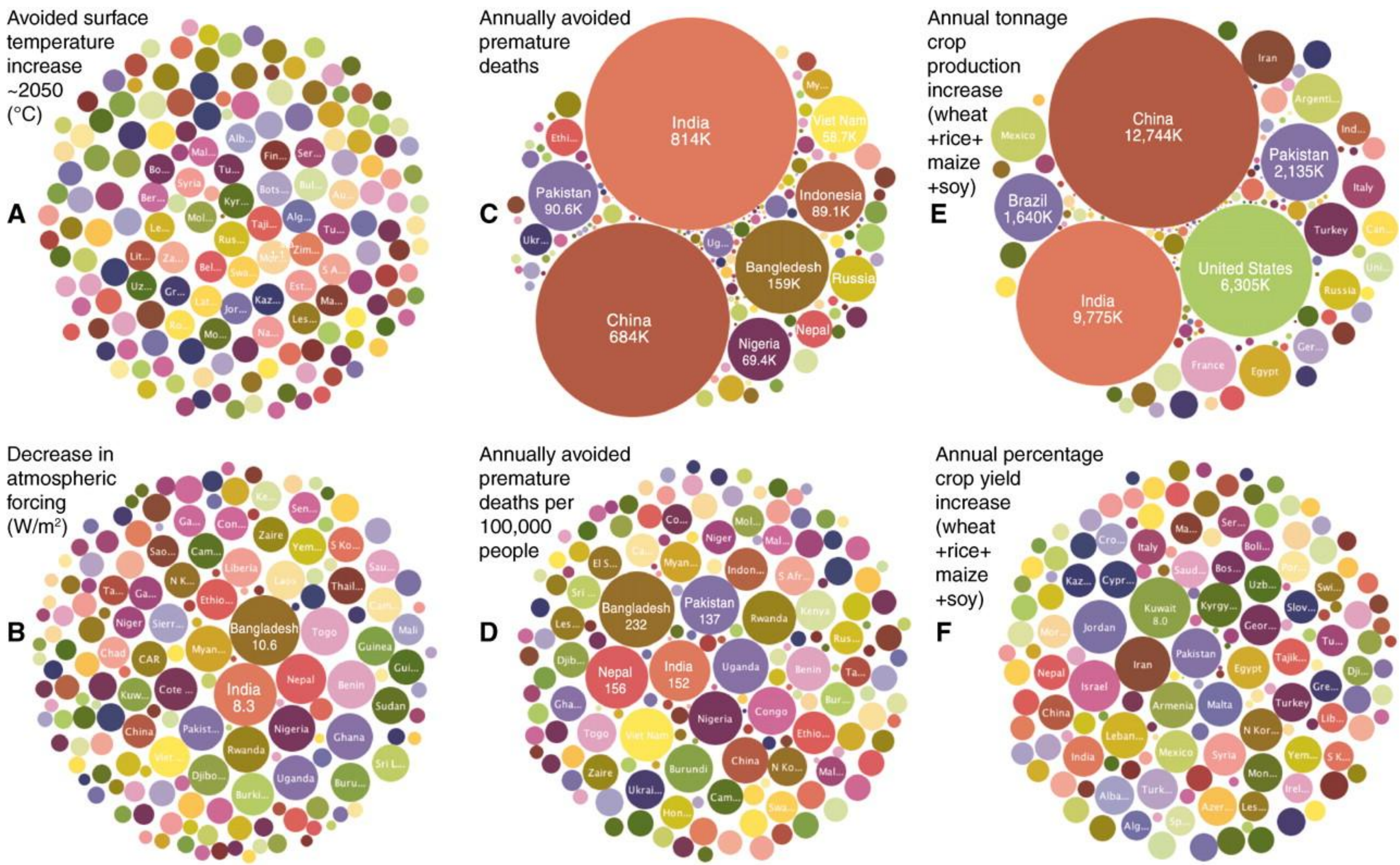
Fig. 3 Global mean radiative forcing (bottom x axes) and temperature response (top x axes) from CH4 and ozone in response to CH4 measures.



D Shindell et al. Science 2012;335:183-189

Fig. 4 National benefits of the CH4 plus BC measures versus the reference scenario.



D Shindell et al. Science 2012;335:183-189

5. International efforts to prevent climate change

The challenge

- **Climate change** is
  - **Global** in causes/effects;
  - **Long-term** and potentially irreversible
  - Raises fundamental issues of **responsibility**, **equity**
  - **Action needs to be negotiated** among states
- **Fossil fuels** integral to the way our economies and societies function; key assets of several countries
- **Countries differ** on many dimensions (wealth, technology, resources, population etc)
- **Divergent views** on emissions reductions goals and burden sharing

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Timeline

1987	**Montreal Protocol** on ozone depletion
1988	UNEP/WMO establish **IPCC**
1992	**Rio Earth Summit** and adoption of **UNFCCC**
1997	COP 3 adopts **Kyoto Protocol**.
2002	Delhi Declaration at COP 8 highlights adaptation
2005	**Kyoto Protocol** enters into force. Establishes Adaptation Fund. EU ETS starts.
2006	Stern Review: mitigation, carbon prices, adaptation, forests, technology
2007	**Bali Action Plan** – nationally appropriate mitigation actions
2008-12	Kyoto first commitment period
2009	COP 15 - **Copenhagen Accord**
2010	Cancun COP 16
2011	Durban - new agreement with “legal force” from 2020
2012	**Doha COP 18** – Kyoto extension; loss & damage

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UNFCCC

"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.“

and based on

“common but differentiated responsibilities”

I. Tension between pollution paradigm and sustainable development goals

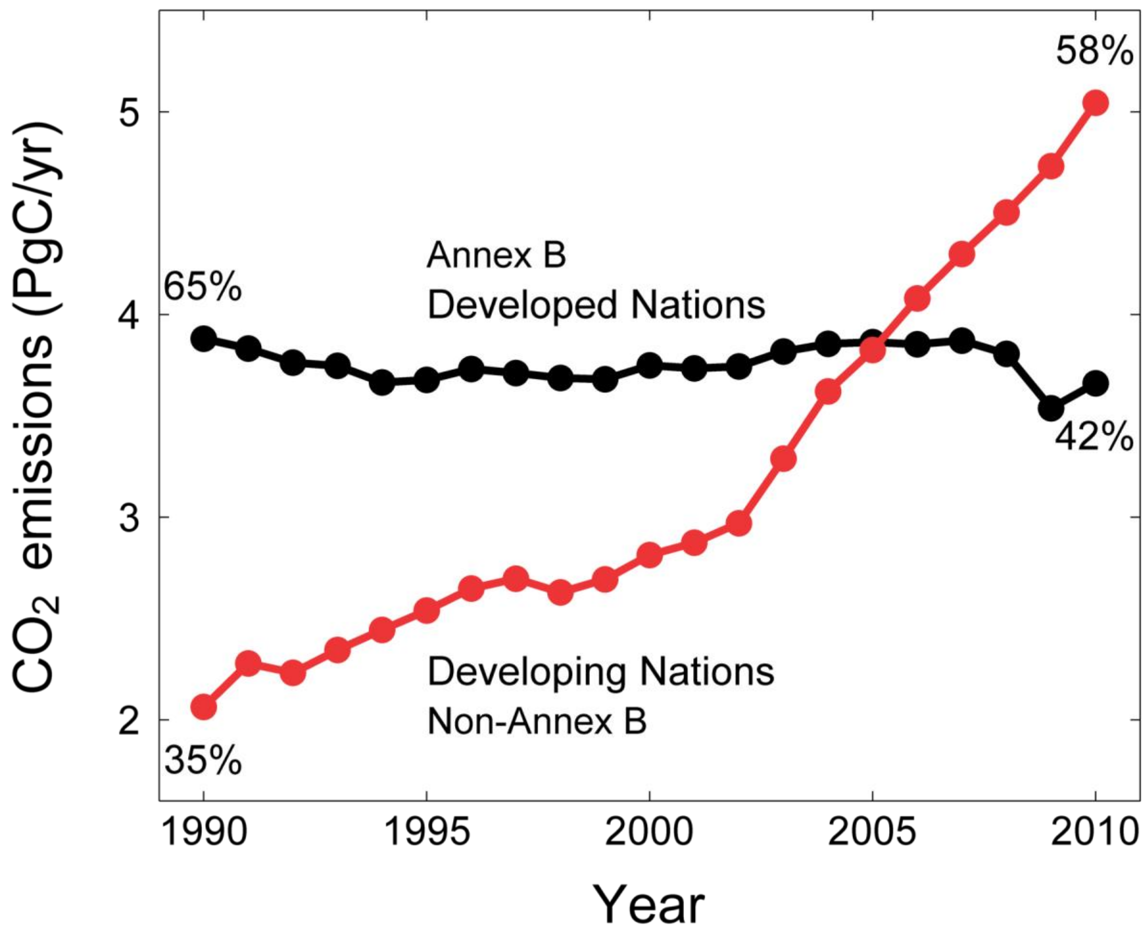
II. Unhelpfully created rigid divide between “North” and “South”

III. Focus initially largely on mitigation and avoidance rather than adaptation

Territorial emissions as per the Kyoto Protocol

The Kyoto Protocol is based on the global distribution of emissions in 1990

The global distribution of emissions is now starkly different



Share of global emissions in 2010

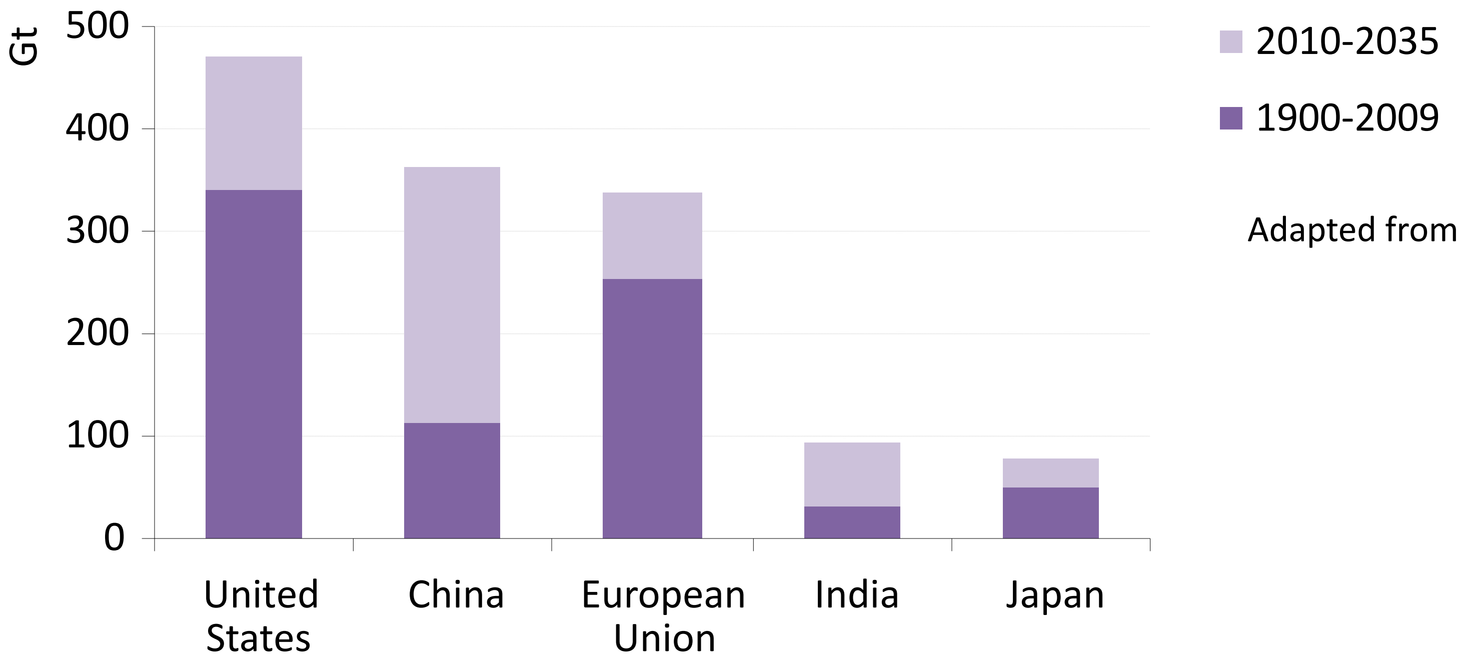
In 2011:

- Annex B 60%
- Non-Annex B 40%

Source: CDIAC Data; Le Quéré et al. 2012; Global Carbon Project 2012

Changing pattern of emissions

Cumulative energy-related CO_2 emissions in selected countries and regions in the New Policies Scenario, 1900-2035



Adapted from IEA WEO

By 2035, cumulative CO_2 emissions from today exceed three-quarters of the total since 1900, and China's per-capita emissions match the OECD average

Crunch Issues

- **Political & Ethical**:
  - (i) Interests of current vs. future generations (level of ambition)
  - (ii) Current rich vs. current poor (burden sharing and risk tolerance/resilience)
  - (iii) Impacts on vital ecosystems and ecosystem services
  - (iv) Risks of irreversible system change

  ➔ Balance between: adaptation, mitigation & geo-engineering
- **Competing approaches**: Kyoto (legal, top down) vs. "Copenhagen" or MEF (top-down targets vs. bottom-up). Exclusive or complementary?
- **Finance**: developed countries pledged short term (~US$30bn 2010-12) and long-term (~US$100bn p.a. by 2020) funding. Will they deliver?
- **Technical & Economic**: Monitoring, reporting and verification; Reforming/scaling up CDM; technology etc etc