Energy and the Built Environment
CRP 470.004 /570.004

Christian E. Casillas

Lecture 11

Climate Change

Outline

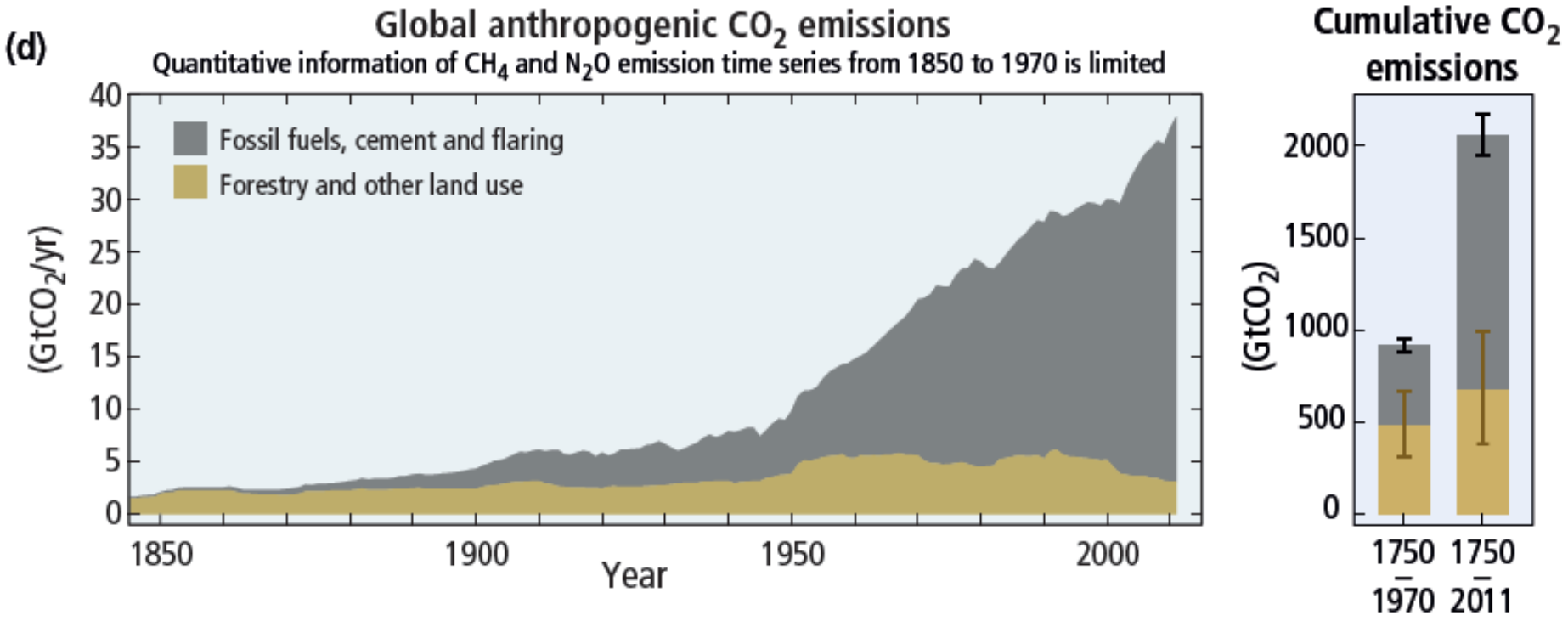
1. Review homework and energy efficiency
2. Talk about class projects
3. Talk about remaining schedule
4. Climate change

The IPCC

- Established in 1988 under the auspices of the UN
- Three working groups:
  - WGI: physical science of climate change
  - WGII: impact on nature and society
  - WGIII: methods for mitigation
- 5 Comprehensive assessments have been released
  - 1990, 1995, 2001, 2007, 2014

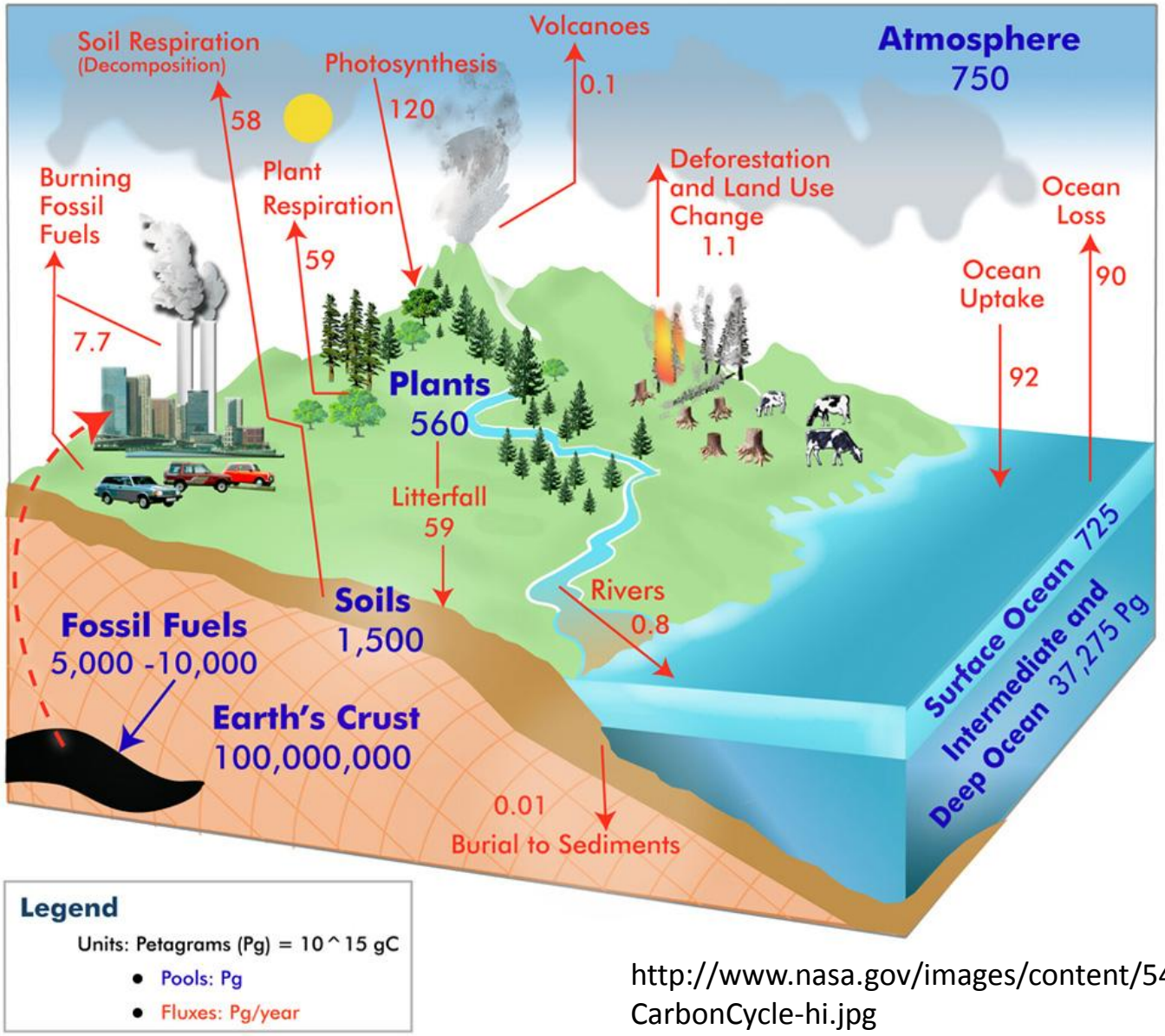
The science of climate change

- Atmospheric concentrations 35% above preindustrial levels, methane 250% higher, and nitrous oxide 20% higher
- Evidence of warming: global ave temp, sea level rise, ice melt



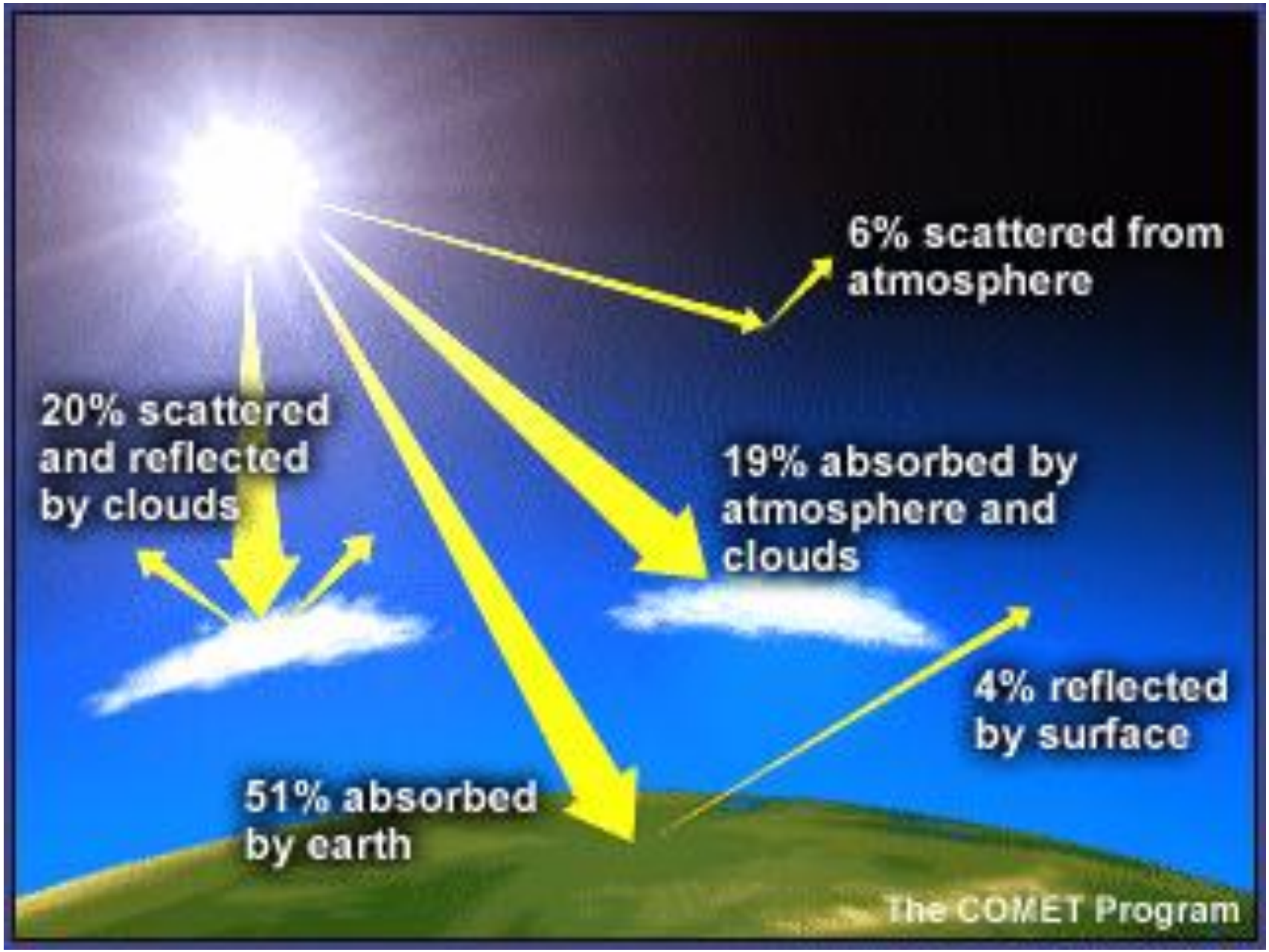
Source: IPCC, Summary for Policy Makers, AR5 2014

Global Carbon Cycle



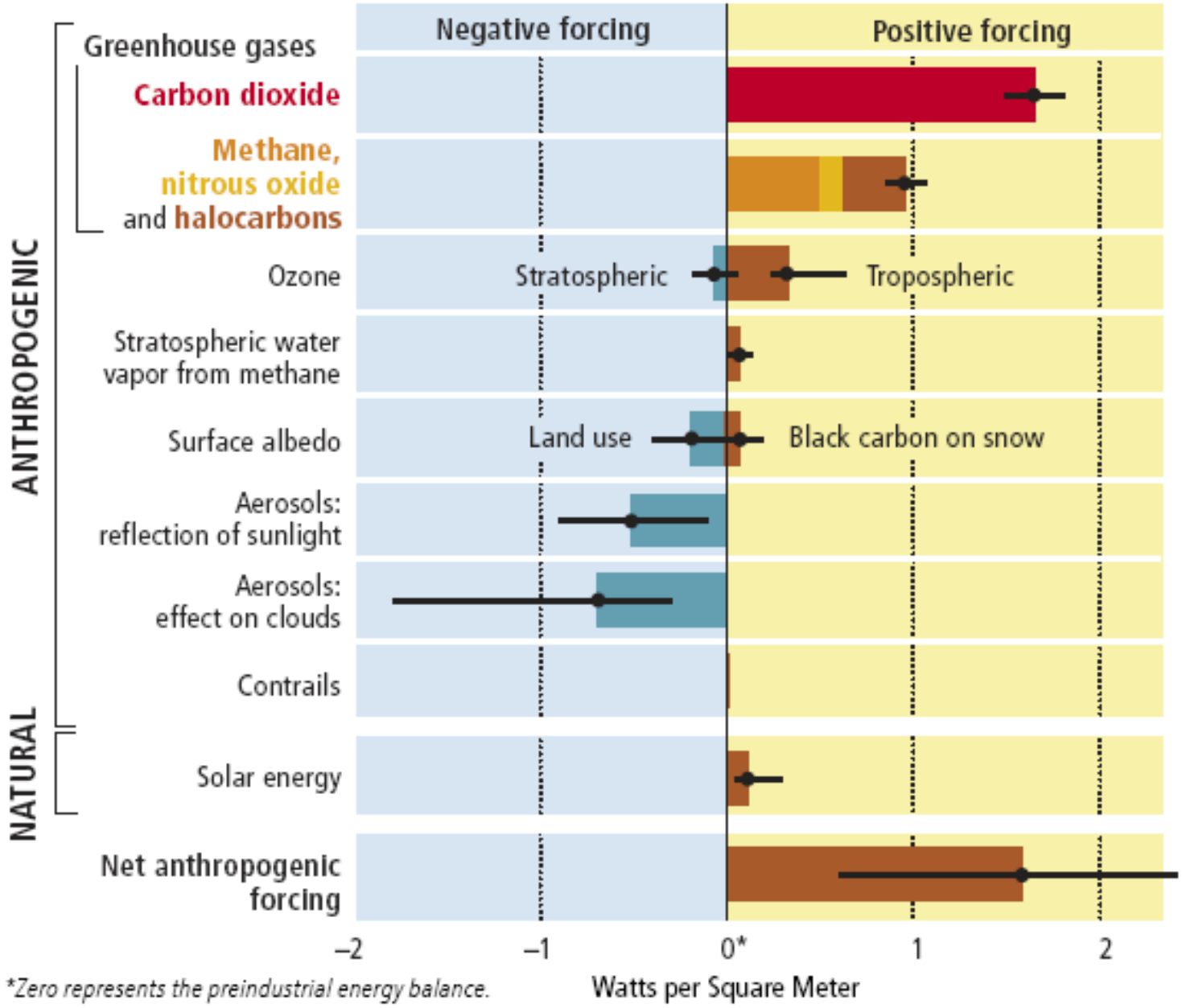
http://www.nasa.gov/images/content/544800main_globe-CarbonCycle-hi.jpg

Copyright 2010 GLOBE Carbon Cycle Project, a collaborative project between the University of New Hampshire, Charles University and the GLOBE Program Office.
Data Sources: Adapted from Houghton, R.A. Balancing the Global Carbon Budget. Annu. Rev. Earth Planet. Sci. 007.35:313-347, updated emissions values are from the Global Carbon Project: Carbon Budget 2009.



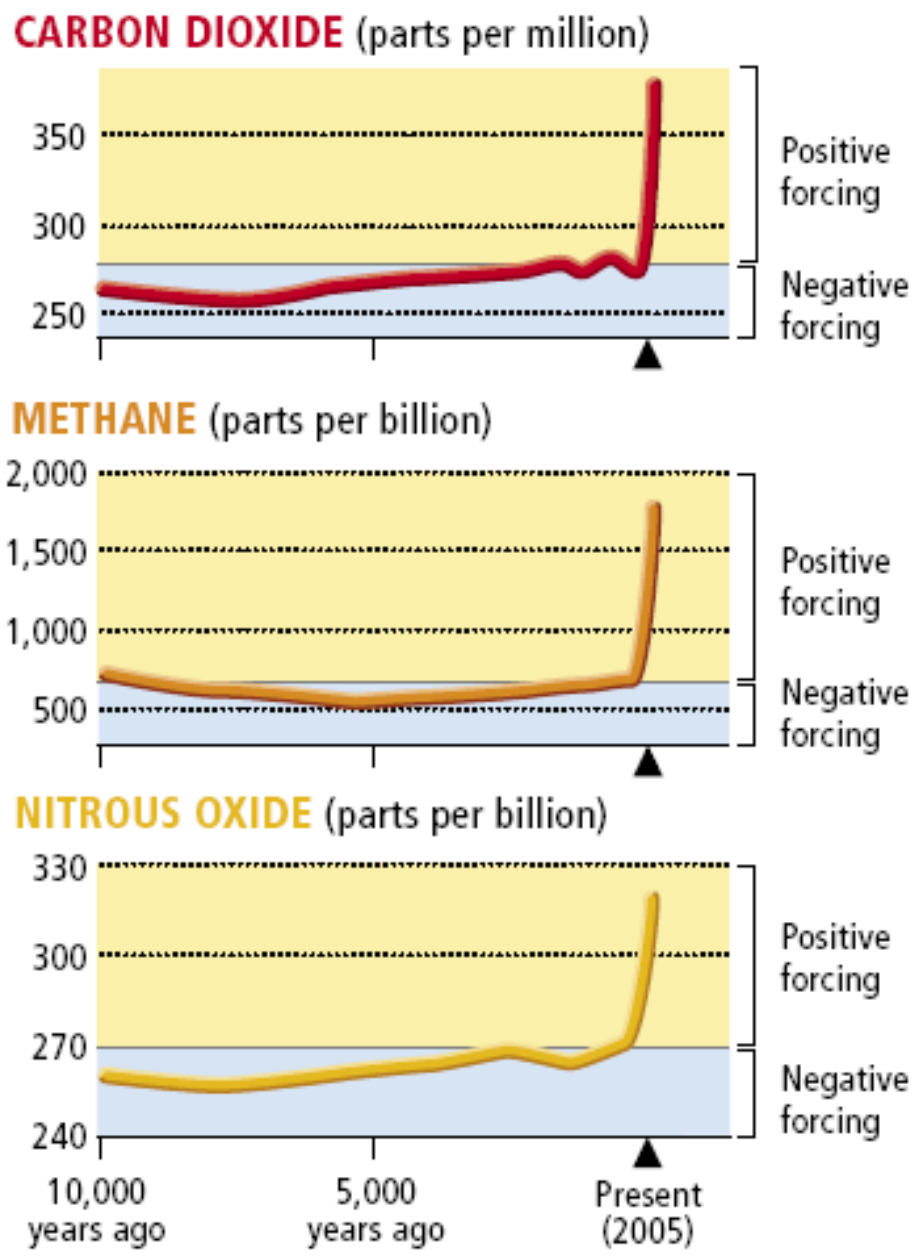
https://www.ucar.edu/learn/1_3_1.htm

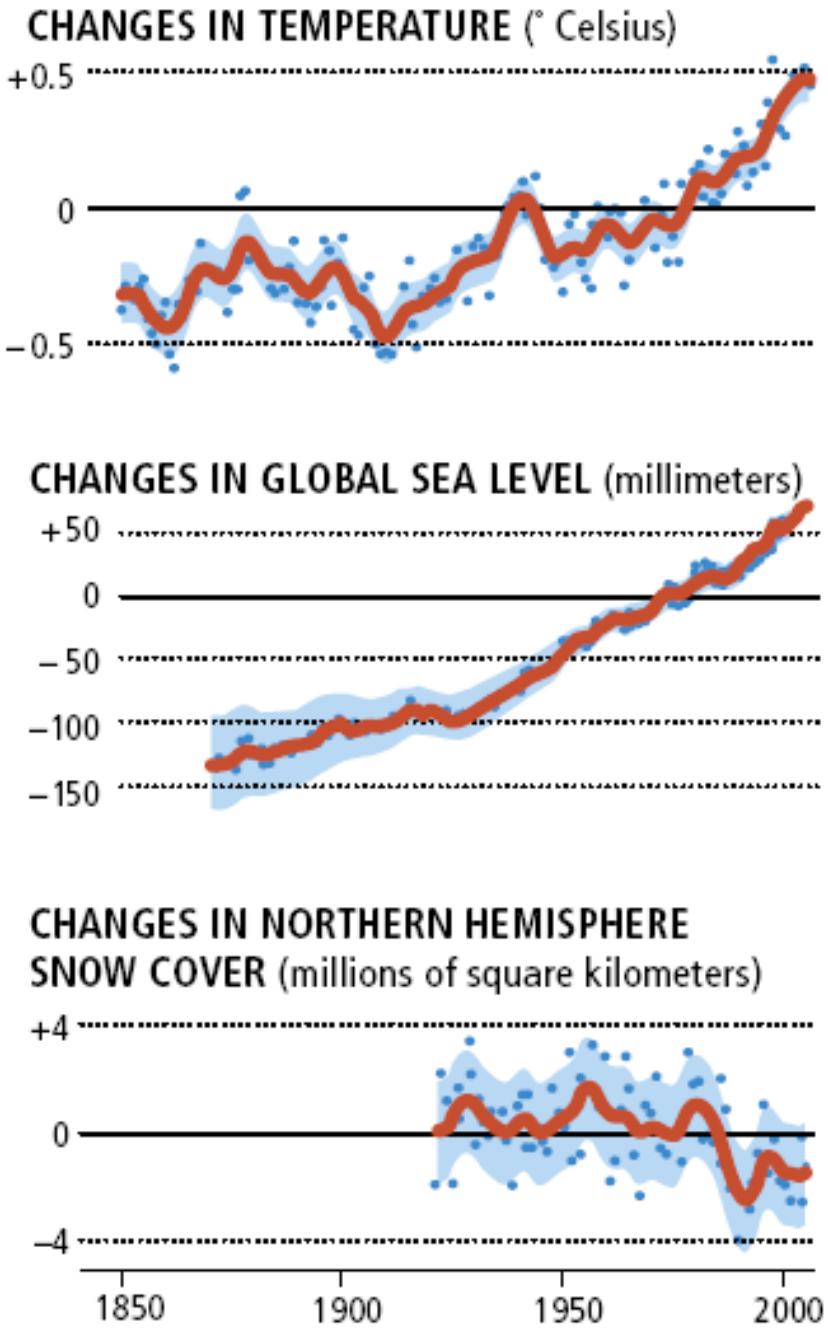
Radiative Forcing: The Overview



Collins, William, et al. (2007) "The Physical Science Behind Climate Change", Scientific American

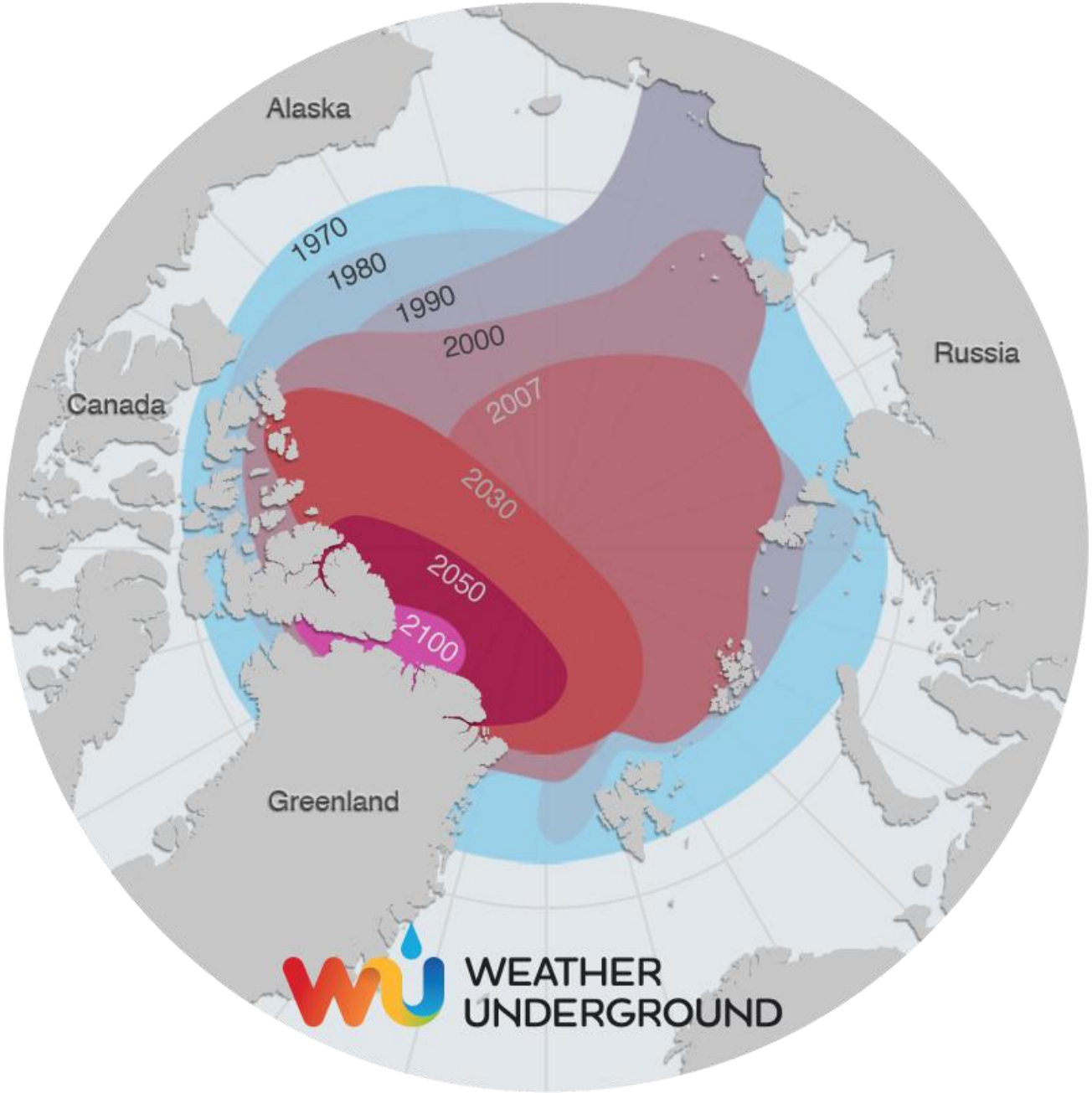
Greenhouse Gases: The Major Forcings





Collins, William, et al. (2007) “The Physical Science Behind Climate Change”, Scientific American

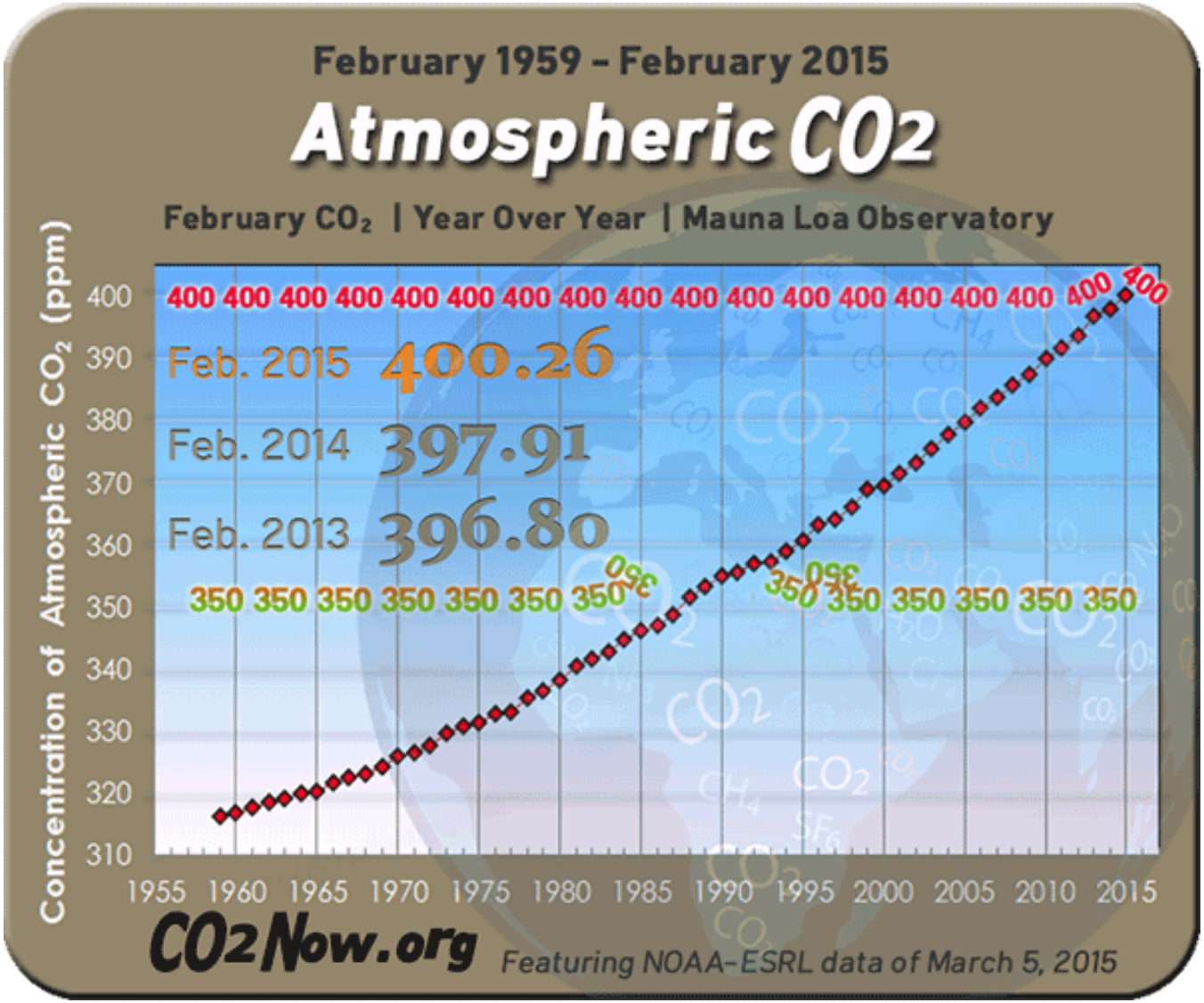
Melting of Arctic Sea Ice



The smoking gun

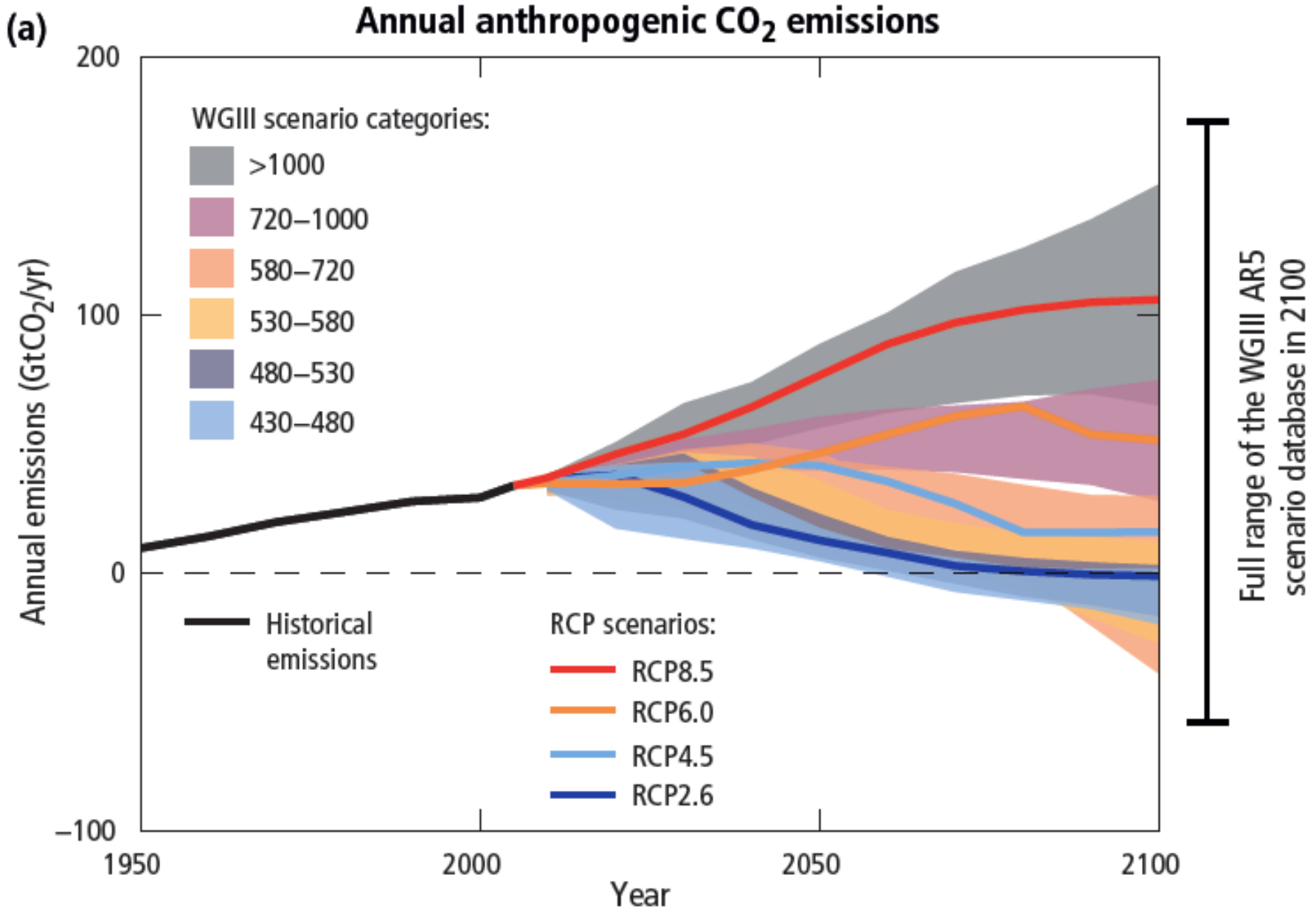
- Essentially all of the observed climate-change phenomena are consistent with the predictions of climate science for GHG-induced warming.
- No alternative "culprit" identified so far – no potential cause of climate change other than greenhouse gases – yields this "fingerprint" match.
- A credible skeptic would need to explain both what the alternative cause of the observed changes is and how it could be that GHGs are NOT having the effects that all current scientific understanding says they should have. (No skeptic has done either thing.)

Global PPM

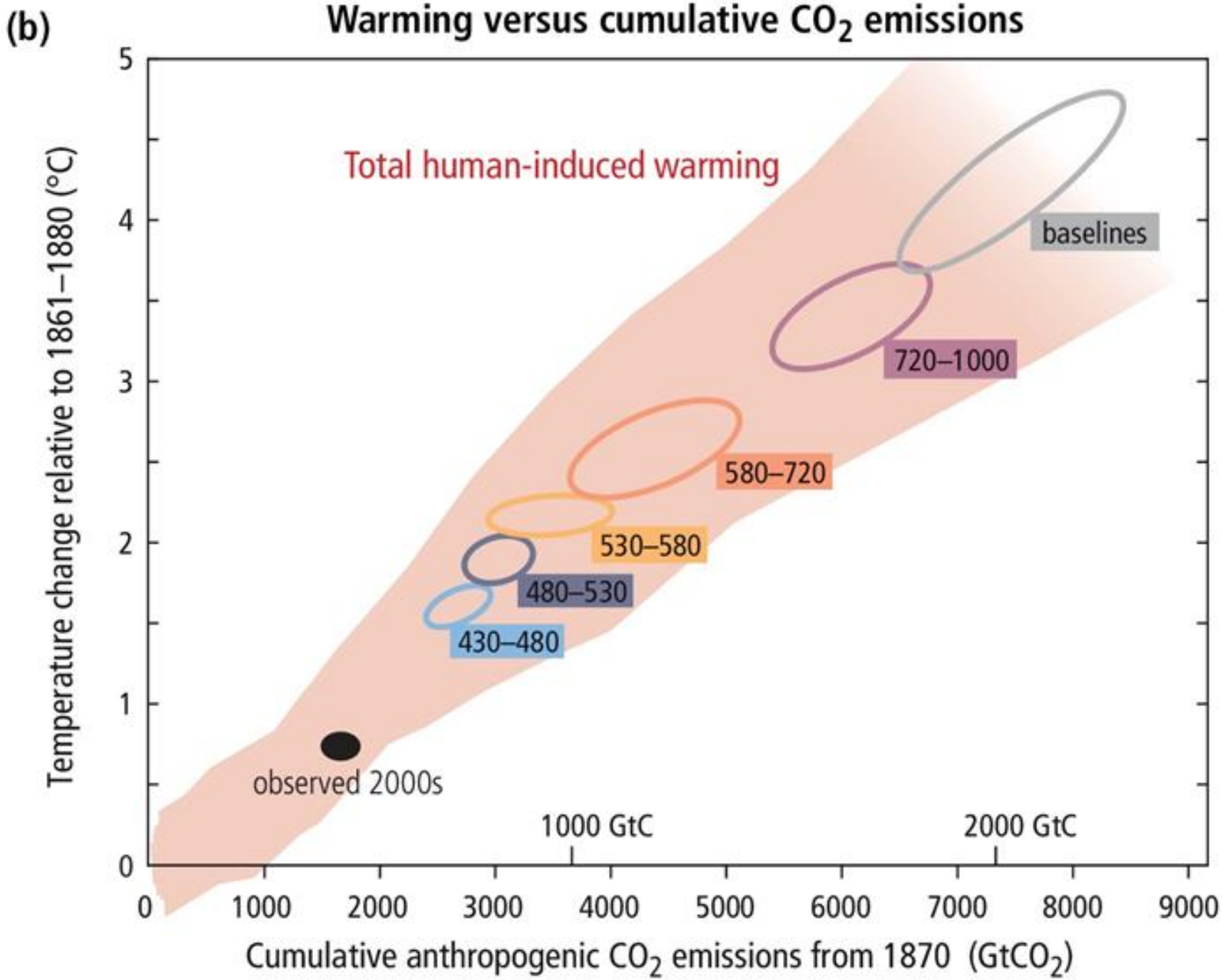

February 1959 – February 2015
Atmospheric CO2
February CO2 | Year Over Year | Mauna Loa Observatory
Concentration of Atmospheric CO2 (ppm)
400
390
380
370
360
350
340
330
320
310
Feb. 2015 400.26
Feb. 2014 397.91
Feb. 2013 396.80
1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
CO2Now.org
Featuring NOAA-ESRL data of March 5, 2015

SPM 3.4 Characteristics of mitigation pathways

There are multiple mitigation pathways that are *likely* to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century. Implementing such reductions poses substantial technological, economic, social and institutional challenges, which increase with delays in additional mitigation and if key technologies are not available. Limiting warming to lower or higher levels involves similar challenges but on different timescales. *{3.4}*



Source: IPCC, Summary for Policy Makers, AR5 2014



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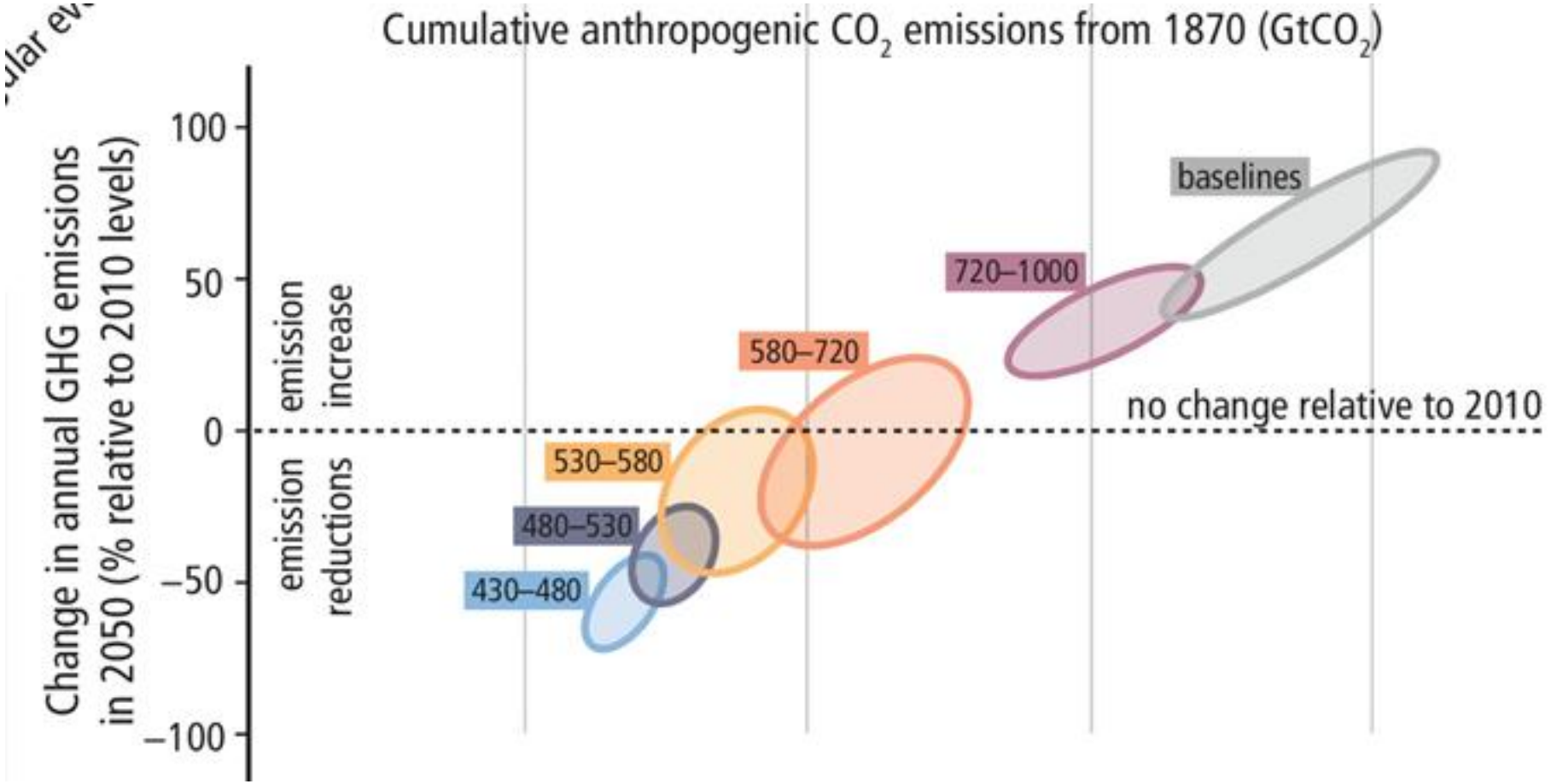


Source: IPCC, Summary for Policy Makers, AR5 2014

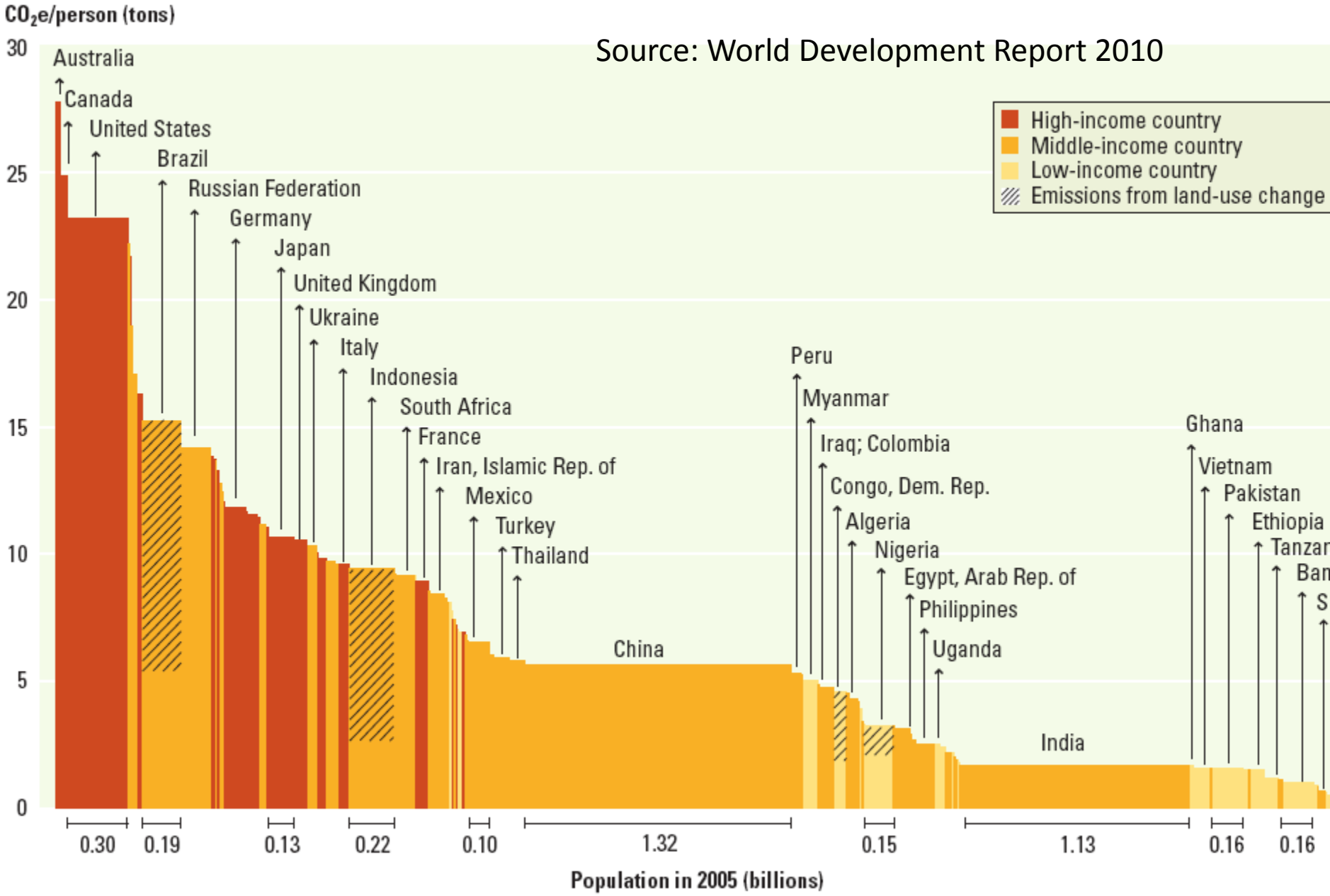
2°C warming above preindustrial temperatures would result in new weather patterns with global consequences. Increased weather variability, more frequent and intense extreme events, and greater exposure to coastal storm surges would lead to a much higher risk of catastrophic and irreversible impacts. Between 100 million and 400 million more people could be at risk of hunger.22 And 1billion to 2 billion more people may no longer have enough water to meet their needs.

Source: World Development Report 2010

Climate Ethics

- evaluating impacts
- considering intergenerational equity
- distributing responsibilities and costs.

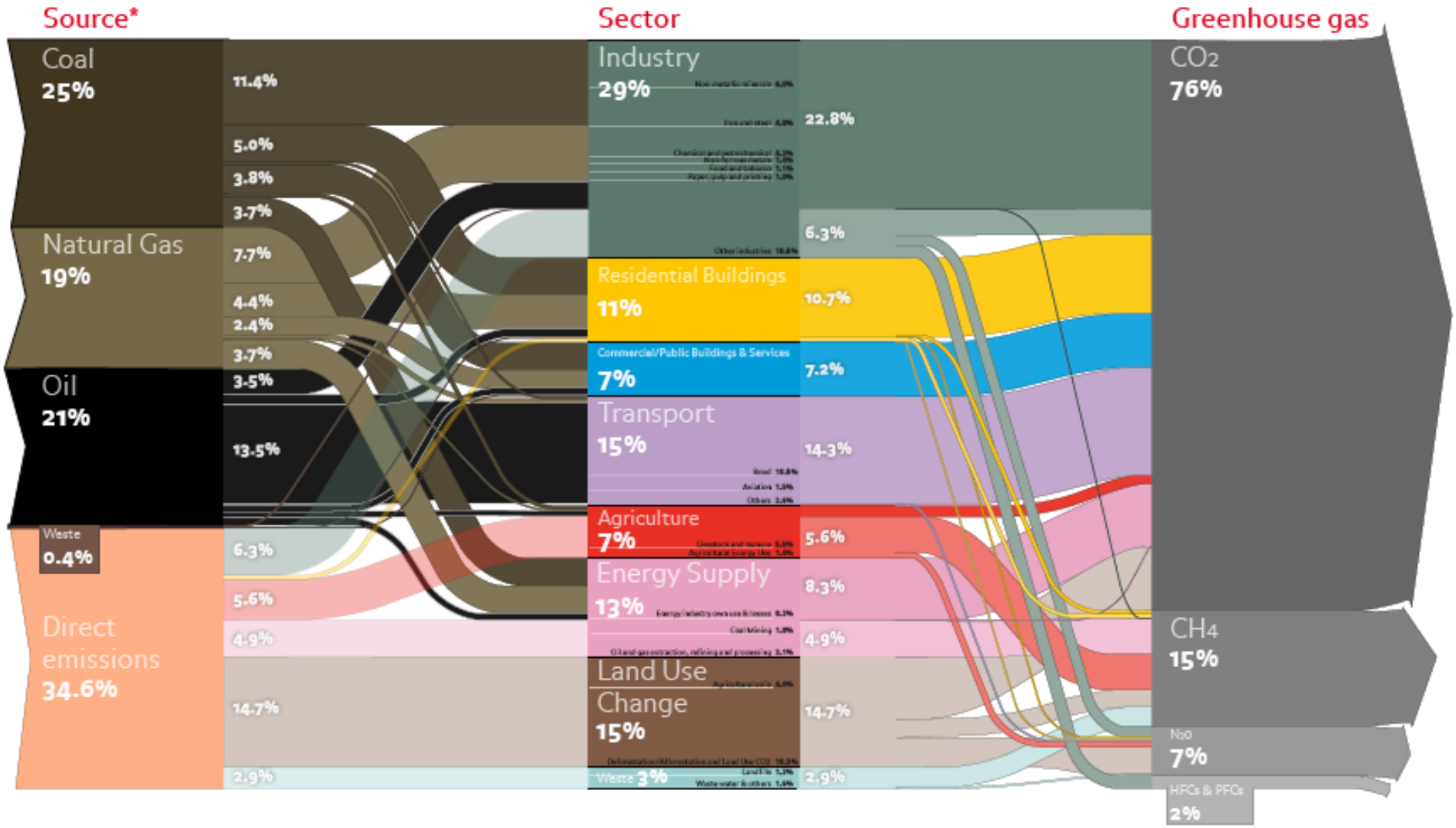
Figure 1.1 Individuals' emissions in high-income countries overwhelm those in developing countries



Source: World Development Report 2010

Sources: Emissions of greenhouse gases in 2005 from WRI 2008, augmented with land-use change emissions from Houghton 2009; population from World Bank 2009c.

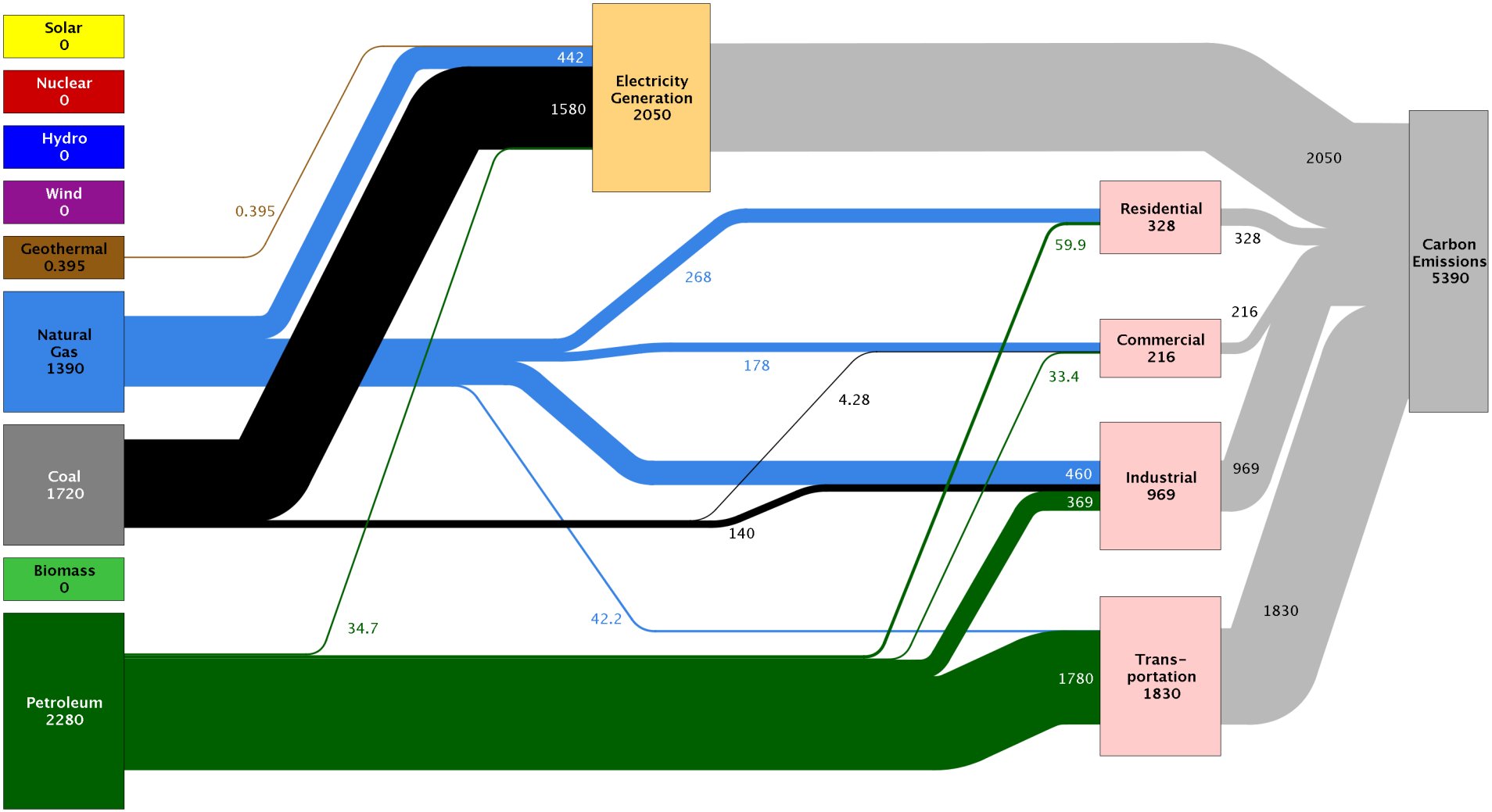
Global GHG emissions 2010



http://www.ecofys.com/files/files/asn-ecofys-2013-world-ghg-emissions-flow-chart-2010.pdf

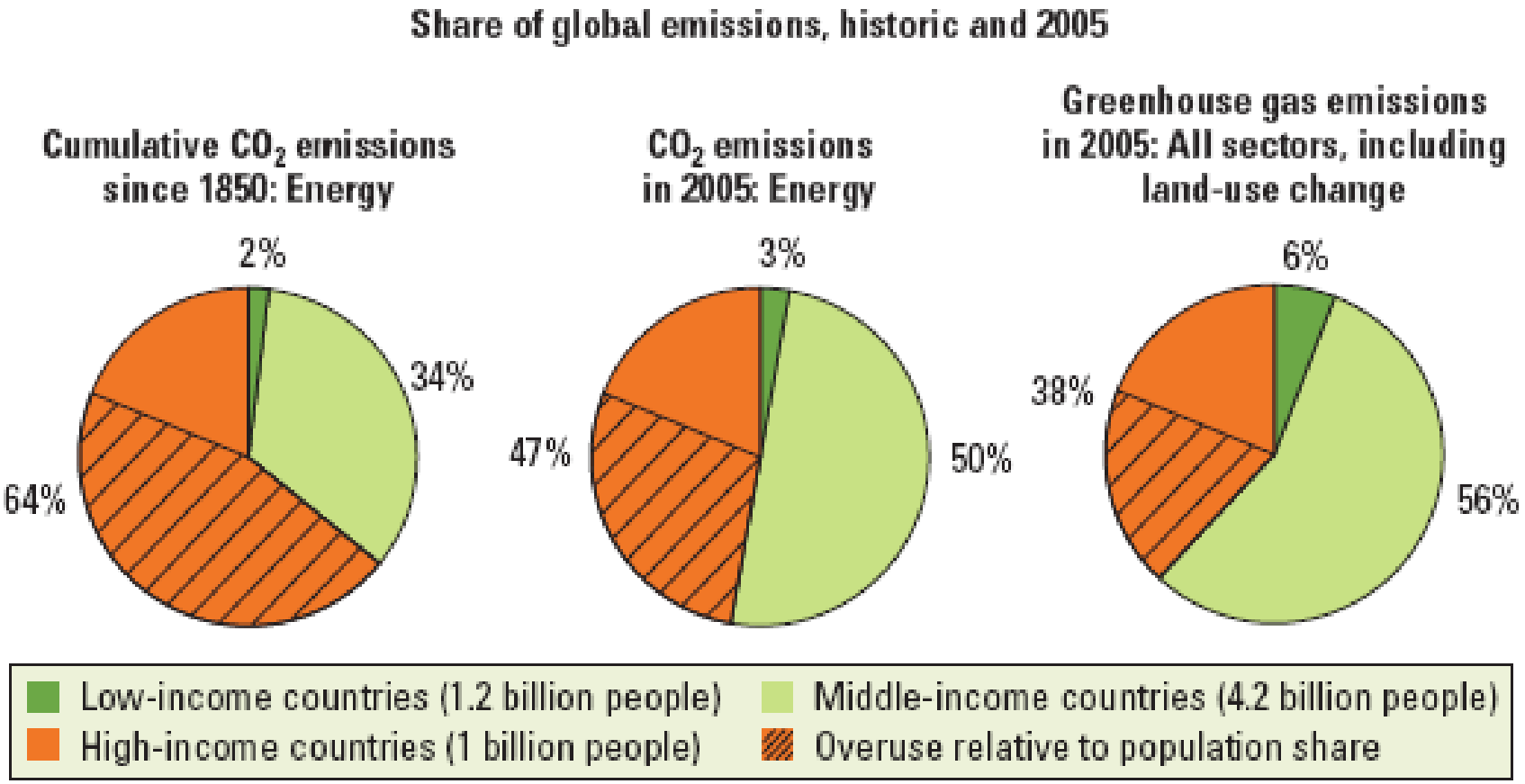
Estimated U.S. Carbon Emissions in 2013: ~5,390 Million Metric Tons

Lawrence Livermore National Laboratory



Source: LLNL 2014. Data is based on DOE/EIA-0035(2014-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Carbon emissions are attributed to their physical source, and are not allocated to end use for electricity consumption in the residential, commercial, industrial and transportation sectors. Petroleum consumption in the electric power sector includes the non-renewable portion of municipal solid waste. Combustion of biologically derived fuels is assumed to have zero net carbon emissions – the lifecycle emissions associated with producing biofuels are included in commercial and industrial emissions. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

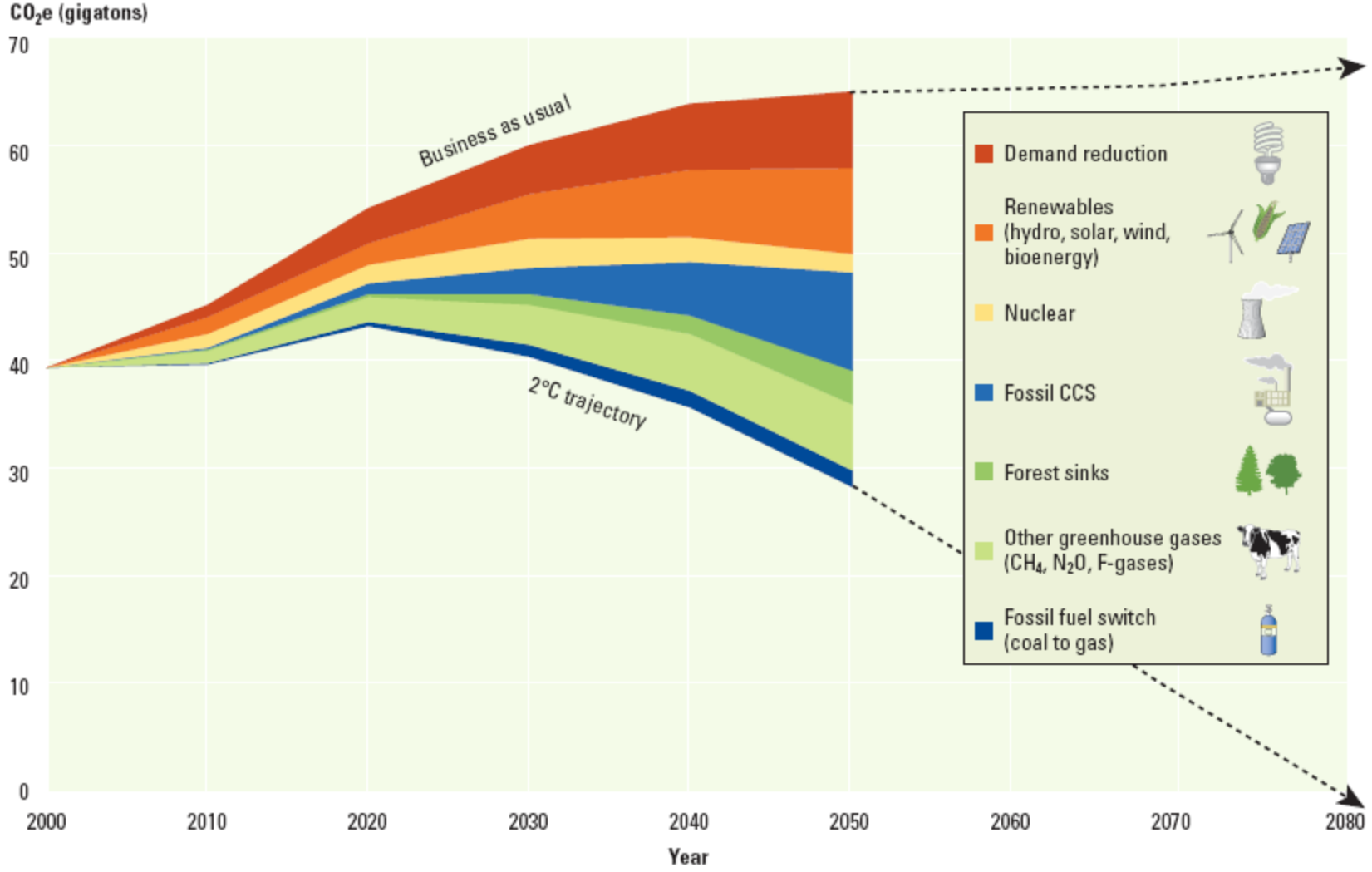
Figure 3 High-income countries have historically contributed a disproportionate share of global emissions and still do



Sources: DOE 2009; World Bank 2008c; WRI 2008 augmented with land-use change emissions from Houghton 2009.

Source: World Development Report 2010

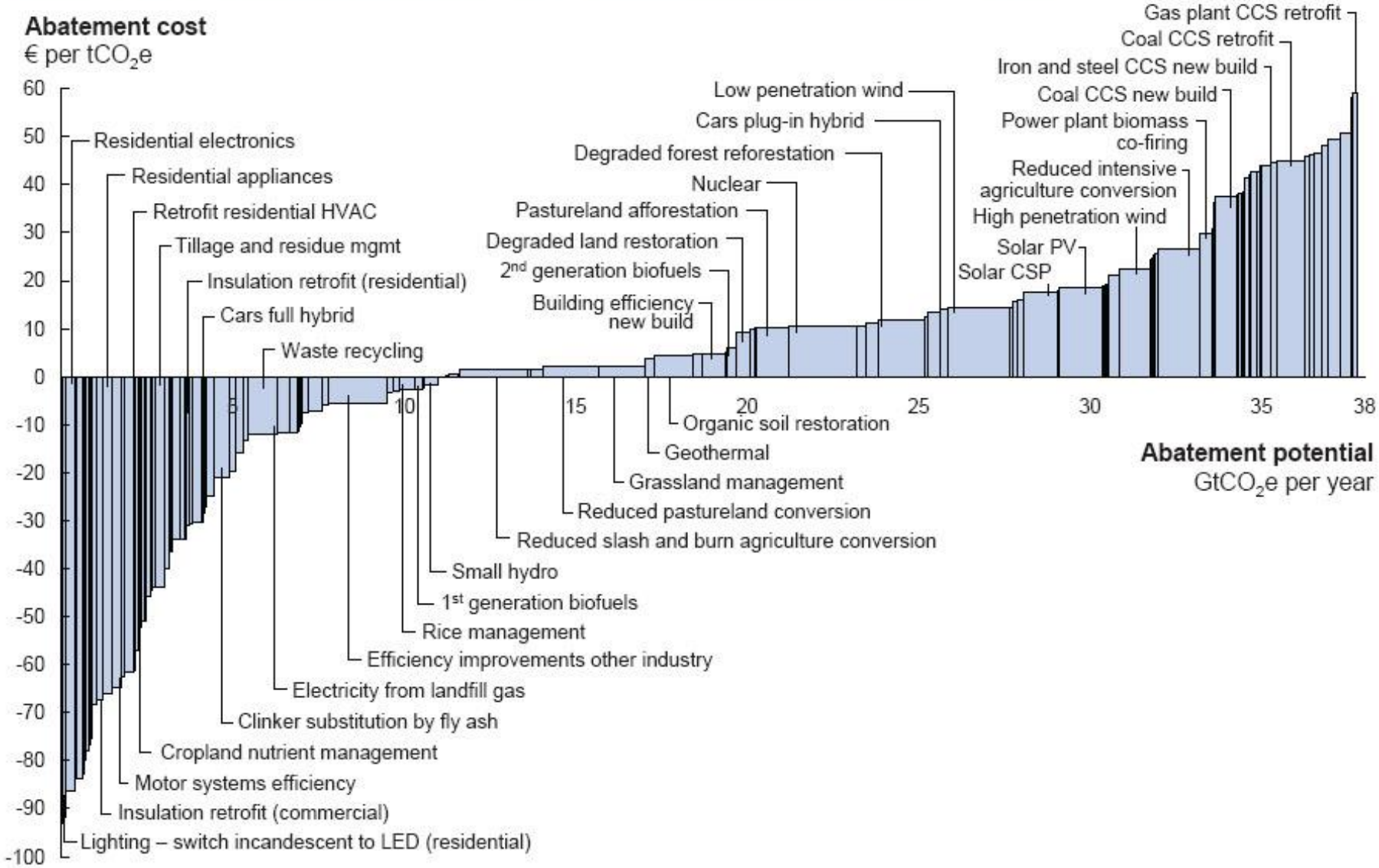
Figure 8 The full portfolio of existing measures and advanced technologies, not a silver bullet, will be needed to get the world onto a 2°C path



Source: WDR team with data from IIASA 2009.

Source: World Development Report 2010

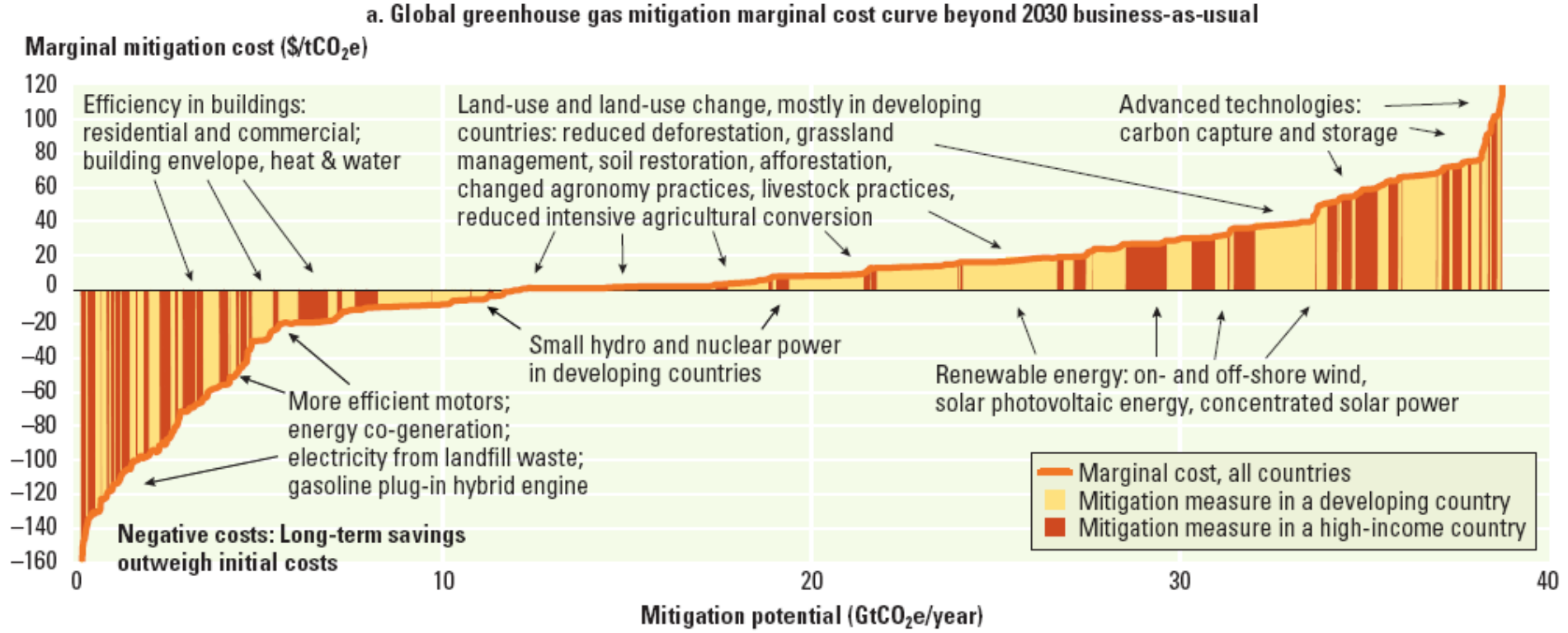
Global GHG abatement cost curve beyond business-as-usual – 2030



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

Source: McKinsey

Figure 1.3 Assessing deadweight losses from partial participation in a climate deal



Source: World Development Report 2010