



Module 1

Understanding the basics of climate change science

Training workshops on
mainstreaming climate change

Training materials developed with the support of the European Commission

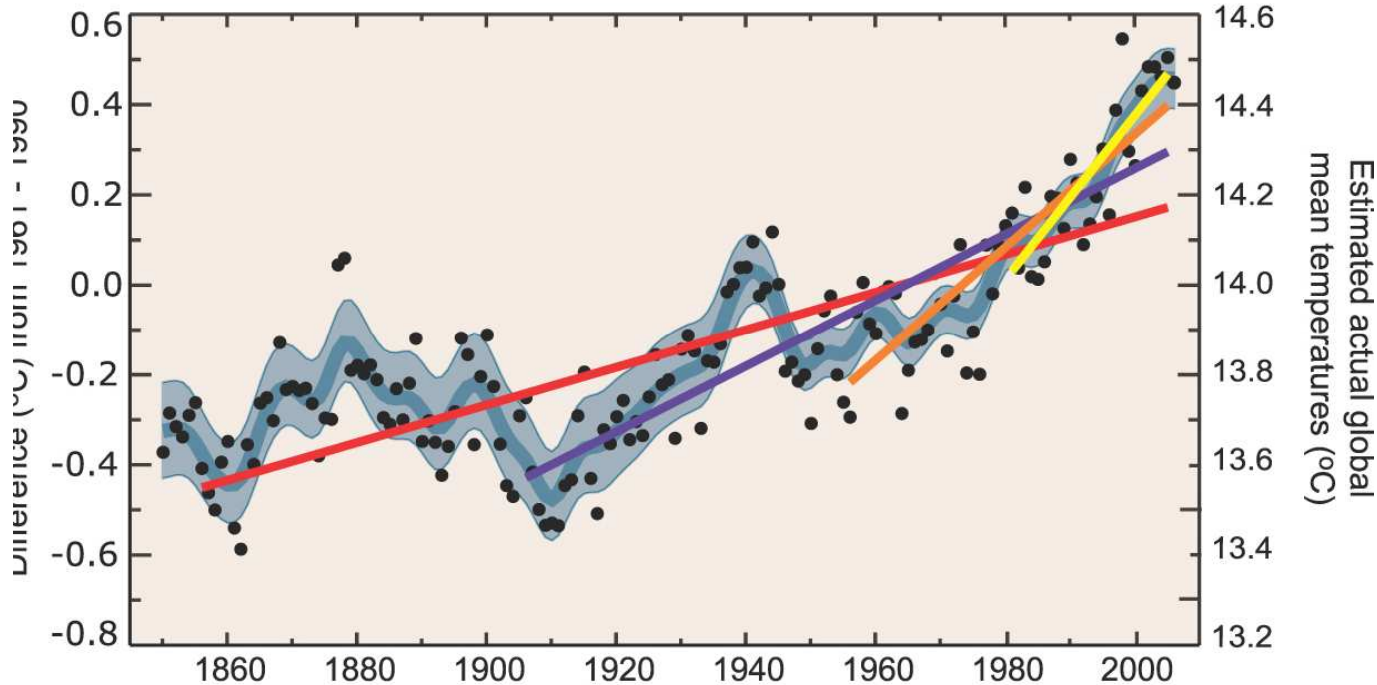
Is climate change real?



- IPCC 4th Assessment Report:
 - “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level”.
- Observed trends:
 - Recent years warmest on record
 - Accelerating increase in global surface temperature and ocean temperature
 - Accelerating rise in sea level

Some observations: trends in global mean temperature

Global Mean Temperature



	Period Years	Rate °C per decade
●	Annual mean	
—	Smoothed series	
■	5-95% decadal error bars	
—	25	0.177±0.052
—	50	0.128±0.026
—	100	0.074±0.018
—	150	0.045±0.012

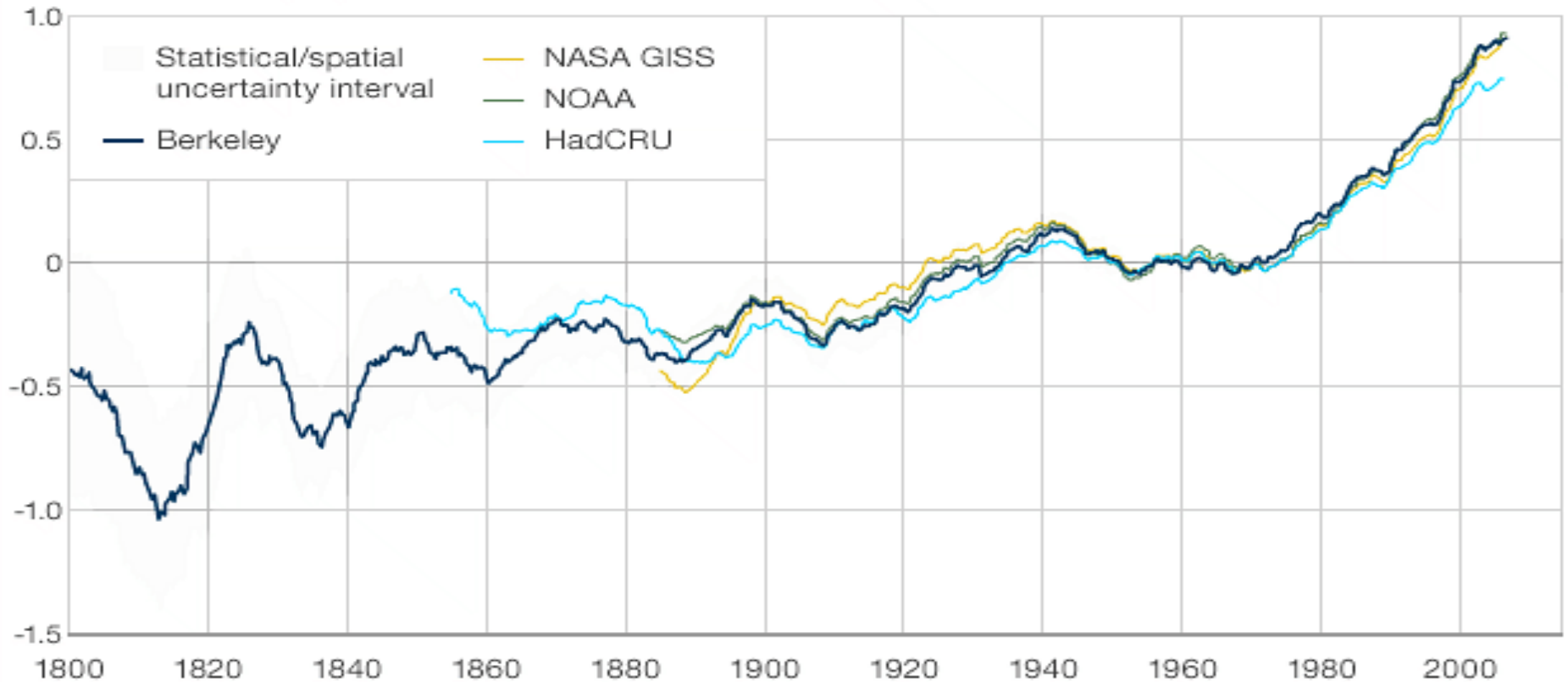
Source: IPCC (2007b) 4th
Assessment Report,
WG I – FAQ 3.1 Fig. 1

Berkeley Earth Surface Temperature Project results (October 2011)



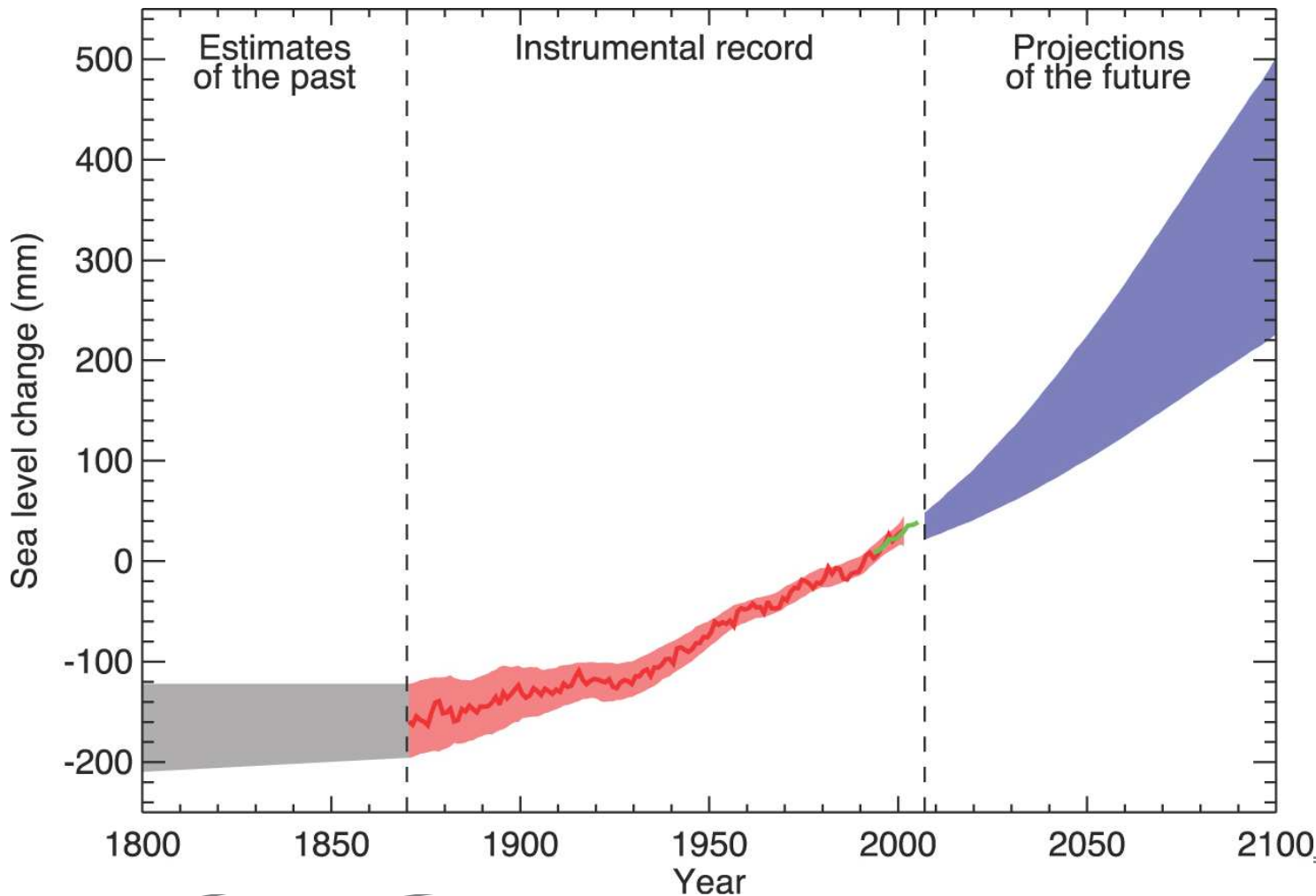
Decadal land-surface average temperature

Temperature anomaly (°C)



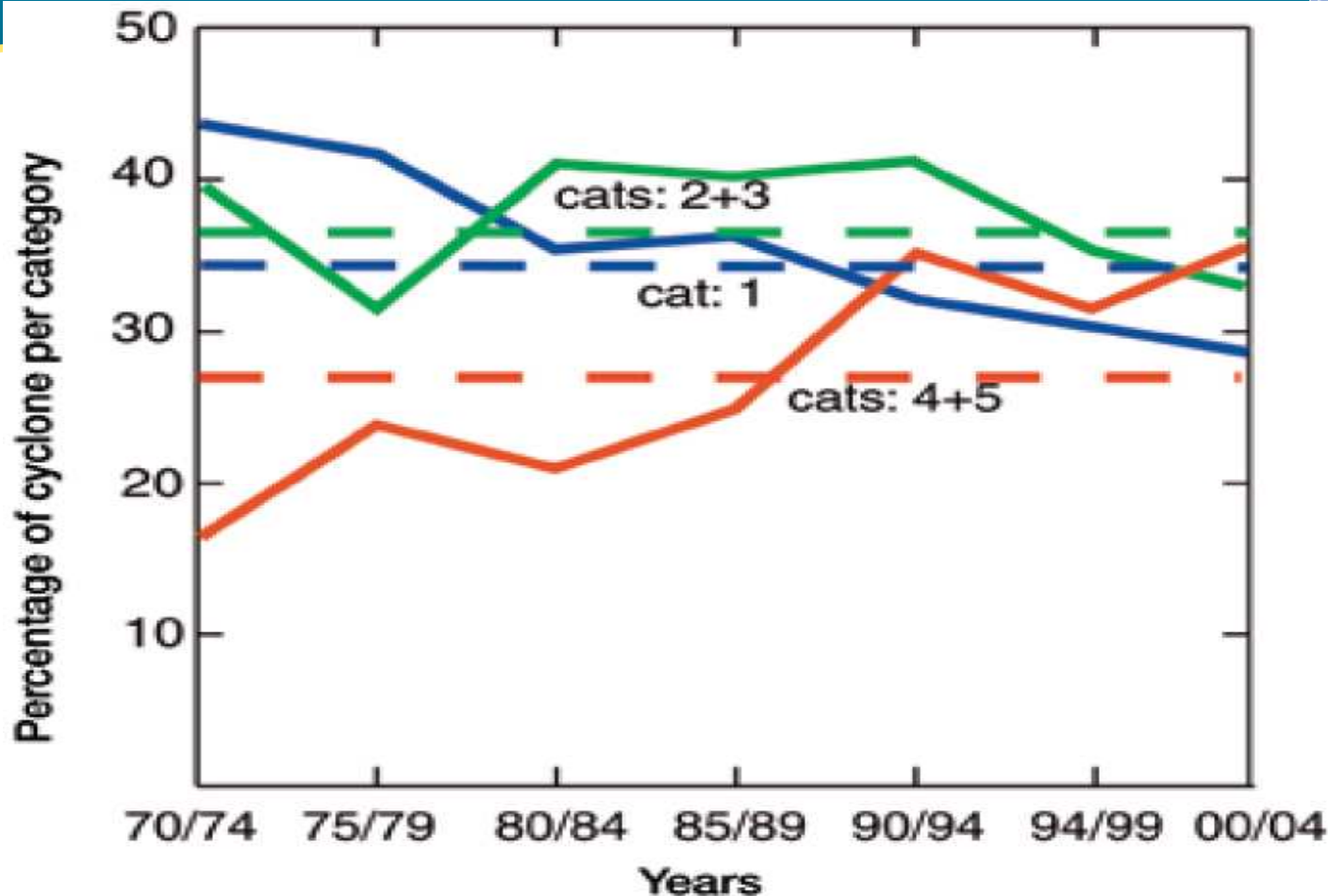
Source: Berkeley Earth Project

Observations and projections: global sea level change



Source: IPCC
(2007b) 4th
Assessment
Report, WG I –
FAQ 5.1 Fig. 1

Observations: intensity of cyclones



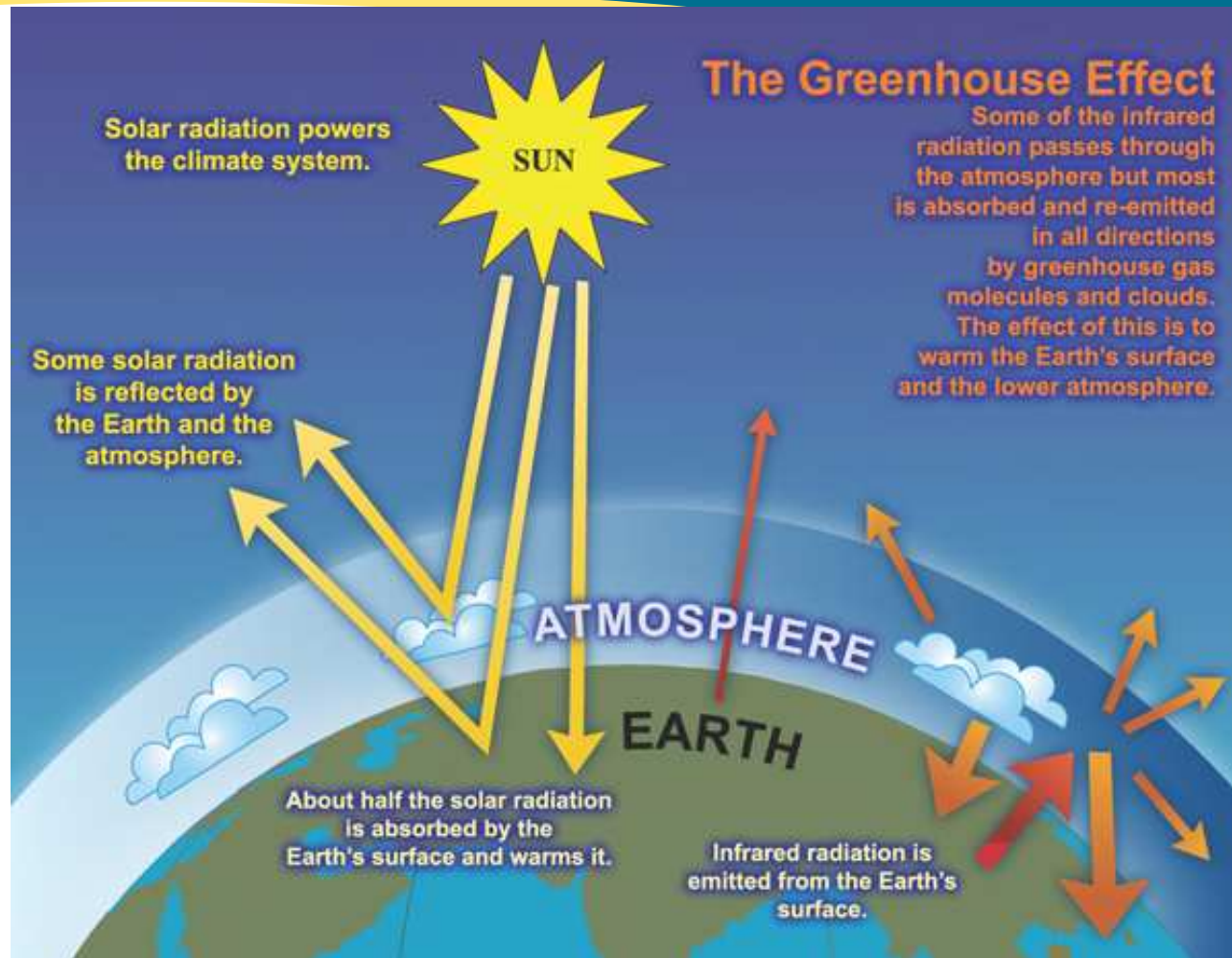
Worldwide: %age of Category 1 cyclone (blue curve), sum of Category 2 and 3 (green curve), sum of category 4 and 5 (red curve) on 5 years period. Dashed lines are averages for each category from 1970 to 2004 (Source: Petit & Prudent 2008, p. 42, from Webster et al 2005)

What are the causes of climate change?



- *Natural variation* is an inherent feature of the climate (e.g. driven by solar cycles, earth orbit, volcanoes)
- But *anthropogenic emissions of long-lived greenhouse gases* in the atmosphere are a major cause of the changes now being observed

The greenhouse effect



Source: WWF/IPCC,

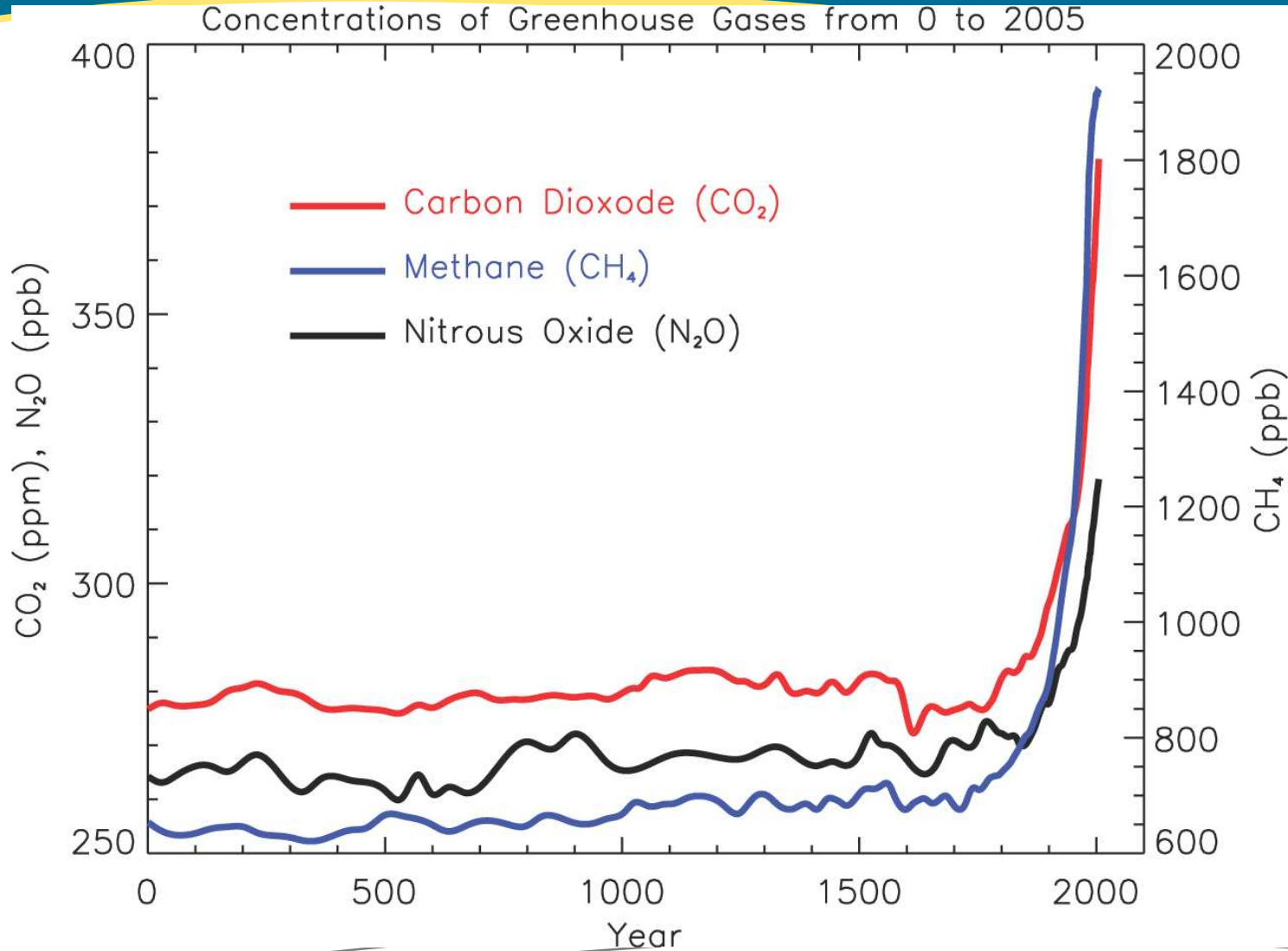
http://wwf.panda.org/about_our_earth/aboutcc/how_cc_works/

What are the main greenhouse gases?



- By decreasing order of abundance:
 - water vapour (H_2O)
 - carbon dioxide (CO_2)
 - methane (CH_4)
 - nitrous oxide (N_2O)
 - ozone (O_3)
 - chlorofluorocarbons (CFC)
 - other halogenated compounds (i.e. gases containing fluorine, chlorine, bromine or iodine) (e.g. hydrofluorocarbons – HFC, sulphur hexafluoride – SF_6)

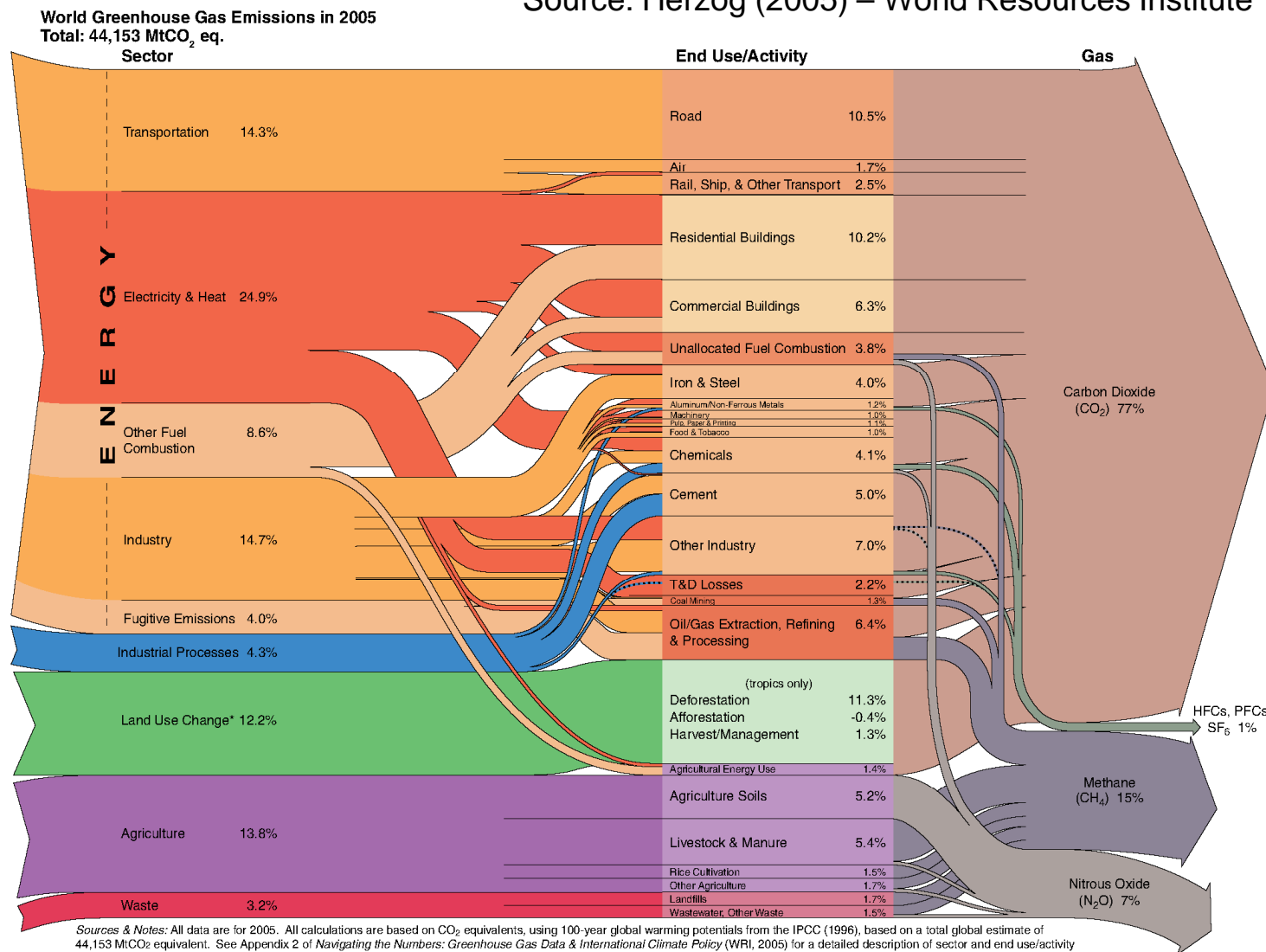
Evolution of GHG concentrations



Source: IPCC
(2007b) 4th
Assessment
Report, WG I –
FAQ 2.1 Fig. 1

Globally, what are the main sources of GHG emissions?

Source: Herzog (2005) – World Resources Institute



Sources & Notes: All data are for 2005. All calculations are based on CO₂ equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 44,153 MtCO₂ equivalent. See Appendix 2 of *Navigating the Numbers: Greenhouse Gas Data & International Climate Policy* (WRI, 2005) for a detailed description of sector and end use/activity definitions, as well as data sources. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

* Land Use Change includes both emissions and absorptions, and is based on analysis that uses revised methodologies compared to previous versions of this chart. These data are subject to significant uncertainties.

What are the main consequences?

Biophysical impacts

Changes in t°
Changes in rainfall patterns
Shifts in seasons
More frequent or severe storms, floods, droughts
Raised sea level
Erosion, desertification
Changes in water quality/availability
Changes in ecosystems
Biodiversity loss
Disease & pest outbreaks,
...



Socioeconomic impacts

Damage to or destruction of infrastructure
Reduced food security, malnutrition
Economic disruption, loss of livelihoods, social disruption
Increased mortality and morbidity
Reduced availability of hydropower
Conflicts, population displacement, human migrations, ...

Recap – Key messages



- Climate change is real, and is driven to a large extent by emissions of greenhouse gases linked to human activities
 - Fossil energy use, deforestation and agriculture are the main culprits
- Climate change is notably characterised by rising temperatures, rising sea level, and more frequent/intense extreme weather events
- Changes in climate system parameters generate a wide range of biophysical and socioeconomic impacts

Key references



- IPCC (2007b) *Climate Change 2007: The Physical Science Basis*. Cambridge University Press, Cambridge, UK & New York, NY, USA
- IPCC website: www.ipcc.ch
- Volunteer-driven information website 'CO₂ Now':
<http://co2now.org/>
- WWF – Climate change explained:
http://wwf.panda.org/about_our_earth/aboutcc/how_cc_works/

References



- Berkeley Earth Surface Temperature Project: <http://berkeleyearth.org>
- Herzog T. (2005) *World Greenhouse Gas Emissions in 2005*. Working paper, World Resources Institute, Washington, DC. Available from: <http://www.wri.org/publication/world-greenhouse-gas-emissions-in-2005>
- IPCC (2007a) *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report. [Core Writing Team, Pachaury R.K. & Reisinger A. (eds.)] Intergovernmental Panel on Climate Change, Geneva. Available from: www.ipcc.ch
- IPCC (2007b) *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K.B., Tignor M. & Miller H.L. (eds.)]. Cambridge University Press, Cambridge, UK & New York, NY, USA. Available from: www.ipcc.ch
- Petit J. & Prudent G. (eds) (2008, reprint 2010) *Climate Change and Biodiversity in the European Union Overseas Entities*. IUCN, Gland, Switzerland and Brussels, Belgium. Available from: <http://data.iucn.org/dbtw-wpd/edocs/2010-064.pdf>
- WWF – Climate change explained: http://wwf.panda.org/about_our_earth/aboutcc/how_cc_works/