

New Results in Climate Change Science Since the IPCC AR4 (2007)

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Cargèse, Corsica, France, 16 September 2009

How does the IPCC work?

Can WGI (Working Group One, the physical science part) of AR4 be trusted? Why, or why not?

How has climate science changed since the papers assessed in AR4?

AR4: written by 152 "Lead Authors"
(22 are "Coordinating Lead Authors").

Governments nominated 700 authors.

25% earned Ph. D. in last 10 years.

75% were not previous IPCC authors.

35% are from developing countries and
countries with economies in transition.

The WGI IPCC report (AR4) took three years to write. More than 30,000 review comments were received on the drafts.

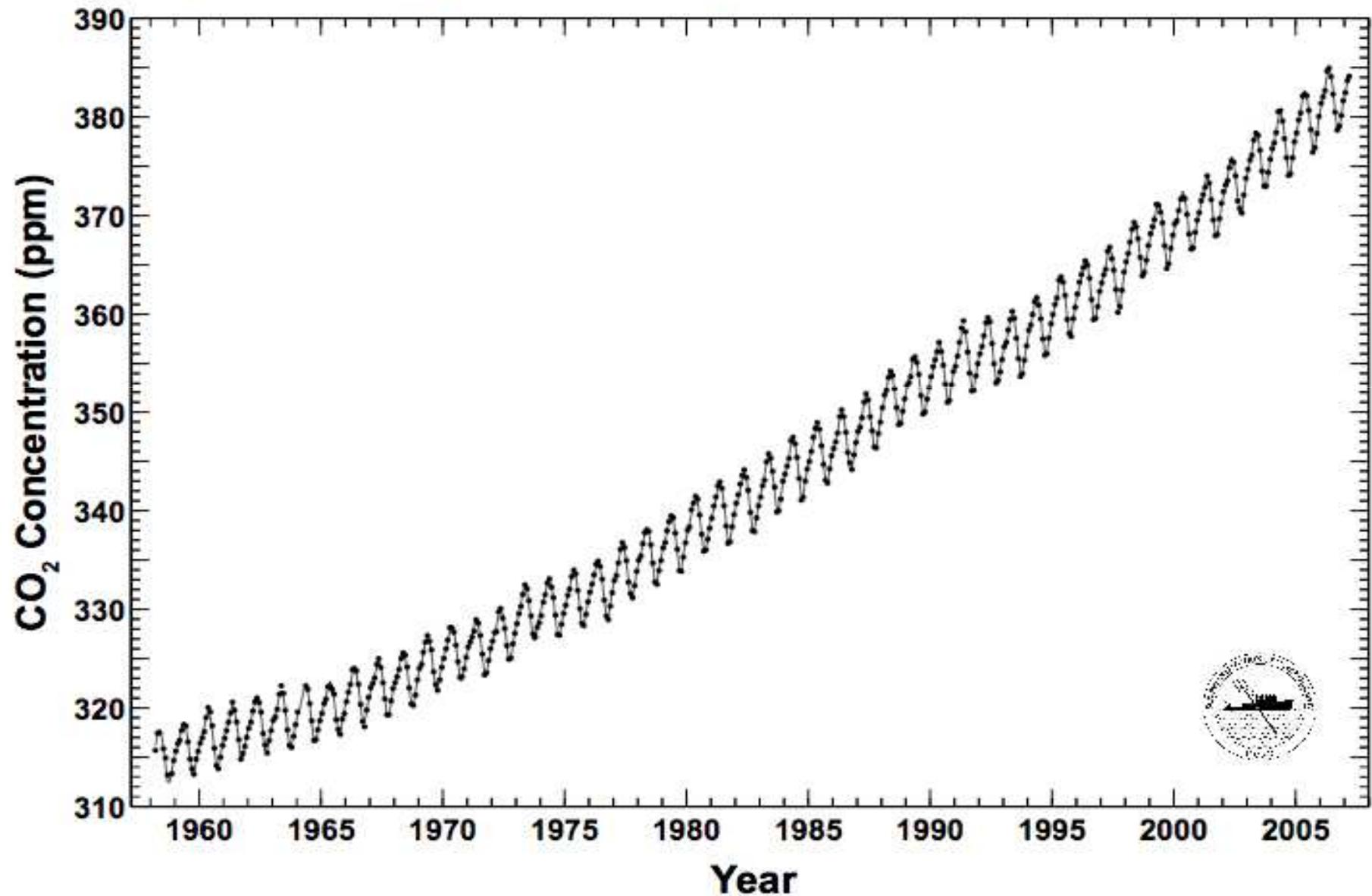
The authors' responses to every comment are in the public record.

The open and transparent IPCC process, multiple stages of peer review, and credentials of the authors, all contribute to the stature of the report.

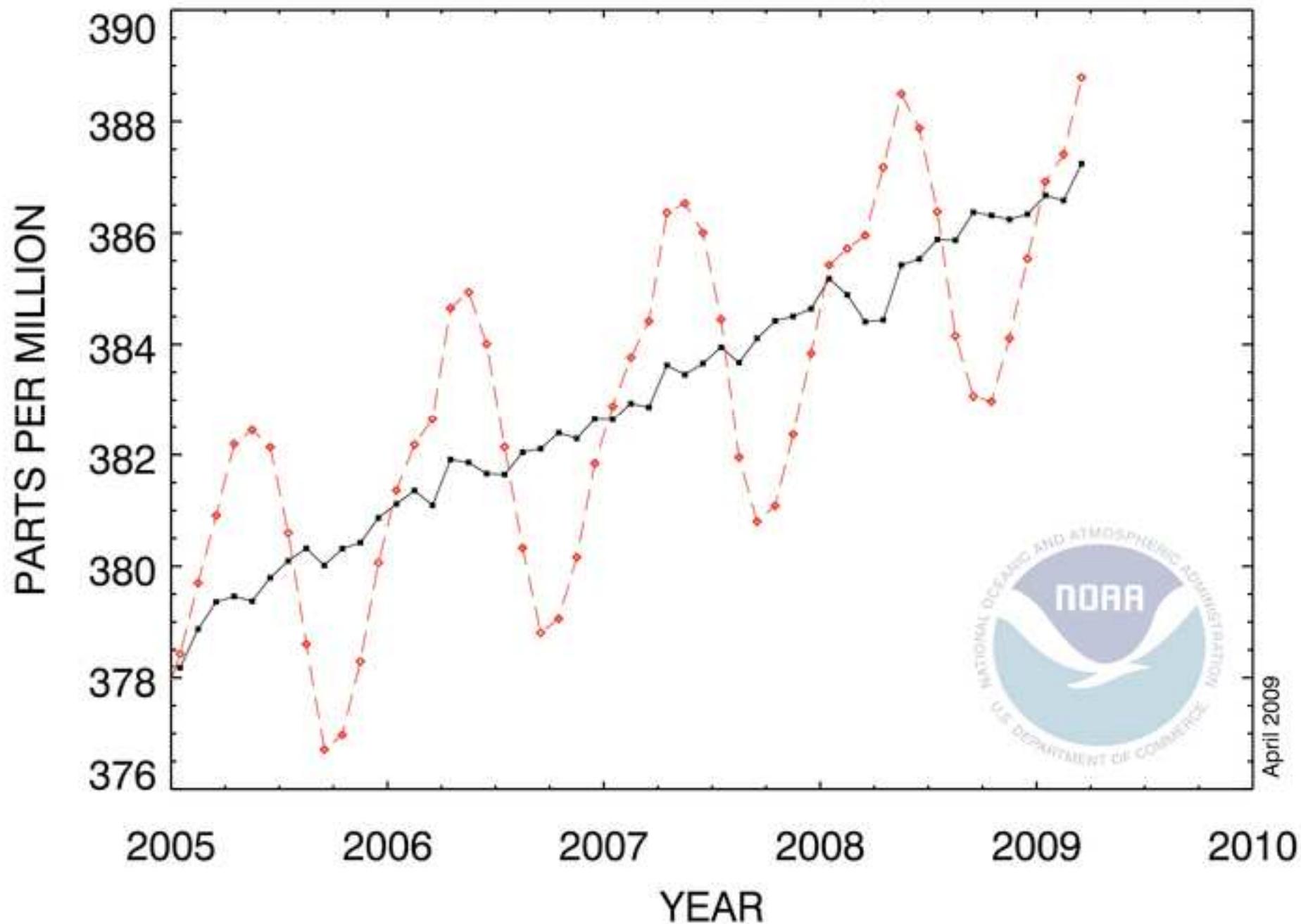
Mauna Loa Observatory, Hawaii Monthly Average Carbon Dioxide Concentration

Data from Scripps CO₂ Program

Last updated March 2007



RECENT MONTHLY MEAN CO₂ AT MAUNA LOA



A United Nations Framework Convention on Climate Change (UNFCCC) meeting will be held in Copenhagen in December 2009 (15th Conference of the Parties, COP15).

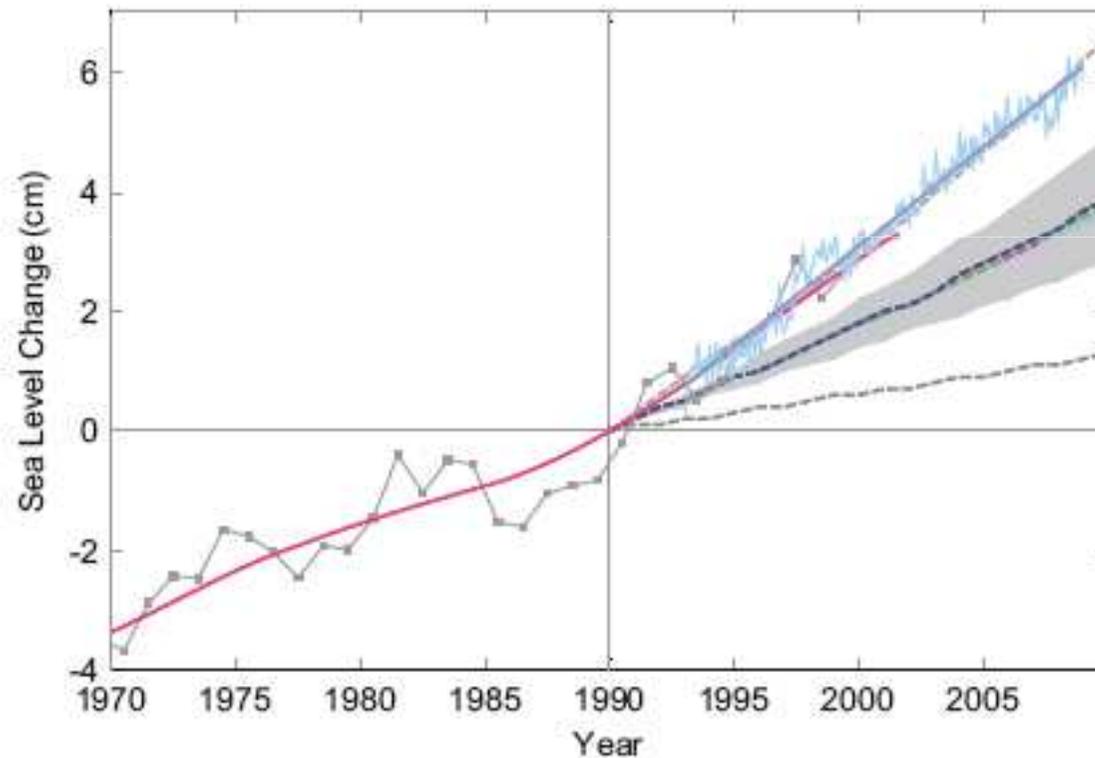
The primary scientific input to those negotiations is AR4, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), published in 2007.

Since the production of the IPCC report, new knowledge has emerged that furthers our understanding of the impacts of human influence on the climate.

To bring this new knowledge together, an international scientific congress, Climate Change: Global Risks, Challenges and Decisions, was held in Copenhagen from 10-12 March 2009.

Change in sea level from 1970 to 2008, relative to the sea level at 1990.

The envelope of IPCC projections is shown for comparison.



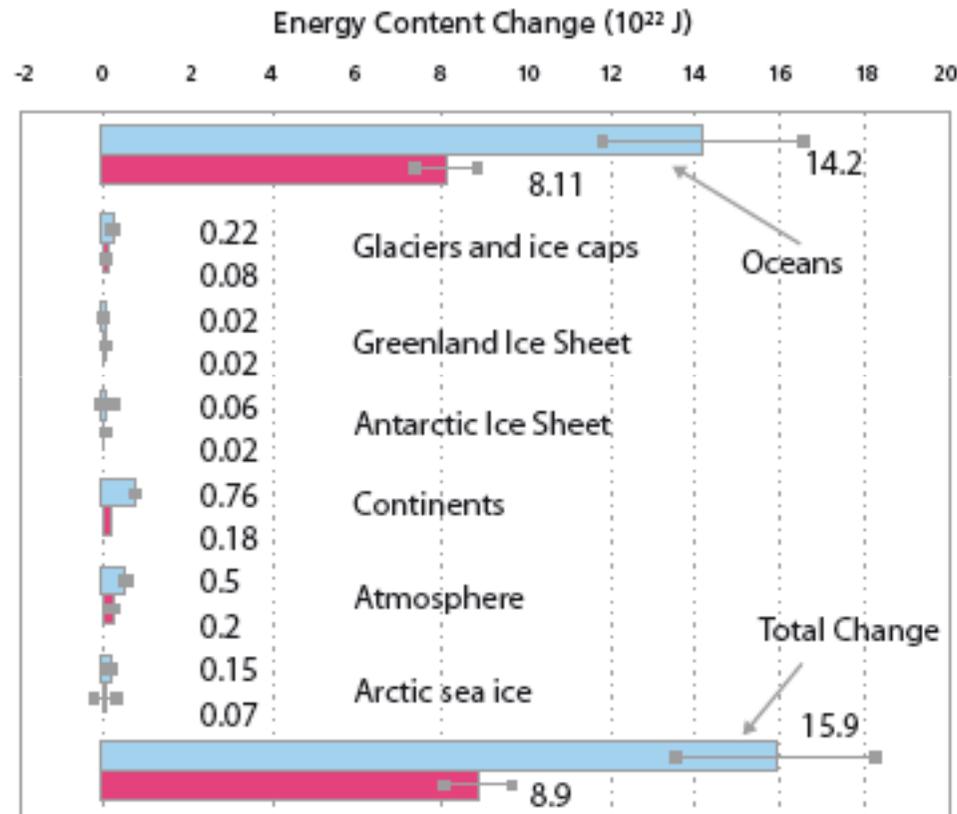
Recent Climate Observations Compared to Projections

Stefan Rahmstorf, Anny Cazenave, John A. Church, James E. Hansen, Ralph F. Keeling, David E. Parker, Richard C. J. Somerville

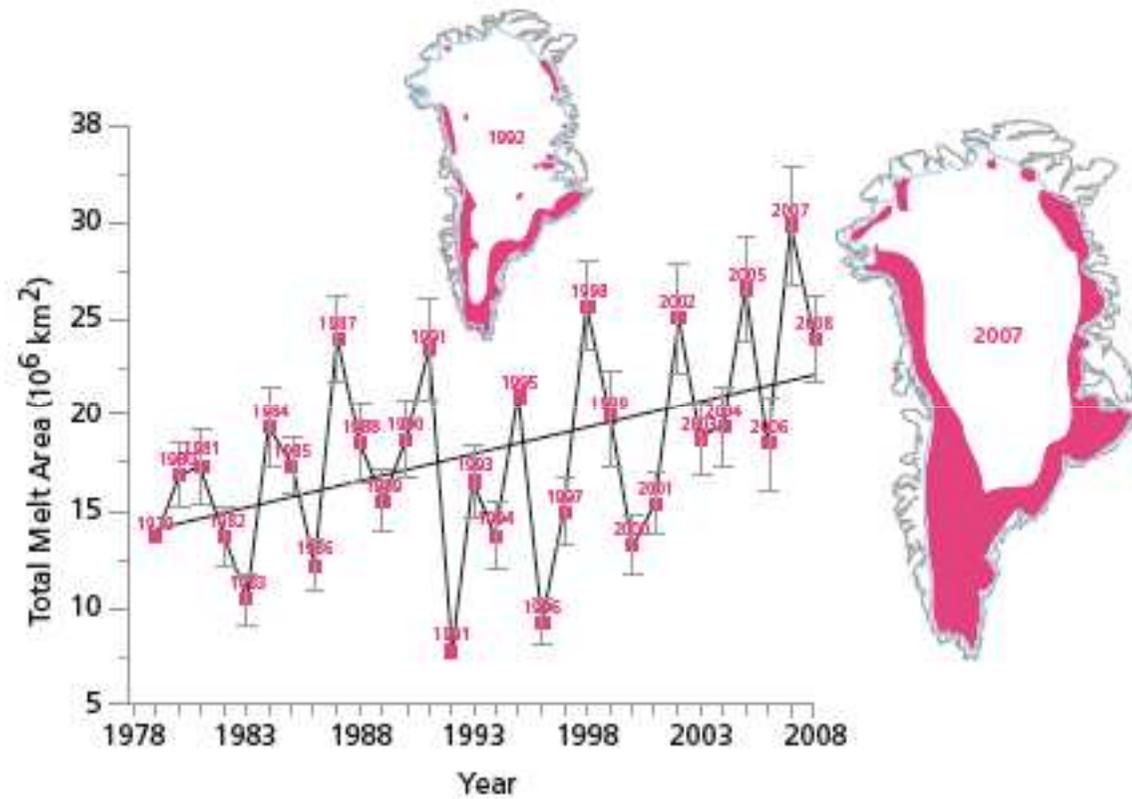
Science, 2007

“Overall, these observational data underscore the concerns about global climate change. Previous projections, as summarized by IPCC, have not exaggerated but may in some respects even have underestimated the change, in particular for sea level.”

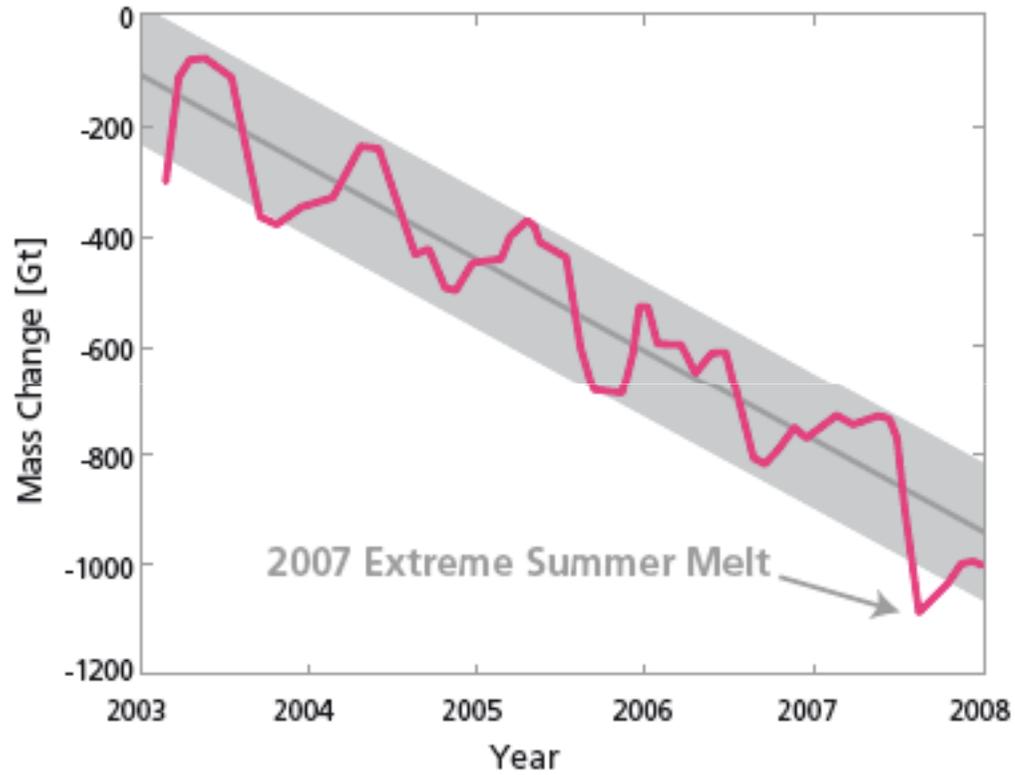
The change in energy content in different components of the Earth System for two periods: 1961-2003 (blue bars) and 1993-2003 (pink bars)



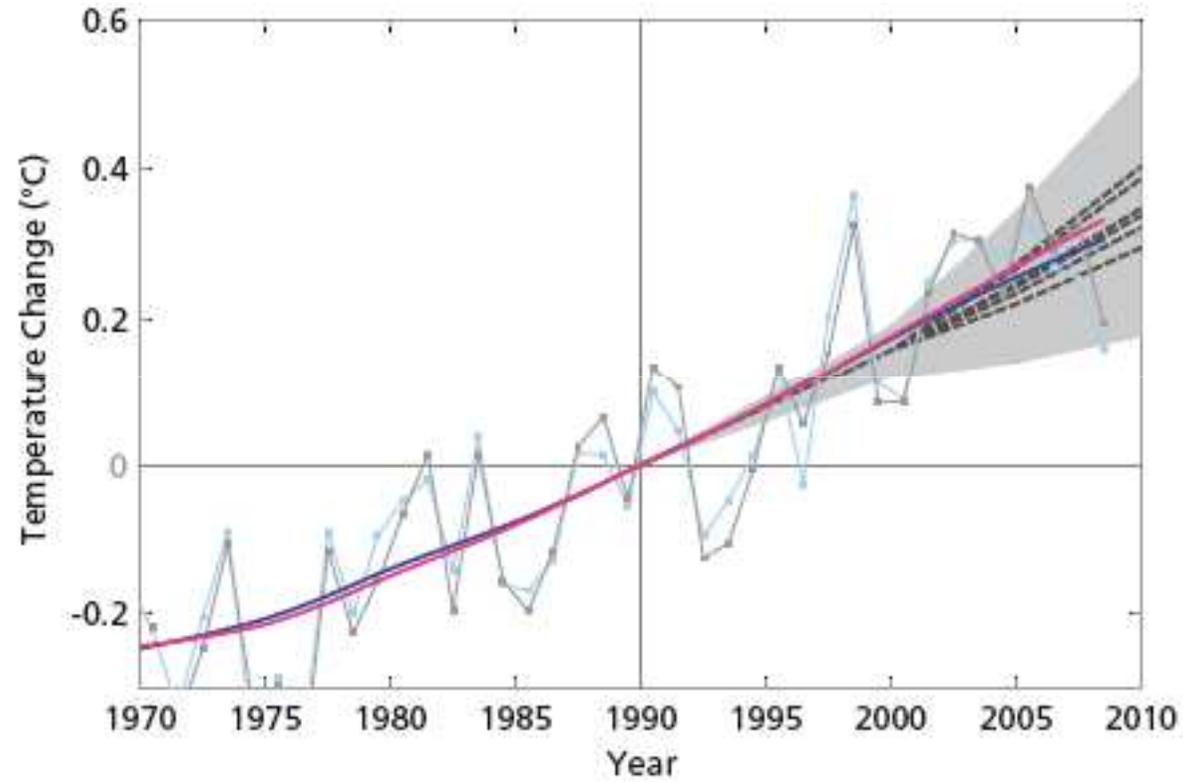
Area of surface melting across the Greenland Ice Sheet



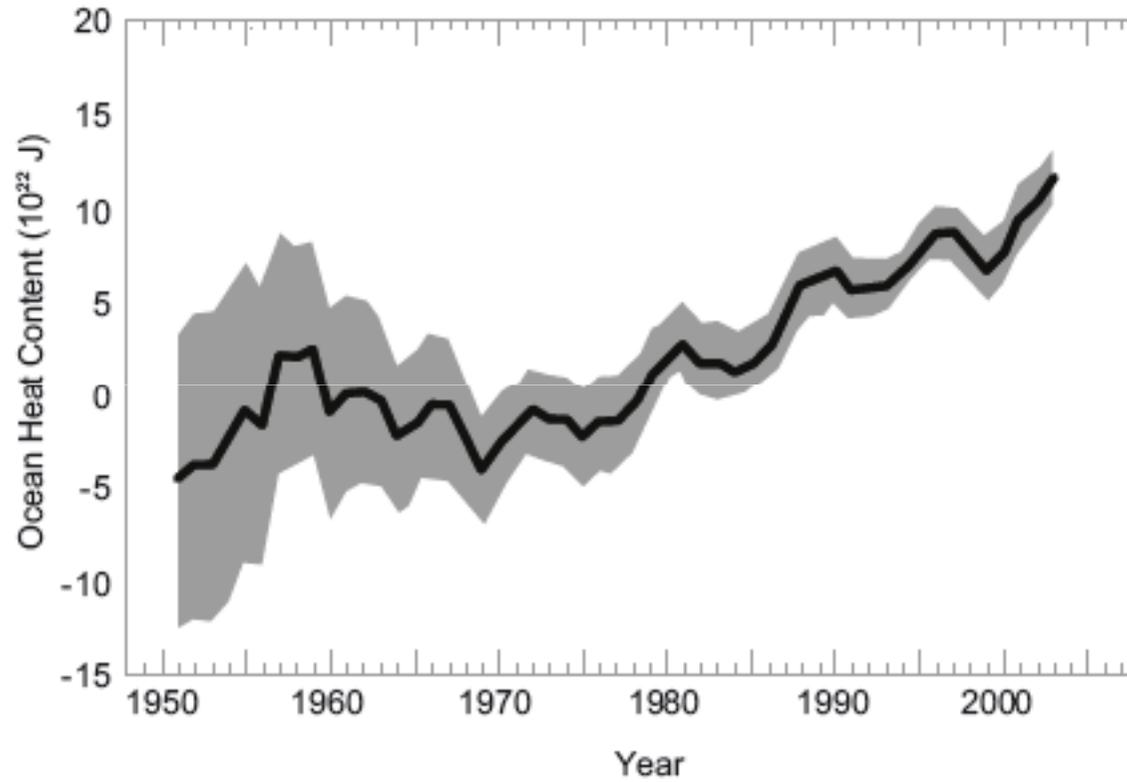
Change in the mass of the Greenland ice sheet from 2003 to 2008



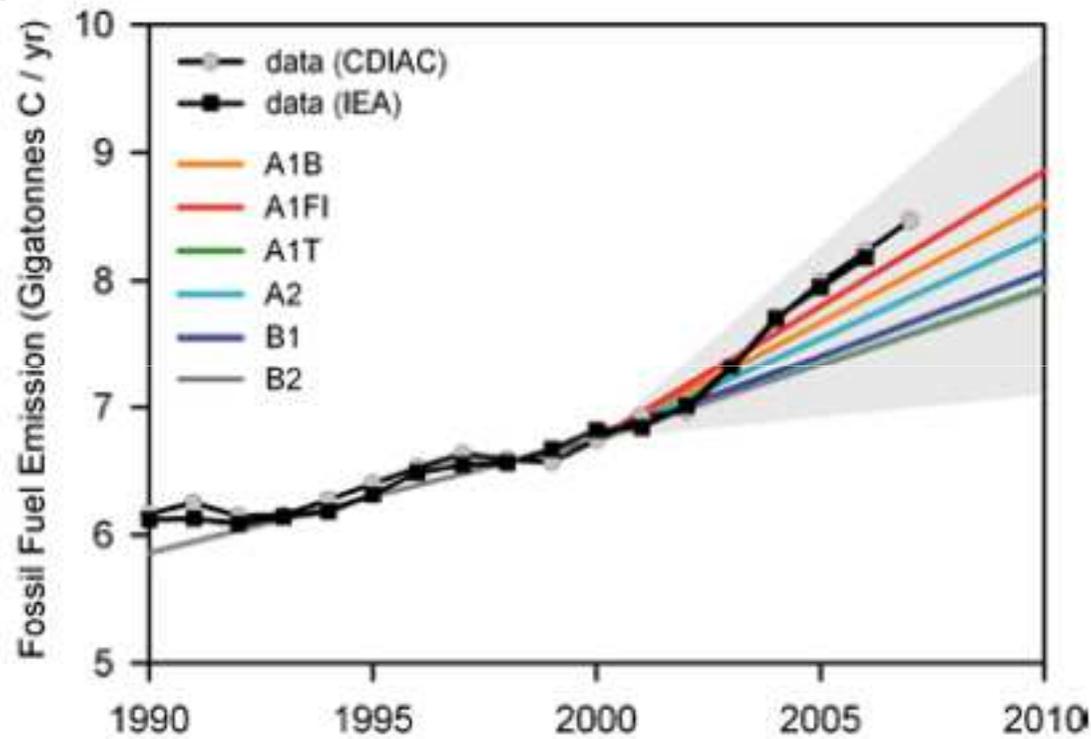
Changes in global average surface air temperature



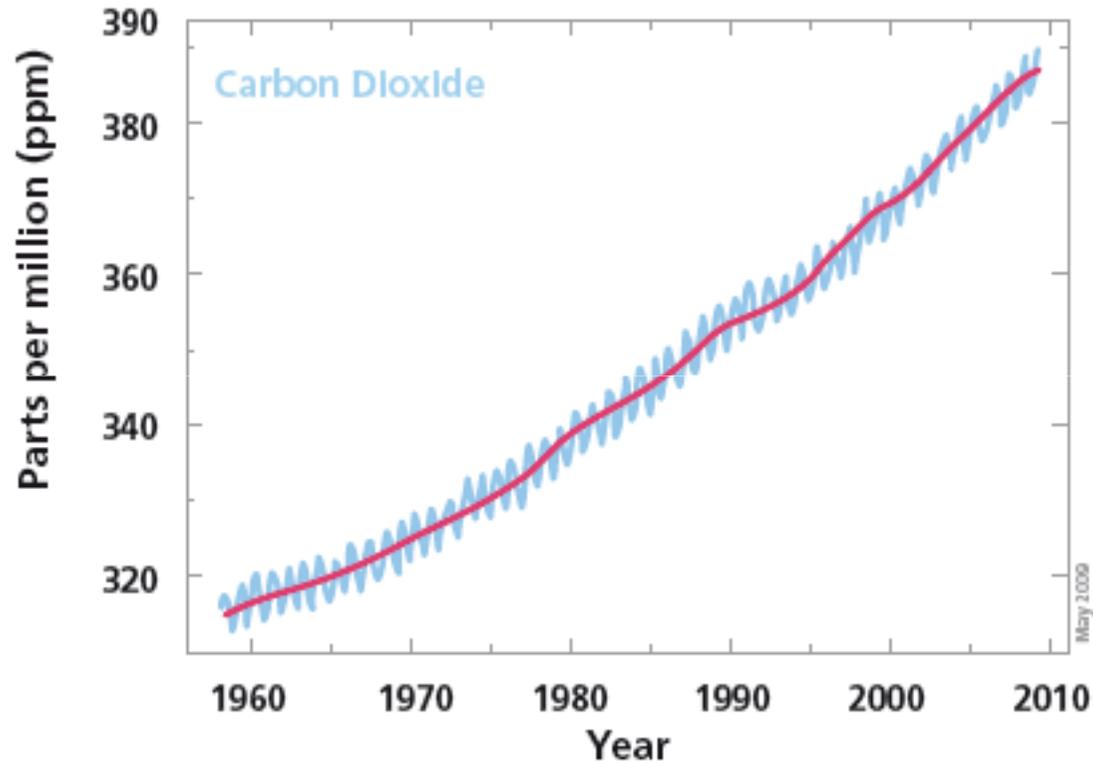
Change in ocean heat content since 1951



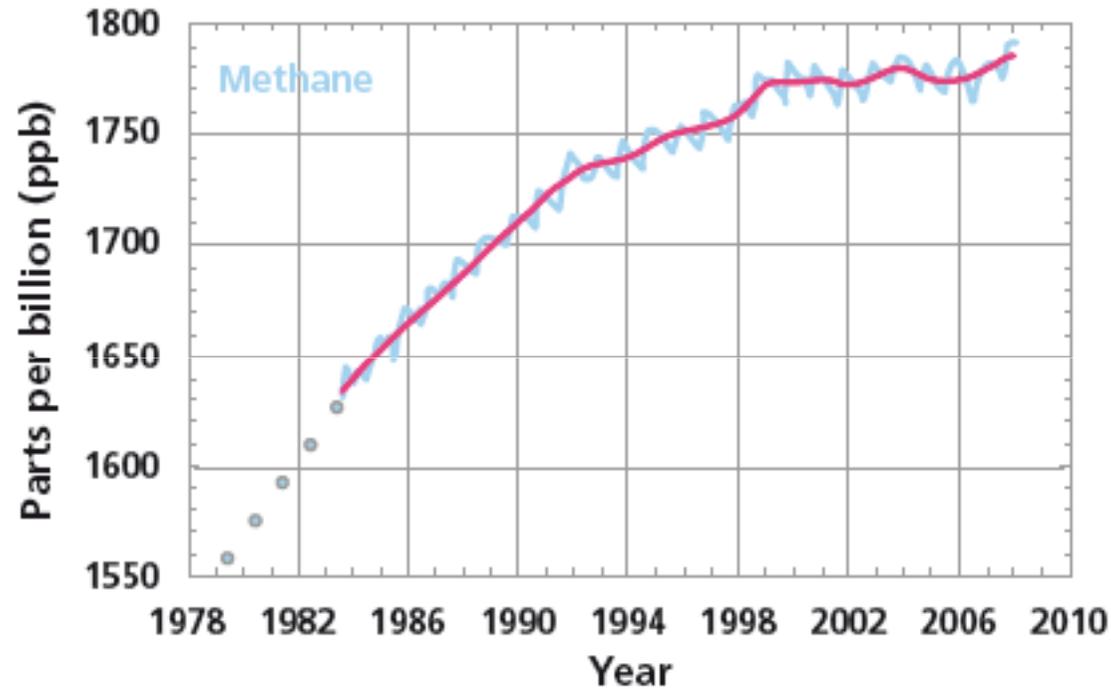
Observed global fossil-fuel and industrial CO2 emissions compared with averages of six IPCC scenarios



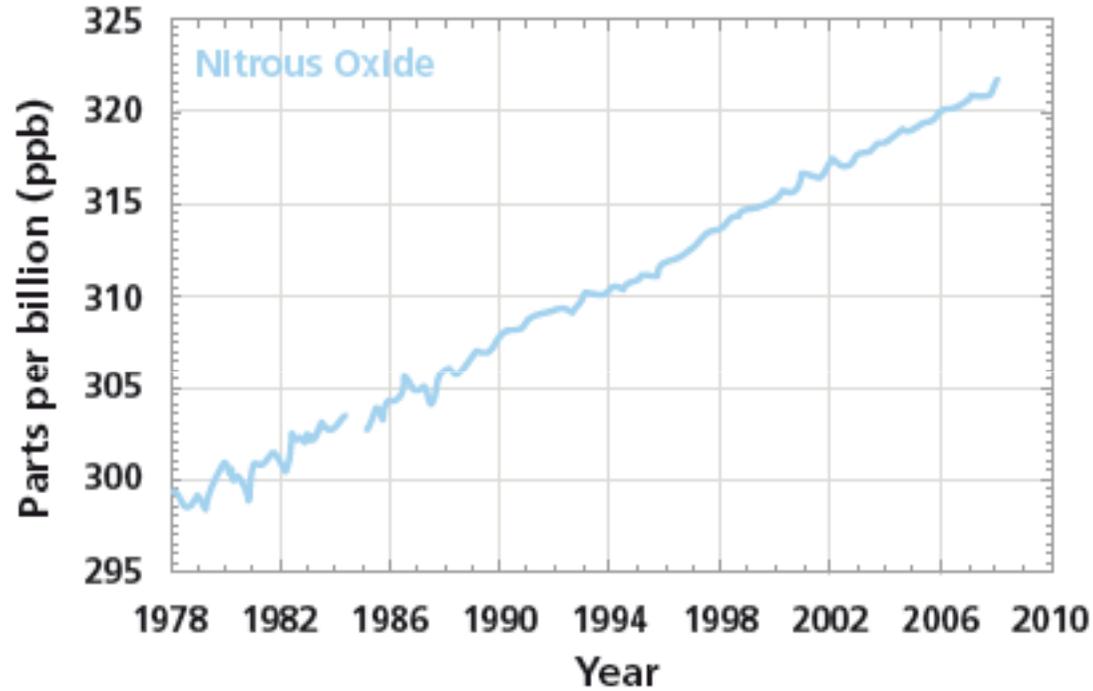
Concentration of carbon dioxide, CO₂, in ppm (parts per million) from 1958 to present

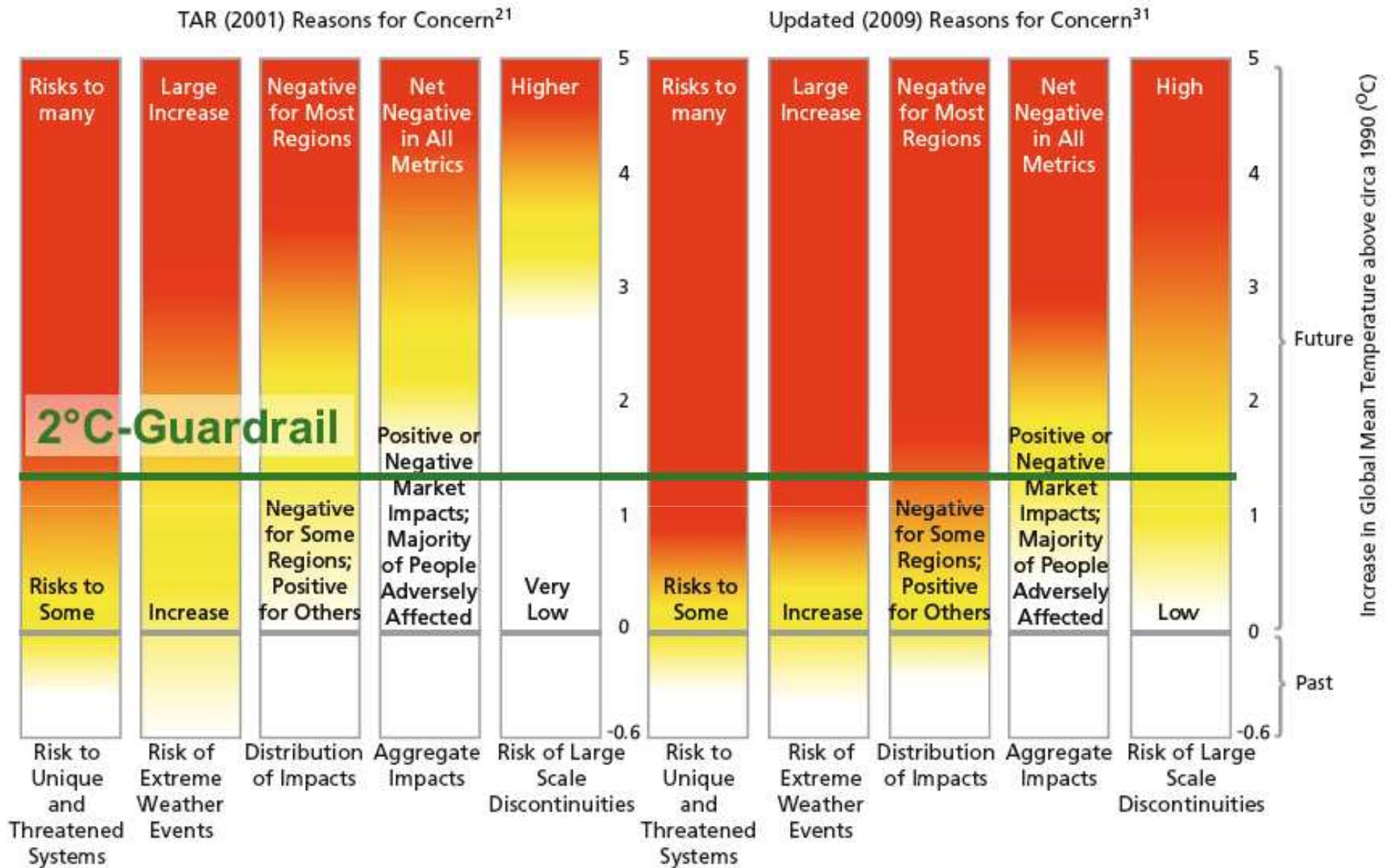


Concentration of atmospheric methane, CH₄, in ppb (parts per billion) from 1979 to present



Concentration of atmospheric nitrous oxide, N₂O, in ppb (parts per billion) from 1978 to present





Impacts of climate change as a function of rise in global average temperature

Characteristics of various emission trajectories

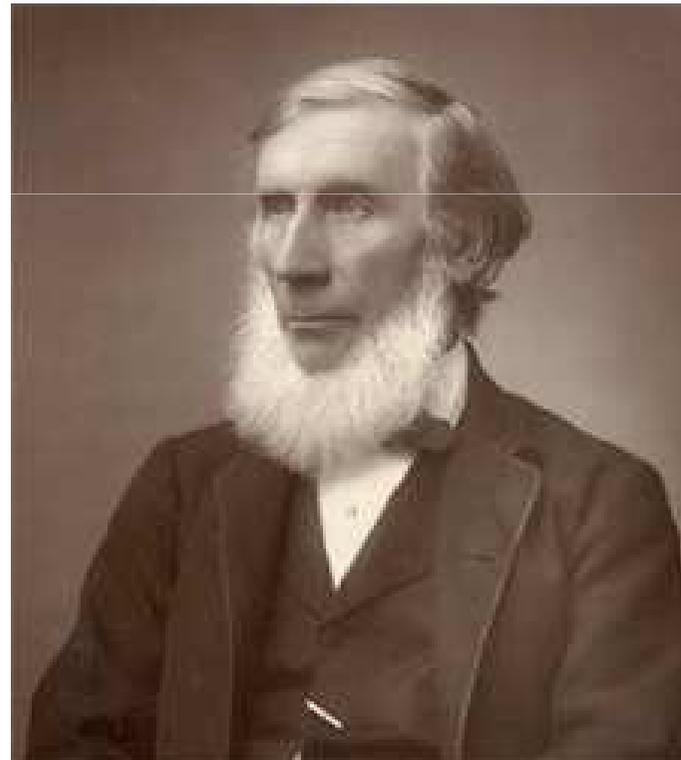
Temperature rise	CO ₂	CO ₂ -eq.	Year of peak emissions	% change in global emissions
Global average temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity	CO ₂ concentration at stabilisation (2005 = 379 ppm)	CO ₂ -eq. concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm)	Peaking year for CO ₂ emissions	Change in CO ₂ emissions in 2050 (percent of 2000 emissions)
°C	ppm	ppm	year	percent
2.0 - 2.4	350 - 400	445 - 490	2000 - 2015	-85 to -50
2.4 - 2.8	400 - 440	490 - 535	2000 - 2020	-60 to -30
2.8 - 3.2	440 - 485	535 - 590	2010 - 2030	-30 to +5
3.2 - 4.0	485 - 570	590 - 710	2020 - 2060	+10 to +60
4.0 - 4.9	570 - 660	710 - 855	2050 - 2080	+25 to +85
4.9 - 6.1	660 - 790	855 - 1130	2060 - 2090	+90 to +140

The greenhouse effect was discovered by [Joseph Fourier](#) in 1824, first reliably experimented on by [John Tyndall](#) in 1858, and first reported quantitatively by [Svante Arrhenius](#) in 1896.

Joseph Fourier



John Tyndall



Heat source

Heat screen

Thermopile, with conical reflectors

Galvanometer

Brass tube with rock-salt plugs at each end. The tube contains the gas that is under study.

Heat source

Gas enters tube

Circulating cold water solves a heat conduction issue

Suction pump

Container of gas or gas mixture to be studied

The gas or gas mixture can pass through some filtration process beforehand

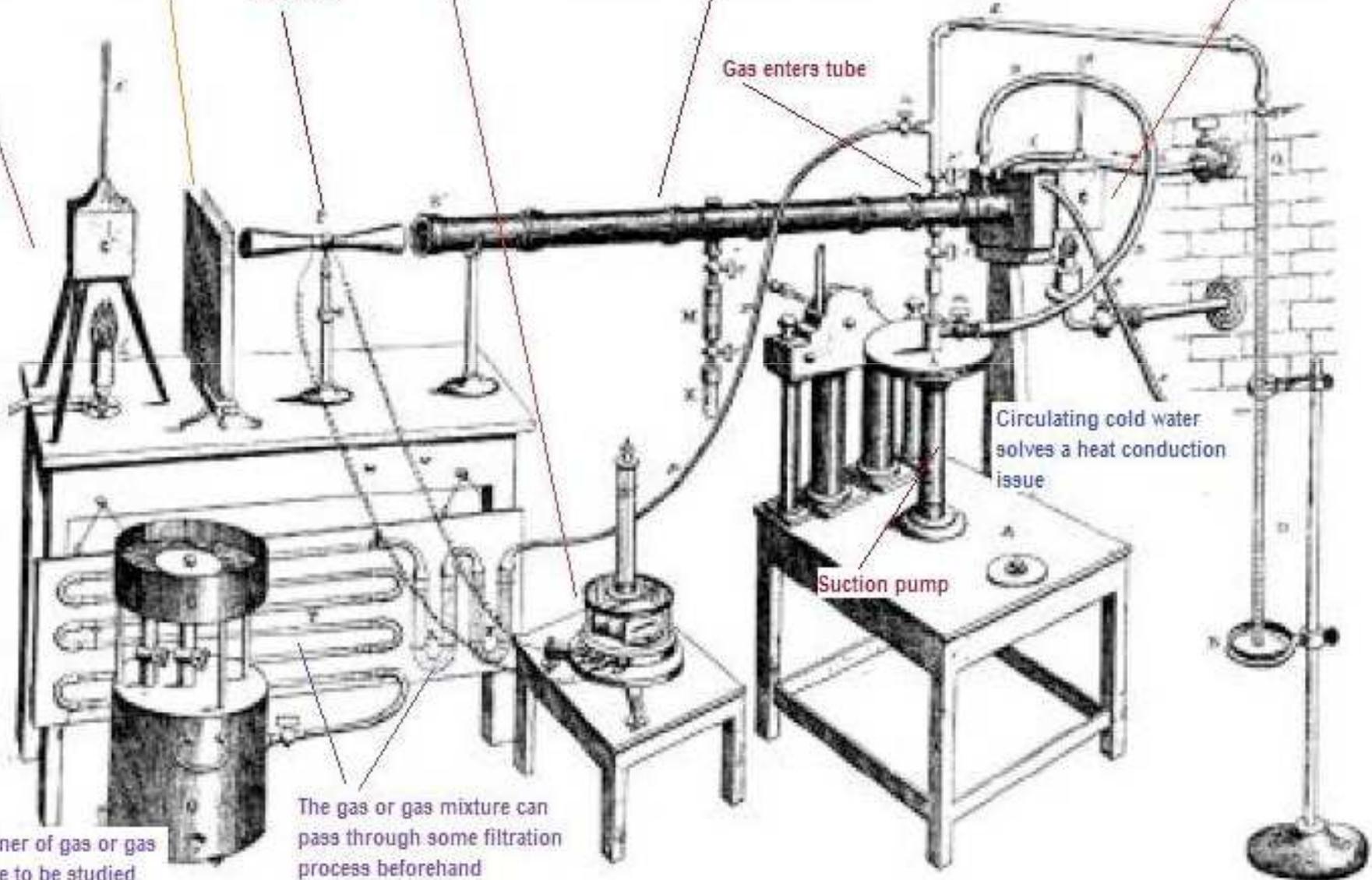




Table 1. CO₂ added to the atmosphere by fossil fuel combustion and a comparison with an analytical expression

Decade	Average amount added per decade (% of N ₂)		Cumulative total added (% of N ₂)	
	measured or estimated	$\gamma(t)$	measured or estimated (since 1860)	$\int_0^t \gamma(t) dt$ (since 1880)
1880—89	0.54	0.57	1.13	0.57
1890—99	0.79	0.77	1.92	1.34
1900—09	1.27	1.03	3.19	2.37
1910—19	1.72	1.37	4.91	3.74
1920—29	2.00	1.83	6.91	5.57
1930—39	2.11	2.47	9.02	8.04
1940—49	2.71	3.17	11.73	11.21
1950—59	3.9	4.4	15.6	15.6
1960—69	5.4	5.8	21.0	21.4
1970—79	7.5	8.0	28.5	29.4
1980—89	10.5	10.4	39.0	39.8
1990—99	14.5	13.7	53.5	53.5
2000—09	20.0	19.0	73.5	72.5

To obtain the particular solutions we have to specify $\gamma(t)$. We shall assume that $\gamma(t)$ may be approximated by

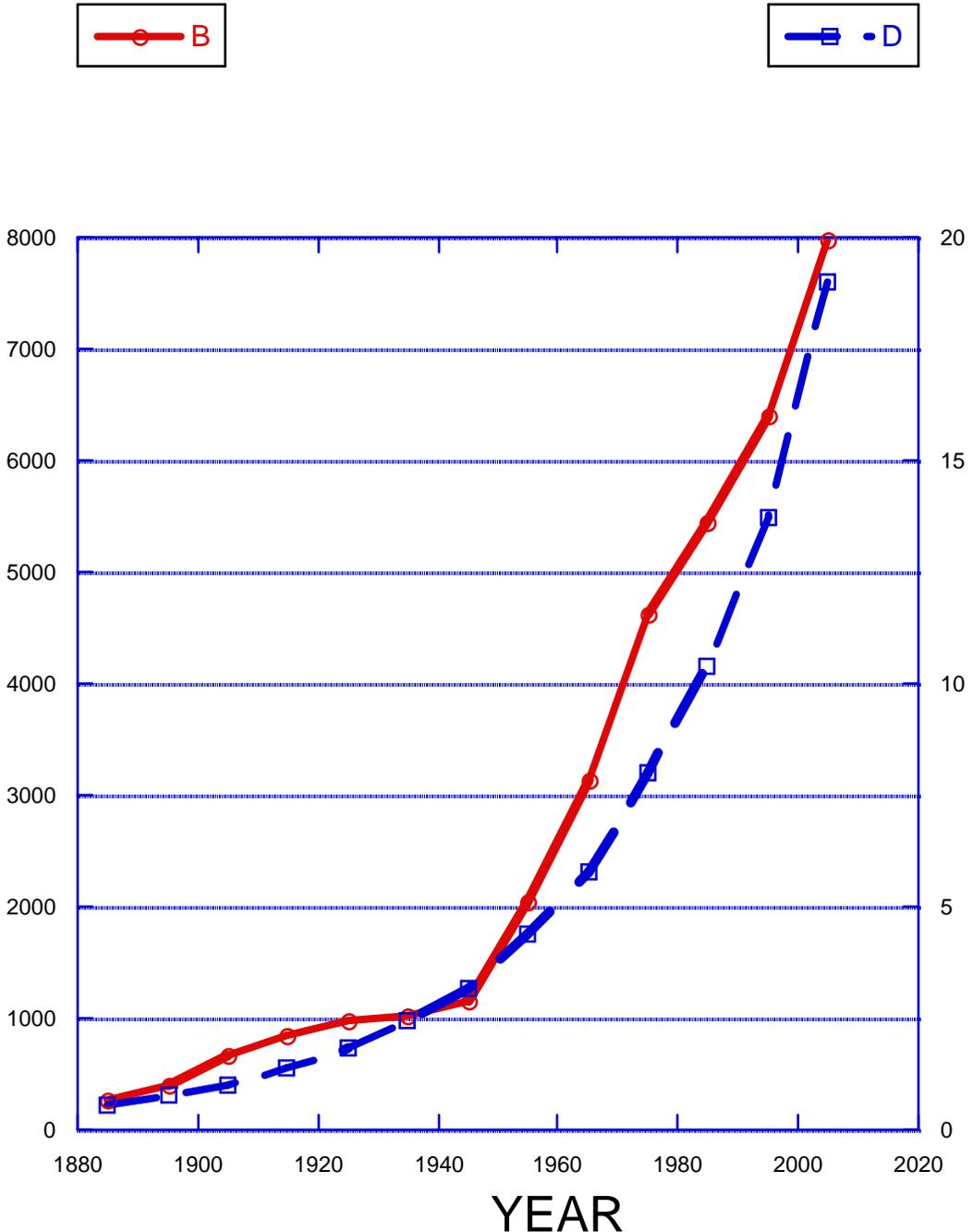
$$\gamma(t) = \gamma_0 e^{rt} \quad (25)$$

where

$$\left. \begin{aligned} \gamma_0 &= 4.96 N_a 10^{-4} \\ r &= 0.029 \text{ year}^{-1} \end{aligned} \right\} \quad (26)$$

which fits the values given by REVELLE and SÜESS (1957) for carbon production until today and also the estimated values to year 2010 with sufficient accuracy if $t=0$ at 1880 (see table 1).

CARBON EMISSIONS - MILLION METRIC TONS



BOLIN'S EXPONENTIAL FUNCTION

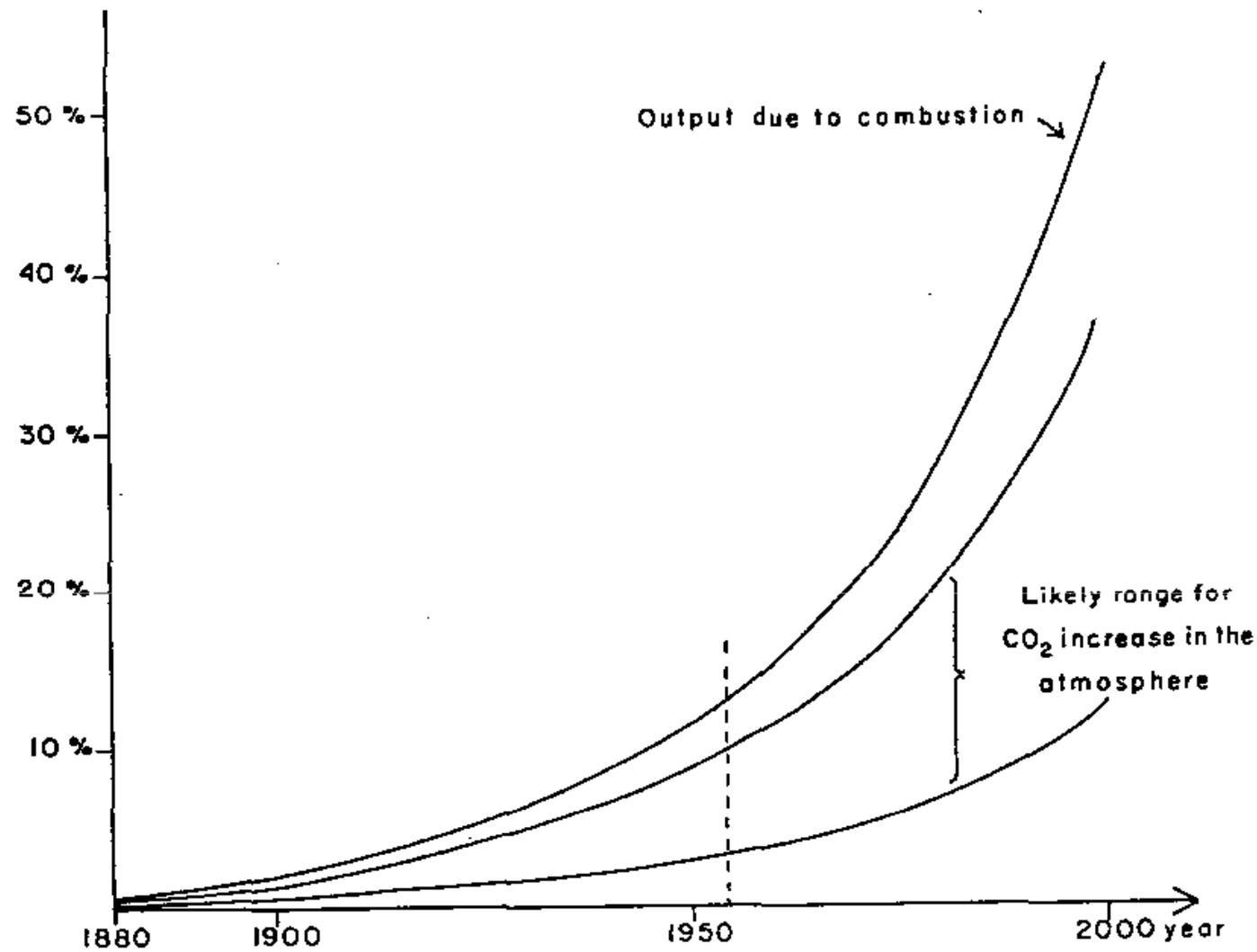
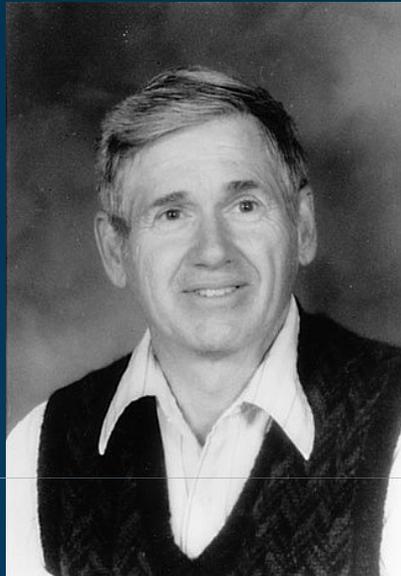
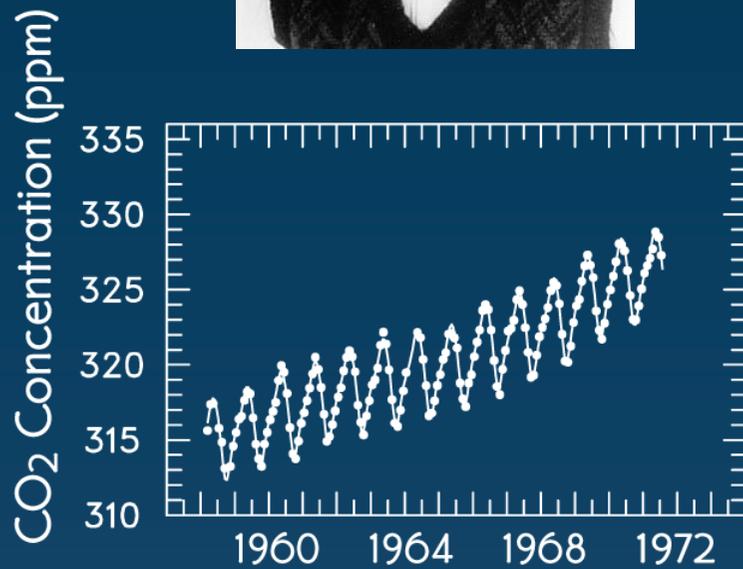


Fig. 5. Estimate of likely range for CO₂ increase in the atmosphere as a result of fossil fuel combustion according to UN estimates.





Charles D. Keeling (1928-2005)



*Image credit: Publication of the National Oceanic & Atmospheric Administration (NOAA), NOAA Central Library;
Photo Date: 1982 February; Photographer: Commander John Bortniak, NOAA Corps (ret.)*





INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



IPCC WORKING GROUP I

Tenth Session

Paris, 29 January – 1 February 2007



Contact Groups:

Wednesday 18:00 - 19:00

Salle VII : Tropical Cyclone Contact Group

Co-chairs: Australia & Madagascar

Notices:

- Wednesday 18:00 Foyer - Snack dinner
- Thursday 09:45 Salle II - Address by Mme Nelly Olin, Minister of Ecology and Sustainable Development, France



Evening Session: Evening session tonight begins at 19:30, Salle II



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)
Working Group I



<http://realclimate.org>

This site is run by excellent climate scientists.

The IPCC reacts in years; this site takes days.

It covers current developments accessibly.

It is up-to-date, indexed, and searchable.

The postings by the scientists are trustworthy.

The comments by bloggers are ... interesting.



What will this picture look like in 2020 or 2050 or 2100? What will the climate be?

