Friedemann Müller ▪ Claudia Neumann ▪ Alexander Ochs

Introduction to the

High-level Transatlantic Workshop on Climate Change

Washington, D.C., November 18, 2002

More information on the INTACT project can be found online at: www.intact-climate.org

* The German Institute for International and Security Affairs (SWP), the largest think tank on international affairs in Western Europe, started the project International Network To Advance Climate Talks (INTACT) at the beginning of this year. INTACT is supported by a generous grant from the German Marshall Fund of the United States.

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Woodrow Wilson
International
Center
for Scholars

LEE H. HAMILTON
Director

SWP

German Institute for International and Security Affairs Stiftung Wissenschaft und Politik

INTACT *
Invitation: High-level Transatlantic Workshop on Climate Change
Washington, DC, November 18, 2002

7 October, 2002

Climate change is the source of considerable political debate in the overall transatlantic relationship. The German Institute for International and Security Affairs (SWP) and the Woodrow Wilson Center (WWC), with the support of the German Marshall Fund of the United States (GMF), invite you to participate in a workshop on November 18, 2002 at the Woodrow Wilson Center to explore opportunities for renewed transatlantic cooperation in this important field.

The workshop will be organized by SWP and WWC for a small, distinguished group of public and private sector leaders from both sides of the Atlantic – about 20 participants each. They will include policymakers, members of the foreign policy community, media, and business, as well as outstanding experts familiar with the climate policy debate and long-term climate challenges.

A shift from the actual transatlantic stalemate on climate policy will only be reached if the participation, not only of key experts but also of those caring for the cohesion of the Atlantic community, can be assured.

The two major sessions will address "Engaging the Private Sector: Joint Industry Perspectives, Opportunities and Obstacles for Technology Breakthroughs," and "Engaging Major Developing Countries." Both sessions will be aimed at finding common ground for transatlantic understanding and partnership.

Please let us know if you are able to attend this conference in Washington, DC at the Wilson Center at 1300 Pennsylvania Ave, NW. We ask that you RSVP by October 21, 2002. Please feel free to contact our colleagues, Friedemann Mueller or Alexander Ochs (SWP) at +49 30 88007-0, or Geoff Dabelko (WWC) at +1 202 691-4178 for additional information or refer to SWP's INTACT project website at www.intact-climate.org.

We look forward to welcoming you at this important workshop.

Sincerely yours,

Lee H. Hamilton
Director
Woodrow Wilson Center

Christoph Bertram
Director
Stiftung Wissenschaft und Politik

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Context for Dialogue

November 11, 2002

INTACT*
High-level Transatlantic Workshop on Climate Change
Washington, D.C., November 18, 2002

The Challenge:

Climate change, according to many, will be one of the biggest challenges of the 21st century. Suggested responses revolve around stabilizing and reducing the concentration of greenhouse gases in the atmosphere. International cooperation is a necessary component of any strategy to bring about stabilization or reductions given the interdependence of the global phenomenon. Currently emissions of greenhouse gases are still increasing despite considerable political attention to the issue.

The United States and Europe have recently adopted different approaches to address climate change. The decisions to pursue alternative strategies have become a political sticking point in the transatlantic relationship, contributing a degree of friction to diplomatic relationships that extend beyond merely the environmental realm. This linkage of the climate change issue to the larger political context of the transatlantic relationship suggests that a broader range of diplomatic and foreign policy actors have interests in actions surrounding climate change.

The Workshop:

The Workshop has been designed to facilitate dialogue and greater understanding around respective U.S. and European approaches to climate change within a broader political, economic, technological, and diplomatic context. The dialogue will therefore include experts on the transatlantic relationship as well as climate experts. The small, distinguished group will include policymakers, foreign policy analysts, business leaders, journalists, and scholars from both sides of the Atlantic. The conversations will occur on a not-for-attribution basis in order to facilitate free and open discussion. Each session will feature five minute presentations by one European and one American to kick off discussion.

Two topics perhaps offer opportunity for transatlantic cooperation and will be the focus of two sessions: 1) engaging developing countries on addressing climate change,

and: 2) private sector and technological approaches to climate change. Many believe a key to successfully addressing climate change is concerned action by populous nations such as China, India, and Brazil where emissions are growing at an increasing rate. The United States and Europe has the opportunity to coordinate their approaches to these developing countries. Second, there have been calls for a major transatlantic "Apollo-type" research and development program to make world energy production and consumption less carbon-dependent. The private sector and technology sector are keys to such an effort and achieving such a goal. Europe and the United States are bound to be at the center of any such effort. Both the roles of developing countries and the roles of the private sector and technology provide central but not exclusive areas for transatlantic dialogue.

The Institutional Setting:

The workshop is organized jointly by the Woodrow Wilson International Center for Scholars (WWICS) and the German Institute for International and Security Affairs (SWP), and sponsored by the German Marshall Fund of the United States (GMF). The main sessions will take place at the Wilson Center 5th floor conference room in the Ronald Reagan Building at 1300 Pennsylvania Ave, NW, on Monday, November 18, 2002. The event is a part of the project INTACT – International Network To Advance Climate Talks, started at the beginning of this year by the SWP, the largest think tank on foreign policy in Western Europe. From its inception, INTACT has been backed by a generous grant from the GMF.

international network to advance climate talks
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Agenda

INTACT*
High-level Transatlantic Workshop on Climate Change
Washington, D.C., November 18, 2002

November 17

7 p.m. **Opening Dinner**
by Invitation of Dr. Eberhard Kölsch, Minister and Deputy Chief of Mission, German Embassy to the United States
Venue: Embassy House
1900 Foxhall Road, NW, Washington, DC 2007

November 18

08:00 – 08:45 **Breakfast and Registration**

08:45 – 09:15 **Welcome Address**
Christoph Bertram and Lee H. Hamilton

Presentation of Project and Workshop Strategy
Geoff Dabelko and Friedemann Müller

09:15 – 10:45 **Session I: Climate Change as a Transatlantic Century Challenge**

Introduced by Carlo Jaeger and Jessica T. Mathews

10:45 – 11:15 Coffee break

11:15 – 12:45 **Session II: Closing the Gap of Misunderstanding: What Drives US and European Climate Politics?**

Introduced by John Ashton and Harlan Watson

12:45 – 01:30 Lunch

01:30 – 03:00 **Session III: Engaging the Private Sector: Joint Industry Perspectives, Opportunities and Obstacles for Technology Breakthroughs**

Introduced by Kevin Fay and William S. Kyte

03:00 – 03:30 Coffee break

03:30 – 05:00 **Session IV: Engaging Major Developing Countries**

Introduced by Elliott Diringer and Michael Grubb

05:00 **Reception**

November 19

t.b.a. **Working brunch with U.S. Congress Representatives**

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U.S. DEPARTMENT of STATE

Fact Sheet
Bureau of Oceans and International Environmental and Scientific Affairs
Washington, DC
October 23, 2002

United States Global Climate Change Policy

On February 14, 2002, President Bush committed the United States to an ambitious climate change strategy that will reduce domestic greenhouse gas (GHG) emissions relative to the size of the American economy. The United States will achieve this goal by cutting its GHG intensity -- how much it emits per unit of economic activity -- by 18% over the next 10 years. This strategy will set America on a path to slow the growth of greenhouse gas emissions, and – as the science justifies -- to stop, and then reverse that growth. The President's policy also continues the United States' leadership role in supporting vital climate change research, laying the groundwork for future action by investing in science, technology, and institutions. In addition, the United States' strategy emphasizes international cooperation and promotes working with other nations to develop an efficient and coordinated response to global climate change. In taking prudent environmental action at home and abroad, the United States is advancing a pro-growth, pro-development approach to addressing this important global challenge.

Cutting GHG Intensity By 18% Over The Next 10 Years

GHG intensity is the ratio of greenhouse gas emissions to economic output. The President's goal is to lower the United States' rate of emissions from an estimated 183 metric tons per million dollars of Gross Domestic Product (GDP) in 2002, to 151 metric tons per million dollars of GDP in 2012. By slowing the growth of greenhouse gases, this policy will put America on a path toward stabilizing GHG concentration in the atmosphere in the long run, while sustaining the economic growth needed to finance our investments in a new, cleaner energy structure. America is already improving its GHG intensity; new policies and programs will accelerate that progress, avoiding more than 500 million metric tons of GHG emissions over the next 10 years -- the equivalent of taking nearly one out of every three cars off the road. This goal is comparable to the average progress that nations participating in the Kyoto Protocol are required to achieve.

Laying the Groundwork for Current and Future Action

Unprecedented Funding for Climate Change-Related Programs. The President's FY 2003 budget request provides $4.5 billion for global climate change-related activities -- a $653 million or 17% increase over FY 2002 -- more than any other nation's commitment. This increase includes nearly $1.8 billion for climate change science, $1.3 billion for climate technologies, and $555 million for the first year of funding for a 5-year, $4.6 billion commitment to tax credits for renewable energy and energy efficient sources and technologies. The budget request also includes $279 million for international activities -- a 29% increase.

A New Tool to Measure and Credit Emissions Reductions. In his February announcement, the President directed the Secretary of Energy to recommend reforms to the Department's existing voluntary greenhouse gas registry, to: (1) ensure that businesses that register voluntary reductions are not penalized under a future climate policy, and (2) give credit to companies that can show real emissions reductions. Toward this end, the United States will improve its voluntary GHG registry to enhance the registry's accuracy, reliability and verifiability, working with and taking into account emerging domestic and international approaches. These improvements will give businesses incentives to invest in new, cleaner technology and voluntarily reduce greenhouse gas emissions.

National Energy Policy. The United States' National Energy Policy recommends tax incentives, business sector challenges, and improved transportation programs, to promote energy efficiency and conservation and to reduce emissions of greenhouse gases through the use of alternative, renewable, and cleaner forms of energy.

Increased Incentives for Carbon Sequestration. To increase the amount of carbon stored by America's farms and forests, the United States will invest up to $47 billion in the next decade for conservation on its farms and forest lands. This partnership with farmers and small land owners will help protect land, water, and air, secure and enhance habitat for wildlife, and greatly expand opportunities to store significant quantities of carbon in trees and the soil, as well as promote other activities to mitigate GHG emissions.

Working With Other Nations to Develop an Efficient and Effective Global Response

Enhanced support in the developing world and for bilateral international cooperation on climate change initiatives. The President's FY2003 budget supports significant funding for science and technology research, development and transfer, including:

- $155 million for the United States Agency for International Development (USAID), which continues to be a major source of climate technology assistance to developing countries.

- $50 million for tropical forest conservation, including $40 million under the Tropical Forest Conservation Act to help countries redirect debt payments toward protecting tropical forests, which store millions of tons of carbon.

- A significant share of the overall funding required to meet the President's commitment of $25 million for climate observation systems in developing countries.

- $68 million for the Global Environment Facility (GEF), to help developing countries better measure and reduce emissions, and invest in clean and renewable energy technologies. In addition, the United States has pledged $500 million over the next four years for the GEF, to help developing countries address environmental problems with potential global impact. The commitment represents a 16% increase over our contribution to the previous replenishment.

Bilateral partnerships. The United States is committed to working with other nations, especially developing countries, to build future prosperity along a cleaner and better path. The President's strategy promotes cooperative relationships with other countries, so that our objectives and activities complement each other in addressing climate change effectively. Over the past year, the United States has engaged in bilateral partnerships with Australia, Canada, China, seven Central American countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), the European Union, India, Italy, Japan, the Republic of Korea and New Zealand, on issues ranging from climate change science to energy and sequestration technology to policy approaches.

[End]

EC GHG emission trends

This chapter presents the main GHG emission trends in the European Community. First, aggregate results are described as regards total GHG emissions and progress towards fulfilling the EC Kyoto target. Then, emission trends are briefly analysed at gas and source level. Finally, a short overview of MS contribution to EC greenhouse gas trends is given.

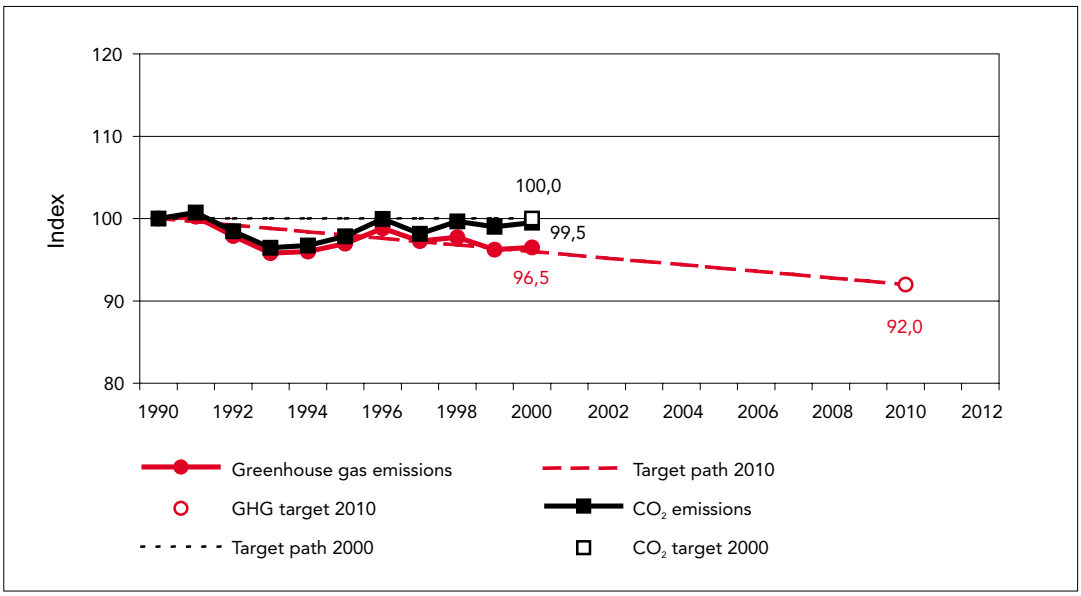
1. Total GHG emissions

The European Community increased greenhouse gas emissions in 2000 compared to 1999, but was well below 1990 levels. In 2000, total EC greenhouse gas emissions without LUCF were 4 059 Tg (CO_2 equivalents), which was 0.3 % above 1999 and 3.5 % below 1990 levels.

In the Kyoto Protocol, the EC agreed to reduce its greenhouse gas emissions by 8 % by 2008–12, from 1990 levels. Assuming a linear target path from 1990 to 2010, total EC greenhouse gas emissions were 0.5 index points above this target path in 2000 (Figure 1). Note that the trend changes slightly, if the EC selects a base year other than 1990 for fluorinated gases, as allowed for under the Kyoto Protocol.

CO_2 is by far the most important greenhouse gas, accounting for 82% of total EC emissions in 2000. In 2000, EC CO_2 emissions without LUCF were 3 325 Tg, which was 0.5 % above 1999 but 0.5 % below 1990 levels. In the UNFCCC, the EC agreed to stabilise its CO_2 emissions at 1990 levels by 2000. This target was achieved by the EC (Figure 1).

Figure 1 **EC greenhouse gas emissions 1990–2000 compared with targets for 2000 and 2008–12 (excluding LUCF)**



Note (1): The linear target path is not intended as an approximation of past and future emission trends. It provides a measure of how close the EC emissions in 2000 are to a linear path of emissions reductions from 1990 to the Kyoto target for 2008–12, assuming that only domestic measures will be used. The unit is index points with 1990 emissions being 100. Therefore, it does not deliver a measure of (possible) compliance of the EC with its greenhouse gas targets in 2008–12, but aims at evaluating overall EC greenhouse gas emissions in 2000.

Note (2): Greenhouse gas emission data for the EC as a whole do not include emissions and removals from LUCF. In addition, no adjustments for temperature variations or electricity trade are considered.

2. Trends by gases

Table 3 gives an overview of the main trends in EC greenhouse gas emissions and removals for 1990–2000. It shows the importance of CO_2 emissions, which account for 82 % of total GHG emissions and reduced slightly since 1990 (–0.5 %). CO_2 emissions increased by 0.5 % in 2000 compared to 1999 mainly in the source categories 1.A.1 'Energy industries' and, to a smaller extent, in 1.A.2 'Manufacturing industries'.

CH_4 emissions account for 8 % of total EC greenhouse gas emissions and decreased by 20 % between 1990 and 2000. In 2000, CH_4 emissions decreased by 2.7 % compared to 1999. The emission reductions in 2000 were mainly achieved in the source categories 1.B.1 'Fugitive emissions from solid fuels', 4.A. 'Enteric fermentation' and 6.A. 'Solid waste disposal on land'.

N_2O emissions are responsible for 8 % of total greenhouse gas emissions and decreased by 16 % between 1990 and 2000. Compared to 1999, N_2O emissions decreased by 0.6 % in 2000. The main source categories reducing N_2O emission in 2000 were 2.B. 'Chemical industry', 1.A.4. 'Other sectors', 4.D. 'Agricultural soils' and 4.B. 'Manure management'.

HFC emissions account for 1.2 % of total EC greenhouse gas emissions and increased by 94 % between 1990 and 2000. In 2000, HFC emissions increased by 16 % compared to 1999. The increases occurred in source category 2.F. 'Consumption of halocarbons and SF_6'.

PFC emissions account for 0.2 % of total EC greenhouse gas emissions and decreased by 49 % between 1990 and 2000. Also in 2000, PFC emissions decreased by 7 % compared to 1999. The decreases were achieved in source category 2.C. 'Metal production'.

SF_6 emissions account for 0.2 % of EC greenhouse gas emissions and increased by 6 % between 1990 and 2000. In 2000, SF_6 emissions decreased by 1 % compared to 1999.

Overview of EC greenhouse gas emissions and removals from 1990 to 2000 in CO_2 equivalents (Gg) Table 3

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)										
Net CO_2 emissions/removals	3.142.800	3.143.456	3.081.363	3.003.776	3.025.494	3.072.137	3.133.856	3.073.187	3.132.504	3.102.360	3.144.119
CO_2 emissions (without LUCF) [6]	3.341.803	3.366.897	3.290.290	3.223.445	3.232.829	3.270.286	3.340.775	3.280.294	3.330.477	3.308.494	3.324.800
CH_4	426.506	415.935	405.076	393.458	383.084	380.897	373.975	363.742	357.818	350.744	341.770
N_2O	400.948	396.960	386.944	375.590	380.672	380.715	390.379	389.499	361.044	340.047	338.111
HFCs	24.426	24.514	24.806	27.250	31.815	35.830	39.974	47.141	51.975	40.672	47.285
PFCs	13.545	11.949	9.788	8.403	7.717	7.765	7.754	7.505	7.405	7.331	6.846
SF_6	8.440	9.074	9.744	10.513	11.361	12.271	12.073	11.986	11.330	9.045	8.955
Total (with net CO_2 emissions/removals)	**4.016.664**	**4.001.889**	**3.917.720**	**3.818.989**	**3.840.143**	**3.889.614**	**3.958.011**	**3.893.060**	**3.922.075**	**3.850.199**	**3.887.086**
Total (without LUCF)	**4.207.624**	**4.217.324**	**4.118.410**	**4.030.489**	**4.039.374**	**4.079.753**	**4.156.875**	**4.092.107**	**4.111.560**	**4.048.197**	**4.059.276**

3. Trends by sources

Table 4 gives an overview of EC greenhouse gas emissions in the main source categories for 1990–2000. Source category 1 'Energy' is by far the most important source category with a share of 81 % in total EC greenhouse emissions (without LUCF). Emissions from source category 1 'Energy' decreased by 1.3 % between 1990 and 2000, but increased in 2000 compared to 1999 by 0.3 %.

Agriculture is the second largest source category accounting for 10 % of total EC greenhouse gas emissions (without LUCF). Emissions from source category 4 'Agriculture' decreased by 6 % between 1990 and 2000 and by 1 % from 1999 to 2000.

Source category 2 'Industrial processes' has a share of 6 % in total EC greenhouse gas emissions and decreased emissions by 15 % between 1990 and 2000. In 2000, emissions increased by 3 % compared to 1999.

Emissions from source category 6 'Waste' account for 3 % of total EC greenhouse gas emissions and reduced by 21 % between 1990 and 2000. Also in 2000, emissions decreased further by 1.5 % compared to 1999.

Table 4 **Overview of EC greenhouse gas emissions in the main source categories 1990 to 2000 in CO_2 equivalents (Gg)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)										
1. Energy	3.320.359	3.352.346	3.278.313	3.212.871	3.207.851	3.243.215	3.315.077	3.248.410	3.293.799	3.268.313	3.276.742
2. Industrial processes	305.039	297.207	286.934	276.046	290.402	296.755	302.954	310.307	287.405	252.639	260.547
3. Solvent and other product use	9.065	8.990	8.794	8.427	8.460	8.498	8.544	8.617	8.662	8.646	8.796
4. Agriculture	416.343	405.557	396.459	390.461	391.371	391.599	395.423	395.150	394.100	393.066	389.535
5. Land-use change and forestry [7]	-190.960	-215.434	-200.690	-211.500	-199.232	-190.139	-198.864	-199.046	-189.485	-197.997	-172.190
6. Waste	154.949	151.386	146.079	140.905	139.373	137.761	132.959	127.845	125.649	123.555	121.702
7. Other	1.865	1.835	1.828	1.776	1.918	1.937	1.929	1.777	1.945	1.977	1.954

4. Trends by Member States

Table 5 gives an overview of MS contribution to the EC greenhouse gas emissions for 1990–2000. The largest emitters in the EU are Germany and the United Kingdom accounting for 24 % and 16 % respectively. France and Italy account for 13 % of EC greenhouse gas emissions each, Spain is responsible for 10 %.

Emission trends vary considerably between MS. Over the whole period 1990 to 2000, seven MS achieved GHG emissions reductions, in particular Germany (–19 %) and the United Kingdom (–13 %) achieved large emission reductions. Eight MS increased emissions with Spain having the largest increases in absolute and relative terms. In 2000, eight EC Member States achieved emission reductions compared to 1999, but seven MS increased emissions.

A more detailed analysis of EC greenhouse gas trends will be published by the EEA in October 2002 (see also Chapter 4.9.3).

Table 5 **Overview of MS contribution to EC greenhouse gas emissions excluding LUCF from 1990 to 2000 in CO_2 equivalents (Gg)**

Member State	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Austria	77.388	81.314	74.893	74.770	76.159	78.606	79.951	81.319	79.458	79.731	79.754
Belgium	143.125	148.442	147.351	145.737	149.651	153.543	155.801	150.927	154.196	151.202	151.930
Denmark	69.360	80.157	73.591	76.332	80.152	77.379	90.937	81.106	75.982	72.916	68.505
Finland	77.093	74.809	71.369	71.667	77.751	75.168	80.536	79.377	76.833	76.131	73.958
France	551.805	574.273	563.240	540.990	537.252	547.090	562.727	553.669	566.973	548.553	542.299
Germany	1.222.765	1.169.013	1.116.027	1.095.819	1.074.128	1.071.181	1.084.357	1.048.155	1.026.475	993.819	991.421
Greece	104.755	104.760	106.172	106.714	109.238	110.429	114.220	119.504	124.343	123.697	129.652
Ireland	53.430	54.096	54.712	54.470	56.366	57.246	58.847	61.295	63.653	65.275	66.277
Italy	522.132	523.063	519.499	506.951	500.495	528.105	521.787	525.854	536.389	539.519	543.464
Luxembourg	10.836	11.380	11.204	11.353	12.661	7.745	7.805	6.804	5.872	5.982	5.949
Netherlands	210.342	221.528	218.515	220.672	222.607	223.608	234.215	223.951	226.533	217.827	216.916
Portugal	65.106	66.938	70.167	68.811	69.115	73.299	71.672	73.800	77.780	85.605	84.700
Spain	286.428	293.570	302.773	287.638	304.672	318.135	310.899	331.168	341.930	370.920	385.987
Sweden	70.566	70.940	69.127	69.183	73.634	72.744	76.423	71.424	72.545	70.505	69.356
United Kingdom	742.492	743.041	719.771	699.383	695.493	685.474	706.699	683.752	682.597	646.514	649.106
EU15	**4.207.624**	**4.217.324**	**4.118.410**	**4.030.489**	**4.039.374**	**4.079.753**	**4.156.875**	**4.092.107**	**4.111.560**	**4.048.197**	**4.059.276**

An introduction to climate change

◆ **Human activities are releasing greenhouse gases into the atmosphere.** Carbon dioxide is produced when fossil fuels are used to generate energy and when forests are cut down and burned. Methane and nitrous oxide are emitted from agricultural activities, changes in land use, and other sources. Artificial chemicals called halocarbons (CFCs, HFCs, PFCs) and other long-lived gases such as sulphur hexafluoride (SF6) are released by industrial processes. Ozone in the lower atmosphere is generated indirectly by automobile exhaust fumes.

◆ **Rising levels of greenhouse gases are expected to cause climate change.** By absorbing infrared radiation, these gases control the way natural energy flows through the climate system. In response to humanity's emissions, the climate will somehow have to adjust to a "thicker blanket" of greenhouse gases in order to maintain the balance between energy arriving from the sun and energy escaping back into space.

◆ **Climate models predict that the global temperature will rise by about 1-3.5°C by the year 2100.** This projected change is larger than any climate change experienced over the last 10,000 years. It is based on current emissions trends and assumes that no efforts are made to limit greenhouse gas emissions. There are many uncertainties about the scale and impacts of climate change, particularly at the regional level. Because of the delaying effect of the oceans, surface temperatures do not respond immediately to greenhouse gas emissions, so climate change will continue for many decades after atmospheric concentrations have stabilized. Meanwhile, the balance of the evidence suggests that the climate may have already started responding to past emissions.

◆ **Climate change is likely to have a significant impact on the global environment.** In general, the faster the climate changes, the greater will be the risk of damage. The mean sea level is expected to rise 15-95 cm by the year 2100, causing flooding of low-lying areas and other damage. Climatic zones (and thus ecosystems and agricultural zones) could shift towards the poles by 150-550 km in the mid-latitude regions. Forests, deserts, rangelands, and other unmanaged ecosystems would face new climatic stresses. As a result, many will decline or fragment, and individual species will become extinct.

◆ **Human society will face new risks and pressures.** Food security is unlikely to be threatened at the global level, but some regions are likely to experience food shortages and hunger. Water resources will be affected as precipitation and evaporation patterns change around the world. Physical infrastructure will be damaged, particularly by sea-level rise and by extreme weather events. Economic activities, human settlements, and human health will experience many direct and indirect effects. The poor and disadvantaged are the most vulnerable to the negative consequences of climate change.

◆ **People and ecosystems will need to adapt to future climatic regimes.** Past and current emissions have already committed the earth to some degree of climate change in the 21st century. Adapting to these effects will require a good understanding of socio-economic and natural systems, their sensitivity to climate change, and their inherent ability to adapt. Many strategies are available for adapting to the expected effects of climate change.

◆ **Stabilizing atmospheric concentrations of greenhouse gases will demand a major effort.** Based on current trends, the total climatic impact of rising greenhouse gas levels will be equal to that caused by a doubling of pre-industrial CO_2 concentrations by 2030, and a trebling or more by 2100. Freezing global CO_2 emissions at their current levels would postpone CO_2-doubling to 2100; emissions would eventually have to fall to about 30% of their current levels for concentrations to stabilize at doubled-CO_2 levels sometime in the future. Given an expanding world economy and growing populations, this would require dramatic improvements in energy efficiency and fundamental changes in other economic sectors.

◆ **The international community is tackling this challenge through the Climate Change Convention.** Adopted in 1992 and now boasting over 175 members, the Convention seeks to stabilize atmospheric concentrations of greenhouse gases at safe levels. It commits developed countries to take measures aimed at returning their emissions to 1990 levels by the year 2000. It further requires all countries to limit their emissions, gather relevant information, develop strategies for adapting to climate change, and cooperate on research and technology.

◆ **The 1997 Kyoto Protocol will require stronger action in the post-2000 period.** The Parties to the Convention have agreed by consensus that developed countries will have a legally binding commitment to reduce their collective emissions of six greenhouse gases by at least 5% compared to 1990 levels by the period 2008-2012. The Protocol also establishes an emissions trading regime and a "clean development mechanism".

◆ **Many options for limiting emissions are available in the short- and medium-term.** Policymakers can encourage energy efficiency and other climate-friendly trends in both the supply and consumption of energy. Key consumers of energy include industries, homes, offices, vehicles, and farms. Efficiency can be improved in large part by providing an appropriate economic and regulatory framework for consumers and investors. This framework should promote cost-effective actions, the best current and future technologies, and "no regrets" solutions that make economic and environmental sense irrespective of climate change. Taxes, regulatory standards, tradable emissions permits, information programmes, voluntary programmes, and the phase-out of counterproductive subsidies can all play a role. Changes in practices and lifestyles, from better urban transport planning to personal habits such as turning out the lights, are also important.

◆ **Energy efficiency gains of 10-30% above baseline trends can be realized over the next 20-30 years at no net cost.** Some researchers believe that much greater gains are also feasible during this period and beyond. Improvements over the baseline can be achieved in all major economic sectors with current knowledge and with today's best technologies. In the longer term, it will be possible to move close to a zero-emissions industrial economy – with the innumerable environmental and economic benefits that this implies.

◆ **Reducing uncertainties about climate change, its impacts, and the costs of various response options is vital.** In the meantime, it will be necessary to balance concerns about risks and damages with concerns about economic development. The prudent response to climate change, therefore, is to adopt a portfolio of actions aimed at controlling emissions, adapting to impacts, and encouraging scientific, technological, and socio-economic research.

Source: United Nations Environment Programme

The Climate Change Convention (UNFCCC)

◆ **The United Nations Framework Convention on Climate Convention is the foundation of global efforts to combat global warming.** Opened for signature in 1992 at the Rio Earth Summit, its ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [human-induced] interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

◆ **The Convention sets out some guiding principles.** The precautionary principle says that the lack of full scientific certainty should not be used as an excuse to postpone action when there is a threat of serious or irreversible damage. The principle of the "common but differentiated responsibilities" of states assigns the lead in combating climate change to developed countries. Other principles deal with the special needs of developing countries and the importance of promoting sustainable development.

◆ **Both developed and developing countries accept a number of general commitments.** All Parties will develop and submit "national communications" containing inventories of greenhouse gas emissions by source and greenhouse gas removals by "sinks". They will adopt national programmes for mitigating climate change and develop strategies for adapting to its impacts. They will also promote technology transfer and the sustainable management, conservation, and enhancement of greenhouse gas sinks and "reservoirs" (such as forests and oceans). In addition, the Parties will take climate change into account in their relevant social, economic, and environmental policies; cooperate in scientific, technical, and educational matters; and promote education, public awareness, and the exchange of information related to climate change.

◆ **Industrialized countries undertake several specific commitments.** Most members of the Organization for Economic Cooperation and Development (OECD) plus the states of Central and Eastern Europe – known collectively as Annex I countries – are committed to adopting policies and measures aimed at returning their greenhouse gas emissions to 1990 levels by the year 2000. They must also submit national communications on a regular basis detailing their climate change strategies. Several states may together adopt a joint emissions target. The countries in transition to a market economy are granted a certain degree of flexibility in implementing their commitments.

◆ **The richest countries shall provide "new and additional financial resources" and facilitate technology transfer.** These so-called Annex II countries (essentially the OECD) will fund the "agreed full cost" incurred by developing countries for

submitting their national communications. These funds must be "new and additional" rather than redirected from existing development aid funds. Annex II Parties will also help finance certain other Convention-related projects, and they will promote and finance the transfer of, or access to, environmentally sound technologies, particularly for developing country Parties. The Convention recognizes that the extent to which developing country Parties implement their commitments will depend on financial and technical assistance from the developed countries.

◆ **The supreme body of the Convention is the Conference of the Parties (COP).** The COP comprises all the states that have ratified or acceded to the Convention (over 175 by May 1999). It held its first meeting (COP-1) in Berlin in 1995 and will continue to meet on a yearly basis unless the Parties decide otherwise. The COP's role is to promote and review the implementation of the Convention. It will periodically review existing commitments in light of the Convention's objective, new scientific findings, and the effectiveness of national climate change programmes. The COP can adopt new commitments through amendments and protocols to the Convention; in December 1997 it adopted the Kyoto Protocol containing stronger emissions-related commitments for developed countries in the post-2000 period.

◆ **The Convention also establishes two subsidiary bodies.** The Subsidiary Body for Scientific and Technological Advice (SBSTA) provides the COP with timely information and advice on scientific and technological matters relating to the Convention. The Subsidiary Body for Implementation (SBI) helps with the assessment and review of the Convention's implementation. Two additional bodies were established by COP-1: the Ad hoc Group on the Berlin Mandate (AGBM), which concluded its work in Kyoto in December 1997, and the Ad hoc Group on Article 13 (AG13), which concluded its work in June 1998.

◆ **A financial mechanism provides funds on a grant or concessional basis.** The Convention states that this mechanism shall be guided by, and be accountable to, the Conference of the Parties, which shall decide on its policies, programme priorities, and eligibility criteria. There should be an equitable and balanced representation of all Parties within a transparent system of governance. The operation of the financial mechanism may be entrusted to one or more international entities. The Convention assigns this role to the Global Environment Facility (GEF) on an interim basis; in 1999 the COP decided to entrust the GEF with this responsibility on an on-going basis and to review the financial mechanism every four years.

◆ **The COP and its subsidiary bodies are serviced by a secretariat.** The interim secretariat that functioned during the negotiation of the Convention became the permanent secretariat in January 1996. The secretariat arranges for sessions of the COP and its subsidiary bodies, drafts official documents, services meetings, compiles and transmits reports submitted to it, facilitates assistance to Parties for the compilation and communication of information, coordinates with secretariats of other relevant international bodies, and reports on its activities to the COP.

Source: United Nations Environment Programme

Greenhouse Gases (GHG)

CO_2	Carbon Dioxide
CH_4	Methane
N_2O	Nitrousoxide
CHC-11	Chlorofluorocarbon-11
HFC-23	Hydrofluorocarbon-23
CF_4	Perfluoromethan

DATA on greenhouse gas emissions and sources

A sample of greenhouse gases affected by human activities

	CO_2 (carbon dioxide)	CH_4 (methane)	N_2O (nitrous oxide)	CFC-11	HCFC-22 (a CFC substitute)	CF_4 (a perfluoro-carbon)	SF_6 (sulphur hexafluoride)
Pre-industrial level	~280 ppmv+	~700 ppbv	~275 ppbv	zero	zero	zero	zero
1994 Concentration	358 ppmv	1720 ppbv	312§ ppbv	268§ pptv	110 pptv	72§ pptv	3-4 pptv
Rate increase*	1.5 ppmv/yr	10 ppbv/yr	0.8 ppbv/yr	0 pptv/yr	5 pptv/yr	1.2 pptv/yr	0.2/pptv/yr
	0.4%/yr	0.6%/yr	0.25%/yr	0%/yr	5%/yr	2%/yr	~5%/yr
Lifetime (years)	50-200++	12+++	120	50	12	50,000	3,200

§ Estimated from 1992-93 data.
\+ 1 ppmv = 1 part per million by volume; 1 ppbv = 1 part per billion by volume; 1 pptv = 1 part per trillion (million million) by volume.
++ No single lifetime for CO2 can be defined because of the different rates of uptake by different sink processes.
+++ This has been defined as an adjustment time which takes into account the indirect effect of methane on its own lifetime.
* The growth rates of CO_2, CH_4 and N_2O are averaged over the decade beginning 1984; halocarbon growth rates are based on recent years (1990s). (Ed. note: 1kg of carbon = 3.664 kg of CO_2.)

Source: Climate Change 1995, IPCC Working Group I, p. 15.

◆ **Carbon dioxide accounted for 82% of total greenhouse gas emissions from developed countries in 1995.** The 1998 review confirmed that fuel combustion is the most important source of CO_2, accounting for 96% of 1995's emissions. Since the 36 Parties included in this review account for a major part of 1990 global carbon dioxide emissions, this seems to confirm carbon dioxide as the most important greenhouse gas resulting from human activities. Governments generally believe that their data on carbon dioxide have a high confidence level (with the exception of land-use change and the forestry sector).

◆ **Methane and nitrous oxide accounted for 12% and 4% of total emissions, respectively.** Confidence levels for data on these gases are medium to low, depending on the sector. For methane, all but five Parties project that their emissions will decline or stabilize. Nitrous oxide trends will also decline or stabilize in the majority of developed countries. These countries' combined emissions of HFCs, PFCs, and SF_6 represented 2% of the 1995 total.

Source: United Nations Environment Programme

POLICY FORUM: CLIMATE CHANGE

Dangerous Climate Impacts and the Kyoto Protocol

Brian C. O'Neill and Michael Oppenheimer

Defining a long-term goal for climate change policy remains a critical international challenge. Article 2 of the UN Framework Convention on Climate Change defines the long-term objective of that agreement as stabilization of greenhouse gas concentrations at a level that avoids "dangerous anthropogenic interference" with the climate system. "Dangerous interference" can be viewed from a variety of perspectives, and the choice will ultimately involve a mixture of scientific, economic, political, ethical, and cultural considerations, among others (*1*). In addition, the links among emissions, greenhouse gas concentrations, climate change, and impacts are uncertain. Furthermore, what might be considered dangerous could change over time.

However, both proponents and detractors of the Kyoto Protocol, which was designed as an initial step to implement the Framework Convention, have begun to demand a definition of long-term objectives. For example, on 11 June 2001, U.S. President George W. Bush stated that the emissions targets embodied in the Kyoto Protocol "were arbitrary and not based upon science" and "no one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."

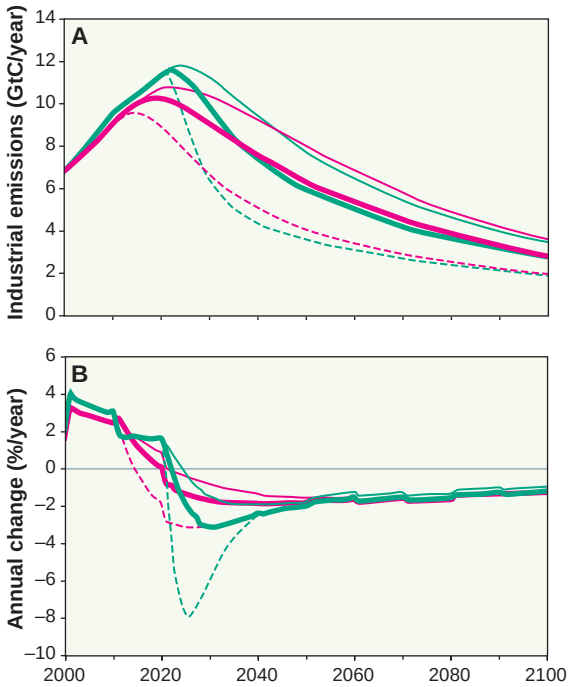
Here, we propose several plausible interpretations of dangerous interference in terms of particular environmental outcomes (*2*) and examine the consistency between the Kyoto Protocol and emissions changes over time that would avoid these outcomes. Although the emissions limits required by the Kyoto Protocol would reduce warming only marginally (*3*), we show that the accord provides a first step that may be necessary for avoiding dangerous interference.

What Impacts Are "Dangerous"?

Attempts to develop limits to warming predate the Framework Convention and have taken a variety of analytical approaches (*4*), including the recent elaboration in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report of a detailed ecological and geophysical framework for interpreting Article 2. We examine the implications of defining "dangerous" according to two of the criteria of "concern" identified by the IPCC (*1*): warming involving risk to unique and threatened systems and warming engendering a risk of large-scale discontinuities in the climate system. These choices can be used to infer an upper limit for future concentrations (*5*, *6*).

Large-scale eradication of coral reef systems provides one marker for policy-makers. Even before the development of the Framework Convention, which calls for a long-term target that will "allow ecosystems to adapt naturally," coral reefs were cited as a potential indicator system (*4*). Coral reefs are charismatic ecosystems with high local economic value and a high degree of biodiversity. They can be found in most of the world's oceans in the latitude belt between 30°N and 30°S. By and large, coral reefs are thought to thrive in climate conditions that are close to their thermal limits for existence. As waters warm toward this limit, corals expel symbiotic zooxanthellae in a process called bleaching. Sustained bleaching over consecutive warm seasons increases the risks permanent loss of the reefs. Widespread bleaching has occurred in the Northern Hemisphere during recent El Niño events, indicating that for some coral reefs, the climate limit is only slightly above current seasonal maximum temperatures. Hoegh-Guldberg (*7*) has estimated that sustained global warming in excess of 1°C would cause bleaching to become an annual event in most oceans, leading to "severe" effects worldwide, even allowing that some acclimation and/or genetic adaptation may occur (*8*).

Outcomes that have even a low probability of occurrence at a given level of warming, particularly within a century or two, but that clearly would be disruptive to societies, could provide markers for policy-makers. Alternatively, so could outcomes that have high probability but a low risk of causing widespread disruption. An example of the first case would be disintegration of the West Antarctic Ice Sheet (WAIS). An example of the second may be the weakening or shutdown of the density-driven, large-scale circulation of the oceans (thermohaline circulation or THC). Complete disintegration of WAIS would raise sea level by 4 to 6 meters, an outcome that certainly ranks as disruptive, even if it occurs gradually. Views on the probability and rate of disintegration for a given global warming vary widely (*9*), largely because current models do not adequately capture certain dynamical features of ice sheets. In general, the probability is thought to be low during this century, increasing gradually thereafter. Limited evidence from proxy data suggests WAIS may have disintegrated in the past during periods only modestly warmer (~2°C global mean) than today; other estimates suggest that disintegration could ultimately occur from about 3°C (global mean) to 10°C (local mean) (*9*). The process of disintegration could extend over anywhere from 5 to 50 centuries, although shorter time scales have also been proposed.



Effects of delay. Global CO_2 emissions (**A**), and annual change in CO_2 emissions (**B**), 2000 to 2100, leading to stabilization of atmospheric CO_2 at 450 ppm by 2100 for a scenario consistent with the Kyoto Protocol (magenta) and a scenario with a 10-year delay (green). Three carbon-cycle parameterizations are used (see text): best guess (thick solid lines), strong uptake (thin solid lines), and weak uptake (thin dashed lines).

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There is strong evidence that the THC had shut down in the past, in association with abrupt regional and perhaps global climate changes (*10*). Most coupled atmosphere-ocean model experiments show weakening of the THC during this century in response to increasing concentrations of greenhouse gases, with some projecting a shutdown if the trends continue (*11*).

Whether a shutdown results in large consequences is sensitive to the timing of regional cooling from shutdown versus regional warming [e.g., in northwest Europe (*12*)], as well as the magnitude of ocean heat transport to the North Atlantic region. The influence of the latter on regional climate may be smaller than some investigators have previously supposed (*13*). We interpret the current state of affairs as a substantial likelihood that forcing due to unrestrained emissions would slow or shut down the THC, but modest probability that THC changes will yield unmanageable outcomes beyond a local scale.

Plausible Targets

A long-term target of 1°C above 1990 global temperatures would prevent severe damage to some reef systems. Taking a precautionary approach because of the very large uncertainties, a limit of 2°C above 1990 global average temperature is justified to protect WAIS. To avert shutdown of the THC, we define a limit at 3°C warming over 100 years, based on Stocker and Schmittner (*14*).

The implications of the temperature limits for concentrations of CO_2 are subject to uncertainties in both the climate sensitivity and future levels of other radiatively active trace gases. For CO_2 stabilization at 450, 550, or 650 ppm, corresponding ranges of global warming over the next 100 years are about 1.2° to 2.3°C, 1.5° to 2.9°C, and 1.7° to 3.2°C, respectively (*11*).

Full protection of coral reefs is probably not feasible for this concentration range. It is plausible that achieving stabilization at 450 ppm would forestall the disintegration of WAIS, but it is by no means certain, because additional warming would occur beyond 2100 (*15*). Avoiding the shutdown of the THC is likely for 450 ppm. We adopt 450 ppm for our illustration as one that could conceivably be applied to these examples.

Implications of Timing

Some studies find justification for preferring reductions sooner rather than later in order to account for the inertia of energy systems, to stimulate technological development, or to hedge against uncertain future concentration limits (*16*). Others conclude that although early investment in research and development may be justified, undertaking emissions reductions later can lower costs, even when accounting for uncertain concentration limits, by avoiding premature retirement of capital, taking advantage of the marginal productivity of capital, and allowing for technical progress (*17*). However, at a certain point, postponing mitigation requires unrealistically rapid emissions reductions, especially for low stabilization targets (*18*). Our ability to identify this point is constrained by our incomplete understanding of the carbon cycle.

The consequences of delay if one assumes a goal of stabilization of atmospheric CO_2 at 450 ppm by 2100 is illustrated in the figure. Because assumptions about the strength of carbon uptake by the terrestrial biosphere are an important determinant of required emissions, we include estimates that span a plausible range of levels of terrestrial uptake (*19*). In one scenario, industrialized countries are assumed to meet the cumulative Kyoto emissions target in 2010; the rest of the world follows a reference path (*20*). Beyond 2010, global emissions necessary to achieve stabilization are calculated with a global carbon-cycle model (*21*). In a second scenario, mitigation is delayed by 10 years, with industrialized countries meeting the Kyoto target in 2020. If reductions are delayed by a decade, growth in global emissions must then be quickly reversed. The subsequent rates of decline in global emissions depend critically on the carbon cycle: with strong terrestrial uptake, required emissions reductions peak at 2% per year; if terrestrial uptake is weak, reductions reach a staggering 8% per year before 2040. Given inertia in energy systems, such high rates of reduction may be prohibitively costly (*22*). Some relief is possible by allowing temporary overshoot of the 450 ppm limit (*23*), although this strategy may still require rapid reductions and also leads to greater climate change over the next century or more (*24*).

Thus delay until 2020 risks foreclosing the option of stabilizing concentrations at 450 ppm, especially if the terrestrial carbon sink turns out to be weak. In contrast, the scenario consistent with the Kyoto targets in 2010 requires challenging but substantially lower reduction rates. Global emissions peak between 2010 and 2020, and fall at between 1 and 3% annually between 2020 and 2040, depending on the carbon-cycle parameterization. Beyond 2050, reductions proceed at about 1.5% per year in all cases.

Stabilizing CO_2 concentrations near 450 ppm would likely preserve the option of avoiding shutdown of the THC and may also forestall the disintegration of WAIS, although it appears to be inadequate for preventing severe damage to at least one unique ecosystem. Taking into account uncertainties in the working of the carbon cycle, the cumulative Kyoto target is consistent with this goal. Delaying reductions by industrial countries beyond 2010 risks foreclosing the 450 ppm option.

References and Notes

1. J. B. Smith *et al.*, in *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J. J. McCarthy *et al.*, Eds. (Cambridge Univ. Press, Cambridge, 2001), pp. 913–967.
2. Compare C. Azar, H. Rodhe, *Science* **276**, 1818 (1997).
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4. F. R. Rijsberman, R. J. Swart, Eds., *Targets and Indicators of Climatic Change* (Stockholm Environment Institute, Stockholm, 1990).
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6. Determining targets and trajectories by optimization of costs and benefits provides an alternative approach. See W. D. Nordhaus, J. Boyer, *Warming the World* (MIT Press, Cambridge, MA, 2000).
7. O. Hoegh-Guldberg, *Mar. Freshw. Res.* **50**, 839 (1999).
8. A. C. Baker, *Nature* **411**, 765 (2001).
9. M. Oppenheimer, *Nature* **393**, 325 (1998).
10. W. S. Broecker, *Science* **278**, 1582 (1997).
11. U. Cubasch *et al.*, in *Climate Change 2001: The Scientific Basis*, J. T. Houghton *et al.*, Eds. (Cambridge Univ. Press, Cambridge, 2001), pp. 525–582.
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13. R. Seager *et al.*, *Q. J. R. Meteorol. Soc.*, in press.
14. T. F. Stocker, A. Schmittner, *Nature* **388**, 862 (1997).
15. Temperature ranges at equilibrium for CO_2 stabilization at 450, 550, and 650 ppm are 1.5° to 3.9°C, 2.0° to 5.2°C, and 2.4° to 6.1°C, respectively. R. T. Watson *et al.*, *Climate Change 2001: The Synthesis Report* (Cambridge Univ. Press, Cambridge, 2001).
16. See, e.g., M. Ha-Duong *et al.*, *Nature* **390**, 270 (1997).
17. See, e.g., T. M. L. Wigley *et al.*, *Nature* **379**, 242 (1996).
18. C. Azar, *Int. J. Environ. Pollut.* **10**, 508 (1998).
19. Supporting online material is available on *Science* Online at www.sciencemag.org/cgi/content/full/296/5575/1971/DC1
20. The reference scenario is taken to be the IPCC A1B marker scenario. N. Nakicenovic *et al.*, *IPCC Special Report on Emissions Scenarios* (Cambridge Univ. Press, Cambridge, 2000).
21. A. Jain *et al.*, *Global Biogeochem. Cycles* **9**, 153 (1995).
22. For example, a cost function that depends on both the degree and rate of emissions reduction (*16*) yields estimated annual total costs peaking at 5 to 12% of gross world product (GWP) in the weak sinks case, depending on the assumed degree of socioeconomic inertia in the energy system. In contrast, in the Kyoto scenarios, costs peak at 1 to 3% of GWP if sinks are assumed to be weak. Calculations assume cost-lowering technical progress of 1% per year, and an inertia time scale of 20 to 50 years. If carbon backstop technologies turn out to be less expensive than implicit in this cost function, costs would be reduced.
23. T. M. L. Wigley, personal communication.
24. For example, we calculate that if the CO_2 concentration is allowed to rise to 500 ppm in 2075 and then return to 450 ppm 150 years later, peak emissions reduction rates fall from 8% per year to 3% per year in the weak sinks case, and the timing of this peak can be delayed from 2025 to 2045. However, global average temperature change is 0.2° to 0.4°C greater in 2100 in this case, depending on the climate sensitivity, which could be significant compared with the range for stabilization at 450 ppm.

25. The authors acknowledge partial support from Environmental Defense, and thank C. Azar, J. Smith, T. Stocker, R. Stouffer, F. Toth, T. Wigley, and anonymous reviewers for helpful comments.

Supporting Online Material
www.sciencemag.org/cgi/content/full/296/5575/1971/DC1

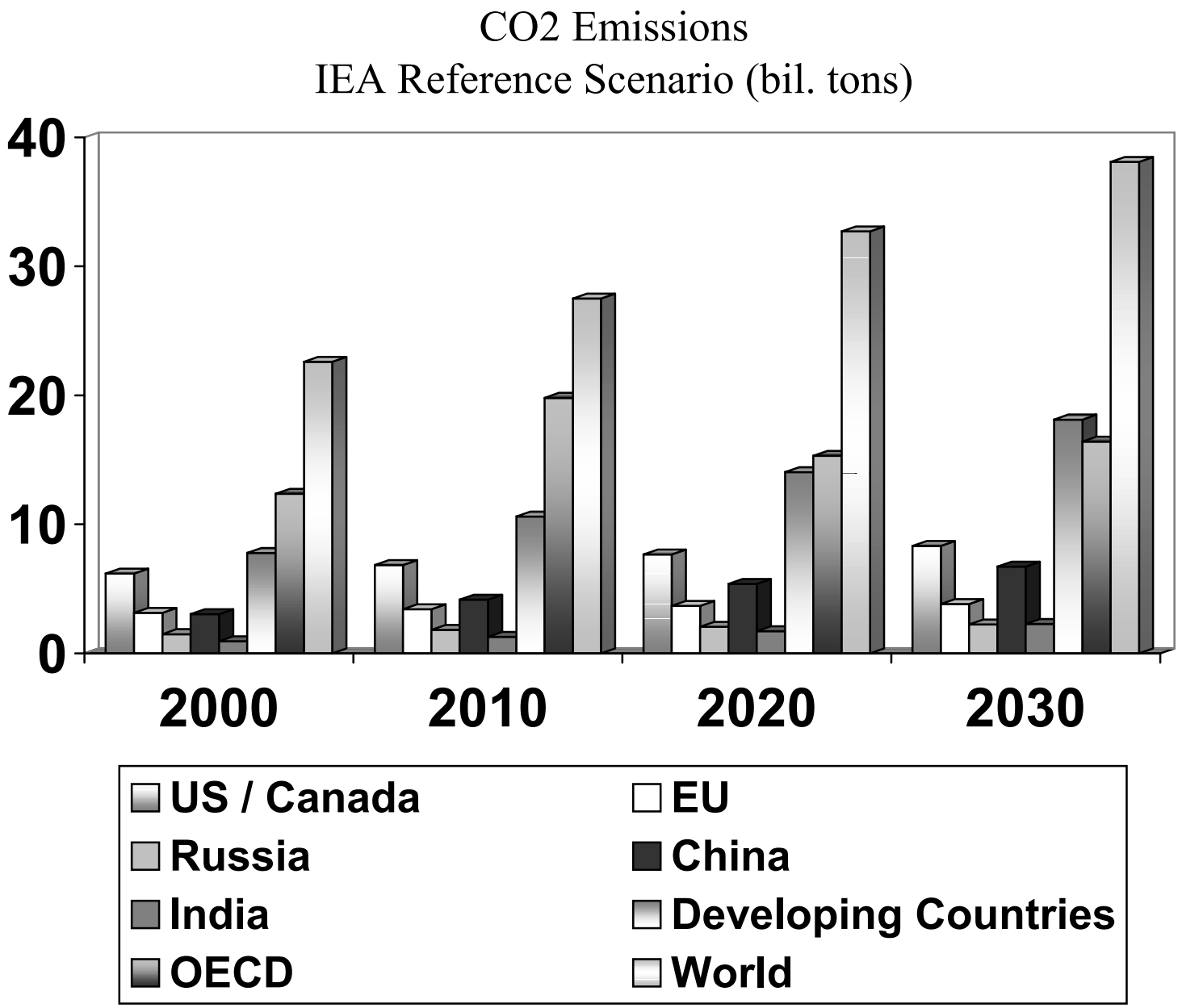
CO_2 Emissions
IEA Reference Scenario*

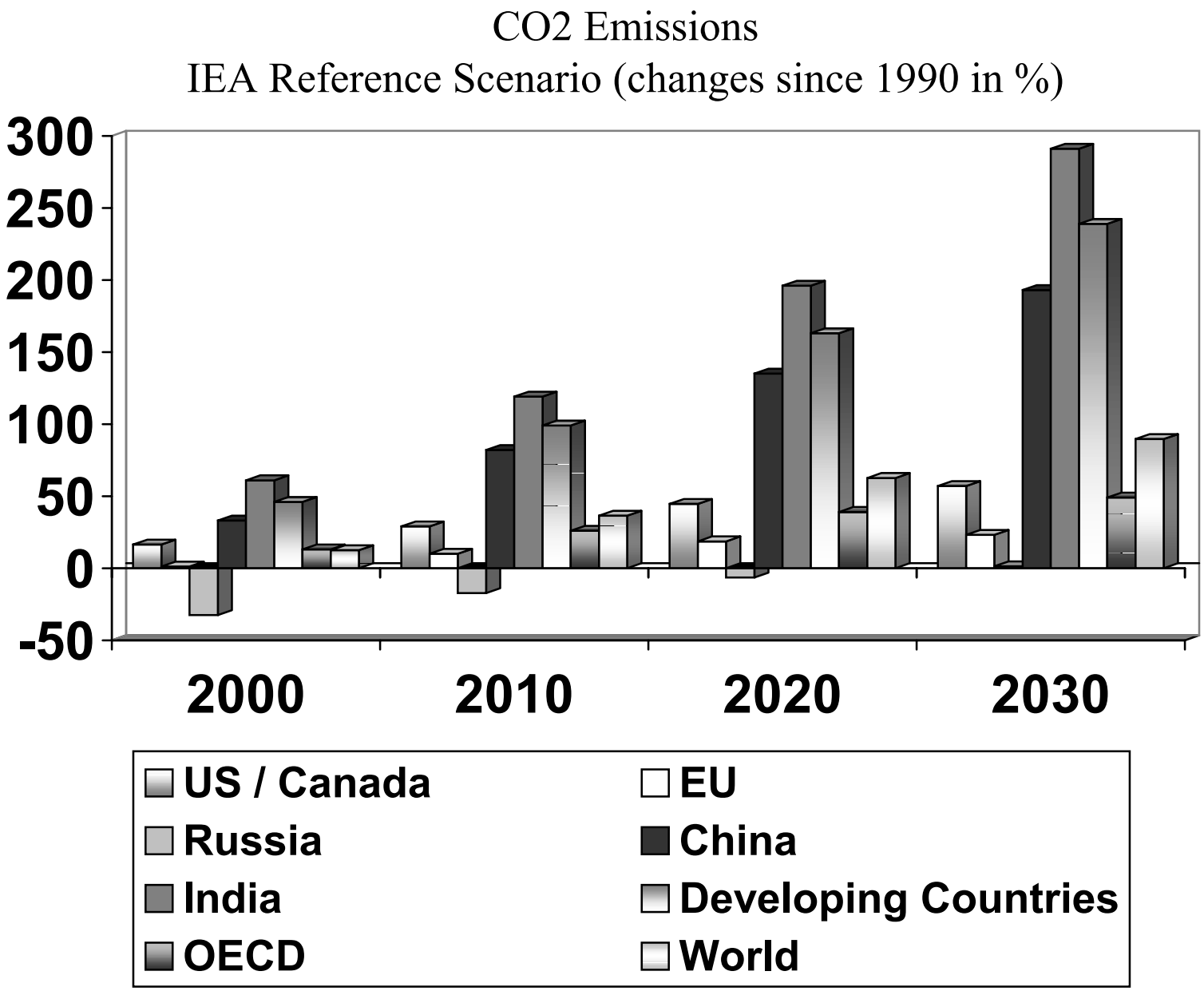
(Billion tons)

	2000	2010	2020	2030
US and Canada	6.18	6.84	7.67	8.33
change since 1990	*16.4%*	*29.0%*	*44.6%*	*57%*
EU	3.15	3.42	3.69	3.83
change since 1990	*1.1%*	*10.0%*	*18.6%*	*23.1%*
Russia	1.49	1.83	2.07	2.24
change since 1990	*-32.6%*	*-17.3%*	*-6.5%*	*1.3%*
China	3.05	4.16	5.39	6.72
change since 1990	*33%*	*82%*	*135%*	*193%*
India	0.94	1.28	1.73	2.28
change since 1990	*61%*	*119%*	*196%*	*291%*
Developing Countries	7.78	10.61	14.04	18.12
change since 1990	*46%*	*99%*	*163%*	*239%*
OECD	12.37	19.80	15.31	16.40
change since 1990	*13%*	*26%*	*39%*	*49%*
World	22.6	27.5	32.7	38.1
change since 1990	*12.5%*	*36.4%*	*62.6%*	*89.6%*

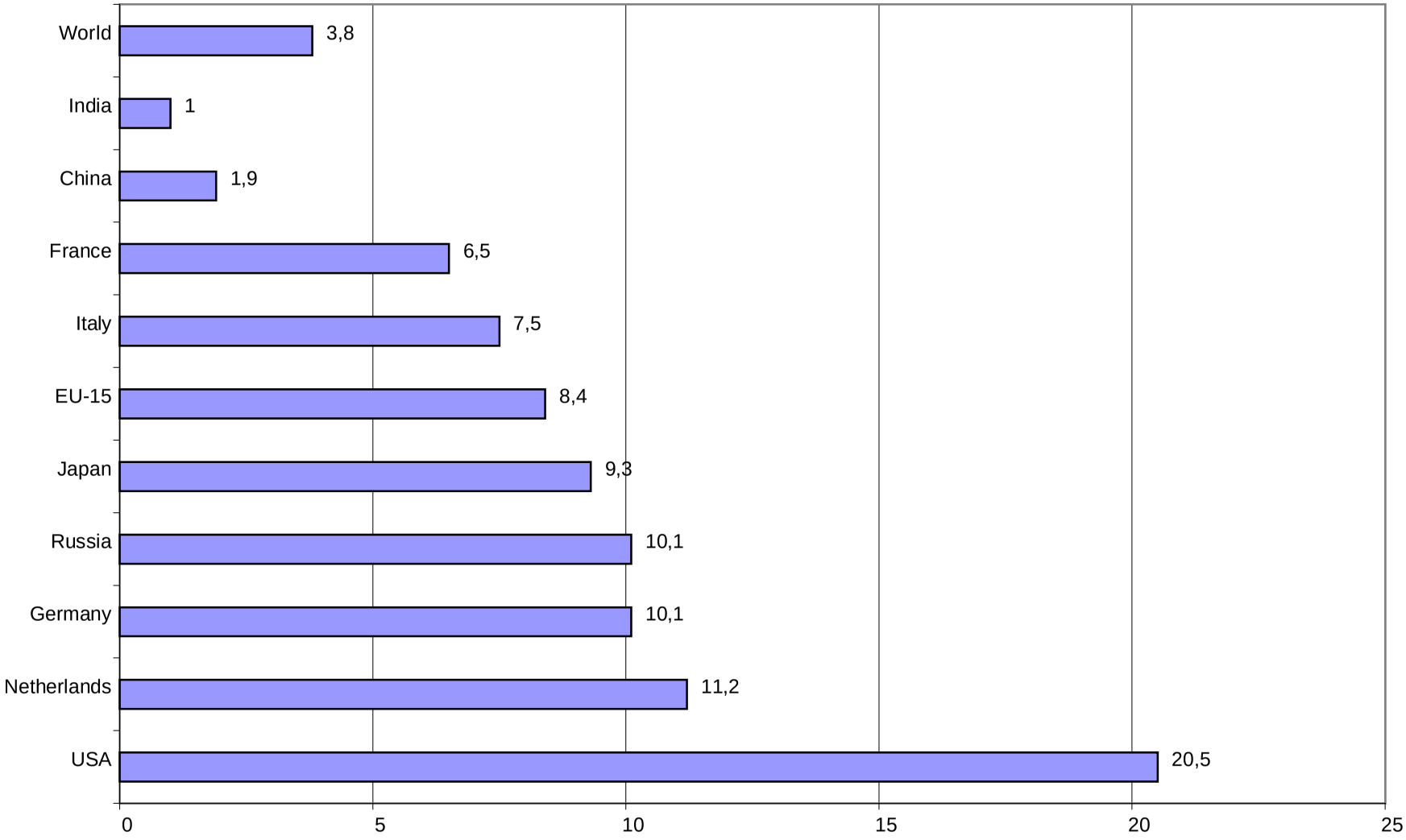
Source: IEA, World Energy Outlook 2002

* "The Reference Scenario projections should not be seen as forecast, but rather as a baseline vision of how energy markets might evolve if governments individually or collectively do nothing more than they have already committed themselves to do."


CO2 Emissions
IEA Reference Scenario (bil. tons)
40
30
20
10
0
2000
2010
2020
2030
US / Canada
EU
Russia
China
India
Developing Countries
OECD
World

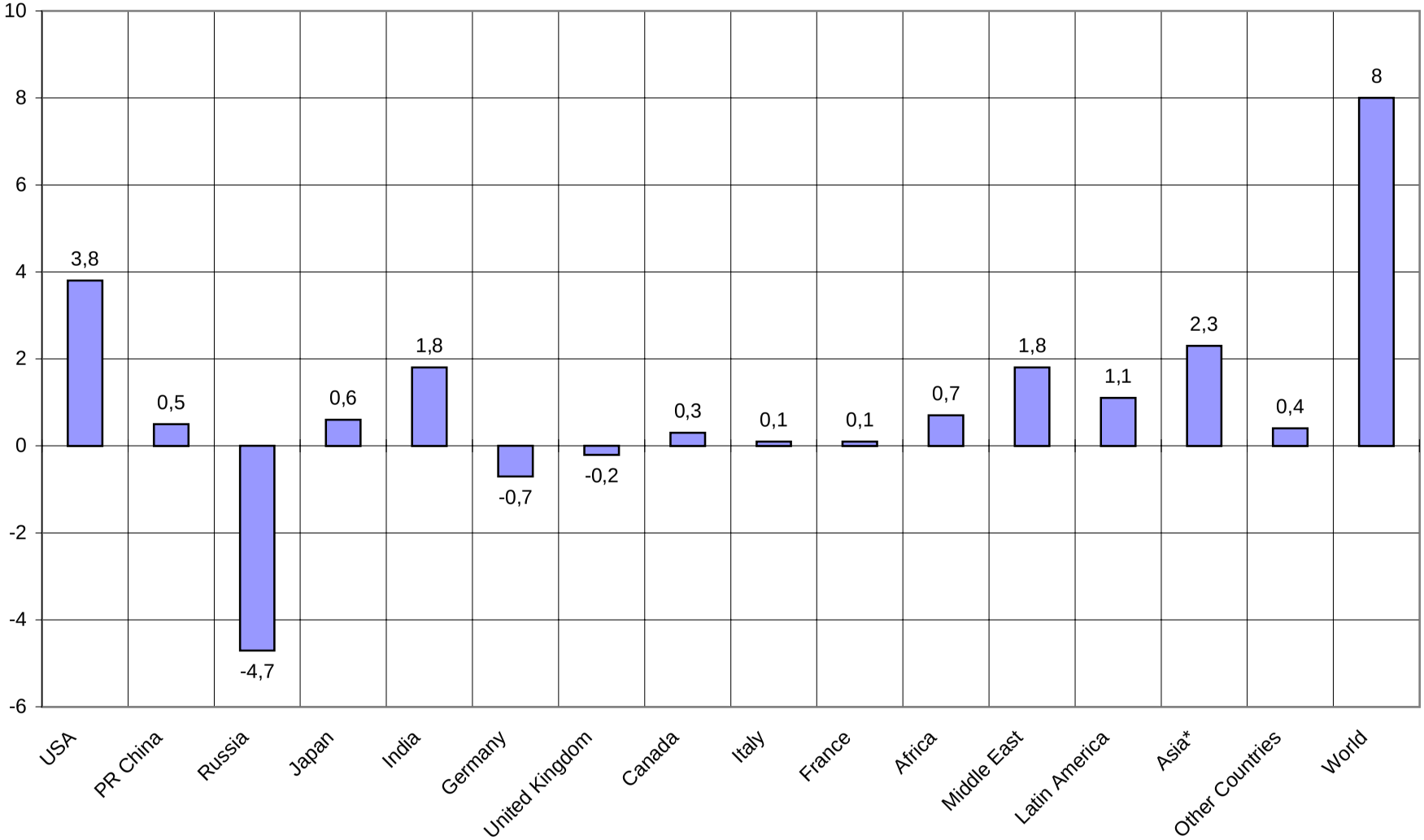

CO2 Emissions
IEA Reference Scenario (changes since 1990 in %)
300
250
200
150
100
50
0
-50
2000
2010
2020
2030
US / Canada
EU
Russia
China
India
Developing Countries
OECD
World

CO2 Emissions per Capita in selected Countries and Regions in 2000
(tons CO2 per Capita)



Source: Wochenbericht des DIW 45/2001

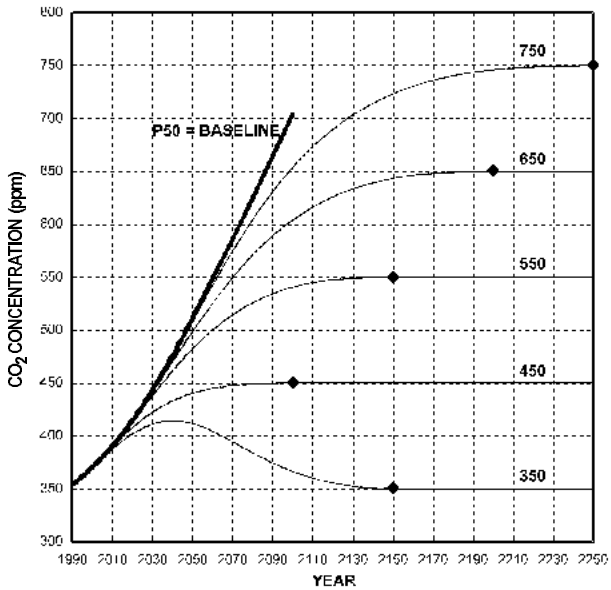
Share of Largest Emitters in Relation to Global CO2 Emissions
1990-2000 in %



* Without Japan, PR China and India
Source: Wochenbericht des DIW 45/2001

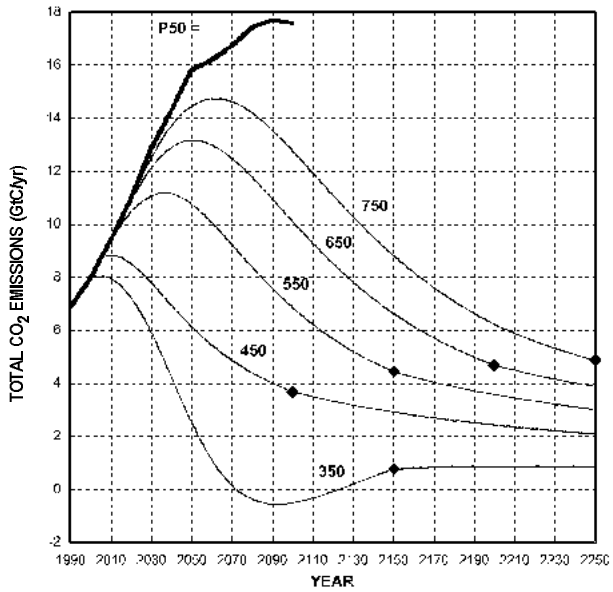
Stabilization of CO_2 Concentration at a Range of Different Target Levels

REVISED WRE STABILIZATION PROFILES



Updated WRE concentration stabilization profiles. Concentrations follow the P50 baseline scenario until 2000,2005,2010, 2015 or 2020 for stabilization levels of 350,450,550, 650 or 750 ppm respectively. The diamonds indicate the date at which stabilization is achieved.

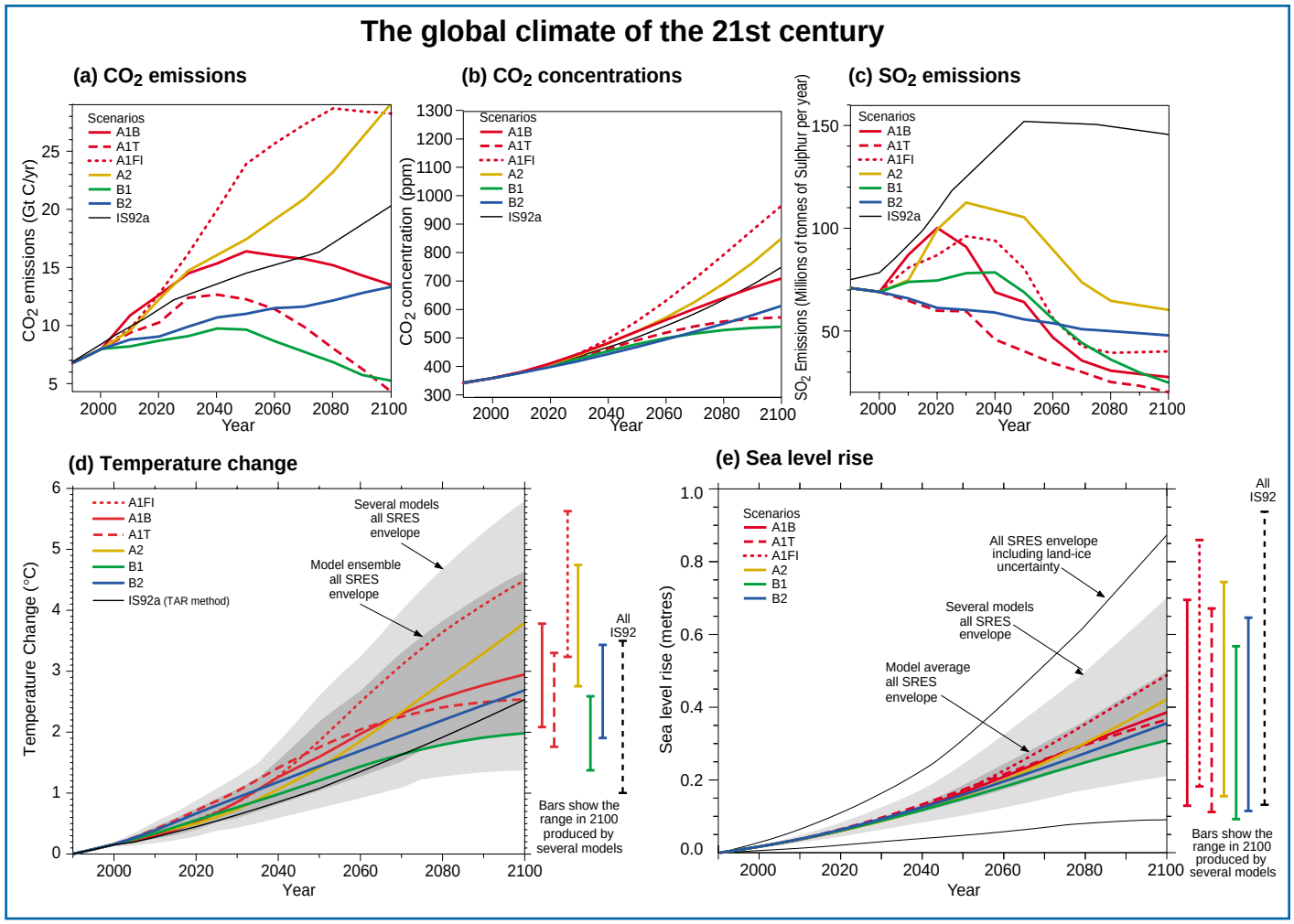
EMISSIONS FOR REVISED WRE STABILIZATION PROFILES



Total CO_2 emissions (fossil plus net land-use) required to follow the updated WRE concentration stabilization profiles shown in Figure 5. The diamonds indicate the date at which stabilization is achieved.

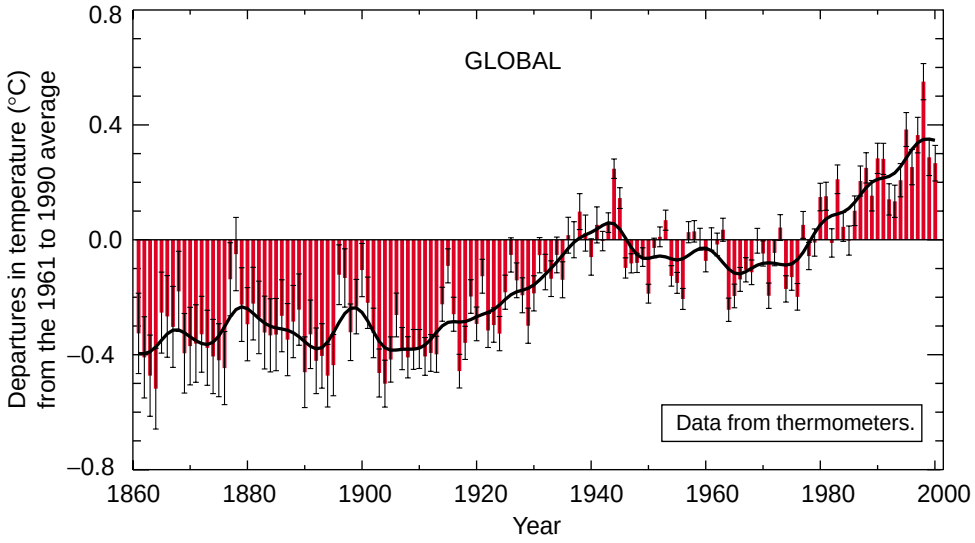
Source: Tom M. L. Wigley, National Center for Atmospheric Research

Estimates of the IPCC Report 2001

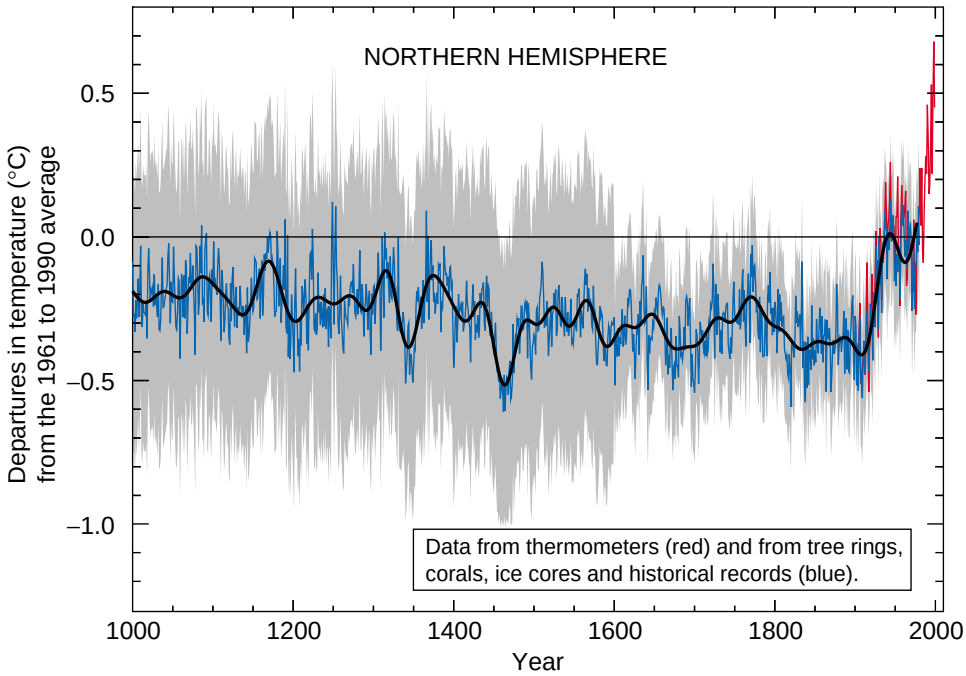


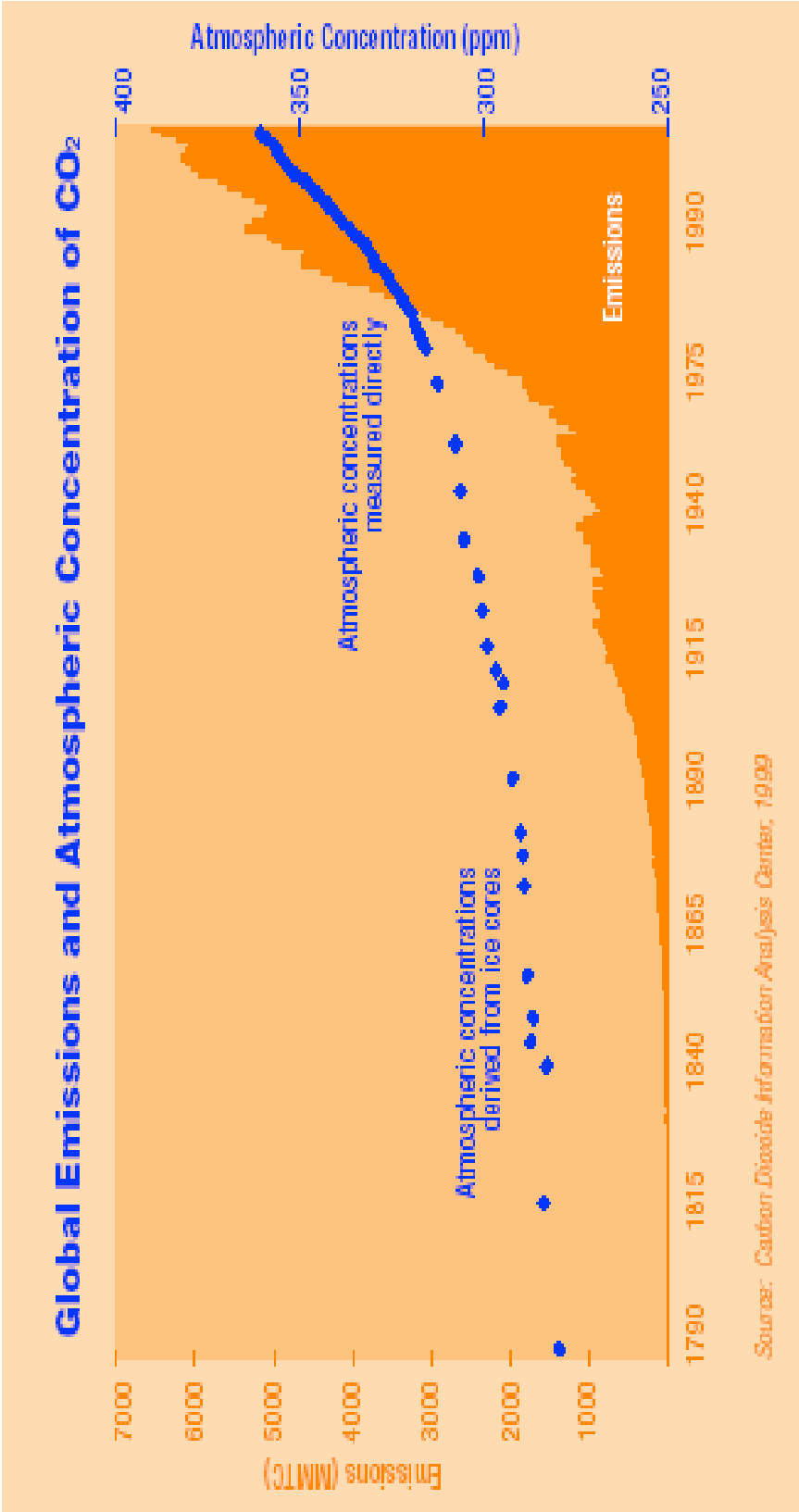
Variations of the Earth's surface temperature for:

(a) the past 140 years



(b) the past 1,000 years




Global Emissions and Atmospheric Concentration of CO_2
Atmospheric Concentration (ppm)
400
350
300
250
Emissions (MMTC)
7000
6000
5000
4000
3000
2000
1000
Atmospheric concentrations measured directly
Atmospheric concentrations derived from ice cores
Emissions
1790
1815
1840
1865
1890
1915
1940
1975
1990
Source: Carbon Dioxide Information Analysis Center, 1999

Glossary

Carbon Sequestration generally refers to capturing carbon – in a carbon sink, such as the oceans, or a terrestrial sink such as forests or soils – so as to keep the carbon out of the atmosphere.

Emissions Trading is an economic incentive – based alternative to command-and-control regulation. In an emissions trading program, sources of a particular pollutant are given permits to release a specified number of tons of the pollutant. The government issues only a limited number of permits consistent with the desired level of emissions. The owners of the permits may keep them and release the pollutants, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold or traded gives the owner an incentive to reduce their emissions.

Environmental Equity or environmental justice refers to the environmental protection for all citizens so that no segment of the population, regardless of race, ethnicity, culture, or income, bears a disproportionate burden of the consequences of environmental pollution.

Global Warming is the progressive gradual rise of the earth's surface temperature thought to be caused by greenhouse effect and responsible for changes in global climate patterns.

Grandfathering of emissions permits is a method by which permits for greenhouse gas emissions may be allocated among emitters and firms in a domestic emissions trading regime according to their historical emissions. Supporters of this method os emissions trading assert that this would be administratively simple but some critics argue that this method would reward firms with high historical emissions and unfairly complicate entry into markets by new firms and emitters.

Greenhouse Effect is the progressive, gradual warming of the earth's atmospheric temperature, caused by the insulating effect of carbon dioxide and other greenhouse gases that have proportionately increased in the atmosphere. The greenhouse effect disturbes the way the earth's climate maintains the balance between incoming and outgoing energy by allowing short-wave radiation from the sun to penetrate through to warm the earth, but preventing the resulting long-wave radiation from escaping back into the atmosphere.

Greenhouse Gases include the common gases of carbon dioxide and water vapor, but also rarer gases such as methane and chlorofluorocarbons (CFCs) whose properties relate to the transmission or reflection of different

types of radiation. The increase in such gases in the atmosphere, which contributes to global warming, is a result of the burning of fossil fuels, the emission of pollutants into the atmosphere, and deforestation.

IPCC *Intergovernmental Panel on Climate Change*. Widely regarded as the most authoritative international voice on the science and impacts of climate change. Established by governments under the auspices of the World Meteorological Organization and UN Environment Programme (UNEP) in 1988, the IPCC produces five-yearly reports assessing the state of scientific knowledge on climate change which represent the international consensus among the hundreds of experts involved. Its Third Assessment Report was finalised in 2001. The IPCC has also published special reports on individual issues, such as sinks.

Sinks Ecosystems, notably forests and oceans, which can remove carbon from the atmosphere by absorbing and storing it, thereby offsetting CO2 emissions.

UNFCCC *United Nations Framework Convention on Climate Change*. Adopted at the June 1992 'Earth Summit' in Rio de Janeiro and in force since March 1994. The Convention's ultimate objective, and that of the Kyoto Protocol and any other instruments attached to the UNFCCC, is 'to achieve ... stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [man-made] interference with the climate system.'