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Energy Use, Carbon Emissions Continue to Rise In New EIA Forecast; Industry Restructuring, Competition Help Lower Electricity Prices

Total energy consumption in the United States is expected to increase by 27 percent over current levels by the year 2020, the Energy Information Administration (EIA) announced today. Consumption is expected to be 4 percent higher than last year's estimate by 2015, the latest year covered in last year's report.

EIA's *Annual Energy Outlook 1998* also projects that higher energy consumption will be reflected in higher carbon emissions. The stabilization of carbon emissions and other greenhouse gases is the subject of international negotiations in Kyoto, Japan, from December 1 to 10, 1997. From 1990 levels, carbon emissions are likely to increase 34 percent by 2010, 40 percent by 2015, and 45 percent by 2020 (Figure 1). The number for 2010 is 5 percent higher than forecast last year.

The higher projections for both energy consumption and carbon emissions result in part from higher projected economic growth and lower electricity prices. Higher demand is projected in all sectors; however, increased demand by automobiles and other modes of travel contributes more than half the increase. The current forecast assumes higher growth in vehicle-miles traveled and slower growth in fuel efficiency for all travel modes. Higher demand in the other sectors results from lower electricity prices, slower efficiency improvements, more expansion of commercial floorspace early in the projection period, more use of traditional home-heating technologies, and higher growth in some energy-intensive industries.

Lower energy prices partially result from restructuring and competition in the electricity industry, where a 20-percent decline in average electricity prices is expected by 2020. Average electricity prices decline from 6.9 cents per kilowatthour in 1996 to 5.5 cents per kilowatthour in 2020 (Figure 2). By 2015, the projected prices are 13 percent lower than forecast in last year's *Annual Energy Outlook*. (All prices are in real, inflation-adjusted 1996 dollars.)

Restructuring is expected to provide continued impetus for operating efficiency improvements, lower production costs, and retirement of high-cost plants. Capital costs for generating equipment are also expected to decline. In addition, financial requirements for construction are expected to change, as a wider range of investors enter the competitive market.

(MORE)

EIA's analysis includes the transition to competitive prices in regions (California, New York, and New England) where plans to implement restructuring are currently in place. Restructuring actions in States without formal plans are omitted, so the projections do not represent the full impact of moving to competitive pricing. (The complete *Annual Energy Outlook 1998,* to be released next month, analyzes a fully competitive electricity market.)

Other forecast highlights

- The average minemouth price of coal is projected to decline from $18.50 a ton in 1996 to $13.27 a ton in 2020. By 2015, the price is expected to be 12 percent lower than EIA forecast a year ago, contributing to the lower electricity price projections. Recent data show a greater impact of productivity on mining cost and price than projected last year. Productivity improvements are also expected to reduce costs for Western surface mines, shifting more production to lower-cost Western mines.

- Natural gas wellhead prices are projected to be $2.54 per thousand cubic feet in 2020, up from $2.24 per thousand cubic feet in 1996. Prices are about 9 percent higher in 2015 than last year's projection, because of a lower assessment of the expansion of the resource base, higher drilling costs as indicated by more recent data, and higher projected demand for natural gas.

- The average world price of crude oil is projected to rise from $20.48 a barrel in 1996 to $22.32 a barrel in 2020. EIA projections for worldwide oil demand are higher than in last year's forecast because of higher assumed economic growth; however, the 2015 price is the same in both forecasts because of expanded production particularly from countries outside the Organization of Petroleum Exporting Countries (OPEC).

- Net oil imports are expected to provide 66 percent of oil consumption in 2020, compared with 46 percent in 1996, as a result of increasing oil consumption and declining domestic production. Crude oil production declines from 6.5 million barrels a day in 1996 to 4.9 million barrels a day in 2020. Although projected oil production in 2015 is the same as in last year's forecast, oil consumption is higher, leading to net petroleum imports that are 11 percent higher in 2015 than projected a year ago.

- Renewable sources of energy are expected to penetrate energy markets at a slower pace than previously forecast, due to electricity restructuring and increased competition with fossil fuel technologies. The assumptions for increased competition in the electricity industry tend to favor the less-capital intensive technologies over coal and baseload renewables. As a result, electricity generation from renewable resources remains relatively stable between 1996 and 2020. The slower penetration of renewable energy sources contributes to the higher carbon emissions in the current forecast.

(MORE)

Reference case projections from the *Annual Energy Outlook 1998* and an overview of the results can be accessed immediately on EIA's World Wide Web Site (http://www.eia.doe.gov). The direct Internet address is: www.eia.doe.gov/oiaf/aeo98/earlyrel.html. The overview is also available from EIA's press contact. The figures referenced above may be viewed, together with this press release, on EIA's Web Site, or they may be obtained from EIA's press contact.

The full *Annual Energy Outlook 1998* will be released on December 18, 1997. The *Outlook* includes cases that analyze the changes caused by different technology and productivity assumptions. Additional cases assume higher or lower economic growth rates and higher or lower world oil prices than those in the reference case. The forecasts in the *Outlook* assume that current legislation and regulations remain in effect.

At the time of its release, copies of the *Annual Energy Outlook 1998* will be available from the U.S. Government Printing Office 202/512-1800 or through EIA's National Energy Information Center, Forrestal Building, Washington, DC 20585, 202/586-8800. The full *Outlook*, its underlying assumptions, and more detailed, regional projections will be available on EIA's Web Site by December 19, 1997.

The report described in this press release was prepared by the Energy Information Administration, the independent statistical and analytical agency within the U.S. Department of Energy. The information contained in the report and the press release should be attributed to the Energy Information Administration and should not be construed as advocating or reflecting any policy position of the Department of Energy or any other organization.

- EIA -

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EIA-97-34

Figure 1. Carbon Emissions from Energy Use, AEO98 vs. AEO97, 1990-2020 (million metric tons)

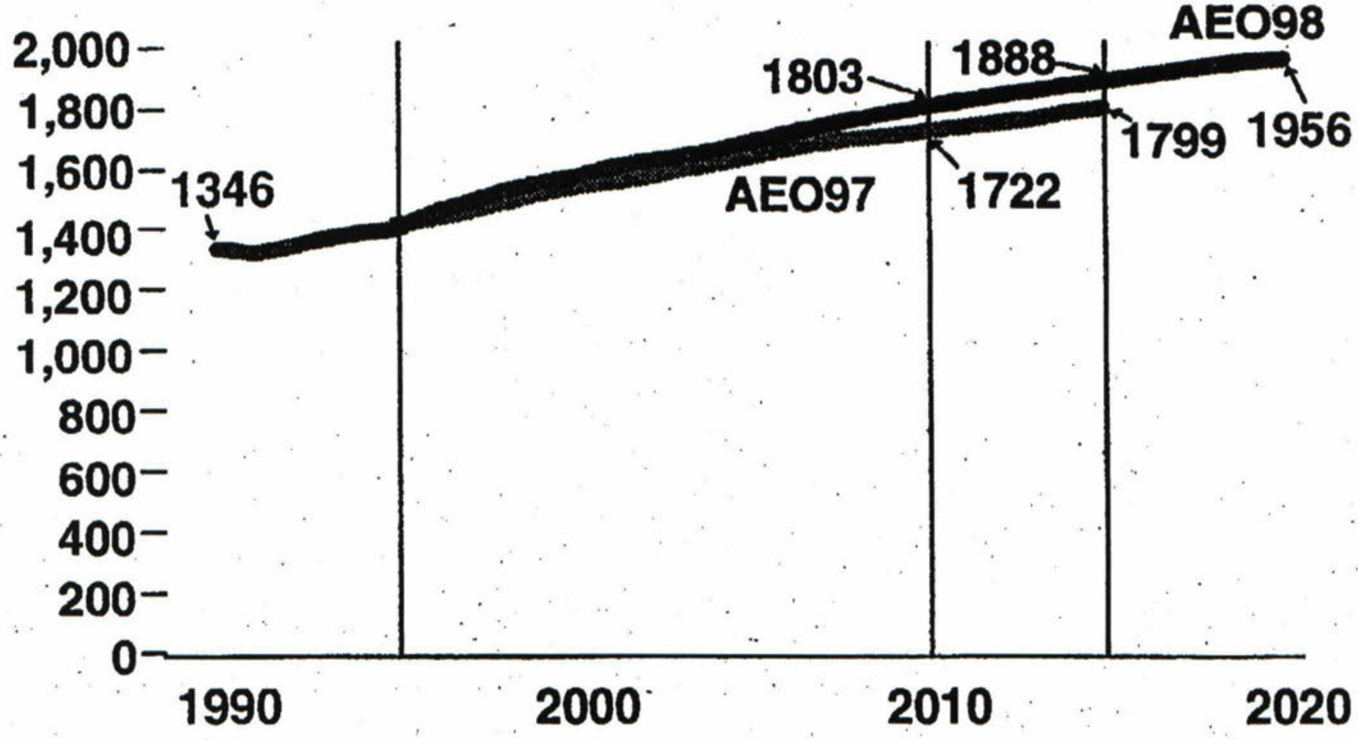
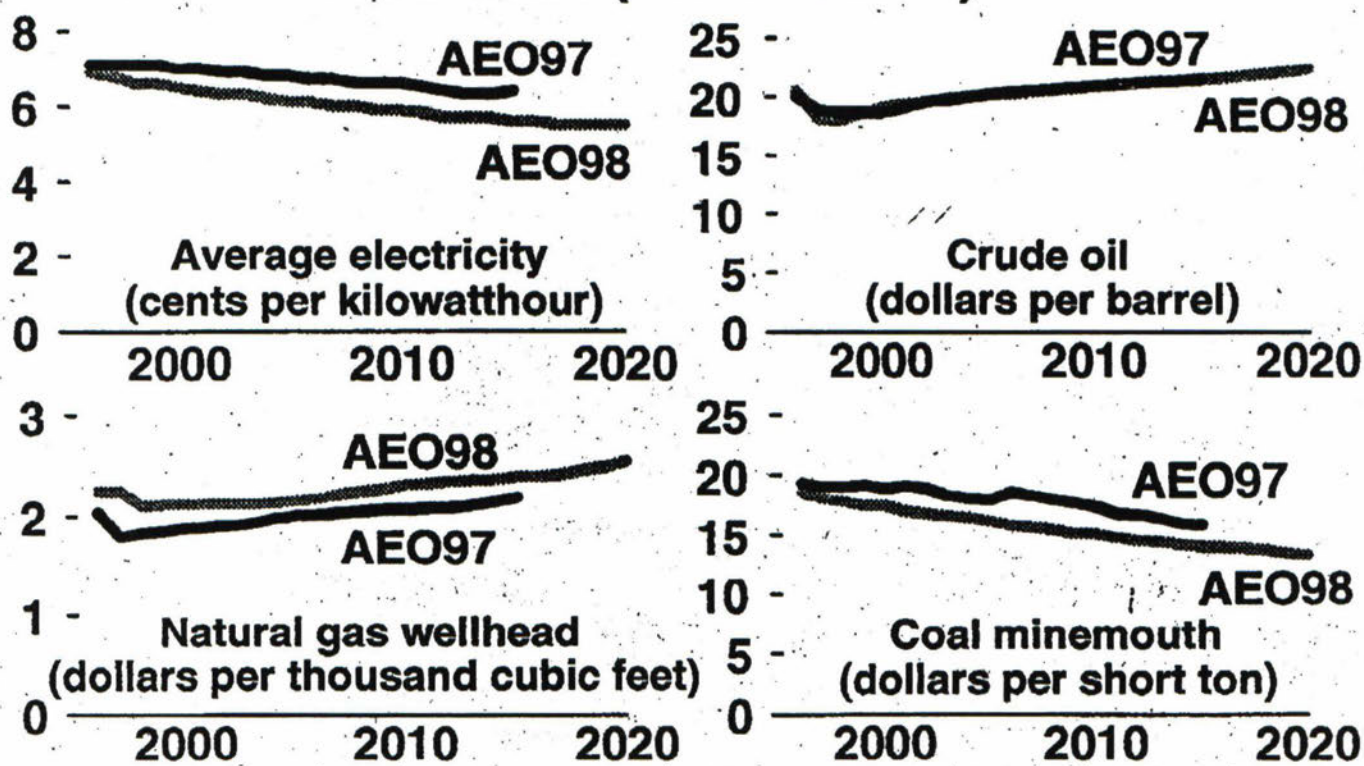


Figure 2. Fuel Prices, AEO98 vs. AEO97, 1996-2020 (1996 dollars)



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Key Issues

The *Annual Energy Outlook 1998* (*AEO98*) is the first *AEO* with projections to 2020. Key issues for the forecast extension are trends in energy efficiency improvements, the effects of increasing production and productivity improvements on energy prices, and the reduction in nuclear generating capacity.

Projections in *AEO98* also reflect a greater shift to electricity market restructuring. Restructuring is addressed through several changes that are assumed to occur in the industry, including a shorter capital recovery period for capacity expansion decisions and a revised financial structure that features a higher cost of capital as the result of higher competitive risk. Both assumptions tend to favor less capital-intensive generation technologies, such as natural gas, over coal or baseload renewable technologies.

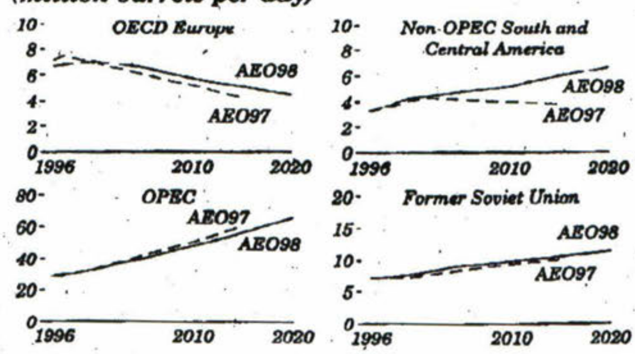
The forecasts include specific restructuring plans in those regions that have announced plans. California, New York, and New England are assumed to begin competitive pricing in 1998. The provisions of the California legislation for stranded cost recovery and price caps are incorporated. In New York and New England, stranded cost recovery is assumed to be phased out by 2008.

Prices

Average world crude oil prices in *AEO98* are projected to be similar to those in *AEO97* (Figure 1), $21.48 a barrel (all prices are in 1996 dollars) in 2015, rising to $22.32 a barrel in 2020. Worldwide demand for oil is expected to reach 116.6 million barrels per day in 2020. Because of higher assumed economic growth, the *AEO98* projection of world oil demand in 2015 is 3 percent higher than the *AEO97* projection—106.2 million barrels per day compared with 102.8 million barrels per day.

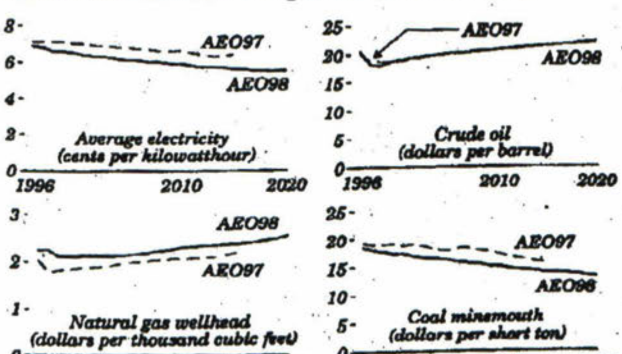
Oil production in the Organization of Petroleum Exporting Countries (OPEC) continues to expand to 2020 in the *AEO98* projections, but OPEC production in 2015 is 7 percent lower than was projected in *AEO97* (Figure 2). Partially offsetting a lower outlook for Persian Gulf production are recent offshore discoveries in Nigeria and Algeria and capacity expansion in Venezuela. It is assumed that Iraqi oil production will not exceed sanction-approved levels until after 1998 and then will increase to full capacity within a decade. OPEC production capacity expansion in the Persian Gulf is lower than in *AEO97* because of a more optimistic assessment of oil production potential and technological advances in non-OPEC countries.

Figure 2. Sources of world oil supply, 1996-2020: AEO97 and AEO98 compared (million barrels per day)



Higher expectations for non-OPEC oil production in *AEO98*, as compared with *AEO97*, maintain world oil prices at *AEO97* levels even with higher world demand. New fields in the North Sea slow the projected production decline in that area. Production in Central and South America increases, particularly in Mexico, Brazil, Colombia, and Argentina. In the oil-producing areas of the Former Soviet Union, current production increases through 2020, mostly due to the development of the Caspian Sea oil fields. Expectations for oil production in Canada and in the offshore areas of West Africa are also higher in *AEO98* than they were in *AEO97*.

Figure 1. Fuel price projections, 1996-2020: AEO97 and AEO98 compared (1996 dollars)



The average wellhead price of natural gas in *AEO98* is projected to increase to $2.38 per thousand cubic

Overview

feet in 2015 (9 percent higher than the $2.18 in *AEO97*), increasing to $2.54 in 2020. Higher price projections are the result of a lower assessment of the expansion of the oil and gas resource base, higher drilling costs as indicated in more recent data, and higher projected demand for natural gas.

In *AEO98*, the average minemouth price of coal is projected to be $13.99 per ton in 2015, 12 percent lower than the $15.84 in *AEO97*. Prices are lower in *AEO98* due to analysis of more recent data showing a greater impact of productivity on mining costs and price, regional analysis of productivity improvements that reduce costs for western surface mines, and a higher share for western coal. By 2020, the price declines to $13.27 per ton as a result of increasing productivity, a continued shift to lower-cost western production, and competitive pressures on labor costs.

AEO97 represented increased competition in electricity markets by incorporating the Federal Energy Regulatory Commission actions on open access, lower costs for gas-fired technologies, and early retirements of higher cost coal-fired plants. In addition, *AEO98* assumes lower operating and maintenance costs as indicated by recent data, lower capital costs and improved efficiency for coal- and gas-fired generation technologies, lower general and administrative costs, early retirement of higher cost nuclear units, changes in financial structure, and transition to competitive prices in California, New York, and New England (as noted above). Average electricity prices decline to 5.5 cents per kilowatthour in 2020. Because of these assumptions and lower coal prices, electricity prices are 13 percent lower than in *AEO97*—5.6 cents per kilowatthour in 2015 in *AEO98*, compared to 6.4 cents in *AEO97*.

Currently evolving legislative actions that could shape the future of the electricity industry are discussed in the "Legislation and Regulations" section of this report. An analysis of the potential impacts of competitive pricing nationwide is included in the "Issues in Focus" section.

Consumption

Total U.S. energy consumption is projected to increase from 94.0 to 118.6 quadrillion British thermal units (Btu) between 1996 and 2020. In 2015 the *AEO98* projection is 4.7 quadrillion Btu (4 percent) higher than in *AEO97*, reflecting higher projected consumption levels in all end-use sectors.

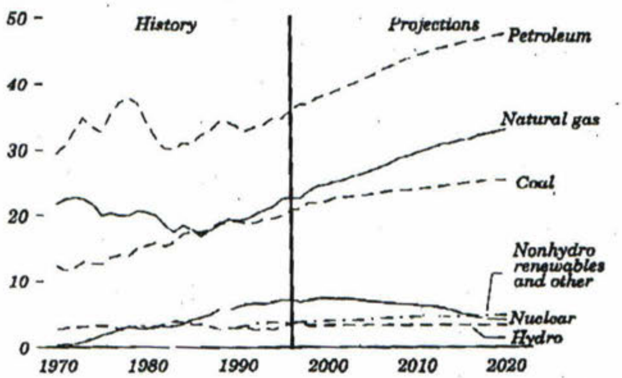
Transportation demand grows at an average annual rate of 1.6 percent through 2020 and is 2.6 quadrillion Btu (8 percent) higher in 2015 compared with *AEO97*. Recent data indicate increased light-duty vehicle travel, particularly by the older age groups and women, and slower growth in efficiency of light-duty vehicles because of continuing consumer preference for improved performance and larger vehicles over efficiency. In 2015, motor gasoline demand is 10 percent (0.9 million barrels per day) higher than was projected in *AEO97*. In *AEO98*, jet fuel demand is 17 percent higher in 2015, reflecting an ongoing trend of more air travel, combined with slower sales of the more efficient wide-body aircraft.

In *AEO98*, residential and commercial demand is higher than in *AEO97* by a total of 1.5 quadrillion Btu (4 percent) in 2015, partly as the result of lower projected electricity prices. In the absence of additional efficiency standards beyond the new refrigerator and room air conditioner standards that were issued in 1997, penetration of more efficient technologies is assumed to occur more slowly than in *AEO97*. In the residential sector, there are also more mobile homes, a more disaggregated representation of end uses, and greater use of the more traditional heating technologies (as indicated by recent data), all contributing to higher projected demand in *AEO98*. Commercial floorspace increases at a faster rate than in *AEO97* early in the projection period, contributing to higher demand in *AEO98*. Industrial sector demand is 2 percent (0.6 quadrillion Btu) higher in 2015, with higher expected growth in some of the more energy-intensive industries partially offset by more rapid efficiency improvements.

AEO98 incorporates the efficiency standards for new energy-using equipment in buildings and for motors mandated through 1994 by the National Appliance Energy Conservation Act of 1987 and the Energy Policy Act of 1992. Several alternative cases in *AEO98* examine the impacts of technology on the projections by assuming the penetration of more energy-efficient technologies in the end-use sectors beyond that projected in the reference case and, conversely, assuming slower penetration of technology improvements. Modifications to residential equipment standards are discussed in "Legislation and Regulations."

Natural gas consumption increases by an average of 1.6 percent a year (Figure 3), with increased demand in all sectors. The most rapid growth is in consumption by electricity generators (excluding cogenerators), which is projected to increase from 3.0 to 10.1 quadrillion Btu between 1996 and 2020. Total gas consumption in 2015 is 0.5 quadrillion Btu (2 percent) higher than in *AEO97*, due to higher projected consumption in the residential, commercial, and industrial sectors.

Figure 3. Energy consumption by fuel, 1970-2020 (quadrillion Btu)



Although coal-fired generation loses market share over the projection period, it accounts for more than one-half of electricity generation (excluding cogeneration). Total coal consumption increases from 20.9 to 25.6 quadrillion Btu between 1996 and 2020, an average annual rate of 0.9 percent. About 90 percent of U.S. coal consumption is used for electricity generation. Coal consumption is 5 percent (1.2 quadrillion Btu) higher than in *AEO97* in 2015, due to an increase in projected consumption for generation.

Demand for petroleum products is projected to grow by an average of 1.2 percent a year through 2020. In 2020, 72 percent of petroleum use is in the transportation sector, up from 66 percent in 1996. Increases in light-duty vehicle miles traveled more than offset the increases in vehicle efficiency throughout the projection period. Continued economic growth also increases petroleum use for air and freight travel and shipping over the forecast horizon. In 2015, total petroleum demand is 7 percent higher than in *AEO97*, due primarily to higher travel and slower efficiency improvements in the transportation sector.

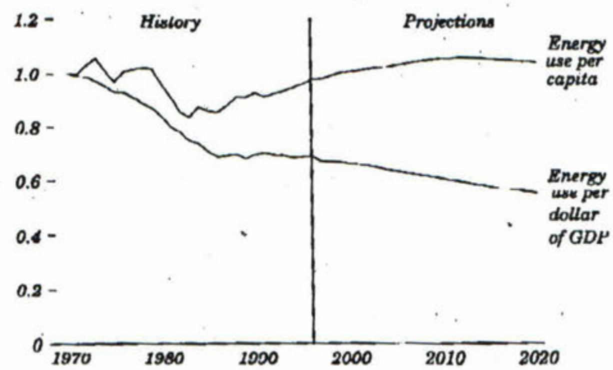
Renewable fuel use increases by an average of 0.5 percent a year. In 2020, 59 percent of the total is for electricity generation and the rest for dispersed heating and cooling, industrial uses, and blending in vehicle fuels. In 2015, renewables consumption is lower than in *AEO97* by 0.2 quadrillion Btu (3 percent) due to lower demand for renewables for electricity generation and for industrial sector cogeneration, as indicated by recent data.

Electricity consumption is projected to grow by 1.4 percent a year through 2020. Efficiency gains in the use of electricity partially offset the continued trend of electrification and the penetration of new electricity-using equipment. Compared to *AEO97*, electricity demand is higher by 0.2 quadrillion Btu (2 percent) in 2015, due to slower efficiency improvements in the residential and commercial sectors and a more disaggregated treatment of residential end uses.

Energy Efficiency

Energy intensity, measured as energy use per dollar of GDP, has generally declined since 1970, particularly during periods of rapid increases in energy prices (Figure 4). From 1970 to 1986, it declined on average by 2.3 percent a year, as the economy shifted to less energy-intensive industries and more efficient technologies. Energy intensity was relatively stable from 1986 to 1996 due to moderate price increases and the growth of more energy-intensive industries. From 1996 to 2020, intensity is projected to decline at an average annual rate of 0.9 percent.

Figure 4. Energy use per capita and per dollar of gross domestic product, 1970-2020 (index, 1970 = 1)



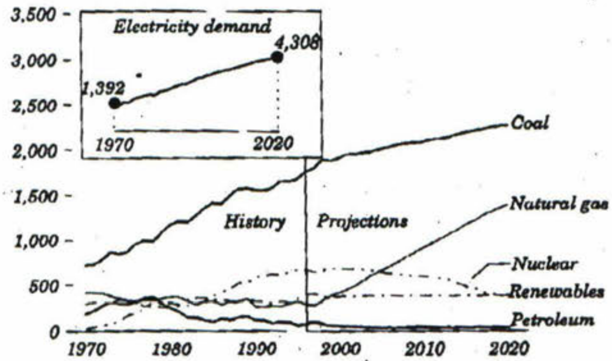
Energy use per capita, which also declined from 1970 through the early 1980s, rose in the mid-1980s as energy prices declined. Per capita energy use is expected to remain relatively stable through 2020 and below the high in the early 1970s, as efficiency gains offset higher demand for energy services.

Overview

Electricity Generation

Electricity generation from nuclear power declines significantly over the projection period (Figure 5). Of the 101 gigawatts of nuclear capacity available in 1996, 52 gigawatts (65 units) are assumed to be retired by 2020, with no new plants constructed by 2020. In *AEO97*, it was assumed that nuclear plants would be retired at the end of their 40-year operating licenses; however, *AEO98* assumes that 24 units will be retired as early as 10 years before their licenses expire. The early retirement assumptions are based on utility announcements and on analysis of the ages and operating costs of the units.

Figure 5. Energy generation by fuel, 1970-2020 (billion kilowatthours)



Generation from both natural gas and coal is projected to increase significantly through 2020 to meet increased demand for electricity and offset the decline in nuclear power. With lower coal prices, lower capital costs for coal-fired generating technologies, and higher electricity demand, the projection for coal-fired generation is higher than the *AEO97* projection. The share of coal generation declines in the *AEO98* forecast to 2020, because the assumptions concerning the restructuring of the electricity industry favor the less capital-intensive gas technologies for new capacity additions. *AEO98* also incorporates a more optimistic assessment of ultimately recoverable natural gas resources, which affects capacity expansion decisions in favor of natural gas technologies. The natural-gas-fired share of electricity generation (excluding cogenerators) more than triples, from 9 percent to 31 percent, between 1996 and 2020.

Generation from renewable energy sources remains nearly stable between 1996 and 2020. Compared with *AEO97*, renewable generation is 2 percent (6 billion kilowatthours) lower in 2015. Renewables penetrate more slowly than they did in *AEO97* due to competition with fossil fuel technologies. In addition, the shorter assumed capital recovery period for new projects weighs against more capital-intensive projects, such as coal and baseload renewables. Biomass generation is significantly lower than in *AEO97* because of lower coal prices and reduced costs for coal technologies, which compete with biomass.

In *AEO98*, hydropower, the main renewable source of electricity generation, is lower in 2020 than in 1996, primarily because regulatory actions limit capacity at existing sites and no large new sites are available for development. Generation from all other renewables increases to 2020, although at slower rates than in *AEO97*.

Production and Imports

U.S. crude oil production declines at an average rate of 1.1 percent a year between 1996 and 2020 to a projected level of 4.9 million barrels a day. Advances in oil exploration and production technologies are insufficient to offset declining resources. In 2015, projected world oil prices are the same in *AEO98* as those in *AEO97*, and domestic crude oil production is also the same at 5.2 million barrels a day. In projections of total petroleum production (Figure 6), increases in the production of natural gas plant liquids partially offset the decline in crude oil production.

Declining production and rising consumption lead to increasing petroleum imports through 2020 (Figure 7). The share of petroleum consumption met by net imports rises from 46 percent in 1996 (measured in barrels per day) to 66 percent in 2020. Comparing *AEO97* to *AEO98*, the 2015 share increases from 61 to 63 percent as a result of higher demand and stable production.

In *AEO98*, dry natural gas production is projected to increase from 19.0 trillion cubic feet in 1996 to 27.4 trillion cubic feet in 2020, an average annual rate of 1.5 percent, to meet most of the growing demand for gas. Net imports of natural gas, primarily from Canada, increase from 2.7 to 4.9 trillion cubic feet between 1996 and 2020. It is assumed that pipeline

Figure 6. Energy production by fuel, 1970-2020 (quadrillion Btu)

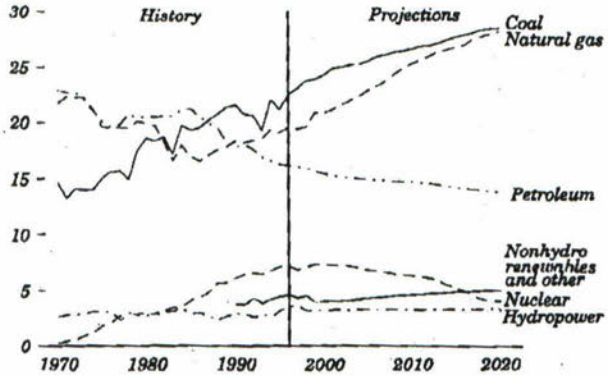
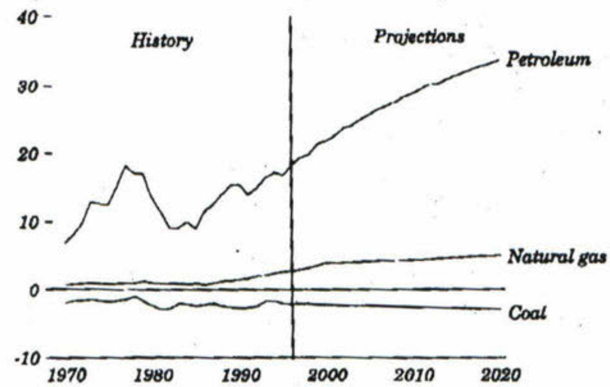


Figure 7. Net energy imports by fuel, 1970-2020 (quadrillion Btu)



capacity from Canada and pipeline utilization rates increase to encourage imports of competitively priced Canadian gas. Net imports of liquefied natural gas increase to 0.3 trillion cubic feet in 2020.

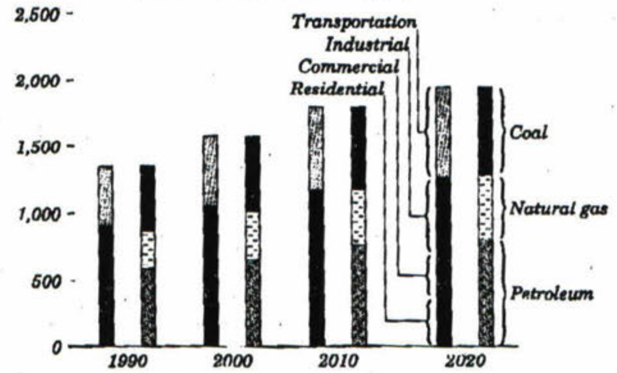
Coal production increases by an average of 1.1 percent a year, from 1,064 million tons in 1996 to 1,376 million tons in 2020, with increasing demand for domestic use and for exports. Exports of steam coal will primarily serve expanding markets for electricity generation in Asia, although exports to Europe and the Americas also increase. Total metallurgical coal exports are essentially unchanged from 1996 to 2020. In 2015, coal production in the *AEO98* projections is higher than in *AEO97* by 58 million tons (5 percent) due to increased consumption by electricity generators, which is offset slightly by a reduction in industrial demand.

Renewable energy production, including hydropower, is projected to increase from 6.9 to 7.7 quadrillion Btu between 1996 and 2020, primarily from industrial biomass, along with municipal solid waste, geothermal, wind, and biomass for electricity generation. With lower consumption in the industrial and generation sectors, the *AEO98* projection for renewable energy production is 0.2 quadrillion Btu (3 percent) lower in 2015 than in *AEO97*.

Carbon Emissions

Carbon emissions from energy use are projected to increase by 1.2 percent a year, to 1,956 million metric tons in 2020 (Figure 8). Projected emissions in 2015 are 5 percent higher than in *AEO97*—1,888 million metric tons compared with 1,799 million metric tons—due to higher energy consumption and lower penetration of renewables. About one-third of the increase from *AEO97* is attributable to increased electricity demand and the resulting increase in consumption of natural gas and coal for generation. Increased use of petroleum in the transportation sector contributes more than 50 percent of the increased emissions in *AEO98* compared to *AEO97*.

Figure 8. U.S. carbon emissions by sector and fuel, 1990-2020 (million metric tons)



The Climate Change Action Plan (CCAP) is a collection of 44 actions developed by the Clinton Administration in 1993 to stabilize greenhouse gas emissions at 1990 levels in 2000. In 1990, carbon emissions from energy use were estimated to be about 1,346 million metric tons. *AEO98* incorporates the impacts of those CCAP provisions related to carbon emissions from energy use, including the Climate Challenge and Climate Wise programs, which foster voluntary reductions in emissions by electric utilities and industry; however, projected emissions exceed 1990 levels in 2000 by 17 percent and in 2020 by 45 percent. Further discussion of carbon emissions is presented in the "Issues in Focus" and "Market Trends" sections.

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Emissions of Greenhouse Gases in the United States 1996

October 1997

Energy Information Administration
Office of Integrated Analysis and Forecasting
U.S. Department of Energy
Washington, DC 20585

Preface

Title XVI, Section 1605(a) of the Energy Policy Act of 1992 (enacted October 24, 1992) provides:

> *Not later than one year after the date of the enactment of this Act, the Secretary, through the Energy Information Administration, shall develop, based on data available to, and obtained by, the Energy Information Administration, an inventory of the national aggregate emissions of each greenhouse gas for each calendar year of the baseline period of 1987 through 1990. The Administrator of the Energy Information Administration shall annually update and analyze such inventory using available data. This subsection does not provide any new data collection authority.*

The first report in this series, *Emissions of Greenhouse Gases 1985-1990*, was published in September 1993. This report—the fifth annual report, as required by law—presents the Energy Information Administration's latest estimates of emissions for carbon dioxide, methane, nitrous oxide, and other greenhouse gases.

Executive Summary

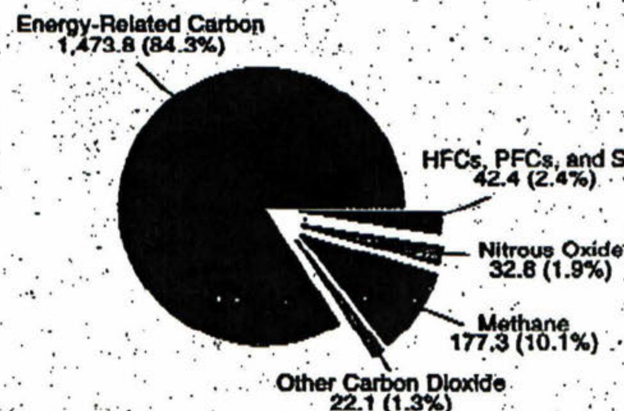
In 1996, U.S. emissions of greenhouse gases increased by 3.4 percent over 1995 emissions, the highest rate of increase in recent years. Although U.S. emissions have been growing since 1991, their growth accelerated in 1996. Greenhouse gas emissions expanded more rapidly than U.S. energy consumption in 1996, and the growth of energy consumption (up 3.2 percent) exceeded the growth of the U.S. economy (up 2.4 percent).[1] Three principal sources contributed to the growth in U.S. greenhouse gas emissions:

- Energy consumption increased more rapidly in 1996 than in recent years, buoyed by strong economic growth and unusually severe weather. Residential and commercial carbon dioxide emissions (including their prorated share of electric utility emissions) expanded by 6.3 and 5.5 percent, respectively.
- The rapid growth of relatively low-carbon natural gas consumption, which has tended to moderate the growth of total carbon dioxide emissions in recent years by "capping" high-carbon coal use, slowed as natural gas prices increased. Consequently, electric utilities met the demand for increased electricity largely with coal-fired power generation. Electric utility carbon dioxide emissions increased by 4.7 percent, divided between a 2.4-percent rise resulting from increased electricity sales and a 2.3-percent increase resulting from the use of fuels with higher carbon content.
- Estimated emissions of exotic gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride—paced by increased emissions of HFC-134a, the widely accepted substitute for chlorofluorocarbons (CFCs)—grew by more than 10 percent in 1996, though from very low levels.

Table ES1 shows trends in emissions of the principal greenhouse gases, measured in million metric tons of gas. In Table ES2, the value shown for each gas is weighted by its global warming potential (GWP), which is as a measure of radiative forcing. This concept, developed by the Intergovernmental Panel on Climate Change (IPCC),[2] provides a comparative measure of the impacts of different greenhouse gases on global warming, with the effect of carbon dioxide being equal to 1 (see "Units for Measuring Greenhouse Gases" on page 5). The GWPs for other greenhouse gases are considerably higher (see discussion in Chapter 1). Overall, GWP-weighted emissions rose by 8.3 percent between 1990 and 1996 and by 3.4 percent between 1995 and 1996. On a GWP-weighted basis, carbon dioxide emissions account for 85 percent of U.S. greenhouse gas emissions (Figure ES1). While carbon dioxide emissions are growing, methane and nitrous oxide emissions have been roughly stable.

Figure ES1. U.S. Greenhouse Gas Emissions by Gas, 1996

Million Metric Tons Carbon Equivalent



Source: EIA estimates documented in this report.

Table ES2 excludes several radiatively important gases: the criteria pollutants carbon monoxide, nitrogen oxides, and particulates, as well as CFCs and hydrochlorofluorocarbons (HCFCs). These gases have ambiguous effects on climate, which are difficult to quantify. In addition, CFCs and HCFCs are specifically excluded from coverage under the international climate treaty, the Framework Convention on Climate Change. (See Chapters 1, 5, and 6 for discussion related to the effects and emissions of these gases.)

[1] Energy Information Administration, *Annual Energy Review 1996*, DOE/EIA-0384(96) (Washington, DC, July 1997), pp. 5 and 367.

[2] Intergovernmental Panel on Climate Change, *Climate Change 1995: The Science of Climate Change* (Cambridge, UK: Cambridge University Press, 1996).

The historical emissions estimates for the years 1989 through 1995 presented in this report are only slightly revised from those in last year's report (see the box on page 2, "What's New in This Report"):

Table ES1. Estimated U.S. Emissions of Greenhouse Gases by Gas, 1989-1996
(Million Metric Tons of Gas)

Gas	1989	1990	1991	1992	1993	1994	1995	P1996
Carbon Dioxide	5,091.8	5,037.1	4,987.3	5,059.8	5,175.9	5,256.1	5,296.9	5,484.9
Methane	31.3	31.6	31.6	31.7	30.8	31.4	30.9	30.9
Nitrous Oxide	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4
Halocarbons and Minor Gases								
CFC-11, CFC-12, CFC-113	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1
HCFC-22	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HFCs, PFCs, and SF_6	*	*	*	*	*	*	*	*
Methyl Chloroform	0.3	0.3	0.2	0.2	0.1	0.1	*	*
Criteria Pollutants								
Carbon Monoxide	93.5	91.3	88.3	85.3	85.4	89.6	83.5	NA
Nitrogen Oxides	21.1	20.9	20.6	20.7	21.1	21.5	19.7	NA
Nonmethane VOCs	21.7	21.4	20.8	20.3	20.5	21.1	20.7	NA

*Less than 50,000 tons of gas. Estimated hydrofluorocarbon, perfluorocarbon, and sulfur hexafluoride emissions combined totaled 0.008 million metric tons in 1989, rising to 0.034 million metric tons in 1996.

P = preliminary data. NA = not available.

Note: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 1995*, DOE/EIA-0573(95) (Washington, DC, October 1996).

Sources: **Carbon dioxide, methane, nitrous oxide emissions:** EIA estimates described in Chapters 2, 3, and 4 of this report. **Halocarbons and minor gases:** 1990 and 1994 estimates from the U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-1994*, EPA-230-R-96-006 (Washington, DC, November 1995), pp. 46-50. Other years from EIA estimates described in Chapter 5 of this report. **Criteria pollutants:** U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emission Trends, 1900-1995*, EPA-454/R-96-007 (Research Triangle Park, NC, October 1996), Tables A-1–A-3, pp. A-2–A-16.

Table ES2. U.S. Emissions of Greenhouse Gases, Based on Global Warming Potential, 1989-1996
(Million Metric Tons of Carbon or Carbon Equivalent)

Gas	1989	1990	1991	1992	1993	1994	1995	P1996
Carbon	1,389	1,374	1,360	1,380	1,412	1,433	1,445	1,496
Methane	179	181	181	182	177	180	177	177
Nitrous Oxide	38	38	38	38	39	40	38	38
HFCs, PFCs, and SF_6	26	25	26	28	27	31	36	42
Total	**1,632**	**1,618**	**1,606**	**1,628**	**1,654**	**1,684**	**1,696**	**1,753**

P = preliminary data.

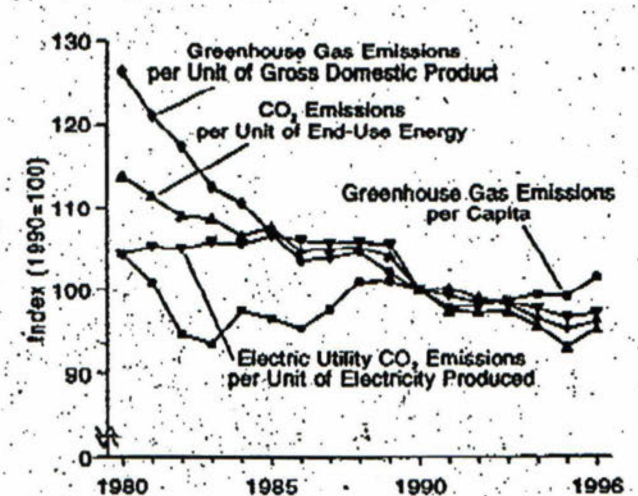
Note: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 1995*, DOE/EIA-0573(95) (Washington, DC, October 1996).

Sources: EIA estimates documented in this report.

Carbon Dioxide

Some 98.5 percent of U.S. anthropogenic carbon dioxide emissions come from the combustion of fossil fuels. Changes in carbon dioxide emissions can be traced to energy consumption trends and changes in the composition of fossil fuels burned to provide energy services. During the 1980s and early 1990s, the energy intensity of the U.S. economy and the carbon intensity of U.S. energy consumption steadily declined (Figure ES2).

Figure ES2. Emissions Intensity of U.S. Gross Domestic Product, Population, Energy Use, and Electricity Production, 1980-1996



Sources: EIA estimates documented in this report.

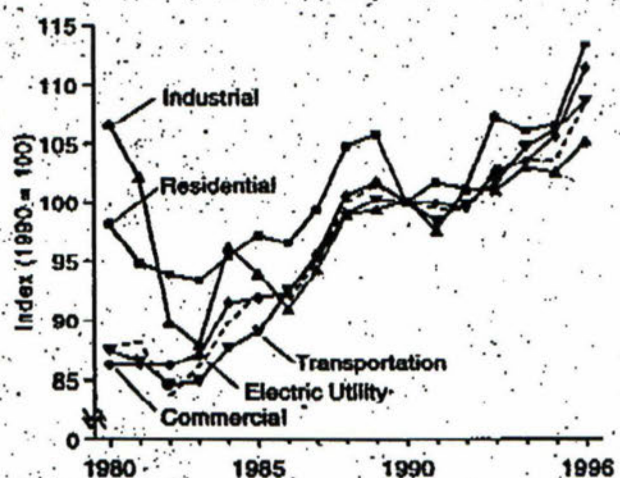
Several unrelated factors caused the decline:

- The deregulation of the natural gas industry bore fruit in the form of greatly increasing gas supplies at low prices. Natural gas use expanded rapidly in the residential, commercial, and industrial sectors, accounting for much of the growth of energy consumption.
- Many events of the period—including the Gulf War, the oil price spike of 1990, the recession of 1991, and the vogue for utility demand-side management programs—tended to restrain the growth of energy consumption.
- Utility operators began to solve nuclear power plant operating problems and, by 1995, were able to produce 17 percent more electricity from nuclear plants than in 1990.
- With more snowfall in the Pacific Northwest, hydroelectric power generation has returned to the levels of the early 1980s. Despite widespread allocation of water to accommodate salmon, 1996 hydroelectric generation was the second highest on record.

Currently, however, the growth in nuclear power generation has leveled off, and it is unlikely that future hydroelectric generation will often match 1996 levels. World oil prices remain relatively low, and the U.S. economy is growing rapidly.

Severe weather conditions in 1996 produced a series of anomalous results: residential and commercial natural gas consumers used 7.8 percent more natural gas and 3.5 percent more electricity than in 1995, and natural gas prices increased sharply. In response to the price signals, electric utilities reduced their gas consumption by 15 percent and substituted coal. The result was a sharp increase in both total carbon emissions and emissions per kilowatthour for the electric utility sector, accompanied by rapid increases in both direct (from natural gas and heating oil) and indirect (from electricity) emissions from the residential and commercial sectors. Emissions from the industrial and transportation sectors increased by a "more normal" 2.6 percent and 2.3 percent, respectively, in 1996 (Figure ES3).

Figure ES3. U.S. Carbon Dioxide Emissions by Sector, 1980-1996

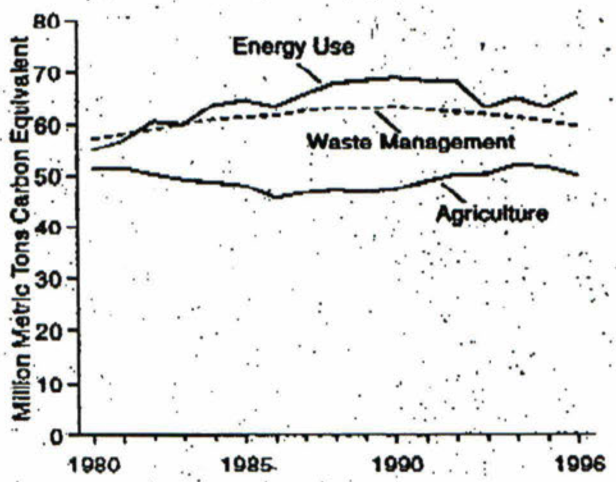


Source: EIA estimates documented in Chapter 2 of this report.

Methane

Methane emissions estimates are more uncertain than those for carbon dioxide. U.S. anthropogenic methane emissions have three principal sources: production and transportation of coal, natural gas, and oil; anaerobic decomposition of municipal waste in landfills; and raising livestock. Smaller sources include combustion of fossil fuels, rice cultivation, and industrial processes. Estimated 1996 methane emissions are unchanged from emissions in 1995 (Figure ES4).

Figure ES4. U.S. Methane Emissions by Source, 1980-1996



Source: EIA estimates documented in Chapter 3 of this report.

Note: Methane emissions from industrial sources were approximately 750,000 metric tons in 1996.

Methane emissions rose during the late 1980s. The principal cause appears to have been increased production from a group of underground coal mines with very high rates of methane emissions. Meanwhile, emissions from municipal landfills appear to have been stable, because growth in the volume of solid waste generated was offset by a growing volume of waste burned for energy recovery and by increased recovery of methane at landfill sites.

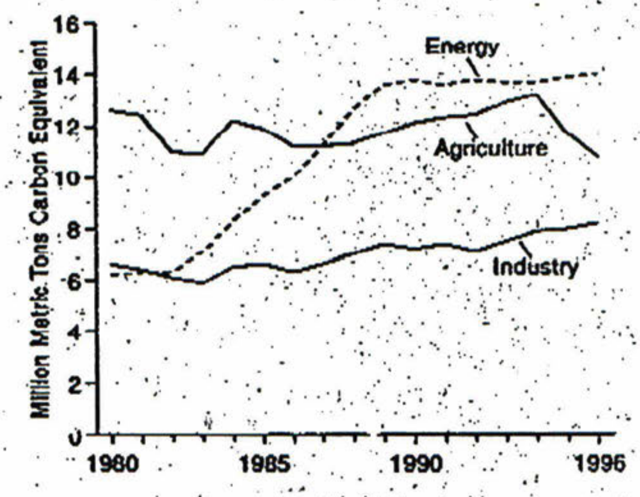
In the 1990s, several factors have tended to limit or reduce estimated methane emissions:

- The rapid expansion of recycling (particularly of paper and garden cuttings) and "waste-to-energy" plants has reduced the volume of material going into landfills. The expansion of landfill methane capture projects (both for energy and emissions control), although much slower, has reduced methane emissions from existing sources.
- Coal mine methane emissions are dominated by a relatively small group of underground coal mines. While the coal industry as a whole has been increasing output in recent years, these mines have suffered from vicissitudes particular to their locations, production economics, and the grades of coal they produce. Output from these mines does not necessarily track with national trends. Further, a number of them have introduced methane capture programs, which have also reduced emissions.

Nitrous Oxide

Nitrous oxide emissions estimates are more uncertain than estimates of methane emissions, and the uncertainty of the estimation methods makes it difficult to be confident of apparent trends. The principal sources are believed to be "excess" emissions from agricultural soils associated with fertilizer use, industrial process emissions, and emissions from combustion of fossil fuels. Nitrous oxide emissions, estimated at 0.45 million metric tons in 1996, are essentially unchanged since 1990. Declining agricultural emissions (due to reduced use of nitrogen fertilizers) have offset slowly increasing energy-related and industrial emissions (Figure ES5).

Figure ES5. U.S. Nitrous Oxide Emissions by Source, 1980-1996



Source: EIA estimates documented in Chapter 4 of this report.

Halocarbons and Related Compounds

Halocarbons and related compounds include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other compounds that act as greenhouse gases. Halocarbons have many uses, but most emissions come from their use as refrigerants in cooling equipment, as solvents, or as blowing agents and from fugitive emissions in industrial processes.

CFCs are currently being phased out because they damage the stratospheric ozone layer. The warming effects of CFCs and HCFCs are offset to some extent because they also destroy ozone, which is a potent greenhouse gas. Compounds that contain no chlorine (such as HFCs and PFCs) do not affect ozone, and their effects on climate are therefore easier to measure.

The available data suggest that emissions of CFCs—about 0.2 million metric tons in 1990—are declining. Estimated HCFC emissions (almost entirely HCFC-22, a popular refrigerant for home air conditioners) have been largely stable since 1993. There is little information about emissions of "new" HCFCs, such as HCFC-141b and HCFC-142b, which are CFC substitutes.

HFC emissions were very low—perhaps 0.006 million metric tons—in 1990. Emissions of HFC-23, a byproduct of HCFC-22 production, have also been roughly stable since 1993. Emissions of the CFC substitutes HFC-134a and HFC-152 have risen substantially in the past 3 years, from a base total of less than 0.001 million metric tons in 1990 (Figure ES6). HFC-134a became the standard automobile air conditioner refrigerant in 1994, and emissions will grow rapidly as CFCs are replaced throughout the automobile fleet. Consumption of HFC-152 is growing rapidly, but it has a relatively low global warming potential of 140.

The principal quantifiable source of PFCs is as a fugitive emission from aluminum smelting. Aluminum smelting rebounded in 1996, after declining in the early 1990s, increasing the estimated emissions of PFCs. In recent years, several PFCs have found markets in the semiconductor industry, but it has proved difficult to obtain reliable information about sales and consumption, other than that the numbers are relatively small.

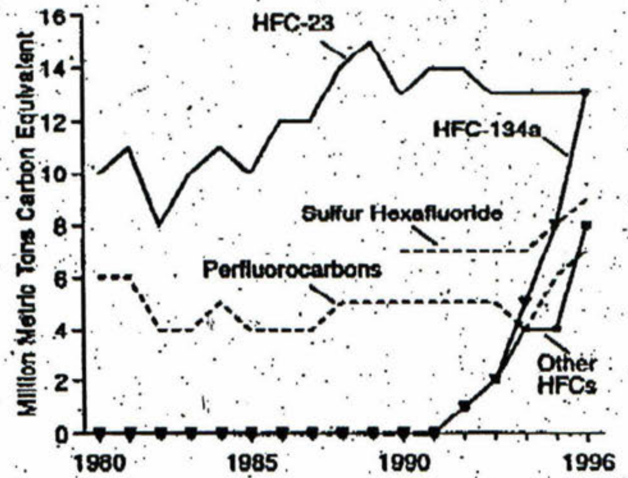
Another compound included in this category is sulfur hexafluoride, which is used primarily as an insulating gas in electrical switchgear. The amounts used are uncertain but appear to be quite small (around 1,000 metric tons per year); however, sulfur hexafluoride has an extremely high global warming potential (around 25,000), and, hence, even small emissions have disproportionate consequences.

Criteria Pollutants

Criteria pollutants (carbon monoxide, nitrogen oxides, and nonmethane volatile organic compounds) are reactive gases that usually decay quickly in the atmosphere. They are not necessarily greenhouse gases themselves, but they can promote atmospheric chemical reactions that create tropospheric ozone, which is a potent greenhouse gas. Because the ozone-creating effect of these gases varies with local atmospheric conditions, it is not possible to compute their effects directly. As precursors to urban "smog," their emissions are regulated under the Clean Air Act. The principal source of emissions of criteria pollutants is the combustion of fossil fuels, particularly in motor vehicles.

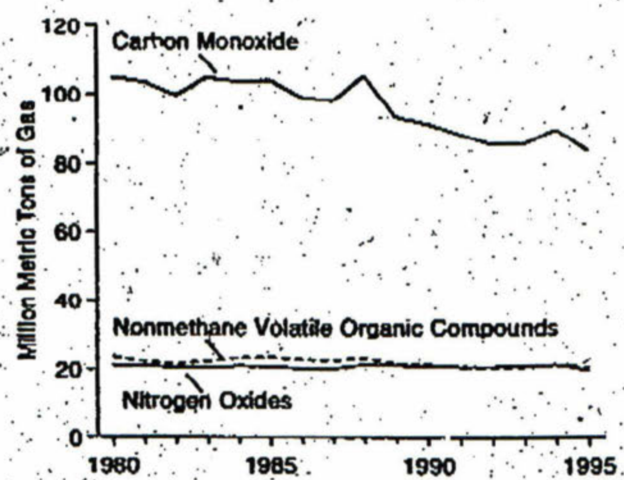
According to estimates from the U.S. Environmental Protection Agency, national-level emissions of carbon monoxide have been declining since the late 1970s (Figure ES7). Emissions of nonmethane volatile organic

Figure ES6. U.S. Emissions HFCs, PFCs, and Sulfur Hexafluoride, 1980-1996



Source: EIA estimates documented in Chapter 5 of this report.

Figure ES7. U.S. Emissions of Selected Criteria Pollutants, 1980-1995



Source: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Pollutant Emission Trends, 1900-1995*, EPA-454/96-007 (Research Triangle Park, NC, October 1996), Tables A-1–A-11, pp. A-2–A-16.

compounds and nitrogen oxides have been essentially unchanged in recent years.

Land Use Issues

Changes in land use can also have large, though difficult to quantify, effects on atmospheric concentrations of greenhouse gases. In the United States, the expansion of forest land and the growth of existing forests are responsible for removing large amounts of carbon from the atmosphere. Several studies of carbon sequestration in U.S. forests suggest that in the late 1980s and early 1990s, some 111 to 238 million metric tons of carbon was sequestered annually, equivalent to about 8 to 17 percent of U.S. anthropogenic carbon emissions.[3] However, considerable uncertainty is associated with this estimate—particularly with the amount of carbon sequestered in forest soils.

The IPCC recommends including emissions and sequestration from land use changes in national inventories, and the U.S. "National Communication" for the Framework Convention follows this practice.[4] The EIA, however, has elected not to include carbon sequestration from forestry in its "total" estimate of U.S. emissions, for the following reasons:

- There is insufficient information to determine the extent, if any, of year-to-year changes in anthropogenic sequestration of carbon. Changes in national sequestration rates can be estimated only at 5-year intervals. The current estimate is an annual average for the period 1987-1992; new data will become available in 1998, covering the 1992-1997 period.
- The magnitude of the sequestration estimate is subject to considerable uncertainty on several counts. The largest source of uncertainty is the amount of carbon sequestered annually in forest soils.

[3] R.A. Birdsey and L.S. Heath, "Carbon Changes in U.S. Forests," in L.A. Joyce (ed.), *Productivity of America's Forests and Climate Change* (Fort Collins, CO: USDA Forest Service, General Technical Report RM-GTR-271, 1995).
[4] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1993*, EPA-230-R-94-014 (Washington DC, September 1994), p. ES-7.

Domestic Cabinet Energy studies

DEPARTMENT OF ENERGY
Washington, DC 20585

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A U.S. Strategy to Reduce Carbon Emissions: Technology Research, Development and Deployment

A national commitment to energy technologies will ensure that the U.S. can reduce and stabilize carbon emissions while maintaining a robust and healthy economy. The U.S. strategy is designed to make this goal a reality through a four part plan: 1) technology research, development and deployment (RD&D) to develop new technologies and increase the use of the best of what is available today; 2) federal tax incentives to spur technology development; 3) statutory and regulatory reform to advance technology innovation and deployment in markets; and 4) actions to accelerate the use of these technologies in federal facilities and vehicles.

The technology RD&D element involves public–private partnerships and deployment initiatives. These actions require additional federal technology funding of $500 million in FY1999 - rising to $1 billion in FY2003. If successful, these actions could help reduce emissions by more than 175 MMT by 2010 and even more in later years. The specific actions are summarized below.

- *Energy Efficient Building Equipment:* Use of more efficient equipment will be accelerated through expanded "Energy Star" labeling, accelerated equipment efficiency standards and other means. Increased RD&D partnerships will cut costs and develop new technologies.
- *21st Century Housing:* Partnerships with builders, suppliers, insurers, state and local governments, and federal regulators will lead to construction of more efficient, attractive and affordable housing.
- *Expanded Partnership for the Next Generation Vehicle (PNGV)*: Increased funding of PNGV will better ensure the development of an 80 mpg mid-size car by 2005. A PNGV light trucks/sport-utility vehicle will also be developed.
- *PNGV for Heavy Trucks:* A partnership with engine manufacturers will double the efficiency of heavy-duty trucks for civilian and military applications.
- *Advanced Aircraft:* Advanced aircraft technologies and air traffic control practices will produce a 35% reduction in greenhouse gases per passenger miles traveled by 2020.
- *Biofuels:* Accelerated RD&D on energy crops, harvesting and fuel conversion processes will significantly expand use of biomass fuels for automobiles and other vehicles.
- *Combined Heat and Power:* Accelerated development of advanced turbines, fuel cells and other technologies along with streamlined permitting and other statutory and regulatory reforms will greatly accelerate use of highly efficient combined heat and power systems in industry.
- *Industries of the Future:* Enhanced industry/government research partnerships in energy intensive industries such as chemicals, aluminum, forest products and steel will produce technologies that cut emissions while improving productivity.
- *Efficient Motors and Production Systems:* Accelerated use of market-ready electric motor systems, steam systems and compressed air storage will improve efficiency, cut emissions and boost productivity across industry.
- *Renewable Energy RD&D:* Expanded research partnerships in key renewable technologies such as wind, photovoltaics, geothermal, biomass and hydropower will accelerate cost reductions and

performance improvements. Coordinated demonstrations and other deployment actions will lay the foundation for the widespread use of these zero-carbon technologies.

- *Advanced Fossil Energy RD&D:* Accelerated RD&D will enable use of coal and natural gas in highly efficient, low-emissions power plants.

- *Carbon Sequestration Technology RD&D:* Research, development and demonstration of advanced sequestration technologies that could enable the continued use of high-carbon fuels such as coal.

- *Advanced Nuclear Power R&D:* Research and development of a proliferation-resistant, low waste reactor will allow zero-carbon nuclear power to be a option for the future.

- *Basic Energy Research:* Research in materials, chemicals, biotechnology, geophysics, advanced computation, environmental and ecological sciences will establish the scientific foundation for revolutionary advances in technology necessary for substantial emissions reductions in the long term.

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Comparision of PCAST Recommendations and Draft White House Climate Technology Strategy

	PCAST Recommended Increment (v.FY98R)		Draft Strategy Budget (above FY98R): Incremental Budget $500M FY99 Level		Draft Strategy Budget (above FY98R): Recommended Budget Increment $500M FY99 Level	
	FY99	FY03	FY99	FY03	FY99	FY03
Buildings Efficiency	49	164	85	210	55	155
Building system design and operation	5	51			5	45
Building equipment and materials	20	74	45	140	25	70
Codes and standards	4	4	5	10	5	5
Cross-cutting activities	20	35	35	60	20	35
Industrial Efficiency	44	129	65	145	55	135
Industries of the future	9	54	20	60	20	60
Cross-cutting activities	32	62	30	60	25	60
Technology access	3	13	15	25	10	15
Transportation Efficiency	65	130	140	260	115	140
PNGV (I & II)	46	71	100	160	80	100
Advanced heavy vehicles	12	42	40	100	35	40
Advanced materials	4	14				
Technology deployment	3	3				
Fossil Energy (net including reductions)	33	87	50	100	50	110
Coal power	-5	-2			15	20
Coal fuels	-7	0				
Gas power	14	-8			15	25
Oil and gas production and processing	9	36				
Carbon sequestration	8	20	50	100	20	50
Methane hydrates	5	12				-10
Hydrogen production from fossil fuels	1	7				
Collaborative international R&D	1	6				5
Management, env. Restor., coop. R&D, et	7	16				
Nuclear	45	176	0	0	30	70
Life extension	-15	-15				
Proliferation-resistant reactors	50	103			30	70
Advanced light water reactors	-15	-15				
Fusion	25	103				
Renewable Energy	130	307	145	245	120	300
Biomass fuels	20	61	25	55		
Biomass power	25	55				
Geothermal	12	22				
Hydrogen	1	2				
Hydropower	3	11				
Photovoltaics	28	63				
Solar Thermal	12	27				
Wind	10	27				
Systems and storage, transmission	5	12				
Solar buildings	2	5				
International assistance	4	7				
Resource assessment and analysis	5	6				
Management, analysis, REPI, other	5	9				
Basic Energy Research	n/a	n/a	0	0	35	50
TOTAL, TECHNOLOGY ELEMENTS	366	993	485	960	460	960
Non-PCAST Items:	40	40	40	0	40	40
PNGV tax incentives						
Renewable energy tax incentives						
Industrial technology tax incentives						
Biofuels tax incentives						
Agriculture and forestry R&D			40			
Advanced aircraft R&D	40	40			40	40
TOTAL, ALL ELEMENTS	406	1033	525	960	500	1000

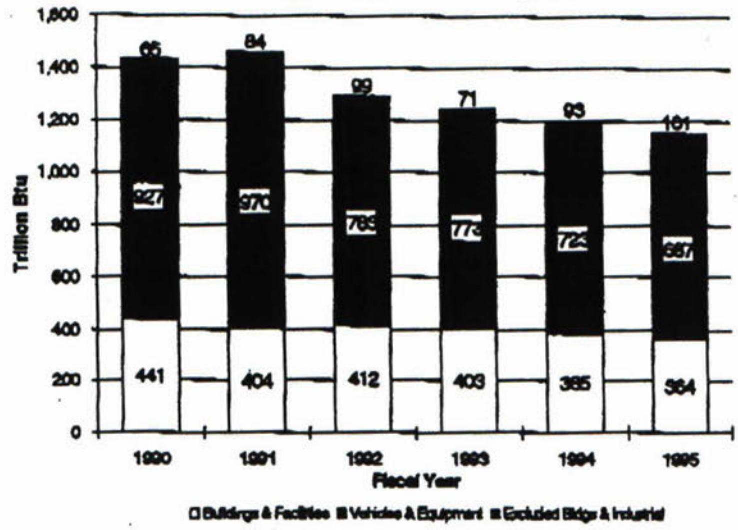
Recommended Changes to White House Draft Climate Strategy at the $500 million level:

1). Additional funding is provided for advanced natural gas and coal generation technology R&D.
2) Additional funding is provided for advanced proliferation-resistant nuclear generation technology R&D.
3) Buildings and transportation R&D are reduced slightly to make room for fossil and nuclear increases.
4) Additional funding is provided for cross-cutting R&D (e.g., industrial sensors and controls).
5) Renewable energy R&D is lowered slightly to be consistent with PCAST.
6) An increment for climate related basic energy research is added.

Federal Government Energy Management

Overview of Federal Energy Use

Figure 1
Federal Energy Consumption, 1990 through 1995



The Federal Government is the single largest energy consumer in the Nation with a widely dispersed pattern of consumption in approximately 500,000 buildings with over 3 billion square feet of floor space. Energy is also used to support vehicle mobility and industrial operations. In total, this represents 2 percent of all energy used in the United States. The cost of this energy was just under $8.0 billion in FY 1995, with $3.6 billion spent in buildings and facilities, $3.4 billion for vehicles and equipment, and $0.9 billion for energy-intensive industrial operations. Figure 1 shows a 19.6% reduction in overall government energy use since FY 1990.

Principal Federal Energy Management Goals

Federal legislation and executive orders set the following goals for energy use:

- Reduce energy use in buildings by 30 percent per gross square foot by the year 2005, compared to a 1985 baseline.
- Reduce Federal industrial energy use by 20 percent by the year 2000, compared to 1990.
- Install in Federal buildings all cost-effective energy and water conservation measures with payback periods of less

than 10 years.

- Significantly increase the use of solar and other renewable energy sources.
- Expand the use of innovative financing and contractual mechanisms such as utility incentive programs and energy savings performance contracts.
- Provide information to state and local governments and the public on beneficial energy management processes

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Progress

In FY 1995, the Government decreased energy consumption in buildings and facilities by 14.2 percent per gross square foot relative to FY 1985. The Government's annual performance toward its energy reduction goals is illustrated in Figure 2. This performance follows an earlier 16.6 percent reduction from FY 1975 to FY 1985.

Figure 2
Federal Performance Toward Building Energy Reduction Goals

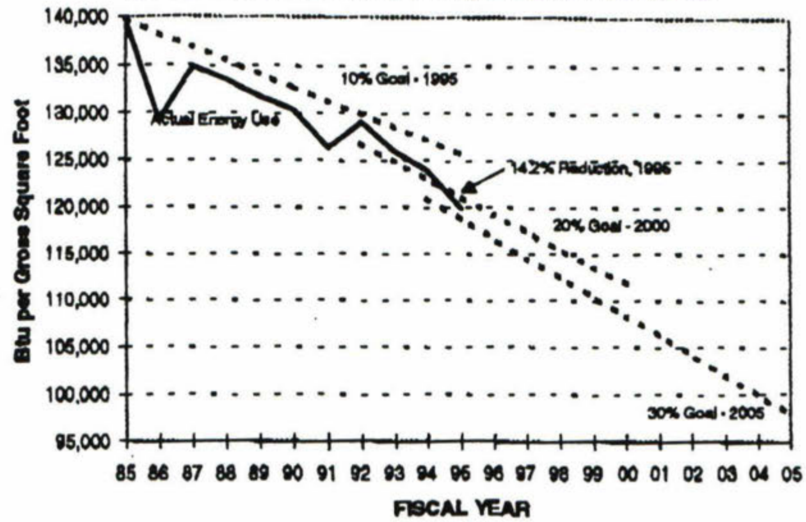
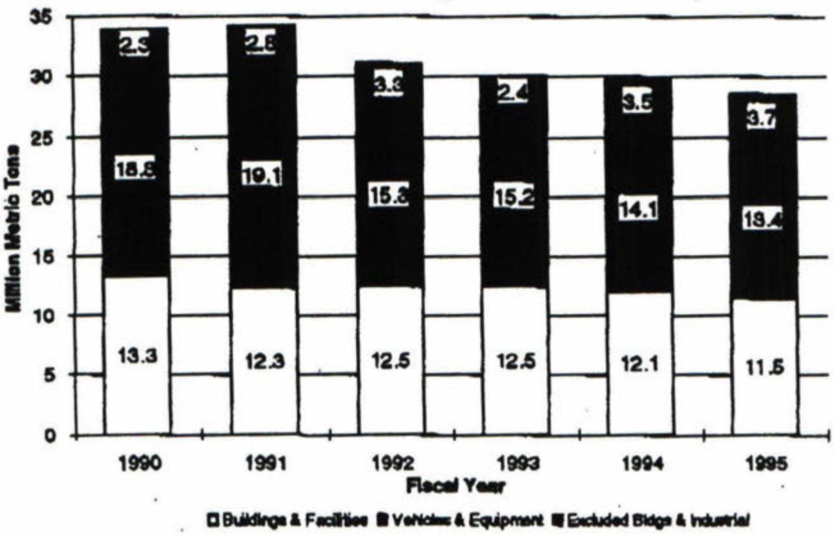


Figure 3
Carbon Emissions from Federal Energy Consumption, 1990 through 1995



From FY 1990 to FY 1995, reductions in Federal energy consumption avoided emissions of 5.2 million metric tons of carbon into the atmosphere. Figure 3 illustrates this trend for those years. When compared to FY 1985, cumulative avoidance of carbon emissions total 13.0 million metric tons.

Federal Energy Management Coordination Efforts

The Federal agencies are each responsible for management of the energy use in their own buildings and operations. Direction and coordination of this effort across all agencies is assigned to the Department of Energy's Federal Energy Management Program (FEMP) and two inter-agency coordinating bodies; the Energy Policy Committee and the Energy Management Task Force.

FEMP'S mission is to reduce the use of energy and the cost of government by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources. FEMP accomplishes its mission by leveraging both Federal and private sector resources to provide financial and technical assistance to other Federal agencies, collecting Government-wide energy consumption and cost data and reporting on the Government's progress in meeting energy reduction goals.

The Energy Policy Committee (established by the Department of Energy Organization Act) is comprised of agency principal energy conservation officers designated at the Assistant Secretary or Assistant Administrator level. The Committee meets periodically to provide policy guidance to the Energy Management Task Force. The Task Force (established by the Federal Energy Management Improvement Act) provides technical advise to the Energy Policy Committee. It establishes working groups to resolve specific technical or programmatic issues, develops new initiatives for Federal implementation, and addresses legislative requirements and other topics to improve energy management.

Agency Implementation

Each agency implements its own unique energy management plan to achieve the above energy goals. These plans generally contain the following key elements.

Project Financing—Reduced congressional appropriations for energy efficiency at Federal facilities (See table) necessitates the increased use of private sector capital to finance efficiency and renewable energy projects.

Agency	FY95	FY96	FY97	FY98 est.
Department of Defense	190	79	51	15
General Services Administration	13	7	20	0
Department of Energy	25	0	0	0

The use of private capital and expertise allows Federal facilities to accomplish energy and cost saving projects at minimal up front cost. When these projects are completed, the government and the private sector firm share the energy and cost savings. When the private sector firm is fully repaid from their share of the delivered savings, all the remaining savings accrue to the government. Agencies have issued several small contracts using these alternative financing methods. Large regional contracts recently put in place by DOE and DOD simplify the procurement process for the agencies and the energy service companies and are speeding the introduction of energy projects and cost savings at Federal facilities.

Technical Assistance—FEMP assists other agencies as they identify and implement cost-effective energy efficiency, renewable energy, and water conservation projects. Components of technical assistance include transforming the procurement process to incorporate energy efficiency, pre-screening and audit activities that lead to project development, design assistance for new construction, training for Federal energy managers, and new technology demonstrations.

Planning, Reporting, and Evaluation—Implementing Congressional and Executive Branch energy policy requires a evaluation of programs and overall agency performance in energy and cost savings and emissions reduction. In addition, communications and outreach efforts help transfer Federal energy management successes to other agencies as well as state and local governments.

Agency Energy Management—The final responsibility for the day-to-day energy efficiency operation of federal facilities, is the responsibility of the tens of thousands of Federal energy managers across the country and around the world. Ultimately, their actions deliver the energy and cost savings at the Federal sites. Each Agency needs to provide support for these managers within the agency's own organization to help them do their jobs. That support requires dedicated staff, funding and management emphasis to ensure these managers can deliver the energy and cost savings.

Continuing Challenges and Opportunities

- The use of private sector financing is currently limited to a select set of Federally owned buildings. Opportunities exist to expand its use to all buildings, vehicles, water conservation projects and to state and local government facilities.

- Current procurement of energy consuming products and appliances favors purchase of the lowest cost product without accounting for the energy expenses over the product life. Opportunities exist to lower energy use and the total cost to the government by reinventing the procurement of energy efficient products and appliances.

- Making Federal buildings energy and cost efficient requires a holistic approach to improving building envelopes, mechanical systems, and the support systems in the communities. Using sustainable technologies in design, and renovation of Federal buildings and supporting the growth of community based resources to build, operate, and maintain these systems can save energy and lower the cost of operating Federal facilities.

- Federal energy management goals have focussed on buildings and facilities while vehicle fuel efficiency has received little attention. Improving vehicle energy efficiency through medium and heavy diesel engine development, turbine engine improvements, and efficiency retrofits provides opportunities which can cut energy use and improve the mission performance of the vehicles.

Department of Energy
Recommended Federal Energy Management Activities
To Reduce Carbon Emissions

The following initiatives address the continuing challenges and opportunities in federal energy management. They will reduce emissions of greenhouse gases through enhanced focus on energy efficiency and renewable energy in the federal sector.

The initiatives address areas of Federal energy management which can:

- deliver the greatest energy savings,
- best leverage private sector funding and expertise,
- transform the Federal procurement system to stimulate the purchase of energy efficient and cost effective products,
- upgrade the performance of Federal buildings to be more energy and cost efficient,
- improve the energy efficiency and mission capability of government vehicles.

Expand Energy Savings Performance Contracting

- *Seek early reauthorization of the Energy Savings Performance Contracting (ESPC) Authority* which expires in May of 2000, pursuant to the Energy Policy Act of 1992. ESPC uses private capital and expertise to accomplish energy and cost saving projects in Federal facilities. When the private sector firm is fully repaid from its share of the delivered savings, all the remaining savings accrue to the government. Agencies have issued several small contracts using this alternative financing method. Large regional contracts recently put in place by DOE and DOD simplify the procurement process and are beginning to speed the introduction of billions of dollars of energy projects and cost savings at Federal facilities. The current authority is part of a 5 year pilot program which has demonstrated the usefulness of the ESPC approach. Early reauthorization can be combined with additional authority extending the use of this valuable contracting method to other areas which could also generate additional energy and cost savings.

- *Extend the ESPC* authority to *cover all Federal buildings* including leased buildings where the Government either pays for the energy use directly or where the Government can negotiate a reduction in lease costs based on assisting the landlord in reducing the energy cost of operating the building.

- *Extend the ESPC authority to cover mobility energy and water conservation.* Current ESPC authority allows use of these contracts only for building energy savings. Mobility energy savings are savings from more efficient energy use in aircraft, ships and vehicles and are estimated by DOE to offer savings of several hundred million dollars per year. These savings can be delivered while improving the mission capability of several classes of aircraft, ships and heavy vehicles. [DOD has expressed reluctance to support this proposal until savings can be verified by an analysis of the current situation.] Water conservation projects save energy because each gallon can contain embedded energy from pumping, heating, chilling and treatment. ESPC will be extended to such projects as low flow plumbing fixture retrofits and upgrading irrigation system efficiency.

- *Extend the ESPC authority to facilities where the Government makes indirect payment of energy expenses*. These include: state hospitals which provide utility services to adjacent Veterans hospitals; National Guard facilities which the state owns but where the Federal Government covers utility expenses; and public housing facilities which are Federally supported but owned by numerous small public housing authorities.

- *Extend ESPC to state and local government facilities*. There are two models that can deliver the benefits of ESPC to states and localities. One would allow states and local governments to access ESPC services for their facilities. Another model would provide resources for transferring the ESPC techniques to State Energy Offices which could become contracting offices for their own state and local facilities.

Reinvent Federal Procurement

- *Establish as standard practice, the purchase of energy efficient products for all Government use.* Government purchasing decisions have traditionally been based on a lowest purchase price and ignored the often tremendous savings that would accrue in energy usage and cost over the life of the more efficient product. The Federal Procurement Challenge, signed by 22 agencies in 1995, began a voluntary program to buy only those products that were in the top 25% of their class for energy efficiency or conformed to Energy Star standards. The early signs of success of this program indicate that the purchase of energy efficient products should be made standard operating procedure for all procurements. Each agency will be asked to designate a senior official charged with implementing standard energy efficient purchasing procedures and participating in the expanded Energy Efficient Products Working Group to share implementation ideas, strategies, successes and reduce barriers.

- *Accelerate the development of Product Energy Efficiency Recommendations.* These cover products that are in the top 25% of their class for energy efficiency or have Energy Star ratings. They provide a guide to Federal purchasers of the energy efficiency level to request in a specification or procurement. FEMP has developed [twenty-two(?)] recommendations for products such as [air conditioning chillers(?)]. A total of approximately 60 are planned. Accelerating the development of the remaining recommendations will allow product purchasers to save energy in their near-term product purchases.

- *Expand outreach and training efforts for Federal purchasers.* To help incorporate energy efficiency into purchasing decisions: increase the number of training courses offered, provide customized sessions with individual agencies, support better, more precise labeling in supply schedules and catalogues, and encourage manufacturers to use the 'Federal top 25%' and Energy Star labeling in their product marketing efforts.

- *Expand outreach and training to include state and local governments.* State and local governments represent a significant volume of purchasing in the U.S., nearly equal to the buying power of the Federal Government. Tools and strategies used at the Federal level will be deployed to state and local governments to expand their use of energy efficiency criteria in purchasing decisions.

- *Use consolidated purchasing to stimulate markets and lower prices.* Consolidated purchasing can lower prices and stimulate markets for new and emerging products which offer lower operating costs by providing higher levels of energy efficiency. This will benefit the Federal government, the tax payer, and the consumer by making higher efficiency products more readily available at lower price across the entire market.

Building for the 21st Century

- *Establish a new level of excellence for Federal building construction and renovation that incorporates energy efficiency, quality, affordability, and sustainability.* By using the latest construction techniques and tapping the knowledge of the building community and local partners, agencies will ensure that Federal buildings reach a level of energy efficiency consistent with the climate change demands of the 21st century. [Add 1-2 sentences of details]

- *Expand Federal leadership in deploying solar and renewable technologies in buildings*. Show Federal leadership by installing solar photovoltaic and solar thermal systems on 20,000 Federal roofs by 2010 in support of the President's 'Million Solar Roof Initiative'. Utilize alternative financing methods to provide the rapid infusion of investment necessary to support the installation of these systems. [Note: DOD owns approximately 3/4 of all Federal buildings and has not yet agreed to support the goal of 20,000 roofs proposed across all agencies.]

- *Expand the use of combined heat and power generation at Federal facilities.* Combined heat and power makes greater us of the waste heat produced in the generation of electricity. It can be applied in the Federal sector in several different ways. The use of combined heat and power could be expanded by connecting Federal buildings to existing district heating systems. Additionally, for new construction, advanced gas turbines can provide electricity and heat in Federal buildings at significantly increased efficiency.

- *Use biomass fuels in Federal boilers.* Biomass would come from agricultural and wood waste and methane from landfill and treatment plant operations. This substitution of fuels would take advantage of local renewable energy sources to displace fossil energy sources. The process will require survey and evaluation of Federal energy systems to support project development.

- *Expand public awareness of energy efficient technologies by showcasing them at National Parks, Federal offices, embassies, military bases, and other facilities.* Expand the number of energy efficient showcase projects at Federal facilities and increase the distribution of interpretive materials to stimulate replication of these energy saving projects in other Federal and non-Federal facilities.

- *Expand the role of interagency energy groups in bringing greater energy efficiency focus to the activities of Federal agencies.* There are many collaborative opportunities among agencies which can further the implementation of energy efficiency nationally. Different agencies fund training programs, provide financing for building upgrades, and provide payment of building energy expenses in low income communities. Expanding the role of the Energy Policy Committee and Interagency Energy Management Task Force and other organizations to coordinate these diverse agency activities will cut Federal energy use and expenses.

- *Increase agency budgets and staffing to expand energy management activities and complete energy efficiency projects*. In recent years the budgets for energy management in DOD, DOE and GSA have been cut by more than 90 %. These Federal appropriations can provide the lowest cost of financing for energy efficiency projects. They also provide the funding necessary for Federal energy managers to identify opportunities and undertake contracting actions using ESPCs and other private financing methods. In some agencies, where facilities are operated by contractor personnel, the energy mangers are being reassigned to non-energy jobs because there are no funds to maintain energy management positions.

Improve aircraft, ship, and heavy vehicle fuel efficiency

- *Improve the energy efficiency of Federal aircraft, ships and vehicles.* Energy use in aircraft, ships and vehicles is responsible for 43% of $8 billion Federal energy bill. This initiative would improve the energy efficiency of main propulsion systems and energy consuming auxiliary systems to reduce fuel consumption and increase operational readiness. In addition this initiative will focus on near- term energy retrofits such as lighting retrofits on ships and re-engining aircraft. The initiative would involve a partnership with the private sector including aircraft and diesel engine manufacturers. Advances under this initiative will have significant application in commercial markets. [Note: DOD has agreed to an initiative on medium and heavy diesel engine development but has not yet agreed to focus on auxiliary system efficiency.]

Domestic Studies

Energy Information Administration

EIA Reports

U.S. Department of Energy
Washington, DC 20585

EMBARGOED UNTIL 12:00 NOON
EASTERN TIME
APRIL 22, 1998

EIA Projects Strong Long-Term Growth in Asian Energy Demand Despite Recent Economic Downturn.

The Kyoto Protocol Could Alter Expected Growth in Emissions in the Industrialized World, but Worldwide Emission Levels Continue to Rise.

Worldwide energy consumption is expected to grow 75 percent between 1995 and 2020 according to the latest *International Energy Outlook 1998* (*IEO98*), released today by the Energy Information Administration (EIA). Asia enjoys robust long-term growth, in spite of the region's currency crisis which started in mid-1997 and continues into 1998. Indeed, *IEO98* expects that the Asian economic recession will not be protracted and the outlook for long-term energy use is virtually the same as projected in last year's report.

By 2020, energy use in developing Asia (including China and India, but excluding Japan, Australia, and New Zealand), surpasses that of all North America by more than 36 percent. In contrast, total energy use in developing Asia is presently 33 percent below that of North America.

Although the economic downturn in Southeast Asia has lowered expectations for near-term growth in the region, the *IEO98* still projects that almost half of the world's future increment in energy demand will be in developing Asia (Figure 1). Strong economic growth in Asia results in improved standards of living which, in turn, will mean increased use of energy for a variety of residential and commercial purposes and for personal transportation. The countries most affected by the crisis include South Korea, Indonesia, Thailand, and Malaysia, which currently account for just under 20 percent of the energy use in developing Asia.

In the developing countries, income per capita is expected to more than double between 1995 and 2020. While this increase is impressive, the developing world will still—on a per capita basis—consume less than one-fifth the energy of the industrialized world. As personal income levels have risen, the demand for personal automobiles has become an important component of consumer demand resulting in higher use of petroleum products for transportation. The potential market for developing Asia is enormous. At the end of 1997, there were an estimated 6.6 motor vehicles per thousand persons in China, as compared with 720 in the United States, 520 in Japan, and 130 in South Korea.

In addition to the Asian recession, the potential consequences of the Kyoto Climate Change Protocol represent another development that may have a substantial impact on future world energy use. The Kyoto Protocol could profoundly affect energy growth in the industrialized world. To achieve emissions targets set in the Protocol, industrialized countries may need to scale back energy demand projected for 2010 by as much as 40 to 60 quadrillion Btu—equivalent to between 20 and 30 million barrels of oil per day. The expectation is that fuel-switching opportunities, emissions trading, and other offsets would moderate actual patterns of adjustment. However, many countries will need to initiate innovative energy policies to attain the Protocol objectives. In any case, even if the Annex I countries that are parties to the Kyoto Protocol were able to achieve the proposed target reductions, worldwide emissions levels would continue to rise by 32 percent between 1990 and 2010 (Figure 2).

Under any conditions, substantial uncertainty accompanies the development of a long-term scenario for world energy supply and demand. However, several occurrences in 1997 make an assessment of energy markets even more difficult than usual. In addition to the potential impact of the Kyoto Protocol and the economic recession in Southeast Asia, developments in the world oil market have been particularly unusual. Recent world oil prices have been especially weak— with prices currently running at a ten year low, OPEC has increased oil production quotas for its members, and the United Nations has increased the amount of oil Iraq is allowed to export.

Other report highlights include:

- If world energy consumption reaches the levels projected in the *IEO98* reference case, carbon emissions will exceed 1990 levels by 44 percent in 2010, and by 81 percent in 2020. By 2010, carbon emissions in the developing world are nearly equal to those in the industrialized world; and by 2020 emissions in the developing world would exceed those of the industrialized world by 27 percent (Figure 3). Developing countries account for more than three-quarters of the world increment in emissions between 1990 and 2020. The sizable rise in emissions from developing countries is partially a result of their continued heavy reliance on coal.

- Natural gas use more than doubles over the projection period, reaching 172 trillion cubic feet in 2020 according to the *IEO98* reference case. On a Btu basis, worldwide gas consumption surpasses coal consumption by 2005. By 2020, gas demand is 11 percent higher than coal demand. Much of the increment in natural gas usage will fuel electricity generation, particularly in the industrialized world where natural gas can replace the other, relatively more carbon-intense fossil fuels. Natural gas demand is expected to grow most quickly in the world's developing countries. In Central and South America, for example, gas use grows by 7 percent annually between 1995 and 2020, where fast-paced development of the infrastructure needed to deliver natural gas to industrial consumers and electric power generators is currently underway.

- Political, economic, and environmental circumstances will be the most influential factors affecting the development of world oil markets. Uncertainties with regard to the final settlement of sanctions in Iraq, development of suitable transportation infrastructure for marketing oil from the Caspian Sea region, and the future behavior of the Organization of Petroleum Exporting Countries (OPEC) all will influence oil markets in the long-term. Over the *IEO98* projection period, OPEC increases its share of the world oil production market from 39 percent in 1996 to 52 percent in 2020.

Copies of *IEO98* are available from the U.S. Government Printing Office 202/512-1800 or through EIA's National Energy Information Center, Room 1F-048, Forrestal Building, Washington, DC 20585, 202/586-8800. The report is also available on EIA's Web Site at **http://www.eia.doe.gov/ieo98/ home.html.** The World Energy Projection System, the model used to generate the projections that appear in *IEO98*, will be available in May 1998, on EIA's Internet Web Site: http//:www.eia.doe.gov. The figures referenced above may be viewed along with this press release on EIA's Web Site or can be requested from the EIA Press Contact.

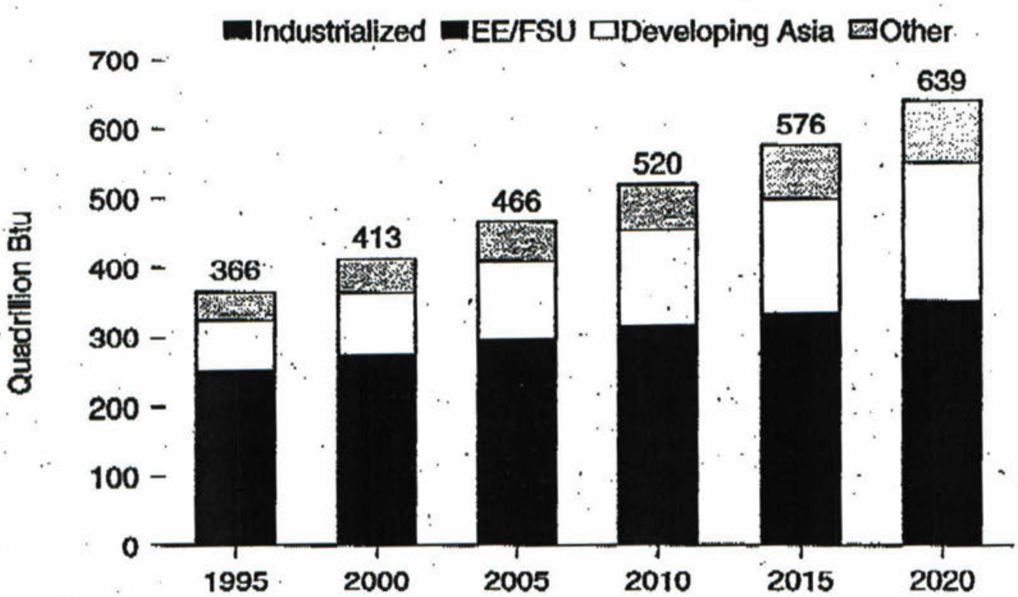
-EIA-

The report described in this press release was prepared by the Energy Information Administration, the independent statistical and analytical agency within the U.S. Department of Energy. The information contained in the report and the press release should be attributed to the Energy Information Administration and should not be construed as advocating or reflecting any policy position of the Department of Energy or any other organization.

EIA Program Contact: Mary J. Hutzler, 202/586-2222
EIA Press Contact: National Energy Information Center, 202/586-8800

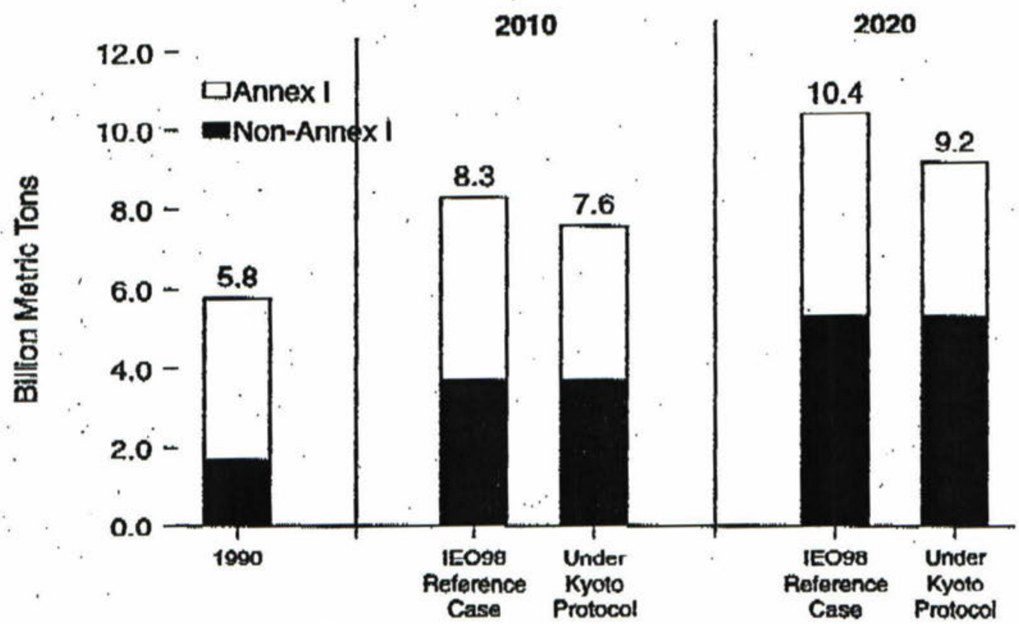
EIA-98-09

Figure 1. World Energy Consumption by Region, 1995-2020



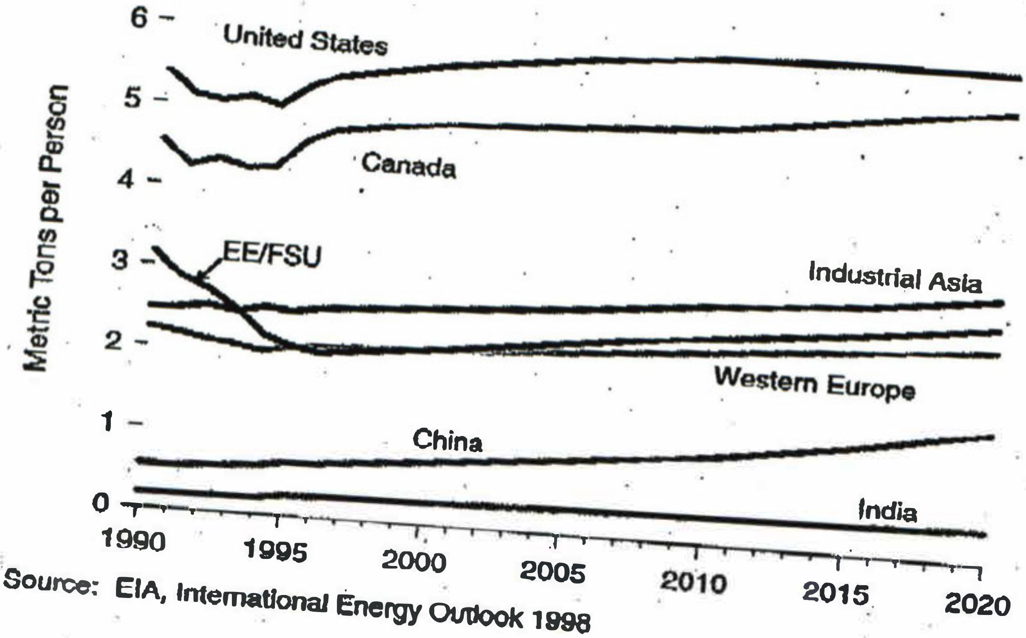
Source: EIA, International Energy Outlook 1998

Figure 2. Carbon Emissions in 1990, 2010, and 2020 in Two Cases: Annex I vs. Non-Annex I



Source: EIA, International Energy Outlook 1998

Figure 3. Carbon Emissions per Capita for Selected Regions and Countries, 1990-2020



Source: EIA, International Energy Outlook 1998

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA

U.S. DEPARTMENT OF COMMERCE

1997-98 El NIÑO
CLIMATE AND WEATHER SUMMARY

JUNE 8, 1998

NOAA/National Weather Service
National Centers for Environmental Prediction
Climate Prediction Center
NOAA/National Climatic Data Center

EL NIÑO AND CLIMATE CHANGE: Record Temperature and Precipitation

SUMMARY

The 1997/98 El Niño, one of the most significant climatic events of the century, produced extreme weather worldwide. El Niños have become more frequent and progressively warmer over the past century, and new data and analysis suggest that global warming is exacerbating the effects of El Niño. Global temperatures for January-May 1998 substantially exceed previous records.

During this latest El Niño, temperature and precipitation records were broken across the United States. Many areas suffered heavy flooding, and a series of severe tornadoes has killed 122 people so far this year, already matching the annual record set in 1984. Elsewhere around the world, El Niño contributed to major droughts and wildfire in Mexico, Indonesia and Brazil; devastating floods in South America; and massive coral bleaching from Panama to Africa to Australia's Great Barrier Reef.

Globally, 1997 was the warmest year on record. Average temperatures for January-May 1998 have since set new all-time highs. Combined land and ocean temperatures for the five-month period exceed the previous record by 0.25 C (0.45 F).

Analysis of data from the ten strongest El Niños of the past century shows that they are occurring more frequently, and that they are becoming progressively warmer. These higher temperatures tend to produce more extreme weather events. Although El Niños occur cyclically, independent of any long-term warming trend, there is observational evidence to suggest that rising global temperatures may be linked to stronger, more frequent El Niños.

THE EL NIÑO PHENOMENON

El Niño, meaning "Little Boy" or "Christ Child" in Spanish, was the name given by fishermen to unusually warm water off the West Coast of South America. El Niños occur every few years and disrupt the ocean-atmosphere system in the tropical Pacific, which subsequently affects weather around the globe. Its far-reaching consequences include increased rainfall across the southern US and Peru, which has caused destructive flooding, and drought in the west Pacific, sometimes associated with devastating fires. During El Niño, the trade winds which normally blow west towards Indonesia, relax in the central and western Pacific, allowing normally cool, nutrient-rich waters off of South America to warm significantly, leading to a decline in these fisheries. As the Pacific's warmest water spreads eastward, the hot humid air which fuels thunderstorms moves with it. El Niño changes the position of the jet stream, winds which affect the weather not only in North and South America, but as far away as Africa and Antarctica.

THE 1997/98 EL NIÑO

The 1997-98 El Niño was first noted by numerical models and scientists at NOAA's Climate Prediction Center in early spring 1997 when sea surface temperatures (SST) in the equatorial Pacific ocean began to increase. By March 1997, the SSTs were approximately 1°C (1.8°F) above normal in the extreme eastern equatorial Pacific and the vicinity of the international dateline. By May 1997, the evolution of the atmospheric and oceanic conditions in the tropical Pacific were consistent with the beginning stages of warm episode, or El Niño, conditions. Along with the increased SSTs, tropical convection began to gradually shift eastward toward the date line. Numerical models indicated that a continued warming trend in the tropical Pacific would persist through the end of the year, and that the warm episode conditions would intensify during the summer. In May 1997, SSTs greater than 29°C (84° F) were observed from Indonesia to 160°W. Equatorial SST anomalies (departures from normal) exceeded +1°C from 175°W eastward to the South American Coast, with values greater than +4°C (7.2°F) observed in the extreme eastern Pacific. These strong conditions have persisted in the tropical Pacific Ocean since June 1997. As of May 1998, strong El Niño conditions continued as SSTs remained above 28°C throughout most of the region. The latest NOAA forecasts indicate a return to near normal conditions in the tropical Pacific during the next 3-6 months. Thereafter, the NCEP coupled model indicates that near normal conditions will persist through the end of 1998.

RISING GLOBAL TEMPERATURES

The most recent near-surface land and sea-surface ocean temperatures, based on weather stations, ocean ships and buoys, and satellites indicate that global temperatures for both land and ocean during 1998 (through May) far exceed all previous record high temperatures (FIGURE 1). Land temperatures are 0.32 C (0.58° F) warmer than any previous January-through-May period. Ocean temperatures are 0.20 C (0.36 F) warmer than any previous January-through-May period. Combined land and ocean temperatures exceed the old record by 0.25 C (0.45° F).

The warmth has clearly been reflected in the US. as temperatures have averaged 4 to 6 deg F above normal throughout the Great Lakes States and the Northeast. A number of new one-day record high temperatures were set during March of this year. They include: 92 F in Connecticut, 95 F in Maryland, 92 F in Massachusetts, 88 F in Vermont, 89 F in Maine, 92 F in New Jersey, and 89 F in New Hampshire.

The record warmth is continuing through May as initial data reports show near-surface land temperatures during May exceeding the previous record set in 1994 by 0.15 C (0.27 F). Ocean temperatures also continue to remain at record high levels in May, exceeding the previous record, set just last year, by 0.15 C (0.27 F). These record high ocean temperatures are persisting despite some cooling of ocean temperatures in the Equatorial Pacific related to the beginning of the demise of the recent El Niño event.

During the past few decades, global temperatures have persistently broken previous record highs every few years, but never to the extent observed in 1998. Each month this year has set a new all-time record high global temperature (FIGURE 2). This is unprecedented and is not likely to occur in a stationary climate. New analyses of tree-rings, historical records, and other proxy measurements indicate that these temperatures are warmer than the planet has experienced for at least the last 600 years.

EL NINO AND GLOBAL WARMING

Examination of data from the ten strongest El Niño events of the Century reveals two general trends: increasing frequency of El Niño events in the past few decades, compared to what was observed earlier this Century; and rising global temperatures during these events (FIGURE 3). It can not be determined from current evidence whether El Niños are becoming more frequent or more intense as a direct result of global warming. It appears evident, however, that the effects of El Niño could be compounded by rising global temperatures. In other words, the extreme weather and climate conditions related to naturally occurring El Niño events could be exacerbated by an ongoing global warming trend. The additional heat near the Earth's surface powers the energy required to evaporate enormous amounts of water. This affects the entire atmospheric water and energy balance.

El Niño events also strongly impact regional precipitation patterns. In the United States, for example, wet conditions ordinarily occur with El Niño events in the west, south, and southeast. This year, however, conditions have been wetter than average throughout virtually the entire country. This continues the Century-long trend toward wetter conditions in the USA, and more extreme rainfall and snowfall events.

Based on records dating back to 1895, many states have broken all-time records for mean temperatures and total precipitation during the period January-May 1998 (Figure Map). During the first five months of 1998, records for total precipitation were broken in California, Maryland, North Carolina, South Carolina and Virginia. For the same time period, Idaho had its second wettest year to date, Rhode Island its third wettest, Nevada its fourth wettest, and Massachusetts, Oregon, and Pennsylvania their fifth wettest year to date. Outside of California and Arizona every state has had above average temperatures with 24 states experiencing much above normal temperatures (in the upper ten percentile). Thirteen states have had their warmest January - May period on record. Seventeen states had much above normal precipitation, nine states had both much above normal precipitation and temperature, and Maryland had both the wettest and warmest period on record to date.

While some regions experience heavy precipitation during El Niño, in others, increased global temperatures lead to conditions that are drier than normal. For example, during the past year, Indonesia and Central America have suffered droughts, which have contributed to catastrophic wildfires.

APPENDIX: JANUARY-MAY (YEAR-TO-DATE) TEMPERATURE AND PRECIPITATION RECORDS IN THE CONTIGUOUS UNITED STATES

Many temperature and precipitation records were broken in the United States during the January through May period, with several regions and 17 states setting records for precipitation and temperature for this period. The Northeast region and 13 states had the warmest January through May period on record, while the East North Central and Central regions and the states of Illinois, Indiana, Maine and Minnesota had the second warmest January through May periods on record. During the same period, the Southwest and West regions, and California, Maryland, North Carolina, South Carolina and Virginia broke records for precipitation dating back to 1985. Idaho also had the second wettest five-month period on record.

(Temperatures in degrees F, Precipitation in inches)

January-May 1998 was the wettest on record (back to 1895) for 2 regions and 5 states:

Region	1998 Value	1998 Percent of Normal	1961-90 Normal	Second Wettest Value & Year
Southeast	27.72"	134%	20.76"	27.31" in 1979
West	19.66"	218%	9.03"	19.04" in 1995

State	1998 Value	1998 Percent of Normal	1961-90 Normal	Second Wettest Value & Year
California	28.04"	228%	12.31"	27.49" in 1909
Maryland	24.55"	141%	17.39"	24.45" in 1924
North Carolina	29.20"	145%	20.08"	26.31" in 1979
South Carolina	29.98"	149%	20.17"	28.64" in 1929
Virginia	27.88"	162%	17.26"	23.30" in 1984

January-May 1998 was the second wettest on record (back to 1895) for 1 state:

State	1998 Value	1998 Percent of Normal	1961-90 Normal	Wettest Value & Year
Idaho	11.89"	134%	8.86"	12.17" in 1996

NOAA/NESDIS/National Climatic Data Center

January-May 1998 was the warmest on record (back to 1895) for 1 region and 13 states:

Region	1998 Value	1998 Dep. from Normal	1961-90 Normal	Second Warmest Value & Year
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Northeast	40.9	+5.4	35.5	39.8 in 1921

State	1998 Value	1998 Dep. from Normal	1961-90 Normal	Second Warmest Value & Year
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Connecticut	43.6	+5.2	38.4	42.8 in 1991
Delaware	50.0	+4.9	45.1	49.5 in 1991
Maryland	48.8	+4.5	44.3	48.6 in 1990
Massachusetts	41.8	+4.6	37.2	41.2 in 1949
Michigan	39.1	+6.1	33.0	38.6 in 1921
New Hampshire	37.9	+5.2	32.7	36.1 in 1953
New Jersey	47.7	+5.4	42.3	46.4 in 1991
New York	40.1	+5.8	34.3	38.9 in 1921
Ohio	46.4	+5.9	40.5	45.8 in 1921
Pennsylvania	44.5	+5.9	38.6	44.0 in 1921
Rhode Island	44.1	+4.5	39.6	43.0 in 1949
Vermont	36.9	+5.3	31.6	35.8 in 1953
Wisconsin	38.7	+7.2	31.5	37.9 in 1987

January-May 1998 was the second warmest on record (back to 1895) for 2 regions and 4 states:

Region	1998 Value	1998 Dep. from Normal	1961-90 Normal	Warmest Value & Year
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East North Central	38.5	+6.4	32.1	39.0 in 1987
Central	48.3	+4.4	43.9	49.0 in 1921

State	1998 Value	1998 Dep. from Normal	1961-90 Normal	Warmest Value & Year
-----	-----	-----------	-------	--------------
Illinois	46.6	+5.2	41.4	47.3 in 1921
Indiana	46.7	+5.3	41.4	47.1 in 1921
Maine	33.60	+4.3	29.3	33.62 in 1913
Minnesota	36.0	+7.3	28.7	37.4 in 1987

NOAA/NESDIS/National Climatic Data Center

MONTHLY CLIMATE HIGHLIGHTS

January 1998

Weather patterns only occasionally deviated from the classic El Niño structure, as Arctic air edged into the northern plains and Pacific storms hit parts of the Pacific Northwest. Frequent storminess continued across the south and east, including a powerful storm that produced flooding in the southeast and one of the worst ice storms on record in parts of New England. In terms of temperatures, arctic air was held at bay, although it occasionally reached the northern plains. Though the temperature fell to -40 F at Jordan, Mont., on the 12th, the only areas of the U.S. where monthly mean temperatures averaged below normal were across portions of Montana and southern California. Monthly mean temperatures were 10 degrees above normal across portions of the Great Basin, northern plains, Ohio Valley, and the Middle Atlantic region.

The persistent storminess lead to record breaking monthly precipitation totals at the following locations: New Orleans, LA (19.28 inches), Mobile, Ala (16.92 inches), Baton Rouge, La. (14.94 inches), Asheville, N.C. (9.96 inches), Roanoke, Va. (7.97 inches), Blacksburg, Va. (7.39 inches), and Burlington, Vt. (5.15 inches). Late in the month, an east coast storm caused beach erosion and dumped record snowfall across the central and southern Appalachians, with Flat Top, W. Va. accumulating 35.0 inches of snow in a 24-hour period on January 27-28. Elsewhere in West Virginia, 24-hour snowfall records were established at Bluefield (21.9 inches) and Beckley (31.0 inches). Storm total snowfall reached 42 inches in Ghent, W. Va. and 40 inches at Beech Mountain, N.C.

During the week of January 5-9, 1998, the eastern U.S. and eastern Canada were severely affected by a storm system with a very deep southerly flow and abundant moisture. This resulted in flooding rains from the lower Mississippi valley through the southeast and into the northeast, accompanied by several tornadoes, and a severe ice storm in parts of the northeast/New England and into Canada.

The heaviest rains and most severe flooding occurred in the mountains of North Carolina and northeast Tennessee, where up to 16 inches of rain fell in a two day period in Jackson County, N.C. Estimates indicated over 500 homes either destroyed or with severe damage in North Carolina, and over 200 homes severely damaged or destroyed in Tennessee. Tornado touchdowns produced some damage in Dublin, Ga. and Easley, S.C. Flooding also was a problem in parts of the lower Mississippi valley and upstate New York.

The severe ice storm mainly affected upstate New York, northern New Hampshire and Vermont, much of Maine, and southeast Canada. Some locations received over 3 inches of rain (in the form of freezing rain). Canada reported over 3 million utility customers without power immediately after the storm, while the northeast U.S. reported over 500,000 customers without power. In Maine, four out of five residents lost electrical service at some point during or after the storm, and nearly 3 million feet of power lines were destroyed. Overall damages were well over \$2 billion for Canada and over \$300 million for the U.S. The last U.S. ice storm to strike with this (or greater) intensity was during February 1994 in the southeast U.S.

February 1998

February was again very warm across most of the continental U.S. aided by the strong El Niño signal. Mean monthly temperatures were as much at 6-16 F above normal across portions of the northern plains. These warm temperatures resulted in many record temperatures including an average temperature of 29.1 F at Sault Ste. Marie, Mich., which was 15.1 F above normal. The only below normal areas in the contiguous U.S. were across portions of the southwest and west coast. Especially impressive was the lack of night-time cold, as temperatures remained above the 20 F mark for the entire month in Topeka, Kan. --the first occurrence since records began 102 years ago. At Madison, Wis., the month's extreme lowest daily temperature was only 11 F, which is equal to their normal daily average February minimum. Unusually cloudy weather continued across a large portion of the eastern half of the country, which acted as a night-time blanket and kept temperatures well above normal. At month's end, the water temperature of Lake Erie at Buffalo was 36 F, the highest on record for the end of the month. The only other seasons that the lake remained unfrozen were 1952-1953 and 1982-1983.

In terms of precipitation, across California and the southwest, four weeks of nearly continuous storminess resulted in widespread flooding, mudslides, and agriculture disruptions. Late in the month a shift in the weather pattern brought some of that storminess out of the southwest and into the northern plains. February precipitation records were set at nearly a dozen locations in the east and at least 19 stations in California. Santa Barbara, Calif., received an incredible monthly total of 21.74 inches, breaking the old record of 17.33 set in 1962 and establishing a record for any month. Records for that location date back to 1867.

Severe thunderstorms produced winds gusts to 104 mph in Miami, 90 mph in Hollywood, and 66 mph in Homestead on the 2nd and 3rd of the month. Over 220,000 Florida Power and Light customers were left without power, as the company said damage to its system was the worst since the "Storm of the Century" in March 1993. Another batch of severe thunderstorms spawned deadly tornadoes across central Florida on February 22-23, killing 42 people.

California Flooding

During the month of February 1998, California was struck by a series of storms due in part to the affects of El Niño. The current estimates indicate over $550 million in damages for the state, with that total expected to climb. The state also reported 17 storm-related deaths for the winter, and 35 counties were declared federal disaster areas. Clear Lake in northern California reached its highest level since 1909, flooding portions of Lakeport, about 90 miles north of San Francisco.

The west coast has dealt with severe flooding for each of the last four winters (including this year). However, the previous three winters were not significantly influenced by El Niño, thus showing that (as climatologists have pointed out in prior years) severe flooding can occur on the west coast during non-El Niño years.

Florida Tornadoes

During the late evening of February 22 and early morning of February 23, 1998, a series of tornadoes ripped across central Florida. At least one of the tornadoes reached an estimated F4 intensity. Forty-two fatalities occurred, over 800 residences were destroyed, another 700 were left uninhabitable, over 3500 were damaged to some extent, and 135,000 utility customers lost power at the height of the storms. Damages from the tornado outbreak exceeded $60 million, and Florida's overall storm damage total since last fall is approximately $500 million. Hardest hit locations in the tornado outbreak were Winter Garden, Altamonte Springs, Sanford, and Campbell. Overall, 54 of Florida's 67 counties were declared federal disaster areas due to storms over the past few months.

March 1998

March's weather featured an impressive cold outbreak (about 150 daily-record lows from March 7-13) followed by a summer-like warm spell (about 200 daily-record highs and more than 20 monthly record highs from March 22-31). The Arctic outbreak produced the coldest weather of the season in many locations across the Central and Southeastern States in an otherwise mild winter. Snow cover protected winter wheat on the central and northern Plains, but in the Southeast, tender vegetation and peach blooms were damaged by three consecutive freezes (March 11-13). March temperatures ranged from 2 to 7 F below normal on the Plains to as much as 5 F above normal in the Great Lakes and Northeastern States. Monthly readings averaged within 2 F of normal in California and the Southwest, although sharply cooler air arrived at month's end, in conjunction with a renewed series of storms.

In California, a month-long stretch without torrential rain--which allowed for recovery from the February deluge--was replaced by cold, wet conditions toward month's end. Monthly rainfall totaled more than 200 percent of normal across parts of southern California, the Southwest, and the southern Plains.

An active storm track across the Central and Midwestern States helped to provide abundant snowfall. Monthly totals of 13.6 inches in Wichita, Kan. and 12.3 inches in Norfolk, Neb. represented more than 50 percent of their respective season-to-date totals. On southern California's Mt. Laguna, the snow depth reached 19 inches on March 29. The last two weather systems also produced a wide variety of severe weather, including several tornadoes. On March 20, a total of 15 people were killed in Georgia and North Carolina. Nine days later, two people in Minnesota died in separate tornadoes.

During a 96-hour period early in the month (March 4-8), 4 to 12 inches of rain inundated parts of the Southeast. The downpours, a culmination of a 5-month wet spell, sent rivers to near-record levels in parts of Alabama, Georgia, and western Florida. Meanwhile in Virginia, a continuation of wet conditions through most of the month resulted in record January-March precipitation in locations such as Roanoke (21.17 inches; 232 percent of normal) and Richmond (19.33 inches; 193 percent).

On March 9, streaks of above-normal temperatures ended at 47 days in Moline, IL and 53 days in Milwaukee, WI. Across the Southeast, a 3-day spell of damaging cold commenced on March 11. In the East, the late-month record warmth came just a few days after a significant snowstorm. On March 22, 5.0 inches fell in New York's Central Park, boosting the season-to-date snowfall to 5.5 inches. Nine days later, the Park posted a March-record-tying high of 86 F. On the last 4 days of the month, highs soared to March-record levels in more than 20 locations. Monthly temperatures ranged from 1 to 14 F above normal in Alaska.

Serious drought continued in Hawaii through March. On Oahu, Honolulu experienced their third-driest March (0.03 inches; 1 percent of normal) and January-March (1.01 inches; 13 percent) periods on record. At the major reporting stations, 6-month rainfall ranged from 4.86 inches (28 percent of normal) in Honolulu to 16.68 inches (59 percent) in Lihue. Hilo received 37.47 inches (47 percent of normal) from October to March, but only 6.21 inches (18 percent) since January 1, 1998.

April 1998

Under the influence of a very strong southern branch of a split jet stream, below-normal temperatures prevailed from California into the Southeast. Monthly departures ranged from -2 to -5 F from California to the central and southern Plains. Meanwhile, readings averaged 2 to 7 F above normal across the Nation's northern tier. Because of the unusual warmth, some fruit trees across the Great Lakes and Northeastern States were already in bloom when more typical weather--resulting in several freezes--returned toward month's end.

The jet stream's active southern branch produced unsettled weather across California and the Southwest. Farther east, several April rainfall records were broken across the Ohio Valley and into the Southeast. At month's end, many rivers--including the middle Mississippi and lower Ohio Rivers--remained very high. In contrast, the procession of storms failed to dampen the South Central United States. The dry spell, which stretched to 6 weeks by the end of April, also affected the immediate Gulf Coast and most of Florida, although a late-month storm boosted topsoil moisture from eastern Texas to Florida.

Deadly tornado outbreaks struck on April 1, 8-9, and 16, claiming 45 lives across five Southeastern States. The last time more people died in April tornadoes was 1979. On the evening of April 8, an F5 (winds in excess of 260 mph) cut a 21-mile swath across Jefferson County, Ala., killing 31 people. Through the first 4 months of 1998, the nation's tornado toll reached 103, the highest calendar-year total since 1984, when 122 died.

During the first half of the month, several storms dumped significant snow from the Southwest to the central High Plains. In the Northeast, however, there was no April snowfall in Rochester, N.Y. for the first time since 1952. Meanwhile, record warmth developed across the Northwest. The last day of the month featured an April-record high of 90 F in Portland, Ore. Nearly all of Alaska wrapped up a third consecutive month with above-normal temperatures. Monthly departures ranged from 0 to +14 F. Drought continued throughout most of Hawaii, although significant improvement occurred in windward (east-facing) areas.

May 1998

The biggest weather story of the month was the tornadoes and severe thunderstorms which pummeled the northern Great Plains eastward across the Great Lakes states to upstate New York and New England from Saturday evening May 30th through Sunday May 31st. At 8:44pm May 30th a strong tornado, tentatively classified as an F4 on the Fujita damage scale, struck Spencer, South Dakota killing 6 persons, injuring 150 and literally destroying up to 90 percent of the town. As the storm system swept eastward during Sunday, 9 additional deaths occurred in Wisconsin, Michigan, Massachusetts and Pennsylvania due to tornadoes and severe thunderstorms. More than 34 tornadoes (preliminary estimate) occurred on Sunday across the northeastern states. Dozens of people were injured and 15 homes were destroyed in Mechanicville, New York. Winds gusted to 107 mph in Dodge County, Wisconsin, 92 mph near Grand Rapids, Michigan, and 70 to 80 mph around Minneapolis, St. Paul, Minnesota.

About the same time in the Pacific Northwest, heavy rains hit central Oregon from Thursday, May 28th through the weekend. The heaviest rains occurred in Crook, Deschutes, Wheeler, and Jefferson Counties with 7 inches near Prineville. Many small streams and rivers overflowed, resulting in the Governor declaring a state of emergency in Crook county. Fifty homes were damaged in Prineville and 400 were evacuated as water spilled over the Ochoco Dam.

The other major weather event was the fires that developed in Mexico and Central America and the resulting smoke plume which blanketed Texas and effected portions of the central part of the nation. By May 15th, 10,000 fires covering more than 6000 acres of Mexico and Central America generated enough smoke and particulate matter to trigger a health alert from the Texas Natural Resource Conservation Commission. The health alert remained in effect through May 25th.

Other significant events included heavy rains of up to 5 inches over the Midwest on May 2nd and 3rd sent roads under 4 to 5 feet of water in portions of Illinois, Indiana, Michigan, Ohio, and West Virginia. On May 7th, tornadoes struck South Carolina and North Carolina. One person was killed in Edgefield, South Carolina, crushed in their mobile home. Forty-five thousand persons were without power in Winston Salem, North Carolina, while 200 people were sent to shelters in Lincoln County, Georgia as a tornado struck near Lincolnton.

For the month of May, 10 persons were killed by tornadoes alone, not counting severe thunderstorm deaths. For the first five months of this year, 120 persons have been killed by tornadoes, compared to the long term average of 61.

Global Surface Mean Temperature Anomalies
January-May

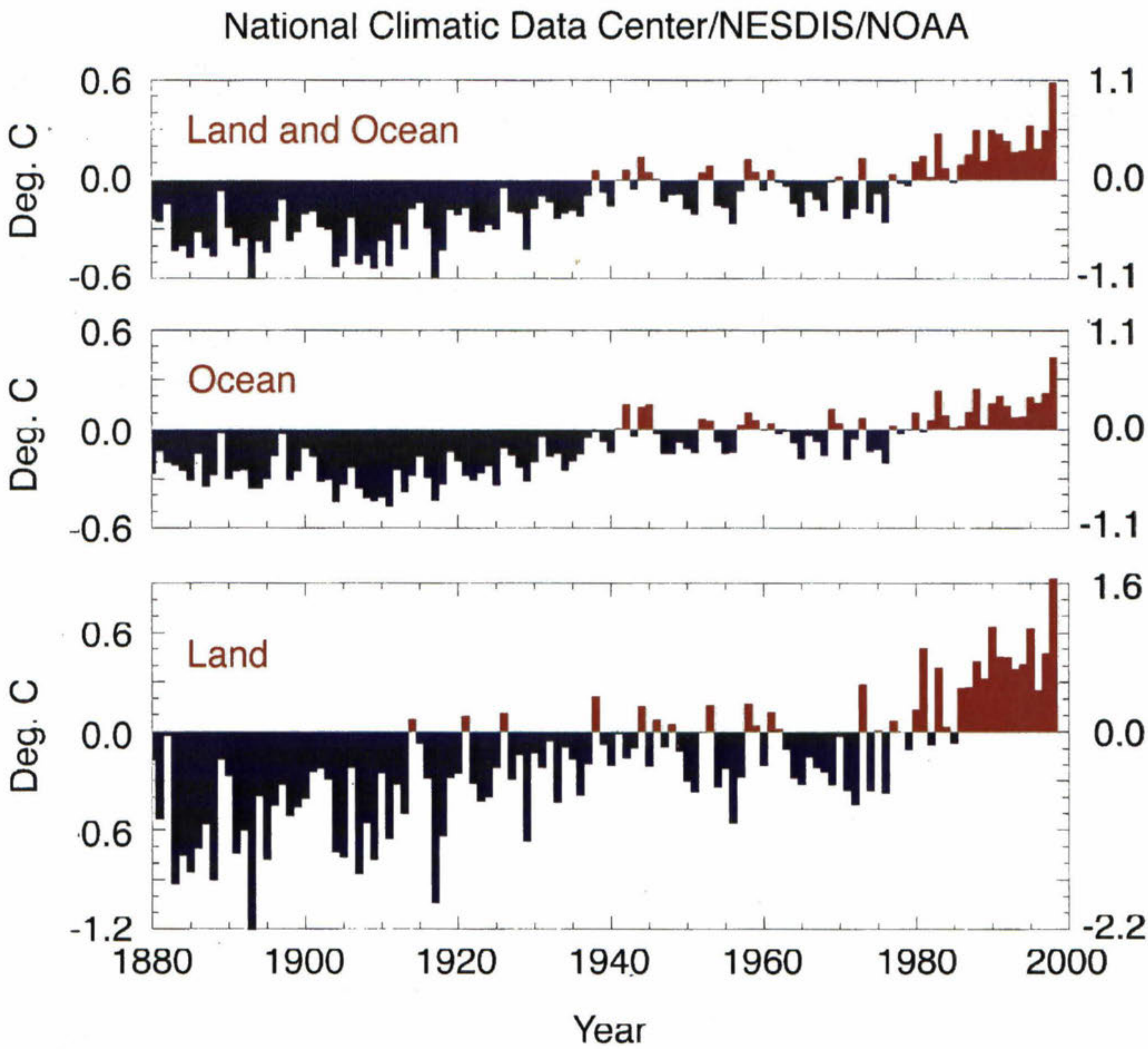


Figure 1
Global near-surface temperature deviations from the 1961-90. Average for land and ocean areas combined, and land and ocean areas separately. Data are based on weather stations, ships of opportunity and research vessels, ocean buoys, and polar-orbiting satellites.
Source: NOAA, National Climatic Data Center

Average 1998 Global Temperature vs. Previous Record for each Month Jan-May

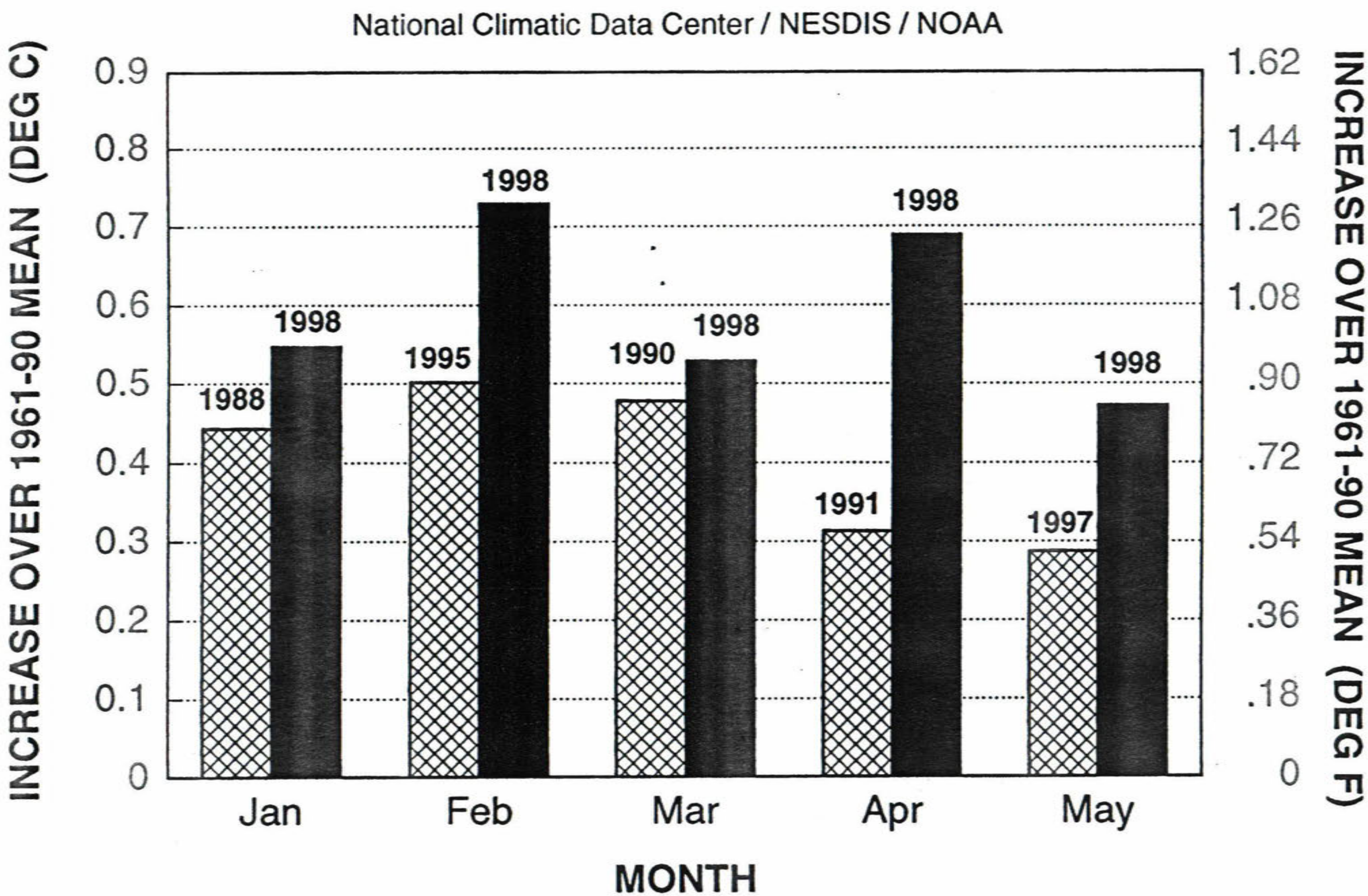
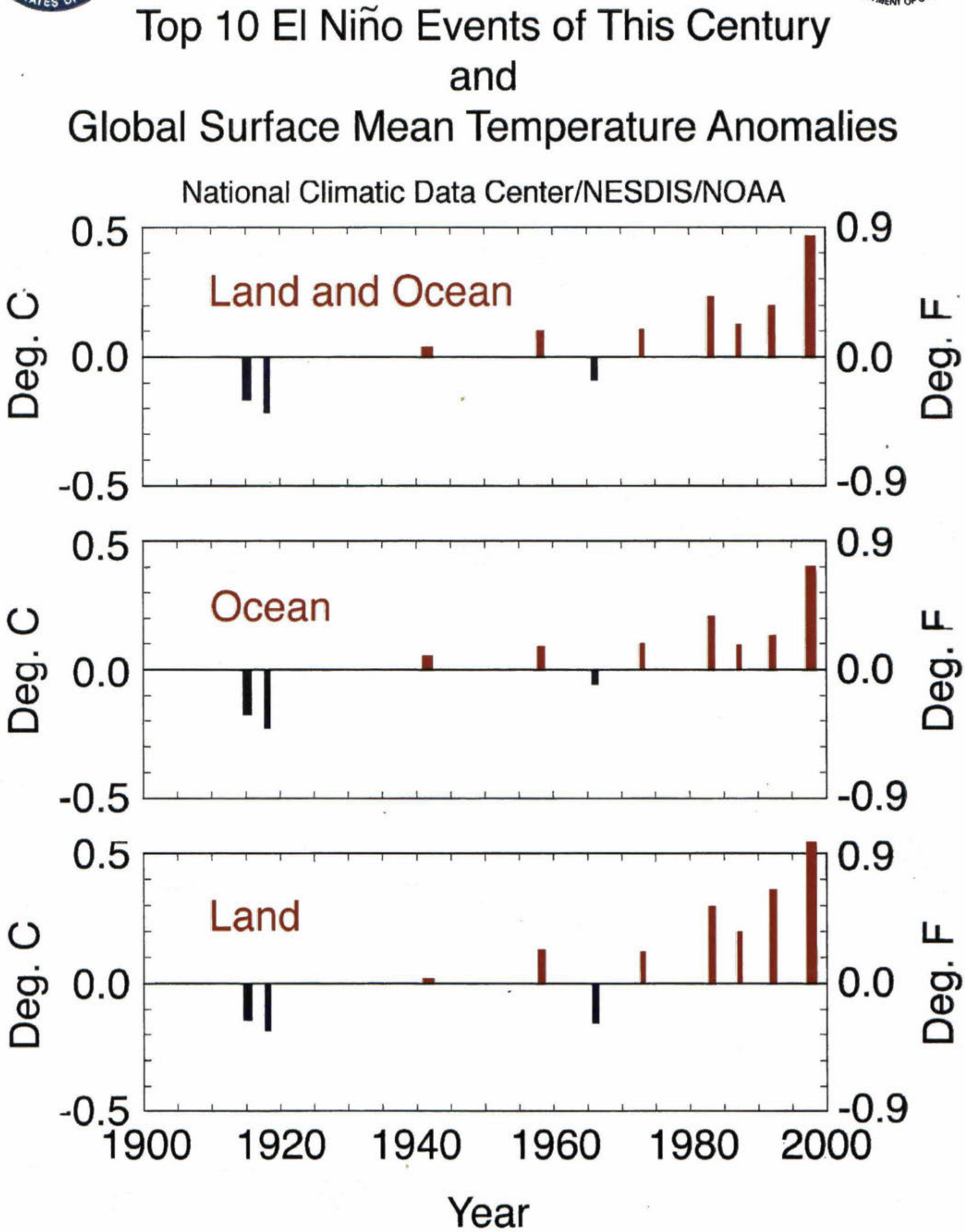


Figure 2
Month-by-month record high global near-surface temperature deviations from the 1961-90 compared to 1998 new-record high temperatures. Data are based on weather stations, ships of opportunity and research vessels, ocean buoys, and polar-orbiting satellites. Records date back to 1880.

Source: NOAA, National Climatic Data Center

Figure 3
Global near-surface temperature deviations from the 1961-90 average for the ten strongest El Niños of the Century. The shortest El Niño events persisted 6 months and the longest 15 months.
Source: NOAA, National Climatic Data Center



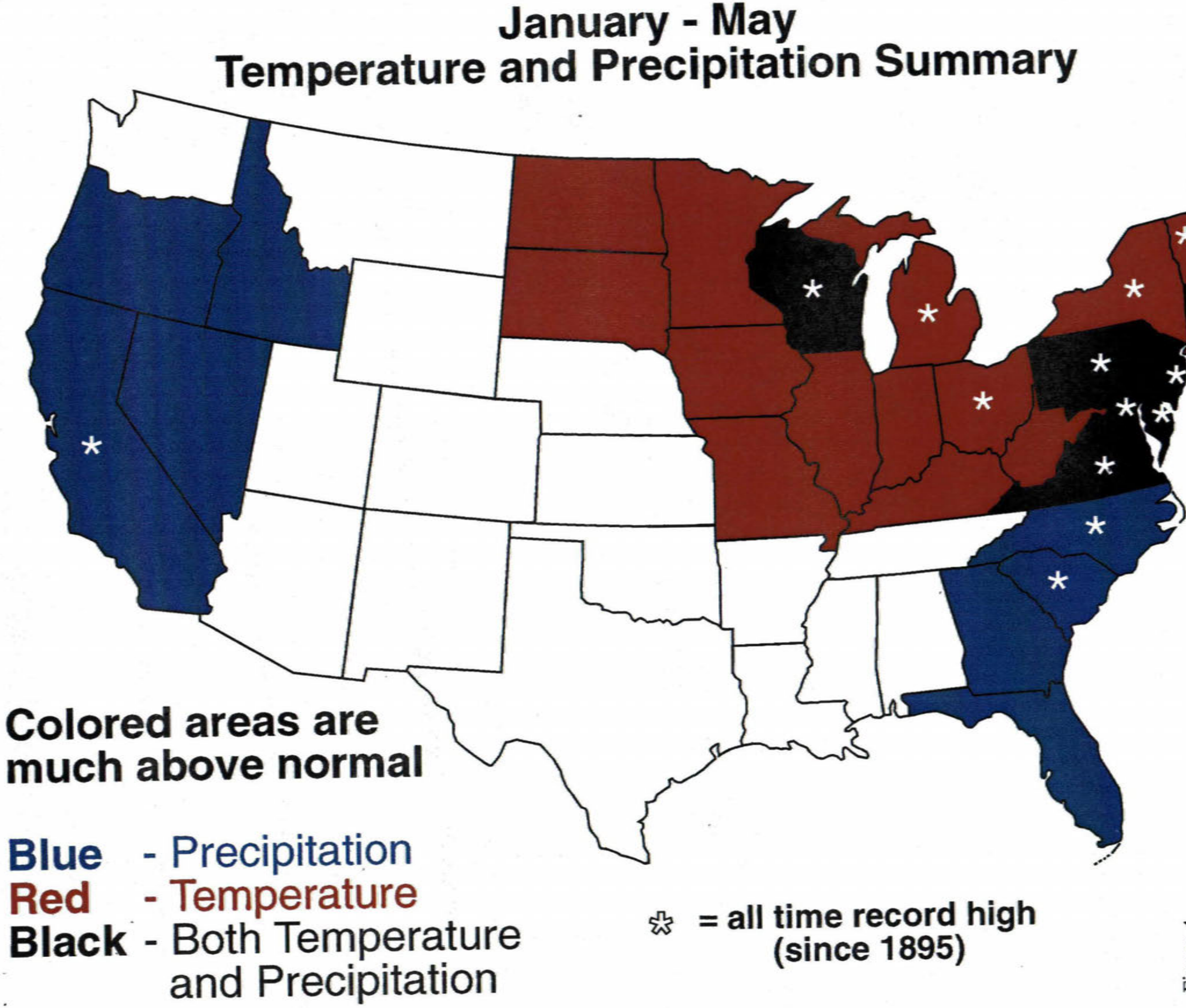
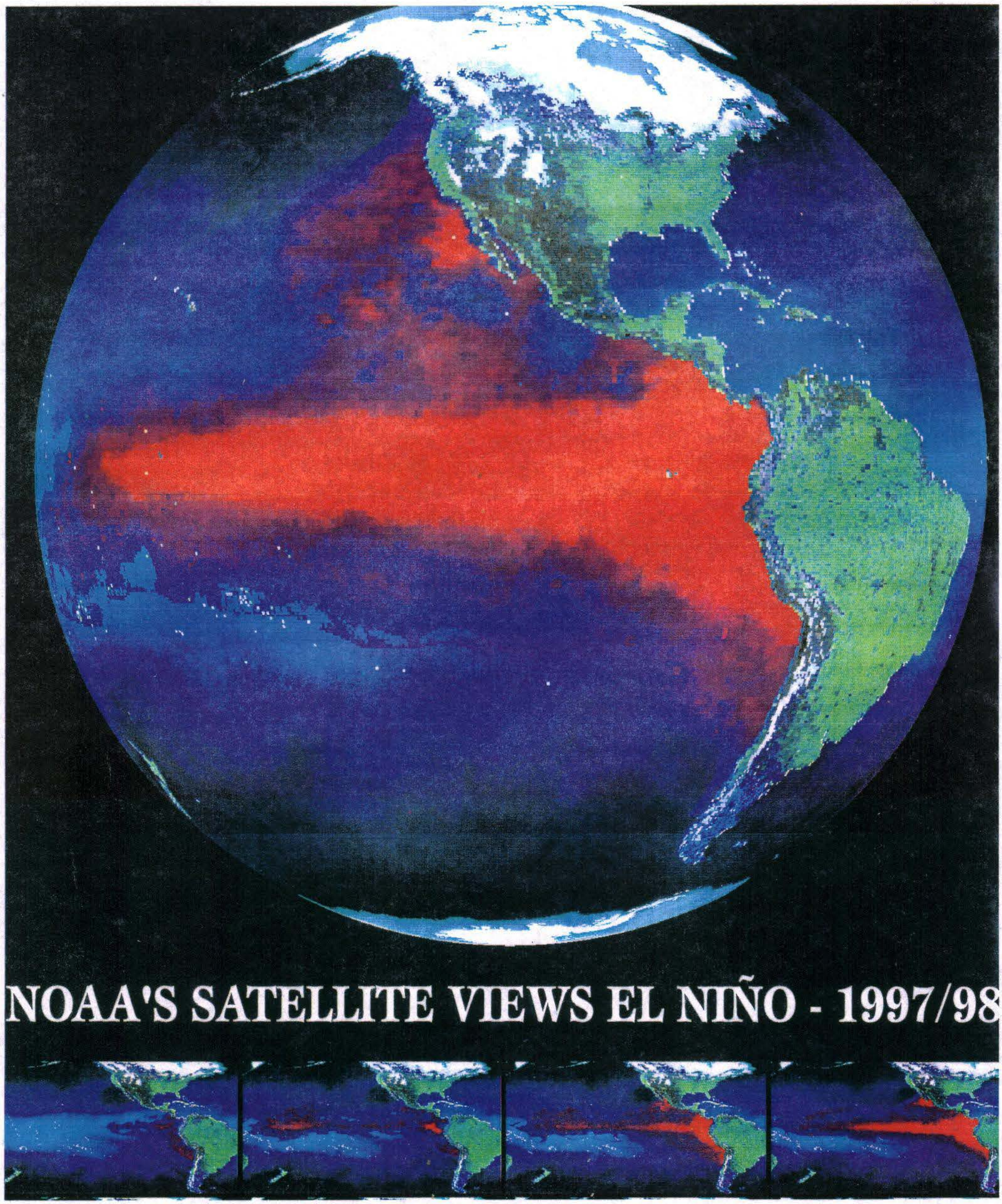


Figure 4
States that have been much above normal (in the upper ten percentiles) for period January through May 1998 are shaded: black --- for both temperature and precipitation, solid gray for temperature only, gray wavy for precipitation only. Those states with an asterisk had all time record highs for temperature or total precipitation. Maryland set all-time record highs for both precipitation and temperature. Records date back to 1895.
Source: NOAA, National Climatic Data Center


NOAA'S SATELLITE VIEWS EL NIÑO - 1997/98

National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

NOAA'S SATELLITE VIEWS EL NIÑO 1997/98

These sea-surface temperature (SST) Images were made from satellite-derived, high-resolution, sea-surface temperature anomalies using data from NOAA's polar-orbiting satellite, NOAA-14. The area depicted in red is the SST anomaly that corresponds to the El Niño "warm pool." Other regions where SSTs exceed normal levels are not highlighted in red, nor are regions shown that might be below normal.

The sequence of eight images in the lower portion of this plate show the development of the El Niño from March 10, 1997 through February 10, 1998 (at approximately 6-week intervals). Shown at the top is the October 10, 1997 image (fifth in the sequence), enlarged onto the Earth's disc of the western hemisphere. At this time, the SST anomaly is roughly twice the size of the United States, extending from the South American shoreline of Chile, northward to the west coast of the United States, and westward to the International Date Line in the mid-Pacific Ocean. At times the SSTs were as much as +9°C above normal. These extremely high temperatures during the early development of the 1997/98 El Niño are the highest ever recorded during any April-July time period.

THE WHITE HOUSE

Office of the Vice President

For Immediate Release Monday, June 8, 1998	Contact: (202) 456-7035

VICE PRESIDENT GORE ANNOUNCES RECORD GLOBAL TEMPERATURES IN THE FIRST FIVE MONTHS OF 1998

New Data Suggests That Global Warming May Be Making Effects of El Nino Even Worse

Washington, DC -- Vice President Gore today announced new data showing record global temperatures in the first five months of 1998, and a new analysis by federal scientists suggesting that global warming may be making the effects of El Nino even worse.

The Vice President released a report by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) showing that average global temperatures for January through May far exceed previous records for those months. The report also shows that over the past century, El Ninos have become more frequent and progressively warmer.

"This century is the warmest in 600 years, 1997 was the warmest year on record, and we've set new temperature records every month since January," Vice President Gore said in remarks at the White House. "This report is a reminder once again that global warming is real, and that unless we act, we can expect more extreme weather in the years ahead."

The Vice President called on Congress to approve the Administration's Climate Change Technology Initiative, which would reduce greenhouse gas emissions by providing $6.3 billion over five years for tax and research incentives to spur the development and use of energy-efficient products and clean energy technologies. The package includes tax credits for consumers who buy super-efficient cars, homes and appliances.

"Regrettably, there are those in Congress who'd rather pretend that climate change is not real," the Vice President said. "It's time for Congress to wake up to the mounting evidence and help us meet this challenge head on. The time to act is now."

The NOAA analysis examined the 10 strongest El Nino events of this century and found that they have become more frequent and warmer. During El Nino, a naturally occurring phenomenon, rising ocean temperatures in the Southern Pacific Ocean set off climatic shifts that can produce extreme heat and extreme precipitation in different regions of the world. Although it is not clear that the increasing frequency and warmth of El Ninos is a direct result of global warming, the analysis suggests that the effects of El Nino are compounded by rising global temperatures.

For the first five months of 1998, new temperature records were set in five states, and new precipitation records in 13. Temperature or precipitation, and in some cases both, were far above normal in 32 states. Tornadoes have killed 122 people this year, matching the annual record set in 1984. Elsewhere around the world, unusually warm ocean temperatures have severely damaged fragile coral reefs from the Florida Keys to Australia, and prolonged drought have contributed to thousands of wildfires in Malaysia, Brazil and Mexico.

"This El Nino gives us a taste of the extreme, erratic weather our children and grandchildren can expect more of unless we reverse the trend of global warming," the Vice President said.

The Vice President directed NOAA and the Federal Emergency Management Agency to work with other agencies in preparing a detailed review of the 1987-88 El Nino, its impacts and its costs. He also announced a new National Aeronautics and Space Administration web site (http://modarch.gsfc.nasa.gov/fire_atlas/fires.html) tracking major forest fires around the world with state-of-the-art satellite imagery.