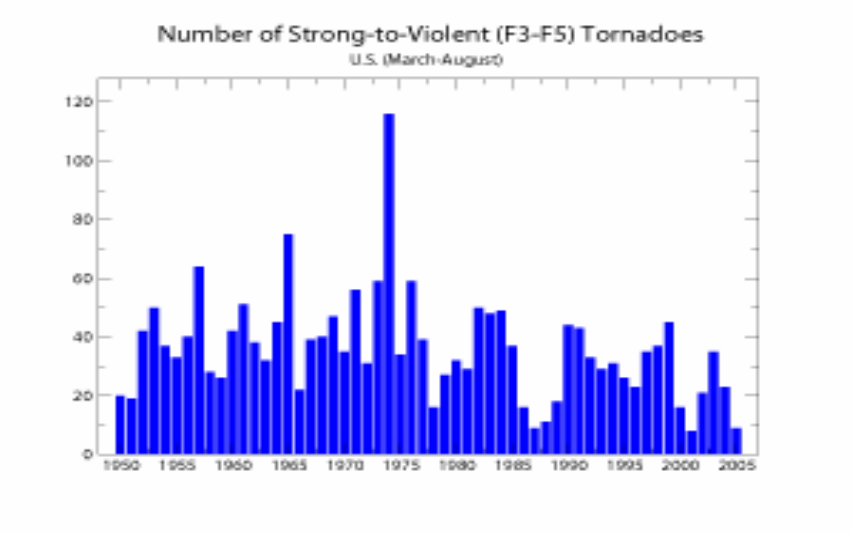
VII. Tornadoes, Floods, Fire, and Drought

> ***AIT*:** "Also in 2004, the all-time record for tornadoes in the United States was broken." (*AIT*, p. 87)

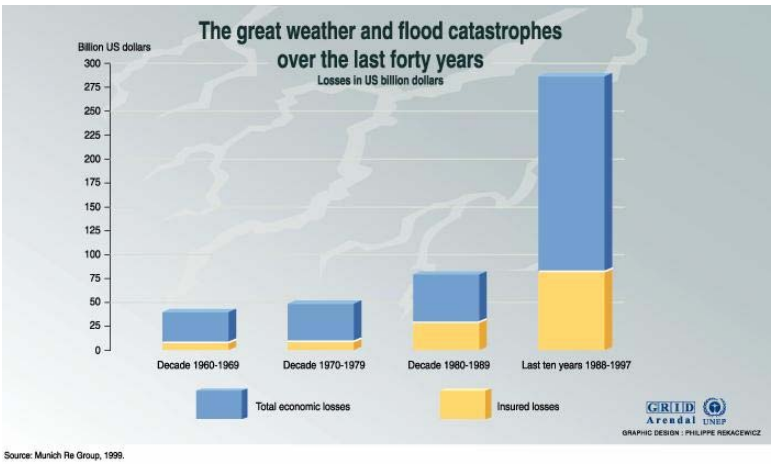
Comment: Tornado frequency has not increased; rather, the detection of smaller tornadoes has increased. If we consider the tornadoes that have been detectable for many decades (i.e. F-3 or greater), there is actually a slightly downward trend since 1950. See the Figure below.



The number of strong tornadoes has declined
Source: National Climate Data Center[1]

Oklahoma experienced its longest tornado-free period in 2003-4 (May 17, 2003-January 20, 2004), and the State had only one tornado of F2 strength or greater in all of 2004.[2] As a whole, the United States has not experienced an F5 tornado—the strongest of all tornadoes—in 7 years, the longest F5-free period in recorded U.S. tornado history.[3] Was that in spite of global warming, or because of it?

> ***AIT*:** "Over the last three decades, insurance companies have seen a 15-fold increase in the amount of money paid to victims of extreme weather. Hurricanes, floods, drought, tornados, wildfires and other natural disasters have caused these losses." (*AIT*, p. 101) Gore presents a graph similar to the Figure below.



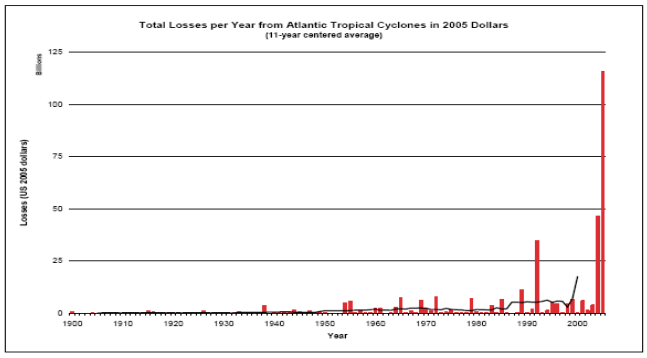
Typical chart of non-adjusted weather-related economic losses

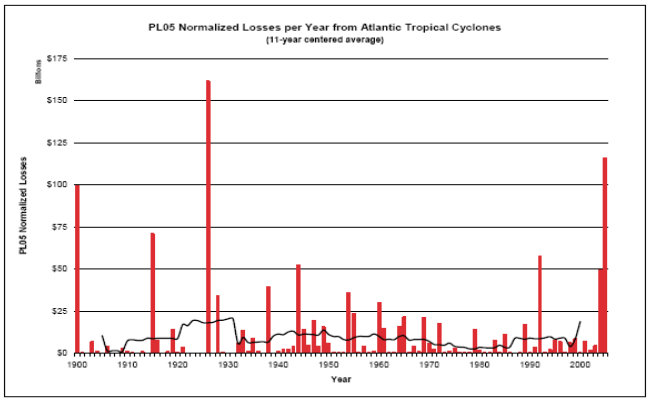
Comment: Gore does not say whether these loss estimates are adjusted for increases in population, wealth, and the consumer price index. Absent careful adjustment for societal factors, it is impossible and unscientific to infer climate trends from weather-related losses.

Kunkel et al. (1999) examined whether increases in mortality and economic losses due to extreme weather events mirrored changes in the physical magnitude of such events.[4] They concluded that "increasing losses are primarily due to increasing vulnerability arising from a variety of societal changes, including a growing population in higher risk coastal areas and large cities, more property subject to damage, and lifestyle and demographic changes subjecting lives and property to greater exposure." Other key findings include:

- Scientists cannot yet quantify the possible contribution of an increase in the frequency of heavy rain events to increases in flood-related damage.
- When hurricane losses are adjusted for changes in population, inflation, and wealth, "there is instead a downward trend."
- "Increasing property losses due to thunderstorm related phenomena (winds, hail, tornadoes) are explained entirely by changes in societal factors, consistent with the observed trends in the thunderstorm phenomena."
- "There is no evidence of changes in drought-related losses (although data are poor) and no apparent trend in climatic drought frequency."
- "There is also no evidence of changes in the frequency of intense heat or cold waves."

In a paper recently submitted for publication, Roger Pielke, Jr. and five colleagues examine the latest data on U.S. economic losses from hurricanes. They found no trend from 1900 to 2005 once the data are "normalized" for changes in population, wealth, and inflation.[5] The Figures below show non-adjusted and adjusted U.S. losses from hurricanes.





Adjust the weather-related losses for population growth, wealth, and inflation, and the warming signal disappears.
Source: Pielke, Jr. et al. (submitted, Nov. 2006)

The issue of primary concern to most people is whether mortality from extreme weather events is increasing or declining. The good news, says economist Indur Goklany, is that, despite the increase of population in high-risk areas, "aggregate mortality and mortality rates due to extreme weather events are generally lower than they used to be."[6] According to Goklany:

> Globally, mortality and mortality rates have declined by 95 percent or more since the 1920s. The largest improvements came from declines in mortality due to droughts and floods, which apparently were responsible for 95 percent of all deaths caused by extreme events during the 20th century. For windstorms, which contributed most of the remaining 5 percent of fatalities, mortality rates were also lower today but there are no clear trends for mortality. Cumulatively, the declines more than compensated for increases due to the 2003 [European] heat wave. With regard to the U.S., current mortality and mortality rates due to extreme temperatures, tornadoes, lightning, floods and hurricanes are also below their peak levels of a few decades ago. The declines for the last four categories range from 55 to 95 percent.

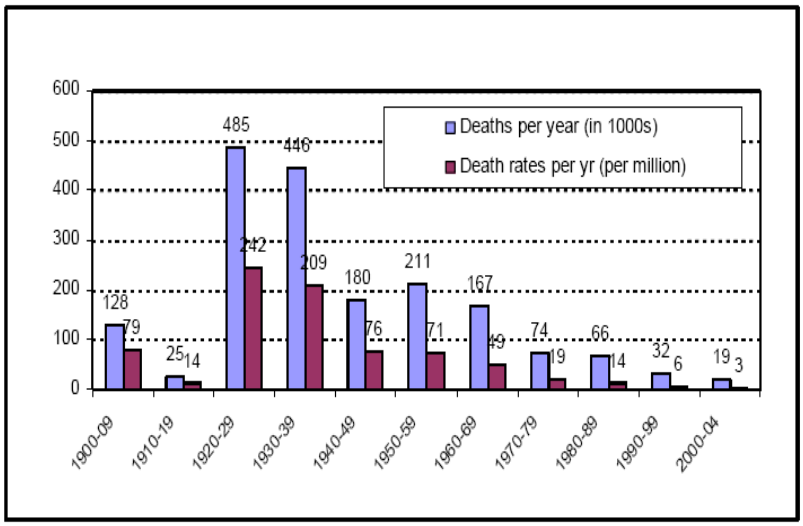


Figure 1: Global Death and Death Rates Due to Extreme Events, 1900-2004. Note that data for the last period are averaged over five years worth of data. Sources; EM-DAT (2005); McEvedy and Jones (1978); WRI (2005).

Weather-related deaths and death rates have declined dramatically. Source: Goklany

> ***AIT*:** "Warmer water increases the moisture content of storms, and warmer air holds more moisture. When storm conditions trigger a downpour, more of it falls in the form of big, one-time rainfalls and snowfalls. Partly as a result, the number of large flood events has increased decade by decade, on every continent." Gore illustrates the last point with a chart titled, "Number of Major Flood Events by Continent and Decade." (*AIT*, p. 106)

Comment: Gore's chart is based on Figure 16.5 (page 448) of the Millennium Ecosystem Assessment (MEA) report, *EcoSystems & Human Well-Being*.[7] As presented in *AIT*, the chart appears to chronicle changes in the number of "major" floods, i.e., events of a certain physical magnitude. In fact, as a glance at the MEA report reveals, what the chart measures are changes in the number of "damaging" floods. Whether or not a flood is classified as "damaging" is heavily influenced by socioeconomic factors. As the MEA report explains: "Only events that are classified as disasters are reported in this database. (An event is declared a disaster if it meets at least one of the following criteria: 10 or more people reported killed; 100 or more people reported affected; international assistance was called; or a state of emergency was declared (OFDA/CRED 2002)."

Obviously, the database is going to be skewed toward more events in later decades, simply because of better reporting, more declared states of emergency, and more calls for international assistance. As the MEA report observes: "Figure 16.5 shows a clear increase in the number of floods since the 1940s for every continent and a roughly constant rate of increase for each decade. However, it should be noted that although the number has been increasing, the actual reporting and recording of floods have also increased since 1940,

due to the improvements in telecommunications and improved coverage of global information."

The MEA report further states: "Flood processes are controlled by many factors, climate being one of them. Other non-climatic factors include changes in terrestrial systems (that is, hydrological and ecological systems [such as wetlands loss and deforestation]) and socioeconomic systems. In Germany, for instance, flood hazards have increased (Van der Plog et al. 2002) partly as a result of changes in engineering practices, agricultural intensification, and urbanization (direct and indirect drivers)." Two other non-climatic factors that massively affect the degree of damage from a particular flood are population growth and economic development in coastal areas and flood plains.

Teasing out a greenhouse warming signal from flood damages affected by both natural climate variability and a host of societal factors may well be beyond human capability. Yet *AIT* presents flood damage data as unambiguous evidence of a global-warming ravaged planet.

The Center for the Study of Carbon Dioxide and Global Change summarizes the literature on floods and climate variability:

- **Asia:** "The results of these [five] studies from Asia provide no support for the climate-alarmist claim that global warming leads to more frequent and severe flooding. If anything, they hint at an *opposite* effect."[8]
- **Europe:** "In light of this body of evidence [17 studies], it is clear that for most of Europe, as well as many other parts of the world, there are simply no compelling real-world data to support the climate-alarmist claim that global warming leads to more frequent and severe flooding."[9]
- **North America:** "Taken together, the research described in this Summary [21 studies] suggests that, if anything, North American flooding tends to become both *less* frequent and *less* severe when the planet warms, although there have been some exceptions to this general rule."[10]

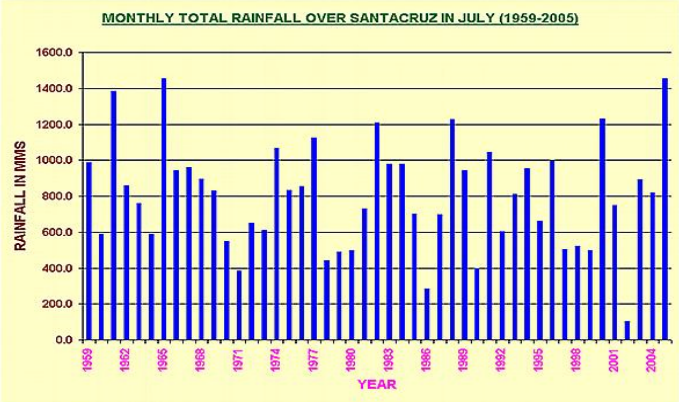
> ***AIT*:** "In many areas of the world, global warming also increases the percentage of annual precipitation that falls as rain instead of snow, which has led to more flooding in spring and early summer. In 2005 Europe had a year of unusual catastrophes similar to the one in the United States." (*AIT*, p. 106)

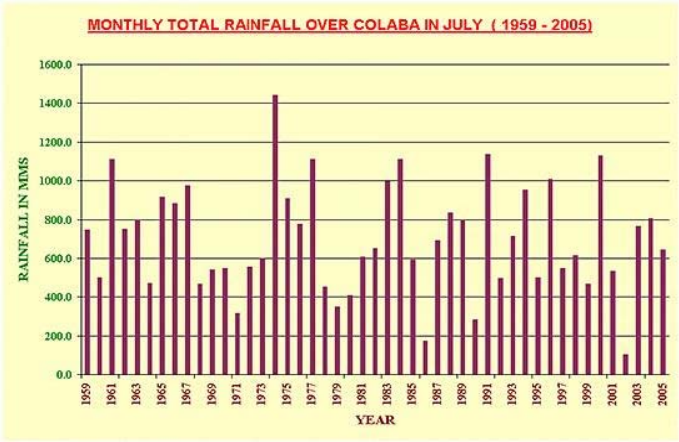
Comment: In other words, we had Katrina; they had disastrous floods. But we did not only have Katrina; we also had a record 668 inches of snowfall on Mammoth Mountain in California during 2005-06—the most in 38 years.[11] Many other ski resorts in California, the Pacific Northwest, Canadian Rockies and Vancouver, U.S. Northern Rockies, Utah, and Colorado posted above-average snowfalls in 2005-2006, and many had "high" snowfalls in 2004-05, including three "record high" snowfalls.[12] Again, was this in spite of global warming, or because of it?

> ***AIT*:** "July 2005, Mumbai [Bombay], India, received 37 inches of rain in 24

> hours—the largest downpour any Indian city has received in one day." (*AIT*, p. 110)

Comment: It is scientifically illegitimate to attribute any particular precipitation event to a gradual increase in average atmospheric temperatures. If global warming were influencing rainfall in Mumbai, we would expect to see it in long-term precipitation records. Mumbai has two weather stations that keep detailed records on precipitation.[13] Neither shows any trend in July rainfall over the past 45 years. See the Figures below.





Mumbai weather stations show no trend in July rainfall over the past 45 years.

> ***AIT*:** "There has also been record flooding in China, which, as one of the planet's oldest civilizations, keeps the best flood records of any nation in the world. Recently, for example, there were huge floods in Sichuan and Shandong provinces." (*AIT*, p.112)

Comment: Catastrophic floods have hit those provinces repeatedly from time immemorial. The Yellow River runs through Shandong Province. A PBS report, "Dealing with the Deluge,"[14] observed:

> Westerners have dubbed it [Yellow River] "China's Sorrow," because over

> the centuries it has killed more people than any other river in the world. In 1887 flooding killed nearly two million people, in 1931 the death toll was almost four million, and in 1938 it was almost one million.

The Yangtze River runs through Sichuan Province. According to Xia Jun of the Chinese Academy of Science and Yongoin Chen of the University of Hong Kong, 23 severe floods occurred in the Yangtze basin from 1843 to 1992—once every seven years on average. The "most disastrous" Yangtze flood in modern times occurred in 1954. "This exceptionally serious flood struck 123 counties and cities and inundated 3.17 million ha of land, forcing 188.8 million people to suffer and taking over 30,000 lives."[15] By comparison, the Yangtze flood of 1998 killed an estimated 3,000 people.

Predictably, *AIT* never mentions the most important "anthropogenic" influences contributing to flood risk on the Yangtze. In a study of the 1998 flood, two Chinese scholars found that "precipitation over the catchments and the floodwater discharge from the upper basin did not exceed the historical maximum."[16] However, land-use changes—including, paradoxically, flood control projects—"greatly increased" the risk of catastrophic flooding:

> Extensive reclamation of the lakes and fluvial islands in the middle basin has considerably reduced the floodwater storage and drainage capacity of these natural landscapes of the Yangtze Basin. Deforestation in the catchment area has induced soil erosion, resulting in a large amount of sediment deposited in reservoirs whose storage capacity is thus reduced. Strengthening the flood defense to protect people living on the floodplain has raised the water level during the flood.

> ***AIT*:** "Wildfires are becoming much more common as hotter temperatures dry out the soil and the leaves. In addition, warmer air produces more lightning. The graph below shows the steady increase in major wildfires in North and South America over the last five decades; the same pattern is found on every other continent as well." (*AIT*, p. 229)

Comment: Gore's graph is based on Figure 16.3 (page 449) of the Millennium Ecosystem Assessment (MEA) report, *Ecosystems & Human Well-Being*.[17] The figure in the MEA report is titled, "Number of Recorded Wildfires." Gore re-labels it as "Number of Major Wildfires." As the MEA report indicates, satellite monitoring of wildfires is a fairly recent development. The big jumps in the number of "recorded" wildfires since 1980 and 1990 are to some extent an artifact of the data. Gore's re-labeling hides this from the reader.

The MEA report confirms that hotter, drier climates tend to produce more wildfires, and hence that global warming will increase wildfire risk in some areas. However, just as Gore ignored societal factors (e.g., population growth in flood plains) affecting the number of "damaging floods," he similarly ignores societal factors affecting the number of "recorded" wildfires. In developing countries, many "wildfires" start as fires people

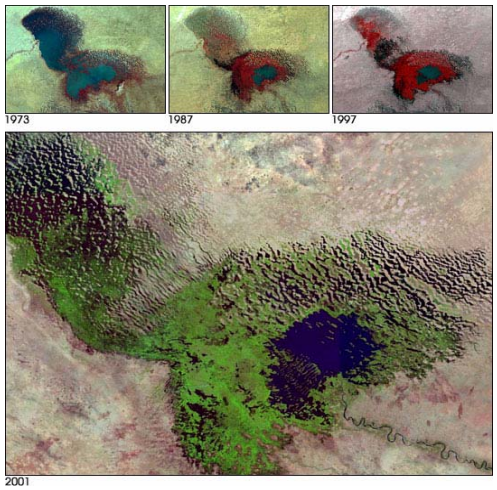
deliberately set to clear land for agriculture, highways, and logging. Gore surely knows this, since on page 227 he laments the fact that "much of the forest destruction" around the world comes from "the burning of brushland for subsistence agriculture and wood for cooking."

Although the number of "recorded" wildfires is increasing, the MEA report finds "a general long-term reduction in the area burned." In the United States, for example, "the area burned has declined more than 90% since 1930." *AIT* fosters the opposite impression—that more and more of the United States is literally going up in smoke.

> ***AIT*:** "The nearby Anhui province [in China] was continuing to suffer a severe drought at the same time the neighboring areas were flooding. One of the reasons for this paradox has to do with the fact that global warming not only increases precipitation world wide but at the same time causes some of it to relocate." (*AIT*, p. 113)

Comment: This is a little too convenient. In Gore's worldview, if there's a downpour, that's global warming. If there's a drought, that's global warming. Global warming can only intensify droughts and floods—never make wet places drier or dry places moister. Floods and droughts were less frequent and less severe in the good old days before SUVs and coal-fired power plants. This is the stuff of fairy tales, not science.

> ***AIT*:** Gore blames global warming for the disappearance of Lake Chad (see the images below), which in turn contributed to famine and genocide in the region. He sermonizes: Lake Chad's "fate is sadly emblematic of a part of the world where climate change can be measured not just in temperature increases but in lives lost." The "more we understand about climate change, the more it looks as if we [the United States, which emits a quarter of the world's greenhouse gases] may be the real culprit." He concludes: "It is time to take a hard honest look at our role in this escalating disaster. We helped manufacture the suffering in Africa, and we have a moral obligation to try to fix it." (*AIT*, p. 117)



Images of Lake Chad
Source: NASA[18]

Comment: A study by Jonathon Foley and Michael Coe of the University of Wisconsin concluded that Lake Chad's decline probably has nothing to do with global warming. The two scientists based their findings on computer models and satellite imagery made available by NASA. They attribute the Lake's condition to a combination of regional climate variability and societal factors such as population increase and overgrazing. *National Geographic* interviewed the researchers and summarized their study:

> Historically, Lake Chad received most of its water from the monsoon rains that fell annually from June to August. But beginning in the late 1960s, the region experienced a series of devastating droughts. As the rains increasingly failed to come, the region began undergoing desertification. At the same time, local people became more and more dependent on the lake as a source of water to replace the water they had previously obtained from the monsoons.[19]

Note that the change from a wet to a dry climate began in the late 1960s, when global climate was still in a cooling trend. The article continues:

> Overgrazing of the savanna is one of the biggest factors in the shrinking of the lake, according to Coe and Foley. "As the climate became drier, the vegetation that supported grazing livestock began to disappear. Vegetation has a big influence, especially in semi-arid regions, in determining weather patterns," said Foley. "The loss of vegetation in itself contributed to a drier climate." The situation is a "domino effect," the researchers say. Overgrazing reduces vegetation, which in turn reduces the ecosystem's ability to recycle moisture back into the atmosphere. That contributes to the retreat of the monsoons. The consequent drought conditions have triggered a huge increase in the use of lake water for irrigation, while the Sahara has gradually edged southward.

In short, the Lake Chad disaster was one part local climate variation, one part local tragedy of the commons. Yet Gore blames the USA. He calls global warming a "moral issue," but for him it is actually a *moralizing* issue. Global warming allows Gore to discover moral agency and guilt in the workings of inanimate nature. It allows him to "blame America first" for misfortunes around the world that may be entirely due to local actions and/or climatic factors beyond human control.

> ***AIT*:** "Global warming also sucks more moisture out of the soil. Partly as a consequence, desertification has been increasing in the world decade by decade." (*AIT*, p. 118)

Comment: Why then do pan evaporation studies, such as Roderick and Farquhar (2004),[20] indicate that evaporation from soils has been decreasing since the 1950s in the

former Soviet Union, Eurasia, Australia, and North America? Roderick and Farquhar say "it is now clear that many places in the Northern Hemisphere, and in Australia, have become less arid," and that "in these places, the terrestrial surface is both warmer and effectively wetter." Their data suggest that the Earth's surface is "literally becoming more like a gardener's 'greenhouse'."

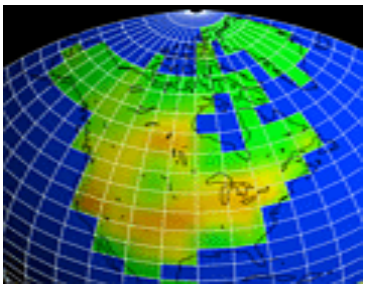
Although intuitively plausible, a link between global warming and drought is more difficult to establish than Gore seems to think. No U.S. drought in recent decades was as severe as the drought of the 1930s. See the image below.

The Dust Bowl

Nor was the 1930s drought outside the range of natural variability. Consider this excerpt from NOAA's Paleoclimatology Program:

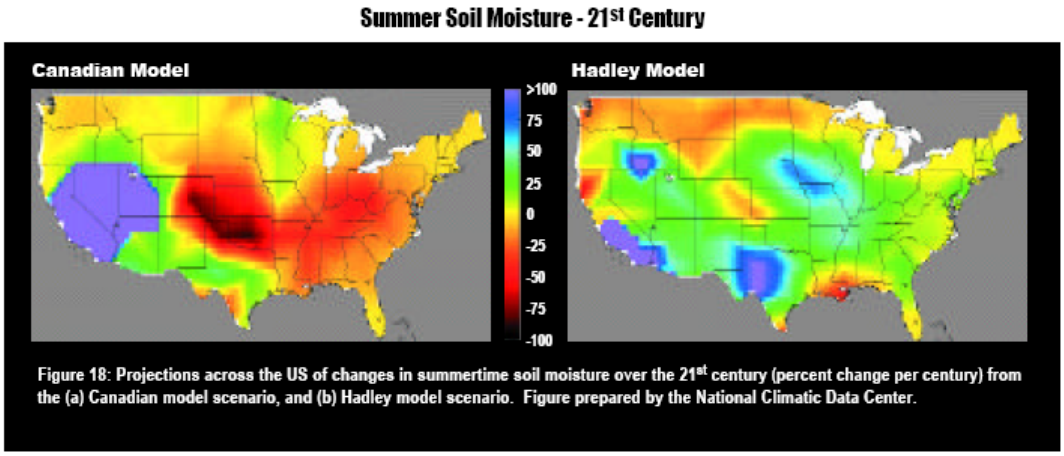
> Longer records show strong evidence for a drought [in the 16th century] that appears to have been more severe in some areas of central North America than anything we have experienced in the 20th century, including the 1930s drought. Tree-ring records from around North America document episodes of severe drought during the last half of the 16th century. Drought is reconstructed as far east as Jamestown, Virginia, where tree rings reflect several extended periods of drought that coincided with the disappearance of the Roanoke Colonists, and difficult times for the Jamestown colony. These droughts were extremely severe and lasted for three to six years, a long time for such severe drought conditions to persist in this region of North America. Coincident droughts, or the same droughts, are apparent in tree-ring records from Mexico to British Columbia, and from California to the East Coast …[21]

***AIT*:** "The map [below] shows what is projected to happen to soil moisture in the United States with the doubling of CO_2, which would happen in less than 50 years if we continue business as usual. According to scientists, it will lead, among other things to a loss in soil moisture of up to 35% in vast growing areas of our country." (*AIT*, p. 121)



Source: Princeton GDFL R15 Climate Model

Comment: The map shows what one climate model (the Princeton Geophysical Fluid Dynamics Laboratory R15 model) projects would happen to U.S. soil moisture with a doubling of CO_2. Not all models reach this conclusion. The Clinton-Gore Administration used two models—Canadian Climate Center and Hadley Center—to produce its major global warming report, *U.S. National Assessment of the Potential Consequences of Climate Variability and Change*.[22] Like the Princeton model, the Canadian model predicts increased dryness. The Hadley model, on the other hand, predicts increased wetness. See the image below.



Source: U.S. Global Change Research Program, *National Assessment* report, p. 552.

In a report commissioned by the Pew Center on Global Climate Change, Kenneth Frederick and Peter Gleick described the different results predicted by those models:

> The Canadian model suggests runoff would decline in all regions except California. In 12 of the 18 regions, runoff declines by more than 20 percent, an outcome that would have serious adverse impacts. In contrast, the Hadley model projects increases in average runoff in most regions; the majority of the nation's arid and semiarid regions would have significantly more water, reducing problems of water scarcity but perhaps increasing the threat of floods.[23]

Faced with conflicting model results, it makes sense to look at real-world data. Andreadis and Letternmaier (2006) constructed a time series of soil moisture and runoff over the continental United States for the period from 1925 to 2003. They found that drought duration, severity, and frequency had increased in the Southwest and parts of the interior of the West, but that most of the country had become wetter:

> Over much of the country, there has been a wetting trend which is reflected in a predominance of upward trends in both model-derived soil moisture and runoff. These trends are generally consistent with increases in precipitation during the latter half of the 20th century observed over most of the U.S….Furthermore, trends in the simulated runoff are similar to those in observed records of streamflow at a set of index stations that have been minimally affected by anthropogenic activities. Trends in drought characteristics (duration, frequency, severity, and extent) are similar to those in soil moisture and runoff, i.e., droughts have, for the most part, become shorter, less frequent, less severe, and cover a smaller portion of the country over the last century.[24]

***AIT*:** "In 2005 the Amazon suffered the longest and worst drought in recorded history—with devastating effects." (*AIT*, p. 141)

Comment: RealClimate.Org, a Web site set up to debunk global warming "skeptics," concludes in a lengthy post that it is not possible to link the Brazilian drought to global warming or, more specifically, the warm seas that spawned so many Atlantic hurricanes in 2005:

> A quick statistical analysis suggests that SST variability cannot account for all of the precipitation anomaly over the Amazon (R^2 ~ 20% over the Amazon region, e.g. Carauar, Manaus, & S.Gab. do Cachoeira for the January-November rainfall). Furthermore, the present SST-based regression models do not give a large reduction in rainfall for 2005. It is important to keep in mind that more than one factor (e.g. ENSO, local effects) may affect the rainfall, and extreme events can arise when several conditions coincide in time and space (e.g. a combination of favorable SST anomalies, atmospheric circulation, local effects, etc)…In summary, it does not appear possible to say that this single event is attributable to climate change as the noise in the rainfall statistics is large.[25]

Unsurprisingly, *AIT* takes no notice of a beneficial warming-related trend in the Amazon, reported in two studies. Nemani et al. (2003), analyzing satellite data from 1982 to 1999, found that "global changes in climate have eased several critical climatic constraints to plant growth, such that net primary production increased 6%…globally." The Amazon rain forests accounted for 42% of the observed increase in plant growth.[26] Cao et al. (2004) found similar results.[27] As one commentator put it, "In general, where temperatures restricted plant growth, it got warmer; where sunlight was needed, clouds

dissipated; and where it was too dry, it rained more."[28]

Gore fails to make a credible case that global warming is making the weather more dangerous. The frequency of strong tornadoes in the United States has declined slightly since 1950; increased property damages due to floods and storms are chiefly due to socio-economic factors such as development in flood plains and coastal areas; globally, deaths from extreme weather events have declined by 95 percent or more since the 1920s; long-term rainfall records for the month of July in Mumbai, India exhibit no greenhouse warming signal; U.S. CO_2 emissions are not to blame for the disappearance of Lake Chad; U.S. droughts were more severe during the 1930s and the latter half of the 16th century than during recent decades; Brazil's 2005 drought has no discernible global warming link; and global warming appears to have increased the bio-productivity of rainforests throughout the world.

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[2] http://climate.ocs.ou.edu/monthly_summary.html.
[3] Christopher C. Burt, "Twisted Weather," *New York Times*, July 23, 2006.
[4] Kunkel, K.E., R.A. Pielke, Jr., and S.A. Shangnon. 1999. Temporal fluctuations in weather and climate extremes that cause economic and human health impacts: a review, Bulletin *of the American Meteorological Society*, 80: 1077-1098.
[5] Pielke, Jr., R.A., R.A. Gratz, C.W. Landsea, D. Collins, M. Saunders, and R. Masulin, R. 2006. Normalized Hurricane Damages in the United States, 1900-2005.
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[10] http://www.co2science.org/scripts/CO2ScienceB2C/subject/f/summaries/floodsnortham.jsp
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[19] Hillary Mayell, "Shrinking African Lake Offers Lesson on Finite Resources," *National Geographic News*, April 26, 2001, http://news.nationalgeographic.com/news/2001/04/0426_lakechadshrinks.html.
[20] Roderick, M.L. and G.D. Farquhar. 2004. Changes in Australian pan evaporation from 1970 to 2002. *International Journal of Climatology* 24: 1077-1090, reviewed by the Center for the Study of Carbon Dioxide and Global Change, "Earth's Terrestrial Environment is Becoming More Like a Gardener's Greenhouse," 14, June 2006, http://www.co2science.org/scripts/CO2ScienceB2C/articles/V9/N24/EDIT.jsp.
[21] http://www.ncdc.noaa.gov/paleo/drought/drght_data.html
[22] http://www.usgcrp.gov/usgcrp/nacc/
[23] Kenneth Frederick and Peter Gleick, Water & Global Climate Change: Potential Impacts on U.S. Water Resources, Pew Center on Global Climate Change, September 27, 1999, p. 10, http://www.pewclimate.org/docUploads/clim%5Fchange%2Epdf.

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