The Big US Drought of 1988

(It was very bad)

- Was the drought counsel from NCAR good?
  - Yes, NCAR seemed to explain the science and dampen the hype.
  - It was natural variability, not an effect from global warming.
  (These are other severe events.)
- Winter precip in Arizona vs Washington.
- A century of climate change for the Pacific Ocean.
- Ready for scan, Dec 12, 2006, Doc RJ0402, 47 pages.

How to find a document?
http://dss.ucar.edu/docs/papers-scanned/papers.html

Roy Jenne
Dec 12, 2006
The Big US Drought of 1988

~ Index ~

   › Wilson Quarterly, Spring 1988

2. US drought of 1988; hurricanes (2004-05), link to warming (2 p)
   › Also the big Mississippi flood of 1993

3. News clips from NCAR, June 1988 (4 p)

4. News clips by NCAR, July 1988 (9 p)

5. NCAR news clips for Aug 1988 (13 p)

6. Drought severity indices (US maps), 1895-1983 (9 p)

7. Winter precip in Arizona vs Washington; Pacific PDO (5 p)

8. A century of climate change for Pacific Ocean (2 p)
Greenhouse Effect?

As Americans sweltered through the summer of 1988, many climatologists warned that planet Earth could be experiencing the onset of the “greenhouse effect,” caused by the buildup of man-made carbon dioxide in the atmosphere. [See WQ, “Climate,” Winter 1988.]

Maybe not, says Heim, a meteorologist at the U.S. National Climatic Data Center. During the past two decades, he notes, the United States has endured five of the warmest years since recordkeeping began in 1895. But it has also experienced seven of the 20 coldest years. The link between last summer’s heat wave and the greenhouse effect, Heim believes, remains ambiguous at best.

Likewise, the destructive drought of 1988 “was not as bad as the droughts of the 1930s and 1950s—and probably other[s] that occurred before weather records were kept.” In 1934, drought afflicted 61 percent of the country, from western New York state to the Pacific coast. On April 14, 1935, several people suffocated in a dust storm that struck Stratford, Texas. During 1953–54, drought covered 51 percent of the country. Last year’s drought affected 45 percent; the year brought the driest growing season on record in only 12 percent of the nation’s area.

Since the 1950s, Heim reports, despite scattered dry years, the nation actually has been experiencing a wet spell. Eight of the 20 wettest years on record have occurred during the 1970s and ’80s. Last year, unnoticed by the news media, the desert Southwest was being “drenched by the wettest weather in decades.”

Viewed in historical perspective, Heim concludes, the hot, dry weather of 1988 was “simply the latest in a long series of similar fluctuations that characterize the climatic history of our country.”
The US Drought of 1988; Hurricanes (2004,05); Link to Warming?
Roy Jenne
Aug 2006

The US had a major drought in the summer of 1988. It was a major problem but there had been even bigger ones in the past.

1. The big US drought of 1988
   The northern US suffered a severe huge drought in 1988. About Sep 1988 I was asked to be part of an interagency panel (20 of us) to comment on whether the big US drought should be viewed as due to natural variability or due to global warming. We had statistics back to 1900. One plot showed the percentage of continental US land area that was too dry, year by year for the past 90 years. Another chart showed the area that was too wet for the same 90 years. These plots showed ups and downs, but the character of the plots had not changed with time. All but one in our panel said that the drought should be ascribed to natural variability and not to global warming. We said that it wasn’t good enough to say that we were not sure whether it was due to variability or global warming.
   - I think that our panel gave good advice. The advice was consistent with past statistics and with what then happened from 1989-2005.
   - Our meeting chair (Alan Hecht) carried this message to a major TV news person the next evening. The message was a surprise. They expected the reason to be “global warming.”

2. The effect of the news. Sell the farm?
   The US news about the big drought was very intense in the summer of 1988. I liked to have the news coverage, but there was too much tendency to link the huge drought to global warming. The excess hype is not harmless. There are people deciding whether to give up and sell their farms (at a low price). There are other people setting the cost of insurance. If people really believe that there will be many more droughts, year after year, they are likely to make bad decisions.
   - A whole series of drought years did not follow 1988.

   Four hurricanes damaged Florida in Aug-Sep 2004. The national news was intense and it often blamed global warming. Hurricane Katrina hit New Orleans Aug 29, 2005. New Orleans had very bad floods because it is below sea level and the dikes broke. The news about hurricanes and damage was very intense during Sep-Oct 2005, and global warming was a big part of the news (as for the drought of 1988). This collection of papers about the hurricanes of 2004 and 2005 is to provide a little history of what happened and what was said.
   - The news stories to public and policy people sounded like there had been a 50% to 80% increase in hurricane intensity due to global warming. This is wrong.
     - The heavy, heavy news told the public that all these recent hurricanes must be driven by global warming (wrong).

Headlines:
- Lots of hurricanes. It must be global warming.
- Almost twice as many intense hurricanes in the world since 1970 –an 80% increase (the story of Sep-Oct 2005). It’s due to global warming. Help!
- Global warming? You better believe it. (Sep 24, 2005, hurricanes) Help, Help!
4. **But, but:**
   The old hands at hurricane analysis and forecasting were upset with the loud news going to the public and to policy makers.
   - The dominant 99% of news preached global warming.
   - You need to know about changes in measuring hurricanes before you just use the dataset.
   - Why wasn’t there a big emphasis on the huge historical ups and downs in hurricane activity that happened during the past 100 years?

   There has been a little warming from 1970 – 2005, and this will tend to put more water vapor into the air—giving a little more “fuel” for hurricanes.
   - It is very important to try to scale the size of this effect.
   - By looking at climate model runs and looking for extra precipitation, we can try to scale the size of this effect.
     - For 1970 – 2005, it may be a 0.5 to 1.0% effect, but it has not been detected as yet—to too small.
     - By year 2100, it might be a 5% effect.  

5. Unbalanced or false news has consequences.
   Some people are deciding whether to sell their house. Some groups are setting insurance rates for storm damage. The Congress is trying to set policy. It helps these decisions if the news is accurate and well-balanced.

   This big rain event did not just move through the US. It got stuck in mid-US, giving a lot of precip. And a big flood. I have a book about the Flood of 1993.

7. The reason for wrong or unbalanced news:
   - Part of the problem is with the news media
   - But a fair part of the problem is with the subset of scientists who feed such info into the news system.
News Clips from NCAR, summer 1988

- The summer of 1988 was very hot and dry over Northern USA-48.
- NCAR saves news clippings that mention NCAR or staff at NCAR.
- I have selected some stories from June, July, & August 1988

3 pages from June 1988 follow

Roy Jenne
NCAR
Aug 2006
Troubleshooters ponder Drought of ’88

Knight-Ridder newspapers

One absolutely perfect, sunny day follows another. And it couldn’t be worse.

The spring dry spell has turned into the Drought of ’88 — blistering its way from Chihuahua to Calgary, from California to Cleveland.

Northwestern Mexico is suffering its worst drought in 20 years. Cattle are dying by the thousands on sun-scorched fields. In Canada, the central wheat lands are withering under their worst drought since the ’30s.

And in between, the United States broils: Reservoirs drying up in California. Prairie fires in Montana. Utah’s Great Salt Lake dropping. Sixty Indiana counties designated disaster areas.

In Michigan, farmers pray for rain in the next week or so. If they don’t get it, they’ll lose much of their wheat and cherry crops.

Meanwhile, the National Weather Service continues to predict more beautiful, dry days for the Midwest and Upper Plains.

What’s causing this drought? Ocean currents, sunspots and the greenhouse effect are among the possible culprits.

Kevin Trenberth, head of the climate analysis section for the National Center for Atmospheric Research in Boulder, Colo., says the drought began last winter with the return of the ocean current known as El Nino.

El Nino — Spanish for “Christ Child,” so named because it usually shows up around Christmastime — appears irregularly. It warms the Pacific Ocean waters off the coast of South America and causes shifts in the equatorial winds.

This past winter, El Nino managed to split the jet stream — the band of upper-atmosphere winds that influences weather systems — into two weakened forks that carried little moisture inland, Trenberth said. Part went up into British Columbia. Part went down into Mexico.

The result: no rain in between.

“Now it has turned completely the reverse,” he said, explaining that the sea temperatures off South America are cold again.

“That means that most of the weather activity is being pushed out west, toward Indonesia.”

Trenberth said the United States is shifting into a summer weather pattern that typically scatters thunder-showers in the country’s midsection, but offers few drenching weather fronts.

What about sunspots?

Some scientists have noticed an association between droughts and an 11-year cycle of sunspot activity.

In fact, the last notable drought was 11 years ago in 1977. But Trenberth, along with other scientists, dismissed the notion with: “I wouldn’t write home about it.”

Prof. Richard Peltier, of the University of Toronto’s department of physics, said the current heat is just part of a cycle.

“This is the sort of thing that happens infrequently but naturally ... one of those natural, awful fluctuations that occur,” Peltier said.

Most scientists agree there is a greenhouse effect. But is this particular North American drought connected to long-range global warming caused by an increase in carbon dioxide and other gases in the atmosphere?

“I don’t think we can answer until we have a little perspective, say 10 years,” said Trenberth. Others agree.

The greenhouse effect is a warming of the world occurring because the sun’s energy is trapped near the earth’s surface by a layer of man-made gases high in the atmosphere.

“The world is warming,” Michael Oppenheimer, senior scientist with the World Defense Fund, said. “The warming is probably due to the enhanced greenhouse effect. And as the earth warms, precipitation patterns change.

“Globally the world has warmed one degree Fahrenheit over the last century. And it will probably go up another six degrees by the end of the next century.”

The two experts’ points were underlined last week by a group of prominent environmental scientists who met in Washington. Fearing the consequences of the greenhouse effect, they urged immediate programs to cut the emissions of carbon dioxide and other gases from industrial combustion.

If not, the scientists warned that the middle latitudes of the Northern Hemisphere — America’s corn and wheat belt — could become deserts.
Experts debate drought's cause

By J. Sebastian Sinisi
Denver Post Staff Writer

The drought now searing 1,231 counties in 30 states is caused by:

1. A one-time shift in wind and thunderstorm patterns that normally draw moist air from the Gulf of Mexico and drop it over the Midwest.
3. High-pressure cells sitting for weeks over the central part of the country because they're held in place by low-pressure centers parked off both coasts.
4. The "greenhouse effect" whereby carbon dioxide — pumped into the air from burning fossil fuels — raises atmospheric temperatures and bodes to make the Midwest a drier place.

It depends on whom you ask.

This drought is not caused by the 22-year cycles of sunspot activity, said Dr. Walter Roberts at the National Center for Atmospheric Research in Boulder, Colorado, a world authority on the relation between sunspot activity and the weather. He said the droughts of the 1970s, 1950s and 1930s were linked to sunspots, and the next recurrence isn't due until the mid-to-late 1990s.

This drought, Roberts said, is the result of "persistent high-pressure systems" sitting over the central U.S. Those systems are blocked in place by "non-migratory low-pressure" systems off both coasts. "Typically, these systems remain in place six to eight weeks," he said. "They can either remain in place or break up at any time." They've been in place for eight weeks now.

A "displaced polar vortex" theory

Please see WHY on 3-A
Experts debate drought's cause

WHY from Page 1-A

ry is favored by Dr. Melvyn Shapiro, chief of the meteorological research group at the National Oceanic and Atmospheric Administration facility in Boulder. In this scenario, wind patterns that normally draw Gulf moisture and dump it as rain over the Midwest at this time of year have shifted to the north, over Canada.

Instead of the normal pattern of tilting toward America's Great Plains, Shapiro said, the "tilt" has been to the other side of the northern hemisphere — where Siberia is experiencing unseasonably wet and cool weather.

"The way the atmosphere works, there's always a balancing effect," he said. "Which is why we shouldn't mistake a local phenomenon for a global one. There's no question we have a problem, with this weather anomaly burning up large parts of the country. But it's local — and those who say this is part of a worldwide warming trend are missing the point of weather balancing out elsewhere.

"You could be sitting in Kansas City with 106-degree weather, and conclude "Yes! This is the greenhouse effect finally hitting us." But, over in Siberia, their weather is skewed the other way from what it normally is."

Roberts said there has been a worldwide warming trend since 1900, with a dip between 1940 and 1970, and continued warming since then. The global average has been one degree Fahrenheit warmer since 1900 — which doesn't sound like much, but is significant in the long-range picture. An average rise of just three degrees centigrade, according to the greenhouse theory that Roberts supports, by the middle of the next century could melt polar ice caps and raise worldwide sea levels up to 3 feet.

A dip was from 1945 to 1976

3°C by 2050 is much too fast

- Roy Bome
Is the Earth Feverish?

UNDER THE SUN

'88 Drought Spurs Debate On Whether Prophesied 'Greenhouse Effect' Is Here

By RONALD KOTULAK
Chicago Tribune

8 pages follow with news clips from July 1988

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THE DROUGHT COULD BE JUST A 50-YEAR FLUCTUATION OR A PORTENT OF THE PREDICTED 'GREENHOUSE EFFECT' CAUSED BY FOSSIL FUELS AND OTHER POLLUTANTS

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July 5, 1988
Is the Earth Feverish?

Scientists suspect the drought of '88 may be a sign the temperature of the globe is rising more than ordinary atmospheric eccentricity. Is it, atmospheric scientists ask, a sign of more to come? Is it, indeed, a sign that the long-dreaded “greenhouse effect” has taken hold?

Nobody really knows. But a few researchers are saying that global warming has begun and that the current drought is the kind of climatic anomaly they expect to see more often. If so, agriculture may be in real trouble.

"I'm afraid we're going to lose some farmers, and we've lost enough already in my state," North Dakota
Time to cool global greenhouse

By Robert C. Cowen

THANKS partly to the severe North American drought, the greenhouse climate threat hit front pages and prime-time TV news recently. But, having raised the alarm about heat-trapping air pollution, the news media quickly shifted their attention elsewhere.

In fact, news interest faded so fast there has been little reporting of the conclusions of the global conference on the subject that Canada played host to in Toronto during the last four days of June. Yet those conclusions go to the core of the perplexing question of how seriously to take an environmental threat that is ill-defined and will take decades to develop fully.

The technical discussions revealed, once again, that scientists cannot yet foretell just what a global average warming of one to several degrees will mean environmentally or how fast it is likely to develop. But they also emphasized that we can't wait for clearer vision. We must begin now to curb the accumulation of heat-trapping pollution.

This represents a watershed in scientific opinion on the subject. Greenhouse researcher Stephen H. Schneider of the National Center for Atmospheric Research in Boulder, Colo., observed, "There has been a radical increase in the number of scientists who think we should do something about the problem," according to Chemical and Engineering News.

The greenhouse gases include carbon dioxide (CO₂) released in burning fossil fuels and wood from forest destruction; methane from rice paddies, livestock, and other aspects of farming; chlorofluoro-
carbons (which also destroy the ozone layer); and some other man-made pollutants. Scientists were originally concerned mainly about CO₂. But they now realize that the other gases, taken together, have a comparable warming effect. Thus the climate-warming pollution is building up faster than most experts had expected even half a decade ago.

Therefore, in spite of the scientists' uncertainties about the possible climatic effects, the conference urged nations to begin now to develop cooperative international plans to cut back on the pollution. Specifically, it recommends cutting CO₂ emissions by 50 percent or more from current levels in the long run. As a first stage, it urges a 20 percent cut by the year 2005. It also urges steps to reduce emission of other greenhouse gases.

This is an immense challenge. It speaks directly to national and international energy use and development which now are raising the emissions of greenhouse gases. To cut back those emissions would require a radical rethink of the global economy. That includes special help for developing nations, which cannot pollute their way to wealth as did the present industrial countries.

To adopt these objectives or whatever goals are realistic and establish a workable strategy to meet them will take long and painful international discussion. This is an effort in which the industrial countries - especially the United States, which is the worst greenhouse polluter - should take the lead.

A Tuesday column. Robert C. Cowen is the Monitor's natural science editor.

This was a severe drought that covered a wide area of the U.S. There was lots and lots of news about it in July and Aug 1988. - Roy Jenne, now Aug 2006
Drought Stirs Storm of Theories on Its Origins

Lack of Volcanic Activity, Greenhouse Effect, El Niño All Offered as Cause of Long Dry Spell

By THOMAS H. MAUGH II and LINDA ROACH MONROE.
Times Staff Writers

Picture a vast river of air 60 miles wide, a mile thick, 10 miles above the ground and moving at speeds as high as 200 m.p.h. Normally in the spring and summer, this river called the jet stream crashes across the northern Rockies and sweeps eastward through the Great Plains, bringing storms from the Pacific Ocean and drawing up other storms from as far away as the Gulf of Mexico to quench the thirsty agricultural fields of the Midwest.

But not this year.

This spring, for reasons that still have scientists mystified, the jet stream split into two parts—one swooping as far north as Hudson Bay, one veering along the southern border of the United States—before rejoining far out over the Atlantic.

These two branches trapped a massive high-pressure ridge over the central United States, locking out cooling storms and producing the heat wave and drought that have devastated America's heartland.

And despite the temporary respite resulting from a Pacific storm that forced its way through the high-pressure ridge at the end of June, weather forecasters say the jet stream has not significantly altered its position and the drought could continue for another month or more.

"We don't know why it's splitting like that, and we don't know why it is staying so long," said meteorologist David Miskus of the National Weather Service in Camp Spring, Md. "If we knew why, we'd be millionaires."

Many researchers are offering partial explanations, however.

Some say the drought is caused by volcanoes—or more specifically the lack of recent volcanic activity. Others say it is a lingering effect of El Nino, a massive body of warm water off the Pacific Coast of South America. Some link it to solar

A few say the heat and drought are the first stages of the long-predicted "greenhouse" warming caused by the burning of fossil fuels—although virtually all agree that the heat and drought overshadow what conditions will be like when greenhouse warming does arrive.

There seems little doubt that temperatures this year will set a record. Climatologist James E. Hansen of the NASA Goddard Institute for Space Studies in New York City last month told a Senate committee that the first five months of the year were "so warm globally that we conclude that 1988 will be the warmest year on record unless there is a remarkable, improbable cooling in the remainder of the year."

Most scientists agree that Earth is slowly warming, with global temperatures having risen by as much as 1.25 degrees Fahrenheit since the mid-1800s and with the four hottest years in history having occurred in the 1980s. Hansen caught the attention of the world when he said he was 95% certain that greenhouse warming has already begun.

But the greenhouse effect is a broad brush that paints only the wide background of climate. The finer details, such as droughts in the U.S. heartland and monsoons in India, must be superimposed, painted in by transient localized conditions. As physicist Paul Handler of the University of Illinois in Champaign-Urbana asked: "If the greenhouse effect is here this year, why wasn't it there last year? Nineteen eighty-seven was a very warm year globally, but it didn't produce any droughts in the U.S."

Most researchers say the current drought is simply part of normal climate variability produced by volcanoes and El Ninos as well as other factors.

"Normal climate is a 30-year average," said atmospheric scientist Michael E. Schlesinger of Oregon State University. "It's like saying the normal family has an average of 2.2 children. No family has 2.2 children, so every family is abnormal and, in the same way, every year is abnormal."

Handler thinks this summer's drought is caused by a lack of volcanic activity near Earth's Equator. In fact, he predicted the drought last fall—apparently the only researcher to do so publicly. The University of Illinois, in a press release, circulated the prediction at the time.

Volcanic eruptions spew sulfur dioxide gas into the stratosphere, the upper layer of Earth's atmosphere. In the presence of sunlight, the sulfur dioxide is converted into sulfuric acid, which condenses with water to form extremely small particles called aerosols.

PATRICK LYNCH / Los Angeles Times
SCIENTISTS are unsure whether the severe drought conditions that have hit the U.S. and are beginning to spread to other countries are the much-awaited first ominous harbinger of the "greenhouse effect."

A few are willing to stick their necks out and say the 1-degree increase in the globe's average temperature since the turn of the century is due to the greenhouse effect. Others say the current drought is probably being exacerbated by the greenhouse-effect, but they can't prove it. Still others insist the drought is a dramatic but normal climatic fluctuation.

Most scientists agree, however, that the pollutants man has been dumping into the atmosphere will eventually lead to a global warming of perhaps 3 to 8 degrees by the year 2050, and governments are taking them seriously.

"There is a good deal of speculation that the present drought may be one of the signs of the greenhouse warming," said Walter Orr Roberts, president emeritus of the University Corporation for Atmospheric Research, which manages the National Center for Atmospheric Research in Boulder, Colo.

"But that is uncertain. The year-to-year climatic fluctuations are compe-
Low river levels beached this Mississippi River barge last week at Friers Point, Miss. At left, a cow stands in a sun-baked pasture near Prairie Home, Neb. Record warmth of the 1980s and this year's severe drought has some scientists saying the "greenhouse effect" may already be affecting world climate.

minimize their losses. Winners will want to know how to take advantage of their new bounty.

There will be winners and losers within countries as well. Great Lakes shipping, for instance, will decline if lake levels fall because boats will be forced to carry less cargo in shallower waters. But railroads will win by picking up the extra business that the boats lose.

"National governments are reacting to the greenhouse issue with concern, and they probably should," said Stanley Changnon, an Illinois State Water Survey senior scientist. "We ought to be monitoring what's going on. To be informed is one thing, to act is another. At this point one cannot say with certainty what the weather changes will be.

"The science for predicting climatic changes isn't very solid yet, but it's something to be concerned about. We ought to be figuring out what might happen and what kind of indicators we might expect to see to know that the change is occurring."

The urgency is generated not only by the current drought but by long-term indications that the Earth is getting warmer. Besides the 1-degree increase in average global temperatures throughout this century, scientists at the University of East Anglia Climate Research Center in England found that, so far in the 1980s, three years have been the hottest in more than a century.

This year is also set to break the high temperature mark, James Hansen, a NASA climatologist, testified before the Senate Energy and Natural Resources Committee last week. He called these warming trends a sure sign that the greenhouse effect already has started.

Testifying before the same committee, Syukuro Manabe, an atmospheric scientist at Princeton's Geophysical Fluid Dynamics Laboratory and one of the first to call attention to the greenhouse effect, said the volume of greenhouse pollutants in the atmosphere is expected to double by the middle of the next century.

In 1900 the level of carbon dioxide in the atmosphere was 290 parts per million parts of atmosphere, he said. The level has now reached 350 parts per million, and in the next 50 years all the gases that contribute to the greenhouse effect are expected to climb to about 600 parts per million.

"So it is likely even now that the greenhouse effect is helping to aggravate this summer's dryness," he said. "The drought is mostly a natural climatic fluctuation. The greenhouse effect will tend to shift the climate in the drying direction so it will make droughts more frequent as the warming proceeds."
Two years of drought fuel fears of worsening ‘greenhouse effect’

"We’ve got another extensive summer drought in the U.S., and I think you have to start taking it seriously. So if, say, three of the next five years are like this, then it’s going to be a strong warning to us."

Ralph Cicerone

Modern computer models of weather patterns and the greenhouse effect predict the patterns of hot, dry extremes that are beginning to emerge.

What is both distressing and encouraging is that the phenomenon is linked to the human production of pollutants and byproducts. This suggests that modification of human behavior can curtail the greenhouse effect.

The strongest link is to the carbon dioxide gas produced by the burning of fossil fuels, particularly gasoline, and the release of chlorofluorocarbons by aerosols, refrigerants and plastic foam insulators.

Because of the scare created by the recent discovery of a large hole in the protective ozone layer in the Earth’s upper atmosphere, chlorofluorocarbon production in this country has been curtailed, an encouraging sign that harmful activities can quickly change.

Other major factors pinpointed by scientists is the release of methane gas, particularly through cattle and sheep flatulence and burping; the decay of organic material in wetlands and rice paddies; coal mining; and natural gas exploration.

"We don’t know exactly what percentage of methane is coming from what source," said Cicerone. "We are working hard on that now."

Still he notes that the number of cattle in the world doubled to about 1.3 billion between 1930 and 1985, and that methane production could be curtailed if demand for meat in the diet dropped.

The challenge faced by experts in dealing with the greenhouse effect lies in convincing the world of their theories before they have collected the quantities of evidence they are accustomed to having.

“We have to stop acting like every prediction is an exaggeration,” said Cicerone. “What we are finding out is that nature has some surprises, and the system may not be as stable as we hope it is.”
Is greenhouse warming causing the drought?

This year the central United States is in the grip of a severe heat wave and drought.

Last year was the warmest one, world-wide, since the invention of the thermometer. Accurate measurements go back only 100 years, but over this time no comparable period has been as warm worldwide as the 1980s.

Three years during this decade have broken all past global heat records. Right now, continental U.S. rivers like the Mississippi and Missouri are at record low levels. Irrigation water in many North American continental areas is scarce, and water tables are falling.

In contrast, both coasts have been relatively cold this spring, even though things are warm for the world as a whole. Persistently low barometric pressures are responsible for the cold coasts. The lows simply are not migrating eastward as they usually do, but are standing still, a weather phenomenon that happens from time to time, but is not yet fully understood. Correspondingly, there has been a strong and persistent high pressure over the center of the country, inhibiting rain and making it unusually warm.

The drought in the heartland has rivaled that of the Dust Bowl years of the 1930s. But until the lows start moving, the drought will persist. If the heat and drought continue through this month, corn and other crops will suffer drastically. Already agricultural damage is substantial.

There is strong consensus in the climatological profession that the world is warming up at a very fast rate. If this warming continues through the next century and into the following one, we will equal the warm climate of the Cretaceous Age 65 to 100 million years ago, when dinosaurs roamed the earth, and trees grew close to the North Pole.

This, we believe, is due to the greenhouse effect of carbon dioxide and other "greenhouse gases" that are produced mainly by human activity. The warming should climax in perhaps 300 to 500 years, according to best present estimates.

A big question now widely debated is whether the drought is a sign of the onset of this greenhouse warming. Jim Hansen of the National Aeronautics and Space Administration and a highly competent greenhouse effect expert, says almost certainly "yes."

I would say "maybe and maybe not." Many of my colleagues at the National Center for Atmospheric Research concur with me. Here are my main reasons:

- The hot and dry climate is extreme in the United States, but it is not outside the range of fluctuations of the historical past when the greenhouse effect was not present. That's why I say "maybe not."
- Yet, the pattern, with colder and wetter coasts and dry continental heartlands, is just what we think a greenhouse effect will make happen more frequently.
- Moreover, the globally warm period of the last eight years suggests we are in a strong warming trend like that of the greenhouse effect. That's why I say "maybe."
- Confusing the picture, however, the Eurasian heartland seems at this time not to be sharing the hot, dry weather of central North America. It should also more often be hot and dry there under the greenhouse effect.

Summing it all up, I'd add that one cannot judge a trend like the greenhouse warming by next page
Is greenhouse warming causing the drought? - continued

...present problems in seacoast areas.

The world situation is such that the greenhouse gases are continuing to increase, and will probably do so for at least 100 years — unless we ban fossil fuel usage worldwide, and take other heroic measures such as converting rapidly to nuclear energy with its hazards, or renewable energy sources (solar, biomass, etc.) with their higher costs.

With global population growth, and with the rising expectations of the developing world, I cannot see a prospect of averting a continued warming. Thus, I suspect we are left with the prime option of learning how to live well in a warmer world. Moreover, I am confident that it can be done.

Walter Orr Roberts, president emeritus of the University Corp. for Atmospheric Research and professor at the University of Colorado, writes occasional columns for the Daily Camera. Questions can be sent to him in care of Discovery, Daily Camera, P.O. Box 591, Boulder 80301.

Dallas, TX

THE MORNING NEWS

June 25, 1988 (390,000)

Solar flare expected to cause magnetic storm

LOS ANGELES — The largest solar flare in four years exploded from the sun Friday, spurring warnings that a major magnetic storm probably will disrupt global communications and satellite operations Monday. "I've got a major storm warning out for Monday," and it likely will ebb into a minor magnetic storm Tuesday, said Chris Balch, duty forecaster at the National Oceanic and Atmospheric Administration's Space Environment Laboratory in Boulder, Colo. The flare, an explosive release of hot gas, electrically charged particles and X-rays, poses no direct threat to life on Earth. But the magnetic storm could disrupt such ordinary matters as long-distance phone calls and electric power transmission.
NCAR News Clips, Summer 1988

The Summer of 1988 was very hot and dry over northern USA-48.

August 1988

12 pages follow with selected stories from the NCAR Aug 1988 news clips
THE GLOBAL GREENHOUSE FINALLY HAS LEADERS SWEATING

As the mercury climbs, policymakers are looking for ways to cut back on fossil fuels.

FIRE. It is chemistry at its most basic. Substances made of carbon and hydrogen—oil, for instance—react with oxygen and release energy. The byproducts: water and carbon dioxide. That equation propelled the Industrial Revolution and created mighty industrial economies. Today the world’s factories, cars, and power plants burn enough gas, coal, and oil to spew more than 5.5 billion tons of carbon into the earth’s atmosphere every year.

FOREST-FELLING. Debt-ridden developing nations will be hard pressed to embrace provisions that will make energy projects more expensive or penalize economic growth. Some of those countries now owe as much as 20% to 40% of their foreign debt for energy projects. Take China. It plans to use its coal reserves, 50% of the world’s stock, to increase coal consumption four times by 2000 as part of its drive to boost per capita income. At the same time, nations such as Brazil and Indonesia are felling huge tracts of forest for lumber or to clear farmland. Those nations may cut back only if industrial nations are willing to help finance clean-energy projects, forgive debts, allow additional time to comply with any fossil fuel curbs, and pay for the preservation of forests. “If we benefit from their resources or actions, we probably need to pay for it,” says John Topping, president of the Climate Institute, an interest group created to draw attention to the global warming.

Norway’s Prime Minister Gro Harlem Brundtland, who insists that climate change is the “second-greatest threat to world security, behind only nuclear war,” and Canadian Prime Minister Brian Mulroney laid the groundwork for the Toronto conference. There, representatives endorsed a rollback of carbon emissions by 20% by 2005, half from energy efficiency, the rest from using non-fossil fuels; a reassessment of nuclear power; and increased funding for research on the economics of switching energy sources, alternative energy technologies, and climate change. The recommendations will be the basis for a United Nations meeting in 1997 that will attempt to draw up the first international agreements on climate change. The most

Hot spells origins are very cloudy

By Robert Irion

Coming on the heels of a hot summer in 1987, the crop-withering weather that has plagued much of the country since May has renewed concerns that disturbing, long-term climatic trends could be at work.

But don’t lose your cool just yet, scientists say. Although the

So why the fuss? Try human nature.

“Every time it gets hotter than normal, people talk about the greenhouse effect,” said climatologist Kevin Trenberth. “Every time it gets colder than normal, they talk about an Ice Age. People always have to ascribe a cause to anything that’s other than normal.”

“But weather is never normal. Variability is a fundamental part of weather.”

Trenberth, who studies large-scale weather patterns at the National Center for Atmospheric Research in Boulder, Co., said the summer of 1988 is indeed remarkable for its persistent heat and drought patterns and for the speed with which they developed.

“There’s no inevitability to the succession of things,” said Donald Gilman, chief of the Climate Analysis Center in Washington. “Records bounce around from year to year, and it’s crazy to predict from them.”

Gilman said there are some “weak statistical relationships” between one summer and the next. For instance, there were several hot, dry summers during the Dust Bowl 1930s, and several more in the 1950s.
'Greenhouse Effect'
Fueling Policy Makers
Concept From 19th Century 'Is Here'

By Michael Weisskopf
Washington Post Staff Writer

In 1896, the Swedish chemist Svante Arrhenius became the first global weatherman. His country was industrializing, using more and more coal, and Arrhenius predicted that the concentration of heat-reflecting gases in the atmosphere would increase significantly as factories poured out pollution. Using back-of-the-envelope calculations, he ventured that doubling those gases over a few centuries would raise the Earth's temperature 7 degrees.

The Earth's temperature has not increased enough to blame today's drought on the greenhouse effect, said Manabe, but the dryness is a "foretaste" of the next century.

A pair of Senate hearings three years apart demonstrated the extent to which the consensus has hardened and begun to attract policymakers. At a greenhouse hearing in December 1985, scientists testified to a virtually empty chamber. The weather was cold and greenhouse warming seemed like a nebulous problem for the distant future.

On a hot, rainless day this past June, Hansen of the National Aeronautics and Space Administration filled a room with senators, lobbyists and reporters to proclaim with 99 percent certainty that the greenhouse effect "is changing our climate now."

Web page 6
Be very careful

Weird weather is not so unusual

By Robert C. Cowen
Staff writer of The Christian Science Monitor

Record heat over North America. A wet summer for Britain. Floods in Sudan. It's weather as usual for meteorologists who take the global view.

They aren't ready to say pollution-driven global warming has caused any shift in basic weather patterns. But some of them do urge preparations for a time when such a climate shift may indeed occur.

Namias says, "I can't see it and I can't see it particularly tied to CO2." This reflects the general assessment of climate scientists that one year's drought doesn't mean general climatic warming. They note that the dust bowl drought of 1934-36 arose long before man-made warming would have been involved.

Climate researchers made this point again last week in a hearing on global warming held by the US Senate Energy and Natural Resources Committee. But, as Stephen Schneider of the National Center for Atmospheric Research at Boulder, Colo., explained, "there is concern that we are assaulting the environment much faster than we are understanding it."

Looking at the immediate past trend, Namias says he can clearly trace this year's drought development back six months. He explains that the pattern appears to be locked in by three high-pressure systems over the North Pacific, United States, and North Atlantic respectively. These set the main air circulation pattern. They are linked to a series of hemisphere-encircling high- and low-pressure areas called planetary waves. It is this basic general pressure pattern that guides air circulation so that, with drought over North America, Britain has a cold, damp summer.

Weather pattern
for the drought
By Gary Schmitz
Denver Post Washington Bureau

WASHINGTON — A Colorado scientist and a Reagan administration official clashed Thursday over whether immediate steps should be taken to reduce pollution that is heating the Earth's atmosphere.

Stephen Schneider of the National Center for Atmospheric Research in Boulder said unanswered questions about global warming should not delay control efforts.

"We are changing the climate much faster than we can understand," Schneider testified before the Senate Energy Committee. "Unless the broad nature of the problem is recognized, and met with a comparably broad set of solutions... we will increase the likelihood of being victims of our own short-sightedness."

But Donna Fitzpatrick, associate undersecretary of the Energy Department, insisted that "significant gaps in our knowledge" make any quick response unwise.

"Reduce uncertainties"
"Scientific uncertainties," Fitzpatrick declared, "must be reduced before we commit the nation's economic future to drastic and potentially misplaced policies."

Though the Energy Department official acknowledged that "the available evidence is sufficient cause for serious concern," she said the government should limit itself to additional study.

Following her testimony, Fitzpatrick left the hearing before she could be questioned. Angry over her unexpected departure, Colorado Democratic Sen. Tim Wirth, who called and chaired the hearing, said he had hoped to ask Fitzpatrick why the Reagan administration had failed to respond to mounting indications of the severity of global warming.

Wirth sponsoring bill
Wirth last month introduced a far-reaching measure to deal with the greenhouse problem. The bill sets a goal of reducing emissions of carbon dioxide by 20 percent over the next two decades.

To do so, it promotes a massive shift away from fossil fuels like coal and oil that produce carbon dioxide, and toward energy efficiency, natural gas and, perhaps, nuclear energy.

Schneider offered the bill an unqualified endorsement, saying the most troublesome aspect of the greenhouse effect is the rapid rate at which temperatures appear to be rising.

"Anything we can do to slow it down makes good sense," he said. "We shouldn't put down measures that will diminish the problem a few percentage points... little steps, if you aid them up, can cut the problem in half."
## Climatologist says cities distort ‘greenhouse’ data

**By LYNN LUDLOW**  
San Francisco Examiner

San Francisco’s official weather station, located at a dozen different sites since 1875, illustrates why former state climatologist Jim Goodridge is so upset about warnings of a long-term global warmup blamed on the computer-predicted “greenhouse effect.”

He said his own records show the average of California’s mean annual temperatures actually has decreased slightly over the last 60 years.

If the cities are left out, however, the stations in rural counties show a decrease in average temperatures over the last six decades.

**NATIONAL WEATHER** Service lead forecaster Jan Null said he agrees completely with those who say urban weather stations are unsuitable for climatic research.

“If you just look at the numbers,” Null said, “you’re measuring urbanization instead of climate.”

Ken Watt

Far more outspoken in his skepticism is Kenneth Watt, an environmental scientist at UC-Davis.

“Nobody is challenging the notion that there’s an increase in carbon dioxide, but there’s complete disagreement on the consequences and what should be done,” he said. “It’s a very complex problem, and most people see just a few of the jigsaw pieces.”

Watt said he sifts through the same data used by NASA and, if he eliminates urban temperatures, reaches a conclusion totally opposite of the doomsayers.

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## ‘Greenhouse’ study, not action, backed

**By Robert A. Rankin**  
Washington Bureau

WASHINGTON — Senior Reagan administration officials, while acknowledging that the Earth’s rapid heating from the “greenhouse effect” is “cause for serious concern,” said Thursday that research rather than action is the best way to cope with the phenomenon for now.

“Significant gaps exist in our knowledge of the greenhouse effect,” said Donna Fitzpatrick, associate undersecretary of energy. “These scientific uncertainties must be reduced before we commit the nation’s economic future to drastic and potentially misplaced policy responses.”

But Dr. Stephen Schneider of the National Center for Atmospheric Research voiced disdain for what he called “platitudes about scientific uncertainty as an excuse to avoid action.”

Scientists remain uncertain about how the phenomenon will affect different regions, cloud formation, vegetation growth and how fast oceans can absorb carbon dioxide, Fitzpatrick stressed. Conceding that point, Schneider insisted that “slowing it down buys us more time to adapt.”

He endorsed the Wirth bill, which raises standards for energy efficiency to reduce carbon dioxide, encourages development of non-fossil fuel technologies such as solar and nucelar power and halts destruction of tropical forests, which absorb carbon dioxide.

The Reagan administration is still studying the Wirth bill, Fitzpatrick said, adding “in general, we prefer technological solutions to regulatory ones.”
Warming trend

Wirth holds hearing on measure to reduce carbon dioxide to slow greenhouse effect

By ROBERT ENGELMAN
Scripps Howard News Service

WASHINGTON — Not enough is known about the greenhouse effect to justify a government attack on the problem, a federal official told a Senate committee yesterday.

But a scientific expert on the effect, which some scientists think is contributing to near-record heat and drought this summer, said continuing scientific uncertainty should not stand in the way of efforts to reduce emissions of the gases that may cause global warming.

Sen. Timothy Wirth, D-Colo., chaired the hearing of the Senate energy committee to consider the implications of a bill he and others introduced a few weeks ago to slow the greenhouse effect.

The bill sets a goal of reducing carbon dioxide emissions by 20% in the next 12 years.

BUT DONNA FITZPATRICK, associate undersecretary of the Energy Department, testified that reducing the gases by the amounts contemplated in Wirth's bill would require new federal regulations the administration is not prepared to endorse.

"We believe the action of the type called for...would impose significant costs on some sectors of the economy both within the United States and worldwide," she said.

"Without further scientific understanding, we cannot be assured these actions would be either effective or efficient. A large-scale regulatory..."

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Congress OKs More Aid for Poor

Chronicle Wire Services

The House and Senate approved a $1.4 billion hunger relief bill yesterday that would increase food stamp benefits and extend emergency food assistance programs for the needy.

Both houses adopted the compromise measure by voice vote and sent it to President Reagan, who is expected to sign it.

Delay Urged in Bill On Greenhouse Effect

Administration officials took a go-slow position on legislation to address the greenhouse effect, saying Congress should delay action until scientists better understand the global warming trend.

Energy Department officials told the Senate Energy and Natural Resources Committee that the nation's economy might be unnecessarily damaged by hasty action to force deep reductions in industrial emissions, which are believed to be responsible for increasing temperatures.

They said that more research was needed to fill important gaps in scientific knowledge about climate change before the government could determine an appropriate response.

Donna Fitzpatrick, associate undersecretary for energy, said the United States could not single-handedly change global climate patterns and that "unilateral actions could harm the nation's international competitiveness."

Stephen Schneider of the National Center for Atmospheric Research argued that the world already faces temperature increases posing serious environmental and social problems and that further delay would only open the door for faster and even more disruptive warming.
Coast-to-coast roasting

Unusual high-pressure system baking nation from sea to shining sea

By The New York Times News Service

NEW YORK — Almost the entire country, from California to Cape Cod, Mass., is roasting in scorching heat.

The reason: an unusual set of meteorological conditions brought on by the spread of high-pressure air.

This has expanded from the Middle West, where it has persisted for a sweltering month, all across the northern United States.

Climatologist James Firor, of the National Center for Atmospheric Research in Boulder, Colo., said: "If the greenhouse gases continue to increase, and they seem to be going up, then the probability of heat waves could go up."

Salem, OR

Greenhouse effect

Have the recent reports about the threats of the greenhouse effect caused our new mayor to reflect on what it means for us in river city?

Sooner or later public servants will have to grapple with hard choices: Is Salem going to be part of the solution or part of the problem?

Heat? You ain't seen nothing yet

More arid summers for next 10 years?

WASHINGTON (AP) — The hot, dry weather in most of the nation this summer may just be a hint of things to come.

Researchers using five computer-simulated climate models forecast that summers in the United States generally will be drier over the next 10 years, although the models differ on how widespread the dry spell will be.

Climate observers disagree about the relationship between drought and the greenhouse effect, in which carbon dioxide, methane and other gases accumulating in the air trap energy from the sun and raise the Earth's temperature. But most express concern about increases in these gases.

To study the problem, William W. Kellogg of the National Center for Atmospheric Research in Boulder, Colo., and Zong-d Chi Zhao of Peking University used five different climate models to calculate the effect on soil moisture. Their findings were reported in the current edition of the Journal of Climate.
Lack of volcanic activity one drought explanation

By The Los Angeles Times

Picture a vast river of air 60 miles wide, a mile thick, 10 miles above the ground and moving at speeds as high as 200 mph. In most springs and summers, this river called the jet stream crashes across the northern Rockies and sweeps eastward through the Great Plains, bringing storms from the Pacific Ocean and drawing up other storms from as far away as the Gulf of Mexico to quench the thirsty agricultural fields of the Midwest.

But not this year.

This spring, for reasons that still have scientists mystified, the jet stream split into two parts— one swooping as far north as the Hudson Bay, one veering along the southern border of the United States— before rejoining far out over the Atlantic.

The two branches trapped a massive high pressure ridge over the central United States, which locked out the cooling storms and produced the heat wave and the drought that have devastated America's heartland.

Most researchers say the current drought is simply part of normal climate variability, produced by volcanoes and El Ninos, as well as other factors.

But physicist Paul Handler of the University of Illinois in Champaign-Urbana disagrees that the greenhouse effect is responsible for the drought. "If the greenhouse effect is here this year," he asks, "why wasn't it there last year? Nineteen eighty-seven was a very warm year globally, but it didn't produce any droughts in the U.S."

Most researchers say the current drought is simply part of normal climate variability, produced by volcanoes and El Ninos, as well as other factors. "Normal climate is a 30-year average," said atmospheric scientist Michael E. Schlesinger of Oregon State University. "It's like saying the normal family has an average of 2.2 children. No family has 2.2 children, so every family is abnormal and, in the same way, every year is abnormal."

Meteorologist Jerome Namias of Scripps believes that the El Nino-Southern Oscillation is linked to the current drought through a convoluted chain of events that he concides would be virtually impossible to prove.

The link is that the 1986-87 El Nino-Southern Oscillation event may have helped establish large bodies of cooler-than-normal water in the Pacific and Atlantic oceans. Those, in turn, may have a role in maintaining "troughs" of stormy low-pressure air off both coasts that are helping to lock dry air into place over the central United States.

"We don't understand how those cold bodies would maintain these troughs, but the fact that they are sitting there now, and are ... cold enough, would give one a strong feeling that there is a connection there to be made," said Bill Holland, head of the oceanography section at the National Center for Atmospheric Research in Boulder, Colo.

Others were skeptical about such a connection between the El Nino-Southern Oscillation and the drought, but conceded the possibility that it could exist.

Two-and-a-half years ago, warm surface water began traveling westward along the Equator in the Pacific Ocean— the classical El Nino-Southern Oscillation phenomenon. In 1982-83, a similar, but much stronger, event had devastated fisheries off the U.S. Pacific coast.

Although the 1986-87 El Nino-Southern Oscillation was weaker than the 1982-83 version, it lasted much longer than most scientists had expected. It also was unusual in that it left behind a huge pool of cooler-than-normal surface water in the northern Pacific.

With temperatures as much as 5 degrees Fahrenheit below normal, the cool water stretched from the Pacific Coast to Japan and from Canada to Mexico last summer and fall. Today, the water has drifted slightly northward and warmed a bit.

End of page 66
'88 drought may signal major problems ahead

By Newsday

No one need wonder why American farm families are beginning to suspect that, "God's against us."

Drought, added to years of poor crop and livestock prices, bankruptcies and farm foreclosures, has delivered another crushing blow to the men and women who work to feed the United States.

But this time around, the drought may reflect more than ordinary atmospheric eccentricity. Is it, atmospheric scientists wonder, by any chance, the beginning of a new era? Is it, indeed, a sign that the long-dreaded "greenhouse effect" has taken hold?

Nobody really knows. But a few researchers are saying that global warming has begun and that the current drought is the kind of climatic anomaly they expect to see more often. If so, agriculture may be in real trouble.

According to the National Weather Service's long-range forecasting center, hot, dry weather will continue to plague the Farm Belt through the next 30 days, or perhaps even longer.

The drought is not, however, much different from droughts that seem to recur every 50 years or so. The most memorable, of course, was the Dust Bowl era of the 1930s. Before that, another major dry period put American farmers through the wringer in the 1880s.

"Is this, or is this not, caused by the greenhouse effect?" asked Stephen Schneider, a climatologist at the National Center for Atmospheric Research in Boulder, Colo.

Unfortunately, weather records have not been kept long enough to say whether this is somehow different or is part of a long-standing pattern of wet and dry cycles that has run for centuries.

Climate specialist James E. Hansen of NASA, for example, recently told the U.S. Senate Committee on Energy and Natural Resources that he is 99 percent certain that a global warming is becoming evident.

Two research groups, Hansen's in New York City and Thomas Wigley's at the University of East Anglia in England, recently reported that 1987 was among the warmest years on record — warmer, indeed, than the Dust Bowl years — averaged on a worldwide basis. And during the first five months of 1988, the Earth has grown warmer still.

Atmospheric scientist Michael McElroy at Harvard University said that although it's hard to be sure whether greenhouse warming is involved in the current drought, "The situation at the moment is more or less what you'd expect with enhanced greenhouse gases."

As Schneider sees the problem, humans — by altering the whole Earth's atmosphere — are engaged in an enormous gamble, and the different conditions such as drought represent "the faces on a multi-faceted pair of dice."

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We had quite good info from 1895 on.

R. Johnson

Pattern of wet and dry cycles

Also individual dry years
Fossil fuels, air conditioners, El Nino or the vagaries of drought cycles? What is causing the summer sizzle? Are the soaring temperatures a dress rehearsal for a steam-bath-like 21st century? Is the greenhouse effect already upon us?

Or was the nation just overdue for a dry hot spell?

As the world is jarred by the threat of global climate change, the spotlight turns to the usually quiet labs in Boulder, the mecca of atmospheric scientists.

What are the physicists saying at the National Bureau of Standards? What about the atmospheric chemists at the National Center for Atmospheric Research? the meteorologists at National Oceanic and Atmospheric Administration? the environmental researchers at the University of Colorado?

The agreement from Boulder: Everyone, at the very least, should be concerned; at the very most, scared gasless about the greenhouse effect. Reducing chlorofluorocarbon levels, switching from coal and oil to natural gas or solar, and replanting forests denuded by development should become a top priority globally.

The conflict in Boulder: Scientists differ on which human-caused or nature-caused phenomena are the biggest players in the changing global climate.

"I’m not saying there’s no greenhouse effect," said George Kiladis, of CU’s Cooperative Institute for Research in the Environmental Sciences. "But I don’t know how you can say the drought this year is due to carbon dioxide but other droughts in the past weren’t!"

Says Walter Orr Roberts, ex-director of NCAR: "I know there are uncertainties about greenhouse warming and the effect on climate. But this is one of the best established long-term trends of climate. By the middle of the next century, the greenhouse effect will put the world’s climate into a re-

Note: The present warming cycle started about 1820. This was before any appreciable greenhouse effect. By the 1988 drought we had added enough carbon dioxide to get some greenhouse effect."
world has seen three El Ninos since 1975, 1976, 1982, 1986 — but not a single anti-El Nino. An anti-El Nino is just starting — the Peru coastal water is 7 degrees Fahrenheit colder than normal — and could send global temperatures downward this winter.

Beyond that, he will say, “It’s always dicey making predictions.” But he expects the anti-El Nino will bring a colder than normal winter to Canada and a warmer than normal winter to the American Southeast. Colorado lies between the two jet streams affected by the El Ninos, so probably won’t feel the effect.

Jerry Meehl and Warren Washington at NCAR’s community climate modeling center are studying what would happen if the amount of carbon dioxide in the air doubles.

Carbon dioxide acts like the panes of glass in a greenhouse, allowing sunlight through, but trapping the heat that would otherwise escape from the ground.

“The idea is that more carbon dioxide will trap more heat,” Meehl said. “The question is: Would that really happen?”

Some believe the ocean’s ability to absorb heat will lessen the greenhouse effect on mid-continent cities and farms; others say more CO2 will mean more clouds, and therefore less than-sizzling temperatures.

Other models, though, show that a small amount of carbon dioxide warming will exacerbate the sizzle by melting sea ice, warming the ocean and starting a vicious cycle of ocean atmospheric warming.

The latest data, combined with an expected geometric increase in the use of fossil fuels, indicate the CO2 in the air could double by 2050.

Washington and Meehl have been using the super CRAY computers to do their modeling for just nine years, so the models still are somewhat crude.

The great challenge is to create a model that separates the carbon dioxide from all the natural vagaries in the weather. “To separate the naturally occurring effects from the CO2 driven effects is real difficult,” Meehl said.

And then there is the matter of the Little Ice Age.

The CO2 build-up usually has been attributed to too many automobiles, too much factory smoke, too much modern living.

But temperature records show the Earth has been warming up, not since the advent of the Industrial Revolution in the mid-19th century, but since the 1600s.

That’s when the so-called Little Ice Age reached its zenith and began retreating.

“One drought does not a CO2-warming make,” said Meehl. “It’s hard to say one drought is caused by one effect.”

Says Kiladis: “It was almost as warm as it is now around the year 1000, and that wasn’t CO2. The point is: Climate fluctuates all the time and will get warmer or colder regardless of CO2.”

Climate modeling brings together atmospheric chemists, soil hydrologists, oceanographers, economists and biologists studying tropical deforestation. The implications of the greenhouse effect will ripple through society’s infrastructure, affecting growing seasons and economies, said Meehl.

All the models — by NCAR, Goddard Space Center and a few other agencies — agree that some type of warming will occur.

“Everybody agrees there has been an increase in net radiation at the surface compared to pre-industrial levels,” says meteorologist Henry Diaz, who studies the El Nino phenomenon with Kiladis at CIERES. “But we don’t know the exact response of the Earth’s climate as the gases increase.”

The NCAR models show dryer, hotter, longer summers in mid-continent — perhaps an increase in temperature of 2 to 4 degrees Fahrenheit.

_Continued_

...and that, most scientists to rein in people who want to make more of the climate modeling,” Meehl said.

“It’s a global problem,” said Meehl, explaining the people’s interest. “It’s happening outside the window and there are certain mysteries to it. We’re seeing hints of what may be happening.”

Walter Orr Roberts isn’t ready to say this year’s drought is caused by the greenhouse effect.

But he believes it’s a good “rehearsal” for inevitable dry, hot summers next century.

“I consider the greenhouse warming to be a very near certainty in the future,” said Roberts. “I expect it is going to require changes in agriculture ... transportation ... recreation ... aviation ... all kinds of things.”

Roberts applauds the bill that U.S. Sen. Tim Wirth, D-Colo., introduced last week that sets as a goal a 20 percent reduction in greenhouse gases.

But, he says, “I suspect in spite of our best efforts, we are going to have to adapt and plan to a changing climate. We need to begin that adaptation immediately. Far greater attention needs to be given to adaptation to a new climate regime.”

The ringing of alarms in the face of an uncertain future sounds like “frying the wolf” to some politicians and some consumers — and that is a constant dilemma to scientists.

“People will say the theory of warming is uncertain,” said Roberts. “How much are we willing to spend to accommodate something that may not happen?”

Weather is confounding enough to have embarrassed bucketfuls of scientists who confidently predicted the beginning of dire climatic trends.

In the 1970s, there were four years in a row of declining sea ice. “This is it, that’s the CO2 signal,” some insisted. The next four years, the sea ice expanded, and while the temperatures when downward, scientists were burned.

Also in the 1970s, a few severe winters in a row had some convinced that a new ice age was coming.

“People have very short memories of this stuff,” said Kiladis. “A theory can be right for a few years and then fluctuate in the other direction,” said Meehl.

“It’s been a severe winter — in Washington, D.C., particularly — everyone decides it must be an ice age.”
Climatologists Provide Refreshing Explanation For Nation’s Heat Wave

By ROBERT IRION
Chicago Tribune

CHICAGO — Coming on the heels of a hot summer in 1987, the crop-withering weather that has plagued much of the country for more than two months has renewed concern that disturbing, long-term climate trends could be at work.

But don't lose your cool just yet, scientists say. Although the causes of large-scale weather patterns, such as heat waves and droughts, remain poorly understood, most climatologists agree that it is premature to push the hot weather panic button.

After all, they say, the 20th Century has to have one year that is the hottest, and 1988 is just as likely as any other year to take the title. Strange weather?"

And, they point out, this decade is not at all remarkable, weatherwise. Four summers have been significantly warmer than normal — 1980, 1983, 1987 and 1988 — but three have been significantly cooler — 1982, 1985 and 1986. Up to last year, the average summer temperature for the decade was normal, and is now only about 1 degree above normal.

As for the greenhouse effect, a theory claiming that Earth will gradually warm up as humans dump more and more pollutants into the atmosphere, evidence is building that it is no longer fiction. But even the most pessimistic projections call for average temperature increases of 3 to 8 degrees by 2030 — or only a very small fraction of a degree per year.

The small greenhouse increase that might have occurred this year certainly is not enough to account for the blistering summer.

Human Nature
So why the fuss? Try human nature.
"Every time it gets hotter than normal, people talk about the greenhouse effect," said climatologist Kevin Trenberth. "Every time it gets colder than normal, they talk about an Ice Age. People always have to ascribe a cause to anything that's other than normal."

"But weather is never normal. Variability is a fundamental part of weather."

Trenberth, who studies large-scale weather patterns at the National Center for Atmospheric Research in Boulder, Colo., said the summer of 1988 is indeed remarkable for its persistent heat and drought patterns, and for the speed with which they developed.

By studying how these patterns might be linked with ocean temperatures and other phenomena around the globe, Trenberth and other researchers hope to learn more about the incredibly complex motions of the Earth's atmosphere that cause all weather.

"There's no inevitability to the succession of things," said Donald Gilman, chief of the Climate Analysis Center in Washington, D.C. "Records bounce around from year to year, and it's crazy to predict from them."

Gilman said that there are some "weak statistical relationships" between one summer and the next. For instance, there were several hot, dry summers during the Dust Bowl 1930s, and several more in the 1950s.

Note: Much of the news of summer 1988 made it sound like we might get one bad drought year after another. This was not a good message to give the public. The summers of 1989 thru 2006 have not verified the bleak news of 1988. But there can be long-term climate changes -- Roy Tenne

Aug 2006
Climatologists Provide Refreshing Explanation For Nation's Heat Wave - continued

Based on those events, it would not be unusual for the summer of 1989 to be warmer than normal. But it's also far from a sure thing. After 1955, the current king of the hot summers, weather patterns were quite temperate for many years.

"There was a lot of discussion that farmers were getting spoiled after the mid-1950s," Gilman recalled.

It is also unwise to base drastic conclusions on local weather conditions, scientists say. Complaints about hot summers in a particular city, state or region ignore the rest of the world, a cardinal sin since there is evidence that weather patterns are truly global in nature.

Cool In Some Areas

"Some parts of the U.S. have been cool and moist, and Western Europe is miserably cold and damp," said National Weather Service meteorologist Paul Merzock. "It's pretty clear that the circulation over the entire Northern Hemisphere has been way out of whack."

Currently, the best researchers can do is examine 1988's patterns and try to discern the causes behind the whacky effects. They know why the hot, dry weather is happening, but they don't know why it started or what will make it end.

The drought of 1988 effectively began last year, when warm surface temperatures in the Pacific Ocean — an effect known as El Nino — created an unusually strong ridge of fair weather off the California coast.

This ridge forced many Pacific storms to head northward into Canada and Alaska, and the middle of the country started to dry out.

This year, the dryness got worse for a different reason: The jet stream, a 200-mile-an-hour river of air in the atmosphere, looped up into Canada instead of following its normal route across the northern half of the U.S.

As a result, moist storm systems guided by the jet stream missed the central U.S. entirely. This was the case throughout most of April, May and June.

Recently, the jet stream has behaved more properly. It's still farther north than usual, but it has straightened out, allowing some storm systems to drift down through the Midwest.

The extreme heat is due to yet another phenomenon: a "Bermuda high," or an extremely powerful area of fair weather centered off the mid-Atlantic coast. This huge area spins clockwise, pushing steamy air from the Gulf of Mexico up through the Midwest.

Why El Nino formed, why the jet stream suddenly veered off course and why the Bermuda high grew so powerful are questions that climatologists cannot yet answer. They are among the many central mysteries of weather on Earth.

"The whole thing is a mess," summarized meteorologist Jerome Nemias of the Scripps Institution of Oceanography in La Jolla, Calif. "There's many interacting factors at the surface, in the air, over land and over sea. It's very difficult to take apart.

"Everybody knows about day-to-day weather, but we're dealing here with ensembles of months, seasons and years."

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(Weather patterns for 1988)

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1. The summer of 1988 was very hot and dry in the USA but cool and moist in Europe.
ATLAS OF MONTHLY PALMER DROUGHT SEVERITY INDICES (1895-1930)
FOR THE CONTIGUOUS UNITED STATES

(Plus a similar book for 1931-1983)

AUG 1917

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National Climatic Data Center

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noaa
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, N.C.
APR 1985

Page 32
Winter Precip in Arizona vs Washington, Pacific PDO

- Headline: “Melting snowpack spooks Utah”
- Arizona and New Mexico get their wettest winter in a century (in early 2005)
- The Pacific Northwest and Montana were very dry
- A high Pacific Index value often gives a wet Arizona and a dry Washington
- The Pacific Decadal Oscillation is also related to fish and bird changes over the Pacific
  - And to the circulation changes, and to ups and downs in global warming. See the charts here.
- Ready to scan May 11, 2005 (15 p), Doc RJ0382

Document RJ0382
Roy Jenne
May 10, 2005
NCAR
Melting snowpack spooks Utah

About 372 percent of normal snowfall in some areas creates flooding concern

By Paul Foy
Associated Press

CEDAR CITY, Utah — As the weather warms, this scenic high-desert town is rushing to make preparations before an enormous accumulation of waterlogged snow begins to melt in the mountains and creates the threat of spectacular flooding.

Crews have started raising the bed of a state highway and fortifying ditches city officials are praying for gradual warming that would melt the snow slowly; and officials of two counties already have declared states of emergency they may not need for a month.

Snow has accumulated as much as 372 percent of normal at some higher elevations, nearly 13 feet deep at some spots on the high sprawling plateau above Cedar City, home of more than 20,000 people and Southern Utah University.

"That snowpack — it's scary," City Manager Jim Allan said of Midway Valley, a 9,800-foot mountain saddle near Cedar Breaks National Monument, which is still snowed in.

Pacific storms this past winter favored the drought-weary Southwest, piling snow on southern Utah and giving Arizona and New Mexico their wettest winter in a century, while the Pacific Northwest and northern Rockies were uncharacteristically dry.

“We got Washington’s snowpack, is what it boils down to,” said Randy Julander, Utah’s federal snow survey supervisor.

And all that snow on the plateau above Cedar City has an unusually high water content.


The flood threat in Arizona and New Mexico is diminishing with warming weather and gradual melting, and Nevada hopes to absorb its runoff in depleted reservoirs.

However, a cool, wet spring could spell trouble for Utah if it leads to a sudden break into snow-melting summer temperatures, McNerney said.

Crews are working to channel the meandering Virgin River at St. George, a booming retirement community. Springdale, in the scenic canyon just outside Zion National Park, sits almost entirely on the river’s floodplain. Downstream, crews at Mesquite, Nev., failed in an attempt to coax the river back into an old channel and away from eroded banks that in January forced dozens from their homes.

For two months, the city has been fortifying Coal Creek and ditches all around Cedar City, cleaning out creek beds and filling sand bags.

So far, Coal Creek, which cuts through town, is flowing at little more than 50 cubic feet per second. At the height of runoff, it's expected to run at 40 times that amount or more.

- Lots of snow in southern Utah.
- Arizona and New Mexico got their wettest winter in a century.
- Pacific storms favored the drought weary Southwest during this past winter.
- The Pacific Northwest and northern Rockies were unusually dry.

April 18, 2005
Daily Camera
Boulder, Colo.
Washington drought declared

State's snowpack averages are at 26 percent of normal

By David Ammons
Associated Press

OLYMPIA, Wash. — Washington Gov. Christine Gregoire, girding for the region's worst drought in 28 years, on Thursday declared a statewide drought emergency.

For growers like Charlie de la Chapelle in the lower Yakima Valley, it wasn't a moment too soon. The state needs to get cracking on long-term solutions to the cycle of lush years and tinder-dry years like this one, he said. The region desperately needs water storage projects, he said in an interview from his apple and pear orchard near Sunnyside in central Washington.

"It's danged tough," he said. "We've been in this industry for four generations and this is the worst we've had. There will be dead and dying trees in July and we will have to tariage to save the most valuable crops."

"Too many of us will go out of business here and I will do my best not to go out of business."

Users with junior water rights in some areas can expect to get just 18 percent of their normal water.

Gregoire has been eyeing the situation for weeks, and decided Thursday to declare a state of emergency and gear up the state government to help.

She traveled to the hardest-hit region, the Yakima Valley, to announce her decision.

Gregoire directed an interagency Emergency Drought Committee to set up an emergency command center to track and coordinate the government's response and make sure state resources get where they are needed.

She ordered the National Guard to prepare for combating wildfires this summer and requested the Legislature to boost drought-related appropriations by $8.2 million.

"While water shortages won't affect all areas of the state in precisely the same way, it seems very likely that all areas of our state will experience at least some level of drought this year," Gregoire said.

"We need to start taking action now, and all of us need to be part of the solution."

As the Pacific Northwest awaits the worst drought since 1977, precipitation is at or near record lows across the state, and mountain snowpack averages are running 26 percent of normal. Many rivers are at or near record lows for this time of year.

The water shortage hurts farmers, hydropower production, fish production, irrigation and other sectors of the region's agribusiness economy — and has people worried about an unusually bad fire season.

The drought is plaguing Washington, Oregon, Idaho and Montana.

Meteorologists blame a weak El Niño, which brought unusually mild weather to the region in January, February and, now, March.

Gregoire's emergency declaration authorizes the state Department of Ecology to issue emergency water permits and temporary transfers of water rights, and releases funding from the state's Drought Emergency Account.

Ecology Director Jay Manning said his agency will focus on helping farmers, communities and streams get the water they need.

"Unfortunately, I cannot promise that everyone will get all the water they want," Manning said. "In some cases, we will be able to provide only enough water for people to get by. We will manage available water supplies the best we can, but we can't replace what nature doesn't give us."

The state departments of agriculture, health, and fish and wildlife will work with his agency to identify problems. Manning said the state Conservation Commission will work with local conservation districts and individual farmers on best practices for conservation and irrigation.

The Employment Security Department will focus on getting jobless benefits to those who are thrown out of work, and the state Department of Natural Resources will work with the guard to coordinate forest firefighting.

Using lessons learned in the 2001 drought, many farmers, hatcheries and communities aren't caught flat-footed, Manning said in a statement the governor's office released. Some areas are using treated waste water for landscape irrigation, replenishing wetlands and washing equipment. Farmers have replaced open ditches with pipes, and irrigators are getting more efficient, he said.
Researchers Consider U.S. Southwest's Response to Warmer, Drier Conditions Oct 9, 2001

In 2000, the popular press frequently referred to reports that the southwestern United States might experience a shift from relatively wet to dry conditions during the next couple of decades (see http://topex-www.jpl.nasa.gov/discover/ PDO.html). These predictions stemmed from observations that the Pacific Decadal Oscillation (PDO) appeared to abruptly change from a "positive" to a "negative" phase in 1999 (Figure 1). During the mid-twentieth century, a similar negative phase of the PDO was accompanied by prolonged dry conditions in the southwest.

By extrapolation, some climatologists predicted future drought in the southwest. Such a change would heavily affect land use planning in the region, because national demographics have stressed the region's resources over the past century. From 1990 to 2000, for instance, the population of Nevada and Arizona increased by almost 2.3 million people (http://www.census.gov/population/www/ cen2000/respop.html). To discuss potential scenarios of landscape and ecosystem response to 25 years of hot and dry climate, scientists from diverse disciplines gathered at the University of Arizona in April 2001. The objectives of this workshop were to address evidence supporting predictions of warmer and drier climate and the possible landscape responses (http://geologywruags.gov/sw/workshop/).

Climate as a Driver of Landscape Change

During the twentieth century, annual precipitation varied substantially in western North America, with the Pacific Northwest generally alternating phases with the southwest (Figure 1). This pattern expresses a north-south seesaw opposition such that when one region is wet, the other is usually dry. During a negative PDO, similar to conditions from the mid-1940s to the early 1960s, less precipitation and runoff occur in the southwest. Precipitation trends over the past century, though, reveal local increases as well as decreases, with much of the change occurring in seasonal precipitation. Changes in the frequency, magnitude, or spatial properties of El Niño and La Niña events may exert significant influence on precipitation patterns in the southwest. Hence, seasonal precipitation and the frequency of large-magnitude storms are difficult to predict. In contrast, temperature is temporally continuous and forecasts are typically more reliable than precipitation forecasts. Recorded temperature during the twentieth century shows a slight overall warming with an additional 2-3°C rise forecast for the southwest over the next 30 years.

Are Predictions Based on Empirical Indices Reliable?

Our predictions of future climate variability in the southwest are highly uncertain. Although understanding of climatic processes in this region advanced considerably in recent years, key issues regarding atmospheric response times and process transitions remain unresolved. Perhaps the best example is the PDO, an index that correlates with a variety of climatic-driven responses ranging from oceanic fisheries to flood frequency. Future climate of the southwest cannot be accurately predicted in either the short or long term because of seasonally variable climatic drivers. For example, there is a strong relation between the El Niño-Southern Oscillation and winter precipitation; as a result, winter drought can be forecast months in advance from La Niña conditions. However, predicting the summer monsoon remains difficult. It is understandably attractive to use an index, such as the PDO, as the basis for seasonal or annual climate predictions. However, predicting future response to PDO depends on numerous tenuous assumptions, including stationarity of atmospheric processes during global warming, as well as requiring one index to account for all aspects of climatic variability. Hence, extrapolating time series of climatic indices is an uncertain enterprise. Despite prediction uncertainties, it is crucial to examine the impact of potential climatic changes on landscape-response scenarios.

Geomorphic Response

If future conditions match those prevalent during the negative PDO of the mid-twentieth century, the frequency of flooding, particularly in larger river systems, should decrease. Lower precipitation, particularly at higher elevations, would also reduce groundwater recharge, resulting in less baseflow discharge. Warmer, drier conditions would likely diminish alluvial-fan flooding, reducing channel change in downstream-branching ephemeral streams. Channels fed by surface-water runoff would be more affected than groundwater-fed channels. In the absence of frequent large floods, with no local base-level changes, arroyos will likely continue to aggrade by storing sediment within floodplains.

Eolian transport is a function of wind speed and duration, sediment size and availability, sediment bonding by chemical and biologic crusts, and surface roughness. As the most extensive period of eolian activity recorded in the southwest occurred during 1956, a negative shift in the PDO could lead to increased frequency of dust storms. Warmer daytime temperatures could lead to more thermal convection and stronger winds. In contrast, local reductions in fine sediment supply from diminished fluvial transport may lessen eolian transport as sediment sources are depleted. Hill slopes may respond in different ways, depending on vegetation cover and landscape position. During the past century, grazing of fine fuels and proactive fire suppression have

Eos May Go to 2
Fig. 1. Precipitation anomalies for Washington (top), Arizona (middle), and the Pacific Decadal Oscillation (PDO) (bottom) are shown. Arizona typically is in phase with PDO while Washington typically is out-of-phase (data courtesy of M. D. Dettinger). Jagged black lines in the top two parts of the figure are the smoothed average of precipitation anomalies.

multiplied the density of trees in southwestern forests, which are now susceptible to crown fires. These fuels reached maturity in the relatively wet decades since 1976 and are now susceptible to catastrophic fire in the next extended drought. Following crown fires and a loss of root strength, there may be accelerated surface erosion and increased mass wasting during infrequent large-magnitude storms in the steep uplands. In contrast, on sparsely vegetated piedmonts, sediment yields will likely decrease with less runoff.

Vegetation Response and Nutrient Cycling

Soil nutrients and water availability exert fundamental controls on the distribution and migration of native and invasive species, and vegetation communities are important modifiers of geomorphic processes. Consequently, both drought seasonality and geography influence the health of biologic soil crusts and vascular plants. Crusts stabilize soil from eolian transport, roughen the ground surface, retain moisture, accumulate seeds, and stimulate plant biomass through nitrogen fixation. However, prolonged drought weakens biologic crusts and reduces or changes plant cover protecting surface soils and could lead to remobilization of existing eolian deposits or playa fringes and increased erosion of hill slopes. In addition, increased exposure of surface soils could lead to transport of Coccidioides immitis spores, a dimorphic soil-inhabiting fungus that causes valley fever (Coccidioidomycosis).

U.S. Southwest (cont. on page 478)
A Century of Climate Change for Pacific Ocean

- An important review paper (*Science*, 10 Jan 2003, p 217)
  - See next 2 pages here.

- An atmospheric circulation index for 1905 – on
  - Describes dominance of zonal or meridional flow in the Atlantic – Eurasian region.

- The global air temp does change in step with the circulation index.
  - So does the fish regime.
  - And so does CO2 at Hawaii.

- There was a shift in regimes about 1976.
  - In the mid-1970s, the Pacific changed from a cool “anchovy regime” to a warm “sardine regime.”
  - They ask: Was there another regime shift in the late 1990s?

- Years (two full cycles in the Pacific): their numbers:

  1900 – 1925    Cool phase
  1925 – 1950    Warm phase
  1950 – 1975    Cool phase
  1975 – mid 1990s    Warm phase

- Global air temp changes; my numbers:

  1910 – 1943    Atmosphere is warming
  1943 – 1976    Atmosphere is cooling
  1976 – recent    Atmosphere is warming

Roy Jenne
Jan 21, 2003
A stronger and broader California Current regime, associated with a shallower coastal thermocline from California to British Columbia, leading to enhanced primary productivity (Fig. 2). Offshore biological variability is similar to that observed off California.