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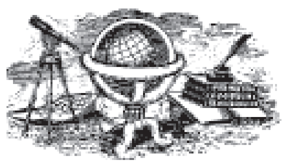
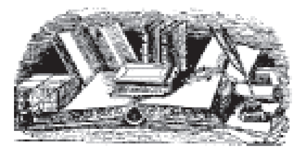
A NEWSLETTER FORUM ON CLIMATE SCIENCE FOR NON-SPECIALISTS

Michael A Fortune*
Climate Science Forum, Silver Spring, Maryland

CLIMATE SCIENCE FORUM



Reliable News and Analysis
in Climate Science



http://climate-science.org

1. INTRODUCTION

Climate Science Forum focuses on recent findings in climate science and on scientists' discussion of climate variation, climate change, paleoclimates and other issues from published literature, meetings and interviews. It is written by atmospheric scientists for non–specialists in climate, in language accessible to decision makers and the interested public.

As an applied climatologist, you, the reader strive to present information about your products and services to decision makers in business, in federal, state and local government, and perhaps in the news media. If you are a climate researcher, you hope to deliver your salient findings to these same audiences as well as your colleagues, but reports and journal papers typically do not reach the non-specialists. This newsletter is designed to bridge the information gap between climate scientist and user of climate information.

The editors of *Climate Science Forum* solicit your help in gathering your findings and presenting them in language readily understood by leaders and opinion makers in business and government around the world.

Climate Science Forum does not assume editorial positions in any matter of science or policy. Rather we feature a "Forum" that strives to present the viewpoints of several spokespersons who differ on their interpretations of key issues in climate science. Forums have covered the issue of Land Use and Climate Change; whether human society has likely affected the recent temperature rise on Earth or not; whether climate prediction models are able to forecast regional and seasonal climate correctly; whether society might benefit more from lowering air pollutants first before lowering carbon dioxide emissions. All of these discussions may be viewed on the Preprint volume CD (section 3).

The newsletter has a variety of features, including a "Climate Science Classroom"; Letters to the Editor; Reports on climate conferences and meetings; Seasonal climate summaries; and Interviews of some well-known climate scientists.

The online *Climate Science Forum* uses active links to original articles or documents in its citations.

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2. WE NEED HELP !

★ We need Editorial Board members.

★ We need news of your findings, published results and work in progress. Investigators and their students are invited to write succinct summaries for non-specialists that we will publish.

★ We need associates to work with us to produce the newsletter. We are eager to associate with University departments, faculty, state climatologists, regional climate centers and others who may be able to assist in producing a professional publication with appeal to multiple sectors of society.

3. NEWSLETTER EXAMPLES FOLLOW

Below is the complete issue of Spring 2003, also available also at the newsletter site http://climate-science.org . Other issues illustrate examples of interviews, seasonal climate summaries, and forum discussions. They have been placed in Preprint 4.12, Second AMS Users' Conference (Fortune, 2004) on this CD.

4. Reference

Fortune, M., 2004: An "honestly neutral" newsletter on climate variations and change for users of climate products. Preprint 4.12, Second AMS Users Conference, Seattle WA, American Meteorological Society, Boston MA.

CLIMATE SCIENCE FORUM

Reliable News and Analysis in Climate Science

SPRING 2003 - Volume 2 Number 1

Land Use affects climate “as much El Niño does”

Roger Pielke: Even climates of faraway places are affected by regional land use practices

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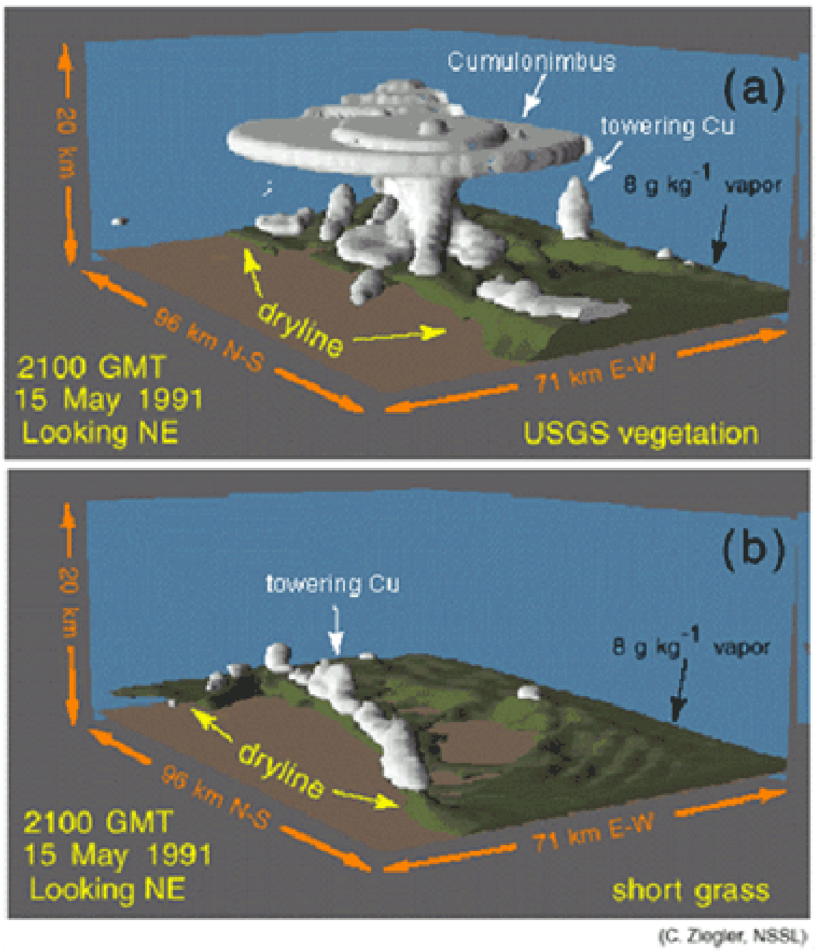


The 2 figures to the right show a computer simulation of thunderstorm cloud development over the Great Plains with two types of landscapes. At the top, the "real landscape" of crops, shrubs, and grasslands was used. The model simulated a large thunderstorm (which actually occurred in the real world). At the bottom, the "original landscape" of shortgrass prairie was used. The original landscape had less vegetation,so there was less water vapor to fuel thunderstorms. As a result, the model simulated only small cumulus clouds.
Credit: Conrad Ziegler, National Severe Storms Laboratory

Modern civilization has changed the face of Earth wherever people have settled in large numbers. Farms have replaced forests, cattle ranches have replaced grazing buffalo and horses, cities and suburbs have replaced farms, forests, and marshes. Deserts have replaced grazing lands. These land use changes are known to have changed climate, but they are poorly documented before the age of satellites. In Europe and China, where land has been settled a long time, it may not be possible to know what the climate was like before human settlement began to affect it.

According to Roger A Pielke Sr., professor of atmospheric science at Colorado State University and State climatologist of Colorado, human use of the land is now altering the climate of some regions as much as greenhouse gases are doing. He claims that land use practices have impacted the climate as much as El Niño, which is famous for altering the climate of some regions for 2 to 5 years. But unlike El Niño, land use practices can not be considered temporary.

FULL ARTICLE

Land Cover versus Greenhouse Gases as a Climate Forcing :*Michael MacCracken responds to Roger Pielke*

LETTERS to the Editor

Roger A. Pielke Sr. writes:

The Spring 2003 issue of *Climate Science Forum* mischaracterizes certain aspects of our research conclusions.

With respect to the effect of land-use changes on the Earth's climate system, it is the spatial redistribution of heat that makes it analogous to El Niño events. However, human use of the land has changed the surface of the Earth over larger areas than the area of well-above average temperatures in tropical Pacific waters during an El Niño. While both El Niño and land-use changes alter the general circulation model (GCM) simulations of the jet stream as a result of teleconnections (which are climate effects observed at large distances from the cause), they do not induce the same simulated changes in the spatial pattern of the jet stream.

While there have, as of yet, been no GCM sensitivity simulations of the effect of potential future land-use changes, the land-use changes which have already occurred appear to have altered the climate, and may have had an effect on the Earth's climate system that is at least as large as associated with the radiative effect of doubling carbon dioxide concentrations. Both high latitude regional cooling and warming occur in our land-use change GCM experiments. Such regional high latitude warming and cooling has been observed in the last 30 years. This work is reported in http://blue.atmos.colostate.edu/publications/pdf/R-258.pdf .

With respect to monitoring the heat content of the oceans, the use of ocean heat storage change is proposed as a quantitative measure of Earth system warming or cooling as a result of radiative flux divergence at the top of the atmosphere. The ocean is by far the dominant reservoir of heat changes within the Earth system over decadal time scales. Thus we can use heat changes in the ocean to diagnose this radiative imbalance. Net heat input or removal from the Earth's climate system must be associated with fluxes through the top of the atmosphere. The ocean does not provide, however, any predictive information on the future direction of climate change. Since the units of measurement are Joules, the rate of accumulation or loss of Joules tells us the radiative imbalance. Our work documents that the radiative imbalance of the Earth's climate system (as dominated by the oceans) for the 1950s to 1990s was about 0.3 Watts per square meter. This is not the heating "averaged over the entire surface of the Earth", as reported in the Science Forum. This work is in http://blue.atmos.colostate.edu/publications/pdf/R-247.pdf

On Dr. MacCracken's response, I am not a "climate skeptic." I have written in many papers that humans are altering the climate system. Our work suggests that the spatial redistribution of heat is more important in driving climate variability and change that can be attributed to human activity, than the globally-averaged radiative effect of additional CO_2. Human-caused influences that redistribute heat over the Earth include land-use change, the effect of CO_2 and nitrogen deposition on plant growth and soil processes, and radiative and cloud microphysical effects due to pollution aerosols from vehicles, industry, and land disturbances. A summary of my view and that of the American Association of State Climatologists regarding the complex, multi-dimensional character of the Earth's climate system is available from the U.S. House Committee on Energy and Commerce at http://energycommerce.house.gov/107/hearings/07252002Hearing676/Pielke,Sr.1144.htm

CLIMATE SCIENCE FORUM

Reliable News and Analysis in Climate Science

SPRING 2003 - Volume 2 Number 1

Land Use affects climate "as much as El Niño does"

Roger Pielke: Climates of places far away are affected by regional land use practices

Response - Land Cover versus Greenhouse Gases as a Climate Forcing
Dr. Michael MacCracken responds to Roger Pielke.

Roger A Pielke

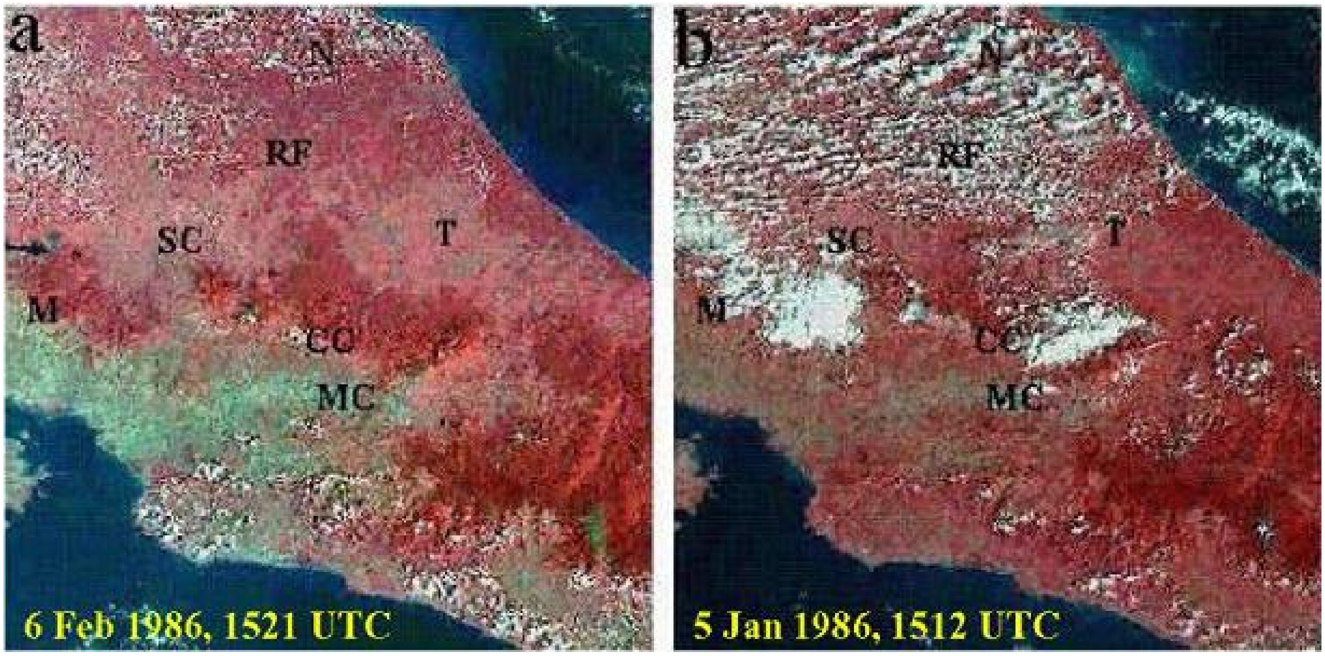
Roger Pielke created one of the first atmospheric simulation models for small and medium scale processes. The Regional Atmospheric Modeling System (RAMS) is now widely used to simulate sea breezes, cumulus cloud and thunderstorm development, and effects of land disturbances (such as irrigated, deforested, and urbanized land surfaces) on the atmosphere. Pielke is a Professor of Atmopheric Science at Colorado State University;and is the State Climatologist of Colorado. As director of the Association of State Climatologists, he has testified before Congress on matters of climate change and policy. Pielke has published over 220 peer-reviewed scientific papers and has co-authored five books. He is, or has been, Chief Editor of 3 prominent journals in Meteorology and Geophysics.

Modern civilization has changed the face of Earth wherever people have settled in large numbers. Farms have replaced forests, cattle ranches have replaced grazing buffalo and horses, cities and suburbs have replaced farms, forests, and marshes. Deserts have replaced grazing lands. These land use changes are known to have changed climate, but they are poorly documented before the age of satellites. In Europe and China, where land has been settled a long time, it may not be possible to know what the climate was like before human settlement began to affect it.

According to Roger A Pielke Sr., professor of atmospheric science at Colorado State University and State climatologist of Colorado, human use of the land over the last few centuries may have altered the local climate of some regions as much as greenhouse gases have done in the same places. While these gases generally cause warming, land use practices may cause either cooling or warming, or drying or moistening. Pielke also claims that land use has impacted the climate as much as El Niño, which is famous for altering the climate of some regions for 2 to 5 years. But unlike El Niño, land use practices can not be considered temporary.

Land Use affects cloud patterns, rainfall, and storms. Pielke reviewed over 200 studies of the effect of various land surfaces on generating cumulus clouds, and associated rainfall and thunderstorms (footnote 1). The studies concur that wet soils, especially on irrigated land, augment an area's rainfall in the growing season. If so, then irrigation has in fact helped to increase the average rainfall of North America. On the other hand, when a grassland is replaced by a desert, or a forested region by a grassland, rainfall decreases. This has probably contributed to the decrease in rainfall over Africa and Asia.

Pielke now argues that landscape change probably affects the Earth in the same way that El Niño does. When El Niño occurs, it provokes tremendous thunderstorm activity in the central and eastern Pacific Ocean where storms usually are not frequent. Not only is the tropical rainfall pattern changed, but winds carry the heat released in these thunderstorms for thousands of miles. That changes the global wind circulation, which alters the patterns of rainfall and drought in much of North and South America, Asia, Australia and Africa. Similarly, long-term changes in land cover due to deforestation, irrigation, and farming alter the location and number of thunderstorms, which changes the global circulation. So these practices have probably altered the climate of local and distant regions alike, just as El Niño does when it returns every few years.



Landsat satellite images of Costa Rica and Nicaragua. On the left (a), forest is shown in red or dark pink, at M, RF, and N; while deforested cropland at SC and T is shown in pink. On the right on another day, cumulus clouds have formed over the forested areas but not over the cropland at the same elevation. Cumulus clouds develop rain showers more often over forested areas.
Photo credit: U.S. Nair, National Space Science and Technology Center, Huntsville, AL.

Today's climate is different because humans have changed the land. Chase and Pielke simulated the climate of the seasons in a "*model*" of the atmosphere and landscape, using two distinct representations of the Earth's surface (footnote 2) . One was the actual land cover, including human disturbances, and the other was a reconstruction of the original natural land cover. In simulating climate over 10 years, they saw these differences in going from the original vegetation to the current landscape:

- In the Tropics, the pattern of thunderstorm rainfall changed in a way that resembles the difference between a typical year and an El Niño year.

- In the northern continents in the winter, the jet stream was weaker, wider, and located farther north.

- Along with the jet stream changes, the simulated winter temperatures in North America, Europe and Siberia were higher. According to Pielke, the result is consistent with recent actual observations of higher air temperatures in northern lands in winter.

- "Land use changes should be expected to have global effects", the authors say, adding that regional changes seem to affect the climates of faraway continents through the process of *teleconnection*. Since the changes that show up in their simulation of both Tropical and northern winter climates resemble the changes that have been observed, they *suggest* that human land use may have already changed the climate of Earth.

Critics note that humans have been changing the landscape for the last several *centuries*, while the warming in northern winters has been observed mainly over the *last 30 years*. There is a problem with the timing. Moreover, some of the land use changes should have caused cooling. See the response of Dr. Michael MacCracken, below.

We use poor indicators of climate change – Pielke offers a new one. Roger Pielke wants to use a different indicator to track climate change, and to see if models are reproducing the changes. We have emphasized global average temperature too much , he says, but we need to track storage of heat in the sea, which will change future climate.

He has a problem with using *global average temperature rise* to measure the impact of greenhouse gases on climate. Temperature can be years out of step with whatever causes an imbalance between energy arriving at and leaving the Earth. Scientists call these causative factors "*climate forcings.*" They include such things as a release of dust or volcanic ash, greenhouse gases, and changes in the intensity of sunlight. Being massive, the oceans take centuries to warm up to a new stable temperature, after a jump in greenhouse gas levels. So as the oceans slowly absorb additional heat, and store it, the atmospheric warming is delayed for many years by the slow response of the ocean. This continues even after greenhouse gases stabilize. (See the side box on how we measure climate change.)

Pielke wants to track the potential for future climate change, by measuring the heat energy stored in the deep Ocean. How much energy have the Oceans stored? Pielke uses the work of NOAA's Sydney Levitus (footnote 3) to estimate the

How to Measure global climate change

Scientists measure the climatic effect of some disturbance (whether it's a greenhouse gas, a release of dust, or a hotter sun) by looking at the effect on the "radiative balance", which is simply the balance of incoming energy arriving at Earth, and the outgoing energy leaving Earth. If more energy arrives than leaves, then some part of Earth will warm up. The effect of a disturbance has been measured as a "Global Warming Potential" (GWP), in units of tons of equivalent carbon dioxide (CO_2) – the amount of CO_2 that changes the radiative balance by the same amount.

The radiative balance or imbalance is measured high above the atmosphere in Watts per square meter (W/m2) of land or sea surface. A positive value indicates a possible future temperature change. But Pielke points out that part of the change has already occurred, while the remainder has *yet to be realized*, because some energy was stored in the Oceans. This slows the rate of warming of the atmosphere. The more heat that the ocean stores, the less warming we see *now*, but the more warming we'll have in the future as the climate system tries to get to equilibrium.

excess energy stored. Levitus wrote that the Pacific and Atlantic Oceans have warmed since the 1950s, and the Indian Ocean since the 1960s, while the atmosphere began to warm rapidly in the mid-1970s. Large areas of the North Atlantic warmed, while the Labrador Sea cooled. The heat was stored primarily in deep layers, below 300 meters down to 3000 meters. Surface waters did not store most of the energy, but rather transported it to the deep ocean.

Using oceanographic measurements, Levitus found the oceans warmed in 25 of the 35 years from 1957 to 1992, so on average, the planet has warmed. Some 15 years ago James Hansen* publicly speculated that "excess heat must be accumulating primarily in the ocean" because the heat budget of Earth was observed to be not in balance. Levitus states that the ocean measurements confirm that, at least for the 35 year period.

From the results, Pielke calculated that the planet warmed at the rate of 0.3 W/m^2, averaged over the entire surface of the Earth, in the 40 years ending in 1995.

This heat storage is a response to *all* human and natural factors that cause climate change. Humans do more than release gases into the atmosphere; by changing the landscape, they alter the natural flows of energy and water into the atmosphere and oceans. Global temperature and "Global Warming Potential" measure only *part* of the human impact.

"Humans have an even greater effect on climate than is suggested by the IPCC** ", asserts Pielke. "The human influence on climate is significant and multi-faceted."

But humans do much more: by changing the landscape, they alter the natural flows of energy and water into the atmosphere. Global Warming Potential measures only *part* of the human impact. Pielke wants to measure the heat energy stored in the deep Ocean (in units of Joules per decade †)as an indicator of future climate change.

Editor's note: Knowing how much heat is stored is not enough to be able to predict the future warming. To get really useful information on future temperature change, we also must understand more about the circulation of the oceans; the energy imbalance at the top of the atmosphere in the past, present, and future; the evaporation of water from the oceans, and more. The indicator that Pielke proposes, though, is useful in predicting the *direction* of climate change.

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† A Joule is the metric unit of energy, equal to about 1/4 of a calorie.

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* James Hansen, climate scientist at NASA Goddard Institute for Space Studies, received widespread attention in 1988 for his statements on atmospheric warming to Congress.

** Intergovernmental Panel on Climate Change, of the United Nations Environment Programme.

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1. "Influence of the spatial distribution of vegetation and soils on the prediction of cumulus convective rainfall," by R.A. Pielke Sr, *Reviews of Geophysics*, v.39, 151-177, year 2001.

2. "Simulated impacts of historical land cover changes on global climate in northern winter," by T. Chase, R. Pielke Sr., T. Kittel, R. Nemani, S. Running, *Climate Dynamics*, v. 16, p. 93–105, year 2000.

3. "Warming of the World Ocean," by Sydney Levitus, J. Antonov, T. Boyer, and C. Stephens, *Science*, v. 287, p. 2225, Mar.

LETTERS to the Editor

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The Spring 2003 issue of *Climate Science Forum* mischaracterizes certain aspects of our research conclusions.

With respect to the effect of land-use changes on the Earth's climate system, it is the spatial redistribution of heat that makes it analogous to El Niño events. However, human use of the land has changed the surface of the Earth over larger areas than the area of well-above average temperatures in tropical Pacific waters during an El Niño. While both El Niño and land-use changes alter the general circulation model (GCM) simulations of the jet stream as a result of teleconnections (which are climate effects observed at large distances from the cause), they do not induce the same simulated changes in the spatial pattern of the jet stream.

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Land Cover versus Greenhouse Gases as a Climate Forcing

Michael MacCracken responds to Roger Pielke

Roger and I agree that land cover change should be included in efforts to explain past climate change and project future changes. Recent studies including the 2001 IPCC** report indicate that land cover change can alter local and regional climates. And Roger correctly suggests that local forcings can have global consequences, though possibly small.

We differ in comparing the influence of land cover to the climatic effects of greenhouse gases (see my article, footnote 4). I think that Roger's statement that "Land Use affects climate as much as greenhouse gases do" is seriously misleading. For a variety of reasons, land cover changes can lead to warming in some locations or cooling in other regions. Indeed, as Chase and Pielke indicate (footnote 2), the global average effect of all the land cover change is small, even though there are significant regional effects to which we may have adapted over the past century. While we don't know how human activity will change land cover in the future, it is likely that the net global effect will be modest.

In contrast, the climatic changes from rising levels of greenhouse gases will likely be substantial. The amount of projected warming is well beyond conditions that the world has experienced in millions of years. There is no indication that land cover change may initiate the deterioration of either the Greenland or the West Antarctica ice sheets, thereby raising sea level by several meters. Even where the local temperature changes from land use effects and greenhouse effects are comparable, it is not clear how much of the Earth will respond to human land use in that way, whereas virtually the whole Earth will be substantially warmed by greenhouse gases for many centuries.

It is also misleading to compare the total climatic effect of land cover changes over many centuries to the rapid fluctuations caused by El Niño. As far as the ability of society to adapt, the rate of change makes a huge difference. It is much easier for societies to adjust to slow and steady changes (e.g., due to land use) than to large, short-term fluctuations caused by El Niño. Also, the area of the sea surface undergoing temperature changes during El Niño is likely much larger than the area that will undergo significant changes in land cover.

Roger implied that IPCC put too much focus on the global average temperature. I am pleased that Roger, in contrast to other climate skeptics, apparently agrees with the authors of the IPCC and US National Assessment that there is value in paying attention to model results at the regional scales (I note that he relied upon regional results from his model simulations in footnote 2.)

What about the suggestion to use ocean heat storage as a climate indicator? Well, in addition to being hard to measure, the amount of heat in the ocean does not tell us how much more the climate will change (as Roger suggests). The heat being stored is actually slowing the change in the atmosphere.

Let me close by agreeing that the climatic influences of land cover changes do merit attention. In addition, when we include land cover change, we make the task of projecting future climates more complex and challenging, especially on the regional scale.

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4. “Do the Uncertainty Ranges in the IPCC and U. S. National Assessments Account Adequately for Possibly Overlooked Climatic Influences? An Editorial Comment,” by M.C. MacCracken, *Climatic Change*, **v. 52**, 13-23, 2002.

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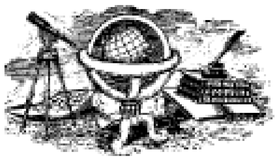

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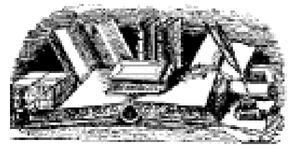

From the American Meteorological Society meeting in Long Beach

Will El Niño become permanent on a warmer Earth?

George S Philander, a Princeton University scientist who discovered many key mechanisms of El Niño, provocatively asked the audience of the American Meteorological Society, “Will global warming induce a permanent el Niño ? It has happened before!”. Philander maintains that the Earth remained “stuck” in the warm phase of the El Niño - Southern Oscillation (ENSO) until 3 million years ago. In this permanent El Niño, the waters of the eastern tropical Pacific were as warm as those in the west, with no upwelling of cold water from the deep ocean off California or Peru. The transition of the Pacific Ocean between a warm El Niño phase and a cold La Niña phase is sensitive to small disturbances. Since 3 million years ago, the climate of Earth has also become more sensitive to disturbances, such as variations in the strength of sunlight. Philander cautions that human society is introducing another disturbance – a large increase of CO_2 over background levels – at a time when the Earth is nearly as warm as it was 3 million years ago. He implies that with a little further warming, the Ocean might shift into an El Niño state that does not go away.

Philander and Alexy Fedorov wrote a review [1] about how ENSO/El Niño is changing in *Science*. A change clearly occurred around 1977 or 1980: since then, El Niños (the warm phase of ENSO) have been quite strong and brief; and La Niñas (the cold phase) have been mild but long-lasting – persisting several years. If one recognizes that the Pacific Ocean may undergo a “decadal oscillation” in which each cycle lasts 10 to 20 years, then the 1980 shift makes perfect sense, and we are due for another one. The debate about changes in El Niño then becomes a debate about the reality of this decadal oscillation, and the evidence is not clear.

El Niño cycled on and off even in a “hothouse” climate

Looking to the past for clues about a warmer Earth

The Pacific Ocean cycles between a warm El Niño state, a neutral state, and a cold La Niña state, over irregular periods of 5 to 15 years in the current climate. This cycle is termed the “El Niño - Southern Oscillation” or *ENSO*. There are reasons to suspect that the El Niño state becomes permanent when the climate of Earth is much warmer (see accompanying article). We can look at evidence of what the Earth was like in past Ages when in fact the planet was much warmer. The Eocene (from 55 to 35 million years ago) is such an era; after the demise of the dinosaurs, but long before humans appeared, temperatures remained above freezing over all northern continents, and the deep ocean was some 10°C warmer than it is today. Levels of carbon dioxide (CO_2) were about 50% higher than they are now, and twice as high as the levels of the pre-industrial age.

Physical evidence of ancient El Niño behavior is not enough to know if the condition was permanent. Danish scientist Matthew Huber gets around that problem by simulating the warm Eocene climate with a oceanic-atmospheric *model*. This particular model “produces a faithful reproduction of modern day ENSO variability”, says Huber. Using the ancient geography, vegetation, and CO_2 levels, the model produced a climate much warmer than today’s, but with ocean currents and temperatures that went through realistic El Niño cycles. In the tropics, the air did not warm as much as it did on the rest of the Earth, and the tropical Oceans showed structure and behavior similiar to modern Oceans. To support these results from a model, the authors present evidence of annual layered sediments in two lakes, having ENSO-like variations in the Eocene sediments. Huber concludes that the Eocene did have El Niño/La Niña behavior, even though it was very warm, and that a permanent El Niño did not take hold.

These results may help us understand how the Ocean responds to a warmer global climate. Huber wrote his conclusions in a report in *Science* [2].

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1. “Is El Niño Changing ?”, by Alexy Fedorov and S. George Philander, *Science*, v. 288, 1997–2001.

2. “Eocene El Niño: Evidence for robust tropical dynamics in the ‘Hothouse’ ”, by Matthew Huber and Rodrigo Caballero. *Science*, v. 299, 877–880, 7 Feb. 2003.

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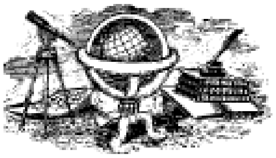

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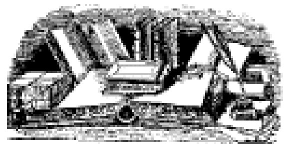

From the American Meteorological Society meeting in Long Beach

Sardines and Anchovies indicate a 50 year cycle in Pacific climate

Like the canary in a coal mine, certain fish species may be sensitive to subtle climate shifts and may indicate a climatic "regime change". At the recent meeting of the American Meteorological Society in Long Beach, CA, Francisco Chavez, an oceanographer of the Monterey Bay Aquarium laid out the evidence for a 50 year climate cycle in Pacific Ocean waters and the atmosphere above. A warm "sardine regime" alternates with a cool "anchovy regime", each lasting about 25 years; regimes shifted in the 1920's, 1950, mid-1970's, and the late-1990's. Mindful of the now-famous phrases *El Niño* and *La Niña* for the Southern Oscillation of the Pacific, Chavez, with tongue in cheek, dubs the sardine regime "*El Viejo*" and the anchovy regime "*La Vieja*".

The collapse of the sardine fishery in California after 1950 led to John Steinbeck's famous novel Cannery Row. When the sardines were abundant, as from 1977 until recently, Pacific waters were warmer, and off California and Peru, upwelling of deep water was weak, surface currents were slow, nutrients low, and primary production reduced. (Primary production is the generation of living matter by plants and one-celled organisms using sunlight, CO_2 and water.) On the Asian side of the Pacific, and near Alaska, opposite conditions prevailed: nutrients were high, and primary production was enhanced. Sardines were abundant in both areas.

In the "anchovy" or cool regime from 1950 to 1977, and now returning since the late 1990's, waters off California and Peru benefit from nutrient-rich, cold water welling up from the deep ocean. These nutrients nurture more plankton which support anchovies and salmon. Again, Alaska (where salmon became fewer) and Asia (where waters became less productive) experience the opposite effects.

The atmosphere also participated in these regimes. From about 1940 until 1976, when the ocean was a bit cooler, global air temperatures rose slowly or not at all, and carbon dioxide levels increased more slowly than they did later. Chavez subtracted the 100 year trends from the annual values to compute "departures from the trends" of air temperature and CO_2 concentrations. Also the stormy Aleutian Low pressure system was weak in the time of the anchovy regime. That aided the southward flow of cold water in the California current, which brings nutrients to California. In contrast, after 1976, global average temperatures and the levels of CO_2 increased faster than the 100 year trend, in the "time of the sardines." The Aleutian Low was strong, and salmon were abundant in Alaska (but deficient in the Pacific Northwest).

In reviewing the work of many others, Chavez has demonstrated a 50 year natural cycle in the Pacific basin (atmosphere, ocean, and biosphere). He cautions that the causes of the variations, and the relation to El Niño / La Niña, are not yet understood. Further, multi-decade natural variations like "El Viejo - La Vieja" complicate the interpretation of climate change, which depends heavily on the evidence of the last 100 to 140 years of instrumental records. A full report of Chavez' work appears in *Science* magazine[1]

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1. The article is in *Science*, v. 299, 217-221, 10 Jan. 2003.

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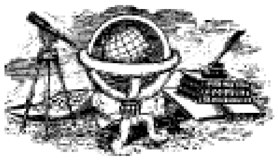

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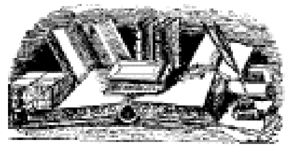

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CLIMATE BRIEFS

Rainfall variability slowed growth but raised species diversity

Climate refers not only to average conditions in a particular place, but also to the variations around the average. These may be oscillations, slow or fast, or there may be a long term trend. The variability of climate seemed to strongly affect living communities, but proof has been scarce.

In a controlled experiment on experimental plots of native grasses, a team demonstrated that large swings in rainfall patterns reduced the productivity of plants, even with no change in average rainfall (footnote 1). Yet the variations increased the variety of plant species able to live on the experimental plots. A team of 3 biologists under Alan Knapp of Kansas State University altered the length of time between rainfall events, and increased the rainfall in at least one event, though the total rainfall for the year was the same in all the plots.

"This study is the first to manipulate climate variability in an intact ecosystem, without altering the average climate," said Quentin Wheeler of the National Science Foundation. Knapp added, "When these native grassland plots, exposed to more variable rainfall, were compared with plots that received rainfall in a natural pattern, the overall growth of all plants decreased. More variable rainfall led to lower amounts of water in the soil in the top 30 centimeters. Since this is where most plant roots occur, and where soil microbes are most abundant, grasses were water-stressed."

In contrast, diversity of plants increased in the plots with more variable rainfall (more species were found). Whatever the reason for that, plant communities can be significantly changed, and the cycling of carbon can be slowed, in as little as four years when grasslands are confronted with a more variable climate.

Knapp added that climate extremes, such as more severe droughts or frequent heavy rains, can affect living communities as much as long term increases in temperature, or changes in average rainfall.

Two new topics in Next IPCC Report on Climate Change

Carbon sequestration and prediction of Regional Climate Change will be given special status in the next report of the international scientific body, the Intergovernmental Panel on Climate Change (IPCC) in 2007, according to the new Chair of the IPCC.

Sequestration is the deliberate removal of carbon dioxide (CO_2) from the atmosphere or from exhaust gas. The carbon may be stored in living systems such as wood in new forests, in mineral form deep underground, or even in the deep ocean. Because it is deliberate, sequestration can be an important part of a climate policy of a nation or the world.

Another controversial climate issue is the forecast of regional effects of climate change, especially forecasts made by model simulations. The issue includes the thorny scientific problem of predicting future changes in a region's climate, which (many say) is beyond the ability of current climate science and modeling. It also embraces the prediction of regional impacts of global-average changes in climate.

National Research Council: Abrupt climate change is likely

Abrupt changes of climate have occurred repeatedly in recent, historic, prehistoric, and geological records. Future changes are likely to be abrupt and to have serious consequences. So say the eleven authors of the National Research Council (NRC) report Abrupt Climate Change: Inevitable Surprises, in a Review that recently appeared in *Science* [2]

Evidently the climate system has often shifted from one state to another in remarkably abrupt ways. During the Ice Ages, some regions underwent temperature changes that were half as great as the global change going from an Ice Age to an ice-free climate – and these changes occurred in about 10 years ! During 140 years of instrumental observations, there has been an abrupt warming in the Arctic of the 1920's, several droughts like the Dust Bowl of the 1930's, and a sudden change in Pacific Ocean climates in 1976 that was manifested in diverse ways around the world.

Sudden climatic change requires a trigger and an amplifier, many examples of which the NRC identified. Nevertheless, "general circulation models" that simulate the climate often underestimate or fail to capture the pattern of changes. "Either some natural forcings have been omitted from the experiments", or the models do not estimate the extent of climate response to triggers, they say.

Understanding how climate change impacts ecosystems and human societies has been achieved by analyzing slow and gradual change. But abrupt change will likely harm immobile or long-lived creatures and individuals the most. A few studies conclude that faster and less anticipated climate change is very costly.
The authors conclude that an increase in human forcing of climate may elevate the probability of triggering abrupt climate changes.

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1. "Rainfall Variability, Carbon Cycling, and Plant Species Diversity in a Mesic Grassland", by Alan K. Knapp, and 11 others. *Science*, v 298, 2202-2205, 13 Dec 2002.

2. "Abrupt Climate Change", by R.B. Alley and 10 others, *Science*, v.299, 2005–2009, 28 Mar 2003.

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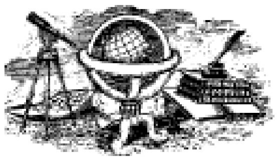

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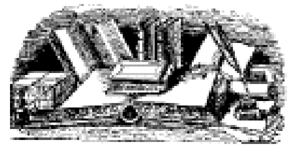

From the National Academy of Sciences:

US Climate Plan lacks a Vision, priorities, and resources

(Feb. 26, 2003) The US government's plan for Climate Change Science "lacks a vision, clear goals, and explicit priorities," the National Academy of Sciences (NAS) said today. The new US Climate Change Science Program had asked the Academy to critique the Draft Plan, released last November. "While past climate-change science has focused on how climate is changing, future science must focus on research that directly supports decision making, " said Thomas Graedel, Professor of Industrial Ecology at Yale, and chair of the Academy committee. We must understand how climate changes will affect human societies and natural ecosystems, and how to reduce these effects, he added.

The Academy recommends a major revision. One year ago the White House created a new Climate Change Research Initiative (CCRI), that is supposed to deliver answers to policymakers on key scientific questions within 2 to 4 years. But the Academy doubted that Science can deliver the results within 4 years. Instead, they suggest, CCRI should do research that directly helps decision making, without regard to time periods.

Too many cooks. "There are too many decision makers", the report adds. There are 13 separate federal agencies and departments involved in the policy, science and technology of climate change. The Academy implied that the CCRI initiative is doomed to failure, unless it is given clear management.

Outmoded Top-Down Approach. The Plan was criticized for adopting an "outmoded, one-way, top-down mode" of communicating with stakeholders and policy makers. The authors seemed to prefer "new techniques for engaging members of the public in choosing public policy," though they did not say what these were.

Emphasize the Impacts. The Academy wanted emphasis on "Impacts" of climate change and "Adaptation" to it. Previous national and international reports did that, but the new Draft Plan does not build on them. The Academy referred to the *U.S. National Assessment*, and the *Third Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) of the United Nations.

Climate Modeling. The goals for climate modeling were seen as too ambitious. The goal of fully understanding cloud-climate feedbacks in 2 – 4 years was deemed "unrealistic." Ways to get more supercomputing power, and to train the next generation of professionals, are not spelled out nor funded.

Uncertainty. The Academy praised the discussions on "scientific uncertainty." But the Plan did not identify which climate uncertainties need to be reduced, especially for decision makers.

To really achieve the goals, the Nation must: (1) build new intellectual talent and human resources;
(2) spend a lot more on computing resources; and (3) propose funding for new programs, which has not been done.

The Climate Change Science Program will release its final Plan by June 25.