



# Can a Good Climate Go Bad?

*Understanding the Diagnosis*

A large, curved view of the Earth from space, showing the blue oceans, white clouds, and brown/green landmasses, set against the blackness of space. The Earth's horizon is visible at the top and bottom of the frame.

## Part 3: Climate Now Climate Future

6th Annual Environmental Health Sciences Summer Institute for K-12 Educators  
University of Texas, Austin

Before we can understand climate change, we need to know what determines climate from place to place...

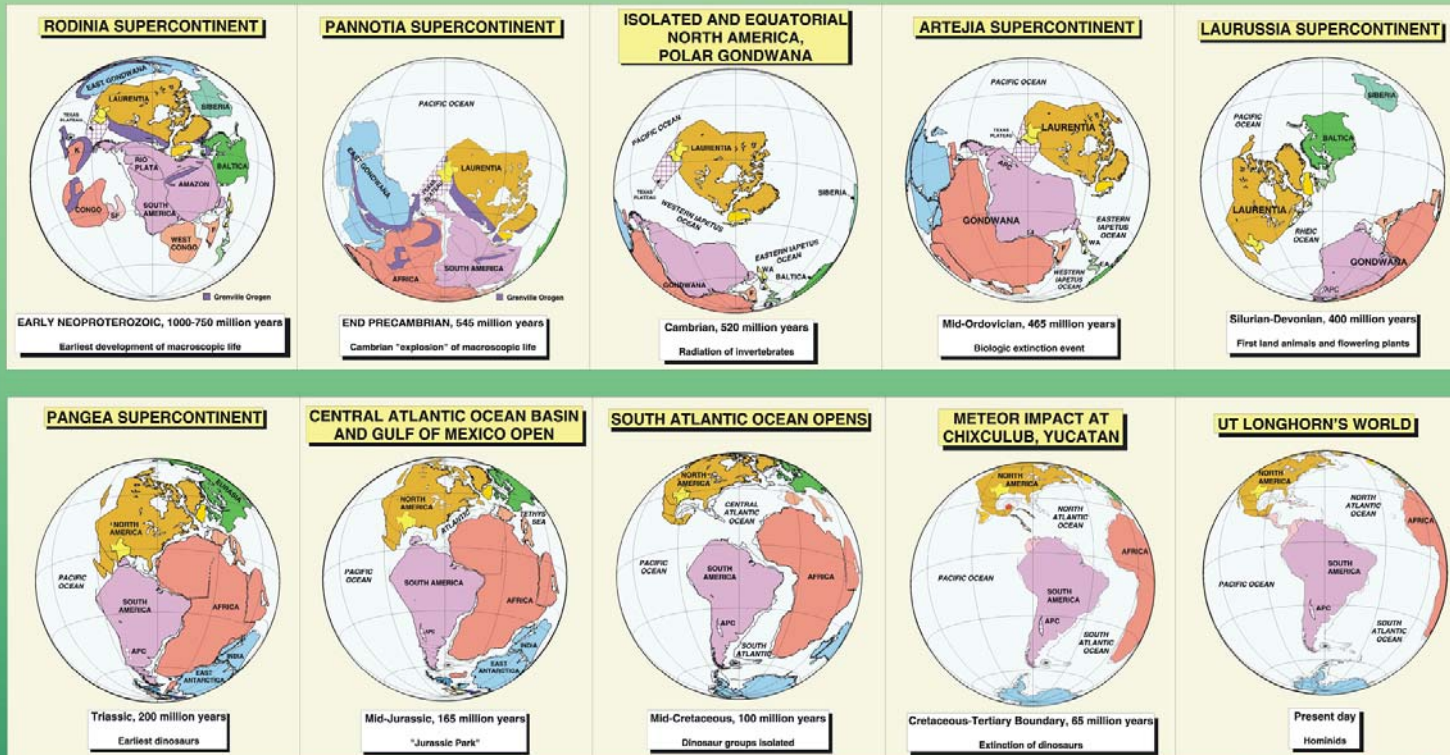
[www.ig.utexas.edu/research/projects/plates/#movies](http://www.ig.utexas.edu/research/projects/plates/#movies)

# Climates in Comparison



## THE MAKING OF TEXAS

Ian W.D. Dalziel and L.M. Gahagan  
 Institute for Geophysics; The University of Texas at Austin;  
 4412 Spicewood Springs Road, Bldg. 600; Austin, Texas 78759;  
 e-mail: [ian@utig.ig.utexas.edu](mailto:ian@utig.ig.utexas.edu)

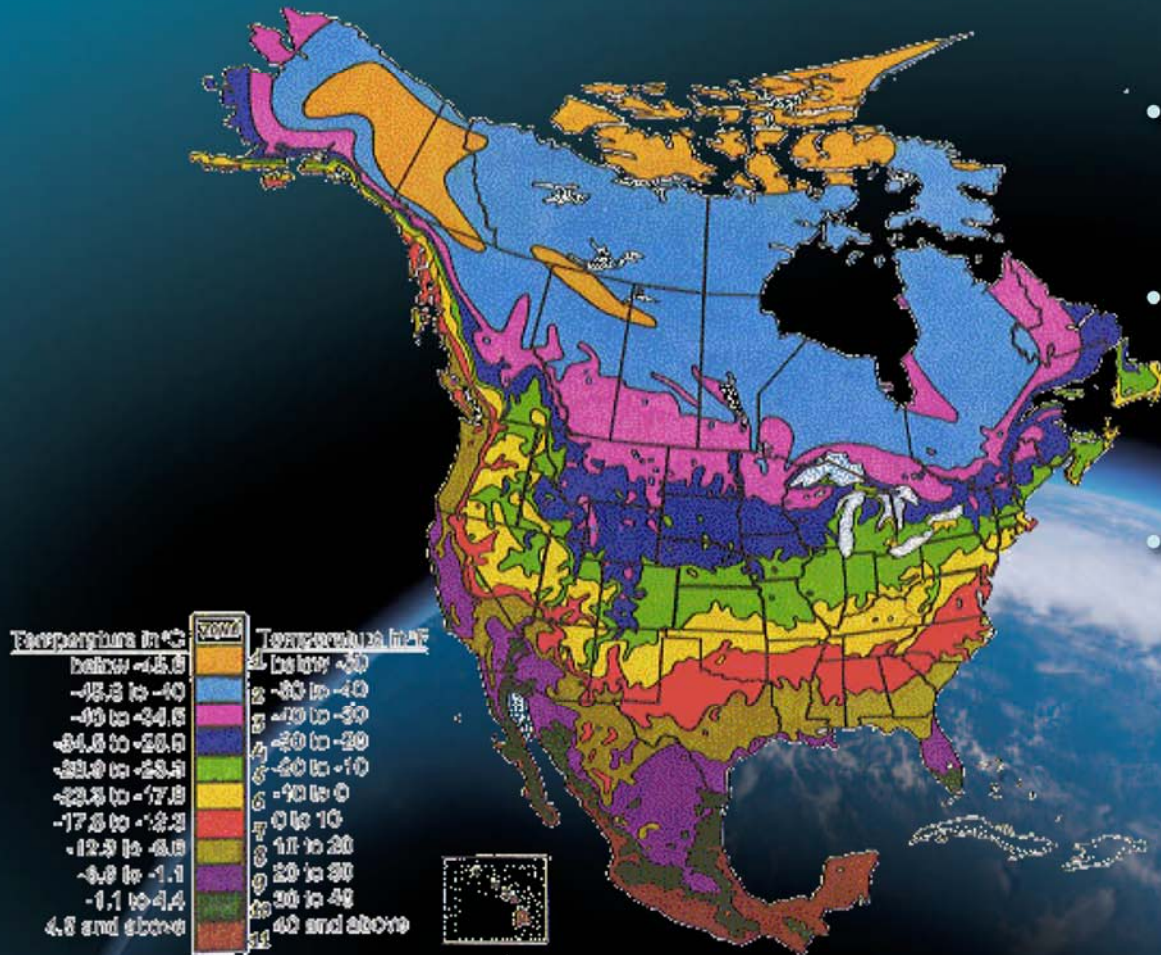




1990 USDA Climatic Zone Map

# What is weather?

- The average weather for a region over a long period of time – 30 years or more
- Determined by latitude, altitude, topography, proximity to oceans/position in land mass, and aspect
- Characterized by temperature, winds, and rainfall





# Article Discussion

## *What Makes Good Climates Go Bad?*

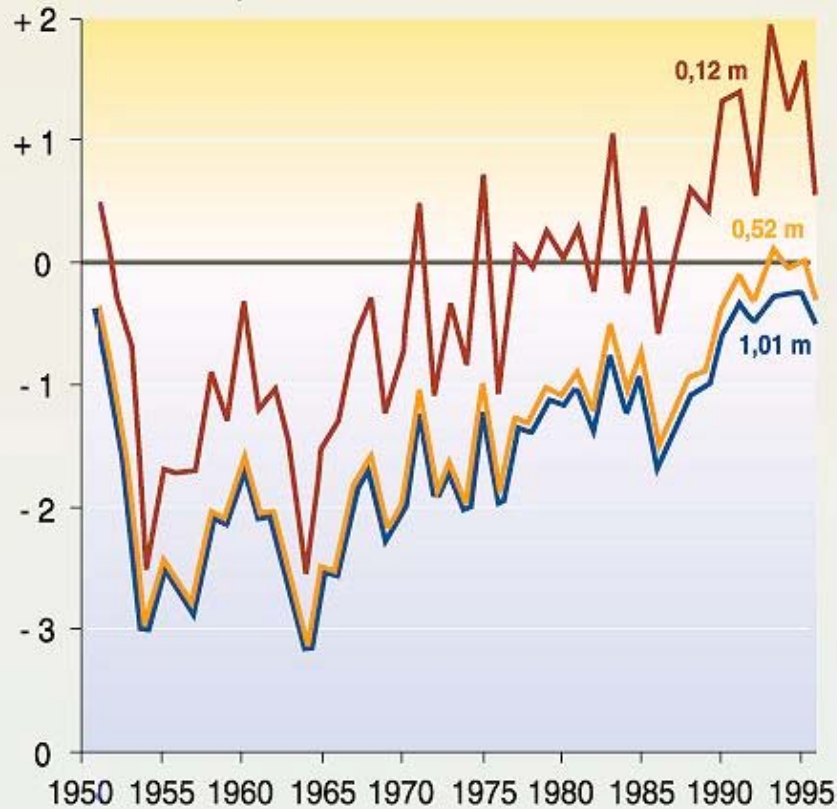
By Mickey Glantz, NCAR





## Change in permafrost temperatures at various depths in Fairbanks (Alaska)

Mean annual temperature °C



Soil depth (in meter)

— 0,12 m

— 0,52 m

— 1,01 m

GRID  
Arendal UNEP

GRAPHIC DESIGN : PHILIPPE REKACEWICZ

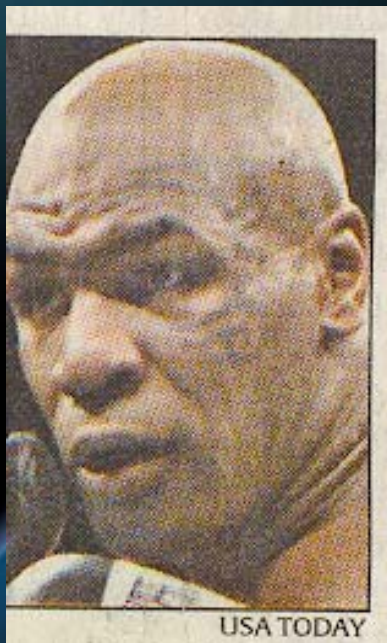
Source: Romarovsky, in Impacts of global climate change in the Arctic regions, IASC, Tromsø, April 1999.

**Permafrost in the Arctic is melting, leading to infrastructure damage as well as disrupting subsistence life styles**





*USA Today*  
Monday,  
June 13, 2005



**Tyson: 'I'm just  
happy it's over'**

## The debate's over: Globe is warming

Politicians, corporations and religious groups differ mainly on how to fix the problem

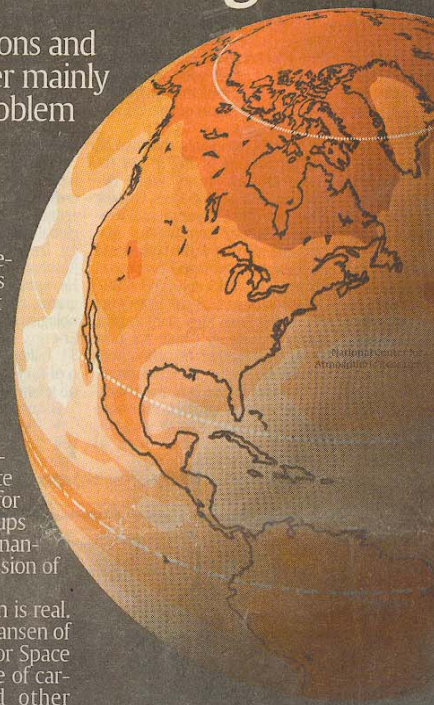
By Dan Vergano  
USA TODAY

Don't look now, but the ground has shifted on global warming. After decades of debate over whether the planet is heating and, if so, whose fault it is, divergent groups are joining hands with little fanfare to deal with a problem they say people can no longer avoid.

**Cover story** General Electric is the latest big corporate convert; politicians at the state and national level are looking for solutions; and religious groups are taking philosophical and financial stands to slow the progression of climate change.

They agree that the problem is real. A recent study led by James Hansen of the NASA Goddard Institute for Space Studies confirms that, because of carbon dioxide emissions and other greenhouse gases, Earth is trapping more energy from the sun than it is re-

Please see COVER STORY next page ▶

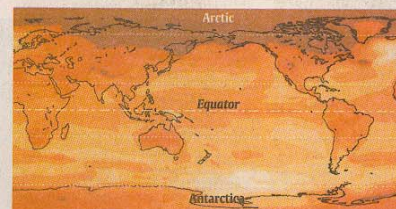
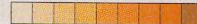


### A warming world

This simulation compares air temperatures near Earth's surface during the last 20 years of the 20th century with projections of temperatures during the last 20 years of the 21st century. The greatest warming occurs in the Arctic and Antarctica.

#### Projected temperature increase from 2000 to 2100

0 1.8 3.6 5.4 7.2 °Fahrenheit



Note: The Community Climate System Model map is the product of computer simulations developed at the National Center for Atmospheric Research with input from university and federal climate scientists.

Source: National Center for Atmospheric Research

USA TODAY



**2ND-QTR SIZZLE**  
**PROFITS AT 900**  
**COMPANIES** (P. 74)

**PAYING FOR COLLEGE**  
**BEWARE OF THOSE**  
**HIGH 529 FEES** (P. 96)

**TERRORISM** WHAT  
**COMPANIES STILL**  
**NEED TO DO** (P. 26)

The McGraw-Hill Companies

# BusinessWeek

NOVEMBER 14, 2005

www.businessweek.com

## GLOBAL WARMING

Why Business Is Taking It So Seriously

BY JOHN CAREY (P. 60)



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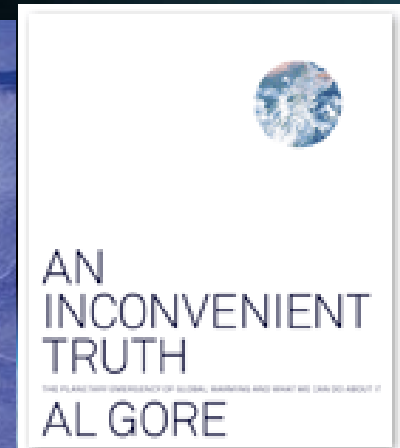
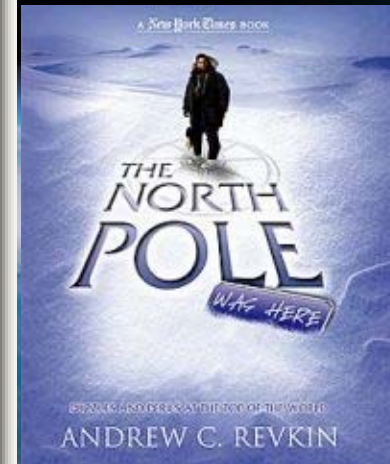
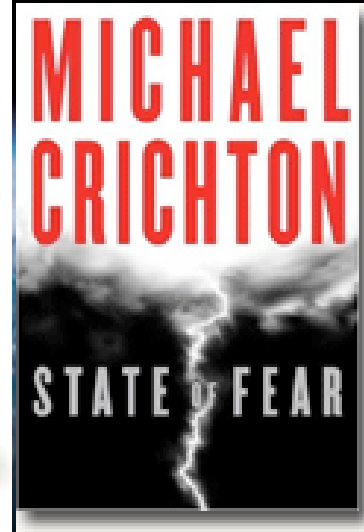
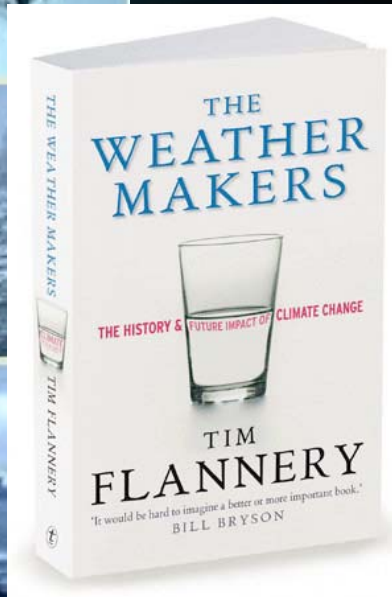
SCENES FROM THE MOVIE  
THE DAY AFTER TOMORROW



# Activity:

## Climate in the News

### *Listening Critically to its Voices*



Source: [DayAfterTomorrowFacts.org](http://DayAfterTomorrowFacts.org), a project of the [Energy Future Coalition](http://EnergyFutureCoalition.org)

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**Iceberg above surface --**

**What we see of a news event**

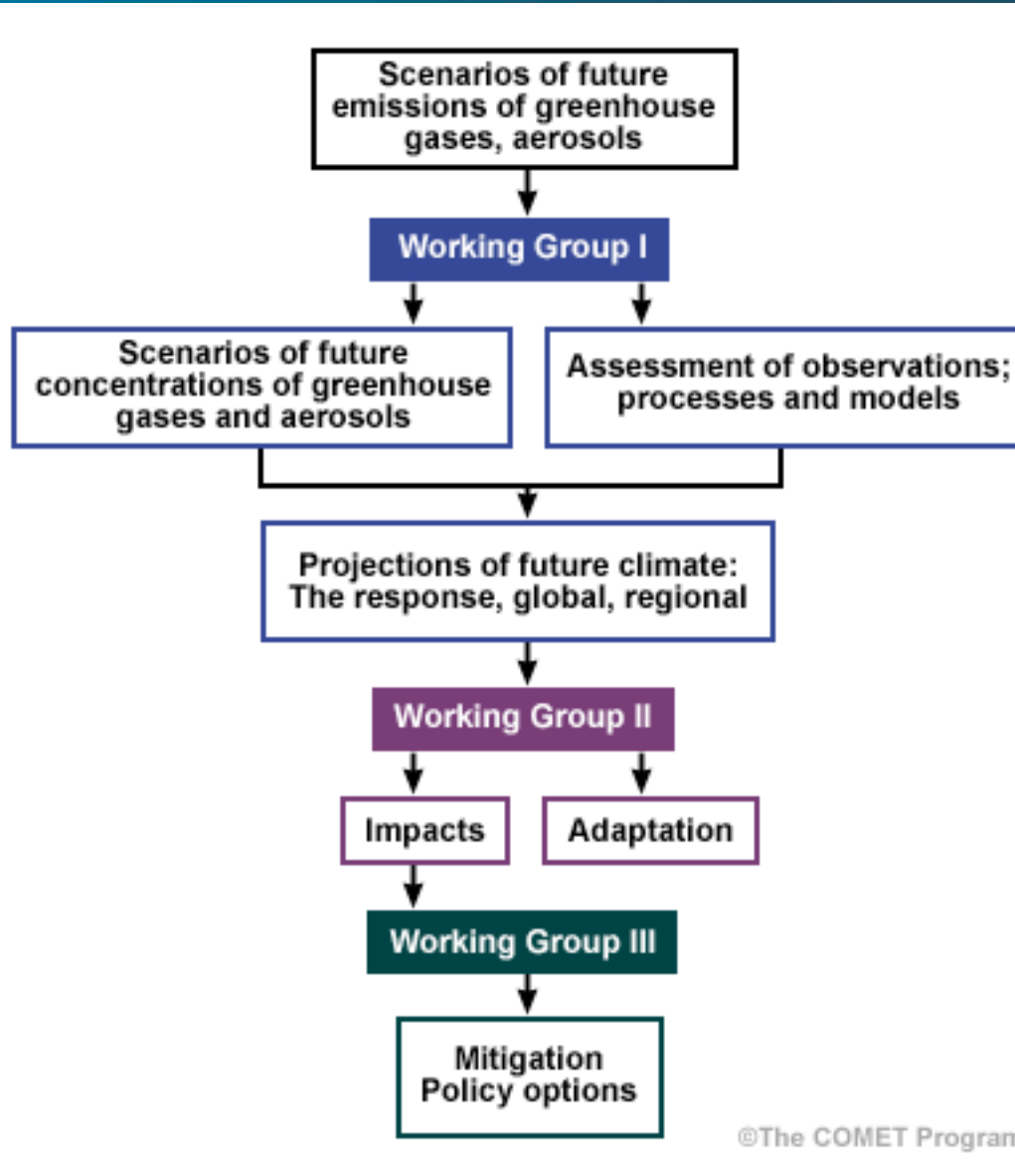
**Patterns - just under the surface**

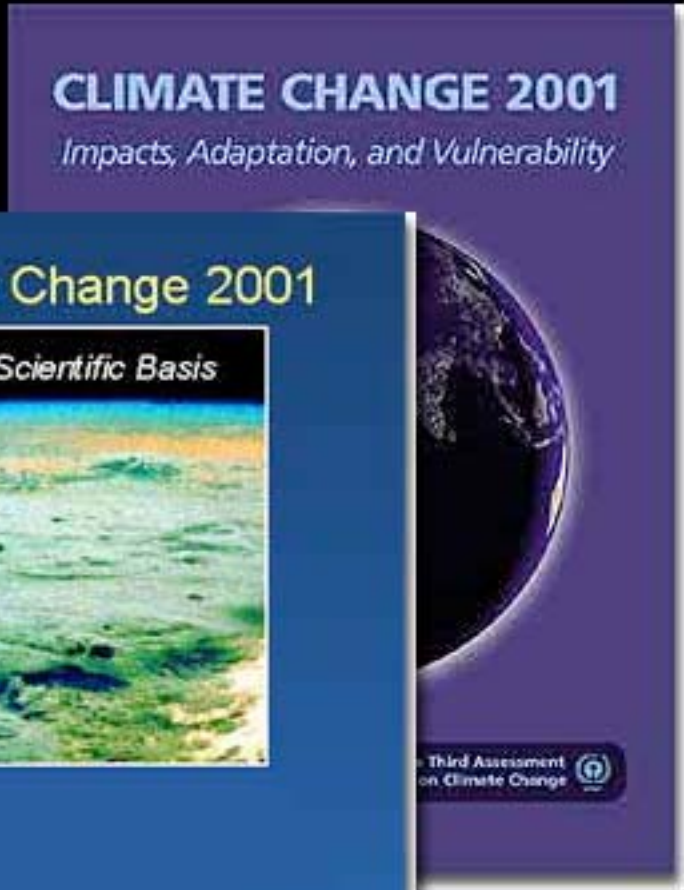
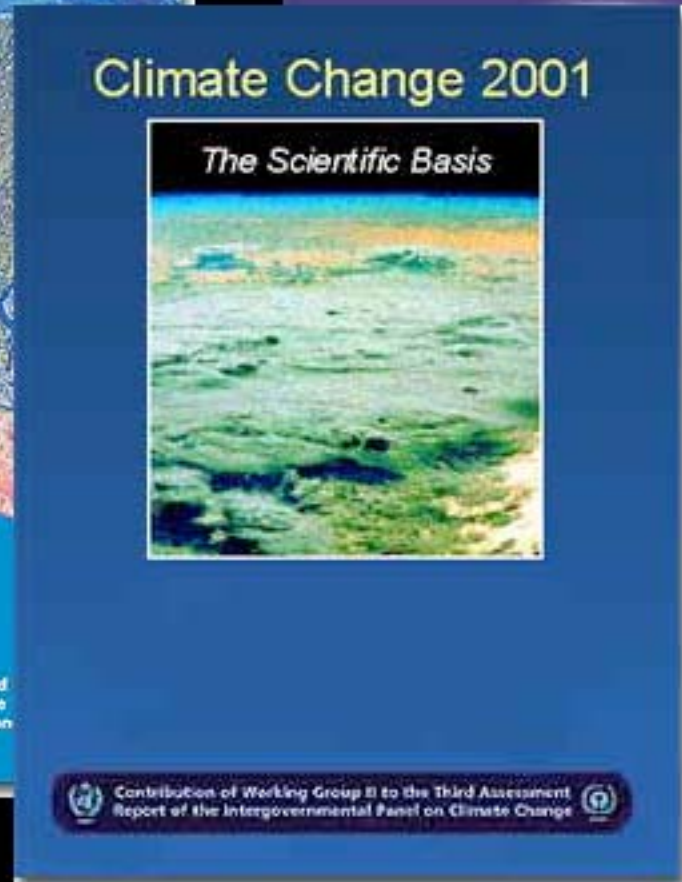
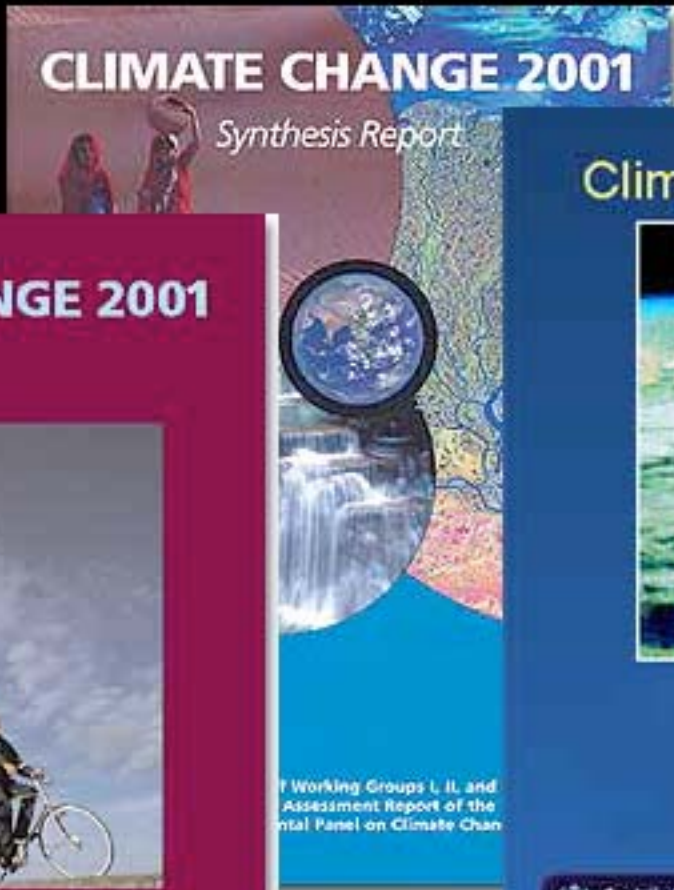
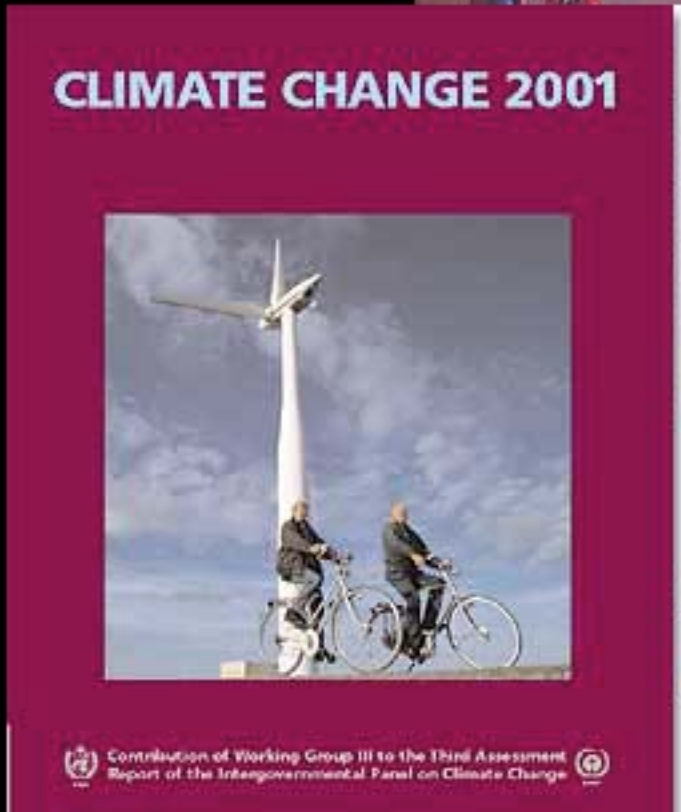
**Underlying structures, root causes,  
or deep seated values**



# The Dominant Voice of Science on the Issue of Climate Change:

## Intergovernmental Panel on Climate Change (IPCC)







# *The Science ... Some Basics*

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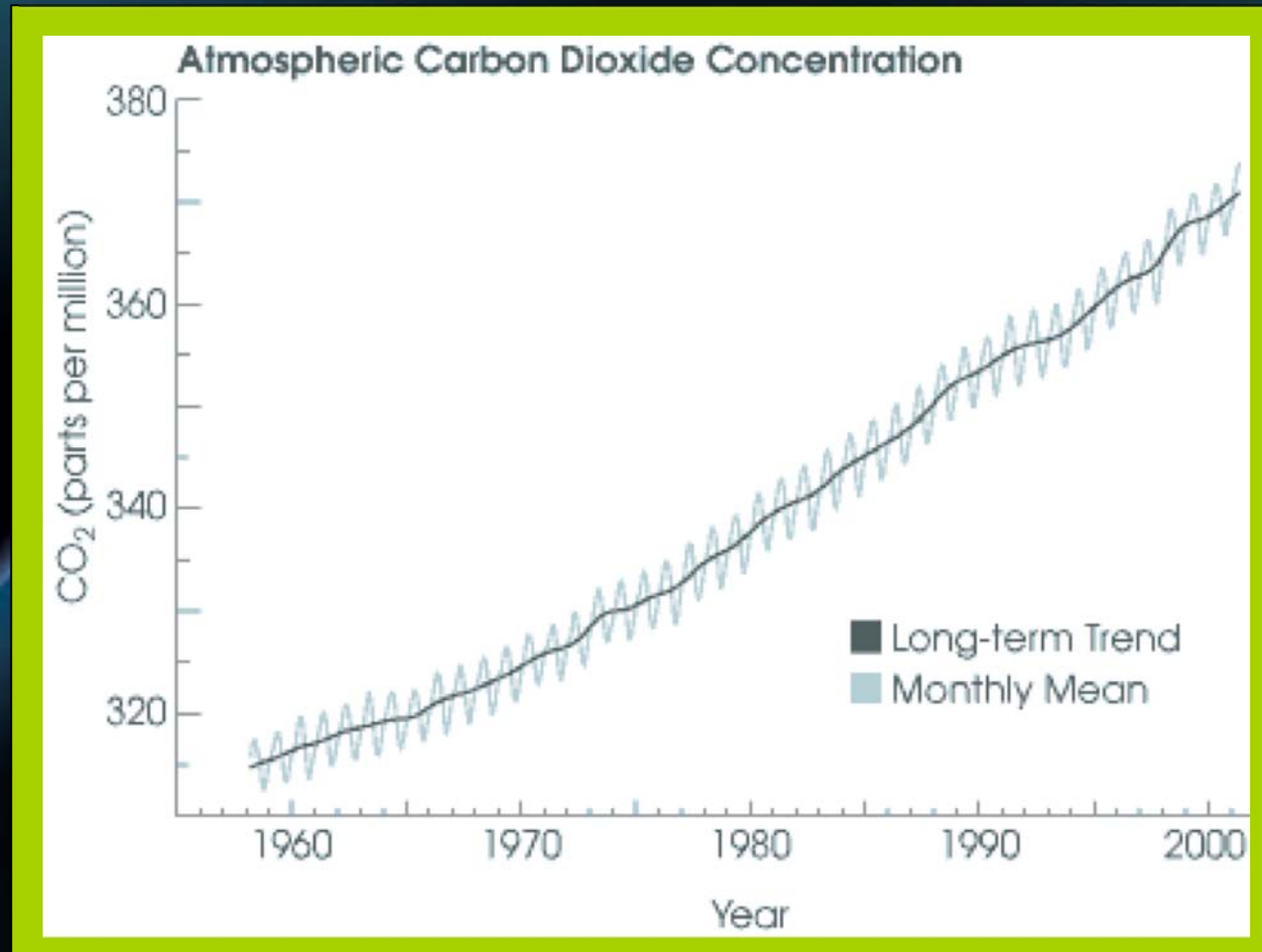
# What We Know About Climate Change

- ✓ Water vapor, CO<sub>2</sub>, and other greenhouse gases act to warm the atmosphere by absorbing some of Earth's outgoing radiation and re-radiating some this energy back to the surface.
- ✓ CO<sub>2</sub> levels in the atmosphere have risen more than 30% since widespread fossil fuel use began -- the highest in more than 400,000 years.
- ✓ Earth's average surface temperature has risen more than one degree F (0.6 degrees C) since 1900.
- ✓ The thickness and extent of the Arctic's sea ice have decreased dramatically over the last 50 years.
- ✓ Glaciers are retreating.

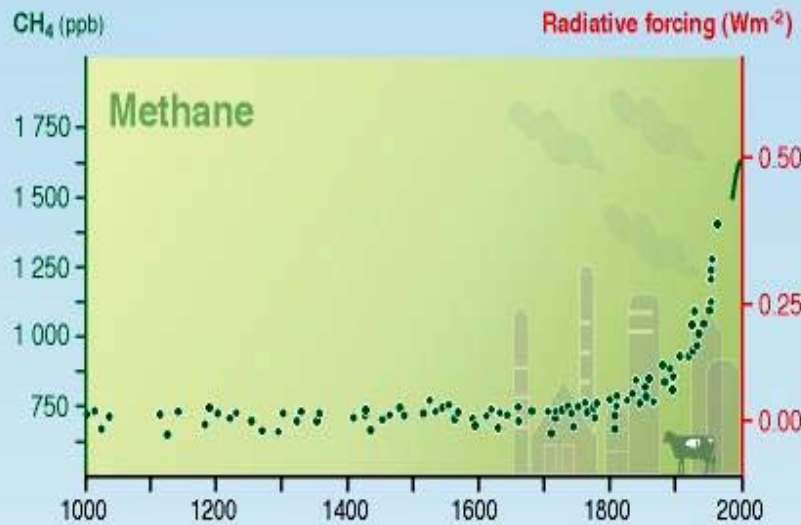
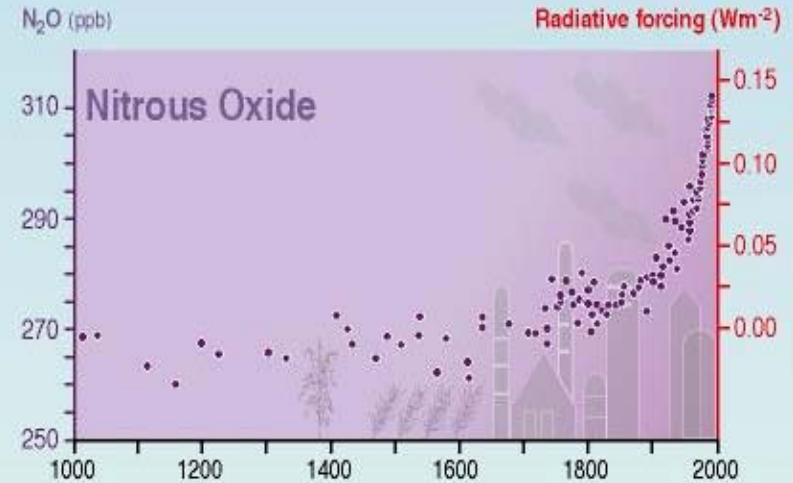
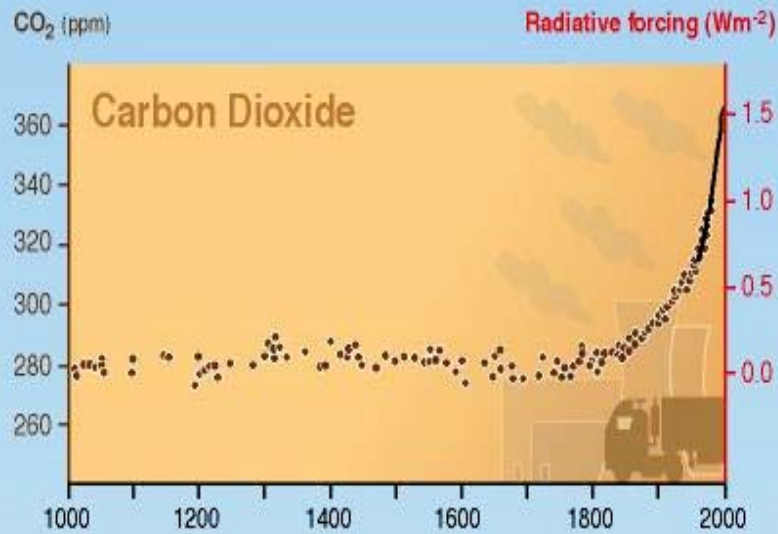




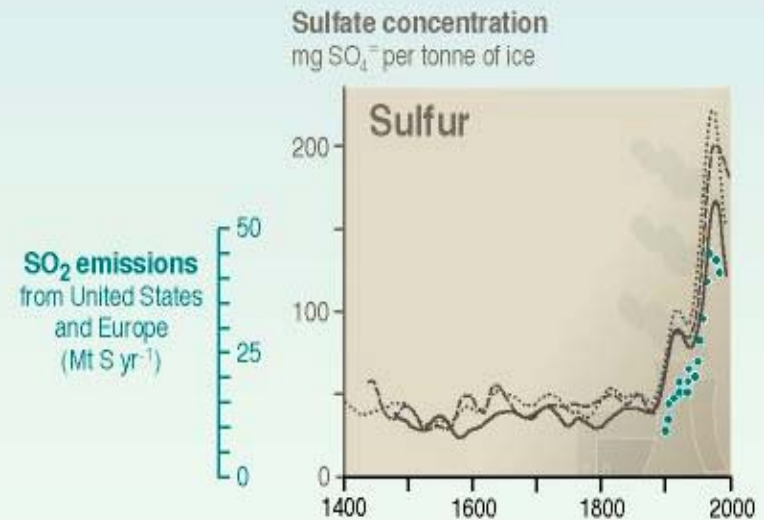
# Concentration of Carbon Dioxide (CO<sup>2</sup>)



# Changing Atmospheric Composition: Indicators of the Human Influence



**Sulfate aerosols deposited in Greenland ice**



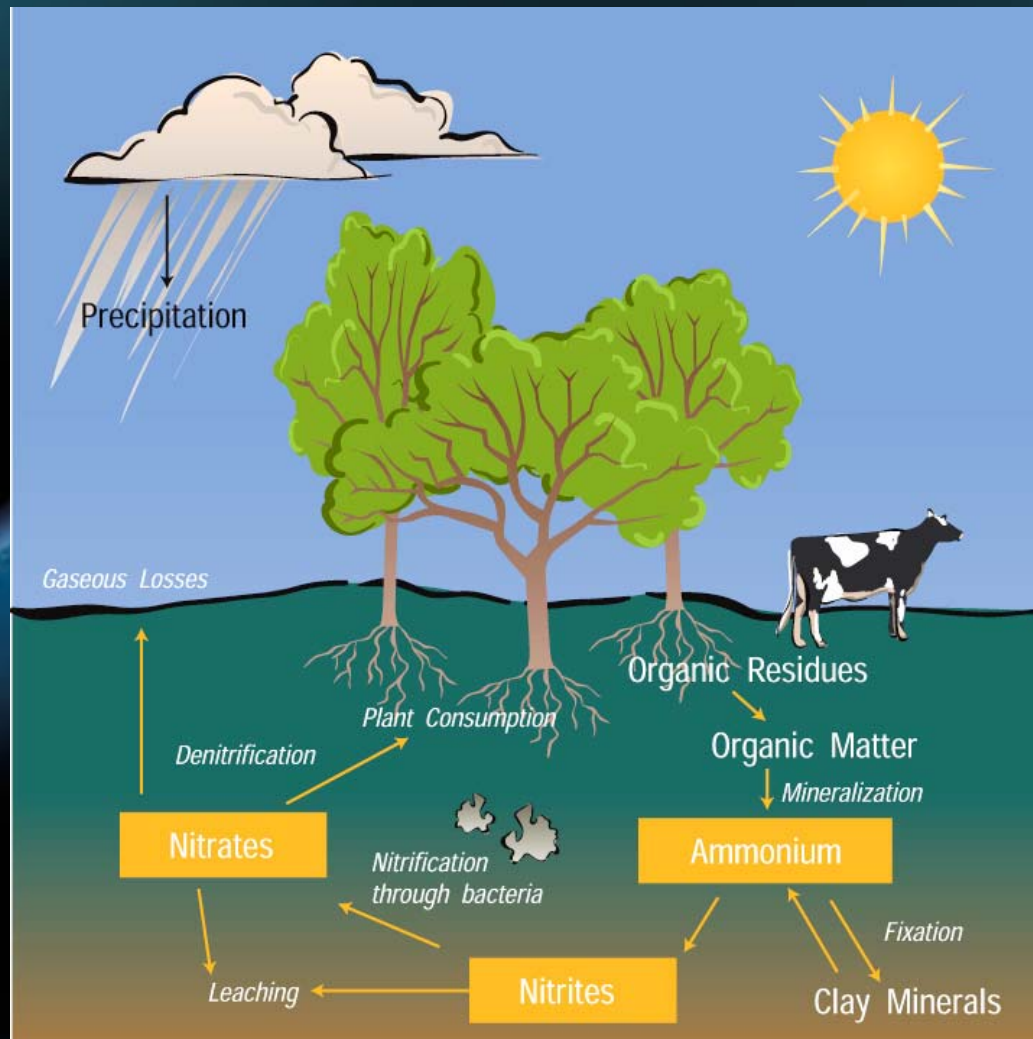




# Algae Bloom in the Baltic Sea

**Warmer seas are likely to lead to an increase in intensity, duration, and extent of harmful algal blooms**

# The Nitrogen Cycle Game







Carbon, Climate, and Laser Technology

## The Carbon Cycle Pursuit Game

### Teacher's Guide

- [www.atd.ucar.edu/apol/biocomplexity](http://www.atd.ucar.edu/apol/biocomplexity)
- [www.eo.ucar.edu](http://www.eo.ucar.edu)

#### Subject Focus:

Earth Science  
Biology  
Chemistry

#### Materials & Preparations

#### Time:

**Preparation:** 30 minutes  
to make one game,  
although the process can  
be greatly expedited by  
involving students

**Introduction:** 10 minutes

**Playing time:** 30 minutes

#### National Science Content Standards Addressed:

Standards C, D, and F

#### Learning Objectives:

- Learn the biological carbon cycle as each team moves as carbon through the atmosphere, oceans, biosphere, and lithosphere
- Correctly identify and use the terms carbon source, sink, and reservoir
- Learn about human's role today in impacting the carbon cycle
- Understand that the carbon cycle is a dynamic system that plays a significant role in Earth's atmospheric composition
- Understand that changes in Earth's atmospheric composition impact climate and life on Earth

#### Objective of Game:

Small groups of 2-3 students work together to correctly answer questions about the carbon cycle and advance through all seven carbon reservoirs on the game board before their opposing team.

[http://www.atd.ucar.edu/apol/Library\\_Activities.htm](http://www.atd.ucar.edu/apol/Library_Activities.htm)

The Main **Greenhouse Gases**

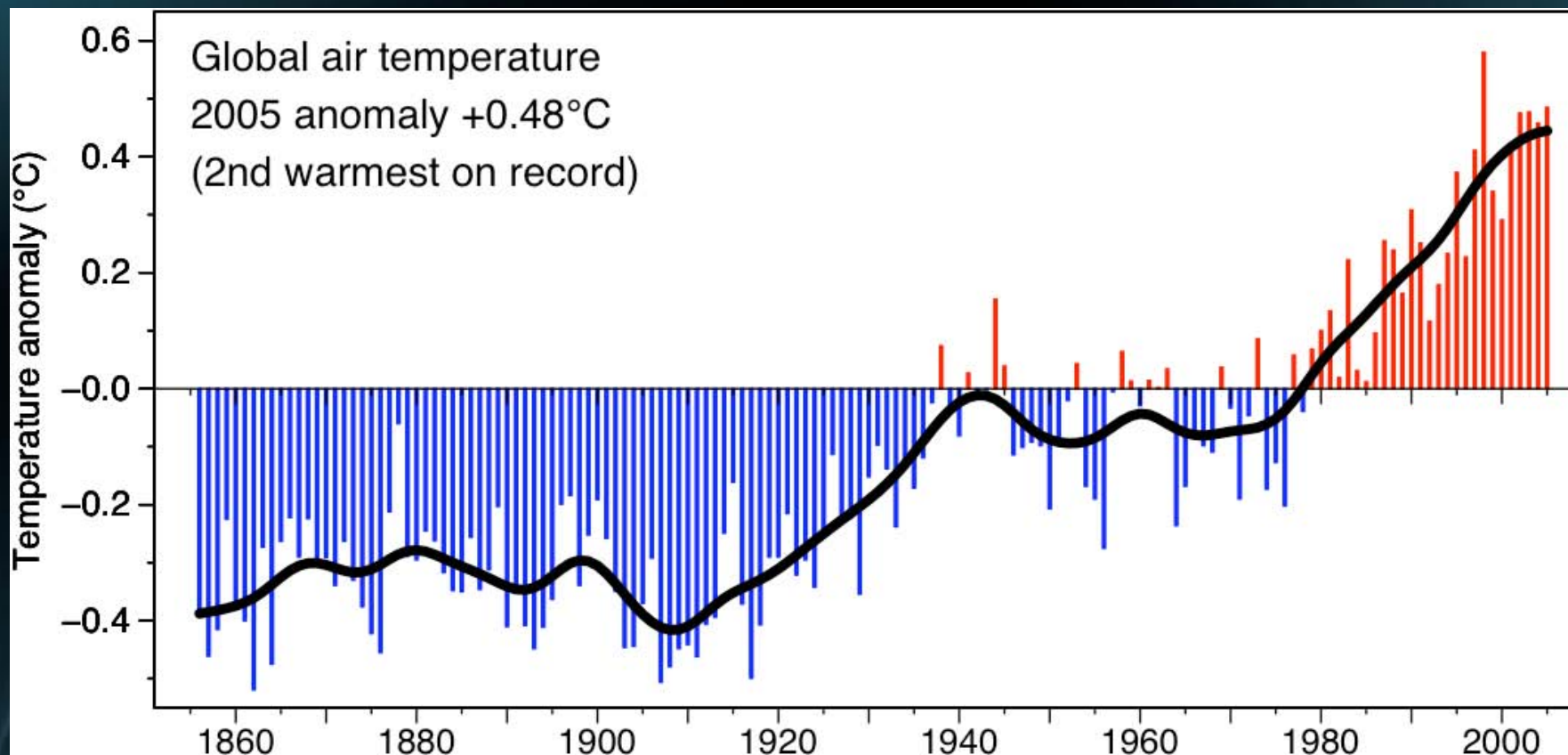
Greenhouse gases	Chemical formula	Pre-industrial concentration (ppbv)	Concentration in 1994 (ppbv)	Atmospheric lifetime (years)*	Anthropogenic sources	Global warming potential (GWP)**
Carbon dioxide	CO <sub>2</sub>	278,000	358,000	Variable	Fossil-fuel combustion Land-use conversion Cement production	1
Methane	CH <sub>4</sub>	700	1,721	12.2+/-3	Fossil fuels Rice paddies Waste dumps Livestock	21***
Nitrous oxide	N <sub>2</sub> O	275	311	120	Fertilizer Industrial processes Combustion	310
CFC-12	CCl <sub>2</sub> F <sub>2</sub>	0	0.503	102	Liquid coolants Foams	6,200-7,100****
HCFC-22	CHClF <sub>2</sub>	0	0.105	12.1	Liquid coolants	1,300-1,400****
Perfluoro-methane	CF <sub>4</sub>	0	0.070	50,000	Production of aluminum	6,500
Sulfur hexa-fluoride	SF <sub>6</sub>	0	0.032	3,200	Dielectric fluid	23,900



# Annual Global Mean Surface Temperature



Earth's average surface temperature increased 1 degree F. (.6 degrees C.) during the 20th century.



# Top 5 Warmest Years Worldwide

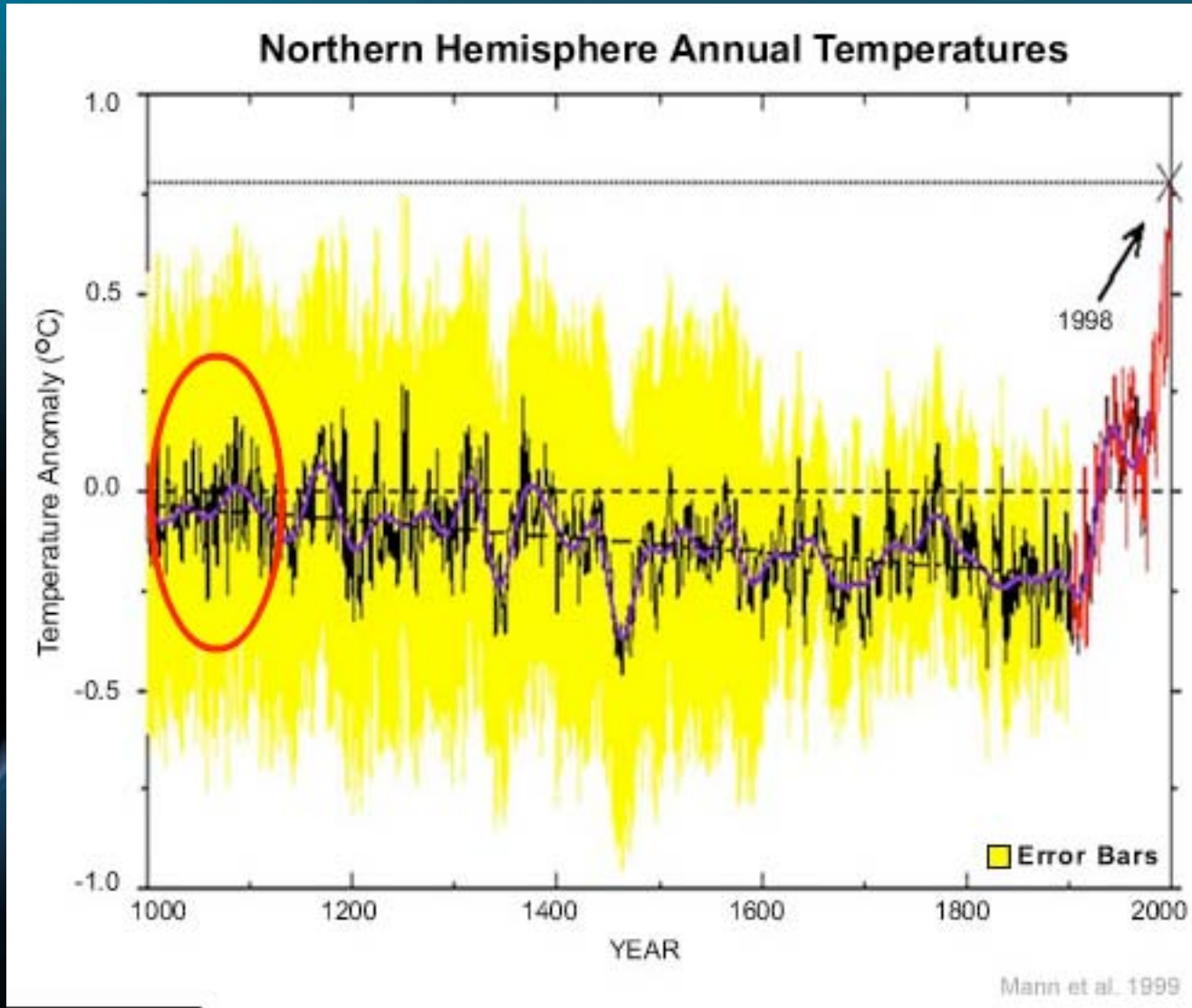
## Since the 1890s

1. 2005
2. 1998
3. 2002
4. 2003
5. 2004

Note: The first 6 months of 2006  
are the warmest on record.

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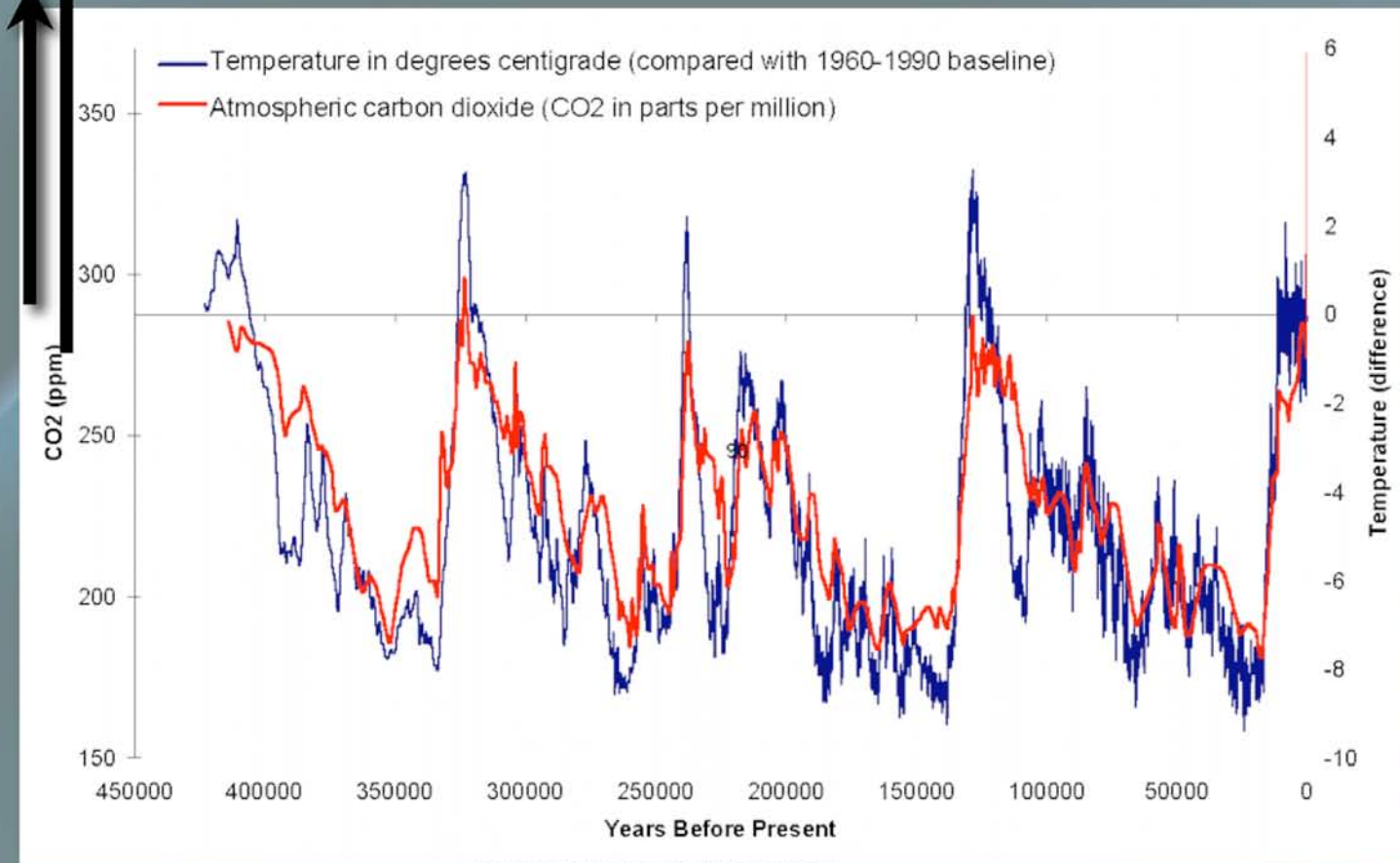




**600ppmv CO<sub>2</sub> by 2060**

# Climate in the Ice Cores -- Now Extends Back 1 Million Years!

**381 ppmv  
CO<sub>2</sub> in 2005**





# Glaciers are Retreating Globally

In Switzerland...

In Alaska...



from "Rhone-Glacier and its Ice Grotto" M. Carlen & Fotohaus Geiger



c. 1950 • Univ. of Alaska Library



© 2001 Gary Braasch

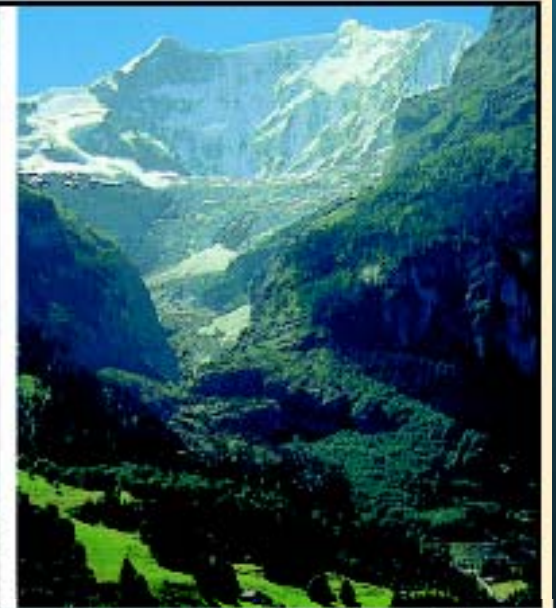
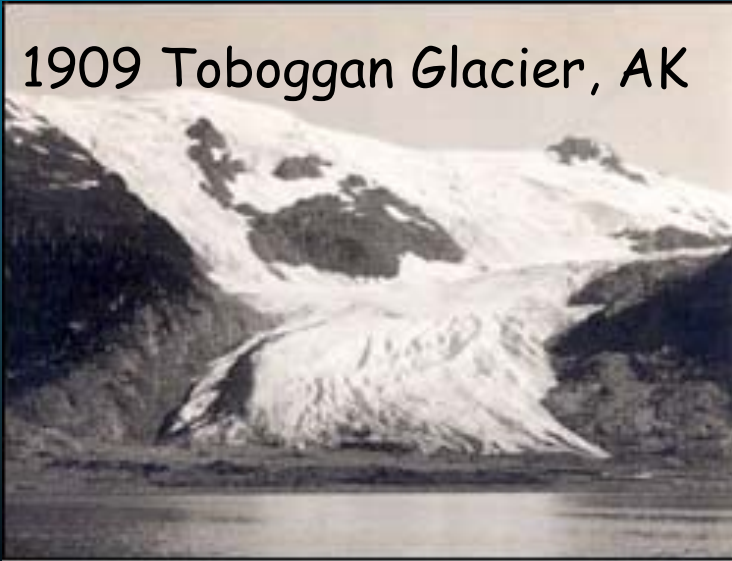


© 2002 Gary Braasch



# Evidence for the Reality of Climate Change

1909 Toboggan Glacier, AK



1858 Grindelwald Glacier, Switzerland



1951 Franz Josef glacier New Zealand



# And in Africa

## The Melting Snows of Kilimanjaro



Sources: Meeting of the American Association for the Advancement of Science (AAAS), February 2001 ; Earthobservatory.nasa.gov.

# Climate Change effects on Coral



## **Coral reef bleaching has been detected around the world**

Caribbean - Florida Keys, Bermuda, Bahamas

Pacific - Mexico, the Philippines, Panama, the Galapagos, Australia, Papua New Guinea, American Samoa, Fiji

Persian Gulf

Indian Ocean – Seychelles, Kenya, Reunion, Mauritius, Somalia, Madagascar, Maldives, Indonesia, Sri Lanka, Gulf of Thailand, Andaman Islands, Malaysia, Oman, India, and Cambodia

- Increasing CO<sub>2</sub> reduces alkalinity of surface waters, reducing coral calcification, producing weaker and smaller skeletons
- Warmer ocean temperatures cause corals to expel color-producing algae that live inside them and are crucial to their survival - a process called coral bleaching
- Coral can recover after a short episode of warmer water, but if it persists, the coral die



Branching coral



Brain coral



**coral bleaching events are expected to increase**





# Recent Fire Research Re: Fires in the West



Bob Kambitsch, National Interagency Fire Center

**Science***express*

Perspective

**Is Global Warming Causing More, Larger Wildfires?**

Steven W. Running

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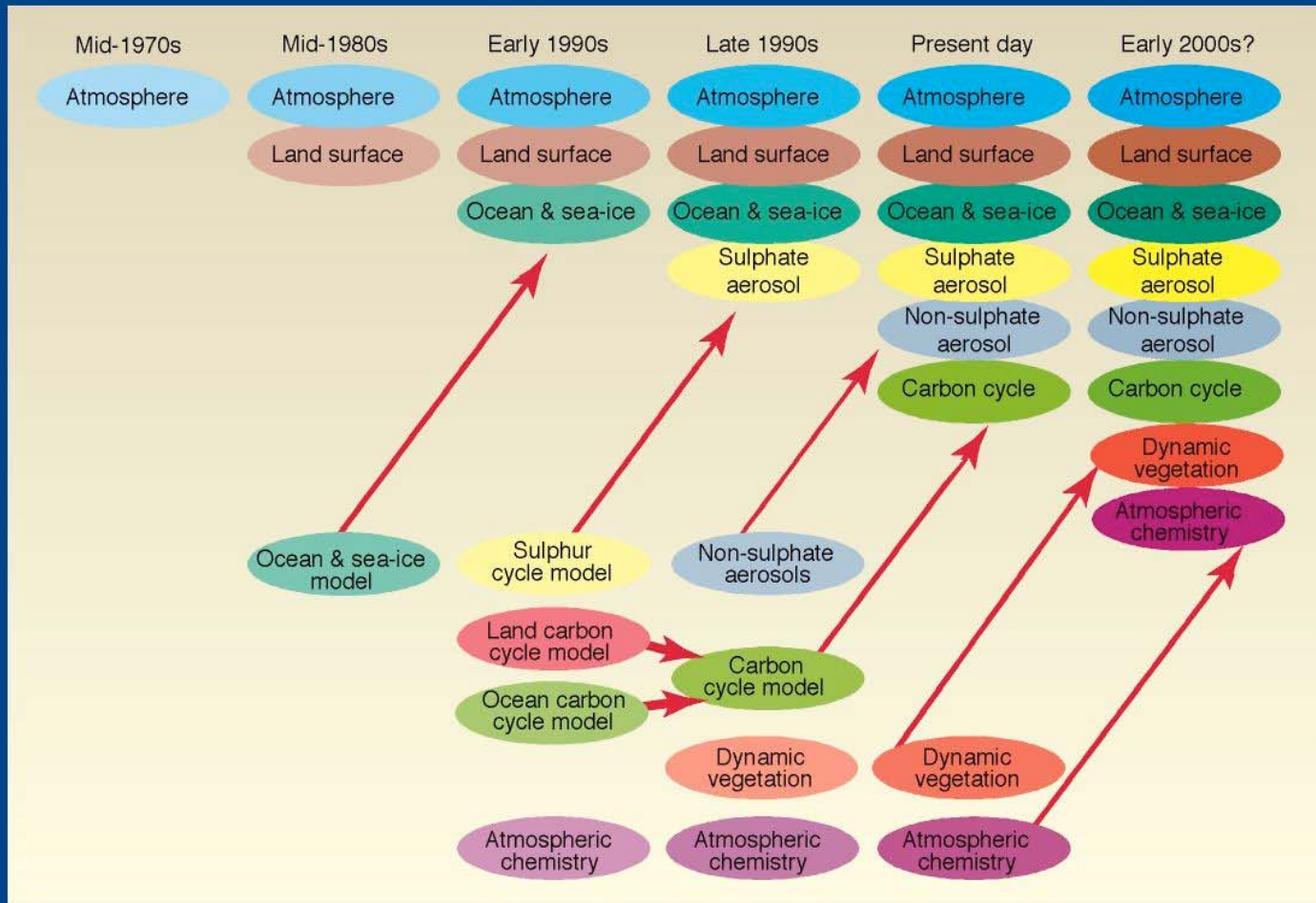
# Evaluation of Climate Models

- How well do models simulate present climate?
- How well do they simulate past climate change?
- Can natural factors explain the last 100 years?
- Can human factors explain recent changes?



# Evolution of Climate Models

## The development of climate models, past, present and future

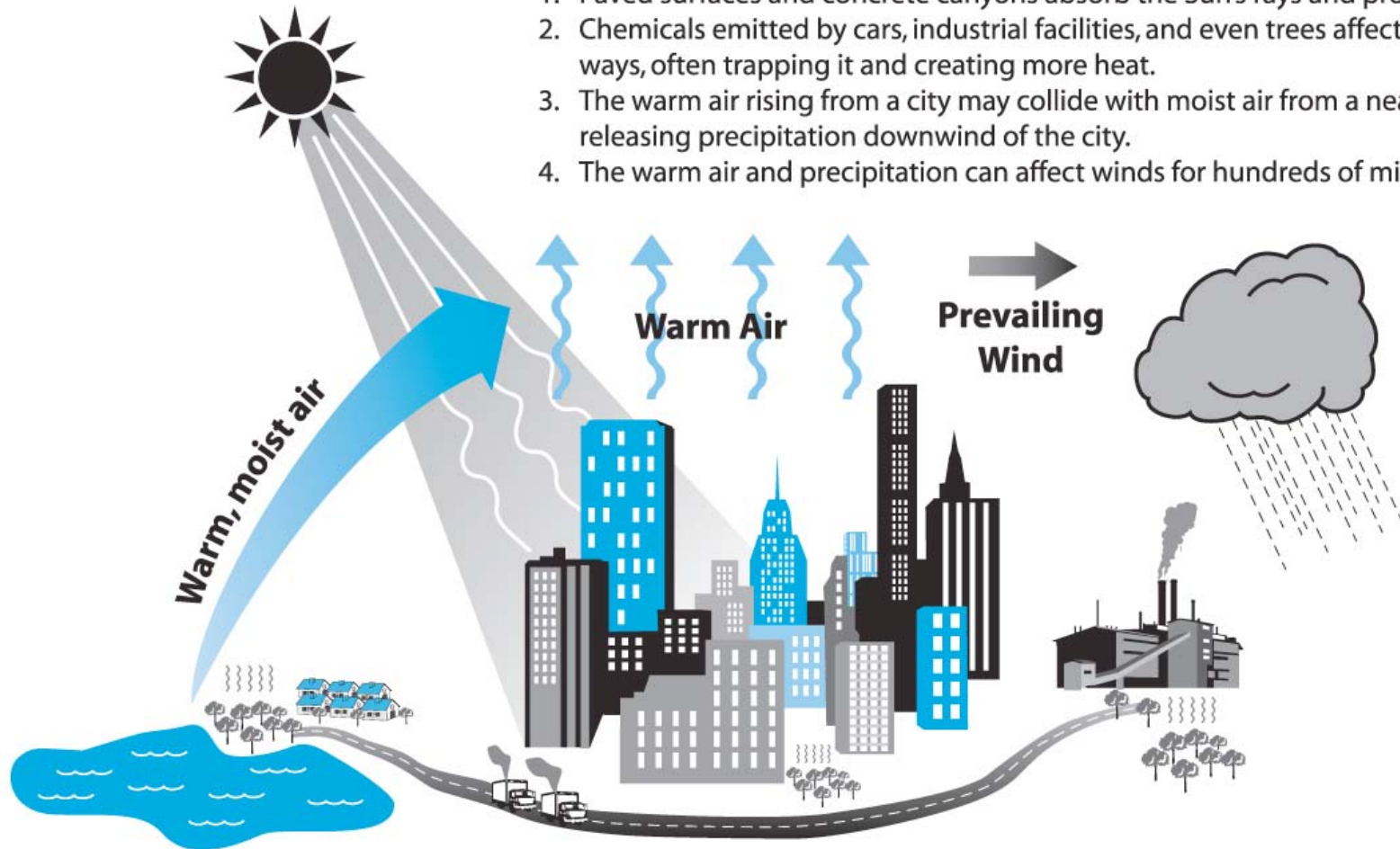


WG1 - TS BOX 3  
FIGURE 1

## Urban Heat Island Effect

Urban areas influence the atmosphere through a number of processes:

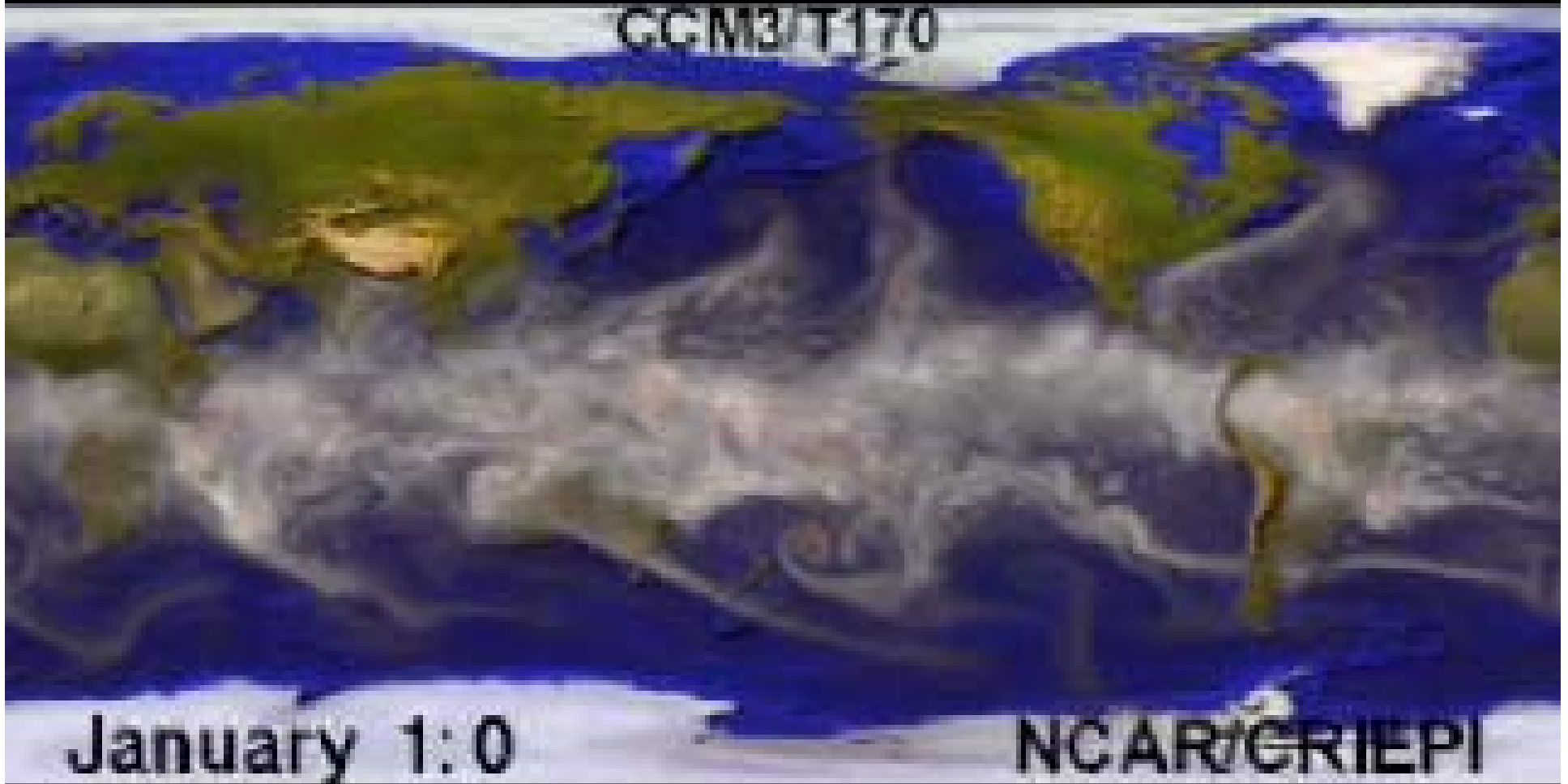
1. Paved surfaces and concrete canyons absorb the Sun's rays and produce heat.
2. Chemicals emitted by cars, industrial facilities, and even trees affect sunshine in different ways, often trapping it and creating more heat.
3. The warm air rising from a city may collide with moist air from a nearby body of water, releasing precipitation downwind of the city.
4. The warm air and precipitation can affect winds for hundreds of miles.







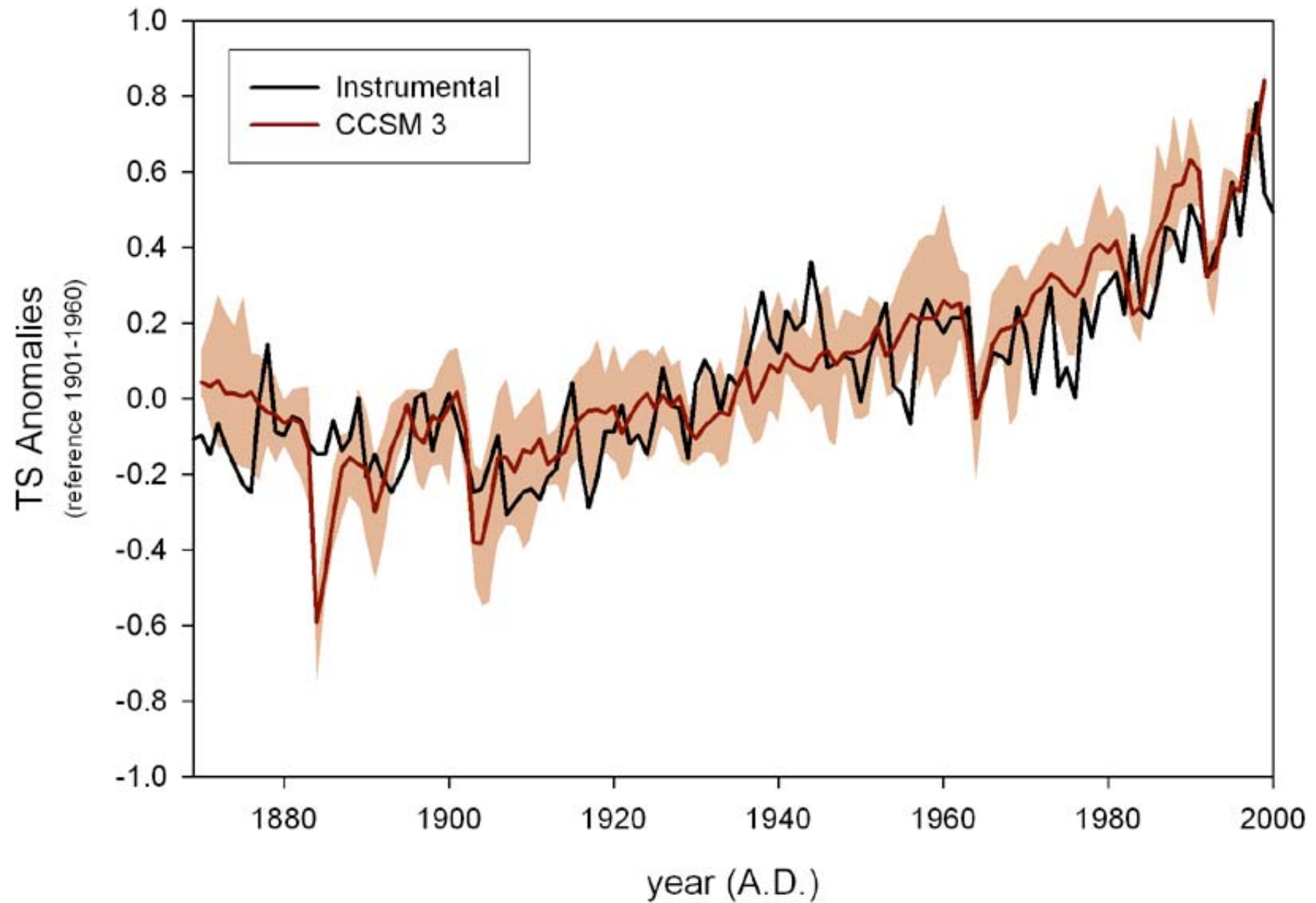
# CCSM Simulation of the Real World



Water Vapor Content (Clouds) in White  
Precipitation in Orange



# The Past Century's Climate





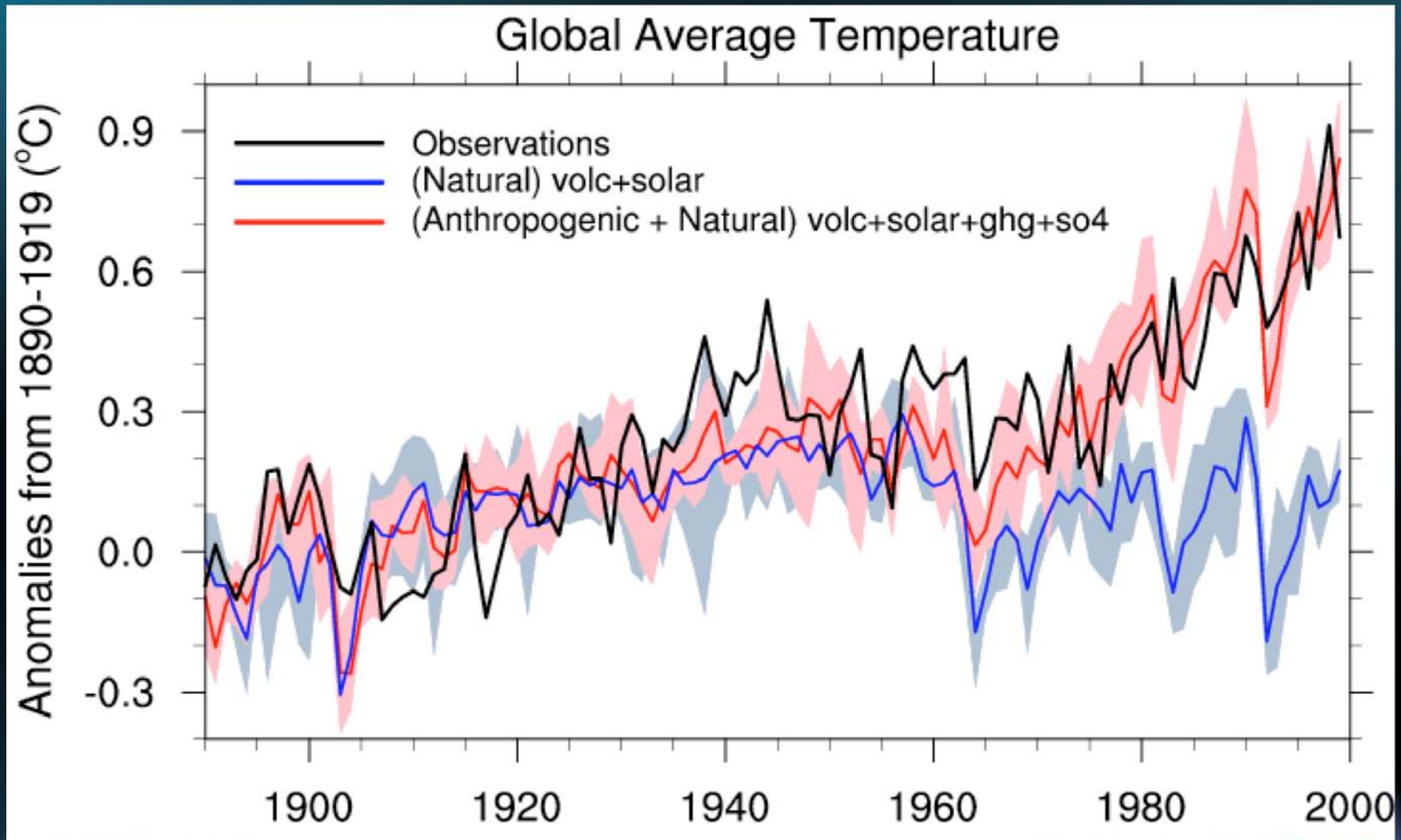


# Can Natural Factors Alone Explain the Recent Temperature Record?

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# Simulation of 20<sup>th</sup> Century Warming





## Question:

What Is Meant by the Term “Uncertainties”  
When Speaking of Climate Models?

**Response:** Jerry Meehl et. al  
*Climate Future: Voices of Science*



**Confidence in the  
ability of models to  
project future climates  
has increased...**



# IPCC Climate Model Scenarios

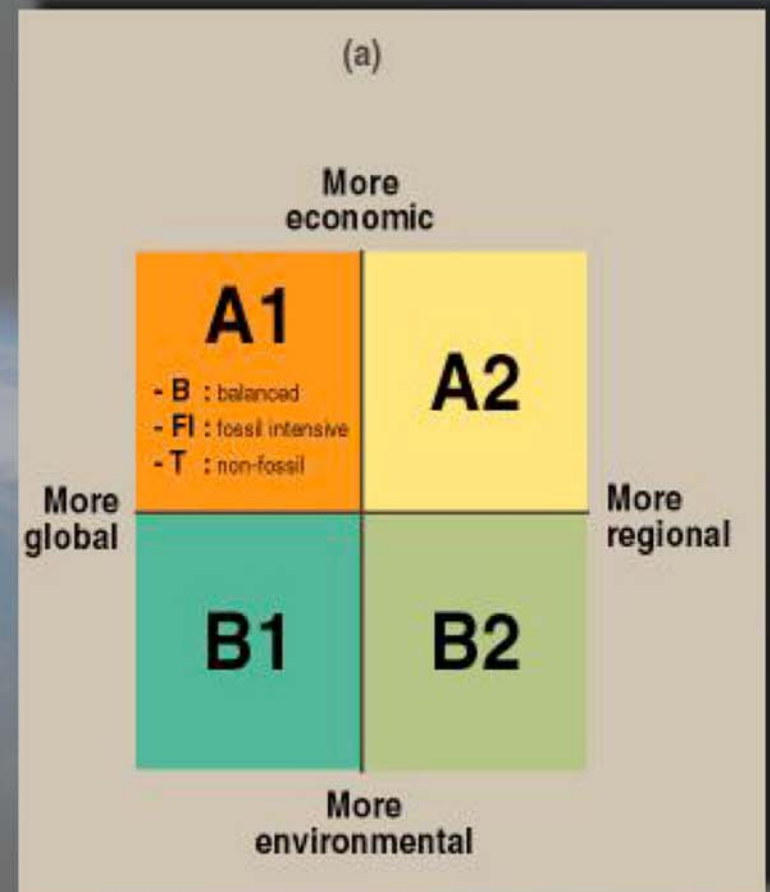
**A1:** A world of rapid economic growth and rapid introductions of new and more Efficient technologies

**A2:** A very heterogenous world with an emphasis on family values and local traditions

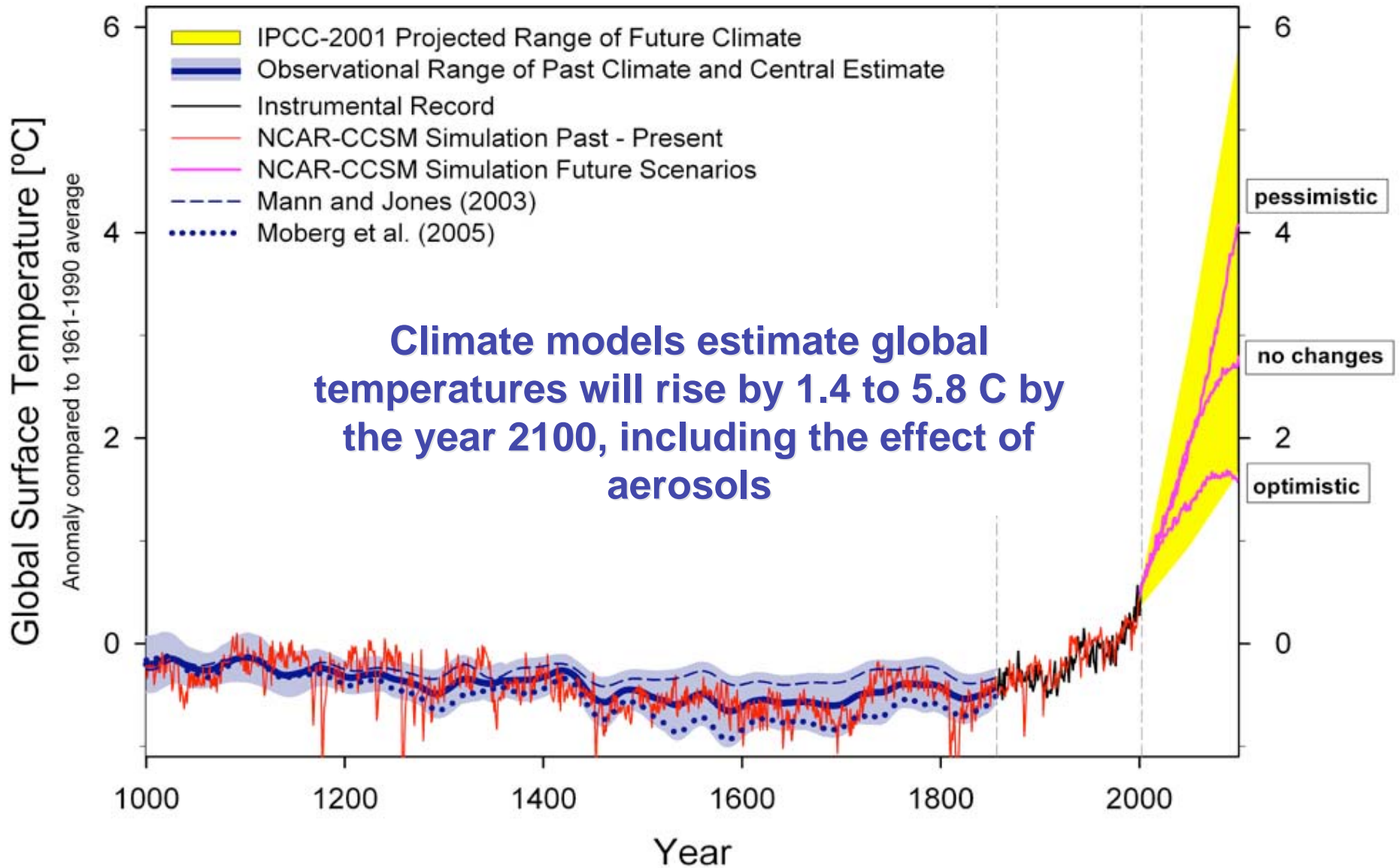
**B1:** A world of *dematerialization* and introduction of clean technologies

**B2:** A world with an emphasis on local solutions to economic and environmental sustainability

IS92a: *Business as usual* scenario (1992)

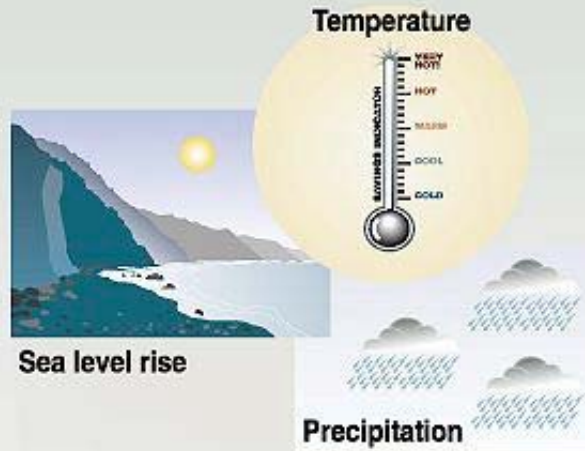


# Simulation of Past, Present and Future



## Potential climate changes impact

Climate models estimate global temperatures will rise by 1.4 to 5.8 C by the year 2100, including the effect of aerosols



## Impacts on...

Health	Agriculture	Forest	Water resources	coastal areas	Species and natural areas
 <p>Weather-related mortality Infectious diseases Air-quality respiratory illnesses</p>	 <p>Crop yields Irrigation demands</p>	 <p>Forest composition Geographic range of forest Forest health and productivity</p>	 <p>Water supply Water quality Competition for water</p>	 <p>Erosion of beaches Inundation of coastal lands additional costs to protect coastal communities</p>	 <p>Loss of habitat and species Cryosphere: diminishing glaciers</p>

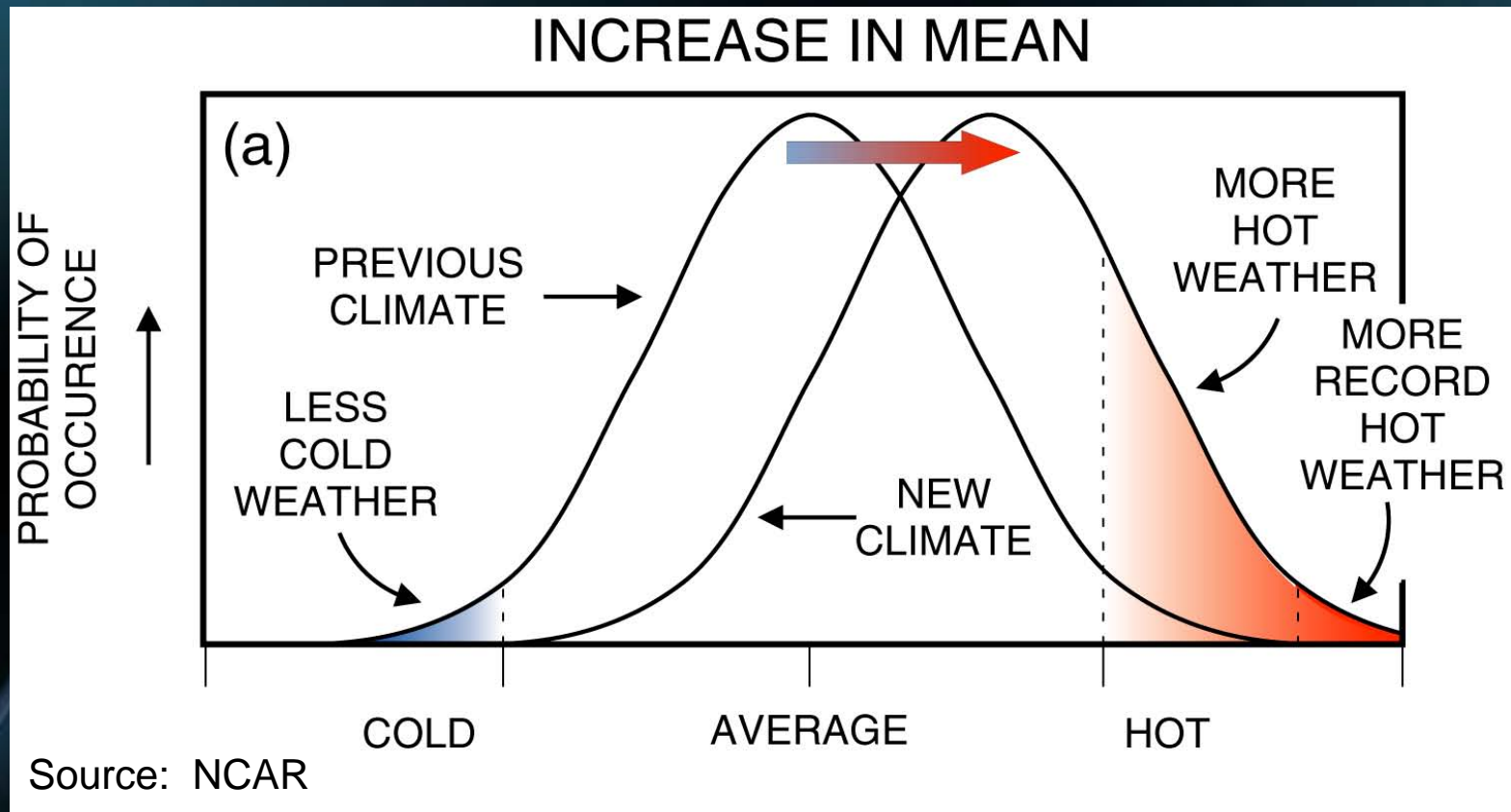


Source: United States environmental protection agency (EPA).

GRAPHIC DESIGN : PHILIPPE REKACEWICZ



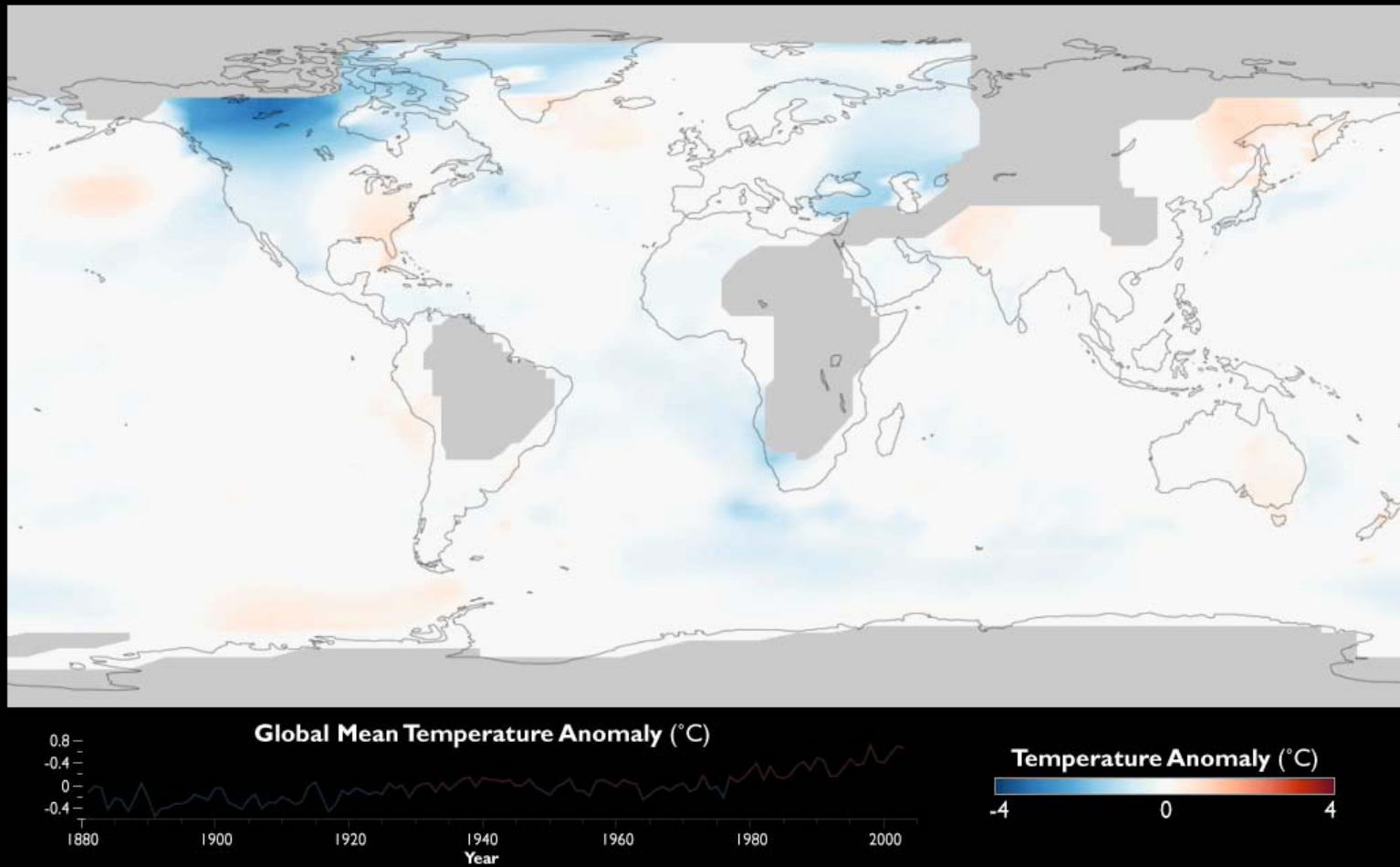
# Climate Change -- Manifestation in terms of Weather (climate extremes)



*Lake Dillon, Colorado, August 8, 2002*



# Simulations of Future Climate



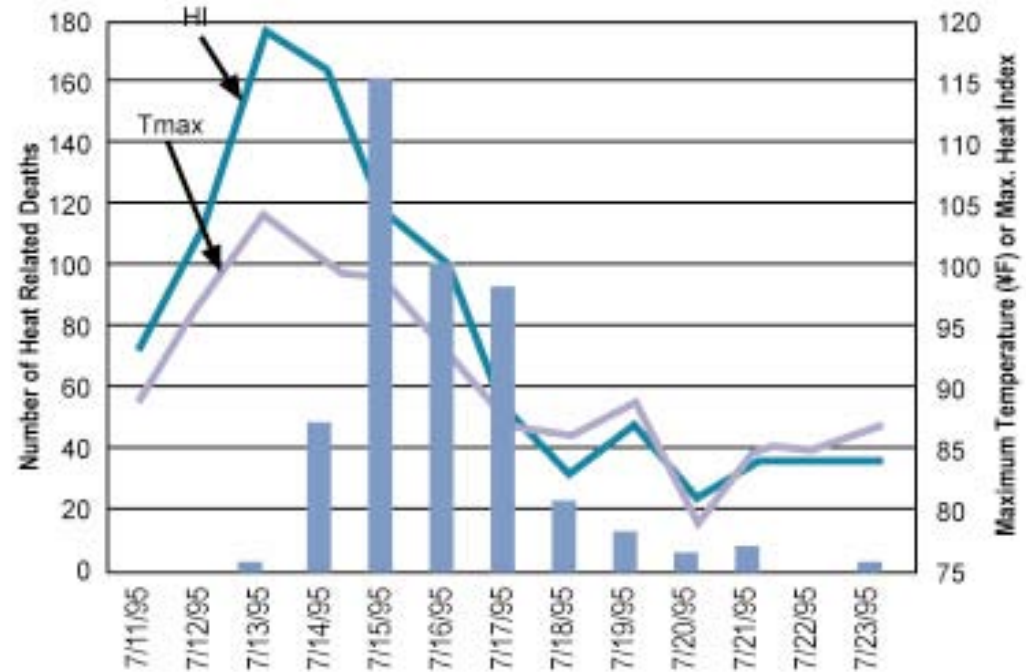




ILLINOIS, 1999 — CHICAGO HEAT INDEX HITS RECORD 119°F. HEAT WAVE KILLS 250 ACROSS EASTERN U.S.

### Heat Related Deaths - Chicago, July 1995

Maximum Temperature and Heat Index



This graph tracks maximum temperature (Tmax), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate number of deaths for the day.



INTERNATIONAL

## Record heatwave sweeps through Europe

21 July 2006 04:22

## Carbon plan as Britain swelters

David Adam, London  
July 20, 2006

### Heatwave death toll rises in US

Severe heat across much of the US has claimed at least 22 lives around the country, officials say.

At least 10 states have suffered heat-related deaths as a swathe of the US has sweltered above 38C (100F), although temperatures are set to fall.



Families in St Louis were forced into unorthodox ways of cooling off

## Fires, budget woes burn out Texas Forest Service

By CHRISTINE S. DIAMOND, Cox East Texas

Saturday, July 08, 2006

Faced with an unending siege of wildfires across Texas since early 2005, the state agency responsible for helping rural Texas suppress wildfires is itself about burned out.

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# THE INDEPENDENT

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21 July 20

## Temperature set to hit 100 degrees - and global warming is to blame

By Michael McCarthy and Steve Connor  
Published: 19 July 2006

# LEADER TIMES

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[Larger Text](#) [Smaller Text](#)

## Area officials get input on flood relief

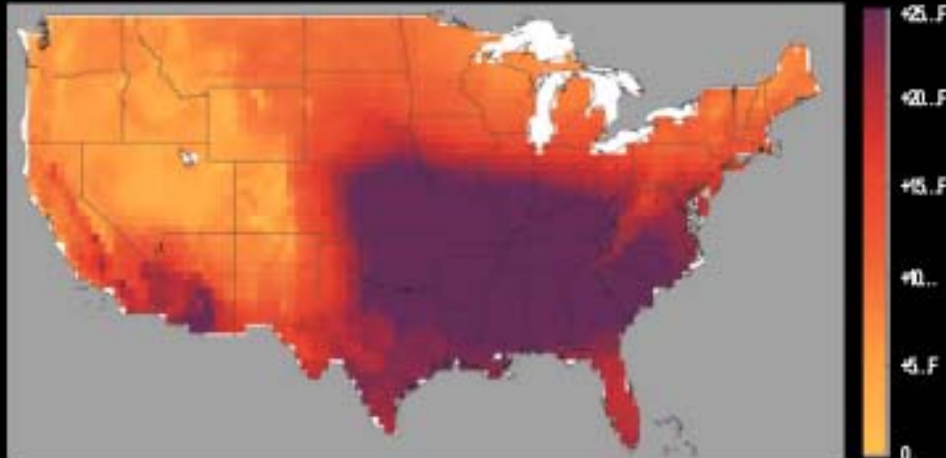
Friday, July 21, 2006

**Activity:**  
Decisions Decisions  
- Energy Use when the Heat is On

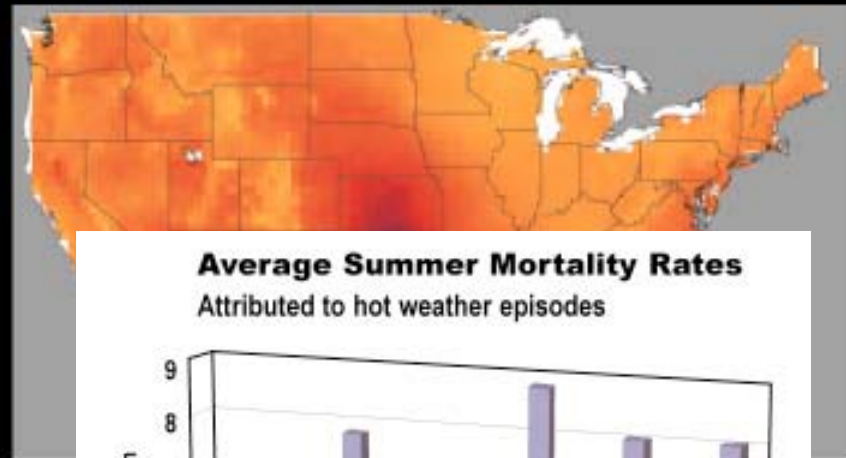


## July Heat Index Change - 21st century

Canadian Model



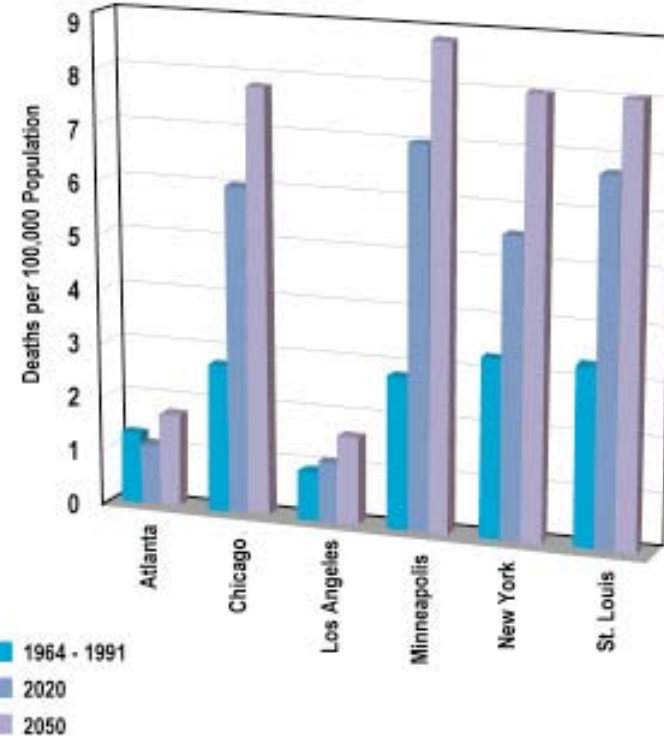
Hadley Model



Both models project substantial increases in the July heat index (which combines temperature and humidity) over the 21st century. The maps show the projected increase in average daily July heat index relative to the present. In the central US, where the Canadian model projects increases of more than 25°F. For example, a city that currently has a July heat index of 100°F would reach a heat index of 115°F in the Hadley model, and 130°F in the Canadian model.

### Average Summer Mortality Rates

Attributed to hot weather episodes



- Risk of death and serious illness increases, principally for older age groups and the urban poor
- Exacerbated by increased humidity and air pollution
- Greatest impact in mid- to high latitude cities
- Warmer winters will decrease winter mortality, but balance is unknown

**What If...**

**we stopped all GHG emissions now.  
Would that prevent climate change?**

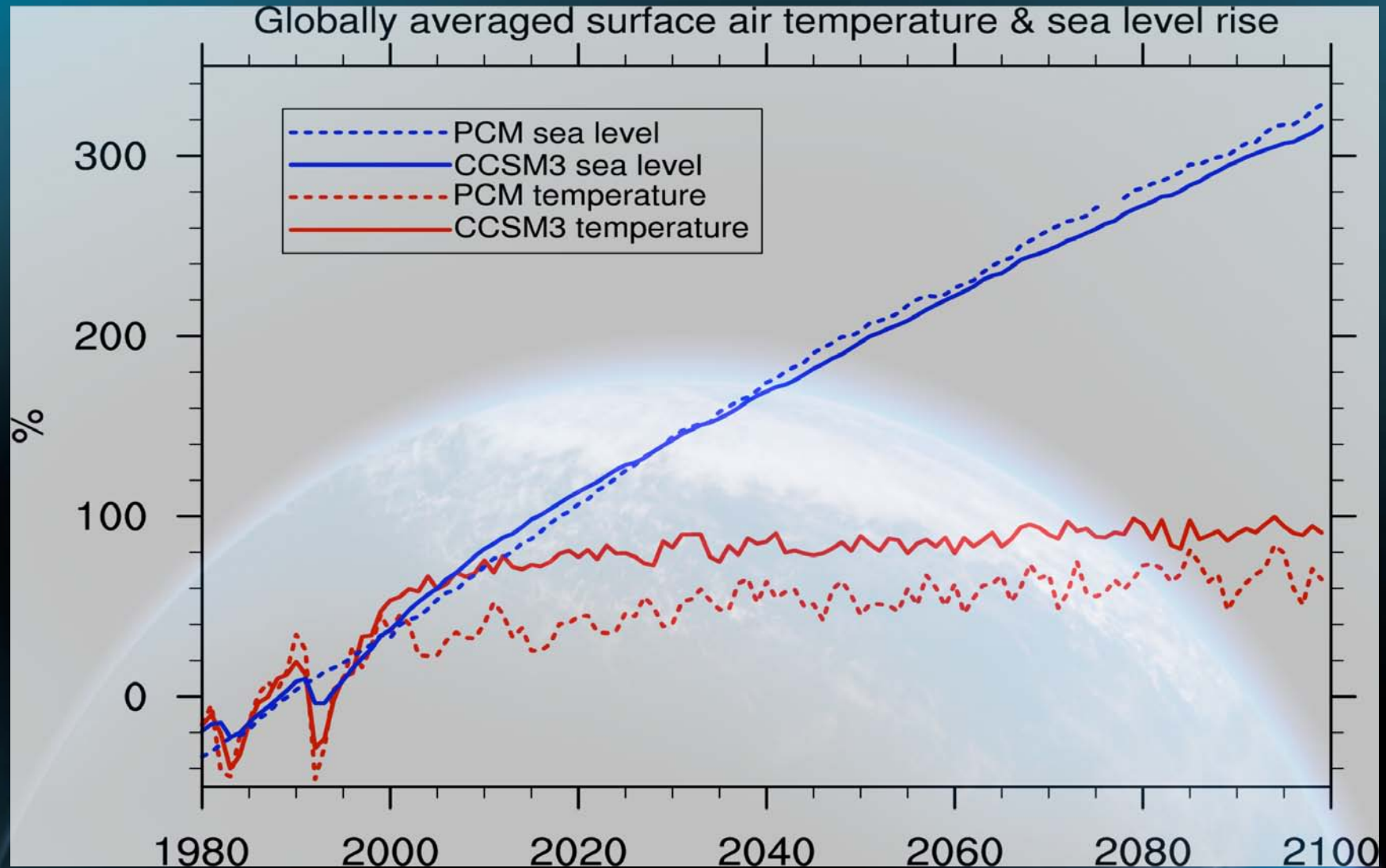
**Response:**

**Bill Collins, NCAR**

*Voices of Science: "Climate Commitment"*



# “Commitment” to Further Climate Change





# Simulations of Future Climate: IPCC AR4

- Over the next decade or two, all models produce similar warming trends in global surface temperatures, regardless of the scenario (550, 690 or 820 ppmv by 2100).
- By mid-century, the choice of scenario becomes more important for the magnitude of warming, and by the end of the 21st Century there are clear consequences for which scenario is followed.
- Nearly half of the early 21st Century climate change arises from warming we are already committed to.

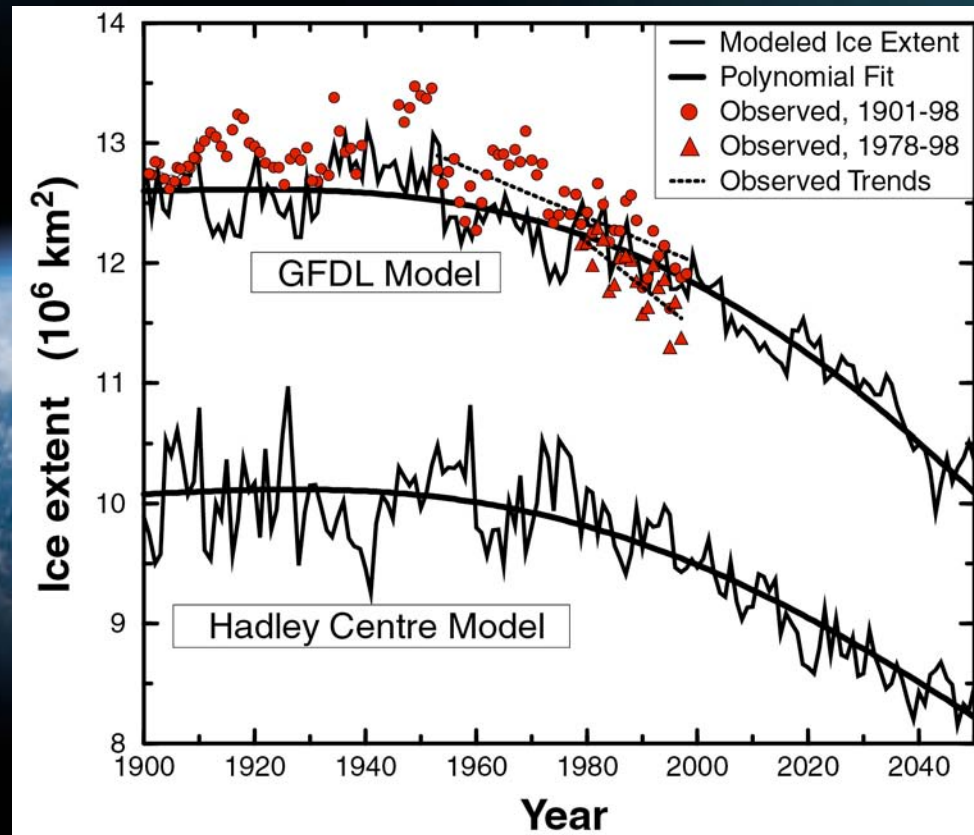
# *Climate Future: Voices of Science*

Climate Change Impacts --  
Today, Tomorrow

6th Annual Environmental Health Sciences Summer Institute for K-12 Educators  
University of Texas, Austin

# Sea Ice Area Extent Decreasing

- Both models predict decrease in sea ice extent
- Both models, and observations, show that the decrease in sea ice extent is accelerating



(Vinnikov *et al.*, 1999, *Science*; Chapter 7)



# Arctic Ice Is Thinning

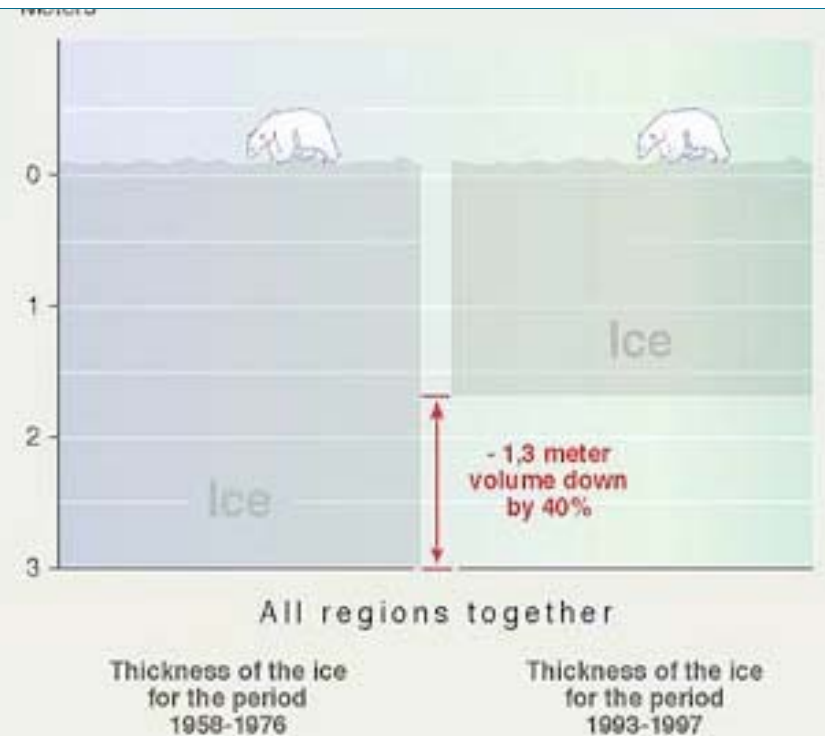
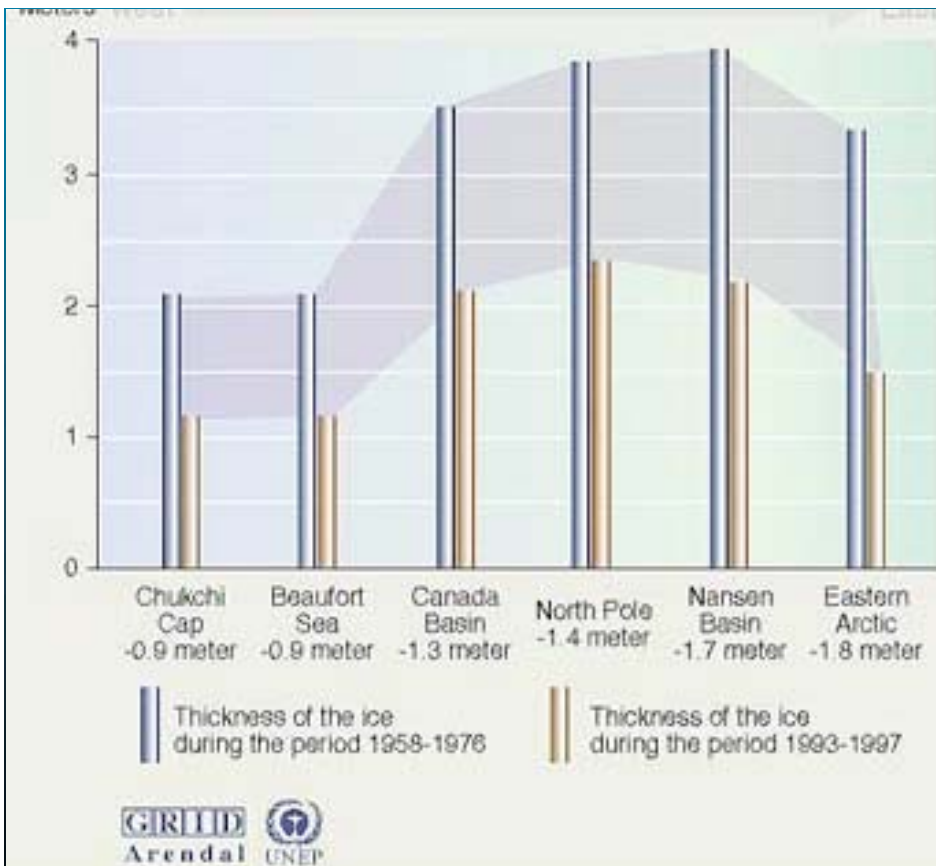
## Thinning of the Arctic sea-ice

The height of the bars represent the reduction of ice thickness (draft) from the period 1958-1976 to 1993-1997

### Location of the sampling points

Ice draft in the 90s is over a meter thinner than three decades earlier





Note: comparison of sea-ice draft data acquired on submarine cruises between 1993 and 1997 with data from 1958-1976 indicates that mean ice draft at the end of the melt season has decreased by 1,3 m (from 3,1 m to 1,8 m). Value is down by 40%

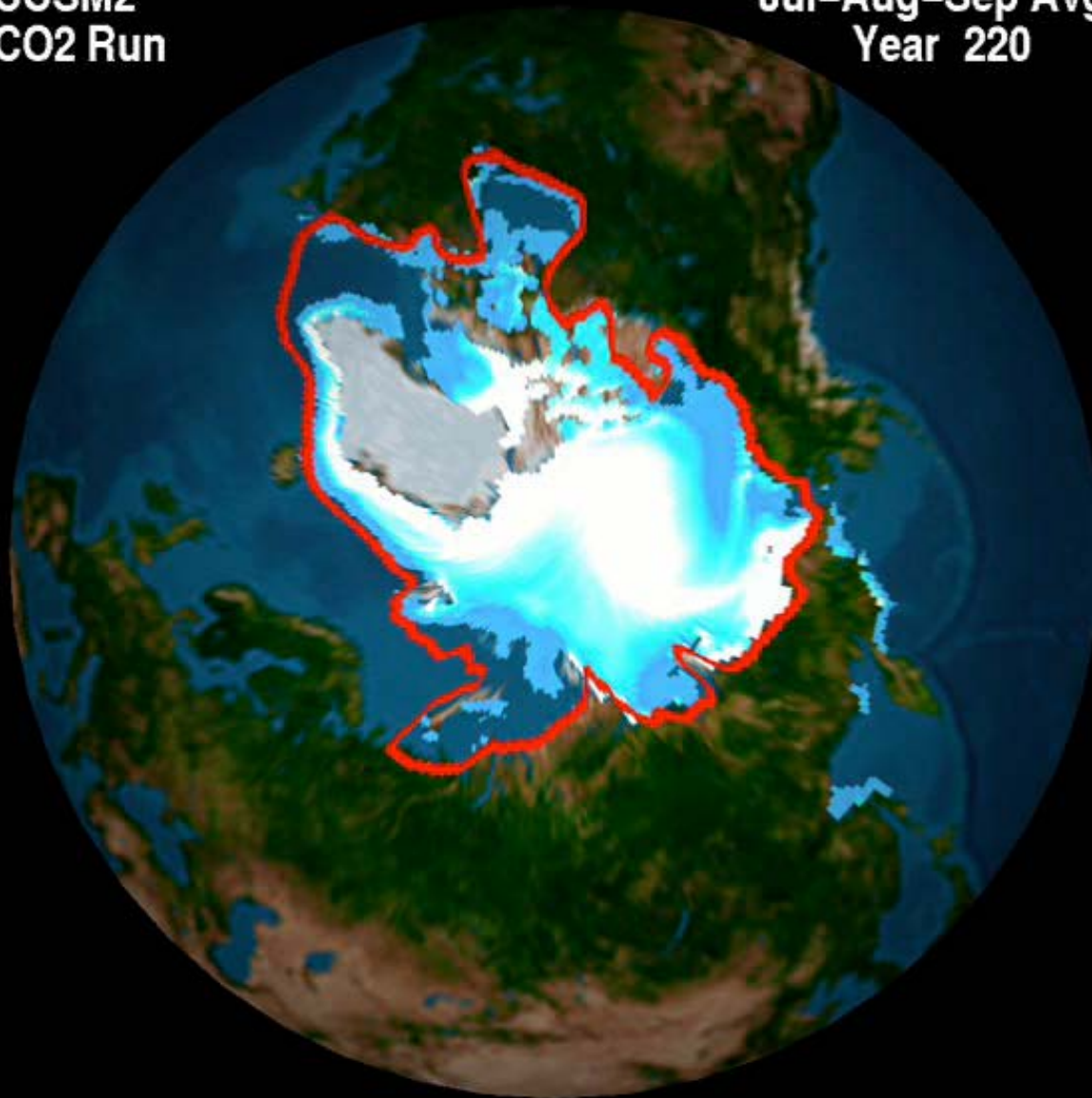
Sources: D.A. Rothrock, Y.Yu and G.A. Maykut, Thinning of the Arctic sea-ice cover, University of Washington, Seattle, 1999.

# Arctic Ice Is Thinning

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CCSM2  
CO2 Run

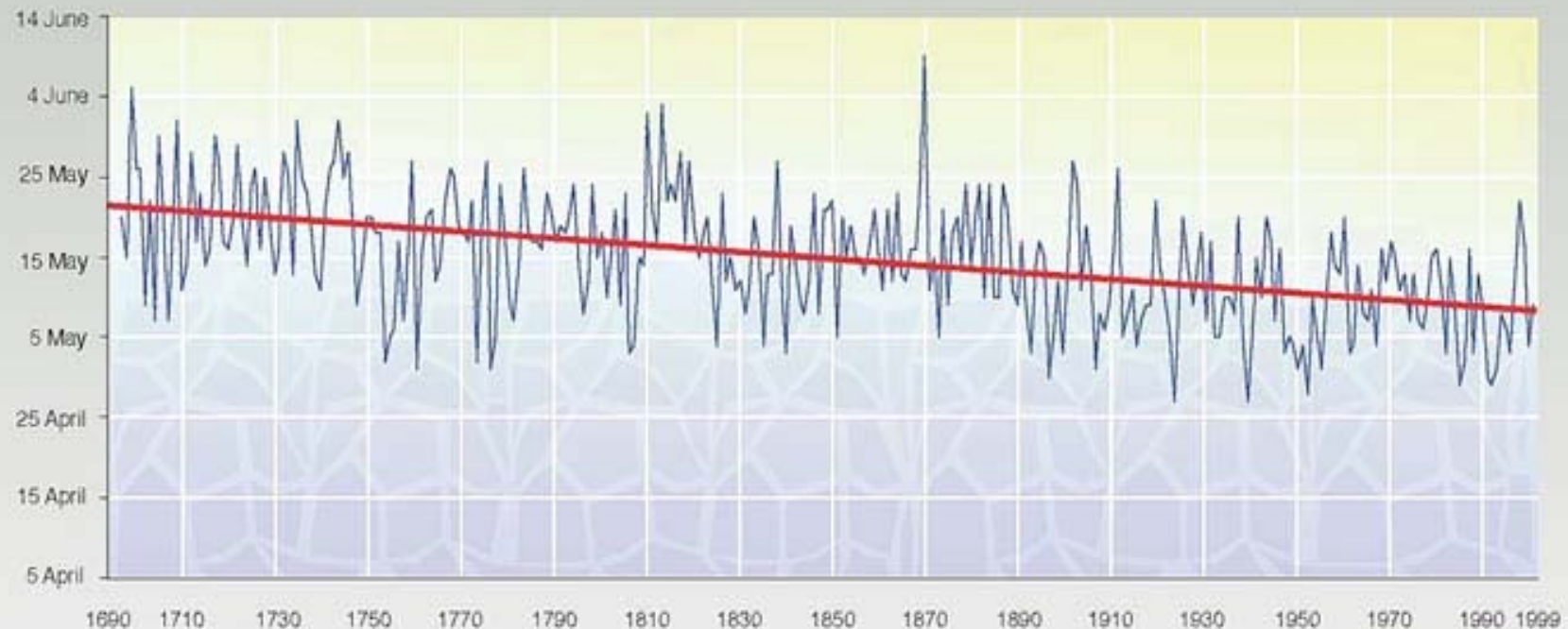
Jul-Aug-Sep Avg  
Year 220





# Ice is breaking up earlier on rivers and lakes in the spring around the world

Evolution of the ice-breaking date in the River Tornio (Finland)



GRID  
Arendal UNEP

GRAPHIC DESIGN: THILIPPE RENACQWIG

Source: Trends in the Finnish Environment 1997, fig. 1.7, updated in February 2000.



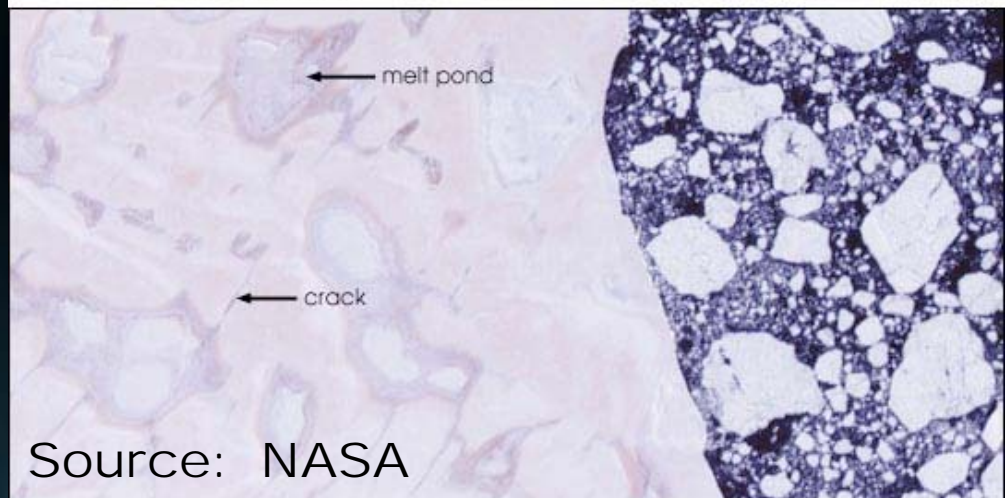
# Collapse of Antarctic Ice Shelf Unprecedented

PRESS RELEASE

Date Released: Friday, August 5, 2005



## A Calamity in the Making?



Source: NASA

Source: ABC



Figure 3. Lands Close to Sea Level: U.S. Atlantic and Gulf Coasts

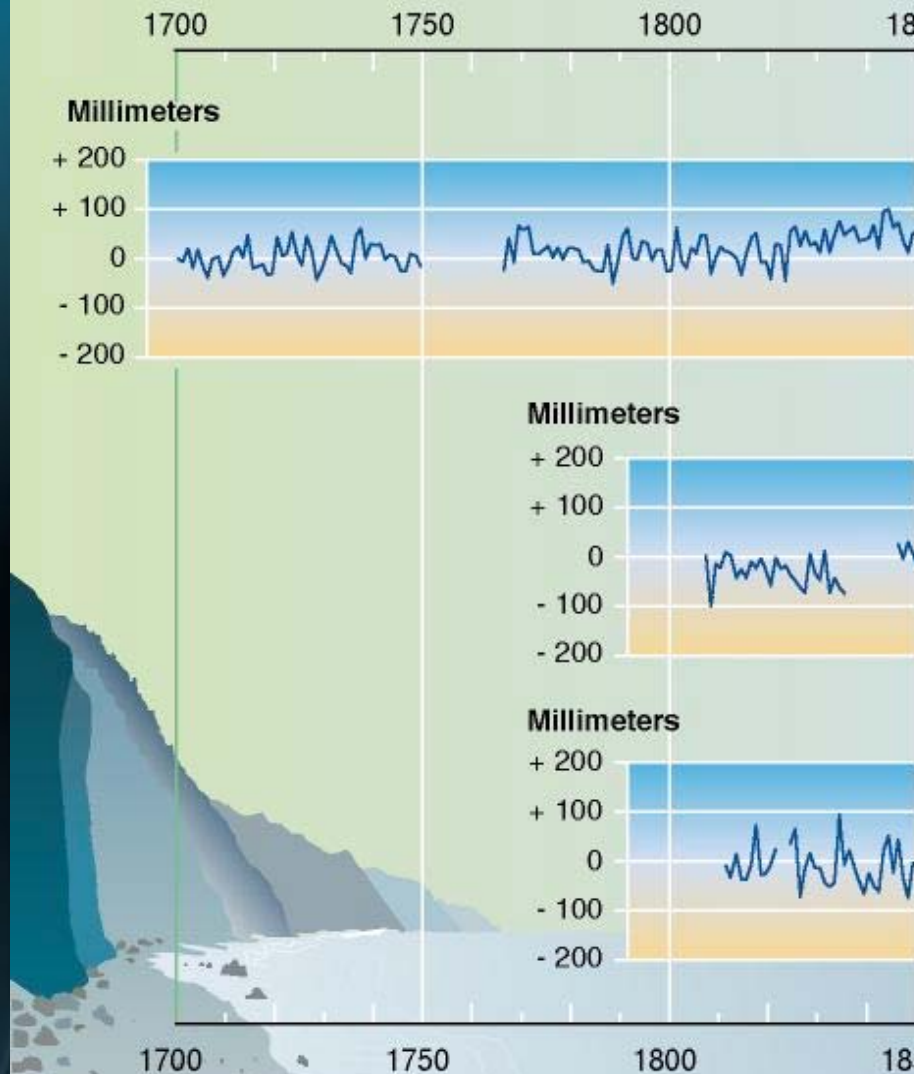


Source: EPA

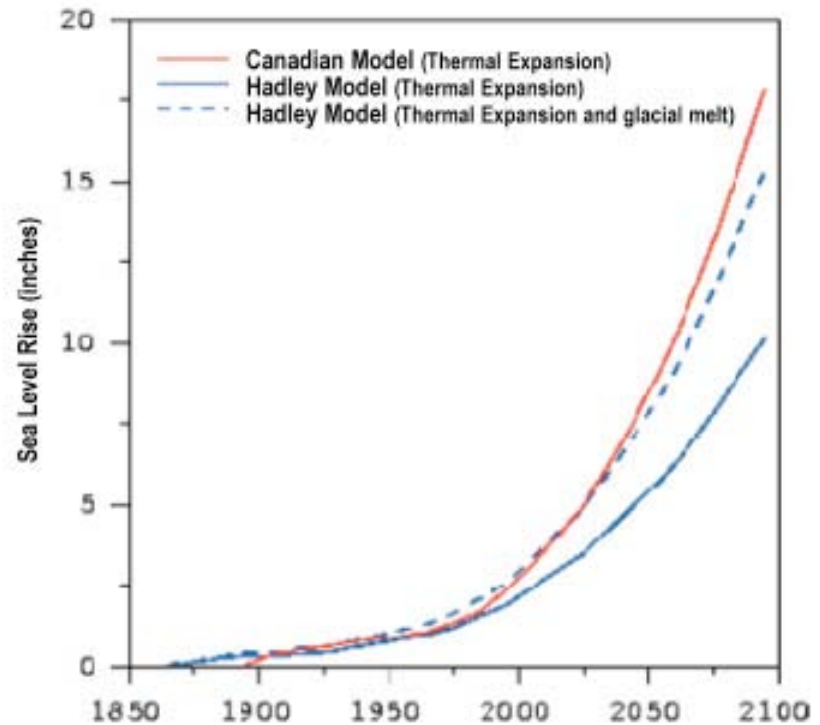


# Sea Levels have risen

## Relative sea level over the last 300 years

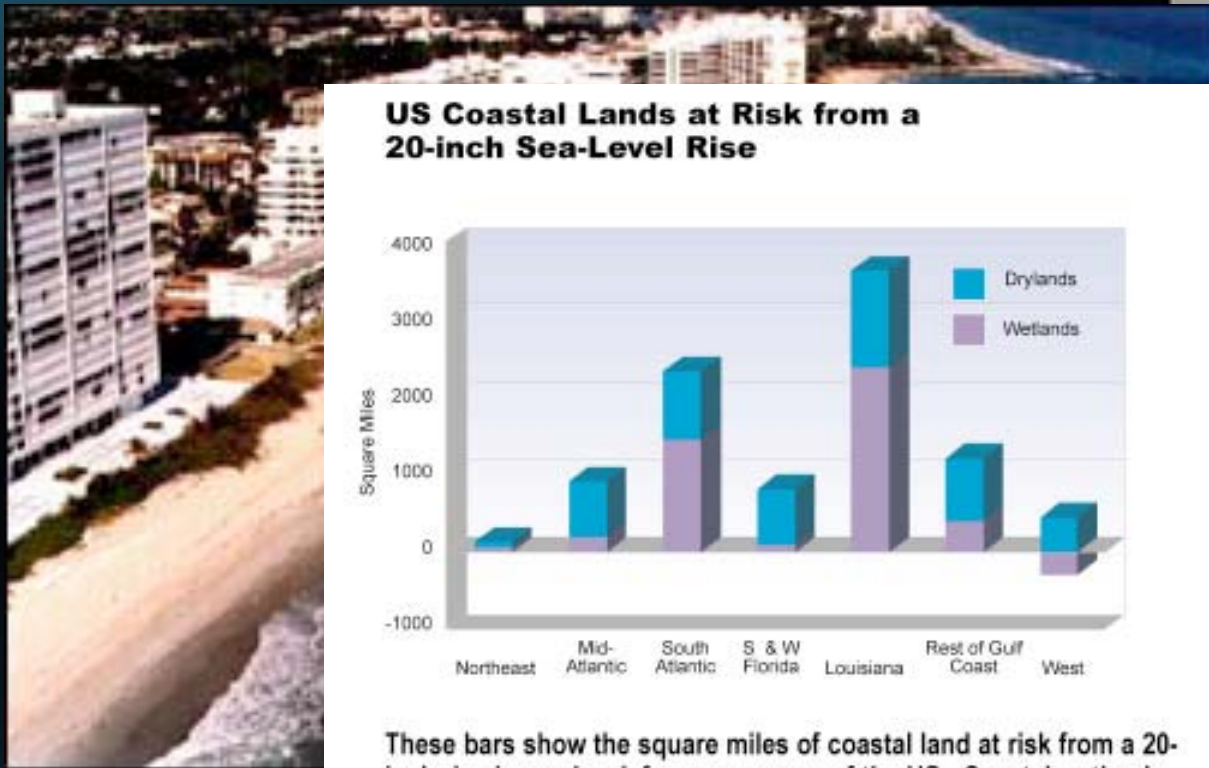


## Sea-level Rise Projections



Historic and projected changes in sea level based on the Canadian and Hadley model simulations. The Canadian model projection includes only the effects of thermal expansion of warming ocean waters. The Hadley projection includes both thermal expansion and the additional sea-level rise projected due to melting of land-based glaciers. Neither model includes consideration of possible sea-level changes due to polar ice melting or accumulation of snow on Greenland and Antarctica.

# Endangering Coastal Properties



These bars show the square miles of coastal land at risk from a 20-inch rise in sea level, for seven areas of the US. Coastal wetlands projected to be inundated are shown in yellow while drylands projected to be inundated are shown in blue.



# How Does Lose of Glaciers, Snow, and Sea Ice Impact the Earth?

## Sea Level Activity Demo

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**Are hurricanes changing with  
global warming?**





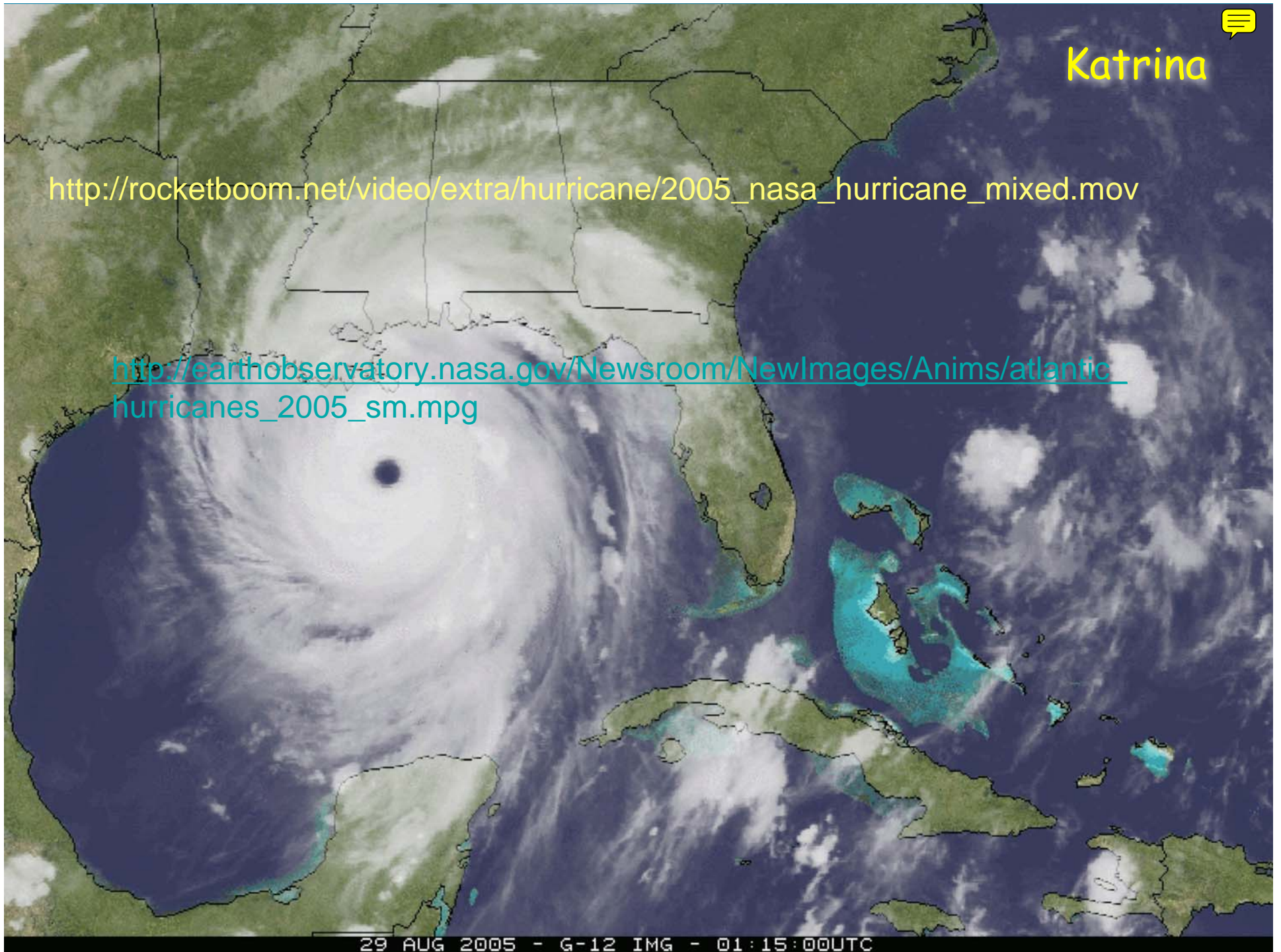


# Katrina

[http://rocketboom.net/video/extra/hurricane/2005\\_nasa\\_hurricane\\_mixed.mov](http://rocketboom.net/video/extra/hurricane/2005_nasa_hurricane_mixed.mov)

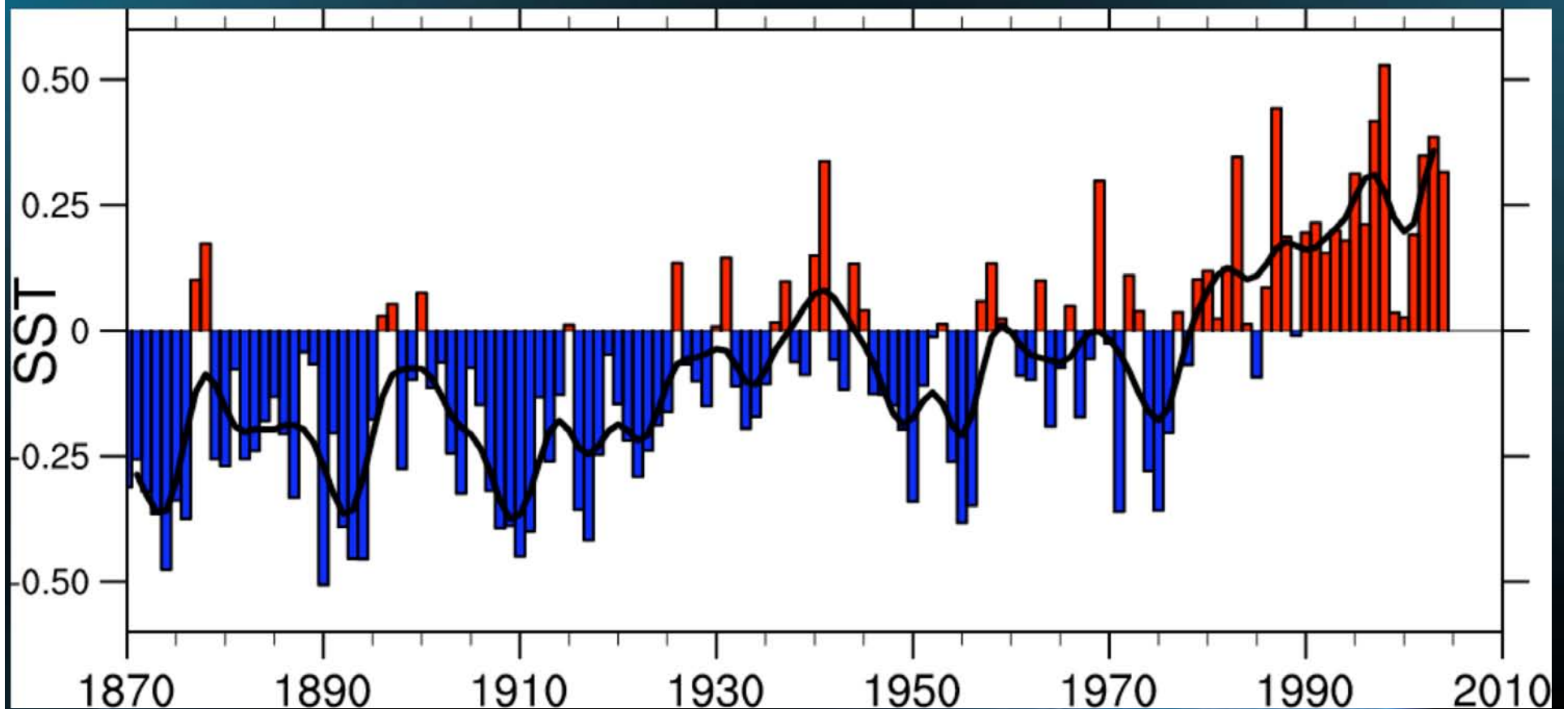
[http://earthobservatory.nasa.gov/Newsroom/NewImages/Anims/atlantic\\_hurricanes\\_2005\\_sm.mpg](http://earthobservatory.nasa.gov/Newsroom/NewImages/Anims/atlantic_hurricanes_2005_sm.mpg)

29 AUG 2005 - G-12 IMG - 01:15:00UTC





# Warming of the Tropical Oceans





# How big is the effect from global warming?

*"Since 1970 tropical SSTs have increased  $>0.5^{\circ}\text{C}$  and water vapor has increased  $>3.5\%$*

*So area water vapor available to storms has increased  $1.035^2 = 1.07$  or  $7\%$ .*

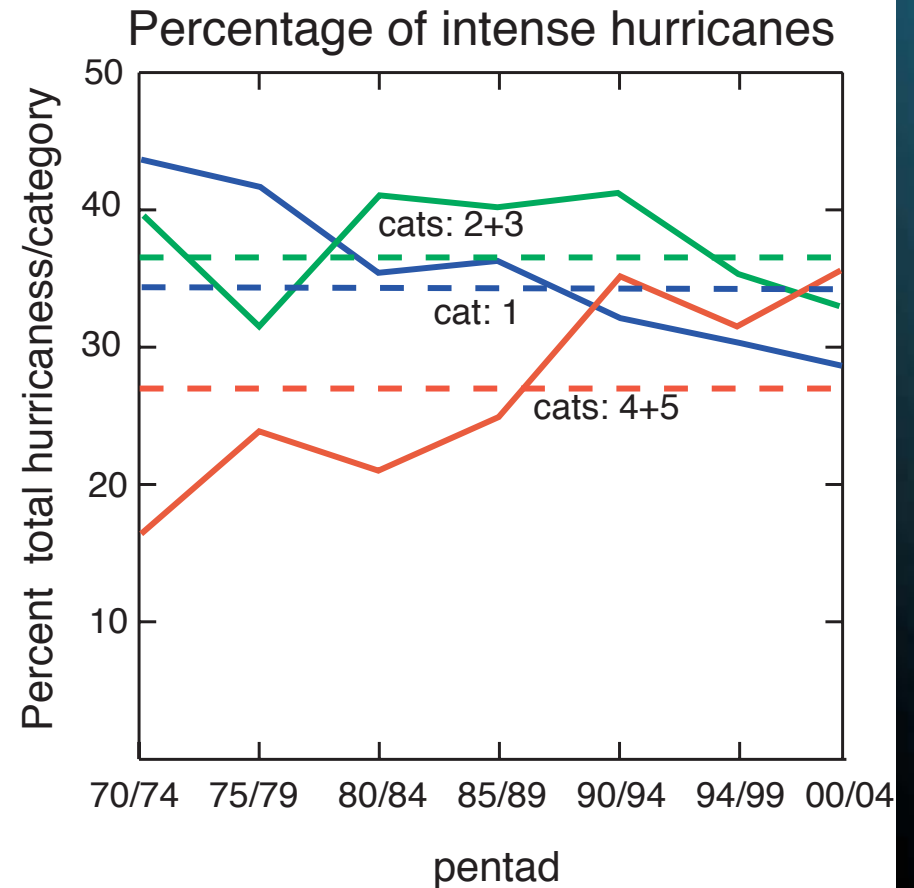
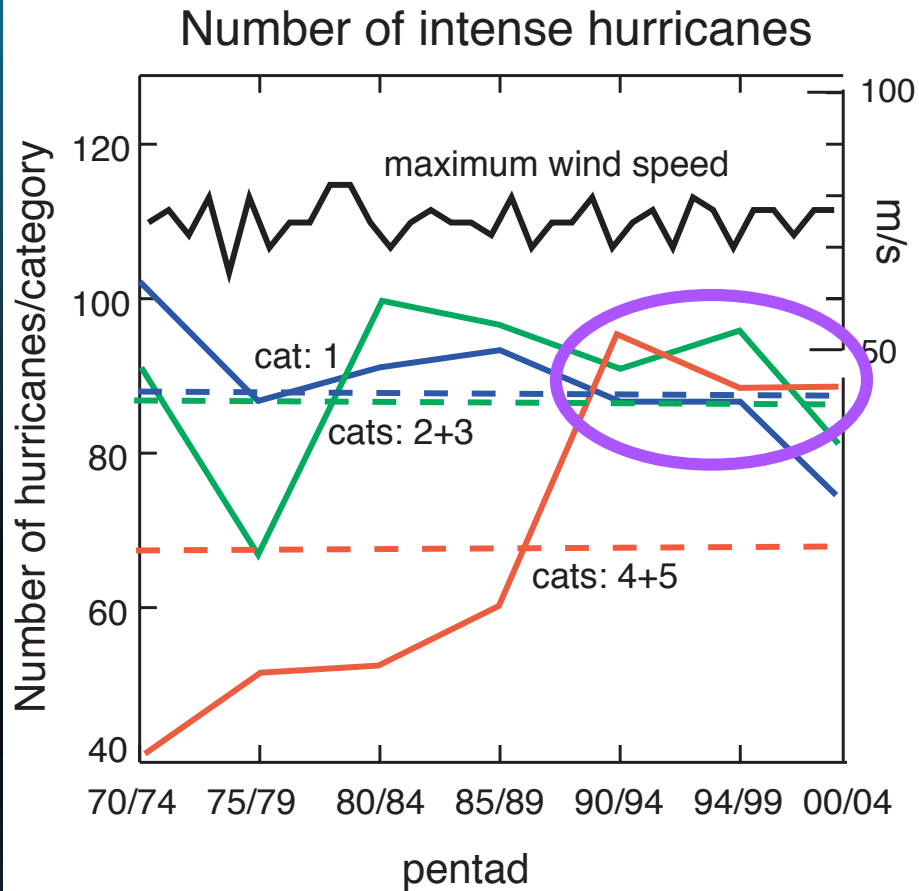
*This means increases in rainfall and latent heat release in storms has increased by order  $7\%$ .*

*The added rainfall and resulting flooding is enough to breach levees designed without accounting for global warming."*

Jim Hurrell, NCAR



# Large Increase in Number of Category 4 and 5 Hurricanes



From Webster et al (2005)

# Climate Change Health Impacts

- Changes in mortality due to heat stress
- Changes in geographic ranges and seasonality of transmission of vector-borne infectious diseases
- Increasing frequency of extreme events (storms, floods, droughts, cyclones)
- Environmental degradation

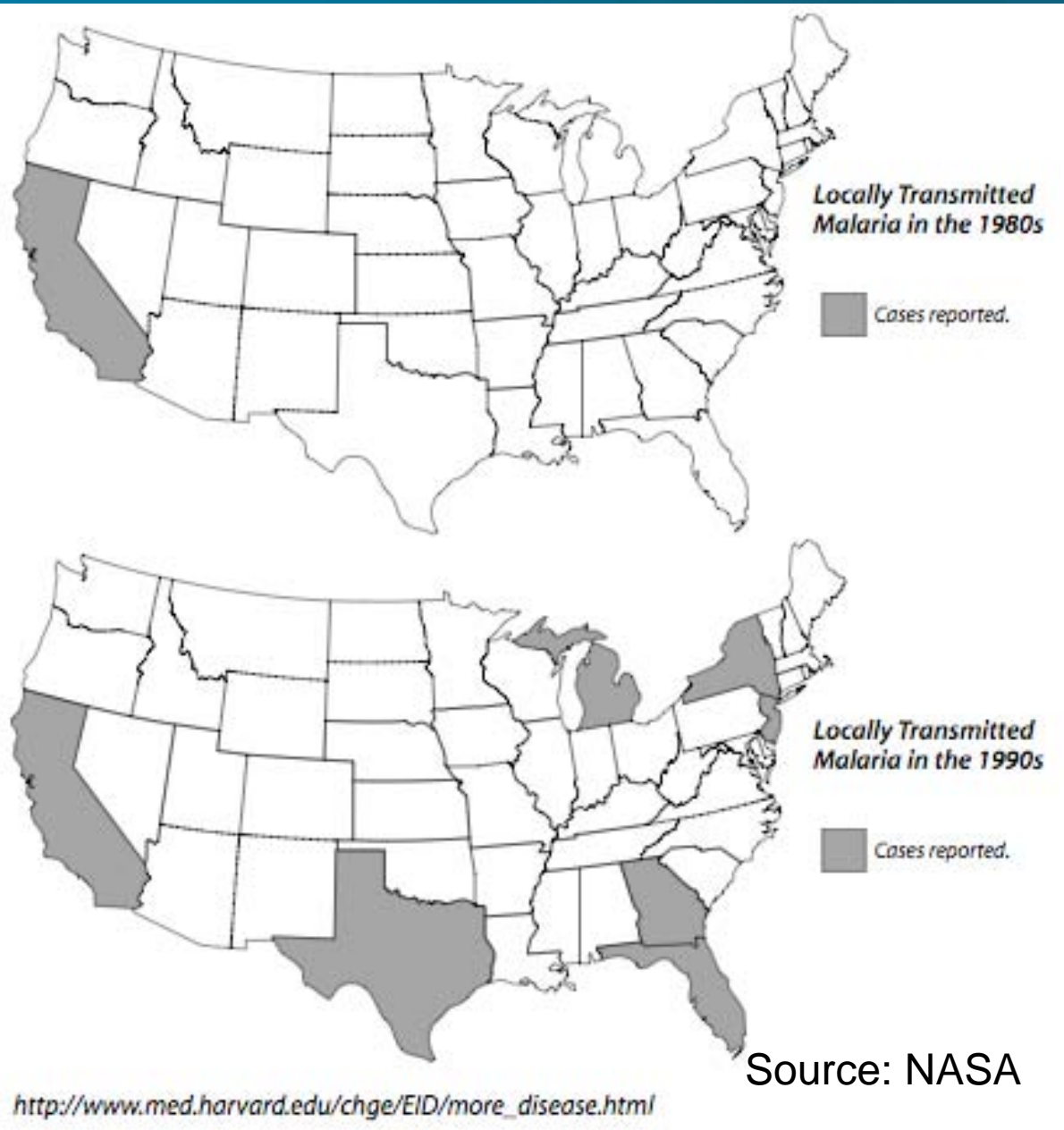














# Activity: Climate Change and Human Health





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## Mosquito Vectors



Disease	Vector	Population at risk (million) <sup>1</sup>	Number of people currently infected or new cases per year	Present distribution	Likelihood of altered distribution
Malaria	Mosquito	2,400 <sup>2</sup>	300-500 million	Tropics and Subtropics	
Schistosomiasis	Water snail	600	200 million	Tropics and Subtropics	
Lymphatic Filariasis	Mosquito	1 094 <sup>3</sup>	117 million	Tropics and Subtropics	
African Trypanosomiasis (Sleeping sickness)	Tsetse fly	55 <sup>4</sup>	250 000 to 300 000 cases per year	Tropical Africa	
Dracunculiasis (Guinea worm)	Crustacean (Copepod)	100 <sup>5</sup>	100 000 per year	South Asia, Arabian Peninsula, Central-West Africa	
Leishmaniasis	Phlebotomine sand fly	350	12 million infected, 500 000 new cases per year <sup>6</sup>	Asia, Southern Europe, Africa, Americas	
Onchocerciasis (River blindness)	Black fly	123	17.5 million	Africa, Latin America	
American Trypanosomiasis (Chagas disease)	Triatomine bug	100 <sup>7</sup>	18 million	Central and South America	
Dengue	Mosquito	1,800	10-30 million per year	All Tropical countries	
Yellow Fever	Mosquito	450	more than 5 000 cases per year	Tropical South America, Africa	

1. Top three entries are population-prorated projections, based on 1989 estimates.

 Highly likely    Very likely    Likely    Unknown

2. WHO, 1994.

3. Michael and Bundy, 1995.

4. WHO, 1994.

5. Ranque, personal communication.

6. Annual incidence of visceral leishmaniasis; annual incidence of cutaneous leishmaniasis is 1-1.5 million cases/yr (PAHO, 1994).

7. WHO, 1995.

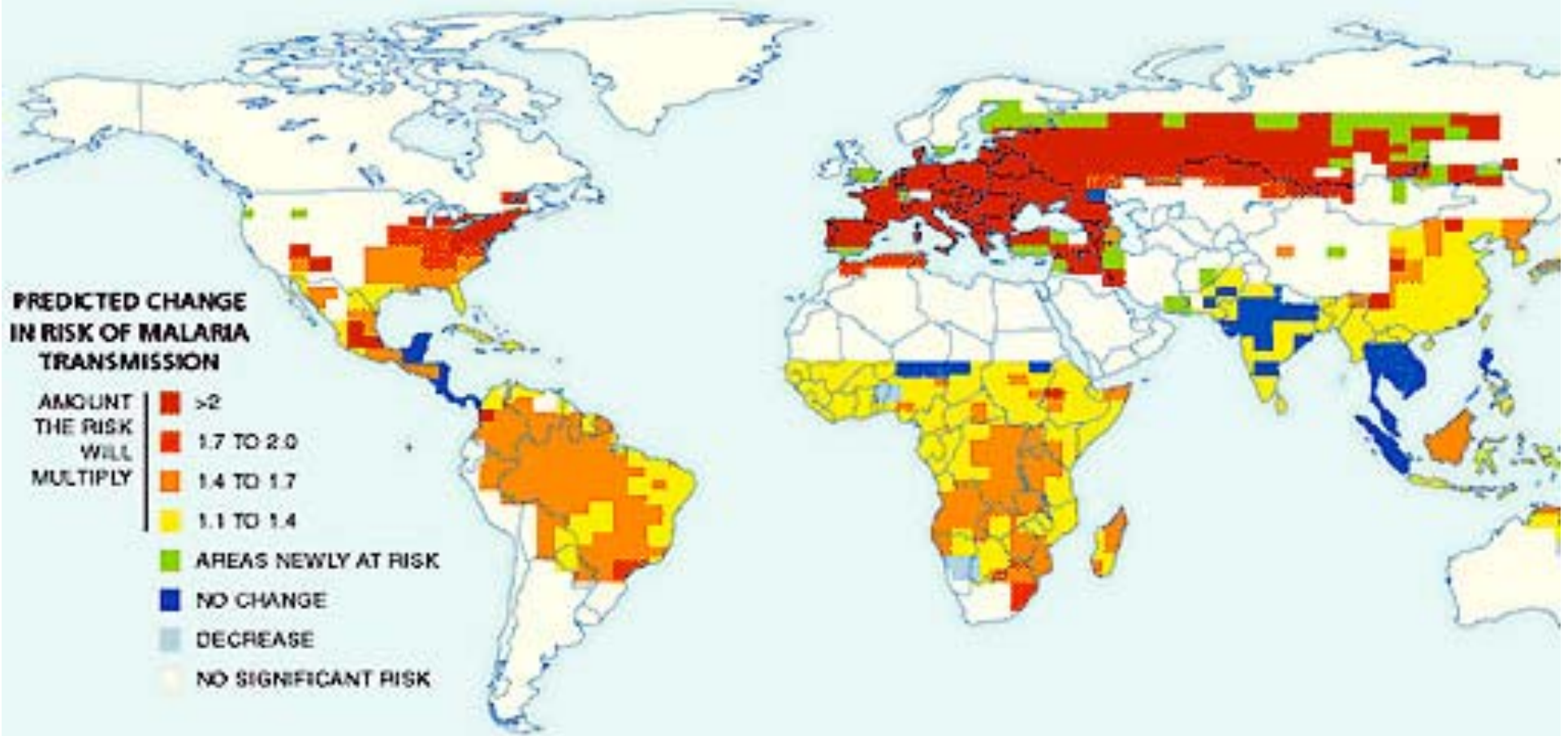
   
 GRID Arendal UNEP  
 GRAPHIC DESIGN: PHILIPPE REKACERWICZ

Source: Climate change 1995, impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.



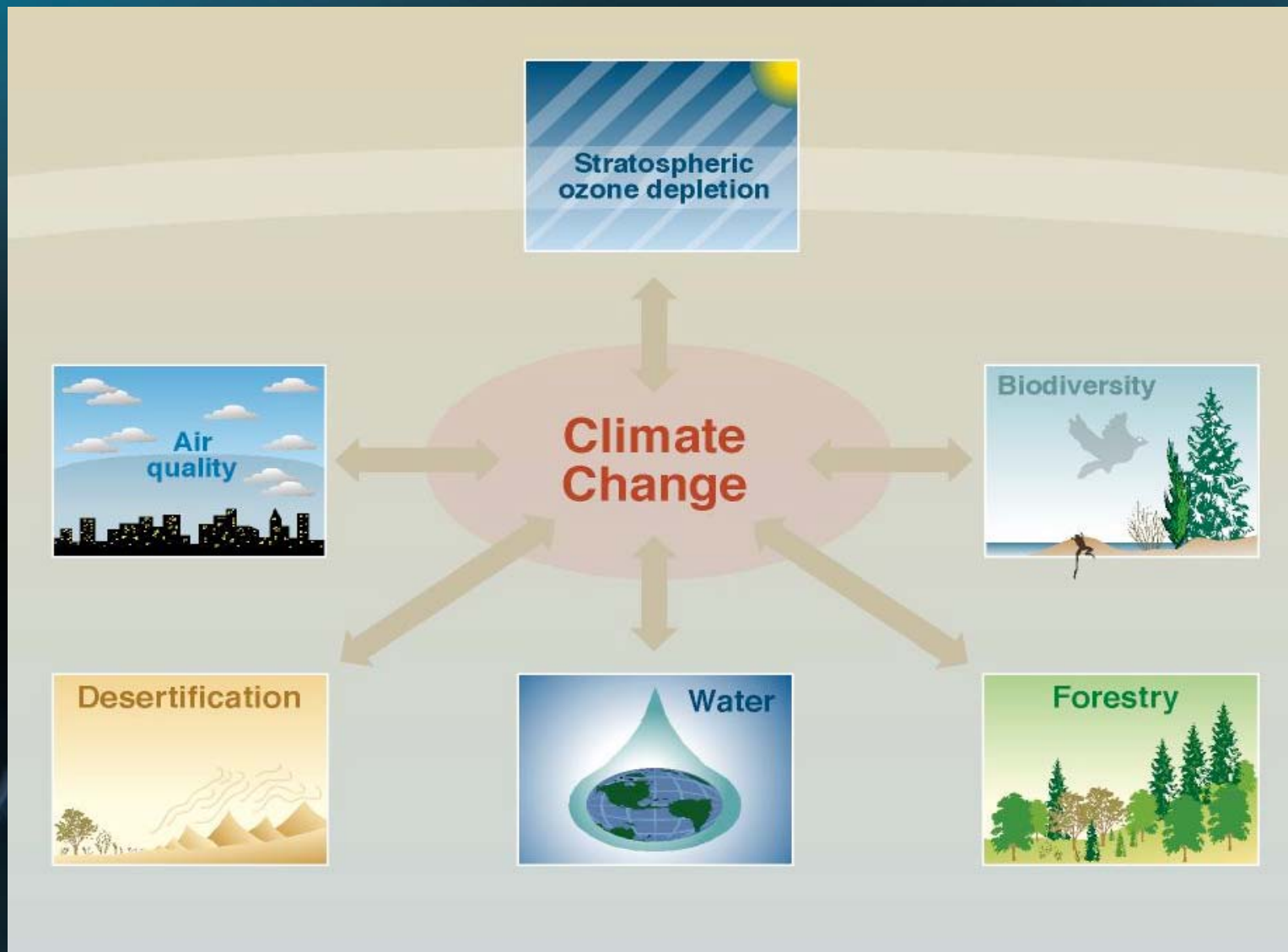


# Malaria

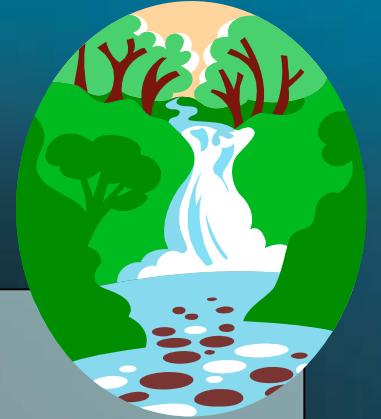




# Climate change and other environmental issues are inter-linked



# The Key Areas of Concern for the US



- Water Resources
  - Changes in flow regimes - mean annual flows, seasonal flow, probability of extreme high flow
    - Shift towards higher winter flows is likely to lead to greater flooding (River Sierra flows could be 20 times greater in the very wet years than in the dry years)
    - Clear mountain lakes, coastal waters and rivers could get murky and polluted as most of the precipitation would occur in the form of rain
  - Increased open water evaporation - declines in lake levels in some cases
  - Retreat of glaciers in NA will affect water resources

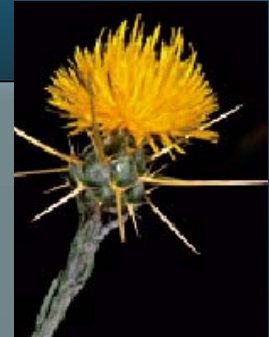


- Natural Resources
  - With warmer and drier summers, wildfires could become more frequent
  - Shift of tree line northwards will cause the alpine tundra to shrink
  - Changes in phenology of plants and animals may disrupt the vital interactions within the biological component of the ecosystem
  - The pest regimes may change and warmer climate could increase the incidence of pests eg outbreak of pine bark beetle may become more prominent or destructive
  - Despite the fertilizing effect of a CO<sub>2</sub> enriched atmosphere, forest productivity may be reduced by these factors



- Wild Life

- Loss of habitat due to climate related shifts of ecosystems - isolated ecosystems particularly vulnerable
- Impacts on fish population due to warmer temperatures, seasonal flow regimes, lake levels
  - In California cold-water fish species greenspotted rockfish has dropped by half since the 1970s, and the proportion of southern warm-water fish species Garibaldi has increased nearly 50% (*Confronting Climate Change in California - The Union of Concerned Scientists*)
- Increased drought conditions north of the Great Plains will significantly reduce the US breeding duck population



## Human risks

- Greater incidences of extreme weather events - heat waves, hurricanes, landslides
- Spread of diseases- warmer climate would favour the spread of pathogen carrying vectors

## Economic losses

- Agriculture would be affected due to water scarcity - 87% of California's crop area is irrigated
- Enhanced growth of crop under warmer conditions could reduce yields
- Increased ground water salinity resulting from more frequent and serious drought and salt water intrusion could negatively impact the region's aquaculture industry

# End of Part 3

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