



## >> How does the Tsunami Warning System work?

Here is how the basic tsunami warning system works in the Pacific Northwest area. First, a key concept - there are two sources of tsunami for Washington coastal waters - a distant source and a local source.

- [Schematic Diagram](#)
- [Tsunami Terminology](#)
- [Who does what](#)

**A local source** - if you feel violent shaking for several minutes, head for higher ground. The earthquake is your warning. The most likely source for a violent earthquake of this magnitude is from the [Cascadia Subduction Zone](#) just off our coast. The last associated earthquake was estimated to be 9.0 in magnitude on Jan 26, 1700, and was similar to the Dec 26, 2004 Sumatra 9.0 magnitude earthquake and subsequent Indian Ocean Basin tsunami.

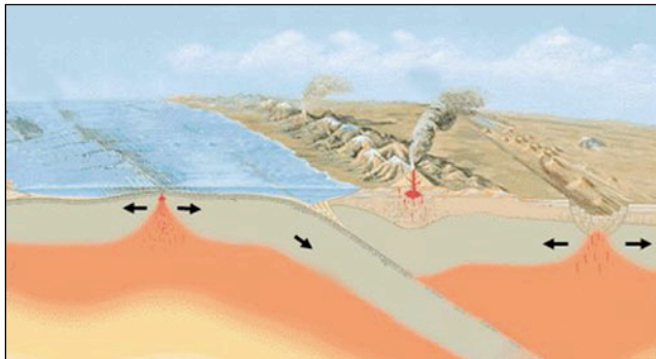
**What To Do?** - Simulations show the initial tsunami wave from the 1700 event reached the coast in 20 to 30 minutes - so time is limited. Geologic history showed waves with this event were as high as 30 feet. So you must get at least that high above sea level.

To top it off, the earthquake will also result in the coastal area subsiding as much as six feet, meaning the ground and roadways will likely be very uneven, and you are now that much lower to sea level. Since the roads will be in pieces, evacuation must be on foot. Another form of evacuation is vertical evacuation into a sturdy building of at least three stories and climb to at least the third story.

Other area earthquake faults could produce such strong violent quakes, such as the Seattle fault that produced a tsunami in Puget Sound about 1100 years ago. Yet, the most likely source for a local tsunami is the Cascadia Subduction Zone off our coast.

**A Distant Source** - The perimeter of the Pacific Ocean Basin, nicknamed the Ring of Fire, has a number of earthquake sources that can produce strong earthquakes of 7.0 magnitude or greater. During the 20th century, there were three 9.0 magnitude or greater quakes, the last was the 1964 Alaskan quake of 9.2 magnitude that produced a tsunami throughout the Pacific Basin. These kind of earthquakes permit a lead time of hours before their subsequent tsunami reaches the Washington coastline. Tsunamis from distant locations like Japan or Chile will take over 10 hours to get here, while from Alaska, only three to six hours.

Tsunamis generated from both sources of earthquakes do penetrate into the Puget Sound region via the Strait of Juan de Fuca and up coastal rivers, harbors and bays, but lose energy as they move further inland.



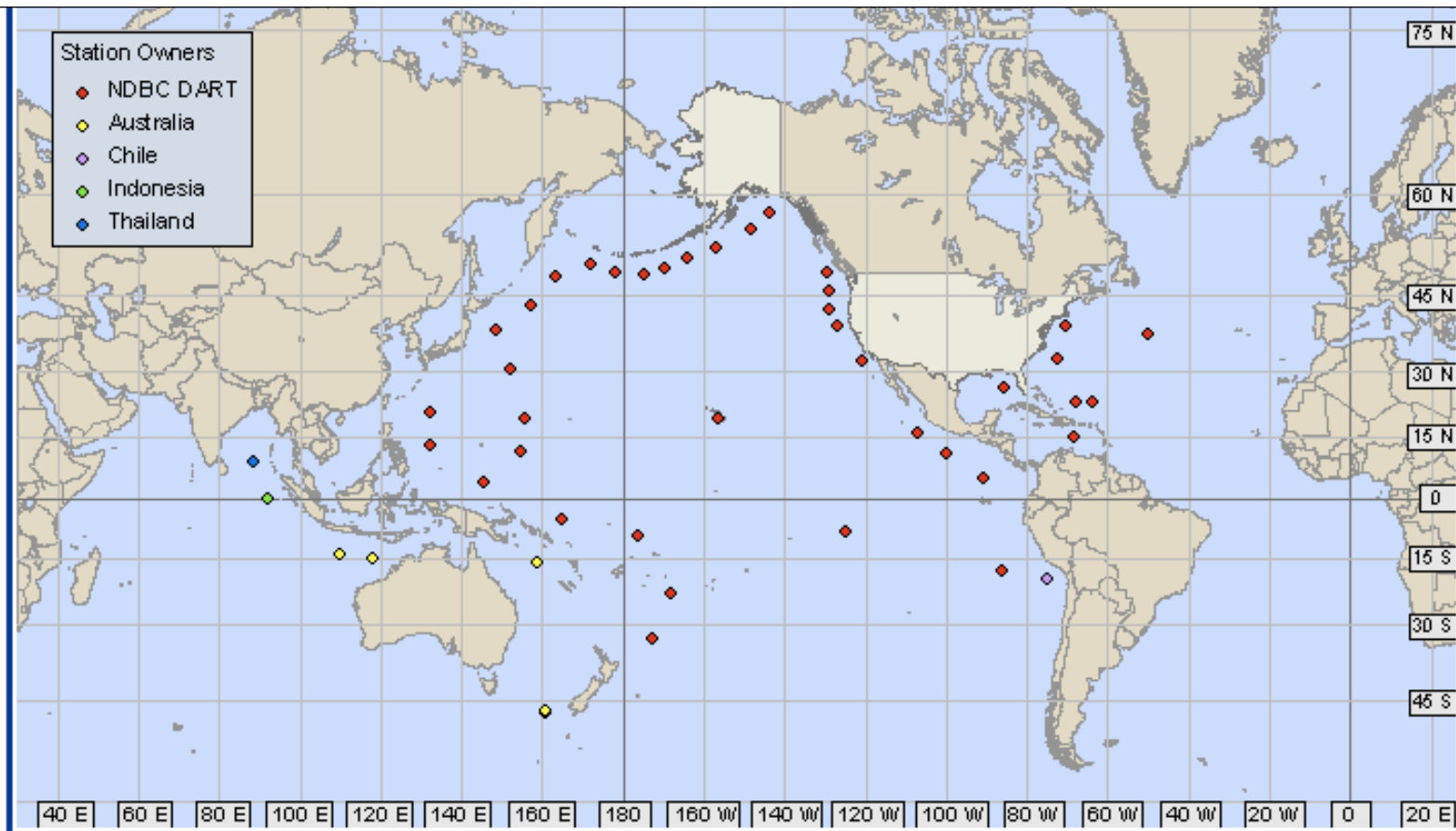
The Cascadia Subduction Zone is a very long sloping fault that stretches from mid-Vancouver Island to Northern California. It separates the Juan de Fuca and North America plates. New ocean floor is being created offshore of Washington and Oregon. As more material wells up along the ocean ridge, the ocean floor is pushed toward and beneath the continent. The Cascadia Subduction Zone is where the two plates meet.

### HOW BIG ARE CASCADIA SUBDUCTION ZONE QUAKES?

Great Subduction Zone earthquakes are the largest earthquakes in the world, and can exceed magnitude 9.0. Earthquake size is proportional to fault area, and the Cascadia Subduction Zone is a very long sloping fault that stretches from mid-Vancouver Island to Northern California. It separates the Juan de Fuca and North America plates. Because of the very large fault area, the Cascadia Subduction Zone could produce a very large earthquake, magnitude 9.0 or greater, if rupture occurred over its whole area.

### HOW OFTEN ARE CASCADIA SUBDUCTION ZONE QUAKES?

The last known great earthquake in the northwest was in [January, 1700](#), just over 300 years ago. Geological evidence indicates that great earthquakes may have occurred at least seven times in the last 3,500 years, suggesting a return time of 400 to 600 years.



Tsunami Watch - An alert issued to areas outside the warned area. The area included in the watch is based on the magnitude of the earthquake. For earthquakes over magnitude 7.0, the watch area is 1 hour tsunami travel time outside the warning zone. For all earthquakes over magnitude 7.5, the watch area is 3 hours tsunami travel time outside the warning zone. The watch will either be upgraded to a warning in subsequent bulletins or will be cancelled depending on the severity of the tsunami.

Tsunami Warning - Indicates that a tsunami is imminent and that coastal locations in the warned area should prepare for flooding. The initial warning is typically based on seismic information alone. Earthquakes over magnitude 7.0 trigger a warning covering the coastal regions within 2 hours tsunami travel time from the epicenter. When the magnitude is over 7.5, the warned area is increased to 3 hours tsunami travel time. As water level data showing the tsunami is recorded, the warning will either be cancelled, restricted, expanded

APRIL 3, 2006

www.time.com AOL Keyword: TIME

SPECIAL REPORT GLOBAL WARMING

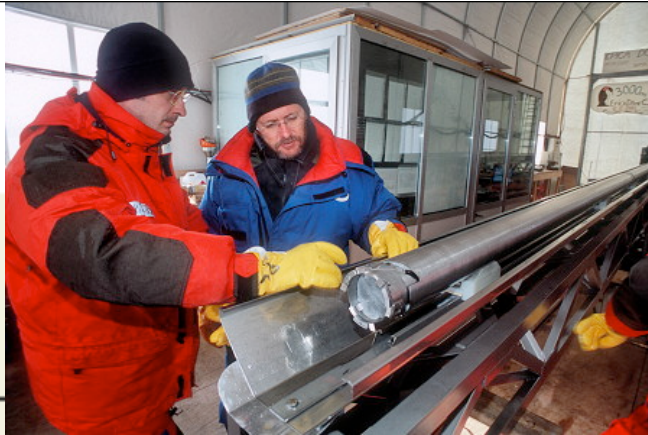
# TIME

BE  
WORRIED.  
BE **VERY**  
WORRIED.

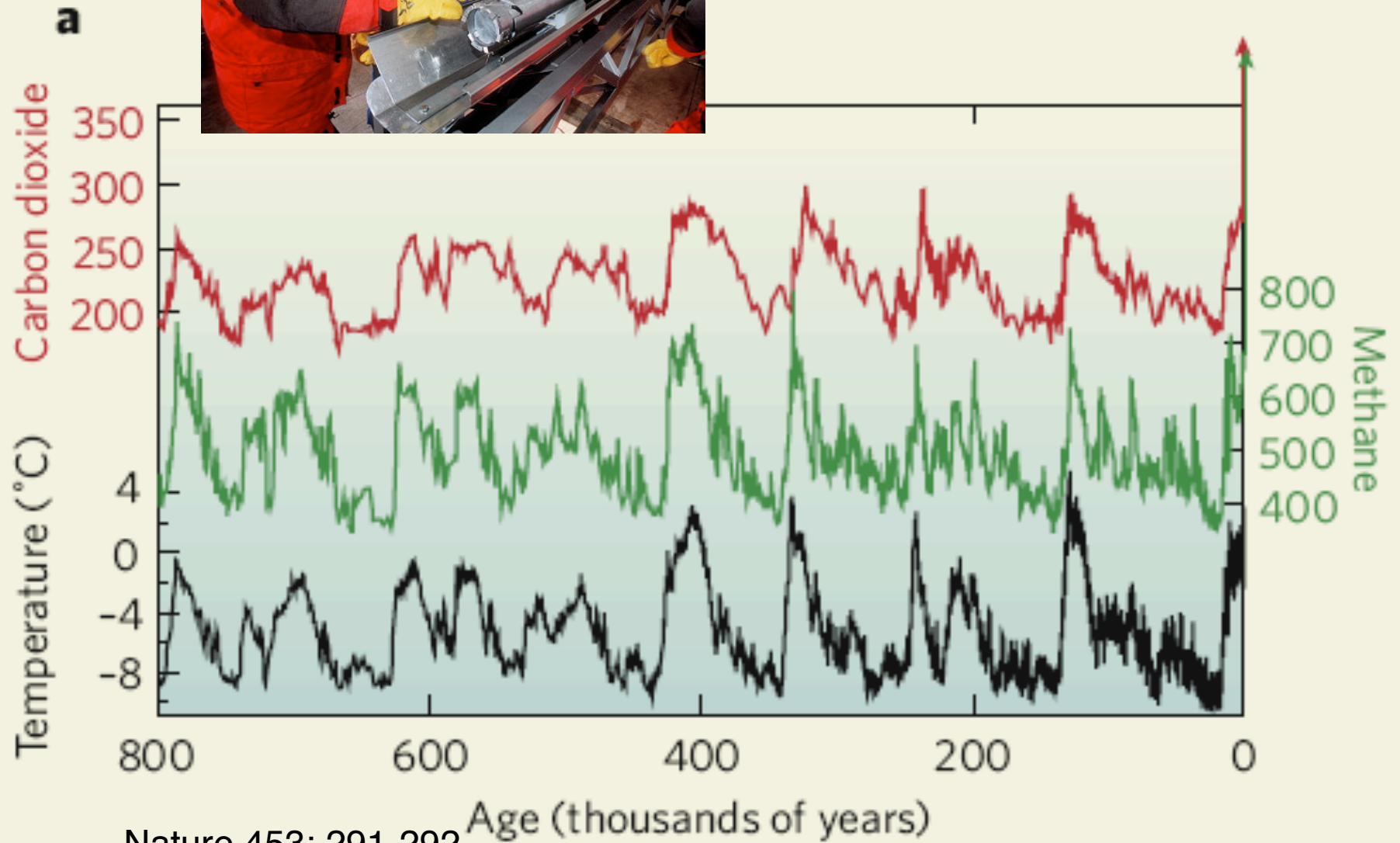
Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well

EARTH AT THE **TIPPING POINT**  
HOW IT THREATENS YOUR **HEALTH**  
HOW **CHINA & INDIA** CAN HELP  
SAVE THE WORLD—OR DESTROY IT  
THE CLIMATE **CRUSADERS**

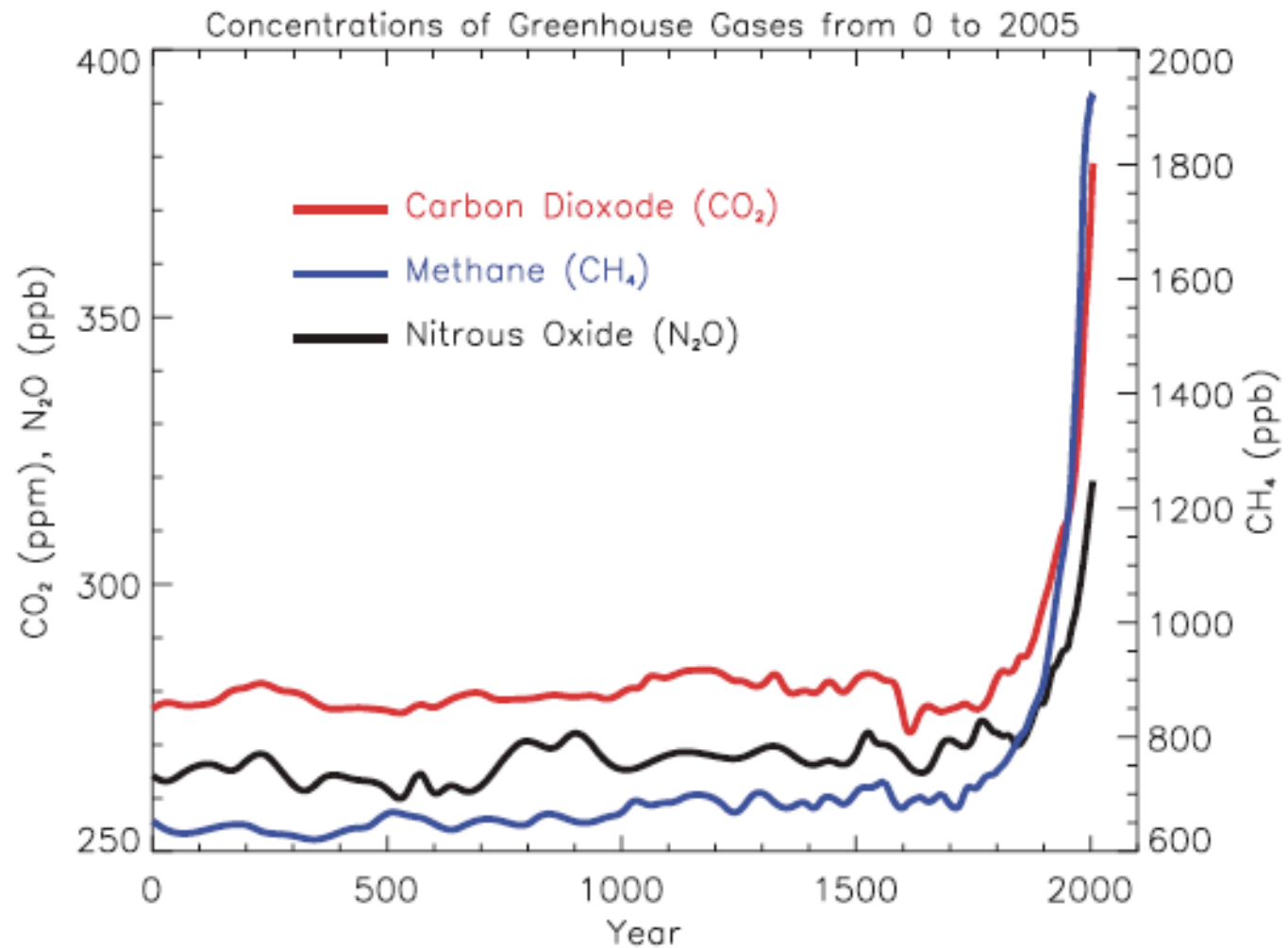




[www.gdargaud.net/Antarctica/Epica.htm](http://www.gdargaud.net/Antarctica/Epica.htm)



Nature 453: 291-292



**FAQ 2.1, Figure 1.** *Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. (Data combined and simplified from Chapters 6 and 2 of this report.)*

# Keeling Curve

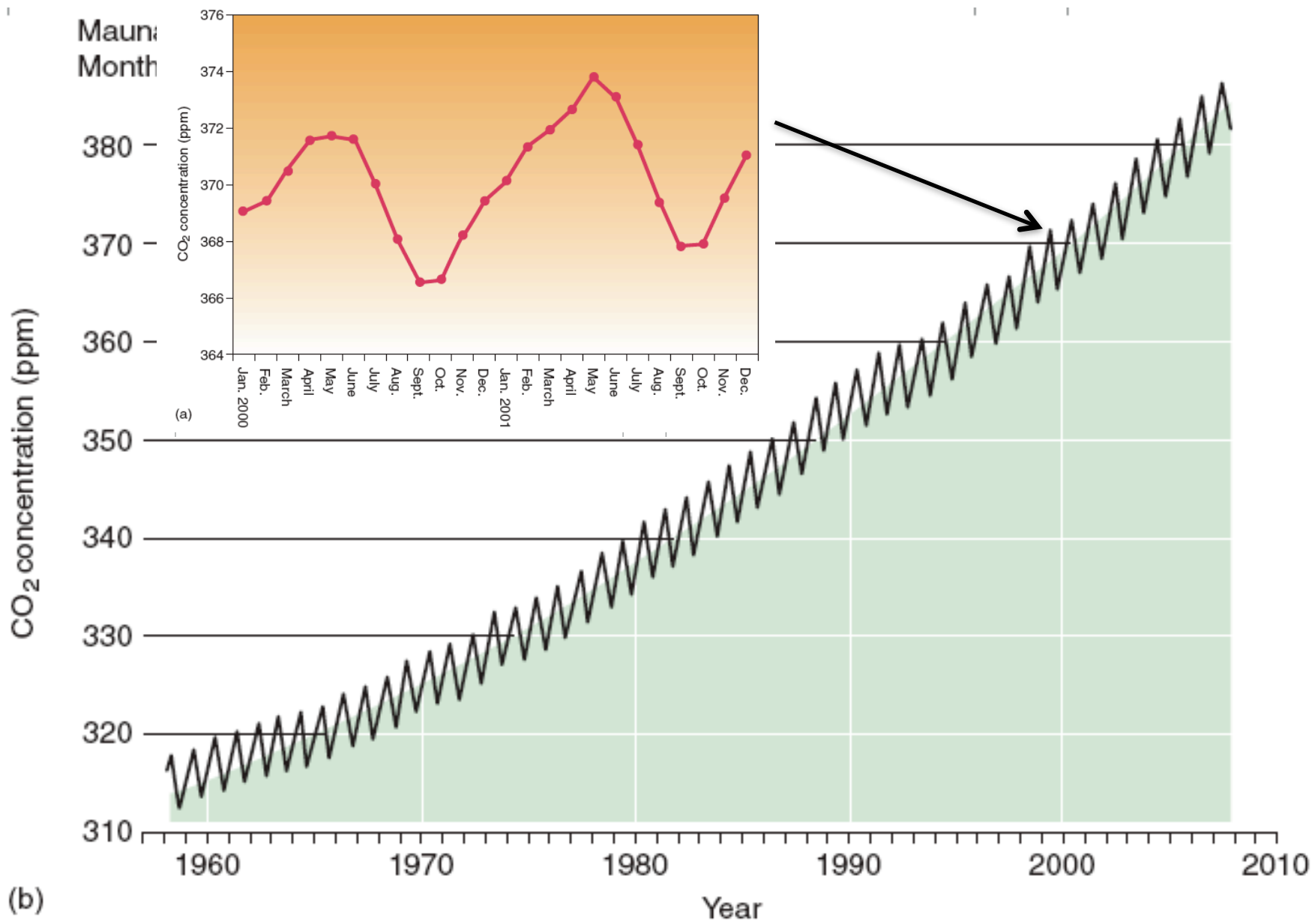
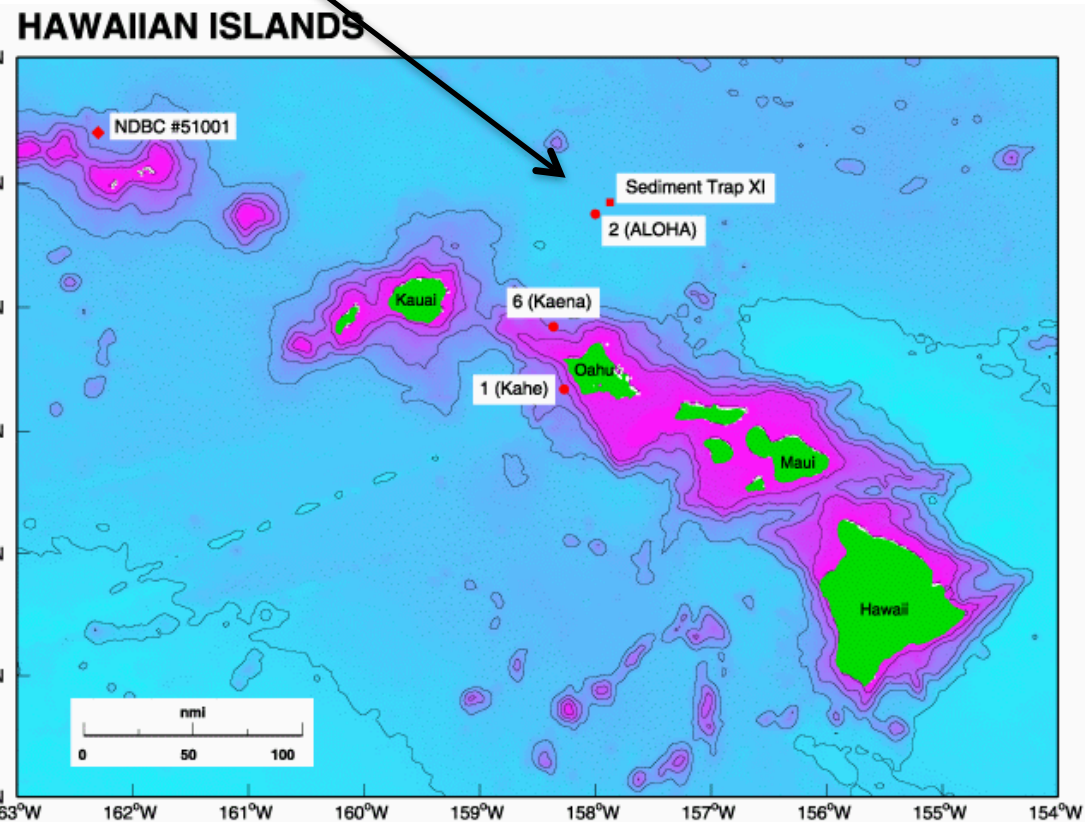
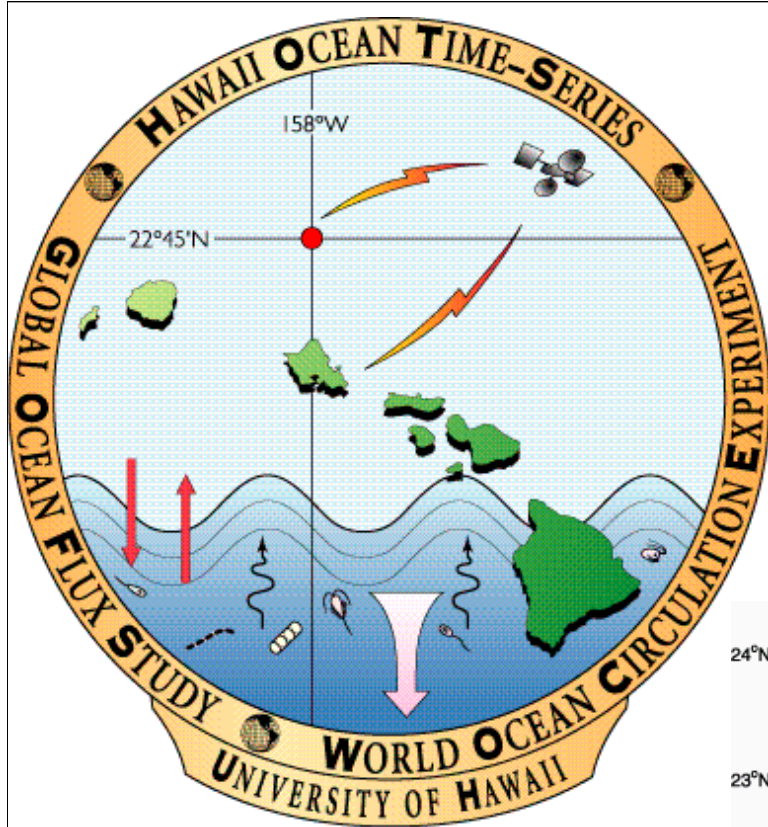
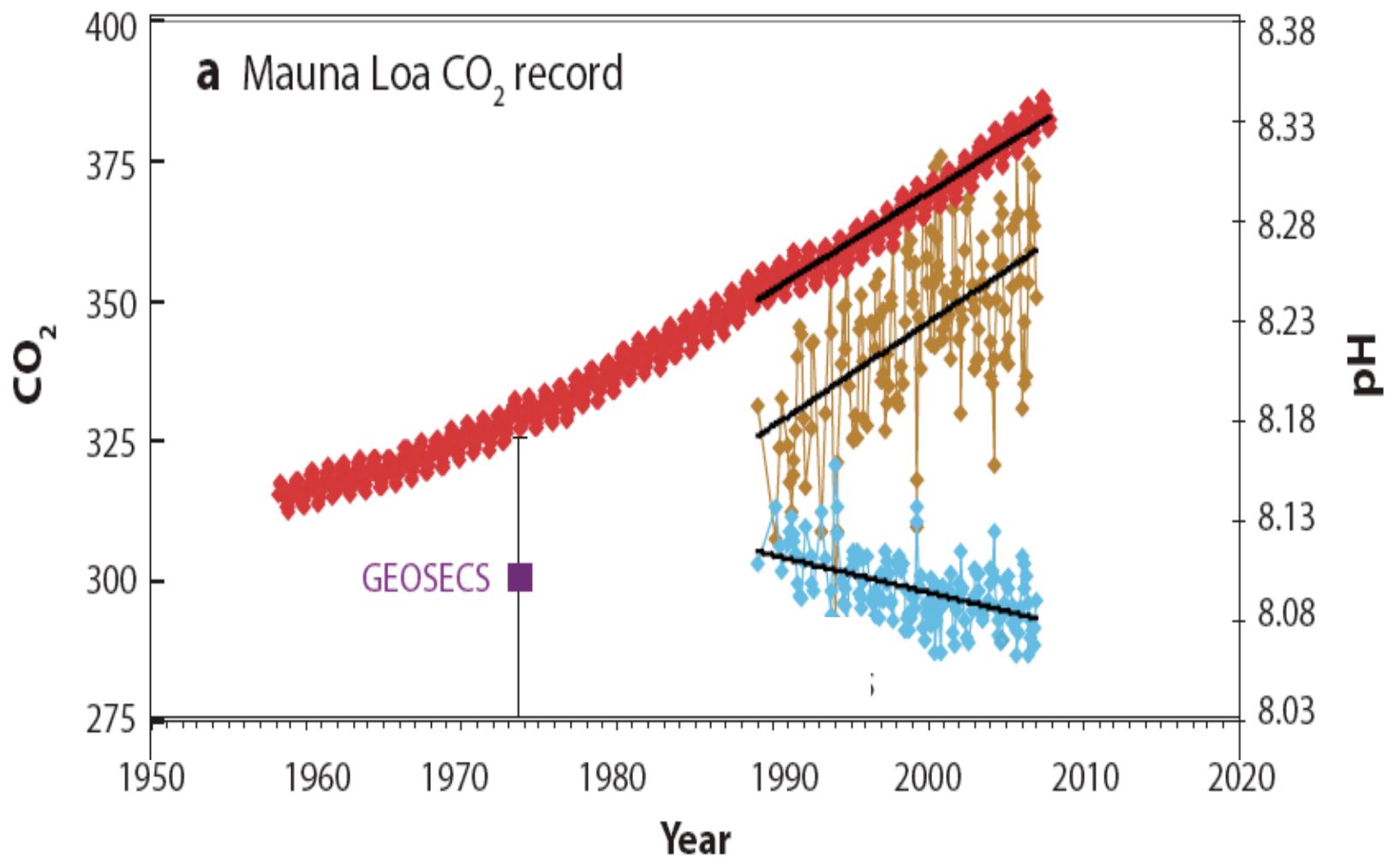


Fig. 7.11







# Intergovernmental Panel on Climate Change (IPCC)

## The IPCC Sequence of Key Findings.....

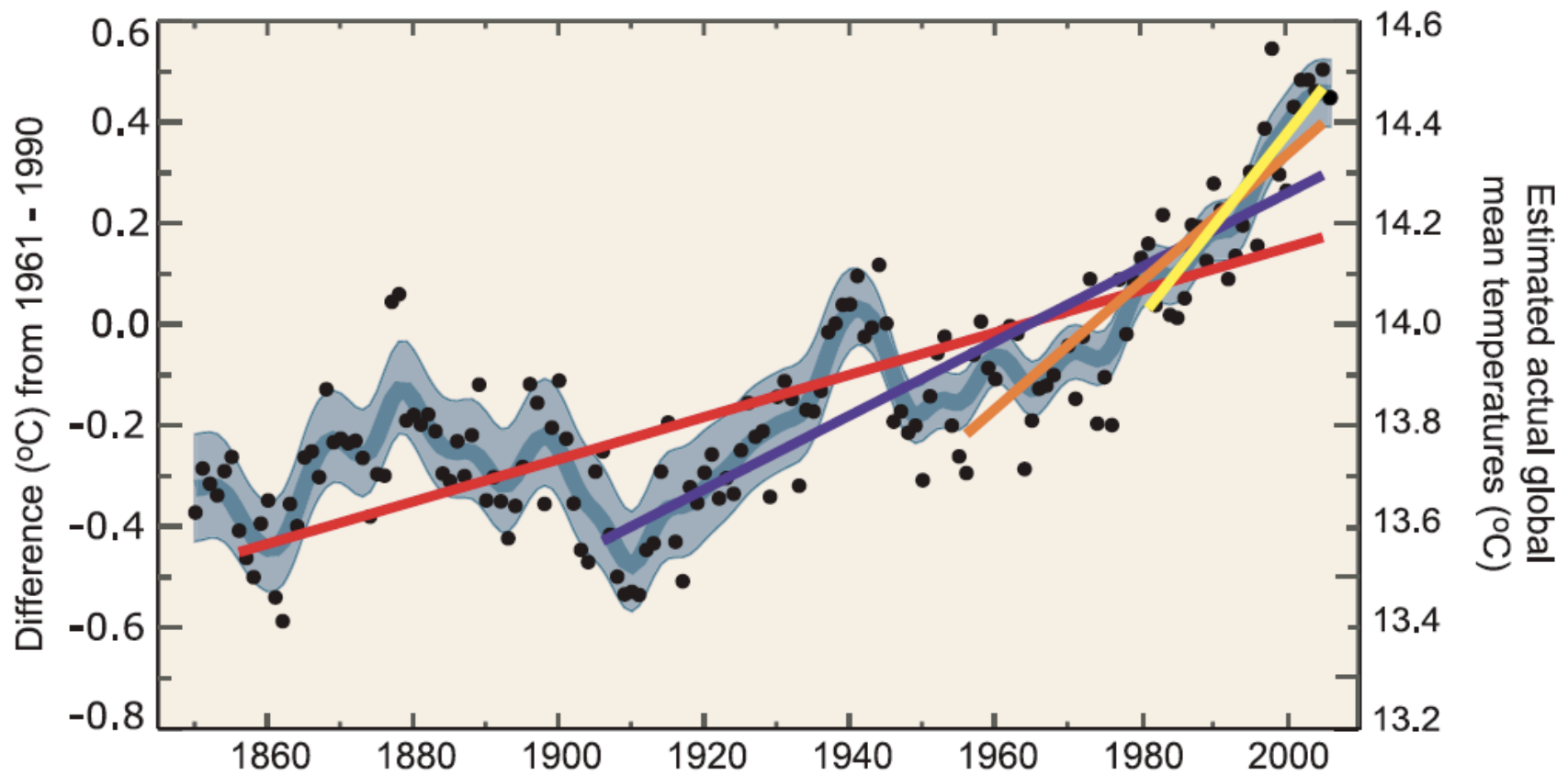
IPCC (1990) Broad overview of climate change science, discussion of uncertainties and evidence for warming.

IPCC (1995) “The balance of evidence suggests a discernible human influence on global climate.”

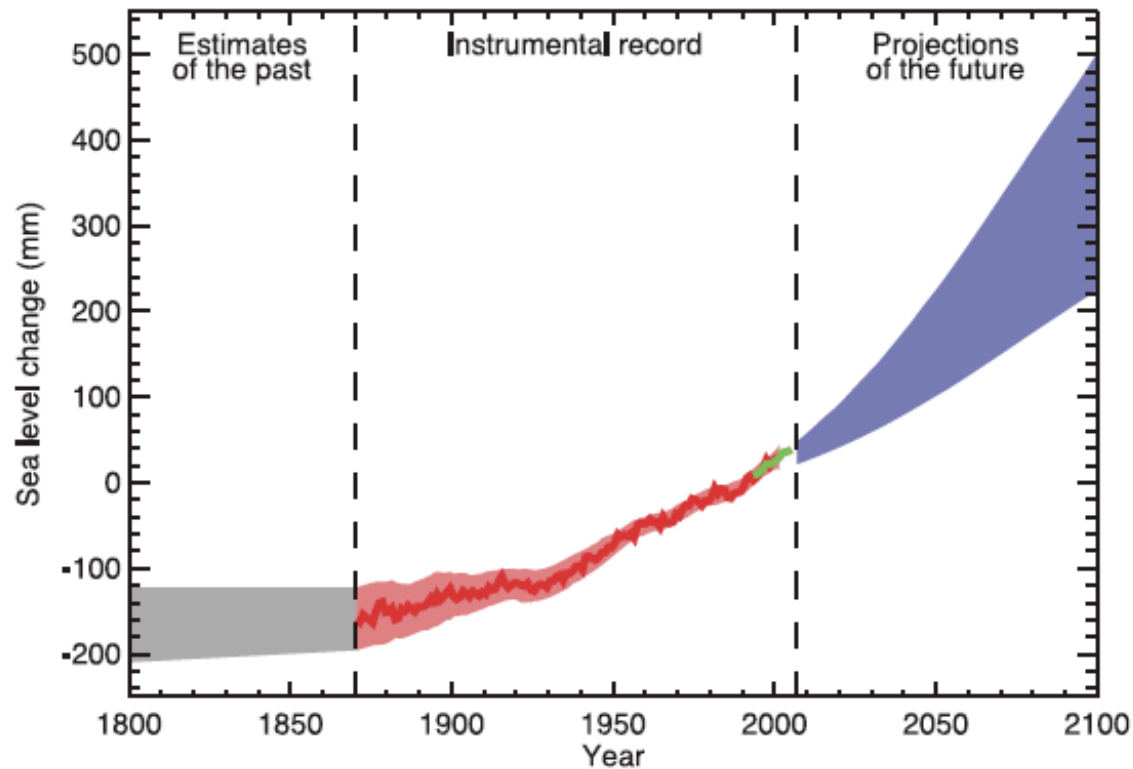
IPCC (2001) “Most of the warming of the past 50 years is likely (>66%) to be attributable to human activities.”

IPCC (2007) “Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases.”

# Global Mean Temperature



	Period Years	Rate °C per decade
● Annual mean		
— Smoothed series		
■ 5-95% decadal error bars		
	25	0.177±0.052
	50	0.128±0.026
	100	0.074±0.018
	150	0.045±0.012

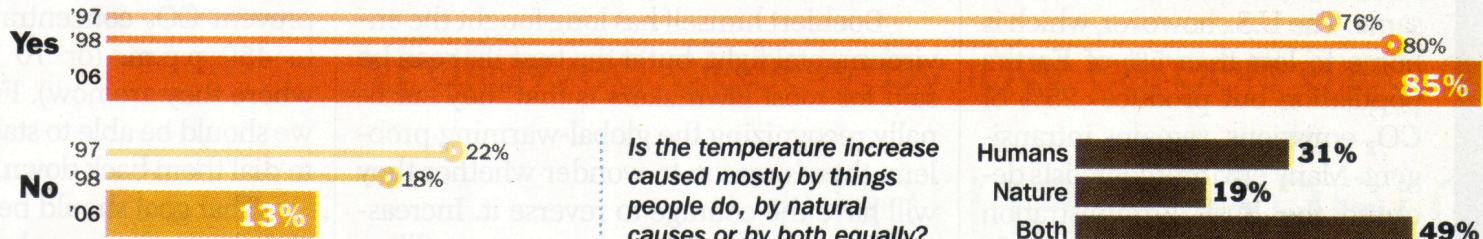


**FAQ 5.1, Figure 1.** *Time series of global mean sea level (deviation from the 1980-1999 mean) in the past and as projected for the future. For the period before 1870, global measurements of sea level are not available. The grey shading shows the uncertainty in the estimated long-term rate of sea level change (Section 6.4.3). The red line is a reconstruction of global mean sea level from tide gauges (Section 5.5.2.1), and the red shading denotes the range of variations from a smooth curve. The green line shows global mean sea level observed from satellite altimetry. The blue shading represents the range of model projections for the SRES A1B scenario for the 21st century, relative to the 1980 to 1999 mean, and has been calculated independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario (see Chapter 10 for a discussion of sea level rise projections for other scenarios considered in this report). Over many centuries or millennia, sea level could rise by several metres (Section 10.7.4).*

# SEEING THE PROBLEM, NOT THE SOLUTION

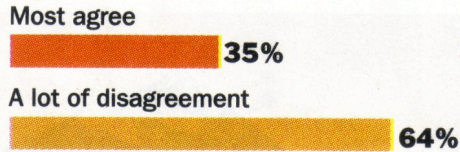
**MORE PEOPLE THINK THE EARTH IS GETTING WARMER**, but they're split on whether humans are the cause

Has the world's temperature been going up slowly over the past 100 years?

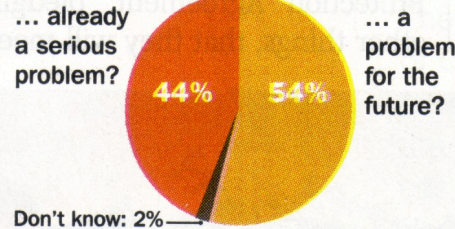


**MOST PEOPLE AREN'T AWARE OF THE BROAD SCIENTIFIC CONSENSUS** on warming. The majority sees it as a problem for future generations

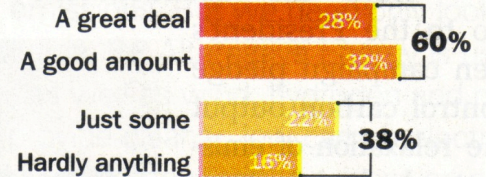
Do you think most scientists agree with one another about global warming, or do you think there is a lot of disagreement on this issue?



Is global warming ...

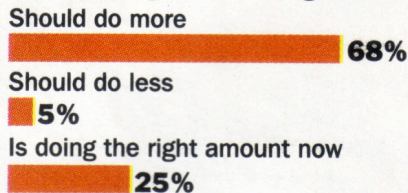


How much do you think can be done to reduce the amount of future global warming?

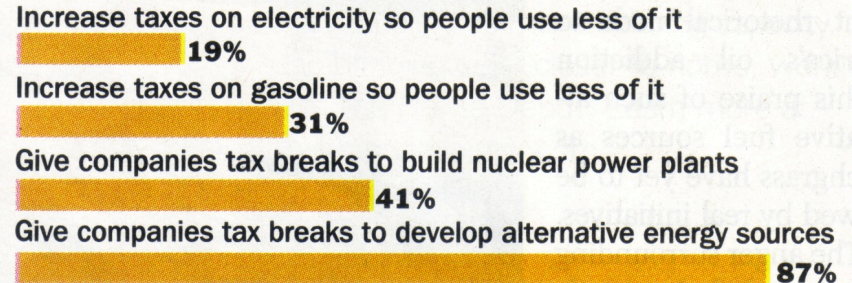


**A STRONG MAJORITY WANTS MORE DONE**, but there's little appetite for higher taxes to reduce energy consumption

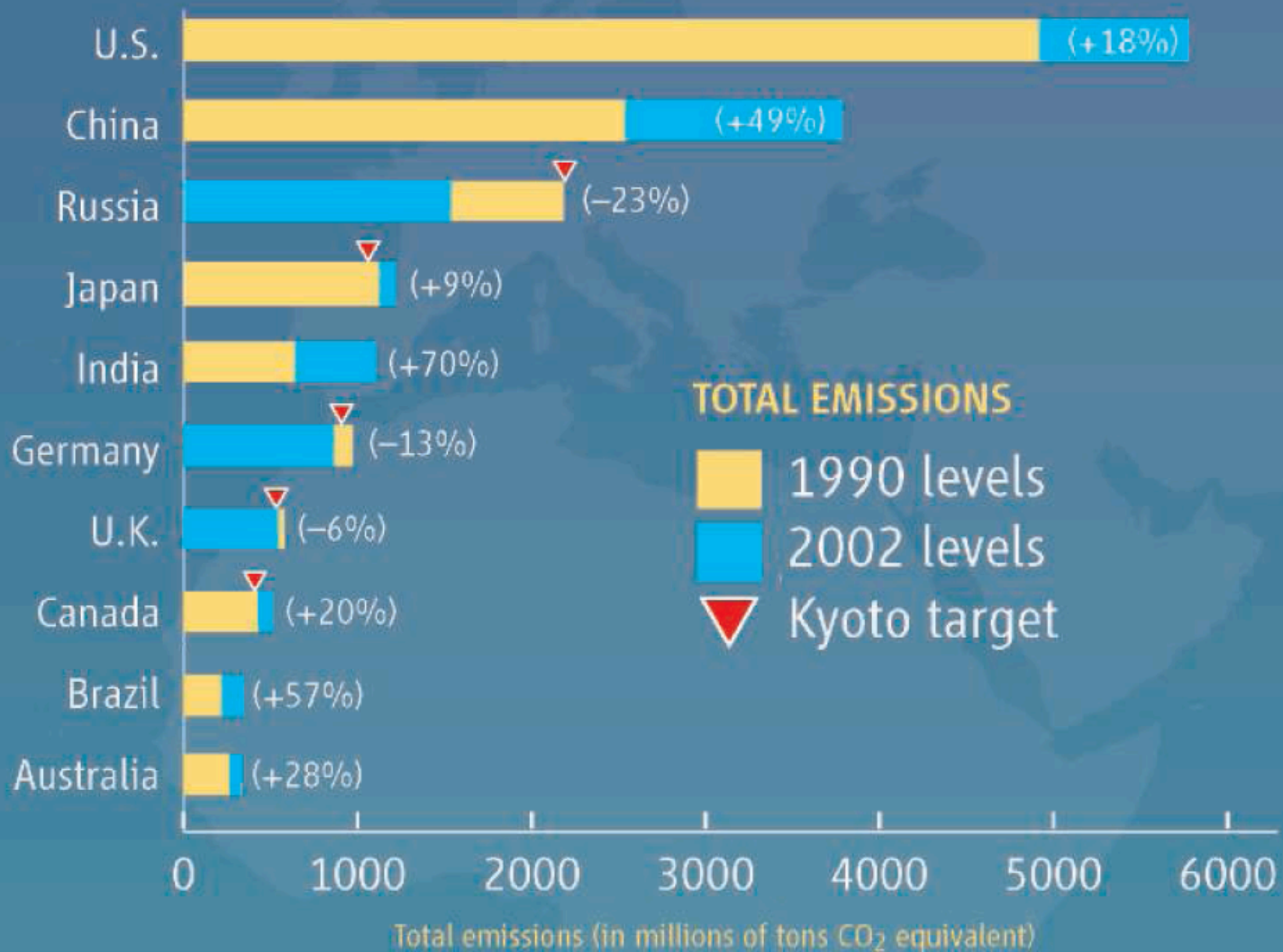
Do you think the Federal Government should do more to try to deal with global warming?



Percentage who favor the following as a way for the government to try to reduce global warming:



This TIME/ABC News/Stanford University poll was conducted by telephone March 9-14 among 1,002 adult Americans by TNS of Horsham, Pa. The margin of error is ±3 percentage points. Data for 1997 and 1998 are from an Ohio State University poll. "Don't know" responses omitted for some questions.



**Follow the carbon.** The United States and China, with no obligation to meet Kyoto targets, have stretched their lead as the world's biggest carbon emitters. Among Kyoto ratifiers listed here, Russia and Germany have cut total emissions and exceeded Kyoto targets, whereas Japan and Canada face daunting challenges to meet their targets. The percentages in parentheses reflect changes in emissions from 1990 to 2002.

SOURCE: CLIMATE ANALYSIS INDICATORS TOOL; WORLD RESOURCES INSTITUTE; UNITED NATIONS

# CO2 levels rising faster as oceans trap less of greenhouse gas

Last Updated: Tuesday, October 23, 2007 | 9:06 AM ET  
The Associated Press

Just days after the Nobel Prize was awarded for work that documents global warming, an alarming new study finds that carbon dioxide in the atmosphere is increasing faster than expected.

Carbon dioxide emissions were 35 per cent higher in 2006 than in 1990, a much faster growth rate than anticipated, researchers led by Josep G. Canadell, of Australia's Commonwealth Scientific and Industrial Research Organization, report in Tuesday's edition of Proceedings of the National Academy of Sciences.

Increased industrial use of fossil fuels coupled with a decline in the gas absorbed by the oceans and land were listed as causes of the increase.

"In addition to the growth of global population and wealth, we now know that significant contributions to the growth of atmospheric CO2 arise from the slowdown" of nature's ability to take the gas out of the air, said Canadell, director of the Global Carbon Project at the research organization.

The changes "characterize a carbon cycle that is generating stronger-than-expected and sooner-than-expected climate forcing," the researchers report.

Kevin Trenberth of the climate analysis section of the National Center for Atmospheric Research in Boulder, Colo. said the "paper raises some very important issues that the public should be aware of: Namely that concentrations of CO2 are increasing at much higher rates than previously expected and this is in spite of the Kyoto Protocol that is designed to hold them down in Western countries."

## Oceans absorbing less CO2

Alan Robock, associate director of the Center for Environmental Prediction at Rutgers University, added: "What is really shocking is the reduction of the oceanic CO2 sink," meaning the ability of the ocean to absorb carbon dioxide, removing it from the atmosphere.

The researchers blamed that reduction on changes in wind circulation, but Robock said he also thinks rising ocean temperatures reduce the ability to take in the gas.

"Think that a warm Coke has less fizz than a cold Coke," he said.

Neither Robock nor Trenberth was part of Canadell's research team.

Carbon dioxide is the leading greenhouse gas, so named because the accumulation of such gases in the atmosphere can help trap heat from the sun, causing potentially dangerous warming of the planet.

While most atmospheric scientists accept the idea, finding ways to reduce greenhouse gas emissions has been a political problem because of potential economic effects. Earlier this month, the Nobel Peace Prize was awarded to the United Nations Intergovernmental Panel on Climate Change and former U.S. vice-president Al Gore for their work in calling attention to global warming.

## Change happening faster than predicted

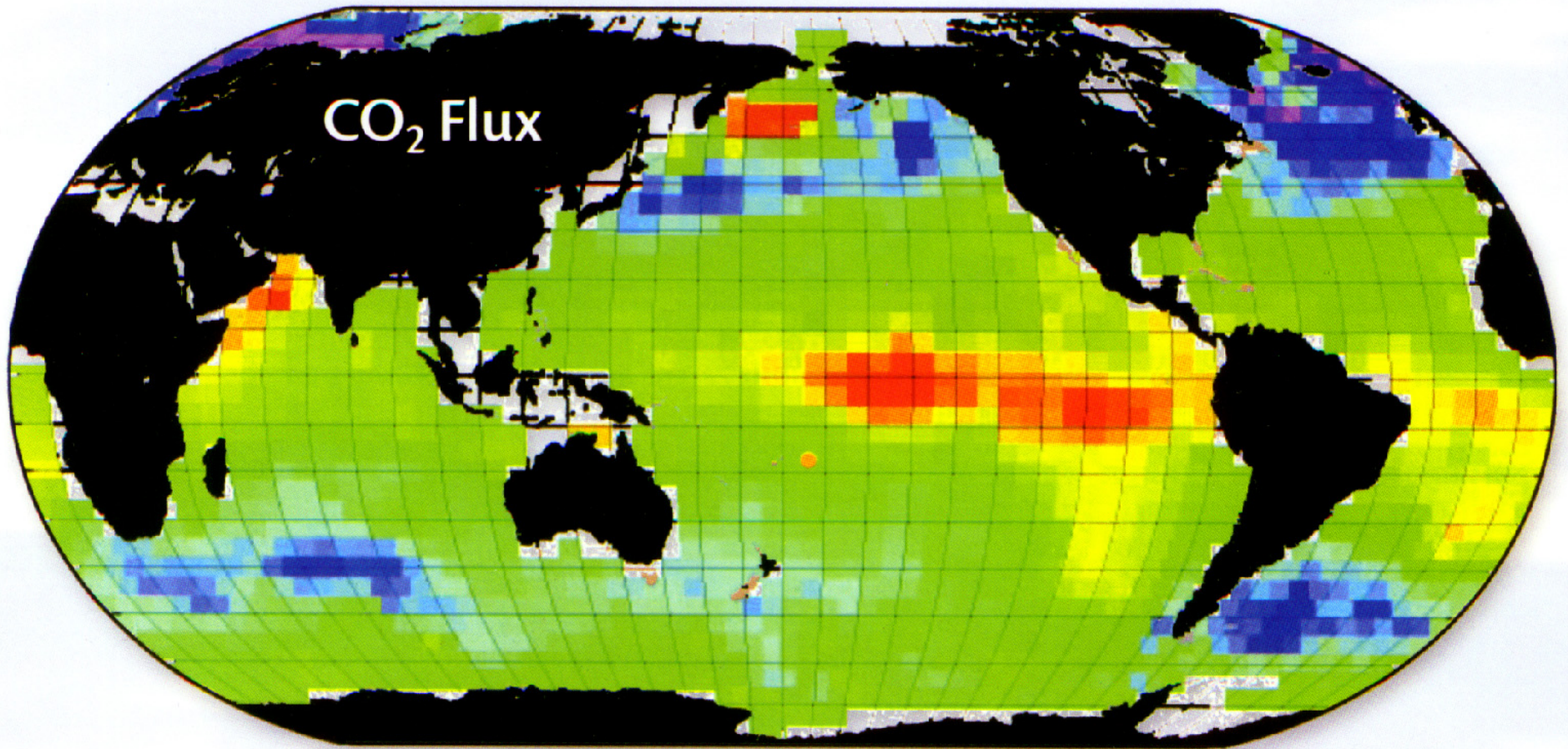
"It turns out that global warming critics were right when they said that global climate models did not do a good job at predicting climate change," Robock commented. "But what has been wrong recently is that the climate is changing even faster than the models said. In fact, Arctic sea ice is melting much faster than any models predicted, and sea level is rising much faster than IPCC previously predicted."

Emissions:

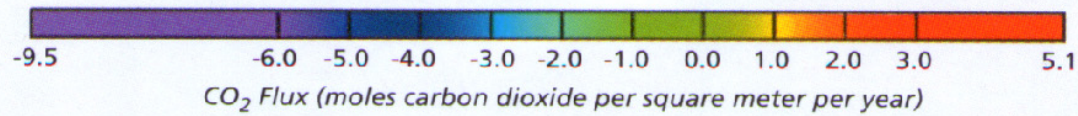
growth of world economy  
carbon intensity of activities

Removal/emission:

land  
ocean



T. Takahashi



JGOFS