



The University of Texas at Austin  
Environmental Science Institute

*Hot Science - Cool Talk # 63*

***Global Warming -  
Lone Star Impacts***

**Dr. Gerald North  
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**Environmental Science Institute**  
UNIVERSITY OF TEXAS AT AUSTIN

*Hot Science - Cool Talks* Vol. 63

# Global Warming - Lone Star Impacts

Gerald R. North  
Texas A&M University  
g-north@tamu.edu

# Man-made climate change

- It is surely real
- It will continue
- It will impact Texas
- Our choices

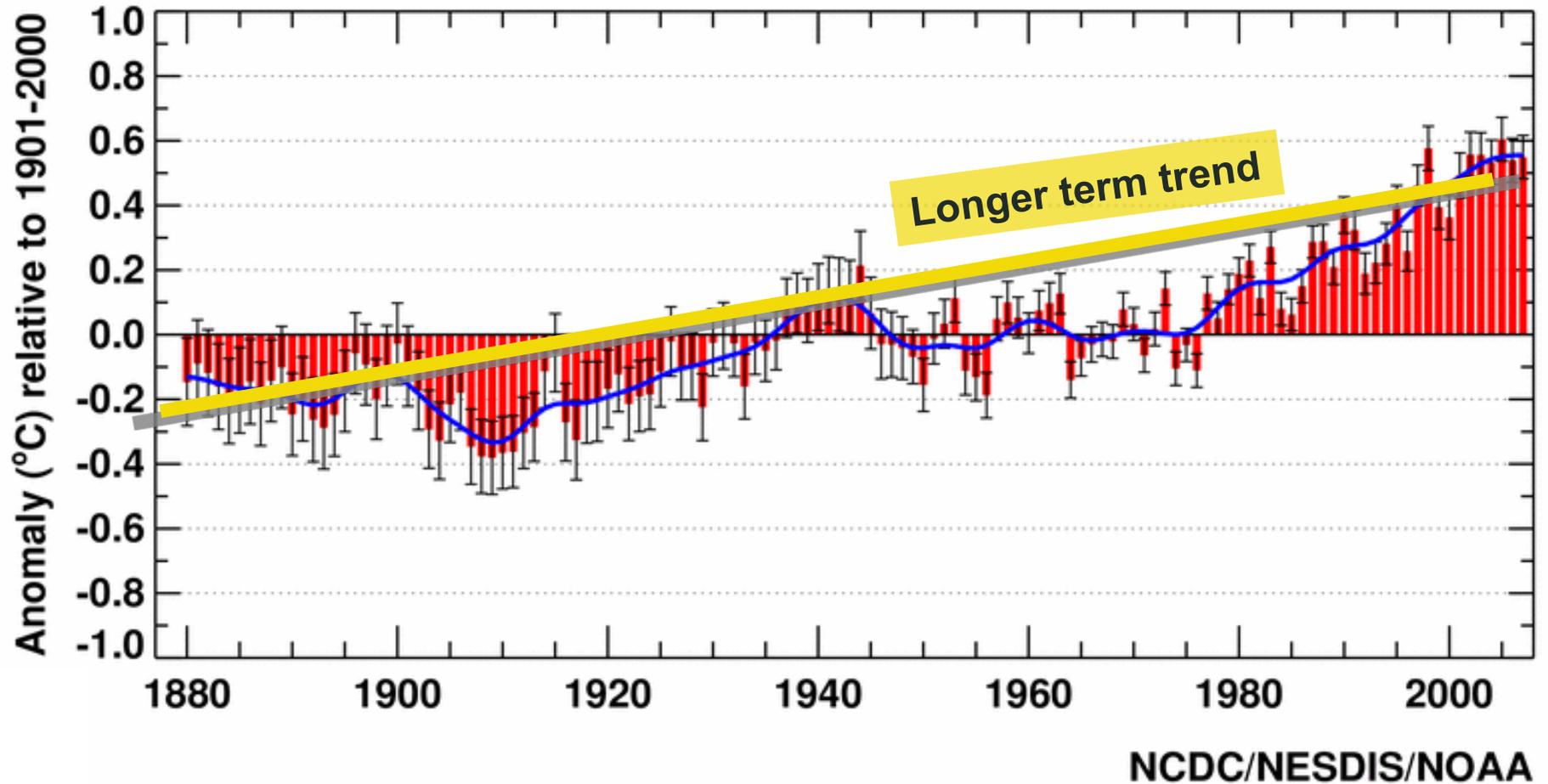


**Temperature Anomaly:** deviation from average temperature over a period of time. If anomaly is positive, temperature is higher than average. If the anomaly is negative, temperature is lower than average.

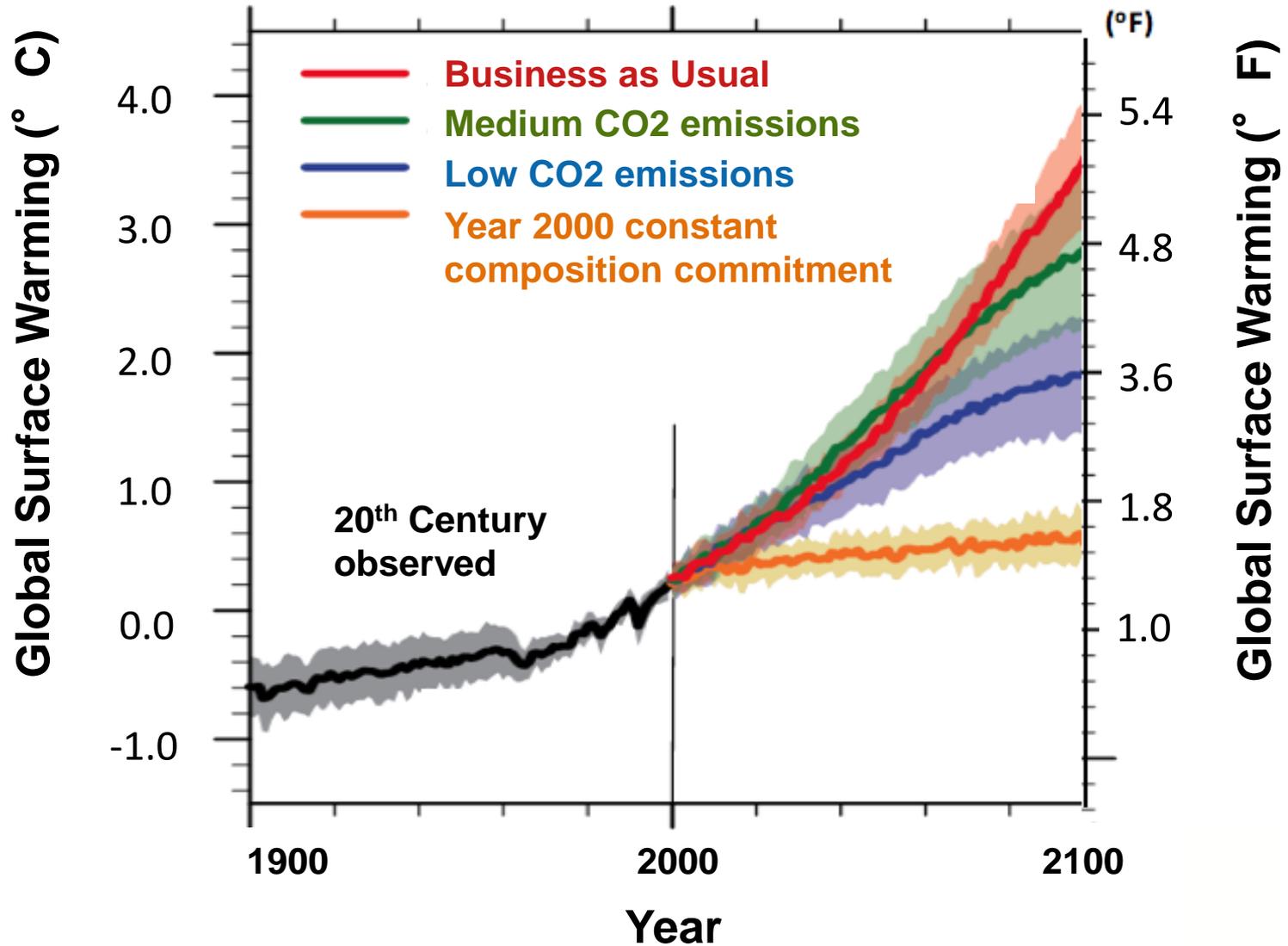
*It is important to know over what period of time is the average being taken. The anomaly could be different if the average is taken over 100 years versus 1000 years.*

# It is surely real

## Global Annual Mean Temperature



# It will continue





# It will impact Texas



drier west



wetter east



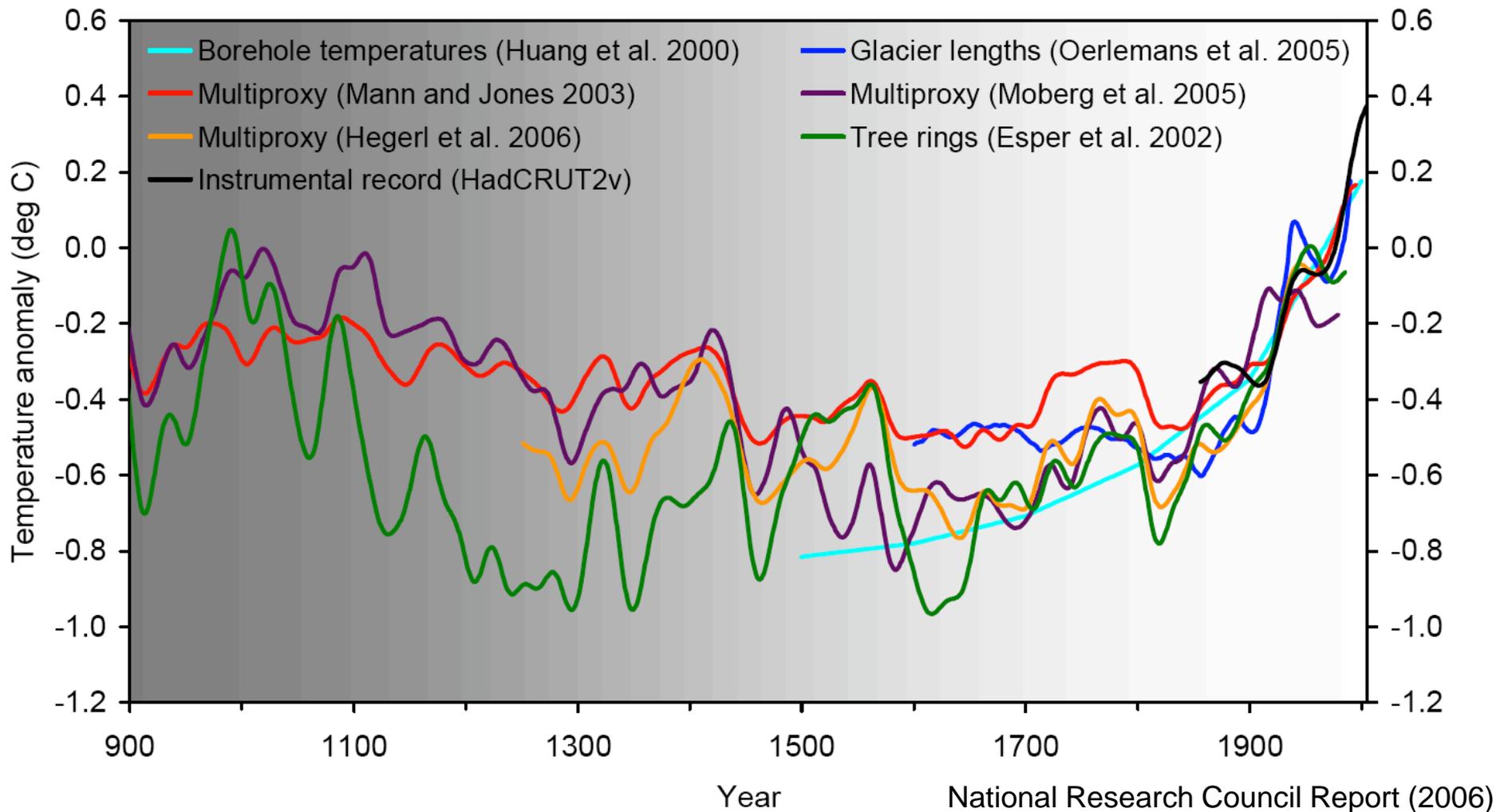
# Our Choices

We could sit back  
and adapt to it:



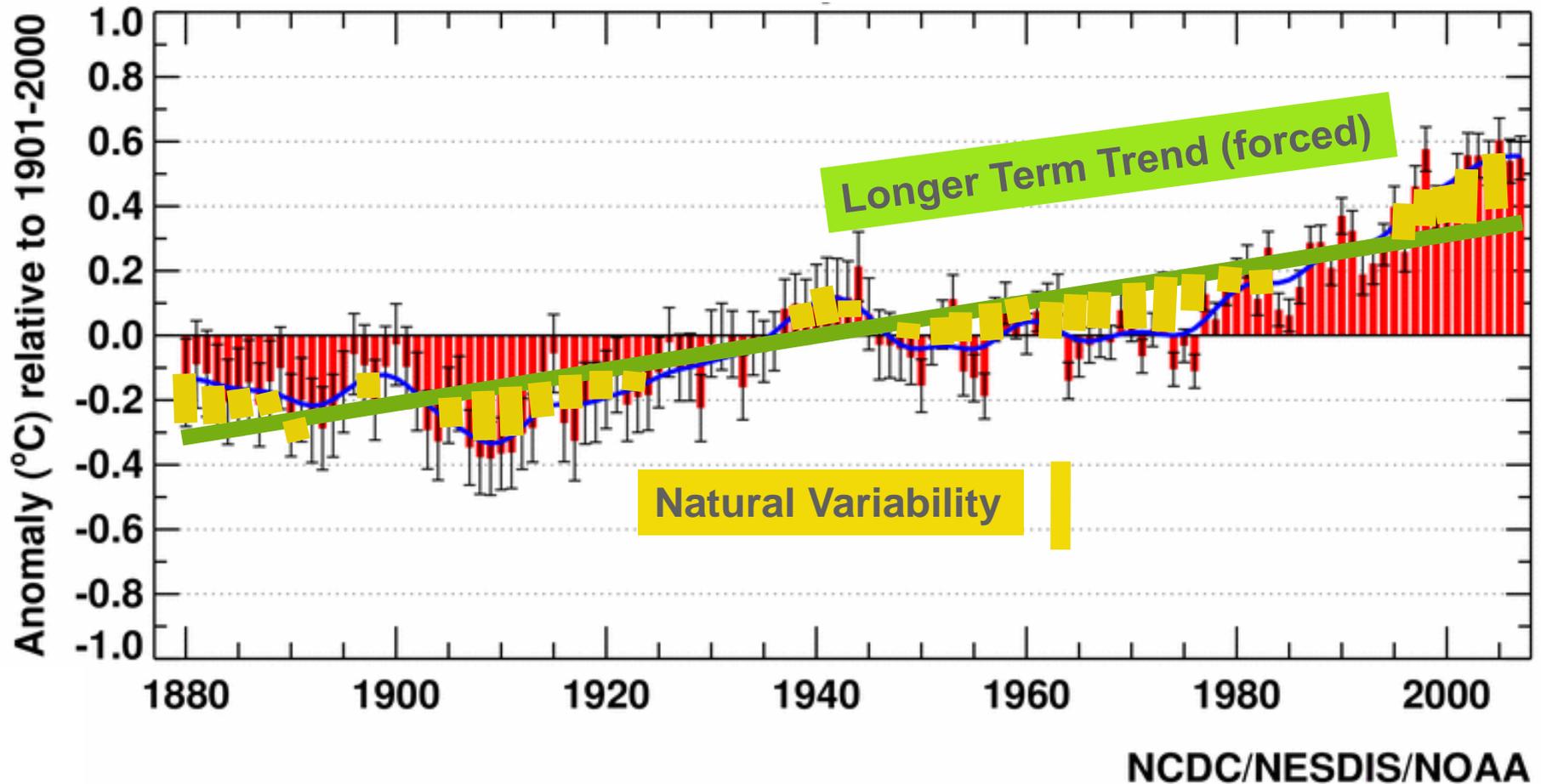
**Or take responsibility.  
It may be cheaper.**

# Many climate records show temperatures increasing



# Climate is constantly changing: some fluctuations are natural, some “forced”

## Global Annual Mean Temperature



# The Greenhouse Effect

Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth's surface and the lower atmosphere.

Solar radiation powers the climate system.



Some solar radiation is reflected by the Earth and the atmosphere.

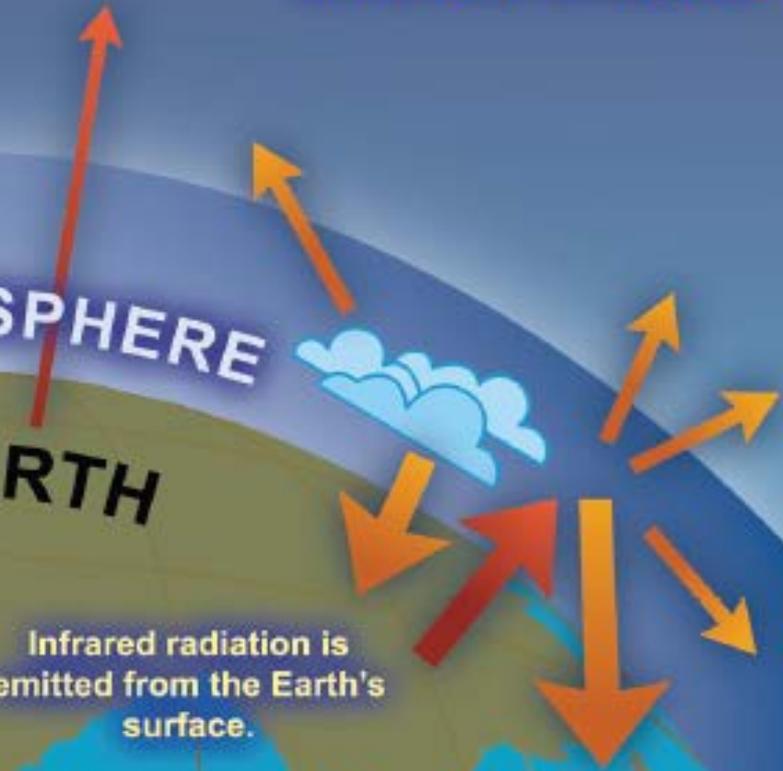


About half the solar radiation is absorbed by the Earth's surface and warms it.

ATMOSPHERE

EARTH

Infrared radiation is emitted from the Earth's surface.



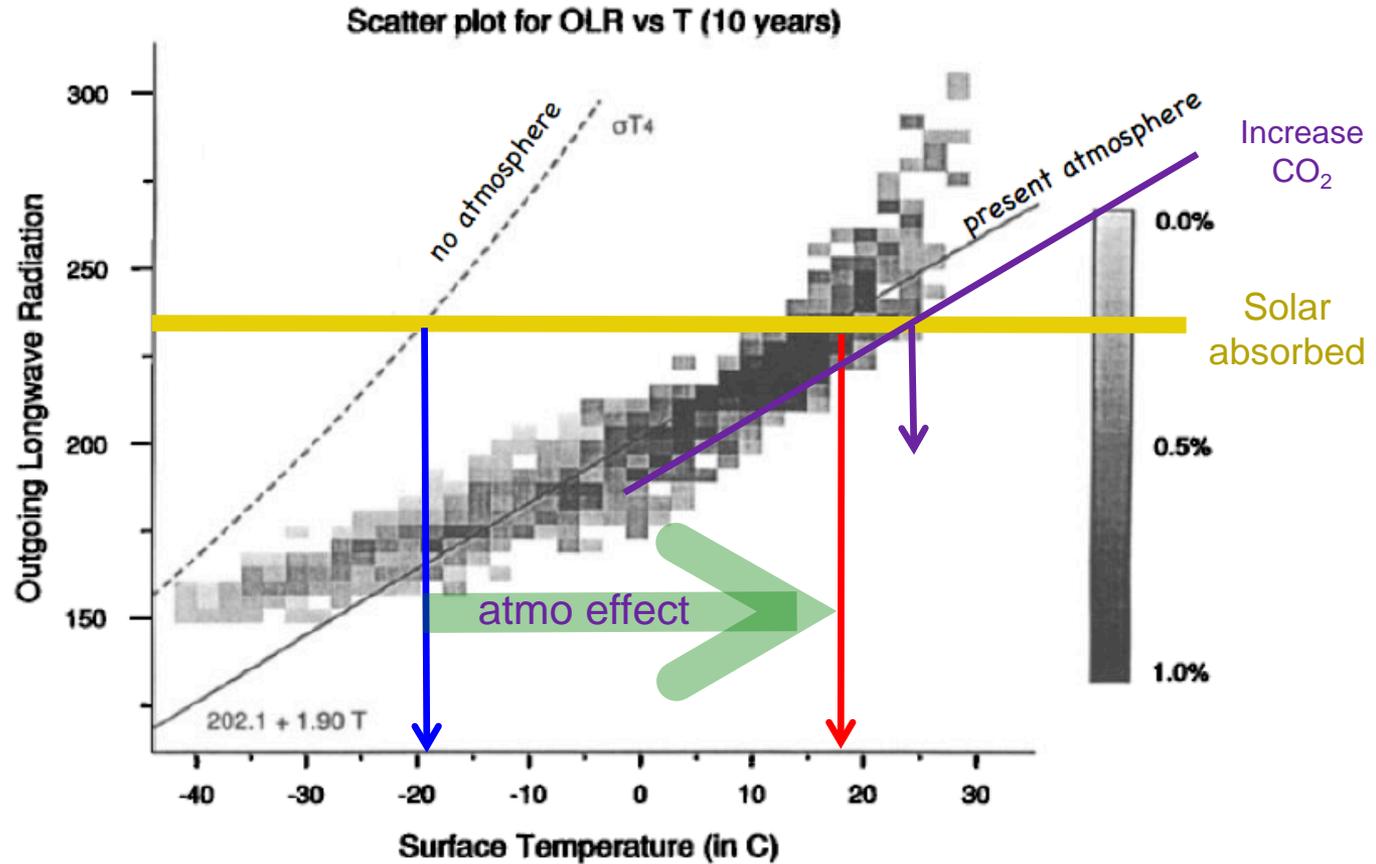
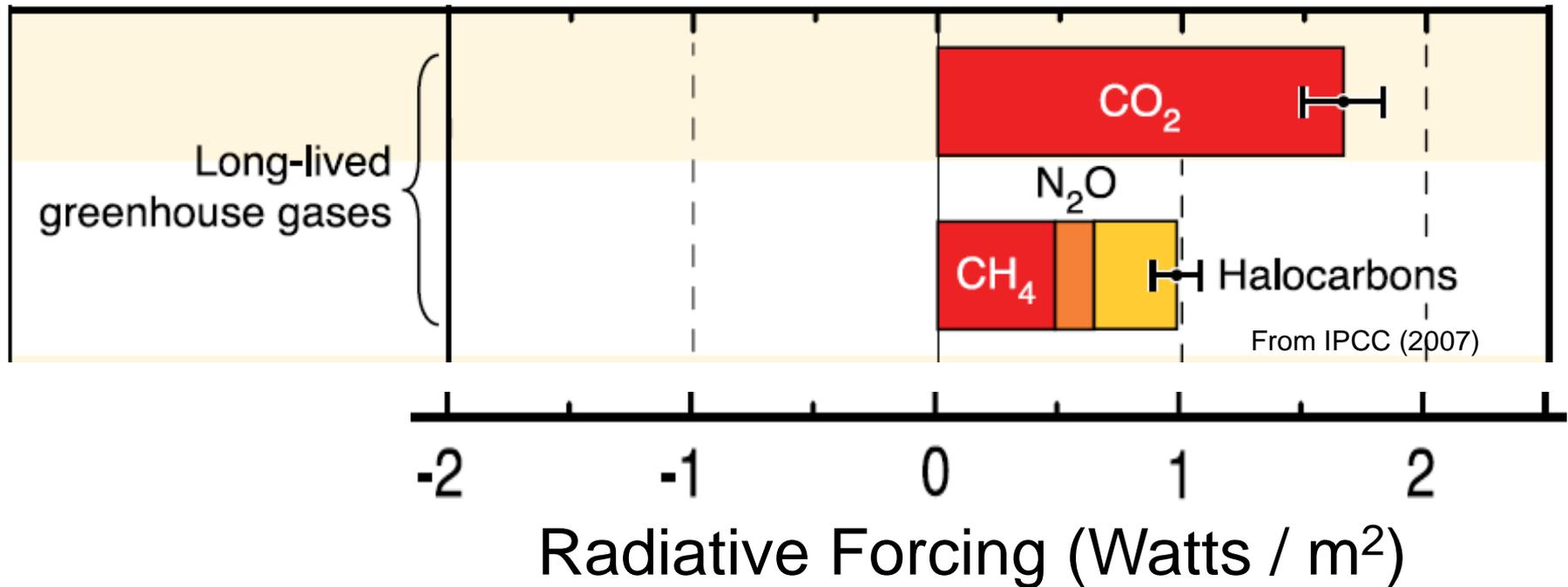


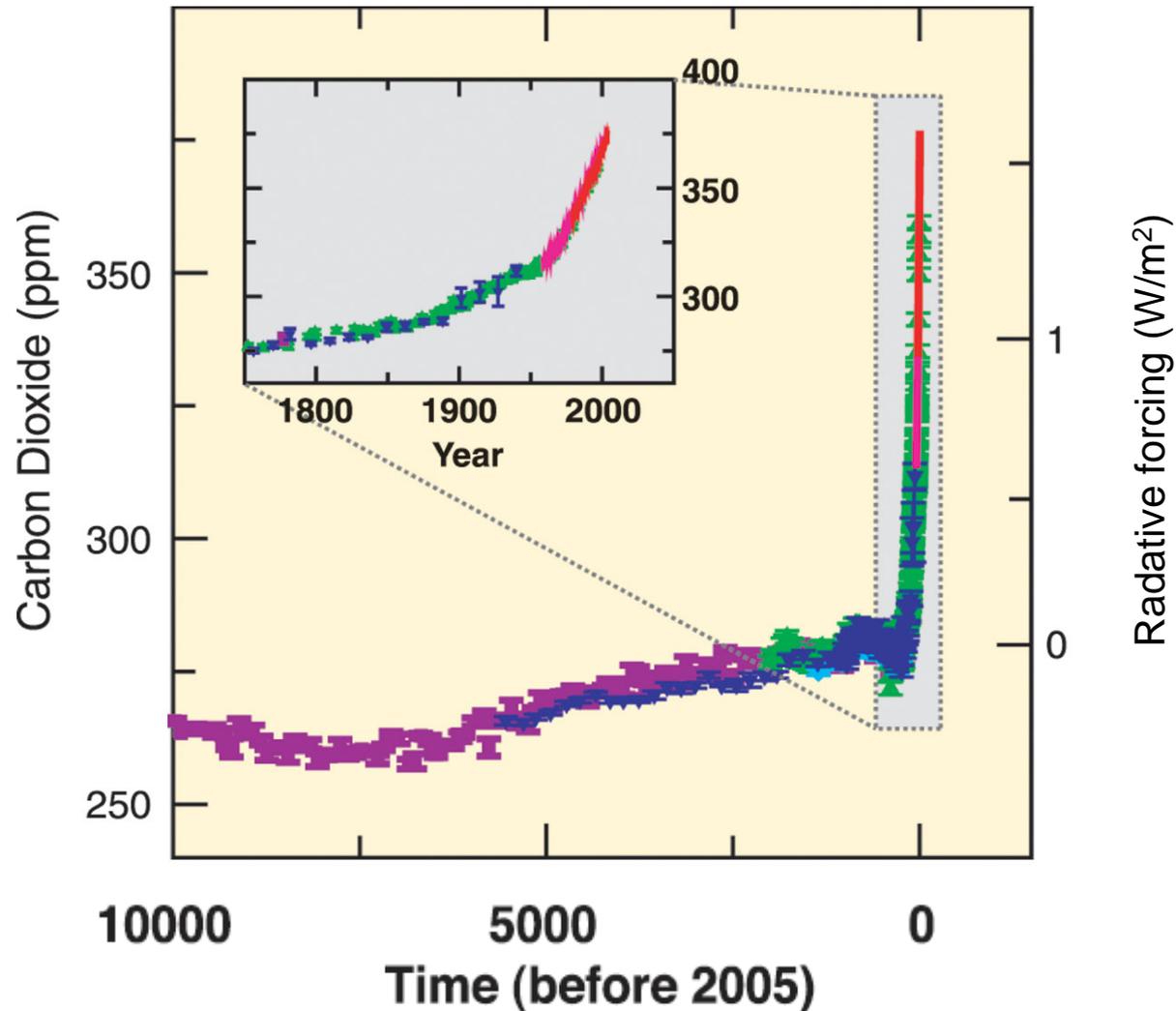
Fig. 2. Scatter plot of OLR versus surface temperature from 30°N to 90°N from the 10-year data set. The scale on the right indicates the percent of total. Note that there is a cosine of latitude weighting to account for the differing grid point areas.

# There are many greenhouse gases



Water vapor acts as a 'feedback' in the climate system.  
As the planet warms, more water vapor goes into the atmosphere, increasing warming.

# Carbon dioxide has been increasing since the Industrial Revolution



# The Intergovernmental Panel on Climate Change (IPCC) agrees that the main cause of recent warming is humans

## CLIMATE CHANGE 2007 SYNTHESIS REPORT



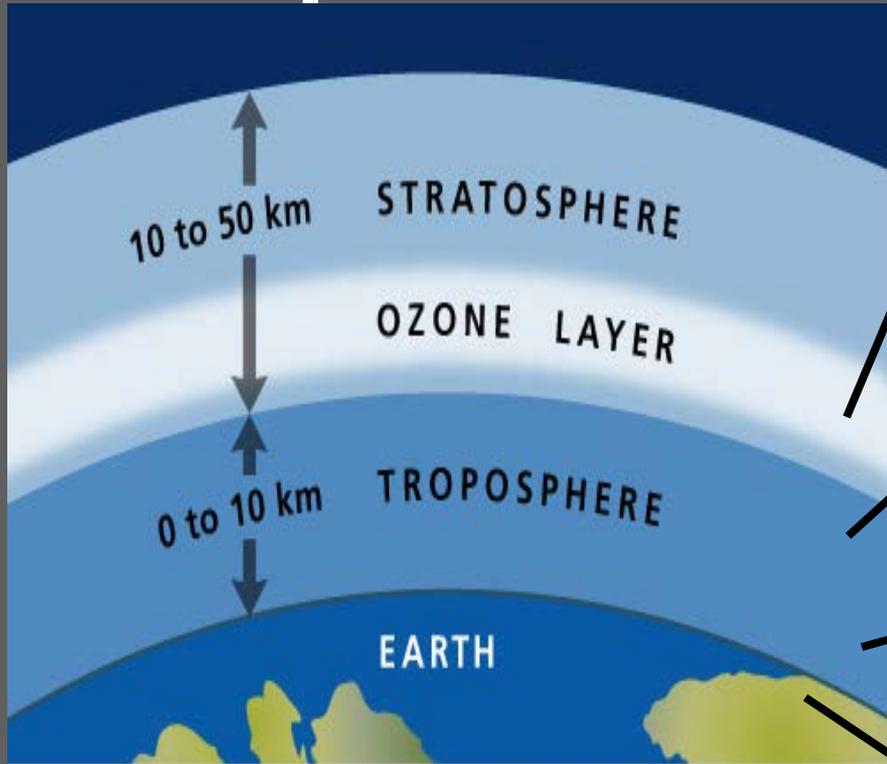
WMO A Report of the Intergovernmental Panel on Climate Change UNEP

... based on well-established scientific evidence, it has been demonstrated that the warming of recent climate is due to a considerable confidence interval. Quantitative estimates of the warming at continental scales (the warming estimates is higher than for the temperature) than for the 28.1}



Ask the experts

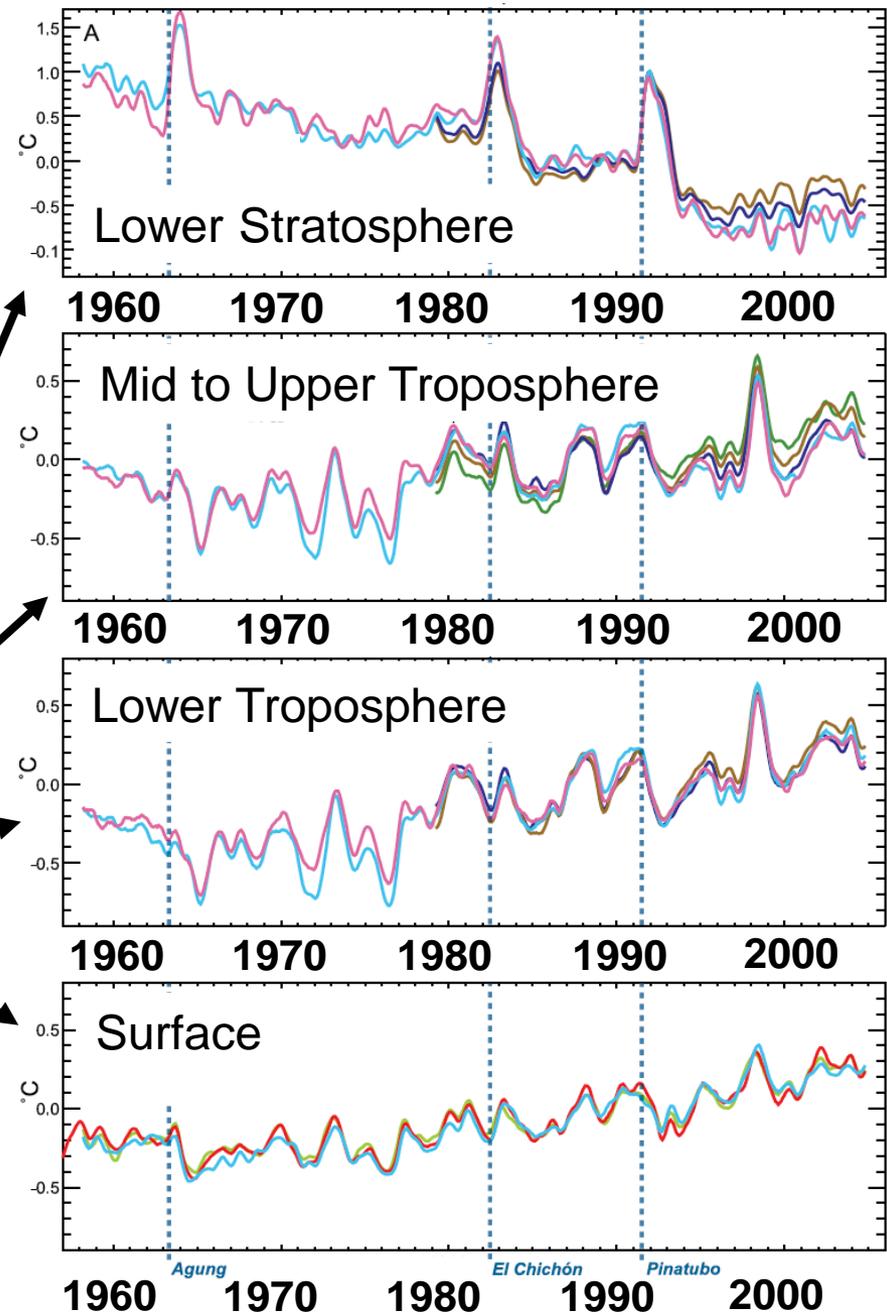
# Temperature



<http://www.cec.org/>

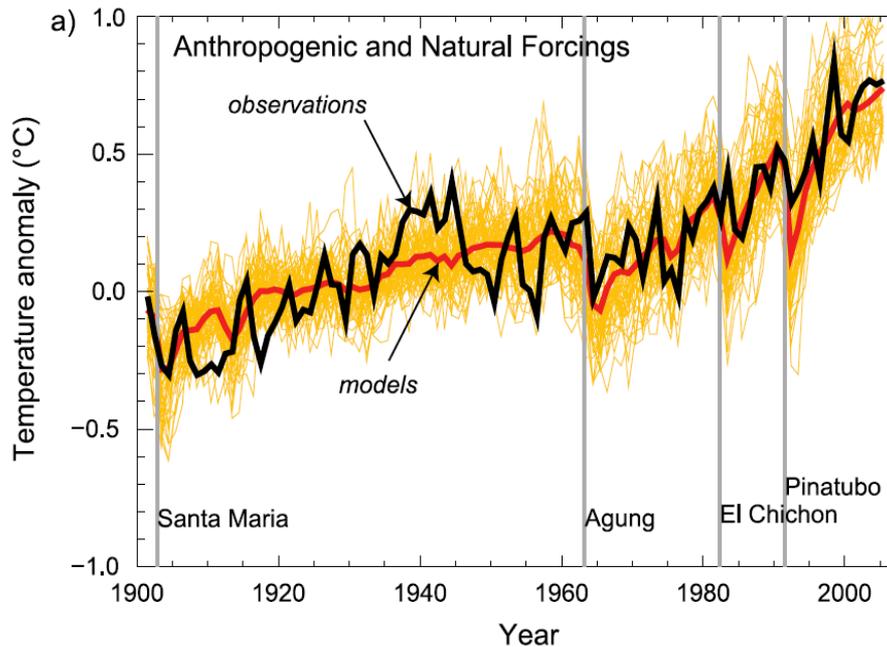
After IPCC (2007)

## Observed Air Temperatures

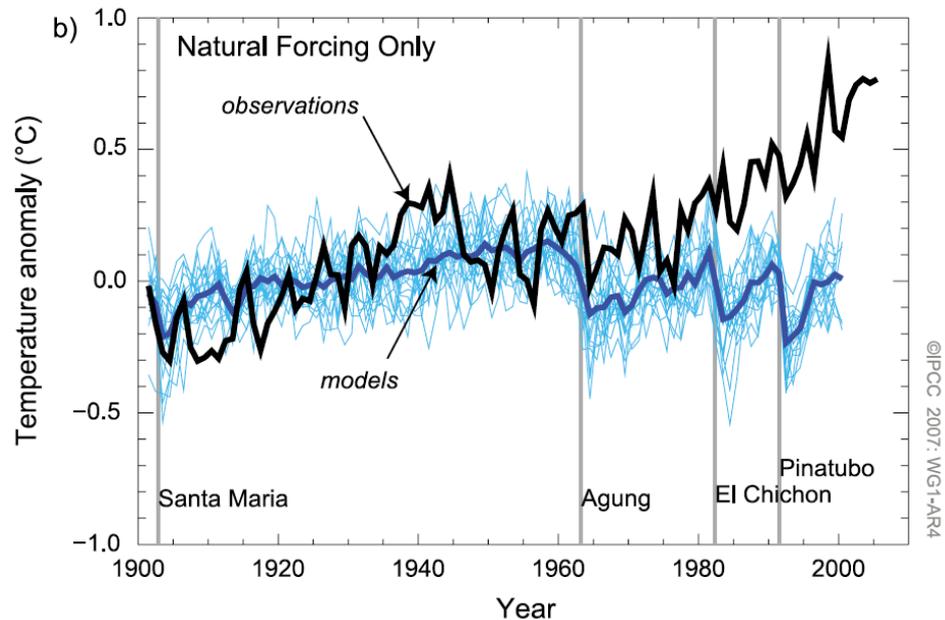


# Model experiments point the finger

## Global Mean Surface Temperature Anomalies



with human activity



without human activity

A fortune teller with long dark hair and a headscarf is shown from the chest up, holding a glowing blue and white globe of the Earth. A large red prohibition sign (a circle with a diagonal slash) is overlaid on the entire scene. The background is dark with ornate patterns.

**It will continue**

The past and present can give us clues, but to look into the future...

we need a physics-based climate model.

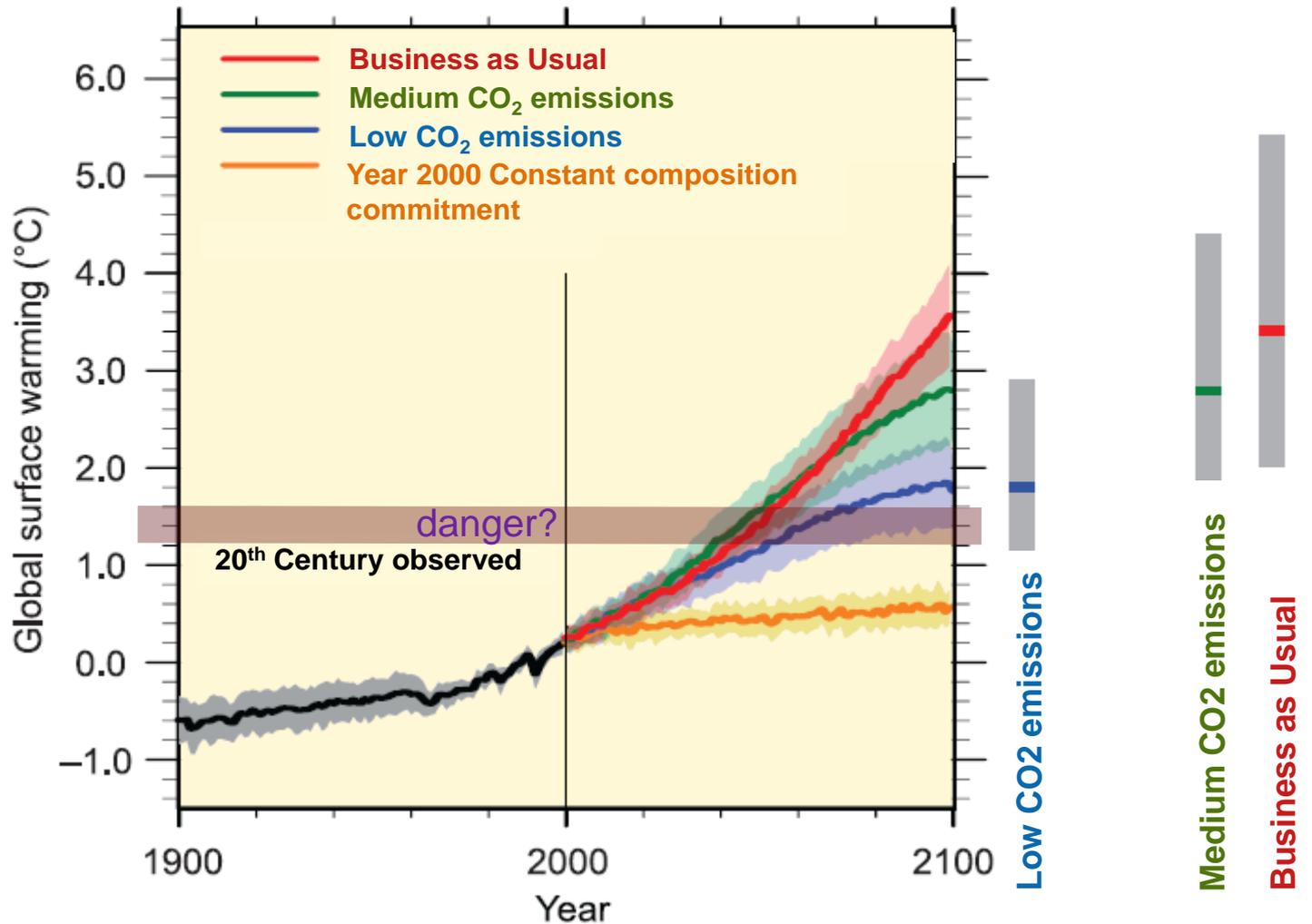
**not this**

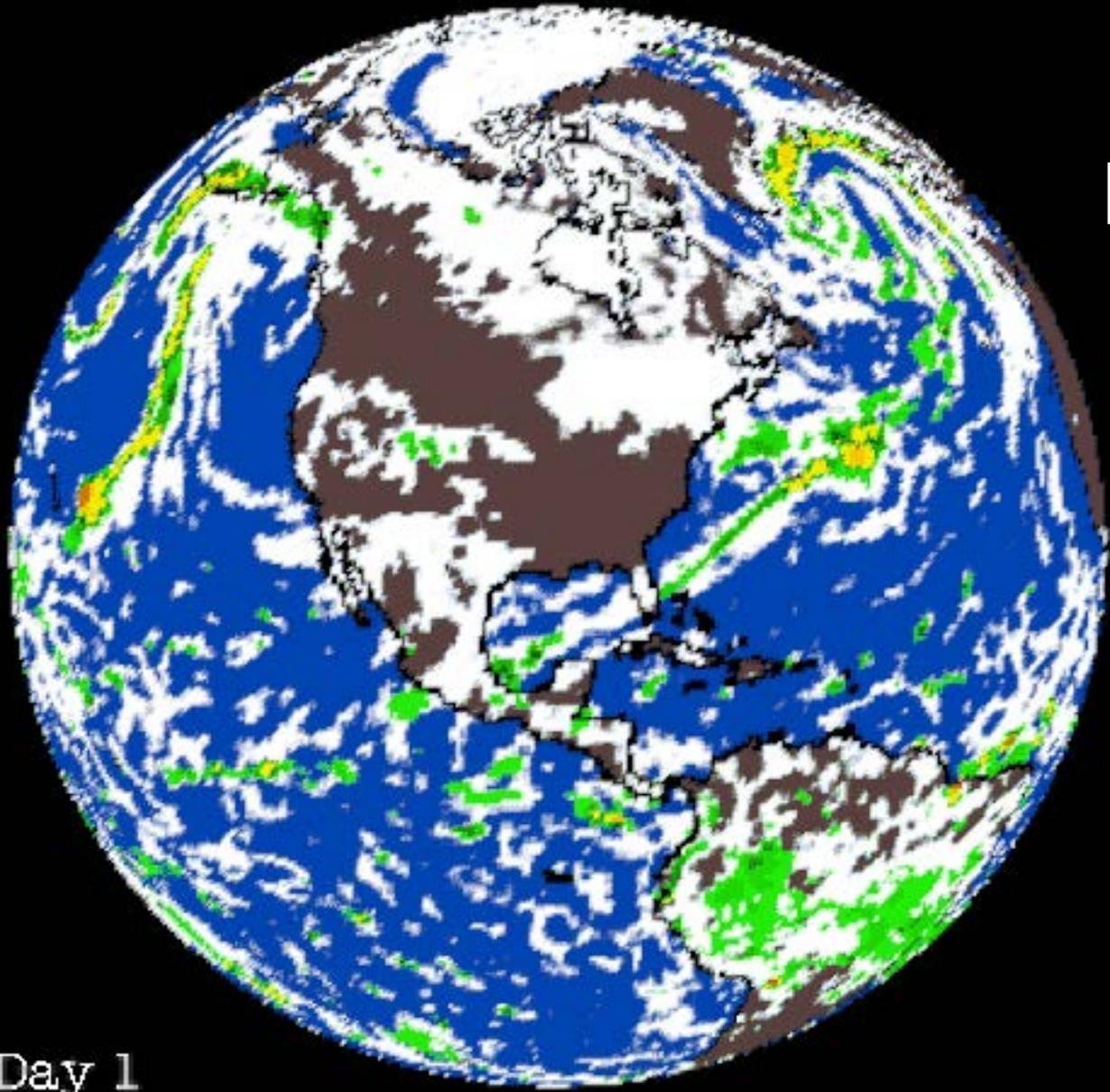


# Climate models help us forecast

- Future global and regional temperatures
- Future sea levels
- Future global ice patterns
- Future moisture distributions
- Future changes in natural variability

# Predicted warming for different scenarios





**Resolution  
about  
75 km**

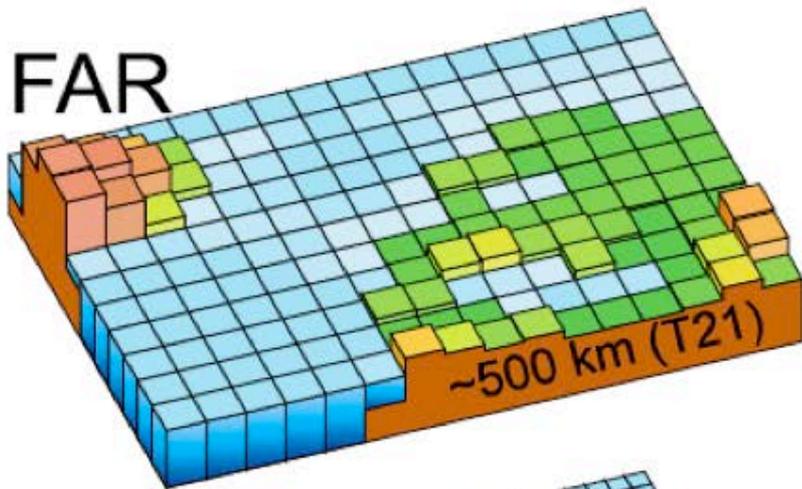
Day 1



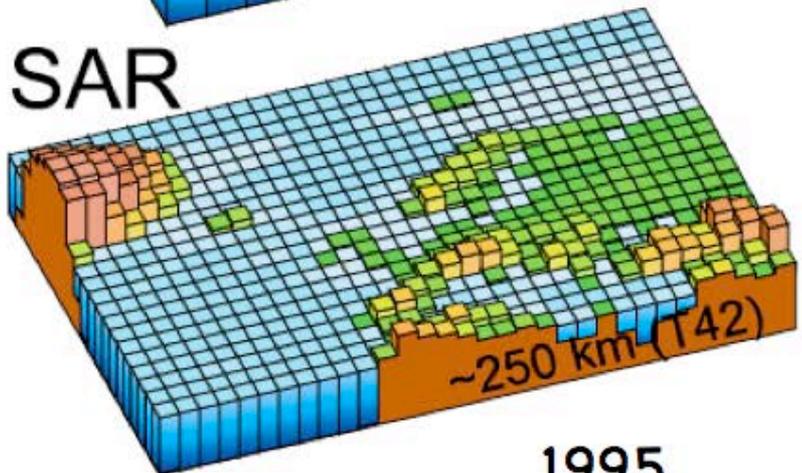
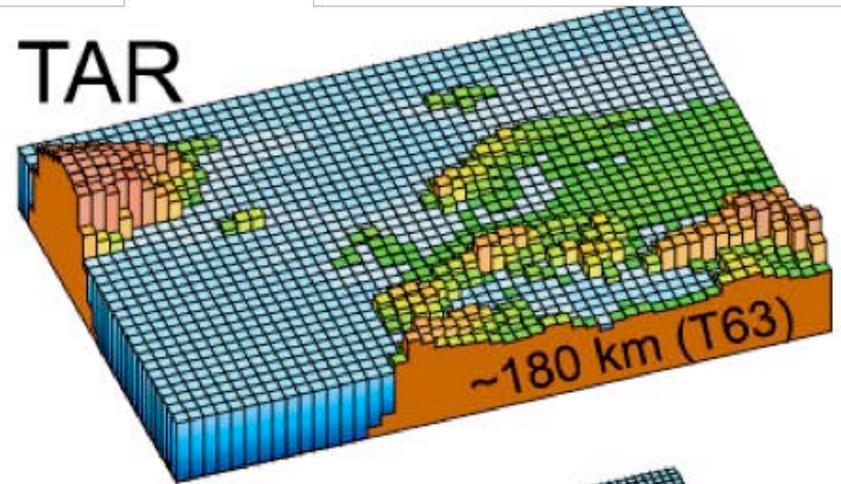
**Higher spatial resolution  
usually translates to better  
simulations.**

# Progress in model resolution: 1990 to 2007

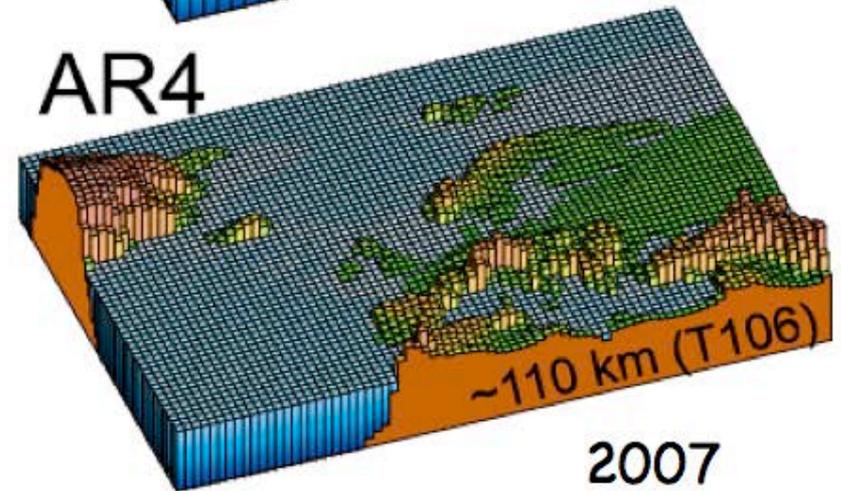
1990



2001



1995

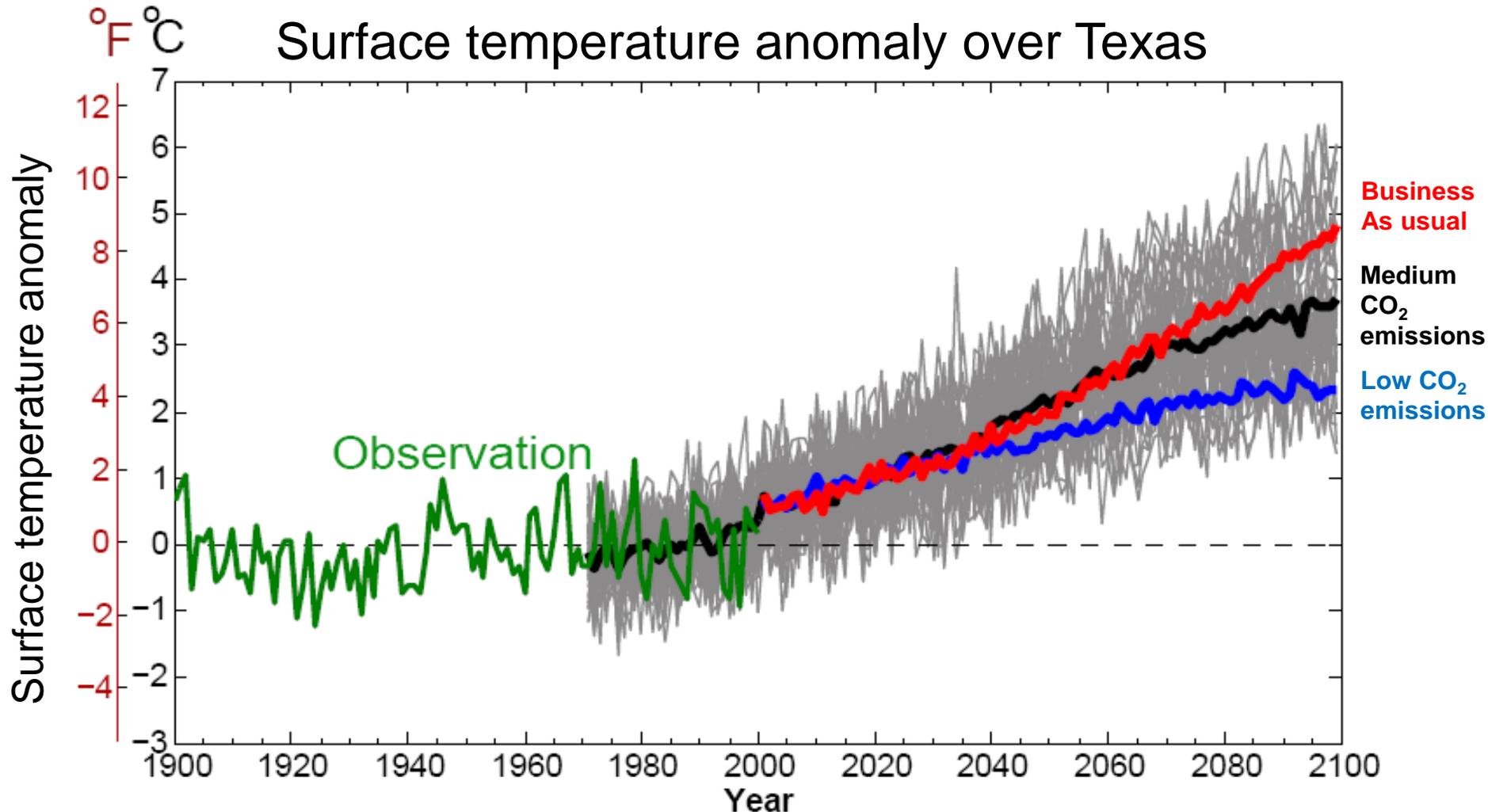


2007

# It will impact Texas

- Texas will warm approximately as the global average
- Mid-latitude Storm Tracks are likely to move Polewards
- West TX will very likely be drier than it is now
- The US Southeast will receive more rain
- In both cases the incidence of long extremes may increase

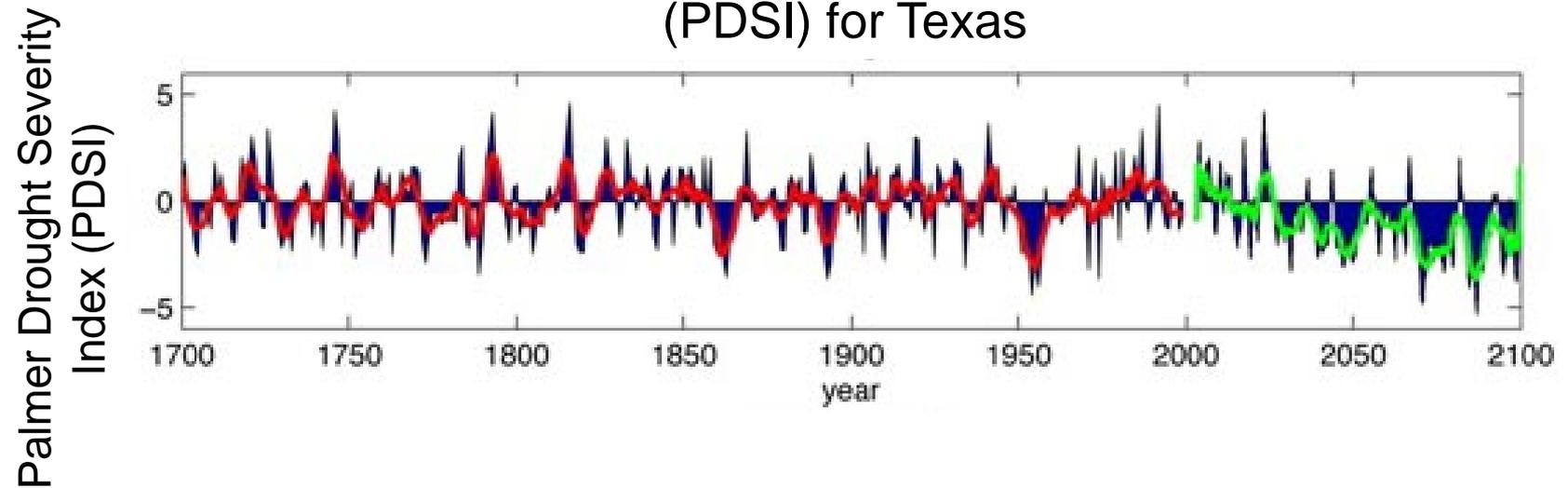
# A warmer future for Texas



After Banner et al. (in review 2009)

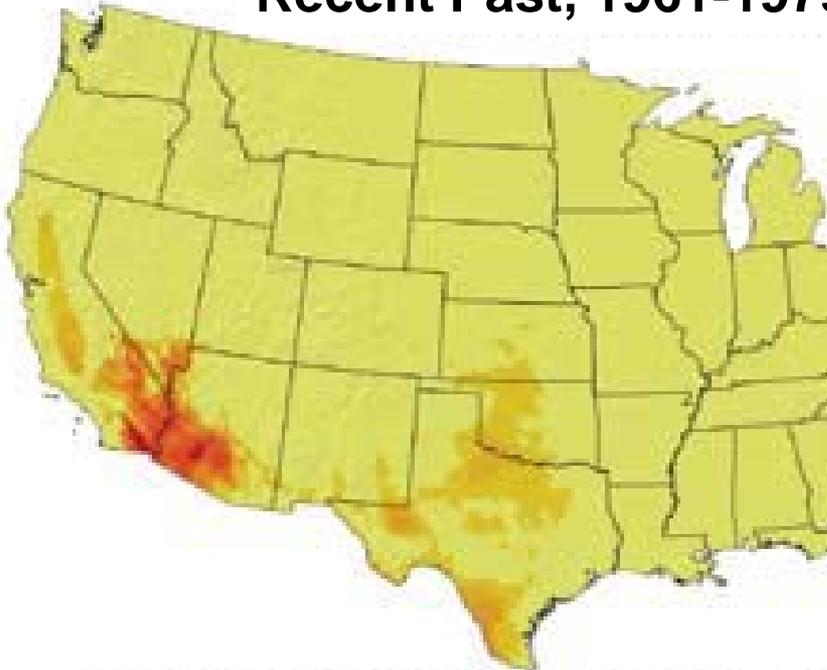
# A warmer future for Texas

Tree Ring Palmer Drought Severity Index  
(PDSI) for Texas

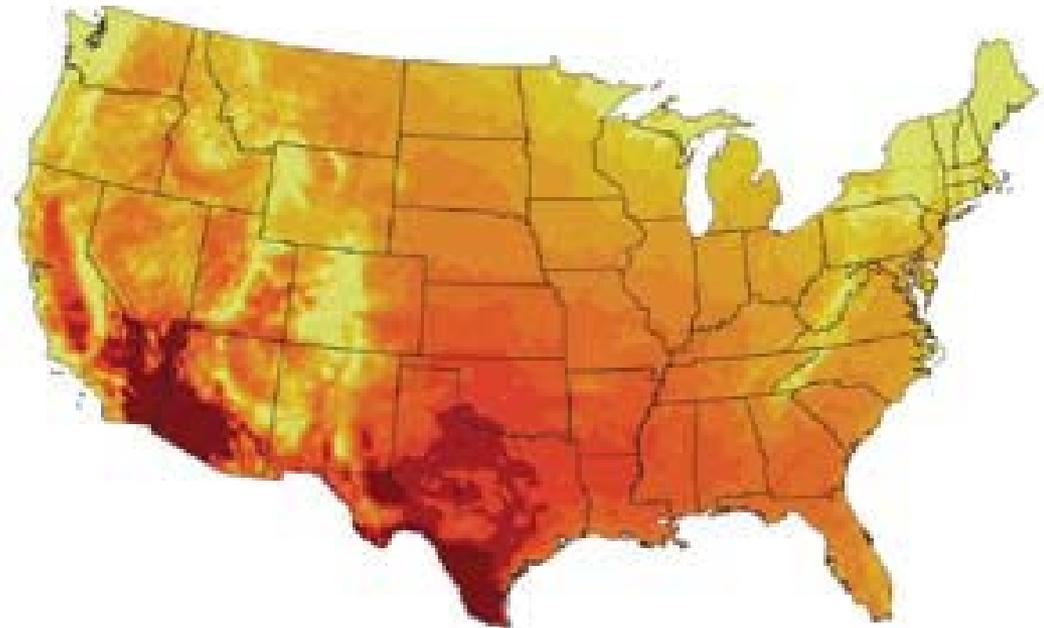


# A warmer future for Texas

Recent Past, 1961-1979



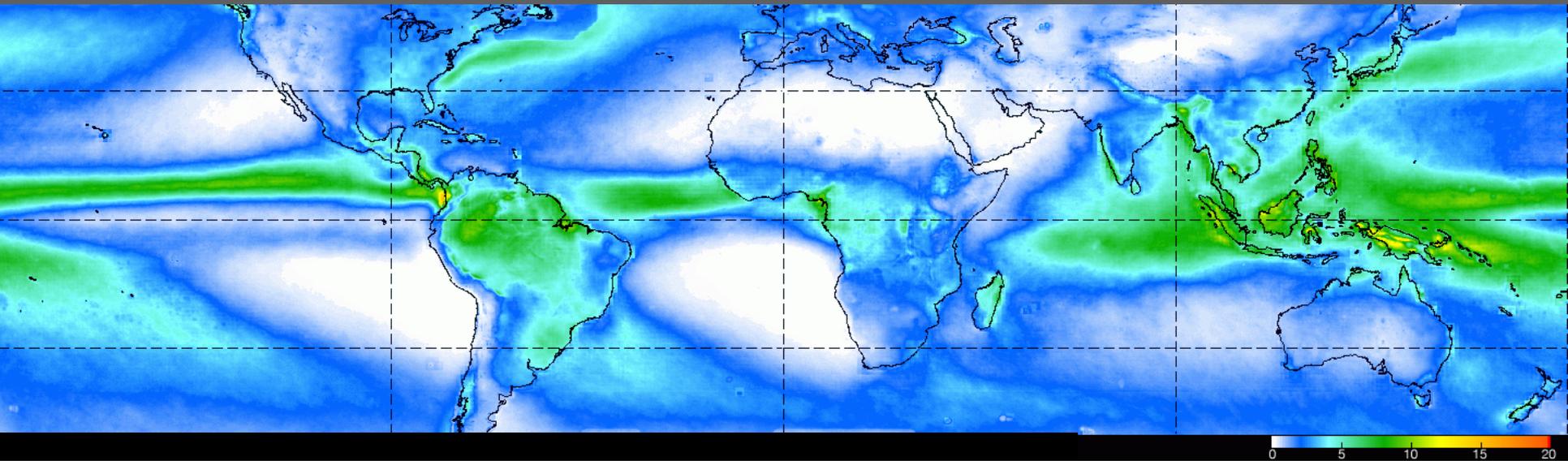
Business as Usual Scenario, 2080-2099



100 days of 100 °F  
Are you ready?

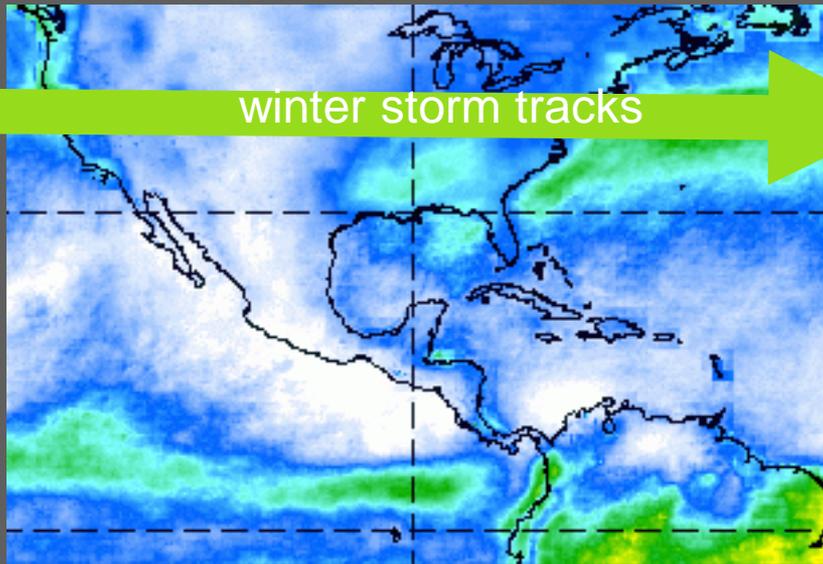


# Present precipitation

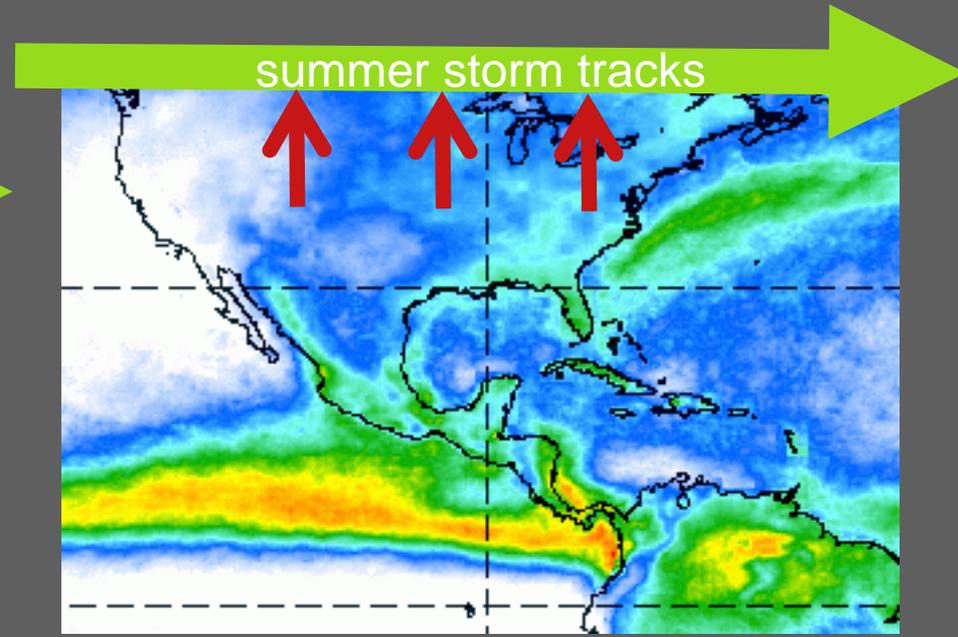


Average of all available  
rainfall from 1998-2008

# Focusing in on North America



Winter



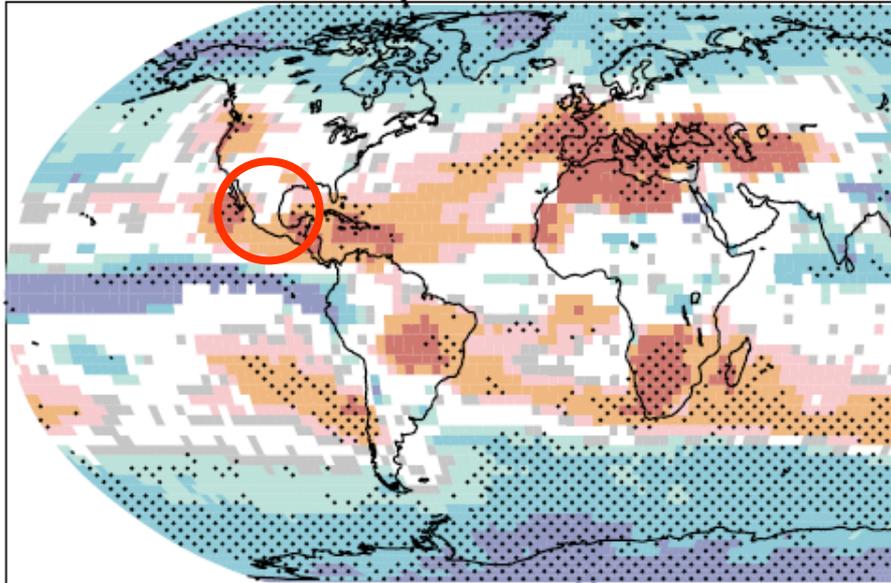
Summer

**Models suggest that tracks  
will move Northwards**

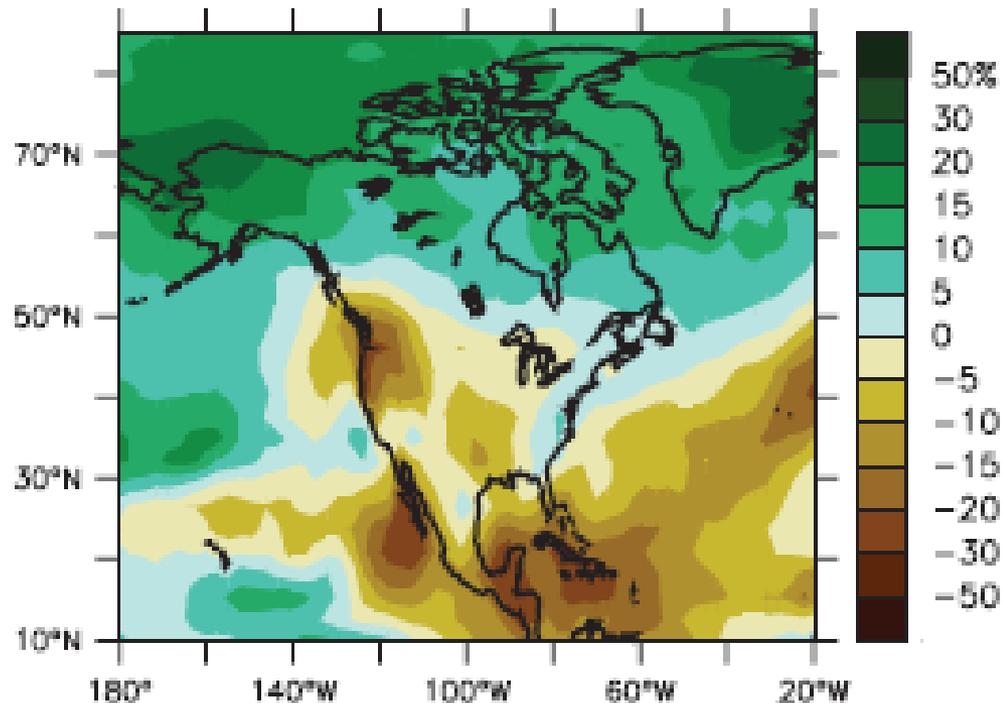
# A drier US Southwest

Winter

Projected change  
(in 2090 - 2099 for /



Winter

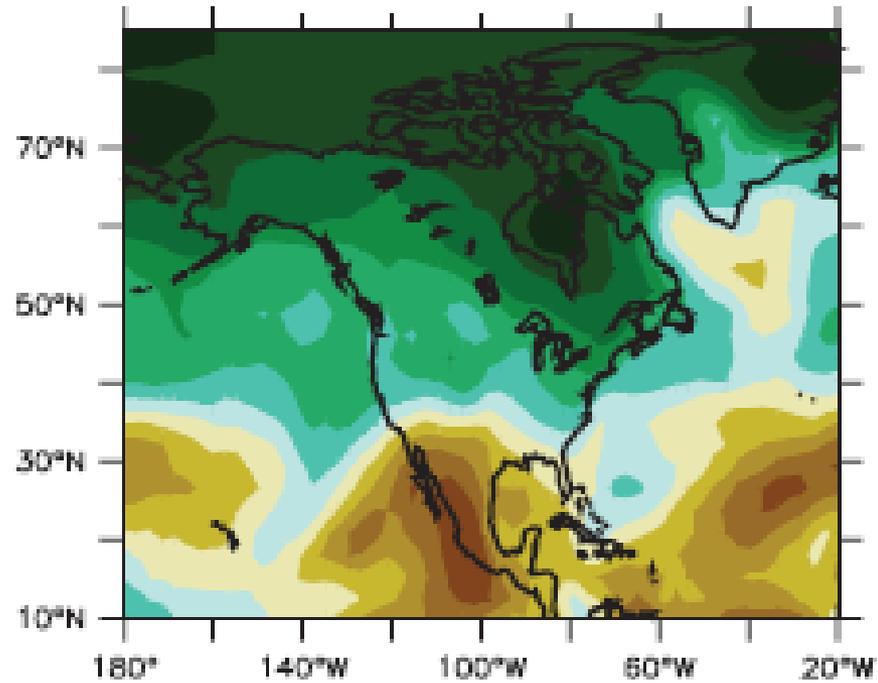
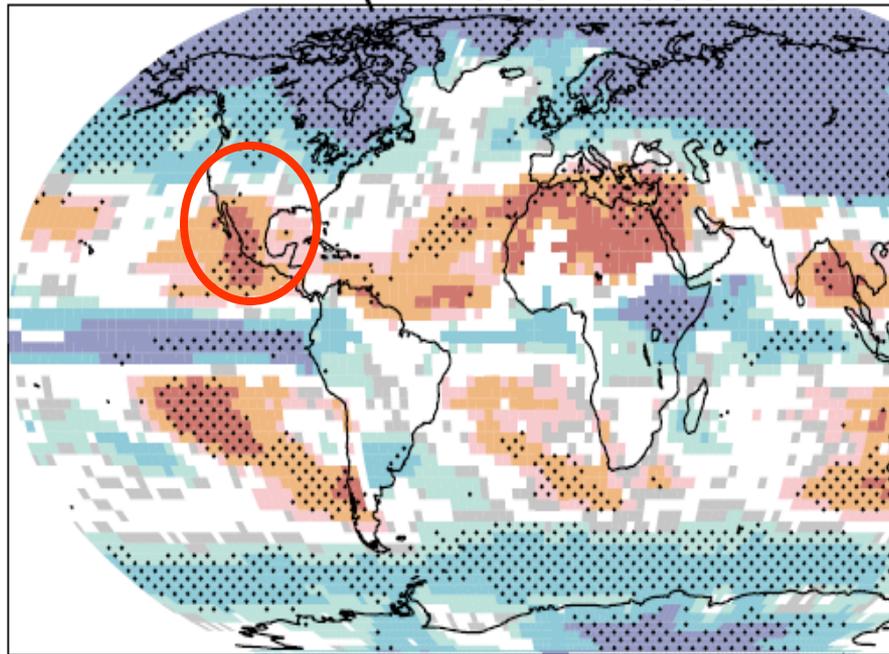


Projected change in winter precipitation  
for last decade of this century

# A drier US Southwest

Projected change  
(in 2090 - 2099 for A1E)

## Summer



©IPCC 2007: WG1-AR4

## Summer

Projected change in summer precipitation  
for last decade of this century

# Concerns for Texas in 2100

- Hotter with longer summers
- drier winters especially in the West
- Sea level rises of about one foot, but maybe . . .
- Hurricanes: more of them or more intense (???)
  - Too soon to tell
- Water in TX may get very costly (drying rivers, etc.)



# Our choices:

## 1. The do-nothing strategy

- Sit tight, our grandkids can always move away
- Don't listen to scientists, instead smear and vilify them, they created a hoax
- Whine: All this will cost too much and will mean higher taxes
- Cash in on quick profits, 2100 will find its own way

## 2. Agree, but still do nothing

- Delay action and blame the rest of the world
- Future technology will save us (geo-engineering)
- Hope that we run out of fossil fuels before its too late



# 3. Do the right thing

- Be realistic about the science
  - Take prudent actions, there is time to act
  - Educate friends about how science works
  - All science is tentative, but here there is enough evidence to act sensibly
- Be careful of the sources of your information
  - For example, what is ‘Clean Coal’?
- Don’t just rely on the past In long term planning (water resources, harbor updating, etc.)



# Often doing the right thing has other virtues

- Saving energy and water saves money
- Saving energy enhances our national security
- Public transportation saves energy
- Texas can continue to be the world leader in Energy
  - 100's of GigaWatts of power await us in wind and solar

# Finally

- If you are a student, consider a career in science. It is a marvelous profession. It is competitive, exciting, and there is no feeling quite like discovery.
- It really does beat Wall Street.
- We need you.
- Thanks

# Dr. Gerald R. North



Professor Gerald R. North is the Distinguished Professor of Atmospheric Sciences and Oceanography, and holder of the Harold J. Haynes Endowed Chair in Geosciences at Texas A&M University. North and his research group study climate change and its origins. They work with simplified climate models which lend themselves to analytical study, estimation theory as applied to observing systems, and the testing of all climate models through statistical approaches.