ATM S 111: Global Warming
Global Warming Primer

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Day 2: June 22 2010

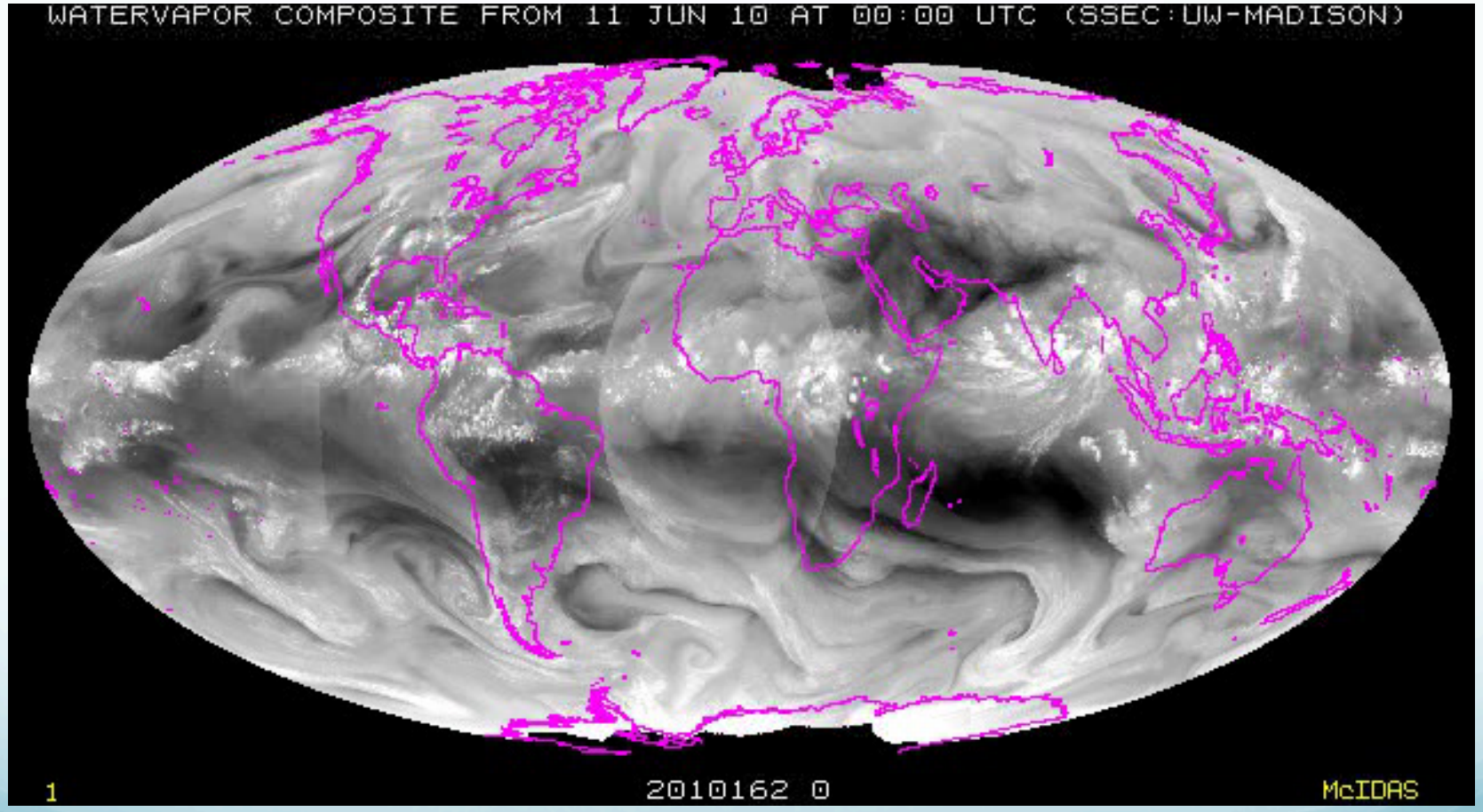
Class Website!

- http://www.atmos.washington.edu/academics/classes/2010Q3/111/ (hopefully linked from your myuw page)
- PDF versions of my slideshows will be posted on the website.
  - I will try to post these the day before.
  - I will pass out hard copies of the most important figures from lectures, especially if they are not in the textbook.
- Homework assignments
- Announcements
- Extra readings

Reading Assignments

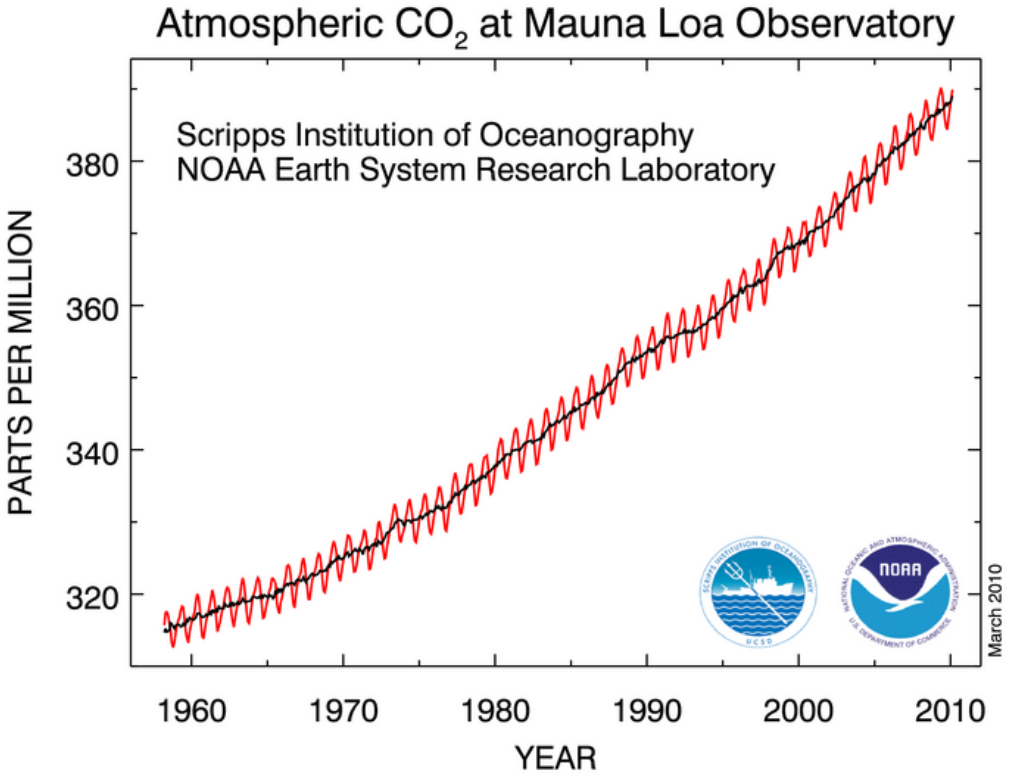
- From last time:
  - Make sure you've read Rough Guide p. 3-19 "Climate Change: A Primer"
    - The Big Picture
    - The Outlook
    - What Can We Do About It
- Next reading assignment:
  - Rough Guide p. 20-31 "The Greenhouse Effect"
  - If it's about hotels in Melbourne you might have bought the wrong Rough Guide.
- This week's homework (due Tuesday June 29) will cover material from pp 3-31 and M-Th lectures.

The Atmosphere from Space



We Modify the Composition of the Atmosphere

- Carbon dioxide (CO_2) has been measured at Mauna Loa, Hawaii since 1958



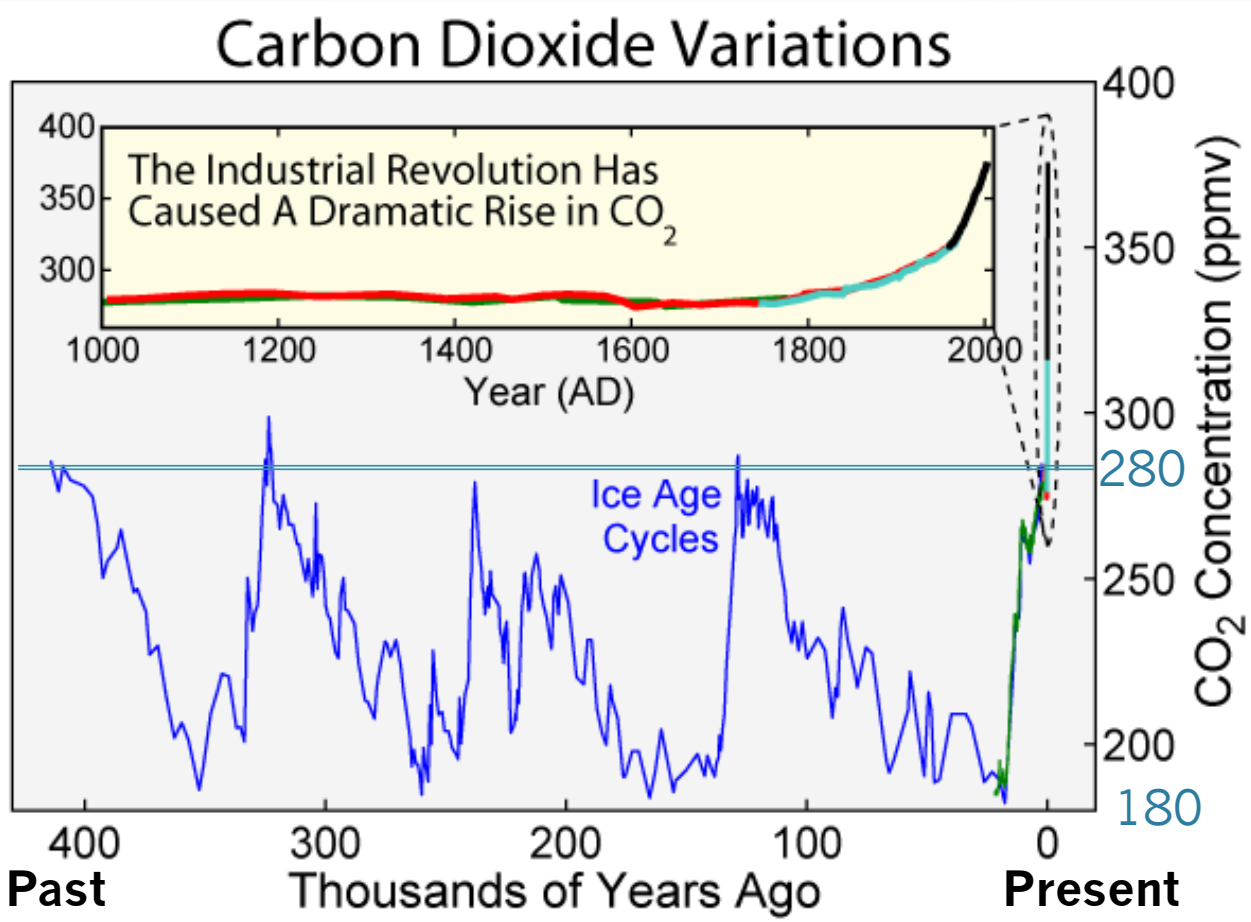
"Keeling curve": first measured by David Keeling in March '58

~ **25% increase** since the first measurement

Human induced:
Due to **fossil fuel burning** (80%) and deforestation (20%)

Let's Look Way Back to 450,000 Years

- We're at **387 ppm** now



Natural variation over Ice Age Cycles: **180-280 ppm**

Current rate of increase is **100-1000 times faster** than nature can change CO_2

Img src: Global Warming Art

CO_2 is a Greenhouse Gas

- Greenhouse gases **slow heat loss to space**
  - Has been known for a long time (J. Fourier in 1824)

Joseph Fourier

This is why it's hot

The Sun heats the Earth.

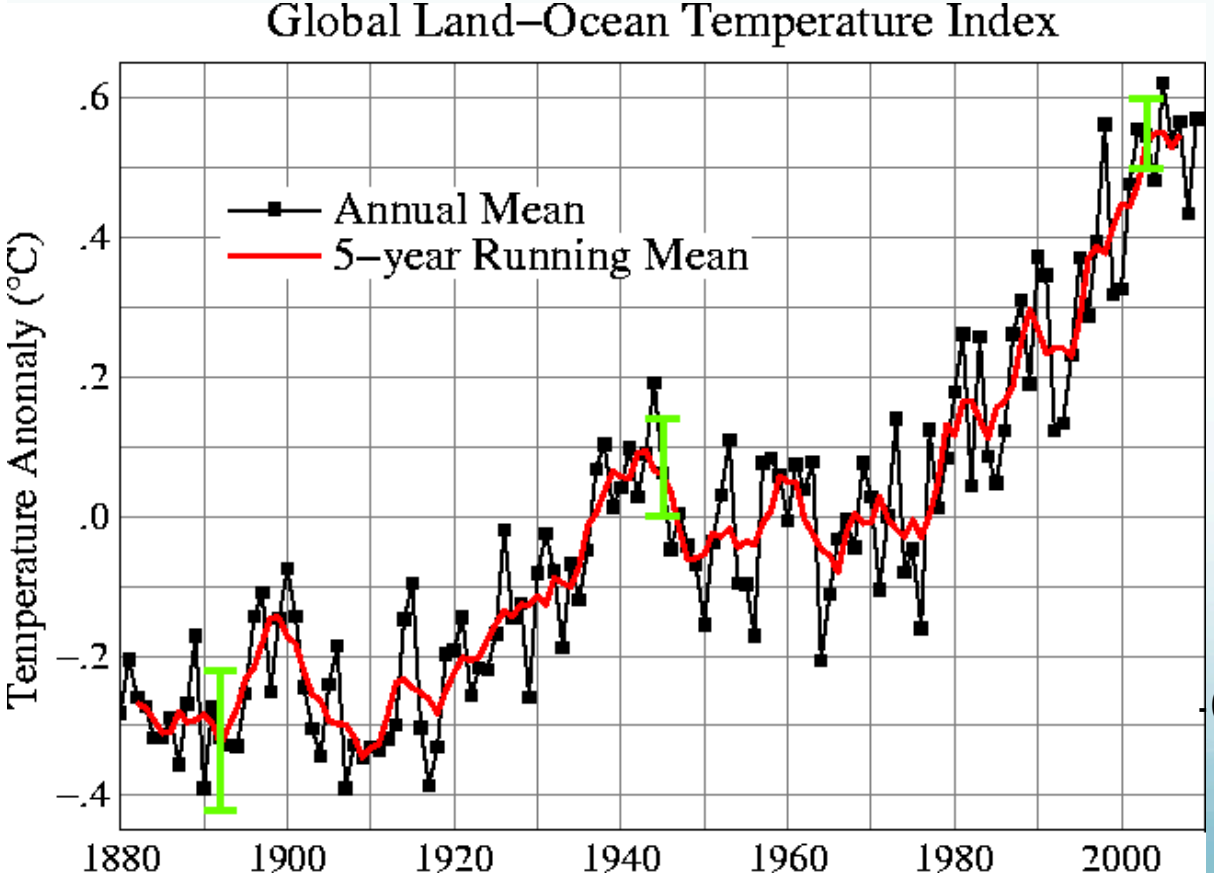
Greenhouse gases cause the Earth to be a lot warmer than if there was no atmosphere:

58° F or 32° C warmer

The natural greenhouse effect

The Earth is Warming

- More CO_2 -> warmer atmosphere (eventually)
- Has it been getting warmer?

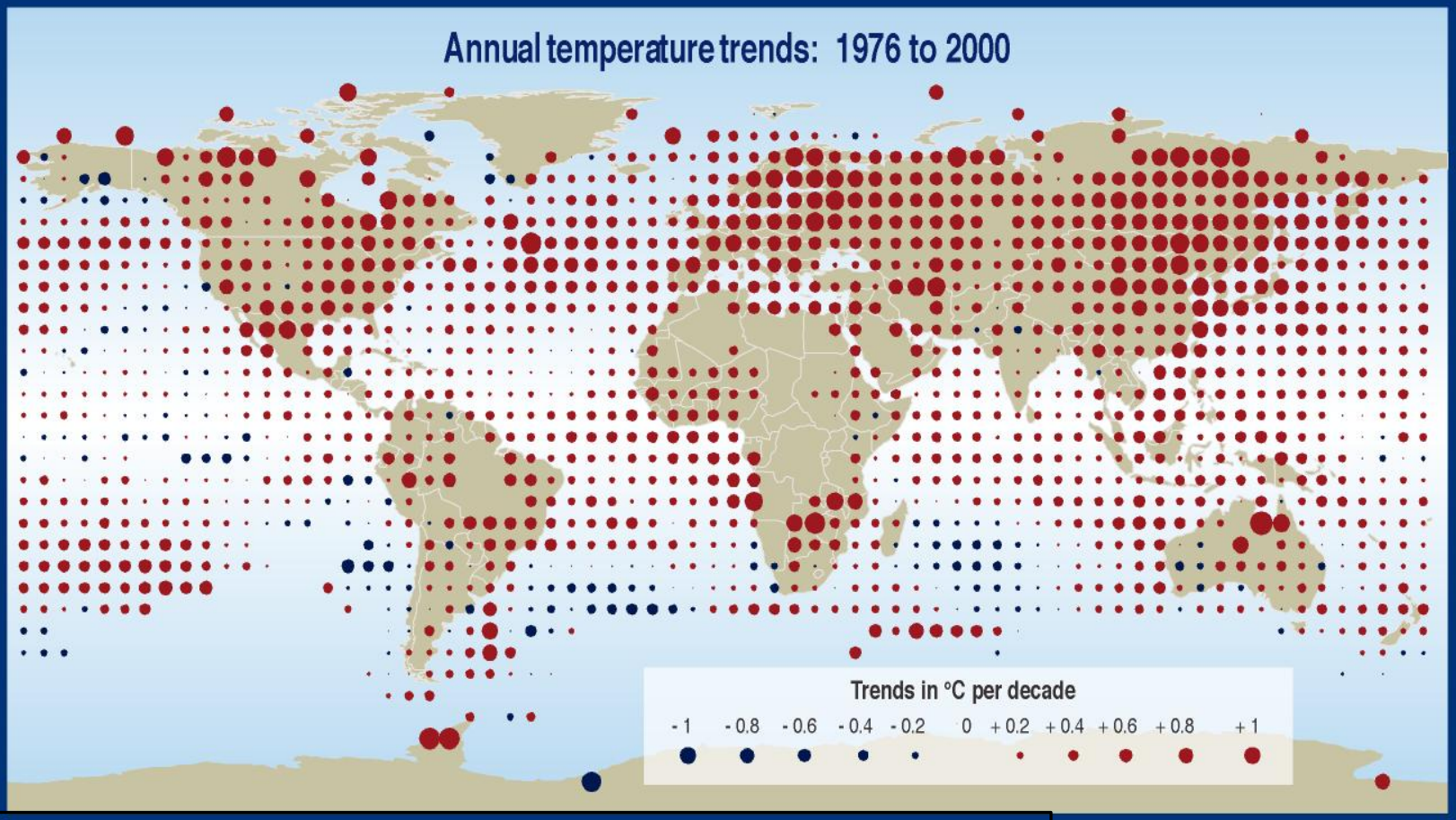


It's warmed about **0.8° C (1.5° F)** in the last 130 years

Especially rapid warming since the mid-'70s

9 out of the top 10 hottest years on record were the **last 9 years**

Src: NASA GISS



SYR - FIGURE 2-6b

Warming has happened **almost everywhere**.
Northern high latitudes have warmed the most.
Land has warmed more than **ocean**.

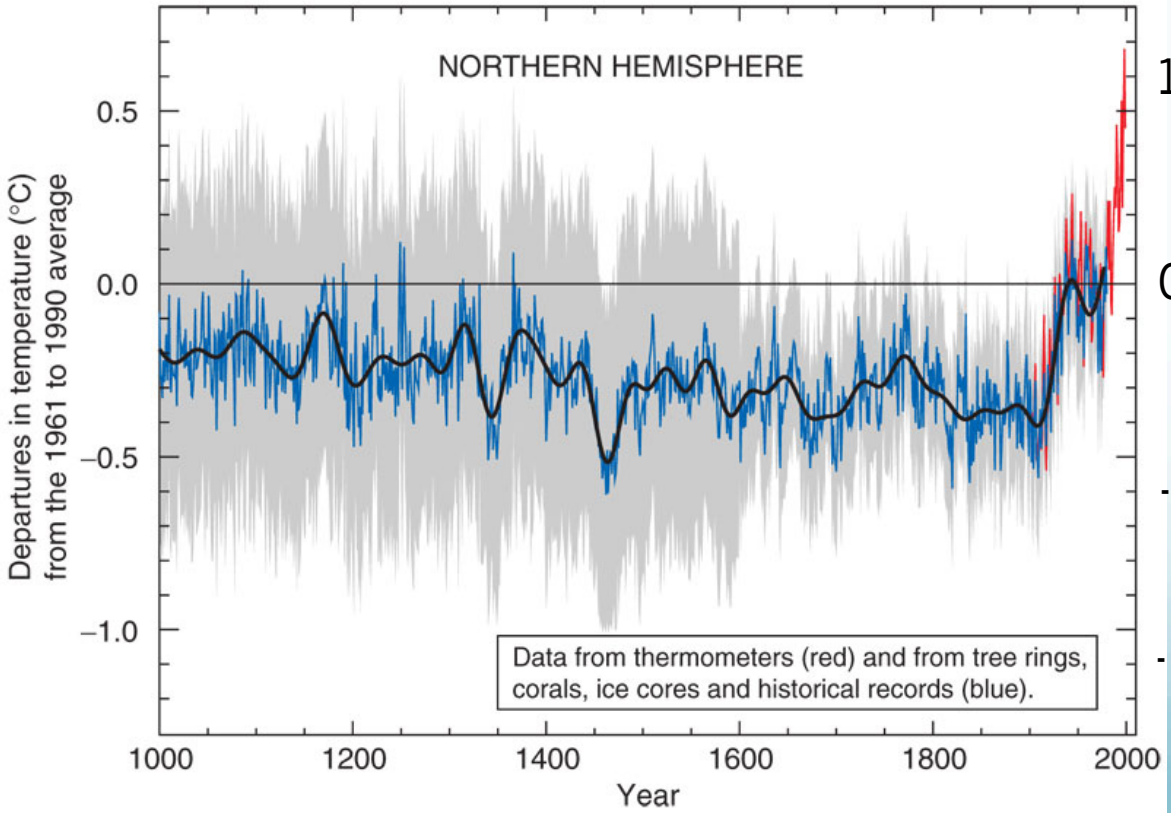
IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Src: IPCC AR3

Hasn't This Data Been Faked?

- No, we're confident about the thermometer data
- Recent controversy has been about **tree ring** reconstructions (known as the **"hockey stick"**):



1° F
0° F
-1° F
-2° F

This is **much less certain**, and only represents the Northern Hemisphere anyway (gray area indicates uncertainty).

We'll discuss this and **other controversies** more later…

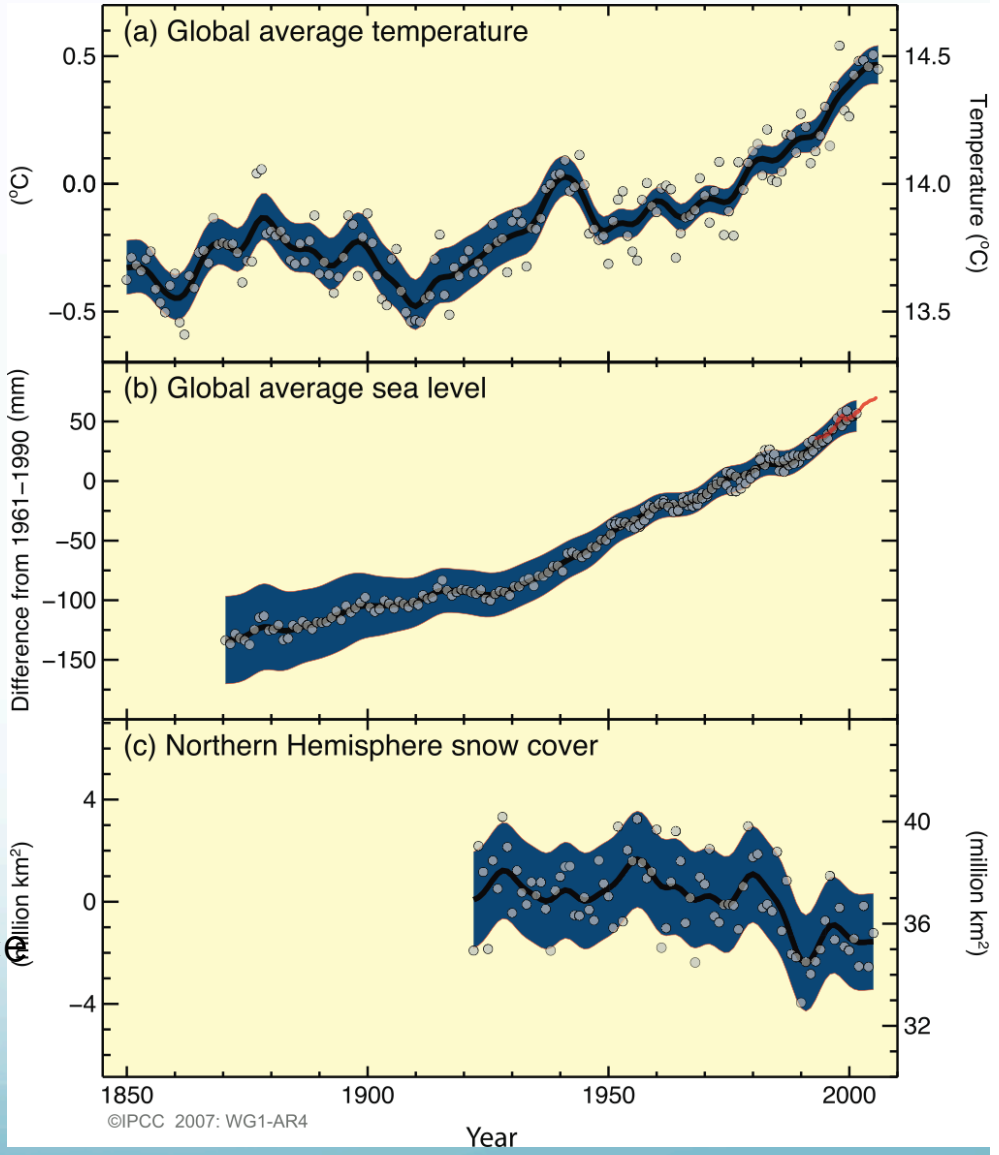
Src: IPCC AR3

What Else is Happening?

- As **temperatures** rise →
- **Sea level** is rising →
  20 cm = 8 inches
- **Snow cover** is decreasing →

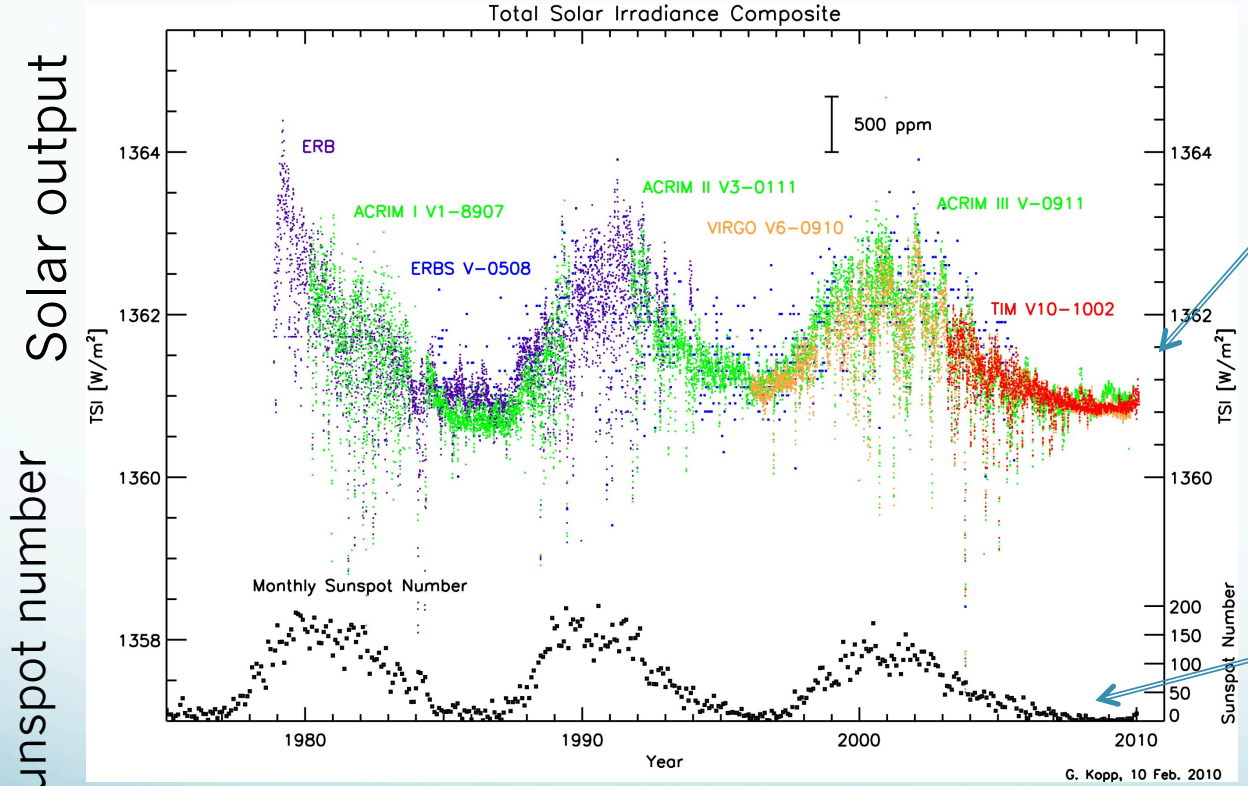
Also glaciers are melting, Arctic sea ice is melting, species are shifting, etc

Src: IPCC AR4



Could the Sun be the Cause?

- **No**, the Sun is nearly the **weakest it's been in 30 years**



Solar output

Sunspot number

Sun is very weak now

Deepest solar minimum in terms of sunspots in **100 years** (more sunspots → slightly hotter Sun)

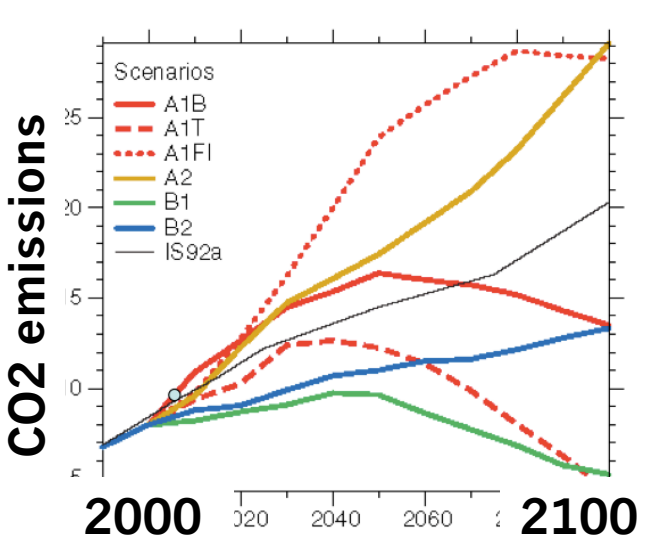
1975 **Year** **2010**

In general, **strength of solar variability is very weak** (0.1% from max to min)

What's Predicted for the Future?

- Best calculated with a **climate model**
  - There is uncertainty associated with these models
- Also must take into account **human behavior**
  - Will we reduce emissions, or will we burn fossil fuels more and more rapidly?
  - What will developing countries do?
- Scenarios provided by economists, policy makers, etc:

Src: IPCC AR3



A2 (business as usual)

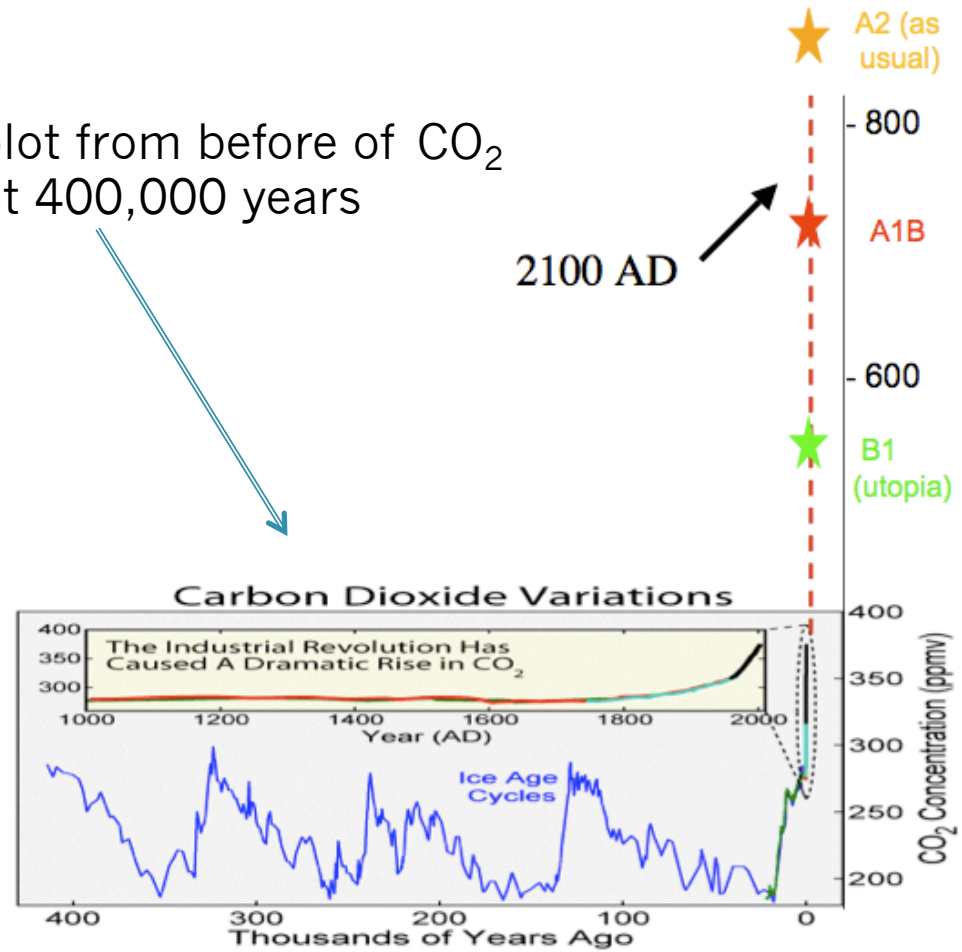
A1B

B1 (utopia)

Scenarios

- The scenarios produce the following CO_2 values:

Same plot from before of CO_2 over last 400,000 years



←Cutting fossil fuel usage means we avoid these really high concentrations

←But even in "utopia" scenario, CO_2 will likely increase much more than it has already

Controversy About All This?

- No doubt about these things:
  - The greenhouse effect
  - That CO_2 and other greenhouse gases are increasing
  - That increases in CO_2 are due to human activities, mostly in industrialized nations.
- "Skeptics" tend to argue for:
  - "Negative feedbacks" that keep the temperature changes small
  - Or that warming wouldn't be such a bad thing
  - Or about flaws in a particular study
- Be wary:
  - Much of "the debate" (on both sides) is not very scientific
  - Let's sort out fact from fiction!