

# Climate Change

AT350



*Massachusetts vs. EPA. Nov. 29, 2006.*

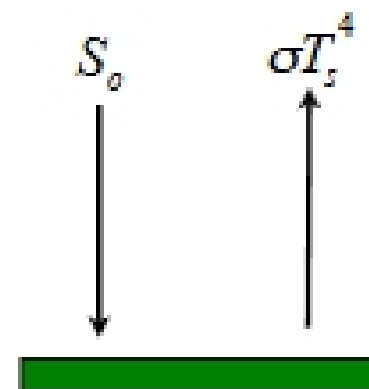
JUSTICE SCALIA: "...your assertion is that after the pollutant leaves the air and goes up into the stratosphere it is contributing to global warming."

MR. MILKEY: "Respectfully, Your Honor, it is not the stratosphere. It's the troposphere."

JUSTICE SCALIA: "Troposphere, whatever. I told you before I'm not a scientist. That's why I don't want to have to deal with global warming, to tell you the truth."

- Some basic physics/the theoretical basis
- Observations
- Attribution
- Outlook for the future

## Radiative balance: no atmosphere



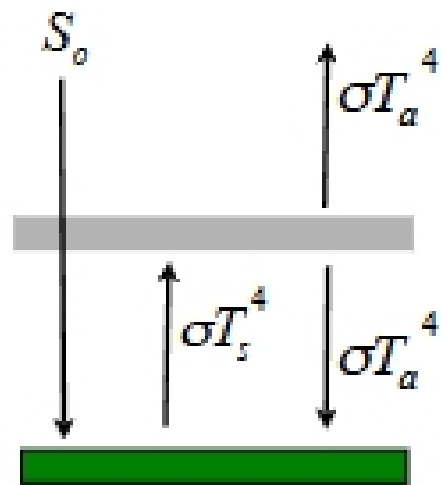
outgoing = incoming

$$\sigma T_s^4 = S_0$$

so:

$$T_s^4 = \frac{S_0}{\sigma}$$

## One layer atmosphere



Balance for atmosphere

$$\sigma T_s^4 = 2\sigma T_a^4$$

Balance for earth system

$$\sigma T_a^4 = S_o$$

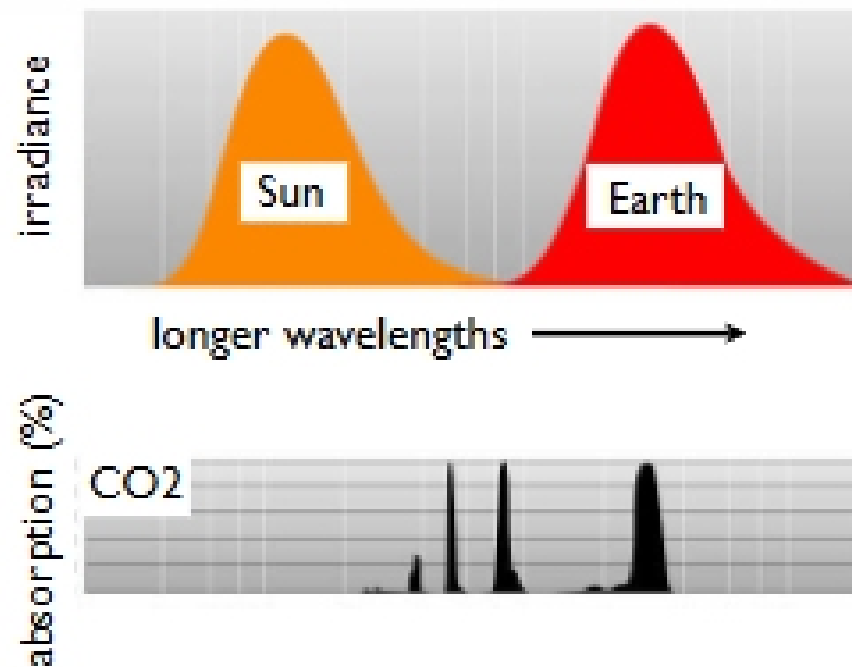
SO :

$$T_s^4 = 2 \frac{S_o}{\sigma}$$

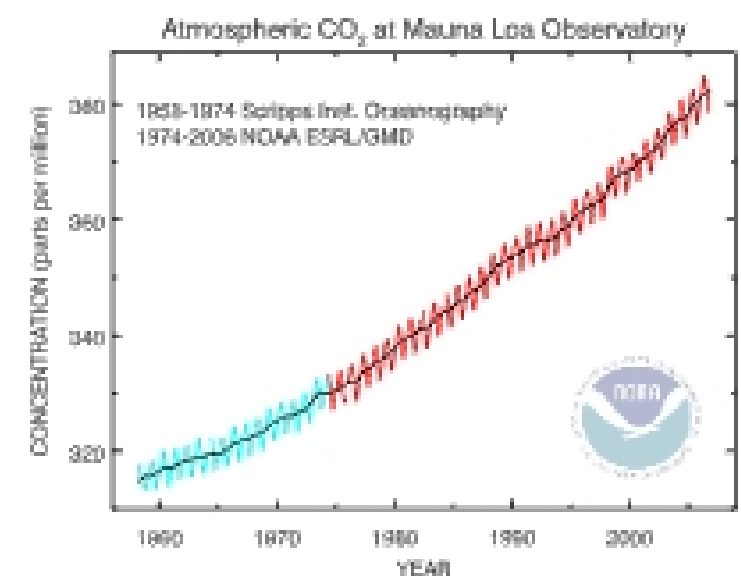
Earth's radiative equilibrium temperature: -18 C

Global mean surface temperature: + 15 C

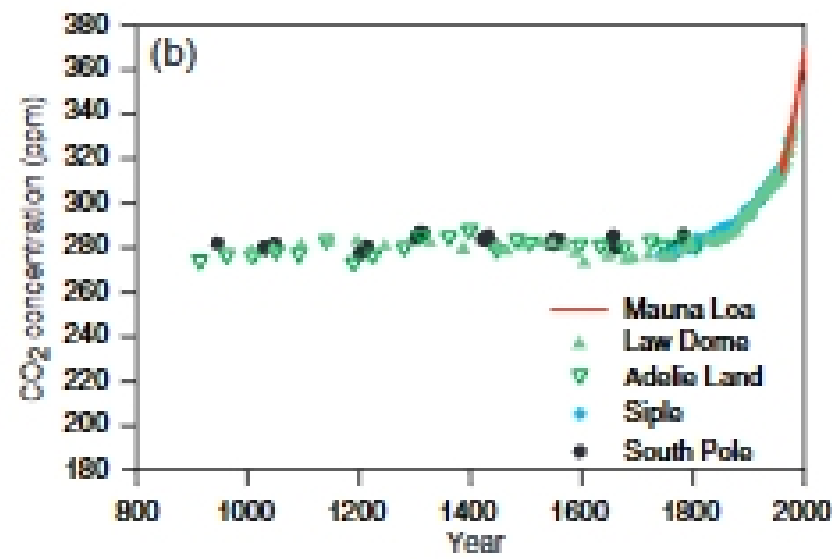
## Absorption spectra



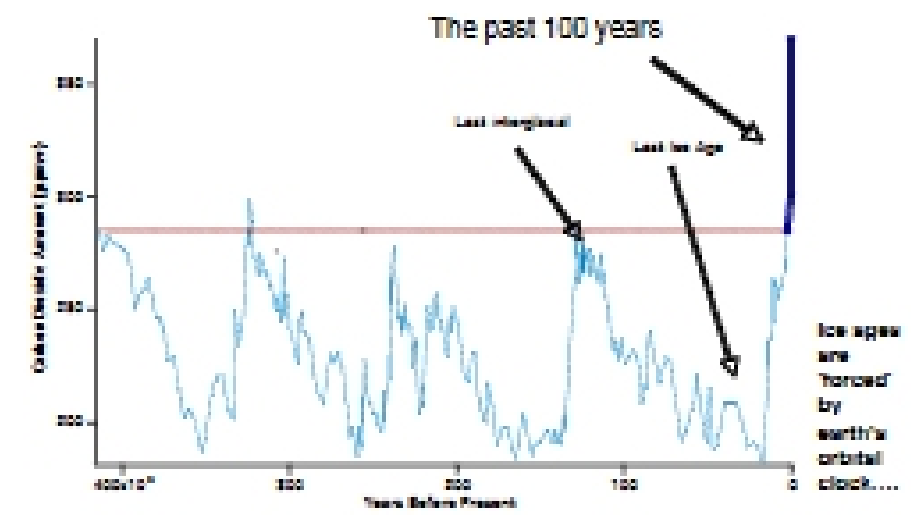
## Some observations: CO2



## CO2 from Antarctic ice cores

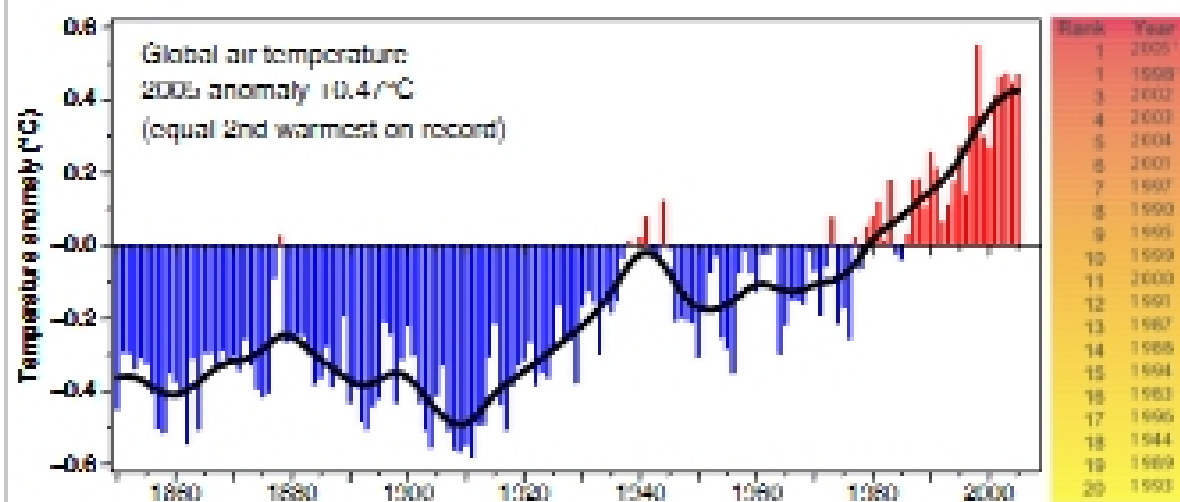


## CO2 from Vostok



It is well established that there is more carbon dioxide in the atmosphere today than there was in more than the past half million years.

## Observed temperatures



## Observed temperature trends

June-August, 1880-2005

