

# Agenda

- **Posters from 1:30 to 2:00. Talks start at 2:00**
- Big Picture
  - John Miller: Why study the Carbon Cycle?
  - Arlyn Andrews: Carbon Cycle Research in ESRL and beyond
- Observations/Synthesis
  - Pieter Tans: A brief history of the ESRL global carbon cycle observing system
  - Andy Jacobson: The CarbonTracker Modeling Effort
- ESRL Linkages
  - Greg Frost: Carbon Cycle Linkages to Air Quality
  - Adam Hirsch: The Need for Accurate Atmospheric Transport in Carbon Cycle Research
  - Randy Dole: Looking Ahead: Toward Development of an Integrated Earth System Analysis



**EARTH SYSTEM RESEARCH LABORATORY**  
*Serving Society through Science*



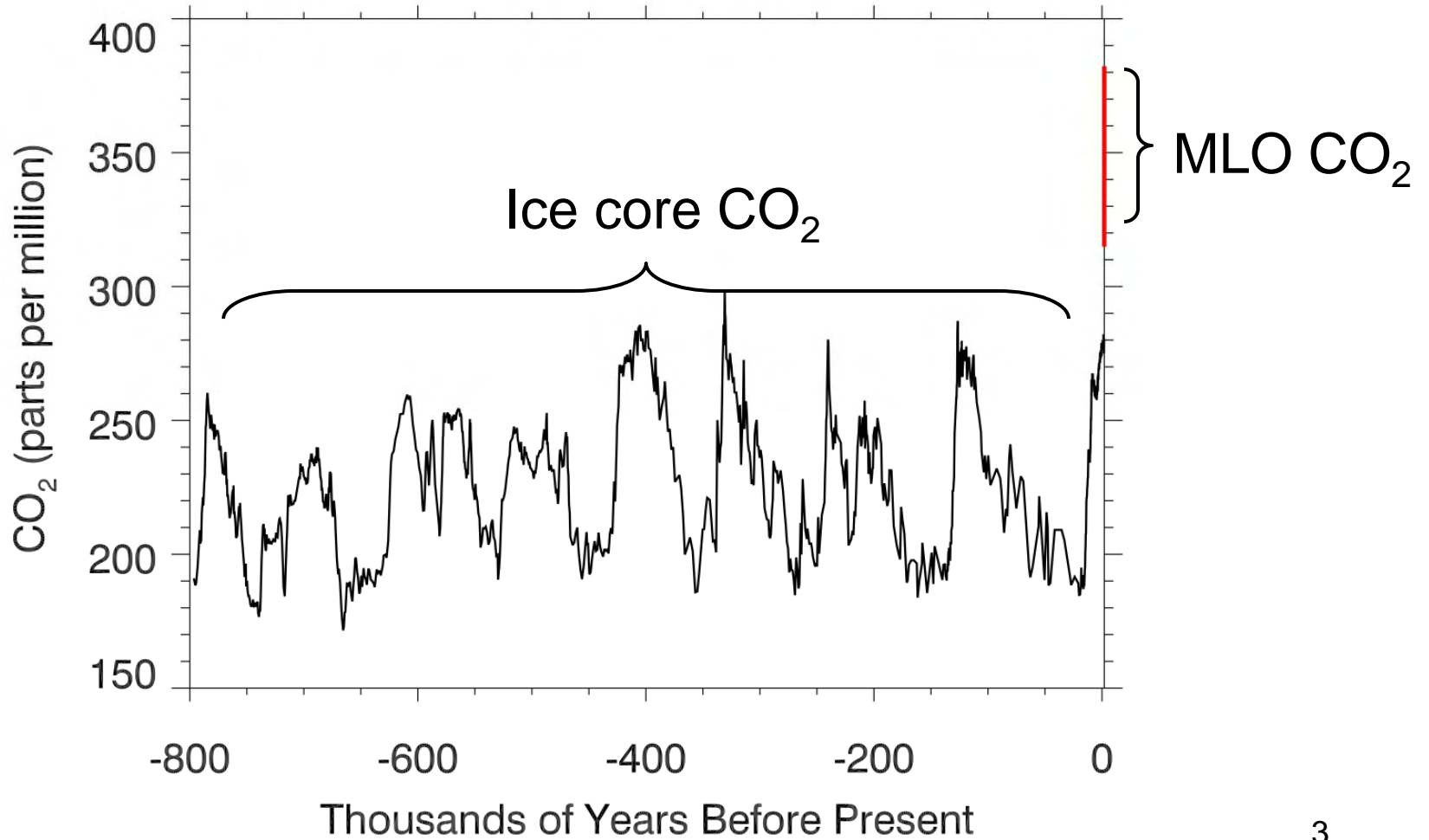
# Science Questions



- Carbon Cycle Basics
  - Paleo CO<sub>2</sub>
  - Surface Fluxes
- Fossil Fuel Emissions and their fate
- Rising CO<sub>2</sub>: what is the impact?
  - Climate change
  - Ocean Acidification

*John B. Miller*

# Paleo-CO<sub>2</sub>



$$d[\text{CO}_2]_{\text{atm}}/dt = + 4 \text{ PgC/yr}$$

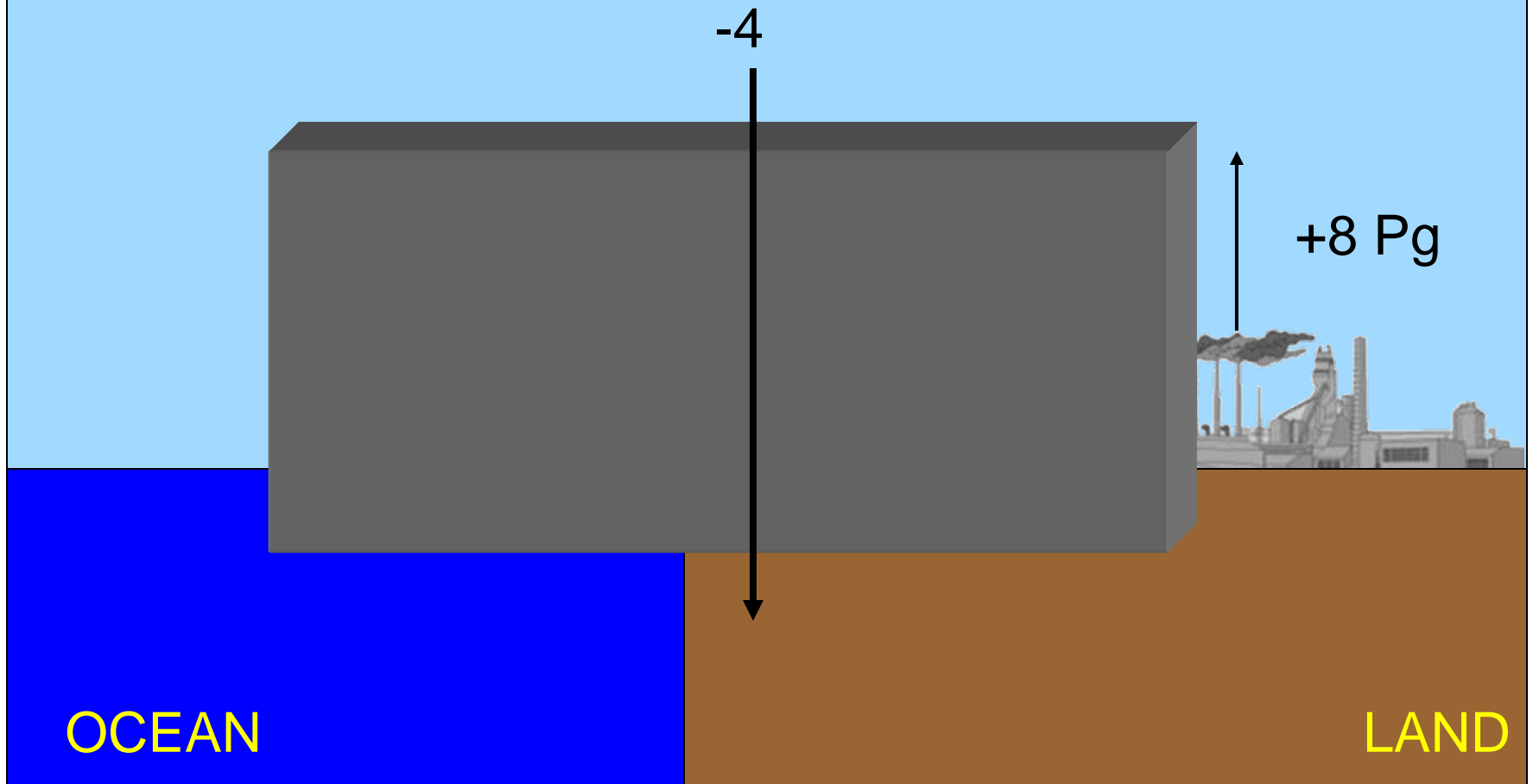
+4



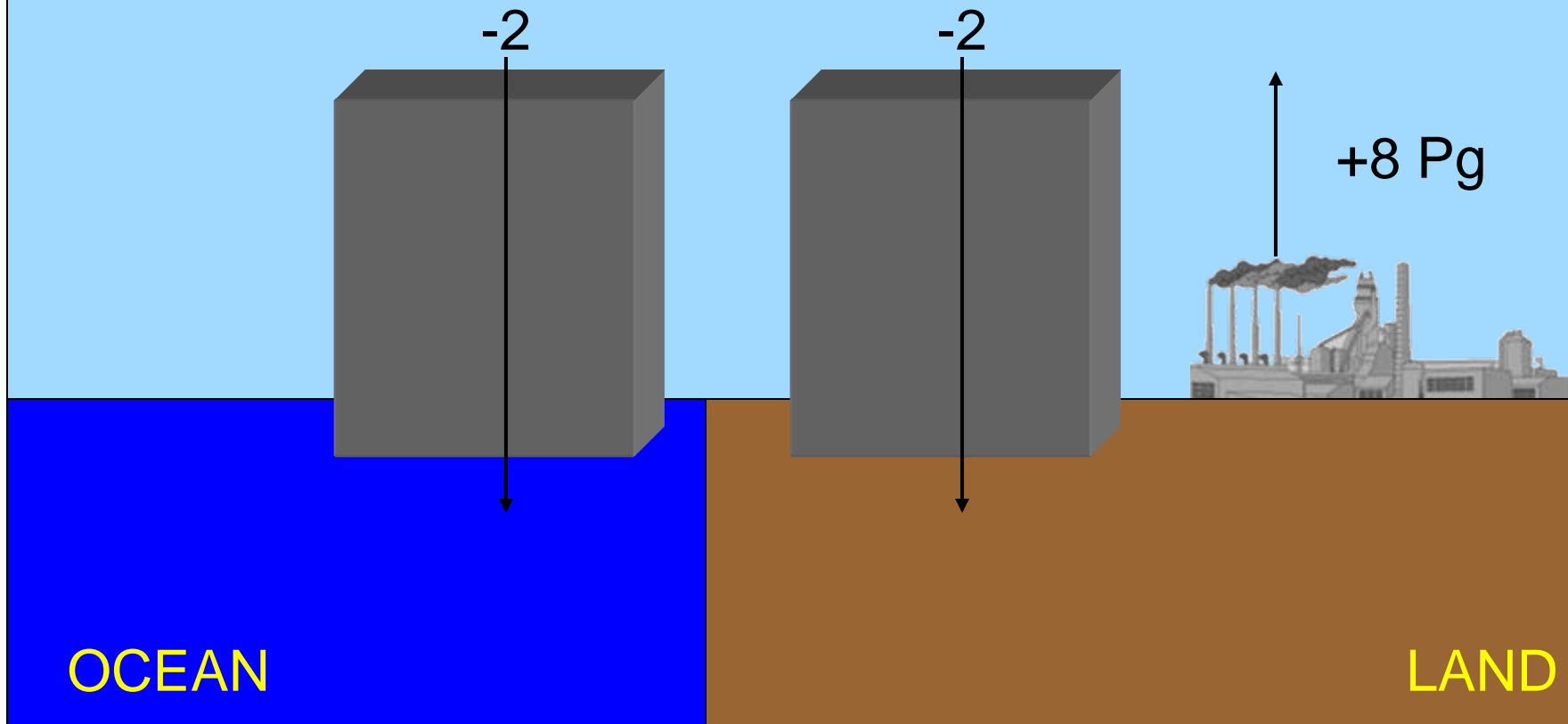
OCEAN

LAND

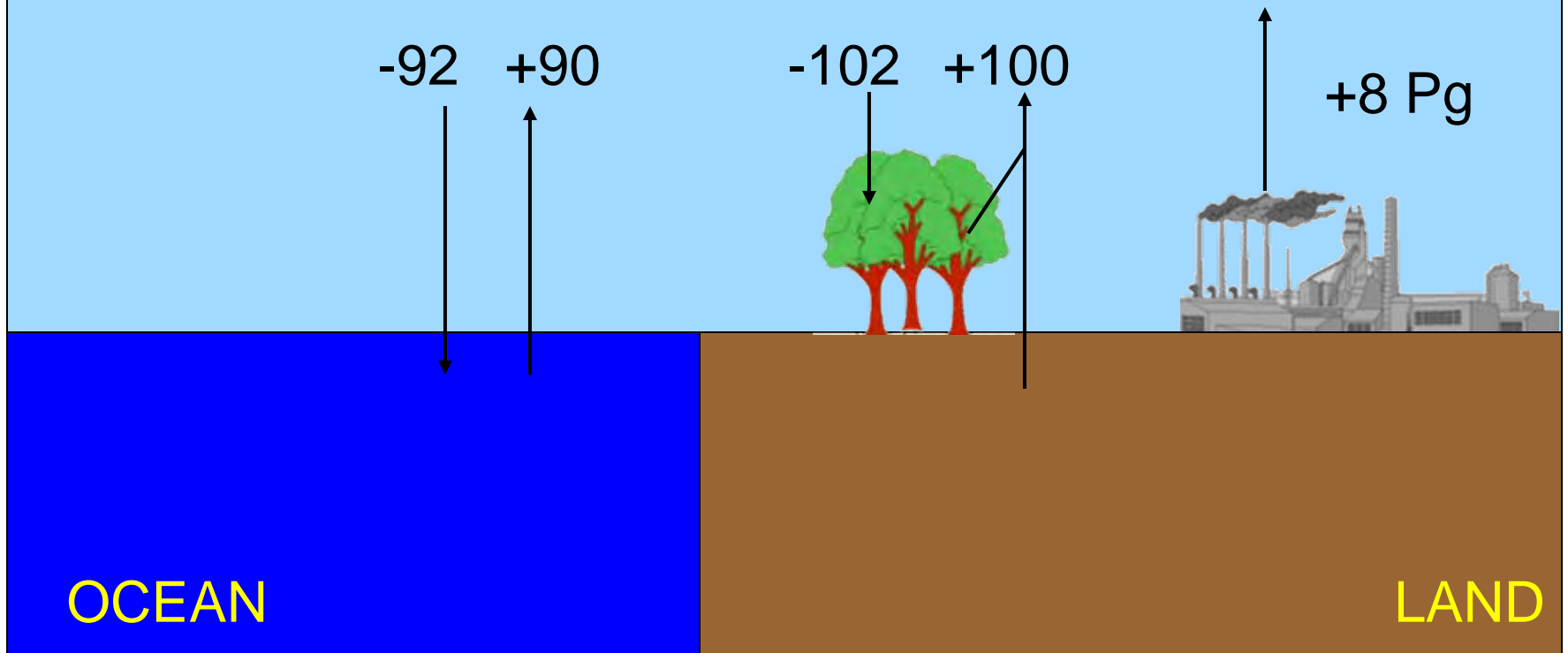
$$d[\text{CO}_2]_{\text{atm}}/dt - F_{\text{fos}} = F_{\text{surface}} = -4 \text{ PgC}$$



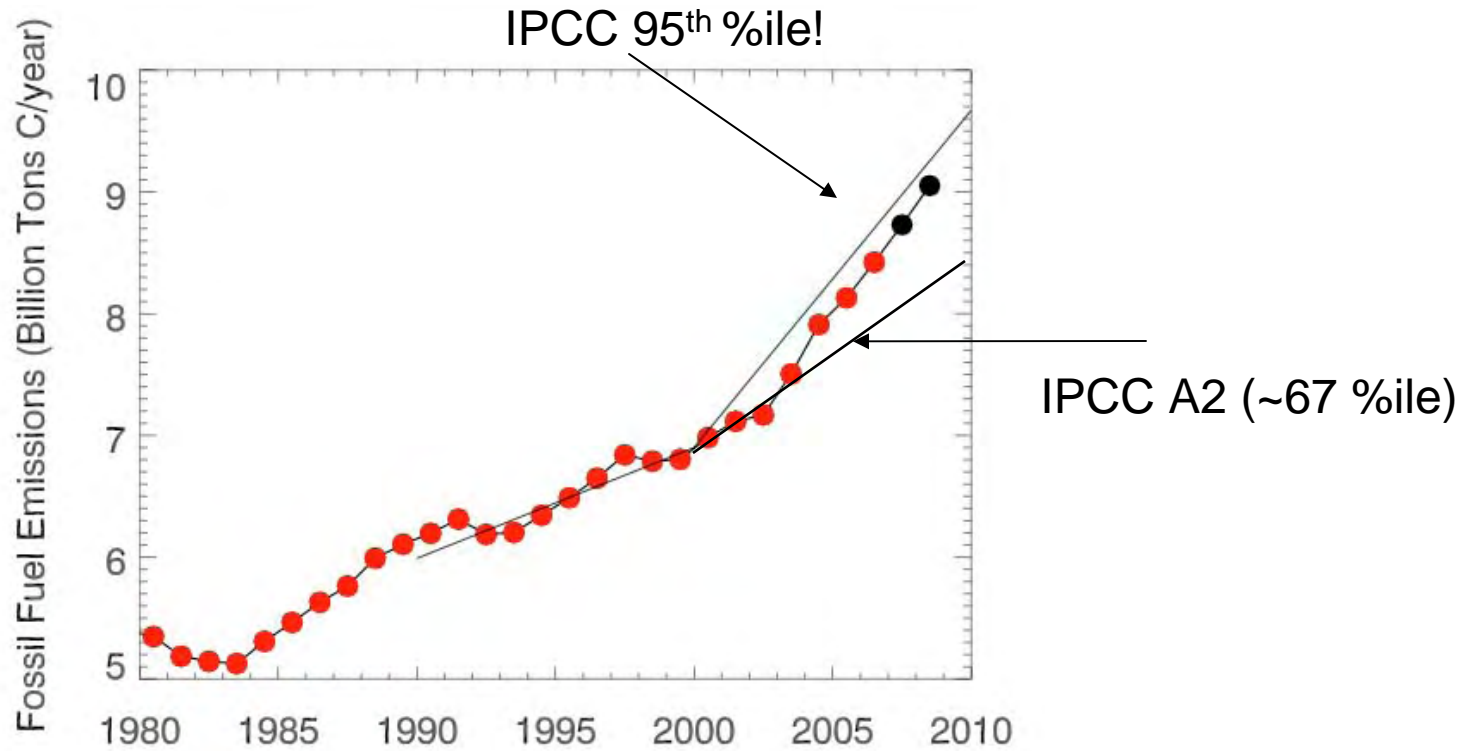
$$d[\text{CO}_2]_{\text{atm}}/dt - F_{\text{fos}} = F_{\text{ocean}} + F_{\text{land}} = -4 \text{ PgC}$$



$$d[\text{CO}_2]_{\text{atm}}/dt = F_{\text{fos}} + F_{\text{atm-oce}} + F_{\text{oce-atm}} + F_{\text{ph}} + F_{\text{resp}}$$

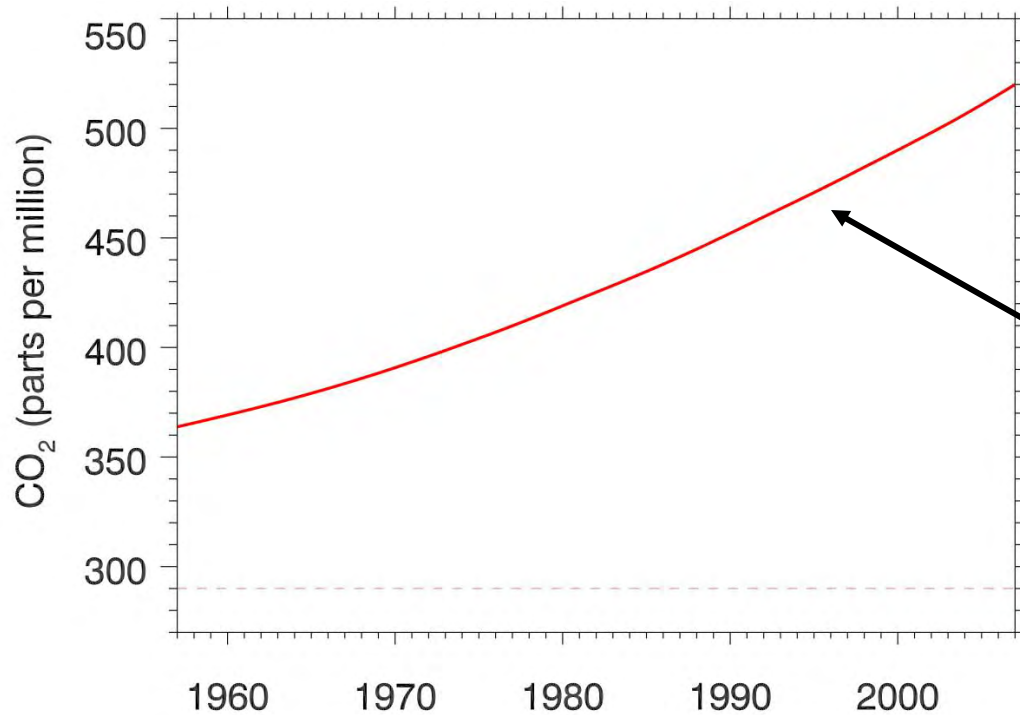


# Fossil Fuel Emissions



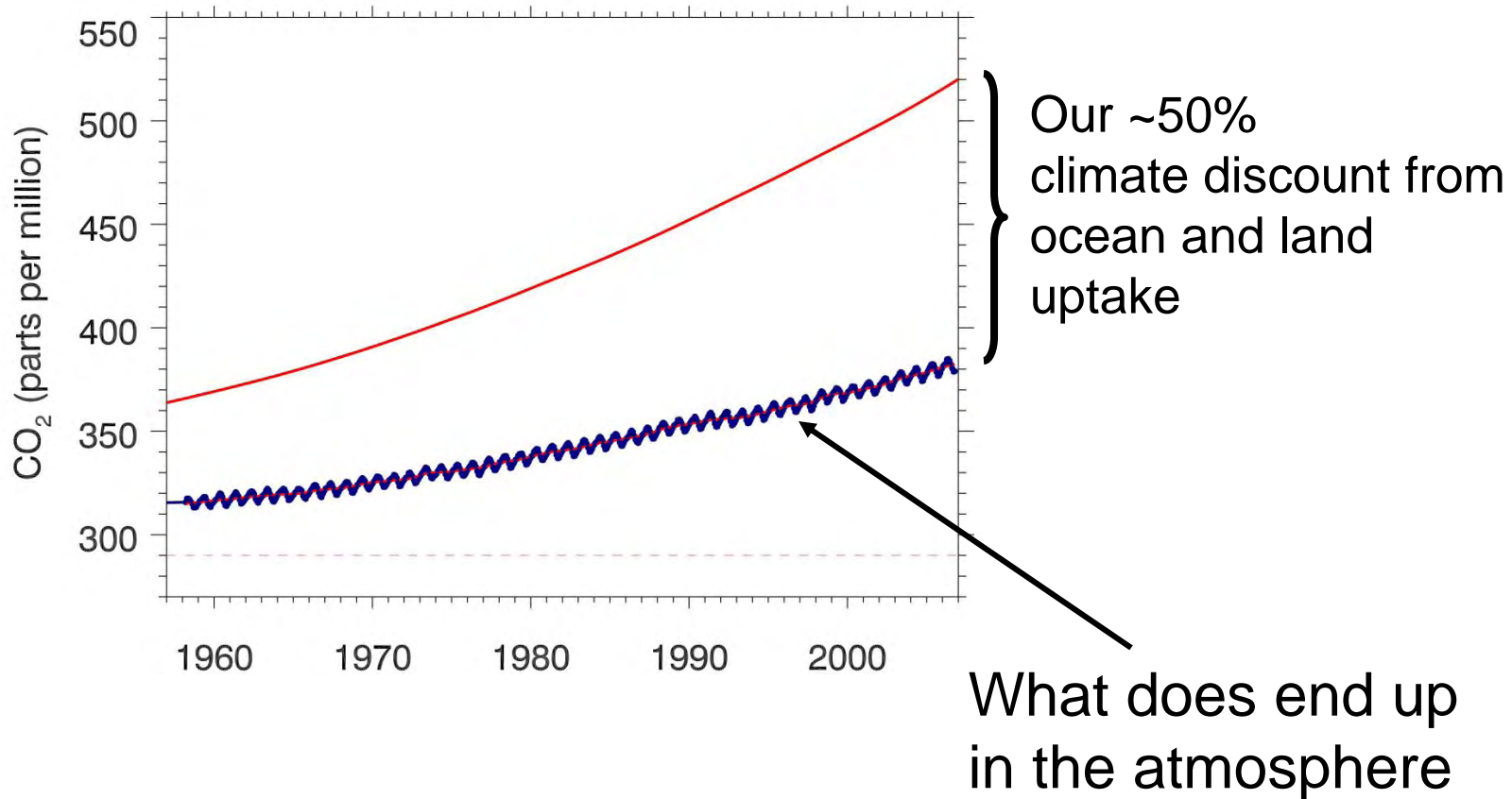


# Fate of Fossil Fuel Emissions



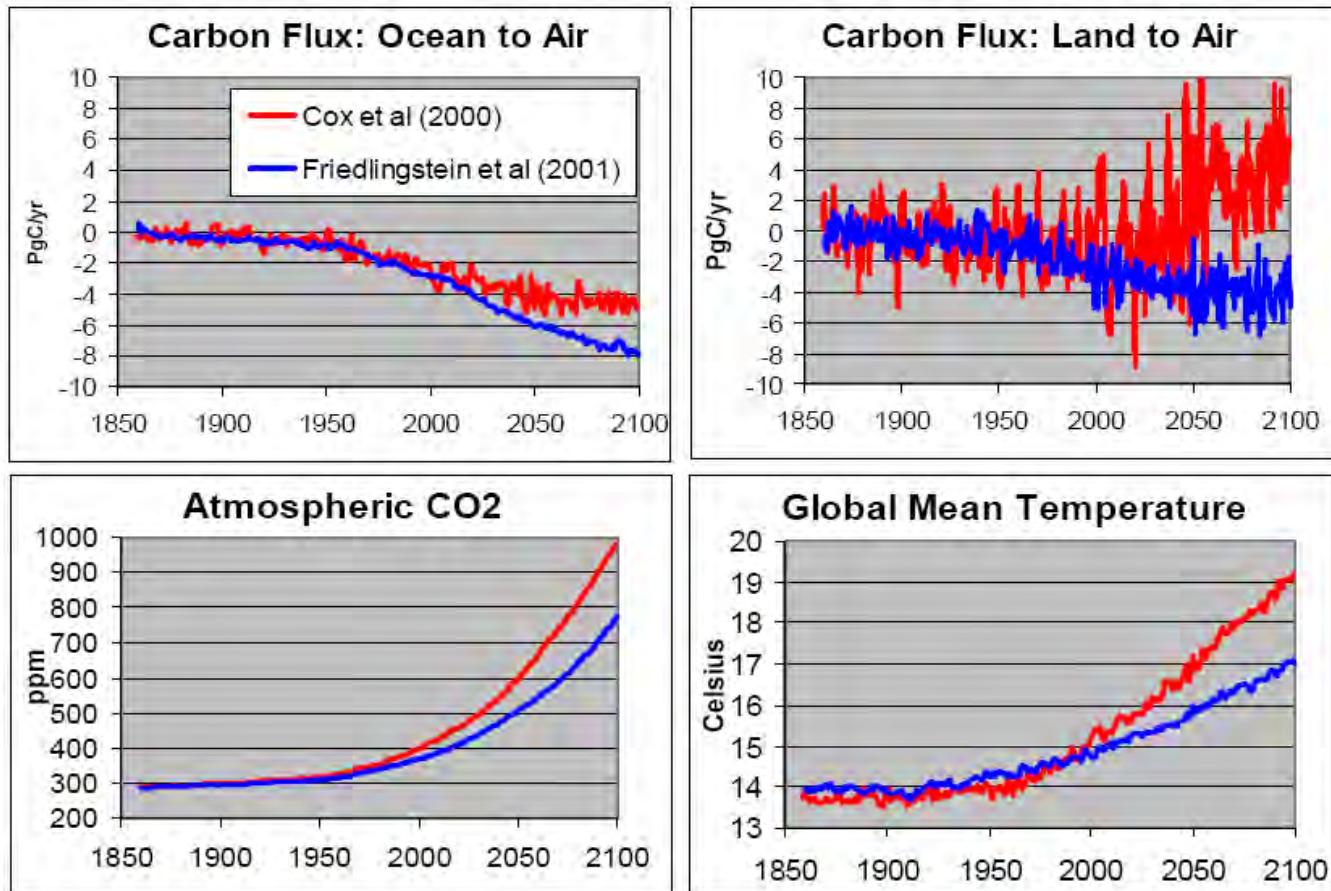
If all the fossil fuel  
CO<sub>2</sub> ended up in  
the atmosphere

# Fate of Fossil Fuel Emissions



How long will we keep getting our discount?

# Coupled Climate Carbon Cycle (C<sup>4</sup>) Models



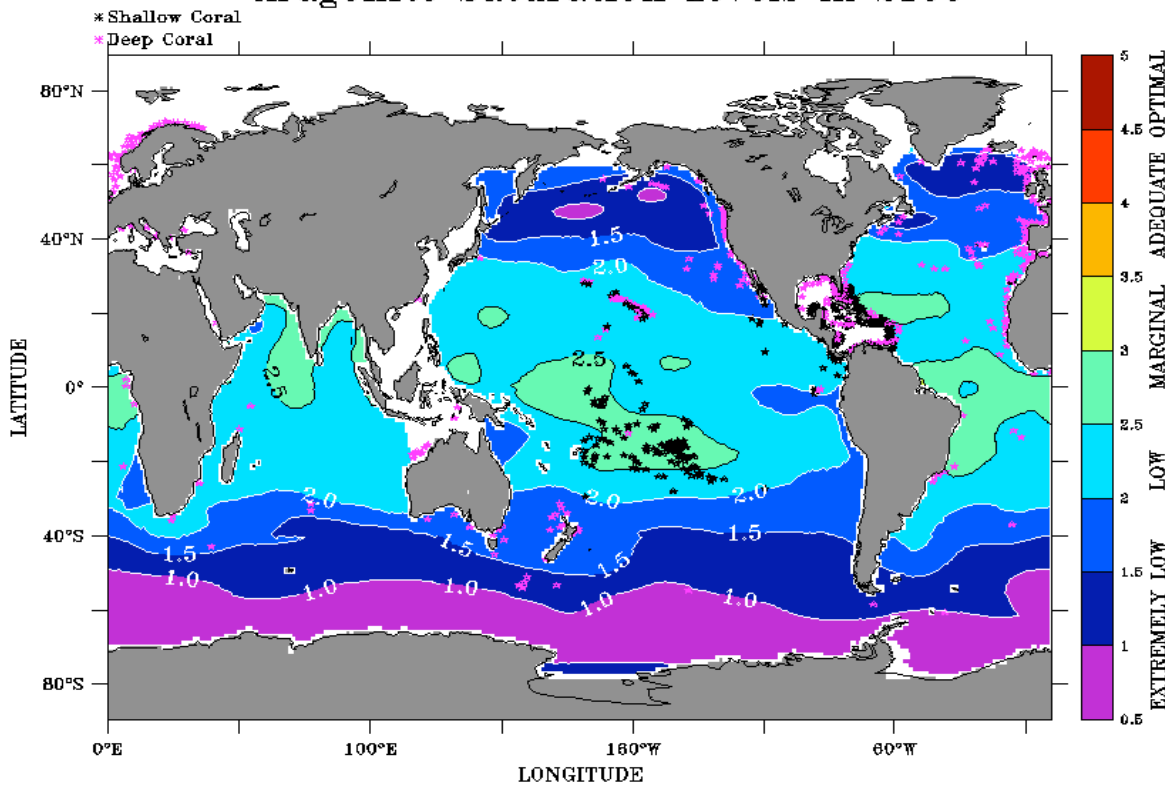
*Courtesy Scott Denning*

Permafrost releases not accounted for!

# Ocean Acidification

As CO<sub>2</sub> increases, ocean pH decreases

Aragonite Saturation Levels in 2100



Aragonite Saturation from Orr et al 2005

Courtesy Dick Feely

- Independent of warming
- Ability of marine organisms to form CaCO<sub>3</sub> is reduced.
- Potential for radical changes to marine food webs.

# Controls on Atmospheric CO<sub>2</sub>

