

# **EOSC 112: THE FLUID EARTH**

## ***PROCESSES OF GLOBAL CLIMATE CHANGE***

**Intro-2**

**Read: Kump et al. Chap.1**

**Check: Key Terms, Review Questions,  
Problems.**

**Global Environmental Change vs Smog, Local  
Water Pollution**

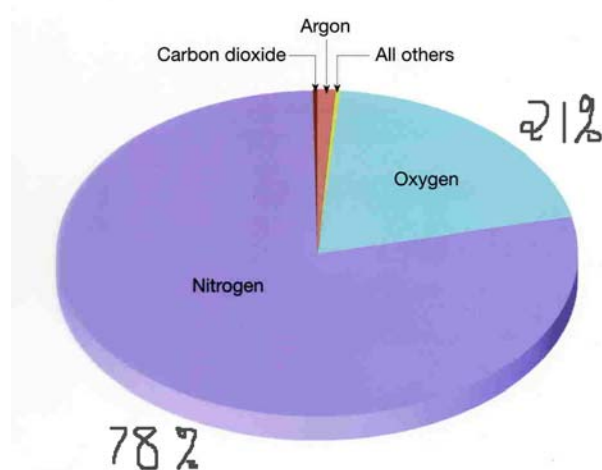
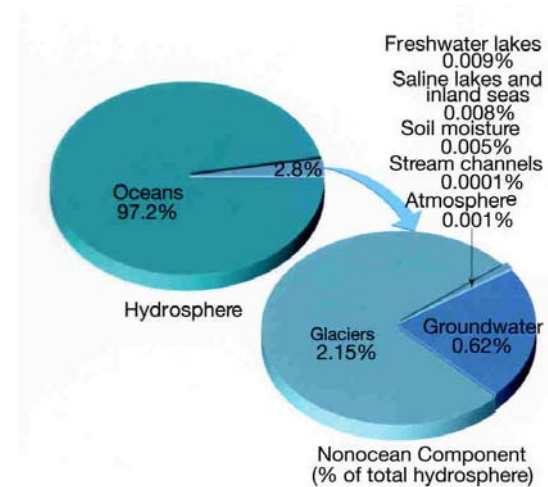
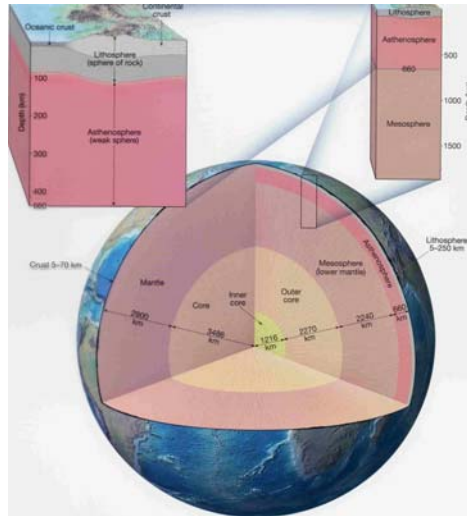
**Systems vs Single Entity**



**Composed of interacting components**

**Ex.: Earth System → Solid Earth (fig.)  
Hydrosphere (fig.)  
Atmosphere (fig.)  
Biota**

# Figures representing components of the Earth System



**In order to study environmental change, one needs to study what causes the changes. Some agents of change result from “mother nature”, others are man-made. With respect to the Earth system or its sub-systems, we define agents as internal or external influences on the system depending on whether they are included (internal) in the system or not (external).**

**Ex.: External influence to the Earth system: The Sun**  
**External influence to the Ocean-Atm.: Volcanoes**  
**Influence internal to the Earth system: Plate tectonics**  
**Influence internal to the Ocean-Atm.: El Nino**

# Short-Term Climate Change

- **Global Warming:**

**Earth's surface temperature is rising 0.5°C rise (based on linear trend) during last century. (fig.)**

**Notice that the upward trend is not uniform: cooling episode present (1950s-60s); volcano cooling (1963-64, 1982-83, 1991-92).**

**How does this Global Warming compare to regional temperature changes? (fig.)**

# Figures representing T rise at the Earth's surface

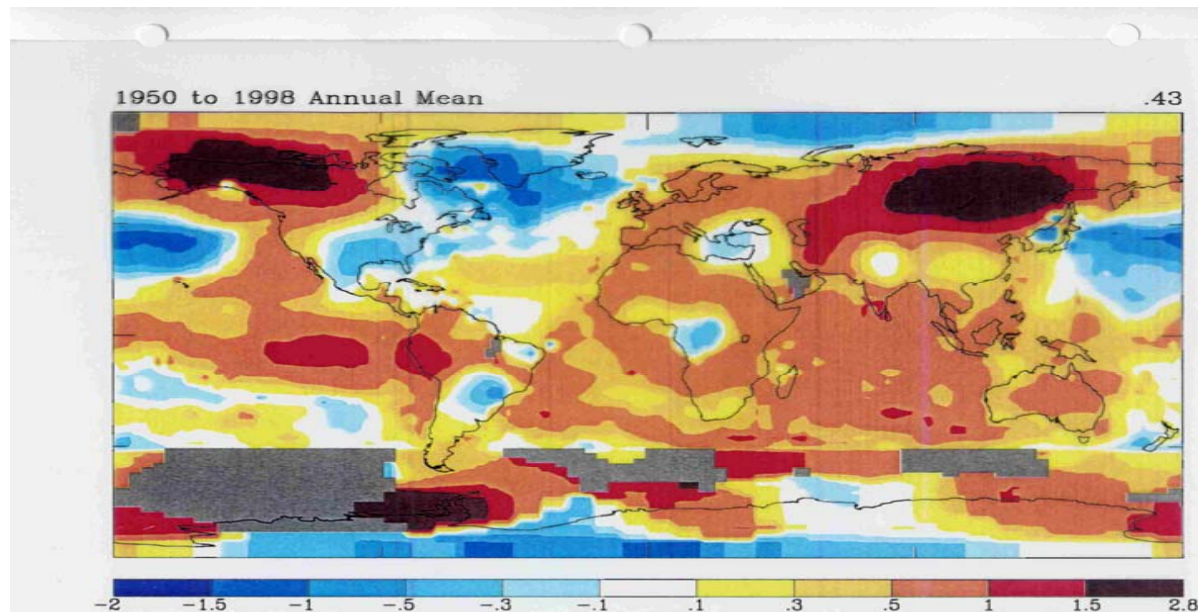
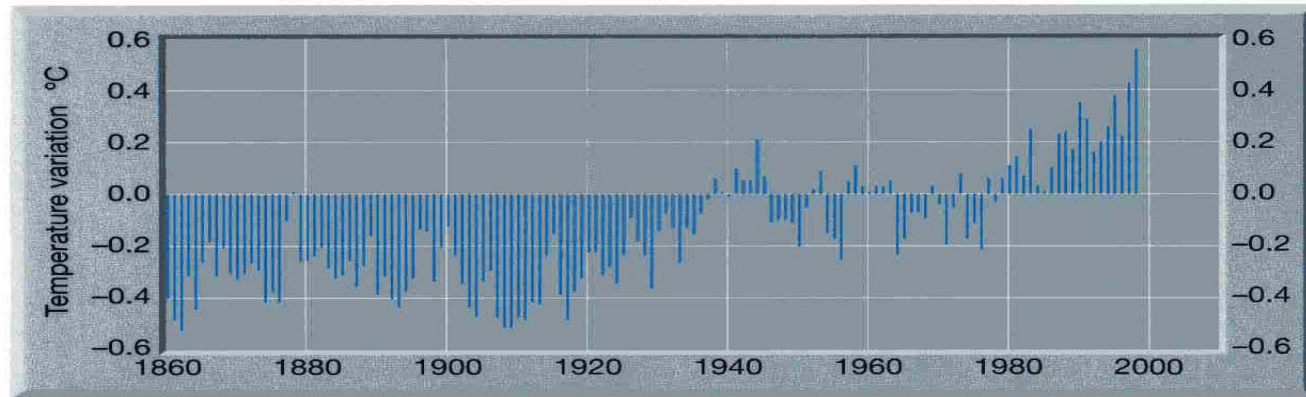


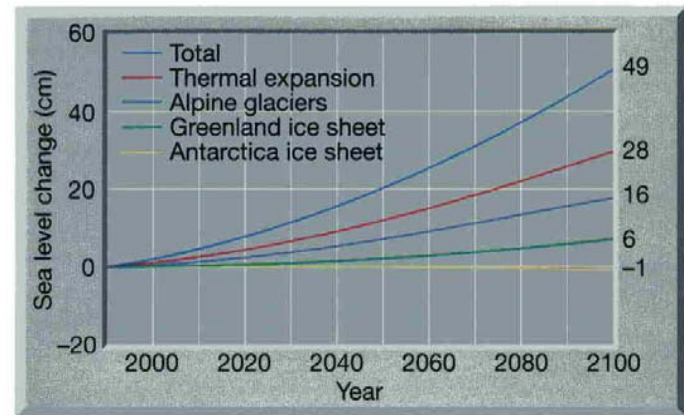
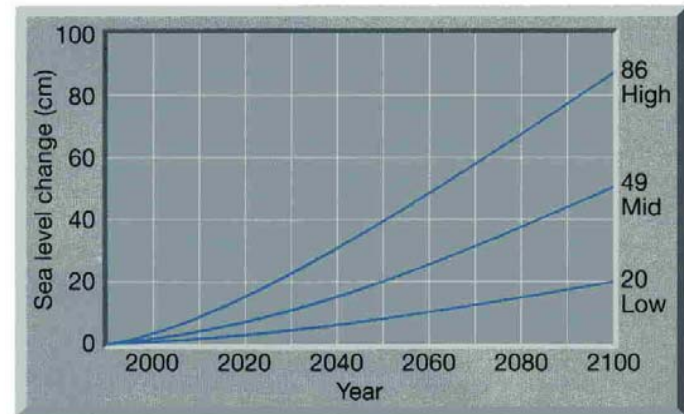
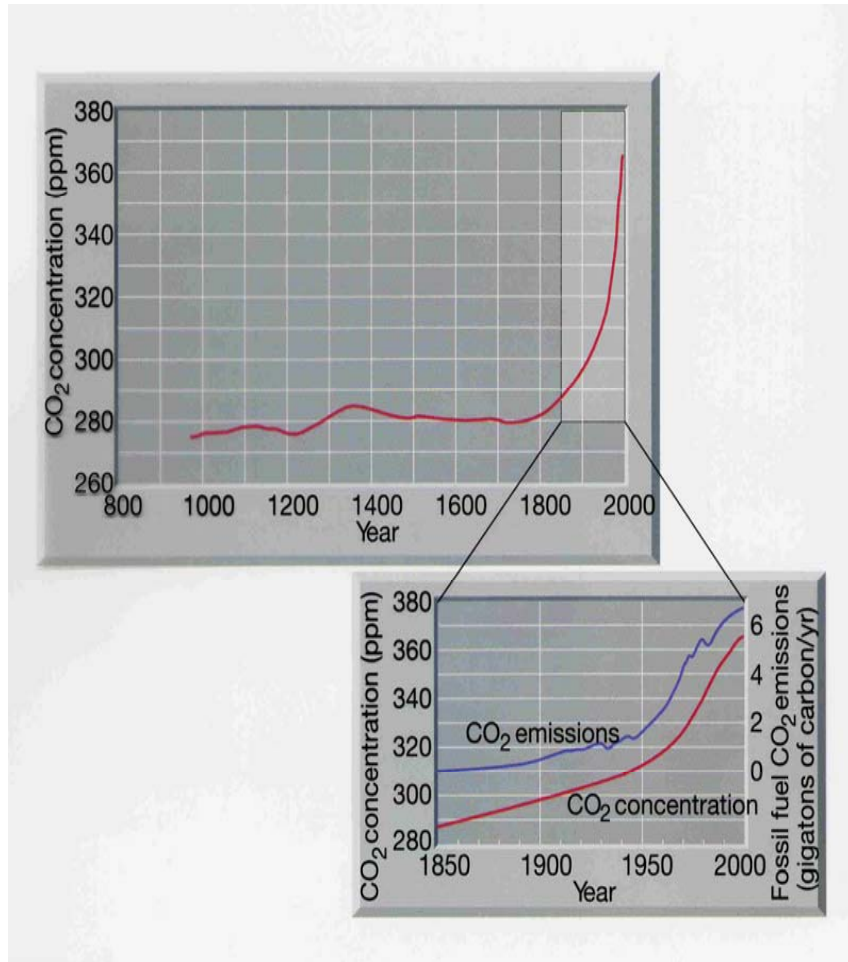
Figure 2. Change of surface temperature during 1950-98 based on local linear trends.

# Greenhouse Effect

- Atmospheric process that keeps the surface of planets warmer than it would be in the absence of an atmosphere.
- Major causes of the rise in CO<sub>2</sub> concentrations:  
    Burning of coal, oil and natural gas. (fig.)
- Consequences:  
    Rise of Sea Level (fig.),  
    Droughts,  
    Insect “Pests”.



# Figures representing the increasing concentrations of atmospheric CO<sub>2</sub> and its effect on sea level change





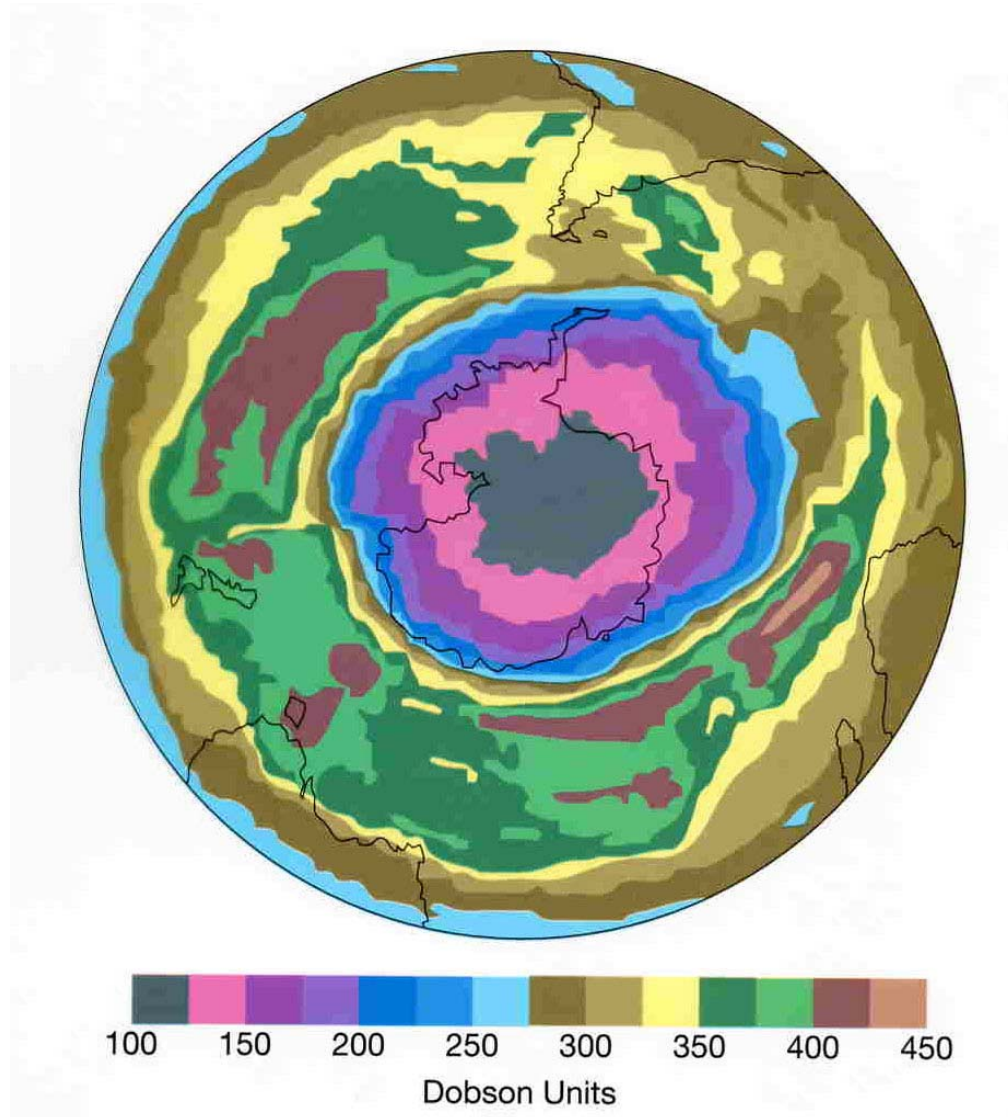
## Ozone (O<sub>3</sub>) Depletion

- Stratospheric O<sub>3</sub> provides protection against UV rays.
- Total O<sub>3</sub> amounts decreased by ~ 50% between 1975 and 1991 over Antarctica during Octobers. (fig.)
- Intricate chemistry of chlorine compounds + particular stratospheric wind patterns produce the *Ozone Hole*.

## Loss of Biodiversity

- Modern-day example: Deforestation followed by loss of ecosystem.

# Figure representing Ozone distribution over the Southern Hemisphere



# Problems that need our attention

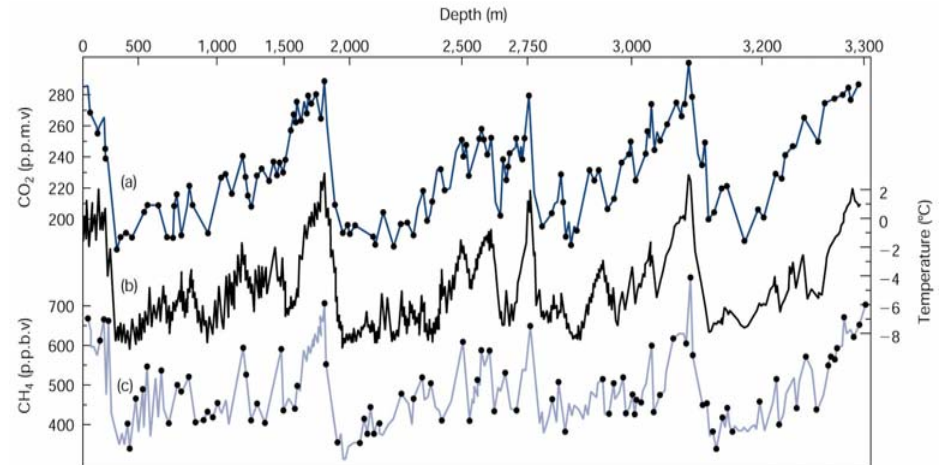
- Consider the time scales involved in the process:
- $O_3$ : “short” (residence time of Freons in stratosphere  $\sim 100$  yrs + phased out)
- Global Warming: “medium” (concentrations of  $CO_2$  elevated for Kyr, slowly absorbed by ocean, removal from ocean  $\sim$  Myr).
- Biodiversity: “long” (recovery  $\sim$  tens of Myr).

# Long-Term Climate Change

- **Geologic time scale: (fig.)**  
Dinosaur extinction, Ice Ages, Homo Sapiens, Holocene inter-glacial
- **Glacial/Inter-glacial cycles:**  
The Quaternary is characterised by a succession of Ice Ages with a periodicity ~ 100Kys.  
Ice cores indicate that T, CO<sub>2</sub>, MH<sub>4</sub> show similar variations over time (fig.).

# Figures representing the Geologic Time Scale and Measurements from Ice Cores

Eon	Era	Period	Epoch	Development of Plants and Animals	Relative Time Span of Eras
Phanerozoic	Cenozoic	Quaternary	Holocene 0.01	Humans develop	Cenozoic
			Pleistocene 1.8		Mesozoic
		Tertiary	Pliocene 5.3	"Age of Mammals"	Paleozoic
			Miocene 23.8		
			Oligocene 33.7		
			Eocene 54.8		
	Mesozoic	Cretaceous	Paleocene 65.0	Extinction of dinosaurs and many other species	Precambrian
				First flowering plants	
			144	First birds	
			206	Dinosaurs dominant	
	Paleozoic	Triassic	248	Extinction of trilobites and many other marine animals	
		Permian	290	First reptiles	
		Carboniferous	Pennsylvanian 323	Large coal swamps	
			Mississippian 354	Amphibians abundant	
		Devonian	417	First insect fossils	
		Silurian	443	Fishes dominant	
		Ordovician	490	First land plants	
		Cambrian	540	First fishes	
Proterozoic	Archean	Hadean	Collectively called Precambrian, comprises about 88% of the geologic time scale	First multicelled organisms	
				First one-celled organisms	
				Origin of Earth	



Copyright © 2004 Pearson Prentice Hall, Inc.

- **Asteroid Impact and Mass Extinction:**  
Cretaceous-Tertiary boundary marked by extinction of  $\sim 75\%$  of existing species.  
Recovery characterised by a change in the dominant species.

Changes to the Earth system caused by human activities are less dramatic, but are occurring on a faster time scale compared to natural changes.

- **Solar Luminosity:**  
Solar lum. (4,6 billion years ago)  $\approx 70\%$  Solar lum. (today). But water existed on the Earth prior to 2 billion years ago. Probable reason: *Enhanced Greenhouse Effect*.