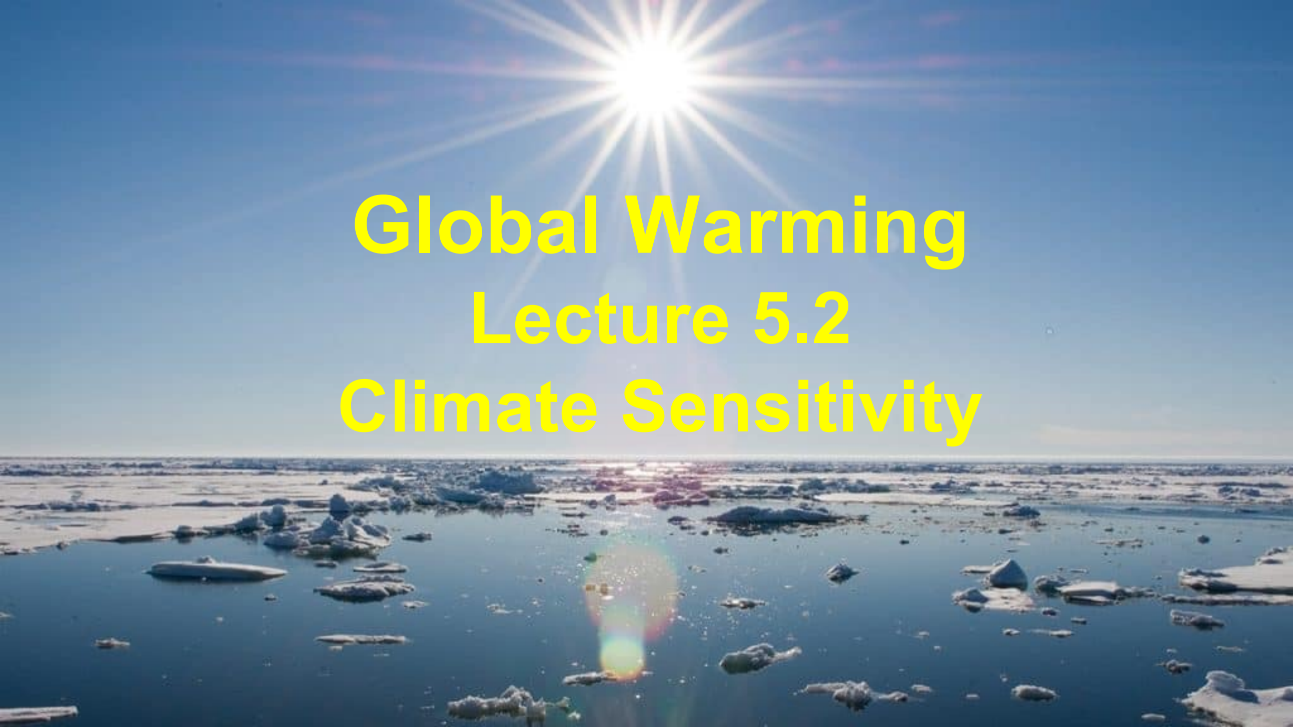

Global Warming
Lecture 5.2
Climate Sensitivity

Climate sensitivity

The change in global-mean surface temperature due to some radiative forcing. It is often quantified as ΔT_{2x}, the increase in global-mean temperature when the CO_2 is doubled.

Logarithmic Effect of CO_2

<u>Doubling</u> CO_2 always produces the same warming: ΔT_{2x}

e.g.

CO2:	100 ppm	->	200ppm	->	400ppm	->	800ppm
T :	250K	->	255K	->	260K	->	265K
ΔT :			+5K		+5K		+5K

Total global-mean surface temperature increase

Final CO_2

$$2^{\frac{\Delta T}{\Delta T_{2x}}} = \frac{(CO_2)_f}{(CO_2)_0}$$

Global-mean surface temperature increase when CO_2 is doubled

(Climate sensitivity)

Initial CO_2

Climate Sensitivity

$$2^{\frac{\Delta T}{\Delta T_{2x}}} = \frac{(CO_2)_f}{(CO_2)_0}$$

- ΔT, $(CO_2)_f$, $(CO_2)_0$: three “variables”. Knowing 2 of them we could get the third one; knowing three of them we could estimate the “constant” ΔT_{2x} (like what we did in the blackbody lab)

Example: What’s the temperature change if we increase CO_2 from 200ppm to 600ppm (assuming ΔT_{2x}=5K)?

$$2^{\frac{\Delta T}{5K}} = \frac{600ppm}{200ppm}, \Delta T = 8K$$

Climate Sensitivity

$$2^{\frac{\Delta T}{\Delta T_{2x}}} = \frac{(CO_2)_f}{(CO_2)_0}$$

- ΔT, $(CO_2)_f$, $(CO_2)_0$: three "variables". Knowing 2 of them we could get the third one; knowing three of them we could estimate the "constant" ΔT_{2x} (like what we did in the blackbody lab)
- ΔT_{2x}: "constant" for certain climate, but it changes as climate changes due to feedbacks
- e.g., when temperature increases, water vapor feedback gets stronger, so ΔT_{2x} will get larger with increasing temperature

We can rewrite this equation as follows:

You can use ln as log here

$$2^{\frac{\Delta T}{\Delta T_{2x}}} = \frac{(CO_2)_f}{(CO_2)_0}$$

$$\log\ 2^{\frac{\Delta T}{\Delta T_{2x}}} = \log \frac{(CO_2)_f}{(CO_2)_0}$$

$$\log(a^b) = b\log(a)$$

$$\frac{\Delta T}{\Delta T_{2x}} \log 2 = \log \frac{(CO_2)_f}{(CO_2)_0}$$

$$\frac{\Delta T}{\Delta T_{2x}} = \frac{\log \frac{(CO_2)_f}{(CO_2)_0}}{\log 2}$$

$$\boxed{\Delta T_{2x} = \Delta T \left(\frac{\log 2}{\log\left(\frac{(CO_2)_f}{(CO_2)_0}\right)} \right)}$$

Review: Zachos curve

PETM: Paleocene-Eocene Thermal Maximum