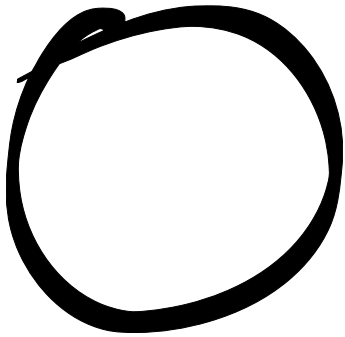


Static rock in space, plus sun

Temperature is determined by energy input, i.e., solar output.

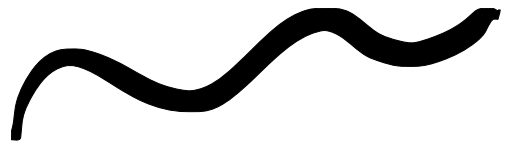


273 C K
454 F R

28
noon



5R

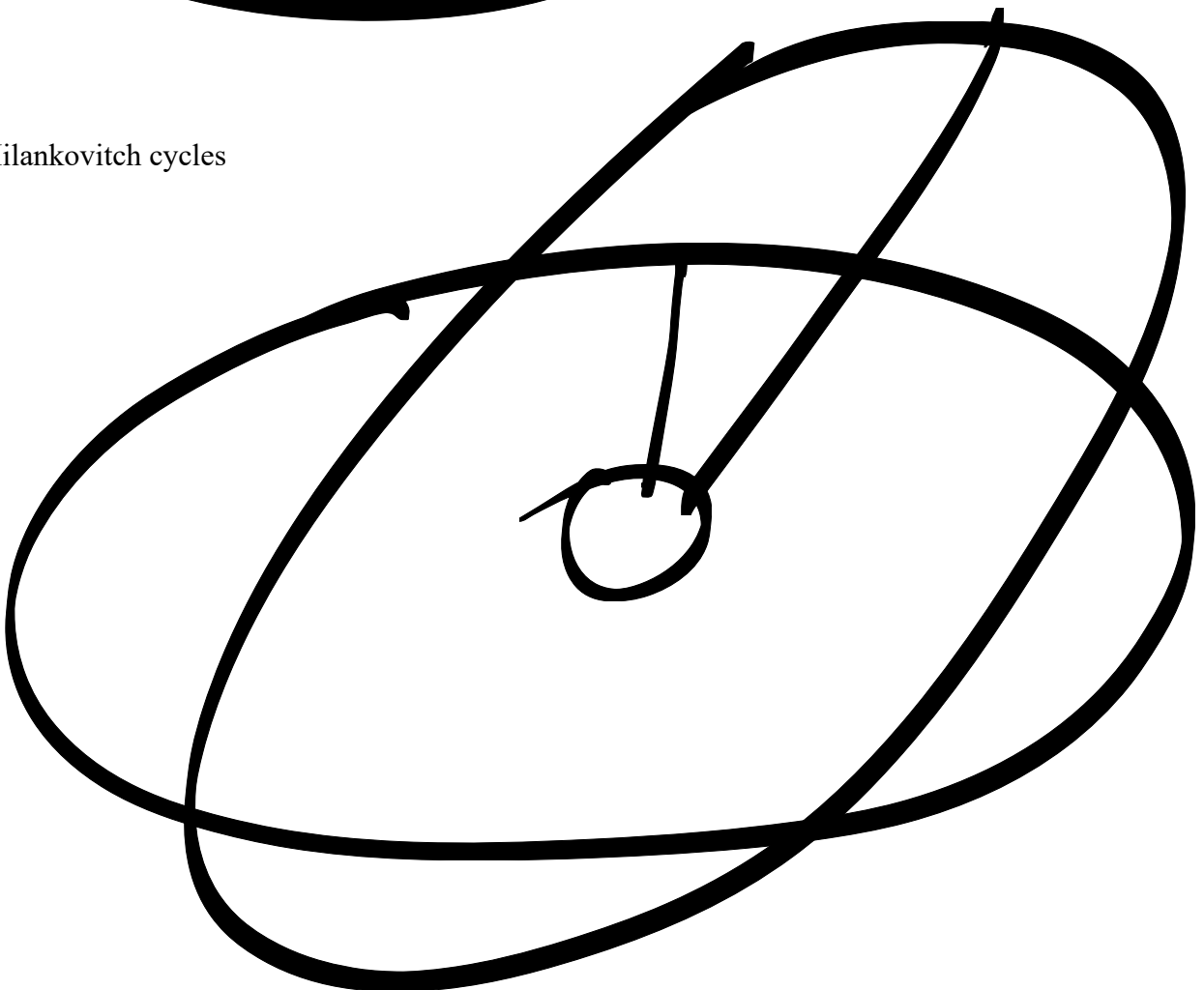


Hypothetical earth without atmosphere and ocean

Seasons



Milankovitch cycles



The effect of an atmosphere

The atmosphere changes the amount of energy coming in and going out.

Gases that hold heat in are greenhouse gasses (GHGs)

Dust and clouds can reflect energy out, lowering the temperature. (Volcanoes)

Some temperature moderation, but still big swings.

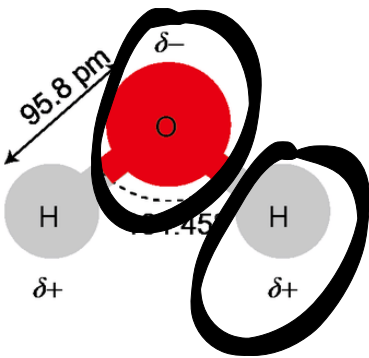
+200 - 300



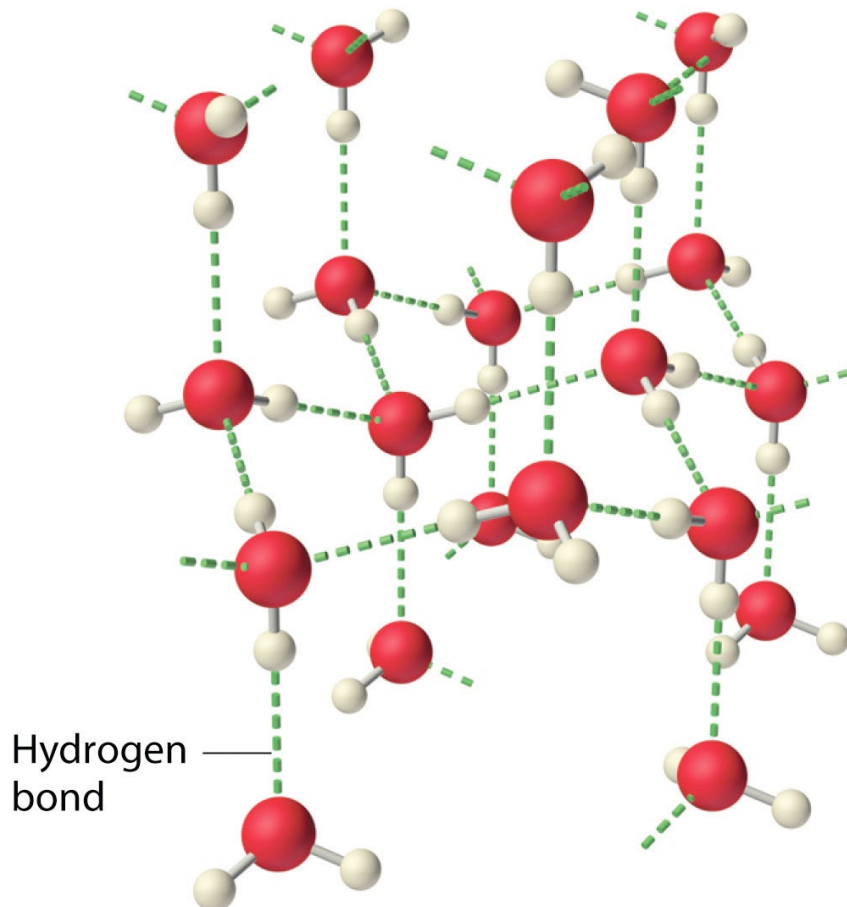
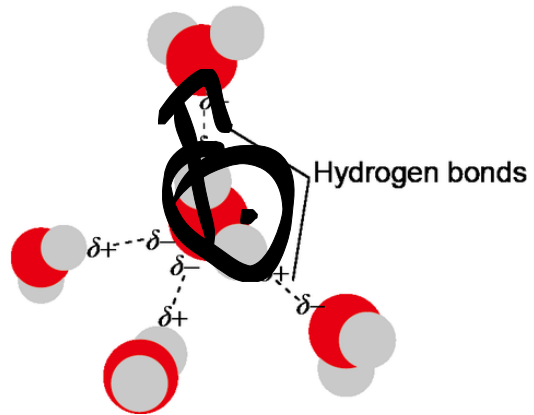


Water magic – structure of water

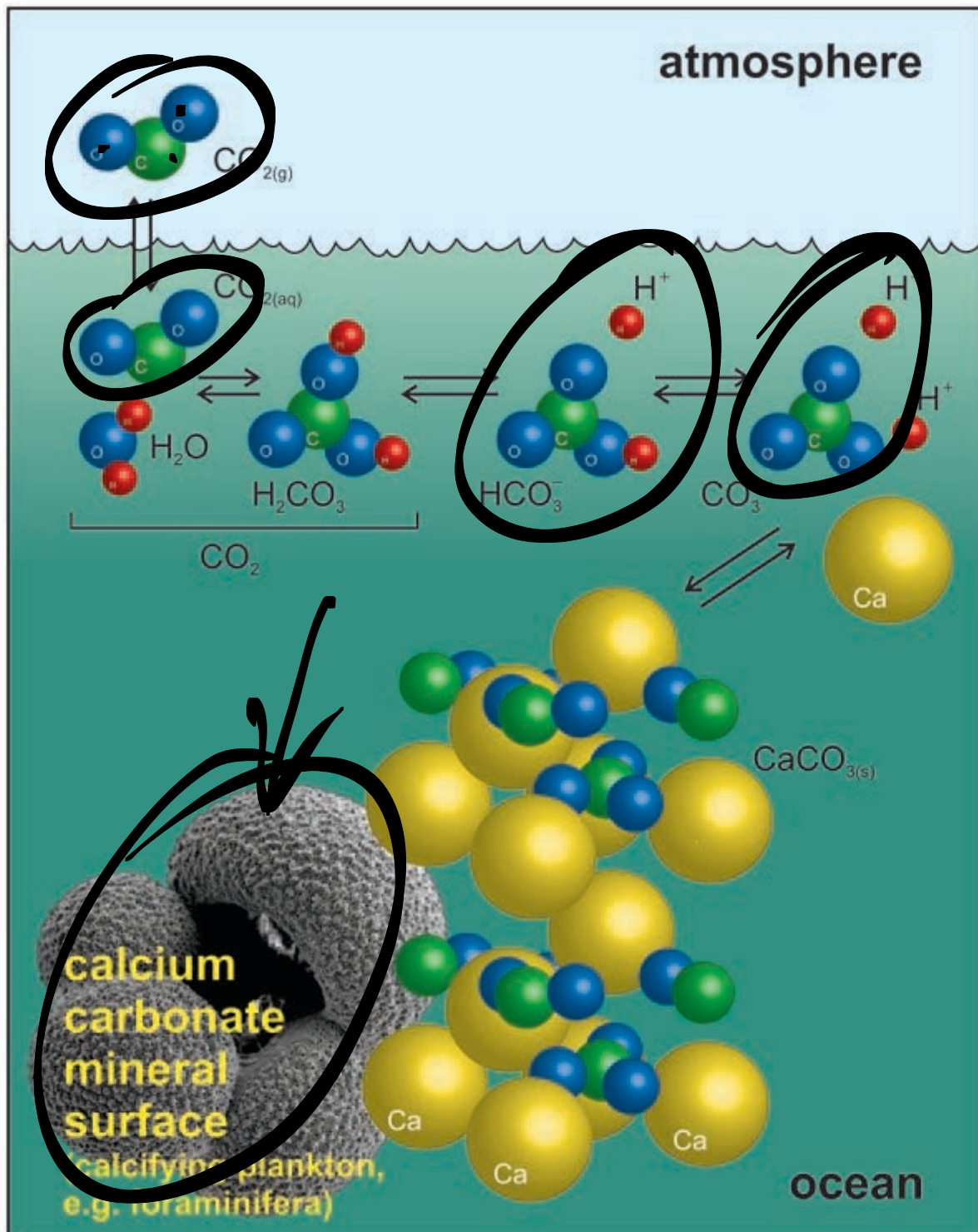
(a)



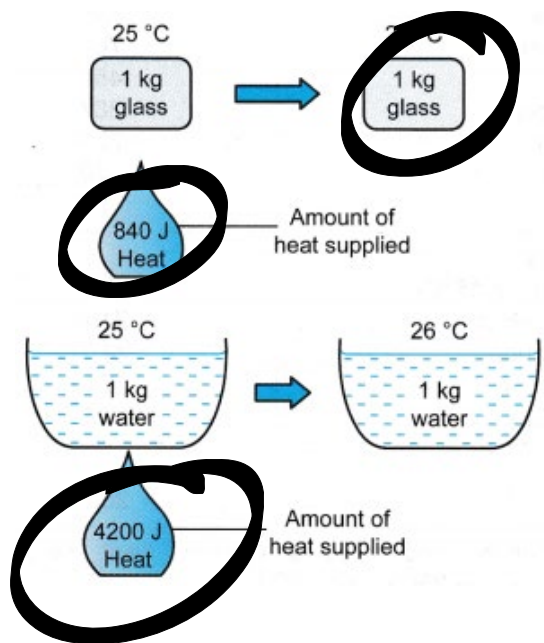
(b)



Ocean acidification – more CO₂ in the atmosphere increases CO₂ in the oceans, which makes the ocean more acid.



Specific heat



5x
+ 2000 J

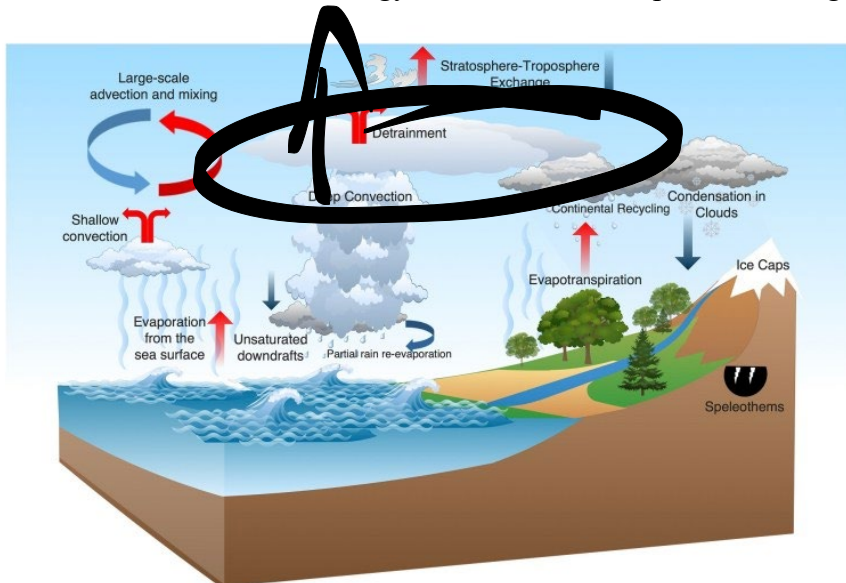


The earth with oceans

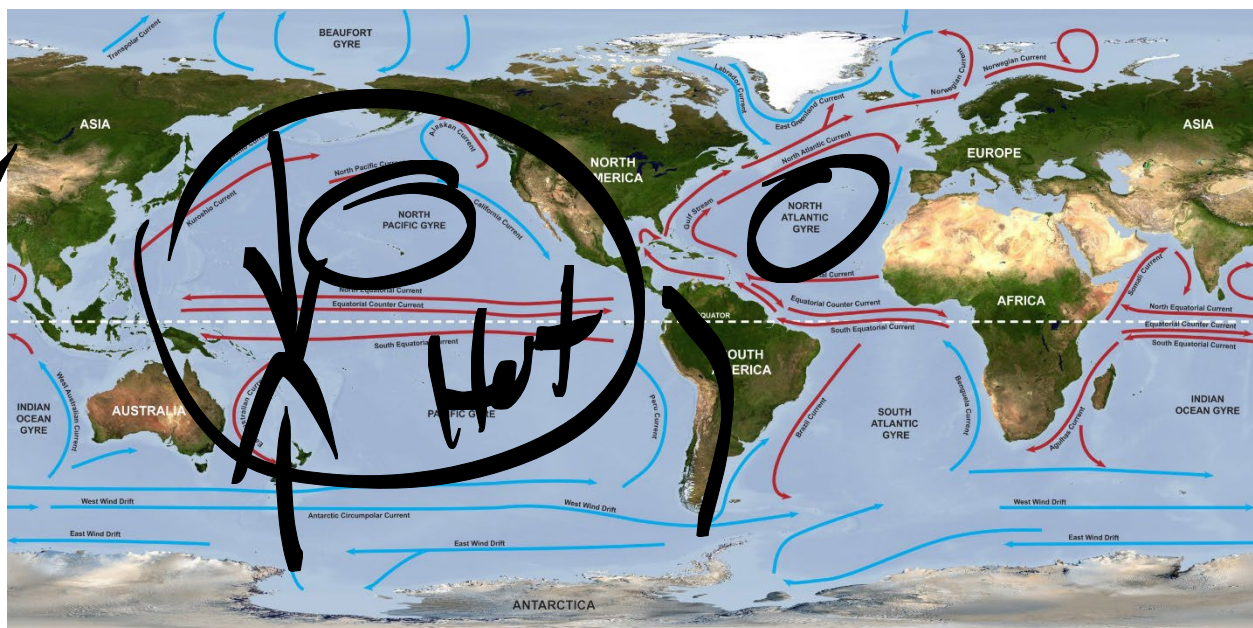
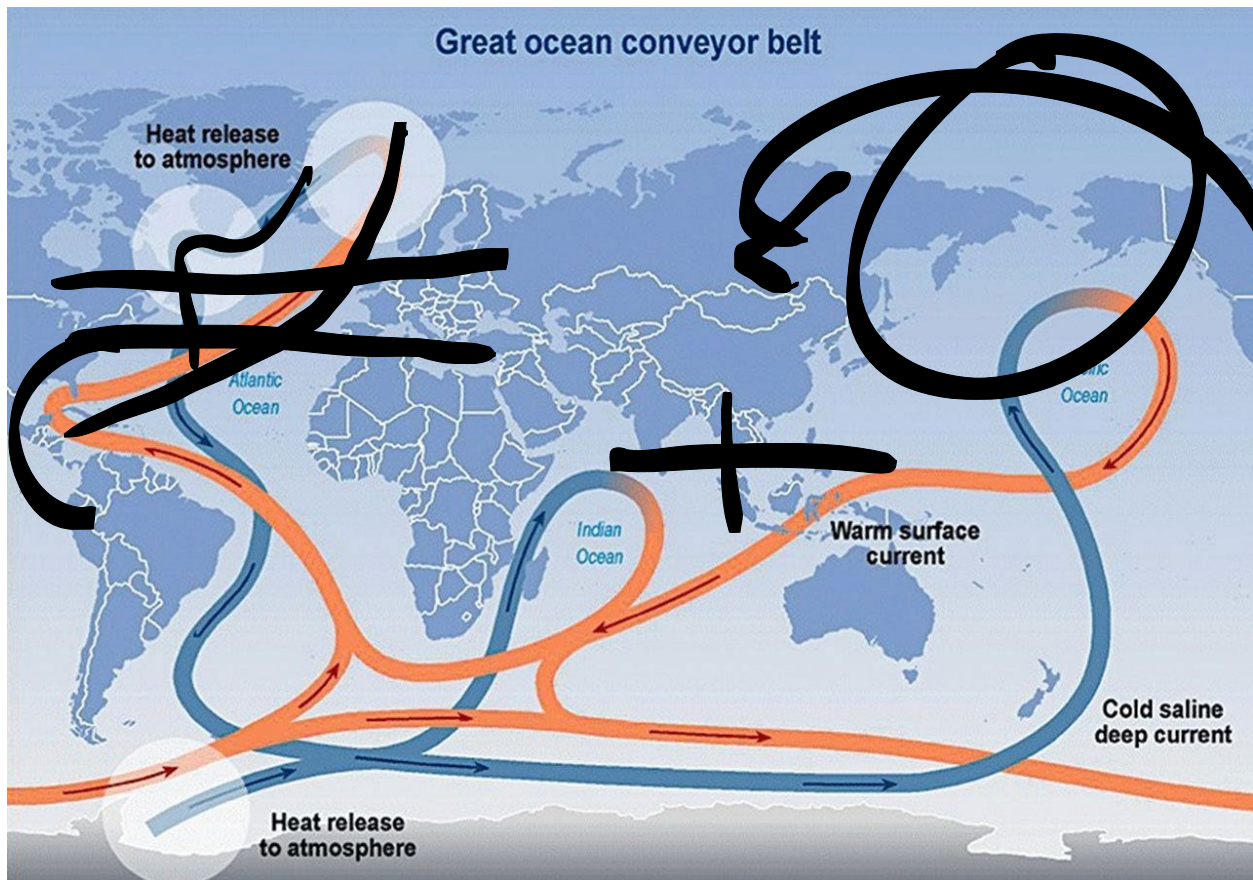


Average 12,000 feet deep.

Oceans adsorb most solar energy and buffer the temperature changes.



How the oceans affect local climate, moving warm and cold water around the world.



20 year ~~year~~ of weather

Water vapor as GHG

The water vapor in the atmosphere is determined solely by temperature. It is increased when other GHGs or changes in solar radiation change the set point. It then acts as an amplifier. This sets up the system for climate cycles.

Colder earth, more snow and ice, which reflect more heat into space, and the planet gets colder.

Melting snow and ice expose vegetation and open water, which absorb heat, and increase warming.

EXPANSION

