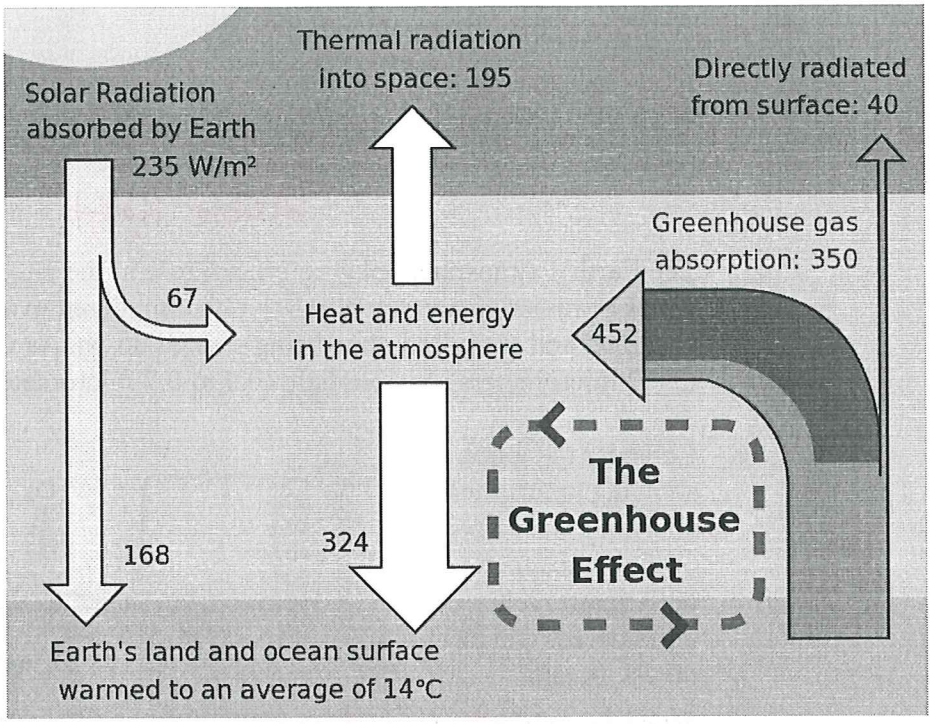
INST 2403 Activity

The Greenhouse Effect



The Earth system gives off the same amount of energy that it absorbs from the Sun. If this did not happen and our planet absorbed more energy than it gives off, Earth would continuously become warmer and warmer.

By setting the incoming solar radiation absorbed by Earth equal to the outgoing radiation emitted by Earth, we can estimate that the effective temperature of Earth would be 255K (0°F). Note that this estimate assumes that Earth has no atmosphere and reflects 30% of the incoming sunlight.

1. What is the total average amount of energy that every square meter of the Earth receives from the sun every second? (We will (over-)simplify our conversation by referring to this energy per second or power per square meter simply by "energy")

   235 (Joules) [1 W = 1 J/sec]

2. How much "energy" does the Earth (plus atmosphere) radiate back into outer space?

   195 + 40 = 235 (J)

3. From which sources does the Earth's *surface* receive "energy"?

   Solar radiation ⇒ Sun and the atmosphere

4. How much "energy" does the Earth's *surface* receive from these sources total?

   168 + 324 = 492 (J)

5. How much "energy" does the Earth's *surface* emit in total?

   452 + 40 = 492 (J)

6. Describe the resulting apparent paradox, keeping in mind that the Greenhouse Effect heats the surface of the Earth by 40 degrees.

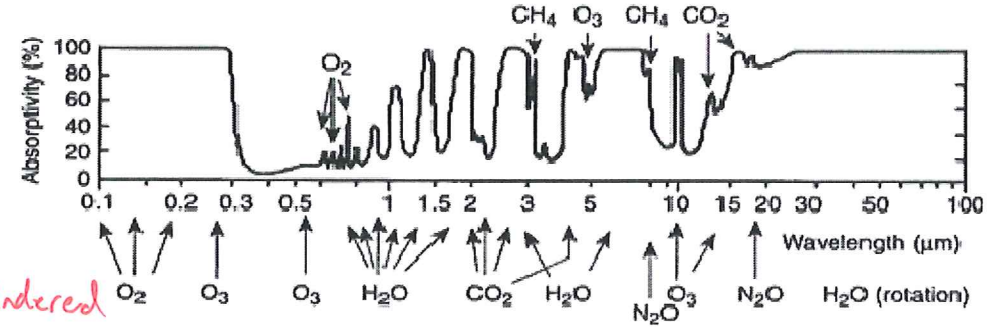
   There is no net energy flow, yet the surface of the Earth is warmer than it would be without the atmosphere.

7. What kind of radiation do we primarily receive from the sun? Hint: Think back to the peak of its blackbody curve.

Visible light

The Earth's atmosphere plays a crucial role in the Greenhouse effect, because some forms of radiation can travel relatively unhindered in air, while others get frequently absorbed and reemitted, thus being slowed down. As very crude categories, use UV (0.1 to 0.2 micrometers), visible light (0.4 to 0.7 micrometers), IR (1 to 20 micrometers).

8. Consider the graph showing atmospheric abortion. Which types of electromagnetic radiation travels unhindered, which others do not?



Visible light: unhindered

IR, UV: get absorbed & reemitted.

9. Which gases are primarily responsible for atmospheric absorption?

H_2O, CH_4, CO_2, O_3

10. What happens to the radiation absorbed by the Earth's atmosphere?

It gets reemitted, reradiated into the atmosphere.

11. Due to the radiation emitted by the Earth's atmosphere and absorbed by the Earth's surface, is the Earth's temperature near its surface going to be warmer or cooler than it would be without this radiation?

Warmer (of course)

12. Describe the atmospheric Greenhouse Effect in your own words.

Visible light from the sun warms the earth's surface. Reemitted IR gets absorbed by the atmosphere, which (partially) reradiates it to be absorbed by the surface.

13. Compare the two concepts "Greenhouse Effect" and "Global Warming".

The greenhouse effect is the (stable) warming of the Earth's surface by a given (set) amount. By changing the content of the atmosphere (more greenhouse gases), the surface slowly warms even more.

14. What are the issues in global warming and climate change?

Many of the effects are hard to measure and there are feedback-loops, which make this a very complex (non-linear) phenomenon.