The greenhouse effect

Astronomy 101
Syracuse University, Fall 2020
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Announcements

Project 4's peer feedback guidance is posted (see the website).
Project 5 will be posted Friday.

Discussion / office hours

Because people are leaving campus, I'll be holding the rest of my discussion hours on Zoom.

I will be in the same Zoom room as the course whenever I'm in my office; you can drop by any time you want. I guarantee I'll be there:

- Today from 4PM-6PM
- Friday from 11AM-1PM

If you want to make up a lab or similar, you can do that during my office hours today, too. (Please speak up in chat if you plan to do that, since I can only accommodate a few folks.)

I will likely be around Wednesday much of the day, too. I will spend much of the day tomorrow answering email, so if you want to contact me that way, please do!

Final project proposals

We'd like you to submit a brief "proposal" for your final project. This is just a paragraph or so telling us:

- What you're planning on doing
- If you're working with other people:
  - Who's in your group
  - What each of you will be doing

We don't have a way for you to submit these yet; we're figuring that out. But you can go ahead and write the text!

We'll ask you for your proposals this weekend.

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A planet will settle on a temperature where:

Incoming sunlight = Outgoing thermal radiation

Thermal radiation from 5700 K star = Thermal radiation from 300 K planet

Incoming (mostly) visible light = Outgoing far infrared

What could we do to the Earth to change its temperature?

Remember: as an object's temperature increases, the amount of thermal radiation it emits increases rapidly. In symbols:

$$\text{intensity} \propto T^4$$

This means that a 1% increase in Earth's temperature produces a 4% increase in outgoing thermal radiation.

But, since the radiation Earth emits must be equal to the amount it absorbs, we also have the other way around:

For every 4% increase in the amount of radiation the Earth absorbs, its temperature must go up by 1%

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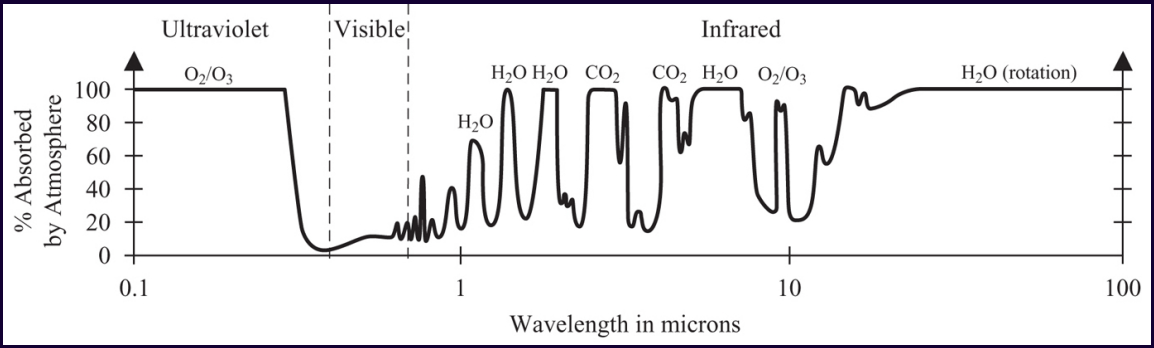
The greenhouse effect



- So planets' temperature set by radiation balance:
  - Incoming thermal radiation from Sun – visible
  - Outgoing thermal radiation from planet – infrared
- What happens if you have an atmosphere that reflects IR, but not visible light?
- The outgoing thermal radiation is greatly reduced!

This is called the *greenhouse effect*.

The greenhouse effect

Venus has a *tremendously thick* atmosphere and a powerful greenhouse effect.

- Its atmosphere contains a great deal of CO_2, which reflects IR strongly
- The thermal radiation that would carry heat away from Venus can't get out
- It is over 400 K hotter than was predicted by the calculation you are doing this week

Earth has a *thinner* atmosphere.

- Nitrogen doesn't absorb strongly at any relevant wavelengths
- H_2O and CO_2 are strong greenhouse gases, but they are only a bit of the atmosphere
- We are about 20 K warmer than predicted by that crude math
- These gases are very important for determining Earth's temperature!