

Atmospheric Structure, Weather, and Climate

11-2-2005

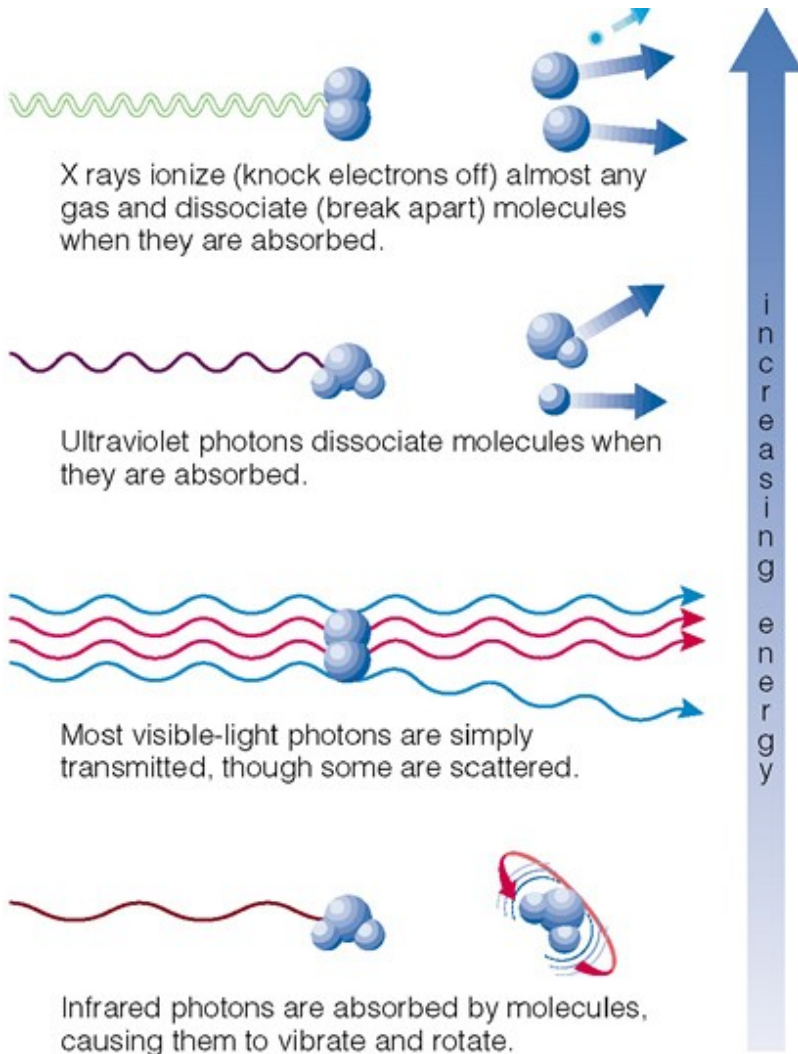
Opening Discussion

- Have you seen anything interesting in the news?
- <http://hubblesite.org/newscenter/newsdesk/archi>
- One vote that reducing greenhouse gas emissions isn't important. Is there really a problem and it is because of us?
- CO₂ sources and concentrations. We don't know exactly how much CO₂ is produced by volcanism, but the best estimate is 150 times smaller than human emissions.
- What can you do about the greenhouse effect?

More Minute Essay Questions

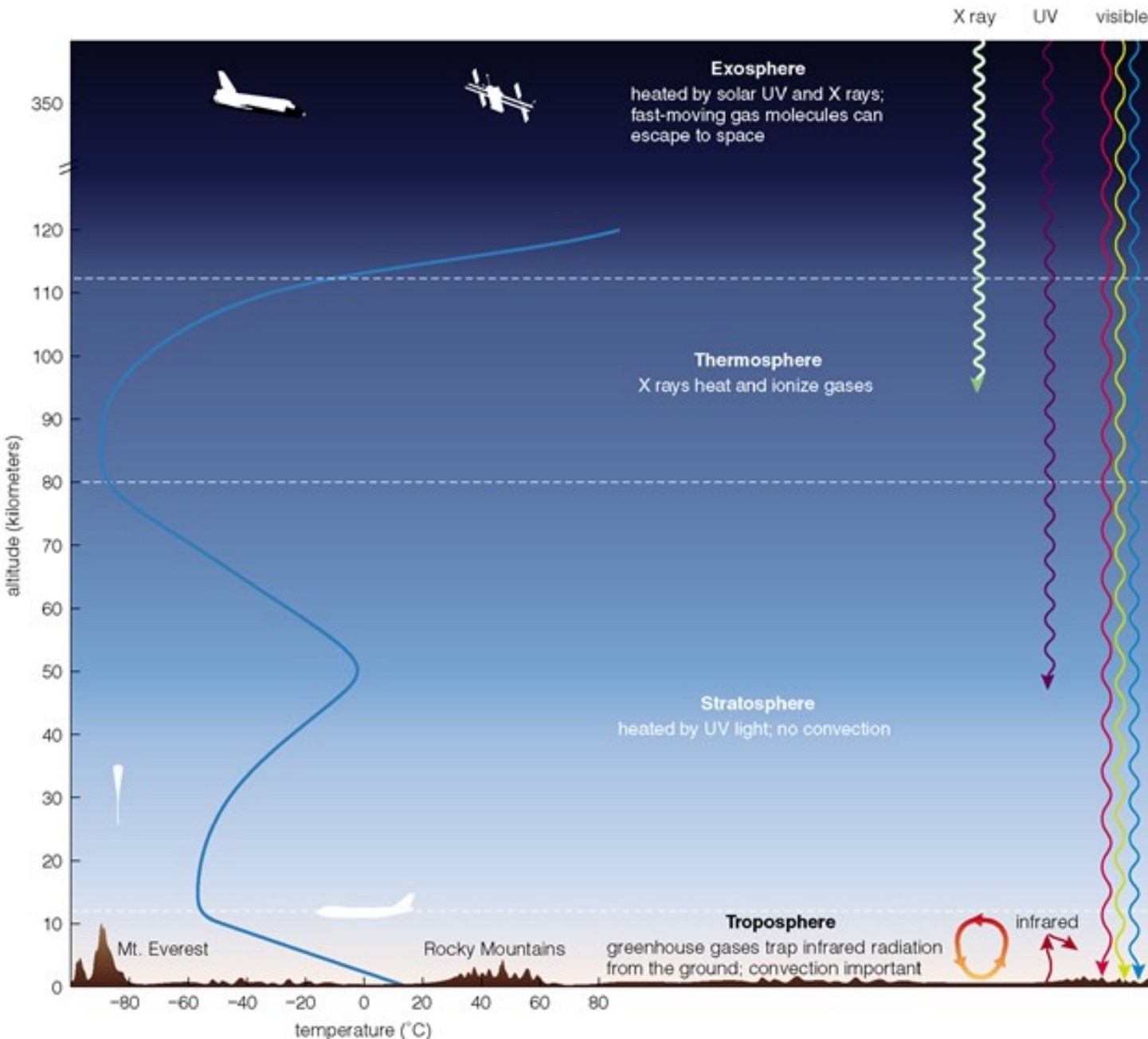
- “The Day After Tomorrow”: Global warming vs. another ice age.
- Smog/particulates vs. greenhouse gases.
- Importing greenhouses.
- Protecting astronauts from micrometeorites, X-rays, and high energy UV.
- Pressure and phases of water.
- Going trick or treating. Halloween candy.
- http://en.wikipedia.org/wiki/Global_warming
- http://en.wikipedia.org/wiki/Greenhouse_gas

Light Interacting with Atmospheres



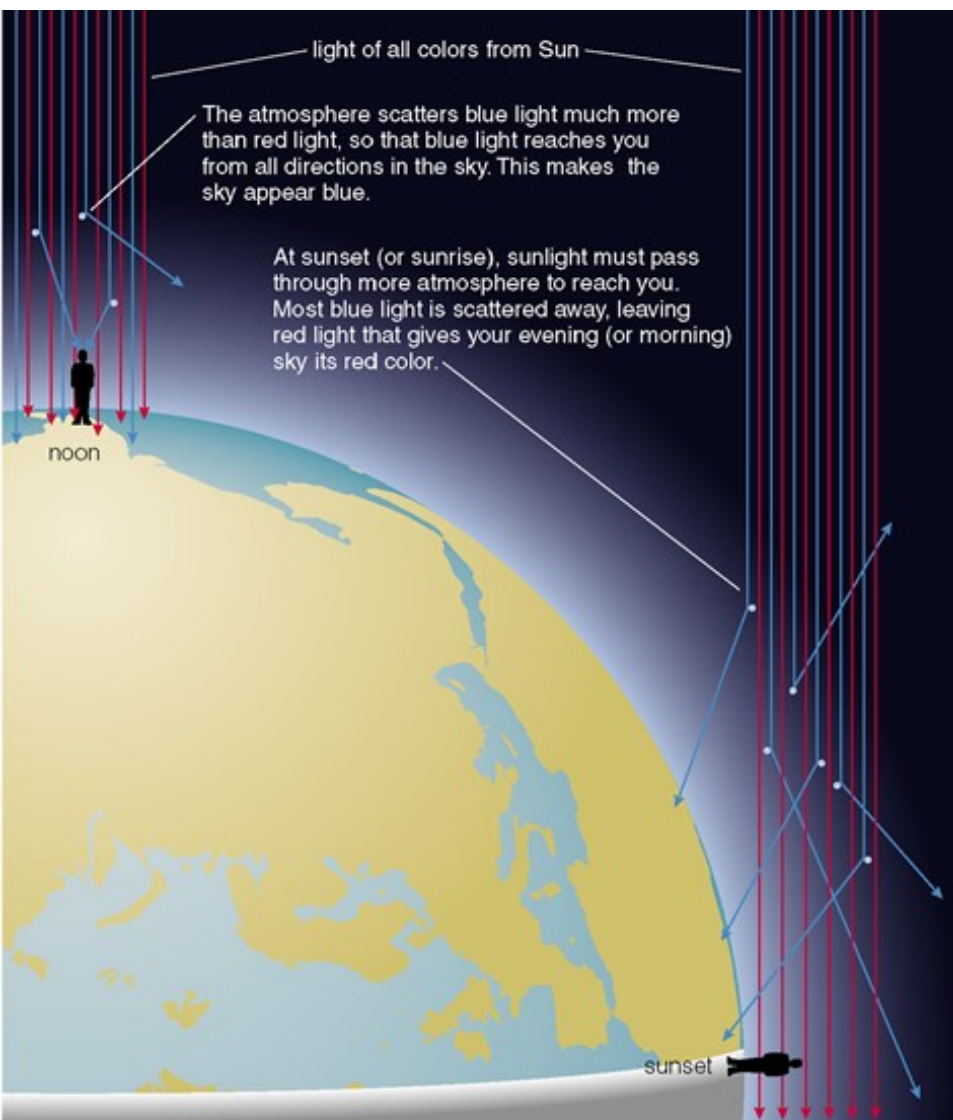
- To understand the structure and dynamics of atmospheres we need to understand how gases interact with different types of light.
- X-ray absorption dissociates molecules and ionizes atoms.
- UV absorption dissociated loosely bound molecules.
- Visible light is transmitted or scattered.
- IR light is absorbed giving rotational or vibrational energy.

Earth's Atmospheric Structure



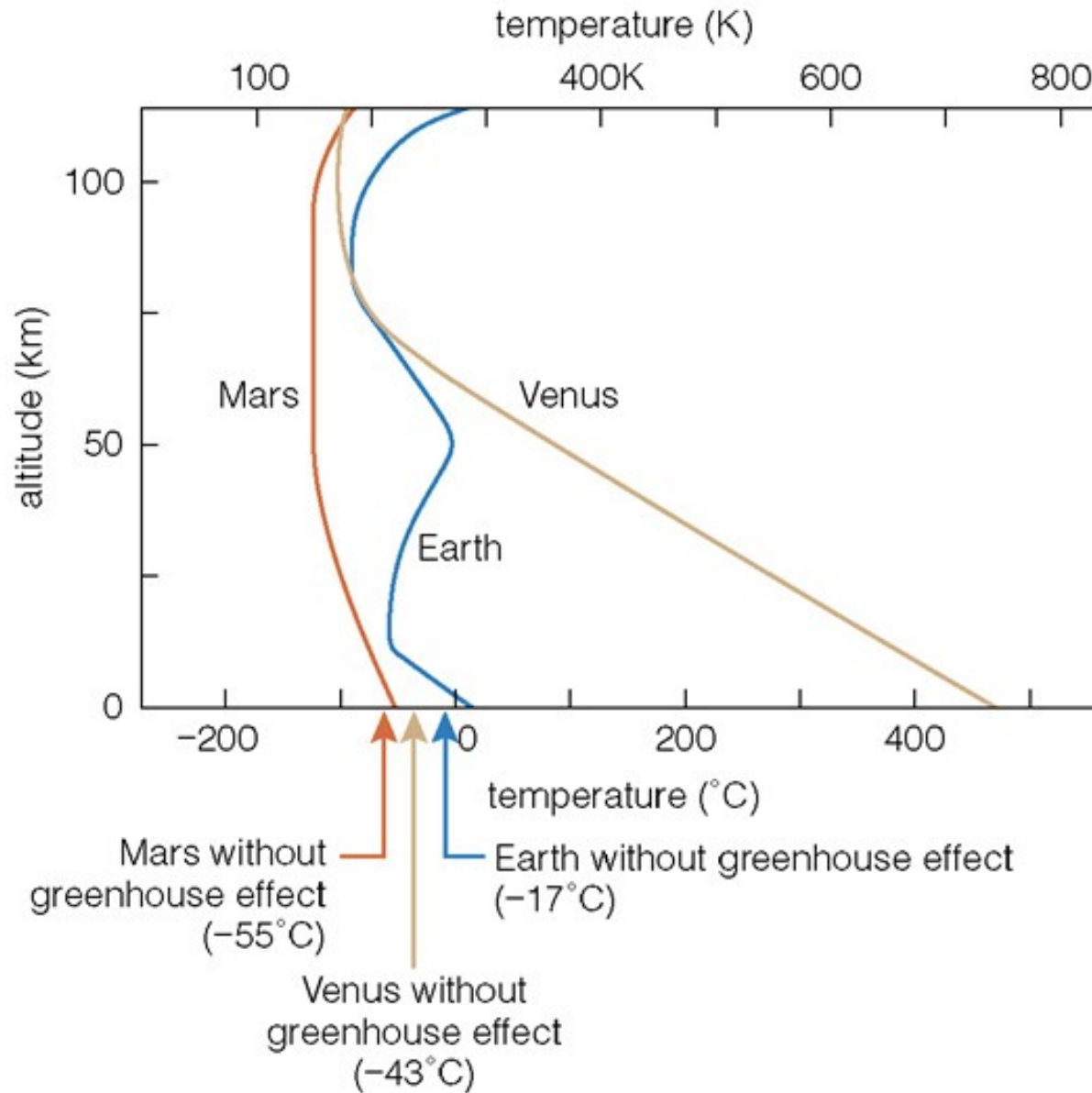
- “Layers” of atmosphere determined by how the air interacts with light.
- Everything we do happens down in the troposphere where IR absorption drives the dynamics.
- Other layers absorb Sun light.

Why the Sky is Blue



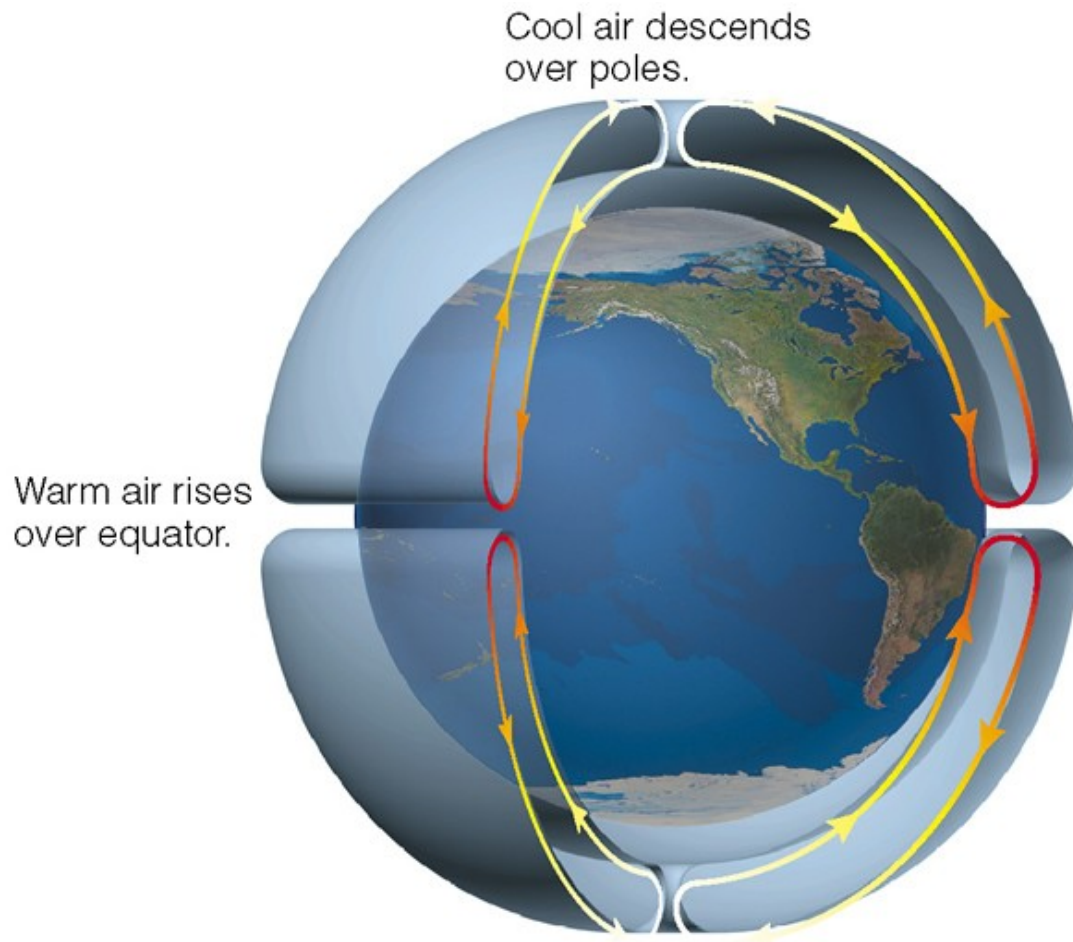
- We talked about this some last time, but it bears repeating. The sky is blue because blue light is scattered more than red light.
- This is also the reason why sunsets are red. Blue light doesn't pass through that much atmosphere well and by that distance some red light has been slightly scattered.
- This type of scattering is mostly forward scattering like from dust in the air.

Comparisons to other Planets



Circulation Cells

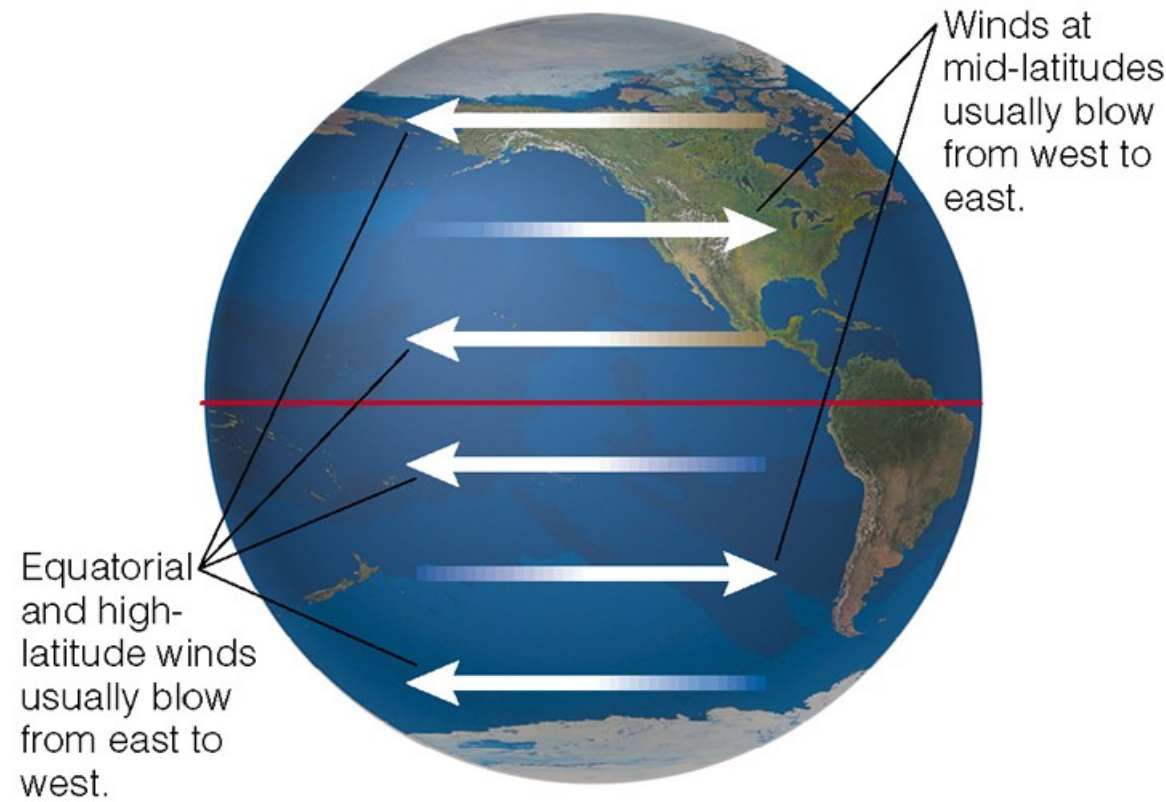
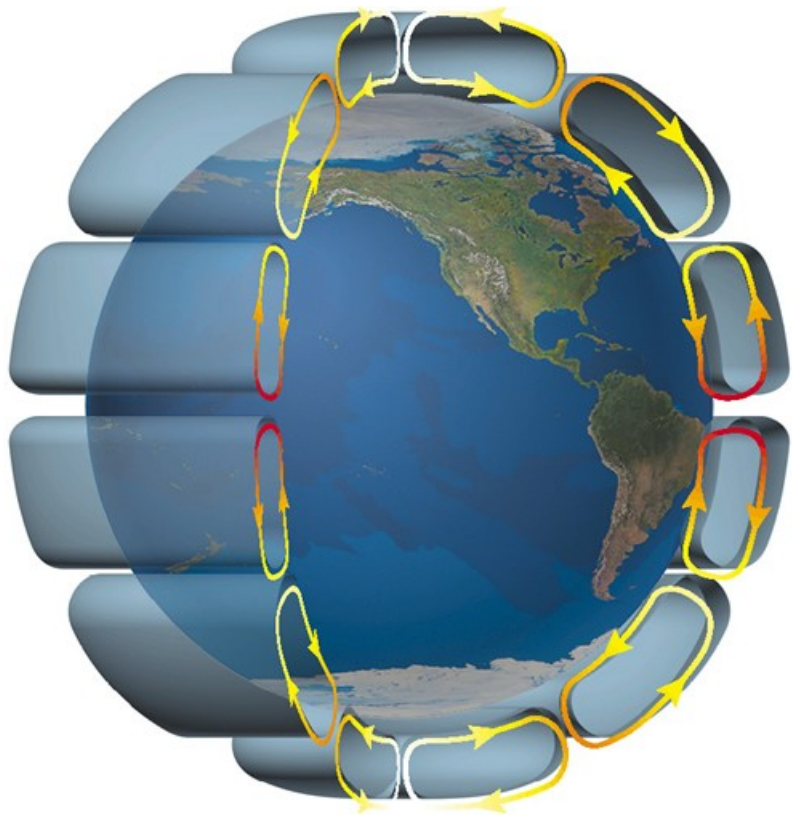
- Air will naturally move to transport heat around a planet. In a convective like manner hot air rises and cold air sinks, but you also have hotter equatorial air swapping with colder polar air.
- If nothing stopped it, the cells would look like this and the planet would be a fairly uniform temperature. That is true on Venus. The thin Martian atmosphere leaves the poles much colder than the equator.



Coriolis Effect

- If a planet spins, then air moving from one latitude to another is also changing its radius of rotation. The air has to conserve angular momentum so it must slow down or speed up depending on whether it is moving toward or away from the equator.
- This is why large weather systems where air moves in toward a low pressure region spin in characteristic directions and those directions are the opposite for the north and south hemispheres.

Global Wind Patterns



Climate Change

- Climate is a long term average of weather. There are four main factors that can lead to changes in climate.
- Solar brightening – main sequence stars get brighter as they age. Our Sun is roughly 30% brighter now than it was 4 billion years ago.
- Changes in axis tilt.
- Changes in planetary reflection – changes in fractional coverage for clouds, ice, aerosols, trees, pavement, etc.
- Changes in greenhouse gas abundance.

Minute Essay

Remember that we have a quiz at the beginning of next class. Bring a calculator for it unless you are good at doing things like logarithms and 4th roots in your head.